



Stellaris[®] LM3S2U93 Microcontroller

DATA SHEET

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**TEXAS
INSTRUMENTS**



Cortex
Intelligent Processors by ARM

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Revision History

The revision history table notes changes made between the indicated revisions of the LM3S2U93 data sheet.

Table 1. Revision History

| Date | Revision | Description |
|--------------|----------|---|
| January 2012 | 11425 | <ul style="list-style-type: none"> ■ In System Control chapter: <ul style="list-style-type: none"> – Clarified that an external LDO cannot be used. – Clarified system clock requirements when the ADC module is in operation. – Added important note to write the RCC register before the RCC2 register. ■ In Hibernation chapter: <ul style="list-style-type: none"> – Changed terminology from non-volatile memory to battery-backed memory. – Numerous clarifications, including adding a section "System Implementation". – Clarified Hibernation module register reset conditions. ■ In Internal Memory chapter, clarified programming and use of the non-volatile registers. ■ In GPIO chapter, corrected "GPIO Pins With Non-Zero Reset Values" table and added note that if the same signal is assigned to two different GPIO port pins, the signal is assigned to the port with the lowest letter. ■ In EPI chapter: <ul style="list-style-type: none"> – Clarified table "Capabilities of Host Bus 8 and Host Bus 16 Modes". – Corrected bit and register resets for FREQ (Frequency Range) in EPI SDRAM Configuration (EPISDRAMCFG) register. – Corrected bit and register resets for MAXWAIT (Maximum Wait) in EPI Host-Bus 8 Configuration (EPIHB8CFG) and EPI Host-Bus 16 Configuration (EPIHB16CFG) registers. Also clarified bit descriptions in these registers. – Corrected bit definitions for the EPSZ and ERSZ bits in the EPI Address Map (EPIADDRMAP) register. – Corrected size of COUNT bit field in EPI Read FIFO Count (EPIRFIFOCNT) register. ■ In Timer chapter, clarified timer modes and interrupts. ■ In ADC chapter, added "ADC Input Equivalency Diagram". ■ In UART chapter, clarified interrupt behavior. ■ In SSI chapter, corrected SSIClk in the figure "Synchronous Serial Frame Format (Single Transfer)" and clarified behavior of transmit bits in interrupt registers. ■ In I²C chapter, corrected bit and register reset values for IDLE bit in I²C Master Control/Status (I2CMCS) register. ■ In Analog Comparators chapter, clarified internal reference programming. ■ In PWM chapter, clarified PWM Interrupt Enable (PWMINTEN) register description. ■ In Signal Tables chapter, clarified VDDC and LDO pin descriptions. ■ In Electrical Characteristics chapter: |

Table 1. Revision History (continued)

| Date | Revision | Description |
|------|----------|--|
| | | <ul style="list-style-type: none"> <li data-bbox="532 281 1455 333">– In Maximum Ratings table, deleted parameter "Input voltage for a GPIO configured as an analog input". <li data-bbox="532 352 1455 384">– In Recommended DC Operating Conditions table, corrected values for I_{OH} parameter. <li data-bbox="532 403 1455 455">– In JTAG Characteristics, table, corrected values for parameters "TCK clock Low time" and "TCK clock High time". <li data-bbox="532 474 1455 506">– In LDO Regulator Characteristics table, added clarifying footnote to C_{LDO} parameter. <li data-bbox="532 525 1455 577">– In System Clock Characteristics with ADC Operation table, added clarifying footnote to F_{sysadc} parameter. <li data-bbox="532 596 1455 648">– In Sleep Modes AC Characteristics table, split parameter "Time to wake from interrupt" into sleep mode and deep-sleep mode parameters. <li data-bbox="532 667 1455 699">– In SSI Characteristics table, corrected value for parameter "SSIClk cycle time". <li data-bbox="532 718 1455 749">– Deleted erroneously included Ethernet Controller tables, since this part does not have Ethernet. <li data-bbox="532 768 1455 821">– In Analog Comparator Characteristics table, added parameter "Input voltage range" and corrected values for parameter "Input common mode voltage range". <li data-bbox="532 840 1455 892">– In Analog Comparator Voltage Reference Characteristics table, corrected values for absolute accuracy parameters. <li data-bbox="532 911 1455 942">– Deleted table "USB Controller DC Characteristics". <li data-bbox="532 961 1455 993">– In Nominal Power Consumption table, added parameter for sleep mode. <li data-bbox="532 1012 1455 1064">– In Maximum Current Consumption section, changed reference value for MOSC and temperature in tables that follow. <li data-bbox="532 1083 1455 1115">– Deleted table "External VDDC Source Current Specifications". <li data-bbox="500 1134 1455 1165">■ Additional minor data sheet clarifications and corrections. |

Table 1. Revision History (*continued*)

| Date | Revision | Description |
|------------|----------|--|
| July 2011 | 9970 | <ul style="list-style-type: none"> ■ Corrected "Reset Sources" table. ■ Added Important Note that RCC register must be written before RCC2 register. ■ Added missing Start Calibration (<i>CAL</i>) bit to the Precision Internal Oscillator Calibration (PIOCCAL) register. ■ Added missing Precision Internal Oscillator Statistics (PIOCSTAT) register. ■ In Hibernation Module chapter, deleted section "Special Considerations When Using a 4.194304-MHz Crystal" as this content was added to the errata document. ■ Added a note that all GPIO signals are 5-V tolerant when configured as inputs except for PB0 and PB1, which are limited to 3.6 V. ■ Corrected LIN Mode bit names in UART Interrupt Clear (UARTICR) register. ■ Corrected pin number for \overline{RST} in table "Connections for Unused Signals" (other pin tables were correct). ■ In the "Operating Characteristics" chapter: <ul style="list-style-type: none"> – In the "Thermal Characteristics" table, the Thermal resistance value was changed. – In the "ESD Absolute Maximum Ratings" table, the V_{ESDCDM} parameter was changed and the V_{ESDMM} parameter was deleted. ■ The "Electrical Characteristics" chapter was reorganized by module. In addition, some of the Recommended DC Operating Conditions, LDO Regulator, Clock, GPIO, EPI, Hibernation Module, ADC, and SSI characteristics were finalized. ■ Additional minor data sheet clarifications and corrections. |
| March 2011 | 9538 | Started tracking revision history. |

About This Document

This data sheet provides reference information for the LM3S2U93 microcontroller, describing the functional blocks of the system-on-chip (SoC) device designed around the ARM® Cortex™-M3 core.

Audience

This manual is intended for system software developers, hardware designers, and application developers.

About This Manual

This document is organized into sections that correspond to each major feature.

Related Documents

The following related documents are available on the Stellaris® web site at www.ti.com/stellaris:

- *Stellaris® Errata*
- *ARM® Cortex™-M3 Errata*
- *Cortex™-M3/M4 Instruction Set Technical User's Manual*
- *Stellaris® Boot Loader User's Guide*
- *Stellaris® Graphics Library User's Guide*
- *Stellaris® Peripheral Driver Library User's Guide*
- *Stellaris® ROM User's Guide*

The following related documents are also referenced:

- *ARM® Debug Interface V5 Architecture Specification*
- *ARM® Embedded Trace Macrocell Architecture Specification*
- *IEEE Standard 1149.1-Test Access Port and Boundary-Scan Architecture*

This documentation list was current as of publication date. Please check the web site for additional documentation, including application notes and white papers.

Documentation Conventions

This document uses the conventions shown in Table 2 on page 36.

Table 2. Documentation Conventions

| Notation | Meaning |
|---------------------------------------|--|
| General Register Notation | |
| REGISTER | APB registers are indicated in uppercase bold. For example, PBORCTL is the Power-On and Brown-Out Reset Control register. If a register name contains a lowercase n, it represents more than one register. For example, SRCRn represents any (or all) of the three Software Reset Control registers: SRCR0 , SRCR1 , and SRCR2 . |
| bit | A single bit in a register. |
| bit field | Two or more consecutive and related bits. |
| offset 0xnnn | A hexadecimal increment to a register's address, relative to that module's base address as specified in Table 2-4 on page 79. |
| Register N | Registers are numbered consecutively throughout the document to aid in referencing them. The register number has no meaning to software. |
| reserved | Register bits marked <i>reserved</i> are reserved for future use. In most cases, reserved bits are set to 0; however, user software should not rely on the value of a reserved bit. To provide software compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| yy:xx | The range of register bits inclusive from xx to yy. For example, 31:15 means bits 15 through 31 in that register. |
| Register Bit/Field Types | |
| RC | Software can read this field. The bit or field is cleared by hardware after reading the bit/field. |
| RO | Software can read this field. Always write the chip reset value. |
| R/W | Software can read or write this field. |
| R/WC | Software can read or write this field. Writing to it with any value clears the register. |
| R/W1C | Software can read or write this field. A write of a 0 to a W1C bit does not affect the bit value in the register. A write of a 1 clears the value of the bit in the register; the remaining bits remain unchanged. This register type is primarily used for clearing interrupt status bits where the read operation provides the interrupt status and the write of the read value clears only the interrupts being reported at the time the register was read. |
| R/W1S | Software can read or write a 1 to this field. A write of a 0 to a R/W1S bit does not affect the bit value in the register. |
| W1C | Software can write this field. A write of a 0 to a W1C bit does not affect the bit value in the register. A write of a 1 clears the value of the bit in the register; the remaining bits remain unchanged. A read of the register returns no meaningful data. This register is typically used to clear the corresponding bit in an interrupt register. |
| WO | Only a write by software is valid; a read of the register returns no meaningful data. |
| Register Bit/Field Reset Value | |
| 0 | Bit cleared to 0 on chip reset. |
| 1 | Bit set to 1 on chip reset. |
| - | Nondeterministic. |
| Pin/Signal Notation | |
| [] | Pin alternate function; a pin defaults to the signal without the brackets. |
| pin | Refers to the physical connection on the package. |
| signal | Refers to the electrical signal encoding of a pin. |

Table 2. Documentation Conventions (continued)

| Notation | Meaning |
|--|--|
| assert a signal | Change the value of the signal from the logically False state to the logically True state. For active High signals, the asserted signal value is 1 (High); for active Low signals, the asserted signal value is 0 (Low). The active polarity (High or Low) is defined by the signal name (see <code>SIGNAL</code> and <code>$\overline{\text{SIGNAL}}$</code> below). |
| deassert a signal | Change the value of the signal from the logically True state to the logically False state. |
| <code>$\overline{\text{SIGNAL}}$</code> | Signal names are in uppercase and in the Courier font. An overbar on a signal name indicates that it is active Low. To assert <code>$\overline{\text{SIGNAL}}$</code> is to drive it Low; to deassert <code>$\overline{\text{SIGNAL}}$</code> is to drive it High. |
| <code>SIGNAL</code> | Signal names are in uppercase and in the Courier font. An active High signal has no overbar. To assert <code>SIGNAL</code> is to drive it High; to deassert <code>SIGNAL</code> is to drive it Low. |
| Numbers | |
| X | An uppercase X indicates any of several values is allowed, where X can be any legal pattern. For example, a binary value of 0X00 can be either 0100 or 0000, a hex value of 0xX is 0x0 or 0x1, and so on. |
| 0x | Hexadecimal numbers have a prefix of 0x. For example, 0x00FF is the hexadecimal number FF. All other numbers within register tables are assumed to be binary. Within conceptual information, binary numbers are indicated with a b suffix, for example, 1011b, and decimal numbers are written without a prefix or suffix. |

1 Architectural Overview

Texas Instruments is the industry leader in bringing 32-bit capabilities and the full benefits of ARM[®] Cortex[™]-M-based microcontrollers to the broadest reach of the microcontroller market. For current users of 8- and 16-bit MCUs, Stellaris[®] with Cortex-M offers a direct path to the strongest ecosystem of development tools, software and knowledge in the industry. Designers who migrate to Stellaris benefit from great tools, small code footprint and outstanding performance. Even more important, designers can enter the ARM ecosystem with full confidence in a compatible roadmap from \$1 to 1 GHz. For users of current 32-bit MCUs, the Stellaris family offers the industry's first implementation of Cortex-M3 and the Thumb-2 instruction set. With blazingly-fast responsiveness, Thumb-2 technology combines both 16-bit and 32-bit instructions to deliver the best balance of code density and performance. Thumb-2 uses 26 percent less memory than pure 32-bit code to reduce system cost while delivering 25 percent better performance. The Texas Instruments Stellaris family of microcontrollers—the first ARM Cortex-M3 based controllers— brings high-performance 32-bit computing to cost-sensitive embedded microcontroller applications.

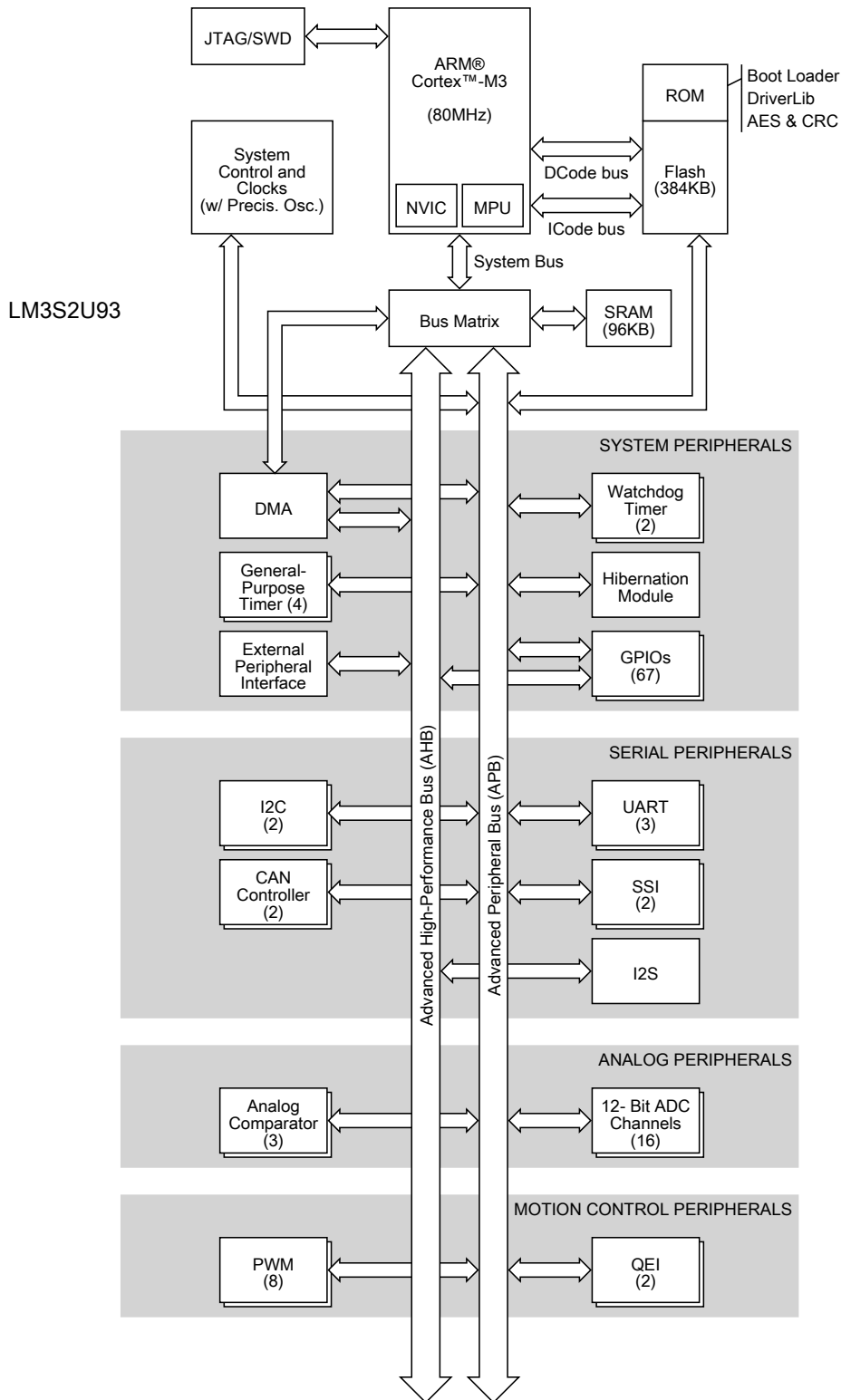
1.1 Overview

The Stellaris LM3S2U93 microcontroller combines complex integration and high performance with the following feature highlights:

- ARM Cortex-M3 Processor Core
- High Performance: 80-MHz operation; 100 DMIPS performance
- 384 KB single-cycle Flash memory
- 96 KB single-cycle SRAM
- Internal ROM loaded with StellarisWare[®] software
- External Peripheral Interface (EPI)
- Advanced Communication Interfaces: UART, SSI, I2C, I2S, CAN
- System Integration: general-purpose timers, watchdog timers, DMA, general-purpose I/Os
- Advanced motion control using PWMs, fault inputs, and quadrature encoder inputs
- Analog support: analog and digital comparators, Analog-to-Digital Converters (ADC), on-chip voltage regulator
- JTAG and ARM Serial Wire Debug (SWD)
- 100-pin LQFP package
- 108-ball BGA package
- Industrial (-40°C to 85°C) temperature range

Figure 1-1 on page 39 depicts the features on the Stellaris LM3S2U93 microcontroller. Note that there are two on-chip buses that connect the core to the peripherals. The Advanced Peripheral Bus (APB) bus is the legacy bus. The Advanced High-Performance Bus (AHB) bus provides better back-to-back access performance than the APB bus.

Figure 1-1. Stellaris LM3S2U93 Microcontroller High-Level Block Diagram



For applications requiring extreme conservation of power, the LM3S2U93 microcontroller features a battery-backed Hibernation module to efficiently power down the LM3S2U93 to a low-power state during extended periods of inactivity. With a power-up/power-down sequencer, a continuous time counter (RTC), a pair of match registers, an APB interface to the system bus, and dedicated battery-backed memory, the Hibernation module positions the LM3S2U93 microcontroller perfectly for battery applications.

In addition, the LM3S2U93 microcontroller offers the advantages of ARM's widely available development tools, System-on-Chip (SoC) infrastructure IP applications, and a large user community. Additionally, the microcontroller uses ARM's Thumb®-compatible Thumb-2 instruction set to reduce memory requirements and, thereby, cost. Finally, the LM3S2U93 microcontroller is code-compatible to all members of the extensive Stellaris family; providing flexibility to fit precise needs.

Texas Instruments offers a complete solution to get to market quickly, with evaluation and development boards, white papers and application notes, an easy-to-use peripheral driver library, and a strong support, sales, and distributor network.

1.2 Target Applications

The Stellaris family is positioned for cost-conscious applications requiring significant control processing and connectivity capabilities such as:

- Gaming equipment
- Home and commercial site monitoring and control
- Motion control
- Medical instrumentation
- Test and measurement equipment
- Factory automation
- Fire and security
- Lighting control
- Transportation

1.3 Features

The LM3S2U93 microcontroller component features and general function are discussed in more detail in the following section.

1.3.1 ARM Cortex-M3 Processor Core

All members of the Stellaris product family, including the LM3S2U93 microcontroller, are designed around an ARM Cortex-M3 processor core. The ARM Cortex-M3 processor provides the core for a high-performance, low-cost platform that meets the needs of minimal memory implementation, reduced pin count, and low power consumption, while delivering outstanding computational performance and exceptional system response to interrupts.

1.3.1.1 Processor Core (see page 60)

- 32-bit ARM Cortex-M3 architecture optimized for small-footprint embedded applications
- 80-MHz operation; 100 DMIPS performance
- Outstanding processing performance combined with fast interrupt handling

- Thumb-2 mixed 16-/32-bit instruction set delivers the high performance expected of a 32-bit ARM core in a compact memory size usually associated with 8- and 16-bit devices, typically in the range of a few kilobytes of memory for microcontroller-class applications
 - Single-cycle multiply instruction and hardware divide
 - Atomic bit manipulation (bit-banding), delivering maximum memory utilization and streamlined peripheral control
 - Unaligned data access, enabling data to be efficiently packed into memory
- Fast code execution permits slower processor clock or increases sleep mode time
- Harvard architecture characterized by separate buses for instruction and data
- Efficient processor core, system and memories
- Hardware division and fast digital-signal-processing orientated multiply accumulate
- Saturating arithmetic for signal processing
- Deterministic, high-performance interrupt handling for time-critical applications
- Memory protection unit (MPU) to provide a privileged mode for protected operating system functionality
- Enhanced system debug with extensive breakpoint and trace capabilities
- Serial Wire Debug and Serial Wire Trace reduce the number of pins required for debugging and tracing
- Migration from the ARM7 processor family for better performance and power efficiency
- Optimized for single-cycle Flash memory usage
- Ultra-low power consumption with integrated sleep modes

1.3.1.2 System Timer (SysTick) (see page 103)

ARM Cortex-M3 includes an integrated system timer, SysTick. SysTick provides a simple, 24-bit, clear-on-write, decrementing, wrap-on-zero counter with a flexible control mechanism. The counter can be used in several different ways, for example:

- An RTOS tick timer that fires at a programmable rate (for example, 100 Hz) and invokes a SysTick routine
- A high-speed alarm timer using the system clock
- A variable rate alarm or signal timer—the duration is range-dependent on the reference clock used and the dynamic range of the counter
- A simple counter used to measure time to completion and time used
- An internal clock-source control based on missing/meeting durations.

1.3.1.3 Nested Vectored Interrupt Controller (NVIC) (see page 104)

The LM3S2U93 controller includes the ARM Nested Vectored Interrupt Controller (NVIC). The NVIC and Cortex-M3 prioritize and handle all exceptions in Handler Mode. The processor state is automatically stored to the stack on an exception and automatically restored from the stack at the end of the Interrupt Service Routine (ISR). The interrupt vector is fetched in parallel to the state saving, enabling efficient interrupt entry. The processor supports tail-chaining, meaning that back-to-back interrupts can be performed without the overhead of state saving and restoration. Software can set eight priority levels on 7 exceptions (system handlers) and 52 interrupts.

- Deterministic, fast interrupt processing: always 12 cycles, or just 6 cycles with tail-chaining
- External non-maskable interrupt signal (NMI) available for immediate execution of NMI handler for safety critical applications
- Dynamically reprioritizable interrupts
- Exceptional interrupt handling via hardware implementation of required register manipulations

1.3.1.4 System Control Block (SCB) (see page 106)

The SCB provides system implementation information and system control, including configuration, control, and reporting of system exceptions.

1.3.1.5 Memory Protection Unit (MPU) (see page 106)

The MPU supports the standard ARM7 Protected Memory System Architecture (PMSA) model. The MPU provides full support for protection regions, overlapping protection regions, access permissions, and exporting memory attributes to the system.

1.3.2 On-Chip Memory

The LM3S2U93 microcontroller is integrated with the following set of on-chip memory and features:

- 96 KB single-cycle SRAM
- 384 KB single-cycle Flash memory up to 50 MHz; a prefetch buffer improves performance above 50 MHz
- Internal ROM loaded with StellarisWare software:
 - Stellaris Peripheral Driver Library
 - Stellaris Boot Loader
 - Advanced Encryption Standard (AES) cryptography tables
 - Cyclic Redundancy Check (CRC) error detection functionality

1.3.2.1 SRAM (see page 315)

The LM3S2U93 microcontroller provides 96 KB of single-cycle on-chip SRAM. The internal SRAM of the Stellaris devices is located at offset 0x2000.0000 of the device memory map.

Because read-modify-write (RMW) operations are very time consuming, ARM has introduced *bit-banding* technology in the Cortex-M3 processor. With a bit-band-enabled processor, certain regions in the memory map (SRAM and peripheral space) can use address aliases to access individual bits in a single, atomic operation.

Data can be transferred to and from the SRAM using the Micro Direct Memory Access Controller (μ DMA).

1.3.2.2 Flash Memory (see page 317)

The LM3S2U93 microcontroller provides 384 KB of single-cycle on-chip Flash memory (above 50 MHz, the Flash memory can be accessed in a single cycle as long as the code is linear; branches incur a one-cycle stall). The Flash memory is organized as a set of 1-KB blocks that can be individually erased. Erasing a block causes the entire contents of the block to be reset to all 1s. These blocks are paired into a set of 2-KB blocks that can be individually protected. The blocks can be marked as read-only or execute-only, providing different levels of code protection. Read-only blocks cannot be erased or programmed, protecting the contents of those blocks from being modified. Execute-only blocks cannot be erased or programmed, and can only be read by the controller instruction fetch mechanism, protecting the contents of those blocks from being read by either the controller or by a debugger.

1.3.2.3 ROM (see page 315)

The LM3S2U93 ROM is preprogrammed with the following software and programs:

- Stellaris Peripheral Driver Library
- Stellaris Boot Loader
- Advanced Encryption Standard (AES) cryptography tables
- Cyclic Redundancy Check (CRC) error-detection functionality

The Stellaris Peripheral Driver Library is a royalty-free software library for controlling on-chip peripherals with a boot-loader capability. The library performs both peripheral initialization and control functions, with a choice of polled or interrupt-driven peripheral support. In addition, the library is designed to take full advantage of the stellar interrupt performance of the ARM Cortex-M3 core. No special pragmas or custom assembly code prologue/epilogue functions are required. For applications that require in-field programmability, the royalty-free Stellaris Boot Loader can act as an application loader and support in-field firmware updates.

The Advanced Encryption Standard (AES) is a publicly defined encryption standard used by the U.S. Government. AES is a strong encryption method with reasonable performance and size. In addition, it is fast in both hardware and software, is fairly easy to implement, and requires little memory. The Texas Instruments encryption package is available with full source code, and is based on lesser general public license (LGPL) source. An LGPL means that the code can be used within an application without any copyleft implications for the application (the code does not automatically become open source). Modifications to the package source, however, must be open source.

CRC (Cyclic Redundancy Check) is a technique to validate a span of data has the same contents as when previously checked. This technique can be used to validate correct receipt of messages (nothing lost or modified in transit), to validate data after decompression, to validate that Flash memory contents have not been changed, and for other cases where the data needs to be validated. A CRC is preferred over a simple checksum (e.g. XOR all bits) because it catches changes more readily.

1.3.3 External Peripheral Interface (see page 475)

The External Peripheral Interface (EPI) provides access to external devices using a parallel path. Unlike communications peripherals such as SSI, UART, and I²C, the EPI is designed to act like a bus to external peripherals and memory.

The EPI has the following features:

- 8/16/32-bit dedicated parallel bus for external peripherals and memory
- Memory interface supports contiguous memory access independent of data bus width, thus enabling code execution directly from SDRAM, SRAM and Flash memory
- Blocking and non-blocking reads
- Separates processor from timing details through use of an internal write FIFO
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Separate channels for read and write
 - Read channel request asserted by programmable levels on the internal non-blocking read FIFO (NBRFIFO)
 - Write channel request asserted by empty on the internal write FIFO (WFIFO)

The EPI supports three primary functional modes: Synchronous Dynamic Random Access Memory (SDRAM) mode, Traditional Host-Bus mode, and General-Purpose mode. The EPI module also provides custom GPIOs; however, unlike regular GPIOs, the EPI module uses a FIFO in the same way as a communication mechanism and is speed-controlled using clocking.

- Synchronous Dynamic Random Access Memory (SDRAM) mode
 - Supports x16 (single data rate) SDRAM at up to 50 MHz
 - Supports low-cost SDRAMs up to 64 MB (512 megabits)
 - Includes automatic refresh and access to all banks/rows
 - Includes a Sleep/Standby mode to keep contents active with minimal power draw
 - Multiplexed address/data interface for reduced pin count
- Host-Bus mode
 - Traditional x8 and x16 MCU bus interface capabilities
 - Similar device compatibility options as PIC, ATmega, 8051, and others
 - Access to SRAM, NOR Flash memory, and other devices, with up to 1 MB of addressing in unmultiplexed mode and 256 MB in multiplexed mode (512 MB in Host-Bus 16 mode with no byte selects)
 - Support of both muxed and de-muxed address and data
 - Access to a range of devices supporting the non-address FIFO x8 and x16 interface variant, with support for external FIFO (XFIFO) EMPTY and FULL signals
 - Speed controlled, with read and write data wait-state counters
 - Chip select modes include ALE, CSn, Dual CSn and ALE with dual CSn
 - Manual chip-enable (or use extra address pins)

- General-Purpose mode
 - Wide parallel interfaces for fast communications with CPLDs and FPGAs
 - Data widths up to 32 bits
 - Data rates up to 150 MB/second
 - Optional "address" sizes from 4 bits to 20 bits
 - Optional clock output, read/write strobes, framing (with counter-based size), and clock-enable input
- General parallel GPIO
 - 1 to 32 bits, FIFOed with speed control
 - Useful for custom peripherals or for digital data acquisition and actuator controls

1.3.4 Serial Communications Peripherals

The LM3S2U93 controller supports both asynchronous and synchronous serial communications with:

- Two CAN 2.0 A/B controllers
- Three UARTs with IrDA and ISO 7816 support (one UART with modem flow control and status)
- Two I²C modules
- Two Synchronous Serial Interface modules (SSI)
- Integrated Interchip Sound (I²S) module

The following sections provide more detail on each of these communications functions.

1.3.4.1 Controller Area Network (see page 884)

Controller Area Network (CAN) is a multicast shared serial-bus standard for connecting electronic control units (ECUs). CAN was specifically designed to be robust in electromagnetically noisy environments and can utilize a differential balanced line like RS-485 or twisted-pair wire. Originally created for automotive purposes, it is now used in many embedded control applications (for example, industrial or medical). Bit rates up to 1 Mbps are possible at network lengths below 40 meters. Decreased bit rates allow longer network distances (for example, 125 Kbps at 500m).

A transmitter sends a message to all CAN nodes (broadcasting). Each node decides on the basis of the identifier received whether it should process the message. The identifier also determines the priority that the message enjoys in competition for bus access. Each CAN message can transmit from 0 to 8 bytes of user information.

The LM3S2U93 microcontroller includes two CAN units with the following features:

- CAN protocol version 2.0 part A/B
- Bit rates up to 1 Mbps
- 32 message objects with individual identifier masks

- Maskable interrupt
- Disable Automatic Retransmission mode for Time-Triggered CAN (TTCAN) applications
- Programmable Loopback mode for self-test operation
- Programmable FIFO mode enables storage of multiple message objects
- Gluelessly attaches to an external CAN transceiver through the `CANnTX` and `CANnRX` signals

1.3.4.2 UART (see page 703)

A Universal Asynchronous Receiver/Transmitter (UART) is an integrated circuit used for RS-232C serial communications, containing a transmitter (parallel-to-serial converter) and a receiver (serial-to-parallel converter), each clocked separately.

The LM3S2U93 microcontroller includes three fully programmable 16C550-type UARTs. Although the functionality is similar to a 16C550 UART, this UART design is not register compatible. The UART can generate individually masked interrupts from the Rx, Tx, modem flow control, modem status, and error conditions. The module generates a single combined interrupt when any of the interrupts are asserted and are unmasked.

The three UARTs have the following features:

- Programmable baud-rate generator allowing speeds up to 5 Mbps for regular speed (divide by 16) and 10 Mbps for high speed (divide by 8)
- Separate 16x8 transmit (TX) and receive (RX) FIFOs to reduce CPU interrupt service loading
- Programmable FIFO length, including 1-byte deep operation providing conventional double-buffered interface
- FIFO trigger levels of 1/8, 1/4, 1/2, 3/4, and 7/8
- Standard asynchronous communication bits for start, stop, and parity
- Line-break generation and detection
- Fully programmable serial interface characteristics
 - 5, 6, 7, or 8 data bits
 - Even, odd, stick, or no-parity bit generation/detection
 - 1 or 2 stop bit generation
- IrDA serial-IR (SIR) encoder/decoder providing
 - Programmable use of IrDA Serial Infrared (SIR) or UART input/output
 - Support of IrDA SIR encoder/decoder functions for data rates up to 115.2 Kbps half-duplex
 - Support of normal 3/16 and low-power (1.41-2.23 μ s) bit durations
 - Programmable internal clock generator enabling division of reference clock by 1 to 256 for low-power mode bit duration

- Support for communication with ISO 7816 smart cards
- Full modem handshake support (on UART1)
- LIN protocol support
- Standard FIFO-level and End-of-Transmission interrupts
- Efficient transfers using Micro Direct Memory Access Controller (μDMA)
 - Separate channels for transmit and receive
 - Receive single request asserted when data is in the FIFO; burst request asserted at programmed FIFO level
 - Transmit single request asserted when there is space in the FIFO; burst request asserted at programmed FIFO level

1.3.4.3 I²C (see page 809)

The Inter-Integrated Circuit (I²C) bus provides bi-directional data transfer through a two-wire design (a serial data line SDA and a serial clock line SCL). The I²C bus interfaces to external I²C devices such as serial memory (RAMs and ROMs), networking devices, LCDs, tone generators, and so on. The I²C bus may also be used for system testing and diagnostic purposes in product development and manufacture.

Each device on the I²C bus can be designated as either a master or a slave. Each I²C module supports both sending and receiving data as either a master or a slave and can operate simultaneously as both a master and a slave. Both the I²C master and slave can generate interrupts.

The LM3S2U93 microcontroller includes two I²C modules with the following features:

- Devices on the I²C bus can be designated as either a master or a slave
 - Supports both transmitting and receiving data as either a master or a slave
 - Supports simultaneous master and slave operation
- Four I²C modes
 - Master transmit
 - Master receive
 - Slave transmit
 - Slave receive
- Two transmission speeds: Standard (100 Kbps) and Fast (400 Kbps)
- Master and slave interrupt generation
 - Master generates interrupts when a transmit or receive operation completes (or aborts due to an error)
 - Slave generates interrupts when data has been transferred or requested by a master or when a START or STOP condition is detected

- Master with arbitration and clock synchronization, multimaster support, and 7-bit addressing mode

1.3.4.4 SSI (see page 767)

Synchronous Serial Interface (SSI) is a four-wire bi-directional communications interface that converts data between parallel and serial. The SSI module performs serial-to-parallel conversion on data received from a peripheral device, and parallel-to-serial conversion on data transmitted to a peripheral device. The SSI module can be configured as either a master or slave device. As a slave device, the SSI module can also be configured to disable its output, which allows a master device to be coupled with multiple slave devices. The TX and RX paths are buffered with separate internal FIFOs.

The SSI module also includes a programmable bit rate clock divider and prescaler to generate the output serial clock derived from the SSI module's input clock. Bit rates are generated based on the input clock and the maximum bit rate is determined by the connected peripheral.

The LM3S2U93 microcontroller includes two SSI modules with the following features:

- Programmable interface operation for Freescale SPI, MICROWIRE, or Texas Instruments synchronous serial interfaces
- Master or slave operation
- Programmable clock bit rate and prescaler
- Separate transmit and receive FIFOs, each 16 bits wide and 8 locations deep
- Programmable data frame size from 4 to 16 bits
- Internal loopback test mode for diagnostic/debug testing
- Standard FIFO-based interrupts and End-of-Transmission interrupt
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Separate channels for transmit and receive
 - Receive single request asserted when data is in the FIFO; burst request asserted when FIFO contains 4 entries
 - Transmit single request asserted when there is space in the FIFO; burst request asserted when FIFO contains 4 entries

1.3.4.5 Inter-Integrated Circuit Sound (I²S) Interface (see page 847)

The I²S interface is a configurable serial audio core that contains a transmit module and a receive module. The module is configurable for the I²S as well as Left-Justified and Right-Justified serial audio formats. Data can be in one of four modes: Stereo, Mono, Compact 16-bit Stereo and Compact 8-Bit Stereo.

The transmit and receive modules each have an 8-entry audio-sample FIFO. An audio sample can consist of a Left and Right Stereo sample, a Mono sample, or a Left and Right Compact Stereo sample. In Compact 16-Bit Stereo, each FIFO entry contains both the 16-bit left and 16-bit right samples, allowing efficient data transfers and requiring less memory space. In Compact 8-bit Stereo, each FIFO entry contains an 8-bit left and an 8-bit right sample, reducing memory requirements further.

Both the transmitter and receiver are capable of being a master or a slave.

The Stellaris I²S interface has the following features:

- Configurable audio format supporting I²S, Left-justification, and Right-justification
- Configurable sample size from 8 to 32 bits
- Mono and Stereo support
- 8-, 16-, and 32-bit FIFO interface for packing memory
- Independent transmit and receive 8-entry FIFOs
- Configurable FIFO-level interrupt and μ DMA requests
- Independent transmit and receive MCLK direction control
- Transmit and receive internal MCLK sources
- Independent transmit and receive control for serial clock and word select
- MCLK and SCLK can be independently set to master or slave
- Configurable transmit zero or last sample when FIFO empty
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Separate channels for transmit and receive
 - Burst requests
 - Channel requests asserted when FIFO contains required amount of data

1.3.5 System Integration

The LM3S2U93 microcontroller provides a variety of standard system functions integrated into the device, including:

- Direct Memory Access Controller (DMA)
- System control and clocks including on-chip precision 16-MHz oscillator
- Four 32-bit timers (up to eight 16-bit)
- Eight Capture Compare PWM (CCP) pins
- Lower-power battery-backed Hibernation module
- Real-Time Clock in Hibernation module
- Two Watchdog Timers
 - One timer runs off the main oscillator
 - One timer runs off the precision internal oscillator
- Up to 67 GPIOs, depending on configuration
 - Highly flexible pin muxing allows use as GPIO or one of several peripheral functions

- Independently configurable to 2, 4 or 8 mA drive capability
- Up to 4 GPIOs can have 18 mA drive capability

The following sections provide more detail on each of these functions.

1.3.5.1 Direct Memory Access (see page 359)

The LM3S2U93 microcontroller includes a Direct Memory Access (DMA) controller, known as micro-DMA (μ DMA). The μ DMA controller provides a way to offload data transfer tasks from the Cortex-M3 processor, allowing for more efficient use of the processor and the available bus bandwidth. The μ DMA controller can perform transfers between memory and peripherals. It has dedicated channels for each supported on-chip module and can be programmed to automatically perform transfers between peripherals and memory as the peripheral is ready to transfer more data. The μ DMA controller provides the following features:

- ARM PrimeCell[®] 32-channel configurable μ DMA controller
- Support for memory-to-memory, memory-to-peripheral, and peripheral-to-memory in multiple transfer modes
 - Basic for simple transfer scenarios
 - Ping-pong for continuous data flow
 - Scatter-gather for a programmable list of arbitrary transfers initiated from a single request
- Highly flexible and configurable channel operation
 - Independently configured and operated channels
 - Dedicated channels for supported on-chip modules
 - Primary and secondary channel assignments
 - One channel each for receive and transmit path for bidirectional modules
 - Dedicated channel for software-initiated transfers
 - Per-channel configurable priority scheme
 - Optional software-initiated requests for any channel
- Two levels of priority
- Design optimizations for improved bus access performance between μ DMA controller and the processor core
 - μ DMA controller access is subordinate to core access
 - RAM striping
 - Peripheral bus segmentation
- Data sizes of 8, 16, and 32 bits
- Transfer size is programmable in binary steps from 1 to 1024

- Source and destination address increment size of byte, half-word, word, or no increment
- Maskable peripheral requests
- Interrupt on transfer completion, with a separate interrupt per channel

1.3.5.2 System Control and Clocks (see page 181)

System control determines the overall operation of the device. It provides information about the device, controls power-saving features, controls the clocking of the device and individual peripherals, and handles reset detection and reporting.

- Device identification information: version, part number, SRAM size, Flash memory size, and so on
- Power control
 - On-chip fixed Low Drop-Out (LDO) voltage regulator
 - Hibernation module handles the power-up/down 3.3 V sequencing and control for the core digital logic and analog circuits
 - Low-power options for microcontroller: Sleep and Deep-sleep modes with clock gating
 - Low-power options for on-chip modules: software controls shutdown of individual peripherals and memory
 - 3.3-V supply brown-out detection and reporting via interrupt or reset
- Multiple clock sources for microcontroller system clock
 - Precision Oscillator (PIOSC): On-chip resource providing a 16 MHz $\pm 1\%$ frequency at room temperature
 - 16 MHz $\pm 3\%$ across temperature
 - Can be recalibrated with 7-bit trim resolution
 - Software power down control for low power modes
 - Main Oscillator (MOSC): A frequency-accurate clock source by one of two means: an external single-ended clock source is connected to the OSC0 input pin, or an external crystal is connected across the OSC0 input and OSC1 output pins.
 - External crystal used with or without on-chip PLL: select supported frequencies from 1 MHz to 16.384 MHz.
 - External oscillator: from DC to maximum device speed
 - Internal 30-kHz Oscillator: on chip resource providing a 30 kHz $\pm 50\%$ frequency, used during power-saving modes
 - 32.768-kHz external oscillator for the Hibernation Module: eliminates need for additional crystal for main clock source
- Flexible reset sources
 - Power-on reset (POR)
 - Reset pin assertion

- Brown-out reset (BOR) detector alerts to system power drops
- Software reset
- Watchdog timer reset
- MOSC failure

1.3.5.3 Programmable Timers (see page 550)

Programmable timers can be used to count or time external events that drive the Timer input pins. Each GPTM block provides two 16-bit timers/counters that can be configured to operate independently as timers or event counters, or configured to operate as one 32-bit timer or one 32-bit Real-Time Clock (RTC). Timers can also be used to trigger analog-to-digital (ADC) conversions.

The General-Purpose Timer Module (GPTM) contains four GPTM blocks with the following functional options:

- Operating modes:
 - 16- or 32-bit programmable one-shot timer
 - 16- or 32-bit programmable periodic timer
 - 16-bit general-purpose timer with an 8-bit prescaler
 - 32-bit Real-Time Clock (RTC) when using an external 32.768-KHz clock as the input
 - 16-bit input-edge count- or time-capture modes
 - 16-bit PWM mode with software-programmable output inversion of the PWM signal
- Count up or down
- Daisy chaining of timer modules to allow a single timer to initiate multiple timing events
- ADC event trigger
- User-enabled stalling when the microcontroller asserts CPU Halt flag during debug (excluding RTC mode)
- Ability to determine the elapsed time between the assertion of the timer interrupt and entry into the interrupt service routine.
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Dedicated channel for each timer
 - Burst request generated on timer interrupt

1.3.5.4 CCP Pins (see page 558)

Capture Compare PWM pins (CCP) can be used by the General-Purpose Timer Module to time/count external events using the CCP pin as an input. Alternatively, the GPTM can generate a simple PWM output on the CCP pin.

The LM3S2U93 microcontroller includes eight Capture Compare PWM pins (CCP) that can be programmed to operate in the following modes:

- Capture: The GP Timer is incremented/decremented by programmed events on the CCP input. The GP Timer captures and stores the current timer value when a programmed event occurs.
- Compare: The GP Timer is incremented/decremented by programmed events on the CCP input. The GP Timer compares the current value with a stored value and generates an interrupt when a match occurs.
- PWM: The GP Timer is incremented/decremented by the system clock. A PWM signal is generated based on a match between the counter value and a value stored in a match register and is output on the CCP pin.

1.3.5.5 Hibernation Module (see page 287)

The Hibernation module provides logic to switch power off to the main processor and peripherals and to wake on external or time-based events. The Hibernation module includes power-sequencing logic and has the following features:

- 32-bit real-time counter (RTC)
 - Two 32-bit RTC match registers for timed wake-up and interrupt generation
 - RTC predivider trim for making fine adjustments to the clock rate
- Two mechanisms for power control
 - System power control using discrete external regulator
 - On-chip power control using internal switches under register control
- Dedicated pin for waking using an external signal
- RTC operational and hibernation memory valid as long as V_{BAT} is valid
- Low-battery detection, signaling, and interrupt generation
- Clock source from a 32.768-kHz external oscillator or a 4.194304-MHz crystal; 32.768-kHz external oscillator can be used for main controller clock
- 64 32-bit words of battery-backed memory to save state during hibernation
- Programmable interrupts for RTC match, external wake, and low battery events

1.3.5.6 Watchdog Timers (see page 597)

A watchdog timer is used to regain control when a system has failed due to a software error or to the failure of an external device to respond in the expected way. The Stellaris Watchdog Timer can generate an interrupt or a reset when a time-out value is reached. In addition, the Watchdog Timer is ARM FiRM-compliant and can be configured to generate an interrupt to the microcontroller on its first time-out, and to generate a reset signal on its second time-out. Once the Watchdog Timer has been configured, the lock register can be written to prevent the timer configuration from being inadvertently altered.

The LM3S2U93 microcontroller has two Watchdog Timer modules: Watchdog Timer 0 uses the system clock for its timer clock; Watchdog Timer 1 uses the PIOSC as its timer clock. The Stellaris Watchdog Timer module has the following features:

- 32-bit down counter with a programmable load register
- Separate watchdog clock with an enable
- Programmable interrupt generation logic with interrupt masking
- Lock register protection from runaway software
- Reset generation logic with an enable/disable
- User-enabled stalling when the microcontroller asserts the CPU Halt flag during debug

1.3.5.7 Programmable GPIOs (see page 419)

General-purpose input/output (GPIO) pins offer flexibility for a variety of connections. The Stellaris GPIO module is comprised of nine physical GPIO blocks, each corresponding to an individual GPIO port. The GPIO module is FiRM-compliant (compliant to the ARM Foundation IP for Real-Time Microcontrollers specification) and supports 0-67 programmable input/output pins. The number of GPIOs available depends on the peripherals being used (see “Signal Tables” on page 1052 for the signals available to each GPIO pin).

- Up to 67 GPIOs, depending on configuration
- Highly flexible pin muxing allows use as GPIO or one of several peripheral functions
- 5-V-tolerant in input configuration
- Two means of port access: either Advanced High-Performance Bus (AHB) with better back-to-back access performance, or the legacy Advanced Peripheral Bus (APB) for backwards-compatibility with existing code
- Fast toggle capable of a change every clock cycle for ports on AHB, every two clock cycles for ports on APB
- Programmable control for GPIO interrupts
 - Interrupt generation masking
 - Edge-triggered on rising, falling, or both
 - Level-sensitive on High or Low values
- Bit masking in both read and write operations through address lines
- Can be used to initiate an ADC sample sequence
- Pins configured as digital inputs are Schmitt-triggered
- Programmable control for GPIO pad configuration
 - Weak pull-up or pull-down resistors

- 2-mA, 4-mA, and 8-mA pad drive for digital communication; up to four pads can sink 18-mA for high-current applications
- Slew rate control for the 8-mA drive
- Open drain enables
- Digital input enables

1.3.6 Advanced Motion Control

The LM3S2U93 microcontroller provides motion control functions integrated into the device, including:

- Eight advanced PWM outputs for motion and energy applications
- Four fault inputs to promote low-latency shutdown
- Two Quadrature Encoder Inputs (QEI)

The following provides more detail on these motion control functions.

1.3.6.1 PWM (see page 949)

Pulse width modulation (PWM) is a powerful technique for digitally encoding analog signal levels. High-resolution counters are used to generate a square wave, and the duty cycle of the square wave is modulated to encode an analog signal. Typical applications include switching power supplies and motor control. The LM3S2U93 PWM module consists of four PWM generator blocks and a control block. Each PWM generator block contains one timer (16-bit down or up/down counter), two comparators, a PWM signal generator, a dead-band generator, and an interrupt/ADC-trigger selector. Each PWM generator block produces two PWM signals that can either be independent signals or a single pair of complementary signals with dead-band delays inserted.

Each PWM generator has the following features:

- Four fault-condition handling inputs to quickly provide low-latency shutdown and prevent damage to the motor being controlled
- One 16-bit counter
 - Runs in Down or Up/Down mode
 - Output frequency controlled by a 16-bit load value
 - Load value updates can be synchronized
 - Produces output signals at zero and load value
- Two PWM comparators
 - Comparator value updates can be synchronized
 - Produces output signals on match
- PWM signal generator
 - Output PWM signal is constructed based on actions taken as a result of the counter and PWM comparator output signals

- Produces two independent PWM signals
- Dead-band generator
 - Produces two PWM signals with programmable dead-band delays suitable for driving a half-H bridge
 - Can be bypassed, leaving input PWM signals unmodified
- Can initiate an ADC sample sequence

The control block determines the polarity of the PWM signals and which signals are passed through to the pins. The output of the PWM generation blocks are managed by the output control block before being passed to the device pins. The PWM control block has the following options:

- PWM output enable of each PWM signal
- Optional output inversion of each PWM signal (polarity control)
- Optional fault handling for each PWM signal
- Synchronization of timers in the PWM generator blocks
- Synchronization of timer/comparator updates across the PWM generator blocks
- Extended PWM synchronization of timer/comparator updates across the PWM generator blocks
- Interrupt status summary of the PWM generator blocks
- Extended PWM fault handling, with multiple fault signals, programmable polarities, and filtering
- PWM generators can be operated independently or synchronized with other generators

1.3.6.2 QEI (see page 1027)

A quadrature encoder, also known as a 2-channel incremental encoder, converts linear displacement into a pulse signal. By monitoring both the number of pulses and the relative phase of the two signals, the position, direction of rotation, and speed can be tracked. In addition, a third channel, or index signal, can be used to reset the position counter. The Stellaris quadrature encoder with index (QEI) module interprets the code produced by a quadrature encoder wheel to integrate position over time and determine direction of rotation. In addition, it can capture a running estimate of the velocity of the encoder wheel. The input frequency of the QEI inputs may be as high as 1/4 of the processor frequency (for example, 20 MHz for a 80-MHz system).

The LM3S2U93 microcontroller includes two QEI modules providing control of two motors at the same time with the following features:

- Position integrator that tracks the encoder position
- Programmable noise filter on the inputs
- Velocity capture using built-in timer
- The input frequency of the QEI inputs may be as high as 1/4 of the processor frequency (for example, 12.5 MHz for a 50-MHz system)
- Interrupt generation on:

- Index pulse
- Velocity-timer expiration
- Direction change
- Quadrature error detection

1.3.7 Analog

The LM3S2U93 microcontroller provides analog functions integrated into the device, including:

- Two 12-bit Analog-to-Digital Converters (ADC) with 16 analog input channels and a sample rate of one million samples/second
- Three analog comparators
- 16 digital comparators
- On-chip voltage regulator

The following provides more detail on these analog functions.

1.3.7.1 ADC (see page 622)

An analog-to-digital converter (ADC) is a peripheral that converts a continuous analog voltage to a discrete digital number. The Stellaris ADC module features 12-bit conversion resolution and supports 16 input channels plus an internal temperature sensor. Four buffered sample sequencers allow rapid sampling of up to 16 analog input sources without controller intervention. Each sample sequencer provides flexible programming with fully configurable input source, trigger events, interrupt generation, and sequencer priority. Each ADC module has a digital comparator function that allows the conversion value to be diverted to a comparison unit that provides eight digital comparators.

The LM3S2U93 microcontroller provides two ADC modules with the following features:

- 16 shared analog input channels
- 12-bit precision ADC with an accurate 10-bit data compatibility mode
- Single-ended and differential-input configurations
- On-chip internal temperature sensor
- Maximum sample rate of one million samples/second
- Optional phase shift in sample time programmable from 22.5° to 337.5°
- Four programmable sample conversion sequencers from one to eight entries long, with corresponding conversion result FIFOs
- Flexible trigger control
 - Controller (software)
 - Timers
 - Analog Comparators

- PWM
- GPIO
- Hardware averaging of up to 64 samples
- Digital comparison unit providing eight digital comparators
- Converter uses an internal 3-V reference or an external reference
- Power and ground for the analog circuitry is separate from the digital power and ground
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Dedicated channel for each sample sequencer
 - ADC module uses burst requests for DMA

1.3.7.2 Analog Comparators (see page 935)

An analog comparator is a peripheral that compares two analog voltages and provides a logical output that signals the comparison result. The LM3S2U93 microcontroller provides three independent integrated analog comparators that can be configured to drive an output or generate an interrupt or ADC event.

The comparator can provide its output to a device pin, acting as a replacement for an analog comparator on the board, or it can be used to signal the application via interrupts or triggers to the ADC to cause it to start capturing a sample sequence. The interrupt generation and ADC triggering logic is separate. This means, for example, that an interrupt can be generated on a rising edge and the ADC triggered on a falling edge.

The LM3S2U93 microcontroller provides three independent integrated analog comparators with the following functions:

- Compare external pin input to external pin input or to internal programmable voltage reference
- Compare a test voltage against any one of the following voltages:
 - An individual external reference voltage
 - A shared single external reference voltage
 - A shared internal reference voltage

1.3.8 JTAG and ARM Serial Wire Debug (see page 169)

The Joint Test Action Group (JTAG) port is an IEEE standard that defines a Test Access Port and Boundary Scan Architecture for digital integrated circuits and provides a standardized serial interface for controlling the associated test logic. The TAP, Instruction Register (IR), and Data Registers (DR) can be used to test the interconnections of assembled printed circuit boards and obtain manufacturing information on the components. The JTAG Port also provides a means of accessing and controlling design-for-test features such as I/O pin observation and control, scan testing, and debugging. Texas Instruments replaces the ARM SW-DP and JTAG-DP with the ARM Serial Wire JTAG Debug Port (SWJ-DP) interface. The SWJ-DP interface combines the SWD and JTAG debug ports into one module providing all the normal JTAG debug and test functionality plus real-time access to system memory without halting the core or requiring any target resident code. The SWJ-DP interface has the following features:

- IEEE 1149.1-1990 compatible Test Access Port (TAP) controller
- Four-bit Instruction Register (IR) chain for storing JTAG instructions
- IEEE standard instructions: BYPASS, IDCODE, SAMPLE/PRELOAD, EXTEST and INTEST
- ARM additional instructions: APACC, DPACC and ABORT
- Integrated ARM Serial Wire Debug (SWD)
 - Serial Wire JTAG Debug Port (SWJ-DP)
 - Flash Patch and Breakpoint (FPB) unit for implementing breakpoints
 - Data Watchpoint and Trace (DWT) unit for implementing watchpoints, trigger resources, and system profiling
 - Instrumentation Trace Macrocell (ITM) for support of printf style debugging
 - Trace Port Interface Unit (TPIU) for bridging to a Trace Port Analyzer

1.3.9 Packaging and Temperature

- Industrial-range (-40°C to 85°C) 100-pin RoHS-compliant LQFP package
- Industrial-range (-40°C to 85°C) 108-ball RoHS-compliant BGA package

1.4 Hardware Details

Details on the pins and package can be found in the following sections:

- “Pin Diagram” on page 1050
- “Signal Tables” on page 1052
- “Operating Characteristics” on page 1127
- “Electrical Characteristics” on page 1128
- “Package Information” on page 1191

2 The Cortex-M3 Processor

The ARM® Cortex™-M3 processor provides a high-performance, low-cost platform that meets the system requirements of minimal memory implementation, reduced pin count, and low power consumption, while delivering outstanding computational performance and exceptional system response to interrupts. Features include:

- 32-bit ARM® Cortex™-M3 architecture optimized for small-footprint embedded applications
- 80-MHz operation; 100 DMIPS performance
- Outstanding processing performance combined with fast interrupt handling
- Thumb-2 mixed 16-/32-bit instruction set delivers the high performance expected of a 32-bit ARM core in a compact memory size usually associated with 8- and 16-bit devices, typically in the range of a few kilobytes of memory for microcontroller-class applications
 - Single-cycle multiply instruction and hardware divide
 - Atomic bit manipulation (bit-banding), delivering maximum memory utilization and streamlined peripheral control
 - Unaligned data access, enabling data to be efficiently packed into memory
- Fast code execution permits slower processor clock or increases sleep mode time
- Harvard architecture characterized by separate buses for instruction and data
- Efficient processor core, system and memories
- Hardware division and fast digital-signal-processing orientated multiply accumulate
- Saturating arithmetic for signal processing
- Deterministic, high-performance interrupt handling for time-critical applications
- Memory protection unit (MPU) to provide a privileged mode for protected operating system functionality
- Enhanced system debug with extensive breakpoint and trace capabilities
- Serial Wire Debug and Serial Wire Trace reduce the number of pins required for debugging and tracing
- Migration from the ARM7 processor family for better performance and power efficiency
- Optimized for single-cycle Flash memory usage
- Ultra-low power consumption with integrated sleep modes

The Stellaris® family of microcontrollers builds on this core to bring high-performance 32-bit computing to cost-sensitive embedded microcontroller applications, such as factory automation and control, industrial control power devices, building and home automation, and stepper motor control.

This chapter provides information on the Stellaris implementation of the Cortex-M3 processor, including the programming model, the memory model, the exception model, fault handling, and power management.

For technical details on the instruction set, see the *Cortex™-M3/M4 Instruction Set Technical User's Manual*.

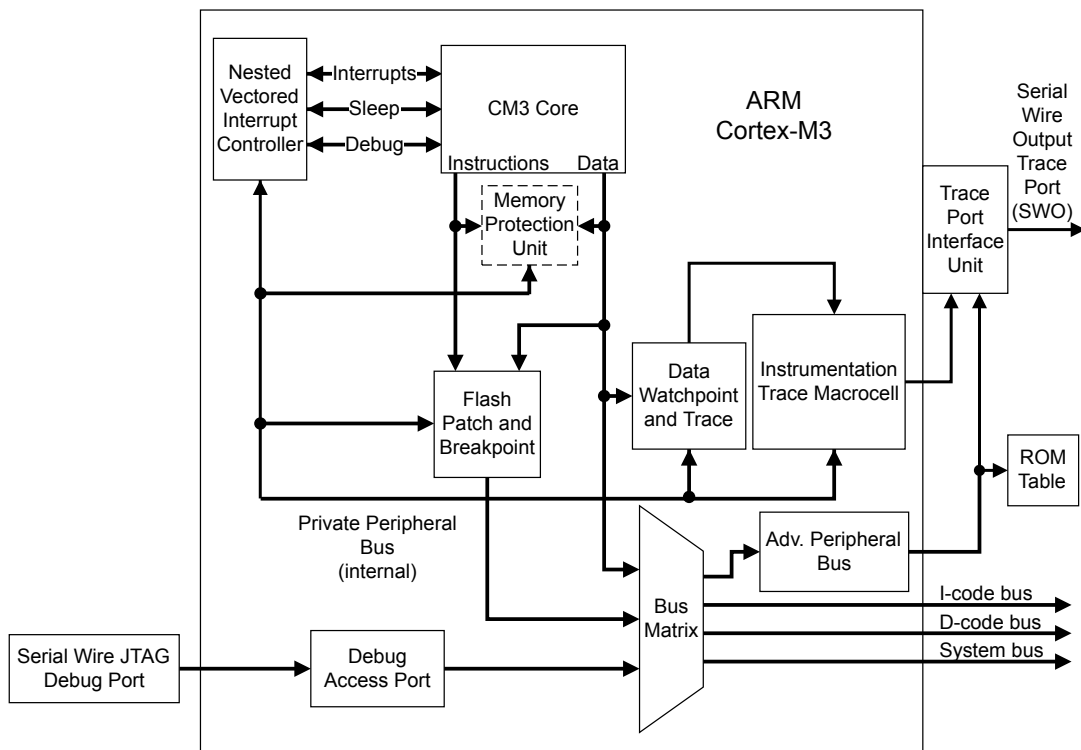
2.1 Block Diagram

The Cortex-M3 processor is built on a high-performance processor core, with a 3-stage pipeline Harvard architecture, making it ideal for demanding embedded applications. The processor delivers exceptional power efficiency through an efficient instruction set and extensively optimized design, providing high-end processing hardware including a range of single-cycle and SIMD multiplication and multiply-with-accumulate capabilities, saturating arithmetic and dedicated hardware division.

To facilitate the design of cost-sensitive devices, the Cortex-M3 processor implements tightly coupled system components that reduce processor area while significantly improving interrupt handling and system debug capabilities. The Cortex-M3 processor implements a version of the Thumb® instruction set based on Thumb-2 technology, ensuring high code density and reduced program memory requirements. The Cortex-M3 instruction set provides the exceptional performance expected of a modern 32-bit architecture, with the high code density of 8-bit and 16-bit microcontrollers.

The Cortex-M3 processor closely integrates a nested interrupt controller (NVIC), to deliver industry-leading interrupt performance. The Stellaris NVIC includes a non-maskable interrupt (NMI) and provides eight interrupt priority levels. The tight integration of the processor core and NVIC provides fast execution of interrupt service routines (ISRs), dramatically reducing interrupt latency. The hardware stacking of registers and the ability to suspend load-multiple and store-multiple operations further reduce interrupt latency. Interrupt handlers do not require any assembler stubs which removes code overhead from the ISRs. Tail-chaining optimization also significantly reduces the overhead when switching from one ISR to another. To optimize low-power designs, the NVIC integrates with the sleep modes, including Deep-sleep mode, which enables the entire device to be rapidly powered down.

Figure 2-1. CPU Block Diagram



2.2 Overview

2.2.1 System-Level Interface

The Cortex-M3 processor provides multiple interfaces using AMBA® technology to provide high-speed, low-latency memory accesses. The core supports unaligned data accesses and implements atomic bit manipulation that enables faster peripheral controls, system spinlocks, and thread-safe Boolean data handling.

The Cortex-M3 processor has a memory protection unit (MPU) that provides fine-grain memory control, enabling applications to implement security privilege levels and separate code, data and stack on a task-by-task basis.

2.2.2 Integrated Configurable Debug

The Cortex-M3 processor implements a complete hardware debug solution, providing high system visibility of the processor and memory through either a traditional JTAG port or a 2-pin Serial Wire Debug (SWD) port that is ideal for microcontrollers and other small package devices. The Stellaris implementation replaces the ARM SW-DP and JTAG-DP with the ARM CoreSight™-compliant Serial Wire JTAG Debug Port (SWJ-DP) interface. The SWJ-DP interface combines the SWD and JTAG debug ports into one module. See the *ARM® Debug Interface V5 Architecture Specification* for details on SWJ-DP.

For system trace, the processor integrates an Instrumentation Trace Macrocell (ITM) alongside data watchpoints and a profiling unit. To enable simple and cost-effective profiling of the system trace events, a Serial Wire Viewer (SWV) can export a stream of software-generated messages, data trace, and profiling information through a single pin.

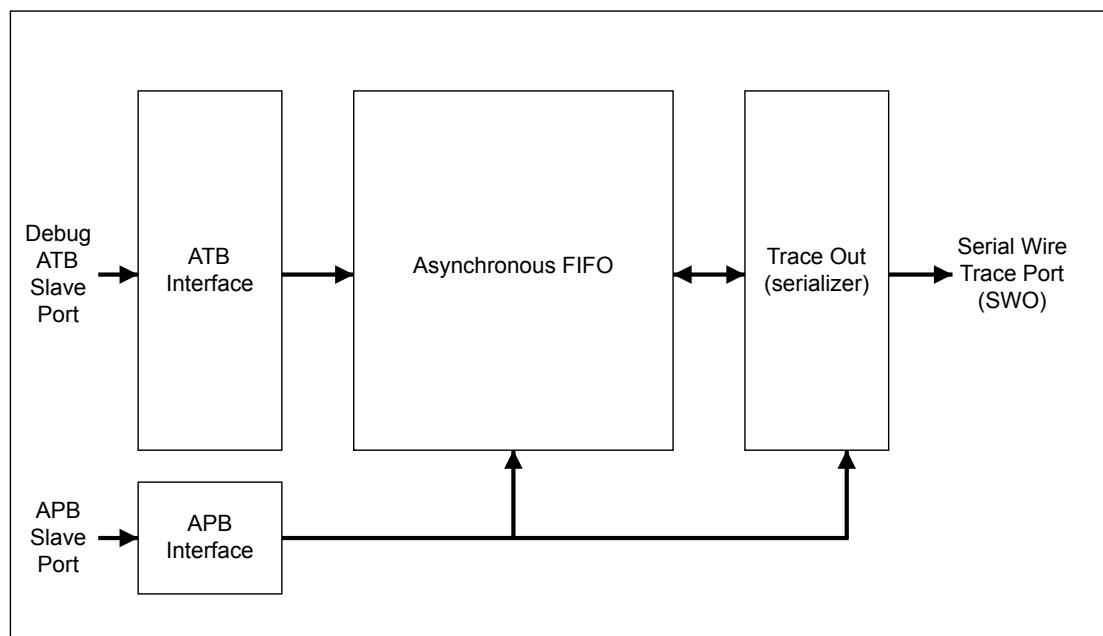
The Flash Patch and Breakpoint Unit (FPB) provides up to eight hardware breakpoint comparators that debuggers can use. The comparators in the FPB also provide remap functions of up to eight words in the program code in the CODE memory region. This enables applications stored in a read-only area of Flash memory to be patched in another area of on-chip SRAM or Flash memory. If a patch is required, the application programs the FPB to remap a number of addresses. When those addresses are accessed, the accesses are redirected to a remap table specified in the FPB configuration.

For more information on the Cortex-M3 debug capabilities, see the *ARM® Debug Interface V5 Architecture Specification*.

2.2.3 Trace Port Interface Unit (TPIU)

The TPIU acts as a bridge between the Cortex-M3 trace data from the ITM, and an off-chip Trace Port Analyzer, as shown in Figure 2-2 on page 63.

Figure 2-2. TPIU Block Diagram



2.2.4 Cortex-M3 System Component Details

The Cortex-M3 includes the following system components:

- **SysTick**
A 24-bit count-down timer that can be used as a Real-Time Operating System (RTOS) tick timer or as a simple counter (see “System Timer (SysTick)” on page 103).
- **Nested Vectored Interrupt Controller (NVIC)**
An embedded interrupt controller that supports low latency interrupt processing (see “Nested Vectored Interrupt Controller (NVIC)” on page 104).
- **System Control Block (SCB)**

The programming model interface to the processor. The SCB provides system implementation information and system control, including configuration, control, and reporting of system exceptions (see “System Control Block (SCB)” on page 106).

- Memory Protection Unit (MPU)

Improves system reliability by defining the memory attributes for different memory regions. The MPU provides up to eight different regions and an optional predefined background region (see “Memory Protection Unit (MPU)” on page 106).

2.3 Programming Model

This section describes the Cortex-M3 programming model. In addition to the individual core register descriptions, information about the processor modes and privilege levels for software execution and stacks is included.

2.3.1 Processor Mode and Privilege Levels for Software Execution

The Cortex-M3 has two modes of operation:

- Thread mode

Used to execute application software. The processor enters Thread mode when it comes out of reset.

- Handler mode

Used to handle exceptions. When the processor has finished exception processing, it returns to Thread mode.

In addition, the Cortex-M3 has two privilege levels:

- Unprivileged

In this mode, software has the following restrictions:

- Limited access to the `MSR` and `MRS` instructions and no use of the `CPS` instruction
- No access to the system timer, NVIC, or system control block
- Possibly restricted access to memory or peripherals

- Privileged

In this mode, software can use all the instructions and has access to all resources.

In Thread mode, the **CONTROL** register (see page 78) controls whether software execution is privileged or unprivileged. In Handler mode, software execution is always privileged.

Only privileged software can write to the **CONTROL** register to change the privilege level for software execution in Thread mode. Unprivileged software can use the `SVC` instruction to make a supervisor call to transfer control to privileged software.

2.3.2 Stacks

The processor uses a full descending stack, meaning that the stack pointer indicates the last stacked item on the memory. When the processor pushes a new item onto the stack, it decrements the stack pointer and then writes the item to the new memory location. The processor implements two stacks:

the main stack and the process stack, with a pointer for each held in independent registers (see the **SP** register on page 68).

In Thread mode, the **CONTROL** register (see page 78) controls whether the processor uses the main stack or the process stack. In Handler mode, the processor always uses the main stack. The options for processor operations are shown in Table 2-1 on page 65.

Table 2-1. Summary of Processor Mode, Privilege Level, and Stack Use

| Processor Mode | Use | Privilege Level | Stack Used |
|----------------|--------------------|---|--|
| Thread | Applications | Privileged or unprivileged ^a | Main stack or process stack ^a |
| Handler | Exception handlers | Always privileged | Main stack |

a. See **CONTROL** (page 78).

2.3.3 Register Map

Figure 2-3 on page 65 shows the Cortex-M3 register set. Table 2-2 on page 66 lists the Core registers. The core registers are not memory mapped and are accessed by register name, so the base address is n/a (not applicable) and there is no offset.

Figure 2-3. Cortex-M3 Register Set

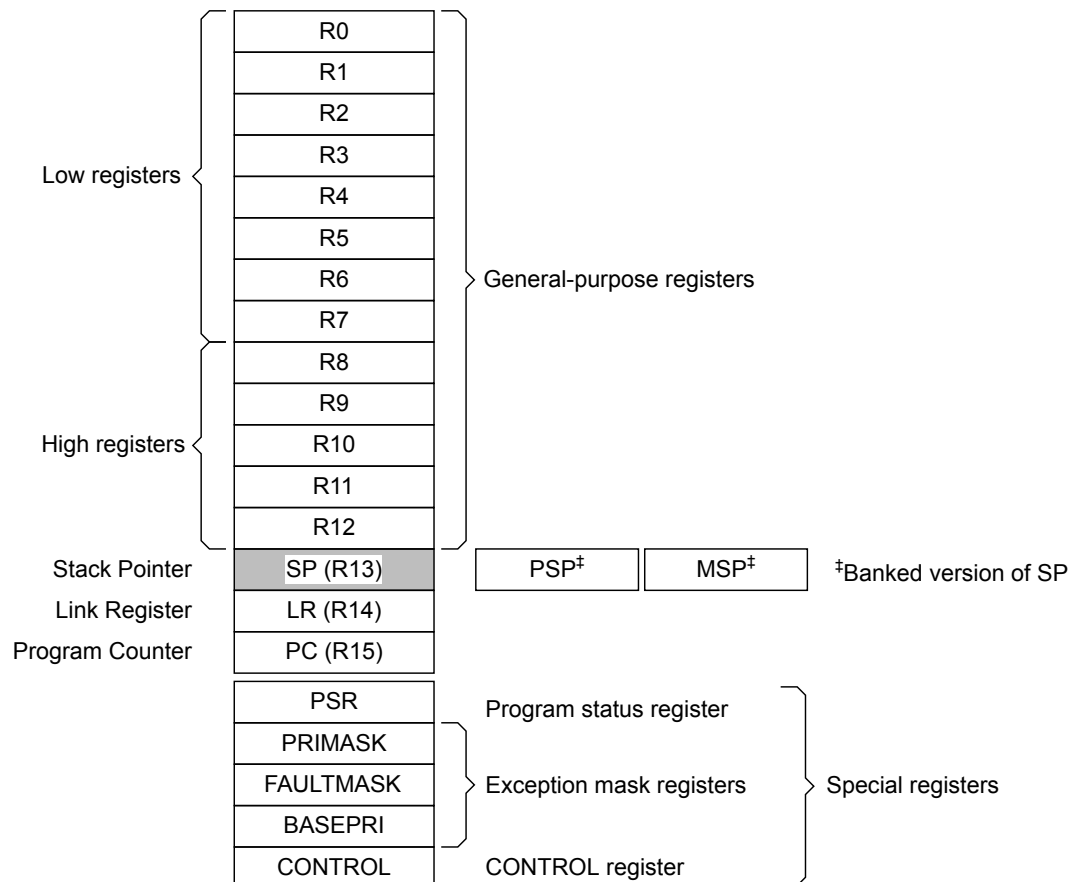


Table 2-2. Processor Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|-----------|------|-------------|------------------------------------|----------|
| - | R0 | R/W | - | Cortex General-Purpose Register 0 | 67 |
| - | R1 | R/W | - | Cortex General-Purpose Register 1 | 67 |
| - | R2 | R/W | - | Cortex General-Purpose Register 2 | 67 |
| - | R3 | R/W | - | Cortex General-Purpose Register 3 | 67 |
| - | R4 | R/W | - | Cortex General-Purpose Register 4 | 67 |
| - | R5 | R/W | - | Cortex General-Purpose Register 5 | 67 |
| - | R6 | R/W | - | Cortex General-Purpose Register 6 | 67 |
| - | R7 | R/W | - | Cortex General-Purpose Register 7 | 67 |
| - | R8 | R/W | - | Cortex General-Purpose Register 8 | 67 |
| - | R9 | R/W | - | Cortex General-Purpose Register 9 | 67 |
| - | R10 | R/W | - | Cortex General-Purpose Register 10 | 67 |
| - | R11 | R/W | - | Cortex General-Purpose Register 11 | 67 |
| - | R12 | R/W | - | Cortex General-Purpose Register 12 | 67 |
| - | SP | R/W | - | Stack Pointer | 68 |
| - | LR | R/W | 0xFFFF.FFFF | Link Register | 69 |
| - | PC | R/W | - | Program Counter | 70 |
| - | PSR | R/W | 0x0100.0000 | Program Status Register | 71 |
| - | PRIMASK | R/W | 0x0000.0000 | Priority Mask Register | 75 |
| - | FAULTMASK | R/W | 0x0000.0000 | Fault Mask Register | 76 |
| - | BASEPRI | R/W | 0x0000.0000 | Base Priority Mask Register | 77 |
| - | CONTROL | R/W | 0x0000.0000 | Control Register | 78 |

2.3.4 Register Descriptions

This section lists and describes the Cortex-M3 registers, in the order shown in Figure 2-3 on page 65. The core registers are not memory mapped and are accessed by register name rather than offset.

Note: The register type shown in the register descriptions refers to type during program execution in Thread mode and Handler mode. Debug access can differ.

Register 1: Cortex General-Purpose Register 0 (R0)

Register 2: Cortex General-Purpose Register 1 (R1)

Register 3: Cortex General-Purpose Register 2 (R2)

Register 4: Cortex General-Purpose Register 3 (R3)

Register 5: Cortex General-Purpose Register 4 (R4)

Register 6: Cortex General-Purpose Register 5 (R5)

Register 7: Cortex General-Purpose Register 6 (R6)

Register 8: Cortex General-Purpose Register 7 (R7)

Register 9: Cortex General-Purpose Register 8 (R8)

Register 10: Cortex General-Purpose Register 9 (R9)

Register 11: Cortex General-Purpose Register 10 (R10)

Register 12: Cortex General-Purpose Register 11 (R11)

Register 13: Cortex General-Purpose Register 12 (R12)

The **Rn** registers are 32-bit general-purpose registers for data operations and can be accessed from either privileged or unprivileged mode.

Cortex General-Purpose Register 0 (R0)

Type R/W, reset -

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | DATA | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DATA | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

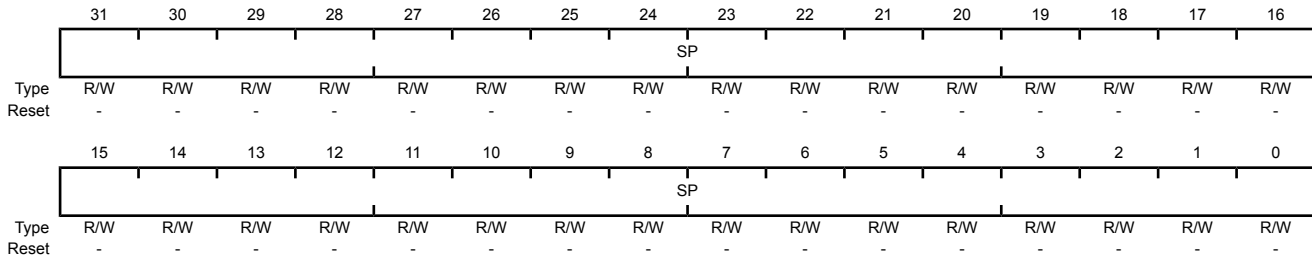
| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|----------------|
| 31:0 | DATA | R/W | - | Register data. |

Register 14: Stack Pointer (SP)

The **Stack Pointer (SP)** is register R13. In Thread mode, the function of this register changes depending on the `ASP` bit in the **Control Register (CONTROL)** register. When the `ASP` bit is clear, this register is the **Main Stack Pointer (MSP)**. When the `ASP` bit is set, this register is the **Process Stack Pointer (PSP)**. On reset, the `ASP` bit is clear, and the processor loads the **MSP** with the value from address `0x0000.0000`. The **MSP** can only be accessed in privileged mode; the **PSP** can be accessed in either privileged or unprivileged mode.

Stack Pointer (SP)

Type R/W, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 31:0 | SP | R/W | - | This field is the address of the stack pointer. |

Register 15: Link Register (LR)

The **Link Register (LR)** is register R14, and it stores the return information for subroutines, function calls, and exceptions. **LR** can be accessed from either privileged or unprivileged mode.

`EXC_RETURN` is loaded into **LR** on exception entry. See Table 2-10 on page 96 for the values and description.

Link Register (LR)

Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | LINK | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | LINK | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

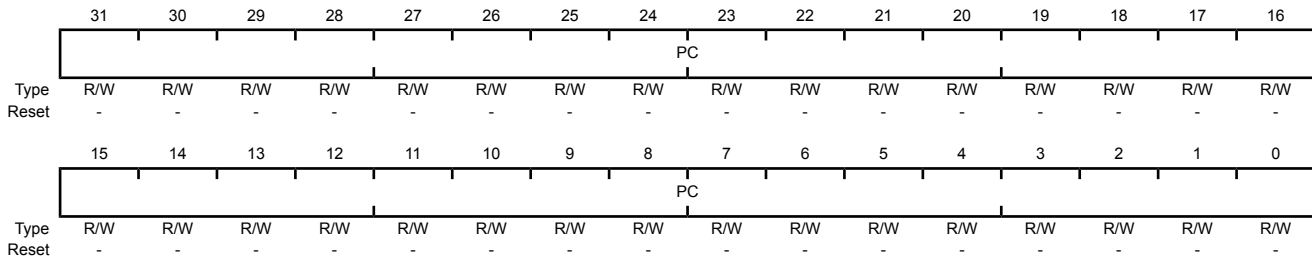
| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|-----------------------------------|
| 31:0 | LINK | R/W | 0xFFFF.FFFF | This field is the return address. |

Register 16: Program Counter (PC)

The **Program Counter (PC)** is register R15, and it contains the current program address. On reset, the processor loads the **PC** with the value of the reset vector, which is at address 0x0000.0004. Bit 0 of the reset vector is loaded into the **THUMB** bit of the **EPSR** at reset and must be 1. The **PC** register can be accessed in either privileged or unprivileged mode.

Program Counter (PC)

Type R/W, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 31:0 | PC | R/W | - | This field is the current program address. |

Register 17: Program Status Register (PSR)

Note: This register is also referred to as **xPSR**.

The **Program Status Register (PSR)** has three functions, and the register bits are assigned to the different functions:

- **Application Program Status Register (APSR)**, bits 31:27,
- **Execution Program Status Register (EPSR)**, bits 26:24, 15:10
- **Interrupt Program Status Register (IPSR)**, bits 6:0

The **PSR**, **IPSR**, and **EPSR** registers can only be accessed in privileged mode; the **APSR** register can be accessed in either privileged or unprivileged mode.

APSR contains the current state of the condition flags from previous instruction executions.

EPSR contains the Thumb state bit and the execution state bits for the If-Then (**IT**) instruction or the Interruptible-Continuable Instruction (**ICI**) field for an interrupted load multiple or store multiple instruction. Attempts to read the **EPSR** directly through application software using the **MSR** instruction always return zero. Attempts to write the **EPSR** using the **MSR** instruction in application software are always ignored. Fault handlers can examine the **EPSR** value in the stacked **PSR** to determine the operation that faulted (see “Exception Entry and Return” on page 94).

IPSR contains the exception type number of the current Interrupt Service Routine (**ISR**).

These registers can be accessed individually or as a combination of any two or all three registers, using the register name as an argument to the **MSR** or **MRS** instructions. For example, all of the registers can be read using **PSR** with the **MRS** instruction, or **APSR** only can be written to using **APSR** with the **MSR** instruction. page 71 shows the possible register combinations for the **PSR**. See the **MRS** and **MSR** instruction descriptions in the *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information about how to access the program status registers.

Table 2-3. PSR Register Combinations

| Register | Type | Combination |
|--------------|---------------------|---|
| PSR | R/W ^{a, b} | APSR , EPSR , and IPSR |
| IEPSR | RO | EPSR and IPSR |
| IAPSR | R/W ^a | APSR and IPSR |
| EAPSR | R/W ^b | APSR and EPSR |

a. The processor ignores writes to the **IPSR** bits.

b. Reads of the **EPSR** bits return zero, and the processor ignores writes to these bits.

Program Status Register (PSR)

Type R/W, reset 0x0100.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|-----|-----|-----|----------|----------|----|-------|----------|----|----|----|----|----|----|----|
| | N | Z | C | V | Q | ICI / IT | | THUMB | reserved | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | ICI / IT | | | | reserved | | | | ISRNUM | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 31 | N | R/W | 0 | <p>APSR Negative or Less Flag</p> <p>Value Description</p> <p>1 The previous operation result was negative or less than.</p> <p>0 The previous operation result was positive, zero, greater than, or equal.</p> <p>The value of this bit is only meaningful when accessing PSR or APSR.</p> |
| 30 | Z | R/W | 0 | <p>APSR Zero Flag</p> <p>Value Description</p> <p>1 The previous operation result was zero.</p> <p>0 The previous operation result was non-zero.</p> <p>The value of this bit is only meaningful when accessing PSR or APSR.</p> |
| 29 | C | R/W | 0 | <p>APSR Carry or Borrow Flag</p> <p>Value Description</p> <p>1 The previous add operation resulted in a carry bit or the previous subtract operation did not result in a borrow bit.</p> <p>0 The previous add operation did not result in a carry bit or the previous subtract operation resulted in a borrow bit.</p> <p>The value of this bit is only meaningful when accessing PSR or APSR.</p> |
| 28 | V | R/W | 0 | <p>APSR Overflow Flag</p> <p>Value Description</p> <p>1 The previous operation resulted in an overflow.</p> <p>0 The previous operation did not result in an overflow.</p> <p>The value of this bit is only meaningful when accessing PSR or APSR.</p> |
| 27 | Q | R/W | 0 | <p>APSR DSP Overflow and Saturation Flag</p> <p>Value Description</p> <p>1 DSP Overflow or saturation has occurred.</p> <p>0 DSP overflow or saturation has not occurred since reset or since the bit was last cleared.</p> <p>The value of this bit is only meaningful when accessing PSR or APSR. This bit is cleared by software using an MRS instruction.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 26:25 | ICI / IT | RO | 0x0 | <p>EPSR ICI / IT status</p> <p>These bits, along with bits 15:10, contain the Interruptible-Continuable Instruction (ICI) field for an interrupted load multiple or store multiple instruction or the execution state bits of the IT instruction.</p> <p>When EPSR holds the ICI execution state, bits 26:25 are zero.</p> <p>The If-Then block contains up to four instructions following an IT instruction. Each instruction in the block is conditional. The conditions for the instructions are either all the same, or some can be the inverse of others. See the <i>Cortex™-M3/M4 Instruction Set Technical User's Manual</i> for more information.</p> <p>The value of this field is only meaningful when accessing PSR or EPSR.</p> |
| 24 | THUMB | RO | 1 | <p>EPSR Thumb State</p> <p>This bit indicates the Thumb state and should always be set.</p> <p>The following can clear the THUMB bit:</p> <ul style="list-style-type: none"> ■ The BLX, BX and POP{PC} instructions ■ Restoration from the stacked xPSR value on an exception return ■ Bit 0 of the vector value on an exception entry or reset <p>Attempting to execute instructions when this bit is clear results in a fault or lockup. See "Lockup" on page 98 for more information.</p> <p>The value of this bit is only meaningful when accessing PSR or EPSR.</p> |
| 23:16 | reserved | RO | 0x00 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 15:10 | ICI / IT | RO | 0x0 | <p>EPSR ICI / IT status</p> <p>These bits, along with bits 26:25, contain the Interruptible-Continuable Instruction (ICI) field for an interrupted load multiple or store multiple instruction or the execution state bits of the IT instruction.</p> <p>When an interrupt occurs during the execution of an LDM, STM, PUSH or POP instruction, the processor stops the load multiple or store multiple instruction operation temporarily and stores the next register operand in the multiple operation to bits 15:12. After servicing the interrupt, the processor returns to the register pointed to by bits 15:12 and resumes execution of the multiple load or store instruction. When EPSR holds the ICI execution state, bits 11:10 are zero.</p> <p>The If-Then block contains up to four instructions following a 16-bit IT instruction. Each instruction in the block is conditional. The conditions for the instructions are either all the same, or some can be the inverse of others. See the <i>Cortex™-M3/M4 Instruction Set Technical User's Manual</i> for more information.</p> <p>The value of this field is only meaningful when accessing PSR or EPSR.</p> |
| 9:7 | reserved | RO | 0x0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|-------------------------|------|-------|--|-------|-------------|------|-------------|------|----------|------|-----|------|------------|------|-------------------------|------|-----------|------|-------------|-----------|----------|------|--------|------|--------------------|------|----------|------|--------|------|---------|------|--------------------|------|--------------------|-----|-----|------|---------------------|-----------|----------|
| 6:0 | ISRNUM | RO | 0x00 | <p>IPSR ISR Number</p> <p>This field contains the exception type number of the current Interrupt Service Routine (ISR).</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>0x00</td><td>Thread mode</td></tr> <tr><td>0x01</td><td>Reserved</td></tr> <tr><td>0x02</td><td>NMI</td></tr> <tr><td>0x03</td><td>Hard fault</td></tr> <tr><td>0x04</td><td>Memory management fault</td></tr> <tr><td>0x05</td><td>Bus fault</td></tr> <tr><td>0x06</td><td>Usage fault</td></tr> <tr><td>0x07-0x0A</td><td>Reserved</td></tr> <tr><td>0x0B</td><td>SVCall</td></tr> <tr><td>0x0C</td><td>Reserved for Debug</td></tr> <tr><td>0x0D</td><td>Reserved</td></tr> <tr><td>0x0E</td><td>PendSV</td></tr> <tr><td>0x0F</td><td>SysTick</td></tr> <tr><td>0x10</td><td>Interrupt Vector 0</td></tr> <tr><td>0x11</td><td>Interrupt Vector 1</td></tr> <tr><td>...</td><td>...</td></tr> <tr><td>0x46</td><td>Interrupt Vector 54</td></tr> <tr><td>0x47-0x7F</td><td>Reserved</td></tr> </tbody> </table> | Value | Description | 0x00 | Thread mode | 0x01 | Reserved | 0x02 | NMI | 0x03 | Hard fault | 0x04 | Memory management fault | 0x05 | Bus fault | 0x06 | Usage fault | 0x07-0x0A | Reserved | 0x0B | SVCall | 0x0C | Reserved for Debug | 0x0D | Reserved | 0x0E | PendSV | 0x0F | SysTick | 0x10 | Interrupt Vector 0 | 0x11 | Interrupt Vector 1 | ... | ... | 0x46 | Interrupt Vector 54 | 0x47-0x7F | Reserved |
| Value | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x00 | Thread mode | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x01 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x02 | NMI | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x03 | Hard fault | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x04 | Memory management fault | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x05 | Bus fault | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x06 | Usage fault | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x07-0x0A | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0B | SVCall | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0C | Reserved for Debug | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0D | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0E | PendSV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0F | SysTick | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x10 | Interrupt Vector 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x11 | Interrupt Vector 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x46 | Interrupt Vector 54 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x47-0x7F | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

See “Exception Types” on page 89 for more information.

The value of this field is only meaningful when accessing **PSR** or **IPSR**.

Register 18: Priority Mask Register (PRIMASK)

The **PRIMASK** register prevents activation of all exceptions with programmable priority. Reset, non-maskable interrupt (NMI), and hard fault are the only exceptions with fixed priority. Exceptions should be disabled when they might impact the timing of critical tasks. This register is only accessible in privileged mode. The **MSR** and **MRS** instructions are used to access the **PRIMASK** register, and the **CPS** instruction may be used to change the value of the **PRIMASK** register. See the *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information on these instructions. For more information on exception priority levels, see “Exception Types” on page 89.

Priority Mask Register (PRIMASK)

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | PRIMASK |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:1 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | PRIMASK | R/W | 0 | Priority Mask |
| | | | | Value Description |
| | | | | 1 Prevents the activation of all exceptions with configurable priority. |
| | | | | 0 No effect. |

Register 19: Fault Mask Register (FAULTMASK)

The **FAULTMASK** register prevents activation of all exceptions except for the Non-Maskable Interrupt (NMI). Exceptions should be disabled when they might impact the timing of critical tasks. This register is only accessible in privileged mode. The **MSR** and **MRS** instructions are used to access the **FAULTMASK** register, and the **CPS** instruction may be used to change the value of the **FAULTMASK** register. See the *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information on these instructions. For more information on exception priority levels, see “Exception Types” on page 89.

Fault Mask Register (FAULTMASK)

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | FAULTMASK |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|------------|---|
| 31:1 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | FAULTMASK | R/W | 0 | Fault Mask |

Value Description

1 Prevents the activation of all exceptions except for NMI.

0 No effect.

The processor clears the **FAULTMASK** bit on exit from any exception handler except the NMI handler.

Register 20: Base Priority Mask Register (BASEPRI)

The **BASEPRI** register defines the minimum priority for exception processing. When **BASEPRI** is set to a nonzero value, it prevents the activation of all exceptions with the same or lower priority level as the **BASEPRI** value. Exceptions should be disabled when they might impact the timing of critical tasks. This register is only accessible in privileged mode. For more information on exception priority levels, see “Exception Types” on page 89.

Base Priority Mask Register (BASEPRI)

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|---------|-----|-----|----------|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | BASEPRI | | | reserved | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | |
|-----------|--|------|-----------|--|-------|-------------|-----|------------------------------|-----|--|-----|--|-----|--|-----|--|-----|--|-----|--|-----|--|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | | | | | |
| 7:5 | BASEPRI | R/W | 0x0 | <p>Base Priority</p> <p>Any exception that has a programmable priority level with the same or lower priority as the value of this field is masked. The PRIMASK register can be used to mask all exceptions with programmable priority levels. Higher priority exceptions have lower priority levels.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>All exceptions are unmasked.</td> </tr> <tr> <td>0x1</td> <td>All exceptions with priority level 1-7 are masked.</td> </tr> <tr> <td>0x2</td> <td>All exceptions with priority level 2-7 are masked.</td> </tr> <tr> <td>0x3</td> <td>All exceptions with priority level 3-7 are masked.</td> </tr> <tr> <td>0x4</td> <td>All exceptions with priority level 4-7 are masked.</td> </tr> <tr> <td>0x5</td> <td>All exceptions with priority level 5-7 are masked.</td> </tr> <tr> <td>0x6</td> <td>All exceptions with priority level 6-7 are masked.</td> </tr> <tr> <td>0x7</td> <td>All exceptions with priority level 7 are masked.</td> </tr> </tbody> </table> | Value | Description | 0x0 | All exceptions are unmasked. | 0x1 | All exceptions with priority level 1-7 are masked. | 0x2 | All exceptions with priority level 2-7 are masked. | 0x3 | All exceptions with priority level 3-7 are masked. | 0x4 | All exceptions with priority level 4-7 are masked. | 0x5 | All exceptions with priority level 5-7 are masked. | 0x6 | All exceptions with priority level 6-7 are masked. | 0x7 | All exceptions with priority level 7 are masked. |
| Value | Description | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | All exceptions are unmasked. | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | All exceptions with priority level 1-7 are masked. | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | All exceptions with priority level 2-7 are masked. | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | All exceptions with priority level 3-7 are masked. | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | All exceptions with priority level 4-7 are masked. | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | All exceptions with priority level 5-7 are masked. | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | All exceptions with priority level 6-7 are masked. | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | All exceptions with priority level 7 are masked. | | | | | | | | | | | | | | | | | | | | | |
| 4:0 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | | | | | |

Register 21: Control Register (CONTROL)

The **CONTROL** register controls the stack used and the privilege level for software execution when the processor is in Thread mode. This register is only accessible in privileged mode.

Handler mode always uses **MSP**, so the processor ignores explicit writes to the **ASP** bit of the **CONTROL** register when in Handler mode. The exception entry and return mechanisms automatically update the **CONTROL** register based on the **EXC_RETURN** value (see Table 2-10 on page 96). In an OS environment, threads running in Thread mode should use the process stack and the kernel and exception handlers should use the main stack. By default, Thread mode uses **MSP**. To switch the stack pointer used in Thread mode to **PSP**, either use the **MSR** instruction to set the **ASP** bit, as detailed in the *Cortex™-M3/M4 Instruction Set Technical User's Manual*, or perform an exception return to Thread mode with the appropriate **EXC_RETURN** value, as shown in Table 2-10 on page 96.

Note: When changing the stack pointer, software must use an **ISB** instruction immediately after the **MSR** instruction, ensuring that instructions after the **ISB** execute use the new stack pointer. See the *Cortex™-M3/M4 Instruction Set Technical User's Manual*.

Control Register (CONTROL)

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | | ASP | TMPL |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:2 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | ASP | R/W | 0 | Active Stack Pointer Value Description 1 PSP is the current stack pointer. 0 MSP is the current stack pointer In Handler mode, this bit reads as zero and ignores writes. The Cortex-M3 updates this bit automatically on exception return. |
| 0 | TMPL | R/W | 0 | Thread Mode Privilege Level Value Description 1 Unprivileged software can be executed in Thread mode. 0 Only privileged software can be executed in Thread mode. |

2.3.5 Exceptions and Interrupts

The Cortex-M3 processor supports interrupts and system exceptions. The processor and the Nested Vectored Interrupt Controller (NVIC) prioritize and handle all exceptions. An exception changes the normal flow of software control. The processor uses Handler mode to handle all exceptions except for reset. See “Exception Entry and Return” on page 94 for more information.

The NVIC registers control interrupt handling. See “Nested Vectored Interrupt Controller (NVIC)” on page 104 for more information.

2.3.6 Data Types

The Cortex-M3 supports 32-bit words, 16-bit halfwords, and 8-bit bytes. The processor also supports 64-bit data transfer instructions. All instruction and data memory accesses are little endian. See “Memory Regions, Types and Attributes” on page 81 for more information.

2.4 Memory Model

This section describes the processor memory map, the behavior of memory accesses, and the bit-banding features. The processor has a fixed memory map that provides up to 4 GB of addressable memory.

The memory map for the LM3S2U93 controller is provided in Table 2-4 on page 79. In this manual, register addresses are given as a hexadecimal increment, relative to the module’s base address as shown in the memory map.

The regions for SRAM and peripherals include bit-band regions. Bit-banding provides atomic operations to bit data (see “Bit-Banding” on page 84).

The processor reserves regions of the Private peripheral bus (PPB) address range for core peripheral registers (see “Cortex-M3 Peripherals” on page 103).

Note: Within the memory map, all reserved space returns a bus fault when read or written.

Table 2-4. Memory Map

| Start | End | Description | For details, see page ... |
|-------------------------|-------------|---|---------------------------|
| Memory | | | |
| 0x0000.0000 | 0x0005.FFFF | On-chip Flash | 317 |
| 0x0006.0000 | 0x00FF.FFFF | Reserved | - |
| 0x0100.0000 | 0x1FFF.FFFF | Reserved for ROM | 315 |
| 0x2000.0000 | 0x2001.FFFF | Bit-banded on-chip SRAM | 315 |
| 0x2002.0000 | 0x21FF.FFFF | Reserved | - |
| 0x2200.0000 | 0x222F.FFFF | Bit-band alias of bit-banded on-chip SRAM starting at 0x2000.0000 | 315 |
| 0x2230.0000 | 0x3FFF.FFFF | Reserved | - |
| FIRM Peripherals | | | |
| 0x4000.0000 | 0x4000.0FFF | Watchdog timer 0 | 600 |
| 0x4000.1000 | 0x4000.1FFF | Watchdog timer 1 | 600 |
| 0x4000.2000 | 0x4000.3FFF | Reserved | - |
| 0x4000.4000 | 0x4000.4FFF | GPIO Port A | 432 |
| 0x4000.5000 | 0x4000.5FFF | GPIO Port B | 432 |
| 0x4000.6000 | 0x4000.6FFF | GPIO Port C | 432 |

Table 2-4. Memory Map (continued)

| Start | End | Description | For details, see page ... |
|--------------------|-------------|----------------------------|---------------------------|
| 0x4000.7000 | 0x4000.7FFF | GPIO Port D | 432 |
| 0x4000.8000 | 0x4000.8FFF | SSI0 | 781 |
| 0x4000.9000 | 0x4000.9FFF | SSI1 | 781 |
| 0x4000.A000 | 0x4000.BFFF | Reserved | - |
| 0x4000.C000 | 0x4000.CFFF | UART0 | 717 |
| 0x4000.D000 | 0x4000.DFFF | UART1 | 717 |
| 0x4000.E000 | 0x4000.EFFF | UART2 | 717 |
| 0x4000.F000 | 0x4001.FFFF | Reserved | - |
| Peripherals | | | |
| 0x4002.0000 | 0x4002.0FFF | I ² C 0 | 825 |
| 0x4002.1000 | 0x4002.1FFF | I ² C 1 | 825 |
| 0x4002.2000 | 0x4002.3FFF | Reserved | - |
| 0x4002.4000 | 0x4002.4FFF | GPIO Port E | 432 |
| 0x4002.5000 | 0x4002.5FFF | GPIO Port F | 432 |
| 0x4002.6000 | 0x4002.6FFF | GPIO Port G | 432 |
| 0x4002.7000 | 0x4002.7FFF | GPIO Port H | 432 |
| 0x4002.8000 | 0x4002.8FFF | PWM | 964 |
| 0x4002.9000 | 0x4002.BFFF | Reserved | - |
| 0x4002.C000 | 0x4002.CFFF | QE10 | 1033 |
| 0x4002.D000 | 0x4002.DFFF | QE11 | 1033 |
| 0x4002.E000 | 0x4002.FFFF | Reserved | - |
| 0x4003.0000 | 0x4003.0FFF | Timer 0 | 566 |
| 0x4003.1000 | 0x4003.1FFF | Timer 1 | 566 |
| 0x4003.2000 | 0x4003.2FFF | Timer 2 | 566 |
| 0x4003.3000 | 0x4003.3FFF | Timer 3 | 566 |
| 0x4003.4000 | 0x4003.7FFF | Reserved | - |
| 0x4003.8000 | 0x4003.8FFF | ADC0 | 644 |
| 0x4003.9000 | 0x4003.9FFF | ADC1 | 644 |
| 0x4003.A000 | 0x4003.BFFF | Reserved | - |
| 0x4003.C000 | 0x4003.CFFF | Analog Comparators | 935 |
| 0x4003.D000 | 0x4003.DFFF | GPIO Port J | 432 |
| 0x4003.E000 | 0x4003.FFFF | Reserved | - |
| 0x4004.0000 | 0x4004.0FFF | CAN0 Controller | 904 |
| 0x4004.1000 | 0x4004.1FFF | CAN1 Controller | 904 |
| 0x4004.2000 | 0x4005.3FFF | Reserved | - |
| 0x4005.4000 | 0x4005.4FFF | I ² S0 | 859 |
| 0x4005.5000 | 0x4005.7FFF | Reserved | - |
| 0x4005.8000 | 0x4005.8FFF | GPIO Port A (AHB aperture) | 432 |
| 0x4005.9000 | 0x4005.9FFF | GPIO Port B (AHB aperture) | 432 |
| 0x4005.A000 | 0x4005.AFFF | GPIO Port C (AHB aperture) | 432 |
| 0x4005.B000 | 0x4005.BFFF | GPIO Port D (AHB aperture) | 432 |

Table 2-4. Memory Map (continued)

| Start | End | Description | For details, see page ... |
|-------------------------------|-------------|---|---------------------------|
| 0x4005.C000 | 0x4005.CFFF | GPIO Port E (AHB aperture) | 432 |
| 0x4005.D000 | 0x4005.DFFF | GPIO Port F (AHB aperture) | 432 |
| 0x4005.E000 | 0x4005.EFFF | GPIO Port G (AHB aperture) | 432 |
| 0x4005.F000 | 0x4005.FFFF | GPIO Port H (AHB aperture) | 432 |
| 0x4006.0000 | 0x4006.0FFF | GPIO Port J (AHB aperture) | 432 |
| 0x4006.1000 | 0x400C.FFFF | Reserved | - |
| 0x400D.0000 | 0x400D.0FFF | EPI 0 | 506 |
| 0x400D.1000 | 0x400F.BFFF | Reserved | - |
| 0x400F.C000 | 0x400F.CFFF | Hibernation Module | 297 |
| 0x400F.D000 | 0x400F.DFFF | Flash memory control | 323 |
| 0x400F.E000 | 0x400F.EFFF | System control | 199 |
| 0x400F.F000 | 0x400F.FFFF | μDMA | 380 |
| 0x4010.0000 | 0x41FF.FFFF | Reserved | - |
| 0x4200.0000 | 0x43FF.FFFF | Bit-banded alias of 0x4000.0000 through 0x400F.FFFF | - |
| 0x4400.0000 | 0x5FFF.FFFF | Reserved | - |
| 0x6000.0000 | 0xDFFF.FFFF | EPI0 mapped peripheral and RAM | - |
| Private Peripheral Bus | | | |
| 0xE000.0000 | 0xE000.0FFF | Instrumentation Trace Macrocell (ITM) | 62 |
| 0xE000.1000 | 0xE000.1FFF | Data Watchpoint and Trace (DWT) | 62 |
| 0xE000.2000 | 0xE000.2FFF | Flash Patch and Breakpoint (FPB) | 62 |
| 0xE000.3000 | 0xE000.DFFF | Reserved | - |
| 0xE000.E000 | 0xE000.EFFF | Cortex-M3 Peripherals (SysTick, NVIC, MPU and SCB) | 111 |
| 0xE000.F000 | 0xE003.FFFF | Reserved | - |
| 0xE004.0000 | 0xE004.0FFF | Trace Port Interface Unit (TPIU) | 63 |
| 0xE004.1000 | 0xFFFF.FFFF | Reserved | - |

2.4.1 Memory Regions, Types and Attributes

The memory map and the programming of the MPU split the memory map into regions. Each region has a defined memory type, and some regions have additional memory attributes. The memory type and attributes determine the behavior of accesses to the region.

The memory types are:

- Normal: The processor can re-order transactions for efficiency and perform speculative reads.
- Device: The processor preserves transaction order relative to other transactions to Device or Strongly Ordered memory.
- Strongly Ordered: The processor preserves transaction order relative to all other transactions.

The different ordering requirements for Device and Strongly Ordered memory mean that the memory system can buffer a write to Device memory but must not buffer a write to Strongly Ordered memory.

An additional memory attribute is Execute Never (XN), which means the processor prevents instruction accesses. A fault exception is generated only on execution of an instruction executed from an XN region.

2.4.2 Memory System Ordering of Memory Accesses

For most memory accesses caused by explicit memory access instructions, the memory system does not guarantee that the order in which the accesses complete matches the program order of the instructions, providing the order does not affect the behavior of the instruction sequence. Normally, if correct program execution depends on two memory accesses completing in program order, software must insert a memory barrier instruction between the memory access instructions (see “Software Ordering of Memory Accesses” on page 83).

However, the memory system does guarantee ordering of accesses to Device and Strongly Ordered memory. For two memory access instructions A1 and A2, if both A1 and A2 are accesses to either Device or Strongly Ordered memory, and if A1 occurs before A2 in program order, A1 is always observed before A2.

2.4.3 Behavior of Memory Accesses

Table 2-5 on page 82 shows the behavior of accesses to each region in the memory map. See “Memory Regions, Types and Attributes” on page 81 for more information on memory types and the XN attribute. Stellaris devices may have reserved memory areas within the address ranges shown below (refer to Table 2-4 on page 79 for more information).

Table 2-5. Memory Access Behavior

| Address Range | Memory Region | Memory Type | Execute Never (XN) | Description |
|---------------------------|------------------------|------------------|--------------------|--|
| 0x0000.0000 - 0x1FFF.FFFF | Code | Normal | - | This executable region is for program code. Data can also be stored here. |
| 0x2000.0000 - 0x3FFF.FFFF | SRAM | Normal | - | This executable region is for data. Code can also be stored here. This region includes bit band and bit band alias areas (see Table 2-6 on page 84). |
| 0x4000.0000 - 0x5FFF.FFFF | Peripheral | Device | XN | This region includes bit band and bit band alias areas (see Table 2-7 on page 84). |
| 0x6000.0000 - 0x9FFF.FFFF | External RAM | Normal | - | This executable region is for data. |
| 0xA000.0000 - 0xDFFF.FFFF | External device | Device | XN | This region is for external device memory. |
| 0xE000.0000- 0xE00F.FFFF | Private peripheral bus | Strongly Ordered | XN | This region includes the NVIC, system timer, and system control block. |
| 0xE010.0000- 0xFFFF.FFFF | Reserved | - | - | - |

The Code, SRAM, and external RAM regions can hold programs. However, it is recommended that programs always use the Code region because the Cortex-M3 has separate buses that can perform instruction fetches and data accesses simultaneously.

The MPU can override the default memory access behavior described in this section. For more information, see “Memory Protection Unit (MPU)” on page 106.

The Cortex-M3 prefetches instructions ahead of execution and speculatively prefetches from branch target addresses.

2.4.4 Software Ordering of Memory Accesses

The order of instructions in the program flow does not always guarantee the order of the corresponding memory transactions for the following reasons:

- The processor can reorder some memory accesses to improve efficiency, providing this does not affect the behavior of the instruction sequence.
- The processor has multiple bus interfaces.
- Memory or devices in the memory map have different wait states.
- Some memory accesses are buffered or speculative.

“Memory System Ordering of Memory Accesses” on page 82 describes the cases where the memory system guarantees the order of memory accesses. Otherwise, if the order of memory accesses is critical, software must include memory barrier instructions to force that ordering. The Cortex-M3 has the following memory barrier instructions:

- The Data Memory Barrier (DMB) instruction ensures that outstanding memory transactions complete before subsequent memory transactions.
- The Data Synchronization Barrier (DSB) instruction ensures that outstanding memory transactions complete before subsequent instructions execute.
- The Instruction Synchronization Barrier (ISB) instruction ensures that the effect of all completed memory transactions is recognizable by subsequent instructions.

Memory barrier instructions can be used in the following situations:

- MPU programming
 - If the MPU settings are changed and the change must be effective on the very next instruction, use a DSB instruction to ensure the effect of the MPU takes place immediately at the end of context switching.
 - Use an ISB instruction to ensure the new MPU setting takes effect immediately after programming the MPU region or regions, if the MPU configuration code was accessed using a branch or call. If the MPU configuration code is entered using exception mechanisms, then an ISB instruction is not required.
- Vector table

If the program changes an entry in the vector table and then enables the corresponding exception, use a DMB instruction between the operations. The DMB instruction ensures that if the exception is taken immediately after being enabled, the processor uses the new exception vector.
- Self-modifying code

If a program contains self-modifying code, use an ISB instruction immediately after the code modification in the program. The ISB instruction ensures subsequent instruction execution uses the updated program.
- Memory map switching

If the system contains a memory map switching mechanism, use a `DSB` instruction after switching the memory map in the program. The `DSB` instruction ensures subsequent instruction execution uses the updated memory map.

- Dynamic exception priority change

When an exception priority has to change when the exception is pending or active, use `DSB` instructions after the change. The change then takes effect on completion of the `DSB` instruction.

Memory accesses to Strongly Ordered memory, such as the System Control Block, do not require the use of `DMB` instructions.

For more information on the memory barrier instructions, see the *Cortex™-M3/M4 Instruction Set Technical User's Manual*.

2.4.5 Bit-Banding

A bit-band region maps each word in a bit-band alias region to a single bit in the bit-band region. The bit-band regions occupy the lowest 1 MB of the SRAM and peripheral memory regions. Accesses to the 32-MB SRAM alias region map to the 1-MB SRAM bit-band region, as shown in Table 2-6 on page 84. Accesses to the 32-MB peripheral alias region map to the 1-MB peripheral bit-band region, as shown in Table 2-7 on page 84. For the specific address range of the bit-band regions, see Table 2-4 on page 79.

Note: A word access to the SRAM or the peripheral bit-band alias region maps to a single bit in the SRAM or peripheral bit-band region.

A word access to a bit band address results in a word access to the underlying memory, and similarly for halfword and byte accesses. This allows bit band accesses to match the access requirements of the underlying peripheral.

Table 2-6. SRAM Memory Bit-Banding Regions

| Address Range | Memory Region | Instruction and Data Accesses |
|---------------------------|----------------------|---|
| 0x2000.0000 - 0x200F.FFFF | SRAM bit-band region | Direct accesses to this memory range behave as SRAM memory accesses, but this region is also bit addressable through bit-band alias. |
| 0x2200.0000 - 0x23FF.FFFF | SRAM bit-band alias | Data accesses to this region are remapped to bit band region. A write operation is performed as read-modify-write. Instruction accesses are not remapped. |

Table 2-7. Peripheral Memory Bit-Banding Regions

| Address Range | Memory Region | Instruction and Data Accesses |
|---------------------------|----------------------------|--|
| 0x4000.0000 - 0x400F.FFFF | Peripheral bit-band region | Direct accesses to this memory range behave as peripheral memory accesses, but this region is also bit addressable through bit-band alias. |
| 0x4200.0000 - 0x43FF.FFFF | Peripheral bit-band alias | Data accesses to this region are remapped to bit band region. A write operation is performed as read-modify-write. Instruction accesses are not permitted. |

The following formula shows how the alias region maps onto the bit-band region:

$$\text{bit_word_offset} = (\text{byte_offset} \times 32) + (\text{bit_number} \times 4)$$

$$\text{bit_word_addr} = \text{bit_band_base} + \text{bit_word_offset}$$

where:

`bit_word_offset`

The position of the target bit in the bit-band memory region.

`bit_word_addr`

The address of the word in the alias memory region that maps to the targeted bit.

`bit_band_base`

The starting address of the alias region.

`byte_offset`

The number of the byte in the bit-band region that contains the targeted bit.

`bit_number`

The bit position, 0-7, of the targeted bit.

Figure 2-4 on page 86 shows examples of bit-band mapping between the SRAM bit-band alias region and the SRAM bit-band region:

- The alias word at 0x23FF.FFE0 maps to bit 0 of the bit-band byte at 0x200F.FFFF:

$$0x23FF.FFE0 = 0x2200.0000 + (0x000F.FFFF*32) + (0*4)$$

- The alias word at 0x23FF.FFFC maps to bit 7 of the bit-band byte at 0x200F.FFFF:

$$0x23FF.FFFC = 0x2200.0000 + (0x000F.FFFF*32) + (7*4)$$

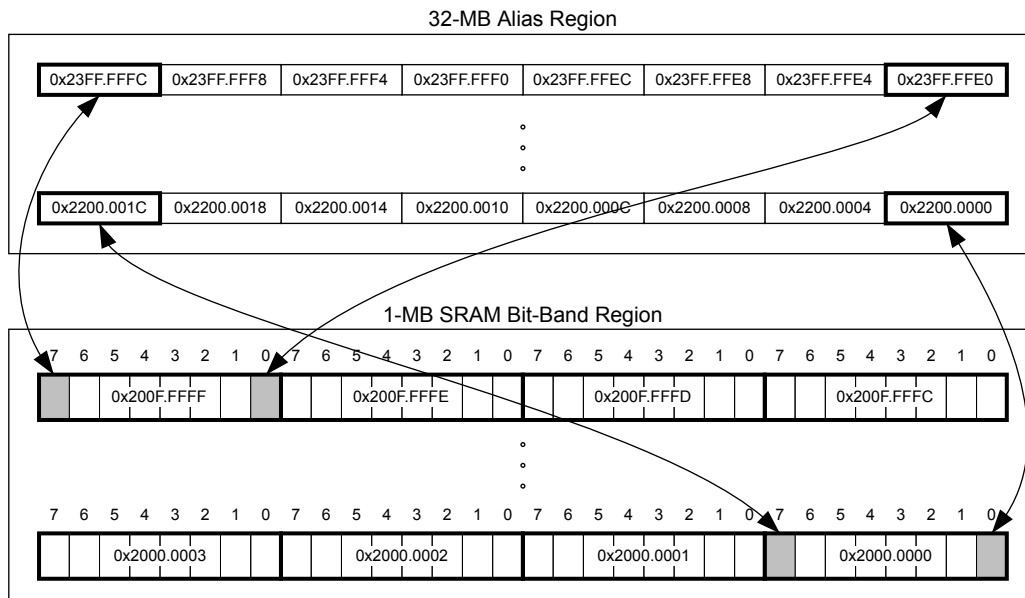
- The alias word at 0x2200.0000 maps to bit 0 of the bit-band byte at 0x2000.0000:

$$0x2200.0000 = 0x2200.0000 + (0*32) + (0*4)$$

- The alias word at 0x2200.001C maps to bit 7 of the bit-band byte at 0x2000.0000:

$$0x2200.001C = 0x2200.0000 + (0*32) + (7*4)$$

Figure 2-4. Bit-Band Mapping



2.4.5.1 Directly Accessing an Alias Region

Writing to a word in the alias region updates a single bit in the bit-band region.

Bit 0 of the value written to a word in the alias region determines the value written to the targeted bit in the bit-band region. Writing a value with bit 0 set writes a 1 to the bit-band bit, and writing a value with bit 0 clear writes a 0 to the bit-band bit.

Bits 31:1 of the alias word have no effect on the bit-band bit. Writing 0x01 has the same effect as writing 0xFF. Writing 0x00 has the same effect as writing 0x0E.

When reading a word in the alias region, 0x0000.0000 indicates that the targeted bit in the bit-band region is clear and 0x0000.0001 indicates that the targeted bit in the bit-band region is set.

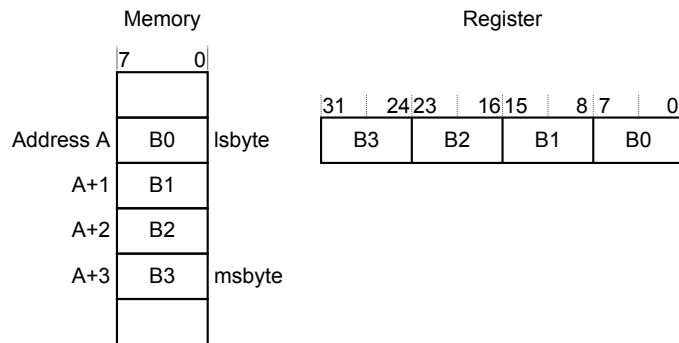
2.4.5.2 Directly Accessing a Bit-Band Region

“Behavior of Memory Accesses” on page 82 describes the behavior of direct byte, halfword, or word accesses to the bit-band regions.

2.4.6 Data Storage

The processor views memory as a linear collection of bytes numbered in ascending order from zero. For example, bytes 0-3 hold the first stored word, and bytes 4-7 hold the second stored word. Data is stored in little-endian format, with the least-significant byte (lsbyte) of a word stored at the lowest-numbered byte, and the most-significant byte (msbyte) stored at the highest-numbered byte. Figure 2-5 on page 87 illustrates how data is stored.

Figure 2-5. Data Storage



2.4.7 Synchronization Primitives

The Cortex-M3 instruction set includes pairs of synchronization primitives which provide a non-blocking mechanism that a thread or process can use to obtain exclusive access to a memory location. Software can use these primitives to perform a guaranteed read-modify-write memory update sequence or for a semaphore mechanism.

A pair of synchronization primitives consists of:

- A Load-Exclusive instruction, which is used to read the value of a memory location and requests exclusive access to that location.
- A Store-Exclusive instruction, which is used to attempt to write to the same memory location and returns a status bit to a register. If this status bit is clear, it indicates that the thread or process gained exclusive access to the memory and the write succeeds; if this status bit is set, it indicates that the thread or process did not gain exclusive access to the memory and no write was performed.

The pairs of Load-Exclusive and Store-Exclusive instructions are:

- The word instructions `LDREX` and `STREX`
- The halfword instructions `LDREXH` and `STREXH`
- The byte instructions `LDREXB` and `STREXB`

Software must use a Load-Exclusive instruction with the corresponding Store-Exclusive instruction.

To perform an exclusive read-modify-write of a memory location, software must:

1. Use a Load-Exclusive instruction to read the value of the location.
2. Modify the value, as required.
3. Use a Store-Exclusive instruction to attempt to write the new value back to the memory location.
4. Test the returned status bit.

If the status bit is clear, the read-modify-write completed successfully. If the status bit is set, no write was performed, which indicates that the value returned at step 1 might be out of date. The software must retry the entire read-modify-write sequence.

Software can use the synchronization primitives to implement a semaphore as follows:

1. Use a Load-Exclusive instruction to read from the semaphore address to check whether the semaphore is free.
2. If the semaphore is free, use a Store-Exclusive to write the claim value to the semaphore address.
3. If the returned status bit from step 2 indicates that the Store-Exclusive succeeded, then the software has claimed the semaphore. However, if the Store-Exclusive failed, another process might have claimed the semaphore after the software performed step 1.

The Cortex-M3 includes an exclusive access monitor that tags the fact that the processor has executed a Load-Exclusive instruction. The processor removes its exclusive access tag if:

- It executes a CLREX instruction.
- It executes a Store-Exclusive instruction, regardless of whether the write succeeds.
- An exception occurs, which means the processor can resolve semaphore conflicts between different threads.

For more information about the synchronization primitive instructions, see the *Cortex™-M3/M4 Instruction Set Technical User's Manual*.

2.5 Exception Model

The ARM Cortex-M3 processor and the Nested Vectored Interrupt Controller (NVIC) prioritize and handle all exceptions in Handler Mode. The processor state is automatically stored to the stack on an exception and automatically restored from the stack at the end of the Interrupt Service Routine (ISR). The vector is fetched in parallel to the state saving, enabling efficient interrupt entry. The processor supports tail-chaining, which enables back-to-back interrupts to be performed without the overhead of state saving and restoration.

Table 2-8 on page 90 lists all exception types. Software can set eight priority levels on seven of these exceptions (system handlers) as well as on 52 interrupts (listed in Table 2-9 on page 91).

Priorities on the system handlers are set with the NVIC **System Handler Priority n (SYSPRIn)** registers. Interrupts are enabled through the NVIC **Interrupt Set Enable n (ENn)** register and prioritized with the NVIC **Interrupt Priority n (PRIn)** registers. Priorities can be grouped by splitting priority levels into preemption priorities and subpriorities. All the interrupt registers are described in “Nested Vectored Interrupt Controller (NVIC)” on page 104.

Internally, the highest user-programmable priority (0) is treated as fourth priority, after a Reset, Non-Maskable Interrupt (NMI), and a Hard Fault, in that order. Note that 0 is the default priority for all the programmable priorities.

Important: After a write to clear an interrupt source, it may take several processor cycles for the NVIC to see the interrupt source de-assert. Thus if the interrupt clear is done as the last action in an interrupt handler, it is possible for the interrupt handler to complete while the NVIC sees the interrupt as still asserted, causing the interrupt handler to be re-entered errantly. This situation can be avoided by either clearing the interrupt source at the beginning of the interrupt handler or by performing a read or write after the write to clear the interrupt source (and flush the write buffer).

See “Nested Vectored Interrupt Controller (NVIC)” on page 104 for more information on exceptions and interrupts.

2.5.1 Exception States

Each exception is in one of the following states:

- **Inactive.** The exception is not active and not pending.
- **Pending.** The exception is waiting to be serviced by the processor. An interrupt request from a peripheral or from software can change the state of the corresponding interrupt to pending.
- **Active.** An exception that is being serviced by the processor but has not completed.
Note: An exception handler can interrupt the execution of another exception handler. In this case, both exceptions are in the active state.
- **Active and Pending.** The exception is being serviced by the processor, and there is a pending exception from the same source.

2.5.2 Exception Types

The exception types are:

- **Reset.** Reset is invoked on power up or a warm reset. The exception model treats reset as a special form of exception. When reset is asserted, the operation of the processor stops, potentially at any point in an instruction. When reset is deasserted, execution restarts from the address provided by the reset entry in the vector table. Execution restarts as privileged execution in Thread mode.
- **NMI.** A non-maskable Interrupt (NMI) can be signaled using the NMI signal or triggered by software using the **Interrupt Control and State (INTCTRL)** register. This exception has the highest priority other than reset. NMI is permanently enabled and has a fixed priority of -2. NMIs cannot be masked or prevented from activation by any other exception or preempted by any exception other than reset.
- **Hard Fault.** A hard fault is an exception that occurs because of an error during exception processing, or because an exception cannot be managed by any other exception mechanism. Hard faults have a fixed priority of -1, meaning they have higher priority than any exception with configurable priority.
- **Memory Management Fault.** A memory management fault is an exception that occurs because of a memory protection related fault, including access violation and no match. The MPU or the fixed memory protection constraints determine this fault, for both instruction and data memory transactions. This fault is used to abort instruction accesses to Execute Never (XN) memory regions, even if the MPU is disabled.
- **Bus Fault.** A bus fault is an exception that occurs because of a memory-related fault for an instruction or data memory transaction such as a prefetch fault or a memory access fault. This fault can be enabled or disabled.
- **Usage Fault.** A usage fault is an exception that occurs because of a fault related to instruction execution, such as:
 - An undefined instruction
 - An illegal unaligned access
 - Invalid state on instruction execution

- An error on exception return

An unaligned address on a word or halfword memory access or division by zero can cause a usage fault when the core is properly configured.

- **SVC**Call. A supervisor call (SVC) is an exception that is triggered by the SVC instruction. In an OS environment, applications can use SVC instructions to access OS kernel functions and device drivers.
- **Debug Monitor**. This exception is caused by the debug monitor (when not halting). This exception is only active when enabled. This exception does not activate if it is a lower priority than the current activation.
- **PendSV**. PendSV is a pendable, interrupt-driven request for system-level service. In an OS environment, use PendSV for context switching when no other exception is active. PendSV is triggered using the **Interrupt Control and State (INTCTRL)** register.
- **SysTick**. A SysTick exception is an exception that the system timer generates when it reaches zero when it is enabled to generate an interrupt. Software can also generate a SysTick exception using the **Interrupt Control and State (INTCTRL)** register. In an OS environment, the processor can use this exception as system tick.
- **Interrupt (IRQ)**. An interrupt, or IRQ, is an exception signaled by a peripheral or generated by a software request and fed through the NVIC (prioritized). All interrupts are asynchronous to instruction execution. In the system, peripherals use interrupts to communicate with the processor. Table 2-9 on page 91 lists the interrupts on the LM3S2U93 controller.

For an asynchronous exception, other than reset, the processor can execute another instruction between when the exception is triggered and when the processor enters the exception handler.

Privileged software can disable the exceptions that Table 2-8 on page 90 shows as having configurable priority (see the **SYSHNDCTRL** register on page 147 and the **DIS0** register on page 120).

For more information about hard faults, memory management faults, bus faults, and usage faults, see “Fault Handling” on page 96.

Table 2-8. Exception Types

| Exception Type | Vector Number | Priority ^a | Vector Address or Offset ^b | Activation |
|------------------------------|---------------|---------------------------|---------------------------------------|--|
| - | 0 | - | 0x0000.0000 | Stack top is loaded from the first entry of the vector table on reset. |
| Reset | 1 | -3 (highest) | 0x0000.0004 | Asynchronous |
| Non-Maskable Interrupt (NMI) | 2 | -2 | 0x0000.0008 | Asynchronous |
| Hard Fault | 3 | -1 | 0x0000.000C | - |
| Memory Management | 4 | programmable ^c | 0x0000.0010 | Synchronous |
| Bus Fault | 5 | programmable ^c | 0x0000.0014 | Synchronous when precise and asynchronous when imprecise |
| Usage Fault | 6 | programmable ^c | 0x0000.0018 | Synchronous |
| - | 7-10 | - | - | Reserved |
| SVCCall | 11 | programmable ^c | 0x0000.002C | Synchronous |
| Debug Monitor | 12 | programmable ^c | 0x0000.0030 | Synchronous |
| - | 13 | - | - | Reserved |

Table 2-8. Exception Types (continued)

| Exception Type | Vector Number | Priority ^a | Vector Address or Offset ^b | Activation |
|----------------|---------------|---------------------------|---------------------------------------|--------------|
| PendSV | 14 | programmable ^c | 0x0000.0038 | Asynchronous |
| SysTick | 15 | programmable ^c | 0x0000.003C | Asynchronous |
| Interrupts | 16 and above | programmable ^d | 0x0000.0040 and above | Asynchronous |

a. 0 is the default priority for all the programmable priorities.

b. See "Vector Table" on page 92.

c. See **SYSPRI1** on page 144.

d. See **PRIn** registers on page 128.

Table 2-9. Interrupts

| Vector Number | Interrupt Number (Bit in Interrupt Registers) | Vector Address or Offset | Description |
|---------------|---|---------------------------|-------------------------|
| 0-15 | - | 0x0000.0000 - 0x0000.003C | Processor exceptions |
| 16 | 0 | 0x0000.0040 | GPIO Port A |
| 17 | 1 | 0x0000.0044 | GPIO Port B |
| 18 | 2 | 0x0000.0048 | GPIO Port C |
| 19 | 3 | 0x0000.004C | GPIO Port D |
| 20 | 4 | 0x0000.0050 | GPIO Port E |
| 21 | 5 | 0x0000.0054 | UART0 |
| 22 | 6 | 0x0000.0058 | UART1 |
| 23 | 7 | 0x0000.005C | SSI0 |
| 24 | 8 | 0x0000.0060 | I ² C0 |
| 25 | 9 | 0x0000.0064 | PWM Fault |
| 26 | 10 | 0x0000.0068 | PWM Generator 0 |
| 27 | 11 | 0x0000.006C | PWM Generator 1 |
| 28 | 12 | 0x0000.0070 | PWM Generator 2 |
| 29 | 13 | 0x0000.0074 | QEI0 |
| 30 | 14 | 0x0000.0078 | ADC0 Sequence 0 |
| 31 | 15 | 0x0000.007C | ADC0 Sequence 1 |
| 32 | 16 | 0x0000.0080 | ADC0 Sequence 2 |
| 33 | 17 | 0x0000.0084 | ADC0 Sequence 3 |
| 34 | 18 | 0x0000.0088 | Watchdog Timers 0 and 1 |
| 35 | 19 | 0x0000.008C | Timer 0A |
| 36 | 20 | 0x0000.0090 | Timer 0B |
| 37 | 21 | 0x0000.0094 | Timer 1A |
| 38 | 22 | 0x0000.0098 | Timer 1B |
| 39 | 23 | 0x0000.009C | Timer 2A |
| 40 | 24 | 0x0000.00A0 | Timer 2B |
| 41 | 25 | 0x0000.00A4 | Analog Comparator 0 |
| 42 | 26 | 0x0000.00A8 | Analog Comparator 1 |
| 43 | 27 | 0x0000.00AC | Analog Comparator 2 |
| 44 | 28 | 0x0000.00B0 | System Control |

Table 2-9. Interrupts (continued)

| Vector Number | Interrupt Number (Bit in Interrupt Registers) | Vector Address or Offset | Description |
|---------------|---|--------------------------|----------------------|
| 45 | 29 | 0x0000.00B4 | Flash Memory Control |
| 46 | 30 | 0x0000.00B8 | GPIO Port F |
| 47 | 31 | 0x0000.00BC | GPIO Port G |
| 48 | 32 | 0x0000.00C0 | GPIO Port H |
| 49 | 33 | 0x0000.00C4 | UART2 |
| 50 | 34 | 0x0000.00C8 | SSI1 |
| 51 | 35 | 0x0000.00CC | Timer 3A |
| 52 | 36 | 0x0000.00D0 | Timer 3B |
| 53 | 37 | 0x0000.00D4 | I ² C1 |
| 54 | 38 | 0x0000.00D8 | QEI1 |
| 55 | 39 | 0x0000.00DC | CAN0 |
| 56 | 40 | 0x0000.00E0 | CAN1 |
| 57-58 | 41-42 | - | Reserved |
| 59 | 43 | 0x0000.00EC | Hibernation Module |
| 60 | 44 | - | Reserved |
| 61 | 45 | 0x0000.00F4 | PWM Generator 3 |
| 62 | 46 | 0x0000.00F8 | μDMA Software |
| 63 | 47 | 0x0000.00FC | μDMA Error |
| 64 | 48 | 0x0000.0100 | ADC1 Sequence 0 |
| 65 | 49 | 0x0000.0104 | ADC1 Sequence 1 |
| 66 | 50 | 0x0000.0108 | ADC1 Sequence 2 |
| 67 | 51 | 0x0000.010C | ADC1 Sequence 3 |
| 68 | 52 | 0x0000.0110 | I ² S0 |
| 69 | 53 | 0x0000.0114 | EPI |
| 70 | 54 | 0x0000.0118 | GPIO Port J |

2.5.3 Exception Handlers

The processor handles exceptions using:

- **Interrupt Service Routines (ISRs).** Interrupts (IRQx) are the exceptions handled by ISRs.
- **Fault Handlers.** Hard fault, memory management fault, usage fault, and bus fault are fault exceptions handled by the fault handlers.
- **System Handlers.** NMI, PendSV, SVCall, SysTick, and the fault exceptions are all system exceptions that are handled by system handlers.

2.5.4 Vector Table

The vector table contains the reset value of the stack pointer and the start addresses, also called exception vectors, for all exception handlers. The vector table is constructed using the vector address or offset shown in Table 2-8 on page 90. Figure 2-6 on page 93 shows the order of the exception vectors in the vector table. The least-significant bit of each vector must be 1, indicating that the exception handler is Thumb code

Figure 2-6. Vector Table

| Exception number | IRQ number | Offset | Vector |
|------------------|------------|--------|-------------------------|
| 70 | 54 | 0x0118 | IRQ54 |
| . | . | . | . |
| . | . | . | . |
| 18 | 2 | 0x004C | IRQ2 |
| 17 | 1 | 0x0048 | IRQ1 |
| 16 | 0 | 0x0044 | IRQ0 |
| 15 | -1 | 0x0040 | Systick |
| 14 | -2 | 0x003C | PendSV |
| 13 | | 0x0038 | Reserved |
| 12 | | | Reserved for Debug |
| 11 | -5 | 0x002C | SVCcall |
| 10 | | | Reserved |
| 9 | | | |
| 8 | | | |
| 7 | | | |
| 6 | -10 | 0x0018 | Usage fault |
| 5 | -11 | 0x0014 | Bus fault |
| 4 | -12 | 0x0010 | Memory management fault |
| 3 | -13 | 0x000C | Hard fault |
| 2 | -14 | 0x0008 | NMI |
| 1 | | 0x0004 | Reset |
| | | 0x0000 | Initial SP value |

On system reset, the vector table is fixed at address 0x0000.0000. Privileged software can write to the **Vector Table Offset (VTABLE)** register to relocate the vector table start address to a different memory location, in the range 0x0000.0200 to 0x3FFF.FE00 (see “Vector Table” on page 92). Note that when configuring the **VTABLE** register, the offset must be aligned on a 512-byte boundary.

2.5.5 Exception Priorities

As Table 2-8 on page 90 shows, all exceptions have an associated priority, with a lower priority value indicating a higher priority and configurable priorities for all exceptions except Reset, Hard fault, and NMI. If software does not configure any priorities, then all exceptions with a configurable priority have a priority of 0. For information about configuring exception priorities, see page 144 and page 128.

Note: Configurable priority values for the Stellaris implementation are in the range 0-7. This means that the Reset, Hard fault, and NMI exceptions, with fixed negative priority values, always have higher priority than any other exception.

For example, assigning a higher priority value to IRQ[0] and a lower priority value to IRQ[1] means that IRQ[1] has higher priority than IRQ[0]. If both IRQ[1] and IRQ[0] are asserted, IRQ[1] is processed before IRQ[0].

If multiple pending exceptions have the same priority, the pending exception with the lowest exception number takes precedence. For example, if both IRQ[0] and IRQ[1] are pending and have the same priority, then IRQ[0] is processed before IRQ[1].

When the processor is executing an exception handler, the exception handler is preempted if a higher priority exception occurs. If an exception occurs with the same priority as the exception being handled, the handler is not preempted, irrespective of the exception number. However, the status of the new interrupt changes to pending.

2.5.6 Interrupt Priority Grouping

To increase priority control in systems with interrupts, the NVIC supports priority grouping. This grouping divides each interrupt priority register entry into two fields:

- An upper field that defines the group priority
- A lower field that defines a subpriority within the group

Only the group priority determines preemption of interrupt exceptions. When the processor is executing an interrupt exception handler, another interrupt with the same group priority as the interrupt being handled does not preempt the handler.

If multiple pending interrupts have the same group priority, the subpriority field determines the order in which they are processed. If multiple pending interrupts have the same group priority and subpriority, the interrupt with the lowest IRQ number is processed first.

For information about splitting the interrupt priority fields into group priority and subpriority, see page 138.

2.5.7 Exception Entry and Return

Descriptions of exception handling use the following terms:

- **Preemption.** When the processor is executing an exception handler, an exception can preempt the exception handler if its priority is higher than the priority of the exception being handled. See “Interrupt Priority Grouping” on page 94 for more information about preemption by an interrupt. When one exception preempts another, the exceptions are called nested exceptions. See “Exception Entry” on page 95 for more information.
- **Return.** Return occurs when the exception handler is completed, and there is no pending exception with sufficient priority to be serviced and the completed exception handler was not handling a late-arriving exception. The processor pops the stack and restores the processor state to the state it had before the interrupt occurred. See “Exception Return” on page 95 for more information.
- **Tail-Chaining.** This mechanism speeds up exception servicing. On completion of an exception handler, if there is a pending exception that meets the requirements for exception entry, the stack pop is skipped and control transfers to the new exception handler.
- **Late-Arriving.** This mechanism speeds up preemption. If a higher priority exception occurs during state saving for a previous exception, the processor switches to handle the higher priority exception and initiates the vector fetch for that exception. State saving is not affected by late arrival because the state saved is the same for both exceptions. Therefore, the state saving continues uninterrupted. The processor can accept a late arriving exception until the first instruction of the exception handler of the original exception enters the execute stage of the processor. On

return from the exception handler of the late-arriving exception, the normal tail-chaining rules apply.

2.5.7.1 Exception Entry

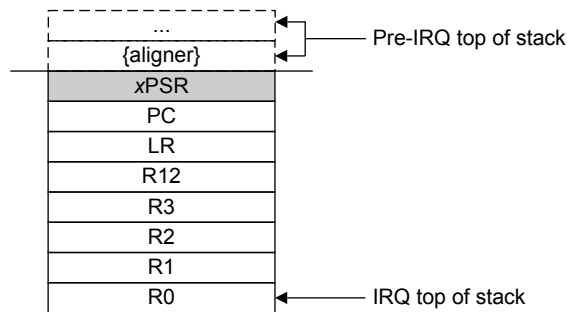
Exception entry occurs when there is a pending exception with sufficient priority and either the processor is in Thread mode or the new exception is of higher priority than the exception being handled, in which case the new exception preempts the original exception.

When one exception preempts another, the exceptions are nested.

Sufficient priority means the exception has more priority than any limits set by the mask registers (see **PRIMASK** on page 75, **FAULTMASK** on page 76, and **BASEPRI** on page 77). An exception with less priority than this is pending but is not handled by the processor.

When the processor takes an exception, unless the exception is a tail-chained or a late-arriving exception, the processor pushes information onto the current stack. This operation is referred to as *stacking* and the structure of eight data words is referred to as *stack frame*.

Figure 2-7. Exception Stack Frame



Immediately after stacking, the stack pointer indicates the lowest address in the stack frame.

The stack frame includes the return address, which is the address of the next instruction in the interrupted program. This value is restored to the **PC** at exception return so that the interrupted program resumes.

In parallel to the stacking operation, the processor performs a vector fetch that reads the exception handler start address from the vector table. When stacking is complete, the processor starts executing the exception handler. At the same time, the processor writes an **EXC_RETURN** value to the **LR**, indicating which stack pointer corresponds to the stack frame and what operation mode the processor was in before the entry occurred.

If no higher-priority exception occurs during exception entry, the processor starts executing the exception handler and automatically changes the status of the corresponding pending interrupt to active.

If another higher-priority exception occurs during exception entry, known as late arrival, the processor starts executing the exception handler for this exception and does not change the pending status of the earlier exception.

2.5.7.2 Exception Return

Exception return occurs when the processor is in Handler mode and executes one of the following instructions to load the **EXC_RETURN** value into the **PC**:

- An **LDM** or **POP** instruction that loads the **PC**

- A `BX` instruction using any register
- An `LDR` instruction with the `PC` as the destination

`EXC_RETURN` is the value loaded into the `LR` on exception entry. The exception mechanism relies on this value to detect when the processor has completed an exception handler. The lowest four bits of this value provide information on the return stack and processor mode. Table 2-10 on page 96 shows the `EXC_RETURN` values with a description of the exception return behavior.

`EXC_RETURN` bits 31:4 are all set. When this value is loaded into the `PC`, it indicates to the processor that the exception is complete, and the processor initiates the appropriate exception return sequence.

Table 2-10. Exception Return Behavior

| <code>EXC_RETURN</code> [31:0] | Description |
|--------------------------------|---|
| 0xFFFF.FFF0 | Reserved |
| 0xFFFF.FFF1 | Return to Handler mode. Exception return uses state from MSP . Execution uses MSP after return. |
| 0xFFFF.FFF2 - 0xFFFF.FFF8 | Reserved |
| 0xFFFF.FFF9 | Return to Thread mode. Exception return uses state from MSP . Execution uses MSP after return. |
| 0xFFFF.FFFA - 0xFFFF.FFFC | Reserved |
| 0xFFFF.FFFD | Return to Thread mode. Exception return uses state from PSP . Execution uses PSP after return. |
| 0xFFFF.FFFE - 0xFFFF.FFFF | Reserved |

2.6 Fault Handling

Faults are a subset of the exceptions (see “Exception Model” on page 88). The following conditions generate a fault:

- A bus error on an instruction fetch or vector table load or a data access.
- An internally detected error such as an undefined instruction or an attempt to change state with a `BX` instruction.
- Attempting to execute an instruction from a memory region marked as Non-Executable (XN).
- An MPU fault because of a privilege violation or an attempt to access an unmanaged region.

2.6.1 Fault Types

Table 2-11 on page 96 shows the types of fault, the handler used for the fault, the corresponding fault status register, and the register bit that indicates the fault has occurred. See page 151 for more information about the fault status registers.

Table 2-11. Faults

| Fault | Handler | Fault Status Register | Bit Name |
|----------------------------|------------|--------------------------------|----------|
| Bus error on a vector read | Hard fault | Hard Fault Status (HFAULTSTAT) | VECT |

Table 2-11. Faults (continued)

| Fault | Handler | Fault Status Register | Bit Name |
|--|-------------------------|---|-------------------|
| Fault escalated to a hard fault | Hard fault | Hard Fault Status (HFAULTSTAT) | FORCED |
| MPU or default memory mismatch on instruction access | Memory management fault | Memory Management Fault Status (MFAULTSTAT) | IERR ^a |
| MPU or default memory mismatch on data access | Memory management fault | Memory Management Fault Status (MFAULTSTAT) | DERR |
| MPU or default memory mismatch on exception stacking | Memory management fault | Memory Management Fault Status (MFAULTSTAT) | MSTKE |
| MPU or default memory mismatch on exception unstacking | Memory management fault | Memory Management Fault Status (MFAULTSTAT) | MUSTKE |
| Bus error during exception stacking | Bus fault | Bus Fault Status (BFAULTSTAT) | BSTKE |
| Bus error during exception unstacking | Bus fault | Bus Fault Status (BFAULTSTAT) | BUSTKE |
| Bus error during instruction prefetch | Bus fault | Bus Fault Status (BFAULTSTAT) | IBUS |
| Precise data bus error | Bus fault | Bus Fault Status (BFAULTSTAT) | PRECISE |
| Imprecise data bus error | Bus fault | Bus Fault Status (BFAULTSTAT) | IMPRE |
| Attempt to access a coprocessor | Usage fault | Usage Fault Status (UFAULTSTAT) | NOCP |
| Undefined instruction | Usage fault | Usage Fault Status (UFAULTSTAT) | UNDEF |
| Attempt to enter an invalid instruction set state ^b | Usage fault | Usage Fault Status (UFAULTSTAT) | INVSTAT |
| Invalid EXC_RETURN value | Usage fault | Usage Fault Status (UFAULTSTAT) | INVPC |
| Illegal unaligned load or store | Usage fault | Usage Fault Status (UFAULTSTAT) | UNALIGN |
| Divide by 0 | Usage fault | Usage Fault Status (UFAULTSTAT) | DIV0 |

a. Occurs on an access to an XN region even if the MPU is disabled.

b. Attempting to use an instruction set other than the Thumb instruction set, or returning to a non load-store-multiple instruction with ICI continuation.

2.6.2 Fault Escalation and Hard Faults

All fault exceptions except for hard fault have configurable exception priority (see **SYSPRI1** on page 144). Software can disable execution of the handlers for these faults (see **SYSHNDCTRL** on page 147).

Usually, the exception priority, together with the values of the exception mask registers, determines whether the processor enters the fault handler, and whether a fault handler can preempt another fault handler as described in “Exception Model” on page 88.

In some situations, a fault with configurable priority is treated as a hard fault. This process is called priority escalation, and the fault is described as *escalated to hard fault*. Escalation to hard fault occurs when:

- A fault handler causes the same kind of fault as the one it is servicing. This escalation to hard fault occurs because a fault handler cannot preempt itself because it must have the same priority as the current priority level.
- A fault handler causes a fault with the same or lower priority as the fault it is servicing. This situation happens because the handler for the new fault cannot preempt the currently executing fault handler.
- An exception handler causes a fault for which the priority is the same as or lower than the currently executing exception.

- A fault occurs and the handler for that fault is not enabled.

If a bus fault occurs during a stack push when entering a bus fault handler, the bus fault does not escalate to a hard fault. Thus if a corrupted stack causes a fault, the fault handler executes even though the stack push for the handler failed. The fault handler operates but the stack contents are corrupted.

Note: Only Reset and NMI can preempt the fixed priority hard fault. A hard fault can preempt any exception other than Reset, NMI, or another hard fault.

2.6.3 Fault Status Registers and Fault Address Registers

The fault status registers indicate the cause of a fault. For bus faults and memory management faults, the fault address register indicates the address accessed by the operation that caused the fault, as shown in Table 2-12 on page 98.

Table 2-12. Fault Status and Fault Address Registers

| Handler | Status Register Name | Address Register Name | Register Description |
|-------------------------|---|--|----------------------|
| Hard fault | Hard Fault Status (HFAULTSTAT) | - | page 157 |
| Memory management fault | Memory Management Fault Status (MFAULTSTAT) | Memory Management Fault Address (MMADDR) | page 151 page 158 |
| Bus fault | Bus Fault Status (BFAULTSTAT) | Bus Fault Address (FAULTADDR) | page 151 page 159 |
| Usage fault | Usage Fault Status (UFAULTSTAT) | - | page 151 |

2.6.4 Lockup

The processor enters a lockup state if a hard fault occurs when executing the NMI or hard fault handlers. When the processor is in the lockup state, it does not execute any instructions. The processor remains in lockup state until it is reset, an NMI occurs, or it is halted by a debugger.

Note: If the lockup state occurs from the NMI handler, a subsequent NMI does not cause the processor to leave the lockup state.

2.7 Power Management

The Cortex-M3 processor sleep modes reduce power consumption:

- Sleep mode stops the processor clock.
- Deep-sleep mode stops the system clock and switches off the PLL and Flash memory.

The SLEEPDEEP bit of the **System Control (SYSCTRL)** register selects which sleep mode is used (see page 140). For more information about the behavior of the sleep modes, see “System Control” on page 195.

This section describes the mechanisms for entering sleep mode and the conditions for waking up from sleep mode, both of which apply to Sleep mode and Deep-sleep mode.

2.7.1 Entering Sleep Modes

This section describes the mechanisms software can use to put the processor into one of the sleep modes.

The system can generate spurious wake-up events, for example a debug operation wakes up the processor. Therefore, software must be able to put the processor back into sleep mode after such an event. A program might have an idle loop to put the processor back to sleep mode.

2.7.1.1 Wait for Interrupt

The wait for interrupt instruction, `WFI`, causes immediate entry to sleep mode unless the wake-up condition is true (see “Wake Up from WFI or Sleep-on-Exit” on page 99). When the processor executes a `WFI` instruction, it stops executing instructions and enters sleep mode. See the *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information.

2.7.1.2 Wait for Event

The wait for event instruction, `WFE`, causes entry to sleep mode conditional on the value of a one-bit event register. When the processor executes a `WFE` instruction, it checks the event register. If the register is 0, the processor stops executing instructions and enters sleep mode. If the register is 1, the processor clears the register and continues executing instructions without entering sleep mode.

If the event register is 1, the processor must not enter sleep mode on execution of a `WFE` instruction. Typically, this situation occurs if an `SEV` instruction has been executed. Software cannot access this register directly.

See the *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information.

2.7.1.3 Sleep-on-Exit

If the `SLEEPEXIT` bit of the `SYSCTRL` register is set, when the processor completes the execution of all exception handlers, it returns to Thread mode and immediately enters sleep mode. This mechanism can be used in applications that only require the processor to run when an exception occurs.

2.7.2 Wake Up from Sleep Mode

The conditions for the processor to wake up depend on the mechanism that cause it to enter sleep mode.

2.7.2.1 Wake Up from WFI or Sleep-on-Exit

Normally, the processor wakes up only when the NVIC detects an exception with sufficient priority to cause exception entry. Some embedded systems might have to execute system restore tasks after the processor wakes up and before executing an interrupt handler. Entry to the interrupt handler can be delayed by setting the `PRIMASK` bit and clearing the `FAULTMASK` bit. If an interrupt arrives that is enabled and has a higher priority than current exception priority, the processor wakes up but does not execute the interrupt handler until the processor clears `PRIMASK`. For more information about `PRIMASK` and `FAULTMASK`, see page 75 and page 76.

2.7.2.2 Wake Up from WFE

The processor wakes up if it detects an exception with sufficient priority to cause exception entry.

In addition, if the `SEVONPEND` bit in the `SYSCTRL` register is set, any new pending interrupt triggers an event and wakes up the processor, even if the interrupt is disabled or has insufficient priority to cause exception entry. For more information about `SYSCTRL`, see page 140.

2.8 Instruction Set Summary

The processor implements a version of the Thumb instruction set. Table 2-13 on page 100 lists the supported instructions.

Note: In Table 2-13 on page 100:

- Angle brackets, <>, enclose alternative forms of the operand
- Braces, {}, enclose optional operands
- The Operands column is not exhaustive
- Op2 is a flexible second operand that can be either a register or a constant
- Most instructions can use an optional condition code suffix

For more information on the instructions and operands, see the instruction descriptions in the *Cortex™-M3/M4 Instruction Set Technical User's Manual*.

Table 2-13. Cortex-M3 Instruction Summary

| Mnemonic | Operands | Brief Description | Flags |
|-----------|----------------------|--|------------|
| ADC, ADCS | {Rd,} Rn, Op2 | Add with carry | N, Z, C, V |
| ADD, ADDS | {Rd,} Rn, Op2 | Add | N, Z, C, V |
| ADD, ADDW | {Rd,} Rn, #imm12 | Add | N, Z, C, V |
| ADR | Rd, label | Load PC-relative address | - |
| AND, ANDS | {Rd,} Rn, Op2 | Logical AND | N, Z, C |
| ASR, ASRS | Rd, Rm, <Rs #n> | Arithmetic shift right | N, Z, C |
| B | label | Branch | - |
| BFC | Rd, #lsb, #width | Bit field clear | - |
| BFI | Rd, Rn, #lsb, #width | Bit field insert | - |
| BIC, BICS | {Rd,} Rn, Op2 | Bit clear | N, Z, C |
| BKPT | #imm | Breakpoint | - |
| BL | label | Branch with link | - |
| BLX | Rm | Branch indirect with link | - |
| BX | Rm | Branch indirect | - |
| CBNZ | Rn, label | Compare and branch if non-zero | - |
| CBZ | Rn, label | Compare and branch if zero | - |
| CLREX | - | Clear exclusive | - |
| CLZ | Rd, Rm | Count leading zeros | - |
| CMN | Rn, Op2 | Compare negative | N, Z, C, V |
| CMP | Rn, Op2 | Compare | N, Z, C, V |
| CPSID | i | Change processor state, disable interrupts | - |
| CPSIE | i | Change processor state, enable interrupts | - |
| DMB | - | Data memory barrier | - |
| DSB | - | Data synchronization barrier | - |
| EOR, EORS | {Rd,} Rn, Op2 | Exclusive OR | N, Z, C |
| ISB | - | Instruction synchronization barrier | - |
| IT | - | If-Then condition block | - |

Table 2-13. Cortex-M3 Instruction Summary (continued)

| Mnemonic | Operands | Brief Description | Flags |
|---------------|------------------------|---|------------|
| LDM | Rn{!}, reglist | Load multiple registers, increment after | - |
| LDMDB, LDMEA | Rn{!}, reglist | Load multiple registers, decrement before | - |
| LDMFD, LDMIA | Rn{!}, reglist | Load multiple registers, increment after | - |
| LDR | Rt, [Rn, #offset] | Load register with word | - |
| LDRB, LDRBT | Rt, [Rn, #offset] | Load register with byte | - |
| LDRD | Rt, Rt2, [Rn, #offset] | Load register with two bytes | - |
| LDREX | Rt, [Rn, #offset] | Load register exclusive | - |
| LDREXB | Rt, [Rn] | Load register exclusive with byte | - |
| LDREXH | Rt, [Rn] | Load register exclusive with halfword | - |
| LDRH, LDRHT | Rt, [Rn, #offset] | Load register with halfword | - |
| LDRSB, LDRSBT | Rt, [Rn, #offset] | Load register with signed byte | - |
| LDRSH, LDRSHT | Rt, [Rn, #offset] | Load register with signed halfword | - |
| LDRT | Rt, [Rn, #offset] | Load register with word | - |
| LSL, LSLS | Rd, Rm, <Rs #n> | Logical shift left | N, Z, C |
| LSR, LSRS | Rd, Rm, <Rs #n> | Logical shift right | N, Z, C |
| MLA | Rd, Rn, Rm, Ra | Multiply with accumulate, 32-bit result | - |
| MLS | Rd, Rn, Rm, Ra | Multiply and subtract, 32-bit result | - |
| MOV, MOVS | Rd, Op2 | Move | N, Z, C |
| MOV, MOVW | Rd, #imm16 | Move 16-bit constant | N, Z, C |
| MOVT | Rd, #imm16 | Move top | - |
| MRS | Rd, spec_reg | Move from special register to general register | - |
| MSR | spec_reg, Rm | Move from general register to special register | N, Z, C, V |
| MUL, MULS | {Rd,} Rn, Rm | Multiply, 32-bit result | N, Z |
| MVN, MVNS | Rd, Op2 | Move NOT | N, Z, C |
| NOP | - | No operation | - |
| ORN, ORNS | {Rd,} Rn, Op2 | Logical OR NOT | N, Z, C |
| ORR, ORRS | {Rd,} Rn, Op2 | Logical OR | N, Z, C |
| POP | reglist | Pop registers from stack | - |
| PUSH | reglist | Push registers onto stack | - |
| RBIT | Rd, Rn | Reverse bits | - |
| REV | Rd, Rn | Reverse byte order in a word | - |
| REV16 | Rd, Rn | Reverse byte order in each halfword | - |
| REVSH | Rd, Rn | Reverse byte order in bottom halfword and sign extend | - |
| ROR, RORS | Rd, Rm, <Rs #n> | Rotate right | N, Z, C |
| RRX, RRXS | Rd, Rm | Rotate right with extend | N, Z, C |
| RSB, RSBS | {Rd,} Rn, Op2 | Reverse subtract | N, Z, C, V |
| SBC, SBSCS | {Rd,} Rn, Op2 | Subtract with carry | N, Z, C, V |
| SBFX | Rd, Rn, #lsb, #width | Signed bit field extract | - |

Table 2-13. Cortex-M3 Instruction Summary (continued)

| Mnemonic | Operands | Brief Description | Flags |
|---------------|---------------------------|--|---------|
| SDIV | {Rd,} Rn, Rm | Signed divide | - |
| SEV | - | Send event | - |
| SMLAL | RdLo, RdHi, Rn, Rm | Signed multiply with accumulate (32x32+64), 64-bit result | - |
| SMULL | RdLo, RdHi, Rn, Rm | Signed multiply (32x32), 64-bit result | - |
| SSAT | Rd, #n, Rm {,shift #s} | Signed saturate | Q |
| STM | Rn{!}, reglist | Store multiple registers, increment after | - |
| STMDB, STMEA | Rn{!}, reglist | Store multiple registers, decrement before | - |
| STMFD, STMIA | Rn{!}, reglist | Store multiple registers, increment after | - |
| STR | Rt, [Rn {, #offset}] | Store register word | - |
| STRB, STRBT | Rt, [Rn {, #offset}] | Store register byte | - |
| STRD | Rt, Rt2, [Rn {, #offset}] | Store register two words | - |
| STREX | Rt, Rt, [Rn {, #offset}] | Store register exclusive | - |
| STREXB | Rd, Rt, [Rn] | Store register exclusive byte | - |
| STREXH | Rd, Rt, [Rn] | Store register exclusive halfword | - |
| STRH, STRHT | Rt, [Rn {, #offset}] | Store register halfword | - |
| STRSB, STRSBT | Rt, [Rn {, #offset}] | Store register signed byte | - |
| STRSH, STRSHT | Rt, [Rn {, #offset}] | Store register signed halfword | - |
| STRT | Rt, [Rn {, #offset}] | Store register word | - |
| SUB, SUBS | {Rd,} Rn, Op2 | Subtract | N,Z,C,V |
| SUB, SUBW | {Rd,} Rn, #imm12 | Subtract 12-bit constant | N,Z,C,V |
| SVC | #imm | Supervisor call | - |
| SXTB | {Rd,} Rm {,ROR #n} | Sign extend a byte | - |
| SXTH | {Rd,} Rm {,ROR #n} | Sign extend a halfword | - |
| TBB | [Rn, Rm] | Table branch byte | - |
| TBH | [Rn, Rm, LSL #1] | Table branch halfword | - |
| TEQ | Rn, Op2 | Test equivalence | N,Z,C |
| TST | Rn, Op2 | Test | N,Z,C |
| UBFX | Rd, Rn, #lsb, #width | Unsigned bit field extract | - |
| UDIV | {Rd,} Rn, Rm | Unsigned divide | - |
| UMLAL | RdLo, RdHi, Rn, Rm | Unsigned multiply with accumulate (32x32+32+32), 64-bit result | - |
| UMULL | RdLo, RdHi, Rn, Rm | Unsigned multiply (32x 2), 64-bit result | - |
| USAT | Rd, #n, Rm {,shift #s} | Unsigned Saturate | Q |
| UXTB | {Rd,} Rm, {,ROR #n} | Zero extend a Byte | - |
| UXTH | {Rd,} Rm, {,ROR #n} | Zero extend a Halfword | - |
| WFE | - | Wait for event | - |
| WFI | - | Wait for interrupt | - |

3 Cortex-M3 Peripherals

This chapter provides information on the Stellaris® implementation of the Cortex-M3 processor peripherals, including:

- **SysTick** (see page 103)
 - Provides a simple, 24-bit clear-on-write, decrementing, wrap-on-zero counter with a flexible control mechanism.
- **Nested Vectored Interrupt Controller (NVIC)** (see page 104)
 - Facilitates low-latency exception and interrupt handling
 - Controls power management
 - Implements system control registers
- **System Control Block (SCB)** (see page 106)
 - Provides system implementation information and system control, including configuration, control, and reporting of system exceptions.
- **Memory Protection Unit (MPU)** (see page 106)
 - Supports the standard ARMv7 Protected Memory System Architecture (PMSA) model. The MPU provides full support for protection regions, overlapping protection regions, access permissions, and exporting memory attributes to the system.

Table 3-1 on page 103 shows the address map of the Private Peripheral Bus (PPB). Some peripheral register regions are split into two address regions, as indicated by two addresses listed.

Table 3-1. Core Peripheral Register Regions

| Address | Core Peripheral | Description (see page ...) |
|--|--------------------------------------|----------------------------|
| 0xE000.E010-0xE000.E01F | System Timer | 103 |
| 0xE000.E100-0xE000.E4EF 0xE000.EF00-0xE000.EF03 | Nested Vectored Interrupt Controller | 104 |
| 0xE000.E008-0xE000.E00F 0xE000.ED00-0xE000.ED3F | System Control Block | 106 |
| 0xE000.ED90-0xE000.EDB8 | Memory Protection Unit | 106 |

3.1 Functional Description

This chapter provides information on the Stellaris implementation of the Cortex-M3 processor peripherals: SysTick, NVIC, SCB and MPU.

3.1.1 System Timer (SysTick)

Cortex-M3 includes an integrated system timer, SysTick, which provides a simple, 24-bit clear-on-write, decrementing, wrap-on-zero counter with a flexible control mechanism. The counter can be used in several different ways, for example as:

- An RTOS tick timer that fires at a programmable rate (for example, 100 Hz) and invokes a SysTick routine.
- A high-speed alarm timer using the system clock.

- A variable rate alarm or signal timer—the duration is range-dependent on the reference clock used and the dynamic range of the counter.
- A simple counter used to measure time to completion and time used.
- An internal clock source control based on missing/meeting durations. The `COUNT` bit in the **STCTRL** control and status register can be used to determine if an action completed within a set duration, as part of a dynamic clock management control loop.

The timer consists of three registers:

- **SysTick Control and Status (STCTRL)**: A control and status counter to configure its clock, enable the counter, enable the SysTick interrupt, and determine counter status.
- **SysTick Reload Value (STRELOAD)**: The reload value for the counter, used to provide the counter's wrap value.
- **SysTick Current Value (STCURRENT)**: The current value of the counter.

When enabled, the timer counts down on each clock from the reload value to zero, reloads (wraps) to the value in the **STRELOAD** register on the next clock edge, then decrements on subsequent clocks. Clearing the **STRELOAD** register disables the counter on the next wrap. When the counter reaches zero, the `COUNT` status bit is set. The `COUNT` bit clears on reads.

Writing to the **STCURRENT** register clears the register and the `COUNT` status bit. The write does not trigger the SysTick exception logic. On a read, the current value is the value of the register at the time the register is accessed.

The SysTick counter runs on the system clock. If this clock signal is stopped for low power mode, the SysTick counter stops. Ensure software uses aligned word accesses to access the SysTick registers.

Note: When the processor is halted for debugging, the counter does not decrement.

3.1.2 Nested Vectored Interrupt Controller (NVIC)

This section describes the Nested Vectored Interrupt Controller (NVIC) and the registers it uses. The NVIC supports:

- 52 interrupts.
- A programmable priority level of 0-7 for each interrupt. A higher level corresponds to a lower priority, so level 0 is the highest interrupt priority.
- Low-latency exception and interrupt handling.
- Level and pulse detection of interrupt signals.
- Dynamic reprioritization of interrupts.
- Grouping of priority values into group priority and subpriority fields.
- Interrupt tail-chaining.
- An external Non-maskable interrupt (NMI).

The processor automatically stacks its state on exception entry and unstacks this state on exception exit, with no instruction overhead, providing low latency exception handling.

3.1.2.1 Level-Sensitive and Pulse Interrupts

The processor supports both level-sensitive and pulse interrupts. Pulse interrupts are also described as edge-triggered interrupts.

A level-sensitive interrupt is held asserted until the peripheral deasserts the interrupt signal. Typically this happens because the ISR accesses the peripheral, causing it to clear the interrupt request. A pulse interrupt is an interrupt signal sampled synchronously on the rising edge of the processor clock. To ensure the NVIC detects the interrupt, the peripheral must assert the interrupt signal for at least one clock cycle, during which the NVIC detects the pulse and latches the interrupt.

When the processor enters the ISR, it automatically removes the pending state from the interrupt (see “Hardware and Software Control of Interrupts” on page 105 for more information). For a level-sensitive interrupt, if the signal is not deasserted before the processor returns from the ISR, the interrupt becomes pending again, and the processor must execute its ISR again. As a result, the peripheral can hold the interrupt signal asserted until it no longer needs servicing.

3.1.2.2 Hardware and Software Control of Interrupts

The Cortex-M3 latches all interrupts. A peripheral interrupt becomes pending for one of the following reasons:

- The NVIC detects that the interrupt signal is High and the interrupt is not active.
- The NVIC detects a rising edge on the interrupt signal.
- Software writes to the corresponding interrupt set-pending register bit, or to the **Software Trigger Interrupt (SWTRIG)** register to make a Software-Generated Interrupt pending. See the `INT` bit in the `PEND0` register on page 122 or **SWTRIG** on page 130.

A pending interrupt remains pending until one of the following:

- The processor enters the ISR for the interrupt, changing the state of the interrupt from pending to active. Then:
 - For a level-sensitive interrupt, when the processor returns from the ISR, the NVIC samples the interrupt signal. If the signal is asserted, the state of the interrupt changes to pending, which might cause the processor to immediately re-enter the ISR. Otherwise, the state of the interrupt changes to inactive.
 - For a pulse interrupt, the NVIC continues to monitor the interrupt signal, and if this is pulsed the state of the interrupt changes to pending and active. In this case, when the processor returns from the ISR the state of the interrupt changes to pending, which might cause the processor to immediately re-enter the ISR.

If the interrupt signal is not pulsed while the processor is in the ISR, when the processor returns from the ISR the state of the interrupt changes to inactive.
- Software writes to the corresponding interrupt clear-pending register bit
 - For a level-sensitive interrupt, if the interrupt signal is still asserted, the state of the interrupt does not change. Otherwise, the state of the interrupt changes to inactive.

- For a pulse interrupt, the state of the interrupt changes to inactive, if the state was pending or to active, if the state was active and pending.

3.1.3 System Control Block (SCB)

The System Control Block (SCB) provides system implementation information and system control, including configuration, control, and reporting of the system exceptions.

3.1.4 Memory Protection Unit (MPU)

This section describes the Memory protection unit (MPU). The MPU divides the memory map into a number of regions and defines the location, size, access permissions, and memory attributes of each region. The MPU supports independent attribute settings for each region, overlapping regions, and export of memory attributes to the system.

The memory attributes affect the behavior of memory accesses to the region. The Cortex-M3 MPU defines eight separate memory regions, 0-7, and a background region.

When memory regions overlap, a memory access is affected by the attributes of the region with the highest number. For example, the attributes for region 7 take precedence over the attributes of any region that overlaps region 7.

The background region has the same memory access attributes as the default memory map, but is accessible from privileged software only.

The Cortex-M3 MPU memory map is unified, meaning that instruction accesses and data accesses have the same region settings.

If a program accesses a memory location that is prohibited by the MPU, the processor generates a memory management fault, causing a fault exception and possibly causing termination of the process in an OS environment. In an OS environment, the kernel can update the MPU region setting dynamically based on the process to be executed. Typically, an embedded OS uses the MPU for memory protection.

Configuration of MPU regions is based on memory types (see “Memory Regions, Types and Attributes” on page 81 for more information).

Table 3-2 on page 106 shows the possible MPU region attributes. See the section called “MPU Configuration for a Stellaris Microcontroller” on page 110 for guidelines for programming a microcontroller implementation.

Table 3-2. Memory Attributes Summary

| Memory Type | Description |
|------------------|---|
| Strongly Ordered | All accesses to Strongly Ordered memory occur in program order. |
| Device | Memory-mapped peripherals |
| Normal | Normal memory |

To avoid unexpected behavior, disable the interrupts before updating the attributes of a region that the interrupt handlers might access.

Ensure software uses aligned accesses of the correct size to access MPU registers:

- Except for the **MPU Region Attribute and Size (MPUATTR)** register, all MPU registers must be accessed with aligned word accesses.
- The **MPUATTR** register can be accessed with byte or aligned halfword or word accesses.

The processor does not support unaligned accesses to MPU registers.

When setting up the MPU, and if the MPU has previously been programmed, disable unused regions to prevent any previous region settings from affecting the new MPU setup.

3.1.4.1 Updating an MPU Region

To update the attributes for an MPU region, the **MPU Region Number (MPUNUMBER)**, **MPU Region Base Address (MPUBASE)** and **MPUATTR** registers must be updated. Each register can be programmed separately or with a multiple-word write to program all of these registers. You can use the **MPUBASEx** and **MPUATTRx** aliases to program up to four regions simultaneously using an STM instruction.

Updating an MPU Region Using Separate Words

This example simple code configures one region:

```

; R1 = region number
; R2 = size/enable
; R3 = attributes
; R4 = address
LDR R0,=MPUNUMBER           ; 0xE000ED98, MPU region number register
STR R1, [R0, #0x0]         ; Region Number
STR R4, [R0, #0x4]         ; Region Base Address
STRH R2, [R0, #0x8]       ; Region Size and Enable
STRH R3, [R0, #0xA]       ; Region Attribute

```

Disable a region before writing new region settings to the MPU if you have previously enabled the region being changed. For example:

```

; R1 = region number
; R2 = size/enable
; R3 = attributes
; R4 = address
LDR R0,=MPUNUMBER           ; 0xE000ED98, MPU region number register
STR R1, [R0, #0x0]         ; Region Number
BIC R2, R2, #1              ; Disable
STRH R2, [R0, #0x8]       ; Region Size and Enable
STR R4, [R0, #0x4]         ; Region Base Address
STRH R3, [R0, #0xA]       ; Region Attribute
ORR R2, #1                  ; Enable
STRH R2, [R0, #0x8]       ; Region Size and Enable

```

Software must use memory barrier instructions:

- Before MPU setup, if there might be outstanding memory transfers, such as buffered writes, that might be affected by the change in MPU settings.
- After MPU setup, if it includes memory transfers that must use the new MPU settings.

However, memory barrier instructions are not required if the MPU setup process starts by entering an exception handler, or is followed by an exception return, because the exception entry and exception return mechanism cause memory barrier behavior.

Software does not need any memory barrier instructions during MPU setup, because it accesses the MPU through the Private Peripheral Bus (PPB), which is a Strongly Ordered memory region.

For example, if all of the memory access behavior is intended to take effect immediately after the programming sequence, then a `DSB` instruction and an `ISB` instruction should be used. A `DSB` is required after changing MPU settings, such as at the end of context switch. An `ISB` is required if the code that programs the MPU region or regions is entered using a branch or call. If the programming sequence is entered using a return from exception, or by taking an exception, then an `ISB` is not required.

Updating an MPU Region Using Multi-Word Writes

The MPU can be programmed directly using multi-word writes, depending how the information is divided. Consider the following reprogramming:

```
; R1 = region number
; R2 = address
; R3 = size, attributes in one
LDR R0, =MPUNUMBER ; 0xE000ED98, MPU region number register
STR R1, [R0, #0x0] ; Region Number
STR R2, [R0, #0x4] ; Region Base Address
STR R3, [R0, #0x8] ; Region Attribute, Size and Enable
```

An `STM` instruction can be used to optimize this:

```
; R1 = region number
; R2 = address
; R3 = size, attributes in one
LDR R0, =MPUNUMBER ; 0xE000ED98, MPU region number register
STM R0, {R1-R3} ; Region number, address, attribute, size and enable
```

This operation can be done in two words for pre-packed information, meaning that the **MPU Region Base Address (MPUBASE)** register (see page 164) contains the required region number and has the `VALID` bit set. This method can be used when the data is statically packed, for example in a boot loader:

```
; R1 = address and region number in one
; R2 = size and attributes in one
LDR R0, =MPUBASE ; 0xE000ED9C, MPU Region Base register
STR R1, [R0, #0x0] ; Region base address and region number combined
; with VALID (bit 4) set
STR R2, [R0, #0x4] ; Region Attribute, Size and Enable
```

Subregions

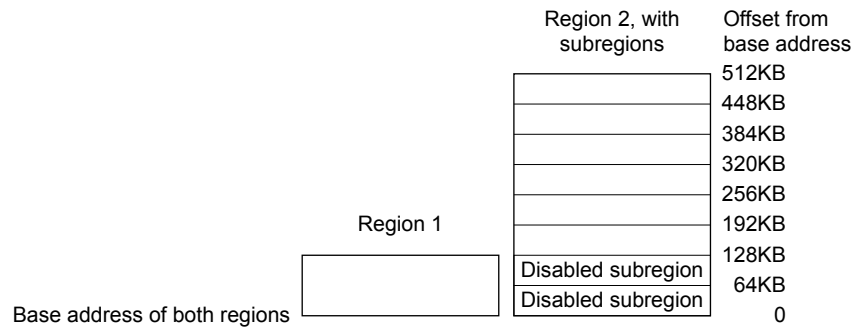
Regions of 256 bytes or more are divided into eight equal-sized subregions. Set the corresponding bit in the `SRD` field of the **MPU Region Attribute and Size (MPUATTR)** register (see page 166) to disable a subregion. The least-significant bit of the `SRD` field controls the first subregion, and the most-significant bit controls the last subregion. Disabling a subregion means another region overlapping the disabled range matches instead. If no other enabled region overlaps the disabled subregion, the MPU issues a fault.

Regions of 32, 64, and 128 bytes do not support subregions. With regions of these sizes, the `SRD` field must be configured to `0x00`, otherwise the MPU behavior is unpredictable.

Example of SRD Use

Two regions with the same base address overlap. Region one is 128 KB, and region two is 512 KB. To ensure the attributes from region one apply to the first 128 KB region, configure the `SRD` field for region two to 0x03 to disable the first two subregions, as Figure 3-1 on page 109 shows.

Figure 3-1. SRD Use Example



3.1.4.2 MPU Access Permission Attributes

The access permission bits, `TEX`, `S`, `C`, `B`, `AP`, and `XN` of the `MPUATTR` register, control access to the corresponding memory region. If an access is made to an area of memory without the required permissions, then the MPU generates a permission fault.

Table 3-3 on page 109 shows the encodings for the `TEX`, `C`, `B`, and `S` access permission bits. All encodings are shown for completeness, however the current implementation of the Cortex-M3 does not support the concept of cacheability or shareability. Refer to the section called “MPU Configuration for a Stellaris Microcontroller” on page 110 for information on programming the MPU for Stellaris implementations.

Table 3-3. TEX, S, C, and B Bit Field Encoding

| TEX | S | C | B | Memory Type | Shareability | Other Attributes |
|------|----------------|---|----------------|-------------------|---------------|--|
| 000b | x ^a | 0 | 0 | Strongly Ordered | Shareable | - |
| 000 | x ^a | 0 | 1 | Device | Shareable | - |
| 000 | 0 | 1 | 0 | Normal | Not shareable | Outer and inner write-through. No write allocate. |
| 000 | 1 | 1 | 0 | Normal | Shareable | |
| 000 | 0 | 1 | 1 | Normal | Not shareable | |
| 000 | 1 | 1 | 1 | Normal | Shareable | |
| 001 | 0 | 0 | 0 | Normal | Not shareable | Outer and inner noncacheable. |
| 001 | 1 | 0 | 0 | Normal | Shareable | |
| 001 | x ^a | 0 | 1 | Reserved encoding | - | - |
| 001 | x ^a | 1 | 0 | Reserved encoding | - | - |
| 001 | 0 | 1 | 1 | Normal | Not shareable | Outer and inner write-back. Write and read allocate. |
| 001 | 1 | 1 | 1 | Normal | Shareable | |
| 010 | x ^a | 0 | 0 | Device | Not shareable | Nonshared Device. |
| 010 | x ^a | 0 | 1 | Reserved encoding | - | - |
| 010 | x ^a | 1 | x ^a | Reserved encoding | - | - |

Table 3-3. TEX, S, C, and B Bit Field Encoding (continued)

| TEX | S | C | B | Memory Type | Shareability | Other Attributes |
|-----|---|---|---|-------------|---------------|--|
| 1BB | 0 | A | A | Normal | Not shareable | Cached memory (BB = outer policy, AA = inner policy). See Table 3-4 for the encoding of the AA and BB bits. |
| 1BB | 1 | A | A | Normal | Shareable | |

a. The MPU ignores the value of this bit.

Table 3-4 on page 110 shows the cache policy for memory attribute encodings with a `TEX` value in the range of 0x4-0x7.

Table 3-4. Cache Policy for Memory Attribute Encoding

| Encoding, AA or BB | Corresponding Cache Policy |
|--------------------|-------------------------------------|
| 00 | Non-cacheable |
| 01 | Write back, write and read allocate |
| 10 | Write through, no write allocate |
| 11 | Write back, no write allocate |

Table 3-5 on page 110 shows the `AP` encodings in the `MPUATTR` register that define the access permissions for privileged and unprivileged software.

Table 3-5. AP Bit Field Encoding

| AP Bit Field | Privileged Permissions | Unprivileged Permissions | Description |
|--------------|------------------------|--------------------------|--|
| 000 | No access | No access | All accesses generate a permission fault. |
| 001 | R/W | No access | Access from privileged software only. |
| 010 | R/W | RO | Writes by unprivileged software generate a permission fault. |
| 011 | R/W | R/W | Full access. |
| 100 | Unpredictable | Unpredictable | Reserved. |
| 101 | RO | No access | Reads by privileged software only. |
| 110 | RO | RO | Read-only, by privileged or unprivileged software. |
| 111 | RO | RO | Read-only, by privileged or unprivileged software. |

MPU Configuration for a Stellaris Microcontroller

Stellaris microcontrollers have only a single processor and no caches. As a result, the MPU should be programmed as shown in Table 3-6 on page 110.

Table 3-6. Memory Region Attributes for Stellaris Microcontrollers

| Memory Region | TEX | S | C | B | Memory Type and Attributes |
|---------------|------|---|---|---|--|
| Flash memory | 000b | 0 | 1 | 0 | Normal memory, non-shareable, write-through |
| Internal SRAM | 000b | 1 | 1 | 0 | Normal memory, shareable, write-through |
| External SRAM | 000b | 1 | 1 | 1 | Normal memory, shareable, write-back, write-allocate |
| Peripherals | 000b | 1 | 0 | 1 | Device memory, shareable |

In current Stellaris microcontroller implementations, the shareability and cache policy attributes do not affect the system behavior. However, using these settings for the MPU regions can make the application code more portable. The values given are for typical situations.

3.1.4.3 MPU Mismatch

When an access violates the MPU permissions, the processor generates a memory management fault (see “Exceptions and Interrupts” on page 79 for more information). The **MFAULTSTAT** register indicates the cause of the fault. See page 151 for more information.

3.2 Register Map

Table 3-7 on page 111 lists the Cortex-M3 Peripheral SysTick, NVIC, MPU and SCB registers. The offset listed is a hexadecimal increment to the register's address, relative to the Core Peripherals base address of 0xE000.E000.

Note: Register spaces that are not used are reserved for future or internal use. Software should not modify any reserved memory address.

Table 3-7. Peripherals Register Map

| Offset | Name | Type | Reset | Description | See page |
|--|-----------|------|-------------|-------------------------------------|----------|
| System Timer (SysTick) Registers | | | | | |
| 0x010 | STCTRL | R/W | 0x0000.0004 | SysTick Control and Status Register | 114 |
| 0x014 | STRELOAD | R/W | 0x0000.0000 | SysTick Reload Value Register | 116 |
| 0x018 | STCURRENT | R/WC | 0x0000.0000 | SysTick Current Value Register | 117 |
| Nested Vectored Interrupt Controller (NVIC) Registers | | | | | |
| 0x100 | EN0 | R/W | 0x0000.0000 | Interrupt 0-31 Set Enable | 118 |
| 0x104 | EN1 | R/W | 0x0000.0000 | Interrupt 32-54 Set Enable | 119 |
| 0x180 | DIS0 | R/W | 0x0000.0000 | Interrupt 0-31 Clear Enable | 120 |
| 0x184 | DIS1 | R/W | 0x0000.0000 | Interrupt 32-54 Clear Enable | 121 |
| 0x200 | PEND0 | R/W | 0x0000.0000 | Interrupt 0-31 Set Pending | 122 |
| 0x204 | PEND1 | R/W | 0x0000.0000 | Interrupt 32-54 Set Pending | 123 |
| 0x280 | UNPEND0 | R/W | 0x0000.0000 | Interrupt 0-31 Clear Pending | 124 |
| 0x284 | UNPEND1 | R/W | 0x0000.0000 | Interrupt 32-54 Clear Pending | 125 |
| 0x300 | ACTIVE0 | RO | 0x0000.0000 | Interrupt 0-31 Active Bit | 126 |
| 0x304 | ACTIVE1 | RO | 0x0000.0000 | Interrupt 32-54 Active Bit | 127 |
| 0x400 | PRI0 | R/W | 0x0000.0000 | Interrupt 0-3 Priority | 128 |
| 0x404 | PRI1 | R/W | 0x0000.0000 | Interrupt 4-7 Priority | 128 |
| 0x408 | PRI2 | R/W | 0x0000.0000 | Interrupt 8-11 Priority | 128 |
| 0x40C | PRI3 | R/W | 0x0000.0000 | Interrupt 12-15 Priority | 128 |
| 0x410 | PRI4 | R/W | 0x0000.0000 | Interrupt 16-19 Priority | 128 |

Table 3-7. Peripherals Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|---|------------|-------|-------------|---|----------|
| 0x414 | PRI5 | R/W | 0x0000.0000 | Interrupt 20-23 Priority | 128 |
| 0x418 | PRI6 | R/W | 0x0000.0000 | Interrupt 24-27 Priority | 128 |
| 0x41C | PRI7 | R/W | 0x0000.0000 | Interrupt 28-31 Priority | 128 |
| 0x420 | PRI8 | R/W | 0x0000.0000 | Interrupt 32-35 Priority | 128 |
| 0x424 | PRI9 | R/W | 0x0000.0000 | Interrupt 36-39 Priority | 128 |
| 0x428 | PRI10 | R/W | 0x0000.0000 | Interrupt 40-43 Priority | 128 |
| 0x42C | PRI11 | R/W | 0x0000.0000 | Interrupt 44-47 Priority | 128 |
| 0x430 | PRI12 | R/W | 0x0000.0000 | Interrupt 48-51 Priority | 128 |
| 0x434 | PRI13 | R/W | 0x0000.0000 | Interrupt 52-54 Priority | 128 |
| 0xF00 | SWTRIG | WO | 0x0000.0000 | Software Trigger Interrupt | 130 |
| System Control Block (SCB) Registers | | | | | |
| 0x008 | ACTLR | R/W | 0x0000.0000 | Auxiliary Control | 131 |
| 0xD00 | CPUID | RO | 0x412F.C230 | CPU ID Base | 133 |
| 0xD04 | INTCTRL | R/W | 0x0000.0000 | Interrupt Control and State | 134 |
| 0xD08 | VTABLE | R/W | 0x0000.0000 | Vector Table Offset | 137 |
| 0xD0C | APINT | R/W | 0xFA05.0000 | Application Interrupt and Reset Control | 138 |
| 0xD10 | SYSCTRL | R/W | 0x0000.0000 | System Control | 140 |
| 0xD14 | CFGCTRL | R/W | 0x0000.0200 | Configuration and Control | 142 |
| 0xD18 | SYSPRI1 | R/W | 0x0000.0000 | System Handler Priority 1 | 144 |
| 0xD1C | SYSPRI2 | R/W | 0x0000.0000 | System Handler Priority 2 | 145 |
| 0xD20 | SYSPRI3 | R/W | 0x0000.0000 | System Handler Priority 3 | 146 |
| 0xD24 | SYSHNDCTRL | R/W | 0x0000.0000 | System Handler Control and State | 147 |
| 0xD28 | FAULTSTAT | R/W1C | 0x0000.0000 | Configurable Fault Status | 151 |
| 0xD2C | HFAULTSTAT | R/W1C | 0x0000.0000 | Hard Fault Status | 157 |
| 0xD34 | MMADDR | R/W | - | Memory Management Fault Address | 158 |
| 0xD38 | FAULTADDR | R/W | - | Bus Fault Address | 159 |
| Memory Protection Unit (MPU) Registers | | | | | |
| 0xD90 | MPUTYPE | RO | 0x0000.0800 | MPU Type | 160 |
| 0xD94 | MPUCTRL | R/W | 0x0000.0000 | MPU Control | 161 |
| 0xD98 | MPUNUMBER | R/W | 0x0000.0000 | MPU Region Number | 163 |
| 0xD9C | MPUBASE | R/W | 0x0000.0000 | MPU Region Base Address | 164 |
| 0xDA0 | MPUATTR | R/W | 0x0000.0000 | MPU Region Attribute and Size | 166 |

Table 3-7. Peripherals Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|----------|------|-------------|---------------------------------------|----------|
| 0xDA4 | MPUBASE1 | R/W | 0x0000.0000 | MPU Region Base Address Alias 1 | 164 |
| 0xDA8 | MPUATTR1 | R/W | 0x0000.0000 | MPU Region Attribute and Size Alias 1 | 166 |
| 0xDAC | MPUBASE2 | R/W | 0x0000.0000 | MPU Region Base Address Alias 2 | 164 |
| 0xDB0 | MPUATTR2 | R/W | 0x0000.0000 | MPU Region Attribute and Size Alias 2 | 166 |
| 0xDB4 | MPUBASE3 | R/W | 0x0000.0000 | MPU Region Base Address Alias 3 | 164 |
| 0xDB8 | MPUATTR3 | R/W | 0x0000.0000 | MPU Region Attribute and Size Alias 3 | 166 |

3.3 System Timer (SysTick) Register Descriptions

This section lists and describes the System Timer registers, in numerical order by address offset.

Register 1: SysTick Control and Status Register (STCTRL), offset 0x010

Note: This register can only be accessed from privileged mode.

The SysTick **STCTRL** register enables the SysTick features.

SysTick Control and Status Register (STCTRL)

Base 0xE000.E000

Offset 0x010

Type R/W, reset 0x0000.0004

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|---------|-------|--------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | COUNT | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | CLK_SRC | INTEN | ENABLE | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|--|------|-------|--|-------|-------------|---|--|---|---|
| 31:17 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 16 | COUNT | RO | 0 | Count Flag <table border="0" style="margin-left: 20px;"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>The SysTick timer has not counted to 0 since the last time this bit was read.</td> </tr> <tr> <td>1</td> <td>The SysTick timer has counted to 0 since the last time this bit was read.</td> </tr> </table> <p>This bit is cleared by a read of the register or if the STCURRENT register is written with any value.</p> <p>If read by the debugger using the DAP, this bit is cleared only if the MasterType bit in the AHB-AP Control Register is clear. Otherwise, the COUNT bit is not changed by the debugger read. See the <i>ARM® Debug Interface V5 Architecture Specification</i> for more information on MasterType.</p> | Value | Description | 0 | The SysTick timer has not counted to 0 since the last time this bit was read. | 1 | The SysTick timer has counted to 0 since the last time this bit was read. |
| Value | Description | | | | | | | | | |
| 0 | The SysTick timer has not counted to 0 since the last time this bit was read. | | | | | | | | | |
| 1 | The SysTick timer has counted to 0 since the last time this bit was read. | | | | | | | | | |
| 15:3 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 2 | CLK_SRC | R/W | 1 | Clock Source <table border="0" style="margin-left: 20px;"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>External reference clock. (Not implemented for most Stellaris microcontrollers.)</td> </tr> <tr> <td>1</td> <td>System clock</td> </tr> </table> <p>Because an external reference clock is not implemented, this bit must be set in order for SysTick to operate.</p> | Value | Description | 0 | External reference clock. (Not implemented for most Stellaris microcontrollers.) | 1 | System clock |
| Value | Description | | | | | | | | | |
| 0 | External reference clock. (Not implemented for most Stellaris microcontrollers.) | | | | | | | | | |
| 1 | System clock | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 1 | INTEN | R/W | 0 | Interrupt Enable Value Description 0 Interrupt generation is disabled. Software can use the <code>COUNT</code> bit to determine if the counter has ever reached 0. 1 An interrupt is generated to the NVIC when SysTick counts to 0. |
| 0 | ENABLE | R/W | 0 | Enable Value Description 0 The counter is disabled. 1 Enables SysTick to operate in a multi-shot way. That is, the counter loads the <code>RELOAD</code> value and begins counting down. On reaching 0, the <code>COUNT</code> bit is set and an interrupt is generated if enabled by <code>INTEN</code> . The counter then loads the <code>RELOAD</code> value again and begins counting. |

Register 2: SysTick Reload Value Register (STRELOAD), offset 0x014

Note: This register can only be accessed from privileged mode.

The **STRELOAD** register specifies the start value to load into the **SysTick Current Value (STCURRENT)** register when the counter reaches 0. The start value can be between 0x1 and 0x00FF.FFFF. A start value of 0 is possible but has no effect because the SysTick interrupt and the **COUNT** bit are activated when counting from 1 to 0.

SysTick can be configured as a multi-shot timer, repeated over and over, firing every N+1 clock pulses, where N is any value from 1 to 0x00FF.FFFF. For example, if a tick interrupt is required every 100 clock pulses, 99 must be written into the **RELOAD** field.

SysTick Reload Value Register (STRELOAD)

Base 0xE000.E000

Offset 0x014

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|--------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | RELOAD | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | RELOAD | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:24 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 23:0 | RELOAD | R/W | 0x00.0000 | Reload Value Value to load into the SysTick Current Value (STCURRENT) register when the counter reaches 0. |

Register 3: SysTick Current Value Register (STCURRENT), offset 0x018

Note: This register can only be accessed from privileged mode.

The **STCURRENT** register contains the current value of the SysTick counter.

SysTick Current Value Register (STCURRENT)

Base 0xE000.E000

Offset 0x018

Type R/WC, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|------|------|------|------|------|------|------|---------|------|------|------|------|------|------|------|
| | reserved | | | | | | | | CURRENT | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | CURRENT | | | | | | | | | | | | | | | |
| Type | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC | R/WC |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|--|
| 31:24 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 23:0 | CURRENT | R/WC | 0x00.0000 | Current Value This field contains the current value at the time the register is accessed. No read-modify-write protection is provided, so change with care. This register is write-clear. Writing to it with any value clears the register. Clearing this register also clears the COUNT bit of the STCTRL register. |

3.4 NVIC Register Descriptions

This section lists and describes the NVIC registers, in numerical order by address offset.

The NVIC registers can only be fully accessed from privileged mode, but interrupts can be pended while in unprivileged mode by enabling the **Configuration and Control (CFGCTRL)** register. Any other unprivileged mode access causes a bus fault.

Ensure software uses correctly aligned register accesses. The processor does not support unaligned accesses to NVIC registers.

An interrupt can enter the pending state even if it is disabled.

Before programming the **VTABLE** register to relocate the vector table, ensure the vector table entries of the new vector table are set up for fault handlers, NMI, and all enabled exceptions such as interrupts. For more information, see page 137.

Register 4: Interrupt 0-31 Set Enable (EN0), offset 0x100

Note: This register can only be accessed from privileged mode.

See Table 2-9 on page 91 for interrupt assignments.

If a pending interrupt is enabled, the NVIC activates the interrupt based on its priority. If an interrupt is not enabled, asserting its interrupt signal changes the interrupt state to pending, but the NVIC never activates the interrupt, regardless of its priority.

Interrupt 0-31 Set Enable (EN0)

Base 0xE000.E000

Offset 0x100

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|------------------|
| 31:0 | INT | R/W | 0x0000.0000 | Interrupt Enable |

| Value | Description |
|-------|--|
| 0 | On a read, indicates the interrupt is disabled. On a write, no effect. |
| 1 | On a read, indicates the interrupt is enabled. On a write, enables the interrupt. |

A bit can only be cleared by setting the corresponding `INT[n]` bit in the `DISn` register.

Register 5: Interrupt 32-54 Set Enable (EN1), offset 0x104

Note: This register can only be accessed from privileged mode.

The **EN1** register enables interrupts and shows which interrupts are enabled. Bit 0 corresponds to Interrupt 32; bit 22 corresponds to Interrupt 54. See Table 2-9 on page 91 for interrupt assignments.

If a pending interrupt is enabled, the NVIC activates the interrupt based on its priority. If an interrupt is not enabled, asserting its interrupt signal changes the interrupt state to pending, but the NVIC never activates the interrupt, regardless of its priority.

Interrupt 32-54 Set Enable (EN1)

Base 0xE000.E000

Offset 0x104

Type R/W, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | reserved | | | | | | | | | INT | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|--|-----------|---|
| 31:23 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 22:0 | INT | R/W | 0x00.0000 | Interrupt Enable |
| | Value | Description | | |
| | 0 | On a read, indicates the interrupt is disabled. On a write, no effect. | | |
| | 1 | On a read, indicates the interrupt is enabled. On a write, enables the interrupt. | | |

A bit can only be cleared by setting the corresponding `INT[n]` bit in the **DIS1** register.

Register 6: Interrupt 0-31 Clear Enable (DIS0), offset 0x180**Note:** This register can only be accessed from privileged mode.

See Table 2-9 on page 91 for interrupt assignments.

Interrupt 0-31 Clear Enable (DIS0)

Base 0xE000.E000

Offset 0x180

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|-------------------|
| 31:0 | INT | R/W | 0x0000.0000 | Interrupt Disable |

Value Description

0 On a read, indicates the interrupt is disabled.
On a write, no effect.

1 On a read, indicates the interrupt is enabled.
On a write, clears the corresponding `INT[n]` bit in the **EN0** register, disabling interrupt [n].

Register 7: Interrupt 32-54 Clear Enable (DIS1), offset 0x184

Note: This register can only be accessed from privileged mode.

The **DIS1** register disables interrupts. Bit 0 corresponds to Interrupt 32; bit 22 corresponds to Interrupt 54. See Table 2-9 on page 91 for interrupt assignments.

Interrupt 32-54 Clear Enable (DIS1)

Base 0xE000.E000

Offset 0x184

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | INT | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:23 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| | | | | |
|------|-----|-----|-----------|-------------------|
| 22:0 | INT | R/W | 0x00.0000 | Interrupt Disable |
|------|-----|-----|-----------|-------------------|

Value Description

| | |
|---|---|
| 0 | On a read, indicates the interrupt is disabled. |
|---|---|

| | |
|--|------------------------|
| | On a write, no effect. |
|--|------------------------|

| | |
|---|--|
| 1 | On a read, indicates the interrupt is enabled. |
|---|--|

| | |
|--|---|
| | On a write, clears the corresponding <code>INT[n]</code> bit in the EN1 register, disabling interrupt [n]. |
|--|---|

Register 8: Interrupt 0-31 Set Pending (PEND0), offset 0x200**Note:** This register can only be accessed from privileged mode.

See Table 2-9 on page 91 for interrupt assignments.

Interrupt 0-31 Set Pending (PEND0)

Base 0xE000.E000

Offset 0x200

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|-----------------------|
| 31:0 | INT | R/W | 0x0000.0000 | Interrupt Set Pending |

| Value | Description |
|-------|--|
| 0 | On a read, indicates that the interrupt is not pending. On a write, no effect. |
| 1 | On a read, indicates that the interrupt is pending. On a write, the corresponding interrupt is set to pending even if it is disabled. |

If the corresponding interrupt is already pending, setting a bit has no effect.

A bit can only be cleared by setting the corresponding `INT[n]` bit in the **UNPEND0** register.

Register 9: Interrupt 32-54 Set Pending (PEND1), offset 0x204

Note: This register can only be accessed from privileged mode.

The **PEND1** register forces interrupts into the pending state and shows which interrupts are pending. Bit 0 corresponds to Interrupt 32; bit 22 corresponds to Interrupt 54. See Table 2-9 on page 91 for interrupt assignments.

Interrupt 32-54 Set Pending (PEND1)

Base 0xE000.E000

Offset 0x204

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | INT | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:23 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 22:0 | INT | R/W | 0x00.0000 | Interrupt Set Pending |

| Value | Description |
|-------|--|
| 0 | On a read, indicates that the interrupt is not pending. On a write, no effect. |
| 1 | On a read, indicates that the interrupt is pending. On a write, the corresponding interrupt is set to pending even if it is disabled. |

If the corresponding interrupt is already pending, setting a bit has no effect.

A bit can only be cleared by setting the corresponding `INT[n]` bit in the **UNPEND1** register.

Register 10: Interrupt 0-31 Clear Pending (UNPEND0), offset 0x280**Note:** This register can only be accessed from privileged mode.

See Table 2-9 on page 91 for interrupt assignments.

Interrupt 0-31 Clear Pending (UNPEND0)

Base 0xE000.E000

Offset 0x280

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|-------------------------|
| 31:0 | INT | R/W | 0x0000.0000 | Interrupt Clear Pending |

Value Description

0 On a read, indicates that the interrupt is not pending.
On a write, no effect.

1 On a read, indicates that the interrupt is pending.
On a write, clears the corresponding `INT[n]` bit in the **PEND0** register, so that interrupt [n] is no longer pending.
Setting a bit does not affect the active state of the corresponding interrupt.

Register 11: Interrupt 32-54 Clear Pending (UNPEND1), offset 0x284

Note: This register can only be accessed from privileged mode.

The **UNPEND1** register shows which interrupts are pending and removes the pending state from interrupts. Bit 0 corresponds to Interrupt 32; bit 22 corresponds to Interrupt 54. See Table 2-9 on page 91 for interrupt assignments.

Interrupt 32-54 Clear Pending (UNPEND1)

Base 0xE000.E000

Offset 0x284

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | INT | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:23 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 22:0 | INT | R/W | 0x00.0000 | Interrupt Clear Pending |

Value Description

0 On a read, indicates that the interrupt is not pending.
On a write, no effect.

1 On a read, indicates that the interrupt is pending.
On a write, clears the corresponding `INT[n]` bit in the **PEND1** register, so that interrupt [n] is no longer pending.
Setting a bit does not affect the active state of the corresponding interrupt.

Register 12: Interrupt 0-31 Active Bit (ACTIVE0), offset 0x300**Note:** This register can only be accessed from privileged mode.

See Table 2-9 on page 91 for interrupt assignments.

Caution – Do not manually set or clear the bits in this register.

Interrupt 0-31 Active Bit (ACTIVE0)

Base 0xE000.E000

Offset 0x300

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|-----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | INT | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INT | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|------------------|
| 31:0 | INT | RO | 0x0000.0000 | Interrupt Active |

Value Description

0 The corresponding interrupt is not active.

1 The corresponding interrupt is active, or active and pending.

Register 13: Interrupt 32-54 Active Bit (ACTIVE1), offset 0x304

Note: This register can only be accessed from privileged mode.

The **ACTIVE1** register indicates which interrupts are active. Bit 0 corresponds to Interrupt 32; bit 22 corresponds to Interrupt 54. See Table 2-9 on page 91 for interrupt assignments.

Caution – Do not manually set or clear the bits in this register.

Interrupt 32-54 Active Bit (ACTIVE1)

Base 0xE000.E000

Offset 0x304

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|-----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | INT | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INT | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:23 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 22:0 | INT | RO | 0x00.0000 | Interrupt Active |
| | | | | Value Description |
| | | | | 0 The corresponding interrupt is not active. |
| | | | | 1 The corresponding interrupt is active, or active and pending. |

- Register 14: Interrupt 0-3 Priority (PRI0), offset 0x400**
Register 15: Interrupt 4-7 Priority (PRI1), offset 0x404
Register 16: Interrupt 8-11 Priority (PRI2), offset 0x408
Register 17: Interrupt 12-15 Priority (PRI3), offset 0x40C
Register 18: Interrupt 16-19 Priority (PRI4), offset 0x410
Register 19: Interrupt 20-23 Priority (PRI5), offset 0x414
Register 20: Interrupt 24-27 Priority (PRI6), offset 0x418
Register 21: Interrupt 28-31 Priority (PRI7), offset 0x41C
Register 22: Interrupt 32-35 Priority (PRI8), offset 0x420
Register 23: Interrupt 36-39 Priority (PRI9), offset 0x424
Register 24: Interrupt 40-43 Priority (PRI10), offset 0x428
Register 25: Interrupt 44-47 Priority (PRI11), offset 0x42C
Register 26: Interrupt 48-51 Priority (PRI12), offset 0x430
Register 27: Interrupt 52-54 Priority (PRI13), offset 0x434

Note: This register can only be accessed from privileged mode.

The **PRIn** registers provide 3-bit priority fields for each interrupt. These registers are byte accessible. Each register holds four priority fields that are assigned to interrupts as follows:

| PRIn Register Bit Field | Interrupt |
|-------------------------|------------------|
| Bits 31:29 | Interrupt [4n+3] |
| Bits 23:21 | Interrupt [4n+2] |
| Bits 15:13 | Interrupt [4n+1] |
| Bits 7:5 | Interrupt [4n] |

See Table 2-9 on page 91 for interrupt assignments.

Each priority level can be split into separate group priority and subpriority fields. The **PRIGROUP** field in the **Application Interrupt and Reset Control (APINT)** register (see page 138) indicates the position of the binary point that splits the priority and subpriority fields.

These registers can only be accessed from privileged mode.

Interrupt 0-3 Priority (PRIO)

Base 0xE000.E000

Offset 0x400

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|------|-----|-----|----------|----|----|----|------|-----|-----|----------|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | INTD | | | reserved | | | | INTC | | | reserved | | | | | |
| Type | R/W | R/W | R/W | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INTB | | | reserved | | | | INTA | | | reserved | | | | | |
| Type | R/W | R/W | R/W | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:29 | INTD | R/W | 0x0 | Interrupt Priority for Interrupt [4n+3] This field holds a priority value, 0-7, for the interrupt with the number [4n+3], where n is the number of the Interrupt Priority register (n=0 for PRIO , and so on). The lower the value, the greater the priority of the corresponding interrupt. |
| 28:24 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 23:21 | INTC | R/W | 0x0 | Interrupt Priority for Interrupt [4n+2] This field holds a priority value, 0-7, for the interrupt with the number [4n+2], where n is the number of the Interrupt Priority register (n=0 for PRIO , and so on). The lower the value, the greater the priority of the corresponding interrupt. |
| 20:16 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:13 | INTB | R/W | 0x0 | Interrupt Priority for Interrupt [4n+1] This field holds a priority value, 0-7, for the interrupt with the number [4n+1], where n is the number of the Interrupt Priority register (n=0 for PRIO , and so on). The lower the value, the greater the priority of the corresponding interrupt. |
| 12:8 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:5 | INTA | R/W | 0x0 | Interrupt Priority for Interrupt [4n] This field holds a priority value, 0-7, for the interrupt with the number [4n], where n is the number of the Interrupt Priority register (n=0 for PRIO , and so on). The lower the value, the greater the priority of the corresponding interrupt. |
| 4:0 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 28: Software Trigger Interrupt (SWTRIG), offset 0xF00

Note: Only privileged software can enable unprivileged access to the **SWTRIG** register.

Writing an interrupt number to the **SWTRIG** register generates a Software Generated Interrupt (SGI). See Table 2-9 on page 91 for interrupt assignments.

When the **MAINPEND** bit in the **Configuration and Control (CFGCTRL)** register (see page 142) is set, unprivileged software can access the **SWTRIG** register.

Software Trigger Interrupt (SWTRIG)

Base 0xE000.E000
Offset 0xF00
Type WO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|-------|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | INTID | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | WO | WO | WO | WO | WO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:6 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5:0 | INTID | WO | 0x00 | Interrupt ID This field holds the interrupt ID of the required SGI. For example, a value of 0x3 generates an interrupt on IRQ3. |

3.5 System Control Block (SCB) Register Descriptions

This section lists and describes the System Control Block (SCB) registers, in numerical order by address offset. The SCB registers can only be accessed from privileged mode.

All registers must be accessed with aligned word accesses except for the **FAULTSTAT** and **SYSPRI1-SYSPRI3** registers, which can be accessed with byte or aligned halfword or word accesses. The processor does not support unaligned accesses to system control block registers.

Register 29: Auxiliary Control (ACTLR), offset 0x008

Note: This register can only be accessed from privileged mode.

The **ACTLR** register provides disable bits for **IT** folding, write buffer use for accesses to the default memory map, and interruption of multi-cycle instructions. By default, this register is set to provide optimum performance from the Cortex-M3 processor and does not normally require modification.

Auxiliary Control (ACTLR)

Base 0xE000.E000

Offset 0x008

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|---------|---------|---------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | DISFOLD | DISWBUF | DISMCYC | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:3 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | DISFOLD | R/W | 0 | Disable IT Folding Value Description 0 No effect. 1 Disables IT folding. In some situations, the processor can start executing the first instruction in an IT block while it is still executing the IT instruction. This behavior is called <i>IT folding</i> , and improves performance. However, IT folding can cause jitter in looping. If a task must avoid jitter, set the DISFOLD bit before executing the task, to disable IT folding. |
| 1 | DISWBUF | R/W | 0 | Disable Write Buffer Value Description 0 No effect. 1 Disables write buffer use during default memory map accesses. In this situation, all bus faults are precise bus faults but performance is decreased because any store to memory must complete before the processor can execute the next instruction. Note: This bit only affects write buffers implemented in the Cortex-M3 processor. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 0 | DISMCYC | R/W | 0 | Disable Interrupts of Multiple Cycle Instructions |
| | | | | Value Description |
| | | | | 0 No effect. |
| | | | | 1 Disables interruption of load multiple and store multiple instructions. In this situation, the interrupt latency of the processor is increased because any <i>LDM</i> or <i>STM</i> must complete before the processor can stack the current state and enter the interrupt handler. |

Register 30: CPU ID Base (CPUID), offset 0xD00

Note: This register can only be accessed from privileged mode.

The **CPUID** register contains the ARM® Cortex™-M3 processor part number, version, and implementation information.

CPU ID Base (CPUID)

Base 0xE000.E000

Offset 0xD00

Type RO, reset 0x412F.C230

| | | | | | | | | | | | | | | | | |
|-------|--------|----|----|----|----|----|----|----|-----|----|----|----|-----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | IMP | | | | | | | | VAR | | | | CON | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PARTNO | | | | | | | | | | | | REV | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 31:24 | IMP | RO | 0x41 | Implementer Code Value Description 0x41 ARM |
| 23:20 | VAR | RO | 0x2 | Variant Number Value Description 0x2 The rn value in the mpn product revision identifier, for example, the 2 in r2p0. |
| 19:16 | CON | RO | 0xF | Constant Value Description 0xF Always reads as 0xF. |
| 15:4 | PARTNO | RO | 0xC23 | Part Number Value Description 0xC23 Cortex-M3 processor. |
| 3:0 | REV | RO | 0x0 | Revision Number Value Description 0x0 The pn value in the mpn product revision identifier, for example, the 0 in r2p0. |

Register 31: Interrupt Control and State (INTCTRL), offset 0xD04

Note: This register can only be accessed from privileged mode.

The **INCTRL** register provides a set-pending bit for the NMI exception, and set-pending and clear-pending bits for the PendSV and SysTick exceptions. In addition, bits in this register indicate the exception number of the exception being processed, whether there are preempted active exceptions, the exception number of the highest priority pending exception, and whether any interrupts are pending.

When writing to **INCTRL**, the effect is unpredictable when writing a 1 to both the **PENDSV** and **UNPENDSV** bits, or writing a 1 to both the **PENDSTSET** and **PENDSTCLR** bits.

Interrupt Control and State (INTCTRL)

Base 0xE000.E000

Offset 0xD04

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|---------|----------|----|--------|----------|-----------|-----------|----------|--------|---------|----------|----|----|---------|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | NMISSET | reserved | | PENDSV | UNPENDSV | PENDSTSET | PENDSTCLR | reserved | ISRPRE | ISRPEND | reserved | | | VECPEND | | |
| Type | R/W | RO | RO | R/W | WO | R/W | WO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | VECPEND | | | | RETBASE | reserved | | | | | VECACT | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|-------------|
|-----------|------|------|-------|-------------|

| | | | | |
|----|---------|-----|---|-----------------|
| 31 | NMISSET | R/W | 0 | NMI Set Pending |
|----|---------|-----|---|-----------------|

Value Description

| | |
|---|---|
| 0 | On a read, indicates an NMI exception is not pending. |
|---|---|

| |
|------------------------|
| On a write, no effect. |
|------------------------|

| | |
|---|---|
| 1 | On a read, indicates an NMI exception is pending. |
|---|---|

| |
|---|
| On a write, changes the NMI exception state to pending. |
|---|

Because NMI is the highest-priority exception, normally the processor enters the NMI exception handler as soon as it registers the setting of this bit, and clears this bit on entering the interrupt handler. A read of this bit by the NMI exception handler returns 1 only if the **NMI** signal is reasserted while the processor is executing that handler.

| | | | | |
|-------|----------|----|-----|---|
| 30:29 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
|-------|----------|----|-----|---|

| | | | | |
|----|--------|-----|---|--------------------|
| 28 | PENDSV | R/W | 0 | PendSV Set Pending |
|----|--------|-----|---|--------------------|

Value Description

| | |
|---|---|
| 0 | On a read, indicates a PendSV exception is not pending. |
|---|---|

| |
|------------------------|
| On a write, no effect. |
|------------------------|

| | |
|---|---|
| 1 | On a read, indicates a PendSV exception is pending. |
|---|---|

| |
|--|
| On a write, changes the PendSV exception state to pending. |
|--|

Setting this bit is the only way to set the PendSV exception state to pending. This bit is cleared by writing a 1 to the **UNPENDSV** bit.

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|--|
| 27 | UNPENDSV | WO | 0 | <p>PendSV Clear Pending</p> <p>Value Description</p> <p>0 On a write, no effect.</p> <p>1 On a write, removes the pending state from the PendSV exception.</p> <p>This bit is write only; on a register read, its value is unknown.</p> |
| 26 | PENDSTSET | R/W | 0 | <p>SysTick Set Pending</p> <p>Value Description</p> <p>0 On a read, indicates a SysTick exception is not pending. On a write, no effect.</p> <p>1 On a read, indicates a SysTick exception is pending. On a write, changes the SysTick exception state to pending.</p> <p>This bit is cleared by writing a 1 to the PENDSTCLR bit.</p> |
| 25 | PENDSTCLR | WO | 0 | <p>SysTick Clear Pending</p> <p>Value Description</p> <p>0 On a write, no effect.</p> <p>1 On a write, removes the pending state from the SysTick exception.</p> <p>This bit is write only; on a register read, its value is unknown.</p> |
| 24 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 23 | ISRPRE | RO | 0 | <p>Debug Interrupt Handling</p> <p>Value Description</p> <p>0 The release from halt does not take an interrupt.</p> <p>1 The release from halt takes an interrupt.</p> <p>This bit is only meaningful in Debug mode and reads as zero when the processor is not in Debug mode.</p> |
| 22 | ISRPEND | RO | 0 | <p>Interrupt Pending</p> <p>Value Description</p> <p>0 No interrupt is pending.</p> <p>1 An interrupt is pending.</p> <p>This bit provides status for all interrupts excluding NMI and Faults.</p> |
| 21:19 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|--|------|-------|--|-------|-------------|------|---|------|--|------|-----|------|------------|------|-------------------------|------|-----------|------|-------------|-----------|----------|------|--------|------|--------------------|------|----------|------|--------|------|---------|------|--------------------|------|--------------------|-----|-----|------|---------------------|-----------|----------|
| 18:12 | VECPEND | RO | 0x00 | <p>Interrupt Pending Vector Number</p> <p>This field contains the exception number of the highest priority pending enabled exception. The value indicated by this field includes the effect of the BASEPRI and FAULTMASK registers, but not any effect of the PRIMASK register.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>0x00</td><td>No exceptions are pending</td></tr> <tr><td>0x01</td><td>Reserved</td></tr> <tr><td>0x02</td><td>NMI</td></tr> <tr><td>0x03</td><td>Hard fault</td></tr> <tr><td>0x04</td><td>Memory management fault</td></tr> <tr><td>0x05</td><td>Bus fault</td></tr> <tr><td>0x06</td><td>Usage fault</td></tr> <tr><td>0x07-0x0A</td><td>Reserved</td></tr> <tr><td>0x0B</td><td>SVCall</td></tr> <tr><td>0x0C</td><td>Reserved for Debug</td></tr> <tr><td>0x0D</td><td>Reserved</td></tr> <tr><td>0x0E</td><td>PendSV</td></tr> <tr><td>0x0F</td><td>SysTick</td></tr> <tr><td>0x10</td><td>Interrupt Vector 0</td></tr> <tr><td>0x11</td><td>Interrupt Vector 1</td></tr> <tr><td>...</td><td>...</td></tr> <tr><td>0x46</td><td>Interrupt Vector 54</td></tr> <tr><td>0x47-0x7F</td><td>Reserved</td></tr> </tbody> </table> | Value | Description | 0x00 | No exceptions are pending | 0x01 | Reserved | 0x02 | NMI | 0x03 | Hard fault | 0x04 | Memory management fault | 0x05 | Bus fault | 0x06 | Usage fault | 0x07-0x0A | Reserved | 0x0B | SVCall | 0x0C | Reserved for Debug | 0x0D | Reserved | 0x0E | PendSV | 0x0F | SysTick | 0x10 | Interrupt Vector 0 | 0x11 | Interrupt Vector 1 | ... | ... | 0x46 | Interrupt Vector 54 | 0x47-0x7F | Reserved |
| Value | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x00 | No exceptions are pending | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x01 | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x02 | NMI | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x03 | Hard fault | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x04 | Memory management fault | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x05 | Bus fault | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x06 | Usage fault | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x07-0x0A | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0B | SVCall | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0C | Reserved for Debug | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0D | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0E | PendSV | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0F | SysTick | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x10 | Interrupt Vector 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x11 | Interrupt Vector 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ... | ... | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x46 | Interrupt Vector 54 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x47-0x7F | Reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | RETBASE | RO | 0 | <p>Return to Base</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>0</td><td>There are preempted active exceptions to execute.</td></tr> <tr><td>1</td><td>There are no active exceptions, or the currently executing exception is the only active exception.</td></tr> </tbody> </table> <p>This bit provides status for all interrupts excluding NMI and Faults. This bit only has meaning if the processor is currently executing an ISR (the Interrupt Program Status (IPSR) register is non-zero).</p> | Value | Description | 0 | There are preempted active exceptions to execute. | 1 | There are no active exceptions, or the currently executing exception is the only active exception. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Value | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0 | There are preempted active exceptions to execute. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 | There are no active exceptions, or the currently executing exception is the only active exception. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10:7 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 6:0 | VECACT | RO | 0x00 | <p>Interrupt Pending Vector Number</p> <p>This field contains the active exception number. The exception numbers can be found in the description for the VECPEND field. If this field is clear, the processor is in Thread mode. This field contains the same value as the ISRNUM field in the IPSR register.</p> <p>Subtract 16 from this value to obtain the IRQ number required to index into the Interrupt Set Enable (ENn), Interrupt Clear Enable (DISn), Interrupt Set Pending (PENDn), Interrupt Clear Pending (UNPENDn), and Interrupt Priority (PRIn) registers (see page 71).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Register 32: Vector Table Offset (VTABLE), offset 0xD08

Note: This register can only be accessed from privileged mode.

The **VTABLE** register indicates the offset of the vector table base address from memory address 0x0000.0000.

Vector Table Offset (VTABLE)

Base 0xE000.E000

Offset 0xD08

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|------|--------|-----|-----|-----|----------|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | BASE | OFFSET | | | | | | | | | | | | |
| Type | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | OFFSET | | | | | | | reserved | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:30 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 29 | BASE | R/W | 0 | Vector Table Base Value Description 0 The vector table is in the code memory region. 1 The vector table is in the SRAM memory region. |
| 28:9 | OFFSET | R/W | 0x000.00 | Vector Table Offset When configuring the <i>OFFSET</i> field, the offset must be aligned to the number of exception entries in the vector table. Because there are 54 interrupts, the offset must be aligned on a 512-byte boundary. |
| 8:0 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 33: Application Interrupt and Reset Control (APINT), offset 0xD0C

Note: This register can only be accessed from privileged mode.

The **APINT** register provides priority grouping control for the exception model, endian status for data accesses, and reset control of the system. To write to this register, 0x05FA must be written to the **VECTKEY** field, otherwise the write is ignored.

The **PRIGROUP** field indicates the position of the binary point that splits the **INTx** fields in the **Interrupt Priority (PRIx)** registers into separate group priority and subpriority fields. Table 3-8 on page 138 shows how the **PRIGROUP** value controls this split. The bit numbers in the Group Priority Field and Subpriority Field columns in the table refer to the bits in the **INTA** field. For the **INTB** field, the corresponding bits are 15:13; for **INTC**, 23:21; and for **INTD**, 31:29.

Note: Determining preemption of an exception uses only the group priority field.

Table 3-8. Interrupt Priority Levels

| PRIGROUP Bit Field | Binary Point ^a | Group Priority Field | Subpriority Field | Group Priorities | Subpriorities |
|--------------------|---------------------------|----------------------|-------------------|------------------|---------------|
| 0x0 - 0x4 | bxxx. | [7:5] | None | 8 | 1 |
| 0x5 | bxx.y | [7:6] | [5] | 4 | 2 |
| 0x6 | bx.yy | [7] | [6:5] | 2 | 4 |
| 0x7 | b.yyy | None | [7:5] | 1 | 8 |

a. **INTx** field showing the binary point. An x denotes a group priority field bit, and a y denotes a subpriority field bit.

Application Interrupt and Reset Control (APINT)

Base 0xE000.E000

Offset 0xD0C

Type R/W, reset 0xFA05.0000

| | | | | | | | | | | | | | | | | |
|-------|-----------|----------|-----|-----|-----|----------|-----|-----|-----|----------|-----|-----|-----|-----------|-----------|-----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | VECTKEY | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | ENDIANESS | reserved | | | | PRIGROUP | | | | reserved | | | | SYSRESREQ | VECTLRACT | VECTRESET |
| Type | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | RO | RO | RO | RO | WO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|--------|---|
| 31:16 | VECTKEY | R/W | 0xFA05 | Register Key This field is used to guard against accidental writes to this register. 0x05FA must be written to this field in order to change the bits in this register. On a read, 0xFA05 is returned. |
| 15 | ENDIANESS | RO | 0 | Data Endianess The Stellaris implementation uses only little-endian mode so this is cleared to 0. |
| 14:11 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------------|------|-------|--|
| 10:8 | PRIGROUP | R/W | 0x0 | Interrupt Priority Grouping This field determines the split of group priority from subpriority (see Table 3-8 on page 138 for more information). |
| 7:3 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | SYSRESREQ | WO | 0 | System Reset Request Value Description 0 No effect. 1 Resets the core and all on-chip peripherals except the Debug interface. This bit is automatically cleared during the reset of the core and reads as 0. |
| 1 | VECTCLRACT | WO | 0 | Clear Active NMI / Fault This bit is reserved for Debug use and reads as 0. This bit must be written as a 0, otherwise behavior is unpredictable. |
| 0 | VECTRESET | WO | 0 | System Reset This bit is reserved for Debug use and reads as 0. This bit must be written as a 0, otherwise behavior is unpredictable. |

Register 34: System Control (SYSCTRL), offset 0xD10**Note:** This register can only be accessed from privileged mode.The **SYSCTRL** register controls features of entry to and exit from low-power state.

System Control (SYSCTRL)

Base 0xE000.E000

Offset 0xD10

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-----------|----------|-----------|-----------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | SEVONPEND | reserved | SLEEPDEEP | SLEEPEXIT | reserved |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | RO | R/W | R/W | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-----------|---|
| 31:5 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | SEVONPEND | R/W | 0 | Wake Up on Pending Value Description 0 Only enabled interrupts or events can wake up the processor; disabled interrupts are excluded. 1 Enabled events and all interrupts, including disabled interrupts, can wake up the processor. When an event or interrupt enters the pending state, the event signal wakes up the processor from <i>WFE</i> . If the processor is not waiting for an event, the event is registered and affects the next <i>WFE</i> . The processor also wakes up on execution of a <i>SEV</i> instruction or an external event. |
| 3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | SLEEPDEEP | R/W | 0 | Deep Sleep Enable Value Description 0 Use Sleep mode as the low power mode. 1 Use Deep-sleep mode as the low power mode. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|---|
| 1 | SLEEPEXIT | R/W | 0 | <p>Sleep on ISR Exit</p> <p>Value Description</p> <p>0 When returning from Handler mode to Thread mode, do not sleep when returning to Thread mode.</p> <p>1 When returning from Handler mode to Thread mode, enter sleep or deep sleep on return from an ISR.</p> <p>Setting this bit enables an interrupt-driven application to avoid returning to an empty main application.</p> |
| 0 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |

Register 35: Configuration and Control (CFGCTRL), offset 0xD14

Note: This register can only be accessed from privileged mode.

The **CFGCTRL** register controls entry to Thread mode and enables: the handlers for NMI, hard fault and faults escalated by the **FAULTMASK** register to ignore bus faults; trapping of divide by zero and unaligned accesses; and access to the **SWTRIG** register by unprivileged software (see page 130).

Configuration and Control (CFGCTRL)

Base 0xE000.E000

Offset 0xD14

Type R/W, reset 0x0000.0200

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----------|-----------|----------|----|----|-----|------|-----------|----------|----------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | STKALIGN | BFHFNMIGN | reserved | | | | DIV0 | UNALIGNED | reserved | MAINPEND | BASETHR |
| Type | RO | RO | RO | RO | RO | RO | R/W | R/W | RO | RO | RO | R/W | R/W | RO | R/W | R/W | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-----------|--|
| 31:10 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9 | STKALIGN | R/W | 1 | Stack Alignment on Exception Entry Value Description 0 The stack is 4-byte aligned. 1 The stack is 8-byte aligned. On exception entry, the processor uses bit 9 of the stacked PSR to indicate the stack alignment. On return from the exception, it uses this stacked bit to restore the correct stack alignment. |
| 8 | BFHFNMIGN | R/W | 0 | Ignore Bus Fault in NMI and Fault This bit enables handlers with priority -1 or -2 to ignore data bus faults caused by load and store instructions. The setting of this bit applies to the hard fault, NMI, and FAULTMASK escalated handlers. Value Description 0 Data bus faults caused by load and store instructions cause a lock-up. 1 Handlers running at priority -1 and -2 ignore data bus faults caused by load and store instructions. Set this bit only when the handler and its data are in absolutely safe memory. The normal use of this bit is to probe system devices and bridges to detect control path problems and fix them. |
| 7:5 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|---|
| 4 | DIV0 | R/W | 0 | <p>Trap on Divide by 0</p> <p>This bit enables faulting or halting when the processor executes an <i>SDIV</i> or <i>UDIV</i> instruction with a divisor of 0.</p> <p>Value Description</p> <p>0 Do not trap on divide by 0. A divide by zero returns a quotient of 0.</p> <p>1 Trap on divide by 0.</p> |
| 3 | UNALIGNED | R/W | 0 | <p>Trap on Unaligned Access</p> <p>Value Description</p> <p>0 Do not trap on unaligned halfword and word accesses.</p> <p>1 Trap on unaligned halfword and word accesses. An unaligned access generates a usage fault.</p> <p>Unaligned <i>LDM</i>, <i>STM</i>, <i>LDRD</i>, and <i>STRD</i> instructions always fault regardless of whether <i>UNALIGNED</i> is set.</p> |
| 2 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 1 | MAINPEND | R/W | 0 | <p>Allow Main Interrupt Trigger</p> <p>Value Description</p> <p>0 Disables unprivileged software access to the SWTRIG register.</p> <p>1 Enables unprivileged software access to the SWTRIG register (see page 130).</p> |
| 0 | BASETHR | R/W | 0 | <p>Thread State Control</p> <p>Value Description</p> <p>0 The processor can enter Thread mode only when no exception is active.</p> <p>1 The processor can enter Thread mode from any level under the control of an <i>EXC_RETURN</i> value (see "Exception Return" on page 95 for more information).</p> |

Register 36: System Handler Priority 1 (SYSPRI1), offset 0xD18

Note: This register can only be accessed from privileged mode.

The **SYSPRI1** register configures the priority level, 0 to 7 of the usage fault, bus fault, and memory management fault exception handlers. This register is byte-accessible.

System Handler Priority 1 (SYSPRI1)

Base 0xE000.E000

Offset 0xD18

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|----------|----|----|----|----|-------|-----|-----|----------|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | USAGE | | | reserved | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | BUS | | | reserved | | | | | MEM | | | reserved | | | | |
| Type | R/W | R/W | R/W | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:24 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 23:21 | USAGE | R/W | 0x0 | Usage Fault Priority This field configures the priority level of the usage fault. Configurable priority values are in the range 0-7, with lower values having higher priority. |
| 20:16 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:13 | BUS | R/W | 0x0 | Bus Fault Priority This field configures the priority level of the bus fault. Configurable priority values are in the range 0-7, with lower values having higher priority. |
| 12:8 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:5 | MEM | R/W | 0x0 | Memory Management Fault Priority This field configures the priority level of the memory management fault. Configurable priority values are in the range 0-7, with lower values having higher priority. |
| 4:0 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 37: System Handler Priority 2 (SYSPRI2), offset 0xD1C

Note: This register can only be accessed from privileged mode.

The **SYSPRI2** register configures the priority level, 0 to 7 of the SVCcall handler. This register is byte-accessible.

System Handler Priority 2 (SYSPRI2)

Base 0xE000.E000

Offset 0xD1C

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|----------|----|----|----|----|----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | SVC | | | reserved | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:29 | SVC | R/W | 0x0 | SVCcall Priority This field configures the priority level of SVCcall. Configurable priority values are in the range 0-7, with lower values having higher priority. |
| 28:0 | reserved | RO | 0x000.0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 38: System Handler Priority 3 (SYSPRI3), offset 0xD20

Note: This register can only be accessed from privileged mode.

The **SYSPRI3** register configures the priority level, 0 to 7 of the SysTick exception and PendSV handlers. This register is byte-accessible.

System Handler Priority 3 (SYSPRI3)

Base 0xE000.E000

Offset 0xD20

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|----------|----|----|----|----|--------|-----|-----|----------|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | TICK | | | reserved | | | | | PENDSV | | | reserved | | | | |
| Type | R/W | R/W | R/W | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DEBUG | | | reserved | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:29 | TICK | R/W | 0x0 | SysTick Exception Priority This field configures the priority level of the SysTick exception. Configurable priority values are in the range 0-7, with lower values having higher priority. |
| 28:24 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 23:21 | PENDSV | R/W | 0x0 | PendSV Priority This field configures the priority level of PendSV. Configurable priority values are in the range 0-7, with lower values having higher priority. |
| 20:8 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:5 | DEBUG | R/W | 0x0 | Debug Priority This field configures the priority level of Debug. Configurable priority values are in the range 0-7, with lower values having higher priority. |
| 4:0 | reserved | RO | 0x0.0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 39: System Handler Control and State (SYSHNDCTRL), offset 0xD24

Note: This register can only be accessed from privileged mode.

The **SYSHNDCTRL** register enables the system handlers, and indicates the pending status of the usage fault, bus fault, memory management fault, and SVC exceptions as well as the active status of the system handlers.

If a system handler is disabled and the corresponding fault occurs, the processor treats the fault as a hard fault.

This register can be modified to change the pending or active status of system exceptions. An OS kernel can write to the active bits to perform a context switch that changes the current exception type.

Caution – Software that changes the value of an active bit in this register without correct adjustment to the stacked content can cause the processor to generate a fault exception. Ensure software that writes to this register retains and subsequently restores the current active status.

If the value of a bit in this register must be modified after enabling the system handlers, a read-modify-write procedure must be used to ensure that only the required bit is modified.

System Handler Control and State (SYSHNDCTRL)

Base 0xE000.E000

Offset 0xD24

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|------|------|--------|------|-------|----------|-----|------|----------|----|----|------|----------|------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | USAGE | BUS | MEM |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SVC | BUSP | MEMP | USAGEP | TICK | PNDSV | reserved | MON | SVCA | reserved | | | USGA | reserved | BUSA | MEMA |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | RO | R/W | R/W | RO | RO | RO | R/W | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:19 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 18 | USAGE | R/W | 0 | Usage Fault Enable Value Description 0 Disables the usage fault exception. 1 Enables the usage fault exception. |
| 17 | BUS | R/W | 0 | Bus Fault Enable Value Description 0 Disables the bus fault exception. 1 Enables the bus fault exception. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 16 | MEM | R/W | 0 | <p>Memory Management Fault Enable</p> <p>Value Description</p> <p>0 Disables the memory management fault exception.</p> <p>1 Enables the memory management fault exception.</p> |
| 15 | SVC | R/W | 0 | <p>SVC Call Pending</p> <p>Value Description</p> <p>0 An SVC call exception is not pending.</p> <p>1 An SVC call exception is pending.</p> <p>This bit can be modified to change the pending status of the SVC call exception.</p> |
| 14 | BUSP | R/W | 0 | <p>Bus Fault Pending</p> <p>Value Description</p> <p>0 A bus fault exception is not pending.</p> <p>1 A bus fault exception is pending.</p> <p>This bit can be modified to change the pending status of the bus fault exception.</p> |
| 13 | MEMP | R/W | 0 | <p>Memory Management Fault Pending</p> <p>Value Description</p> <p>0 A memory management fault exception is not pending.</p> <p>1 A memory management fault exception is pending.</p> <p>This bit can be modified to change the pending status of the memory management fault exception.</p> |
| 12 | USAGEP | R/W | 0 | <p>Usage Fault Pending</p> <p>Value Description</p> <p>0 A usage fault exception is not pending.</p> <p>1 A usage fault exception is pending.</p> <p>This bit can be modified to change the pending status of the usage fault exception.</p> |
| 11 | TICK | R/W | 0 | <p>SysTick Exception Active</p> <p>Value Description</p> <p>0 A SysTick exception is not active.</p> <p>1 A SysTick exception is active.</p> <p>This bit can be modified to change the active status of the SysTick exception, however, see the Caution above before setting this bit.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 10 | PNSV | R/W | 0 | <p>PendSV Exception Active</p> <p>Value Description</p> <p>0 A PendSV exception is not active.</p> <p>1 A PendSV exception is active.</p> <p>This bit can be modified to change the active status of the PendSV exception, however, see the Caution above before setting this bit.</p> |
| 9 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | MON | R/W | 0 | <p>Debug Monitor Active</p> <p>Value Description</p> <p>0 The Debug monitor is not active.</p> <p>1 The Debug monitor is active.</p> |
| 7 | SVCA | R/W | 0 | <p>SVC Call Active</p> <p>Value Description</p> <p>0 SVC call is not active.</p> <p>1 SVC call is active.</p> <p>This bit can be modified to change the active status of the SVC call exception, however, see the Caution above before setting this bit.</p> |
| 6:4 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | USGA | R/W | 0 | <p>Usage Fault Active</p> <p>Value Description</p> <p>0 Usage fault is not active.</p> <p>1 Usage fault is active.</p> <p>This bit can be modified to change the active status of the usage fault exception, however, see the Caution above before setting this bit.</p> |
| 2 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | BUSA | R/W | 0 | <p>Bus Fault Active</p> <p>Value Description</p> <p>0 Bus fault is not active.</p> <p>1 Bus fault is active.</p> <p>This bit can be modified to change the active status of the bus fault exception, however, see the Caution above before setting this bit.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 0 | MEMA | R/W | 0 | Memory Management Fault Active |
| | | | | Value Description |
| | | | | 0 Memory management fault is not active. |
| | | | | 1 Memory management fault is active. |
| | | | | This bit can be modified to change the active status of the memory management fault exception, however, see the Caution above before setting this bit. |

Register 40: Configurable Fault Status (FAULTSTAT), offset 0xD28

Note: This register can only be accessed from privileged mode.

The **FAULTSTAT** register indicates the cause of a memory management fault, bus fault, or usage fault. Each of these functions is assigned to a subregister as follows:

- **Usage Fault Status (UFAULTSTAT)**, bits 31:16
- **Bus Fault Status (BFAULTSTAT)**, bits 15:8
- **Memory Management Fault Status (MFAULTSTAT)**, bits 7:0

FAULTSTAT is byte accessible. **FAULTSTAT** or its subregisters can be accessed as follows:

- The complete **FAULTSTAT** register, with a word access to offset 0xD28
- The **MFAULTSTAT**, with a byte access to offset 0xD28
- The **MFAULTSTAT** and **BFAULTSTAT**, with a halfword access to offset 0xD28
- The **BFAULTSTAT**, with a byte access to offset 0xD29
- The **UFAULTSTAT**, with a halfword access to offset 0xD2A

Bits are cleared by writing a 1 to them.

In a fault handler, the true faulting address can be determined by:

1. Read and save the **Memory Management Fault Address (MMADDR)** or **Bus Fault Address (FAULTADDR)** value.
2. Read the **MMARV** bit in **MFAULTSTAT**, or the **BFARV** bit in **BFAULTSTAT** to determine if the **MMADDR** or **FAULTADDR** contents are valid.

Software must follow this sequence because another higher priority exception might change the **MMADDR** or **FAULTADDR** value. For example, if a higher priority handler preempts the current fault handler, the other fault might change the **MMADDR** or **FAULTADDR** value.

Configurable Fault Status (FAULTSTAT)

Base 0xE000.E000

Offset 0xD28

Type R/W1C, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|----------|----|-------|--------|-------|---------|---------|----------|----------|----|-------|--------|----------|---------|-------|
| | reserved | | | | | | DIV0 | UNALIGN | reserved | | | | NOCP | INVPC | INVSTAT | UNDEF |
| Type | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | BFARV | reserved | | BSTKE | BUSTKE | IMPRE | PRECISE | IBUS | MMARV | reserved | | MSTKE | MUSTKE | reserved | DERR | IERR |
| Type | R/W1C | RO | RO | R/W1C | R/W1C | R/W1C | R/W1C | R/W1C | R/W1C | RO | RO | R/W1C | R/W1C | RO | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:26 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-------|--|
| 25 | DIV0 | R/W1C | 0 | <p>Divide-by-Zero Usage Fault</p> <p>Value Description</p> <p>0 No divide-by-zero fault has occurred, or divide-by-zero trapping is not enabled.</p> <p>1 The processor has executed an <code>SDIV</code> or <code>UDIV</code> instruction with a divisor of 0.</p> <p>When this bit is set, the PC value stacked for the exception return points to the instruction that performed the divide by zero.</p> <p>Trapping on divide-by-zero is enabled by setting the <code>DIV0</code> bit in the Configuration and Control (CFGCTRL) register (see page 142).</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 24 | UNALIGN | R/W1C | 0 | <p>Unaligned Access Usage Fault</p> <p>Value Description</p> <p>0 No unaligned access fault has occurred, or unaligned access trapping is not enabled.</p> <p>1 The processor has made an unaligned memory access.</p> <p>Unaligned <code>LDM</code>, <code>STM</code>, <code>LDRD</code>, and <code>STRD</code> instructions always fault regardless of the configuration of this bit.</p> <p>Trapping on unaligned access is enabled by setting the <code>UNALIGNED</code> bit in the CFGCTRL register (see page 142).</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 23:20 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 19 | NOCP | R/W1C | 0 | <p>No Coprocessor Usage Fault</p> <p>Value Description</p> <p>0 A usage fault has not been caused by attempting to access a coprocessor.</p> <p>1 The processor has attempted to access a coprocessor.</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 18 | INVPC | R/W1C | 0 | <p>Invalid PC Load Usage Fault</p> <p>Value Description</p> <p>0 A usage fault has not been caused by attempting to load an invalid PC value.</p> <p>1 The processor has attempted an illegal load of <code>EXC_RETURN</code> to the PC as a result of an invalid context or an invalid <code>EXC_RETURN</code> value.</p> <p>When this bit is set, the PC value stacked for the exception return points to the instruction that tried to perform the illegal load of the PC.</p> <p>This bit is cleared by writing a 1 to it.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-------|---|
| 17 | INVSTAT | R/W1C | 0 | <p>Invalid State Usage Fault</p> <p>Value Description</p> <p>0 A usage fault has not been caused by an invalid state.</p> <p>1 The processor has attempted to execute an instruction that makes illegal use of the EPSR register.</p> <p>When this bit is set, the PC value stacked for the exception return points to the instruction that attempted the illegal use of the Execution Program Status Register (EPSR) register.</p> <p>This bit is not set if an undefined instruction uses the EPSR register. This bit is cleared by writing a 1 to it.</p> |
| 16 | UNDEF | R/W1C | 0 | <p>Undefined Instruction Usage Fault</p> <p>Value Description</p> <p>0 A usage fault has not been caused by an undefined instruction.</p> <p>1 The processor has attempted to execute an undefined instruction.</p> <p>When this bit is set, the PC value stacked for the exception return points to the undefined instruction.</p> <p>An undefined instruction is an instruction that the processor cannot decode.</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 15 | BFARV | R/W1C | 0 | <p>Bus Fault Address Register Valid</p> <p>Value Description</p> <p>0 The value in the Bus Fault Address (FAULTADDR) register is not a valid fault address.</p> <p>1 The FAULTADDR register is holding a valid fault address.</p> <p>This bit is set after a bus fault, where the address is known. Other faults can clear this bit, such as a memory management fault occurring later. If a bus fault occurs and is escalated to a hard fault because of priority, the hard fault handler must clear this bit. This action prevents problems if returning to a stacked active bus fault handler whose FAULTADDR register value has been overwritten.</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 14:13 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|-------|-------|---|
| 12 | BSTKE | R/W1C | 0 | <p>Stack Bus Fault</p> <p>Value Description</p> <p>0 No bus fault has occurred on stacking for exception entry.</p> <p>1 Stacking for an exception entry has caused one or more bus faults.</p> <p>When this bit is set, the SP is still adjusted but the values in the context area on the stack might be incorrect. A fault address is not written to the FAULTADDR register.</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 11 | BUSTKE | R/W1C | 0 | <p>Unstack Bus Fault</p> <p>Value Description</p> <p>0 No bus fault has occurred on unstacking for a return from exception.</p> <p>1 Unstacking for a return from exception has caused one or more bus faults.</p> <p>This fault is chained to the handler. Thus, when this bit is set, the original return stack is still present. The SP is not adjusted from the failing return, a new save is not performed, and a fault address is not written to the FAULTADDR register.</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 10 | IMPRE | R/W1C | 0 | <p>Imprecise Data Bus Error</p> <p>Value Description</p> <p>0 An imprecise data bus error has not occurred.</p> <p>1 A data bus error has occurred, but the return address in the stack frame is not related to the instruction that caused the error.</p> <p>When this bit is set, a fault address is not written to the FAULTADDR register.</p> <p>This fault is asynchronous. Therefore, if the fault is detected when the priority of the current process is higher than the bus fault priority, the bus fault becomes pending and becomes active only when the processor returns from all higher-priority processes. If a precise fault occurs before the processor enters the handler for the imprecise bus fault, the handler detects that both the IMPRE bit is set and one of the precise fault status bits is set.</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 9 | PRECISE | R/W1C | 0 | <p>Precise Data Bus Error</p> <p>Value Description</p> <p>0 A precise data bus error has not occurred.</p> <p>1 A data bus error has occurred, and the PC value stacked for the exception return points to the instruction that caused the fault.</p> <p>When this bit is set, the fault address is written to the FAULTADDR register.</p> <p>This bit is cleared by writing a 1 to it.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-------|---|
| 8 | IBUS | R/W1C | 0 | <p>Instruction Bus Error</p> <p>Value Description</p> <p>0 An instruction bus error has not occurred.</p> <p>1 An instruction bus error has occurred.</p> <p>The processor detects the instruction bus error on prefetching an instruction, but sets this bit only if it attempts to issue the faulting instruction.</p> <p>When this bit is set, a fault address is not written to the FAULTADDR register.</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 7 | MMARV | R/W1C | 0 | <p>Memory Management Fault Address Register Valid</p> <p>Value Description</p> <p>0 The value in the Memory Management Fault Address (MMADDR) register is not a valid fault address.</p> <p>1 The MMADDR register is holding a valid fault address.</p> <p>If a memory management fault occurs and is escalated to a hard fault because of priority, the hard fault handler must clear this bit. This action prevents problems if returning to a stacked active memory management fault handler whose MMADDR register value has been overwritten.</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 6:5 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 4 | MSTKE | R/W1C | 0 | <p>Stack Access Violation</p> <p>Value Description</p> <p>0 No memory management fault has occurred on stacking for exception entry.</p> <p>1 Stacking for an exception entry has caused one or more access violations.</p> <p>When this bit is set, the SP is still adjusted but the values in the context area on the stack might be incorrect. A fault address is not written to the MMADDR register.</p> <p>This bit is cleared by writing a 1 to it.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-------|---|
| 3 | MUSTKE | R/W1C | 0 | <p>Unstack Access Violation</p> <p>Value Description</p> <p>0 No memory management fault has occurred on unstacking for a return from exception.</p> <p>1 Unstacking for a return from exception has caused one or more access violations.</p> <p>This fault is chained to the handler. Thus, when this bit is set, the original return stack is still present. The SP is not adjusted from the failing return, a new save is not performed, and a fault address is not written to the MMADDR register.</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 2 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 1 | DERR | R/W1C | 0 | <p>Data Access Violation</p> <p>Value Description</p> <p>0 A data access violation has not occurred.</p> <p>1 The processor attempted a load or store at a location that does not permit the operation.</p> <p>When this bit is set, the PC value stacked for the exception return points to the faulting instruction and the address of the attempted access is written to the MMADDR register.</p> <p>This bit is cleared by writing a 1 to it.</p> |
| 0 | IERR | R/W1C | 0 | <p>Instruction Access Violation</p> <p>Value Description</p> <p>0 An instruction access violation has not occurred.</p> <p>1 The processor attempted an instruction fetch from a location that does not permit execution.</p> <p>This fault occurs on any access to an XN region, even when the MPU is disabled or not present.</p> <p>When this bit is set, the PC value stacked for the exception return points to the faulting instruction and the address of the attempted access is not written to the MMADDR register.</p> <p>This bit is cleared by writing a 1 to it.</p> |

Register 41: Hard Fault Status (HFAULTSTAT), offset 0xD2C

Note: This register can only be accessed from privileged mode.

The **HFAULTSTAT** register gives information about events that activate the hard fault handler.

Bits are cleared by writing a 1 to them.

Hard Fault Status (HFAULTSTAT)

Base 0xE000.E000

Offset 0xD2C

Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|--------|----------|----|----|----|----|----|----|----|----|----|----|----|------|----------|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | DBG | FORCED | reserved | | | | | | | | | | | | | | |
| Type | R/W1C | R/W1C | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | VECT | reserved | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-------|--|
| 31 | DBG | R/W1C | 0 | Debug Event This bit is reserved for Debug use. This bit must be written as a 0, otherwise behavior is unpredictable. |
| 30 | FORCED | R/W1C | 0 | Forced Hard Fault Value Description 0 No forced hard fault has occurred. 1 A forced hard fault has been generated by escalation of a fault with configurable priority that cannot be handled, either because of priority or because it is disabled. When this bit is set, the hard fault handler must read the other fault status registers to find the cause of the fault. This bit is cleared by writing a 1 to it. |
| 29:2 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | VECT | R/W1C | 0 | Vector Table Read Fault Value Description 0 No bus fault has occurred on a vector table read. 1 A bus fault occurred on a vector table read. This error is always handled by the hard fault handler. When this bit is set, the PC value stacked for the exception return points to the instruction that was preempted by the exception. This bit is cleared by writing a 1 to it. |
| 0 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 42: Memory Management Fault Address (MMADDR), offset 0xD34

Note: This register can only be accessed from privileged mode.

The **MMADDR** register contains the address of the location that generated a memory management fault. When an unaligned access faults, the address in the **MMADDR** register is the actual address that faulted. Because a single read or write instruction can be split into multiple aligned accesses, the fault address can be any address in the range of the requested access size. Bits in the **Memory Management Fault Status (MFAULTSTAT)** register indicate the cause of the fault and whether the value in the **MMADDR** register is valid (see page 151).

Memory Management Fault Address (MMADDR)

Base 0xE000.E000

Offset 0xD34

Type R/W, reset -

| | | | | | | | | | | | | | | | | |
|-------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | ADDR | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | ADDR | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 31:0 | ADDR | R/W | - | Fault Address When the MMARV bit of MFAULTSTAT is set, this field holds the address of the location that generated the memory management fault. |

Register 43: Bus Fault Address (FAULTADDR), offset 0xD38

Note: This register can only be accessed from privileged mode.

The **FAULTADDR** register contains the address of the location that generated a bus fault. When an unaligned access faults, the address in the **FAULTADDR** register is the one requested by the instruction, even if it is not the address of the fault. Bits in the **Bus Fault Status (BFAULTSTAT)** register indicate the cause of the fault and whether the value in the **FAULTADDR** register is valid (see page 151).

Bus Fault Address (FAULTADDR)

Base 0xE000.E000

Offset 0xD38

Type R/W, reset -

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | ADDR | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | ADDR | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 31:0 | ADDR | R/W | - | Fault Address When the FAULTADDRV bit of BFAULTSTAT is set, this field holds the address of the location that generated the bus fault. |

3.6 Memory Protection Unit (MPU) Register Descriptions

This section lists and describes the Memory Protection Unit (MPU) registers, in numerical order by address offset.

The MPU registers can only be accessed from privileged mode.

Register 44: MPU Type (MPUTYPE), offset 0xD90

Note: This register can only be accessed from privileged mode.

The **MPUTYPE** register indicates whether the MPU is present, and if so, how many regions it supports.

MPU Type (MPUTYPE)

Base 0xE000.E000

Offset 0xD90

Type RO, reset 0x0000.0800

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----------|----|----|----|----|----|----|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | IREGION | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DREGION | | | | | | | | reserved | | | | | | | SEPARATE |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:24 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 23:16 | IREGION | RO | 0x00 | Number of I Regions This field indicates the number of supported MPU instruction regions. This field always contains 0x00. The MPU memory map is unified and is described by the DREGION field. |
| 15:8 | DREGION | RO | 0x08 | Number of D Regions Value Description 0x08 Indicates there are eight supported MPU data regions. |
| 7:1 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | SEPARATE | RO | 0 | Separate or Unified MPU Value Description 0 Indicates the MPU is unified. |

Register 45: MPU Control (MPUCTRL), offset 0xD94

Note: This register can only be accessed from privileged mode.

The **MPUCTRL** register enables the MPU, enables the default memory map background region, and enables use of the MPU when in the hard fault, Non-maskable Interrupt (NMI), and **Fault Mask Register (FAULTMASK)** escalated handlers.

When the `ENABLE` and `PRIVDEFEN` bits are both set:

- For privileged accesses, the default memory map is as described in “Memory Model” on page 79. Any access by privileged software that does not address an enabled memory region behaves as defined by the default memory map.
- Any access by unprivileged software that does not address an enabled memory region causes a memory management fault.

Execute Never (XN) and Strongly Ordered rules always apply to the System Control Space regardless of the value of the `ENABLE` bit.

When the `ENABLE` bit is set, at least one region of the memory map must be enabled for the system to function unless the `PRIVDEFEN` bit is set. If the `PRIVDEFEN` bit is set and no regions are enabled, then only privileged software can operate.

When the `ENABLE` bit is clear, the system uses the default memory map, which has the same memory attributes as if the MPU is not implemented (see Table 2-5 on page 82 for more information). The default memory map applies to accesses from both privileged and unprivileged software.

When the MPU is enabled, accesses to the System Control Space and vector table are always permitted. Other areas are accessible based on regions and whether `PRIVDEFEN` is set.

Unless `HFNMIENA` is set, the MPU is not enabled when the processor is executing the handler for an exception with priority `-1` or `-2`. These priorities are only possible when handling a hard fault or NMI exception or when **FAULTMASK** is enabled. Setting the `HFNMIENA` bit enables the MPU when operating with these two priorities.

MPU Control (MPUCTRL)

Base 0xE000.E000

Offset 0xD94

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-----------|----------|--------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | PRIVDEFEN | HFNMIENA | ENABLE | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:3 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|---|
| 2 | PRIVDEFEN | R/W | 0 | <p>MPU Default Region</p> <p>This bit enables privileged software access to the default memory map.</p> <p>Value Description</p> <p>0 If the MPU is enabled, this bit disables use of the default memory map. Any memory access to a location not covered by any enabled region causes a fault.</p> <p>1 If the MPU is enabled, this bit enables use of the default memory map as a background region for privileged software accesses.</p> <p>When this bit is set, the background region acts as if it is region number -1. Any region that is defined and enabled has priority over this default map.</p> <p>If the MPU is disabled, the processor ignores this bit.</p> |
| 1 | HFNMIENA | R/W | 0 | <p>MPU Enabled During Faults</p> <p>This bit controls the operation of the MPU during hard fault, NMI, and FAULTMASK handlers.</p> <p>Value Description</p> <p>0 The MPU is disabled during hard fault, NMI, and FAULTMASK handlers, regardless of the value of the <i>ENABLE</i> bit.</p> <p>1 The MPU is enabled during hard fault, NMI, and FAULTMASK handlers.</p> <p>When the MPU is disabled and this bit is set, the resulting behavior is unpredictable.</p> |
| 0 | ENABLE | R/W | 0 | <p>MPU Enable</p> <p>Value Description</p> <p>0 The MPU is disabled.</p> <p>1 The MPU is enabled.</p> <p>When the MPU is disabled and the <i>HFNMIENA</i> bit is set, the resulting behavior is unpredictable.</p> |

Register 46: MPU Region Number (MPUNUMBER), offset 0xD98

Note: This register can only be accessed from privileged mode.

The **MPUNUMBER** register selects which memory region is referenced by the **MPU Region Base Address (MPUBASE)** and **MPU Region Attribute and Size (MPUATTR)** registers. Normally, the required region number should be written to this register before accessing the **MPUBASE** or the **MPUATTR** register. However, the region number can be changed by writing to the **MPUBASE** register with the **VALID** bit set (see page 164). This write updates the value of the **REGION** field.

MPU Region Number (MPUNUMBER)

Base 0xE000.E000

Offset 0xD98

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|--------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | NUMBER | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:3 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2:0 | NUMBER | R/W | 0x0 | MPU Region to Access This field indicates the MPU region referenced by the MPUBASE and MPUATTR registers. The MPU supports eight memory regions. |

Register 47: MPU Region Base Address (MPUBASE), offset 0xD9C**Register 48: MPU Region Base Address Alias 1 (MPUBASE1), offset 0xDA4****Register 49: MPU Region Base Address Alias 2 (MPUBASE2), offset 0xDAC****Register 50: MPU Region Base Address Alias 3 (MPUBASE3), offset 0xDB4**

Note: This register can only be accessed from privileged mode.

The **MPUBASE** register defines the base address of the MPU region selected by the **MPU Region Number (MPUNUMBER)** register and can update the value of the **MPUNUMBER** register. To change the current region number and update the **MPUNUMBER** register, write the **MPUBASE** register with the **VALID** bit set.

The **ADDR** field is bits 31:*N* of the **MPUBASE** register. Bits (*N*-1):5 are reserved. The region size, as specified by the **SIZE** field in the **MPU Region Attribute and Size (MPUATTR)** register, defines the value of *N* where:

$$N = \text{Log}_2(\text{Region size in bytes})$$

If the region size is configured to 4 GB in the **MPUATTR** register, there is no valid **ADDR** field. In this case, the region occupies the complete memory map, and the base address is 0x0000.0000.

The base address is aligned to the size of the region. For example, a 64-KB region must be aligned on a multiple of 64 KB, for example, at 0x0001.0000 or 0x0002.0000.

MPU Region Base Address (MPUBASE)

Base 0xE000.E000

Offset 0xD9C

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-------|----------|--------|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | ADDR | | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | ADDR | | | | | | | | | | | | VALID | reserved | REGION | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | WO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|------------|--|
| 31:5 | ADDR | R/W | 0x0000.000 | <p>Base Address Mask</p> <p>Bits 31:<i>N</i> in this field contain the region base address. The value of <i>N</i> depends on the region size, as shown above. The remaining bits (<i>N</i>-1):5 are reserved.</p> <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 4 | VALID | WO | 0 | Region Number Valid Value Description 0 The MPUNUMBER register is not changed and the processor updates the base address for the region specified in the MPUNUMBER register and ignores the value of the REGION field. 1 The MPUNUMBER register is updated with the value of the REGION field and the base address is updated for the region specified in the REGION field. This bit is always read as 0. |
| 3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2:0 | REGION | R/W | 0x0 | Region Number On a write, contains the value to be written to the MPUNUMBER register. On a read, returns the current region number in the MPUNUMBER register. |

Register 51: MPU Region Attribute and Size (MPUATTR), offset 0xDA0**Register 52: MPU Region Attribute and Size Alias 1 (MPUATTR1), offset 0xDA8****Register 53: MPU Region Attribute and Size Alias 2 (MPUATTR2), offset 0xDB0****Register 54: MPU Region Attribute and Size Alias 3 (MPUATTR3), offset 0xDB8**

Note: This register can only be accessed from privileged mode.

The **MPUATTR** register defines the region size and memory attributes of the MPU region specified by the **MPU Region Number (MPUNUMBER)** register and enables that region and any subregions.

The **MPUATTR** register is accessible using word or halfword accesses with the most-significant halfword holding the region attributes and the least-significant halfword holds the region size and the region and subregion enable bits.

The MPU access permission attribute bits, **XN**, **AP**, **TEX**, **S**, **C**, and **B**, control access to the corresponding memory region. If an access is made to an area of memory without the required permissions, then the MPU generates a permission fault.

The **SIZE** field defines the size of the MPU memory region specified by the **MPUNUMBER** register as follows:

$$(\text{Region size in bytes}) = 2^{(\text{SIZE}+1)}$$

The smallest permitted region size is 32 bytes, corresponding to a **SIZE** value of 4. Table 3-9 on page 166 gives example **SIZE** values with the corresponding region size and value of **N** in the **MPU Region Base Address (MPUBASE)** register.

Table 3-9. Example SIZE Field Values

| SIZE Encoding | Region Size | Value of N ^a | Note |
|---------------|-------------|---|------------------------|
| 00100b (0x4) | 32 B | 5 | Minimum permitted size |
| 01001b (0x9) | 1 KB | 10 | - |
| 10011b (0x13) | 1 MB | 20 | - |
| 11101b (0x1D) | 1 GB | 30 | - |
| 11111b (0x1F) | 4 GB | No valid ADDR field in MPUBASE ; the region occupies the complete memory map. | Maximum possible size |

a. Refers to the **N** parameter in the **MPUBASE** register (see page 164).

MPU Region Attribute and Size (MPUATTR)

Base 0xE000.E000

Offset 0xDA0

Type R/W, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|-----|-----|-----|----------|-----|-----|----------|----------|----|-----|------|-----|-----|-----|--------|
| | reserved | | | XN | reserved | AP | | reserved | | | TEX | | S | C | B | |
| Type | RO | RO | RO | R/W | RO | R/W | R/W | R/W | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SRD | | | | | | | | reserved | | | SIZE | | | | ENABLE |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:29 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | XN | R/W | 0 | Instruction Access Disable Value Description 0 Instruction fetches are enabled. 1 Instruction fetches are disabled. |
| 27 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 26:24 | AP | R/W | 0 | Access Privilege For information on using this bit field, see Table 3-5 on page 110. |
| 23:22 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 21:19 | TEX | R/W | 0x0 | Type Extension Mask For information on using this bit field, see Table 3-3 on page 109. |
| 18 | S | R/W | 0 | Shareable For information on using this bit, see Table 3-3 on page 109. |
| 17 | C | R/W | 0 | Cacheable For information on using this bit, see Table 3-3 on page 109. |
| 16 | B | R/W | 0 | Bufferable For information on using this bit, see Table 3-3 on page 109. |
| 15:8 | SRD | R/W | 0x00 | Subregion Disable Bits Value Description 0 The corresponding subregion is enabled. 1 The corresponding subregion is disabled. Region sizes of 128 bytes and less do not support subregions. When writing the attributes for such a region, configure the SRD field as 0x00. See the section called "Subregions" on page 108 for more information. |
| 7:6 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5:1 | SIZE | R/W | 0x0 | Region Size Mask The SIZE field defines the size of the MPU memory region specified by the MPUNUMBER register. Refer to Table 3-9 on page 166 for more information. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---------------------------|
| 0 | ENABLE | R/W | 0 | Region Enable |
| | | | | Value Description |
| | | | | 0 The region is disabled. |
| | | | | 1 The region is enabled. |

4 JTAG Interface

The Joint Test Action Group (JTAG) port is an IEEE standard that defines a Test Access Port and Boundary Scan Architecture for digital integrated circuits and provides a standardized serial interface for controlling the associated test logic. The TAP, Instruction Register (IR), and Data Registers (DR) can be used to test the interconnections of assembled printed circuit boards and obtain manufacturing information on the components. The JTAG Port also provides a means of accessing and controlling design-for-test features such as I/O pin observation and control, scan testing, and debugging.

The JTAG port is comprised of four pins: TCK, TMS, TDI, and TDO. Data is transmitted serially into the controller on TDI and out of the controller on TDO. The interpretation of this data is dependent on the current state of the TAP controller. For detailed information on the operation of the JTAG port and TAP controller, please refer to the *IEEE Standard 1149.1-Test Access Port and Boundary-Scan Architecture*.

The Stellaris® JTAG controller works with the ARM JTAG controller built into the Cortex-M3 core by multiplexing the TDO outputs from both JTAG controllers. ARM JTAG instructions select the ARM TDO output while Stellaris JTAG instructions select the Stellaris TDO output. The multiplexer is controlled by the Stellaris JTAG controller, which has comprehensive programming for the ARM, Stellaris, and unimplemented JTAG instructions.

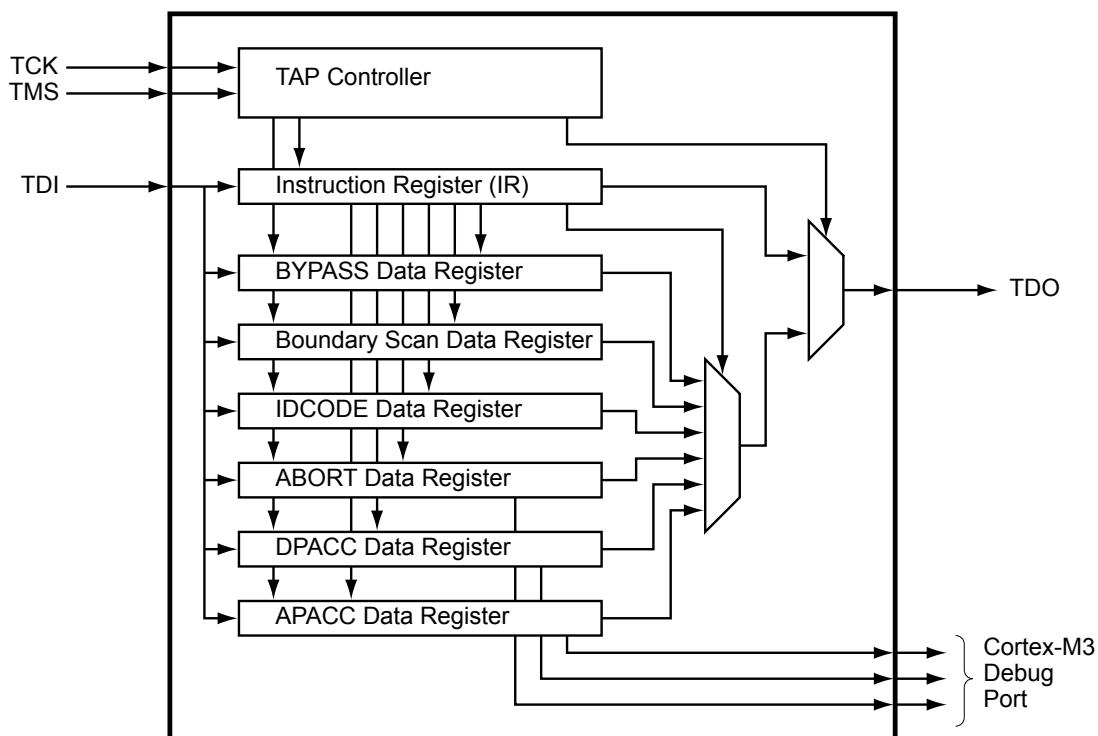
The Stellaris JTAG module has the following features:

- IEEE 1149.1-1990 compatible Test Access Port (TAP) controller
- Four-bit Instruction Register (IR) chain for storing JTAG instructions
- IEEE standard instructions: BYPASS, IDCODE, SAMPLE/PRELOAD, EXTEST and INTEST
- ARM additional instructions: APACC, DPACC and ABORT
- Integrated ARM Serial Wire Debug (SWD)
 - Serial Wire JTAG Debug Port (SWJ-DP)
 - Flash Patch and Breakpoint (FPB) unit for implementing breakpoints
 - Data Watchpoint and Trace (DWT) unit for implementing watchpoints, trigger resources, and system profiling
 - Instrumentation Trace Macrocell (ITM) for support of printf style debugging
 - Trace Port Interface Unit (TPIU) for bridging to a Trace Port Analyzer

See the *ARM® Debug Interface V5 Architecture Specification* for more information on the ARM JTAG controller.

4.1 Block Diagram

Figure 4-1. JTAG Module Block Diagram



4.2 Signal Description

The following table lists the external signals of the JTAG/SWD controller and describes the function of each. The JTAG/SWD controller signals are alternate functions for some GPIO signals, however note that the reset state of the pins is for the JTAG/SWD function. The JTAG/SWD controller signals are under commit protection and require a special process to be configured as GPIOs, see “Commit Control” on page 427. The column in the table below titled “Pin Mux/Pin Assignment” lists the GPIO pin placement for the JTAG/SWD controller signals. The $AFSEL$ bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) is set to choose the JTAG/SWD function. The number in parentheses is the encoding that must be programmed into the PMC_n field in the **GPIO Port Control (GPIOPTL)** register (page 461) to assign the JTAG/SWD controller signals to the specified GPIO port pin. For more information on configuring GPIOs, see “General-Purpose Input/Outputs (GPIOs)” on page 419.

Table 4-1. JTAG_SWD_SWO Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|---------------------|
| SWCLK | 80 | PC0 (3) | I | TTL | JTAG/SWD CLK. |
| SWDIO | 79 | PC1 (3) | I/O | TTL | JTAG TMS and SWDIO. |
| SWO | 77 | PC3 (3) | O | TTL | JTAG TDO and SWO. |
| TCK | 80 | PC0 (3) | I | TTL | JTAG/SWD CLK. |
| TDI | 78 | PC2 (3) | I | TTL | JTAG TDI. |
| TDO | 77 | PC3 (3) | O | TTL | JTAG TDO and SWO. |

Table 4-1. JTAG_SWD_SWO Signals (100LQFP) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|---------------------|
| TMS | 79 | PC1 (3) | I | TTL | JTAG TMS and SWDIO. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 4-2. JTAG_SWD_SWO Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|---------------------|
| SWCLK | A9 | PC0 (3) | I | TTL | JTAG/SWD CLK. |
| SWDIO | B9 | PC1 (3) | I/O | TTL | JTAG TMS and SWDIO. |
| SWO | A10 | PC3 (3) | O | TTL | JTAG TDO and SWO. |
| TCK | A9 | PC0 (3) | I | TTL | JTAG/SWD CLK. |
| TDI | B8 | PC2 (3) | I | TTL | JTAG TDI. |
| TDO | A10 | PC3 (3) | O | TTL | JTAG TDO and SWO. |
| TMS | B9 | PC1 (3) | I | TTL | JTAG TMS and SWDIO. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

4.3 Functional Description

A high-level conceptual drawing of the JTAG module is shown in Figure 4-1 on page 170. The JTAG module is composed of the Test Access Port (TAP) controller and serial shift chains with parallel update registers. The TAP controller is a simple state machine controlled by the TCK and TMS inputs. The current state of the TAP controller depends on the sequence of values captured on TMS at the rising edge of TCK. The TAP controller determines when the serial shift chains capture new data, shift data from TDI towards TDO, and update the parallel load registers. The current state of the TAP controller also determines whether the Instruction Register (IR) chain or one of the Data Register (DR) chains is being accessed.

The serial shift chains with parallel load registers are comprised of a single Instruction Register (IR) chain and multiple Data Register (DR) chains. The current instruction loaded in the parallel load register determines which DR chain is captured, shifted, or updated during the sequencing of the TAP controller.

Some instructions, like EXTEST and INTEST, operate on data currently in a DR chain and do not capture, shift, or update any of the chains. Instructions that are not implemented decode to the BYPASS instruction to ensure that the serial path between TDI and TDO is always connected (see Table 4-4 on page 177 for a list of implemented instructions).

See “JTAG and Boundary Scan” on page 1129 for JTAG timing diagrams.

Note: Of all the possible reset sources, only Power-On reset (POR) and the assertion of the $\overline{\text{RST}}$ input have any effect on the JTAG module. The pin configurations are reset by both the $\overline{\text{RST}}$ input and POR, whereas the internal JTAG logic is only reset with POR. See “Reset Sources” on page 182 for more information on reset.

4.3.1 JTAG Interface Pins

The JTAG interface consists of four standard pins: TCK, TMS, TDI, and TDO. These pins and their associated state after a power-on reset or reset caused by the $\overline{\text{RST}}$ input are given in Table 4-3. Detailed information on each pin follows. Refer to “General-Purpose Input/Outputs (GPIOs)” on page 419 for information on how to reprogram the configuration of these pins.

Table 4-3. JTAG Port Pins State after Power-On Reset or $\overline{\text{RST}}$ assertion

| Pin Name | Data Direction | Internal Pull-Up | Internal Pull-Down | Drive Strength | Drive Value |
|----------|----------------|------------------|--------------------|----------------|-------------|
| TCK | Input | Enabled | Disabled | N/A | N/A |
| TMS | Input | Enabled | Disabled | N/A | N/A |
| TDI | Input | Enabled | Disabled | N/A | N/A |
| TDO | Output | Enabled | Disabled | 2-mA driver | High-Z |

4.3.1.1 Test Clock Input (TCK)

The TCK pin is the clock for the JTAG module. This clock is provided so the test logic can operate independently of any other system clocks and to ensure that multiple JTAG TAP controllers that are daisy-chained together can synchronously communicate serial test data between components. During normal operation, TCK is driven by a free-running clock with a nominal 50% duty cycle. When necessary, TCK can be stopped at 0 or 1 for extended periods of time. While TCK is stopped at 0 or 1, the state of the TAP controller does not change and data in the JTAG Instruction and Data Registers is not lost.

By default, the internal pull-up resistor on the TCK pin is enabled after reset, assuring that no clocking occurs if the pin is not driven from an external source. The internal pull-up and pull-down resistors can be turned off to save internal power as long as the TCK pin is constantly being driven by an external source (see page 449 and page 451).

4.3.1.2 Test Mode Select (TMS)

The TMS pin selects the next state of the JTAG TAP controller. TMS is sampled on the rising edge of TCK. Depending on the current TAP state and the sampled value of TMS, the next state may be entered. Because the TMS pin is sampled on the rising edge of TCK, the *IEEE Standard 1149.1* expects the value on TMS to change on the falling edge of TCK.

Holding TMS high for five consecutive TCK cycles drives the TAP controller state machine to the Test-Logic-Reset state. When the TAP controller enters the Test-Logic-Reset state, the JTAG module and associated registers are reset to their default values. This procedure should be performed to initialize the JTAG controller. The JTAG Test Access Port state machine can be seen in its entirety in Figure 4-2 on page 173.

By default, the internal pull-up resistor on the TMS pin is enabled after reset. Changes to the pull-up resistor settings on GPIO Port C should ensure that the internal pull-up resistor remains enabled on PC1/TMS; otherwise JTAG communication could be lost (see page 449).

4.3.1.3 Test Data Input (TDI)

The TDI pin provides a stream of serial information to the IR chain and the DR chains. TDI is sampled on the rising edge of TCK and, depending on the current TAP state and the current instruction, may present this data to the proper shift register chain. Because the TDI pin is sampled on the rising edge of TCK, the *IEEE Standard 1149.1* expects the value on TDI to change on the falling edge of TCK.

By default, the internal pull-up resistor on the TDI pin is enabled after reset. Changes to the pull-up resistor settings on GPIO Port C should ensure that the internal pull-up resistor remains enabled on PC2/TDI; otherwise JTAG communication could be lost (see page 449).

4.3.1.4 Test Data Output (TDO)

The TDO pin provides an output stream of serial information from the IR chain or the DR chains. The value of TDO depends on the current TAP state, the current instruction, and the data in the

this information to be shifted out on TDO during the TAP controller's SHIFT states. While the sampled data is being shifted out of the chain on TDO, new data is being shifted into the serial shift register on TDI. This new data is stored in the parallel load register during the TAP controller's UPDATE states. Each of the shift registers is discussed in detail in "Register Descriptions" on page 177.

4.3.4 Operational Considerations

Certain operational parameters must be considered when using the JTAG module. Because the JTAG pins can be programmed to be GPIOs, board configuration and reset conditions on these pins must be considered. In addition, because the JTAG module has integrated ARM Serial Wire Debug, the method for switching between these two operational modes is described below.

4.3.4.1 GPIO Functionality

When the microcontroller is reset with either a POR or $\overline{\text{RST}}$, the JTAG/SWD port pins default to their JTAG/SWD configurations. The default configuration includes enabling digital functionality (DEN[3:0] set in the **Port C GPIO Digital Enable (GPIODEN)** register), enabling the pull-up resistors (PUE[3:0] set in the **Port C GPIO Pull-Up Select (GPIOPUR)** register), disabling the pull-down resistors (PDE[3:0] cleared in the **Port C GPIO Pull-Down Select (GPIOPDR)** register) and enabling the alternate hardware function (AFSEL[3:0] set in the **Port C GPIO Alternate Function Select (GPIOAFSEL)** register) on the JTAG/SWD pins. See page 443, page 449, page 451, and page 454.

It is possible for software to configure these pins as GPIOs after reset by clearing AFSEL[3:0] in the **Port C GPIOAFSEL** register. If the user does not require the JTAG/SWD port for debugging or board-level testing, this provides four more GPIOs for use in the design.

Caution – It is possible to create a software sequence that prevents the debugger from connecting to the Stellaris microcontroller. If the program code loaded into flash immediately changes the JTAG pins to their GPIO functionality, the debugger may not have enough time to connect and halt the controller before the JTAG pin functionality switches. As a result, the debugger may be locked out of the part. This issue can be avoided with a software routine that restores JTAG functionality based on an external or software trigger.

The GPIO commit control registers provide a layer of protection against accidental programming of critical hardware peripherals. Protection is provided for the NMI pin (PB7) and the four JTAG/SWD pins (PC[3:0]). Writes to protected bits of the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 443), **GPIO Pull Up Select (GPIOPUR)** register (see page 449), **GPIO Pull-Down Select (GPIOPDR)** register (see page 451), and **GPIO Digital Enable (GPIODEN)** register (see page 454) are not committed to storage unless the **GPIO Lock (GPIOLOCK)** register (see page 456) has been unlocked and the appropriate bits of the **GPIO Commit (GPIOCR)** register (see page 457) have been set.

4.3.4.2 Communication with JTAG/SWD

Because the debug clock and the system clock can be running at different frequencies, care must be taken to maintain reliable communication with the JTAG/SWD interface. In the Capture-DR state, the result of the previous transaction, if any, is returned, together with a 3-bit ACK response. Software should check the ACK response to see if the previous operation has completed before initiating a new transaction. Alternatively, if the system clock is at least 8 times faster than the debug clock (TCK or SWCLK), the previous operation has enough time to complete and the ACK bits do not have to be checked.

4.3.4.3 Recovering a "Locked" Microcontroller

Note: Performing the sequence below restores the non-volatile registers discussed in “Non-Volatile Register Programming” on page 321 to their factory default values. The mass erase of the Flash memory caused by the sequence below occurs prior to the non-volatile registers being restored.

If software configures any of the JTAG/SWD pins as GPIO and loses the ability to communicate with the debugger, there is a debug port unlock sequence that can be used to recover the microcontroller. Performing a total of ten JTAG-to-SWD and SWD-to-JTAG switch sequences while holding the microcontroller in reset mass erases the Flash memory. The debug port unlock sequence is:

1. Assert and hold the \overline{RST} signal.
2. Apply power to the device.
3. Perform steps 1 and 2 of the JTAG-to-SWD switch sequence on the section called “JTAG-to-SWD Switching” on page 176.
4. Perform steps 1 and 2 of the SWD-to-JTAG switch sequence on the section called “SWD-to-JTAG Switching” on page 176.
5. Perform steps 1 and 2 of the JTAG-to-SWD switch sequence.
6. Perform steps 1 and 2 of the SWD-to-JTAG switch sequence.
7. Perform steps 1 and 2 of the JTAG-to-SWD switch sequence.
8. Perform steps 1 and 2 of the SWD-to-JTAG switch sequence.
9. Perform steps 1 and 2 of the JTAG-to-SWD switch sequence.
10. Perform steps 1 and 2 of the SWD-to-JTAG switch sequence.
11. Perform steps 1 and 2 of the JTAG-to-SWD switch sequence.
12. Perform steps 1 and 2 of the SWD-to-JTAG switch sequence.
13. Release the \overline{RST} signal.
14. Wait 400 ms.
15. Power-cycle the microcontroller.

4.3.4.4 ARM Serial Wire Debug (SWD)

In order to seamlessly integrate the ARM Serial Wire Debug (SWD) functionality, a serial-wire debugger must be able to connect to the Cortex-M3 core without having to perform, or have any knowledge of, JTAG cycles. This integration is accomplished with a SWD preamble that is issued before the SWD session begins.

The switching preamble used to enable the SWD interface of the SWJ-DP module starts with the TAP controller in the Test-Logic-Reset state. From here, the preamble sequences the TAP controller through the following states: Run Test Idle, Select DR, Select IR, Test Logic Reset, Test Logic Reset, Run Test Idle, Run Test Idle, Select DR, Select IR, Test Logic Reset, Test Logic Reset, Run Test Idle, Run Test Idle, Select DR, Select IR, and Test Logic Reset states.

Stepping through this sequence of the TAP state machine enables the SWD interface and disables the JTAG interface. For more information on this operation and the SWD interface, see the *ARM® Debug Interface V5 Architecture Specification*.

Because this sequence is a valid series of JTAG operations that could be issued, the ARM JTAG TAP controller is not fully compliant to the *IEEE Standard 1149.1*. This instance is the only one where the ARM JTAG TAP controller does not meet full compliance with the specification. Due to the low probability of this sequence occurring during normal operation of the TAP controller, it should not affect normal performance of the JTAG interface.

JTAG-to-SWD Switching

To switch the operating mode of the Debug Access Port (DAP) from JTAG to SWD mode, the external debug hardware must send the switching preamble to the microcontroller. The 16-bit TMS command for switching to SWD mode is defined as b1110.0111.1001.1110, transmitted LSB first. This command can also be represented as 0xE79E when transmitted LSB first. The complete switch sequence should consist of the following transactions on the TCK/SWCLK and TMS/SWDIO signals:

1. Send at least 50 TCK/SWCLK cycles with TMS/SWDIO High to ensure that both JTAG and SWD are in their reset/idle states.
2. Send the 16-bit JTAG-to-SWD switch command, 0xE79E, on TMS.
3. Send at least 50 TCK/SWCLK cycles with TMS/SWDIO High to ensure that if SWJ-DP was already in SWD mode, the SWD goes into the line reset state before sending the switch sequence.

SWD-to-JTAG Switching

To switch the operating mode of the Debug Access Port (DAP) from SWD to JTAG mode, the external debug hardware must send a switch command to the microcontroller. The 16-bit TMS command for switching to JTAG mode is defined as b1110.0111.0011.1100, transmitted LSB first. This command can also be represented as 0xE73C when transmitted LSB first. The complete switch sequence should consist of the following transactions on the TCK/SWCLK and TMS/SWDIO signals:

1. Send at least 50 TCK/SWCLK cycles with TMS/SWDIO High to ensure that both JTAG and SWD are in their reset/idle states.
2. Send the 16-bit SWD-to-JTAG switch command, 0xE73C, on TMS.
3. Send at least 50 TCK/SWCLK cycles with TMS/SWDIO High to ensure that if SWJ-DP was already in JTAG mode, the JTAG goes into the Test Logic Reset state before sending the switch sequence.

4.4 Initialization and Configuration

After a Power-On-Reset or an external reset ($\overline{\text{RST}}$), the JTAG pins are automatically configured for JTAG communication. No user-defined initialization or configuration is needed. However, if the user application changes these pins to their GPIO function, they must be configured back to their JTAG functionality before JTAG communication can be restored. To return the pins to their JTAG functions, enable the four JTAG pins (PC[3:0]) for their alternate function using the **GPIOAFSEL** register. In addition to enabling the alternate functions, any other changes to the GPIO pad configurations on the four JTAG pins (PC[3:0]) should be returned to their default settings.

4.5 Register Descriptions

The registers in the JTAG TAP Controller or Shift Register chains are not memory mapped and are not accessible through the on-chip Advanced Peripheral Bus (APB). Instead, the registers within the JTAG controller are all accessed serially through the TAP Controller. These registers include the Instruction Register and the six Data Registers.

4.5.1 Instruction Register (IR)

The JTAG TAP Instruction Register (IR) is a four-bit serial scan chain connected between the JTAG TDI and TDO pins with a parallel load register. When the TAP Controller is placed in the correct states, bits can be shifted into the IR. Once these bits have been shifted into the chain and updated, they are interpreted as the current instruction. The decode of the IR bits is shown in Table 4-4. A detailed explanation of each instruction, along with its associated Data Register, follows.

Table 4-4. JTAG Instruction Register Commands

| IR[3:0] | Instruction | Description |
|------------|------------------|--|
| 0x0 | EXTEST | Drives the values preloaded into the Boundary Scan Chain by the SAMPLE/PRELOAD instruction onto the pads. |
| 0x1 | INTEST | Drives the values preloaded into the Boundary Scan Chain by the SAMPLE/PRELOAD instruction into the controller. |
| 0x2 | SAMPLE / PRELOAD | Captures the current I/O values and shifts the sampled values out of the Boundary Scan Chain while new preload data is shifted in. |
| 0x8 | ABORT | Shifts data into the ARM Debug Port Abort Register. |
| 0xA | DPACC | Shifts data into and out of the ARM DP Access Register. |
| 0xB | APACC | Shifts data into and out of the ARM AC Access Register. |
| 0xE | IDCODE | Loads manufacturing information defined by the <i>IEEE Standard 1149.1</i> into the IDCODE chain and shifts it out. |
| 0xF | BYPASS | Connects TDI to TDO through a single Shift Register chain. |
| All Others | Reserved | Defaults to the BYPASS instruction to ensure that TDI is always connected to TDO. |

4.5.1.1 EXTEST Instruction

The EXTEST instruction is not associated with its own Data Register chain. Instead, the EXTEST instruction uses the data that has been preloaded into the Boundary Scan Data Register using the SAMPLE/PRELOAD instruction. When the EXTEST instruction is present in the Instruction Register, the preloaded data in the Boundary Scan Data Register associated with the outputs and output enables are used to drive the GPIO pads rather than the signals coming from the core. With tests that drive known values out of the controller, this instruction can be used to verify connectivity. While the EXTEST instruction is present in the Instruction Register, the Boundary Scan Data Register can be accessed to sample and shift out the current data and load new data into the Boundary Scan Data Register.

4.5.1.2 INTEST Instruction

The INTEST instruction is not associated with its own Data Register chain. Instead, the INTEST instruction uses the data that has been preloaded into the Boundary Scan Data Register using the SAMPLE/PRELOAD instruction. When the INTEST instruction is present in the Instruction Register, the preloaded data in the Boundary Scan Data Register associated with the inputs are used to drive the signals going into the core rather than the signals coming from the GPIO pads. With tests that drive known values into the controller, this instruction can be used for testing. It is important to note that although the RST input pin is on the Boundary Scan Data Register chain, it is only observable.

While the INTEST instruction is present in the Instruction Register, the Boundary Scan Data Register can be accessed to sample and shift out the current data and load new data into the Boundary Scan Data Register.

4.5.1.3 **SAMPLE/PRELOAD Instruction**

The SAMPLE/PRELOAD instruction connects the Boundary Scan Data Register chain between TDI and TDO. This instruction samples the current state of the pad pins for observation and preloads new test data. Each GPIO pad has an associated input, output, and output enable signal. When the TAP controller enters the Capture DR state during this instruction, the input, output, and output-enable signals to each of the GPIO pads are captured. These samples are serially shifted out on TDO while the TAP controller is in the Shift DR state and can be used for observation or comparison in various tests.

While these samples of the inputs, outputs, and output enables are being shifted out of the Boundary Scan Data Register, new data is being shifted into the Boundary Scan Data Register from TDI. Once the new data has been shifted into the Boundary Scan Data Register, the data is saved in the parallel load registers when the TAP controller enters the Update DR state. This update of the parallel load register preloads data into the Boundary Scan Data Register that is associated with each input, output, and output enable. This preloaded data can be used with the EXTEST and INTEST instructions to drive data into or out of the controller. See “Boundary Scan Data Register” on page 179 for more information.

4.5.1.4 **ABORT Instruction**

The ABORT instruction connects the associated ABORT Data Register chain between TDI and TDO. This instruction provides read and write access to the ABORT Register of the ARM Debug Access Port (DAP). Shifting the proper data into this Data Register clears various error bits or initiates a DAP abort of a previous request. See the “ABORT Data Register” on page 180 for more information.

4.5.1.5 **DPACC Instruction**

The DPACC instruction connects the associated DPACC Data Register chain between TDI and TDO. This instruction provides read and write access to the DPACC Register of the ARM Debug Access Port (DAP). Shifting the proper data into this register and reading the data output from this register allows read and write access to the ARM debug and status registers. See “DPACC Data Register” on page 180 for more information.

4.5.1.6 **APACC Instruction**

The APACC instruction connects the associated APACC Data Register chain between TDI and TDO. This instruction provides read and write access to the APACC Register of the ARM Debug Access Port (DAP). Shifting the proper data into this register and reading the data output from this register allows read and write access to internal components and buses through the Debug Port. See “APACC Data Register” on page 180 for more information.

4.5.1.7 **IDCODE Instruction**

The IDCODE instruction connects the associated IDCODE Data Register chain between TDI and TDO. This instruction provides information on the manufacturer, part number, and version of the ARM core. This information can be used by testing equipment and debuggers to automatically configure input and output data streams. IDCODE is the default instruction loaded into the JTAG Instruction Register when a Power-On-Reset (POR) is asserted, or the Test-Logic-Reset state is entered. See “IDCODE Data Register” on page 179 for more information.

4.5.1.8 BYPASS Instruction

The BYPASS instruction connects the associated BYPASS Data Register chain between TDI and TDO. This instruction is used to create a minimum length serial path between the TDI and TDO ports. The BYPASS Data Register is a single-bit shift register. This instruction improves test efficiency by allowing components that are not needed for a specific test to be bypassed in the JTAG scan chain by loading them with the BYPASS instruction. See “BYPASS Data Register” on page 179 for more information.

4.5.2 Data Registers

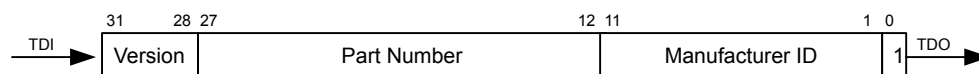
The JTAG module contains six Data Registers. These serial Data Register chains include: IDCODE, BYPASS, Boundary Scan, APACC, DPACC, and ABORT and are discussed in the following sections.

4.5.2.1 IDCODE Data Register

The format for the 32-bit IDCODE Data Register defined by the *IEEE Standard 1149.1* is shown in Figure 4-3. The standard requires that every JTAG-compliant microcontroller implement either the IDCODE instruction or the BYPASS instruction as the default instruction. The LSB of the IDCODE Data Register is defined to be a 1 to distinguish it from the BYPASS instruction, which has an LSB of 0. This definition allows auto-configuration test tools to determine which instruction is the default instruction.

The major uses of the JTAG port are for manufacturer testing of component assembly and program development and debug. To facilitate the use of auto-configuration debug tools, the IDCODE instruction outputs a value of 0x4BA0.0477. This value allows the debuggers to automatically configure themselves to work correctly with the Cortex-M3 during debug.

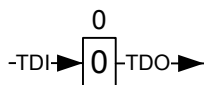
Figure 4-3. IDCODE Register Format



4.5.2.2 BYPASS Data Register

The format for the 1-bit BYPASS Data Register defined by the *IEEE Standard 1149.1* is shown in Figure 4-4. The standard requires that every JTAG-compliant microcontroller implement either the BYPASS instruction or the IDCODE instruction as the default instruction. The LSB of the BYPASS Data Register is defined to be a 0 to distinguish it from the IDCODE instruction, which has an LSB of 1. This definition allows auto-configuration test tools to determine which instruction is the default instruction.

Figure 4-4. BYPASS Register Format



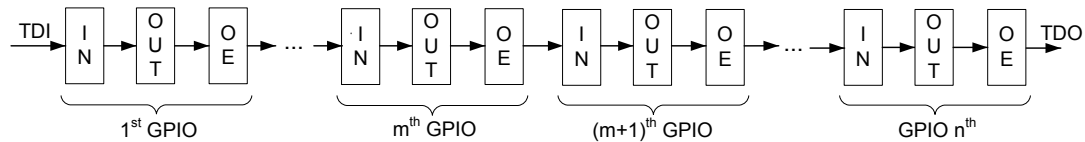
4.5.2.3 Boundary Scan Data Register

The format of the Boundary Scan Data Register is shown in Figure 4-5. Each GPIO pin, starting with a GPIO pin next to the JTAG port pins, is included in the Boundary Scan Data Register. Each

GPIO pin has three associated digital signals that are included in the chain. These signals are input, output, and output enable, and are arranged in that order as shown in the figure.

When the Boundary Scan Data Register is accessed with the SAMPLE/PRELOAD instruction, the input, output, and output enable from each digital pad are sampled and then shifted out of the chain to be verified. The sampling of these values occurs on the rising edge of TCK in the Capture DR state of the TAP controller. While the sampled data is being shifted out of the Boundary Scan chain in the Shift DR state of the TAP controller, new data can be preloaded into the chain for use with the EXTEST and INTEST instructions. The EXTEST instruction forces data out of the controller, and the INTEST instruction forces data into the controller.

Figure 4-5. Boundary Scan Register Format



4.5.2.4 APACC Data Register

The format for the 35-bit APACC Data Register defined by ARM is described in the *ARM® Debug Interface V5 Architecture Specification*.

4.5.2.5 DPACC Data Register

The format for the 35-bit DPACC Data Register defined by ARM is described in the *ARM® Debug Interface V5 Architecture Specification*.

4.5.2.6 ABORT Data Register

The format for the 35-bit ABORT Data Register defined by ARM is described in the *ARM® Debug Interface V5 Architecture Specification*.

5 System Control

System control configures the overall operation of the device and provides information about the device. Configurable features include reset control, NMI operation, power control, clock control, and low-power modes.

5.1 Signal Description

The following table lists the external signals of the System Control module and describes the function of each. The NMI signal is the alternate function for the GPIO_{PB7} signal and functions as a GPIO after reset. PB7 is under commit protection and requires a special process to be configured as any alternate function or to subsequently return to the GPIO function, see “Commit Control” on page 427. The column in the table below titled “Pin Mux/Pin Assignment” lists the GPIO pin placement for the NMI signal. The AFSEL bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the NMI function. The number in parentheses is the encoding that must be programmed into the PMCN field in the **GPIO Port Control (GPIOCTL)** register (page 461) to assign the NMI signal to the specified GPIO port pin. For more information on configuring GPIOs, see “General-Purpose Input/Outputs (GPIOs)” on page 419. The remaining signals (with the word “fixed” in the Pin Mux/Pin Assignment column) have a fixed pin assignment and function.

Table 5-1. System Control & Clocks Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|---|
| NMI | 89 | PB7 (4) | I | TTL | Non-maskable interrupt. |
| OSC0 | 48 | fixed | I | Analog | Main oscillator crystal input or an external clock reference input. |
| OSC1 | 49 | fixed | O | Analog | Main oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| RST | 64 | fixed | I | TTL | System reset input. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 5-2. System Control & Clocks Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|---|
| NMI | A8 | PB7 (4) | I | TTL | Non-maskable interrupt. |
| OSC0 | L11 | fixed | I | Analog | Main oscillator crystal input or an external clock reference input. |
| OSC1 | M11 | fixed | O | Analog | Main oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| RST | H11 | fixed | I | TTL | System reset input. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

5.2 Functional Description

The System Control module provides the following capabilities:

- Device identification, see “Device Identification” on page 182
- Local control, such as reset (see “Reset Control” on page 182), power (see “Power Control” on page 187) and clock control (see “Clock Control” on page 188)

- System control (Run, Sleep, and Deep-Sleep modes), see “System Control” on page 195

5.2.1 Device Identification

Several read-only registers provide software with information on the microcontroller, such as version, part number, SRAM size, Flash memory size, and other features. See the **DID0** (page 200), **DID1** (page 229), **DC0-DC9** (page 231) and **NVMSTAT** (page 253) registers.

5.2.2 Reset Control

This section discusses aspects of hardware functions during reset as well as system software requirements following the reset sequence.

5.2.2.1 Reset Sources

The LM3S2U93 microcontroller has six sources of reset:

1. Power-on reset (POR) (see page 183).
2. External reset input pin (\overline{RST}) assertion (see page 183).
3. Internal brown-out (BOR) detector (see page 185).
4. Software-initiated reset (with the software reset registers) (see page 185).
5. A watchdog timer reset condition violation (see page 186).
6. MOSC failure (see page 187).

Table 5-3 provides a summary of results of the various reset operations.

Table 5-3. Reset Sources

| Reset Source | Core Reset? | JTAG Reset? | On-Chip Peripherals Reset? |
|--|-------------|-------------|----------------------------|
| Power-On Reset | Yes | Yes | Yes |
| \overline{RST} | Yes | Yes | Yes |
| Brown-Out Reset | Yes | Yes | Yes |
| Software System Request Reset using the <i>SYSRESREQ</i> bit in the APINT register. | Yes | Yes | Yes |
| Software System Request Reset using the <i>VECTRESET</i> bit in the APINT register. | Yes | No | No |
| Software Peripheral Reset | No | Yes | Yes ^a |
| Watchdog Reset | Yes | Yes | Yes |
| MOSC Failure Reset | Yes | Yes | Yes |

a. Programmable on a module-by-module basis using the Software Reset Control Registers.

After a reset, the **Reset Cause (RESC)** register is set with the reset cause. The bits in this register are sticky and maintain their state across multiple reset sequences, except when an internal POR is the cause, in which case, all the bits in the **RESC** register are cleared except for the POR indicator. A bit in the **RESC** register can be cleared by writing a 0.

At any reset that resets the core, the user has the opportunity to direct the core to execute the ROM Boot Loader or the application in Flash memory by using any GPIO signal as configured in the **Boot Configuration (BOOTCFG)** register.

At reset, the ROM is mapped over the Flash memory so that the ROM boot sequence is always executed. The boot sequence executed from ROM is as follows:

1. The **BA** bit (below) is cleared such that ROM is mapped to 0x01xx.xxxx and Flash memory is mapped to address 0x0.
2. The **BOOTCFG** register is read. If the **EN** bit is clear, the status of the specified GPIO pin is compared with the specified polarity. If the status matches the specified polarity, the ROM is mapped to address 0x0000.0000 and execution continues out of the ROM Boot Loader.
3. If the status doesn't match the specified polarity, the data at address 0x0000.0004 is read, and if the data at this address is 0xFFFF.FFFF, the ROM is mapped to address 0x0000.0000 and execution continues out of the ROM Boot Loader.
4. If there is valid data at address 0x0000.0004, the stack pointer (**SP**) is loaded from Flash memory at address 0x0000.0000 and the program counter (**PC**) is loaded from address 0x0000.0004. The user application begins executing.

For example, if the **BOOTCFG** register is written and committed with the value of 0x0000.3C01, then **PB7** is examined at reset to determine if the ROM Boot Loader should be executed. If **PB7** is Low, the core unconditionally begins executing the ROM boot loader. If **PB7** is High, then the application in Flash memory is executed if the reset vector at location 0x0000.0004 is not 0xFFFF.FFFF. Otherwise, the ROM boot loader is executed.

5.2.2.2 Power-On Reset (POR)

The internal Power-On Reset (POR) circuit monitors the power supply voltage (V_{DD}) and generates a reset signal to all of the internal logic including JTAG when the power supply ramp reaches a threshold value (V_{TH}). The microcontroller must be operating within the specified operating parameters when the on-chip power-on reset pulse is complete (see “Power and Brown-Out” on page 1131). For applications that require the use of an external reset signal to hold the microcontroller in reset longer than the internal POR, the \overline{RST} input may be used as discussed in “External \overline{RST} Pin” on page 183.

The Power-On Reset sequence is as follows:

1. The microcontroller waits for internal POR to go inactive.
2. The internal reset is released and the core loads from memory the initial stack pointer, the initial program counter, and the first instruction designated by the program counter, and then begins execution.

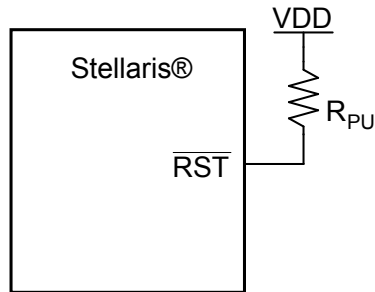
The internal POR is only active on the initial power-up of the microcontroller and when the microcontroller wakes from hibernation. The Power-On Reset timing is shown in Figure 25-4 on page 1131.

5.2.2.3 External \overline{RST} Pin

Note: It is recommended that the trace for the \overline{RST} signal must be kept as short as possible. Be sure to place any components connected to the \overline{RST} signal as close to the microcontroller as possible.

If the application only uses the internal POR circuit, the $\overline{\text{RST}}$ input must be connected to the power supply (V_{DD}) through an optional pull-up resistor (0 to 100K Ω) as shown in Figure 5-1 on page 184.

Figure 5-1. Basic $\overline{\text{RST}}$ Configuration



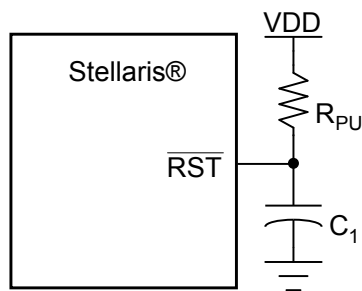
$R_{\text{PU}} = 0$ to 100 k Ω

The external reset pin ($\overline{\text{RST}}$) resets the microcontroller including the core and all the on-chip peripherals except the JTAG TAP controller (see “JTAG Interface” on page 169). The external reset sequence is as follows:

1. The external reset pin ($\overline{\text{RST}}$) is asserted for the duration specified by T_{MIN} and then de-asserted (see “Reset” on page 1132).
2. The internal reset is released and the core loads from memory the initial stack pointer, the initial program counter, and the first instruction designated by the program counter, and then begins execution.

To improve noise immunity and/or to delay reset at power up, the $\overline{\text{RST}}$ input may be connected to an RC network as shown in Figure 5-2 on page 184.

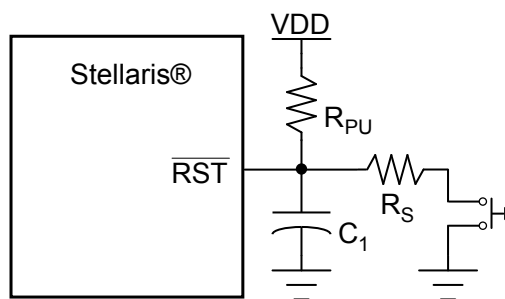
Figure 5-2. External Circuitry to Extend Power-On Reset



$R_{\text{PU}} = 1$ k Ω to 100 k Ω

$C_1 = 1$ nF to 10 μF

If the application requires the use of an external reset switch, Figure 5-3 on page 185 shows the proper circuitry to use.

Figure 5-3. Reset Circuit Controlled by Switch

Typical $R_{PU} = 10 \text{ k}\Omega$

Typical $R_S = 470 \Omega$

$C_1 = 10 \text{ nF}$

The R_{PU} and C_1 components define the power-on delay.

The external reset timing is shown in Figure 25-7 on page 1132.

5.2.2.4 Brown-Out Reset (BOR)

The microcontroller provides a brown-out detection circuit that triggers if the power supply (V_{DD}) drops below a brown-out threshold voltage (V_{BTH}). If a brown-out condition is detected, the system may generate an interrupt or a system reset. The default condition is to reset the microcontroller. Brown-out resets are controlled with the **Power-On and Brown-Out Reset Control (PBORCTL)** register. The `BORIOR` bit in the **PBORCTL** register must be set for a brown-out condition to trigger a reset; if `BORIOR` is clear, an interrupt is generated. When a Brown-out condition occurs during a Flash PROGRAM or ERASE operation, a full system reset is always triggered without regard to the setting in the **PBORCTL** register.

The brown-out reset sequence is as follows:

1. When V_{DD} drops below V_{BTH} , an internal BOR condition is set.
2. If the BOR condition exists, an internal reset is asserted.
3. The internal reset is released and the microcontroller fetches and loads the initial stack pointer, the initial program counter, the first instruction designated by the program counter, and begins execution.
4. The internal BOR condition is reset after 500 μs to prevent another BOR condition from being set before software has a chance to investigate the original cause.

The result of a brown-out reset is equivalent to that of an assertion of the external $\overline{\text{RST}}$ input, and the reset is held active until the proper V_{DD} level is restored. The **RESC** register can be examined in the reset interrupt handler to determine if a Brown-Out condition was the cause of the reset, thus allowing software to determine what actions are required to recover.

The internal Brown-Out Reset timing is shown in Figure 25-5 on page 1131.

5.2.2.5 Software Reset

Software can reset a specific peripheral or generate a reset to the entire microcontroller.

Peripherals can be individually reset by software via three registers that control reset signals to each on-chip peripheral (see the **SRCRn** registers, page 280). If the bit position corresponding to a peripheral is set and subsequently cleared, the peripheral is reset. The encoding of the reset registers is consistent with the encoding of the clock gating control for peripherals and on-chip functions (see “System Control” on page 195).

The entire microcontroller, including the core, can be reset by software by setting the `SYSRESREQ` bit in the **Application Interrupt and Reset Control (APINT)** register. The software-initiated system reset sequence is as follows:

1. A software microcontroller reset is initiated by setting the `SYSRESREQ` bit.
2. An internal reset is asserted.
3. The internal reset is deasserted and the microcontroller loads from memory the initial stack pointer, the initial program counter, and the first instruction designated by the program counter, and then begins execution.

The core only can be reset by software by setting the `VECTRESET` bit in the **APINT** register. The software-initiated core reset sequence is as follows:

1. A core reset is initiated by setting the `VECTRESET` bit.
2. An internal reset is asserted.
3. The internal reset is deasserted and the microcontroller loads from memory the initial stack pointer, the initial program counter, and the first instruction designated by the program counter, and then begins execution.

The software-initiated system reset timing is shown in Figure 25-8 on page 1132.

5.2.2.6 Watchdog Timer Reset

The Watchdog Timer module's function is to prevent system hangs. The LM3S2U93 microcontroller has two Watchdog Timer modules in case one watchdog clock source fails. One watchdog is run off the system clock and the other is run off the Precision Internal Oscillator (PIOSC). Each module operates in the same manner except that because the PIOSC watchdog timer module is in a different clock domain, register accesses must have a time delay between them. The watchdog timer can be configured to generate an interrupt to the microcontroller on its first time-out and to generate a reset on its second time-out.

After the watchdog's first time-out event, the 32-bit watchdog counter is reloaded with the value of the **Watchdog Timer Load (WDTLOAD)** register and resumes counting down from that value. If the timer counts down to zero again before the first time-out interrupt is cleared, and the reset signal has been enabled, the watchdog timer asserts its reset signal to the microcontroller. The watchdog timer reset sequence is as follows:

1. The watchdog timer times out for the second time without being serviced.
2. An internal reset is asserted.
3. The internal reset is released and the microcontroller loads from memory the initial stack pointer, the initial program counter, and the first instruction designated by the program counter, and then begins execution.

For more information on the Watchdog Timer module, see “Watchdog Timers” on page 597.

The watchdog reset timing is shown in Figure 25-9 on page 1133.

5.2.3 Non-Maskable Interrupt

The microcontroller has three sources of non-maskable interrupt (NMI):

- The assertion of the NMI signal
- A main oscillator verification error
- The NMISET bit in the **Interrupt Control and State (INTCTRL)** register in the Cortex™-M3 (see page 134).

Software must check the cause of the interrupt in order to distinguish among the sources.

5.2.3.1 NMI Pin

The NMI signal is the alternate function for GPIO port pin PB7. The alternate function must be enabled in the GPIO for the signal to be used as an interrupt, as described in “General-Purpose Input/Outputs (GPIOs)” on page 419. Note that enabling the NMI alternate function requires the use of the GPIO lock and commit function just like the GPIO port pins associated with JTAG/SWD functionality, see page 457. The active sense of the NMI signal is High; asserting the enabled NMI signal above V_{IH} initiates the NMI interrupt sequence.

5.2.3.2 Main Oscillator Verification Failure

The LM3S2U93 microcontroller provides a main oscillator verification circuit that generates an error condition if the oscillator is running too fast or too slow. If the main oscillator verification circuit is enabled and a failure occurs, a power-on reset is generated and control is transferred to the NMI handler. The NMI handler is used to address the main oscillator verification failure because the necessary code can be removed from the general reset handler, speeding up reset processing. The detection circuit is enabled by setting the CVAL bit in the **Main Oscillator Control (MOSCCTL)** register. The main oscillator verification error is indicated in the main oscillator fail status (MOSCFAIL) bit in the **Reset Cause (RESC)** register. The main oscillator verification circuit action is described in more detail in “Main Oscillator Verification Circuit” on page 195.

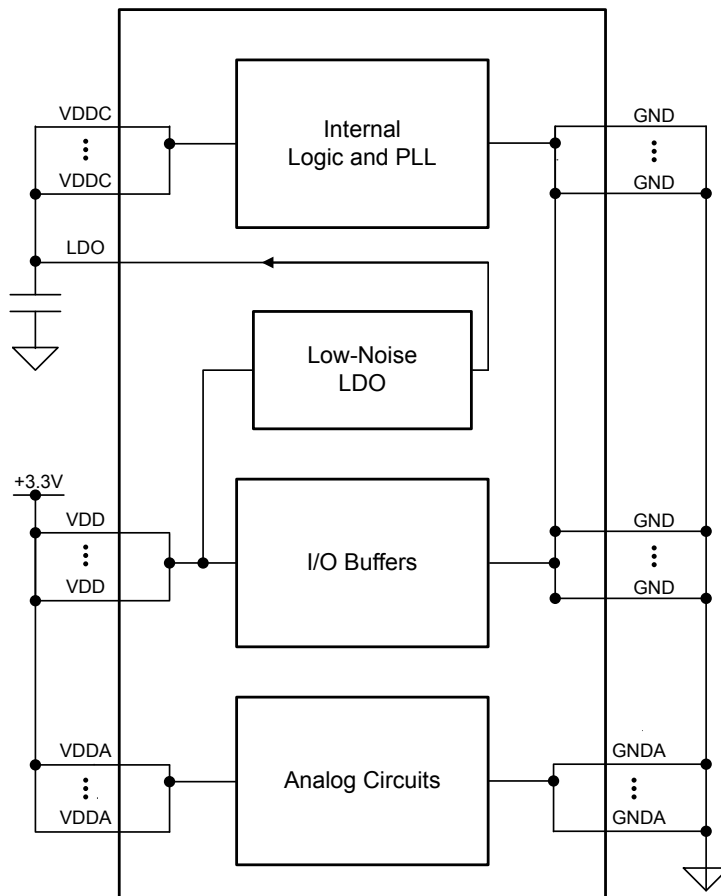
5.2.4 Power Control

The Stellaris® microcontroller provides an integrated LDO regulator that is used to provide power to the majority of the microcontroller's internal logic. Figure 5-4 shows the power architecture.

An external LDO may not be used.

Note: VDDA must be supplied with a voltage that meets the specification in Table 25-2 on page 1128, or the microcontroller does not function properly. VDDA is the supply for all of the analog circuitry on the device, including the clock circuitry.

Figure 5-4. Power Architecture



5.2.5 Clock Control

System control determines the control of clocks in this part.

5.2.5.1 Fundamental Clock Sources

There are multiple clock sources for use in the microcontroller:

- **Precision Internal Oscillator (PIOSC).** The precision internal oscillator is an on-chip clock source that is the clock source the microcontroller uses during and following POR. It does not require the use of any external components and provides a clock that is 16 MHz \pm 1% at room temperature and \pm 3% across temperature. The PIOSC allows for a reduced system cost in applications that require an accurate clock source. If the main oscillator is required, software must enable the main oscillator following reset and allow the main oscillator to stabilize before changing the clock reference. If the Hibernation Module clock source is a 32.768-kHz oscillator, the precision internal oscillator can be trimmed by software based on a reference clock for increased accuracy.
- **Main Oscillator (MOSC).** The main oscillator provides a frequency-accurate clock source by one of two means: an external single-ended clock source is connected to the OSC0 input pin, or an external crystal is connected across the OSC0 input and OSC1 output pins. If the PLL is being used, the crystal value must be one of the supported frequencies between 3.579545 MHz to

16.384 MHz (inclusive). If the PLL is not being used, the crystal may be any one of the supported frequencies between 1 MHz to 16.384 MHz. The single-ended clock source range is from DC through the specified speed of the microcontroller. The supported crystals are listed in the XTAL bit field in the **RCC** register (see page 211).

- **Internal 30-kHz Oscillator.** The internal 30-kHz oscillator provides an operational frequency of 30 kHz \pm 50%. It is intended for use during Deep-Sleep power-saving modes. This power-savings mode benefits from reduced internal switching and also allows the MOSC to be powered down.
- **Hibernation Module Clock Source.** The Hibernation module can be clocked in one of two ways. The first way is a 4.194304-MHz crystal connected to the XOSC0 and XOSC1 pins. This clock signal is divided by 128 internally to produce the 32.768-kHz clock reference. The second way is a 32.768-kHz oscillator connected to the XOSC0 pin. The 32.768-kHz oscillator can be used for the system clock, thus eliminating the need for an additional crystal or oscillator. The Hibernation module clock source is intended to provide the system with a real-time clock source and may also provide an accurate source of Deep-Sleep or Hibernate mode power savings.

The internal system clock (SysClk), is derived from any of the above sources plus two others: the output of the main internal PLL and the precision internal oscillator divided by four (4 MHz \pm 1%). The frequency of the PLL clock reference must be in the range of 3.579545 MHz to 16.384 MHz (inclusive). Table 5-4 on page 189 shows how the various clock sources can be used in a system.

Table 5-4. Clock Source Options

| Clock Source | Drive PLL? | | Used as SysClk? | |
|--|------------|----|-----------------|----|
| | Yes | No | Yes | No |
| Precision Internal Oscillator | Yes | | Yes | |
| Precision Internal Oscillator divide by 4 (4 MHz \pm 1%) | No | | Yes | |
| Main Oscillator | Yes | | Yes | |
| Internal 30-kHz Oscillator | No | | Yes | |
| Hibernation Module 32.768-kHz Oscillator | No | | Yes | |
| Hibernation Module 4.194304-MHz Crystal | No | | No | |

5.2.5.2 Clock Configuration

The **Run-Mode Clock Configuration (RCC)** and **Run-Mode Clock Configuration 2 (RCC2)** registers provide control for the system clock. The **RCC2** register is provided to extend fields that offer additional encodings over the **RCC** register. When used, the **RCC2** register field values are used by the logic over the corresponding field in the **RCC** register. In particular, **RCC2** provides for a larger assortment of clock configuration options. These registers control the following clock functionality:

- Source of clocks in sleep and deep-sleep modes
- System clock derived from PLL or other clock source
- Enabling/disabling of oscillators and PLL
- Clock divisors

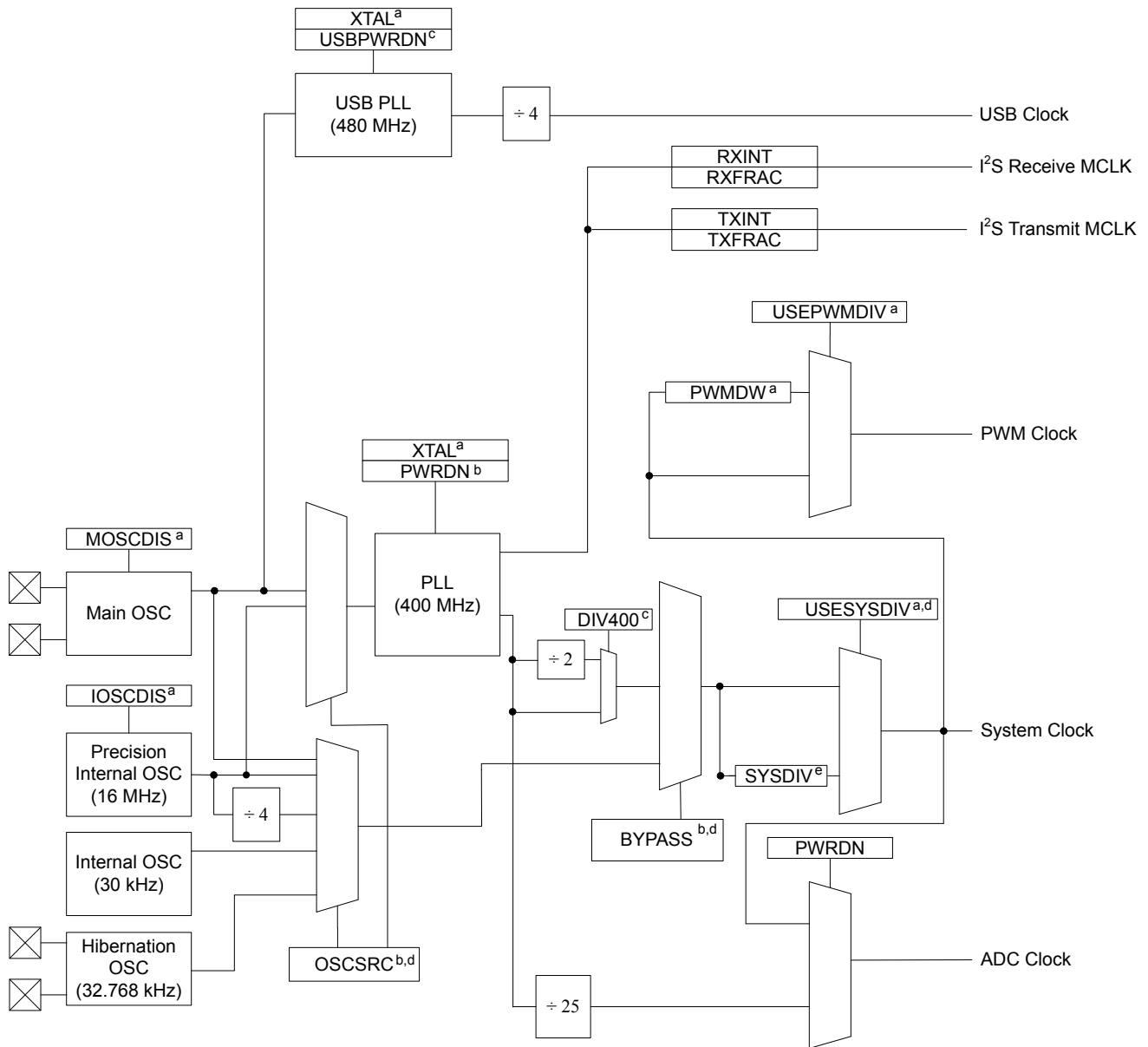
- Crystal input selection

Important: Write the **RCC** register prior to writing the **RCC2** register. If a subsequent write to the **RCC** register is required, include another register access after writing the **RCC** register and before writing the **RCC2** register.

Figure 5-5 shows the logic for the main clock tree. The peripheral blocks are driven by the system clock signal and can be individually enabled/disabled. When the PLL is enabled, the ADC clock signal is automatically divided down to 16 MHz from the PLL output for proper ADC operation. The PWM clock signal is a synchronous divide of the system clock to provide the PWM circuit with more range (set with `PWMDIV` in **RCC**).

Note: When the ADC module is in operation, the system clock must be at least 16 MHz.

Figure 5-5. Main Clock Tree



- a. Control provided by **RCC** register bit/field.
 b. Control provided by **RCC** register bit/field or **RCC2** register bit/field, if overridden with **RCC2** register bit USERCC2.
 c. Control provided by **RCC2** register bit/field.
 d. Also may be controlled by **DSLPLCLKCFG** when in deep sleep mode.
 e. Control provided by **RCC** register SYSDIV field, **RCC2** register SYSDIV2 field if overridden with USERCC2 bit, or [SYSDIV2, SYSDIV2LSB] if both USERCC2 and DIV400 bits are set.

Note: The figure above shows all features available on all Stellaris® Firestorm-class microcontrollers. Not all peripherals may be available on this device.

Using the SYSDIV and SYSDIV2 Fields

In the **RCC** register, the **SYSDIV** field specifies which divisor is used to generate the system clock from either the PLL output or the oscillator source (depending on how the **BYPASS** bit in this register

is configured). When using the PLL, the VCO frequency of 400 MHz is predivided by 2 before the divisor is applied. Table 5-5 shows how the `SYSDIV` encoding affects the system clock frequency, depending on whether the PLL is used (`BYPASS=0`) or another clock source is used (`BYPASS=1`). The divisor is equivalent to the `SYSDIV` encoding plus 1. For a list of possible clock sources, see Table 5-4 on page 189.

Table 5-5. Possible System Clock Frequencies Using the SYSDIV Field

| SYSDIV | Divisor | Frequency (BYPASS=0) | Frequency (BYPASS=1) | StellarisWare® Parameter ^a |
|--------|---------|----------------------|---------------------------|---------------------------------------|
| 0x0 | /1 | reserved | Clock source frequency/2 | SYSTL_SYSDIV_1 ^b |
| 0x1 | /2 | reserved | Clock source frequency/2 | SYSTL_SYSDIV_2 |
| 0x2 | /3 | 66.67 MHz | Clock source frequency/3 | SYSTL_SYSDIV_3 |
| 0x3 | /4 | 50 MHz | Clock source frequency/4 | SYSTL_SYSDIV_4 |
| 0x4 | /5 | 40 MHz | Clock source frequency/5 | SYSTL_SYSDIV_5 |
| 0x5 | /6 | 33.33 MHz | Clock source frequency/6 | SYSTL_SYSDIV_6 |
| 0x6 | /7 | 28.57 MHz | Clock source frequency/7 | SYSTL_SYSDIV_7 |
| 0x7 | /8 | 25 MHz | Clock source frequency/8 | SYSTL_SYSDIV_8 |
| 0x8 | /9 | 22.22 MHz | Clock source frequency/9 | SYSTL_SYSDIV_9 |
| 0x9 | /10 | 20 MHz | Clock source frequency/10 | SYSTL_SYSDIV_10 |
| 0xA | /11 | 18.18 MHz | Clock source frequency/11 | SYSTL_SYSDIV_11 |
| 0xB | /12 | 16.67 MHz | Clock source frequency/12 | SYSTL_SYSDIV_12 |
| 0xC | /13 | 15.38 MHz | Clock source frequency/13 | SYSTL_SYSDIV_13 |
| 0xD | /14 | 14.29 MHz | Clock source frequency/14 | SYSTL_SYSDIV_14 |
| 0xE | /15 | 13.33 MHz | Clock source frequency/15 | SYSTL_SYSDIV_15 |
| 0xF | /16 | 12.5 MHz (default) | Clock source frequency/16 | SYSTL_SYSDIV_16 |

a. This parameter is used in functions such as `SysCtlClockSet()` in the Stellaris Peripheral Driver Library.

b. `SYSTL_SYSDIV_1` does not set the `USESYSDIV` bit. As a result, using this parameter without enabling the PLL results in the system clock having the same frequency as the clock source.

The `SYSDIV2` field in the **RCC2** register is 2 bits wider than the `SYSDIV` field in the **RCC** register so that additional larger divisors up to /64 are possible, allowing a lower system clock frequency for improved Deep Sleep power consumption. When using the PLL, the VCO frequency of 400 MHz is predivided by 2 before the divisor is applied. The divisor is equivalent to the `SYSDIV2` encoding plus 1. Table 5-6 shows how the `SYSDIV2` encoding affects the system clock frequency, depending on whether the PLL is used (`BYPASS2=0`) or another clock source is used (`BYPASS2=1`). For a list of possible clock sources, see Table 5-4 on page 189.

Table 5-6. Examples of Possible System Clock Frequencies Using the SYSDIV2 Field

| SYSDIV2 | Divisor | Frequency (BYPASS2=0) | Frequency (BYPASS2=1) | StellarisWare Parameter ^a |
|---------|---------|-----------------------|---------------------------|--------------------------------------|
| 0x00 | /1 | reserved | Clock source frequency/2 | SYSTL_SYSDIV_1 ^b |
| 0x01 | /2 | reserved | Clock source frequency/2 | SYSTL_SYSDIV_2 |
| 0x02 | /3 | 66.67 MHz | Clock source frequency/3 | SYSTL_SYSDIV_3 |
| 0x03 | /4 | 50 MHz | Clock source frequency/4 | SYSTL_SYSDIV_4 |
| 0x04 | /5 | 40 MHz | Clock source frequency/5 | SYSTL_SYSDIV_5 |
| ... | ... | ... | ... | ... |
| 0x09 | /10 | 20 MHz | Clock source frequency/10 | SYSTL_SYSDIV_10 |
| ... | ... | ... | ... | ... |

Table 5-6. Examples of Possible System Clock Frequencies Using the SYSDIV2 Field (continued)

| SYSDIV2 | Divisor | Frequency (BYPASS2=0) | Frequency (BYPASS2=1) | StellarisWare Parameter ^a |
|---------|---------|-----------------------|---------------------------|--------------------------------------|
| 0x3F | /64 | 3.125 MHz | Clock source frequency/64 | SYSCTL_SYSDIV_64 |

a. This parameter is used in functions such as SysCtlClockSet() in the Stellaris Peripheral Driver Library.

b. SYSCTL_SYSDIV_1 does not set the USESYSDIV bit. As a result, using this parameter without enabling the PLL results in the system clock having the same frequency as the clock source.

To allow for additional frequency choices when using the PLL, the DIV400 bit is provided along with the SYSDIV2LSB bit. When the DIV400 bit is set, bit 22 becomes the LSB for SYSDIV2. In this situation, the divisor is equivalent to the (SYSDIV2 encoding with SYSDIV2LSB appended) plus one. Table 5-7 shows the frequency choices when DIV400 is set. When the DIV400 bit is clear, SYSDIV2LSB is ignored, and the system clock frequency is determined as shown in Table 5-6 on page 192.

Table 5-7. Examples of Possible System Clock Frequencies with DIV400=1

| SYSDIV2 | SYSDIV2LSB | Divisor | Frequency (BYPASS2=0) ^a | StellarisWare Parameter ^b |
|---------|------------|---------|------------------------------------|--------------------------------------|
| 0x00 | reserved | /2 | reserved | - |
| 0x01 | 0 | /3 | reserved | - |
| | 1 | /4 | reserved | - |
| 0x02 | 0 | /5 | 80 MHz | SYSCTL_SYSDIV_2_5 |
| | 1 | /6 | 66.67 MHz | SYSCTL_SYSDIV_3 |
| 0x03 | 0 | /7 | reserved | - |
| | 1 | /8 | 50 MHz | SYSCTL_SYSDIV_4 |
| 0x04 | 0 | /9 | 44.44 MHz | SYSCTL_SYSDIV_4_5 |
| | 1 | /10 | 40 MHz | SYSCTL_SYSDIV_5 |
| ... | ... | ... | ... | ... |
| 0x3F | 0 | /127 | 3.15 MHz | SYSCTL_SYSDIV_63_5 |
| | 1 | /128 | 3.125 MHz | SYSCTL_SYSDIV_64 |

a. Note that DIV400 and SYSDIV2LSB are only valid when BYPASS2=0.

b. This parameter is used in functions such as SysCtlClockSet() in the Stellaris Peripheral Driver Library.

5.2.5.3 Precision Internal Oscillator Operation (PIOSC)

The microcontroller powers up with the PIOSC running. If another clock source is desired, the PIOSC must remain enabled as it is used for internal functions. The PIOSC can only be disabled during Deep-Sleep mode. It can be powered down by setting the IOSCDIS bit in the **RCC** register.

The PIOSC generates a 16-MHz clock with a $\pm 1\%$ accuracy at room temperatures. Across the extended temperature range, the accuracy is $\pm 3\%$. At the factory, the PIOSC is set to 16 MHz at room temperature, however, the frequency can be trimmed for other voltage or temperature conditions using software in one of three ways:

- Default calibration: clear the UTEN bit and set the UPDATE bit in the **Precision Internal Oscillator Calibration (PIOSCCAL)** register.
- User-defined calibration: The user can program the UT value to adjust the PIOSC frequency. As the UT value increases, the generated period increases. To commit a new UT value, first set the

UTEN bit, then program the UT field, and then set the UPDATE bit. The adjustment finishes within a few clock periods and is glitch free.

- Automatic calibration using the Hibernation module with a functioning 32.768-kHz clock source: Set the CAL bit in the **PIOSCCAL** register; the results of the calibration are shown in the RESULT field in the **Precision Internal Oscillator Statistic (PIOSCSTAT)** register. After calibration is complete, the PIOSC is trimmed using the trimmed value returned in the CT field.

5.2.5.4 Crystal Configuration for the Main Oscillator (MOSC)

The main oscillator supports the use of a select number of crystals. If the main oscillator is used by the PLL as a reference clock, the supported range of crystals is 3.579545 to 16.384 MHz, otherwise, the range of supported crystals is 1 to 16.384 MHz.

The XTAL bit in the **RCC** register (see page 211) describes the available crystal choices and default programming values.

Software configures the **RCC** register XTAL field with the crystal number. If the PLL is used in the design, the XTAL field value is internally translated to the PLL settings.

5.2.5.5 Main PLL Frequency Configuration

The main PLL is disabled by default during power-on reset and is enabled later by software if required. Software specifies the output divisor to set the system clock frequency and enables the main PLL to drive the output. The PLL operates at 400 MHz, but is divided by two prior to the application of the output divisor, unless the DIV400 bit in the **RCC2** register is set.

To configure the PIOSC to be the clock source for the main PLL, program the OSCRC2 field in the **Run-Mode Clock Configuration 2 (RCC2)** register to be 0x1.

If the main oscillator provides the clock reference to the main PLL, the translation provided by hardware and used to program the PLL is available for software in the **XTAL to PLL Translation (PLLCFG)** register (see page 215). The internal translation provides a translation within $\pm 1\%$ of the targeted PLL VCO frequency. Table 25-8 on page 1134 shows the actual PLL frequency and error for a given crystal choice.

The Crystal Value field (XTAL) in the **Run-Mode Clock Configuration (RCC)** register (see page 211) describes the available crystal choices and default programming of the **PLLCFG** register. Any time the XTAL field changes, the new settings are translated and the internal PLL settings are updated.

5.2.5.6 PLL Modes

- Normal: The PLL multiplies the input clock reference and drives the output.
- Power-Down: Most of the PLL internal circuitry is disabled and the PLL does not drive the output.

The modes are programmed using the **RCC/RCC2** register fields (see page 211 and page 218).

5.2.5.7 PLL Operation

If a PLL configuration is changed, the PLL output frequency is unstable until it reconverges (relocks) to the new setting. The time between the configuration change and relock is T_{READY} (see Table 25-7 on page 1133). During the relock time, the affected PLL is not usable as a clock reference.

The PLL is changed by one of the following:

- Change to the XTAL value in the **RCC** register—writes of the same value do not cause a relock.

- Change in the PLL from Power-Down to Normal mode.

A counter clocked by the system clock is used to measure the T_{READY} requirement. If the system clock is the main oscillator and it is running off an 8.192 MHz or slower external oscillator clock, the down counter is set to 0x1200 (that is, ~600 μs at an 8.192 MHz). If the system clock is running off the PIOSC or an external oscillator clock that is faster than 8.192 MHz, the down counter is set to 0x2400. Hardware is provided to keep the PLL from being used as a system clock until the T_{READY} condition is met after one of the two changes above. It is the user's responsibility to have a stable clock source (like the main oscillator) before the **RCC/RCC2** register is switched to use the PLL.

If the main PLL is enabled and the system clock is switched to use the PLL in one step, the system control hardware continues to clock the microcontroller from the oscillator selected by the **RCC/RCC2** register until the main PLL is stable (T_{READY} time met), after which it changes to the PLL. Software can use many methods to ensure that the system is clocked from the main PLL, including periodically polling the `PLLLRIS` bit in the **Raw Interrupt Status (RIS)** register, and enabling the PLL Lock interrupt.

5.2.5.8 Main Oscillator Verification Circuit

The clock control includes circuitry to ensure that the main oscillator is running at the appropriate frequency. The circuit monitors the main oscillator frequency and signals if the frequency is outside of the allowable band of attached crystals.

The detection circuit is enabled using the `CVAL` bit in the **Main Oscillator Control (MOSCCTL)** register. If this circuit is enabled and detects an error, the following sequence is performed by the hardware:

1. The `MOSCFAIL` bit in the **Reset Cause (RESC)** register is set.
2. If the internal oscillator (PIOSC) is disabled, it is enabled.
3. The system clock is switched from the main oscillator to the PIOSC.
4. An internal power-on reset is initiated that lasts for 32 PIOSC periods.
5. Reset is de-asserted and the processor is directed to the NMI handler during the reset sequence.

5.2.6 System Control

For power-savings purposes, the **RCGCn**, **SCGCn**, and **DCGCn** registers control the clock gating logic for each peripheral or block in the system while the microcontroller is in Run, Sleep, and Deep-Sleep mode, respectively. These registers are located in the System Control register map starting at offsets 0x600, 0x700, and 0x800, respectively. There must be a delay of 3 system clocks after a peripheral module clock is enabled in the **RCGC** register before any module registers are accessed.

There are four levels of operation for the microcontroller defined as:

- Run mode
- Sleep mode
- Deep-Sleep mode
- Hibernate mode

The following sections describe the different modes in detail.

Caution – If the Cortex-M3 Debug Access Port (DAP) has been enabled, and the device wakes from a low power sleep or deep-sleep mode, the core may start executing code before all clocks to peripherals have been restored to their Run mode configuration. The DAP is usually enabled by software tools accessing the JTAG or SWD interface when debugging or flash programming. If this condition occurs, a Hard Fault is triggered when software accesses a peripheral with an invalid clock.

A software delay loop can be used at the beginning of the interrupt routine that is used to wake up a system from a WFI (Wait For Interrupt) instruction. This stalls the execution of any code that accesses a peripheral register that might cause a fault. This loop can be removed for production software as the DAP is most likely not enabled during normal execution.

Because the DAP is disabled by default (power on reset), the user can also power cycle the device. The DAP is not enabled unless it is enabled through the JTAG or SWD interface.

5.2.6.1 Run Mode

In Run mode, the microcontroller actively executes code. Run mode provides normal operation of the processor and all of the peripherals that are currently enabled by the **RCGCn** registers. The system clock can be any of the available clock sources including the PLL.

5.2.6.2 Sleep Mode

In Sleep mode, the clock frequency of the active peripherals is unchanged, but the processor and the memory subsystem are not clocked and therefore no longer execute code. Sleep mode is entered by the Cortex-M3 core executing a WFI (Wait for Interrupt) instruction. Any properly configured interrupt event in the system brings the processor back into Run mode. See “Power Management” on page 98 for more details.

Peripherals are clocked that are enabled in the **SCGCn** registers when auto-clock gating is enabled (see the **RCC** register) or the **RCGCn** registers when the auto-clock gating is disabled. The system clock has the same source and frequency as that during Run mode.

5.2.6.3 Deep-Sleep Mode

In Deep-Sleep mode, the clock frequency of the active peripherals may change (depending on the Run mode clock configuration) in addition to the processor clock being stopped. An interrupt returns the microcontroller to Run mode from one of the sleep modes; the sleep modes are entered on request from the code. Deep-Sleep mode is entered by first setting the **SLEEPDEEP** bit in the **System Control (SYSCTRL)** register (see page 140) and then executing a WFI instruction. Any properly configured interrupt event in the system brings the processor back into Run mode. See “Power Management” on page 98 for more details.

The Cortex-M3 processor core and the memory subsystem are not clocked in Deep-Sleep mode. Peripherals are clocked that are enabled in the **DCGCn** registers when auto-clock gating is enabled (see the **RCC** register) or the **RCGCn** registers when auto-clock gating is disabled. The system clock source is specified in the **DSLPCCLKCFG** register. When the **DSLPCCLKCFG** register is used, the internal oscillator source is powered up, if necessary, and other clocks are powered down. If the PLL is running at the time of the WFI instruction, hardware powers the PLL down and overrides the **SYSDIV** field of the active **RCC/RCC2** register, to be determined by the **DSDIVORIDE** setting in the **DSLPCCLKCFG** register, up to /16 or /64 respectively. When the Deep-Sleep exit event occurs, hardware brings the system clock back to the source and frequency it had at the onset of Deep-Sleep mode before enabling the clocks that had been stopped during the Deep-Sleep duration. If the PIOSC is used as the PLL reference clock source, it may continue to provide the clock during Deep-Sleep. See page 222.

5.2.6.4 Hibernate Mode

In this mode, the power supplies are turned off to the main part of the microcontroller and only the Hibernation module's circuitry is active. An external wake event or RTC event is required to bring the microcontroller back to Run mode. The Cortex-M3 processor and peripherals outside of the Hibernation module see a normal "power on" sequence and the processor starts running code. Software can determine if the microcontroller has been restarted from Hibernate mode by inspecting the Hibernation module registers. For more information on the operation of Hibernate mode, see "Hibernation Module" on page 287.

5.3 Initialization and Configuration

The PLL is configured using direct register writes to the **RCC/RCC2** register. If the **RCC2** register is being used, the **USERCC2** bit must be set and the appropriate **RCC2** bit/field is used. The steps required to successfully change the PLL-based system clock are:

1. Bypass the PLL and system clock divider by setting the **BYPASS** bit and clearing the **USESYS** bit in the **RCC** register, thereby configuring the microcontroller to run off a "raw" clock source and allowing for the new PLL configuration to be validated before switching the system clock to the PLL.
2. Select the crystal value (**XTAL**) and oscillator source (**OSCSRC**), and clear the **PWRDN** bit in **RCC/RCC2**. Setting the **XTAL** field automatically pulls valid PLL configuration data for the appropriate crystal, and clearing the **PWRDN** bit powers and enables the PLL and its output.
3. Select the desired system divider (**SYSDIV**) in **RCC/RCC2** and set the **USESYS** bit in **RCC**. The **SYSDIV** field determines the system frequency for the microcontroller.
4. Wait for the PLL to lock by polling the **PLLLRIS** bit in the **Raw Interrupt Status (RIS)** register.
5. Enable use of the PLL by clearing the **BYPASS** bit in **RCC/RCC2**.

5.4 Register Map

Table 5-8 on page 197 lists the System Control registers, grouped by function. The offset listed is a hexadecimal increment to the register's address, relative to the System Control base address of 0x400F.E000.

Note: Spaces in the System Control register space that are not used are reserved for future or internal use. Software should not modify any reserved memory address.

Additional Flash and ROM registers defined in the System Control register space are described in the "Internal Memory" on page 314.

Table 5-8. System Control Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|------|------|-------------|-------------------------|----------|
| 0x000 | DID0 | RO | - | Device Identification 0 | 200 |
| 0x004 | DID1 | RO | - | Device Identification 1 | 229 |
| 0x008 | DC0 | RO | 0x017F.00BF | Device Capabilities 0 | 231 |
| 0x010 | DC1 | RO | - | Device Capabilities 1 | 232 |
| 0x014 | DC2 | RO | 0x570F.5337 | Device Capabilities 2 | 234 |

Table 5-8. System Control Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|-------------|-------|-------------|---|----------|
| 0x018 | DC3 | RO | 0xBFFF.FFFF | Device Capabilities 3 | 236 |
| 0x01C | DC4 | RO | 0x0004.F1FF | Device Capabilities 4 | 239 |
| 0x020 | DC5 | RO | 0x0F30.00FF | Device Capabilities 5 | 241 |
| 0x024 | DC6 | RO | 0x0000.0000 | Device Capabilities 6 | 243 |
| 0x028 | DC7 | RO | 0xFFFF.FFFF | Device Capabilities 7 | 244 |
| 0x02C | DC8 | RO | 0xFFFF.FFFF | Device Capabilities 8 ADC Channels | 248 |
| 0x030 | PBORCTL | R/W | 0x0000.0002 | Brown-Out Reset Control | 202 |
| 0x040 | SRCR0 | R/W | 0x00000000 | Software Reset Control 0 | 280 |
| 0x044 | SRCR1 | R/W | 0x00000000 | Software Reset Control 1 | 282 |
| 0x048 | SRCR2 | R/W | 0x00000000 | Software Reset Control 2 | 285 |
| 0x050 | RIS | RO | 0x0000.0000 | Raw Interrupt Status | 203 |
| 0x054 | IMC | R/W | 0x0000.0000 | Interrupt Mask Control | 205 |
| 0x058 | MISC | R/W1C | 0x0000.0000 | Masked Interrupt Status and Clear | 207 |
| 0x05C | RESC | R/W | - | Reset Cause | 209 |
| 0x060 | RCC | R/W | 0x078E.3AD1 | Run-Mode Clock Configuration | 211 |
| 0x064 | PLLCFG | RO | - | XTAL to PLL Translation | 215 |
| 0x06C | GPIOHBCTL | R/W | 0x0000.0000 | GPIO High-Performance Bus Control | 216 |
| 0x070 | RCC2 | R/W | 0x07C0.6810 | Run-Mode Clock Configuration 2 | 218 |
| 0x07C | MOSCCTL | R/W | 0x0000.0000 | Main Oscillator Control | 221 |
| 0x100 | RCGC0 | R/W | 0x00000040 | Run Mode Clock Gating Control Register 0 | 254 |
| 0x104 | RCGC1 | R/W | 0x00000000 | Run Mode Clock Gating Control Register 1 | 262 |
| 0x108 | RCGC2 | R/W | 0x00000000 | Run Mode Clock Gating Control Register 2 | 274 |
| 0x110 | SCGC0 | R/W | 0x00000040 | Sleep Mode Clock Gating Control Register 0 | 257 |
| 0x114 | SCGC1 | R/W | 0x00000000 | Sleep Mode Clock Gating Control Register 1 | 266 |
| 0x118 | SCGC2 | R/W | 0x00000000 | Sleep Mode Clock Gating Control Register 2 | 276 |
| 0x120 | DCGC0 | R/W | 0x00000040 | Deep Sleep Mode Clock Gating Control Register 0 | 260 |
| 0x124 | DCGC1 | R/W | 0x00000000 | Deep-Sleep Mode Clock Gating Control Register 1 | 270 |
| 0x128 | DCGC2 | R/W | 0x00000000 | Deep Sleep Mode Clock Gating Control Register 2 | 278 |
| 0x144 | DSLPLCLKCFG | R/W | 0x0780.0000 | Deep Sleep Clock Configuration | 222 |
| 0x150 | PIOSCCAL | R/W | 0x0000.0000 | Precision Internal Oscillator Calibration | 224 |
| 0x154 | PIOSCSTAT | RO | 0x0000.0040 | Precision Internal Oscillator Statistics | 226 |
| 0x170 | I2SMCLKCFG | R/W | 0x0000.0000 | I2S MCLK Configuration | 227 |

Table 5-8. System Control Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|---------|------|-------------|---|----------|
| 0x190 | DC9 | RO | 0x00FF.00FF | Device Capabilities 9 ADC Digital Comparators | 251 |
| 0x1A0 | NVMSTAT | RO | 0x0000.0001 | Non-Volatile Memory Information | 253 |

5.5 Register Descriptions

All addresses given are relative to the System Control base address of 0x400F.E000.

Register 1: Device Identification 0 (DID0), offset 0x000

This register identifies the version of the microcontroller. Each microcontroller is uniquely identified by the combined values of the `CLASS` field in the **DID0** register and the `PARTNO` field in the **DID1** register.

Device Identification 0 (DID0)

Base 0x400F.E000

Offset 0x000

Type RO, reset -

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|----|----|----------|----|----|----|-------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | VER | | | reserved | | | | CLASS | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MAJOR | | | | | | | | MINOR | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description | | | | |
|-----------|--|------|-------|--|-------|-------------|------|--|
| 31 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | |
| 30:28 | VER | RO | 0x1 | <p>DID0 Version</p> <p>This field defines the DID0 register format version. The version number is numeric. The value of the <code>VER</code> field is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x1</td> <td>Second version of the DID0 register format.</td> </tr> </tbody> </table> | Value | Description | 0x1 | Second version of the DID0 register format. |
| Value | Description | | | | | | | |
| 0x1 | Second version of the DID0 register format. | | | | | | | |
| 27:24 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | |
| 23:16 | CLASS | RO | 0x06 | <p>Device Class</p> <p>The <code>CLASS</code> field value identifies the internal design from which all mask sets are generated for all microcontrollers in a particular product line. The <code>CLASS</code> field value is changed for new product lines, for changes in fab process (for example, a remap or shrink), or any case where the <code>MAJOR</code> or <code>MINOR</code> fields require differentiation from prior microcontrollers. The value of the <code>CLASS</code> field is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x06</td> <td>Stellaris® Firestorm-class microcontrollers</td> </tr> </tbody> </table> | Value | Description | 0x06 | Stellaris® Firestorm-class microcontrollers |
| Value | Description | | | | | | | |
| 0x06 | Stellaris® Firestorm-class microcontrollers | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | |
|-----------|---|------|-------|---|-------|-------------|-----|---|-----|--|-----|---|
| 15:8 | MAJOR | RO | - | <p>Major Revision</p> <p>This field specifies the major revision number of the microcontroller. The major revision reflects changes to base layers of the design. The major revision number is indicated in the part number as a letter (A for first revision, B for second, and so on). This field is encoded as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Revision A (initial device)</td> </tr> <tr> <td>0x1</td> <td>Revision B (first base layer revision)</td> </tr> <tr> <td>0x2</td> <td>Revision C (second base layer revision)</td> </tr> </tbody> </table> <p>and so on.</p> | Value | Description | 0x0 | Revision A (initial device) | 0x1 | Revision B (first base layer revision) | 0x2 | Revision C (second base layer revision) |
| Value | Description | | | | | | | | | | | |
| 0x0 | Revision A (initial device) | | | | | | | | | | | |
| 0x1 | Revision B (first base layer revision) | | | | | | | | | | | |
| 0x2 | Revision C (second base layer revision) | | | | | | | | | | | |
| 7:0 | MINOR | RO | - | <p>Minor Revision</p> <p>This field specifies the minor revision number of the microcontroller. The minor revision reflects changes to the metal layers of the design. The MINOR field value is reset when the MAJOR field is changed. This field is numeric and is encoded as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Initial device, or a major revision update.</td> </tr> <tr> <td>0x1</td> <td>First metal layer change.</td> </tr> <tr> <td>0x2</td> <td>Second metal layer change.</td> </tr> </tbody> </table> <p>and so on.</p> | Value | Description | 0x0 | Initial device, or a major revision update. | 0x1 | First metal layer change. | 0x2 | Second metal layer change. |
| Value | Description | | | | | | | | | | | |
| 0x0 | Initial device, or a major revision update. | | | | | | | | | | | |
| 0x1 | First metal layer change. | | | | | | | | | | | |
| 0x2 | Second metal layer change. | | | | | | | | | | | |

Register 2: Brown-Out Reset Control (PBORCTL), offset 0x030

This register is responsible for controlling reset conditions after initial power-on reset.

Brown-Out Reset Control (PBORCTL)

Base 0x400F.E000
 Offset 0x030
 Type R/W, reset 0x0000.0002

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | | BORIOR | reserved |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:2 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | BORIOR | R/W | 1 | BOR Interrupt or Reset |
| | | | | Value Description |
| | | | 0 | A Brown Out Event causes an interrupt to be generated to the interrupt controller. |
| | | | 1 | A Brown Out Event causes a reset of the microcontroller. |
| 0 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 3: Raw Interrupt Status (RIS), offset 0x050

This register indicates the status for system control raw interrupts. An interrupt is sent to the interrupt controller if the corresponding bit in the **Interrupt Mask Control (IMC)** register is set. Writing a 1 to the corresponding bit in the **Masked Interrupt Status and Clear (MISC)** register clears an interrupt status bit.

Raw Interrupt Status (RIS)

Base 0x400F.E000

Offset 0x050

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|------------|----------|---------|----------|----|----|----|--------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | MOSCPUPRIS | reserved | PLLLRIS | reserved | | | | BORRIS | reserved |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------------|------|-----------|--|
| 31:9 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | MOSCPUPRIS | RO | 0 | <p>MOSC Power Up Raw Interrupt Status</p> <p>Value Description</p> <p>1 Sufficient time has passed for the MOSC to reach the expected frequency. The value for this power-up time is indicated by T_{MOSC_START}.</p> <p>0 Sufficient time has not passed for the MOSC to reach the expected frequency.</p> <p>This bit is cleared by writing a 1 to the MOSCPUPMIS bit in the MISC register.</p> |
| 7 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6 | PLLLRIS | RO | 0 | <p>PLL Lock Raw Interrupt Status</p> <p>Value Description</p> <p>1 The PLL timer has reached T_{READY} indicating that sufficient time has passed for the PLL to lock.</p> <p>0 The PLL timer has not reached T_{READY}.</p> <p>This bit is cleared by writing a 1 to the PLLLMIS bit in the MISC register.</p> |
| 5:2 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 1 | BORRIS | RO | 0 | <p>Brown-Out Reset Raw Interrupt Status</p> <p>Value Description</p> <p>1 A brown-out condition is currently active.</p> <p>0 A brown-out condition is not currently active.</p> <p>Note the BORIOR bit in the PBORCTL register must be cleared to cause an interrupt due to a Brown Out Event.</p> <p>This bit is cleared by writing a 1 to the BORMIS bit in the MISC register.</p> |
| 0 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |

Register 4: Interrupt Mask Control (IMC), offset 0x054

This register contains the mask bits for system control raw interrupts. A raw interrupt, indicated by a bit being set in the **Raw Interrupt Status (RIS)** register, is sent to the interrupt controller if the corresponding bit in this register is set.

Interrupt Mask Control (IMC)

Base 0x400F.E000
Offset 0x054
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|-----------|----------|--------|----------|----|----|----|-------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | MOSCPUPIM | reserved | PLLLIM | reserved | | | | BORIM | reserved |
| Type | RO | RO | RO | RO | RO | RO | RO | R/W | RO | R/W | RO | RO | RO | RO | R/W | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-----------|--|
| 31:9 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | MOSCPUPIM | R/W | 0 | MOSC Power Up Interrupt Mask Value Description 1 An interrupt is sent to the interrupt controller when the MOSCPUPRIS bit in the RIS register is set. 0 The MOSCPUPRIS interrupt is suppressed and not sent to the interrupt controller. |
| 7 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6 | PLLLIM | R/W | 0 | PLL Lock Interrupt Mask Value Description 1 An interrupt is sent to the interrupt controller when the PLLLRIS bit in the RIS register is set. 0 The PLLLRIS interrupt is suppressed and not sent to the interrupt controller. |
| 5:2 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 1 | BORIM | R/W | 0 | Brown-Out Reset Interrupt Mask Value Description 1 An interrupt is sent to the interrupt controller when the BORRIS bit in the RIS register is set. 0 The BORRIS interrupt is suppressed and not sent to the interrupt controller. |
| 0 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 5: Masked Interrupt Status and Clear (MISC), offset 0x058

On a read, this register gives the current masked status value of the corresponding interrupt in the **Raw Interrupt Status (RIS)** register. All of the bits are R/W1C, thus writing a 1 to a bit clears the corresponding raw interrupt bit in the **RIS** register (see page 203).

Masked Interrupt Status and Clear (MISC)

Base 0x400F.E000
Offset 0x058
Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|------------|----------|---------|----------|----|----|----|--------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | MOSCPUPMIS | reserved | PLLLMIS | reserved | | | | BORMIS | reserved |
| Type | RO | RO | RO | RO | RO | RO | RO | R/W1C | RO | R/W1C | RO | RO | RO | RO | R/W1C | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------------|-------|-----------|--|
| 31:9 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | MOSCPUPMIS | R/W1C | 0 | MOSC Power Up Masked Interrupt Status Value Description 1 When read, a 1 indicates that an unmasked interrupt was signaled because sufficient time has passed for the MOSC PLL to lock. Writing a 1 to this bit clears it and also the MOSCPUPRIS bit in the RIS register. 0 When read, a 0 indicates that sufficient time has not passed for the MOSC PLL to lock. A write of 0 has no effect on the state of this bit. |
| 7 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6 | PLLLMIS | R/W1C | 0 | PLL Lock Masked Interrupt Status Value Description 1 When read, a 1 indicates that an unmasked interrupt was signaled because sufficient time has passed for the PLL to lock. Writing a 1 to this bit clears it and also the PLLLRIS bit in the RIS register. 0 When read, a 0 indicates that sufficient time has not passed for the PLL to lock. A write of 0 has no effect on the state of this bit. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-------|--|
| 5:2 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | BORMIS | R/W1C | 0 | BOR Masked Interrupt Status Value Description 1 When read, a 1 indicates that an unmasked interrupt was signaled because of a brown-out condition. Writing a 1 to this bit clears it and also the BORRIS bit in the RIS register. 0 When read, a 0 indicates that a brown-out condition has not occurred. A write of 0 has no effect on the state of this bit. |
| 0 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 6: Reset Cause (RESC), offset 0x05C

This register is set with the reset cause after reset. The bits in this register are sticky and maintain their state across multiple reset sequences, except when an power-on reset is the cause, in which case, all bits other than POR in the **RESC** register are cleared.

Reset Cause (RESC)

Base 0x400F.E000

Offset 0x05C

Type R/W, reset -

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|------|-----|------|-----|-----|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | MOSCFAIL |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | WDT1 | SW | WDT0 | BOR | POR | EXT |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:17 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 16 | MOSCFAIL | R/W | - | MOSC Failure Reset |
| | | | | Value Description |
| | | | | 1 When read, this bit indicates that the MOSC circuit was enabled for clock validation and failed, generating a reset event. |
| | | | | 0 When read, this bit indicates that a MOSC failure has not generated a reset since the previous power-on reset. Writing a 0 to this bit clears it. |
| 15:6 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | WDT1 | R/W | - | Watchdog Timer 1 Reset |
| | | | | Value Description |
| | | | | 1 When read, this bit indicates that Watchdog Timer 1 timed out and generated a reset. |
| | | | | 0 When read, this bit indicates that Watchdog Timer 1 has not generated a reset since the previous power-on reset. Writing a 0 to this bit clears it. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 4 | SW | R/W | - | <p>Software Reset</p> <p>Value Description</p> <p>1 When read, this bit indicates that a software reset has caused a reset event.</p> <p>0 When read, this bit indicates that a software reset has not generated a reset since the previous power-on reset. Writing a 0 to this bit clears it.</p> |
| 3 | WDT0 | R/W | - | <p>Watchdog Timer 0 Reset</p> <p>Value Description</p> <p>1 When read, this bit indicates that Watchdog Timer 0 timed out and generated a reset.</p> <p>0 When read, this bit indicates that Watchdog Timer 0 has not generated a reset since the previous power-on reset. Writing a 0 to this bit clears it.</p> |
| 2 | BOR | R/W | - | <p>Brown-Out Reset</p> <p>Value Description</p> <p>1 When read, this bit indicates that a brown-out reset has caused a reset event.</p> <p>0 When read, this bit indicates that a brown-out reset has not generated a reset since the previous power-on reset. Writing a 0 to this bit clears it.</p> |
| 1 | POR | R/W | - | <p>Power-On Reset</p> <p>Value Description</p> <p>1 When read, this bit indicates that a power-on reset has caused a reset event.</p> <p>0 When read, this bit indicates that a power-on reset has not generated a reset. Writing a 0 to this bit clears it.</p> |
| 0 | EXT | R/W | - | <p>External Reset</p> <p>Value Description</p> <p>1 When read, this bit indicates that an external reset (\overline{RST} assertion) has caused a reset event.</p> <p>0 When read, this bit indicates that an external reset (\overline{RST} assertion) has not caused a reset event since the previous power-on reset. Writing a 0 to this bit clears it.</p> |

Register 7: Run-Mode Clock Configuration (RCC), offset 0x060

The bits in this register configure the system clock and oscillators.

Important: Write the **RCC** register prior to writing the **RCC2** register. If a subsequent write to the **RCC** register is required, include another register access after writing the **RCC** register and before writing the **RCC2** register.

Run-Mode Clock Configuration (RCC)

Base 0x400F.E000

Offset 0x060

Type R/W, reset 0x078E.3AD1

| | | | | | | | | | | | | | | | | |
|-------|----------|----|-------|----------|--------|--------|-----|-----|-----|-----------|----------|-----------|--------|---------|---------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | ACG | SYSDIV | | | | USESYSDIV | reserved | USEPWMDIV | PWMDIV | | | reserved |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | RO | R/W | R/W | R/W | R/W | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | PWRDN | reserved | BYPASS | XTAL | | | | OSCSRC | | reserved | | IOSCDIS | MOSCDIS | |
| Type | RO | RO | R/W | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:28 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 27 | ACG | R/W | 0 | <p>Auto Clock Gating</p> <p>This bit specifies whether the system uses the Sleep-Mode Clock Gating Control (SCGCn) registers and Deep-Sleep-Mode Clock Gating Control (DCGCn) registers if the microcontroller enters a Sleep or Deep-Sleep mode (respectively).</p> <p>Value Description</p> <p>1 The SCGCn or DCGCn registers are used to control the clocks distributed to the peripherals when the microcontroller is in a sleep mode. The SCGCn and DCGCn registers allow unused peripherals to consume less power when the microcontroller is in a sleep mode.</p> <p>0 The Run-Mode Clock Gating Control (RCGCn) registers are used when the microcontroller enters a sleep mode.</p> <p>The RCGCn registers are always used to control the clocks in Run mode.</p> |
| 26:23 | SYSDIV | R/W | 0xF | <p>System Clock Divisor</p> <p>Specifies which divisor is used to generate the system clock from either the PLL output or the oscillator source (depending on how the BYPASS bit in this register is configured). See Table 5-5 on page 192 for bit encodings.</p> <p>If the SYSDIV value is less than MINSYSDIV (see page 232), and the PLL is being used, then the MINSYSDIV value is used as the divisor.</p> <p>If the PLL is not being used, the SYSDIV value can be less than MINSYSDIV.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------------|------|-------|---|
| 22 | USESYSCLKDIV | R/W | 0 | <p>Enable System Clock Divider</p> <p>Value Description</p> <p>1 The system clock divider is the source for the system clock. The system clock divider is forced to be used when the PLL is selected as the source.</p> <p>If the USERCC2 bit in the RCC2 register is set, then the SYSDIV2 field in the RCC2 register is used as the system clock divider rather than the SYSDIV field in this register.</p> <p>0 The system clock is used undivided.</p> |
| 21 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 20 | USEPWMDIV | R/W | 0 | <p>Enable PWM Clock Divisor</p> <p>Value Description</p> <p>1 The PWM clock divider is the source for the PWM clock.</p> <p>0 The system clock is the source for the PWM clock.</p> <p>Note that when the PWM divisor is used, it is applied to the clock for both PWM modules.</p> |
| 19:17 | PWMDIV | R/W | 0x7 | <p>PWM Unit Clock Divisor</p> <p>This field specifies the binary divisor used to predivide the system clock down for use as the timing reference for the PWM module. The rising edge of this clock is synchronous with the system clock.</p> <p>Value Divisor</p> <p>0x0 /2</p> <p>0x1 /4</p> <p>0x2 /8</p> <p>0x3 /16</p> <p>0x4 /32</p> <p>0x5 /64</p> <p>0x6 /64</p> <p>0x7 /64 (default)</p> |
| 16:14 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13 | PWRDN | R/W | 1 | <p>PLL Power Down</p> <p>Value Description</p> <p>1 The PLL is powered down. Care must be taken to ensure that another clock source is functioning and that the BYPASS bit is set before setting this bit.</p> <p>0 The PLL is operating normally.</p> |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|---|---------------------------------------|-------|--|-------|---|---------------------------------------|------|-----------|----------|------|------------|----------|------|-----------|----------|------|------------|----------|------|--|--------------|------|--|------------|------|--|-------|------|--|-----------|------|--|------------|------|--|-------|------|--|----------|------|--|---------------------|------|--|-----------|------|--|------------|------|--|-------|------|--|-----------|------|--|----------|------|--|----------|------|--|------------|------|--|-----------|------|--|--------------|------|--|----------|------|--|------------|
| 12 | reserved | RO | 1 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 11 | BYPASS | R/W | 1 | <p>PLL Bypass</p> <p>Value Description</p> <p>1 The system clock is derived from the OSC source and divided by the divisor specified by SYSDIV.</p> <p>0 The system clock is the PLL output clock divided by the divisor specified by SYSDIV.</p> <p>See Table 5-5 on page 192 for programming guidelines.</p> <p>Note: The ADC must be clocked from the PLL or directly from a 16-MHz clock source to operate properly.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10:6 | XTAL | R/W | 0x0B | <p>Crystal Value</p> <p>This field specifies the crystal value attached to the main oscillator. The encoding for this field is provided below. Depending on the crystal used, the PLL frequency may not be exactly 400 MHz, see Table 25-8 on page 1134 for more information.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Crystal Frequency (MHz) Not Using the PLL</th> <th>Crystal Frequency (MHz) Using the PLL</th> </tr> </thead> <tbody> <tr><td>0x00</td><td>1.000 MHz</td><td>reserved</td></tr> <tr><td>0x01</td><td>1.8432 MHz</td><td>reserved</td></tr> <tr><td>0x02</td><td>2.000 MHz</td><td>reserved</td></tr> <tr><td>0x03</td><td>2.4576 MHz</td><td>reserved</td></tr> <tr><td>0x04</td><td></td><td>3.579545 MHz</td></tr> <tr><td>0x05</td><td></td><td>3.6864 MHz</td></tr> <tr><td>0x06</td><td></td><td>4 MHz</td></tr> <tr><td>0x07</td><td></td><td>4.096 MHz</td></tr> <tr><td>0x08</td><td></td><td>4.9152 MHz</td></tr> <tr><td>0x09</td><td></td><td>5 MHz</td></tr> <tr><td>0x0A</td><td></td><td>5.12 MHz</td></tr> <tr><td>0x0B</td><td></td><td>6 MHz (reset value)</td></tr> <tr><td>0x0C</td><td></td><td>6.144 MHz</td></tr> <tr><td>0x0D</td><td></td><td>7.3728 MHz</td></tr> <tr><td>0x0E</td><td></td><td>8 MHz</td></tr> <tr><td>0x0F</td><td></td><td>8.192 MHz</td></tr> <tr><td>0x10</td><td></td><td>10.0 MHz</td></tr> <tr><td>0x11</td><td></td><td>12.0 MHz</td></tr> <tr><td>0x12</td><td></td><td>12.288 MHz</td></tr> <tr><td>0x13</td><td></td><td>13.56 MHz</td></tr> <tr><td>0x14</td><td></td><td>14.31818 MHz</td></tr> <tr><td>0x15</td><td></td><td>16.0 MHz</td></tr> <tr><td>0x16</td><td></td><td>16.384 MHz</td></tr> </tbody> </table> | Value | Crystal Frequency (MHz) Not Using the PLL | Crystal Frequency (MHz) Using the PLL | 0x00 | 1.000 MHz | reserved | 0x01 | 1.8432 MHz | reserved | 0x02 | 2.000 MHz | reserved | 0x03 | 2.4576 MHz | reserved | 0x04 | | 3.579545 MHz | 0x05 | | 3.6864 MHz | 0x06 | | 4 MHz | 0x07 | | 4.096 MHz | 0x08 | | 4.9152 MHz | 0x09 | | 5 MHz | 0x0A | | 5.12 MHz | 0x0B | | 6 MHz (reset value) | 0x0C | | 6.144 MHz | 0x0D | | 7.3728 MHz | 0x0E | | 8 MHz | 0x0F | | 8.192 MHz | 0x10 | | 10.0 MHz | 0x11 | | 12.0 MHz | 0x12 | | 12.288 MHz | 0x13 | | 13.56 MHz | 0x14 | | 14.31818 MHz | 0x15 | | 16.0 MHz | 0x16 | | 16.384 MHz |
| Value | Crystal Frequency (MHz) Not Using the PLL | Crystal Frequency (MHz) Using the PLL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x00 | 1.000 MHz | reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x01 | 1.8432 MHz | reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x02 | 2.000 MHz | reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x03 | 2.4576 MHz | reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x04 | | 3.579545 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x05 | | 3.6864 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x06 | | 4 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x07 | | 4.096 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x08 | | 4.9152 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x09 | | 5 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0A | | 5.12 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0B | | 6 MHz (reset value) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0C | | 6.144 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0D | | 7.3728 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0E | | 8 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0F | | 8.192 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x10 | | 10.0 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x11 | | 12.0 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x12 | | 12.288 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x13 | | 13.56 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x14 | | 14.31818 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x15 | | 16.0 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x16 | | 16.384 MHz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|--|------|-------|--|-------|--------------|-----|--|-----|---|-----|--|-----|--------------------------------------|
| 5:4 | OSCSRC | R/W | 0x1 | <p>Oscillator Source</p> <p>Selects the input source for the OSC. The values are:</p> <table border="0"> <tr> <td>Value</td> <td>Input Source</td> </tr> <tr> <td>0x0</td> <td>MOSC Main oscillator</td> </tr> <tr> <td>0x1</td> <td>PIOSC Precision internal oscillator (default)</td> </tr> <tr> <td>0x2</td> <td>PIOSC/4 Precision internal oscillator / 4</td> </tr> <tr> <td>0x3</td> <td>30 kHz 30-kHz internal oscillator</td> </tr> </table> <p>For additional oscillator sources, see the RCC2 register.</p> | Value | Input Source | 0x0 | MOSC Main oscillator | 0x1 | PIOSC Precision internal oscillator (default) | 0x2 | PIOSC/4 Precision internal oscillator / 4 | 0x3 | 30 kHz 30-kHz internal oscillator |
| Value | Input Source | | | | | | | | | | | | | |
| 0x0 | MOSC Main oscillator | | | | | | | | | | | | | |
| 0x1 | PIOSC Precision internal oscillator (default) | | | | | | | | | | | | | |
| 0x2 | PIOSC/4 Precision internal oscillator / 4 | | | | | | | | | | | | | |
| 0x3 | 30 kHz 30-kHz internal oscillator | | | | | | | | | | | | | |
| 3:2 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 1 | IOSCDIS | R/W | 0 | <p>Precision Internal Oscillator Disable</p> <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>1</td> <td>The precision internal oscillator (PIOSC) is disabled.</td> </tr> <tr> <td>0</td> <td>The precision internal oscillator is enabled.</td> </tr> </table> | Value | Description | 1 | The precision internal oscillator (PIOSC) is disabled. | 0 | The precision internal oscillator is enabled. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 1 | The precision internal oscillator (PIOSC) is disabled. | | | | | | | | | | | | | |
| 0 | The precision internal oscillator is enabled. | | | | | | | | | | | | | |
| 0 | MOSCDIS | R/W | 1 | <p>Main Oscillator Disable</p> <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>1</td> <td>The main oscillator is disabled (default).</td> </tr> <tr> <td>0</td> <td>The main oscillator is enabled.</td> </tr> </table> | Value | Description | 1 | The main oscillator is disabled (default). | 0 | The main oscillator is enabled. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 1 | The main oscillator is disabled (default). | | | | | | | | | | | | | |
| 0 | The main oscillator is enabled. | | | | | | | | | | | | | |

Register 8: XTAL to PLL Translation (PLLCFG), offset 0x064

This register provides a means of translating external crystal frequencies into the appropriate PLL settings. This register is initialized during the reset sequence and updated anytime that the `XTAL` field changes in the **Run-Mode Clock Configuration (RCC)** register (see page 211).

The PLL frequency is calculated using the **PLLCFG** field values, as follows:

$$\text{PLLFreq} = \text{OSCFreq} * F / (R + 1)$$

XTAL to PLL Translation (PLLCFG)

Base 0x400F.E000

Offset 0x064

Type RO, reset -

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | F | | | | | | | | | | R | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:14 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13:5 | F | RO | - | PLL F Value This field specifies the value supplied to the PLL's F input. |
| 4:0 | R | RO | - | PLL R Value This field specifies the value supplied to the PLL's R input. |

Register 9: GPIO High-Performance Bus Control (GPIOHBCTL), offset 0x06C

This register controls which internal bus is used to access each GPIO port. When a bit is clear, the corresponding GPIO port is accessed across the legacy Advanced Peripheral Bus (APB) bus and through the APB memory aperture. When a bit is set, the corresponding port is accessed across the Advanced High-Performance Bus (AHB) bus and through the AHB memory aperture. Each GPIO port can be individually configured to use AHB or APB, but may be accessed only through one aperture. The AHB bus provides better back-to-back access performance than the APB bus. The address aperture in the memory map changes for the ports that are enabled for AHB access (see Table 9-7 on page 430).

GPIO High-Performance Bus Control (GPIOHBCTL)

Base 0x400F.E000
 Offset 0x06C
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | PORTJ | PORTH | PORTG | PORTF | PORTE | PORTD | PORTC | PORTB | PORTA |
| Type | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|--|
| 31:9 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | PORTJ | R/W | 0 | Port J Advanced High-Performance Bus This bit defines the memory aperture for Port J. Value Description 1 Advanced High-Performance Bus (AHB) 0 Advanced Peripheral Bus (APB). This bus is the legacy bus. |
| 7 | PORTH | R/W | 0 | Port H Advanced High-Performance Bus This bit defines the memory aperture for Port H. Value Description 1 Advanced High-Performance Bus (AHB) 0 Advanced Peripheral Bus (APB). This bus is the legacy bus. |
| 6 | PORTG | R/W | 0 | Port G Advanced High-Performance Bus This bit defines the memory aperture for Port G. Value Description 1 Advanced High-Performance Bus (AHB) 0 Advanced Peripheral Bus (APB). This bus is the legacy bus. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 5 | PORTF | R/W | 0 | Port F Advanced High-Performance Bus This bit defines the memory aperture for Port F. Value Description 1 Advanced High-Performance Bus (AHB) 0 Advanced Peripheral Bus (APB). This bus is the legacy bus. |
| 4 | PORTE | R/W | 0 | Port E Advanced High-Performance Bus This bit defines the memory aperture for Port E. Value Description 1 Advanced High-Performance Bus (AHB) 0 Advanced Peripheral Bus (APB). This bus is the legacy bus. |
| 3 | PORTD | R/W | 0 | Port D Advanced High-Performance Bus This bit defines the memory aperture for Port D. Value Description 1 Advanced High-Performance Bus (AHB) 0 Advanced Peripheral Bus (APB). This bus is the legacy bus. |
| 2 | PORTC | R/W | 0 | Port C Advanced High-Performance Bus This bit defines the memory aperture for Port C. Value Description 1 Advanced High-Performance Bus (AHB) 0 Advanced Peripheral Bus (APB). This bus is the legacy bus. |
| 1 | PORTB | R/W | 0 | Port B Advanced High-Performance Bus This bit defines the memory aperture for Port B. Value Description 1 Advanced High-Performance Bus (AHB) 0 Advanced Peripheral Bus (APB). This bus is the legacy bus. |
| 0 | PORTA | R/W | 0 | Port A Advanced High-Performance Bus This bit defines the memory aperture for Port A. Value Description 1 Advanced High-Performance Bus (AHB) 0 Advanced Peripheral Bus (APB). This bus is the legacy bus. |

Register 10: Run-Mode Clock Configuration 2 (RCC2), offset 0x070

This register overrides the **RCC** equivalent register fields, as shown in Table 5-9, when the `USERCC2` bit is set, allowing the extended capabilities of the **RCC2** register to be used while also providing a means to be backward-compatible to previous parts. Each **RCC2** field that supersedes an **RCC** field is located at the same LSB bit position; however, some **RCC2** fields are larger than the corresponding **RCC** field.

Table 5-9. RCC2 Fields that Override RCC Fields

| RCC2 Field... | Overrides RCC Field |
|------------------------------------|-----------------------------------|
| <code>SYSDIV2</code> , bits[28:23] | <code>SYSDIV</code> , bits[26:23] |
| <code>PWRDN2</code> , bit[13] | <code>PWRDN</code> , bit[13] |
| <code>BYPASS2</code> , bit[11] | <code>BYPASS</code> , bit[11] |
| <code>OSCSRC2</code> , bits[6:4] | <code>OSCSRC</code> , bits[5:4] |

Important: Write the **RCC** register prior to writing the **RCC2** register. If a subsequent write to the **RCC** register is required, include another register access after writing the **RCC** register and before writing the **RCC2** register.

Run-Mode Clock Configuration 2 (RCC2)

Base 0x400F.E000
 Offset 0x070
 Type R/W, reset 0x07C0.6810

| | | | | | | | | | | | | | | | | |
|-------|----------|--------|----------|----------|---------|----------|-----|-----|------------|----------|-----|-----|----------|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | USERCC2 | DIV400 | reserved | SYSDIV2 | | | | | SYSDIV2LSB | reserved | | | | | | |
| Type | R/W | R/W | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | PWRDN2 | reserved | BYPASS2 | reserved | | | | OSCSRC2 | | | reserved | | | |
| Type | RO | RO | R/W | RO | R/W | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | RO | RO |
| Reset | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 31 | USERCC2 | R/W | 0 | Use RCC2 |
| | | | | Value Description |
| | | | | 1 The RCC2 register fields override the RCC register fields. |
| | | | | 0 The RCC register fields are used, and the fields in RCC2 are ignored. |
| 30 | DIV400 | R/W | 0 | Divide PLL as 400 MHz vs. 200 MHz |
| | | | | This bit, along with the <code>SYSDIV2LSB</code> bit, allows additional frequency choices. |
| | | | | Value Description |
| | | | | 1 Append the <code>SYSDIV2LSB</code> bit to the <code>SYSDIV2</code> field to create a 7 bit divisor using the 400 MHz PLL output, see Table 5-7 on page 193. |
| | | | | 0 Use <code>SYSDIV2</code> as is and apply to 200 MHz predivided PLL output. See Table 5-6 on page 192 for programming guidelines. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------------|------|-------|---|
| 29 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28:23 | SYSDIV2 | R/W | 0x0F | System Clock Divisor 2 Specifies which divisor is used to generate the system clock from either the PLL output or the oscillator source (depending on how the <code>BYPASS2</code> bit is configured). <code>SYSDIV2</code> is used for the divisor when both the <code>USESYSCLK</code> bit in the <code>RCC</code> register and the <code>USERCC2</code> bit in this register are set. See Table 5-6 on page 192 for programming guidelines. |
| 22 | SYSDIV2LSB | R/W | 1 | Additional LSB for <code>SYSDIV2</code> When <code>DIV400</code> is set, this bit becomes the LSB of <code>SYSDIV2</code> . If <code>DIV400</code> is clear, this bit is not used. See Table 5-6 on page 192 for programming guidelines. This bit can only be set or cleared when <code>DIV400</code> is set. |
| 21:14 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13 | PWRDN2 | R/W | 1 | Power-Down PLL 2 Value Description 1 The PLL is powered down. 0 The PLL operates normally. |
| 12 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 11 | BYPASS2 | R/W | 1 | PLL Bypass 2 Value Description 1 The system clock is derived from the OSC source and divided by the divisor specified by <code>SYSDIV2</code> . 0 The system clock is the PLL output clock divided by the divisor specified by <code>SYSDIV2</code> . See Table 5-6 on page 192 for programming guidelines. Note: The ADC must be clocked from the PLL or directly from a 16-MHz clock source to operate properly. |
| 10:7 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 6:4 | OSCSRC2 | R/W | 0x1 | Oscillator Source 2 Selects the input source for the OSC. The values are: Value Description 0x0 MOSC Main oscillator 0x1 PIOSC Precision internal oscillator 0x2 PIOSC/4 Precision internal oscillator / 4 0x3 30 kHz 30-kHz internal oscillator 0x4-0x6 Reserved 0x7 32.768 kHz 32.768-kHz external oscillator |
| 3:0 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 11: Main Oscillator Control (MOSCCTL), offset 0x07C

This register provides the ability to enable the MOSC clock verification circuit. When enabled, this circuit monitors the frequency of the MOSC to verify that the oscillator is operating within specified limits. If the clock goes invalid after being enabled, the microcontroller issues a power-on reset and reboots to the NMI handler.

Main Oscillator Control (MOSCCTL)

Base 0x400F.E000

Offset 0x07C

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:1 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | CVAL | R/W | 0 | Clock Validation for MOSC |
| | | | | Value Description |
| | | | | 1 The MOSC monitor circuit is enabled. |
| | | | | 0 The MOSC monitor circuit is disabled. |

Register 12: Deep Sleep Clock Configuration (DSLPCCLKCFG), offset 0x144

This register provides configuration information for the hardware control of Deep Sleep Mode.

Deep Sleep Clock Configuration (DSLPCCLKCFG)

Base 0x400F.E000
 Offset 0x144
 Type R/W, reset 0x0780.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|------------|-----|-----|----------|-----|-----|----------|----------|-----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | DSDIVORIDE | | | | | | reserved | | | | | | |
| Type | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | DSOSCSRC | | | | reserved | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | |
|-----------|-------------|------|-------|---|-------|-------------|-----|----|-----|----|-----|----|-----|----|-----|-----|------|-----|
| 31:29 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | |
| 28:23 | DSDIVORIDE | R/W | 0x0F | <p>Divider Field Override</p> <p>If Deep-Sleep mode is enabled when the PLL is running, the PLL is disabled. This 6-bit field contains a system divider field that overrides the <code>SYSDIV</code> field in the <code>RCC</code> register or the <code>SYSDIV2</code> field in the <code>RCC2</code> register during Deep Sleep. This divider is applied to the source selected by the <code>DSOSCSRC</code> field.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>/1</td> </tr> <tr> <td>0x1</td> <td>/2</td> </tr> <tr> <td>0x2</td> <td>/3</td> </tr> <tr> <td>0x3</td> <td>/4</td> </tr> <tr> <td>...</td> <td>...</td> </tr> <tr> <td>0x3F</td> <td>/64</td> </tr> </tbody> </table> | Value | Description | 0x0 | /1 | 0x1 | /2 | 0x2 | /3 | 0x3 | /4 | ... | ... | 0x3F | /64 |
| Value | Description | | | | | | | | | | | | | | | | | |
| 0x0 | /1 | | | | | | | | | | | | | | | | | |
| 0x1 | /2 | | | | | | | | | | | | | | | | | |
| 0x2 | /3 | | | | | | | | | | | | | | | | | |
| 0x3 | /4 | | | | | | | | | | | | | | | | | |
| ... | ... | | | | | | | | | | | | | | | | | |
| 0x3F | /64 | | | | | | | | | | | | | | | | | |
| 22:7 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | |
|-----------|--|------|-------|--|-------|-------------|-----|--|-----|---|-----|----------|-----|--|---------|----------|-----|---|
| 6:4 | DSOSCSRC | R/W | 0x0 | <p>Clock Source</p> <p>Specifies the clock source during Deep-Sleep mode.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td> <p>MOSC</p> <p>Use the main oscillator as the source.</p> <p>Note: If the PIOSC is being used as the clock reference for the PLL, the PIOSC is the clock source instead of MOSC in Deep-Sleep mode.</p> </td> </tr> <tr> <td>0x1</td> <td> <p>PIOSC</p> <p>Use the precision internal 16-MHz oscillator as the source.</p> </td> </tr> <tr> <td>0x2</td> <td>Reserved</td> </tr> <tr> <td>0x3</td> <td> <p>30 kHz</p> <p>Use the 30-kHz internal oscillator as the source.</p> </td> </tr> <tr> <td>0x4-0x6</td> <td>Reserved</td> </tr> <tr> <td>0x7</td> <td> <p>32.768 kHz</p> <p>Use the Hibernation module 32.768-kHz external oscillator as the source.</p> </td> </tr> </tbody> </table> | Value | Description | 0x0 | <p>MOSC</p> <p>Use the main oscillator as the source.</p> <p>Note: If the PIOSC is being used as the clock reference for the PLL, the PIOSC is the clock source instead of MOSC in Deep-Sleep mode.</p> | 0x1 | <p>PIOSC</p> <p>Use the precision internal 16-MHz oscillator as the source.</p> | 0x2 | Reserved | 0x3 | <p>30 kHz</p> <p>Use the 30-kHz internal oscillator as the source.</p> | 0x4-0x6 | Reserved | 0x7 | <p>32.768 kHz</p> <p>Use the Hibernation module 32.768-kHz external oscillator as the source.</p> |
| Value | Description | | | | | | | | | | | | | | | | | |
| 0x0 | <p>MOSC</p> <p>Use the main oscillator as the source.</p> <p>Note: If the PIOSC is being used as the clock reference for the PLL, the PIOSC is the clock source instead of MOSC in Deep-Sleep mode.</p> | | | | | | | | | | | | | | | | | |
| 0x1 | <p>PIOSC</p> <p>Use the precision internal 16-MHz oscillator as the source.</p> | | | | | | | | | | | | | | | | | |
| 0x2 | Reserved | | | | | | | | | | | | | | | | | |
| 0x3 | <p>30 kHz</p> <p>Use the 30-kHz internal oscillator as the source.</p> | | | | | | | | | | | | | | | | | |
| 0x4-0x6 | Reserved | | | | | | | | | | | | | | | | | |
| 0x7 | <p>32.768 kHz</p> <p>Use the Hibernation module 32.768-kHz external oscillator as the source.</p> | | | | | | | | | | | | | | | | | |
| 3:0 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | |

Register 13: Precision Internal Oscillator Calibration (PIOSCCAL), offset 0x150

This register provides the ability to update or recalibrate the precision internal oscillator. Note that a 32.768-kHz oscillator must be used as the Hibernation module clock source for the user to be able to calibrate the PIOSC.

Precision Internal Oscillator Calibration (PIOSCCAL)

Base 0x400F.E000
 Offset 0x150
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----------|----|----|----|----|-----|--------|----------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | UTEN | reserved | | | | | | | | | | | | | | |
| Type | R/W | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | CAL | UPDATE | reserved | UT | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | R/W | R/W | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|--|
| 31 | UTEN | R/W | 0 | Use User Trim Value Value Description 1 The trim value in bits[6:0] of this register are used for any update trim operation. 0 The factory calibration value is used for an update trim operation. |
| 30:10 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9 | CAL | R/W | 0 | Start Calibration Value Description 1 Starts a new calibration of the PIOSC. Results are in the PIOSCSTAT register. The resulting trim value from the operation is active in the PIOSC after the calibration completes. The result overrides any previous update trim operation whether the calibration passes or fails. 0 No action. This bit is auto-cleared after it is set. |
| 8 | UPDATE | R/W | 0 | Update Trim Value Description 1 Updates the PIOSC trim value with the UT bit or the DT bit in the PIOSCSTAT register. Used with UTEN . 0 No action. This bit is auto-cleared after the update. |
| 7 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 6:0 | UT | R/W | 0x0 | User Trim Value User trim value that can be loaded into the PIOSC. Refer to "Main PLL Frequency Configuration" on page 194 for more information on calibrating the PIOSC. |

Register 14: Precision Internal Oscillator Statistics (PIOSCSTAT), offset 0x154

This register provides the user information on the PIOSC calibration. Note that a 32.768-kHz oscillator must be used as the Hibernation module clock source for the user to be able to calibrate the PIOSC.

Precision Internal Oscillator Statistics (PIOSCSTAT)

Base 0x400F.E000

Offset 0x154

Type RO, reset 0x0000.0040

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|--------|----|----------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | DT | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | RESULT | | reserved | CT | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:23 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 22:16 | DT | RO | - | Default Trim Value This field contains the default trim value. This value is loaded into the PIOSC after every full power-up. |
| 15:10 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9:8 | RESULT | RO | 0 | Calibration Result Value Description 0x0 Calibration has not been attempted. 0x1 The last calibration operation completed to meet 1% accuracy. 0x2 The last calibration operation failed to meet 1% accuracy. 0x3 Reserved |
| 7 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6:0 | CT | RO | 0x40 | Calibration Trim Value This field contains the trim value from the last calibration operation. After factory calibration CT and DT are the same. |

Register 15: I²S MCLK Configuration (I2SMCLKCFG), offset 0x170

This register configures the receive and transmit fractional clock dividers for the for the I²S master transmit and receive clocks (I2S0TXMCLK and I2S0RXMCLK). Varying the integer and fractional inputs for the clocks allows greater accuracy in hitting the target I²S clock frequencies. Refer to “Clock Control” on page 852 for combinations of the TXI and TXF bits and the RXI and RXF bits that provide MCLK frequencies within acceptable error limits.

I2S MCLK Configuration (I2SMCLKCFG)

Base 0x400F.E000
Offset 0x170
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | RXEN | reserved | | | | | | | | | | | | | | |
| Type | R/W | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | TXEN | reserved | | | | | | | | | | | | | | |
| Type | R/W | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31 | RXEN | R/W | 0 | RX Clock Enable Value Description 1 The I ² S receive clock generator is enabled. 0 The I ² S receive clock generator is disabled. If the RXSLV bit in the I²S Module Configuration (I2SCFG) register is set, then the I2S0RXMCLK must be externally generated. |
| 30 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 29:20 | RXI | R/W | 0x0 | RX Clock Integer Input This field contains the integer input for the receive clock generator. |
| 19:16 | RXF | R/W | 0x0 | RX Clock Fractional Input This field contains the fractional input for the receive clock generator. |
| 15 | TXEN | R/W | 0 | TX Clock Enable Value Description 1 The I ² S transmit clock generator is enabled. 0 The I ² S transmit clock generator is disabled. If the TXSLV bit in the I²S Module Configuration (I2SCFG) register is set, then the I2S0TXMCLK must be externally generated. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 14 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13:4 | TXI | R/W | 0x00 | TX Clock Integer Input This field contains the integer input for the transmit clock generator. |
| 3:0 | TXF | R/W | 0x0 | TX Clock Fractional Input This field contains the fractional input for the transmit clock generator. |

Register 16: Device Identification 1 (DID1), offset 0x004

This register identifies the device family, part number, temperature range, pin count, and package type. Each microcontroller is uniquely identified by the combined values of the `CLASS` field in the `DID0` register and the `PARTNO` field in the `DID1` register.

Device Identification 1 (DID1)

Base 0x400F.E000

Offset 0x004

Type RO, reset -

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----------|-----|----|----|------|--------|----|-----|----|------|------|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | VER | | | | FAM | | | | PARTNO | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PINCOUNT | | | reserved | | | | TEMP | | | PKG | | ROHS | QUAL | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | 1 | - | - |

| Bit/Field | Name | Type | Reset | Description | | | | |
|-----------|---|------|-------|---|-------|-------------|------|---|
| 31:28 | VER | RO | 0x1 | <p>DID1 Version</p> <p>This field defines the DID1 register format version. The version number is numeric. The value of the <code>VER</code> field is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x1</td> <td>Second version of the DID1 register format.</td> </tr> </tbody> </table> | Value | Description | 0x1 | Second version of the DID1 register format. |
| Value | Description | | | | | | | |
| 0x1 | Second version of the DID1 register format. | | | | | | | |
| 27:24 | FAM | RO | 0x0 | <p>Family</p> <p>This field provides the family identification of the device within the Luminary Micro product portfolio. The value is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Stellaris family of microcontrollers, that is, all devices with external part numbers starting with LM3S.</td> </tr> </tbody> </table> | Value | Description | 0x0 | Stellaris family of microcontrollers, that is, all devices with external part numbers starting with LM3S. |
| Value | Description | | | | | | | |
| 0x0 | Stellaris family of microcontrollers, that is, all devices with external part numbers starting with LM3S. | | | | | | | |
| 23:16 | PARTNO | RO | 0x93 | <p>Part Number</p> <p>This field provides the part number of the device within the family. The value is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x93</td> <td>LM3S2U93</td> </tr> </tbody> </table> | Value | Description | 0x93 | LM3S2U93 |
| Value | Description | | | | | | | |
| 0x93 | LM3S2U93 | | | | | | | |
| 15:13 | PINCOUNT | RO | 0x2 | <p>Package Pin Count</p> <p>This field specifies the number of pins on the device package. The value is encoded as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x2</td> <td>100-pin package</td> </tr> </tbody> </table> | Value | Description | 0x2 | 100-pin package |
| Value | Description | | | | | | | |
| 0x2 | 100-pin package | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 12:8 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:5 | TEMP | RO | - | Temperature Range This field specifies the temperature rating of the device. The value is encoded as follows (all other encodings are reserved): Value Description 0x0 Commercial temperature range (0°C to 70°C) 0x1 Industrial temperature range (-40°C to 85°C) 0x2 Extended temperature range (-40°C to 105°C) |
| 4:3 | PKG | RO | - | Package Type This field specifies the package type. The value is encoded as follows (all other encodings are reserved): Value Description 0x0 SOIC package 0x1 LQFP package 0x2 BGA package |
| 2 | ROHS | RO | 1 | RoHS-Compliance This bit specifies whether the device is RoHS-compliant. A 1 indicates the part is RoHS-compliant. |
| 1:0 | QUAL | RO | - | Qualification Status This field specifies the qualification status of the device. The value is encoded as follows (all other encodings are reserved): Value Description 0x0 Engineering Sample (unqualified) 0x1 Pilot Production (unqualified) 0x2 Fully Qualified |

Register 17: Device Capabilities 0 (DC0), offset 0x008

This register is predefined by the part and can be used to verify features.

Device Capabilities 0 (DC0)

Base 0x400F.E000

Offset 0x008

Type RO, reset 0x017F.00BF

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|---------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | SRAMSZ | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | FLASHSZ | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|--------|--|
| 31:16 | SRAMSZ | RO | 0x017F | SRAM Size Indicates the size of the on-chip SRAM memory. Value Description 0x017F 96 KB of SRAM |
| 15:0 | FLASHSZ | RO | 0x00BF | Flash Size Indicates the size of the on-chip flash memory. Value Description 0x00BF 384 KB of Flash |

Register 18: Device Capabilities 1 (DC1), offset 0x010

This register is predefined by the part and can be used to verify features. If any bit is clear in this register, the module is not present. The corresponding bit in the RCGC0, SCGC0, and DCGC0 registers cannot be set.

Device Capabilities 1 (DC1)

Base 0x400F.E000

Offset 0x010

Type RO, reset -

| | | | | | | | | | | | | | | | | |
|-------|-----------|----|----|------|------------|----|------------|------|----------|-----|---------|-----|----------|-----|------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | WDT1 | reserved | | CAN1 | CAN0 | reserved | | | PWM | reserved | | ADC1 | ADC0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MINSYSDIV | | | | MAXADC1SPD | | MAXADC0SPD | | MPU | HIB | TEMPSNS | PLL | WDT0 | SWO | SWD | JTAG |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | - | - | - | - | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | WDT1 | RO | 1 | Watchdog Timer 1 Present When set, indicates that watchdog timer 1 is present. |
| 27:26 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 25 | CAN1 | RO | 1 | CAN Module 1 Present When set, indicates that CAN unit 1 is present. |
| 24 | CAN0 | RO | 1 | CAN Module 0 Present When set, indicates that CAN unit 0 is present. |
| 23:21 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 20 | PWM | RO | 1 | PWM Module Present When set, indicates that the PWM module is present. |
| 19:18 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 17 | ADC1 | RO | 1 | ADC Module 1 Present When set, indicates that ADC module 1 is present. |
| 16 | ADC0 | RO | 1 | ADC Module 0 Present When set, indicates that ADC module 0 is present |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------------|------|-------|--|
| 15:12 | MINSYSDIV | RO | - | <p>System Clock Divider</p> <p>Minimum 4-bit divider value for system clock. The reset value is hardware-dependent. See the RCC register for how to change the system clock divisor using the SYSDIV bit.</p> <p>Value Description</p> <p>0x1 Specifies an 80-MHz CPU clock with a PLL divider of 2.5.</p> <p>0x2 Specifies a 66.67-MHz CPU clock with a PLL divider of 3.</p> <p>0x3 Specifies a 50-MHz CPU clock with a PLL divider of 4.</p> <p>0x7 Specifies a 25-MHz clock with a PLL divider of 8.</p> <p>0x9 Specifies a 20-MHz clock with a PLL divider of 10.</p> |
| 11:10 | MAXADC1SPD | RO | 0x3 | <p>Max ADC1 Speed</p> <p>This field indicates the maximum rate at which the ADC samples data.</p> <p>Value Description</p> <p>0x3 1M samples/second</p> |
| 9:8 | MAXADC0SPD | RO | 0x3 | <p>Max ADC0 Speed</p> <p>This field indicates the maximum rate at which the ADC samples data.</p> <p>Value Description</p> <p>0x3 1M samples/second</p> |
| 7 | MPU | RO | 1 | <p>MPU Present</p> <p>When set, indicates that the Cortex-M3 Memory Protection Unit (MPU) module is present. See the "Cortex-M3 Peripherals" chapter for details on the MPU.</p> |
| 6 | HIB | RO | 1 | <p>Hibernation Module Present</p> <p>When set, indicates that the Hibernation module is present.</p> |
| 5 | TEMPSNS | RO | 1 | <p>Temp Sensor Present</p> <p>When set, indicates that the on-chip temperature sensor is present.</p> |
| 4 | PLL | RO | 1 | <p>PLL Present</p> <p>When set, indicates that the on-chip Phase Locked Loop (PLL) is present.</p> |
| 3 | WDT0 | RO | 1 | <p>Watchdog Timer 0 Present</p> <p>When set, indicates that watchdog timer 0 is present.</p> |
| 2 | SWO | RO | 1 | <p>SWO Trace Port Present</p> <p>When set, indicates that the Serial Wire Output (SWO) trace port is present.</p> |
| 1 | SWD | RO | 1 | <p>SWD Present</p> <p>When set, indicates that the Serial Wire Debugger (SWD) is present.</p> |
| 0 | JTAG | RO | 1 | <p>JTAG Present</p> <p>When set, indicates that the JTAG debugger interface is present.</p> |

Register 19: Device Capabilities 2 (DC2), offset 0x014

This register is predefined by the part and can be used to verify features. If any bit is clear in this register, the module is not present. The corresponding bit in the RCGC0, SCGC0, and DCGC0 registers cannot be set.

Device Capabilities 2 (DC2)

Base 0x400F.E000

Offset 0x014

Type RO, reset 0x570F.5337

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|------|----------|------|----------|-------|-------|-------|----------|----|------|--------|----------|--------|--------|-------|
| | reserved | EPI0 | reserved | I2S0 | reserved | COMP2 | COMP1 | COMP0 | reserved | | | TIMER3 | TIMER2 | TIMER1 | TIMER0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | I2C1 | reserved | I2C0 | reserved | | QE1 | QE0 | reserved | | SSI1 | SSI0 | reserved | UART2 | UART1 | UART0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 30 | EPI0 | RO | 1 | EPI Module 0 Present When set, indicates that EPI module 0 is present. |
| 29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | I2S0 | RO | 1 | I2S Module 0 Present When set, indicates that I2S module 0 is present. |
| 27 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 26 | COMP2 | RO | 1 | Analog Comparator 2 Present When set, indicates that analog comparator 2 is present. |
| 25 | COMP1 | RO | 1 | Analog Comparator 1 Present When set, indicates that analog comparator 1 is present. |
| 24 | COMP0 | RO | 1 | Analog Comparator 0 Present When set, indicates that analog comparator 0 is present. |
| 23:20 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 19 | TIMER3 | RO | 1 | Timer Module 3 Present When set, indicates that General-Purpose Timer module 3 is present. |
| 18 | TIMER2 | RO | 1 | Timer Module 2 Present When set, indicates that General-Purpose Timer module 2 is present. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 17 | TIMER1 | RO | 1 | Timer Module 1 Present When set, indicates that General-Purpose Timer module 1 is present. |
| 16 | TIMER0 | RO | 1 | Timer Module 0 Present When set, indicates that General-Purpose Timer module 0 is present. |
| 15 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 14 | I2C1 | RO | 1 | I2C Module 1 Present When set, indicates that I2C module 1 is present. |
| 13 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 12 | I2C0 | RO | 1 | I2C Module 0 Present When set, indicates that I2C module 0 is present. |
| 11:10 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9 | QE11 | RO | 1 | QE1 Module 1 Present When set, indicates that QE1 module 1 is present. |
| 8 | QE10 | RO | 1 | QE1 Module 0 Present When set, indicates that QE1 module 0 is present. |
| 7:6 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | SSI1 | RO | 1 | SSI Module 1 Present When set, indicates that SSI module 1 is present. |
| 4 | SSI0 | RO | 1 | SSI Module 0 Present When set, indicates that SSI module 0 is present. |
| 3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | UART2 | RO | 1 | UART Module 2 Present When set, indicates that UART module 2 is present. |
| 1 | UART1 | RO | 1 | UART Module 1 Present When set, indicates that UART module 1 is present. |
| 0 | UART0 | RO | 1 | UART Module 0 Present When set, indicates that UART module 0 is present. |

Register 20: Device Capabilities 3 (DC3), offset 0x018

This register is predefined by the part and can be used to verify features. If any bit is clear in this register, the module is not present. The corresponding bit in the RCGC0, SCGC0, and DCGC0 registers cannot be set.

Device Capabilities 3 (DC3)

Base 0x400F.E000
 Offset 0x018
 Type RO, reset 0xBFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|----------|----------|--------|---------|------|--------|---------|------|----------|----------|----------|----------|----------|----------|----------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | 32KHZ | reserved | CCP5 | CCP4 | CCP3 | CCP2 | CCP1 | CCP0 | ADC0AIN7 | ADC0AIN6 | ADC0AIN5 | ADC0AIN4 | ADC0AIN3 | ADC0AIN2 | ADC0AIN1 | ADC0AIN0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PWMFAULT | C2O | C2PLUS | C2MINUS | C1O | C1PLUS | C1MINUS | C0O | C0PLUS | C0MINUS | PWM5 | PWM4 | PWM3 | PWM2 | PWM1 | PWM0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31 | 32KHZ | RO | 1 | 32KHz Input Clock Available When set, indicates an even CCP pin is present and can be used as a 32-KHz input clock. |
| 30 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 29 | CCP5 | RO | 1 | CCP5 Pin Present When set, indicates that Capture/Compare/PWM pin 5 is present. |
| 28 | CCP4 | RO | 1 | CCP4 Pin Present When set, indicates that Capture/Compare/PWM pin 4 is present. |
| 27 | CCP3 | RO | 1 | CCP3 Pin Present When set, indicates that Capture/Compare/PWM pin 3 is present. |
| 26 | CCP2 | RO | 1 | CCP2 Pin Present When set, indicates that Capture/Compare/PWM pin 2 is present. |
| 25 | CCP1 | RO | 1 | CCP1 Pin Present When set, indicates that Capture/Compare/PWM pin 1 is present. |
| 24 | CCP0 | RO | 1 | CCP0 Pin Present When set, indicates that Capture/Compare/PWM pin 0 is present. |
| 23 | ADC0AIN7 | RO | 1 | ADC Module 0 AIN7 Pin Present When set, indicates that ADC module 0 input pin 7 is present. |
| 22 | ADC0AIN6 | RO | 1 | ADC Module 0 AIN6 Pin Present When set, indicates that ADC module 0 input pin 6 is present. |
| 21 | ADC0AIN5 | RO | 1 | ADC Module 0 AIN5 Pin Present When set, indicates that ADC module 0 input pin 5 is present. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 20 | ADC0AIN4 | RO | 1 | ADC Module 0 AIN4 Pin Present When set, indicates that ADC module 0 input pin 4 is present. |
| 19 | ADC0AIN3 | RO | 1 | ADC Module 0 AIN3 Pin Present When set, indicates that ADC module 0 input pin 3 is present. |
| 18 | ADC0AIN2 | RO | 1 | ADC Module 0 AIN2 Pin Present When set, indicates that ADC module 0 input pin 2 is present. |
| 17 | ADC0AIN1 | RO | 1 | ADC Module 0 AIN1 Pin Present When set, indicates that ADC module 0 input pin 1 is present. |
| 16 | ADC0AIN0 | RO | 1 | ADC Module 0 AIN0 Pin Present When set, indicates that ADC module 0 input pin 0 is present. |
| 15 | PWMFAULT | RO | 1 | PWM Fault Pin Present When set, indicates that a PWM Fault pin is present. See DC5 for specific Fault pins on this device. |
| 14 | C2O | RO | 1 | C2o Pin Present When set, indicates that the analog comparator 2 output pin is present. |
| 13 | C2PLUS | RO | 1 | C2+ Pin Present When set, indicates that the analog comparator 2 (+) input pin is present. |
| 12 | C2MINUS | RO | 1 | C2- Pin Present When set, indicates that the analog comparator 2 (-) input pin is present. |
| 11 | C1O | RO | 1 | C1o Pin Present When set, indicates that the analog comparator 1 output pin is present. |
| 10 | C1PLUS | RO | 1 | C1+ Pin Present When set, indicates that the analog comparator 1 (+) input pin is present. |
| 9 | C1MINUS | RO | 1 | C1- Pin Present When set, indicates that the analog comparator 1 (-) input pin is present. |
| 8 | C0O | RO | 1 | C0o Pin Present When set, indicates that the analog comparator 0 output pin is present. |
| 7 | C0PLUS | RO | 1 | C0+ Pin Present When set, indicates that the analog comparator 0 (+) input pin is present. |
| 6 | C0MINUS | RO | 1 | C0- Pin Present When set, indicates that the analog comparator 0 (-) input pin is present. |
| 5 | PWM5 | RO | 1 | PWM5 Pin Present When set, indicates that the PWM pin 5 is present. |
| 4 | PWM4 | RO | 1 | PWM4 Pin Present When set, indicates that the PWM pin 4 is present. |
| 3 | PWM3 | RO | 1 | PWM3 Pin Present When set, indicates that the PWM pin 3 is present. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 2 | PWM2 | RO | 1 | PWM2 Pin Present When set, indicates that the PWM pin 2 is present. |
| 1 | PWM1 | RO | 1 | PWM1 Pin Present When set, indicates that the PWM pin 1 is present. |
| 0 | PWM0 | RO | 1 | PWM0 Pin Present When set, indicates that the PWM pin 0 is present. |

Register 21: Device Capabilities 4 (DC4), offset 0x01C

This register is predefined by the part and can be used to verify features. If any bit is clear in this register, the module is not present. The corresponding bit in the RCGC0, SCGC0, and DCGC0 registers cannot be set.

Device Capabilities 4 (DC4)

Base 0x400F.E000

Offset 0x01C

Type RO, reset 0x0004.F1FF

| | | | | | | | | | | | | | | | | |
|-------|----------|------|------|-----|----------|----|----|-------|-------|-------|-------|-------|-------|-------|----------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | PICAL | reserved | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | CCP7 | CCP6 | UDMA | ROM | reserved | | | GPIOJ | GPIOH | GPIOG | GPIOF | GPIOE | GIPOD | GPIOC | GPIOB | GPIOA |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:19 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 18 | PICAL | RO | 1 | PIOSC Calibrate When set, indicates that the PIOSC can be calibrated. |
| 17:16 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15 | CCP7 | RO | 1 | CCP7 Pin Present When set, indicates that Capture/Compare/PWM pin 7 is present. |
| 14 | CCP6 | RO | 1 | CCP6 Pin Present When set, indicates that Capture/Compare/PWM pin 6 is present. |
| 13 | UDMA | RO | 1 | Micro-DMA Module Present When set, indicates that the micro-DMA module present. |
| 12 | ROM | RO | 1 | Internal Code ROM Present When set, indicates that internal code ROM is present. |
| 11:9 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | GPIOJ | RO | 1 | GPIO Port J Present When set, indicates that GPIO Port J is present. |
| 7 | GPIOH | RO | 1 | GPIO Port H Present When set, indicates that GPIO Port H is present. |
| 6 | GPIOG | RO | 1 | GPIO Port G Present When set, indicates that GPIO Port G is present. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|---|
| 5 | GPIOF | RO | 1 | GPIO Port F Present When set, indicates that GPIO Port F is present. |
| 4 | GPIOE | RO | 1 | GPIO Port E Present When set, indicates that GPIO Port E is present. |
| 3 | GPIOD | RO | 1 | GPIO Port D Present When set, indicates that GPIO Port D is present. |
| 2 | GPIOC | RO | 1 | GPIO Port C Present When set, indicates that GPIO Port C is present. |
| 1 | GPIOB | RO | 1 | GPIO Port B Present When set, indicates that GPIO Port B is present. |
| 0 | GPIOA | RO | 1 | GPIO Port A Present When set, indicates that GPIO Port A is present. |

Register 22: Device Capabilities 5 (DC5), offset 0x020

This register is predefined by the part and can be used to verify features. If any bit is clear in this register, the module is not present. The corresponding bit in the RCGC0, SCGC0, and DCGC0 registers cannot be set.

Device Capabilities 5 (DC5)

Base 0x400F.E000
Offset 0x020
Type RO, reset 0x0F30.00FF

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|-----------|-----------|-----------|-----------|----------|------|---------|----------|----------|------|------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | PWMFAULT3 | PWMFAULT2 | PWMFAULT1 | PWMFAULT0 | reserved | | PWMEFLT | PWMESYNC | reserved | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PWM7 | PWM6 | PWM5 | PWM4 | PWM3 | PWM2 | PWM1 | PWM0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|---|
| 31:28 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 27 | PWMFAULT3 | RO | 1 | PWM Fault 3 Pin Present When set, indicates that the PWM Fault 3 pin is present. |
| 26 | PWMFAULT2 | RO | 1 | PWM Fault 2 Pin Present When set, indicates that the PWM Fault 2 pin is present. |
| 25 | PWMFAULT1 | RO | 1 | PWM Fault 1 Pin Present When set, indicates that the PWM Fault 1 pin is present. |
| 24 | PWMFAULT0 | RO | 1 | PWM Fault 0 Pin Present When set, indicates that the PWM Fault 0 pin is present. |
| 23:22 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 21 | PWMEFLT | RO | 1 | PWM Extended Fault Active When set, indicates that the PWM Extended Fault feature is active. |
| 20 | PWMESYNC | RO | 1 | PWM Extended SYNC Active When set, indicates that the PWM Extended SYNC feature is active. |
| 19:8 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | PWM7 | RO | 1 | PWM7 Pin Present When set, indicates that the PWM pin 7 is present. |
| 6 | PWM6 | RO | 1 | PWM6 Pin Present When set, indicates that the PWM pin 6 is present. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 5 | PWM5 | RO | 1 | PWM5 Pin Present When set, indicates that the PWM pin 5 is present. |
| 4 | PWM4 | RO | 1 | PWM4 Pin Present When set, indicates that the PWM pin 4 is present. |
| 3 | PWM3 | RO | 1 | PWM3 Pin Present When set, indicates that the PWM pin 3 is present. |
| 2 | PWM2 | RO | 1 | PWM2 Pin Present When set, indicates that the PWM pin 2 is present. |
| 1 | PWM1 | RO | 1 | PWM1 Pin Present When set, indicates that the PWM pin 1 is present. |
| 0 | PWM0 | RO | 1 | PWM0 Pin Present When set, indicates that the PWM pin 0 is present. |

Register 23: Device Capabilities 6 (DC6), offset 0x024

This register is predefined by the part and can be used to verify features. If any bit is clear in this register, the module is not present. The corresponding bit in the RCGC0, SCGC0, and DCGC0 registers cannot be set.

Device Capabilities 6 (DC6)

Base 0x400F.E000

Offset 0x024

Type RO, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:0 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 24: Device Capabilities 7 (DC7), offset 0x028

This register is predefined by the part and can be used to verify uDMA channel features. A 1 indicates the channel is available on this device; a 0 that the channel is only available on other devices in the family. Most channels have primary and secondary assignments. If the primary function is not available on this microcontroller, the secondary function becomes the primary function. If the secondary function is not available, the primary function is the only option.

Device Capabilities 7 (DC7)

Base 0x400F.E000
Offset 0x028
Type RO, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | DMACH30 | DMACH29 | DMACH28 | DMACH27 | DMACH26 | DMACH25 | DMACH24 | DMACH23 | DMACH22 | DMACH21 | DMACH20 | DMACH19 | DMACH18 | DMACH17 | DMACH16 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DMACH15 | DMACH14 | DMACH13 | DMACH12 | DMACH11 | DMACH10 | DMACH9 | DMACH8 | DMACH7 | DMACH6 | DMACH5 | DMACH4 | DMACH3 | DMACH2 | DMACH1 | DMACH0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31 | reserved | RO | 1 | Reserved Reserved for uDMA channel 31. |
| 30 | DMACH30 | RO | 1 | SW When set, indicates uDMA channel 30 is available for software transfers. |
| 29 | DMACH29 | RO | 1 | I2S0_TX / CAN1_TX When set, indicates uDMA channel 29 is available and connected to the transmit path of I2S module 0. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of CAN module 1 transmit. |
| 28 | DMACH28 | RO | 1 | I2S0_RX / CAN1_RX When set, indicates uDMA channel 28 is available and connected to the receive path of I2S module 0. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of CAN module 1 receive. |
| 27 | DMACH27 | RO | 1 | CAN1_TX / ADC1_SS3 When set, indicates uDMA channel 27 is available and connected to the transmit path of CAN module 1. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of ADC module 1 Sample Sequencer 3. |
| 26 | DMACH26 | RO | 1 | CAN1_RX / ADC1_SS2 When set, indicates uDMA channel 26 is available and connected to the receive path of CAN module 1. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of ADC module 1 Sample Sequencer 2. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 25 | DMACH25 | RO | 1 | SSI1_TX / ADC1_SS1 When set, indicates uDMA channel 25 is available and connected to the transmit path of SSI module 1. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of ADC module 1 Sample Sequencer 1. |
| 24 | DMACH24 | RO | 1 | SSI1_RX / ADC1_SS0 When set, indicates uDMA channel 24 is available and connected to the receive path of SSI module 1. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of ADC module 1 Sample Sequencer 0. |
| 23 | DMACH23 | RO | 1 | UART1_TX / CAN2_TX When set, indicates uDMA channel 23 is available and connected to the transmit path of UART module 1. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of CAN module 2 transmit. |
| 22 | DMACH22 | RO | 1 | UART1_RX / CAN2_RX When set, indicates uDMA channel 22 is available and connected to the receive path of UART module 1. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of CAN module 2 receive. |
| 21 | DMACH21 | RO | 1 | Timer1B / EPI0_WFIFO When set, indicates uDMA channel 21 is available and connected to Timer 1B. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of EPI module 0 write FIFO (WFIFO). |
| 20 | DMACH20 | RO | 1 | Timer1A / EPI0_NBRFIFO When set, indicates uDMA channel 20 is available and connected to Timer 1A. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of EPI module 0 non-blocking read FIFO (NBRFIFO). |
| 19 | DMACH19 | RO | 1 | Timer0B / Timer1B When set, indicates uDMA channel 19 is available and connected to Timer 0B. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of Timer 1B. |
| 18 | DMACH18 | RO | 1 | Timer0A / Timer1A When set, indicates uDMA channel 18 is available and connected to Timer 0A. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of Timer 1A. |
| 17 | DMACH17 | RO | 1 | ADC0_SS3 When set, indicates uDMA channel 17 is available and connected to ADC module 0 Sample Sequencer 3. |
| 16 | DMACH16 | RO | 1 | ADC0_SS2 When set, indicates uDMA channel 16 is available and connected to ADC module 0 Sample Sequencer 2. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 15 | DMACH15 | RO | 1 | ADC0_SS1 / Timer2B When set, indicates uDMA channel 15 is available and connected to ADC module 0 Sample Sequencer 1. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of Timer 2B. |
| 14 | DMACH14 | RO | 1 | ADC0_SS0 / Timer2A When set, indicates uDMA channel 14 is available and connected to ADC module 0 Sample Sequencer 0. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of Timer 2A. |
| 13 | DMACH13 | RO | 1 | CAN0_TX / UART2_TX When set, indicates uDMA channel 13 is available and connected to the transmit path of CAN module 0. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of UART module 2 transmit. |
| 12 | DMACH12 | RO | 1 | CAN0_RX / UART2_RX When set, indicates uDMA channel 12 is available and connected to the receive path of CAN module 0. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of UART module 2 receive. |
| 11 | DMACH11 | RO | 1 | SSI0_TX / SSI1_TX When set, indicates uDMA channel 11 is available and connected to the transmit path of SSI module 0. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of SSI module 1 transmit. |
| 10 | DMACH10 | RO | 1 | SSI0_RX / SSI1_RX When set, indicates uDMA channel 10 is available and connected to the receive path of SSI module 0. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of SSI module 1 receive. |
| 9 | DMACH9 | RO | 1 | UART0_TX / UART1_TX When set, indicates uDMA channel 9 is available and connected to the transmit path of UART module 0. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of UART module 1 transmit. |
| 8 | DMACH8 | RO | 1 | UART0_RX / UART1_RX When set, indicates uDMA channel 8 is available and connected to the receive path of UART module 0. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of UART module 1 receive. |
| 7 | DMACH7 | RO | 1 | ETH_TX / Timer2B When set, indicates uDMA channel 7 is available and connected to the transmit path of the Ethernet module. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of Timer 2B. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 6 | DMACH6 | RO | 1 | ETH_RX / Timer2A When set, indicates uDMA channel 6 is available and connected to the receive path of the Ethernet module. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of Timer 2A. |
| 5 | DMACH5 | RO | 1 | USB_EP3_TX / Timer2B When set, indicates uDMA channel 5 is available and connected to the transmit path of USB endpoint 3. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of Timer 2B. |
| 4 | DMACH4 | RO | 1 | USB_EP3_RX / Timer2A When set, indicates uDMA channel 4 is available and connected to the receive path of USB endpoint 3. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of Timer 2A. |
| 3 | DMACH3 | RO | 1 | USB_EP2_TX / Timer3B When set, indicates uDMA channel 3 is available and connected to the transmit path of USB endpoint 2. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of Timer 3B. |
| 2 | DMACH2 | RO | 1 | USB_EP2_RX / Timer3A When set, indicates uDMA channel 2 is available and connected to the receive path of USB endpoint 2. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of Timer 3A. |
| 1 | DMACH1 | RO | 1 | USB_EP1_TX / UART2_TX When set, indicates uDMA channel 1 is available and connected to the transmit path of USB endpoint 1. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of UART module 2 transmit. |
| 0 | DMACH0 | RO | 1 | USB_EP1_RX / UART2_RX When set, indicates uDMA channel 0 is available and connected to the receive path of USB endpoint 1. If the corresponding bit in the DMACHASGN register is set, the channel is connected instead to the secondary channel assignment of UART module 2 receive. |

Register 25: Device Capabilities 8 ADC Channels (DC8), offset 0x02C

This register is predefined by the part and can be used to verify features.

Device Capabilities 8 ADC Channels (DC8)

Base 0x400F.E000

Offset 0x02C

Type RO, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | ADC1AIN15 | ADC1AIN14 | ADC1AIN13 | ADC1AIN12 | ADC1AIN11 | ADC1AIN10 | ADC1AIN9 | ADC1AIN8 | ADC1AIN7 | ADC1AIN6 | ADC1AIN5 | ADC1AIN4 | ADC1AIN3 | ADC1AIN2 | ADC1AIN1 | ADC1AIN0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | ADC0AIN15 | ADC0AIN14 | ADC0AIN13 | ADC0AIN12 | ADC0AIN11 | ADC0AIN10 | ADC0AIN9 | ADC0AIN8 | ADC0AIN7 | ADC0AIN6 | ADC0AIN5 | ADC0AIN4 | ADC0AIN3 | ADC0AIN2 | ADC0AIN1 | ADC0AIN0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|--|
| 31 | ADC1AIN15 | RO | 1 | ADC Module 1 AIN15 Pin Present When set, indicates that ADC module 1 input pin 15 is present. |
| 30 | ADC1AIN14 | RO | 1 | ADC Module 1 AIN14 Pin Present When set, indicates that ADC module 1 input pin 14 is present. |
| 29 | ADC1AIN13 | RO | 1 | ADC Module 1 AIN13 Pin Present When set, indicates that ADC module 1 input pin 13 is present. |
| 28 | ADC1AIN12 | RO | 1 | ADC Module 1 AIN12 Pin Present When set, indicates that ADC module 1 input pin 12 is present. |
| 27 | ADC1AIN11 | RO | 1 | ADC Module 1 AIN11 Pin Present When set, indicates that ADC module 1 input pin 11 is present. |
| 26 | ADC1AIN10 | RO | 1 | ADC Module 1 AIN10 Pin Present When set, indicates that ADC module 1 input pin 10 is present. |
| 25 | ADC1AIN9 | RO | 1 | ADC Module 1 AIN9 Pin Present When set, indicates that ADC module 1 input pin 9 is present. |
| 24 | ADC1AIN8 | RO | 1 | ADC Module 1 AIN8 Pin Present When set, indicates that ADC module 1 input pin 8 is present. |
| 23 | ADC1AIN7 | RO | 1 | ADC Module 1 AIN7 Pin Present When set, indicates that ADC module 1 input pin 7 is present. |
| 22 | ADC1AIN6 | RO | 1 | ADC Module 1 AIN6 Pin Present When set, indicates that ADC module 1 input pin 6 is present. |
| 21 | ADC1AIN5 | RO | 1 | ADC Module 1 AIN5 Pin Present When set, indicates that ADC module 1 input pin 5 is present. |
| 20 | ADC1AIN4 | RO | 1 | ADC Module 1 AIN4 Pin Present When set, indicates that ADC module 1 input pin 4 is present. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|--|
| 19 | ADC1AIN3 | RO | 1 | ADC Module 1 AIN3 Pin Present When set, indicates that ADC module 1 input pin 3 is present. |
| 18 | ADC1AIN2 | RO | 1 | ADC Module 1 AIN2 Pin Present When set, indicates that ADC module 1 input pin 2 is present. |
| 17 | ADC1AIN1 | RO | 1 | ADC Module 1 AIN1 Pin Present When set, indicates that ADC module 1 input pin 1 is present. |
| 16 | ADC1AIN0 | RO | 1 | ADC Module 1 AIN0 Pin Present When set, indicates that ADC module 1 input pin 0 is present. |
| 15 | ADC0AIN15 | RO | 1 | ADC Module 0 AIN15 Pin Present When set, indicates that ADC module 0 input pin 15 is present. |
| 14 | ADC0AIN14 | RO | 1 | ADC Module 0 AIN14 Pin Present When set, indicates that ADC module 0 input pin 14 is present. |
| 13 | ADC0AIN13 | RO | 1 | ADC Module 0 AIN13 Pin Present When set, indicates that ADC module 0 input pin 13 is present. |
| 12 | ADC0AIN12 | RO | 1 | ADC Module 0 AIN12 Pin Present When set, indicates that ADC module 0 input pin 12 is present. |
| 11 | ADC0AIN11 | RO | 1 | ADC Module 0 AIN11 Pin Present When set, indicates that ADC module 0 input pin 11 is present. |
| 10 | ADC0AIN10 | RO | 1 | ADC Module 0 AIN10 Pin Present When set, indicates that ADC module 0 input pin 10 is present. |
| 9 | ADC0AIN9 | RO | 1 | ADC Module 0 AIN9 Pin Present When set, indicates that ADC module 0 input pin 9 is present. |
| 8 | ADC0AIN8 | RO | 1 | ADC Module 0 AIN8 Pin Present When set, indicates that ADC module 0 input pin 8 is present. |
| 7 | ADC0AIN7 | RO | 1 | ADC Module 0 AIN7 Pin Present When set, indicates that ADC module 0 input pin 7 is present. |
| 6 | ADC0AIN6 | RO | 1 | ADC Module 0 AIN6 Pin Present When set, indicates that ADC module 0 input pin 6 is present. |
| 5 | ADC0AIN5 | RO | 1 | ADC Module 0 AIN5 Pin Present When set, indicates that ADC module 0 input pin 5 is present. |
| 4 | ADC0AIN4 | RO | 1 | ADC Module 0 AIN4 Pin Present When set, indicates that ADC module 0 input pin 4 is present. |
| 3 | ADC0AIN3 | RO | 1 | ADC Module 0 AIN3 Pin Present When set, indicates that ADC module 0 input pin 3 is present. |
| 2 | ADC0AIN2 | RO | 1 | ADC Module 0 AIN2 Pin Present When set, indicates that ADC module 0 input pin 2 is present. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 1 | ADC0AIN1 | RO | 1 | ADC Module 0 AIN1 Pin Present When set, indicates that ADC module 0 input pin 1 is present. |
| 0 | ADC0AIN0 | RO | 1 | ADC Module 0 AIN0 Pin Present When set, indicates that ADC module 0 input pin 0 is present. |

Register 26: Device Capabilities 9 ADC Digital Comparators (DC9), offset 0x190

This register is predefined by the part and can be used to verify features.

Device Capabilities 9 ADC Digital Comparators (DC9)

Base 0x400F.E000

Offset 0x190

Type RO, reset 0x00FF.00FF

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|---------|---------|---------|---------|---------|---------|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | ADC1DC7 | ADC1DC6 | ADC1DC5 | ADC1DC4 | ADC1DC3 | ADC1DC2 | ADC1DC1 | ADC1DC0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | ADC0DC7 | ADC0DC6 | ADC0DC5 | ADC0DC4 | ADC0DC3 | ADC0DC2 | ADC0DC1 | ADC0DC0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:24 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 23 | ADC1DC7 | RO | 1 | ADC1 DC7 Present When set, indicates that ADC module 1 Digital Comparator 7 is present. |
| 22 | ADC1DC6 | RO | 1 | ADC1 DC6 Present When set, indicates that ADC module 1 Digital Comparator 6 is present. |
| 21 | ADC1DC5 | RO | 1 | ADC1 DC5 Present When set, indicates that ADC module 1 Digital Comparator 5 is present. |
| 20 | ADC1DC4 | RO | 1 | ADC1 DC4 Present When set, indicates that ADC module 1 Digital Comparator 4 is present. |
| 19 | ADC1DC3 | RO | 1 | ADC1 DC3 Present When set, indicates that ADC module 1 Digital Comparator 3 is present. |
| 18 | ADC1DC2 | RO | 1 | ADC1 DC2 Present When set, indicates that ADC module 1 Digital Comparator 2 is present. |
| 17 | ADC1DC1 | RO | 1 | ADC1 DC1 Present When set, indicates that ADC module 1 Digital Comparator 1 is present. |
| 16 | ADC1DC0 | RO | 1 | ADC1 DC0 Present When set, indicates that ADC module 1 Digital Comparator 0 is present. |
| 15:8 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | ADC0DC7 | RO | 1 | ADC0 DC7 Present When set, indicates that ADC module 0 Digital Comparator 7 is present. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|--|
| 6 | ADC0DC6 | RO | 1 | ADC0 DC6 Present When set, indicates that ADC module 0 Digital Comparator 6 is present. |
| 5 | ADC0DC5 | RO | 1 | ADC0 DC5 Present When set, indicates that ADC module 0 Digital Comparator 5 is present. |
| 4 | ADC0DC4 | RO | 1 | ADC0 DC4 Present When set, indicates that ADC module 0 Digital Comparator 4 is present. |
| 3 | ADC0DC3 | RO | 1 | ADC0 DC3 Present When set, indicates that ADC module 0 Digital Comparator 3 is present. |
| 2 | ADC0DC2 | RO | 1 | ADC0 DC2 Present When set, indicates that ADC module 0 Digital Comparator 2 is present. |
| 1 | ADC0DC1 | RO | 1 | ADC0 DC1 Present When set, indicates that ADC module 0 Digital Comparator 1 is present. |
| 0 | ADC0DC0 | RO | 1 | ADC0 DC0 Present When set, indicates that ADC module 0 Digital Comparator 0 is present. |

Register 27: Non-Volatile Memory Information (NVMSTAT), offset 0x1A0

This register is predefined by the part and can be used to verify features.

Non-Volatile Memory Information (NVMSTAT)

Base 0x400F.E000

Offset 0x1A0

Type RO, reset 0x0000.0001

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | FWB |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:1 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | FWB | RO | 1 | 32 Word Flash Write Buffer Active When set, indicates that the 32 word Flash memory write buffer feature is active. |

Register 28: Run Mode Clock Gating Control Register 0 (RCGC0), offset 0x100

This register controls the clock gating logic in normal Run mode. Each bit controls a clock enable for a given interface, function, or module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled (saving power). If the module is unlocked, reads or writes to the module generate a bus fault. The reset state of these bits is 0 (unlocked) unless otherwise noted, so that all functional modules are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or modules to control. This configuration is implemented to assure reasonable code compatibility with other family and future parts. **RCGC0** is the clock configuration register for running operation, **SCGC0** for Sleep operation, and **DCGC0** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

Run Mode Clock Gating Control Register 0 (RCGC0)

Base 0x400F.E000

Offset 0x100

Type R/W, reset 0x00000040

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|------|------------|-----|------------|------|----------|-----|----------|-----|----------|----------|------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | WDT1 | reserved | | CAN1 | CAN0 | reserved | | | PWM | reserved | | ADC1 | ADC0 |
| Type | RO | RO | RO | R/W | RO | RO | R/W | R/W | RO | RO | RO | R/W | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | MAXADC1SPD | | MAXADC0SPD | | reserved | HIB | reserved | | WDT0 | reserved | | |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | R/W | RO | R/W | RO | RO | R/W | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | WDT1 | R/W | 0 | WDT1 Clock Gating Control This bit controls the clock gating for the Watchdog Timer module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 27:26 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 25 | CAN1 | R/W | 0 | CAN1 Clock Gating Control This bit controls the clock gating for CAN module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 24 | CAN0 | R/W | 0 | CAN0 Clock Gating Control This bit controls the clock gating for CAN module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|---------------------|------|-------|--|-------|-------------|-----|-------------------|-----|---------------------|-----|---------------------|-----|---------------------|
| 23:21 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 20 | PWM | R/W | 0 | <p>PWM Clock Gating Control</p> <p>This bit controls the clock gating for the PWM module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> | | | | | | | | | | |
| 19:18 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 17 | ADC1 | R/W | 0 | <p>ADC1 Clock Gating Control</p> <p>This bit controls the clock gating for SAR ADC module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> | | | | | | | | | | |
| 16 | ADC0 | R/W | 0 | <p>ADC0 Clock Gating Control</p> <p>This bit controls the clock gating for ADC module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> | | | | | | | | | | |
| 15:12 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 11:10 | MAXADC1SPD | R/W | 0 | <p>ADC1 Sample Speed</p> <p>This field sets the rate at which ADC module 1 samples data. You cannot set the rate higher than the maximum rate. You can set the sample rate by setting the MAXADC1SPD bit as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x3</td> <td>1M samples/second</td> </tr> <tr> <td>0x2</td> <td>500K samples/second</td> </tr> <tr> <td>0x1</td> <td>250K samples/second</td> </tr> <tr> <td>0x0</td> <td>125K samples/second</td> </tr> </tbody> </table> | Value | Description | 0x3 | 1M samples/second | 0x2 | 500K samples/second | 0x1 | 250K samples/second | 0x0 | 125K samples/second |
| Value | Description | | | | | | | | | | | | | |
| 0x3 | 1M samples/second | | | | | | | | | | | | | |
| 0x2 | 500K samples/second | | | | | | | | | | | | | |
| 0x1 | 250K samples/second | | | | | | | | | | | | | |
| 0x0 | 125K samples/second | | | | | | | | | | | | | |
| 9:8 | MAXADC0SPD | R/W | 0 | <p>ADC0 Sample Speed</p> <p>This field sets the rate at which ADC0 samples data. You cannot set the rate higher than the maximum rate. You can set the sample rate by setting the MAXADC0SPD bit as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x3</td> <td>1M samples/second</td> </tr> <tr> <td>0x2</td> <td>500K samples/second</td> </tr> <tr> <td>0x1</td> <td>250K samples/second</td> </tr> <tr> <td>0x0</td> <td>125K samples/second</td> </tr> </tbody> </table> | Value | Description | 0x3 | 1M samples/second | 0x2 | 500K samples/second | 0x1 | 250K samples/second | 0x0 | 125K samples/second |
| Value | Description | | | | | | | | | | | | | |
| 0x3 | 1M samples/second | | | | | | | | | | | | | |
| 0x2 | 500K samples/second | | | | | | | | | | | | | |
| 0x1 | 250K samples/second | | | | | | | | | | | | | |
| 0x0 | 125K samples/second | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 7 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6 | HIB | R/W | 1 | HIB Clock Gating Control This bit controls the clock gating for the Hibernation module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 5:4 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | WDT0 | R/W | 0 | WDT0 Clock Gating Control This bit controls the clock gating for the Watchdog Timer module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 2:0 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 29: Sleep Mode Clock Gating Control Register 0 (SCGC0), offset 0x110

This register controls the clock gating logic in Sleep mode. Each bit controls a clock enable for a given interface, function, or module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled (saving power). If the module is unlocked, reads or writes to the module generate a bus fault. The reset state of these bits is 0 (unlocked) unless otherwise noted, so that all functional modules are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or modules to control. This configuration is implemented to assure reasonable code compatibility with other family and future parts. **RCGC0** is the clock configuration register for running operation, **SCGC0** for Sleep operation, and **DCGC0** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

Sleep Mode Clock Gating Control Register 0 (SCGC0)

Base 0x400F.E000

Offset 0x110

Type R/W, reset 0x00000040

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|------|------------|-----|------------|------|----------|-----|----------|-----|----------|----------|------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | WDT1 | reserved | | CAN1 | CAN0 | reserved | | | PWM | reserved | | ADC1 | ADC0 |
| Type | RO | RO | RO | R/W | RO | RO | R/W | R/W | RO | RO | RO | R/W | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | MAXADC1SPD | | MAXADC0SPD | | reserved | HIB | reserved | | WDT0 | reserved | | |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | R/W | RO | R/W | RO | RO | R/W | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | WDT1 | R/W | 0 | WDT1 Clock Gating Control This bit controls the clock gating for Watchdog Timer module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 27:26 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 25 | CAN1 | R/W | 0 | CAN1 Clock Gating Control This bit controls the clock gating for CAN module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 24 | CAN0 | R/W | 0 | CAN0 Clock Gating Control This bit controls the clock gating for CAN module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|---------------------|------|-------|---|-------|-------------|-----|-------------------|-----|---------------------|-----|---------------------|-----|---------------------|
| 23:21 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 20 | PWM | R/W | 0 | <p>PWM Clock Gating Control</p> <p>This bit controls the clock gating for the PWM module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> | | | | | | | | | | |
| 19:18 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 17 | ADC1 | R/W | 0 | <p>ADC1 Clock Gating Control</p> <p>This bit controls the clock gating for ADC module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> | | | | | | | | | | |
| 16 | ADC0 | R/W | 0 | <p>ADC0 Clock Gating Control</p> <p>This bit controls the clock gating for ADC module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> | | | | | | | | | | |
| 15:12 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 11:10 | MAXADC1SPD | R/W | 0 | <p>ADC1 Sample Speed</p> <p>This field sets the rate at which ADC module 1 samples data. You cannot set the rate higher than the maximum rate. You can set the sample rate by setting the <code>MAXADC1SPD</code> bit as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x3</td> <td>1M samples/second</td> </tr> <tr> <td>0x2</td> <td>500K samples/second</td> </tr> <tr> <td>0x1</td> <td>250K samples/second</td> </tr> <tr> <td>0x0</td> <td>125K samples/second</td> </tr> </tbody> </table> | Value | Description | 0x3 | 1M samples/second | 0x2 | 500K samples/second | 0x1 | 250K samples/second | 0x0 | 125K samples/second |
| Value | Description | | | | | | | | | | | | | |
| 0x3 | 1M samples/second | | | | | | | | | | | | | |
| 0x2 | 500K samples/second | | | | | | | | | | | | | |
| 0x1 | 250K samples/second | | | | | | | | | | | | | |
| 0x0 | 125K samples/second | | | | | | | | | | | | | |
| 9:8 | MAXADC0SPD | R/W | 0 | <p>ADC0 Sample Speed</p> <p>This field sets the rate at which ADC module 0 samples data. You cannot set the rate higher than the maximum rate. You can set the sample rate by setting the <code>MAXADC0SPD</code> bit as follows (all other encodings are reserved):</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x3</td> <td>1M samples/second</td> </tr> <tr> <td>0x2</td> <td>500K samples/second</td> </tr> <tr> <td>0x1</td> <td>250K samples/second</td> </tr> <tr> <td>0x0</td> <td>125K samples/second</td> </tr> </tbody> </table> | Value | Description | 0x3 | 1M samples/second | 0x2 | 500K samples/second | 0x1 | 250K samples/second | 0x0 | 125K samples/second |
| Value | Description | | | | | | | | | | | | | |
| 0x3 | 1M samples/second | | | | | | | | | | | | | |
| 0x2 | 500K samples/second | | | | | | | | | | | | | |
| 0x1 | 250K samples/second | | | | | | | | | | | | | |
| 0x0 | 125K samples/second | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 7 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6 | HIB | R/W | 1 | HIB Clock Gating Control This bit controls the clock gating for the Hibernation module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 5:4 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | WDT0 | R/W | 0 | WDT0 Clock Gating Control This bit controls the clock gating for the Watchdog Timer module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 2:0 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 30: Deep Sleep Mode Clock Gating Control Register 0 (DCGC0), offset 0x120

This register controls the clock gating logic in Deep-Sleep mode. Each bit controls a clock enable for a given interface, function, or module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled (saving power). If the module is unlocked, reads or writes to the module generate a bus fault. The reset state of these bits is 0 (unlocked) unless otherwise noted, so that all functional modules are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or modules to control. This configuration is implemented to assure reasonable code compatibility with other family and future parts. **RCGC0** is the clock configuration register for running operation, **SCGC0** for Sleep operation, and **DCGC0** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

Deep Sleep Mode Clock Gating Control Register 0 (DCGC0)

Base 0x400F.E000
Offset 0x120
Type R/W, reset 0x00000040

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|------|----------|----|------|------|----------|-----|-----|----------|----------|------|----------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | WDT1 | reserved | | CAN1 | CAN0 | reserved | | | PWM | reserved | | ADC1 | ADC0 |
| Type | RO | RO | RO | R/W | RO | RO | R/W | R/W | RO | RO | RO | R/W | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | HIB | reserved | | WDT0 | reserved | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | RO | RO | R/W | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | WDT1 | R/W | 0 | WDT1 Clock Gating Control This bit controls the clock gating for the Watchdog Timer module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 27:26 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 25 | CAN1 | R/W | 0 | CAN1 Clock Gating Control This bit controls the clock gating for CAN module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 24 | CAN0 | R/W | 0 | CAN0 Clock Gating Control This bit controls the clock gating for CAN module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 23:21 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 20 | PWM | R/W | 0 | PWM Clock Gating Control This bit controls the clock gating for the PWM module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 19:18 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 17 | ADC1 | R/W | 0 | ADC1 Clock Gating Control This bit controls the clock gating for ADC module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 16 | ADC0 | R/W | 0 | ADC0 Clock Gating Control This bit controls the clock gating for ADC module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 15:7 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6 | HIB | R/W | 1 | HIB Clock Gating Control This bit controls the clock gating for the Hibernation module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 5:4 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | WDT0 | R/W | 0 | WDT0 Clock Gating Control This bit controls the clock gating for the Watchdog Timer module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 2:0 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 31: Run Mode Clock Gating Control Register 1 (RCGC1), offset 0x104

This register controls the clock gating logic in normal Run mode. Each bit controls a clock enable for a given interface, function, or module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled (saving power). If the module is unlocked, reads or writes to the module generate a bus fault. The reset state of these bits is 0 (unlocked) unless otherwise noted, so that all functional modules are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or modules to control. This configuration is implemented to assure reasonable code compatibility with other family and future parts. **RCGC1** is the clock configuration register for running operation, **SCGC1** for Sleep operation, and **DCGC1** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

Run Mode Clock Gating Control Register 1 (RCGC1)

Base 0x400F.E000

Offset 0x104

Type R/W, reset 0x00000000

| | | | | | | | | | | | | | | | | |
|-------|----------|------|----------|------|----------|-------|-------|-------|----------|----|------|--------|----------|--------|--------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | EPI0 | reserved | I2S0 | reserved | COMP2 | COMP1 | COMP0 | reserved | | | TIMER3 | TIMER2 | TIMER1 | TIMER0 | |
| Type | RO | R/W | RO | R/W | RO | R/W | R/W | R/W | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | I2C1 | reserved | I2C0 | reserved | | QE11 | QE10 | reserved | | SSI1 | SSI0 | reserved | UART2 | UART1 | UART0 |
| Type | RO | R/W | RO | R/W | RO | RO | R/W | R/W | RO | RO | R/W | R/W | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 30 | EPI0 | R/W | 0 | EPI0 Clock Gating This bit controls the clock gating for EPI module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | I2S0 | R/W | 0 | I2S0 Clock Gating This bit controls the clock gating for I2S module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 27 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 26 | COMP2 | R/W | 0 | <p>Analog Comparator 2 Clock Gating</p> <p>This bit controls the clock gating for analog comparator 2. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 25 | COMP1 | R/W | 0 | <p>Analog Comparator 1 Clock Gating</p> <p>This bit controls the clock gating for analog comparator 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 24 | COMP0 | R/W | 0 | <p>Analog Comparator 0 Clock Gating</p> <p>This bit controls the clock gating for analog comparator 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 23:20 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 19 | TIMER3 | R/W | 0 | <p>Timer 3 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 3. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 18 | TIMER2 | R/W | 0 | <p>Timer 2 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 2. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 17 | TIMER1 | R/W | 0 | <p>Timer 1 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 16 | TIMER0 | R/W | 0 | <p>Timer 0 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 15 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 14 | I2C1 | R/W | 0 | <p>I2C1 Clock Gating Control</p> <p>This bit controls the clock gating for I2C module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 13 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 12 | I2C0 | R/W | 0 | I2C0 Clock Gating Control This bit controls the clock gating for I2C module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 11:10 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9 | QE11 | R/W | 0 | QE11 Clock Gating Control This bit controls the clock gating for QE1 module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 8 | QE10 | R/W | 0 | QE10 Clock Gating Control This bit controls the clock gating for QE1 module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 7:6 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | SSI1 | R/W | 0 | SSI1 Clock Gating Control This bit controls the clock gating for SSI module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 4 | SSI0 | R/W | 0 | SSI0 Clock Gating Control This bit controls the clock gating for SSI module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | UART2 | R/W | 0 | UART2 Clock Gating Control This bit controls the clock gating for UART module 2. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 1 | UART1 | R/W | 0 | UART1 Clock Gating Control This bit controls the clock gating for UART module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 0 | UART0 | R/W | 0 | UART0 Clock Gating Control This bit controls the clock gating for UART module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |

Register 32: Sleep Mode Clock Gating Control Register 1 (SCGC1), offset 0x114

This register controls the clock gating logic in Sleep mode. Each bit controls a clock enable for a given interface, function, or module. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled (saving power). If the module is unclocked, reads or writes to the module generate a bus fault. The reset state of these bits is 0 (unclocked) unless otherwise noted, so that all functional modules are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or modules to control. This configuration is implemented to assure reasonable code compatibility with other family and future parts. **RCGC1** is the clock configuration register for running operation, **SCGC1** for Sleep operation, and **DCGC1** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

Sleep Mode Clock Gating Control Register 1 (SCGC1)

Base 0x400F.E000

Offset 0x114

Type R/W, reset 0x00000000

| | | | | | | | | | | | | | | | | |
|-------|----------|------|----------|------|----------|-------|-------|-------|----------|----|------|--------|----------|--------|--------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | EPI0 | reserved | I2S0 | reserved | COMP2 | COMP1 | COMP0 | reserved | | | TIMER3 | TIMER2 | TIMER1 | TIMER0 | |
| Type | RO | R/W | RO | R/W | RO | R/W | R/W | R/W | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | I2C1 | reserved | I2C0 | reserved | | QE1 | QE0 | reserved | | SSI1 | SSI0 | reserved | UART2 | UART1 | UART0 |
| Type | RO | R/W | RO | R/W | RO | RO | R/W | R/W | RO | RO | R/W | R/W | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 30 | EPI0 | R/W | 0 | EPI0 Clock Gating This bit controls the clock gating for EPI module 0. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled. If the module is unclocked, a read or write to the module generates a bus fault. |
| 29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | I2S0 | R/W | 0 | I2S0 Clock Gating This bit controls the clock gating for I2S module 0. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled. If the module is unclocked, a read or write to the module generates a bus fault. |
| 27 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 26 | COMP2 | R/W | 0 | <p>Analog Comparator 2 Clock Gating</p> <p>This bit controls the clock gating for analog comparator 2. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 25 | COMP1 | R/W | 0 | <p>Analog Comparator 1 Clock Gating</p> <p>This bit controls the clock gating for analog comparator 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 24 | COMP0 | R/W | 0 | <p>Analog Comparator 0 Clock Gating</p> <p>This bit controls the clock gating for analog comparator 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 23:20 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 19 | TIMER3 | R/W | 0 | <p>Timer 3 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 3. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 18 | TIMER2 | R/W | 0 | <p>Timer 2 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 2. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 17 | TIMER1 | R/W | 0 | <p>Timer 1 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 16 | TIMER0 | R/W | 0 | <p>Timer 0 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 15 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 14 | I2C1 | R/W | 0 | <p>I2C1 Clock Gating Control</p> <p>This bit controls the clock gating for I2C module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 13 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 12 | I2C0 | R/W | 0 | I2C0 Clock Gating Control This bit controls the clock gating for I2C module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 11:10 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9 | QE11 | R/W | 0 | QE11 Clock Gating Control This bit controls the clock gating for QE1 module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 8 | QE10 | R/W | 0 | QE10 Clock Gating Control This bit controls the clock gating for QE1 module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 7:6 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | SSI1 | R/W | 0 | SSI1 Clock Gating Control This bit controls the clock gating for SSI module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 4 | SSI0 | R/W | 0 | SSI0 Clock Gating Control This bit controls the clock gating for SSI module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | UART2 | R/W | 0 | UART2 Clock Gating Control This bit controls the clock gating for UART module 2. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 1 | UART1 | R/W | 0 | UART1 Clock Gating Control This bit controls the clock gating for UART module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 0 | UART0 | R/W | 0 | UART0 Clock Gating Control This bit controls the clock gating for UART module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |

Register 33: Deep-Sleep Mode Clock Gating Control Register 1 (DCGC1), offset 0x124

This register controls the clock gating logic in Deep-Sleep mode. Each bit controls a clock enable for a given interface, function, or module. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled (saving power). If the module is unclocked, reads or writes to the module generate a bus fault. The reset state of these bits is 0 (unclocked) unless otherwise noted, so that all functional modules are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or modules to control. This configuration is implemented to assure reasonable code compatibility with other family and future parts. **RCGC1** is the clock configuration register for running operation, **SCGC1** for Sleep operation, and **DCGC1** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

Deep-Sleep Mode Clock Gating Control Register 1 (DCGC1)

Base 0x400F.E000

Offset 0x124

Type R/W, reset 0x00000000

| | | | | | | | | | | | | | | | | |
|-------|----------|------|----------|------|----------|-------|-------|-------|----------|----|------|--------|----------|--------|--------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | EPI0 | reserved | I2S0 | reserved | COMP2 | COMP1 | COMP0 | reserved | | | TIMER3 | TIMER2 | TIMER1 | TIMER0 | |
| Type | RO | R/W | RO | R/W | RO | R/W | R/W | R/W | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | I2C1 | reserved | I2C0 | reserved | | QE1 | QE0 | reserved | | SSI1 | SSI0 | reserved | UART2 | UART1 | UART0 |
| Type | RO | R/W | RO | R/W | RO | RO | R/W | R/W | RO | RO | R/W | R/W | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 30 | EPI0 | R/W | 0 | EPI0 Clock Gating This bit controls the clock gating for EPI module 0. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled. If the module is unclocked, a read or write to the module generates a bus fault. |
| 29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | I2S0 | R/W | 0 | I2S0 Clock Gating This bit controls the clock gating for I2S module 0. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled. If the module is unclocked, a read or write to the module generates a bus fault. |
| 27 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 26 | COMP2 | R/W | 0 | <p>Analog Comparator 2 Clock Gating</p> <p>This bit controls the clock gating for analog comparator 2. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 25 | COMP1 | R/W | 0 | <p>Analog Comparator 1 Clock Gating</p> <p>This bit controls the clock gating for analog comparator 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 24 | COMP0 | R/W | 0 | <p>Analog Comparator 0 Clock Gating</p> <p>This bit controls the clock gating for analog comparator 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 23:20 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 19 | TIMER3 | R/W | 0 | <p>Timer 3 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 3. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 18 | TIMER2 | R/W | 0 | <p>Timer 2 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 2. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 17 | TIMER1 | R/W | 0 | <p>Timer 1 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 16 | TIMER0 | R/W | 0 | <p>Timer 0 Clock Gating Control</p> <p>This bit controls the clock gating for General-Purpose Timer module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 15 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 14 | I2C1 | R/W | 0 | <p>I2C1 Clock Gating Control</p> <p>This bit controls the clock gating for I2C module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 13 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 12 | I2C0 | R/W | 0 | I2C0 Clock Gating Control This bit controls the clock gating for I2C module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 11:10 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9 | QE11 | R/W | 0 | QE11 Clock Gating Control This bit controls the clock gating for QE1 module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 8 | QE10 | R/W | 0 | QE10 Clock Gating Control This bit controls the clock gating for QE1 module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 7:6 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | SSI1 | R/W | 0 | SSI1 Clock Gating Control This bit controls the clock gating for SSI module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 4 | SSI0 | R/W | 0 | SSI0 Clock Gating Control This bit controls the clock gating for SSI module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | UART2 | R/W | 0 | UART2 Clock Gating Control This bit controls the clock gating for UART module 2. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 1 | UART1 | R/W | 0 | UART1 Clock Gating Control This bit controls the clock gating for UART module 1. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 0 | UART0 | R/W | 0 | UART0 Clock Gating Control This bit controls the clock gating for UART module 0. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |

Register 34: Run Mode Clock Gating Control Register 2 (RCGC2), offset 0x108

This register controls the clock gating logic in normal Run mode. Each bit controls a clock enable for a given interface, function, or module. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled (saving power). If the module is unlocked, reads or writes to the module generate a bus fault. The reset state of these bits is 0 (unlocked) unless otherwise noted, so that all functional modules are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or modules to control. This configuration is implemented to assure reasonable code compatibility with other family and future parts. **RCGC2** is the clock configuration register for running operation, **SCGC2** for Sleep operation, and **DCGC2** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

Run Mode Clock Gating Control Register 2 (RCGC2)

Base 0x400F.E000
 Offset 0x108
 Type R/W, reset 0x00000000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|------|----------|----|----|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | UDMA | reserved | | | | GPIOJ | GPIOH | GPIOG | GPIOF | GPIOE | GPIOD | GPIOC | GPIOB | GPIOA |
| Type | RO | RO | R/W | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:14 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13 | UDMA | R/W | 0 | Micro-DMA Clock Gating Control This bit controls the clock gating for micro-DMA. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 12:9 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | GPIOJ | R/W | 0 | Port J Clock Gating Control This bit controls the clock gating for Port J. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |
| 7 | GPIOH | R/W | 0 | Port H Clock Gating Control This bit controls the clock gating for Port H. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 6 | GPIOG | R/W | 0 | <p>Port G Clock Gating Control</p> <p>This bit controls the clock gating for Port G. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 5 | GPIOF | R/W | 0 | <p>Port F Clock Gating Control</p> <p>This bit controls the clock gating for Port F. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 4 | GPIOE | R/W | 0 | <p>Port E Clock Gating Control</p> <p>Port E Clock Gating Control. This bit controls the clock gating for Port E. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 3 | GPIOD | R/W | 0 | <p>Port D Clock Gating Control</p> <p>Port D Clock Gating Control. This bit controls the clock gating for Port D. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 2 | GPIOC | R/W | 0 | <p>Port C Clock Gating Control</p> <p>This bit controls the clock gating for Port C. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 1 | GPIOB | R/W | 0 | <p>Port B Clock Gating Control</p> <p>This bit controls the clock gating for Port B. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 0 | GPIOA | R/W | 0 | <p>Port A Clock Gating Control</p> <p>This bit controls the clock gating for Port A. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |

Register 35: Sleep Mode Clock Gating Control Register 2 (SCGC2), offset 0x118

This register controls the clock gating logic in Sleep mode. Each bit controls a clock enable for a given interface, function, or module. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled (saving power). If the module is unclocked, reads or writes to the module generate a bus fault. The reset state of these bits is 0 (unclocked) unless otherwise noted, so that all functional modules are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or modules to control. This configuration is implemented to assure reasonable code compatibility with other family and future parts. **RCGC2** is the clock configuration register for running operation, **SCGC2** for Sleep operation, and **DCGC2** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

Sleep Mode Clock Gating Control Register 2 (SCGC2)

Base 0x400F.E000
 Offset 0x118
 Type R/W, reset 0x00000000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|------|----------|----|----|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | UDMA | reserved | | | | GPIOJ | GPIOH | GPIOG | GPIOF | GPIOE | GPIOD | GPIOC | GPIOB | GPIOA |
| Type | RO | RO | R/W | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:14 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13 | UDMA | R/W | 0 | Micro-DMA Clock Gating Control This bit controls the clock gating for micro-DMA. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled. If the module is unclocked, a read or write to the module generates a bus fault. |
| 12:9 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | GPIOJ | R/W | 0 | Port J Clock Gating Control This bit controls the clock gating for Port J. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled. If the module is unclocked, a read or write to the module generates a bus fault. |
| 7 | GPIOH | R/W | 0 | Port H Clock Gating Control This bit controls the clock gating for Port H. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled. If the module is unclocked, a read or write to the module generates a bus fault. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 6 | GPIOG | R/W | 0 | <p>Port G Clock Gating Control</p> <p>This bit controls the clock gating for Port G. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 5 | GPIOF | R/W | 0 | <p>Port F Clock Gating Control</p> <p>This bit controls the clock gating for Port F. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 4 | GPIOE | R/W | 0 | <p>Port E Clock Gating Control</p> <p>Port E Clock Gating Control. This bit controls the clock gating for Port E. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 3 | GPIOD | R/W | 0 | <p>Port D Clock Gating Control</p> <p>Port D Clock Gating Control. This bit controls the clock gating for Port D. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 2 | GPIOC | R/W | 0 | <p>Port C Clock Gating Control</p> <p>This bit controls the clock gating for Port C. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 1 | GPIOB | R/W | 0 | <p>Port B Clock Gating Control</p> <p>This bit controls the clock gating for Port B. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 0 | GPIOA | R/W | 0 | <p>Port A Clock Gating Control</p> <p>This bit controls the clock gating for Port A. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |

Register 36: Deep Sleep Mode Clock Gating Control Register 2 (DCGC2), offset 0x128

This register controls the clock gating logic in Deep-Sleep mode. Each bit controls a clock enable for a given interface, function, or module. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled (saving power). If the module is unclocked, reads or writes to the module generate a bus fault. The reset state of these bits is 0 (unclocked) unless otherwise noted, so that all functional modules are disabled. It is the responsibility of software to enable the ports necessary for the application. Note that these registers may contain more bits than there are interfaces, functions, or modules to control. This configuration is implemented to assure reasonable code compatibility with other family and future parts. **RCGC2** is the clock configuration register for running operation, **SCGC2** for Sleep operation, and **DCGC2** for Deep-Sleep operation. Setting the **ACG** bit in the **Run-Mode Clock Configuration (RCC)** register specifies that the system uses sleep modes.

Deep Sleep Mode Clock Gating Control Register 2 (DCGC2)

Base 0x400F.E000
 Offset 0x128
 Type R/W, reset 0x00000000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|------|----------|----|----|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | UDMA | reserved | | | | GPIOJ | GPIOH | GPIOG | GPIOF | GPIOE | GPIOD | GPIOC | GPIOB | GPIOA |
| Type | RO | RO | R/W | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:14 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13 | UDMA | R/W | 0 | Micro-DMA Clock Gating Control This bit controls the clock gating for micro-DMA. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled. If the module is unclocked, a read or write to the module generates a bus fault. |
| 12:9 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | GPIOJ | R/W | 0 | Port J Clock Gating Control This bit controls the clock gating for Port J. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled. If the module is unclocked, a read or write to the module generates a bus fault. |
| 7 | GPIOH | R/W | 0 | Port H Clock Gating Control This bit controls the clock gating for Port H. If set, the module receives a clock and functions. Otherwise, the module is unclocked and disabled. If the module is unclocked, a read or write to the module generates a bus fault. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 6 | GPIOG | R/W | 0 | <p>Port G Clock Gating Control</p> <p>This bit controls the clock gating for Port G. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 5 | GPIOF | R/W | 0 | <p>Port F Clock Gating Control</p> <p>This bit controls the clock gating for Port F. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 4 | GPIOE | R/W | 0 | <p>Port E Clock Gating Control</p> <p>Port E Clock Gating Control. This bit controls the clock gating for Port E. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 3 | GPIOD | R/W | 0 | <p>Port D Clock Gating Control</p> <p>Port D Clock Gating Control. This bit controls the clock gating for Port D. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 2 | GPIOC | R/W | 0 | <p>Port C Clock Gating Control</p> <p>This bit controls the clock gating for Port C. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 1 | GPIOB | R/W | 0 | <p>Port B Clock Gating Control</p> <p>This bit controls the clock gating for Port B. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |
| 0 | GPIOA | R/W | 0 | <p>Port A Clock Gating Control</p> <p>This bit controls the clock gating for Port A. If set, the module receives a clock and functions. Otherwise, the module is unlocked and disabled. If the module is unlocked, a read or write to the module generates a bus fault.</p> |

Register 37: Software Reset Control 0 (SRCR0), offset 0x040

This register allows individual modules to be reset. Writes to this register are masked by the bits in the **Device Capabilities 1 (DC1)** register.

Software Reset Control 0 (SRCR0)

Base 0x400F.E000

Offset 0x040

Type R/W, reset 0x00000000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|------|----------|----|------|------|----------|-----|-----|----------|----------|------|----------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | WDT1 | reserved | | CAN1 | CAN0 | reserved | | | PWM | reserved | | ADC1 | ADC0 |
| Type | RO | RO | RO | R/W | RO | RO | R/W | R/W | RO | RO | RO | R/W | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | HIB | reserved | | WDT0 | reserved | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | RO | RO | R/W | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | WDT1 | R/W | 0 | WDT1 Reset Control When this bit is set, Watchdog Timer module 1 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 27:26 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 25 | CAN1 | R/W | 0 | CAN1 Reset Control When this bit is set, CAN module 1 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 24 | CAN0 | R/W | 0 | CAN0 Reset Control When this bit is set, CAN module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 23:21 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 20 | PWM | R/W | 0 | PWM Reset Control When this bit is set, PWM module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 19:18 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 17 | ADC1 | R/W | 0 | <p>ADC1 Reset Control</p> <p>When this bit is set, ADC module 1 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set.</p> |
| 16 | ADC0 | R/W | 0 | <p>ADC0 Reset Control</p> <p>When this bit is set, ADC module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set.</p> |
| 15:7 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 6 | HIB | R/W | 0 | <p>HIB Reset Control</p> <p>When this bit is set, the Hibernation module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set.</p> |
| 5:4 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 3 | WDT0 | R/W | 0 | <p>WDT0 Reset Control</p> <p>When this bit is set, Watchdog Timer module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set.</p> |
| 2:0 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |

Register 38: Software Reset Control 1 (SRCR1), offset 0x044

This register allows individual modules to be reset. Writes to this register are masked by the bits in the **Device Capabilities 2 (DC2)** register.

Software Reset Control 1 (SRCR1)

Base 0x400F.E000

Offset 0x044

Type R/W, reset 0x00000000

| | | | | | | | | | | | | | | | | |
|-------|----------|------|----------|------|----------|-------|-------|-------|----------|----|------|--------|----------|--------|--------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | EPI0 | reserved | I2S0 | reserved | COMP2 | COMP1 | COMP0 | reserved | | | TIMER3 | TIMER2 | TIMER1 | TIMER0 | |
| Type | RO | R/W | RO | R/W | RO | R/W | R/W | R/W | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | I2C1 | reserved | I2C0 | reserved | | QE11 | QE10 | reserved | | SSI1 | SSI0 | reserved | UART2 | UART1 | UART0 |
| Type | RO | R/W | RO | R/W | RO | RO | R/W | R/W | RO | RO | R/W | R/W | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 30 | EPI0 | R/W | 0 | EPI0 Reset Control When this bit is set, EPI module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | I2S0 | R/W | 0 | I2S0 Reset Control When this bit is set, I2S module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 27 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 26 | COMP2 | R/W | 0 | Analog Comp 2 Reset Control When this bit is set, Analog Comparator module 2 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 25 | COMP1 | R/W | 0 | Analog Comp 1 Reset Control When this bit is set, Analog Comparator module 1 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 24 | COMP0 | R/W | 0 | Analog Comp 0 Reset Control When this bit is set, Analog Comparator module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 23:20 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 19 | TIMER3 | R/W | 0 | Timer 3 Reset Control Timer 3 Reset Control. When this bit is set, General-Purpose Timer module 3 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 18 | TIMER2 | R/W | 0 | Timer 2 Reset Control When this bit is set, General-Purpose Timer module 2 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 17 | TIMER1 | R/W | 0 | Timer 1 Reset Control When this bit is set, General-Purpose Timer module 1 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 16 | TIMER0 | R/W | 0 | Timer 0 Reset Control When this bit is set, General-Purpose Timer module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 15 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 14 | I2C1 | R/W | 0 | I2C1 Reset Control When this bit is set, I2C module 1 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 13 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 12 | I2C0 | R/W | 0 | I2C0 Reset Control When this bit is set, I2C module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 11:10 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9 | QE11 | R/W | 0 | QE11 Reset Control When this bit is set, QE1 module 1 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 8 | QE10 | R/W | 0 | QE10 Reset Control When this bit is set, QE1 module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 7:6 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | SSI1 | R/W | 0 | SSI1 Reset Control When this bit is set, SSI module 1 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 4 | SSI0 | R/W | 0 | SSI0 Reset Control When this bit is set, SSI module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | UART2 | R/W | 0 | UART2 Reset Control When this bit is set, UART module 2 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 1 | UART1 | R/W | 0 | UART1 Reset Control When this bit is set, UART module 1 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 0 | UART0 | R/W | 0 | UART0 Reset Control When this bit is set, UART module 0 is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |

Register 39: Software Reset Control 2 (SRCR2), offset 0x048

This register allows individual modules to be reset. Writes to this register are masked by the bits in the **Device Capabilities 4 (DC4)** register.

Software Reset Control 2 (SRCR2)

Base 0x400F.E000

Offset 0x048

Type R/W, reset 0x00000000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|------|----------|----|----|----|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | UDMA | reserved | | | | GPIOJ | GPIOH | GPIOG | GPIOF | GPIOE | GPIOD | GPIOC | GPIOB | GPIOA |
| Type | RO | RO | R/W | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:14 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13 | UDMA | R/W | 0 | Micro-DMA Reset Control When this bit is set, uDMA module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 12:9 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | GPIOJ | R/W | 0 | Port J Reset Control When this bit is set, Port J module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 7 | GPIOH | R/W | 0 | Port H Reset Control When this bit is set, Port H module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 6 | GPIOG | R/W | 0 | Port G Reset Control When this bit is set, Port G module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 5 | GPIOF | R/W | 0 | Port F Reset Control When this bit is set, Port F module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 4 | GPIOE | R/W | 0 | Port E Reset Control When this bit is set, Port E module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 3 | GPIOD | R/W | 0 | Port D Reset Control When this bit is set, Port D module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 2 | GPIOC | R/W | 0 | Port C Reset Control When this bit is set, Port C module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 1 | GPIOB | R/W | 0 | Port B Reset Control When this bit is set, Port B module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |
| 0 | GPIOA | R/W | 0 | Port A Reset Control When this bit is set, Port A module is reset. All internal data is lost and the registers are returned to their reset states. This bit must be manually cleared after being set. |

6 Hibernation Module

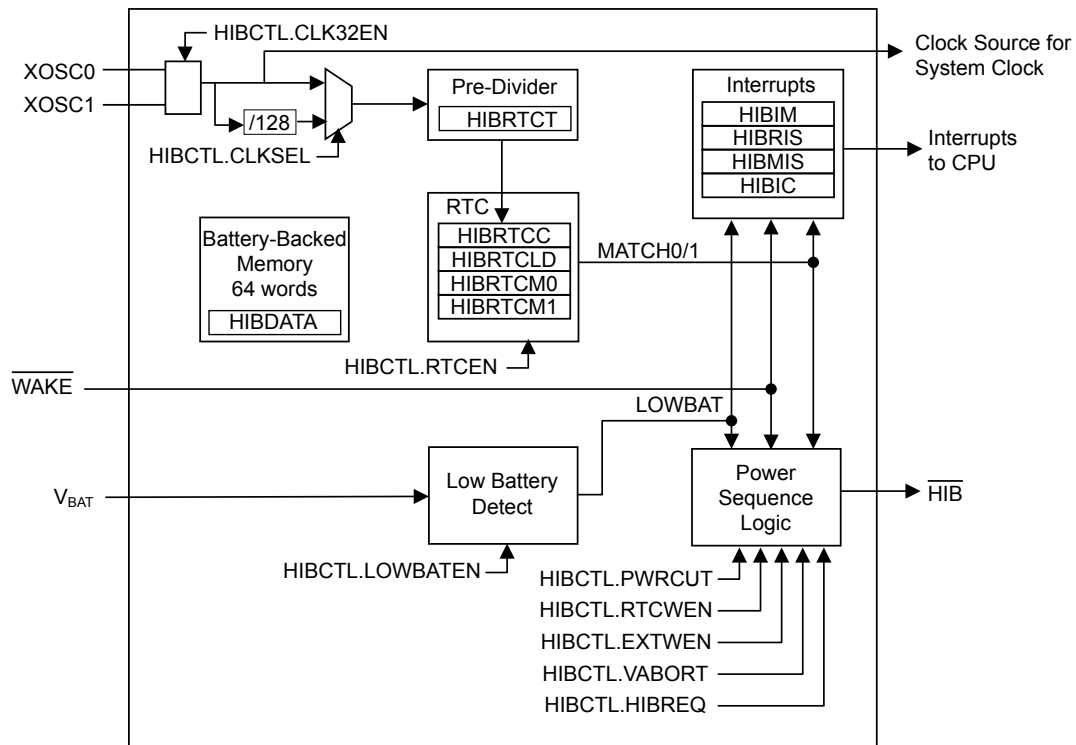
The Hibernation Module manages removal and restoration of power to provide a means for reducing power consumption. When the processor and peripherals are idle, power can be completely removed with only the Hibernation module remaining powered. Power can be restored based on an external signal or at a certain time using the built-in Real-Time Clock (RTC). The Hibernation module can be independently supplied from a battery or an auxiliary power supply.

The Hibernation module has the following features:

- 32-bit real-time counter (RTC)
 - Two 32-bit RTC match registers for timed wake-up and interrupt generation
 - RTC predivider trim for making fine adjustments to the clock rate
- Two mechanisms for power control
 - System power control using discrete external regulator
 - On-chip power control using internal switches under register control
- Dedicated pin for waking using an external signal
- RTC operational and hibernation memory valid as long as V_{BAT} is valid
- Low-battery detection, signaling, and interrupt generation
- Clock source from a 32.768-kHz external oscillator or a 4.194304-MHz crystal; 32.768-kHz external oscillator can be used for main controller clock
- 64 32-bit words of battery-backed memory to save state during hibernation
- Programmable interrupts for RTC match, external wake, and low battery events

6.1 Block Diagram

Figure 6-1. Hibernation Module Block Diagram



6.2 Signal Description

The following table lists the external signals of the Hibernation module and describes the function of each. These signals have dedicated functions and are not alternate functions for any GPIO signals.

Table 6-1. Hibernate Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|---|
| HIB | 51 | fixed | O | OD | An output that indicates the processor is in Hibernate mode. |
| VBAT | 55 | fixed | - | Power | Power source for the Hibernation module. It is normally connected to the positive terminal of a battery and serves as the battery backup/Hibernation module power-source supply. |
| WAKE | 50 | fixed | I | TTL | An external input that brings the processor out of Hibernate mode when asserted. |
| XOSC0 | 52 | fixed | I | Analog | Hibernation module oscillator crystal input or an external clock reference input. Note that this is either a 4.194304-MHz crystal or a 32.768-kHz oscillator for the Hibernation module RTC. See the CLKSEL bit in the HIBCTL register. |
| XOSC1 | 53 | fixed | O | Analog | Hibernation module oscillator crystal output. Leave unconnected when using a single-ended clock source. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 6-2. Hibernate Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|--------------------------|------------|--------------------------|----------|--------------------------|--|
| $\overline{\text{HIB}}$ | M12 | fixed | O | OD | An output that indicates the processor is in Hibernate mode. |
| VBAT | L12 | fixed | - | Power | Power source for the Hibernation module. It is normally connected to the positive terminal of a battery and serves as the battery backup/Hibernation module power-source supply. |
| $\overline{\text{WAKE}}$ | M10 | fixed | I | TTL | An external input that brings the processor out of Hibernate mode when asserted. |
| XOSC0 | K11 | fixed | I | Analog | Hibernation module oscillator crystal input or an external clock reference input. Note that this is either a 4.194304-MHz crystal or a 32.768-kHz oscillator for the Hibernation module RTC. See the CLKSEL bit in the HIBCTL register. |
| XOSC1 | K12 | fixed | O | Analog | Hibernation module oscillator crystal output. Leave unconnected when using a single-ended clock source. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

6.3 Functional Description

The Hibernation module provides two mechanisms for power control:

- The first mechanism controls the power to the microcontroller with a control signal ($\overline{\text{HIB}}$) that signals an external voltage regulator to turn on or off.
- The second mechanism uses internal switches to control power to the Cortex-M3 as well as to most analog and digital functions while retaining I/O pin power (VDD3ON mode).

The Hibernation module power source is determined dynamically. The supply voltage of the Hibernation module is the larger of the main voltage source (V_{DD}) or the battery/auxiliary voltage source (V_{BAT}). The Hibernation module also has an independent clock source to maintain a real-time clock (RTC) when the system clock is powered down.

Once in hibernation, the module signals an external voltage regulator to turn the power back on when an external pin ($\overline{\text{WAKE}}$) is asserted or when the internal RTC reaches a certain value. The Hibernation module can also detect when the battery voltage is low and optionally prevent hibernation when this occurs.

When waking from hibernation, the $\overline{\text{HIB}}$ signal is deasserted. The return of V_{DD} causes a POR to be executed. The time from when the $\overline{\text{WAKE}}$ signal is asserted to when code begins execution is equal to the wake-up time ($t_{\text{WAKE_TO_HIB}}$) plus the power-on reset time (T_{IRPOR}).

6.3.1 Register Access Timing

Because the Hibernation module has an independent clocking domain, certain registers must be written only with a timing gap between accesses. The delay time is $t_{\text{HIB_REG_ACCESS}}$, therefore software must guarantee that this delay is inserted between back-to-back writes to certain Hibernation registers or between a write followed by a read to those same registers. Software may make use of the **WRC** bit in the **Hibernation Control (HIBCTL)** register to ensure that the required timing gap has elapsed. This bit is cleared on a write operation and set once the write completes, indicating to software that another write or read may be started safely. Software should poll **HIBCTL** for **WRC=1** prior to accessing any affected register. The following registers are subject to this timing restriction:

- Hibernation RTC Counter (HIBRTCC)
- Hibernation RTC Match 0 (HIBRTCM0)
- Hibernation RTC Match 1 (HIBRTCM1)
- Hibernation RTC Load (HIBRTCLD)
- Hibernation RTC Trim (HIBRTCT)
- Hibernation Data (HIBDATA)

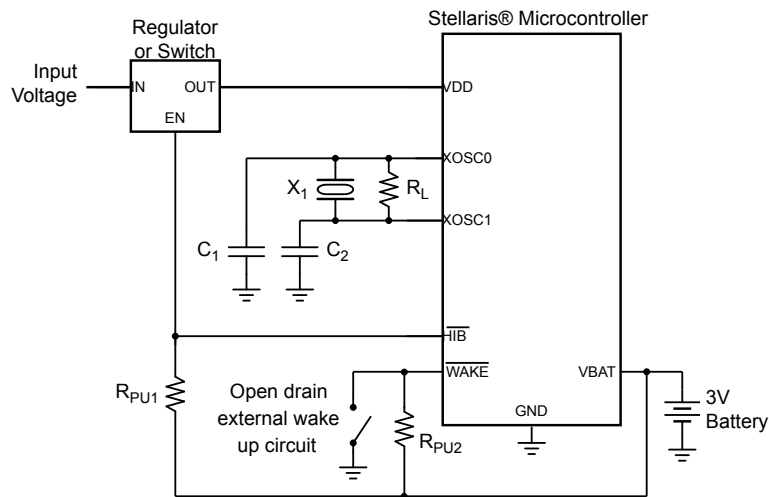
Back-to-back reads from Hibernation module registers have no timing restrictions. Reads are performed at the full peripheral clock rate.

6.3.2 Hibernation Clock Source

In systems where the Hibernation module is used to put the microcontroller into hibernation, the module must be clocked by an external source that is independent from the main system clock, even if the RTC feature is not used. An external oscillator or crystal is used for this purpose. To use a crystal, a 4.194304-MHz crystal is connected to the `XOSC0` and `XOSC1` pins. This clock signal is divided by 128 internally to produce a 32.768-kHz Hibernation clock reference. Alternatively, a 32.768-kHz oscillator can be connected to the `XOSC0` pin, leaving `XOSC1` unconnected. Care must be taken that the voltage amplitude of the 32.768-kHz oscillator is less than V_{BAT} , otherwise, the Hibernation module may draw power from the oscillator and not V_{BAT} during hibernation. See Figure 6-2 on page 291 and Figure 6-3 on page 291.

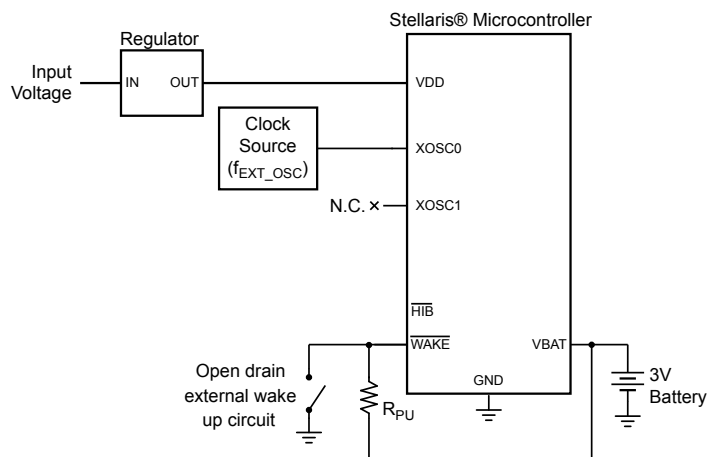
The Hibernation clock source is enabled by setting the `CLK32EN` bit of the `HIBCTL` register. The type of clock source is selected by clearing the `CLKSEL` bit for a 4.194304-MHz crystal and setting the `CLKSEL` bit for a 32.768-kHz oscillator. If a crystal is used for the clock source, the software must leave a delay of t_{HIBOSC_START} after writing to the `CLK32EN` bit and before any other accesses to the Hibernation module registers. The delay allows the crystal to power up and stabilize. If an oscillator is used for the clock source, no delay is needed.

Figure 6-2. Using a Crystal as the Hibernation Clock Source



- Note:**
- X_1 = Crystal frequency is f_{XOSC_XTAL} .
 - $C_{1,2}$ = Capacitor value derived from crystal vendor load capacitance specifications.
 - R_L = Load resistor is R_{XOSC_LOAD} .
 - R_{PU1} = Pull-up resistor 1 (value and voltage source (V_{BAT} or Input Voltage) determined by regulator or switch enable input characteristics).
 - R_{PU2} = Pull-up resistor 2 is 200 k Ω
- See "Hibernation Clock Source Specifications" on page 1135 for specific parameter values.

Figure 6-3. Using a Dedicated Oscillator as the Hibernation Clock Source with VDD3ON Mode



- Note:** R_{PU} = Pull-up resistor is 1 M Ω

6.3.3 System Implementation

Several different system configurations are possible when using the Hibernation module:

- Using a single battery source, where the battery provides both V_{DD} and V_{BAT} .

- Using the VDD3ON mode, where V_{DD} continues to be powered in hibernation, allowing the GPIO pins to retain their states, as shown in Figure 6-3 on page 291. In this mode, V_{DDC} is powered off internally.
- Using separate sources for V_{DD} and V_{BAT} , as shown in Figure 6-2 on page 291.
- Using a regulator to provide both V_{DD} and V_{BAT} with a switch enabled by \overline{HIB} to remove V_{DD} during hibernation.

Adding external capacitance to the V_{BAT} supply reduces the accuracy of the low-battery measurement and should be avoided if possible. The diagrams referenced in this section only show the connection to the Hibernation pins and not to the full system.

If the application does not require the use of the Hibernation module, refer to “Connections for Unused Signals” on page 1125. In this situation, the HIB bit in the **Run Mode Clock Gating Control Register 0 (RCGC0)** register must be cleared, disabling the system clock to the Hibernation module and Hibernation module registers are not accessible.

6.3.4 Battery Management

Important: System-level factors may affect the accuracy of the low battery detect circuit. The designer should consider battery type, discharge characteristics, and a test load during battery voltage measurements.

The Hibernation module can be independently powered by a battery or an auxiliary power source using the V_{BAT} pin. The module can monitor the voltage level of the battery and detect when the voltage drops below V_{LOWBAT} . The module can also be configured so that it does not go into Hibernate mode if the battery voltage drops below this threshold. Battery voltage is not measured while in Hibernate mode.

The Hibernation module can be configured to detect a low battery condition by setting the $LOWBATEN$ bit of the **HIBCTL** register. In this configuration, the $LOWBAT$ bit of the **Hibernation Raw Interrupt Status (HIBRIS)** register is set when the battery level is low. If the $VABORT$ bit in the **HIBCTL** register is also set, then the module is prevented from entering Hibernate mode when a low battery is detected. The module can also be configured to generate an interrupt for the low-battery condition (see “Interrupts and Status” on page 294).

Note that the Hibernation module draws power from whichever source (V_{BAT} or V_{DD}) has the higher voltage. Therefore, it is important to design the circuit to ensure that V_{DD} is higher than V_{BAT} under nominal conditions or else the Hibernation module draws power from the battery even when V_{DD} is available.

6.3.5 Real-Time Clock

The Hibernation module includes a 32-bit counter that increments once per second with the proper configuration (see “Hibernation Clock Source” on page 290). The 32.768-kHz clock signal, either directly from the 32.768-kHz oscillator or from the 4.194304-MHz crystal divided by 128, is fed into a predivider register that counts down the 32.768-kHz clock ticks to achieve a once per second clock rate for the RTC. The rate can be adjusted to compensate for inaccuracies in the clock source by using the predivider trim register, **HIBRTCT**. This register has a nominal value of 0x7FFF, and is used for one second out of every 64 seconds to divide the input clock. This configuration allows the software to make fine corrections to the clock rate by adjusting the predivider trim register up or down from 0x7FFF. The predivider trim should be adjusted up from 0x7FFF in order to slow down the RTC rate and down from 0x7FFF in order to speed up the RTC rate.

The Hibernation module includes two 32-bit match registers that are compared to the value of the RTC counter. The match registers can be used to wake the processor from Hibernate mode or to generate an interrupt to the processor if it is not in hibernation.

The RTC must be enabled with the `RTCEN` bit of the `HIBCTL` register. The value of the RTC can be set at any time by writing to the `HIBRTCLD` register. The predivider trim can be adjusted by reading and writing the `HIBRTCT` register. The predivider uses this register once every 64 seconds to adjust the clock rate. The two match registers can be set by writing to the `HIBRTCM0` and `HIBRTCM1` registers. The RTC can be configured to generate interrupts by using the interrupt registers (see “Interrupts and Status” on page 294). As long as the RTC is enabled and a valid V_{BAT} is present, the RTC continues counting, regardless of whether V_{DD} is present or if the part is in hibernation.

6.3.6 Battery-Backed Memory

The Hibernation module contains 64 32-bit words of memory that are powered from the battery or auxiliary power supply and therefore retained during hibernation. The processor software can save state information in this memory prior to hibernation and recover the state upon waking. The battery-backed memory can be accessed through the `HIBDATA` registers. If both V_{DD} and V_{BAT} are removed, the contents of the `HIBDATA` registers are not retained.

6.3.7 Power Control Using \overline{HIB}

Important: The Hibernation Module requires special system implementation considerations when using \overline{HIB} to control power, as it is intended to power-down all other sections of the microcontroller. All system signals and power supplies that connect to the chip must be driven to 0 V_{DC} or powered down with the same regulator controlled by \overline{HIB} .

The Hibernation module controls power to the microcontroller through the use of the \overline{HIB} pin which is intended to be connected to the enable signal of the external regulator(s) providing 3.3 V to the microcontroller and other circuits. When the \overline{HIB} signal is asserted by the Hibernation module, the external regulator is turned off and no longer powers the microcontroller and any parts of the system that are powered by the regulator. The Hibernation module remains powered from the V_{BAT} supply (which could be a battery or an auxiliary power source) until a Wake event. Power to the microcontroller is restored by deasserting the \overline{HIB} signal, which causes the external regulator to turn power back on to the chip.

6.3.8 Power Control Using VDD3ON Mode

The Hibernation module may also be configured to cut power to all internal modules. While in this state, all pins are configured as inputs. In the `VDD3ON` mode, the regulator should maintain 3.3 V power to the microcontroller during Hibernate. This power control mode is enabled by setting the `VDD3ON` bit in `HIBCTL`.

6.3.9 Initiating Hibernate

Hibernate mode is initiated when the `HIBREQ` bit of the `HIBCTL` register is set. If a wake-up condition has not been configured using the `PINWEN` or `RTCWEN` bits in the `HIBCTL` register, the hibernation request is ignored. If a Flash memory write operation is in progress when the `HIBREQ` bit is set, an interlock feature holds off the transition into Hibernate mode until the write has completed.

6.3.10 Waking from Hibernate

The Hibernation module is configured to wake from the external \overline{WAKE} pin by setting the `PINWEN` bit of the `HIBCTL` register. It is configured to wake from RTC match by setting the `RTCWEN` bit. Note that the \overline{WAKE} pin uses the Hibernation module's internal power supply as the logic 1 reference.

Upon either external wake-up or RTC match, the Hibernation module delays coming out of hibernation until V_{DD} is above the minimum specified voltage, see Table 25-2 on page 1128.

When the Hibernation module wakes, the microcontroller performs a normal power-on reset. Note that this reset does not reset the Hibernation module, but does reset the rest of the microcontroller. Software can detect that the power-on was due to a wake from hibernation by examining the raw interrupt status register (see “Interrupts and Status” on page 294) and by looking for state data in the battery-backed memory (see “Battery-Backed Memory” on page 293).

6.3.11 Interrupts and Status

The Hibernation module can generate interrupts when the following conditions occur:

- Assertion of \overline{WAKE} pin
- RTC match
- Low battery detected

All of the interrupts are ORed together before being sent to the interrupt controller, so the Hibernation module can only generate a single interrupt request to the controller at any given time. The software interrupt handler can service multiple interrupt events by reading the **Hibernation Masked Interrupt Status (HIBMIS)** register. Software can also read the status of the Hibernation module at any time by reading the **HIBRIS** register which shows all of the pending events. This register can be used after waking from hibernation to see if the wake condition was caused by the \overline{WAKE} signal or the RTC match.

The events that can trigger an interrupt are configured by setting the appropriate bits in the **Hibernation Interrupt Mask (HIBIM)** register. Pending interrupts can be cleared by writing the corresponding bit in the **Hibernation Interrupt Clear (HIBIC)** register.

6.4 Initialization and Configuration

The Hibernation module has several different configurations. The following sections show the recommended programming sequence for various scenarios. The examples below assume that a 32.768-kHz oscillator is used, and thus always set the **CLKSEL** bit of the **HIBCTL** register. If a 4.194304-MHz crystal is used instead, then the **CLKSEL** bit remains cleared. Because the Hibernation module runs at 32.768 kHz and is asynchronous to the rest of the microcontroller, which is run off the system clock, software must allow a delay of $t_{HIB_REG_ACCESS}$ after writes to certain registers (see “Register Access Timing” on page 289). The registers that require a delay are listed in a note in “Register Map” on page 296 as well as in each register description.

6.4.1 Initialization

The Hibernation module comes out of reset with the system clock enabled to the module, but if the system clock to the module has been disabled, then it must be re-enabled, even if the RTC feature is not used. See page 254.

If a 4.194304-MHz crystal is used as the Hibernation module clock source, perform the following step:

1. Write 0x40 to the **HIBCTL** register at offset 0x10 to enable the crystal and select the divide-by-128 input path.

If a 32.678-kHz single-ended oscillator is used as the Hibernation module clock source, then perform the following steps:

1. Write 0x44 to the **HIBCTL** register at offset 0x10 to enable the oscillator input and bypass the on-chip oscillator.
2. No delay is necessary.

The above steps are only necessary when the entire system is initialized for the first time. If the microcontroller has been in hibernation, then the Hibernation module has already been powered up and the above steps are not necessary. The software can detect that the Hibernation module and clock are already powered by examining the **CLK32EN** bit of the **HIBCTL** register.

Table 6-3 on page 295 illustrates how the clocks function with various bit setting both in normal operation and in hibernation.

Table 6-3. Hibernation Module Clock Operation

| CLK32EN | PINWEN | RTCWEN | CLKSEL | RTCEN | Result Normal Operation | Result Hibernation |
|---------|--------|--------|--------|-------|--|--|
| 0 | X | X | X | X | Hibernation module disabled | Hibernation module disabled |
| 1 | 0 | 0 | 0 | 1 | RTC match capability enabled. Module clocked from 4.184304-MHz crystal. | No hibernation |
| 1 | 0 | 0 | 1 | 1 | RTC match capability enabled. Module clocked from 32.768-kHz oscillator. | No hibernation |
| 1 | 0 | 1 | X | 1 | Module clocked from selected source | RTC match for wake-up event |
| 1 | 1 | 0 | X | 0 | Module clocked from selected source | Clock is powered down during hibernation and powered up again on external wake-up event. |
| 1 | 1 | 0 | X | 1 | Module clocked from selected source | Clock is powered up during hibernation for RTC. Wake up on external event. |
| 1 | 1 | 1 | X | 1 | Module clocked from selected source | RTC match or external wake-up event, whichever occurs first. |

6.4.2 RTC Match Functionality (No Hibernation)

Use the following steps to implement the RTC match functionality of the Hibernation module:

1. Write the required RTC match value to one of the **HIBRTCMn** registers at offset 0x004 or 0x008.
2. Write the required RTC load value to the **HIBRTCLD** register at offset 0x00C.
3. Set the required RTC match interrupt mask in the **RTCALT0** and **RTCALT1** bits (bits 1:0) in the **HIBIM** register at offset 0x014.
4. Write 0x0000.0041 to the **HIBCTL** register at offset 0x010 to enable the RTC to begin counting.

6.4.3 RTC Match/Wake-Up from Hibernation

Use the following steps to implement the RTC match and wake-up functionality of the Hibernation module:

1. Write the required RTC match value to the **HIBRTCMn** registers at offset 0x004 or 0x008.
2. Write the required RTC load value to the **HIBRTCLD** register at offset 0x00C.

3. Write any data to be retained during power cut to the **HIBDATA** register at offsets 0x030-0x12C.
4. Set the RTC Match Wake-Up and start the hibernation sequence by writing 0x0000.004F to the **HIBCTL** register at offset 0x010.

6.4.4 External Wake-Up from Hibernation

Use the following steps to implement the Hibernation module with the external $\overline{\text{WAKE}}$ pin as the wake-up source for the microcontroller:

1. Write any data to be retained during power cut to the **HIBDATA** register at offsets 0x030-0x12C.
2. Enable the external wake and start the hibernation sequence by writing 0x0000.0056 to the **HIBCTL** register at offset 0x010.

Note that in this mode, if the RTC is disabled, then the Hibernation clock source is powered down during Hibernate mode and is powered up again on the external wake event to save power during hibernation. If the RTC is enabled before hibernation, it continues to operate during hibernation.

6.4.5 RTC or External Wake-Up from Hibernation

1. Write the required RTC match value to the **HIBRTCMn** registers at offset 0x004 or 0x008.
2. Write the required RTC load value to the **HIBRTCLD** register at offset 0x00C.
3. Write any data to be retained during power cut to the **HIBDATA** register at offsets 0x030-0x12C.
4. Set the RTC Match/External Wake-Up and start the hibernation sequence by writing 0x0000.005F to the **HIBCTL** register at offset 0x010.

6.5 Register Map

Table 6-4 on page 297 lists the Hibernation registers. All addresses given are relative to the Hibernation Module base address at 0x400F.C000. Note that the system clock to the Hibernation module must be enabled before the registers can be programmed (see page 254). There must be a delay of 3 system clocks after the Hibernation module clock is enabled before any Hibernation module registers are accessed.

Note: **HIBRTCC**, **HIBRTCM0**, **HIBRTCM1**, **HIBRTCLD**, **HIBRTCT**, and **HIBDATA** are on the Hibernation module clock domain and have special timing requirements. Software should make use of the **WRC** bit in the **HIBCTL** register to ensure that the required timing gap has elapsed. If the **WRC** bit is clear, any attempted write access is ignored. See “Register Access Timing” on page 289.

Important: The Hibernation module registers are reset under two conditions:

1. A system reset when the **RTCEN** and the **PINWEN** bits in the **HIBCTL** register are both cleared.
2. A cold POR, when both the V_{DD} and V_{BAT} supplies are removed.

Any other reset condition is ignored by the Hibernation module.

Table 6-4. Hibernation Module Register Map

| Offset | Name | Type | Reset | Description | See page |
|-----------------|----------|-------|-------------|-------------------------------------|----------|
| 0x000 | HIBRTCC | RO | 0x0000.0000 | Hibernation RTC Counter | 298 |
| 0x004 | HIBRTCM0 | R/W | 0xFFFF.FFFF | Hibernation RTC Match 0 | 299 |
| 0x008 | HIBRTCM1 | R/W | 0xFFFF.FFFF | Hibernation RTC Match 1 | 300 |
| 0x00C | HIBRTCLD | R/W | 0xFFFF.FFFF | Hibernation RTC Load | 301 |
| 0x010 | HIBCTL | R/W | 0x8000.0000 | Hibernation Control | 302 |
| 0x014 | HIBIM | R/W | 0x0000.0000 | Hibernation Interrupt Mask | 305 |
| 0x018 | HIBRIS | RO | 0x0000.0000 | Hibernation Raw Interrupt Status | 307 |
| 0x01C | HIBMIS | RO | 0x0000.0000 | Hibernation Masked Interrupt Status | 309 |
| 0x020 | HIBIC | R/W1C | 0x0000.0000 | Hibernation Interrupt Clear | 311 |
| 0x024 | HIBRTCT | R/W | 0x0000.7FFF | Hibernation RTC Trim | 312 |
| 0x030- 0x12C | HIBDATA | R/W | - | Hibernation Data | 313 |

6.6 Register Descriptions

The remainder of this section lists and describes the Hibernation module registers, in numerical order by address offset.

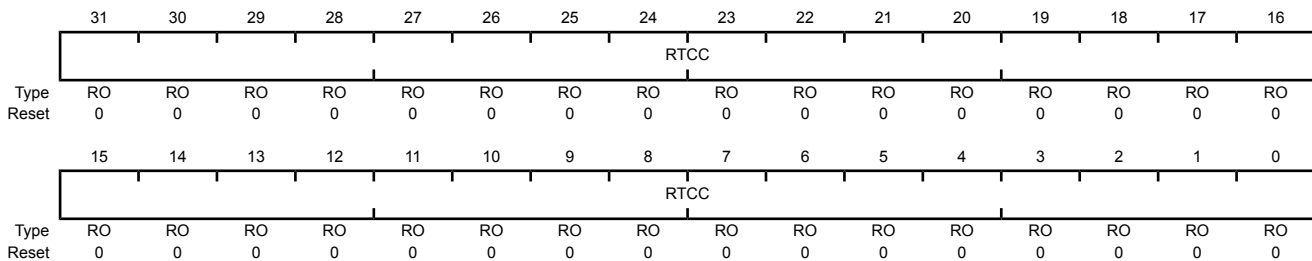
Register 1: Hibernation RTC Counter (HIBRTCC), offset 0x000

This register is the current 32-bit value of the RTC counter.

Note: **HIBRTCC**, **HIBRTCM0**, **HIBRTCM1**, **HIBRTCLD**, **HIBRTCT**, and **HIBDATA** are on the Hibernation module clock domain and have special timing requirements. Software should make use of the **WRC** bit in the **HIBCTL** register to ensure that the required timing gap has elapsed. If the **WRC** bit is clear, any attempted write access is ignored. See “Register Access Timing” on page 289.

Hibernation RTC Counter (HIBRTCC)

Base 0x400F.C000
 Offset 0x000
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|-------------|
| 31:0 | RTCC | RO | 0x0000.0000 | RTC Counter |

A read returns the 32-bit counter value, which represents the seconds elapsed since the RTC was enabled. This register is read-only. To change the value, use the **HIBRTCLD** register.

Register 2: Hibernation RTC Match 0 (HIBRTCM0), offset 0x004

This register is the 32-bit match 0 register for the RTC counter.

Note: **HIBRTCC**, **HIBRTCM0**, **HIBRTCM1**, **HIBRTCLD**, **HIBRTCT**, and **HIBDATA** are on the Hibernation module clock domain and have special timing requirements. Software should make use of the **WRC** bit in the **HIBCTL** register to ensure that the required timing gap has elapsed. If the **WRC** bit is clear, any attempted write access is ignored. See “Register Access Timing” on page 289.

Hibernation RTC Match 0 (HIBRTCM0)

Base 0x400F.C000

Offset 0x004

Type R/W, reset 0xFFFF.FFFF

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | RTCM0 | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | RTCM0 | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------------|-------------|
| 31:0 | RTCM0 | R/W | 0xFFFF.FFFF | RTC Match 0 |

A write loads the value into the RTC match register.

A read returns the current match value.

Register 3: Hibernation RTC Match 1 (HIBRTCM1), offset 0x008

This register is the 32-bit match 1 register for the RTC counter.

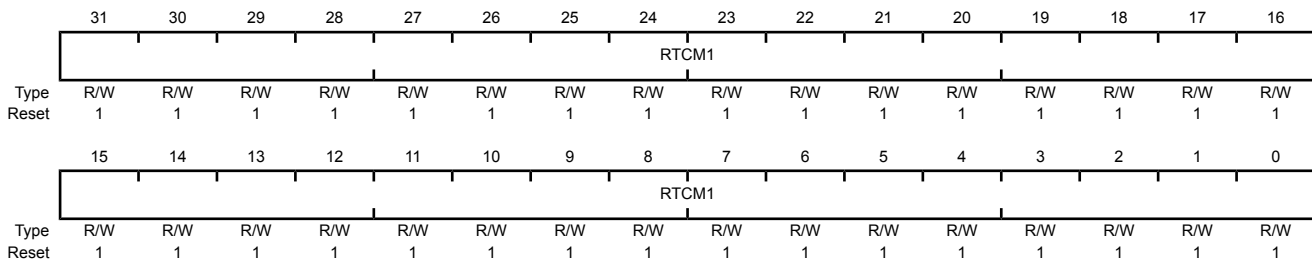
Note: **HIBRTCC**, **HIBRTCM0**, **HIBRTCM1**, **HIBRTCLD**, **HIBRTCT**, and **HIBDATA** are on the Hibernation module clock domain and have special timing requirements. Software should make use of the **WRC** bit in the **HIBCTL** register to ensure that the required timing gap has elapsed. If the **WRC** bit is clear, any attempted write access is ignored. See “Register Access Timing” on page 289.

Hibernation RTC Match 1 (HIBRTCM1)

Base 0x400F.C000

Offset 0x008

Type R/W, reset 0xFFFF.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------------|-------------|
| 31:0 | RTCM1 | R/W | 0xFFFF.FFFF | RTC Match 1 |

A write loads the value into the RTC match register.
A read returns the current match value.

Register 4: Hibernation RTC Load (HIBRTCLD), offset 0x00C

This register is used to load a 32-bit value loaded into the RTC counter. The load occurs immediately upon this register being written.

Note: **HIBRTCC**, **HIBRTCM0**, **HIBRTCM1**, **HIBRTCLD**, **HIBRTCT**, and **HIBDATA** are on the Hibernation module clock domain and have special timing requirements. Software should make use of the **WRC** bit in the **HIBCTL** register to ensure that the required timing gap has elapsed. If the **WRC** bit is clear, any attempted write access is ignored. See “Register Access Timing” on page 289.

Hibernation RTC Load (HIBRTCLD)

Base 0x400F.C000

Offset 0x00C

Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | RTCLD | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | RTCLD | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------------|---|
| 31:0 | RTCLD | R/W | 0xFFFF.FFFF | RTC Load A write loads the current value into the RTC counter (RTCC). A read returns the 32-bit load value. |

Register 5: Hibernation Control (HIBCTL), offset 0x010

This register is the control register for the Hibernation module. This register must be written last before a hibernate event is issued. Writes to other registers after the HIBREQ bit is set are not guaranteed to complete before hibernation is entered.

Hibernation Control (HIBCTL)

Base 0x400F.C000
 Offset 0x010
 Type R/W, reset 0x8000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----------|----|----|----|----|----|--------|--------|---------|----------|--------|--------|--------|--------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | WRC | reserved | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | VDD3ON | VABORT | CLK32EN | LOWBATEN | PINWEN | RTCWEN | CLKSEL | HIBREQ | RTCEN |
| Type | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31 | WRC | RO | 1 | <p>Write Complete/Capable</p> <p>Value Description</p> <p>0 The interface is processing a prior write and is busy. Any write operation that is attempted while WRC is 0 results in undetermined behavior.</p> <p>1 The interface is ready to accept a write.</p> <p>Software must poll this bit between write requests and defer writes until WRC=1 to ensure proper operation.</p> <p>The bit name WRC means "Write Complete," which is the normal use of the bit (between write accesses). However, because the bit is set out-of-reset, the name can also mean "Write Capable" which simply indicates that the interface may be written to by software. This difference may be exploited by software at reset time to detect which method of programming is appropriate: 0 = software delay loops required; 1 = WRC paced available.</p> |
| 30:9 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | VDD3ON | R/W | 0 | <p>VDD Powered</p> <p>Value Description</p> <p>1 The internal switches control the power to the on-chip modules (VDD3ON mode).</p> <p>0 The internal switches are not used. The HIB signal should be used to control an external switch or regulator.</p> <p>Note that regardless of the status of the VDD3ON bit, the HIB signal is asserted during Hibernate mode. Thus, when VDD3ON is set, the HIB signal should not be connected to the 3.3V regulator, and the 3.3V power source should remain connected.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 7 | VABORT | R/W | 0 | Power Cut Abort Enable Value Description 1 When this bit is set, the battery voltage level is checked before entering hibernation. If V_{BAT} is less than V_{LOWBAT} , the microcontroller does not go into hibernation. 0 The microcontroller goes into hibernation regardless of the voltage level of the battery. |
| 6 | CLK32EN | R/W | 0 | Clocking Enable This bit must be enabled to use the Hibernation module. Value Description 1 The Hibernation module clock source is enabled. 0 The Hibernation module clock source is disabled. |
| 5 | LOWBATEN | R/W | 0 | Low Battery Monitoring Enable Value Description 1 Low battery voltage detection is enabled. When this bit is set, the battery voltage level is checked before entering hibernation. If V_{BAT} is less than V_{LOWBAT} , the LOWBAT bit in the HIBRIS register is set. 0 Low battery monitoring is disabled. |
| 4 | PINWEN | R/W | 0 | External \overline{WAKE} Pin Enable Value Description 1 An assertion of the \overline{WAKE} pin takes the microcontroller out of hibernation. 0 The status of the \overline{WAKE} pin has no effect on hibernation. |
| 3 | RTCWEN | R/W | 0 | RTC Wake-up Enable Value Description 1 An RTC match event (the value the HIBRTCC register matches the value of the HIBRTCM0 or HIBRTCM1 register) takes the microcontroller out of hibernation. 0 An RTC match event has no effect on hibernation. |
| 2 | CLKSEL | R/W | 0 | Hibernation Module Clock Select Value Description 1 Use raw output. Use this value for a 32.768-kHz oscillator. 0 Use Divide-by-128 output. Use this value for a 4.194304-MHz crystal. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 1 | HIBREQ | R/W | 0 | Hibernation Request Value Description 1 Set this bit to initiate hibernation. 0 No hibernation request. After a wake-up event, this bit is automatically cleared by hardware. A hibernation request is ignored if both the <code>PINWEN</code> and <code>RTCWEN</code> bits are clear. |
| 0 | RTCEN | R/W | 0 | RTC Timer Enable Value Description 1 The Hibernation module RTC is enabled. 0 The Hibernation module RTC is disabled. |

Register 6: Hibernation Interrupt Mask (HIBIM), offset 0x014

This register is the interrupt mask register for the Hibernation module interrupt sources. Each bit in this register masks the corresponding bit in the **Hibernation Raw Interrupt Status (HIBRIS)** register. If a bit is unmasked, the interrupt is sent to the interrupt controller. If the bit is masked, the interrupt is not sent to the interrupt controller.

Hibernation Interrupt Mask (HIBIM)

Base 0x400F.C000

Offset 0x014

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|------|--------|---------|---------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | EXTW | LOWBAT | RTCALT1 | RTCALT0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | EXTW | R/W | 0 | External Wake-Up Interrupt Mask Value Description 1 An interrupt is sent to the interrupt controller when the EXTW bit in the HIBRIS register is set. 0 The EXTW interrupt is suppressed and not sent to the interrupt controller. |
| 2 | LOWBAT | R/W | 0 | Low Battery Voltage Interrupt Mask Value Description 1 An interrupt is sent to the interrupt controller when the LOWBAT bit in the HIBRIS register is set. 0 The LOWBAT interrupt is suppressed and not sent to the interrupt controller. |
| 1 | RTCALT1 | R/W | 0 | RTC Alert 1 Interrupt Mask Value Description 1 An interrupt is sent to the interrupt controller when the RTCALT1 bit in the HIBRIS register is set. 0 The RTCALT1 interrupt is suppressed and not sent to the interrupt controller. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|--|
| 0 | RTCALTO | R/W | 0 | RTC Alert 0 Interrupt Mask |
| | | | | Value Description |
| | | | | 1 An interrupt is sent to the interrupt controller when the <code>RTCALTO</code> bit in the HIBRIS register is set. |
| | | | | 0 The <code>RTCALTO</code> interrupt is suppressed and not sent to the interrupt controller. |

Register 7: Hibernation Raw Interrupt Status (HIBRIS), offset 0x018

This register is the raw interrupt status for the Hibernation module interrupt sources. Each bit can be masked by clearing the corresponding bit in the **HIBIM** register. When a bit is masked, the interrupt is not sent to the interrupt controller. Bits in this register are cleared by writing a 1 to the corresponding bit in the **Hibernation Interrupt Clear (HIBIC)** register or by entering hibernation.

Hibernation Raw Interrupt Status (HIBRIS)

Base 0x400F.C000

Offset 0x018

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|------|--------|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | EXTW | LOWBAT | RTCALT1 | RTCALT0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|--|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | EXTW | RO | 0 | External Wake-Up Raw Interrupt Status Value Description 1 The $\overline{\text{WAKE}}$ pin has been asserted. 0 The $\overline{\text{WAKE}}$ pin has not been asserted. This bit is cleared by writing a 1 to the EXTW bit in the HIBIC register. |
| 2 | LOWBAT | RO | 0 | Low Battery Voltage Raw Interrupt Status Value Description 1 The battery voltage dropped below V_{LOWBAT} . 0 The battery voltage has not dropped below V_{LOWBAT} . This bit is cleared by writing a 1 to the LOWBAT bit in the HIBIC register. |
| 1 | RTCALT1 | RO | 0 | RTC Alert 1 Raw Interrupt Status Value Description 1 The value of the HIBRTCC register matches the value in the HIBRTCM1 register. 0 No match This bit is cleared by writing a 1 to the RTCALT1 bit in the HIBIC register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 0 | RTCALTO | RO | 0 | RTC Alert 0 Raw Interrupt Status |
| | | | | Value Description |
| | | | | 1 The value of the HIBRTCC register matches the value in the HIBRTCM0 register. |
| | | | | 0 No match |
| | | | | This bit is cleared by writing a 1 to the RTCALTO bit in the HIBIC register. |

Register 8: Hibernation Masked Interrupt Status (HIBMIS), offset 0x01C

This register is the masked interrupt status for the Hibernation module interrupt sources. Bits in this register are the AND of the corresponding bits in the **HIBRIS** and **HIBIM** registers. When both corresponding bits are set, the bit in this register is set, and the interrupt is sent to the interrupt controller.

Hibernation Masked Interrupt Status (HIBMIS)

Base 0x400F.C000

Offset 0x01C

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|------|--------|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | EXTW | LOWBAT | RTCALT1 | RTCALT0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | EXTW | RO | 0 | External Wake-Up Masked Interrupt Status Value Description 1 An unmasked interrupt was signaled due to a $\overline{\text{WAKE}}$ pin assertion. 0 An external wake-up interrupt has not occurred or is masked. This bit is cleared by writing a 1 to the EXTW bit in the HIBIC register. |
| 2 | LOWBAT | RO | 0 | Low Battery Voltage Masked Interrupt Status Value Description 1 An unmasked interrupt was signaled due to a low battery voltage condition. 0 A low battery voltage interrupt has not occurred or is masked. This bit is cleared by writing a 1 to the LOWBAT bit in the HIBIC register. |
| 1 | RTCALT1 | RO | 0 | RTC Alert 1 Masked Interrupt Status Value Description 1 An unmasked interrupt was signaled due to an RTC match. 0 An RTC match interrupt has not occurred or is masked. This bit is cleared by writing a 1 to the RTCALT1 bit in the HIBIC register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 0 | RTCALTO | RO | 0 | RTC Alert 0 Masked Interrupt Status |
| | | | | Value Description |
| | | | | 1 An unmasked interrupt was signaled due to an RTC match. |
| | | | | 0 An RTC match interrupt has not occurred or is masked. |
| | | | | This bit is cleared by writing a 1 to the RTCALTO bit in the HIBIC register. |

Register 9: Hibernation Interrupt Clear (HIBIC), offset 0x020

This register is the interrupt write-one-to-clear register for the Hibernation module interrupt sources. Writing a 1 to a bit clears the corresponding interrupt in the **HIBRIS** register.

Hibernation Interrupt Clear (HIBIC)

Base 0x400F.C000

Offset 0x020

Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-------|--------|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | EXTW | LOWBAT | RTCALT1 | RTCALT0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | EXTW | R/W1C | 0 | External Wake-Up Masked Interrupt Clear Writing a 1 to this bit clears the EXTW bit in the HIBRIS and HIBMIS registers. Reads return an indeterminate value. |
| 2 | LOWBAT | R/W1C | 0 | Low Battery Voltage Masked Interrupt Clear Writing a 1 to this bit clears the LOWBAT bit in the HIBRIS and HIBMIS registers. Reads return an indeterminate value. |
| 1 | RTCALT1 | R/W1C | 0 | RTC Alert1 Masked Interrupt Clear Writing a 1 to this bit clears the RTCALT1 bit in the HIBRIS and HIBMIS registers. Reads return an indeterminate value. |
| 0 | RTCALT0 | R/W1C | 0 | RTC Alert0 Masked Interrupt Clear Writing a 1 to this bit clears the RTCALT0 bit in the HIBRIS and HIBMIS registers. Reads return an indeterminate value. |

Register 10: Hibernation RTC Trim (HIBRTCT), offset 0x024

This register contains the value that is used to trim the RTC clock predivider. It represents the computed underflow value that is used during the trim cycle. It is represented as $0x7FFF \pm N$ clock cycles, where N is the number of clock cycles to add or subtract every 63 seconds.

Note: **HIBRTCC**, **HIBRTCM0**, **HIBRTCM1**, **HIBRTCLD**, **HIBRTCT**, and **HIBDATA** are on the Hibernation module clock domain and have special timing requirements. Software should make use of the **WRC** bit in the **HIBCTL** register to ensure that the required timing gap has elapsed. If the **WRC** bit is clear, any attempted write access is ignored. See “Register Access Timing” on page 289.

Hibernation RTC Trim (HIBRTCT)

Base 0x400F.C000
 Offset 0x024
 Type R/W, reset 0x0000.7FFF

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | TRIM | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|--|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | TRIM | R/W | 0x7FFF | RTC Trim Value This value is loaded into the RTC predivider every 64 seconds. It is used to adjust the RTC rate to account for drift and inaccuracy in the clock source. Compensation can be adjusted by software by moving the default value of 0x7FFF up or down. Moving the value up slows down the RTC and moving the value down speeds up the RTC. |

Register 11: Hibernation Data (HIBDATA), offset 0x030-0x12C

This address space is implemented as a 64x32-bit memory (256 bytes). It can be loaded by the system processor in order to store state information and does not lose power during a power cut operation as long as a battery is present.

Note: **HIBRTCC**, **HIBRTCM0**, **HIBRTCM1**, **HIBRTCLD**, **HIBRTCT**, and **HIBDATA** are on the Hibernation module clock domain and have special timing requirements. Software should make use of the **WRC** bit in the **HIBCTL** register to ensure that the required timing gap has elapsed. If the **WRC** bit is clear, any attempted write access is ignored. See “Register Access Timing” on page 289.

Hibernation Data (HIBDATA)

Base 0x400F.C000
Offset 0x030-0x12C
Type R/W, reset -

| | | | | | | | | | | | | | | | | |
|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | RTD | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | RTD | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|----------------------------|
| 31:0 | RTD | R/W | - | Hibernation Module NV Data |

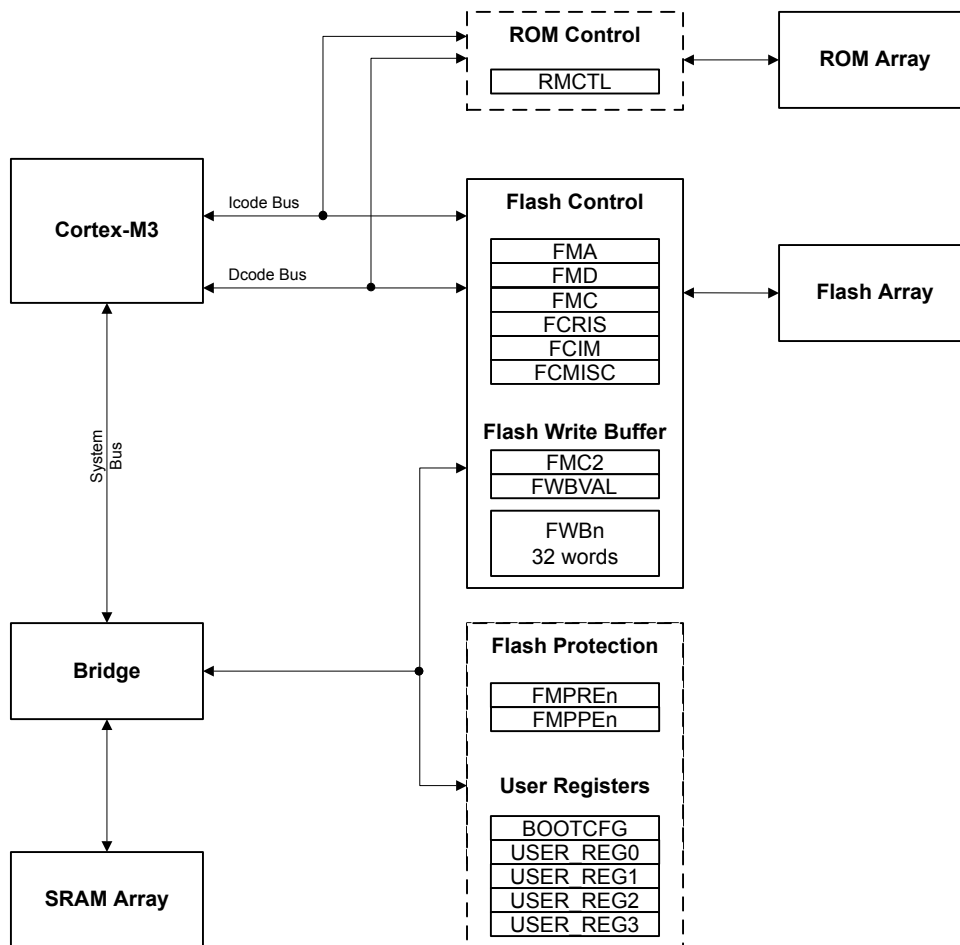
7 Internal Memory

The LM3S2U93 microcontroller comes with 96 KB of bit-banded SRAM, internal ROM, and 384 KB of Flash memory. The Flash memory controller provides a user-friendly interface, making Flash memory programming a simple task. Flash memory protection can be applied to the Flash memory on a 2-KB block basis.

7.1 Block Diagram

Figure 7-1 on page 314 illustrates the internal memory blocks and control logic. The dashed boxes in the figure indicate registers residing in the System Control module.

Figure 7-1. Internal Memory Block Diagram



7.2 Functional Description

This section describes the functionality of the SRAM, ROM, and Flash memories.

Note: The μ DMA controller can transfer data to and from the on-chip SRAM. However, because the Flash memory and ROM are located on a separate internal bus, it is not possible to transfer data from the Flash memory or ROM with the μ DMA controller.

7.2.1 SRAM

The internal SRAM of the Stellaris® devices is located at address 0x2000.0000 of the device memory map. To reduce the number of time consuming read-modify-write (RMW) operations, ARM provides bit-banding technology in the processor. With a bit-band-enabled processor, certain regions in the memory map (SRAM and peripheral space) can use address aliases to access individual bits in a single, atomic operation. The bit-band base is located at address 0x2200.0000.

The bit-band alias is calculated by using the formula:

$$\text{bit-band alias} = \text{bit-band base} + (\text{byte offset} * 32) + (\text{bit number} * 4)$$

For example, if bit 3 at address 0x2000.1000 is to be modified, the bit-band alias is calculated as:

$$0x2200.0000 + (0x1000 * 32) + (3 * 4) = 0x2202.000C$$

With the alias address calculated, an instruction performing a read/write to address 0x2202.000C allows direct access to only bit 3 of the byte at address 0x2000.1000.

For details about bit-banding, see “Bit-Banding” on page 84.

Note: The SRAM is implemented using two 32-bit wide SRAM banks (separate SRAM arrays). The banks are partitioned such that one bank contains all even words (the even bank) and the other contains all odd words (the odd bank). A write access that is followed immediately by a read access to the same bank incurs a stall of a single clock cycle. However, a write to one bank followed by a read of the other bank can occur in successive clock cycles without incurring any delay.

7.2.2 ROM

The internal ROM of the Stellaris device is located at address 0x0100.0000 of the device memory map. Detailed information on the ROM contents can be found in the *Stellaris® ROM User's Guide*.

The ROM contains the following components:

- Stellaris Boot Loader and vector table
- Stellaris Peripheral Driver Library (DriverLib) release for product-specific peripherals and interfaces
- Advanced Encryption Standard (AES) cryptography tables
- Cyclic Redundancy Check (CRC) error detection functionality

The boot loader is used as an initial program loader (when the Flash memory is empty) as well as an application-initiated firmware upgrade mechanism (by calling back to the boot loader). The Peripheral Driver Library APIs in ROM can be called by applications, reducing Flash memory requirements and freeing the Flash memory to be used for other purposes (such as additional features in the application). Advance Encryption Standard (AES) is a publicly defined encryption standard used by the U.S. Government and Cyclic Redundancy Check (CRC) is a technique to validate a span of data has the same contents as when previously checked.

7.2.2.1 Boot Loader Overview

The Stellaris Boot Loader is used to download code to the Flash memory of a device without the use of a debug interface. When the core is reset, the user has the opportunity to direct the core to execute the ROM Boot Loader or the application in Flash memory by using any GPIO signal in Ports A-H as configured in the **Boot Configuration (BOOTCFG)** register.

At reset, the ROM is mapped over the Flash memory so that the ROM boot sequence is always executed. The boot sequence executed from ROM is as follows:

1. The **BA** bit (below) is cleared such that ROM is mapped to 0x01xx.xxxx and Flash memory is mapped to address 0x0.
2. The **BOOTCFG** register is read. If the **EN** bit is clear, the status of the specified GPIO pin is compared with the specified polarity. If the status matches the specified polarity, the ROM is mapped to address 0x0000.0000 and execution continues out of the ROM Boot Loader.
3. If the status doesn't match the specified polarity, the data at address 0x0000.0004 is read, and if the data at this address is 0xFFFF.FFFF, the ROM is mapped to address 0x0000.0000 and execution continues out of the ROM Boot Loader.
4. If there is data at address 0x0000.0004 that is not 0xFFFF.FFFF, the stack pointer (**SP**) is loaded from Flash memory at address 0x0000.0000 and the program counter (**PC**) is loaded from address 0x0000.0004. The user application begins executing.

The boot loader uses a simple packet interface to provide synchronous communication with the device. The speed of the boot loader is determined by the internal oscillator (PIOSC) frequency as it does not enable the PLL. The following serial interfaces can be used:

- UART0
- SSI0
- I²C0

For simplicity, both the data format and communication protocol are identical for all serial interfaces.

Note: The Flash-memory-resident version of the Boot Loader also supports CAN and USB.

See the *Stellaris® Boot Loader User's Guide* for information on the boot loader software.

7.2.2.2 Stellaris Peripheral Driver Library

The Stellaris Peripheral Driver Library contains a file called `driverlib/rom.h` that assists with calling the peripheral driver library functions in the ROM. The detailed description of each function is available in the *Stellaris® ROM User's Guide*. See the "Using the ROM" chapter of the *Stellaris® Peripheral Driver Library User's Guide* for more details on calling the ROM functions and using `driverlib/rom.h`.

A table at the beginning of the ROM points to the entry points for the APIs that are provided in the ROM. Accessing the API through these tables provides scalability; while the API locations may change in future versions of the ROM, the API tables will not. The tables are split into two levels; the main table contains one pointer per peripheral which points to a secondary table that contains one pointer per API that is associated with that peripheral. The main table is located at 0x0100.0010, right after the Cortex-M3 vector table in the ROM.

DriverLib functions are described in detail in the *Stellaris® Peripheral Driver Library User's Guide*.

Additional APIs are available for graphics and USB functions, but are not preloaded into ROM. The Stellaris Graphics Library provides a set of graphics primitives and a widget set for creating graphical user interfaces on Stellaris microcontroller-based boards that have a graphical display (for more information, see the *Stellaris® Graphics Library User's Guide*).

7.2.2.3 Advanced Encryption Standard (AES) Cryptography Tables

AES is a strong encryption method with reasonable performance and size. AES is fast in both hardware and software, is fairly easy to implement, and requires little memory. AES is ideal for applications that can use pre-arranged keys, such as setup during manufacturing or configuration. Four data tables used by the XySSL AES implementation are provided in the ROM. The first is the forward S-box substitution table, the second is the reverse S-box substitution table, the third is the forward polynomial table, and the final is the reverse polynomial table. See the *Stellaris® ROM User's Guide* for more information on AES.

7.2.2.4 Cyclic Redundancy Check (CRC) Error Detection

The CRC technique can be used to validate correct receipt of messages (nothing lost or modified in transit), to validate data after decompression, to validate that Flash memory contents have not been changed, and for other cases where the data needs to be validated. A CRC is preferred over a simple checksum (e.g. XOR all bits) because it catches changes more readily. See the *Stellaris® ROM User's Guide* for more information on CRC.

7.2.3 Flash Memory

At system clock speeds of 50 MHz and below, the Flash memory is read in a single cycle. The Flash memory is organized as a set of 1-KB blocks that can be individually erased. An individual 32-bit word can be programmed to change bits from 1 to 0. In addition, a write buffer provides the ability to concurrently program 32 continuous words in Flash memory. Erasing a block causes the entire contents of the block to be reset to all 1s. The 1-KB blocks are paired into sets of 2-KB blocks that can be individually protected. The protection allows blocks to be marked as read-only or execute-only, providing different levels of code protection. Read-only blocks cannot be erased or programmed, protecting the contents of those blocks from being modified. Execute-only blocks cannot be erased or programmed and can only be read by the controller instruction fetch mechanism, protecting the contents of those blocks from being read by either the controller or by a debugger.

Caution – The Stellaris Flash memory array has ECC which uses a test port into the Flash memory to continually scan the array for ECC errors and to correct any that are detected. This operation is transparent to the microcontroller. The BIST must scan the entire memory array occasionally to ensure integrity, taking about five minutes to do so. In systems where the microcontroller is frequently powered for less than five minutes, power should be removed from the microcontroller in a controlled manner to ensure proper operation. This controlled manner can either be through entering Hibernate mode or software can request permission to power down the part using the USDREQ bit in the Flash Control (FCTL) register and wait to receive an acknowledge from the USDACK bit prior to removing power. If the microcontroller is powered down using this controlled method, the BIST engine keeps track of where it was in the memory array and it always scans the complete array after any aggregate of five minutes powered-on, regardless of the number of intervening power cycles. If the microcontroller is powered down before five minutes of being powered up, BIST starts again from wherever it left off before the last controlled power-down or from 0 if there never was a controlled power down. An occasional short power down is not a concern, but the microcontroller should not always be powered down frequently in an uncontrolled manner. The microcontroller can be power-cycled as frequently as necessary if it is powered-down in a controlled manner.

7.2.3.1 Prefetch Buffer

The Flash memory controller has a prefetch buffer that is automatically used when the CPU frequency is greater than 50 MHz. In this mode, the Flash memory operates at half of the system clock. The prefetch buffer fetches two 32-bit words per clock allowing instructions to be fetched with no wait states while code is executing linearly. The fetch buffer includes a branch speculation mechanism

that recognizes a branch and avoids extra wait states by not reading the next word pair. Also, short loop branches often stay in the buffer. As a result, some branches can be executed with no wait states. Other branches incur a single wait state.

7.2.3.2 Flash Memory Protection

The user is provided two forms of Flash memory protection per 2-KB Flash memory block in six pairs of 32-bit wide registers. The policy for each protection form is controlled by individual bits (per policy per block) in the **FMPPEn** and **FMPREn** registers.

- **Flash Memory Protection Program Enable (FMPPEn)**: If a bit is set, the corresponding block may be programmed (written) or erased. If a bit is cleared, the corresponding block may not be changed.
- **Flash Memory Protection Read Enable (FMPREn)**: If a bit is set, the corresponding block may be executed or read by software or debuggers. If a bit is cleared, the corresponding block may only be executed, and contents of the memory block are prohibited from being read as data.

The policies may be combined as shown in Table 7-1 on page 318.

Table 7-1. Flash Memory Protection Policy Combinations

| FMPPEn | FMPREn | Protection |
|--------|--------|--|
| 0 | 0 | Execute-only protection. The block may only be executed and may not be written or erased. This mode is used to protect code. |
| 1 | 0 | The block may be written, erased or executed, but not read. This combination is unlikely to be used. |
| 0 | 1 | Read-only protection. The block may be read or executed but may not be written or erased. This mode is used to lock the block from further modification while allowing any read or execute access. |
| 1 | 1 | No protection. The block may be written, erased, executed or read. |

A Flash memory access that attempts to read a read-protected block (**FMPREn** bit is set) is prohibited and generates a bus fault. A Flash memory access that attempts to program or erase a program-protected block (**FMPPEn** bit is set) is prohibited and can optionally generate an interrupt (by setting the **AMASK** bit in the **Flash Controller Interrupt Mask (FCIM)** register) to alert software developers of poorly behaving software during the development and debug phases. Note that if a **FMPREn** bit is cleared, all read accesses to the Flash memory block are disallowed, including any data accesses. Care must be taken not to store required data in a Flash memory block that has the associated **FMPREn** bit cleared.

The factory settings for the **FMPREn** and **FMPPEn** registers are a value of 1 for all implemented banks. These settings create a policy of open access and programmability. The register bits may be changed by clearing the specific register bit. The changes are effective immediately, but are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing any type of reset sequence. The changes are committed using the **Flash Memory Control (FMC)** register. Details on programming these bits are discussed in “Non-Volatile Register Programming” on page 321.

7.2.3.3 Interrupts

The Flash memory controller can generate interrupts when the following conditions are observed:

- Programming Interrupt - signals when a program or erase action is complete.

- Access Interrupt - signals when a program or erase action has been attempted on a 2-kB block of memory that is protected by its corresponding **FMPPEn** bit.

The interrupt events that can trigger a controller-level interrupt are defined in the **Flash Controller Masked Interrupt Status (FCMIS)** register (see page 330) by setting the corresponding **MASK** bits. If interrupts are not used, the raw interrupt status is always visible via the **Flash Controller Raw Interrupt Status (FCRIS)** register (see page 329).

Interrupts are always cleared (for both the **FCMIS** and **FCRIS** registers) by writing a 1 to the corresponding bit in the **Flash Controller Masked Interrupt Status and Clear (FCMISC)** register (see page 331).

7.2.3.4 Flash Memory Programming

The Stellaris devices provide a user-friendly interface for Flash memory programming. All erase/program operations are handled via three registers: **Flash Memory Address (FMA)**, **Flash Memory Data (FMD)**, and **Flash Memory Control (FMC)**. Note that if the debug capabilities of the microcontroller have been deactivated, resulting in a "locked" state, a recovery sequence must be performed in order to reactivate the debug module. See "Recovering a "Locked" Microcontroller" on page 175.

During a Flash memory operation (write, page erase, or mass erase) access to the Flash memory is inhibited. As a result, instruction and literal fetches are held off until the Flash memory operation is complete. If instruction execution is required during a Flash memory operation, the code that is executing must be placed in SRAM and executed from there while the flash operation is in progress.

Caution – The Flash memory is divided into sectors of electrically separated address ranges of 4 KB each, aligned on 4 KB boundaries. Erase/program operations on a 1-KB page have an electrical effect on the other three 1-KB pages within the sector. A specific 1-KB page must be erased after 6 total erase/program cycles occur to the other pages within its 4-KB sector. The following sequence of operations on a 4-KB sector of Flash memory (Page 0..3) provides an example:

- Page 3 is erase and programmed with values.
- Page 0, Page 1, and Page 2 are erased and then programmed with values. At this point Page 3 has been affected by 3 erase/program cycles.
- Page 0, Page 1, and Page 2 are again erased and then programmed with values. At this point Page 3 has been affected by 6 erase/program cycles.
- If the contents of Page 3 must continue to be valid, Page 3 must be erased and reprogrammed before any other page in this sector has another erase or program operation.

To program a 32-bit word

1. Write source data to the **FMD** register.
2. Write the target address to the **FMA** register.
3. Write the Flash memory write key and the **WRITE** bit (a value of 0xA442.0001) to the **FMC** register.
4. Poll the **FMC** register until the **WRITE** bit is cleared.

Important: To ensure proper operation, two writes to the same word must be separated by an ERASE. The following two sequences are allowed:

- ERASE -> PROGRAM value -> PROGRAM 0x0000.0000
- ERASE -> PROGRAM value -> ERASE

The following sequence is NOT allowed:

- ERASE -> PROGRAM value -> PROGRAM value
-

To perform an erase of a 1-KB page

1. Write the page address to the **FMA** register.
2. Write the Flash memory write key and the **ERASE** bit (a value of 0xA442.0002) to the **FMC** register.
3. Poll the **FMC** register until the **ERASE** bit is cleared or, alternatively, enable the programming interrupt using the **PMASK** bit in the **FCIM** register.

To perform a mass erase of the Flash memory

1. Write the Flash memory write key and the **MERASE** bit (a value of 0xA442.0004) to the **FMC** register.
2. Poll the **FMC** register until the **MERASE** bit is cleared or, alternatively, enable the programming interrupt using the **PMASK** bit in the **FCIM** register.

7.2.3.5 32-Word Flash Memory Write Buffer

A 32-word write buffer provides the capability to perform faster write accesses to the Flash memory by concurrently programming 32 words with a single buffered Flash memory write operation. The buffered Flash memory write operation takes the same amount of time as the single word write operation controlled by bit 0 in the **FMC** register. The data for the buffered write is written to the **Flash Write Buffer (FWBn)** registers.

The registers are 32-word aligned with Flash memory, and therefore the register **FWB0** corresponds with the address in **FMA** where bits [6:0] of **FMA** are all 0. **FWB1** corresponds with the address in **FMA** + 0x4 and so on. Only the **FWBn** registers that have been updated since the previous buffered Flash memory write operation are written. The **Flash Write Buffer Valid (FWBVAL)** register shows which registers have been written since the last buffered Flash memory write operation. This register contains a bit for each of the 32 **FWBn** registers, where bit[n] of **FWBVAL** corresponds to **FWBn**. The **FWBn** register has been updated if the corresponding bit in the **FWBVAL** register is set.

To program 32 words with a single buffered Flash memory write operation

1. Write the source data to the **FWBn** registers.
2. Write the target address to the **FMA** register. This must be a 32-word aligned address (that is, bits [6:0] in **FMA** must be 0s).
3. Write the Flash memory write key and the **WRBUF** bit (a value of 0xA442.0001) to the **FMC2** register.

4. Poll the **FMC2** register until the `WRBUF` bit is cleared or wait for the `PMIS` interrupt to be signaled.

7.2.3.6 Non-Volatile Register Programming

This section discusses how to update the registers shown in Table 7-2 on page 322 that are resident within the Flash memory itself. These registers exist in a separate space from the main Flash memory array and are not affected by an ERASE or MASS ERASE operation. With the exception of the **Boot Configuration (BOOTCFG)** register, the settings in these registers can be written, their functions verified, and their values read back before they are committed, at which point they become non-volatile. If a value in one of these registers has not been committed, any type of reset restores the last committed value or the default value if the register has never been committed. Once the register contents are committed, the only way to restore the factory default values is to perform the sequence described in “Recovering a “Locked” Microcontroller” on page 175.

To write to a non-volatile register:

- Bits can only be changed from 1 to 0.
- For all registers except the **BOOTCFG** register, write the data to the register address provided in the register description. For the **BOOTCFG** register, write the data to the **FMD** register.
- The registers can be read to verify their contents. To verify what is to be stored in the **BOOTCFG** register, read the **FMD** register. Reading the **BOOTCFG** register returns the previously committed value or the default value if the register has never been committed.
- The new values are effectively immediately for all registers except **BOOTCFG**, as the new value for the register is not stored in the register until it has been committed.
- Prior to committing the register value, any type of reset restores the last committed value or the default value if the register has never been committed.

To commit a new value to a non-volatile register:

- Write the data as described above.
- Write to the **FMA** register the value shown in Table 7-2 on page 322.
- Write the Flash memory write key and set the `COMT` bit in the **FMC** register. These values must be written to the **FMC** register at the same time.
- Committing a non-volatile register has the same timing as a write to regular Flash memory, defined by T_{PROG} , as shown in Table 25-19 on page 1138. Software can poll the `COMT` bit in the **FMC** register to determine when the operation is complete, or an interrupt can be enabled by setting the `PMASK` bit in the **FCIM** register.
- When committing the **BOOTCFG** register, the `INVDRIS` bit in the **FCRIS** register is set if a bit that has already been committed as a 0 is attempted to be committed as a 1.
- Once the value has been committed, any type of reset has no effect on the register contents.
- Changes to the **BOOTCFG** register are effective after the next reset.
- The `NW` bit in the **USER_REG0**, **USER_REG1**, **USER_REG2**, **USER_REG3**, and **BOOTCFG** registers is cleared when the register is committed. Once this bit is cleared, additional changes to the register are not allowed.

Important: After being committed, these registers can only be restored to their factory default values by performing the sequence described in “Recovering a “Locked” Microcontroller” on page 175. The mass erase of the main Flash memory array caused by the sequence is performed prior to restoring these registers.

Table 7-2. User-Programmable Flash Memory Resident Registers

| Register to be Committed | FMA Value | Data Source |
|--------------------------|-------------|-------------|
| FMPRE0 | 0x0000.0000 | FMPRE0 |
| FMPRE1 | 0x0000.0002 | FMPRE1 |
| FMPRE2 | 0x0000.0004 | FMPRE2 |
| FMPRE3 | 0x0000.0006 | FMPRE3 |
| FMPRE4 | 0x0000.0008 | FMPRE4 |
| FMPRE5 | 0x0000.000A | FMPRE5 |
| FMPPE0 | 0x0000.0001 | FMPPE0 |
| FMPPE1 | 0x0000.0003 | FMPPE1 |
| FMPPE2 | 0x0000.0005 | FMPPE2 |
| FMPPE3 | 0x0000.0007 | FMPPE3 |
| FMPRE4 | 0x0000.0009 | FMPRE4 |
| FMPRE5 | 0x0000.000B | FMPRE5 |
| USER_REG0 | 0x8000.0000 | USER_REG0 |
| USER_REG1 | 0x8000.0001 | USER_REG1 |
| USER_REG2 | 0x8000.0002 | USER_REG2 |
| USER_REG3 | 0x8000.0003 | USER_REG3 |
| BOOTCFG | 0x7510.0000 | FMD |

7.3 Register Map

Table 7-3 on page 322 lists the ROM Controller register and the Flash memory and control registers. The offset listed is a hexadecimal increment to the register's address. The Flash memory register offsets are relative to the Flash memory control base address of 0x400F.D000. The ROM and Flash memory protection register offsets are relative to the System Control base address of 0x400F.E000.

Table 7-3. Flash Register Map

| Offset | Name | Type | Reset | Description | See page |
|--|--------|-------|-------------|--|----------|
| Flash Memory Registers (Flash Control Offset) | | | | | |
| 0x000 | FMA | R/W | 0x0000.0000 | Flash Memory Address | 324 |
| 0x004 | FMD | R/W | 0x0000.0000 | Flash Memory Data | 325 |
| 0x008 | FMC | R/W | 0x0000.0000 | Flash Memory Control | 326 |
| 0x00C | FCRIS | RO | 0x0000.0000 | Flash Controller Raw Interrupt Status | 329 |
| 0x010 | FCIM | R/W | 0x0000.0000 | Flash Controller Interrupt Mask | 330 |
| 0x014 | FCMISC | R/W1C | 0x0000.0000 | Flash Controller Masked Interrupt Status and Clear | 331 |
| 0x020 | FMC2 | R/W | 0x0000.0000 | Flash Memory Control 2 | 332 |

Table 7-3. Flash Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|---|-----------|-------|-------------|--|----------|
| 0x030 | FWBVAL | R/W | 0x0000.0000 | Flash Write Buffer Valid | 333 |
| 0x0F8 | FCTL | R/W | 0x0000.0000 | Flash Control | 334 |
| 0x100 - 0x17C | FWBn | R/W | 0x0000.0000 | Flash Write Buffer n | 335 |
| Memory Registers (System Control Offset) | | | | | |
| 0x0F0 | RMCTL | R/W1C | - | ROM Control | 336 |
| 0x130 | FMPRE0 | R/W | 0xFFFF.FFFF | Flash Memory Protection Read Enable 0 | 337 |
| 0x200 | FMPRE0 | R/W | 0xFFFF.FFFF | Flash Memory Protection Read Enable 0 | 337 |
| 0x134 | FMPPE0 | R/W | 0xFFFF.FFFF | Flash Memory Protection Program Enable 0 | 338 |
| 0x400 | FMPPE0 | R/W | 0xFFFF.FFFF | Flash Memory Protection Program Enable 0 | 338 |
| 0x1D0 | BOOTCFG | R/W | 0xFFFF.FFFE | Boot Configuration | 339 |
| 0x1E0 | USER_REG0 | R/W | 0xFFFF.FFFF | User Register 0 | 341 |
| 0x1E4 | USER_REG1 | R/W | 0xFFFF.FFFF | User Register 1 | 342 |
| 0x1E8 | USER_REG2 | R/W | 0xFFFF.FFFF | User Register 2 | 343 |
| 0x1EC | USER_REG3 | R/W | 0xFFFF.FFFF | User Register 3 | 344 |
| 0x204 | FMPRE1 | R/W | 0xFFFF.FFFF | Flash Memory Protection Read Enable 1 | 345 |
| 0x208 | FMPRE2 | R/W | 0xFFFF.FFFF | Flash Memory Protection Read Enable 2 | 346 |
| 0x20C | FMPRE3 | R/W | 0xFFFF.FFFF | Flash Memory Protection Read Enable 3 | 347 |
| 0x210 | FMPRE4 | R/W | 0xFFFF.FFFF | Flash Memory Protection Read Enable 4 | 348 |
| 0x214 | FMPRE5 | R/W | 0xFFFF.FFFF | Flash Memory Protection Read Enable 5 | 349 |
| 0x218 | FMPRE6 | R/W | 0x0000.0000 | Flash Memory Protection Read Enable 6 | 350 |
| 0x21C | FMPRE7 | R/W | 0x0000.0000 | Flash Memory Protection Read Enable 7 | 351 |
| 0x404 | FMPPE1 | R/W | 0xFFFF.FFFF | Flash Memory Protection Program Enable 1 | 352 |
| 0x408 | FMPPE2 | R/W | 0xFFFF.FFFF | Flash Memory Protection Program Enable 2 | 353 |
| 0x40C | FMPPE3 | R/W | 0xFFFF.FFFF | Flash Memory Protection Program Enable 3 | 354 |
| 0x410 | FMPPE4 | R/W | 0xFFFF.FFFF | Flash Memory Protection Program Enable 4 | 355 |
| 0x414 | FMPPE5 | R/W | 0xFFFF.FFFF | Flash Memory Protection Program Enable 5 | 356 |
| 0x418 | FMPPE6 | R/W | 0x0000.0000 | Flash Memory Protection Program Enable 6 | 357 |
| 0x41C | FMPPE7 | R/W | 0x0000.0000 | Flash Memory Protection Program Enable 7 | 358 |

7.4 Flash Memory Register Descriptions (Flash Control Offset)

This section lists and describes the Flash Memory registers, in numerical order by address offset. Registers in this section are relative to the Flash control base address of 0x400F.D000.

Register 1: Flash Memory Address (FMA), offset 0x000

During a write operation, this register contains a 4-byte-aligned address and specifies where the data is written. During erase operations, this register contains a 1 KB-aligned CPU byte address and specifies which block is erased. Note that the alignment requirements must be met by software or the results of the operation are unpredictable.

Flash Memory Address (FMA)

Base 0x400F.D000

Offset 0x000

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|--------|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | OFFSET | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | OFFSET | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:19 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 18:0 | OFFSET | R/W | 0x0 | Address Offset Address offset in Flash memory where operation is performed, except for non-volatile registers (see "Non-Volatile Register Programming" on page 321 for details on values for this field). |

Register 2: Flash Memory Data (FMD), offset 0x004

This register contains the data to be written during the programming cycle or read during the read cycle. Note that the contents of this register are undefined for a read access of an execute-only block. This register is not used during erase cycles.

Flash Memory Data (FMD)

Base 0x400F.D000

Offset 0x004

Type R/W, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | DATA | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DATA | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|---|
| 31:0 | DATA | R/W | 0x0000.0000 | Data Value Data value for write operation. |

Register 3: Flash Memory Control (FMC), offset 0x008

When this register is written, the Flash memory controller initiates the appropriate access cycle for the location specified by the **Flash Memory Address (FMA)** register (see page 324). If the access is a write access, the data contained in the **Flash Memory Data (FMD)** register (see page 325) is written to the specified address.

This register must be the final register written and initiates the memory operation. The four control bits in the lower byte of this register are used to initiate memory operations.

Care must be taken not to set multiple control bits as the results of such an operation are unpredictable.

Caution – If any of bits [15:4] are written to 1, the device may become inoperable. These bits should always be written to 0. In all registers, the value of a reserved bit should be preserved across a read-modify-write operation.

Flash Memory Control (FMC)

Base 0x400F.D000
Offset 0x008
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|------|--------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | WRKEY | | | | | | | | | | | | | | | |
| Type | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | COMT | MERASE | ERASE | WRITE |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|--|
| 31:16 | WRKEY | WO | 0x0000 | Flash Memory Write Key This field contains a write key, which is used to minimize the incidence of accidental Flash memory writes. The value 0xA442 must be written into this field for a Flash memory write to occur. Writes to the FMC register without this <code>WRKEY</code> value are ignored. A read of this field returns the value 0. |
| 15:4 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 3 | COMT | R/W | 0 | <p>Commit Register Value</p> <p>This bit is used to commit writes to Flash-memory-resident registers and to monitor the progress of that process.</p> <p>Value Description</p> <p>1 Set this bit to commit (write) the register value to a Flash-memory-resident register. When read, a 1 indicates that the previous commit access is not complete.</p> <p>0 A write of 0 has no effect on the state of this bit. When read, a 0 indicates that the previous commit access is complete.</p> <p>See “Non-Volatile Register Programming” on page 321 for more information on programming Flash-memory-resident registers.</p> |
| 2 | MERASE | R/W | 0 | <p>Mass Erase Flash Memory</p> <p>This bit is used to mass erase the Flash main memory and to monitor the progress of that process.</p> <p>Value Description</p> <p>1 Set this bit to erase the Flash main memory. When read, a 1 indicates that the previous mass erase access is not complete.</p> <p>0 A write of 0 has no effect on the state of this bit. When read, a 0 indicates that the previous mass erase access is complete.</p> <p>For information on erase time, see “Flash Memory” on page 1138.</p> |
| 1 | ERASE | R/W | 0 | <p>Erase a Page of Flash Memory</p> <p>This bit is used to erase a page of Flash memory and to monitor the progress of that process.</p> <p>Value Description</p> <p>1 Set this bit to erase the Flash memory page specified by the contents of the FMA register. When read, a 1 indicates that the previous page erase access is not complete.</p> <p>0 A write of 0 has no effect on the state of this bit. When read, a 0 indicates that the previous page erase access is complete.</p> <p>For information on erase time, see “Flash Memory” on page 1138.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|---|
| 0 | WRITE | R/W | 0 | <p>Write a Word into Flash Memory</p> <p>This bit is used to write a word into Flash memory and to monitor the progress of that process.</p> <p>Value Description</p> <p>1 Set this bit to write the data stored in the FMD register into the Flash memory location specified by the contents of the FMA register.</p> <p>When read, a 1 indicates that the write update access is not complete.</p> <p>0 A write of 0 has no effect on the state of this bit.</p> <p>When read, a 0 indicates that the previous write update access is complete.</p> |

For information on programming time, see "Flash Memory" on page 1138.

Register 4: Flash Controller Raw Interrupt Status (FCRIS), offset 0x00C

This register indicates that the Flash memory controller has an interrupt condition. An interrupt is sent to the interrupt controller only if the corresponding **FCIM** register bit is set.

Flash Controller Raw Interrupt Status (FCRIS)

Base 0x400F.D000

Offset 0x00C

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | PRIS | ARIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | |
|-----------|---|------|------------|--|---|---|---|--|
| 31:2 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | |
| 1 | PRIS | RO | 0 | <p>Programming Raw Interrupt Status</p> <p>This bit provides status on programming cycles which are write or erase actions generated through the FMC or FMC2 register bits (see page 326 and page 332).</p> <p>Value Description</p> <table border="0"> <tr> <td>1</td> <td>The programming or erase cycle has completed.</td> </tr> <tr> <td>0</td> <td>The programming or erase cycle has not completed.</td> </tr> </table> <p>This status is sent to the interrupt controller when the PMASK bit in the FCIM register is set.</p> <p>This bit is cleared by writing a 1 to the PMISC bit in the FCMISC register.</p> | 1 | The programming or erase cycle has completed. | 0 | The programming or erase cycle has not completed. |
| 1 | The programming or erase cycle has completed. | | | | | | | |
| 0 | The programming or erase cycle has not completed. | | | | | | | |
| 0 | ARIS | RO | 0 | <p>Access Raw Interrupt Status</p> <p>Value Description</p> <table border="0"> <tr> <td>1</td> <td>A program or erase action was attempted on a block of Flash memory that contradicts the protection policy for that block as set in the FMPPEn registers.</td> </tr> <tr> <td>0</td> <td>No access has tried to improperly program or erase the Flash memory.</td> </tr> </table> <p>This status is sent to the interrupt controller when the AMASK bit in the FCIM register is set.</p> <p>This bit is cleared by writing a 1 to the AMISC bit in the FCMISC register.</p> | 1 | A program or erase action was attempted on a block of Flash memory that contradicts the protection policy for that block as set in the FMPPEn registers. | 0 | No access has tried to improperly program or erase the Flash memory. |
| 1 | A program or erase action was attempted on a block of Flash memory that contradicts the protection policy for that block as set in the FMPPEn registers. | | | | | | | |
| 0 | No access has tried to improperly program or erase the Flash memory. | | | | | | | |

Register 5: Flash Controller Interrupt Mask (FCIM), offset 0x010

This register controls whether the Flash memory controller generates interrupts to the controller.

Flash Controller Interrupt Mask (FCIM)

Base 0x400F.D000

Offset 0x010

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|-------|-------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | PMASK | AMASK | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | |
|-----------|---|------|------------|--|---|---|---|---|
| 31:2 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | |
| 1 | PMASK | R/W | 0 | <p>Programming Interrupt Mask</p> <p>This bit controls the reporting of the programming raw interrupt status to the interrupt controller.</p> <p>Value Description</p> <table border="0"> <tr> <td>1</td> <td>An interrupt is sent to the interrupt controller when the <code>PRIS</code> bit is set.</td> </tr> <tr> <td>0</td> <td>The <code>PRIS</code> interrupt is suppressed and not sent to the interrupt controller.</td> </tr> </table> | 1 | An interrupt is sent to the interrupt controller when the <code>PRIS</code> bit is set. | 0 | The <code>PRIS</code> interrupt is suppressed and not sent to the interrupt controller. |
| 1 | An interrupt is sent to the interrupt controller when the <code>PRIS</code> bit is set. | | | | | | | |
| 0 | The <code>PRIS</code> interrupt is suppressed and not sent to the interrupt controller. | | | | | | | |
| 0 | AMASK | R/W | 0 | <p>Access Interrupt Mask</p> <p>This bit controls the reporting of the access raw interrupt status to the interrupt controller.</p> <p>Value Description</p> <table border="0"> <tr> <td>1</td> <td>An interrupt is sent to the interrupt controller when the <code>ARIS</code> bit is set.</td> </tr> <tr> <td>0</td> <td>The <code>ARIS</code> interrupt is suppressed and not sent to the interrupt controller.</td> </tr> </table> | 1 | An interrupt is sent to the interrupt controller when the <code>ARIS</code> bit is set. | 0 | The <code>ARIS</code> interrupt is suppressed and not sent to the interrupt controller. |
| 1 | An interrupt is sent to the interrupt controller when the <code>ARIS</code> bit is set. | | | | | | | |
| 0 | The <code>ARIS</code> interrupt is suppressed and not sent to the interrupt controller. | | | | | | | |

Register 6: Flash Controller Masked Interrupt Status and Clear (FCMISC), offset 0x014

This register provides two functions. First, it reports the cause of an interrupt by indicating which interrupt source or sources are signalling the interrupt. Second, it serves as the method to clear the interrupt reporting.

Flash Controller Masked Interrupt Status and Clear (FCMISC)

Base 0x400F.D000

Offset 0x014

Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | | PMISC | AMISC |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|------------|---|
| 31:2 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | PMISC | R/W1C | 0 | Programming Masked Interrupt Status and Clear Value Description 1 When read, a 1 indicates that an unmasked interrupt was signaled because a programming cycle completed. Writing a 1 to this bit clears <code>PMISC</code> and also the <code>PRIS</code> bit in the <code>FCRIS</code> register (see page 329). 0 When read, a 0 indicates that a programming cycle complete interrupt has not occurred. A write of 0 has no effect on the state of this bit. |
| 0 | AMISC | R/W1C | 0 | Access Masked Interrupt Status and Clear Value Description 1 When read, a 1 indicates that an unmasked interrupt was signaled because a program or erase action was attempted on a block of Flash memory that contradicts the protection policy for that block as set in the <code>FMPPEn</code> registers. Writing a 1 to this bit clears <code>AMISC</code> and also the <code>ARIS</code> bit in the <code>FCRIS</code> register (see page 329). 0 When read, a 0 indicates that no improper accesses have occurred. A write of 0 has no effect on the state of this bit. |

Register 7: Flash Memory Control 2 (FMC2), offset 0x020

When this register is written, the Flash memory controller initiates the appropriate access cycle for the location specified by the **Flash Memory Address (FMA)** register (see page 324). If the access is a write access, the data contained in the **Flash Write Buffer (FWB)** registers is written.

This register must be the final register written as it initiates the memory operation.

Flash Memory Control 2 (FMC2)

Base 0x400F.D000

Offset 0x020

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | WRKEY | | | | | | | | | | | | | | | |
| Type | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | WRBUF |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | WRKEY | WO | 0x0000 | Flash Memory Write Key This field contains a write key, which is used to minimize the incidence of accidental Flash memory writes. The value 0xA442 must be written into this field for a write to occur. Writes to the FMC2 register without this WRKEY value are ignored. A read of this field returns the value 0. |
| 15:1 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | WRBUF | R/W | 0 | Buffered Flash Memory Write This bit is used to start a buffered write to Flash memory. Value Description 1 Set this bit to write the data stored in the FWBn registers to the location specified by the contents of the FMA register. When read, a 1 indicates that the previous buffered Flash memory write access is not complete. 0 A write of 0 has no effect on the state of this bit. When read, a 0 indicates that the previous buffered Flash memory write access is complete. |

For information on programming time, see "Flash Memory" on page 1138.

Register 8: Flash Write Buffer Valid (FWBVAL), offset 0x030

This register provides a bitwise status of which **FWB_n** registers have been written by the processor since the last write of the Flash memory write buffer. The entries with a 1 are written on the next write of the Flash memory write buffer. This register is cleared after the write operation by hardware. A protection violation on the write operation also clears this status.

Software can program the same 32 words to various Flash memory locations by setting the **FWB_[n]** bits after they are cleared by the write operation. The next write operation then uses the same data as the previous one. In addition, if a **FWB_n** register change should not be written to Flash memory, software can clear the corresponding **FWB_[n]** bit to preserve the existing data when the next write operation occurs.

Flash Write Buffer Valid (FWBVAL)

Base 0x400F.D000

Offset 0x030

Type R/W, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | FWB[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | FWB[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---------------------------|
| 31:0 | FWB[n] | R/W | 0x0 | Flash Memory Write Buffer |

Value Description

- | | |
|---|--|
| 1 | The corresponding FWB_n register has been updated since the last buffer write operation and is ready to be written to Flash memory. |
| 0 | The corresponding FWB_n register has no new data to be written. |

Bit 0 corresponds to **FWB0**, offset 0x100, and bit 31 corresponds to **FWB31**, offset 0x13C.

Register 9: Flash Control (FCTL), offset 0x0F8

This register is used to ensure that the microcontroller is powered down in a controlled fashion in systems where power is cycled more frequently than once every five minutes. The `USDREQ` bit should be set to indicate that power is going to be turned off. Software should poll the `USDACK` bit to determine when it is acceptable to power down.

Note that this power-down process is not required if the microcontroller enters Hibernate mode prior to power being removed.

Flash Control (FCTL)

Base 0x400F.D000

Offset 0x0F8

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | | USDACK | USDREQ |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:2 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | USDACK | RO | 0 | User Shut Down Acknowledge Value Description 1 The microcontroller can be powered down. 0 The microcontroller cannot yet be powered down. This bit should be set within 50 ms of setting the <code>USDREQ</code> bit. |
| 0 | USDREQ | R/W | 0 | User Shut Down Request Value Description 1 Requests permission to power down the microcontroller. 0 No effect. |

Register 10: Flash Write Buffer n (FWBn), offset 0x100 - 0x17C

These 32 registers hold the contents of the data to be written into the Flash memory on a buffered Flash memory write operation. The offset selects one of the 32-bit registers. Only **FWBn** registers that have been updated since the preceding buffered Flash memory write operation are written into the Flash memory, so it is not necessary to write the entire bank of registers in order to write 1 or 2 words. The **FWBn** registers are written into the Flash memory with the **FWB0** register corresponding to the address contained in **FMA**. **FWB1** is written to the address **FMA+0x4** etc. Note that only data bits that are 0 result in the Flash memory being modified. A data bit that is 1 leaves the content of the Flash memory bit at its previous value.

Flash Write Buffer n (FWBn)

Base 0x400F.D000
Offset 0x100 - 0x17C
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | DATA | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DATA | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|---|
| 31:0 | DATA | R/W | 0x0000.0000 | Data Data to be written into the Flash memory. |

7.5 Memory Register Descriptions (System Control Offset)

The remainder of this section lists and describes the registers that reside in the System Control address space, in numerical order by address offset. Registers in this section are relative to the System Control base address of 0x400F.E000.

Register 11: ROM Control (RMCTL), offset 0x0F0

This register provides control of the ROM controller state. This register offset is relative to the System Control base address of 0x400F.E000.

At reset, the ROM is mapped over the Flash memory so that the ROM boot sequence is always executed. The boot sequence executed from ROM is as follows:

1. The **BA** bit (below) is cleared such that ROM is mapped to 0x01xx.xxxx and Flash memory is mapped to address 0x0.
2. The **BOOTCFG** register is read. If the **EN** bit is clear, the status of the specified GPIO pin is compared with the specified polarity. If the status matches the specified polarity, the ROM is mapped to address 0x0000.0000 and execution continues out of the ROM Boot Loader.
3. If the status doesn't match the specified polarity, the data at address 0x0000.0004 is read, and if the data at this address is 0xFFFF.FFFF, the ROM is mapped to address 0x0000.0000 and execution continues out of the ROM Boot Loader.
4. If there is data at address 0x0000.0004 that is not 0xFFFF.FFFF, the stack pointer (**SP**) is loaded from Flash memory at address 0x0000.0000 and the program counter (**PC**) is loaded from address 0x0000.0004. The user application begins executing.

ROM Control (RMCTL)

Base 0x400F.E000
Offset 0x0F0
Type R/W1C, reset -

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | BA |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|------------|---|
| 31:1 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | BA | R/W1C | 1 | Boot Alias |

Value Description

| Value | Description |
|-------|---|
| 1 | The microcontroller's ROM appears at address 0x0. |
| 0 | The Flash memory is at address 0x0. |

This bit is cleared by writing a 1 to this bit position.

Register 12: Flash Memory Protection Read Enable 0 (FMPRE0), offset 0x130 and 0x200

Note: This register is aliased for backwards compatibility.

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the read-only protection bits for each 2-KB flash block (**FMPPEn** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPREN** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPREN** and **FMPPEn** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Read Enable 0 (FMPRE0)

Base 0x400F.E000
Offset 0x130 and 0x200
Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | READ_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | READ_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | READ_ENABLE | R/W | 0xFFFFFFFF | Flash Read Enable Configures 2-KB flash blocks to be read or executed only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | | 0xFFFFFFFF Bits [31:0] each enable protection on a 2-KB block of Flash memory up to the total of 64 KB. |

Register 13: Flash Memory Protection Program Enable 0 (FMPPE0), offset 0x134 and 0x400

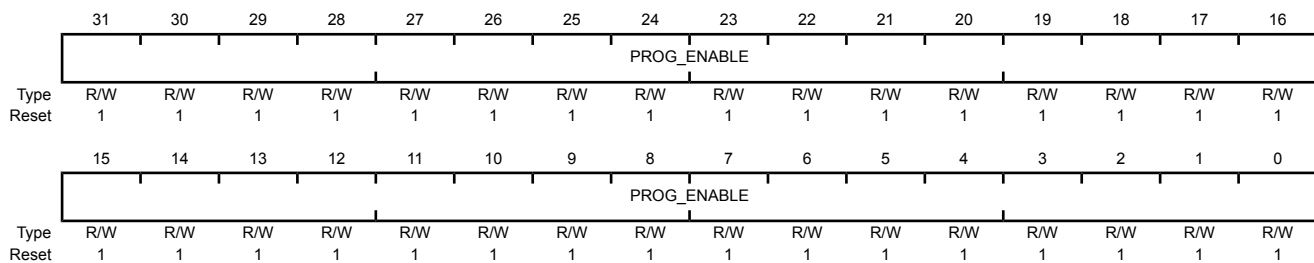
Note: This register is aliased for backwards compatability.

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPPE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPPE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Program Enable 0 (FMPPE0)

Base 0x400F.E000
 Offset 0x134 and 0x400
 Type R/W, reset 0xFFFF.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | PROG_ENABLE | R/W | 0xFFFFFFFF | Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | 0xFFFFFFFF | Bits [31:0] each enable protection on a 2-KB block of Flash memory up to the total of 64 KB. |

Register 14: Boot Configuration (BOOTCFG), offset 0x1D0

Note: Offset is relative to System Control base address of 0x400FE000.

This register provides configuration of a GPIO pin to enable the ROM Boot Loader as well as a write-once mechanism to disable external debugger access to the device. Upon reset, the user has the opportunity to direct the core to execute the ROM Boot Loader or the application in Flash memory by using any GPIO signal from Ports A-H as configured by the bits in this register. If the EN bit is set or the specified pin does not have the required polarity, the system control module checks address 0x000.0004 to see if the Flash memory has a valid reset vector. If the data at address 0x0000.0004 is 0xFFFF.FFFF, then it is assumed that the Flash memory has not yet been programmed, and the core executes the ROM Boot Loader. The DBG0 bit (bit 0) is set to 0 from the factory and the DBG1 bit (bit 1) is set to 1, which enables external debuggers. Clearing the DBG1 bit disables any external debugger access to the device permanently, starting with the next power-up cycle of the device. The NW bit (bit 31) indicates that the register has not yet been committed and is controlled through hardware to ensure that the register is only committed once. Prior to being committed, bits can only be changed from 1 to 0. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175.

Boot Configuration (BOOTCFG)

Base 0x400F.E000

Offset 0x1D0

Type R/W, reset 0xFFFF.FFFE

| | | | | | | | | | | | | | | | | |
|-------|------|----------|-----|-----|-----|-----|-----|----------|----|----|----|----|----|----|------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | NW | reserved | | | | | | | | | | | | | | |
| Type | R/W | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PORT | | | PIN | | POL | EN | reserved | | | | | | | DBG1 | DBG0 |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | RO | RO | RO | RO | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|--|
| 31 | NW | R/W | 1 | Not Written When set, this bit indicates that this 32-bit register has not been committed. When clear, this bit specifies that this register has been committed and may not be committed again. |
| 30:16 | reserved | RO | 0x7FFF | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | |
|-----------|-------------|------|-------|---|-------|-------------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|
| 15:13 | PORT | R/W | 0x7 | <p>Boot GPIO Port</p> <p>This field selects the port of the GPIO port pin that enables the ROM boot loader at reset.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>0x0</td><td>Port A</td></tr> <tr><td>0x1</td><td>Port B</td></tr> <tr><td>0x2</td><td>Port C</td></tr> <tr><td>0x3</td><td>Port D</td></tr> <tr><td>0x4</td><td>Port E</td></tr> <tr><td>0x5</td><td>Port F</td></tr> <tr><td>0x6</td><td>Port G</td></tr> <tr><td>0x7</td><td>Port H</td></tr> </tbody> </table> | Value | Description | 0x0 | Port A | 0x1 | Port B | 0x2 | Port C | 0x3 | Port D | 0x4 | Port E | 0x5 | Port F | 0x6 | Port G | 0x7 | Port H |
| Value | Description | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | Port A | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | Port B | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | Port C | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | Port D | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | Port E | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | Port F | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | Port G | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | Port H | | | | | | | | | | | | | | | | | | | | | |
| 12:10 | PIN | R/W | 0x7 | <p>Boot GPIO Pin</p> <p>This field selects the pin number of the GPIO port pin that enables the ROM boot loader at reset.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr><td>0x0</td><td>Pin 0</td></tr> <tr><td>0x1</td><td>Pin 1</td></tr> <tr><td>0x2</td><td>Pin 2</td></tr> <tr><td>0x3</td><td>Pin 3</td></tr> <tr><td>0x4</td><td>Pin 4</td></tr> <tr><td>0x5</td><td>Pin 5</td></tr> <tr><td>0x6</td><td>Pin 6</td></tr> <tr><td>0x7</td><td>Pin 7</td></tr> </tbody> </table> | Value | Description | 0x0 | Pin 0 | 0x1 | Pin 1 | 0x2 | Pin 2 | 0x3 | Pin 3 | 0x4 | Pin 4 | 0x5 | Pin 5 | 0x6 | Pin 6 | 0x7 | Pin 7 |
| Value | Description | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | Pin 0 | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | Pin 1 | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | Pin 2 | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | Pin 3 | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | Pin 4 | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | Pin 5 | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | Pin 6 | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | Pin 7 | | | | | | | | | | | | | | | | | | | | | |
| 9 | POL | R/W | 0x1 | <p>Boot GPIO Polarity</p> <p>When set, this bit selects a high level for the GPIO port pin to enable the ROM boot loader at reset. When clear, this bit selects a low level for the GPIO port pin.</p> | | | | | | | | | | | | | | | | | | |
| 8 | EN | R/W | 0x1 | <p>Boot GPIO Enable</p> <p>Clearing this bit enables the use of a GPIO pin to enable the ROM Boot Loader at reset. When this bit is set, the contents of address 0x0000.0004 are checked to see if the Flash memory has been programmed. If the contents are not 0xFFFF.FFFF, the core executes out of Flash memory. If the Flash has not been programmed, the core executes out of ROM.</p> | | | | | | | | | | | | | | | | | | |
| 7:2 | reserved | RO | 0x3F | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> | | | | | | | | | | | | | | | | | | |
| 1 | DBG1 | R/W | 1 | <p>Debug Control 1</p> <p>The DBG1 bit must be 1 and DBG0 must be 0 for debug to be available.</p> | | | | | | | | | | | | | | | | | | |
| 0 | DBG0 | R/W | 0x0 | <p>Debug Control 0</p> <p>The DBG1 bit must be 1 and DBG0 must be 0 for debug to be available.</p> | | | | | | | | | | | | | | | | | | |

Register 15: User Register 0 (USER_REG0), offset 0x1E0

Note: Offset is relative to System Control base address of 0x400FE000.

This register provides 31 bits of user-defined data that is non-volatile and can only be committed once. Bit 31 indicates that the register is available to be committed and is controlled through hardware to ensure that the register is only committed once. Prior to being committed, bits can only be changed from 1 to 0. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. The write-once characteristics of this register are useful for keeping static information like communication addresses that need to be unique per part and would otherwise require an external EEPROM or other non-volatile device. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in “Recovering a “Locked” Microcontroller” on page 175.

User Register 0 (USER_REG0)

Base 0x400F.E000

Offset 0x1E0

Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | NW | DATA | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DATA | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|------------|--|
| 31 | NW | R/W | 1 | Not Written When set, this bit indicates that this 32-bit register has not been committed. When clear, this bit specifies that this register has been committed and may not be committed again. |
| 30:0 | DATA | R/W | 0x7FFFFFFF | User Data Contains the user data value. This field is initialized to all 1s and can only be committed once. |

Register 16: User Register 1 (USER_REG1), offset 0x1E4

Note: Offset is relative to System Control base address of 0x400FE000.

This register provides 31 bits of user-defined data that is non-volatile and can only be written once. Bit 31 indicates that the register is available to be written and is controlled through hardware to ensure that the register is only written once. The write-once characteristics of this register are useful for keeping static information like communication addresses that need to be unique per part and would otherwise require an external EEPROM or other non-volatile device.

User Register 1 (USER_REG1)

Base 0x400F.E000

Offset 0x1E4

Type R/W, reset 0xFFFF.FFFF

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | NW | DATA | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DATA | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|------------|--|
| 31 | NW | R/W | 1 | Not Written When set, this bit indicates that this 32-bit register has not been committed. When clear, this bit specifies that this register has been committed and may not be committed again. |
| 30:0 | DATA | R/W | 0x7FFFFFFF | User Data Contains the user data value. This field is initialized to all 1s and can only be committed once. |

Register 17: User Register 2 (USER_REG2), offset 0x1E8

Note: Offset is relative to System Control base address of 0x400FE000.

This register provides 31 bits of user-defined data that is non-volatile and can only be written once. Bit 31 indicates that the register is available to be written and is controlled through hardware to ensure that the register is only written once. The write-once characteristics of this register are useful for keeping static information like communication addresses that need to be unique per part and would otherwise require an external EEPROM or other non-volatile device.

User Register 2 (USER_REG2)

Base 0x400F.E000

Offset 0x1E8

Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | NW | DATA | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DATA | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|------------|--|
| 31 | NW | R/W | 1 | Not Written When set, this bit indicates that this 32-bit register has not been committed. When clear, this bit specifies that this register has been committed and may not be committed again. |
| 30:0 | DATA | R/W | 0x7FFFFFFF | User Data Contains the user data value. This field is initialized to all 1s and can only be committed once. |

Register 18: User Register 3 (USER_REG3), offset 0x1EC

Note: Offset is relative to System Control base address of 0x400FE000.

This register provides 31 bits of user-defined data that is non-volatile and can only be written once. Bit 31 indicates that the register is available to be written and is controlled through hardware to ensure that the register is only written once. The write-once characteristics of this register are useful for keeping static information like communication addresses that need to be unique per part and would otherwise require an external EEPROM or other non-volatile device.

User Register 3 (USER_REG3)

Base 0x400F.E000
 Offset 0x1EC
 Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|------|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | NW | DATA | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DATA | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|------------|--|
| 31 | NW | R/W | 1 | Not Written When set, this bit indicates that this 32-bit register has not been committed. When clear, this bit specifies that this register has been committed and may not be committed again. |
| 30:0 | DATA | R/W | 0x7FFFFFFF | User Data Contains the user data value. This field is initialized to all 1s and can only be committed once. |

Register 19: Flash Memory Protection Read Enable 1 (FMPRE1), offset 0x204

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the read-only protection bits for each 2-KB flash block (**FMPPEn** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPREN** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPREN** and **FMPPEn** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 64 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Read Enable 1 (FMPRE1)

Base 0x400F.E000

Offset 0x204

Type R/W, reset 0xFFFFFFFF

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | READ_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | READ_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | READ_ENABLE | R/W | 0xFFFFFFFF | Flash Read Enable Configures 2-KB flash blocks to be read or executed only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | 0xFFFFFFFF | Bits [31:0] each enable protection on a 2-KB block of Flash memory in memory range from 65 to 128 KB. |

Register 20: Flash Memory Protection Read Enable 2 (FMPRE2), offset 0x208

Note: Offset is relative to System Control base address of 0x400FE000.

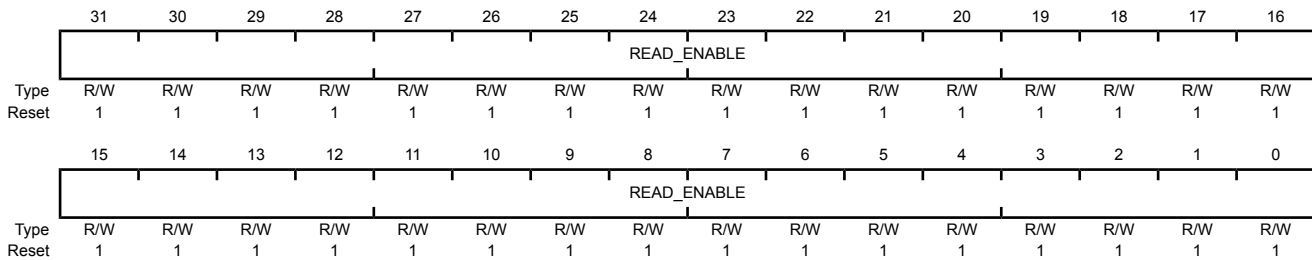
This register stores the read-only protection bits for each 2-KB flash block (**FMPPEn** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPREN** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPREN** and **FMPPEn** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 128 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Read Enable 2 (FMPRE2)

Base 0x400F.E000

Offset 0x208

Type R/W, reset 0xFFFF.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | READ_ENABLE | R/W | 0xFFFFFFFF | Flash Read Enable Configures 2-KB flash blocks to be read or executed only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | 0xFFFFFFFF | Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 129 to 192 KB. |

Register 21: Flash Memory Protection Read Enable 3 (FMPRE3), offset 0x20C

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the read-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPRE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPRE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 192 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Read Enable 3 (FMPRE3)

Base 0x400F.E000

Offset 0x20C

Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | READ_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | READ_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | READ_ENABLE | R/W | 0xFFFFFFFF | Flash Read Enable Configures 2-KB flash blocks to be read or executed only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | 0xFFFFFFFF | Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 193 to 256 KB. |

Register 22: Flash Memory Protection Read Enable 4 (FMPRE4), offset 0x210

Note: Offset is relative to System Control base address of 0x400FE000.

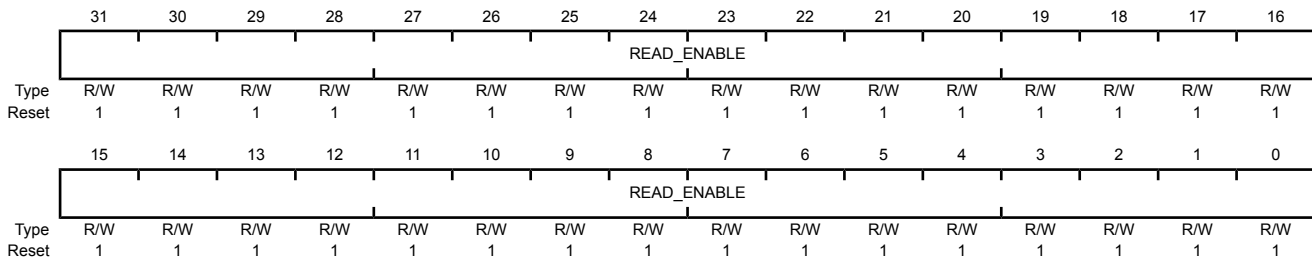
This register stores the read-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPRE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPRE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 192 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Read Enable 4 (FMPRE4)

Base 0x400F.E000

Offset 0x210

Type R/W, reset 0xFFFFFFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | READ_ENABLE | R/W | 0xFFFFFFFF | Flash Read Enable Configures 2-KB flash blocks to be read or executed only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | 0xFFFFFFFF | Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 257 to 320 KB. |

Register 23: Flash Memory Protection Read Enable 5 (FMPRE5), offset 0x214

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the read-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPRE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPRE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 192 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Read Enable 5 (FMPRE5)

Base 0x400F.E000

Offset 0x214

Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | READ_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | READ_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | READ_ENABLE | R/W | 0xFFFFFFFF | Flash Read Enable Configures 2-KB flash blocks to be read or executed only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | 0xFFFFFFFF | Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 321 to 384 KB. |

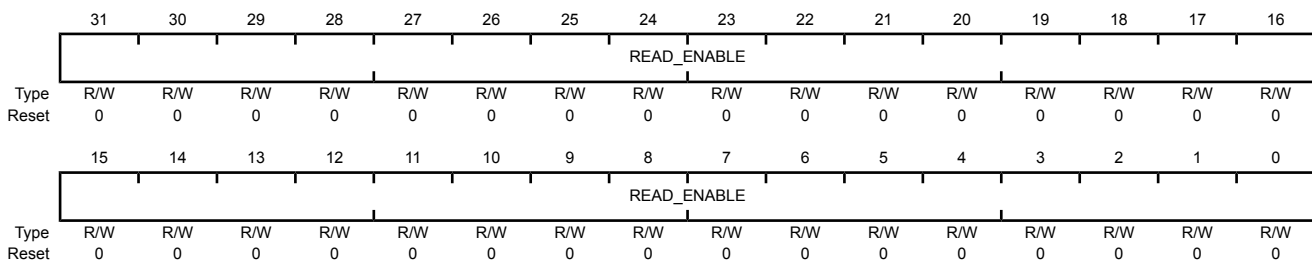
Register 24: Flash Memory Protection Read Enable 6 (FMPRE6), offset 0x218

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the read-only protection bits for each 2-KB flash block (**FMPPEn** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPREN** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPREN** and **FMPPEn** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 192 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Read Enable 6 (FMPRE6)

Base 0x400F.E000
 Offset 0x218
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | READ_ENABLE | R/W | 0x00000000 | Flash Read Enable Configures 2-KB flash blocks to be read or executed only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | 0x00000000 | Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 385 to 448 KB. |

Register 25: Flash Memory Protection Read Enable 7 (FMPRE7), offset 0x21C

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the read-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPRE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPRE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 192 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Read Enable 7 (FMPRE7)

Base 0x400F.E000

Offset 0x21C

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | READ_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | READ_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | READ_ENABLE | R/W | 0x00000000 | Flash Read Enable Configures 2-KB flash blocks to be read or executed only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | | 0x00000000 Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 449 to 512 KB. |

Register 26: Flash Memory Protection Program Enable 1 (FMPPE1), offset 0x404

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPPE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPPE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 64 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Program Enable 1 (FMPPE1)

Base 0x400F.E000

Offset 0x404

Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | PROG_ENABLE | R/W | 0xFFFFFFFF | Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | | 0xFFFFFFFF Bits [31:0] each enable protection on a 2-KB block of Flash memory in memory range from 65 to 128 KB. |

Register 27: Flash Memory Protection Program Enable 2 (FMPPE2), offset 0x408

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPPE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPPE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 128 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Program Enable 2 (FMPPE2)

Base 0x400F.E000

Offset 0x408

Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | PROG_ENABLE | R/W | 0xFFFFFFFF | Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | | 0xFFFFFFFF Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 129 to 192 KB. |

Register 28: Flash Memory Protection Program Enable 3 (FMPPE3), offset 0x40C

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPPE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPPE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 192 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Program Enable 3 (FMPPE3)

Base 0x400F.E000

Offset 0x40C

Type R/W, reset 0xFFFFFFFF

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | PROG_ENABLE | R/W | 0xFFFFFFFF | Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | | 0xFFFFFFFF Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 193 to 256 KB. |

Register 29: Flash Memory Protection Program Enable 4 (FMPPE4), offset 0x410

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPPE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPPE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 192 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Program Enable 4 (FMPPE4)

Base 0x400F.E000

Offset 0x410

Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | PROG_ENABLE | R/W | 0xFFFFFFFF | Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | | 0xFFFFFFFF Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 257 to 320 KB. |

Register 30: Flash Memory Protection Program Enable 5 (FMPPE5), offset 0x414

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPPE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPPE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 192 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Program Enable 5 (FMPPE5)

Base 0x400F.E000

Offset 0x414

Type R/W, reset 0xFFFF.FFFF

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | PROG_ENABLE | R/W | 0xFFFFFFFF | Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | | 0xFFFFFFFF Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 321 to 384 KB. |

Register 31: Flash Memory Protection Program Enable 6 (FMPPE6), offset 0x418

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPPE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPPE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 192 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Program Enable 6 (FMPPE6)

Base 0x400F.E000

Offset 0x418

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | PROG_ENABLE | R/W | 0x00000000 | Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | 0x00000000 | Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 385 to 448 KB. |

Register 32: Flash Memory Protection Program Enable 7 (FMPPE7), offset 0x41C

Note: Offset is relative to System Control base address of 0x400FE000.

This register stores the execute-only protection bits for each 2-KB flash block (**FMPPE_n** stores the execute-only bits). Flash memory up to a total of 64 KB is controlled by this register. Other **FMPPE_n** registers (if any) provide protection for other 64K blocks. This register is loaded during the power-on reset sequence. The factory settings for the **FMPPE_n** and **FMPPE_n** registers are a value of 1 for all implemented banks. This achieves a policy of open access and programmability. The register bits may be changed by writing the specific register bit. However, this register is R/W0; the user can only change the protection bit from a 1 to a 0 (and may NOT change a 0 to a 1). The changes are not permanent until the register is committed (saved), at which point the bit change is permanent. If a bit is changed from a 1 to a 0 and not committed, it may be restored by executing a power-on reset sequence. The reset value shown only applies to power-on reset; any other type of reset does not affect this register. Once committed, the only way to restore the factory default value of this register is to perform the sequence detailed in "Recovering a "Locked" Microcontroller" on page 175. If the Flash memory size on the device is less than 192 KB, this register usually reads as zeroes, but software should not rely on these bits to be zero. For additional information, see "Flash Memory Protection" on page 318.

Flash Memory Protection Program Enable 7 (FMPPE7)

Base 0x400F.E000
Offset 0x41C
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|-------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PROG_ENABLE | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|------------|---|
| 31:0 | PROG_ENABLE | R/W | 0x00000000 | Flash Programming Enable Configures 2-KB flash blocks to be execute only. The policies may be combined as shown in the table "Flash Protection Policy Combinations". |
| | | | | Value Description |
| | | | 0x00000000 | Bits [31:0] each enable protection on a 2-KB block of Flash memory in the range from 449 to 512 KB. |

8 Micro Direct Memory Access (μDMA)

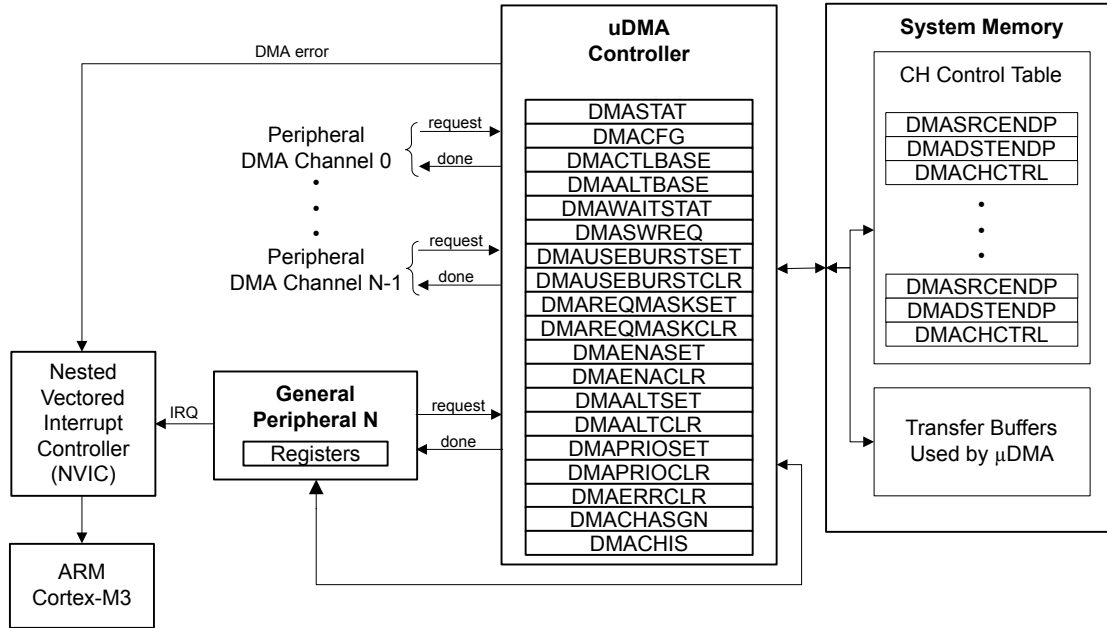
The LM3S2U93 microcontroller includes a Direct Memory Access (DMA) controller, known as micro-DMA (μDMA). The μDMA controller provides a way to offload data transfer tasks from the Cortex™-M3 processor, allowing for more efficient use of the processor and the available bus bandwidth. The μDMA controller can perform transfers between memory and peripherals. It has dedicated channels for each supported on-chip module and can be programmed to automatically perform transfers between peripherals and memory as the peripheral is ready to transfer more data. The μDMA controller provides the following features:

- ARM® PrimeCell® 32-channel configurable μDMA controller
- Support for memory-to-memory, memory-to-peripheral, and peripheral-to-memory in multiple transfer modes
 - Basic for simple transfer scenarios
 - Ping-pong for continuous data flow
 - Scatter-gather for a programmable list of arbitrary transfers initiated from a single request
- Highly flexible and configurable channel operation
 - Independently configured and operated channels
 - Dedicated channels for supported on-chip modules
 - Primary and secondary channel assignments
 - One channel each for receive and transmit path for bidirectional modules
 - Dedicated channel for software-initiated transfers
 - Per-channel configurable priority scheme
 - Optional software-initiated requests for any channel
- Two levels of priority
- Design optimizations for improved bus access performance between μDMA controller and the processor core
 - μDMA controller access is subordinate to core access
 - RAM striping
 - Peripheral bus segmentation
- Data sizes of 8, 16, and 32 bits
- Transfer size is programmable in binary steps from 1 to 1024
- Source and destination address increment size of byte, half-word, word, or no increment
- Maskable peripheral requests

- Interrupt on transfer completion, with a separate interrupt per channel

8.1 Block Diagram

Figure 8-1. μ DMA Block Diagram



8.2 Functional Description

The μ DMA controller is a flexible and highly configurable DMA controller designed to work efficiently with the microcontroller's Cortex-M3 processor core. It supports multiple data sizes and address increment schemes, multiple levels of priority among DMA channels, and several transfer modes to allow for sophisticated programmed data transfers. The μ DMA controller's usage of the bus is always subordinate to the processor core, so it never holds up a bus transaction by the processor. Because the μ DMA controller is only using otherwise-idle bus cycles, the data transfer bandwidth it provides is essentially free, with no impact on the rest of the system. The bus architecture has been optimized to greatly enhance the ability of the processor core and the μ DMA controller to efficiently share the on-chip bus, thus improving performance. The optimizations include RAM striping and peripheral bus segmentation, which in many cases allow both the processor core and the μ DMA controller to access the bus and perform simultaneous data transfers.

The μ DMA controller can transfer data to and from the on-chip SRAM. However, because the Flash memory and ROM are located on a separate internal bus, it is not possible to transfer data from the Flash memory or ROM with the μ DMA controller.

Each peripheral function that is supported has a dedicated channel on the μ DMA controller that can be configured independently. The μ DMA controller implements a unique configuration method using channel control structures that are maintained in system memory by the processor. While simple transfer modes are supported, it is also possible to build up sophisticated "task" lists in memory that allow the μ DMA controller to perform arbitrary-sized transfers to and from arbitrary locations as part of a single transfer request. The μ DMA controller also supports the use of ping-pong buffering to accommodate constant streaming of data to or from a peripheral.

Each channel also has a configurable arbitration size. The arbitration size is the number of items that are transferred in a burst before the μ DMA controller re-arbitrates for channel priority. Using the arbitration size, it is possible to control exactly how many items are transferred to or from a peripheral each time it makes a μ DMA service request.

8.2.1 Channel Assignments

μ DMA channels 0-31 are assigned to peripherals according to the following table. The **DMA Channel Assignment (DMACHASGN)** register (see page 408) can be used to specify the primary or secondary assignment. If the primary function is not available on this microcontroller, the secondary function becomes the primary function. If the secondary function is not available, the primary function is the only option.

Note: Channels noted in the table as "Available for software" may be assigned to peripherals in the future. However, they are currently available for software use. Channel 30 is dedicated for software use.

Because of the way the μ DMA controller interacts with peripherals, the μ DMA channel for the peripheral must be enabled in order for the μ DMA controller to be able to read and write the peripheral registers, even if a different μ DMA channel is used to perform the μ DMA transfer. To minimize confusion and chance of software errors, it is best practice to use a peripheral's μ DMA channel for performing all μ DMA transfers for that peripheral, even if it is processor-triggered and using AUTO mode, which could be considered a software transfer. Note that if the software channel is used, interrupts occur on the dedicated μ DMA interrupt vector. If the peripheral channel is used, then the interrupt occurs on the interrupt vector for the peripheral.

Table 8-1. μ DMA Channel Assignments

| μ DMA Channel | Primary Assignment | Secondary Assignment |
|-------------------|--------------------------|--------------------------|
| 0 | Available for software | UART2 Receive |
| 1 | Available for software | UART2 Transmit |
| 2 | Available for software | General-Purpose Timer 3A |
| 3 | Available for software | General-Purpose Timer 3B |
| 4 | Available for software | General-Purpose Timer 2A |
| 5 | Available for software | General-Purpose Timer 2B |
| 6 | Available for software | General-Purpose Timer 2A |
| 7 | Available for software | General-Purpose Timer 2B |
| 8 | UART0 Receive | UART1 Receive |
| 9 | UART0 Transmit | UART1 Transmit |
| 10 | SSI0 Receive | SSI1 Receive |
| 11 | SSI0 Transmit | SSI1 Transmit |
| 12 | Available for software | UART2 Receive |
| 13 | Available for software | UART2 Transmit |
| 14 | ADC0 Sample Sequencer 0 | General-Purpose Timer 2A |
| 15 | ADC0 Sample Sequencer 1 | General-Purpose Timer 2B |
| 16 | ADC0 Sample Sequencer 2 | Available for software |
| 17 | ADC0 Sample Sequencer 3 | Available for software |
| 18 | General-Purpose Timer 0A | General-Purpose Timer 1A |
| 19 | General-Purpose Timer 0B | General-Purpose Timer 1B |

Table 8-1. μ DMA Channel Assignments (*continued*)

| μ DMA Channel | Primary Assignment | Secondary Assignment |
|-------------------|----------------------------|-------------------------|
| 20 | General-Purpose Timer 1A | EPI0 NBRFIFO |
| 21 | General-Purpose Timer 1B | EPI0 WFIFO |
| 22 | UART1 Receive | Available for software |
| 23 | UART1 Transmit | Available for software |
| 24 | SSI1 Receive | ADC1 Sample Sequencer 0 |
| 25 | SSI1 Transmit | ADC1 Sample Sequencer 1 |
| 26 | Available for software | ADC1 Sample Sequencer 2 |
| 27 | Available for software | ADC1 Sample Sequencer 3 |
| 28 | I ² S0 Receive | Available for software |
| 29 | I ² S0 Transmit | Available for software |
| 30 | Dedicated for software use | |
| 31 | Reserved | |

8.2.2 Priority

The μ DMA controller assigns priority to each channel based on the channel number and the priority level bit for the channel. Channel number 0 has the highest priority and as the channel number increases, the priority of a channel decreases. Each channel has a priority level bit to provide two levels of priority: default priority and high priority. If the priority level bit is set, then that channel has higher priority than all other channels at default priority. If multiple channels are set for high priority, then the channel number is used to determine relative priority among all the high priority channels.

The priority bit for a channel can be set using the **DMA Channel Priority Set (DMAPRIOSET)** register and cleared with the **DMA Channel Priority Clear (DMAPRIOCLR)** register.

8.2.3 Arbitration Size

When a μ DMA channel requests a transfer, the μ DMA controller arbitrates among all the channels making a request and services the μ DMA channel with the highest priority. Once a transfer begins, it continues for a selectable number of transfers before re-arbitrating among the requesting channels again. The arbitration size can be configured for each channel, ranging from 1 to 1024 item transfers. After the μ DMA controller transfers the number of items specified by the arbitration size, it then checks among all the channels making a request and services the channel with the highest priority.

If a lower priority μ DMA channel uses a large arbitration size, the latency for higher priority channels is increased because the μ DMA controller completes the lower priority burst before checking for higher priority requests. Therefore, lower priority channels should not use a large arbitration size for best response on high priority channels.

The arbitration size can also be thought of as a burst size. It is the maximum number of items that are transferred at any one time in a burst. Here, the term arbitration refers to determination of μ DMA channel priority, not arbitration for the bus. When the μ DMA controller arbitrates for the bus, the processor always takes priority. Furthermore, the μ DMA controller is held off whenever the processor must perform a bus transaction on the same bus, even in the middle of a burst transfer.

8.2.4 Request Types

The μ DMA controller responds to two types of requests from a peripheral: single or burst. Each peripheral may support either or both types of requests. A single request means that the peripheral

is ready to transfer one item, while a burst request means that the peripheral is ready to transfer multiple items.

The μ DMA controller responds differently depending on whether the peripheral is making a single request or a burst request. If both are asserted, and the μ DMA channel has been set up for a burst transfer, then the burst request takes precedence. See Table 8-2 on page 363, which shows how each peripheral supports the two request types.

Table 8-2. Request Type Support

| Peripheral | Single Request Signal | Burst Request Signal |
|-----------------------|-----------------------|------------------------------|
| ADC | None | Sequencer IE bit |
| EPI WFIFO | None | WFIFO Level (configurable) |
| EPI NBRFIFO | None | NBRFIFO Level (configurable) |
| General-Purpose Timer | Raw interrupt pulse | None |
| I ² S TX | None | FIFO service request |
| I ² S RX | None | FIFO service request |
| SSI TX | TX FIFO Not Full | TX FIFO Level (fixed at 4) |
| SSI RX | RX FIFO Not Empty | RX FIFO Level (fixed at 4) |
| UART TX | TX FIFO Not Full | TX FIFO Level (configurable) |
| UART RX | RX FIFO Not Empty | RX FIFO Level (configurable) |

8.2.4.1 Single Request

When a single request is detected, and not a burst request, the μ DMA controller transfers one item and then stops to wait for another request.

8.2.4.2 Burst Request

When a burst request is detected, the μ DMA controller transfers the number of items that is the lesser of the arbitration size or the number of items remaining in the transfer. Therefore, the arbitration size should be the same as the number of data items that the peripheral can accommodate when making a burst request. For example, the UART generates a burst request based on the FIFO trigger level. In this case, the arbitration size should be set to the amount of data that the FIFO can transfer when the trigger level is reached. A burst transfer runs to completion once it is started, and cannot be interrupted, even by a higher priority channel. Burst transfers complete in a shorter time than the same number of non-burst transfers.

It may be desirable to use only burst transfers and not allow single transfers. For example, perhaps the nature of the data is such that it only makes sense when transferred together as a single unit rather than one piece at a time. The single request can be disabled by using the **DMA Channel Useburst Set (DMAUSEBURSTSET)** register. By setting the bit for a channel in this register, the μ DMA controller only responds to burst requests for that channel.

8.2.5 Channel Configuration

The μ DMA controller uses an area of system memory to store a set of channel control structures in a table. The control table may have one or two entries for each μ DMA channel. Each entry in the table structure contains source and destination pointers, transfer size, and transfer mode. The control table can be located anywhere in system memory, but it must be contiguous and aligned on a 1024-byte boundary.

Table 8-3 on page 364 shows the layout in memory of the channel control table. Each channel may have one or two control structures in the control table: a primary control structure and an optional

alternate control structure. The table is organized so that all of the primary entries are in the first half of the table, and all the alternate structures are in the second half of the table. The primary entry is used for simple transfer modes where transfers can be reconfigured and restarted after each transfer is complete. In this case, the alternate control structures are not used and therefore only the first half of the table must be allocated in memory; the second half of the control table is not necessary, and that memory can be used for something else. If a more complex transfer mode is used such as ping-pong or scatter-gather, then the alternate control structure is also used and memory space should be allocated for the entire table.

Any unused memory in the control table may be used by the application. This includes the control structures for any channels that are unused by the application as well as the unused control word for each channel.

Table 8-3. Control Structure Memory Map

| Offset | Channel |
|--------|---------------|
| 0x0 | 0, Primary |
| 0x10 | 1, Primary |
| ... | ... |
| 0x1F0 | 31, Primary |
| 0x200 | 0, Alternate |
| 0x210 | 1, Alternate |
| ... | ... |
| 0x3F0 | 31, Alternate |

Table 8-4 shows an individual control structure entry in the control table. Each entry is aligned on a 16-byte boundary. The entry contains four long words: the source end pointer, the destination end pointer, the control word, and an unused entry. The end pointers point to the ending address of the transfer and are inclusive. If the source or destination is non-incrementing (as for a peripheral register), then the pointer should point to the transfer address.

Table 8-4. Channel Control Structure

| Offset | Description |
|--------|-------------------------|
| 0x000 | Source End Pointer |
| 0x004 | Destination End Pointer |
| 0x008 | Control Word |
| 0x00C | Unused |

The control word contains the following fields:

- Source and destination data sizes
- Source and destination address increment size
- Number of transfers before bus arbitration
- Total number of items to transfer
- Useburst flag
- Transfer mode

The control word and each field are described in detail in “ μ DMA Channel Control Structure” on page 382. The μ DMA controller updates the transfer size and transfer mode fields as the transfer is performed. At the end of a transfer, the transfer size indicates 0, and the transfer mode indicates "stopped." Because the control word is modified by the μ DMA controller, it must be reconfigured before each new transfer. The source and destination end pointers are not modified, so they can be left unchanged if the source or destination addresses remain the same.

Prior to starting a transfer, a μ DMA channel must be enabled by setting the appropriate bit in the **DMA Channel Enable Set (DMAENASET)** register. A channel can be disabled by setting the channel bit in the **DMA Channel Enable Clear (DMAENACLR)** register. At the end of a complete μ DMA transfer, the controller automatically disables the channel.

8.2.6 Transfer Modes

The μ DMA controller supports several transfer modes. Two of the modes support simple one-time transfers. Several complex modes support a continuous flow of data.

8.2.6.1 Stop Mode

While Stop is not actually a transfer mode, it is a valid value for the mode field of the control word. When the mode field has this value, the μ DMA controller does not perform any transfers and disables the channel if it is enabled. At the end of a transfer, the μ DMA controller updates the control word to set the mode to Stop.

8.2.6.2 Basic Mode

In Basic mode, the μ DMA controller performs transfers as long as there are more items to transfer, and a transfer request is present. This mode is used with peripherals that assert a μ DMA request signal whenever the peripheral is ready for a data transfer. Basic mode should not be used in any situation where the request is momentary even though the entire transfer should be completed. For example, a software-initiated transfer creates a momentary request, and in Basic mode, only the number of transfers specified by the `ARBSIZE` field in the **DMA Channel Control Word (DMACHCTL)** register is transferred on a software request, even if there is more data to transfer.

When all of the items have been transferred using Basic mode, the μ DMA controller sets the mode for that channel to Stop.

8.2.6.3 Auto Mode

Auto mode is similar to Basic mode, except that once a transfer request is received, the transfer runs to completion, even if the μ DMA request is removed. This mode is suitable for software-triggered transfers. Generally, Auto mode is not used with a peripheral.

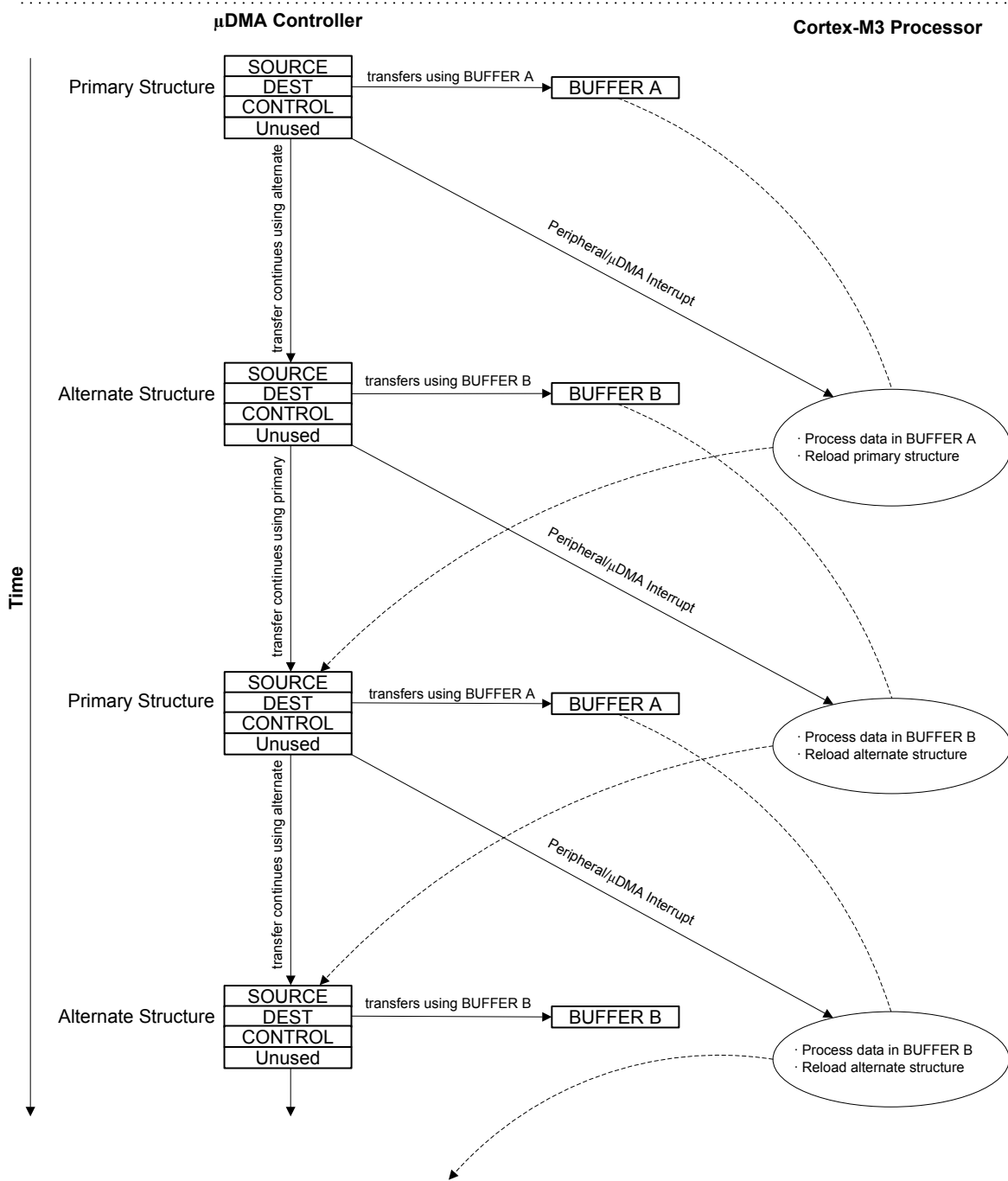
When all the items have been transferred using Auto mode, the μ DMA controller sets the mode for that channel to Stop.

8.2.6.4 Ping-Pong

Ping-Pong mode is used to support a continuous data flow to or from a peripheral. To use Ping-Pong mode, both the primary and alternate data structures must be implemented. Both structures are set up by the processor for data transfer between memory and a peripheral. The transfer is started using the primary control structure. When the transfer using the primary control structure is complete, the μ DMA controller reads the alternate control structure for that channel to continue the transfer. Each time this happens, an interrupt is generated, and the processor can reload the control structure for the just-completed transfer. Data flow can continue indefinitely this way, using the primary and alternate control structures to switch back and forth between buffers as the data flows to or from the peripheral.

Refer to Figure 8-2 on page 366 for an example showing operation in Ping-Pong mode.

Figure 8-2. Example of Ping-Pong μ DMA Transaction



8.2.6.5 Memory Scatter-Gather

Memory Scatter-Gather mode is a complex mode used when data must be transferred to or from varied locations in memory instead of a set of contiguous locations in a memory buffer. For example,

a gather μ DMA operation could be used to selectively read the payload of several stored packets of a communication protocol and store them together in sequence in a memory buffer.

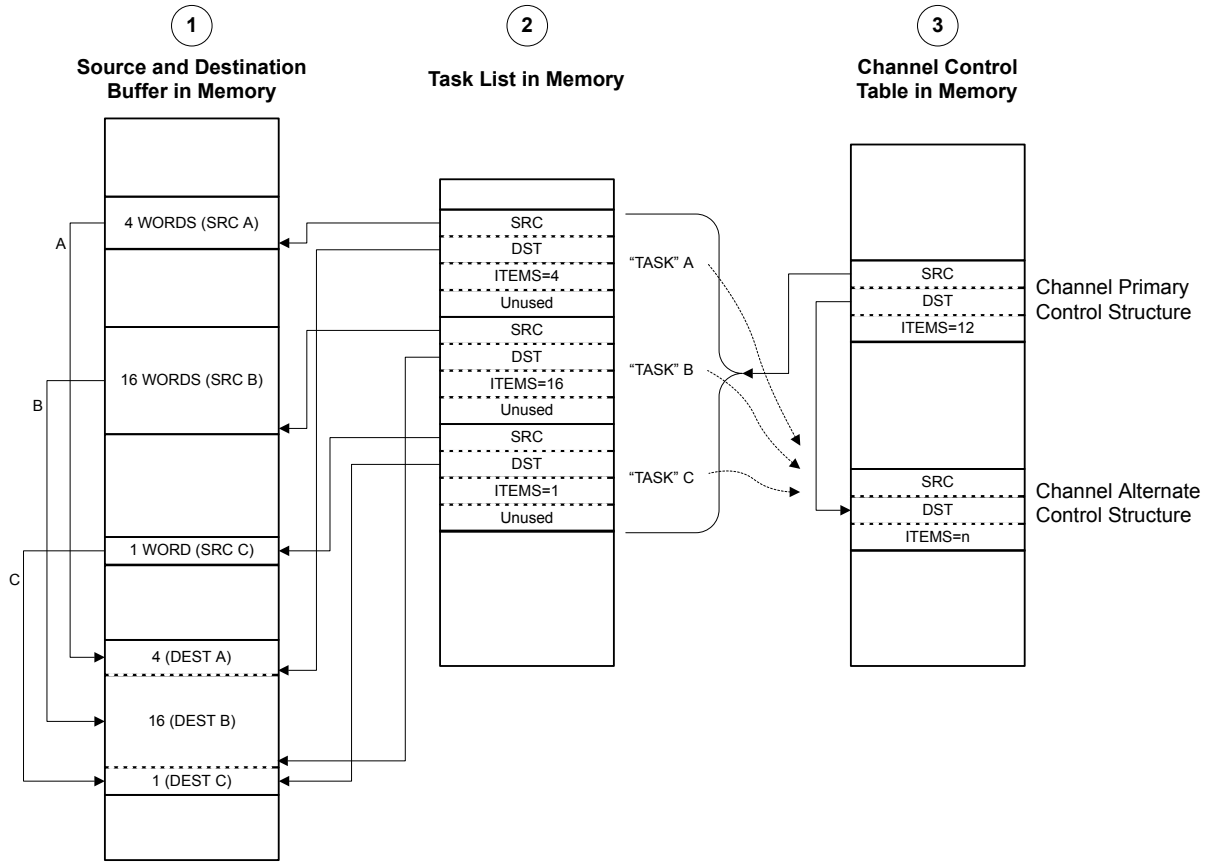
In Memory Scatter-Gather mode, the primary control structure is used to program the alternate control structure from a table in memory. The table is set up by the processor software and contains a list of control structures, each containing the source and destination end pointers, and the control word for a specific transfer. The mode of each control word must be set to Scatter-Gather mode. Each entry in the table is copied in turn to the alternate structure where it is then executed. The μ DMA controller alternates between using the primary control structure to copy the next transfer instruction from the list and then executing the new transfer instruction. The end of the list is marked by programming the control word for the last entry to use Auto transfer mode. Once the last transfer is performed using Auto mode, the μ DMA controller stops. A completion interrupt is generated only after the last transfer. It is possible to loop the list by having the last entry copy the primary control structure to point back to the beginning of the list (or to a new list). It is also possible to trigger a set of other channels to perform a transfer, either directly, by programming a write to the software trigger for another channel, or indirectly, by causing a peripheral action that results in a μ DMA request.

By programming the μ DMA controller using this method, a set of arbitrary transfers can be performed based on a single μ DMA request.

Refer to Figure 8-3 on page 368 and Figure 8-4 on page 369, which show an example of operation in Memory Scatter-Gather mode. This example shows a *gather* operation, where data in three separate buffers in memory is copied together into one buffer. Figure 8-3 on page 368 shows how the application sets up a μ DMA task list in memory that is used by the controller to perform three sets of copy operations from different locations in memory. The primary control structure for the channel that is used for the operation is configured to copy from the task list to the alternate control structure.

Figure 8-4 on page 369 shows the sequence as the μ DMA controller performs the three sets of copy operations. First, using the primary control structure, the μ DMA controller loads the alternate control structure with task A. It then performs the copy operation specified by task A, copying the data from the source buffer A to the destination buffer. Next, the μ DMA controller again uses the primary control structure to load task B into the alternate control structure, and then performs the B operation with the alternate control structure. The process is repeated for task C.

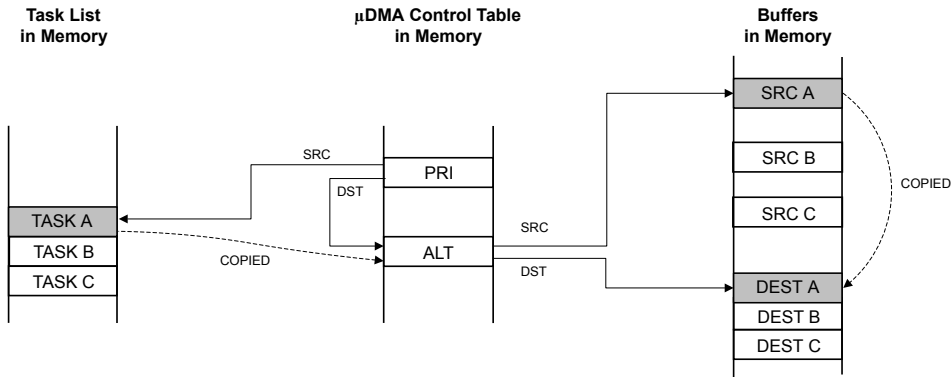
Figure 8-3. Memory Scatter-Gather, Setup and Configuration



NOTES:

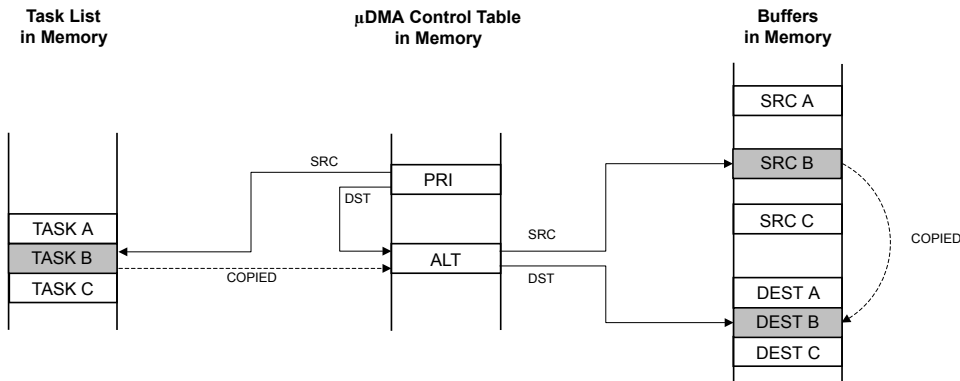
1. Application has a need to copy data items from three separate locations in memory into one combined buffer.
2. Application sets up μ DMA "task list" in memory, which contains the pointers and control configuration for three μ DMA copy "tasks."
3. Application sets up the channel primary control structure to copy each task configuration, one at a time, to the alternate control structure, where it is executed by the μ DMA controller.
4. The SRC and DST pointers in the task list must point to the last location in the corresponding buffer.

Figure 8-4. Memory Scatter-Gather, μ DMA Copy Sequence



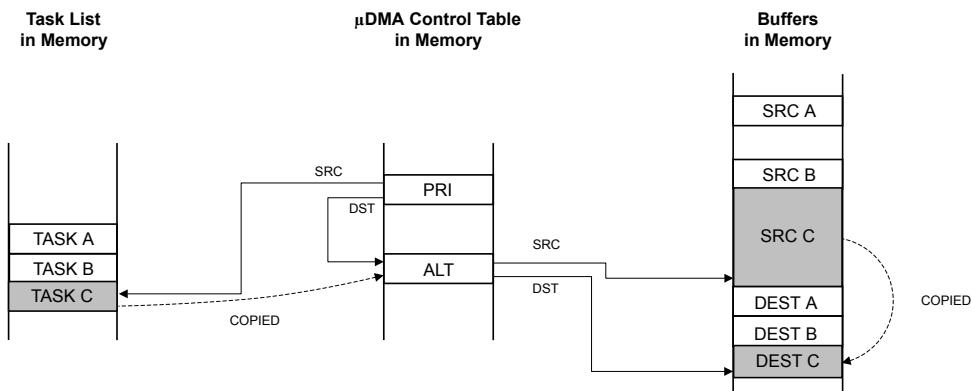
Using the channel's primary control structure, the μ DMA controller copies task A configuration to the channel's alternate control structure.

Then, using the channel's alternate control structure, the μ DMA controller copies data from the source buffer A to the destination buffer.



Using the channel's primary control structure, the μ DMA controller copies task B configuration to the channel's alternate control structure.

Then, using the channel's alternate control structure, the μ DMA controller copies data from the source buffer B to the destination buffer.



Using the channel's primary control structure, the μ DMA controller copies task C configuration to the channel's alternate control structure.

Then, using the channel's alternate control structure, the μ DMA controller copies data from the source buffer C to the destination buffer.

8.2.6.6 Peripheral Scatter-Gather

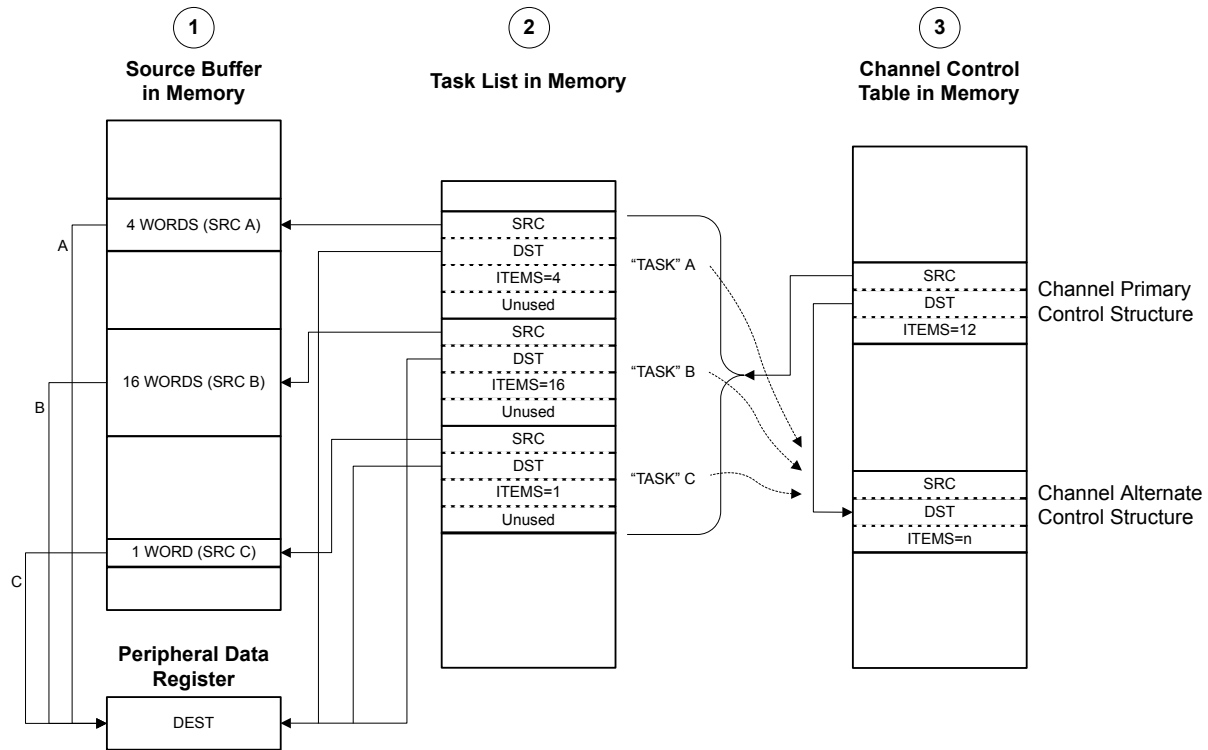
Peripheral Scatter-Gather mode is very similar to Memory Scatter-Gather, except that the transfers are controlled by a peripheral making a μ DMA request. Upon detecting a request from the peripheral, the μ DMA controller uses the primary control structure to copy one entry from the list to the alternate control structure and then performs the transfer. At the end of this transfer, the next transfer is started only if the peripheral again asserts a μ DMA request. The μ DMA controller continues to perform transfers from the list only when the peripheral is making a request, until the last transfer is complete. A completion interrupt is generated only after the last transfer.

By using this method, the μ DMA controller can transfer data to or from a peripheral from a set of arbitrary locations whenever the peripheral is ready to transfer data.

Refer to Figure 8-5 on page 371 and Figure 8-6 on page 372, which show an example of operation in Peripheral Scatter-Gather mode. This example shows a gather operation, where data from three separate buffers in memory is copied to a single peripheral data register. Figure 8-5 on page 371 shows how the application sets up a μ DMA task list in memory that is used by the controller to perform three sets of copy operations from different locations in memory. The primary control structure for the channel that is used for the operation is configured to copy from the task list to the alternate control structure.

Figure 8-6 on page 372 shows the sequence as the μ DMA controller performs the three sets of copy operations. First, using the primary control structure, the μ DMA controller loads the alternate control structure with task A. It then performs the copy operation specified by task A, copying the data from the source buffer A to the peripheral data register. Next, the μ DMA controller again uses the primary control structure to load task B into the alternate control structure, and then performs the B operation with the alternate control structure. The process is repeated for task C.

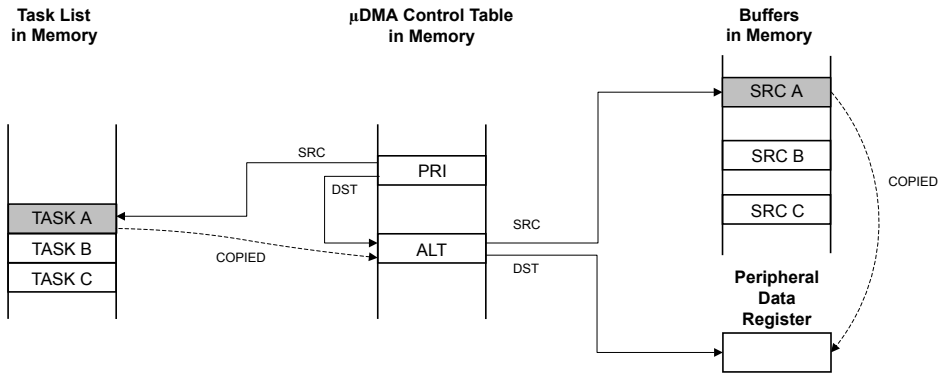
Figure 8-5. Peripheral Scatter-Gather, Setup and Configuration



NOTES:

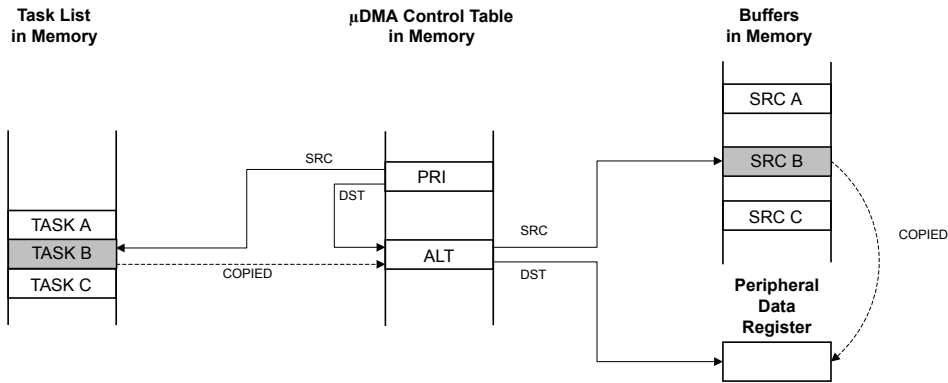
1. Application has a need to copy data items from three separate locations in memory into a peripheral data register.
2. Application sets up μ DMA "task list" in memory, which contains the pointers and control configuration for three μ DMA copy "tasks."
3. Application sets up the channel primary control structure to copy each task configuration, one at a time, to the alternate control structure, where it is executed by the μ DMA controller.

Figure 8-6. Peripheral Scatter-Gather, μ DMA Copy Sequence



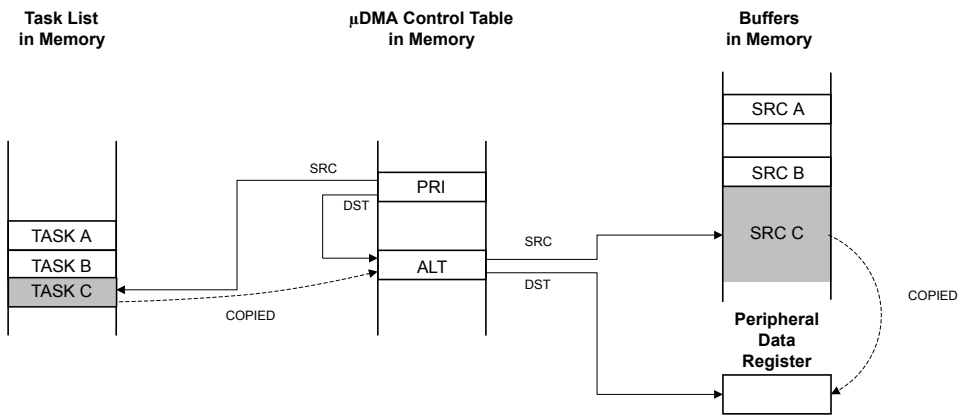
Using the channel's primary control structure, the μ DMA controller copies task A configuration to the channel's alternate control structure.

Then, using the channel's alternate control structure, the μ DMA controller copies data from the source buffer A to the peripheral data register.



Using the channel's primary control structure, the μ DMA controller copies task B configuration to the channel's alternate control structure.

Then, using the channel's alternate control structure, the μ DMA controller copies data from the source buffer B to the peripheral data register.



Using the channel's primary control structure, the μ DMA controller copies task C configuration to the channel's alternate control structure.

Then, using the channel's alternate control structure, the μ DMA controller copies data from the source buffer C to the peripheral data register.

8.2.7 Transfer Size and Increment

The μ DMA controller supports transfer data sizes of 8, 16, or 32 bits. The source and destination data size must be the same for any given transfer. The source and destination address can be auto-incremented by bytes, half-words, or words, or can be set to no increment. The source and destination address increment values can be set independently, and it is not necessary for the address increment to match the data size as long as the increment is the same or larger than the data size. For example, it is possible to perform a transfer using 8-bit data size, but using an address increment of full words (4 bytes). The data to be transferred must be aligned in memory according to the data size (8, 16, or 32 bits).

Table 8-5 shows the configuration to read from a peripheral that supplies 8-bit data.

Table 8-5. μ DMA Read Example: 8-Bit Peripheral

| Field | Configuration |
|-------------------------------|----------------------------------|
| Source data size | 8 bits |
| Destination data size | 8 bits |
| Source address increment | No increment |
| Destination address increment | Byte |
| Source end pointer | Peripheral read FIFO register |
| Destination end pointer | End of the data buffer in memory |

8.2.8 Peripheral Interface

Each peripheral that supports μ DMA has a single request and/or burst request signal that is asserted when the peripheral is ready to transfer data (see Table 8-2 on page 363). The request signal can be disabled or enabled using the **DMA Channel Request Mask Set (DMAREQMASET)** and **DMA Channel Request Mask Clear (DMAREQMASKCLR)** registers. The μ DMA request signal is disabled, or masked, when the channel request mask bit is set. When the request is not masked, the μ DMA channel is configured correctly and enabled, and the peripheral asserts the request signal, the μ DMA controller begins the transfer.

Note: When using μ DMA to transfer data to and from a peripheral, the peripheral must disable all interrupts to the NVIC.

When a μ DMA transfer is complete, the μ DMA controller generates an interrupt, see “Interrupts and Errors” on page 374 for more information.

For more information on how a specific peripheral interacts with the μ DMA controller, refer to the DMA Operation section in the chapter that discusses that peripheral.

8.2.9 Software Request

One μ DMA channel is dedicated to software-initiated transfers. This channel also has a dedicated interrupt to signal completion of a μ DMA transfer. A transfer is initiated by software by first configuring and enabling the transfer, and then issuing a software request using the **DMA Channel Software Request (DMASWREQ)** register. For software-based transfers, the Auto transfer mode should be used.

It is possible to initiate a transfer on any channel using the **DMASWREQ** register. If a request is initiated by software using a peripheral μ DMA channel, then the completion interrupt occurs on the interrupt vector for the peripheral instead of the software interrupt vector. Any channel may be used for software requests as long as the corresponding peripheral is not using μ DMA for data transfer.

8.2.10 Interrupts and Errors

When a μ DMA transfer is complete, the μ DMA controller generates a completion interrupt on the interrupt vector of the peripheral. Therefore, if μ DMA is used to transfer data for a peripheral and interrupts are used, then the interrupt handler for that peripheral must be designed to handle the μ DMA transfer completion interrupt. If the transfer uses the software μ DMA channel, then the completion interrupt occurs on the dedicated software μ DMA interrupt vector (see Table 8-6 on page 374).

When μ DMA is enabled for a peripheral, the μ DMA controller stops the normal transfer interrupts for a peripheral from reaching the interrupt controller (the interrupts are still reported in the peripheral's interrupt registers). Thus, when a large amount of data is transferred using μ DMA, instead of receiving multiple interrupts from the peripheral as data flows, the interrupt controller receives only one interrupt when the transfer is complete. Unmasked peripheral error interrupts continue to be sent to the interrupt controller.

When a μ DMA channel generates a completion interrupt, the `CHIS` bit corresponding to the peripheral channel is set in the **DMA Channel Interrupt Status (DMACHIS)** register (see page 409). This register can be used by the peripheral interrupt handler code to determine if the interrupt was caused by the μ DMA channel or an error event reported by the peripheral's interrupt registers. The completion interrupt request from the μ DMA controller is automatically cleared when the interrupt handler is activated.

If the μ DMA controller encounters a bus or memory protection error as it attempts to perform a data transfer, it disables the μ DMA channel that caused the error and generates an interrupt on the μ DMA error interrupt vector. The processor can read the **DMA Bus Error Clear (DMAERRCLR)** register to determine if an error is pending. The `ERRCLR` bit is set if an error occurred. The error can be cleared by writing a 1 to the `ERRCLR` bit.

Table 8-6 shows the dedicated interrupt assignments for the μ DMA controller.

Table 8-6. μ DMA Interrupt Assignments

| Interrupt | Assignment |
|-----------|-------------------------------------|
| 46 | μ DMA Software Channel Transfer |
| 47 | μ DMA Error |

8.3 Initialization and Configuration

8.3.1 Module Initialization

Before the μ DMA controller can be used, it must be enabled in the System Control block and in the peripheral. The location of the channel control structure must also be programmed.

The following steps should be performed one time during system initialization:

1. The μ DMA peripheral must be enabled in the System Control block. To do this, set the `UDMA` bit of the System Control **RCGC2** register (see page 274).
2. Enable the μ DMA controller by setting the `MASTEREN` bit of the **DMA Configuration (DMACFG)** register.
3. Program the location of the channel control table by writing the base address of the table to the **DMA Channel Control Base Pointer (DMACTLBASE)** register. The base address must be aligned on a 1024-byte boundary.

8.3.2 Configuring a Memory-to-Memory Transfer

μDMA channel 30 is dedicated for software-initiated transfers. However, any channel can be used for software-initiated, memory-to-memory transfer if the associated peripheral is not being used.

8.3.2.1 Configure the Channel Attributes

First, configure the channel attributes:

1. Program bit 30 of the **DMA Channel Priority Set (DMAPRIOSET)** or **DMA Channel Priority Clear (DMAPRIOCLR)** registers to set the channel to High priority or Default priority.
2. Set bit 30 of the **DMA Channel Primary Alternate Clear (DMAALTCLR)** register to select the primary channel control structure for this transfer.
3. Set bit 30 of the **DMA Channel Useburst Clear (DMAUSEBURSTCLR)** register to allow the μDMA controller to respond to single and burst requests.
4. Set bit 30 of the **DMA Channel Request Mask Clear (DMAREQMASKCLR)** register to allow the μDMA controller to recognize requests for this channel.

8.3.2.2 Configure the Channel Control Structure

Now the channel control structure must be configured.

This example transfers 256 words from one memory buffer to another. Channel 30 is used for a software transfer, and the control structure for channel 30 is at offset 0x1E0 of the channel control table. The channel control structure for channel 30 is located at the offsets shown in Table 8-7.

Table 8-7. Channel Control Structure Offsets for Channel 30

| Offset | Description |
|----------------------------|------------------------------------|
| Control Table Base + 0x1E0 | Channel 30 Source End Pointer |
| Control Table Base + 0x1E4 | Channel 30 Destination End Pointer |
| Control Table Base + 0x1E8 | Channel 30 Control Word |

Configure the Source and Destination

The source and destination end pointers must be set to the last address for the transfer (inclusive).

1. Program the source end pointer at offset 0x1E0 to the address of the source buffer + 0x3FC.
2. Program the destination end pointer at offset 0x1E4 to the address of the destination buffer + 0x3FC.

The control word at offset 0x1E8 must be programmed according to Table 8-8.

Table 8-8. Channel Control Word Configuration for Memory Transfer Example

| Field in DMACHCTL | Bits | Value | Description |
|-------------------|-------|-------|--------------------------------------|
| DSTINC | 31:30 | 2 | 32-bit destination address increment |
| DSTSIZE | 29:28 | 2 | 32-bit destination data size |
| SRCINC | 27:26 | 2 | 32-bit source address increment |
| SRCSIZE | 25:24 | 2 | 32-bit source data size |
| reserved | 23:18 | 0 | Reserved |

Table 8-8. Channel Control Word Configuration for Memory Transfer Example (continued)

| Field in DMACHCTL | Bits | Value | Description |
|-------------------|-------|-------|--------------------------------|
| ARBSIZE | 17:14 | 3 | Arbitrates after 8 transfers |
| XFERSIZE | 13:4 | 255 | Transfer 256 items |
| NXTUSEBURST | 3 | 0 | N/A for this transfer type |
| XFERMODE | 2:0 | 2 | Use Auto-request transfer mode |

8.3.2.3 Start the Transfer

Now the channel is configured and is ready to start.

1. Enable the channel by setting bit 30 of the **DMA Channel Enable Set (DMAENASET)** register.
2. Issue a transfer request by setting bit 30 of the **DMA Channel Software Request (DMASWREQ)** register.

The μ DMA transfer begins. If the interrupt is enabled, then the processor is notified by interrupt when the transfer is complete. If needed, the status can be checked by reading bit 30 of the **DMAENASET** register. This bit is automatically cleared when the transfer is complete. The status can also be checked by reading the **XFERMODE** field of the channel control word at offset 0x1E8. This field is automatically cleared at the end of the transfer.

8.3.3 Configuring a Peripheral for Simple Transmit

This example configures the μ DMA controller to transmit a buffer of data to a peripheral. The peripheral has a transmit FIFO with a trigger level of 4. The example peripheral uses μ DMA channel 7.

8.3.3.1 Configure the Channel Attributes

First, configure the channel attributes:

1. Configure bit 7 of the **DMA Channel Priority Set (DMAPRIOSET)** or **DMA Channel Priority Clear (DMAPRIOCLR)** registers to set the channel to High priority or Default priority.
2. Set bit 7 of the **DMA Channel Primary Alternate Clear (DMAALTCLR)** register to select the primary channel control structure for this transfer.
3. Set bit 7 of the **DMA Channel Useburst Clear (DMAUSEBURSTCLR)** register to allow the μ DMA controller to respond to single and burst requests.
4. Set bit 7 of the **DMA Channel Request Mask Clear (DMAREQMASKCLR)** register to allow the μ DMA controller to recognize requests for this channel.

8.3.3.2 Configure the Channel Control Structure

This example transfers 64 bytes from a memory buffer to the peripheral's transmit FIFO register using μ DMA channel 7. The control structure for channel 7 is at offset 0x070 of the channel control table. The channel control structure for channel 7 is located at the offsets shown in Table 8-9.

Table 8-9. Channel Control Structure Offsets for Channel 7

| Offset | Description |
|----------------------------|------------------------------|
| Control Table Base + 0x070 | Channel 7 Source End Pointer |

Table 8-9. Channel Control Structure Offsets for Channel 7 (continued)

| Offset | Description |
|----------------------------|-----------------------------------|
| Control Table Base + 0x074 | Channel 7 Destination End Pointer |
| Control Table Base + 0x078 | Channel 7 Control Word |

Configure the Source and Destination

The source and destination end pointers must be set to the last address for the transfer (inclusive). Because the peripheral pointer does not change, it simply points to the peripheral's data register.

1. Program the source end pointer at offset 0x070 to the address of the source buffer + 0x3F.
2. Program the destination end pointer at offset 0x074 to the address of the peripheral's transmit FIFO register.

The control word at offset 0x078 must be programmed according to Table 8-10.

Table 8-10. Channel Control Word Configuration for Peripheral Transmit Example

| Field in DMACHCTL | Bits | Value | Description |
|-------------------|-------|-------|--|
| DSTINC | 31:30 | 3 | Destination address does not increment |
| DSTSIZE | 29:28 | 0 | 8-bit destination data size |
| SRCINC | 27:26 | 0 | 8-bit source address increment |
| SRCSIZE | 25:24 | 0 | 8-bit source data size |
| reserved | 23:18 | 0 | Reserved |
| ARBSIZE | 17:14 | 2 | Arbitrates after 4 transfers |
| XFERSIZE | 13:4 | 63 | Transfer 64 items |
| NXTUSEBURST | 3 | 0 | N/A for this transfer type |
| XFERMODE | 2:0 | 1 | Use Basic transfer mode |

Note: In this example, it is not important if the peripheral makes a single request or a burst request. Because the peripheral has a FIFO that triggers at a level of 4, the arbitration size is set to 4. If the peripheral does make a burst request, then 4 bytes are transferred, which is what the FIFO can accommodate. If the peripheral makes a single request (if there is any space in the FIFO), then one byte is transferred at a time. If it is important to the application that transfers only be made in bursts, then the Channel Useburst `SET[7]` bit should be set in the **DMA Channel Useburst Set (DMAUSEBURSTSET)** register.

8.3.3.3 Start the Transfer

Now the channel is configured and is ready to start.

1. Enable the channel by setting bit 7 of the **DMA Channel Enable Set (DMAENASET)** register.

The μ DMA controller is now configured for transfer on channel 7. The controller makes transfers to the peripheral whenever the peripheral asserts a μ DMA request. The transfers continue until the entire buffer of 64 bytes has been transferred. When that happens, the μ DMA controller disables the channel and sets the `XFERMODE` field of the channel control word to 0 (Stopped). The status of the transfer can be checked by reading bit 7 of the **DMA Channel Enable Set (DMAENASET)** register. This bit is automatically cleared when the transfer is complete. The status can also be checked by reading the `XFERMODE` field of the channel control word at offset 0x078. This field is automatically cleared at the end of the transfer.

If peripheral interrupts are enabled, then the peripheral interrupt handler receives an interrupt when the entire transfer is complete.

8.3.4 Configuring a Peripheral for Ping-Pong Receive

This example configures the μ DMA controller to continuously receive 8-bit data from a peripheral into a pair of 64-byte buffers. The peripheral has a receive FIFO with a trigger level of 8. The example peripheral uses μ DMA channel 8.

8.3.4.1 Configure the Channel Attributes

First, configure the channel attributes:

1. Configure bit 8 of the **DMA Channel Priority Set (DMAPRIOSET)** or **DMA Channel Priority Clear (DMAPRIOCLR)** registers to set the channel to High priority or Default priority.
2. Set bit 8 of the **DMA Channel Primary Alternate Clear (DMAALTCLR)** register to select the primary channel control structure for this transfer.
3. Set bit 8 of the **DMA Channel Useburst Clear (DMAUSEBURSTCLR)** register to allow the μ DMA controller to respond to single and burst requests.
4. Set bit 8 of the **DMA Channel Request Mask Clear (DMAREQMASKCLR)** register to allow the μ DMA controller to recognize requests for this channel.

8.3.4.2 Configure the Channel Control Structure

This example transfers bytes from the peripheral's receive FIFO register into two memory buffers of 64 bytes each. As data is received, when one buffer is full, the μ DMA controller switches to use the other.

To use Ping-Pong buffering, both primary and alternate channel control structures must be used. The primary control structure for channel 8 is at offset 0x080 of the channel control table, and the alternate channel control structure is at offset 0x280. The channel control structures for channel 8 are located at the offsets shown in Table 8-11.

Table 8-11. Primary and Alternate Channel Control Structure Offsets for Channel 8

| Offset | Description |
|----------------------------|---|
| Control Table Base + 0x080 | Channel 8 Primary Source End Pointer |
| Control Table Base + 0x084 | Channel 8 Primary Destination End Pointer |
| Control Table Base + 0x088 | Channel 8 Primary Control Word |
| Control Table Base + 0x280 | Channel 8 Alternate Source End Pointer |
| Control Table Base + 0x284 | Channel 8 Alternate Destination End Pointer |
| Control Table Base + 0x288 | Channel 8 Alternate Control Word |

Configure the Source and Destination

The source and destination end pointers must be set to the last address for the transfer (inclusive). Because the peripheral pointer does not change, it simply points to the peripheral's data register. Both the primary and alternate sets of pointers must be configured.

1. Program the primary source end pointer at offset 0x080 to the address of the peripheral's receive buffer.

2. Program the primary destination end pointer at offset 0x084 to the address of ping-pong buffer A + 0x3F.
3. Program the alternate source end pointer at offset 0x280 to the address of the peripheral's receive buffer.
4. Program the alternate destination end pointer at offset 0x284 to the address of ping-pong buffer B + 0x3F.

The primary control word at offset 0x088 and the alternate control word at offset 0x288 are initially programmed the same way.

1. Program the primary channel control word at offset 0x088 according to Table 8-12.
2. Program the alternate channel control word at offset 0x288 according to Table 8-12.

Table 8-12. Channel Control Word Configuration for Peripheral Ping-Pong Receive Example

| Field in DMACHCTL | Bits | Value | Description |
|-------------------|-------|-------|-------------------------------------|
| DSTINC | 31:30 | 0 | 8-bit destination address increment |
| DSTSIZE | 29:28 | 0 | 8-bit destination data size |
| SRCINC | 27:26 | 3 | Source address does not increment |
| SRCSIZE | 25:24 | 0 | 8-bit source data size |
| reserved | 23:18 | 0 | Reserved |
| ARBSIZE | 17:14 | 3 | Arbitrates after 8 transfers |
| XFERSIZE | 13:4 | 63 | Transfer 64 items |
| NXTUSEBURST | 3 | 0 | N/A for this transfer type |
| XFERMODE | 2:0 | 3 | Use Ping-Pong transfer mode |

Note: In this example, it is not important if the peripheral makes a single request or a burst request. Because the peripheral has a FIFO that triggers at a level of 8, the arbitration size is set to 8. If the peripheral does make a burst request, then 8 bytes are transferred, which is what the FIFO can accommodate. If the peripheral makes a single request (if there is any data in the FIFO), then one byte is transferred at a time. If it is important to the application that transfers only be made in bursts, then the Channel Useburst `SET[8]` bit should be set in the **DMA Channel Useburst Set (DMAUSEBURSTSET)** register.

8.3.4.3 Configure the Peripheral Interrupt

An interrupt handler should be configured when using μ DMA Ping-Pong mode, it is best to use an interrupt handler. However, the Ping-Pong mode can be configured without interrupts by polling. The interrupt handler is triggered after each buffer is complete.

1. Configure and enable an interrupt handler for the peripheral.

8.3.4.4 Enable the μ DMA Channel

Now the channel is configured and is ready to start.

1. Enable the channel by setting bit 8 of the **DMA Channel Enable Set (DMAENASET)** register.

8.3.4.5 Process Interrupts

The μ DMA controller is now configured and enabled for transfer on channel 8. When the peripheral asserts the μ DMA request signal, the μ DMA controller makes transfers into buffer A using the primary channel control structure. When the primary transfer to buffer A is complete, it switches to the alternate channel control structure and makes transfers into buffer B. At the same time, the primary channel control word mode field is configured to indicate Stopped, and an interrupt is

When an interrupt is triggered, the interrupt handler must determine which buffer is complete and process the data or set a flag that the data must be processed by non-interrupt buffer processing code. Then the next buffer transfer must be set up.

In the interrupt handler:

1. Read the primary channel control word at offset 0x088 and check the `XFERMODE` field. If the field is 0, this means buffer A is complete. If buffer A is complete, then:
 - a. Process the newly received data in buffer A or signal the buffer processing code that buffer A has data available.
 - b. Reprogram the primary channel control word at offset 0x88 according to Table 8-12 on page 379.
2. Read the alternate channel control word at offset 0x288 and check the `XFERMODE` field. If the field is 0, this means buffer B is complete. If buffer B is complete, then:
 - a. Process the newly received data in buffer B or signal the buffer processing code that buffer B has data available.
 - b. Reprogram the alternate channel control word at offset 0x288 according to Table 8-12 on page 379.

8.3.5 Configuring Channel Assignments

Channel assignments for each μ DMA channel can be changed using the `DMACHASGN` register. Each bit represents a μ DMA channel. If the bit is set, then the secondary function is used for the channel.

Refer to Table 8-1 on page 361 for channel assignments.

For example, to use SS11 Receive on channel 8 instead of UART0, set bit 8 of the `DMACHASGN` register.

8.4 Register Map

Table 8-13 on page 381 lists the μ DMA channel control structures and registers. The channel control structure shows the layout of one entry in the channel control table. The channel control table is located in system memory, and the location is determined by the application, that is, the base address is n/a (not applicable). In the table below, the offset for the channel control structures is the offset from the entry in the channel control table. See “Channel Configuration” on page 363 and Table 8-3 on page 364 for a description of how the entries in the channel control table are located in memory. The μ DMA register addresses are given as a hexadecimal increment, relative to the μ DMA base address of 0x400F.F000. Note that the μ DMA module clock must be enabled before the registers can be programmed (see page 274). There must be a delay of 3 system clocks after the μ DMA module clock is enabled before any μ DMA module registers are accessed.

Table 8-13. μ DMA Register Map

| Offset | Name | Type | Reset | Description | See page |
|---|-----------------|-------|-------------|---|----------|
| μDMA Channel Control Structure (Offset from Channel Control Table Base) | | | | | |
| 0x000 | DMASRCENDP | R/W | - | DMA Channel Source Address End Pointer | 383 |
| 0x004 | DMADSTENDP | R/W | - | DMA Channel Destination Address End Pointer | 384 |
| 0x008 | DMACHCTL | R/W | - | DMA Channel Control Word | 385 |
| μDMA Registers (Offset from μDMA Base Address) | | | | | |
| 0x000 | DMASTAT | RO | 0x001F.0000 | DMA Status | 390 |
| 0x004 | DMACFG | WO | - | DMA Configuration | 392 |
| 0x008 | DMACTLBASE | R/W | 0x0000.0000 | DMA Channel Control Base Pointer | 393 |
| 0x00C | DMAALTBASE | RO | 0x0000.0200 | DMA Alternate Channel Control Base Pointer | 394 |
| 0x010 | DMAWAITSTAT | RO | 0xFFFF.FFC0 | DMA Channel Wait-on-Request Status | 395 |
| 0x014 | DMASWREQ | WO | - | DMA Channel Software Request | 396 |
| 0x018 | DMAUSEBURSTSET | R/W | 0x0000.0000 | DMA Channel Useburst Set | 397 |
| 0x01C | DMAUSEBURSTCLR | WO | - | DMA Channel Useburst Clear | 398 |
| 0x020 | DMAREQMASKSET | R/W | 0x0000.0000 | DMA Channel Request Mask Set | 399 |
| 0x024 | DMAREQMASKCLR | WO | - | DMA Channel Request Mask Clear | 400 |
| 0x028 | DMAENASET | R/W | 0x0000.0000 | DMA Channel Enable Set | 401 |
| 0x02C | DMAENACLAR | WO | - | DMA Channel Enable Clear | 402 |
| 0x030 | DMAALTSET | R/W | 0x0000.0000 | DMA Channel Primary Alternate Set | 403 |
| 0x034 | DMAALTCLR | WO | - | DMA Channel Primary Alternate Clear | 404 |
| 0x038 | DMAPRIOSET | R/W | 0x0000.0000 | DMA Channel Priority Set | 405 |
| 0x03C | DMAPRIOCLR | WO | - | DMA Channel Priority Clear | 406 |
| 0x04C | DMAERRCLR | R/W | 0x0000.0000 | DMA Bus Error Clear | 407 |
| 0x500 | DMACHASGN | R/W | 0x0000.0000 | DMA Channel Assignment | 408 |
| 0x504 | DMACHIS | R/W1C | 0x0000.0000 | DMA Channel Interrupt Status | 409 |
| 0xFD0 | DMAPeriphID4 | RO | 0x0000.0004 | DMA Peripheral Identification 4 | 414 |
| 0xFE0 | DMAPeriphID0 | RO | 0x0000.0030 | DMA Peripheral Identification 0 | 410 |
| 0xFE4 | DMAPeriphID1 | RO | 0x0000.00B2 | DMA Peripheral Identification 1 | 411 |
| 0xFE8 | DMAPeriphID2 | RO | 0x0000.000B | DMA Peripheral Identification 2 | 412 |
| 0xFEC | DMAPeriphID3 | RO | 0x0000.0000 | DMA Peripheral Identification 3 | 413 |
| 0xFF0 | DMAPrimeCellID0 | RO | 0x0000.000D | DMA PrimeCell Identification 0 | 415 |
| 0xFF4 | DMAPrimeCellID1 | RO | 0x0000.00F0 | DMA PrimeCell Identification 1 | 416 |
| 0xFF8 | DMAPrimeCellID2 | RO | 0x0000.0005 | DMA PrimeCell Identification 2 | 417 |

Table 8-13. μ DMA Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|-----------------|------|-------------|--------------------------------|----------|
| 0xFFC | DMAPrimeCellID3 | RO | 0x0000.00B1 | DMA PrimeCell Identification 3 | 418 |

8.5 μ DMA Channel Control Structure

The μ DMA Channel Control Structure holds the transfer settings for a μ DMA channel. Each channel has two control structures, which are located in a table in system memory. Refer to “Channel Configuration” on page 363 for an explanation of the Channel Control Table and the Channel Control Structure.

The channel control structure is one entry in the channel control table. Each channel has a primary and alternate structure. The primary control structures are located at offsets 0x0, 0x10, 0x20 and so on. The alternate control structures are located at offsets 0x200, 0x210, 0x220, and so on.

Register 1: DMA Channel Source Address End Pointer (DMASRCENDP), offset 0x000

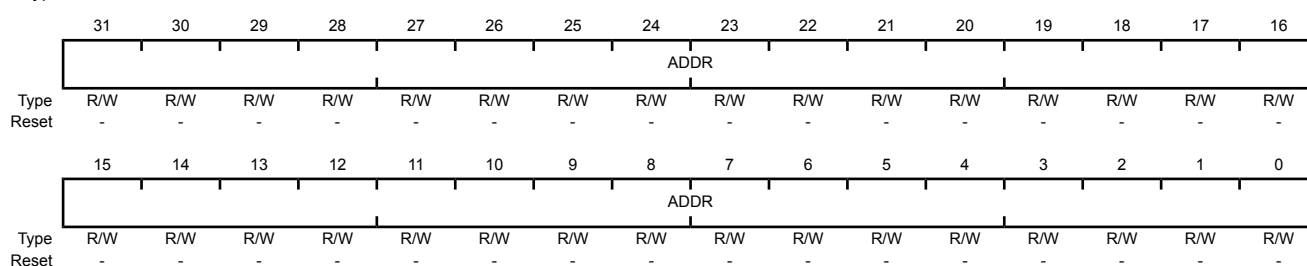
DMA Channel Source Address End Pointer (DMASRCENDP) is part of the Channel Control Structure and is used to specify the source address for a μ DMA transfer.

The μ DMA controller can transfer data to and from the on-chip SRAM. However, because the Flash memory and ROM are located on a separate internal bus, it is not possible to transfer data from the Flash memory or ROM with the μ DMA controller.

Note: The offset specified is from the base address of the control structure in system memory, not the μ DMA module base address.

DMA Channel Source Address End Pointer (DMASRCENDP)

Base n/a
Offset 0x000
Type R/W, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 31:0 | ADDR | R/W | - | Source Address End Pointer This field points to the last address of the μ DMA transfer source (inclusive). If the source address is not incrementing (the SRCINC field in the DMACHCTL register is 0x3), then this field points at the source location itself (such as a peripheral data register). |

Register 2: DMA Channel Destination Address End Pointer (DMADSTENDP), offset 0x004

DMA Channel Destination Address End Pointer (DMADSTENDP) is part of the Channel Control Structure and is used to specify the destination address for a μ DMA transfer.

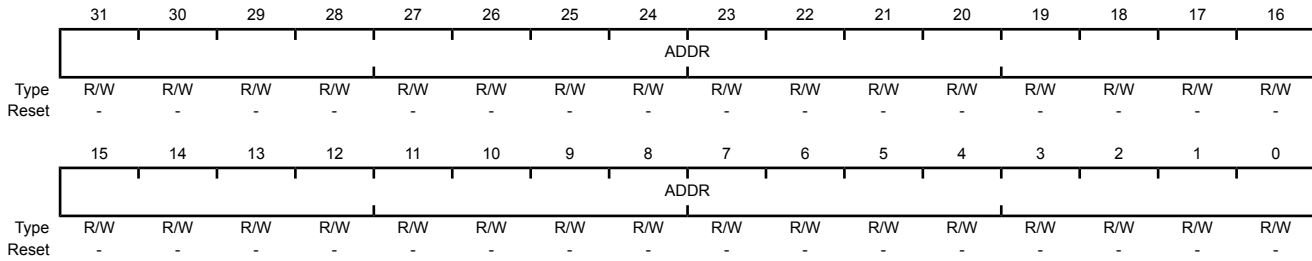
Note: The offset specified is from the base address of the control structure in system memory, not the μ DMA module base address.

DMA Channel Destination Address End Pointer (DMADSTENDP)

Base n/a

Offset 0x004

Type R/W, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 31:0 | ADDR | R/W | - | Destination Address End Pointer This field points to the last address of the μ DMA transfer destination (inclusive). If the destination address is not incrementing (the <i>DSTINC</i> field in the DMACHCTL register is 0x3), then this field points at the destination location itself (such as a peripheral data register). |

Register 3: DMA Channel Control Word (DMACHCTL), offset 0x008

DMA Channel Control Word (DMACHCTL) is part of the Channel Control Structure and is used to specify parameters of a μ DMA transfer.

Note: The offset specified is from the base address of the control structure in system memory, not the μ DMA module base address.

DMA Channel Control Word (DMACHCTL)

Base n/a
Offset 0x008
Type R/W, reset -

| | | | | | | | | | | | | | | | | |
|-------|---------|-----|----------|-----|--------|-----|---------|-----|----------|-----|-----|-----|-------------|----------|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | DSTINC | | DSTSIZE | | SRCINC | | SRCSIZE | | reserved | | | | ARBSIZE | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | ARBSIZE | | XFERSIZE | | | | | | | | | | NXTUSEBURST | XFERMODE | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|--|
| 31:30 | DSTINC | R/W | - | <p>Destination Address Increment</p> <p>This field configures the destination address increment.</p> <p>The address increment value must be equal or greater than the value of the destination size (DSTSIZE).</p> <p>Value Description</p> <p>0x0 Byte Increment by 8-bit locations</p> <p>0x1 Half-word Increment by 16-bit locations</p> <p>0x2 Word Increment by 32-bit locations</p> <p>0x3 No increment Address remains set to the value of the Destination Address End Pointer (DMADSTENDP) for the channel</p> |
| 29:28 | DSTSIZE | R/W | - | <p>Destination Data Size</p> <p>This field configures the destination item data size.</p> <p>Note: DSTSIZE must be the same as SRCSIZE.</p> <p>Value Description</p> <p>0x0 Byte 8-bit data size</p> <p>0x1 Half-word 16-bit data size</p> <p>0x2 Word 32-bit data size</p> <p>0x3 Reserved</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 27:26 | SRCINC | R/W | - | <p>Source Address Increment</p> <p>This field configures the source address increment. The address increment value must be equal or greater than the value of the source size (SRCSIZE).</p> <p>Value Description</p> <p>0x0 Byte Increment by 8-bit locations</p> <p>0x1 Half-word Increment by 16-bit locations</p> <p>0x2 Word Increment by 32-bit locations</p> <p>0x3 No increment Address remains set to the value of the Source Address End Pointer (DMASRCENDE) for the channel</p> |
| 25:24 | SRCSIZE | R/W | - | <p>Source Data Size</p> <p>This field configures the source item data size.</p> <p>Note: DSTSIZE must be the same as SRCSIZE.</p> <p>Value Description</p> <p>0x0 Byte 8-bit data size.</p> <p>0x1 Half-word 16-bit data size.</p> <p>0x2 Word 32-bit data size.</p> <p>0x3 Reserved</p> |
| 23:18 | reserved | R/W | - | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|--|------|-------|---|-------|-------------|-----|--|-----|-------------|-----|-------------|-----|-------------|-----|--------------|-----|--------------|-----|--------------|-----|---------------|-----|---------------|-----|---------------|---------|----------------|
| 17:14 | ARBSIZE | R/W | - | <p>Arbitration Size</p> <p>This field configures the number of transfers that can occur before the μDMA controller re-arbitrates. The possible arbitration rate configurations represent powers of 2 and are shown below.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>1 Transfer Arbitrates after each μDMA transfer</td> </tr> <tr> <td>0x1</td> <td>2 Transfers</td> </tr> <tr> <td>0x2</td> <td>4 Transfers</td> </tr> <tr> <td>0x3</td> <td>8 Transfers</td> </tr> <tr> <td>0x4</td> <td>16 Transfers</td> </tr> <tr> <td>0x5</td> <td>32 Transfers</td> </tr> <tr> <td>0x6</td> <td>64 Transfers</td> </tr> <tr> <td>0x7</td> <td>128 Transfers</td> </tr> <tr> <td>0x8</td> <td>256 Transfers</td> </tr> <tr> <td>0x9</td> <td>512 Transfers</td> </tr> <tr> <td>0xA-0xF</td> <td>1024 Transfers</td> </tr> </tbody> </table> <p>In this configuration, no arbitration occurs during the μDMA transfer because the maximum transfer size is 1024.</p> | Value | Description | 0x0 | 1 Transfer Arbitrates after each μ DMA transfer | 0x1 | 2 Transfers | 0x2 | 4 Transfers | 0x3 | 8 Transfers | 0x4 | 16 Transfers | 0x5 | 32 Transfers | 0x6 | 64 Transfers | 0x7 | 128 Transfers | 0x8 | 256 Transfers | 0x9 | 512 Transfers | 0xA-0xF | 1024 Transfers |
| Value | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | 1 Transfer Arbitrates after each μ DMA transfer | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | 2 Transfers | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | 4 Transfers | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | 8 Transfers | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | 16 Transfers | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | 32 Transfers | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | 64 Transfers | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | 128 Transfers | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x8 | 256 Transfers | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x9 | 512 Transfers | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0xA-0xF | 1024 Transfers | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 13:4 | XFERSIZE | R/W | - | <p>Transfer Size (minus 1)</p> <p>This field configures the total number of items to transfer. The value of this field is 1 less than the number to transfer (value 0 means transfer 1 item). The maximum value for this 10-bit field is 1023 which represents a transfer size of 1024 items.</p> <p>The transfer size is the number of items, not the number of bytes. If the data size is 32 bits, then this value is the number of 32-bit words to transfer.</p> <p>The μDMA controller updates this field immediately prior to entering the arbitration process, so it contains the number of outstanding items that is necessary to complete the μDMA cycle.</p> | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | NXTUSEBURST | R/W | - | <p>Next Useburst</p> <p>This field controls whether the Useburst $SET[n]$ bit is automatically set for the last transfer of a peripheral scatter-gather operation. Normally, for the last transfer, if the number of remaining items to transfer is less than the arbitration size, the μDMA controller uses single transfers to complete the transaction. If this bit is set, then the controller uses a burst transfer to complete the last transfer.</p> | | | | | | | | | | | | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | |
|-----------|-------------------------------------|------|-------|---|-------|-------------|-----|------|-----|-------|-----|--------------|-----|-----------|-----|-----------------------|-----|---------------------------------|-----|---------------------------|-----|-------------------------------------|
| 2:0 | XFERMODE | R/W | - | <p>μDMA Transfer Mode</p> <p>This field configures the operating mode of the μDMA cycle. Refer to “Transfer Modes” on page 365 for a detailed explanation of transfer modes.</p> <p>Because this register is in system RAM, it has no reset value. Therefore, this field should be initialized to 0 before the channel is enabled.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Stop</td> </tr> <tr> <td>0x1</td> <td>Basic</td> </tr> <tr> <td>0x2</td> <td>Auto-Request</td> </tr> <tr> <td>0x3</td> <td>Ping-Pong</td> </tr> <tr> <td>0x4</td> <td>Memory Scatter-Gather</td> </tr> <tr> <td>0x5</td> <td>Alternate Memory Scatter-Gather</td> </tr> <tr> <td>0x6</td> <td>Peripheral Scatter-Gather</td> </tr> <tr> <td>0x7</td> <td>Alternate Peripheral Scatter-Gather</td> </tr> </tbody> </table> | Value | Description | 0x0 | Stop | 0x1 | Basic | 0x2 | Auto-Request | 0x3 | Ping-Pong | 0x4 | Memory Scatter-Gather | 0x5 | Alternate Memory Scatter-Gather | 0x6 | Peripheral Scatter-Gather | 0x7 | Alternate Peripheral Scatter-Gather |
| Value | Description | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | Stop | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | Basic | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | Auto-Request | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | Ping-Pong | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | Memory Scatter-Gather | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | Alternate Memory Scatter-Gather | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | Peripheral Scatter-Gather | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | Alternate Peripheral Scatter-Gather | | | | | | | | | | | | | | | | | | | | | |

XFERMODE Bit Field Values.

Stop

Channel is stopped or configuration data is invalid. No more transfers can occur.

Basic

For each trigger (whether from a peripheral or a software request), the μ DMA controller performs the number of transfers specified by the `ARBSIZE` field.

Auto-Request

The initial request (software- or peripheral-initiated) is sufficient to complete the entire transfer of `XFERSIZE` items without any further requests.

Ping-Pong

This mode uses both the primary and alternate control structures for this channel. When the number of transfers specified by the `XFERMODE` field have completed for the current control structure (primary or alternate), the μ DMA controller switches to the other one. These switches continue until one of the control structures is not set to ping-pong mode. At that point, the μ DMA controller stops. An interrupt is generated on completion of the transfers configured by each control structure. See “Ping-Pong” on page 365.

Memory Scatter-Gather

When using this mode, the primary control structure for the channel is configured to allow a list of operations (tasks) to be performed. The source address pointer specifies the start of a table of tasks to be copied to the alternate control structure for this channel. The `XFERMODE` field for the alternate control structure should be configured to 0x5 (Alternate memory scatter-gather) to perform the task. When the task completes, the μ DMA switches back to the primary channel control structure, which then copies the next task to the alternate control structure. This process continues until the table of tasks is empty. The last task must have an `XFERMODE` value other than 0x5. Note that for continuous operation, the last task can update the primary channel control structure back to the start of the list or to another list. See “Memory Scatter-Gather” on page 366.

Alternate Memory Scatter-Gather

This value must be used in the alternate channel control data structure when the μ DMA controller operates in Memory Scatter-Gather mode.

Peripheral Scatter-Gather

This value must be used in the primary channel control data structure when the μ DMA controller operates in Peripheral Scatter-Gather mode. In this mode, the μ DMA controller operates exactly the same as in Memory Scatter-Gather mode, except that instead of performing the number of transfers specified by the `XFERSIZE` field in the alternate control structure at one time, the μ DMA controller only performs the number of transfers specified by the `ARBSIZE` field per trigger; see Basic mode for details. See "Peripheral Scatter-Gather" on page 370.

Alternate Peripheral Scatter-Gather

This value must be used in the alternate channel control data structure when the μ DMA controller operates in Peripheral Scatter-Gather mode.

8.6 μ DMA Register Descriptions

The register addresses given are relative to the μ DMA base address of 0x400F.F000.

Register 4: DMA Status (DMASTAT), offset 0x000

The **DMA Status (DMASTAT)** register returns the status of the μ DMA controller. You cannot read this register when the μ DMA controller is in the reset state.

DMA Status (DMASTAT)

Base 0x400F.F000

Offset 0x000

Type RO, reset 0x001F.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-------|----|----|----------|----------|----|----|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | DMACHANS | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | STATE | | | | reserved | | | MASTEN |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|---|------|-------|--|-------|-------------|-----|------|-----|----------------------------------|-----|-----------------------------|-----|----------------------------------|-----|----------------------|-----|---------------------------|-----|---|-----|----------------------------------|-----|---------|-----|------|---------|-----------|
| 31:21 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | | | | | | | | | | | |
| 20:16 | DMACHANS | RO | 0x1F | Available μ DMA Channels Minus 1 This field contains a value equal to the number of μ DMA channels the μ DMA controller is configured to use, minus one. The value of 0x1F corresponds to 32 μ DMA channels. | | | | | | | | | | | | | | | | | | | | | | | | |
| 15:8 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | | | | | | | | | | | |
| 7:4 | STATE | RO | 0x0 | Control State Machine Status This field shows the current status of the control state machine. Status can be one of the following. <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Idle</td> </tr> <tr> <td>0x1</td> <td>Reading channel controller data.</td> </tr> <tr> <td>0x2</td> <td>Reading source end pointer.</td> </tr> <tr> <td>0x3</td> <td>Reading destination end pointer.</td> </tr> <tr> <td>0x4</td> <td>Reading source data.</td> </tr> <tr> <td>0x5</td> <td>Writing destination data.</td> </tr> <tr> <td>0x6</td> <td>Waiting for μDMA request to clear.</td> </tr> <tr> <td>0x7</td> <td>Writing channel controller data.</td> </tr> <tr> <td>0x8</td> <td>Stalled</td> </tr> <tr> <td>0x9</td> <td>Done</td> </tr> <tr> <td>0xA-0xF</td> <td>Undefined</td> </tr> </tbody> </table> | Value | Description | 0x0 | Idle | 0x1 | Reading channel controller data. | 0x2 | Reading source end pointer. | 0x3 | Reading destination end pointer. | 0x4 | Reading source data. | 0x5 | Writing destination data. | 0x6 | Waiting for μ DMA request to clear. | 0x7 | Writing channel controller data. | 0x8 | Stalled | 0x9 | Done | 0xA-0xF | Undefined |
| Value | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | Idle | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | Reading channel controller data. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | Reading source end pointer. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | Reading destination end pointer. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | Reading source data. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | Writing destination data. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | Waiting for μ DMA request to clear. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | Writing channel controller data. | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x8 | Stalled | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x9 | Done | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0xA-0xF | Undefined | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3:1 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 0 | MASTEN | RO | 0 | Master Enable Status |
| | | | | Value Description |
| | | | | 0 The μ DMA controller is disabled. |
| | | | | 1 The μ DMA controller is enabled. |

Register 5: DMA Configuration (DMACFG), offset 0x004

The **DMACFG** register controls the configuration of the μ DMA controller.

DMA Configuration (DMACFG)

Base 0x400F.F000

Offset 0x004

Type WO, reset -

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | MASTEN |
| Type | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:1 | reserved | WO | - | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | MASTEN | WO | - | Controller Master Enable |
| | | | | Value Description |
| | | | | 0 Disables the μ DMA controller. |
| | | | | 1 Enables μ DMA controller. |

Register 6: DMA Channel Control Base Pointer (DMACTLBASE), offset 0x008

The **DMACTLBASE** register must be configured so that the base pointer points to a location in system memory.

The amount of system memory that must be assigned to the μ DMA controller depends on the number of μ DMA channels used and whether the alternate channel control data structure is used. See “Channel Configuration” on page 363 for details about the Channel Control Table. The base address must be aligned on a 1024-byte boundary. This register cannot be read when the μ DMA controller is in the reset state.

DMA Channel Control Base Pointer (DMACTLBASE)

Base 0x400F.F000

Offset 0x008

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|------|-----|-----|-----|-----|-----|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | ADDR | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | ADDR | | | | | | reserved | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

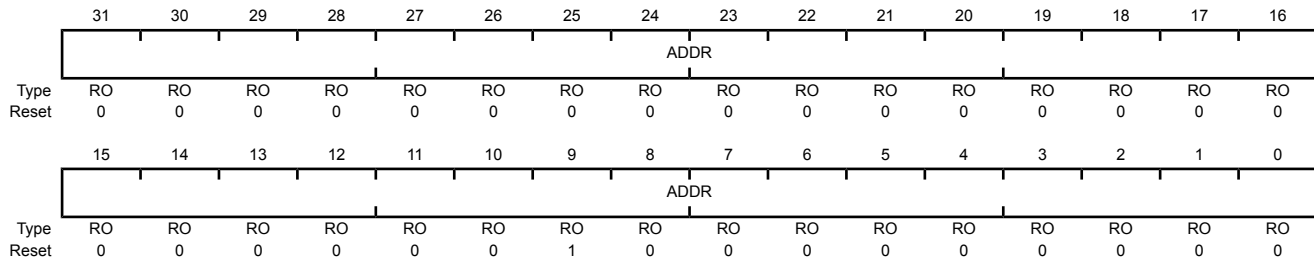
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:10 | ADDR | R/W | 0x0000.00 | Channel Control Base Address This field contains the pointer to the base address of the channel control table. The base address must be 1024-byte aligned. |
| 9:0 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 7: DMA Alternate Channel Control Base Pointer (DMAALTBASE), offset 0x00C

The **DMAALTBASE** register returns the base address of the alternate channel control data. This register removes the necessity for application software to calculate the base address of the alternate channel control structures. This register cannot be read when the μ DMA controller is in the reset state.

DMA Alternate Channel Control Base Pointer (DMAALTBASE)

Base 0x400F.F000
 Offset 0x00C
 Type RO, reset 0x0000.0200



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|--|
| 31:0 | ADDR | RO | 0x0000.0200 | Alternate Channel Address Pointer This field provides the base address of the alternate channel control structures. |

Register 8: DMA Channel Wait-on-Request Status (DMAWAITSTAT), offset 0x010

This read-only register indicates that the μ DMA channel is waiting on a request. A peripheral can hold off the μ DMA from performing a single request until the peripheral is ready for a burst request to enhance the μ DMA performance. The use of this feature is dependent on the design of the peripheral and is not controllable by software in any way. This register cannot be read when the μ DMA controller is in the reset state.

DMA Channel Wait-on-Request Status (DMAWAITSTAT)

Base 0x400F.F000

Offset 0x010

Type RO, reset 0xFFFF.FFC0

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | WAITREQ[n] | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | WAITREQ[n] | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------------|------|-------------|---|
| 31:0 | WAITREQ[n] | RO | 0xFFFF.FFC0 | Channel [n] Wait Status These bits provide the channel wait-on-request status. Bit 0 corresponds to channel 0. |
| | | | | Value Description |
| | | | | 1 The corresponding channel is waiting on a request. |
| | | | | 0 The corresponding channel is not waiting on a request. |

Register 9: DMA Channel Software Request (DMASWREQ), offset 0x014

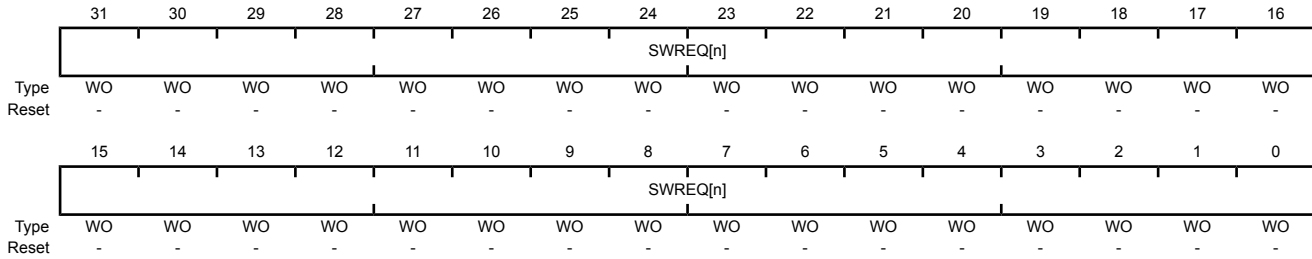
Each bit of the **DMASWREQ** register represents the corresponding μ DMA channel. Setting a bit generates a request for the specified μ DMA channel.

DMA Channel Software Request (DMASWREQ)

Base 0x400F.F000

Offset 0x014

Type WO, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:0 | SWREQ[n] | WO | - | Channel [n] Software Request These bits generate software requests. Bit 0 corresponds to channel 0. |
| | | | | Value Description |
| | | | | 1 Generate a software request for the corresponding channel. |
| | | | | 0 No request generated. |
| | | | | These bits are automatically cleared when the software request has been completed. |

Register 10: DMA Channel Useburst Set (DMAUSEBURSTSET), offset 0x018

Each bit of the **DMAUSEBURSTSET** register represents the corresponding μ DMA channel. Setting a bit disables the channel's single request input from generating requests, configuring the channel to only accept burst requests. Reading the register returns the status of USEBURST.

If the amount of data to transfer is a multiple of the arbitration (burst) size, the corresponding $SET[n]$ bit is cleared after completing the final transfer. If there are fewer items remaining to transfer than the arbitration (burst) size, the μ DMA controller automatically clears the corresponding $SET[n]$ bit, allowing the remaining items to transfer using single requests. In order to resume transfers using burst requests, the corresponding bit must be set again. A bit should not be set if the corresponding peripheral does not support the burst request model.

Refer to “Request Types” on page 362 for more details about request types.

DMA Channel Useburst Set (DMAUSEBURSTSET)

Base 0x400F.F000
Offset 0x018
Type R/W, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | SET[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SET[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------------|--------------------------|
| 31:0 | SET[n] | R/W | 0x0000.0000 | Channel [n] Useburst Set |

Value Description

- | | |
|---|---|
| 0 | μ DMA channel [n] responds to single or burst requests. |
| 1 | μ DMA channel [n] responds only to burst requests. |

Bit 0 corresponds to channel 0. This bit is automatically cleared as described above. A bit can also be manually cleared by setting the corresponding $CLR[n]$ bit in the **DMAUSEBURSTCLR** register.

Register 11: DMA Channel Useburst Clear (DMAUSEBURSTCLR), offset 0x01C

Each bit of the **DMAUSEBURSTCLR** register represents the corresponding μ DMA channel. Setting a bit clears the corresponding **SET[n]** bit in the **DMAUSEBURSTSET** register.

DMA Channel Useburst Clear (DMAUSEBURSTCLR)

Base 0x400F.F000

Offset 0x01C

Type WO, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|----------------------------|
| 31:0 | CLR[n] | WO | - | Channel [n] Useburst Clear |

| Value | Description |
|-------|--|
| 0 | No effect. |
| 1 | Setting a bit clears the corresponding SET[n] bit in the DMAUSEBURSTSET register meaning that μ DMA channel [n] responds to single and burst requests. |

Register 12: DMA Channel Request Mask Set (DMAREQMASKSET), offset 0x020

Each bit of the **DMAREQMASKSET** register represents the corresponding μ DMA channel. Setting a bit disables μ DMA requests for the channel. Reading the register returns the request mask status. When a μ DMA channel's request is masked, that means the peripheral can no longer request μ DMA transfers. The channel can then be used for software-initiated transfers.

DMA Channel Request Mask Set (DMAREQMASKSET)

Base 0x400F.F000
Offset 0x020
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | SET[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SET[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------------|------------------------------|
| 31:0 | SET[n] | R/W | 0x0000.0000 | Channel [n] Request Mask Set |

Value Description

| Value | Description |
|-------|--|
| 0 | The peripheral associated with channel [n] is enabled to request μ DMA transfers. |
| 1 | The peripheral associated with channel [n] is not able to request μ DMA transfers. Channel [n] may be used for software-initiated transfers. |

Bit 0 corresponds to channel 0. A bit can only be cleared by setting the corresponding `CLR[n]` bit in the **DMAREQMASKCLR** register.

Register 13: DMA Channel Request Mask Clear (DMAREQMASKCLR), offset 0x024

Each bit of the **DMAREQMASKCLR** register represents the corresponding μ DMA channel. Setting a bit clears the corresponding **SET[n]** bit in the **DMAREQMASKSET** register.

DMA Channel Request Mask Clear (DMAREQMASKCLR)

Base 0x400F.F000

Offset 0x024

Type WO, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--------------------------------|
| 31:0 | CLR[n] | WO | - | Channel [n] Request Mask Clear |

Value Description

0 No effect.

1 Setting a bit clears the corresponding **SET[n]** bit in the **DMAREQMASKSET** register meaning that the peripheral associated with channel [n] is enabled to request μ DMA transfers.

Register 14: DMA Channel Enable Set (DMAENASET), offset 0x028

Each bit of the **DMAENASET** register represents the corresponding μ DMA channel. Setting a bit enables the corresponding μ DMA channel. Reading the register returns the enable status of the channels. If a channel is enabled but the request mask is set (**DMAREQMASKSET**), then the channel can be used for software-initiated transfers.

DMA Channel Enable Set (DMAENASET)

Base 0x400F.F000
Offset 0x028
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | SET[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SET[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------------|------------------------|
| 31:0 | SET[n] | R/W | 0x0000.0000 | Channel [n] Enable Set |

| Value | Description |
|-------|------------------------------------|
| 0 | μ DMA Channel [n] is disabled. |
| 1 | μ DMA Channel [n] is enabled. |

Bit 0 corresponds to channel 0. A bit can only be cleared by setting the corresponding **CLR[n]** bit in the **DMAENACLR** register.

Register 15: DMA Channel Enable Clear (DMAENACL_R), offset 0x02C

Each bit of the **DMAENACL_R** register represents the corresponding μ DMA channel. Setting a bit clears the corresponding **SET[n]** bit in the **DMAENASET** register.

DMA Channel Enable Clear (DMAENACL_R)

Base 0x400F.F000

Offset 0x02C

Type WO, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--------------------------------|
| 31:0 | CLR[n] | WO | - | Clear Channel [n] Enable Clear |

| Value | Description |
|-------|---|
| 0 | No effect. |
| 1 | Setting a bit clears the corresponding SET[n] bit in the DMAENASET register meaning that channel [n] is disabled for μ DMA transfers. |

Note: The controller disables a channel when it completes the μ DMA cycle.

Register 16: DMA Channel Primary Alternate Set (DMAALTSET), offset 0x030

Each bit of the **DMAALTSET** register represents the corresponding μ DMA channel. Setting a bit configures the μ DMA channel to use the alternate control data structure. Reading the register returns the status of which control data structure is in use for the corresponding μ DMA channel.

DMA Channel Primary Alternate Set (DMAALTSET)

Base 0x400F.F000
Offset 0x030
Type R/W, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | SET[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SET[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------------|---------------------------|
| 31:0 | SET[n] | R/W | 0x0000.0000 | Channel [n] Alternate Set |

Value Description

- | | |
|---|---|
| 0 | μ DMA channel [n] is using the primary control structure. |
| 1 | μ DMA channel [n] is using the alternate control structure. |

Bit 0 corresponds to channel 0. A bit can only be cleared by setting the corresponding CLR[n] bit in the **DMAALTCLR** register.

Note: For Ping-Pong and Scatter-Gather cycle types, the μ DMA controller automatically sets these bits to select the alternate channel control data structure.

Register 17: DMA Channel Primary Alternate Clear (DMAALTCLR), offset 0x034

Each bit of the **DMAALTCLR** register represents the corresponding μ DMA channel. Setting a bit clears the corresponding **SET[n]** bit in the **DMAALTSET** register.

DMA Channel Primary Alternate Clear (DMAALTCLR)

Base 0x400F.F000

Offset 0x034

Type WO, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|-----------------------------|
| 31:0 | CLR[n] | WO | - | Channel [n] Alternate Clear |

| Value | Description |
|-------|--|
| 0 | No effect. |
| 1 | Setting a bit clears the corresponding SET[n] bit in the DMAALTSET register meaning that channel [n] is using the primary control structure. |

Note: For Ping-Pong and Scatter-Gather cycle types, the μ DMA controller automatically sets these bits to select the alternate channel control data structure.

Register 18: DMA Channel Priority Set (DMAPRIOSET), offset 0x038

Each bit of the **DMAPRIOSET** register represents the corresponding μ DMA channel. Setting a bit configures the μ DMA channel to have a high priority level. Reading the register returns the status of the channel priority mask.

DMA Channel Priority Set (DMAPRIOSET)

Base 0x400F.F000
Offset 0x038
Type R/W, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | SET[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SET[n] | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------------|--------------------------|
| 31:0 | SET[n] | R/W | 0x0000.0000 | Channel [n] Priority Set |

Value Description

- 0 μ DMA channel [n] is using the default priority level.
- 1 μ DMA channel [n] is using a high priority level.

Bit 0 corresponds to channel 0. A bit can only be cleared by setting the corresponding CLR[n] bit in the **DMAPRIOCLR** register.

Register 19: DMA Channel Priority Clear (DMAPRIOCLR), offset 0x03C

Each bit of the **DMAPRIOCLR** register represents the corresponding μ DMA channel. Setting a bit clears the corresponding **SET[n]** bit in the **DMAPRIOSET** register.

DMA Channel Priority Clear (DMAPRIOCLR)

Base 0x400F.F000

Offset 0x03C

Type WO, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 31:0 | CLR[n] | WO | - | Channel [n] Priority Clear |
| | | | | Value Description |
| | | | | 0 No effect. |
| | | | | 1 Setting a bit clears the corresponding SET[n] bit in the DMAPRIOSET register meaning that channel [n] is using the default priority level. |

Register 20: DMA Bus Error Clear (DMAERRCLR), offset 0x04C

The **DMAERRCLR** register is used to read and clear the μ DMA bus error status. The error status is set if the μ DMA controller encountered a bus error while performing a transfer. If a bus error occurs on a channel, that channel is automatically disabled by the μ DMA controller. The other channels are unaffected.

DMA Bus Error Clear (DMAERRCLR)

Base 0x400F.F000
Offset 0x04C
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | ERRCLR |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:1 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| | | | | |
|---|--------|-------|---|----------------------------|
| 0 | ERRCLR | R/W1C | 0 | μ DMA Bus Error Status |
|---|--------|-------|---|----------------------------|

Value Description

| Value | Description |
|-------|--------------------------|
| 0 | No bus error is pending. |
| 1 | A bus error is pending. |

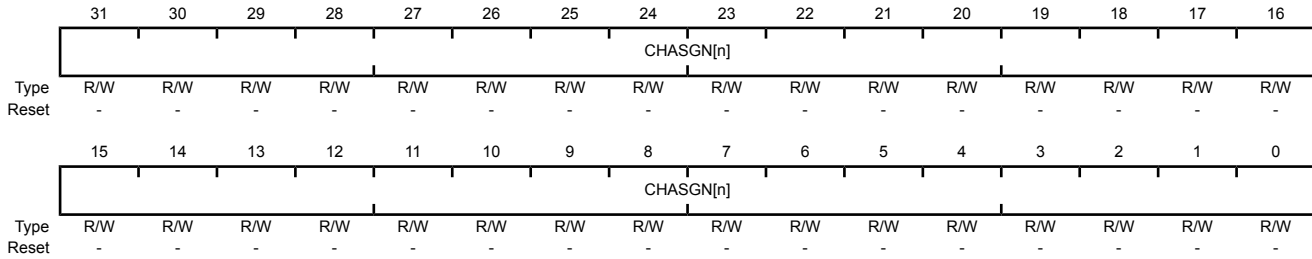
This bit is cleared by writing a 1 to it.

Register 21: DMA Channel Assignment (DMACHASGN), offset 0x500

Each bit of the **DMACHASGN** register represents the corresponding μ DMA channel. Setting a bit selects the secondary channel assignment as specified in Table 8-1 on page 361.

DMA Channel Assignment (DMACHASGN)

Base 0x400F.F000
 Offset 0x500
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|---|
| 31:0 | CHASGN[n] | R/W | - | Channel [n] Assignment Select |
| | | | | Value Description |
| | | | | 0 Use the primary channel assignment. |
| | | | | 1 Use the secondary channel assignment. |

Register 22: DMA Channel Interrupt Status (DMACHIS), offset 0x504

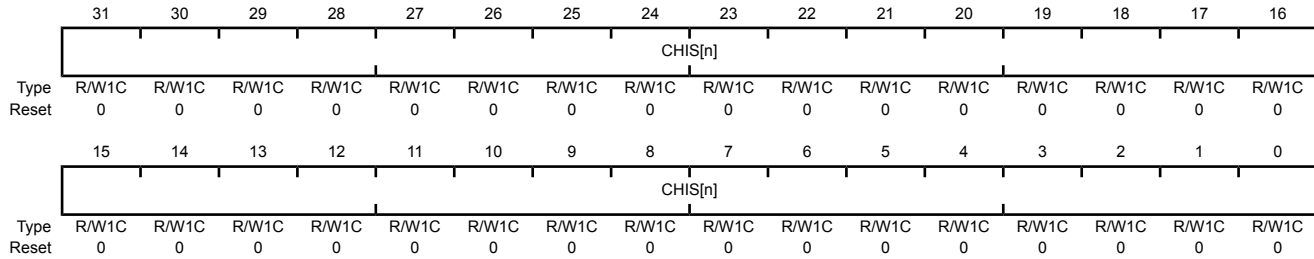
Each bit of the **DMACHIS** register represents the corresponding μ DMA channel. A bit is set when that μ DMA channel causes a completion interrupt. The bits are cleared by a writing a 1.

DMA Channel Interrupt Status (DMACHIS)

Base 0x400F.F000

Offset 0x504

Type R/W1C, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|-------|-------------|------------------------------|
| 31:0 | CHIS[n] | R/W1C | 0x0000.0000 | Channel [n] Interrupt Status |

Value Description

1 The corresponding μ DMA channel caused an interrupt.

0 The corresponding μ DMA channel has not caused an interrupt.

This bit is cleared by writing a 1 to it.

Register 23: DMA Peripheral Identification 0 (DMAPeriphID0), offset 0xFE0

The DMAPeriphIDn registers are hard-coded, and the fields within the registers determine the reset values.

DMA Peripheral Identification 0 (DMAPeriphID0)

Base 0x400F.F000
 Offset 0xFE0
 Type RO, reset 0x0000.0030

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID0 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID0 | RO | 0x30 | μ DMA Peripheral ID Register [7:0] Can be used by software to identify the presence of this peripheral. |

Register 24: DMA Peripheral Identification 1 (DMAPeriphID1), offset 0xFE4

The **DMAPeriphIDn** registers are hard-coded, and the fields within the registers determine the reset values.

DMA Peripheral Identification 1 (DMAPeriphID1)

Base 0x400F.F000

Offset 0xFE4

Type RO, reset 0x0000.00B2

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID1 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID1 | RO | 0xB2 | μDMA Peripheral ID Register [15:8] Can be used by software to identify the presence of this peripheral. |

Register 25: DMA Peripheral Identification 2 (DMAPeriphID2), offset 0xFE8

The DMAPeriphIDn registers are hard-coded, and the fields within the registers determine the reset values.

DMA Peripheral Identification 2 (DMAPeriphID2)

Base 0x400F.F000
 Offset 0xFE8
 Type RO, reset 0x0000.000B

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID2 | RO | 0x0B | μ DMA Peripheral ID Register [23:16] Can be used by software to identify the presence of this peripheral. |

Register 26: DMA Peripheral Identification 3 (DMAPeriphID3), offset 0xFEC

The **DMAPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

DMA Peripheral Identification 3 (DMAPeriphID3)

Base 0x400F.F000

Offset 0xFEC

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID3 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID3 | RO | 0x00 | μDMA Peripheral ID Register [31:24] Can be used by software to identify the presence of this peripheral. |

Register 27: DMA Peripheral Identification 4 (DMAPeriphID4), offset 0xFD0

The DMAPeriphIDn registers are hard-coded, and the fields within the registers determine the reset values.

DMA Peripheral Identification 4 (DMAPeriphID4)

Base 0x400F.F000
 Offset 0xFD0
 Type RO, reset 0x0000.0004

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID4 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID4 | RO | 0x04 | μ DMA Peripheral ID Register Can be used by software to identify the presence of this peripheral. |

Register 28: DMA PrimeCell Identification 0 (DMAPCellID0), offset 0xFF0

The **DMAPCellIDn** registers are hard-coded, and the fields within the registers determine the reset values.

DMA PrimeCell Identification 0 (DMAPCellID0)

Base 0x400F.F000

Offset 0xFF0

Type RO, reset 0x0000.000D

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID0 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID0 | RO | 0x0D | μDMA PrimeCell ID Register [7:0] Provides software a standard cross-peripheral identification system. |

Register 29: DMA PrimeCell Identification 1 (DMAPCellID1), offset 0xFF4

The **DMAPCellIDn** registers are hard-coded, and the fields within the registers determine the reset values.

DMA PrimeCell Identification 1 (DMAPCellID1)

Base 0x400F.F000
 Offset 0xFF4
 Type RO, reset 0x0000.00F0

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID1 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID1 | RO | 0xF0 | μ DMA PrimeCell ID Register [15:8] Provides software a standard cross-peripheral identification system. |

Register 30: DMA PrimeCell Identification 2 (DMAPCellID2), offset 0xFF8

The **DMAPCellIDn** registers are hard-coded, and the fields within the registers determine the reset values.

DMA PrimeCell Identification 2 (DMAPCellID2)

Base 0x400F.F000

Offset 0xFF8

Type RO, reset 0x0000.0005

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:8 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID2 | RO | 0x05 | μDMA PrimeCell ID Register [23:16] Provides software a standard cross-peripheral identification system. |

Register 31: DMA PrimeCell Identification 3 (DMAPCellID3), offset 0xFFC

The **DMAPCellIDn** registers are hard-coded, and the fields within the registers determine the reset values.

DMA PrimeCell Identification 3 (DMAPCellID3)

Base 0x400F.F000
 Offset 0xFFC
 Type RO, reset 0x0000.00B1

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID3 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:8 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID3 | RO | 0xB1 | μ DMA PrimeCell ID Register [31:24] Provides software a standard cross-peripheral identification system. |

9 General-Purpose Input/Outputs (GPIOs)

The GPIO module is composed of nine physical GPIO blocks, each corresponding to an individual GPIO port (Port A, Port B, Port C, Port D, Port E, Port F, Port G, Port H, Port J). The GPIO module supports up to 67 programmable input/output pins, depending on the peripherals being used.

The GPIO module has the following features:

- Up to 67 GPIOs, depending on configuration
- Highly flexible pin muxing allows use as GPIO or one of several peripheral functions
- 5-V-tolerant in input configuration
- Two means of port access: either Advanced High-Performance Bus (AHB) with better back-to-back access performance, or the legacy Advanced Peripheral Bus (APB) for backwards-compatibility with existing code
- Fast toggle capable of a change every clock cycle for ports on AHB, every two clock cycles for ports on APB
- Programmable control for GPIO interrupts
 - Interrupt generation masking
 - Edge-triggered on rising, falling, or both
 - Level-sensitive on High or Low values
- Bit masking in both read and write operations through address lines
- Can be used to initiate an ADC sample sequence
- Pins configured as digital inputs are Schmitt-triggered
- Programmable control for GPIO pad configuration
 - Weak pull-up or pull-down resistors
 - 2-mA, 4-mA, and 8-mA pad drive for digital communication; up to four pads can sink 18-mA for high-current applications
 - Slew rate control for the 8-mA drive
 - Open drain enables
 - Digital input enables

9.1 Signal Description

GPIO signals have alternate hardware functions. The following table lists the GPIO pins and their analog and digital alternate functions. The A_{INx} and V_{REFA} analog signals are not 5-V tolerant and go through an isolation circuit before reaching their circuitry. These signals are configured by clearing the corresponding DEN bit in the **GPIO Digital Enable (GPIODEN)** register and setting the corresponding $AMSEL$ bit in the **GPIO Analog Mode Select (GPIOAMSEL)** register. Other analog

signals are 5-V tolerant and are connected directly to their circuitry (C0-, C0+, C1-, C1+, C2-, C2+). These signals are configured by clearing the DEN bit in the **GPIO Digital Enable (GPIODEN)** register. All GPIO signals are 5-V tolerant when configured as inputs except for PB0 and PB1, which are limited to 3.6 V. The digital alternate hardware functions are enabled by setting the appropriate bit in the **GPIO Alternate Function Select (GPIOAFSEL)** and **GPIODEN** registers and configuring the PMC_x bit field in the **GPIO Port Control (GPIOPCTL)** register to the numeric encoding shown in the table below. Note that each pin must be programmed individually; no type of grouping is implied by the columns in the table. Table entries that are shaded gray are the default values for the corresponding GPIO pin.

Important: All GPIO pins are configured as GPIOs and tri-stated by default (**GPIOAFSEL=0**, **GPIODEN=0**, **GPIOPDR=0**, **GPIOPUR=0**, and **GPIOPCTL=0**), with the exception of the pins shown in the table below. A Power-On-Reset (\overline{POR}) or asserting \overline{RST} puts the pins back to their default state.

Table 9-1. GPIO Pins With Non-Zero Reset Values

| GPIO Pins | Default State | GPIOAFSEL | GPIODEN | GPIOPDR | GPIOPUR | GPIOPCTL |
|-----------|-------------------|-----------|---------|---------|---------|----------|
| PA[1:0] | UART0 | 0 | 0 | 0 | 0 | 0x1 |
| PA[5:2] | SSI0 | 0 | 0 | 0 | 0 | 0x2 |
| PB[3:2] | I ² C0 | 0 | 0 | 0 | 0 | 0x3 |
| PC[3:0] | JTAG/SWD | 1 | 1 | 0 | 1 | 0x1 |

Table 9-2. GPIO Pins and Alternate Functions (100LQFP)

| IO | Pin | Analog Function | Digital Function (GPIOPCTL PMC _x Bit Field Encoding) ^a | | | | | | | | | | | |
|-----|-----|-----------------|--|--------|--------------|--------|--------|--------|------|---------|-----------|------|----|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| PA0 | 26 | - | U0Rx | - | - | - | - | - | - | - | I2C1SCL | U1Rx | - | - |
| PA1 | 27 | - | U0Tx | - | - | - | - | - | - | - | I2C1SDA | U1Tx | - | - |
| PA2 | 28 | - | SSI0Clk | - | - | PWM4 | - | - | - | - | I2S0RXSD | - | - | - |
| PA3 | 29 | - | SSI0Fss | - | - | PWM5 | - | - | - | - | I2S0RWCLK | - | - | - |
| PA4 | 30 | - | SSI0Rx | - | - | PWM6 | CAN0Rx | - | - | - | I2S0TXSCK | - | - | - |
| PA5 | 31 | - | SSI0Tx | - | - | PWM7 | CAN0Tx | - | - | - | I2S0TXWS | - | - | - |
| PA6 | 34 | - | I2C1SCL | CCP1 | - | PWM0 | PWM4 | CAN0Rx | - | - | U1CTS | - | - | - |
| PA7 | 35 | - | I2C1SDA | CCP4 | - | PWM1 | PWM5 | CAN0Tx | CCP3 | - | U1DCD | - | - | - |
| PB0 | 66 | - | CCP0 | PWM2 | - | - | U1Rx | - | - | - | - | - | - | - |
| PB1 | 67 | - | CCP2 | PWM3 | - | CCP1 | U1Tx | - | - | - | - | - | - | - |
| PB2 | 72 | - | I2C0SCL | IDX0 | - | CCP3 | CCP0 | - | - | - | - | - | - | - |
| PB3 | 65 | - | I2C0SDA | Fault0 | - | Fault3 | - | - | - | - | - | - | - | - |
| PB4 | 92 | AIN10 C0- | - | - | - | U2Rx | CAN0Rx | IDX0 | U1Rx | EPI0S23 | - | - | - | - |
| PB5 | 91 | AIN11 C1- | C0o | CCP5 | CCP6 | CCP0 | CAN0Tx | CCP2 | U1Tx | EPI0S22 | - | - | - | - |
| PB6 | 90 | VREFA C0+ | CCP1 | CCP7 | C0o | Fault1 | IDX0 | CCP5 | - | - | I2S0TXSCK | - | - | - |
| PB7 | 89 | - | - | - | - | NMI | - | - | - | - | - | - | - | - |
| PC0 | 80 | - | - | - | TCK SWCLK | - | - | - | - | - | - | - | - | - |

Table 9-2. GPIO Pins and Alternate Functions (100LQFP) (continued)

| IO | Pin | Analog Function | Digital Function (GPIO PCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | |
|-----|-----|-----------------|---|---------|-----------|--------|--------|------|-----|-----------|-----------|---------|------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| PC1 | 79 | - | - | - | TMS SWDIO | - | - | - | - | - | - | - | - |
| PC2 | 78 | - | - | - | TDI | - | - | - | - | - | - | - | - |
| PC3 | 77 | - | - | - | TDO SWO | - | - | - | - | - | - | - | - |
| PC4 | 25 | - | CCP5 | PhA0 | - | PWM6 | CCP2 | CCP4 | - | EPI0S2 | CCP1 | - | - |
| PC5 | 24 | C1+ | CCP1 | C1o | C0o | Fault2 | CCP3 | - | - | EPI0S3 | - | - | - |
| PC6 | 23 | C2+ | CCP3 | PhB0 | C2o | PWM7 | U1Rx | CCP0 | - | EPI0S4 | - | - | - |
| PC7 | 22 | C2- | CCP4 | PhB0 | - | CCP0 | U1Tx | - | C1o | EPI0S5 | - | - | - |
| PD0 | 10 | AIN15 | PWM0 | CAN0Rx | IDX0 | U2Rx | U1Rx | CCP6 | - | I2S0RXSCK | U1CTS | - | - |
| PD1 | 11 | AIN14 | PWM1 | CAN0Tx | PhA0 | U2Tx | U1Tx | CCP7 | - | I2S0RXWS | U1DCD | CCP2 | PhB1 |
| PD2 | 12 | AIN13 | U1Rx | CCP6 | PWM2 | CCP5 | - | - | - | EPI0S20 | - | - | - |
| PD3 | 13 | AIN12 | U1Tx | CCP7 | PWM3 | CCP0 | - | - | - | EPI0S21 | - | - | - |
| PD4 | 97 | AIN7 | CCP0 | CCP3 | - | - | - | - | - | I2S0RXSD | U1RI | EPI0S19 | - |
| PD5 | 98 | AIN6 | CCP2 | CCP4 | - | - | - | - | - | I2S0RMLK | U2Rx | EPI0S28 | - |
| PD6 | 99 | AIN5 | Fault0 | - | - | - | - | - | - | I2S0TXSCK | U2Tx | EPI0S29 | - |
| PD7 | 100 | AIN4 | IDX0 | C0o | CCP1 | - | - | - | - | I2S0TXWS | U1DTR | EPI0S30 | - |
| PE0 | 74 | - | PWM4 | SSI1Clk | CCP3 | - | - | - | - | EPI0S8 | - | - | - |
| PE1 | 75 | - | PWM5 | SSI1Fss | Fault0 | CCP2 | CCP6 | - | - | EPI0S9 | - | - | - |
| PE2 | 95 | AIN9 | CCP4 | SSI1Rx | PhB1 | PhA0 | CCP2 | - | - | EPI0S24 | - | - | - |
| PE3 | 96 | AIN8 | CCP1 | SSI1Tx | PhA1 | PhB0 | CCP7 | - | - | EPI0S25 | - | - | - |
| PE4 | 6 | AIN3 | CCP3 | - | - | Fault0 | U2Tx | CCP2 | - | - | I2S0TXWS | - | - |
| PE5 | 5 | AIN2 | CCP5 | - | - | - | - | - | - | - | I2S0TXSD | - | - |
| PE6 | 2 | AIN1 | PWM4 | C1o | - | - | - | - | - | - | U1CTS | - | - |
| PE7 | 1 | AIN0 | PWM5 | C2o | - | - | - | - | - | - | U1DCD | - | - |
| PF0 | 47 | - | CAN1Rx | PhB0 | PWM0 | - | - | - | - | I2S0TXSD | U1DSR | - | - |
| PF1 | 61 | - | CAN1Tx | IDX1 | PWM1 | - | - | - | - | I2S0TXMLK | U1RTS | CCP3 | - |
| PF2 | 60 | - | - | PWM4 | - | PWM2 | - | - | - | - | SSI1Clk | - | - |
| PF3 | 59 | - | - | PWM5 | - | PWM3 | - | - | - | - | SSI1Fss | - | - |
| PF4 | 58 | - | CCP0 | C0o | - | Fault0 | - | - | - | EPI0S12 | SSI1Rx | - | - |
| PF5 | 46 | - | CCP2 | C1o | - | - | - | - | - | EPI0S15 | SSI1Tx | - | - |
| PF6 | 43 | - | CCP1 | C2o | - | PhA0 | - | - | - | - | I2S0TXMLK | U1RTS | - |
| PF7 | 42 | - | CCP4 | - | - | PhB0 | - | - | - | EPI0S12 | Fault1 | - | - |
| PG0 | 19 | - | U2Rx | PWM0 | I2C1SCL | PWM4 | - | - | - | EPI0S13 | - | - | - |
| PG1 | 18 | - | U2Tx | PWM1 | I2C1SDA | PWM5 | - | - | - | EPI0S14 | - | - | - |
| PG2 | 17 | - | PWM0 | - | - | Fault0 | - | - | - | IDX1 | I2S0RXSD | - | - |
| PG3 | 16 | - | PWM1 | - | - | Fault2 | - | - | - | Fault0 | I2S0RMLK | - | - |
| PG4 | 41 | - | CCP3 | - | - | Fault1 | - | - | - | EPI0S15 | PWM6 | U1RI | - |
| PG5 | 40 | - | CCP5 | - | - | IDX0 | Fault1 | - | - | PWM7 | I2S0RXSCK | U1DTR | - |
| PG6 | 37 | - | PhA1 | - | - | PWM6 | - | - | - | Fault1 | I2S0RXWS | U1RI | - |
| PG7 | 36 | - | PhB1 | - | - | PWM7 | - | - | - | CCP5 | EPI0S31 | - | - |

Table 9-2. GPIO Pins and Alternate Functions (100LQFP) (continued)

| IO | Pin | Analog Function | Digital Function (GPIOCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | | |
|-----|-----|-----------------|---|--------|---|--------|---|---|---|---|---------|------|--------|---------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| PH0 | 86 | - | CCP6 | PWM2 | - | - | - | - | - | - | EPI0S6 | PWM4 | - | - |
| PH1 | 85 | - | CCP7 | PWM3 | - | - | - | - | - | - | EPI0S7 | PWM5 | - | - |
| PH2 | 84 | - | IDX1 | C1o | - | Fault3 | - | - | - | - | EPI0S1 | - | - | - |
| PH3 | 83 | - | PhB0 | Fault0 | - | - | - | - | - | - | EPI0S0 | - | - | - |
| PH4 | 76 | - | - | - | - | - | - | - | - | - | EPI0S10 | - | - | SSI1Clk |
| PH5 | 63 | - | - | - | - | - | - | - | - | - | EPI0S11 | - | Fault2 | SSI1Fss |
| PH6 | 62 | - | - | - | - | - | - | - | - | - | EPI0S26 | - | PWM4 | SSI1Rx |
| PH7 | 15 | - | - | - | - | - | - | - | - | - | EPI0S27 | - | PWM5 | SSI1Tx |
| PJ0 | 14 | - | - | - | - | - | - | - | - | - | EPI0S16 | - | PWM0 | I2C1SCL |
| PJ1 | 87 | - | - | - | - | - | - | - | - | - | EPI0S17 | - | PWM1 | I2C1SDA |
| PJ2 | 39 | - | - | - | - | - | - | - | - | - | EPI0S18 | CCP0 | Fault0 | - |

a. The digital signals that are shaded gray are the power-on default values for the corresponding GPIO pin.

Table 9-3. GPIO Pins and Alternate Functions (108BGA)

| IO | Pin | Analog Function | Digital Function (GPIOCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | | |
|-----|-----|-----------------|---|--------|-----------|--------|--------|--------|------|---------|-----------|------|----|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| PA0 | L3 | - | U0Rx | - | - | - | - | - | - | - | I2C1SCL | U1Rx | - | - |
| PA1 | M3 | - | U0Tx | - | - | - | - | - | - | - | I2C1SDA | U1Tx | - | - |
| PA2 | M4 | - | SSI0Clk | - | - | PWM4 | - | - | - | - | I2S0RXSD | - | - | - |
| PA3 | L4 | - | SSI0Fss | - | - | PWM5 | - | - | - | - | I2S0RMCLK | - | - | - |
| PA4 | L5 | - | SSI0Rx | - | - | PWM6 | CAN0Rx | - | - | - | I2S0TXSCK | - | - | - |
| PA5 | M5 | - | SSI0Tx | - | - | PWM7 | CAN0Tx | - | - | - | I2S0TXWS | - | - | - |
| PA6 | L6 | - | I2C1SCL | CCP1 | - | PWM0 | PWM4 | CAN0Rx | - | - | U1CTS | - | - | - |
| PA7 | M6 | - | I2C1SDA | CCP4 | - | PWM1 | PWM5 | CAN0Tx | CCP3 | - | U1DCD | - | - | - |
| PB0 | E12 | - | CCP0 | PWM2 | - | - | U1Rx | - | - | - | - | - | - | - |
| PB1 | D12 | - | CCP2 | PWM3 | - | CCP1 | U1Tx | - | - | - | - | - | - | - |
| PB2 | A11 | - | I2C0SCL | IDX0 | - | CCP3 | CCP0 | - | - | - | - | - | - | - |
| PB3 | E11 | - | I2C0SDA | Fault0 | - | Fault3 | - | - | - | - | - | - | - | - |
| PB4 | A6 | AIN10 C0- | - | - | - | U2Rx | CAN0Rx | IDX0 | U1Rx | EPI0S23 | - | - | - | - |
| PB5 | B7 | AIN11 C1- | C0o | CCP5 | CCP6 | CCP0 | CAN0Tx | CCP2 | U1Tx | EPI0S22 | - | - | - | - |
| PB6 | A7 | VREFA C0+ | CCP1 | CCP7 | C0o | Fault1 | IDX0 | CCP5 | - | - | I2S0TXSCK | - | - | - |
| PB7 | A8 | - | - | - | - | NMI | - | - | - | - | - | - | - | - |
| PC0 | A9 | - | - | - | TCK SWCLK | - | - | - | - | - | - | - | - | - |
| PC1 | B9 | - | - | - | TMS SWDIO | - | - | - | - | - | - | - | - | - |
| PC2 | B8 | - | - | - | TDI | - | - | - | - | - | - | - | - | - |
| PC3 | A10 | - | - | - | TDO SWO | - | - | - | - | - | - | - | - | - |

Table 9-3. GPIO Pins and Alternate Functions (108BGA) (continued)

| IO | Pin | Analog Function | Digital Function (GPIOCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | |
|-----|-----|-----------------|---|---------|---------|--------|--------|------|-----|------------|------------|---------|------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| PC4 | L1 | - | CCP5 | PhA0 | - | PWM6 | CCP2 | CCP4 | - | EPI0S2 | CCP1 | - | - |
| PC5 | M1 | C1+ | CCP1 | C1o | C0o | Fault2 | CCP3 | - | - | EPI0S3 | - | - | - |
| PC6 | M2 | C2+ | CCP3 | PhB0 | C2o | PWM7 | U1Rx | CCP0 | - | EPI0S4 | - | - | - |
| PC7 | L2 | C2- | CCP4 | PhB0 | - | CCP0 | U1Tx | - | C1o | EPI0S5 | - | - | - |
| PD0 | G1 | AIN15 | PWM0 | CAN0Rx | IDX0 | U2Rx | U1Rx | CCP6 | - | I2S0RXSCK | U1CTS | - | - |
| PD1 | G2 | AIN14 | PWM1 | CAN0Tx | PhA0 | U2Tx | U1Tx | CCP7 | - | I2S0RXWS | U1DCD | CCP2 | PhB1 |
| PD2 | H2 | AIN13 | U1Rx | CCP6 | PWM2 | CCP5 | - | - | - | EPI0S20 | - | - | - |
| PD3 | H1 | AIN12 | U1Tx | CCP7 | PWM3 | CCP0 | - | - | - | EPI0S21 | - | - | - |
| PD4 | B5 | AIN7 | CCP0 | CCP3 | - | - | - | - | - | I2S0RXSD | U1RI | EPI0S19 | - |
| PD5 | C6 | AIN6 | CCP2 | CCP4 | - | - | - | - | - | I2S0RXSCK | U2Rx | EPI0S28 | - |
| PD6 | A3 | AIN5 | Fault0 | - | - | - | - | - | - | I2S0TXSCK | U2Tx | EPI0S29 | - |
| PD7 | A2 | AIN4 | IDX0 | C0o | CCP1 | - | - | - | - | I2S0TXWS | U1DTR | EPI0S30 | - |
| PE0 | B11 | - | PWM4 | SSI1Clk | CCP3 | - | - | - | - | EPI0S8 | - | - | - |
| PE1 | A12 | - | PWM5 | SSI1Fss | Fault0 | CCP2 | CCP6 | - | - | EPI0S9 | - | - | - |
| PE2 | A4 | AIN9 | CCP4 | SSI1Rx | PhB1 | PhA0 | CCP2 | - | - | EPI0S24 | - | - | - |
| PE3 | B4 | AIN8 | CCP1 | SSI1Tx | PhA1 | PhB0 | CCP7 | - | - | EPI0S25 | - | - | - |
| PE4 | B2 | AIN3 | CCP3 | - | - | Fault0 | U2Tx | CCP2 | - | - | I2S0TXWS | - | - |
| PE5 | B3 | AIN2 | CCP5 | - | - | - | - | - | - | - | I2S0TXSD | - | - |
| PE6 | A1 | AIN1 | PWM4 | C1o | - | - | - | - | - | - | U1CTS | - | - |
| PE7 | B1 | AIN0 | PWM5 | C2o | - | - | - | - | - | - | U1DCD | - | - |
| PF0 | M9 | - | CAN1Rx | PhB0 | PWM0 | - | - | - | - | I2S0TXSD | U1DSR | - | - |
| PF1 | H12 | - | CAN1Tx | IDX1 | PWM1 | - | - | - | - | I2S0TXMCLK | U1RTS | CCP3 | - |
| PF2 | J11 | - | - | PWM4 | - | PWM2 | - | - | - | - | SSI1Clk | - | - |
| PF3 | J12 | - | - | PWM5 | - | PWM3 | - | - | - | - | SSI1Fss | - | - |
| PF4 | L9 | - | CCP0 | C0o | - | Fault0 | - | - | - | EPI0S12 | SSI1Rx | - | - |
| PF5 | L8 | - | CCP2 | C1o | - | - | - | - | - | EPI0S15 | SSI1Tx | - | - |
| PF6 | M8 | - | CCP1 | C2o | - | PhA0 | - | - | - | - | I2S0TXMCLK | U1RTS | - |
| PF7 | K4 | - | CCP4 | - | - | PhB0 | - | - | - | EPI0S12 | Fault1 | - | - |
| PG0 | K1 | - | U2Rx | PWM0 | I2C1SCL | PWM4 | - | - | - | EPI0S13 | - | - | - |
| PG1 | K2 | - | U2Tx | PWM1 | I2C1SDA | PWM5 | - | - | - | EPI0S14 | - | - | - |
| PG2 | J1 | - | PWM0 | - | - | Fault0 | - | - | - | IDX1 | I2S0RXSD | - | - |
| PG3 | J2 | - | PWM1 | - | - | Fault2 | - | - | - | Fault0 | I2S0RXMCLK | - | - |
| PG4 | K3 | - | CCP3 | - | - | Fault1 | - | - | - | EPI0S15 | PWM6 | U1RI | - |
| PG5 | M7 | - | CCP5 | - | - | IDX0 | Fault1 | - | - | PWM7 | I2S0RXSCK | U1DTR | - |
| PG6 | L7 | - | PhA1 | - | - | PWM6 | - | - | - | Fault1 | I2S0RXWS | U1RI | - |
| PG7 | C10 | - | PhB1 | - | - | PWM7 | - | - | - | CCP5 | EPI0S31 | - | - |
| PH0 | C9 | - | CCP6 | PWM2 | - | - | - | - | - | EPI0S6 | PWM4 | - | - |
| PH1 | C8 | - | CCP7 | PWM3 | - | - | - | - | - | EPI0S7 | PWM5 | - | - |
| PH2 | D11 | - | IDX1 | C1o | - | Fault3 | - | - | - | EPI0S1 | - | - | - |
| PH3 | D10 | - | PhB0 | Fault0 | - | - | - | - | - | EPI0S0 | - | - | - |

Table 9-3. GPIO Pins and Alternate Functions (108BGA) (continued)

| IO | Pin | Analog Function | Digital Function (GPIOCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | |
|-----|-----|-----------------|---|---|---|---|---|---|---|---------|------|--------|---------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| PH4 | B10 | - | - | - | - | - | - | - | - | EPI0S10 | - | - | SSI1Clk |
| PH5 | F10 | - | - | - | - | - | - | - | - | EPI0S11 | - | Fault2 | SSI1Fss |
| PH6 | G3 | - | - | - | - | - | - | - | - | EPI0S26 | - | PWM4 | SSI1Rx |
| PH7 | H3 | - | - | - | - | - | - | - | - | EPI0S27 | - | PWM5 | SSI1Tx |
| PJ0 | F3 | - | - | - | - | - | - | - | - | EPI0S16 | - | PWM0 | I2C1SCL |
| PJ1 | B6 | - | - | - | - | - | - | - | - | EPI0S17 | - | PWM1 | I2C1SDA |
| PJ2 | K6 | - | - | - | - | - | - | - | - | EPI0S18 | CCP0 | Fault0 | - |

a. The digital signals that are shaded gray are the power-on default values for the corresponding GPIO pin.

9.2 Functional Description

Each GPIO port is a separate hardware instantiation of the same physical block (see Figure 9-1 on page 424 and Figure 9-2 on page 425). The LM3S2U93 microcontroller contains nine ports and thus nine of these physical GPIO blocks. Note that not all pins may be implemented on every block. Some GPIO pins can function as I/O signals for the on-chip peripheral modules. For information on which GPIO pins are used for alternate hardware functions, refer to Table 23-5 on page 1083.

Figure 9-1. Digital I/O Pads

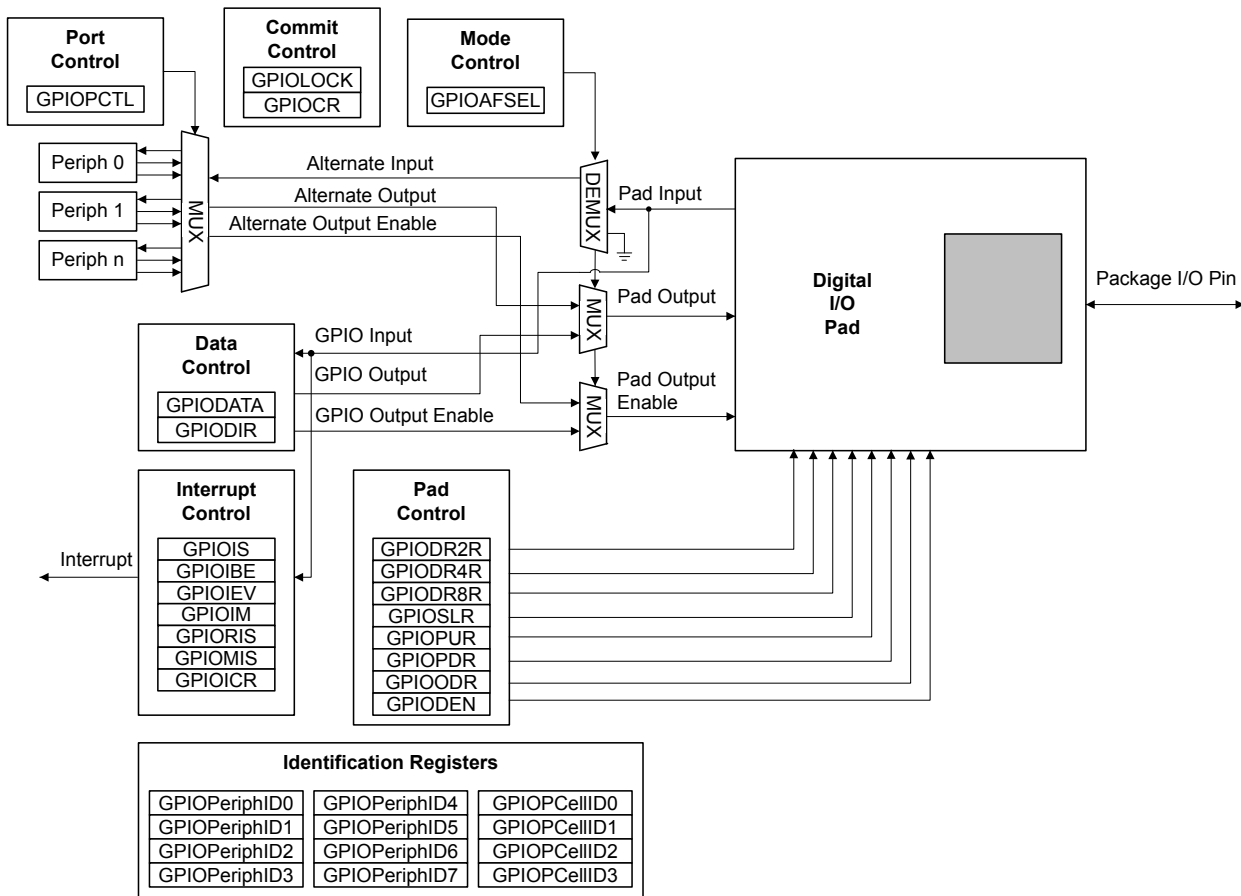
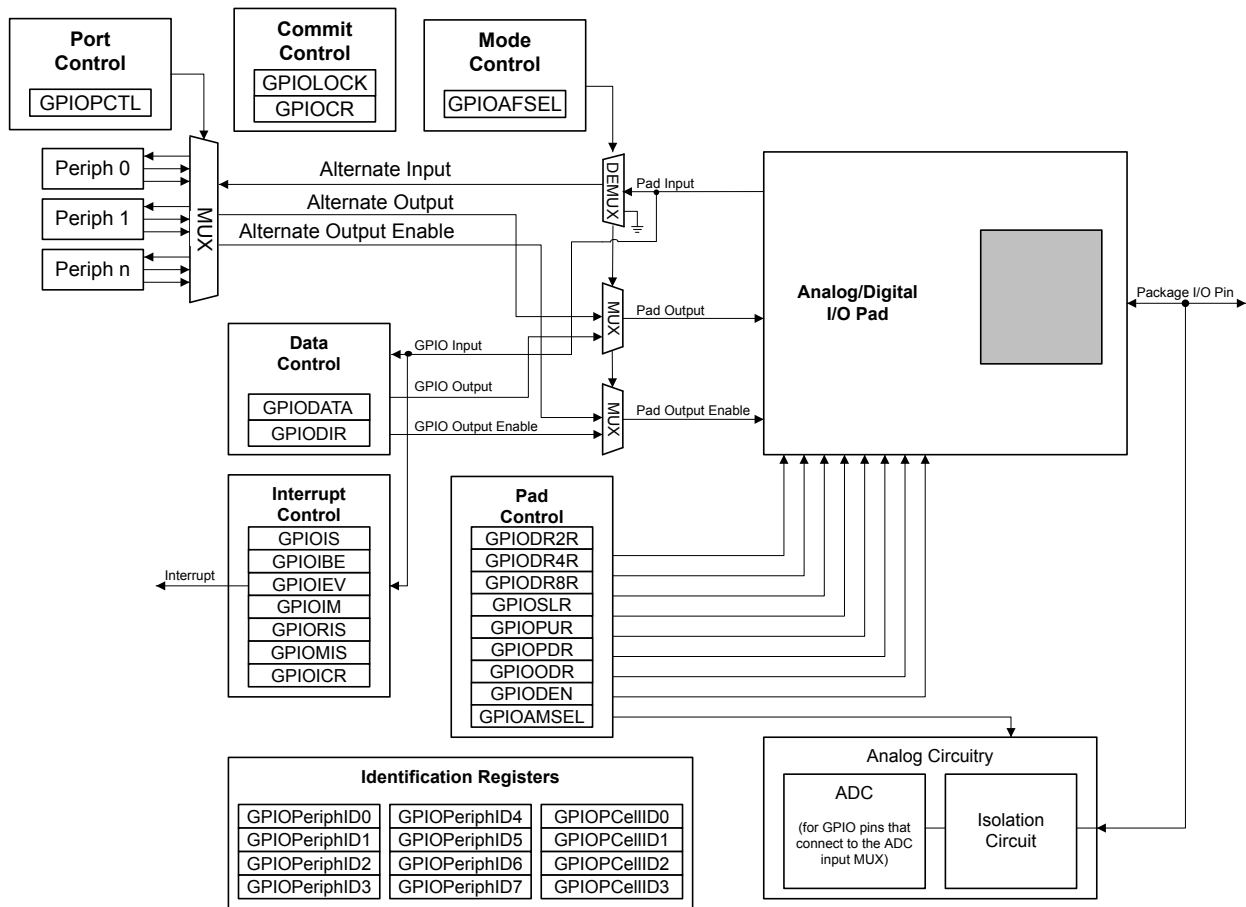


Figure 9-2. Analog/Digital I/O Pads



9.2.1 Data Control

The data control registers allow software to configure the operational modes of the GPIOs. The data direction register configures the GPIO as an input or an output while the data register either captures incoming data or drives it out to the pads.

Caution – It is possible to create a software sequence that prevents the debugger from connecting to the Stellaris® microcontroller. If the program code loaded into flash immediately changes the JTAG pins to their GPIO functionality, the debugger may not have enough time to connect and halt the controller before the JTAG pin functionality switches. As a result, the debugger may be locked out of the part. This issue can be avoided with a software routine that restores JTAG functionality based on an external or software trigger.

9.2.1.1 Data Direction Operation

The **GPIO Direction (GPIODIR)** register (see page 434) is used to configure each individual pin as an input or output. When the data direction bit is cleared, the GPIO is configured as an input, and the corresponding data register bit captures and stores the value on the GPIO port. When the data direction bit is set, the GPIO is configured as an output, and the corresponding data register bit is driven out on the GPIO port.

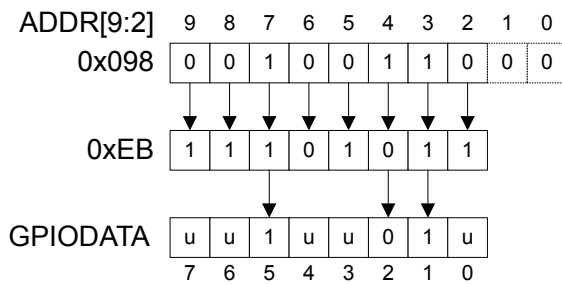
9.2.1.2 Data Register Operation

To aid in the efficiency of software, the GPIO ports allow for the modification of individual bits in the **GPIO Data (GPIODATA)** register (see page 433) by using bits [9:2] of the address bus as a mask. In this manner, software drivers can modify individual GPIO pins in a single instruction without affecting the state of the other pins. This method is more efficient than the conventional method of performing a read-modify-write operation to set or clear an individual GPIO pin. To implement this feature, the **GPIODATA** register covers 256 locations in the memory map.

During a write, if the address bit associated with that data bit is set, the value of the **GPIODATA** register is altered. If the address bit is cleared, the data bit is left unchanged.

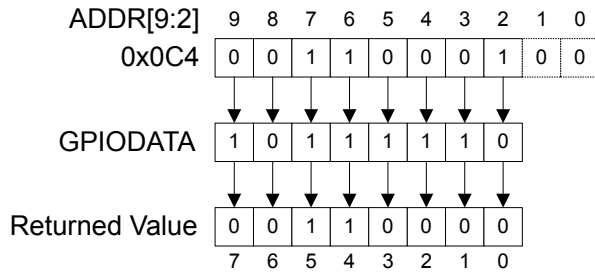
For example, writing a value of 0xEB to the address GPIODATA + 0x098 has the results shown in Figure 9-3, where u indicates that data is unchanged by the write.

Figure 9-3. GPIODATA Write Example



During a read, if the address bit associated with the data bit is set, the value is read. If the address bit associated with the data bit is cleared, the data bit is read as a zero, regardless of its actual value. For example, reading address GPIODATA + 0x0C4 yields as shown in Figure 9-4.

Figure 9-4. GPIODATA Read Example



9.2.2 Interrupt Control

The interrupt capabilities of each GPIO port are controlled by a set of seven registers. These registers are used to select the source of the interrupt, its polarity, and the edge properties. When one or more GPIO inputs cause an interrupt, a single interrupt output is sent to the interrupt controller for the entire GPIO port. For edge-triggered interrupts, software must clear the interrupt to enable any further interrupts. For a level-sensitive interrupt, the external source must hold the level constant for the interrupt to be recognized by the controller.

Three registers define the edge or sense that causes interrupts:

- **GPIO Interrupt Sense (GPIOIS)** register (see page 435)

- **GPIO Interrupt Both Edges (GPIOIBE)** register (see page 436)
- **GPIO Interrupt Event (GPIOIEV)** register (see page 437)

Interrupts are enabled/disabled via the **GPIO Interrupt Mask (GPIOIM)** register (see page 438).

When an interrupt condition occurs, the state of the interrupt signal can be viewed in two locations: the **GPIO Raw Interrupt Status (GPIORIS)** and **GPIO Masked Interrupt Status (GPIOMIS)** registers (see page 439 and page 440). As the name implies, the **GPIOMIS** register only shows interrupt conditions that are allowed to be passed to the interrupt controller. The **GPIORIS** register indicates that a GPIO pin meets the conditions for an interrupt, but has not necessarily been sent to the interrupt controller.

Interrupts are cleared by writing a 1 to the appropriate bit of the **GPIO Interrupt Clear (GPIOICR)** register (see page 442).

When programming the interrupt control registers (**GPIOIS**, **GPIOIBE**, or **GPIOIEV**), the interrupts should be masked (**GPIOIM** cleared). Writing any value to an interrupt control register can generate a spurious interrupt if the corresponding bits are enabled.

9.2.2.1 ADC Trigger Source

In addition to providing GPIO functionality, $PB4$ can also be used as an external trigger for the ADC. If $PB4$ is configured as a non-masked interrupt pin (the appropriate bit of **GPIOIM** is set), an interrupt for Port B is generated, and an external trigger signal is sent to the ADC. If the **ADC Event Multiplexer Select (ADCEMUX)** register is configured to use the external trigger, an ADC conversion is initiated. See page 655.

If no other Port B pins are being used to generate interrupts, the **Interrupt 0-31 Set Enable (EN0)** register can disable the Port B interrupts, and the ADC interrupt can be used to read back the converted data. Otherwise, the Port B interrupt handler must ignore and clear interrupts on $PB4$ and wait for the ADC interrupt, or the ADC interrupt must be disabled in the **EN0** register and the Port B interrupt handler must poll the ADC registers until the conversion is completed. See page 118 for more information.

9.2.3 Mode Control

The GPIO pins can be controlled by either software or hardware. Software control is the default for most signals and corresponds to the GPIO mode, where the **GPIODATA** register is used to read or write the corresponding pins. When hardware control is enabled via the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 443), the pin state is controlled by its alternate function (that is, the peripheral).

Further pin muxing options are provided through the **GPIO Port Control (GPIOPCTL)** register which selects one of several peripheral functions for each GPIO. For information on the configuration options, refer to Table 23-5 on page 1083.

Note: If any pin is to be used as an ADC input, the appropriate bit in the **GPIOAMSEL** register must be set to disable the analog isolation circuit.

9.2.4 Commit Control

The GPIO commit control registers provide a layer of protection against accidental programming of critical hardware peripherals. Protection is provided for the **NMI** pin ($PB7$) and the four JTAG/SWD pins ($PC[3:0]$). Writes to protected bits of the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 443), **GPIO Pull Up Select (GPIOPUR)** register (see page 449), **GPIO Pull-Down Select (GPIOPDR)** register (see page 451), and **GPIO Digital Enable (GPIDEN)** register (see

page 454) are not committed to storage unless the **GPIO Lock (GPIOLOCK)** register (see page 456) has been unlocked and the appropriate bits of the **GPIO Commit (GPIOCR)** register (see page 457) have been set.

9.2.5 Pad Control

The pad control registers allow software to configure the GPIO pads based on the application requirements. The pad control registers include the **GPIODR2R**, **GPIODR4R**, **GPIODR8R**, **GPIOODR**, **GPIOPUR**, **GPIOPDR**, **GPIOSLR**, and **GIODEN** registers. These registers control drive strength, open-drain configuration, pull-up and pull-down resistors, slew-rate control and digital input enable for each GPIO.

For special high-current applications, the GPIO output buffers may be used with the following restrictions. With the GPIO pins configured as 8-mA output drivers, a total of four GPIO outputs may be used to sink current loads up to 18 mA each. At 18-mA sink current loading, the V_{OL} value is specified as 1.2 V. The high-current GPIO package pins must be selected such that there are only a maximum of two per side of the physical package or BGA pin group with the total number of high-current GPIO outputs not exceeding four for the entire package.

9.2.6 Identification

The identification registers configured at reset allow software to detect and identify the module as a GPIO block. The identification registers include the **GPIOPeriphID0-GIOPeriphID7** registers as well as the **GPIOCellID0-GIOPCellID3** registers.

9.3 Initialization and Configuration

The GPIO modules may be accessed via two different memory apertures. The legacy aperture, the Advanced Peripheral Bus (APB), is backwards-compatible with previous Stellaris parts. The other aperture, the Advanced High-Performance Bus (AHB), offers the same register map but provides better back-to-back access performance than the APB bus. These apertures are mutually exclusive. The aperture enabled for a given GPIO port is controlled by the appropriate bit in the **GPIOHBCTL** register (see page 216).

To use the pins in a particular GPIO port, the clock for the port must be enabled by setting the appropriate GPIO Port bit field ($GPIO_n$) in the **RCGC2** register (see page 274).

When the internal POR signal is asserted and until otherwise configured, all GPIO pins are configured to be undriven (tristate): **GPIOAFSEL=0**, **GIODEN=0**, **GPIOPDR=0**, and **GPIOPUR=0**, except for the pins shown in Table 9-1 on page 420. Table 9-4 on page 428 shows all possible configurations of the GPIO pads and the control register settings required to achieve them. Table 9-5 on page 429 shows how a rising edge interrupt is configured for pin 2 of a GPIO port.

Table 9-4. GPIO Pad Configuration Examples

| Configuration | GPIO Register Bit Value ^a | | | | | | | | | |
|--|--------------------------------------|-----|-----|-----|-----|-----|------|------|------|-----|
| | AFSEL | DIR | ODR | DEN | PUR | PDR | DR2R | DR4R | DR8R | SLR |
| Digital Input (GPIO) | 0 | 0 | 0 | 1 | ? | ? | X | X | X | X |
| Digital Output (GPIO) | 0 | 1 | 0 | 1 | ? | ? | ? | ? | ? | ? |
| Open Drain Output (GPIO) | 0 | 1 | 1 | 1 | X | X | ? | ? | ? | ? |
| Open Drain Input/Output (I ² C) | 1 | X | 1 | 1 | X | X | ? | ? | ? | ? |
| Digital Input (Timer CCP) | 1 | X | 0 | 1 | ? | ? | X | X | X | X |

Table 9-4. GPIO Pad Configuration Examples (continued)

| Configuration | GPIO Register Bit Value ^a | | | | | | | | | |
|-----------------------------|--------------------------------------|-----|-----|-----|-----|-----|------|------|------|-----|
| | AFSEL | DIR | ODR | DEN | PUR | PDR | DR2R | DR4R | DR8R | SLR |
| Digital Input (QEI) | 1 | X | 0 | 1 | ? | ? | X | X | X | X |
| Digital Output (PWM) | 1 | X | 0 | 1 | ? | ? | ? | ? | ? | ? |
| Digital Output (Timer PWM) | 1 | X | 0 | 1 | ? | ? | ? | ? | ? | ? |
| Digital Input/Output (SSI) | 1 | X | 0 | 1 | ? | ? | ? | ? | ? | ? |
| Digital Input/Output (UART) | 1 | X | 0 | 1 | ? | ? | ? | ? | ? | ? |
| Analog Input (Comparator) | 0 | 0 | 0 | 0 | 0 | 0 | X | X | X | X |
| Digital Output (Comparator) | 1 | X | 0 | 1 | ? | ? | ? | ? | ? | ? |

a. X=Ignored (don't care bit)

?=Can be either 0 or 1, depending on the configuration

Table 9-5. GPIO Interrupt Configuration Example

| Register | Desired Interrupt Event Trigger | Pin 2 Bit Value ^a | | | | | | | |
|----------|--|------------------------------|---|---|---|---|---|---|---|
| | | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| GPIOIS | 0=edge 1=level | X | X | X | X | X | 0 | X | X |
| GPIOIBE | 0=single edge 1=both edges | X | X | X | X | X | 0 | X | X |
| GPIOIEV | 0=Low level, or falling edge 1=High level, or rising edge | X | X | X | X | X | 1 | X | X |
| GPIOIM | 0=masked 1=not masked | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

a. X=Ignored (don't care bit)

9.4 Register Map

Table 9-7 on page 430 lists the GPIO registers. Each GPIO port can be accessed through one of two bus apertures. The legacy aperture, the Advanced Peripheral Bus (APB), is backwards-compatible with previous Stellaris parts. The other aperture, the Advanced High-Performance Bus (AHB), offers the same register map but provides better back-to-back access performance than the APB bus.

Important: The GPIO registers in this chapter are duplicated in each GPIO block; however, depending on the block, all eight bits may not be connected to a GPIO pad. In those cases, writing to unconnected bits has no effect, and reading unconnected bits returns no meaningful data.

The offset listed is a hexadecimal increment to the register's address, relative to that GPIO port's base address:

- GPIO Port A (APB): 0x4000.4000
- GPIO Port A (AHB): 0x4005.8000

- GPIO Port B (APB): 0x4000.5000
- GPIO Port B (AHB): 0x4005.9000
- GPIO Port C (APB): 0x4000.6000
- GPIO Port C (AHB): 0x4005.A000
- GPIO Port D (APB): 0x4000.7000
- GPIO Port D (AHB): 0x4005.B000
- GPIO Port E (APB): 0x4002.4000
- GPIO Port E (AHB): 0x4005.C000
- GPIO Port F (APB): 0x4002.5000
- GPIO Port F (AHB): 0x4005.D000
- GPIO Port G (APB): 0x4002.6000
- GPIO Port G (AHB): 0x4005.E000
- GPIO Port H (APB): 0x4002.7000
- GPIO Port H (AHB): 0x4005.F000
- GPIO Port J (APB): 0x4003.D000
- GPIO Port J (AHB): 0x4006.0000

Note that each GPIO module clock must be enabled before the registers can be programmed (see page 274). There must be a delay of 3 system clocks after the GPIO module clock is enabled before any GPIO module registers are accessed.

Important: All GPIO pins are configured as GPIOs and tri-stated by default (**GPIOAFSEL**=0, **GPIODEN**=0, **GPIOPDR**=0, **GPIOPUR**=0, and **GPIOPCTL**=0, with the exception of the pins shown in the table below. A Power-On-Reset (\overline{POR}) or asserting \overline{RST} puts the pins back to their default state.

Table 9-6. GPIO Pins With Non-Zero Reset Values

| GPIO Pins | Default State | GPIOAFSEL | GPIODEN | GPIOPDR | GPIOPUR | GPIOPCTL |
|-----------|-------------------|-----------|---------|---------|---------|----------|
| PA[1:0] | UART0 | 0 | 0 | 0 | 0 | 0x1 |
| PA[5:2] | SSIO | 0 | 0 | 0 | 0 | 0x2 |
| PB[3:2] | I ² C0 | 0 | 0 | 0 | 0 | 0x3 |
| PC[3:0] | JTAG/SWD | 1 | 1 | 0 | 1 | 0x1 |

The default register type for the **GPIOCR** register is RO for all GPIO pins with the exception of the **NMI** pin and the four JTAG/SWD pins (**PB7** and **PC[3:0]**). These five pins are the only GPIOs that are protected by the **GPIOCR** register. Because of this, the register type for GPIO Port B7 and GPIO Port C[3:0] is R/W.

The default reset value for the **GPIOCR** register is 0x0000.00FF for all GPIO pins, with the exception of the **NMI** pin and the four JTAG/SWD pins (**PB7** and **PC[3:0]**). To ensure that the JTAG port is not accidentally programmed as GPIO pins, the **PC[3:0]** pins default to non-committable. Similarly, to ensure that the **NMI** pin is not accidentally programmed as a GPIO pin, the **PB7** pin defaults to non-committable. Because of this, the default reset value of **GPIOCR** for GPIO Port B is 0x0000.007F while the default reset value of **GPIOCR** for Port C is 0x0000.00F0.

Table 9-7. GPIO Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|----------|------|-------------|-------------|----------|
| 0x000 | GPIODATA | R/W | 0x0000.0000 | GPIO Data | 433 |

Table 9-7. GPIO Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|---------------|------|-------------|----------------------------------|----------|
| 0x400 | GPDIR | R/W | 0x0000.0000 | GPIO Direction | 434 |
| 0x404 | GPIOIS | R/W | 0x0000.0000 | GPIO Interrupt Sense | 435 |
| 0x408 | GPIOIBE | R/W | 0x0000.0000 | GPIO Interrupt Both Edges | 436 |
| 0x40C | GPIOIEV | R/W | 0x0000.0000 | GPIO Interrupt Event | 437 |
| 0x410 | GPIOIM | R/W | 0x0000.0000 | GPIO Interrupt Mask | 438 |
| 0x414 | GPORIS | RO | 0x0000.0000 | GPIO Raw Interrupt Status | 439 |
| 0x418 | GPOMIS | RO | 0x0000.0000 | GPIO Masked Interrupt Status | 440 |
| 0x41C | GPIOICR | W1C | 0x0000.0000 | GPIO Interrupt Clear | 442 |
| 0x420 | GPIOAFSEL | R/W | - | GPIO Alternate Function Select | 443 |
| 0x500 | GPIDR2R | R/W | 0x0000.00FF | GPIO 2-mA Drive Select | 445 |
| 0x504 | GPIDR4R | R/W | 0x0000.0000 | GPIO 4-mA Drive Select | 446 |
| 0x508 | GPIDR8R | R/W | 0x0000.0000 | GPIO 8-mA Drive Select | 447 |
| 0x50C | GPIOODR | R/W | 0x0000.0000 | GPIO Open Drain Select | 448 |
| 0x510 | GPPOPUR | R/W | - | GPIO Pull-Up Select | 449 |
| 0x514 | GPPOPDR | R/W | 0x0000.0000 | GPIO Pull-Down Select | 451 |
| 0x518 | GPPOSLR | R/W | 0x0000.0000 | GPIO Slew Rate Control Select | 453 |
| 0x51C | GPPODEN | R/W | - | GPIO Digital Enable | 454 |
| 0x520 | GPPOLOCK | R/W | 0x0000.0001 | GPIO Lock | 456 |
| 0x524 | GPPOCR | - | - | GPIO Commit | 457 |
| 0x528 | GPPOAMSEL | R/W | 0x0000.0000 | GPIO Analog Mode Select | 459 |
| 0x52C | GPPOPCTL | R/W | - | GPIO Port Control | 461 |
| 0xFD0 | GPPOPeriphID4 | RO | 0x0000.0000 | GPIO Peripheral Identification 4 | 463 |
| 0xFD4 | GPPOPeriphID5 | RO | 0x0000.0000 | GPIO Peripheral Identification 5 | 464 |
| 0xFD8 | GPPOPeriphID6 | RO | 0x0000.0000 | GPIO Peripheral Identification 6 | 465 |
| 0xFDC | GPPOPeriphID7 | RO | 0x0000.0000 | GPIO Peripheral Identification 7 | 466 |
| 0xFE0 | GPPOPeriphID0 | RO | 0x0000.0061 | GPIO Peripheral Identification 0 | 467 |
| 0xFE4 | GPPOPeriphID1 | RO | 0x0000.0000 | GPIO Peripheral Identification 1 | 468 |
| 0xFE8 | GPPOPeriphID2 | RO | 0x0000.0018 | GPIO Peripheral Identification 2 | 469 |
| 0xFEC | GPPOPeriphID3 | RO | 0x0000.0001 | GPIO Peripheral Identification 3 | 470 |
| 0xFF0 | GPPOPCellID0 | RO | 0x0000.000D | GPIO PrimeCell Identification 0 | 471 |
| 0xFF4 | GPPOPCellID1 | RO | 0x0000.00F0 | GPIO PrimeCell Identification 1 | 472 |
| 0xFF8 | GPPOPCellID2 | RO | 0x0000.0005 | GPIO PrimeCell Identification 2 | 473 |

Table 9-7. GPIO Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|-------------|------|-------------|---------------------------------|----------|
| 0xFFC | GPIOCellID3 | RO | 0x0000.00B1 | GPIO PrimeCell Identification 3 | 474 |

9.5 Register Descriptions

The remainder of this section lists and describes the GPIO registers, in numerical order by address offset.

Register 1: GPIO Data (GPIODATA), offset 0x000

The **GPIODATA** register is the data register. In software control mode, values written in the **GPIODATA** register are transferred onto the GPIO port pins if the respective pins have been configured as outputs through the **GPIO Direction (GPIODIR)** register (see page 434).

In order to write to **GPIODATA**, the corresponding bits in the mask, resulting from the address bus bits [9:2], must be set. Otherwise, the bit values remain unchanged by the write.

Similarly, the values read from this register are determined for each bit by the mask bit derived from the address used to access the data register, bits [9:2]. Bits that are set in the address mask cause the corresponding bits in **GPIODATA** to be read, and bits that are clear in the address mask cause the corresponding bits in **GPIODATA** to be read as 0, regardless of their value.

A read from **GPIODATA** returns the last bit value written if the respective pins are configured as outputs, or it returns the value on the corresponding input pin when these are configured as inputs. All bits are cleared by a reset.

GPIO Data (GPIODATA)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x000
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DATA | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | DATA | R/W | 0x00 | GPIO Data This register is virtually mapped to 256 locations in the address space. To facilitate the reading and writing of data to these registers by independent drivers, the data read from and written to the registers are masked by the eight address lines [9:2]. Reads from this register return its current state. Writes to this register only affect bits that are not masked by ADDR[9:2] and are configured as outputs. See "Data Register Operation" on page 426 for examples of reads and writes. |

Register 2: GPIO Direction (GPIODIR), offset 0x400

The **GPIODIR** register is the data direction register. Setting a bit in the **GPIODIR** register configures the corresponding pin to be an output, while clearing a bit configures the corresponding pin to be an input. All bits are cleared by a reset, meaning all GPIO pins are inputs by default.

GPIO Direction (GPIODIR)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x400
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DIR | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | DIR | R/W | 0x00 | GPIO Data Direction |
| | | | | Value Description |
| | | | | 0 Corresponding pin is an input. |
| | | | | 1 Corresponding pins is an output. |

Register 3: GPIO Interrupt Sense (GPIOIS), offset 0x404

The **GPIOIS** register is the interrupt sense register. Setting a bit in the **GPIOIS** register configures the corresponding pin to detect levels, while clearing a bit configures the corresponding pin to detect edges. All bits are cleared by a reset.

GPIO Interrupt Sense (GPIOIS)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x404

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | IS | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

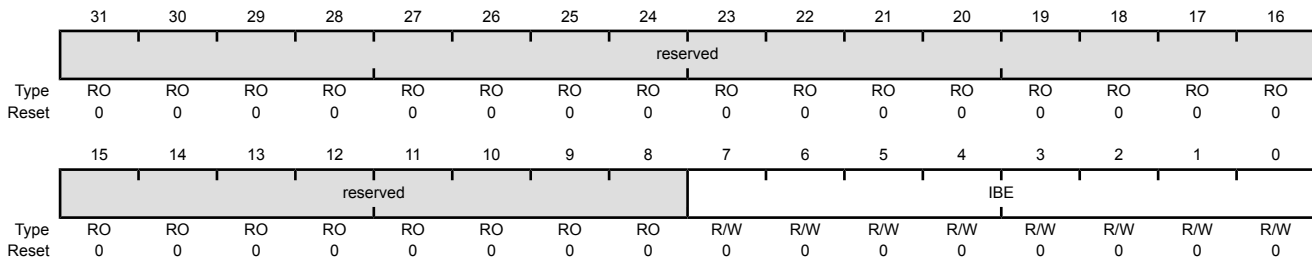
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | IS | R/W | 0x00 | GPIO Interrupt Sense |
| | | | | Value Description |
| | | | | 0 The edge on the corresponding pin is detected (edge-sensitive). |
| | | | | 1 The level on the corresponding pin is detected (level-sensitive). |

Register 4: GPIO Interrupt Both Edges (GPIOIBE), offset 0x408

The **GPIOIBE** register allows both edges to cause interrupts. When the corresponding bit in the **GPIO Interrupt Sense (GPIOIS)** register (see page 435) is set to detect edges, setting a bit in the **GPIOIBE** register configures the corresponding pin to detect both rising and falling edges, regardless of the corresponding bit in the **GPIO Interrupt Event (GPIOIEV)** register (see page 437). Clearing a bit configures the pin to be controlled by the **GPIOIEV** register. All bits are cleared by a reset.

GPIO Interrupt Both Edges (GPIOIBE)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x408
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | IBE | R/W | 0x00 | GPIO Interrupt Both Edges |
| | | | | Value Description |
| | | | | 0 Interrupt generation is controlled by the GPIO Interrupt Event (GPIOIEV) register (see page 437). |
| | | | | 1 Both edges on the corresponding pin trigger an interrupt. |

Register 5: GPIO Interrupt Event (GPIOIEV), offset 0x40C

The **GPIOIEV** register is the interrupt event register. Setting a bit in the **GPIOIEV** register configures the corresponding pin to detect rising edges or high levels, depending on the corresponding bit value in the **GPIO Interrupt Sense (GPIOIS)** register (see page 435). Clearing a bit configures the pin to detect falling edges or low levels, depending on the corresponding bit value in the **GPIOIS** register. All bits are cleared by a reset.

GPIO Interrupt Event (GPIOIEV)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x40C
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | IEV | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

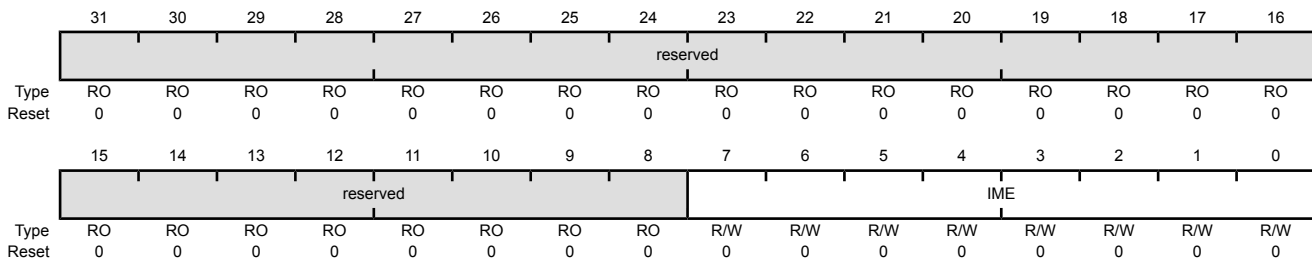
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | IEV | R/W | 0x00 | GPIO Interrupt Event |
| | | | | Value Description |
| | | | | 0 A falling edge or a Low level on the corresponding pin triggers an interrupt. |
| | | | | 1 A rising edge or a High level on the corresponding pin triggers an interrupt. |

Register 6: GPIO Interrupt Mask (GPIOIM), offset 0x410

The **GPIOIM** register is the interrupt mask register. Setting a bit in the **GPIOIM** register allows interrupts that are generated by the corresponding pin to be sent to the interrupt controller on the combined interrupt signal. Clearing a bit prevents an interrupt on the corresponding pin from being sent to the interrupt controller. All bits are cleared by a reset.

GPIO Interrupt Mask (GPIOIM)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x410
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:8 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | IME | R/W | 0x00 | GPIO Interrupt Mask Enable |

| Value | Description |
|-------|---|
| 0 | The interrupt from the corresponding pin is masked. |
| 1 | The interrupt from the corresponding pin is sent to the interrupt controller. |

Register 7: GPIO Raw Interrupt Status (GPIORIS), offset 0x414

The **GPIORIS** register is the raw interrupt status register. A bit in this register is set when an interrupt condition occurs on the corresponding GPIO pin. If the corresponding bit in the **GPIO Interrupt Mask (GPIOIM)** register (see page 438) is set, the interrupt is sent to the interrupt controller. Bits read as zero indicate that corresponding input pins have not initiated an interrupt. A bit in this register can be cleared by writing a 1 to the corresponding bit in the **GPIO Interrupt Clear (GPIOICR)** register.

GPIO Raw Interrupt Status (GPIORIS)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x414

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | RIS | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:8 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | RIS | RO | 0x00 | GPIO Interrupt Raw Status |
| | | | | Value Description |
| | | | | 1 An interrupt condition has occurred on the corresponding pin. |
| | | | | 0 An interrupt condition has not occurred on the corresponding pin. |

A bit is cleared by writing a 1 to the corresponding bit in the **GPIOICR** register.

Register 8: GPIO Masked Interrupt Status (GPIOMIS), offset 0x418

The **GPIOMIS** register is the masked interrupt status register. If a bit is set in this register, the corresponding interrupt has triggered an interrupt to the interrupt controller. If a bit is clear, either no interrupt has been generated, or the interrupt is masked.

In addition to providing GPIO functionality, **PB4** can also be used as an external trigger for the ADC. If **PB4** is configured as a non-masked interrupt pin (the appropriate bit of **GPIOIM** is set), an interrupt for Port B is generated, and an external trigger signal is sent to the ADC. If the **ADC Event Multiplexer Select (ADCEMUX)** register is configured to use the external trigger, an ADC conversion is initiated. See page 655.

If no other Port B pins are being used to generate interrupts, the **Interrupt 0-31 Set Enable (EN0)** register can disable the Port B interrupts, and the ADC interrupt can be used to read back the converted data. Otherwise, the Port B interrupt handler must ignore and clear interrupts on **PB4** and wait for the ADC interrupt, or the ADC interrupt must be disabled in the **EN0** register and the Port B interrupt handler must poll the ADC registers until the conversion is completed. See page 118 for more information.

GPIOMIS is the state of the interrupt after masking.

GPIO Masked Interrupt Status (GPIOMIS)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x418
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | MIS | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:8 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

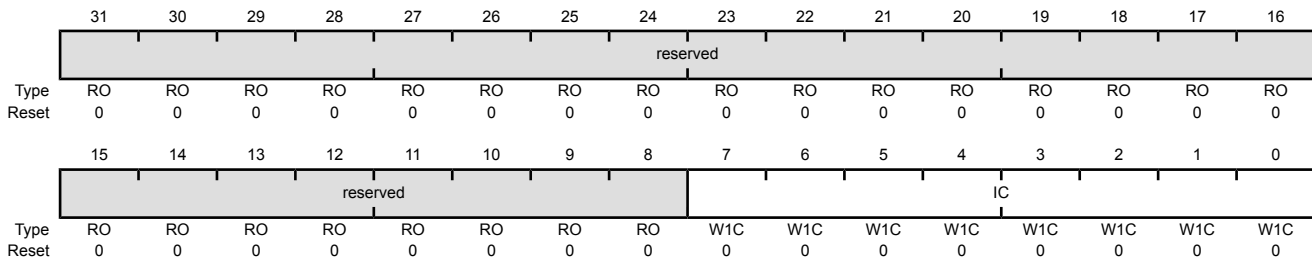
| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 7:0 | MIS | RO | 0x00 | GPIO Masked Interrupt Status |
| | | | | Value Description |
| | | | | 1 An interrupt condition on the corresponding pin has triggered an interrupt to the interrupt controller. |
| | | | | 0 An interrupt condition on the corresponding pin is masked or has not occurred. |
| | | | | A bit is cleared by writing a 1 to the corresponding bit in the GPIOICR register. |

Register 9: GPIO Interrupt Clear (GPIOICR), offset 0x41C

The **GPIOICR** register is the interrupt clear register. Writing a 1 to a bit in this register clears the corresponding interrupt bit in the **GPIOIRIS** and **GPIOMIS** registers. Writing a 0 has no effect.

GPIO Interrupt Clear (GPIOICR)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x41C
 Type W1C, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-------------------|----------|--|-------|---|
| 31:8 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | IC | W1C | 0x00 | GPIO Interrupt Clear |
| Value Description | | | | |
| | 1 | The corresponding interrupt is cleared. | | |
| | 0 | The corresponding interrupt is unaffected. | | |

Register 10: GPIO Alternate Function Select (GPIOAFSEL), offset 0x420

The **GPIOAFSEL** register is the mode control select register. If a bit is clear, the pin is used as a GPIO and is controlled by the GPIO registers. Setting a bit in this register configures the corresponding GPIO line to be controlled by an associated peripheral. Several possible peripheral functions are multiplexed on each GPIO. The **GPIO Port Control (GPIOPCTL)** register is used to select one of the possible functions. Table 23-5 on page 1083 details which functions are muxed on each GPIO pin. The reset value for this register is 0x0000.0000 for GPIO ports that are not listed in the table below.

Important: All GPIO pins are configured as GPIOs and tri-stated by default (**GPIOAFSEL**=0, **GIODEN**=0, **GPIOPDR**=0, **GPIOPUR**=0, and **GPIOPCTL**=0, with the exception of the pins shown in the table below. A Power-On-Reset (\overline{POR}) or asserting \overline{RST} puts the pins back to their default state.

Table 9-8. GPIO Pins With Non-Zero Reset Values

| GPIO Pins | Default State | GPIOAFSEL | GIODEN | GPIOPDR | GPIOPUR | GPIOPCTL |
|-----------|-------------------|-----------|--------|---------|---------|----------|
| PA[1:0] | UART0 | 0 | 0 | 0 | 0 | 0x1 |
| PA[5:2] | SSI0 | 0 | 0 | 0 | 0 | 0x2 |
| PB[3:2] | I ² C0 | 0 | 0 | 0 | 0 | 0x3 |
| PC[3:0] | JTAG/SWD | 1 | 1 | 0 | 1 | 0x1 |

Caution – It is possible to create a software sequence that prevents the debugger from connecting to the Stellaris microcontroller. If the program code loaded into flash immediately changes the JTAG pins to their GPIO functionality, the debugger may not have enough time to connect and halt the controller before the JTAG pin functionality switches. As a result, the debugger may be locked out of the part. This issue can be avoided with a software routine that restores JTAG functionality based on an external or software trigger.

The GPIO commit control registers provide a layer of protection against accidental programming of critical hardware peripherals. Protection is provided for the **NMI** pin (**PB7**) and the four **JTAG/SWD** pins (**PC[3:0]**). Writes to protected bits of the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 443), **GPIO Pull Up Select (GPIOPUR)** register (see page 449), **GPIO Pull-Down Select (GPIOPDR)** register (see page 451), and **GPIO Digital Enable (GIODEN)** register (see page 454) are not committed to storage unless the **GPIO Lock (GPIOLOCK)** register (see page 456) has been unlocked and the appropriate bits of the **GPIO Commit (GPIOCR)** register (see page 457) have been set.

When using the I²C module, in addition to setting the **GPIOAFSEL** register bits for the I²C clock and data pins, the data pins should be set to open drain using the **GPIO Open Drain Select (GPIOODR)** register (see examples in “Initialization and Configuration” on page 428).

GPIO Alternate Function Select (GPIOAFSEL)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000

Offset 0x420
 Type R/W, reset -

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | AFSEL | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | AFSEL | R/W | - | GPIO Alternate Function Select |

| Value | Description |
|-------|--|
| 0 | The associated pin functions as a GPIO and is controlled by the GPIO registers. |
| 1 | The associated pin functions as a peripheral signal and is controlled by the alternate hardware function. The reset value for this register is 0x0000.0000 for GPIO ports that are not listed in Table 9-1 on page 420. |

Register 11: GPIO 2-mA Drive Select (GPIODR2R), offset 0x500

The **GPIODR2R** register is the 2-mA drive control register. Each GPIO signal in the port can be individually configured without affecting the other pads. When setting the **DRV2** bit for a GPIO signal, the corresponding **DRV4** bit in the **GPIODR4R** register and **DRV8** bit in the **GPIODR8R** register are automatically cleared by hardware. By default, all GPIO pins have 2-mA drive.

GPIO 2-mA Drive Select (GPIODR2R)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x500

Type R/W, reset 0x0000.00FF

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DRV2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | DRV2 | R/W | 0xFF | Output Pad 2-mA Drive Enable |

Value Description

| Value | Description |
|-------|--|
| 1 | The corresponding GPIO pin has 2-mA drive. |
| 0 | The drive for the corresponding GPIO pin is controlled by the GPIODR4R or GPIODR8R register. |

Setting a bit in either the **GPIODR4** register or the **GPIODR8** register clears the corresponding 2-mA enable bit. The change is effective on the second clock cycle after the write if accessing GPIO via the APB memory aperture. If using AHB access, the change is effective on the next clock cycle.

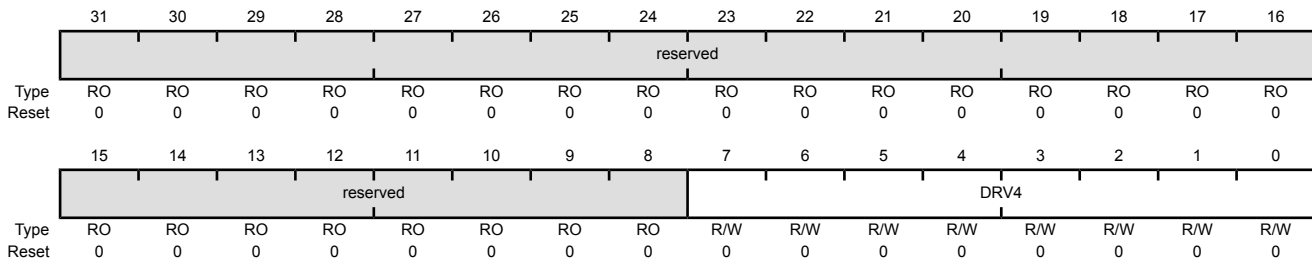
Register 12: GPIO 4-mA Drive Select (GPIODR4R), offset 0x504

The **GPIODR4R** register is the 4-mA drive control register. Each GPIO signal in the port can be individually configured without affecting the other pads. When setting the **DRV4** bit for a GPIO signal, the corresponding **DRV2** bit in the **GPIODR2R** register and **DRV8** bit in the **GPIODR8R** register are automatically cleared by hardware.

GPIO 4-mA Drive Select (GPIODR4R)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x504

Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | DRV4 | R/W | 0x00 | Output Pad 4-mA Drive Enable |

Value Description

- 1 The corresponding GPIO pin has 4-mA drive.
- 0 The drive for the corresponding GPIO pin is controlled by the **GPIODR2R** or **GPIODR8R** register.

Setting a bit in either the **GPIODR2** register or the **GPIODR8** register clears the corresponding 4-mA enable bit. The change is effective on the second clock cycle after the write if accessing GPIO via the APB memory aperture. If using AHB access, the change is effective on the next clock cycle.

Register 13: GPIO 8-mA Drive Select (GPIODR8R), offset 0x508

The **GPIODR8R** register is the 8-mA drive control register. Each GPIO signal in the port can be individually configured without affecting the other pads. When setting the **DRV8** bit for a GPIO signal, the corresponding **DRV2** bit in the **GPIODR2R** register and **DRV4** bit in the **GPIODR4R** register are automatically cleared by hardware. The 8-mA setting is also used for high-current operation.

Note: There is no configuration difference between 8-mA and high-current operation. The additional current capacity results from a shift in the V_{OH}/V_{OL} levels. See “Recommended Operating Conditions” on page 1128 for further information.

GPIO 8-mA Drive Select (GPIODR8R)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x508
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DRV8 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | DRV8 | R/W | 0x00 | Output Pad 8-mA Drive Enable |

Value Description

| Value | Description |
|-------|--|
| 1 | The corresponding GPIO pin has 8-mA drive. |
| 0 | The drive for the corresponding GPIO pin is controlled by the GPIODR2R or GPIODR4R register. |

Setting a bit in either the **GPIODR2** register or the **GPIODR4** register clears the corresponding 8-mA enable bit. The change is effective on the second clock cycle after the write if accessing GPIO via the APB memory aperture. If using AHB access, the change is effective on the next clock cycle.

Register 14: GPIO Open Drain Select (GPIOODR), offset 0x50C

The **GPIOODR** register is the open drain control register. Setting a bit in this register enables the open-drain configuration of the corresponding GPIO pad. When open-drain mode is enabled, the corresponding bit should also be set in the **GPIO Digital Enable (GPIODEN)** register (see page 454). Corresponding bits in the drive strength and slew rate control registers (**GPIODR2R**, **GPIODR4R**, **GPIODR8R**, and **GPIOSLR**) can be set to achieve the desired rise and fall times. The GPIO acts as an input if the corresponding bit in the **GPIODIR** register is cleared. If open drain is selected while the GPIO is configured as an input, the GPIO will remain an input and the open-drain selection has no effect until the GPIO is changed to an output.

When using the I²C module, in addition to configuring the pin to open drain, the **GPIO Alternate Function Select (GPIOAFSEL)** register bits for the I²C clock and data pins should be set (see examples in “Initialization and Configuration” on page 428).

GPIO Open Drain Select (GPIOODR)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x50C
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | ODE | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | |
|-------------------|----------|--|-----------|---|--|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | |
| 7:0 | ODE | R/W | 0x00 | Output Pad Open Drain Enable | |
| Value Description | | | | | |
| | 1 | The corresponding pin is configured as open drain. | | | |
| | 0 | The corresponding pin is not configured as open drain. | | | |

Register 15: GPIO Pull-Up Select (GPIOPUR), offset 0x510

The **GPIOPUR** register is the pull-up control register. When a bit is set, a weak pull-up resistor on the corresponding GPIO signal is enabled. Setting a bit in **GPIOPUR** automatically clears the corresponding bit in the **GPIO Pull-Down Select (GPIOPDR)** register (see page 451). Write access to this register is protected with the **GPIOCR** register. Bits in **GPIOCR** that are cleared prevent writes to the equivalent bit in this register.

Important: All GPIO pins are configured as GPIOs and tri-stated by default (**GPIOAFSEL**=0, **GIODEN**=0, **GPIOPDR**=0, **GPIOPUR**=0, and **GPIOCTL**=0, with the exception of the pins shown in the table below. A Power-On-Reset (\overline{POR}) or asserting \overline{RST} puts the pins back to their default state.

Table 9-9. GPIO Pins With Non-Zero Reset Values

| GPIO Pins | Default State | GPIOAFSEL | GIODEN | GPIOPDR | GPIOPUR | GPIOCTL |
|-----------|-------------------|-----------|--------|---------|---------|---------|
| PA[1:0] | UART0 | 0 | 0 | 0 | 0 | 0x1 |
| PA[5:2] | SSI0 | 0 | 0 | 0 | 0 | 0x2 |
| PB[3:2] | I ² C0 | 0 | 0 | 0 | 0 | 0x3 |
| PC[3:0] | JTAG/SWD | 1 | 1 | 0 | 1 | 0x1 |

Note: The GPIO commit control registers provide a layer of protection against accidental programming of critical hardware peripherals. Protection is provided for the **NMI** pin (**PB7**) and the four **JTAG/SWD** pins (**PC[3:0]**). Writes to protected bits of the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 443), **GPIO Pull Up Select (GPIOPUR)** register (see page 449), **GPIO Pull-Down Select (GPIOPDR)** register (see page 451), and **GPIO Digital Enable (GIODEN)** register (see page 454) are not committed to storage unless the **GPIO Lock (GPIOLOCK)** register (see page 456) has been unlocked and the appropriate bits of the **GPIO Commit (GPIOCR)** register (see page 457) have been set.

GPIO Pull-Up Select (GPIOPUR)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x510

Type R/W, reset -

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PUE | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| | | | | |
|-----|-----|-----|---|-------------------------|
| 7:0 | PUE | R/W | - | Pad Weak Pull-Up Enable |
|-----|-----|-----|---|-------------------------|

Value Description

- 1 The corresponding pin has a weak pull-up resistor.
- 0 The corresponding pin is not affected.

Setting a bit in the **GPIOPDR** register clears the corresponding bit in the **GPIOPUR** register. The change is effective on the second clock cycle after the write if accessing GPIO via the APB memory aperture. If using AHB access, the change is effective on the next clock cycle. The reset value for this register is 0x0000.0000 for GPIO ports that are not listed in Table 9-1 on page 420.

Register 16: GPIO Pull-Down Select (GPIOPDR), offset 0x514

The **GPIOPDR** register is the pull-down control register. When a bit is set, a weak pull-down resistor on the corresponding GPIO signal is enabled. Setting a bit in **GPIOPDR** automatically clears the corresponding bit in the **GPIO Pull-Up Select (GPIOPUR)** register (see page 449).

Important: All GPIO pins are configured as GPIOs and tri-stated by default (**GPIOAFSEL**=0, **GIODEN**=0, **GPIOPDR**=0, **GPIOPUR**=0, and **GPIOCTL**=0, with the exception of the pins shown in the table below. A Power-On-Reset (**POR**) or asserting **RST** puts the pins back to their default state.

Table 9-10. GPIO Pins With Non-Zero Reset Values

| GPIO Pins | Default State | GPIOAFSEL | GIODEN | GPIOPDR | GPIOPUR | GPIOCTL |
|-----------|-------------------|-----------|--------|---------|---------|---------|
| PA[1:0] | UART0 | 0 | 0 | 0 | 0 | 0x1 |
| PA[5:2] | SSI0 | 0 | 0 | 0 | 0 | 0x2 |
| PB[3:2] | I ² C0 | 0 | 0 | 0 | 0 | 0x3 |
| PC[3:0] | JTAG/SWD | 1 | 1 | 0 | 1 | 0x1 |

Note: The GPIO commit control registers provide a layer of protection against accidental programming of critical hardware peripherals. Protection is provided for the **NMI** pin (**PB7**) and the four **JTAG/SWD** pins (**PC[3:0]**). Writes to protected bits of the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 443), **GPIO Pull Up Select (GPIOPUR)** register (see page 449), **GPIO Pull-Down Select (GPIOPDR)** register (see page 451), and **GPIO Digital Enable (GIODEN)** register (see page 454) are not committed to storage unless the **GPIO Lock (GPIOLOCK)** register (see page 456) has been unlocked and the appropriate bits of the **GPIO Commit (GPIOCR)** register (see page 457) have been set.

GPIO Pull-Down Select (GPIOPDR)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x514
 Type R/W, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PDE | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|--|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PDE | R/W | 0x00 | Pad Weak Pull-Down Enable |
| | | | | Value Description |
| | | | | 1 The corresponding pin has a weak pull-down resistor. |
| | | | | 0 The corresponding pin is not affected. |
| | | | | Setting a bit in the GPIOPUR register clears the corresponding bit in the GPIOPDR register. The change is effective on the second clock cycle after the write if accessing GPIO via the APB memory aperture. If using AHB access, the change is effective on the next clock cycle. |

Register 17: GPIO Slew Rate Control Select (GPIOSLR), offset 0x518

The **GPIOSLR** register is the slew rate control register. Slew rate control is only available when using the 8-mA drive strength option via the **GPIO 8-mA Drive Select (GPIO8R)** register (see page 447).

GPIO Slew Rate Control Select (GPIOSLR)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x518

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | SRL | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | SRL | R/W | 0x00 | Slew Rate Limit Enable (8-mA drive only) |
| | | | | Value Description |
| | | | | 1 Slew rate control is enabled for the corresponding pin. |
| | | | | 0 Slew rate control is disabled for the corresponding pin. |

Register 18: GPIO Digital Enable (GPIODEN), offset 0x51C

Note: Pins configured as digital inputs are Schmitt-triggered.

The **GPIODEN** register is the digital enable register. By default, all GPIO signals except those listed below are configured out of reset to be undriven (tristate). Their digital function is disabled; they do not drive a logic value on the pin and they do not allow the pin voltage into the GPIO receiver. To use the pin as a digital input or output (either GPIO or alternate function), the corresponding **GPIODEN** bit must be set.

Important: All GPIO pins are configured as GPIOs and tri-stated by default (**GPIOAFSEL**=0, **GPIODEN**=0, **GPIOPDR**=0, **GPIOPUR**=0, and **GPIOCTL**=0, with the exception of the pins shown in the table below. A Power-On-Reset (\overline{POR}) or asserting \overline{RST} puts the pins back to their default state.

Table 9-11. GPIO Pins With Non-Zero Reset Values

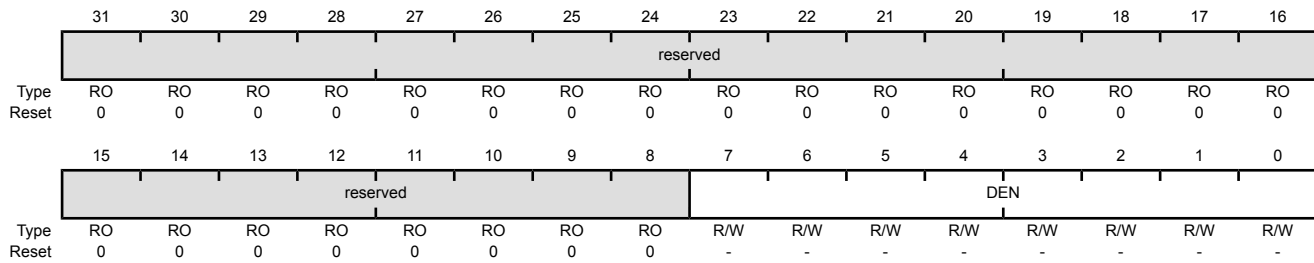
| GPIO Pins | Default State | GPIOAFSEL | GPIODEN | GPIOPDR | GPIOPUR | GPIOCTL |
|-----------|-------------------|-----------|---------|---------|---------|---------|
| PA[1:0] | UART0 | 0 | 0 | 0 | 0 | 0x1 |
| PA[5:2] | SSI0 | 0 | 0 | 0 | 0 | 0x2 |
| PB[3:2] | I ² C0 | 0 | 0 | 0 | 0 | 0x3 |
| PC[3:0] | JTAG/SWD | 1 | 1 | 0 | 1 | 0x1 |

Note: The GPIO commit control registers provide a layer of protection against accidental programming of critical hardware peripherals. Protection is provided for the **NMI** pin (**PB7**) and the four **JTAG/SWD** pins (**PC[3:0]**). Writes to protected bits of the **GPIO Alternate Function Select (GPIOAFSEL)** register (see page 443), **GPIO Pull Up Select (GPIOPUR)** register (see page 449), **GPIO Pull-Down Select (GPIOPDR)** register (see page 451), and **GPIO Digital Enable (GPIODEN)** register (see page 454) are not committed to storage unless the **GPIO Lock (GPIOLOCK)** register (see page 456) has been unlocked and the appropriate bits of the **GPIO Commit (GPIOCR)** register (see page 457) have been set.

GPIO Digital Enable (GPIODEN)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000

Offset 0x51C
 Type R/W, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | DEN | R/W | - | Digital Enable |

| Value | Description |
|-------|---|
| 0 | The digital functions for the corresponding pin are disabled. |
| 1 | The digital functions for the corresponding pin are enabled. |

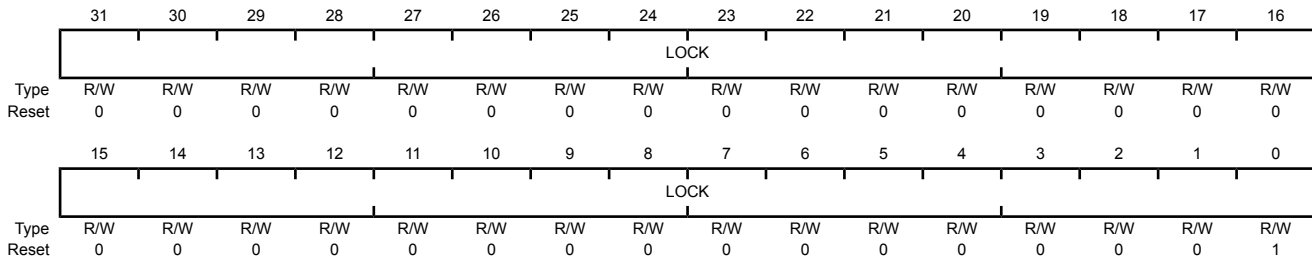
The reset value for this register is 0x0000.0000 for GPIO ports that are not listed in Table 9-1 on page 420.

Register 19: GPIO Lock (GPIOLOCK), offset 0x520

The **GPIOLOCK** register enables write access to the **GPIOCR** register (see page 457). Writing 0x4C4F.434B to the **GPIOLOCK** register unlocks the **GPIOCR** register. Writing any other value to the **GPIOLOCK** register re-enables the locked state. Reading the **GPIOLOCK** register returns the lock status rather than the 32-bit value that was previously written. Therefore, when write accesses are disabled, or locked, reading the **GPIOLOCK** register returns 0x0000.0001. When write accesses are enabled, or unlocked, reading the **GPIOLOCK** register returns 0x0000.0000.

GPIO Lock (GPIOLOCK)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x520
 Type R/W, reset 0x0000.0001



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|-------------|
| 31:0 | LOCK | R/W | 0x0000.0001 | GPIO Lock |

A write of the value 0x4C4F.434B unlocks the **GPIO Commit (GPIOCR)** register for write access. A write of any other value or a write to the **GPIOCR** register reapplies the lock, preventing any register updates. A read of this register returns the following values:

| Value | Description |
|-------|---|
| 0x1 | The GPIOCR register is locked and may not be modified. |
| 0x0 | The GPIOCR register is unlocked and may be modified. |

Register 20: GPIO Commit (GPIOCR), offset 0x524

The **GPIOCR** register is the commit register. The value of the **GPIOCR** register determines which bits of the **GPIOAFSEL**, **GPIOPUR**, **GPIOPDR**, and **GIODEN** registers are committed when a write to these registers is performed. If a bit in the **GPIOCR** register is cleared, the data being written to the corresponding bit in the **GPIOAFSEL**, **GPIOPUR**, **GPIOPDR**, or **GIODEN** registers cannot be committed and retains its previous value. If a bit in the **GPIOCR** register is set, the data being written to the corresponding bit of the **GPIOAFSEL**, **GPIOPUR**, **GPIOPDR**, or **GIODEN** registers is committed to the register and reflects the new value.

The contents of the **GPIOCR** register can only be modified if the status in the **GPIOLOCK** register is unlocked. Writes to the **GPIOCR** register are ignored if the status in the **GPIOLOCK** register is locked.

Important: This register is designed to prevent accidental programming of the registers that control connectivity to the NMI and JTAG/SWD debug hardware. By initializing the bits of the **GPIOCR** register to 0 for **PB7** and **PC[3:0]**, the NMI and JTAG/SWD debug port can only be converted to GPIOs through a deliberate set of writes to the **GPIOLOCK**, **GPIOCR**, and the corresponding registers.

Because this protection is currently only implemented on the NMI and JTAG/SWD pins on **PB7** and **PC[3:0]**, all of the other bits in the **GPIOCR** registers cannot be written with 0x0. These bits are hardwired to 0x1, ensuring that it is always possible to commit new values to the **GPIOAFSEL**, **GPIOPUR**, **GPIOPDR**, or **GIODEN** register bits of these other pins.

GPIO Commit (GPIOCR)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x524

Type -, reset -

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CR | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | - | - | - | - | - | - | - | - |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| | | | | |
|-----|----|---|---|-------------|
| 7:0 | CR | - | - | GPIO Commit |
|-----|----|---|---|-------------|

Value Description

1 The corresponding **GPIOAFSEL**, **GPIOPUR**, **GPIOPDR**, or **GIODEN** bits can be written.

0 The corresponding **GPIOAFSEL**, **GPIOPUR**, **GPIOPDR**, or **GIODEN** bits cannot be written.

Note: The default register type for the **GPIOCR** register is RO for all GPIO pins with the exception of the **NMI** pin and the four JTAG/SWD pins (**PB7** and **PC[3:0]**). These five pins are the only GPIOs that are protected by the **GPIOCR** register. Because of this, the register type for GPIO Port B7 and GPIO Port C[3:0] is R/W.

The default reset value for the **GPIOCR** register is 0x0000.00FF for all GPIO pins, with the exception of the **NMI** pin and the four JTAG/SWD pins (**PB7** and **PC[3:0]**). To ensure that the JTAG port is not accidentally programmed as GPIO pins, the **PC[3:0]** pins default to non-committable. Similarly, to ensure that the **NMI** pin is not accidentally programmed as a GPIO pin, the **PB7** pin defaults to non-committable. Because of this, the default reset value of **GPIOCR** for GPIO Port B is 0x0000.007F while the default reset value of **GPIOCR** for Port C is 0x0000.00F0.

Register 21: GPIO Analog Mode Select (GPIOAMSEL), offset 0x528

Important: This register is only valid for ports D and E; the corresponding base addresses for the remaining ports are not valid.

If any pin is to be used as an ADC input, the appropriate bit in **GPIOAMSEL** must be set to disable the analog isolation circuit.

The **GPIOAMSEL** register controls isolation circuits to the analog side of a unified I/O pad. Because the GPIOs may be driven by a 5-V source and affect analog operation, analog circuitry requires isolation from the pins when they are not used in their analog function.

Each bit of this register controls the isolation circuitry for the corresponding GPIO signal. For information on which GPIO pins can be used for ADC functions, refer to Table 23-5 on page 1083.

GPIO Analog Mode Select (GPIOAMSEL)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0x528

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-----------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | GPIOAMSEL | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|---|
| 7:0 | GPIOAMSEL | R/W | 0x00 | GPIO Analog Mode Select |
| | | | | Value Description |
| | | | | 1 The analog function of the pin is enabled, the isolation is disabled, and the pin is capable of analog functions. |
| | | | | 0 The analog function of the pin is disabled, the isolation is enabled, and the pin is capable of digital functions as specified by the other GPIO configuration registers. |
| | | | | Note: This register and bits are only valid for GPIO signals that share analog function through a unified I/O pad. |
| | | | | The reset state of this register is 0 for all signals. |

Register 22: GPIO Port Control (GPIOCTL), offset 0x52C

The **GPIOCTL** register is used in conjunction with the **GPIOAFSEL** register and selects the specific peripheral signal for each GPIO pin when using the alternate function mode. Most bits in the **GPIOAFSEL** register are cleared on reset, therefore most GPIO pins are configured as GPIOs by default. When a bit is set in the **GPIOAFSEL** register, the corresponding GPIO signal is controlled by an associated peripheral. The **GPIOCTL** register selects one out of a set of peripheral functions for each GPIO, providing additional flexibility in signal definition. For information on the defined encodings for the bit fields in this register, refer to Table 23-5 on page 1083. The reset value for this register is 0x0000.0000 for GPIO ports that are not listed in the table below.

Note: If the same signal is assigned to two different GPIO port pins, the signal is assigned to the port with the lowest letter and the assignment to the higher letter port is ignored.

Important: All GPIO pins are configured as GPIOs and tri-stated by default (**GPIOAFSEL**=0, **GIODEN**=0, **GPIOPDR**=0, **GPIOPUR**=0, and **GPIOCTL**=0, with the exception of the pins shown in the table below. A Power-On-Reset (\overline{POR}) or asserting \overline{RST} puts the pins back to their default state.

Table 9-12. GPIO Pins With Non-Zero Reset Values

| GPIO Pins | Default State | GPIOAFSEL | GIODEN | GPIOPDR | GPIOPUR | GPIOCTL |
|-----------|-------------------|-----------|--------|---------|---------|---------|
| PA[1:0] | UART0 | 0 | 0 | 0 | 0 | 0x1 |
| PA[5:2] | SSI0 | 0 | 0 | 0 | 0 | 0x2 |
| PB[3:2] | I ² C0 | 0 | 0 | 0 | 0 | 0x3 |
| PC[3:0] | JTAG/SWD | 1 | 1 | 0 | 1 | 0x1 |

GPIO Port Control (GPIOCTL)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000

Offset 0x52C

Type R/W, reset -

| | | | | | | | | | | | | | | | | |
|-------|------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | PMC7 | | | | PMC6 | | | | PMC5 | | | | PMC4 | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | PMC3 | | | | PMC2 | | | | PMC1 | | | | PMC0 | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 31:28 | PMC7 | R/W | - | Port Mux Control 7 This field controls the configuration for GPIO pin 7. |
| 27:24 | PMC6 | R/W | - | Port Mux Control 6 This field controls the configuration for GPIO pin 6. |
| 23:20 | PMC5 | R/W | - | Port Mux Control 5 This field controls the configuration for GPIO pin 5. |
| 19:16 | PMC4 | R/W | - | Port Mux Control 4 This field controls the configuration for GPIO pin 4. |
| 15:12 | PMC3 | R/W | - | Port Mux Control 3 This field controls the configuration for GPIO pin 3. |
| 11:8 | PMC2 | R/W | - | Port Mux Control 2 This field controls the configuration for GPIO pin 2. |
| 7:4 | PMC1 | R/W | - | Port Mux Control 1 This field controls the configuration for GPIO pin 1. |
| 3:0 | PMC0 | R/W | - | Port Mux Control 0 This field controls the configuration for GPIO pin 0. |

Register 23: GPIO Peripheral Identification 4 (GPIOPeriphID4), offset 0xFD0

The **GPIOPeriphID4**, **GPIOPeriphID5**, **GPIOPeriphID6**, and **GPIOPeriphID7** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 4 (GPIOPeriphID4)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFD0
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID4 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

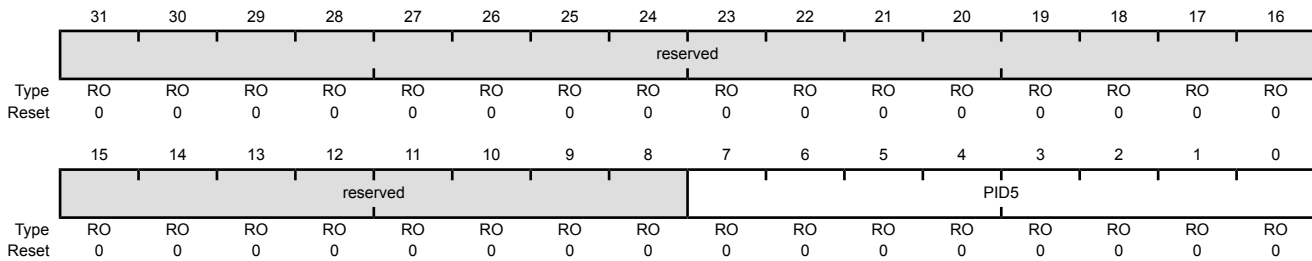
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID4 | RO | 0x00 | GPIO Peripheral ID Register [7:0] |

Register 24: GPIO Peripheral Identification 5 (GPIOPeriphID5), offset 0xFD4

The **GPIOPeriphID4**, **GPIOPeriphID5**, **GPIOPeriphID6**, and **GPIOPeriphID7** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 5 (GPIOPeriphID5)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFD4
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID5 | RO | 0x00 | GPIO Peripheral ID Register [15:8] |

Register 25: GPIO Peripheral Identification 6 (GPIOPeriphID6), offset 0xFD8

The **GPIOPeriphID4**, **GPIOPeriphID5**, **GPIOPeriphID6**, and **GPIOPeriphID7** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 6 (GPIOPeriphID6)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFD8

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID6 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

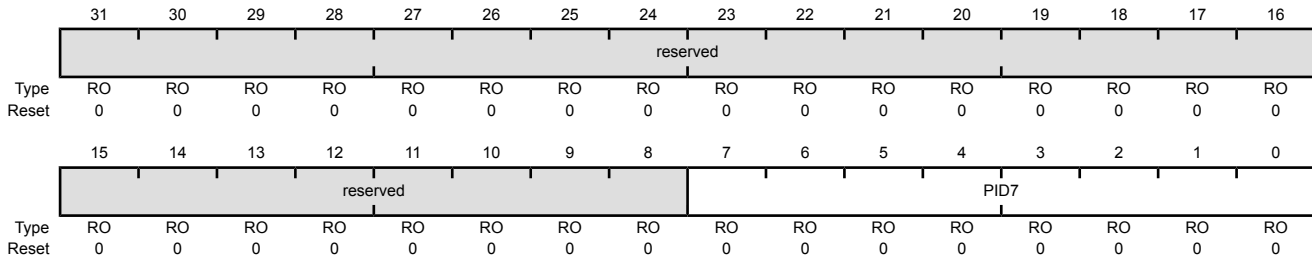
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID6 | RO | 0x00 | GPIO Peripheral ID Register [23:16] |

Register 26: GPIO Peripheral Identification 7 (GPIOPeriphID7), offset 0xFDC

The **GPIOPeriphID4**, **GPIOPeriphID5**, **GPIOPeriphID6**, and **GPIOPeriphID7** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 7 (GPIOPeriphID7)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFDC
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID7 | RO | 0x00 | GPIO Peripheral ID Register [31:24] |

Register 27: GPIO Peripheral Identification 0 (GPIOPeriphID0), offset 0xFE0

The **GPIOPeriphID0**, **GPIOPeriphID1**, **GPIOPeriphID2**, and **GPIOPeriphID3** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 0 (GPIOPeriphID0)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFE0

Type RO, reset 0x0000.0061

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID0 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 |

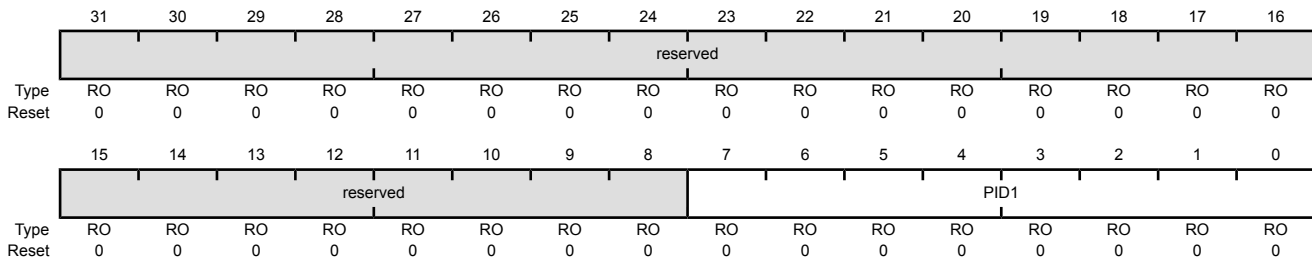
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID0 | RO | 0x61 | GPIO Peripheral ID Register [7:0] Can be used by software to identify the presence of this peripheral. |

Register 28: GPIO Peripheral Identification 1 (GPIOPeriphID1), offset 0xFE4

The **GPIOPeriphID0**, **GPIOPeriphID1**, **GPIOPeriphID2**, and **GPIOPeriphID3** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 1 (GPIOPeriphID1)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFE4
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID1 | RO | 0x00 | GPIO Peripheral ID Register [15:8] Can be used by software to identify the presence of this peripheral. |

Register 29: GPIO Peripheral Identification 2 (GPIOPeriphID2), offset 0xFE8

The **GPIOPeriphID0**, **GPIOPeriphID1**, **GPIOPeriphID2**, and **GPIOPeriphID3** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 2 (GPIOPeriphID2)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFE8

Type RO, reset 0x0000.0018

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

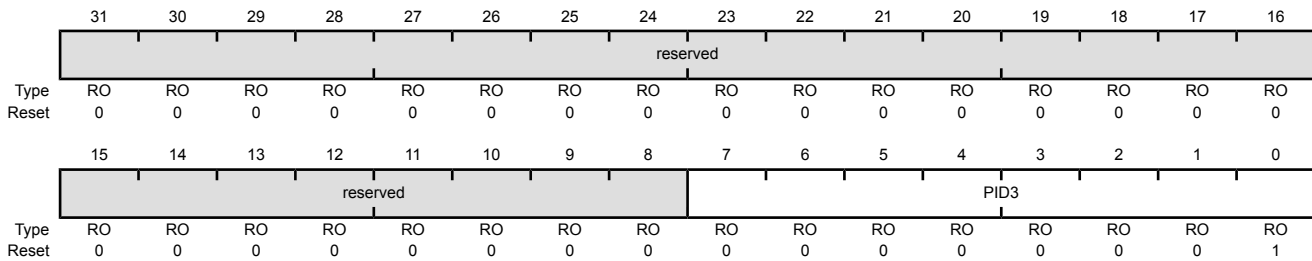
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID2 | RO | 0x18 | GPIO Peripheral ID Register [23:16] Can be used by software to identify the presence of this peripheral. |

Register 30: GPIO Peripheral Identification 3 (GPIOPeriphID3), offset 0xFEC

The **GPIOPeriphID0**, **GPIOPeriphID1**, **GPIOPeriphID2**, and **GPIOPeriphID3** registers can conceptually be treated as one 32-bit register; each register contains eight bits of the 32-bit register, used by software to identify the peripheral.

GPIO Peripheral Identification 3 (GPIOPeriphID3)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFEC
 Type RO, reset 0x0000.0001



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID3 | RO | 0x01 | GPIO Peripheral ID Register [31:24] Can be used by software to identify the presence of this peripheral. |

Register 31: GPIO PrimeCell Identification 0 (GPIOCellID0), offset 0xFF0

The **GPIOCellID0**, **GPIOCellID1**, **GPIOCellID2**, and **GPIOCellID3** registers are four 8-bit wide registers, that can conceptually be treated as one 32-bit register. The register is used as a standard cross-peripheral identification system.

GPIO PrimeCell Identification 0 (GPIOCellID0)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFF0
 Type RO, reset 0x0000.000D

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID0 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |

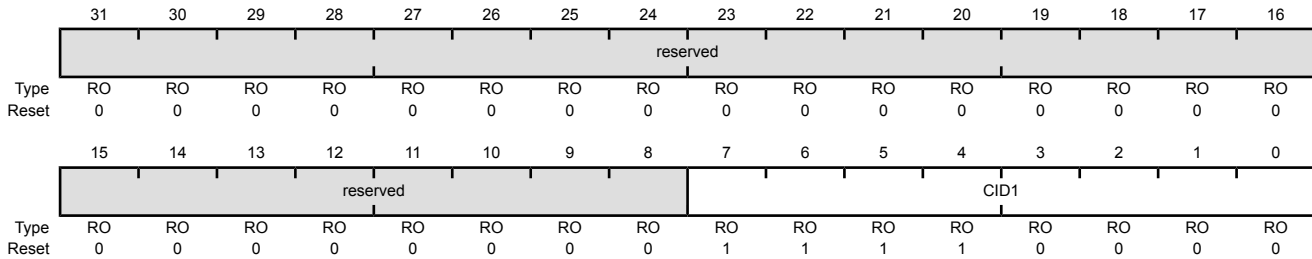
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID0 | RO | 0x0D | GPIO PrimeCell ID Register [7:0] Provides software a standard cross-peripheral identification system. |

Register 32: GPIO PrimeCell Identification 1 (GPIOCellID1), offset 0xFF4

The **GPIOCellID0**, **GPIOCellID1**, **GPIOCellID2**, and **GPIOCellID3** registers are four 8-bit wide registers, that can conceptually be treated as one 32-bit register. The register is used as a standard cross-peripheral identification system.

GPIO PrimeCell Identification 1 (GPIOCellID1)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFF4
 Type RO, reset 0x0000.00F0



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID1 | RO | 0xF0 | GPIO PrimeCell ID Register [15:8] Provides software a standard cross-peripheral identification system. |

Register 33: GPIO PrimeCell Identification 2 (GPIOCellID2), offset 0xFF8

The **GPIOCellID0**, **GPIOCellID1**, **GPIOCellID2**, and **GPIOCellID3** registers are four 8-bit wide registers, that can conceptually be treated as one 32-bit register. The register is used as a standard cross-peripheral identification system.

GPIO PrimeCell Identification 2 (GPIOCellID2)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFF8
 Type RO, reset 0x0000.0005

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

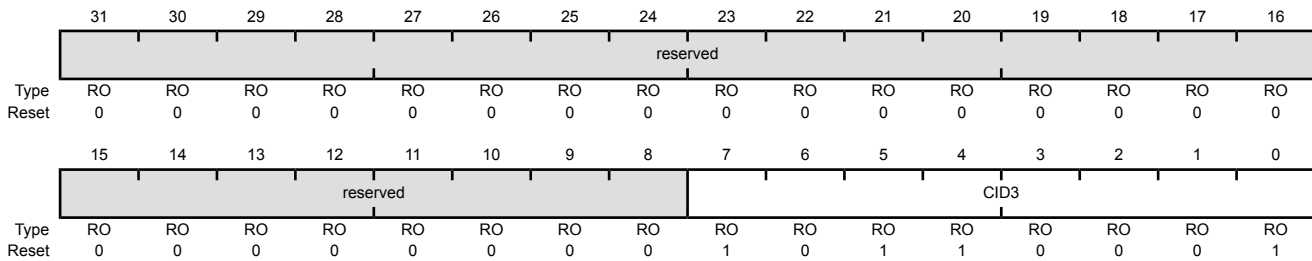
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID2 | RO | 0x05 | GPIO PrimeCell ID Register [23:16] Provides software a standard cross-peripheral identification system. |

Register 34: GPIO PrimeCell Identification 3 (GPIOCellID3), offset 0xFFC

The **GPIOCellID0**, **GPIOCellID1**, **GPIOCellID2**, and **GPIOCellID3** registers are four 8-bit wide registers, that can conceptually be treated as one 32-bit register. The register is used as a standard cross-peripheral identification system.

GPIO PrimeCell Identification 3 (GPIOCellID3)

GPIO Port A (APB) base: 0x4000.4000
 GPIO Port A (AHB) base: 0x4005.8000
 GPIO Port B (APB) base: 0x4000.5000
 GPIO Port B (AHB) base: 0x4005.9000
 GPIO Port C (APB) base: 0x4000.6000
 GPIO Port C (AHB) base: 0x4005.A000
 GPIO Port D (APB) base: 0x4000.7000
 GPIO Port D (AHB) base: 0x4005.B000
 GPIO Port E (APB) base: 0x4002.4000
 GPIO Port E (AHB) base: 0x4005.C000
 GPIO Port F (APB) base: 0x4002.5000
 GPIO Port F (AHB) base: 0x4005.D000
 GPIO Port G (APB) base: 0x4002.6000
 GPIO Port G (AHB) base: 0x4005.E000
 GPIO Port H (APB) base: 0x4002.7000
 GPIO Port H (AHB) base: 0x4005.F000
 GPIO Port J (APB) base: 0x4003.D000
 GPIO Port J (AHB) base: 0x4006.0000
 Offset 0xFFC
 Type RO, reset 0x0000.00B1



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID3 | RO | 0xB1 | GPIO PrimeCell ID Register [31:24] Provides software a standard cross-peripheral identification system. |

10 External Peripheral Interface (EPI)

The External Peripheral Interface is a high-speed parallel bus for external peripherals or memory. It has several modes of operation to interface gluelessly to many types of external devices. The External Peripheral Interface is similar to a standard microprocessor address/data bus, except that it must typically be connected to just one type of external device. Enhanced capabilities include μ DMA support, clocking control and support for external FIFO buffers.

The EPI has the following features:

- 8/16/32-bit dedicated parallel bus for external peripherals and memory
- Memory interface supports contiguous memory access independent of data bus width, thus enabling code execution directly from SDRAM, SRAM and Flash memory
- Blocking and non-blocking reads
- Separates processor from timing details through use of an internal write FIFO
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Separate channels for read and write
 - Read channel request asserted by programmable levels on the internal non-blocking read FIFO (NBRFIFO)
 - Write channel request asserted by empty on the internal write FIFO (WFIFO)

The EPI supports three primary functional modes: Synchronous Dynamic Random Access Memory (SDRAM) mode, Traditional Host-Bus mode, and General-Purpose mode. The EPI module also provides custom GPIOs; however, unlike regular GPIOs, the EPI module uses a FIFO in the same way as a communication mechanism and is speed-controlled using clocking.

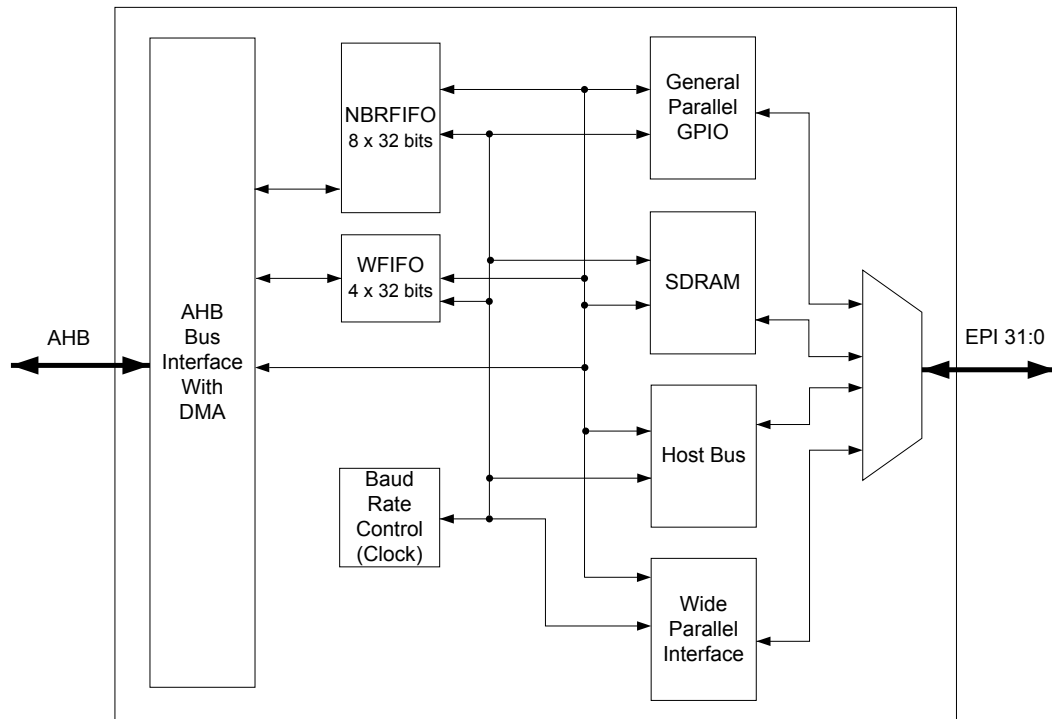
- Synchronous Dynamic Random Access Memory (SDRAM) mode
 - Supports x16 (single data rate) SDRAM at up to 50 MHz
 - Supports low-cost SDRAMs up to 64 MB (512 megabits)
 - Includes automatic refresh and access to all banks/rows
 - Includes a Sleep/Standby mode to keep contents active with minimal power draw
 - Multiplexed address/data interface for reduced pin count
- Host-Bus mode
 - Traditional x8 and x16 MCU bus interface capabilities
 - Similar device compatibility options as PIC, ATmega, 8051, and others
 - Access to SRAM, NOR Flash memory, and other devices, with up to 1 MB of addressing in unmultiplexed mode and 256 MB in multiplexed mode (512 MB in Host-Bus 16 mode with no byte selects)

- Support of both muxed and de-muxed address and data
- Access to a range of devices supporting the non-address FIFO x8 and x16 interface variant, with support for external FIFO (XFIFO) EMPTY and FULL signals
- Speed controlled, with read and write data wait-state counters
- Chip select modes include ALE, CSn, Dual CSn and ALE with dual CSn
- Manual chip-enable (or use extra address pins)
- General-Purpose mode
 - Wide parallel interfaces for fast communications with CPLDs and FPGAs
 - Data widths up to 32 bits
 - Data rates up to 150 MB/second
 - Optional "address" sizes from 4 bits to 20 bits
 - Optional clock output, read/write strobes, framing (with counter-based size), and clock-enable input
- General parallel GPIO
 - 1 to 32 bits, FIFOed with speed control
 - Useful for custom peripherals or for digital data acquisition and actuator controls

10.1 EPI Block Diagram

Figure 10-1 on page 477 provides a block diagram of a Stellaris[®] EPI module.

Figure 10-1. EPI Block Diagram



10.2 Signal Description

The following table lists the external signals of the EPI controller and describes the function of each. The EPI controller signals are alternate functions for GPIO signals and default to be GPIO signals at reset. The column in the table below titled "Pin Mux/Pin Assignment" lists the GPIO pin placement for the EPI signals. The `AFSEL` bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the EPI controller function. The number in parentheses is the encoding that must be programmed into the `PMCn` field in the **GPIO Port Control (GPIOPTL)** register (page 461) to assign the EPI signals to the specified GPIO port pins. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 419.

Table 10-1. External Peripheral Interface Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|-------------------------|
| EPI0S0 | 83 | PH3 (8) | I/O | TTL | EPI module 0 signal 0. |
| EPI0S1 | 84 | PH2 (8) | I/O | TTL | EPI module 0 signal 1. |
| EPI0S2 | 25 | PC4 (8) | I/O | TTL | EPI module 0 signal 2. |
| EPI0S3 | 24 | PC5 (8) | I/O | TTL | EPI module 0 signal 3. |
| EPI0S4 | 23 | PC6 (8) | I/O | TTL | EPI module 0 signal 4. |
| EPI0S5 | 22 | PC7 (8) | I/O | TTL | EPI module 0 signal 5. |
| EPI0S6 | 86 | PH0 (8) | I/O | TTL | EPI module 0 signal 6. |
| EPI0S7 | 85 | PH1 (8) | I/O | TTL | EPI module 0 signal 7. |
| EPI0S8 | 74 | PE0 (8) | I/O | TTL | EPI module 0 signal 8. |
| EPI0S9 | 75 | PE1 (8) | I/O | TTL | EPI module 0 signal 9. |
| EPI0S10 | 76 | PH4 (8) | I/O | TTL | EPI module 0 signal 10. |

Table 10-1. External Peripheral Interface Signals (100LQFP) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|-------------------------|
| EPI0S11 | 63 | PH5 (8) | I/O | TTL | EPI module 0 signal 11. |
| EPI0S12 | 42 58 | PF7 (8) PF4 (8) | I/O | TTL | EPI module 0 signal 12. |
| EPI0S13 | 19 | PG0 (8) | I/O | TTL | EPI module 0 signal 13. |
| EPI0S14 | 18 | PG1 (8) | I/O | TTL | EPI module 0 signal 14. |
| EPI0S15 | 41 46 | PG4 (8) PF5 (8) | I/O | TTL | EPI module 0 signal 15. |
| EPI0S16 | 14 | PJ0 (8) | I/O | TTL | EPI module 0 signal 16. |
| EPI0S17 | 87 | PJ1 (8) | I/O | TTL | EPI module 0 signal 17. |
| EPI0S18 | 39 | PJ2 (8) | I/O | TTL | EPI module 0 signal 18. |
| EPI0S19 | 97 | PD4 (10) | I/O | TTL | EPI module 0 signal 19. |
| EPI0S20 | 12 | PD2 (8) | I/O | TTL | EPI module 0 signal 20. |
| EPI0S21 | 13 | PD3 (8) | I/O | TTL | EPI module 0 signal 21. |
| EPI0S22 | 91 | PB5 (8) | I/O | TTL | EPI module 0 signal 22. |
| EPI0S23 | 92 | PB4 (8) | I/O | TTL | EPI module 0 signal 23. |
| EPI0S24 | 95 | PE2 (8) | I/O | TTL | EPI module 0 signal 24. |
| EPI0S25 | 96 | PE3 (8) | I/O | TTL | EPI module 0 signal 25. |
| EPI0S26 | 62 | PH6 (8) | I/O | TTL | EPI module 0 signal 26. |
| EPI0S27 | 15 | PH7 (8) | I/O | TTL | EPI module 0 signal 27. |
| EPI0S28 | 98 | PD5 (10) | I/O | TTL | EPI module 0 signal 28. |
| EPI0S29 | 99 | PD6 (10) | I/O | TTL | EPI module 0 signal 29. |
| EPI0S30 | 100 | PD7 (10) | I/O | TTL | EPI module 0 signal 30. |
| EPI0S31 | 36 | PG7 (9) | I/O | TTL | EPI module 0 signal 31. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 10-2. External Peripheral Interface Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|-------------------------|
| EPI0S0 | D10 | PH3 (8) | I/O | TTL | EPI module 0 signal 0. |
| EPI0S1 | D11 | PH2 (8) | I/O | TTL | EPI module 0 signal 1. |
| EPI0S2 | L1 | PC4 (8) | I/O | TTL | EPI module 0 signal 2. |
| EPI0S3 | M1 | PC5 (8) | I/O | TTL | EPI module 0 signal 3. |
| EPI0S4 | M2 | PC6 (8) | I/O | TTL | EPI module 0 signal 4. |
| EPI0S5 | L2 | PC7 (8) | I/O | TTL | EPI module 0 signal 5. |
| EPI0S6 | C9 | PH0 (8) | I/O | TTL | EPI module 0 signal 6. |
| EPI0S7 | C8 | PH1 (8) | I/O | TTL | EPI module 0 signal 7. |
| EPI0S8 | B11 | PE0 (8) | I/O | TTL | EPI module 0 signal 8. |
| EPI0S9 | A12 | PE1 (8) | I/O | TTL | EPI module 0 signal 9. |
| EPI0S10 | B10 | PH4 (8) | I/O | TTL | EPI module 0 signal 10. |
| EPI0S11 | F10 | PH5 (8) | I/O | TTL | EPI module 0 signal 11. |
| EPI0S12 | K4 L9 | PF7 (8) PF4 (8) | I/O | TTL | EPI module 0 signal 12. |

Table 10-2. External Peripheral Interface Signals (108BGA) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|-------------------------|
| EPI0S13 | K1 | PG0 (8) | I/O | TTL | EPI module 0 signal 13. |
| EPI0S14 | K2 | PG1 (8) | I/O | TTL | EPI module 0 signal 14. |
| EPI0S15 | K3 L8 | PG4 (8) PF5 (8) | I/O | TTL | EPI module 0 signal 15. |
| EPI0S16 | F3 | PJ0 (8) | I/O | TTL | EPI module 0 signal 16. |
| EPI0S17 | B6 | PJ1 (8) | I/O | TTL | EPI module 0 signal 17. |
| EPI0S18 | K6 | PJ2 (8) | I/O | TTL | EPI module 0 signal 18. |
| EPI0S19 | B5 | PD4 (10) | I/O | TTL | EPI module 0 signal 19. |
| EPI0S20 | H2 | PD2 (8) | I/O | TTL | EPI module 0 signal 20. |
| EPI0S21 | H1 | PD3 (8) | I/O | TTL | EPI module 0 signal 21. |
| EPI0S22 | B7 | PB5 (8) | I/O | TTL | EPI module 0 signal 22. |
| EPI0S23 | A6 | PB4 (8) | I/O | TTL | EPI module 0 signal 23. |
| EPI0S24 | A4 | PE2 (8) | I/O | TTL | EPI module 0 signal 24. |
| EPI0S25 | B4 | PE3 (8) | I/O | TTL | EPI module 0 signal 25. |
| EPI0S26 | G3 | PH6 (8) | I/O | TTL | EPI module 0 signal 26. |
| EPI0S27 | H3 | PH7 (8) | I/O | TTL | EPI module 0 signal 27. |
| EPI0S28 | C6 | PD5 (10) | I/O | TTL | EPI module 0 signal 28. |
| EPI0S29 | A3 | PD6 (10) | I/O | TTL | EPI module 0 signal 29. |
| EPI0S30 | A2 | PD7 (10) | I/O | TTL | EPI module 0 signal 30. |
| EPI0S31 | C10 | PG7 (9) | I/O | TTL | EPI module 0 signal 31. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

10.3 Functional Description

The EPI controller provides a glueless, programmable interface to a variety of common external peripherals such as SDRAM x 16, Host Bus x8 and x16 devices, RAM, NOR Flash memory, CPLDs and FPGAs. In addition, the EPI controller provides custom GPIO that can use a FIFO with speed control by using either the internal write FIFO (WFIFO) or the non-blocking read FIFO (NBRFIFO). The WFIFO can hold 4 words of data that are written to the external interface at the rate controlled by the **EPI Main Baud Rate (EPIBAUD)** register. The NBRFIFO can hold 8 words of data and samples at the rate controlled by the **EPIBAUD** register. The EPI controller provides predictable operation and thus has an advantage over regular GPIO which has more variable timing due to on-chip bus arbitration and delays across bus bridges. Blocking reads stall the CPU until the transaction completes. Non-blocking reads are performed in the background and allow the processor to continue operation. In addition, write data can also be stored in the WFIFO to allow multiple writes with no stalls.

Note: Both the **WTAV** bit field in the **EPIWFIFOCNT** register and the **WBUSY** bit in the **EPISTAT** register must be polled to determine if there is a current write transaction from the WFIFO. If both of these bits are clear, then a new bus access may begin.

Main read and write operations can be performed in subsets of the range 0x6000.0000 to 0xDFFF.FFFF. A read from an address mapped location uses the offset and size to control the address and size of the external operation. When performing a multi-value load, the read is done as a burst (when available) to maximize performance. A write to an address mapped location uses

the offset and size to control the address and size of the external operation. When performing a multi-value store, the write is done as a burst (when available) to maximize performance.

NAND Flash memory (x8) can be read natively. Automatic programming support is not provided; programming must be done by the user following the manufacturer's protocol. Automatic page ECC is also not supported, but can be performed in software.

10.3.1 Non-Blocking Reads

The EPI Controller supports a special kind of read called a non-blocking read, also referred to as a posted read. Where a normal read stalls the processor or μ DMA until the data is returned, a non-blocking read is performed in the background.

A non-blocking read is configured by writing the start address into a **EPIRADDRn** register, the size per transaction into a **EPIRSIZEn** register, and then the count of operations into a **EPIRPSTDn** register. After each read is completed, the result is written into the NBRFIFO and the **EPIRADDRn** register is incremented by the size (1, 2, or 4).

If the NBRFIFO is filled, then the reads pause until space is made available. The NBRFIFO can be configured to interrupt the processor or trigger the μ DMA based on fullness using the **EPIFIFOLVL** register. By using the trigger/interrupt method, the μ DMA (or processor) can keep space available in the NBRFIFO and allow the reads to continue unimpeded.

When performing non-blocking reads, the SDRAM controller issues two additional read transactions after the burst request is terminated. The data for these additional transfers is discarded. This situation is transparent to the user other than the additional EPI bus activity and can safely be ignored.

Two non-blocking read register sets are available to allow sequencing and ping-pong use. When one completes, the other then activates. So, for example, if 20 words are to be read from 0x100 and 10 words from 0x200, the **EPIRPSTD0** register can be set up with the read from 0x100 (with a count of 20), and the **EPIRPSTD1** register can be set up with the read from 0x200 (with a count of 10). When **EPIRPSTD0** finishes (count goes to 0), the **EPIRPSTD1** register then starts its operation. The NBRFIFO has then passed 30 values. When used with the μ DMA, it may transfer 30 values (simple sequence), or the primary/alternate model may be used to handle the first 20 in one way and the second 10 in another. It is also possible to reload the **EPIRPSTD0** register when it is finished (and the **EPIRPSTD1** register is active); thereby, keeping the interface constantly busy.

To cancel a non-blocking read, the **EPIRPSTDn** register is cleared. Care must be taken, however if the register set was active to drain away any values read into the NBRFIFO and ensure that any read in progress is allowed to complete.

To ensure that the cancel is complete, the following algorithm is used (using the **EPIRPSTD0** register for example):

```
EPIRPSTD0 = 0;
while ((EPISTAT & 0x11) == 0x10)
; // we are active and busy
// if here, then other one is active or interface no longer busy
cnt = (EPIRADDR0 - original_address) / EPIRSIZE0; // count of values read
cnt -= values_read_so_far;
// cnt is now number left in FIFO
while (cnt--)
```


value = **EPIREADFIFO**; // drain

The above algorithm can be optimized in code; however, the important point is to wait for the cancel to complete because the external interface could have been in the process of reading a value when the cancel came in, and it must be allowed to complete.

10.3.2 DMA Operation

The μ DMA can be used to achieve maximum transfer rates on the EPI through the NBRFIFO and the WFIFO. The μ DMA has one channel for write and one for read. The write channel copies values to the WFIFO when the WFIFO is at the level specified by the **EPI FIFO Level Selects (EPIFIFOLVL)** register. The non-blocking read channel copies values from the NBRFIFO when the NBRFIFO is at the level specified by the **EPIFIFOLVL** register. For non-blocking reads, the start address, the size per transaction, and the count of elements must be programmed in the μ DMA. Note that both non-blocking read register sets can be used, and they fill the NBRFIFO such that one runs to completion, then the next one starts (they do not interleave). Using the NBRFIFO provides the best possible transfer rate.

For blocking reads, the μ DMA software channel (or another unused channel) is used for memory-to-memory transfers (or memory to peripheral, where some other peripheral is used). In this situation, the μ DMA stalls until the read is complete and is not able to service another channel until the read is done. As a result, the arbitration size should normally be programmed to one access at a time. The μ DMA controller can also transfer from and to the NBRFIFO and the WFIFO using the μ DMA software channel in memory mode, however, the μ DMA is stalled once the NBRFIFO is empty or the WFIFO is full. Note that when the μ DMA controller is stalled, the core continues operation. See “Micro Direct Memory Access (μ DMA)” on page 359 for more information on configuring the μ DMA.

The size of the FIFOs must be taken into consideration when configuring the μ DMA to transfer data to and from the EPI. The arbitration size should be 4 or less when writing to EPI address space and 8 or less when reading from EPI address space.

10.4 Initialization and Configuration

To enable and initialize the EPI controller, the following steps are necessary:

1. Enable the EPI module using the **RCGC1** register. See page 262.
2. Enable the clock to the appropriate GPIO module via the **RCGC2** register. See page 274. To find out which GPIO port to enable, refer to “Signal Description” on page 477.
3. Set the GPIO **AFSEL** bits for the appropriate pins. See page 443. To determine which GPIOs to configure, see Table 23-4 on page 1075.
4. Configure the GPIO current level and/or slew rate as specified for the mode selected. See page 445 and page 453.
5. Configure the **PMCh** fields in the **GPIOPCTL** register to assign the EPI signals to the appropriate pins. See page 461 and Table 23-5 on page 1083.
6. Select the mode for the EPI block to SDRAM, HB8, HB16, or general parallel use, using the **MODE** field in the **EPI Configuration (EPICFG)** register. Set the mode-specific details (if needed) using the appropriate mode configuration **EPI Host Bus Configuration (EPIHBnCFGn)** registers for the desired chip-select configuration. Set the **EPI Main Baud Rate (EPIBAUD)** register if the baud rate must be slower than the system clock rate.

7. Configure the address mapping using the **EPI Address Map (EPIADDRMAP)** register. The selected start address and range is dependent on the type of external device and maximum address (as appropriate). For example, for a 512-megabit SDRAM, program the `ERADR` field to 0x1 for address 0x6000.0000 or 0x2 for address 0x8000.0000; and program the `ERSZ` field to 0x3 for 256 MB. If using General-Purpose mode and no address at all, program the `EPADR` field to 0x1 for address 0xA000.0000 or 0x2 for address 0xC000.0000; and program the `EPSZ` field to 0x0 for 256 bytes.
8. To read or write directly, use the mapped address area (configured with the **EPIADDRMAP** register). Up to 4 or 5 writes can be performed at once without blocking. Each read is blocked until the value is retrieved.
9. To perform a non-blocking read, see “Non-Blocking Reads” on page 480.

The following sub-sections describe the initialization and configuration for each of the modes of operation. Care must be taken to initialize everything properly to ensure correct operation. Control of the GPIO states is also important, as changes may cause the external device to interpret pin states as actions or commands (see “Register Descriptions” on page 432). Normally, a pull-up or pull-down is needed on the board to at least control the chip-select or chip-enable as the Stellaris GPIOs come out of reset in tri-state.

10.4.1 SDRAM Mode

When activating the SDRAM mode, it is important to consider a few points:

1. Generally, it takes over 100 μ s from when the mode is activated to when the first operation is allowed. The SDRAM controller begins the SDRAM initialization sequence as soon as the mode is selected and enabled via the **EPICFG** register. It is important that the GPIOs are properly configured before the SDRAM mode is enabled, as the EPI controller is relying on the GPIO block's ability to drive the pins immediately. As part of the initialization sequence, the LOAD MODE REGISTER command is automatically sent to the SDRAM with a value of 0x27, which sets a CAS latency of 2 and a full page burst length.
2. The `INITSEQ` bit in the **EPI Status (EPISTAT)** register can be checked to determine when the initialization sequence is complete.
3. When using a frequency range and/or refresh value other than the default value, it is important to configure the `FREQ` and `RFSH` fields in the **EPI SDRAM Configuration (EPISDRAMCFG)** register shortly after activating the mode. After the 100- μ s startup time, the EPI block must be configured properly to keep the SDRAM contents stable.
4. The `SLEEP` bit in the **EPISDRAMCFG** register may be configured to put the SDRAM into a low-power self-refreshing state. It is important to note that the SDRAM mode must not be disabled once enabled, or else the SDRAM is no longer clocked and the contents are lost.
5. Before entering SLEEP mode, make sure all non-blocking reads and normal reads and writes have completed. If the system is running at 30 to 50 MHz, wait 2 EPI clocks after clearing the `SLEEP` bit before executing non-blocking reads, or normal reads and writes. If the system is configured to greater than 50 MHz, wait 5 EPI clocks before read and write transactions. For all other configurations, wait 1 EPI clock.

The `SIZE` field of the **EPISDRAMCFG** register must be configured correctly based on the amount of SDRAM in the system.

The `FREQ` field must be configured according to the value that represents the range being used. Based on the range selected, the number of external clocks used between certain operations (for example, `PRECHARGE` or `ACTIVATE`) is determined. If a higher frequency is given than is used, then the only downside is that the peripheral is slower (uses more cycles for these delays). If a lower frequency is given, incorrect operation occurs.

See “External Peripheral Interface (EPI)” on page 1139 for timing details for the SDRAM mode.

10.4.1.1 External Signal Connections

Table 10-3 on page 483 defines how EPI module signals should be connected to SDRAMs. The table applies when using a SDRAM up to 512 megabits. Note that the EPI signals must use 8-mA drive when interfacing to SDRAM, see page 447. Any unused EPI controller signals can be used as GPIOs or another alternate function.

Table 10-3. EPI SDRAM Signal Connections

| EPI Signal | SDRAM Signal ^a | |
|-----------------|---------------------------|-----|
| EPI0S0 | A0 | D0 |
| EPI0S1 | A1 | D1 |
| EPI0S2 | A2 | D2 |
| EPI0S3 | A3 | D3 |
| EPI0S4 | A4 | D4 |
| EPI0S5 | A5 | D5 |
| EPI0S6 | A6 | D6 |
| EPI0S7 | A7 | D7 |
| EPI0S8 | A8 | D8 |
| EPI0S9 | A9 | D9 |
| EPI0S10 | A10 | D10 |
| EPI0S11 | A11 | D11 |
| EPI0S12 | A12 ^b | D12 |
| EPI0S13 | BA0 | D13 |
| EPI0S14 | BA1 | D14 |
| EPI0S15 | D15 | |
| EPI0S16 | DQML | |
| EPI0S17 | DQMH | |
| EPI0S18 | CASn | |
| EPI0S19 | RASn | |
| EPI0S20-EPI0S27 | not used | |
| EPI0S28 | WEn | |
| EPI0S29 | CSn | |
| EPI0S30 | CKE | |
| EPI0S31 | CLK | |

a. If 2 signals are listed, connect the EPI signal to both pins.

b. Only for 256/512 megabit SDRAMs

10.4.1.2 Refresh Configuration

The refresh count is based on the external clock speed and the number of rows per bank as well as the refresh period. The `RFSH` field represents how many external clock cycles remain before an AUTO-REFRESH is required. The normal formula is:

$$RFSH = (t_{Refresh_us} / number_rows) / ext_clock_period$$

A refresh period is normally 64 ms, or 64000 μ s. The number of rows is normally 4096 or 8192. The `ext_clock_period` is a value expressed in μ sec and is derived by dividing 1000 by the clock speed expressed in MHz. So, 50 MHz is $1000/50=20$ ns, or 0.02 μ s. A typical SDRAM is 4096 rows per bank if the system clock is running at 50 MHz with an **EPIBAUD** register value of 0:

$$RFSH = (64000/4096) / 0.02 = 15.625 \mu s / 0.02 \mu s = 781.25$$

The default value in the `RFSH` field is 750 decimal or 0x2EE to allow for a margin of safety and providing 15 μ s per refresh. It is important to note that this number should always be smaller or equal to what is required by the above equation. For example, if running the external clock at 25 MHz (40 ns per clock period), 390 is the highest number that may be used. Note that the external clock may be 25 MHz when the system clock is 25 MHz or when the system clock is 50 MHz and configuring the `COUNT0` field in the **EPIBAUD** register to 1 (divide by 2).

If a number larger than allowed is used, the SDRAM is not refreshed often enough, and data is lost.

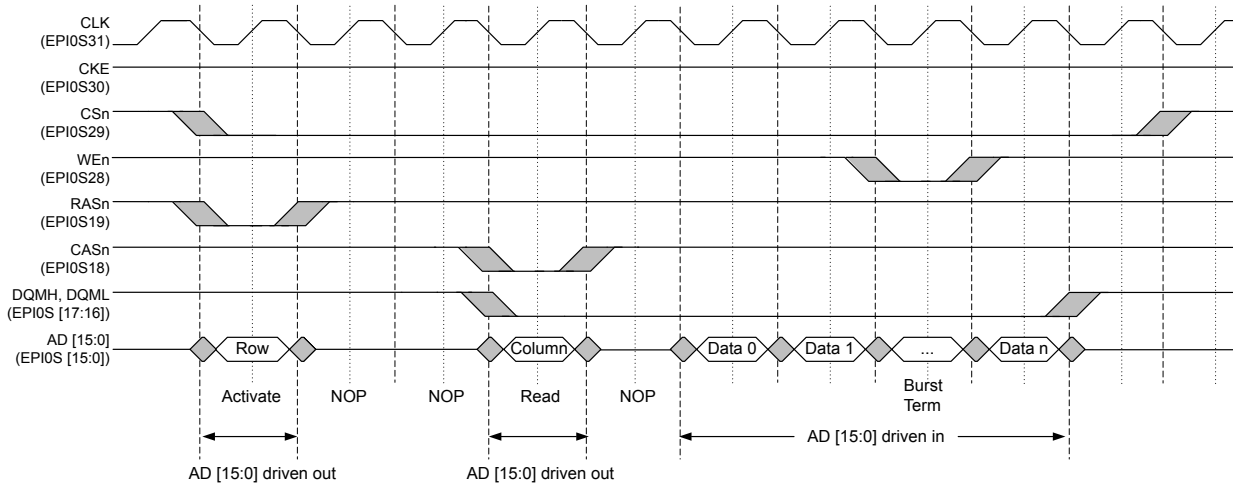
10.4.1.3 Bus Interface Speed

The EPI Controller SDRAM interface can operate up to 50 MHz. The `COUNT0` field in the **EPIBAUD** register configures the speed of the EPI clock. For system clock (SysClk) speeds up to 50 MHz, the `COUNT0` field can be 0x0000, and the SDRAM interface can run at the same speed as SysClk. However, if SysClk is running at higher speeds, the bus interface can run only as fast as half speed, and the `COUNT0` field must be configured to at least 0x0001.

10.4.1.4 Non-Blocking Read Cycle

Figure 10-2 on page 485 shows a non-blocking read cycle of n halfwords; n can be any number greater than or equal to 1. The cycle begins with the Activate command and the row address on the `EPIOS[15:0]` signals. With the programmed CAS latency of 2, the Read command with the column address on the `EPIOS[15:0]` signals follows after 2 clock cycles. Following one more NOP cycle, data is read in on the `EPIOS[15:0]` signals on every rising clock edge. The Burst Terminate command is issued during the cycle when the next-to-last halfword is read in. The `DQMH` and `DQML` signals are deasserted after the last halfword of data is received; the `CSn` signal deasserts on the following clock cycle, signaling the end of the read cycle. At least one clock period of inactivity separates any two SDRAM cycles.

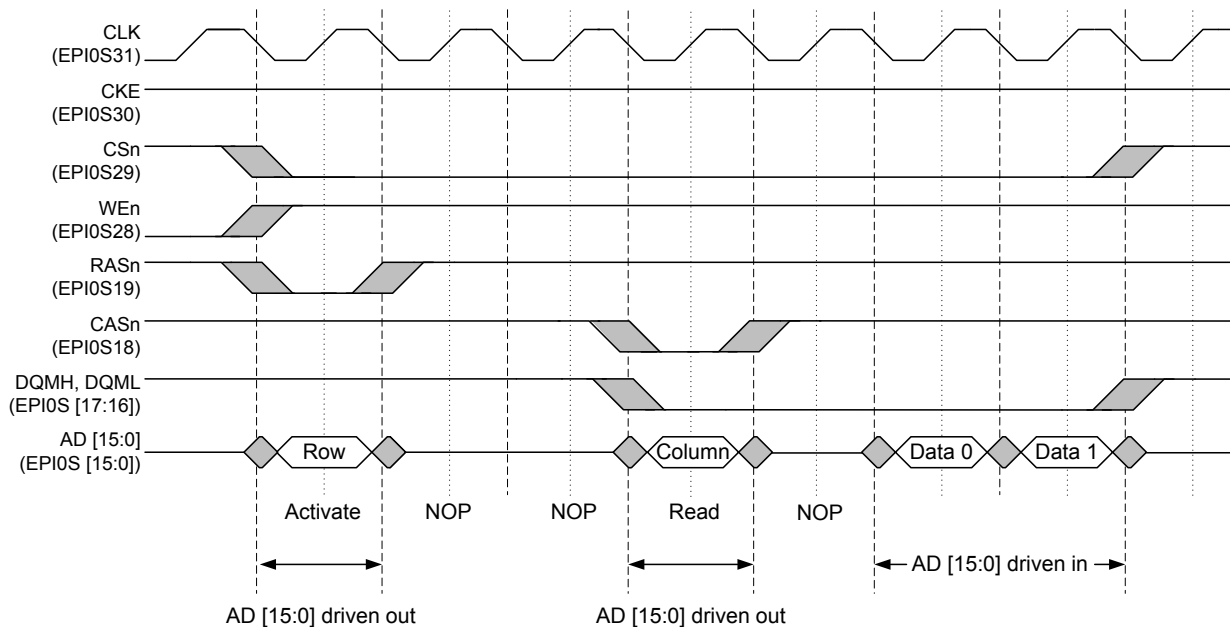
Figure 10-2. SDRAM Non-Blocking Read Cycle



10.4.1.5 Normal Read Cycle

Figure 10-3 on page 485 shows a normal read cycle of n halfwords; n can be 1 or 2. The cycle begins with the Activate command and the row address on the $EPIOS[15:0]$ signals. With the programmed CAS latency of 2, the Read command with the column address on the $EPIOS[15:0]$ signals follows after 2 clock cycles. Following one more NOP cycle, data is read in on the $EPIOS[15:0]$ signals on every rising clock edge. The DQMH, DQML, and CSn signals are deasserted after the last halfword of data is received, signaling the end of the cycle. At least one clock period of inactivity separates any two SDRAM cycles.

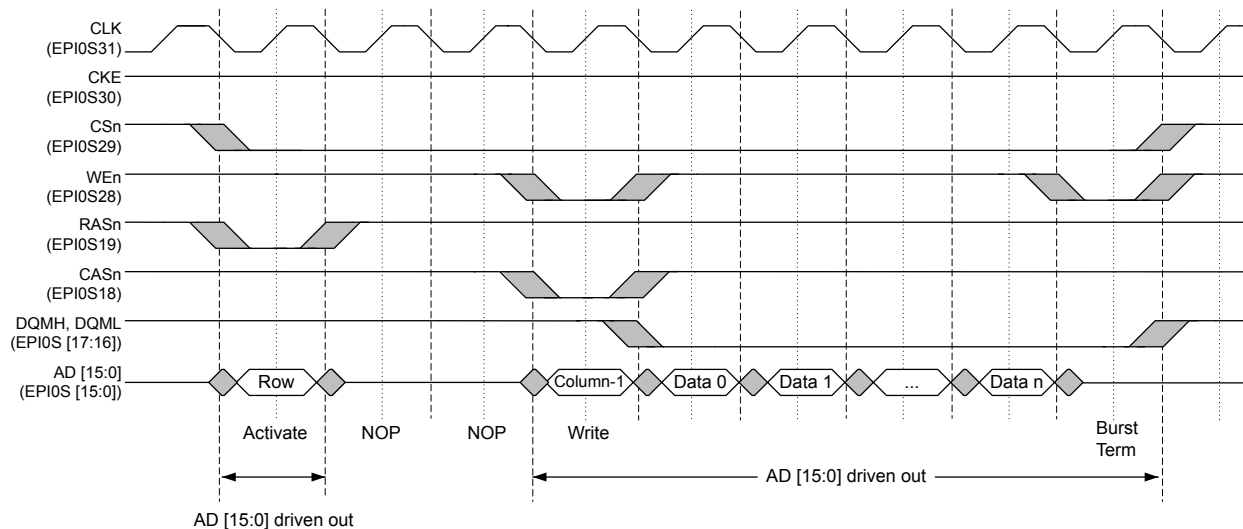
Figure 10-3. SDRAM Normal Read Cycle



10.4.1.6 Write Cycle

Figure 10-4 on page 486 shows a write cycle of n halfwords; n can be any number greater than or equal to 1. The cycle begins with the Activate command and the row address on the $EPIOS[15:0]$ signals. With the programmed CAS latency of 2, the Write command with the column address on the $EPIOS[15:0]$ signals follows after 2 clock cycles. When writing to SDRAMs, the Write command is presented with the first halfword of data. Because the address lines and the data lines are multiplexed, the column address is modified to be (programmed address - 1). During the Write command, the DQMH and DQML signals are high, so no data is written to the SDRAM. On the next clock, the DQMH and DQML signals are asserted, and the data associated with the programmed address is written. The Burst Terminate command occurs during the clock cycle following the write of the last halfword of data. The WEn , DQMH, DQML, and CSn signals are deasserted after the last halfword of data is received, signaling the end of the access. At least one clock period of inactivity separates any two SDRAM cycles.

Figure 10-4. SDRAM Write Cycle



10.4.2 Host Bus Mode

Host Bus supports the traditional 8-bit and 16-bit interfaces popularized by the 8051 devices and SRAM devices. This interface is asynchronous and uses strobe pins to control activity. Addressable memory can be doubled using Host Bus-16 mode as it performs half-word accesses. The $EPIOS0$ is the LSB of the address and is equivalent to the internal Cortex-M3 A1 address. $EPIOS0$ should be connected to A0 of 16-bit memories.

10.4.2.1 Control Pins

The main three strobes are Address Latch Enable (ALE), Write (WRn), and Read (RDn , sometimes called OEn). Note that the timings are designed for older logic and so are hold-time vs. setup-time specific. The polarity of the read and write strobes can be active High or active Low by clearing or setting the $RDHIGH$ and $WRHIGH$ bits in the **EPI Host-Bus n Configuration 2 (EPIHBnCFG2)** register.

The ALE can be changed to an active-low chip select signal, CSn , through the **EPIHBnCFG2** register. The ALE is best used for Host-Bus muxed mode in which EPI address and data pins are shared. All Host-Bus accesses have an address phase followed by a data phase. The ALE indicates to an

external latch to capture the address then hold it until the data phase. CS_n is best used for Host-Bus unmuxed mode in which EPI address and data pins are separate. The CS_n indicates when the address and data phases of a read or write access are occurring. Both the ALE and the CS_n modes can be enhanced to access external devices using settings in the **EPIHBnCFG2** register. Wait states can be added to the data phase of the access using the **WRWS** and **RDWS** bits in the **EPIHBnCFG2** register.

For FIFO mode, the ALE is not used, and two input holds are optionally supported to gate input and output to what the XFIFO can handle.

Host-Bus 8 and Host-Bus 16 modes are very configurable. The user has the ability to connect external devices to the EPI signals, as well as control whether byte select signals are provided in HB16 mode. These capabilities depend on the configuration of the **MODE** field in the **EPIHBnCFG** register and the **CSCFG** field in the **EPIHBnCFG2** register, and the **BSEL** bit in the **EPIHB16CFG** register. The **CSCFGEXT** bit extends the chip select configuration possibilities by providing the most significant bit of the **CSCFG** field.

If one of the Dual-Chip-Select modes is selected (**CSCFG** is 0x2 or 0x3 in the **EPIHBnCFG2** register), both chip selects can share the peripheral or the memory space, or one chip select can use the peripheral space and the other can use the memory space. In the **EPIADDRMAP** register, if the **EPADR** field is not 0x0 and the **ERADR** field is 0x0, then the address specified by **EPADR** is used for both chip selects, with CS_{0n} being asserted when the MSB of the address range is 0 and CS_{1n} being asserted when the MSB of the address range is 1. If the **ERADR** field is not 0x0 and the **EPADR** field is 0x0, then the address specified by **ERADR** is used for both chip selects, with the MSB performing the same delineation. If both the **EPADR** and the **ERADR** are not 0x0, then CS_{0n} is asserted for either address range defined by **EPADR** and CS_{1n} is asserted for either address range defined by **ERADR**.

If the **CSBAUD** bit in the **EPIHBnCFG2** register is set in Dual-chip select mode, the 2 chip selects can use different clock frequencies, wait states and strobe polarity. If the **CSBAUD** bit is clear, both chip selects use the clock frequency, wait states, and strobe polarity defined for CS_{0n}.

When **BSEL**=1 in the **EPIHB16CFG** register, byte select signals are provided, so byte-sized data can be read and written at any address, however these signals reduce the available address width by 2 pins. The byte select signals are active Low. **BSEL0n** corresponds to the LSB of the halfword, and **BSEL1n** corresponds to the MSB of the halfword.

When **BSEL**=0, byte reads and writes at odd addresses only act on the even byte, and byte writes at even addresses write invalid values into the odd byte. As a result, accesses should be made as half-words (16-bits) or words (32-bits). In C/C++, programmers should use only short int and long int for accesses. Also, because data accesses in HB16 mode with no byte selects are on 2-byte boundaries, the available address space is doubled. For example, 28 bits of address accesses 512 MB in this mode. Table 10-4 on page 487 shows the capabilities of the HB8 and HB16 modes as well as the available address bits with the possible combinations of these bits.

Although the **EPIOS31** signal can be configured for the EPI clock signal in Host-Bus mode, it is not required and should be configured as a GPIO to reduce EMI in the system.

Table 10-4. Capabilities of Host Bus 8 and Host Bus 16 Modes

| Host Bus Type | MODE | CSCFG | Max # of External Devices | BSEL | Byte Access | Available Address | Addressable Memory |
|---------------|------|----------|---------------------------|------|-------------|-------------------|--------------------|
| HB8 | 0x0 | 0x0, 0x1 | 1 | N/A | Always | 28 bits | 256 MB |
| HB8 | 0x0 | 0x2 | 2 | N/A | Always | 27 bits | 128 MB |
| HB8 | 0x0 | 0x3 | 2 | N/A | Always | 26 bits | 64 MB |

Table 10-4. Capabilities of Host Bus 8 and Host Bus 16 Modes (continued)

| Host Bus Type | MODE | CSCFG | Max # of External Devices | BSEL | Byte Access | Available Address | Addressable Memory |
|---------------|------|----------|---------------------------|------|-------------|----------------------|--------------------|
| HB8 | 0x1 | 0x0, 0x1 | 1 | N/A | Always | 20 bits | 1 MB |
| HB8 | 0x1 | 0x2 | 2 | N/A | Always | 19 bits | 512 kB |
| HB8 | 0x1 | 0x3 | 2 | N/A | Always | 18 bits | 256 kB |
| HB8 | 0x3 | 0x1 | 1 | N/A | Always | none | - |
| HB8 | 0x3 | 0x3 | 2 | N/A | Always | none | - |
| HB16 | 0x0 | 0x0, 0x1 | 1 | 0 | No | 28 bits ^a | 512 MB |
| HB16 | 0x0 | 0x0, 0x1 | 1 | 1 | Yes | 26 bits ^b | 128 MB |
| HB16 | 0x0 | 0x2 | 2 | 0 | No | 27 bits ^a | 256 MB |
| HB16 | 0x0 | 0x2 | 2 | 1 | Yes | 25 bits ^b | 64 MB |
| HB16 | 0x0 | 0x3 | 2 | 0 | No | 26 bits ^a | 128 MB |
| HB16 | 0x0 | 0x3 | 2 | 1 | Yes | 24 bits ^b | 32 MB |
| HB16 | 0x1 | 0x0, 0x1 | 1 | 0 | No | 12 bits ^a | 8 kB |
| HB16 | 0x1 | 0x0, 0x1 | 1 | 1 | Yes | 10 bits ^b | 2 kB |
| HB16 | 0x1 | 0x2 | 2 | 0 | No | 11 bits ^a | 4 kB |
| HB16 | 0x1 | 0x2 | 2 | 1 | Yes | 9 bits ^b | 1 kB |
| HB16 | 0x1 | 0x3 | 2 | 0 | No | 10 bits ^a | 2 kB |
| HB16 | 0x1 | 0x3 | 2 | 1 | Yes | 8 bits ^b | 512 B |
| HB16 | 0x3 | 0x1 | 1 | 0 | No | none | - |
| HB16 | 0x3 | 0x1 | 1 | 1 | Yes | none | - |
| HB16 | 0x3 | 0x3 | 2 | 0 | No | none | - |
| HB16 | 0x3 | 0x3 | 2 | 1 | Yes | none | - |

a. If byte selects are not used, data accesses are on 2-byte boundaries. As a result, the available address space is doubled.

b. Two EPI signals are used for byte selects, reducing the available address space by two bits.

Table 10-5 on page 488 shows how the $EPI[31:0]$ signals function while in Host-Bus 8 mode. Notice that the signal configuration changes based on the address/data mode selected by the **MODE** field in the **EPIHB8CFG2** register and on the chip select configuration selected by the **CSCFG** field in the same register.

Although the $EPI0S31$ signal can be configured for the EPI clock signal in Host-Bus mode, it is not required and should be configured as a GPIO to reduce EMI in the system. Any unused EPI controller signals can be used as GPIOs or another alternate function.

Table 10-5. EPI Host-Bus 8 Signal Connections

| EPI Signal | CSCFG | HB8 Signal (MODE =ADMUX) | HB8 Signal (MODE =ADNOMUX (Cont. Read)) | HB8 Signal (MODE =XFIFO) |
|------------|----------------|--------------------------|---|--------------------------|
| EPI0S0 | X ^a | AD0 | D0 | D0 |
| EPI0S1 | X | AD1 | D1 | D1 |
| EPI0S2 | X | AD2 | D2 | D2 |
| EPI0S3 | X | AD3 | D3 | D3 |
| EPI0S4 | X | AD4 | D4 | D4 |
| EPI0S5 | X | AD5 | D5 | D5 |

Table 10-5. EPI Host-Bus 8 Signal Connections (continued)

| EPI Signal | CSCFG | HB8 Signal (MODE =ADMUX) | HB8 Signal (MODE =ADNOMUX (Cont. Read)) | HB8 Signal (MODE =XFIFO) |
|------------|-------|--------------------------|---|--------------------------|
| EPI0S6 | X | AD6 | D6 | D6 |
| EPI0S7 | X | AD7 | D7 | D7 |
| EPI0S8 | X | A8 | A0 | - |
| EPI0S9 | X | A9 | A1 | - |
| EPI0S10 | X | A10 | A2 | - |
| EPI0S11 | X | A11 | A3 | - |
| EPI0S12 | X | A12 | A4 | - |
| EPI0S13 | X | A13 | A5 | - |
| EPI0S14 | X | A14 | A6 | - |
| EPI0S15 | X | A15 | A7 | - |
| EPI0S16 | X | A16 | A8 | - |
| EPI0S17 | X | A17 | A9 | - |
| EPI0S18 | X | A18 | A10 | - |
| EPI0S19 | X | A19 | A11 | - |
| EPI0S20 | X | A20 | A12 | - |
| EPI0S21 | X | A21 | A13 | - |
| EPI0S22 | X | A22 | A14 | - |
| EPI0S23 | X | A23 | A15 | - |
| EPI0S24 | X | A24 | A16 | - |
| EPI0S25 | 0x0 | A25 ^b | A17 | - |
| | 0x1 | | | - |
| | 0x2 | | | CS1n |
| | 0x3 | | | - |
| EPI0S26 | 0x0 | A26 | A18 | EMPTY |
| | 0x1 | | | |
| | 0x2 | | | |
| | 0x3 | CS0n | CS0n | |
| EPI0S27 | 0x0 | A27 | A19 | FFULL |
| | 0x1 | | | |
| | 0x2 | CS1n | CS1n | |
| | 0x3 | | | |
| EPI0S28 | X | RDn/OEn | RDn/OEn | RDn |
| EPI0S29 | X | WRn | WRn | WRn |
| EPI0S30 | 0x0 | ALE | ALE | - |
| | 0x1 | CSn | CSn | CSn |
| | 0x2 | CS0n | CS0n | CS0n |
| | 0x3 | ALE | ALE | - |
| EPI0S31 | X | Clock ^c | Clock ^c | Clock ^c |

a. "X" indicates the state of this field is a don't care.

b. When an entry straddles several row, the signal configuration is the same for all rows.

c. The clock signal is not required for this mode and has unspecified timing relationships to other signals.

Table 10-6 on page 490 shows how the `EPI[31:0]` signals function while in Host-Bus 16 mode. Notice that the signal configuration changes based on the address/data mode selected by the `MODE` field in the **EPIHB16CFG2** register, on the chip select configuration selected by the `CSCFG` field in the same register, and on whether byte selects are used as configured by the `BSEL` bit in the **EPIHB16CFG** register.

Although the `EPI0S31` signal can be configured for the EPI clock signal in Host-Bus mode, it is not required and should be configured as a GPIO to reduce EMI in the system. Any unused EPI controller signals can be used as GPIOs or another alternate function.

Table 10-6. EPI Host-Bus 16 Signal Connections

| EPI Signal | CSCFG | BSEL | HB16 Signal (MODE =ADMUX) | HB16 Signal (MODE =ADNOMUX (Cont. Read)) | HB16 Signal (MODE =XFIFO) |
|------------|----------------|------|---------------------------|--|---------------------------|
| EPI0S0 | X ^a | X | AD0 ^b | D0 | D0 |
| EPI0S1 | X | X | AD1 | D1 | D1 |
| EPI0S2 | X | X | AD2 | D2 | D2 |
| EPI0S3 | X | X | AD3 | D3 | D3 |
| EPI0S4 | X | X | AD4 | D4 | D4 |
| EPI0S5 | X | X | AD5 | D5 | D5 |
| EPI0S6 | X | X | AD6 | D6 | D6 |
| EPI0S7 | X | X | AD7 | D7 | D7 |
| EPI0S8 | X | X | AD8 | D8 | D8 |
| EPI0S9 | X | X | AD9 | D9 | D9 |
| EPI0S10 | X | X | AD10 | D10 | D10 |
| EPI0S11 | X | X | AD11 | D11 | D11 |
| EPI0S12 | X | X | AD12 | D12 | D12 |
| EPI0S13 | X | X | AD13 | D13 | D13 |
| EPI0S14 | X | X | AD14 | D14 | D14 |
| EPI0S15 | X | X | AD15 | D15 | D15 |
| EPI0S16 | X | X | A16 | A0 ^b | - |
| EPI0S17 | X | X | A17 | A1 | - |
| EPI0S18 | X | X | A18 | A2 | - |
| EPI0S19 | X | X | A19 | A3 | - |
| EPI0S20 | X | X | A20 | A4 | - |
| EPI0S21 | X | X | A21 | A5 | - |
| EPI0S22 | X | X | A22 | A6 | - |
| EPI0S23 | X ^c | 0 | A23 | A7 | - |
| | | 1 | | | |

Table 10-6. EPI Host-Bus 16 Signal Connections (continued)

| EPI Signal | CSCFG | BSEL | HB16 Signal (MODE =ADMUX) | HB16 Signal (MODE =ADNOMUX (Cont. Read)) | HB16 Signal (MODE =XFIFO) |
|------------|-------|--------|---------------------------|--|---------------------------|
| EPI0S24 | 0x0 | 0 | A24 | A8 | - |
| | | 1 | | | |
| | 0x1 | 0 | | | |
| | | 1 | | | |
| | 0x2 | 0 | | | |
| | | 1 | | | |
| 0x3 | 0 | BSEL0n | BSEL0n | | |
| | 1 | | | | |
| EPI0S25 | 0x0 | X | A25 | A9 | - |
| | | | 0x1 | | |
| | 0x2 | 0 | A25 | A9 | CS1n |
| | | 1 | BSEL0n | BSEL0n | |
| | 0x3 | 0 | A25 | A9 | -- |
| | | 1 | BSEL1n | BSEL1n | |
| EPI0S26 | 0x0 | 0 | A26 | A10 | FEMPTY |
| | | 1 | BSEL0n | BSEL0n | |
| | 0x1 | 0 | A26 | A10 | |
| | | 1 | BSEL0n | BSEL0n | |
| | 0x2 | 0 | A26 | A10 | |
| | | 1 | BSEL1n | BSEL1n | |
| 0x3 | X | CS0n | CS0n | | |
| EPI0S27 | 0x0 | 0 | A27 | A11 | FFULL |
| | | 1 | BSEL1n | BSEL1n | |
| | 0x1 | 0 | A27 | A11 | |
| | | 1 | BSEL1n | BSEL1n | |
| | 0x2 | X | CS1n | CS1n | |
| | 0x3 | X | | | |
| EPI0S28 | X | X | RDn/OEn | RDn/OEn | RDn |
| EPI0S29 | X | X | WRn | WRn | WRn |
| EPI0S30 | 0x0 | X | ALE | ALE | - |
| | 0x1 | X | CSn | CSn | CSn |
| | 0x2 | X | CS0n | CS0n | CS0n |
| | 0x3 | X | ALE | ALE | - |
| EPI0S31 | X | X | Clock ^d | Clock ^d | Clock ^d |

a. "X" indicates the state of this field is a don't care.

b. In this mode, half-word accesses are used. A0 is the LSB of the address and is equivalent to the internal Cortex-M3 A1 address. This pin should be connected to A0 of 16-bit memories.

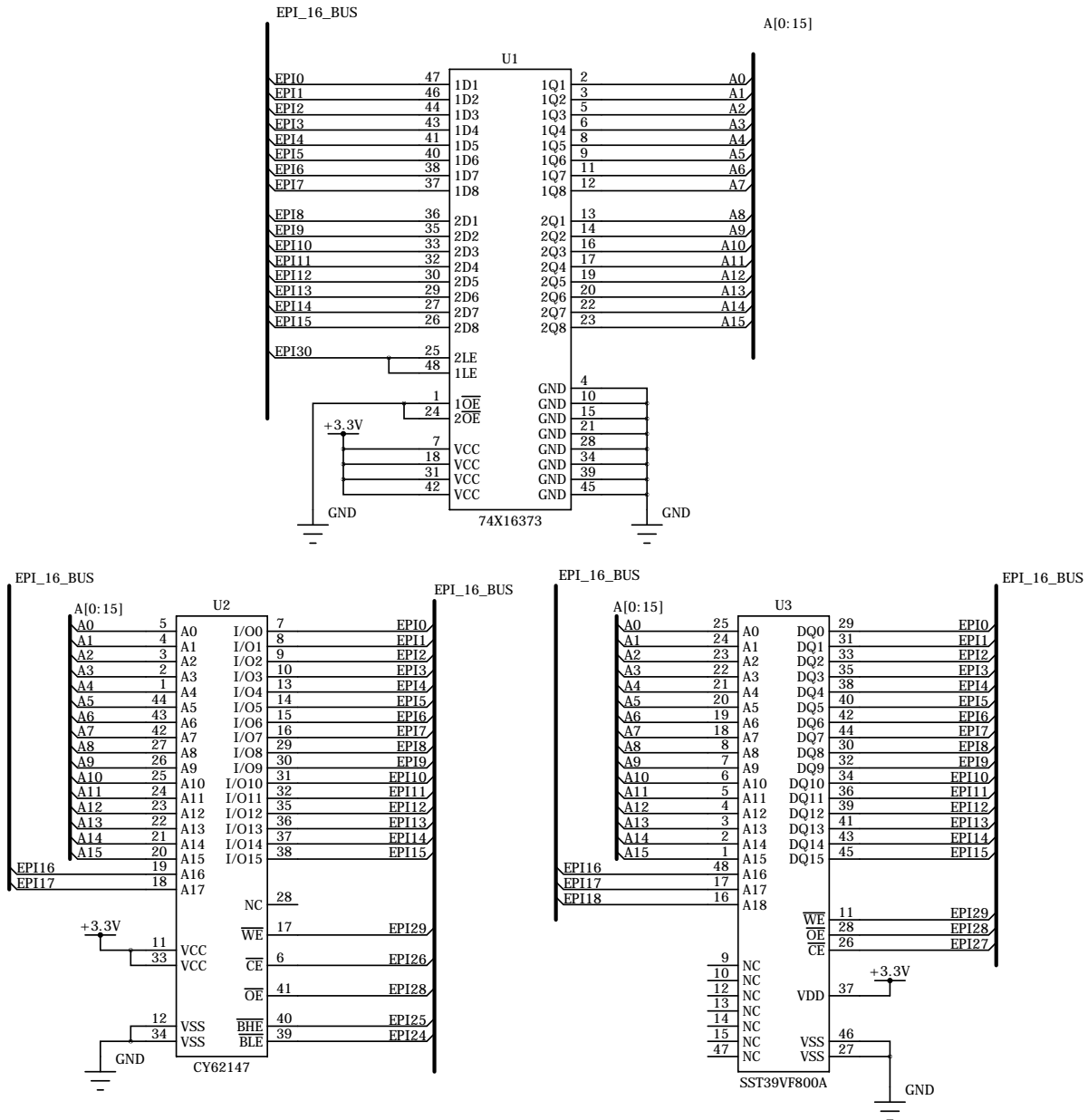
c. When an entry straddles several row, the signal configuration is the same for all rows.

d. The clock signal is not required for this mode and has unspecified timing relationships to other signals.

10.4.2.2 SRAM support

Figure 10-5 on page 492 shows how to connect the EPI signals to a 16-bit SRAM and a 16-bit Flash memory with muxed address and memory using byte selects and dual chip selects with ALE. This schematic is just an example of how to connect the signals; timing and loading have not been analyzed. In addition, not all bypass capacitors are shown.

Figure 10-5. Example Schematic for Muxed Host-Bus 16 Mode



10.4.2.3 Speed of Transactions

The COUNT0 field in the **EPIBAUD** register must be configured to set the main transaction rate based on what the slave device can support (including wiring considerations). The main control

transitions are normally $\frac{1}{2}$ the baud rate (`COUNT0 = 1`) because the EPI block forces data vs. control to change on alternating clocks. When using dual chip selects, each chip select can access the bus using differing baud rates by setting the `CSBAUD` bit in the **EPIHBnCFG2** register. In this case, the `COUNT0` field controls the `CS0n` transactions, and the `COUNT1` field controls the `CS1n` transactions.

Additionally, the Host-Bus mode provides read and write wait states for the data portion to support different classes of device. These wait states stretch the data period (hold the rising edge of data strobe) and may be used in all four sub-modes. The wait states are set using the `WRWS` and `RDWS` bits in the **EPI Host-Bus n Configuration (EPIHBnCFG)** register.

10.4.2.4 Sub-Modes of Host Bus 8/16

The EPI controller supports four variants of the Host-Bus model using 8 or 16 bits of data in all four cases. The four sub-modes are selected using the `MODE` bits in the **EPIHBnCFG** register, and are:

1. Address and data are muxed. This scheme is used by many 8051 devices, some Microchip PIC parts, and some ATmega parts. When used for standard SRAMs, a latch must be used between the microcontroller and the SRAM. This sub-mode is provided for compatibility with existing devices that support data transfers without a latch (that is, CPLDs). In general, the de-muxed sub-mode should normally be used. The ALE configuration should be used in this mode, as all Host-Bus accesses have an address phase followed by a data phase. The ALE indicates to an external latch to capture the address then hold until the data phase. The ALE configuration is controlled by configuring the `CSCFG` field to be `0x0` in the **EPIHBnCFG2** register. The ALE can be enhanced to access two external devices with two separate `CSn` signals. By configuring the `CSCFG` field to be `0x3` in the **EPIHBnCFG2** register, `EPIOS30` functions as ALE, `EPIOS27` functions as `CS1n`, and `EPIOS26` functions as `CS0n`. The `CSn` is best used for Host-Bus unmuxed mode, in which EPI address and data pins are separate. The `CSn` indicates when the address and data phases of a read or write access are occurring.
2. Address and data are separate with 8 or 16 bits of data and up to 20 bits of address (1 MB). This scheme is used by more modern 8051 devices, as well as some PIC and ATmega parts. This mode is generally used with real SRAMs, many EEPROMs, and many NOR Flash memory devices. Note that there is no hardware command write support for Flash memory devices; this mode should only be used for Flash memory devices programmed at manufacturing time. If a Flash memory device must be written and does not support a direct programming model, the command mechanism must be performed in software. The `CSn` configuration should be used in this mode. The `CSn` signal indicates when the address and data phases of a read or write access is occurring. The `CSn` configuration is controlled by configuring the `CSCFG` field to be `0x1` in the **EPIHBnCFG2** register.
3. Continuous read mode where address and data are separate. This sub-mode is used for real SRAMs which can be read more quickly by only changing the address (and not using `RDN/OEN` strobing). In this sub-mode, reads are performed by keeping the read mode selected (output enable is asserted) and then changing the address pins. The data pins are changed by the SRAM after the address pins change. For example, to read data from address `0x100` and then `0x101`, the EPI controller asserts the output-enable signal and then configures the address pins to `0x100`; the EPI controller then captures what is on the data pins and increments `A0` to 1 (so the address is now `0x101`); the EPI controller then captures what is on the data pins. Note that this mode consumes higher power because the SRAM must continuously drive the data pins. This mode is not practical in HB16 mode for normal SRAMs because there are generally not enough address bits available. Writes are not permitted in this mode.
4. FIFO mode uses 8 or 16 bits of data, removes ALE and address pins and optionally adds external XFIFO FULL/EMPTY flag inputs. This scheme is used by many devices, such as radios,

communication devices (including USB2 devices), and some FPGA configurations (FIFO through block RAM). This sub-mode provides the data side of the normal Host-Bus interface, but is paced by the FIFO control signals. It is important to consider that the XFIFO FULL/EMPTY control signals may stall the interface and could have an impact on blocking read latency from the processor or μ DMA.

The `WORD` bit in the **EPIHBnCFG2** register can be set to use memory more efficiently. By default, the EPI controller uses data bits [7:0] for Host-Bus 8 accesses or bits [15:0] for Host-Bus 16 accesses. When the `WORD` bit is set, the EPI controller can automatically route bytes of data onto the correct byte lanes such that bytes or words of data can be transferred on the correct byte or half-word bits on the entire bus. For example, the most significant byte of data will be transferred on bits [31:28] in host-bus 8 mode and the most significant word of data will be transferred on bits [31:16] of Host-Bus 16 mode. In addition, for the three modes above (1, 2, 4) that the Host-Bus 16 mode supports, byte select signals can be optionally implemented by setting the `BSEL` bit in the **EPIHB16CFG** register.

Note: Byte accesses should not be attempted if the `BSEL` bit has not been enabled in Host-Bus 16 Mode.

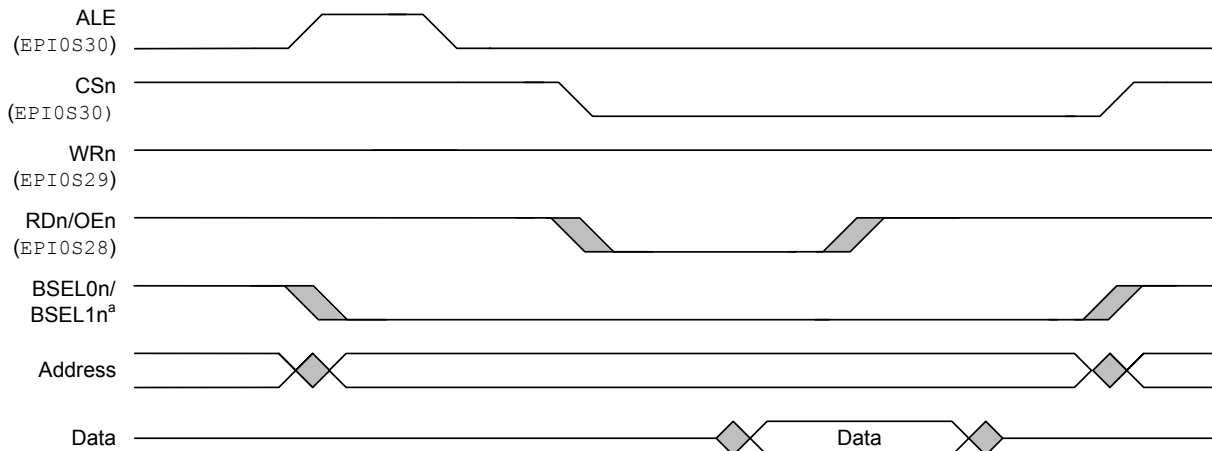
See “External Peripheral Interface (EPI)” on page 1139 for timing details for the Host-Bus mode.

10.4.2.5 Bus Operation

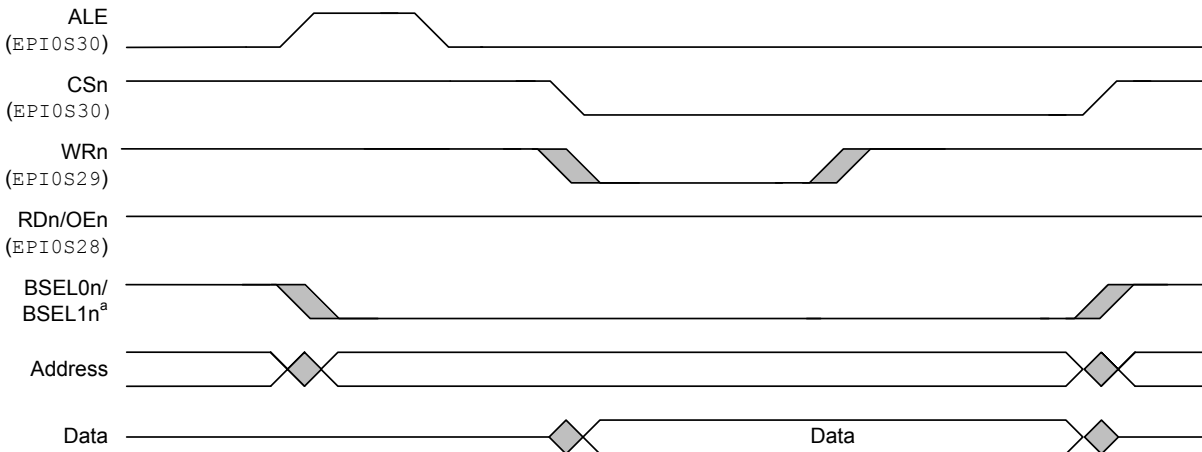
Bus operation is the same in Host-Bus 8 and Host-Bus 16 modes and is asynchronous. Timing diagrams show both ALE and CSn operation, but only one signal or the other is used in all modes except for ALE with dual chip selects mode (`CSCFG` field is 0x3 in the **EPIHBnCFG2** register). Address and data on write cycles are held after the CSn signal is deasserted. The optional HB16 byte select signals have the same timing as the address signals. If wait states are required in the bus access, they can be inserted during the data phase of the access using the `WRWS` and `RDWS` bits in the **EPIHBnCFG2** register. Each wait state adds 2 EPI clock cycles to the duration of the WRn or RDn strobe. During idle cycles, the address and muxed address data signals maintain the state of the last cycle.

Figure 10-6 on page 494 shows a basic Host-Bus read cycle. Figure 10-7 on page 495 shows a basic Host-Bus write cycle. Both of these figures show address and data signals in the non-multiplexed mode (`MODE` field is 0x1 in the **EPIHBnCFG** register).

Figure 10-6. Host-Bus Read Cycle, MODE = 0x1, WRHIGH = 0, RDHIGH = 0

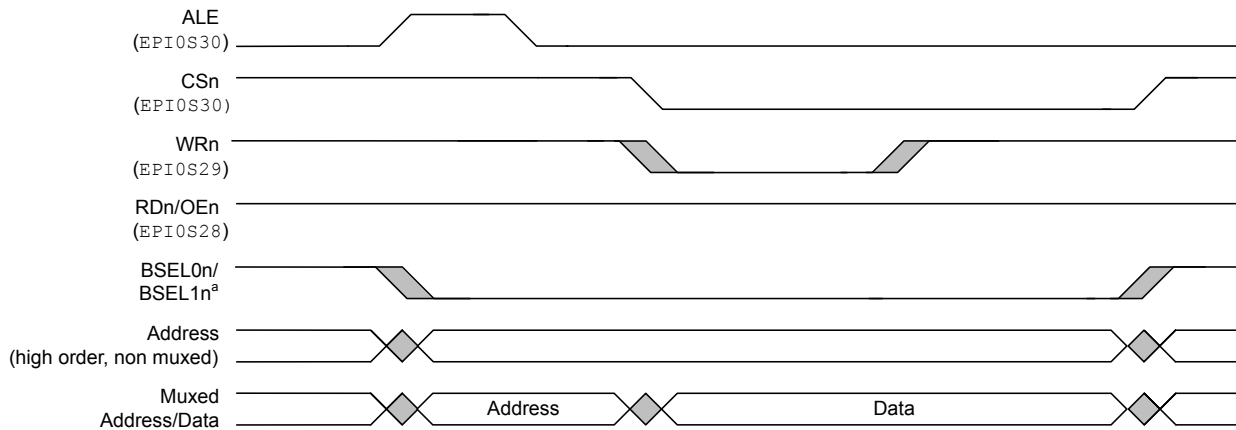


^a BSEL0n and BSEL1n are available in Host-Bus 16 mode only.

Figure 10-7. Host-Bus Write Cycle, MODE = 0x1, WRHIGH = 0, RDHIGH = 0

^a BSEL0n and BSEL1n are available in Host-Bus 16 mode only.

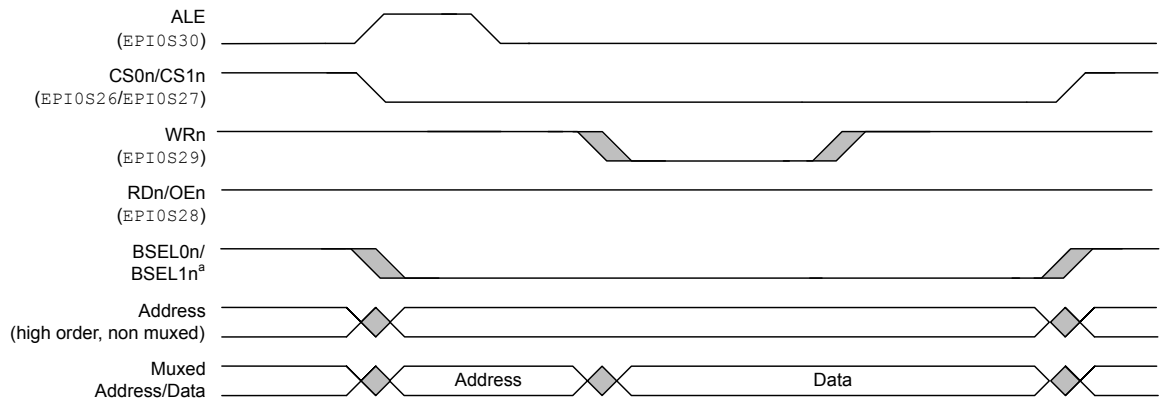
Figure 10-8 on page 495 shows a write cycle with the address and data signals multiplexed (MODE field is 0x0 in the **EPIHBnCFG** register). A read cycle would look similar, with the RDn strobe being asserted along with CSn and data being latched on the rising edge of RDn.

Figure 10-8. Host-Bus Write Cycle with Multiplexed Address and Data, MODE = 0x0, WRHIGH = 0, RDHIGH = 0

^a BSEL0n and BSEL1n are available in Host-Bus 16 mode only.

When using ALE with dual CSn configuration (CSCFG field is 0x3 in the **EPIHBnCFG2** register), the appropriate CSn signal is asserted at the same time as ALE, as shown in Figure 10-9 on page 496.

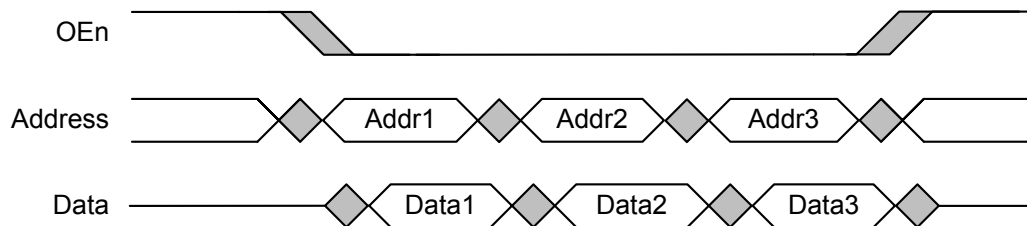
Figure 10-9. Host-Bus Write Cycle with Multiplexed Address and Data and ALE with Dual CSn



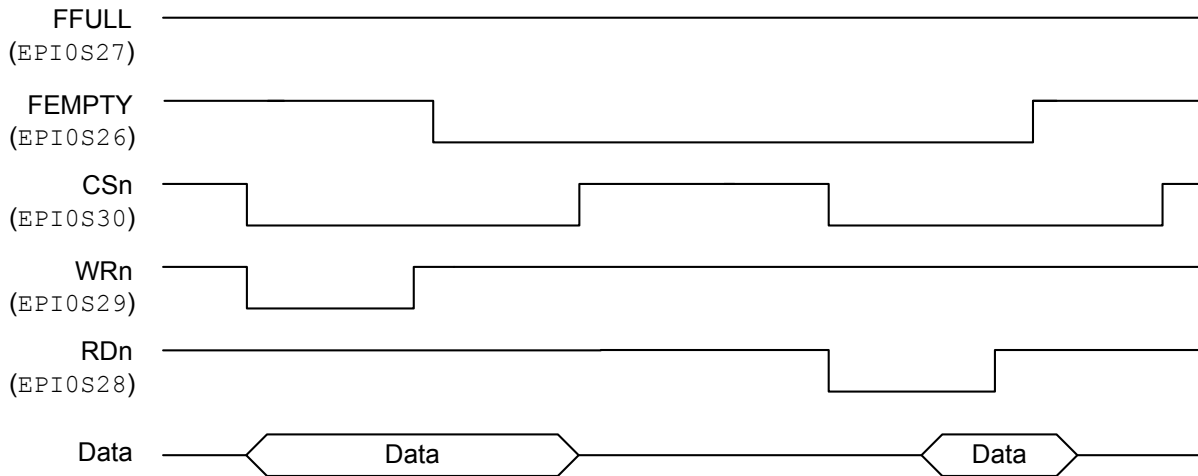
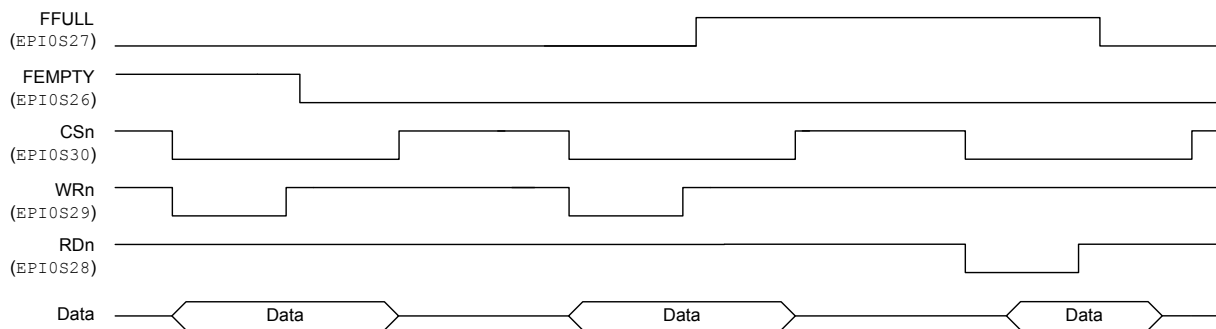
^a BSEL0n and BSEL1n are available in Host-Bus 16 mode only.

Figure 10-10 on page 496 shows continuous read mode accesses. In this mode, reads are performed by keeping the read mode selected (output enable is asserted) and then changing the address pins. The data pins are changed by the SRAM after the address pins change.

Figure 10-10. Continuous Read Mode Accesses



FIFO mode accesses are the same as normal read and write accesses, except that the ALE signal and address pins are not present. Two input signals can be used to indicate when the XFIFO is full or empty to gate transactions and avoid overruns and underruns. The FFULL and FEMPTY signals are synchronized and must be recognized as asserted by the microcontroller for 2 system clocks before they affect transaction status. The MAXWAIT field in the **EPIHBnCFG** register defines the maximum number of EPI clocks to wait while the FEMPTY or FFULL signal is holding off a transaction. Figure 10-11 on page 497 shows how the FEMPTY signal should respond to a write and read from the XFIFO. Figure 10-12 on page 497 shows how the FEMPTY and FFULL signals should respond to 2 writes and 1 read from an external FIFO that contains two entries.

Figure 10-11. Write Followed by Read to External FIFO**Figure 10-12. Two-Entry FIFO**

10.4.3 General-Purpose Mode

The **General-Purpose Mode Configuration (EPIGPCFG)** register is used to configure the control, data, and address pins, if used. Any unused EPI controller signals can be used as GPIOs or another alternate function. The general-purpose configuration can be used for custom interfaces with FPGAs, CPLDs, and digital data acquisition and actuator control.

Important: The **RD2CYC** bit in the **EPIGPCFG** register must be set at all times in General-Purpose mode to ensure proper operation.

General-Purpose mode is designed for three general types of use:

- Extremely high-speed clocked interfaces to FPGAs and CPLDs. Three sizes of data and optional address are supported. Framing and clock-enable functions permit more optimized interfaces.
- General parallel GPIO. From 1 to 32 pins may be written or read, with the speed precisely controlled by the **EPIBAUD** register baud rate (when used with the **WFIFO** and/or the **NBRFIFO**) or by the rate of accesses from software or μ DMA. Examples of this type of use include:
 - Reading 20 sensors at fixed time periods by configuring 20 pins to be inputs, configuring the **COUNT0** field in the **EPIBAUD** register to some divider, and then using non-blocking reads.

- Implementing a very wide ganged PWM/PCM with fixed frequency for driving actuators, LEDs, etc.
- Implementing SDIO 4-bit mode where commands are driven or captured on 6 pins with fixed timing, fed by the μ DMA.
- General custom interfaces of any speed.

The configuration allows for choice of an output clock (free-running or gated), a framing signal (with frame size), a ready input (to stretch transactions), a read and write strobe, an address (of varying sizes), and data (of varying sizes). Additionally, provisions are made for separating data and address phases.

The interface has the following optional features:

- Use of the EPI clock output is controlled by the `CLKPIN` bit in the **EPIGPCFG** register. Unlocked uses include general-purpose I/O and asynchronous interfaces (optionally using RD and WR strobes). Clocked interfaces allow for higher speeds and are much easier to connect to FPGAs and CPLDs (which usually include input clocks).
- EPI clock, if used, may be free running or gated depending on the `CLKGATE` bit in the **EPIGPCFG** register. A free-running EPI clock requires another method for determining when data is live, such as the frame pin or RD/WR strobes. A gated clock approach uses a setup-time model in which the EPI clock controls when transactions are starting and stopping. The gated clock is held high until a new transaction is started and goes high at the end of the cycle where RD/WR/FRAME and address (and data if write) are emitted.
- Use of the ready input (iRDY) from the external device is controlled by the `RDYEN` bit in the **EPIGPCFG** register. The iRDY signal uses `EPI0S27` and may only be used with a free-running clock. iRDY gates transactions, no matter what state they are in. When iRDY is deasserted, the transaction is held off from completing.
- Use of the frame output (FRAME) is controlled by the `FRMPIN` bit in the **EPIGPCFG** register. The frame pin may be used whether the clock is output or not, and whether the clock is free running or not. It may also be used along with the iRDY signal. The frame may be a pulse (one clock) or may be 50/50 split across the frame size (controlled by the `FRM50` bit in the **EPIGPCFG** register). The frame count (the size of the frame as specified by the `FRMCNT` field in the **EPIGPCFG** register) may be between 1 and 15 clocks for pulsed and between 2 and 30 clocks for 50/50. The frame pin counts transactions and not clocks; a transaction is any clock where the RD or WR strobe is high (if used). So, if the `FRMCNT` bit is set, then the frame pin pulses every other transaction; if 2-cycle reads and writes are used, it pulses every other address phase. `FRM50` must be used with this in mind as it may hold state for many clocks waiting for the next transaction.
- Use of the RD and WR outputs is controlled by the `RW` bit in the **EPIGPCFG** register. For interfaces where the direction is known (in advance, related to frame size, or other means), these strobes are not needed. For most other interfaces, RD and WR are used so the external peripheral knows what transaction is taking place, and if any transaction is taking place.
- Separation of address/request and data phases may be used on writes using the `WR2CYC` bit in the **EPIGPCFG** register. This configuration allows the external peripheral extra time to act. Address and data phases must be separated on reads, and the `RD2CYC` bit in the **EPIGPCFG** register must be set. When configured to use an address as specified by the `ASIZE` field in the **EPIGPCFG** register, the address is emitted on the with the RD strobe (first cycle) and data is

expected to be returned on the next cycle (when RD is not asserted). If no address is used, then RD is asserted on the first cycle and data is captured on the second cycle (when RD is not asserted), allowing more setup time for data.

For writes, the output may be in one or two cycles. In the two-cycle case, the address (if any) is emitted on the first cycle with the WR strobe and the data is emitted on the second cycle (with WR not asserted). Although split address and write data phases are not normally needed for logic reasons, it may be useful to make read and write timings match. If 2-cycle reads or writes are used, the RW bit is automatically set.

- Address may be emitted (controlled by the ASIZE field in the **EPIGPCFG** register). The address may be up to 4 bits (16 possible values), up to 12 bits (4096 possible values), or up to 20 bits (1 M possible values). Size of address limits size of data, for example, 4 bits of address support up to 24 bits data. 4-bit address uses EPIOS[27:24]; 12-bit address uses EPIOS[27:16]; 20-bit address uses EPIOS[27:8]. The address signals may be used by the external peripheral as an address, code (command), or for other unrelated uses (such as a chip enable). If the chosen address/data combination does not use all of the EPI signals, the unused pins can be used as GPIOs or for other functions. For example, when using a 4-bit address with an 8-bit data, the pins assigned to EPIS0[23:8] can be assigned to other functions.
- Data may be 8 bits, 16 bits, 24 bits, or 32 bits (controlled by the DSIZE field in the **EPIGPCFG** register). 32-bit data cannot be used with address or EPI clock or any other signal. 24-bit data can only be used with 4-bit address or no address. 32-bit data requires that either the WR2CYC bit or the RD2CYC bit in the **EPIGPCFG** register is set.
- Memory can be used more efficiently by using the Word Access Mode. By default, the EPI controller uses data bits [7:0] when the DSIZE field in the **EPIGPCFG** register is 0x0; data bits [15:0] when the DSIZE field is 0x1; data bits [23:0] when the DSIZE field is 0x2; and data bits [31:0] when the DSIZE field is 0x3. When the WORD bit in the **EPIGPCFG2** register is set, the EPI controller automatically routes bytes of data onto the correct byte lanes such that data can be stored in bits [31:8] for DSIZE=0x0 and bits [31:16] for DSIZE=0x1.
- When using the EPI controller as a GPIO interface, writes are FIFOed (up to 4 can be held at any time), and up to 32 pins are changed using the **EPIBAUD** clock rate specified by COUNT0. As a result, output pin control can be very precisely controlled as a function of time. By contrast, when writing to normal GPIOs, writes can only occur 8-bits at a time and take up to two clock cycles to complete. In addition, the write itself may be further delayed by the bus due to μ DMA or draining of a previous write. With both GPIO and the EPI controller, reads may be performed directly, in which case the current pin states are read back. With the EPI controller, the non-blocking interface may also be used to perform reads based on a fixed time rule via the **EPIBAUD** clock rate.

Table 10-7 on page 499 shows how the EPIOS[31:0] signals function while in General-Purpose mode. Notice that the address connections vary depending on the data-width restrictions of the external peripheral.

Table 10-7. EPI General Purpose Signal Connections

| EPI Signal | General-Purpose Signal (D8, A20) | General- Purpose Signal (D16, A12) | General- Purpose Signal (D24, A4) | General- Purpose Signal (D32) |
|------------|----------------------------------|------------------------------------|-----------------------------------|-------------------------------|
| EPIOS0 | D0 | D0 | D0 | D0 |
| EPIOS1 | D1 | D1 | D1 | D1 |
| EPIOS2 | D2 | D2 | D2 | D2 |

Table 10-7. EPI General Purpose Signal Connections (*continued*)

| EPI Signal | General-Purpose Signal (D8, A20) | General- Purpose Signal (D16, A12) | General- Purpose Signal (D24, A4) | General- Purpose Signal (D32) |
|------------|----------------------------------|------------------------------------|-----------------------------------|-------------------------------|
| EPI0S3 | D3 | D3 | D3 | D3 |
| EPI0S4 | D4 | D4 | D4 | D4 |
| EPI0S5 | D5 | D5 | D5 | D5 |
| EPI0S6 | D6 | D6 | D6 | D6 |
| EPI0S7 | D7 | D7 | D7 | D7 |
| EPI0S8 | A0 | D8 | D8 | D8 |
| EPI0S9 | A1 | D9 | D9 | D9 |
| EPI0S10 | A2 | D10 | D10 | D10 |
| EPI0S11 | A3 | D11 | D11 | D11 |
| EPI0S12 | A4 | D12 | D12 | D12 |
| EPI0S13 | A5 | D13 | D13 | D13 |
| EPI0S14 | A6 | D14 | D14 | D14 |
| EPI0S15 | A7 | D15 | D15 | D15 |
| EPI0S16 | A8 | A0 ^a | D16 | D16 |
| EPI0S17 | A9 | A1 | D17 | D17 |
| EPI0S18 | A10 | A2 | D18 | D18 |
| EPI0S19 | A11 | A3 | D19 | D19 |
| EPI0S20 | A12 | A4 | D20 | D20 |
| EPI0S21 | A13 | A5 | D21 | D21 |
| EPI0S22 | A14 | A6 | D22 | D22 |
| EPI0S23 | A15 | A7 | D23 | D23 |
| EPI0S24 | A16 | A8 | A0 ^b | D24 |
| EPI0S25 | A17 | A9 | A1 | D25 |
| EPI0S26 | A18 | A10 | A2 | D26 |
| EPI0S27 | A19/iRDY ^c | A11/iRDY ^c | A3/iRDY ^c | D27 |
| EPI0S28 | WR | WR | WR | D28 |
| EPI0S29 | RD | RD | RD | D29 |
| EPI0S30 | Frame | Frame | Frame | D30 |
| EPI0S31 | Clock | Clock | Clock | D31 |

a. In this mode, half-word accesses are used. A0 is the LSB of the address and is equivalent to the system A1 address.

b. In this mode, word accesses are used. A0 is the LSB of the address and is equivalent to the system A2 address.

c. This signal is iRDY if the RDYEN bit in the **EPIGPCFG** register is set.

10.4.3.1 Bus Operation

A basic access is 1 EPI clock for write cycles and 2 EPI clocks for read cycles. An additional EPI clock can be inserted into a write cycle by setting the WR2CYC bit in the **EPIGPCFG** register. Note that the RD2CYC bit must always be set in the **EPIGPCFG** register.

Figure 10-13. Single-Cycle Write Access, FRM50=0, FRMCNT=0, WRCYC=0

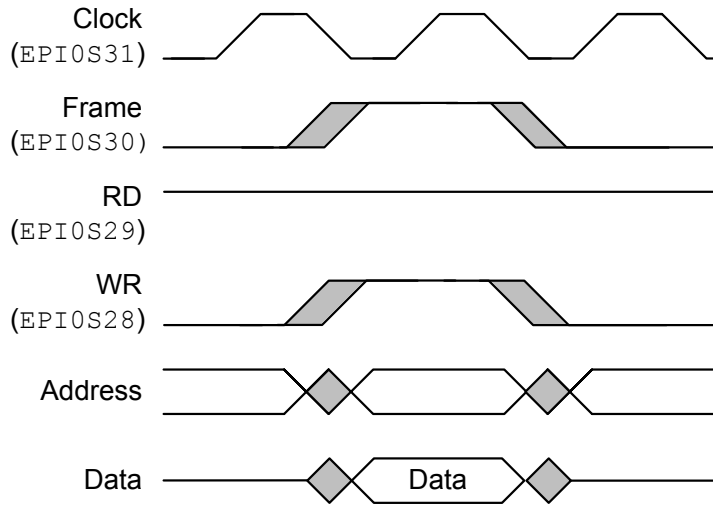


Figure 10-14. Two-Cycle Read, Write Accesses, FRM50=0, FRMCNT=0, RDCYC=1, WRCYC=1

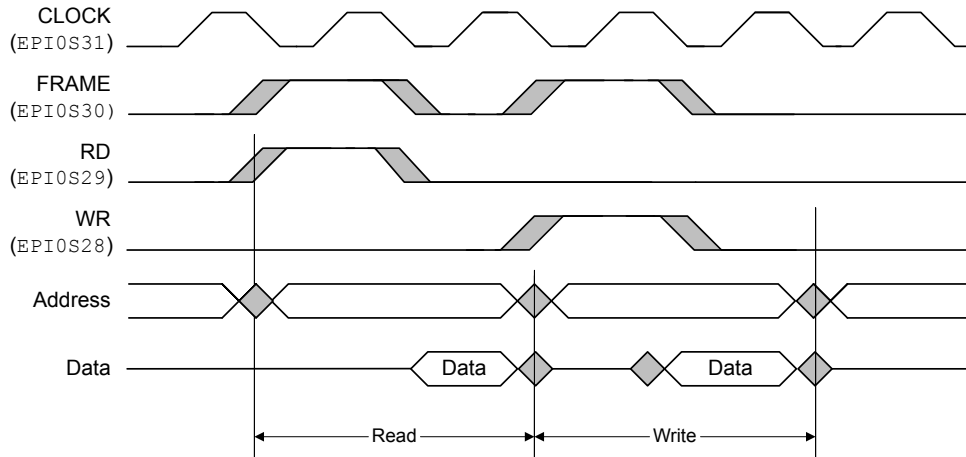
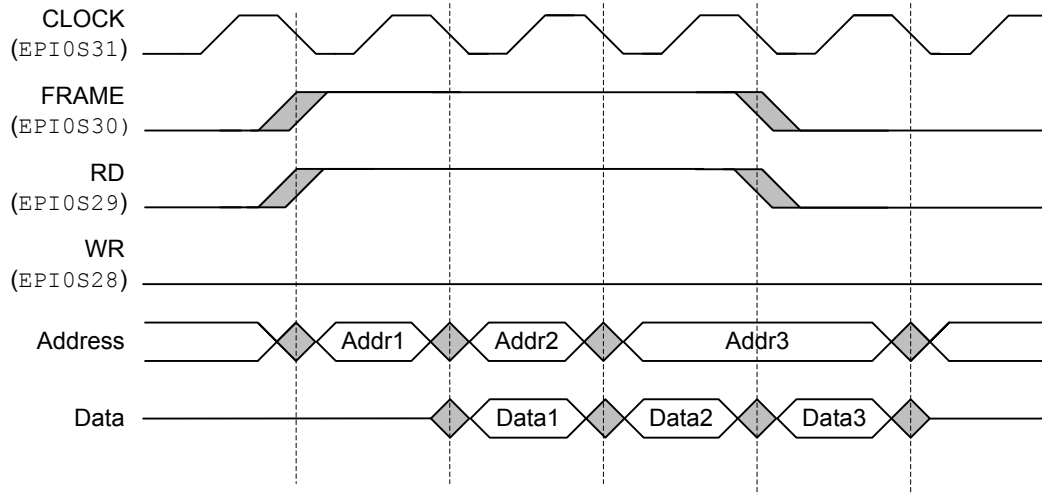


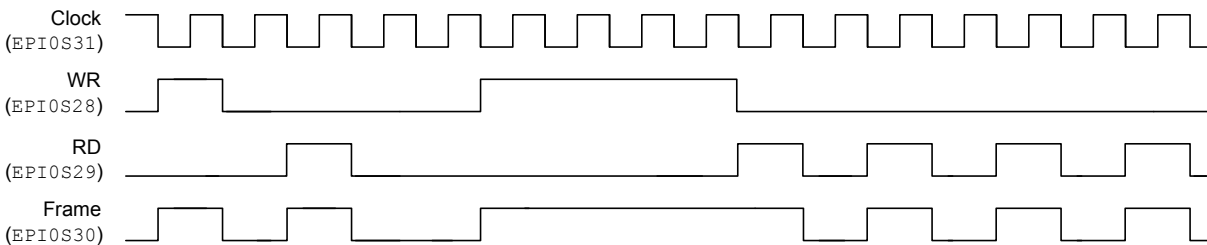
Figure 10-15. Read Accesses, FRM50=0, FRMCNT=0, RDCYC=1



FRAME Signal Operation

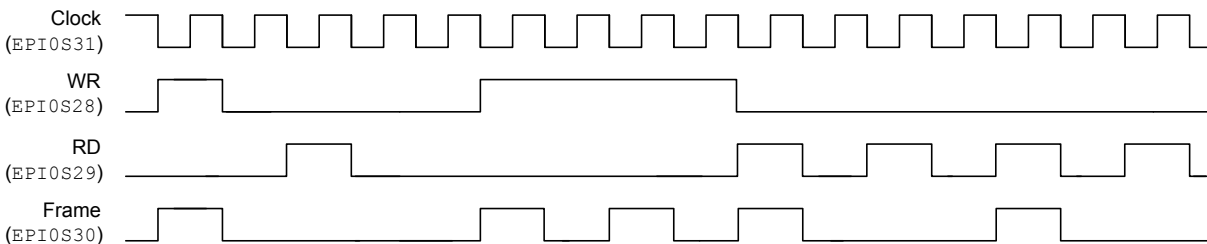
The operation of the FRAME signal is controlled by the FRMCNT and FRM50 bits. When FRM50 is clear, the FRAME signal is high whenever the WR or RD strobe is high. When FRMCNT is clear, the FRAME signal is simply the logical OR of the WR and RD strobes so the FRAME signal is high during every read or write access, see Figure 10-16 on page 502.

Figure 10-16. FRAME Signal Operation, FRM50=0 and FRMCNT=0

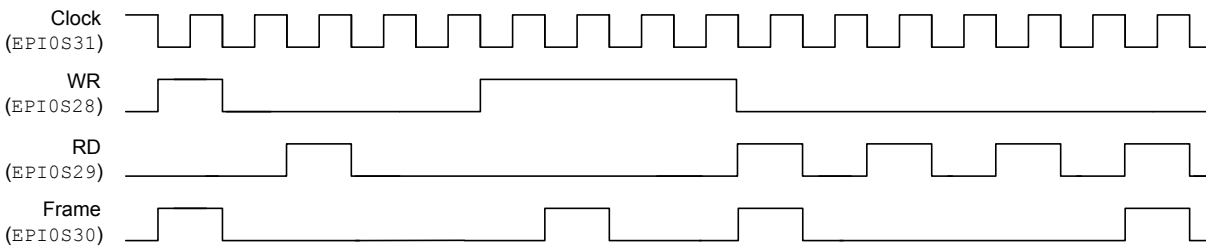


If the FRMCNT field is 0x1, then the FRAME signal pulses high during every other read or write access, see Figure 10-17 on page 502.

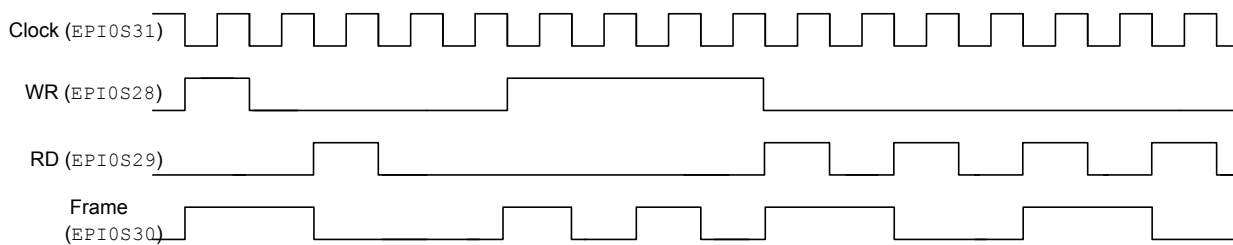
Figure 10-17. FRAME Signal Operation, FRM50=0 and FRMCNT=1



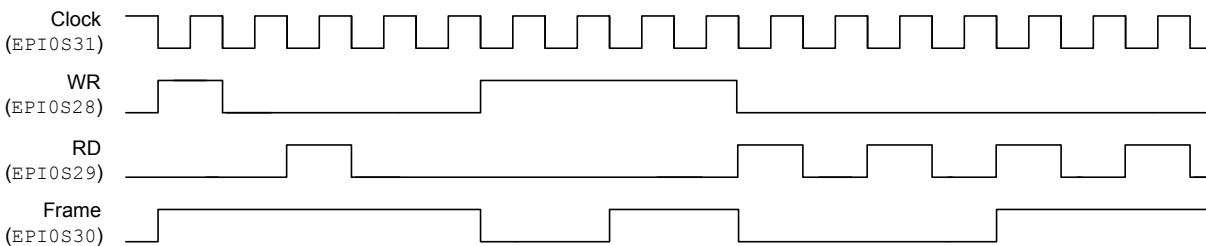
If the FRMCNT field is 0x2 and FRM50 is clear, then the FRAME signal pulses high during every third access, and so on for every value of FRMCNT, see Figure 10-18 on page 503.

Figure 10-18. FRAME Signal Operation, FRM50=0 and FRMCNT=2

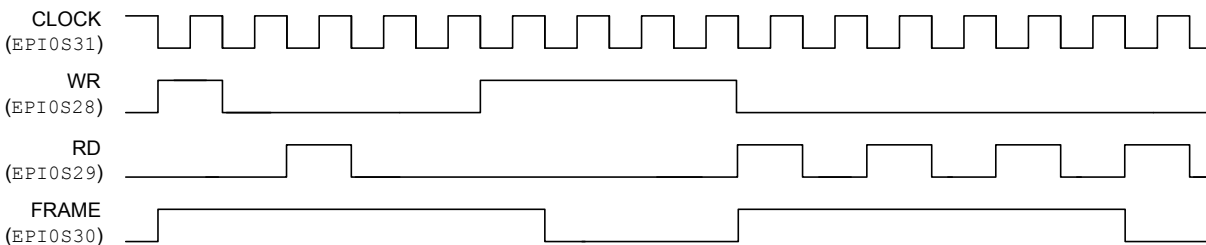
When `FRM50` is set, the FRAME signal transitions on the rising edge of either the WR or RD strobes. When `FRMCNT=0`, the FRAME signal transitions on the rising edge of WR or RD for every access, see Figure 10-19 on page 503.

Figure 10-19. FRAME Signal Operation, FRM50=1 and FRMCNT=0

When `FRMCNT=1`, the FRAME signal transitions on the rising edge of the WR or RD strobes for every other access, see Figure 10-20 on page 503.

Figure 10-20. FRAME Signal Operation, FRM50=1 and FRMCNT=1

When `FRMCNT=2`, the FRAME signal transitions the rising edge of the WR or RD strobes for every third access, and so on for every value of `FRMCNT`, see Figure 10-21 on page 503.

Figure 10-21. FRAME Signal Operation, FRM50=1 and FRMCNT=2

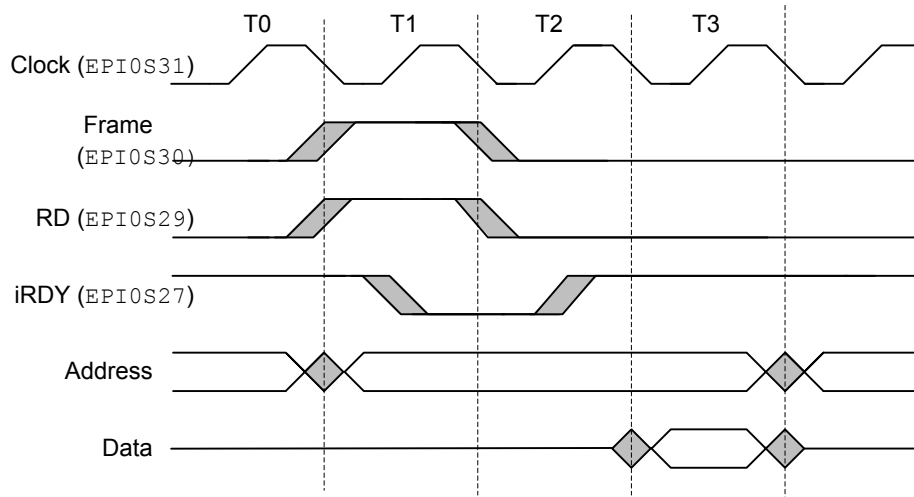
iRDY Signal Operation

The ready input (iRDY) signal can be used to lengthen bus cycles and is enabled by the `RDYEN` bit in the `EPIGPCFG` register. iRDY is input on `EPI0S27` and may only be used with a free-running clock (`CLKGATE` is clear). If iRDY is deasserted, further transactions are held off until the iRDY signal is asserted again. iRDY is sampled on the falling edge of the EPI clock and gates transactions, no matter what state they are in.

A two-cycle access has two phases in the bus cycle. The first clock is the address phase, and the second clock is the data phase. If iRDY is sampled Low at the start of the address phase, as shown in Figure 25-21 on page 1143, then the address phase is extended (`FRAME`, `RD`, and Address are all asserted) until after iRDY has been sampled High again. Data is sampled on the subsequent rising edge.

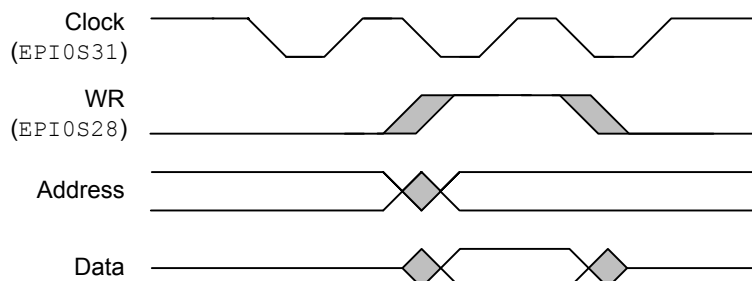
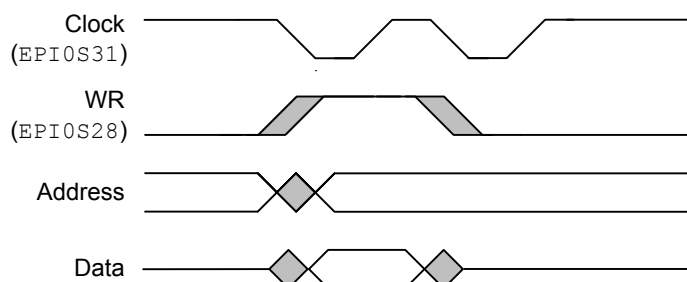
If iRDY is sampled Low at the start of the data phase, as shown in Figure 10-22 on page 504, the `FRAME`, `RD`, Address, and Data signals behave as they would during a normal transaction in T1. The data phase (T2) is extended with only Address being asserted until iRDY is recognized as asserted again. Data is latched on the subsequent rising edge.

Figure 10-22. iRDY Signal Operation, `FRM50=0`, `FRMCNT=0`, and `RD2CYC=1`



EPI Clock Operation

If the `CLKGATE` bit in the `EPIGPCFG` register is clear, the EPI clock always toggles when General-purpose mode is enabled. If `CLKGATE` is set, the clock is output only when a transaction is occurring, otherwise the clock is held high. If the `WR2CYC` bit is clear, the EPI clock begins toggling 1 cycle before the `WR` strobe goes high. If the `WR2CYC` bit is set, the EPI clock begins toggling when the `WR` strobe goes high. The clock stops toggling after the first rising edge after the `WR` strobe is deasserted. The `RD` strobe operates in the same manner as the `WR` strobe when the `WR2CYC` bit is set, as the `RD2CYC` bit must always be set. See Figure 10-23 on page 505 and Figure 10-24 on page 505.

Figure 10-23. EPI Clock Operation, CLKGATE=1, WR2CYC=0**Figure 10-24. EPI Clock Operation, CLKGATE=1, WR2CYC=1**

10.5 Register Map

Table 10-8 on page 505 lists the EPI registers. The offset listed is a hexadecimal increment to the register's address, relative to the base address of 0x400D.0000. Note that the EPI controller clock must be enabled before the registers can be programmed (see page 262). There must be a delay of 3 system clocks after the EPI module clock is enabled before any EPI module registers are accessed.

Note: A back-to-back write followed by a read of the same register reads the value that written by the first write access, not the value from the second write access. (This situation only occurs when the processor core attempts this action, the μ DMA does not do this.) To read back what was just written, another instruction must be generated between the write and read. Read-write does not have this issue, so use of read-write for clear of error interrupt cause is not affected.

Table 10-8. External Peripheral Interface (EPI) Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|-------------|------|-------------|-----------------------------------|----------|
| 0x000 | EPICFG | R/W | 0x0000.0000 | EPI Configuration | 507 |
| 0x004 | EPIBAUD | R/W | 0x0000.0000 | EPI Main Baud Rate | 508 |
| 0x010 | EPISDRAMCFG | R/W | 0x82EE.0000 | EPI SDRAM Configuration | 510 |
| 0x010 | EPIHB8CFG | R/W | 0x0000.FF00 | EPI Host-Bus 8 Configuration | 512 |
| 0x010 | EPIHB16CFG | R/W | 0x0000.FF00 | EPI Host-Bus 16 Configuration | 515 |
| 0x010 | EPIGPCFG | R/W | 0x0000.0000 | EPI General-Purpose Configuration | 519 |
| 0x014 | EPIHB8CFG2 | R/W | 0x0000.0000 | EPI Host-Bus 8 Configuration 2 | 524 |

Table 10-8. External Peripheral Interface (EPI) Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|--------------|-------|-------------|--|----------|
| 0x014 | EPIHB16CFG2 | R/W | 0x0000.0000 | EPI Host-Bus 16 Configuration 2 | 527 |
| 0x014 | EPIGPCFG2 | R/W | 0x0000.0000 | EPI General-Purpose Configuration 2 | 530 |
| 0x01C | EPIADDRMAP | R/W | 0x0000.0000 | EPI Address Map | 531 |
| 0x020 | EPIRSIZE0 | R/W | 0x0000.0003 | EPI Read Size 0 | 533 |
| 0x024 | EPIRADDR0 | R/W | 0x0000.0000 | EPI Read Address 0 | 534 |
| 0x028 | EPIRPSTD0 | R/W | 0x0000.0000 | EPI Non-Blocking Read Data 0 | 535 |
| 0x030 | EPIRSIZE1 | R/W | 0x0000.0003 | EPI Read Size 1 | 533 |
| 0x034 | EPIRADDR1 | R/W | 0x0000.0000 | EPI Read Address 1 | 534 |
| 0x038 | EPIRPSTD1 | R/W | 0x0000.0000 | EPI Non-Blocking Read Data 1 | 535 |
| 0x060 | EPISTAT | RO | 0x0000.0000 | EPI Status | 537 |
| 0x06C | EPIRFIFOCNT | RO | - | EPI Read FIFO Count | 539 |
| 0x070 | EPIREADFIFO | RO | - | EPI Read FIFO | 540 |
| 0x074 | EPIREADFIFO1 | RO | - | EPI Read FIFO Alias 1 | 540 |
| 0x078 | EPIREADFIFO2 | RO | - | EPI Read FIFO Alias 2 | 540 |
| 0x07C | EPIREADFIFO3 | RO | - | EPI Read FIFO Alias 3 | 540 |
| 0x080 | EPIREADFIFO4 | RO | - | EPI Read FIFO Alias 4 | 540 |
| 0x084 | EPIREADFIFO5 | RO | - | EPI Read FIFO Alias 5 | 540 |
| 0x088 | EPIREADFIFO6 | RO | - | EPI Read FIFO Alias 6 | 540 |
| 0x08C | EPIREADFIFO7 | RO | - | EPI Read FIFO Alias 7 | 540 |
| 0x200 | EPIFIFOLVL | R/W | 0x0000.0033 | EPI FIFO Level Selects | 541 |
| 0x204 | EPIWFIFOCNT | RO | 0x0000.0004 | EPI Write FIFO Count | 543 |
| 0x210 | EPIIM | R/W | 0x0000.0000 | EPI Interrupt Mask | 544 |
| 0x214 | EPIRIS | RO | 0x0000.0004 | EPI Raw Interrupt Status | 545 |
| 0x218 | EPIMIS | RO | 0x0000.0000 | EPI Masked Interrupt Status | 547 |
| 0x21C | EPIEISC | R/W1C | 0x0000.0000 | EPI Error and Interrupt Status and Clear | 548 |

10.6 Register Descriptions

This section lists and describes the EPI registers, in numerical order by address offset.

Register 1: EPI Configuration (EPICFG), offset 0x000

Important: The `MODE` field determines which configuration register is accessed for offsets 0x010 and 0x014. Any write to the `EPICFG` register resets the register contents at offsets 0x010 and 0x014.

The configuration register is used to enable the block, select a mode, and select the basic pin use (based on the mode). Note that attempting to program an undefined `MODE` field clears the `BLKEN` bit and disables the EPI controller.

EPI Configuration (EPICFG)

Base 0x400D.0000
Offset 0x000
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-------|------|-----|-----|--|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | BLKEN | MODE | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|--|
| 31:5 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | BLKEN | R/W | 0 | Block Enable |
| | | | | Value Description |
| | | | | 0 The EPI controller is disabled. |
| | | | | 1 The EPI controller is enabled. |
| 3:0 | MODE | R/W | 0x0 | Mode Select |
| | | | | Value Description |
| | | | | 0x0 General Purpose General-Purpose mode. Control, address, and data pins are configured using the <code>EPIGPCFG</code> and <code>EPIGPCFG2</code> registers. |
| | | | | 0x1 SDRAM Supports SDR SDRAM. Control, address, and data pins are configured using the <code>EPISDRAMCFG</code> register. |
| | | | | 0x2 8-Bit Host-Bus (HB8) Host-bus 8-bit interface (also known as the MCU interface). Control, address, and data pins are configured using the <code>EPIHB8CFG</code> and <code>EPIHB8CFG2</code> registers. |
| | | | | 0x3 16-Bit Host-Bus (HB16) Host-bus 16-bit interface (standard SRAM). Control, address, and data pins are configured using the <code>EPIHB16CFG</code> and <code>EPIHB16CFG2</code> registers. |
| | | | | 0x3-0xF Reserved |

Register 2: EPI Main Baud Rate (EPIBAUD), offset 0x004

The system clock is used internally to the EPI Controller. The baud rate counter can be used to divide the system clock down to control the speed on the external interface. If the mode selected emits an external EPI clock, this register defines the EPI clock emitted. If the mode selected does not use an EPI clock, this register controls the speed of changes on the external interface. Care must be taken to program this register properly so that the speed of the external bus corresponds to the speed of the external peripheral and puts acceptable current load on the pins. COUNT0 is the bit field used in all modes except in HB8 and HB16 modes with dual chip selects when different baud rates are selected, see page 524 and page 527. If different baud rates are used, COUNT0 is associated with the address range specified by CS0n and COUNT1 is associated with the address range specified by CS1.

The COUNTn field is not a straight divider or count. The EPI Clock on EPI0S31 is related to the COUNTn field and the system clock as follows:

If COUNTn = 0,

$$EPIClockFreq = SystemClockFreq$$

otherwise:

$$EPIClockFreq = \frac{SystemClockFreq}{\left(\left\lfloor \frac{COUNTn}{2} \right\rfloor + 1\right) \times 2}$$

where the symbol around COUNTn/2 is the floor operator, meaning the largest integer less than or equal to COUNTn/2.

So, for example, a COUNTn of 0x0001 results in a clock rate of 1/2(system clock); a COUNTn of 0x0002 or 0x0003 results in a clock rate of 1/4(system clock).

EPI Main Baud Rate (EPIBAUD)

Base 0x400D.0000
Offset 0x004
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | COUNT1 | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | COUNT0 | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|--------|---|
| 31:16 | COUNT1 | RO | 0x0000 | <p>Baud Rate Counter 1</p> <p>This bit field is only valid with multiple chip selects which are enabled when the CSCFG field is 0x2 or 0x3 and the CSBAUD bit is set in the EPIHBnCFG2 register.</p> <p>This bit field contains a counter used to divide the system clock by the count.</p> <p>A count of 0 means the system clock is used as is.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|--------|--|
| 15:0 | COUNT0 | R/W | 0x0000 | Baud Rate Counter 0 This bit field contains a counter used to divide the system clock by the count. A count of 0 means the system clock is used as is. |

Register 3: EPI SDRAM Configuration (EPISDRAMCFG), offset 0x010

Important: The `MODE` field in the `EPICFG` register determines which configuration register is accessed for offsets 0x010 and 0x014.

To access `EPISDRAMCFG`, the `MODE` field must be 0x1.

The SDRAM Configuration register is used to specify several parameters for the SDRAM controller. Note that this register is reset when the `MODE` field in the `EPICFG` register is changed. If another mode is selected and the SDRAM mode is selected again, the values must be reinitialized.

The SDRAM interface is designed to interface to x16 SDR SDRAMs of 64 MHz or higher, with the address and data pins overlapped (wire ORed on the board). See Table 10-3 on page 483 for pin assignments.

EPI SDRAM Configuration (EPISDRAMCFG)

Base 0x400D.0000
 Offset 0x010
 Type R/W, reset 0x82EE.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|----------|----|----|------|-------|----------|-----|-----|-----|-----|-----|------|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | FREQ | | reserved | | | RFSH | | | | | | | | | | |
| Type | R/W | R/W | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | SLEEP | reserved | | | | | | SIZE | | |
| Type | RO | RO | RO | RO | RO | RO | R/W | RO | RO | RO | RO | RO | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|--------------|------|-------|--|-------|-------------|-----|------------|-----|-------------|-----|-------------|-----|--------------|
| 31:30 | FREQ | R/W | 0x2 | <p>EPI Frequency Range</p> <p>This field configures the frequency range used for delay references by internal counters. This EPI frequency is the system frequency with the divider programmed by the <code>COUNT0</code> bit in the <code>EPICBAUDn</code> register bit. This field affects the power up, precharge, and auto refresh delays. This field does not affect the refresh counting, which is configured separately using the <code>RFSH</code> field (and is based on system clock rate and number of rows per bank). The ranges are:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>0 - 15 MHz</td> </tr> <tr> <td>0x1</td> <td>15 - 30 MHz</td> </tr> <tr> <td>0x2</td> <td>30 - 50 MHz</td> </tr> <tr> <td>0x3</td> <td>50 - 100 MHz</td> </tr> </tbody> </table> | Value | Description | 0x0 | 0 - 15 MHz | 0x1 | 15 - 30 MHz | 0x2 | 30 - 50 MHz | 0x3 | 50 - 100 MHz |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | 0 - 15 MHz | | | | | | | | | | | | | |
| 0x1 | 15 - 30 MHz | | | | | | | | | | | | | |
| 0x2 | 30 - 50 MHz | | | | | | | | | | | | | |
| 0x3 | 50 - 100 MHz | | | | | | | | | | | | | |
| 29:27 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 26:16 | RFSH | R/W | 0x2EE | <p>Refresh Counter</p> <p>This field contains the refresh counter in system clocks. The reset value of 0x2EE provides a refresh period of 64 ms when using a 50 MHz clock.</p> | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 15:10 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9 | SLEEP | R/W | 0 | Sleep Mode Value Description 0 No effect. 1 The SDRAM is put into low power state, but is self-refreshed. |
| 8:2 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1:0 | SIZE | R/W | 0x0 | Size of SDRAM The value of this field affects address pins and behavior. Value Description 0x0 64 megabits (8MB) 0x1 128 megabits (16MB) 0x2 256 megabits (32MB) 0x3 512 megabits (64MB) |

Register 4: EPI Host-Bus 8 Configuration (EPIHB8CFG), offset 0x010

Important: The `MODE` field in the `EPICFG` register determines which configuration register is accessed for offsets 0x010 and 0x014.

To access `EPIHB8CFG`, the `MODE` field must be 0x2.

The Host Bus 8 Configuration register is activated when the HB8 mode is selected. The HB8 mode supports muxed address/data (overlay of lower 8 address and all 8 data pins), separate address/data, and address-less FIFO mode. Note that this register is reset when the `MODE` field in the `EPICFG` register is changed. If another mode is selected and the HB8 mode is selected again, the values must be reinitialized.

This mode is intended to support SRAMs, Flash memory (read), FIFOs, CPLDs/FPGAs, and devices with an MCU/HostBus slave or 8-bit FIFO interface support.

Refer to Table 10-5 on page 488 for information on signal configuration controlled by this register and the `EPIHB8CFG2` register.

If less address pins are required, the corresponding `AFSEL` bit (page 443) should not be enabled so the EPI controller does not drive those pins, and they are available as standard GPIOs.

EPI Host-Bus 8 Mode can be configured to use one chip select with and without the use of ALE. If an alternative to chip selects are required, a chip enable can be handled in one of three ways:

1. Manually control via GPIOs.
2. Associate one or more upper address pins to CE. Because CE is normally CEn, lower addresses are not used. For example, if pins `EPI0S27` and `EPI0S26` are used for Device 1 and 0 respectively, then address 0x6800.0000 accesses Device 0 (Device 1 has its CEn high), and 0x6400.0000 accesses Device 1 (Device 0 has its CEn high). The pull-up behavior on the corresponding GPIOs must be properly configured to ensure that the pins are disabled when the interface is not in use.
3. With certain SRAMs, the ALE can be used as CEn because the address remains stable after the ALE strobe. The subsequent `WRn` or `RDn` signals write or read when ALE is low thus providing CEn functionality.

EPI Host-Bus 8 Configuration (EPIHB8CFG)

Base 0x400D.0000
 Offset 0x010
 Type R/W, reset 0x0000.FF00

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-------|-------|--------|--------|----------|----|------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | XFFEN | XFEEN | WRHIGH | RDHIGH | reserved | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MAXWAIT | | | | | | | | WRWS | | RDWS | | reserved | | MODE | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:24 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 23 | XFFEN | R/W | 0 | External FIFO FULL Enable Value Description 0 No effect. 1 An external FIFO full signal can be used to control write cycles. If this bit is set and the FFULL full signal is high, XFIFO writes are stalled. |
| 22 | XFEEN | R/W | 0 | External FIFO EMPTY Enable Value Description 0 No effect. 1 An external FIFO empty signal can be used to control read cycles. If this bit is set and the FEMPTY signal is high, XFIFO reads are stalled. |
| 21 | WRHIGH | R/W | 0 | WRITE Strobe Polarity Value Description 0 The WRITE strobe for CS0n is WRn (active Low). 1 The WRITE strobe for CS0n is WR (active High). |
| 20 | RDHIGH | R/W | 0 | READ Strobe Polarity Value Description 0 The READ strobe for CS0n is RDn (active Low). 1 The READ strobe for CS0n is RD (active High). |
| 19:16 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:8 | MAXWAIT | R/W | 0xFF | Maximum Wait This field defines the maximum number of external clocks to wait while an external FIFO ready signal is holding off a transaction (FFULL and FEMPTY). When the MAXWAIT value is reached the ERRRIS interrupt status bit is set in the EPIRIS register. When this field is clear, the transaction can be held off forever without a system interrupt. Note: When the MODE field is configured to be 0x2 and the BLKEN bit is set in the EPICFG register, enabling HB8 mode, this field defaults to 0xFF. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 7:6 | WRWS | R/W | 0x0 | <p>Write Wait States</p> <p>This field adds wait states to the data phase of CS0n (the address phase is not affected). The effect is to delay the rising edge of WRn (or the falling edge of WR). Each wait state adds 2 EPI clock cycles to the access time.</p> <p>Value Description</p> <p>0x0 Active WRn is 2 EPI clocks.</p> <p>0x1 Active WRn is 4 EPI clocks.</p> <p>0x2 Active WRn is 6 EPI clocks.</p> <p>0x3 Active WRn is 8 EPI clocks.</p> <p>This field is used in conjunction with the EPIBAUD register.</p> |
| 5:4 | RDWS | R/W | 0x0 | <p>Read Wait States</p> <p>This field adds wait states to the data phase of CS0n (the address phase is not affected).</p> <p>The effect is to delay the rising edge of RDn/Oen (or the falling edge of RD). Each wait state adds 2 EPI clock cycles to the access time.</p> <p>Value Description</p> <p>0x0 Active RDn is 2 EPI clocks.</p> <p>0x1 Active RDn is 4 EPI clocks.</p> <p>0x2 Active RDn is 6 EPI clocks.</p> <p>0x3 Active RDn is 8 EPI clocks.</p> <p>This field is used in conjunction with the EPIBAUD register</p> |
| 3:2 | reserved | RO | 0x0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 1:0 | MODE | R/W | 0x0 | <p>Host Bus Sub-Mode</p> <p>This field determines which of four Host Bus 8 sub-modes to use. Sub-mode use is determined by the connected external peripheral. See Table 10-5 on page 488 for information on how this bit field affects the operation of the EPI signals.</p> <p>Value Description</p> <p>0x0 ADMUX – AD[7:0] Data and Address are muxed.</p> <p>0x1 ADNONMUX – D[7:0] Data and address are separate.</p> <p>0x2 Continuous Read - D[7:0] This mode is the same as ADNONMUX, but uses address switch for multiple reads instead of OEn strobing.</p> <p>0x3 XFIFO – D[7:0] This mode adds XFIFO controls with sense of XFIFO full and XFIFO empty. This mode uses no address or ALE.</p> |

Register 5: EPI Host-Bus 16 Configuration (EPIHB16CFG), offset 0x010

Important: The `MODE` field in the `EPICFG` register determines which configuration register is accessed for offsets 0x010 and 0x014.

To access `EPIHB16CFG`, the `MODE` field must be 0x3.

The Host Bus 16 sub-configuration register is activated when the HB16 mode is selected. The HB16 mode supports muxed address/data (overlay of lower 16 address and all 16 data pins), separated address/data, and address-less FIFO mode. Note that this register is reset when the `MODE` field in the `EPICFG` register is changed. If another mode is selected and the HB16 mode is selected again, the values must be reinitialized.

This mode is intended to support SRAMs, Flash memory (read), FIFOs, and CPLDs/FPGAs, and devices with an MCU/HostBus slave or 16-bit FIFO interface support.

Refer to Table 10-6 on page 490 for information on signal configuration controlled by this register and the `EPIHB16CFG2` register.

If less address pins are required, the corresponding `AFSEL` bit (page 443) should not be enabled so the EPI controller does not drive those pins, and they are available as standard GPIOs.

EPI Host-Bus 16 Mode can be configured to use one to four chip selects with and without the use of ALE. If an alternative to chip selects are required, a chip enable can be handled in one of three ways:

1. Manually control via GPIOs.
2. Associate one or more upper address pins to CE. Because CE is normally CEn, lower addresses are not used. For example, if pins `EPI0S27` and `EPI0S26` are used for Device 1 and 0 respectively, then address 0x6800.0000 accesses Device 0 (Device 1 has its CEn high), and 0x6400.0000 accesses Device 1 (Device 0 has its CEn high). The pull-up behavior on the corresponding GPIOs must be properly configured to ensure that the pins are disabled when the interface is not in use.
3. With certain SRAMs, the ALE can be used as CEn because the address remains stable after the ALE strobe. The subsequent `WRn` or `RDn` signals write or read when ALE is low thus providing CEn functionality.

EPI Host-Bus 16 Configuration (EPIHB16CFG)

Base 0x400D.0000

Offset 0x010

Type R/W, reset 0x0000.FF00

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-------|-------|--------|--------|----------|------|------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | XFFEN | XFEEN | WRHIGH | RDHIGH | reserved | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MAXWAIT | | | | | | | | WRWS | | RDWS | | reserved | BSEL | MODE | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:24 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 23 | XFFEN | R/W | 0 | <p>External FIFO FULL Enable</p> <p>Value Description</p> <p>0 No effect.</p> <p>1 An external FIFO full signal can be used to control write cycles. If this bit is set and the FFULL signal is high, XFIFO writes are stalled.</p> |
| 22 | XFEEN | R/W | 0 | <p>External FIFO EMPTY Enable</p> <p>Value Description</p> <p>1 An external FIFO empty signal can be used to control read cycles. If this bit is set and the FEMPTY signal is high, XFIFO reads are stalled.</p> <p>0 No effect.</p> |
| 21 | WRHIGH | R/W | 0 | <p>WRITE Strobe Polarity</p> <p>Value Description</p> <p>0 The WRITE strobe for CS0n is WRn (active Low).</p> <p>1 The WRITE strobe for CS0n is WR (active High).</p> |
| 20 | RDHIGH | R/W | 0 | <p>READ Strobe Polarity</p> <p>Value Description</p> <p>0 The READ strobe for CS0n is RDn (active Low).</p> <p>1 The READ strobe is RD (active High).</p> |
| 19:16 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:8 | MAXWAIT | R/W | 0xFF | <p>Maximum Wait</p> <p>This field defines the maximum number of external clocks to wait while an external FIFO ready signal is holding off a transaction (FFULL and FEMPTY).</p> <p>When this field is clear, the transaction can be held off forever without a system interrupt.</p> <p>Note: When the MODE field is configured to be 0x3 and the BLKEN bit is set in the EPICFG register, enabling HB16 mode, this field defaults to 0xFF.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 7:6 | WRWS | R/W | 0x0 | <p>Write Wait States</p> <p>This field adds wait states to the data phase of CS0n (the address phase is not affected). The effect is to delay the rising edge of WRn (or the falling edge of WR). Each wait state adds 2 EPI clock cycles to the access time.</p> <p>Value Description</p> <p>0x0 Active WRn is 2 EPI clocks.</p> <p>0x1 Active WRn is 4 EPI clocks.</p> <p>0x2 Active WRn is 6 EPI clocks.</p> <p>0x3 Active WRn is 8 EPI clocks.</p> <p>This field is used in conjunction with the EPIBAUD register.</p> |
| 5:4 | RDWS | R/W | 0x0 | <p>Read Wait States</p> <p>This field adds wait states to the data phase of CS0n (the address phase is not affected).</p> <p>The effect is to delay the rising edge of RDn/Oen (or the falling edge of RD). Each wait state adds 2 EPI clock cycles to the access time.</p> <p>Value Description</p> <p>0x0 Active RDn is 2 EPI clocks.</p> <p>0x1 Active RDn is 4 EPI clocks.</p> <p>0x2 Active RDn is 6 EPI clocks.</p> <p>0x3 Active RDn is 8 EPI clocks.</p> <p>This field is used in conjunction with the EPIBAUD register</p> |
| 3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | BSEL | R/W | 0 | <p>Byte Select Configuration</p> <p>This bit enables byte select operation.</p> <p>Value Description</p> <p>0 No Byte Selects Data is read and written as 16 bits.</p> <p>1 Enable Byte Selects Two EPI signals function as byte select signals to allow 8-bit transfers. See Table 10-6 on page 490 for details on which EPI signals are used.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 1:0 | MODE | R/W | 0x0 | <p>Host Bus Sub-Mode</p> <p>This field determines which of three Host Bus 16 sub-modes to use. Sub-mode use is determined by the connected external peripheral. See Table 10-6 on page 490 for information on how this bit field affects the operation of the EPI signals.</p> <p>Value Description</p> <p>0x0 ADMUX – AD[15:0] Data and Address are muxed.</p> <p>0x1 ADNONMUX – D[15:0] Data and address are separate. This mode is not practical in HB16 mode for normal peripherals because there are generally not enough address bits available.</p> <p>0x2 Continuous Read - D[15:0] This mode is the same as ADNONMUX, but uses address switch for multiple reads instead of OEn strobing. This mode is not practical in HB16 mode for normal SRAMs because there are generally not enough address bits available.</p> <p>0x3 XFIFO – D[15:0] This mode adds XFIFO controls with sense of XFIFO full and XFIFO empty. This mode uses no address or ALE.</p> |

Register 6: EPI General-Purpose Configuration (EPIGPCFG), offset 0x010

Important: The `MODE` field in the `EPICFG` register determines which configuration register is accessed for offsets 0x010 and 0x014.

To access `EPIGPCFG`, the `MODE` field must be 0x0.

The `RD2CYC` bit must be set at all times in General-Purpose mode to ensure proper operation.

The General-Purpose configuration register is used to configure the control, data, and address pins. This mode can be used for custom interfaces with FPGAs, CPLDs, and for digital data acquisition and actuator control. Note that this register is reset when the `MODE` field in the `EPICFG` register is changed. If another mode is selected and the General-purpose mode is selected again, the register the values must be reinitialized.

This mode is designed for 3 general types of use:

- Extremely high-speed clocked interfaces to FPGAs and CPLDs, with 3 sizes of data and optional address. Framing and clock-enable permit more optimized interfaces.
- General parallel GPIO. From 1 to 32 pins may be written or read, with the speed precisely controlled by the baud rate in the `EPIBAUD` register (when used with the `NBRFIFO` and/or the `WFIFO`) or by rate of accesses from software or μ DMA.
- General custom interfaces of any speed.

The configuration allows for choice of an output clock (free running or gated), a framing signal (with frame size), a ready input (to stretch transactions), read and write strobes, address of varying sizes, and data of varying sizes. Additionally, provisions are made for splitting address and data phases on the external interface.

EPI General-Purpose Configuration (EPIGPCFG)

Base 0x400D.0000

Offset 0x010

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|---------|---------|----------|-------|--------|-------|----------|-----|-----|-------|----------|----------|--------|----------|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | CLKPIN | CLKGATE | reserved | RDYEN | FRMPIN | FRM50 | FRMCNT | | | RW | reserved | WR2CYC | RD2CYC | reserved | | |
| Type | R/W | R/W | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | R/W | R/W | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MAXWAIT | | | | | | reserved | | | ASIZE | | reserved | | DSIZE | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | R/W | R/W | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|-------------|
|-----------|------|------|-------|-------------|

| | | | | |
|----|--------|-----|---|-----------|
| 31 | CLKPIN | R/W | 0 | Clock Pin |
|----|--------|-----|---|-----------|

| Value | Description |
|-------|-------------|
|-------|-------------|

| | |
|---|------------------|
| 0 | No clock output. |
|---|------------------|

| | |
|---|---|
| 1 | <code>EPI0S31</code> functions as the EPI clock output. |
|---|---|

The EPI clock is generated from the `COUNT0` field in the `EPIBAUD` register (as is the system clock which is divided down from it).

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 30 | CLKGATE | R/W | 0 | <p>Clock Gated</p> <p>Value Description</p> <p>0 The EPI clock is free running.</p> <p>1 The EPI clock is output only when there is data to write or read (current transaction); otherwise the EPI clock is held low.</p> <p>Note that <code>EPI0S27</code> is an <code>iRDY</code> signal if <code>RDYEN</code> is set. <code>CLKGATE</code> is ignored if <code>CLKPIN</code> is 0 or if the <code>COUNT0</code> field in the EPIBAUD register is cleared.</p> |
| 29 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | RDYEN | R/W | 0 | <p>Ready Enable</p> <p>Value Description</p> <p>0 The external peripheral does not drive an <code>iRDY</code> signal and is assumed to be ready always.</p> <p>1 The external peripheral drives an <code>iRDY</code> signal into pin <code>EPI0S27</code>.</p> <p>The ready enable signal may only be used with a free-running EPI clock (<code>CLKGATE=0</code>).</p> <p>The external <code>iRDY</code> signal is sampled on the falling edge of the EPI clock. Setup and hold times must be met to ensure registration on the next falling EPI clock edge.</p> <p>This bit is ignored if <code>CLKPIN</code> is 0 or <code>CLKGATE</code> is 1.</p> |
| 27 | FRMPIN | R/W | 0 | <p>Framing Pin</p> <p>Value Description</p> <p>0 No framing signal is output.</p> <p>1 A framing signal is output on <code>EPI0S30</code>.</p> <p>Framing has no impact on data itself, but forms a context for the external peripheral. When used with a free-running EPI clock, the <code>FRAME</code> signal forms the valid signal. When used with a gated EPI clock, it is usually used to form a frame size.</p> |
| 26 | FRM50 | R/W | 0 | <p>50/50 Frame</p> <p>Value Description</p> <p>0 The <code>FRAME</code> signal is output as a single pulse, and then held low for the count.</p> <p>1 The <code>FRAME</code> signal is output as 50/50 duty cycle using count (see <code>FRMCNT</code>).</p> <p>This bit is ignored if <code>FRMPIN</code> is 0.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 25:22 | FRMCNT | R/W | 0x0 | <p>Frame Count</p> <p>This field specifies the size of the frame in EPI clocks. The frame counter is used to determine the frame size. The count is FRMCNT+1. So, a FRMCNT of 0 forms a pure transaction valid signal (held high during transactions, low otherwise).</p> <p>A FRMCNT of 0 with FRM50 set inverts the FRAME signal on each transaction. A FRMCNT of 1 means the FRAME signal is inverted every other transaction; a value of 15 means every sixteenth transaction.</p> <p>If FRM50 is set, the frame is held high for FRMCNT+1 transactions, then held low for that many transactions, and so on.</p> <p>If FRM50 is clear, the frame is pulsed high for one EPI clock and then low for FRMCNT EPI clocks.</p> <p>This field is ignored if FRMPIN is 0.</p> |
| 21 | RW | R/W | 0 | <p>Read and Write</p> <p>Value Description</p> <p>0 RD and WR strobes are not output.</p> <p>1 RD and WR strobes are asserted on EPI0S29 and EPI0S28. RD is asserted high on the rising edge of the EPI clock when a read is being performed. WR is asserted high on the rising edge of the EPI clock when a write is being performed</p> <p>This bit is forced to 1 when RD2CYC and/or WR2CYC is 1.</p> |
| 20 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 19 | WR2CYC | R/W | 0 | <p>2-Cycle Writes</p> <p>Value Description</p> <p>0 Data is output on the same EPI clock cycle as the address.</p> <p>1 Writes are two EPI clock cycles long, with address on one EPI clock cycle (with the WR strobe asserted) and data written on the following EPI clock cycle (with WR strobe de-asserted). The next address (if any) is in the cycle following.</p> <p>When this bit is set, then the RW bit is forced to be set.</p> |
| 18 | RD2CYC | R/W | 0 | <p>2-Cycle Reads</p> <p>Value Description</p> <p>0 Data is captured on the EPI clock cycle with READ strobe asserted.</p> <p>1 Reads are two EPI clock cycles, with address on one EPI clock cycle (with the RD strobe asserted) and data captured on the following EPI clock cycle (with the RD strobe de-asserted). The next address (if any) is in the cycle following.</p> <p>When this bit is set, then the RW bit is forced to be set.</p> <hr/> <p>Caution – This bit must be set at all times in General-Purpose mode to ensure proper operation.</p> <hr/> |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|--|------|-------|---|-------|-------------|-----|------------|-----|--------------------|-----|--|-----|--|
| 17:16 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 15:8 | MAXWAIT | R/W | 0x00 | <p>Maximum Wait</p> <p>This field defines the maximum number of EPI clocks to wait while the iRDY signal (see RDYEN) is holding off a transaction. If this field is 0, the transaction is held forever. If the maximum wait of 255 clocks (MAXWAIT=0xFF) is exceeded, an error interrupt occurs and the transaction is aborted/ignored.</p> <p>Note: When the MODE field is configured to be 0x0 and the BLKEN bit is set in the EPICFG register, enabling General-Purpose mode, this field defaults to 0xFF.</p> | | | | | | | | | | |
| 7:6 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 5:4 | ASIZE | R/W | 0x0 | <p>Address Bus Size</p> <p>This field defines the size of the address bus. The address can be up to 4-bits wide with a 24-bit data bus, up to 12-bits wide with a 16-bit data bus, and up to 20-bits wide with an 8-bit data bus. If the full address bus is not used, use the least significant address bits. Any unused address bits can be used as GPIOs by clearing the AFSEL bit for the corresponding GPIOs. Also, if RDYEN is 1, then the address sizes are 1 smaller (3, 11, 19).</p> <p>The values are:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>No address</td> </tr> <tr> <td>0x1</td> <td>Up to 4 bits wide.</td> </tr> <tr> <td>0x2</td> <td>Up to 12 bits wide. This size cannot be used with 24-bit data.</td> </tr> <tr> <td>0x3</td> <td>Up to 20 bits wide. This size cannot be used with data sizes other than 8.</td> </tr> </tbody> </table> | Value | Description | 0x0 | No address | 0x1 | Up to 4 bits wide. | 0x2 | Up to 12 bits wide. This size cannot be used with 24-bit data. | 0x3 | Up to 20 bits wide. This size cannot be used with data sizes other than 8. |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | No address | | | | | | | | | | | | | |
| 0x1 | Up to 4 bits wide. | | | | | | | | | | | | | |
| 0x2 | Up to 12 bits wide. This size cannot be used with 24-bit data. | | | | | | | | | | | | | |
| 0x3 | Up to 20 bits wide. This size cannot be used with data sizes other than 8. | | | | | | | | | | | | | |
| 3:2 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|----------------------------------|------|-------|--|-------|-------------|-----|--------------------------------|-----|----------------------------------|-----|----------------------------------|-----|----------------------------------|
| 1:0 | DSIZE | R/W | 0x0 | <p>Size of Data Bus</p> <p>This field defines the size of the data bus (starting at EPI0S0). Subsets of these numbers can be created by clearing the AFSEL bit for the corresponding GPIOs. Note that size 32 may not be used with clock, frame, address, or other control.</p> <p>The values are:</p> <table><thead><tr><th>Value</th><th>Description</th></tr></thead><tbody><tr><td>0x0</td><td>8 Bits Wide (EPI0S0 to EPI0S7)</td></tr><tr><td>0x1</td><td>16 Bits Wide (EPI0S0 to EPI0S15)</td></tr><tr><td>0x2</td><td>24 Bits Wide (EPI0S0 to EPI0S23)</td></tr><tr><td>0x3</td><td>32 Bits Wide (EPI0S0 to EPI0S31)</td></tr></tbody></table> <p>This size may not be used with an EPI clock. This value is normally used for acquisition input and actuator control as well as other general-purpose uses that require 32 bits per direction.</p> | Value | Description | 0x0 | 8 Bits Wide (EPI0S0 to EPI0S7) | 0x1 | 16 Bits Wide (EPI0S0 to EPI0S15) | 0x2 | 24 Bits Wide (EPI0S0 to EPI0S23) | 0x3 | 32 Bits Wide (EPI0S0 to EPI0S31) |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | 8 Bits Wide (EPI0S0 to EPI0S7) | | | | | | | | | | | | | |
| 0x1 | 16 Bits Wide (EPI0S0 to EPI0S15) | | | | | | | | | | | | | |
| 0x2 | 24 Bits Wide (EPI0S0 to EPI0S23) | | | | | | | | | | | | | |
| 0x3 | 32 Bits Wide (EPI0S0 to EPI0S31) | | | | | | | | | | | | | |

Register 7: EPI Host-Bus 8 Configuration 2 (EPIHB8CFG2), offset 0x014

Important: The `MODE` field in the `EPICFG` register determines which configuration register is accessed for offsets 0x010 and 0x014.

To access `EPIHB8CFG2`, the `MODE` field must be 0x2.

This register is used to configure operation while in Host-Bus 8 mode. Note that this register is reset when the `MODE` field in the `EPICFG` register is changed. If another mode is selected and the Host-Bus 8 mode is selected again, the values must be reinitialized.

EPI Host-Bus 8 Configuration 2 (EPIHB8CFG2)

Base 0x400D.0000

Offset 0x014

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----------|----|----|----|--------|-------|-----|------|----------|------|--------|----------|----------|----|----|--|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | WORD | reserved | | | | CSBAUD | CSCFG | | | reserved | | WRHIGH | RDHIGH | reserved | | | |
| Type | R/W | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | R/W | R/W | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | WRWS | | RDWS | | reserved | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31 | WORD | R/W | 0 | <p>Word Access Mode</p> <p>By default, the EPI controller uses data bits [7:0] for Host-Bus 8 accesses. When using Word Access mode, the EPI controller can automatically route bytes of data onto the correct byte lanes such that data can be stored in bits [31:8]. When <code>WORD</code> is set, short and long variables can be used in C programs.</p> <p>Value Description</p> <p>0 Word Access mode is disabled.</p> <p>1 Word Access mode is enabled.</p> |
| 30:27 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 26 | CSBAUD | R/W | 0 | <p>Chip Select Baud Rate</p> <p>Value Description</p> <p>0 Same Baud Rate</p> <p>Both CS0n and CS1n use the baud rate for the external bus that is defined by the <code>COUNT0</code> field in the <code>EPIBAUD</code> register.</p> <p>1 Different Baud Rates</p> <p>CS0n uses the baud rate for the external bus that is defined by the <code>COUNT0</code> field in the <code>EPIBAUD</code> register. CS1n uses the baud rate defined by the <code>COUNT1</code> field in the <code>EPIBAUD</code> register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 25:24 | CSCFG | R/W | 0x0 | <p>Chip Select Configuration</p> <p>This field controls the chip select options, including an ALE format, a single chip select, two chip selects, and an ALE combined with two chip selects.</p> <p>Value Description</p> <p>0x0 ALE Configuration EPIOS30 is used as an address latch (ALE). The ALE signal is generally used when the address and data are muxed (HB8MODE field in the EPIHB8CFG register is 0x0). The ALE signal is used by an external latch to hold the address through the bus cycle.</p> <p>0x1 CSn Configuration EPIOS30 is used as a Chip Select (CSn). When using this mode, the address and data are generally not muxed (HB8MODE field in the EPIHB8CFG register is 0x1). However, if address and data muxing is needed, the WR signal (EPIOS29) and the RD signal (EPIOS28) can be used to latch the address when CSn is low.</p> <p>0x2 Dual CSn Configuration EPIOS30 is used as CS0n and EPIOS27 is used as CS1n. Whether CS0n or CS1n is asserted is determined by two methods. If only external RAM or external PER is enabled in the address map, the most significant address bit for a respective external address map controls CS0n or CS1n. If both external RAM and external PER is enabled, CS0n is mapped to PER and CS1n is mapped to RAM. This configuration can be used for a RAM bank split between 2 devices as well as when using both an external RAM and an external peripheral.</p> <p>0x3 ALE with Dual CSn Configuration EPIOS30 is used as address latch (ALE), EPIOS27 is used as CS1n, and EPIOS26 is used as CS0n. Whether CS0n or CS1n is asserted is determined by the most significant address bit for a respective external address map.</p> |
| 23:22 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 21 | WRHIGH | R/W | 0 | <p>CS1n WRITE Strobe Polarity</p> <p>This field is used if the CSBAUD bit in the EPIHBnCFG2 register is enabled.</p> <p>Value Description</p> <p>0 The WRITE strobe for CS1n accesses is WRn (active Low).</p> <p>1 The WRITE strobe for CS1n accesses is WR (active High).</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 20 | RDHIGH | R/W | 0 | <p>CS1n READ Strobe Polarity</p> <p>This field is used if the CSBAUD bit in the EPIHBnCFG2 register is enabled.</p> <p>Value Description</p> <p>0 The READ strobe for CS1n accesses is RDn (active Low).</p> <p>1 The READ strobe for CS1n accesses is RD (active High).</p> |
| 19:8 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:6 | WRWS | R/W | 0x0 | <p>CS1n Write Wait States</p> <p>This field adds wait states to the data phase of CS1n accesses (the address phase is not affected).</p> <p>The effect is to delay the rising edge of WRn (or the falling edge of WR). Each wait state encoding adds 2 EPI clock cycles to the access time.</p> <p>Value Description</p> <p>0x0 Active WRn is 2 EPI clocks.</p> <p>0x1 Active WRn is 4 EPI clocks</p> <p>0x2 Active WRn is 6 EPI clocks</p> <p>0x3 Active WRn is 8 EPI clocks</p> |
| 5:4 | RDWS | R/W | 0x0 | <p>CS1n Read Wait States</p> <p>This field adds wait states to the data phase of CS1n accesses (the address phase is not affected).</p> <p>The effect is to delay the rising edge of RDn/Oen (or the falling edge of RD). Each wait state encoding adds 2 EPI clock cycles to the access time.</p> <p>Value Description</p> <p>0x0 Active RDn is 2 EPI clocks</p> <p>0x1 Active RDn is 4 EPI clocks</p> <p>0x2 Active RDn is 6 EPI clocks</p> <p>0x3 Active RDn is 8 EPI clocks</p> |
| 3:0 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 8: EPI Host-Bus 16 Configuration 2 (EPIHB16CFG2), offset 0x014

Important: The `MODE` field in the `EPICFG` register determines which configuration register is accessed for offsets 0x010 and 0x014.

To access `EPIHB16CFG2`, the `MODE` field must be 0x3.

This register is used to configure operation while in Host-Bus 16 mode. Note that this register is reset when the `MODE` field in the `EPICFG` register is changed. If another mode is selected and the Host-Bus 16 mode is selected again, the values must be reinitialized.

EPI Host-Bus 16 Configuration 2 (EPIHB16CFG2)

Base 0x400D.0000

Offset 0x014

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----------|----|----|----|--------|-------|-----|----------|-----|----------|--------|----------|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | WORD | reserved | | | | CSBAUD | CSCFG | | reserved | | WRHIGH | RDHIGH | reserved | | | |
| Type | R/W | RO | RO | RO | RO | R/W | R/W | R/W | RO | RO | R/W | R/W | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | WRWS | | reserved | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | |
|--|-------------------------------|------|-------|--|---|-------------------------------|---|------------------------------|---|----------------------|--|--|
| 31 | WORD | R/W | 0 | <p>Word Access Mode</p> <p>By default, the EPI controller uses data bits [15:0] for Host-Bus 16 accesses. When using Word Access mode, the EPI controller can automatically route bytes of data onto the correct byte lanes such that data can be stored in bits [31:16]. When <code>WORD</code> is set, long variables can be used in C programs.</p> <p>Value Description</p> <table border="0"> <tr> <td>0</td> <td>Word Access mode is disabled.</td> </tr> <tr> <td>1</td> <td>Word Access mode is enabled.</td> </tr> </table> | 0 | Word Access mode is disabled. | 1 | Word Access mode is enabled. | | | | |
| 0 | Word Access mode is disabled. | | | | | | | | | | | |
| 1 | Word Access mode is enabled. | | | | | | | | | | | |
| 30:27 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | |
| 26 | CSBAUD | R/W | 0 | <p>Chip Select Baud Rate</p> <p>Value Description</p> <table border="0"> <tr> <td>0</td> <td>Same Baud Rate</td> </tr> <tr> <td colspan="2">All CSn use the baud rate for the external bus that is defined by the <code>COUNT0</code> field in the <code>EPIBAUD</code> register.</td> </tr> <tr> <td>1</td> <td>Different Baud Rates</td> </tr> <tr> <td colspan="2">CS0n uses the baud rate for the external bus that is defined by the <code>COUNT0</code> field in the <code>EPIBAUD</code> register. CS1n uses the baud rate defined by the <code>COUNT1</code> field in the <code>EPIBAUD</code> register.</td> </tr> </table> | 0 | Same Baud Rate | All CSn use the baud rate for the external bus that is defined by the <code>COUNT0</code> field in the <code>EPIBAUD</code> register. | | 1 | Different Baud Rates | CS0n uses the baud rate for the external bus that is defined by the <code>COUNT0</code> field in the <code>EPIBAUD</code> register. CS1n uses the baud rate defined by the <code>COUNT1</code> field in the <code>EPIBAUD</code> register. | |
| 0 | Same Baud Rate | | | | | | | | | | | |
| All CSn use the baud rate for the external bus that is defined by the <code>COUNT0</code> field in the <code>EPIBAUD</code> register. | | | | | | | | | | | | |
| 1 | Different Baud Rates | | | | | | | | | | | |
| CS0n uses the baud rate for the external bus that is defined by the <code>COUNT0</code> field in the <code>EPIBAUD</code> register. CS1n uses the baud rate defined by the <code>COUNT1</code> field in the <code>EPIBAUD</code> register. | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 25:24 | CSCFG | R/W | 0x0 | <p>Chip Select Configuration</p> <p>This field controls the chip select options, including an ALE format, a single chip select, two chip selects, and an ALE combined with two chip selects.</p> <p>Value Description</p> <p>0x0 ALE Configuration <i>EPI0S30</i> is used as an address latch (ALE). When using this mode, the address and data should be muxed (<i>HB16MODE</i> field in the EPIHB16CFG register should be configured to 0x0). If needed, the address can be latched by external logic.</p> <p>0x1 CSn Configuration <i>EPI0S30</i> is used as a Chip Select (CSn). When using this mode, the address and data should not be muxed (<i>MODE</i> field in the EPIHB16CFG register should be configured to 0x1). In this mode, the WR signal (<i>EPI0S29</i>) and the RD signal (<i>EPI0S28</i>) are used to latch the address when CSn is low.</p> <p>0x2 Dual CSn Configuration <i>EPI0S30</i> is used as CS0n and <i>EPI0S27</i> is used as CS1n. Whether CS0n or CS1n is asserted is determined by the most significant address bit for a respective external address map. This configuration can be used for a RAM bank split between 2 devices as well as when using both an external RAM and an external peripheral.</p> <p>0x3 ALE with Dual CSn Configuration <i>EPI0S30</i> is used as address latch (ALE), <i>EPI0S27</i> is used as CS1n, and <i>EPI0S26</i> is used as CS0n. Whether CS0n or CS1n is asserted is determined by the most significant address bit for a respective external address map.</p> |
| 23:22 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 21 | WRHIGH | R/W | 0 | <p>CS1n WRITE Strobe Polarity</p> <p>This field is used if <i>CSBAUD</i> bit of the EPIHBnCFG2 register is enabled.</p> <p>Value Description</p> <p>0 The WRITE strobe for CS1n accesses is WRn (active Low).</p> <p>1 The WRITE strobe for CS1n accesses is WR (active High).</p> |
| 20 | RDHIGH | R/W | 0 | <p>CS1n READ Strobe Polarity</p> <p>This field is used if <i>CSBAUD</i> bit of the EPIHBnCFG2 register is enabled.</p> <p>Value Description</p> <p>0 The READ strobe for CS1n accesses is RDn (active Low).</p> <p>1 The READ strobe for CS1n accesses is RD (active High).</p> |
| 19:8 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 7:6 | WRWS | R/W | 0x0 | <p>CS1n Write Wait States</p> <p>This field adds wait states to the data phase of CS1n accesses (the address phase is not affected).</p> <p>The effect is to delay the rising edge of WRn (or the falling edge of WR). Each wait state encoding adds 2 EPI clock cycles to the access time.</p> <p>Value Description</p> <p>0x0 Active WRn is 2 EPI clocks</p> <p>0x1 Active WRn is 4 EPI clocks.</p> <p>0x2 Active WRn is 6 EPI clocks</p> <p>0x3 Active WRn is 8 EPI clocks</p> |
| 5:0 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |

Register 9: EPI General-Purpose Configuration 2 (EPIGPCFG2), offset 0x014

Important: The `MODE` field in the `EPICFG` register determines which configuration register is accessed for offsets 0x010 and 0x014.

To access `EPIGPCFG2`, the `MODE` field must be 0x0.

This register is used to configure operation while in General-Purpose mode. Note that this register is reset when the `MODE` field in the `EPICFG` register is changed. If another mode is selected and the General-Purpose mode is selected again, the values must be reinitialized.

EPI General-Purpose Configuration 2 (EPIGPCFG2)

Base 0x400D.0000
 Offset 0x014
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | WORD | reserved | | | | | | | | | | | | | | |
| Type | R/W | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|--|
| 31 | WORD | R/W | 0 | <p>Word Access Mode</p> <p>By default, the EPI controller uses data bits [7:0] when the <code>DSIZE</code> field in the <code>EPIGPCFG</code> register is 0x0; data bits [15:0] when the <code>DSIZE</code> field is 0x1; data bits [23:0] when the <code>DSIZE</code> field is 0x2; and data bits [31:0] when the <code>DSIZE</code> field is 0x3.</p> <p>When using Word Access mode, the EPI controller can automatically route bytes of data onto the correct byte lanes such that data can be stored in bits [31:8] for <code>DSIZE=0x0</code> and bits [31:16] for <code>DSIZE=0x1</code>. For <code>DSIZE=0x2</code> or <code>0x3</code>, this bit must be clear.</p> <p>Value Description</p> <p>0 Word Access mode is disabled.</p> <p>1 Word Access mode is enabled.</p> |
| 30:0 | reserved | RO | 0x000.0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 10: EPI Address Map (EPIADDRMAP), offset 0x01C

This register enables address mapping. The EPI controller can directly address memory and peripherals. In addition, the EPI controller supports address mapping to allow indirect accesses in the External RAM and External Peripheral areas.

If the external device is a peripheral, including a FIFO or a directly addressable device, the `EPSZ` and `EPADR` bit fields should be configured for the address space. If the external device is SDRAM, SRAM, or NOR Flash memory, the `ERADR` and `ERSZ` bit fields should be configured for the address space.

If one of the dual chip select modes is selected (`CSCFG` is 0x2 or 0x3 in the `EPIHBnCFG2` register), both chip selects can share the peripheral or the memory space, or one chip select can use the peripheral space and the other can use the memory space. In the `EPIADDRMAP` register, if the `EPADR` field is not 0x0 and the `ERADR` field is 0x0, then the address specified by `EPADR` is used for both chip selects, with `CS0n` being asserted when the MSB of the address range is 0 and `CS1n` being asserted when the MSB of the address range is 1. If the `ERADR` field is not 0x0 and the `EPADR` field is 0x0, then the address specified by `ERADR` is used for both chip selects, with the MSB performing the same delineation. If both the `EPADR` and the `ERADR` are not 0x0, then `CS0n` is asserted for either address range defined by `EPADR` and `CS1n` is asserted for either address range defined by `ERADR`.

EPI Address Map (EPIADDRMAP)

Base 0x400D.0000
Offset 0x01C
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|-----|-------|-----|------|-----|-------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | EPSZ | | EPADR | | ERSZ | | ERADR | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:6 | EPSZ | R/W | 0x0 | <p>External Peripheral Size</p> <p>This field selects the size of the external peripheral. If the size of the external peripheral is larger, a bus fault occurs. If the size of the external peripheral is smaller, it wraps (upper address bits unused).</p> <p>Note: When not using byte selects in Host-Bus 16, data is accessed on 2-byte boundaries. As a result, the available address space is double the amount shown below.</p> |

Value Description

| Value | Description |
|-------|--|
| 0x0 | 256 bytes; lower address range: 0x00 to 0xFF |
| 0x1 | 64 KB; lower address range: 0x0000 to 0xFFFF |
| 0x2 | 16 MB; lower address range: 0x00.0000 to 0xFF.FFFF |
| 0x3 | 512 MB; lower address range: 0x000.0000 to 0x1FFF.FFFF |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|---|
| 5:4 | EPADR | R/W | 0x0 | External Peripheral Address This field selects address mapping for the external peripheral area. Value Description 0x0 Not mapped 0x1 At 0xA000.0000 0x2 At 0xC000.0000 0x3 reserved |
| 3:2 | ERSZ | R/W | 0x0 | External RAM Size This field selects the size of mapped RAM. If the size of the external memory is larger, a bus fault occurs. If the size of the external memory is smaller, it wraps (upper address bits unused): Value Description 0x0 256 bytes; lower address range: 0x00 to 0xFF 0x1 64 KB; lower address range: 0x0000 to 0xFFFF 0x2 16 MB; lower address range: 0x00.0000 to 0xFF.FFFF 0x3 512 MB; lower address range: 0x000.0000 to 0x1FFF.FFFF |
| 1:0 | ERADR | R/W | 0x0 | External RAM Address Selects address mapping for external RAM area: Value Description 0x0 Not mapped 0x1 At 0x6000.0000 0x2 At 0x8000.0000 0x3 reserved |

Register 11: EPI Read Size 0 (EPIRSIZE0), offset 0x020**Register 12: EPI Read Size 1 (EPIRSIZE1), offset 0x030**

This register selects the size of transactions when performing non-blocking reads with the **EPIRPSTDn** registers. This size affects how the external address is incremented.

The **SIZE** field must match the external data width as configured in the **EPIHBnCFG** or **EPIGPCFG** register if the **WORD** bit is clear in the **EPIHBnCFG2** or **EPIGPCFG2** register. If the **WORD** bit is set, the **SIZE** field must be greater than or equal to the external data width.

SDRAM mode uses a 16-bit data interface. If **SIZE** is 0x1, data is returned on the least significant bits (D[7:0]), and the remaining bits D[31:8] are all zeros, therefore the data on bits D[15:8] is lost. If **SIZE** is 0x2, data is returned on the least significant bits (D[15:0]), and the remaining bits D[31:16] are all zeros.

Note that changing this register while a read is active has an unpredictable effect.

EPI Read Size 0 (EPIRSIZE0)

Base 0x400D.0000

Offset 0x020

Type R/W, reset 0x0000.0003

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | SIZE | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|---------------------|------------|---|
| 31:2 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1:0 | SIZE | R/W | 0x3 | Current Size |
| | Value | Description | | |
| | 0x0 | reserved | | |
| | 0x1 | Byte (8 bits) | | |
| | 0x2 | Half-word (16 bits) | | |
| | 0x3 | Word (32 bits) | | |

Register 13: EPI Read Address 0 (EPIRADDR0), offset 0x024

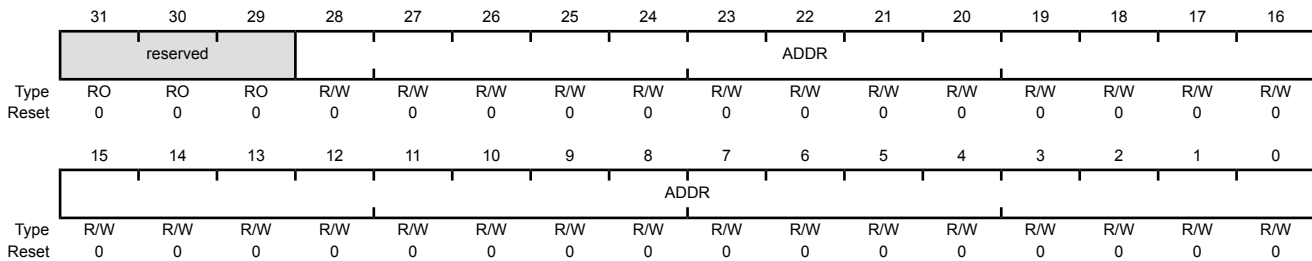
Register 14: EPI Read Address 1 (EPIRADDR1), offset 0x034

This register holds the current address value. When performing non-blocking reads via the **EPIRSTDn** registers, this register's value forms the address (when used by the mode). That is, when an **EPIRSTDn** register is written with a non-0 value, this register is used as the first address. After each read, it is incremented by the size specified by the corresponding **EPIRSIZEn** register. Thus at the end of a read, this register contains the next address for the next read. For example, if the last read was 0x20, and the size is word, then the register contains 0x24. When a non-blocking read is cancelled, this register contains the next address that would have been read had it not been cancelled. For example, if reading by bytes and 0x103 had been read but not 0x104, this register contains 0x104. In this manner, the system can determine the number of values in the NBRFIFO to drain.

Note that changing this register while a read is active has an unpredictable effect due to race condition.

EPI Read Address 0 (EPIRADDR0)

Base 0x400D.0000
 Offset 0x024
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:29 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28:0 | ADDR | R/W | 0x000.0000 | Current Address Next address to read. |

Register 15: EPI Non-Blocking Read Data 0 (EPIRPSTD0), offset 0x028**Register 16: EPI Non-Blocking Read Data 1 (EPIRPSTD1), offset 0x038**

This register sets up a non-blocking read via the external interface. A non-blocking read is started by writing to this register with the count (other than 0). Clearing this register terminates an active non-blocking read as well as cancelling any that are pending. This register should always be cleared before writing a value other than 0; failure to do so can cause improper operation. Note that both NBR channels can be enabled at the same time, but NBR channel 0 has the highest priority and channel 1 does not start until channel 0 is finished.

The first address is based on the corresponding **EPIADDRn** register. The address register is incremented by the size specified by the **EPIRSIZEn** register after each read. If the size is less than a word, only the least significant bits of data are filled into the NBRFIFO; the most significant bits are cleared.

Note that all three registers may be written using one STM instruction, such as with a structure copy in C/C++.

The data may be read from the **EPIREADFIFO** register after the read cycle is completed. The interrupt mechanism is normally used to trigger the FIFO reads via ISR or μ DMA.

If the countdown has not reached 0 and the NBRFIFO is full, the external interface waits until a NBRFIFO entry becomes available to continue.

Note: if a blocking read or write is performed through the address mapped area (at 0x6000.0000 through 0xDFFF.FFFF), any current non-blocking read is paused (at the next safe boundary), and the blocking request is inserted. After completion of any blocking reads or writes, the non-blocking reads continue from where they were paused.

The other way to read data is via the address mapped locations (see the **EPIADDRMAP** register), but this method is blocking (core or μ DMA waits until result is returned).

To cancel a non-blocking read, clear this register. To make sure that all values read are drained from the NBRFIFO, the **EPISTAT** register must be consulted to be certain that bits **NBRBUSY** and **ACTIVE** are cleared. One of these registers should not be cleared until either the other **EPIRPSTDn** register becomes active or the external interface is not busy. At that point, the corresponding **EPIADDRn** register indicates how many values were read.

EPI Non-Blocking Read Data 0 (EPIRPSTD0)

Base 0x400D.0000
Offset 0x028
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | POSTCNT | | | | | | | | | | | | |
| Type | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:13 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 12:0 | POSTCNT | R/W | 0x000 | Post Count A write of a non-zero value starts a read operation for that count. Note that it is the software's responsibility to handle address wrap-around. Reading this register provides the current count. A write of 0 cancels a non-blocking read (whether active now or pending). Prior to writing a non-zero value, this register must first be cleared. |

Register 17: EPI Status (EPISTAT), offset 0x060

This register indicates which non-blocking read register is currently active; it also indicates whether the external interface is busy performing a write or non-blocking read (it cannot be performing a blocking read, as the bus would be blocked and as a result, this register could not be accessed).

This register is useful to determining which non-blocking read register is active when both are loaded with values and when implementing sequencing or sharing.

This register is also useful when canceling non-blocking reads, as it shows how many values were read by the canceled side.

EPI Status (EPISTAT)

Base 0x400D.0000

Offset 0x060

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|-------|--------|---------|---------|-------|---------|----------|----|----|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | CELOW | XFFULL | XFEMPTY | INITSEQ | WBUSY | NBRBUSY | reserved | | | ACTIVE |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:10 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9 | CELOW | RO | 0 | <p>Clock Enable Low</p> <p>This bit provides information on the clock status when in general-purpose mode and the RDYEN bit is set.</p> <p>Value Description</p> <p>0 The external device is not gating the clock.</p> |
| 8 | XFFULL | RO | 0 | <p>External FIFO Full</p> <p>This bit provides information on the XFIFO when in the FIFO sub-mode of the Host Bus n mode with the XFFEN bit set in the EPIHBnCFG register. The EPI0S26 signal reflects the status of this bit.</p> <p>Value Description</p> <p>0 The external device is not gating the clock.</p> <p>1 The XFIFO is signaling as full (the FIFO full signal is high). Attempts to write in this case are stalled until the XFIFO full signal goes low or the counter times out as specified by the MAXWAIT field.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 7 | XFEMPTY | RO | 0 | <p>External FIFO Empty</p> <p>This bit provides information on the XFIFO when in the FIFO sub-mode of the Host Bus n mode with the XFEEN bit set in the EPIHBnCFG register. The EPIOS27 signal reflects the status of this bit.</p> <p>Value Description</p> <p>0 The external device is not gating the clock.</p> <p>1 The XFIFO is signaling as empty (the FIFO empty signal is high).</p> <p>Attempts to read in this case are stalled until the XFIFO empty signal goes low or the counter times out as specified by the MAXWAIT field.</p> |
| 6 | INITSEQ | RO | 0 | <p>Initialization Sequence</p> <p>Value Description</p> <p>0 The SDRAM interface is not in the wakeup period.</p> <p>1 The SDRAM interface is running through the wakeup period (greater than 100 μs).</p> <p>If an attempt is made to read or write the SDRAM during this period, the access is held off until the wakeup period is complete.</p> |
| 5 | WBUSY | RO | 0 | <p>Write Busy</p> <p>Value Description</p> <p>0 The external interface is not performing a write.</p> <p>1 The external interface is performing a write.</p> |
| 4 | NBRBUSY | RO | 0 | <p>Non-Blocking Read Busy</p> <p>Value Description</p> <p>0 The external interface is not performing a non-blocking read.</p> <p>1 The external interface is performing a non-blocking read, or if the non-blocking read is paused due to a write.</p> |
| 3:1 | reserved | RO | 0x0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 0 | ACTIVE | RO | 0 | <p>Register Active</p> <p>Value Description</p> <p>0 If NBRBUSY is set, the EPIRPSTD0 register is active. If the NBRBUSY bit is clear, then neither EPIRPSTDx register is active.</p> <p>1 The EPIRPSTD1 register is active.</p> |

Register 18: EPI Read FIFO Count (EPIRFIFOCNT), offset 0x06C

This register returns the number of values in the NBRFIFO (the data in the NBRFIFO can be read via the **EPIREADFIFO** register). A race is possible, but that only means that more values may come in after this register has been read.

EPI Read FIFO Count (EPIRFIFOCNT)

Base 0x400D.0000

Offset 0x06C

Type RO, reset -

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-------|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | COUNT | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3:0 | COUNT | RO | - | FIFO Count Number of filled entries in the NBRFIFO. |

Register 19: EPI Read FIFO (EPIREADFIFO), offset 0x070

Register 20: EPI Read FIFO Alias 1 (EPIREADFIFO1), offset 0x074

Register 21: EPI Read FIFO Alias 2 (EPIREADFIFO2), offset 0x078

Register 22: EPI Read FIFO Alias 3 (EPIREADFIFO3), offset 0x07C

Register 23: EPI Read FIFO Alias 4 (EPIREADFIFO4), offset 0x080

Register 24: EPI Read FIFO Alias 5 (EPIREADFIFO5), offset 0x084

Register 25: EPI Read FIFO Alias 6 (EPIREADFIFO6), offset 0x088

Register 26: EPI Read FIFO Alias 7 (EPIREADFIFO7), offset 0x08C

Important: This register is read-sensitive. See the register description for details.

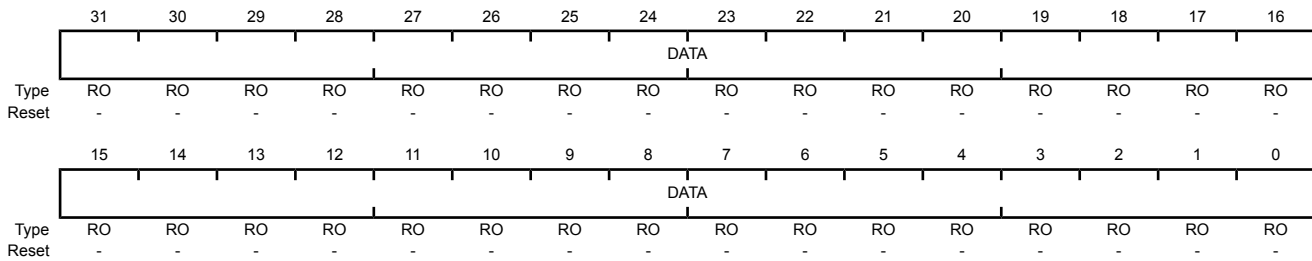
This register returns the contents of the NBRFIFO or 0 if the NBRFIFO is empty. Each read returns the data that is at the top of the NBRFIFO, and then empties that value from the NBRFIFO. The alias registers can be used with the LDmia instruction for more efficient operation (for up to 8 registers). See *Cortex™-M3/M4 Instruction Set Technical User's Manual* for more information on the LDmia instruction.

EPI Read FIFO (EPIREADFIFO)

Base 0x400D.0000

Offset 0x070

Type RO, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 31:0 | DATA | RO | - | Reads Data This field contains the data that is at the top of the NBRFIFO. After being read, the NBRFIFO entry is removed. |

Register 27: EPI FIFO Level Selects (EPIFIFOLVL), offset 0x200

This register allows selection of the FIFO levels which trigger an interrupt to the interrupt controller or, more efficiently, a DMA request to the μ DMA. The NBRFIFO select triggers on fullness such that it triggers on match or above (more full). The WFIFO triggers on emptiness such that it triggers on match or below (less entries).

It should be noted that the FIFO triggers are not identical to other such FIFOs in Stellaris peripherals. In particular, empty and full triggers are provided to avoid wait states when using blocking operations.

The settings in this register are only meaningful if the μ DMA is active or the interrupt is enabled.

Additionally, this register allows protection against writes stalling and notification of performing blocking reads which stall for extra time due to preceding writes. The two functions behave in a non-orthogonal way because read and write are not orthogonal.

The write error bit configures the system such that an attempted write to an already full WFIFO abandons the write and signals an error interrupt to prevent accidental latencies due to stalling writes.

The read error bit configures the system such that after a read has been stalled due to any preceding writes in the WFIFO, the error interrupt is generated. Note that the excess stall is not prevented, but an interrupt is generated after the fact to notify that it has happened.

EPI FIFO Level Selects (EPIFIFOLVL)

Base 0x400D.0000
Offset 0x200
Type R/W, reset 0x0000.0033

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|--------|-----|-----|----------|--------|-----|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | WFERR | RSERR |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | WRFIFO | | | reserved | RDFIFO | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:18 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| | | | | |
|----|-------|-----|---|------------------|
| 17 | WFERR | R/W | 0 | Write Full Error |
|----|-------|-----|---|------------------|

Value Description

- | | |
|---|---|
| 0 | The Write Full error interrupt is disabled. Writes are stalled when the WFIFO is full until a space becomes available but an error is not generated. Note that the Cortex-M3 write buffer may hide that stall if no other memory transactions are attempted during that time. |
| 1 | This bit enables the Write Full error interrupt (WTFULL in the EPIEISC register) to be generated when a write is attempted and the WFIFO is full. The write stalls until a WFIFO entry becomes available. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 16 | RSERR | R/W | 0 | <p>Read Stall Error</p> <p>Value Description</p> <p>0 The Read Stalled error interrupt is disabled. Reads behave as normal and are stalled until any preceding writes have completed and the read has returned a result.</p> <p>1 This bit enables the Read Stalled error interrupt (<code>RSTALL</code> in the EPIEISC register) to be generated when a read is attempted and the WFIFO is not empty. The read is still stalled during the time the WFIFO drains, but this error notifies the application that this excess delay has occurred.</p> <p>Note that the configuration of this bit has no effect on non-blocking reads.</p> |
| 15:7 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6:4 | WRFIFO | R/W | 0x3 | <p>Write FIFO</p> <p>This field configures the trigger point for the WFIFO.</p> <p>Value Description</p> <p>0x0 Trigger when there are any spaces available in the WFIFO.</p> <p>0x1 reserved</p> <p>0x2 Trigger when there are up to 3 spaces available in the WFIFO.</p> <p>0x3 Trigger when there are up to 2 spaces available in the WFIFO.</p> <p>0x4 Trigger when there is 1 space available in the WFIFO.</p> <p>0x5-0x7 reserved</p> |
| 3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2:0 | RDFIFO | R/W | 0x3 | <p>Read FIFO</p> <p>This field configures the trigger point for the NBRFIFO.</p> <p>Value Description</p> <p>0x0 reserved</p> <p>0x1 Trigger when there are 1 or more entries in the NBRFIFO.</p> <p>0x2 Trigger when there are 2 or more entries in the NBRFIFO.</p> <p>0x3 Trigger when there are 4 or more entries in the NBRFIFO.</p> <p>0x4 Trigger when there are 6 or more entries in the NBRFIFO.</p> <p>0x5 Trigger when there are 7 or more entries in the NBRFIFO.</p> <p>0x6 Trigger when there are 8 entries in the NBRFIFO.</p> <p>0x7 reserved</p> |

Register 28: EPI Write FIFO Count (EPIWFIFOCNT), offset 0x204

This register contains the number of slots currently available in the WFIFO. This register may be used for polled writes to avoid stalling and for blocking reads to avoid excess stalling (due to undrained writes). An example use for writes may be:

```
for (idx = 0; idx < cnt; idx++) {
while (EPIWFIFOCNT == 0) ;
*ext_ram = *mydata++;
}
```

The above code ensures that writes to the address mapped location do not occur unless the WFIFO has room. Although polling makes the code wait (spinning in the loop), it does not prevent interrupts being serviced due to bus stalling.

EPI Write FIFO Count (EPIWFIFOCNT)

Base 0x400D.0000

Offset 0x204

Type RO, reset 0x0000.0004

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|------|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | WTAV | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:3 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2:0 | WTAV | RO | 0x4 | Available Write Transactions The number of write transactions available in the WFIFO. When clear, a write is stalled waiting for a slot to become free (from a preceding write completing). |

Register 29: EPI Interrupt Mask (EPIIM), offset 0x210

This register is the interrupt mask set or clear register. For each interrupt source (read, write, and error), a mask value of 1 allows the interrupt source to trigger an interrupt to the interrupt controller; a mask value of 0 prevents the interrupt source from triggering an interrupt.

Note that interrupt masking has no effect on μ DMA, which operates off the raw source of the read and write interrupts.

EPI Interrupt Mask (EPIIM)

Base 0x400D.0000
 Offset 0x210
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|------|------|-------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | WRIM | RDIM | ERRIM | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:3 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | WRIM | R/W | 0 | Write FIFO Empty Interrupt Mask Value Description 0 WRRIS in the EPIRIS register is masked and does not cause an interrupt. 1 WRRIS in the EPIRIS register is not masked and can trigger an interrupt to the interrupt controller. |
| 1 | RDIM | R/W | 0 | Read FIFO Full Interrupt Mask Value Description 0 RDRIS in the EPIRIS register is masked and does not cause an interrupt. 1 RDRIS in the EPIRIS register is not masked and can trigger an interrupt to the interrupt controller. |
| 0 | ERRIM | R/W | 0 | Error Interrupt Mask Value Description 0 ERRIS in the EPIRIS register is masked and does not cause an interrupt. 1 ERRIS in the EPIRIS register is not masked and can trigger an interrupt to the interrupt controller. |

Register 30: EPI Raw Interrupt Status (EPIRIS), offset 0x214

This register is the raw interrupt status register. On a read, it gives the current state of each interrupt source. A write has no effect.

Note that raw status for read and write is set or cleared based on FIFO fullness as controlled by **EPIFIFOLVL**.

Raw status for error is held until the error is cleared by writing to the **EPIEISC** register.

EPI Raw Interrupt Status (EPIRIS)

Base 0x400D.0000

Offset 0x214

Type RO, reset 0x0000.0004

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | WRRIS | RDRIS | ERRIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:3 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | WRRIS | RO | 1 | Write Raw Interrupt Status Value Description 0 The number of available entries in the WFIFO is above the range specified by the <code>WRFIFO</code> field in the EPIFIFOLVL register. 1 The number of available entries in the WFIFO is within the trigger range specified by the <code>WRFIFO</code> field in the EPIFIFOLVL register. This bit is cleared when the level in the WFIFO is above the trigger point programmed by the <code>WRFIFO</code> field. |
| 1 | RDRIS | RO | 0 | Read Raw Interrupt Status Value Description 0 The number of valid entries in the NBRFIFO is below the trigger range specified by the <code>RDFIFO</code> field in the EPIFIFOLVL register. 1 The number of valid entries in the NBRFIFO is in the trigger range specified by the <code>RDFIFO</code> field in the EPIFIFOLVL register. This bit is cleared when the level in the NBRFIFO is below the trigger point programmed by the <code>RDFIFO</code> field. |

| Bit/Field | Name | Type | Reset | Description | | | | |
|-----------|--|------|-------|--|---|----------------------------|---|--|
| 0 | ERRRIS | RO | 0 | <p>Error Raw Interrupt Status</p> <p>The error interrupt occurs in the following situations:</p> <ul style="list-style-type: none">■ WFIFO Full. For a full WFIFO to generate an error interrupt, the WFERR bit in the EPIFIFOLVL register must be set.■ Read Stalled. For a stalled read to generate an error interrupt, the RSERR bit in the EPIFIFOLVL register must be set.■ Timeout. If the MAXWAIT field in the EPIGPCFG register is configured to a value other than 0, a timeout error occurs when iRDY or XFIFO not-ready signals hold a transaction for more than the count in the MAXWAIT field. <p>Value Description</p> <table border="1"><tr><td>0</td><td>An error has not occurred.</td></tr><tr><td>1</td><td>A WFIFO Full, a Read Stalled, or a Timeout error has occurred.</td></tr></table> <p>To determine which error occurred, read the status of the EPI Error Interrupt Status and Clear (EPIEISC) register. This bit is cleared by writing a 1 to the bit in the EPIEISC register that caused the interrupt.</p> | 0 | An error has not occurred. | 1 | A WFIFO Full, a Read Stalled, or a Timeout error has occurred. |
| 0 | An error has not occurred. | | | | | | | |
| 1 | A WFIFO Full, a Read Stalled, or a Timeout error has occurred. | | | | | | | |

Register 31: EPI Masked Interrupt Status (EPIMIS), offset 0x218

This register is the masked interrupt status register. On read, it gives the current state of each interrupt source (read, write, and error) after being masked via the **EPIIM** register. A write has no effect.

The values returned are the ANDing of the **EPIIM** and **EPIRIS** registers. If a bit is set in this register, the interrupt is sent to the interrupt controller.

EPI Masked Interrupt Status (EPIMIS)

Base 0x400D.0000

Offset 0x218

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-------|-------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | WRMIS | RDMIS | ERRMIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:3 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | WRMIS | RO | 0 | Write Masked Interrupt Status Value Description 0 The number of available entries in the WFIFO is above the range specified by the trigger level or the interrupt is masked. 1 The number of available entries in the WFIFO is within the range specified by the trigger level (the WRFIFO field in the EPIFIFOLVL register) and the WRIM bit in the EPIIM register is set, triggering an interrupt to the interrupt controller. |
| 1 | RDMIS | RO | 0 | Read Masked Interrupt Status Value Description 0 The number of valid entries in the NBRFIFO is below the range specified by the trigger level or the interrupt is masked. 1 The number of valid entries in the NBRFIFO is within the range specified by the trigger level (the RDFIFO field in the EPIFIFOLVL register) and the RDIM bit in the EPIIM register is set, triggering an interrupt to the interrupt controller. |
| 0 | ERRMIS | RO | 0 | Error Masked Interrupt Status Value Description 0 An error has not occurred or the interrupt is masked. 1 A WFIFO Full, a Read Stalled, or a Timeout error has occurred and the ERIM bit in the EPIIM register is set, triggering an interrupt to the interrupt controller. |

Register 32: EPI Error and Interrupt Status and Clear (EPIEISC), offset 0x21C

This register is used to clear a pending error interrupt. Clearing any defined bit in the **EPIEISC** has no effect; setting a bit clears the error source and the raw error returns to 0. When any of these bits are read as set it indicates that the **ERRRIS** bit in the **EPIRIS** register is set and an EPI controller error is sent to the interrupt controller if the **ERIM** bit in the **EPIIM** register is set. If any of bits [2:0] are written as 1, the register bit being written to, as well as the **ERRRIS** bit in the **EPIRIS** register and the **ERIM** bit in the **EPIIM** register are cleared. Note that writing to this register and reading back immediately (pipelined by the processor) returns the old register contents. One cycle is needed between write and read.

EPI Error and Interrupt Status and Clear (EPIEISC)

Base 0x400D.0000
 Offset 0x21C
 Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|--------|--------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | WTFULL | RSTALL | TOUT |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-------|--|
| 31:3 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | WTFULL | R/W1C | 0 | Write FIFO Full Error Value Description 0 The WFERR bit is not enabled or no writes are stalled. 1 The WFERR bit is enabled and a write is stalled due to the WFIFO being full. Writing a 1 to this bit clears it, as well as as the ERRRIS and ERIM bits. |
| 1 | RSTALL | R/W1C | 0 | Read Stalled Error Value Description 0 The RSERR bit is not enabled or no pending reads are stalled. 1 The RSERR bit is enabled and a pending read is stalled due to writes in the WFIFO . Writing a 1 to this bit clears it, as well as as the ERRRIS and ERIM bits. |

| Bit/Field | Name | Type | Reset | Description | | | | |
|-----------|--------------------------------|-------|-------|--|---|--------------------------------|---|-------------------------------|
| 0 | TOUT | R/W1C | 0 | <p>Timeout Error</p> <p>This bit is the timeout error source. The timeout error occurs when the iRDY or XFIFO not-ready signals hold a transaction for more than the count in the MAXWAIT field (when not 0).</p> <p>Value Description</p> <table><tbody><tr><td>0</td><td>No timeout error has occurred.</td></tr><tr><td>1</td><td>A timeout error has occurred.</td></tr></tbody></table> <p>Writing a 1 to this bit clears it, as well as as the ERRRIS and ERIM bits.</p> | 0 | No timeout error has occurred. | 1 | A timeout error has occurred. |
| 0 | No timeout error has occurred. | | | | | | | |
| 1 | A timeout error has occurred. | | | | | | | |

11 General-Purpose Timers

Programmable timers can be used to count or time external events that drive the Timer input pins. The Stellaris[®] General-Purpose Timer Module (GPTM) contains four GPTM blocks. Each GPTM block provides two 16-bit timers/counters (referred to as Timer A and Timer B) that can be configured to operate independently as timers or event counters, or concatenated to operate as one 32-bit timer or one 32-bit Real-Time Clock (RTC). Timers can also be used to trigger μ DMA transfers.

In addition, timers can be used to trigger analog-to-digital conversions (ADC). The ADC trigger signals from all of the general-purpose timers are ORed together before reaching the ADC module, so only one timer should be used to trigger ADC events.

The GPT Module is one timing resource available on the Stellaris microcontrollers. Other timer resources include the System Timer (SysTick) (see 103) and the PWM timer in the PWM module (see “PWM Timer” on page 954).

The General-Purpose Timer Module (GPTM) contains four GPTM blocks with the following functional options:

- Operating modes:
 - 16- or 32-bit programmable one-shot timer
 - 16- or 32-bit programmable periodic timer
 - 16-bit general-purpose timer with an 8-bit prescaler
 - 32-bit Real-Time Clock (RTC) when using an external 32.768-KHz clock as the input
 - 16-bit input-edge count- or time-capture modes
 - 16-bit PWM mode with software-programmable output inversion of the PWM signal
- Count up or down
- Daisy chaining of timer modules to allow a single timer to initiate multiple timing events
- ADC event trigger
- User-enabled stalling when the microcontroller asserts CPU Halt flag during debug (excluding RTC mode)
- Ability to determine the elapsed time between the assertion of the timer interrupt and entry into the interrupt service routine.
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Dedicated channel for each timer
 - Burst request generated on timer interrupt

11.1 Block Diagram

In the block diagram, the specific Capture Compare PWM (CCP) pins available depend on the Stellaris device. See Table 11-1 on page 551 for the available CCP pins and their timer assignments.

Figure 11-1. GPTM Module Block Diagram

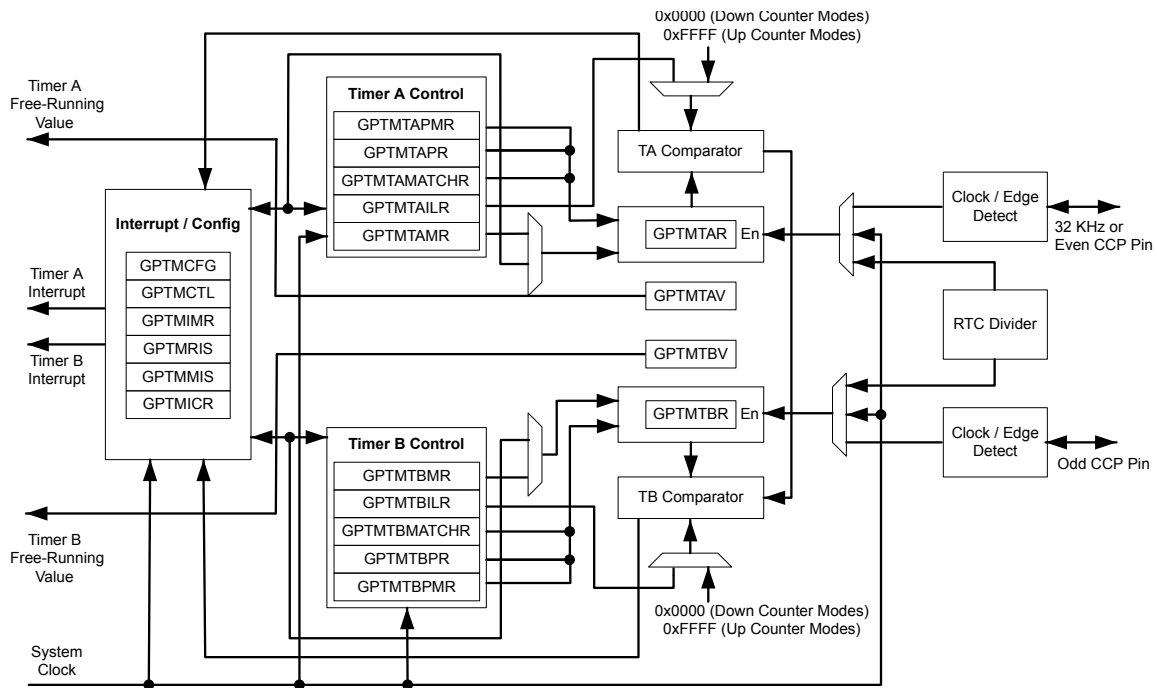


Table 11-1. Available CCP Pins

| Timer | 16-Bit Up/Down Counter | Even CCP Pin | Odd CCP Pin |
|---------|------------------------|--------------|-------------|
| Timer 0 | TimerA | CCP0 | - |
| | TimerB | - | CCP1 |
| Timer 1 | TimerA | CCP2 | - |
| | TimerB | - | CCP3 |
| Timer 2 | TimerA | CCP4 | - |
| | TimerB | - | CCP5 |
| Timer 3 | TimerA | CCP6 | - |
| | TimerB | - | CCP7 |

11.2 Signal Description

The following table lists the external signals of the GP Timer module and describes the function of each. The GP Timer signals are alternate functions for some GPIO signals and default to be GPIO signals at reset. The column in the table below titled "Pin Mux/Pin Assignment" lists the possible GPIO pin placements for these GP Timer signals. The `AFSEL` bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the GP Timer function. The number in parentheses is the encoding that must be programmed into the `PMCn` field in the **GPIO Port Control (GPIOPCTL)** register (page 461) to assign the GP Timer signal to the specified GPIO port pin. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 419.

Table 11-2. General-Purpose Timers Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|--|--|----------|--------------------------|------------------------|
| CCP0 | 13 22 23 39 58 66 72 91 97 | PD3 (4) PC7 (4) PC6 (6) PJ2 (9) PF4 (1) PB0 (1) PB2 (5) PB5 (4) PD4 (1) | I/O | TTL | Capture/Compare/PWM 0. |
| CCP1 | 24 25 34 43 67 90 96 100 | PC5 (1) PC4 (9) PA6 (2) PF6 (1) PB1 (4) PB6 (1) PE3 (1) PD7 (3) | I/O | TTL | Capture/Compare/PWM 1. |
| CCP2 | 6 11 25 46 67 75 91 95 98 | PE4 (6) PD1 (10) PC4 (5) PF5 (1) PB1 (1) PE1 (4) PB5 (6) PE2 (5) PD5 (1) | I/O | TTL | Capture/Compare/PWM 2. |
| CCP3 | 6 23 24 35 41 61 72 74 97 | PE4 (1) PC6 (1) PC5 (5) PA7 (7) PG4 (1) PF1 (10) PB2 (4) PE0 (3) PD4 (2) | I/O | TTL | Capture/Compare/PWM 3. |
| CCP4 | 22 25 35 42 95 98 | PC7 (1) PC4 (6) PA7 (2) PF7 (1) PE2 (1) PD5 (2) | I/O | TTL | Capture/Compare/PWM 4. |
| CCP5 | 5 12 25 36 40 90 91 | PE5 (1) PD2 (4) PC4 (1) PG7 (8) PG5 (1) PB6 (6) PB5 (2) | I/O | TTL | Capture/Compare/PWM 5. |
| CCP6 | 10 12 75 86 91 | PD0 (6) PD2 (2) PE1 (5) PH0 (1) PB5 (3) | I/O | TTL | Capture/Compare/PWM 6. |

Table 11-2. General-Purpose Timers Signals (100LQFP) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|----------------------------|---|----------|--------------------------|------------------------|
| CCP7 | 11 13 85 90 96 | PD1 (6) PD3 (2) PH1 (1) PB6 (2) PE3 (5) | I/O | TTL | Capture/Compare/PWM 7. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 11-3. General-Purpose Timers Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|---|--|----------|--------------------------|------------------------|
| CCP0 | H1 L2 M2 K6 L9 E12 A11 B7 B5 | PD3 (4) PC7 (4) PC6 (6) PJ2 (9) PF4 (1) PB0 (1) PB2 (5) PB5 (4) PD4 (1) | I/O | TTL | Capture/Compare/PWM 0. |
| CCP1 | M1 L1 L6 M8 D12 A7 B4 A2 | PC5 (1) PC4 (9) PA6 (2) PF6 (1) PB1 (4) PB6 (1) PE3 (1) PD7 (3) | I/O | TTL | Capture/Compare/PWM 1. |
| CCP2 | B2 G2 L1 L8 D12 A12 B7 A4 C6 | PE4 (6) PD1 (10) PC4 (5) PF5 (1) PB1 (1) PE1 (4) PB5 (6) PE2 (5) PD5 (1) | I/O | TTL | Capture/Compare/PWM 2. |
| CCP3 | B2 M2 M1 M6 K3 H12 A11 B11 B5 | PE4 (1) PC6 (1) PC5 (5) PA7 (7) PG4 (1) PF1 (10) PB2 (4) PE0 (3) PD4 (2) | I/O | TTL | Capture/Compare/PWM 3. |
| CCP4 | L2 L1 M6 K4 A4 C6 | PC7 (1) PC4 (6) PA7 (2) PF7 (1) PE2 (1) PD5 (2) | I/O | TTL | Capture/Compare/PWM 4. |

Table 11-3. General-Purpose Timers Signals (108BGA) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|------------------------|
| CCP5 | B3 | PE5 (1) | I/O | TTL | Capture/Compare/PWM 5. |
| | H2 | PD2 (4) | | | |
| | L1 | PC4 (1) | | | |
| | C10 | PG7 (8) | | | |
| | M7 | PG5 (1) | | | |
| | A7 | PB6 (6) | | | |
| | B7 | PB5 (2) | | | |
| CCP6 | G1 | PD0 (6) | I/O | TTL | Capture/Compare/PWM 6. |
| | H2 | PD2 (2) | | | |
| | A12 | PE1 (5) | | | |
| | C9 | PH0 (1) | | | |
| | B7 | PB5 (3) | | | |
| CCP7 | G2 | PD1 (6) | I/O | TTL | Capture/Compare/PWM 7. |
| | H1 | PD3 (2) | | | |
| | C8 | PH1 (1) | | | |
| | A7 | PB6 (2) | | | |
| | B4 | PE3 (5) | | | |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

11.3 Functional Description

The main components of each GPTM block are two free-running up/down counters (referred to as Timer A and Timer B), two match registers, two prescaler match registers, two shadow registers, and two load/initialization registers and their associated control functions. The exact functionality of each GPTM is controlled by software and configured through the register interface. Timer A and Timer B can be used individually, in which case they have a 16-bit counting range. In addition, Timer A and Timer B can be concatenated to provide a 32-bit counting range. Note that the prescaler can only be used when the timers are used individually.

The available modes for each GPTM block are shown in Table 11-4 on page 554. Note that when counting down in one-shot or periodic modes, the prescaler acts as a true prescaler and contains the least-significant bits of the count. When counting up in one-shot or periodic modes, the prescaler acts as a timer extension and holds the most-significant bits of the count. In input edge count mode, the prescaler always acts as a timer extension, regardless of the count direction.

Table 11-4. General-Purpose Timer Capabilities

| Mode | Timer Use | Count Direction | Counter Size | Prescaler Size ^a |
|------------|--------------|-----------------|--------------|-----------------------------|
| One-shot | Individual | Up or Down | 16-bit | 8-bit |
| | Concatenated | Up or Down | 32-bit | - |
| Periodic | Individual | Up or Down | 16-bit | 8-bit |
| | Concatenated | Up or Down | 32-bit | - |
| RTC | Concatenated | Up | 32-bit | - |
| Edge Count | Individual | Down | 16-bit | 8-bit |
| Edge Time | Individual | Down | 16-bit | - |
| PWM | Individual | Down | 16-bit | - |

a. The prescaler is only available when the timers are used individually

Software configures the GPTM using the **GPTM Configuration (GPTMCFG)** register (see page 567), the **GPTM Timer A Mode (GPTMTAMR)** register (see page 568), and the **GPTM Timer B Mode**

(**GPTMTBMR**) register (see page 570). When in one of the concatenated modes, Timer A and Timer B can only operate in one mode. However, when configured in an individual mode, Timer A and Timer B can be independently configured in any combination of the individual modes.

11.3.1 GPTM Reset Conditions

After reset has been applied to the GPTM module, the module is in an inactive state, and all control registers are cleared and in their default states. Counters Timer A and Timer B are initialized to all 1s, along with their corresponding load registers: the **GPTM Timer A Interval Load (GPTMTAILR)** register (see page 585) and the **GPTM Timer B Interval Load (GPTMTBILR)** register (see page 586) and shadow registers: the **GPTM Timer A Value (GPTMTAV)** register (see page 595) and the **GPTM Timer B Value (GPTMTBV)** register (see page 596). The prescale counters are initialized to 0x00: the **GPTM Timer A Prescale (GPTMTAPR)** register (see page 589) and the **GPTM Timer B Prescale (GPTMTBPR)** register (see page 590).

11.3.2 Timer Modes

This section describes the operation of the various timer modes. When using Timer A and Timer B in concatenated mode, only the Timer A control and status bits must be used; there is no need to use Timer B control and status bits. The GPTM is placed into individual/split mode by writing a value of 0x4 to the **GPTM Configuration (GPTMCFG)** register (see page 567). In the following sections, the variable "n" is used in bit field and register names to imply either a Timer A function or a Timer B function. Throughout this section, the timeout event in down-count mode is 0x0 and in up-count mode is the value in the **GPTM Timer n Interval Load (GPTMTnILR)** and the optional **GPTM Timer n Prescale (GPTMTnPR)** registers.

11.3.2.1 One-Shot/Periodic Timer Mode

The selection of one-shot or periodic mode is determined by the value written to the T_nMR field of the **GPTM Timer n Mode (GPTMTnMR)** register (see page 568). The timer is configured to count up or down using the T_nCDIR bit in the **GPTMTnMR** register.

When software sets the T_nEN bit in the **GPTM Control (GPTMCTL)** register (see page 572), the timer begins counting up from 0x0 or down from its preloaded value. Alternatively, if the T_nWOT bit is set in the **GPTMTnMR** register, once the T_nEN bit is set, the timer waits for a trigger to begin counting (see the section called "Wait-for-Trigger Mode" on page 556). Table 11-5 on page 555 shows the values that are loaded into the timer registers when the timer is enabled.

Table 11-5. Counter Values When the Timer is Enabled in Periodic or One-Shot Modes

| Register | Count Down Mode | Count Up Mode |
|----------|------------------|---------------|
| T_nR | GPTMTnILR | 0x0 |
| T_nV | GPTMTnILR | 0x0 |

When the timer is counting down and it reaches the timeout event (0x0), the timer reloads its start value from the **GPTMTnILR** and the **GPTMTnPR** registers on the next cycle. When the timer is counting up and it reaches the timeout event (the value in the **GPTMTnILR** and the optional **GPTMTnPR** registers), the timer reloads with 0x0. If configured to be a one-shot timer, the timer stops counting and clears the T_nEN bit in the **GPTMCTL** register. If configured as a periodic timer, the timer starts counting again on the next cycle.

In periodic, snap-shot mode (T_nMR field is 0x2 and the T_nSNAPS bit is set in the **GPTMTnMR** register), the value of the timer at the time-out event is loaded into the **GPTMTnR** register. The free-running counter value is shown in the **GPTMTnV** register. In this manner, software can determine the time elapsed from the interrupt assertion to the ISR entry by examining the snapshot values

and the current value of the free-running timer. Snapshot mode is not available when the timer is configured in one-shot mode.

In addition to reloading the count value, the GPTM generates interrupts and triggers when it reaches the time-out event. The GPTM sets the $TnTORIS$ bit in the **GPTM Raw Interrupt Status (GPTMRIS)** register (see page 577), and holds it until it is cleared by writing the **GPTM Interrupt Clear (GPTMICR)** register (see page 583). If the time-out interrupt is enabled in the **GPTM Interrupt Mask (GPTMIMR)** register (see page 575), the GPTM also sets the $TnTOMIS$ bit in the **GPTM Masked Interrupt Status (GPTMMIS)** register (see page 580). By setting the $TnMIE$ bit in the **GPTMTnMR** register, an interrupt condition can also be generated when the Timer value equals the value loaded into the **GPTM Timer n Match (GPTMTnMATCHR)** and **GPTM Timer n Prescale Match (GPTMTnPMR)** registers. This interrupt has the same status, masking, and clearing functions as the time-out interrupt, but uses the match interrupt bits instead (for example, the raw interrupt status is monitored via $TnMRIS$ bit in the **GPTM Raw Interrupt Status (GPTMRIS)** register). Note that the interrupt status bits are not updated by the hardware unless the $TnMIE$ bit in the **GPTMTnMR** register is set, which is different than the behavior for the time-out interrupt. The ADC trigger is enabled by setting the $TnOTE$ bit in **GPTMCTL**. The μ DMA trigger is enabled by configuring and enabling the appropriate μ DMA channel. See “Channel Configuration” on page 363.

If software updates the **GPTMTnILR** register while the counter is counting down, the counter loads the new value on the next clock cycle and continues counting from the new value. If software updates the **GPTMTnILR** register while the counter is counting up, the timeout event is changed on the next cycle to the new value. If software updates the **GPTM Timer n Value (GPTMTnV)** register while the counter is counting up or down, the counter loads the new value on the next clock cycle and continues counting from the new value..

If the $TnSTALL$ bit in the **GPTMCTL** register is set, the timer freezes counting while the processor is halted by the debugger. The timer resumes counting when the processor resumes execution.

The following table shows a variety of configurations for a 16-bit free-running timer while using the prescaler. All values assume an 80-MHz clock with $Tc=12.5$ ns (clock period). The prescaler can only be used when a 16/32-bit timer is configured in 16-bit mode.

Table 11-6. 16-Bit Timer With Prescaler Configurations

| Prescale (8-bit value) | # of Timer Clocks (Tc) ^a | Max Time | Units |
|------------------------|---|----------|-------|
| 00000000 | 1 | 0.8192 | ms |
| 00000001 | 2 | 1.6384 | ms |
| 00000010 | 3 | 2.4576 | ms |
| ----- | -- | -- | -- |
| 11111101 | 254 | 208.0768 | ms |
| 11111110 | 255 | 208.896 | ms |
| 11111111 | 256 | 209.7152 | ms |

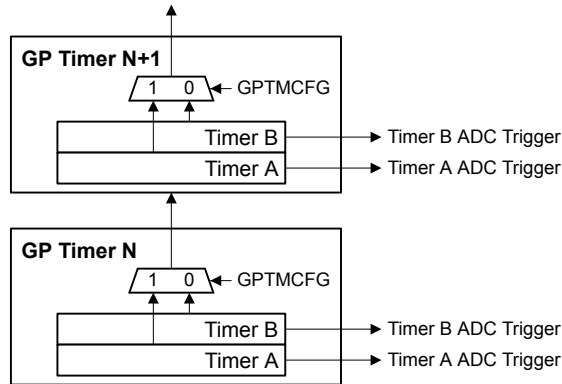
a. Tc is the clock period.

Wait-for-Trigger Mode

The Wait-for-Trigger mode allows daisy chaining of the timer modules such that once configured, a single timer can initiate multiple timing events using the Timer triggers. Wait-for-Trigger mode is enabled by setting the $TnWOT$ bit in the **GPTMTnMR** register. When the $TnWOT$ bit is set, Timer N+1 does not begin counting until the timer in the previous position in the daisy chain (Timer N) reaches its time-out event. The daisy chain is configured such that GPTM1 always follows GPTM0, GPTM2 follows GPTM1, and so on. If Timer A is in 32-bit mode (controlled by the $GPTMCFG$ bit in the **GPTMCFG** register), it triggers Timer A in the next module. If Timer A is in 16-bit mode, it triggers

Timer B in the same module, and Timer B triggers Timer A in the next module. Care must be taken that the `TAWOT` bit is never set in `GPTM0`. Figure 11-2 on page 557 shows how the `GPTMCFG` bit affects the daisy chain. This function is valid for both one-shot and periodic modes.

Figure 11-2. Timer Daisy Chain



11.3.2.2 Real-Time Clock Timer Mode

In Real-Time Clock (RTC) mode, the concatenated versions of the Timer A and Timer B registers are configured as an up-counter. When RTC mode is selected for the first time after reset, the counter is loaded with a value of `0x1`. All subsequent load values must be written to the **GPTM Timer A Interval Load (GPTMTAILR)** register (see page 585). Table 11-7 on page 557 shows the values that are loaded into the timer registers when the timer is enabled.

Table 11-7. Counter Values When the Timer is Enabled in RTC Mode

| Register | Count Down Mode | Count Up Mode |
|----------|-----------------|---------------|
| TnR | Not available | 0x1 |
| TnV | Not available | 0x1 |

The input clock on a CCP input is required to be 32.768 KHz in RTC mode. The clock signal is then divided down to a 1-Hz rate and is passed along to the input of the counter.

When software writes the `TAEN` bit in the `GPTMCTL` register, the counter starts counting up from its preloaded value of `0x1`. When the current count value matches the preloaded value in the `GPTMTAMATCHR` register, the GPTM asserts the `RTCRES` bit in `GPTMRIS` and continues counting until either a hardware reset, or it is disabled by software (clearing the `TAEN` bit). When the timer value reaches the terminal count, the timer rolls over and continues counting up from `0x0`. If the RTC interrupt is enabled in `GPTMIMR`, the GPTM also sets the `RTCMIS` bit in `GPTMMIS` and generates a controller interrupt. The status flags are cleared by writing the `RTCCINT` bit in `GPTMICR`.

In this mode, the `GPTMTnR` and `GPTMTnV` registers always have the same value.

In addition to generating interrupts, a μ DMA trigger can be generated. The μ DMA trigger is enabled by configuring and enabling the appropriate μ DMA channel. See “Channel Configuration” on page 363.

If the `TASTALL` bit in the `GPTMCTL` register is set, the timer does not freeze when the processor is halted by the debugger if the `RTCEN` bit is set in `GPTMCTL`.

11.3.2.3 Input Edge-Count Mode

Note: For rising-edge detection, the input signal must be High for at least two system clock periods following the rising edge. Similarly, for falling-edge detection, the input signal must be Low for at least two system clock periods following the falling edge. Based on this criteria, the maximum input frequency for edge detection is 1/4 of the system frequency.

In Edge-Count mode, the timer is configured as a 24-bit down-counter including the optional prescaler with the upper count value stored in the **GPTM Timer n Prescale (GPTMTnPR)** register and the lower bits in the **GPTMTnR** register. In this mode, the timer is capable of capturing three types of events: rising edge, falling edge, or both. To place the timer in Edge-Count mode, the **TnCMR** bit of the **GPTMTnMR** register must be cleared. The type of edge that the timer counts is determined by the **TnEVENT** fields of the **GPTMCTL** register. During initialization, the **GPTMTnMATCHR** and **GPTMTnPMR** registers are configured so that the difference between the value in the **GPTMTnILR** and **GPTMTnPR** registers and the **GPTMTnMATCHR** and **GPTMTnPMR** registers equals the number of edge events that must be counted. Table 11-8 on page 558 shows the values that are loaded into the timer registers when the timer is enabled.

Table 11-8. Counter Values When the Timer is Enabled in Input Edge-Count Mode

| Register | Count Down Mode | Count Up Mode |
|----------|-----------------|---------------|
| TnR | GPTMTnILR | Not available |
| TnV | GPTMTnILR | Not available |

When software writes the **TnEN** bit in the **GPTM Control (GPTMCTL)** register, the timer is enabled for event capture. Each input event on the CCP pin decrements the counter by 1 until the event count matches **GPTMTnMATCHR** and **GPTMTnPMR**. When the counts match, the GPTM asserts the **CnMRIS** bit in the **GPTM Raw Interrupt Status (GPTMRIS)** register, and holds it until it is cleared by writing the **GPTM Interrupt Clear (GPTMICR)** register. If the capture mode match interrupt is enabled in the **GPTM Interrupt Mask (GPTMIMR)** register, the GPTM also sets the **CnMMIS** bit in the **GPTM Masked Interrupt Status (GPTMMIS)** register. In this mode, the **GPTMTnR** register holds the count of the input events while the **GPTMTnV** register holds the free-running timer value.

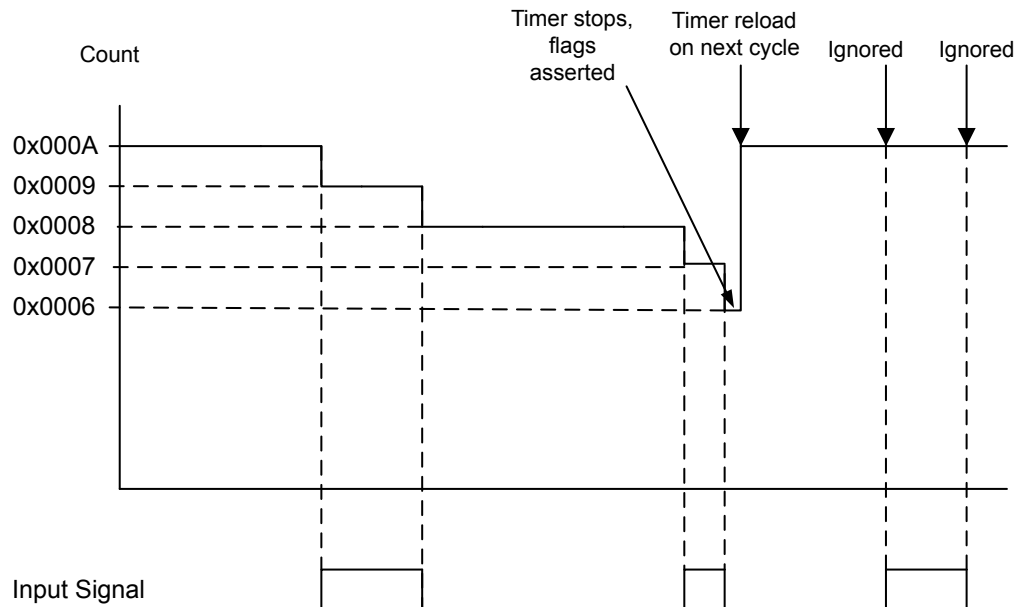
In addition to generating interrupts, an ADC and/or a μ DMA trigger can be generated. The ADC trigger is enabled by setting the **TnOTE** bit in **GPTMCTL**. The μ DMA trigger is enabled by configuring and enabling the appropriate μ DMA channel. See “Channel Configuration” on page 363.

After the match value is reached, the counter is then reloaded using the value in **GPTMTnILR** and **GPTMTnPR** registers, and stopped because the GPTM automatically clears the **TnEN** bit in the **GPTMCTL** register. Once the event count has been reached, all further events are ignored until **TnEN** is re-enabled by software.

Figure 11-3 on page 559 shows how Input Edge-Count mode works. In this case, the timer start value is set to **GPTMTnILR** = 0x000A and the match value is set to **GPTMTnMATCHR** = 0x0006 so that four edge events are counted. The counter is configured to detect both edges of the input signal.

Note that the last two edges are not counted because the timer automatically clears the **TnEN** bit after the current count matches the value in the **GPTMTnMATCHR** register.

Figure 11-3. Input Edge-Count Mode Example



11.3.2.4 Input Edge-Time Mode

Note: For rising-edge detection, the input signal must be High for at least two system clock periods following the rising edge. Similarly, for falling edge detection, the input signal must be Low for at least two system clock periods following the falling edge. Based on this criteria, the maximum input frequency for edge detection is 1/4 of the system frequency.

The prescaler is not available in 16-Bit Input Edge-Time mode.

In Edge-Time mode, the timer is configured as a 16-bit down-counter. In this mode, the timer is initialized to the value loaded in the **GPTMTnLR** register. The timer is capable of capturing three types of events: rising edge, falling edge, or both. The timer is placed into Edge-Time mode by setting the **TnCMR** bit in the **GPTMTnMR** register, and the type of event that the timer captures is determined by the **TnEVENT** fields of the **GPTMCTL** register. Table 11-9 on page 559 shows the values that are loaded into the timer registers when the timer is enabled.

Table 11-9. Counter Values When the Timer is Enabled in Input Event-Count Mode

| Register | Count Down Mode | Count Up Mode |
|------------|-----------------|---------------|
| TnR | GPTMTnLR | Not available |
| TnV | GPTMTnLR | Not available |

When software writes the **TnEN** bit in the **GPTMCTL** register, the timer is enabled for event capture. When the selected input event is detected, the current timer counter value is captured in the **GPTMTnR** register and is available to be read by the microcontroller. The GPTM then asserts the **CnERIS** bit in the **GPTM Raw Interrupt Status (GPTMRIS)** register, and holds it until it is cleared by writing the **GPTM Interrupt Clear (GPTMICR)** register. If the capture mode event interrupt is enabled in the **GPTM Interrupt Mask (GPTMIMR)** register, the GPTM also sets the **CnEMIS** bit in the **GPTM Masked Interrupt Status (GPTMMIS)** register. In this mode, the **GPTMTnR** register holds the time at which the selected input event occurred while the **GPTMTnV** register holds the free-running timer value. These registers can be read to determine the time that elapsed between the interrupt assertion and the entry into the ISR.

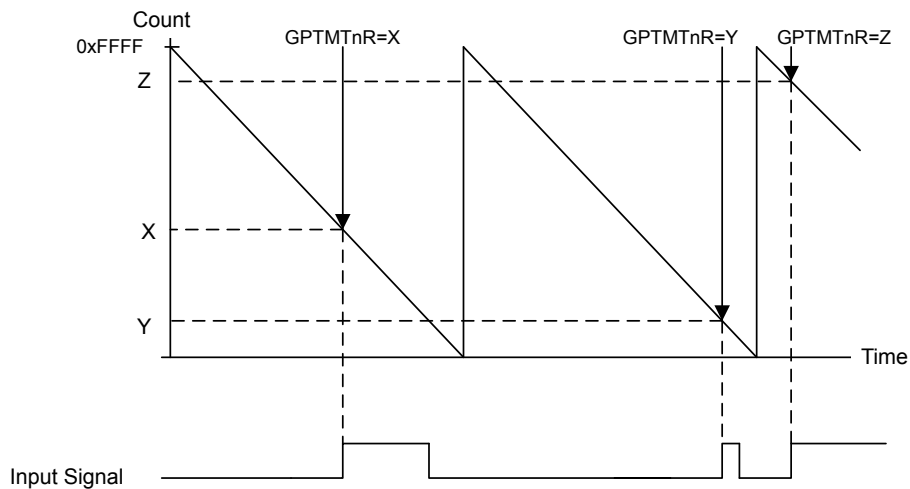
In addition to generating interrupts, an ADC and/or a μ DMA trigger can be generated. The ADC trigger is enabled by setting the $TnOTE$ bit in **GPTMCTL**. The μ DMA trigger is enabled by configuring and enabling the appropriate μ DMA channel. See “Channel Configuration” on page 363.

After an event has been captured, the timer does not stop counting. It continues to count until the $TnEN$ bit is cleared. When the timer reaches the timeout value, it is reloaded with the value from the **GPTMTnILR** register.

Figure 11-4 on page 560 shows how input edge timing mode works. In the diagram, it is assumed that the start value of the timer is the default value of 0xFFFF, and the timer is configured to capture rising edge events.

Each time a rising edge event is detected, the current count value is loaded into the **GPTMTnR** register, and is held there until another rising edge is detected (at which point the new count value is loaded into the **GPTMTnR** register).

Figure 11-4. 16-Bit Input Edge-Time Mode Example



11.3.2.5 PWM Mode

Note: The prescaler is not available in 16-Bit PWM mode.

The GPTM supports a simple PWM generation mode. In PWM mode, the timer is configured as a 16-bit down-counter with a start value (and thus period) defined by the **GPTMTnILR** register. In this mode, the PWM frequency and period are synchronous events and therefore guaranteed to be glitch free. PWM mode is enabled with the **GPTMTnMR** register by setting the $TnAMS$ bit to 0x1, the $TnCMR$ bit to 0x0, and the $TnMR$ field to 0x1 or 0x2. Table 11-10 on page 560 shows the values that are loaded into the timer registers when the timer is enabled.

Table 11-10. Counter Values When the Timer is Enabled in PWM Mode

| Register | Count Down Mode | Count Up Mode |
|----------------|------------------|---------------|
| GPTMTnR | GPTMTnILR | Not available |
| GPTMTnV | GPTMTnILR | Not available |

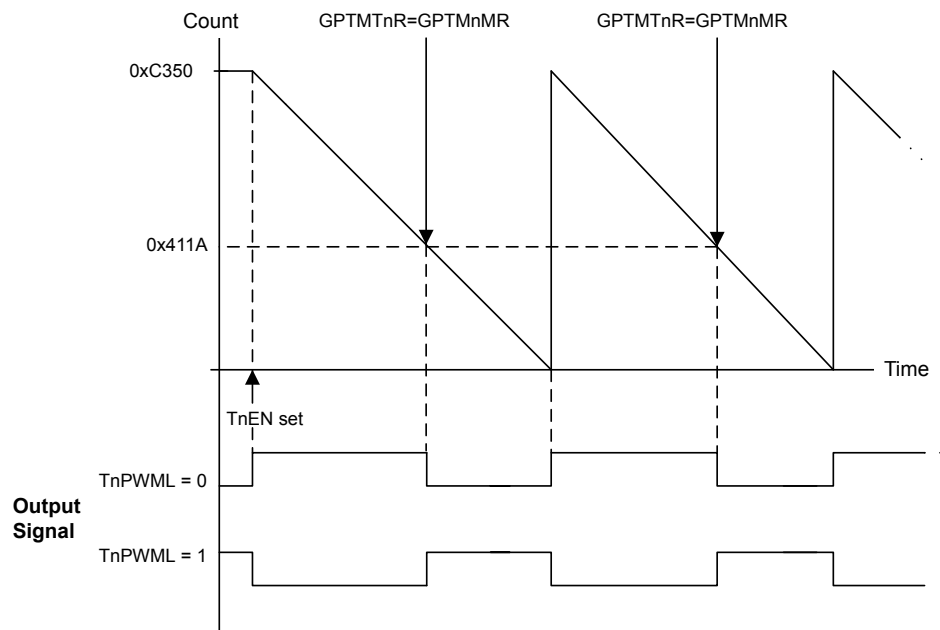
When software writes the T_nEN bit in the **GPTMCTL** register, the counter begins counting down until it reaches the 0x0 state. On the next counter cycle in periodic mode, the counter reloads its start value from the **GPTMTnILR** register and continues counting until disabled by software clearing the T_nEN bit in the **GPTMCTL** register. No interrupts or status bits are asserted in PWM mode.

In this mode, the **GPTMTnR** and **GPTMTnV** registers always have the same value.

The output PWM signal asserts when the counter is at the value of the **GPTMTnILR** register (its start state), and is deasserted when the counter value equals the value in the **GPTMTnMATCHR** register. Software has the capability of inverting the output PWM signal by setting the T_nPWML bit in the **GPTMCTL** register.

Figure 11-5 on page 561 shows how to generate an output PWM with a 1-ms period and a 66% duty cycle assuming a 50-MHz input clock and $T_nPWML = 0$ (duty cycle would be 33% for the $T_nPWML = 1$ configuration). For this example, the start value is **GPTMTnILR**=0xC350 and the match value is **GPTMTnMATCHR**=0x411A.

Figure 11-5. 16-Bit PWM Mode Example



11.3.3 DMA Operation

The timers each have a dedicated μ DMA channel and can provide a request signal to the μ DMA controller. The request is a burst type and occurs whenever a timer raw interrupt condition occurs. The arbitration size of the μ DMA transfer should be set to the amount of data that should be transferred whenever a timer event occurs.

For example, to transfer 256 items, 8 items at a time every 10 ms, configure a timer to generate a periodic timeout at 10 ms. Configure the μ DMA transfer for a total of 256 items, with a burst size of 8 items. Each time the timer times out, the μ DMA controller transfers 8 items, until all 256 items have been transferred.

No other special steps are needed to enable Timers for μ DMA operation. Refer to “Micro Direct Memory Access (μ DMA)” on page 359 for more details about programming the μ DMA controller.

11.3.4 Accessing Concatenated Register Values

The GPTM is placed into concatenated mode by writing a 0x0 or a 0x1 to the `GPTMCFG` bit field in the **GPTM Configuration (GPTMCFG)** register. In both configurations, certain registers are concatenated to form pseudo 32-bit registers. These registers include:

- **GPTM Timer A Interval Load (GPTMTAILR)** register [15:0], see page 585
- **GPTM Timer B Interval Load (GPTMTBILR)** register [15:0], see page 586
- **GPTM Timer A (GPTMTAR)** register [15:0], see page 593
- **GPTM Timer B (GPTMTBR)** register [15:0], see page 594
- **GPTM Timer A Value (GPTMTAV)** register [15:0], see page 595
- **GPTM Timer B Value (GPTMTBV)** register [15:0], see page 596
- **GPTM Timer A Match (GPTMTAMATCHR)** register [15:0], see page 587
- **GPTM Timer B Match (GPTMTBMATCHR)** register [15:0], see page 588

In the 32-bit modes, the GPTM translates a 32-bit write access to **GPTMTAILR** into a write access to both **GPTMTAILR** and **GPTMTBILR**. The resulting word ordering for such a write operation is:

```
GPTMTBILR[15:0]:GPTMTAILR[15:0]
```

Likewise, a 32-bit read access to **GPTMTAR** returns the value:

```
GPTMTBR[15:0]:GPTMTAR[15:0]
```

A 32-bit read access to **GPTMTAV** returns the value:

```
GPTMTBV[15:0]:GPTMTAV[15:0]
```

11.4 Initialization and Configuration

To use a GPTM, the appropriate `TIMERN` bit must be set in the **RCGC1** register (see page 262). If using any CCP pins, the clock to the appropriate GPIO module must be enabled via the **RCGC1** register (see page 262). To find out which GPIO port to enable, refer to Table 23-4 on page 1075. Configure the `PMCn` fields in the **GPIOPCTL** register to assign the CCP signals to the appropriate pins (see page 461 and Table 23-5 on page 1083).

This section shows module initialization and configuration examples for each of the supported timer modes.

11.4.1 One-Shot/Periodic Timer Mode

The GPTM is configured for One-Shot and Periodic modes by the following sequence:

1. Ensure the timer is disabled (the `TnEN` bit in the **GPTMCTL** register is cleared) before making any changes.
2. Write the **GPTM Configuration Register (GPTMCFG)** with a value of 0x0000.0000.

3. Configure the T_{nMR} field in the **GPTM Timer n Mode Register (GPTMTnMR)**:
 - a. Write a value of 0x1 for One-Shot mode.
 - b. Write a value of 0x2 for Periodic mode.
4. Optionally configure the T_{nSNAPS} , T_{nWOT} , T_{nMTE} , and T_{nCDIR} bits in the **GPTMTnMR** register to select whether to capture the value of the free-running timer at time-out, use an external trigger to start counting, configure an additional trigger or interrupt, and count up or down.
5. Load the start value into the **GPTM Timer n Interval Load Register (GPTMTnILR)**.
6. If interrupts are required, set the appropriate bits in the **GPTM Interrupt Mask Register (GPTMIMR)**.
7. Set the T_{nEN} bit in the **GPTMCTL** register to enable the timer and start counting.
8. Poll the **GPTMRIS** register or wait for the interrupt to be generated (if enabled). In both cases, the status flags are cleared by writing a 1 to the appropriate bit of the **GPTM Interrupt Clear Register (GPTMICR)**.

If the T_{nMIE} bit in the **GPTMTnMR** register is set, the RTC_{RIS} bit in the **GPTMRIS** register is set, and the timer continues counting. In One-Shot mode, the timer stops counting after the time-out event. To re-enable the timer, repeat the sequence. A timer configured in Periodic mode reloads the timer and continues counting after the time-out event.

11.4.2 Real-Time Clock (RTC) Mode

To use the RTC mode, the timer must have a 32.768-KHz input signal on an even CCP input. To enable the RTC feature, follow these steps:

1. Ensure the timer is disabled (the TA_{EN} bit is cleared) before making any changes.
2. Write the **GPTM Configuration Register (GPTMCFG)** with a value of 0x0000.0001.
3. Write the match value to the **GPTM Timer n Match Register (GPTMTnMATCHR)**.
4. Set/clear the RTC_{EN} bit in the **GPTM Control Register (GPTMCTL)** as needed.
5. If interrupts are required, set the RTC_{IM} bit in the **GPTM Interrupt Mask Register (GPTMIMR)**.
6. Set the TA_{EN} bit in the **GPTMCTL** register to enable the timer and start counting.

When the timer count equals the value in the **GPTMTnMATCHR** register, the GPTM asserts the RTC_{RIS} bit in the **GPTMRIS** register and continues counting until Timer A is disabled or a hardware reset. The interrupt is cleared by writing the $RTCC_{INT}$ bit in the **GPTMICR** register.

11.4.3 Input Edge-Count Mode

A timer is configured to Input Edge-Count mode by the following sequence:

1. Ensure the timer is disabled (the T_{nEN} bit is cleared) before making any changes.
2. Write the **GPTM Configuration (GPTMCFG)** register with a value of 0x0000.0004.

3. In the **GPTM Timer Mode (GPTMTnMR)** register, write the $TnCMR$ field to 0x0 and the $TnMR$ field to 0x3.
4. Configure the type of event(s) that the timer captures by writing the $TnEVENT$ field of the **GPTM Control (GPTMCTL)** register.
5. If a prescaler is to be used, write the prescale value to the **GPTM Timer n Prescale Register (GPTMTnPR)**.
6. Load the timer start value into the **GPTM Timer n Interval Load (GPTMTnILR)** register.
7. Load the event count into the **GPTM Timer n Match (GPTMTnMATCHR)** register.
8. If interrupts are required, set the $CnMIM$ bit in the **GPTM Interrupt Mask (GPTMIMR)** register.
9. Set the $TnEN$ bit in the **GPTMCTL** register to enable the timer and begin waiting for edge events.
10. Poll the $CnMRIS$ bit in the **GPTMRIS** register or wait for the interrupt to be generated (if enabled). In both cases, the status flags are cleared by writing a 1 to the $CnMCINT$ bit of the **GPTM Interrupt Clear (GPTMICR)** register.

When counting down in Input Edge-Count Mode, the timer stops after the programmed number of edge events has been detected. To re-enable the timer, ensure that the $TnEN$ bit is cleared and repeat #4 on page 564 through #9 on page 564.

11.4.4 Input Edge Timing Mode

A timer is configured to Input Edge Timing mode by the following sequence:

1. Ensure the timer is disabled (the $TnEN$ bit is cleared) before making any changes.
2. Write the **GPTM Configuration (GPTMCFG)** register with a value of 0x0000.0004.
3. In the **GPTM Timer Mode (GPTMTnMR)** register, write the $TnCMR$ field to 0x1 and the $TnMR$ field to 0x3.
4. Configure the type of event that the timer captures by writing the $TnEVENT$ field of the **GPTM Control (GPTMCTL)** register.
5. Load the timer start value into the **GPTM Timer n Interval Load (GPTMTnILR)** register.
6. If interrupts are required, set the $CnEIM$ bit in the **GPTM Interrupt Mask (GPTMIMR)** register.
7. Set the $TnEN$ bit in the **GPTM Control (GPTMCTL)** register to enable the timer and start counting.
8. Poll the $CnERIS$ bit in the **GPTMRIS** register or wait for the interrupt to be generated (if enabled). In both cases, the status flags are cleared by writing a 1 to the $CnECINT$ bit of the **GPTM Interrupt Clear (GPTMICR)** register. The time at which the event happened can be obtained by reading the **GPTM Timer n (GPTMTnR)** register.

In Input Edge Timing mode, the timer continues running after an edge event has been detected, but the timer interval can be changed at any time by writing the **GPTMTnILR** register. The change takes effect at the next cycle after the write.

11.4.5 PWM Mode

A timer is configured to PWM mode using the following sequence:

1. Ensure the timer is disabled (the T_{nEN} bit is cleared) before making any changes.
2. Write the **GPTM Configuration (GPTMCFG)** register with a value of 0x0000.0004.
3. In the **GPTM Timer Mode (GPTMTnMR)** register, set the T_{nAMS} bit to 0x1, the T_{nCMR} bit to 0x0, and the T_{nMR} field to 0x2.
4. Configure the output state of the PWM signal (whether or not it is inverted) in the T_{nPWML} field of the **GPTM Control (GPTMCTL)** register.
5. Load the timer start value into the **GPTM Timer n Interval Load (GPTMTnILR)** register.
6. Load the **GPTM Timer n Match (GPTMTnMATCHR)** register with the match value.
7. Set the T_{nEN} bit in the **GPTM Control (GPTMCTL)** register to enable the timer and begin generation of the output PWM signal.

In PWM Timing mode, the timer continues running after the PWM signal has been generated. The PWM period can be adjusted at any time by writing the **GPTMTnILR** register, and the change takes effect at the next cycle after the write.

11.5 Register Map

Table 11-11 on page 565 lists the GPTM registers. The offset listed is a hexadecimal increment to the register's address, relative to that timer's base address:

- Timer 0: 0x4003.0000
- Timer 1: 0x4003.1000
- Timer 2: 0x4003.2000
- Timer 3: 0x4003.3000

Note that the GP Timer module clock must be enabled before the registers can be programmed (see page 262). There must be a delay of 3 system clocks after the Timer module clock is enabled before any Timer module registers are accessed.

Table 11-11. Timers Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|----------|------|-------------|------------------------------|----------|
| 0x000 | GPTMCFG | R/W | 0x0000.0000 | GPTM Configuration | 567 |
| 0x004 | GPTMTAMR | R/W | 0x0000.0000 | GPTM Timer A Mode | 568 |
| 0x008 | GPTMTBMR | R/W | 0x0000.0000 | GPTM Timer B Mode | 570 |
| 0x00C | GPTMCTL | R/W | 0x0000.0000 | GPTM Control | 572 |
| 0x018 | GPTMIMR | R/W | 0x0000.0000 | GPTM Interrupt Mask | 575 |
| 0x01C | GPTMRIS | RO | 0x0000.0000 | GPTM Raw Interrupt Status | 577 |
| 0x020 | GPTMMIS | RO | 0x0000.0000 | GPTM Masked Interrupt Status | 580 |
| 0x024 | GPTMICR | W1C | 0x0000.0000 | GPTM Interrupt Clear | 583 |

Table 11-11. Timers Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|--------------|------|-------------|----------------------------|----------|
| 0x028 | GPTMTAILR | R/W | 0xFFFF.FFFF | GPTM Timer A Interval Load | 585 |
| 0x02C | GPTMTBILR | R/W | 0x0000.FFFF | GPTM Timer B Interval Load | 586 |
| 0x030 | GPTMTAMATCHR | R/W | 0xFFFF.FFFF | GPTM Timer A Match | 587 |
| 0x034 | GPTMTBMATCHR | R/W | 0x0000.FFFF | GPTM Timer B Match | 588 |
| 0x038 | GPTMTAPR | R/W | 0x0000.0000 | GPTM Timer A Prescale | 589 |
| 0x03C | GPTMTBPR | R/W | 0x0000.0000 | GPTM Timer B Prescale | 590 |
| 0x040 | GPTMTAPMR | R/W | 0x0000.0000 | GPTM TimerA Prescale Match | 591 |
| 0x044 | GPTMTBPMR | R/W | 0x0000.0000 | GPTM TimerB Prescale Match | 592 |
| 0x048 | GPTMTAR | RO | 0xFFFF.FFFF | GPTM Timer A | 593 |
| 0x04C | GPTMTBR | RO | 0x0000.FFFF | GPTM Timer B | 594 |
| 0x050 | GPTMTAV | RW | 0xFFFF.FFFF | GPTM Timer A Value | 595 |
| 0x054 | GPTMTBV | RW | 0x0000.FFFF | GPTM Timer B Value | 596 |

11.6 Register Descriptions

The remainder of this section lists and describes the GPTM registers, in numerical order by address offset.

Register 1: GPTM Configuration (GPTMCFG), offset 0x000

This register configures the global operation of the GPTM module. The value written to this register determines whether the GPTM is in 32- or 16-bit mode.

Important: Bits in this register should only be changed when the TAEN and TBEN bits in the GPTMCTL register are cleared.

GPTM Configuration (GPTMCFG)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x000
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|---------|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | GPTMCFG | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | |
|-----------|---|------|------------|---|-------|-------------|-----|-----------------------------|-----|---|---------|----------|-----|---|---------|----------|
| 31:3 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | |
| 2:0 | GPTMCFG | R/W | 0x0 | GPTM Configuration The GPTMCFG values are defined as follows: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>32-bit timer configuration.</td> </tr> <tr> <td>0x1</td> <td>32-bit real-time clock (RTC) counter configuration.</td> </tr> <tr> <td>0x2-0x3</td> <td>Reserved</td> </tr> <tr> <td>0x4</td> <td>16-bit timer configuration. The function is controlled by bits 1:0 of GPTMTAMR and GPTMTBMR.</td> </tr> <tr> <td>0x5-0x7</td> <td>Reserved</td> </tr> </tbody> </table> | Value | Description | 0x0 | 32-bit timer configuration. | 0x1 | 32-bit real-time clock (RTC) counter configuration. | 0x2-0x3 | Reserved | 0x4 | 16-bit timer configuration. The function is controlled by bits 1:0 of GPTMTAMR and GPTMTBMR. | 0x5-0x7 | Reserved |
| Value | Description | | | | | | | | | | | | | | | |
| 0x0 | 32-bit timer configuration. | | | | | | | | | | | | | | | |
| 0x1 | 32-bit real-time clock (RTC) counter configuration. | | | | | | | | | | | | | | | |
| 0x2-0x3 | Reserved | | | | | | | | | | | | | | | |
| 0x4 | 16-bit timer configuration. The function is controlled by bits 1:0 of GPTMTAMR and GPTMTBMR. | | | | | | | | | | | | | | | |
| 0x5-0x7 | Reserved | | | | | | | | | | | | | | | |

Register 2: GPTM Timer A Mode (GPTMTAMR), offset 0x004

This register configures the GPTM based on the configuration selected in the **GPTMCFG** register. When in PWM mode, set the **TAAMS** bit, clear the **TACMR** bit, and configure the **TAMR** field to 0x1 or 0x2.

This register controls the modes for Timer A when it is used individually. When Timer A and Timer B are concatenated, this register controls the modes for both Timer A and Timer B, and the contents of **GPTMTBMR** are ignored.

Important: Bits in this register should only be changed when the **TAEN** bit in the **GPTMCTL** register is cleared.

GPTM Timer A Mode (GPTMTAMR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x004
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|---------|-------|-------|--------|-------|-------|------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | TASNAPS | TAWOT | TAMIE | TACDIR | TAAMS | TACMR | TAMR | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | TASNAPS | R/W | 0 | GPTM Timer A Snap-Shot Mode Value Description 0 Snap-shot mode is disabled. 1 If Timer A is configured in the periodic mode, the actual free-running value of Timer A is loaded at the time-out event into the GPTM Timer A (GPTMTAR) register. If the timer prescaler is used, the prescaler snapshot is loaded into the GPTM Timer A (GPTMTAPR) . |
| 6 | TAWOT | R/W | 0 | GPTM Timer A Wait-on-Trigger Value Description 0 Timer A begins counting as soon as it is enabled. 1 If Timer A is enabled (TAEN is set in the GPTMCTL register), Timer A does not begin counting until it receives a trigger from the timer in the previous position in the daisy chain, see Figure 11-2 on page 557. This function is valid for both one-shot and periodic modes. |

This bit must be clear for GP Timer Module 0, Timer A.

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 5 | TAMIE | R/W | 0 | <p>GPTM Timer A Match Interrupt Enable</p> <p>Value Description</p> <p>0 The match interrupt is disabled.</p> <p>1 An interrupt is generated when the match value in the GPTMTAMATCHR register is reached in the one-shot and periodic modes.</p> |
| 4 | TACDIR | R/W | 0 | <p>GPTM Timer A Count Direction</p> <p>Value Description</p> <p>0 The timer counts down.</p> <p>1 When in one-shot or periodic mode, the timer counts up. When counting up, the timer starts from a value of 0x0.</p> <p>When in PWM or RTC mode, the status of this bit is ignored. PWM mode always counts down and RTC mode always counts up.</p> |
| 3 | TAAMS | R/W | 0 | <p>GPTM Timer A Alternate Mode Select</p> <p>The TAAMS values are defined as follows:</p> <p>Value Description</p> <p>0 Capture mode is enabled.</p> <p>1 PWM mode is enabled.</p> <p>Note: To enable PWM mode, you must also clear the TACMR bit and configure the TAMR field to 0x1 or 0x2.</p> |
| 2 | TACMR | R/W | 0 | <p>GPTM Timer A Capture Mode</p> <p>The TACMR values are defined as follows:</p> <p>Value Description</p> <p>0 Edge-Count mode</p> <p>1 Edge-Time mode</p> |
| 1:0 | TAMR | R/W | 0x0 | <p>GPTM Timer A Mode</p> <p>The TAMR values are defined as follows:</p> <p>Value Description</p> <p>0x0 Reserved</p> <p>0x1 One-Shot Timer mode</p> <p>0x2 Periodic Timer mode</p> <p>0x3 Capture mode</p> <p>The Timer mode is based on the timer configuration defined by bits 2:0 in the GPTMCFG register.</p> |

Register 3: GPTM Timer B Mode (GPTMTBMR), offset 0x008

This register configures the GPTM based on the configuration selected in the **GPTMCFG** register. When in PWM mode, set the **TBAMS** bit, clear the **TBCMR** bit, and configure the **TBMR** field to 0x1 or 0x2.

This register controls the modes for Timer B when it is used individually. When Timer A and Timer B are concatenated, this register is ignored and **GPTMTBMR** controls the modes for both Timer A and Timer B.

Important: Bits in this register should only be changed when the **TBEN** bit in the **GPTMCTL** register is cleared.

GPTM Timer B Mode (GPTMTBMR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x008
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|---------|-------|-------|--------|-------|-------|------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | TBSNAPS | TBWOT | TBMIE | TBCDIR | TBAMS | TBCMR | TBMR | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|--|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | TBSNAPS | R/W | 0 | GPTM Timer B Snap-Shot Mode Value Description 0 Snap-shot mode is disabled. 1 If Timer B is configured in the periodic mode, the actual free-running value of Timer B is loaded at the time-out event into the GPTM Timer B (GPTMTBR) register. If the timer prescaler is used, the prescaler snapshot is loaded into the GPTM Timer B (GPTMTBPR) . |
| 6 | TBWOT | R/W | 0 | GPTM Timer B Wait-on-Trigger Value Description 0 Timer B begins counting as soon as it is enabled. 1 If Timer B is enabled (TBEN is set in the GPTMCTL register), Timer B does not begin counting until it receives an it receives a trigger from the timer in the previous position in the daisy chain, see Figure 11-2 on page 557. This function is valid for both one-shot and periodic modes. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 5 | TBMIE | R/W | 0 | <p>GPTM Timer B Match Interrupt Enable</p> <p>Value Description</p> <p>0 The match interrupt is disabled.</p> <p>1 An interrupt is generated when the match value in the GPTMTBMATCHR register is reached in the one-shot and periodic modes.</p> |
| 4 | TBCDIR | R/W | 0 | <p>GPTM Timer B Count Direction</p> <p>Value Description</p> <p>0 The timer counts down.</p> <p>1 When in one-shot or periodic mode, the timer counts up. When counting up, the timer starts from a value of 0x0.</p> <p>When in PWM or RTC mode, the status of this bit is ignored. PWM mode always counts down and RTC mode always counts up.</p> |
| 3 | TBAMS | R/W | 0 | <p>GPTM Timer B Alternate Mode Select</p> <p>The TBAMS values are defined as follows:</p> <p>Value Description</p> <p>0 Capture mode is enabled.</p> <p>1 PWM mode is enabled.</p> <p>Note: To enable PWM mode, you must also clear the TBCMR bit and configure the TBMR field to 0x1 or 0x2.</p> |
| 2 | TBCMR | R/W | 0 | <p>GPTM Timer B Capture Mode</p> <p>The TBCMR values are defined as follows:</p> <p>Value Description</p> <p>0 Edge-Count mode</p> <p>1 Edge-Time mode</p> |
| 1:0 | TBMR | R/W | 0x0 | <p>GPTM Timer B Mode</p> <p>The TBMR values are defined as follows:</p> <p>Value Description</p> <p>0x0 Reserved</p> <p>0x1 One-Shot Timer mode</p> <p>0x2 Periodic Timer mode</p> <p>0x3 Capture mode</p> <p>The timer mode is based on the timer configuration defined by bits 2:0 in the GPTMCFG register.</p> |

Register 4: GPTM Control (GPTMCTL), offset 0x00C

This register is used alongside the **GPTMCFG** and **GMTMTnMR** registers to fine-tune the timer configuration, and to enable other features such as timer stall and the output trigger. The output trigger can be used to initiate transfers on the ADC module.

Important: Bits in this register should only be changed when the **TnEN** bit for the respective timer is cleared.

GPTM Control (GPTMCTL)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x00C
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|--------|-------|----------|---------|---------|------|----------|--------|-------|-------|---------|---------|------|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | TBPWML | TBOTE | reserved | TBEVENT | TBSTALL | TBEN | reserved | TAPWML | TAOTE | RTCEN | TAEVENT | TASTALL | TAEN | | |
| Type | RO | R/W | R/W | RO | R/W | R/W | R/W | R/W | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:15 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 14 | TBPWML | R/W | 0 | GPTM Timer B PWM Output Level The TBPWML values are defined as follows: Value Description 0 Output is unaffected. 1 Output is inverted. |
| 13 | TBOTE | R/W | 0 | GPTM Timer B Output Trigger Enable The TBOTE values are defined as follows: Value Description 0 The output Timer B ADC trigger is disabled. 1 The output Timer B ADC trigger is enabled. In addition, the ADC must be enabled and the timer selected as a trigger source with the EMn bit in the ADCEMUX register (see page 655). |
| 12 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|--|------|-------|---|-------|-------------|-----|---|-----|--|-----|----------|-----|------------|
| 11:10 | TBEVENT | R/W | 0x0 | <p>GPTM Timer B Event Mode</p> <p>The TBEVENT values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Positive edge</td> </tr> <tr> <td>0x1</td> <td>Negative edge</td> </tr> <tr> <td>0x2</td> <td>Reserved</td> </tr> <tr> <td>0x3</td> <td>Both edges</td> </tr> </tbody> </table> | Value | Description | 0x0 | Positive edge | 0x1 | Negative edge | 0x2 | Reserved | 0x3 | Both edges |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | Positive edge | | | | | | | | | | | | | |
| 0x1 | Negative edge | | | | | | | | | | | | | |
| 0x2 | Reserved | | | | | | | | | | | | | |
| 0x3 | Both edges | | | | | | | | | | | | | |
| 9 | TBSTALL | R/W | 0 | <p>GPTM Timer B Stall Enable</p> <p>The TBSTALL values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Timer B continues counting while the processor is halted by the debugger.</td> </tr> <tr> <td>1</td> <td>Timer B freezes counting while the processor is halted by the debugger.</td> </tr> </tbody> </table> <p>If the processor is executing normally, the TBSTALL bit is ignored.</p> | Value | Description | 0 | Timer B continues counting while the processor is halted by the debugger. | 1 | Timer B freezes counting while the processor is halted by the debugger. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | Timer B continues counting while the processor is halted by the debugger. | | | | | | | | | | | | | |
| 1 | Timer B freezes counting while the processor is halted by the debugger. | | | | | | | | | | | | | |
| 8 | TBEN | R/W | 0 | <p>GPTM Timer B Enable</p> <p>The TBEN values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Timer B is disabled.</td> </tr> <tr> <td>1</td> <td>Timer B is enabled and begins counting or the capture logic is enabled based on the GPTMCFG register.</td> </tr> </tbody> </table> | Value | Description | 0 | Timer B is disabled. | 1 | Timer B is enabled and begins counting or the capture logic is enabled based on the GPTMCFG register. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | Timer B is disabled. | | | | | | | | | | | | | |
| 1 | Timer B is enabled and begins counting or the capture logic is enabled based on the GPTMCFG register. | | | | | | | | | | | | | |
| 7 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 6 | TAPWML | R/W | 0 | <p>GPTM Timer A PWM Output Level</p> <p>The TAPWML values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Output is unaffected.</td> </tr> <tr> <td>1</td> <td>Output is inverted.</td> </tr> </tbody> </table> | Value | Description | 0 | Output is unaffected. | 1 | Output is inverted. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | Output is unaffected. | | | | | | | | | | | | | |
| 1 | Output is inverted. | | | | | | | | | | | | | |
| 5 | TAOTE | R/W | 0 | <p>GPTM Timer A Output Trigger Enable</p> <p>The TAOTE values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>The output Timer A ADC trigger is disabled.</td> </tr> <tr> <td>1</td> <td>The output Timer A ADC trigger is enabled.</td> </tr> </tbody> </table> <p>In addition, the ADC must be enabled and the timer selected as a trigger source with the EM_n bit in the ADCEMUX register (see page 655).</p> | Value | Description | 0 | The output Timer A ADC trigger is disabled. | 1 | The output Timer A ADC trigger is enabled. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | The output Timer A ADC trigger is disabled. | | | | | | | | | | | | | |
| 1 | The output Timer A ADC trigger is enabled. | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|--|------|-------|--|-------|-------------|-----|---|-----|--|-----|----------|-----|------------|
| 4 | RTCEN | R/W | 0 | <p>GPTM RTC Stall Enable</p> <p>The <code>RTCEN</code> values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>RTC counting freezes while the processor is halted by the debugger.</td> </tr> <tr> <td>1</td> <td>RTC counting continues while the processor is halted by the debugger.</td> </tr> </tbody> </table> <p>If the <code>RTCEN</code> bit is set, it prevents the timer from stalling in all operating modes, even if <code>ThSTALL</code> is set.</p> | Value | Description | 0 | RTC counting freezes while the processor is halted by the debugger. | 1 | RTC counting continues while the processor is halted by the debugger. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | RTC counting freezes while the processor is halted by the debugger. | | | | | | | | | | | | | |
| 1 | RTC counting continues while the processor is halted by the debugger. | | | | | | | | | | | | | |
| 3:2 | TAEVENT | R/W | 0x0 | <p>GPTM Timer A Event Mode</p> <p>The <code>TAEVENT</code> values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Positive edge</td> </tr> <tr> <td>0x1</td> <td>Negative edge</td> </tr> <tr> <td>0x2</td> <td>Reserved</td> </tr> <tr> <td>0x3</td> <td>Both edges</td> </tr> </tbody> </table> | Value | Description | 0x0 | Positive edge | 0x1 | Negative edge | 0x2 | Reserved | 0x3 | Both edges |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | Positive edge | | | | | | | | | | | | | |
| 0x1 | Negative edge | | | | | | | | | | | | | |
| 0x2 | Reserved | | | | | | | | | | | | | |
| 0x3 | Both edges | | | | | | | | | | | | | |
| 1 | TASTALL | R/W | 0 | <p>GPTM Timer A Stall Enable</p> <p>The <code>TASTALL</code> values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Timer A continues counting while the processor is halted by the debugger.</td> </tr> <tr> <td>1</td> <td>Timer A freezes counting while the processor is halted by the debugger.</td> </tr> </tbody> </table> <p>If the processor is executing normally, the <code>TASTALL</code> bit is ignored.</p> | Value | Description | 0 | Timer A continues counting while the processor is halted by the debugger. | 1 | Timer A freezes counting while the processor is halted by the debugger. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | Timer A continues counting while the processor is halted by the debugger. | | | | | | | | | | | | | |
| 1 | Timer A freezes counting while the processor is halted by the debugger. | | | | | | | | | | | | | |
| 0 | TAEN | R/W | 0 | <p>GPTM Timer A Enable</p> <p>The <code>TAEN</code> values are defined as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Timer A is disabled.</td> </tr> <tr> <td>1</td> <td>Timer A is enabled and begins counting or the capture logic is enabled based on the <code>GPTMCFG</code> register.</td> </tr> </tbody> </table> | Value | Description | 0 | Timer A is disabled. | 1 | Timer A is enabled and begins counting or the capture logic is enabled based on the <code>GPTMCFG</code> register. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | Timer A is disabled. | | | | | | | | | | | | | |
| 1 | Timer A is enabled and begins counting or the capture logic is enabled based on the <code>GPTMCFG</code> register. | | | | | | | | | | | | | |

Register 5: GPTM Interrupt Mask (GPTMIMR), offset 0x018

This register allows software to enable/disable GPTM controller-level interrupts. Setting a bit enables the corresponding interrupt, while clearing a bit disables it.

GPTM Interrupt Mask (GPTMIMR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x018
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|-------|-------|-------|--------|----------|----|----|-----|-------|-------|-------|-------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | TBMIM | CBEIM | CBMIM | TBTOIM | reserved | | | | TAMIM | RTCIM | CAEIM | CAMIM | TATOIM |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | R/W | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|------------------------|------|----------|--|-------|-------------|---|------------------------|---|-----------------------|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 11 | TBMIM | R/W | 0 | GPTM Timer B Match Interrupt Mask The TBMIM values are defined as follows: <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Interrupt is disabled.</td> </tr> <tr> <td>1</td> <td>Interrupt is enabled.</td> </tr> </table> | Value | Description | 0 | Interrupt is disabled. | 1 | Interrupt is enabled. |
| Value | Description | | | | | | | | | |
| 0 | Interrupt is disabled. | | | | | | | | | |
| 1 | Interrupt is enabled. | | | | | | | | | |
| 10 | CBEIM | R/W | 0 | GPTM Timer B Capture Mode Event Interrupt Mask The CBEIM values are defined as follows: <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Interrupt is disabled.</td> </tr> <tr> <td>1</td> <td>Interrupt is enabled.</td> </tr> </table> | Value | Description | 0 | Interrupt is disabled. | 1 | Interrupt is enabled. |
| Value | Description | | | | | | | | | |
| 0 | Interrupt is disabled. | | | | | | | | | |
| 1 | Interrupt is enabled. | | | | | | | | | |
| 9 | CBMIM | R/W | 0 | GPTM Timer B Capture Mode Match Interrupt Mask The CBMIM values are defined as follows: <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Interrupt is disabled.</td> </tr> <tr> <td>1</td> <td>Interrupt is enabled.</td> </tr> </table> | Value | Description | 0 | Interrupt is disabled. | 1 | Interrupt is enabled. |
| Value | Description | | | | | | | | | |
| 0 | Interrupt is disabled. | | | | | | | | | |
| 1 | Interrupt is enabled. | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 8 | TBTOIM | R/W | 0 | GPTM Timer B Time-Out Interrupt Mask The TBTOIM values are defined as follows: Value Description 0 Interrupt is disabled. 1 Interrupt is enabled. |
| 7:5 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | TAMIM | R/W | 0 | GPTM Timer A Match Interrupt Mask The TAMIM values are defined as follows: Value Description 0 Interrupt is disabled. 1 Interrupt is enabled. |
| 3 | RTCIM | R/W | 0 | GPTM RTC Interrupt Mask The RTCIM values are defined as follows: Value Description 0 Interrupt is disabled. 1 Interrupt is enabled. |
| 2 | CAEIM | R/W | 0 | GPTM Timer A Capture Mode Event Interrupt Mask The CAEIM values are defined as follows: Value Description 0 Interrupt is disabled. 1 Interrupt is enabled. |
| 1 | CAMIM | R/W | 0 | GPTM Timer A Capture Mode Match Interrupt Mask The CAMIM values are defined as follows: Value Description 0 Interrupt is disabled. 1 Interrupt is enabled. |
| 0 | TATOIM | R/W | 0 | GPTM Timer A Time-Out Interrupt Mask The TATOIM values are defined as follows: Value Description 0 Interrupt is disabled. 1 Interrupt is enabled. |

Register 6: GPTM Raw Interrupt Status (GPTMRIS), offset 0x01C

This register shows the state of the GPTM's internal interrupt signal. These bits are set whether or not the interrupt is masked in the **GPTMIMR** register. Each bit can be cleared by writing a 1 to its corresponding bit in **GPTMICR**.

GPTM Raw Interrupt Status (GPTMRIS)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x01C
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|--------|--------|--------|---------|----------|----|----|----|--------|--------|--------|--------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | TBMRIS | CBERIS | CBMRIS | TBTORIS | reserved | | | | TAMRIS | RTCRIS | CAERIS | CAMRIS | TATORIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|--|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 11 | TBMRIS | RO | 0 | GPTM Timer B Match Raw Interrupt Value Description 1 The TBMIE bit is set in the GPTMTBMR register, and the match values in the GPTMTBMATCHR and (optionally) GPTMTBPMR registers have been reached when configured in one-shot or periodic mode. 0 The match value has not been reached. This bit is cleared by writing a 1 to the TBMCINT bit in the GPTMICR register. |
| 10 | CBERIS | RO | 0 | GPTM Timer B Capture Mode Event Raw Interrupt Value Description 1 A capture mode event has occurred for Timer B. This interrupt asserts when the subtimer is configured in Input Edge-Time mode. 0 The capture mode event for Timer B has not occurred. This bit is cleared by writing a 1 to the CBECINT bit in the GPTMICR register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 9 | CBMRIS | RO | 0 | <p>GPTM Timer B Capture Mode Match Raw Interrupt</p> <p>Value Description</p> <p>1 The capture mode match has occurred for Timer B. This interrupt asserts when the values in the GPTMTBR and GPTMTBPR match the values in the GPTMTBMATCHR and GPTMTBPMR when configured in Input Edge-Time mode.</p> <p>0 The capture mode match for Timer B has not occurred.</p> <p>This bit is cleared by writing a 1 to the CBMCINT bit in the GPTMICR register.</p> |
| 8 | TBTORIS | RO | 0 | <p>GPTM Timer B Time-Out Raw Interrupt</p> <p>Value Description</p> <p>1 Timer B has timed out. This interrupt is asserted when a one-shot or periodic mode timer reaches its count limit (0 or the value loaded into GPTMTBILR, depending on the count direction).</p> <p>0 Timer B has not timed out.</p> <p>This bit is cleared by writing a 1 to the TBTOCINT bit in the GPTMICR register.</p> |
| 7:5 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 4 | TAMRIS | RO | 0 | <p>GPTM Timer A Match Raw Interrupt</p> <p>Value Description</p> <p>1 The TAMIE bit is set in the GPTMTAMR register, and the match value in the GPTMTAMATCHR and (optionally) GPTMTAPMR registers have been reached when configured in one-shot or periodic mode.</p> <p>0 The match value has not been reached.</p> <p>This bit is cleared by writing a 1 to the TAMCINT bit in the GPTMICR register.</p> |
| 3 | RTCRIIS | RO | 0 | <p>GPTM RTC Raw Interrupt</p> <p>Value Description</p> <p>1 The RTC event has occurred.</p> <p>0 The RTC event has not occurred.</p> <p>This bit is cleared by writing a 1 to the RTCCINT bit in the GPTMICR register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 2 | CAERIS | RO | 0 | <p>GPTM Timer A Capture Mode Event Raw Interrupt</p> <p>Value Description</p> <p>1 A capture mode event has occurred for Timer A. This interrupt asserts when the subtimer is configured in Input Edge-Time mode.</p> <p>0 The capture mode event for Timer A has not occurred.</p> <p>This bit is cleared by writing a 1 to the CAECINT bit in the GPTMICR register.</p> |
| 1 | CAMRIS | RO | 0 | <p>GPTM Timer A Capture Mode Match Raw Interrupt</p> <p>Value Description</p> <p>1 A capture mode match has occurred for Timer A. This interrupt asserts when the values in the GPTMTAR and GPTMTAPR match the values in the GPTMTAMATCHR and GPTMTAPMR when configured in Input Edge-Time mode.</p> <p>0 The capture mode match for Timer A has not occurred.</p> <p>This bit is cleared by writing a 1 to the CAMCINT bit in the GPTMICR register.</p> |
| 0 | TATORIS | RO | 0 | <p>GPTM Timer A Time-Out Raw Interrupt</p> <p>Value Description</p> <p>1 Timer A has timed out. This interrupt is asserted when a one-shot or periodic mode timer reaches its count limit (0 or the value loaded into GPTMTAILR, depending on the count direction).</p> <p>0 Timer A has not timed out.</p> <p>This bit is cleared by writing a 1 to the TATOCINT bit in the GPTMICR register.</p> |

Register 7: GPTM Masked Interrupt Status (GPTMMIS), offset 0x020

This register show the state of the GPTM's controller-level interrupt. If an interrupt is unmasked in **GPTMIMR**, and there is an event that causes the interrupt to be asserted, the corresponding bit is set in this register. All bits are cleared by writing a 1 to the corresponding bit in **GPTMICR**.

GPTM Masked Interrupt Status (GPTMMIS)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x020
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|--------|--------|--------|---------|----------|----|----|----|--------|--------|--------|--------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | TBMMIS | CBEMIS | CBMMIS | TBTOMIS | reserved | | | | TAMMIS | RTCMIS | CAEMIS | CAMMIS | TATOMIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|--|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 11 | TBMMIS | RO | 0 | GPTM Timer B Match Masked Interrupt Value Description 1 An unmasked Timer B Mode Match interrupt has occurred. 0 A Timer B Mode Match interrupt has not occurred or is masked. This bit is cleared by writing a 1 to the TBMCINT bit in the GPTMICR register. |
| 10 | CBEMIS | RO | 0 | GPTM Timer B Capture Mode Event Masked Interrupt Value Description 1 An unmasked Capture B event interrupt has occurred. 0 A Capture B event interrupt has not occurred or is masked. This bit is cleared by writing a 1 to the CBECINT bit in the GPTMICR register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 9 | CBMMIS | RO | 0 | <p>GPTM Timer B Capture Mode Match Masked Interrupt</p> <p>Value Description</p> <p>1 An unmasked Capture B Match interrupt has occurred.</p> <p>0 A Capture B Mode Match interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the CBMCINT bit in the GPTMICR register.</p> |
| 8 | TBTOMIS | RO | 0 | <p>GPTM Timer B Time-Out Masked Interrupt</p> <p>Value Description</p> <p>1 An unmasked Timer B Time-Out interrupt has occurred.</p> <p>0 A Timer B Time-Out interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the TBTOCINT bit in the GPTMICR register.</p> |
| 7:5 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | TAMMIS | RO | 0 | <p>GPTM Timer A Match Masked Interrupt</p> <p>Value Description</p> <p>1 An unmasked Timer A Mode Match interrupt has occurred.</p> <p>0 A Timer A Mode Match interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the TAMCINT bit in the GPTMICR register.</p> |
| 3 | RTCMIS | RO | 0 | <p>GPTM RTC Masked Interrupt</p> <p>Value Description</p> <p>1 An unmasked RTC event interrupt has occurred.</p> <p>0 An RTC event interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the RTCCINT bit in the GPTMICR register.</p> |
| 2 | CAEMIS | RO | 0 | <p>GPTM Timer A Capture Mode Event Masked Interrupt</p> <p>Value Description</p> <p>1 An unmasked Capture A event interrupt has occurred.</p> <p>0 A Capture A event interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the CAECINT bit in the GPTMICR register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 1 | CAMMIS | RO | 0 | <p>GPTM Timer A Capture Mode Match Masked Interrupt</p> <p>Value Description</p> <p>1 An unmasked Capture A Match interrupt has occurred.</p> <p>0 A Capture A Mode Match interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the CAMCINT bit in the GPTMICR register.</p> |
| 0 | TATOMIS | RO | 0 | <p>GPTM Timer A Time-Out Masked Interrupt</p> <p>Value Description</p> <p>1 An unmasked Timer A Time-Out interrupt has occurred.</p> <p>0 A Timer A Time-Out interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the TATOCINT bit in the GPTMICR register.</p> |

Register 8: GPTM Interrupt Clear (GPTMICR), offset 0x024

This register is used to clear the status bits in the **GPTMRIS** and **GPTMMIS** registers. Writing a 1 to a bit clears the corresponding bit in the **GPTMRIS** and **GPTMMIS** registers.

GPTM Interrupt Clear (GPTMICR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x024
 Type W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|---------|---------|---------|----------|----------|----|----|---------|---------|---------|---------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | TBMCINT | CBECINT | CBMCINT | TBTOCINT | reserved | | | TAMCINT | RTCCINT | CAECINT | CAMCINT | TATOCINT |
| Type | RO | RO | RO | RO | W1C | W1C | W1C | W1C | RO | RO | RO | W1C | W1C | W1C | W1C | W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|--|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 11 | TBMCINT | W1C | 0 | GPTM Timer B Match Interrupt Clear Writing a 1 to this bit clears the TBMRIS bit in the GPTMRIS register and the TBMMIS bit in the GPTMMIS register. |
| 10 | CBECINT | W1C | 0 | GPTM Timer B Capture Mode Event Interrupt Clear Writing a 1 to this bit clears the CBERIS bit in the GPTMRIS register and the CBEMIS bit in the GPTMMIS register. |
| 9 | CBMCINT | W1C | 0 | GPTM Timer B Capture Mode Match Interrupt Clear Writing a 1 to this bit clears the CBMRIS bit in the GPTMRIS register and the CBMMIS bit in the GPTMMIS register. |
| 8 | TBTOCINT | W1C | 0 | GPTM Timer B Time-Out Interrupt Clear Writing a 1 to this bit clears the TBTORIS bit in the GPTMRIS register and the TBTOMIS bit in the GPTMMIS register. |
| 7:5 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | TAMCINT | W1C | 0 | GPTM Timer A Match Interrupt Clear Writing a 1 to this bit clears the TAMRIS bit in the GPTMRIS register and the TAMMIS bit in the GPTMMIS register. |
| 3 | RTCCINT | W1C | 0 | GPTM RTC Interrupt Clear Writing a 1 to this bit clears the RTCRIIS bit in the GPTMRIS register and the RTCMIS bit in the GPTMMIS register. |
| 2 | CAECINT | W1C | 0 | GPTM Timer A Capture Mode Event Interrupt Clear Writing a 1 to this bit clears the CAERIS bit in the GPTMRIS register and the CAEMIS bit in the GPTMMIS register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 1 | CAMCINT | W1C | 0 | GPTM Timer A Capture Mode Match Interrupt Clear Writing a 1 to this bit clears the CAMRIS bit in the GPTMRIS register and the CAMMIS bit in the GPTMMIS register. |
| 0 | TATOCINT | W1C | 0 | GPTM Timer A Time-Out Raw Interrupt Writing a 1 to this bit clears the TATORIS bit in the GPTMRIS register and the TATOMIS bit in the GPTMMIS register. |

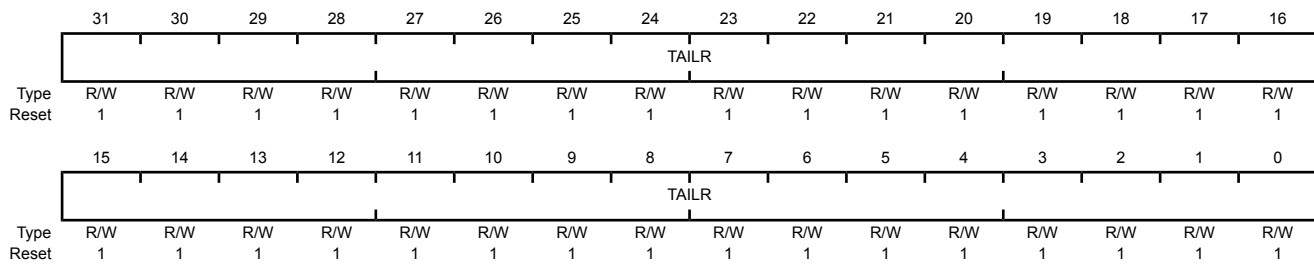
Register 9: GPTM Timer A Interval Load (GPTMTAILR), offset 0x028

When the timer is counting down, this register is used to load the starting count value into the timer. When the timer is counting up, this register sets the upper bound for the timeout event.

When a GPTM is configured to one of the 32-bit modes, **GPTMTAILR** appears as a 32-bit register (the upper 16-bits correspond to the contents of the **GPTM Timer B Interval Load (GPTMTBILR)** register). In a 16-bit mode, the upper 16 bits of this register read as 0s and have no effect on the state of **GPTMTBILR**.

GPTM Timer A Interval Load (GPTMTAILR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x028
 Type R/W, reset 0xFFFF.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------------|---|
| 31:0 | TAILR | R/W | 0xFFFF.FFFF | GPTM Timer A Interval Load Register Writing this field loads the counter for Timer A. A read returns the current value of GPTMTAILR . |

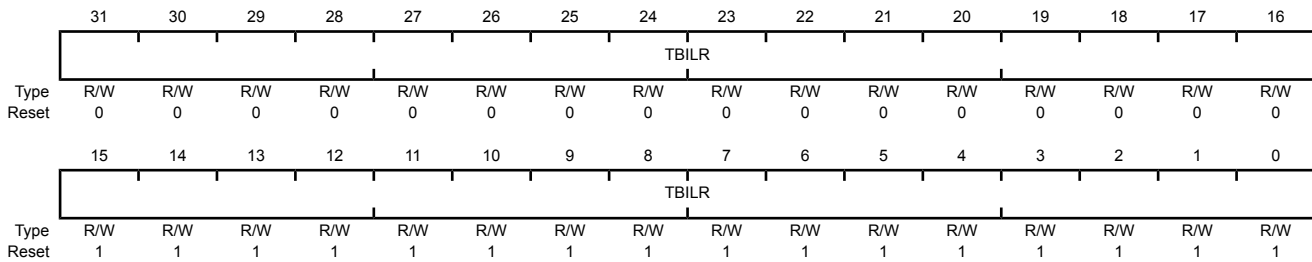
Register 10: GPTM Timer B Interval Load (GPTMTBILR), offset 0x02C

When the timer is counting down, this register is used to load the starting count value into the timer. When the timer is counting up, this register sets the upper bound for the timeout event.

When a GPTM is configured to one of the 32-bit modes, the contents of bits 15:0 in this register are loaded into the upper 16 bits of the **GPTMTAILR** register. Reads from this register return the current value of Timer B and writes are ignored. In a 16-bit mode, bits 15:0 are used for the load value. Bits 31:16 are reserved in both cases.

GPTM Timer B Interval Load (GPTMTBILR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x02C
 Type R/W, reset 0x0000.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------------|--|
| 31:0 | TBILR | R/W | 0x0000.FFFF | GPTM Timer B Interval Load Register Writing this field loads the counter for Timer B. A read returns the current value of GPTMTBILR . When a GPTM is in 32-bit mode, writes are ignored, and reads return the current value of GPTMTBILR . |

Register 11: GPTM Timer A Match (GPTMTAMATCHR), offset 0x030

This register is loaded with a match value. Interrupts can be generated when the timer value is equal to the value in this register in one-shot or periodic mode.

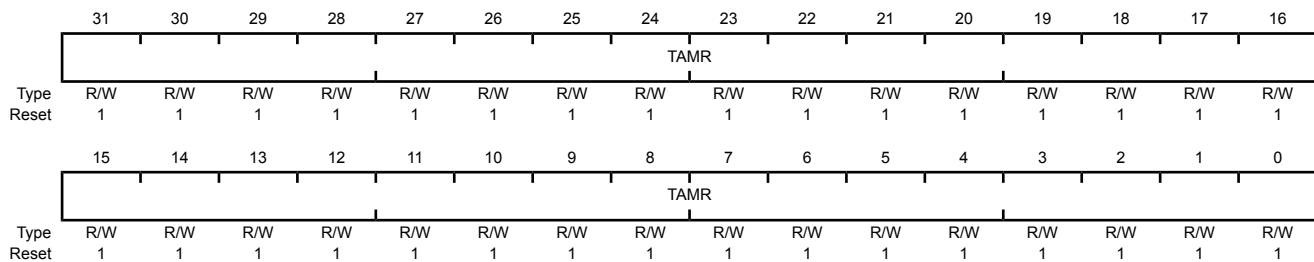
In Edge-Count mode, this register along with **GPTMTAILR**, determines how many edge events are counted. The total number of edge events counted is equal to the value in **GPTMTAILR** minus this value.

In PWM mode, this value along with **GPTMTAILR**, determines the duty cycle of the output PWM signal.

When a GPTM is configured to one of the 32-bit modes, **GPTMTAMATCHR** appears as a 32-bit register (the upper 16-bits correspond to the contents of the **GPTM Timer B Match (GPTMTBMATCHR)** register). In a 16-bit mode, the upper 16 bits of this register read as 0s and have no effect on the state of **GPTMTBMATCHR**.

GPTM Timer A Match (GPTMTAMATCHR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x030
 Type R/W, reset 0xFFFF.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|---|
| 31:0 | TAMR | R/W | 0xFFFF.FFFF | GPTM Timer A Match Register This value is compared to the GPTMTAR register to determine match events. |

Register 12: GPTM Timer B Match (GPTMTBMATCHR), offset 0x034

This register is loaded with a match value. Interrupts can be generated when the timer value is equal to the value in this register in one-shot or periodic mode.

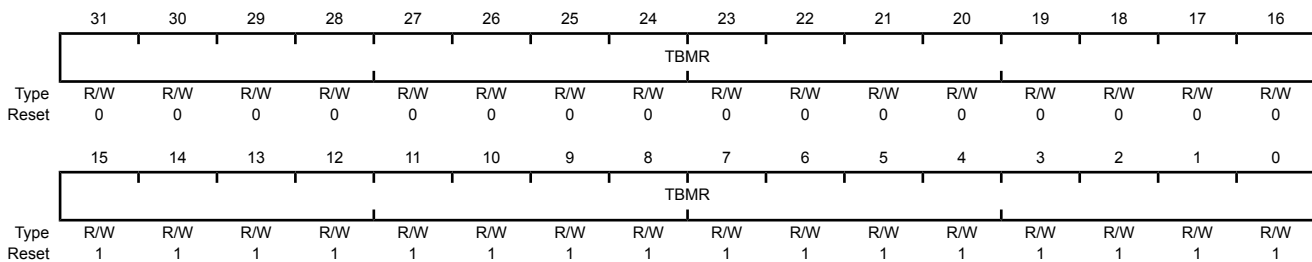
In Edge-Count mode, this register along with **GPTMTBILR**, determines how many edge events are counted. The total number of edge events counted is equal to the value in **GPTMTBILR** minus this value.

In PWM mode, this value along with **GPTMTBILR**, determines the duty cycle of the output PWM signal.

When a GPTM is configured to one of the 32-bit modes, the contents of bits 15:0 in this register are loaded into the upper 16 bits of the **GPTMTAMATCHR** register. Reads from this register return the current match value of Timer B and writes are ignored. In a 16-bit mode, bits 15:0 are used for the match value. Bits 31:16 are reserved in both cases.

GPTM Timer B Match (GPTMTBMATCHR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x034
 Type R/W, reset 0x0000.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|---|
| 31:0 | TBMR | R/W | 0x0000.FFFF | GPTM Timer B Match Register This value is compared to the GPTMTBR register to determine match events. |

Register 13: GPTM Timer A Prescale (GPTMTAPR), offset 0x038

This register allows software to extend the range of the 16-bit timers in periodic and one-shot modes. In Edge-Count mode, this register is the MSB of the 24-bit count value.

GPTM Timer A Prescale (GPTMTAPR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x038
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | TAPSR | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

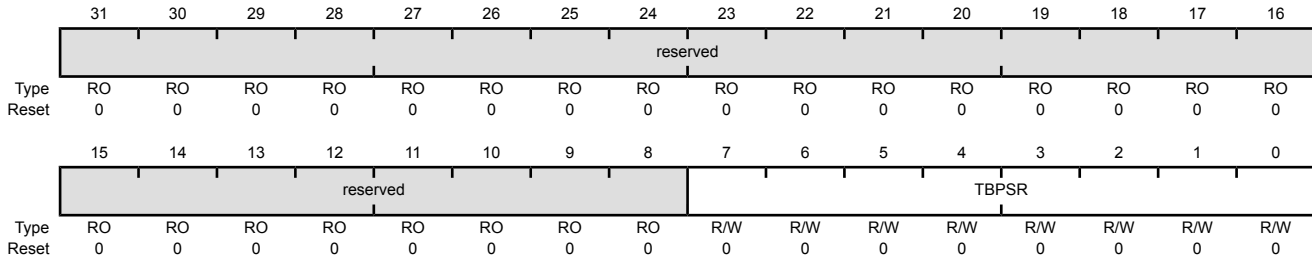
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:8 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | TAPSR | R/W | 0x00 | GPTM Timer A Prescale The register loads this value on a write. A read returns the current value of the register. Refer to Table 11-6 on page 556 for more details and an example. |

Register 14: GPTM Timer B Prescale (GPTMTBPR), offset 0x03C

This register allows software to extend the range of the 16-bit timers in periodic and one-shot modes. In Edge-Count mode, this register is the MSB of the 24-bit count value.

GPTM Timer B Prescale (GPTMTBPR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x03C
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:8 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | TBPSR | R/W | 0x00 | GPTM Timer B Prescale The register loads this value on a write. A read returns the current value of this register. Refer to Table 11-6 on page 556 for more details and an example. |

Register 15: GPTM TimerA Prescale Match (GPTMTAPMR), offset 0x040

This register effectively extends the range of **GPTMTAMATCHR** to 24 bits when operating in 16-bit one-shot or periodic mode.

GPTM TimerA Prescale Match (GPTMTAPMR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x040
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|--------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | TAPSMR | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

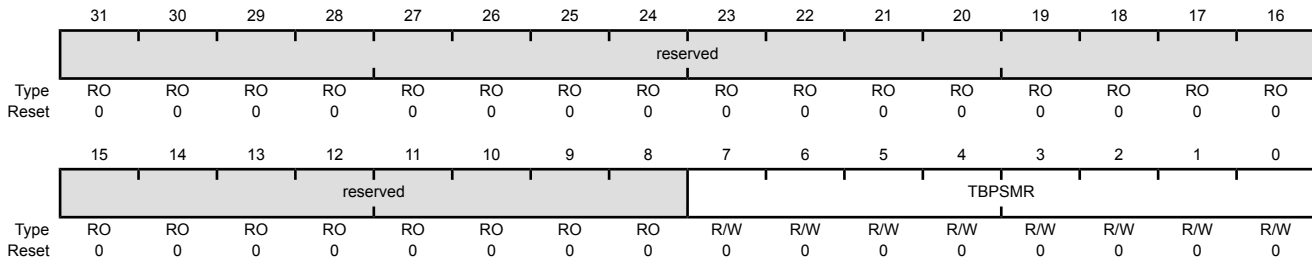
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:8 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | TAPSMR | R/W | 0x00 | GPTM TimerA Prescale Match This value is used alongside GPTMTAMATCHR to detect timer match events while using a prescaler. |

Register 16: GPTM TimerB Prescale Match (GPTMTBPMR), offset 0x044

This register effectively extends the range of **GPTMTBMATCHR** to 24 bits when operating in 16-bit one-shot or periodic mode.

GPTM TimerB Prescale Match (GPTMTBPMR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x044
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:8 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | TBPSMR | R/W | 0x00 | GPTM TimerB Prescale Match This value is used alongside GPTMTBMATCHR to detect timer match events while using a prescaler. |

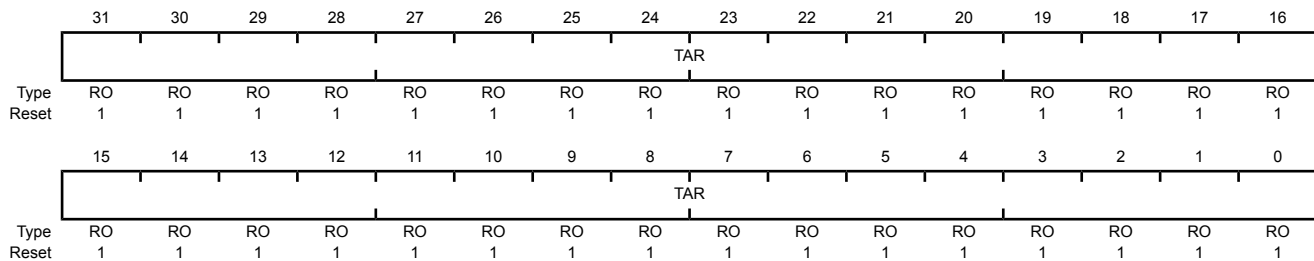
Register 17: GPTM Timer A (GPTMTAR), offset 0x048

This register shows the current value of the Timer A counter in all cases except for Input Edge Count and Time modes. In the Input Edge Count mode, this register contains the number of edges that have occurred. In the Input Edge Time mode, this register contains the time at which the last edge event took place. Also in Input Edge-Count mode, bits 23:16 contain the upper 8 bits of the count.

When a GPTM is configured to one of the 32-bit modes, **GPTMTAR** appears as a 32-bit register (the upper 16-bits correspond to the contents of the **GPTM Timer B (GPTMTBR)** register). In the 16-bit Input Edge Count, Input Edge Time, and PWM modes, bits 15:0 contain the value of the counter and bits 23:16 contain the value of the prescaler, which is the upper 8 bits of the count. Bits 31:24 always read as 0. To read the value of the prescaler in 16-bit One-Shot and Periodic modes, read bits [23:16] in the **GPTMTAV** register.

GPTM Timer A (GPTMTAR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x048
 Type RO, reset 0xFFFF.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|-----------------------|
| 31:0 | TAR | RO | 0xFFFF.FFFF | GPTM Timer A Register |

A read returns the current value of the **GPTM Timer A Count Register**, in all cases except for Input Edge Count and Time modes. In the Input Edge Count mode, this register contains the number of edges that have occurred. In the Input Edge Time mode, this register contains the time at which the last edge event took place.

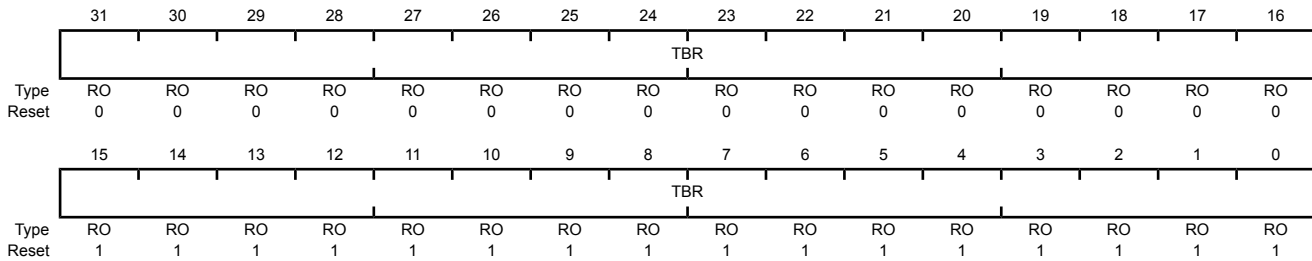
Register 18: GPTM Timer B (GPTMTBR), offset 0x04C

This register shows the current value of the Timer B counter in all cases except for Input Edge Count and Time modes. In the Input Edge Count mode, this register contains the number of edges that have occurred. In the Input Edge Time mode, this register contains the time at which the last edge event took place. Also in Input Edge-Count mode, bits 23:16 contain the upper 8 bits of the count.

When a GPTM is configured to one of the 32-bit modes, the contents of bits 15:0 in this register are loaded into the upper 16 bits of the **GPTMTAR** register. Reads from this register return the current value of Timer B. In a 16-bit mode, bits 15:0 contain the value of the counter and bits 23:16 contain the value of the prescaler in Input Edge Count, Input Edge Time, and PWM modes, which is the upper 8 bits of the count. Bits 31:24 always read as 0. To read the value of the prescaler in 16-bit One-Shot and Periodic modes, read bits [23:16] in the **GPTMTBV** register.

GPTM Timer B (GPTMTBR)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x04C
 Type RO, reset 0x0000.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|-----------------------|
| 31:0 | TBR | RO | 0x0000.FFFF | GPTM Timer B Register |

A read returns the current value of the **GPTM Timer B Count Register**, in all cases except for Input Edge Count and Time modes. In the Input Edge Count mode, this register contains the number of edges that have occurred. In the Input Edge Time mode, this register contains the time at which the last edge event took place.

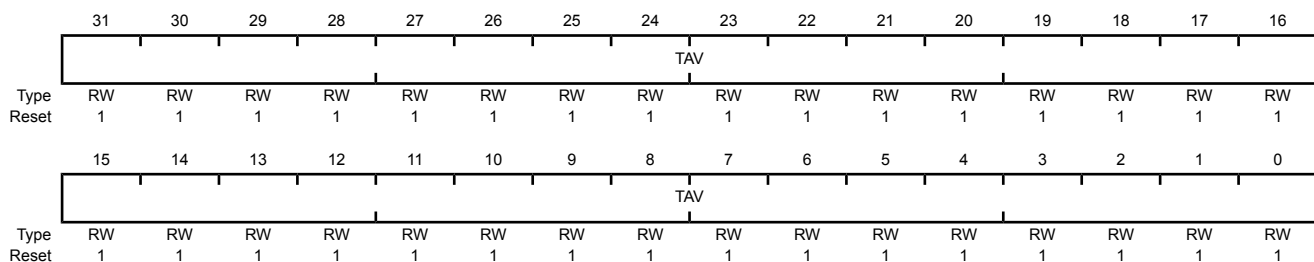
Register 19: GPTM Timer A Value (GPTMTAV), offset 0x050

When read, this register shows the current, free-running value of Timer A in all modes. Software can use this value to determine the time elapsed between an interrupt and the ISR entry when using the snapshot feature with the periodic operating mode. When written, the value written into this register is loaded into the **GPTMTAR** register on the next clock cycle. In Input Edge-Count mode, bits 23:16 contain the upper 8 bits of the count.

When a GPTM is configured to one of the 32-bit modes, **GPTMTAV** appears as a 32-bit register (the upper 16-bits correspond to the contents of the **GPTM Timer B Value (GPTMTBV)** register). In a 16-bit mode, bits 15:0 contain the value of the counter and bits 23:16 contain the current, free-running value of the prescaler, which is the upper 8 bits of the count in Input Edge Count, Input Edge Time, PWM and one-shot or periodic up count modes. In one-shot or periodic down count modes, the prescaler stored in 23:16 is a true prescaler, meaning bits 23:16 count down before decrementing the value in bits 15:0. The prescaler in bits 31:24 always reads as 0.

GPTM Timer A Value (GPTMTAV)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x050
 Type RW, reset 0xFFFF.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|--------------------|
| 31:0 | TAV | RW | 0xFFFF.FFFF | GPTM Timer A Value |

A read returns the current, free-running value of Timer A in all modes. When written, the value written into this register is loaded into the **GPTMTAR** register on the next clock cycle.

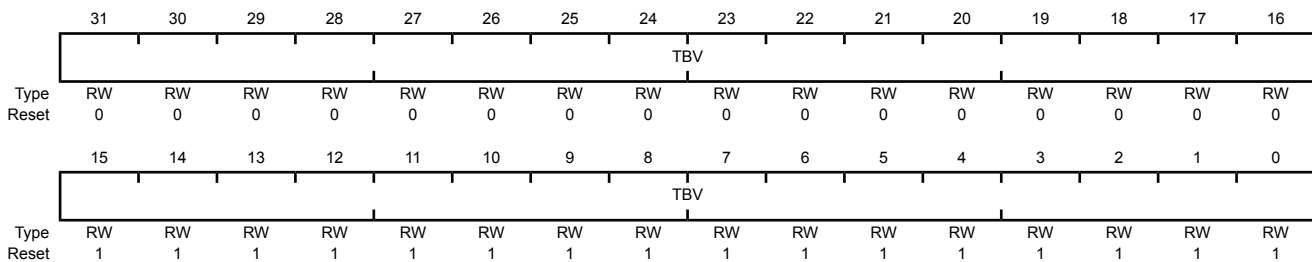
Register 20: GPTM Timer B Value (GPTMTBV), offset 0x054

When read, this register shows the current, free-running value of Timer B in all modes. Software can use this value to determine the time elapsed between an interrupt and the ISR entry. When written, the value written into this register is loaded into the **GPTMTBR** register on the next clock cycle. In Input Edge-Count mode, bits 23:16 contain the upper 8 bits of the count.

When a GPTM is configured to one of the 32-bit modes, the contents of bits 15:0 in this register are loaded into the upper 16 bits of the **GPTMTAV** register. Reads from this register return the current free-running value of Timer B. In a 16-bit mode, bits 15:0 contain the value of the counter and bits 23:16 contain the current, free-running value of the prescaler, which is the upper 8 bits of the count in Input Edge Count, Input Edge Time, PWM and one-shot or periodic up count modes. In one-shot or periodic down count modes, the prescaler stored in 23:16 is a true prescaler, meaning bits 23:16 count down before decrementing the value in bits 15:0. The prescaler in bits 31:24 always reads as 0.

GPTM Timer B Value (GPTMTBV)

Timer 0 base: 0x4003.0000
 Timer 1 base: 0x4003.1000
 Timer 2 base: 0x4003.2000
 Timer 3 base: 0x4003.3000
 Offset 0x054
 Type RW, reset 0x0000.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|--|
| 31:0 | TBV | RW | 0x0000.FFFF | GPTM Timer B Value A read returns the current, free-running value of Timer A in all modes. When written, the value written into this register is loaded into the GPTMTAR register on the next clock cycle. |

12 Watchdog Timers

A watchdog timer can generate an interrupt or a reset when a time-out value is reached. The watchdog timer is used to regain control when a system has failed due to a software error or due to the failure of an external device to respond in the expected way. The LM3S2U93 microcontroller has two Watchdog Timer Modules, one module is clocked by the system clock (Watchdog Timer 0) and the other is clocked by the PIOSC (Watchdog Timer 1). The two modules are identical except that WDT1 is in a different clock domain, and therefore requires synchronizers. As a result, WDT1 has a bit defined in the **Watchdog Timer Control (WDTCTL)** register to indicate when a write to a WDT1 register is complete. Software can use this bit to ensure that the previous access has completed before starting the next access.

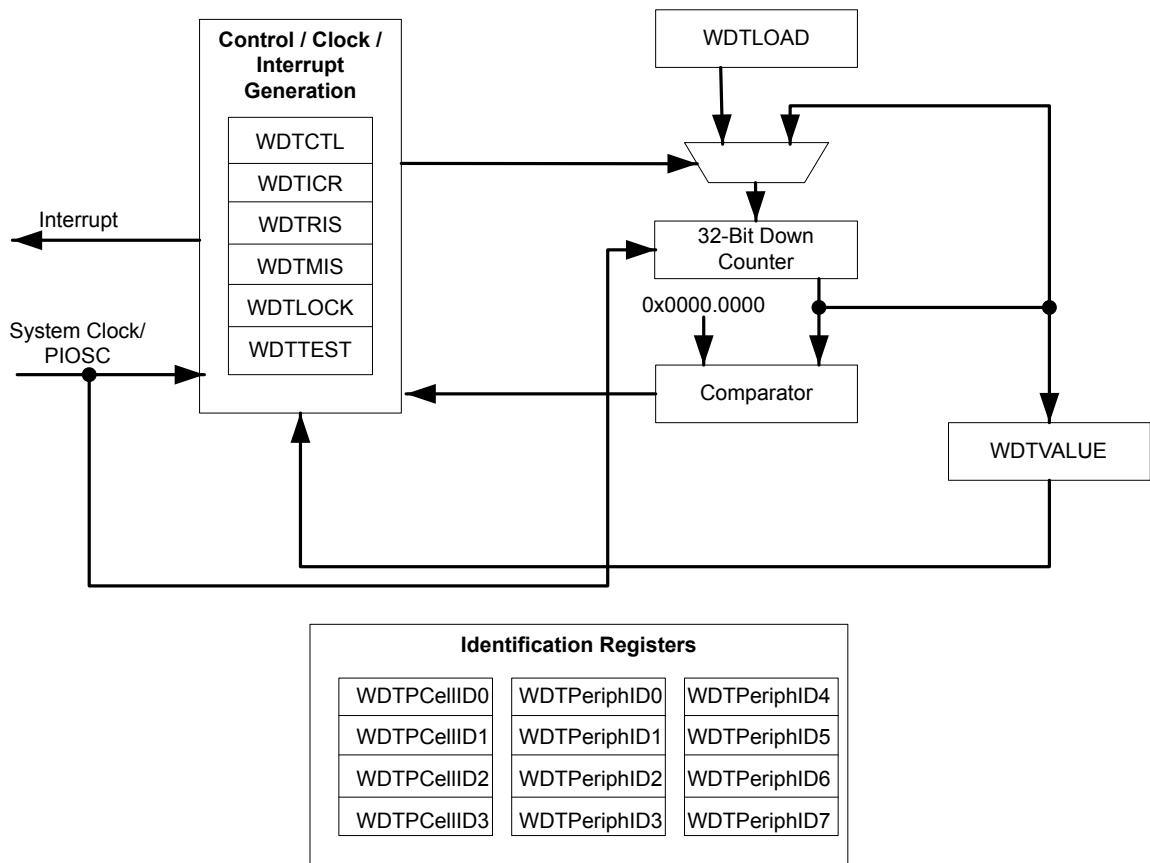
The Stellaris® LM3S2U93 controller has two Watchdog Timer modules with the following features:

- 32-bit down counter with a programmable load register
- Separate watchdog clock with an enable
- Programmable interrupt generation logic with interrupt masking
- Lock register protection from runaway software
- Reset generation logic with an enable/disable
- User-enabled stalling when the microcontroller asserts the CPU Halt flag during debug

The Watchdog Timer can be configured to generate an interrupt to the controller on its first time-out, and to generate a reset signal on its second time-out. Once the Watchdog Timer has been configured, the lock register can be written to prevent the timer configuration from being inadvertently altered.

12.1 Block Diagram

Figure 12-1. WDT Module Block Diagram



12.2 Functional Description

The Watchdog Timer module generates the first time-out signal when the 32-bit counter reaches the zero state after being enabled; enabling the counter also enables the watchdog timer interrupt. After the first time-out event, the 32-bit counter is re-loaded with the value of the **Watchdog Timer Load (WDTLOAD)** register, and the timer resumes counting down from that value. Once the Watchdog Timer has been configured, the **Watchdog Timer Lock (WDTLOCK)** register is written, which prevents the timer configuration from being inadvertently altered by software.

If the timer counts down to its zero state again before the first time-out interrupt is cleared, and the reset signal has been enabled by setting the `RESEN` bit in the **WDTCTL** register, the Watchdog timer asserts its reset signal to the system. If the interrupt is cleared before the 32-bit counter reaches its second time-out, the 32-bit counter is loaded with the value in the **WDTLOAD** register, and counting resumes from that value.

If **WDTLOAD** is written with a new value while the Watchdog Timer counter is counting, then the counter is loaded with the new value and continues counting.

Writing to **WDTLOAD** does not clear an active interrupt. An interrupt must be specifically cleared by writing to the **Watchdog Interrupt Clear (WDTICR)** register.

The Watchdog module interrupt and reset generation can be enabled or disabled as required. When the interrupt is re-enabled, the 32-bit counter is preloaded with the load register value and not its last state.

12.2.1 Register Access Timing

Because the Watchdog Timer 1 module has an independent clocking domain, its registers must be written with a timing gap between accesses. Software must guarantee that this delay is inserted between back-to-back writes to WDT1 registers or between a write followed by a read to the registers. The timing for back-to-back reads from the WDT1 module has no restrictions. The **WRC** bit in the **Watchdog Control (WDTCTL)** register for WDT1 indicates that the required timing gap has elapsed. This bit is cleared on a write operation and set once the write completes, indicating to software that another write or read may be started safely. Software should poll **WDTCTL** for **WRC=1** prior to accessing another register. Note that WDT0 does not have this restriction as it runs off the system clock.

12.3 Initialization and Configuration

To use the WDT, its peripheral clock must be enabled by setting the **WDT** bit in the **RCGC0** register, see page 254.

The Watchdog Timer is configured using the following sequence:

1. Load the **WDTLOAD** register with the desired timer load value.
2. If WDT1, wait for the **WRC** bit in the **WDTCTL** register to be set.
3. If the Watchdog is configured to trigger system resets, set the **RESEN** bit in the **WDTCTL** register.
4. If WDT1, wait for the **WRC** bit in the **WDTCTL** register to be set.
5. Set the **INTEN** bit in the **WDTCTL** register to enable the Watchdog and lock the control register.

If software requires that all of the watchdog registers are locked, the Watchdog Timer module can be fully locked by writing any value to the **WDTLOCK** register. To unlock the Watchdog Timer, write a value of 0x1ACC.E551.

12.4 Register Map

Table 12-1 on page 600 lists the Watchdog registers. The offset listed is a hexadecimal increment to the register's address, relative to the Watchdog Timer base address:

- WDT0: 0x4000.0000
- WDT1: 0x4000.1000

Note that the Watchdog Timer module clock must be enabled before the registers can be programmed (see page 254).

Table 12-1. Watchdog Timers Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|-----------------|------|--|--------------------------------------|----------|
| 0x000 | WDTLOAD | R/W | 0xFFFF.FFFF | Watchdog Load | 601 |
| 0x004 | WDTVALUE | RO | 0xFFFF.FFFF | Watchdog Value | 602 |
| 0x008 | WDTCTL | R/W | 0x0000.0000 (WDT0) 0x8000.0000 (WDT1) | Watchdog Control | 603 |
| 0x00C | WDTICR | WO | - | Watchdog Interrupt Clear | 605 |
| 0x010 | WDTRIS | RO | 0x0000.0000 | Watchdog Raw Interrupt Status | 606 |
| 0x014 | WDTMIS | RO | 0x0000.0000 | Watchdog Masked Interrupt Status | 607 |
| 0x418 | WDTTEST | R/W | 0x0000.0000 | Watchdog Test | 608 |
| 0xC00 | WDTLOCK | R/W | 0x0000.0000 | Watchdog Lock | 609 |
| 0xFD0 | WDTPeriphID4 | RO | 0x0000.0000 | Watchdog Peripheral Identification 4 | 610 |
| 0xFD4 | WDTPeriphID5 | RO | 0x0000.0000 | Watchdog Peripheral Identification 5 | 611 |
| 0xFD8 | WDTPeriphID6 | RO | 0x0000.0000 | Watchdog Peripheral Identification 6 | 612 |
| 0xFDC | WDTPeriphID7 | RO | 0x0000.0000 | Watchdog Peripheral Identification 7 | 613 |
| 0xFE0 | WDTPeriphID0 | RO | 0x0000.0005 | Watchdog Peripheral Identification 0 | 614 |
| 0xFE4 | WDTPeriphID1 | RO | 0x0000.0018 | Watchdog Peripheral Identification 1 | 615 |
| 0xFE8 | WDTPeriphID2 | RO | 0x0000.0018 | Watchdog Peripheral Identification 2 | 616 |
| 0xFEC | WDTPeriphID3 | RO | 0x0000.0001 | Watchdog Peripheral Identification 3 | 617 |
| 0xFF0 | WDTPrimeCellID0 | RO | 0x0000.000D | Watchdog PrimeCell Identification 0 | 618 |
| 0xFF4 | WDTPrimeCellID1 | RO | 0x0000.00F0 | Watchdog PrimeCell Identification 1 | 619 |
| 0xFF8 | WDTPrimeCellID2 | RO | 0x0000.0006 | Watchdog PrimeCell Identification 2 | 620 |
| 0xFFC | WDTPrimeCellID3 | RO | 0x0000.00B1 | Watchdog PrimeCell Identification 3 | 621 |

12.5 Register Descriptions

The remainder of this section lists and describes the WDT registers, in numerical order by address offset.

Register 1: Watchdog Load (WDTLOAD), offset 0x000

This register is the 32-bit interval value used by the 32-bit counter. When this register is written, the value is immediately loaded and the counter restarts counting down from the new value. If the **WDTLOAD** register is loaded with 0x0000.0000, an interrupt is immediately generated.

Watchdog Load (WDTLOAD)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0x000

Type R/W, reset 0xFFFF.FFFF

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | WDTLOAD | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | WDTLOAD | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------------|---------------------|
| 31:0 | WDTLOAD | R/W | 0xFFFF.FFFF | Watchdog Load Value |

Register 2: Watchdog Value (WDTVALUE), offset 0x004

This register contains the current count value of the timer.

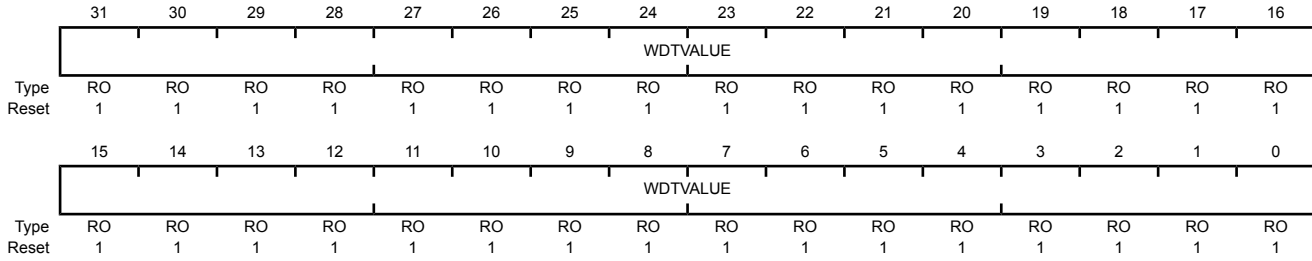
Watchdog Value (WDTVALUE)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0x004

Type RO, reset 0xFFFF.FFFF



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------------|---|
| 31:0 | WDTVALUE | RO | 0xFFFF.FFFF | Watchdog Value Current value of the 32-bit down counter. |

Register 3: Watchdog Control (WDTCTL), offset 0x008

This register is the watchdog control register. The watchdog timer can be configured to generate a reset signal (on second time-out) or an interrupt on time-out.

When the watchdog interrupt has been enabled by setting the `INTEN` bit, all subsequent writes to the `INTEN` bit are ignored. The only mechanism that can re-enable writes to this bit is a hardware reset.

Important: Because the Watchdog Timer 1 module has an independent clocking domain, its registers must be written with a timing gap between accesses. Software must guarantee that this delay is inserted between back-to-back writes to WDT1 registers or between a write followed by a read to the registers. The timing for back-to-back reads from the WDT1 module has no restrictions. The `WRC` bit in the **Watchdog Control (WDTCTL)** register for WDT1 indicates that the required timing gap has elapsed. This bit is cleared on a write operation and set once the write completes, indicating to software that another write or read may be started safely. Software should poll **WDTCTL** for `WRC=1` prior to accessing another register. Note that WDT0 does not have this restriction as it runs off the system clock and therefore does not have a `WRC` bit.

Watchdog Control (WDTCTL)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0x008

Type R/W, reset 0x0000.0000 (WDT0) and 0x8000.0000 (WDT1)

| | | | | | | | | | | | | | | | | | |
|-------|----------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-------|-------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | WRC | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | RESEN | INTEN | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|--|
| 31 | WRC | RO | 1 | Write Complete The <code>WRC</code> values are defined as follows: Value Description 0 A write access to one of the WDT1 registers is in progress. 1 A write access is not in progress, and WDT1 registers can be read or written. |
| 30:2 | reserved | RO | 0x000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Note: This bit is reserved for WDT0 and has a reset value of 0.

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 1 | RESEN | R/W | 0 | Watchdog Reset Enable The RESEN values are defined as follows: Value Description 0 Disabled. 1 Enable the Watchdog module reset output. |
| 0 | INTEN | R/W | 0 | Watchdog Interrupt Enable The INTEN values are defined as follows: Value Description 0 Interrupt event disabled (once this bit is set, it can only be cleared by a hardware reset). 1 Interrupt event enabled. Once enabled, all writes are ignored. |

Register 4: Watchdog Interrupt Clear (WDTICR), offset 0x00C

This register is the interrupt clear register. A write of any value to this register clears the Watchdog interrupt and reloads the 32-bit counter from the **WDTLOAD** register. Value for a read or reset is indeterminate.

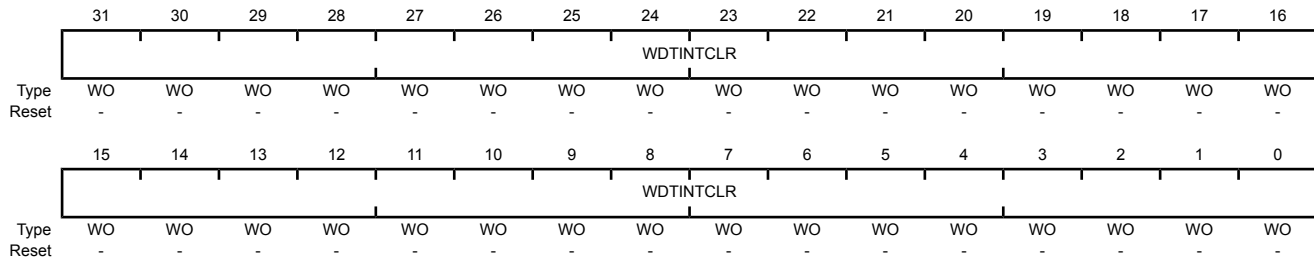
Watchdog Interrupt Clear (WDTICR)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0x00C

Type WO, reset -



| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|--------------------------|
| 31:0 | WDTINTCLR | WO | - | Watchdog Interrupt Clear |

Register 5: Watchdog Raw Interrupt Status (WDTRIS), offset 0x010

This register is the raw interrupt status register. Watchdog interrupt events can be monitored via this register if the controller interrupt is masked.

Watchdog Raw Interrupt Status (WDTRIS)

WDT0 base: 0x4000.0000
 WDT1 base: 0x4000.1000
 Offset 0x010
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | WDTRIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:1 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | WDTRIS | RO | 0 | Watchdog Raw Interrupt Status |

| Value | Description |
|-------|---|
| 1 | A watchdog time-out event has occurred. |
| 0 | The watchdog has not timed out. |

Register 6: Watchdog Masked Interrupt Status (WDTMIS), offset 0x014

This register is the masked interrupt status register. The value of this register is the logical AND of the raw interrupt bit and the Watchdog interrupt enable bit.

Watchdog Masked Interrupt Status (WDTMIS)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0x014

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | WDTMIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:1 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | WDTMIS | RO | 0 | Watchdog Masked Interrupt Status |
| | | | | Value Description |
| | | | | 1 A watchdog time-out event has been signalled to the interrupt controller. |
| | | | | 0 The watchdog has not timed out or the watchdog timer interrupt is masked. |

Register 7: Watchdog Test (WDTTEST), offset 0x418

This register provides user-enabled stalling when the microcontroller asserts the CPU halt flag during debug.

Watchdog Test (WDTTEST)

WDT0 base: 0x4000.0000
 WDT1 base: 0x4000.1000
 Offset 0x418
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|-------|----------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | STALL | reserved | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | R/W | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|--|
| 31:9 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | STALL | R/W | 0 | Watchdog Stall Enable |
| | | | | Value Description 1 If the microcontroller is stopped with a debugger, the watchdog timer stops counting. Once the microcontroller is restarted, the watchdog timer resumes counting. 0 The watchdog timer continues counting if the microcontroller is stopped with a debugger. |
| 7:0 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 8: Watchdog Lock (WDTLOCK), offset 0xC00

Writing 0x1ACC.E551 to the **WDTLOCK** register enables write access to all other registers. Writing any other value to the **WDTLOCK** register re-enables the locked state for register writes to all the other registers. Reading the **WDTLOCK** register returns the lock status rather than the 32-bit value written. Therefore, when write accesses are disabled, reading the **WDTLOCK** register returns 0x0000.0001 (when locked; otherwise, the returned value is 0x0000.0000 (unlocked)).

Watchdog Lock (WDTLOCK)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0xC00

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | WDTLOCK | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | WDTLOCK | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-------------|-------------|------|-------------|---|-------|-------------|-------------|--------|-------------|----------|
| 31:0 | WDTLOCK | R/W | 0x0000.0000 | Watchdog Lock A write of the value 0x1ACC.E551 unlocks the watchdog registers for write access. A write of any other value reapplies the lock, preventing any register updates. A read of this register returns the following values: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0000.0001</td> <td>Locked</td> </tr> <tr> <td>0x0000.0000</td> <td>Unlocked</td> </tr> </tbody> </table> | Value | Description | 0x0000.0001 | Locked | 0x0000.0000 | Unlocked |
| Value | Description | | | | | | | | | |
| 0x0000.0001 | Locked | | | | | | | | | |
| 0x0000.0000 | Unlocked | | | | | | | | | |

Register 9: Watchdog Peripheral Identification 4 (WDTPeriphID4), offset 0xFD0

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog Peripheral Identification 4 (WDTPeriphID4)

WDT0 base: 0x4000.0000
 WDT1 base: 0x4000.1000
 Offset 0xFD0
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID4 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID4 | RO | 0x00 | WDT Peripheral ID Register [7:0] |

Register 10: Watchdog Peripheral Identification 5 (WDTPeriphID5), offset 0xFD4

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog Peripheral Identification 5 (WDTPeriphID5)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0xFD4

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID5 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID5 | RO | 0x00 | WDT Peripheral ID Register [15:8] |

Register 11: Watchdog Peripheral Identification 6 (WDTPeriphID6), offset 0xFD8

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog Peripheral Identification 6 (WDTPeriphID6)

WDT0 base: 0x4000.0000
 WDT1 base: 0x4000.1000
 Offset 0xFD8
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID6 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID6 | RO | 0x00 | WDT Peripheral ID Register [23:16] |

Register 12: Watchdog Peripheral Identification 7 (WDTPeriphID7), offset 0xFDC

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog Peripheral Identification 7 (WDTPeriphID7)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0xFDC

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID7 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

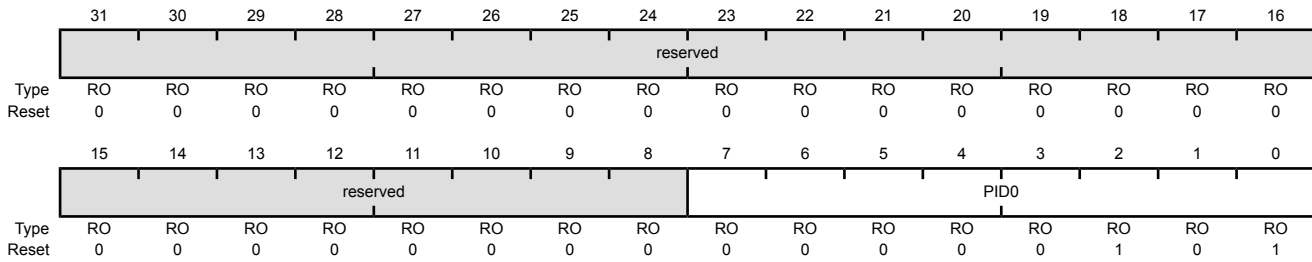
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID7 | RO | 0x00 | WDT Peripheral ID Register [31:24] |

Register 13: Watchdog Peripheral Identification 0 (WDTPeriphID0), offset 0xFE0

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog Peripheral Identification 0 (WDTPeriphID0)

WDT0 base: 0x4000.0000
 WDT1 base: 0x4000.1000
 Offset 0xFE0
 Type RO, reset 0x0000.0005



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID0 | RO | 0x05 | Watchdog Peripheral ID Register [7:0] |

Register 14: Watchdog Peripheral Identification 1 (WDTPeriphID1), offset 0xFE4

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog Peripheral Identification 1 (WDTPeriphID1)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0xFE4

Type RO, reset 0x0000.0018

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID1 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID1 | RO | 0x18 | Watchdog Peripheral ID Register [15:8] |

Register 15: Watchdog Peripheral Identification 2 (WDTPeriphID2), offset 0xFE8

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog Peripheral Identification 2 (WDTPeriphID2)

WDT0 base: 0x4000.0000
 WDT1 base: 0x4000.1000
 Offset 0xFE8
 Type RO, reset 0x0000.0018

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID2 | RO | 0x18 | Watchdog Peripheral ID Register [23:16] |

Register 16: Watchdog Peripheral Identification 3 (WDTPeriphID3), offset 0xFEC

The **WDTPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog Peripheral Identification 3 (WDTPeriphID3)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0xFEC

Type RO, reset 0x0000.0001

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID3 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID3 | RO | 0x01 | Watchdog Peripheral ID Register [31:24] |

Register 17: Watchdog PrimeCell Identification 0 (WDTPCellID0), offset 0xFF0

The **WDTPCellIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog PrimeCell Identification 0 (WDTPCellID0)

WDT0 base: 0x4000.0000
 WDT1 base: 0x4000.1000
 Offset 0xFF0
 Type RO, reset 0x0000.000D

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID0 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID0 | RO | 0x0D | Watchdog PrimeCell ID Register [7:0] |

Register 18: Watchdog PrimeCell Identification 1 (WDTPCellID1), offset 0xFF4

The **WDTPCellIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog PrimeCell Identification 1 (WDTPCellID1)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0xFF4

Type RO, reset 0x0000.00F0

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID1 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID1 | RO | 0xF0 | Watchdog PrimeCell ID Register [15:8] |

Register 19: Watchdog PrimeCell Identification 2 (WDTPCellID2), offset 0xFF8

The **WDTPCellIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog PrimeCell Identification 2 (WDTPCellID2)

WDT0 base: 0x4000.0000
 WDT1 base: 0x4000.1000
 Offset 0xFF8
 Type RO, reset 0x0000.0006

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID2 | RO | 0x06 | Watchdog PrimeCell ID Register [23:16] |

Register 20: Watchdog PrimeCell Identification 3 (WDTPCellID3), offset 0xFFC

The **WDTPCellIDn** registers are hard-coded and the fields within the register determine the reset value.

Watchdog PrimeCell Identification 3 (WDTPCellID3)

WDT0 base: 0x4000.0000

WDT1 base: 0x4000.1000

Offset 0xFFC

Type RO, reset 0x0000.00B1

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID3 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID3 | RO | 0xB1 | Watchdog PrimeCell ID Register [31:24] |

13 Analog-to-Digital Converter (ADC)

An analog-to-digital converter (ADC) is a peripheral that converts a continuous analog voltage to a discrete digital number. Two identical converter modules are included, which share 16 input channels.

The Stellaris[®] ADC module features 12-bit conversion resolution and supports 16 input channels, plus an internal temperature sensor. Each ADC module contains four programmable sequencers allowing the sampling of multiple analog input sources without controller intervention. Each sample sequencer provides flexible programming with fully configurable input source, trigger events, interrupt generation, and sequencer priority. A digital comparator function is included which allows the conversion value to be diverted to a digital comparator module. Each ADC module provides eight digital comparators. Each digital comparator evaluates the ADC conversion value against its two user-defined values to determine the operational range of the signal. The trigger source for ADC0 and ADC1 may be independent or the two ADC modules may operate from the same trigger source and operate on the same or different inputs. A phase shifter can delay the start of sampling by a specified phase angle. When using both ADC modules, it is possible to configure the converters to start the conversions coincidentally or within a relative phase from each other, see “Sample Phase Control” on page 628.

The Stellaris LM3S2U93 microcontroller provides two ADC modules with each having the following features:

- 16 shared analog input channels
- 12-bit precision ADC with an accurate 10-bit data compatibility mode
- Single-ended and differential-input configurations
- On-chip internal temperature sensor
- Maximum sample rate of one million samples/second
- Optional phase shift in sample time programmable from 22.5° to 337.5°
- Four programmable sample conversion sequencers from one to eight entries long, with corresponding conversion result FIFOs
- Flexible trigger control
 - Controller (software)
 - Timers
 - Analog Comparators
 - PWM
 - GPIO
- Hardware averaging of up to 64 samples
- Digital comparison unit providing eight digital comparators
- Converter uses an internal 3-V reference or an external reference

- Power and ground for the analog circuitry is separate from the digital power and ground
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Dedicated channel for each sample sequencer
 - ADC module uses burst requests for DMA

13.1 Block Diagram

The Stellaris microcontroller contains two identical Analog-to-Digital Converter modules. These two modules, ADC0 and ADC1, share the same 16 analog input channels. Each ADC module operates independently and can therefore execute different sample sequences, sample any of the analog input channels at any time, and generate different interrupts and triggers. Figure 13-1 on page 623 shows how the two modules are connected to analog inputs and the system bus.

Figure 13-1. Implementation of Two ADC Blocks

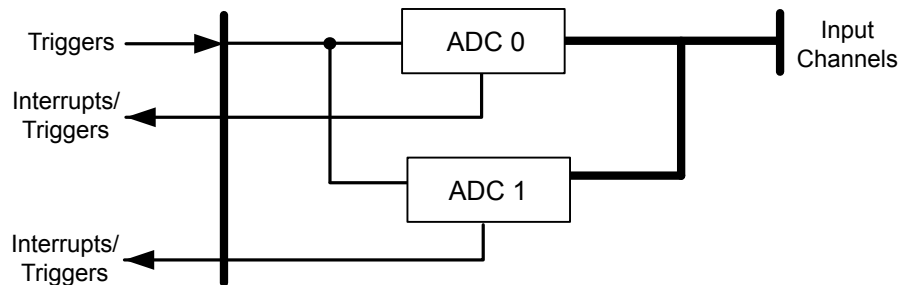
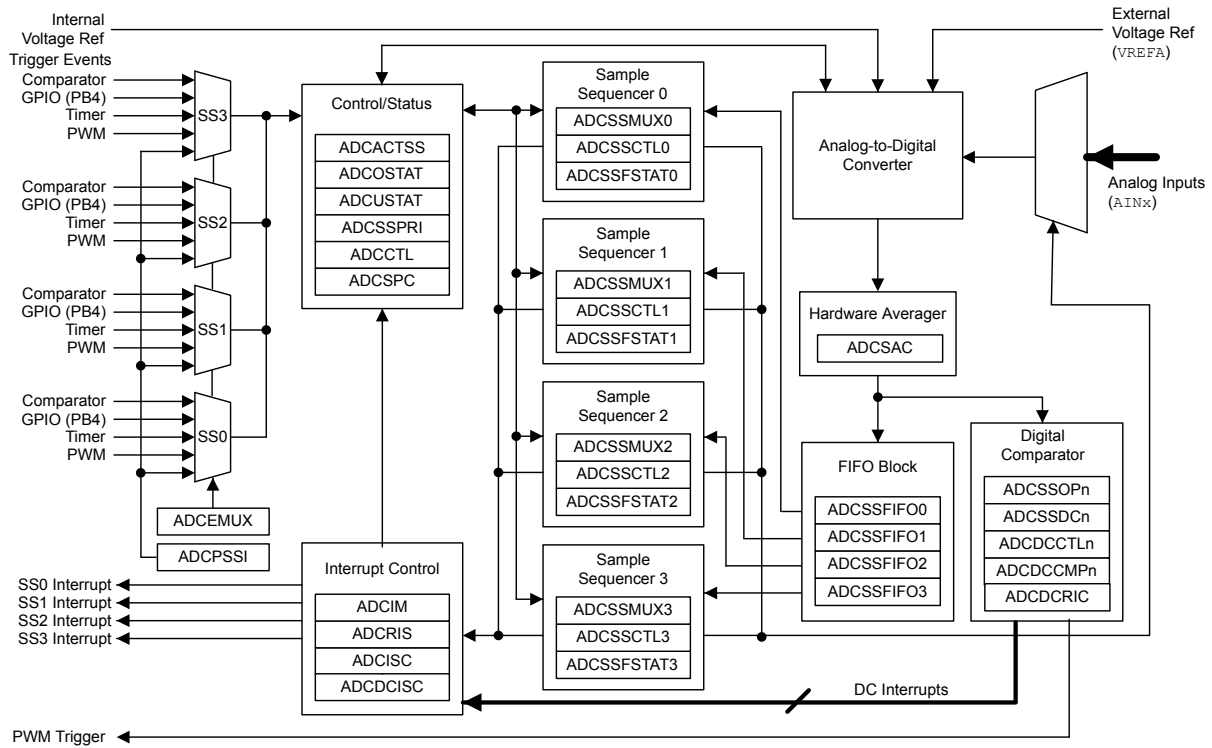


Figure 13-2 on page 624 provides details on the internal configuration of the ADC controls and data registers.

Figure 13-2. ADC Module Block Diagram



13.2 Signal Description

The following table lists the external signals of the ADC module and describes the function of each. The ADC signals are analog functions for some GPIO signals. The column in the table below titled "Pin Mux/Pin Assignment" lists the GPIO pin placement for the ADC signals. The AIN_x and VREFA analog signals are not 5-V tolerant and go through an isolation circuit before reaching their circuitry. These signals are configured by clearing the corresponding DEN bit in the **GPIO Digital Enable (GPIO DEN)** register and setting the corresponding AMSEL bit in the **GPIO Analog Mode Select (GPIO AMSEL)** register. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 419.

Table 13-1. ADC Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|--------------------------------------|
| AIN0 | 1 | PE7 | I | Analog | Analog-to-digital converter input 0. |
| AIN1 | 2 | PE6 | I | Analog | Analog-to-digital converter input 1. |
| AIN2 | 5 | PE5 | I | Analog | Analog-to-digital converter input 2. |
| AIN3 | 6 | PE4 | I | Analog | Analog-to-digital converter input 3. |
| AIN4 | 100 | PD7 | I | Analog | Analog-to-digital converter input 4. |
| AIN5 | 99 | PD6 | I | Analog | Analog-to-digital converter input 5. |
| AIN6 | 98 | PD5 | I | Analog | Analog-to-digital converter input 6. |
| AIN7 | 97 | PD4 | I | Analog | Analog-to-digital converter input 7. |
| AIN8 | 96 | PE3 | I | Analog | Analog-to-digital converter input 8. |
| AIN9 | 95 | PE2 | I | Analog | Analog-to-digital converter input 9. |

Table 13-1. ADC Signals (100LQFP) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|---|
| AIN10 | 92 | PB4 | I | Analog | Analog-to-digital converter input 10. |
| AIN11 | 91 | PB5 | I | Analog | Analog-to-digital converter input 11. |
| AIN12 | 13 | PD3 | I | Analog | Analog-to-digital converter input 12. |
| AIN13 | 12 | PD2 | I | Analog | Analog-to-digital converter input 13. |
| AIN14 | 11 | PD1 | I | Analog | Analog-to-digital converter input 14. |
| AIN15 | 10 | PD0 | I | Analog | Analog-to-digital converter input 15. |
| VREFA | 90 | PB6 | I | Analog | This input provides a reference voltage used to specify the input voltage at which the ADC converts to a maximum value. In other words, the voltage that is applied to VREFA is the voltage with which an AIN _n signal is converted to 4095. The VREFA input is limited to the range specified in Table 25-26 on page 1145 . |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 13-2. ADC Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|---|
| AIN0 | B1 | PE7 | I | Analog | Analog-to-digital converter input 0. |
| AIN1 | A1 | PE6 | I | Analog | Analog-to-digital converter input 1. |
| AIN2 | B3 | PE5 | I | Analog | Analog-to-digital converter input 2. |
| AIN3 | B2 | PE4 | I | Analog | Analog-to-digital converter input 3. |
| AIN4 | A2 | PD7 | I | Analog | Analog-to-digital converter input 4. |
| AIN5 | A3 | PD6 | I | Analog | Analog-to-digital converter input 5. |
| AIN6 | C6 | PD5 | I | Analog | Analog-to-digital converter input 6. |
| AIN7 | B5 | PD4 | I | Analog | Analog-to-digital converter input 7. |
| AIN8 | B4 | PE3 | I | Analog | Analog-to-digital converter input 8. |
| AIN9 | A4 | PE2 | I | Analog | Analog-to-digital converter input 9. |
| AIN10 | A6 | PB4 | I | Analog | Analog-to-digital converter input 10. |
| AIN11 | B7 | PB5 | I | Analog | Analog-to-digital converter input 11. |
| AIN12 | H1 | PD3 | I | Analog | Analog-to-digital converter input 12. |
| AIN13 | H2 | PD2 | I | Analog | Analog-to-digital converter input 13. |
| AIN14 | G2 | PD1 | I | Analog | Analog-to-digital converter input 14. |
| AIN15 | G1 | PD0 | I | Analog | Analog-to-digital converter input 15. |
| VREFA | A7 | PB6 | I | Analog | This input provides a reference voltage used to specify the input voltage at which the ADC converts to a maximum value. In other words, the voltage that is applied to VREFA is the voltage with which an AIN _n signal is converted to 4095. The VREFA input is limited to the range specified in Table 25-26 on page 1145 . |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

13.3 Functional Description

The Stellaris ADC collects sample data by using a programmable sequence-based approach instead of the traditional single or double-sampling approaches found on many ADC modules. Each *sample sequence* is a fully programmed series of consecutive (back-to-back) samples, allowing the ADC to collect data from multiple input sources without having to be re-configured or serviced by the processor. The programming of each sample in the sample sequence includes parameters such as the input source and mode (differential versus single-ended input), interrupt generation on sample completion, and the indicator for the last sample in the sequence. In addition, the μ DMA can be used to more efficiently move data from the sample sequencers without CPU intervention.

13.3.1 Sample Sequencers

The sampling control and data capture is handled by the sample sequencers. All of the sequencers are identical in implementation except for the number of samples that can be captured and the depth of the FIFO. Table 13-3 on page 626 shows the maximum number of samples that each sequencer can capture and its corresponding FIFO depth. Each sample that is captured is stored in the FIFO. In this implementation, each FIFO entry is a 32-bit word, with the lower 12 bits containing the conversion result.

Table 13-3. Samples and FIFO Depth of Sequencers

| Sequencer | Number of Samples | Depth of FIFO |
|-----------|-------------------|---------------|
| SS3 | 1 | 1 |
| SS2 | 4 | 4 |
| SS1 | 4 | 4 |
| SS0 | 8 | 8 |

For a given sample sequence, each sample is defined by bit fields in the **ADC Sample Sequence Input Multiplexer Select (ADCSSMUX_n)** and **ADC Sample Sequence Control (ADCSSCTL_n)** registers, where "n" corresponds to the sequence number. The **ADCSSMUX_n** fields select the input pin, while the **ADCSSCTL_n** fields contain the sample control bits corresponding to parameters such as temperature sensor selection, interrupt enable, end of sequence, and differential input mode. Sample sequencers are enabled by setting the respective **ASEN_n** bit in the **ADC Active Sample Sequencer (ADCACTSS)** register and should be configured before being enabled. Sampling is then initiated by setting the **SS_n** bit in the **ADC Processor Sample Sequence Initiate (ADCPSSI)** register. In addition, sample sequences may be initiated on multiple ADC modules simultaneously using the **GSYNC** and **SYNCWAIT** bits in the **ADCPSSI** register during the configuration of each ADC module. For more information on using these bits, refer to page 665.

When configuring a sample sequence, multiple uses of the same input pin within the same sequence are allowed. In the **ADCSSCTL_n** register, the **IEN_n** bits can be set for any combination of samples, allowing interrupts to be generated after every sample in the sequence if necessary. Also, the **END** bit can be set at any point within a sample sequence. For example, if Sequencer 0 is used, the **END** bit can be set in the nibble associated with the fifth sample, allowing Sequencer 0 to complete execution of the sample sequence after the fifth sample.

After a sample sequence completes execution, the result data can be retrieved from the **ADC Sample Sequence Result FIFO (ADCSSFIFO_n)** registers. The FIFOs are simple circular buffers that read a single address to "pop" result data. For software debug purposes, the positions of the FIFO head and tail pointers are visible in the **ADC Sample Sequence FIFO Status (ADCSSFSTAT_n)** registers along with **FULL** and **EMPTY** status flags. If a write is attempted when the FIFO is full, the write does not occur and an overflow condition is indicated. Overflow and underflow conditions are monitored using the **ADCOSTAT** and **ADCUSTAT** registers.

13.3.2 Module Control

Outside of the sample sequencers, the remainder of the control logic is responsible for tasks such as:

- Interrupt generation
- DMA operation
- Sequence prioritization
- Trigger configuration
- Comparator configuration
- External voltage reference
- Sample phase control

Most of the ADC control logic runs at the ADC clock rate of 16 MHz. The internal ADC divider is configured for 16-MHz operation automatically by hardware when the system XTAL is selected with the PLL.

13.3.2.1 Interrupts

The register configurations of the sample sequencers and digital comparators dictate which events generate raw interrupts, but do not have control over whether the interrupt is actually sent to the interrupt controller. The ADC module's interrupt signals are controlled by the state of the MASK bits in the **ADC Interrupt Mask (ADCIM)** register. Interrupt status can be viewed at two locations: the **ADC Raw Interrupt Status (ADCRISt)** register, which shows the raw status of the various interrupt signals; and the **ADC Interrupt Status and Clear (ADCISC)** register, which shows active interrupts that are enabled by the ADCIM register. Sequencer interrupts are cleared by writing a 1 to the corresponding IN bit in ADCISC. Digital comparator interrupts are cleared by writing a 1 to the **ADC Digital Comparator Interrupt Status and Clear (ADCDCISC)** register.

13.3.2.2 DMA Operation

DMA may be used to increase efficiency by allowing each sample sequencer to operate independently and transfer data without processor intervention or reconfiguration. The ADC module provides a request signal from each sample sequencer to the associated dedicated channel of the μ DMA controller. The ADC does not support single transfer requests. A burst transfer request is asserted when the interrupt bit for the sample sequence is set (IE bit in the **ADCSSCTLn** register is set).

The arbitration size of the μ DMA transfer must be a power of 2, and the associated IE bits in the **ADDSSCTLn** register must be set. For example, if the μ DMA channel of SS0 has an arbitration size of four, the IE3 bit (4th sample) and the IE7 bit (8th sample) must be set. Thus the μ DMA request occurs every time 4 samples have been acquired. No other special steps are needed to enable the ADC module for μ DMA operation.

Refer to the “Micro Direct Memory Access (μ DMA)” on page 359 for more details about programming the μ DMA controller.

13.3.2.3 Prioritization

When sampling events (triggers) happen concurrently, they are prioritized for processing by the values in the **ADC Sample Sequencer Priority (ADCSSPRI)** register. Valid priority values are in the range of 0-3, with 0 being the highest priority and 3 being the lowest. Multiple active sample

sequencer units with the same priority do not provide consistent results, so software must ensure that all active sample sequencer units have a unique priority value.

13.3.2.4 Sampling Events

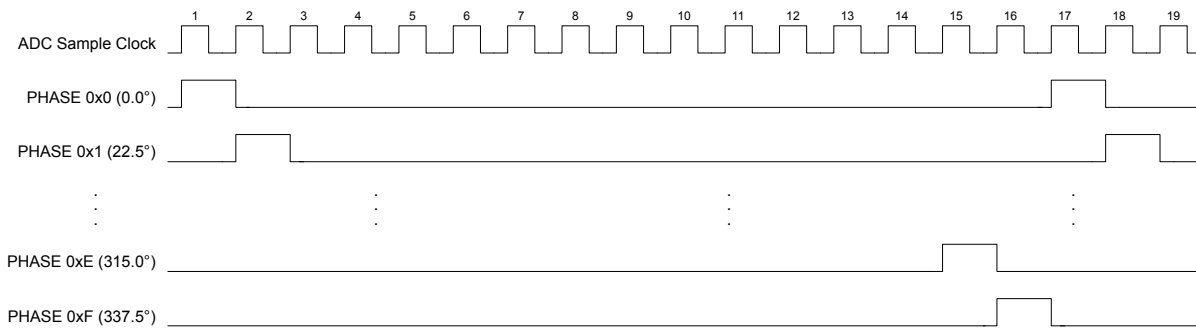
Sample triggering for each sample sequencer is defined in the **ADC Event Multiplexer Select (ADCEMUX)** register. Trigger sources include processor (default), analog comparators, an external signal on GPIO $PB4$, a GP Timer, a PWM generator, and continuous sampling. The processor triggers sampling by setting the SS_x bits in the **ADC Processor Sample Sequence Initiate (ADCPSSI)** register.

Care must be taken when using the continuous sampling trigger. If a sequencer's priority is too high, it is possible to starve other lower priority sequencers. Generally, a sample sequencer using continuous sampling should be set to the lowest priority. Continuous sampling can be used with a digital comparator to cause an interrupt when a particular voltage is seen on an input.

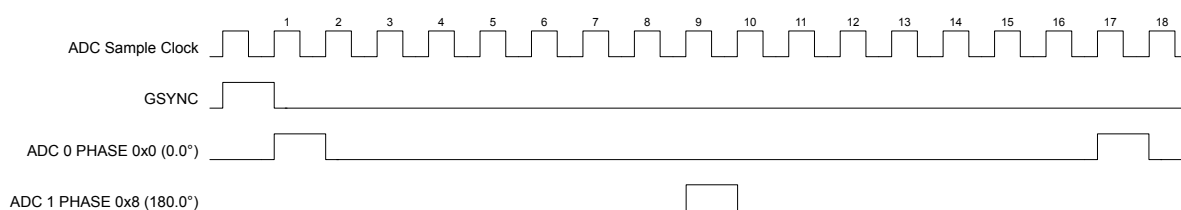
13.3.2.5 Sample Phase Control

The trigger source for ADC0 and ADC1 may be independent or the two ADC modules may operate from the same trigger source and operate on the same or different inputs. If the converters are running at the same sample rate, they may be configured to start the conversions coincidentally or with one of 15 different discrete phases relative to each other. The sample time can be delayed from the standard sampling time in 22.5° increments up to 337.5° using the **ADC Sample Phase Control (ADCSPC)** register. Figure 13-3 on page 628 shows an example of various phase relationships at a 1 Msps rate.

Figure 13-3. ADC Sample Phases

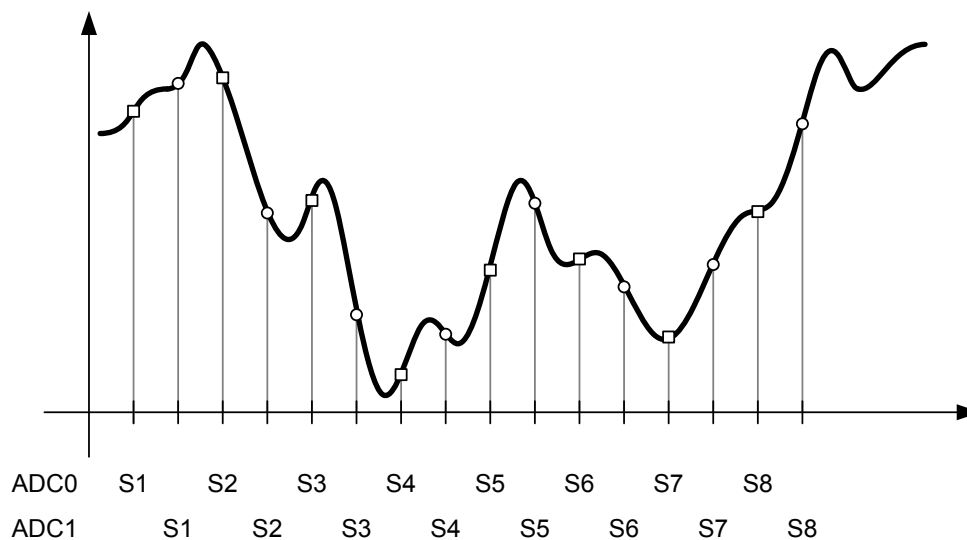


This feature can be used to double the sampling rate of an input. Both ADC module 0 and ADC module 1 can be programmed to sample the same input. ADC module 0 could sample at the standard position (the $PHASE$ field in the **ADCSPC** register is $0x0$). ADC module 1 can be configured to sample at 180° ($PHASE = 0x8$). The two modules can be synchronized using the $GSYNC$ and $SYNCWAIT$ bits in the **ADC Processor Sample Sequence Initiate (ADCPSSI)** register. Software could then combine the results from the two modules to create a sample rate of two million samples/second at 16 MHz as shown in Figure 13-4 on page 629.

Figure 13-4. Doubling the ADC Sample Rate

Using the **ADCSPC** register, ADC0 and ADC1 may provide a number of interesting applications:

- Coincident sampling of different signals. The sample sequence steps run coincidentally in both converters.
 - ADC Module 0, **ADCSPC** = 0x0, sampling *A_{IN0}*
 - ADC Module 1, **ADCSPC** = 0x0, sampling *A_{IN1}*
- Skewed sampling of the same signal. The sample sequence steps are 1/2 of an ADC clock (500 μ s for a 1Ms/s ADC) out of phase with each other. This configuration doubles the conversion bandwidth of a single input when software combines the results as shown in Figure 13-5 on page 629.
 - ADC Module 0, **ADCSPC** = 0x0, sampling *A_{IN0}*
 - ADC Module 1, **ADCSPC** = 0x8, sampling *A_{IN0}*

Figure 13-5. Skewed Sampling

13.3.3 Hardware Sample Averaging Circuit

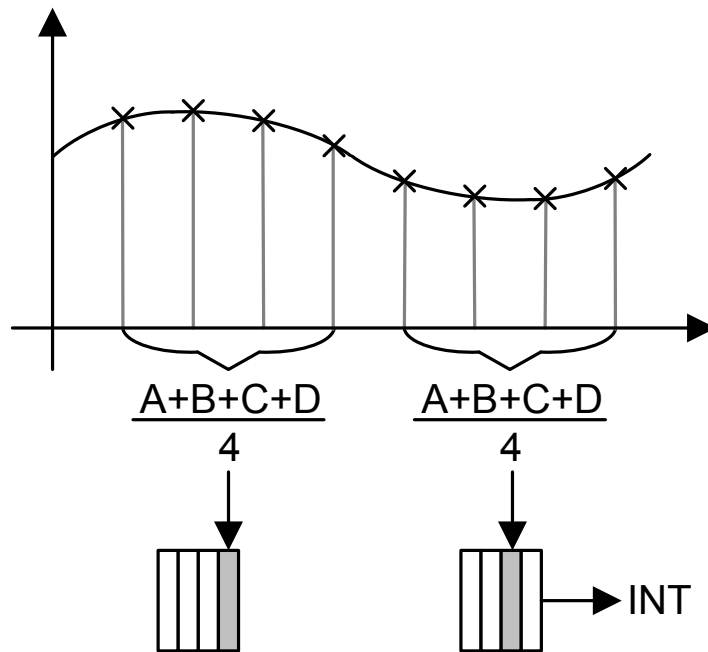
Higher precision results can be generated using the hardware averaging circuit, however, the improved results are at the cost of throughput. Up to 64 samples can be accumulated and averaged to form a single data entry in the sequencer FIFO. Throughput is decreased proportionally to the

number of samples in the averaging calculation. For example, if the averaging circuit is configured to average 16 samples, the throughput is decreased by a factor of 16.

By default the averaging circuit is off, and all data from the converter passes through to the sequencer FIFO. The averaging hardware is controlled by the **ADC Sample Averaging Control (ADCSAC)** register (see page 667). A single averaging circuit has been implemented, thus all input channels receive the same amount of averaging whether they are single-ended or differential.

Figure 13-6 shows an example in which the **ADCSAC** register is set to 0x2 for 4x hardware oversampling and the **IE1** bit is set for the sample sequence, resulting in an interrupt after the second averaged value is stored in the FIFO.

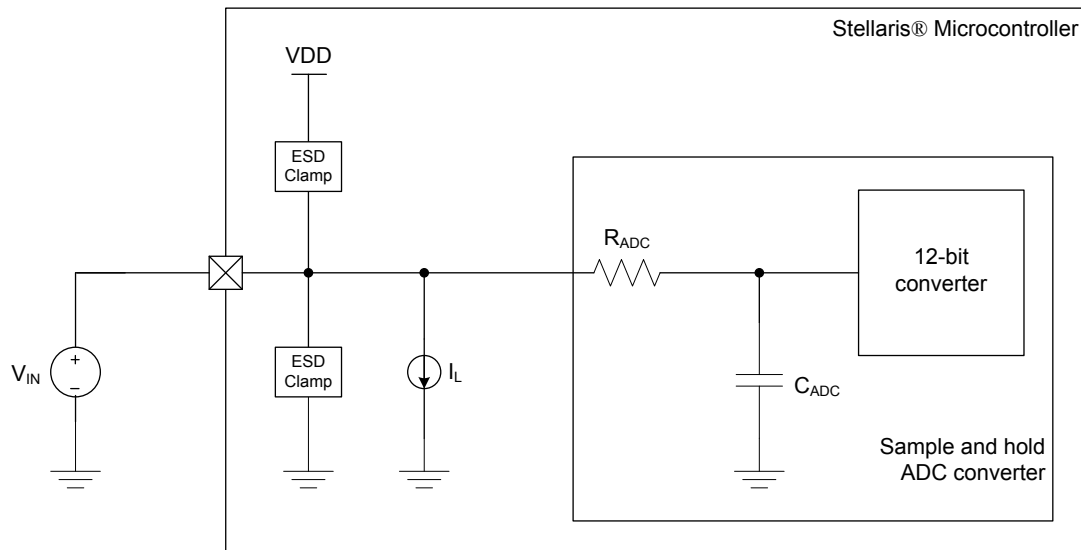
Figure 13-6. Sample Averaging Example



13.3.4 Analog-to-Digital Converter

The Analog-to-Digital Converter (ADC) module uses a Successive Approximation Register (SAR) architecture to deliver a 12-bit, low-power, high-precision conversion value. The ADC defaults to a 10-bit conversion result, providing backwards compatibility with previous generations of Stellaris microcontrollers. To enable 12-bit resolution, set the **RES** bit in the **ADC Control (ADCCTL)** register. The successive-approximation algorithm uses a current mode D/A converter to achieve lower settling time, resulting in higher conversion speeds for the A/D converter. In addition, built-in sample-and-hold circuitry with offset-calibration circuitry improves conversion accuracy. The ADC must be run from the PLL or a 16-MHz clock source. Figure 13-7 shows the ADC input equivalency diagram; for parameter values, see “Analog-to-Digital Converter (ADC)” on page 1144.

Figure 13-7. ADC Input Equivalency Diagram

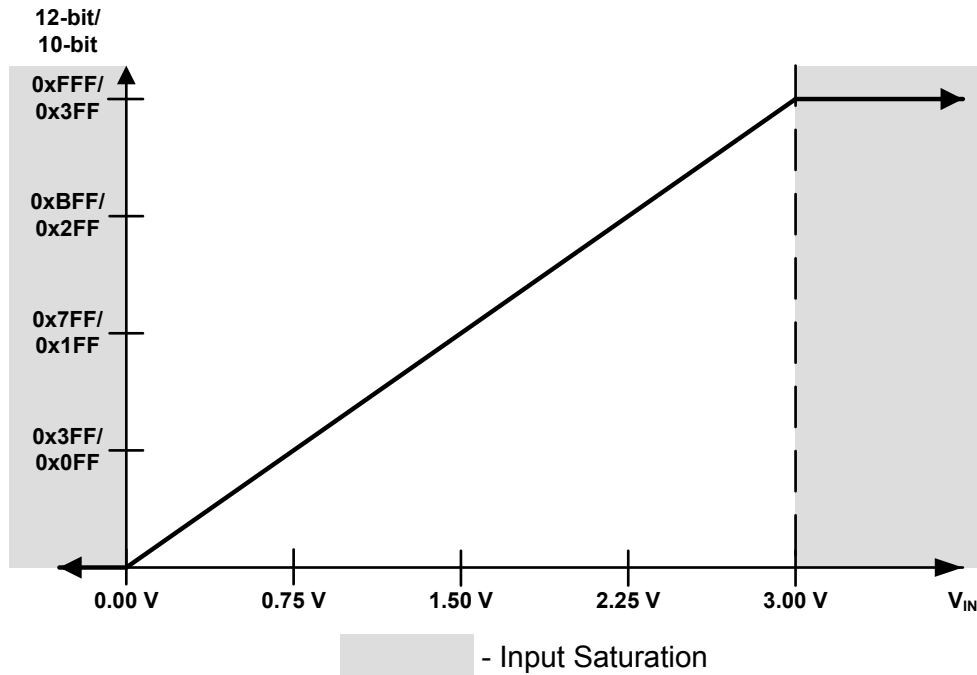


The ADC operates from both the 3.3-V analog and 1.2-V digital power supplies. The ADC clock can be configured to reduce power consumption when ADC conversions are not required (see “System Control” on page 195). The analog inputs are connected to the ADC through specially balanced input paths to minimize the distortion and cross-talk on the inputs. Detailed information on the ADC power supplies and analog inputs can be found in “Analog-to-Digital Converter (ADC)” on page 1144.

13.3.4.1 Internal Voltage Reference

The band-gap circuitry generates an internal 3.0 V reference that can be used by the ADC to produce a conversion value from the selected analog input. The range of this conversion value is from 0x000 to 0xFFFF in 12-bit mode, or 0x3FF in 10-bit mode. In single-ended-input mode, the 0x000 value corresponds to an analog input voltage of 0.0 V; the 0xFFFF in 12-bit mode, or 0x3FF in 10-bit mode value corresponds to an analog input voltage of 3.0 V. This configuration results in a resolution of approximately 0.7 mV in 12-bit mode and 2.9 mV per ADC code in 10-bit mode. While the analog input pads can handle voltages beyond this range, the ADC conversions saturate in under-voltage and over-voltage cases. Figure 13-8 on page 632 shows the ADC conversion function of the analog inputs.

Figure 13-8. Internal Voltage Conversion Result



13.3.4.2 External Voltage Reference

The ADC can use an external voltage reference to produce the conversion value from the selected analog input by configuring the V_{REF} field in the **ADC Control (ADCCTL)** register. The V_{REF} field specifies whether to use the internal, an external reference in the 3.0 V range, or an external reference in the 1.0 V range. While the range of the conversion value remains the same (0x000 to 0xFFF or 0x3FF), the analog voltage associated with the 0xFFF or 0x3FF value corresponds to the value of the voltage when using the 3.0-V setting and three times the voltage when using the 1.0-V setting, resulting in a smaller voltage resolution per ADC code. Ground is always used as the reference level for the minimum conversion value. Analog input voltages above the external voltage reference saturate to 0xFFF or 0x3FF while those below 0.0 V continue to saturate at 0x000. The V_{REFA} specification defines the useful range for the external voltage reference, see Table 25-26 on page 1145. Care must be taken to supply a reference voltage of acceptable quality.

Figure 13-9 on page 633 shows the ADC conversion function of the analog inputs when using an the 3.0-V setting on the external voltage reference. Figure 13-10 on page 633 shows the ADC conversion function when using the 1.0-V setting on the external voltage reference.

The external voltage reference can be more accurate than the internal reference by using a high-precision source or trimming the source.

Figure 13-9. External Voltage Conversion Result with 3.0-V Setting

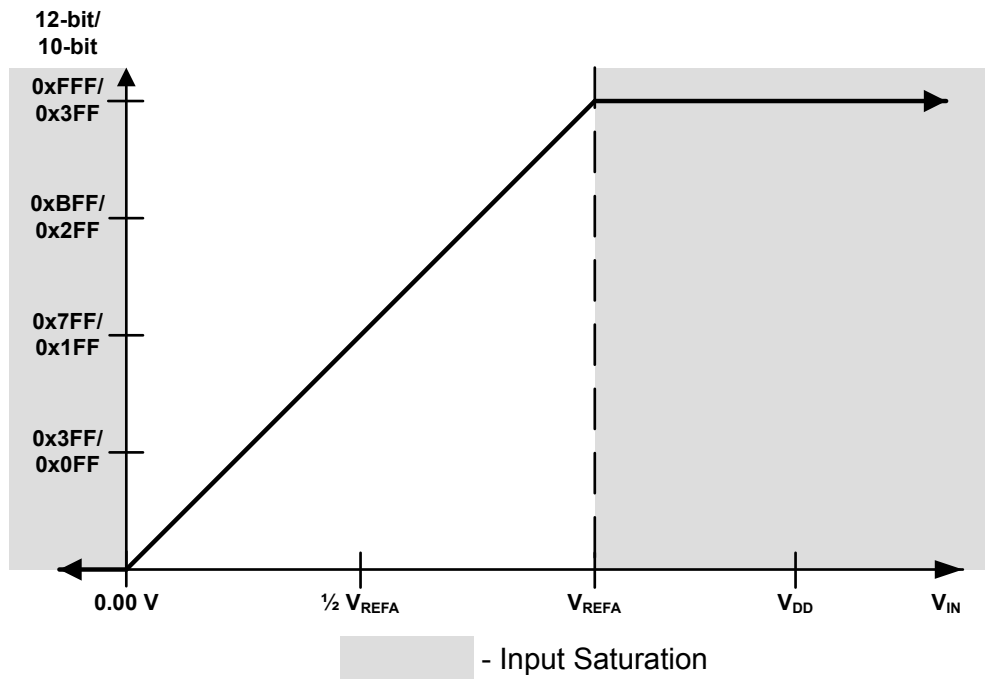
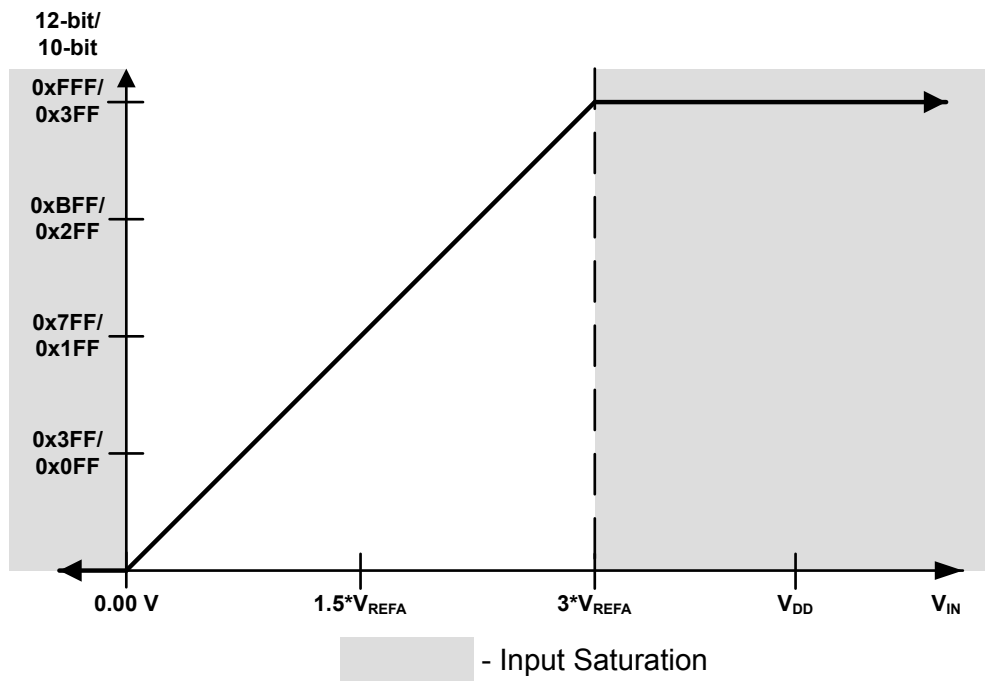


Figure 13-10. External Voltage Conversion Result with 1.0-V Setting



13.3.5 Differential Sampling

In addition to traditional single-ended sampling, the ADC module supports differential sampling of two analog input channels. To enable differential sampling, software must set the D_n bit in the **ADCSSCTL0n** register in a step's configuration nibble.

When a sequence step is configured for differential sampling, the input pair to sample must be configured in the **ADCSSMUXn** register. Differential pair 0 samples analog inputs 0 and 1; differential pair 1 samples analog inputs 2 and 3; and so on (see Table 13-4 on page 634). The ADC does not support other differential pairings such as analog input 0 with analog input 3.

Table 13-4. Differential Sampling Pairs

| Differential Pair | Analog Inputs |
|-------------------|---------------|
| 0 | 0 and 1 |
| 1 | 2 and 3 |
| 2 | 4 and 5 |
| 3 | 6 and 7 |
| 4 | 8 and 9 |
| 5 | 10 and 11 |
| 6 | 12 and 13 |
| 7 | 14 and 15 |

The voltage sampled in differential mode is the difference between the odd and even channels:

ΔV (differential voltage) = V_{IN_EVEN} (even channel) – V_{IN_ODD} (odd channel), therefore:

- If $\Delta V = 0$, then the conversion result = 0x1FF for 10-bit and 0x7FF for 12-bit
- If $\Delta V > 0$, then the conversion result > 0x1FF (range is 0x1FF–0x3FF) for 10-bit and > 0x7FF (range is 0x7FF - 0xFFF) for 12-bit
- If $\Delta V < 0$, then the conversion result < 0x1FF (range is 0–0x1FF) for 10-bit and < 0x7FF (range is 0 - 0x7FF) for 12-bit

The differential pairs assign polarities to the analog inputs: the even-numbered input is always positive, and the odd-numbered input is always negative. In order for a valid conversion result to appear, the negative input must be in the range of ± 1.5 V of the positive input. If an analog input is greater than 3 V or less than 0 V (the valid range for analog inputs), the input voltage is clipped, meaning it appears as either 3 V or 0 V, respectively, to the ADC.

Figure 13-11 on page 635 shows an example of the negative input centered at 1.5 V. In this configuration, the differential range spans from -1.5 V to 1.5 V. Figure 13-12 on page 635 shows an example where the negative input is centered at 0.75 V, meaning inputs on the positive input saturate past a differential voltage of -0.75 V because the input voltage is less than 0 V. Figure 13-13 on page 636 shows an example of the negative input centered at 2.25 V, where inputs on the positive channel saturate past a differential voltage of 0.75 V since the input voltage would be greater than 3 V.

Figure 13-11. Differential Sampling Range, $V_{IN_ODD} = 1.5\text{ V}$

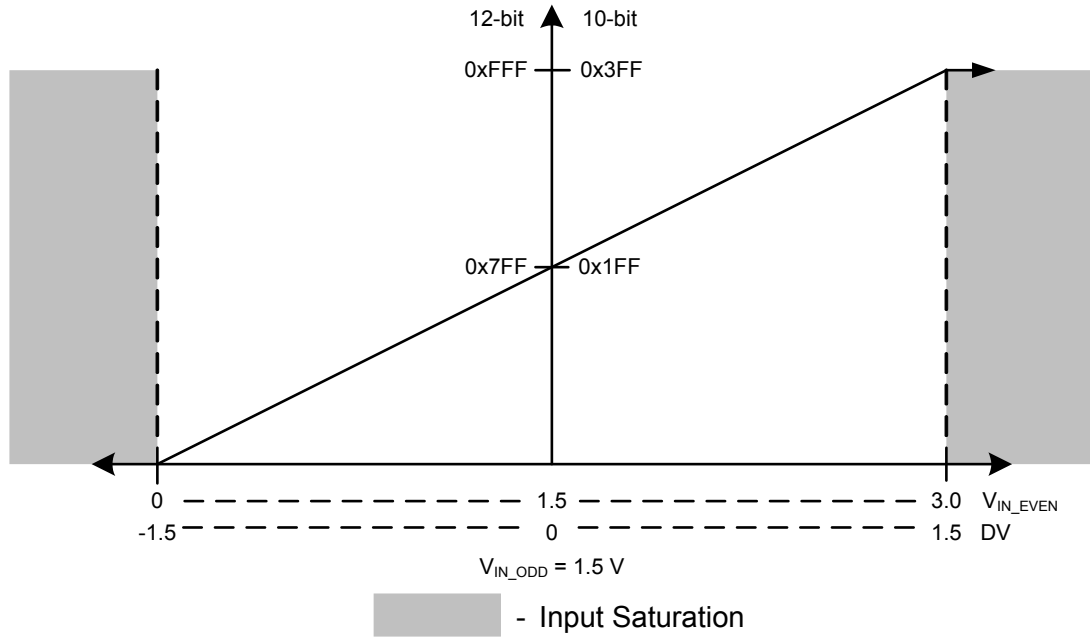


Figure 13-12. Differential Sampling Range, $V_{IN_ODD} = 0.75\text{ V}$

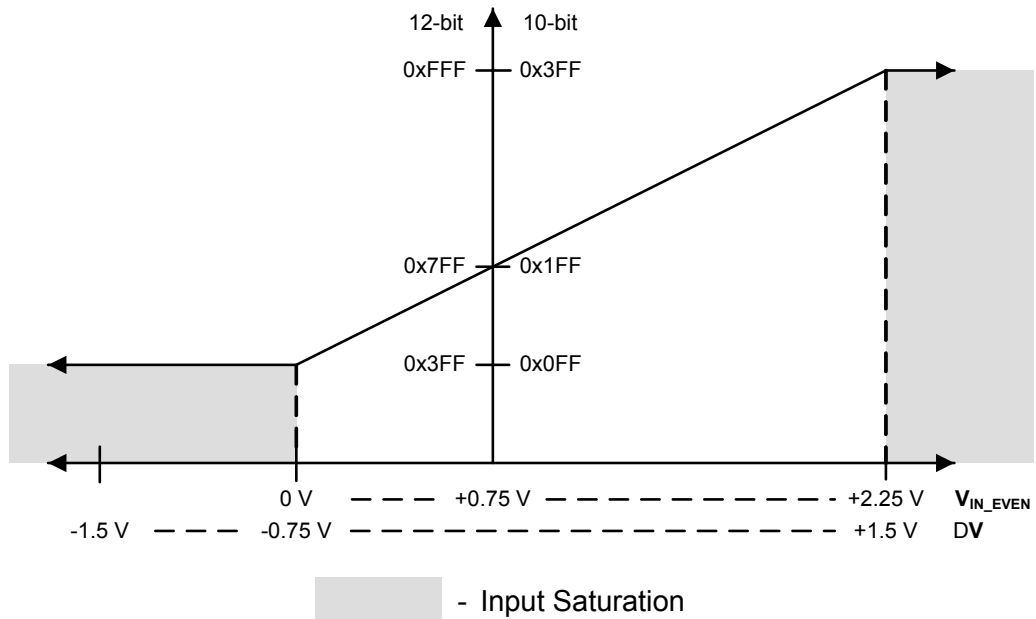
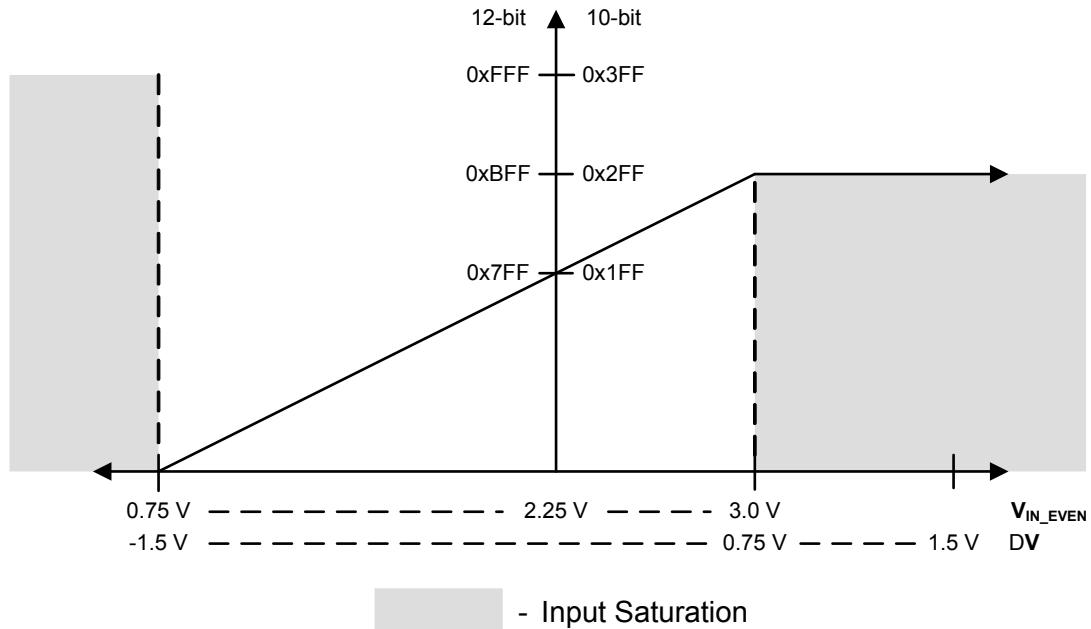


Figure 13-13. Differential Sampling Range, $V_{IN_ODD} = 2.25\text{ V}$



13.3.6 Internal Temperature Sensor

The temperature sensor serves two primary purposes: 1) to notify the system that internal temperature is too high or low for reliable operation and 2) to provide temperature measurements for calibration of the Hibernate module RTC trim value.

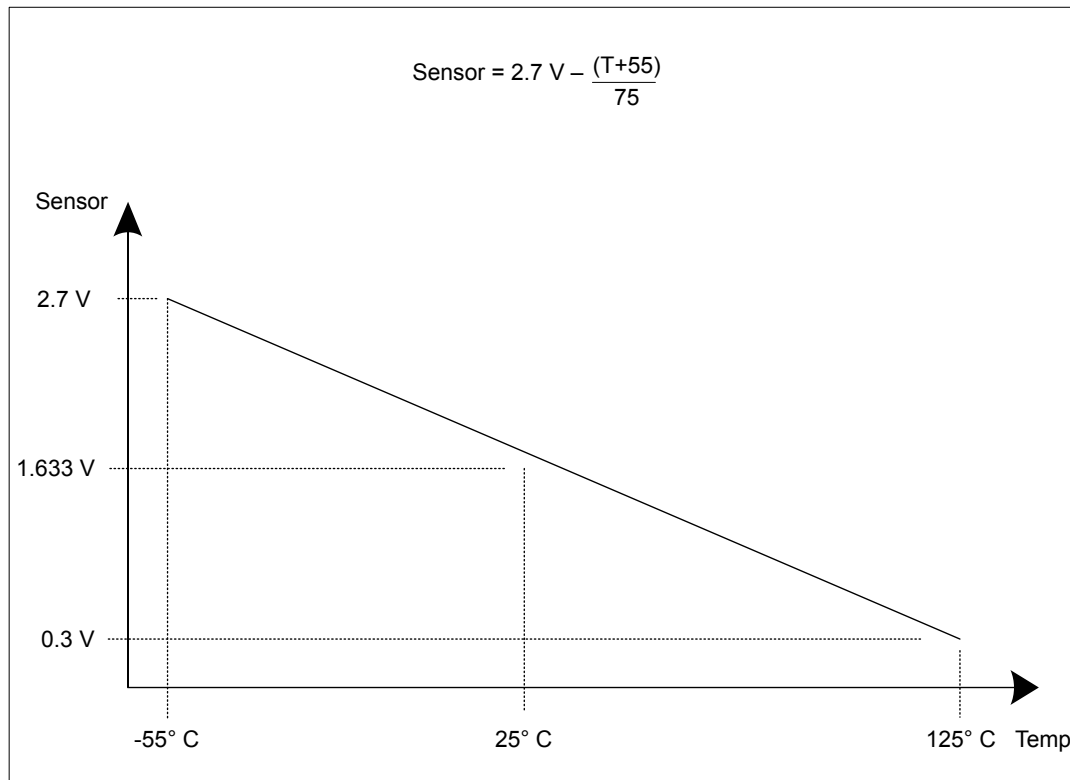
The temperature sensor does not have a separate enable, because it also contains the bandgap reference and must always be enabled. The reference is supplied to other analog modules; not just the ADC. In addition, the temperature sensor has a second power-down input in the 3.3 V domain which provides control by the Hibernation module.

The internal temperature sensor provides an analog temperature reading as well as a reference voltage. This reference voltage, $SENSO$, is given by the following equation:

$$SENSO = 2.7 - ((T + 55) / 75)$$

This relation is shown in Figure 13-14 on page 637.

Figure 13-14. Internal Temperature Sensor Characteristic



The temperature sensor reading can be sampled in a sample sequence by setting the TS_n bit in the **ADCSSCTLn** register. The temperature reading from the temperature sensor can also be given as a function of the ADC value. The following formula calculates temperature (in °C) based on the ADC reading:

$$\text{Temperature} = 147.5 - ((225 \times \text{ADC}) / 4095)$$

13.3.7 Digital Comparator Unit

An ADC is commonly used to sample an external signal and to monitor its value to ensure that it remains in a given range. To automate this monitoring procedure and reduce the amount of processor overhead that is required, each module provides eight digital comparators. Conversions from the ADC that are sent to the digital comparators are compared against the user programmable limits in the **ADC Digital Comparator Range (ADCDCMPn)** registers. If the observed signal moves out of the acceptable range, a processor interrupt can be generated and/or a trigger can be sent to the PWM module. The digital comparators four operational modes (Once, Always, Hysteresis Once, Hysteresis Always) can be applied to three separate regions (low band, mid band, high band) as defined by the user.

13.3.7.1 Output Functions

ADC conversions can either be stored in the ADC Sample Sequence FIFOs or compared using the digital comparator resources as defined by the S_nDCOP bits in the **ADC Sample Sequence n Operation (ADCSSOPn)** register. These selected ADC conversions are used by their respective digital comparator to monitor the external signal. Each comparator has two possible output functions: processor interrupts and triggers.

Each function has its own state machine to track the monitored signal. Even though the interrupt and trigger functions can be enabled individually or both at the same time, the same conversion data is used by each function to determine if the right conditions have been met to assert the associated output.

Interrupts

The digital comparator interrupt function is enabled by setting the `CIE` bit in the **ADC Digital Comparator Control (ADCDCCTLn)** register. This bit enables the interrupt function state machine to start monitoring the incoming ADC conversions. When the appropriate set of conditions is met, and the `DCONSSx` bit is set in the **ADCIM** register, an interrupt is sent to the interrupt controller.

Triggers

The digital comparator trigger function is enabled by setting the `CTE` bit in the **ADCDCCTLn** register. This bit enables the trigger function state machine to start monitoring the incoming ADC conversions. When the appropriate set of conditions is met, the corresponding digital comparator trigger to the PWM module is asserted.

13.3.7.2 Operational Modes

Four operational modes are provided to support a broad range of applications and multiple possible signaling requirements: Always, Once, Hysteresis Always, and Hysteresis Once. The operational mode is selected using the `CIM` or `CTM` field in the **ADCDCCTLn** register.

Always Mode

In the Always operational mode, the associated interrupt or trigger is asserted whenever the ADC conversion value meets its comparison criteria. The result is a string of assertions on the interrupt or trigger while the conversions are within the appropriate range.

Once Mode

In the Once operational mode, the associated interrupt or trigger is asserted whenever the ADC conversion value meets its comparison criteria, and the previous ADC conversion value did not. The result is a single assertion of the interrupt or trigger when the conversions are within the appropriate range.

Hysteresis-Always Mode

The Hysteresis-Always operational mode can only be used in conjunction with the low-band or high-band regions because the mid-band region must be crossed and the opposite region entered to clear the hysteresis condition. In the Hysteresis-Always mode, the associated interrupt or trigger is asserted in the following cases: 1) the ADC conversion value meets its comparison criteria or 2) a previous ADC conversion value has met the comparison criteria, and the hysteresis condition has not been cleared by entering the opposite region. The result is a string of assertions on the interrupt or trigger that continue until the opposite region is entered.

Hysteresis-Once Mode

The Hysteresis-Once operational mode can only be used in conjunction with the low-band or high-band regions because the mid-band region must be crossed and the opposite region entered to clear the hysteresis condition. In the Hysteresis-Once mode, the associated interrupt or trigger is asserted only when the ADC conversion value meets its comparison criteria, the hysteresis condition is clear, and the previous ADC conversion did not meet the comparison criteria. The result is a single assertion on the interrupt or trigger.

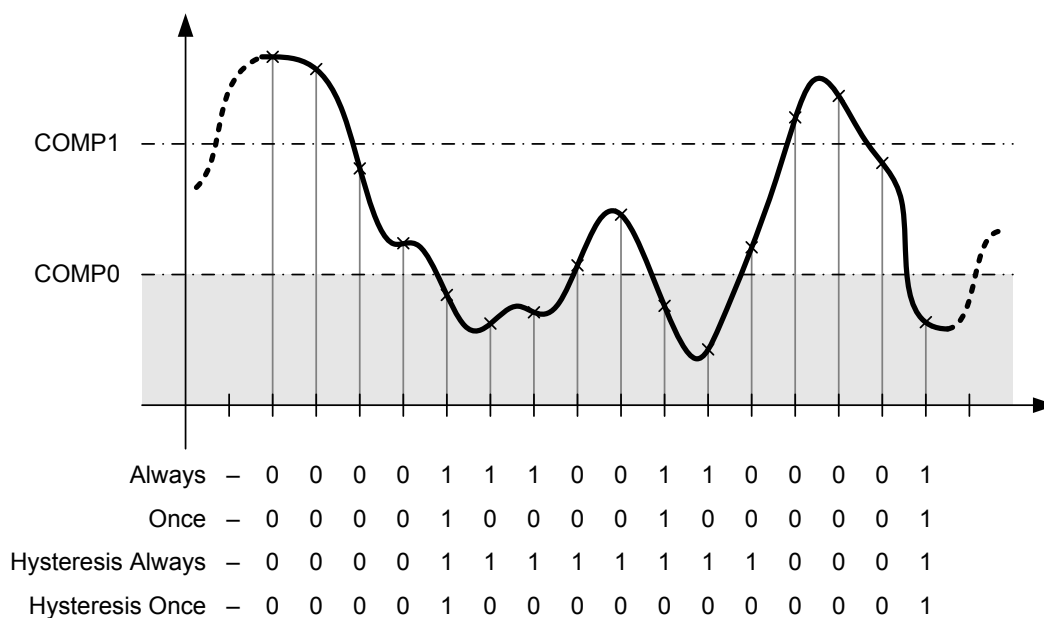
13.3.7.3 Function Ranges

The two comparison values, `COMP0` and `COMP1`, in the **ADC Digital Comparator Range (ADCDCMPn)** register effectively break the conversion area into three distinct regions. These regions are referred to as the low-band (less than or equal to `COMP0`), mid-band (greater than `COMP0` but less than or equal to `COMP1`), and high-band (greater than `COMP1`) regions. `COMP0` and `COMP1` may be programmed to the same value, effectively creating two regions, but `COMP1` must always be greater than or equal to the value of `COMP0`. A `COMP1` value that is less than `COMP0` generates unpredictable results.

Low-Band Operation

To operate in the low-band region, either the `CIC` field or the `CTC` field in the **ADCDCCTLn** register must be programmed to `0x0`. This setting causes interrupts or triggers to be generated in the low-band region as defined by the programmed operational mode. An example of the state of the interrupt/trigger signal in the low-band region for each of the operational modes is shown in Figure 13-15 on page 639. Note that a "0" in a column following the operational mode name (Always, Once, Hysteresis Always, and Hysteresis Once) indicates that the interrupt or trigger signal is de-asserted and a "1" indicates that the signal is asserted.

Figure 13-15. Low-Band Operation (`CIC=0x0` and/or `CTC=0x0`)

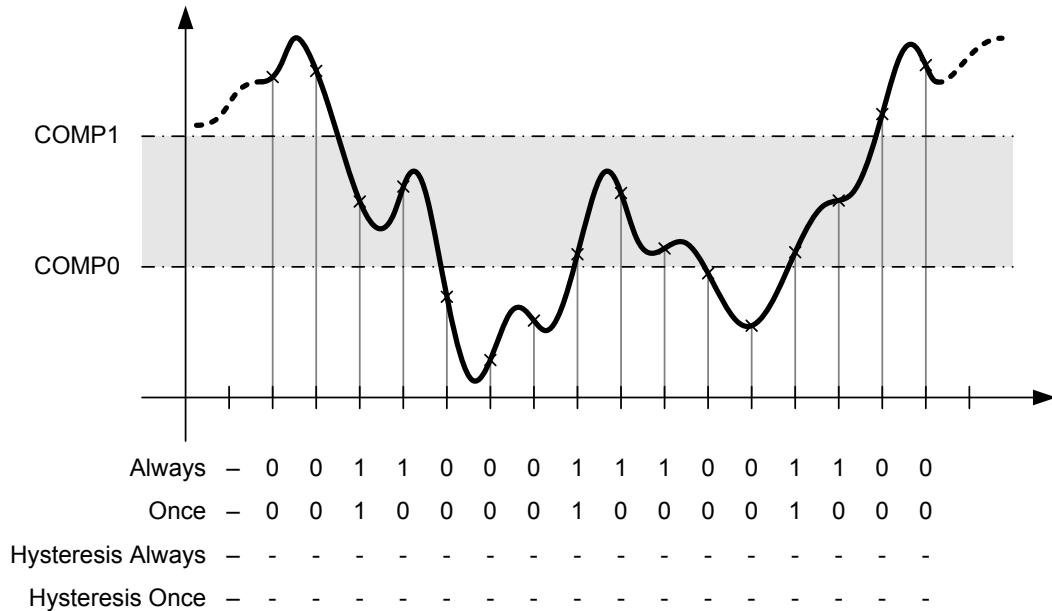


Mid-Band Operation

To operate in the mid-band region, either the `CIC` field or the `CTC` field in the **ADCDCCTLn** register must be programmed to `0x1`. This setting causes interrupts or triggers to be generated in the mid-band region according the operation mode. Only the Always and Once operational modes are available in the mid-band region. An example of the state of the interrupt/trigger signal in the mid-band region for each of the allowed operational modes is shown in Figure 13-16 on page 640. Note that a "0" in

a column following the operational mode name (Always or Once) indicates that the interrupt or trigger signal is de-asserted and a "1" indicates that the signal is asserted.

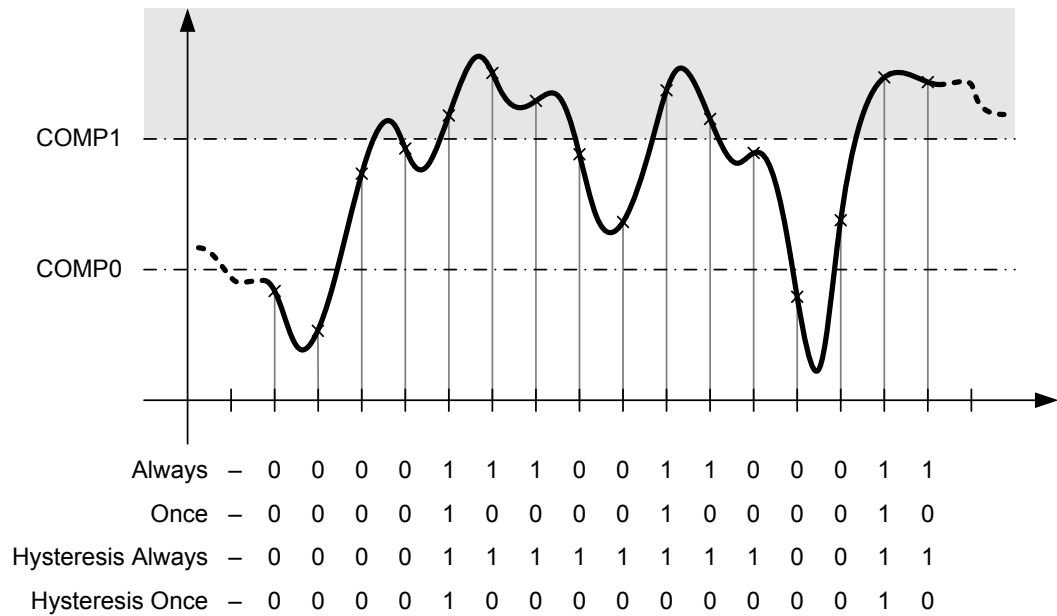
Figure 13-16. Mid-Band Operation (CIC=0x1 and/or CTC=0x1)



High-Band Operation

To operate in the high-band region, either the `CIC` field or the `CTC` field in the `ADCDCCTLn` register must be programmed to 0x3. This setting causes interrupts or triggers to be generated in the high-band region according the operation mode. An example of the state of the interrupt/trigger signal in the high-band region for each of the allowed operational modes is shown in Figure 13-17 on page 641. Note that a "0" in a column following the operational mode name (Always, Once, Hysteresis Always, and Hysteresis Once) indicates that the interrupt or trigger signal is de-asserted and a "1" indicates that the signal is asserted.

Figure 13-17. High-Band Operation (CIC=0x3 and/or CTC=0x3)



13.4 Initialization and Configuration

In order for the ADC module to be used, the PLL must be enabled and programmed to a supported crystal frequency in the **RCC** register (see page 211). Using unsupported frequencies can cause faulty operation in the ADC module.

13.4.1 Module Initialization

Initialization of the ADC module is a simple process with very few steps: enabling the clock to the ADC, disabling the analog isolation circuit associated with all inputs that are to be used, and reconfiguring the sample sequencer priorities (if needed).

The initialization sequence for the ADC is as follows:

1. Enable the ADC clock by using the **RCGC0** register (see page 254).
2. Enable the clock to the appropriate GPIO modules via the **RCGC2** register (see page 274). To find out which GPIO ports to enable, refer to “Signal Description” on page 624.
3. Set the GPIO **AFSEL** bits for the ADC input pins (see page 443). To determine which GPIOs to configure, see Table 23-4 on page 1075.
4. Configure the **AIN_x** and **VREFA** signals to be analog inputs by clearing the corresponding **DEN** bit in the **GPIO Digital Enable (GPIODEN)** register (see page 454).
5. Disable the analog isolation circuit for all ADC input pins that are to be used by writing a 1 to the appropriate bits of the **GPIOAMSEL** register (see page 459) in the associated GPIO block.

- If required by the application, reconfigure the sample sequencer priorities in the **ADCSSPRI** register. The default configuration has Sample Sequencer 0 with the highest priority and Sample Sequencer 3 as the lowest priority.

13.4.2 Sample Sequencer Configuration

Configuration of the sample sequencers is slightly more complex than the module initialization because each sample sequencer is completely programmable.

The configuration for each sample sequencer should be as follows:

- Ensure that the sample sequencer is disabled by clearing the corresponding **ASEN_n** bit in the **ADCACTSS** register. Programming of the sample sequencers is allowed without having them enabled. Disabling the sequencer during programming prevents erroneous execution if a trigger event were to occur during the configuration process.
- Configure the trigger event for the sample sequencer in the **ADCEMUX** register.
- For each sample in the sample sequence, configure the corresponding input source in the **ADCSSMUX_n** register.
- For each sample in the sample sequence, configure the sample control bits in the corresponding nibble in the **ADCSSCTL_n** register. When programming the last nibble, ensure that the **END** bit is set. Failure to set the **END** bit causes unpredictable behavior.
- If interrupts are to be used, set the corresponding **MASK** bit in the **ADCIM** register.
- Enable the sample sequencer logic by setting the corresponding **ASEN_n** bit in the **ADCACTSS** register.

13.5 Register Map

Table 13-5 on page 642 lists the ADC registers. The offset listed is a hexadecimal increment to the register's address, relative to that ADC module's base address of:

- ADC0: 0x4003.8000
- ADC1: 0x4003.9000

Note that the ADC module clock must be enabled before the registers can be programmed (see page 254). There must be a delay of 3 system clocks after the ADC module clock is enabled before any ADC module registers are accessed.

Table 13-5. ADC Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|----------|-------|-------------|--------------------------------|----------|
| 0x000 | ADCACTSS | R/W | 0x0000.0000 | ADC Active Sample Sequencer | 645 |
| 0x004 | ADCRIS | RO | 0x0000.0000 | ADC Raw Interrupt Status | 646 |
| 0x008 | ADCIM | R/W | 0x0000.0000 | ADC Interrupt Mask | 648 |
| 0x00C | ADCISC | R/W1C | 0x0000.0000 | ADC Interrupt Status and Clear | 650 |
| 0x010 | ADCOSTAT | R/W1C | 0x0000.0000 | ADC Overflow Status | 653 |
| 0x014 | ADCEMUX | R/W | 0x0000.0000 | ADC Event Multiplexer Select | 655 |

Table 13-5. ADC Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|-------------|-------|-------------|---|----------|
| 0x018 | ADCUSTAT | R/W1C | 0x0000.0000 | ADC Underflow Status | 660 |
| 0x020 | ADCSSPRI | R/W | 0x0000.3210 | ADC Sample Sequencer Priority | 661 |
| 0x024 | ADCSPC | R/W | 0x0000.0000 | ADC Sample Phase Control | 663 |
| 0x028 | ADCPSSI | R/W | - | ADC Processor Sample Sequence Initiate | 665 |
| 0x030 | ADCACSAC | R/W | 0x0000.0000 | ADC Sample Averaging Control | 667 |
| 0x034 | ADCDCISC | R/W1C | 0x0000.0000 | ADC Digital Comparator Interrupt Status and Clear | 668 |
| 0x038 | ADCCTL | R/W | 0x0000.0000 | ADC Control | 670 |
| 0x040 | ADCSSMUX0 | R/W | 0x0000.0000 | ADC Sample Sequence Input Multiplexer Select 0 | 671 |
| 0x044 | ADCSSCTL0 | R/W | 0x0000.0000 | ADC Sample Sequence Control 0 | 673 |
| 0x048 | ADCSSFIFO0 | RO | - | ADC Sample Sequence Result FIFO 0 | 676 |
| 0x04C | ADCSSFSTAT0 | RO | 0x0000.0100 | ADC Sample Sequence FIFO 0 Status | 677 |
| 0x050 | ADCSSOP0 | R/W | 0x0000.0000 | ADC Sample Sequence 0 Operation | 679 |
| 0x054 | ADCSSDC0 | R/W | 0x0000.0000 | ADC Sample Sequence 0 Digital Comparator Select | 681 |
| 0x060 | ADCSSMUX1 | R/W | 0x0000.0000 | ADC Sample Sequence Input Multiplexer Select 1 | 683 |
| 0x064 | ADCSSCTL1 | R/W | 0x0000.0000 | ADC Sample Sequence Control 1 | 684 |
| 0x068 | ADCSSFIFO1 | RO | - | ADC Sample Sequence Result FIFO 1 | 676 |
| 0x06C | ADCSSFSTAT1 | RO | 0x0000.0100 | ADC Sample Sequence FIFO 1 Status | 677 |
| 0x070 | ADCSSOP1 | R/W | 0x0000.0000 | ADC Sample Sequence 1 Operation | 686 |
| 0x074 | ADCSSDC1 | R/W | 0x0000.0000 | ADC Sample Sequence 1 Digital Comparator Select | 687 |
| 0x080 | ADCSSMUX2 | R/W | 0x0000.0000 | ADC Sample Sequence Input Multiplexer Select 2 | 683 |
| 0x084 | ADCSSCTL2 | R/W | 0x0000.0000 | ADC Sample Sequence Control 2 | 684 |
| 0x088 | ADCSSFIFO2 | RO | - | ADC Sample Sequence Result FIFO 2 | 676 |
| 0x08C | ADCSSFSTAT2 | RO | 0x0000.0100 | ADC Sample Sequence FIFO 2 Status | 677 |
| 0x090 | ADCSSOP2 | R/W | 0x0000.0000 | ADC Sample Sequence 2 Operation | 686 |
| 0x094 | ADCSSDC2 | R/W | 0x0000.0000 | ADC Sample Sequence 2 Digital Comparator Select | 687 |
| 0x0A0 | ADCSSMUX3 | R/W | 0x0000.0000 | ADC Sample Sequence Input Multiplexer Select 3 | 689 |
| 0x0A4 | ADCSSCTL3 | R/W | 0x0000.0002 | ADC Sample Sequence Control 3 | 690 |
| 0x0A8 | ADCSSFIFO3 | RO | - | ADC Sample Sequence Result FIFO 3 | 676 |
| 0x0AC | ADCSSFSTAT3 | RO | 0x0000.0100 | ADC Sample Sequence FIFO 3 Status | 677 |
| 0x0B0 | ADCSSOP3 | R/W | 0x0000.0000 | ADC Sample Sequence 3 Operation | 691 |
| 0x0B4 | ADCSSDC3 | R/W | 0x0000.0000 | ADC Sample Sequence 3 Digital Comparator Select | 692 |
| 0xD00 | ADCDCRIC | R/W | 0x0000.0000 | ADC Digital Comparator Reset Initial Conditions | 693 |

Table 13-5. ADC Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|------------|------|-------------|----------------------------------|----------|
| 0xE00 | ADDCDCCTL0 | R/W | 0x0000.0000 | ADC Digital Comparator Control 0 | 698 |
| 0xE04 | ADDCDCCTL1 | R/W | 0x0000.0000 | ADC Digital Comparator Control 1 | 698 |
| 0xE08 | ADDCDCCTL2 | R/W | 0x0000.0000 | ADC Digital Comparator Control 2 | 698 |
| 0xE0C | ADDCDCCTL3 | R/W | 0x0000.0000 | ADC Digital Comparator Control 3 | 698 |
| 0xE10 | ADDCDCCTL4 | R/W | 0x0000.0000 | ADC Digital Comparator Control 4 | 698 |
| 0xE14 | ADDCDCCTL5 | R/W | 0x0000.0000 | ADC Digital Comparator Control 5 | 698 |
| 0xE18 | ADDCDCCTL6 | R/W | 0x0000.0000 | ADC Digital Comparator Control 6 | 698 |
| 0xE1C | ADDCDCCTL7 | R/W | 0x0000.0000 | ADC Digital Comparator Control 7 | 698 |
| 0xE40 | ADCDCCMP0 | R/W | 0x0000.0000 | ADC Digital Comparator Range 0 | 701 |
| 0xE44 | ADCDCCMP1 | R/W | 0x0000.0000 | ADC Digital Comparator Range 1 | 701 |
| 0xE48 | ADCDCCMP2 | R/W | 0x0000.0000 | ADC Digital Comparator Range 2 | 701 |
| 0xE4C | ADCDCCMP3 | R/W | 0x0000.0000 | ADC Digital Comparator Range 3 | 701 |
| 0xE50 | ADCDCCMP4 | R/W | 0x0000.0000 | ADC Digital Comparator Range 4 | 701 |
| 0xE54 | ADCDCCMP5 | R/W | 0x0000.0000 | ADC Digital Comparator Range 5 | 701 |
| 0xE58 | ADCDCCMP6 | R/W | 0x0000.0000 | ADC Digital Comparator Range 6 | 701 |
| 0xE5C | ADCDCCMP7 | R/W | 0x0000.0000 | ADC Digital Comparator Range 7 | 701 |

13.6 Register Descriptions

The remainder of this section lists and describes the ADC registers, in numerical order by address offset.

Register 1: ADC Active Sample Sequencer (ADCACTSS), offset 0x000

This register controls the activation of the sample sequencers. Each sample sequencer can be enabled or disabled independently.

ADC Active Sample Sequencer (ADCACTSS)

ADC0 base: 0x4003.8000

ADC1 base: 0x4003.9000

Offset 0x000

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-------|-------|-------|-------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | ASEN3 | ASEN2 | ASEN1 | ASEN0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | ASEN3 | R/W | 0 | ADC SS3 Enable Value Description 1 Sample Sequencer 3 is enabled. 0 Sample Sequencer 3 is disabled. |
| 2 | ASEN2 | R/W | 0 | ADC SS2 Enable Value Description 1 Sample Sequencer 2 is enabled. 0 Sample Sequencer 2 is disabled. |
| 1 | ASEN1 | R/W | 0 | ADC SS1 Enable Value Description 1 Sample Sequencer 1 is enabled. 0 Sample Sequencer 1 is disabled. |
| 0 | ASEN0 | R/W | 0 | ADC SS0 Enable Value Description 1 Sample Sequencer 0 is enabled. 0 Sample Sequencer 0 is disabled. |

Register 2: ADC Raw Interrupt Status (ADCRIS), offset 0x004

This register shows the status of the raw interrupt signal of each sample sequencer. These bits may be polled by software to look for interrupt conditions without sending the interrupts to the interrupt controller.

ADC Raw Interrupt Status (ADCRIS)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x004
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|------|------|------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | INRDC |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | INR3 | INR2 | INR1 | INR0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:17 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 16 | INRDC | RO | 0 | Digital Comparator Raw Interrupt Status Value Description 1 At least one bit in the ADCDCISC register is set, meaning that a digital comparator interrupt has occurred. 0 All bits in the ADCDCISC register are clear. |
| 15:4 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | INR3 | RO | 0 | SS3 Raw Interrupt Status Value Description 1 A sample has completed conversion and the respective ADCSSCTL3 IEn bit is set, enabling a raw interrupt. 0 An interrupt has not occurred. This bit is cleared by writing a 1 to the IN3 bit in the ADCISC register. |
| 2 | INR2 | RO | 0 | SS2 Raw Interrupt Status Value Description 1 A sample has completed conversion and the respective ADCSSCTL2 IEn bit is set, enabling a raw interrupt. 0 An interrupt has not occurred. This bit is cleared by writing a 1 to the IN2 bit in the ADCISC register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 1 | INR1 | RO | 0 | <p>SS1 Raw Interrupt Status</p> <p>Value Description</p> <p>1 A sample has completed conversion and the respective ADCSSCTL1 I_{En} bit is set, enabling a raw interrupt.</p> <p>0 An interrupt has not occurred.</p> <p>This bit is cleared by writing a 1 to the $IN1$ bit in the ADCISC register.</p> |
| 0 | INR0 | RO | 0 | <p>SS0 Raw Interrupt Status</p> <p>Value Description</p> <p>1 A sample has completed conversion and the respective ADCSSCTL0 I_{En} bit is set, enabling a raw interrupt.</p> <p>0 An interrupt has not occurred.</p> <p>This bit is cleared by writing a 1 to the $IN0$ bit in the ADCISC register.</p> |

Register 3: ADC Interrupt Mask (ADCIM), offset 0x008

This register controls whether the sample sequencer and digital comparator raw interrupt signals are sent to the interrupt controller. Each raw interrupt signal can be masked independently. Only a single DCONSS_n bit should be set at any given time. Setting more than one of these bits results in the INRDC bit from the ADCRIS register being masked, and no interrupt is generated on any of the sample sequencer interrupt lines.

ADC Interrupt Mask (ADCIM)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x008
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|---------|---------|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | DCONSS3 | DCONSS2 | DCONSS1 | DCONSS0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | MASK3 | MASK2 | MASK1 | MASK0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:20 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 19 | DCONSS3 | R/W | 0 | Digital Comparator Interrupt on SS3 Value Description 1 The raw interrupt signal from the digital comparators (INRDC bit in the ADCRIS register) is sent to the interrupt controller on the SS3 interrupt line. 0 The status of the digital comparators does not affect the SS3 interrupt status. |
| 18 | DCONSS2 | R/W | 0 | Digital Comparator Interrupt on SS2 Value Description 1 The raw interrupt signal from the digital comparators (INRDC bit in the ADCRIS register) is sent to the interrupt controller on the SS2 interrupt line. 0 The status of the digital comparators does not affect the SS2 interrupt status. |
| 17 | DCONSS1 | R/W | 0 | Digital Comparator Interrupt on SS1 Value Description 1 The raw interrupt signal from the digital comparators (INRDC bit in the ADCRIS register) is sent to the interrupt controller on the SS1 interrupt line. 0 The status of the digital comparators does not affect the SS1 interrupt status. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 16 | DCONSS0 | R/W | 0 | Digital Comparator Interrupt on SS0 Value Description 1 The raw interrupt signal from the digital comparators (<i>INRDC</i> bit in the ADCRIS register) is sent to the interrupt controller on the SS0 interrupt line. 0 The status of the digital comparators does not affect the SS0 interrupt status. |
| 15:4 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | MASK3 | R/W | 0 | SS3 Interrupt Mask Value Description 1 The raw interrupt signal from Sample Sequencer 3 (ADCRIS register <i>INR3</i> bit) is sent to the interrupt controller. 0 The status of Sample Sequencer 3 does not affect the SS3 interrupt status. |
| 2 | MASK2 | R/W | 0 | SS2 Interrupt Mask Value Description 1 The raw interrupt signal from Sample Sequencer 2 (ADCRIS register <i>INR2</i> bit) is sent to the interrupt controller. 0 The status of Sample Sequencer 2 does not affect the SS2 interrupt status. |
| 1 | MASK1 | R/W | 0 | SS1 Interrupt Mask Value Description 1 The raw interrupt signal from Sample Sequencer 1 (ADCRIS register <i>INR1</i> bit) is sent to the interrupt controller. 0 The status of Sample Sequencer 1 does not affect the SS1 interrupt status. |
| 0 | MASK0 | R/W | 0 | SS0 Interrupt Mask Value Description 1 The raw interrupt signal from Sample Sequencer 0 (ADCRIS register <i>INR0</i> bit) is sent to the interrupt controller. 0 The status of Sample Sequencer 0 does not affect the SS0 interrupt status. |

Register 4: ADC Interrupt Status and Clear (ADCISC), offset 0x00C

This register provides the mechanism for clearing sample sequencer interrupt conditions and shows the status of interrupts generated by the sample sequencers and the digital comparators which have been sent to the interrupt controller. When read, each bit field is the logical AND of the respective **INR** and **MASK** bits. Sample sequencer interrupts are cleared by writing a 1 to the corresponding bit position. Digital comparator interrupts are cleared by writing a 1 to the appropriate bits in the **ADCDCISC** register. If software is polling the **ADCRIS** instead of generating interrupts, the sample sequence **INR_n** bits are still cleared via the **ADCISC** register, even if the **IN_n** bit is not set.

ADC Interrupt Status and Clear (ADCISC)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x00C
 Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|---------|---------|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | DCINSS3 | DCINSS2 | DCINSS1 | DCINSS0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | IN3 | IN2 | IN1 | IN0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:20 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 19 | DCINSS3 | RO | 0 | Digital Comparator Interrupt Status on SS3 Value Description 1 Both the INRDC bit in the ADCRIS register and the DCONSS3 bit in the ADCIM register are set, providing a level-based interrupt to the interrupt controller. 0 No interrupt has occurred or the interrupt is masked. This bit is cleared by writing a 1 to it. Clearing this bit also clears the INRDC bit in the ADCRIS register. |
| 18 | DCINSS2 | RO | 0 | Digital Comparator Interrupt Status on SS2 Value Description 1 Both the INRDC bit in the ADCRIS register and the DCONSS2 bit in the ADCIM register are set, providing a level-based interrupt to the interrupt controller. 0 No interrupt has occurred or the interrupt is masked. This bit is cleared by writing a 1 to it. Clearing this bit also clears the INRDC bit in the ADCRIS register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-------|---|
| 17 | DCINSS1 | RO | 0 | <p>Digital Comparator Interrupt Status on SS1</p> <p>Value Description</p> <p>1 Both the <code>INRDC</code> bit in the ADCRIS register and the <code>DCONSS1</code> bit in the ADCIM register are set, providing a level-based interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1 to it. Clearing this bit also clears the <code>INRDC</code> bit in the ADCRIS register.</p> |
| 16 | DCINSS0 | RO | 0 | <p>Digital Comparator Interrupt Status on SS0</p> <p>Value Description</p> <p>1 Both the <code>INRDC</code> bit in the ADCRIS register and the <code>DCONSS0</code> bit in the ADCIM register are set, providing a level-based interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1 to it. Clearing this bit also clears the <code>INRDC</code> bit in the ADCRIS register.</p> |
| 15:4 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 3 | IN3 | R/W1C | 0 | <p>SS3 Interrupt Status and Clear</p> <p>Value Description</p> <p>1 Both the <code>INR3</code> bit in the ADCRIS register and the <code>MASK3</code> bit in the ADCIM register are set, providing a level-based interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the <code>INR3</code> bit in the ADCRIS register.</p> |
| 2 | IN2 | R/W1C | 0 | <p>SS2 Interrupt Status and Clear</p> <p>Value Description</p> <p>1 Both the <code>INR2</code> bit in the ADCRIS register and the <code>MASK2</code> bit in the ADCIM register are set, providing a level-based interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the <code>INR2</code> bit in the ADCRIS register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|-------|-------|---|
| 1 | IN1 | R/W1C | 0 | <p>SS1 Interrupt Status and Clear</p> <p>Value Description</p> <p>1 Both the <code>INR1</code> bit in the ADCRIS register and the <code>MASK1</code> bit in the ADCIM register are set, providing a level-based interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the <code>INR1</code> bit in the ADCRIS register.</p> |
| 0 | IN0 | R/W1C | 0 | <p>SS0 Interrupt Status and Clear</p> <p>Value Description</p> <p>1 Both the <code>INR0</code> bit in the ADCRIS register and the <code>MASK0</code> bit in the ADCIM register are set, providing a level-based interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the <code>INR0</code> bit in the ADCRIS register.</p> |

Register 5: ADC Overflow Status (ADCOSTAT), offset 0x010

This register indicates overflow conditions in the sample sequencer FIFOs. Once the overflow condition has been handled by software, the condition can be cleared by writing a 1 to the corresponding bit position.

ADC Overflow Status (ADCOSTAT)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x010
 Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-----|-------|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | OV3 | OV2 | OV1 | OV0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|------------|--|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | OV3 | R/W1C | 0 | SS3 FIFO Overflow Value Description 1 The FIFO for Sample Sequencer 3 has hit an overflow condition, meaning that the FIFO is full and a write was requested. When an overflow is detected, the most recent write is dropped. 0 The FIFO has not overflowed. This bit is cleared by writing a 1. |
| 2 | OV2 | R/W1C | 0 | SS2 FIFO Overflow Value Description 1 The FIFO for Sample Sequencer 2 has hit an overflow condition, meaning that the FIFO is full and a write was requested. When an overflow is detected, the most recent write is dropped. 0 The FIFO has not overflowed. This bit is cleared by writing a 1. |
| 1 | OV1 | R/W1C | 0 | SS1 FIFO Overflow Value Description 1 The FIFO for Sample Sequencer 1 has hit an overflow condition, meaning that the FIFO is full and a write was requested. When an overflow is detected, the most recent write is dropped. 0 The FIFO has not overflowed. This bit is cleared by writing a 1. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|-------|-------|---|
| 0 | OV0 | R/W1C | 0 | SS0 FIFO Overflow |
| | | | | Value Description |
| | | | | 1 The FIFO for Sample Sequencer 0 has hit an overflow condition, meaning that the FIFO is full and a write was requested. When an overflow is detected, the most recent write is dropped. |
| | | | | 0 The FIFO has not overflowed. |
| | | | | This bit is cleared by writing a 1. |

Register 6: ADC Event Multiplexer Select (ADCEMUX), offset 0x014

The **ADCEMUX** selects the event (trigger) that initiates sampling for each sample sequencer. Each sample sequencer can be configured with a unique trigger source.

ADC Event Multiplexer Select (ADCEMUX)

ADC0 base: 0x4003.8000

ADC1 base: 0x4003.9000

Offset 0x014

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | EM3 | | | | EM2 | | | | EM1 | | | | EM0 | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|---|------|-------|---|-------|-------|-----|---|-----|--|-----|--|-----|--|-----|---|-----|---|-----|---|-----|---|-----|---|-----|---|---------|----------|--|--|--|-----|------------------------------|--|--|--|
| 15:12 | EM3 | R/W | 0x0 | <p>SS3 Trigger Select</p> <p>This field selects the trigger source for Sample Sequencer 3. The valid configurations for this field are:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Event</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td> <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> </td> </tr> <tr> <td>0x1</td> <td> <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> </td> </tr> <tr> <td>0x2</td> <td> <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> </td> </tr> <tr> <td>0x3</td> <td> <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> </td> </tr> <tr> <td>0x4</td> <td> <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> </td> </tr> <tr> <td>0x5</td> <td> <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> </td> </tr> <tr> <td>0x6</td> <td> <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> </td> </tr> <tr> <td>0x7</td> <td> <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> </td> </tr> <tr> <td>0x8</td> <td> <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> </td> </tr> <tr> <td>0x9</td> <td> <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> </td> </tr> <tr> <td>0xA-0xE</td> <td>reserved</td> <td></td> <td></td> <td></td> </tr> <tr> <td>0xF</td> <td>Always (continuously sample)</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> | Value | Event | 0x0 | <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> | 0x1 | <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> | 0x2 | <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> | 0x3 | <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> | 0x4 | <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> | 0x5 | <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> | 0x6 | <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> | 0x7 | <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> | 0x8 | <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> | 0x9 | <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> | 0xA-0xE | reserved | | | | 0xF | Always (continuously sample) | | | |
| Value | Event | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x8 | <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x9 | <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0xA-0xE | reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0xF | Always (continuously sample) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|---|------|-------|--|-------|-------|-----|---|-----|--|-----|--|-----|--|-----|---|-----|---|-----|---|-----|---|-----|---|-----|---|---------|----------|--|--|--|-----|------------------------------|--|--|--|
| 11:8 | EM2 | R/W | 0x0 | <p>SS2 Trigger Select</p> <p>This field selects the trigger source for Sample Sequencer 2.</p> <p>The valid configurations for this field are:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Event</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td> <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> </td> </tr> <tr> <td>0x1</td> <td> <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> </td> </tr> <tr> <td>0x2</td> <td> <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> </td> </tr> <tr> <td>0x3</td> <td> <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> </td> </tr> <tr> <td>0x4</td> <td> <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> </td> </tr> <tr> <td>0x5</td> <td> <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> </td> </tr> <tr> <td>0x6</td> <td> <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> </td> </tr> <tr> <td>0x7</td> <td> <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> </td> </tr> <tr> <td>0x8</td> <td> <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> </td> </tr> <tr> <td>0x9</td> <td> <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> </td> </tr> <tr> <td>0xA-0xE</td> <td>reserved</td> <td></td> <td></td> <td></td> </tr> <tr> <td>0xF</td> <td>Always (continuously sample)</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> | Value | Event | 0x0 | <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> | 0x1 | <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> | 0x2 | <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> | 0x3 | <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> | 0x4 | <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> | 0x5 | <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> | 0x6 | <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> | 0x7 | <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> | 0x8 | <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> | 0x9 | <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> | 0xA-0xE | reserved | | | | 0xF | Always (continuously sample) | | | |
| Value | Event | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x8 | <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x9 | <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0xA-0xE | reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0xF | Always (continuously sample) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|---|------|-------|---|-------|-------|-----|---|-----|--|-----|--|-----|--|-----|---|-----|---|-----|---|-----|---|-----|---|-----|---|---------|----------|--|--|--|-----|------------------------------|--|--|--|
| 7:4 | EM1 | R/W | 0x0 | <p>SS1 Trigger Select</p> <p>This field selects the trigger source for Sample Sequencer 1. The valid configurations for this field are:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Event</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td> <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> </td> </tr> <tr> <td>0x1</td> <td> <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> </td> </tr> <tr> <td>0x2</td> <td> <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> </td> </tr> <tr> <td>0x3</td> <td> <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> </td> </tr> <tr> <td>0x4</td> <td> <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> </td> </tr> <tr> <td>0x5</td> <td> <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> </td> </tr> <tr> <td>0x6</td> <td> <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> </td> </tr> <tr> <td>0x7</td> <td> <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> </td> </tr> <tr> <td>0x8</td> <td> <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> </td> </tr> <tr> <td>0x9</td> <td> <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> </td> </tr> <tr> <td>0xA-0xE</td> <td>reserved</td> <td></td> <td></td> <td></td> </tr> <tr> <td>0xF</td> <td>Always (continuously sample)</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> | Value | Event | 0x0 | <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> | 0x1 | <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> | 0x2 | <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> | 0x3 | <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> | 0x4 | <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> | 0x5 | <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> | 0x6 | <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> | 0x7 | <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> | 0x8 | <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> | 0x9 | <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> | 0xA-0xE | reserved | | | | 0xF | Always (continuously sample) | | | |
| Value | Event | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x8 | <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x9 | <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0xA-0xE | reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0xF | Always (continuously sample) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|---|------|-------|---|-------|-------|-----|---|-----|--|-----|--|-----|--|-----|---|-----|---|-----|---|-----|---|-----|---|-----|---|---------|----------|--|--|--|-----|------------------------------|--|--|--|
| 3:0 | EM0 | R/W | 0x0 | <p>SS0 Trigger Select</p> <p>This field selects the trigger source for Sample Sequencer 0</p> <p>The valid configurations for this field are:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Event</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td> <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> </td> </tr> <tr> <td>0x1</td> <td> <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> </td> </tr> <tr> <td>0x2</td> <td> <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> </td> </tr> <tr> <td>0x3</td> <td> <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> </td> </tr> <tr> <td>0x4</td> <td> <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> </td> </tr> <tr> <td>0x5</td> <td> <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> </td> </tr> <tr> <td>0x6</td> <td> <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> </td> </tr> <tr> <td>0x7</td> <td> <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> </td> </tr> <tr> <td>0x8</td> <td> <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> </td> </tr> <tr> <td>0x9</td> <td> <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> </td> </tr> <tr> <td>0xA-0xE</td> <td>reserved</td> <td></td> <td></td> <td></td> </tr> <tr> <td>0xF</td> <td>Always (continuously sample)</td> <td></td> <td></td> <td></td> </tr> </tbody> </table> | Value | Event | 0x0 | <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> | 0x1 | <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> | 0x2 | <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> | 0x3 | <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> | 0x4 | <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> | 0x5 | <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> | 0x6 | <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> | 0x7 | <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> | 0x8 | <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> | 0x9 | <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> | 0xA-0xE | reserved | | | | 0xF | Always (continuously sample) | | | |
| Value | Event | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | <p>Processor (default)</p> <p>The trigger is initiated by setting the SS_n bit in the ADCPSSI register.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | <p>Analog Comparator 0</p> <p>This trigger is configured by the Analog Comparator Control 0 (ACCTL0) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | <p>Analog Comparator 1</p> <p>This trigger is configured by the Analog Comparator Control 1 (ACCTL1) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | <p>Analog Comparator 2</p> <p>This trigger is configured by the Analog Comparator Control 2 (ACCTL2) register (page 947).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | <p>External (GPIO $PB4$)</p> <p>This trigger is connected to the GPIO interrupt for $PB4$ (see “ADC Trigger Source” on page 427).</p> <p>Note: $PB4$ can be used to trigger the ADC. However, the $PB4/AIN10$ pin cannot be used as both a GPIO and an analog input.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | <p>Timer</p> <p>In addition, the trigger must be enabled with the $TnOTE$ bit in the GPTMCTL register (page 572).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | <p>PWM0</p> <p>The PWM generator 0 trigger can be configured with the PWM0 Interrupt and Trigger Enable (PWM0INTEN) register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | <p>PWM1</p> <p>The PWM generator 1 trigger can be configured with the PWM1INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x8 | <p>PWM2</p> <p>The PWM generator 2 trigger can be configured with the PWM2INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x9 | <p>PWM3</p> <p>The PWM generator 3 trigger can be configured with the PWM3INTEN register (page 995).</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0xA-0xE | reserved | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0xF | Always (continuously sample) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Register 7: ADC Underflow Status (ADCUSTAT), offset 0x018

This register indicates underflow conditions in the sample sequencer FIFOs. The corresponding underflow condition is cleared by writing a 1 to the relevant bit position.

ADC Underflow Status (ADCUSTAT)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x018
 Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-----|-------|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | UV3 | UV2 | UV1 | UV0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|---|-------|------------|--|-------|-------------|---|---|---|-------------------------------|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 3 | UV3 | R/W1C | 0 | <p>SS3 FIFO Underflow</p> <p>The valid configurations for this field are shown below. This bit is cleared by writing a 1.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>The FIFO for the Sample Sequencer has hit an underflow condition, meaning that the FIFO is empty and a read was requested. The problematic read does not move the FIFO pointers, and 0s are returned.</td> </tr> <tr> <td>0</td> <td>The FIFO has not underflowed.</td> </tr> </tbody> </table> | Value | Description | 1 | The FIFO for the Sample Sequencer has hit an underflow condition, meaning that the FIFO is empty and a read was requested. The problematic read does not move the FIFO pointers, and 0s are returned. | 0 | The FIFO has not underflowed. |
| Value | Description | | | | | | | | | |
| 1 | The FIFO for the Sample Sequencer has hit an underflow condition, meaning that the FIFO is empty and a read was requested. The problematic read does not move the FIFO pointers, and 0s are returned. | | | | | | | | | |
| 0 | The FIFO has not underflowed. | | | | | | | | | |
| 2 | UV2 | R/W1C | 0 | <p>SS2 FIFO Underflow</p> <p>The valid configurations are the same as those for the UV3 field. This bit is cleared by writing a 1.</p> | | | | | | |
| 1 | UV1 | R/W1C | 0 | <p>SS1 FIFO Underflow</p> <p>The valid configurations are the same as those for the UV3 field. This bit is cleared by writing a 1.</p> | | | | | | |
| 0 | UV0 | R/W1C | 0 | <p>SS0 FIFO Underflow</p> <p>The valid configurations are the same as those for the UV3 field. This bit is cleared by writing a 1.</p> | | | | | | |

Register 8: ADC Sample Sequencer Priority (ADCSSPRI), offset 0x020

This register sets the priority for each of the sample sequencers. Out of reset, Sequencer 0 has the highest priority, and Sequencer 3 has the lowest priority. When reconfiguring sequence priorities, each sequence must have a unique priority for the ADC to operate properly.

ADC Sample Sequencer Priority (ADCSSPRI)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x020
 Type R/W, reset 0x0000.3210

| | | | | | | | | | | | | | | | | |
|-------|----------|----|-----|-----|----------|----|-----|-----|----------|----|-----|-----|----------|----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | SS3 | | reserved | | SS2 | | reserved | | SS1 | | reserved | | SS0 | |
| Type | RO | RO | R/W | R/W | RO | RO | R/W | R/W | RO | RO | R/W | R/W | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|--|
| 31:14 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13:12 | SS3 | R/W | 0x3 | SS3 Priority This field contains a binary-encoded value that specifies the priority encoding of Sample Sequencer 3. A priority encoding of 0x0 is highest and 0x3 is lowest. The priorities assigned to the sequencers must be uniquely mapped. The ADC may not operate properly if two or more fields are equal. |
| 11:10 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9:8 | SS2 | R/W | 0x2 | SS2 Priority This field contains a binary-encoded value that specifies the priority encoding of Sample Sequencer 2. A priority encoding of 0x0 is highest and 0x3 is lowest. The priorities assigned to the sequencers must be uniquely mapped. The ADC may not operate properly if two or more fields are equal. |
| 7:6 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5:4 | SS1 | R/W | 0x1 | SS1 Priority This field contains a binary-encoded value that specifies the priority encoding of Sample Sequencer 1. A priority encoding of 0x0 is highest and 0x3 is lowest. The priorities assigned to the sequencers must be uniquely mapped. The ADC may not operate properly if two or more fields are equal. |
| 3:2 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 1:0 | SS0 | R/W | 0x0 | SS0 Priority This field contains a binary-encoded value that specifies the priority encoding of Sample Sequencer 0. A priority encoding of 0x0 is highest and 0x3 is lowest. The priorities assigned to the sequencers must be uniquely mapped. The ADC may not operate properly if two or more fields are equal. |

Register 9: ADC Sample Phase Control (ADCSPC), offset 0x024

This register allows the ADC module to sample at one of 16 different discrete phases from 0.0° through 337.5°. For example, the sample rate could be effectively doubled by sampling a signal using one ADC module configured with the standard sample time and the second ADC module configured with a 180.0° phase lag.

Note: Care should be taken when the PHASE field is non-zero, as the resulting delay in sampling the AIN_x input may result in undesirable system consequences. The time from ADC trigger to sample is increased and could make the response time longer than anticipated. The added latency could have ramifications in the system design. Designers should carefully consider the impact of this delay.

ADC Sample Phase Control (ADCSPC)

ADC0 base: 0x4003.8000

ADC1 base: 0x4003.9000

Offset 0x024

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | PHASE | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|---|
| 3:0 | PHASE | R/W | 0x0 | Phase Difference This field selects the sample phase difference from the standard sample time. |
| | | | | Value Description |
| | | | 0x0 | ADC sample lags by 0.0° |
| | | | 0x1 | ADC sample lags by 22.5° |
| | | | 0x2 | ADC sample lags by 45.0° |
| | | | 0x3 | ADC sample lags by 67.5° |
| | | | 0x4 | ADC sample lags by 90.0° |
| | | | 0x5 | ADC sample lags by 112.5° |
| | | | 0x6 | ADC sample lags by 135.0° |
| | | | 0x7 | ADC sample lags by 157.5° |
| | | | 0x8 | ADC sample lags by 180.0° |
| | | | 0x9 | ADC sample lags by 202.5° |
| | | | 0xA | ADC sample lags by 225.0° |
| | | | 0xB | ADC sample lags by 247.5° |
| | | | 0xC | ADC sample lags by 270.0° |
| | | | 0xD | ADC sample lags by 292.5° |
| | | | 0xE | ADC sample lags by 315.0° |
| | | | 0xF | ADC sample lags by 337.5° |

Register 10: ADC Processor Sample Sequence Initiate (ADCPSSI), offset 0x028

This register provides a mechanism for application software to initiate sampling in the sample sequencers. Sample sequences can be initiated individually or in any combination. When multiple sequences are triggered simultaneously, the priority encodings in **ADCSSPRI** dictate execution order.

This register also provides a means to configure and then initiate concurrent sampling on all ADC modules. To do this, the first ADC module should be configured. The **ADCPSSI** register for that module should then be written. The appropriate **SS** bits should be set along with the **SYNCWAIT** bit. Additional ADC modules should then be configured following the same procedure. Once the final ADC module is configured, its **ADCPSSI** register should be written with the appropriate **SS** bits set along with the **GSYNC** bit. All of the ADC modules then begin concurrent sampling according to their configuration.

ADC Processor Sample Sequence Initiate (ADCPSSI)

ADC0 base: 0x4003.8000

ADC1 base: 0x4003.9000

Offset 0x028

Type R/W, reset -

| | | | | | | | | | | | | | | | | | |
|-------|----------|----------|----|----|-----|----------|----------|----|----|----|----|----|-----|-----|-----|-----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | GSYNC | reserved | | | | SYNCWAIT | reserved | | | | | | | | | | |
| Type | R/W | RO | RO | RO | R/W | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | SS3 | SS2 | SS1 | SS0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | WO | WO | WO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|--|
| 31 | GSYNC | R/W | 0 | Global Synchronize |
| | | | | Value Description |
| | | | | 1 This bit initiates sampling in multiple ADC modules at the same time. Any ADC module that has been initialized by setting an SS_n bit and the SYNCWAIT bit starts sampling once this bit is written. |
| | | | | 0 This bit is cleared once sampling has been initiated. |
| 30:28 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 27 | SYNCWAIT | R/W | 0 | Synchronize Wait |
| | | | | Value Description |
| | | | | 1 This bit allows the sample sequences to be initiated, but delays sampling until the GSYNC bit is set. |
| | | | | 0 Sampling begins when a sample sequence has been initiated. |
| 26:4 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 3 | SS3 | WO | - | <p>SS3 Initiate</p> <p>Value Description</p> <p>1 Begin sampling on Sample Sequencer 3, if the sequencer is enabled in the ADCACTSS register.</p> <p>0 No effect.</p> <p>Only a write by software is valid; a read of this register returns no meaningful data.</p> |
| 2 | SS2 | WO | - | <p>SS2 Initiate</p> <p>Value Description</p> <p>1 Begin sampling on Sample Sequencer 2, if the sequencer is enabled in the ADCACTSS register.</p> <p>0 No effect.</p> <p>Only a write by software is valid; a read of this register returns no meaningful data.</p> |
| 1 | SS1 | WO | - | <p>SS1 Initiate</p> <p>Value Description</p> <p>1 Begin sampling on Sample Sequencer 1, if the sequencer is enabled in the ADCACTSS register.</p> <p>0 No effect.</p> <p>Only a write by software is valid; a read of this register returns no meaningful data.</p> |
| 0 | SS0 | WO | - | <p>SS0 Initiate</p> <p>Value Description</p> <p>1 Begin sampling on Sample Sequencer 0, if the sequencer is enabled in the ADCACTSS register.</p> <p>0 No effect.</p> <p>Only a write by software is valid; a read of this register returns no meaningful data.</p> |

Register 11: ADC Sample Averaging Control (ADCSAC), offset 0x030

This register controls the amount of hardware averaging applied to conversion results. The final conversion result stored in the FIFO is averaged from 2^{AVG} consecutive ADC samples at the specified ADC speed. If AVG is 0, the sample is passed directly through without any averaging. If AVG=6, then 64 consecutive ADC samples are averaged to generate one result in the sequencer FIFO. An AVG=7 provides unpredictable results.

ADC Sample Averaging Control (ADCSAC)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x030
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | AVG | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|--|
| 31:3 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2:0 | AVG | R/W | 0x0 | Hardware Averaging Control Specifies the amount of hardware averaging that will be applied to ADC samples. The AVG field can be any value between 0 and 6. Entering a value of 7 creates unpredictable results. |
| | | | | Value Description |
| | | | | 0x0 No hardware oversampling |
| | | | | 0x1 2x hardware oversampling |
| | | | | 0x2 4x hardware oversampling |
| | | | | 0x3 8x hardware oversampling |
| | | | | 0x4 16x hardware oversampling |
| | | | | 0x5 32x hardware oversampling |
| | | | | 0x6 64x hardware oversampling |
| | | | | 0x7 reserved |

Register 12: ADC Digital Comparator Interrupt Status and Clear (ADCDCISC), offset 0x034

This register provides status and acknowledgement of digital comparator interrupts. One bit is provided for each comparator.

ADC Digital Comparator Interrupt Status and Clear (ADCDCISC)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x034
 Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|--------|--------|--------|--------|--------|--------|--------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DCINT7 | DCINT6 | DCINT5 | DCINT4 | DCINT3 | DCINT2 | DCINT1 | DCINT0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C | R/W1C | R/W1C | R/W1C | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | DCINT7 | R/W1C | 0 | Digital Comparator 7 Interrupt Status and Clear Value Description 1 Digital Comparator 7 has generated an interrupt. 0 No interrupt. This bit is cleared by writing a 1. |
| 6 | DCINT6 | R/W1C | 0 | Digital Comparator 6 Interrupt Status and Clear Value Description 1 Digital Comparator 6 has generated an interrupt. 0 No interrupt. This bit is cleared by writing a 1. |
| 5 | DCINT5 | R/W1C | 0 | Digital Comparator 5 Interrupt Status and Clear Value Description 1 Digital Comparator 5 has generated an interrupt. 0 No interrupt. This bit is cleared by writing a 1. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|-------|-------|---|
| 4 | DCINT4 | R/W1C | 0 | <p>Digital Comparator 4 Interrupt Status and Clear</p> <p>Value Description</p> <p>1 Digital Comparator 4 has generated an interrupt.</p> <p>0 No interrupt.</p> <p>This bit is cleared by writing a 1.</p> |
| 3 | DCINT3 | R/W1C | 0 | <p>Digital Comparator 3 Interrupt Status and Clear</p> <p>Value Description</p> <p>1 Digital Comparator 3 has generated an interrupt.</p> <p>0 No interrupt.</p> <p>This bit is cleared by writing a 1.</p> |
| 2 | DCINT2 | R/W1C | 0 | <p>Digital Comparator 2 Interrupt Status and Clear</p> <p>Value Description</p> <p>1 Digital Comparator 2 has generated an interrupt.</p> <p>0 No interrupt.</p> <p>This bit is cleared by writing a 1.</p> |
| 1 | DCINT1 | R/W1C | 0 | <p>Digital Comparator 1 Interrupt Status and Clear</p> <p>Value Description</p> <p>1 Digital Comparator 1 has generated an interrupt.</p> <p>0 No interrupt.</p> <p>This bit is cleared by writing a 1.</p> |
| 0 | DCINT0 | R/W1C | 0 | <p>Digital Comparator 0 Interrupt Status and Clear</p> <p>Value Description</p> <p>1 Digital Comparator 0 has generated an interrupt.</p> <p>0 No interrupt.</p> <p>This bit is cleared by writing a 1.</p> |

Register 13: ADC Control (ADCCTL), offset 0x038

This register configures various ADC module attributes, including the ADC resolution and the voltage reference. The resolution of the ADC defaults to 10-bit for backwards compatibility with other members of the Stellaris family, but can be configured to 12-bit resolution. The voltage reference for the conversion can be the internal 3.0-V reference, an external voltage reference in the range of 2.4 V to 3.06 V, or an external voltage reference in the range of 0.8 V to 1.02 V.

ADC Control (ADCCTL)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x038
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-----|----------|----|------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | RES | reserved | | VREF | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|--|
| 31:5 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | RES | R/W | 0 | Sample Resolution Value Description 1 The ADC returns 12-bit data to the FIFOs. 0 The ADC returns 10-bit data to the FIFOs. |
| 3:2 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1:0 | VREF | R/W | 0x0 | Voltage Reference Select Value Description 0x0 Internal Reference The internal reference as the voltage reference. The conversion range is from 0 V to 3.0 V. 0x1 3.0 V External Reference A 3.0 V external VREFEA input is the voltage reference. The ADC conversion range is 0.0 V to the voltage of the VREFEA input. 0x2 Reserved 0x3 1.0 V External Reference A 1.0 V external VREFEA input is the voltage reference. The ADC conversion range is 0.0 V to three times the voltage of the VREFEA input. |

Register 14: ADC Sample Sequence Input Multiplexer Select 0 (ADCSSMUX0), offset 0x040

This register defines the analog input configuration for each sample in a sequence executed with Sample Sequencer 0. This register is 32 bits wide and contains information for eight possible samples.

ADC Sample Sequence Input Multiplexer Select 0 (ADCSSMUX0)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x040
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | MUX7 | | | | MUX6 | | | | MUX5 | | | | MUX4 | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MUX3 | | | | MUX2 | | | | MUX1 | | | | MUX0 | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 31:28 | MUX7 | R/W | 0x0 | 8th Sample Input Select The MUX7 field is used during the eighth sample of a sequence executed with the sample sequencer. It specifies which of the analog inputs is sampled for the analog-to-digital conversion. The value set here indicates the corresponding pin, for example, a value of 0x1 indicates the input is AIN1. |
| 27:24 | MUX6 | R/W | 0x0 | 7th Sample Input Select The MUX6 field is used during the seventh sample of a sequence executed with the sample sequencer. It specifies which of the analog inputs is sampled for the analog-to-digital conversion. |
| 23:20 | MUX5 | R/W | 0x0 | 6th Sample Input Select The MUX5 field is used during the sixth sample of a sequence executed with the sample sequencer. It specifies which of the analog inputs is sampled for the analog-to-digital conversion. |
| 19:16 | MUX4 | R/W | 0x0 | 5th Sample Input Select The MUX4 field is used during the fifth sample of a sequence executed with the sample sequencer. It specifies which of the analog inputs is sampled for the analog-to-digital conversion. |
| 15:12 | MUX3 | R/W | 0x0 | 4th Sample Input Select The MUX3 field is used during the fourth sample of a sequence executed with the sample sequencer. It specifies which of the analog inputs is sampled for the analog-to-digital conversion. |
| 11:8 | MUX2 | R/W | 0x0 | 3rd Sample Input Select The MUX2 field is used during the third sample of a sequence executed with the sample sequencer. It specifies which of the analog inputs is sampled for the analog-to-digital conversion. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 7:4 | MUX1 | R/W | 0x0 | 2nd Sample Input Select The MUX1 field is used during the second sample of a sequence executed with the sample sequencer. It specifies which of the analog inputs is sampled for the analog-to-digital conversion. |
| 3:0 | MUX0 | R/W | 0x0 | 1st Sample Input Select The MUX0 field is used during the first sample of a sequence executed with the sample sequencer. It specifies which of the analog inputs is sampled for the analog-to-digital conversion. |

Register 15: ADC Sample Sequence Control 0 (ADCSSCTL0), offset 0x044

This register contains the configuration information for each sample for a sequence executed with a sample sequencer. When configuring a sample sequence, the `END` bit must be set for the final sample, whether it be after the first sample, eighth sample, or any sample in between. This register is 32 bits wide and contains information for eight possible samples.

ADC Sample Sequence Control 0 (ADCSSCTL0)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x044
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|-----|-----|------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | TS7 | IE7 | END7 | D7 | TS6 | IE6 | END6 | D6 | TS5 | IE5 | END5 | D5 | TS4 | IE4 | END4 | D4 |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | TS3 | IE3 | END3 | D3 | TS2 | IE2 | END2 | D2 | TS1 | IE1 | END1 | D1 | TS0 | IE0 | END0 | D0 |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 31 | TS7 | R/W | 0 | 8th Sample Temp Sensor Select |
| | | | | Value Description |
| | | | | 1 The temperature sensor is read during the eighth sample of the sample sequence. |
| | | | | 0 The input pin specified by the ADCSSMUXn register is read during the eighth sample of the sample sequence. |
| 30 | IE7 | R/W | 0 | 8th Sample Interrupt Enable |
| | | | | Value Description |
| | | | | 1 The raw interrupt signal (<code>INR0</code> bit) is asserted at the end of the eighth sample's conversion. If the <code>MASK0</code> bit in the ADCIM register is set, the interrupt is promoted to the interrupt controller. |
| | | | | 0 The raw interrupt is not asserted to the interrupt controller. |
| | | | | It is legal to have multiple samples within a sequence generate interrupts. |
| 29 | END7 | R/W | 0 | 8th Sample is End of Sequence |
| | | | | Value Description |
| | | | | 1 The eighth sample is the last sample of the sequence. |
| | | | | 0 Another sample in the sequence is the final sample. |
| | | | | It is possible to end the sequence on any sample position. Software must set an <code>ENDn</code> bit somewhere within the sequence. Samples defined after the sample containing a set <code>ENDn</code> bit are not requested for conversion even though the fields may be non-zero. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 28 | D7 | R/W | 0 | 8th Sample Diff Input Select Value Description 1 The analog input is differentially sampled. The corresponding ADCSSMUXn nibble must be set to the pair number "i", where the paired inputs are "2i and 2i+1". 0 The analog inputs are not differentially sampled. Because the temperature sensor does not have a differential option, this bit must not be set when the TS7 bit is set. |
| 27 | TS6 | R/W | 0 | 7th Sample Temp Sensor Select Same definition as TS7 but used during the seventh sample. |
| 26 | IE6 | R/W | 0 | 7th Sample Interrupt Enable Same definition as IE7 but used during the seventh sample. |
| 25 | END6 | R/W | 0 | 7th Sample is End of Sequence Same definition as END7 but used during the seventh sample. |
| 24 | D6 | R/W | 0 | 7th Sample Diff Input Select Same definition as D7 but used during the seventh sample. |
| 23 | TS5 | R/W | 0 | 6th Sample Temp Sensor Select Same definition as TS7 but used during the sixth sample. |
| 22 | IE5 | R/W | 0 | 6th Sample Interrupt Enable Same definition as IE7 but used during the sixth sample. |
| 21 | END5 | R/W | 0 | 6th Sample is End of Sequence Same definition as END7 but used during the sixth sample. |
| 20 | D5 | R/W | 0 | 6th Sample Diff Input Select Same definition as D7 but used during the sixth sample. |
| 19 | TS4 | R/W | 0 | 5th Sample Temp Sensor Select Same definition as TS7 but used during the fifth sample. |
| 18 | IE4 | R/W | 0 | 5th Sample Interrupt Enable Same definition as IE7 but used during the fifth sample. |
| 17 | END4 | R/W | 0 | 5th Sample is End of Sequence Same definition as END7 but used during the fifth sample. |
| 16 | D4 | R/W | 0 | 5th Sample Diff Input Select Same definition as D7 but used during the fifth sample. |
| 15 | TS3 | R/W | 0 | 4th Sample Temp Sensor Select Same definition as TS7 but used during the fourth sample. |
| 14 | IE3 | R/W | 0 | 4th Sample Interrupt Enable Same definition as IE7 but used during the fourth sample. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 13 | END3 | R/W | 0 | 4th Sample is End of Sequence Same definition as END7 but used during the fourth sample. |
| 12 | D3 | R/W | 0 | 4th Sample Diff Input Select Same definition as D7 but used during the fourth sample. |
| 11 | TS2 | R/W | 0 | 3rd Sample Temp Sensor Select Same definition as TS7 but used during the third sample. |
| 10 | IE2 | R/W | 0 | 3rd Sample Interrupt Enable Same definition as IE7 but used during the third sample. |
| 9 | END2 | R/W | 0 | 3rd Sample is End of Sequence Same definition as END7 but used during the third sample. |
| 8 | D2 | R/W | 0 | 3rd Sample Diff Input Select Same definition as D7 but used during the third sample. |
| 7 | TS1 | R/W | 0 | 2nd Sample Temp Sensor Select Same definition as TS7 but used during the second sample. |
| 6 | IE1 | R/W | 0 | 2nd Sample Interrupt Enable Same definition as IE7 but used during the second sample. |
| 5 | END1 | R/W | 0 | 2nd Sample is End of Sequence Same definition as END7 but used during the second sample. |
| 4 | D1 | R/W | 0 | 2nd Sample Diff Input Select Same definition as D7 but used during the second sample. |
| 3 | TS0 | R/W | 0 | 1st Sample Temp Sensor Select Same definition as TS7 but used during the first sample. |
| 2 | IE0 | R/W | 0 | 1st Sample Interrupt Enable Same definition as IE7 but used during the first sample. |
| 1 | END0 | R/W | 0 | 1st Sample is End of Sequence Same definition as END7 but used during the first sample. |
| 0 | D0 | R/W | 0 | 1st Sample Diff Input Select Same definition as D7 but used during the first sample. |

Register 16: ADC Sample Sequence Result FIFO 0 (ADCSSFIFO0), offset 0x048

Register 17: ADC Sample Sequence Result FIFO 1 (ADCSSFIFO1), offset 0x068

Register 18: ADC Sample Sequence Result FIFO 2 (ADCSSFIFO2), offset 0x088

Register 19: ADC Sample Sequence Result FIFO 3 (ADCSSFIFO3), offset 0x0A8

Important: This register is read-sensitive. See the register description for details.

This register contains the conversion results for samples collected with the sample sequencer (the **ADCSSFIFO0** register is used for Sample Sequencer 0, **ADCSSFIFO1** for Sequencer 1, **ADCSSFIFO2** for Sequencer 2, and **ADCSSFIFO3** for Sequencer 3). Reads of this register return conversion result data in the order sample 0, sample 1, and so on, until the FIFO is empty. If the FIFO is not properly handled by software, overflow and underflow conditions are registered in the **ADCOSTAT** and **ADCUSTAT** registers.

ADC Sample Sequence Result FIFO n (ADCSSFIFO_n)

ADC0 base: 0x4003.8000

ADC1 base: 0x4003.9000

Offset 0x048

Type RO, reset -

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|------|----|----|----|----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | DATA | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | - | - | - | - | - | - | - | - | - | - | - | - |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 11:0 | DATA | RO | - | Conversion Result Data |

Register 20: ADC Sample Sequence FIFO 0 Status (ADCSSFSTAT0), offset 0x04C

Register 21: ADC Sample Sequence FIFO 1 Status (ADCSSFSTAT1), offset 0x06C

Register 22: ADC Sample Sequence FIFO 2 Status (ADCSSFSTAT2), offset 0x08C

Register 23: ADC Sample Sequence FIFO 3 Status (ADCSSFSTAT3), offset 0x0AC

This register provides a window into the sample sequencer, providing full/empty status information as well as the positions of the head and tail pointers. The reset value of 0x100 indicates an empty FIFO with the head and tail pointers both pointing to index 0. The **ADCSSFSTAT0** register provides status on FIFO0, which has 8 entries; **ADCSSFSTAT1** on FIFO1, which has 4 entries; **ADCSSFSTAT2** on FIFO2, which has 4 entries; and **ADCSSFSTAT3** on FIFO3 which has a single entry.

ADC Sample Sequence FIFO 0 Status (ADCSSFSTAT0)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x04C
 Type RO, reset 0x0000.0100

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|------|----------|----|----|-------|------|----|----|----|------|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | FULL | reserved | | | EMPTY | HPTR | | | | TPTR | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:13 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 12 | FULL | RO | 0 | FIFO Full Value Description 1 The FIFO is currently full. 0 The FIFO is not currently full. |
| 11:9 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | EMPTY | RO | 1 | FIFO Empty Value Description 1 The FIFO is currently empty. 0 The FIFO is not currently empty. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 7:4 | HPTR | RO | 0x0 | FIFO Head Pointer This field contains the current "head" pointer index for the FIFO, that is, the next entry to be written. Valid values are 0x0-0x7 for FIFO0; 0x0-0x3 for FIFO1 and FIFO2; and 0x0 for FIFO3. |
| 3:0 | TPTR | RO | 0x0 | FIFO Tail Pointer This field contains the current "tail" pointer index for the FIFO, that is, the next entry to be read. Valid values are 0x0-0x7 for FIFO0; 0x0-0x3 for FIFO1 and FIFO2; and 0x0 for FIFO3. |

Register 24: ADC Sample Sequence 0 Operation (ADCSSOP0), offset 0x050

This register determines whether the sample from the given conversion on Sample Sequence 0 is saved in the Sample Sequence FIFO0 or sent to the digital comparator unit.

ADC Sample Sequence 0 Operation (ADCSSOP0)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x050
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|--------|----------|----|----|--------|----------|----|----|--------|----------|----|----|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | S7DCOP | reserved | | | S6DCOP | reserved | | | S5DCOP | reserved | | | S4DCOP |
| Type | RO | RO | RO | R/W | RO | RO | RO | R/W | RO | RO | RO | R/W | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | S3DCOP | reserved | | | S2DCOP | reserved | | | S1DCOP | reserved | | | S0DCOP |
| Type | RO | RO | RO | R/W | RO | RO | RO | R/W | RO | RO | RO | R/W | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:29 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 28 | S7DCOP | R/W | 0 | Sample 7 Digital Comparator Operation Value Description 1 The eighth sample is sent to the digital comparator unit specified by the <i>S7DCSEL</i> bit in the ADCSSDC0 register, and the value is not written to the FIFO. 0 The eighth sample is saved in Sample Sequence FIFO0. |
| 27:25 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 24 | S6DCOP | R/W | 0 | Sample 6 Digital Comparator Operation Same definition as <i>S7DCOP</i> but used during the seventh sample. |
| 23:21 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 20 | S5DCOP | R/W | 0 | Sample 5 Digital Comparator Operation Same definition as <i>S7DCOP</i> but used during the sixth sample. |
| 19:17 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 16 | S4DCOP | R/W | 0 | Sample 4 Digital Comparator Operation Same definition as <i>S7DCOP</i> but used during the fifth sample. |
| 15:13 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 12 | S3DCOP | R/W | 0 | Sample 3 Digital Comparator Operation Same definition as S7DCOP but used during the fourth sample. |
| 11:9 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | S2DCOP | R/W | 0 | Sample 2 Digital Comparator Operation Same definition as S7DCOP but used during the third sample. |
| 7:5 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | S1DCOP | R/W | 0 | Sample 1 Digital Comparator Operation Same definition as S7DCOP but used during the second sample. |
| 3:1 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | S0DCOP | R/W | 0 | Sample 0 Digital Comparator Operation Same definition as S7DCOP but used during the first sample. |

Register 25: ADC Sample Sequence 0 Digital Comparator Select (ADCSSDC0), offset 0x054

This register determines which digital comparator receives the sample from the given conversion on Sample Sequence 0, if the corresponding S_nDCOP bit in the **ADCSSOP0** register is set.

ADC Sample Sequence 0 Digital Comparator Select (ADCSSDC0)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x054
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|---------|-----|-----|-----|---------|-----|-----|-----|---------|-----|-----|-----|---------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | S7DCSEL | | | | S6DCSEL | | | | S5DCSEL | | | | S4DCSEL | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | S3DCSEL | | | | S2DCSEL | | | | S1DCSEL | | | | S0DCSEL | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | |
|-----------|---|------|-------|---|-------|-------------|-----|---|-----|---|-----|---|-----|---|-----|---|-----|---|-----|---|-----|---|
| 31:28 | S7DCSEL | R/W | 0x0 | <p>Sample 7 Digital Comparator Select</p> <p>When the $S7DCOP$ bit in the ADCSSOP0 register is set, this field indicates which digital comparator unit (and its associated set of control registers) receives the eighth sample from Sample Sequencer 0.</p> <p>Note: Values not listed are reserved.</p> <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0x0</td> <td>Digital Comparator Unit 0 (ADCDCCMP0 and ADCDCCTL0)</td> </tr> <tr> <td>0x1</td> <td>Digital Comparator Unit 1 (ADCDCCMP1 and ADCDCCTL1)</td> </tr> <tr> <td>0x2</td> <td>Digital Comparator Unit 2 (ADCDCCMP2 and ADCDCCTL2)</td> </tr> <tr> <td>0x3</td> <td>Digital Comparator Unit 3 (ADCDCCMP3 and ADCDCCTL3)</td> </tr> <tr> <td>0x4</td> <td>Digital Comparator Unit 4 (ADCDCCMP4 and ADCDCCTL4)</td> </tr> <tr> <td>0x5</td> <td>Digital Comparator Unit 5 (ADCDCCMP5 and ADCDCCTL5)</td> </tr> <tr> <td>0x6</td> <td>Digital Comparator Unit 6 (ADCDCCMP6 and ADCDCCTL6)</td> </tr> <tr> <td>0x7</td> <td>Digital Comparator Unit 7 (ADCDCCMP7 and ADCDCCTL7)</td> </tr> </table> | Value | Description | 0x0 | Digital Comparator Unit 0 (ADCDCCMP0 and ADCDCCTL0) | 0x1 | Digital Comparator Unit 1 (ADCDCCMP1 and ADCDCCTL1) | 0x2 | Digital Comparator Unit 2 (ADCDCCMP2 and ADCDCCTL2) | 0x3 | Digital Comparator Unit 3 (ADCDCCMP3 and ADCDCCTL3) | 0x4 | Digital Comparator Unit 4 (ADCDCCMP4 and ADCDCCTL4) | 0x5 | Digital Comparator Unit 5 (ADCDCCMP5 and ADCDCCTL5) | 0x6 | Digital Comparator Unit 6 (ADCDCCMP6 and ADCDCCTL6) | 0x7 | Digital Comparator Unit 7 (ADCDCCMP7 and ADCDCCTL7) |
| Value | Description | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | Digital Comparator Unit 0 (ADCDCCMP0 and ADCDCCTL0) | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | Digital Comparator Unit 1 (ADCDCCMP1 and ADCDCCTL1) | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | Digital Comparator Unit 2 (ADCDCCMP2 and ADCDCCTL2) | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | Digital Comparator Unit 3 (ADCDCCMP3 and ADCDCCTL3) | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | Digital Comparator Unit 4 (ADCDCCMP4 and ADCDCCTL4) | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | Digital Comparator Unit 5 (ADCDCCMP5 and ADCDCCTL5) | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | Digital Comparator Unit 6 (ADCDCCMP6 and ADCDCCTL6) | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | Digital Comparator Unit 7 (ADCDCCMP7 and ADCDCCTL7) | | | | | | | | | | | | | | | | | | | | | |
| 27:24 | S6DCSEL | R/W | 0x0 | <p>Sample 6 Digital Comparator Select</p> <p>This field has the same encodings as $S7DCSEL$ but is used during the seventh sample.</p> | | | | | | | | | | | | | | | | | | |
| 23:20 | S5DCSEL | R/W | 0x0 | <p>Sample 5 Digital Comparator Select</p> <p>This field has the same encodings as $S7DCSEL$ but is used during the sixth sample.</p> | | | | | | | | | | | | | | | | | | |
| 19:16 | S4DCSEL | R/W | 0x0 | <p>Sample 4 Digital Comparator Select</p> <p>This field has the same encodings as $S7DCSEL$ but is used during the fifth sample.</p> | | | | | | | | | | | | | | | | | | |
| 15:12 | S3DCSEL | R/W | 0x0 | <p>Sample 3 Digital Comparator Select</p> <p>This field has the same encodings as $S7DCSEL$ but is used during the fourth sample.</p> | | | | | | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|--|
| 11:8 | S2DCSEL | R/W | 0x0 | Sample 2 Digital Comparator Select This field has the same encodings as S7DCSEL but is used during the third sample. |
| 7:4 | S1DCSEL | R/W | 0x0 | Sample 1 Digital Comparator Select This field has the same encodings as S7DCSEL but is used during the second sample. |
| 3:0 | S0DCSEL | R/W | 0x0 | Sample 0 Digital Comparator Select This field has the same encodings as S7DCSEL but is used during the first sample. |

Register 26: ADC Sample Sequence Input Multiplexer Select 1 (ADCSSMUX1), offset 0x060

Register 27: ADC Sample Sequence Input Multiplexer Select 2 (ADCSSMUX2), offset 0x080

This register defines the analog input configuration for each sample in a sequence executed with Sample Sequencer 1 or 2. These registers are 16 bits wide and contain information for four possible samples. See the **ADCSSMUX0** register on page 671 for detailed bit descriptions. The **ADCSSMUX1** register affects Sample Sequencer 1 and the **ADCSSMUX2** register affects Sample Sequencer 2.

ADC Sample Sequence Input Multiplexer Select 1 (ADCSSMUX1)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x060
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MUX3 | | | | MUX2 | | | | MUX1 | | | | MUX0 | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:12 | MUX3 | R/W | 0x0 | 4th Sample Input Select |
| 11:8 | MUX2 | R/W | 0x0 | 3rd Sample Input Select |
| 7:4 | MUX1 | R/W | 0x0 | 2nd Sample Input Select |
| 3:0 | MUX0 | R/W | 0x0 | 1st Sample Input Select |

Register 28: ADC Sample Sequence Control 1 (ADCSSCTL1), offset 0x064

Register 29: ADC Sample Sequence Control 2 (ADCSSCTL2), offset 0x084

These registers contain the configuration information for each sample for a sequence executed with Sample Sequencer 1 or 2. When configuring a sample sequence, the **END** bit must be set for the final sample, whether it be after the first sample, fourth sample, or any sample in between. These registers are 16-bits wide and contain information for four possible samples. See the **ADCSSCTL0** register on page 673 for detailed bit descriptions. The **ADCSSCTL1** register configures Sample Sequencer 1 and the **ADCSSCTL2** register configures Sample Sequencer 2.

ADC Sample Sequence Control 1 (ADCSSCTL1)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x064
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|------|-----|-----|-----|------|-----|-----|-----|------|-----|-----|-----|------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | TS3 | IE3 | END3 | D3 | TS2 | IE2 | END2 | D2 | TS1 | IE1 | END1 | D1 | TS0 | IE0 | END0 | D0 |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15 | TS3 | R/W | 0 | 4th Sample Temp Sensor Select Same definition as TS7 but used during the fourth sample. |
| 14 | IE3 | R/W | 0 | 4th Sample Interrupt Enable Same definition as IE7 but used during the fourth sample. |
| 13 | END3 | R/W | 0 | 4th Sample is End of Sequence Same definition as END7 but used during the fourth sample. |
| 12 | D3 | R/W | 0 | 4th Sample Diff Input Select Same definition as D7 but used during the fourth sample. |
| 11 | TS2 | R/W | 0 | 3rd Sample Temp Sensor Select Same definition as TS7 but used during the third sample. |
| 10 | IE2 | R/W | 0 | 3rd Sample Interrupt Enable Same definition as IE7 but used during the third sample. |
| 9 | END2 | R/W | 0 | 3rd Sample is End of Sequence Same definition as END7 but used during the third sample. |
| 8 | D2 | R/W | 0 | 3rd Sample Diff Input Select Same definition as D7 but used during the third sample. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 7 | TS1 | R/W | 0 | 2nd Sample Temp Sensor Select Same definition as TS7 but used during the second sample. |
| 6 | IE1 | R/W | 0 | 2nd Sample Interrupt Enable Same definition as IE7 but used during the second sample. |
| 5 | END1 | R/W | 0 | 2nd Sample is End of Sequence Same definition as END7 but used during the second sample. |
| 4 | D1 | R/W | 0 | 2nd Sample Diff Input Select Same definition as D7 but used during the second sample. |
| 3 | TS0 | R/W | 0 | 1st Sample Temp Sensor Select Same definition as TS7 but used during the first sample. |
| 2 | IE0 | R/W | 0 | 1st Sample Interrupt Enable Same definition as IE7 but used during the first sample. |
| 1 | END0 | R/W | 0 | 1st Sample is End of Sequence Same definition as END7 but used during the first sample. |
| 0 | D0 | R/W | 0 | 1st Sample Diff Input Select Same definition as D7 but used during the first sample. |

Register 30: ADC Sample Sequence 1 Operation (ADCSSOP1), offset 0x070

Register 31: ADC Sample Sequence 2 Operation (ADCSSOP2), offset 0x090

This register determines whether the sample from the given conversion on Sample Sequence n is saved in the Sample Sequence n FIFO or sent to the digital comparator unit. The **ADCSSOP1** register controls Sample Sequencer 1 and the **ADCSSOP2** register controls Sample Sequencer 2.

ADC Sample Sequence 1 Operation (ADCSSOP1)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x070
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|--------|----------|----|----|--------|----------|----|----|--------|----------|----|----|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | S3DCOP | reserved | | | S2DCOP | reserved | | | S1DCOP | reserved | | | S0DCOP |
| Type | RO | RO | RO | R/W | RO | RO | RO | R/W | RO | RO | RO | R/W | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|--|
| 31:13 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 12 | S3DCOP | R/W | 0 | Sample 3 Digital Comparator Operation Value Description 1 The fourth sample is sent to the digital comparator unit specified by the S3DCSEL bit in the ADCSSDC0n register, and the value is not written to the FIFO. 0 The fourth sample is saved in Sample Sequence FIFO. |
| 11:9 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | S2DCOP | R/W | 0 | Sample 2 Digital Comparator Operation Same definition as S3DCOP but used during the third sample. |
| 7:5 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | S1DCOP | R/W | 0 | Sample 1 Digital Comparator Operation Same definition as S3DCOP but used during the second sample. |
| 3:1 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | S0DCOP | R/W | 0 | Sample 0 Digital Comparator Operation Same definition as S3DCOP but used during the first sample. |

Register 32: ADC Sample Sequence 1 Digital Comparator Select (ADCSSDC1), offset 0x074

Register 33: ADC Sample Sequence 2 Digital Comparator Select (ADCSSDC2), offset 0x094

These registers determine which digital comparator receives the sample from the given conversion on Sample Sequence n if the corresponding S_nDCOP bit in the **ADCSSOPn** register is set. The **ADCSSDC1** register controls the selection for Sample Sequencer 1 and the **ADCSSDC2** register controls the selection for Sample Sequencer 2.

ADC Sample Sequence 1 Digital Comparator Select (ADCSSDC1)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x074
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|---------|-----|-----|-----|---------|-----|-----|-----|---------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | S3DCSEL | | | | S2DCSEL | | | | S1DCSEL | | | | S0DCSEL | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | |
|-----------|--|------|--------|---|-------|-------------|-----|--|-----|--|-----|--|-----|--|-----|--|-----|--|-----|--|-----|--|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | | | | | |
| 15:12 | S3DCSEL | R/W | 0x0 | <p>Sample 3 Digital Comparator Select</p> <p>When the $S3DCOP$ bit in the ADCSSOPn register is set, this field indicates which digital comparator unit (and its associated set of control registers) receives the eighth sample from Sample Sequencer n.</p> <p>Note: Values not listed are reserved.</p> <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0x0</td> <td>Digital Comparator Unit 0 (ADCDCOMP0 and ADCCCTL0)</td> </tr> <tr> <td>0x1</td> <td>Digital Comparator Unit 1 (ADCDCOMP1 and ADCCCTL1)</td> </tr> <tr> <td>0x2</td> <td>Digital Comparator Unit 2 (ADCDCOMP2 and ADCCCTL2)</td> </tr> <tr> <td>0x3</td> <td>Digital Comparator Unit 3 (ADCDCOMP3 and ADCCCTL3)</td> </tr> <tr> <td>0x4</td> <td>Digital Comparator Unit 4 (ADCDCOMP4 and ADCCCTL4)</td> </tr> <tr> <td>0x5</td> <td>Digital Comparator Unit 5 (ADCDCOMP5 and ADCCCTL5)</td> </tr> <tr> <td>0x6</td> <td>Digital Comparator Unit 6 (ADCDCOMP6 and ADCCCTL6)</td> </tr> <tr> <td>0x7</td> <td>Digital Comparator Unit 7 (ADCDCOMP7 and ADCCCTL7)</td> </tr> </table> | Value | Description | 0x0 | Digital Comparator Unit 0 (ADCDCOMP0 and ADCCCTL0) | 0x1 | Digital Comparator Unit 1 (ADCDCOMP1 and ADCCCTL1) | 0x2 | Digital Comparator Unit 2 (ADCDCOMP2 and ADCCCTL2) | 0x3 | Digital Comparator Unit 3 (ADCDCOMP3 and ADCCCTL3) | 0x4 | Digital Comparator Unit 4 (ADCDCOMP4 and ADCCCTL4) | 0x5 | Digital Comparator Unit 5 (ADCDCOMP5 and ADCCCTL5) | 0x6 | Digital Comparator Unit 6 (ADCDCOMP6 and ADCCCTL6) | 0x7 | Digital Comparator Unit 7 (ADCDCOMP7 and ADCCCTL7) |
| Value | Description | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | Digital Comparator Unit 0 (ADCDCOMP0 and ADCCCTL0) | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | Digital Comparator Unit 1 (ADCDCOMP1 and ADCCCTL1) | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | Digital Comparator Unit 2 (ADCDCOMP2 and ADCCCTL2) | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | Digital Comparator Unit 3 (ADCDCOMP3 and ADCCCTL3) | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | Digital Comparator Unit 4 (ADCDCOMP4 and ADCCCTL4) | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | Digital Comparator Unit 5 (ADCDCOMP5 and ADCCCTL5) | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | Digital Comparator Unit 6 (ADCDCOMP6 and ADCCCTL6) | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | Digital Comparator Unit 7 (ADCDCOMP7 and ADCCCTL7) | | | | | | | | | | | | | | | | | | | | | |
| 11:8 | S2DCSEL | R/W | 0x0 | <p>Sample 2 Digital Comparator Select</p> <p>This field has the same encodings as S3DCSEL but is used during the third sample.</p> | | | | | | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|--|
| 7:4 | S1DCSEL | R/W | 0x0 | Sample 1 Digital Comparator Select This field has the same encodings as S3DCSEL but is used during the second sample. |
| 3:0 | S0DCSEL | R/W | 0x0 | Sample 0 Digital Comparator Select This field has the same encodings as S3DCSEL but is used during the first sample. |

Register 34: ADC Sample Sequence Input Multiplexer Select 3 (ADCSSMUX3), offset 0x0A0

This register defines the analog input configuration for the sample executed with Sample Sequencer 3. This register is 4 bits wide and contains information for one possible sample. See the **ADCSSMUX0** register on page 671 for detailed bit descriptions.

ADC Sample Sequence Input Multiplexer Select 3 (ADCSSMUX3)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x0A0
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | MUX0 | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3:0 | MUX0 | R/W | 0 | 1st Sample Input Select |

Register 35: ADC Sample Sequence Control 3 (ADCSSCTL3), offset 0x0A4

This register contains the configuration information for a sample executed with Sample Sequencer 3. The `END0` bit is always set as this sequencer can execute only one sample. This register is 4 bits wide and contains information for one possible sample. See the `ADCSSCTL0` register on page 673 for detailed bit descriptions.

ADC Sample Sequence Control 3 (ADCSSCTL3)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x0A4
 Type R/W, reset 0x0000.0002

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-----|-----|------|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | TS0 | IE0 | END0 | D0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | TS0 | R/W | 0 | 1st Sample Temp Sensor Select Same definition as <code>TS7</code> but used during the first sample. |
| 2 | IE0 | R/W | 0 | 1st Sample Interrupt Enable Same definition as <code>IE7</code> but used during the first sample. |
| 1 | END0 | R/W | 1 | 1st Sample is End of Sequence Same definition as <code>END7</code> but used during the first sample. Because this sequencer has only one entry, this bit must be set. |
| 0 | D0 | R/W | 0 | 1st Sample Diff Input Select Same definition as <code>D7</code> but used during the first sample. |

Register 36: ADC Sample Sequence 3 Operation (ADCSSOP3), offset 0x0B0

This register determines whether the sample from the given conversion on Sample Sequence 3 is saved in the Sample Sequence 3 FIFO or sent to the digital comparator unit.

ADC Sample Sequence 3 Operation (ADCSSOP3)

ADC0 base: 0x4003.8000

ADC1 base: 0x4003.9000

Offset 0x0B0

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | | S0DCOP | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:1 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | S0DCOP | R/W | 0 | Sample 0 Digital Comparator Operation |

Value Description

- | | |
|---|--|
| 1 | The sample is sent to the digital comparator unit specified by the S0DCSEL bit in the ADCSSDC03 register, and the value is not written to the FIFO. |
| 0 | The sample is saved in Sample Sequence FIFO3. |

Register 37: ADC Sample Sequence 3 Digital Comparator Select (ADCSSDC3), offset 0x0B4

This register determines which digital comparator receives the sample from the given conversion on Sample Sequence 3 if the corresponding S_nDCOP bit in the **ADCSSOP3** register is set.

ADC Sample Sequence 3 Digital Comparator Select (ADCSSDC3)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0x0B4
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|---------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | S0DCSEL | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3:0 | S0DCSEL | R/W | 0x0 | Sample 0 Digital Comparator Select When the $S0DCOP$ bit in the ADCSSOP3 register is set, this field indicates which digital comparator unit (and its associated set of control registers) receives the sample from Sample Sequencer 3. |

Note: Values not listed are reserved.

| Value | Description |
|-------|--|
| 0x0 | Digital Comparator Unit 0 (ADCDCOMP0 and ADCCCTL0) |
| 0x1 | Digital Comparator Unit 1 (ADCDCOMP1 and ADCCCTL1) |
| 0x2 | Digital Comparator Unit 2 (ADCDCOMP2 and ADCCCTL2) |
| 0x3 | Digital Comparator Unit 3 (ADCDCOMP3 and ADCCCTL3) |
| 0x4 | Digital Comparator Unit 4 (ADCDCOMP4 and ADCCCTL4) |
| 0x5 | Digital Comparator Unit 5 (ADCDCOMP5 and ADCCCTL5) |
| 0x6 | Digital Comparator Unit 6 (ADCDCOMP6 and ADCCCTL6) |
| 0x7 | Digital Comparator Unit 7 (ADCDCOMP7 and ADCCCTL7) |

Register 38: ADC Digital Comparator Reset Initial Conditions (ADCDCRIC), offset 0xD00

This register provides the ability to reset any of the digital comparator interrupt or trigger functions back to their initial conditions. Resetting these functions ensures that the data that is being used by the interrupt and trigger functions in the digital comparator unit is not stale.

ADC Digital Comparator Reset Initial Conditions (ADCDCRIC)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0xD00
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|---------|---------|---------|---------|---------|---------|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | DCTRIG7 | DCTRIG6 | DCTRIG5 | DCTRIG4 | DCTRIG3 | DCTRIG2 | DCTRIG1 | DCTRIG0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DCINT7 | DCINT6 | DCINT5 | DCINT4 | DCINT3 | DCINT2 | DCINT1 | DCINT0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:24 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 23 | DCTRIG7 | R/W | 0 | Digital Comparator Trigger 7 Value Description 1 Resets the Digital Comparator 7 trigger unit to its initial conditions. 0 No effect. When the trigger has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the trigger, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used. After setting this bit, software should wait until the bit clears before continuing. |
| 22 | DCTRIG6 | R/W | 0 | Digital Comparator Trigger 6 Value Description 1 Resets the Digital Comparator 6 trigger unit to its initial conditions. 0 No effect. When the trigger has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the trigger, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 21 | DCTRIG5 | R/W | 0 | <p>Digital Comparator Trigger 5</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 5 trigger unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the trigger has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the trigger, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |
| 20 | DCTRIG4 | R/W | 0 | <p>Digital Comparator Trigger 4</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 4 trigger unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the trigger has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the trigger, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |
| 19 | DCTRIG3 | R/W | 0 | <p>Digital Comparator Trigger 3</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 3 trigger unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the trigger has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the trigger, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |
| 18 | DCTRIG2 | R/W | 0 | <p>Digital Comparator Trigger 2</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 2 trigger unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the trigger has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the trigger, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 17 | DCTRIG1 | R/W | 0 | <p>Digital Comparator Trigger 1</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 1 trigger unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the trigger has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the trigger, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |
| 16 | DCTRIG0 | R/W | 0 | <p>Digital Comparator Trigger 0</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 0 trigger unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the trigger has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the trigger, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |
| 15:8 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | DCINT7 | R/W | 0 | <p>Digital Comparator Interrupt 7</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 7 interrupt unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the interrupt has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the interrupt, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |
| 6 | DCINT6 | R/W | 0 | <p>Digital Comparator Interrupt 6</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 6 interrupt unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the interrupt has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the interrupt, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 5 | DCINT5 | R/W | 0 | <p>Digital Comparator Interrupt 5</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 5 interrupt unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the interrupt has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the interrupt, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |
| 4 | DCINT4 | R/W | 0 | <p>Digital Comparator Interrupt 4</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 4 interrupt unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the interrupt has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the interrupt, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |
| 3 | DCINT3 | R/W | 0 | <p>Digital Comparator Interrupt 3</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 3 interrupt unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the interrupt has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the interrupt, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |
| 2 | DCINT2 | R/W | 0 | <p>Digital Comparator Interrupt 2</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 2 interrupt unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the interrupt has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the interrupt, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 1 | DCINT1 | R/W | 0 | <p>Digital Comparator Interrupt 1</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 1 interrupt unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the interrupt has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the interrupt, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |
| 0 | DCINT0 | R/W | 0 | <p>Digital Comparator Interrupt 0</p> <p>Value Description</p> <p>1 Resets the Digital Comparator 0 interrupt unit to its initial conditions.</p> <p>0 No effect.</p> <p>When the interrupt has been cleared, this bit is automatically cleared. Because the digital comparators use the current and previous ADC conversion values to determine when to assert the interrupt, it is important to reset the digital comparator to initial conditions when starting a new sequence so that stale data is not used.</p> |

Register 39: ADC Digital Comparator Control 0 (ADCDCCTL0), offset 0xE00

Register 40: ADC Digital Comparator Control 1 (ADCDCCTL1), offset 0xE04

Register 41: ADC Digital Comparator Control 2 (ADCDCCTL2), offset 0xE08

Register 42: ADC Digital Comparator Control 3 (ADCDCCTL3), offset 0xE0C

Register 43: ADC Digital Comparator Control 4 (ADCDCCTL4), offset 0xE10

Register 44: ADC Digital Comparator Control 5 (ADCDCCTL5), offset 0xE14

Register 45: ADC Digital Comparator Control 6 (ADCDCCTL6), offset 0xE18

Register 46: ADC Digital Comparator Control 7 (ADCDCCTL7), offset 0xE1C

This register provides the comparison encodings that generate an interrupt and/or PWM trigger. See "Interrupt/ADC-Trigger Selector" on page 957 for more information on using the ADC digital comparators to trigger a PWM generator.

ADC Digital Comparator Control 0 (ADCDCCTL0)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0xE00
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|-----|-----|-----|-----|-----|----|----|----------|-----|-----|-----|-----|-----|-----|--|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | | |
| | reserved | | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | |
| | reserved | | | CTE | CTC | | | CTM | | | reserved | | | CIE | CIC | | CIM | |
| Type | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:13 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

12 CTE R/W 0 Comparison Trigger Enable

| Value | Description |
|-------|---|
| 1 | Enables the trigger function state machine. The ADC conversion data is used to determine if a trigger should be generated according to the programming of the CTC and CTM fields. |
| 0 | Disables the trigger function state machine. ADC conversion data is ignored by the trigger function. |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|---|------|-------|---|-------|-------------|-----|--|-----|---|-----|--|-----|---|
| 11:10 | CTC | R/W | 0x0 | <p>Comparison Trigger Condition</p> <p>This field specifies the operational region in which a trigger is generated when the ADC conversion data is compared against the values of COMP0 and COMP1. The COMP0 and COMP1 fields are defined in the ADCDCMPx registers.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Low Band ADC Data < COMP0 ≤ COMP1</td> </tr> <tr> <td>0x1</td> <td>Mid Band COMP0 ≤ ADC Data < COMP1</td> </tr> <tr> <td>0x2</td> <td>reserved</td> </tr> <tr> <td>0x3</td> <td>High Band COMP0 ≤ COMP1 ≤ ADC Data</td> </tr> </tbody> </table> | Value | Description | 0x0 | Low Band ADC Data < COMP0 ≤ COMP1 | 0x1 | Mid Band COMP0 ≤ ADC Data < COMP1 | 0x2 | reserved | 0x3 | High Band COMP0 ≤ COMP1 ≤ ADC Data |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | Low Band ADC Data < COMP0 ≤ COMP1 | | | | | | | | | | | | | |
| 0x1 | Mid Band COMP0 ≤ ADC Data < COMP1 | | | | | | | | | | | | | |
| 0x2 | reserved | | | | | | | | | | | | | |
| 0x3 | High Band COMP0 ≤ COMP1 ≤ ADC Data | | | | | | | | | | | | | |
| 9:8 | CTM | R/W | 0x0 | <p>Comparison Trigger Mode</p> <p>This field specifies the mode by which the trigger comparison is made.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Always This mode generates a trigger every time the ADC conversion data falls within the selected operational region.</td> </tr> <tr> <td>0x1</td> <td>Once This mode generates a trigger the first time that the ADC conversion data enters the selected operational region.</td> </tr> <tr> <td>0x2</td> <td>Hysteresis Always This mode generates a trigger when the ADC conversion data falls within the selected operational region and continues to generate the trigger until the hysteresis condition is cleared by entering the opposite operational region. Note that the hysteresis modes are only defined for CTC encodings of 0x0 and 0x3.</td> </tr> <tr> <td>0x3</td> <td>Hysteresis Once This mode generates a trigger the first time that the ADC conversion data falls within the selected operational region. No additional triggers are generated until the hysteresis condition is cleared by entering the opposite operational region. Note that the hysteresis modes are only defined for CTC encodings of 0x0 and 0x3.</td> </tr> </tbody> </table> | Value | Description | 0x0 | Always This mode generates a trigger every time the ADC conversion data falls within the selected operational region. | 0x1 | Once This mode generates a trigger the first time that the ADC conversion data enters the selected operational region. | 0x2 | Hysteresis Always This mode generates a trigger when the ADC conversion data falls within the selected operational region and continues to generate the trigger until the hysteresis condition is cleared by entering the opposite operational region. Note that the hysteresis modes are only defined for CTC encodings of 0x0 and 0x3. | 0x3 | Hysteresis Once This mode generates a trigger the first time that the ADC conversion data falls within the selected operational region. No additional triggers are generated until the hysteresis condition is cleared by entering the opposite operational region. Note that the hysteresis modes are only defined for CTC encodings of 0x0 and 0x3. |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | Always This mode generates a trigger every time the ADC conversion data falls within the selected operational region. | | | | | | | | | | | | | |
| 0x1 | Once This mode generates a trigger the first time that the ADC conversion data enters the selected operational region. | | | | | | | | | | | | | |
| 0x2 | Hysteresis Always This mode generates a trigger when the ADC conversion data falls within the selected operational region and continues to generate the trigger until the hysteresis condition is cleared by entering the opposite operational region. Note that the hysteresis modes are only defined for CTC encodings of 0x0 and 0x3. | | | | | | | | | | | | | |
| 0x3 | Hysteresis Once This mode generates a trigger the first time that the ADC conversion data falls within the selected operational region. No additional triggers are generated until the hysteresis condition is cleared by entering the opposite operational region. Note that the hysteresis modes are only defined for CTC encodings of 0x0 and 0x3. | | | | | | | | | | | | | |
| 7:5 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 4 | CIE | R/W | 0 | <p>Comparison Interrupt Enable</p> <p>Value Description</p> <p>1 Enables the comparison interrupt. The ADC conversion data is used to determine if an interrupt should be generated according to the programming of the CIE and CIM fields.</p> <p>0 Disables the comparison interrupt. ADC conversion data has no effect on interrupt generation.</p> |
| 3:2 | CIC | R/W | 0x0 | <p>Comparison Interrupt Condition</p> <p>This field specifies the operational region in which an interrupt is generated when the ADC conversion data is compared against the values of COMP0 and COMP1. The COMP0 and COMP1 fields are defined in the ADCDCCMPx registers.</p> <p>Value Description</p> <p>0x0 Low Band ADC Data < COMP0 ≤ COMP1</p> <p>0x1 Mid Band COMP0 ≤ ADC Data < COMP1</p> <p>0x2 reserved</p> <p>0x3 High Band COMP0 < COMP1 ≤ ADC Data</p> |
| 1:0 | CIM | R/W | 0x0 | <p>Comparison Interrupt Mode</p> <p>This field specifies the mode by which the interrupt comparison is made.</p> <p>Value Description</p> <p>0x0 Always This mode generates an interrupt every time the ADC conversion data falls within the selected operational region.</p> <p>0x1 Once This mode generates an interrupt the first time that the ADC conversion data enters the selected operational region.</p> <p>0x2 Hysteresis Always This mode generates an interrupt when the ADC conversion data falls within the selected operational region and continues to generate the interrupt until the hysteresis condition is cleared by entering the opposite operational region. Note that the hysteresis modes are only defined for CTC encodings of 0x0 and 0x3.</p> <p>0x3 Hysteresis Once This mode generates an interrupt the first time that the ADC conversion data falls within the selected operational region. No additional interrupts are generated until the hysteresis condition is cleared by entering the opposite operational region. Note that the hysteresis modes are only defined for CTC encodings of 0x0 and 0x3.</p> |

Register 47: ADC Digital Comparator Range 0 (ADCDCMP0), offset 0xE40

Register 48: ADC Digital Comparator Range 1 (ADCDCMP1), offset 0xE44

Register 49: ADC Digital Comparator Range 2 (ADCDCMP2), offset 0xE48

Register 50: ADC Digital Comparator Range 3 (ADCDCMP3), offset 0xE4C

Register 51: ADC Digital Comparator Range 4 (ADCDCMP4), offset 0xE50

Register 52: ADC Digital Comparator Range 5 (ADCDCMP5), offset 0xE54

Register 53: ADC Digital Comparator Range 6 (ADCDCMP6), offset 0xE58

Register 54: ADC Digital Comparator Range 7 (ADCDCMP7), offset 0xE5C

This register defines the comparison values that are used to determine if the ADC conversion data falls in the appropriate operating region.

Note: The value in the COMP1 field must be greater than or equal to the value in the COMP0 field or unexpected results can occur.

If the RES bit in the ADCCTL register is clear, selecting 10-bit resolution, use only bits [25:16] in the COMP1 field and bits [9:0] in the COMP0 field; otherwise unexpected results can occur.

ADC Digital Comparator Range 0 (ADCDCMP0)

ADC0 base: 0x4003.8000
 ADC1 base: 0x4003.9000
 Offset 0xE40
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | COMP1 | | | | | | | | | | | |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | COMP0 | | | | | | | | | | | |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:28 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 27:16 | COMP1 | R/W | 0x000 | Compare 1 The value in this field is compared against the ADC conversion data. The result of the comparison is used to determine if the data lies within the high-band region. Note that the value of COMP1 must be greater than or equal to the value of COMP0. |
| 15:12 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|---|
| 11:0 | COMP0 | R/W | 0x000 | Compare 0 The value in this field is compared against the ADC conversion data. The result of the comparison is used to determine if the data lies within the low-band region. |

14 Universal Asynchronous Receivers/Transmitters (UARTs)

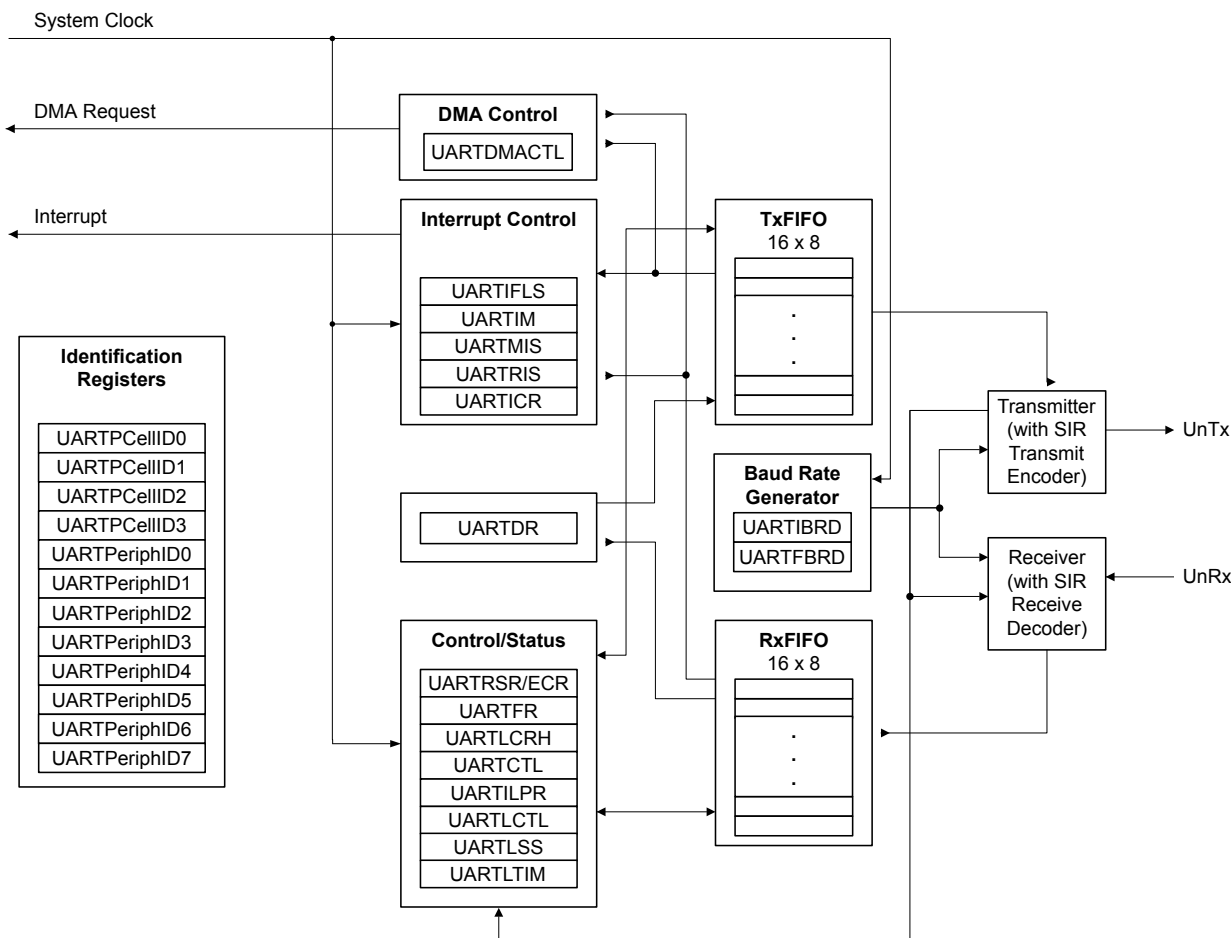
The Stellaris® LM3S2U93 controller includes three Universal Asynchronous Receiver/Transmitter (UART) with the following features:

- Programmable baud-rate generator allowing speeds up to 5 Mbps for regular speed (divide by 16) and 10 Mbps for high speed (divide by 8)
- Separate 16x8 transmit (TX) and receive (RX) FIFOs to reduce CPU interrupt service loading
- Programmable FIFO length, including 1-byte deep operation providing conventional double-buffered interface
- FIFO trigger levels of 1/8, 1/4, 1/2, 3/4, and 7/8
- Standard asynchronous communication bits for start, stop, and parity
- Line-break generation and detection
- Fully programmable serial interface characteristics
 - 5, 6, 7, or 8 data bits
 - Even, odd, stick, or no-parity bit generation/detection
 - 1 or 2 stop bit generation
- IrDA serial-IR (SIR) encoder/decoder providing
 - Programmable use of IrDA Serial Infrared (SIR) or UART input/output
 - Support of IrDA SIR encoder/decoder functions for data rates up to 115.2 Kbps half-duplex
 - Support of normal 3/16 and low-power (1.41-2.23 μ s) bit durations
 - Programmable internal clock generator enabling division of reference clock by 1 to 256 for low-power mode bit duration
- Support for communication with ISO 7816 smart cards
- Full modem handshake support (on UART1)
- LIN protocol support
- Standard FIFO-level and End-of-Transmission interrupts
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Separate channels for transmit and receive
 - Receive single request asserted when data is in the FIFO; burst request asserted at programmed FIFO level

- Transmit single request asserted when there is space in the FIFO; burst request asserted at programmed FIFO level

14.1 Block Diagram

Figure 14-1. UART Module Block Diagram



14.2 Signal Description

The following table lists the external signals of the UART module and describes the function of each. The UART signals are alternate functions for some GPIO signals and default to be GPIO signals at reset, with the exception of the U0Rx and U0Tx pins which default to the UART function. The column in the table below titled "Pin Mux/Pin Assignment" lists the possible GPIO pin placements for these UART signals. The AFSEL bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the UART function. The number in parentheses is the encoding that must be programmed into the PMCN field in the **GPIO Port Control (GPIOCTL)** register (page 461) to assign the UART signal to the specified GPIO port pin. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 419.

Table 14-1. UART Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|----------------------------------|--|----------|--------------------------|---|
| U0Rx | 26 | PA0 (1) | I | TTL | UART module 0 receive. When in IrDA mode, this signal has IrDA modulation. |
| U0Tx | 27 | PA1 (1) | O | TTL | UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation. |
| U1CTS | 2 10 34 | PE6 (9) PD0 (9) PA6 (9) | I | TTL | UART module 1 Clear To Send modem flow control input signal. |
| U1DCD | 1 11 35 | PE7 (9) PD1 (9) PA7 (9) | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| U1DSR | 47 | PF0 (9) | I | TTL | UART module 1 Data Set Ready modem output control line. |
| U1DTR | 40 100 | PG5 (10) PD7 (9) | O | TTL | UART module 1 Data Terminal Ready modem status input signal. |
| U1RI | 37 41 97 | PG6 (10) PG4 (10) PD4 (9) | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| U1RTS | 43 61 | PF6 (10) PF1 (9) | O | TTL | UART module 1 Request to Send modem flow control output line. |
| U1Rx | 10 12 23 26 66 92 | PD0 (5) PD2 (1) PC6 (5) PA0 (9) PB0 (5) PB4 (7) | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| U1Tx | 11 13 22 27 67 91 | PD1 (5) PD3 (1) PC7 (5) PA1 (9) PB1 (5) PB5 (7) | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| U2Rx | 10 19 92 98 | PD0 (4) PG0 (1) PB4 (4) PD5 (9) | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| U2Tx | 6 11 18 99 | PE4 (5) PD1 (4) PG1 (1) PD6 (9) | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 14-2. UART Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|----------------|-------------------------------|----------|--------------------------|---|
| U0Rx | L3 | PA0 (1) | I | TTL | UART module 0 receive. When in IrDA mode, this signal has IrDA modulation. |
| U0Tx | M3 | PA1 (1) | O | TTL | UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation. |
| U1CTS | A1 G1 L6 | PE6 (9) PD0 (9) PA6 (9) | I | TTL | UART module 1 Clear To Send modem flow control input signal. |

Table 14-2. UART Signals (108BGA) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|-----------------------------------|--|----------|--------------------------|---|
| U1DCD | B1 G2 M6 | PE7 (9) PD1 (9) PA7 (9) | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| U1DSR | M9 | PF0 (9) | I | TTL | UART module 1 Data Set Ready modem output control line. |
| U1DTR | M7 A2 | PG5 (10) PD7 (9) | O | TTL | UART module 1 Data Terminal Ready modem status input signal. |
| U1RI | L7 K3 B5 | PG6 (10) PG4 (10) PD4 (9) | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| U1RTS | M8 H12 | PF6 (10) PF1 (9) | O | TTL | UART module 1 Request to Send modem flow control output line. |
| U1Rx | G1 H2 M2 L3 E12 A6 | PD0 (5) PD2 (1) PC6 (5) PA0 (9) PB0 (5) PB4 (7) | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| U1Tx | G2 H1 L2 M3 D12 B7 | PD1 (5) PD3 (1) PC7 (5) PA1 (9) PB1 (5) PB5 (7) | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| U2Rx | G1 K1 A6 C6 | PD0 (4) PG0 (1) PB4 (4) PD5 (9) | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| U2Tx | B2 G2 K2 A3 | PE4 (5) PD1 (4) PG1 (1) PD6 (9) | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

14.3 Functional Description

Each Stellaris UART performs the functions of parallel-to-serial and serial-to-parallel conversions. It is similar in functionality to a 16C550 UART, but is not register compatible.

The UART is configured for transmit and/or receive via the `TXE` and `RXE` bits of the **UART Control (UARTCTL)** register (see page 731). Transmit and receive are both enabled out of reset. Before any control registers are programmed, the UART must be disabled by clearing the `UARTEN` bit in **UARTCTL**. If the UART is disabled during a TX or RX operation, the current transaction is completed prior to the UART stopping.

The UART module also includes a serial IR (SIR) encoder/decoder block that can be connected to an infrared transceiver to implement an IrDA SIR physical layer. The SIR function is programmed using the **UARTCTL** register.

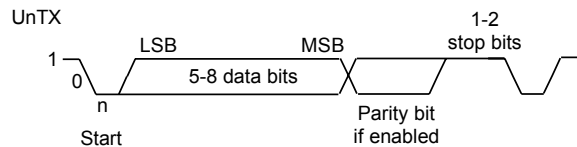
14.3.1 Transmit/Receive Logic

The transmit logic performs parallel-to-serial conversion on the data read from the transmit FIFO. The control logic outputs the serial bit stream beginning with a start bit and followed by the data bits

(LSB first), parity bit, and the stop bits according to the programmed configuration in the control registers. See Figure 14-2 on page 707 for details.

The receive logic performs serial-to-parallel conversion on the received bit stream after a valid start pulse has been detected. Overrun, parity, frame error checking, and line-break detection are also performed, and their status accompanies the data that is written to the receive FIFO.

Figure 14-2. UART Character Frame



14.3.2 Baud-Rate Generation

The baud-rate divisor is a 22-bit number consisting of a 16-bit integer and a 6-bit fractional part. The number formed by these two values is used by the baud-rate generator to determine the bit period. Having a fractional baud-rate divisor allows the UART to generate all the standard baud rates.

The 16-bit integer is loaded through the **UART Integer Baud-Rate Divisor (UARTIBRD)** register (see page 727) and the 6-bit fractional part is loaded with the **UART Fractional Baud-Rate Divisor (UARTFBRD)** register (see page 728). The baud-rate divisor (BRD) has the following relationship to the system clock (where *BRDI* is the integer part of the BRD and *BRDF* is the fractional part, separated by a decimal place.)

$$BRD = BRDI + BRDF = \text{UARTSysClk} / (\text{ClkDiv} * \text{Baud Rate})$$

where *UARTSysClk* is the system clock connected to the UART, and *ClkDiv* is either 16 (if *HSE* in **UARTCTL** is clear) or 8 (if *HSE* is set).

The 6-bit fractional number (that is to be loaded into the *DIVFRAC* bit field in the **UARTFBRD** register) can be calculated by taking the fractional part of the baud-rate divisor, multiplying it by 64, and adding 0.5 to account for rounding errors:

$$\text{UARTFBRD}[\text{DIVFRAC}] = \text{integer}(\text{BRDF} * 64 + 0.5)$$

The UART generates an internal baud-rate reference clock at 8x or 16x the baud-rate (referred to as *Baud8* and *Baud16*, depending on the setting of the *HSE* bit (bit 5) in **UARTCTL**). This reference clock is divided by 8 or 16 to generate the transmit clock, and is used for error detection during receive operations. Note that the state of the *HSE* bit has no effect on clock generation in ISO 7816 smart card mode (when the *SMART* bit in the **UARTCTL** register is set).

Along with the **UART Line Control, High Byte (UARTLCRH)** register (see page 729), the **UARTIBRD** and **UARTFBRD** registers form an internal 30-bit register. This internal register is only updated when a write operation to **UARTLCRH** is performed, so any changes to the baud-rate divisor must be followed by a write to the **UARTLCRH** register for the changes to take effect.

To update the baud-rate registers, there are four possible sequences:

- **UARTIBRD** write, **UARTFBRD** write, and **UARTLCRH** write
- **UARTFBRD** write, **UARTIBRD** write, and **UARTLCRH** write
- **UARTIBRD** write and **UARTLCRH** write

- **UARTFBRD** write and **UARTLCRH** write

14.3.3 Data Transmission

Data received or transmitted is stored in two 16-byte FIFOs, though the receive FIFO has an extra four bits per character for status information. For transmission, data is written into the transmit FIFO. If the UART is enabled, it causes a data frame to start transmitting with the parameters indicated in the **UARTLCRH** register. Data continues to be transmitted until there is no data left in the transmit FIFO. The **BUSY** bit in the **UART Flag (UARTFR)** register (see page 723) is asserted as soon as data is written to the transmit FIFO (that is, if the FIFO is non-empty) and remains asserted while data is being transmitted. The **BUSY** bit is negated only when the transmit FIFO is empty, and the last character has been transmitted from the shift register, including the stop bits. The UART can indicate that it is busy even though the UART may no longer be enabled.

When the receiver is idle (the $UnRx$ signal is continuously 1), and the data input goes Low (a start bit has been received), the receive counter begins running and data is sampled on the eighth cycle of $Baud16$ or fourth cycle of $Baud8$ depending on the setting of the **HSE** bit (bit 5) in **UARTCTL** (described in “Transmit/Receive Logic” on page 706).

The start bit is valid and recognized if the $UnRx$ signal is still low on the eighth cycle of $Baud16$ (**HSE** clear) or the fourth cycle of $Baud8$ (**HSE** set), otherwise it is ignored. After a valid start bit is detected, successive data bits are sampled on every 16th cycle of $Baud16$ or 8th cycle of $Baud8$ (that is, one bit period later) according to the programmed length of the data characters and value of the **HSE** bit in **UARTCTL**. The parity bit is then checked if parity mode is enabled. Data length and parity are defined in the **UARTLCRH** register.

Lastly, a valid stop bit is confirmed if the $UnRx$ signal is High, otherwise a framing error has occurred. When a full word is received, the data is stored in the receive FIFO along with any error bits associated with that word.

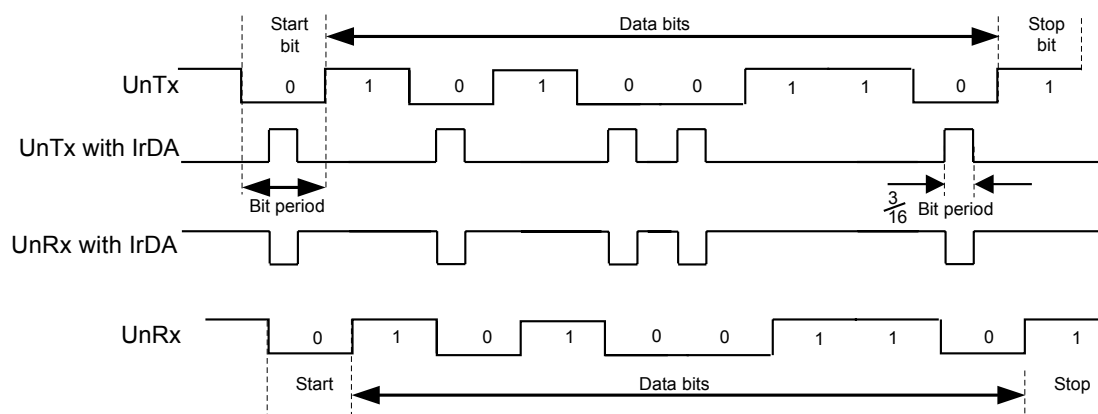
14.3.4 Serial IR (SIR)

The UART peripheral includes an IrDA serial-IR (SIR) encoder/decoder block. The IrDA SIR block provides functionality that converts between an asynchronous UART data stream and a half-duplex serial SIR interface. No analog processing is performed on-chip. The role of the SIR block is to provide a digital encoded output and decoded input to the UART. When enabled, the SIR block uses the $UnTx$ and $UnRx$ pins for the SIR protocol. These signals should be connected to an infrared transceiver to implement an IrDA SIR physical layer link. The SIR block can receive and transmit, but it is only half-duplex so it cannot do both at the same time. Transmission must be stopped before data can be received. The IrDA SIR physical layer specifies a minimum 10-ms delay between transmission and reception. The SIR block has two modes of operation:

- In normal IrDA mode, a zero logic level is transmitted as a high pulse of 3/16th duration of the selected baud rate bit period on the output pin, while logic one levels are transmitted as a static LOW signal. These levels control the driver of an infrared transmitter, sending a pulse of light for each zero. On the reception side, the incoming light pulses energize the photo transistor base of the receiver, pulling its output LOW and driving the UART input pin LOW.
- In low-power IrDA mode, the width of the transmitted infrared pulse is set to three times the period of the internally generated $IrLPBaud16$ signal (1.63 μ s, assuming a nominal 1.8432 MHz frequency) by changing the appropriate bit in the **UARTCR** register. See page 726 for more information on IrDA low-power pulse-duration configuration.

Figure 14-3 on page 709 shows the UART transmit and receive signals, with and without IrDA modulation.

Figure 14-3. IrDA Data Modulation



In both normal and low-power IrDA modes:

- During transmission, the UART data bit is used as the base for encoding
- During reception, the decoded bits are transferred to the UART receive logic

The IrDA SIR physical layer specifies a half-duplex communication link, with a minimum 10-ms delay between transmission and reception. This delay must be generated by software because it is not automatically supported by the UART. The delay is required because the infrared receiver electronics might become biased or even saturated from the optical power coupled from the adjacent transmitter LED. This delay is known as latency or receiver setup time.

14.3.5 ISO 7816 Support

The UART offers basic support to allow communication with an ISO 7816 smartcard. When bit 3 (*SMART*) of the **UARTCTL** register is set, the *UnTx* signal is used as a bit clock, and the *UnRx* signal is used as the half-duplex communication line connected to the smartcard. A GPIO signal can be used to generate the reset signal to the smartcard. The remaining smartcard signals should be provided by the system design. The maximum clock rate in this mode is system clock / 16.

When using ISO 7816 mode, the **UARTLCRH** register must be set to transmit 8-bit words (*WLEN* bits 6:5 configured to 0x3) with EVEN parity (*PEN* set and *EPS* set). In this mode, the UART automatically uses 2 stop bits, and the *STP2* bit of the **UARTLCRH** register is ignored.

If a parity error is detected during transmission, *UnRx* is pulled Low during the second stop bit. In this case, the UART aborts the transmission, flushes the transmit FIFO and discards any data it contains, and raises a parity error interrupt, allowing software to detect the problem and initiate retransmission of the affected data. Note that the UART does not support automatic retransmission in this case.

14.3.6 Modem Handshake Support

This section describes how to configure and use the modem flow control and status signals for UART1 when connected as a DTE (data terminal equipment) or as a DCE (data communications equipment). In general, a modem is a DCE and a computing device that connects to a modem is the DTE.

14.3.6.1 Signaling

The status signals provided by UART1 differ based on whether the UART is used as a DTE or DCE. When used as a DTE, the modem flow control and status signals are defined as:

- $\overline{\text{UICTS}}$ is Clear To Send
- $\overline{\text{UIDSR}}$ is Data Set Ready
- $\overline{\text{UIDCD}}$ is Data Carrier Detect
- $\overline{\text{UIRI}}$ is Ring Indicator
- $\overline{\text{UIRTS}}$ is Request To Send
- $\overline{\text{UIDTR}}$ is Data Terminal Ready

When used as a DCE, the the modem flow control and status signals are defined as:

- $\overline{\text{UICTS}}$ is Request To Send
- $\overline{\text{UIDSR}}$ is Data Terminal Ready
- $\overline{\text{UIRTS}}$ is Clear To Send
- $\overline{\text{UIDTR}}$ is Data Set Ready

Note that the support for DCE functions Data Carrier Detect and Ring Indicator are not provided. If these signals are required, their function can be emulated by using a general-purpose I/O signal and providing software support.

14.3.6.2 Flow Control

Flow control can be accomplished by either hardware or software. The following sections describe the different methods.

Hardware Flow Control (RTS/CTS)

Hardware flow control between two devices is accomplished by connecting the $\overline{\text{UIRTS}}$ output to the Clear-To-Send input on the receiving device, and connecting the Request-To-Send output on the receiving device to the $\overline{\text{UICTS}}$ input.

The $\overline{\text{UICTS}}$ input controls the transmitter. The transmitter may only transmit data when the $\overline{\text{UICTS}}$ input is asserted. The $\overline{\text{UIRTS}}$ output signal indicates the state of the receive FIFO. $\overline{\text{UICTS}}$ remains asserted until the preprogrammed watermark level is reached, indicating that the Receive FIFO has no space to store additional characters.

The **UARTCTL** register bits 15 (CTSEN) and 14 (RTSEN) specify the flow control mode as shown in Table 14-3 on page 710.

Table 14-3. Flow Control Mode

| CTSEN | RTSEN | Description |
|-------|-------|----------------------------------|
| 1 | 1 | RTS and CTS flow control enabled |
| 1 | 0 | Only CTS flow control enabled |
| 0 | 1 | Only RTS flow control enabled |

Table 14-3. Flow Control Mode (continued)

| CTSEN | RTSEN | Description |
|-------|-------|--|
| 0 | 0 | Both RTS and CTS flow control disabled |

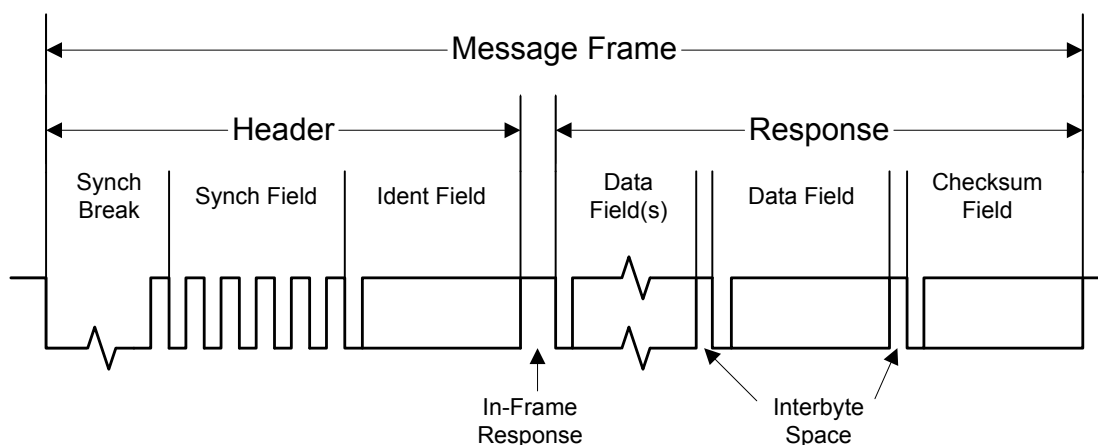
Note that when `RTSEN` is 1, software cannot modify the \overline{UIRTS} output value through the `UARTCTL` register Request to Send (`RTS`) bit, and the status of the `RTS` bit should be ignored.

Software Flow Control (Modem Status Interrupts)

Software flow control between two devices is accomplished by using interrupts to indicate the status of the UART. Interrupts may be generated for the \overline{UIDSR} , \overline{UIDCD} , \overline{UICTS} , and \overline{UIRI} signals using bits 3:0 of the `UARTIM` register, respectively. The raw and masked interrupt status may be checked using the `UARTRIS` and `UARTMIS` register. These interrupts may be cleared using the `UARTICR` register.

14.3.7 LIN Support

The UART module offers hardware support for the LIN protocol as either a master or a slave. The LIN mode is enabled by setting the `LIN` bit in the `UARTCTL` register. A LIN message is identified by the use of a Sync Break at the beginning of the message. The Sync Break is a transmission of a series of 0s. The Sync Break is followed by the Sync data field (0x55). Figure 14-4 on page 711 illustrates the structure of a LIN message.

Figure 14-4. LIN Message

The UART should be configured as followed to operate in LIN mode:

1. Configure the UART for 1 start bit, 8 data bits, no parity, and 1 stop bit. Enable the Transmit FIFO.
2. Set the `LIN` bit in the `UARTCTL` register.

When preparing to send a LIN message, the TXFIFO should contain the Sync data (0x55) at FIFO location 0 and the Identifier data at location 1, followed by the data to be transmitted, and with the checksum in the final FIFO entry.

14.3.7.1 LIN Master

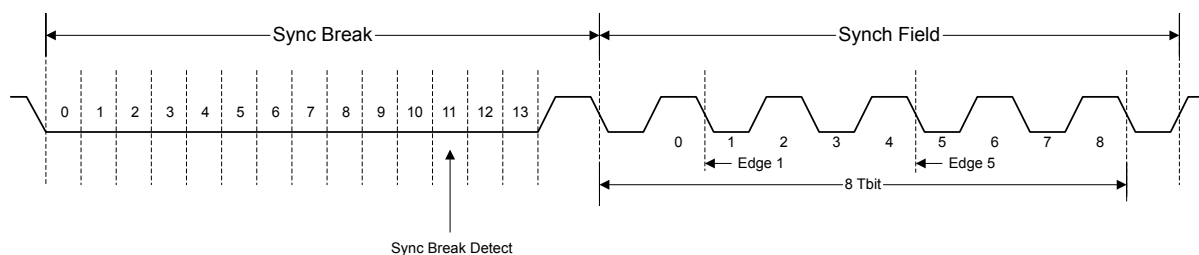
The UART is enabled to be the LIN master by setting the `MASTER` bit in the `UARTLCTL` register. The length of the Sync Break is programmable using the `BLEN` field in the `UARTLCTL` register and can be 13-16 bits (baud clock cycles).

14.3.7.2 LIN Slave

The LIN UART slave is required to adjust its baud rate to that of the LIN master. In slave mode, the LIN UART recognizes the Sync Break, which must be at least 13 bits in duration. A timer is provided to capture timing data on the 1st and 5th falling edges of the Sync field so that the baud rate can be adjusted to match the master.

After detecting a Sync Break, the UART waits for the synchronization field. The first falling edge generates an interrupt using the `LME1RIS` bit in the `UARTRIS` register, and the timer value is captured and stored in the `UARTLSS` register (T1). On the fifth falling edge, a second interrupt is generated using the `LME5RIS` bit in the `UARTRIS` register, and the timer value is captured again (T2). The actual baud rate can be calculated using $(T2-T1)/8$, and the local baud rate should be adjusted as needed. Figure 14-5 on page 712 illustrates the synchronization field.

Figure 14-5. LIN Synchronization Field



14.3.8 FIFO Operation

The UART has two 16x8 FIFOs; one for transmit and one for receive. Both FIFOs are accessed via the `UART Data (UARTDR)` register (see page 718). Read operations of the `UARTDR` register return a 12-bit value consisting of 8 data bits and 4 error flags while write operations place 8-bit data in the transmit FIFO.

Out of reset, both FIFOs are disabled and act as 1-byte-deep holding registers. The FIFOs are enabled by setting the `FEN` bit in `UARTLCRH` (page 729).

FIFO status can be monitored via the `UART Flag (UARTFR)` register (see page 723) and the `UART Receive Status (UARTRSR)` register. Hardware monitors empty, full and overrun conditions. The `UARTFR` register contains empty and full flags (`TXFE`, `TXFF`, `RXFE`, and `RXFF` bits), and the `UARTRSR` register shows overrun status via the `OE` bit. If the FIFOs are disabled, the empty and full flags are set according to the status of the 1-byte-deep holding registers.

The trigger points at which the FIFOs generate interrupts is controlled via the `UART Interrupt FIFO Level Select (UARTIFLS)` register (see page 735). Both FIFOs can be individually configured to trigger interrupts at different levels. Available configurations include $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, and $\frac{7}{8}$. For example, if the $\frac{1}{4}$ option is selected for the receive FIFO, the UART generates a receive interrupt after 4 data bytes are received. Out of reset, both FIFOs are configured to trigger an interrupt at the $\frac{1}{2}$ mark.

14.3.9 Interrupts

The UART can generate interrupts when the following conditions are observed:

- Overrun Error
- Break Error
- Parity Error
- Framing Error
- Receive Timeout
- Transmit (when condition defined in the `TXIFLSEL` bit in the **UARTIFLS** register is met, or if the `EOT` bit in **UARTCTL** is set, when the last bit of all transmitted data leaves the serializer)
- Receive (when condition defined in the `RXIFLSEL` bit in the **UARTIFLS** register is met)

All of the interrupt events are ORed together before being sent to the interrupt controller, so the UART can only generate a single interrupt request to the controller at any given time. Software can service multiple interrupt events in a single interrupt service routine by reading the **UART Masked Interrupt Status (UARTMIS)** register (see page 745).

The interrupt events that can trigger a controller-level interrupt are defined in the **UART Interrupt Mask (UARTIM)** register (see page 737) by setting the corresponding `IM` bits. If interrupts are not used, the raw interrupt status is always visible via the **UART Raw Interrupt Status (UARTRIS)** register (see page 741).

Interrupts are always cleared (for both the **UARTMIS** and **UARTRIS** registers) by writing a 1 to the corresponding bit in the **UART Interrupt Clear (UARTICR)** register (see page 749).

The receive timeout interrupt is asserted when the receive FIFO is not empty, and no further data is received over a 32-bit period. The receive timeout interrupt is cleared either when the FIFO becomes empty through reading all the data (or by reading the holding register), or when a 1 is written to the corresponding bit in the **UARTICR** register.

The receive interrupt changes state when one of the following events occurs:

- If the FIFOs are enabled and the receive FIFO reaches the programmed trigger level, the `RXRIS` bit is set. The receive interrupt is cleared by reading data from the receive FIFO until it becomes less than the trigger level, or by clearing the interrupt by writing a 1 to the `RXIC` bit.
- If the FIFOs are disabled (have a depth of one location) and data is received thereby filling the location, the `RXRIS` bit is set. The receive interrupt is cleared by performing a single read of the receive FIFO, or by clearing the interrupt by writing a 1 to the `RXIC` bit.

The transmit interrupt changes state when one of the following events occurs:

- If the FIFOs are enabled and the transmit FIFO reaches the programmed trigger level, the `TXRIS` bit is set. The transmit interrupt is cleared by writing data to the transmit FIFO until it becomes greater than the trigger level, or by clearing the interrupt by writing a 1 to the `TXIC` bit.
- If the FIFOs are disabled (have a depth of one location) and there is no data present in the transmitters single location, the `TXRIS` bit is set. It is cleared by performing a single write to the transmit FIFO, or by clearing the interrupt by writing a 1 to the `TXIC` bit.

14.3.10 Loopback Operation

The UART can be placed into an internal loopback mode for diagnostic or debug work by setting the `LBE` bit in the **UARTCTL** register (see page 731). In loopback mode, data transmitted on the `UnTx` output is received on the `UnRx` input. Note that the `LBE` bit should be set before the UART is enabled.

14.3.11 DMA Operation

The UART provides an interface to the μ DMA controller with separate channels for transmit and receive. The DMA operation of the UART is enabled through the **UART DMA Control (UARTDMACTL)** register. When DMA operation is enabled, the UART asserts a DMA request on the receive or transmit channel when the associated FIFO can transfer data. For the receive channel, a single transfer request is asserted whenever any data is in the receive FIFO. A burst transfer request is asserted whenever the amount of data in the receive FIFO is at or above the FIFO trigger level configured in the **UARTIFLS** register. For the transmit channel, a single transfer request is asserted whenever there is at least one empty location in the transmit FIFO. The burst request is asserted whenever the transmit FIFO contains fewer characters than the FIFO trigger level. The single and burst DMA transfer requests are handled automatically by the μ DMA controller depending on how the DMA channel is configured.

To enable DMA operation for the receive channel, set the `RXDMAE` bit of the **DMA Control (UARTDMACTL)** register. To enable DMA operation for the transmit channel, set the `TXDMAE` bit of the **UARTDMACTL** register. The UART can also be configured to stop using DMA for the receive channel if a receive error occurs. If the `DMAERR` bit of the **UARTDMACR** register is set and a receive error occurs, the DMA receive requests are automatically disabled. This error condition can be cleared by clearing the appropriate UART error interrupt.

If DMA is enabled, then the μ DMA controller triggers an interrupt when a transfer is complete. The interrupt occurs on the UART interrupt vector. Therefore, if interrupts are used for UART operation and DMA is enabled, the UART interrupt handler must be designed to handle the μ DMA completion interrupt.

See “Micro Direct Memory Access (μ DMA)” on page 359 for more details about programming the μ DMA controller.

14.4 Initialization and Configuration

To enable and initialize the UART, the following steps are necessary:

1. The peripheral clock must be enabled by setting the `UART0`, `UART1`, or `UART2` bits in the **RCGC1** register (see page 262).
2. The clock to the appropriate GPIO module must be enabled via the **RCGC2** register in the System Control module (see page 274).
3. Set the GPIO `AFSEL` bits for the appropriate pins (see page 443). To determine which GPIOs to configure, see Table 23-4 on page 1075.
4. Configure the GPIO current level and/or slew rate as specified for the mode selected (see page 445 and page 453).
5. Configure the `PMCn` fields in the **GPIOPCTL** register to assign the UART signals to the appropriate pins (see page 461 and Table 23-5 on page 1083).

To use the UART, the peripheral clock must be enabled by setting the appropriate bit in the **RCGC1** register (page 262). In addition, the clock to the appropriate GPIO module must be enabled via the **RCGC2** register (page 274) in the System Control module. To find out which GPIO port to enable, refer to Table 23-5 on page 1083.

This section discusses the steps that are required to use a UART module. For this example, the UART clock is assumed to be 20 MHz, and the desired UART configuration is:

- 115200 baud rate
- Data length of 8 bits
- One stop bit
- No parity
- FIFOs disabled
- No interrupts

The first thing to consider when programming the UART is the baud-rate divisor (BRD), because the **UARTIBRD** and **UARTFBRD** registers must be written before the **UARTLCRH** register. Using the equation described in “Baud-Rate Generation” on page 707, the BRD can be calculated:

$$\text{BRD} = 20,000,000 / (16 * 115,200) = 10.8507$$

which means that the **DIVINT** field of the **UARTIBRD** register (see page 727) should be set to 10 decimal or 0xA. The value to be loaded into the **UARTFBRD** register (see page 728) is calculated by the equation:

$$\text{UARTFBRD}[\text{DIVFRAC}] = \text{integer}(0.8507 * 64 + 0.5) = 54$$

With the BRD values in hand, the UART configuration is written to the module in the following order:

1. Disable the UART by clearing the **UARTEN** bit in the **UARTCTL** register.
2. Write the integer portion of the BRD to the **UARTIBRD** register.
3. Write the fractional portion of the BRD to the **UARTFBRD** register.
4. Write the desired serial parameters to the **UARTLCRH** register (in this case, a value of 0x0000.0060).
5. Optionally, configure the μ DMA channel (see “Micro Direct Memory Access (μ DMA)” on page 359) and enable the DMA option(s) in the **UARTDMACTL** register.
6. Enable the UART by setting the **UARTEN** bit in the **UARTCTL** register.

14.5 Register Map

Table 14-4 on page 716 lists the UART registers. The offset listed is a hexadecimal increment to the register’s address, relative to that UART’s base address:

- UART0: 0x4000.C000
- UART1: 0x4000.D000
- UART2: 0x4000.E000

Note that the UART module clock must be enabled before the registers can be programmed (see page 262). There must be a delay of 3 system clocks after the UART module clock is enabled before any UART module registers are accessed.

Note: The UART must be disabled (see the `UARTEN` bit in the `UARTCTL` register on page 731) before any of the control registers are reprogrammed. When the UART is disabled during a TX or RX operation, the current transaction is completed prior to the UART stopping.

Table 14-4. UART Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|----------------|------|-------------|-----------------------------------|----------|
| 0x000 | UARTDR | R/W | 0x0000.0000 | UART Data | 718 |
| 0x004 | UARTSR/UARTSCR | R/W | 0x0000.0000 | UART Receive Status/Error Clear | 720 |
| 0x018 | UARTFR | RO | 0x0000.0090 | UART Flag | 723 |
| 0x020 | UARTILPR | R/W | 0x0000.0000 | UART IrDA Low-Power Register | 726 |
| 0x024 | UARTIBRD | R/W | 0x0000.0000 | UART Integer Baud-Rate Divisor | 727 |
| 0x028 | UARTFBRD | R/W | 0x0000.0000 | UART Fractional Baud-Rate Divisor | 728 |
| 0x02C | UARTLCRH | R/W | 0x0000.0000 | UART Line Control | 729 |
| 0x030 | UARTCTL | R/W | 0x0000.0300 | UART Control | 731 |
| 0x034 | UARTIFLS | R/W | 0x0000.0012 | UART Interrupt FIFO Level Select | 735 |
| 0x038 | UARTIM | R/W | 0x0000.0000 | UART Interrupt Mask | 737 |
| 0x03C | UARTIS | RO | 0x0000.000F | UART Raw Interrupt Status | 741 |
| 0x040 | UARTMIS | RO | 0x0000.0000 | UART Masked Interrupt Status | 745 |
| 0x044 | UARTICR | W1C | 0x0000.0000 | UART Interrupt Clear | 749 |
| 0x048 | UARTDMACTL | R/W | 0x0000.0000 | UART DMA Control | 751 |
| 0x090 | UARTLCTL | R/W | 0x0000.0000 | UART LIN Control | 752 |
| 0x094 | UARTLSS | RO | 0x0000.0000 | UART LIN Snap Shot | 753 |
| 0x098 | UARTLTIM | RO | 0x0000.0000 | UART LIN Timer | 754 |
| 0xFD0 | UARTPeriphID4 | RO | 0x0000.0000 | UART Peripheral Identification 4 | 755 |
| 0xFD4 | UARTPeriphID5 | RO | 0x0000.0000 | UART Peripheral Identification 5 | 756 |
| 0xFD8 | UARTPeriphID6 | RO | 0x0000.0000 | UART Peripheral Identification 6 | 757 |
| 0xFDC | UARTPeriphID7 | RO | 0x0000.0000 | UART Peripheral Identification 7 | 758 |
| 0xFE0 | UARTPeriphID0 | RO | 0x0000.0060 | UART Peripheral Identification 0 | 759 |
| 0xFE4 | UARTPeriphID1 | RO | 0x0000.0000 | UART Peripheral Identification 1 | 760 |
| 0xFE8 | UARTPeriphID2 | RO | 0x0000.0018 | UART Peripheral Identification 2 | 761 |
| 0xFEC | UARTPeriphID3 | RO | 0x0000.0001 | UART Peripheral Identification 3 | 762 |
| 0xFF0 | UARTPCellID0 | RO | 0x0000.000D | UART PrimeCell Identification 0 | 763 |
| 0xFF4 | UARTPCellID1 | RO | 0x0000.00F0 | UART PrimeCell Identification 1 | 764 |

Table 14-4. UART Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|--------------|------|-------------|---------------------------------|----------|
| 0xFF8 | UARTPCellID2 | RO | 0x0000.0005 | UART PrimeCell Identification 2 | 765 |
| 0xFFC | UARTPCellID3 | RO | 0x0000.00B1 | UART PrimeCell Identification 3 | 766 |

14.6 Register Descriptions

The remainder of this section lists and describes the UART registers, in numerical order by address offset.

Register 1: UART Data (UARTDR), offset 0x000

Important: This register is read-sensitive. See the register description for details.

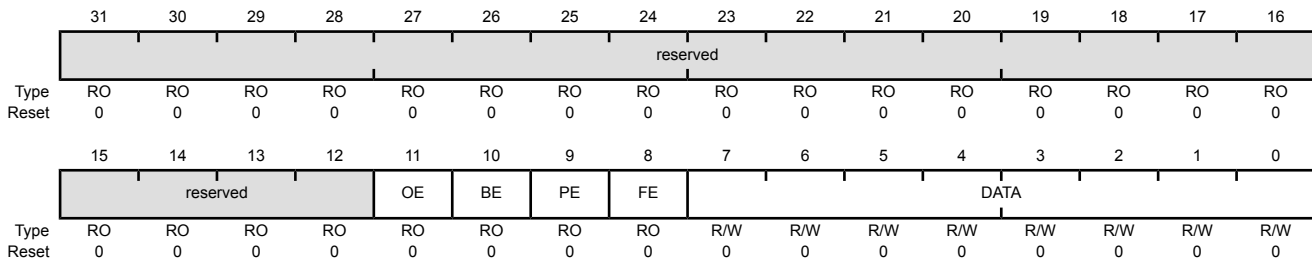
This register is the data register (the interface to the FIFOs).

For transmitted data, if the FIFO is enabled, data written to this location is pushed onto the transmit FIFO. If the FIFO is disabled, data is stored in the transmitter holding register (the bottom word of the transmit FIFO). A write to this register initiates a transmission from the UART.

For received data, if the FIFO is enabled, the data byte and the 4-bit status (break, frame, parity, and overrun) is pushed onto the 12-bit wide receive FIFO. If the FIFO is disabled, the data byte and status are stored in the receiving holding register (the bottom word of the receive FIFO). The received data can be retrieved by reading this register.

UART Data (UARTDR)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x000
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 11 | OE | RO | 0 | UART Overrun Error Value Description 1 New data was received when the FIFO was full, resulting in data loss. 0 No data has been lost due to a FIFO overrun. |
| 10 | BE | RO | 0 | UART Break Error Value Description 1 A break condition has been detected, indicating that the receive data input was held Low for longer than a full-word transmission time (defined as start, data, parity, and stop bits). 0 No break condition has occurred In FIFO mode, this error is associated with the character at the top of the FIFO. When a break occurs, only one 0 character is loaded into the FIFO. The next character is only enabled after the received data input goes to a 1 (marking state), and the next valid start bit is received. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 9 | PE | RO | 0 | <p>UART Parity Error</p> <p>Value Description</p> <p>1 The parity of the received data character does not match the parity defined by bits 2 and 7 of the UARTLCRH register.</p> <p>0 No parity error has occurred</p> <p>In FIFO mode, this error is associated with the character at the top of the FIFO.</p> |
| 8 | FE | RO | 0 | <p>UART Framing Error</p> <p>Value Description</p> <p>1 The received character does not have a valid stop bit (a valid stop bit is 1).</p> <p>0 No framing error has occurred</p> |
| 7:0 | DATA | R/W | 0x00 | <p>Data Transmitted or Received</p> <p>Data that is to be transmitted via the UART is written to this field.</p> <p>When read, this field contains the data that was received by the UART.</p> |

Register 2: UART Receive Status/Error Clear (UARTRSR/UARTECR), offset 0x004

The **UARTRSR/UARTECR** register is the receive status register/error clear register.

In addition to the **UARTDR** register, receive status can also be read from the **UARTRSR** register. If the status is read from this register, then the status information corresponds to the entry read from **UARTDR** prior to reading **UARTRSR**. The status information for overrun is set immediately when an overrun condition occurs.

The **UARTRSR** register cannot be written.

A write of any value to the **UARTECR** register clears the framing, parity, break, and overrun errors. All the bits are cleared on reset.

Read-Only Status Register

UART Receive Status/Error Clear (UARTRSR/UARTECR)

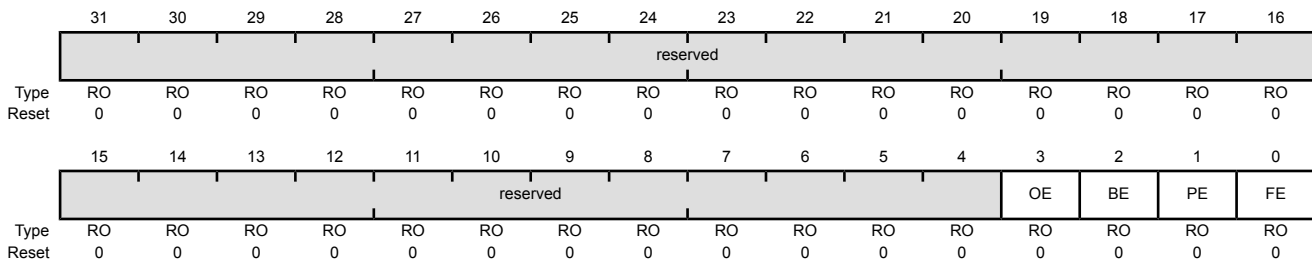
UART0 base: 0x4000.C000

UART1 base: 0x4000.D000

UART2 base: 0x4000.E000

Offset 0x004

Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|--|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | OE | RO | 0 | UART Overrun Error |
| | | | | Value Description |
| | | | | 1 New data was received when the FIFO was full, resulting in data loss. |
| | | | | 0 No data has been lost due to a FIFO overrun. |
| | | | | This bit is cleared by a write to UARTECR . |
| | | | | The FIFO contents remain valid because no further data is written when the FIFO is full, only the contents of the shift register are overwritten. The CPU must read the data in order to empty the FIFO. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 2 | BE | RO | 0 | <p>UART Break Error</p> <p>Value Description</p> <p>1 A break condition has been detected, indicating that the receive data input was held Low for longer than a full-word transmission time (defined as start, data, parity, and stop bits).</p> <p>0 No break condition has occurred</p> <p>This bit is cleared to 0 by a write to UARTECR.</p> <p>In FIFO mode, this error is associated with the character at the top of the FIFO. When a break occurs, only one 0 character is loaded into the FIFO. The next character is only enabled after the receive data input goes to a 1 (marking state) and the next valid start bit is received.</p> |
| 1 | PE | RO | 0 | <p>UART Parity Error</p> <p>Value Description</p> <p>1 The parity of the received data character does not match the parity defined by bits 2 and 7 of the UARTLCRH register.</p> <p>0 No parity error has occurred</p> <p>This bit is cleared to 0 by a write to UARTECR.</p> |
| 0 | FE | RO | 0 | <p>UART Framing Error</p> <p>Value Description</p> <p>1 The received character does not have a valid stop bit (a valid stop bit is 1).</p> <p>0 No framing error has occurred</p> <p>This bit is cleared to 0 by a write to UARTECR.</p> <p>In FIFO mode, this error is associated with the character at the top of the FIFO.</p> |

Write-Only Error Clear Register

UART Receive Status/Error Clear (UARTRSR/UARTECR)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x004
 Type WO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DATA | | | | | | | |
| Type | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | WO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | DATA | WO | 0x00 | Error Clear A write to this register of any data clears the framing, parity, break, and overrun flags. |

Register 3: UART Flag (UARTFR), offset 0x018

The **UARTFR** register is the flag register. After reset, the **TXFF**, **RXFF**, and **BUSY** bits are 0, and **TXFE** and **RXFE** bits are 1. The **RI**, **DCD**, **DSR** and **CTS** bits indicate the modem flow control and status. Note that the modem bits are only implemented on UART1 and are reserved on UART0 and UART2.

UART Flag (UARTFR)

UART0 base: 0x4000.C000

UART1 base: 0x4000.D000

UART2 base: 0x4000.E000

Offset 0x018

Type RO, reset 0x0000.0090

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|------|------|------|------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | RI | TXFE | RXFF | TXFF | RXFE | BUSY | DCD | DSR | CTS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|--|
| 31:9 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 8 | RI | RO | 0 | Ring Indicator Value Description 1 The URI signal is asserted. 0 The URI signal is not asserted. This bit is implemented only on UART1 and is reserved for UART0 and UART2. |
| 7 | TXFE | RO | 1 | UART Transmit FIFO Empty The meaning of this bit depends on the state of the FEN bit in the UARTLCRH register. Value Description 1 If the FIFO is disabled (FEN is 0), the transmit holding register is empty. If the FIFO is enabled (FEN is 1), the transmit FIFO is empty. 0 The transmitter has data to transmit. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 6 | RXFF | RO | 0 | <p>UART Receive FIFO Full</p> <p>The meaning of this bit depends on the state of the <code>FEN</code> bit in the UARTLCRH register.</p> <p>Value Description</p> <p>1 If the FIFO is disabled (<code>FEN</code> is 0), the receive holding register is full. If the FIFO is enabled (<code>FEN</code> is 1), the receive FIFO is full.</p> <p>0 The receiver can receive data.</p> |
| 5 | TXFF | RO | 0 | <p>UART Transmit FIFO Full</p> <p>The meaning of this bit depends on the state of the <code>FEN</code> bit in the UARTLCRH register.</p> <p>Value Description</p> <p>1 If the FIFO is disabled (<code>FEN</code> is 0), the transmit holding register is full. If the FIFO is enabled (<code>FEN</code> is 1), the transmit FIFO is full.</p> <p>0 The transmitter is not full.</p> |
| 4 | RXFE | RO | 1 | <p>UART Receive FIFO Empty</p> <p>The meaning of this bit depends on the state of the <code>FEN</code> bit in the UARTLCRH register.</p> <p>Value Description</p> <p>1 If the FIFO is disabled (<code>FEN</code> is 0), the receive holding register is empty. If the FIFO is enabled (<code>FEN</code> is 1), the receive FIFO is empty.</p> <p>0 The receiver is not empty.</p> |
| 3 | BUSY | RO | 0 | <p>UART Busy</p> <p>Value Description</p> <p>1 The UART is busy transmitting data. This bit remains set until the complete byte, including all stop bits, has been sent from the shift register.</p> <p>0 The UART is not busy.</p> <p>This bit is set as soon as the transmit FIFO becomes non-empty (regardless of whether UART is enabled).</p> |
| 2 | DCD | RO | 0 | <p>Data Carrier Detect</p> <p>Value Description</p> <p>1 The <code>U1DCD</code> signal is asserted.</p> <p>0 The <code>U1DCD</code> signal is not asserted.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 1 | DSR | RO | 0 | Data Set Ready Value Description 1 The U1DSR signal is asserted. 0 The U1DSR signal is not asserted. This bit is implemented only on UART1 and is reserved for UART0 and UART2. |
| 0 | CTS | RO | 0 | Clear To Send Value Description 1 The U1CTS signal is asserted. 0 The U1CTS signal is not asserted. This bit is implemented only on UART1 and is reserved for UART0 and UART2. |

Register 4: UART IrDA Low-Power Register (UARTILPR), offset 0x020

The **UARTILPR** register stores the 8-bit low-power counter divisor value used to derive the low-power SIR pulse width clock by dividing down the system clock (SysClk). All the bits are cleared when reset.

The internal $F_{IrLPBaud16}$ clock is generated by dividing down SysClk according to the low-power divisor value written to **UARTILPR**. The duration of SIR pulses generated when low-power mode is enabled is three times the period of the $F_{IrLPBaud16}$ clock. The low-power divisor value is calculated as follows:

$$ILPDVSR = SysClk / F_{IrLPBaud16}$$

where $F_{IrLPBaud16}$ is nominally 1.8432 MHz.

The divisor must be programmed such that $1.42 \text{ MHz} < F_{IrLPBaud16} < 2.12 \text{ MHz}$, resulting in a low-power pulse duration of 1.41–2.11 μs (three times the period of $F_{IrLPBaud16}$). The minimum frequency of $F_{IrLPBaud16}$ ensures that pulses less than one period of $F_{IrLPBaud16}$ are rejected, but pulses greater than 1.4 μs are accepted as valid pulses.

Note: Zero is an illegal value. Programming a zero value results in no $F_{IrLPBaud16}$ pulses being generated.

UART IrDA Low-Power Register (UARTILPR)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x020
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|---------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | ILPDVSR | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | ILPDVSR | R/W | 0x00 | IrDA Low-Power Divisor This field contains the 8-bit low-power divisor value. |

Register 5: UART Integer Baud-Rate Divisor (UARTIBRD), offset 0x024

The **UARTIBRD** register is the integer part of the baud-rate divisor value. All the bits are cleared on reset. The minimum possible divide ratio is 1 (when **UARTIBRD**=0), in which case the **UARTFBRD** register is ignored. When changing the **UARTIBRD** register, the new value does not take effect until transmission/reception of the current character is complete. Any changes to the baud-rate divisor must be followed by a write to the **UARTLCRH** register. See “Baud-Rate Generation” on page 707 for configuration details.

UART Integer Baud-Rate Divisor (UARTIBRD)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x024
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DIVINT | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

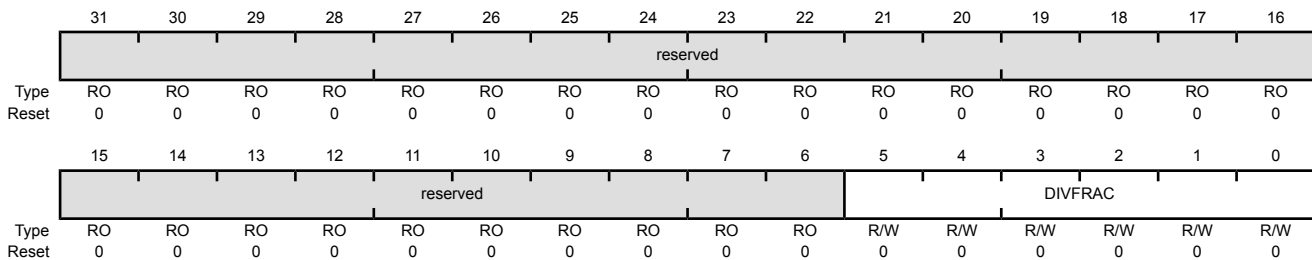
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | DIVINT | R/W | 0x0000 | Integer Baud-Rate Divisor |

Register 6: UART Fractional Baud-Rate Divisor (UARTFBRD), offset 0x028

The **UARTFBRD** register is the fractional part of the baud-rate divisor value. All the bits are cleared on reset. When changing the **UARTFBRD** register, the new value does not take effect until transmission/reception of the current character is complete. Any changes to the baud-rate divisor must be followed by a write to the **UARTLCRH** register. See “Baud-Rate Generation” on page 707 for configuration details.

UART Fractional Baud-Rate Divisor (UARTFBRD)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x028
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:6 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5:0 | DIVFRAC | R/W | 0x0 | Fractional Baud-Rate Divisor |

Register 7: UART Line Control (UARTLCRH), offset 0x02C

The **UARTLCRH** register is the line control register. Serial parameters such as data length, parity, and stop bit selection are implemented in this register.

When updating the baud-rate divisor (**UARTIBRD** and/or **UARTIFRD**), the **UARTLCRH** register must also be written. The write strobe for the baud-rate divisor registers is tied to the **UARTLCRH** register.

UART Line Control (UARTLCRH)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x02C
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-----|------|-----|-----|------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | SPS | WLEN | | FEN | STP2 | EPS | PEN | BRK |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|------------------|------|-----------|--|-------|-------------|-----|------------------|-----|--------|-----|--------|-----|--------|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 7 | SPS | R/W | 0 | UART Stick Parity Select When bits 1, 2, and 7 of UARTLCRH are set, the parity bit is transmitted and checked as a 0. When bits 1 and 7 are set and 2 is cleared, the parity bit is transmitted and checked as a 1. When this bit is cleared, stick parity is disabled. | | | | | | | | | | |
| 6:5 | WLEN | R/W | 0x0 | UART Word Length The bits indicate the number of data bits transmitted or received in a frame as follows: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>5 bits (default)</td> </tr> <tr> <td>0x1</td> <td>6 bits</td> </tr> <tr> <td>0x2</td> <td>7 bits</td> </tr> <tr> <td>0x3</td> <td>8 bits</td> </tr> </tbody> </table> | Value | Description | 0x0 | 5 bits (default) | 0x1 | 6 bits | 0x2 | 7 bits | 0x3 | 8 bits |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | 5 bits (default) | | | | | | | | | | | | | |
| 0x1 | 6 bits | | | | | | | | | | | | | |
| 0x2 | 7 bits | | | | | | | | | | | | | |
| 0x3 | 8 bits | | | | | | | | | | | | | |
| 4 | FEN | R/W | 0 | UART Enable FIFOs Value Description 1 The transmit and receive FIFO buffers are enabled (FIFO mode). 0 The FIFOs are disabled (Character mode). The FIFOs become 1-byte-deep holding registers. | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 3 | STP2 | R/W | 0 | <p>UART Two Stop Bits Select</p> <p>Value Description</p> <p>1 Two stop bits are transmitted at the end of a frame. The receive logic does not check for two stop bits being received. When in 7816 smartcard mode (the <code>SMART</code> bit is set in the <code>UARTCTL</code> register), the number of stop bits is forced to 2.</p> <p>0 One stop bit is transmitted at the end of a frame.</p> |
| 2 | EPS | R/W | 0 | <p>UART Even Parity Select</p> <p>Value Description</p> <p>1 Even parity generation and checking is performed during transmission and reception, which checks for an even number of 1s in data and parity bits.</p> <p>0 Odd parity is performed, which checks for an odd number of 1s.</p> <p>This bit has no effect when parity is disabled by the <code>PEN</code> bit.</p> |
| 1 | PEN | R/W | 0 | <p>UART Parity Enable</p> <p>Value Description</p> <p>1 Parity checking and generation is enabled.</p> <p>0 Parity is disabled and no parity bit is added to the data frame.</p> |
| 0 | BRK | R/W | 0 | <p>UART Send Break</p> <p>Value Description</p> <p>1 A Low level is continually output on the <code>UnTx</code> signal, after completing transmission of the current character. For the proper execution of the break command, software must set this bit for at least two frames (character periods).</p> <p>0 Normal use.</p> |

Register 8: UART Control (UARTCTL), offset 0x030

The **UARTCTL** register is the control register. All the bits are cleared on reset except for the Transmit Enable (**TXE**) and Receive Enable (**RXE**) bits, which are set.

To enable the UART module, the **UARTEN** bit must be set. If software requires a configuration change in the module, the **UARTEN** bit must be cleared before the configuration changes are written. If the UART is disabled during a transmit or receive operation, the current transaction is completed prior to the UART stopping.

Note that bits [15:14,11:10] are only implemented on UART1. These bits are reserved on UART0 and UART2.

Note: The **UARTCTL** register should not be changed while the UART is enabled or else the results are unpredictable. The following sequence is recommended for making changes to the **UARTCTL** register.

1. Disable the UART.
2. Wait for the end of transmission or reception of the current character.
3. Flush the transmit FIFO by clearing bit 4 (**FEN**) in the line control register (**UARTLCRH**).
4. Reprogram the control register.
5. Enable the UART.

UART Control (UARTCTL)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x030
 Type R/W, reset 0x0000.0300

| | | | | | | | | | | | | | | | | |
|-------|----------|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-------|-------|-------|--------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | CTSEN | RTSEN | reserved | RTS | DTR | RXE | TXE | LBE | LIN | HSE | EOT | SMART | SIRLP | SIREN | UARTEN | |
| Type | R/W | R/W | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 15 | CTSEN | R/W | 0 | <p>Enable Clear To Send</p> <p>Value Description</p> <p>1 CTS hardware flow control is enabled. Data is only transmitted when the U1CTS signal is asserted.</p> <p>0 CTS hardware flow control is disabled.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 14 | RTSEN | R/W | 0 | <p>Enable Request to Send</p> <p>Value Description</p> <p>1 RTS hardware flow control is enabled. Data is only requested (by asserting U1RTS) when the receive FIFO has available entries.</p> <p>0 RTS hardware flow control is disabled.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 13:12 | reserved | RO | 0 | <p>Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation.</p> |
| 11 | RTS | R/W | 0 | <p>Request to Send</p> <p>When RTSEN is clear, the status of this bit is reflected on the U1RTS signal. If RTSEN is set, this bit is ignored on a write and should be ignored on read.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 10 | DTR | R/W | 0 | <p>Data Terminal Ready</p> <p>This bit sets the state of the U1DTR output.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 9 | RXE | R/W | 1 | <p>UART Receive Enable</p> <p>Value Description</p> <p>1 The receive section of the UART is enabled.</p> <p>0 The receive section of the UART is disabled.</p> <p>If the UART is disabled in the middle of a receive, it completes the current character before stopping.</p> <p>Note: To enable reception, the UARTEN bit must also be set.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 8 | TXE | R/W | 1 | <p>UART Transmit Enable</p> <p>Value Description</p> <p>1 The transmit section of the UART is enabled.</p> <p>0 The transmit section of the UART is disabled.</p> <p>If the UART is disabled in the middle of a transmission, it completes the current character before stopping.</p> <p>Note: To enable transmission, the <code>UARTEN</code> bit must also be set.</p> |
| 7 | LBE | R/W | 0 | <p>UART Loop Back Enable</p> <p>Value Description</p> <p>1 The <code>UnTx</code> path is fed through the <code>UnRx</code> path.</p> <p>0 Normal operation.</p> |
| 6 | LIN | R/W | 0 | <p>LIN Mode Enable</p> <p>Value Description</p> <p>1 The UART operates in LIN mode.</p> <p>0 Normal operation.</p> |
| 5 | HSE | R/W | 0 | <p>High-Speed Enable</p> <p>Value Description</p> <p>0 The UART is clocked using the system clock divided by 16.</p> <p>1 The UART is clocked using the system clock divided by 8.</p> <p>Note: System clock used is also dependent on the baud-rate divisor configuration (see page 727) and page 728).</p> <p>The state of this bit has no effect on clock generation in ISO 7816 smart card mode (the <code>SMART</code> bit is set).</p> |
| 4 | EOT | R/W | 0 | <p>End of Transmission</p> <p>This bit determines the behavior of the <code>TXRIS</code> bit in the <code>UARTRIS</code> register.</p> <p>Value Description</p> <p>1 The <code>TXRIS</code> bit is set only after all transmitted data, including stop bits, have cleared the serializer.</p> <p>0 The <code>TXRIS</code> bit is set when the transmit FIFO condition specified in <code>UARTIFLS</code> is met.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 3 | SMART | R/W | 0 | <p>ISO 7816 Smart Card Support</p> <p>Value Description</p> <p>1 The UART operates in Smart Card mode.</p> <p>0 Normal operation.</p> <p>The application must ensure that it sets 8-bit word length (<i>WLEN</i> set to 0x3) and even parity (<i>PEN</i> set to 1, <i>EPS</i> set to 1, <i>SPS</i> set to 0) in UARTLCRH when using ISO 7816 mode.</p> <p>In this mode, the value of the <i>STP2</i> bit in UARTLCRH is ignored and the number of stop bits is forced to 2. Note that the UART does not support automatic retransmission on parity errors. If a parity error is detected on transmission, all further transmit operations are aborted and software must handle retransmission of the affected byte or message.</p> |
| 2 | SIRLP | R/W | 0 | <p>UART SIR Low-Power Mode</p> <p>This bit selects the IrDA encoding mode.</p> <p>Value Description</p> <p>1 The UART operates in SIR Low-Power mode. Low-level bits are transmitted with a pulse width which is 3 times the period of the <i>IrLpBaud16</i> input signal, regardless of the selected bit rate.</p> <p>0 Low-level bits are transmitted as an active High pulse with a width of 3/16th of the bit period.</p> <p>Setting this bit uses less power, but might reduce transmission distances. See page 726 for more information.</p> |
| 1 | SIREN | R/W | 0 | <p>UART SIR Enable</p> <p>Value Description</p> <p>1 The IrDA SIR block is enabled, and the UART will transmit and receive data using SIR protocol.</p> <p>0 Normal operation.</p> |
| 0 | UARTEN | R/W | 0 | <p>UART Enable</p> <p>Value Description</p> <p>1 The UART is enabled.</p> <p>0 The UART is disabled.</p> <p>If the UART is disabled in the middle of transmission or reception, it completes the current character before stopping.</p> |

Register 9: UART Interrupt FIFO Level Select (UARTIFLS), offset 0x034

The **UARTIFLS** register is the interrupt FIFO level select register. You can use this register to define the FIFO level at which the **TXRIS** and **RXRIS** bits in the **UARTRIS** register are triggered.

The interrupts are generated based on a transition through a level rather than being based on the level. That is, the interrupts are generated when the fill level progresses through the trigger level. For example, if the receive trigger level is set to the half-way mark, the interrupt is triggered as the module is receiving the 9th character.

Out of reset, the **TXIFLSEL** and **RXIFLSEL** bits are configured so that the FIFOs trigger an interrupt at the half-way mark.

UART Interrupt FIFO Level Select (UARTIFLS)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x034
 Type R/W, reset 0x0000.0012

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----------|-----|-----|----------|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | RXIFLSEL | | | TXIFLSEL | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:6 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| | | | | |
|-----|----------|-----|-----|--|
| 5:3 | RXIFLSEL | R/W | 0x2 | UART Receive Interrupt FIFO Level Select The trigger points for the receive interrupt are as follows: |
|-----|----------|-----|-----|--|

| Value | Description |
|---------|---|
| 0x0 | RX FIFO $\geq \frac{1}{8}$ full |
| 0x1 | RX FIFO $\geq \frac{1}{4}$ full |
| 0x2 | RX FIFO $\geq \frac{1}{2}$ full (default) |
| 0x3 | RX FIFO $\geq \frac{3}{4}$ full |
| 0x4 | RX FIFO $\geq \frac{7}{8}$ full |
| 0x5-0x7 | Reserved |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 2:0 | TXIFLSEL | R/W | 0x2 | UART Transmit Interrupt FIFO Level Select The trigger points for the transmit interrupt are as follows: |

| Value | Description |
|---------|--|
| 0x0 | TX FIFO \leq $\frac{7}{8}$ empty |
| 0x1 | TX FIFO \leq $\frac{3}{4}$ empty |
| 0x2 | TX FIFO \leq $\frac{1}{2}$ empty (default) |
| 0x3 | TX FIFO \leq $\frac{1}{4}$ empty |
| 0x4 | TX FIFO \leq $\frac{1}{8}$ empty |
| 0x5-0x7 | Reserved |

Note: If the `EOT` bit in `UARTCTL` is set (see page 731), the transmit interrupt is generated once the FIFO is completely empty and all data including stop bits have left the transmit serializer. In this case, the setting of `TXIFLSEL` is ignored.

Register 10: UART Interrupt Mask (UARTIM), offset 0x038

The **UARTIM** register is the interrupt mask set/clear register.

On a read, this register gives the current value of the mask on the relevant interrupt. Setting a bit allows the corresponding raw interrupt signal to be routed to the interrupt controller. Clearing a bit prevents the raw interrupt signal from being sent to the interrupt controller.

Note that bits [3:0] are only implemented on UART1. These bits are reserved on UART0 and UART2.

UART Interrupt Mask (UARTIM)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x038
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|--------|--------|----------|----------|------|------|------|------|------|------|------|-------|-------|-------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | LME5IM | LME1IM | LMSBIM | reserved | reserved | OEIM | BEIM | PEIM | FEIM | RTIM | TXIM | RXIM | DSRIM | DCDIM | CTSIM | RIIM |
| Type | R/W | R/W | R/W | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:16 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15 | LME5IM | R/W | 0 | LIN Mode Edge 5 Interrupt Mask Value Description 1 An interrupt is sent to the interrupt controller when the LME5RIS bit in the UARTRIS register is set. 0 The LME5RIS interrupt is suppressed and not sent to the interrupt controller. |
| 14 | LME1IM | R/W | 0 | LIN Mode Edge 1 Interrupt Mask Value Description 1 An interrupt is sent to the interrupt controller when the LME1RIS bit in the UARTRIS register is set. 0 The LME1RIS interrupt is suppressed and not sent to the interrupt controller. |
| 13 | LMSBIM | R/W | 0 | LIN Mode Sync Break Interrupt Mask Value Description 1 An interrupt is sent to the interrupt controller when the LMSBRIS bit in the UARTRIS register is set. 0 The LMSBRIS interrupt is suppressed and not sent to the interrupt controller. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 12:11 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 10 | OEIM | R/W | 0 | <p>UART Overrun Error Interrupt Mask</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the <code>OERIS</code> bit in the UARTRIS register is set.</p> <p>0 The <code>OERIS</code> interrupt is suppressed and not sent to the interrupt controller.</p> |
| 9 | BEIM | R/W | 0 | <p>UART Break Error Interrupt Mask</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the <code>BERIS</code> bit in the UARTRIS register is set.</p> <p>0 The <code>BERIS</code> interrupt is suppressed and not sent to the interrupt controller.</p> |
| 8 | PEIM | R/W | 0 | <p>UART Parity Error Interrupt Mask</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the <code>PERIS</code> bit in the UARTRIS register is set.</p> <p>0 The <code>PERIS</code> interrupt is suppressed and not sent to the interrupt controller.</p> |
| 7 | FEIM | R/W | 0 | <p>UART Framing Error Interrupt Mask</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the <code>FERIS</code> bit in the UARTRIS register is set.</p> <p>0 The <code>FERIS</code> interrupt is suppressed and not sent to the interrupt controller.</p> |
| 6 | RTIM | R/W | 0 | <p>UART Receive Time-Out Interrupt Mask</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the <code>RTRIS</code> bit in the UARTRIS register is set.</p> <p>0 The <code>RTRIS</code> interrupt is suppressed and not sent to the interrupt controller.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 5 | TXIM | R/W | 0 | <p>UART Transmit Interrupt Mask</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the TXRIS bit in the UARTRIS register is set.</p> <p>0 The TXRIS interrupt is suppressed and not sent to the interrupt controller.</p> |
| 4 | RXIM | R/W | 0 | <p>UART Receive Interrupt Mask</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the RXRIS bit in the UARTRIS register is set.</p> <p>0 The RXRIS interrupt is suppressed and not sent to the interrupt controller.</p> |
| 3 | DSRIM | R/W | 0 | <p>UART Data Set Ready Modem Interrupt Mask</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the DSRRIS bit in the UARTRIS register is set.</p> <p>0 The DSRRIS interrupt is suppressed and not sent to the interrupt controller.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 2 | DCDIM | R/W | 0 | <p>UART Data Carrier Detect Modem Interrupt Mask</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the DCDRIS bit in the UARTRIS register is set.</p> <p>0 The DCDRIS interrupt is suppressed and not sent to the interrupt controller.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 1 | CTSIM | R/W | 0 | <p>UART Clear to Send Modem Interrupt Mask</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the CTSRIS bit in the UARTRIS register is set.</p> <p>0 The CTSRIS interrupt is suppressed and not sent to the interrupt controller.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 0 | RIM | R/W | 0 | UART Ring Indicator Modem Interrupt Mask |
| | | | | Value Description |
| | | | 1 | An interrupt is sent to the interrupt controller when the <code>RIRIS</code> bit in the UARTRIS register is set. |
| | | | 0 | The <code>RIRIS</code> interrupt is suppressed and not sent to the interrupt controller. |
| | | | | This bit is implemented only on UART1 and is reserved for UART0 and UART2. |

Register 11: UART Raw Interrupt Status (UARTRIS), offset 0x03C

The **UARTRIS** register is the raw interrupt status register. On a read, this register gives the current raw status value of the corresponding interrupt. A write has no effect.

Note that bits [3:0] are only implemented on UART1. These bits are reserved on UART0 and UART2.

UART Raw Interrupt Status (UARTRIS)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x03C
 Type RO, reset 0x0000.000F

| | | | | | | | | | | | | | | | | |
|-------|----------|---------|---------|----------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|-------|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | LME5RIS | LME1RIS | LMSBRIS | reserved | OERIS | BERIS | PERIS | FERIS | RTRIS | TXRIS | RXRIS | DSRRIS | DCDRIS | CTSRIS | RIRIS | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:16 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15 | LME5RIS | RO | 0 | LIN Mode Edge 5 Raw Interrupt Status Value Description 1 The timer value at the 5th falling edge of the LIN Sync Field has been captured. 0 No interrupt This bit is cleared by writing a 1 to the LME5IC bit in the UARTICR register. |
| 14 | LME1RIS | RO | 0 | LIN Mode Edge 1 Raw Interrupt Status Value Description 1 The timer value at the 1st falling edge of the LIN Sync Field has been captured. 0 No interrupt This bit is cleared by writing a 1 to the LME1IC bit in the UARTICR register. |
| 13 | LMSBRIS | RO | 0 | LIN Mode Sync Break Raw Interrupt Status Value Description 1 A LIN Sync Break has been detected. 0 No interrupt This bit is cleared by writing a 1 to the LMSBIC bit in the UARTICR register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 12:11 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 10 | OERIS | RO | 0 | <p>UART Overrun Error Raw Interrupt Status</p> <p>Value Description</p> <p>1 An overrun error has occurred.</p> <p>0 No interrupt</p> <p>This bit is cleared by writing a 1 to the OEIC bit in the UARTICR register.</p> |
| 9 | BERIS | RO | 0 | <p>UART Break Error Raw Interrupt Status</p> <p>Value Description</p> <p>1 A break error has occurred.</p> <p>0 No interrupt</p> <p>This bit is cleared by writing a 1 to the BEIC bit in the UARTICR register.</p> |
| 8 | PERIS | RO | 0 | <p>UART Parity Error Raw Interrupt Status</p> <p>Value Description</p> <p>1 A parity error has occurred.</p> <p>0 No interrupt</p> <p>This bit is cleared by writing a 1 to the PEIC bit in the UARTICR register.</p> |
| 7 | FERIS | RO | 0 | <p>UART Framing Error Raw Interrupt Status</p> <p>Value Description</p> <p>1 A framing error has occurred.</p> <p>0 No interrupt</p> <p>This bit is cleared by writing a 1 to the FEIC bit in the UARTICR register.</p> |
| 6 | RTRIS | RO | 0 | <p>UART Receive Time-Out Raw Interrupt Status</p> <p>Value Description</p> <p>1 A receive time out has occurred.</p> <p>0 No interrupt</p> <p>This bit is cleared by writing a 1 to the RTIC bit in the UARTICR register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 5 | TXRIS | RO | 0 | <p>UART Transmit Raw Interrupt Status</p> <p>Value Description</p> <p>1 If the EOT bit in the UARTCTL register is clear, the transmit FIFO level has passed through the condition defined in the UARTIFLS register.</p> <p>If the EOT bit is set, the last bit of all transmitted data and flags has left the serializer.</p> <p>0 No interrupt</p> <p>This bit is cleared by writing a 1 to the TXIC bit in the UARTICR register or by writing data to the transmit FIFO until it becomes greater than the trigger level, if the FIFO is enabled, or by writing a single byte if the FIFO is disabled.</p> |
| 4 | RXRIS | RO | 0 | <p>UART Receive Raw Interrupt Status</p> <p>Value Description</p> <p>1 The receive FIFO level has passed through the condition defined in the UARTIFLS register.</p> <p>0 No interrupt</p> <p>This bit is cleared by writing a 1 to the RXIC bit in the UARTICR register or by reading data from the receive FIFO until it becomes less than the trigger level, if the FIFO is enabled, or by reading a single byte if the FIFO is disabled.</p> |
| 3 | DSRRIS | RO | 0 | <p>UART Data Set Ready Modem Raw Interrupt Status</p> <p>Value Description</p> <p>1 Data Set Ready used for software flow control.</p> <p>0 No interrupt</p> <p>This bit is cleared by writing a 1 to the DSRIC bit in the UARTICR register.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 2 | DCDRIS | RO | 0 | <p>UART Data Carrier Detect Modem Raw Interrupt Status</p> <p>Value Description</p> <p>1 Data Carrier Detect used for software flow control.</p> <p>0 No interrupt</p> <p>This bit is cleared by writing a 1 to the DCDIC bit in the UARTICR register.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 1 | CTSRIS | RO | 0 | UART Clear to Send Modem Raw Interrupt Status Value Description 1 Clear to Send used for software flow control. 0 No interrupt This bit is cleared by writing a 1 to the CTSIC bit in the UARTICR register. This bit is implemented only on UART1 and is reserved for UART0 and UART2. |
| 0 | RIRIS | RO | 0 | UART Ring Indicator Modem Raw Interrupt Status Value Description 1 Ring Indicator used for software flow control. 0 No interrupt This bit is cleared by writing a 1 to the RIIC bit in the UARTICR register. This bit is implemented only on UART1 and is reserved for UART0 and UART2. |

Register 12: UART Masked Interrupt Status (UARTMIS), offset 0x040

The **UARTMIS** register is the masked interrupt status register. On a read, this register gives the current masked status value of the corresponding interrupt. A write has no effect.

Note that bits [3:0] are only implemented on UART1. These bits are reserved on UART0 and UART2.

UART Masked Interrupt Status (UARTMIS)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x040
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|---------|---------|----------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|-------|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | LME5MIS | LME1MIS | LMSBMIS | reserved | OEMIS | BEMIS | PEMIS | FEMIS | RTMIS | TXMIS | RXMIS | DSRMIS | DCDMIS | CTSMIS | RIMIS | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:16 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15 | LME5MIS | RO | 0 | LIN Mode Edge 5 Masked Interrupt Status Value Description 1 An unmasked interrupt was signaled due to the 5th falling edge of the LIN Sync Field. 0 An interrupt has not occurred or is masked. This bit is cleared by writing a 1 to the LME5IC bit in the UARTICR register. |
| 14 | LME1MIS | RO | 0 | LIN Mode Edge 1 Masked Interrupt Status Value Description 1 An unmasked interrupt was signaled due to the 1st falling edge of the LIN Sync Field. 0 An interrupt has not occurred or is masked. This bit is cleared by writing a 1 to the LME1IC bit in the UARTICR register. |
| 13 | LMSBMIS | RO | 0 | LIN Mode Sync Break Masked Interrupt Status Value Description 1 An unmasked interrupt was signaled due to the receipt of a LIN Sync Break. 0 An interrupt has not occurred or is masked. This bit is cleared by writing a 1 to the LMSBIC bit in the UARTICR register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 12:11 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 10 | OEMIS | RO | 0 | <p>UART Overrun Error Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to an overrun error.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the OEIC bit in the UARTICR register.</p> |
| 9 | BEMIS | RO | 0 | <p>UART Break Error Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to a break error.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the BEIC bit in the UARTICR register.</p> |
| 8 | PEMIS | RO | 0 | <p>UART Parity Error Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to a parity error.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the PEIC bit in the UARTICR register.</p> |
| 7 | FEMIS | RO | 0 | <p>UART Framing Error Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to a framing error.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the FEIC bit in the UARTICR register.</p> |
| 6 | RTMIS | RO | 0 | <p>UART Receive Time-Out Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to a receive time out.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the RTIC bit in the UARTICR register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 5 | TXMIS | RO | 0 | <p>UART Transmit Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to passing through the specified transmit FIFO level (if the <code>EOT</code> bit is clear) or due to the transmission of the last data bit (if the <code>EOT</code> bit is set).</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the <code>TXIC</code> bit in the UARTICR register or by writing data to the transmit FIFO until it becomes greater than the trigger level, if the FIFO is enabled, or by writing a single byte if the FIFO is disabled.</p> |
| 4 | RXMIS | RO | 0 | <p>UART Receive Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to passing through the specified receive FIFO level.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the <code>RXIC</code> bit in the UARTICR register or by reading data from the receive FIFO until it becomes less than the trigger level, if the FIFO is enabled, or by reading a single byte if the FIFO is disabled.</p> |
| 3 | DSRMIS | RO | 0 | <p>UART Data Set Ready Modem Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to Data Set Ready.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the <code>DSRIC</code> bit in the UARTICR register.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 2 | DCDMIS | RO | 0 | <p>UART Data Carrier Detect Modem Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to Data Carrier Detect.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the <code>DCDIC</code> bit in the UARTICR register.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 1 | CTSMIS | RO | 0 | <p>UART Clear to Send Modem Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to Clear to Send.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the CTSIC bit in the UARTICR register.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 0 | RIMIS | RO | 0 | <p>UART Ring Indicator Modem Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked interrupt was signaled due to Ring Indicator.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the RIIC bit in the UARTICR register.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |

Register 13: UART Interrupt Clear (UARTICR), offset 0x044

The **UARTICR** register is the interrupt clear register. On a write of 1, the corresponding interrupt (both raw interrupt and masked interrupt, if enabled) is cleared. A write of 0 has no effect.

Note that bits [3:0] are only implemented on UART1. These bits are reserved on UART0 and UART2.

UART Interrupt Clear (UARTICR)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x044
 Type W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|--------|--------|----------|------|------|------|------|------|------|------|--------|--------|--------|-------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | LME5IC | LME1IC | LMSBIC | reserved | OEIC | BEIC | PEIC | FEIC | RTIC | TXIC | RXIC | DSRMIC | DCDMIC | CTSMIC | RIMIC | |
| Type | W1C | W1C | W1C | RO | RO | W1C | W1C | W1C | W1C | W1C | W1C | W1C | W1C | W1C | W1C | W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:16 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15 | LME5IC | W1C | 0 | LIN Mode Edge 5 Interrupt Clear Writing a 1 to this bit clears the LME5RIS bit in the UARTRIS register and the LME5MIS bit in the UARTMIS register. |
| 14 | LME1IC | W1C | 0 | LIN Mode Edge 1 Interrupt Clear Writing a 1 to this bit clears the LME1RIS bit in the UARTRIS register and the LME1MIS bit in the UARTMIS register. |
| 13 | LMSBIC | W1C | 0 | LIN Mode Sync Break Interrupt Clear Writing a 1 to this bit clears the LMSBRIS bit in the UARTRIS register and the LMSBMIS bit in the UARTMIS register. |
| 12:11 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 10 | OEIC | W1C | 0 | Overrun Error Interrupt Clear Writing a 1 to this bit clears the OERIS bit in the UARTRIS register and the OEMIS bit in the UARTMIS register. |
| 9 | BEIC | W1C | 0 | Break Error Interrupt Clear Writing a 1 to this bit clears the BERIS bit in the UARTRIS register and the BEMIS bit in the UARTMIS register. |
| 8 | PEIC | W1C | 0 | Parity Error Interrupt Clear Writing a 1 to this bit clears the PERIS bit in the UARTRIS register and the PEMIS bit in the UARTMIS register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 7 | FEIC | W1C | 0 | <p>Framing Error Interrupt Clear</p> <p>Writing a 1 to this bit clears the FERIS bit in the UARTRIS register and the FEMIS bit in the UARTMIS register.</p> |
| 6 | RTIC | W1C | 0 | <p>Receive Time-Out Interrupt Clear</p> <p>Writing a 1 to this bit clears the RTRIS bit in the UARTRIS register and the RTMIS bit in the UARTMIS register.</p> |
| 5 | TXIC | W1C | 0 | <p>Transmit Interrupt Clear</p> <p>Writing a 1 to this bit clears the TXRIS bit in the UARTRIS register and the TXMIS bit in the UARTMIS register.</p> |
| 4 | RXIC | W1C | 0 | <p>Receive Interrupt Clear</p> <p>Writing a 1 to this bit clears the RXRIS bit in the UARTRIS register and the RXMIS bit in the UARTMIS register.</p> |
| 3 | DSRMIC | W1C | 0 | <p>UART Data Set Ready Modem Interrupt Clear</p> <p>Writing a 1 to this bit clears the DSRRIS bit in the UARTRIS register and the DSRMIS bit in the UARTMIS register.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 2 | DCDMIC | W1C | 0 | <p>UART Data Carrier Detect Modem Interrupt Clear</p> <p>Writing a 1 to this bit clears the DCDRIS bit in the UARTRIS register and the DCDMIS bit in the UARTMIS register.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 1 | CTSMIC | W1C | 0 | <p>UART Clear to Send Modem Interrupt Clear</p> <p>Writing a 1 to this bit clears the CTSRIS bit in the UARTRIS register and the CTSMIS bit in the UARTMIS register.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |
| 0 | RIMIC | W1C | 0 | <p>UART Ring Indicator Modem Interrupt Clear</p> <p>Writing a 1 to this bit clears the RIRIS bit in the UARTRIS register and the RIMIS bit in the UARTMIS register.</p> <p>This bit is implemented only on UART1 and is reserved for UART0 and UART2.</p> |

Register 14: UART DMA Control (UARTDMACTL), offset 0x048

The **UARTDMACTL** register is the DMA control register.

UART DMA Control (UARTDMACTL)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x048
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|--------|--------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | DMAERR | TXDMAE | RXDMAE |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

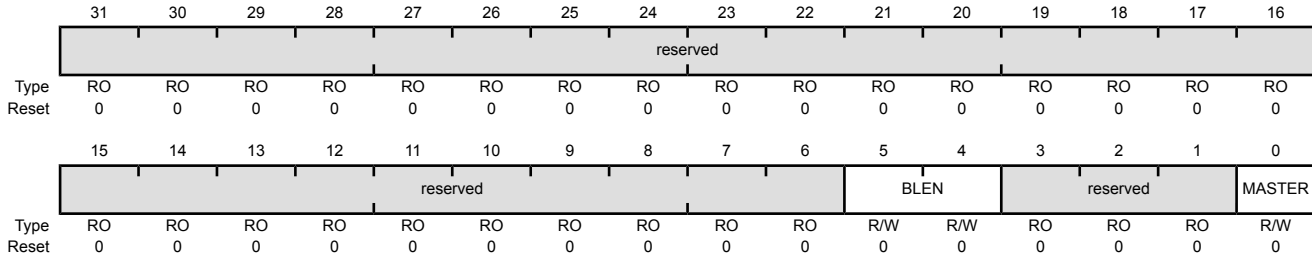
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:3 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | DMAERR | R/W | 0 | DMA on Error Value Description 1 μDMA receive requests are automatically disabled when a receive error occurs. 0 μDMA receive requests are unaffected when a receive error occurs. |
| 1 | TXDMAE | R/W | 0 | Transmit DMA Enable Value Description 1 μDMA for the transmit FIFO is enabled. 0 μDMA for the transmit FIFO is disabled. |
| 0 | RXDMAE | R/W | 0 | Receive DMA Enable Value Description 1 μDMA for the receive FIFO is enabled. 0 μDMA for the receive FIFO is disabled. |

Register 15: UART LIN Control (UARTLCTL), offset 0x090

The **UARTLCTL** register is the configures the operation of the UART when in LIN mode.

UART LIN Control (UARTLCTL)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x090
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|--|
| 31:6 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5:4 | BLEN | R/W | 0x0 | Sync Break Length Value Description 0x3 Sync break length is 16T bits 0x2 Sync break length is 15T bits 0x1 Sync break length is 14T bits 0x0 Sync break length is 13T bits (default) |
| 3:1 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | MASTER | R/W | 0 | LIN Master Enable Value Description 1 The UART operates as a LIN master. 0 The UART operates as a LIN slave. |

Register 16: UART LIN Snap Shot (UARTLSS), offset 0x094

The **UARTLSS** register captures the free-running timer value when either the Sync Edge 1 or the Sync Edge 5 is detected in LIN mode.

UART LIN Snap Shot (UARTLSS)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x094
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | TSS | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

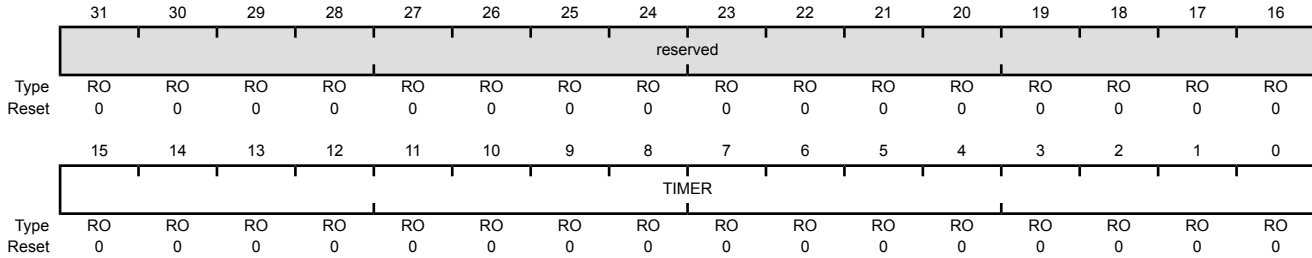
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | TSS | RO | 0x0000 | Timer Snap Shot This field contains the value of the free-running timer when either the Sync Edge 5 or the Sync Edge 1 was detected. |

Register 17: UART LIN Timer (UARTLTIM), offset 0x098

The **UARTLTIM** register contains the current timer value for the free-running timer that is used to calculate the baud rate when in LIN slave mode. The value in this register is used along with the value in the **UART LIN Snap Shot (UARTLSS)** register to adjust the baud rate to match that of the master.

UART LIN Timer (UARTLTIM)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0x098
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | TIMER | RO | 0x0000 | Timer Value This field contains the value of the free-running timer. |

Register 18: UART Peripheral Identification 4 (UARTPeriphID4), offset 0xFD0

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART Peripheral Identification 4 (UARTPeriphID4)

UART0 base: 0x4000.C000

UART1 base: 0x4000.D000

UART2 base: 0x4000.E000

Offset 0xFD0

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID4 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

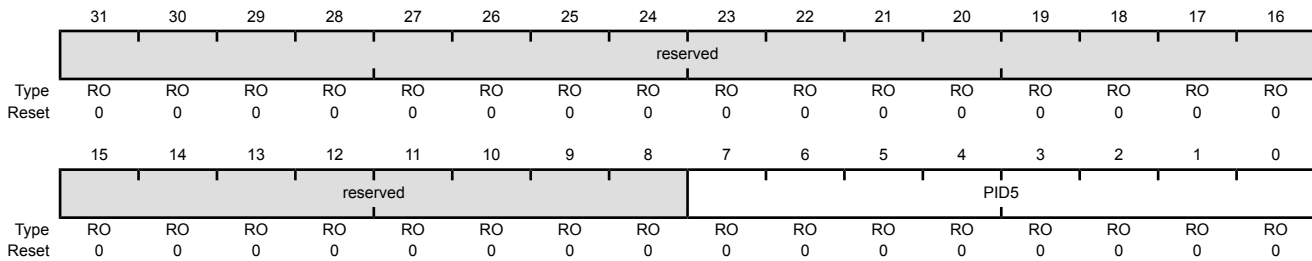
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID4 | RO | 0x00 | UART Peripheral ID Register [7:0] Can be used by software to identify the presence of this peripheral. |

Register 19: UART Peripheral Identification 5 (UARTPeriphID5), offset 0xFD4

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART Peripheral Identification 5 (UARTPeriphID5)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0xFD4
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID5 | RO | 0x00 | UART Peripheral ID Register [15:8] Can be used by software to identify the presence of this peripheral. |

Register 20: UART Peripheral Identification 6 (UARTPeriphID6), offset 0xFD8

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART Peripheral Identification 6 (UARTPeriphID6)

UART0 base: 0x4000.C000

UART1 base: 0x4000.D000

UART2 base: 0x4000.E000

Offset 0xFD8

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID6 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

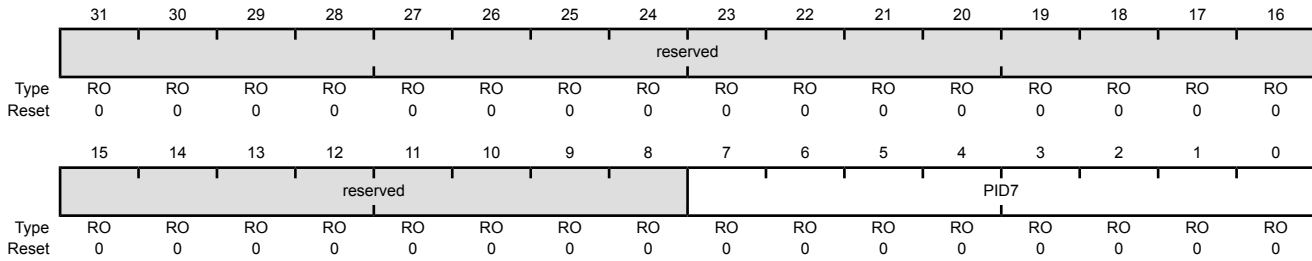
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID6 | RO | 0x00 | UART Peripheral ID Register [23:16] Can be used by software to identify the presence of this peripheral. |

Register 21: UART Peripheral Identification 7 (UARTPeriphID7), offset 0xFDC

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART Peripheral Identification 7 (UARTPeriphID7)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0xFDC
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID7 | RO | 0x00 | UART Peripheral ID Register [31:24] Can be used by software to identify the presence of this peripheral. |

Register 22: UART Peripheral Identification 0 (UARTPeriphID0), offset 0xFE0

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART Peripheral Identification 0 (UARTPeriphID0)

UART0 base: 0x4000.C000

UART1 base: 0x4000.D000

UART2 base: 0x4000.E000

Offset 0xFE0

Type RO, reset 0x0000.0060

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID0 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 |

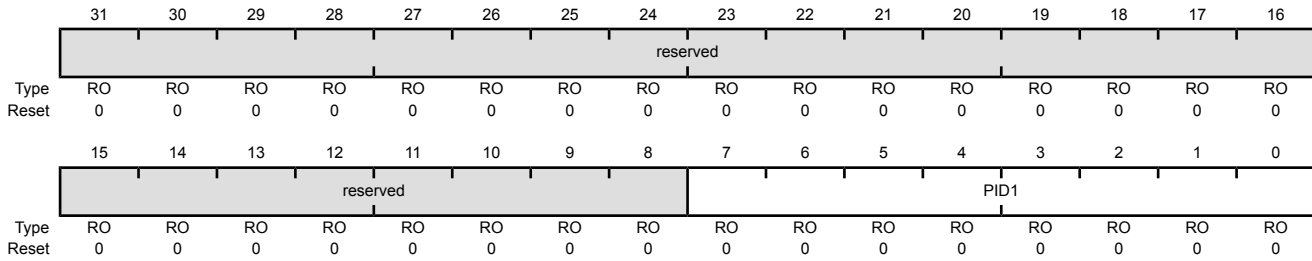
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID0 | RO | 0x60 | UART Peripheral ID Register [7:0] Can be used by software to identify the presence of this peripheral. |

Register 23: UART Peripheral Identification 1 (UARTPeriphID1), offset 0xFE4

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART Peripheral Identification 1 (UARTPeriphID1)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0xFE4
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID1 | RO | 0x00 | UART Peripheral ID Register [15:8] Can be used by software to identify the presence of this peripheral. |

Register 24: UART Peripheral Identification 2 (UARTPeriphID2), offset 0xFE8

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART Peripheral Identification 2 (UARTPeriphID2)

UART0 base: 0x4000.C000

UART1 base: 0x4000.D000

UART2 base: 0x4000.E000

Offset 0xFE8

Type RO, reset 0x0000.0018

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID2 | RO | 0x18 | UART Peripheral ID Register [23:16] Can be used by software to identify the presence of this peripheral. |

Register 25: UART Peripheral Identification 3 (UARTPeriphID3), offset 0xFEC

The **UARTPeriphIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART Peripheral Identification 3 (UARTPeriphID3)

UART0 base: 0x4000.C000

UART1 base: 0x4000.D000

UART2 base: 0x4000.E000

Offset 0xFEC

Type RO, reset 0x0000.0001

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID3 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID3 | RO | 0x01 | UART Peripheral ID Register [31:24] Can be used by software to identify the presence of this peripheral. |

Register 26: UART PrimeCell Identification 0 (UARTPCellID0), offset 0xFF0

The **UARTPCellIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART PrimeCell Identification 0 (UARTPCellID0)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0xFF0
 Type RO, reset 0x0000.000D

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID0 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |

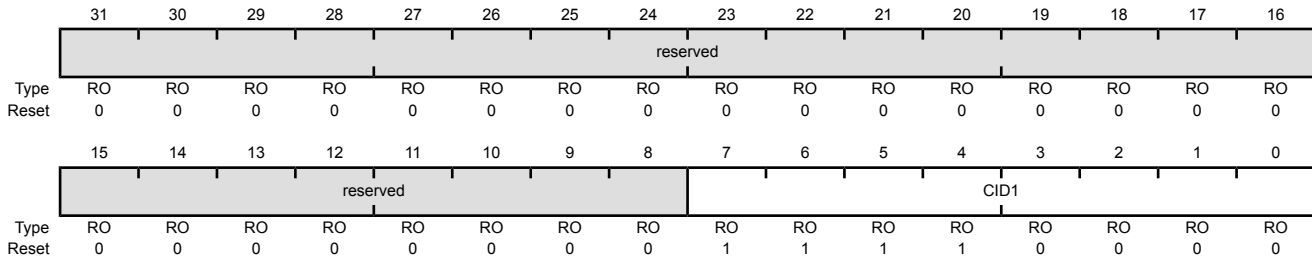
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID0 | RO | 0x0D | UART PrimeCell ID Register [7:0] Provides software a standard cross-peripheral identification system. |

Register 27: UART PrimeCell Identification 1 (UARTPCelIID1), offset 0xFF4

The **UARTPCelIIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART PrimeCell Identification 1 (UARTPCelIID1)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0xFF4
 Type RO, reset 0x0000.00F0



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID1 | RO | 0xF0 | UART PrimeCell ID Register [15:8] Provides software a standard cross-peripheral identification system. |

Register 28: UART PrimeCell Identification 2 (UARTPCelIID2), offset 0xFF8

The **UARTPCelIIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART PrimeCell Identification 2 (UARTPCelIID2)

UART0 base: 0x4000.C000

UART1 base: 0x4000.D000

UART2 base: 0x4000.E000

Offset 0xFF8

Type RO, reset 0x0000.0005

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID2 | RO | 0x05 | UART PrimeCell ID Register [23:16] Provides software a standard cross-peripheral identification system. |

Register 29: UART PrimeCell Identification 3 (UARTPCelIID3), offset 0xFFC

The **UARTPCelIIDn** registers are hard-coded and the fields within the registers determine the reset values.

UART PrimeCell Identification 3 (UARTPCelIID3)

UART0 base: 0x4000.C000
 UART1 base: 0x4000.D000
 UART2 base: 0x4000.E000
 Offset 0xFFC
 Type RO, reset 0x0000.00B1

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID3 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID3 | RO | 0xB1 | UART PrimeCell ID Register [31:24] Provides software a standard cross-peripheral identification system. |

15 Synchronous Serial Interface (SSI)

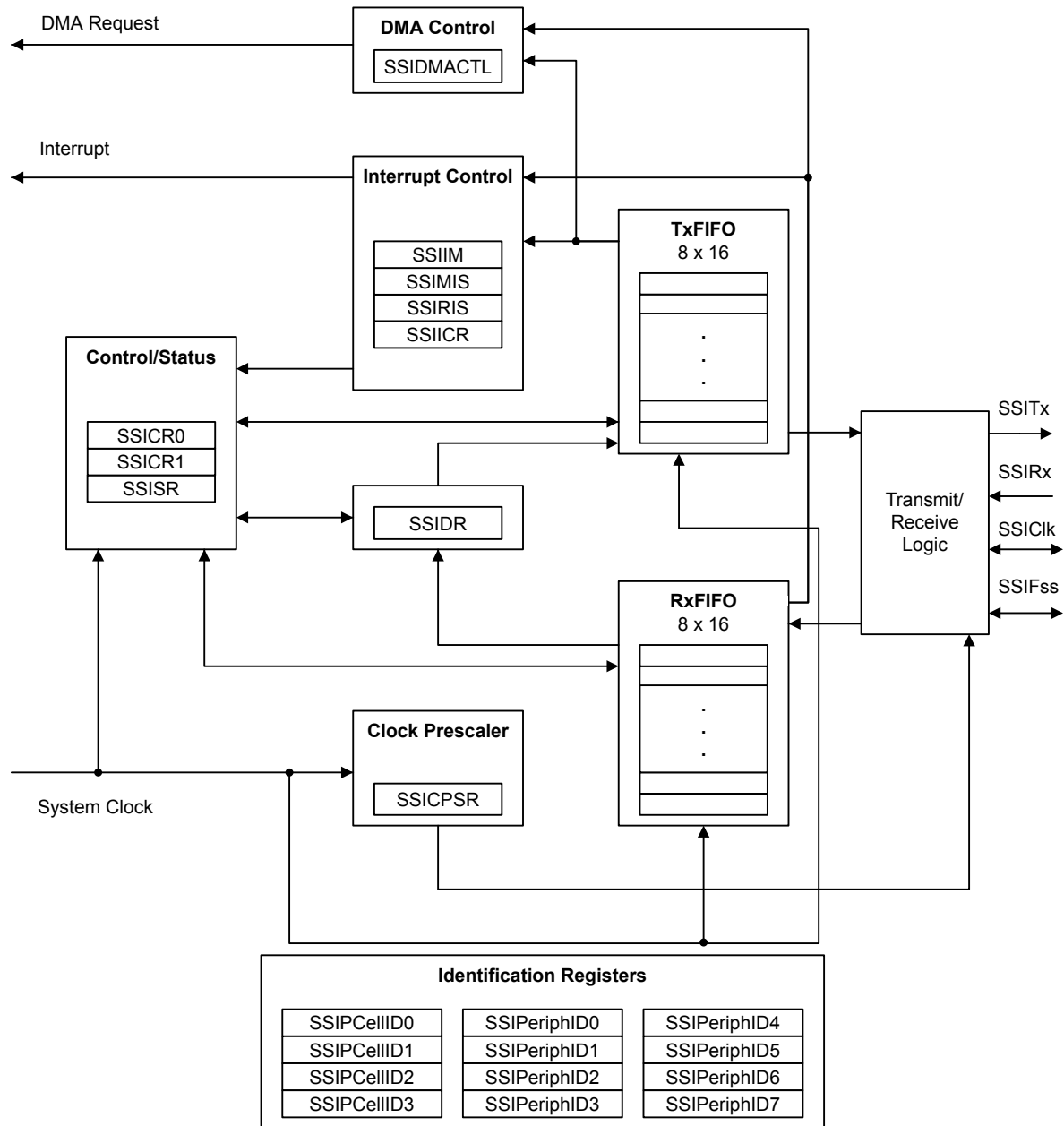
The Stellaris® microcontroller includes two Synchronous Serial Interface (SSI) modules. Each SSI is a master or slave interface for synchronous serial communication with peripheral devices that have either Freescale SPI, MICROWIRE, or Texas Instruments synchronous serial interfaces.

The Stellaris LM3S2U93 controller includes two SSI modules with the following features:

- Programmable interface operation for Freescale SPI, MICROWIRE, or Texas Instruments synchronous serial interfaces
- Master or slave operation
- Programmable clock bit rate and prescaler
- Separate transmit and receive FIFOs, each 16 bits wide and 8 locations deep
- Programmable data frame size from 4 to 16 bits
- Internal loopback test mode for diagnostic/debug testing
- Standard FIFO-based interrupts and End-of-Transmission interrupt
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Separate channels for transmit and receive
 - Receive single request asserted when data is in the FIFO; burst request asserted when FIFO contains 4 entries
 - Transmit single request asserted when there is space in the FIFO; burst request asserted when FIFO contains 4 entries

15.1 Block Diagram

Figure 15-1. SSI Module Block Diagram



15.2 Signal Description

The following table lists the external signals of the SSI module and describes the function of each. The SSI signals are alternate functions for some GPIO signals and default to be GPIO signals at reset., with the exception of the `SSI0Clk`, `SSI0Fss`, `SSI0Rx`, and `SSI0Tx` pins which default to the SSI function. The column in the table below titled "Pin Mux/Pin Assignment" lists the possible GPIO pin placements for the SSI signals. The `AFSEL` bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the SSI function. The number in

parentheses is the encoding that must be programmed into the PMC_n field in the **GPIO Port Control (GPIOPCTL)** register (page 461) to assign the SSI signal to the specified GPIO port pin. For more information on configuring GPIOs, see “General-Purpose Input/Outputs (GPIOs)” on page 419.

Table 15-1. SSI Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|----------------|--------------------------------|----------|--------------------------|------------------------|
| SSI0Clk | 28 | PA2 (1) | I/O | TTL | SSI module 0 clock. |
| SSI0Fss | 29 | PA3 (1) | I/O | TTL | SSI module 0 frame. |
| SSI0Rx | 30 | PA4 (1) | I | TTL | SSI module 0 receive. |
| SSI0Tx | 31 | PA5 (1) | O | TTL | SSI module 0 transmit. |
| SSI1Clk | 60 74 76 | PF2 (9) PE0 (2) PH4 (11) | I/O | TTL | SSI module 1 clock. |
| SSI1Fss | 59 63 75 | PF3 (9) PH5 (11) PE1 (2) | I/O | TTL | SSI module 1 frame. |
| SSI1Rx | 58 62 95 | PF4 (9) PH6 (11) PE2 (2) | I | TTL | SSI module 1 receive. |
| SSI1Tx | 15 46 96 | PH7 (11) PF5 (9) PE3 (2) | O | TTL | SSI module 1 transmit. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 15-2. SSI Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|-------------------|--------------------------------|----------|--------------------------|------------------------|
| SSI0Clk | M4 | PA2 (1) | I/O | TTL | SSI module 0 clock. |
| SSI0Fss | L4 | PA3 (1) | I/O | TTL | SSI module 0 frame. |
| SSI0Rx | L5 | PA4 (1) | I | TTL | SSI module 0 receive. |
| SSI0Tx | M5 | PA5 (1) | O | TTL | SSI module 0 transmit. |
| SSI1Clk | J11 B11 B10 | PF2 (9) PE0 (2) PH4 (11) | I/O | TTL | SSI module 1 clock. |
| SSI1Fss | J12 F10 A12 | PF3 (9) PH5 (11) PE1 (2) | I/O | TTL | SSI module 1 frame. |
| SSI1Rx | L9 G3 A4 | PF4 (9) PH6 (11) PE2 (2) | I | TTL | SSI module 1 receive. |
| SSI1Tx | H3 L8 B4 | PH7 (11) PF5 (9) PE3 (2) | O | TTL | SSI module 1 transmit. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

15.3 Functional Description

The SSI performs serial-to-parallel conversion on data received from a peripheral device. The CPU accesses data, control, and status information. The transmit and receive paths are buffered with internal FIFO memories allowing up to eight 16-bit values to be stored independently in both transmit

and receive modes. The SSI also supports the μ DMA interface. The transmit and receive FIFOs can be programmed as destination/source addresses in the μ DMA module. μ DMA operation is enabled by setting the appropriate bit(s) in the **SSIDMACTL** register (see page 796).

15.3.1 Bit Rate Generation

The SSI includes a programmable bit rate clock divider and prescaler to generate the serial output clock. Bit rates are supported to 2 MHz and higher, although maximum bit rate is determined by peripheral devices.

The serial bit rate is derived by dividing down the input clock (SysClk). The clock is first divided by an even prescale value **CPSDVSR** from 2 to 254, which is programmed in the **SSI Clock Prescale (SSICPSR)** register (see page 789). The clock is further divided by a value from 1 to 256, which is $1 + \text{SCR}$, where **SCR** is the value programmed in the **SSI Control 0 (SSICR0)** register (see page 782).

The frequency of the output clock **SSIClk** is defined by:

$$\text{SSIClk} = \text{SysClk} / (\text{CPSDVSR} * (1 + \text{SCR}))$$

Note: For master mode, the system clock must be at least two times faster than the **SSIClk**, with the restriction that **SSIClk** cannot be faster than 25 MHz. For slave mode, the system clock must be at least 12 times faster than the **SSIClk**.

See “Synchronous Serial Interface (SSI)” on page 1145 to view SSI timing parameters.

15.3.2 FIFO Operation

15.3.2.1 Transmit FIFO

The common transmit FIFO is a 16-bit wide, 8-locations deep, first-in, first-out memory buffer. The CPU writes data to the FIFO by writing the **SSI Data (SSIDR)** register (see page 786), and data is stored in the FIFO until it is read out by the transmission logic.

When configured as a master or a slave, parallel data is written into the transmit FIFO prior to serial conversion and transmission to the attached slave or master, respectively, through the **SSITx** pin.

In slave mode, the SSI transmits data each time the master initiates a transaction. If the transmit FIFO is empty and the master initiates, the slave transmits the 8th most recent value in the transmit FIFO. If less than 8 values have been written to the transmit FIFO since the SSI module clock was enabled using the **SSI** bit in the **RGCG1** register, then 0 is transmitted. Care should be taken to ensure that valid data is in the FIFO as needed. The SSI can be configured to generate an interrupt or a μ DMA request when the FIFO is empty.

15.3.2.2 Receive FIFO

The common receive FIFO is a 16-bit wide, 8-locations deep, first-in, first-out memory buffer. Received data from the serial interface is stored in the buffer until read out by the CPU, which accesses the read FIFO by reading the **SSIDR** register.

When configured as a master or slave, serial data received through the **SSIRx** pin is registered prior to parallel loading into the attached slave or master receive FIFO, respectively.

15.3.3 Interrupts

The SSI can generate interrupts when the following conditions are observed:

- Transmit FIFO service (when the transmit FIFO is half full or less)
- Receive FIFO service (when the receive FIFO is half full or more)

- Receive FIFO time-out
- Receive FIFO overrun
- End of transmission

All of the interrupt events are ORed together before being sent to the interrupt controller, so the SSI generates a single interrupt request to the controller regardless of the number of active interrupts. Each of the four individual maskable interrupts can be masked by clearing the appropriate bit in the **SSI Interrupt Mask (SSIIM)** register (see page 790). Setting the appropriate mask bit enables the interrupt.

The individual outputs, along with a combined interrupt output, allow use of either a global interrupt service routine or modular device drivers to handle interrupts. The transmit and receive dynamic dataflow interrupts have been separated from the status interrupts so that data can be read or written in response to the FIFO trigger levels. The status of the individual interrupt sources can be read from the **SSI Raw Interrupt Status (SSIRIS)** and **SSI Masked Interrupt Status (SSIMIS)** registers (see page 791 and page 793, respectively).

The receive FIFO has a time-out period that is 32 periods at the rate of `SSIClk` (whether or not `SSIClk` is currently active) and is started when the RX FIFO goes from EMPTY to not-EMPTY. If the RX FIFO is emptied before 32 clocks have passed, the time-out period is reset. As a result, the ISR should clear the Receive FIFO Time-out Interrupt just after reading out the RX FIFO by writing a 1 to the `RTIC` bit in the **SSI Interrupt Clear (SSIICR)** register. The interrupt should not be cleared so late that the ISR returns before the interrupt is actually cleared, or the ISR may be re-activated unnecessarily.

The End-of-Transmission (EOT) interrupt indicates that the data has been transmitted completely. This interrupt can be used to indicate when it is safe to turn off the SSI module clock or enter sleep mode. In addition, because transmitted data and received data complete at exactly the same time, the interrupt can also indicate that read data is ready immediately, without waiting for the receive FIFO time-out period to complete.

15.3.4 Frame Formats

Each data frame is between 4 and 16 bits long, depending on the size of data programmed, and is transmitted starting with the MSB. There are three basic frame types that can be selected:

- Texas Instruments synchronous serial
- Freescale SPI
- MICROWIRE

For all three formats, the serial clock (`SSIClk`) is held inactive while the SSI is idle, and `SSIClk` transitions at the programmed frequency only during active transmission or reception of data. The idle state of `SSIClk` is utilized to provide a receive timeout indication that occurs when the receive FIFO still contains data after a timeout period.

For Freescale SPI and MICROWIRE frame formats, the serial frame (`SSIFSS`) pin is active Low, and is asserted (pulled down) during the entire transmission of the frame.

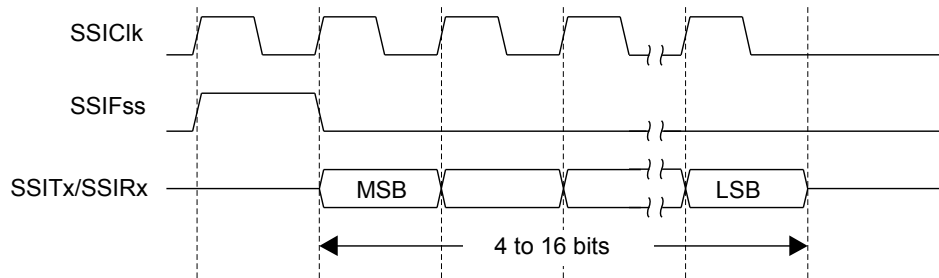
For Texas Instruments synchronous serial frame format, the `SSIFSS` pin is pulsed for one serial clock period starting at its rising edge, prior to the transmission of each frame. For this frame format, both the SSI and the off-chip slave device drive their output data on the rising edge of `SSIClk` and latch data from the other device on the falling edge.

Unlike the full-duplex transmission of the other two frame formats, the MICROWIRE format uses a special master-slave messaging technique which operates at half-duplex. In this mode, when a frame begins, an 8-bit control message is transmitted to the off-chip slave. During this transmit, no incoming data is received by the SSI. After the message has been sent, the off-chip slave decodes it and, after waiting one serial clock after the last bit of the 8-bit control message has been sent, responds with the requested data. The returned data can be 4 to 16 bits in length, making the total frame length anywhere from 13 to 25 bits.

15.3.4.1 Texas Instruments Synchronous Serial Frame Format

Figure 15-2 on page 772 shows the Texas Instruments synchronous serial frame format for a single transmitted frame.

Figure 15-2. TI Synchronous Serial Frame Format (Single Transfer)

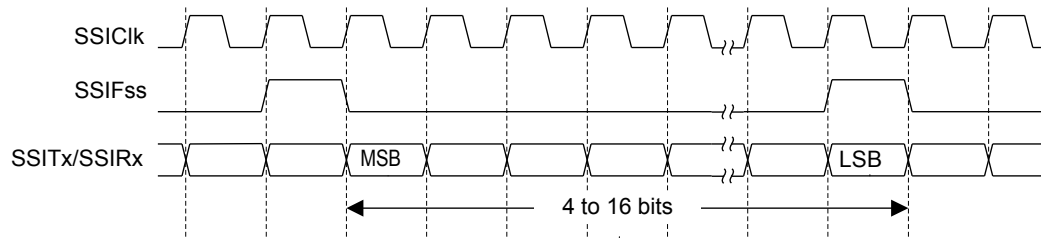


In this mode, $SSIClk$ and $SSIFss$ are forced Low, and the transmit data line $SSITx$ is tristated whenever the SSI is idle. Once the bottom entry of the transmit FIFO contains data, $SSIFss$ is pulsed High for one $SSIClk$ period. The value to be transmitted is also transferred from the transmit FIFO to the serial shift register of the transmit logic. On the next rising edge of $SSIClk$, the MSB of the 4 to 16-bit data frame is shifted out on the $SSITx$ pin. Likewise, the MSB of the received data is shifted onto the $SSIRx$ pin by the off-chip serial slave device.

Both the SSI and the off-chip serial slave device then clock each data bit into their serial shifter on each falling edge of $SSIClk$. The received data is transferred from the serial shifter to the receive FIFO on the first rising edge of $SSIClk$ after the LSB has been latched.

Figure 15-3 on page 772 shows the Texas Instruments synchronous serial frame format when back-to-back frames are transmitted.

Figure 15-3. TI Synchronous Serial Frame Format (Continuous Transfer)



15.3.4.2 Freescale SPI Frame Format

The Freescale SPI interface is a four-wire interface where the `SSIFss` signal behaves as a slave select. The main feature of the Freescale SPI format is that the inactive state and phase of the `SSIClk` signal are programmable through the `SPO` and `SPH` bits in the `SSISCR0` control register.

SPO Clock Polarity Bit

When the `SPO` clock polarity control bit is clear, it produces a steady state Low value on the `SSIClk` pin. If the `SPO` bit is set, a steady state High value is placed on the `SSIClk` pin when data is not being transferred.

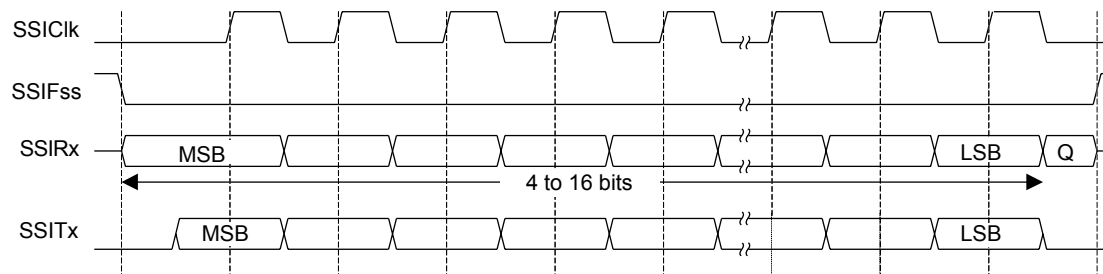
SPH Phase Control Bit

The `SPH` phase control bit selects the clock edge that captures data and allows it to change state. The state of this bit has the most impact on the first bit transmitted by either allowing or not allowing a clock transition before the first data capture edge. When the `SPH` phase control bit is clear, data is captured on the first clock edge transition. If the `SPH` bit is set, data is captured on the second clock edge transition.

15.3.4.3 Freescale SPI Frame Format with `SPO=0` and `SPH=0`

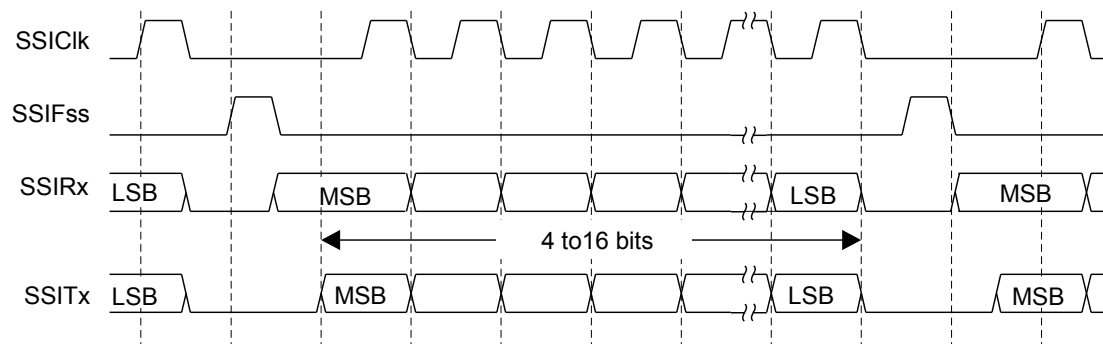
Single and continuous transmission signal sequences for Freescale SPI format with `SPO=0` and `SPH=0` are shown in Figure 15-4 on page 773 and Figure 15-5 on page 773.

Figure 15-4. Freescale SPI Format (Single Transfer) with `SPO=0` and `SPH=0`



Note: Q is undefined.

Figure 15-5. Freescale SPI Format (Continuous Transfer) with `SPO=0` and `SPH=0`



In this configuration, during idle periods:

- `SSIClk` is forced Low

- SSIFSS is forced High
- The transmit data line SSITx is arbitrarily forced Low
- When the SSI is configured as a master, it enables the SSIClk pad
- When the SSI is configured as a slave, it disables the SSIClk pad

If the SSI is enabled and valid data is in the transmit FIFO, the start of transmission is signified by the SSIFSS master signal being driven Low, causing slave data to be enabled onto the SSIRx input line of the master. The master SSITx output pad is enabled.

One half SSIClk period later, valid master data is transferred to the SSITx pin. Once both the master and slave data have been set, the SSIClk master clock pin goes High after one additional half SSIClk period.

The data is now captured on the rising and propagated on the falling edges of the SSIClk signal.

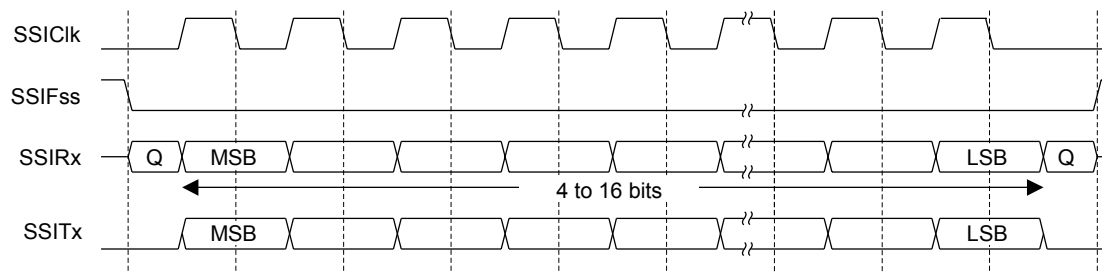
In the case of a single word transmission, after all bits of the data word have been transferred, the SSIFSS line is returned to its idle High state one SSIClk period after the last bit has been captured.

However, in the case of continuous back-to-back transmissions, the SSIFSS signal must be pulsed High between each data word transfer because the slave select pin freezes the data in its serial peripheral register and does not allow it to be altered if the SPH bit is clear. Therefore, the master device must raise the SSIFSS pin of the slave device between each data transfer to enable the serial peripheral data write. On completion of the continuous transfer, the SSIFSS pin is returned to its idle state one SSIClk period after the last bit has been captured.

15.3.4.4 Freescale SPI Frame Format with SPO=0 and SPH=1

The transfer signal sequence for Freescale SPI format with SPO=0 and SPH=1 is shown in Figure 15-6 on page 774, which covers both single and continuous transfers.

Figure 15-6. Freescale SPI Frame Format with SPO=0 and SPH=1



Note: Q is undefined.

In this configuration, during idle periods:

- SSIClk is forced Low
- SSIFSS is forced High
- The transmit data line SSITx is arbitrarily forced Low
- When the SSI is configured as a master, it enables the SSIClk pad

- When the SSI is configured as a slave, it disables the SSIClk pad

If the SSI is enabled and valid data is in the transmit FIFO, the start of transmission is signified by the SSIFSS master signal being driven Low. The master SSITx output is enabled. After an additional one-half SSIClk period, both master and slave valid data are enabled onto their respective transmission lines. At the same time, the SSIClk is enabled with a rising edge transition.

Data is then captured on the falling edges and propagated on the rising edges of the SSIClk signal.

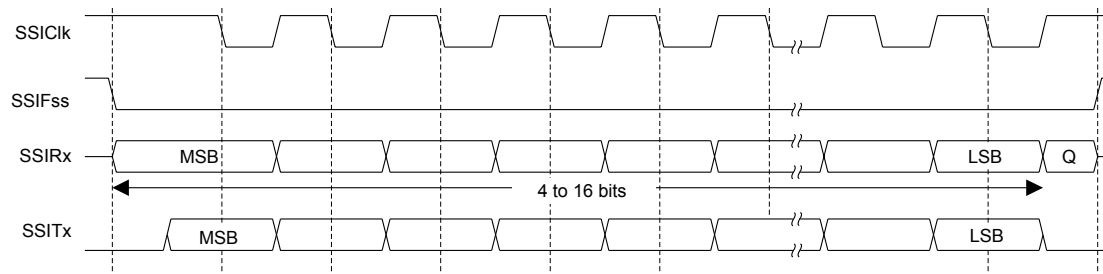
In the case of a single word transfer, after all bits have been transferred, the SSIFSS line is returned to its idle High state one SSIClk period after the last bit has been captured.

For continuous back-to-back transfers, the SSIFSS pin is held Low between successive data words, and termination is the same as that of the single word transfer.

15.3.4.5 Freescale SPI Frame Format with SPO=1 and SPH=0

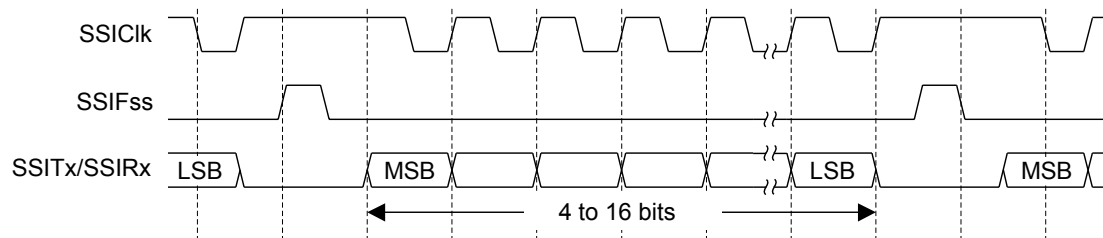
Single and continuous transmission signal sequences for Freescale SPI format with SPO=1 and SPH=0 are shown in Figure 15-7 on page 775 and Figure 15-8 on page 775.

Figure 15-7. Freescale SPI Frame Format (Single Transfer) with SPO=1 and SPH=0



Note: Q is undefined.

Figure 15-8. Freescale SPI Frame Format (Continuous Transfer) with SPO=1 and SPH=0



In this configuration, during idle periods:

- SSIClk is forced High
- SSIFSS is forced High
- The transmit data line SSITx is arbitrarily forced Low
- When the SSI is configured as a master, it enables the SSIClk pad
- When the SSI is configured as a slave, it disables the SSIClk pad

If the SSI is enabled and valid data is in the transmit FIFO, the start of transmission is signified by the $SSIF_{SS}$ master signal being driven Low, causing slave data to be immediately transferred onto the $SSIR_x$ line of the master. The master $SSIT_x$ output pad is enabled.

One-half period later, valid master data is transferred to the $SSIT_x$ line. Once both the master and slave data have been set, the $SSIClk$ master clock pin becomes Low after one additional half $SSIClk$ period, meaning that data is captured on the falling edges and propagated on the rising edges of the $SSIClk$ signal.

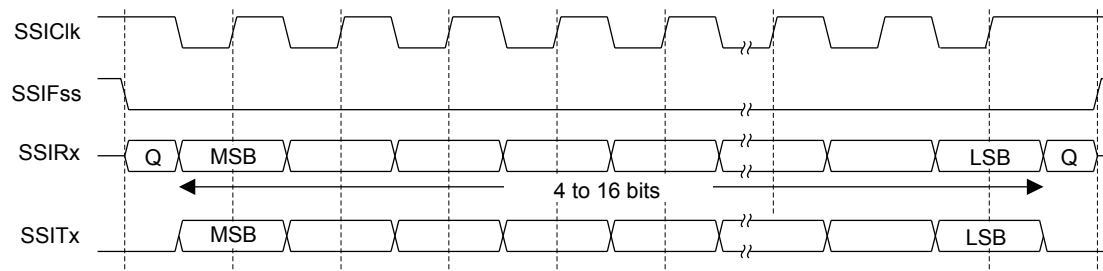
In the case of a single word transmission, after all bits of the data word are transferred, the $SSIF_{SS}$ line is returned to its idle High state one $SSIClk$ period after the last bit has been captured.

However, in the case of continuous back-to-back transmissions, the $SSIF_{SS}$ signal must be pulsed High between each data word transfer because the slave select pin freezes the data in its serial peripheral register and does not allow it to be altered if the SPH bit is clear. Therefore, the master device must raise the $SSIF_{SS}$ pin of the slave device between each data transfer to enable the serial peripheral data write. On completion of the continuous transfer, the $SSIF_{SS}$ pin is returned to its idle state one $SSIClk$ period after the last bit has been captured.

15.3.4.6 Freescale SPI Frame Format with $SPO=1$ and $SPH=1$

The transfer signal sequence for Freescale SPI format with $SPO=1$ and $SPH=1$ is shown in Figure 15-9 on page 776, which covers both single and continuous transfers.

Figure 15-9. Freescale SPI Frame Format with $SPO=1$ and $SPH=1$



Note: Q is undefined.

In this configuration, during idle periods:

- $SSIClk$ is forced High
- $SSIF_{SS}$ is forced High
- The transmit data line $SSIT_x$ is arbitrarily forced Low
- When the SSI is configured as a master, it enables the $SSIClk$ pad
- When the SSI is configured as a slave, it disables the $SSIClk$ pad

If the SSI is enabled and valid data is in the transmit FIFO, the start of transmission is signified by the $SSIF_{SS}$ master signal being driven Low. The master $SSIT_x$ output pad is enabled. After an additional one-half $SSIClk$ period, both master and slave data are enabled onto their respective transmission lines. At the same time, $SSIClk$ is enabled with a falling edge transition. Data is then captured on the rising edges and propagated on the falling edges of the $SSIClk$ signal.

After all bits have been transferred, in the case of a single word transmission, the $SSIF_{SS}$ line is returned to its idle high state one $SSIClk$ period after the last bit has been captured.

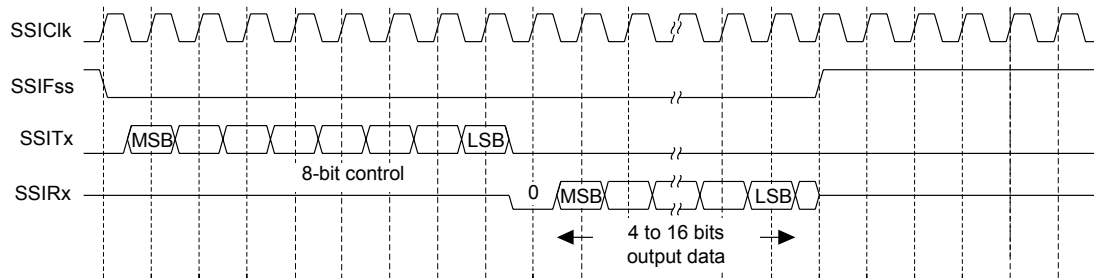
For continuous back-to-back transmissions, the $SSIF_{SS}$ pin remains in its active Low state until the final bit of the last word has been captured and then returns to its idle state as described above.

For continuous back-to-back transfers, the $SSIF_{SS}$ pin is held Low between successive data words and termination is the same as that of the single word transfer.

15.3.4.7 MICROWIRE Frame Format

Figure 15-10 on page 777 shows the MICROWIRE frame format for a single frame. Figure 15-11 on page 778 shows the same format when back-to-back frames are transmitted.

Figure 15-10. MICROWIRE Frame Format (Single Frame)



MICROWIRE format is very similar to SPI format, except that transmission is half-duplex instead of full-duplex and uses a master-slave message passing technique. Each serial transmission begins with an 8-bit control word that is transmitted from the SSI to the off-chip slave device. During this transmission, no incoming data is received by the SSI. After the message has been sent, the off-chip slave decodes it and, after waiting one serial clock after the last bit of the 8-bit control message has been sent, responds with the required data. The returned data is 4 to 16 bits in length, making the total frame length anywhere from 13 to 25 bits.

In this configuration, during idle periods:

- $SSIClk$ is forced Low
- $SSIF_{SS}$ is forced High
- The transmit data line $SSITx$ is arbitrarily forced Low

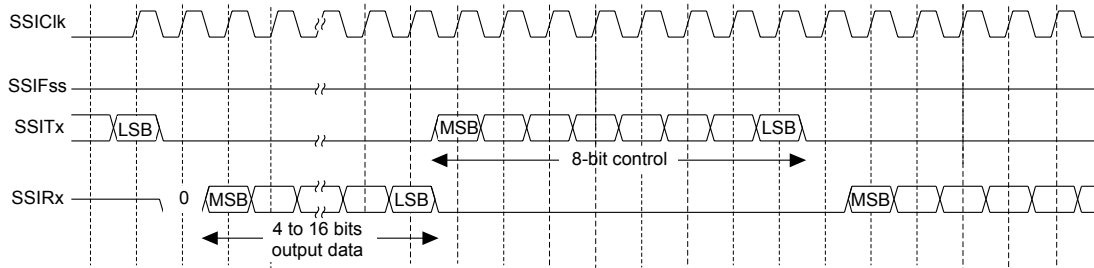
A transmission is triggered by writing a control byte to the transmit FIFO. The falling edge of $SSIF_{SS}$ causes the value contained in the bottom entry of the transmit FIFO to be transferred to the serial shift register of the transmit logic and the MSB of the 8-bit control frame to be shifted out onto the $SSITx$ pin. $SSIF_{SS}$ remains Low for the duration of the frame transmission. The $SSIRx$ pin remains tristated during this transmission.

The off-chip serial slave device latches each control bit into its serial shifter on each rising edge of $SSIClk$. After the last bit is latched by the slave device, the control byte is decoded during a one clock wait-state, and the slave responds by transmitting data back to the SSI. Each bit is driven onto the $SSIRx$ line on the falling edge of $SSIClk$. The SSI in turn latches each bit on the rising edge of $SSIClk$. At the end of the frame, for single transfers, the $SSIF_{SS}$ signal is pulled High one clock period after the last bit has been latched in the receive serial shifter, causing the data to be transferred to the receive FIFO.

Note: The off-chip slave device can tristate the receive line either on the falling edge of $SSIClk$ after the LSB has been latched by the receive shifter or when the $SSIFss$ pin goes High.

For continuous transfers, data transmission begins and ends in the same manner as a single transfer. However, the $SSIFss$ line is continuously asserted (held Low) and transmission of data occurs back-to-back. The control byte of the next frame follows directly after the LSB of the received data from the current frame. Each of the received values is transferred from the receive shifter on the falling edge of $SSIClk$, after the LSB of the frame has been latched into the SSI.

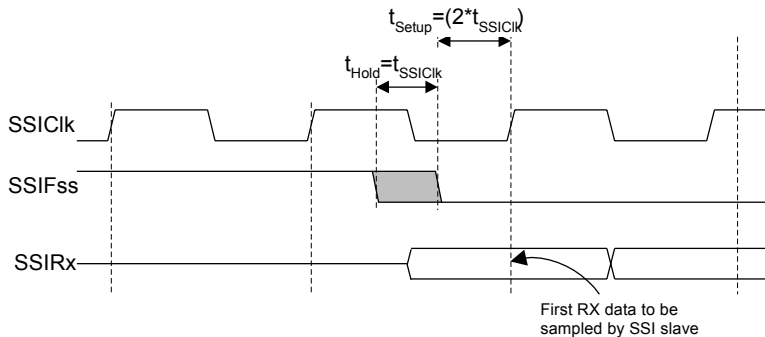
Figure 15-11. MICROWIRE Frame Format (Continuous Transfer)



In the MICROWIRE mode, the SSI slave samples the first bit of receive data on the rising edge of $SSIClk$ after $SSIFss$ has gone Low. Masters that drive a free-running $SSIClk$ must ensure that the $SSIFss$ signal has sufficient setup and hold margins with respect to the rising edge of $SSIClk$.

Figure 15-12 on page 778 illustrates these setup and hold time requirements. With respect to the $SSIClk$ rising edge on which the first bit of receive data is to be sampled by the SSI slave, $SSIFss$ must have a setup of at least two times the period of $SSIClk$ on which the SSI operates. With respect to the $SSIClk$ rising edge previous to this edge, $SSIFss$ must have a hold of at least one $SSIClk$ period.

Figure 15-12. MICROWIRE Frame Format, SSIFss Input Setup and Hold Requirements



15.3.5 DMA Operation

The SSI peripheral provides an interface to the μ DMA controller with separate channels for transmit and receive. The μ DMA operation of the SSI is enabled through the **SSI DMA Control (SSIDMACTL)** register. When μ DMA operation is enabled, the SSI asserts a μ DMA request on the receive or transmit channel when the associated FIFO can transfer data. For the receive channel, a single transfer request is asserted whenever any data is in the receive FIFO. A burst transfer request is asserted whenever the amount of data in the receive FIFO is 4 or more items. For the transmit channel, a single transfer request is asserted whenever at least one empty location is in the transmit FIFO. The burst request is asserted whenever the transmit FIFO has 4 or more empty slots. The

single and burst μ DMA transfer requests are handled automatically by the μ DMA controller depending how the μ DMA channel is configured. To enable μ DMA operation for the receive channel, the `RXDMAE` bit of the **DMA Control (SSIDMACTL)** register should be set. To enable μ DMA operation for the transmit channel, the `TXDMAE` bit of **SSIDMACTL** should be set. If μ DMA is enabled, then the μ DMA controller triggers an interrupt when a transfer is complete. The interrupt occurs on the SSI interrupt vector. Therefore, if interrupts are used for SSI operation and μ DMA is enabled, the SSI interrupt handler must be designed to handle the μ DMA completion interrupt.

See “Micro Direct Memory Access (μ DMA)” on page 359 for more details about programming the μ DMA controller.

15.4 Initialization and Configuration

To enable and initialize the SSI, the following steps are necessary:

1. Enable the SSI module by setting the `SSI` bit in the **RCGC1** register (see page 262).
2. Enable the clock to the appropriate GPIO module via the **RCGC2** register (see page 274). To find out which GPIO port to enable, refer to Table 23-5 on page 1083.
3. Set the GPIO `AFSEL` bits for the appropriate pins (see page 443). To determine which GPIOs to configure, see Table 23-4 on page 1075.
4. Configure the `PMCn` fields in the **GPIOPCTL** register to assign the SSI signals to the appropriate pins. See page 461 and Table 23-5 on page 1083.

For each of the frame formats, the SSI is configured using the following steps:

1. Ensure that the `SSE` bit in the **SSICR1** register is clear before making any configuration changes.
2. Select whether the SSI is a master or slave:
 - a. For master operations, set the **SSICR1** register to 0x0000.0000.
 - b. For slave mode (output enabled), set the **SSICR1** register to 0x0000.0004.
 - c. For slave mode (output disabled), set the **SSICR1** register to 0x0000.000C.
3. Configure the clock prescale divisor by writing the **SSICPSR** register.
4. Write the **SSICR0** register with the following configuration:
 - Serial clock rate (`SCR`)
 - Desired clock phase/polarity, if using Freescale SPI mode (`SPH` and `SPO`)
 - The protocol mode: Freescale SPI, TI SSF, MICROWIRE (`FRF`)
 - The data size (`DSS`)
5. Optionally, configure the μ DMA channel (see “Micro Direct Memory Access (μ DMA)” on page 359) and enable the DMA option(s) in the **SSIDMACTL** register.
6. Enable the SSI by setting the `SSE` bit in the **SSICR1** register.

As an example, assume the SSI must be configured to operate with the following parameters:

- Master operation
- Freescale SPI mode (SPO=1, SPH=1)
- 1 Mbps bit rate
- 8 data bits

Assuming the system clock is 20 MHz, the bit rate calculation would be:

$$\text{SSIClk} = \text{SysClk} / (\text{CPSDVSR} * (1 + \text{SCR}))$$

$$1 \times 10^6 = 20 \times 10^6 / (\text{CPSDVSR} * (1 + \text{SCR}))$$

In this case, if CPSDVSR=0x2, SCR must be 0x9.

The configuration sequence would be as follows:

1. Ensure that the SSE bit in the **SSICR1** register is clear.
2. Write the **SSICR1** register with a value of 0x0000.0000.
3. Write the **SSICPSR** register with a value of 0x0000.0002.
4. Write the **SSICR0** register with a value of 0x0000.09C7.
5. The SSI is then enabled by setting the SSE bit in the **SSICR1** register.

15.5 Register Map

Table 15-3 on page 780 lists the SSI registers. The offset listed is a hexadecimal increment to the register's address, relative to that SSI module's base address:

- SSI0: 0x4000.8000
- SSI1: 0x4000.9000

Note that the SSI module clock must be enabled before the registers can be programmed (see page 262). There must be a delay of 3 system clocks after the SSI module clock is enabled before any SSI module registers are accessed.

Note: The SSI must be disabled (see the SSE bit in the **SSICR1** register) before any of the control registers are reprogrammed.

Table 15-3. SSI Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|---------|------|-------------|--------------------|----------|
| 0x000 | SSICR0 | R/W | 0x0000.0000 | SSI Control 0 | 782 |
| 0x004 | SSICR1 | R/W | 0x0000.0000 | SSI Control 1 | 784 |
| 0x008 | SSIDR | R/W | 0x0000.0000 | SSI Data | 786 |
| 0x00C | SSISR | RO | 0x0000.0003 | SSI Status | 787 |
| 0x010 | SSICPSR | R/W | 0x0000.0000 | SSI Clock Prescale | 789 |
| 0x014 | SSIIM | R/W | 0x0000.0000 | SSI Interrupt Mask | 790 |

Table 15-3. SSI Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|--------------|------|-------------|---------------------------------|----------|
| 0x018 | SSIRIS | RO | 0x0000.0008 | SSI Raw Interrupt Status | 791 |
| 0x01C | SSIMIS | RO | 0x0000.0000 | SSI Masked Interrupt Status | 793 |
| 0x020 | SSIICR | W1C | 0x0000.0000 | SSI Interrupt Clear | 795 |
| 0x024 | SSIDMACTL | R/W | 0x0000.0000 | SSI DMA Control | 796 |
| 0xFD0 | SSIPeriphID4 | RO | 0x0000.0000 | SSI Peripheral Identification 4 | 797 |
| 0xFD4 | SSIPeriphID5 | RO | 0x0000.0000 | SSI Peripheral Identification 5 | 798 |
| 0xFD8 | SSIPeriphID6 | RO | 0x0000.0000 | SSI Peripheral Identification 6 | 799 |
| 0xFDC | SSIPeriphID7 | RO | 0x0000.0000 | SSI Peripheral Identification 7 | 800 |
| 0xFE0 | SSIPeriphID0 | RO | 0x0000.0022 | SSI Peripheral Identification 0 | 801 |
| 0xFE4 | SSIPeriphID1 | RO | 0x0000.0000 | SSI Peripheral Identification 1 | 802 |
| 0xFE8 | SSIPeriphID2 | RO | 0x0000.0018 | SSI Peripheral Identification 2 | 803 |
| 0xFEC | SSIPeriphID3 | RO | 0x0000.0001 | SSI Peripheral Identification 3 | 804 |
| 0xFF0 | SSIPCellID0 | RO | 0x0000.000D | SSI PrimeCell Identification 0 | 805 |
| 0xFF4 | SSIPCellID1 | RO | 0x0000.00F0 | SSI PrimeCell Identification 1 | 806 |
| 0xFF8 | SSIPCellID2 | RO | 0x0000.0005 | SSI PrimeCell Identification 2 | 807 |
| 0xFFC | SSIPCellID3 | RO | 0x0000.00B1 | SSI PrimeCell Identification 3 | 808 |

15.6 Register Descriptions

The remainder of this section lists and describes the SSI registers, in numerical order by address offset.

Register 1: SSI Control 0 (SSICR0), offset 0x000

The **SSICR0** register contains bit fields that control various functions within the SSI module. Functionality such as protocol mode, clock rate, and data size are configured in this register.

SSI Control 0 (SSICR0)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0x000
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SCR | | | | | | | | SPH | SPO | FRF | | DSS | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:8 | SCR | R/W | 0x00 | SSI Serial Clock Rate This bit field is used to generate the transmit and receive bit rate of the SSI. The bit rate is: $BR = SysClk / (CPSDVSR * (1 + SCR))$ where CPSDVSR is an even value from 2-254 programmed in the SSICPSR register, and SCR is a value from 0-255. |
| 7 | SPH | R/W | 0 | SSI Serial Clock Phase This bit is only applicable to the Freescale SPI Format. The SPH control bit selects the clock edge that captures data and allows it to change state. This bit has the most impact on the first bit transmitted by either allowing or not allowing a clock transition before the first data capture edge. Value Description 0 Data is captured on the first clock edge transition. 1 Data is captured on the second clock edge transition. |
| 6 | SPO | R/W | 0 | SSI Serial Clock Polarity Value Description 0 A steady state Low value is placed on the SSIClk pin. 1 A steady state High value is placed on the SSIClk pin when data is not being transferred. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 5:4 | FRF | R/W | 0x0 | SSI Frame Format Select Value Frame Format 0x0 Freescale SPI Frame Format 0x1 Texas Instruments Synchronous Serial Frame Format 0x2 MICROWIRE Frame Format 0x3 Reserved |
| 3:0 | DSS | R/W | 0x0 | SSI Data Size Select Value Data Size 0x0-0x2 Reserved 0x3 4-bit data 0x4 5-bit data 0x5 6-bit data 0x6 7-bit data 0x7 8-bit data 0x8 9-bit data 0x9 10-bit data 0xA 11-bit data 0xB 12-bit data 0xC 13-bit data 0xD 14-bit data 0xE 15-bit data 0xF 16-bit data |

Register 2: SSI Control 1 (SSICR1), offset 0x004

The **SSICR1** register contains bit fields that control various functions within the SSI module. Master and slave mode functionality is controlled by this register.

SSI Control 1 (SSICR1)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0x004
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | EOT | SOD | MS | SSE | LBM |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:5 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | EOT | R/W | 0 | End of Transmission Value Description 0 The TXRIS interrupt indicates that the transmit FIFO is half full or less. 1 The End of Transmit interrupt mode for the TXRIS interrupt is enabled. |
| 3 | SOD | R/W | 0 | SSI Slave Mode Output Disable This bit is relevant only in the Slave mode ($MS=1$). In multiple-slave systems, it is possible for the SSI master to broadcast a message to all slaves in the system while ensuring that only one slave drives data onto the serial output line. In such systems, the TXD lines from multiple slaves could be tied together. To operate in such a system, the SOD bit can be configured so that the SSI slave does not drive the SSITx pin. Value Description 0 SSI can drive the SSITx output in Slave mode. 1 SSI must not drive the SSITx output in Slave mode. |
| 2 | MS | R/W | 0 | SSI Master/Slave Select This bit selects Master or Slave mode and can be modified only when the SSI is disabled ($SSE=0$). Value Description 0 The SSI is configured as a master. 1 The SSI is configured as a slave. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 1 | SSE | R/W | 0 | SSI Synchronous Serial Port Enable Value Description 0 SSI operation is disabled. 1 SSI operation is enabled. Note: This bit must be cleared before any control registers are reprogrammed. |
| 0 | LBM | R/W | 0 | SSI Loopback Mode Value Description 0 Normal serial port operation enabled. 1 Output of the transmit serial shift register is connected internally to the input of the receive serial shift register. |

Register 3: SSI Data (SSIDR), offset 0x008

Important: This register is read-sensitive. See the register description for details.

The **SSIDR** register is 16-bits wide. When the **SSIDR** register is read, the entry in the receive FIFO that is pointed to by the current FIFO read pointer is accessed. When a data value is removed by the SSI receive logic from the incoming data frame, it is placed into the entry in the receive FIFO pointed to by the current FIFO write pointer.

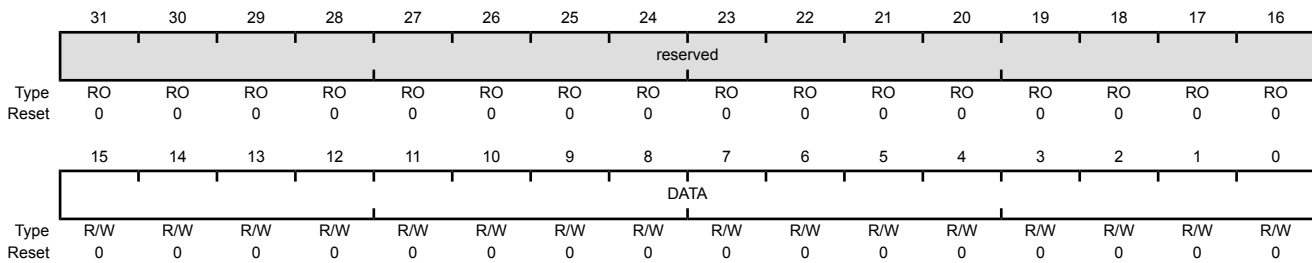
When the **SSIDR** register is written to, the entry in the transmit FIFO that is pointed to by the write pointer is written to. Data values are removed from the transmit FIFO one value at a time by the transmit logic. Each data value is loaded into the transmit serial shifter, then serially shifted out onto the **SSITx** pin at the programmed bit rate.

When a data size of less than 16 bits is selected, the user must right-justify data written to the transmit FIFO. The transmit logic ignores the unused bits. Received data less than 16 bits is automatically right-justified in the receive buffer.

When the SSI is programmed for MICROWIRE frame format, the default size for transmit data is eight bits (the most significant byte is ignored). The receive data size is controlled by the programmer. The transmit FIFO and the receive FIFO are not cleared even when the **SSE** bit in the **SSICR1** register is cleared, allowing the software to fill the transmit FIFO before enabling the SSI.

SSI Data (SSIDR)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0x008
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | DATA | R/W | 0x0000 | SSI Receive/Transmit Data A read operation reads the receive FIFO. A write operation writes the transmit FIFO. Software must right-justify data when the SSI is programmed for a data size that is less than 16 bits. Unused bits at the top are ignored by the transmit logic. The receive logic automatically right-justifies the data. |

Register 4: SSI Status (SSISR), offset 0x00C

The **SSISR** register contains bits that indicate the FIFO fill status and the SSI busy status.

SSI Status (SSISR)

SSI0 base: 0x4000.8000

SSI1 base: 0x4000.9000

Offset 0x00C

Type RO, reset 0x0000.0003

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | BSY | RFF | RNE | TNF | TFE |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:5 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | BSY | RO | 0 | SSI Busy Bit Value Description 0 The SSI is idle. 1 The SSI is currently transmitting and/or receiving a frame, or the transmit FIFO is not empty. |
| 3 | RFF | RO | 0 | SSI Receive FIFO Full Value Description 0 The receive FIFO is not full. 1 The receive FIFO is full. |
| 2 | RNE | RO | 0 | SSI Receive FIFO Not Empty Value Description 0 The receive FIFO is empty. 1 The receive FIFO is not empty. |
| 1 | TNF | RO | 1 | SSI Transmit FIFO Not Full Value Description 0 The transmit FIFO is full. 1 The transmit FIFO is not full. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|-----------------------------------|
| 0 | TFE | RO | 1 | SSI Transmit FIFO Empty |
| | | | | Value Description |
| | | | | 0 The transmit FIFO is not empty. |
| | | | | 1 The transmit FIFO is empty. |

Register 5: SSI Clock Prescale (SSICPSR), offset 0x010

The **SSICPSR** register specifies the division factor which is used to derive the **SSIClk** from the system clock. The clock is further divided by a value from 1 to 256, which is $1 + \text{SCR}$. **SCR** is programmed in the **SSICR0** register. The frequency of the **SSIClk** is defined by:

$$\text{SSIClk} = \text{SysClk} / (\text{CPSDVSR} * (1 + \text{SCR}))$$

The value programmed into this register must be an even number between 2 and 254. The least-significant bit of the programmed number is hard-coded to zero. If an odd number is written to this register, data read back from this register has the least-significant bit as zero.

SSI Clock Prescale (SSICPSR)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0x010
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|---------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CPSDVSR | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:8 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CPSDVSR | R/W | 0x00 | SSI Clock Prescale Divisor This value must be an even number from 2 to 254, depending on the frequency of SSIClk . The LSB always returns 0 on reads. |

Register 6: SSI Interrupt Mask (SSIIM), offset 0x014

The **SSIIM** register is the interrupt mask set or clear register. It is a read/write register and all bits are cleared on reset.

On a read, this register gives the current value of the mask on the corresponding interrupt. Setting a bit sets the mask, preventing the interrupt from being signaled to the interrupt controller. Clearing a bit clears the corresponding mask, enabling the interrupt to be sent to the interrupt controller.

SSI Interrupt Mask (SSIIM)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0x014
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|------|------|------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | TXIM | RXIM | RTIM | RORIM |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:4 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | TXIM | R/W | 0 | SSI Transmit FIFO Interrupt Mask Value Description 0 The transmit FIFO interrupt is masked. 1 The transmit FIFO interrupt is not masked. |
| 2 | RXIM | R/W | 0 | SSI Receive FIFO Interrupt Mask Value Description 0 The receive FIFO interrupt is masked. 1 The receive FIFO interrupt is not masked. |
| 1 | RTIM | R/W | 0 | SSI Receive Time-Out Interrupt Mask Value Description 0 The receive FIFO time-out interrupt is masked. 1 The receive FIFO time-out interrupt is not masked. |
| 0 | RORIM | R/W | 0 | SSI Receive Overrun Interrupt Mask Value Description 0 The receive FIFO overrun interrupt is masked. 1 The receive FIFO overrun interrupt is not masked. |

Register 7: SSI Raw Interrupt Status (SSIRIS), offset 0x018

The **SSIRIS** register is the raw interrupt status register. On a read, this register gives the current raw status value of the corresponding interrupt prior to masking. A write has no effect.

SSI Raw Interrupt Status (SSIRIS)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0x018
 Type RO, reset 0x0000.0008

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-------|-------|-------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | TXRIS | RXRIS | RTRIS | RORRIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:4 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | TXRIS | RO | 1 | SSI Transmit FIFO Raw Interrupt Status Value Description 0 No interrupt. 1 If the EOT bit in the SSICR1 register is clear, the transmit FIFO is half empty or less. If the EOT bit is set, the transmit FIFO is empty, and the last bit has been transmitted out of the serializer. This bit is cleared when the transmit FIFO is more than half full (if the EOT bit is clear) or when it has any data in it (if the EOT bit is set). |
| 2 | RXRIS | RO | 0 | SSI Receive FIFO Raw Interrupt Status Value Description 0 No interrupt. 1 The receive FIFO is half full or more. This bit is cleared when the receive FIFO is less than half full. |
| 1 | RTRIS | RO | 0 | SSI Receive Time-Out Raw Interrupt Status Value Description 0 No interrupt. 1 The receive time-out has occurred. This bit is cleared when a 1 is written to the RTIC bit in the SSI Interrupt Clear (SSIICR) register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 0 | RORRIS | RO | 0 | SSI Receive Overrun Raw Interrupt Status Value Description 0 No interrupt. 1 The receive FIFO has overflowed This bit is cleared when a 1 is written to the RORIC bit in the SSI Interrupt Clear (SSIICR) register. |

Register 8: SSI Masked Interrupt Status (SSIMIS), offset 0x01C

The **SSIMIS** register is the masked interrupt status register. On a read, this register gives the current masked status value of the corresponding interrupt. A write has no effect.

SSI Masked Interrupt Status (SSIMIS)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0x01C
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-------|-------|-------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | TXMIS | RXMIS | RTMIS | RORMIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:4 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | TXMIS | RO | 0 | SSI Transmit FIFO Masked Interrupt Status Value Description 0 An interrupt has not occurred or is masked. 1 An unmasked interrupt was signaled due to the transmit FIFO being half empty or less (if the <code>EOT</code> bit is clear) or due to the transmission of the last data bit (if the <code>EOT</code> bit is set). This bit is cleared when the transmit FIFO is more than half empty (if the <code>EOT</code> bit is clear) or when it has any data in it (if the <code>EOT</code> bit is set). |
| 2 | RXMIS | RO | 0 | SSI Receive FIFO Masked Interrupt Status Value Description 0 An interrupt has not occurred or is masked. 1 An unmasked interrupt was signaled due to the receive FIFO being half full or more. This bit is cleared when the receive FIFO is less than half full. |
| 1 | RTMIS | RO | 0 | SSI Receive Time-Out Masked Interrupt Status Value Description 0 An interrupt has not occurred or is masked. 1 An unmasked interrupt was signaled due to the receive time out. This bit is cleared when a 1 is written to the <code>RTIC</code> bit in the SSI Interrupt Clear (SSIICR) register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 0 | RORMIS | RO | 0 | SSI Receive Overrun Masked Interrupt Status Value Description 0 An interrupt has not occurred or is masked. 1 An unmasked interrupt was signaled due to the receive FIFO overflowing. This bit is cleared when a 1 is written to the RORIC bit in the SSI Interrupt Clear (SSIICR) register. |

Register 9: SSI Interrupt Clear (SSIICR), offset 0x020

The **SSIICR** register is the interrupt clear register. On a write of 1, the corresponding interrupt is cleared. A write of 0 has no effect.

SSI Interrupt Clear (SSIICR)

SSI0 base: 0x4000.8000

SSI1 base: 0x4000.9000

Offset 0x020

Type W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|------|-------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | RTIC | RORIC | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | W1C | W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:2 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | RTIC | W1C | 0 | SSI Receive Time-Out Interrupt Clear Writing a 1 to this bit clears the <code>RTRIS</code> bit in the SSIRIS register and the <code>RTMIS</code> bit in the SSIMIS register. |
| 0 | RORIC | W1C | 0 | SSI Receive Overrun Interrupt Clear Writing a 1 to this bit clears the <code>RORRIS</code> bit in the SSIRIS register and the <code>RORMIS</code> bit in the SSIMIS register. |

Register 10: SSI DMA Control (SSIDMACTL), offset 0x024

The **SSIDMACTL** register is the μ DMA control register.

SSI DMA Control (SSIDMACTL)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0x024
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | TXDMAE | RXDMAE |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:2 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | TXDMAE | R/W | 0 | Transmit DMA Enable Value Description 0 μ DMA for the transmit FIFO is disabled. 1 μ DMA for the transmit FIFO is enabled. |
| 0 | RXDMAE | R/W | 0 | Receive DMA Enable Value Description 0 μ DMA for the receive FIFO is disabled. 1 μ DMA for the receive FIFO is enabled. |

Register 11: SSI Peripheral Identification 4 (SSIPeriphID4), offset 0xFD0

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

SSI Peripheral Identification 4 (SSIPeriphID4)

SSI0 base: 0x4000.8000

SSI1 base: 0x4000.9000

Offset 0xFD0

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID4 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID4 | RO | 0x00 | SSI Peripheral ID Register [7:0] Can be used by software to identify the presence of this peripheral. |

Register 12: SSI Peripheral Identification 5 (SSIPeriphID5), offset 0xFD4

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

SSI Peripheral Identification 5 (SSIPeriphID5)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0xFD4
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID5 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID5 | RO | 0x00 | SSI Peripheral ID Register [15:8] Can be used by software to identify the presence of this peripheral. |

Register 13: SSI Peripheral Identification 6 (SSIPeriphID6), offset 0xFD8

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

SSI Peripheral Identification 6 (SSIPeriphID6)

SSI0 base: 0x4000.8000

SSI1 base: 0x4000.9000

Offset 0xFD8

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID6 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID6 | RO | 0x00 | SSI Peripheral ID Register [23:16] Can be used by software to identify the presence of this peripheral. |

Register 14: SSI Peripheral Identification 7 (SSIPeriphID7), offset 0xFDC

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

SSI Peripheral Identification 7 (SSIPeriphID7)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0xFDC
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID7 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID7 | RO | 0x00 | SSI Peripheral ID Register [31:24] Can be used by software to identify the presence of this peripheral. |

Register 15: SSI Peripheral Identification 0 (SSIPeriphID0), offset 0xFE0

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

SSI Peripheral Identification 0 (SSIPeriphID0)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0xFE0
 Type RO, reset 0x0000.0022

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID0 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID0 | RO | 0x22 | SSI Peripheral ID Register [7:0] Can be used by software to identify the presence of this peripheral. |

Register 16: SSI Peripheral Identification 1 (SSIPeriphID1), offset 0xFE4

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

SSI Peripheral Identification 1 (SSIPeriphID1)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0xFE4
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID1 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID1 | RO | 0x00 | SSI Peripheral ID Register [15:8] Can be used by software to identify the presence of this peripheral. |

Register 17: SSI Peripheral Identification 2 (SSIPeriphID2), offset 0xFE8

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

SSI Peripheral Identification 2 (SSIPeriphID2)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0xFE8
 Type RO, reset 0x0000.0018

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID2 | RO | 0x18 | SSI Peripheral ID Register [23:16] Can be used by software to identify the presence of this peripheral. |

Register 18: SSI Peripheral Identification 3 (SSIPeriphID3), offset 0xFEC

The **SSIPeriphIDn** registers are hard-coded and the fields within the register determine the reset value.

SSI Peripheral Identification 3 (SSIPeriphID3)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0xFEC
 Type RO, reset 0x0000.0001

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PID3 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | PID3 | RO | 0x01 | SSI Peripheral ID Register [31:24] Can be used by software to identify the presence of this peripheral. |

Register 19: SSI PrimeCell Identification 0 (SSIPCellID0), offset 0xFF0

The **SSIPCellIDn** registers are hard-coded, and the fields within the register determine the reset value.

SSI PrimeCell Identification 0 (SSIPCellID0)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0xFF0
 Type RO, reset 0x0000.000D

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID0 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID0 | RO | 0x0D | SSI PrimeCell ID Register [7:0] Provides software a standard cross-peripheral identification system. |

Register 20: SSI PrimeCell Identification 1 (SSIPCellID1), offset 0xFF4

The **SSIPCellIDn** registers are hard-coded, and the fields within the register determine the reset value.

SSI PrimeCell Identification 1 (SSIPCellID1)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0xFF4
 Type RO, reset 0x0000.00F0

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID1 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID1 | RO | 0xF0 | SSI PrimeCell ID Register [15:8] Provides software a standard cross-peripheral identification system. |

Register 21: SSI PrimeCell Identification 2 (SSIPCellID2), offset 0xFF8

The **SSIPCellIDn** registers are hard-coded, and the fields within the register determine the reset value.

SSI PrimeCell Identification 2 (SSIPCellID2)

SSI0 base: 0x4000.8000

SSI1 base: 0x4000.9000

Offset 0xFF8

Type RO, reset 0x0000.0005

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID2 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID2 | RO | 0x05 | SSI PrimeCell ID Register [23:16] Provides software a standard cross-peripheral identification system. |

Register 22: SSI PrimeCell Identification 3 (SSIPCellID3), offset 0xFFC

The **SSIPCellIDn** registers are hard-coded, and the fields within the register determine the reset value.

SSI PrimeCell Identification 3 (SSIPCellID3)

SSI0 base: 0x4000.8000
 SSI1 base: 0x4000.9000
 Offset 0xFFC
 Type RO, reset 0x0000.00B1

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | CID3 | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | CID3 | RO | 0xB1 | SSI PrimeCell ID Register [31:24] Provides software a standard cross-peripheral identification system. |

16 Inter-Integrated Circuit (I²C) Interface

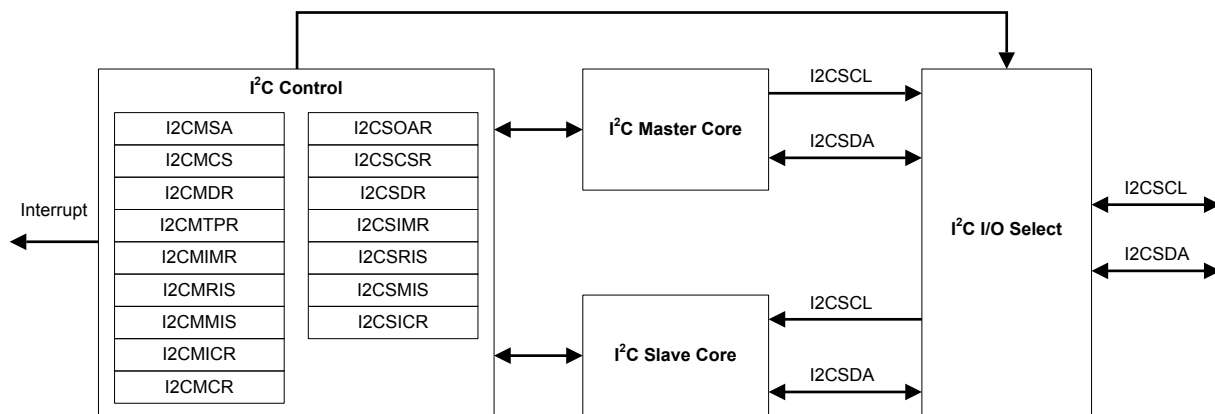
The Inter-Integrated Circuit (I²C) bus provides bi-directional data transfer through a two-wire design (a serial data line SDA and a serial clock line SCL), and interfaces to external I²C devices such as serial memory (RAMs and ROMs), networking devices, LCDs, tone generators, and so on. The I²C bus may also be used for system testing and diagnostic purposes in product development and manufacture. The LM3S2U93 microcontroller includes two I²C modules, providing the ability to interact (both transmit and receive) with other I²C devices on the bus.

The Stellaris® LM3S2U93 controller includes two I²C modules with the following features:

- Devices on the I²C bus can be designated as either a master or a slave
 - Supports both transmitting and receiving data as either a master or a slave
 - Supports simultaneous master and slave operation
- Four I²C modes
 - Master transmit
 - Master receive
 - Slave transmit
 - Slave receive
- Two transmission speeds: Standard (100 Kbps) and Fast (400 Kbps)
- Master and slave interrupt generation
 - Master generates interrupts when a transmit or receive operation completes (or aborts due to an error)
 - Slave generates interrupts when data has been transferred or requested by a master or when a START or STOP condition is detected
- Master with arbitration and clock synchronization, multimaster support, and 7-bit addressing mode

16.1 Block Diagram

Figure 16-1. I²C Block Diagram



16.2 Signal Description

The following table lists the external signals of the I²C interface and describes the function of each. The I²C interface signals are alternate functions for some GPIO signals and default to be GPIO signals at reset., with the exception of the I2C0SCL and I2CSDA pins which default to the I²C function. The column in the table below titled "Pin Mux/Pin Assignment" lists the possible GPIO pin placements for the I²C signals. The AFSEL bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the I²C function. The number in parentheses is the encoding that must be programmed into the PMC_n field in the **GPIO Port Control (GPIOPCTL)** register (page 461) to assign the I²C signal to the specified GPIO port pin. Note that the I²C pins should be set to open drain using the **GPIO Open Drain Select (GPIOODR)** register. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 419.

Table 16-1. I2C Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|----------------------|---|----------|--------------------------|----------------------------------|
| I2C0SCL | 72 | PB2 (1) | I/O | OD | I ² C module 0 clock. |
| I2C0SDA | 65 | PB3 (1) | I/O | OD | I ² C module 0 data. |
| I2C1SCL | 14 19 26 34 | PJ0 (11) PG0 (3) PA0 (8) PA6 (1) | I/O | OD | I ² C module 1 clock. |
| I2C1SDA | 18 27 35 87 | PG1 (3) PA1 (8) PA7 (1) PJ1 (11) | I/O | OD | I ² C module 1 data. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 16-2. I2C Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|----------------------------------|
| I2C0SCL | A11 | PB2 (1) | I/O | OD | I ² C module 0 clock. |

Table 16-2. I2C Signals (108BGA) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|----------------------|---|----------|--------------------------|----------------------------------|
| I2C0SDA | E11 | PB3 (1) | I/O | OD | I ² C module 0 data. |
| I2C1SCL | F3 K1 L3 L6 | PJ0 (11) PG0 (3) PA0 (8) PA6 (1) | I/O | OD | I ² C module 1 clock. |
| I2C1SDA | K2 M3 M6 B6 | PG1 (3) PA1 (8) PA7 (1) PJ1 (11) | I/O | OD | I ² C module 1 data. |

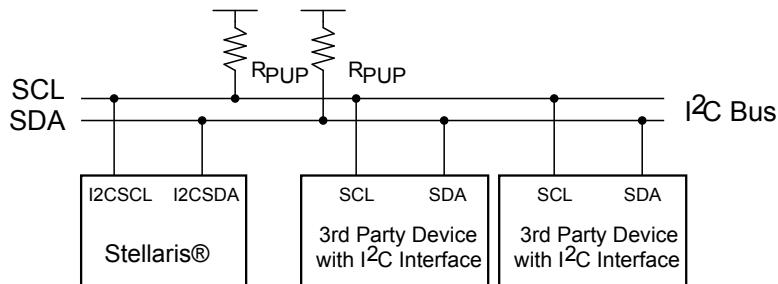
a. The TTL designation indicates the pin has TTL-compatible voltage levels.

16.3 Functional Description

Each I²C module is comprised of both master and slave functions. For proper operation, the SDA and SCL pins must be configured as open-drain signals. A typical I²C bus configuration is shown in Figure 16-2.

See “Inter-Integrated Circuit (I²C) Interface” on page 1147 for I²C timing diagrams.

Figure 16-2. I²C Bus Configuration



16.3.1 I²C Bus Functional Overview

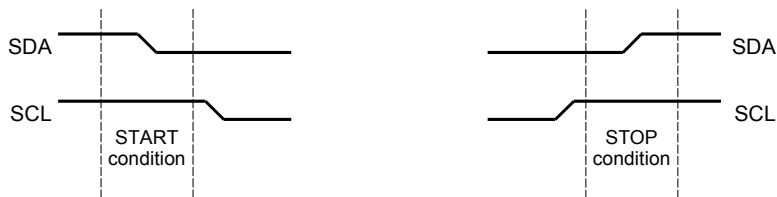
The I²C bus uses only two signals: SDA and SCL, named I2CSDA and I2CSCL on Stellaris microcontrollers. SDA is the bi-directional serial data line and SCL is the bi-directional serial clock line. The bus is considered idle when both lines are High.

Every transaction on the I²C bus is nine bits long, consisting of eight data bits and a single acknowledge bit. The number of bytes per transfer (defined as the time between a valid START and STOP condition, described in “START and STOP Conditions” on page 811) is unrestricted, but each byte has to be followed by an acknowledge bit, and data must be transferred MSB first. When a receiver cannot receive another complete byte, it can hold the clock line SCL Low and force the transmitter into a wait state. The data transfer continues when the receiver releases the clock SCL.

16.3.1.1 START and STOP Conditions

The protocol of the I²C bus defines two states to begin and end a transaction: START and STOP. A High-to-Low transition on the SDA line while the SCL is High is defined as a START condition, and a Low-to-High transition on the SDA line while SCL is High is defined as a STOP condition. The bus is considered busy after a START condition and free after a STOP condition. See Figure 16-3.

Figure 16-3. START and STOP Conditions



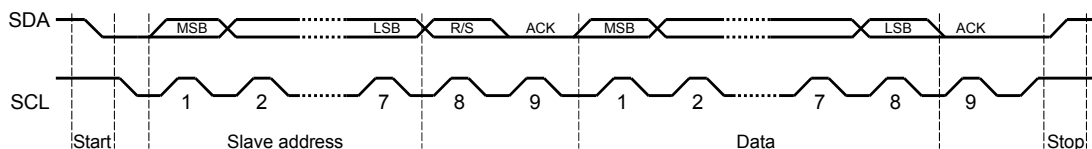
The STOP bit determines if the cycle stops at the end of the data cycle or continues on to a repeated START condition. To generate a single transmit cycle, the **I²C Master Slave Address (I2CMSA)** register is written with the desired address, the R/S bit is cleared, and the Control register is written with ACK=X (0 or 1), STOP=1, START=1, and RUN=1 to perform the operation and stop. When the operation is completed (or aborted due an error), the interrupt pin becomes active and the data may be read from the **I²C Master Data (I2CMDR)** register. When the I²C module operates in Master receiver mode, the ACK bit is normally set causing the I²C bus controller to transmit an acknowledge automatically after each byte. This bit must be cleared when the I²C bus controller requires no further data to be transmitted from the slave transmitter.

When operating in slave mode, two bits in the **I²C Slave Raw Interrupt Status (I2CSRIS)** register indicate detection of start and stop conditions on the bus; while two bits in the **I²C Slave Masked Interrupt Status (I2CSMIS)** register allow start and stop conditions to be promoted to controller interrupts (when interrupts are enabled).

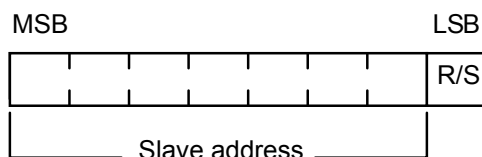
16.3.1.2 Data Format with 7-Bit Address

Data transfers follow the format shown in Figure 16-4. After the START condition, a slave address is transmitted. This address is 7-bits long followed by an eighth bit, which is a data direction bit (R/S bit in the **I2CMSA** register). If the R/S bit is clear, it indicates a transmit operation (send), and if it is set, it indicates a request for data (receive). A data transfer is always terminated by a STOP condition generated by the master, however, a master can initiate communications with another device on the bus by generating a repeated START condition and addressing another slave without first generating a STOP condition. Various combinations of receive/transmit formats are then possible within a single transfer.

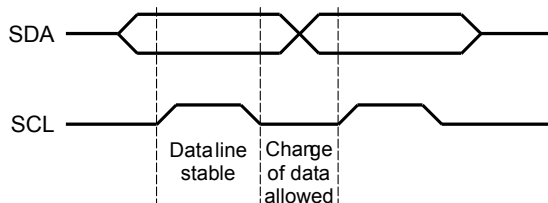
Figure 16-4. Complete Data Transfer with a 7-Bit Address



The first seven bits of the first byte make up the slave address (see Figure 16-5). The eighth bit determines the direction of the message. A zero in the R/S position of the first byte means that the master transmits (sends) data to the selected slave, and a one in this position means that the master receives data from the slave.

Figure 16-5. R/S Bit in First Byte**16.3.1.3 Data Validity**

The data on the SDA line must be stable during the high period of the clock, and the data line can only change when SCL is Low (see Figure 16-6).

Figure 16-6. Data Validity During Bit Transfer on the I²C Bus**16.3.1.4 Acknowledge**

All bus transactions have a required acknowledge clock cycle that is generated by the master. During the acknowledge cycle, the transmitter (which can be the master or slave) releases the SDA line. To acknowledge the transaction, the receiver must pull down SDA during the acknowledge clock cycle. The data transmitted out by the receiver during the acknowledge cycle must comply with the data validity requirements described in “Data Validity” on page 813.

When a slave receiver does not acknowledge the slave address, SDA must be left High by the slave so that the master can generate a STOP condition and abort the current transfer. If the master device is acting as a receiver during a transfer, it is responsible for acknowledging each transfer made by the slave. Because the master controls the number of bytes in the transfer, it signals the end of data to the slave transmitter by not generating an acknowledge on the last data byte. The slave transmitter must then release SDA to allow the master to generate the STOP or a repeated START condition.

16.3.1.5 Arbitration

A master may start a transfer only if the bus is idle. It's possible for two or more masters to generate a START condition within minimum hold time of the START condition. In these situations, an arbitration scheme takes place on the SDA line, while SCL is High. During arbitration, the first of the competing master devices to place a '1' (High) on SDA while another master transmits a '0' (Low) switches off its data output stage and retires until the bus is idle again.

Arbitration can take place over several bits. Its first stage is a comparison of address bits, and if both masters are trying to address the same device, arbitration continues on to the comparison of data bits.

16.3.2 Available Speed Modes

The I²C bus can run in either Standard mode (100 kbps) or Fast mode (400 kbps). The selected mode should match the speed of the other I²C devices on the bus.

16.3.2.1 Standard and Fast Modes

Standard and Fast modes are selected using a value in the **I²C Master Timer Period (I2CMTPR)** register that results in an SCL frequency of 100 kbps for Standard mode.

The I²C clock rate is determined by the parameters *CLK_PRD*, *TIMER_PRD*, *SCL_LP*, and *SCL_HP* where:

CLK_PRD is the system clock period

SCL_LP is the low phase of SCL (fixed at 6)

SCL_HP is the high phase of SCL (fixed at 4)

TIMER_PRD is the programmed value in the **I2CMTPR** register (see page 833).

The I²C clock period is calculated as follows:

$$SCL_PERIOD = 2 \times (1 + TIMER_PRD) \times (SCL_LP + SCL_HP) \times CLK_PRD$$

For example:

$$CLK_PRD = 50 \text{ ns}$$

$$TIMER_PRD = 2$$

$$SCL_LP=6$$

$$SCL_HP=4$$

yields a SCL frequency of:

$$1/SCL_PERIOD = 333 \text{ Khz}$$

Table 16-3 gives examples of the timer periods that should be used to generate SCL frequencies based on various system clock frequencies.

Table 16-3. Examples of I²C Master Timer Period versus Speed Mode

| System Clock | Timer Period | Standard Mode | Timer Period | Fast Mode |
|--------------|--------------|---------------|--------------|-----------|
| 4 MHz | 0x01 | 100 Kbps | - | - |
| 6 MHz | 0x02 | 100 Kbps | - | - |
| 12.5 MHz | 0x06 | 89 Kbps | 0x01 | 312 Kbps |
| 16.7 MHz | 0x08 | 93 Kbps | 0x02 | 278 Kbps |
| 20 MHz | 0x09 | 100 Kbps | 0x02 | 333 Kbps |
| 25 MHz | 0x0C | 96.2 Kbps | 0x03 | 312 Kbps |
| 33 MHz | 0x10 | 97.1 Kbps | 0x04 | 330 Kbps |
| 40 MHz | 0x13 | 100 Kbps | 0x04 | 400 Kbps |
| 50 MHz | 0x18 | 100 Kbps | 0x06 | 357 Kbps |
| 80 MHz | 0x27 | 100 Kbps | 0x09 | 400 Kbps |

16.3.3 Interrupts

The I²C can generate interrupts when the following conditions are observed:

- Master transaction completed
- Master arbitration lost

- Master transaction error
- Slave transaction received
- Slave transaction requested
- Stop condition on bus detected
- Start condition on bus detected

The I²C master and I²C slave modules have separate interrupt signals. While both modules can generate interrupts for multiple conditions, only a single interrupt signal is sent to the interrupt controller.

16.3.3.1 I²C Master Interrupts

The I²C master module generates an interrupt when a transaction completes (either transmit or receive), when arbitration is lost, or when an error occurs during a transaction. To enable the I²C master interrupt, software must set the `IM` bit in the **I²C Master Interrupt Mask (I2CMIMR)** register. When an interrupt condition is met, software must check the `ERROR` and `ARBLST` bits in the **I²C Master Control/Status (I2CMCS)** register to verify that an error didn't occur during the last transaction and to ensure that arbitration has not been lost. An error condition is asserted if the last transaction wasn't acknowledged by the slave. If an error is not detected and the master has not lost arbitration, the application can proceed with the transfer. The interrupt is cleared by writing a 1 to the `IC` bit in the **I²C Master Interrupt Clear (I2CMICR)** register.

If the application doesn't require the use of interrupts, the raw interrupt status is always visible via the **I²C Master Raw Interrupt Status (I2CMRIS)** register.

16.3.3.2 I²C Slave Interrupts

The slave module can generate an interrupt when data has been received or requested. This interrupt is enabled by setting the `DATAIM` bit in the **I²C Slave Interrupt Mask (I2CSIMR)** register. Software determines whether the module should write (transmit) or read (receive) data from the **I²C Slave Data (I2CSDR)** register, by checking the `RREQ` and `TREQ` bits of the **I²C Slave Control/Status (I2CSCR)** register. If the slave module is in receive mode and the first byte of a transfer is received, the `FBR` bit is set along with the `RREQ` bit. The interrupt is cleared by setting the `DATAIC` bit in the **I²C Slave Interrupt Clear (I2CSICR)** register.

In addition, the slave module can generate an interrupt when a start and stop condition is detected. These interrupts are enabled by setting the `STARTIM` and `STOPIM` bits of the **I²C Slave Interrupt Mask (I2CSIMR)** register and cleared by writing a 1 to the `STOPIC` and `STARTIC` bits of the **I²C Slave Interrupt Clear (I2CSICR)** register.

If the application doesn't require the use of interrupts, the raw interrupt status is always visible via the **I²C Slave Raw Interrupt Status (I2CSRIS)** register.

16.3.4 Loopback Operation

The I²C modules can be placed into an internal loopback mode for diagnostic or debug work by setting the `LPBK` bit in the **I²C Master Configuration (I2CMCR)** register. In loopback mode, the SDA and SCL signals from the master and slave modules are tied together.

16.3.5 Command Sequence Flow Charts

This section details the steps required to perform the various I²C transfer types in both master and slave mode.

16.3.5.1 I²C Master Command Sequences

The figures that follow show the command sequences available for the I²C master.

Figure 16-7. Master Single TRANSMIT

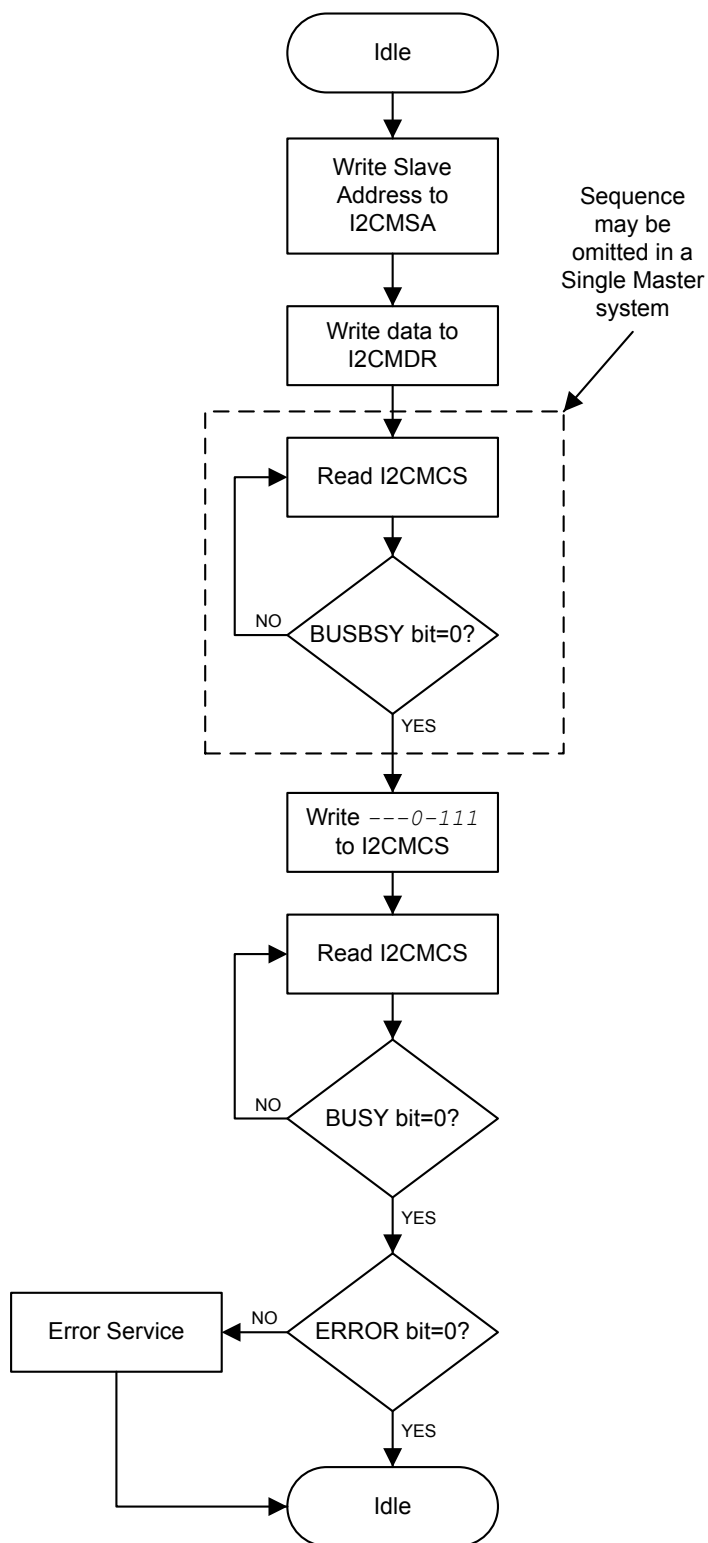


Figure 16-8. Master Single RECEIVE

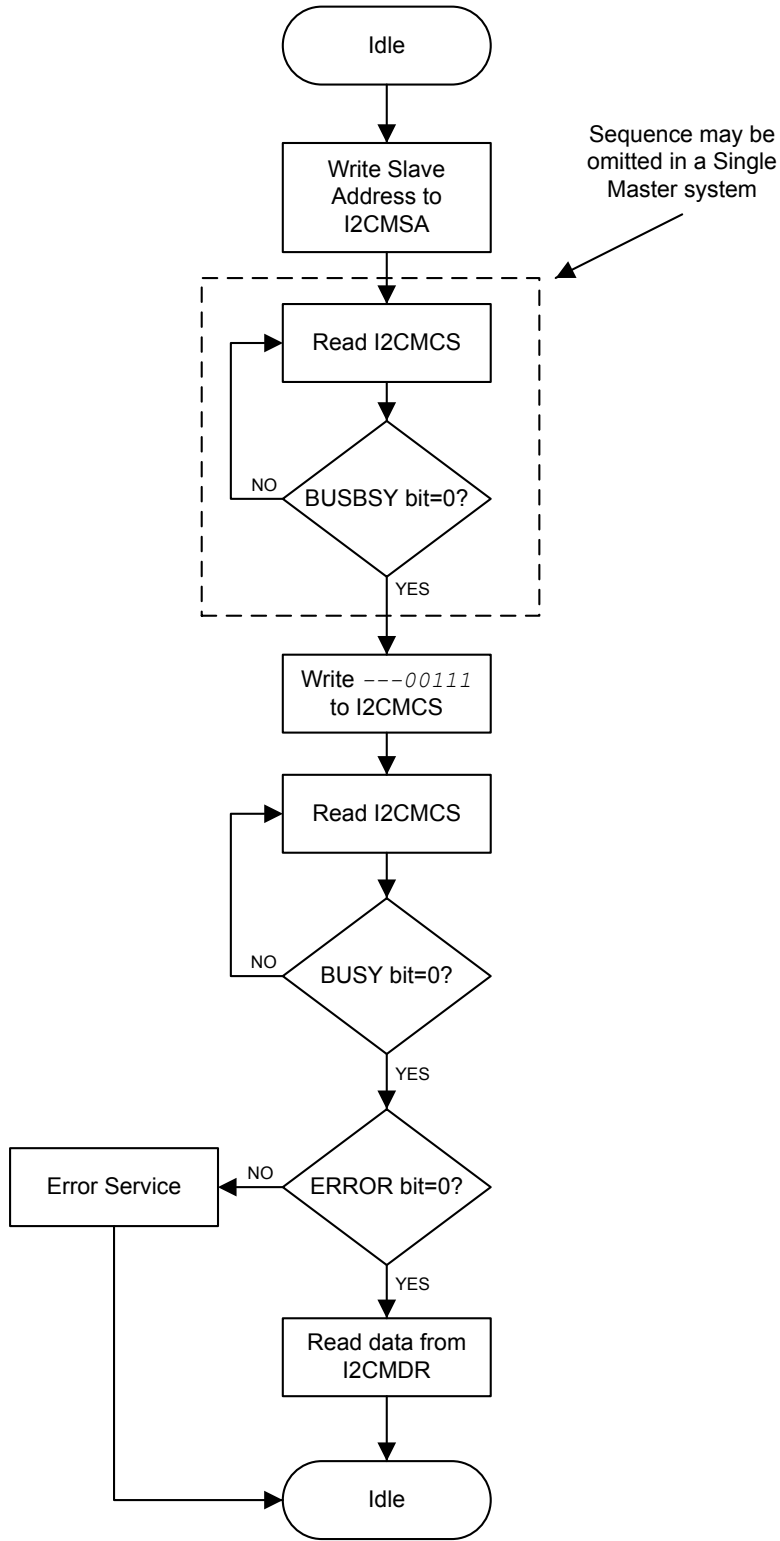


Figure 16-9. Master TRANSMIT with Repeated START

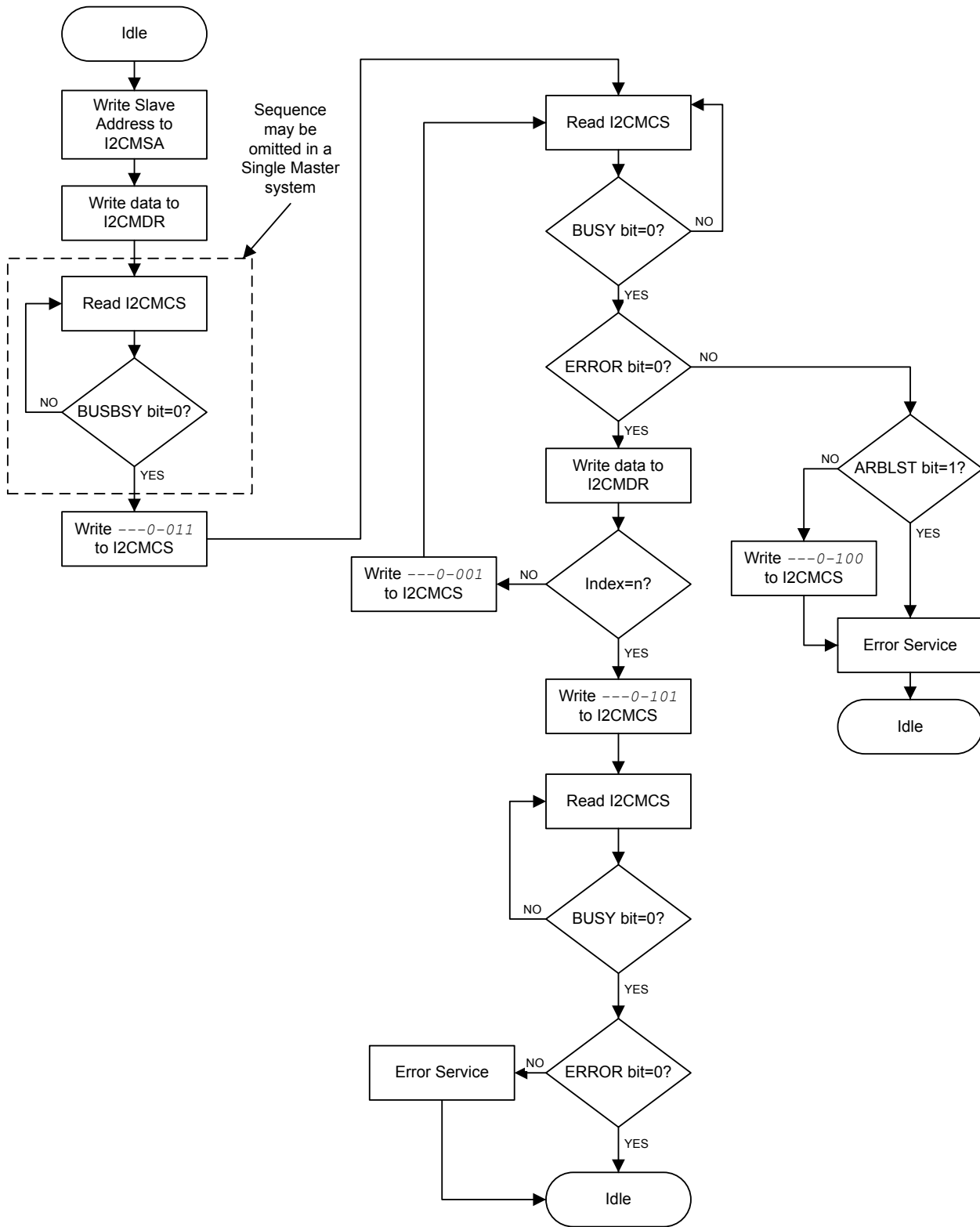


Figure 16-10. Master RECEIVE with Repeated START

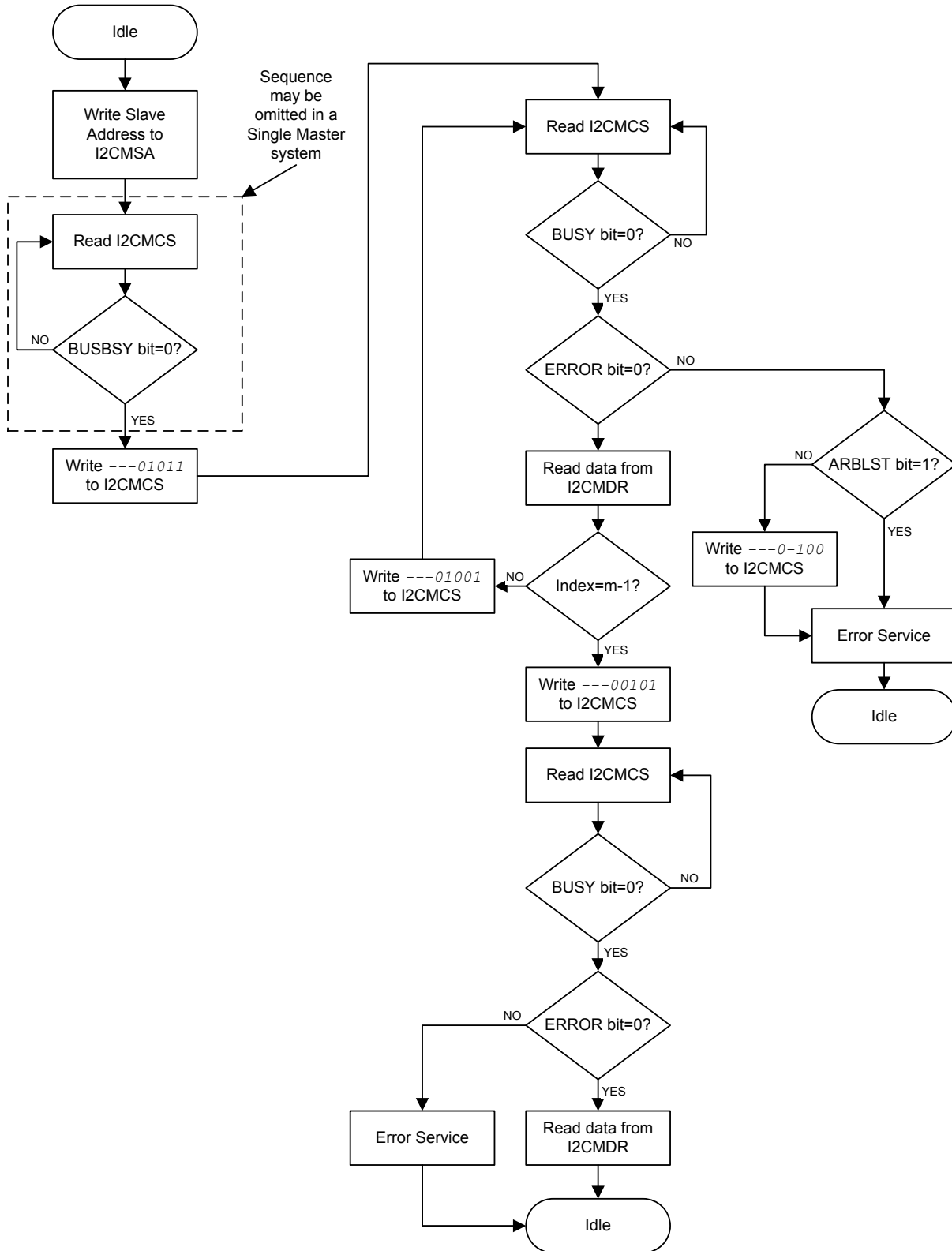


Figure 16-11. Master RECEIVE with Repeated START after TRANSMIT with Repeated START

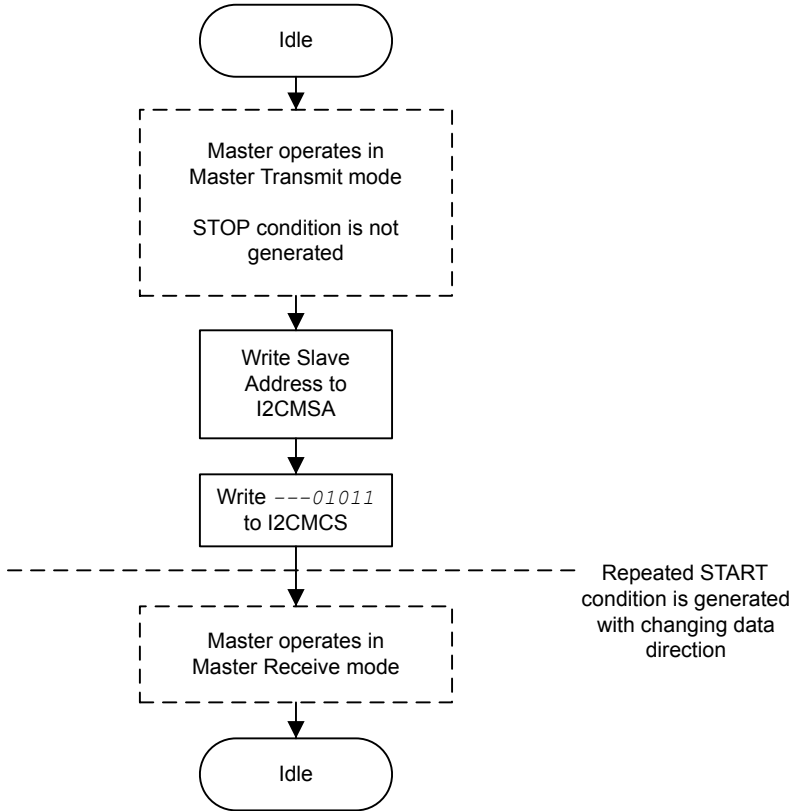
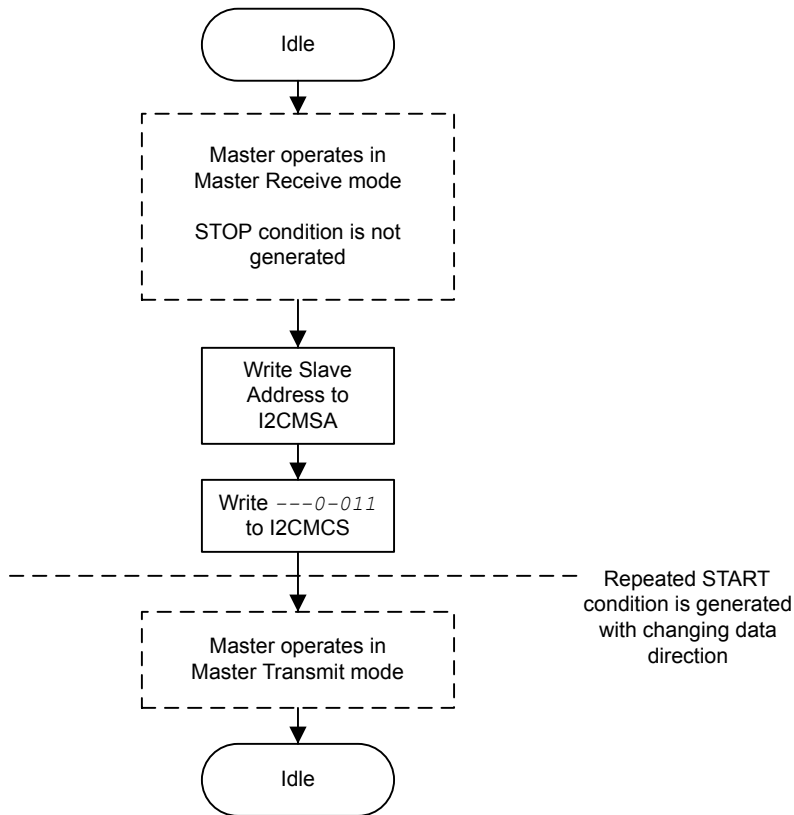


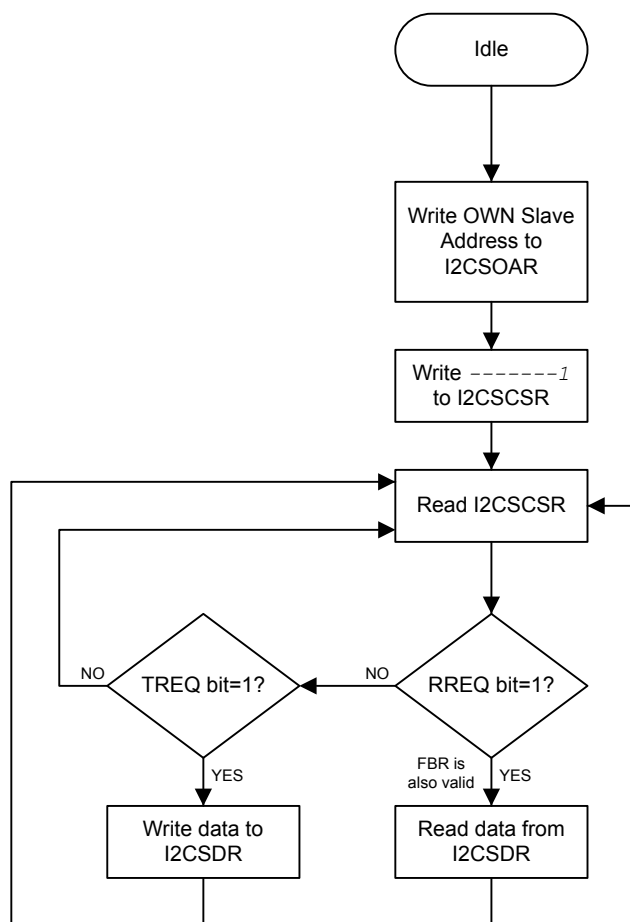
Figure 16-12. Master TRANSMIT with Repeated START after RECEIVE with Repeated START



16.3.5.2 I²C Slave Command Sequences

Figure 16-13 on page 823 presents the command sequence available for the I²C slave.

Figure 16-13. Slave Command Sequence



16.4 Initialization and Configuration

The following example shows how to configure the I²C module to transmit a single byte as a master. This assumes the system clock is 20 MHz.

1. Enable the I²C clock by writing a value of 0x0000.1000 to the **RCGC1** register in the System Control module (see page 262).
2. Enable the clock to the appropriate GPIO module via the **RCGC2** register in the System Control module (see page 274). To find out which GPIO port to enable, refer to Table 23-5 on page 1083.
3. In the GPIO module, enable the appropriate pins for their alternate function using the **GPIOAFSEL** register (see page 443). To determine which GPIOs to configure, see Table 23-4 on page 1075.
4. Enable the I²C pins for open-drain operation. See page 448.
5. Configure the **PMC_n** fields in the **GPIOPCTL** register to assign the I²C signals to the appropriate pins. See page 461 and Table 23-5 on page 1083.
6. Initialize the I²C Master by writing the **I2CMCR** register with a value of 0x0000.0010.

- Set the desired SCL clock speed of 100 Kbps by writing the **I2CMTPR** register with the correct value. The value written to the **I2CMTPR** register represents the number of system clock periods in one SCL clock period. The TPR value is determined by the following equation:

$$\begin{aligned} \text{TPR} &= (\text{System Clock} / (2 * (\text{SCL_LP} + \text{SCL_HP}) * \text{SCL_CLK})) - 1; \\ \text{TPR} &= (20\text{MHz} / (2 * (6+4) * 100000)) - 1; \\ \text{TPR} &= 9 \end{aligned}$$

Write the **I2CMTPR** register with the value of 0x0000.0009.

- Specify the slave address of the master and that the next operation is a Transmit by writing the **I2CMSA** register with a value of 0x0000.0076. This sets the slave address to 0x3B.
- Place data (byte) to be transmitted in the data register by writing the **I2CMDR** register with the desired data.
- Initiate a single byte transmit of the data from Master to Slave by writing the **I2CMCS** register with a value of 0x0000.0007 (STOP, START, RUN).
- Wait until the transmission completes by polling the **I2CMCS** register's **BUSBSY** bit until it has been cleared.
- Check the **ERROR** bit in the **I2CMCS** register to confirm the transmit was acknowledged.

16.5 Register Map

Table 16-4 on page 824 lists the I²C registers. All addresses given are relative to the I²C base address:

- I²C 0: 0x4002.0000
- I²C 1: 0x4002.1000

Note that the I²C module clock must be enabled before the registers can be programmed (see page 262). There must be a delay of 3 system clocks after the I²C module clock is enabled before any I²C module registers are accessed.

The `hw_i2c.h` file in the StellarisWare[®] Driver Library uses a base address of 0x800 for the I²C slave registers. Be aware when using registers with offsets between 0x800 and 0x818 that StellarisWare uses an offset between 0x000 and 0x018 with the slave base address.

Table 16-4. Inter-Integrated Circuit (I²C) Interface Register Map

| Offset | Name | Type | Reset | Description | See page |
|------------------------------|---------|------|-------------|---------------------------------|----------|
| I²C Master | | | | | |
| 0x000 | I2CMSA | R/W | 0x0000.0000 | I2C Master Slave Address | 826 |
| 0x004 | I2CMCS | R/W | 0x0000.0020 | I2C Master Control/Status | 827 |
| 0x008 | I2CMDR | R/W | 0x0000.0000 | I2C Master Data | 832 |
| 0x00C | I2CMTPR | R/W | 0x0000.0001 | I2C Master Timer Period | 833 |
| 0x010 | I2CMIMR | R/W | 0x0000.0000 | I2C Master Interrupt Mask | 834 |
| 0x014 | I2CMRIS | RO | 0x0000.0000 | I2C Master Raw Interrupt Status | 835 |

Table 16-4. Inter-Integrated Circuit (I²C) Interface Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|-----------------------------|---------|------|-------------|------------------------------------|----------|
| 0x018 | I2CMMIS | RO | 0x0000.0000 | I2C Master Masked Interrupt Status | 836 |
| 0x01C | I2CMICR | WO | 0x0000.0000 | I2C Master Interrupt Clear | 837 |
| 0x020 | I2CMCR | R/W | 0x0000.0000 | I2C Master Configuration | 838 |
| I²C Slave | | | | | |
| 0x800 | I2CSOAR | R/W | 0x0000.0000 | I2C Slave Own Address | 839 |
| 0x804 | I2CSCSR | RO | 0x0000.0000 | I2C Slave Control/Status | 840 |
| 0x808 | I2CSDR | R/W | 0x0000.0000 | I2C Slave Data | 842 |
| 0x80C | I2CSIMR | R/W | 0x0000.0000 | I2C Slave Interrupt Mask | 843 |
| 0x810 | I2CSRIS | RO | 0x0000.0000 | I2C Slave Raw Interrupt Status | 844 |
| 0x814 | I2CSMIS | RO | 0x0000.0000 | I2C Slave Masked Interrupt Status | 845 |
| 0x818 | I2CSICR | WO | 0x0000.0000 | I2C Slave Interrupt Clear | 846 |

16.6 Register Descriptions (I²C Master)

The remainder of this section lists and describes the I²C master registers, in numerical order by address offset.

Register 1: I²C Master Slave Address (I2CMSA), offset 0x000

This register consists of eight bits: seven address bits (A6-A0), and a Receive/Send bit, which determines if the next operation is a Receive (High), or Transmit (Low).

I2C Master Slave Address (I2CMSA)

I2C 0 base: 0x4002.0000
 I2C 1 base: 0x4002.1000
 Offset 0x000
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | SA | | | | | | | R/S |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:1 | SA | R/W | 0x00 | I ² C Slave Address This field specifies bits A6 through A0 of the slave address. |
| 0 | R/S | R/W | 0 | Receive/Send The R/S bit specifies if the next operation is a Receive (High) or Transmit (Low). |
| | | | | Value Description |
| | | | | 0 Transmit |
| | | | | 1 Receive |

Register 2: I²C Master Control/Status (I2CMCS), offset 0x004

This register accesses status bits when read and control bits when written. When read, the status register indicates the state of the I²C bus controller. When written, the control register configures the I²C controller operation.

The **START** bit generates the **START** or **REPEATED START** condition. The **STOP** bit determines if the cycle stops at the end of the data cycle or continues on to a repeated **START** condition. To generate a single transmit cycle, the **I²C Master Slave Address (I2CMSA)** register is written with the desired address, the **R/S** bit is cleared, and this register is written with **ACK=X** (0 or 1), **STOP=1**, **START=1**, and **RUN=1** to perform the operation and stop. When the operation is completed (or aborted due an error), an interrupt becomes active and the data may be read from the **I2CMDR** register. When the I²C module operates in Master receiver mode, the **ACK** bit is normally set, causing the I²C bus controller to transmit an acknowledge automatically after each byte. This bit must be cleared when the I²C bus controller requires no further data to be transmitted from the slave transmitter.

Read-Only Status Register

I2C Master Control/Status (I2CMCS)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x004

Type RO, reset 0x0000.0020

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|--------|------|--------|---------|--------|-------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | BUSBSY | IDLE | ARBLST | DATAACK | ADRACK | ERROR | BUSY |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |

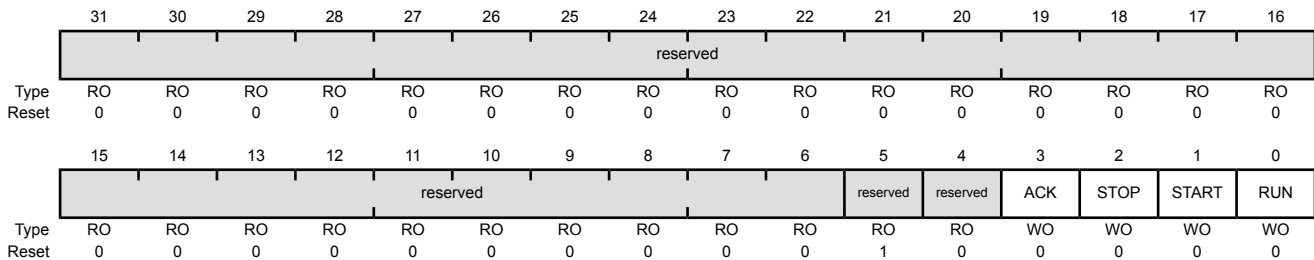
| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:7 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6 | BUSBSY | RO | 0 | Bus Busy Value Description 0 The I ² C bus is idle. 1 The I ² C bus is busy. The bit changes based on the START and STOP conditions. |
| 5 | IDLE | RO | 1 | I ² C Idle Value Description 0 The I ² C controller is not idle. 1 The I ² C controller is idle. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 4 | ARBLST | RO | 0 | Arbitration Lost Value Description 0 The I ² C controller won arbitration. 1 The I ² C controller lost arbitration. |
| 3 | DATAACK | RO | 0 | Acknowledge Data Value Description 0 The transmitted data was acknowledged 1 The transmitted data was not acknowledged. |
| 2 | ADRACK | RO | 0 | Acknowledge Address Value Description 0 The transmitted address was acknowledged 1 The transmitted address was not acknowledged. |
| 1 | ERROR | RO | 0 | Error Value Description 0 No error was detected on the last operation. 1 An error occurred on the last operation. The error can be from the slave address not being acknowledged or the transmit data not being acknowledged. |
| 0 | BUSY | RO | 0 | I ² C Busy Value Description 0 The controller is idle. 1 The controller is busy. When the <i>BUSY</i> bit is set, the other status bits are not valid. |

Write-Only Control Register

I2C Master Control/Status (I2CMCS)

I2C 0 base: 0x4002.0000
 I2C 1 base: 0x4002.1000
 Offset 0x004
 Type WO, reset 0x0000.0020



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:6 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | reserved | RO | 1 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | ACK | WO | 0 | Data Acknowledge Enable Value Description 0 The received data byte is not acknowledged automatically by the master. 1 The received data byte is acknowledged automatically by the master. See field decoding in Table 16-5 on page 830. |
| 2 | STOP | WO | 0 | Generate STOP Value Description 0 The controller does not generate the STOP condition. 1 The controller generates the STOP condition. See field decoding in Table 16-5 on page 830. |
| 1 | START | WO | 0 | Generate START Value Description 0 The controller does not generate the START condition. 1 The controller generates the START or repeated START condition. See field decoding in . |
| 0 | RUN | WO | 0 | I ² C Master Enable Value Description 0 The master is disabled. 1 The master is enabled to transmit or receive data. See field decoding in Table 16-5 on page 830. |

Table 16-5. Write Field Decoding for I2CMCS[3:0] Field

| Current State | I2CMSA[0] | I2CMCS[3:0] | | | | Description |
|-----------------|---|----------------|------|-------|-----|---|
| | R/S | ACK | STOP | START | RUN | |
| Idle | 0 | X ^a | 0 | 1 | 1 | START condition followed by TRANSMIT (master goes to the Master Transmit state). |
| | 0 | X | 1 | 1 | 1 | START condition followed by a TRANSMIT and STOP condition (master remains in Idle state). |
| | 1 | 0 | 0 | 1 | 1 | START condition followed by RECEIVE operation with negative ACK (master goes to the Master Receive state). |
| | 1 | 0 | 1 | 1 | 1 | START condition followed by RECEIVE and STOP condition (master remains in Idle state). |
| | 1 | 1 | 0 | 1 | 1 | START condition followed by RECEIVE (master goes to the Master Receive state). |
| | 1 | 1 | 1 | 1 | 1 | Illegal |
| | All other combinations not listed are non-operations. | | | | | NOP |
| Master Transmit | X | X | 0 | 0 | 1 | TRANSMIT operation (master remains in Master Transmit state). |
| | X | X | 1 | 0 | 0 | STOP condition (master goes to Idle state). |
| | X | X | 1 | 0 | 1 | TRANSMIT followed by STOP condition (master goes to Idle state). |
| | 0 | X | 0 | 1 | 1 | Repeated START condition followed by a TRANSMIT (master remains in Master Transmit state). |
| | 0 | X | 1 | 1 | 1 | Repeated START condition followed by TRANSMIT and STOP condition (master goes to Idle state). |
| | 1 | 0 | 0 | 1 | 1 | Repeated START condition followed by a RECEIVE operation with a negative ACK (master goes to Master Receive state). |
| | 1 | 0 | 1 | 1 | 1 | Repeated START condition followed by a TRANSMIT and STOP condition (master goes to Idle state). |
| | 1 | 1 | 0 | 1 | 1 | Repeated START condition followed by RECEIVE (master goes to Master Receive state). |
| | 1 | 1 | 1 | 1 | 1 | Illegal. |
| | All other combinations not listed are non-operations. | | | | | NOP. |

Table 16-5. Write Field Decoding for I2CMCS[3:0] Field (continued)

| Current State | I2CMSA[0] | I2CMCS[3:0] | | | | Description |
|----------------|---|-------------|------|-------|-----|--|
| | R/S | ACK | STOP | START | RUN | |
| Master Receive | X | 0 | 0 | 0 | 1 | RECEIVE operation with negative ACK (master remains in Master Receive state). |
| | X | X | 1 | 0 | 0 | STOP condition (master goes to Idle state). ^b |
| | X | 0 | 1 | 0 | 1 | RECEIVE followed by STOP condition (master goes to Idle state). |
| | X | 1 | 0 | 0 | 1 | RECEIVE operation (master remains in Master Receive state). |
| | X | 1 | 1 | 0 | 1 | Illegal. |
| | 1 | 0 | 0 | 1 | 1 | Repeated START condition followed by RECEIVE operation with a negative ACK (master remains in Master Receive state). |
| | 1 | 0 | 1 | 1 | 1 | Repeated START condition followed by RECEIVE and STOP condition (master goes to Idle state). |
| | 1 | 1 | 0 | 1 | 1 | Repeated START condition followed by RECEIVE (master remains in Master Receive state). |
| | 0 | X | 0 | 1 | 1 | Repeated START condition followed by TRANSMIT (master goes to Master Transmit state). |
| | 0 | X | 1 | 1 | 1 | Repeated START condition followed by TRANSMIT and STOP condition (master goes to Idle state). |
| | All other combinations not listed are non-operations. | | | | | |

a. An X in a table cell indicates the bit can be 0 or 1.

b. In Master Receive mode, a STOP condition should be generated only after a Data Negative Acknowledge executed by the master or an Address Negative Acknowledge executed by the slave.

Register 3: I²C Master Data (I2CMDR), offset 0x008

Important: This register is read-sensitive. See the register description for details.

This register contains the data to be transmitted when in the Master Transmit state and the data received when in the Master Receive state.

I2C Master Data (I2CMDR)

I2C 0 base: 0x4002.0000
 I2C 1 base: 0x4002.1000
 Offset 0x008
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DATA | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | DATA | R/W | 0x00 | Data Transferred Data transferred during transaction. |

Register 4: I²C Master Timer Period (I2CMTPR), offset 0x00C

This register specifies the period of the SCL clock.

I2C Master Timer Period (I2CMTPR)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x00C

Type R/W, reset 0x0000.0001

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | TPR | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:7 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6:0 | TPR | R/W | 0x1 | <p>SCL Clock Period</p> <p>This field specifies the period of the SCL clock.</p> $SCL_PRD = 2 \times (1 + TPR) \times (SCL_LP + SCL_HP) \times CLK_PRD$ <p>where:</p> <p><i>SCL_PRD</i> is the SCL line period (I²C clock).</p> <p><i>TPR</i> is the Timer Period register value (range of 1 to 127).</p> <p><i>SCL_LP</i> is the SCL Low period (fixed at 6).</p> <p><i>SCL_HP</i> is the SCL High period (fixed at 4).</p> <p><i>CLK_PRD</i> is the system clock period in ns.</p> |

Register 5: I²C Master Interrupt Mask (I2CMIMR), offset 0x010

This register controls whether a raw interrupt is promoted to a controller interrupt.

I2C Master Interrupt Mask (I2CMIMR)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x010

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | | IM | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:1 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | IM | R/W | 0 | Interrupt Mask |

| Value | Description |
|-------|--|
| 1 | The master interrupt is sent to the interrupt controller when the RIS bit in the I2CMRIS register is set. |
| 0 | The RIS interrupt is suppressed and not sent to the interrupt controller. |

Register 6: I²C Master Raw Interrupt Status (I2CMRIS), offset 0x014

This register specifies whether an interrupt is pending.

I2C Master Raw Interrupt Status (I2CMRIS)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x014

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | RIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:1 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | RIS | RO | 0 | Raw Interrupt Status |

| Value | Description |
|-------|--------------------------------|
| 1 | A master interrupt is pending. |
| 0 | No interrupt. |

This bit is cleared by writing a 1 to the IC bit in the I2CMICR register.

Register 7: I²C Master Masked Interrupt Status (I2CMMIS), offset 0x018

This register specifies whether an interrupt was signaled.

I2C Master Masked Interrupt Status (I2CMMIS)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x018

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | MIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:1 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | MIS | RO | 0 | Masked Interrupt Status |

Value Description

- 1 An unmasked master interrupt was signaled and is pending.
- 0 An interrupt has not occurred or is masked.

This bit is cleared by writing a 1 to the IC bit in the I2CMICR register.

Register 8: I²C Master Interrupt Clear (I2CMICR), offset 0x01C

This register clears the raw and masked interrupts.

I2C Master Interrupt Clear (I2CMICR)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x01C

Type WO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | | IC | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:1 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | IC | WO | 0 | <p>Interrupt Clear</p> <p>Writing a 1 to this bit clears the RIS bit in the I2CMRIS register and the MIS bit in the I2CMMIS register.</p> <p>A read of this register returns no meaningful data.</p> |

Register 9: I²C Master Configuration (I2CMCR), offset 0x020

This register configures the mode (Master or Slave) and sets the interface for test mode loopback.

I2C Master Configuration (I2CMCR)

I2C 0 base: 0x4002.0000
 I2C 1 base: 0x4002.1000
 Offset 0x020
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|-----|-----|-----|----------|----|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | SFE | MFE | reserved | | LPBK |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:6 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | SFE | R/W | 0 | I ² C Slave Function Enable Value Description 1 Slave mode is enabled. 0 Slave mode is disabled. |
| 4 | MFE | R/W | 0 | I ² C Master Function Enable Value Description 1 Master mode is enabled. 0 Master mode is disabled. |
| 3:1 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | LPBK | R/W | 0 | I ² C Loopback Value Description 1 The controller in a test mode loopback configuration. 0 Normal operation. |

16.7 Register Descriptions (I²C Slave)

The remainder of this section lists and describes the I²C slave registers, in numerical order by address offset.

Register 10: I²C Slave Own Address (I2CSOAR), offset 0x800

This register consists of seven address bits that identify the Stellaris I²C device on the I²C bus.

I2C Slave Own Address (I2CSOAR)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x800

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | OAR | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:7 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 6:0 | OAR | R/W | 0x00 | I ² C Slave Own Address This field specifies bits A6 through A0 of the slave address. |

Register 11: I²C Slave Control/Status (I2CCSR), offset 0x804

This register functions as a control register when written, and a status register when read.

Read-Only Status Register

I2C Slave Control/Status (I2CCSR)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x804

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-----|------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | FBR | TREQ | RREQ |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:3 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | FBR | RO | 0 | <p>First Byte Received</p> <p>Value Description</p> <p>1 The first byte following the slave's own address has been received.</p> <p>0 The first byte has not been received.</p> <p>This bit is only valid when the RREQ bit is set and is automatically cleared when data has been read from the I2CSDR register.</p> <p>Note: This bit is not used for slave transmit operations.</p> |
| 1 | TREQ | RO | 0 | <p>Transmit Request</p> <p>Value Description</p> <p>1 The I²C controller has been addressed as a slave transmitter and is using clock stretching to delay the master until data has been written to the I2CSDR register.</p> <p>0 No outstanding transmit request.</p> |
| 0 | RREQ | RO | 0 | <p>Receive Request</p> <p>Value Description</p> <p>1 The I²C controller has outstanding receive data from the I²C master and is using clock stretching to delay the master until the data has been read from the I2CSDR register.</p> <p>0 No outstanding receive data.</p> |

Write-Only Control Register

I2C Slave Control/Status (I2CSCSR)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x804

Type WO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:1 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | DA | WO | 0 | Device Active |
| | | | | Value Description |
| | | | | 0 Disables the I ² C slave operation. |
| | | | | 1 Enables the I ² C slave operation. |

Once this bit has been set, it should not be set again unless it has been cleared by writing a 0 or by a reset, otherwise transfer failures may occur.

Register 12: I²C Slave Data (I2CSDR), offset 0x808

Important: This register is read-sensitive. See the register description for details.

This register contains the data to be transmitted when in the Slave Transmit state, and the data received when in the Slave Receive state.

I2C Slave Data (I2CSDR)

I2C 0 base: 0x4002.0000
 I2C 1 base: 0x4002.1000
 Offset 0x808
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DATA | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7:0 | DATA | R/W | 0x00 | Data for Transfer This field contains the data for transfer during a slave receive or transmit operation. |

Register 13: I²C Slave Interrupt Mask (I2CSIMR), offset 0x80C

This register controls whether a raw interrupt is promoted to a controller interrupt.

I2C Slave Interrupt Mask (I2CSIMR)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x80C

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|--------|---------|--------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | STOPIM | STARTIM | DATAIM | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | STOPIM | R/W | 0 | Stop Condition Interrupt Mask Value Description 1 The STOP condition interrupt is sent to the interrupt controller when the STOPRIS bit in the I2CSRIS register is set. 0 The STOPRIS interrupt is suppressed and not sent to the interrupt controller. |
| 1 | STARTIM | R/W | 0 | Start Condition Interrupt Mask Value Description 1 The START condition interrupt is sent to the interrupt controller when the STARTRIS bit in the I2CSRIS register is set. 0 The STARTRIS interrupt is suppressed and not sent to the interrupt controller. |
| 0 | DATAIM | R/W | 0 | Data Interrupt Mask Value Description 1 The data received or data requested interrupt is sent to the interrupt controller when the DATARIS bit in the I2CSRIS register is set. 0 The DATARIS interrupt is suppressed and not sent to the interrupt controller. |

Register 14: I²C Slave Raw Interrupt Status (I2CSRIS), offset 0x810

This register specifies whether an interrupt is pending.

I2C Slave Raw Interrupt Status (I2CSRIS)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x810

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|---------|----------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | STOPRIS | STARTRIS | DATARIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | STOPRIS | RO | 0 | <p>Stop Condition Raw Interrupt Status</p> <p>Value Description</p> <p>1 A STOP condition interrupt is pending.</p> <p>0 No interrupt.</p> <p>This bit is cleared by writing a 1 to the STOPIC bit in the I2CSICR register.</p> |
| 1 | STARTRIS | RO | 0 | <p>Start Condition Raw Interrupt Status</p> <p>Value Description</p> <p>1 A START condition interrupt is pending.</p> <p>0 No interrupt.</p> <p>This bit is cleared by writing a 1 to the STARTIC bit in the I2CSICR register.</p> |
| 0 | DATARIS | RO | 0 | <p>Data Raw Interrupt Status</p> <p>Value Description</p> <p>1 A data received or data requested interrupt is pending.</p> <p>0 No interrupt.</p> <p>This bit is cleared by writing a 1 to the DATAIC bit in the I2CSICR register.</p> |

Register 15: I²C Slave Masked Interrupt Status (I2CSMIS), offset 0x814

This register specifies whether an interrupt was signaled.

I2C Slave Masked Interrupt Status (I2CSMIS)

I2C 0 base: 0x4002.0000

I2C 1 base: 0x4002.1000

Offset 0x814

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|---------|----------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | STOPMIS | STARTMIS | DATAMIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | STOPMIS | RO | 0 | <p>Stop Condition Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked STOP condition interrupt was signaled is pending.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the STOPIC bit in the I2CSICR register.</p> |
| 1 | STARTMIS | RO | 0 | <p>Start Condition Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked START condition interrupt was signaled is pending.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the STARTIC bit in the I2CSICR register.</p> |
| 0 | DATAMIS | RO | 0 | <p>Data Masked Interrupt Status</p> <p>Value Description</p> <p>1 An unmasked data received or data requested interrupt was signaled is pending.</p> <p>0 An interrupt has not occurred or is masked.</p> <p>This bit is cleared by writing a 1 to the DATAIC bit in the I2CSICR register.</p> |

Register 16: I²C Slave Interrupt Clear (I2CSICR), offset 0x818

This register clears the raw interrupt. A read of this register returns no meaningful data.

I2C Slave Interrupt Clear (I2CSICR)

I2C 0 base: 0x4002.0000
 I2C 1 base: 0x4002.1000
 Offset 0x818
 Type WO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|--------|---------|--------|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | STOPIC | STARTIC | DATAIC | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | WO | WO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:3 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | STOPIC | WO | 0 | Stop Condition Interrupt Clear Writing a 1 to this bit clears the STOPRIS bit in the I2CSRIS register and the STOPMIS bit in the I2CSMIS register. A read of this register returns no meaningful data. |
| 1 | STARTIC | WO | 0 | Start Condition Interrupt Clear Writing a 1 to this bit clears the STOPRIS bit in the I2CSRIS register and the STOPMIS bit in the I2CSMIS register. A read of this register returns no meaningful data. |
| 0 | DATAIC | WO | 0 | Data Interrupt Clear Writing a 1 to this bit clears the STOPRIS bit in the I2CSRIS register and the STOPMIS bit in the I2CSMIS register. A read of this register returns no meaningful data. |

17 Inter-Integrated Circuit Sound (I²S) Interface

The I²S module is a configurable serial audio core that contains a transmit module and a receive module. The module is configurable for the I²S as well as Left-Justified and Right-Justified serial audio formats. Data can be in one of four modes: Stereo, Mono, Compact 16-bit Stereo and Compact 8-Bit Stereo.

The transmit and receive modules each have an 8-entry audio-sample FIFO. An audio sample can consist of a Left and Right Stereo sample, a Mono sample, or a Left and Right Compact Stereo sample. In Compact 16-Bit Stereo, each FIFO entry contains both the 16-bit left and 16-bit right samples, allowing efficient data transfers and requiring less memory space. In Compact 8-bit Stereo, each FIFO entry contains an 8-bit left and an 8-bit right sample, reducing memory requirements further.

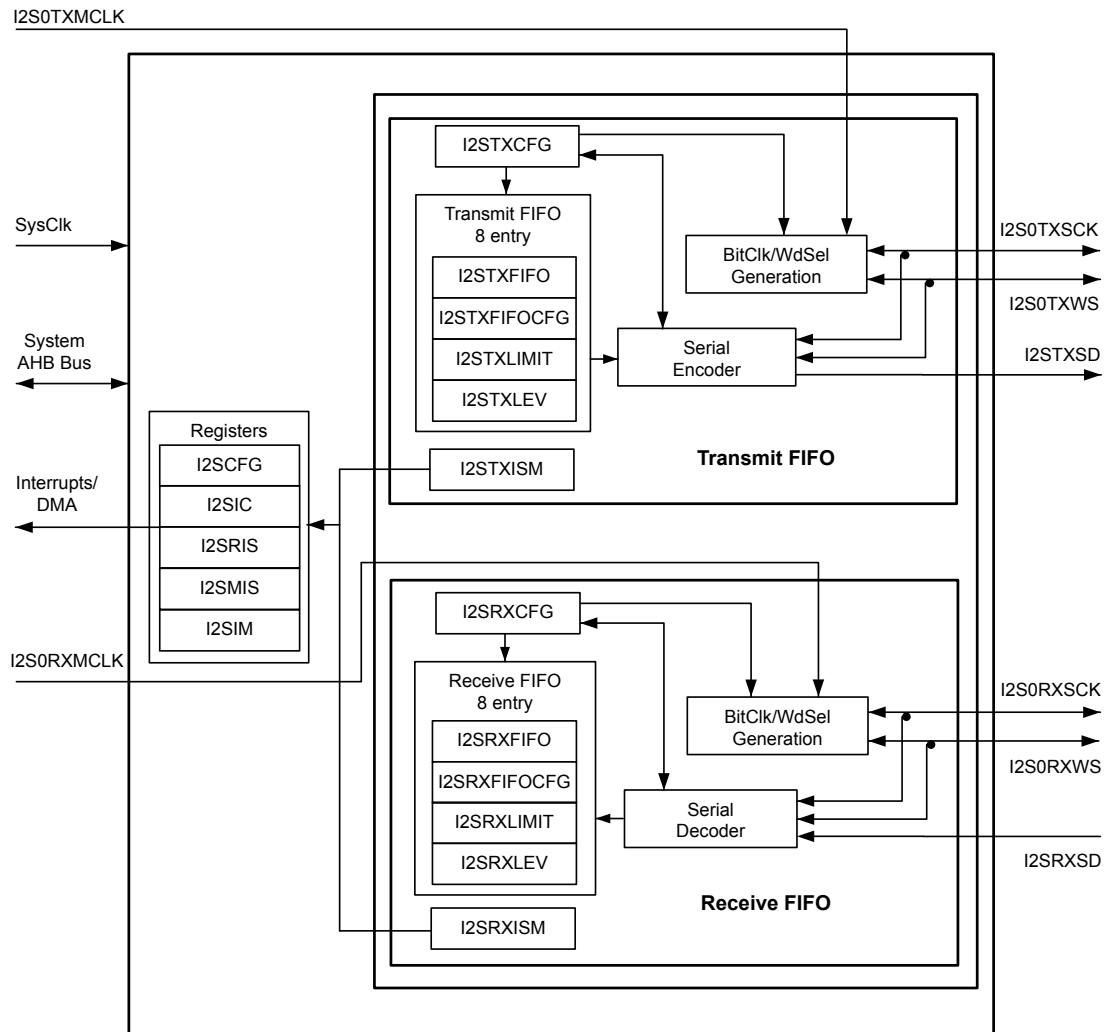
Both the transmitter and receiver are capable of being a master or a slave.

The Stellaris® I²S module has the following features:

- Configurable audio format supporting I²S, Left-justification, and Right-justification
- Configurable sample size from 8 to 32 bits
- Mono and Stereo support
- 8-, 16-, and 32-bit FIFO interface for packing memory
- Independent transmit and receive 8-entry FIFOs
- Configurable FIFO-level interrupt and μ DMA requests
- Independent transmit and receive MCLK direction control
- Transmit and receive internal MCLK sources
- Independent transmit and receive control for serial clock and word select
- MCLK and SCLK can be independently set to master or slave
- Configurable transmit zero or last sample when FIFO empty
- Efficient transfers using Micro Direct Memory Access Controller (μ DMA)
 - Separate channels for transmit and receive
 - Burst requests
 - Channel requests asserted when FIFO contains required amount of data

17.1 Block Diagram

Figure 17-1. I²S Block Diagram



17.2 Signal Description

The following table lists the external signals of the I²S module and describes the function of each. The I²S module signals are alternate functions for some GPIO signals and default to be GPIO signals at reset. The column in the table below titled "Pin Mux/Pin Assignment" lists the possible GPIO pin placements for the I²S signals. The **AFSEL** bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the I²S function. The number in parentheses is the encoding that must be programmed into the **PMC_n** field in the **GPIO Port Control (GPIOPCTL)** register (page 461) to assign the I²S signal to the specified GPIO port pin. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 419.

Table 17-1. I2S Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|------------|----------------|-------------------------------|----------|--------------------------|--|
| I2S0RXMCLK | 16 29 98 | PG3 (9) PA3 (9) PD5 (8) | I/O | TTL | I ² S module 0 receive master clock. |
| I2S0RXSCK | 10 40 | PD0 (8) PG5 (9) | I/O | TTL | I ² S module 0 receive clock. |
| I2S0RXSD | 17 28 97 | PG2 (9) PA2 (9) PD4 (8) | I/O | TTL | I ² S module 0 receive data. |
| I2S0RXWS | 11 37 | PD1 (8) PG6 (9) | I/O | TTL | I ² S module 0 receive word select. |
| I2S0TXMCLK | 43 61 | PF6 (9) PF1 (8) | I/O | TTL | I ² S module 0 transmit master clock. |
| I2S0TXSCK | 30 90 99 | PA4 (9) PB6 (9) PD6 (8) | I/O | TTL | I ² S module 0 transmit clock. |
| I2S0TXSD | 5 47 | PE5 (9) PF0 (8) | I/O | TTL | I ² S module 0 transmit data. |
| I2S0TXWS | 6 31 100 | PE4 (9) PA5 (9) PD7 (8) | I/O | TTL | I ² S module 0 transmit word select. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 17-2. I2S Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|------------|----------------|-------------------------------|----------|--------------------------|--|
| I2S0RXMCLK | J2 L4 C6 | PG3 (9) PA3 (9) PD5 (8) | I/O | TTL | I ² S module 0 receive master clock. |
| I2S0RXSCK | G1 M7 | PD0 (8) PG5 (9) | I/O | TTL | I ² S module 0 receive clock. |
| I2S0RXSD | J1 M4 B5 | PG2 (9) PA2 (9) PD4 (8) | I/O | TTL | I ² S module 0 receive data. |
| I2S0RXWS | G2 L7 | PD1 (8) PG6 (9) | I/O | TTL | I ² S module 0 receive word select. |
| I2S0TXMCLK | M8 H12 | PF6 (9) PF1 (8) | I/O | TTL | I ² S module 0 transmit master clock. |
| I2S0TXSCK | L5 A7 A3 | PA4 (9) PB6 (9) PD6 (8) | I/O | TTL | I ² S module 0 transmit clock. |
| I2S0TXSD | B3 M9 | PE5 (9) PF0 (8) | I/O | TTL | I ² S module 0 transmit data. |
| I2S0TXWS | B2 M5 A2 | PE4 (9) PA5 (9) PD7 (8) | I/O | TTL | I ² S module 0 transmit word select. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

17.3 Functional Description

The Inter-Integrated Circuit Sound (I²S) module contains separate transmit and receive engines. Each engine consists of the following:

- Serial encoder for the transmitter; serial decoder for the receiver
- 8-entry FIFO to store sample data
- Independent configuration of all programmable settings

The basic programming model of the I²S block is as follows:

- Configuration
 - Overall I²S module configuration in the **I²S Module Configuration (I2SCFG)** register. This register is used to select the MCLK source and enable the receiver and transmitter.
 - Transmit and receive configuration in the **I²S Transmit Module Configuration (I2STXCFG)** and **I²S Receive Module Configuration (I2SRXCFG)** registers. These registers set the basic parameters for the receiver and transmitter such as data configuration (justification, delay, read mode, sample size, and system data size); SCLK (polarity and source); and word select polarity.
 - Transmit and receive FIFO configuration in the **I²S Transmit FIFO Configuration (I2STXFIFOCFG)** and **I²S Receive FIFO Configuration (I2SRXFIFOCFG)** registers. These registers select the Compact Stereo mode size (16-bit or 8-bit), provide indication of whether the next sample is Left or Right, and select mono mode for the receiver.
- FIFO
 - Transmit and receive FIFO data in the **I²S Transmit FIFO Data (I2STXFIFO)** and **I²S Receive FIFO Data (I2SRXFIFO)** registers
 - Information on FIFO data levels in the **I²S Transmit FIFO Level (I2STXLEV)** and **I²S Receive FIFO Level (I2SRXLEV)** registers
 - Configuration for FIFO service requests based on FIFO levels in the **I²S Transmit FIFO Limit (I2STXLIMIT)** and **I²S Receive FIFO Limit (I2SRXLIM)** registers
- Interrupt Control
 - Interrupt masking configuration in the **I²S Interrupt Mask (I2SIM)** register
 - Raw and masked interrupt status in the **I²S Raw Interrupt Status (I2SRIS)** and **I²S Masked Interrupt Status (I2SMIS)** registers
 - Interrupt clearing through the **I²S Interrupt Clear (I2SIC)** register
 - Configuration for FIFO service requests interrupts and transmit/receive error interrupts in the **I²S Transmit Interrupt Status and Mask (I2STXISM)** and **I²S Receive Interrupt Status and Mask (I2SRXISM)** registers

Figure 17-2 on page 851 provides an example of an I²S data transfer. Figure 17-3 on page 851 provides an example of an Left-Justified data transfer. Figure 17-4 on page 851 provides an example of an Right-Justified data transfer.

Figure 17-2. I²S Data Transfer

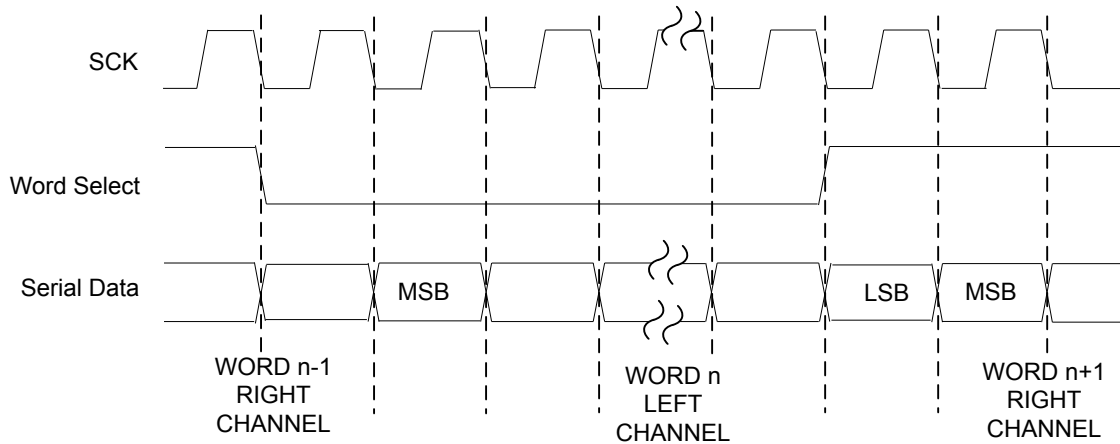


Figure 17-3. Left-Justified Data Transfer

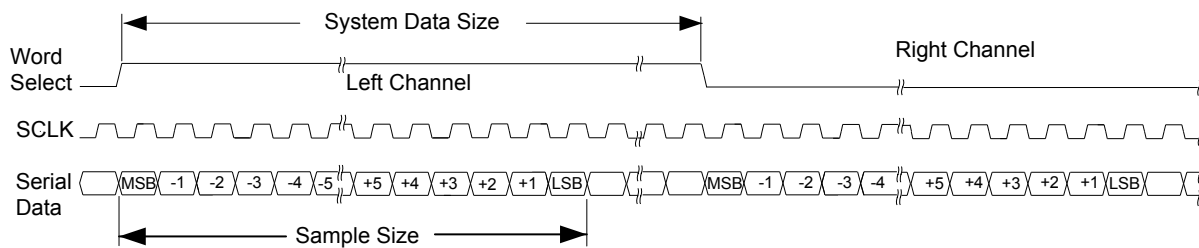
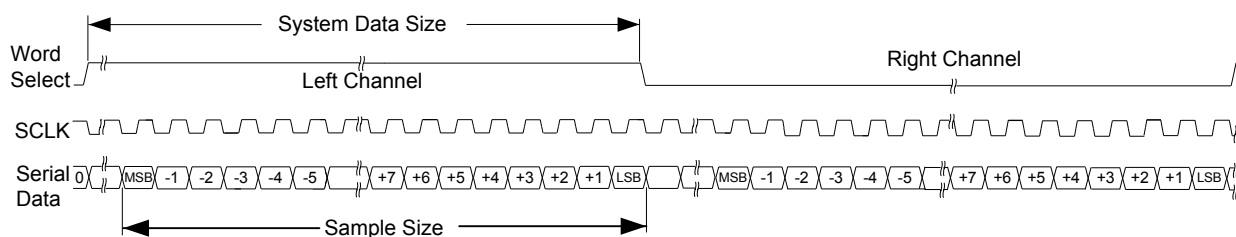


Figure 17-4. Right-Justified Data Transfer



17.3.1 Transmit

The transmitter consists of a serial encoder, an 8-entry FIFO, and control logic. The transmitter has independent MCLK (I2S0TXMCLK), SCLK (I2S0TXSCK), and Word-Select (I2S0TXWS) signals.

17.3.1.1 Serial Encoder

The serial encoder reads audio samples from the receive FIFO and converts them into an audio stream. By configuring the serial encoder, common audio formats I²S, Left-Justified, and Right-Justified are supported. The MSB is transmitted first. The sample size and system data size

are configurable with the *SSZ* and *SDSZ* bits in the **I²S Transmit Module Configuration (I2STXCFG)** register. The sample size is the number of bits of data being transmitted, and the system data size is the number of *I2S0TXSCK* transitions between the word select transitions. The system data size must be large enough to accommodate the maximum sample size. In Mono mode, the sample data is repeated in both the left and right channels. When the FIFO is empty, the user may select either transmission of zeros or of the last sample. The serial encoder is enabled using the *TXEN* bit in the **I²S Module Configuration (I2SCFG)** register.

17.3.1.2 FIFO Operation

The transmit FIFO stores eight Mono samples or eight Stereo sample-pairs of data and is accessed through the **I²S Transmit FIFO Data (I2STXFIFO)** register. The FIFO interface for the audio data is different based on the Write mode, defined by the **I²S Transmit FIFO Configuration (I2STXFIFOCFG)** Compact Stereo Sample Size bit (*CSS*) and the **I2STXCFG** Write Mode field (*WM*). All data samples are MSB-aligned. Table 17-3 on page 852 defines the interface for each Write mode. Stereo samples are written first left then right. The next sample (right or left) to be written is indicated by the *LRS* bit in the **I2STXFIFOCFG** register.

Table 17-3. I²S Transmit FIFO Interface

| <i>WM</i> field in I2STXCFG | <i>CSS</i> bit in I2STXFIFOCFG | Write Mode | Sample Width | Samples per FIFO Write | Data Alignment |
|-----------------------------|--------------------------------|-------------------------|--------------|------------------------|--------------------------------|
| 0x0 | don't care | Stereo | 8-32 bits | 1 | MSB |
| 0x1 | 0 | Compact Stereo - 16 bit | 8-16 bits | 2 | MSB Right [31:16], Left [15:0] |
| 0x1 | 1 | Compact Stereo - 8 bit | 8 bits | 2 | Right [15:8], Left[7:0] |
| 0x2 | don't care | Mono | 8-32 bits | 1 | MSB |

The number of samples in the transmit FIFO can be read using the **I²S Transmit FIFO Level (I2STXLEV)** register. The value ranges from 0 to 16. Stereo and compact stereo sample pairs are counted as two. The mono samples also increment the count by two, therefore, four mono samples will have a count of eight.

17.3.1.3 Clock Control

The transmitter MCLK and SCLK can be independently programmed to be the master or slave. The transmitter is programmed to be the master or slave of the SCLK using the *MSL* bit in the **I2STXCFG** register. When the transmitter is the master, the *I2S0TXSCK* frequency is the specified *I2S0TXMCLK* divided by four. The *I2S0TXSCK* may be inverted using the *SCP* bit in the **I2STXCFG** register.

The transmitter can also be the master or slave of the MCLK. When the transmitter is the master, the PLL must be active and a fractional clock divider must be programmed. See page 227 for the setup for the master *I2S0TXMCLK* source. An external transmit *I2S0TXMCLK* does not require the use of the PLL and is selected using the *TXSLV* bit in the **I2SCFG** register.

The following tables show combinations of the *TXINT* and *TXFRAC* bits in the **I²S MCLK Configuration (I2SMCLKCFG)** register that provide MCLK frequencies within acceptable error limits. In the table, *F_s* is the sampling frequency in kHz and possible crystal frequencies are shown in MHz across the top row of the table. The words "not supported" in the table mean that it is not possible to obtain the specified sampling frequencies with the specified crystal frequency within the error tolerance of 0.3%. The values in the table are based on the following values:

$$\text{MCLK} = F_s \times 256$$

$$\text{PLL} = 400 \text{ MHz}$$

The Integer value is taken from the result of the following calculation:

$\text{ROUND}(\text{PLL}/\text{MCLK})$

The remaining fractional component is converted to binary, and the first four bits are the Fractional value.

Table 17-4. Crystal Frequency (Values from 3.5795 MHz to 5 MHz)

| Sampling Frequency Fs (kHz) | Crystal Frequency (MHz) | | | | | | | | | | | |
|--------------------------------|-------------------------|------------|---------------|------------|---------|------------|---------|------------|---------------|------------|---------|------------|
| | 3.5795 | | 3.6864 | | 4 | | 4.096 | | 4.9152 | | 5 | |
| | Integer | Fractional | Integer | Fractional | Integer | Fractional | Integer | Fractional | Integer | Fractional | Integer | Fractional |
| 8 | 195 | 12 | 194 | 6 | 195 | 5 | 196 | 0 | 194 | 6 | 195 | 5 |
| 11.025 | 142 | 1 | 141 | 1 | 141 | 12 | 142 | 4 | 141 | 1 | 141 | 12 |
| 12 | 130 | 8 | 129 | 10 | 130 | 3 | 130 | 11 | 129 | 10 | 130 | 3 |
| 16 | 97 | 14 | 97 | 3 | 97 | 10 | 98 | 0 | 97 | 3 | 97 | 10 |
| 22.05 | 71 | 0 | 70 | 8 | 70 | 14 | 71 | 2 | 70 | 8 | 70 | 14 |
| 24 | 65 | 4 | 64 | 13 | 65 | 2 | 65 | 5 | 64 | 13 | 65 | 2 |
| 32 | 48 | 15 | 48 | 10 | 48 | 13 | 49 | 0 | 48 | 10 | 48 | 13 |
| 44.1 | 35 | 8 | 35 | 4 | 35 | 7 | 35 | 9 | 35 | 4 | 35 | 7 |
| 48 | 32 | 10 | 32 | 6 | 32 | 9 | 32 | 11 | 32 | 6 | 32 | 9 |
| 64 | 24 | 8 | 24 | 5 | 24 | 7 | 24 | 8 | 24 | 5 | 24 | 7 |
| 88.2 | 17 | 12 | 17 | 10 | 17 | 11 | 17 | 12 | 17 | 10 | 17 | 11 |
| 96 | 16 | 5 | 16 | 3 | 16 | 4 | 16 | 5 | 16 | 3 | 16 | 4 |
| 128 | 12 | 4 | 12 | 2 | 12 | 3 | 12 | 4 | 12 | 2 | 12 | 3 |
| 176.4 | 8 | 14 | 8 | 13 | 8 | 14 | 8 | 14 | 8 | 13 | 8 | 14 |
| 192 | Not supported | | Not supported | | 8 | 2 | 8 | 3 | Not supported | | 8 | 2 |

Table 17-5. Crystal Frequency (Values from 5.12 MHz to 8.192 MHz)

| Sampling Frequency Fs (kHz) | Crystal Frequency (MHz) | | | | | | | | | | | |
|--------------------------------|-------------------------|------------|---------|------------|---------------|------------|---------------|------------|---------|------------|---------|------------|
| | 5.12 | | 6 | | 6.144 | | 7.3728 | | 8 | | 8.192 | |
| | Integer | Fractional | Integer | Fractional | Integer | Fractional | Integer | Fractional | Integer | Fractional | Integer | Fractional |
| 8 | 195 | 0 | 195 | 5 | 195 | 0 | 194 | 6 | 195 | 5 | 194 | 11 |
| 11.025 | 141 | 8 | 141 | 12 | 141 | 8 | 141 | 1 | 141 | 12 | 141 | 4 |
| 12 | 130 | 0 | 130 | 3 | 130 | 0 | 129 | 10 | 130 | 3 | 129 | 12 |
| 16 | 97 | 8 | 97 | 10 | 97 | 8 | 97 | 3 | 97 | 10 | 97 | 5 |
| 22.05 | 70 | 12 | 70 | 14 | 70 | 12 | 70 | 8 | 70 | 14 | 70 | 10 |
| 24 | 65 | 0 | 65 | 2 | 65 | 0 | 64 | 13 | 65 | 2 | 64 | 14 |
| 32 | 48 | 12 | 48 | 13 | 48 | 12 | 48 | 10 | 48 | 13 | 48 | 11 |
| 44.1 | 35 | 6 | 35 | 7 | 35 | 6 | 35 | 4 | 35 | 7 | 35 | 5 |
| 48 | 32 | 8 | 32 | 9 | 32 | 8 | 32 | 6 | 32 | 9 | 32 | 7 |
| 64 | 24 | 6 | 24 | 7 | 24 | 6 | 24 | 5 | 24 | 7 | 24 | 5 |
| 88.2 | 17 | 11 | 17 | 11 | 17 | 11 | 17 | 10 | 17 | 11 | 17 | 11 |
| 96 | 16 | 4 | 16 | 4 | 16 | 4 | 16 | 3 | 16 | 4 | 16 | 4 |
| 128 | 12 | 3 | 12 | 3 | 12 | 3 | 12 | 2 | 12 | 3 | 12 | 3 |
| 176.4 | Not supported | | 8 | 14 | Not supported | | 8 | 13 | 8 | 14 | 8 | 13 |
| 192 | 8 | 2 | 8 | 2 | 8 | 2 | Not supported | | 8 | 2 | 8 | 2 |

Table 17-6. Crystal Frequency (Values from 10 MHz to 14.3181 MHz)

| Sampling Frequency Fs (kHz) | Crystal Frequency (MHz) | | | | | | | | | |
|-----------------------------|-------------------------|------------|---------|------------|---------|------------|---------------|------------|---------------|------------|
| | 10 | | 12 | | 12.288 | | 13.56 | | 14.3181 | |
| | Integer | Fractional | Integer | Fractional | Integer | Fractional | Integer | Fractional | Integer | Fractional |
| 8 | 195 | 5 | 195 | 5 | 196 | 0 | 194 | 3 | 195 | 12 |
| 11.025 | 141 | 12 | 141 | 12 | 142 | 4 | 140 | 15 | 142 | 1 |
| 12 | 130 | 3 | 130 | 3 | 130 | 11 | 129 | 8 | 130 | 8 |
| 16 | 97 | 10 | 97 | 10 | 98 | 0 | 97 | 2 | 97 | 14 |
| 22.05 | 70 | 14 | 70 | 14 | 71 | 2 | 70f | 7 | 71 | 0 |
| 24 | 65 | 2 | 65 | 2 | 65 | 5 | 64 | 12 | 65 | 4 |
| 32 | 48 | 13 | 48 | 13 | 49 | 0 | 48 | 9 | 48 | 15 |
| 44.1 | 35 | 7 | 35 | 7 | 35 | 9 | 35 | 4 | 35 | 8 |
| 48 | 32 | 9 | 32 | 9 | 32 | 11 | 32 | 6 | 32 | 10 |
| 64 | 24 | 7 | 24 | 7 | 24 | 8 | 24 | 4 | 24 | 8 |
| 88.2 | 17 | 11 | 17 | 11 | 17 | 12 | 17 | 10 | 17 | 12 |
| 96 | 16 | 4 | 16 | 4 | 16 | 5 | 16 | 3 | 16 | 5 |
| 128 | 12 | 3 | 12 | 3 | 12 | 4 | 12 | 2 | 12 | 4 |
| 176.4 | 8 | 14 | 8 | 14 | 8 | 14 | 8 | 13 | 8 | 14 |
| 192 | 8 | 2 | 8 | 2 | 8 | 3 | Not supported | | Not supported | |

Table 17-7. Crystal Frequency (Values from 16 MHz to 16.384 MHz)

| Sampling Frequency Fs (kHz) | Crystal Frequency (MHz) | | | |
|-----------------------------|-------------------------|------------|---------|------------|
| | 16 | | 16.384 | |
| | Integer | Fractional | Integer | Fractional |
| 8 | 195 | 5 | 192 | 0 |
| 11.025 | 141 | 12 | 139 | 5 |
| 12 | 130 | 3 | 128 | 0 |
| 16 | 97 | 10 | 96 | 0 |
| 22.05 | 70 | 14 | 69 | 11 |
| 24 | 65 | 2 | 64 | 0 |
| 32 | 48 | 13 | 48 | 0 |
| 44.1 | 35 | 7 | 34 | 13 |
| 48 | 32 | 9 | 32 | 0 |
| 64 | 24 | 7 | 24 | 0 |
| 88.2 | 17 | 11 | 17 | 7 |
| 96 | 16 | 4 | 16 | 0 |
| 128 | 12 | 3 | 12 | 0 |
| 176.4 | 8 | 14 | 8 | 11 |
| 192 | 8 | 2 | 8 | 0 |

17.3.1.4 Interrupt Control

A single interrupt is asserted to the CPU whenever any of the transmit or receive sources is asserted. The transmit module has two interrupt sources: the FIFO service request and write error. The interrupts may be masked using the TXSRIM and TXWEIM bits in the I²S Interrupt Mask (I2SIM)

register. The status of the interrupt source is indicated by the **I²S Raw Interrupt Status (I2SRIS)** register. The status of enabled interrupts is indicated by the **I²S Masked Interrupt Status (I2SMIS)** register. The FIFO level interrupt has a second level of masking using the **FFM** bit in the **I²S Transmit Interrupt Status and Mask (I2STXISM)** register.

The FIFO service request interrupt is asserted when the FIFO level (indicated by the **LEVEL** field in the **I²S Transmit FIFO Level (I2STXLEV)** register) is below the FIFO limit (programmed using the **I²S Transmit FIFO Limit (I2STXLIMIT)** register) and both the **TXSRIM** and **FFM** bits are set. If software attempts to write to a full FIFO, a Transmit FIFO Write error occurs (indicated by the **TXWERIS** bit in the **I²S Raw Interrupt Status (I2SRIS)** register). The **TXWERIS** bit in the **I2SRIS** register and the **TXWEMIS** bit in the **I2SMIS** register are cleared by setting the **TXWEIC** bit in the **I²S Interrupt Clear (I2SIC)** register.

17.3.1.5 DMA Support

The μ DMA can be used to more efficiently stream data to and from the I²S bus. The I²S transmit and receive modules have separate μ DMA channels. The FIFO Interrupt Mask bit (**FFM**) in the **I2STXISM** register must be set for the request signaling to propagate to the μ DMA module. See “Micro Direct Memory Access (μ DMA)” on page 359 for channel configuration.

The I²S module uses the μ DMA burst request signal, not the single request. Thus each time a μ DMA request is made, the μ DMA controller transfers the number of items specified as the burst size for the μ DMA channel. Therefore, the μ DMA channel burst size and the I²S FIFO service request limit must be set to the same value (using the **LIMIT** field in the **I2STXLIMIT** register).

17.3.2 Receive

The receiver consists of a serial decoder, an 8-entry FIFO, and control logic. The receiver has independent **MCLK (I2S0RXMCLK)**, **SCLK (I2S0RXSCK)**, and **Word-Select (I2S0RXWS)** signals.

17.3.2.1 Serial Decoder

The serial decoder accepts incoming audio stream data and places the sample data in the receive FIFO. By configuring the serial decoder, common audio formats I²S, Left-Justified, and Right-Justified are supported. The MSB is transmitted first. The sample size and system data size are configurable with the **SSZ** and **SDSZ** bits in the **I²S Receive Module Configuration (I2SRXCFG)** register. The sample size is the number of bits of data being received, and the system data size is the number of **I2S0RXSCK** transitions between the word select transitions. The system data size must be large enough to accommodate the maximum sample size. Any bits received after the LSB are 0s. If the FIFO is full, the incoming sample (in Mono) or sample-pairs (Stereo) are dropped until the FIFO has space. The serial decoder is enabled using the **RXEN** bit in the **I2SCFG** register.

17.3.2.2 FIFO Operation

The receive FIFO stores eight Mono samples or eight Stereo sample-pairs of data and is accessed through the **I²S Receive FIFO Data (I2SRXFIFO)** register. Table 17-8 on page 856 defines the interface for each Read mode. All data is stored MSB-aligned. The Stereo data is read left sample then right.

In Mono mode, the FIFO interface can be configured to read the right or left channel by setting the FIFO Mono Mode bit (**FMM**) in the **I²S Receive FIFO Configuration (I2SRXFIFOCFG)** register. This enables reads from a single channel, where the channel selected can be either the right or left as determined by the **LRP** bit in the **I2SRXCFG** register.

Table 17-8. I²S Receive FIFO Interface

| RM bit in I2RXCFG | CSS bit in I2SRXFIFOCFG | Read Mode | Sample Width | Samples per FIFO Read | Data Alignment |
|-------------------|-------------------------|--|--------------|-----------------------|--------------------------------|
| 0 | don't care | Stereo | 8-32 bits | 1 | MSB |
| 1 | 0 | Compact Stereo - 16 bit | 8-16 bits | 2 | MSB Right [31:15], Left [15:0] |
| 1 | 1 | Compact Stereo - 8 bit | 8 bits | 2 | Right [15:8] Left[7:0] |
| 0 | don't care | Mono (FMM bit in the I2SRXFIFOCFG register must be set.) | 8-32 bits | 1 | MSB |

The number of samples in the receive FIFO can be read using the **I²S Receive FIFO Level (I2SRXLEV)** register. The value ranges from 0 to 16. Stereo and compact stereo sample pairs are counted as two. The mono samples also increment the count by two, therefore four Mono samples will have a count of eight.

17.3.2.3 Clock Control

The receiver MCLK and SCLK can be independently programmed to be the master or slave. The receiver is programmed to be the master or slave of the SCLK using the **MSL** bit in the **I2SRXCFG** register. When the receiver is the master, the **I2S0RXSCK** frequency is the specified **I2S0RXMCLK** divided by four. The **I2S0RXSCK** may be inverted using the **SCP** bit in the **I2SRXCFG** register.

The receiver can also be the master or slave of the MCLK. When the receiver is the master, the PLL must be active and a fractional clock divider must be programmed. See page 227 for the setup for the master **I2S0RXMCLK** source. An external transmit **I2S0RXMCLK** does not require the use of the PLL and is selected using the **RXSLV** bit in the **I2SCFG** register.

Refer to "Clock Control" on page 852 for combinations of the **RXINT** and **RXFRAC** bits in the **I²S MCLK Configuration (I2SMCLKCFG)** register that provide MCLK frequencies within acceptable error limits. In the table, F_s is the sampling frequency in kHz and possible crystal frequencies are shown in MHz across the top row of the table. The words "not supported" in the table mean that it is not possible to obtain the specified sampling frequencies with the specified crystal frequency within the error tolerance of 0.3%.

17.3.2.4 Interrupt Control

A single interrupt is asserted to the CPU whenever any of the transmit or receive sources is asserted. The receive module has two interrupt sources: the FIFO service request and read error. The interrupts may be masked using the **RXSRIM** and **RXREIM** bits in the **I2SIM** register. The status of the interrupt source is indicated by the **I2SRIS** register. The status of enabled interrupts is indicated by the **I2SMIS** register. The FIFO service request interrupt has a second level of masking using the **FMM** bit in the **I²S Receive Interrupt Status and Mask (I2SRXISM)** register. The sources may be masked using the **I2SIM** register.

The FIFO service request interrupt is asserted when the FIFO level (indicated by the **LEVEL** field in the **I²S Receive FIFO Level (I2SRXLEV)** register) is above the FIFO limit (programmed using the **I²S Receive FIFO Limit (I2SRXLIMIT)** register) and both the **RXSRIM** and **FMM** bits are set. An error occurs when reading an empty FIFO or if a stereo sample pair is not read left then right. To clear an interrupt, write a 1 to the appropriate bit in the **I2SIC** register. If software attempts to read an empty FIFO or if a stereo sample pair is not read left then right, a Receive FIFO Read error occurs (indicated by the **RXRERIS** bit in the **I2SRIS** register). The **RXRERIS** bit in the **I2SRIS** register and the **RXREMIS** bit in the **I2SMIS** register are cleared by setting the **RXREIC** bit in the **I2SIC** register.

17.3.2.5 DMA Support

The μ DMA can be used to more efficiently stream data to and from the I²S bus. The I²S transmit and receive modules have separate μ DMA channels. The FIFO Interrupt Mask bit (FFM) in the **I2SRXISM** register must be set for the request signaling to propagate to the μ DMA module. See “Micro Direct Memory Access (μ DMA)” on page 359 for channel configuration.

The I²S module uses the μ DMA burst request signal, not the single request. Thus each time a μ DMA request is made, the μ DMA controller transfers the number of items specified as the burst size for the μ DMA channel. Therefore, the μ DMA channel burst size and the I²S FIFO service request limit must be set to the same value (using the LIMIT field in the **I2SRXLIMIT** register).

17.4 Initialization and Configuration

The default setup for the I²S transmit and receive is to use external MCLK, external SCLK, Stereo, I²S audio format, and 32-bit data samples. The following example shows how to configure a system using the internal MCLK, internal SCLK, Compact Stereo, and Left-Justified audio format with 16-bit data samples.

1. Enable the I²S peripheral clock by writing a value of 0x1000.0000 to the **RCGC1** register in the System Control module (see page 262).
2. Enable the clock to the appropriate GPIO module via the **RCGC2** register in the System Control module (see page 274). To find out which GPIO port to enable, refer to Table 23-5 on page 1083.
3. In the GPIO module, enable the appropriate pins for their alternate function using the **GPIOAFSEL** register (see page 443). To determine which GPIOs to configure, see Table 23-4 on page 1075.
4. Configure the PMCN fields in the **GPIOCTL** register to assign the I²S signals to the appropriate pins (see page 461 and Table 23-5 on page 1083).
5. Set up the MCLK sources for a 48-kHz sample rate. The input crystal is assumed to be 6 MHz for this example (internal source).
 - Enable the PLL by clearing the PWRDWN bit in the **RCC** register in the System Control module (see page 211).
 - Set the MCLK dividers and enable them by writing 0x0208.0208 to the **I2SMCLKCFG** register in the System Control module (see page 227).
 - Enable the MCLK internal sources by writing 0x8208.8208 to the **I2SMCLKCFG** register in the System Control module.

To allow an external MCLK to be used, set bits 4 and 5 of the **I2SCFG** register. Starting up the PLL and enabling the MCLK sources is not required.
6. Set up the Serial Bit Clock SCLK source. By default, the SCLK is externally sourced.
 - Receiver: Masters the I2S0RXSCK by ORing 0x0040.0000 into the **I2SRXCFG** register.
 - Transmitter: Masters the I2S0TXSCK by ORing 0x0040.0000 into the **I2STXCFG** register.
7. Configure the Serial Encoder/Decoder (Left-Justified, Compact Stereo, 16-bit samples, 32-bit system data size).

- Set the audio format using the Justification (JST), Data Delay (DLY), SCLK polarity (SCP), and Left-Right Polarity (LRP) bits written to the **I2STXCFG** and **I2SRXCFG** registers. The settings are shown in the table below.

Table 17-9. Audio Formats Configuration

| Audio Format | I2STXCFG/I2SRXCFG Register Bit | | | |
|------------------|--------------------------------|-----|-----|-----|
| | JST | DLY | SCP | LRP |
| I ² S | 0 | 1 | 0 | 1 |
| Left-Justified | 0 | 0 | 0 | 0 |
| Right-Justified | 1 | 0 | 0 | 0 |

- Write 0x0140.3DF0 to both the **I2STXCFG** and **I2SRXCFG** registers to program the following configurations:
 - Set the sample size to 16 bits using the *SSZ* field of the **I2STXCFG** and **I2SRXCFG** registers.
 - Set the system data size to 32 bits using the *SDSZ* field of the **I2STXCFG** and **I2SRXCFG** registers.
 - Set the Write and Read modes using the *WM* and *RM* fields in the **I2STXCFG** and **I2SRXCFG** registers, respectively.
8. Set up the FIFO limits for triggering interrupts (also used for μ DMA)
 - Set up the transmit FIFO to trigger when it has less than four sample pairs by writing a 0x0000.0008 to the **I2STXLIMIT** register.
 - Set up the receive FIFO to trigger when there are more than four sample pairs by writing a 0x0000.00008 to the **I2SRXLIMIT** register.
 9. Enable interrupts.
 - Enable the transmit FIFO interrupt by setting the *FFM* bit in the **I2STXISM** register (write 0x0000.0001).
 - Set up the receive FIFO interrupts by setting the *FFM* bit in the **I2SRXISM** register (write 0x0000.0001).
 - Enable the TX FIFO service request, the TX Error, the RX FIFO service request, and the RX Error interrupts to be sent to the CPU by writing a 0x0000.0033 to the **I2SSIM** register.
 10. Enable the Serial Encoder and Serial Decoders by writing a 0x0000.0003 to the **I2SCFG** register.

17.5 Register Map

Table 17-10 on page 859 lists the I²S registers. The offset listed is a hexadecimal increment to the register's address, relative to the I²S interface base address of 0x4005.4000. Note that the I²S module clock must be enabled before the registers can be programmed (see page 262). There must be a delay of 3 system clocks after the I²S module clock is enabled before any I²S module registers are accessed.

Table 17-10. Inter-Integrated Circuit Sound (I²S) Interface Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|--------------|------|-------------|--|----------|
| 0x000 | I2STXFIFO | WO | 0x0000.0000 | I2S Transmit FIFO Data | 860 |
| 0x004 | I2STXFIFOCFG | R/W | 0x0000.0000 | I2S Transmit FIFO Configuration | 861 |
| 0x008 | I2STXCFCG | R/W | 0x1400.7DF0 | I2S Transmit Module Configuration | 862 |
| 0x00C | I2STXLIMIT | R/W | 0x0000.0000 | I2S Transmit FIFO Limit | 864 |
| 0x010 | I2STXISM | R/W | 0x0000.0000 | I2S Transmit Interrupt Status and Mask | 865 |
| 0x018 | I2STXLEV | RO | 0x0000.0000 | I2S Transmit FIFO Level | 866 |
| 0x800 | I2SRXFIFO | RO | 0x0000.0000 | I2S Receive FIFO Data | 867 |
| 0x804 | I2SRXFIFOCFG | R/W | 0x0000.0000 | I2S Receive FIFO Configuration | 868 |
| 0x808 | I2SRXCFCG | R/W | 0x1400.7DF0 | I2S Receive Module Configuration | 869 |
| 0x80C | I2SRXLIMIT | R/W | 0x0000.7FFF | I2S Receive FIFO Limit | 872 |
| 0x810 | I2SRXISM | R/W | 0x0000.0000 | I2S Receive Interrupt Status and Mask | 873 |
| 0x818 | I2SRXLEV | RO | 0x0000.0000 | I2S Receive FIFO Level | 874 |
| 0xC00 | I2SCFCG | R/W | 0x0000.0000 | I2S Module Configuration | 875 |
| 0xC10 | I2SIM | R/W | 0x0000.0000 | I2S Interrupt Mask | 877 |
| 0xC14 | I2SRIS | RO | 0x0000.0000 | I2S Raw Interrupt Status | 879 |
| 0xC18 | I2SMIS | RO | 0x0000.0000 | I2S Masked Interrupt Status | 881 |
| 0xC1C | I2SIC | WO | 0x0000.0000 | I2S Interrupt Clear | 883 |

17.6 Register Descriptions

The remainder of this section lists and describes the I²S registers, in numerical order by address offset.

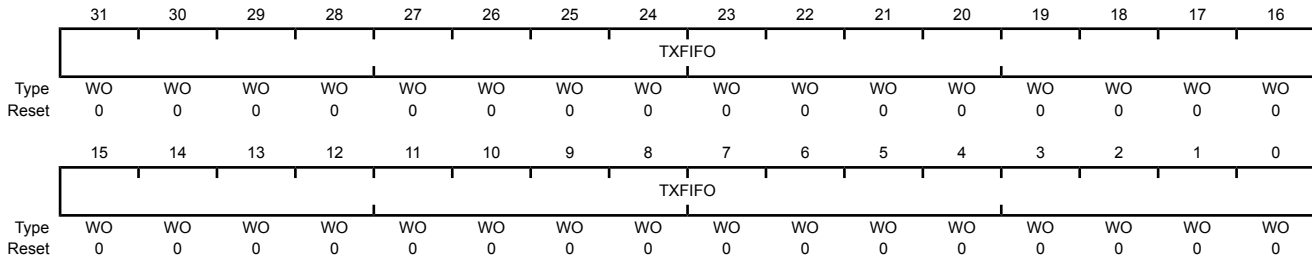
Register 1: I²S Transmit FIFO Data (I2STXFIFO), offset 0x000

This register is the 32-bit serial audio transmit data register. In Stereo mode, the data is written left, right, left, right, and so on. The `LRS` bit in the **I²S Transmit FIFO Configuration (I2STXFIFOCFG)** register can be read to verify the next position expected. In Compact 16-bit mode, bits [31:16] contain the right sample, and bits [15:0] contain the left sample. In Compact 8-bit mode, bits [15:8] contain the right sample, and bits [7:0] contain the left sample. In Mono mode, each 32-bit entry is a single sample.

Note that if the FIFO is full and a write is attempted, a transmit FIFO write error is generated.

I2S Transmit FIFO Data (I2STXFIFO)

Base 0x4005.4000
 Offset 0x000
 Type WO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------------|--|
| 31:0 | TXFIFO | WO | 0x0000.0000 | TX Data Serial audio sample data to be transmitted. |

Register 2: I²S Transmit FIFO Configuration (I2STXFIFOCFG), offset 0x004

This register configures the sample for dual-channel operation. In Stereo mode, the LRS bit toggles between left and right samples as the Transmit FIFO is written. The left sample is written first, followed by the right.

I2S Transmit FIFO Configuration (I2STXFIFOCFG)

Base 0x4005.4000

Offset 0x004

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | CSS | LRS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|--|
| 31:2 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | CSS | R/W | 0 | Compact Stereo Sample Size Value Description 0 The transmitter is in Compact 16-bit Stereo Mode with a 16-bit sample size. 1 The transmitter is in Compact 8-bit Stereo Mode with an 8-bit sample size. |
| 0 | LRS | R/W | 0 | Left-Right Sample Indicator Value Description 0 The left sample is the next position. 1 The right sample is the next position. In Mono mode and Compact stereo mode, this bit toggles as if it were in Stereo mode, but it has no meaning and should be ignored. |

Register 3: I²S Transmit Module Configuration (I2STXCFG), offset 0x008

This register controls the configuration of the Transmit module.

I2S Transmit Module Configuration (I2STXCFG)

Base 0x4005.4000
 Offset 0x008
 Type R/W, reset 0x1400.7DF0

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|------|-----|-----|-----|-----|-----|----------|-----|-----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | JST | DLY | SCP | LRP | WM | | FMT | MSL | reserved | | | | | |
| Type | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SSZ | | | | SDSZ | | | | | | reserved | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | RO |
| Reset | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:30 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 29 | JST | R/W | 0 | Justification of Output Data Value Description 0 The data is Left-Justified. 1 The data is Right-Justified. |
| 28 | DLY | R/W | 1 | Data Delay Value Description 0 Data is latched on the next latching edge of I2S0TXSCK as defined by the SCP bit. This bit should be clear in Left-Justified or Right-Justified mode. 1 A one-I2S0TXSCK delay from the edge of I2S0TXWS is inserted before data is latched. This bit should be set in I ² S mode. |
| 27 | SCP | R/W | 0 | SCLK Polarity Value Description 0 Data and the I2S0TXWS signal (when the MSL bit is set) are launched on the falling edge of I2S0TXSCK. 1 Data and the I2S0TXWS signal (when the MSL bit is set) are launched on the rising edge of I2S0TXSCK. |
| 26 | LRP | R/W | 1 | Left/Right Clock Polarity Value Description 0 I2S0TXWS is high during the transmission of the left channel data. 1 I2S0TXWS is high during the transmission of the right channel data. |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | |
|-----------|--|------|-------|---|-------|-------------|-----|--|-----|--|--|--|-----|-----------|-----|----------|
| 25:24 | WM | R/W | 0x0 | <p>Write Mode</p> <p>This bit field selects the mode in which the transmit data is stored in the FIFO and transmitted.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Stereo mode</td> </tr> <tr> <td>0x1</td> <td>Compact Stereo mode</td> </tr> <tr> <td></td> <td>Left/Right sample packed. Refer to I2STXFIFOCFG for 8/16-bit sample size selection.</td> </tr> <tr> <td>0x2</td> <td>Mono mode</td> </tr> <tr> <td>0x3</td> <td>reserved</td> </tr> </tbody> </table> | Value | Description | 0x0 | Stereo mode | 0x1 | Compact Stereo mode | | Left/Right sample packed. Refer to I2STXFIFOCFG for 8/16-bit sample size selection. | 0x2 | Mono mode | 0x3 | reserved |
| Value | Description | | | | | | | | | | | | | | | |
| 0x0 | Stereo mode | | | | | | | | | | | | | | | |
| 0x1 | Compact Stereo mode | | | | | | | | | | | | | | | |
| | Left/Right sample packed. Refer to I2STXFIFOCFG for 8/16-bit sample size selection. | | | | | | | | | | | | | | | |
| 0x2 | Mono mode | | | | | | | | | | | | | | | |
| 0x3 | reserved | | | | | | | | | | | | | | | |
| 23 | FMT | R/W | 0 | <p>FIFO Empty</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>All zeroes are transmitted if the FIFO is empty.</td> </tr> <tr> <td>1</td> <td>The last sample is transmitted if the FIFO is empty.</td> </tr> </tbody> </table> | Value | Description | 0 | All zeroes are transmitted if the FIFO is empty. | 1 | The last sample is transmitted if the FIFO is empty. | | | | | | |
| Value | Description | | | | | | | | | | | | | | | |
| 0 | All zeroes are transmitted if the FIFO is empty. | | | | | | | | | | | | | | | |
| 1 | The last sample is transmitted if the FIFO is empty. | | | | | | | | | | | | | | | |
| 22 | MSL | R/W | 0 | <p>SCLK Master/Slave</p> <p>Source of serial bit clock (I2S0TXSCK) and Word Select (I2S0TXWS).</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>The transmitter is a slave using the externally driven I2S0TXSCK and I2S0TXWS signals.</td> </tr> <tr> <td>1</td> <td>The transmitter is a master using the internally generated I2S0TXSCK and I2S0TXWS signals.</td> </tr> </tbody> </table> | Value | Description | 0 | The transmitter is a slave using the externally driven I2S0TXSCK and I2S0TXWS signals. | 1 | The transmitter is a master using the internally generated I2S0TXSCK and I2S0TXWS signals. | | | | | | |
| Value | Description | | | | | | | | | | | | | | | |
| 0 | The transmitter is a slave using the externally driven I2S0TXSCK and I2S0TXWS signals. | | | | | | | | | | | | | | | |
| 1 | The transmitter is a master using the internally generated I2S0TXSCK and I2S0TXWS signals. | | | | | | | | | | | | | | | |
| 21:16 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | |
| 15:10 | SSZ | R/W | 0x1F | <p>Sample Size</p> <p>This field contains the number of bits minus one in the sample.</p> <p>Note: This field is only used in Right-Justified mode. Unused bits are not masked.</p> | | | | | | | | | | | | |
| 9:4 | SDSZ | R/W | 0x1F | <p>System Data Size</p> <p>This field contains the number of bits minus one during the high or low phase of the I2S0TXWS signal.</p> | | | | | | | | | | | | |
| 3:0 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | |

Register 4: I²S Transmit FIFO Limit (I2STXLIMIT), offset 0x00C

This register sets the lower FIFO limit at which a FIFO service request is issued.

I2S Transmit FIFO Limit (I2STXLIMIT)

Base 0x4005.4000
 Offset 0x00C
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|-----|-------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | LIMIT | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|--|
| 31:5 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4:0 | LIMIT | R/W | 0x00 | <p>FIFO Limit</p> <p>This field sets the FIFO level at which a FIFO service request is issued, generating an interrupt or a μDMA transfer request.</p> <p>The transmit FIFO generates a service request when the number of items in the FIFO is less than the level specified by the <code>LIMIT</code> field. For example, if the <code>LIMIT</code> field is set to 8, then a service request is generated when there are less than 8 samples remaining in the transmit FIFO.</p> |

Register 5: I²S Transmit Interrupt Status and Mask (I2STXISM), offset 0x010

This register indicates the transmit interrupt status and interrupt masking control.

I2S Transmit Interrupt Status and Mask (I2STXISM)

Base 0x4005.4000

Offset 0x010

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | FFI |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | FFM |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:17 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 16 | FFI | RO | 0 | Transmit FIFO Service Request Interrupt Value Description 0 The FIFO level is equal to or above the FIFO limit. 1 The FIFO level is below the FIFO limit. |
| 15:1 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | FFM | R/W | 0 | FIFO Interrupt Mask Value Description 0 The FIFO interrupt is masked and not sent to the CPU. 1 The FIFO interrupt is enabled to be sent to the interrupt controller. |

Register 6: I²S Transmit FIFO Level (I2STXLEV), offset 0x018

The number of samples in the transmit FIFO can be read using the **I2STXLEV** register. The value ranges from 0 to 16. Stereo and Compact Stereo sample-pairs are counted as two. Mono samples also increment the count by two. For example, the **LEVEL** field is set to eight if there are four Mono samples.

I2S Transmit FIFO Level (I2STXLEV)

Base 0x4005.4000
 Offset 0x018
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-------|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | LEVEL | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:5 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4:0 | LEVEL | RO | 0x00 | Number of Audio Samples This field contains the number of samples in the FIFO. |

Register 7: I²S Receive FIFO Data (I2SRXFIFO), offset 0x800

Important: This register is read-sensitive. See the register description for details.

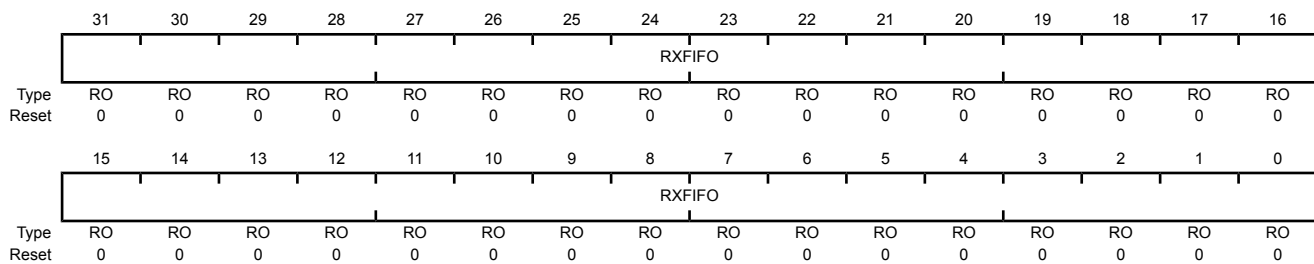
This register is the 32-bit serial audio receive data register. In Stereo mode, the data is read left, right, left, right, and so on. The LRS bit in the **I²S Receive FIFO Configuration (I2SRXFIFOCFG)** register can be read to verify the next position expected. In Compact 16-bit mode, bits [31:16] contain the right sample, and bits [15:0] contain the left sample. In Compact 8-bit mode, bits [15:8] contain the right sample, and bits [7:0] contain the left sample. In Mono mode, each 32-bit entry is a single sample. If the FIFO is empty, a read of this register returns a value of 0x0000.0000 and generates a receive FIFO read error.

I2S Receive FIFO Data (I2SRXFIFO)

Base 0x4005.4000

Offset 0x800

Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------------|--|
| 31:0 | RXFIFO | RO | 0x0000.0000 | RX Data Serial audio sample data received. The read of an empty FIFO returns a value of 0x0. |

Register 8: I²S Receive FIFO Configuration (I2SRXFIFOCFG), offset 0x804

This register configures the sample for dual-channel operation. In Stereo mode, the LRS bit toggles between Left and Right as the samples are read from the receive FIFO. In Mono mode, both the left and right samples are stored in the FIFO. The FMM bit can be used to read only the left or right sample as determined by the LRP bit. In Compact Stereo 8- or 16-bit mode, both the left and right samples are read in one access from the FIFO.

I2S Receive FIFO Configuration (I2SRXFIFOCFG)

Base 0x4005.4000
 Offset 0x804
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | FMM | CSS | LRS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:3 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | FMM | R/W | 0 | FIFO Mono Mode Value Description 0 The receiver is in Stereo Mode. 1 The receiver is in Mono mode. If the LRP bit in the I2SRXCFG register is clear, data is read while the I2S0RXWS signal is low (Right Channel); if the LRP bit is set, data is read while the I2S0RXWS signal is high (Left Channel). |
| 1 | CSS | R/W | 0 | Compact Stereo Sample Size Value Description 0 The receiver is in Compact 16-bit Stereo Mode with a 16-bit sample size. 1 The receiver is in Compact 8-bit Stereo Mode with a 8-bit sample size. |
| 0 | LRS | R/W | 0 | Left-Right Sample Indicator Value Description 0 The left sample is the next position to be read. 1 The right sample is the next position to be read. This bit is only meaningful in Compact Stereo Mode. |

Register 9: I²S Receive Module Configuration (I2SRXCFG), offset 0x808

This register controls the configuration of the receive module.

I2S Receive Module Configuration (I2SRXCFG)

Base 0x4005.4000

Offset 0x808

Type R/W, reset 0x1400.7DF0

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|------|-----|----------|-----|----------|-----|----------|-----|-----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | JST | DLY | SCP | LRP | reserved | RM | reserved | MSL | reserved | | | | | |
| Type | RO | RO | R/W | R/W | R/W | R/W | RO | R/W | RO | R/W | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SSZ | | | | SDSZ | | | | | | reserved | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | RO |
| Reset | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:30 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 29 | JST | R/W | 0 | Justification of Input Data Value Description 0 The data is Left-Justified. 1 The data is Right-Justified. |
| 28 | DLY | R/W | 1 | Data Delay Value Description 0 Data is latched on the next latching edge of I2S0RXSCK as defined by the SCP bit. This bit should be clear in Left-Justified or Right-Justified mode. 1 A one-I2S0RXSCK delay from the edge of I2S0RXWS is inserted before data is latched. This bit should be set in I ² S mode. |
| 27 | SCP | R/W | 0 | SCLK Polarity Value Description 0 Data is latched on the rising edge and the I2S0RXWS signal (when the MSL bit is set) is launched on the falling edge of I2S0RXSCK. 1 Data is latched on the falling edge and the I2S0RXWS signal (when the MSL bit is set) is launched on the rising edge of I2S0RXSCK. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 26 | LRP | R/W | 1 | <p>Left/Right Clock Polarity</p> <p>Value Description</p> <p>0 In Stereo mode, I2S0RXWS is high during the transmission of the left channel data. In Mono mode, data is read while the I2S0RXWS signal is low (Right Channel).</p> <p>1 In Stereo mode, I2S0RXWS is high during the transmission of the right channel data. In Mono mode, data is read while the I2S0RXWS signal is high (Left Channel).</p> |
| 25 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 24 | RM | R/W | 0 | <p>Read Mode</p> <p>This bit selects the mode in which the receive data is received and stored in the FIFO.</p> <p>Value Description</p> <p>0 Stereo/Mono mode I2SRXFIFOCFG FMM bit specifies Stereo or Mono FIFO read behavior.</p> <p>1 Compact Stereo mode Left/Right sample packed. Refer to I2SRXFIFOCFG for 8/16-bit sample size selection.</p> |
| 23 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 22 | MSL | R/W | 0 | <p>SCLK Master/Slave</p> <p>Value Description</p> <p>0 The receiver is a slave and uses the externally driven I2S0RXSCK and I2S0RXWS signals.</p> <p>1 The receiver is a master and uses the internally generated I2S0RXSCK and I2S0RXWS signals.</p> |
| 21:16 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:10 | SSZ | R/W | 0x1F | <p>Sample Size</p> <p>This field contains the number of bits minus one in the sample.</p> |
| 9:4 | SDSZ | R/W | 0x1F | <p>System Data Size</p> <p>This field contains the number of bits minus one during the high or low phase of the I2S0RXWS signal.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 3:0 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 10: I²S Receive FIFO Limit (I2SRXLIMIT), offset 0x80C

This register sets the upper FIFO limit at which a FIFO service request is issued.

I2S Receive FIFO Limit (I2SRXLIMIT)

Base 0x4005.4000
 Offset 0x80C
 Type R/W, reset 0x0000.7FFF

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|-----|-------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | LIMIT | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|--|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:5 | reserved | RO | 0x7FF | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4:0 | LIMIT | R/W | 0x1F | <p>FIFO Limit</p> <p>This field sets the FIFO level at which a FIFO service request is issued, generating an interrupt or a μDMA transfer request.</p> <p>The receive FIFO generates a service request when the number of items in the FIFO is greater than the level specified by the LIMIT field. For example, if the LIMIT field is set to 4, then a service request is generated when there are more than 4 samples remaining in the transmit FIFO.</p> |

Register 11: I²S Receive Interrupt Status and Mask (I2SRXISM), offset 0x810

This register indicates the receive interrupt status and interrupt masking control.

I2S Receive Interrupt Status and Mask (I2SRXISM)

Base 0x4005.4000

Offset 0x810

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | FFI |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | FFM |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:17 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 16 | FFI | RO | 0 | Receive FIFO Service Request Interrupt Value Description 0 The FIFO level is equal to or below the FIFO limit. 1 The FIFO level is above the FIFO limit. |
| 15:1 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | FFM | R/W | 0 | FIFO Interrupt Mask Value Description 0 The FIFO interrupt is masked and not sent to the CPU. 1 The FIFO interrupt is enabled to be sent to the interrupt controller. |

Register 12: I²S Receive FIFO Level (I2SRXLEV), offset 0x818

The number of samples in the receive FIFO can be read using the **I2SRXLEV** register. The value ranges from 0 to 16. Stereo and Compact Stereo sample pairs are counted as two. Mono samples also increment the count by two. For example, the LEVEL field is set to eight if there are four Mono samples.

I2S Receive FIFO Level (I2SRXLEV)

Base 0x4005.4000
 Offset 0x818
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-------|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | LEVEL | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:5 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 4:0 | LEVEL | RO | 0x00 | Number of Audio Samples This field contains the number of samples in the FIFO. |

Register 13: I²S Module Configuration (I2SCFG), offset 0xC00

This register enables the transmit and receive serial engines and sets the source of the I2S0TXMCLK and I2S0RXMCLK signals.

I2S Module Configuration (I2SCFG)

Base 0x4005.4000
Offset 0xC00
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|-------|-------|----------|----|------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | RXSLV | TXSLV | reserved | | RXEN | TXEN |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:6 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | RXSLV | R/W | 0 | Use External I2S0RXMCLK Value Description 0 The receiver uses the internally generated MCLK as the I2S0RXMCLK signal. See "Clock Control" on page 852 for information on how to program the I2S0RXMCLK. 1 The receiver uses the externally driven I2S0RXMCLK signal. |
| 4 | TXSLV | R/W | 0 | Use External I2S0TXMCLK Value Description 0 The transmitter uses the internally generated MCLK as the I2S0TXMCLK signal. See "Clock Control" on page 852 for information on how to program the I2S0TXMCLK. 1 The transmitter uses the externally driven I2S0TXMCLK signal. |
| 3:2 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | RXEN | R/W | 0 | Serial Receive Engine Enable Value Description 0 Disables the serial receive engine. 1 Enables the serial receive engine. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|--|
| 0 | TXEN | R/W | 0 | Serial Transmit Engine Enable |
| | | | | Value Description |
| | | | | 0 Disables the serial transmit engine. |
| | | | | 1 Enables the serial transmit engine. |

Register 14: I²S Interrupt Mask (I2SIM), offset 0xC10

This register masks the interrupts to the CPU.

I2S Interrupt Mask (I2SIM)

Base 0x4005.4000

Offset 0xC10

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|--------|--------|----------|----|--------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | RXREIM | RXSRIM | reserved | | TXWEIM | TXSRIM |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | RO | RO | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:6 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | RXREIM | R/W | 0 | Receive FIFO Read Error Value Description 0 The receive FIFO read error interrupt is masked and not sent to the CPU. 1 The receive FIFO read error is enabled to be sent to the interrupt controller. |
| 4 | RXSRIM | R/W | 0 | Receive FIFO Service Request Value Description 0 The receive FIFO service request interrupt is masked and not sent to the CPU. 1 The receive FIFO service request is enabled to be sent to the interrupt controller. |
| 3:2 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | TXWEIM | R/W | 0 | Transmit FIFO Write Error Value Description 0 The transmit FIFO write error interrupt is masked and not sent to the CPU. 1 The transmit FIFO write error is enabled to be sent to the interrupt controller. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 0 | TXSRIM | R/W | 0 | Transmit FIFO Service Request |
| | | | | Value Description |
| | | | | 0 The transmit FIFO service request interrupt is masked and not sent to the CPU. |
| | | | | 1 The transmit FIFO service request is enabled to be sent to the interrupt controller. |

Register 15: I²S Raw Interrupt Status (I2SRIS), offset 0xC14

This register reads the unmasked interrupt status.

I2S Raw Interrupt Status (I2SRIS)

Base 0x4005.4000
Offset 0xC14
Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|---------|---------|----------|----|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | RXRERIS | RXSRRIS | reserved | | TXWERIS | TXSRRIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:6 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | RXRERIS | RO | 0 | Receive FIFO Read Error Value Description 1 A receive FIFO read error interrupt has occurred. 0 No interrupt This bit is cleared by setting the <code>RXREIC</code> bit in the <code>I2SIC</code> register. |
| 4 | RXSRRIS | RO | 0 | Receive FIFO Service Request Value Description 1 A receive FIFO service request interrupt has occurred. 0 No interrupt This bit is cleared when the level in the receive FIFO has risen to a value greater than the value programmed in the <code>LIMIT</code> field in the <code>I2SRXLIMIT</code> register. |
| 3:2 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | TXWERIS | RO | 0 | Transmit FIFO Write Error Value Description 1 A transmit FIFO write error interrupt has occurred. 0 No interrupt This bit is cleared by setting the <code>TXWEIC</code> bit in the <code>I2SIC</code> register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 0 | TXSRRIS | RO | 0 | Transmit FIFO Service Request |
| | | | | Value Description |
| | | | | 1 A transmit FIFO service request interrupt has occurred. |
| | | | | 0 No interrupt |
| | | | | This bit is cleared when the level in the transmit FIFO has fallen to a value less than the value programmed in the <code>LIMIT</code> field in the I2STXLIMIT register. |

Register 16: I²S Masked Interrupt Status (I2SMIS), offset 0xC18

This register reads the masked interrupt status. The mask is defined in the **I2SIM** register.

I2S Masked Interrupt Status (I2SMIS)

Base 0x4005.4000
Offset 0xC18
Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|---------|---------|----------|----|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | RXREMIS | RXSRMIS | reserved | | TXWEMIS | TXSRMIS |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:6 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | RXREMIS | RO | 0 | Receive FIFO Read Error Value Description 1 An unmasked interrupt was signaled due to a receive FIFO read error. 0 An interrupt has not occurred or is masked. This bit is cleared by setting the RXREIC bit in the I2SIC register. |
| 4 | RXSRMIS | RO | 0 | Receive FIFO Service Request Value Description 1 An unmasked interrupt was signaled due to a receive FIFO service request. 0 An interrupt has not occurred or is masked. This bit is cleared when the level in the receive FIFO has risen to a value greater than the value programmed in the LIMIT field in the I2SRXLIMIT register. |
| 3:2 | reserved | RO | 0s0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | TXWEMIS | RO | 0 | Transmit FIFO Write Error Value Description 1 An unmasked interrupt was signaled due to a transmit FIFO write error. 0 An interrupt has not occurred or is masked. This bit is cleared by setting the TXWEIC bit in the I2SIC register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 0 | TXSRMIS | RO | 0 | Transmit FIFO Service Request |
| | | | | Value Description |
| | | | | 1 An unmasked interrupt was signaled due to a transmit FIFO service request. |
| | | | | 0 An interrupt has not occurred or is masked. |
| | | | | This bit is cleared when the level in the transmit FIFO has fallen to a value less than the value programmed in the <code>LIMIT</code> field in the I2STXLIMIT register. |

Register 17: I²S Interrupt Clear (I2SIC), offset 0xC1C

Writing a 1 to a bit in this register clears the corresponding interrupt.

I2S Interrupt Clear (I2SIC)

Base 0x4005.4000

Offset 0xC1C

Type WO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|--------|----------|----|----|--------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | RXREIC | reserved | | | TXWEIC | reserved |
| Type | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO | WO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:6 | reserved | WO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | RXREIC | WO | 0 | Receive FIFO Read Error Writing a 1 to this bit clears the RXRERIS bit in the I2CRIS register and the RXREMIS bit in the I2CMIS register. |
| 4:2 | reserved | WO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | TXWEIC | WO | 0 | Transmit FIFO Write Error Writing a 1 to this bit clears the TXWERIS bit in the I2CRIS register and the TXWEMIS bit in the I2CMIS register. |
| 0 | reserved | WO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

18 Controller Area Network (CAN) Module

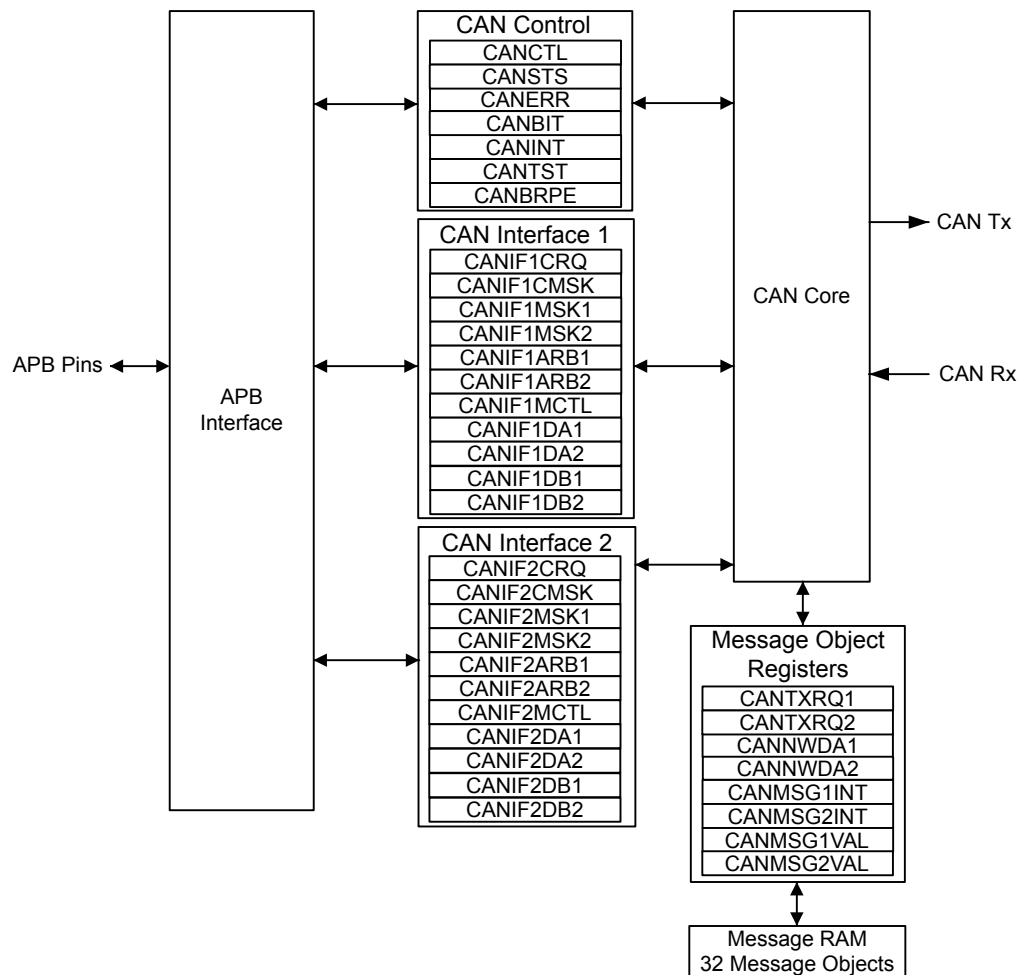
Controller Area Network (CAN) is a multicast, shared serial bus standard for connecting electronic control units (ECUs). CAN was specifically designed to be robust in electromagnetically-noisy environments and can utilize a differential balanced line like RS-485 or a more robust twisted-pair wire. Originally created for automotive purposes, it is also used in many embedded control applications (such as industrial and medical). Bit rates up to 1 Mbps are possible at network lengths less than 40 meters. Decreased bit rates allow longer network distances (for example, 125 Kbps at 500 meters).

The Stellaris[®] LM3S2U93 microcontroller includes two CAN units with the following features:

- CAN protocol version 2.0 part A/B
- Bit rates up to 1 Mbps
- 32 message objects with individual identifier masks
- Maskable interrupt
- Disable Automatic Retransmission mode for Time-Triggered CAN (TTCAN) applications
- Programmable Loopback mode for self-test operation
- Programmable FIFO mode enables storage of multiple message objects
- Gluelessly attaches to an external CAN transceiver through the CAN_nTX and CAN_nRX signals

18.1 Block Diagram

Figure 18-1. CAN Controller Block Diagram



18.2 Signal Description

The following table lists the external signals of the CAN controller and describes the function of each. The CAN controller signals are alternate functions for some GPIO signals and default to be GPIO signals at reset. The column in the table below titled "Pin Mux/Pin Assignment" lists the possible GPIO pin placements for the CAN signals. The **AFSEL** bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the CAN controller function. The number in parentheses is the encoding that must be programmed into the **PMC_n** field in the **GPIO Port Control (GPIOCTL)** register (page 461) to assign the CAN signal to the specified GPIO port pin. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 419.

Table 18-1. Controller Area Network Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|------------------------|
| CAN0Rx | 10 | PD0 (2) | I | TTL | CAN module 0 receive. |
| | 30 | PA4 (5) | | | |
| | 34 | PA6 (6) | | | |
| | 92 | PB4 (5) | | | |
| CAN0Tx | 11 | PD1 (2) | O | TTL | CAN module 0 transmit. |
| | 31 | PA5 (5) | | | |
| | 35 | PA7 (6) | | | |
| | 91 | PB5 (5) | | | |
| CAN1Rx | 47 | PF0 (1) | I | TTL | CAN module 1 receive. |
| CAN1Tx | 61 | PF1 (1) | O | TTL | CAN module 1 transmit. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 18-2. Controller Area Network Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|------------------------|
| CAN0Rx | G1 | PD0 (2) | I | TTL | CAN module 0 receive. |
| | L5 | PA4 (5) | | | |
| | L6 | PA6 (6) | | | |
| | A6 | PB4 (5) | | | |
| CAN0Tx | G2 | PD1 (2) | O | TTL | CAN module 0 transmit. |
| | M5 | PA5 (5) | | | |
| | M6 | PA7 (6) | | | |
| | B7 | PB5 (5) | | | |
| CAN1Rx | M9 | PF0 (1) | I | TTL | CAN module 1 receive. |
| CAN1Tx | H12 | PF1 (1) | O | TTL | CAN module 1 transmit. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

18.3 Functional Description

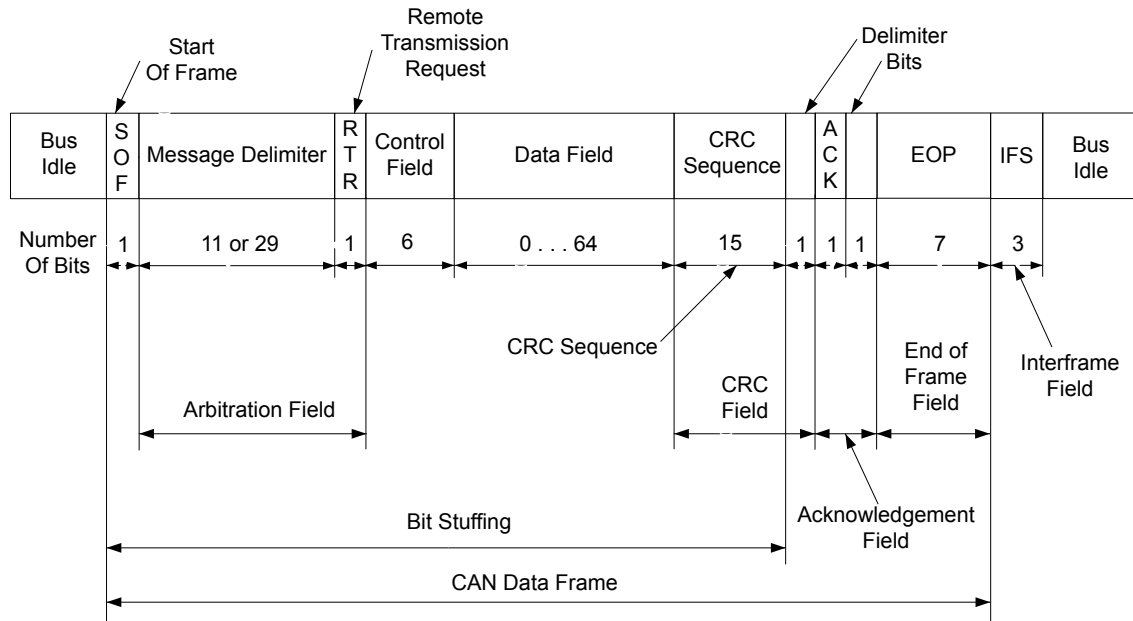
The Stellaris CAN controller conforms to the CAN protocol version 2.0 (parts A and B). Message transfers that include data, remote, error, and overload frames with an 11-bit identifier (standard) or a 29-bit identifier (extended) are supported. Transfer rates can be programmed up to 1 Mbps.

The CAN module consists of three major parts:

- CAN protocol controller and message handler
- Message memory
- CAN register interface

A data frame contains data for transmission, whereas a remote frame contains no data and is used to request the transmission of a specific message object. The CAN data/remote frame is constructed as shown in Figure 18-2.

Figure 18-2. CAN Data/Remote Frame



The protocol controller transfers and receives the serial data from the CAN bus and passes the data on to the message handler. The message handler then loads this information into the appropriate message object based on the current filtering and identifiers in the message object memory. The message handler is also responsible for generating interrupts based on events on the CAN bus.

The message object memory is a set of 32 identical memory blocks that hold the current configuration, status, and actual data for each message object. These memory blocks are accessed via either of the CAN message object register interfaces.

The message memory is not directly accessible in the Stellaris memory map, so the Stellaris CAN controller provides an interface to communicate with the message memory via two CAN interface register sets for communicating with the message objects. The message object memory cannot be directly accessed, so these two interfaces must be used to read or write to each message object. The two message object interfaces allow parallel access to the CAN controller message objects when multiple objects may have new information that must be processed. In general, one interface is used for transmit data and one for receive data.

18.3.1 Initialization

To use the CAN controller, the peripheral clock must be enabled using the **RCGC0** register (see page 254). In addition, the clock to the appropriate GPIO module must be enabled via the **RCGC2** register (see page 274). To find out which GPIO port to enable, refer to Table 23-4 on page 1075. Set the GPIO **AFSEL** bits for the appropriate pins (see page 443). Configure the **PMCN** fields in the **GPIOPCTL** register to assign the CAN signals to the appropriate pins. See page 461 and Table 23-5 on page 1083.

Software initialization is started by setting the **INIT** bit in the **CAN Control (CANCTL)** register (with software or by a hardware reset) or by going bus-off, which occurs when the transmitter's error counter exceeds a count of 255. While **INIT** is set, all message transfers to and from the CAN bus are stopped and the **CANnTX** signal is held High. Entering the initialization state does not change the configuration of the CAN controller, the message objects, or the error counters. However, some configuration registers are only accessible while in the initialization state.

To initialize the CAN controller, set the **CAN Bit Timing (CANBIT)** register and configure each message object. If a message object is not needed, label it as not valid by clearing the `MSGVAL` bit in the **CAN IFn Arbitration 2 (CANIFnARB2)** register. Otherwise, the whole message object must be initialized, as the fields of the message object may not have valid information, causing unexpected results. Both the `INIT` and `CCE` bits in the **CANCTL** register must be set in order to access the **CANBIT** register and the **CAN Baud Rate Prescaler Extension (CANBRPE)** register to configure the bit timing. To leave the initialization state, the `INIT` bit must be cleared. Afterwards, the internal Bit Stream Processor (BSP) synchronizes itself to the data transfer on the CAN bus by waiting for the occurrence of a sequence of 11 consecutive recessive bits (indicating a bus idle condition) before it takes part in bus activities and starts message transfers. Message object initialization does not require the CAN to be in the initialization state and can be done on the fly. However, message objects should all be configured to particular identifiers or set to not valid before message transfer starts. To change the configuration of a message object during normal operation, clear the `MSGVAL` bit in the **CANIFnARB2** register to indicate that the message object is not valid during the change. When the configuration is completed, set the `MSGVAL` bit again to indicate that the message object is once again valid.

18.3.2 Operation

Two sets of CAN Interface Registers (**CANIF1x** and **CANIF2x**) are used to access the message objects in the Message RAM. The CAN controller coordinates transfers to and from the Message RAM to and from the registers. The two sets are independent and identical and can be used to queue transactions. Generally, one interface is used to transmit data and one is used to receive data.

Once the CAN module is initialized and the `INIT` bit in the **CANCTL** register is cleared, the CAN module synchronizes itself to the CAN bus and starts the message transfer. As each message is received, it goes through the message handler's filtering process, and if it passes through the filter, is stored in the message object specified by the `MNUM` bit in the **CAN IFn Command Request (CANIFnCRQ)** register. The whole message (including all arbitration bits, data-length code, and eight data bytes) is stored in the message object. If the Identifier Mask (the `MSK` bits in the **CAN IFn Mask 1** and **CAN IFn Mask 2 (CANIFnMSKn)** registers) is used, the arbitration bits that are masked to "don't care" may be overwritten in the message object.

The CPU may read or write each message at any time via the CAN Interface Registers. The message handler guarantees data consistency in case of concurrent accesses.

The transmission of message objects is under the control of the software that is managing the CAN hardware. Message objects can be used for one-time data transfers or can be permanent message objects used to respond in a more periodic manner. Permanent message objects have all arbitration and control set up, and only the data bytes are updated. At the start of transmission, the appropriate `TXRQST` bit in the **CAN Transmission Request n (CANTXRQn)** register and the `NEWDAT` bit in the **CAN New Data n (CANNWDAn)** register are set. If several transmit messages are assigned to the same message object (when the number of message objects is not sufficient), the whole message object has to be configured before the transmission of this message is requested.

The transmission of any number of message objects may be requested at the same time; they are transmitted according to their internal priority, which is based on the message identifier (`MNUM`) for the message object, with 1 being the highest priority and 32 being the lowest priority. Messages may be updated or set to not valid any time, even when their requested transmission is still pending. The old data is discarded when a message is updated before its pending transmission has started. Depending on the configuration of the message object, the transmission of a message may be requested autonomously by the reception of a remote frame with a matching identifier.

Transmission can be automatically started by the reception of a matching remote frame. To enable this mode, set the `RMTEEN` bit in the **CAN IFn Message Control (CANIFnMCTL)** register. A matching received remote frame causes the `TXRQST` bit to be set, and the message object automatically transfers its data or generates an interrupt indicating a remote frame was requested. A remote frame can be strictly a single message identifier, or it can be a range of values specified in the message object. The CAN mask registers, **CANIFnMSK_n**, configure which groups of frames are identified as remote frame requests. The `UMASK` bit in the **CANIFnMCTL** register enables the `MSK` bits in the **CANIFnMSK_n** register to filter which frames are identified as a remote frame request. The `MXTD` bit in the **CANIFnMSK2** register should be set if a remote frame request is expected to be triggered by 29-bit extended identifiers.

18.3.3 Transmitting Message Objects

If the internal transmit shift register of the CAN module is ready for loading, and if a data transfer is not occurring between the CAN Interface Registers and message RAM, the valid message object with the highest priority that has a pending transmission request is loaded into the transmit shift register by the message handler and the transmission is started. The message object's `NEWDAT` bit in the **CANNWDAn** register is cleared. After a successful transmission, and if no new data was written to the message object since the start of the transmission, the `TXRQST` bit in the **CANTXRQn** register is cleared. If the CAN controller is configured to interrupt on a successful transmission of a message object, (the `TXIE` bit in the **CAN IFn Message Control (CANIFnMCTL)** register is set), the `INTPND` bit in the **CANIFnMCTL** register is set after a successful transmission. If the CAN module has lost the arbitration or if an error occurred during the transmission, the message is re-transmitted as soon as the CAN bus is free again. If, meanwhile, the transmission of a message with higher priority has been requested, the messages are transmitted in the order of their priority.

18.3.4 Configuring a Transmit Message Object

The following steps illustrate how to configure a transmit message object.

1. In the **CAN IFn Command Mask (CANIFnCMASK)** register:
 - Set the `WRNRD` bit to specify a write to the **CANIFnCMASK** register; specify whether to transfer the `IDMASK`, `DIR`, and `MXTD` of the message object into the **CAN IFn** registers using the `MASK` bit
 - Specify whether to transfer the `ID`, `DIR`, `XTD`, and `MSGVAL` of the message object into the interface registers using the `ARB` bit
 - Specify whether to transfer the control bits into the interface registers using the `CONTROL` bit
 - Specify whether to clear the `INTPND` bit in the **CANIFnMCTL** register using the `CLRINTPND` bit
 - Specify whether to clear the `NEWDAT` bit in the **CANNWDAn** register using the `NEWDAT` bit
 - Specify which bits to transfer using the `DATAA` and `DATAB` bits
2. In the **CANIFnMSK1** register, use the `MSK[15:0]` bits to specify which of the bits in the 29-bit or 11-bit message identifier are used for acceptance filtering. Note that `MSK[15:0]` in this register are used for bits [15:0] of the 29-bit message identifier and are not used for an 11-bit identifier. A value of 0x00 enables all messages to pass through the acceptance filtering. Also

note that in order for these bits to be used for acceptance filtering, they must be enabled by setting the `UMASK` bit in the **CANIFnMCTL** register.

3. In the **CANIFnMSK2** register, use the `MSK[12:0]` bits to specify which of the bits in the 29-bit or 11-bit message identifier are used for acceptance filtering. Note that `MSK[12:0]` are used for bits [28:16] of the 29-bit message identifier; whereas `MSK[12:2]` are used for bits [10:0] of the 11-bit message identifier. Use the `MXTD` and `MDIR` bits to specify whether to use `XTD` and `DIR` for acceptance filtering. A value of 0x00 enables all messages to pass through the acceptance filtering. Also note that in order for these bits to be used for acceptance filtering, they must be enabled by setting the `UMASK` bit in the **CANIFnMCTL** register.
4. For a 29-bit identifier, configure `ID[15:0]` in the **CANIFnARB1** register for bits [15:0] of the message identifier and `ID[12:0]` in the **CANIFnARB2** register for bits [28:16] of the message identifier. Set the `XTD` bit to indicate an extended identifier; set the `DIR` bit to indicate transmit; and set the `MSGVAL` bit to indicate that the message object is valid.
5. For an 11-bit identifier, disregard the **CANIFnARB1** register and configure `ID[12:2]` in the **CANIFnARB2** register for bits [10:0] of the message identifier. Clear the `XTD` bit to indicate a standard identifier; set the `DIR` bit to indicate transmit; and set the `MSGVAL` bit to indicate that the message object is valid.
6. In the **CANIFnMCTL** register:
 - Optionally set the `UMASK` bit to enable the mask (`MSK`, `MXTD`, and `MDIR` specified in the **CANIFnMSK1** and **CANIFnMSK2** registers) for acceptance filtering
 - Optionally set the `TXIE` bit to enable the `INTPND` bit to be set after a successful transmission
 - Optionally set the `RMTEN` bit to enable the `TXRQST` bit to be set on the reception of a matching remote frame allowing automatic transmission
 - Set the `EOB` bit for a single message object
 - Configure the `DLC[3:0]` field to specify the size of the data frame. Take care during this configuration not to set the `NEWDAT`, `MSGLST`, `INTPND` or `TXRQST` bits.
7. Load the data to be transmitted into the **CAN IFn Data (CANIFnDA1, CANIFnDA2, CANIFnDB1, CANIFnDB2)** registers. Byte 0 of the CAN data frame is stored in `DATA[7:0]` in the **CANIFnDA1** register.
8. Program the number of the message object to be transmitted in the `MNUM` field in the **CAN IFn Command Request (CANIFnCRQ)** register.
9. When everything is properly configured, set the `TXRQST` bit in the **CANIFnMCTL** register. Once this bit is set, the message object is available to be transmitted, depending on priority and bus availability. Note that setting the `RMTEN` bit in the **CANIFnMCTL** register can also start message transmission if a matching remote frame has been received.

18.3.5 Updating a Transmit Message Object

The CPU may update the data bytes of a Transmit Message Object any time via the CAN Interface Registers and neither the `MSGVAL` bit in the **CANIFnARB2** register nor the `TXRQST` bits in the **CANIFnMCTL** register have to be cleared before the update.

Even if only some of the data bytes are to be updated, all four bytes of the corresponding **CANIFnDAn/CANIFnDBn** register have to be valid before the content of that register is transferred to the message object. Either the CPU must write all four bytes into the **CANIFnDAn/CANIFnDBn** register or the message object is transferred to the **CANIFnDAn/CANIFnDBn** register before the CPU writes the new data bytes.

In order to only update the data in a message object, the **WRNRD**, **DATAA** and **DATAB** bits in the **CANIFnMSKn** register are set, followed by writing the updated data into **CANIFnDA1**, **CANIFnDA2**, **CANIFnDB1**, and **CANIFnDB2** registers, and then the number of the message object is written to the **MNUM** field in the **CAN IFn Command Request (CANIFnCRQ)** register. To begin transmission of the new data as soon as possible, set the **TXRQST** bit in the **CANIFnMSKn** register.

To prevent the clearing of the **TXRQST** bit in the **CANIFnMCTL** register at the end of a transmission that may already be in progress while the data is updated, the **NEWDAT** and **TXRQST** bits have to be set at the same time in the **CANIFnMCTL** register. When these bits are set at the same time, **NEWDAT** is cleared as soon as the new transmission has started.

18.3.6 Accepting Received Message Objects

When the arbitration and control field (the **ID** and **XTD** bits in the **CANIFnARB2** and the **RMTEN** and **DLC[3:0]** bits of the **CANIFnMCTL** register) of an incoming message is completely shifted into the CAN controller, the message handling capability of the controller starts scanning the message RAM for a matching valid message object. To scan the message RAM for a matching message object, the controller uses the acceptance filtering programmed through the mask bits in the **CANIFnMSKn** register and enabled using the **UMASK** bit in the **CANIFnMCTL** register. Each valid message object, starting with object 1, is compared with the incoming message to locate a matching message object in the message RAM. If a match occurs, the scanning is stopped and the message handler proceeds depending on whether it is a data frame or remote frame that was received.

18.3.7 Receiving a Data Frame

The message handler stores the message from the CAN controller receive shift register into the matching message object in the message RAM. The data bytes, all arbitration bits, and the **DLC** bits are all stored into the corresponding message object. In this manner, the data bytes are connected with the identifier even if arbitration masks are used. The **NEWDAT** bit of the **CANIFnMCTL** register is set to indicate that new data has been received. The CPU should clear this bit when it reads the message object to indicate to the controller that the message has been received, and the buffer is free to receive more messages. If the CAN controller receives a message and the **NEWDAT** bit is already set, the **MSGLST** bit in the **CANIFnMCTL** register is set to indicate that the previous data was lost. If the system requires an interrupt on successful reception of a frame, the **RXIE** bit of the **CANIFnMCTL** register should be set. In this case, the **INTPND** bit of the same register is set, causing the **CANINT** register to point to the message object that just received a message. The **TXRQST** bit of this message object should be cleared to prevent the transmission of a remote frame.

18.3.8 Receiving a Remote Frame

A remote frame contains no data, but instead specifies which object should be transmitted. When a remote frame is received, three different configurations of the matching message object have to be considered:

Table 18-3. Message Object Configurations

| Configuration in CANIFnMCTL | Description |
|--|---|
| <ul style="list-style-type: none"> ■ DIR = 1 (direction = transmit); programmed in the CANIFnARB2 register ■ RMTEN = 1 (set the TXRQST bit of the CANIFnMCTL register at reception of the frame to enable transmission) ■ UMASK = 1 or 0 | At the reception of a matching remote frame, the TXRQST bit of this message object is set. The rest of the message object remains unchanged, and the controller automatically transfers the data in the message object as soon as possible. |
| <ul style="list-style-type: none"> ■ DIR = 1 (direction = transmit); programmed in the CANIFnARB2 register ■ RMTEN = 0 (do not change the TXRQST bit of the CANIFnMCTL register at reception of the frame) ■ UMASK = 0 (ignore mask in the CANIFnMSK_n register) | At the reception of a matching remote frame, the TXRQST bit of this message object remains unchanged, and the remote frame is ignored. This remote frame is disabled, the data is not transferred and nothing indicates that the remote frame ever happened. |
| <ul style="list-style-type: none"> ■ DIR = 1 (direction = transmit); programmed in the CANIFnARB2 register ■ RMTEN = 0 (do not change the TXRQST bit of the CANIFnMCTL register at reception of the frame) ■ UMASK = 1 (use mask (MSK, MXTD, and MDIR in the CANIFnMSK_n register) for acceptance filtering) | At the reception of a matching remote frame, the TXRQST bit of this message object is cleared. The arbitration and control field (ID + XTD + RMTEN + DLC) from the shift register is stored into the message object in the message RAM, and the NEWDAT bit of this message object is set. The data field of the message object remains unchanged; the remote frame is treated similar to a received data frame. This mode is useful for a remote data request from another CAN device for which the Stellaris controller does not have readily available data. The software must fill the data and answer the frame manually. |

18.3.9 Receive/Transmit Priority

The receive/transmit priority for the message objects is controlled by the message number. Message object 1 has the highest priority, while message object 32 has the lowest priority. If more than one transmission request is pending, the message objects are transmitted in order based on the message object with the lowest message number. This prioritization is separate from that of the message identifier which is enforced by the CAN bus. As a result, if message object 1 and message object 2 both have valid messages to be transmitted, message object 1 is always transmitted first regardless of the message identifier in the message object itself.

18.3.10 Configuring a Receive Message Object

The following steps illustrate how to configure a receive message object.

1. Program the **CAN IF_n Command Mask (CANIFnCMASK)** register as described in the “Configuring a Transmit Message Object” on page 889 section, except that the WRNRD bit is set to specify a write to the message RAM.
2. Program the **CANIFnMSK1** and **CANIFnMSK2** registers as described in the “Configuring a Transmit Message Object” on page 889 section to configure which bits are used for acceptance filtering. Note that in order for these bits to be used for acceptance filtering, they must be enabled by setting the UMASK bit in the **CANIFnMCTL** register.
3. In the **CANIFnMSK2** register, use the MSK[12:0] bits to specify which of the bits in the 29-bit or 11-bit message identifier are used for acceptance filtering. Note that MSK[12:0] are used for bits [28:16] of the 29-bit message identifier; whereas MSK[12:2] are used for bits [10:0] of the 11-bit message identifier. Use the MXTD and MDIR bits to specify whether to use XTD and

DIR for acceptance filtering. A value of 0x00 enables all messages to pass through the acceptance filtering. Also note that in order for these bits to be used for acceptance filtering, they must be enabled by setting the UMASK bit in the **CANIFnMCTL** register.

4. Program the **CANIFnARB1** and **CANIFnARB2** registers as described in the “Configuring a Transmit Message Object” on page 889 section to program XTD and ID bits for the message identifier to be received; set the MSGVAL bit to indicate a valid message; and clear the DIR bit to specify receive.
5. In the **CANIFnMCTL** register:
 - Optionally set the UMASK bit to enable the mask (MSK, MXTD, and MDIR specified in the **CANIFnMSK1** and **CANIFnMSK2** registers) for acceptance filtering
 - Optionally set the RXIE bit to enable the INTPND bit to be set after a successful reception
 - Clear the RMTEN bit to leave the TXRQST bit unchanged
 - Set the EOB bit for a single message object
 - Configure the DLC[3:0] field to specify the size of the data frame

Take care during this configuration not to set the NEWDAT, MSGLST, INTPND or TXRQST bits.
6. Program the number of the message object to be received in the MNUM field in the **CAN IFn Command Request (CANIFnCRQ)** register. Reception of the message object begins as soon as a matching frame is available on the CAN bus.

When the message handler stores a data frame in the message object, it stores the received Data Length Code and eight data bytes in the **CANIFnDA1**, **CANIFnDA2**, **CANIFnDB1**, and **CANIFnDB2** register. Byte 0 of the CAN data frame is stored in DATA[7:0] in the **CANIFnDA1** register. If the Data Length Code is less than 8, the remaining bytes of the message object are overwritten by unspecified values.

The CAN mask registers can be used to allow groups of data frames to be received by a message object. The CAN mask registers, **CANIFnMSKn**, configure which groups of frames are received by a message object. The UMASK bit in the **CANIFnMCTL** register enables the MSK bits in the **CANIFnMSKn** register to filter which frames are received. The MXTD bit in the **CANIFnMSK2** register should be set if only 29-bit extended identifiers are expected by this message object.

18.3.11 Handling of Received Message Objects

The CPU may read a received message any time via the CAN Interface registers because the data consistency is guaranteed by the message handler state machine.

Typically, the CPU first writes 0x007F to the **CANIFnCMSGK** register and then writes the number of the message object to the **CANIFnCRQ** register. That combination transfers the whole received message from the message RAM into the Message Buffer registers (**CANIFnMSKn**, **CANIFnARBn**, and **CANIFnMCTL**). Additionally, the NEWDAT and INTPND bits are cleared in the message RAM, acknowledging that the message has been read and clearing the pending interrupt generated by this message object.

If the message object uses masks for acceptance filtering, the **CANIFnARBn** registers show the full, unmasked ID for the received message.

The `NEWDAT` bit in the `CANIFnMCTL` register shows whether a new message has been received since the last time this message object was read. The `MSGLST` bit in the `CANIFnMCTL` register shows whether more than one message has been received since the last time this message object was read. `MSGLST` is not automatically cleared, and should be cleared by software after reading its status.

Using a remote frame, the CPU may request new data from another CAN node on the CAN bus. Setting the `TXRQST` bit of a receive object causes the transmission of a remote frame with the receive object's identifier. This remote frame triggers the other CAN node to start the transmission of the matching data frame. If the matching data frame is received before the remote frame could be transmitted, the `TXRQST` bit is automatically reset. This prevents the possible loss of data when the other device on the CAN bus has already transmitted the data slightly earlier than expected.

18.3.11.1 Configuration of a FIFO Buffer

With the exception of the `EOB` bit in the `CANIFnMCTL` register, the configuration of receive message objects belonging to a FIFO buffer is the same as the configuration of a single receive message object (see "Configuring a Receive Message Object" on page 892). To concatenate two or more message objects into a FIFO buffer, the identifiers and masks (if used) of these message objects have to be programmed to matching values. Due to the implicit priority of the message objects, the message object with the lowest message object number is the first message object in a FIFO buffer. The `EOB` bit of all message objects of a FIFO buffer except the last one must be cleared. The `EOB` bit of the last message object of a FIFO buffer is set, indicating it is the last entry in the buffer.

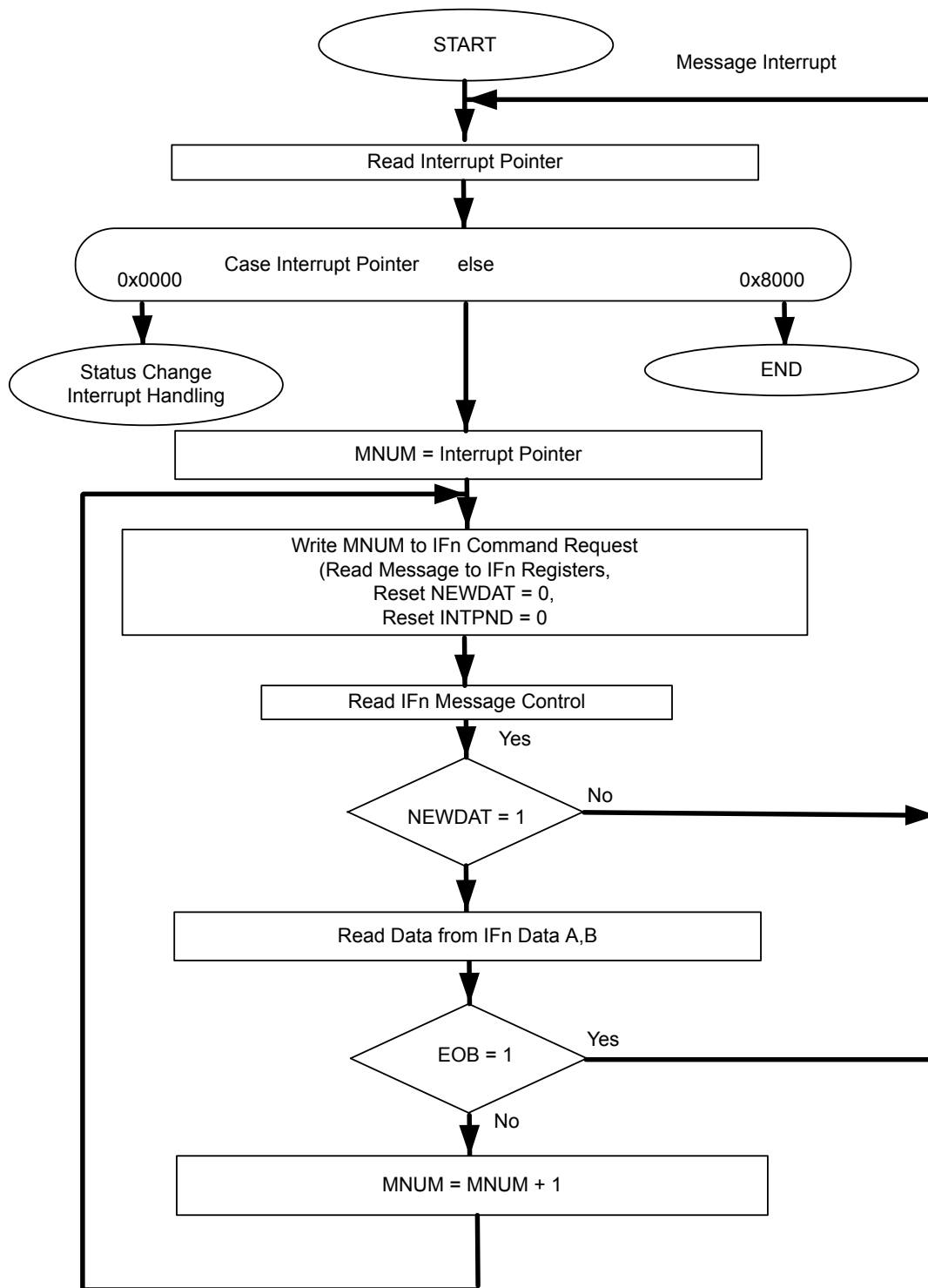
18.3.11.2 Reception of Messages with FIFO Buffers

Received messages with identifiers matching to a FIFO buffer are stored starting with the message object with the lowest message number. When a message is stored into a message object of a FIFO buffer, the `NEWDAT` of the `CANIFnMCTL` register bit of this message object is set. By setting `NEWDAT` while `EOB` is clear, the message object is locked and cannot be written to by the message handler until the CPU has cleared the `NEWDAT` bit. Messages are stored into a FIFO buffer until the last message object of this FIFO buffer is reached. Until all of the preceding message objects have been released by clearing the `NEWDAT` bit, all further messages for this FIFO buffer are written into the last message object of the FIFO buffer and therefore overwrite previous messages.

18.3.11.3 Reading from a FIFO Buffer

When the CPU transfers the contents of a message object from a FIFO buffer by writing its number to the `CANIFnCRQ` register, the `TXRQST` and `CLRINTPND` bits in the `CANIFnCMSK` register should be set such that the `NEWDAT` and `INTPEND` bits in the `CANIFnMCTL` register are cleared after the read. The values of these bits in the `CANIFnMCTL` register always reflect the status of the message object before the bits are cleared. To assure the correct function of a FIFO buffer, the CPU should read out the message objects starting with the message object with the lowest message number. When reading from the FIFO buffer, the user should be aware that a new received message is placed in the message object with the lowest message number for which the `NEWDAT` bit of the `CANIFnMCTL` register is clear. As a result, the order of the received messages in the FIFO is not guaranteed. Figure 18-3 on page 895 shows how a set of message objects which are concatenated to a FIFO Buffer can be handled by the CPU.

Figure 18-3. Message Objects in a FIFO Buffer



18.3.12 Handling of Interrupts

If several interrupts are pending, the **CAN Interrupt (CANINT)** register points to the pending interrupt with the highest priority, disregarding their chronological order. The status interrupt has the highest

priority. Among the message interrupts, the message object's interrupt with the lowest message number has the highest priority. A message interrupt is cleared by clearing the message object's `INTPND` bit in the **CANIFnMCTL** register or by reading the **CAN Status (CANSTS)** register. The status Interrupt is cleared by reading the **CANSTS** register.

The interrupt identifier `INTID` in the **CANINT** register indicates the cause of the interrupt. When no interrupt is pending, the register reads as `0x0000`. If the value of the `INTID` field is different from 0, then an interrupt is pending. If the `IE` bit is set in the **CANCTL** register, the interrupt line to the interrupt controller is active. The interrupt line remains active until the `INTID` field is 0, meaning that all interrupt sources have been cleared (the cause of the interrupt is reset), or until `IE` is cleared, which disables interrupts from the CAN controller.

The `INTID` field of the **CANINT** register points to the pending message interrupt with the highest interrupt priority. The `SIE` bit in the **CANCTL** register controls whether a change of the `RXOK`, `TXOK`, and `LEC` bits in the **CANSTS** register can cause an interrupt. The `EIE` bit in the **CANCTL** register controls whether a change of the `BOFF` and `EWARN` bits in the **CANSTS** register can cause an interrupt. The `IE` bit in the **CANCTL** register controls whether any interrupt from the CAN controller actually generates an interrupt to the interrupt controller. The **CANINT** register is updated even when the `IE` bit in the **CANCTL** register is clear, but the interrupt is not indicated to the CPU.

A value of `0x8000` in the **CANINT** register indicates that an interrupt is pending because the CAN module has updated, but not necessarily changed, the **CANSTS** register, indicating that either an error or status interrupt has been generated. A write access to the **CANSTS** register can clear the `RXOK`, `TXOK`, and `LEC` bits in that same register; however, the only way to clear the source of a status interrupt is to read the **CANSTS** register.

The source of an interrupt can be determined in two ways during interrupt handling. The first is to read the `INTID` bit in the **CANINT** register to determine the highest priority interrupt that is pending, and the second is to read the **CAN Message Interrupt Pending (CANMSGnINT)** register to see all of the message objects that have pending interrupts.

An interrupt service routine reading the message that is the source of the interrupt may read the message and clear the message object's `INTPND` bit at the same time by setting the `CLRINTPND` bit in the **CANIFnCMSK** register. Once the `INTPND` bit has been cleared, the **CANINT** register contains the message number for the next message object with a pending interrupt.

18.3.13 Test Mode

A Test Mode is provided which allows various diagnostics to be performed. Test Mode is entered by setting the `TEST` bit in the **CANCTL** register. Once in Test Mode, the `TX[1:0]`, `LBACK`, `SILENT` and `BASIC` bits in the **CAN Test (CANTST)** register can be used to put the CAN controller into the various diagnostic modes. The `RX` bit in the **CANTST** register allows monitoring of the `CANnRX` signal. All **CANTST** register functions are disabled when the `TEST` bit is cleared.

18.3.13.1 Silent Mode

Silent Mode can be used to analyze the traffic on a CAN bus without affecting it by the transmission of dominant bits (Acknowledge Bits, Error Frames). The CAN Controller is put in Silent Mode setting the `SILENT` bit in the **CANTST** register. In Silent Mode, the CAN controller is able to receive valid data frames and valid remote frames, but it sends only recessive bits on the CAN bus and cannot start a transmission. If the CAN Controller is required to send a dominant bit (ACK bit, overload flag, or active error flag), the bit is rerouted internally so that the CAN Controller monitors this dominant bit, although the CAN bus remains in recessive state.

18.3.13.2 Loopback Mode

Loopback mode is useful for self-test functions. In Loopback Mode, the CAN Controller internally routes the `CANnTX` signal on to the `CANnRX` signal and treats its own transmitted messages as received messages and stores them (if they pass acceptance filtering) into the message buffer. The CAN Controller is put in Loopback Mode by setting the `LBACK` bit in the `CANTST` register. To be independent from external stimulation, the CAN Controller ignores acknowledge errors (a recessive bit sampled in the acknowledge slot of a data/remote frame) in Loopback Mode. The actual value of the `CANnRX` signal is disregarded by the CAN Controller. The transmitted messages can be monitored on the `CANnTX` signal.

18.3.13.3 Loopback Combined with Silent Mode

Loopback Mode and Silent Mode can be combined to allow the CAN Controller to be tested without affecting a running CAN system connected to the `CANnTX` and `CANnRX` signals. In this mode, the `CANnRX` signal is disconnected from the CAN Controller and the `CANnTX` signal is held recessive. This mode is enabled by setting both the `LBACK` and `SILENT` bits in the `CANTST` register.

18.3.13.4 Basic Mode

Basic Mode allows the CAN Controller to be operated without the Message RAM. In Basic Mode, The CANIF1 registers are used as the transmit buffer. The transmission of the contents of the IF1 registers is requested by setting the `BUSY` bit of the `CANIF1CRQ` register. The CANIF1 registers are locked while the `BUSY` bit is set. The `BUSY` bit indicates that a transmission is pending. As soon the CAN bus is idle, the CANIF1 registers are loaded into the shift register of the CAN Controller and transmission is started. When the transmission has completed, the `BUSY` bit is cleared and the locked CANIF1 registers are released. A pending transmission can be aborted at any time by clearing the `BUSY` bit in the `CANIF1CRQ` register while the CANIF1 registers are locked. If the CPU has cleared the `BUSY` bit, a possible retransmission in case of lost arbitration or an error is disabled.

The CANIF2 Registers are used as a receive buffer. After the reception of a message, the contents of the shift register are stored in the CANIF2 registers, without any acceptance filtering. Additionally, the actual contents of the shift register can be monitored during the message transfer. Each time a read message object is initiated by setting the `BUSY` bit of the `CANIF2CRQ` register, the contents of the shift register are stored into the CANIF2 registers.

In Basic Mode, all message-object-related control and status bits and of the control bits of the `CANIFnCMSK` registers are not evaluated. The message number of the `CANIFnCRQ` registers is also not evaluated. In the `CANIF2MCTL` register, the `NEWDAT` and `MSGLST` bits retain their function, the `DLC[3:0]` field shows the received DLC, the other control bits are cleared.

Basic Mode is enabled by setting the `BASIC` bit in the `CANTST` register.

18.3.13.5 Transmit Control

Software can directly override control of the `CANnTX` signal in four different ways.

- `CANnTX` is controlled by the CAN Controller
- The sample point is driven on the `CANnTX` signal to monitor the bit timing
- `CANnTX` drives a low value
- `CANnTX` drives a high value

The last two functions, combined with the readable CAN receive pin `CANnRX`, can be used to check the physical layer of the CAN bus.

The Transmit Control function is enabled by programming the `TX[1:0]` field in the **CANTST** register. The three test functions for the `CANnTX` signal interfere with all CAN protocol functions. `TX[1:0]` must be cleared when CAN message transfer or Loopback Mode, Silent Mode, or Basic Mode are selected.

18.3.14 Bit Timing Configuration Error Considerations

Even if minor errors in the configuration of the CAN bit timing do not result in immediate failure, the performance of a CAN network can be reduced significantly. In many cases, the CAN bit synchronization amends a faulty configuration of the CAN bit timing to such a degree that only occasionally an error frame is generated. In the case of arbitration, however, when two or more CAN nodes simultaneously try to transmit a frame, a misplaced sample point may cause one of the transmitters to become error passive. The analysis of such sporadic errors requires a detailed knowledge of the CAN bit synchronization inside a CAN node and of the CAN nodes' interaction on the CAN bus.

18.3.15 Bit Time and Bit Rate

The CAN system supports bit rates in the range of lower than 1 Kbps up to 1000 Kbps. Each member of the CAN network has its own clock generator. The timing parameter of the bit time can be configured individually for each CAN node, creating a common bit rate even though the CAN nodes' oscillator periods may be different.

Because of small variations in frequency caused by changes in temperature or voltage and by deteriorating components, these oscillators are not absolutely stable. As long as the variations remain inside a specific oscillator's tolerance range, the CAN nodes are able to compensate for the different bit rates by periodically resynchronizing to the bit stream.

According to the CAN specification, the bit time is divided into four segments (see Figure 18-4 on page 899): the Synchronization Segment, the Propagation Time Segment, the Phase Buffer Segment 1, and the Phase Buffer Segment 2. Each segment consists of a specific, programmable number of time quanta (see Table 18-4 on page 899). The length of the time quantum (t_q), which is the basic time unit of the bit time, is defined by the CAN controller's input clock (f_{sys}) and the Baud Rate Prescaler (**BRP**):

$$t_q = BRP / f_{sys}$$

The f_{sys} input clock is the system clock frequency as configured by the **RCC** or **RCC2** registers (see page 211 or page 218).

The Synchronization Segment Sync is that part of the bit time where edges of the CAN bus level are expected to occur; the distance between an edge that occurs outside of `Sync` and the `Sync` is called the phase error of that edge.

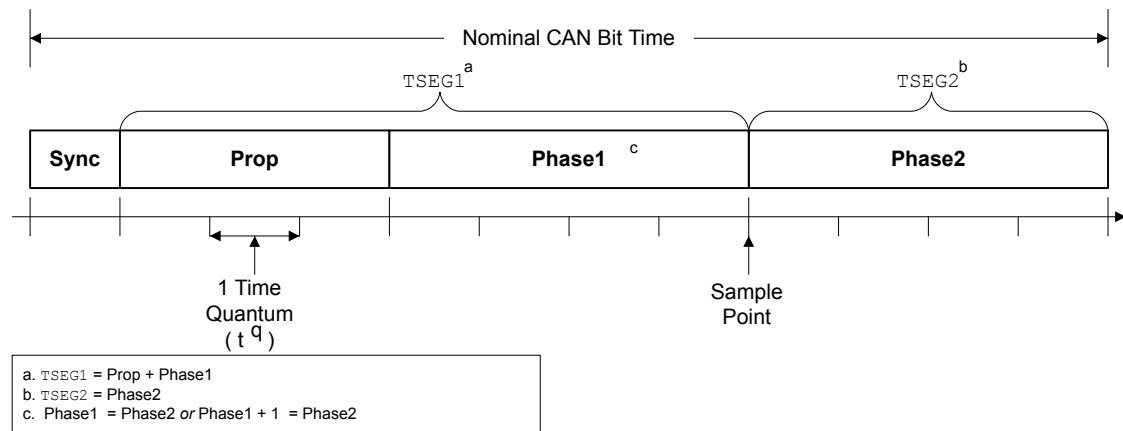
The Propagation Time Segment Prop is intended to compensate for the physical delay times within the CAN network.

The Phase Buffer Segments Phase1 and Phase2 surround the Sample Point.

The (Re-)Synchronization Jump Width (SJW) defines how far a resynchronization may move the Sample Point inside the limits defined by the Phase Buffer Segments to compensate for edge phase errors.

A given bit rate may be met by different bit-time configurations, but for the proper function of the CAN network, the physical delay times and the oscillator's tolerance range have to be considered.

Figure 18-4. CAN Bit Time

Table 18-4. CAN Protocol Ranges^a

| Parameter | Range | Remark |
|-----------|----------------|---|
| BRP | [1 .. 64] | Defines the length of the time quantum t_q . The CANBRPE register can be used to extend the range to 1024. |
| Sync | 1 t_q | Fixed length, synchronization of bus input to system clock |
| Prop | [1 .. 8] t_q | Compensates for the physical delay times |
| Phase1 | [1 .. 8] t_q | May be lengthened temporarily by synchronization |
| Phase2 | [1 .. 8] t_q | May be shortened temporarily by synchronization |
| SJW | [1 .. 4] t_q | May not be longer than either Phase Buffer Segment |

a. This table describes the minimum programmable ranges required by the CAN protocol.

The bit timing configuration is programmed in two register bytes in the **CANBIT** register. In the **CANBIT** register, the four components TSEG2, TSEG1, SJW, and BRP have to be programmed to a numerical value that is one less than its functional value; so instead of values in the range of [1..n], values in the range of [0..n-1] are programmed. That way, for example, SJW (functional range of [1..4]) is represented by only two bits in the SJW bit field. Table 18-5 shows the relationship between the **CANBIT** register values and the parameters.

Table 18-5. CANBIT Register Values

| CANBIT Register Field | Setting |
|-----------------------|-------------------|
| TSEG2 | Phase2 - 1 |
| TSEG1 | Prop + Phase1 - 1 |
| SJW | SJW - 1 |
| BRP | BRP |

Therefore, the length of the bit time is (programmed values):

$$[TSEG1 + TSEG2 + 3] \times t_q$$

or (functional values):

$$[Sync + Prop + Phase1 + Phase2] \times t_q$$

The data in the **CANBIT** register is the configuration input of the CAN protocol controller. The baud rate prescaler (configured by the BRP field) defines the length of the time quantum, the basic time

unit of the bit time; the bit timing logic (configured by TSEG1, TSEG2, and SJW) defines the number of time quanta in the bit time.

The processing of the bit time, the calculation of the position of the sample point, and occasional synchronizations are controlled by the CAN controller and are evaluated once per time quantum.

The CAN controller translates messages to and from frames. In addition, the controller generates and discards the enclosing fixed format bits, inserts and extracts stuff bits, calculates and checks the CRC code, performs the error management, and decides which type of synchronization is to be used. The bit value is received or transmitted at the sample point. The information processing time (IPT) is the time after the sample point needed to calculate the next bit to be transmitted on the CAN bus. The IPT includes any of the following: retrieving the next data bit, handling a CRC bit, determining if bit stuffing is required, generating an error flag or simply going idle.

The IPT is application-specific but may not be longer than $2 t_q$; the CAN's IPT is $0 t_q$. Its length is the lower limit of the programmed length of Phase2. In case of synchronization, Phase2 may be shortened to a value less than IPT, which does not affect bus timing.

18.3.16 Calculating the Bit Timing Parameters

Usually, the calculation of the bit timing configuration starts with a required bit rate or bit time. The resulting bit time (1/bit rate) must be an integer multiple of the system clock period.

The bit time may consist of 4 to 25 time quanta. Several combinations may lead to the required bit time, allowing iterations of the following steps.

The first part of the bit time to be defined is Prop. Its length depends on the delay times measured in the system. A maximum bus length as well as a maximum node delay has to be defined for expandable CAN bus systems. The resulting time for Prop is converted into time quanta (rounded up to the nearest integer multiple of t_q).

Sync is $1 t_q$ long (fixed), which leaves $(\text{bit time} - \text{Prop} - 1) t_q$ for the two Phase Buffer Segments. If the number of remaining t_q is even, the Phase Buffer Segments have the same length, that is, $\text{Phase2} = \text{Phase1}$, else $\text{Phase2} = \text{Phase1} + 1$.

The minimum nominal length of Phase2 has to be regarded as well. Phase2 may not be shorter than the CAN controller's Information Processing Time, which is, depending on the actual implementation, in the range of $[0..2] t_q$.

The length of the synchronization jump width is set to the least of 4, Phase1 or Phase2.

The oscillator tolerance range necessary for the resulting configuration is calculated by the formula given below:

$$(1 - df) \times f_{nom} \leq f_{osc} \leq (1 + df) \times f_{nom}$$

where:

- df = Maximum tolerance of oscillator frequency
- f_{osc} = Actual oscillator frequency
- f_{nom} = Nominal oscillator frequency

Maximum frequency tolerance must take into account the following formulas:

$$df \leq \frac{(Phase_seg1, Phase_seg2) \min}{2 \times (13 \times tbit - Phase_Seg2)}$$

$$df \max = 2 \times df \times f_{nom}$$

where:

- Phase1 and Phase2 are from Table 18-4 on page 899
- tbit = Bit Time
- dfmax = Maximum difference between two oscillators

If more than one configuration is possible, that configuration allowing the highest oscillator tolerance range should be chosen.

CAN nodes with different system clocks require different configurations to come to the same bit rate. The calculation of the propagation time in the CAN network, based on the nodes with the longest delay times, is done once for the whole network.

The CAN system's oscillator tolerance range is limited by the node with the lowest tolerance range.

The calculation may show that bus length or bit rate have to be decreased or that the oscillator frequencies' stability has to be increased in order to find a protocol-compliant configuration of the CAN bit timing.

18.3.16.1 Example for Bit Timing at High Baud Rate

In this example, the frequency of CAN clock is 25 MHz, and the bit rate is 1 Mbps.

$$\text{bit time} = 1 \mu\text{s} = n * t_q = 5 * t_q$$

$$t_q = 200 \text{ ns}$$

$$t_q = (\text{Baud rate Prescaler}) / \text{CAN Clock}$$

$$\text{Baud rate Prescaler} = t_q * \text{CAN Clock}$$

$$\text{Baud rate Prescaler} = 200\text{E}-9 * 25\text{E}6 = 5$$

$$t_{\text{Sync}} = 1 * t_q = 200 \text{ ns}$$

\\fixed at 1 time quanta

delay of bus driver 50 ns

delay of receiver circuit 30 ns

delay of bus line (40m) 220 ns

$$t_{\text{Prop}} 400 \text{ ns} = 2 * t_q$$

\\400 is next integer multiple of t_q

$$\text{bit time} = t_{\text{Sync}} + t_{\text{TSeg1}} + t_{\text{TSeg2}} = 5 * t_q$$

$$\text{bit time} = t_{\text{Sync}} + t_{\text{Prop}} + t_{\text{Phase 1}} + t_{\text{Phase 2}}$$

$$t_{\text{Phase 1}} + t_{\text{Phase 2}} = \text{bit time} - t_{\text{Sync}} - t_{\text{Prop}}$$

$$t_{\text{Phase 1}} + t_{\text{Phase 2}} = (5 * t_q) - (1 * t_q) - (2 * t_q)$$

$$t_{\text{Phase 1}} + t_{\text{Phase 2}} = 2 * t_q$$

$$t_{\text{Phase 1}} = 1 * t_q$$

$$t_{\text{Phase 2}} = 1 * t_q$$

\\tPhase2 = tPhase1

```

tTSeg1 = tProp + tPhase1
tTSeg1 = (2 * tq) + (1 * tq)
tTSeg1 = 3 * tq

tTSeg2 = tPhase2
tTSeg2 = (Information Processing Time + 1) * tq
tTSeg2 = 1 * tq                \\Assumes IPT=0

tSJW = 1 * tq                \\Least of 4, Phase1 and Phase2
    
```

In the above example, the bit field values for the **CANBIT** register are:

| | |
|-------|--|
| TSEG2 | = TSeg2 -1 = 1-1 = 0 |
| TSEG1 | = TSeg1 -1 = 3-1 = 2 |
| SJW | = SJW -1 = 1-1 = 0 |
| BRP | = Baud rate prescaler - 1 = 5-1 =4 |

The final value programmed into the **CANBIT** register = 0x0204.

18.3.16.2 Example for Bit Timing at Low Baud Rate

In this example, the frequency of the CAN clock is 50 MHz, and the bit rate is 100 Kbps.

```

bit time = 10 μs = n * tq = 10 * tq
tq = 1 μs
tq = (Baud rate Prescaler)/CAN Clock
Baud rate Prescaler = tq * CAN Clock
Baud rate Prescaler = 1E-6 * 50E6 = 50

tSync = 1 * tq = 1 μs                \\fixed at 1 time quanta

delay of bus driver 200 ns
delay of receiver circuit 80 ns
delay of bus line (40m) 220 ns
tProp 1 μs = 1 * tq                \\1 μs is next integer multiple of tq

bit time = tSync + tTSeg1 + tTSeg2 = 10 * tq
bit time = tSync + tProp + tPhase 1 + tPhase2
tPhase 1 + tPhase2 = bit time - tSync - tProp
tPhase 1 + tPhase2 = (10 * tq) - (1 * tq) - (1 * tq)
tPhase 1 + tPhase2 = 8 * tq
tPhase1 = 4 * tq
tPhase2 = 4 * tq                \\tPhase1 = tPhase2
    
```

```

tTSeg1 = tProp + tPhase1
tTSeg1 = (1 * tq) + (4 * tq)
tTSeg1 = 5 * tq
tTSeg2 = tPhase2
tTSeg2 = (Information Processing Time + 4) × tq
tTSeg2 = 4 * tq                                \\Assumes IPT=0

tSJW = 4 * tq                                \\Least of 4, Phase1, and Phase2

```

| | |
|-------|--|
| TSEG2 | = TSeg2 -1 = 4-1 = 3 |
| TSEG1 | = TSeg1 -1 = 5-1 = 4 |
| SJW | = SJW -1 = 4-1 = 3 |
| BRP | = Baud rate prescaler - 1 = 50-1 =49 |

The final value programmed into the **CANBIT** register = 0x34F1.

18.4 Register Map

Table 18-6 on page 903 lists the registers. All addresses given are relative to the CAN base address of:

- CAN0: 0x4004.0000
- CAN1: 0x4004.1000

Note that the CAN controller clock must be enabled before the registers can be programmed (see page 254). There must be a delay of 3 system clocks after the CAN module clock is enabled before any CAN module registers are accessed.

Table 18-6. CAN Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|-----------|------|-------------|-----------------------------------|----------|
| 0x000 | CANCTL | R/W | 0x0000.0001 | CAN Control | 906 |
| 0x004 | CANSTS | R/W | 0x0000.0000 | CAN Status | 908 |
| 0x008 | CANERR | RO | 0x0000.0000 | CAN Error Counter | 911 |
| 0x00C | CANBIT | R/W | 0x0000.2301 | CAN Bit Timing | 912 |
| 0x010 | CANINT | RO | 0x0000.0000 | CAN Interrupt | 913 |
| 0x014 | CANTST | R/W | 0x0000.0000 | CAN Test | 914 |
| 0x018 | CANBRPE | R/W | 0x0000.0000 | CAN Baud Rate Prescaler Extension | 916 |
| 0x020 | CANIF1CRQ | R/W | 0x0000.0001 | CAN IF1 Command Request | 917 |

Table 18-6. CAN Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|------------|------|-------------|---------------------------------|----------|
| 0x024 | CANIF1CMSK | R/W | 0x0000.0000 | CAN IF1 Command Mask | 918 |
| 0x028 | CANIF1MSK1 | R/W | 0x0000.FFFF | CAN IF1 Mask 1 | 921 |
| 0x02C | CANIF1MSK2 | R/W | 0x0000.FFFF | CAN IF1 Mask 2 | 922 |
| 0x030 | CANIF1ARB1 | R/W | 0x0000.0000 | CAN IF1 Arbitration 1 | 924 |
| 0x034 | CANIF1ARB2 | R/W | 0x0000.0000 | CAN IF1 Arbitration 2 | 925 |
| 0x038 | CANIF1MCTL | R/W | 0x0000.0000 | CAN IF1 Message Control | 927 |
| 0x03C | CANIF1DA1 | R/W | 0x0000.0000 | CAN IF1 Data A1 | 930 |
| 0x040 | CANIF1DA2 | R/W | 0x0000.0000 | CAN IF1 Data A2 | 930 |
| 0x044 | CANIF1DB1 | R/W | 0x0000.0000 | CAN IF1 Data B1 | 930 |
| 0x048 | CANIF1DB2 | R/W | 0x0000.0000 | CAN IF1 Data B2 | 930 |
| 0x080 | CANIF2CRQ | R/W | 0x0000.0001 | CAN IF2 Command Request | 917 |
| 0x084 | CANIF2CMSK | R/W | 0x0000.0000 | CAN IF2 Command Mask | 918 |
| 0x088 | CANIF2MSK1 | R/W | 0x0000.FFFF | CAN IF2 Mask 1 | 921 |
| 0x08C | CANIF2MSK2 | R/W | 0x0000.FFFF | CAN IF2 Mask 2 | 922 |
| 0x090 | CANIF2ARB1 | R/W | 0x0000.0000 | CAN IF2 Arbitration 1 | 924 |
| 0x094 | CANIF2ARB2 | R/W | 0x0000.0000 | CAN IF2 Arbitration 2 | 925 |
| 0x098 | CANIF2MCTL | R/W | 0x0000.0000 | CAN IF2 Message Control | 927 |
| 0x09C | CANIF2DA1 | R/W | 0x0000.0000 | CAN IF2 Data A1 | 930 |
| 0x0A0 | CANIF2DA2 | R/W | 0x0000.0000 | CAN IF2 Data A2 | 930 |
| 0x0A4 | CANIF2DB1 | R/W | 0x0000.0000 | CAN IF2 Data B1 | 930 |
| 0x0A8 | CANIF2DB2 | R/W | 0x0000.0000 | CAN IF2 Data B2 | 930 |
| 0x100 | CANTXRQ1 | RO | 0x0000.0000 | CAN Transmission Request 1 | 931 |
| 0x104 | CANTXRQ2 | RO | 0x0000.0000 | CAN Transmission Request 2 | 931 |
| 0x120 | CANNWDA1 | RO | 0x0000.0000 | CAN New Data 1 | 932 |
| 0x124 | CANNWDA2 | RO | 0x0000.0000 | CAN New Data 2 | 932 |
| 0x140 | CANMSG1INT | RO | 0x0000.0000 | CAN Message 1 Interrupt Pending | 933 |
| 0x144 | CANMSG2INT | RO | 0x0000.0000 | CAN Message 2 Interrupt Pending | 933 |
| 0x160 | CANMSG1VAL | RO | 0x0000.0000 | CAN Message 1 Valid | 934 |
| 0x164 | CANMSG2VAL | RO | 0x0000.0000 | CAN Message 2 Valid | 934 |

18.5 CAN Register Descriptions

The remainder of this section lists and describes the CAN registers, in numerical order by address offset. There are two sets of Interface Registers that are used to access the Message Objects in

the Message RAM: **CANIF1x** and **CANIF2x**. The function of the two sets are identical and are used to queue transactions.

Register 1: CAN Control (CANCTL), offset 0x000

This control register initializes the module and enables test mode and interrupts.

The bus-off recovery sequence (see CAN Specification Rev. 2.0) cannot be shortened by setting or clearing `INIT`. If the device goes bus-off, it sets `INIT`, stopping all bus activities. Once `INIT` has been cleared by the CPU, the device then waits for 129 occurrences of Bus Idle (129 * 11 consecutive High bits) before resuming normal operations. At the end of the bus-off recovery sequence, the Error Management Counters are reset.

During the waiting time after `INIT` is cleared, each time a sequence of 11 High bits has been monitored, a `BITERROR0` code is written to the **CANSTS** register (the `LEC` field = 0x5), enabling the CPU to readily check whether the CAN bus is stuck Low or continuously disturbed, and to monitor the proceeding of the bus-off recovery sequence.

CAN Control (CANCTL)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x000
 Type R/W, reset 0x0000.0001

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|-----|-----|----------|-----|-----|-----|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | TEST | CCE | DAR | reserved | EIE | SIE | IE | INIT |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|---|------|-----------|--|-------|-------------|---|---|---|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 7 | TEST | R/W | 0 | Test Mode Enable | | | | | | |
| | | | | <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>The CAN controller is operating normally.</td> </tr> <tr> <td>1</td> <td>The CAN controller is in test mode.</td> </tr> </table> | Value | Description | 0 | The CAN controller is operating normally. | 1 | The CAN controller is in test mode. |
| Value | Description | | | | | | | | | |
| 0 | The CAN controller is operating normally. | | | | | | | | | |
| 1 | The CAN controller is in test mode. | | | | | | | | | |
| 6 | CCE | R/W | 0 | Configuration Change Enable | | | | | | |
| | | | | <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Write accesses to the CANBIT register are not allowed.</td> </tr> <tr> <td>1</td> <td>Write accesses to the CANBIT register are allowed if the <code>INIT</code> bit is 1.</td> </tr> </table> | Value | Description | 0 | Write accesses to the CANBIT register are not allowed. | 1 | Write accesses to the CANBIT register are allowed if the <code>INIT</code> bit is 1. |
| Value | Description | | | | | | | | | |
| 0 | Write accesses to the CANBIT register are not allowed. | | | | | | | | | |
| 1 | Write accesses to the CANBIT register are allowed if the <code>INIT</code> bit is 1. | | | | | | | | | |
| 5 | DAR | R/W | 0 | Disable Automatic-Retransmission | | | | | | |
| | | | | <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Auto-retransmission of disturbed messages is enabled.</td> </tr> <tr> <td>1</td> <td>Auto-retransmission is disabled.</td> </tr> </table> | Value | Description | 0 | Auto-retransmission of disturbed messages is enabled. | 1 | Auto-retransmission is disabled. |
| Value | Description | | | | | | | | | |
| 0 | Auto-retransmission of disturbed messages is enabled. | | | | | | | | | |
| 1 | Auto-retransmission is disabled. | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|--|------|-------|---|-------|-------------|---|---|---|--|
| 4 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 3 | EIE | R/W | 0 | Error Interrupt Enable <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>No error status interrupt is generated.</td> </tr> <tr> <td>1</td> <td>A change in the <i>BOFF</i> or <i>EWARN</i> bits in the CANSTS register generates an interrupt.</td> </tr> </tbody> </table> | Value | Description | 0 | No error status interrupt is generated. | 1 | A change in the <i>BOFF</i> or <i>EWARN</i> bits in the CANSTS register generates an interrupt. |
| Value | Description | | | | | | | | | |
| 0 | No error status interrupt is generated. | | | | | | | | | |
| 1 | A change in the <i>BOFF</i> or <i>EWARN</i> bits in the CANSTS register generates an interrupt. | | | | | | | | | |
| 2 | SIE | R/W | 0 | Status Interrupt Enable <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>No status interrupt is generated.</td> </tr> <tr> <td>1</td> <td>An interrupt is generated when a message has successfully been transmitted or received, or a CAN bus error has been detected. A change in the <i>TXOK</i>, <i>RXOK</i> or <i>LEC</i> bits in the CANSTS register generates an interrupt.</td> </tr> </tbody> </table> | Value | Description | 0 | No status interrupt is generated. | 1 | An interrupt is generated when a message has successfully been transmitted or received, or a CAN bus error has been detected. A change in the <i>TXOK</i> , <i>RXOK</i> or <i>LEC</i> bits in the CANSTS register generates an interrupt. |
| Value | Description | | | | | | | | | |
| 0 | No status interrupt is generated. | | | | | | | | | |
| 1 | An interrupt is generated when a message has successfully been transmitted or received, or a CAN bus error has been detected. A change in the <i>TXOK</i> , <i>RXOK</i> or <i>LEC</i> bits in the CANSTS register generates an interrupt. | | | | | | | | | |
| 1 | IE | R/W | 0 | CAN Interrupt Enable <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Interrupts disabled.</td> </tr> <tr> <td>1</td> <td>Interrupts enabled.</td> </tr> </tbody> </table> | Value | Description | 0 | Interrupts disabled. | 1 | Interrupts enabled. |
| Value | Description | | | | | | | | | |
| 0 | Interrupts disabled. | | | | | | | | | |
| 1 | Interrupts enabled. | | | | | | | | | |
| 0 | INIT | R/W | 1 | Initialization <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Normal operation.</td> </tr> <tr> <td>1</td> <td>Initialization started.</td> </tr> </tbody> </table> | Value | Description | 0 | Normal operation. | 1 | Initialization started. |
| Value | Description | | | | | | | | | |
| 0 | Normal operation. | | | | | | | | | |
| 1 | Initialization started. | | | | | | | | | |

Register 2: CAN Status (CANSTS), offset 0x004

Important: This register is read-sensitive. See the register description for details.

The status register contains information for interrupt servicing such as Bus-Off, error count threshold, and error types.

The LEC field holds the code that indicates the type of the last error to occur on the CAN bus. This field is cleared when a message has been transferred (reception or transmission) without error. The unused error code 0x7 may be written by the CPU to manually set this field to an invalid error so that it can be checked for a change later.

An error interrupt is generated by the BOFF and EWARN bits, and a status interrupt is generated by the RXOK, TXOK, and LEC bits, if the corresponding enable bits in the **CAN Control (CANCTL)** register are set. A change of the EPASS bit or a write to the RXOK, TXOK, or LEC bits does not generate an interrupt.

Reading the **CAN Status (CANSTS)** register clears the **CAN Interrupt (CANINT)** register, if it is pending.

CAN Status (CANSTS)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x004
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|-------|-------|------|------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | BOFF | EWARN | EPASS | RXOK | TXOK | LEC | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|---|------|-----------|---|-------|-------------|---|--|---|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 7 | BOFF | RO | 0 | Bus-Off Status | | | | | | |
| | | | | <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>The CAN controller is not in bus-off state.</td> </tr> <tr> <td>1</td> <td>The CAN controller is in bus-off state.</td> </tr> </table> | Value | Description | 0 | The CAN controller is not in bus-off state. | 1 | The CAN controller is in bus-off state. |
| Value | Description | | | | | | | | | |
| 0 | The CAN controller is not in bus-off state. | | | | | | | | | |
| 1 | The CAN controller is in bus-off state. | | | | | | | | | |
| 6 | EWARN | RO | 0 | Warning Status | | | | | | |
| | | | | <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Both error counters are below the error warning limit of 96.</td> </tr> <tr> <td>1</td> <td>At least one of the error counters has reached the error warning limit of 96.</td> </tr> </table> | Value | Description | 0 | Both error counters are below the error warning limit of 96. | 1 | At least one of the error counters has reached the error warning limit of 96. |
| Value | Description | | | | | | | | | |
| 0 | Both error counters are below the error warning limit of 96. | | | | | | | | | |
| 1 | At least one of the error counters has reached the error warning limit of 96. | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|--|------|-------|--|-------|-------------|---|---|---|--|
| 5 | EPASS | RO | 0 | <p>Error Passive</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>The CAN module is in the Error Active state, that is, the receive or transmit error count is less than or equal to 127.</td> </tr> <tr> <td>1</td> <td>The CAN module is in the Error Passive state, that is, the receive or transmit error count is greater than 127.</td> </tr> </tbody> </table> | Value | Description | 0 | The CAN module is in the Error Active state, that is, the receive or transmit error count is less than or equal to 127. | 1 | The CAN module is in the Error Passive state, that is, the receive or transmit error count is greater than 127. |
| Value | Description | | | | | | | | | |
| 0 | The CAN module is in the Error Active state, that is, the receive or transmit error count is less than or equal to 127. | | | | | | | | | |
| 1 | The CAN module is in the Error Passive state, that is, the receive or transmit error count is greater than 127. | | | | | | | | | |
| 4 | RXOK | R/W | 0 | <p>Received a Message Successfully</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Since this bit was last cleared, no message has been successfully received.</td> </tr> <tr> <td>1</td> <td>Since this bit was last cleared, a message has been successfully received, independent of the result of the acceptance filtering.</td> </tr> </tbody> </table> <p>This bit must be cleared by writing a 0 to it.</p> | Value | Description | 0 | Since this bit was last cleared, no message has been successfully received. | 1 | Since this bit was last cleared, a message has been successfully received, independent of the result of the acceptance filtering. |
| Value | Description | | | | | | | | | |
| 0 | Since this bit was last cleared, no message has been successfully received. | | | | | | | | | |
| 1 | Since this bit was last cleared, a message has been successfully received, independent of the result of the acceptance filtering. | | | | | | | | | |
| 3 | TXOK | R/W | 0 | <p>Transmitted a Message Successfully</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Since this bit was last cleared, no message has been successfully transmitted.</td> </tr> <tr> <td>1</td> <td>Since this bit was last cleared, a message has been successfully transmitted error-free and acknowledged by at least one other node.</td> </tr> </tbody> </table> <p>This bit must be cleared by writing a 0 to it.</p> | Value | Description | 0 | Since this bit was last cleared, no message has been successfully transmitted. | 1 | Since this bit was last cleared, a message has been successfully transmitted error-free and acknowledged by at least one other node. |
| Value | Description | | | | | | | | | |
| 0 | Since this bit was last cleared, no message has been successfully transmitted. | | | | | | | | | |
| 1 | Since this bit was last cleared, a message has been successfully transmitted error-free and acknowledged by at least one other node. | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------|---|------|-------|--|-------|-------------|-----|----------|-----|-------------|--|---|-----|--------------|--|---|-----|-----------|--|---|-----|-------------|--|---|--|--|-----|-------------|--|---|--|---|-----|-----------|--|---|-----|----------|--|---|
| 2:0 | LEC | R/W | 0x0 | <p>Last Error Code</p> <p>This is the type of the last error to occur on the CAN bus.</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>No Error</td> </tr> <tr> <td>0x1</td> <td>Stuff Error</td> </tr> <tr> <td></td> <td>More than 5 equal bits in a sequence have occurred in a part of a received message where this is not allowed.</td> </tr> <tr> <td>0x2</td> <td>Format Error</td> </tr> <tr> <td></td> <td>A fixed format part of the received frame has the wrong format.</td> </tr> <tr> <td>0x3</td> <td>ACK Error</td> </tr> <tr> <td></td> <td>The message transmitted was not acknowledged by another node.</td> </tr> <tr> <td>0x4</td> <td>Bit 1 Error</td> </tr> <tr> <td></td> <td>When a message is transmitted, the CAN controller monitors the data lines to detect any conflicts. When the arbitration field is transmitted, data conflicts are a part of the arbitration protocol. When other frame fields are transmitted, data conflicts are considered errors.</td> </tr> <tr> <td></td> <td>A Bit 1 Error indicates that the device wanted to send a High level (logical 1) but the monitored bus value was Low (logical 0).</td> </tr> <tr> <td>0x5</td> <td>Bit 0 Error</td> </tr> <tr> <td></td> <td>A Bit 0 Error indicates that the device wanted to send a Low level (logical 0), but the monitored bus value was High (logical 1).</td> </tr> <tr> <td></td> <td>During bus-off recovery, this status is set each time a sequence of 11 High bits has been monitored. By checking for this status, software can monitor the proceeding of the bus-off recovery sequence without any disturbances to the bus.</td> </tr> <tr> <td>0x6</td> <td>CRC Error</td> </tr> <tr> <td></td> <td>The CRC checksum was incorrect in the received message, indicating that the calculated value received did not match the calculated CRC of the data.</td> </tr> <tr> <td>0x7</td> <td>No Event</td> </tr> <tr> <td></td> <td>When the LEC bit shows this value, no CAN bus event was detected since this value was written to the LEC field.</td> </tr> </tbody> </table> | Value | Description | 0x0 | No Error | 0x1 | Stuff Error | | More than 5 equal bits in a sequence have occurred in a part of a received message where this is not allowed. | 0x2 | Format Error | | A fixed format part of the received frame has the wrong format. | 0x3 | ACK Error | | The message transmitted was not acknowledged by another node. | 0x4 | Bit 1 Error | | When a message is transmitted, the CAN controller monitors the data lines to detect any conflicts. When the arbitration field is transmitted, data conflicts are a part of the arbitration protocol. When other frame fields are transmitted, data conflicts are considered errors. | | A Bit 1 Error indicates that the device wanted to send a High level (logical 1) but the monitored bus value was Low (logical 0). | 0x5 | Bit 0 Error | | A Bit 0 Error indicates that the device wanted to send a Low level (logical 0), but the monitored bus value was High (logical 1). | | During bus-off recovery, this status is set each time a sequence of 11 High bits has been monitored. By checking for this status, software can monitor the proceeding of the bus-off recovery sequence without any disturbances to the bus. | 0x6 | CRC Error | | The CRC checksum was incorrect in the received message, indicating that the calculated value received did not match the calculated CRC of the data. | 0x7 | No Event | | When the LEC bit shows this value, no CAN bus event was detected since this value was written to the LEC field. |
| Value | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | No Error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | Stuff Error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | More than 5 equal bits in a sequence have occurred in a part of a received message where this is not allowed. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | Format Error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | A fixed format part of the received frame has the wrong format. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | ACK Error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | The message transmitted was not acknowledged by another node. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x4 | Bit 1 Error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | When a message is transmitted, the CAN controller monitors the data lines to detect any conflicts. When the arbitration field is transmitted, data conflicts are a part of the arbitration protocol. When other frame fields are transmitted, data conflicts are considered errors. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | A Bit 1 Error indicates that the device wanted to send a High level (logical 1) but the monitored bus value was Low (logical 0). | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x5 | Bit 0 Error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | A Bit 0 Error indicates that the device wanted to send a Low level (logical 0), but the monitored bus value was High (logical 1). | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | During bus-off recovery, this status is set each time a sequence of 11 High bits has been monitored. By checking for this status, software can monitor the proceeding of the bus-off recovery sequence without any disturbances to the bus. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x6 | CRC Error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | The CRC checksum was incorrect in the received message, indicating that the calculated value received did not match the calculated CRC of the data. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0x7 | No Event | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | When the LEC bit shows this value, no CAN bus event was detected since this value was written to the LEC field. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Register 3: CAN Error Counter (CANERR), offset 0x008

This register contains the error counter values, which can be used to analyze the cause of an error.

CAN Error Counter (CANERR)

CAN0 base: 0x4004.0000

CAN1 base: 0x4004.1000

Offset 0x008

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|-----|----|----|----|----|----|-----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | RP | | REC | | | | | | TEC | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|---|------|--------|--|-------|-------------|---|---|---|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 15 | RP | RO | 0 | Received Error Passive | | | | | | |
| | | | | <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>The Receive Error counter is below the Error Passive level (127 or less).</td> </tr> <tr> <td>1</td> <td>The Receive Error counter has reached the Error Passive level (128 or greater).</td> </tr> </tbody> </table> | Value | Description | 0 | The Receive Error counter is below the Error Passive level (127 or less). | 1 | The Receive Error counter has reached the Error Passive level (128 or greater). |
| Value | Description | | | | | | | | | |
| 0 | The Receive Error counter is below the Error Passive level (127 or less). | | | | | | | | | |
| 1 | The Receive Error counter has reached the Error Passive level (128 or greater). | | | | | | | | | |
| 14:8 | REC | RO | 0x00 | Receive Error Counter This field contains the state of the receiver error counter (0 to 127). | | | | | | |
| 7:0 | TEC | RO | 0x00 | Transmit Error Counter This field contains the state of the transmit error counter (0 to 255). | | | | | | |

Register 4: CAN Bit Timing (CANBIT), offset 0x00C

This register is used to program the bit width and bit quantum. Values are programmed to the system clock frequency. This register is write-enabled by setting the `CCE` and `INIT` bits in the `CANCTL` register. See “Bit Time and Bit Rate” on page 898 for more information.

CAN Bit Timing (CANBIT)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x00C
 Type R/W, reset 0x0000.2301

| | | | | | | | | | | | | | | | | |
|-------|----------|-------|-----|-----|-------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | TSEG2 | | | TSEG1 | | | | SJW | | BRP | | | | | |
| Type | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|--|
| 31:15 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 14:12 | TSEG2 | R/W | 0x2 | Time Segment after Sample Point 0x00-0x07: The actual interpretation by the hardware of this value is such that one more than the value programmed here is used. So, for example, the reset value of 0x2 means that 3 (2+1) bit time quanta are defined for <code>Phase2</code> (see Figure 18-4 on page 899). The bit time quanta is defined by the <code>BRP</code> field. |
| 11:8 | TSEG1 | R/W | 0x3 | Time Segment Before Sample Point 0x00-0x0F: The actual interpretation by the hardware of this value is such that one more than the value programmed here is used. So, for example, the reset value of 0x3 means that 4 (3+1) bit time quanta are defined for <code>Phase1</code> (see Figure 18-4 on page 899). The bit time quanta is defined by the <code>BRP</code> field. |
| 7:6 | SJW | R/W | 0x0 | (Re)Synchronization Jump Width 0x00-0x03: The actual interpretation by the hardware of this value is such that one more than the value programmed here is used. During the start of frame (SOF), if the CAN controller detects a phase error (misalignment), it can adjust the length of <code>TSEG2</code> or <code>TSEG1</code> by the value in <code>SJW</code> . So the reset value of 0 adjusts the length by 1 bit time quanta. |
| 5:0 | BRP | R/W | 0x1 | Baud Rate Prescaler The value by which the oscillator frequency is divided for generating the bit time quanta. The bit time is built up from a multiple of this quantum. 0x00-0x03F: The actual interpretation by the hardware of this value is such that one more than the value programmed here is used. <code>BRP</code> defines the number of CAN clock periods that make up 1 bit time quanta, so the reset value is 2 bit time quanta (1+1). The <code>CANBRPE</code> register can be used to further divide the bit time. |

Register 5: CAN Interrupt (CANINT), offset 0x010

This register indicates the source of the interrupt.

If several interrupts are pending, the **CAN Interrupt (CANINT)** register points to the pending interrupt with the highest priority, disregarding the order in which the interrupts occurred. An interrupt remains pending until the CPU has cleared it. If the **INTID** field is not 0x0000 (the default) and the **IE** bit in the **CANCTL** register is set, the interrupt is active. The interrupt line remains active until the **INTID** field is cleared by reading the **CANSTS** register, or until the **IE** bit in the **CANCTL** register is cleared.

Note: Reading the **CAN Status (CANSTS)** register clears the **CAN Interrupt (CANINT)** register, if it is pending.

CAN Interrupt (CANINT)

CAN0 base: 0x4004.0000

CAN1 base: 0x4004.1000

Offset 0x010

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | INTID | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|---------------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | INTID | RO | 0x0000 | Interrupt Identifier The number in this field indicates the source of the interrupt. |
| | | | Value | Description |
| | | | 0x0000 | No interrupt pending |
| | | | 0x0001-0x0020 | Number of the message object that caused the interrupt |
| | | | 0x0021-0x7FFF | Reserved |
| | | | 0x8000 | Status Interrupt |
| | | | 0x8001-0xFFFF | Reserved |

Register 6: CAN Test (CANTST), offset 0x014

This register is used for self-test and external pin access. It is write-enabled by setting the `TEST` bit in the `CANCTL` register. Different test functions may be combined, however, CAN transfers are affected if the `TX` bits in this register are not zero.

CAN Test (CANTST)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x014
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|-----|-----|-------|--------|-------|----------|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | RX | TX | | LBACK | SILENT | BASIC | reserved | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | | | | | | | | | |
|-----------|--|------|-----------|--|-------|-------------|-----|-------------------------------------|---|--|-----|--------------|--|--|-----|------------|--|---|-----|-------------|--|--|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | | | | | | | | | |
| 7 | RX | RO | 0 | Receive Observation | | | | | | | | | | | | | | | | | | |
| | | | | <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>The <code>CANnRx</code> pin is low.</td> </tr> <tr> <td>1</td> <td>The <code>CANnRx</code> pin is high.</td> </tr> </table> | Value | Description | 0 | The <code>CANnRx</code> pin is low. | 1 | The <code>CANnRx</code> pin is high. | | | | | | | | | | | | |
| Value | Description | | | | | | | | | | | | | | | | | | | | | |
| 0 | The <code>CANnRx</code> pin is low. | | | | | | | | | | | | | | | | | | | | | |
| 1 | The <code>CANnRx</code> pin is high. | | | | | | | | | | | | | | | | | | | | | |
| 6:5 | TX | R/W | 0x0 | Transmit Control | | | | | | | | | | | | | | | | | | |
| | | | | Overrides control of the <code>CANnTx</code> pin. | | | | | | | | | | | | | | | | | | |
| | | | | <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0x0</td> <td>CAN Module Control</td> </tr> <tr> <td></td> <td><code>CANnTx</code> is controlled by the CAN module; default operation</td> </tr> <tr> <td>0x1</td> <td>Sample Point</td> </tr> <tr> <td></td> <td>The sample point is driven on the <code>CANnTx</code> signal. This mode is useful to monitor bit timing.</td> </tr> <tr> <td>0x2</td> <td>Driven Low</td> </tr> <tr> <td></td> <td><code>CANnTx</code> drives a low value. This mode is useful for checking the physical layer of the CAN bus.</td> </tr> <tr> <td>0x3</td> <td>Driven High</td> </tr> <tr> <td></td> <td><code>CANnTx</code> drives a high value. This mode is useful for checking the physical layer of the CAN bus.</td> </tr> </table> | Value | Description | 0x0 | CAN Module Control | | <code>CANnTx</code> is controlled by the CAN module; default operation | 0x1 | Sample Point | | The sample point is driven on the <code>CANnTx</code> signal. This mode is useful to monitor bit timing. | 0x2 | Driven Low | | <code>CANnTx</code> drives a low value. This mode is useful for checking the physical layer of the CAN bus. | 0x3 | Driven High | | <code>CANnTx</code> drives a high value. This mode is useful for checking the physical layer of the CAN bus. |
| Value | Description | | | | | | | | | | | | | | | | | | | | | |
| 0x0 | CAN Module Control | | | | | | | | | | | | | | | | | | | | | |
| | <code>CANnTx</code> is controlled by the CAN module; default operation | | | | | | | | | | | | | | | | | | | | | |
| 0x1 | Sample Point | | | | | | | | | | | | | | | | | | | | | |
| | The sample point is driven on the <code>CANnTx</code> signal. This mode is useful to monitor bit timing. | | | | | | | | | | | | | | | | | | | | | |
| 0x2 | Driven Low | | | | | | | | | | | | | | | | | | | | | |
| | <code>CANnTx</code> drives a low value. This mode is useful for checking the physical layer of the CAN bus. | | | | | | | | | | | | | | | | | | | | | |
| 0x3 | Driven High | | | | | | | | | | | | | | | | | | | | | |
| | <code>CANnTx</code> drives a high value. This mode is useful for checking the physical layer of the CAN bus. | | | | | | | | | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | |
|-----------|----------|------|-------|---|---|
| 4 | LBACK | R/W | 0 | Loopback Mode | |
| | | | | Value | Description |
| | | | | 0 | Loopback mode is disabled. |
| | | | | 1 | Loopback mode is enabled. In loopback mode, the data from the transmitter is routed into the receiver. Any data on the receive input is ignored. |
| 3 | SILENT | R/W | 0 | Silent Mode | |
| | | | | Value | Description |
| | | | | 0 | Silent mode is disabled. |
| | | | | 1 | Silent mode is enabled. In silent mode, the CAN controller does not transmit data but instead monitors the bus. This mode is also known as Bus Monitor mode. |
| 2 | BASIC | R/W | 0 | Basic Mode | |
| | | | | Value | Description |
| | | | | 0 | Basic mode is disabled. |
| | | | | 1 | Basic mode is enabled. In basic mode, software should use the CANIF1 registers as the transmit buffer and use the CANIF2 registers as the receive buffer. |
| 1:0 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | |

Register 7: CAN Baud Rate Prescaler Extension (CANBRPE), offset 0x018

This register is used to further divide the bit time set with the `BRP` bit in the `CANBIT` register. It is write-enabled by setting the `CCE` bit in the `CANCTL` register.

CAN Baud Rate Prescaler Extension (CANBRPE)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x018
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|------|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | BRPE | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|--|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3:0 | BRPE | R/W | 0x0 | Baud Rate Prescaler Extension 0x00-0x0F: Extend the <code>BRP</code> bit in the <code>CANBIT</code> register to values up to 1023. The actual interpretation by the hardware is one more than the value programmed by <code>BRPE</code> (MSBs) and <code>BRP</code> (LSBs). |

Register 8: CAN IF1 Command Request (CANIF1CRQ), offset 0x020**Register 9: CAN IF2 Command Request (CANIF2CRQ), offset 0x080**

A message transfer is started as soon as there is a write of the message object number to the MNUM field when the TXRQST bit in the CANIF1MCTL register is set. With this write operation, the BUSY bit is automatically set to indicate that a transfer between the CAN Interface Registers and the internal message RAM is in progress. After a wait time of 3 to 6 CAN_CLK periods, the transfer between the interface register and the message RAM completes, which then clears the BUSY bit.

CAN IF1 Command Request (CANIF1CRQ)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x020
 Type R/W, reset 0x0000.0001

| | | | | | | | | | | | | | | | | |
|-------|----------|----------|----|----|----|----|----|----|----|----|------|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | BUSY | reserved | | | | | | | | | MNUM | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15 | BUSY | RO | 0 | Busy Flag |
| | | | | Value Description |
| | | | | 0 This bit is cleared when read/write action has finished. |
| | | | | 1 This bit is set when a write occurs to the message number in this register. |
| 14:6 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5:0 | MNUM | R/W | 0x01 | Message Number |
| | | | | Selects one of the 32 message objects in the message RAM for data transfer. The message objects are numbered from 1 to 32. |
| | | | | Value Description |
| | | | | 0x00 Reserved |
| | | | | 0 is not a valid message number; it is interpreted as 0x20, or object 32. |
| | | | | 0x01-0x20 Message Number |
| | | | | Indicates specified message object 1 to 32. |
| | | | | 0x21-0x3F Reserved |
| | | | | Not a valid message number; values are shifted and it is interpreted as 0x01-0x1F. |

Register 10: CAN IF1 Command Mask (CANIF1CMSK), offset 0x024

Register 11: CAN IF2 Command Mask (CANIF2CMSK), offset 0x084

Reading the Command Mask registers provides status for various functions. Writing to the Command Mask registers specifies the transfer direction and selects which buffer registers are the source or target of the data transfer.

Note that when a read from the message object buffer occurs when the WRNRD bit is clear and the CLRINTPND and/or NEWDAT bits are set, the interrupt pending and/or new data flags in the message object buffer are cleared.

CAN IF1 Command Mask (CANIF1CMSK)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x024
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-------|------|-----|---------|-----------|-----------------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | WRNRD | MASK | ARB | CONTROL | CLRINTPND | NEWDAT / TXRQST | DATAA | DATAB |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | WRNRD | R/W | 0 | Write, Not Read |
| | | | | Value Description |
| | | | | 0 Transfer the data in the CAN message object specified by the the MNUM field in the CANIFnCRQ register into the CANIFn registers. |
| | | | | 1 Transfer the data in the CANIFn registers to the CAN message object specified by the MNUM field in the CAN Command Request (CANIFnCRQ). |
| | | | | Note: Interrupt pending and new data conditions in the message buffer can be cleared by reading from the buffer (WRNRD = 0) when the CLRINTPND and/or NEWDAT bits are set. |
| 6 | MASK | R/W | 0 | Access Mask Bits |
| | | | | Value Description |
| | | | | 0 Mask bits unchanged. |
| | | | | 1 Transfer IDMASK + DIR + MXTD of the message object into the Interface registers. |

| Bit/Field | Name | Type | Reset | Description | | |
|-----------|-----------------|------|-------|---|---|--|
| 5 | ARB | R/W | 0 | Access Arbitration Bits | | |
| | | | | Value | Description | |
| | | | | 0 | Arbitration bits unchanged. | |
| | | | | 1 | Transfer ID + DIR + XTD + MSGVAL of the message object into the Interface registers. | |
| 4 | CONTROL | R/W | 0 | Access Control Bits | | |
| | | | | Value | Description | |
| | | | | 0 | Control bits unchanged. | |
| | | | | 1 | Transfer control bits from the CANIFnMCTL register into the Interface registers. | |
| 3 | CLRINTPND | R/W | 0 | Clear Interrupt Pending Bit | | |
| | | | | The function of this bit depends on the configuration of the WRNRD bit. | | |
| | | | | Value | Description | |
| | | | | 0 | If WRNRD is clear, the interrupt pending status is transferred from the message buffer into the CANIFnMCTL register. If WRNRD is set, the INTPND bit in the message object remains unchanged. | |
| 2 | NEWDAT / TXRQST | R/W | 0 | NEWDAT / TXRQST Bit | | |
| | | | | The function of this bit depends on the configuration of the WRNRD bit. | | |
| | | | | Value | Description | |
| | | | | 0 | If WRNRD is clear, the value of the new data status is transferred from the message buffer into the CANIFnMCTL register. If WRNRD is set, a transmission is not requested. | |
| 1 | 1 | 1 | 1 | If WRNRD is clear, the interrupt pending status is cleared in the message buffer. Note the value of this bit that is transferred to the CANIFnMCTL register always reflects the status of the bits before clearing. If WRNRD is set, the INTPND bit is cleared in the message object. | | |
| | | | | 1 | If WRNRD is clear, the new data status is cleared in the message buffer. Note the value of this bit that is transferred to the CANIFnMCTL register always reflects the status of the bits before clearing. If WRNRD is set, a transmission is requested. Note that when this bit is set, the TXRQST bit in the CANIFnMCTL register is ignored. | |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|---|------|-------|---|-------|-------------|---|-------------------------------|---|---|
| 1 | DATAA | R/W | 0 | <p>Access Data Byte 0 to 3</p> <p>The function of this bit depends on the configuration of the WRNRD bit.</p> <table><thead><tr><th>Value</th><th>Description</th></tr></thead><tbody><tr><td>0</td><td>Data bytes 0-3 are unchanged.</td></tr><tr><td>1</td><td>If WRNRD is clear, transfer data bytes 0-3 in CANIFnDA1 and CANIFnDA2 to the message object. If WRNRD is set, transfer data bytes 0-3 in message object to CANIFnDA1 and CANIFnDA2.</td></tr></tbody></table> | Value | Description | 0 | Data bytes 0-3 are unchanged. | 1 | If WRNRD is clear, transfer data bytes 0-3 in CANIFnDA1 and CANIFnDA2 to the message object. If WRNRD is set, transfer data bytes 0-3 in message object to CANIFnDA1 and CANIFnDA2 . |
| Value | Description | | | | | | | | | |
| 0 | Data bytes 0-3 are unchanged. | | | | | | | | | |
| 1 | If WRNRD is clear, transfer data bytes 0-3 in CANIFnDA1 and CANIFnDA2 to the message object. If WRNRD is set, transfer data bytes 0-3 in message object to CANIFnDA1 and CANIFnDA2 . | | | | | | | | | |
| 0 | DATAB | R/W | 0 | <p>Access Data Byte 4 to 7</p> <p>The function of this bit depends on the configuration of the WRNRD bit as follows:</p> <table><thead><tr><th>Value</th><th>Description</th></tr></thead><tbody><tr><td>0</td><td>Data bytes 4-7 are unchanged.</td></tr><tr><td>1</td><td>If WRNRD is clear, transfer data bytes 4-7 in CANIFnDA1 and CANIFnDA2 to the message object. If WRNRD is set, transfer data bytes 4-7 in message object to CANIFnDA1 and CANIFnDA2.</td></tr></tbody></table> | Value | Description | 0 | Data bytes 4-7 are unchanged. | 1 | If WRNRD is clear, transfer data bytes 4-7 in CANIFnDA1 and CANIFnDA2 to the message object. If WRNRD is set, transfer data bytes 4-7 in message object to CANIFnDA1 and CANIFnDA2 . |
| Value | Description | | | | | | | | | |
| 0 | Data bytes 4-7 are unchanged. | | | | | | | | | |
| 1 | If WRNRD is clear, transfer data bytes 4-7 in CANIFnDA1 and CANIFnDA2 to the message object. If WRNRD is set, transfer data bytes 4-7 in message object to CANIFnDA1 and CANIFnDA2 . | | | | | | | | | |

Register 12: CAN IF1 Mask 1 (CANIF1MSK1), offset 0x028**Register 13: CAN IF2 Mask 1 (CANIF2MSK1), offset 0x088**

The mask information provided in this register accompanies the data (**CANIFnDAn**), arbitration information (**CANIFnARBn**), and control information (**CANIFnMCTL**) to the message object in the message RAM. The mask is used with the **ID** bit in the **CANIFnARBn** register for acceptance filtering. Additional mask information is contained in the **CANIFnMSK2** register.

CAN IF1 Mask 1 (CANIF1MSK1)

CAN0 base: 0x4004.0000

CAN1 base: 0x4004.1000

Offset 0x028

Type R/W, reset 0x0000.FFFF

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MSK | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|--|--------|--|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | MSK | R/W | 0xFFFF | Identifier Mask When using a 29-bit identifier, these bits are used for bits [15:0] of the ID. The MSK field in the CANIFnMSK2 register are used for bits [28:16] of the ID. When using an 11-bit identifier, these bits are ignored. |
| | Value | Description | | |
| | 0 | The corresponding identifier field (ID) in the message object cannot inhibit the match in acceptance filtering. | | |
| | 1 | The corresponding identifier field (ID) is used for acceptance filtering. | | |

Register 14: CAN IF1 Mask 2 (CANIF1MSK2), offset 0x02C

Register 15: CAN IF2 Mask 2 (CANIF2MSK2), offset 0x08C

This register holds extended mask information that accompanies the **CANIFnMSK1** register.

CAN IF1 Mask 2 (CANIF1MSK2)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x02C
 Type R/W, reset 0x0000.FFFF

| | | | | | | | | | | | | | | | | |
|-------|----------|------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MXTD | MDIR | reserved | | | | | | | | | | | | | |
| Type | R/W | R/W | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|---|------|--------|---|-------|-------------|---|---|---|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 15 | MXTD | R/W | 1 | Mask Extended Identifier <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>The extended identifier bit (<i>X</i>TD in the CANIFnARB2 register) has no effect on the acceptance filtering.</td> </tr> <tr> <td>1</td> <td>The extended identifier bit <i>X</i>TD is used for acceptance filtering.</td> </tr> </table> | Value | Description | 0 | The extended identifier bit (<i>X</i> TD in the CANIFnARB2 register) has no effect on the acceptance filtering. | 1 | The extended identifier bit <i>X</i> TD is used for acceptance filtering. |
| Value | Description | | | | | | | | | |
| 0 | The extended identifier bit (<i>X</i> TD in the CANIFnARB2 register) has no effect on the acceptance filtering. | | | | | | | | | |
| 1 | The extended identifier bit <i>X</i> TD is used for acceptance filtering. | | | | | | | | | |
| 14 | MDIR | R/W | 1 | Mask Message Direction <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>The message direction bit (<i>D</i>IR in the CANIFnARB2 register) has no effect for acceptance filtering.</td> </tr> <tr> <td>1</td> <td>The message direction bit <i>D</i>IR is used for acceptance filtering.</td> </tr> </table> | Value | Description | 0 | The message direction bit (<i>D</i> IR in the CANIFnARB2 register) has no effect for acceptance filtering. | 1 | The message direction bit <i>D</i> IR is used for acceptance filtering. |
| Value | Description | | | | | | | | | |
| 0 | The message direction bit (<i>D</i> IR in the CANIFnARB2 register) has no effect for acceptance filtering. | | | | | | | | | |
| 1 | The message direction bit <i>D</i> IR is used for acceptance filtering. | | | | | | | | | |
| 13 | reserved | RO | 1 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|--|------|-------|---|-------|-------------|---|--|---|--|
| 12:0 | MSK | R/W | 0xFF | <p>Identifier Mask</p> <p>When using a 29-bit identifier, these bits are used for bits [28:16] of the ID. The <code>MSK</code> field in the <code>CANIFnMSK1</code> register are used for bits [15:0] of the ID. When using an 11-bit identifier, <code>MSK[12:2]</code> are used for bits [10:0] of the ID.</p> <table><thead><tr><th>Value</th><th>Description</th></tr></thead><tbody><tr><td>0</td><td>The corresponding identifier field (<code>ID</code>) in the message object cannot inhibit the match in acceptance filtering.</td></tr><tr><td>1</td><td>The corresponding identifier field (<code>ID</code>) is used for acceptance filtering.</td></tr></tbody></table> | Value | Description | 0 | The corresponding identifier field (<code>ID</code>) in the message object cannot inhibit the match in acceptance filtering. | 1 | The corresponding identifier field (<code>ID</code>) is used for acceptance filtering. |
| Value | Description | | | | | | | | | |
| 0 | The corresponding identifier field (<code>ID</code>) in the message object cannot inhibit the match in acceptance filtering. | | | | | | | | | |
| 1 | The corresponding identifier field (<code>ID</code>) is used for acceptance filtering. | | | | | | | | | |

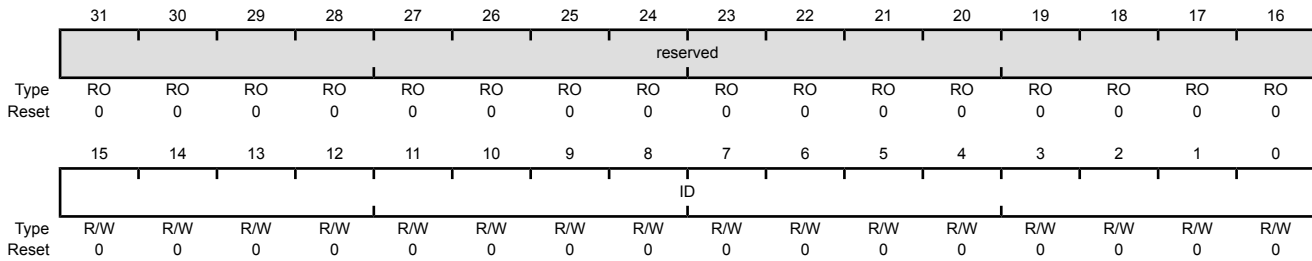
Register 16: CAN IF1 Arbitration 1 (CANIF1ARB1), offset 0x030

Register 17: CAN IF2 Arbitration 1 (CANIF2ARB1), offset 0x090

These registers hold the identifiers for acceptance filtering.

CAN IF1 Arbitration 1 (CANIF1ARB1)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x030
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | ID | R/W | 0x0000 | <p>Message Identifier</p> <p>This bit field is used with the <code>ID</code> field in the CANIFnARB2 register to create the message identifier.</p> <p>When using a 29-bit identifier, bits 15:0 of the CANIFnARB1 register are [15:0] of the ID, while bits 12:0 of the CANIFnARB2 register are [28:16] of the ID.</p> <p>When using an 11-bit identifier, these bits are not used.</p> |

Register 18: CAN IF1 Arbitration 2 (CANIF1ARB2), offset 0x034**Register 19: CAN IF2 Arbitration 2 (CANIF2ARB2), offset 0x094**

These registers hold information for acceptance filtering.

CAN IF1 Arbitration 2 (CANIF1ARB2)

CAN0 base: 0x4004.0000

CAN1 base: 0x4004.1000

Offset 0x034

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MSGVAL | XTD | DIR | | | | | | | ID | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| | | | | |
|----|--------|-----|---|---------------|
| 15 | MSGVAL | R/W | 0 | Message Valid |
|----|--------|-----|---|---------------|

| Value | Description |
|-------|---|
| 0 | The message object is ignored by the message handler. |
| 1 | The message object is configured and ready to be considered by the message handler within the CAN controller. |

All unused message objects should have this bit cleared during initialization and before clearing the `INIT` bit in the `CANCTL` register. The `MSGVAL` bit must also be cleared before any of the following bits are modified or if the message object is no longer required: the `ID` fields in the `CANIFnARBn` registers, the `XTD` and `DIR` bits in the `CANIFnARB2` register, or the `DLC` field in the `CANIFnMCTL` register.

| | | | | |
|----|-----|-----|---|---------------------|
| 14 | XTD | R/W | 0 | Extended Identifier |
|----|-----|-----|---|---------------------|

| Value | Description |
|-------|--|
| 0 | An 11-bit Standard Identifier is used for this message object. |
| 1 | A 29-bit Extended Identifier is used for this message object. |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|---|------|-------|---|-------|-------------|---|--|---|---|
| 13 | DIR | R/W | 0 | <p>Message Direction</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Receive. When the <code>TXRQST</code> bit in the CANIFnMCTL register is set, a remote frame with the identifier of this message object is received. On reception of a data frame with matching identifier, that message is stored in this message object.</td> </tr> <tr> <td>1</td> <td>Transmit. When the <code>TXRQST</code> bit in the CANIFnMCTL register is set, the respective message object is transmitted as a data frame. On reception of a remote frame with matching identifier, the <code>TXRQST</code> bit of this message object is set (if <code>RMTEN=1</code>).</td> </tr> </tbody> </table> | Value | Description | 0 | Receive. When the <code>TXRQST</code> bit in the CANIFnMCTL register is set, a remote frame with the identifier of this message object is received. On reception of a data frame with matching identifier, that message is stored in this message object. | 1 | Transmit. When the <code>TXRQST</code> bit in the CANIFnMCTL register is set, the respective message object is transmitted as a data frame. On reception of a remote frame with matching identifier, the <code>TXRQST</code> bit of this message object is set (if <code>RMTEN=1</code>). |
| Value | Description | | | | | | | | | |
| 0 | Receive. When the <code>TXRQST</code> bit in the CANIFnMCTL register is set, a remote frame with the identifier of this message object is received. On reception of a data frame with matching identifier, that message is stored in this message object. | | | | | | | | | |
| 1 | Transmit. When the <code>TXRQST</code> bit in the CANIFnMCTL register is set, the respective message object is transmitted as a data frame. On reception of a remote frame with matching identifier, the <code>TXRQST</code> bit of this message object is set (if <code>RMTEN=1</code>). | | | | | | | | | |
| 12:0 | ID | R/W | 0x000 | <p>Message Identifier</p> <p>This bit field is used with the <code>ID</code> field in the CANIFnARB2 register to create the message identifier.</p> <p>When using a 29-bit identifier, <code>ID[15:0]</code> of the CANIFnARB1 register are [15:0] of the ID, while these bits, <code>ID[12:0]</code>, are [28:16] of the ID.</p> <p>When using an 11-bit identifier, <code>ID[12:2]</code> are used for bits [10:0] of the ID. The <code>ID</code> field in the CANIFnARB1 register is ignored.</p> | | | | | | |

Register 20: CAN IF1 Message Control (CANIF1MCTL), offset 0x038**Register 21: CAN IF2 Message Control (CANIF2MCTL), offset 0x098**

This register holds the control information associated with the message object to be sent to the Message RAM.

CAN IF1 Message Control (CANIF1MCTL)

CAN0 base: 0x4004.0000

CAN1 base: 0x4004.1000

Offset 0x038

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|--------|--------|-------|------|------|-------|--------|-----|----------|----|----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | NEWDAT | MSGLST | INTPND | UMASK | TXIE | RXIE | RMTEN | TXRQST | EOB | reserved | | | DLC | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|--|------|--------|---|-------|-------------|---|--|---|--|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 15 | NEWDAT | R/W | 0 | New Data <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>No new data has been written into the data portion of this message object by the message handler since the last time this flag was cleared by the CPU.</td> </tr> <tr> <td>1</td> <td>The message handler or the CPU has written new data into the data portion of this message object.</td> </tr> </tbody> </table> | Value | Description | 0 | No new data has been written into the data portion of this message object by the message handler since the last time this flag was cleared by the CPU. | 1 | The message handler or the CPU has written new data into the data portion of this message object. |
| Value | Description | | | | | | | | | |
| 0 | No new data has been written into the data portion of this message object by the message handler since the last time this flag was cleared by the CPU. | | | | | | | | | |
| 1 | The message handler or the CPU has written new data into the data portion of this message object. | | | | | | | | | |
| 14 | MSGLST | R/W | 0 | Message Lost <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>No message was lost since the last time this bit was cleared by the CPU.</td> </tr> <tr> <td>1</td> <td>The message handler stored a new message into this object when NEWDAT was set; the CPU has lost a message.</td> </tr> </tbody> </table> <p>This bit is only valid for message objects when the DIR bit in the CANIFnARB2 register is clear (receive).</p> | Value | Description | 0 | No message was lost since the last time this bit was cleared by the CPU. | 1 | The message handler stored a new message into this object when NEWDAT was set; the CPU has lost a message. |
| Value | Description | | | | | | | | | |
| 0 | No message was lost since the last time this bit was cleared by the CPU. | | | | | | | | | |
| 1 | The message handler stored a new message into this object when NEWDAT was set; the CPU has lost a message. | | | | | | | | | |
| 13 | INTPND | R/W | 0 | Interrupt Pending <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>This message object is not the source of an interrupt.</td> </tr> <tr> <td>1</td> <td>This message object is the source of an interrupt. The interrupt identifier in the CANINT register points to this message object if there is not another interrupt source with a higher priority.</td> </tr> </tbody> </table> | Value | Description | 0 | This message object is not the source of an interrupt. | 1 | This message object is the source of an interrupt. The interrupt identifier in the CANINT register points to this message object if there is not another interrupt source with a higher priority. |
| Value | Description | | | | | | | | | |
| 0 | This message object is not the source of an interrupt. | | | | | | | | | |
| 1 | This message object is the source of an interrupt. The interrupt identifier in the CANINT register points to this message object if there is not another interrupt source with a higher priority. | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|--|------|-------|--|-------|-------------|---|--|---|--|
| 12 | UMASK | R/W | 0 | Use Acceptance Mask <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>Mask is ignored.</td> </tr> <tr> <td>1</td> <td>Use mask (MSK, MXTD, and MDIR bits in the CANIFnMSKn registers) for acceptance filtering.</td> </tr> </table> | Value | Description | 0 | Mask is ignored. | 1 | Use mask (MSK, MXTD, and MDIR bits in the CANIFnMSKn registers) for acceptance filtering. |
| Value | Description | | | | | | | | | |
| 0 | Mask is ignored. | | | | | | | | | |
| 1 | Use mask (MSK, MXTD, and MDIR bits in the CANIFnMSKn registers) for acceptance filtering. | | | | | | | | | |
| 11 | TXIE | R/W | 0 | Transmit Interrupt Enable <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>The INTPND bit in the CANIFnMCTL register is unchanged after a successful transmission of a frame.</td> </tr> <tr> <td>1</td> <td>The INTPND bit in the CANIFnMCTL register is set after a successful transmission of a frame.</td> </tr> </table> | Value | Description | 0 | The INTPND bit in the CANIFnMCTL register is unchanged after a successful transmission of a frame. | 1 | The INTPND bit in the CANIFnMCTL register is set after a successful transmission of a frame. |
| Value | Description | | | | | | | | | |
| 0 | The INTPND bit in the CANIFnMCTL register is unchanged after a successful transmission of a frame. | | | | | | | | | |
| 1 | The INTPND bit in the CANIFnMCTL register is set after a successful transmission of a frame. | | | | | | | | | |
| 10 | RXIE | R/W | 0 | Receive Interrupt Enable <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>The INTPND bit in the CANIFnMCTL register is unchanged after a successful reception of a frame.</td> </tr> <tr> <td>1</td> <td>The INTPND bit in the CANIFnMCTL register is set after a successful reception of a frame.</td> </tr> </table> | Value | Description | 0 | The INTPND bit in the CANIFnMCTL register is unchanged after a successful reception of a frame. | 1 | The INTPND bit in the CANIFnMCTL register is set after a successful reception of a frame. |
| Value | Description | | | | | | | | | |
| 0 | The INTPND bit in the CANIFnMCTL register is unchanged after a successful reception of a frame. | | | | | | | | | |
| 1 | The INTPND bit in the CANIFnMCTL register is set after a successful reception of a frame. | | | | | | | | | |
| 9 | RMTEN | R/W | 0 | Remote Enable <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>At the reception of a remote frame, the TXRQST bit in the CANIFnMCTL register is left unchanged.</td> </tr> <tr> <td>1</td> <td>At the reception of a remote frame, the TXRQST bit in the CANIFnMCTL register is set.</td> </tr> </table> | Value | Description | 0 | At the reception of a remote frame, the TXRQST bit in the CANIFnMCTL register is left unchanged. | 1 | At the reception of a remote frame, the TXRQST bit in the CANIFnMCTL register is set. |
| Value | Description | | | | | | | | | |
| 0 | At the reception of a remote frame, the TXRQST bit in the CANIFnMCTL register is left unchanged. | | | | | | | | | |
| 1 | At the reception of a remote frame, the TXRQST bit in the CANIFnMCTL register is set. | | | | | | | | | |
| 8 | TXRQST | R/W | 0 | Transmit Request <table border="0"> <tr> <td>Value</td> <td>Description</td> </tr> <tr> <td>0</td> <td>This message object is not waiting for transmission.</td> </tr> <tr> <td>1</td> <td>The transmission of this message object is requested and is not yet done.</td> </tr> </table> <p>Note: If the WRNRD and TXRQST bits in the CANIFnCMSK register are set, this bit is ignored.</p> | Value | Description | 0 | This message object is not waiting for transmission. | 1 | The transmission of this message object is requested and is not yet done. |
| Value | Description | | | | | | | | | |
| 0 | This message object is not waiting for transmission. | | | | | | | | | |
| 1 | The transmission of this message object is requested and is not yet done. | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description | | | | | | |
|-----------|---|------|-------|---|-------|-------------|---------|---|---------|--|
| 7 | EOB | R/W | 0 | End of Buffer <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Message object belongs to a FIFO Buffer and is not the last message object of that FIFO Buffer.</td> </tr> <tr> <td>1</td> <td>Single message object or last message object of a FIFO Buffer.</td> </tr> </tbody> </table> <p>This bit is used to concatenate two or more message objects (up to 32) to build a FIFO buffer. For a single message object (thus not belonging to a FIFO buffer), this bit must be set.</p> | Value | Description | 0 | Message object belongs to a FIFO Buffer and is not the last message object of that FIFO Buffer. | 1 | Single message object or last message object of a FIFO Buffer. |
| Value | Description | | | | | | | | | |
| 0 | Message object belongs to a FIFO Buffer and is not the last message object of that FIFO Buffer. | | | | | | | | | |
| 1 | Single message object or last message object of a FIFO Buffer. | | | | | | | | | |
| 6:4 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | |
| 3:0 | DLC | R/W | 0x0 | Data Length Code <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0-0x8</td> <td>Specifies the number of bytes in the data frame.</td> </tr> <tr> <td>0x9-0xF</td> <td>Defaults to a data frame with 8 bytes.</td> </tr> </tbody> </table> <p>The DLC field in the CANIFnMCTL register of a message object must be defined the same as in all the corresponding objects with the same identifier at other nodes. When the message handler stores a data frame, it writes DLC to the value given by the received message.</p> | Value | Description | 0x0-0x8 | Specifies the number of bytes in the data frame. | 0x9-0xF | Defaults to a data frame with 8 bytes. |
| Value | Description | | | | | | | | | |
| 0x0-0x8 | Specifies the number of bytes in the data frame. | | | | | | | | | |
| 0x9-0xF | Defaults to a data frame with 8 bytes. | | | | | | | | | |

Register 22: CAN IF1 Data A1 (CANIF1DA1), offset 0x03C

Register 23: CAN IF1 Data A2 (CANIF1DA2), offset 0x040

Register 24: CAN IF1 Data B1 (CANIF1DB1), offset 0x044

Register 25: CAN IF1 Data B2 (CANIF1DB2), offset 0x048

Register 26: CAN IF2 Data A1 (CANIF2DA1), offset 0x09C

Register 27: CAN IF2 Data A2 (CANIF2DA2), offset 0x0A0

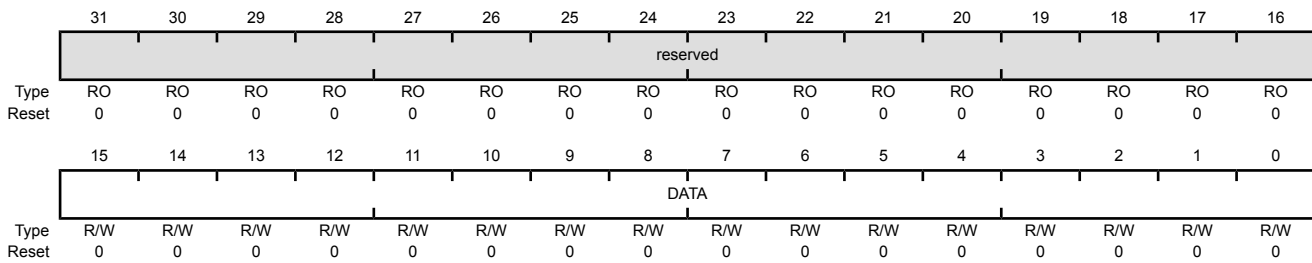
Register 28: CAN IF2 Data B1 (CANIF2DB1), offset 0x0A4

Register 29: CAN IF2 Data B2 (CANIF2DB2), offset 0x0A8

These registers contain the data to be sent or that has been received. In a CAN data frame, data byte 0 is the first byte to be transmitted or received and data byte 7 is the last byte to be transmitted or received. In CAN's serial bit stream, the MSB of each byte is transmitted first.

CAN IF1 Data A1 (CANIF1DA1)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x03C
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | DATA | R/W | 0x0000 | Data The CANIFnDA1 registers contain data bytes 1 and 0; CANIFnDA2 data bytes 3 and 2; CANIFnDB1 data bytes 5 and 4; and CANIFnDB2 data bytes 7 and 6. |

Register 30: CAN Transmission Request 1 (CANTXRQ1), offset 0x100**Register 31: CAN Transmission Request 2 (CANTXRQ2), offset 0x104**

The **CANTXRQ1** and **CANTXRQ2** registers hold the **TXRQST** bits of the 32 message objects. By reading out these bits, the CPU can check which message object has a transmission request pending. The **TXRQST** bit of a specific message object can be changed by three sources: (1) the CPU via the **CANIFnMCTL** register, (2) the message handler state machine after the reception of a remote frame, or (3) the message handler state machine after a successful transmission.

The **CANTXRQ1** register contains the **TXRQST** bits of the first 16 message objects in the message RAM; the **CANTXRQ2** register contains the **TXRQST** bits of the second 16 message objects.

CAN Transmission Request 1 (CANTXRQ1)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x100
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | TXRQST | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|--|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | TXRQST | RO | 0x0000 | Transmission Request Bits |
| | Value | Description | | |
| | 0 | The corresponding message object is not waiting for transmission. | | |
| | 1 | The transmission of the corresponding message object is requested and is not yet done. | | |

Register 32: CAN New Data 1 (CANNWDA1), offset 0x120

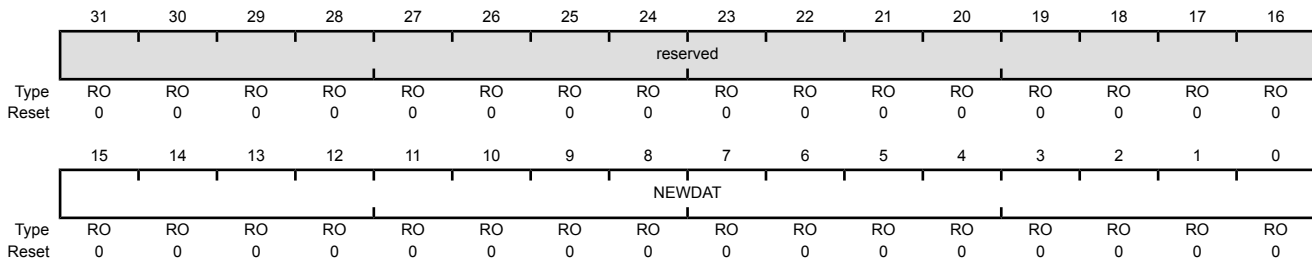
Register 33: CAN New Data 2 (CANNWDA2), offset 0x124

The **CANNWDA1** and **CANNWDA2** registers hold the **NEWDAT** bits of the 32 message objects. By reading these bits, the CPU can check which message object has its data portion updated. The **NEWDAT** bit of a specific message object can be changed by three sources: (1) the CPU via the **CANIFnMCTL** register, (2) the message handler state machine after the reception of a data frame, or (3) the message handler state machine after a successful transmission.

The **CANNWDA1** register contains the **NEWDAT** bits of the first 16 message objects in the message RAM; the **CANNWDA2** register contains the **NEWDAT** bits of the second 16 message objects.

CAN New Data 1 (CANNWDA1)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x120
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | NEWDAT | RO | 0x0000 | New Data Bits |
| | | | | Value Description |
| | | | | 0 No new data has been written into the data portion of the corresponding message object by the message handler since the last time this flag was cleared by the CPU. |
| | | | | 1 The message handler or the CPU has written new data into the data portion of the corresponding message object. |

Register 34: CAN Message 1 Interrupt Pending (CANMSG1INT), offset 0x140**Register 35: CAN Message 2 Interrupt Pending (CANMSG2INT), offset 0x144**

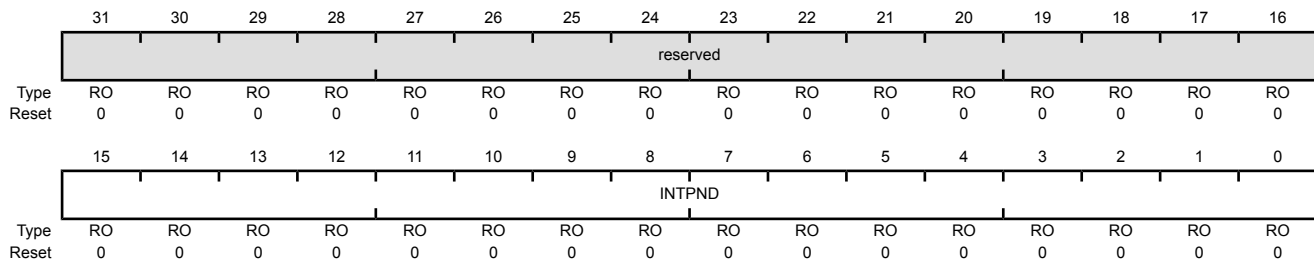
The **CANMSG1INT** and **CANMSG2INT** registers hold the **INTPND** bits of the 32 message objects. By reading these bits, the CPU can check which message object has an interrupt pending. The **INTPND** bit of a specific message object can be changed through two sources: (1) the CPU via the **CANIFnMCTL** register, or (2) the message handler state machine after the reception or transmission of a frame.

This field is also encoded in the **CANINT** register.

The **CANMSG1INT** register contains the **INTPND** bits of the first 16 message objects in the message RAM; the **CANMSG2INT** register contains the **INTPND** bits of the second 16 message objects.

CAN Message 1 Interrupt Pending (CANMSG1INT)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x140
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|---|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | INTPND | RO | 0x0000 | Interrupt Pending Bits |
| | Value | Description | | |
| | 0 | The corresponding message object is not the source of an interrupt. | | |
| | 1 | The corresponding message object is the source of an interrupt. | | |

Register 36: CAN Message 1 Valid (CANMSG1VAL), offset 0x160

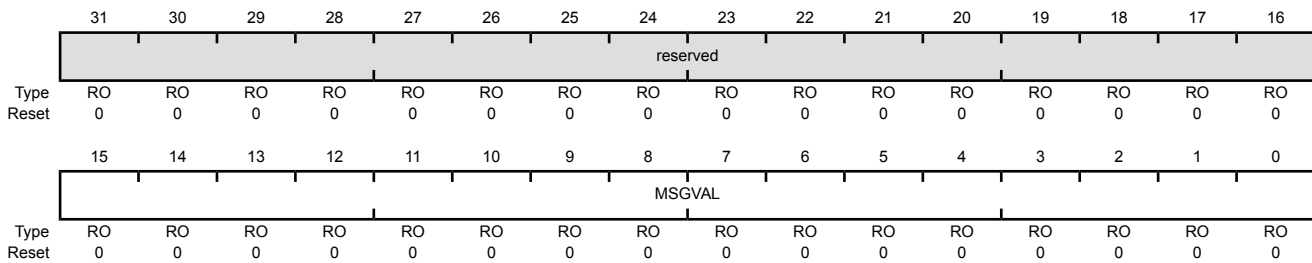
Register 37: CAN Message 2 Valid (CANMSG2VAL), offset 0x164

The **CANMSG1VAL** and **CANMSG2VAL** registers hold the **MSGVAL** bits of the 32 message objects. By reading these bits, the CPU can check which message object is valid. The message valid bit of a specific message object can be changed with the **CANIFnARB2** register.

The **CANMSG1VAL** register contains the **MSGVAL** bits of the first 16 message objects in the message RAM; the **CANMSG2VAL** register contains the **MSGVAL** bits of the second 16 message objects in the message RAM.

CAN Message 1 Valid (CANMSG1VAL)

CAN0 base: 0x4004.0000
 CAN1 base: 0x4004.1000
 Offset 0x160
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | MSGVAL | RO | 0x0000 | Message Valid Bits |
| | | | | Value Description |
| | | | | 0 The corresponding message object is not configured and is ignored by the message handler. |
| | | | | 1 The corresponding message object is configured and should be considered by the message handler. |

19 Analog Comparators

An analog comparator is a peripheral that compares two analog voltages and provides a logical output that signals the comparison result.

Note: Not all comparators have the option to drive an output pin. See “Signal Description” on page 936 for more information.

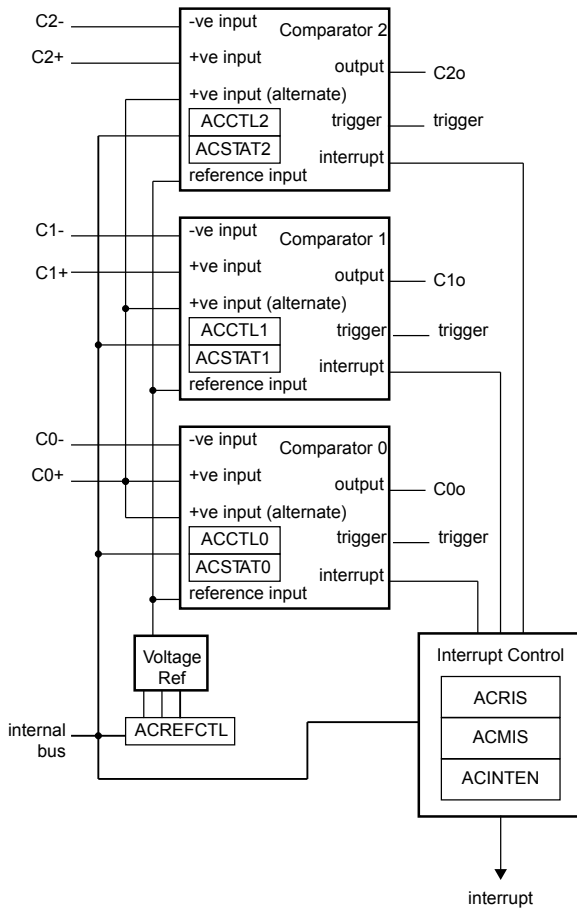
The comparator can provide its output to a device pin, acting as a replacement for an analog comparator on the board. In addition, the comparator can signal the application via interrupts or trigger the start of a sample sequence in the ADC. The interrupt generation and ADC triggering logic is separate and independent. This flexibility means, for example, that an interrupt can be generated on a rising edge and the ADC triggered on a falling edge.

The Stellaris® LM3S2U93 microcontroller provides three independent integrated analog comparators with the following functions:

- Compare external pin input to external pin input or to internal programmable voltage reference
- Compare a test voltage against any one of the following voltages:
 - An individual external reference voltage
 - A shared single external reference voltage
 - A shared internal reference voltage

19.1 Block Diagram

Figure 19-1. Analog Comparator Module Block Diagram



19.2 Signal Description

The following table lists the external signals of the Analog Comparators and describes the function of each. The Analog Comparator output signals are alternate functions for some GPIO signals and default to be GPIO signals at reset. The column in the table below titled "Pin Mux/Pin Assignment" lists the possible GPIO pin placements for the Analog Comparator signals. The `AFSEL` bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the Analog Comparator function. The number in parentheses is the encoding that must be programmed into the `PMCn` field in the **GPIO Port Control (GPIOCTL)** register (page 461) to assign the Analog Comparator signal to the specified GPIO port pin. The positive and negative input signals are configured by clearing the `DEN` bit in the **GPIO Digital Enable (GPIODEN)** register. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 419.

Table 19-1. Analog Comparators Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|-------------------------------------|
| C0+ | 90 | PB6 | I | Analog | Analog comparator 0 positive input. |
| C0- | 92 | PB4 | I | Analog | Analog comparator 0 negative input. |

Table 19-1. Analog Comparators Signals (100LQFP) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|-----------------------------|---|----------|--------------------------|-------------------------------------|
| C0o | 24 58 90 91 100 | PC5 (3) PF4 (2) PB6 (3) PB5 (1) PD7 (2) | O | TTL | Analog comparator 0 output. |
| C1+ | 24 | PC5 | I | Analog | Analog comparator 1 positive input. |
| C1- | 91 | PB5 | I | Analog | Analog comparator 1 negative input. |
| C1o | 2 22 24 46 84 | PE6 (2) PC7 (7) PC5 (2) PF5 (2) PH2 (2) | O | TTL | Analog comparator 1 output. |
| C2+ | 23 | PC6 | I | Analog | Analog comparator 2 positive input. |
| C2- | 22 | PC7 | I | Analog | Analog comparator 2 negative input. |
| C2o | 1 23 43 | PE7 (2) PC6 (3) PF6 (2) | O | TTL | Analog comparator 2 output. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 19-2. Analog Comparators Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|-----------------------------|---|----------|--------------------------|-------------------------------------|
| C0+ | A7 | PB6 | I | Analog | Analog comparator 0 positive input. |
| C0- | A6 | PB4 | I | Analog | Analog comparator 0 negative input. |
| C0o | M1 L9 A7 B7 A2 | PC5 (3) PF4 (2) PB6 (3) PB5 (1) PD7 (2) | O | TTL | Analog comparator 0 output. |
| C1+ | M1 | PC5 | I | Analog | Analog comparator 1 positive input. |
| C1- | B7 | PB5 | I | Analog | Analog comparator 1 negative input. |
| C1o | A1 L2 M1 L8 D11 | PE6 (2) PC7 (7) PC5 (2) PF5 (2) PH2 (2) | O | TTL | Analog comparator 1 output. |
| C2+ | M2 | PC6 | I | Analog | Analog comparator 2 positive input. |
| C2- | L2 | PC7 | I | Analog | Analog comparator 2 negative input. |
| C2o | B1 M2 M8 | PE7 (2) PC6 (3) PF6 (2) | O | TTL | Analog comparator 2 output. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

19.3 Functional Description

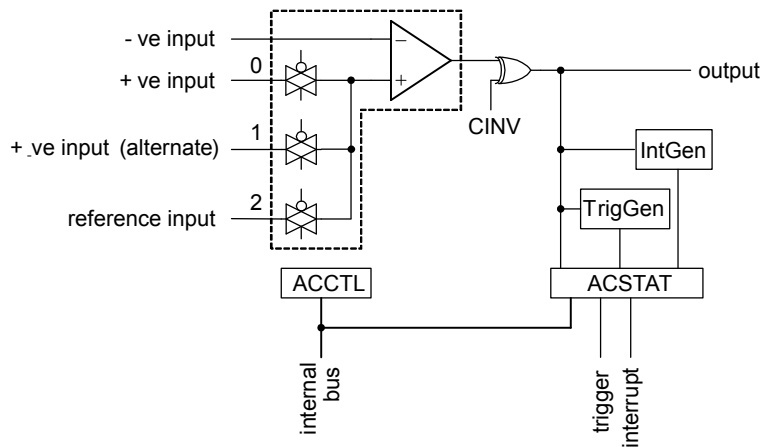
The comparator compares the VIN- and VIN+ inputs to produce an output, VOUT.

$$VIN- < VIN+, VOUT = 1$$

$$VIN- > VIN+, VOUT = 0$$

As shown in Figure 19-2 on page 938, the input source for VIN- is an external input, C_{n-}. In addition to an external input, C_{n+}, input sources for VIN+ can be the C0+ or an internal reference, V_{IREF}.

Figure 19-2. Structure of Comparator Unit



A comparator is configured through two status/control registers, **Analog Comparator Control (ACCTL)** and **Analog Comparator Status (ACSTAT)**. The internal reference is configured through one control register, **Analog Comparator Reference Voltage Control (ACREFCTL)**. Interrupt status and control are configured through three registers, **Analog Comparator Masked Interrupt Status (ACMIS)**, **Analog Comparator Raw Interrupt Status (ACRIS)**, and **Analog Comparator Interrupt Enable (ACINTEN)**.

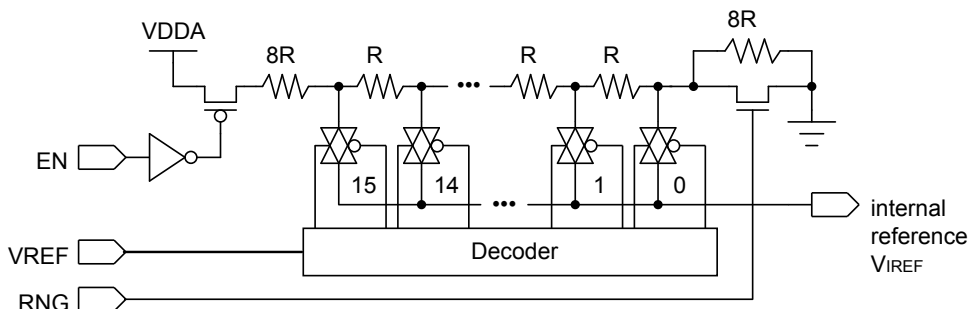
Typically, the comparator output is used internally to generate an interrupt as controlled by the I_{SEN} bit in the **ACCTL** register. The output may also be used to drive an external pin, Co or generate an analog-to-digital converter (ADC) trigger.

Important: The ASRCP bits in the **ACCTL** register must be set before using the analog comparators.

19.3.1 Internal Reference Programming

The structure of the internal reference is shown in Figure 19-3 on page 938. The internal reference is controlled by a single configuration register (**ACREFCTL**).

Figure 19-3. Comparator Internal Reference Structure



The internal reference can be programmed in one of two modes (low range or high range) depending on the RNG bit in the **ACREFCTL** register. When RNG is clear, the internal reference is in high-range mode, and when RNG is set the internal reference is in low-range mode.

In each range, the internal reference, V_{IREF} , has 16 pre-programmed thresholds or step values. The threshold to be used to compare the external input voltage against is selected using the V_{REF} field in the **ACREFCTL** register.

In the high-range mode, the V_{IREF} threshold voltages start at the ideal high-range starting voltage of $V_{DDA}/3.875$ and increase in ideal constant voltage steps of $V_{DDA}/31$.

In the low-range mode, the V_{IREF} threshold voltages start at:0V and increase in ideal constant voltage steps of $V_{DDA}/23$. The ideal V_{IREF} step voltages for each mode and their dependence on the RNG and V_{REF} fields are summarized in Table 19-3 on page 939.

Table 19-3. Internal Reference Voltage and ACREFTL Field Values

| ACREFCTL Register | | Output Reference Voltage Based on V_{REF} Field Value |
|-------------------|---------------|--|
| EN Bit Value | RNG Bit Value | |
| EN=0 | RNG=X | 0 V (GND) for any value of V_{REF} . It is recommended that $RNG=1$ and $V_{REF}=0$ to minimize noise on the reference ground. |
| EN=1 | RNG=0 | <p>Total resistance in ladder is 31 R.</p> $V_{IREF} = V_{DDA} \times \frac{RV_{REF}}{R_T}$ $V_{IREF} = V_{DDA} \times \frac{(V_{REF} + 8)}{31}$ $V_{IREF} = 0.85 + 0.106 \times V_{REF}$ <p>The range of internal reference in this mode is 0.85-2.448 V.</p> |
| | RNG=1 | <p>Total resistance in ladder is 23 R.</p> $V_{IREF} = V_{DDA} \times \frac{RV_{REF}}{R_T}$ $V_{IREF} = V_{DDA} \times \frac{V_{REF}}{23}$ $V_{IREF} = 0.143 \times V_{REF}$ <p>The range of internal reference for this mode is 0-2.152 V.</p> |

19.4 Initialization and Configuration

The following example shows how to configure an analog comparator to read back its output value from an internal register.

1. Enable the analog comparator clock by writing a value of 0x0010.0000 to the **RCGC1** register in the System Control module (see page 262).
2. Enable the clock to the appropriate GPIO modules via the **RCGC2** register (see page 274). To find out which GPIO ports to enable, refer to Table 23-5 on page 1083.
3. In the GPIO module, enable the GPIO port/pin associated with the input signals as GPIO inputs. To determine which GPIO to configure, see Table 23-4 on page 1075.
4. Configure the **PMC_n** fields in the **GPIOPCTL** register to assign the analog comparator output signals to the appropriate pins (see page 461 and Table 23-5 on page 1083).
5. Configure the internal voltage reference to 1.65 V by writing the **ACREFCTL** register with the value 0x0000.030C.
6. Configure the comparator to use the internal voltage reference and to *not* invert the output by writing the **ACCTL_n** register with the value of 0x0000.040C.
7. Delay for 10 μ s.
8. Read the comparator output value by reading the **ACSTAT_n** register's **OVAL** value.

Change the level of the comparator negative input signal **C-** to see the **OVAL** value change.

19.5 Register Map

Table 19-4 on page 940 lists the comparator registers. The offset listed is a hexadecimal increment to the register's address, relative to the Analog Comparator base address of 0x4003.C000. Note that the analog comparator clock must be enabled before the registers can be programmed (see page 262). There must be a delay of 3 system clocks after the analog comparator module clock is enabled before any analog comparator module registers are accessed.

Table 19-4. Analog Comparators Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|----------|-------|-------------|---|----------|
| 0x000 | ACMIS | R/W1C | 0x0000.0000 | Analog Comparator Masked Interrupt Status | 942 |
| 0x004 | ACRIS | RO | 0x0000.0000 | Analog Comparator Raw Interrupt Status | 943 |
| 0x008 | ACINTEN | R/W | 0x0000.0000 | Analog Comparator Interrupt Enable | 944 |
| 0x010 | ACREFCTL | R/W | 0x0000.0000 | Analog Comparator Reference Voltage Control | 945 |
| 0x020 | ACSTAT0 | RO | 0x0000.0000 | Analog Comparator Status 0 | 946 |
| 0x024 | ACCTL0 | R/W | 0x0000.0000 | Analog Comparator Control 0 | 947 |
| 0x040 | ACSTAT1 | RO | 0x0000.0000 | Analog Comparator Status 1 | 946 |
| 0x044 | ACCTL1 | R/W | 0x0000.0000 | Analog Comparator Control 1 | 947 |
| 0x060 | ACSTAT2 | RO | 0x0000.0000 | Analog Comparator Status 2 | 946 |
| 0x064 | ACCTL2 | R/W | 0x0000.0000 | Analog Comparator Control 2 | 947 |

19.6 Register Descriptions

The remainder of this section lists and describes the Analog Comparator registers, in numerical order by address offset.

Register 1: Analog Comparator Masked Interrupt Status (ACMIS), offset 0x000

This register provides a summary of the interrupt status (masked) of the comparators.

Analog Comparator Masked Interrupt Status (ACMIS)

Base 0x4003.C000

Offset 0x000

Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-----|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | IN2 | IN1 | IN0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|------------|---|
| 31:3 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | IN2 | R/W1C | 0 | <p>Comparator 2 Masked Interrupt Status</p> <p>Value Description</p> <p>1 The IN2 bits in the ACRIS register and the ACINTEN registers are set, providing an interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the IN2 bit in the ACRIS register.</p> |
| 1 | IN1 | R/W1C | 0 | <p>Comparator 1 Masked Interrupt Status</p> <p>Value Description</p> <p>1 The IN1 bits in the ACRIS register and the ACINTEN registers are set, providing an interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the IN1 bit in the ACRIS register.</p> |
| 0 | IN0 | R/W1C | 0 | <p>Comparator 0 Masked Interrupt Status</p> <p>Value Description</p> <p>1 The IN0 bits in the ACRIS register and the ACINTEN registers are set, providing an interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the IN0 bit in the ACRIS register.</p> |

Register 2: Analog Comparator Raw Interrupt Status (ACRIS), offset 0x004

This register provides a summary of the interrupt status (raw) of the comparators. The bits in this register must be enabled to generate interrupts using the **ACINTEN** register.

Analog Comparator Raw Interrupt Status (ACRIS)

Base 0x4003.C000

Offset 0x004

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | IN2 | IN1 | IN0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:3 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | IN2 | RO | 0 | <p>Comparator 2 Interrupt Status</p> <p>Value Description</p> <p>1 Comparator 2 has generated an interrupt for an event as configured by the ISEN bit in the ACCTL2 register.</p> <p>0 An interrupt has not occurred.</p> <p>This bit is cleared by writing a 1 to the IN2 bit in the ACMIS register.</p> |
| 1 | IN1 | RO | 0 | <p>Comparator 1 Interrupt Status</p> <p>Value Description</p> <p>1 Comparator 1 has generated an interrupt for an event as configured by the ISEN bit in the ACCTL1 register.</p> <p>0 An interrupt has not occurred.</p> <p>This bit is cleared by writing a 1 to the IN1 bit in the ACMIS register.</p> |
| 0 | IN0 | RO | 0 | <p>Comparator 0 Interrupt Status</p> <p>Value Description</p> <p>1 Comparator 0 has generated an interrupt for an event as configured by the ISEN bit in the ACCTL0 register.</p> <p>0 An interrupt has not occurred.</p> <p>This bit is cleared by writing a 1 to the IN0 bit in the ACMIS register.</p> |

Register 3: Analog Comparator Interrupt Enable (ACINTEN), offset 0x008

This register provides the interrupt enable for the comparators.

Analog Comparator Interrupt Enable (ACINTEN)

Base 0x4003.C000
 Offset 0x008
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | IN2 | IN1 | IN0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:3 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 2 | IN2 | R/W | 0 | Comparator 2 Interrupt Enable Value Description 1 The raw interrupt signal comparator 2 is sent to the interrupt controller. 0 A comparator 2 interrupt does not affect the interrupt status. |
| 1 | IN1 | R/W | 0 | Comparator 1 Interrupt Enable Value Description 1 The raw interrupt signal comparator 1 is sent to the interrupt controller. 0 A comparator 1 interrupt does not affect the interrupt status. |
| 0 | IN0 | R/W | 0 | Comparator 0 Interrupt Enable Value Description 1 The raw interrupt signal comparator 0 is sent to the interrupt controller. 0 A comparator 0 interrupt does not affect the interrupt status. |

Register 4: Analog Comparator Reference Voltage Control (ACREFCTL), offset 0x010

This register specifies whether the resistor ladder is powered on as well as the range and tap.

Analog Comparator Reference Voltage Control (ACREFCTL)

Base 0x4003.C000

Offset 0x010

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|-----|-----|----------|----|----|----|-----|------|-----|-----|--|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | EN | RNG | reserved | | | | | VREF | | | |
| Type | RO | RO | RO | RO | RO | RO | R/W | R/W | RO | RO | RO | RO | R/W | R/W | R/W | R/W | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:10 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 9 | EN | R/W | 0 | Resistor Ladder Enable Value Description 0 The resistor ladder is unpowered. 1 Powers on the resistor ladder. The resistor ladder is connected to V_{DDA} . This bit is cleared at reset so that the internal reference consumes the least amount of power if it is not used. |
| 8 | RNG | R/W | 0 | Resistor Ladder Range Value Description 0 The resistor ladder has a total resistance of 31 R. 1 The resistor ladder has a total resistance of 23 R. |
| 7:4 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3:0 | VREF | R/W | 0x0 | Resistor Ladder Voltage Ref The V_{REF} bit field specifies the resistor ladder tap that is passed through an analog multiplexer. The voltage corresponding to the tap position is the internal reference voltage available for comparison. See Table 19-3 on page 939 for some output reference voltage examples. |

Register 5: Analog Comparator Status 0 (ACSTAT0), offset 0x020

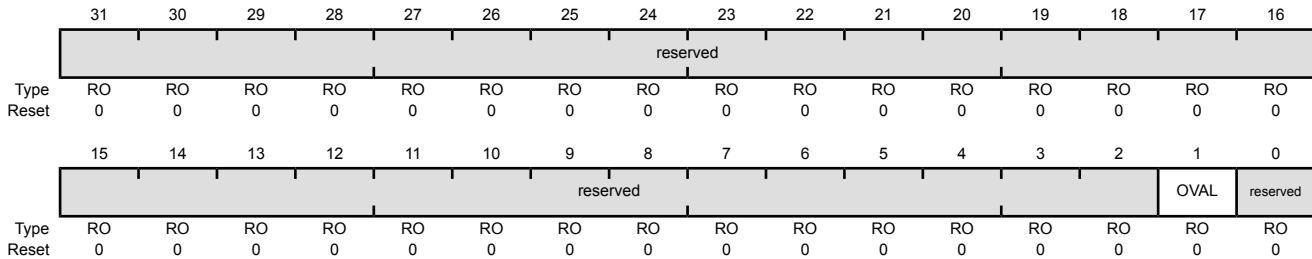
Register 6: Analog Comparator Status 1 (ACSTAT1), offset 0x040

Register 7: Analog Comparator Status 2 (ACSTAT2), offset 0x060

These registers specify the current output value of the comparator.

Analog Comparator Status 0 (ACSTAT0)

Base 0x4003.C000
 Offset 0x020
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:2 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | OVAL | RO | 0 | Comparator Output Value Value Description 0 VIN- > VIN+ 1 VIN- < VIN+ VIN- is the voltage on the C _{n-} pin. VIN+ is the voltage on the C _{n+} pin, the C0+ pin, or the internal voltage reference (V _{REF}) as defined by the ASRCP bit in the ACCTL register. |
| 0 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

Register 8: Analog Comparator Control 0 (ACCTL0), offset 0x024**Register 9: Analog Comparator Control 1 (ACCTL1), offset 0x044****Register 10: Analog Comparator Control 2 (ACCTL2), offset 0x064**

These registers configure the comparator's input and output.

Analog Comparator Control 0 (ACCTL0)

Base 0x4003.C000

Offset 0x024

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|------|-------|-----|----|----------|--------|------|-----|--------|------|-----|------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | TOEN | ASRCP | | | reserved | TSLVAL | TSEN | | ISLVAL | ISEN | | CINV | reserved |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 11 | TOEN | R/W | 0 | Trigger Output Enable Value Description 0 ADC events are suppressed and not sent to the ADC. 1 ADC events are sent to the ADC. |
| 10:9 | ASRCP | R/W | 0x0 | Analog Source Positive The ASRCP field specifies the source of input voltage to the VIN+ terminal of the comparator. The encodings for this field are as follows: Value Description 0x0 Pin value of Cn+ 0x1 Pin value of C0+ 0x2 Internal voltage reference (V _{REF}) 0x3 Reserved |
| 8 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | TSLVAL | R/W | 0 | Trigger Sense Level Value Value Description 0 An ADC event is generated if the comparator output is Low. 1 An ADC event is generated if the comparator output is High. |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|--|------|-------|--|-------|-------------|-----|--|-----|--|-----|-------------|-----|-------------|
| 6:5 | TSEN | R/W | 0x0 | <p>Trigger Sense</p> <p>The TSEN field specifies the sense of the comparator output that generates an ADC event. The sense conditioning is as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Level sense, see TSLVAL</td> </tr> <tr> <td>0x1</td> <td>Falling edge</td> </tr> <tr> <td>0x2</td> <td>Rising edge</td> </tr> <tr> <td>0x3</td> <td>Either edge</td> </tr> </tbody> </table> | Value | Description | 0x0 | Level sense, see TSLVAL | 0x1 | Falling edge | 0x2 | Rising edge | 0x3 | Either edge |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | Level sense, see TSLVAL | | | | | | | | | | | | | |
| 0x1 | Falling edge | | | | | | | | | | | | | |
| 0x2 | Rising edge | | | | | | | | | | | | | |
| 0x3 | Either edge | | | | | | | | | | | | | |
| 4 | ISLVAL | R/W | 0 | <p>Interrupt Sense Level Value</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>An interrupt is generated if the comparator output is Low.</td> </tr> <tr> <td>1</td> <td>An interrupt is generated if the comparator output is High.</td> </tr> </tbody> </table> | Value | Description | 0 | An interrupt is generated if the comparator output is Low. | 1 | An interrupt is generated if the comparator output is High. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | An interrupt is generated if the comparator output is Low. | | | | | | | | | | | | | |
| 1 | An interrupt is generated if the comparator output is High. | | | | | | | | | | | | | |
| 3:2 | ISEN | R/W | 0x0 | <p>Interrupt Sense</p> <p>The ISEN field specifies the sense of the comparator output that generates an interrupt. The sense conditioning is as follows:</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Level sense, see ISLVAL</td> </tr> <tr> <td>0x1</td> <td>Falling edge</td> </tr> <tr> <td>0x2</td> <td>Rising edge</td> </tr> <tr> <td>0x3</td> <td>Either edge</td> </tr> </tbody> </table> | Value | Description | 0x0 | Level sense, see ISLVAL | 0x1 | Falling edge | 0x2 | Rising edge | 0x3 | Either edge |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | Level sense, see ISLVAL | | | | | | | | | | | | | |
| 0x1 | Falling edge | | | | | | | | | | | | | |
| 0x2 | Rising edge | | | | | | | | | | | | | |
| 0x3 | Either edge | | | | | | | | | | | | | |
| 1 | CINV | R/W | 0 | <p>Comparator Output Invert</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>The output of the comparator is unchanged.</td> </tr> <tr> <td>1</td> <td>The output of the comparator is inverted prior to being processed by hardware.</td> </tr> </tbody> </table> | Value | Description | 0 | The output of the comparator is unchanged. | 1 | The output of the comparator is inverted prior to being processed by hardware. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | The output of the comparator is unchanged. | | | | | | | | | | | | | |
| 1 | The output of the comparator is inverted prior to being processed by hardware. | | | | | | | | | | | | | |
| 0 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |

20 Pulse Width Modulator (PWM)

Pulse width modulation (PWM) is a powerful technique for digitally encoding analog signal levels. High-resolution counters are used to generate a square wave, and the duty cycle of the square wave is modulated to encode an analog signal. Typical applications include switching power supplies and motor control.

The Stellaris® microcontroller contains one PWM module, with four PWM generator blocks and a control block, for a total of 8 PWM outputs. The control block determines the polarity of the PWM signals, and which signals are passed through to the pins.

Each PWM generator block produces two PWM signals that share the same timer and frequency and can either be programmed with independent actions or as a single pair of complementary signals with dead-band delays inserted. The output signals, `pwmA'` and `pwmB'`, of the PWM generation blocks are managed by the output control block before being passed to the device pins as `PWM0` and `PWM1` or `PWM2` and `PWM3`, and so on.

The Stellaris PWM module provides a great deal of flexibility and can generate simple PWM signals, such as those required by a simple charge pump as well as paired PWM signals with dead-band delays, such as those required by a half-H bridge driver. Three generator blocks can also generate the full six channels of gate controls required by a 3-phase inverter bridge.

Each PWM generator block has the following features:

- Four fault-condition handling inputs to quickly provide low-latency shutdown and prevent damage to the motor being controlled
- One 16-bit counter
 - Runs in Down or Up/Down mode
 - Output frequency controlled by a 16-bit load value
 - Load value updates can be synchronized
 - Produces output signals at zero and load value
- Two PWM comparators
 - Comparator value updates can be synchronized
 - Produces output signals on match
- PWM signal generator
 - Output PWM signal is constructed based on actions taken as a result of the counter and PWM comparator output signals
 - Produces two independent PWM signals
- Dead-band generator
 - Produces two PWM signals with programmable dead-band delays suitable for driving a half-H bridge
 - Can be bypassed, leaving input PWM signals unmodified

- Can initiate an ADC sample sequence

The control block determines the polarity of the PWM signals and which signals are passed through to the pins. The output of the PWM generation blocks are managed by the output control block before being passed to the device pins. The PWM control block has the following options:

- PWM output enable of each PWM signal
- Optional output inversion of each PWM signal (polarity control)
- Optional fault handling for each PWM signal
- Synchronization of timers in the PWM generator blocks
- Synchronization of timer/comparator updates across the PWM generator blocks
- Extended PWM synchronization of timer/comparator updates across the PWM generator blocks
- Interrupt status summary of the PWM generator blocks
- Extended PWM fault handling, with multiple fault signals, programmable polarities, and filtering
- PWM generators can be operated independently or synchronized with other generators

20.1 Block Diagram

Figure 20-1 on page 951 provides the Stellaris PWM module diagram and Figure 20-2 on page 951 provides a more detailed diagram of a Stellaris PWM generator. The LM3S2U93 controller contains four generator blocks that generate eight independent PWM signals or four paired PWM signals with dead-band delays inserted.

Figure 20-1. PWM Module Diagram

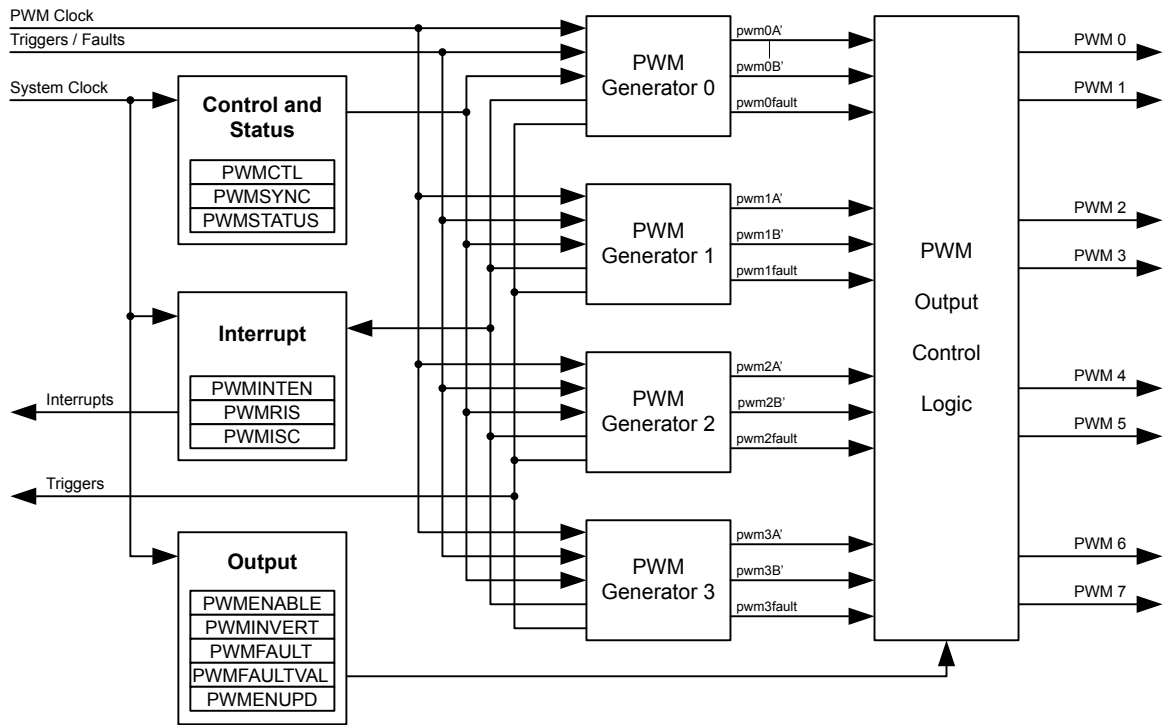
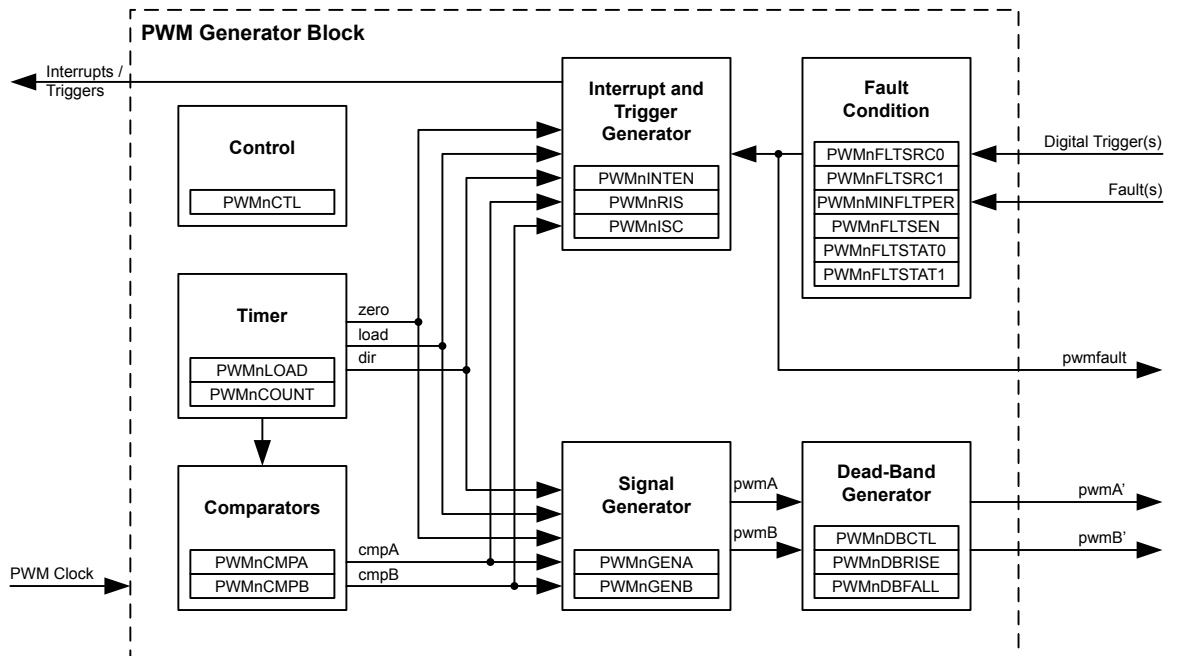


Figure 20-2. PWM Generator Block Diagram



20.2 Signal Description

The following table lists the external signals of the PWM module and describes the function of each. The PWM controller signals are alternate functions for some GPIO signals and default to be GPIO

signals at reset. The column in the table below titled "Pin Mux/Pin Assignment" lists the possible GPIO pin placements for these PWM signals. The `AFSEL` bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the PWM function. The number in parentheses is the encoding that must be programmed into the `PMCn` field in the **GPIO Port Control (GPIOCTL)** register (page 461) to assign the PWM signal to the specified GPIO port pin. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 419.

Table 20-1. PWM Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|--|
| Fault0 | 6 | PE4 (4) | I | TTL | PWM Fault 0. |
| | 16 | PG3 (8) | | | |
| | 17 | PG2 (4) | | | |
| | 39 | PJ2 (10) | | | |
| | 58 | PF4 (4) | | | |
| | 65 | PB3 (2) | | | |
| | 75 | PE1 (3) | | | |
| | 83 | PH3 (2) | | | |
| | 99 | PD6 (1) | | | |
| Fault1 | 37 | PG6 (8) | I | TTL | PWM Fault 1. |
| | 40 | PG5 (5) | | | |
| | 41 | PG4 (4) | | | |
| | 42 | PF7 (9) | | | |
| | 90 | PB6 (4) | | | |
| Fault2 | 16 | PG3 (4) | I | TTL | PWM Fault 2. |
| | 24 | PC5 (4) | | | |
| | 63 | PH5 (10) | | | |
| Fault3 | 65 | PB3 (4) | I | TTL | PWM Fault 3. |
| | 84 | PH2 (4) | | | |
| PWM0 | 10 | PD0 (1) | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | 14 | PJ0 (10) | | | |
| | 17 | PG2 (1) | | | |
| | 19 | PG0 (2) | | | |
| | 34 | PA6 (4) | | | |
| | 47 | PF0 (3) | | | |
| PWM1 | 11 | PD1 (1) | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | 16 | PG3 (1) | | | |
| | 18 | PG1 (2) | | | |
| | 35 | PA7 (4) | | | |
| | 61 | PF1 (3) | | | |
| | 87 | PJ1 (10) | | | |
| PWM2 | 12 | PD2 (3) | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | 60 | PF2 (4) | | | |
| | 66 | PB0 (2) | | | |
| | 86 | PH0 (2) | | | |
| PWM3 | 13 | PD3 (3) | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | 59 | PF3 (4) | | | |
| | 67 | PB1 (2) | | | |
| | 85 | PH1 (2) | | | |

Table 20-1. PWM Signals (100LQFP) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|---|---|----------|--------------------------|--|
| PWM4 | 2 19 28 34 60 62 74 86 | PE6 (1) PG0 (4) PA2 (4) PA6 (5) PF2 (2) PH6 (10) PE0 (1) PH0 (9) | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| PWM5 | 1 15 18 29 35 59 75 85 | PE7 (1) PH7 (10) PG1 (4) PA3 (4) PA7 (5) PF3 (2) PE1 (1) PH1 (9) | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| PWM6 | 25 30 37 41 | PC4 (4) PA4 (4) PG6 (4) PG4 (9) | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| PWM7 | 23 31 36 40 | PC6 (4) PA5 (4) PG7 (4) PG5 (8) | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 20-2. PWM Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|---|--|----------|--------------------------|--------------|
| Fault0 | B2 J2 J1 K6 L9 E11 A12 D10 A3 | PE4 (4) PG3 (8) PG2 (4) PJ2 (10) PF4 (4) PB3 (2) PE1 (3) PH3 (2) PD6 (1) | I | TTL | PWM Fault 0. |
| Fault1 | L7 M7 K3 K4 A7 | PG6 (8) PG5 (5) PG4 (4) PF7 (9) PB6 (4) | I | TTL | PWM Fault 1. |
| Fault2 | J2 M1 F10 | PG3 (4) PC5 (4) PH5 (10) | I | TTL | PWM Fault 2. |
| Fault3 | E11 D11 | PB3 (4) PH2 (4) | I | TTL | PWM Fault 3. |

Table 20-2. PWM Signals (108BGA) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|--|---|----------|--------------------------|--|
| PWM0 | G1 F3 J1 K1 L6 M9 | PD0 (1) PJ0 (10) PG2 (1) PG0 (2) PA6 (4) PF0 (3) | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| PWM1 | G2 J2 K2 M6 H12 B6 | PD1 (1) PG3 (1) PG1 (2) PA7 (4) PF1 (3) PJ1 (10) | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| PWM2 | H2 J11 E12 C9 | PD2 (3) PF2 (4) PB0 (2) PH0 (2) | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| PWM3 | H1 J12 D12 C8 | PD3 (3) PF3 (4) PB1 (2) PH1 (2) | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| PWM4 | A1 K1 M4 L6 J11 G3 B11 C9 | PE6 (1) PG0 (4) PA2 (4) PA6 (5) PF2 (2) PH6 (10) PE0 (1) PH0 (9) | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| PWM5 | B1 H3 K2 L4 M6 J12 A12 C8 | PE7 (1) PH7 (10) PG1 (4) PA3 (4) PA7 (5) PF3 (2) PE1 (1) PH1 (9) | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| PWM6 | L1 L5 L7 K3 | PC4 (4) PA4 (4) PG6 (4) PG4 (9) | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| PWM7 | M2 M5 C10 M7 | PC6 (4) PA5 (4) PG7 (4) PG5 (8) | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

20.3 Functional Description

20.3.1 PWM Timer

The timer in each PWM generator runs in one of two modes: Count-Down mode or Count-Up/Down mode. In Count-Down mode, the timer counts from the load value to zero, goes back to the load value, and continues counting down. In Count-Up/Down mode, the timer counts from zero up to the load value, back down to zero, back up to the load value, and so on. Generally, Count-Down mode

is used for generating left- or right-aligned PWM signals, while the Count-Up/Down mode is used for generating center-aligned PWM signals.

The timers output three signals that are used in the PWM generation process: the direction signal (this is always Low in Count-Down mode, but alternates between Low and High in Count-Up/Down mode), a single-clock-cycle-width High pulse when the counter is zero, and a single-clock-cycle-width High pulse when the counter is equal to the load value. Note that in Count-Down mode, the zero pulse is immediately followed by the load pulse. In the figures in this chapter, these signals are labelled "dir," "zero," and "load."

20.3.2 PWM Comparators

Each PWM generator has two comparators that monitor the value of the counter; when either comparator matches the counter, they output a single-clock-cycle-width High pulse, labelled "cmpA" and "cmpB" in the figures in this chapter. When in Count-Up/Down mode, these comparators match both when counting up and when counting down, and thus are qualified by the counter direction signal. These qualified pulses are used in the PWM generation process. If either comparator match value is greater than the counter load value, then that comparator never outputs a High pulse.

Figure 20-3 on page 956 shows the behavior of the counter and the relationship of these pulses when the counter is in Count-Down mode. Figure 20-4 on page 956 shows the behavior of the counter and the relationship of these pulses when the counter is in Count-Up/Down mode. In these figures, the following definitions apply:

- LOAD is the value in the **PWMnLOAD** register
- COMPA is the value in the **PWMnCMPA** register
- COMPB is the value in the **PWMnCMPB** register
- 0 is the value zero
- load is the internal signal that has a single-clock-cycle-width High pulse when the counter is equal to the load value
- zero is the internal signal that has a single-clock-cycle-width High pulse when the counter is zero
- cmpA is the internal signal that has a single-clock-cycle-width High pulse when the counter is equal to COMPA
- cmpB is the internal signal that has a single-clock-cycle-width High pulse when the counter is equal to COMPB
- dir is the internal signal that indicates the count direction

Figure 20-3. PWM Count-Down Mode

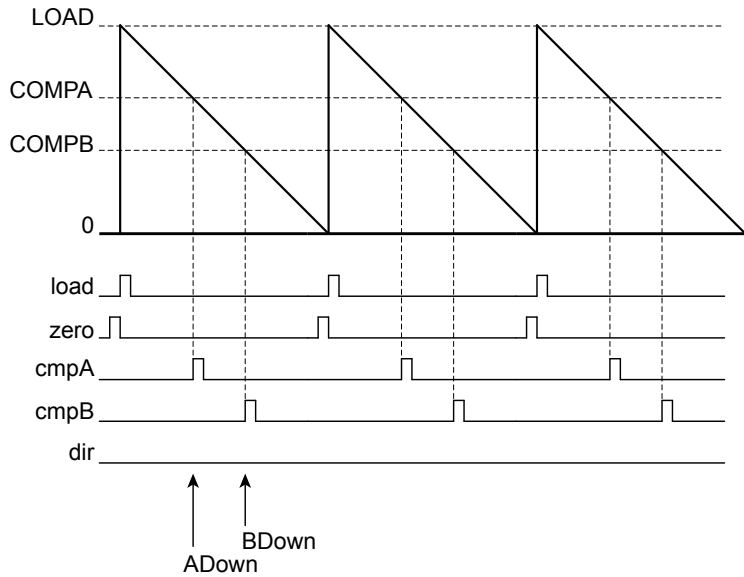
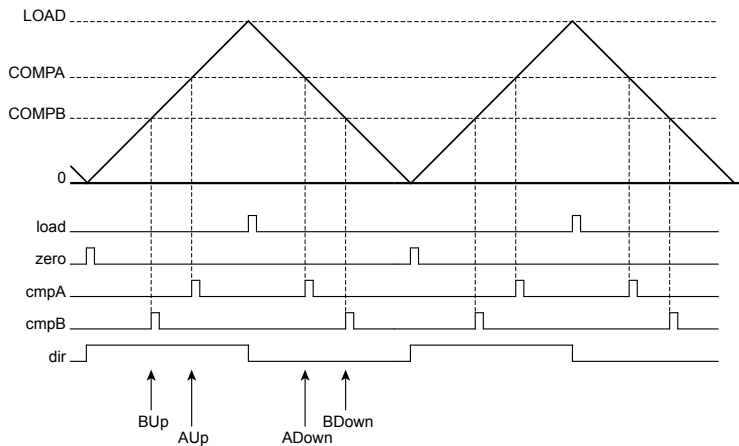


Figure 20-4. PWM Count-Up/Down Mode



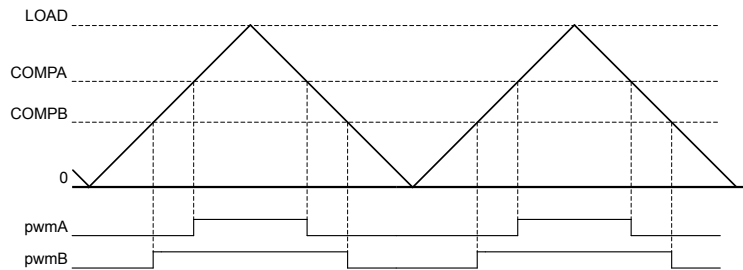
20.3.3 PWM Signal Generator

Each PWM generator takes the load, zero, cmpA, and cmpB pulses (qualified by the dir signal) and generates two internal PWM signals, pwmA and pwmB. In Count-Down mode, there are four events that can affect these signals: zero, load, match A down, and match B down. In Count-Up/Down mode, there are six events that can affect these signals: zero, load, match A down, match A up, match B down, and match B up. The match A or match B events are ignored when they coincide with the zero or load events. If the match A and match B events coincide, the first signal, pwmA, is generated based only on the match A event, and the second signal, pwmB, is generated based only on the match B event.

For each event, the effect on each output PWM signal is programmable: it can be left alone (ignoring the event), it can be toggled, it can be driven Low, or it can be driven High. These actions can be used to generate a pair of PWM signals of various positions and duty cycles, which do or do not overlap. Figure 20-5 on page 957 shows the use of Count-Up/Down mode to generate a pair of

center-aligned, overlapped PWM signals that have different duty cycles. This figure shows the pwmA and pwmB signals before they have passed through the dead-band generator.

Figure 20-5. PWM Generation Example In Count-Up/Down Mode



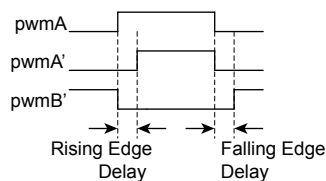
In this example, the first generator is set to drive High on match A up, drive Low on match A down, and ignore the other four events. The second generator is set to drive High on match B up, drive Low on match B down, and ignore the other four events. Changing the value of comparator A changes the duty cycle of the pwmA signal, and changing the value of comparator B changes the duty cycle of the pwmB signal.

20.3.4 Dead-Band Generator

The pwmA and pwmB signals produced by each PWM generator are passed to the dead-band generator. If the dead-band generator is disabled, the PWM signals simply pass through to the pwmA' and pwmB' signals unmodified. If the dead-band generator is enabled, the pwmB signal is lost and two PWM signals are generated based on the pwmA signal. The first output PWM signal, pwmA' is the pwmA signal with the rising edge delayed by a programmable amount. The second output PWM signal, pwmB', is the inversion of the pwmA signal with a programmable delay added between the falling edge of the pwmA signal and the rising edge of the pwmB' signal.

The resulting signals are a pair of active High signals where one is always High, except for a programmable amount of time at transitions where both are Low. These signals are therefore suitable for driving a half-H bridge, with the dead-band delays preventing shoot-through current from damaging the power electronics. Figure 20-6 on page 957 shows the effect of the dead-band generator on the pwmA signal and the resulting pwmA' and pwmB' signals that are transmitted to the output control block.

Figure 20-6. PWM Dead-Band Generator



20.3.5 Interrupt/ADC-Trigger Selector

Each PWM generator also takes the same four (or six) counter events and uses them to generate an interrupt or an ADC trigger. Any of these events or a set of these events can be selected as a source for an interrupt; when any of the selected events occur, an interrupt is generated. Additionally, the same event, a different event, the same set of events, or a different set of events can be selected as a source for an ADC trigger; when any of these selected events occur, an ADC trigger pulse is generated. The selection of events allows the interrupt or ADC trigger to occur at a specific position

within the pwmA or pwmB signal. Note that interrupts and ADC triggers are based on the raw events; delays in the PWM signal edges caused by the dead-band generator are not taken into account.

20.3.6 Synchronization Methods

The PWM module provides four PWM generators, each providing two PWM outputs that may be used in a wide variety of applications. Generally speaking, the PWM is used in one of two categories of operation:

- **Unsynchronized.** The PWM generator and its two output signals are used alone, independent of other PWM generators.
- **Synchronized.** The PWM generator and its two outputs signals are used in conjunction with other PWM generators using a common, unified time base. If multiple PWM generators are configured with the same counter load value, synchronization can be used to guarantee that they also have the same count value (the PWM generators must be configured before they are synchronized). With this feature, more than two PWM_n signals can be produced with a known relationship between the edges of those signals because the counters always have the same values. Other states in the module provide mechanisms to maintain the common time base and mutual synchronization.

The counter in a PWM generator can be reset to zero by writing the **PWM Time Base Sync (PWMSYNC)** register and setting the $SYNC_n$ bit associated with the generator. Multiple PWM generators can be synchronized together by setting all necessary $SYNC_n$ bits in one access. For example, setting the $SYNC_0$ and $SYNC_1$ bits in the **PWMSYNC** register causes the counters in PWM generators 0 and 1 to reset together.

Additional synchronization can occur between multiple PWM generators by updating register contents in one of the following three ways:

- **Immediately.** The write value has immediate effect, and the hardware reacts immediately.
- **Locally Synchronized.** The write value does not affect the logic until the counter reaches the value zero at the end of the PWM cycle. In this case, the effect of the write is deferred, providing a guaranteed defined behavior and preventing overly short or overly long output PWM pulses.
- **Globally Synchronized.** The write value does not affect the logic until two sequential events have occurred: (1) the Update mode for the generator function is programmed for global synchronization in the **PWMnCTL** register, and (2) the counter reaches zero at the end of the PWM cycle. In this case, the effect of the write is deferred until the end of the PWM cycle following the end of all updates. This mode allows multiple items in multiple PWM generators to be updated simultaneously without odd effects during the update; everything runs from the old values until a point at which they all run from the new values. The Update mode of the load and comparator match values can be individually configured in each PWM generator block. It typically makes sense to use the synchronous update mechanism across PWM generator blocks when the timers in those blocks are synchronized, although this is not required in order for this mechanism to function properly.

The following registers provide either local or global synchronization based on the state of various Update mode bits and fields in the **PWMnCTL** register ($LOADUPD$; $CMPAUPD$; $CMPBUPD$):

- Generator Registers: **PWMnLOAD**, **PWMnCMPA**, and **PWMnCMPB**

The following registers default to immediate update, but are provided with the optional functionality of synchronously updating rather than having all updates take immediate effect:

- Module-Level Register: **PWMENABLE** (based on the state of the `ENUPDn` bits in the `PWMENUPD` register).
- Generator Register: **PWMnGENA**, **PWMnGENB**, **PWMnDBCTL**, **PWMnDBRISE**, and **PWMnDBFALL** (based on the state of various Update mode bits and fields in the **PWMnCTL** register (`GENAUPD`; `GENBUPD`; `DBCTLUPD`; `DBRISEUPD`; `DBFALLUPD`)).

All other registers are considered statically provisioned for the execution of an application or are used dynamically for purposes unrelated to maintaining synchronization and therefore do not need synchronous update functionality.

20.3.7 Fault Conditions

A fault condition is one in which the controller must be signaled to stop normal PWM function and then set the `PWMn` signals to a safe state. Two basic situations cause fault conditions:

- The microcontroller is stalled and cannot perform the necessary computation in the time required for motion control
- An external error or event is detected

The PWM generator can use the following inputs to generate a fault condition, including:

- `FAULTn` pin assertion
- A stall of the controller generated by the debugger
- The trigger of an ADC digital comparator

Fault conditions are calculated on a per-PWM generator basis. Each PWM generator configures the necessary conditions to indicate a fault condition exists. This method allows the development of applications with dependent and independent control.

Four fault input pins (`FAULT0-FAULT3`) are available. These inputs may be used with circuits that generate an active High or active Low signal to indicate an error condition. A `FAULTn` pins may be individually programmed for the appropriate logic sense using the **PWMnFLTSEN** register.

The PWM generator's mode control, including fault condition handling, is provided in the **PWMnCTL** register. This register determines whether the input or a combination of `FAULTn` input signals and/or digital comparator triggers (as configured by the **PWMnFLTSRC0** and **PWMnFLTSRC1** registers) is used to generate a fault condition. The **PWMnCTL** register also selects whether the fault condition is maintained as long as the external condition lasts or if it is latched until the fault condition until cleared by software. Finally, this register also enables a counter that may be used to extend the period of a fault condition for external events to assure that the duration is a minimum length. The minimum fault period count is specified in the **PWMnMINFLTPER** register.

Status regarding the specific fault cause is provided in the **PWMnFLTSTAT0** and **PWMnFLTSTAT1** registers.

PWM generator fault conditions may be promoted to a controller interrupt using the **PWMINTEN** register.

20.3.8 Output Control Block

The output control block takes care of the final conditioning of the `pwmA'` and `pwmB'` signals before they go to the pins as the `PWMn` signals. Via a single register, the **PWM Output Enable** (**PWENABLE**) register, the set of PWM signals that are actually enabled to the pins can be modified.

This function can be used, for example, to perform commutation of a brushless DC motor with a single register write (and without modifying the individual PWM generators, which are modified by the feedback control loop). In addition, the updating of the bits in the **PWMENABLE** register can be configured to be immediate or locally or globally synchronized to the next synchronous update using the **PWM Enable Update (PWMENUPTD)** register.

During fault conditions, the PWM output signals, PWM_n , usually must be driven to safe values so that external equipment may be safely controlled. The **PWMFAULT** register specifies whether during a fault condition, the generated signal continues to be passed driven or to an encoding specified in the **PWMFAULTVAL** register.

A final inversion can be applied to any of the PWM_n signals, making them active Low instead of the default active High using the **PWM Output Inversion (PWMINVERT)**. The inversion is applied even if a value has been enabled in the **PWMFAULT** register and specified in the **PWMFAULTVAL** register. In other words, if a bit is set in the **PWMFAULT**, **PWMFAULTVAL**, and **PWMINVERT** registers, the output on the PWM_n signal is 0, not 1 as specified in the **PWMFAULTVAL** register.

20.4 Initialization and Configuration

The following example shows how to initialize PWM Generator 0 with a 25-kHz frequency, a 25% duty cycle on the $PWM0$ pin, and a 75% duty cycle on the $PWM1$ pin. This example assumes the system clock is 20 MHz.

1. Enable the PWM clock by writing a value of 0x0010.0000 to the **RCGC0** register in the System Control module (see page 254).
2. Enable the clock to the appropriate GPIO module via the **RCGC2** register in the System Control module (see page 274).
3. In the GPIO module, enable the appropriate pins for their alternate function using the **GPIOAFSEL** register. To determine which GPIOs to configure, see Table 23-4 on page 1075.
4. Configure the PMC_n fields in the **GPIOPCTL** register to assign the PWM signals to the appropriate pins (see page 461 and Table 23-5 on page 1083).
5. Configure the **Run-Mode Clock Configuration (RCC)** register in the System Control module to use the PWM divide ($USEPWMDIV$) and set the divider ($PWMDIV$) to divide by 2 (000).
6. Configure the PWM generator for countdown mode with immediate updates to the parameters.
 - Write the **PWM0CTL** register with a value of 0x0000.0000.
 - Write the **PWM0GENA** register with a value of 0x0000.008C.
 - Write the **PWM0GENB** register with a value of 0x0000.080C.
7. Set the period. For a 25-KHz frequency, the period = $1/25,000$, or 40 microseconds. The PWM clock source is 10 MHz; the system clock divided by 2. Thus there are 400 clock ticks per period. Use this value to set the **PWM0LOAD** register. In Count-Down mode, set the **LOAD** field in the **PWM0LOAD** register to the requested period minus one.
 - Write the **PWM0LOAD** register with a value of 0x0000.018F.
8. Set the pulse width of the $PWM0$ pin for a 25% duty cycle.
 - Write the **PWM0CMPA** register with a value of 0x0000.012B.

9. Set the pulse width of the `PWM1` pin for a 75% duty cycle.
 - Write the `PWM0CMPB` register with a value of `0x0000.0063`.
10. Start the timers in PWM generator 0.
 - Write the `PWM0CTL` register with a value of `0x0000.0001`.
11. Enable PWM outputs.
 - Write the `PWMENABLE` register with a value of `0x0000.0003`.

20.5 Register Map

Table 20-3 on page 961 lists the PWM registers. The offset listed is a hexadecimal increment to the register's address, relative to the PWM module's base address:

- PWM0: `0x4002.8000`

Note that the PWM module clock must be enabled before the registers can be programmed (see page 254). There must be a delay of 3 system clocks after the PWM module clock is enabled before any PWM module registers are accessed.

Table 20-3. PWM Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|-------------|-------|-------------|-----------------------------------|----------|
| 0x000 | PWMCTL | R/W | 0x0000.0000 | PWM Master Control | 965 |
| 0x004 | PWMSYNC | R/W | 0x0000.0000 | PWM Time Base Sync | 967 |
| 0x008 | PWMENABLE | R/W | 0x0000.0000 | PWM Output Enable | 968 |
| 0x00C | PWMINVERT | R/W | 0x0000.0000 | PWM Output Inversion | 970 |
| 0x010 | PWMFAULT | R/W | 0x0000.0000 | PWM Output Fault | 972 |
| 0x014 | PWMINTEN | R/W | 0x0000.0000 | PWM Interrupt Enable | 974 |
| 0x018 | PWMRIS | RO | 0x0000.0000 | PWM Raw Interrupt Status | 976 |
| 0x01C | PWMISC | R/W1C | 0x0000.0000 | PWM Interrupt Status and Clear | 979 |
| 0x020 | PWMSTATUS | RO | 0x0000.0000 | PWM Status | 982 |
| 0x024 | PWMFAULTVAL | R/W | 0x0000.0000 | PWM Fault Condition Value | 984 |
| 0x028 | PWMENUPD | R/W | 0x0000.0000 | PWM Enable Update | 986 |
| 0x040 | PWM0CTL | R/W | 0x0000.0000 | PWM0 Control | 990 |
| 0x044 | PWM0INTEN | R/W | 0x0000.0000 | PWM0 Interrupt and Trigger Enable | 995 |
| 0x048 | PWM0RIS | RO | 0x0000.0000 | PWM0 Raw Interrupt Status | 998 |
| 0x04C | PWM0ISC | R/W1C | 0x0000.0000 | PWM0 Interrupt Status and Clear | 1000 |
| 0x050 | PWM0LOAD | R/W | 0x0000.0000 | PWM0 Load | 1002 |
| 0x054 | PWM0COUNT | RO | 0x0000.0000 | PWM0 Counter | 1003 |
| 0x058 | PWM0CMPA | R/W | 0x0000.0000 | PWM0 Compare A | 1004 |

Table 20-3. PWM Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|---------------|-------|-------------|-----------------------------------|----------|
| 0x05C | PWM0CMPB | R/W | 0x0000.0000 | PWM0 Compare B | 1005 |
| 0x060 | PWM0GENA | R/W | 0x0000.0000 | PWM0 Generator A Control | 1006 |
| 0x064 | PWM0GENB | R/W | 0x0000.0000 | PWM0 Generator B Control | 1009 |
| 0x068 | PWM0DBCTL | R/W | 0x0000.0000 | PWM0 Dead-Band Control | 1012 |
| 0x06C | PWM0DBRISE | R/W | 0x0000.0000 | PWM0 Dead-Band Rising-Edge Delay | 1013 |
| 0x070 | PWM0DBFALL | R/W | 0x0000.0000 | PWM0 Dead-Band Falling-Edge-Delay | 1014 |
| 0x074 | PWM0FLTSRC0 | R/W | 0x0000.0000 | PWM0 Fault Source 0 | 1015 |
| 0x078 | PWM0FLTSRC1 | R/W | 0x0000.0000 | PWM0 Fault Source 1 | 1017 |
| 0x07C | PWM0MINFLTPER | R/W | 0x0000.0000 | PWM0 Minimum Fault Period | 1020 |
| 0x080 | PWM1CTL | R/W | 0x0000.0000 | PWM1 Control | 990 |
| 0x084 | PWM1INTEN | R/W | 0x0000.0000 | PWM1 Interrupt and Trigger Enable | 995 |
| 0x088 | PWM1RIS | RO | 0x0000.0000 | PWM1 Raw Interrupt Status | 998 |
| 0x08C | PWM1ISC | R/W1C | 0x0000.0000 | PWM1 Interrupt Status and Clear | 1000 |
| 0x090 | PWM1LOAD | R/W | 0x0000.0000 | PWM1 Load | 1002 |
| 0x094 | PWM1COUNT | RO | 0x0000.0000 | PWM1 Counter | 1003 |
| 0x098 | PWM1CMPA | R/W | 0x0000.0000 | PWM1 Compare A | 1004 |
| 0x09C | PWM1CMPB | R/W | 0x0000.0000 | PWM1 Compare B | 1005 |
| 0x0A0 | PWM1GENA | R/W | 0x0000.0000 | PWM1 Generator A Control | 1006 |
| 0x0A4 | PWM1GENB | R/W | 0x0000.0000 | PWM1 Generator B Control | 1009 |
| 0x0A8 | PWM1DBCTL | R/W | 0x0000.0000 | PWM1 Dead-Band Control | 1012 |
| 0x0AC | PWM1DBRISE | R/W | 0x0000.0000 | PWM1 Dead-Band Rising-Edge Delay | 1013 |
| 0x0B0 | PWM1DBFALL | R/W | 0x0000.0000 | PWM1 Dead-Band Falling-Edge-Delay | 1014 |
| 0x0B4 | PWM1FLTSRC0 | R/W | 0x0000.0000 | PWM1 Fault Source 0 | 1015 |
| 0x0B8 | PWM1FLTSRC1 | R/W | 0x0000.0000 | PWM1 Fault Source 1 | 1017 |
| 0x0BC | PWM1MINFLTPER | R/W | 0x0000.0000 | PWM1 Minimum Fault Period | 1020 |
| 0x0C0 | PWM2CTL | R/W | 0x0000.0000 | PWM2 Control | 990 |
| 0x0C4 | PWM2INTEN | R/W | 0x0000.0000 | PWM2 Interrupt and Trigger Enable | 995 |
| 0x0C8 | PWM2RIS | RO | 0x0000.0000 | PWM2 Raw Interrupt Status | 998 |
| 0x0CC | PWM2ISC | R/W1C | 0x0000.0000 | PWM2 Interrupt Status and Clear | 1000 |
| 0x0D0 | PWM2LOAD | R/W | 0x0000.0000 | PWM2 Load | 1002 |
| 0x0D4 | PWM2COUNT | RO | 0x0000.0000 | PWM2 Counter | 1003 |
| 0x0D8 | PWM2CMPA | R/W | 0x0000.0000 | PWM2 Compare A | 1004 |

Table 20-3. PWM Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|---------------|-------|-------------|-----------------------------------|----------|
| 0x0DC | PWM2CMPB | R/W | 0x0000.0000 | PWM2 Compare B | 1005 |
| 0x0E0 | PWM2GENA | R/W | 0x0000.0000 | PWM2 Generator A Control | 1006 |
| 0x0E4 | PWM2GENB | R/W | 0x0000.0000 | PWM2 Generator B Control | 1009 |
| 0x0E8 | PWM2DBCTL | R/W | 0x0000.0000 | PWM2 Dead-Band Control | 1012 |
| 0x0EC | PWM2DBRISE | R/W | 0x0000.0000 | PWM2 Dead-Band Rising-Edge Delay | 1013 |
| 0x0F0 | PWM2DBFALL | R/W | 0x0000.0000 | PWM2 Dead-Band Falling-Edge-Delay | 1014 |
| 0x0F4 | PWM2FLTSRC0 | R/W | 0x0000.0000 | PWM2 Fault Source 0 | 1015 |
| 0x0F8 | PWM2FLTSRC1 | R/W | 0x0000.0000 | PWM2 Fault Source 1 | 1017 |
| 0x0FC | PWM2MINFLTPER | R/W | 0x0000.0000 | PWM2 Minimum Fault Period | 1020 |
| 0x100 | PWM3CTL | R/W | 0x0000.0000 | PWM3 Control | 990 |
| 0x104 | PWM3INTEN | R/W | 0x0000.0000 | PWM3 Interrupt and Trigger Enable | 995 |
| 0x108 | PWM3RIS | RO | 0x0000.0000 | PWM3 Raw Interrupt Status | 998 |
| 0x10C | PWM3ISC | R/W1C | 0x0000.0000 | PWM3 Interrupt Status and Clear | 1000 |
| 0x110 | PWM3LOAD | R/W | 0x0000.0000 | PWM3 Load | 1002 |
| 0x114 | PWM3COUNT | RO | 0x0000.0000 | PWM3 Counter | 1003 |
| 0x118 | PWM3CMPA | R/W | 0x0000.0000 | PWM3 Compare A | 1004 |
| 0x11C | PWM3CMPB | R/W | 0x0000.0000 | PWM3 Compare B | 1005 |
| 0x120 | PWM3GENA | R/W | 0x0000.0000 | PWM3 Generator A Control | 1006 |
| 0x124 | PWM3GENB | R/W | 0x0000.0000 | PWM3 Generator B Control | 1009 |
| 0x128 | PWM3DBCTL | R/W | 0x0000.0000 | PWM3 Dead-Band Control | 1012 |
| 0x12C | PWM3DBRISE | R/W | 0x0000.0000 | PWM3 Dead-Band Rising-Edge Delay | 1013 |
| 0x130 | PWM3DBFALL | R/W | 0x0000.0000 | PWM3 Dead-Band Falling-Edge-Delay | 1014 |
| 0x134 | PWM3FLTSRC0 | R/W | 0x0000.0000 | PWM3 Fault Source 0 | 1015 |
| 0x138 | PWM3FLTSRC1 | R/W | 0x0000.0000 | PWM3 Fault Source 1 | 1017 |
| 0x13C | PWM3MINFLTPER | R/W | 0x0000.0000 | PWM3 Minimum Fault Period | 1020 |
| 0x800 | PWM0FLTSEN | R/W | 0x0000.0000 | PWM0 Fault Pin Logic Sense | 1021 |
| 0x804 | PWM0FLTSTAT0 | - | 0x0000.0000 | PWM0 Fault Status 0 | 1022 |
| 0x808 | PWM0FLTSTAT1 | - | 0x0000.0000 | PWM0 Fault Status 1 | 1024 |
| 0x880 | PWM1FLTSEN | R/W | 0x0000.0000 | PWM1 Fault Pin Logic Sense | 1021 |
| 0x884 | PWM1FLTSTAT0 | - | 0x0000.0000 | PWM1 Fault Status 0 | 1022 |
| 0x888 | PWM1FLTSTAT1 | - | 0x0000.0000 | PWM1 Fault Status 1 | 1024 |
| 0x900 | PWM2FLTSEN | R/W | 0x0000.0000 | PWM2 Fault Pin Logic Sense | 1021 |

Table 20-3. PWM Register Map (continued)

| Offset | Name | Type | Reset | Description | See page |
|--------|--------------|------|-------------|----------------------------|----------|
| 0x904 | PWM2FLTSTAT0 | - | 0x0000.0000 | PWM2 Fault Status 0 | 1022 |
| 0x908 | PWM2FLTSTAT1 | - | 0x0000.0000 | PWM2 Fault Status 1 | 1024 |
| 0x980 | PWM3FLTSEN | R/W | 0x0000.0000 | PWM3 Fault Pin Logic Sense | 1021 |
| 0x984 | PWM3FLTSTAT0 | - | 0x0000.0000 | PWM3 Fault Status 0 | 1022 |
| 0x988 | PWM3FLTSTAT1 | - | 0x0000.0000 | PWM3 Fault Status 1 | 1024 |

20.6 Register Descriptions

The remainder of this section lists and describes the PWM registers, in numerical order by address offset.

Register 1: PWM Master Control (PWMCTL), offset 0x000

This register provides master control over the PWM generation blocks.

PWM Master Control (PWMCTL)

PWM0 base: 0x4002.8000

Offset 0x000

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-------------|-------------|-------------|-------------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | GLOBALSYNC3 | GLOBALSYNC2 | GLOBALSYNC1 | GLOBALSYNC0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|--------|---|
| 31:4 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | GLOBALSYNC3 | R/W | 0 | Update PWM Generator 3 Value Description 1 Any queued update to a load or comparator register in PWM generator 3 is applied the next time the corresponding counter becomes zero. 0 No effect. This bit automatically clears when the updates have completed; it cannot be cleared by software. |
| 2 | GLOBALSYNC2 | R/W | 0 | Update PWM Generator 2 Value Description 1 Any queued update to a load or comparator register in PWM generator 2 is applied the next time the corresponding counter becomes zero. 0 No effect. This bit automatically clears when the updates have completed; it cannot be cleared by software. |
| 1 | GLOBALSYNC1 | R/W | 0 | Update PWM Generator 1 Value Description 1 Any queued update to a load or comparator register in PWM generator 1 is applied the next time the corresponding counter becomes zero. 0 No effect. This bit automatically clears when the updates have completed; it cannot be cleared by software. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------------|------|-------|--|
| 0 | GLOBALSYNC0 | R/W | 0 | Update PWM Generator 0 |
| | | | | Value Description |
| | | | 1 | Any queued update to a load or comparator register in PWM generator 0 is applied the next time the corresponding counter becomes zero. |
| | | | 0 | No effect. |
| | | | | This bit automatically clears when the updates have completed; it cannot be cleared by software. |

Register 2: PWM Time Base Sync (PWMSYNC), offset 0x004

This register provides a method to perform synchronization of the counters in the PWM generation blocks. Setting a bit in this register causes the specified counter to reset back to 0; setting multiple bits resets multiple counters simultaneously. The bits auto-clear after the reset has occurred; reading them back as zero indicates that the synchronization has completed.

PWM Time Base Sync (PWMSYNC)

PWM0 base: 0x4002.8000

Offset 0x004

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-------|-------|-------|-------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | SYNC3 | SYNC2 | SYNC1 | SYNC0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | SYNC3 | R/W | 0 | Reset Generator 3 Counter Value Description 1 Resets the PWM generator 3 counter. 0 No effect. |
| 2 | SYNC2 | R/W | 0 | Reset Generator 2 Counter Value Description 1 Resets the PWM generator 2 counter. 0 No effect. |
| 1 | SYNC1 | R/W | 0 | Reset Generator 1 Counter Value Description 1 Resets the PWM generator 1 counter. 0 No effect. |
| 0 | SYNC0 | R/W | 0 | Reset Generator 0 Counter Value Description 1 Resets the PWM generator 0 counter. 0 No effect. |

Register 3: PWM Output Enable (PWMENTABLE), offset 0x008

This register provides a master control of which generated pwmA' and pwmB' signals are output to the PWM_n pins. By disabling a PWM output, the generation process can continue (for example, when the time bases are synchronized) without driving PWM signals to the pins. When bits in this register are set, the corresponding pwmA' or pwmB' signal is passed through to the output stage. When bits are clear, the pwmA' or pwmB' signal is replaced by a zero value which is also passed to the output stage. The **PWMINVERT** register controls the output stage, so if the corresponding bit is set in that register, the value seen on the PWM_n signal is inverted from what is configured by the bits in this register. Updates to the bits in this register can be immediate or locally or globally synchronized to the next synchronous update as controlled by the ENUPD_n fields in the **PWMENUPD** register.

PWM Output Enable (PWMENTABLE)

PWM0 base: 0x4002.8000
 Offset 0x008
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|--------|--------|--------|--------|--------|--------|--------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PWM7EN | PWM6EN | PWM5EN | PWM4EN | PWM3EN | PWM2EN | PWM1EN | PWM0EN |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | PWM7EN | R/W | 0 | PWM7 Output Enable Value Description 1 The generated pwm3B' signal is passed to the PWM7 pin. 0 The PWM7 signal has a zero value. |
| 6 | PWM6EN | R/W | 0 | PWM6 Output Enable Value Description 1 The generated pwm3A' signal is passed to the PWM6 pin. 0 The PWM6 signal has a zero value. |
| 5 | PWM5EN | R/W | 0 | PWM5 Output Enable Value Description 1 The generated pwm2B' signal is passed to the PWM5 pin. 0 The PWM5 signal has a zero value. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 4 | PWM4EN | R/W | 0 | <p>PWM4 Output Enable</p> <p>Value Description</p> <p>1 The generated pwm2A' signal is passed to the PWM4 pin.</p> <p>0 The PWM4 signal has a zero value.</p> |
| 3 | PWM3EN | R/W | 0 | <p>PWM3 Output Enable</p> <p>Value Description</p> <p>1 The generated pwm1B' signal is passed to the PWM3 pin.</p> <p>0 The PWM3 signal has a zero value.</p> |
| 2 | PWM2EN | R/W | 0 | <p>PWM2 Output Enable</p> <p>Value Description</p> <p>1 The generated pwm1A' signal is passed to the PWM2 pin.</p> <p>0 The PWM2 signal has a zero value.</p> |
| 1 | PWM1EN | R/W | 0 | <p>PWM1 Output Enable</p> <p>Value Description</p> <p>1 The generated pwm0B' signal is passed to the PWM1 pin.</p> <p>0 The PWM1 signal has a zero value.</p> |
| 0 | PWM0EN | R/W | 0 | <p>PWM0 Output Enable</p> <p>Value Description</p> <p>1 The generated pwm0A' signal is passed to the PWM0 pin.</p> <p>0 The PWM0 signal has a zero value.</p> |

Register 4: PWM Output Inversion (PWMINVERT), offset 0x00C

This register provides a master control of the polarity of the PWM_n signals on the device pins. The $pwmA'$ and $pwmB'$ signals generated by the PWM generator are active High; but can be made active Low via this register. Disabled PWM channels are also passed through the output inverter (if so configured) so that inactive signals can be High. In addition, if the **PWMFAULT** register enables a specific value to be placed on the PWM_n signals during a fault condition, that value is inverted if the corresponding bit in this register is set.

PWM Output Inversion (PWMINVERT)

PWM0 base: 0x4002.8000
 Offset 0x00C
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|---------|---------|---------|---------|---------|---------|---------|---------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PWM7INV | PWM6INV | PWM5INV | PWM4INV | PWM3INV | PWM2INV | PWM1INV | PWM0INV |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | PWM7INV | R/W | 0 | Invert PWM_7 Signal Value Description 1 The PWM_7 signal is inverted. 0 The PWM_7 signal is not inverted. |
| 6 | PWM6INV | R/W | 0 | Invert PWM_6 Signal Value Description 1 The PWM_6 signal is inverted. 0 The PWM_6 signal is not inverted. |
| 5 | PWM5INV | R/W | 0 | Invert PWM_5 Signal Value Description 1 The PWM_5 signal is inverted. 0 The PWM_5 signal is not inverted. |
| 4 | PWM4INV | R/W | 0 | Invert PWM_4 Signal Value Description 1 The PWM_4 signal is inverted. 0 The PWM_4 signal is not inverted. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 3 | PWM3INV | R/W | 0 | Invert PWM3 Signal Value Description 1 The PWM3 signal is inverted. 0 The PWM3 signal is not inverted. |
| 2 | PWM2INV | R/W | 0 | Invert PWM2 Signal Value Description 1 The PWM2 signal is inverted. 0 The PWM2 signal is not inverted. |
| 1 | PWM1INV | R/W | 0 | Invert PWM1 Signal Value Description 1 The PWM1 signal is inverted. 0 The PWM1 signal is not inverted. |
| 0 | PWM0INV | R/W | 0 | Invert PWM0 Signal Value Description 1 The PWM0 signal is inverted. 0 The PWM0 signal is not inverted. |

Register 5: PWM Output Fault (PWMFAULT), offset 0x010

This register controls the behavior of the PWM_n outputs in the presence of fault conditions. Both the fault inputs ($FAULT_n$ pins and digital comparator outputs) and debug events are considered fault conditions. On a fault condition, each pwmA' or pwmB' signal can be passed through unmodified or driven to the value specified by the corresponding bit in the **PWMFAULTVAL** register. For outputs that are configured for pass-through, the debug event handling on the corresponding PWM generator also determines if the pwmA' or pwmB' signal continues to be generated.

Fault condition control occurs before the output inverter, so PWM signals driven to a specified value on fault are inverted if the channel is configured for inversion (therefore, the pin is driven to the logical complement of the specified value on a fault condition).

PWM Output Fault (PWMFAULT)

PWM0 base: 0x4002.8000
 Offset 0x010
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|--------|--------|--------|--------|--------|--------|--------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | FAULT7 | FAULT6 | FAULT5 | FAULT4 | FAULT3 | FAULT2 | FAULT1 | FAULT0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | FAULT7 | R/W | 0 | <p>PWM7 Fault</p> <p>Value Description</p> <p>1 The PWM7 output signal is driven to the value specified by the PWM7 bit in the PWMFAULTVAL register.</p> <p>0 The generated pwm3B' signal is passed to the PWM7 pin.</p> |
| 6 | FAULT6 | R/W | 0 | <p>PWM6 Fault</p> <p>Value Description</p> <p>1 The PWM6 output signal is driven to the value specified by the PWM6 bit in the PWMFAULTVAL register.</p> <p>0 The generated pwm3A' signal is passed to the PWM6 pin.</p> |
| 5 | FAULT5 | R/W | 0 | <p>PWM5 Fault</p> <p>Value Description</p> <p>1 The PWM5 output signal is driven to the value specified by the PWM5 bit in the PWMFAULTVAL register.</p> <p>0 The generated pwm2B' signal is passed to the PWM5 pin.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 4 | FAULT4 | R/W | 0 | <p>PWM4 Fault</p> <p>Value Description</p> <p>1 The PWM4 output signal is driven to the value specified by the PWM4 bit in the PWMFAULTVAL register.</p> <p>0 The generated pwm2A' signal is passed to the PWM4 pin.</p> |
| 3 | FAULT3 | R/W | 0 | <p>PWM3 Fault</p> <p>Value Description</p> <p>1 The PWM3 output signal is driven to the value specified by the PWM3 bit in the PWMFAULTVAL register.</p> <p>0 The generated pwm1B' signal is passed to the PWM3 pin.</p> |
| 2 | FAULT2 | R/W | 0 | <p>PWM2 Fault</p> <p>Value Description</p> <p>1 The PWM2 output signal is driven to the value specified by the PWM2 bit in the PWMFAULTVAL register.</p> <p>0 The generated pwm1A' signal is passed to the PWM2 pin.</p> |
| 1 | FAULT1 | R/W | 0 | <p>PWM1 Fault</p> <p>Value Description</p> <p>1 The PWM1 output signal is driven to the value specified by the PWM1 bit in the PWMFAULTVAL register.</p> <p>0 The generated pwm0B' signal is passed to the PWM1 pin.</p> |
| 0 | FAULT0 | R/W | 0 | <p>PWM0 Fault</p> <p>Value Description</p> <p>1 The PWM0 output signal is driven to the value specified by the PWM0 bit in the PWMFAULTVAL register.</p> <p>0 The generated pwm0A' signal is passed to the PWM0 pin.</p> |

Register 6: PWM Interrupt Enable (PWMINTEN), offset 0x014

This register controls the global interrupt generation capabilities of the PWM module. The events that can cause an interrupt are the fault input and the individual interrupts from the PWM generators.

Note: The "n" in the INTFAULT_n and INTPWM_n bits in this register correspond to the PWM generators, not to the FAULT_n signals.

PWM Interrupt Enable (PWMINTEN)

PWM0 base: 0x4002.8000
 Offset 0x014
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-----------|-----------|-----------|-----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | INTFAULT3 | INTFAULT2 | INTFAULT1 | INTFAULT0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | INTPWM3 | INTPWM2 | INTPWM1 | INTPWM0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|---|
| 31:20 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 19 | INTFAULT3 | R/W | 0 | Interrupt Fault 3 Value Description 1 An interrupt is sent to the interrupt controller when the fault condition for PWM generator 3 is asserted. 0 The fault condition for PWM generator 3 is suppressed and not sent to the interrupt controller. |
| 18 | INTFAULT2 | R/W | 0 | Interrupt Fault 2 Value Description 1 An interrupt is sent to the interrupt controller when the fault condition for PWM generator 2 is asserted. 0 The fault condition for PWM generator 2 is suppressed and not sent to the interrupt controller. |
| 17 | INTFAULT1 | R/W | 0 | Interrupt Fault 1 Value Description 1 An interrupt is sent to the interrupt controller when the fault condition for PWM generator 1 is asserted. 0 The fault condition for PWM generator 1 is suppressed and not sent to the interrupt controller. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|--|
| 16 | INTFAULT0 | R/W | 0 | <p>Interrupt Fault 0</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the fault condition for PWM generator 0 is asserted.</p> <p>0 The fault condition for PWM generator 0 is suppressed and not sent to the interrupt controller.</p> |
| 15:4 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | INTPWM3 | R/W | 0 | <p>PWM3 Interrupt Enable</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the PWM generator 3 block asserts an interrupt.</p> <p>0 The PWM generator 3 interrupt is suppressed and not sent to the interrupt controller.</p> |
| 2 | INTPWM2 | R/W | 0 | <p>PWM2 Interrupt Enable</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the PWM generator 2 block asserts an interrupt.</p> <p>0 The PWM generator 2 interrupt is suppressed and not sent to the interrupt controller.</p> |
| 1 | INTPWM1 | R/W | 0 | <p>PWM1 Interrupt Enable</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the PWM generator 1 block asserts an interrupt.</p> <p>0 The PWM generator 1 interrupt is suppressed and not sent to the interrupt controller.</p> |
| 0 | INTPWM0 | R/W | 0 | <p>PWM0 Interrupt Enable</p> <p>Value Description</p> <p>1 An interrupt is sent to the interrupt controller when the PWM generator 0 block asserts an interrupt.</p> <p>0 The PWM generator 0 interrupt is suppressed and not sent to the interrupt controller.</p> |

Register 7: PWM Raw Interrupt Status (PWMRIS), offset 0x018

This register provides the current set of interrupt sources that are asserted, regardless of whether they are enabled to cause an interrupt to be asserted to the interrupt controller. The fault interrupt is asserted based on the fault condition source that is specified by the **PWMnCTL**, **PWMnFLTSRC0** and **PWMnFLTSRC1** registers. The fault interrupt is latched on detection and must be cleared through the **PWM Interrupt Status and Clear (PWMISC)** register. The actual value of the **FAULTn** signals can be observed using the **PWMSTATUS** register.

The PWM generator interrupts simply reflect the status of the PWM generators and are cleared via the interrupt status register in the PWM generator blocks. If a bit is set, the event is active; if a bit is clear the event is not active.

PWM Raw Interrupt Status (PWMRIS)

PWM0 base: 0x4002.8000
 Offset 0x018
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-----------|-----------|-----------|-----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | INTFAULT3 | INTFAULT2 | INTFAULT1 | INTFAULT0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | INTPWM3 | INTPWM2 | INTPWM1 | INTPWM0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|--|
| 31:20 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 19 | INTFAULT3 | RO | 0 | Interrupt Fault PWM 3 Value Description 1 The fault condition for PWM generator 3 is asserted. 0 The fault condition for PWM generator 3 has not been asserted. This bit is cleared by writing a 1 to the INTFAULT3 bit in the PWMISC register. |
| 18 | INTFAULT2 | RO | 0 | Interrupt Fault PWM 2 Value Description 1 The fault condition for PWM generator 2 is asserted. 0 The fault condition for PWM generator 2 has not been asserted. This bit is cleared by writing a 1 to the INTFAULT2 bit in the PWMISC register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|--|
| 17 | INTFAULT1 | RO | 0 | <p>Interrupt Fault PWM 1</p> <p>Value Description</p> <p>1 The fault condition for PWM generator 1 is asserted.</p> <p>0 The fault condition for PWM generator 1 has not been asserted.</p> <p>This bit is cleared by writing a 1 to the INTFAULT1 bit in the PWMISC register.</p> |
| 16 | INTFAULT0 | RO | 0 | <p>Interrupt Fault PWM 0</p> <p>Value Description</p> <p>1 The fault condition for PWM generator 0 is asserted.</p> <p>0 The fault condition for PWM generator 0 has not been asserted.</p> <p>This bit is cleared by writing a 1 to the INTFAULT0 bit in the PWMISC register.</p> |
| 15:4 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | INTPWM3 | RO | 0 | <p>PWM3 Interrupt Asserted</p> <p>Value Description</p> <p>1 The PWM generator 3 block interrupt is asserted.</p> <p>0 The PWM generator 3 block interrupt has not been asserted.</p> <p>The PWM3RIS register shows the source of this interrupt. This bit is cleared by writing a 1 to the corresponding bit in the PWM3ISC register.</p> |
| 2 | INTPWM2 | RO | 0 | <p>PWM2 Interrupt Asserted</p> <p>Value Description</p> <p>1 The PWM generator 2 block interrupt is asserted.</p> <p>0 The PWM generator 2 block interrupt has not been asserted.</p> <p>The PWM2RIS register shows the source of this interrupt. This bit is cleared by writing a 1 to the corresponding bit in the PWM2ISC register.</p> |
| 1 | INTPWM1 | RO | 0 | <p>PWM1 Interrupt Asserted</p> <p>Value Description</p> <p>1 The PWM generator 1 block interrupt is asserted.</p> <p>0 The PWM generator 1 block interrupt has not been asserted.</p> <p>The PWM1RIS register shows the source of this interrupt. This bit is cleared by writing a 1 to the corresponding bit in the PWM1ISC register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|-------------------------|
| 0 | INTPWM0 | RO | 0 | PWM0 Interrupt Asserted |

Value Description

1 The PWM generator 0 block interrupt is asserted.

0 The PWM generator 0 block interrupt has not been asserted.

The **PWM0RIS** register shows the source of this interrupt. This bit is cleared by writing a 1 to the corresponding bit in the **PWM0ISC** register.

Register 8: PWM Interrupt Status and Clear (PWMISC), offset 0x01C

This register provides a summary of the interrupt status of the individual PWM generator blocks. If a fault interrupt is set, the corresponding `FAULTn` input has caused an interrupt. For the fault interrupt, a write of 1 to that bit position clears the latched interrupt status. If an block interrupt bit is set, the corresponding generator block is asserting an interrupt. The individual interrupt status registers, **PWMnISC**, in each block must be consulted to determine the reason for the interrupt and used to clear the interrupt.

PWM Interrupt Status and Clear (PWMISC)

PWM0 base: 0x4002.8000

Offset 0x01C

Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|-----------|-----------|-----------|-----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | INTFAULT3 | INTFAULT2 | INTFAULT1 | INTFAULT0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | INTPWM3 | INTPWM2 | INTPWM1 | INTPWM0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|-------|-------|---|
| 31:20 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 19 | INTFAULT3 | R/W1C | 0 | <p>FAULT3 Interrupt Asserted</p> <p>Value Description</p> <p>1 An enabled interrupt for the fault condition for PWM generator 3 is asserted or is latched.</p> <p>0 The fault condition for PWM generator 3 has not been asserted or is not enabled.</p> <p>Writing a 1 to this bit clears it and the <code>INTFAULT3</code> bit in the PWMRIS register.</p> |
| 18 | INTFAULT2 | R/W1C | 0 | <p>FAULT2 Interrupt Asserted</p> <p>Value Description</p> <p>1 An enabled interrupt for the fault condition for PWM generator 2 is asserted or is latched.</p> <p>0 The fault condition for PWM generator 2 has not been asserted or is not enabled.</p> <p>Writing a 1 to this bit clears it and the <code>INTFAULT2</code> bit in the PWMRIS register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|-------|-------|---|
| 17 | INTFAULT1 | R/W1C | 0 | <p>FAULT1 Interrupt Asserted</p> <p>Value Description</p> <p>1 An enabled interrupt for the fault condition for PWM generator 1 is asserted or is latched.</p> <p>0 The fault condition for PWM generator 1 has not been asserted or is not enabled.</p> <p>Writing a 1 to this bit clears it and the INTFAULT1 bit in the PWMRIS register.</p> |
| 16 | INTFAULT0 | R/W1C | 0 | <p>FAULT0 Interrupt Asserted</p> <p>Value Description</p> <p>1 An enabled interrupt for the fault condition for PWM generator 0 is asserted or is latched.</p> <p>0 The fault condition for PWM generator 0 has not been asserted or is not enabled.</p> <p>Writing a 1 to this bit clears it and the INTFAULT0 bit in the PWMRIS register.</p> |
| 15:4 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | INTPWM3 | RO | 0 | <p>PWM3 Interrupt Status</p> <p>Value Description</p> <p>1 An enabled interrupt for the PWM generator 3 block is asserted.</p> <p>0 The PWM generator 3 block interrupt is not asserted or is not enabled.</p> <p>The PWM3RIS register shows the source of this interrupt. This bit is cleared by writing a 1 to the corresponding bit in the PWM3ISC register.</p> |
| 2 | INTPWM2 | RO | 0 | <p>PWM2 Interrupt Status</p> <p>Value Description</p> <p>1 An enabled interrupt for the PWM generator 2 block is asserted.</p> <p>0 The PWM generator 2 block interrupt is not asserted or is not enabled.</p> <p>The PWM2RIS register shows the source of this interrupt. This bit is cleared by writing a 1 to the corresponding bit in the PWM2ISC register.</p> |
| 1 | INTPWM1 | RO | 0 | <p>PWM1 Interrupt Status</p> <p>Value Description</p> <p>1 An enabled interrupt for the PWM generator 1 block is asserted.</p> <p>0 The PWM generator 1 block interrupt is not asserted or is not enabled.</p> <p>The PWM1RIS register shows the source of this interrupt. This bit is cleared by writing a 1 to the corresponding bit in the PWM1ISC register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|--|
| 0 | INTPWM0 | RO | 0 | PWM0 Interrupt Status |
| | | | | Value Description |
| | | | | 1 An enabled interrupt for the PWM generator 0 block is asserted. |
| | | | | 0 The PWM generator 0 block interrupt is not asserted or is not enabled. |

The **PWM0RIS** register shows the source of this interrupt. This bit is cleared by writing a 1 to the corresponding bit in the **PWM0ISC** register.

Register 9: PWM Status (PWMSTATUS), offset 0x020

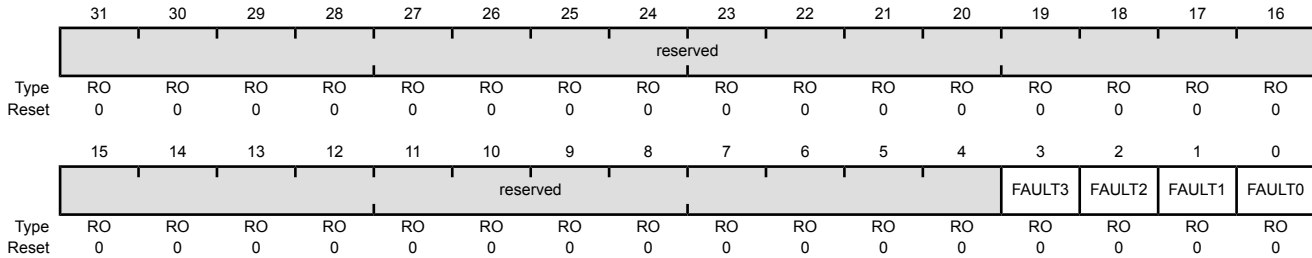
This register provides the unlatched status of the PWM generator fault condition.

PWM Status (PWMSTATUS)

PWM0 base: 0x4002.8000

Offset 0x020

Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | FAULT3 | RO | 0 | Generator 3 Fault Status Value Description 1 The fault condition for PWM generator 3 is asserted. If the FLTSRC bit in the PWM3CTL register is clear, the input is the source of the fault condition, and is therefore asserted. 0 The fault condition for PWM generator 3 is not asserted. |
| 2 | FAULT2 | RO | 0 | Generator 2 Fault Status Value Description 1 The fault condition for PWM generator 2 is asserted. If the FLTSRC bit in the PWM2CTL register is clear, the input is the source of the fault condition, and is therefore asserted. 0 The fault condition for PWM generator 2 is not asserted. |
| 1 | FAULT1 | RO | 0 | Generator 1 Fault Status Value Description 1 The fault condition for PWM generator 1 is asserted. If the FLTSRC bit in the PWM1CTL register is clear, the input is the source of the fault condition, and is therefore asserted. 0 The fault condition for PWM generator 1 is not asserted. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 0 | FAULT0 | RO | 0 | Generator 0 Fault Status |
| | | | | Value Description |
| | | | | 1 The fault condition for PWM generator 0 is asserted. If the <code>FLTSRC</code> bit in the <code>PWM0CTL</code> register is clear, the input is the source of the fault condition, and is therefore asserted. |
| | | | | 0 The fault condition for PWM generator 0 is not asserted. |

Register 10: PWM Fault Condition Value (PWMFAULTVAL), offset 0x024

This register specifies the output value driven on the PWM_n signals during a fault condition if enabled by the corresponding bit in the **PWMFAULT** register. Note that if the corresponding bit in the **PWMINVERT** register is set, the output value is driven to the logical NOT of the bit value in this register.

PWM Fault Condition Value (PWMFAULTVAL)

PWM0 base: 0x4002.8000
 Offset 0x024
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|------|------|------|------|------|------|------|------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | PWM7 | PWM6 | PWM5 | PWM4 | PWM3 | PWM2 | PWM1 | PWM0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|--|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | PWM7 | R/W | 0 | <p>$PWM7$ Fault Value</p> <p>Value Description</p> <p>1 The $PWM7$ output signal is driven High during fault conditions if the FAULT7 bit in the PWMFAULT register is set.</p> <p>0 The $PWM7$ output signal is driven Low during fault conditions if the FAULT7 bit in the PWMFAULT register is set.</p> |
| 6 | PWM6 | R/W | 0 | <p>$PWM6$ Fault Value</p> <p>Value Description</p> <p>1 The $PWM6$ output signal is driven High during fault conditions if the FAULT6 bit in the PWMFAULT register is set.</p> <p>0 The $PWM6$ output signal is driven Low during fault conditions if the FAULT6 bit in the PWMFAULT register is set.</p> |
| 5 | PWM5 | R/W | 0 | <p>$PWM5$ Fault Value</p> <p>Value Description</p> <p>1 The $PWM5$ output signal is driven High during fault conditions if the FAULT5 bit in the PWMFAULT register is set.</p> <p>0 The $PWM5$ output signal is driven Low during fault conditions if the FAULT5 bit in the PWMFAULT register is set.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------|---|
| 4 | PWM4 | R/W | 0 | <p>PWM4 Fault Value</p> <p>Value Description</p> <p>1 The PWM4 output signal is driven High during fault conditions if the FAULT4 bit in the PWMFAULT register is set.</p> <p>0 The PWM4 output signal is driven Low during fault conditions if the FAULT4 bit in the PWMFAULT register is set.</p> |
| 3 | PWM3 | R/W | 0 | <p>PWM3 Fault Value</p> <p>Value Description</p> <p>1 The PWM3 output signal is driven High during fault conditions if the FAULT3 bit in the PWMFAULT register is set.</p> <p>0 The PWM3 output signal is driven Low during fault conditions if the FAULT3 bit in the PWMFAULT register is set.</p> |
| 2 | PWM2 | R/W | 0 | <p>PWM2 Fault Value</p> <p>Value Description</p> <p>1 The PWM2 output signal is driven High during fault conditions if the FAULT2 bit in the PWMFAULT register is set.</p> <p>0 The PWM2 output signal is driven Low during fault conditions if the FAULT2 bit in the PWMFAULT register is set.</p> |
| 1 | PWM1 | R/W | 0 | <p>PWM1 Fault Value</p> <p>Value Description</p> <p>1 The PWM1 output signal is driven High during fault conditions if the FAULT1 bit in the PWMFAULT register is set.</p> <p>0 The PWM1 output signal is driven Low during fault conditions if the FAULT1 bit in the PWMFAULT register is set.</p> |
| 0 | PWM0 | R/W | 0 | <p>PWM0 Fault Value</p> <p>Value Description</p> <p>1 The PWM0 output signal is driven High during fault conditions if the FAULT0 bit in the PWMFAULT register is set.</p> <p>0 The PWM0 output signal is driven Low during fault conditions if the FAULT0 bit in the PWMFAULT register is set.</p> |

Register 11: PWM Enable Update (PWMENUPD), offset 0x028

This register specifies when updates to the PWM_nEN bit in the **PWMENABLE** register are performed. The PWM_nEN bit enables the pwmA' or pwmB' output to be passed to the microcontroller's pin. Updates can be immediate or locally or globally synchronized to the next synchronous update.

PWM Enable Update (PWMENUPD)

PWM0 base: 0x4002.8000
 Offset 0x028
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|--------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | ENUPD7 | | ENUPD6 | | ENUPD5 | | ENUPD4 | | ENUPD3 | | ENUPD2 | | ENUPD1 | | ENUPD0 | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|--|------|-------|--|-------|-------------|-----|---|-----|----------|-----|---|-----|--|
| 31:16 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | | | | | | | | | | |
| 15:14 | ENUPD7 | R/W | 0 | <p>$PWM7$ Enable Update Mode</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Immediate Writes to the $PWM7EN$ bit in the PWMENABLE register are used by the PWM generator immediately.</td> </tr> <tr> <td>0x1</td> <td>Reserved</td> </tr> <tr> <td>0x2</td> <td>Locally Synchronized Writes to the $PWM7EN$ bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0.</td> </tr> <tr> <td>0x3</td> <td>Globally Synchronized Writes to the $PWM7EN$ bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0 after a synchronous update has been requested through the PWM Master Control (PWMCTL) register.</td> </tr> </tbody> </table> | Value | Description | 0x0 | Immediate Writes to the $PWM7EN$ bit in the PWMENABLE register are used by the PWM generator immediately. | 0x1 | Reserved | 0x2 | Locally Synchronized Writes to the $PWM7EN$ bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0. | 0x3 | Globally Synchronized Writes to the $PWM7EN$ bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0 after a synchronous update has been requested through the PWM Master Control (PWMCTL) register. |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | Immediate Writes to the $PWM7EN$ bit in the PWMENABLE register are used by the PWM generator immediately. | | | | | | | | | | | | | |
| 0x1 | Reserved | | | | | | | | | | | | | |
| 0x2 | Locally Synchronized Writes to the $PWM7EN$ bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0. | | | | | | | | | | | | | |
| 0x3 | Globally Synchronized Writes to the $PWM7EN$ bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0 after a synchronous update has been requested through the PWM Master Control (PWMCTL) register. | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 13:12 | ENUPD6 | R/W | 0 | <p>PWM6 Enable Update Mode</p> <p>Value Description</p> <p>0x0 Immediate Writes to the <code>PWM6EN</code> bit in the PWMENABLE register are used by the PWM generator immediately.</p> <p>0x1 Reserved</p> <p>0x2 Locally Synchronized Writes to the <code>PWM6EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0.</p> <p>0x3 Globally Synchronized Writes to the <code>PWM6EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0 after a synchronous update has been requested through the PWM Master Control (PWMCTL) register.</p> |
| 11:10 | ENUPD5 | R/W | 0 | <p>PWM5 Enable Update Mode</p> <p>Value Description</p> <p>0x0 Immediate Writes to the <code>PWM5EN</code> bit in the PWMENABLE register are used by the PWM generator immediately.</p> <p>0x1 Reserved</p> <p>0x2 Locally Synchronized Writes to the <code>PWM5EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0.</p> <p>0x3 Globally Synchronized Writes to the <code>PWM5EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0 after a synchronous update has been requested through the PWM Master Control (PWMCTL) register.</p> |
| 9:8 | ENUPD4 | R/W | 0 | <p>PWM4 Enable Update Mode</p> <p>Value Description</p> <p>0x0 Immediate Writes to the <code>PWM4EN</code> bit in the PWMENABLE register are used by the PWM generator immediately.</p> <p>0x1 Reserved</p> <p>0x2 Locally Synchronized Writes to the <code>PWM4EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0.</p> <p>0x3 Globally Synchronized Writes to the <code>PWM4EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0 after a synchronous update has been requested through the PWM Master Control (PWMCTL) register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 7:6 | ENUPD3 | R/W | 0 | <p>PWM3 Enable Update Mode</p> <p>Value Description</p> <p>0x0 Immediate Writes to the <code>PWM3EN</code> bit in the PWMENABLE register are used by the PWM generator immediately.</p> <p>0x1 Reserved</p> <p>0x2 Locally Synchronized Writes to the <code>PWM3EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0.</p> <p>0x3 Globally Synchronized Writes to the <code>PWM3EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0 after a synchronous update has been requested through the PWM Master Control (PWMCTL) register.</p> |
| 5:4 | ENUPD2 | R/W | 0 | <p>PWM2 Enable Update Mode</p> <p>Value Description</p> <p>0x0 Immediate Writes to the <code>PWM2EN</code> bit in the PWMENABLE register are used by the PWM generator immediately.</p> <p>0x1 Reserved</p> <p>0x2 Locally Synchronized Writes to the <code>PWM2EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0.</p> <p>0x3 Globally Synchronized Writes to the <code>PWM2EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0 after a synchronous update has been requested through the PWM Master Control (PWMCTL) register.</p> |
| 3:2 | ENUPD1 | R/W | 0 | <p>PWM1 Enable Update Mode</p> <p>Value Description</p> <p>0x0 Immediate Writes to the <code>PWM1EN</code> bit in the PWMENABLE register are used by the PWM generator immediately.</p> <p>0x1 Reserved</p> <p>0x2 Locally Synchronized Writes to the <code>PWM1EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0.</p> <p>0x3 Globally Synchronized Writes to the <code>PWM1EN</code> bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0 after a synchronous update has been requested through the PWM Master Control (PWMCTL) register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 1:0 | ENUPD0 | R/W | 0 | PWM0 Enable Update Mode Value Description 0x0 Immediate Writes to the PWM0EN bit in the PWMENABLE register are used by the PWM generator immediately. 0x1 Reserved 0x2 Locally Synchronized Writes to the PWM0EN bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0. 0x3 Globally Synchronized Writes to the PWM0EN bit in the PWMENABLE register are used by the PWM generator the next time the counter is 0 after a synchronous update has been requested through the PWM Master Control (PWMCTL) register. |

Register 12: PWM0 Control (PWM0CTL), offset 0x040

Register 13: PWM1 Control (PWM1CTL), offset 0x080

Register 14: PWM2 Control (PWM2CTL), offset 0x0C0

Register 15: PWM3 Control (PWM3CTL), offset 0x100

These registers configure the PWM signal generation blocks (PWM0CTL controls the PWM generator 0 block, and so on). The Register Update mode, Debug mode, Counting mode, and Block Enable mode are all controlled via these registers. The blocks produce the PWM signals, which can be either two independent PWM signals (from the same counter), or a paired set of PWM signals with dead-band delays added.

The PWM0 block produces the PWM0 and PWM1 outputs, the PWM1 block produces the PWM2 and PWM3 outputs, the PWM2 block produces the PWM4 and PWM5 outputs, and the PWM3 block produces the PWM6 and PWM7 outputs.

PWM0 Control (PWM0CTL)

PWM0 base: 0x4002.8000
 Offset 0x040
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|-----------|-----|-----------|-----|----------|-----|---------|-----|---------|-----|---------|---------|---------|-------|-----------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | LATCH | MINFLTPER | FLTSRC |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | DBFALLUPD | | DBRISEUPD | | DBCTLUPD | | GENBUPD | | GENAUPD | | CMPBUPD | CMPAUPD | LOADUPD | DEBUG | MODE | ENABLE |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:19 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 18 | LATCH | R/W | 0 | Latch Fault Input |
| | | | | Value Description |
| | | | 0 | Fault Condition Not Latched A fault condition is in effect for as long as the generating source is asserting. |
| | | | 1 | Fault Condition Latched A fault condition is set as the result of the assertion of the faulting source and is held (latched) while the PWMISC INTFAULTn bit is set. Clearing the INTFAULTn bit clears the fault condition. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|--|
| 17 | MINFLTPER | R/W | 0 | <p>Minimum Fault Period</p> <p>This bit specifies that the PWM generator enables a one-shot counter to provide a minimum fault condition period.</p> <p>The timer begins counting on the rising edge of the fault condition to extend the condition for a minimum duration of the count value. The timer ignores the state of the fault condition while counting.</p> <p>The minimum fault delay is in effect only when the MINFLTPER bit is set. If a detected fault is in the process of being extended when the MINFLTPER bit is cleared, the fault condition extension is aborted.</p> <p>The delay time is specified by the PWMnMINFLTPER register MFP field value. The effect of this is to pulse stretch the fault condition input.</p> <p>The delay value is defined by the PWM clock period. Because the fault input is not synchronized to the PWM clock, the period of the time is $PWMClock * (MFP \text{ value} + 1)$ or $PWMClock * (MFP \text{ value} + 2)$.</p> <p>The delay function makes sense only if the fault source is unlatched. A latched fault source makes the fault condition appear asserted until cleared by software and negates the utility of the extend feature. It applies to all fault condition sources as specified in the FLTSRC field.</p> <p>Value Description</p> <p>0 The FAULT input deassertion is unaffected.</p> <p>1 The PWMnMINFLTPER one-shot counter is active and extends the period of the fault condition to a minimum period.</p> |
| 16 | FLTSRC | R/W | 0 | <p>Fault Condition Source</p> <p>Value Description</p> <p>0 The Fault condition is determined by the Fault0 input.</p> <p>1 The Fault condition is determined by the configuration of the PWMnFLTSRC0 and PWMnFLTSRC1 registers.</p> |
| 15:14 | DBFALLUPD | R/W | 0x0 | <p>PWMnDBFALL Update Mode</p> <p>Value Description</p> <p>0x0 Immediate</p> <p>The PWMnDBFALL register value is immediately updated on a write.</p> <p>0x1 Reserved</p> <p>0x2 Locally Synchronized</p> <p>Updates to the register are reflected to the generator the next time the counter is 0.</p> <p>0x3 Globally Synchronized</p> <p>Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|---|
| 13:12 | DBRISEUPD | R/W | 0x0 | <p>PWMnDBRISE Update Mode</p> <p>Value Description</p> <p>0x0 Immediate The PWMnDBRISE register value is immediately updated on a write.</p> <p>0x1 Reserved</p> <p>0x2 Locally Synchronized Updates to the register are reflected to the generator the next time the counter is 0.</p> <p>0x3 Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register.</p> |
| 11:10 | DBCTLUPD | R/W | 0x0 | <p>PWMnDBCTL Update Mode</p> <p>Value Description</p> <p>0x0 Immediate The PWMnDBCTL register value is immediately updated on a write.</p> <p>0x1 Reserved</p> <p>0x2 Locally Synchronized Updates to the register are reflected to the generator the next time the counter is 0.</p> <p>0x3 Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register.</p> |
| 9:8 | GENBUPD | R/W | 0x0 | <p>PWMnGENB Update Mode</p> <p>Value Description</p> <p>0x0 Immediate The PWMnGENB register value is immediately updated on a write.</p> <p>0x1 Reserved</p> <p>0x2 Locally Synchronized Updates to the register are reflected to the generator the next time the counter is 0.</p> <p>0x3 Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register.</p> |

| Bit/Field | Name | Type | Reset | Description | | | | | | | | | | |
|-----------|---|------|-------|---|-------|-------------|-----|--|-----|---|-----|--|-----|---|
| 7:6 | GENAUPD | R/W | 0x0 | <p>PWMnGENA Update Mode</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0x0</td> <td>Immediate The PWMnGENA register value is immediately updated on a write.</td> </tr> <tr> <td>0x1</td> <td>Reserved</td> </tr> <tr> <td>0x2</td> <td>Locally Synchronized Updates to the register are reflected to the generator the next time the counter is 0.</td> </tr> <tr> <td>0x3</td> <td>Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register.</td> </tr> </tbody> </table> | Value | Description | 0x0 | Immediate The PWMnGENA register value is immediately updated on a write. | 0x1 | Reserved | 0x2 | Locally Synchronized Updates to the register are reflected to the generator the next time the counter is 0. | 0x3 | Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register. |
| Value | Description | | | | | | | | | | | | | |
| 0x0 | Immediate The PWMnGENA register value is immediately updated on a write. | | | | | | | | | | | | | |
| 0x1 | Reserved | | | | | | | | | | | | | |
| 0x2 | Locally Synchronized Updates to the register are reflected to the generator the next time the counter is 0. | | | | | | | | | | | | | |
| 0x3 | Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register. | | | | | | | | | | | | | |
| 5 | CMPBUPD | R/W | 0 | <p>Comparator B Update Mode</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Locally Synchronized Updates to the PWMnCMPB register are reflected to the generator the next time the counter is 0.</td> </tr> <tr> <td>1</td> <td>Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register.</td> </tr> </tbody> </table> | Value | Description | 0 | Locally Synchronized Updates to the PWMnCMPB register are reflected to the generator the next time the counter is 0. | 1 | Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | Locally Synchronized Updates to the PWMnCMPB register are reflected to the generator the next time the counter is 0. | | | | | | | | | | | | | |
| 1 | Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register. | | | | | | | | | | | | | |
| 4 | CMPAUPD | R/W | 0 | <p>Comparator A Update Mode</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Locally Synchronized Updates to the PWMnCMPA register are reflected to the generator the next time the counter is 0.</td> </tr> <tr> <td>1</td> <td>Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register.</td> </tr> </tbody> </table> | Value | Description | 0 | Locally Synchronized Updates to the PWMnCMPA register are reflected to the generator the next time the counter is 0. | 1 | Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | Locally Synchronized Updates to the PWMnCMPA register are reflected to the generator the next time the counter is 0. | | | | | | | | | | | | | |
| 1 | Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register. | | | | | | | | | | | | | |
| 3 | LOADUPD | R/W | 0 | <p>Load Register Update Mode</p> <table border="1"> <thead> <tr> <th>Value</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>Locally Synchronized Updates to the PWMnLOAD register are reflected to the generator the next time the counter is 0.</td> </tr> <tr> <td>1</td> <td>Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register.</td> </tr> </tbody> </table> | Value | Description | 0 | Locally Synchronized Updates to the PWMnLOAD register are reflected to the generator the next time the counter is 0. | 1 | Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register. | | | | |
| Value | Description | | | | | | | | | | | | | |
| 0 | Locally Synchronized Updates to the PWMnLOAD register are reflected to the generator the next time the counter is 0. | | | | | | | | | | | | | |
| 1 | Globally Synchronized Updates to the register are delayed until the next time the counter is 0 after a synchronous update has been requested through the PWMCTL register. | | | | | | | | | | | | | |

| Bit/Field | Name | Type | Reset | Description |
|--|--------|------|-------|--|
| 2 | DEBUG | R/W | 0 | Debug Mode |
| | | | | Value Description |
| | | | | 0 The counter stops running when it next reaches 0 and continues running again when no longer in Debug mode. |
| 1 The counter always runs when in Debug mode. | | | | |
| 1 | MODE | R/W | 0 | Counter Mode |
| | | | | Value Description |
| | | | | 0 The counter counts down from the load value to 0 and then wraps back to the load value (Count-Down mode). |
| 1 The counter counts up from 0 to the load value, back down to 0, and then repeats (Count-Up/Down mode). | | | | |
| 0 | ENABLE | R/W | 0 | PWM Block Enable |
| | | | | Value Description |
| | | | | 0 The entire PWM generation block is disabled and not clocked. |
| 1 The PWM generation block is enabled and produces PWM signals. | | | | |

Register 16: PWM0 Interrupt and Trigger Enable (PWM0INTEN), offset 0x044

Register 17: PWM1 Interrupt and Trigger Enable (PWM1INTEN), offset 0x084

Register 18: PWM2 Interrupt and Trigger Enable (PWM2INTEN), offset 0x0C4

Register 19: PWM3 Interrupt and Trigger Enable (PWM3INTEN), offset 0x104

These registers control the interrupt and ADC trigger generation capabilities of the PWM generators (**PWM0INTEN** controls the PWM generator 0 block, and so on). The events that can cause an interrupt, or an ADC trigger are:

- The counter being equal to the load register
- The counter being equal to zero
- The counter being equal to the **PWMnCMPA** register while counting up
- The counter being equal to the **PWMnCMPA** register while counting down
- The counter being equal to the **PWMnCMPB** register while counting up
- The counter being equal to the **PWMnCMPB** register while counting down

Any combination of these events can generate either an interrupt or an ADC trigger, though no determination can be made as to the actual event that caused an ADC trigger if more than one is specified. The **PWMnRIS** register provides information about which events have caused raw interrupts.

PWM0 Interrupt and Trigger Enable (PWM0INTEN)

PWM0 base: 0x4002.8000
Offset 0x044
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|---------|---------|---------|---------|-----------|-----------|----------|----|----------|----------|----------|----------|------------|------------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | TRCMPBD | TRCMPBU | TRCMPAD | TRCMPAU | TRCNTLOAD | TRCNTZERO | reserved | | INTCMPBD | INTCMPBU | INTCMPAD | INTCMPAU | INTCNTLOAD | INTCNTZERO |
| Type | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|--|-------|---|
| 31:14 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13 | TRCMPBD | R/W | 0 | Trigger for Counter= PWMnCMPB Down |
| | Value | Description | | |
| | 1 | An ADC trigger pulse is output when the counter matches the value in the PWMnCMPB register value while counting down. | | |
| | 0 | No ADC trigger is output. | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|-------|---|
| 12 | TRCMPBU | R/W | 0 | Trigger for Counter= PWMnCMPB Up Value Description 1 An ADC trigger pulse is output when the counter matches the value in the PWMnCMPB register value while counting up. 0 No ADC trigger is output. |
| 11 | TRCMPAD | R/W | 0 | Trigger for Counter= PWMnCMPA Down Value Description 1 An ADC trigger pulse is output when the counter matches the value in the PWMnCMPA register value while counting down. 0 No ADC trigger is output. |
| 10 | TRCMPAU | R/W | 0 | Trigger for Counter= PWMnCMPA Up Value Description 1 An ADC trigger pulse is output when the counter matches the value in the PWMnCMPA register value while counting up. 0 No ADC trigger is output. |
| 9 | TRCNTLOAD | R/W | 0 | Trigger for Counter= PWMnLOAD Value Description 1 An ADC trigger pulse is output when the counter matches the PWMnLOAD register. 0 No ADC trigger is output. |
| 8 | TRCNTZERO | R/W | 0 | Trigger for Counter=0 Value Description 1 An ADC trigger pulse is output when the counter is 0. 0 No ADC trigger is output. |
| 7:6 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | INTCMPBD | R/W | 0 | Interrupt for Counter= PWMnCMPB Down Value Description 1 A raw interrupt occurs when the counter matches the value in the PWMnCMPB register value while counting down. 0 No interrupt. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------------|------|-------|---|
| 4 | INTCMPBU | R/W | 0 | Interrupt for Counter= PWMnCMPB Up Value Description 1 A raw interrupt occurs when the counter matches the value in the PWMnCMPB register value while counting up. 0 No interrupt. |
| 3 | INTCMPAD | R/W | 0 | Interrupt for Counter= PWMnCMPA Down Value Description 1 A raw interrupt occurs when the counter matches the value in the PWMnCMPA register value while counting down. 0 No interrupt. |
| 2 | INTCMPAU | R/W | 0 | Interrupt for Counter= PWMnCMPA Up Value Description 1 A raw interrupt occurs when the counter matches the value in the PWMnCMPA register value while counting up. 0 No interrupt. |
| 1 | INTCNTLOAD | R/W | 0 | Interrupt for Counter= PWMnLOAD Value Description 1 A raw interrupt occurs when the counter matches the value in the PWMnLOAD register value. 0 No interrupt. |
| 0 | INTCNTZERO | R/W | 0 | Interrupt for Counter=0 Value Description 1 A raw interrupt occurs when the counter is zero. 0 No interrupt. |

Register 20: PWM0 Raw Interrupt Status (PWM0RIS), offset 0x048

Register 21: PWM1 Raw Interrupt Status (PWM1RIS), offset 0x088

Register 22: PWM2 Raw Interrupt Status (PWM2RIS), offset 0x0C8

Register 23: PWM3 Raw Interrupt Status (PWM3RIS), offset 0x108

These registers provide the current set of interrupt sources that are asserted, regardless of whether they cause an interrupt to be asserted to the controller (**PWM0RIS** controls the PWM generator 0 block, and so on). If a bit is set, the event has occurred; if a bit is clear, the event has not occurred. Bits in this register are cleared by writing a 1 to the corresponding bit in the **PWMnISC** register.

PWM0 Raw Interrupt Status (PWM0RIS)

PWM0 base: 0x4002.8000
 Offset 0x048
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----------|----------|----------|----------|------------|------------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | INTCMPBD | INTCMPBU | INTCMPAD | INTCMPAU | INTCNTLOAD | INTCNTZERO |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 31:6 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | INTCMPBD | RO | 0 | Comparator B Down Interrupt Status Value Description 1 The counter has matched the value in the PWMnCMPB register while counting down. 0 An interrupt has not occurred. This bit is cleared by writing a 1 to the INTCMPBD bit in the PWMnISC register. |
| 4 | INTCMPBU | RO | 0 | Comparator B Up Interrupt Status Value Description 1 The counter has matched the value in the PWMnCMPB register while counting up. 0 An interrupt has not occurred. This bit is cleared by writing a 1 to the INTCMPBU bit in the PWMnISC register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------------|------|-------|---|
| 3 | INTCMPAD | RO | 0 | <p>Comparator A Down Interrupt Status</p> <p>Value Description</p> <p>1 The counter has matched the value in the PWMnCMPA register while counting down.</p> <p>0 An interrupt has not occurred.</p> <p>This bit is cleared by writing a 1 to the INTCMPAD bit in the PWMnISC register.</p> |
| 2 | INTCMPAU | RO | 0 | <p>Comparator A Up Interrupt Status</p> <p>Value Description</p> <p>1 The counter has matched the value in the PWMnCMPA register while counting up.</p> <p>0 An interrupt has not occurred.</p> <p>This bit is cleared by writing a 1 to the INTCMPAU bit in the PWMnISC register.</p> |
| 1 | INTCNTLOAD | RO | 0 | <p>Counter=Load Interrupt Status</p> <p>Value Description</p> <p>1 The counter has matched the value in the PWMnLOAD register.</p> <p>0 An interrupt has not occurred.</p> <p>This bit is cleared by writing a 1 to the INTCNTLOAD bit in the PWMnISC register.</p> |
| 0 | INTCNTZERO | RO | 0 | <p>Counter=0 Interrupt Status</p> <p>Value Description</p> <p>1 The counter has matched zero.</p> <p>0 An interrupt has not occurred.</p> <p>This bit is cleared by writing a 1 to the INTCNTZERO bit in the PWMnISC register.</p> |

Register 24: PWM0 Interrupt Status and Clear (PWM0ISC), offset 0x04C

Register 25: PWM1 Interrupt Status and Clear (PWM1ISC), offset 0x08C

Register 26: PWM2 Interrupt Status and Clear (PWM2ISC), offset 0x0CC

Register 27: PWM3 Interrupt Status and Clear (PWM3ISC), offset 0x10C

These registers provide the current set of interrupt sources that are asserted to the interrupt controller (**PWM0ISC** controls the PWM generator 0 block, and so on). A bit is set if the event has occurred and is enabled in the **PWMnINTEN** register; if a bit is clear, the event has not occurred or is not enabled. These are R/W1C registers; writing a 1 to a bit position clears the corresponding interrupt reason.

PWM0 Interrupt Status and Clear (PWM0ISC)

PWM0 base: 0x4002.8000
 Offset 0x04C
 Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----------|----------|----------|----------|------------|------------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | INTCMPBD | INTCMPBU | INTCMPAD | INTCMPAU | INTCNTLOAD | INTCNTZERO |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C | R/W1C | R/W1C | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-------|--|
| 31:6 | reserved | RO | 0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 5 | INTCMPBD | R/W1C | 0 | Comparator B Down Interrupt Value Description 1 The INTCMPBD bits in the PWMnRIS and PWMnINTEN registers are set, providing an interrupt to the interrupt controller. 0 No interrupt has occurred or the interrupt is masked. This bit is cleared by writing a 1. Clearing this bit also clears the INTCMPBD bit in the PWMnRIS register. |
| 4 | INTCMPBU | R/W1C | 0 | Comparator B Up Interrupt Value Description 1 The INTCMPBU bits in the PWMnRIS and PWMnINTEN registers are set, providing an interrupt to the interrupt controller. 0 No interrupt has occurred or the interrupt is masked. This bit is cleared by writing a 1. Clearing this bit also clears the INTCMPBU bit in the PWMnRIS register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|------------|-------|-------|---|
| 3 | INTCMPAD | R/W1C | 0 | <p>Comparator A Down Interrupt</p> <p>Value Description</p> <p>1 The INTCMPAD bits in the PWMnRIS and PWMnINTEN registers are set, providing an interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the INTCMPAD bit in the PWMnRIS register.</p> |
| 2 | INTCMPAU | R/W1C | 0 | <p>Comparator A Up Interrupt</p> <p>Value Description</p> <p>1 The INTCMPAU bits in the PWMnRIS and PWMnINTEN registers are set, providing an interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the INTCMPAU bit in the PWMnRIS register.</p> |
| 1 | INTCNTLOAD | R/W1C | 0 | <p>Counter=Load Interrupt</p> <p>Value Description</p> <p>1 The INTCNTLOAD bits in the PWMnRIS and PWMnINTEN registers are set, providing an interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the INTCNTLOAD bit in the PWMnRIS register.</p> |
| 0 | INTCNTZERO | R/W1C | 0 | <p>Counter=0 Interrupt</p> <p>Value Description</p> <p>1 The INTCNTZERO bits in the PWMnRIS and PWMnINTEN registers are set, providing an interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the INTCNTZERO bit in the PWMnRIS register.</p> |

Register 28: PWM0 Load (PWM0LOAD), offset 0x050

Register 29: PWM1 Load (PWM1LOAD), offset 0x090

Register 30: PWM2 Load (PWM2LOAD), offset 0x0D0

Register 31: PWM3 Load (PWM3LOAD), offset 0x110

These registers contain the load value for the PWM counter (**PWM0LOAD** controls the PWM generator 0 block, and so on). Based on the counter mode configured by the **MODE** bit in the **PWMnCTL** register, this value is either loaded into the counter after it reaches zero or is the limit of up-counting after which the counter decrements back to zero. When this value matches the counter, a pulse is output which can be configured to drive the generation of the pwmA and/or pwmB signal (via the **PWMnGENA/PWMnGENB** register) or drive an interruptor ADC trigger (via the **PWMnINTEN** register).

If the Load Value Update mode is locally synchronized (based on the **LOADUPD** field encoding in the **PWMnCTL** register), the 16-bit **LOAD** value is used the next time the counter reaches zero. If the update mode is globally synchronized, it is used the next time the counter reaches zero after a synchronous update has been requested through the **PWM Master Control (PWMCTL)** register (see page 965). If this register is re-written before the actual update occurs, the previous value is never used and is lost.

PWM0 Load (PWM0LOAD)

PWM0 base: 0x4002.8000
 Offset 0x050
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | LOAD | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | LOAD | R/W | 0x0000 | Counter Load Value The counter load value. |

Register 32: PWM0 Counter (PWM0COUNT), offset 0x054**Register 33: PWM1 Counter (PWM1COUNT), offset 0x094****Register 34: PWM2 Counter (PWM2COUNT), offset 0x0D4****Register 35: PWM3 Counter (PWM3COUNT), offset 0x114**

These registers contain the current value of the PWM counter (**PWM0COUNT** is the value of the PWM generator 0 block, and so on). When this value matches zero or the value in the **PWMnLOAD**, **PWMnCMPA**, or **PWMnCMPB** registers, a pulse is output which can be configured to drive the generation of a PWM signal or drive an interrupt or ADC trigger.

PWM0 Counter (PWM0COUNT)

PWM0 base: 0x4002.8000

Offset 0x054

Type RO, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | COUNT | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | COUNT | RO | 0x0000 | Counter Value The current value of the counter. |

Register 36: PWM0 Compare A (PWM0CMPA), offset 0x058

Register 37: PWM1 Compare A (PWM1CMPA), offset 0x098

Register 38: PWM2 Compare A (PWM2CMPA), offset 0x0D8

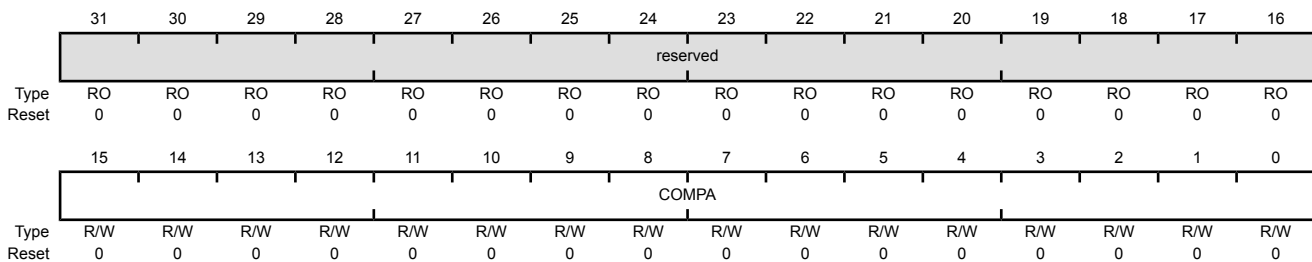
Register 39: PWM3 Compare A (PWM3CMPA), offset 0x118

These registers contain a value to be compared against the counter (**PWM0CMPA** controls the PWM generator 0 block, and so on). When this value matches the counter, a pulse is output which can be configured to drive the generation of the pwmA and pwmB signals (via the **PWMnGENA** and **PWMnGENB** registers) or drive an interrupt or ADC trigger (via the **PWMnINTEN** register). If the value of this register is greater than the **PWMnLOAD** register (see page 1002), then no pulse is ever output.

If the comparator A update mode is locally synchronized (based on the **COMPAUPD** bit in the **PWMnCTL** register), the 16-bit **COMPA** value is used the next time the counter reaches zero. If the update mode is globally synchronized, it is used the next time the counter reaches zero after a synchronous update has been requested through the **PWM Master Control (PWMCTL)** register (see page 965). If this register is rewritten before the actual update occurs, the previous value is never used and is lost.

PWM0 Compare A (PWM0CMPA)

PWM0 base: 0x4002.8000
 Offset 0x058
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:16 | reserved | RO | 0x00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | COMPA | R/W | 0x00 | Comparator A Value The value to be compared against the counter. |

Register 40: PWM0 Compare B (PWM0CMPB), offset 0x05C**Register 41: PWM1 Compare B (PWM1CMPB), offset 0x09C****Register 42: PWM2 Compare B (PWM2CMPB), offset 0x0DC****Register 43: PWM3 Compare B (PWM3CMPB), offset 0x11C**

These registers contain a value to be compared against the counter (**PWM0CMPB** controls the PWM generator 0 block, and so on). When this value matches the counter, a pulse is output which can be configured to drive the generation of the pwmA and pwmB signals (via the **PWMnGENA** and **PWMnGENB** registers) or drive an interrupt or ADC trigger (via the **PWMnINTEN** register). If the value of this register is greater than the **PWMnLOAD** register, no pulse is ever output.

If the comparator B update mode is locally synchronized (based on the **COMPBUPD** bit in the **PWMnCTL** register), the 16-bit **COMPB** value is used the next time the counter reaches zero. If the update mode is globally synchronized, it is used the next time the counter reaches zero after a synchronous update has been requested through the **PWM Master Control (PWMCTL)** register (see page 965). If this register is rewritten before the actual update occurs, the previous value is never used and is lost.

PWM0 Compare B (PWM0CMPB)

PWM0 base: 0x4002.8000

Offset 0x05C

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | COMPB | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | COMPB | R/W | 0x0000 | Comparator B Value The value to be compared against the counter. |

Register 44: PWM0 Generator A Control (PWM0GENA), offset 0x060

Register 45: PWM1 Generator A Control (PWM1GENA), offset 0x0A0

Register 46: PWM2 Generator A Control (PWM2GENA), offset 0x0E0

Register 47: PWM3 Generator A Control (PWM3GENA), offset 0x120

These registers control the generation of the pwmA signal based on the load and zero output pulses from the counter, as well as the compare A and compare B pulses from the comparators (**PWM0GENA** controls the PWM generator 0 block, and so on). When the counter is running in Count-Down mode, only four of these events occur; when running in Count-Up/Down mode, all six occur. These events provide great flexibility in the positioning and duty cycle of the resulting PWM signal.

The **PWM0GENA** register controls generation of the pwm0A signal; **PWM1GENA**, the pwm1A signal; **PWM2GENA**, the pwm2A signal; and **PWM3GENA**, the pwm3A signal.

If a zero or load event coincides with a compare A or compare B event, the zero or load action is taken and the compare A or compare B action is ignored. If a compare A event coincides with a compare B event, the compare A action is taken and the compare B action is ignored.

If the Generator A update mode is immediate (based on the **GENAUPD** field encoding in the **PWMnCTL** register), the **ACTCMPBD**, **ACTCMPBU**, **ACTCMPAD**, **ACTCMPAU**, **ACTLOAD**, and **ACTZERO** values are used immediately. If the update mode is locally synchronized, these values are used the next time the counter reaches zero. If the update mode is globally synchronized, these values are used the next time the counter reaches zero after a synchronous update has been requested through the **PWM Master Control (PWMCTL)** register (see page 965). If this register is rewritten before the actual update occurs, the previous value is never used and is lost.

PWM0 Generator A Control (PWM0GENA)

PWM0 base: 0x4002.8000
Offset 0x060
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----------|-----|----------|-----|----------|-----|----------|-----|---------|-----|---------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | ACTCMPBD | | ACTCMPBU | | ACTCMPAD | | ACTCMPAU | | ACTLOAD | | ACTZERO | |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 11:10 | ACTCMPBD | R/W | 0x0 | <p>Action for Comparator B Down</p> <p>This field specifies the action to be taken when the counter matches comparator B while counting down.</p> <p>Value Description</p> <p>0x0 Do nothing.</p> <p>0x1 Invert pwmA.</p> <p>0x2 Drive pwmA Low.</p> <p>0x3 Drive pwmA High.</p> |
| 9:8 | ACTCMPBU | R/W | 0x0 | <p>Action for Comparator B Up</p> <p>This field specifies the action to be taken when the counter matches comparator B while counting up. This action can only occur when the MODE bit in the PWMnCTL register is set.</p> <p>Value Description</p> <p>0x0 Do nothing.</p> <p>0x1 Invert pwmA.</p> <p>0x2 Drive pwmA Low.</p> <p>0x3 Drive pwmA High.</p> |
| 7:6 | ACTCMPAD | R/W | 0x0 | <p>Action for Comparator A Down</p> <p>This field specifies the action to be taken when the counter matches comparator A while counting down.</p> <p>Value Description</p> <p>0x0 Do nothing.</p> <p>0x1 Invert pwmA.</p> <p>0x2 Drive pwmA Low.</p> <p>0x3 Drive pwmA High.</p> |
| 5:4 | ACTCMPAU | R/W | 0x0 | <p>Action for Comparator A Up</p> <p>This field specifies the action to be taken when the counter matches comparator A while counting up. This action can only occur when the MODE bit in the PWMnCTL register is set.</p> <p>Value Description</p> <p>0x0 Do nothing.</p> <p>0x1 Invert pwmA.</p> <p>0x2 Drive pwmA Low.</p> <p>0x3 Drive pwmA High.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 3:2 | ACTLOAD | R/W | 0x0 | Action for Counter=LOAD This field specifies the action to be taken when the counter matches the value in the PWMnLOAD register. Value Description 0x0 Do nothing. 0x1 Invert pwmA. 0x2 Drive pwmA Low. 0x3 Drive pwmA High. |
| 1:0 | ACTZERO | R/W | 0x0 | Action for Counter=0 This field specifies the action to be taken when the counter is zero. Value Description 0x0 Do nothing. 0x1 Invert pwmA. 0x2 Drive pwmA Low. 0x3 Drive pwmA High. |

Register 48: PWM0 Generator B Control (PWM0GENB), offset 0x064**Register 49: PWM1 Generator B Control (PWM1GENB), offset 0x0A4****Register 50: PWM2 Generator B Control (PWM2GENB), offset 0x0E4****Register 51: PWM3 Generator B Control (PWM3GENB), offset 0x124**

These registers control the generation of the pwmB signal based on the load and zero output pulses from the counter, as well as the compare A and compare B pulses from the comparators (**PWM0GENB** controls the PWM generator 0 block, and so on). When the counter is running in Count-Down mode, only four of these events occur; when running in Count-Up/Down mode, all six occur. These events provide great flexibility in the positioning and duty cycle of the resulting PWM signal.

The **PWM0GENB** register controls generation of the pwm0B signal; **PWM1GENB**, the pwm1B signal; **PWM2GENB**, the pwm2B signal; and **PWM3GENB**, the pwm3B signal.

If a zero or load event coincides with a compare A or compare B event, the zero or load action is taken and the compare A or compare B action is ignored. If a compare A event coincides with a compare B event, the compare B action is taken and the compare A action is ignored.

If the Generator B update mode is immediate (based on the GENBUPD field encoding in the **PWMnCTL** register), the ACTCMPBD, ACTCMPBU, ACTCMPAD, ACTCMPAU, ACTLOAD, and ACTZERO values are used immediately. If the update mode is locally synchronized, these values are used the next time the counter reaches zero. If the update mode is globally synchronized, these values are used the next time the counter reaches zero after a synchronous update has been requested through the **PWM Master Control (PWMCTL)** register (see page 965). If this register is rewritten before the actual update occurs, the previous value is never used and is lost.

PWM0 Generator B Control (PWM0GENB)

PWM0 base: 0x4002.8000

Offset 0x064

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----------|-----|----------|-----|----------|-----|----------|-----|---------|-----|---------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | ACTCMPBD | | ACTCMPBU | | ACTCMPAD | | ACTCMPAU | | ACTLOAD | | ACTZERO | |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|----------|---|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 11:10 | ACTCMPBD | R/W | 0x0 | <p>Action for Comparator B Down</p> <p>This field specifies the action to be taken when the counter matches comparator B while counting down.</p> <p>Value Description</p> <p>0x0 Do nothing.</p> <p>0x1 Invert pwmB.</p> <p>0x2 Drive pwmB Low.</p> <p>0x3 Drive pwmB High.</p> |
| 9:8 | ACTCMPBU | R/W | 0x0 | <p>Action for Comparator B Up</p> <p>This field specifies the action to be taken when the counter matches comparator B while counting up. This action can only occur when the MODE bit in the PWMnCTL register is set.</p> <p>Value Description</p> <p>0x0 Do nothing.</p> <p>0x1 Invert pwmB.</p> <p>0x2 Drive pwmB Low.</p> <p>0x3 Drive pwmB High.</p> |
| 7:6 | ACTCMPAD | R/W | 0x0 | <p>Action for Comparator A Down</p> <p>This field specifies the action to be taken when the counter matches comparator A while counting down.</p> <p>Value Description</p> <p>0x0 Do nothing.</p> <p>0x1 Invert pwmB.</p> <p>0x2 Drive pwmB Low.</p> <p>0x3 Drive pwmB High.</p> |
| 5:4 | ACTCMPAU | R/W | 0x0 | <p>Action for Comparator A Up</p> <p>This field specifies the action to be taken when the counter matches comparator A while counting up. This action can only occur when the MODE bit in the PWMnCTL register is set.</p> <p>Value Description</p> <p>0x0 Do nothing.</p> <p>0x1 Invert pwmB.</p> <p>0x2 Drive pwmB Low.</p> <p>0x3 Drive pwmB High.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|--|
| 3:2 | ACTLOAD | R/W | 0x0 | Action for Counter=LOAD This field specifies the action to be taken when the counter matches the load value. Value Description 0x0 Do nothing. 0x1 Invert pwmB. 0x2 Drive pwmB Low. 0x3 Drive pwmB High. |
| 1:0 | ACTZERO | R/W | 0x0 | Action for Counter=0 This field specifies the action to be taken when the counter is 0. Value Description 0x0 Do nothing. 0x1 Invert pwmB. 0x2 Drive pwmB Low. 0x3 Drive pwmB High. |

Register 52: PWM0 Dead-Band Control (PWM0DBCTL), offset 0x068

Register 53: PWM1 Dead-Band Control (PWM1DBCTL), offset 0x0A8

Register 54: PWM2 Dead-Band Control (PWM2DBCTL), offset 0x0E8

Register 55: PWM3 Dead-Band Control (PWM3DBCTL), offset 0x128

The **PWMnDBCTL** register controls the dead-band generator, which produces the **PWMn** signals based on the **pwmA** and **pwmB** signals. When disabled, the **pwmA** signal passes through to the **pwmA'** signal and the **pwmB** signal passes through to the **pwmB'** signal. When dead-band control is enabled, the **pwmB** signal is ignored, the **pwmA'** signal is generated by delaying the rising edge(s) of the **pwmA** signal by the value in the **PWMnDBRISE** register (see page 1013), and the **pwmB'** signal is generated by inverting the **pwmA** signal and delaying the falling edge(s) of the **pwmA** signal by the value in the **PWMnDBFALL** register (see page 1014). The Output Control block outputs the **pwm0A'** signal on the **PWM0** signal and the **pwm0B'** signal on the **PWM1** signal. In a similar manner, **PWM2** and **PWM3** are produced from the **pwm1A'** and **pwm1B'** signals, **PWM4** and **PWM5** are produced from the **pwm2A'** and **pwm2B'** signals, and **PWM6** and **PWM7** are produced from the **pwm3A'** and **pwm3B'** signals.

If the Dead-Band Control mode is immediate (based on the **DBCTLUPD** field encoding in the **PWMnCTL** register), the **ENABLE** bit value is used immediately. If the update mode is locally synchronized, this value is used the next time the counter reaches zero. If the update mode is globally synchronized, this value is used the next time the counter reaches zero after a synchronous update has been requested through the **PWM Master Control (PWMCTL)** register (see page 965). If this register is rewritten before the actual update occurs, the previous value is never used and is lost.

PWM0 Dead-Band Control (PWM0DBCTL)

PWM0 base: 0x4002.8000
 Offset 0x068
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | | | | ENABLE |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:1 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 0 | ENABLE | R/W | 0 | Dead-Band Generator Enable |
| | | | | Value Description |
| | | | | 1 The dead-band generator modifies the pwmA signal by inserting dead bands into the pwmA' and pwmB' signals. |
| | | | | 0 The pwmA and pwmB signals pass through to the pwmA' and pwmB' signals unmodified. |

Register 56: PWM0 Dead-Band Rising-Edge Delay (PWM0DBRISE), offset 0x06C

Register 57: PWM1 Dead-Band Rising-Edge Delay (PWM1DBRISE), offset 0x0AC

Register 58: PWM2 Dead-Band Rising-Edge Delay (PWM2DBRISE), offset 0x0EC

Register 59: PWM3 Dead-Band Rising-Edge Delay (PWM3DBRISE), offset 0x12C

The **PWMnDBRISE** register contains the number of clock cycles to delay the rising edge of the pwmA signal when generating the pwmA' signal. If the dead-band generator is disabled through the **PWMnDBCTL** register, this register is ignored. If the value of this register is larger than the width of a High pulse on the pwmA signal, the rising-edge delay consumes the entire High time of the signal, resulting in no High time on the output. Care must be taken to ensure that the pwmA High time always exceeds the rising-edge delay.

If the Dead-Band Rising-Edge Delay mode is immediate (based on the **DBRISEUPD** field encoding in the **PWMnCTL** register), the 12-bit **RISEDELAY** value is used immediately. If the update mode is locally synchronized, this value is used the next time the counter reaches zero. If the update mode is globally synchronized, this value is used the next time the counter reaches zero after a synchronous update has been requested through the **PWM Master Control (PWMCTL)** register (see page 965). If this register is rewritten before the actual update occurs, the previous value is never used and is lost.

PWM0 Dead-Band Rising-Edge Delay (PWM0DBRISE)

PWM0 base: 0x4002.8000
Offset 0x06C
Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | RISEDELAY | | | | | | | | | | | |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|----------|---|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 11:0 | RISEDELAY | R/W | 0x000 | Dead-Band Rise Delay The number of clock cycles to delay the rising edge of pwmA' after the rising edge of pwmA. |

Register 60: PWM0 Dead-Band Falling-Edge-Delay (PWM0DBFALL), offset 0x070

Register 61: PWM1 Dead-Band Falling-Edge-Delay (PWM1DBFALL), offset 0x0B0

Register 62: PWM2 Dead-Band Falling-Edge-Delay (PWM2DBFALL), offset 0x0F0

Register 63: PWM3 Dead-Band Falling-Edge-Delay (PWM3DBFALL), offset 0x130

The **PWMnDBFALL** register contains the number of clock cycles to delay the rising edge of the pwmB' signal from the falling edge of the pwmA signal. If the dead-band generator is disabled through the **PWMnDBCTL** register, this register is ignored. If the value of this register is larger than the width of a Low pulse on the pwmA signal, the falling-edge delay consumes the entire Low time of the signal, resulting in no Low time on the output. Care must be taken to ensure that the pwmA Low time always exceeds the falling-edge delay.

If the Dead-Band Falling-Edge-Delay mode is immediate (based on the **DBFALLUP** field encoding in the **PWMnCTL** register), the 12-bit **FALLDELAY** value is used immediately. If the update mode is locally synchronized, this value is used the next time the counter reaches zero. If the update mode is globally synchronized, this value is used the next time the counter reaches zero after a synchronous update has been requested through the **PWM Master Control (PWMCTL)** register (see page 965). If this register is rewritten before the actual update occurs, the previous value is never used and is lost.

PWM0 Dead-Band Falling-Edge-Delay (PWM0DBFALL)

PWM0 base: 0x4002.8000
 Offset 0x070
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|-----------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | FALLDELAY | | | | | | | | | | | |
| Type | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|----------|---|
| 31:12 | reserved | RO | 0x0000.0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 11:0 | FALLDELAY | R/W | 0x000 | Dead-Band Fall Delay The number of clock cycles to delay the falling edge of pwmB' from the rising edge of pwmA. |

Register 64: PWM0 Fault Source 0 (PWM0FLTSRC0), offset 0x074**Register 65: PWM1 Fault Source 0 (PWM1FLTSRC0), offset 0x0B4****Register 66: PWM2 Fault Source 0 (PWM2FLTSRC0), offset 0x0F4****Register 67: PWM3 Fault Source 0 (PWM3FLTSRC0), offset 0x134**

This register specifies which fault pin inputs are used to generate a fault condition. Each bit in the following register indicates whether the corresponding fault pin is included in the fault condition. All enabled fault pins are ORed together to form the **PWMnFLTSRC0** portion of the fault condition. The **PWMnFLTSRC0** fault condition is then ORed with the **PWMnFLTSRC1** fault condition to generate the final fault condition for the PWM generator.

If the **FLTSRC** bit in the **PWMnCTL** register (see page 990) is clear, only the **Fault0** signal affects the fault condition generated. Otherwise, sources defined in **PWMnFLTSRC0** and **PWMnFLTSRC1** affect the fault condition generated.

PWM0 Fault Source 0 (PWM0FLTSRC0)

PWM0 base: 0x4002.8000

Offset 0x074

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|--------|--------|--------|--------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | FAULT3 | FAULT2 | FAULT1 | FAULT0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:4 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | FAULT3 | R/W | 0 | Fault3 Input |
| | | | | Value Description |
| | | | 0 | The Fault3 signal is suppressed and cannot generate a fault condition. |
| | | | 1 | The Fault3 signal value is ORed with all other fault condition generation inputs (Faultn signals and digital comparators). |

Note: The **FLTSRC** bit in the **PWMnCTL** register must be set for this bit to affect fault condition generation.

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|--|
| 2 | FAULT2 | R/W | 0 | <p>Fault2 Input</p> <p>Value Description</p> <p>0 The Fault2 signal is suppressed and cannot generate a fault condition.</p> <p>1 The Fault2 signal value is ORed with all other fault condition generation inputs (Faultn signals and digital comparators).</p> <p>Note: The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation.</p> |
| 1 | FAULT1 | R/W | 0 | <p>Fault1 Input</p> <p>Value Description</p> <p>0 The Fault1 signal is suppressed and cannot generate a fault condition.</p> <p>1 The Fault1 signal value is ORed with all other fault condition generation inputs (Faultn signals and digital comparators).</p> <p>Note: The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation.</p> |
| 0 | FAULT0 | R/W | 0 | <p>Fault0 Input</p> <p>Value Description</p> <p>0 The Fault0 signal is suppressed and cannot generate a fault condition.</p> <p>1 The Fault0 signal value is ORed with all other fault condition generation inputs (Faultn signals and digital comparators).</p> <p>Note: The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation.</p> |

Register 68: PWM0 Fault Source 1 (PWM0FLTSRC1), offset 0x078**Register 69: PWM1 Fault Source 1 (PWM1FLTSRC1), offset 0x0B8****Register 70: PWM2 Fault Source 1 (PWM2FLTSRC1), offset 0x0F8****Register 71: PWM3 Fault Source 1 (PWM3FLTSRC1), offset 0x138**

This register specifies which digital comparator triggers from the ADC are used to generate a fault condition. Each bit in the following register indicates whether the corresponding digital comparator trigger is included in the fault condition. All enabled digital comparator triggers are ORed together to form the **PWMnFLTSRC1** portion of the fault condition. The **PWMnFLTSRC1** fault condition is then ORed with the **PWMnFLTSRC0** fault condition to generate the final fault condition for the PWM generator.

If the **FLTSRC** bit in the **PWMnCTL** register (see page 990) is clear, only the PWM_{Fault0} pin affects the fault condition generated. Otherwise, sources defined in **PWMnFLTSRC0** and **PWMnFLTSRC1** affect the fault condition generated.

PWM0 Fault Source 1 (PWM0FLTSRC1)

PWM0 base: 0x4002.8000

Offset 0x078

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-------|-------|-------|-------|-------|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DCMP7 | DCMP6 | DCMP5 | DCMP4 | DCMP3 | DCMP2 | DCMP1 | DCMP0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description | |
|--------------|----------|---|-----------|---|--|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. | |
| 7 | DCMP7 | R/W | 0 | Digital Comparator 7 Value Description 0 The trigger from digital comparator 7 is suppressed and cannot generate a fault condition. 1 The trigger from digital comparator 7 is ORed with all other fault condition generation inputs (Faultn signals and digital comparators). | |
| Note: | | The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation. | | | |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 6 | DCMP6 | R/W | 0 | <p>Digital Comparator 6</p> <p>Value Description</p> <p>0 The trigger from digital comparator 6 is suppressed and cannot generate a fault condition.</p> <p>1 The trigger from digital comparator 6 is ORed with all other fault condition generation inputs (Faultn signals and digital comparators).</p> <p>Note: The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation.</p> |
| 5 | DCMP5 | R/W | 0 | <p>Digital Comparator 5</p> <p>Value Description</p> <p>0 The trigger from digital comparator 5 is suppressed and cannot generate a fault condition.</p> <p>1 The trigger from digital comparator 5 is ORed with all other fault condition generation inputs (Faultn signals and digital comparators).</p> <p>Note: The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation.</p> |
| 4 | DCMP4 | R/W | 0 | <p>Digital Comparator 4</p> <p>Value Description</p> <p>0 The trigger from digital comparator 4 is suppressed and cannot generate a fault condition.</p> <p>1 The trigger from digital comparator 4 is ORed with all other fault condition generation inputs (Faultn signals and digital comparators).</p> <p>Note: The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation.</p> |
| 3 | DCMP3 | R/W | 0 | <p>Digital Comparator 3</p> <p>Value Description</p> <p>0 The trigger from digital comparator 3 is suppressed and cannot generate a fault condition.</p> <p>1 The trigger from digital comparator 3 is ORed with all other fault condition generation inputs (Faultn signals and digital comparators).</p> <p>Note: The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 2 | DCMP2 | R/W | 0 | <p>Digital Comparator 2</p> <p>Value Description</p> <p>0 The trigger from digital comparator 2 is suppressed and cannot generate a fault condition.</p> <p>1 The trigger from digital comparator 2 is ORed with all other fault condition generation inputs (Faultn signals and digital comparators).</p> <p>Note: The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation.</p> |
| 1 | DCMP1 | R/W | 0 | <p>Digital Comparator 1</p> <p>Value Description</p> <p>0 The trigger from digital comparator 1 is suppressed and cannot generate a fault condition.</p> <p>1 The trigger from digital comparator 1 is ORed with all other fault condition generation inputs (Faultn signals and digital comparators).</p> <p>Note: The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation.</p> |
| 0 | DCMP0 | R/W | 0 | <p>Digital Comparator 0</p> <p>Value Description</p> <p>0 The trigger from digital comparator 0 is suppressed and cannot generate a fault condition.</p> <p>1 The trigger from digital comparator 0 is ORed with all other fault condition generation inputs (Faultn signals and digital comparators).</p> <p>Note: The FLTSRC bit in the PWMnCTL register must be set for this bit to affect fault condition generation.</p> |

Register 72: PWM0 Minimum Fault Period (PWM0MINFLTPER), offset 0x07C

Register 73: PWM1 Minimum Fault Period (PWM1MINFLTPER), offset 0x0BC

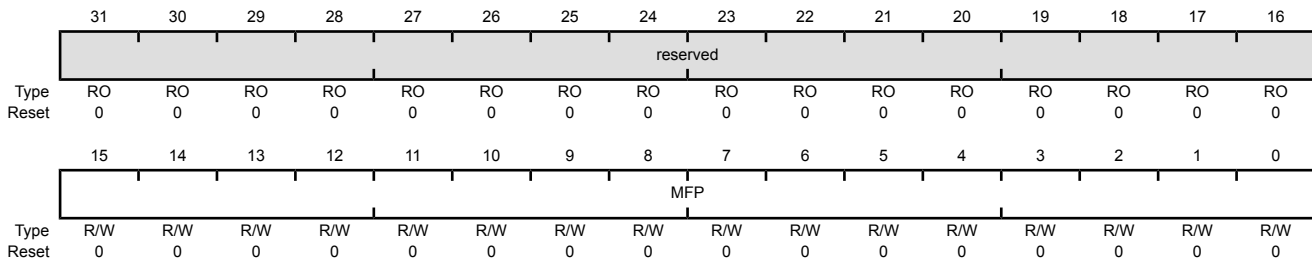
Register 74: PWM2 Minimum Fault Period (PWM2MINFLTPER), offset 0x0FC

Register 75: PWM3 Minimum Fault Period (PWM3MINFLTPER), offset 0x13C

If the `MINFLTPER` bit in the `PWMnCTL` register is set, this register specifies the 16-bit time-extension value to be used in extending the fault condition. The value is loaded into a 16-bit down counter, and the counter value is used to extend the fault condition. The fault condition is released in the clock immediately after the counter value reaches 0. The fault condition is asynchronous to the PWM clock; and the delay value is the product of the PWM clock period and the (MFP field value + 1) or (MFP field value + 2) depending on when the fault condition asserts with respect to the PWM clock. The counter decrements at the PWM clock rate, without pause or condition.

PWM0 Minimum Fault Period (PWM0MINFLTPER)

PWM0 base: 0x4002.8000
 Offset 0x07C
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:16 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 15:0 | MFP | R/W | 0x0000 | Minimum Fault Period The number of PWM clocks by which a fault condition is extended when the delay is enabled by <code>PWMnCTL</code> <code>MINFLTPER</code> . |

Register 76: PWM0 Fault Pin Logic Sense (PWM0FLTSEN), offset 0x800

Register 77: PWM1 Fault Pin Logic Sense (PWM1FLTSEN), offset 0x880

Register 78: PWM2 Fault Pin Logic Sense (PWM2FLTSEN), offset 0x900

Register 79: PWM3 Fault Pin Logic Sense (PWM3FLTSEN), offset 0x980

This register defines the PWM fault pin logic sense.

PWM0 Fault Pin Logic Sense (PWM0FLTSEN)

PWM0 base: 0x4002.8000

Offset 0x800

Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|--------|--------|--------|--------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | FAULT3 | FAULT2 | FAULT1 | FAULT0 | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | FAULT3 | R/W | 0 | Fault3 Sense Value Description 0 An error is indicated if the <code>Fault3</code> signal is High. 1 An error is indicated if the <code>Fault3</code> signal is Low. |
| 2 | FAULT2 | R/W | 0 | Fault2 Sense Value Description 0 An error is indicated if the <code>Fault2</code> signal is High. 1 An error is indicated if the <code>Fault2</code> signal is Low. |
| 1 | FAULT1 | R/W | 0 | Fault1 Sense Value Description 0 An error is indicated if the <code>Fault1</code> signal is High. 1 An error is indicated if the <code>Fault1</code> signal is Low. |
| 0 | FAULT0 | R/W | 0 | Fault0 Sense Value Description 0 An error is indicated if the <code>Fault0</code> signal is High. 1 An error is indicated if the <code>Fault0</code> signal is Low. |

Register 80: PWM0 Fault Status 0 (PWM0FLTSTAT0), offset 0x804

Register 81: PWM1 Fault Status 0 (PWM1FLTSTAT0), offset 0x884

Register 82: PWM2 Fault Status 0 (PWM2FLTSTAT0), offset 0x904

Register 83: PWM3 Fault Status 0 (PWM3FLTSTAT0), offset 0x984

Along with the **PWMnFLTSTAT1** register, this register provides status regarding the fault condition inputs.

If the **LATCH** bit in the **PWMnCTL** register is clear, the contents of the **PWMnFLTSTAT0** register are read-only (RO) and provide the current state of the **FAULTn** inputs.

If the **LATCH** bit in the **PWMnCTL** register is set, the contents of the **PWMnFLTSTAT0** register are read / write 1 to clear (R/W1C) and provide a latched version of the **FAULTn** inputs. In this mode, the register bits are cleared by writing a 1 to a set bit. The **FAULTn** inputs are recorded after their sense is adjusted in the generator.

The contents of this register can only be written if the fault source extensions are enabled (the **FLTSRC** bit in the **PWMnCTL** register is set).

PWM0 Fault Status 0 (PWM0FLTSTAT0)

PWM0 base: 0x4002.8000

Offset 0x804

Type -, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|--------|--------|--------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | FAULT3 | FAULT2 | FAULT1 | FAULT0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | - | - | - | - |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|--------|---|
| 31:4 | reserved | RO | 0x0000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | FAULT3 | - | 0 | <p>Fault Input 3</p> <p>If the PWMnCTL register LATCH bit is clear, this bit is RO and represents the current state of the FAULT3 input signal after the logic sense adjustment.</p> <p>If the PWMnCTL register LATCH bit is set, this bit is R/W1C and represents a sticky version of the FAULT3 input signal after the logic sense adjustment.</p> <ul style="list-style-type: none"> ■ If FAULT3 is set, the input transitioned to the active state previously. ■ If FAULT3 is clear, the input has not transitioned to the active state since the last time it was cleared. ■ The FAULT3 bit is cleared by writing it with the value 1. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------|---|
| 2 | FAULT2 | - | 0 | <p>Fault Input 2</p> <p>If the PWMnCTL register LATCH bit is clear, this bit is RO and represents the current state of the FAULT2 input signal after the logic sense adjustment.</p> <p>If the PWMnCTL register LATCH bit is set, this bit is R/W1C and represents a sticky version of the FAULT2 input signal after the logic sense adjustment.</p> <ul style="list-style-type: none"> ■ If FAULT2 is set, the input transitioned to the active state previously. ■ If FAULT2 is clear, the input has not transitioned to the active state since the last time it was cleared. ■ The FAULT2 bit is cleared by writing it with the value 1. |
| 1 | FAULT1 | - | 0 | <p>Fault Input 1</p> <p>If the PWMnCTL register LATCH bit is clear, this bit is RO and represents the current state of the FAULT1 input signal after the logic sense adjustment.</p> <p>If the PWMnCTL register LATCH bit is set, this bit is R/W1C and represents a sticky version of the FAULT1 input signal after the logic sense adjustment.</p> <ul style="list-style-type: none"> ■ If FAULT1 is set, the input transitioned to the active state previously. ■ If FAULT1 is clear, the input has not transitioned to the active state since the last time it was cleared. ■ The FAULT1 bit is cleared by writing it with the value 1. |
| 0 | FAULT0 | - | 0 | <p>Fault Input 0</p> <p>If the PWMnCTL register LATCH bit is clear, this bit is RO and represents the current state of the input signal after the logic sense adjustment.</p> <p>If the PWMnCTL register LATCH bit is set, this bit is R/W1C and represents a sticky version of the input signal after the logic sense adjustment.</p> <ul style="list-style-type: none"> ■ If FAULT0 is set, the input transitioned to the active state previously. ■ If FAULT0 is clear, the input has not transitioned to the active state since the last time it was cleared. ■ The FAULT0 bit is cleared by writing it with the value 1. |

Register 84: PWM0 Fault Status 1 (PWM0FLTSTAT1), offset 0x808

Register 85: PWM1 Fault Status 1 (PWM1FLTSTAT1), offset 0x888

Register 86: PWM2 Fault Status 1 (PWM2FLTSTAT1), offset 0x908

Register 87: PWM3 Fault Status 1 (PWM3FLTSTAT1), offset 0x988

Along with the **PWMnFLTSTAT0** register, this register provides status regarding the fault condition inputs.

If the **LATCH** bit in the **PWMnCTL** register is clear, the contents of the **PWMnFLTSTAT1** register are read-only (RO) and provide the current state of the digital comparator triggers.

If the **LATCH** bit in the **PWMnCTL** register is set, the contents of the **PWMnFLTSTAT1** register are read / write 1 to clear (R/W1C) and provide a latched version of the digital comparator triggers. In this mode, the register bits are cleared by writing a 1 to a set bit. The contents of this register can only be written if the fault source extensions are enabled (the **FLTSRC** bit in the **PWMnCTL** register is set).

PWM0 Fault Status 1 (PWM0FLTSTAT1)

PWM0 base: 0x4002.8000
 Offset 0x808
 Type -, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|-------|-------|-------|-------|-------|-------|-------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | DCMP7 | DCMP6 | DCMP5 | DCMP4 | DCMP3 | DCMP2 | DCMP1 | DCMP0 |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | - | - | - | - | - | - | - | - |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-----------|---|
| 31:8 | reserved | RO | 0x0000.00 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 7 | DCMP7 | - | 0 | Digital Comparator 7 Trigger If the PWMnCTL register LATCH bit is clear, this bit represents the current state of the Digital Comparator 7 trigger input. If the PWMnCTL register LATCH bit is set, this bit represents a sticky version of the trigger. |
| | | | | <ul style="list-style-type: none"> ■ If DCMP7 is set, the trigger transitioned to the active state previously. ■ If DCMP7 is clear, the trigger has not transitioned to the active state since the last time it was cleared. ■ The DCMP7 bit is cleared by writing it with the value 1. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|--|
| 6 | DCMP6 | - | 0 | <p>Digital Comparator 6 Trigger</p> <p>If the PWMnCTL register <i>LATCH</i> bit is clear, this bit represents the current state of the Digital Comparator 6 trigger input.</p> <p>If the PWMnCTL register <i>LATCH</i> bit is set, this bit represents a sticky version of the trigger.</p> <ul style="list-style-type: none"> ■ If DCMP6 is set, the trigger transitioned to the active state previously. ■ If DCMP6 is clear, the trigger has not transitioned to the active state since the last time it was cleared. ■ The DCMP6 bit is cleared by writing it with the value 1. |
| 5 | DCMP5 | - | 0 | <p>Digital Comparator 5 Trigger</p> <p>If the PWMnCTL register <i>LATCH</i> bit is clear, this bit represents the current state of the Digital Comparator 5 trigger input.</p> <p>If the PWMnCTL register <i>LATCH</i> bit is set, this bit represents a sticky version of the trigger.</p> <ul style="list-style-type: none"> ■ If DCMP5 is set, the trigger transitioned to the active state previously. ■ If DCMP5 is clear, the trigger has not transitioned to the active state since the last time it was cleared. ■ The DCMP5 bit is cleared by writing it with the value 1. |
| 4 | DCMP4 | - | 0 | <p>Digital Comparator 4 Trigger</p> <p>If the PWMnCTL register <i>LATCH</i> bit is clear, this bit represents the current state of the Digital Comparator 4 trigger input.</p> <p>If the PWMnCTL register <i>LATCH</i> bit is set, this bit represents a sticky version of the trigger.</p> <ul style="list-style-type: none"> ■ If DCMP4 is set, the trigger transitioned to the active state previously. ■ If DCMP4 is clear, the trigger has not transitioned to the active state since the last time it was cleared. ■ The DCMP4 bit is cleared by writing it with the value 1. |
| 3 | DCMP3 | - | 0 | <p>Digital Comparator 3 Trigger</p> <p>If the PWMnCTL register <i>LATCH</i> bit is clear, this bit represents the current state of the Digital Comparator 3 trigger input.</p> <p>If the PWMnCTL register <i>LATCH</i> bit is set, this bit represents a sticky version of the trigger.</p> <ul style="list-style-type: none"> ■ If DCMP3 is set, the trigger transitioned to the active state previously. ■ If DCMP3 is clear, the trigger has not transitioned to the active state since the last time it was cleared. ■ The DCMP3 bit is cleared by writing it with the value 1. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------|---|
| 2 | DCMP2 | - | 0 | <p>Digital Comparator 2 Trigger</p> <p>If the PWMnCTL register LATCH bit is clear, this bit represents the current state of the Digital Comparator 2 trigger input.</p> <p>If the PWMnCTL register LATCH bit is set, this bit represents a sticky version of the trigger.</p> <ul style="list-style-type: none">■ If DCMP2 is set, the trigger transitioned to the active state previously.■ If DCMP2 is clear, the trigger has not transitioned to the active state since the last time it was cleared.■ The DCMP2 bit is cleared by writing it with the value 1. |
| 1 | DCMP1 | - | 0 | <p>Digital Comparator 1 Trigger</p> <p>If the PWMnCTL register LATCH bit is clear, this bit represents the current state of the Digital Comparator 1 trigger input.</p> <p>If the PWMnCTL register LATCH bit is set, this bit represents a sticky version of the trigger.</p> <ul style="list-style-type: none">■ If DCMP1 is set, the trigger transitioned to the active state previously.■ If DCMP1 is clear, the trigger has not transitioned to the active state since the last time it was cleared.■ The DCMP1 bit is cleared by writing it with the value 1. |
| 0 | DCMP0 | - | 0 | <p>Digital Comparator 0 Trigger</p> <p>If the PWMnCTL register LATCH bit is clear, this bit represents the current state of the Digital Comparator 0 trigger input.</p> <p>If the PWMnCTL register LATCH bit is set, this bit represents a sticky version of the trigger.</p> <ul style="list-style-type: none">■ If DCMP0 is set, the trigger transitioned to the active state previously.■ If DCMP0 is clear, the trigger has not transitioned to the active state since the last time it was cleared.■ The DCMP0 bit is cleared by writing it with the value 1. |

21 Quadrature Encoder Interface (QEI)

A quadrature encoder, also known as a 2-channel incremental encoder, converts linear displacement into a pulse signal. By monitoring both the number of pulses and the relative phase of the two signals, you can track the position, direction of rotation, and speed. In addition, a third channel, or index signal, can be used to reset the position counter.

The LM3S2U93 microcontroller includes two quadrature encoder interface (QEI) modules. Each QEI module interprets the code produced by a quadrature encoder wheel to integrate position over time and determine direction of rotation. In addition, it can capture a running estimate of the velocity of the encoder wheel.

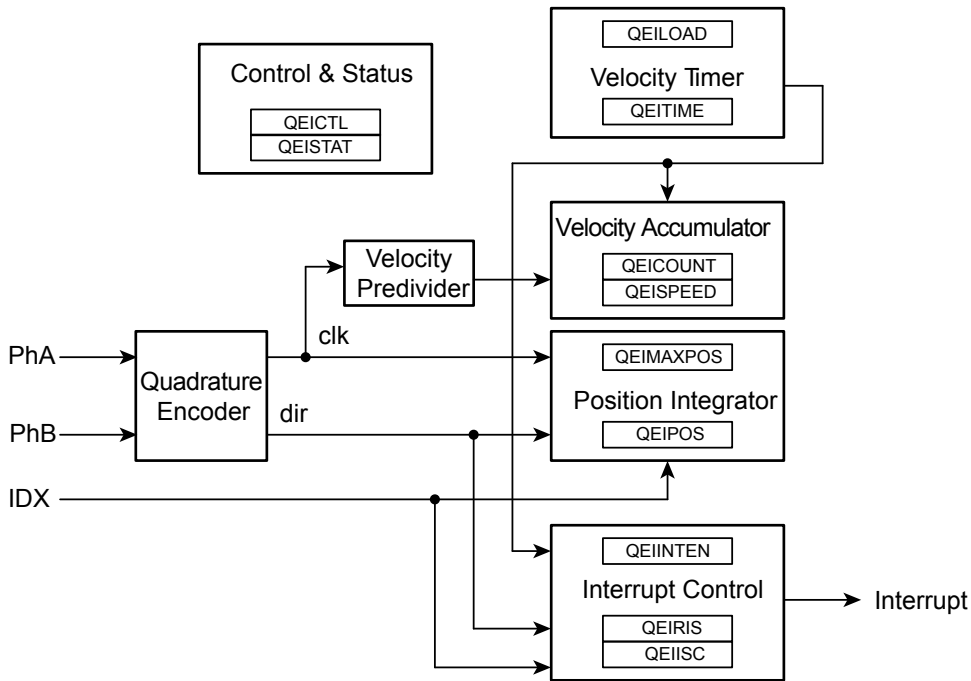
The Stellaris® LM3S2U93 microcontroller includes two QEI modules providing control of two motors at the same time with the following features:

- Position integrator that tracks the encoder position
- Programmable noise filter on the inputs
- Velocity capture using built-in timer
- The input frequency of the QEI inputs may be as high as 1/4 of the processor frequency (for example, 12.5 MHz for a 50-MHz system)
- Interrupt generation on:
 - Index pulse
 - Velocity-timer expiration
 - Direction change
 - Quadrature error detection

21.1 Block Diagram

Figure 21-1 on page 1028 provides a block diagram of a Stellaris QEI module.

Figure 21-1. QEI Block Diagram



21.2 Signal Description

The following table lists the external signals of the QEI module and describes the function of each. The QEI signals are alternate functions for some GPIO signals and default to be GPIO signals at reset. The column in the table below titled "Pin Mux/Pin Assignment" lists the possible GPIO pin placements for these QEI signals. The **AFSEL** bit in the **GPIO Alternate Function Select (GPIOAFSEL)** register (page 443) should be set to choose the QEI function. The number in parentheses is the encoding that must be programmed into the **PMC_n** field in the **GPIO Port Control (GPIOPTCL)** register (page 461) to assign the QEI signal to the specified GPIO port pin. For more information on configuring GPIOs, see "General-Purpose Input/Outputs (GPIOs)" on page 419.

Table 21-1. QEI Signals (100LQFP)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|-----------------------|
| IDX0 | 10 | PD0 (3) | I | TTL | QEI module 0 index. |
| | 40 | PG5 (4) | | | |
| | 72 | PB2 (2) | | | |
| | 90 | PB6 (5) | | | |
| | 92 | PB4 (6) | | | |
| IDX1 | 17 | PG2 (8) | I | TTL | QEI module 1 index. |
| | 61 | PF1 (2) | | | |
| | 84 | PH2 (1) | | | |
| PhA0 | 11 | PD1 (3) | I | TTL | QEI module 0 phase A. |
| | 25 | PC4 (2) | | | |
| | 43 | PF6 (4) | | | |
| | 95 | PE2 (4) | | | |
| PhA1 | 37 | PG6 (1) | I | TTL | QEI module 1 phase A. |
| | 96 | PE3 (3) | | | |

Table 21-1. QEI Signals (100LQFP) (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|-----------------------|
| PhB0 | 22 | PC7 (2) | I | TTL | QEI module 0 phase B. |
| | 23 | PC6 (2) | | | |
| | 42 | PF7 (4) | | | |
| | 47 | PF0 (2) | | | |
| | 83 | PH3 (1) | | | |
| | 96 | PE3 (4) | | | |
| PhB1 | 11 | PD1 (11) | I | TTL | QEI module 1 phase B. |
| | 36 | PG7 (1) | | | |
| | 95 | PE2 (3) | | | |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 21-2. QEI Signals (108BGA)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|-----------------------|
| IDX0 | G1 | PD0 (3) | I | TTL | QEI module 0 index. |
| | M7 | PG5 (4) | | | |
| | A11 | PB2 (2) | | | |
| | A7 | PB6 (5) | | | |
| | A6 | PB4 (6) | | | |
| | A2 | PD7 (1) | | | |
| | | | | | |
| IDX1 | J1 | PG2 (8) | I | TTL | QEI module 1 index. |
| | H12 | PF1 (2) | | | |
| | D11 | PH2 (1) | | | |
| PhA0 | G2 | PD1 (3) | I | TTL | QEI module 0 phase A. |
| | L1 | PC4 (2) | | | |
| | M8 | PF6 (4) | | | |
| | A4 | PE2 (4) | | | |
| PhA1 | L7 | PG6 (1) | I | TTL | QEI module 1 phase A. |
| | B4 | PE3 (3) | | | |
| PhB0 | L2 | PC7 (2) | I | TTL | QEI module 0 phase B. |
| | M2 | PC6 (2) | | | |
| | K4 | PF7 (4) | | | |
| | M9 | PF0 (2) | | | |
| | D10 | PH3 (1) | | | |
| | B4 | PE3 (4) | | | |
| PhB1 | G2 | PD1 (11) | I | TTL | QEI module 1 phase B. |
| | C10 | PG7 (1) | | | |
| | A4 | PE2 (3) | | | |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

21.3 Functional Description

The QEI module interprets the two-bit gray code produced by a quadrature encoder wheel to integrate position over time and determine direction of rotation. In addition, it can capture a running estimate of the velocity of the encoder wheel.

The position integrator and velocity capture can be independently enabled, though the position integrator must be enabled before the velocity capture can be enabled. The two phase signals, PhA and PhB, can be swapped before being interpreted by the QEI module to change the meaning of forward and backward and to correct for miswiring of the system. Alternatively, the phase signals can be interpreted as a clock and direction signal as output by some encoders.

The QEI module input signals have a digital noise filter on them that can be enabled to prevent spurious operation. The noise filter requires that the inputs be stable for a specified number of consecutive clock cycles before updating the edge detector. The filter is enabled by the `FILTEN` bit in the **QEI Control (QEICTL)** register. The frequency of the input update is programmable using the `FILTCNT` bit field in the **QEICTL** register.

The QEI module supports two modes of signal operation: quadrature phase mode and clock/direction mode. In quadrature phase mode, the encoder produces two clocks that are 90 degrees out of phase; the edge relationship is used to determine the direction of rotation. In clock/direction mode, the encoder produces a clock signal to indicate steps and a direction signal to indicate the direction of rotation. This mode is determined by the `SIGMODE` bit of the **QEICTL** register (see page 1034).

When the QEI module is set to use the quadrature phase mode (`SIGMODE` bit is clear), the capture mode for the position integrator can be set to update the position counter on every edge of the `PhA` signal or to update on every edge of both `PhA` and `PhB`. Updating the position counter on every `PhA` and `PhB` edge provides more positional resolution at the cost of less range in the positional counter.

When edges on `PhA` lead edges on `PhB`, the position counter is incremented. When edges on `PhB` lead edges on `PhA`, the position counter is decremented. When a rising and falling edge pair is seen on one of the phases without any edges on the other, the direction of rotation has changed.

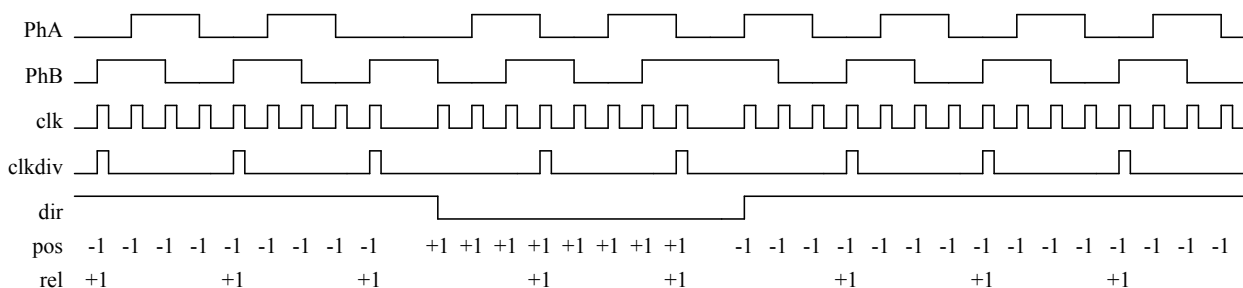
The positional counter is automatically reset on one of two conditions: sensing the index pulse or reaching the maximum position value. The reset mode is determined by the `RESMODE` bit of the **QEICTL** register.

When `RESMODE` is set, the positional counter is reset when the index pulse is sensed. This mode limits the positional counter to the values $[0:N-1]$, where N is the number of phase edges in a full revolution of the encoder wheel. The **QEI Maximum Position (QEIMAXPOS)** register must be programmed with $N-1$ so that the reverse direction from position 0 can move the position counter to $N-1$. In this mode, the position register contains the absolute position of the encoder relative to the index (or home) position once an index pulse has been seen.

When `RESMODE` is clear, the positional counter is constrained to the range $[0:M]$, where M is the programmable maximum value. The index pulse is ignored by the positional counter in this mode.

Velocity capture uses a configurable timer and a count register. The timer counts the number of phase edges (using the same configuration as for the position integrator) in a given time period. The edge count from the previous time period is available to the controller via the **QEI Velocity (QEISPEED)** register, while the edge count for the current time period is being accumulated in the **QEI Velocity Counter (QEICOUNT)** register. As soon as the current time period is complete, the total number of edges counted in that time period is made available in the **QEISPEED** register (overwriting the previous value), the **QEICOUNT** register is cleared, and counting commences on a new time period. The number of edges counted in a given time period is directly proportional to the velocity of the encoder.

Figure 21-2 on page 1031 shows how the Stellaris quadrature encoder converts the phase input signals into clock pulses, the direction signal, and how the velocity predivider operates (in Divide by 4 mode).

Figure 21-2. Quadrature Encoder and Velocity Predivider Operation

The period of the timer is configurable by specifying the load value for the timer in the **QEI Timer Load (QEILOAD)** register. When the timer reaches zero, an interrupt can be triggered, and the hardware reloads the timer with the **QEILOAD** value and continues to count down. At lower encoder speeds, a longer timer period is required to be able to capture enough edges to have a meaningful result. At higher encoder speeds, both a shorter timer period and/or the velocity predivider can be used.

The following equation converts the velocity counter value into an rpm value:

$$\text{rpm} = (\text{clock} * (2 \wedge \text{VELDIV}) * \text{SPEED} * 60) \div (\text{LOAD} * \text{ppr} * \text{edges})$$

where:

clock is the controller clock rate

ppr is the number of pulses per revolution of the physical encoder

edges is 2 or 4, based on the capture mode set in the **QEICTL** register (2 for **CAPMODE** clear and 4 for **CAPMODE** set)

For example, consider a motor running at 600 rpm. A 2048 pulse per revolution quadrature encoder is attached to the motor, producing 8192 phase edges per revolution. With a velocity predivider of $\div 1$ (**VELDIV** is clear) and clocking on both **PhA** and **PhB** edges, this results in 81,920 pulses per second (the motor turns 10 times per second). If the timer were clocked at 10,000 Hz, and the load value was 2,500 ($\frac{1}{4}$ of a second), it would count 20,480 pulses per update. Using the above equation:

$$\text{rpm} = (10000 * 1 * 20480 * 60) \div (2500 * 2048 * 4) = 600 \text{ rpm}$$

Now, consider that the motor is sped up to 3000 rpm. This results in 409,600 pulses per second, or 102,400 every $\frac{1}{4}$ of a second. Again, the above equation gives:

$$\text{rpm} = (10000 * 1 * 102400 * 60) \div (2500 * 2048 * 4) = 3000 \text{ rpm}$$

Care must be taken when evaluating this equation because intermediate values may exceed the capacity of a 32-bit integer. In the above examples, the clock is 10,000 and the divider is 2,500; both could be predivided by 100 (at compile time if they are constants) and therefore be 100 and 25. In fact, if they were compile-time constants, they could also be reduced to a simple multiply by 4, cancelled by the $\div 4$ for the edge-count factor.

Important: Reducing constant factors at compile time is the best way to control the intermediate values of this equation and reduce the processing requirement of computing this equation.

The division can be avoided by selecting a timer load value such that the divisor is a power of 2; a simple shift can therefore be done in place of the division. For encoders with a power of 2 pulses per revolution, the load value can be a power of 2. For other encoders, a load value must be selected such that the product is very close to a power of 2. For example, a 100 pulse-per-revolution encoder

could use a load value of 82, resulting in 32,800 as the divisor, which is 0.09% above 2^{14} . In this case a shift by 15 would be an adequate approximation of the divide in most cases. If absolute accuracy were required, the microcontroller's divide instruction could be used.

The QEI module can produce a controller interrupt on several events: phase error, direction change, reception of the index pulse, and expiration of the velocity timer. Standard masking, raw interrupt status, interrupt status, and interrupt clear capabilities are provided.

21.4 Initialization and Configuration

The following example shows how to configure the Quadrature Encoder module to read back an absolute position:

1. Enable the QEI clock by writing a value of 0x0000.0100 to the **RCGC1** register in the System Control module (see page 262).
2. Enable the clock to the appropriate GPIO module via the **RCGC2** register in the System Control module (see page 274).
3. In the GPIO module, enable the appropriate pins for their alternate function using the **GPIOAFSEL** register. To determine which GPIOs to configure, see Table 23-4 on page 1075.
4. Configure the **PMC_n** fields in the **GPIOPCTL** register to assign the QEI signals to the appropriate pins (see page 461 and Table 23-5 on page 1083).
5. Configure the quadrature encoder to capture edges on both signals and maintain an absolute position by resetting on index pulses. A 1000-line encoder with four edges per line, results in 4000 pulses per revolution; therefore, set the maximum position to 3999 (0xF9F) as the count is zero-based.
 - Write the **QEICTL** register with the value of 0x0000.0018.
 - Write the **QEIMAXPOS** register with the value of 0x0000.0F9F.
6. Enable the quadrature encoder by setting bit 0 of the **QEICTL** register.
7. Delay until the encoder position is required.
8. Read the encoder position by reading the **QEI Position (QEIPOS)** register value.

21.5 Register Map

Table 21-3 on page 1033 lists the QEI registers. The offset listed is a hexadecimal increment to the register's address, relative to the module's base address:

- QEI0: 0x4002.C000
- QEI1: 0x4002.D000

Note that the QEI module clock must be enabled before the registers can be programmed (see page 262). There must be a delay of 3 system clocks after the QEI module clock is enabled before any QEI module registers are accessed.

Table 21-3. QEI Register Map

| Offset | Name | Type | Reset | Description | See page |
|--------|-----------|-------|-------------|--------------------------------|----------|
| 0x000 | QEICTL | R/W | 0x0000.0000 | QEI Control | 1034 |
| 0x004 | QEISTAT | RO | 0x0000.0000 | QEI Status | 1037 |
| 0x008 | QEIPPOS | R/W | 0x0000.0000 | QEI Position | 1038 |
| 0x00C | QEIMAXPOS | R/W | 0x0000.0000 | QEI Maximum Position | 1039 |
| 0x010 | QEILOAD | R/W | 0x0000.0000 | QEI Timer Load | 1040 |
| 0x014 | QEITIME | RO | 0x0000.0000 | QEI Timer | 1041 |
| 0x018 | QEICOUNT | RO | 0x0000.0000 | QEI Velocity Counter | 1042 |
| 0x01C | QEISPEED | RO | 0x0000.0000 | QEI Velocity | 1043 |
| 0x020 | QEIINTEN | R/W | 0x0000.0000 | QEI Interrupt Enable | 1044 |
| 0x024 | QEIRIS | RO | 0x0000.0000 | QEI Raw Interrupt Status | 1046 |
| 0x028 | QEIISC | R/W1C | 0x0000.0000 | QEI Interrupt Status and Clear | 1048 |

21.6 Register Descriptions

The remainder of this section lists and describes the QEI registers, in numerical order by address offset.

Register 1: QEI Control (QEICTL), offset 0x000

This register contains the configuration of the QEI module. Separate enables are provided for the quadrature encoder and the velocity capture blocks; the quadrature encoder must be enabled in order to capture the velocity, but the velocity does not need to be captured in applications that do not need it. The phase signal interpretation, phase swap, Position Update mode, Position Reset mode, and velocity predivider are all set via this register.

QEI Control (QEICTL)

QEI0 base: 0x4002.C000
 QEI1 base: 0x4002.D000
 Offset 0x000
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|--------|---------|------|------|------|--------|-----|-----|-------|---------|----------|---------|------|--------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | FILT CNT | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | FILTEN | STALLEN | INVI | INVB | INVA | VELDIV | | | VELEN | RESMODE | CAPMODE | SIGMODE | SWAP | ENABLE |
| Type | RO | RO | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|---|
| 31:20 | reserved | RO | 0x000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 19:16 | FILT CNT | R/W | 0x0 | Input Filter Prescale Count This field controls the frequency of the input update. When this field is clear, the input is sampled after 2 system clocks. When this field is 0x1, the input is sampled after 3 system clocks. Similarly, when this field is 0xF, the input is sampled after 17 clocks. |
| 15:14 | reserved | RO | 0x0 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 13 | FILTEN | R/W | 0 | Enable Input Filter Value Description 0 The QEI inputs are not filtered. 1 Enables the digital noise filter on the QEI input signals. Inputs must be stable for 3 consecutive clock edges before the edge detector is updated. |
| 12 | STALLEN | R/W | 0 | Stall QEI Value Description 0 The QEI module does not stall when the microcontroller is stopped by a debugger. 1 The QEI module stalls when the microcontroller is stopped by a debugger. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|--|
| 11 | INVI | R/W | 0 | Invert Index Pulse Value Description 0 No effect. 1 Inverts the <code>IDX</code> input. |
| 10 | INVB | R/W | 0 | Invert PhB Value Description 0 No effect. 1 Inverts the <code>PhB</code> input. |
| 9 | INVA | R/W | 0 | Invert PhA Value Description 0 No effect. 1 Inverts the <code>PhA</code> input. |
| 8:6 | VELDIV | R/W | 0x0 | Predivide Velocity This field defines the predivider of the input quadrature pulses before being applied to the <code>QEICOUNT</code> accumulator. Value Predivider 0x0 ÷1 0x1 ÷2 0x2 ÷4 0x3 ÷8 0x4 ÷16 0x5 ÷32 0x6 ÷64 0x7 ÷128 |
| 5 | VELEN | R/W | 0 | Capture Velocity Value Description 0 No effect. 1 Enables capture of the velocity of the quadrature encoder. |
| 4 | RESMODE | R/W | 0 | Reset Mode Value Description 0 The position counter is reset when it reaches the maximum as defined by the <code>MAXPOS</code> field in the <code>QEIMAXPOS</code> register. 1 The position counter is reset when the index pulse is captured. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|---------|------|-------|---|
| 3 | CAPMODE | R/W | 0 | Capture Mode Value Description 0 Only the P_{hA} edges are counted. 1 The P_{hA} and P_{hB} edges are counted, providing twice the positional resolution but half the range. |
| 2 | SIGMODE | R/W | 0 | Signal Mode Value Description 0 The P_{hA} and P_{hB} signals operate as quadrature phase signals. 1 The P_{hA} and P_{hB} signals operate as clock and direction. |
| 1 | SWAP | R/W | 0 | Swap Signals Value Description 0 No effect. 1 Swaps the P_{hA} and P_{hB} signals. |
| 0 | ENABLE | R/W | 0 | Enable QEI Value Description 0 No effect. 1 Enables the quadrature encoder module. |

Register 2: QEI Status (QEISTAT), offset 0x004

This register provides status about the operation of the QEI module.

QEI Status (QEISTAT)

QEI0 base: 0x4002.C000

QEI1 base: 0x4002.D000

Offset 0x004

Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----------|-------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | | | | DIRECTION | ERROR |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

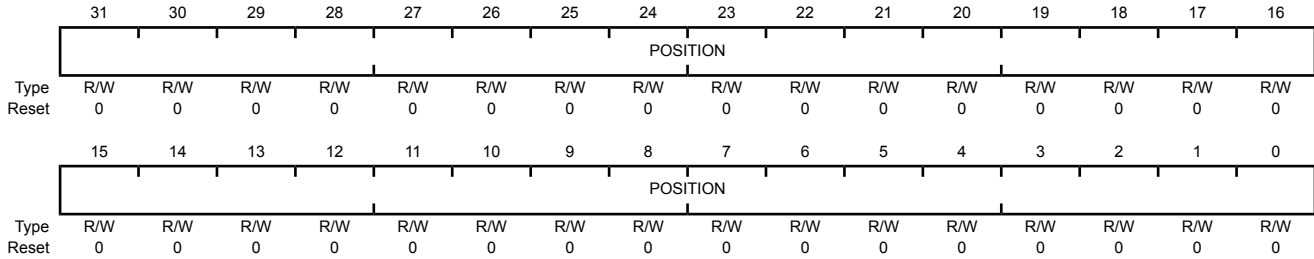
| Bit/Field | Name | Type | Reset | Description |
|-----------|-----------|------|------------|---|
| 31:2 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 1 | DIRECTION | RO | 0 | Direction of Rotation Indicates the direction the encoder is rotating. Value Description 0 The encoder is rotating forward. 1 The encoder is rotating in reverse. |
| 0 | ERROR | RO | 0 | Error Detected Value Description 0 No error. 1 An error was detected in the gray code sequence (that is, both signals changing at the same time). |

Register 3: QEI Position (QEIP0S), offset 0x008

This register contains the current value of the position integrator. The value is updated by the status of the QEI phase inputs and can be set to a specific value by writing to it.

QEI Position (QEIP0S)

QEI0 base: 0x4002.C000
 QEI1 base: 0x4002.D000
 Offset 0x008
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------------|--|
| 31:0 | POSITION | R/W | 0x0000.0000 | Current Position Integrator Value The current value of the position integrator. |

Register 4: QEI Maximum Position (QEIMAXPOS), offset 0x00C

This register contains the maximum value of the position integrator. When moving forward, the position register resets to zero when it increments past this value. When moving in reverse, the position register resets to this value when it decrements from zero.

QEI Maximum Position (QEIMAXPOS)

QEI0 base: 0x4002.C000

QEI1 base: 0x4002.D000

Offset 0x00C

Type R/W, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| | MAXPOS | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | MAXPOS | | | | | | | | | | | | | | | |
| Type | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

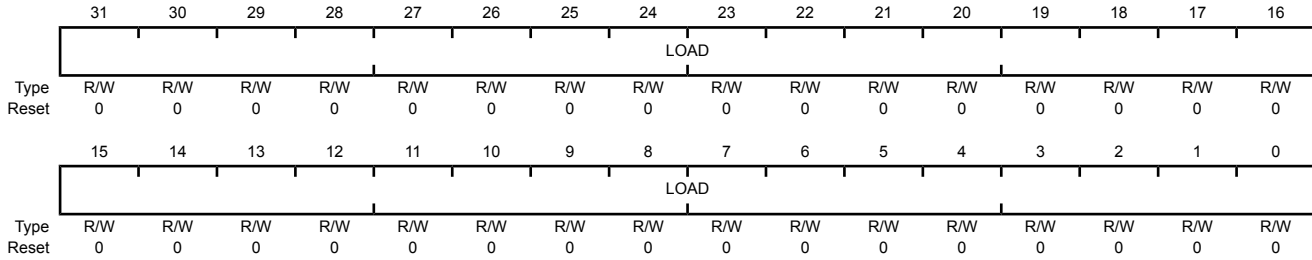
| Bit/Field | Name | Type | Reset | Description |
|-----------|--------|------|-------------|--|
| 31:0 | MAXPOS | R/W | 0x0000.0000 | Maximum Position Integrator Value The maximum value of the position integrator. |

Register 5: QEI Timer Load (QEILOAD), offset 0x010

This register contains the load value for the velocity timer. Because this value is loaded into the timer on the clock cycle after the timer is zero, this value should be one less than the number of clocks in the desired period. So, for example, to have 2000 decimal clocks per timer period, this register should contain 1999 decimal.

QEI Timer Load (QEILOAD)

QEI0 base: 0x4002.C000
 QEI1 base: 0x4002.D000
 Offset 0x010
 Type R/W, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|---|
| 31:0 | LOAD | R/W | 0x0000.0000 | Velocity Timer Load Value The load value for the velocity timer. |

Register 6: QEI Timer (QEITIME), offset 0x014

This register contains the current value of the velocity timer. This counter does not increment when the `VELEN` bit in the `QEICTL` register is clear.

QEI Timer (QEITIME)

QEI0 base: 0x4002.C000

QEI1 base: 0x4002.D000

Offset 0x014

Type RO, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | TIME | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | TIME | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

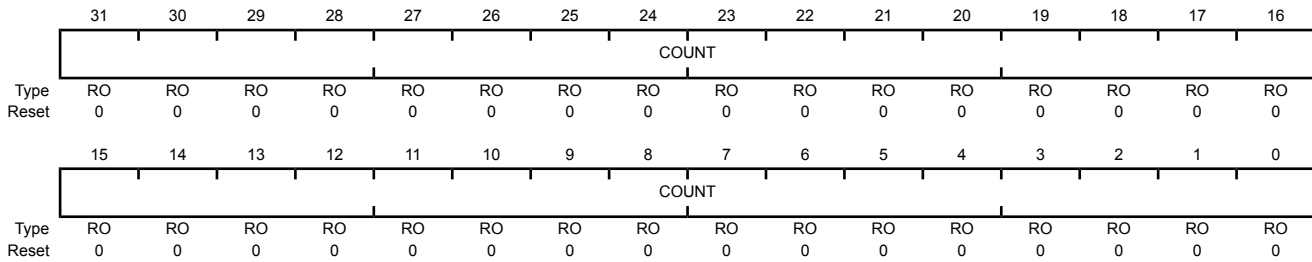
| Bit/Field | Name | Type | Reset | Description |
|-----------|------|------|-------------|--|
| 31:0 | TIME | RO | 0x0000.0000 | Velocity Timer Current Value The current value of the velocity timer. |

Register 7: QEI Velocity Counter (QEICOUNT), offset 0x018

This register contains the running count of velocity pulses for the current time period. Because this count is a running total, the time period to which it applies cannot be known with precision (that is, a read of this register does not necessarily correspond to the time returned by the **QEITIME** register because there is a small window of time between the two reads, during which either value may have changed). The **QEISPEED** register should be used to determine the actual encoder velocity; this register is provided for information purposes only. This counter does not increment when the **VELEN** bit in the **QEICTL** register is clear.

QEI Velocity Counter (QEICOUNT)

QEI0 base: 0x4002.C000
 QEI1 base: 0x4002.D000
 Offset 0x018
 Type RO, reset 0x0000.0000



| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------------|--|
| 31:0 | COUNT | RO | 0x0000.0000 | Velocity Pulse Count The running total of encoder pulses during this velocity timer period. |

Register 8: QEI Velocity (QEISPEED), offset 0x01C

This register contains the most recently measured velocity of the quadrature encoder. This value corresponds to the number of velocity pulses counted in the previous velocity timer period. This register does not update when the `VELEN` bit in the `QEICTL` register is clear.

QEI Velocity (QEISPEED)

QEI0 base: 0x4002.C000

QEI1 base: 0x4002.D000

Offset 0x01C

Type RO, reset 0x0000.0000

| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|-------|-------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| | SPEED | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | SPEED | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|-------|------|-------------|--|
| 31:0 | SPEED | RO | 0x0000.0000 | Velocity The measured speed of the quadrature encoder in pulses per period. |

Register 9: QEI Interrupt Enable (QEIINTEN), offset 0x020

This register contains enables for each of the QEI module interrupts. An interrupt is asserted to the interrupt controller if the corresponding bit in this register is set.

QEI Interrupt Enable (QEIINTEN)

QEI0 base: 0x4002.C000
 QEI1 base: 0x4002.D000
 Offset 0x020
 Type R/W, reset 0x0000.0000

| | | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----------|--------|----------|----------|-----|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| | reserved | | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | reserved | | | | | | | | | | | | INTERROR | INTDIR | INTTIMER | INTINDEX | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W | R/W | R/W | R/W |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|--|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | INTERROR | R/W | 0 | Phase Error Interrupt Enable Value Description 1 An interrupt is sent to the interrupt controller when the INTERROR bit in the QEIRIS register is set. 0 The INTERROR interrupt is suppressed and not sent to the interrupt controller. |
| 2 | INTDIR | R/W | 0 | Direction Change Interrupt Enable Value Description 1 An interrupt is sent to the interrupt controller when the INTDIR bit in the QEIRIS register is set. 0 The INTDIR interrupt is suppressed and not sent to the interrupt controller. |
| 1 | INTTIMER | R/W | 0 | Timer Expires Interrupt Enable Value Description 1 An interrupt is sent to the interrupt controller when the INTTIMER bit in the QEIRIS register is set. 0 The INTTIMER interrupt is suppressed and not sent to the interrupt controller. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 0 | INTINDEX | R/W | 0 | Index Pulse Detected Interrupt Enable |
| | | | | Value Description |
| | | | | 1 An interrupt is sent to the interrupt controller when the INTINDEX bit in the QEIRIS register is set. |
| | | | | 0 The INTINDEX interrupt is suppressed and not sent to the interrupt controller. |

Register 10: QEI Raw Interrupt Status (QEIRIS), offset 0x024

This register provides the current set of interrupt sources that are asserted, regardless of whether they cause an interrupt to be asserted to the controller (configured through the **QEIINTEN** register). If a bit is set, the latched event has occurred; if a bit is clear, the event in question has not occurred.

QEI Raw Interrupt Status (QEIRIS)

QEI0 base: 0x4002.C000
 QEI1 base: 0x4002.D000
 Offset 0x024
 Type RO, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----------|--------|----------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | INTERROR | INTDIR | INTTIMER | INTINDEX |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|------------|--|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | INTERROR | RO | 0 | Phase Error Detected Value Description 1 A phase error has been detected. 0 An interrupt has not occurred. This bit is cleared by writing a 1 to the <code>INTERROR</code> bit in the QEIISC register. |
| 2 | INTDIR | RO | 0 | Direction Change Detected Value Description 1 The rotation direction has changed 0 An interrupt has not occurred. This bit is cleared by writing a 1 to the <code>INTDIR</code> bit in the QEIISC register. |
| 1 | INTTIMER | RO | 0 | Velocity Timer Expired Value Description 1 The velocity timer has expired. 0 An interrupt has not occurred. This bit is cleared by writing a 1 to the <code>INTTIMER</code> bit in the QEIISC register. |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|------|-------|--|
| 0 | INTINDEX | RO | 0 | Index Pulse Asserted |
| | | | | Value Description |
| | | | | 1 The index pulse has occurred. |
| | | | | 0 An interrupt has not occurred. |
| | | | | This bit is cleared by writing a 1 to the INTINDEX bit in the QEISC register. |

Register 11: QEI Interrupt Status and Clear (QEIISC), offset 0x028

This register provides the current set of interrupt sources that are asserted to the controller. If a bit is set, the latched event has occurred and is enabled to generate an interrupt; if a bit is clear the event in question has not occurred or is not enabled to generate an interrupt. This register is R/W1C; writing a 1 to a bit position clears the bit and the corresponding interrupt reason.

QEI Interrupt Status and Clear (QEIISC)

QEI0 base: 0x4002.C000
 QEI1 base: 0x4002.D000
 Offset 0x028
 Type R/W1C, reset 0x0000.0000

| | | | | | | | | | | | | | | | | |
|-------|----------|----|----|----|----|----|----|----|----|----|----|----|----------|--------|----------|----------|
| | 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| | reserved | | | | | | | | | | | | | | | |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| | reserved | | | | | | | | | | | | INTERROR | INTDIR | INTTIMER | INTINDEX |
| Type | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | RO | R/W1C | R/W1C | R/W1C | R/W1C |
| Reset | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|------------|---|
| 31:4 | reserved | RO | 0x0000.000 | Software should not rely on the value of a reserved bit. To provide compatibility with future products, the value of a reserved bit should be preserved across a read-modify-write operation. |
| 3 | INTERROR | R/W1C | 0 | <p>Phase Error Interrupt</p> <p>Value Description</p> <p>1 The INTERROR bits in the QEIRIS register and the QEINTEN registers are set, providing an interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the INTERROR bit in the QEIRIS register.</p> |
| 2 | INTDIR | R/W1C | 0 | <p>Direction Change Interrupt</p> <p>Value Description</p> <p>1 The INTDIR bits in the QEIRIS register and the QEINTEN registers are set, providing an interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the INTDIR bit in the QEIRIS register.</p> |
| 1 | INTTIMER | R/W1C | 0 | <p>Velocity Timer Expired Interrupt</p> <p>Value Description</p> <p>1 The INTTIMER bits in the QEIRIS register and the QEINTEN registers are set, providing an interrupt to the interrupt controller.</p> <p>0 No interrupt has occurred or the interrupt is masked.</p> <p>This bit is cleared by writing a 1. Clearing this bit also clears the INTTIMER bit in the QEIRIS register.</p> |

| Bit/Field | Name | Type | Reset | Description |
|-----------|----------|-------|-------|---|
| 0 | INTINDEX | R/W1C | 0 | Index Pulse Interrupt |
| | | | | Value Description |
| | | | | 1 The INTINDEX bits in the QEIRIS register and the QEINTEN registers are set, providing an interrupt to the interrupt controller. |
| | | | | 0 No interrupt has occurred or the interrupt is masked. |
| | | | | This bit is cleared by writing a 1. Clearing this bit also clears the INTINDEX bit in the QEIRIS register. |

22 Pin Diagram

The LM3S2U93 microcontroller pin diagram is shown below.

Each GPIO signal is identified by its GPIO port unless it defaults to an alternate function on reset. In this case, the GPIO port name is followed by the default alternate function. To see a complete list of possible functions for each pin, see Table 23-5 on page 1083.

Figure 22-1. 100-Pin LQFP Package Pin Diagram

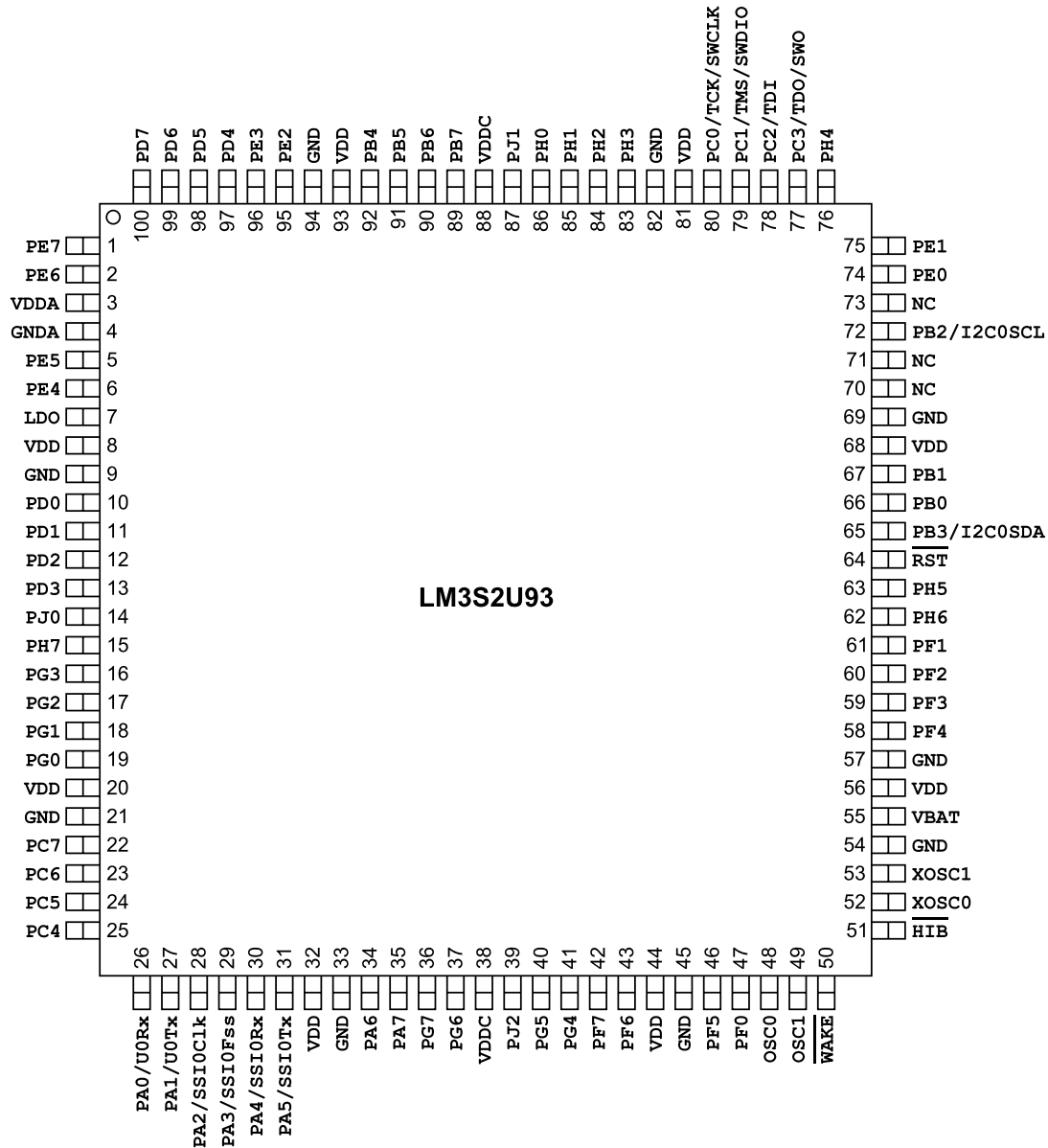
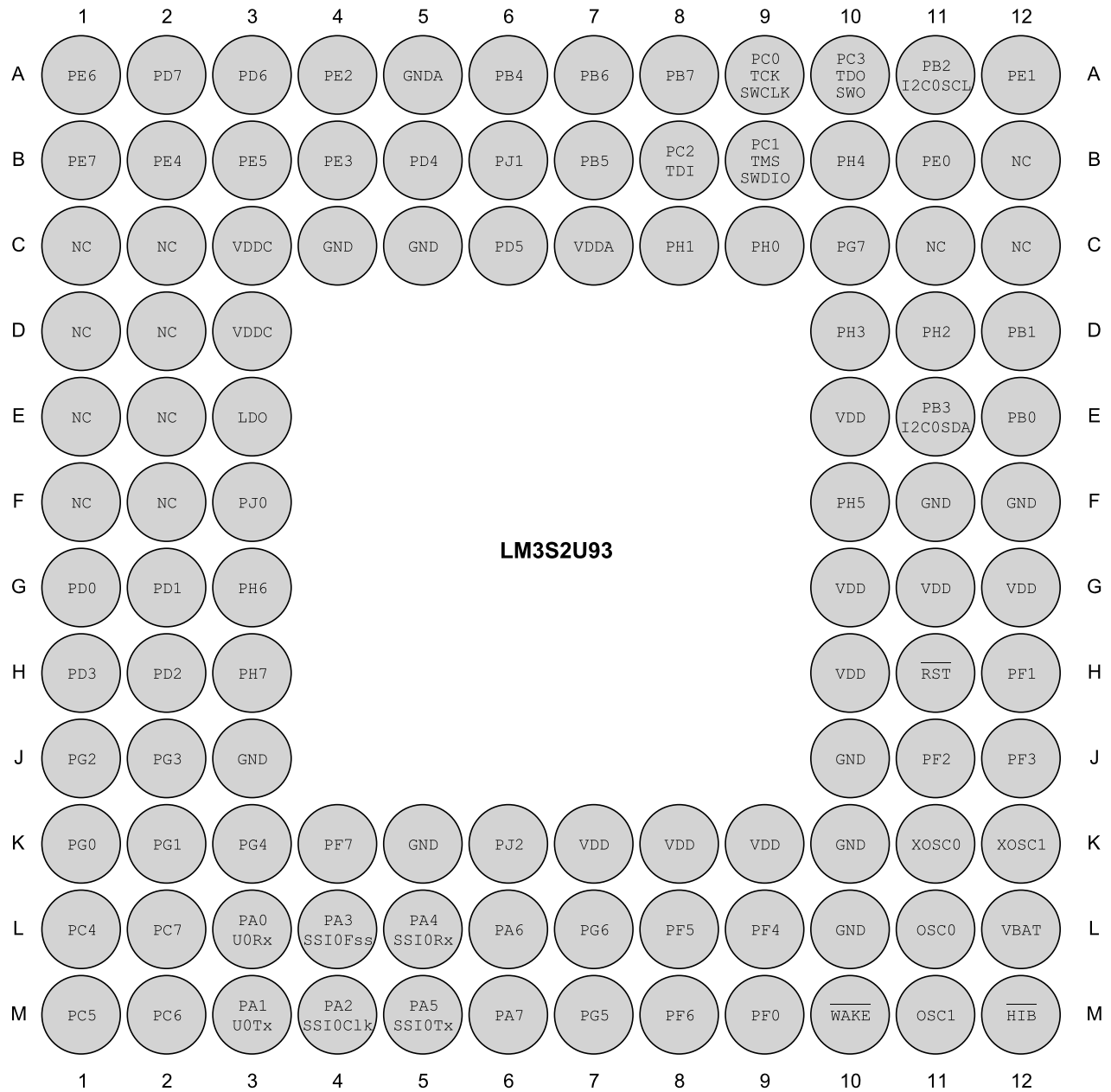


Figure 22-2. 108-Ball BGA Package Pin Diagram (Top View)



23 Signal Tables

The following tables list the signals available for each pin. Signals are configured as GPIOs on reset, except for those noted below. Use the **GPIOAMSEL** register (see page 459) to select analog mode. For a GPIO pin to be used for an alternate digital function, the corresponding bit in the **GPIOAFSEL** register (see page 443) must be set. Further pin muxing options are provided through the PMC_x bit field in the **GPIOCTL** register (see page 461), which selects one of several available peripheral functions for that GPIO.

Important: All GPIO pins are configured as GPIOs by default with the exception of the pins shown in the table below. A Power-On-Reset (\overline{POR}) or asserting \overline{RST} puts the pins back to their default state.

Table 23-1. GPIO Pins With Default Alternate Functions

| GPIO Pin | Default State | GPIOAFSEL Bit | GPIOCTL PMC_x Bit Field |
|----------|-------------------|---------------|---------------------------|
| PA[1:0] | UART0 | 0 | 0x1 |
| PA[5:2] | SSIO | 0 | 0x1 |
| PB[3:2] | I ² C0 | 0 | 0x1 |
| PC[3:0] | JTAG/SWD | 1 | 0x3 |

Table 23-2 on page 1053 shows the pin-to-signal-name mapping, including functional characteristics of the signals. Each possible alternate analog and digital function is listed for each pin.

Table 23-3 on page 1064 lists the signals in alphabetical order by signal name. If it is possible for a signal to be on multiple pins, each possible pin assignment is listed. The "Pin Mux" column indicates the GPIO and the encoding needed in the PMC_x bit field in the **GPIOCTL** register.

Table 23-4 on page 1075 groups the signals by functionality, except for GPIOs. If it is possible for a signal to be on multiple pins, each possible pin assignment is listed.

Table 23-5 on page 1083 lists the GPIO pins and their analog and digital alternate functions. The A_{INx} and V_{REFA} analog signals are not 5-V tolerant and go through an isolation circuit before reaching their circuitry. These signals are configured by clearing the corresponding **DEN** bit in the **GPIO Digital Enable (GPIODEN)** register and setting the corresponding **AMSEL** bit in the **GPIO Analog Mode Select (GPIOAMSEL)** register. Other analog signals are 5-V tolerant and are connected directly to their circuitry ($C0-$, $C0+$, $C1-$, $C1+$, $C2-$, $C2+$). These signals are configured by clearing the **DEN** bit in the **GPIO Digital Enable (GPIODEN)** register. The digital signals are enabled by setting the appropriate bit in the **GPIO Alternate Function Select (GPIOAFSEL)** and **GPIODEN** registers and configuring the PMC_x bit field in the **GPIO Port Control (GPIOCTL)** register to the numeric encoding shown in the table below. Table entries that are shaded gray are the default values for the corresponding GPIO pin.

Table 23-6 on page 1086 lists the signals based on number of possible pin assignments. This table can be used to plan how to configure the pins for a particular functionality. Application Note AN01274 Configuring Stellaris[®] Microcontrollers with Pin Multiplexing provides an overview of the pin muxing implementation, an explanation of how a system designer defines a pin configuration, and examples of the pin configuration process.

Note: All digital inputs are Schmitt triggered.

23.1 100-Pin LQFP Package Pin Tables

Table 23-2. Signals by Pin Number

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|----------|----------|--------------------------|--|
| 1 | PE7 | I/O | TTL | GPIO port E bit 7. |
| | AIN0 | I | Analog | Analog-to-digital converter input 0. |
| | C2o | O | TTL | Analog comparator 2 output. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | U1DCD | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| 2 | PE6 | I/O | TTL | GPIO port E bit 6. |
| | AIN1 | I | Analog | Analog-to-digital converter input 1. |
| | C1o | O | TTL | Analog comparator 1 output. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | U1CTS | I | TTL | UART module 1 Clear To Send modem flow control input signal. |
| 3 | VDDA | - | Power | The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in Table 25-2 on page 1128, regardless of system implementation. |
| 4 | GNDA | - | Power | The ground reference for the analog circuits (ADC, Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions. |
| 5 | PE5 | I/O | TTL | GPIO port E bit 5. |
| | AIN2 | I | Analog | Analog-to-digital converter input 2. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | I2S0TXSD | I/O | TTL | I ² S module 0 transmit data. |
| 6 | PE4 | I/O | TTL | GPIO port E bit 4. |
| | AIN3 | I | Analog | Analog-to-digital converter input 3. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | I2S0TXWS | I/O | TTL | I ² S module 0 transmit word select. |
| | U2Tx | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |
| 7 | LDO | - | Power | Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 µF or greater. The LDO pin must also be connected to the VDDC pins at the board level in addition to the decoupling capacitor(s). |
| 8 | VDD | - | Power | Positive supply for I/O and some logic. |
| 9 | GND | - | Power | Ground reference for logic and I/O pins. |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|-----------|----------|---|---|
| 10 | PD0 | I/O | TTL | GPIO port D bit 0. |
| | AIN15 | I | Analog | Analog-to-digital converter input 15. |
| | CAN0Rx | I | TTL | CAN module 0 receive. |
| | CCP6 | I/O | TTL | Capture/Compare/PWM 6. |
| | I2S0RXSCK | I/O | TTL | I ² S module 0 receive clock. |
| | IDX0 | I | TTL | QEI module 0 index. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | U1CTS | I | TTL | UART module 1 Clear To Send modem flow control input signal. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| U2Rx | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. | |
| 11 | PD1 | I/O | TTL | GPIO port D bit 1. |
| | AIN14 | I | Analog | Analog-to-digital converter input 14. |
| | CAN0Tx | O | TTL | CAN module 0 transmit. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP7 | I/O | TTL | Capture/Compare/PWM 7. |
| | I2S0RXWS | I/O | TTL | I ² S module 0 receive word select. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | PhA0 | I | TTL | QEI module 0 phase A. |
| | PhB1 | I | TTL | QEI module 1 phase B. |
| | U1DCD | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| | U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| U2Tx | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. | |
| 12 | PD2 | I/O | TTL | GPIO port D bit 2. |
| | AIN13 | I | Analog | Analog-to-digital converter input 13. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | CCP6 | I/O | TTL | Capture/Compare/PWM 6. |
| | EPI0S20 | I/O | TTL | EPI module 0 signal 20. |
| | PWM2 | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| 13 | PD3 | I/O | TTL | GPIO port D bit 3. |
| | AIN12 | I | Analog | Analog-to-digital converter input 12. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP7 | I/O | TTL | Capture/Compare/PWM 7. |
| | EPI0S21 | I/O | TTL | EPI module 0 signal 21. |
| | PWM3 | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|-----------|----------|--------------------------|---|
| 14 | PJ0 | I/O | TTL | GPIO port J bit 0. |
| | EPI0S16 | I/O | TTL | EPI module 0 signal 16. |
| | I2C1SCL | I/O | OD | I ² C module 1 clock. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| 15 | PH7 | I/O | TTL | GPIO port H bit 7. |
| | EPI0S27 | I/O | TTL | EPI module 0 signal 27. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | SSI1Tx | O | TTL | SSI module 1 transmit. |
| 16 | PG3 | I/O | TTL | GPIO port G bit 3. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | Fault2 | I | TTL | PWM Fault 2. |
| | I2S0RXCLK | I/O | TTL | I ² S module 0 receive master clock. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| 17 | PG2 | I/O | TTL | GPIO port G bit 2. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | I2S0RXSD | I/O | TTL | I ² S module 0 receive data. |
| | IDX1 | I | TTL | QEI module 1 index. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| 18 | PG1 | I/O | TTL | GPIO port G bit 1. |
| | EPI0S14 | I/O | TTL | EPI module 0 signal 14. |
| | I2C1SDA | I/O | OD | I ² C module 1 data. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | U2Tx | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |
| 19 | PG0 | I/O | TTL | GPIO port G bit 0. |
| | EPI0S13 | I/O | TTL | EPI module 0 signal 13. |
| | I2C1SCL | I/O | OD | I ² C module 1 clock. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | U2Rx | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| 20 | VDD | - | Power | Positive supply for I/O and some logic. |
| 21 | GND | - | Power | Ground reference for logic and I/O pins. |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|----------|----------|--------------------------|---|
| 22 | PC7 | I/O | TTL | GPIO port C bit 7. |
| | C1o | O | TTL | Analog comparator 1 output. |
| | C2- | I | Analog | Analog comparator 2 negative input. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | EPI0S5 | I/O | TTL | EPI module 0 signal 5. |
| | PhB0 | I | TTL | QEI module 0 phase B. |
| | U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| 23 | PC6 | I/O | TTL | GPIO port C bit 6. |
| | C2+ | I | Analog | Analog comparator 2 positive input. |
| | C2o | O | TTL | Analog comparator 2 output. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | EPI0S4 | I/O | TTL | EPI module 0 signal 4. |
| | PWM7 | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| | PhB0 | I | TTL | QEI module 0 phase B. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| 24 | PC5 | I/O | TTL | GPIO port C bit 5. |
| | C0o | O | TTL | Analog comparator 0 output. |
| | C1+ | I | Analog | Analog comparator 1 positive input. |
| | C1o | O | TTL | Analog comparator 1 output. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | EPI0S3 | I/O | TTL | EPI module 0 signal 3. |
| | Fault2 | I | TTL | PWM Fault 2. |
| 25 | PC4 | I/O | TTL | GPIO port C bit 4. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | EPI0S2 | I/O | TTL | EPI module 0 signal 2. |
| | PWM6 | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| | PhA0 | I | TTL | QEI module 0 phase A. |
| 26 | PA0 | I/O | TTL | GPIO port A bit 0. |
| | I2C1SCL | I/O | OD | I ² C module 1 clock. |
| | U0Rx | I | TTL | UART module 0 receive. When in IrDA mode, this signal has IrDA modulation. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|------------|----------|--------------------------|---|
| 27 | PA1 | I/O | TTL | GPIO port A bit 1. |
| | I2C1SDA | I/O | OD | I ² C module 1 data. |
| | U0Tx | O | TTL | UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation. |
| | U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| 28 | PA2 | I/O | TTL | GPIO port A bit 2. |
| | I2S0RXSD | I/O | TTL | I ² S module 0 receive data. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | SSI0Clk | I/O | TTL | SSI module 0 clock. |
| 29 | PA3 | I/O | TTL | GPIO port A bit 3. |
| | I2S0RXMCLK | I/O | TTL | I ² S module 0 receive master clock. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | SSI0Fss | I/O | TTL | SSI module 0 frame. |
| 30 | PA4 | I/O | TTL | GPIO port A bit 4. |
| | CAN0Rx | I | TTL | CAN module 0 receive. |
| | I2S0TXSCK | I/O | TTL | I ² S module 0 transmit clock. |
| | PWM6 | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| | SSI0Rx | I | TTL | SSI module 0 receive. |
| 31 | PA5 | I/O | TTL | GPIO port A bit 5. |
| | CAN0Tx | O | TTL | CAN module 0 transmit. |
| | I2S0TXWS | I/O | TTL | I ² S module 0 transmit word select. |
| | PWM7 | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| | SSI0Tx | O | TTL | SSI module 0 transmit. |
| 32 | VDD | - | Power | Positive supply for I/O and some logic. |
| 33 | GND | - | Power | Ground reference for logic and I/O pins. |
| 34 | PA6 | I/O | TTL | GPIO port A bit 6. |
| | CAN0Rx | I | TTL | CAN module 0 receive. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | I2C1SCL | I/O | OD | I ² C module 1 clock. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | U1CTS | I | TTL | UART module 1 Clear To Send modem flow control input signal. |
| 35 | PA7 | I/O | TTL | GPIO port A bit 7. |
| | CAN0Tx | O | TTL | CAN module 0 transmit. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | I2C1SDA | I/O | OD | I ² C module 1 data. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | U1DCD | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|-----------|----------|--------------------------|--|
| 36 | PG7 | I/O | TTL | GPIO port G bit 7. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | EPI0S31 | I/O | TTL | EPI module 0 signal 31. |
| | PWM7 | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| | PhB1 | I | TTL | QE1 module 1 phase B. |
| 37 | PG6 | I/O | TTL | GPIO port G bit 6. |
| | Fault1 | I | TTL | PWM Fault 1. |
| | I2S0RXWS | I/O | TTL | I ² S module 0 receive word select. |
| | PWM6 | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| | PhA1 | I | TTL | QE1 module 1 phase A. |
| 38 | U1RI | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| | VDDC | - | Power | Positive supply for most of the logic function, including the processor core and most peripherals. The voltage on this pin is 1.3 V and is supplied by the on-chip LDO. The VDDC pins should only be connected to the LDO pin and an external capacitor as specified in Table 25-6 on page 1133. |
| 39 | PJ2 | I/O | TTL | GPIO port J bit 2. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | EPI0S18 | I/O | TTL | EPI module 0 signal 18. |
| | Fault0 | I | TTL | PWM Fault 0. |
| 40 | PG5 | I/O | TTL | GPIO port G bit 5. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | Fault1 | I | TTL | PWM Fault 1. |
| | I2S0RXSCK | I/O | TTL | I ² S module 0 receive clock. |
| | IDX0 | I | TTL | QE1 module 0 index. |
| | PWM7 | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| 41 | U1DTR | O | TTL | UART module 1 Data Terminal Ready modem status input signal. |
| | PG4 | I/O | TTL | GPIO port G bit 4. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | EPI0S15 | I/O | TTL | EPI module 0 signal 15. |
| | Fault1 | I | TTL | PWM Fault 1. |
| | PWM6 | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| 42 | U1RI | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| | PF7 | I/O | TTL | GPIO port F bit 7. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | EPI0S12 | I/O | TTL | EPI module 0 signal 12. |
| | Fault1 | I | TTL | PWM Fault 1. |
| 42 | PhB0 | I | TTL | QE1 module 0 phase B. |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|------------|----------|--------------------------|---|
| 43 | PF6 | I/O | TTL | GPIO port F bit 6. |
| | C2o | O | TTL | Analog comparator 2 output. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | I2S0TXMCLK | I/O | TTL | I ² S module 0 transmit master clock. |
| | PhA0 | I | TTL | QEI module 0 phase A. |
| | U1RTS | O | TTL | UART module 1 Request to Send modem flow control output line. |
| 44 | VDD | - | Power | Positive supply for I/O and some logic. |
| 45 | GND | - | Power | Ground reference for logic and I/O pins. |
| 46 | PF5 | I/O | TTL | GPIO port F bit 5. |
| | C1o | O | TTL | Analog comparator 1 output. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | EPI0S15 | I/O | TTL | EPI module 0 signal 15. |
| | SSI1Tx | O | TTL | SSI module 1 transmit. |
| 47 | PF0 | I/O | TTL | GPIO port F bit 0. |
| | CAN1Rx | I | TTL | CAN module 1 receive. |
| | I2S0TXSD | I/O | TTL | I ² S module 0 transmit data. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | PhB0 | I | TTL | QEI module 0 phase B. |
| | U1DSR | I | TTL | UART module 1 Data Set Ready modem output control line. |
| 48 | OSC0 | I | Analog | Main oscillator crystal input or an external clock reference input. |
| 49 | OSC1 | O | Analog | Main oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| 50 | WAKE | I | TTL | An external input that brings the processor out of Hibernate mode when asserted. |
| 51 | HIB | O | OD | An output that indicates the processor is in Hibernate mode. |
| 52 | XOSC0 | I | Analog | Hibernation module oscillator crystal input or an external clock reference input. Note that this is either a 4.194304-MHz crystal or a 32.768-kHz oscillator for the Hibernation module RTC. See the CLKSEL bit in the HIBCTL register. |
| | XOSC1 | O | Analog | Hibernation module oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| 54 | GND | - | Power | Ground reference for logic and I/O pins. |
| 55 | VBAT | - | Power | Power source for the Hibernation module. It is normally connected to the positive terminal of a battery and serves as the battery backup/Hibernation module power-source supply. |
| 56 | VDD | - | Power | Positive supply for I/O and some logic. |
| 57 | GND | - | Power | Ground reference for logic and I/O pins. |
| 58 | PF4 | I/O | TTL | GPIO port F bit 4. |
| | C0o | O | TTL | Analog comparator 0 output. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | EPI0S12 | I/O | TTL | EPI module 0 signal 12. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | SSI1Rx | I | TTL | SSI module 1 receive. |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|------------|----------|--------------------------|---|
| 59 | PF3 | I/O | TTL | GPIO port F bit 3. |
| | PWM3 | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | SSI1Fss | I/O | TTL | SSI module 1 frame. |
| 60 | PF2 | I/O | TTL | GPIO port F bit 2. |
| | PWM2 | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | SSI1C1k | I/O | TTL | SSI module 1 clock. |
| 61 | PF1 | I/O | TTL | GPIO port F bit 1. |
| | CAN1Tx | O | TTL | CAN module 1 transmit. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | I2S0TXMCLK | I/O | TTL | I ² S module 0 transmit master clock. |
| | IDX1 | I | TTL | QEI module 1 index. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | U1RTS | O | TTL | UART module 1 Request to Send modem flow control output line. |
| 62 | PH6 | I/O | TTL | GPIO port H bit 6. |
| | EPI0S26 | I/O | TTL | EPI module 0 signal 26. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | SSI1Rx | I | TTL | SSI module 1 receive. |
| 63 | PH5 | I/O | TTL | GPIO port H bit 5. |
| | EPI0S11 | I/O | TTL | EPI module 0 signal 11. |
| | Fault2 | I | TTL | PWM Fault 2. |
| | SSI1Fss | I/O | TTL | SSI module 1 frame. |
| 64 | RST | I | TTL | System reset input. |
| 65 | PB3 | I/O | TTL | GPIO port B bit 3. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | Fault3 | I | TTL | PWM Fault 3. |
| | I2C0SDA | I/O | OD | I ² C module 0 data. |
| 66 | PB0 | I/O | TTL | GPIO port B bit 0. This pin is not 5-V tolerant. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | PWM2 | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| 67 | PB1 | I/O | TTL | GPIO port B bit 1. This pin is not 5-V tolerant. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | PWM3 | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| 68 | VDD | - | Power | Positive supply for I/O and some logic. |
| 69 | GND | - | Power | Ground reference for logic and I/O pins. |
| 70 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|----------|----------|--------------------------|--|
| 71 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| 72 | PB2 | I/O | TTL | GPIO port B bit 2. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | I2COSCL | I/O | OD | I ² C module 0 clock. |
| | IDX0 | I | TTL | QEI module 0 index. |
| 73 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| 74 | PE0 | I/O | TTL | GPIO port E bit 0. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | EPI0S8 | I/O | TTL | EPI module 0 signal 8. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | SSI1Clk | I/O | TTL | SSI module 1 clock. |
| 75 | PE1 | I/O | TTL | GPIO port E bit 1. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP6 | I/O | TTL | Capture/Compare/PWM 6. |
| | EPI0S9 | I/O | TTL | EPI module 0 signal 9. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | SSI1Fss | I/O | TTL | SSI module 1 frame. |
| 76 | PH4 | I/O | TTL | GPIO port H bit 4. |
| | EPI0S10 | I/O | TTL | EPI module 0 signal 10. |
| | SSI1Clk | I/O | TTL | SSI module 1 clock. |
| 77 | PC3 | I/O | TTL | GPIO port C bit 3. |
| | SWO | O | TTL | JTAG TDO and SWO. |
| | TDO | O | TTL | JTAG TDO and SWO. |
| 78 | PC2 | I/O | TTL | GPIO port C bit 2. |
| | TDI | I | TTL | JTAG TDI. |
| 79 | PC1 | I/O | TTL | GPIO port C bit 1. |
| | SWDIO | I/O | TTL | JTAG TMS and SWDIO. |
| | TMS | I | TTL | JTAG TMS and SWDIO. |
| 80 | PC0 | I/O | TTL | GPIO port C bit 0. |
| | SWCLK | I | TTL | JTAG/SWD CLK. |
| | TCK | I | TTL | JTAG/SWD CLK. |
| 81 | VDD | - | Power | Positive supply for I/O and some logic. |
| 82 | GND | - | Power | Ground reference for logic and I/O pins. |
| 83 | PH3 | I/O | TTL | GPIO port H bit 3. |
| | EPI0S0 | I/O | TTL | EPI module 0 signal 0. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | PhB0 | I | TTL | QEI module 0 phase B. |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|-----------|----------|--------------------------|---|
| 84 | PH2 | I/O | TTL | GPIO port H bit 2. |
| | C1o | O | TTL | Analog comparator 1 output. |
| | EPI0S1 | I/O | TTL | EPI module 0 signal 1. |
| | Fault3 | I | TTL | PWM Fault 3. |
| | IDX1 | I | TTL | QEI module 1 index. |
| 85 | PH1 | I/O | TTL | GPIO port H bit 1. |
| | CCP7 | I/O | TTL | Capture/Compare/PWM 7. |
| | EPI0S7 | I/O | TTL | EPI module 0 signal 7. |
| | PWM3 | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| 86 | PH0 | I/O | TTL | GPIO port H bit 0. |
| | CCP6 | I/O | TTL | Capture/Compare/PWM 6. |
| | EPI0S6 | I/O | TTL | EPI module 0 signal 6. |
| | PWM2 | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| 87 | PJ1 | I/O | TTL | GPIO port J bit 1. |
| | EPI0S17 | I/O | TTL | EPI module 0 signal 17. |
| | I2C1SDA | I/O | OD | I ² C module 1 data. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| 88 | VDDC | - | Power | Positive supply for most of the logic function, including the processor core and most peripherals. The voltage on this pin is 1.3 V and is supplied by the on-chip LDO. The VDDC pins should only be connected to the LDO pin and an external capacitor as specified in Table 25-6 on page 1133. |
| 89 | PB7 | I/O | TTL | GPIO port B bit 7. |
| | NMI | I | TTL | Non-maskable interrupt. |
| 90 | PB6 | I/O | TTL | GPIO port B bit 6. |
| | C0+ | I | Analog | Analog comparator 0 positive input. |
| | C0o | O | TTL | Analog comparator 0 output. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | CCP7 | I/O | TTL | Capture/Compare/PWM 7. |
| | Fault1 | I | TTL | PWM Fault 1. |
| | I2S0TXSCK | I/O | TTL | I ² S module 0 transmit clock. |
| | IDX0 | I | TTL | QEI module 0 index. |
| | VREFA | I | Analog | This input provides a reference voltage used to specify the input voltage at which the ADC converts to a maximum value. In other words, the voltage that is applied to VREFA is the voltage with which an AIN _n signal is converted to 4095. The VREFA input is limited to the range specified in Table 25-26 on page 1145 . |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|----------|----------|---|--|
| 91 | PB5 | I/O | TTL | GPIO port B bit 5. |
| | AIN11 | I | Analog | Analog-to-digital converter input 11. |
| | C0o | O | TTL | Analog comparator 0 output. |
| | C1- | I | Analog | Analog comparator 1 negative input. |
| | CAN0Tx | O | TTL | CAN module 0 transmit. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | CCP6 | I/O | TTL | Capture/Compare/PWM 6. |
| | EPI0S22 | I/O | TTL | EPI module 0 signal 22. |
| U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. | |
| 92 | PB4 | I/O | TTL | GPIO port B bit 4. |
| | AIN10 | I | Analog | Analog-to-digital converter input 10. |
| | C0- | I | Analog | Analog comparator 0 negative input. |
| | CAN0Rx | I | TTL | CAN module 0 receive. |
| | EPI0S23 | I/O | TTL | EPI module 0 signal 23. |
| | IDX0 | I | TTL | QEI module 0 index. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| | U2Rx | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| 93 | VDD | - | Power | Positive supply for I/O and some logic. |
| 94 | GND | - | Power | Ground reference for logic and I/O pins. |
| 95 | PE2 | I/O | TTL | GPIO port E bit 2. |
| | AIN9 | I | Analog | Analog-to-digital converter input 9. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | EPI0S24 | I/O | TTL | EPI module 0 signal 24. |
| | PhA0 | I | TTL | QEI module 0 phase A. |
| | PhB1 | I | TTL | QEI module 1 phase B. |
| SSI1Rx | I | TTL | SSI module 1 receive. | |
| 96 | PE3 | I/O | TTL | GPIO port E bit 3. |
| | AIN8 | I | Analog | Analog-to-digital converter input 8. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP7 | I/O | TTL | Capture/Compare/PWM 7. |
| | EPI0S25 | I/O | TTL | EPI module 0 signal 25. |
| | PhA1 | I | TTL | QEI module 1 phase A. |
| | PhB0 | I | TTL | QEI module 0 phase B. |
| | SSI1Tx | O | TTL | SSI module 1 transmit. |

Table 23-2. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|------------|----------|---|--|
| 97 | PD4 | I/O | TTL | GPIO port D bit 4. |
| | AIN7 | I | Analog | Analog-to-digital converter input 7. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | EPI0S19 | I/O | TTL | EPI module 0 signal 19. |
| | I2S0RXSD | I/O | TTL | I ² S module 0 receive data. |
| | U1RI | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| 98 | PD5 | I/O | TTL | GPIO port D bit 5. |
| | AIN6 | I | Analog | Analog-to-digital converter input 6. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | EPI0S28 | I/O | TTL | EPI module 0 signal 28. |
| | I2S0RXMCLK | I/O | TTL | I ² S module 0 receive master clock. |
| | U2Rx | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| 99 | PD6 | I/O | TTL | GPIO port D bit 6. |
| | AIN5 | I | Analog | Analog-to-digital converter input 5. |
| | EPI0S29 | I/O | TTL | EPI module 0 signal 29. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | I2S0TXSCK | I/O | TTL | I ² S module 0 transmit clock. |
| U2Tx | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. | |
| 100 | PD7 | I/O | TTL | GPIO port D bit 7. |
| | AIN4 | I | Analog | Analog-to-digital converter input 4. |
| | CO0 | O | TTL | Analog comparator 0 output. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | EPI0S30 | I/O | TTL | EPI module 0 signal 30. |
| | I2S0TXWS | I/O | TTL | I ² S module 0 transmit word select. |
| | IDX0 | I | TTL | QEI module 0 index. |
| U1DTR | O | TTL | UART module 1 Data Terminal Ready modem status input signal. | |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 23-3. Signals by Signal Name

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|--------------------------------------|
| AIN0 | 1 | PE7 | I | Analog | Analog-to-digital converter input 0. |
| AIN1 | 2 | PE6 | I | Analog | Analog-to-digital converter input 1. |
| AIN2 | 5 | PE5 | I | Analog | Analog-to-digital converter input 2. |
| AIN3 | 6 | PE4 | I | Analog | Analog-to-digital converter input 3. |
| AIN4 | 100 | PD7 | I | Analog | Analog-to-digital converter input 4. |
| AIN5 | 99 | PD6 | I | Analog | Analog-to-digital converter input 5. |
| AIN6 | 98 | PD5 | I | Analog | Analog-to-digital converter input 6. |

Table 23-3. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|--|---|----------|--------------------------|---------------------------------------|
| AIN7 | 97 | PD4 | I | Analog | Analog-to-digital converter input 7. |
| AIN8 | 96 | PE3 | I | Analog | Analog-to-digital converter input 8. |
| AIN9 | 95 | PE2 | I | Analog | Analog-to-digital converter input 9. |
| AIN10 | 92 | PB4 | I | Analog | Analog-to-digital converter input 10. |
| AIN11 | 91 | PB5 | I | Analog | Analog-to-digital converter input 11. |
| AIN12 | 13 | PD3 | I | Analog | Analog-to-digital converter input 12. |
| AIN13 | 12 | PD2 | I | Analog | Analog-to-digital converter input 13. |
| AIN14 | 11 | PD1 | I | Analog | Analog-to-digital converter input 14. |
| AIN15 | 10 | PD0 | I | Analog | Analog-to-digital converter input 15. |
| C0+ | 90 | PB6 | I | Analog | Analog comparator 0 positive input. |
| C0- | 92 | PB4 | I | Analog | Analog comparator 0 negative input. |
| C0o | 24 58 90 91 100 | PC5 (3) PF4 (2) PB6 (3) PB5 (1) PD7 (2) | O | TTL | Analog comparator 0 output. |
| C1+ | 24 | PC5 | I | Analog | Analog comparator 1 positive input. |
| C1- | 91 | PB5 | I | Analog | Analog comparator 1 negative input. |
| C1o | 2 22 24 46 84 | PE6 (2) PC7 (7) PC5 (2) PF5 (2) PH2 (2) | O | TTL | Analog comparator 1 output. |
| C2+ | 23 | PC6 | I | Analog | Analog comparator 2 positive input. |
| C2- | 22 | PC7 | I | Analog | Analog comparator 2 negative input. |
| C2o | 1 23 43 | PE7 (2) PC6 (3) PF6 (2) | O | TTL | Analog comparator 2 output. |
| CAN0Rx | 10 30 34 92 | PD0 (2) PA4 (5) PA6 (6) PB4 (5) | I | TTL | CAN module 0 receive. |
| CAN0Tx | 11 31 35 91 | PD1 (2) PA5 (5) PA7 (6) PB5 (5) | O | TTL | CAN module 0 transmit. |
| CAN1Rx | 47 | PF0 (1) | I | TTL | CAN module 1 receive. |
| CAN1Tx | 61 | PF1 (1) | O | TTL | CAN module 1 transmit. |
| CCP0 | 13 22 23 39 58 66 72 91 97 | PD3 (4) PC7 (4) PC6 (6) PJ2 (9) PF4 (1) PB0 (1) PB2 (5) PB5 (4) PD4 (1) | I/O | TTL | Capture/Compare/PWM 0. |

Table 23-3. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|---|--|----------|--------------------------|------------------------|
| CCP1 | 24 25 34 43 67 90 96 100 | PC5 (1) PC4 (9) PA6 (2) PF6 (1) PB1 (4) PB6 (1) PE3 (1) PD7 (3) | I/O | TTL | Capture/Compare/PWM 1. |
| CCP2 | 6 11 25 46 67 75 91 95 98 | PE4 (6) PD1 (10) PC4 (5) PF5 (1) PB1 (1) PE1 (4) PB5 (6) PE2 (5) PD5 (1) | I/O | TTL | Capture/Compare/PWM 2. |
| CCP3 | 6 23 24 35 41 61 72 74 97 | PE4 (1) PC6 (1) PC5 (5) PA7 (7) PG4 (1) PF1 (10) PB2 (4) PE0 (3) PD4 (2) | I/O | TTL | Capture/Compare/PWM 3. |
| CCP4 | 22 25 35 42 95 98 | PC7 (1) PC4 (6) PA7 (2) PF7 (1) PE2 (1) PD5 (2) | I/O | TTL | Capture/Compare/PWM 4. |
| CCP5 | 5 12 25 36 40 90 91 | PE5 (1) PD2 (4) PC4 (1) PG7 (8) PG5 (1) PB6 (6) PB5 (2) | I/O | TTL | Capture/Compare/PWM 5. |
| CCP6 | 10 12 75 86 91 | PD0 (6) PD2 (2) PE1 (5) PH0 (1) PB5 (3) | I/O | TTL | Capture/Compare/PWM 6. |
| CCP7 | 11 13 85 90 96 | PD1 (6) PD3 (2) PH1 (1) PB6 (2) PE3 (5) | I/O | TTL | Capture/Compare/PWM 7. |
| EPI0S0 | 83 | PH3 (8) | I/O | TTL | EPI module 0 signal 0. |
| EPI0S1 | 84 | PH2 (8) | I/O | TTL | EPI module 0 signal 1. |
| EPI0S2 | 25 | PC4 (8) | I/O | TTL | EPI module 0 signal 2. |
| EPI0S3 | 24 | PC5 (8) | I/O | TTL | EPI module 0 signal 3. |

Table 23-3. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|---|--|----------|--------------------------|-------------------------|
| EPI0S4 | 23 | PC6 (8) | I/O | TTL | EPI module 0 signal 4. |
| EPI0S5 | 22 | PC7 (8) | I/O | TTL | EPI module 0 signal 5. |
| EPI0S6 | 86 | PH0 (8) | I/O | TTL | EPI module 0 signal 6. |
| EPI0S7 | 85 | PH1 (8) | I/O | TTL | EPI module 0 signal 7. |
| EPI0S8 | 74 | PE0 (8) | I/O | TTL | EPI module 0 signal 8. |
| EPI0S9 | 75 | PE1 (8) | I/O | TTL | EPI module 0 signal 9. |
| EPI0S10 | 76 | PH4 (8) | I/O | TTL | EPI module 0 signal 10. |
| EPI0S11 | 63 | PH5 (8) | I/O | TTL | EPI module 0 signal 11. |
| EPI0S12 | 42 58 | PF7 (8) PF4 (8) | I/O | TTL | EPI module 0 signal 12. |
| EPI0S13 | 19 | PG0 (8) | I/O | TTL | EPI module 0 signal 13. |
| EPI0S14 | 18 | PG1 (8) | I/O | TTL | EPI module 0 signal 14. |
| EPI0S15 | 41 46 | PG4 (8) PF5 (8) | I/O | TTL | EPI module 0 signal 15. |
| EPI0S16 | 14 | PJ0 (8) | I/O | TTL | EPI module 0 signal 16. |
| EPI0S17 | 87 | PJ1 (8) | I/O | TTL | EPI module 0 signal 17. |
| EPI0S18 | 39 | PJ2 (8) | I/O | TTL | EPI module 0 signal 18. |
| EPI0S19 | 97 | PD4 (10) | I/O | TTL | EPI module 0 signal 19. |
| EPI0S20 | 12 | PD2 (8) | I/O | TTL | EPI module 0 signal 20. |
| EPI0S21 | 13 | PD3 (8) | I/O | TTL | EPI module 0 signal 21. |
| EPI0S22 | 91 | PB5 (8) | I/O | TTL | EPI module 0 signal 22. |
| EPI0S23 | 92 | PB4 (8) | I/O | TTL | EPI module 0 signal 23. |
| EPI0S24 | 95 | PE2 (8) | I/O | TTL | EPI module 0 signal 24. |
| EPI0S25 | 96 | PE3 (8) | I/O | TTL | EPI module 0 signal 25. |
| EPI0S26 | 62 | PH6 (8) | I/O | TTL | EPI module 0 signal 26. |
| EPI0S27 | 15 | PH7 (8) | I/O | TTL | EPI module 0 signal 27. |
| EPI0S28 | 98 | PD5 (10) | I/O | TTL | EPI module 0 signal 28. |
| EPI0S29 | 99 | PD6 (10) | I/O | TTL | EPI module 0 signal 29. |
| EPI0S30 | 100 | PD7 (10) | I/O | TTL | EPI module 0 signal 30. |
| EPI0S31 | 36 | PG7 (9) | I/O | TTL | EPI module 0 signal 31. |
| Fault0 | 6 16 17 39 58 65 75 83 99 | PE4 (4) PG3 (8) PG2 (4) PJ2 (10) PF4 (4) PB3 (2) PE1 (3) PH3 (2) PD6 (1) | I | TTL | PWM Fault 0. |
| Fault1 | 37 40 41 42 90 | PG6 (8) PG5 (5) PG4 (4) PF7 (9) PB6 (4) | I | TTL | PWM Fault 1. |

Table 23-3. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|-------------------------|---|---|----------|--------------------------|---|
| Fault2 | 16 24 63 | PG3 (4) PC5 (4) PH5 (10) | I | TTL | PWM Fault 2. |
| Fault3 | 65 84 | PB3 (4) PH2 (4) | I | TTL | PWM Fault 3. |
| GND | 9 21 33 45 54 57 69 82 94 | fixed | - | Power | Ground reference for logic and I/O pins. |
| GNDA | 4 | fixed | - | Power | The ground reference for the analog circuits (ADC, Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions. |
| $\overline{\text{HTB}}$ | 51 | fixed | O | OD | An output that indicates the processor is in Hibernate mode. |
| I2C0SCL | 72 | PB2 (1) | I/O | OD | I ² C module 0 clock. |
| I2C0SDA | 65 | PB3 (1) | I/O | OD | I ² C module 0 data. |
| I2C1SCL | 14 19 26 34 | PJ0 (11) PG0 (3) PA0 (8) PA6 (1) | I/O | OD | I ² C module 1 clock. |
| I2C1SDA | 18 27 35 87 | PG1 (3) PA1 (8) PA7 (1) PJ1 (11) | I/O | OD | I ² C module 1 data. |
| I2S0RXMCLK | 16 29 98 | PG3 (9) PA3 (9) PD5 (8) | I/O | TTL | I ² S module 0 receive master clock. |
| I2S0RXSCK | 10 40 | PD0 (8) PG5 (9) | I/O | TTL | I ² S module 0 receive clock. |
| I2S0RXSD | 17 28 97 | PG2 (9) PA2 (9) PD4 (8) | I/O | TTL | I ² S module 0 receive data. |
| I2S0RXWS | 11 37 | PD1 (8) PG6 (9) | I/O | TTL | I ² S module 0 receive word select. |
| I2S0TXMCLK | 43 61 | PF6 (9) PF1 (8) | I/O | TTL | I ² S module 0 transmit master clock. |
| I2S0TXSCK | 30 90 99 | PA4 (9) PB6 (9) PD6 (8) | I/O | TTL | I ² S module 0 transmit clock. |
| I2S0TXSD | 5 47 | PE5 (9) PF0 (8) | I/O | TTL | I ² S module 0 transmit data. |
| I2S0TXWS | 6 31 100 | PE4 (9) PA5 (9) PD7 (8) | I/O | TTL | I ² S module 0 transmit word select. |

Table 23-3. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|-----------------------------------|--|----------|--------------------------|--|
| IDX0 | 10 40 72 90 92 100 | PD0 (3) PG5 (4) PB2 (2) PB6 (5) PB4 (6) PD7 (1) | I | TTL | QE1 module 0 index. |
| IDX1 | 17 61 84 | PG2 (8) PF1 (2) PH2 (1) | I | TTL | QE1 module 1 index. |
| LDO | 7 | fixed | - | Power | Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 μ F or greater. The LDO pin must also be connected to the VDDC pins at the board level in addition to the decoupling capacitor(s). |
| NC | 70 71 73 | fixed | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| NMI | 89 | PB7 (4) | I | TTL | Non-maskable interrupt. |
| OSC0 | 48 | fixed | I | Analog | Main oscillator crystal input or an external clock reference input. |
| OSC1 | 49 | fixed | O | Analog | Main oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| PA0 | 26 | - | I/O | TTL | GPIO port A bit 0. |
| PA1 | 27 | - | I/O | TTL | GPIO port A bit 1. |
| PA2 | 28 | - | I/O | TTL | GPIO port A bit 2. |
| PA3 | 29 | - | I/O | TTL | GPIO port A bit 3. |
| PA4 | 30 | - | I/O | TTL | GPIO port A bit 4. |
| PA5 | 31 | - | I/O | TTL | GPIO port A bit 5. |
| PA6 | 34 | - | I/O | TTL | GPIO port A bit 6. |
| PA7 | 35 | - | I/O | TTL | GPIO port A bit 7. |
| PB0 | 66 | - | I/O | TTL | GPIO port B bit 0. This pin is not 5-V tolerant. |
| PB1 | 67 | - | I/O | TTL | GPIO port B bit 1. This pin is not 5-V tolerant. |
| PB2 | 72 | - | I/O | TTL | GPIO port B bit 2. |
| PB3 | 65 | - | I/O | TTL | GPIO port B bit 3. |
| PB4 | 92 | - | I/O | TTL | GPIO port B bit 4. |
| PB5 | 91 | - | I/O | TTL | GPIO port B bit 5. |
| PB6 | 90 | - | I/O | TTL | GPIO port B bit 6. |
| PB7 | 89 | - | I/O | TTL | GPIO port B bit 7. |
| PC0 | 80 | - | I/O | TTL | GPIO port C bit 0. |
| PC1 | 79 | - | I/O | TTL | GPIO port C bit 1. |
| PC2 | 78 | - | I/O | TTL | GPIO port C bit 2. |
| PC3 | 77 | - | I/O | TTL | GPIO port C bit 3. |
| PC4 | 25 | - | I/O | TTL | GPIO port C bit 4. |
| PC5 | 24 | - | I/O | TTL | GPIO port C bit 5. |
| PC6 | 23 | - | I/O | TTL | GPIO port C bit 6. |

Table 23-3. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|--------------------|
| PC7 | 22 | - | I/O | TTL | GPIO port C bit 7. |
| PD0 | 10 | - | I/O | TTL | GPIO port D bit 0. |
| PD1 | 11 | - | I/O | TTL | GPIO port D bit 1. |
| PD2 | 12 | - | I/O | TTL | GPIO port D bit 2. |
| PD3 | 13 | - | I/O | TTL | GPIO port D bit 3. |
| PD4 | 97 | - | I/O | TTL | GPIO port D bit 4. |
| PD5 | 98 | - | I/O | TTL | GPIO port D bit 5. |
| PD6 | 99 | - | I/O | TTL | GPIO port D bit 6. |
| PD7 | 100 | - | I/O | TTL | GPIO port D bit 7. |
| PE0 | 74 | - | I/O | TTL | GPIO port E bit 0. |
| PE1 | 75 | - | I/O | TTL | GPIO port E bit 1. |
| PE2 | 95 | - | I/O | TTL | GPIO port E bit 2. |
| PE3 | 96 | - | I/O | TTL | GPIO port E bit 3. |
| PE4 | 6 | - | I/O | TTL | GPIO port E bit 4. |
| PE5 | 5 | - | I/O | TTL | GPIO port E bit 5. |
| PE6 | 2 | - | I/O | TTL | GPIO port E bit 6. |
| PE7 | 1 | - | I/O | TTL | GPIO port E bit 7. |
| PF0 | 47 | - | I/O | TTL | GPIO port F bit 0. |
| PF1 | 61 | - | I/O | TTL | GPIO port F bit 1. |
| PF2 | 60 | - | I/O | TTL | GPIO port F bit 2. |
| PF3 | 59 | - | I/O | TTL | GPIO port F bit 3. |
| PF4 | 58 | - | I/O | TTL | GPIO port F bit 4. |
| PF5 | 46 | - | I/O | TTL | GPIO port F bit 5. |
| PF6 | 43 | - | I/O | TTL | GPIO port F bit 6. |
| PF7 | 42 | - | I/O | TTL | GPIO port F bit 7. |
| PG0 | 19 | - | I/O | TTL | GPIO port G bit 0. |
| PG1 | 18 | - | I/O | TTL | GPIO port G bit 1. |
| PG2 | 17 | - | I/O | TTL | GPIO port G bit 2. |
| PG3 | 16 | - | I/O | TTL | GPIO port G bit 3. |
| PG4 | 41 | - | I/O | TTL | GPIO port G bit 4. |
| PG5 | 40 | - | I/O | TTL | GPIO port G bit 5. |
| PG6 | 37 | - | I/O | TTL | GPIO port G bit 6. |
| PG7 | 36 | - | I/O | TTL | GPIO port G bit 7. |
| PH0 | 86 | - | I/O | TTL | GPIO port H bit 0. |
| PH1 | 85 | - | I/O | TTL | GPIO port H bit 1. |
| PH2 | 84 | - | I/O | TTL | GPIO port H bit 2. |
| PH3 | 83 | - | I/O | TTL | GPIO port H bit 3. |
| PH4 | 76 | - | I/O | TTL | GPIO port H bit 4. |
| PH5 | 63 | - | I/O | TTL | GPIO port H bit 5. |
| PH6 | 62 | - | I/O | TTL | GPIO port H bit 6. |
| PH7 | 15 | - | I/O | TTL | GPIO port H bit 7. |

Table 23-3. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|--|
| PhA0 | 11 | PD1 (3) | I | TTL | QEI module 0 phase A. |
| | 25 | PC4 (2) | | | |
| | 43 | PF6 (4) | | | |
| | 95 | PE2 (4) | | | |
| PhA1 | 37 | PG6 (1) | I | TTL | QEI module 1 phase A. |
| | 96 | PE3 (3) | | | |
| PhB0 | 22 | PC7 (2) | I | TTL | QEI module 0 phase B. |
| | 23 | PC6 (2) | | | |
| | 42 | PF7 (4) | | | |
| | 47 | PF0 (2) | | | |
| | 83 | PH3 (1) | | | |
| | 96 | PE3 (4) | | | |
| PhB1 | 11 | PD1 (11) | I | TTL | QEI module 1 phase B. |
| | 36 | PG7 (1) | | | |
| | 95 | PE2 (3) | | | |
| PJ0 | 14 | - | I/O | TTL | GPIO port J bit 0. |
| PJ1 | 87 | - | I/O | TTL | GPIO port J bit 1. |
| PJ2 | 39 | - | I/O | TTL | GPIO port J bit 2. |
| PWM0 | 10 | PD0 (1) | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | 14 | PJ0 (10) | | | |
| | 17 | PG2 (1) | | | |
| | 19 | PG0 (2) | | | |
| | 34 | PA6 (4) | | | |
| | 47 | PF0 (3) | | | |
| PWM1 | 11 | PD1 (1) | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | 16 | PG3 (1) | | | |
| | 18 | PG1 (2) | | | |
| | 35 | PA7 (4) | | | |
| | 61 | PF1 (3) | | | |
| | 87 | PJ1 (10) | | | |
| PWM2 | 12 | PD2 (3) | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | 60 | PF2 (4) | | | |
| | 66 | PB0 (2) | | | |
| | 86 | PH0 (2) | | | |
| PWM3 | 13 | PD3 (3) | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | 59 | PF3 (4) | | | |
| | 67 | PB1 (2) | | | |
| | 85 | PH1 (2) | | | |
| PWM4 | 2 | PE6 (1) | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | 19 | PG0 (4) | | | |
| | 28 | PA2 (4) | | | |
| | 34 | PA6 (5) | | | |
| | 60 | PF2 (2) | | | |
| | 62 | PH6 (10) | | | |
| | 74 | PE0 (1) | | | |
| | 86 | PH0 (9) | | | |

Table 23-3. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|-------------------------|---|---|----------|--------------------------|---|
| PWM5 | 1 15 18 29 35 59 75 85 | PE7 (1) PH7 (10) PG1 (4) PA3 (4) PA7 (5) PF3 (2) PE1 (1) PH1 (9) | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| PWM6 | 25 30 37 41 | PC4 (4) PA4 (4) PG6 (4) PG4 (9) | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| PWM7 | 23 31 36 40 | PC6 (4) PA5 (4) PG7 (4) PG5 (8) | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| $\overline{\text{RST}}$ | 64 | fixed | I | TTL | System reset input. |
| SSI0Clk | 28 | PA2 (1) | I/O | TTL | SSI module 0 clock. |
| SSI0Fss | 29 | PA3 (1) | I/O | TTL | SSI module 0 frame. |
| SSI0Rx | 30 | PA4 (1) | I | TTL | SSI module 0 receive. |
| SSI0Tx | 31 | PA5 (1) | O | TTL | SSI module 0 transmit. |
| SSI1Clk | 60 74 76 | PF2 (9) PE0 (2) PH4 (11) | I/O | TTL | SSI module 1 clock. |
| SSI1Fss | 59 63 75 | PF3 (9) PH5 (11) PE1 (2) | I/O | TTL | SSI module 1 frame. |
| SSI1Rx | 58 62 95 | PF4 (9) PH6 (11) PE2 (2) | I | TTL | SSI module 1 receive. |
| SSI1Tx | 15 46 96 | PH7 (11) PF5 (9) PE3 (2) | O | TTL | SSI module 1 transmit. |
| SWCLK | 80 | PC0 (3) | I | TTL | JTAG/SWD CLK. |
| SWDIO | 79 | PC1 (3) | I/O | TTL | JTAG TMS and SWDIO. |
| SWO | 77 | PC3 (3) | O | TTL | JTAG TDO and SWO. |
| TCK | 80 | PC0 (3) | I | TTL | JTAG/SWD CLK. |
| TDI | 78 | PC2 (3) | I | TTL | JTAG TDI. |
| TDO | 77 | PC3 (3) | O | TTL | JTAG TDO and SWO. |
| TMS | 79 | PC1 (3) | I | TTL | JTAG TMS and SWDIO. |
| U0Rx | 26 | PA0 (1) | I | TTL | UART module 0 receive. When in IrDA mode, this signal has IrDA modulation. |
| U0Tx | 27 | PA1 (1) | O | TTL | UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation. |
| U1CTS | 2 10 34 | PE6 (9) PD0 (9) PA6 (9) | I | TTL | UART module 1 Clear To Send modem flow control input signal. |

Table 23-3. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|---|--|----------|--------------------------|--|
| U1DCD | 1 11 35 | PE7 (9) PD1 (9) PA7 (9) | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| U1DSR | 47 | PF0 (9) | I | TTL | UART module 1 Data Set Ready modem output control line. |
| U1DTR | 40 100 | PG5 (10) PD7 (9) | O | TTL | UART module 1 Data Terminal Ready modem status input signal. |
| U1RI | 37 41 97 | PG6 (10) PG4 (10) PD4 (9) | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| U1RTS | 43 61 | PF6 (10) PF1 (9) | O | TTL | UART module 1 Request to Send modem flow control output line. |
| U1Rx | 10 12 23 26 66 92 | PD0 (5) PD2 (1) PC6 (5) PA0 (9) PB0 (5) PB4 (7) | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| U1Tx | 11 13 22 27 67 91 | PD1 (5) PD3 (1) PC7 (5) PA1 (9) PB1 (5) PB5 (7) | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| U2Rx | 10 19 92 98 | PD0 (4) PG0 (1) PB4 (4) PD5 (9) | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| U2Tx | 6 11 18 99 | PE4 (5) PD1 (4) PG1 (1) PD6 (9) | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |
| VBAT | 55 | fixed | - | Power | Power source for the Hibernation module. It is normally connected to the positive terminal of a battery and serves as the battery backup/Hibernation module power-source supply. |
| VDD | 8 20 32 44 56 68 81 93 | fixed | - | Power | Positive supply for I/O and some logic. |
| VDDA | 3 | fixed | - | Power | The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in Table 25-2 on page 1128, regardless of system implementation. |

Table 23-3. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|--------------------------|------------|--------------------------|----------|--------------------------|---|
| VDDC | 38 88 | fixed | - | Power | Positive supply for most of the logic function, including the processor core and most peripherals. The voltage on this pin is 1.3 V and is supplied by the on-chip LDO. The VDDC pins should only be connected to the LDO pin and an external capacitor as specified in Table 25-6 on page 1133. |
| VREFA | 90 | PB6 | I | Analog | This input provides a reference voltage used to specify the input voltage at which the ADC converts to a maximum value. In other words, the voltage that is applied to VREFA is the voltage with which an AIN _n signal is converted to 4095. The VREFA input is limited to the range specified in Table 25-26 on page 1145 . |
| $\overline{\text{WAKE}}$ | 50 | fixed | I | TTL | An external input that brings the processor out of Hibernate mode when asserted. |
| XOSC0 | 52 | fixed | I | Analog | Hibernation module oscillator crystal input or an external clock reference input. Note that this is either a 4.194304-MHz crystal or a 32.768-kHz oscillator for the Hibernation module RTC. See the CLKSEL bit in the HIBCTL register. |
| XOSC1 | 53 | fixed | O | Analog | Hibernation module oscillator crystal output. Leave unconnected when using a single-ended clock source. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 23-4. Signals by Function, Except for GPIO

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|--------------------|----------|-----------------------------|----------|--------------------------|---|
| ADC | AIN0 | 1 | I | Analog | Analog-to-digital converter input 0. |
| | AIN1 | 2 | I | Analog | Analog-to-digital converter input 1. |
| | AIN2 | 5 | I | Analog | Analog-to-digital converter input 2. |
| | AIN3 | 6 | I | Analog | Analog-to-digital converter input 3. |
| | AIN4 | 100 | I | Analog | Analog-to-digital converter input 4. |
| | AIN5 | 99 | I | Analog | Analog-to-digital converter input 5. |
| | AIN6 | 98 | I | Analog | Analog-to-digital converter input 6. |
| | AIN7 | 97 | I | Analog | Analog-to-digital converter input 7. |
| | AIN8 | 96 | I | Analog | Analog-to-digital converter input 8. |
| | AIN9 | 95 | I | Analog | Analog-to-digital converter input 9. |
| | AIN10 | 92 | I | Analog | Analog-to-digital converter input 10. |
| | AIN11 | 91 | I | Analog | Analog-to-digital converter input 11. |
| | AIN12 | 13 | I | Analog | Analog-to-digital converter input 12. |
| | AIN13 | 12 | I | Analog | Analog-to-digital converter input 13. |
| | AIN14 | 11 | I | Analog | Analog-to-digital converter input 14. |
| | AIN15 | 10 | I | Analog | Analog-to-digital converter input 15. |
| | VREFA | 90 | I | Analog | This input provides a reference voltage used to specify the input voltage at which the ADC converts to a maximum value. In other words, the voltage that is applied to VREFA is the voltage with which an AIN _n signal is converted to 4095. The VREFA input is limited to the range specified in Table 25-26 on page 1145 . |
| Analog Comparators | C0+ | 90 | I | Analog | Analog comparator 0 positive input. |
| | C0- | 92 | I | Analog | Analog comparator 0 negative input. |
| | C0o | 24 58 90 91 100 | O | TTL | Analog comparator 0 output. |
| | C1+ | 24 | I | Analog | Analog comparator 1 positive input. |
| | C1- | 91 | I | Analog | Analog comparator 1 negative input. |
| | C1o | 2 22 24 46 84 | O | TTL | Analog comparator 1 output. |
| | C2+ | 23 | I | Analog | Analog comparator 2 positive input. |
| | C2- | 22 | I | Analog | Analog comparator 2 negative input. |
| | C2o | 1 23 43 | O | TTL | Analog comparator 2 output. |

Table 23-4. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description | | |
|-------------------------------|----------|------------|----------|--------------------------|-------------------------|-------------------------|--|
| Controller Area Network | CAN0Rx | 10 | I | TTL | CAN module 0 receive. | | |
| | | 30 | | | | | |
| | | 34 | | | | | |
| | | 92 | | | | | |
| Controller Area Network | CAN0Tx | 11 | O | TTL | CAN module 0 transmit. | | |
| | | 31 | | | | | |
| | | 35 | | | | | |
| | | 91 | | | | | |
| Controller Area Network | CAN1Rx | 47 | I | TTL | CAN module 1 receive. | | |
| | | 61 | O | TTL | | CAN module 1 transmit. | |
| | | | | | | | |
| | | | | | | | |
| External Peripheral Interface | EPI0S0 | 83 | I/O | TTL | EPI module 0 signal 0. | | |
| | EPI0S1 | 84 | I/O | TTL | EPI module 0 signal 1. | | |
| | EPI0S2 | 25 | I/O | TTL | EPI module 0 signal 2. | | |
| | EPI0S3 | 24 | I/O | TTL | EPI module 0 signal 3. | | |
| | EPI0S4 | 23 | I/O | TTL | EPI module 0 signal 4. | | |
| | EPI0S5 | 22 | I/O | TTL | EPI module 0 signal 5. | | |
| | EPI0S6 | 86 | I/O | TTL | EPI module 0 signal 6. | | |
| | EPI0S7 | 85 | I/O | TTL | EPI module 0 signal 7. | | |
| | EPI0S8 | 74 | I/O | TTL | EPI module 0 signal 8. | | |
| | EPI0S9 | 75 | I/O | TTL | EPI module 0 signal 9. | | |
| | EPI0S10 | 76 | I/O | TTL | EPI module 0 signal 10. | | |
| | EPI0S11 | 63 | I/O | TTL | EPI module 0 signal 11. | | |
| | EPI0S12 | 42 | 58 | I/O | TTL | EPI module 0 signal 12. | |
| | | | | | | | |
| | EPI0S13 | 19 | I/O | TTL | EPI module 0 signal 13. | | |
| | EPI0S14 | 18 | I/O | TTL | EPI module 0 signal 14. | | |
| | EPI0S15 | 41 | 46 | I/O | TTL | EPI module 0 signal 15. | |
| | | | | | | | |
| | EPI0S16 | 14 | I/O | TTL | EPI module 0 signal 16. | | |
| | EPI0S17 | 87 | I/O | TTL | EPI module 0 signal 17. | | |
| | EPI0S18 | 39 | I/O | TTL | EPI module 0 signal 18. | | |
| | EPI0S19 | 97 | I/O | TTL | EPI module 0 signal 19. | | |
| | EPI0S20 | 12 | I/O | TTL | EPI module 0 signal 20. | | |
| | EPI0S21 | 13 | I/O | TTL | EPI module 0 signal 21. | | |
| | EPI0S22 | 91 | I/O | TTL | EPI module 0 signal 22. | | |
| | EPI0S23 | 92 | I/O | TTL | EPI module 0 signal 23. | | |
| | EPI0S24 | 95 | I/O | TTL | EPI module 0 signal 24. | | |
| | EPI0S25 | 96 | I/O | TTL | EPI module 0 signal 25. | | |
| | EPI0S26 | 62 | I/O | TTL | EPI module 0 signal 26. | | |
| | EPI0S27 | 15 | I/O | TTL | EPI module 0 signal 27. | | |
| | EPI0S28 | 98 | I/O | TTL | EPI module 0 signal 28. | | |
| EPI0S29 | 99 | I/O | TTL | EPI module 0 signal 29. | | | |
| EPI0S30 | 100 | I/O | TTL | EPI module 0 signal 30. | | | |
| EPI0S31 | 36 | I/O | TTL | EPI module 0 signal 31. | | | |

Table 23-4. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|------------------------|----------|--|----------|--------------------------|------------------------|
| General-Purpose Timers | CCP0 | 13 22 23 39 58 66 72 91 97 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP1 | 24 25 34 43 67 90 96 100 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP2 | 6 11 25 46 67 75 91 95 98 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP3 | 6 23 24 35 41 61 72 74 97 | I/O | TTL | Capture/Compare/PWM 3. |
| | CCP4 | 22 25 35 42 95 98 | I/O | TTL | Capture/Compare/PWM 4. |
| | CCP5 | 5 12 25 36 40 90 91 | I/O | TTL | Capture/Compare/PWM 5. |
| | CCP6 | 10 12 75 86 91 | I/O | TTL | Capture/Compare/PWM 6. |
| | CCP7 | | I/O | TTL | Capture/Compare/PWM 7. |

Table 23-4. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|-----------|------------|----------------------------|----------|--------------------------|---|
| | | 11 13 85 90 96 | | | |
| Hibernate | HIB | 51 | O | OD | An output that indicates the processor is in Hibernate mode. |
| | VBAT | 55 | - | Power | Power source for the Hibernation module. It is normally connected to the positive terminal of a battery and serves as the battery backup/Hibernation module power-source supply. |
| | WAKE | 50 | I | TTL | An external input that brings the processor out of Hibernate mode when asserted. |
| | XOSC0 | 52 | I | Analog | Hibernation module oscillator crystal input or an external clock reference input. Note that this is either a 4.194304-MHz crystal or a 32.768-kHz oscillator for the Hibernation module RTC. See the CLKSEL bit in the HIBCTL register. |
| | XOSC1 | 53 | O | Analog | Hibernation module oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| I2C | I2C0SCL | 72 | I/O | OD | I ² C module 0 clock. |
| | I2C0SDA | 65 | I/O | OD | I ² C module 0 data. |
| | I2C1SCL | 14 19 26 34 | I/O | OD | I ² C module 1 clock. |
| | I2C1SDA | 18 27 35 87 | I/O | OD | I ² C module 1 data. |
| I2S | I2S0RXMCLK | 16 29 98 | I/O | TTL | I ² S module 0 receive master clock. |
| | I2S0RXSCK | 10 40 | I/O | TTL | I ² S module 0 receive clock. |
| | I2S0RXSD | 17 28 97 | I/O | TTL | I ² S module 0 receive data. |
| | I2S0RXWS | 11 37 | I/O | TTL | I ² S module 0 receive word select. |
| | I2S0TXMCLK | 43 61 | I/O | TTL | I ² S module 0 transmit master clock. |
| | I2S0TXSCK | 30 90 99 | I/O | TTL | I ² S module 0 transmit clock. |
| | I2S0TXSD | 5 47 | I/O | TTL | I ² S module 0 transmit data. |
| | I2S0TXWS | 6 31 100 | I/O | TTL | I ² S module 0 transmit word select. |

Table 23-4. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|--------------|----------|------------|----------|--------------------------|---------------------|
| JTAG/SWD/SWO | SWCLK | 80 | I | TTL | JTAG/SWD CLK. |
| | SWDIO | 79 | I/O | TTL | JTAG TMS and SWDIO. |
| | SWO | 77 | O | TTL | JTAG TDO and SWO. |
| | TCK | 80 | I | TTL | JTAG/SWD CLK. |
| | TDI | 78 | I | TTL | JTAG TDI. |
| | TDO | 77 | O | TTL | JTAG TDO and SWO. |
| | TMS | 79 | I | TTL | JTAG TMS and SWDIO. |

Table 23-4. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|----------|----------|---|----------|--------------------------|--|
| PWM | Fault0 | 6 16 17 39 58 65 75 83 99 | I | TTL | PWM Fault 0. |
| | Fault1 | 37 40 41 42 90 | I | TTL | PWM Fault 1. |
| | Fault2 | 16 24 63 | I | TTL | PWM Fault 2. |
| | Fault3 | 65 84 | I | TTL | PWM Fault 3. |
| | PWM0 | 10 14 17 19 34 47 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | PWM1 | 11 16 18 35 61 87 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | PWM2 | 12 60 66 86 | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | PWM3 | 13 59 67 85 | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | PWM4 | 2 19 28 34 60 62 74 86 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | PWM5 | 1 15 18 29 35 59 75 85 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |

Table 23-4. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|----------|----------|---|----------|--------------------------|--|
| | PWM6 | 25 30 37 41 | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| | PWM7 | 23 31 36 40 | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| Power | GND | 9 21 33 45 54 57 69 82 94 | - | Power | Ground reference for logic and I/O pins. |
| | GNDA | 4 | - | Power | The ground reference for the analog circuits (ADC, Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions. |
| | LDO | 7 | - | Power | Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 μ F or greater. The LDO pin must also be connected to the VDDC pins at the board level in addition to the decoupling capacitor(s). |
| | VDD | 8 20 32 44 56 68 81 93 | - | Power | Positive supply for I/O and some logic. |
| | VDDA | 3 | - | Power | The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in Table 25-2 on page 1128, regardless of system implementation. |
| | VDDC | 38 88 | - | Power | Positive supply for most of the logic function, including the processor core and most peripherals. The voltage on this pin is 1.3 V and is supplied by the on-chip LDO. The VDDC pins should only be connected to the LDO pin and an external capacitor as specified in Table 25-6 on page 1133. |

Table 23-4. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|-------------------------|----------------|-----------------------------------|----------|--------------------------|---|
| QEI | IDX0 | 10 40 72 90 92 100 | I | TTL | QEI module 0 index. |
| | IDX1 | 17 61 84 | I | TTL | QEI module 1 index. |
| | PhA0 | 11 25 43 95 | I | TTL | QEI module 0 phase A. |
| | PhA1 | 37 96 | I | TTL | QEI module 1 phase A. |
| | PhB0 | 22 23 42 47 83 96 | I | TTL | QEI module 0 phase B. |
| | PhB1 | 11 36 95 | I | TTL | QEI module 1 phase B. |
| SSI | SSI0Clk | 28 | I/O | TTL | SSI module 0 clock. |
| | SSI0Fss | 29 | I/O | TTL | SSI module 0 frame. |
| | SSI0Rx | 30 | I | TTL | SSI module 0 receive. |
| | SSI0Tx | 31 | O | TTL | SSI module 0 transmit. |
| | SSI1Clk | 60 74 76 | I/O | TTL | SSI module 1 clock. |
| | SSI1Fss | 59 63 75 | I/O | TTL | SSI module 1 frame. |
| | SSI1Rx | 58 62 95 | I | TTL | SSI module 1 receive. |
| SSI1Tx | 15 46 96 | O | TTL | SSI module 1 transmit. | |
| System Control & Clocks | NMI | 89 | I | TTL | Non-maskable interrupt. |
| | OSC0 | 48 | I | Analog | Main oscillator crystal input or an external clock reference input. |
| | OSC1 | 49 | O | Analog | Main oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| | RST | 64 | I | TTL | System reset input. |

Table 23-4. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|----------|----------|----------------------------------|----------|--------------------------|---|
| UART | U0Rx | 26 | I | TTL | UART module 0 receive. When in IrDA mode, this signal has IrDA modulation. |
| | U0Tx | 27 | O | TTL | UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation. |
| | U1CTS | 2 10 34 | I | TTL | UART module 1 Clear To Send modem flow control input signal. |
| | U1DCD | 1 11 35 | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| | U1DSR | 47 | I | TTL | UART module 1 Data Set Ready modem output control line. |
| | U1DTR | 40 100 | O | TTL | UART module 1 Data Terminal Ready modem status input signal. |
| | U1RI | 37 41 97 | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| | U1RTS | 43 61 | O | TTL | UART module 1 Request to Send modem flow control output line. |
| | U1Rx | 10 12 23 26 66 92 | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| | U1Tx | 11 13 22 27 67 91 | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| | U2Rx | 10 19 92 98 | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| | U2Tx | 6 11 18 99 | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 23-5. GPIO Pins and Alternate Functions

| IO | Pin | Analog Function | Digital Function (GPIOCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | | |
|-----|-----|-----------------|---|---|---|------|--------|---|---|---|-----------|------|----|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| PA0 | 26 | - | U0Rx | - | - | - | - | - | - | - | I2C1SCL | U1Rx | - | - |
| PA1 | 27 | - | U0Tx | - | - | - | - | - | - | - | I2C1SDA | U1Tx | - | - |
| PA2 | 28 | - | SSI0Clk | - | - | PWM4 | - | - | - | - | I2S0RXSD | - | - | - |
| PA3 | 29 | - | SSI0Fss | - | - | PWM5 | - | - | - | - | I2S0RXCLK | - | - | - |
| PA4 | 30 | - | SSI0Rx | - | - | PWM6 | CAN0Rx | - | - | - | I2S0TXSCK | - | - | - |
| PA5 | 31 | - | SSI0Tx | - | - | PWM7 | CAN0Tx | - | - | - | I2S0TXWS | - | - | - |

Table 23-5. GPIO Pins and Alternate Functions (continued)

| IO | Pin | Analog Function | Digital Function (GPIOCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | |
|-----|-----|-----------------|---|---------|--------------|--------|--------|--------|------|-----------|-----------|---------|------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| PA6 | 34 | - | I2C1SCL | CCP1 | - | PWM0 | PWM4 | CAN0Rx | - | - | U1CTS | - | - |
| PA7 | 35 | - | I2C1SDA | CCP4 | - | PWM1 | PWM5 | CAN0Tx | CCP3 | - | U1DCD | - | - |
| PB0 | 66 | - | CCP0 | PWM2 | - | - | U1Rx | - | - | - | - | - | - |
| PB1 | 67 | - | CCP2 | PWM3 | - | CCP1 | U1Tx | - | - | - | - | - | - |
| PB2 | 72 | - | I2C0SCL | IDX0 | - | CCP3 | CCP0 | - | - | - | - | - | - |
| PB3 | 65 | - | I2C0SDA | Fault0 | - | Fault3 | - | - | - | - | - | - | - |
| PB4 | 92 | AIN10 C0- | - | - | - | U2Rx | CAN0Rx | IDX0 | U1Rx | EPI0S23 | - | - | - |
| PB5 | 91 | AIN11 C1- | C0o | CCP5 | CCP6 | CCP0 | CAN0Tx | CCP2 | U1Tx | EPI0S22 | - | - | - |
| PB6 | 90 | VREFA C0+ | CCP1 | CCP7 | C0o | Fault1 | IDX0 | CCP5 | - | - | I2S0TXSCK | - | - |
| PB7 | 89 | - | - | - | - | NMI | - | - | - | - | - | - | - |
| PC0 | 80 | - | - | - | TCK SWCLK | - | - | - | - | - | - | - | - |
| PC1 | 79 | - | - | - | TMS SWDIO | - | - | - | - | - | - | - | - |
| PC2 | 78 | - | - | - | TDI | - | - | - | - | - | - | - | - |
| PC3 | 77 | - | - | - | TDO SWO | - | - | - | - | - | - | - | - |
| PC4 | 25 | - | CCP5 | PhA0 | - | PWM6 | CCP2 | CCP4 | - | EPI0S2 | CCP1 | - | - |
| PC5 | 24 | C1+ | CCP1 | C1o | C0o | Fault2 | CCP3 | - | - | EPI0S3 | - | - | - |
| PC6 | 23 | C2+ | CCP3 | PhB0 | C2o | PWM7 | U1Rx | CCP0 | - | EPI0S4 | - | - | - |
| PC7 | 22 | C2- | CCP4 | PhB0 | - | CCP0 | U1Tx | - | C1o | EPI0S5 | - | - | - |
| PD0 | 10 | AIN15 | PWM0 | CAN0Rx | IDX0 | U2Rx | U1Rx | CCP6 | - | I2S0RXSCK | U1CTS | - | - |
| PD1 | 11 | AIN14 | PWM1 | CAN0Tx | PhA0 | U2Tx | U1Tx | CCP7 | - | I2S0RXWS | U1DCD | CCP2 | PhB1 |
| PD2 | 12 | AIN13 | U1Rx | CCP6 | PWM2 | CCP5 | - | - | - | EPI0S20 | - | - | - |
| PD3 | 13 | AIN12 | U1Tx | CCP7 | PWM3 | CCP0 | - | - | - | EPI0S21 | - | - | - |
| PD4 | 97 | AIN7 | CCP0 | CCP3 | - | - | - | - | - | I2S0RXSD | U1RI | EPI0S19 | - |
| PD5 | 98 | AIN6 | CCP2 | CCP4 | - | - | - | - | - | I2S0RXCLK | U2Rx | EPI0S28 | - |
| PD6 | 99 | AIN5 | Fault0 | - | - | - | - | - | - | I2S0TXSCK | U2Tx | EPI0S29 | - |
| PD7 | 100 | AIN4 | IDX0 | C0o | CCP1 | - | - | - | - | I2S0TXWS | U1DTR | EPI0S30 | - |
| PE0 | 74 | - | PWM4 | SSI1Clk | CCP3 | - | - | - | - | EPI0S8 | - | - | - |
| PE1 | 75 | - | PWM5 | SSI1Fss | Fault0 | CCP2 | CCP6 | - | - | EPI0S9 | - | - | - |
| PE2 | 95 | AIN9 | CCP4 | SSI1Rx | PhB1 | PhA0 | CCP2 | - | - | EPI0S24 | - | - | - |
| PE3 | 96 | AIN8 | CCP1 | SSI1Tx | PhA1 | PhB0 | CCP7 | - | - | EPI0S25 | - | - | - |
| PE4 | 6 | AIN3 | CCP3 | - | - | Fault0 | U2Tx | CCP2 | - | - | I2S0TXWS | - | - |
| PE5 | 5 | AIN2 | CCP5 | - | - | - | - | - | - | - | I2S0TXSD | - | - |
| PE6 | 2 | AIN1 | PWM4 | C1o | - | - | - | - | - | - | U1CTS | - | - |
| PE7 | 1 | AIN0 | PWM5 | C2o | - | - | - | - | - | - | U1DCD | - | - |
| PF0 | 47 | - | CAN1Rx | PhB0 | PWM0 | - | - | - | - | I2S0TXSD | U1DSR | - | - |
| PF1 | 61 | - | CAN1Tx | IDX1 | PWM1 | - | - | - | - | I2S0TXCLK | U1RTS | CCP3 | - |

Table 23-5. GPIO Pins and Alternate Functions (continued)

| IO | Pin | Analog Function | Digital Function (GPIOCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | |
|-----|-----|-----------------|---|--------|---------|--------|--------|---|---|---------|------------|--------|---------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| PF2 | 60 | - | - | PWM4 | - | PWM2 | - | - | - | - | SSI1Clk | - | - |
| PF3 | 59 | - | - | PWM5 | - | PWM3 | - | - | - | - | SSI1Fss | - | - |
| PF4 | 58 | - | CCP0 | C0o | - | Fault0 | - | - | - | EPI0S12 | SSI1Rx | - | - |
| PF5 | 46 | - | CCP2 | C1o | - | - | - | - | - | EPI0S15 | SSI1Tx | - | - |
| PF6 | 43 | - | CCP1 | C2o | - | PhA0 | - | - | - | - | I2S0TXMCLK | U1RTS | - |
| PF7 | 42 | - | CCP4 | - | - | PhB0 | - | - | - | EPI0S12 | Fault1 | - | - |
| PG0 | 19 | - | U2Rx | PWM0 | I2C1SCL | PWM4 | - | - | - | EPI0S13 | - | - | - |
| PG1 | 18 | - | U2Tx | PWM1 | I2C1SDA | PWM5 | - | - | - | EPI0S14 | - | - | - |
| PG2 | 17 | - | PWM0 | - | - | Fault0 | - | - | - | IDX1 | I2S0RXSD | - | - |
| PG3 | 16 | - | PWM1 | - | - | Fault2 | - | - | - | Fault0 | I2S0RXMCLK | - | - |
| PG4 | 41 | - | CCP3 | - | - | Fault1 | - | - | - | EPI0S15 | PWM6 | U1RI | - |
| PG5 | 40 | - | CCP5 | - | - | IDX0 | Fault1 | - | - | PWM7 | I2S0RXSCK | U1DTR | - |
| PG6 | 37 | - | PhA1 | - | - | PWM6 | - | - | - | Fault1 | I2S0RXWS | U1RI | - |
| PG7 | 36 | - | PhB1 | - | - | PWM7 | - | - | - | CCP5 | EPI0S31 | - | - |
| PH0 | 86 | - | CCP6 | PWM2 | - | - | - | - | - | EPI0S6 | PWM4 | - | - |
| PH1 | 85 | - | CCP7 | PWM3 | - | - | - | - | - | EPI0S7 | PWM5 | - | - |
| PH2 | 84 | - | IDX1 | C1o | - | Fault3 | - | - | - | EPI0S1 | - | - | - |
| PH3 | 83 | - | PhB0 | Fault0 | - | - | - | - | - | EPI0S0 | - | - | - |
| PH4 | 76 | - | - | - | - | - | - | - | - | EPI0S10 | - | - | SSI1Clk |
| PH5 | 63 | - | - | - | - | - | - | - | - | EPI0S11 | - | Fault2 | SSI1Fss |
| PH6 | 62 | - | - | - | - | - | - | - | - | EPI0S26 | - | PWM4 | SSI1Rx |
| PH7 | 15 | - | - | - | - | - | - | - | - | EPI0S27 | - | PWM5 | SSI1Tx |
| PJ0 | 14 | - | - | - | - | - | - | - | - | EPI0S16 | - | PWM0 | I2C1SCL |
| PJ1 | 87 | - | - | - | - | - | - | - | - | EPI0S17 | - | PWM1 | I2C1SDA |
| PJ2 | 39 | - | - | - | - | - | - | - | - | EPI0S18 | CCP0 | Fault0 | - |

a. The digital signals that are shaded gray are the power-on default values for the corresponding GPIO pin.

Table 23-6. Possible Pin Assignments for Alternate Functions

| # of Possible Assignments | Alternate Function | GPIO Function |
|---------------------------|--------------------|---------------|
| one | AIN0 | PE7 |
| | AIN1 | PE6 |
| | AIN10 | PB4 |
| | AIN11 | PB5 |
| | AIN12 | PD3 |
| | AIN13 | PD2 |
| | AIN14 | PD1 |
| | AIN15 | PD0 |
| | AIN2 | PE5 |
| | AIN3 | PE4 |
| | AIN4 | PD7 |
| | AIN5 | PD6 |
| | AIN6 | PD5 |
| | AIN7 | PD4 |
| | AIN8 | PE3 |
| | AIN9 | PE2 |
| | C0+ | PB6 |
| | C0- | PB4 |
| | C1+ | PC5 |
| | C1- | PB5 |
| | C2+ | PC6 |
| | C2- | PC7 |
| | CAN1Rx | PF0 |
| | CAN1Tx | PF1 |
| | EPI0S0 | PH3 |
| | EPI0S1 | PH2 |
| | EPI0S10 | PH4 |
| | EPI0S11 | PH5 |
| | EPI0S13 | PG0 |
| | EPI0S14 | PG1 |
| | EPI0S16 | PJ0 |
| | EPI0S17 | PJ1 |
| | EPI0S18 | PJ2 |
| | EPI0S19 | PD4 |
| | EPI0S2 | PC4 |
| | EPI0S20 | PD2 |
| | EPI0S21 | PD3 |
| | EPI0S22 | PB5 |
| | EPI0S23 | PB4 |
| | EPI0S24 | PE2 |
| | EPI0S25 | PE3 |

Table 23-6. Possible Pin Assignments for Alternate Functions (continued)

| # of Possible Assignments | Alternate Function | GPIO Function |
|---------------------------|--------------------|---------------|
| | EPI0S26 | PH6 |
| | EPI0S27 | PH7 |
| | EPI0S28 | PD5 |
| | EPI0S29 | PD6 |
| | EPI0S3 | PC5 |
| | EPI0S30 | PD7 |
| | EPI0S31 | PG7 |
| | EPI0S4 | PC6 |
| | EPI0S5 | PC7 |
| | EPI0S6 | PH0 |
| | EPI0S7 | PH1 |
| | EPI0S8 | PE0 |
| | EPI0S9 | PE1 |
| | I2C0SCL | PB2 |
| | I2C0SDA | PB3 |
| | NMI | PB7 |
| | SSI0Clk | PA2 |
| | SSI0Fss | PA3 |
| | SSI0Rx | PA4 |
| | SSI0Tx | PA5 |
| | SWCLK | PC0 |
| | SWDIO | PC1 |
| | SWO | PC3 |
| | TCK | PC0 |
| | TDI | PC2 |
| | TDO | PC3 |
| | TMS | PC1 |
| | U0Rx | PA0 |
| | U0Tx | PA1 |
| | U1DSR | PF0 |
| | VREFA | PB6 |
| two | EPI0S12 | PF4 PF7 |
| | EPI0S15 | PF5 PG4 |
| | Fault3 | PB3 PH2 |
| | I2S0RXSCK | PD0 PG5 |
| | I2S0RXWS | PD1 PG6 |
| | I2S0TXMCLK | PF1 PF6 |
| | I2S0TXSD | PE5 PF0 |
| | PhA1 | PE3 PG6 |
| | U1DTR | PD7 PG5 |
| | U1RTS | PF1 PF6 |

Table 23-6. Possible Pin Assignments for Alternate Functions (continued)

| # of Possible Assignments | Alternate Function | GPIO Function |
|---------------------------|--------------------|-----------------------------|
| three | C2o | PC6 PE7 PF6 |
| | Fault2 | PC5 PG3 PH5 |
| | I2S0RXMCLK | PA3 PD5 PG3 |
| | I2S0RXSD | PA2 PD4 PG2 |
| | I2S0TXSCK | PA4 PB6 PD6 |
| | I2S0TXWS | PA5 PD7 PE4 |
| | IDX1 | PF1 PG2 PH2 |
| | PhB1 | PD1 PE2 PG7 |
| | SSI1Clk | PE0 PF2 PH4 |
| | SSI1Fss | PE1 PF3 PH5 |
| | SSI1Rx | PE2 PF4 PH6 |
| | SSI1Tx | PE3 PF5 PH7 |
| | U1CTS | PA6 PD0 PE6 |
| | U1DCD | PA7 PD1 PE7 |
| | U1RI | PD4 PG4 PG6 |
| four | CAN0Rx | PA4 PA6 PB4 PD0 |
| | CAN0Tx | PA5 PA7 PB5 PD1 |
| | I2C1SCL | PA0 PA6 PG0 PJ0 |
| | I2C1SDA | PA1 PA7 PG1 PJ1 |
| | PWM2 | PB0 PD2 PF2 PH0 |
| | PWM3 | PB1 PD3 PF3 PH1 |
| | PWM6 | PA4 PC4 PG4 PG6 |
| | PWM7 | PA5 PC6 PG5 PG7 |
| | PhA0 | PC4 PD1 PE2 PF6 |
| | U2Rx | PB4 PD0 PD5 PG0 |
| | U2Tx | PD1 PD6 PE4 PG1 |
| five | C0o | PB5 PB6 PC5 PD7 PF4 |
| | C1o | PC5 PC7 PE6 PF5 PH2 |
| | CCP6 | PB5 PD0 PD2 PE1 PH0 |
| | CCP7 | PB6 PD1 PD3 PE3 PH1 |
| | Fault1 | PB6 PF7 PG4 PG5 PG6 |
| six | CCP4 | PA7 PC4 PC7 PD5 PE2 PF7 |
| | IDX0 | PB2 PB4 PB6 PD0 PD7 PG5 |
| | PWM0 | PA6 PD0 PF0 PG0 PG2 PJ0 |
| | PWM1 | PA7 PD1 PF1 PG1 PG3 PJ1 |
| | PhB0 | PC6 PC7 PE3 PF0 PF7 PH3 |
| | U1Rx | PA0 PB0 PB4 PC6 PD0 PD2 |
| | U1Tx | PA1 PB1 PB5 PC7 PD1 PD3 |
| seven | CCP5 | PB5 PB6 PC4 PD2 PE5 PG5 PG7 |

Table 23-6. Possible Pin Assignments for Alternate Functions (continued)

| # of Possible Assignments | Alternate Function | GPIO Function |
|---------------------------|--------------------|-------------------------------------|
| eight | CCP1 | PA6 PB1 PB6 PC4 PC5 PD7 PE3 PF6 |
| | PWM4 | PA2 PA6 PE0 PE6 PF2 PG0 PH0 PH6 |
| | PWM5 | PA3 PA7 PE1 PE7 PF3 PG1 PH1 PH7 |
| nine | CCP0 | PB0 PB2 PB5 PC6 PC7 PD3 PD4 PF4 PJ2 |
| | CCP2 | PB1 PB5 PC4 PD1 PD5 PE1 PE2 PE4 PF5 |
| | CCP3 | PA7 PB2 PC5 PC6 PD4 PE0 PE4 PF1 PG4 |
| | Fault0 | PB3 PD6 PE1 PE4 PF4 PG2 PG3 PH3 PJ2 |

23.2 108-Ball BGA Package Pin Tables

Table 23-7. Signals by Pin Number

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|-----------|----------|--|---|
| A1 | PE6 | I/O | TTL | GPIO port E bit 6. |
| | AIN1 | I | Analog | Analog-to-digital converter input 1. |
| | C1o | O | TTL | Analog comparator 1 output. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | U1CTS | I | TTL | UART module 1 Clear To Send modem flow control input signal. |
| A2 | PD7 | I/O | TTL | GPIO port D bit 7. |
| | AIN4 | I | Analog | Analog-to-digital converter input 4. |
| | C0o | O | TTL | Analog comparator 0 output. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | EPI0S30 | I/O | TTL | EPI module 0 signal 30. |
| | I2S0TXWS | I/O | TTL | I ² S module 0 transmit word select. |
| | IDX0 | I | TTL | QEI module 0 index. |
| U1DTR | O | TTL | UART module 1 Data Terminal Ready modem status input signal. | |
| A3 | PD6 | I/O | TTL | GPIO port D bit 6. |
| | AIN5 | I | Analog | Analog-to-digital converter input 5. |
| | EPI0S29 | I/O | TTL | EPI module 0 signal 29. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | I2S0TXSCK | I/O | TTL | I ² S module 0 transmit clock. |
| | U2Tx | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |
| A4 | PE2 | I/O | TTL | GPIO port E bit 2. |
| | AIN9 | I | Analog | Analog-to-digital converter input 9. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | EPI0S24 | I/O | TTL | EPI module 0 signal 24. |
| | PhA0 | I | TTL | QEI module 0 phase A. |
| | PhB1 | I | TTL | QEI module 1 phase B. |
| | SSI1Rx | I | TTL | SSI module 1 receive. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|-----------|----------|---|---|
| A5 | GNDA | - | Power | The ground reference for the analog circuits (ADC, Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions. |
| A6 | PB4 | I/O | TTL | GPIO port B bit 4. |
| | AIN10 | I | Analog | Analog-to-digital converter input 10. |
| | C0- | I | Analog | Analog comparator 0 negative input. |
| | CAN0Rx | I | TTL | CAN module 0 receive. |
| | EPI0S23 | I/O | TTL | EPI module 0 signal 23. |
| | IDX0 | I | TTL | QE1 module 0 index. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| | U2Rx | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| A7 | PB6 | I/O | TTL | GPIO port B bit 6. |
| | C0+ | I | Analog | Analog comparator 0 positive input. |
| | C0o | O | TTL | Analog comparator 0 output. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | CCP7 | I/O | TTL | Capture/Compare/PWM 7. |
| | Fault1 | I | TTL | PWM Fault 1. |
| | I2S0TXSCK | I/O | TTL | I ² S module 0 transmit clock. |
| | IDX0 | I | TTL | QE1 module 0 index. |
| VREFA | I | Analog | This input provides a reference voltage used to specify the input voltage at which the ADC converts to a maximum value. In other words, the voltage that is applied to VREFA is the voltage with which an AINn signal is converted to 4095. The VREFA input is limited to the range specified in Table 25-26 on page 1145 . | |
| A8 | PB7 | I/O | TTL | GPIO port B bit 7. |
| | NMI | I | TTL | Non-maskable interrupt. |
| A9 | PC0 | I/O | TTL | GPIO port C bit 0. |
| | SWCLK | I | TTL | JTAG/SWD CLK. |
| | TCK | I | TTL | JTAG/SWD CLK. |
| A10 | PC3 | I/O | TTL | GPIO port C bit 3. |
| | SWO | O | TTL | JTAG TDO and SWO. |
| | TDO | O | TTL | JTAG TDO and SWO. |
| A11 | PB2 | I/O | TTL | GPIO port B bit 2. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | I2C0SCL | I/O | OD | I ² C module 0 clock. |
| | IDX0 | I | TTL | QE1 module 0 index. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|----------|----------|--------------------------|---|
| A12 | PE1 | I/O | TTL | GPIO port E bit 1. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP6 | I/O | TTL | Capture/Compare/PWM 6. |
| | EPI0S9 | I/O | TTL | EPI module 0 signal 9. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | SSI1Fss | I/O | TTL | SSI module 1 frame. |
| B1 | PE7 | I/O | TTL | GPIO port E bit 7. |
| | AIN0 | I | Analog | Analog-to-digital converter input 0. |
| | C2o | O | TTL | Analog comparator 2 output. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | U1DCD | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| B2 | PE4 | I/O | TTL | GPIO port E bit 4. |
| | AIN3 | I | Analog | Analog-to-digital converter input 3. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | I2S0TXWS | I/O | TTL | I ² S module 0 transmit word select. |
| | U2Tx | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |
| B3 | PE5 | I/O | TTL | GPIO port E bit 5. |
| | AIN2 | I | Analog | Analog-to-digital converter input 2. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | I2S0TXSD | I/O | TTL | I ² S module 0 transmit data. |
| B4 | PE3 | I/O | TTL | GPIO port E bit 3. |
| | AIN8 | I | Analog | Analog-to-digital converter input 8. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP7 | I/O | TTL | Capture/Compare/PWM 7. |
| | EPI0S25 | I/O | TTL | EPI module 0 signal 25. |
| | PhA1 | I | TTL | QEI module 1 phase A. |
| | PhB0 | I | TTL | QEI module 0 phase B. |
| | SSI1Tx | O | TTL | SSI module 1 transmit. |
| B5 | PD4 | I/O | TTL | GPIO port D bit 4. |
| | AIN7 | I | Analog | Analog-to-digital converter input 7. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | EPI0S19 | I/O | TTL | EPI module 0 signal 19. |
| | I2S0RXSD | I/O | TTL | I ² S module 0 receive data. |
| | U1RI | I | TTL | UART module 1 Ring Indicator modem status input signal. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|----------|----------|---|--|
| B6 | PJ1 | I/O | TTL | GPIO port J bit 1. |
| | EPI0S17 | I/O | TTL | EPI module 0 signal 17. |
| | I2C1SDA | I/O | OD | I ² C module 1 data. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| B7 | PB5 | I/O | TTL | GPIO port B bit 5. |
| | AIN11 | I | Analog | Analog-to-digital converter input 11. |
| | C0o | O | TTL | Analog comparator 0 output. |
| | C1- | I | Analog | Analog comparator 1 negative input. |
| | CAN0Tx | O | TTL | CAN module 0 transmit. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | CCP6 | I/O | TTL | Capture/Compare/PWM 6. |
| | EPI0S22 | I/O | TTL | EPI module 0 signal 22. |
| U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. | |
| B8 | PC2 | I/O | TTL | GPIO port C bit 2. |
| | TDI | I | TTL | JTAG TDI. |
| B9 | PC1 | I/O | TTL | GPIO port C bit 1. |
| | SWDIO | I/O | TTL | JTAG TMS and SWDIO. |
| | TMS | I | TTL | JTAG TMS and SWDIO. |
| B10 | PH4 | I/O | TTL | GPIO port H bit 4. |
| | EPI0S10 | I/O | TTL | EPI module 0 signal 10. |
| | SSI1Clk | I/O | TTL | SSI module 1 clock. |
| B11 | PE0 | I/O | TTL | GPIO port E bit 0. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | EPI0S8 | I/O | TTL | EPI module 0 signal 8. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | SSI1Clk | I/O | TTL | SSI module 1 clock. |
| B12 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| C1 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| C2 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| C3 | VDDC | - | Power | Positive supply for most of the logic function, including the processor core and most peripherals. The voltage on this pin is 1.3 V and is supplied by the on-chip LDO. The VDDC pins should only be connected to the LDO pin and an external capacitor as specified in Table 25-6 on page 1133. |
| C4 | GND | - | Power | Ground reference for logic and I/O pins. |
| C5 | GND | - | Power | Ground reference for logic and I/O pins. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|------------|----------|--------------------------|--|
| C6 | PD5 | I/O | TTL | GPIO port D bit 5. |
| | AIN6 | I | Analog | Analog-to-digital converter input 6. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | EPI0S28 | I/O | TTL | EPI module 0 signal 28. |
| | I2S0RXMCLK | I/O | TTL | I ² S module 0 receive master clock. |
| | U2Rx | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| C7 | VDDA | - | Power | The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in Table 25-2 on page 1128, regardless of system implementation. |
| C8 | PH1 | I/O | TTL | GPIO port H bit 1. |
| | CCP7 | I/O | TTL | Capture/Compare/PWM 7. |
| | EPI0S7 | I/O | TTL | EPI module 0 signal 7. |
| | PWM3 | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| C9 | PH0 | I/O | TTL | GPIO port H bit 0. |
| | CCP6 | I/O | TTL | Capture/Compare/PWM 6. |
| | EPI0S6 | I/O | TTL | EPI module 0 signal 6. |
| | PWM2 | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| C10 | PG7 | I/O | TTL | GPIO port G bit 7. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | EPI0S31 | I/O | TTL | EPI module 0 signal 31. |
| | PWM7 | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| | PhB1 | I | TTL | QEI module 1 phase B. |
| C11 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| C12 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| D1 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| D2 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| D3 | VDDC | - | Power | Positive supply for most of the logic function, including the processor core and most peripherals. The voltage on this pin is 1.3 V and is supplied by the on-chip LDO. The VDDC pins should only be connected to the LDO pin and an external capacitor as specified in Table 25-6 on page 1133. |
| D10 | PH3 | I/O | TTL | GPIO port H bit 3. |
| | EPI0S0 | I/O | TTL | EPI module 0 signal 0. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | PhB0 | I | TTL | QEI module 0 phase B. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|----------|----------|--------------------------|--|
| D11 | PH2 | I/O | TTL | GPIO port H bit 2. |
| | C1o | O | TTL | Analog comparator 1 output. |
| | EPI0S1 | I/O | TTL | EPI module 0 signal 1. |
| | Fault3 | I | TTL | PWM Fault 3. |
| | IDX1 | I | TTL | QEI module 1 index. |
| D12 | PB1 | I/O | TTL | GPIO port B bit 1. This pin is not 5-V tolerant. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | PWM3 | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| E1 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| E2 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| E3 | LDO | - | Power | Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 μ F or greater. The LDO pin must also be connected to the VDDC pins at the board level in addition to the decoupling capacitor(s). |
| E10 | VDD | - | Power | Positive supply for I/O and some logic. |
| E11 | PB3 | I/O | TTL | GPIO port B bit 3. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | Fault3 | I | TTL | PWM Fault 3. |
| | I2C0SDA | I/O | OD | I ² C module 0 data. |
| E12 | PB0 | I/O | TTL | GPIO port B bit 0. This pin is not 5-V tolerant. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | PWM2 | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| F1 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| F2 | NC | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| F3 | PJ0 | I/O | TTL | GPIO port J bit 0. |
| | EPI0S16 | I/O | TTL | EPI module 0 signal 16. |
| | I2C1SCL | I/O | OD | I ² C module 1 clock. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| F10 | PH5 | I/O | TTL | GPIO port H bit 5. |
| | EPI0S11 | I/O | TTL | EPI module 0 signal 11. |
| | Fault2 | I | TTL | PWM Fault 2. |
| | SSI1Fss | I/O | TTL | SSI module 1 frame. |
| F11 | GND | - | Power | Ground reference for logic and I/O pins. |
| F12 | GND | - | Power | Ground reference for logic and I/O pins. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|-----------|----------|---|---|
| G1 | PD0 | I/O | TTL | GPIO port D bit 0. |
| | AIN15 | I | Analog | Analog-to-digital converter input 15. |
| | CAN0Rx | I | TTL | CAN module 0 receive. |
| | CCP6 | I/O | TTL | Capture/Compare/PWM 6. |
| | I2S0RXSCK | I/O | TTL | I ² S module 0 receive clock. |
| | IDX0 | I | TTL | QEI module 0 index. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | U1CTS | I | TTL | UART module 1 Clear To Send modem flow control input signal. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| U2Rx | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. | |
| G2 | PD1 | I/O | TTL | GPIO port D bit 1. |
| | AIN14 | I | Analog | Analog-to-digital converter input 14. |
| | CAN0Tx | O | TTL | CAN module 0 transmit. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP7 | I/O | TTL | Capture/Compare/PWM 7. |
| | I2S0RXWS | I/O | TTL | I ² S module 0 receive word select. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | PhA0 | I | TTL | QEI module 0 phase A. |
| | PhB1 | I | TTL | QEI module 1 phase B. |
| | U1DCD | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| | U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| U2Tx | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. | |
| G3 | PH6 | I/O | TTL | GPIO port H bit 6. |
| | EPI0S26 | I/O | TTL | EPI module 0 signal 26. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | SSI1Rx | I | TTL | SSI module 1 receive. |
| G10 | VDD | - | Power | Positive supply for I/O and some logic. |
| G11 | VDD | - | Power | Positive supply for I/O and some logic. |
| G12 | VDD | - | Power | Positive supply for I/O and some logic. |
| H1 | PD3 | I/O | TTL | GPIO port D bit 3. |
| | AIN12 | I | Analog | Analog-to-digital converter input 12. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP7 | I/O | TTL | Capture/Compare/PWM 7. |
| | EPI0S21 | I/O | TTL | EPI module 0 signal 21. |
| | PWM3 | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|------------|----------|--------------------------|--|
| H2 | PD2 | I/O | TTL | GPIO port D bit 2. |
| | AIN13 | I | Analog | Analog-to-digital converter input 13. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | CCP6 | I/O | TTL | Capture/Compare/PWM 6. |
| | EPI0S20 | I/O | TTL | EPI module 0 signal 20. |
| | PWM2 | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| H3 | PH7 | I/O | TTL | GPIO port H bit 7. |
| | EPI0S27 | I/O | TTL | EPI module 0 signal 27. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | SSI1Tx | O | TTL | SSI module 1 transmit. |
| H10 | VDD | - | Power | Positive supply for I/O and some logic. |
| H11 | RST | I | TTL | System reset input. |
| H12 | PF1 | I/O | TTL | GPIO port F bit 1. |
| | CAN1Tx | O | TTL | CAN module 1 transmit. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | I2S0TXMCLK | I/O | TTL | I ² S module 0 transmit master clock. |
| | IDX1 | I | TTL | QEI module 1 index. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | U1RTS | O | TTL | UART module 1 Request to Send modem flow control output line. |
| J1 | PG2 | I/O | TTL | GPIO port G bit 2. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | I2S0RXSD | I/O | TTL | I ² S module 0 receive data. |
| | IDX1 | I | TTL | QEI module 1 index. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| J2 | PG3 | I/O | TTL | GPIO port G bit 3. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | Fault2 | I | TTL | PWM Fault 2. |
| | I2S0RXMCLK | I/O | TTL | I ² S module 0 receive master clock. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| J3 | GND | - | Power | Ground reference for logic and I/O pins. |
| J10 | GND | - | Power | Ground reference for logic and I/O pins. |
| J11 | PF2 | I/O | TTL | GPIO port F bit 2. |
| | PWM2 | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | SSI1Clk | I/O | TTL | SSI module 1 clock. |
| J12 | PF3 | I/O | TTL | GPIO port F bit 3. |
| | PWM3 | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | SSI1Fss | I/O | TTL | SSI module 1 frame. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|----------|----------|--------------------------|---|
| K1 | PG0 | I/O | TTL | GPIO port G bit 0. |
| | EPI0S13 | I/O | TTL | EPI module 0 signal 13. |
| | I2C1SCL | I/O | OD | I ² C module 1 clock. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | U2Rx | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| K2 | PG1 | I/O | TTL | GPIO port G bit 1. |
| | EPI0S14 | I/O | TTL | EPI module 0 signal 14. |
| | I2C1SDA | I/O | OD | I ² C module 1 data. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | U2Tx | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |
| K3 | PG4 | I/O | TTL | GPIO port G bit 4. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | EPI0S15 | I/O | TTL | EPI module 0 signal 15. |
| | Fault1 | I | TTL | PWM Fault 1. |
| | PWM6 | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| | U1RI | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| K4 | PF7 | I/O | TTL | GPIO port F bit 7. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | EPI0S12 | I/O | TTL | EPI module 0 signal 12. |
| | Fault1 | I | TTL | PWM Fault 1. |
| | PhB0 | I | TTL | QEI module 0 phase B. |
| K5 | GND | - | Power | Ground reference for logic and I/O pins. |
| K6 | PJ2 | I/O | TTL | GPIO port J bit 2. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | EPI0S18 | I/O | TTL | EPI module 0 signal 18. |
| | Fault0 | I | TTL | PWM Fault 0. |
| K7 | VDD | - | Power | Positive supply for I/O and some logic. |
| K8 | VDD | - | Power | Positive supply for I/O and some logic. |
| K9 | VDD | - | Power | Positive supply for I/O and some logic. |
| K10 | GND | - | Power | Ground reference for logic and I/O pins. |
| K11 | XOSC0 | I | Analog | Hibernation module oscillator crystal input or an external clock reference input. Note that this is either a 4.194304-MHz crystal or a 32.768-kHz oscillator for the Hibernation module RTC. See the CLKSEL bit in the HIBCTL register. |
| K12 | XOSC1 | O | Analog | Hibernation module oscillator crystal output. Leave unconnected when using a single-ended clock source. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|-----------|----------|--------------------------|---|
| L1 | PC4 | I/O | TTL | GPIO port C bit 4. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | EPI0S2 | I/O | TTL | EPI module 0 signal 2. |
| | PWM6 | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| | PhA0 | I | TTL | QEI module 0 phase A. |
| L2 | PC7 | I/O | TTL | GPIO port C bit 7. |
| | C1o | O | TTL | Analog comparator 1 output. |
| | C2- | I | Analog | Analog comparator 2 negative input. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | EPI0S5 | I/O | TTL | EPI module 0 signal 5. |
| | PhB0 | I | TTL | QEI module 0 phase B. |
| | U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| L3 | PA0 | I/O | TTL | GPIO port A bit 0. |
| | I2C1SCL | I/O | OD | I ² C module 1 clock. |
| | U0Rx | I | TTL | UART module 0 receive. When in IrDA mode, this signal has IrDA modulation. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| L4 | PA3 | I/O | TTL | GPIO port A bit 3. |
| | I2S0RXCLK | I/O | TTL | I ² S module 0 receive master clock. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | SSI0Fss | I/O | TTL | SSI module 0 frame. |
| L5 | PA4 | I/O | TTL | GPIO port A bit 4. |
| | CAN0Rx | I | TTL | CAN module 0 receive. |
| | I2S0TXSCK | I/O | TTL | I ² S module 0 transmit clock. |
| | PWM6 | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| | SSI0Rx | I | TTL | SSI module 0 receive. |
| L6 | PA6 | I/O | TTL | GPIO port A bit 6. |
| | CAN0Rx | I | TTL | CAN module 0 receive. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | I2C1SCL | I/O | OD | I ² C module 1 clock. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | U1CTS | I | TTL | UART module 1 Clear To Send modem flow control input signal. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|----------|----------|--------------------------|--|
| L7 | PG6 | I/O | TTL | GPIO port G bit 6. |
| | Fault1 | I | TTL | PWM Fault 1. |
| | I2S0RXWS | I/O | TTL | I ² S module 0 receive word select. |
| | PWM6 | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| | PhA1 | I | TTL | QEI module 1 phase A. |
| | U1RI | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| L8 | PF5 | I/O | TTL | GPIO port F bit 5. |
| | C1o | O | TTL | Analog comparator 1 output. |
| | CCP2 | I/O | TTL | Capture/Compare/PWM 2. |
| | EPI0S15 | I/O | TTL | EPI module 0 signal 15. |
| | SSI1Tx | O | TTL | SSI module 1 transmit. |
| L9 | PF4 | I/O | TTL | GPIO port F bit 4. |
| | C0o | O | TTL | Analog comparator 0 output. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | EPI0S12 | I/O | TTL | EPI module 0 signal 12. |
| | Fault0 | I | TTL | PWM Fault 0. |
| | SSI1Rx | I | TTL | SSI module 1 receive. |
| L10 | GND | - | Power | Ground reference for logic and I/O pins. |
| L11 | OSC0 | I | Analog | Main oscillator crystal input or an external clock reference input. |
| L12 | VBAT | - | Power | Power source for the Hibernation module. It is normally connected to the positive terminal of a battery and serves as the battery backup/Hibernation module power-source supply. |
| M1 | PC5 | I/O | TTL | GPIO port C bit 5. |
| | C0o | O | TTL | Analog comparator 0 output. |
| | C1+ | I | Analog | Analog comparator 1 positive input. |
| | C1o | O | TTL | Analog comparator 1 output. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | EPI0S3 | I/O | TTL | EPI module 0 signal 3. |
| | Fault2 | I | TTL | PWM Fault 2. |
| M2 | PC6 | I/O | TTL | GPIO port C bit 6. |
| | C2+ | I | Analog | Analog comparator 2 positive input. |
| | C2o | O | TTL | Analog comparator 2 output. |
| | CCP0 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | EPI0S4 | I/O | TTL | EPI module 0 signal 4. |
| | PWM7 | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| | PhB0 | I | TTL | QEI module 0 phase B. |
| | U1Rx | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|------------|----------|--------------------------|---|
| M3 | PA1 | I/O | TTL | GPIO port A bit 1. |
| | I2C1SDA | I/O | OD | I ² C module 1 data. |
| | U0Tx | O | TTL | UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation. |
| | U1Tx | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| M4 | PA2 | I/O | TTL | GPIO port A bit 2. |
| | I2S0RXSD | I/O | TTL | I ² S module 0 receive data. |
| | PWM4 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | SSI0Clk | I/O | TTL | SSI module 0 clock. |
| M5 | PA5 | I/O | TTL | GPIO port A bit 5. |
| | CAN0Tx | O | TTL | CAN module 0 transmit. |
| | I2S0TXWS | I/O | TTL | I ² S module 0 transmit word select. |
| | PWM7 | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| | SSI0Tx | O | TTL | SSI module 0 transmit. |
| M6 | PA7 | I/O | TTL | GPIO port A bit 7. |
| | CAN0Tx | O | TTL | CAN module 0 transmit. |
| | CCP3 | I/O | TTL | Capture/Compare/PWM 3. |
| | CCP4 | I/O | TTL | Capture/Compare/PWM 4. |
| | I2C1SDA | I/O | OD | I ² C module 1 data. |
| | PWM1 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | PWM5 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| | U1DCD | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| M7 | PG5 | I/O | TTL | GPIO port G bit 5. |
| | CCP5 | I/O | TTL | Capture/Compare/PWM 5. |
| | Fault1 | I | TTL | PWM Fault 1. |
| | I2S0RXSCK | I/O | TTL | I ² S module 0 receive clock. |
| | IDX0 | I | TTL | QEI module 0 index. |
| | PWM7 | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| | U1DTR | O | TTL | UART module 1 Data Terminal Ready modem status input signal. |
| M8 | PF6 | I/O | TTL | GPIO port F bit 6. |
| | C2o | O | TTL | Analog comparator 2 output. |
| | CCP1 | I/O | TTL | Capture/Compare/PWM 1. |
| | I2S0TXMCLK | I/O | TTL | I ² S module 0 transmit master clock. |
| | PhA0 | I | TTL | QEI module 0 phase A. |
| | U1RTS | O | TTL | UART module 1 Request to Send modem flow control output line. |
| M9 | PF0 | I/O | TTL | GPIO port F bit 0. |
| | CAN1Rx | I | TTL | CAN module 1 receive. |
| | I2S0TXSD | I/O | TTL | I ² S module 0 transmit data. |
| | PWM0 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | PhB0 | I | TTL | QEI module 0 phase B. |
| | U1DSR | I | TTL | UART module 1 Data Set Ready modem output control line. |

Table 23-7. Signals by Pin Number (continued)

| Pin Number | Pin Name | Pin Type | Buffer Type ^a | Description |
|------------|--------------------------|----------|--------------------------|---|
| M10 | $\overline{\text{WAKE}}$ | I | TTL | An external input that brings the processor out of Hibernate mode when asserted. |
| M11 | OSC1 | O | Analog | Main oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| M12 | $\overline{\text{HIB}}$ | O | OD | An output that indicates the processor is in Hibernate mode. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 23-8. Signals by Signal Name

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|-----------------------------|---|----------|--------------------------|---------------------------------------|
| AIN0 | B1 | PE7 | I | Analog | Analog-to-digital converter input 0. |
| AIN1 | A1 | PE6 | I | Analog | Analog-to-digital converter input 1. |
| AIN2 | B3 | PE5 | I | Analog | Analog-to-digital converter input 2. |
| AIN3 | B2 | PE4 | I | Analog | Analog-to-digital converter input 3. |
| AIN4 | A2 | PD7 | I | Analog | Analog-to-digital converter input 4. |
| AIN5 | A3 | PD6 | I | Analog | Analog-to-digital converter input 5. |
| AIN6 | C6 | PD5 | I | Analog | Analog-to-digital converter input 6. |
| AIN7 | B5 | PD4 | I | Analog | Analog-to-digital converter input 7. |
| AIN8 | B4 | PE3 | I | Analog | Analog-to-digital converter input 8. |
| AIN9 | A4 | PE2 | I | Analog | Analog-to-digital converter input 9. |
| AIN10 | A6 | PB4 | I | Analog | Analog-to-digital converter input 10. |
| AIN11 | B7 | PB5 | I | Analog | Analog-to-digital converter input 11. |
| AIN12 | H1 | PD3 | I | Analog | Analog-to-digital converter input 12. |
| AIN13 | H2 | PD2 | I | Analog | Analog-to-digital converter input 13. |
| AIN14 | G2 | PD1 | I | Analog | Analog-to-digital converter input 14. |
| AIN15 | G1 | PD0 | I | Analog | Analog-to-digital converter input 15. |
| C0+ | A7 | PB6 | I | Analog | Analog comparator 0 positive input. |
| C0- | A6 | PB4 | I | Analog | Analog comparator 0 negative input. |
| C0o | M1 L9 A7 B7 A2 | PC5 (3) PF4 (2) PB6 (3) PB5 (1) PD7 (2) | O | TTL | Analog comparator 0 output. |
| C1+ | M1 | PC5 | I | Analog | Analog comparator 1 positive input. |
| C1- | B7 | PB5 | I | Analog | Analog comparator 1 negative input. |
| C1o | A1 L2 M1 L8 D11 | PE6 (2) PC7 (7) PC5 (2) PF5 (2) PH2 (2) | O | TTL | Analog comparator 1 output. |
| C2+ | M2 | PC6 | I | Analog | Analog comparator 2 positive input. |
| C2- | L2 | PC7 | I | Analog | Analog comparator 2 negative input. |
| C2o | B1 M2 M8 | PE7 (2) PC6 (3) PF6 (2) | O | TTL | Analog comparator 2 output. |

Table 23-8. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|---|--|----------|--------------------------|------------------------|
| CAN0Rx | G1 L5 L6 A6 | PD0 (2) PA4 (5) PA6 (6) PB4 (5) | I | TTL | CAN module 0 receive. |
| CAN0Tx | G2 M5 M6 B7 | PD1 (2) PA5 (5) PA7 (6) PB5 (5) | O | TTL | CAN module 0 transmit. |
| CAN1Rx | M9 | PF0 (1) | I | TTL | CAN module 1 receive. |
| CAN1Tx | H12 | PF1 (1) | O | TTL | CAN module 1 transmit. |
| CCP0 | H1 L2 M2 K6 L9 E12 A11 B7 B5 | PD3 (4) PC7 (4) PC6 (6) PJ2 (9) PF4 (1) PB0 (1) PB2 (5) PB5 (4) PD4 (1) | I/O | TTL | Capture/Compare/PWM 0. |
| CCP1 | M1 L1 L6 M8 D12 A7 B4 A2 | PC5 (1) PC4 (9) PA6 (2) PF6 (1) PB1 (4) PB6 (1) PE3 (1) PD7 (3) | I/O | TTL | Capture/Compare/PWM 1. |
| CCP2 | B2 G2 L1 L8 D12 A12 B7 A4 C6 | PE4 (6) PD1 (10) PC4 (5) PF5 (1) PB1 (1) PE1 (4) PB5 (6) PE2 (5) PD5 (1) | I/O | TTL | Capture/Compare/PWM 2. |
| CCP3 | B2 M2 M1 M6 K3 H12 A11 B11 B5 | PE4 (1) PC6 (1) PC5 (5) PA7 (7) PG4 (1) PF1 (10) PB2 (4) PE0 (3) PD4 (2) | I/O | TTL | Capture/Compare/PWM 3. |
| CCP4 | L2 L1 M6 K4 A4 C6 | PC7 (1) PC4 (6) PA7 (2) PF7 (1) PE2 (1) PD5 (2) | I/O | TTL | Capture/Compare/PWM 4. |

Table 23-8. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|---|---|----------|--------------------------|-------------------------|
| CCP5 | B3 H2 L1 C10 M7 A7 B7 | PE5 (1) PD2 (4) PC4 (1) PG7 (8) PG5 (1) PB6 (6) PB5 (2) | I/O | TTL | Capture/Compare/PWM 5. |
| CCP6 | G1 H2 A12 C9 B7 | PD0 (6) PD2 (2) PE1 (5) PH0 (1) PB5 (3) | I/O | TTL | Capture/Compare/PWM 6. |
| CCP7 | G2 H1 C8 A7 B4 | PD1 (6) PD3 (2) PH1 (1) PB6 (2) PE3 (5) | I/O | TTL | Capture/Compare/PWM 7. |
| EPI0S0 | D10 | PH3 (8) | I/O | TTL | EPI module 0 signal 0. |
| EPI0S1 | D11 | PH2 (8) | I/O | TTL | EPI module 0 signal 1. |
| EPI0S2 | L1 | PC4 (8) | I/O | TTL | EPI module 0 signal 2. |
| EPI0S3 | M1 | PC5 (8) | I/O | TTL | EPI module 0 signal 3. |
| EPI0S4 | M2 | PC6 (8) | I/O | TTL | EPI module 0 signal 4. |
| EPI0S5 | L2 | PC7 (8) | I/O | TTL | EPI module 0 signal 5. |
| EPI0S6 | C9 | PH0 (8) | I/O | TTL | EPI module 0 signal 6. |
| EPI0S7 | C8 | PH1 (8) | I/O | TTL | EPI module 0 signal 7. |
| EPI0S8 | B11 | PE0 (8) | I/O | TTL | EPI module 0 signal 8. |
| EPI0S9 | A12 | PE1 (8) | I/O | TTL | EPI module 0 signal 9. |
| EPI0S10 | B10 | PH4 (8) | I/O | TTL | EPI module 0 signal 10. |
| EPI0S11 | F10 | PH5 (8) | I/O | TTL | EPI module 0 signal 11. |
| EPI0S12 | K4 L9 | PF7 (8) PF4 (8) | I/O | TTL | EPI module 0 signal 12. |
| EPI0S13 | K1 | PG0 (8) | I/O | TTL | EPI module 0 signal 13. |
| EPI0S14 | K2 | PG1 (8) | I/O | TTL | EPI module 0 signal 14. |
| EPI0S15 | K3 L8 | PG4 (8) PF5 (8) | I/O | TTL | EPI module 0 signal 15. |
| EPI0S16 | F3 | PJ0 (8) | I/O | TTL | EPI module 0 signal 16. |
| EPI0S17 | B6 | PJ1 (8) | I/O | TTL | EPI module 0 signal 17. |
| EPI0S18 | K6 | PJ2 (8) | I/O | TTL | EPI module 0 signal 18. |
| EPI0S19 | B5 | PD4 (10) | I/O | TTL | EPI module 0 signal 19. |
| EPI0S20 | H2 | PD2 (8) | I/O | TTL | EPI module 0 signal 20. |
| EPI0S21 | H1 | PD3 (8) | I/O | TTL | EPI module 0 signal 21. |
| EPI0S22 | B7 | PB5 (8) | I/O | TTL | EPI module 0 signal 22. |
| EPI0S23 | A6 | PB4 (8) | I/O | TTL | EPI module 0 signal 23. |
| EPI0S24 | A4 | PE2 (8) | I/O | TTL | EPI module 0 signal 24. |
| EPI0S25 | B4 | PE3 (8) | I/O | TTL | EPI module 0 signal 25. |

Table 23-8. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|-------------------------|---|--|----------|--------------------------|---|
| EPI0S26 | G3 | PH6 (8) | I/O | TTL | EPI module 0 signal 26. |
| EPI0S27 | H3 | PH7 (8) | I/O | TTL | EPI module 0 signal 27. |
| EPI0S28 | C6 | PD5 (10) | I/O | TTL | EPI module 0 signal 28. |
| EPI0S29 | A3 | PD6 (10) | I/O | TTL | EPI module 0 signal 29. |
| EPI0S30 | A2 | PD7 (10) | I/O | TTL | EPI module 0 signal 30. |
| EPI0S31 | C10 | PG7 (9) | I/O | TTL | EPI module 0 signal 31. |
| Fault0 | B2 J2 J1 K6 L9 E11 A12 D10 A3 | PE4 (4) PG3 (8) PG2 (4) PJ2 (10) PF4 (4) PB3 (2) PE1 (3) PH3 (2) PD6 (1) | I | TTL | PWM Fault 0. |
| Fault1 | L7 M7 K3 K4 A7 | PG6 (8) PG5 (5) PG4 (4) PF7 (9) PB6 (4) | I | TTL | PWM Fault 1. |
| Fault2 | J2 M1 F10 | PG3 (4) PC5 (4) PH5 (10) | I | TTL | PWM Fault 2. |
| Fault3 | E11 D11 | PB3 (4) PH2 (4) | I | TTL | PWM Fault 3. |
| GND | C4 C5 J3 K5 L10 K10 J10 F11 F12 | fixed | - | Power | Ground reference for logic and I/O pins. |
| GNDA | A5 | fixed | - | Power | The ground reference for the analog circuits (ADC, Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions. |
| $\overline{\text{HTB}}$ | M12 | fixed | O | OD | An output that indicates the processor is in Hibernate mode. |
| I2C0SCL | A11 | PB2 (1) | I/O | OD | I ² C module 0 clock. |
| I2C0SDA | E11 | PB3 (1) | I/O | OD | I ² C module 0 data. |
| I2C1SCL | F3 K1 L3 L6 | PJ0 (11) PG0 (3) PA0 (8) PA6 (1) | I/O | OD | I ² C module 1 clock. |
| I2C1SDA | K2 M3 M6 B6 | PG1 (3) PA1 (8) PA7 (1) PJ1 (11) | I/O | OD | I ² C module 1 data. |

Table 23-8. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|------------|---|--|----------|--------------------------|--|
| I2S0RXMCLK | J2 L4 C6 | PG3 (9) PA3 (9) PD5 (8) | I/O | TTL | I ² S module 0 receive master clock. |
| I2S0RXSCK | G1 M7 | PD0 (8) PG5 (9) | I/O | TTL | I ² S module 0 receive clock. |
| I2S0RXSD | J1 M4 B5 | PG2 (9) PA2 (9) PD4 (8) | I/O | TTL | I ² S module 0 receive data. |
| I2S0RXWS | G2 L7 | PD1 (8) PG6 (9) | I/O | TTL | I ² S module 0 receive word select. |
| I2S0TXMCLK | M8 H12 | PF6 (9) PF1 (8) | I/O | TTL | I ² S module 0 transmit master clock. |
| I2S0TXSCK | L5 A7 A3 | PA4 (9) PB6 (9) PD6 (8) | I/O | TTL | I ² S module 0 transmit clock. |
| I2S0TXSD | B3 M9 | PE5 (9) PF0 (8) | I/O | TTL | I ² S module 0 transmit data. |
| I2S0TXWS | B2 M5 A2 | PE4 (9) PA5 (9) PD7 (8) | I/O | TTL | I ² S module 0 transmit word select. |
| IDX0 | G1 M7 A11 A7 A6 A2 | PD0 (3) PG5 (4) PB2 (2) PB6 (5) PB4 (6) PD7 (1) | I | TTL | QE1 module 0 index. |
| IDX1 | J1 H12 D11 | PG2 (8) PF1 (2) PH2 (1) | I | TTL | QE1 module 1 index. |
| LDO | E3 | fixed | - | Power | Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 μ F or greater. The LDO pin must also be connected to the VDDC pins at the board level in addition to the decoupling capacitor(s). |
| NC | C11 C12 B12 C1 C2 D2 D1 E1 E2 F1 F2 | fixed | - | - | No connect. Leave the pin electrically unconnected/isolated. |
| NMI | A8 | PB7 (4) | I | TTL | Non-maskable interrupt. |
| OSC0 | L11 | fixed | I | Analog | Main oscillator crystal input or an external clock reference input. |
| OSC1 | M11 | fixed | O | Analog | Main oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| PA0 | L3 | - | I/O | TTL | GPIO port A bit 0. |

Table 23-8. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|------------|--------------------------|----------|--------------------------|--|
| PA1 | M3 | - | I/O | TTL | GPIO port A bit 1. |
| PA2 | M4 | - | I/O | TTL | GPIO port A bit 2. |
| PA3 | L4 | - | I/O | TTL | GPIO port A bit 3. |
| PA4 | L5 | - | I/O | TTL | GPIO port A bit 4. |
| PA5 | M5 | - | I/O | TTL | GPIO port A bit 5. |
| PA6 | L6 | - | I/O | TTL | GPIO port A bit 6. |
| PA7 | M6 | - | I/O | TTL | GPIO port A bit 7. |
| PB0 | E12 | - | I/O | TTL | GPIO port B bit 0. This pin is not 5-V tolerant. |
| PB1 | D12 | - | I/O | TTL | GPIO port B bit 1. This pin is not 5-V tolerant. |
| PB2 | A11 | - | I/O | TTL | GPIO port B bit 2. |
| PB3 | E11 | - | I/O | TTL | GPIO port B bit 3. |
| PB4 | A6 | - | I/O | TTL | GPIO port B bit 4. |
| PB5 | B7 | - | I/O | TTL | GPIO port B bit 5. |
| PB6 | A7 | - | I/O | TTL | GPIO port B bit 6. |
| PB7 | A8 | - | I/O | TTL | GPIO port B bit 7. |
| PC0 | A9 | - | I/O | TTL | GPIO port C bit 0. |
| PC1 | B9 | - | I/O | TTL | GPIO port C bit 1. |
| PC2 | B8 | - | I/O | TTL | GPIO port C bit 2. |
| PC3 | A10 | - | I/O | TTL | GPIO port C bit 3. |
| PC4 | L1 | - | I/O | TTL | GPIO port C bit 4. |
| PC5 | M1 | - | I/O | TTL | GPIO port C bit 5. |
| PC6 | M2 | - | I/O | TTL | GPIO port C bit 6. |
| PC7 | L2 | - | I/O | TTL | GPIO port C bit 7. |
| PD0 | G1 | - | I/O | TTL | GPIO port D bit 0. |
| PD1 | G2 | - | I/O | TTL | GPIO port D bit 1. |
| PD2 | H2 | - | I/O | TTL | GPIO port D bit 2. |
| PD3 | H1 | - | I/O | TTL | GPIO port D bit 3. |
| PD4 | B5 | - | I/O | TTL | GPIO port D bit 4. |
| PD5 | C6 | - | I/O | TTL | GPIO port D bit 5. |
| PD6 | A3 | - | I/O | TTL | GPIO port D bit 6. |
| PD7 | A2 | - | I/O | TTL | GPIO port D bit 7. |
| PE0 | B11 | - | I/O | TTL | GPIO port E bit 0. |
| PE1 | A12 | - | I/O | TTL | GPIO port E bit 1. |
| PE2 | A4 | - | I/O | TTL | GPIO port E bit 2. |
| PE3 | B4 | - | I/O | TTL | GPIO port E bit 3. |
| PE4 | B2 | - | I/O | TTL | GPIO port E bit 4. |
| PE5 | B3 | - | I/O | TTL | GPIO port E bit 5. |
| PE6 | A1 | - | I/O | TTL | GPIO port E bit 6. |
| PE7 | B1 | - | I/O | TTL | GPIO port E bit 7. |
| PF0 | M9 | - | I/O | TTL | GPIO port F bit 0. |
| PF1 | H12 | - | I/O | TTL | GPIO port F bit 1. |

Table 23-8. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|-----------------------------------|--|----------|--------------------------|-----------------------|
| PF2 | J11 | - | I/O | TTL | GPIO port F bit 2. |
| PF3 | J12 | - | I/O | TTL | GPIO port F bit 3. |
| PF4 | L9 | - | I/O | TTL | GPIO port F bit 4. |
| PF5 | L8 | - | I/O | TTL | GPIO port F bit 5. |
| PF6 | M8 | - | I/O | TTL | GPIO port F bit 6. |
| PF7 | K4 | - | I/O | TTL | GPIO port F bit 7. |
| PG0 | K1 | - | I/O | TTL | GPIO port G bit 0. |
| PG1 | K2 | - | I/O | TTL | GPIO port G bit 1. |
| PG2 | J1 | - | I/O | TTL | GPIO port G bit 2. |
| PG3 | J2 | - | I/O | TTL | GPIO port G bit 3. |
| PG4 | K3 | - | I/O | TTL | GPIO port G bit 4. |
| PG5 | M7 | - | I/O | TTL | GPIO port G bit 5. |
| PG6 | L7 | - | I/O | TTL | GPIO port G bit 6. |
| PG7 | C10 | - | I/O | TTL | GPIO port G bit 7. |
| PH0 | C9 | - | I/O | TTL | GPIO port H bit 0. |
| PH1 | C8 | - | I/O | TTL | GPIO port H bit 1. |
| PH2 | D11 | - | I/O | TTL | GPIO port H bit 2. |
| PH3 | D10 | - | I/O | TTL | GPIO port H bit 3. |
| PH4 | B10 | - | I/O | TTL | GPIO port H bit 4. |
| PH5 | F10 | - | I/O | TTL | GPIO port H bit 5. |
| PH6 | G3 | - | I/O | TTL | GPIO port H bit 6. |
| PH7 | H3 | - | I/O | TTL | GPIO port H bit 7. |
| PhA0 | G2 L1 M8 A4 | PD1 (3) PC4 (2) PF6 (4) PE2 (4) | I | TTL | QE1 module 0 phase A. |
| PhA1 | L7 B4 | PG6 (1) PE3 (3) | I | TTL | QE1 module 1 phase A. |
| PhB0 | L2 M2 K4 M9 D10 B4 | PC7 (2) PC6 (2) PF7 (4) PF0 (2) PH3 (1) PE3 (4) | I | TTL | QE1 module 0 phase B. |
| PhB1 | G2 C10 A4 | PD1 (11) PG7 (1) PE2 (3) | I | TTL | QE1 module 1 phase B. |
| PJ0 | F3 | - | I/O | TTL | GPIO port J bit 0. |
| PJ1 | B6 | - | I/O | TTL | GPIO port J bit 1. |
| PJ2 | K6 | - | I/O | TTL | GPIO port J bit 2. |

Table 23-8. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|-------------------------|--|---|----------|--------------------------|--|
| PWM0 | G1 F3 J1 K1 L6 M9 | PD0 (1) PJ0 (10) PG2 (1) PG0 (2) PA6 (4) PF0 (3) | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| PWM1 | G2 J2 K2 M6 H12 B6 | PD1 (1) PG3 (1) PG1 (2) PA7 (4) PF1 (3) PJ1 (10) | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| PWM2 | H2 J11 E12 C9 | PD2 (3) PF2 (4) PB0 (2) PH0 (2) | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| PWM3 | H1 J12 D12 C8 | PD3 (3) PF3 (4) PB1 (2) PH1 (2) | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| PWM4 | A1 K1 M4 L6 J11 G3 B11 C9 | PE6 (1) PG0 (4) PA2 (4) PA6 (5) PF2 (2) PH6 (10) PE0 (1) PH0 (9) | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| PWM5 | B1 H3 K2 L4 M6 J12 A12 C8 | PE7 (1) PH7 (10) PG1 (4) PA3 (4) PA7 (5) PF3 (2) PE1 (1) PH1 (9) | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |
| PWM6 | L1 L5 L7 K3 | PC4 (4) PA4 (4) PG6 (4) PG4 (9) | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| PWM7 | M2 M5 C10 M7 | PC6 (4) PA5 (4) PG7 (4) PG5 (8) | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| $\overline{\text{RST}}$ | H11 | fixed | I | TTL | System reset input. |
| SSI0Clk | M4 | PA2 (1) | I/O | TTL | SSI module 0 clock. |
| SSI0Fss | L4 | PA3 (1) | I/O | TTL | SSI module 0 frame. |
| SSI0Rx | L5 | PA4 (1) | I | TTL | SSI module 0 receive. |
| SSI0Tx | M5 | PA5 (1) | O | TTL | SSI module 0 transmit. |
| SSI1Clk | J11 B11 B10 | PF2 (9) PE0 (2) PH4 (11) | I/O | TTL | SSI module 1 clock. |

Table 23-8. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|-----------------------------------|--|----------|--------------------------|---|
| SSI1Fss | J12 F10 A12 | PF3 (9) PH5 (11) PE1 (2) | I/O | TTL | SSI module 1 frame. |
| SSI1Rx | L9 G3 A4 | PF4 (9) PH6 (11) PE2 (2) | I | TTL | SSI module 1 receive. |
| SSI1Tx | H3 L8 B4 | PH7 (11) PF5 (9) PE3 (2) | O | TTL | SSI module 1 transmit. |
| SWCLK | A9 | PC0 (3) | I | TTL | JTAG/SWD CLK. |
| SWDIO | B9 | PC1 (3) | I/O | TTL | JTAG TMS and SWDIO. |
| SWO | A10 | PC3 (3) | O | TTL | JTAG TDO and SWO. |
| TCK | A9 | PC0 (3) | I | TTL | JTAG/SWD CLK. |
| TDI | B8 | PC2 (3) | I | TTL | JTAG TDI. |
| TDO | A10 | PC3 (3) | O | TTL | JTAG TDO and SWO. |
| TMS | B9 | PC1 (3) | I | TTL | JTAG TMS and SWDIO. |
| U0Rx | L3 | PA0 (1) | I | TTL | UART module 0 receive. When in IrDA mode, this signal has IrDA modulation. |
| U0Tx | M3 | PA1 (1) | O | TTL | UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation. |
| U1CTS | A1 G1 L6 | PE6 (9) PD0 (9) PA6 (9) | I | TTL | UART module 1 Clear To Send modem flow control input signal. |
| U1DCD | B1 G2 M6 | PE7 (9) PD1 (9) PA7 (9) | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| U1DSR | M9 | PF0 (9) | I | TTL | UART module 1 Data Set Ready modem output control line. |
| U1DTR | M7 A2 | PG5 (10) PD7 (9) | O | TTL | UART module 1 Data Terminal Ready modem status input signal. |
| U1RI | L7 K3 B5 | PG6 (10) PG4 (10) PD4 (9) | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| U1RTS | M8 H12 | PF6 (10) PF1 (9) | O | TTL | UART module 1 Request to Send modem flow control output line. |
| U1Rx | G1 H2 M2 L3 E12 A6 | PD0 (5) PD2 (1) PC6 (5) PA0 (9) PB0 (5) PB4 (7) | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| U1Tx | G2 H1 L2 M3 D12 B7 | PD1 (5) PD3 (1) PC7 (5) PA1 (9) PB1 (5) PB5 (7) | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |

Table 23-8. Signals by Signal Name (continued)

| Pin Name | Pin Number | Pin Mux / Pin Assignment | Pin Type | Buffer Type ^a | Description |
|----------|---|--|----------|--------------------------|--|
| U2Rx | G1 K1 A6 C6 | PD0 (4) PG0 (1) PB4 (4) PD5 (9) | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| U2Tx | B2 G2 K2 A3 | PE4 (5) PD1 (4) PG1 (1) PD6 (9) | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |
| VBAT | L12 | fixed | - | Power | Power source for the Hibernation module. It is normally connected to the positive terminal of a battery and serves as the battery backup/Hibernation module power-source supply. |
| VDD | K7 G12 K8 K9 H10 G10 E10 G11 | fixed | - | Power | Positive supply for I/O and some logic. |
| VDDA | C7 | fixed | - | Power | The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in Table 25-2 on page 1128, regardless of system implementation. |
| VDDC | D3 C3 | fixed | - | Power | Positive supply for most of the logic function, including the processor core and most peripherals. The voltage on this pin is 1.3 V and is supplied by the on-chip LDO. The VDDC pins should only be connected to the LDO pin and an external capacitor as specified in Table 25-6 on page 1133. |
| VREFA | A7 | PB6 | I | Analog | This input provides a reference voltage used to specify the input voltage at which the ADC converts to a maximum value. In other words, the voltage that is applied to VREFA is the voltage with which an AIN _n signal is converted to 4095. The VREFA input is limited to the range specified in Table 25-26 on page 1145. |
| WAKE | M10 | fixed | I | TTL | An external input that brings the processor out of Hibernate mode when asserted. |
| XOSC0 | K11 | fixed | I | Analog | Hibernation module oscillator crystal input or an external clock reference input. Note that this is either a 4.194304-MHz crystal or a 32.768-kHz oscillator for the Hibernation module RTC. See the CLKSEL bit in the HIBCTL register. |
| XOSC1 | K12 | fixed | O | Analog | Hibernation module oscillator crystal output. Leave unconnected when using a single-ended clock source. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 23-9. Signals by Function, Except for GPIO

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|--------------------|----------|-----------------------------|----------|--------------------------|---|
| ADC | AIN0 | B1 | I | Analog | Analog-to-digital converter input 0. |
| | AIN1 | A1 | I | Analog | Analog-to-digital converter input 1. |
| | AIN2 | B3 | I | Analog | Analog-to-digital converter input 2. |
| | AIN3 | B2 | I | Analog | Analog-to-digital converter input 3. |
| | AIN4 | A2 | I | Analog | Analog-to-digital converter input 4. |
| | AIN5 | A3 | I | Analog | Analog-to-digital converter input 5. |
| | AIN6 | C6 | I | Analog | Analog-to-digital converter input 6. |
| | AIN7 | B5 | I | Analog | Analog-to-digital converter input 7. |
| | AIN8 | B4 | I | Analog | Analog-to-digital converter input 8. |
| | AIN9 | A4 | I | Analog | Analog-to-digital converter input 9. |
| | AIN10 | A6 | I | Analog | Analog-to-digital converter input 10. |
| | AIN11 | B7 | I | Analog | Analog-to-digital converter input 11. |
| | AIN12 | H1 | I | Analog | Analog-to-digital converter input 12. |
| | AIN13 | H2 | I | Analog | Analog-to-digital converter input 13. |
| | AIN14 | G2 | I | Analog | Analog-to-digital converter input 14. |
| | AIN15 | G1 | I | Analog | Analog-to-digital converter input 15. |
| | VREFA | A7 | I | Analog | This input provides a reference voltage used to specify the input voltage at which the ADC converts to a maximum value. In other words, the voltage that is applied to VREFA is the voltage with which an AIN _n signal is converted to 4095. The VREFA input is limited to the range specified in Table 25-26 on page 1145 . |
| Analog Comparators | C0+ | A7 | I | Analog | Analog comparator 0 positive input. |
| | C0- | A6 | I | Analog | Analog comparator 0 negative input. |
| | C0o | M1 L9 A7 B7 A2 | O | TTL | Analog comparator 0 output. |
| | C1+ | M1 | I | Analog | Analog comparator 1 positive input. |
| | C1- | B7 | I | Analog | Analog comparator 1 negative input. |
| | C1o | A1 L2 M1 L8 D11 | O | TTL | Analog comparator 1 output. |
| | C2+ | M2 | I | Analog | Analog comparator 2 positive input. |
| | C2- | L2 | I | Analog | Analog comparator 2 negative input. |
| | C2o | B1 M2 M8 | O | TTL | Analog comparator 2 output. |

Table 23-9. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|-------------------------------|----------|----------------------|----------|--------------------------|-------------------------|
| Controller Area Network | CAN0Rx | G1 L5 L6 A6 | I | TTL | CAN module 0 receive. |
| | CAN0Tx | G2 M5 M6 B7 | O | TTL | CAN module 0 transmit. |
| | CAN1Rx | M9 | I | TTL | CAN module 1 receive. |
| | CAN1Tx | H12 | O | TTL | CAN module 1 transmit. |
| External Peripheral Interface | EPI0S0 | D10 | I/O | TTL | EPI module 0 signal 0. |
| | EPI0S1 | D11 | I/O | TTL | EPI module 0 signal 1. |
| | EPI0S2 | L1 | I/O | TTL | EPI module 0 signal 2. |
| | EPI0S3 | M1 | I/O | TTL | EPI module 0 signal 3. |
| | EPI0S4 | M2 | I/O | TTL | EPI module 0 signal 4. |
| | EPI0S5 | L2 | I/O | TTL | EPI module 0 signal 5. |
| | EPI0S6 | C9 | I/O | TTL | EPI module 0 signal 6. |
| | EPI0S7 | C8 | I/O | TTL | EPI module 0 signal 7. |
| | EPI0S8 | B11 | I/O | TTL | EPI module 0 signal 8. |
| | EPI0S9 | A12 | I/O | TTL | EPI module 0 signal 9. |
| | EPI0S10 | B10 | I/O | TTL | EPI module 0 signal 10. |
| | EPI0S11 | F10 | I/O | TTL | EPI module 0 signal 11. |
| | EPI0S12 | K4 L9 | I/O | TTL | EPI module 0 signal 12. |
| | EPI0S13 | K1 | I/O | TTL | EPI module 0 signal 13. |
| | EPI0S14 | K2 | I/O | TTL | EPI module 0 signal 14. |
| | EPI0S15 | K3 L8 | I/O | TTL | EPI module 0 signal 15. |
| | EPI0S16 | F3 | I/O | TTL | EPI module 0 signal 16. |
| | EPI0S17 | B6 | I/O | TTL | EPI module 0 signal 17. |
| | EPI0S18 | K6 | I/O | TTL | EPI module 0 signal 18. |
| | EPI0S19 | B5 | I/O | TTL | EPI module 0 signal 19. |
| | EPI0S20 | H2 | I/O | TTL | EPI module 0 signal 20. |
| | EPI0S21 | H1 | I/O | TTL | EPI module 0 signal 21. |
| | EPI0S22 | B7 | I/O | TTL | EPI module 0 signal 22. |
| | EPI0S23 | A6 | I/O | TTL | EPI module 0 signal 23. |
| | EPI0S24 | A4 | I/O | TTL | EPI module 0 signal 24. |
| | EPI0S25 | B4 | I/O | TTL | EPI module 0 signal 25. |
| | EPI0S26 | G3 | I/O | TTL | EPI module 0 signal 26. |
| | EPI0S27 | H3 | I/O | TTL | EPI module 0 signal 27. |
| | EPI0S28 | C6 | I/O | TTL | EPI module 0 signal 28. |
| | EPI0S29 | A3 | I/O | TTL | EPI module 0 signal 29. |
| | EPI0S30 | A2 | I/O | TTL | EPI module 0 signal 30. |
| EPI0S31 | C10 | I/O | TTL | EPI module 0 signal 31. | |

Table 23-9. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|---------------------------|----------|---|----------|--------------------------|------------------------|
| General-Purpose Timers | CCP0 | H1 L2 M2 K6 L9 E12 A11 B7 B5 | I/O | TTL | Capture/Compare/PWM 0. |
| | CCP1 | M1 L1 L6 M8 D12 A7 B4 A2 | I/O | TTL | Capture/Compare/PWM 1. |
| | CCP2 | B2 G2 L1 L8 D12 A12 B7 A4 C6 | I/O | TTL | Capture/Compare/PWM 2. |
| | CCP3 | B2 M2 M1 M6 K3 H12 A11 B11 B5 | I/O | TTL | Capture/Compare/PWM 3. |
| | CCP4 | L2 L1 M6 K4 A4 C6 | I/O | TTL | Capture/Compare/PWM 4. |
| | CCP5 | B3 H2 L1 C10 M7 A7 B7 | I/O | TTL | Capture/Compare/PWM 5. |
| | CCP6 | G1 H2 A12 C9 B7 | I/O | TTL | Capture/Compare/PWM 6. |
| | CCP7 | | I/O | TTL | Capture/Compare/PWM 7. |

Table 23-9. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|-----------|------------|----------------------------|----------|--------------------------|---|
| | | G2 H1 C8 A7 B4 | | | |
| Hibernate | HIB | M12 | O | OD | An output that indicates the processor is in Hibernate mode. |
| | VBAT | L12 | - | Power | Power source for the Hibernation module. It is normally connected to the positive terminal of a battery and serves as the battery backup/Hibernation module power-source supply. |
| | WAKE | M10 | I | TTL | An external input that brings the processor out of Hibernate mode when asserted. |
| | XOSC0 | K11 | I | Analog | Hibernation module oscillator crystal input or an external clock reference input. Note that this is either a 4.194304-MHz crystal or a 32.768-kHz oscillator for the Hibernation module RTC. See the CLKSEL bit in the HIBCTL register. |
| | XOSC1 | K12 | O | Analog | Hibernation module oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| I2C | I2C0SCL | A11 | I/O | OD | I ² C module 0 clock. |
| | I2C0SDA | E11 | I/O | OD | I ² C module 0 data. |
| | I2C1SCL | F3 K1 L3 L6 | I/O | OD | I ² C module 1 clock. |
| | I2C1SDA | K2 M3 M6 B6 | I/O | OD | I ² C module 1 data. |
| I2S | I2S0RXMCLK | J2 L4 C6 | I/O | TTL | I ² S module 0 receive master clock. |
| | I2S0RXSCK | G1 M7 | I/O | TTL | I ² S module 0 receive clock. |
| | I2S0RXSD | J1 M4 B5 | I/O | TTL | I ² S module 0 receive data. |
| | I2S0RXWS | G2 L7 | I/O | TTL | I ² S module 0 receive word select. |
| | I2S0TXMCLK | M8 H12 | I/O | TTL | I ² S module 0 transmit master clock. |
| | I2S0TXSCK | L5 A7 A3 | I/O | TTL | I ² S module 0 transmit clock. |
| | I2S0TXSD | B3 M9 | I/O | TTL | I ² S module 0 transmit data. |
| | I2S0TXWS | B2 M5 A2 | I/O | TTL | I ² S module 0 transmit word select. |

Table 23-9. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|--------------|----------|------------|----------|--------------------------|---------------------|
| JTAG/SWD/SWO | SWCLK | A9 | I | TTL | JTAG/SWD CLK. |
| | SWDIO | B9 | I/O | TTL | JTAG TMS and SWDIO. |
| | SWO | A10 | O | TTL | JTAG TDO and SWO. |
| | TCK | A9 | I | TTL | JTAG/SWD CLK. |
| | TDI | B8 | I | TTL | JTAG TDI. |
| | TDO | A10 | O | TTL | JTAG TDO and SWO. |
| | TMS | B9 | I | TTL | JTAG TMS and SWDIO. |

Table 23-9. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|----------|----------|---|----------|--------------------------|--|
| PWM | Fault0 | B2 J2 J1 K6 L9 E11 A12 D10 A3 | I | TTL | PWM Fault 0. |
| | Fault1 | L7 M7 K3 K4 A7 | I | TTL | PWM Fault 1. |
| | Fault2 | J2 M1 F10 | I | TTL | PWM Fault 2. |
| | Fault3 | E11 D11 | I | TTL | PWM Fault 3. |
| | PWM0 | G1 F3 J1 K1 L6 M9 | O | TTL | PWM 0. This signal is controlled by PWM Generator 0. |
| | PWM1 | G2 J2 K2 M6 H12 B6 | O | TTL | PWM 1. This signal is controlled by PWM Generator 0. |
| | PWM2 | H2 J11 E12 C9 | O | TTL | PWM 2. This signal is controlled by PWM Generator 1. |
| | PWM3 | H1 J12 D12 C8 | O | TTL | PWM 3. This signal is controlled by PWM Generator 1. |
| | PWM4 | A1 K1 M4 L6 J11 G3 B11 C9 | O | TTL | PWM 4. This signal is controlled by PWM Generator 2. |
| | PWM5 | B1 H3 K2 L4 M6 J12 A12 C8 | O | TTL | PWM 5. This signal is controlled by PWM Generator 2. |

Table 23-9. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|----------|----------|---|----------|--------------------------|--|
| | PWM6 | L1 L5 L7 K3 | O | TTL | PWM 6. This signal is controlled by PWM Generator 3. |
| | PWM7 | M2 M5 C10 M7 | O | TTL | PWM 7. This signal is controlled by PWM Generator 3. |
| Power | GND | C4 C5 J3 K5 L10 K10 J10 F11 F12 | - | Power | Ground reference for logic and I/O pins. |
| | GNDA | A5 | - | Power | The ground reference for the analog circuits (ADC, Analog Comparators, etc.). These are separated from GND to minimize the electrical noise contained on VDD from affecting the analog functions. |
| | LDO | E3 | - | Power | Low drop-out regulator output voltage. This pin requires an external capacitor between the pin and GND of 1 μ F or greater. The LDO pin must also be connected to the VDDC pins at the board level in addition to the decoupling capacitor(s). |
| | VDD | K7 G12 K8 K9 H10 G10 E10 G11 | - | Power | Positive supply for I/O and some logic. |
| | VDDA | C7 | - | Power | The positive supply for the analog circuits (ADC, Analog Comparators, etc.). These are separated from VDD to minimize the electrical noise contained on VDD from affecting the analog functions. VDDA pins must be supplied with a voltage that meets the specification in Table 25-2 on page 1128, regardless of system implementation. |
| | VDDC | D3 C3 | - | Power | Positive supply for most of the logic function, including the processor core and most peripherals. The voltage on this pin is 1.3 V and is supplied by the on-chip LDO. The VDDC pins should only be connected to the LDO pin and an external capacitor as specified in Table 25-6 on page 1133. |

Table 23-9. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|-------------------------|----------------|-----------------------------------|----------|--------------------------|---|
| QEI | IDX0 | G1 M7 A11 A7 A6 A2 | I | TTL | QEI module 0 index. |
| | IDX1 | J1 H12 D11 | I | TTL | QEI module 1 index. |
| | PhA0 | G2 L1 M8 A4 | I | TTL | QEI module 0 phase A. |
| | PhA1 | L7 B4 | I | TTL | QEI module 1 phase A. |
| | PhB0 | L2 M2 K4 M9 D10 B4 | I | TTL | QEI module 0 phase B. |
| | PhB1 | G2 C10 A4 | I | TTL | QEI module 1 phase B. |
| SSI | SSI0Clk | M4 | I/O | TTL | SSI module 0 clock. |
| | SSI0Fss | L4 | I/O | TTL | SSI module 0 frame. |
| | SSI0Rx | L5 | I | TTL | SSI module 0 receive. |
| | SSI0Tx | M5 | O | TTL | SSI module 0 transmit. |
| | SSI1Clk | J11 B11 B10 | I/O | TTL | SSI module 1 clock. |
| | SSI1Fss | J12 F10 A12 | I/O | TTL | SSI module 1 frame. |
| | SSI1Rx | L9 G3 A4 | I | TTL | SSI module 1 receive. |
| SSI1Tx | H3 L8 B4 | O | TTL | SSI module 1 transmit. | |
| System Control & Clocks | NMI | A8 | I | TTL | Non-maskable interrupt. |
| | OSC0 | L11 | I | Analog | Main oscillator crystal input or an external clock reference input. |
| | OSC1 | M11 | O | Analog | Main oscillator crystal output. Leave unconnected when using a single-ended clock source. |
| | RST | H11 | I | TTL | System reset input. |

Table 23-9. Signals by Function, Except for GPIO (continued)

| Function | Pin Name | Pin Number | Pin Type | Buffer Type ^a | Description |
|----------|----------|-----------------------------------|----------|--------------------------|---|
| UART | U0Rx | L3 | I | TTL | UART module 0 receive. When in IrDA mode, this signal has IrDA modulation. |
| | U0Tx | M3 | O | TTL | UART module 0 transmit. When in IrDA mode, this signal has IrDA modulation. |
| | U1CTS | A1 G1 L6 | I | TTL | UART module 1 Clear To Send modem flow control input signal. |
| | U1DCD | B1 G2 M6 | I | TTL | UART module 1 Data Carrier Detect modem status input signal. |
| | U1DSR | M9 | I | TTL | UART module 1 Data Set Ready modem output control line. |
| | U1DTR | M7 A2 | O | TTL | UART module 1 Data Terminal Ready modem status input signal. |
| | U1RI | L7 K3 B5 | I | TTL | UART module 1 Ring Indicator modem status input signal. |
| | U1RTS | M8 H12 | O | TTL | UART module 1 Request to Send modem flow control output line. |
| | U1Rx | G1 H2 M2 L3 E12 A6 | I | TTL | UART module 1 receive. When in IrDA mode, this signal has IrDA modulation. |
| | U1Tx | G2 H1 L2 M3 D12 B7 | O | TTL | UART module 1 transmit. When in IrDA mode, this signal has IrDA modulation. |
| | U2Rx | G1 K1 A6 C6 | I | TTL | UART module 2 receive. When in IrDA mode, this signal has IrDA modulation. |
| | U2Tx | B2 G2 K2 A3 | O | TTL | UART module 2 transmit. When in IrDA mode, this signal has IrDA modulation. |

a. The TTL designation indicates the pin has TTL-compatible voltage levels.

Table 23-10. GPIO Pins and Alternate Functions

| IO | Pin | Analog Function | Digital Function (GPIOCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | | |
|-----|-----|-----------------|---|---|---|------|--------|---|---|---|---------|-----------|----|---|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | |
| PA0 | L3 | - | U0Rx | - | - | - | - | - | - | - | I2C1SCL | U1Rx | - | - |
| PA1 | M3 | - | U0Tx | - | - | - | - | - | - | - | I2C1SDA | U1Tx | - | - |
| PA2 | M4 | - | SSI0Clk | - | - | PWM4 | - | - | - | - | - | I2S0RXSD | - | - |
| PA3 | L4 | - | SSI0Fss | - | - | PWM5 | - | - | - | - | - | I2S0RXCLK | - | - |
| PA4 | L5 | - | SSI0Rx | - | - | PWM6 | CAN0Rx | - | - | - | - | I2S0TXSCK | - | - |
| PA5 | M5 | - | SSI0Tx | - | - | PWM7 | CAN0Tx | - | - | - | - | I2S0TXWS | - | - |

Table 23-10. GPIO Pins and Alternate Functions (continued)

| IO | Pin | Analog Function | Digital Function (GPIOCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | |
|-----|-----|-----------------|---|---------|--------------|--------|--------|--------|------|------------|-----------|---------|------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| PA6 | L6 | - | I2C1SCL | CCP1 | - | PWM0 | PWM4 | CAN0Rx | - | - | U1CTS | - | - |
| PA7 | M6 | - | I2C1SDA | CCP4 | - | PWM1 | PWM5 | CAN0Tx | CCP3 | - | U1DCD | - | - |
| PB0 | E12 | - | CCP0 | PWM2 | - | - | U1Rx | - | - | - | - | - | - |
| PB1 | D12 | - | CCP2 | PWM3 | - | CCP1 | U1Tx | - | - | - | - | - | - |
| PB2 | A11 | - | I2C0SCL | IDX0 | - | CCP3 | CCP0 | - | - | - | - | - | - |
| PB3 | E11 | - | I2C0SDA | Fault0 | - | Fault3 | - | - | - | - | - | - | - |
| PB4 | A6 | AIN10 C0- | - | - | - | U2Rx | CAN0Rx | IDX0 | U1Rx | EPI0S23 | - | - | - |
| PB5 | B7 | AIN11 C1- | C0o | CCP5 | CCP6 | CCP0 | CAN0Tx | CCP2 | U1Tx | EPI0S22 | - | - | - |
| PB6 | A7 | VREFA C0+ | CCP1 | CCP7 | C0o | Fault1 | IDX0 | CCP5 | - | - | I2S0TXSCK | - | - |
| PB7 | A8 | - | - | - | - | NMI | - | - | - | - | - | - | - |
| PC0 | A9 | - | - | - | TCK SWCLK | - | - | - | - | - | - | - | - |
| PC1 | B9 | - | - | - | TMS SWDIO | - | - | - | - | - | - | - | - |
| PC2 | B8 | - | - | - | TDI | - | - | - | - | - | - | - | - |
| PC3 | A10 | - | - | - | TDO SWO | - | - | - | - | - | - | - | - |
| PC4 | L1 | - | CCP5 | PhA0 | - | PWM6 | CCP2 | CCP4 | - | EPI0S2 | CCP1 | - | - |
| PC5 | M1 | C1+ | CCP1 | C1o | C0o | Fault2 | CCP3 | - | - | EPI0S3 | - | - | - |
| PC6 | M2 | C2+ | CCP3 | PhB0 | C2o | PWM7 | U1Rx | CCP0 | - | EPI0S4 | - | - | - |
| PC7 | L2 | C2- | CCP4 | PhB0 | - | CCP0 | U1Tx | - | C1o | EPI0S5 | - | - | - |
| PD0 | G1 | AIN15 | PWM0 | CAN0Rx | IDX0 | U2Rx | U1Rx | CCP6 | - | I2S0RXSCK | U1CTS | - | - |
| PD1 | G2 | AIN14 | PWM1 | CAN0Tx | PhA0 | U2Tx | U1Tx | CCP7 | - | I2S0RXWS | U1DCD | CCP2 | PhB1 |
| PD2 | H2 | AIN13 | U1Rx | CCP6 | PWM2 | CCP5 | - | - | - | EPI0S20 | - | - | - |
| PD3 | H1 | AIN12 | U1Tx | CCP7 | PWM3 | CCP0 | - | - | - | EPI0S21 | - | - | - |
| PD4 | B5 | AIN7 | CCP0 | CCP3 | - | - | - | - | - | I2S0RXSD | U1RI | EPI0S19 | - |
| PD5 | C6 | AIN6 | CCP2 | CCP4 | - | - | - | - | - | I2S0TXMCLK | U2Rx | EPI0S28 | - |
| PD6 | A3 | AIN5 | Fault0 | - | - | - | - | - | - | I2S0TXSCK | U2Tx | EPI0S29 | - |
| PD7 | A2 | AIN4 | IDX0 | C0o | CCP1 | - | - | - | - | I2S0TXWS | U1DTR | EPI0S30 | - |
| PE0 | B11 | - | PWM4 | SSI1Clk | CCP3 | - | - | - | - | EPI0S8 | - | - | - |
| PE1 | A12 | - | PWM5 | SSI1Fss | Fault0 | CCP2 | CCP6 | - | - | EPI0S9 | - | - | - |
| PE2 | A4 | AIN9 | CCP4 | SSI1Rx | PhB1 | PhA0 | CCP2 | - | - | EPI0S24 | - | - | - |
| PE3 | B4 | AIN8 | CCP1 | SSI1Tx | PhA1 | PhB0 | CCP7 | - | - | EPI0S25 | - | - | - |
| PE4 | B2 | AIN3 | CCP3 | - | - | Fault0 | U2Tx | CCP2 | - | - | I2S0TXWS | - | - |
| PE5 | B3 | AIN2 | CCP5 | - | - | - | - | - | - | - | I2S0TXSD | - | - |
| PE6 | A1 | AIN1 | PWM4 | C1o | - | - | - | - | - | - | U1CTS | - | - |
| PE7 | B1 | AIN0 | PWM5 | C2o | - | - | - | - | - | - | U1DCD | - | - |
| PF0 | M9 | - | CAN1Rx | PhB0 | PWM0 | - | - | - | - | I2S0TXSD | U1DSR | - | - |
| PF1 | H12 | - | CAN1Tx | IDX1 | PWM1 | - | - | - | - | I2S0TXMCLK | U1RTS | CCP3 | - |

Table 23-10. GPIO Pins and Alternate Functions (continued)

| IO | Pin | Analog Function | Digital Function (GPIOCTL PMCx Bit Field Encoding) ^a | | | | | | | | | | |
|-----|-----|-----------------|---|--------|---------|--------|--------|---|---|---------|----------|--------|---------|
| | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| PF2 | J11 | - | - | PWM4 | - | PWM2 | - | - | - | - | SSI1Clk | - | - |
| PF3 | J12 | - | - | PWM5 | - | PWM3 | - | - | - | - | SSI1Fss | - | - |
| PF4 | L9 | - | CCP0 | C0o | - | Fault0 | - | - | - | EPI0S12 | SSI1Rx | - | - |
| PF5 | L8 | - | CCP2 | C1o | - | - | - | - | - | EPI0S15 | SSI1Tx | - | - |
| PF6 | M8 | - | CCP1 | C2o | - | PhA0 | - | - | - | - | I2S0RXCK | U1RTS | - |
| PF7 | K4 | - | CCP4 | - | - | PhB0 | - | - | - | EPI0S12 | Fault1 | - | - |
| PG0 | K1 | - | U2Rx | PWM0 | I2C1SCL | PWM4 | - | - | - | EPI0S13 | - | - | - |
| PG1 | K2 | - | U2Tx | PWM1 | I2C1SDA | PWM5 | - | - | - | EPI0S14 | - | - | - |
| PG2 | J1 | - | PWM0 | - | - | Fault0 | - | - | - | IDX1 | I2S0RXSD | - | - |
| PG3 | J2 | - | PWM1 | - | - | Fault2 | - | - | - | Fault0 | I2S0RXCK | - | - |
| PG4 | K3 | - | CCP3 | - | - | Fault1 | - | - | - | EPI0S15 | PWM6 | U1RI | - |
| PG5 | M7 | - | CCP5 | - | - | IDX0 | Fault1 | - | - | PWM7 | I2S0RXCK | U1DTR | - |
| PG6 | L7 | - | PhA1 | - | - | PWM6 | - | - | - | Fault1 | I2S0RXWS | U1RI | - |
| PG7 | C10 | - | PhB1 | - | - | PWM7 | - | - | - | CCP5 | EPI0S31 | - | - |
| PH0 | C9 | - | CCP6 | PWM2 | - | - | - | - | - | EPI0S6 | PWM4 | - | - |
| PH1 | C8 | - | CCP7 | PWM3 | - | - | - | - | - | EPI0S7 | PWM5 | - | - |
| PH2 | D11 | - | IDX1 | C1o | - | Fault3 | - | - | - | EPI0S1 | - | - | - |
| PH3 | D10 | - | PhB0 | Fault0 | - | - | - | - | - | EPI0S0 | - | - | - |
| PH4 | B10 | - | - | - | - | - | - | - | - | EPI0S10 | - | - | SSI1Clk |
| PH5 | F10 | - | - | - | - | - | - | - | - | EPI0S11 | - | Fault2 | SSI1Fss |
| PH6 | G3 | - | - | - | - | - | - | - | - | EPI0S26 | - | PWM4 | SSI1Rx |
| PH7 | H3 | - | - | - | - | - | - | - | - | EPI0S27 | - | PWM5 | SSI1Tx |
| PJ0 | F3 | - | - | - | - | - | - | - | - | EPI0S16 | - | PWM0 | I2C1SCL |
| PJ1 | B6 | - | - | - | - | - | - | - | - | EPI0S17 | - | PWM1 | I2C1SDA |
| PJ2 | K6 | - | - | - | - | - | - | - | - | EPI0S18 | CCP0 | Fault0 | - |

a. The digital signals that are shaded gray are the power-on default values for the corresponding GPIO pin.

Table 23-11. Possible Pin Assignments for Alternate Functions

| # of Possible Assignments | Alternate Function | GPIO Function |
|---------------------------|--------------------|---------------|
| one | AIN0 | PE7 |
| | AIN1 | PE6 |
| | AIN10 | PB4 |
| | AIN11 | PB5 |
| | AIN12 | PD3 |
| | AIN13 | PD2 |
| | AIN14 | PD1 |
| | AIN15 | PD0 |
| | AIN2 | PE5 |
| | AIN3 | PE4 |
| | AIN4 | PD7 |
| | AIN5 | PD6 |
| | AIN6 | PD5 |
| | AIN7 | PD4 |
| | AIN8 | PE3 |
| | AIN9 | PE2 |
| | C0+ | PB6 |
| | C0- | PB4 |
| | C1+ | PC5 |
| | C1- | PB5 |
| | C2+ | PC6 |
| | C2- | PC7 |
| | CAN1Rx | PF0 |
| | CAN1Tx | PF1 |
| | EPI0S0 | PH3 |
| | EPI0S1 | PH2 |
| | EPI0S10 | PH4 |
| | EPI0S11 | PH5 |
| | EPI0S13 | PG0 |
| | EPI0S14 | PG1 |
| | EPI0S16 | PJ0 |
| | EPI0S17 | PJ1 |
| | EPI0S18 | PJ2 |
| | EPI0S19 | PD4 |
| | EPI0S2 | PC4 |
| | EPI0S20 | PD2 |
| | EPI0S21 | PD3 |
| | EPI0S22 | PB5 |
| | EPI0S23 | PB4 |
| | EPI0S24 | PE2 |
| | EPI0S25 | PE3 |

Table 23-11. Possible Pin Assignments for Alternate Functions (continued)

| # of Possible Assignments | Alternate Function | GPIO Function |
|---------------------------|--------------------|---------------|
| | EPI0S26 | PH6 |
| | EPI0S27 | PH7 |
| | EPI0S28 | PD5 |
| | EPI0S29 | PD6 |
| | EPI0S3 | PC5 |
| | EPI0S30 | PD7 |
| | EPI0S31 | PG7 |
| | EPI0S4 | PC6 |
| | EPI0S5 | PC7 |
| | EPI0S6 | PH0 |
| | EPI0S7 | PH1 |
| | EPI0S8 | PE0 |
| | EPI0S9 | PE1 |
| | I2C0SCL | PB2 |
| | I2C0SDA | PB3 |
| | NMI | PB7 |
| | SSI0Clk | PA2 |
| | SSI0Fss | PA3 |
| | SSI0Rx | PA4 |
| | SSI0Tx | PA5 |
| | SWCLK | PC0 |
| | SWDIO | PC1 |
| | SWO | PC3 |
| | TCK | PC0 |
| | TDI | PC2 |
| | TDO | PC3 |
| | TMS | PC1 |
| | U0Rx | PA0 |
| | U0Tx | PA1 |
| | U1DSR | PF0 |
| | VREFA | PB6 |
| two | EPI0S12 | PF7 PF4 |
| | EPI0S15 | PG4 PF5 |
| | Fault3 | PB3 PH2 |
| | I2S0RXSCK | PD0 PG5 |
| | I2S0RXWS | PD1 PG6 |
| | I2S0TXMCLK | PF6 PF1 |
| | I2S0TXSD | PE5 PF0 |
| | PhA1 | PG6 PE3 |
| | U1DTR | PG5 PD7 |
| | U1RTS | PF6 PF1 |

Table 23-11. Possible Pin Assignments for Alternate Functions (continued)

| # of Possible Assignments | Alternate Function | GPIO Function |
|---------------------------|--------------------|-----------------------------|
| three | C2o | PE7 PC6 PF6 |
| | Fault2 | PG3 PC5 PH5 |
| | I2S0RXMCLK | PG3 PA3 PD5 |
| | I2S0RXSD | PG2 PA2 PD4 |
| | I2S0TXSCK | PA4 PB6 PD6 |
| | I2S0TXWS | PE4 PA5 PD7 |
| | IDX1 | PG2 PF1 PH2 |
| | PhB1 | PD1 PG7 PE2 |
| | SSI1Clk | PF2 PE0 PH4 |
| | SSI1Fss | PF3 PH5 PE1 |
| | SSI1Rx | PF4 PH6 PE2 |
| | SSI1Tx | PH7 PF5 PE3 |
| | U1CTS | PE6 PD0 PA6 |
| | U1DCD | PE7 PD1 PA7 |
| | U1RI | PG6 PG4 PD4 |
| four | CAN0Rx | PD0 PA4 PA6 PB4 |
| | CAN0Tx | PD1 PA5 PA7 PB5 |
| | I2C1SCL | PJ0 PG0 PA0 PA6 |
| | I2C1SDA | PG1 PA1 PA7 PJ1 |
| | PWM2 | PD2 PF2 PB0 PH0 |
| | PWM3 | PD3 PF3 PB1 PH1 |
| | PWM6 | PC4 PA4 PG6 PG4 |
| | PWM7 | PC6 PA5 PG7 PG5 |
| | PhA0 | PD1 PC4 PF6 PE2 |
| | U2Rx | PD0 PG0 PB4 PD5 |
| | U2Tx | PE4 PD1 PG1 PD6 |
| five | C0o | PC5 PF4 PB6 PB5 PD7 |
| | C1o | PE6 PC7 PC5 PF5 PH2 |
| | CCP6 | PD0 PD2 PE1 PH0 PB5 |
| | CCP7 | PD1 PD3 PH1 PB6 PE3 |
| | Fault1 | PG6 PG5 PG4 PF7 PB6 |
| six | CCP4 | PC7 PC4 PA7 PF7 PE2 PD5 |
| | IDX0 | PD0 PG5 PB2 PB6 PB4 PD7 |
| | PWM0 | PD0 PJ0 PG2 PG0 PA6 PF0 |
| | PWM1 | PD1 PG3 PG1 PA7 PF1 PJ1 |
| | PhB0 | PC7 PC6 PF7 PF0 PH3 PE3 |
| | U1Rx | PD0 PD2 PC6 PA0 PB0 PB4 |
| | U1Tx | PD1 PD3 PC7 PA1 PB1 PB5 |
| seven | CCP5 | PE5 PD2 PC4 PG7 PG5 PB6 PB5 |

Table 23-11. Possible Pin Assignments for Alternate Functions (continued)

| # of Possible Assignments | Alternate Function | GPIO Function |
|---------------------------|--------------------|-------------------------------------|
| eight | CCP1 | PC5 PC4 PA6 PF6 PB1 PB6 PE3 PD7 |
| | PWM4 | PE6 PG0 PA2 PA6 PF2 PH6 PE0 PH0 |
| | PWM5 | PE7 PH7 PG1 PA3 PA7 PF3 PE1 PH1 |
| nine | CCP0 | PD3 PC7 PC6 PJ2 PF4 PB0 PB2 PB5 PD4 |
| | CCP2 | PE4 PD1 PC4 PF5 PB1 PE1 PB5 PE2 PD5 |
| | CCP3 | PE4 PC6 PC5 PA7 PG4 PF1 PB2 PE0 PD4 |
| | Fault0 | PE4 PG3 PG2 PJ2 PF4 PB3 PE1 PH3 PD6 |

23.3 Connections for Unused Signals

Table 23-12 on page 1125 shows how to handle signals for functions that are not used in a particular system implementation for devices that are in a 100-pin LQFP package. Two options are shown in the table: an acceptable practice and a preferred practice for reduced power consumption and improved EMC characteristics. If a module is not used in a system, and its inputs are grounded, it is important that the clock to the module is never enabled by setting the corresponding bit in the **RCGCx** register.

Table 23-12. Connections for Unused Signals (100-Pin LQFP)

| Function | Signal Name | Pin Number | Acceptable Practice | Preferred Practice |
|----------------|--------------------------|------------|--|--|
| GPIO | All unused GPIOs | - | NC | GND |
| Hibernate | $\overline{\text{HIB}}$ | 51 | NC | NC |
| | VBAT | 55 | NC | GND |
| | $\overline{\text{WAKE}}$ | 50 | NC | GND |
| | XOSC0 | 52 | NC | GND |
| | XOSC1 | 53 | NC | NC |
| No Connects | NC | - | NC | NC |
| System Control | OSC0 | 48 | NC | GND |
| | OSC1 | 49 | NC | NC |
| | $\overline{\text{RST}}$ | 64 | Pull up as shown in Figure 5-1 on page 184 | Connect through a capacitor to GND as close to pin as possible |

Table 23-13 on page 1125 shows how to handle signals for functions that are not used in a particular system implementation for devices that are in a 108-ball BGA package. Two options are shown in the table: an acceptable practice and a preferred practice for reduced power consumption and improved EMC characteristics. If a module is not used in a system, and its inputs are grounded, it is important that the clock to the module is never enabled by setting the corresponding bit in the **RCGCx** register.

Table 23-13. Connections for Unused Signals (108-Ball BGA)

| Function | Signal Name | Pin Number | Acceptable Practice | Preferred Practice |
|----------|------------------|------------|---------------------|--------------------|
| GPIO | All unused GPIOs | - | NC | GND |

Table 23-13. Connections for Unused Signals (108-Ball BGA) (continued)

| Function | Signal Name | Pin Number | Acceptable Practice | Preferred Practice |
|----------------|--------------------------|------------|--|--|
| Hibernate | $\overline{\text{HIB}}$ | M12 | NC | NC |
| | VBAT | L12 | NC | GND |
| | $\overline{\text{WAKE}}$ | M10 | NC | GND |
| | XOSC0 | K11 | NC | GND |
| | XOSC1 | K12 | NC | NC |
| No Connects | NC | - | NC | NC |
| System Control | OSC0 | L11 | NC | GND |
| | OSC1 | M11 | NC | NC |
| | $\overline{\text{RST}}$ | H11 | Pull up as shown in Figure 5-1 on page 184 | Connect through a capacitor to GND as close to pin as possible |

24 Operating Characteristics

Table 24-1. Temperature Characteristics

| Characteristic | Symbol | Value | Unit |
|--|--------|-------------|------|
| Industrial operating temperature range | T_A | -40 to +85 | °C |
| Unpowered storage temperature range | T_S | -65 to +150 | °C |

Table 24-2. Thermal Characteristics

| Characteristic | Symbol | Value | Unit |
|---|---------------|-------------------------------|------|
| Thermal resistance (junction to ambient) ^a | Θ_{JA} | 33 (100LQFP) 31 (108BGA) | °C/W |
| Junction temperature, -40 to +125 ^b | T_J | $T_A + (P \cdot \Theta_{JA})$ | °C |

a. Junction to ambient thermal resistance Θ_{JA} numbers are determined by a package simulator.

b. Power dissipation is a function of temperature.

Table 24-3. ESD Absolute Maximum Ratings^a

| Parameter Name | Min | Nom | Max | Unit |
|----------------|-----|-----|-----|------|
| V_{ESDHBM} | - | - | 2.0 | kV |
| V_{ESDCDM} | - | - | 500 | V |

a. All Stellaris® parts are ESD tested following the JEDEC standard.

25 Electrical Characteristics

25.1 Maximum Ratings

The maximum ratings are the limits to which the device can be subjected without permanently damaging the device. Device reliability may be adversely affected by exposure to absolute-maximum ratings for extended periods.

Note: The device is not guaranteed to operate properly at the maximum ratings.

Table 25-1. Maximum Ratings

| Parameter | Parameter Name ^a | Value | | Unit |
|-----------------------|--|-------|-----------------------|------|
| | | Min | Max | |
| V _{DD} | V _{DD} supply voltage | 0 | 4 | V |
| V _{DDA} | V _{DDA} supply voltage | 0 | 4 | V |
| V _{BAT} | V _{BAT} battery supply voltage | 0 | 4 | V |
| V _{IN_GPIO} | Input voltage ^b | -0.3 | 5.5 | V |
| | Input voltage for PB0 and PB1 when configured as GPIO | -0.3 | V _{DD} + 0.3 | V |
| I _{GPIO MAX} | Maximum current per output pin | - | 25 | mA |
| V _{NON} | Maximum input voltage on a non-power pin when the microcontroller is unpowered | - | 300 | mV |

a. Voltages are measured with respect to GND.

b. Applies to static and dynamic signals including overshoot.

Important: This device contains circuitry to protect the inputs against damage due to high-static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum-rated voltages to this high-impedance circuit. Reliability of operation is enhanced if unused inputs are connected to an appropriate logic voltage level (see “Connections for Unused Signals” on page 1125).

25.2 Recommended Operating Conditions

For special high-current applications, the GPIO output buffers may be used with the following restrictions. With the GPIO pins configured as 8-mA output drivers, a total of four GPIO outputs may be used to sink current loads up to 18 mA each. At 18-mA sink current loading, the V_{OL} value is specified as 1.2 V. The high-current GPIO package pins must be selected such that there are only a maximum of two per side of the physical package or BGA pin group with the total number of high-current GPIO outputs not exceeding four for the entire package.

Table 25-2. Recommended DC Operating Conditions

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|------------------|---|-------|-----|-------|------|
| V _{DD} | V _{DD} supply voltage | 3.0 | 3.3 | 3.6 | V |
| V _{DDA} | V _{DDA} supply voltage | 3.0 | 3.3 | 3.6 | V |
| V _{DDC} | V _{DDC} supply voltage, run mode | 1.235 | 1.3 | 1.365 | V |
| V _{IH} | High-level input voltage | 2.1 | - | 5.0 | V |
| V _{IL} | Low-level input voltage | -0.3 | - | 1.2 | V |

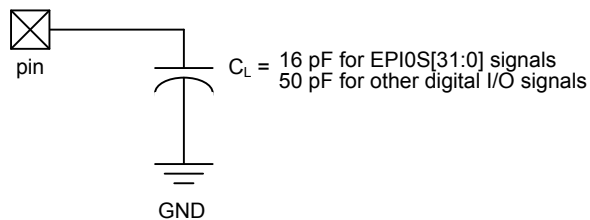
Table 25-2. Recommended DC Operating Conditions (continued)

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|-----------|--|------|-----|-----|------|
| V_{OH} | High-level output voltage | 2.4 | - | - | V |
| V_{OL} | Low-level output voltage | - | - | 0.4 | V |
| I_{OH} | High-level source current, $V_{OH}=2.4\text{ V}^a$ | | | | |
| | 2-mA Drive | -2.0 | - | - | mA |
| | 4-mA Drive | -4.0 | - | - | mA |
| | 8-mA Drive | -8.0 | - | - | mA |
| I_{OL} | Low-level sink current, $V_{OL}=0.4\text{ V}^a$ | | | | |
| | 2-mA Drive | 2.0 | - | - | mA |
| | 4-mA Drive | 4.0 | - | - | mA |
| | 8-mA Drive | 8.0 | - | - | mA |
| | 8-mA Drive, $V_{OL}=1.2\text{ V}$ | 18.0 | - | - | mA |

a. I_O specifications reflect the maximum current where the corresponding output voltage meets the V_{OH}/V_{OL} thresholds. I_O current can exceed these limits (subject to absolute maximum ratings).

25.3 Load Conditions

Unless otherwise specified, the following conditions are true for all timing measurements.

Figure 25-1. Load Conditions

25.4 JTAG and Boundary Scan

Table 25-3. JTAG Characteristics

| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------|-----------------|--|-----|-------------|-----|------|
| J1 | F_{TCK} | TCK operational clock frequency ^a | 0 | - | 10 | MHz |
| J2 | T_{TCK} | TCK operational clock period | 100 | - | - | ns |
| J3 | T_{TCK_LOW} | TCK clock Low time | - | $t_{TCK}/2$ | - | ns |
| J4 | T_{TCK_HIGH} | TCK clock High time | - | $t_{TCK}/2$ | - | ns |
| J5 | T_{TCK_R} | TCK rise time | 0 | - | 10 | ns |
| J6 | T_{TCK_F} | TCK fall time | 0 | - | 10 | ns |
| J7 | T_{TMS_SU} | TMS setup time to TCK rise | 20 | - | - | ns |
| J8 | T_{TMS_HLD} | TMS hold time from TCK rise | 20 | - | - | ns |
| J9 | T_{TDI_SU} | TDI setup time to TCK rise | 25 | - | - | ns |
| J10 | T_{TDI_HLD} | TDI hold time from TCK rise | 25 | - | - | ns |

Table 25-3. JTAG Characteristics (continued)

| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------|----------------------|---|-----|-----|-----|------|
| J11 | T _{TDO_ZDV} | TCK fall to Data Valid from High-Z, 2-mA drive | - | 23 | 35 | ns |
| | | TCK fall to Data Valid from High-Z, 4-mA drive | | 15 | 26 | ns |
| | | TCK fall to Data Valid from High-Z, 8-mA drive | | 14 | 25 | ns |
| | | TCK fall to Data Valid from High-Z, 8-mA drive with slew rate control | | 18 | 29 | ns |
| J12 | T _{TDO_DV} | TCK fall to Data Valid from Data Valid, 2-mA drive | - | 21 | 35 | ns |
| | | TCK fall to Data Valid from Data Valid, 4-mA drive | | 14 | 25 | ns |
| | | TCK fall to Data Valid from Data Valid, 8-mA drive | | 13 | 24 | ns |
| | | TCK fall to Data Valid from Data Valid, 8-mA drive with slew rate control | | 18 | 28 | ns |
| J13 | T _{TDO_DVZ} | TCK fall to High-Z from Data Valid, 2-mA drive | - | 9 | 11 | ns |
| | | TCK fall to High-Z from Data Valid, 4-mA drive | | 7 | 9 | ns |
| | | TCK fall to High-Z from Data Valid, 8-mA drive | | 6 | 8 | ns |
| | | TCK fall to High-Z from Data Valid, 8-mA drive with slew rate control | | 7 | 9 | ns |

a. A ratio of at least 8:1 must be kept between the system clock and TCK.

Figure 25-2. JTAG Test Clock Input Timing

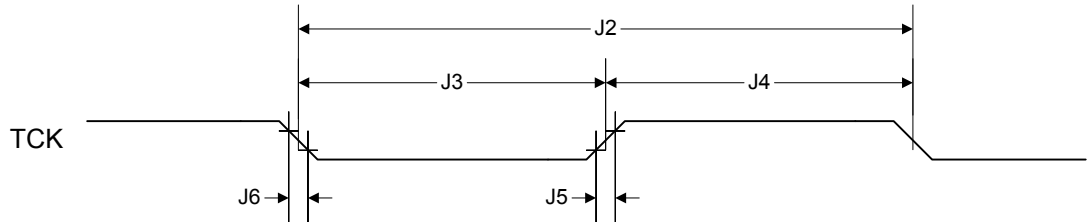
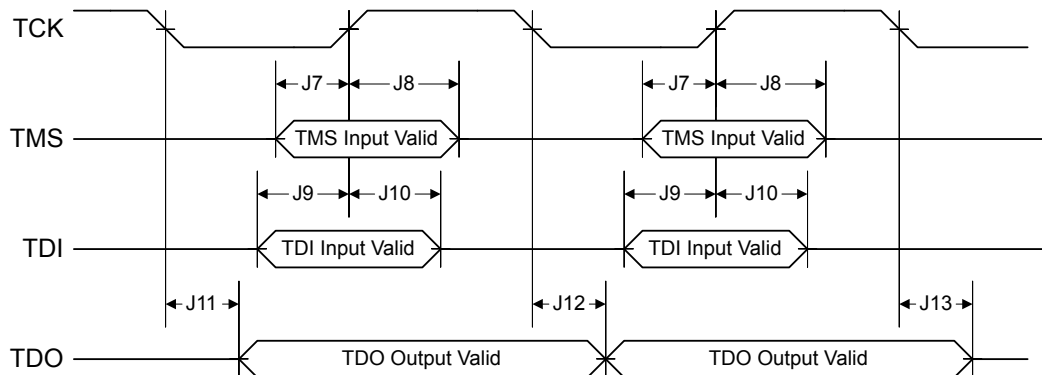


Figure 25-3. JTAG Test Access Port (TAP) Timing



25.5 Power and Brown-Out

Table 25-4. Power Characteristics

| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------|---------------|---|------|-----|------|---------|
| P1 | V_{TH} | Power-On Reset threshold | - | 2 | - | V |
| P2 | V_{BTH} | Brown-Out Reset threshold | 2.85 | 2.9 | 2.95 | V |
| P3 | T_{POR} | Power-On Reset timeout | 6 | - | 18 | ms |
| P4 | T_{BOR} | Brown-Out timeout | - | 500 | - | μ s |
| P5 | T_{IRPOR} | Internal reset timeout after POR | - | - | 2 | ms |
| P6 | T_{IRBOR} | Internal reset timeout after BOR | - | - | 2 | ms |
| P7 | $T_{VDDRISE}$ | Supply voltage (V_{DD}) rise time (0V-3.0V) | - | - | 10 | ms |
| P8 | T_{VDD2_3} | Supply voltage (V_{DD}) rise time (2.0V-3.0V) | - | - | 6 | ms |

Figure 25-4. Power-On Reset Timing

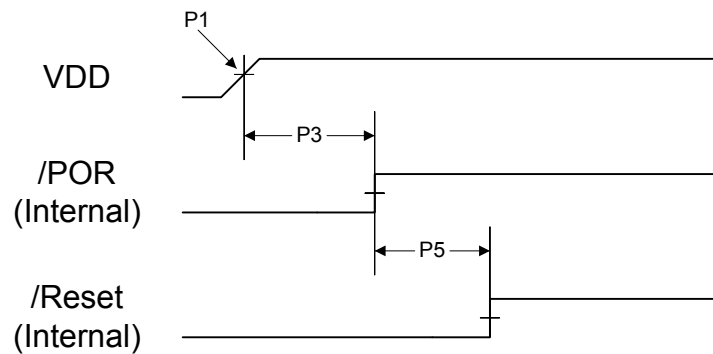


Figure 25-5. Brown-Out Reset Timing

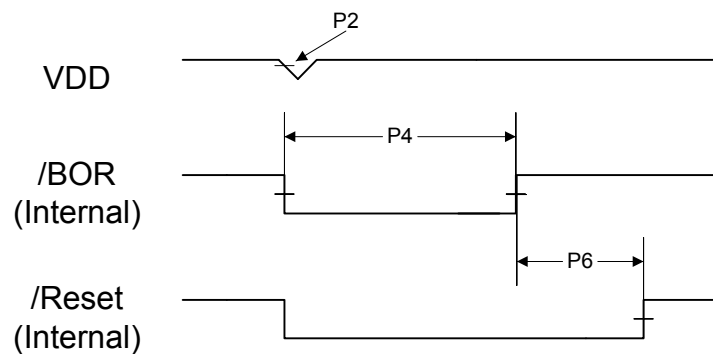
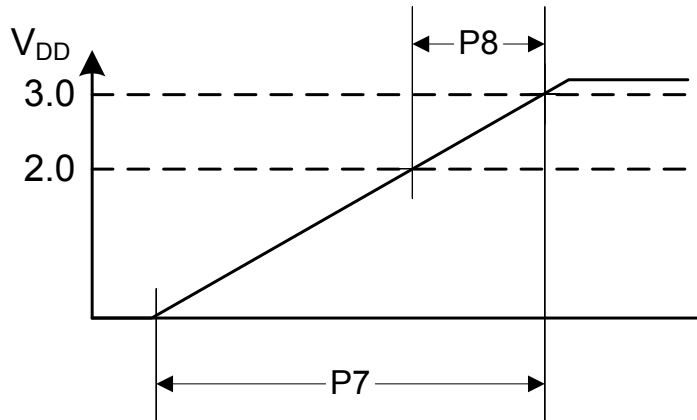


Figure 25-6. Power-On Reset and Voltage Parameters



25.6 Reset

Table 25-5. Reset Characteristics

| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------|-------------|---|-----|-----|-----|---------|
| R1 | T_{IRHWR} | Internal reset timeout after hardware reset (\overline{RST} pin) | - | - | 2 | ms |
| R2 | T_{IRSWR} | Internal reset timeout after software-initiated system reset | - | - | 2 | ms |
| R3 | T_{IRWDR} | Internal reset timeout after watchdog reset | - | - | 2 | ms |
| R4 | T_{IRMFR} | Internal reset timeout after MOSC failure reset | - | - | 2 | ms |
| R5 | T_{MIN} | Minimum \overline{RST} pulse width ^a | 2 | - | - | μ s |

a. This specification must be met in order to guarantee proper reset operation.

Figure 25-7. External Reset Timing (\overline{RST})

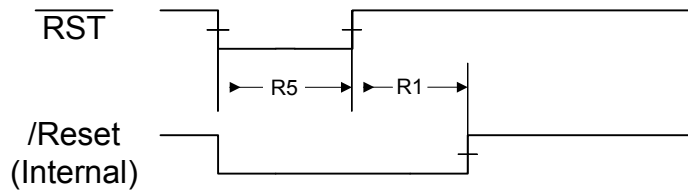


Figure 25-8. Software Reset Timing

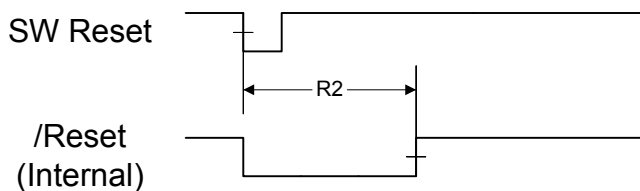
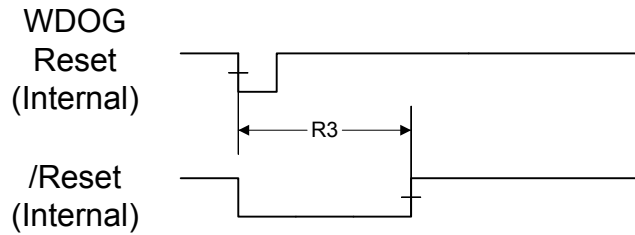
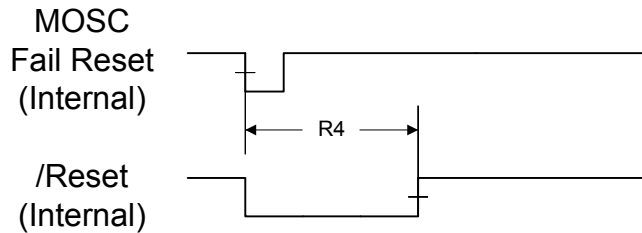


Figure 25-9. Watchdog Reset Timing**Figure 25-10. MOSC Failure Reset Timing**

25.7 On-Chip Low Drop-Out (LDO) Regulator

Table 25-6. LDO Regulator Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|-----------|---|-------|-----|-------|---------------|
| C_{LDO} | External filter capacitor size for internal power supply ^a | 1.0 | - | 3.0 | μF |
| V_{LDO} | LDO output voltage | 1.235 | 1.3 | 1.365 | V |

a. The capacitor should be connected as close as possible to pin 86.

25.8 Clocks

The following sections provide specifications on the various clock sources and mode.

25.8.1 PLL Specifications

The following tables provide specifications for using the PLL.

Table 25-7. Phase Locked Loop (PLL) Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|-----------------|---------------------------------------|--------------------|-----|-------------------|------|
| F_{REF_XTAL} | Crystal reference ^a | 3.579545 | - | 16.384 | MHz |
| F_{REF_EXT} | External clock reference ^a | 3.579545 | - | 16.384 | MHz |
| F_{PLL} | PLL frequency ^b | - | 400 | - | MHz |
| T_{READY} | PLL lock time | 0.562 ^c | - | 1.38 ^d | ms |

a. The exact value is determined by the crystal value programmed into the $XTAL$ field of the **Run-Mode Clock Configuration (RCC)** register.

b. PLL frequency is automatically calculated by the hardware based on the $XTAL$ field of the **RCC** register.

c. Using a 16.384-MHz crystal

d. Using 3.5795-MHz crystal

Table 25-8 on page 1134 shows the actual frequency of the PLL based on the crystal frequency used (defined by the XTAL field in the RCC register).

Table 25-8. Actual PLL Frequency

| XTAL | Crystal Frequency (MHz) | PLL Frequency (MHz) | Error |
|------|-------------------------|---------------------|---------|
| 0x04 | 3.5795 | 400.904 | 0.0023% |
| 0x05 | 3.6864 | 398.1312 | 0.0047% |
| 0x06 | 4.0 | 400 | - |
| 0x07 | 4.096 | 401.408 | 0.0035% |
| 0x08 | 4.9152 | 398.1312 | 0.0047% |
| 0x09 | 5.0 | 400 | - |
| 0x0A | 5.12 | 399.36 | 0.0016% |
| 0x0B | 6.0 | 400 | - |
| 0x0C | 6.144 | 399.36 | 0.0016% |
| 0x0D | 7.3728 | 398.1312 | 0.0047% |
| 0x0E | 8.0 | 400 | - |
| 0x0F | 8.192 | 398.6773333 | 0.0033% |
| 0x10 | 10.0 | 400 | - |
| 0x11 | 12.0 | 400 | - |
| 0x12 | 12.288 | 401.408 | 0.0035% |
| 0x13 | 13.56 | 397.76 | 0.0056% |
| 0x14 | 14.318 | 400.90904 | 0.0023% |
| 0x15 | 16.0 | 400 | - |
| 0x16 | 16.384 | 404.1386667 | 0.010% |

25.8.2 PIOSC Specifications

Table 25-9. PIOSC Clock Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|------------------------|--|-----|--------|-----|------|
| F _{PIOSC25} | Internal 16-MHz precision oscillator frequency variance, factory calibrated at 25 °C | - | ±0.25% | ±1% | - |
| F _{PIOSCT} | Internal 16-MHz precision oscillator frequency variance, factory calibrated at 25 °C, across specified temperature range | - | - | ±3% | - |
| F _{PIOSCUCAL} | Internal 16-MHz precision oscillator frequency variance, user calibrated at a chosen temperature | - | ±0.25% | ±1% | - |

25.8.3 Internal 30-kHz Oscillator Specifications

Table 25-10. 30-kHz Clock Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|------------------------|--------------------------------------|-----|-----|-----|------|
| F _{IOSC30KHZ} | Internal 30-KHz oscillator frequency | 15 | 30 | 45 | KHz |

25.8.4 Hibernation Clock Source Specifications

Table 25-11. Hibernation Clock Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------------------|--|-----|----------|-----|------|
| F _{HIBOSC} | Hibernation module oscillator frequency | - | 4.194304 | - | MHz |
| F _{HIBOSC_XTAL} | Crystal reference for hibernation oscillator | - | 4.194304 | - | MHz |
| T _{HIBOSC_START} | Hibernation oscillator startup time ^a | - | - | 10 | ms |
| F _{HIBOSC_EXT} | External clock reference for hibernation module | - | 32.768 | - | KHz |
| DC _{HIBOSC_EXT} | External clock reference duty cycle | 45 | - | 55 | % |

a. This parameter is highly sensitive to PCB layout and trace lengths, which may make this parameter time longer. Care must be taken in PCB design to minimize trace lengths and RLC (resistance, inductance, capacitance).

Table 25-12. HIB Oscillator Input Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|-----------------------|--|-----|--|-----|------|
| F _{HIBOSC} | Hibernation module oscillator frequency | - | 4.194304 | - | MHz |
| TOL _{HIBOSC} | Hibernation oscillator frequency tolerance | - | Defined by customer application requirements | - | PPM |

25.8.5 Main Oscillator Specifications

Table 25-13. Main Oscillator Clock Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|------------------------------|---|------|-----|--------|------|
| F _{MOSC} | Main oscillator frequency | 1 | - | 16.384 | MHz |
| T _{MOSC_PER} | Main oscillator period | 61 | - | 1000 | ns |
| T _{MOSC_SETTLE} | Main oscillator settling time ^a | 17.5 | - | 20 | ms |
| F _{REF_XTAL_BYPASS} | Crystal reference using the main oscillator (PLL in BYPASS mode) ^b | 1 | - | 16.384 | MHz |
| F _{REF_EXT_BYPASS} | External clock reference (PLL in BYPASS mode) ^b | 0 | - | 50 | MHz |
| DC _{MOSC_EXT} | External clock reference duty cycle | 45 | - | 55 | % |

a. This parameter is highly sensitive to PCB layout and trace lengths, which may make this parameter time longer. Care must be taken in PCB design to minimize trace lengths and RLC (resistance, inductance, capacitance).

b. If the ADC is used, the crystal reference must be 16 MHz ± .03% when the PLL is bypassed.

Table 25-14. Supported MOSC Crystal Frequencies

| Crystal Frequency (MHz) Not Using the PLL | Crystal Frequency (MHz) Using the PLL |
|---|---------------------------------------|
| 1.000 MHz | reserved |
| 1.8432 MHz | reserved |
| 2.000 MHz | reserved |
| 2.4576 MHz | reserved |
| | 3.579545 MHz |
| | 3.6864 MHz |
| | 4 MHz |
| | 4.096 MHz |

Table 25-14. Supported MOSC Crystal Frequencies (continued)

| Crystal Frequency (MHz) Not Using the PLL | Crystal Frequency (MHz) Using the PLL |
|---|---------------------------------------|
| | 4.9152 MHz |
| | 5 MHz |
| | 5.12 MHz |
| | 6 MHz (reset value) |
| | 6.144 MHz |
| | 7.3728 MHz |
| | 8 MHz |
| | 8.192 MHz |
| | 10.0 MHz |
| | 12.0 MHz |
| | 12.288 MHz |
| | 13.56 MHz |
| | 14.31818 MHz |
| | 16.0 MHz |
| | 16.384 MHz |

25.8.6 System Clock Specification with ADC Operation

Table 25-15. System Clock Characteristics with ADC Operation

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------------|--|---------|-----|---------|------|
| F_{sysadc} | System clock frequency when the ADC module is operating (when PLL is bypassed). ^a | 15.9952 | 16 | 16.0048 | MHz |

a. Clock frequency (plus jitter) must be stable inside specified range. ADC can be clocked from the PLL or directly from an external clock source, as long as frequency absolute precision is inside specified range.

25.9 Sleep Modes

Table 25-16. Sleep Modes AC Characteristics^a

| Parameter No | Parameter | Parameter Name | Min | Nom | Max | Unit |
|--------------|---------------------------|---|-----|-----|--------------------|---------------|
| D1 | $T_{\text{WAKE_S}}$ | Time to wake from interrupt in sleep mode, not using the PLL ^b | - | - | 2 | system clocks |
| | $T_{\text{WAKE_DS}}$ | Time to wake from interrupt deep-sleep mode, not using the PLL ^b | - | - | 7 | system clocks |
| D2 | $T_{\text{WAKE_PLL_S}}$ | Time to wake from interrupt in sleep or deep-sleep mode when using the PLL ^b | - | - | T_{READY} | ms |
| D3 | $T_{\text{ENTER_DS}}$ | Time to enter deep-sleep mode from sleep request | - | 0 | 35 ^c | ms |

a. Values in this table assume the IOSC is the clock source during sleep or deep-sleep mode.

b. Specified from registering the interrupt to first instruction.

c. Nominal specification occurs 99.9995% of the time.

25.10 Hibernation Module

The Hibernation module requires special system implementation considerations because it is intended to power down all other sections of its host device, refer to “Hibernation Module” on page 287.

Table 25-17. Hibernation Module Battery Characteristics

| Parameter | Parameter Name | Min | Nominal | Max | Unit |
|---------------------|----------------------------|-----|---------|-----|------|
| V _{BAT} | Battery supply voltage | 2.4 | 3.0 | 3.6 | V |
| V _{LOWBAT} | Low battery detect voltage | 1.8 | - | 2.2 | V |

Table 25-18. Hibernation Module AC Characteristics

| Parameter No | Parameter | Parameter Name | Min | Nom | Max | Unit |
|--------------|-----------------------------|--|-----|-----|-----------------|------|
| H1 | T _{HIB_LOW} | Internal 32.768 KHz clock reference rising edge to $\overline{\text{HIB}}$ asserted | 20 | - | - | μs |
| H2 | T _{HIB_HIGH} | Internal 32.768 KHz clock reference rising edge to $\overline{\text{HIB}}$ deasserted | - | 30 | - | μs |
| H3 | T _{WAKE_TO_HIB} | $\overline{\text{WAKE}}$ assert to $\overline{\text{HIB}}$ desassert (wake up time), internal Hibernation oscillator running during hibernation ^a | 62 | - | 124 | μs |
| H4 | T _{WAKE_TO_HIB} | $\overline{\text{WAKE}}$ assert to $\overline{\text{HIB}}$ desassert (wake up time), internal Hibernation oscillator stopped during hibernation ^a | - | - | 10 | ms |
| H5 | T _{WAKE_CLOCK} | $\overline{\text{WAKE}}$ assertion time, internal Hibernation oscillator running during hibernation | 62 | - | - | μs |
| H6 | T _{WAKE_NOCLOCK} | $\overline{\text{WAKE}}$ assertion time, internal Hibernation oscillator stopped during hibernation ^b | 10 | - | - | ms |
| H7 | T _{HIB_REG_ACCESS} | Time required for a write to a non-volatile register in the HIB module to complete | 92 | - | - | μs |
| H8 | T _{HIB_TO_HIB} | $\overline{\text{HIB}}$ high time between assertions | 100 | - | - | ms |
| H9 | T _{ENTER_HIB} | Time to enter Hibernate mode from hibernation request | - | 0 | 35 ^c | ms |

a. Code begins executing after the time period specified by T_{IRPOR} following the deassertion of $\overline{\text{HIB}}$.

b. This mode is used when the PINWEN bit is set and the RTCEN bit is clear in the HIBCTL register.

c. Nominal specification occurs 99.998% of the time.

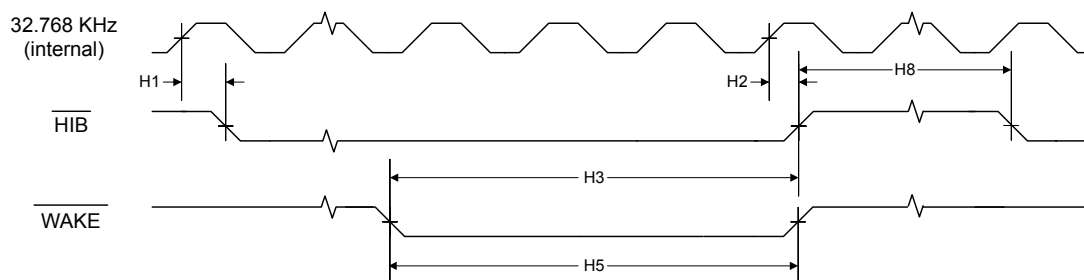
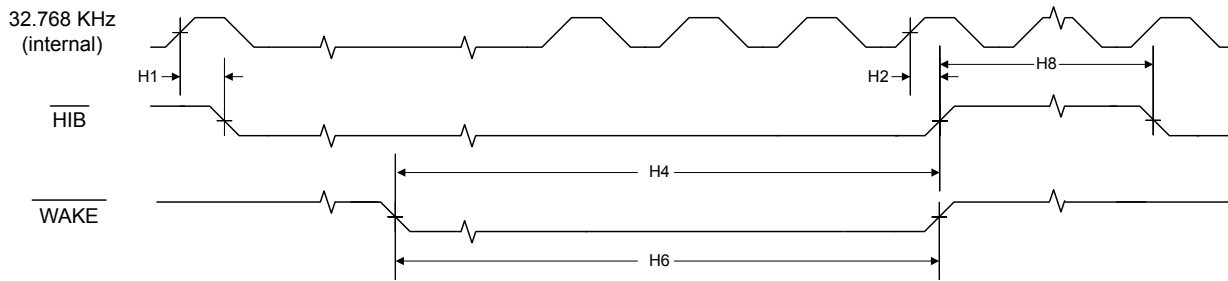
Figure 25-11. Hibernation Module Timing with Internal Oscillator Running in Hibernation

Figure 25-12. Hibernation Module Timing with Internal Oscillator Stopped in Hibernation



25.11 Flash Memory

Table 25-19. Flash Memory Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|--------------------|---|--------|-----|-----|--------|
| PE _{CYC} | Number of guaranteed program/erase cycles before failure ^a | 15,000 | - | - | cycles |
| T _{RET} | Data retention, -40°C to +85°C | 10 | - | - | years |
| T _{PROG} | Word program time | - | - | 1 | ms |
| T _{BPROG} | Buffer program time | - | - | 1 | ms |
| T _{ERASE} | Page erase time | - | - | 12 | ms |
| T _{ME} | Mass erase time | - | - | 16 | ms |

a. A program/erase cycle is defined as switching the bits from 1-> 0 -> 1.

25.12 Input/Output Characteristics

Note: All GPIOs are 5-V tolerant, except PB0 and PB1. See “Signal Description” on page 419 for more information on GPIO configuration.

Table 25-20. GPIO Module Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------------|--|-----|-----|-----|------|
| R _{GPIOPU} | GPIO internal pull-up resistor | 100 | - | 300 | kΩ |
| R _{GPIOPD} | GPIO internal pull-down resistor | 200 | - | 500 | kΩ |
| I _{LKG} | GPIO input leakage current ^a | - | - | 2 | μA |
| T _{GPIOR} | GPIO Rise Time, 2-mA drive ^b | - | 14 | 20 | ns |
| | GPIO Rise Time, 4-mA drive ^b | | 7 | 10 | ns |
| | GPIO Rise Time, 8-mA drive ^b | | 4 | 5 | ns |
| | GPIO Rise Time, 8-mA drive with slew rate control ^b | | 6 | 8 | ns |
| T _{GPIOF} | GPIO Fall Time, 2-mA drive ^c | - | 14 | 21 | ns |
| | GPIO Fall Time, 4-mA drive ^c | | 7 | 11 | ns |
| | GPIO Fall Time, 8-mA drive ^c | | 4 | 6 | ns |
| | GPIO Fall Time, 8-mA drive with slew rate control ^c | | 6 | 8 | ns |

a. The leakage current is measured with GND or VDD applied to the corresponding pin(s). The leakage of digital port pins is measured individually. The port pin is configured as an input and the pullup/pulldown resistor is disabled.

b. Time measured from 20% to 80% of V_{DD}.

c. Time measured from 80% to 20% of V_{DD}.

25.13 External Peripheral Interface (EPI)

When the EPI module is in SDRAM mode, the drive strength must be configured to 8 mA. Table 25-21 on page 1139 shows the rise and fall times in SDRAM mode with 16 pF load conditions. When the EPI module is in Host-Bus or General-Purpose mode, the values in “Input/Output Characteristics” on page 1138 should be used.

Table 25-21. EPI SDRAM Characteristics

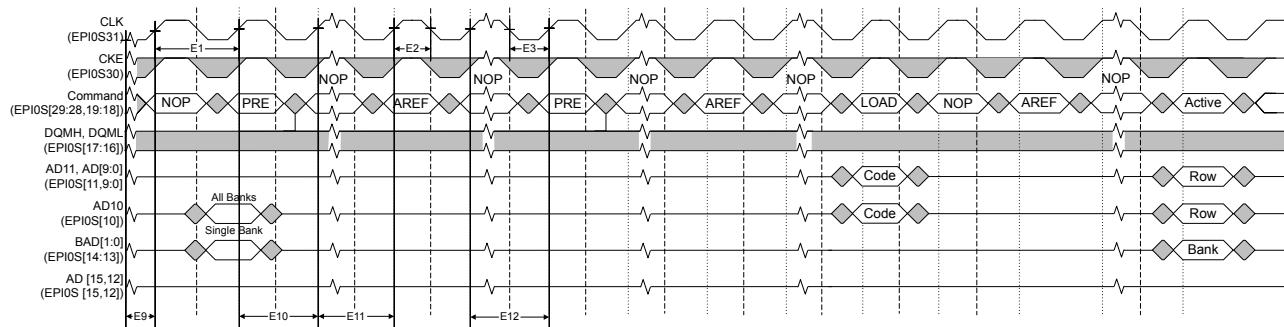
| Parameter | Parameter Name | Condition | Min | Nom | Max | Unit |
|--------------|--|---------------------------|-----|-----|-----|------|
| T_{SDRAMR} | EPI Rise Time (from 20% to 80% of V_{DD}) | 8-mA drive, $C_L = 16$ pF | - | 2 | 3 | ns |
| T_{SDRAMF} | EPI Fall Time (from 80% to 20% of V_{DD}) | 8-mA drive, $C_L = 16$ pF | - | 2 | 3 | ns |

Table 25-22. EPI SDRAM Interface Characteristics^a

| Parameter No | Parameter | Parameter Name | Min | Nom | Max | Unit |
|--------------|-----------|------------------------|-----|-----|-----|---------|
| E1 | T_{CK} | SDRAM Clock period | 20 | - | - | ns |
| E2 | T_{CH} | SDRAM Clock high time | 10 | - | - | ns |
| E3 | T_{CL} | SDRAM Clock low time | 10 | - | - | ns |
| E4 | T_{COV} | CLK to output valid | -5 | - | 5 | ns |
| E5 | T_{COI} | CLK to output invalid | -5 | - | 5 | ns |
| E6 | T_{COT} | CLK to output tristate | -5 | - | 5 | ns |
| E7 | T_S | Input set up to CLK | 10 | - | - | ns |
| E8 | T_H | CLK to input hold | 0 | - | - | ns |
| E9 | T_{PU} | Power-up time | 100 | - | - | μ s |
| E10 | T_{RP} | Precharge all banks | 20 | - | - | ns |
| E11 | T_{RFC} | Auto refresh | 66 | - | - | ns |
| E12 | T_{MRD} | Program mode register | 40 | - | - | ns |

a. The EPI SDRAM interface must use 8-mA drive.

Figure 25-13. SDRAM Initialization and Load Mode Register Timing



- Notes:
1. If CS is high at clock high time, all applied commands are NOP.
 2. The **Mode** register may be loaded prior to the auto refresh cycles if desired.
 3. JEDEC and PC100 specify three clocks.
 4. Outputs are guaranteed High-Z after command is issued.

Figure 25-14. SDRAM Read Timing

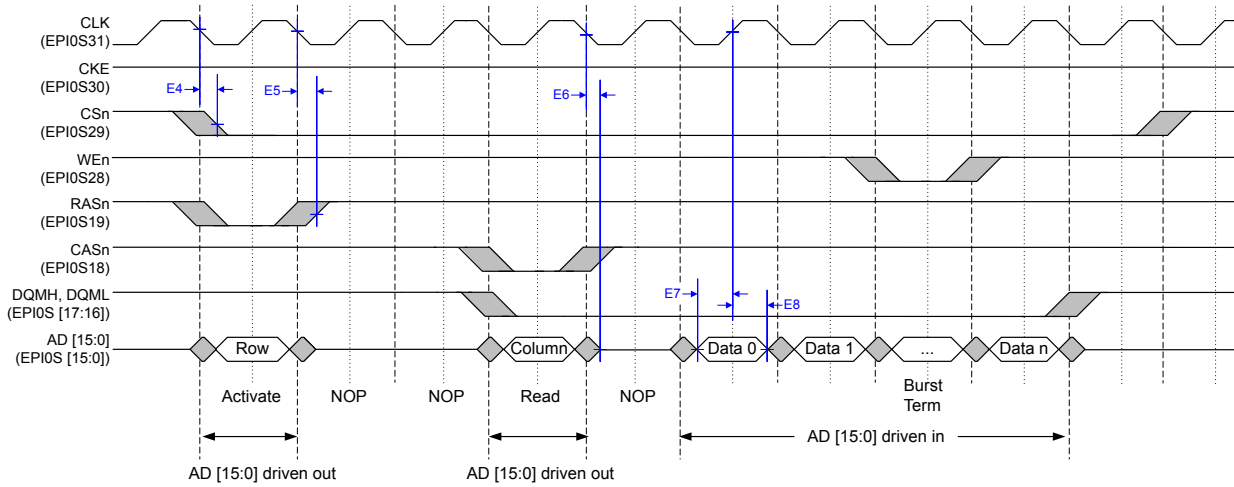


Figure 25-15. SDRAM Write Timing

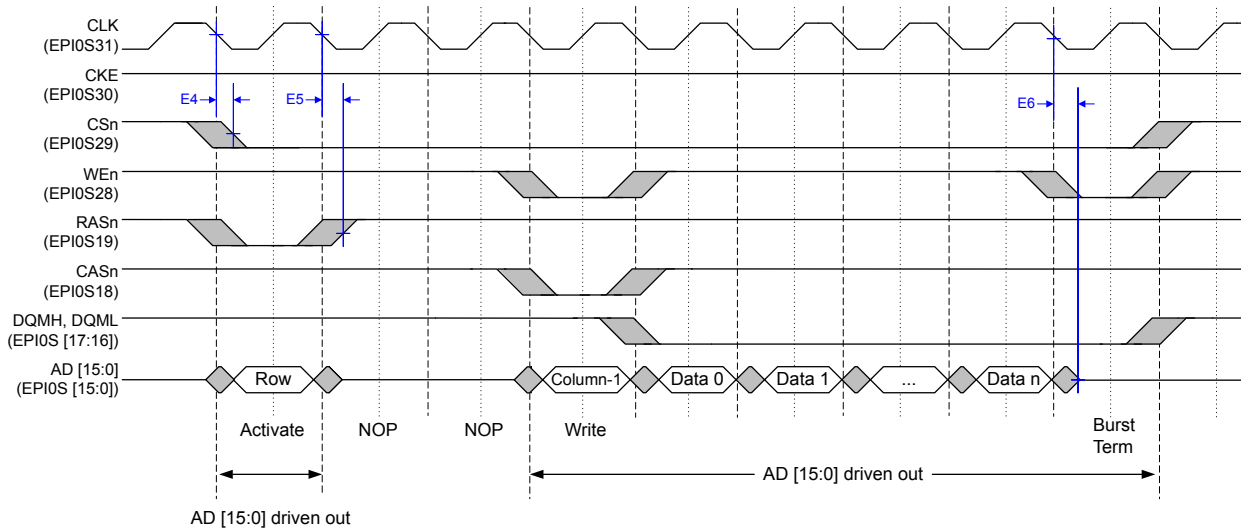
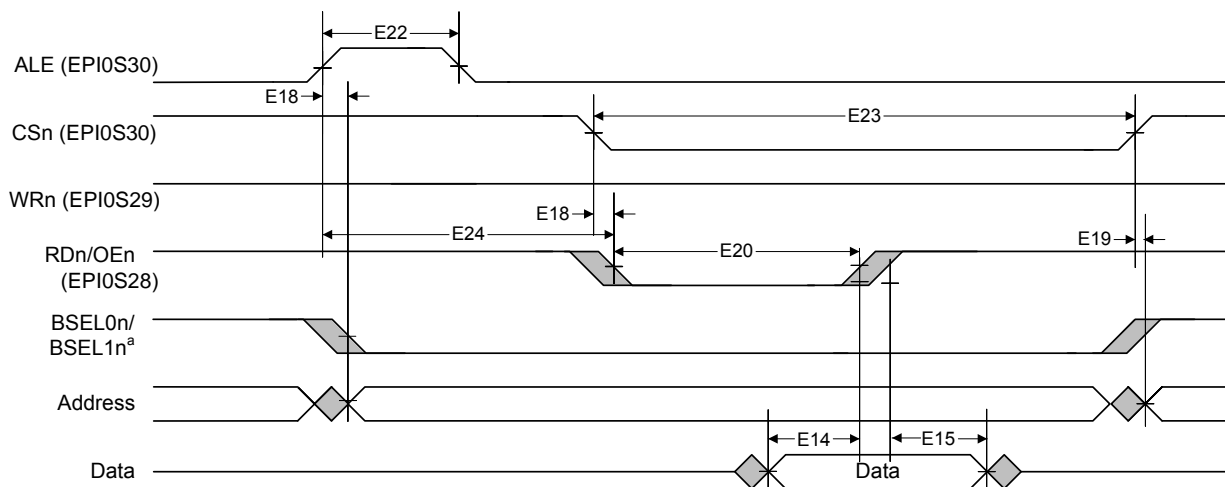


Table 25-23. EPI Host-Bus 8 and Host-Bus 16 Interface Characteristics

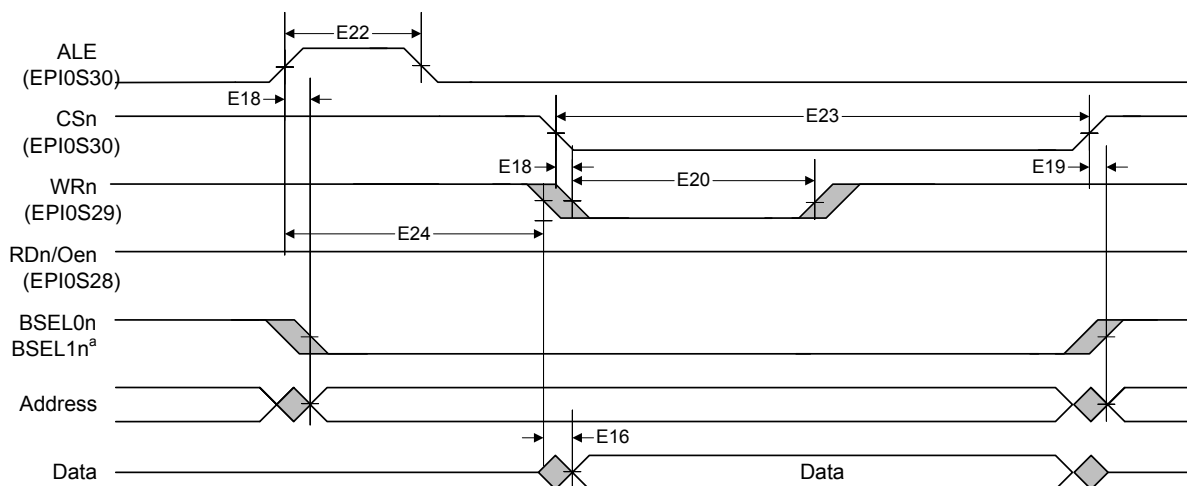
| Parameter No | Parameter | Parameter Name | Min | Nom | Max | Unit |
|--------------|---------------|---|-----|-----|-----|---------------|
| E14 | T_{ISU} | Read data set up time | 10 | - | - | ns |
| E15 | T_{IH} | Read data hold time | 0 | - | - | ns |
| E16 | T_{DV} | WEn to write data valid | - | - | 5 | ns |
| E17 | T_{DI} | Data hold from WEn invalid | 2 | - | - | EPI Clocks |
| E18 | T_{OV} | CSn to output valid | -5 | - | 5 | ns |
| E19 | T_{OINV} | CSn to output invalid | -5 | - | 5 | ns |
| E20 | T_{STLOW} | WEn / RDn strobe width low | 2 | - | - | EPI Clocks |
| E21 | T_{FIFO} | FEMPTY and FFULL setup time to clock edge | 2 | - | - | System Clocks |
| E22 | $T_{ALEHIGH}$ | ALE width high | - | 1 | - | EPI Clocks |

Table 25-23. EPI Host-Bus 8 and Host-Bus 16 Interface Characteristics (continued)

| Parameter No | Parameter | Parameter Name | Min | Nom | Max | Unit |
|--------------|--------------|--|-----|-----|-----|------------|
| E23 | T_{CSLOW} | CSn width low | 4 | - | - | EPI Clocks |
| E24 | T_{ALEST} | ALE rising to WEn / RDn strobe falling | 2 | - | - | EPI Clocks |
| E25 | T_{ALEADD} | ALE falling to ADn tristate | 1 | - | - | EPI Clocks |

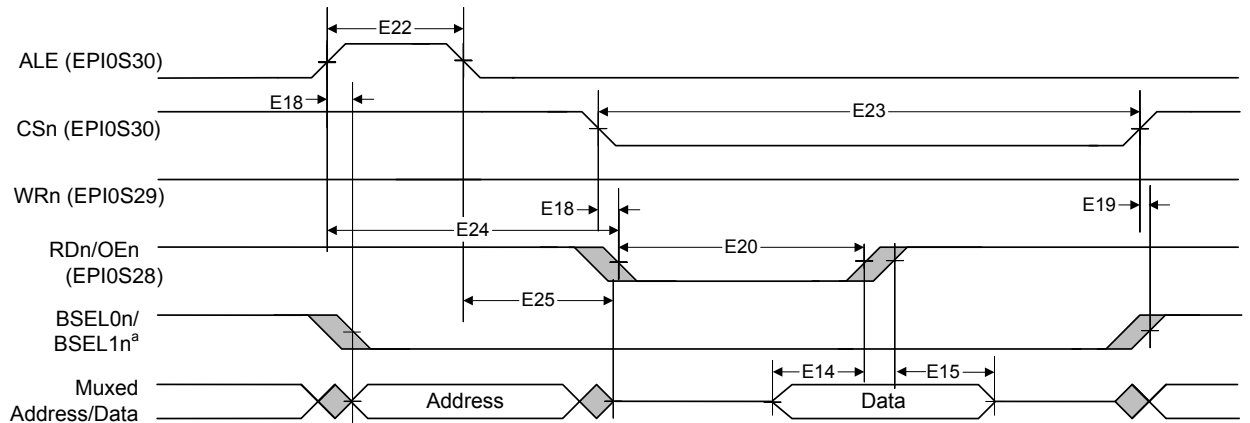
Figure 25-16. Host-Bus 8/16 Mode Read Timing

^a BSEL0n and BSEL1n are available in Host-Bus 16 mode only.

Figure 25-17. Host-Bus 8/16 Mode Write Timing

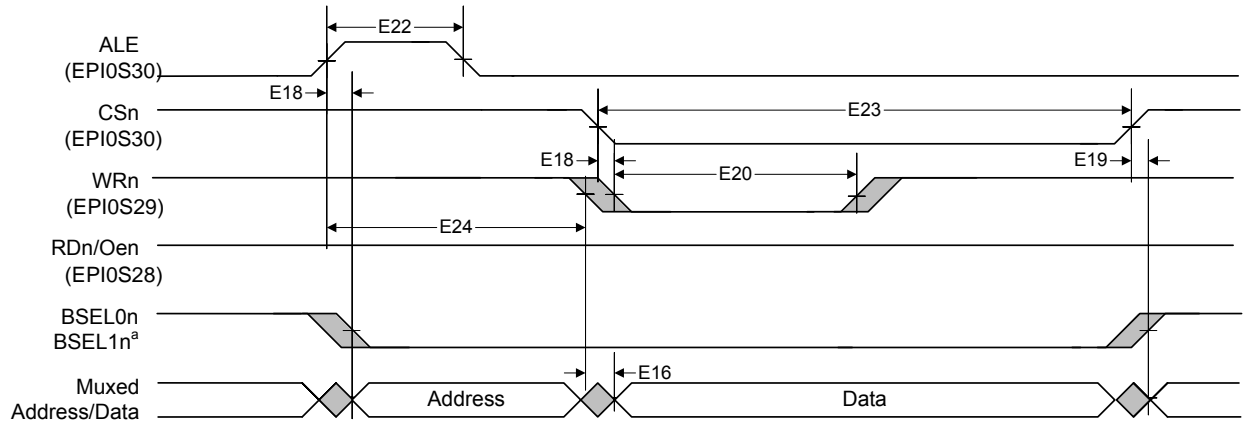
^a BSEL0n and BSEL1n are available in Host-Bus 16 mode only.

Figure 25-18. Host-Bus 8/16 Mode Muxed Read Timing



^a BSEL0n and BSEL1n are available in Host-Bus 16 mode only.

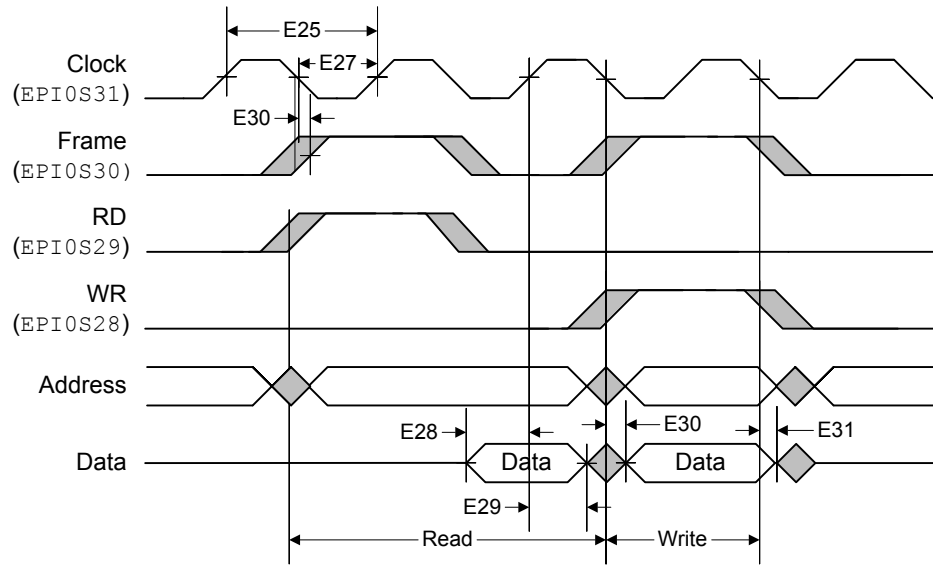
Figure 25-19. Host-Bus 8/16 Mode Muxed Write Timing



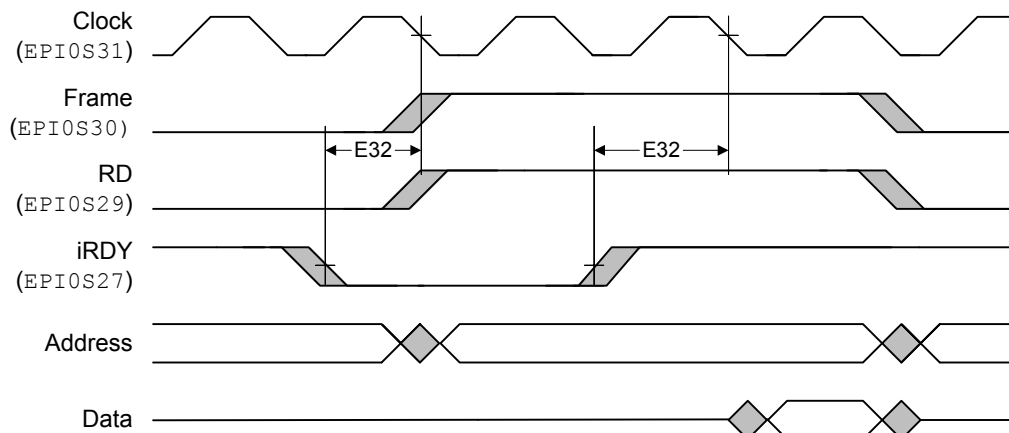
^a BSEL0n and BSEL1n are available in Host-Bus 16 mode only.

Table 25-24. EPI General-Purpose Interface Characteristics

| Parameter No | Parameter | Parameter Name | Min | Nom | Max | Unit |
|--------------|-------------|---|-----|-----|-----|------|
| E25 | T_{CK} | General-Purpose Clock period | 20 | - | - | ns |
| E26 | T_{CH} | General-Purpose Clock high time | 10 | - | - | ns |
| E27 | T_{CL} | General-Purpose Clock low time | 10 | - | - | ns |
| E28 | T_{ISU} | Input signal set up time to rising clock edge | 10 | - | - | ns |
| E29 | T_{IH} | Input signal hold time from rising clock edge | 0 | - | - | ns |
| E30 | T_{DV} | Falling clock edge to output valid | -5 | - | 5 | ns |
| E31 | T_{DI} | Falling clock edge to output invalid | -5 | - | 5 | ns |
| E32 | T_{RDYSU} | iRDY assertion or deassertion set up time to falling clock edge | 10 | - | - | ns |

Figure 25-20. General-Purpose Mode Read and Write Timing

The above figure illustrates accesses where the FRM50 bit is clear, the FRMCNT field is 0x0, the RD2CYC bit is clear, and the WR2CYC bit is clear.

Figure 25-21. General-Purpose Mode iRDY Timing

25.14 Analog-to-Digital Converter (ADC)

Table 25-25. ADC Characteristics^a

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|----------------------|---|---------|-----|----------------------|---------------|
| V _{ADCIN} | Maximum single-ended, full-scale analog input voltage, using internal reference | - | - | 3.0 | V |
| | Maximum single-ended, full-scale analog input voltage, using external reference | - | - | V _{REFA} | V |
| | Minimum single-ended, full-scale analog input voltage | 0.0 | - | - | V |
| | Maximum differential, full-scale analog input voltage, using internal reference | - | - | 1.5 | V |
| | Maximum differential, full-scale analog input voltage, using external reference | - | - | V _{REFA} /2 | V |
| | Minimum differential, full-scale analog input voltage | 0.0 | - | - | V |
| N | Resolution | 12 | | | bits |
| F _{ADC} | ADC internal clock frequency ^b | 15.9952 | 16 | 16.0048 | MHz |
| T _{ADCCONV} | Conversion time ^c | 1 | | | μs |
| F _{ADCCONV} | Conversion rate ^c | 1000 | | | k samples/s |
| T _{ADCSAMP} | Sample time | 125 | - | - | ns |
| T _{LT} | Latency from trigger to start of conversion | - | 2 | - | system clocks |
| I _L | ADC input leakage | - | - | 2.0 | μA |
| R _{ADC} | ADC equivalent resistance | - | - | 10 | kΩ |
| C _{ADC} | ADC equivalent capacitance | 0.9 | 1.0 | 1.1 | pF |
| E _L | Integral nonlinearity (INL) error, 12-bit mode | - | - | ±8 | LSB |
| | Integral nonlinearity (INL) error, 10-bit mode | - | - | ±2 | LSB |
| E _D | Differential nonlinearity (DNL) error, 12-bit mode | - | - | ±4 | LSB |
| | Differential nonlinearity (DNL) error, 10-bit mode | - | - | ±2 | LSB |
| E _O | Offset error, 12-bit mode | - | - | ±40 | LSB |
| | Offset error, 10-bit mode | - | - | ±10 | LSB |
| E _G | Full-scale gain error, 12-bit mode | - | - | ±100 | LSB |
| | Full-scale gain error, 10-bit mode | - | - | ±25 | LSB |
| E _{TS} | Temperature sensor accuracy ^d | - | - | ±5 | °C |

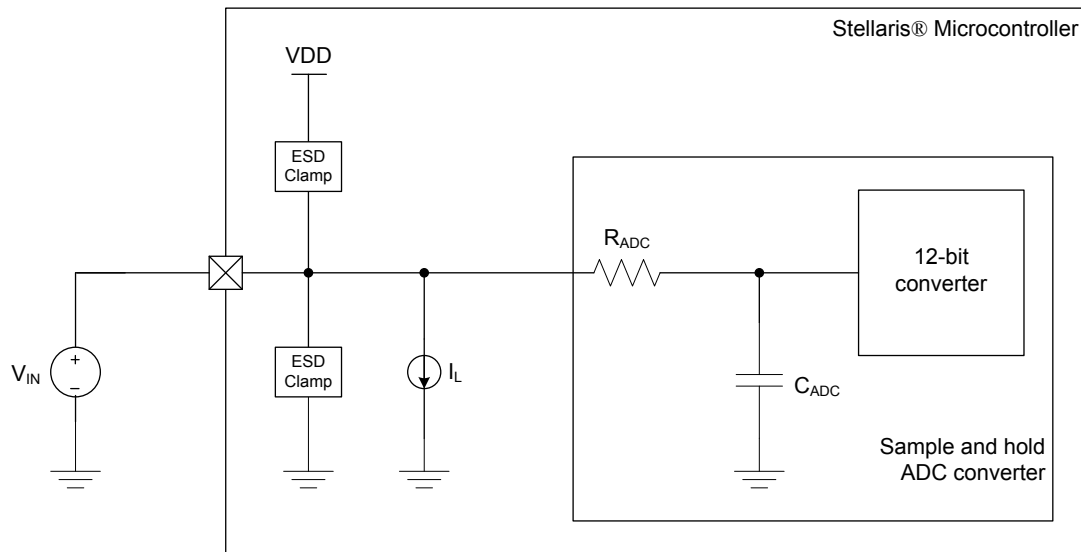
a. The ADC reference voltage is 3.0 V. This reference voltage is internally generated from the 3.3 VDDA supply by a band gap circuit.

b. The ADC must be clocked from the PLL or directly from an external clock source to operate properly.

c. The conversion time and rate scale from the specified number if the ADC internal clock frequency is any value other than 16 MHz.

d. Note that this parameter does not include ADC error.

Figure 25-22. ADC Input Equivalency Diagram

Table 25-26. ADC Module External Reference Characteristics^a

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|-------------------|--|------|-----|------|---------------|
| V_{REFA} | External voltage reference for ADC, when the V_{REF} field in the ADCCTL register is $0x1^b$ | 2.97 | - | 3.03 | V |
| | External voltage reference for ADC, when the V_{REF} field in the ADCCTL register is $0x3^c$ | 0.99 | - | 1.01 | V |
| I_L | External voltage reference leakage current | - | - | 2.0 | μA |

a. Care must be taken to supply a reference voltage of acceptable quality.

b. Ground is always used as the reference level for the minimum conversion value.

c. Ground is always used as the reference level for the minimum conversion value.

Table 25-27. ADC Module Internal Reference Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|-------------------|------------------------------------|-----|-----|-----|------|
| V_{REFI} | Internal voltage reference for ADC | - | 3.0 | - | V |

25.15 Synchronous Serial Interface (SSI)

Table 25-28. SSI Characteristics

| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------|------------------------|------------------------------------|-----|-----|-----|---------------|
| S1 | $T_{\text{CLK_PER}}$ | SSIClk cycle time ^a | 40 | - | - | ns |
| S2 | $T_{\text{CLK_HIGH}}$ | SSIClk high time | - | 0.5 | - | t clk_per |
| S3 | $T_{\text{CLK_LOW}}$ | SSIClk low time | - | 0.5 | - | t clk_per |
| S4 | T_{CLKRF} | SSIClk rise/fall time ^b | - | 4 | 6 | ns |
| S5 | T_{DMD} | Data from master valid delay time | 0 | - | 1 | system clocks |
| S6 | T_{DMS} | Data from master setup time | 1 | - | - | system clocks |
| S7 | T_{DMH} | Data from master hold time | 2 | - | - | system clocks |
| S8 | T_{DSS} | Data from slave setup time | 1 | - | - | system clocks |

Table 25-28. SSI Characteristics (continued)

| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------|------------------|---------------------------|-----|-----|-----|---------------|
| S9 | T _{DSH} | Data from slave hold time | 2 | - | - | system clocks |

- a. In master mode, the system clock must be at least twice as fast as the SSIClk; in slave mode, the system clock must be at least 12 times faster than the SSIClk.
- b. Note that the delays shown are using 8-mA drive strength.

Figure 25-23. SSI Timing for TI Frame Format (FRF=01), Single Transfer Timing Measurement

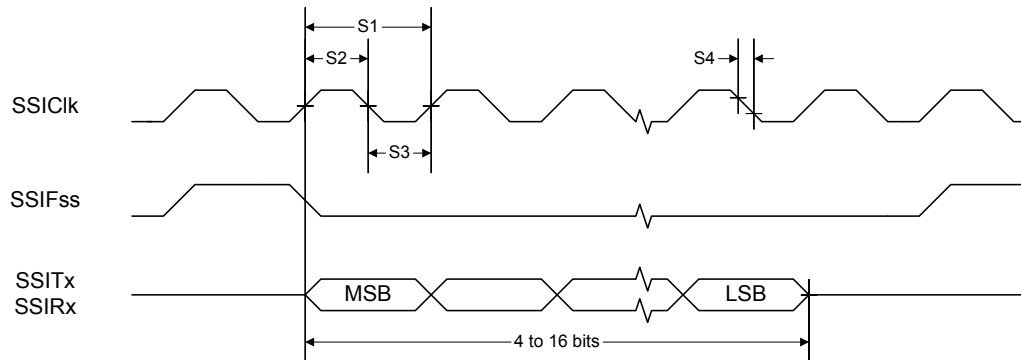


Figure 25-24. SSI Timing for MICROWIRE Frame Format (FRF=10), Single Transfer

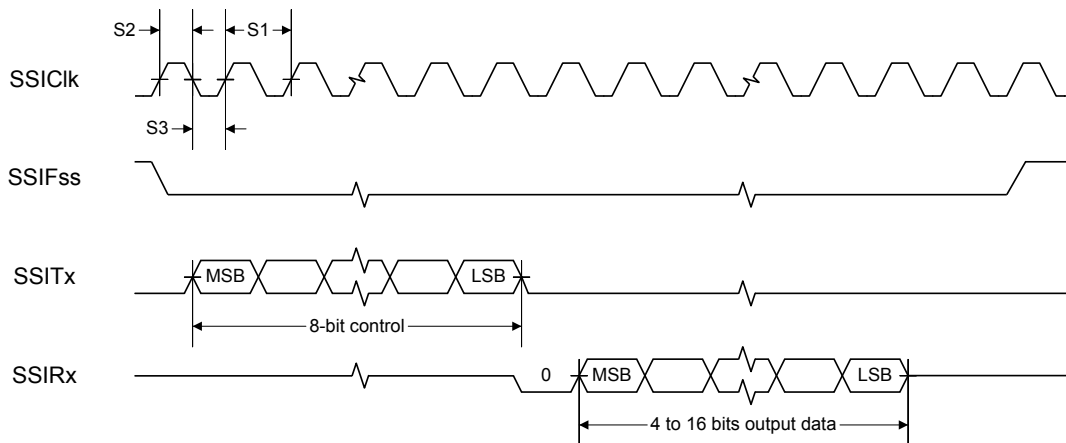
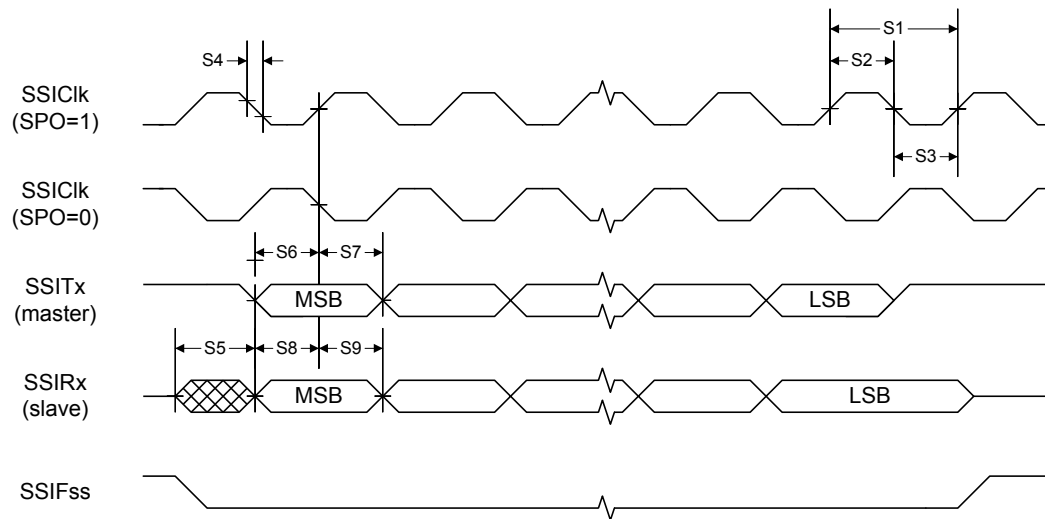


Figure 25-25. SSI Timing for SPI Frame Format (FRF=00), with SPH=1



25.16 Inter-Integrated Circuit (I²C) Interface

Table 25-29. I²C Characteristics

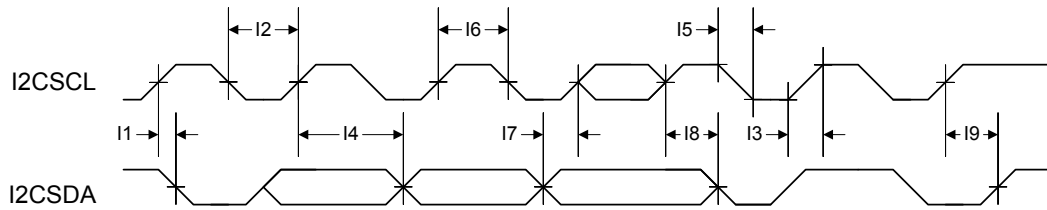
| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|-----------------|-------------------|---|-----|-----|--------------|---------------|
| 11 ^a | T _{SCH} | Start condition hold time | 36 | - | - | system clocks |
| 12 ^a | T _{LP} | Clock Low period | 36 | - | - | system clocks |
| 13 ^b | T _{SRT} | I ² C _{SCL} /I ² C _{SDA} rise time (V _{IL} =0.5 V to V _{IH} =2.4 V) | - | - | (see note b) | ns |
| 14 ^a | T _{DH} | Data hold time | 2 | - | - | system clocks |
| 15 ^c | T _{SFT} | I ² C _{SCL} /I ² C _{SDA} fall time (V _{IH} =2.4 V to V _{IL} =0.5 V) | - | 9 | 10 | ns |
| 16 ^a | T _{HT} | Clock High time | 24 | - | - | system clocks |
| 17 ^a | T _{DS} | Data setup time | 18 | - | - | system clocks |
| 18 ^a | T _{SCSR} | Start condition setup time (for repeated start condition only) | 36 | - | - | system clocks |
| 19 ^a | T _{SCS} | Stop condition setup time | 24 | - | - | system clocks |

a. Values depend on the value programmed into the TPR bit in the I²C Master Timer Period (I²C_{MTPR}) register; a TPR programmed for the maximum I²C_{SCL} frequency (TPR=0x2) results in a minimum output timing as shown in the table above. The I²C interface is designed to scale the actual data transition time to move it to the middle of the I²C_{SCL} Low period. The actual position is affected by the value programmed into the TPR; however, the numbers given in the above values are minimum values.

b. Because I²C_{SCL} and I²C_{SDA} are open-drain-type outputs, which the controller can only actively drive Low, the time I²C_{SCL} or I²C_{SDA} takes to reach a high level depends on external signal capacitance and pull-up resistor values.

c. Specified at a nominal 50 pF load.

Figure 25-26. I²C Timing



25.17 Inter-Integrated Circuit Sound (I²S) Interface

Table 25-30. I²S Master Clock (Receive and Transmit)

| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------|------------------------|----------------|--|-----|-----|------|
| M1 | T _{MCLK_PER} | Cycle time | 20.3 | - | - | ns |
| M2 | T _{MCLKRF} | Rise/fall time | See "Input/Output Characteristics" on page 1138. | | | ns |
| M3 | T _{MCLK_HIGH} | High time | 10 | - | - | ns |
| M4 | T _{MCLK_LOW} | Low time | 10 | - | - | ns |
| M5 | T _{MDC} | Duty cycle | 48 | - | 52 | % |
| M6 | T _{MJITTER} | Jitter | - | - | 2.5 | ns |

Table 25-31. I²S Slave Clock (Receive and Transmit)

| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------|------------------------|----------------|-----|-----|-----|------|
| M7 | T _{SCLK_PER} | Cycle time | 80 | - | - | ns |
| M8 | T _{SCLK_HIGH} | High time | 40 | - | - | ns |
| M9 | T _{SCLK_LOW} | Low time | 40 | - | - | ns |
| M10 | T _{SDC} | Duty cycle | - | 50 | - | % |

Table 25-32. I²S Master Mode

| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------|-------------------|------------------------------|-----|-----|-----|------|
| M11 | T _{MSWS} | SCK fall to WS valid | - | - | 10 | ns |
| M12 | T _{MSD} | SCK fall to TXSD valid | - | - | 10 | ns |
| M13 | T _{MSDS} | RXSD setup time to SCK rise | 10 | - | - | ns |
| M14 | T _{MSDH} | RXSD hold time from SCK rise | 10 | - | - | ns |

Figure 25-27. I²S Master Mode Transmit Timing

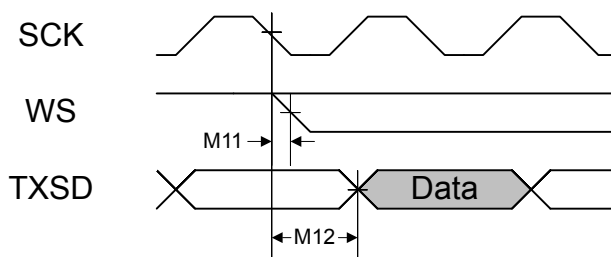
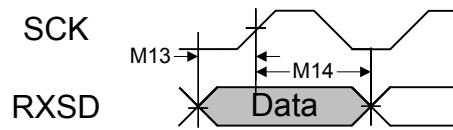
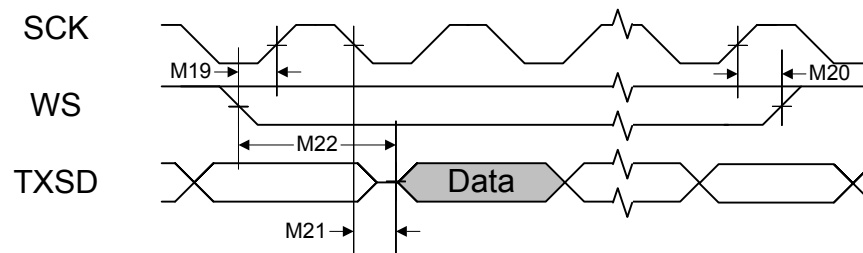
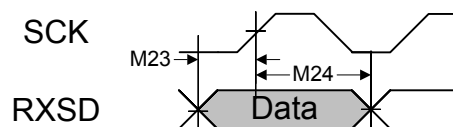


Figure 25-28. I²S Master Mode Receive TimingTable 25-33. I²S Slave Mode

| Parameter No. | Parameter | Parameter Name | Min | Nom | Max | Unit |
|---------------|------------------|---------------------------------|-----|-----|-----|------|
| M15 | T_{SCLK_PER} | Cycle time | 80 | - | - | ns |
| M16 | T_{SCLK_HIGH} | High time | 40 | - | - | ns |
| M17 | T_{SCLK_LOW} | Low time | 40 | - | - | ns |
| M18 | T_{SDC} | Duty cycle | - | 50 | - | % |
| M19 | T_{SSETUP} | WS setup time to SCK rise | - | - | 25 | ns |
| M20 | T_{SHOLD} | WS hold time from SCK rise | - | - | 10 | ns |
| M21 | T_{SSD} | SCK fall to TXSD valid | - | - | 20 | ns |
| M22 | T_{SLSD} | Left-justified mode, WS to TXSD | - | - | 20 | ns |
| M23 | T_{SSDS} | RXSD setup time to SCK rise | 10 | - | - | ns |
| M24 | T_{SSDH} | RXSD hold time from SCK rise | 10 | - | - | ns |

Figure 25-29. I²S Slave Mode Transmit TimingFigure 25-30. I²S Slave Mode Receive Timing

25.18 Analog Comparator

Table 25-34. Analog Comparator Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|--------------------|---------------------------------|-----|-----|--------------|------|
| V_{INP}, V_{INN} | Input voltage range | GND | - | V_{DD} | V |
| V_{CM} | Input common mode voltage range | GND | - | $V_{DD}-1.5$ | V |

Table 25-34. Analog Comparator Characteristics (continued)

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|------------------|--|-----|-----|-----|------|
| V _{OS} | Input offset voltage | - | ±10 | ±25 | mV |
| C _{MRR} | Common mode rejection ratio | 50 | - | - | dB |
| T _{RT} | Response time | - | - | 1.0 | µs |
| T _{MC} | Comparator mode change to Output Valid | - | - | 10 | µs |

Table 25-35. Analog Comparator Voltage Reference Characteristics

| Parameter | Parameter Name | Min | Nom | Max | Unit |
|-----------------|------------------------------|-----|----------------------|---------------------|------|
| R _{HR} | Resolution in high range | - | V _{DDA} /31 | - | V |
| R _{LR} | Resolution in low range | - | V _{DDA} /23 | - | V |
| A _{HR} | Absolute accuracy high range | - | - | ±R _{HR} /2 | V |
| A _{LR} | Absolute accuracy low range | - | - | ±R _{LR} /4 | V |

25.19 Current Consumption

This section provides information on typical and maximum power consumption under various conditions. Unless otherwise indicated, current consumption numbers include use of the on-chip LDO regulator and therefore include I_{DDC}.

25.19.1 Nominal Power Consumption

The following table provides nominal figures for current consumption.

Table 25-36. Nominal Power Consumption

| Parameter | Parameter Name | Conditions | Nom | Unit |
|---------------------------|---|--|-----|------|
| I _{DD_RUN} | Run mode 1 (Flash loop) | V _{DD} = 3.3 V Code= while(1){} executed out of Flash Peripherals = All ON System Clock = 80 MHz (with PLL) Temp = 25°C | 90 | mA |
| I _{DD_SLEEP} | Sleep mode | V _{DD} = 3.3 V Peripherals = All clock gated System Clock = 80 MHz (with PLL) Temp = 25°C | 20 | mA |
| I _{DD_DEEPSLEEP} | Deep-sleep mode | Peripherals = All OFF System Clock = IOS30KHZ/64 Temp = 25°C | 550 | µA |
| I _{HIB_NORTC} | Hibernate mode (external wake, RTC disabled, I/O not powered ^a) | V _{BAT} = 3.0 V V _{DD} = 0 V V _{DDA} = 0 V Peripherals = All OFF System Clock = OFF Hibernate Module = 0 kHz | 30 | µA |

Table 25-36. Nominal Power Consumption (continued)

| Parameter | Parameter Name | Conditions | Nom | Unit |
|----------------------|---|---|-----|------|
| I _{HIB_RTC} | Hibernate mode (RTC enabled, I/O not powered ^a) | V _{BAT} = 3.0 V V _{DD} = 0 V V _{DDA} = 0 V Peripherals = All OFF System Clock = OFF Hibernate Module = 32 kHz | 44 | μA |

a. The VDD3ON mode must be disabled for the I/O ring to be unpowered.

25.19.2 Maximum Current Consumption

The current measurements specified in the table that follows are maximum values under the following conditions:

- V_{DD} = 3.6 V
- V_{DDC} = 1.3 V
- V_{BAT} = 3.25 V
- V_{DDA} = 3.6 V
- Temperature = 25°C
- Clock source (MOSC) = 16.348-MHz crystal oscillator

Table 25-37. Detailed Current Specifications

| Parameter | Parameter Name | Conditions | Max | Unit |
|---------------------------|-------------------------|---|-----|------|
| I _{DD_RUN} | Run mode 1 (Flash loop) | V _{DD} = 3.6 V Code= while(1){} executed out of Flash Peripherals = All ON System Clock = 80 MHz (with PLL) Temperature = 85°C | 135 | mA |
| I _{DD_SLEEP} | Sleep mode | V _{DD} = 3.6 V Peripherals = All Clock Gated System Clock = 80 MHz (with PLL) Temperature = 85°C | 46 | mA |
| I _{DD_DEEPSLEEP} | Deep-Sleep mode | V _{DD} = 3.6 V Peripherals = All Clock Gated System Clock = IOS30/64 Temperature = 85°C | 1.6 | mA |

Table 25-38. Hibernation Detailed Current Specifications

| Parameter | Parameter Name | Conditions | Max | Unit |
|-------------------------|---|--|-----|------|
| $I_{\text{HIB_NORTC}}$ | Hibernate mode (external wake, RTC disabled, I/O not powered ^a) | $V_{\text{BAT}} = 3.25 \text{ V}$ $V_{\text{DD}} = 0 \text{ V}$ $V_{\text{DDA}} = 0 \text{ V}$ Peripherals = All OFF System Clock = OFF Hibernate Module = 0 kHz Temperature = 85°C | 118 | μA |
| $I_{\text{HIB_RTC}}$ | Hibernate mode (RTC enabled, I/O not powered ^a) | $V_{\text{BAT}} = 3.25 \text{ V}$ $V_{\text{DD}} = 0 \text{ V}$ $V_{\text{DDA}} = 0 \text{ V}$ Peripherals = All OFF System Clock = OFF Hibernate Module = 32.768 kHz Temperature = 85°C | 141 | μA |

a. The VDD3ON mode must be disabled for the I/O ring to be unpowered.

A Register Quick Reference

| | | | | | | | | | | | | | | | |
|--|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| The Cortex-M3 Processor | | | | | | | | | | | | | | | |
| R0, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R1, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R2, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R3, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R4, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R5, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R6, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R7, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R8, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R9, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R10, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R11, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| R12, type R/W, , reset - (see page 67) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| SP, type R/W, , reset - (see page 68) | | | | | | | | | | | | | | | |
| SP | | | | | | | | | | | | | | | |
| SP | | | | | | | | | | | | | | | |
| LR, type R/W, , reset 0xFFFF.FFFF (see page 69) | | | | | | | | | | | | | | | |
| LINK | | | | | | | | | | | | | | | |
| LINK | | | | | | | | | | | | | | | |
| PC, type R/W, , reset - (see page 70) | | | | | | | | | | | | | | | |
| PC | | | | | | | | | | | | | | | |
| PC | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|----|----|----|----|----------|----|-------|---------|----|----|----|---------|-------|-------|-----------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| PSR, type R/W, , reset 0x0100.0000 (see page 71) | | | | | | | | | | | | | | | |
| N | Z | C | V | Q | ICI / IT | | THUMB | | | | | | | | |
| ICI / IT | | | | | | | | ISRNUM | | | | | | | |
| PRIMASK, type R/W, , reset 0x0000.0000 (see page 75) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PRIMASK |
| FAULTMASK, type R/W, , reset 0x0000.0000 (see page 76) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | FAULTMASK |
| BASEPRI, type R/W, , reset 0x0000.0000 (see page 77) | | | | | | | | | | | | | | | |
| | | | | | | | | BASEPRI | | | | | | | |
| CONTROL, type R/W, , reset 0x0000.0000 (see page 78) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | ASP | TMPL |
| Cortex-M3 Peripherals | | | | | | | | | | | | | | | |
| System Timer (SysTick) Registers | | | | | | | | | | | | | | | |
| Base 0xE000.E000 | | | | | | | | | | | | | | | |
| STCTRL, type R/W, offset 0x010, reset 0x0000.0004 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CLK_SRC | INTEN | COUNT | ENABLE |
| STRELOAD, type R/W, offset 0x014, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | RELOAD | | | |
| RELOAD | | | | | | | | | | | | | | | |
| STCURRENT, type R/W, offset 0x018, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CURRENT | | | |
| CURRENT | | | | | | | | | | | | | | | |
| Cortex-M3 Peripherals | | | | | | | | | | | | | | | |
| Nested Vectored Interrupt Controller (NVIC) Registers | | | | | | | | | | | | | | | |
| Base 0xE000.E000 | | | | | | | | | | | | | | | |
| EN0, type R/W, offset 0x100, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INT | | | |
| INT | | | | | | | | | | | | | | | |
| EN1, type R/W, offset 0x104, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INT | | | |
| INT | | | | | | | | | | | | | | | |
| DIS0, type R/W, offset 0x180, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INT | | | |
| INT | | | | | | | | | | | | | | | |
| DIS1, type R/W, offset 0x184, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INT | | | |
| INT | | | | | | | | | | | | | | | |
| PEND0, type R/W, offset 0x200, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INT | | | |
| INT | | | | | | | | | | | | | | | |
| PEND1, type R/W, offset 0x204, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INT | | | |
| INT | | | | | | | | | | | | | | | |
| UNPEND0, type R/W, offset 0x280, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INT | | | |
| INT | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|----|----|----|----|----|----|----|------|----|----|----|-----|----|----|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| UNPEND1, type R/W, offset 0x284, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INT | | | |
| INT | | | | | | | | | | | | | | | |
| ACTIVE0, type RO, offset 0x300, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INT | | | | | | | | | | | | | | | |
| INT | | | | | | | | | | | | | | | |
| ACTIVE1, type RO, offset 0x304, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INT | | | |
| INT | | | | | | | | | | | | | | | |
| PRI0, type R/W, offset 0x400, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI1, type R/W, offset 0x404, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI2, type R/W, offset 0x408, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI3, type R/W, offset 0x40C, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI4, type R/W, offset 0x410, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI5, type R/W, offset 0x414, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI6, type R/W, offset 0x418, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI7, type R/W, offset 0x41C, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI8, type R/W, offset 0x420, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI9, type R/W, offset 0x424, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI10, type R/W, offset 0x428, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI11, type R/W, offset 0x42C, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI12, type R/W, offset 0x430, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |
| PRI13, type R/W, offset 0x434, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTD | | | | | | | | INTC | | | | | | | |
| INTB | | | | | | | | INTA | | | | | | | |

| | | | | | | | | | | | | | | | |
|--|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| SWTRIG, type WO, offset 0xF00, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| INTID | | | | | | | | | | | | | | | |
| Cortex-M3 Peripherals | | | | | | | | | | | | | | | |
| System Control Block (SCB) Registers | | | | | | | | | | | | | | | |
| Base 0xE000.E000 | | | | | | | | | | | | | | | |
| ACTLR, type R/W, offset 0x008, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| DISFOLD DISWBUF DISMCYC | | | | | | | | | | | | | | | |
| CPUID, type RO, offset 0xD00, reset 0x412F.C230 | | | | | | | | | | | | | | | |
| IMP VAR CON | | | | | | | | | | | | | | | |
| PARTNO REV | | | | | | | | | | | | | | | |
| INTCTRL, type R/W, offset 0xD04, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| NMISSET PENDSV UNPENDSV PENDSTSET PENDSTCLR ISRPRE ISRPEND VECPEND | | | | | | | | | | | | | | | |
| VECPEND RETBASE VECTACT | | | | | | | | | | | | | | | |
| VTABLE, type R/W, offset 0xD08, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| BASE OFFSET | | | | | | | | | | | | | | | |
| OFFSET | | | | | | | | | | | | | | | |
| APINT, type R/W, offset 0xD0C, reset 0xFA05.0000 | | | | | | | | | | | | | | | |
| VECTKEY | | | | | | | | | | | | | | | |
| ENDIANESS PRIGROUP SYSRESREQ VECTOLRACT VECTRESET | | | | | | | | | | | | | | | |
| SYSCTRL, type R/W, offset 0xD10, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| SEVONPEND SLEEPDEEP SLEEPEXIT | | | | | | | | | | | | | | | |
| CFGCTRL, type R/W, offset 0xD14, reset 0x0000.0200 | | | | | | | | | | | | | | | |
| STKALIGN BFHFNMIGN DIV0 UNALIGNED MAINPEND BASETHR | | | | | | | | | | | | | | | |
| SYSPRI1, type R/W, offset 0xD18, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| BUS USAGE MEM | | | | | | | | | | | | | | | |
| SYSPRI2, type R/W, offset 0xD1C, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| SVC | | | | | | | | | | | | | | | |
| SYSPRI3, type R/W, offset 0xD20, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| TICK PENDSV DEBUG | | | | | | | | | | | | | | | |
| SYSHNDCTRL, type R/W, offset 0xD24, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| SVC BUSP MEMP USAGEP TICK PNDV MON SVCA USGA USAGE BUS MEM | | | | | | | | | | | | | | | |
| BFAV BSTKE BUSTKE IMPRE PRECISE IBUS MMARV MSTKE MUSTKE DERR IERR | | | | | | | | | | | | | | | |
| HFAULTSTAT, type R/W1C, offset 0xD28, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| DBG FORCED VECT | | | | | | | | | | | | | | | |
| MMADDR, type R/W, offset 0xD34, reset - | | | | | | | | | | | | | | | |
| ADDR | | | | | | | | | | | | | | | |
| ADDR | | | | | | | | | | | | | | | |
| FAULTADDR, type R/W, offset 0xD38, reset - | | | | | | | | | | | | | | | |
| ADDR | | | | | | | | | | | | | | | |
| ADDR | | | | | | | | | | | | | | | |

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|--|----|----|----|----|----|----|----|------|----|----|----|------------|----|---------|----|--------|--|--|--|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | | | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | |
| Cortex-M3 Peripherals | | | | | | | | | | | | | | | | | | | |
| Memory Protection Unit (MPU) Registers | | | | | | | | | | | | | | | | | | | |
| Base 0xE000.E000 | | | | | | | | | | | | | | | | | | | |
| MPUTYPE, type RO, offset 0xD90, reset 0x0000.0800 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | IREGION | | | | | | | |
| DREGION | | | | | | | | | | | | SEPARATE | | | | | | | |
| MPUCTRL, type R/W, offset 0xD94, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PRIVDEFEN | | HFNMENA | | ENABLE | | | |
| MPUNUMBER, type R/W, offset 0xD98, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | NUMBER | | | | | | | |
| MPUBASE, type R/W, offset 0xD9C, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | |
| ADDR | | | | | | | | | | | | VALID | | REGION | | | | | |
| MPUBASE1, type R/W, offset 0xDA4, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | |
| ADDR | | | | | | | | | | | | VALID | | REGION | | | | | |
| MPUBASE2, type R/W, offset 0xDAC, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | |
| ADDR | | | | | | | | | | | | VALID | | REGION | | | | | |
| MPUBASE3, type R/W, offset 0xDB4, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | |
| ADDR | | | | | | | | | | | | VALID | | REGION | | | | | |
| MPUATTR, type R/W, offset 0xDA0, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | |
| XN | | | | AP | | | | TEX | | | | S | | C | | B | | | |
| SRD | | | | | | | | SIZE | | | | ENABLE | | | | | | | |
| MPUATTR1, type R/W, offset 0xDA8, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | |
| XN | | | | AP | | | | TEX | | | | S | | C | | B | | | |
| SRD | | | | | | | | SIZE | | | | ENABLE | | | | | | | |
| MPUATTR2, type R/W, offset 0xDB0, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | |
| XN | | | | AP | | | | TEX | | | | S | | C | | B | | | |
| SRD | | | | | | | | SIZE | | | | ENABLE | | | | | | | |
| MPUATTR3, type R/W, offset 0xDB8, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | |
| XN | | | | AP | | | | TEX | | | | S | | C | | B | | | |
| SRD | | | | | | | | SIZE | | | | ENABLE | | | | | | | |
| System Control | | | | | | | | | | | | | | | | | | | |
| Base 0x400F.E000 | | | | | | | | | | | | | | | | | | | |
| DID0, type RO, offset 0x000, reset - (see page 200) | | | | | | | | | | | | | | | | | | | |
| VER | | | | | | | | | | | | CLASS | | | | | | | |
| MAJOR | | | | | | | | | | | | MINOR | | | | | | | |
| PBORCTL, type R/W, offset 0x030, reset 0x0000.0002 (see page 202) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BORIOR | | | | | | | |
| RIS, type RO, offset 0x050, reset 0x0000.0000 (see page 203) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | MOSCPUPRIS | | PLLLRIS | | BORRIS | | | |
| IMC, type R/W, offset 0x054, reset 0x0000.0000 (see page 205) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | MOSCPUPIM | | PLLLIM | | BORIM | | | |

| | | | | | | | | | | | | | | | | | |
|---|-----------|-----------|-----------|-----------|------------|-----------|------------|-----------|-----------|----------|----------|----------|-----------|----------|----------|---------|---------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | |
| DC5, type RO, offset 0x020, reset 0x0F30.00FF (see page 241) | | | | | | | | | | | | | | | | | |
| | | | | | | PWMFAULT3 | PWMFAULT2 | PWMFAULT1 | PWMFAULT0 | | | PWMEFLT | PWME SYNC | | | | |
| | | | | | | | | | | PWM7 | PWM6 | PWM5 | PWM4 | PWM3 | PWM2 | PWM1 | PWM0 |
| DC6, type RO, offset 0x024, reset 0x0000.0000 (see page 243) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| DC7, type RO, offset 0x028, reset 0xFFFF.FFFF (see page 244) | | | | | | | | | | | | | | | | | |
| | DMACH30 | DMACH29 | DMACH28 | DMACH27 | DMACH26 | DMACH25 | DMACH24 | DMACH23 | DMACH22 | DMACH21 | DMACH20 | DMACH19 | DMACH18 | DMACH17 | DMACH16 | | |
| DMACH15 | DMACH14 | DMACH13 | DMACH12 | DMACH11 | DMACH10 | DMACH9 | DMACH8 | DMACH7 | DMACH6 | DMACH5 | DMACH4 | DMACH3 | DMACH2 | DMACH1 | DMACH0 | | |
| DC8, type RO, offset 0x02C, reset 0xFFFF.FFFF (see page 248) | | | | | | | | | | | | | | | | | |
| ADC1AIN15 | ADC1AIN14 | ADC1AIN13 | ADC1AIN12 | ADC1AIN11 | ADC1AIN10 | ADC1AIN9 | ADC1AIN8 | ADC1AIN7 | ADC1AIN6 | ADC1AIN5 | ADC1AIN4 | ADC1AIN3 | ADC1AIN2 | ADC1AIN1 | ADC1AIN0 | | |
| ADC0AIN15 | ADC0AIN14 | ADC0AIN13 | ADC0AIN12 | ADC0AIN11 | ADC0AIN10 | ADC0AIN9 | ADC0AIN8 | ADC0AIN7 | ADC0AIN6 | ADC0AIN5 | ADC0AIN4 | ADC0AIN3 | ADC0AIN2 | ADC0AIN1 | ADC0AIN0 | | |
| DC9, type RO, offset 0x190, reset 0x00FF.00FF (see page 251) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | ADC1DC7 | ADC1DC6 | ADC1DC5 | ADC1DC4 | ADC1DC3 | ADC1DC2 | ADC1DC1 | ADC1DC0 |
| | | | | | | | | | | ADC0DC7 | ADC0DC6 | ADC0DC5 | ADC0DC4 | ADC0DC3 | ADC0DC2 | ADC0DC1 | ADC0DC0 |
| NVMSTAT, type RO, offset 0x1A0, reset 0x0000.0001 (see page 253) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | FWB |
| RCGC0, type R/W, offset 0x100, reset 0x00000040 (see page 254) | | | | | | | | | | | | | | | | | |
| | | | | WDT1 | | | CAN1 | CAN0 | | | | PWM | | | ADC1 | ADC0 | |
| | | | | | MAXADC1SPD | | MAXADC0SPD | | | HIB | | | WDT0 | | | | |
| SCGC0, type R/W, offset 0x110, reset 0x00000040 (see page 257) | | | | | | | | | | | | | | | | | |
| | | | | WDT1 | | | CAN1 | CAN0 | | | | PWM | | | ADC1 | ADC0 | |
| | | | | | MAXADC1SPD | | MAXADC0SPD | | | HIB | | | WDT0 | | | | |
| DCGC0, type R/W, offset 0x120, reset 0x00000040 (see page 260) | | | | | | | | | | | | | | | | | |
| | | | | WDT1 | | | CAN1 | CAN0 | | | | PWM | | | ADC1 | ADC0 | |
| | | | | | | | | | | HIB | | | WDT0 | | | | |
| RCGC1, type R/W, offset 0x104, reset 0x00000000 (see page 262) | | | | | | | | | | | | | | | | | |
| | EPI0 | | I2S0 | | COMP2 | COMP1 | COMP0 | | | | | TIMER3 | TIMER2 | TIMER1 | TIMER0 | | |
| | I2C1 | | I2C0 | | | QE1 | QE0 | | | | SSI1 | SSI0 | | UART2 | UART1 | UART0 | |
| SCGC1, type R/W, offset 0x114, reset 0x00000000 (see page 266) | | | | | | | | | | | | | | | | | |
| | EPI0 | | I2S0 | | COMP2 | COMP1 | COMP0 | | | | | TIMER3 | TIMER2 | TIMER1 | TIMER0 | | |
| | I2C1 | | I2C0 | | | QE1 | QE0 | | | | SSI1 | SSI0 | | UART2 | UART1 | UART0 | |
| DCGC1, type R/W, offset 0x124, reset 0x00000000 (see page 270) | | | | | | | | | | | | | | | | | |
| | EPI0 | | I2S0 | | COMP2 | COMP1 | COMP0 | | | | | TIMER3 | TIMER2 | TIMER1 | TIMER0 | | |
| | I2C1 | | I2C0 | | | QE1 | QE0 | | | | SSI1 | SSI0 | | UART2 | UART1 | UART0 | |
| RCGC2, type R/W, offset 0x108, reset 0x00000000 (see page 274) | | | | | | | | | | | | | | | | | |
| | | UDMA | | | | | GPI0J | GPI0H | GPI0G | GPI0F | GPI0E | GPI0D | GPI0C | GPI0B | GPI0A | | |
| SCGC2, type R/W, offset 0x118, reset 0x00000000 (see page 276) | | | | | | | | | | | | | | | | | |
| | | UDMA | | | | | GPI0J | GPI0H | GPI0G | GPI0F | GPI0E | GPI0D | GPI0C | GPI0B | GPI0A | | |
| DCGC2, type R/W, offset 0x128, reset 0x00000000 (see page 278) | | | | | | | | | | | | | | | | | |
| | | UDMA | | | | | GPI0J | GPI0H | GPI0G | GPI0F | GPI0E | GPI0D | GPI0C | GPI0B | GPI0A | | |
| SRRC0, type R/W, offset 0x040, reset 0x00000000 (see page 280) | | | | | | | | | | | | | | | | | |
| | | | | WDT1 | | | CAN1 | CAN0 | | | | PWM | | | ADC1 | ADC0 | |
| | | | | | | | | | | HIB | | | WDT0 | | | | |
| SRRC1, type R/W, offset 0x044, reset 0x00000000 (see page 282) | | | | | | | | | | | | | | | | | |
| | EPI0 | | I2S0 | | COMP2 | COMP1 | COMP0 | | | | | TIMER3 | TIMER2 | TIMER1 | TIMER0 | | |
| | I2C1 | | I2C0 | | | QE1 | QE0 | | | | | SSI1 | SSI0 | | UART2 | UART1 | UART0 |

| | | | | | | | | | | | | | | | | |
|--|----|----|------|----|----|----|----|--------|--------|---------|----------|--------|--------|--------|--------|---------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| SRCCR2, type R/W, offset 0x048, reset 0x00000000 (see page 285) | | | | | | | | | | | | | | | | |
| | | | UDMA | | | | | GPIOJ | GPIOH | GPIOG | GPIOF | GPIOE | GPIOD | GPIOC | GPIOB | GPIOA |
| Hibernation Module | | | | | | | | | | | | | | | | |
| Base 0x400F.C000 | | | | | | | | | | | | | | | | |
| HIBRTCC, type RO, offset 0x000, reset 0x0000.0000 (see page 298) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | RTCC |
| | | | | | | | | | | | | | | | | RTCC |
| HIBRTCM0, type R/W, offset 0x004, reset 0xFFFF.FFFF (see page 299) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | RTCM0 |
| | | | | | | | | | | | | | | | | RTCM0 |
| HIBRTCM1, type R/W, offset 0x008, reset 0xFFFF.FFFF (see page 300) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | RTCM1 |
| | | | | | | | | | | | | | | | | RTCM1 |
| HIBRTCLD, type R/W, offset 0x00C, reset 0xFFFF.FFFF (see page 301) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | RTCLD |
| | | | | | | | | | | | | | | | | RTCLD |
| HIBCTL, type R/W, offset 0x010, reset 0x8000.0000 (see page 302) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | WRC |
| | | | | | | | | VDD3ON | VABORT | CLK32EN | LOWBATEN | PINWEN | RTCWEN | CLKSEL | HIBREQ | RTCEN |
| HIBIM, type R/W, offset 0x014, reset 0x0000.0000 (see page 305) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | EXTW |
| | | | | | | | | | | | | | | | | LOWBAT |
| | | | | | | | | | | | | | | | | RTCALT1 |
| | | | | | | | | | | | | | | | | RTCALT0 |
| HIBRIS, type RO, offset 0x018, reset 0x0000.0000 (see page 307) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | EXTW |
| | | | | | | | | | | | | | | | | LOWBAT |
| | | | | | | | | | | | | | | | | RTCALT1 |
| | | | | | | | | | | | | | | | | RTCALT0 |
| HIBMIS, type RO, offset 0x01C, reset 0x0000.0000 (see page 309) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | EXTW |
| | | | | | | | | | | | | | | | | LOWBAT |
| | | | | | | | | | | | | | | | | RTCALT1 |
| | | | | | | | | | | | | | | | | RTCALT0 |
| HIBIC, type R/W1C, offset 0x020, reset 0x0000.0000 (see page 311) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | EXTW |
| | | | | | | | | | | | | | | | | LOWBAT |
| | | | | | | | | | | | | | | | | RTCALT1 |
| | | | | | | | | | | | | | | | | RTCALT0 |
| HIBRTCT, type R/W, offset 0x024, reset 0x0000.7FFF (see page 312) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | TRIM |
| HIBDATA, type R/W, offset 0x030-0x12C, reset - (see page 313) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | RTD |
| | | | | | | | | | | | | | | | | RTD |
| Internal Memory | | | | | | | | | | | | | | | | |
| Flash Memory Registers (Flash Control Offset) | | | | | | | | | | | | | | | | |
| Base 0x400F.D000 | | | | | | | | | | | | | | | | |
| FMA, type R/W, offset 0x000, reset 0x0000.0000 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | OFFSET |
| | | | | | | | | | | | | | | | | OFFSET |
| FMD, type R/W, offset 0x004, reset 0x0000.0000 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | DATA |
| | | | | | | | | | | | | | | | | DATA |
| FMC, type R/W, offset 0x008, reset 0x0000.0000 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | WRKEY |
| | | | | | | | | | | | | | | | | COMT |
| | | | | | | | | | | | | | | | | MERASE |
| | | | | | | | | | | | | | | | | ERASE |
| | | | | | | | | | | | | | | | | WRITE |

| | | | | | | | | | | | | | | | | |
|--|------|----|----|-----|----|----|-----|----|----|----|----|----|------|-------------|--------|--|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| FCRIS, type RO, offset 0x00C, reset 0x0000.0000 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | PRIS | ARIS | |
| FCIM, type R/W, offset 0x010, reset 0x0000.0000 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | PMASK | AMASK | |
| FCMISC, type R/W1C, offset 0x014, reset 0x0000.0000 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | PMISC | AMISC | |
| FMC2, type R/W, offset 0x020, reset 0x0000.0000 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | WRKEY | | |
| | | | | | | | | | | | | | | WRBUF | | |
| FWBVAL, type R/W, offset 0x030, reset 0x0000.0000 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | FWB[n] | | |
| | | | | | | | | | | | | | | FWB[n] | | |
| FCTL, type R/W, offset 0x0F8, reset 0x0000.0000 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | USDACK | USDREQ | |
| FWBn, type R/W, offset 0x100 - 0x17C, reset 0x0000.0000 | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | DATA | | |
| | | | | | | | | | | | | | | DATA | | |
| Internal Memory | | | | | | | | | | | | | | | | |
| Memory Registers (System Control Offset) | | | | | | | | | | | | | | | | |
| Base 0x400F.E000 | | | | | | | | | | | | | | | | |
| RMCTL, type R/W1C, offset 0x0F0, reset - | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | BA | | |
| FMPRE0, type R/W, offset 0x130 and 0x200, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | READ_ENABLE | | |
| | | | | | | | | | | | | | | READ_ENABLE | | |
| FMPPE0, type R/W, offset 0x134 and 0x400, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | PROG_ENABLE | | |
| | | | | | | | | | | | | | | PROG_ENABLE | | |
| BOOTCFG, type R/W, offset 0x1D0, reset 0xFFFF.FFFE | | | | | | | | | | | | | | | | |
| NW | PORT | | | PIN | | | POL | EN | | | | | DBG1 | | DBG0 | |
| USER_REG0, type R/W, offset 0x1E0, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | | |
| NW | | | | | | | | | | | | | | | DATA | |
| | | | | | | | | | | | | | | DATA | | |
| USER_REG1, type R/W, offset 0x1E4, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | | |
| NW | | | | | | | | | | | | | | | DATA | |
| | | | | | | | | | | | | | | DATA | | |
| USER_REG2, type R/W, offset 0x1E8, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | | |
| NW | | | | | | | | | | | | | | | DATA | |
| | | | | | | | | | | | | | | DATA | | |
| USER_REG3, type R/W, offset 0x1EC, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | | |
| NW | | | | | | | | | | | | | | | DATA | |
| | | | | | | | | | | | | | | DATA | | |
| FMPRE1, type R/W, offset 0x204, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | READ_ENABLE | | |
| | | | | | | | | | | | | | | READ_ENABLE | | |

| | | | | | | | | | | | | | | | |
|--|----|----------|----|--------|----|---------|----|-------------|----|-------------|----|----------|----|---------|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| FMPRE2, type R/W, offset 0x208, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| FMPRE3, type R/W, offset 0x20C, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| FMPRE4, type R/W, offset 0x210, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| FMPRE5, type R/W, offset 0x214, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| FMPRE6, type R/W, offset 0x218, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| FMPRE7, type R/W, offset 0x21C, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| | | | | | | | | READ_ENABLE | | | | | | | |
| FMPPE1, type R/W, offset 0x404, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| FMPPE2, type R/W, offset 0x408, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| FMPPE3, type R/W, offset 0x40C, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| FMPPE4, type R/W, offset 0x410, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| FMPPE5, type R/W, offset 0x414, reset 0xFFFF.FFFF | | | | | | | | | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| FMPPE6, type R/W, offset 0x418, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| FMPPE7, type R/W, offset 0x41C, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| | | | | | | | | PROG_ENABLE | | | | | | | |
| Micro Direct Memory Access (μDMA) | | | | | | | | | | | | | | | |
| μDMA Channel Control Structure (Offset from Channel Control Table Base) | | | | | | | | | | | | | | | |
| Base n/a | | | | | | | | | | | | | | | |
| DMASRCNDP, type R/W, offset 0x000, reset - | | | | | | | | | | | | | | | |
| | | | | | | | | ADDR | | | | | | | |
| | | | | | | | | ADDR | | | | | | | |
| DMADSTNDP, type R/W, offset 0x004, reset - | | | | | | | | | | | | | | | |
| | | | | | | | | ADDR | | | | | | | |
| | | | | | | | | ADDR | | | | | | | |
| DMACHCTL, type R/W, offset 0x008, reset - | | | | | | | | | | | | | | | |
| DSTINC | | DSTSIZE | | SRCINC | | SRCSIZE | | | | | | | | ARBSIZE | |
| ARBSIZE | | XFERSIZE | | | | | | | | NXTUSEBURST | | XFERMODE | | | |

| | | | | | | | | | | | | | | | |
|--|----|----|----|----|----|----|----|------------|----|----|----|----------|----|--------|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Micro Direct Memory Access (μDMA) | | | | | | | | | | | | | | | |
| μDMA Registers (Offset from μDMA Base Address) | | | | | | | | | | | | | | | |
| Base 0x400F.F000 | | | | | | | | | | | | | | | |
| DMASTAT, type RO, offset 0x000, reset 0x001F.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DMACHANS | | | |
| | | | | | | | | | | | | STATE | | MASTEN | |
| DMACFG, type WO, offset 0x004, reset - | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | MASTEN | |
| DMACTLBASE, type R/W, offset 0x008, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | ADDR | | | | | | | |
| ADDR | | | | | | | | | | | | | | | |
| DMAALTBASE, type RO, offset 0x00C, reset 0x0000.0200 | | | | | | | | | | | | | | | |
| | | | | | | | | ADDR | | | | | | | |
| | | | | | | | | ADDR | | | | | | | |
| DMAWAITSTAT, type RO, offset 0x010, reset 0xFFFF.FFC0 | | | | | | | | | | | | | | | |
| | | | | | | | | WAITREQ[n] | | | | | | | |
| | | | | | | | | WAITREQ[n] | | | | | | | |
| DMASWREQ, type WO, offset 0x014, reset - | | | | | | | | | | | | | | | |
| | | | | | | | | SWREQ[n] | | | | | | | |
| | | | | | | | | SWREQ[n] | | | | | | | |
| DMAUSEBURSTSET, type R/W, offset 0x018, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | SET[n] | | | | | | | |
| | | | | | | | | SET[n] | | | | | | | |
| DMAUSEBURSTCLR, type WO, offset 0x01C, reset - | | | | | | | | | | | | | | | |
| | | | | | | | | CLR[n] | | | | | | | |
| | | | | | | | | CLR[n] | | | | | | | |
| DMAREQMASKSET, type R/W, offset 0x020, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | SET[n] | | | | | | | |
| | | | | | | | | SET[n] | | | | | | | |
| DMAREQMASKCLR, type WO, offset 0x024, reset - | | | | | | | | | | | | | | | |
| | | | | | | | | CLR[n] | | | | | | | |
| | | | | | | | | CLR[n] | | | | | | | |
| DMAENASET, type R/W, offset 0x028, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | SET[n] | | | | | | | |
| | | | | | | | | SET[n] | | | | | | | |
| DMAENACL, type WO, offset 0x02C, reset - | | | | | | | | | | | | | | | |
| | | | | | | | | CLR[n] | | | | | | | |
| | | | | | | | | CLR[n] | | | | | | | |
| DMAALTSET, type R/W, offset 0x030, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | SET[n] | | | | | | | |
| | | | | | | | | SET[n] | | | | | | | |
| DMAALTCLR, type WO, offset 0x034, reset - | | | | | | | | | | | | | | | |
| | | | | | | | | CLR[n] | | | | | | | |
| | | | | | | | | CLR[n] | | | | | | | |
| DMAPRIOSET, type R/W, offset 0x038, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | SET[n] | | | | | | | |
| | | | | | | | | SET[n] | | | | | | | |
| DMAPRIOCLR, type WO, offset 0x03C, reset - | | | | | | | | | | | | | | | |
| | | | | | | | | CLR[n] | | | | | | | |
| | | | | | | | | CLR[n] | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-----------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| DMAERRCLR, type R/W, offset 0x04C, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | ERRCLR |
| DMACHASGN, type R/W, offset 0x500, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | CHASGN[n] |
| | | | | | | | | | | | | | | | CHASGN[n] |
| DMACHIS, type R/W1C, offset 0x504, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | CHIS[n] |
| | | | | | | | | | | | | | | | CHIS[n] |
| DMAPeriphID0, type RO, offset 0xFE0, reset 0x0000.0030 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID0 |
| DMAPeriphID1, type RO, offset 0xFE4, reset 0x0000.00B2 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID1 |
| DMAPeriphID2, type RO, offset 0xFE8, reset 0x0000.000B | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID2 |
| DMAPeriphID3, type RO, offset 0xFEC, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID3 |
| DMAPeriphID4, type RO, offset 0xFD0, reset 0x0000.0004 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID4 |
| DMAPCellID0, type RO, offset 0xFF0, reset 0x0000.000D | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | CID0 |
| DMAPCellID1, type RO, offset 0xFF4, reset 0x0000.00F0 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | CID1 |
| DMAPCellID2, type RO, offset 0xFF8, reset 0x0000.0005 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | CID2 |
| DMAPCellID3, type RO, offset 0xFFC, reset 0x0000.00B1 | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | CID3 |
| General-Purpose Input/Outputs (GPIOs) | | | | | | | | | | | | | | | |
| GPIO Port A (APB) base: 0x4000.4000 | | | | | | | | | | | | | | | |
| GPIO Port A (AHB) base: 0x4005.8000 | | | | | | | | | | | | | | | |
| GPIO Port B (APB) base: 0x4000.5000 | | | | | | | | | | | | | | | |
| GPIO Port B (AHB) base: 0x4005.9000 | | | | | | | | | | | | | | | |
| GPIO Port C (APB) base: 0x4000.6000 | | | | | | | | | | | | | | | |
| GPIO Port C (AHB) base: 0x4005.A000 | | | | | | | | | | | | | | | |
| GPIO Port D (APB) base: 0x4000.7000 | | | | | | | | | | | | | | | |
| GPIO Port D (AHB) base: 0x4005.B000 | | | | | | | | | | | | | | | |
| GPIO Port E (APB) base: 0x4002.4000 | | | | | | | | | | | | | | | |
| GPIO Port E (AHB) base: 0x4005.C000 | | | | | | | | | | | | | | | |
| GPIO Port F (APB) base: 0x4002.5000 | | | | | | | | | | | | | | | |
| GPIO Port F (AHB) base: 0x4005.D000 | | | | | | | | | | | | | | | |
| GPIO Port G (APB) base: 0x4002.6000 | | | | | | | | | | | | | | | |
| GPIO Port G (AHB) base: 0x4005.E000 | | | | | | | | | | | | | | | |
| GPIO Port H (APB) base: 0x4002.7000 | | | | | | | | | | | | | | | |
| GPIO Port H (AHB) base: 0x4005.F000 | | | | | | | | | | | | | | | |
| GPIO Port J (APB) base: 0x4003.D000 | | | | | | | | | | | | | | | |
| GPIO Port J (AHB) base: 0x4006.0000 | | | | | | | | | | | | | | | |
| GPIODATA, type R/W, offset 0x000, reset 0x0000.0000 (see page 433) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | DATA |

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|--|----|----|----|----|----|----|----|----|----|----|----|-------|----|----|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| GPIO DIR, type R/W, offset 0x400, reset 0x0000.0000 (see page 434) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DIR | | | |
| GPIO IS, type R/W, offset 0x404, reset 0x0000.0000 (see page 435) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | IS | | | |
| GPIO IBE, type R/W, offset 0x408, reset 0x0000.0000 (see page 436) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | IBE | | | |
| GPIO IEV, type R/W, offset 0x40C, reset 0x0000.0000 (see page 437) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | IEV | | | |
| GPIO IME, type R/W, offset 0x410, reset 0x0000.0000 (see page 438) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | IME | | | |
| GPIO RIS, type RO, offset 0x414, reset 0x0000.0000 (see page 439) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | RIS | | | |
| GPIO MIS, type RO, offset 0x418, reset 0x0000.0000 (see page 440) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | MIS | | | |
| GPIO IC, type W1C, offset 0x41C, reset 0x0000.0000 (see page 442) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | IC | | | |
| GPIO AFSEL, type R/W, offset 0x420, reset - (see page 443) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AFSEL | | | |
| GPIO DRV2R, type R/W, offset 0x500, reset 0x0000.00FF (see page 445) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DRV2 | | | |
| GPIO DRV4R, type R/W, offset 0x504, reset 0x0000.0000 (see page 446) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DRV4 | | | |
| GPIO DRV8R, type R/W, offset 0x508, reset 0x0000.0000 (see page 447) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DRV8 | | | |
| GPIO ODE, type R/W, offset 0x50C, reset 0x0000.0000 (see page 448) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ODE | | | |
| GPIO PUE, type R/W, offset 0x510, reset - (see page 449) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PUE | | | |
| GPIO PDE, type R/W, offset 0x514, reset 0x0000.0000 (see page 451) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PDE | | | |
| GPIO SRL, type R/W, offset 0x518, reset 0x0000.0000 (see page 453) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | SRL | | | |
| GPIO DEN, type R/W, offset 0x51C, reset - (see page 454) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DEN | | | |

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|--|----|----|----|------|----|----|----|------|----|----|----|-------|----|------|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| GPIOLOCK, type R/W, offset 0x520, reset 0x0000.0001 (see page 456) | | | | | | | | | | | | | | | |
| LOCK | | | | | | | | | | | | | | | |
| LOCK | | | | | | | | | | | | | | | |
| GPIOCR, type -, offset 0x524, reset - (see page 457) | | | | | | | | | | | | | | | |
| CR | | | | | | | | | | | | | | | |
| GPIOAMSEL, type R/W, offset 0x528, reset 0x0000.0000 (see page 459) | | | | | | | | | | | | | | | |
| GPIOAMSEL | | | | | | | | | | | | | | | |
| GPIOPCTL, type R/W, offset 0x52C, reset - (see page 461) | | | | | | | | | | | | | | | |
| PMC7 | | | | PMC6 | | | | PMC5 | | | | PMC4 | | | |
| PMC3 | | | | PMC2 | | | | PMC1 | | | | PMC0 | | | |
| GPIOPeriphID4, type RO, offset 0xFD0, reset 0x0000.0000 (see page 463) | | | | | | | | | | | | | | | |
| PID4 | | | | | | | | | | | | | | | |
| GPIOPeriphID5, type RO, offset 0xFD4, reset 0x0000.0000 (see page 464) | | | | | | | | | | | | | | | |
| PID5 | | | | | | | | | | | | | | | |
| GPIOPeriphID6, type RO, offset 0xFD8, reset 0x0000.0000 (see page 465) | | | | | | | | | | | | | | | |
| PID6 | | | | | | | | | | | | | | | |
| GPIOPeriphID7, type RO, offset 0xFDC, reset 0x0000.0000 (see page 466) | | | | | | | | | | | | | | | |
| PID7 | | | | | | | | | | | | | | | |
| GPIOPeriphID0, type RO, offset 0xFE0, reset 0x0000.0061 (see page 467) | | | | | | | | | | | | | | | |
| PID0 | | | | | | | | | | | | | | | |
| GPIOPeriphID1, type RO, offset 0xFE4, reset 0x0000.0000 (see page 468) | | | | | | | | | | | | | | | |
| PID1 | | | | | | | | | | | | | | | |
| GPIOPeriphID2, type RO, offset 0xFE8, reset 0x0000.0018 (see page 469) | | | | | | | | | | | | | | | |
| PID2 | | | | | | | | | | | | | | | |
| GPIOPeriphID3, type RO, offset 0xFEC, reset 0x0000.0001 (see page 470) | | | | | | | | | | | | | | | |
| PID3 | | | | | | | | | | | | | | | |
| GPIOCellID0, type RO, offset 0xFF0, reset 0x0000.000D (see page 471) | | | | | | | | | | | | | | | |
| CID0 | | | | | | | | | | | | | | | |
| GPIOCellID1, type RO, offset 0xFF4, reset 0x0000.00F0 (see page 472) | | | | | | | | | | | | | | | |
| CID1 | | | | | | | | | | | | | | | |
| GPIOCellID2, type RO, offset 0xFF8, reset 0x0000.0005 (see page 473) | | | | | | | | | | | | | | | |
| CID2 | | | | | | | | | | | | | | | |
| GPIOCellID3, type RO, offset 0xFFC, reset 0x0000.00B1 (see page 474) | | | | | | | | | | | | | | | |
| CID3 | | | | | | | | | | | | | | | |
| External Peripheral Interface (EPI) | | | | | | | | | | | | | | | |
| Base 0x400D.0000 | | | | | | | | | | | | | | | |
| EPICFG, type R/W, offset 0x000, reset 0x0000.0000 (see page 507) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLKEN | | MODE | |

| | | | | | | | | | | | | | | | | | |
|---|---------|----|-------|--------|-------|--------|--------|---------|---------|--------|---------|--------|--------|-------|---------|--------|------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | |
| EPIBAUD, type R/W, offset 0x004, reset 0x0000.0000 (see page 508) | | | | | | | | | | | | | | | | | |
| COUNT1 | | | | | | | | | | | | | | | | | |
| COUNT0 | | | | | | | | | | | | | | | | | |
| EPISDRAMCFG, type R/W, offset 0x010, reset 0x82EE.0000 (see page 510) | | | | | | | | | | | | | | | | | |
| FREQ | | | | RFSH | | | | | | | | | | | | | |
| SLEEP | | | | | | | | | | SIZE | | | | | | | |
| EPIHB8CFG, type R/W, offset 0x010, reset 0x0000.FF00 (see page 512) | | | | | | | | | | | | | | | | | |
| MAXWAIT | | | | | | | | XFFEN | XFEEN | WRHIGH | RDHIGH | | | | | MODE | |
| MAXWAIT | | | | | | | | WRWS | RDWS | | | | | BSEL | MODE | | |
| EPIHB16CFG, type R/W, offset 0x010, reset 0x0000.FF00 (see page 515) | | | | | | | | | | | | | | | | | |
| MAXWAIT | | | | | | | | XFFEN | XFEEN | WRHIGH | RDHIGH | | | | | BSEL | MODE |
| MAXWAIT | | | | | | | | WRWS | RDWS | | | | | ASIZE | DSIZE | | |
| EPIGPCFG, type R/W, offset 0x010, reset 0x0000.0000 (see page 519) | | | | | | | | | | | | | | | | | |
| CLKPIN | CLKGATE | | RDYEN | FRMPIN | FRM50 | FRMCNT | | | | RW | | WR2CYC | RD2CYC | | | | |
| MAXWAIT | | | | | | | | | | | | ASIZE | DSIZE | | | | |
| EPIHB8CFG2, type R/W, offset 0x014, reset 0x0000.0000 (see page 524) | | | | | | | | | | | | | | | | | |
| WORD | | | | CSBAUD | CSCFG | | | | | WRHIGH | RDHIGH | | | | | | |
| | | | | | | | | WRWS | RDWS | | | | | | | | |
| EPIHB16CFG2, type R/W, offset 0x014, reset 0x0000.0000 (see page 527) | | | | | | | | | | | | | | | | | |
| WORD | | | | CSBAUD | CSCFG | | | | | WRHIGH | RDHIGH | | | | | | |
| | | | | | | | | WRWS | RDWS | | | | | | | | |
| EPIGPCFG2, type R/W, offset 0x014, reset 0x0000.0000 (see page 530) | | | | | | | | | | | | | | | | | |
| WORD | | | | | | | | | | | | | | | | | |
| EPIADDRMAP, type R/W, offset 0x01C, reset 0x0000.0000 (see page 531) | | | | | | | | | | | | | | | | | |
| | | | | | | | | EPSZ | EPADR | | | | | ERSZ | ERADR | | |
| EPIRSIZE0, type R/W, offset 0x020, reset 0x0000.0003 (see page 533) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | SIZE | | |
| EPIRSIZE1, type R/W, offset 0x030, reset 0x0000.0003 (see page 533) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | SIZE | | |
| EPIRADDR0, type R/W, offset 0x024, reset 0x0000.0000 (see page 534) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | ADDR | | |
| | | | | | | | | | | | | | | | ADDR | | |
| EPIRADDR1, type R/W, offset 0x034, reset 0x0000.0000 (see page 534) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | ADDR | | |
| | | | | | | | | | | | | | | | ADDR | | |
| EPIRPSTD0, type R/W, offset 0x028, reset 0x0000.0000 (see page 535) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | POSTCNT | | |
| EPIRPSTD1, type R/W, offset 0x038, reset 0x0000.0000 (see page 535) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | POSTCNT | | |
| EPISTAT, type RO, offset 0x060, reset 0x0000.0000 (see page 537) | | | | | | | | | | | | | | | | | |
| | | | | | | CELOW | XFFULL | XFEMPTY | INITSEQ | WBUSY | NBRBUSY | | | | | ACTIVE | |
| EPIRFIFOCNT, type RO, offset 0x06C, reset - (see page 539) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | COUNT | | |

| | | | | | | | | | | | | | | | | | | | | | |
|--|----|----|----|----|----|----|----|---------|----|--------|----|--------|----|---------|----|--------|--|-------|--|------|--|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | | | | | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| EPIREADFIFO, type RO, offset 0x070, reset - (see page 540) | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| EPIREADFIFO1, type RO, offset 0x074, reset - (see page 540) | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| EPIREADFIFO2, type RO, offset 0x078, reset - (see page 540) | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| EPIREADFIFO3, type RO, offset 0x07C, reset - (see page 540) | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| EPIREADFIFO4, type RO, offset 0x080, reset - (see page 540) | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| EPIREADFIFO5, type RO, offset 0x084, reset - (see page 540) | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| EPIREADFIFO6, type RO, offset 0x088, reset - (see page 540) | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| EPIREADFIFO7, type RO, offset 0x08C, reset - (see page 540) | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | |
| EPIFIFOLVL, type R/W, offset 0x200, reset 0x0000.0033 (see page 541) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | WFERR | | RSERR | | | | | | | |
| | | | | | | | | | | WRFIFO | | RDFIFO | | | | | | | | | |
| EPIWFIFOCNT, type RO, offset 0x204, reset 0x0000.0004 (see page 543) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | WTAV | | | | | | | |
| EPIIM, type R/W, offset 0x210, reset 0x0000.0000 (see page 544) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | WRIM | | RDMIS | | ERRMIS | | | | | |
| EPIRIS, type RO, offset 0x214, reset 0x0000.0004 (see page 545) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | WRRIS | | RDRIS | | ERRRIS | | | | | |
| EPIMIS, type RO, offset 0x218, reset 0x0000.0000 (see page 547) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | WRMIS | | RDMIS | | ERRMIS | | | | | |
| EPIEISC, type R/W1C, offset 0x21C, reset 0x0000.0000 (see page 548) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | WTFULL | | RSTALL | | TOUT | | | | | |
| General-Purpose Timers | | | | | | | | | | | | | | | | | | | | | |
| Timer 0 base: 0x4003.0000 | | | | | | | | | | | | | | | | | | | | | |
| Timer 1 base: 0x4003.1000 | | | | | | | | | | | | | | | | | | | | | |
| Timer 2 base: 0x4003.2000 | | | | | | | | | | | | | | | | | | | | | |
| Timer 3 base: 0x4003.3000 | | | | | | | | | | | | | | | | | | | | | |
| GPTMCFG, type R/W, offset 0x000, reset 0x0000.0000 (see page 567) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | GPTMCFG | | | | | | | |
| GPTMTAMR, type R/W, offset 0x004, reset 0x0000.0000 (see page 568) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | TASNAPS | | TAWOT | | TAMIE | | TACDIR | | TAAMS | | TACMR | | TAMR | |

| | | | | | | | | | | | | | | | | | |
|--|----|----|----|-------|---------|---------|---------|---------|---------|--------|--------|--------|---------|---------|---------|---------|----------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | |
| GPTMTBMR, type R/W, offset 0x008, reset 0x0000.0000 (see page 570) | | | | | | | | | | | | | | | | | |
| | | | | | | | | TBSNAPS | TBWOT | TBMIE | TBCDIR | TBAMS | TBCMR | TBMR | | | |
| GPTMCTL, type R/W, offset 0x00C, reset 0x0000.0000 (see page 572) | | | | | | | | | | | | | | | | | |
| TBPWML | | | | TBOTE | TBEVENT | | | TBSTALL | TBEN | TAPWML | | | TAOTE | RTCEN | TAEVENT | TASTALL | TAEN |
| GPTMIMR, type R/W, offset 0x018, reset 0x0000.0000 (see page 575) | | | | | | | | | | | | | | | | | |
| | | | | | | TBMIM | CBEIM | CBMIM | TBTOIM | | | | TAMIM | RTCIM | CAEIM | CAMIM | TATOIM |
| GPTMRIS, type RO, offset 0x01C, reset 0x0000.0000 (see page 577) | | | | | | | | | | | | | | | | | |
| | | | | | | TBMRIS | CBERIS | CBMRIS | TBTORIS | | | | TAMRIS | RTCIS | CAERIS | CAMRIS | TATORIS |
| GPTMMIS, type RO, offset 0x020, reset 0x0000.0000 (see page 580) | | | | | | | | | | | | | | | | | |
| | | | | | | TBMMIS | CBEMIS | CBMMIS | TBTOMIS | | | | TAMMIS | RTCMIS | CAEMIS | CAMMIS | TATOMIS |
| GPTMICR, type W1C, offset 0x024, reset 0x0000.0000 (see page 583) | | | | | | | | | | | | | | | | | |
| | | | | | | TBMCINT | CBECINT | CBMCINT | TBTCINT | | | | TAMCINT | RTCCINT | CAECINT | CAMCINT | TATOCINT |
| GPTMTAILR, type R/W, offset 0x028, reset 0xFFFF.FFFF (see page 585) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | TAILR | | | |
| | | | | | | | | | | | | | | TAILR | | | |
| GPTMTBILR, type R/W, offset 0x02C, reset 0x0000.FFFF (see page 586) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | TBILR | | | |
| | | | | | | | | | | | | | | TBILR | | | |
| GPTMTAMATCHR, type R/W, offset 0x030, reset 0xFFFF.FFFF (see page 587) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | TAMR | | | |
| | | | | | | | | | | | | | | TAMR | | | |
| GPTMTBMATCHR, type R/W, offset 0x034, reset 0x0000.FFFF (see page 588) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | TBMR | | | |
| | | | | | | | | | | | | | | TBMR | | | |
| GPTMTAPR, type R/W, offset 0x038, reset 0x0000.0000 (see page 589) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | TAPSR | | | | | |
| GPTMTBPR, type R/W, offset 0x03C, reset 0x0000.0000 (see page 590) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | TBPSR | | | | | |
| GPTMTAPMR, type R/W, offset 0x040, reset 0x0000.0000 (see page 591) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | TAPSMR | | | | | |
| GPTMTBPMR, type R/W, offset 0x044, reset 0x0000.0000 (see page 592) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | TBPSMR | | | | | |
| GPTMTAR, type RO, offset 0x048, reset 0xFFFF.FFFF (see page 593) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | TAR | | | |
| | | | | | | | | | | | | | | TAR | | | |
| GPTMTBR, type RO, offset 0x04C, reset 0x0000.FFFF (see page 594) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | TBR | | | |
| | | | | | | | | | | | | | | TBR | | | |
| GPTMTAV, type RW, offset 0x050, reset 0xFFFF.FFFF (see page 595) | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | TAV | | | |
| | | | | | | | | | | | | | | TAV | | | |

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|--|----|----|----|----|----|----|-------|----|----|----|----|----|----|-------|--------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| GPTMTBV, type RW, offset 0x054, reset 0x0000.FFFF (see page 596) | | | | | | | | | | | | | | | |
| TBV | | | | | | | | | | | | | | | |
| TBV | | | | | | | | | | | | | | | |
| Watchdog Timers | | | | | | | | | | | | | | | |
| WDT0 base: 0x4000.0000 | | | | | | | | | | | | | | | |
| WDT1 base: 0x4000.1000 | | | | | | | | | | | | | | | |
| WDTLOAD, type R/W, offset 0x000, reset 0xFFFF.FFFF (see page 601) | | | | | | | | | | | | | | | |
| WDTLOAD | | | | | | | | | | | | | | | |
| WDTLOAD | | | | | | | | | | | | | | | |
| WDTVALUE, type RO, offset 0x004, reset 0xFFFF.FFFF (see page 602) | | | | | | | | | | | | | | | |
| WDTVALUE | | | | | | | | | | | | | | | |
| WDTVALUE | | | | | | | | | | | | | | | |
| WDTCTL, type R/W, offset 0x008, reset 0x0000.0000 (WDT0) and 0x8000.0000 (WDT1) (see page 603) | | | | | | | | | | | | | | | |
| WRC | | | | | | | | | | | | | | RESEN | INTEN |
| WDTICR, type WO, offset 0x00C, reset - (see page 605) | | | | | | | | | | | | | | | |
| WDTINTCLR | | | | | | | | | | | | | | | |
| WDTINTCLR | | | | | | | | | | | | | | | |
| WDRIS, type RO, offset 0x010, reset 0x0000.0000 (see page 606) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | WDRIS |
| WDTMIS, type RO, offset 0x014, reset 0x0000.0000 (see page 607) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | WDTMIS |
| WDTTEST, type R/W, offset 0x418, reset 0x0000.0000 (see page 608) | | | | | | | | | | | | | | | |
| | | | | | | | STALL | | | | | | | | |
| WDTLOCK, type R/W, offset 0xC00, reset 0x0000.0000 (see page 609) | | | | | | | | | | | | | | | |
| WDTLOCK | | | | | | | | | | | | | | | |
| WDTLOCK | | | | | | | | | | | | | | | |
| WDTPeriphID4, type RO, offset 0xFD0, reset 0x0000.0000 (see page 610) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID4 |
| WDTPeriphID5, type RO, offset 0xFD4, reset 0x0000.0000 (see page 611) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID5 |
| WDTPeriphID6, type RO, offset 0xFD8, reset 0x0000.0000 (see page 612) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID6 |
| WDTPeriphID7, type RO, offset 0xFDC, reset 0x0000.0000 (see page 613) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID7 |
| WDTPeriphID0, type RO, offset 0xFE0, reset 0x0000.0005 (see page 614) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID0 |
| WDTPeriphID1, type RO, offset 0xFE4, reset 0x0000.0018 (see page 615) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID1 |
| WDTPeriphID2, type RO, offset 0xFE8, reset 0x0000.0018 (see page 616) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID2 |

| | | | | | | | | | | | | | | | |
|--|----|----|----|----------|----|----|----|-----|----|----|----|---------|---------|---------|---------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| WDTPeriphID3, type RO, offset 0xFEC, reset 0x0000.0001 (see page 617) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID3 | | | |
| WDTPCellID0, type RO, offset 0xFF0, reset 0x0000.000D (see page 618) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID0 | | | |
| WDTPCellID1, type RO, offset 0xFF4, reset 0x0000.00F0 (see page 619) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID1 | | | |
| WDTPCellID2, type RO, offset 0xFF8, reset 0x0000.0006 (see page 620) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID2 | | | |
| WDTPCellID3, type RO, offset 0xFFC, reset 0x0000.00B1 (see page 621) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID3 | | | |
| Analog-to-Digital Converter (ADC) ADC0 base: 0x4003.8000 ADC1 base: 0x4003.9000 | | | | | | | | | | | | | | | |
| ADCACTSS, type R/W, offset 0x000, reset 0x0000.0000 (see page 645) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ASEN3 | ASEN2 | ASEN1 | ASEN0 |
| ADCRIS, type RO, offset 0x004, reset 0x0000.0000 (see page 646) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INR3 | INR2 | INR1 | INR0 |
| ADCIM, type R/W, offset 0x008, reset 0x0000.0000 (see page 648) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DCONSS3 | DCONSS2 | DCONSS1 | DCONSS0 |
| | | | | | | | | | | | | MASK3 | MASK2 | MASK1 | MASK0 |
| ADCISC, type R/W1C, offset 0x00C, reset 0x0000.0000 (see page 650) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DCINSS3 | DCINSS2 | DCINSS1 | DCINSS0 |
| | | | | | | | | | | | | IN3 | IN2 | IN1 | IN0 |
| ADCOSTAT, type R/W1C, offset 0x010, reset 0x0000.0000 (see page 653) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | OV3 | OV2 | OV1 | OV0 |
| ADCEMUX, type R/W, offset 0x014, reset 0x0000.0000 (see page 655) | | | | | | | | | | | | | | | |
| EM3 | | | | EM2 | | | | EM1 | | | | EM0 | | | |
| ADCUSTAT, type R/W1C, offset 0x018, reset 0x0000.0000 (see page 660) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | UV3 | UV2 | UV1 | UV0 |
| ADCSSPRI, type R/W, offset 0x020, reset 0x0000.3210 (see page 661) | | | | | | | | | | | | | | | |
| SS3 | | | | SS2 | | | | SS1 | | | | SS0 | | | |
| ADCSPC, type R/W, offset 0x024, reset 0x0000.0000 (see page 663) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PHASE | | | |
| ADCPSSI, type R/W, offset 0x028, reset - (see page 665) | | | | | | | | | | | | | | | |
| GSYNC | | | | SYNCWAIT | | | | | | | | | | | |
| | | | | | | | | | | | | SS3 | SS2 | SS1 | SS0 |
| ADCSCAC, type R/W, offset 0x030, reset 0x0000.0000 (see page 667) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | AVG | | | |

| | | | | | | | | | | | | | | | |
|--|-----|------|----|---------|-----|------|----|---------|--------|--------|--------|---------|--------|--------|--------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| ADCDCISC, type R/W1C, offset 0x034, reset 0x0000.0000 (see page 668) | | | | | | | | | | | | | | | |
| | | | | | | | | DCINT7 | DCINT6 | DCINT5 | DCINT4 | DCINT3 | DCINT2 | DCINT1 | DCINT0 |
| ADCCTL, type R/W, offset 0x038, reset 0x0000.0000 (see page 670) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | RES | VREF | | | |
| ADCSSMUX0, type R/W, offset 0x040, reset 0x0000.0000 (see page 671) | | | | | | | | | | | | | | | |
| MUX7 | | | | MUX6 | | | | MUX5 | | | | MUX4 | | | |
| MUX3 | | | | MUX2 | | | | MUX1 | | | | MUX0 | | | |
| ADCSSCTL0, type R/W, offset 0x044, reset 0x0000.0000 (see page 673) | | | | | | | | | | | | | | | |
| TS7 | IE7 | END7 | D7 | TS6 | IE6 | END6 | D6 | TS5 | IE5 | END5 | D5 | TS4 | IE4 | END4 | D4 |
| TS3 | IE3 | END3 | D3 | TS2 | IE2 | END2 | D2 | TS1 | IE1 | END1 | D1 | TS0 | IE0 | END0 | D0 |
| ADCSSFIFO0, type RO, offset 0x048, reset - (see page 676) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| ADCSSFIFO1, type RO, offset 0x068, reset - (see page 676) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| ADCSSFIFO2, type RO, offset 0x088, reset - (see page 676) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| ADCSSFIFO3, type RO, offset 0x0A8, reset - (see page 676) | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| ADCSSFSTAT0, type RO, offset 0x04C, reset 0x0000.0100 (see page 677) | | | | | | | | | | | | | | | |
| FULL | | | | EMPTY | | | | HPTR | | | | TPTR | | | |
| ADCSSFSTAT1, type RO, offset 0x06C, reset 0x0000.0100 (see page 677) | | | | | | | | | | | | | | | |
| FULL | | | | EMPTY | | | | HPTR | | | | TPTR | | | |
| ADCSSFSTAT2, type RO, offset 0x08C, reset 0x0000.0100 (see page 677) | | | | | | | | | | | | | | | |
| FULL | | | | EMPTY | | | | HPTR | | | | TPTR | | | |
| ADCSSFSTAT3, type RO, offset 0x0AC, reset 0x0000.0100 (see page 677) | | | | | | | | | | | | | | | |
| FULL | | | | EMPTY | | | | HPTR | | | | TPTR | | | |
| ADCSSOP0, type R/W, offset 0x050, reset 0x0000.0000 (see page 679) | | | | | | | | | | | | | | | |
| S7DCOP | | | | S6DCOP | | | | S5DCOP | | | | S4DCOP | | | |
| S3DCOP | | | | S2DCOP | | | | S1DCOP | | | | S0DCOP | | | |
| ADCSSDC0, type R/W, offset 0x054, reset 0x0000.0000 (see page 681) | | | | | | | | | | | | | | | |
| S7DCSEL | | | | S6DCSEL | | | | S5DCSEL | | | | S4DCSEL | | | |
| S3DCSEL | | | | S2DCSEL | | | | S1DCSEL | | | | S0DCSEL | | | |
| ADCSSMUX1, type R/W, offset 0x060, reset 0x0000.0000 (see page 683) | | | | | | | | | | | | | | | |
| MUX3 | | | | MUX2 | | | | MUX1 | | | | MUX0 | | | |
| ADCSSMUX2, type R/W, offset 0x080, reset 0x0000.0000 (see page 683) | | | | | | | | | | | | | | | |
| MUX3 | | | | MUX2 | | | | MUX1 | | | | MUX0 | | | |
| ADCSSCTL1, type R/W, offset 0x064, reset 0x0000.0000 (see page 684) | | | | | | | | | | | | | | | |
| TS3 | IE3 | END3 | D3 | TS2 | IE2 | END2 | D2 | TS1 | IE1 | END1 | D1 | TS0 | IE0 | END0 | D0 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|----|----|----|------|----|----|----|------|----|----|----|------|----|----|----|------|--|-----|--|------|--|--|--|-----|--|--|--|-----|--|--|--|-----|--|--|--|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | | | | | | | | | | | | | | | | | | | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | | | | | | | | | | | | | | | |
| ADDCCTL7, type R/W, offset 0xE1C, reset 0x0000.0000 (see page 698) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | CTE | | | | CTC | | | | CTM | | | | CIE | | CIC | | CIM | | | | | | | | | | | | | | | |
| ADDCCMP0, type R/W, offset 0xE40, reset 0x0000.0000 (see page 701) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ADDCCMP1, type R/W, offset 0xE44, reset 0x0000.0000 (see page 701) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ADDCCMP2, type R/W, offset 0xE48, reset 0x0000.0000 (see page 701) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ADDCCMP3, type R/W, offset 0xE4C, reset 0x0000.0000 (see page 701) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ADDCCMP4, type R/W, offset 0xE50, reset 0x0000.0000 (see page 701) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ADDCCMP5, type R/W, offset 0xE54, reset 0x0000.0000 (see page 701) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ADDCCMP6, type R/W, offset 0xE58, reset 0x0000.0000 (see page 701) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ADDCCMP7, type R/W, offset 0xE5C, reset 0x0000.0000 (see page 701) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COMP0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Universal Asynchronous Receivers/Transmitters (UARTs) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UART0 base: 0x4000.C000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UART1 base: 0x4000.D000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UART2 base: 0x4000.E000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UARTDR, type R/W, offset 0x000, reset 0x0000.0000 (see page 718) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | OE | | | | BE | | | | PE | | | | FE | | | | DATA | | | | | | | | | | | | | | | |
| UARTSR/UARTECR, type RO, offset 0x004, reset 0x0000.0000 (Read-Only Status Register) (see page 720) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| BE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FE | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UARTSR/UARTECR, type WO, offset 0x004, reset 0x0000.0000 (Write-Only Error Clear Register) (see page 720) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UARTFR, type RO, offset 0x018, reset 0x0000.0090 (see page 723) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| RI | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | TXFE | | | | RXFF | | | | TXFF | | | | RXFE | | | | BUSY | | | | DCD | | | | DSR | | | | CTS | | | |
| UARTILPR, type R/W, offset 0x020, reset 0x0000.0000 (see page 726) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ILPDVSR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UARTIBRD, type R/W, offset 0x024, reset 0x0000.0000 (see page 727) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DIVINT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| UARTFBRD, type R/W, offset 0x028, reset 0x0000.0000 (see page 728) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| DIVFRAC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

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|---|---------|---------|----|-----|-------|-------|-------|-------|-------|-------|-------|----------|--------|----------|--------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| UARTLCRH, type R/W, offset 0x02C, reset 0x0000.0000 (see page 729) | | | | | | | | | | | | | | | |
| | | | | | | | | SPS | WLEN | FEN | | STP2 | EPS | PEN | BRK |
| UARTCTL, type R/W, offset 0x030, reset 0x0000.0300 (see page 731) | | | | | | | | | | | | | | | |
| CTSEN | RTSEN | | | RTS | DTR | RXE | TXE | LBE | LIN | HSE | EOT | SMART | SIRLP | SIREN | UARTEN |
| UARTIFLS, type R/W, offset 0x034, reset 0x0000.0012 (see page 735) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | RXIFLSEL | | TXIFLSEL | |
| UARTIM, type R/W, offset 0x038, reset 0x0000.0000 (see page 737) | | | | | | | | | | | | | | | |
| LME5IM | LME1IM | LMSBIM | | | OEIM | BEIM | PEIM | FEIM | RTIM | TXIM | RXIM | DSRIM | DCDIM | CTSIM | RIIM |
| UARTRIS, type RO, offset 0x03C, reset 0x0000.000F (see page 741) | | | | | | | | | | | | | | | |
| LME5RIS | LME1RIS | LMSBRIS | | | OERIS | BERIS | PERIS | FERIS | RTRIS | TXRIS | RXRIS | DSRRIS | DCDRIS | CTSRIS | RIRIS |
| UARTMIS, type RO, offset 0x040, reset 0x0000.0000 (see page 745) | | | | | | | | | | | | | | | |
| LME5MIS | LME1MIS | LMSBMIS | | | OEMIS | BEMIS | PEMIS | FEMIS | RTMIS | TXMIS | RXMIS | DSRMIS | DCDMIS | CTSMIS | RIMIS |
| UARTICR, type W1C, offset 0x044, reset 0x0000.0000 (see page 749) | | | | | | | | | | | | | | | |
| LME5IC | LME1IC | LMSBIC | | | OEIC | BEIC | PEIC | FEIC | RTIC | TXIC | RXIC | DSRMIC | DCDMIC | CTSMIC | RIMIC |
| UARTDMACTL, type R/W, offset 0x048, reset 0x0000.0000 (see page 751) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | DMAERR | TXDMAE | RXDMAE |
| UARTLCTL, type R/W, offset 0x090, reset 0x0000.0000 (see page 752) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | BLEN | | | MASTER |
| UARTLSS, type RO, offset 0x094, reset 0x0000.0000 (see page 753) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | TSS |
| UARTLTIM, type RO, offset 0x098, reset 0x0000.0000 (see page 754) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | TIMER |
| UARTPeriphID4, type RO, offset 0xFD0, reset 0x0000.0000 (see page 755) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID4 |
| UARTPeriphID5, type RO, offset 0xFD4, reset 0x0000.0000 (see page 756) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID5 |
| UARTPeriphID6, type RO, offset 0xFD8, reset 0x0000.0000 (see page 757) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID6 |
| UARTPeriphID7, type RO, offset 0xFDC, reset 0x0000.0000 (see page 758) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID7 |
| UARTPeriphID0, type RO, offset 0xFE0, reset 0x0000.0060 (see page 759) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID0 |
| UARTPeriphID1, type RO, offset 0xFE4, reset 0x0000.0000 (see page 760) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | PID1 |

| | | | | | | | | | | | | | | | | | | | |
|--|----|----|----|----|----|-----|----|-----|----|-------|----|---------|----|--------|----|--------|--|-----|--|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | | | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | |
| UARTPeriphID2, type RO, offset 0xFE8, reset 0x0000.0018 (see page 761) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID2 | | | | | | | |
| UARTPeriphID3, type RO, offset 0xFEC, reset 0x0000.0001 (see page 762) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID3 | | | | | | | |
| UARTPCellID0, type RO, offset 0xFF0, reset 0x0000.000D (see page 763) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID0 | | | | | | | |
| UARTPCellID1, type RO, offset 0xFF4, reset 0x0000.00F0 (see page 764) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID1 | | | | | | | |
| UARTPCellID2, type RO, offset 0xFF8, reset 0x0000.0005 (see page 765) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID2 | | | | | | | |
| UARTPCellID3, type RO, offset 0xFFC, reset 0x0000.00B1 (see page 766) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID3 | | | | | | | |
| Synchronous Serial Interface (SSI) | | | | | | | | | | | | | | | | | | | |
| SSIO base: 0x4000.8000 | | | | | | | | | | | | | | | | | | | |
| SSI1 base: 0x4000.9000 | | | | | | | | | | | | | | | | | | | |
| SSICR0, type R/W, offset 0x000, reset 0x0000.0000 (see page 782) | | | | | | | | | | | | | | | | | | | |
| SCR | | | | | | SPH | | SPO | | FRF | | DSS | | | | | | | |
| SSICR1, type R/W, offset 0x004, reset 0x0000.0000 (see page 784) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | EOT | | SOD | | MS | | SSE | | LBM | |
| SSIDR, type R/W, offset 0x008, reset 0x0000.0000 (see page 786) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DATA | | | | | | | |
| SSISR, type RO, offset 0x00C, reset 0x0000.0003 (see page 787) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | BSY | | RFF | | RNE | | TNF | | TFE | |
| SSICPSR, type R/W, offset 0x010, reset 0x0000.0000 (see page 789) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CPSDVSR | | | | | | | |
| SSIIM, type R/W, offset 0x014, reset 0x0000.0000 (see page 790) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | TXIM | | RXIM | | RTIM | | RORIM | | | |
| SSIRIS, type RO, offset 0x018, reset 0x0000.0008 (see page 791) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | TXRIS | | RXRIS | | RTRIS | | RORRIS | | | |
| SSIMIS, type RO, offset 0x01C, reset 0x0000.0000 (see page 793) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | TXMIS | | RXMIS | | RTMIS | | RORMIS | | | |
| SSIICR, type W1C, offset 0x020, reset 0x0000.0000 (see page 795) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | RTIC | | RORIC | | | | | |
| SSIDMACTL, type R/W, offset 0x024, reset 0x0000.0000 (see page 796) | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | TXDMAE | | RXDMAE | | | | | |

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|---|----|----|----|----|----|----|----|--------|----|------|----|--------|----|---------|----|--------|--|-------|--|------|--|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | | | | | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | | | | | |
| SSIPeriphID4, type RO, offset 0xFD0, reset 0x0000.0000 (see page 797) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID4 | | | | | | | | | |
| SSIPeriphID5, type RO, offset 0xFD4, reset 0x0000.0000 (see page 798) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID5 | | | | | | | | | |
| SSIPeriphID6, type RO, offset 0xFD8, reset 0x0000.0000 (see page 799) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID6 | | | | | | | | | |
| SSIPeriphID7, type RO, offset 0xFDC, reset 0x0000.0000 (see page 800) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID7 | | | | | | | | | |
| SSIPeriphID0, type RO, offset 0xFE0, reset 0x0000.0022 (see page 801) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID0 | | | | | | | | | |
| SSIPeriphID1, type RO, offset 0xFE4, reset 0x0000.0000 (see page 802) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID1 | | | | | | | | | |
| SSIPeriphID2, type RO, offset 0xFE8, reset 0x0000.0018 (see page 803) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID2 | | | | | | | | | |
| SSIPeriphID3, type RO, offset 0xFEC, reset 0x0000.0001 (see page 804) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | PID3 | | | | | | | | | |
| SSIPCellID0, type RO, offset 0xFF0, reset 0x0000.000D (see page 805) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID0 | | | | | | | | | |
| SSIPCellID1, type RO, offset 0xFF4, reset 0x0000.00F0 (see page 806) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID1 | | | | | | | | | |
| SSIPCellID2, type RO, offset 0xFF8, reset 0x0000.0005 (see page 807) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID2 | | | | | | | | | |
| SSIPCellID3, type RO, offset 0xFFC, reset 0x0000.00B1 (see page 808) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | CID3 | | | | | | | | | |
| Inter-Integrated Circuit (I²C) Interface | | | | | | | | | | | | | | | | | | | | | |
| I²C Master | | | | | | | | | | | | | | | | | | | | | |
| I2C 0 base: 0x4002.0000 | | | | | | | | | | | | | | | | | | | | | |
| I2C 1 base: 0x4002.1000 | | | | | | | | | | | | | | | | | | | | | |
| I2CMSA, type R/W, offset 0x000, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | SA | | R/S | | | | | | | |
| I2CMCS, type RO, offset 0x004, reset 0x0000.0020 (Read-Only Status Register) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | BUSBSY | | IDLE | | ARBLST | | DATAACK | | ADRACK | | ERROR | | BUSY | |
| I2CMCS, type WO, offset 0x004, reset 0x0000.0020 (Write-Only Control Register) | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | ACK | | STOP | | START | | RUN | | | |
| I2CMDR, type R/W, offset 0x008, reset 0x0000.0000 | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DATA | | | | | | | | | |

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|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| I2CMTPR, type R/W, offset 0x00C, reset 0x0000.0001 | | | | | | | | | | | | | | | |
| TPR | | | | | | | | | | | | | | | |
| I2CMIMR, type R/W, offset 0x010, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| IM | | | | | | | | | | | | | | | |
| I2CMRIS, type RO, offset 0x014, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| RIS | | | | | | | | | | | | | | | |
| I2CMMIS, type RO, offset 0x018, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| MIS | | | | | | | | | | | | | | | |
| I2CMICR, type WO, offset 0x01C, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| IC | | | | | | | | | | | | | | | |
| I2CMCR, type R/W, offset 0x020, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| SFE MFE LPBK | | | | | | | | | | | | | | | |
| Inter-Integrated Circuit (I²C) Interface | | | | | | | | | | | | | | | |
| I²C Slave | | | | | | | | | | | | | | | |
| I2C 0 base: 0x4002.0000 | | | | | | | | | | | | | | | |
| I2C 1 base: 0x4002.1000 | | | | | | | | | | | | | | | |
| I2CSOAR, type R/W, offset 0x800, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| OAR | | | | | | | | | | | | | | | |
| I2CCSR, type RO, offset 0x804, reset 0x0000.0000 (Read-Only Status Register) | | | | | | | | | | | | | | | |
| FBR TREQ RREQ | | | | | | | | | | | | | | | |
| I2CCSR, type WO, offset 0x804, reset 0x0000.0000 (Write-Only Control Register) | | | | | | | | | | | | | | | |
| DA | | | | | | | | | | | | | | | |
| I2CSDR, type R/W, offset 0x808, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| DATA | | | | | | | | | | | | | | | |
| I2CSIMR, type R/W, offset 0x80C, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| STOPIM STARTIM DATAIM | | | | | | | | | | | | | | | |
| I2CSRIS, type RO, offset 0x810, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| STOPRIS STARTRIS DATARIS | | | | | | | | | | | | | | | |
| I2CSMIS, type RO, offset 0x814, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| STOPMIS STARTMIS DATAMIS | | | | | | | | | | | | | | | |
| I2CSICR, type WO, offset 0x818, reset 0x0000.0000 | | | | | | | | | | | | | | | |
| STOPIC STARTIC DATAIC | | | | | | | | | | | | | | | |
| Inter-Integrated Circuit Sound (I²S) Interface | | | | | | | | | | | | | | | |
| Base 0x4005.4000 | | | | | | | | | | | | | | | |
| I2STXFIFO, type WO, offset 0x000, reset 0x0000.0000 (see page 860) | | | | | | | | | | | | | | | |
| TXFIFO | | | | | | | | | | | | | | | |
| TXFIFO | | | | | | | | | | | | | | | |

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|--|----|-----|-----|-----|-----|----|------|-----|-----|---------|---------|----|----|---------|---------|-----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| I2STXFIFOCFG, type R/W, offset 0x004, reset 0x0000.0000 (see page 861) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | CSS | LRS | |
| I2STXCFG, type R/W, offset 0x008, reset 0x1400.7DF0 (see page 862) | | | | | | | | | | | | | | | | |
| | | JST | DLY | SCP | LRP | | WM | FMT | MSL | | | | | | | |
| | | SSZ | | | | | SDSZ | | | | | | | | | |
| I2STXLIMIT, type R/W, offset 0x00C, reset 0x0000.0000 (see page 864) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | LIMIT | | |
| I2STXISM, type R/W, offset 0x010, reset 0x0000.0000 (see page 865) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | FFI | |
| | | | | | | | | | | | | | | | FFM | |
| I2STXLEV, type RO, offset 0x018, reset 0x0000.0000 (see page 866) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | LEVEL | | |
| I2SRXFIFO, type RO, offset 0x800, reset 0x0000.0000 (see page 867) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |
| I2SRXFIFOCFG, type R/W, offset 0x804, reset 0x0000.0000 (see page 868) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | FMM | CSS | LRS |
| I2SRXCFG, type R/W, offset 0x808, reset 0x1400.7DF0 (see page 869) | | | | | | | | | | | | | | | | |
| | | JST | DLY | SCP | LRP | | RM | | MSL | | | | | | | |
| | | SSZ | | | | | SDSZ | | | | | | | | | |
| I2SRXLIMIT, type R/W, offset 0x80C, reset 0x0000.7FFF (see page 872) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | LIMIT | | |
| I2SRXISM, type R/W, offset 0x810, reset 0x0000.0000 (see page 873) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | FFI | |
| | | | | | | | | | | | | | | | FFM | |
| I2SRXLEV, type RO, offset 0x818, reset 0x0000.0000 (see page 874) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | LEVEL | | |
| I2SCFG, type R/W, offset 0xC00, reset 0x0000.0000 (see page 875) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | RXSLV | TXSLV | | | RXEN | TXEN | |
| I2SIM, type R/W, offset 0xC10, reset 0x0000.0000 (see page 877) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | RXREIM | RXSRIM | | | TXWEIM | TXSRIM | |
| I2SRIS, type RO, offset 0xC14, reset 0x0000.0000 (see page 879) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | RXRERIS | RXSRRIS | | | TXWERIS | TXSRRIS | |
| I2SMIS, type RO, offset 0xC18, reset 0x0000.0000 (see page 881) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | RXREMIS | RXSRMIS | | | TXWEMIS | TXSRMIS | |
| I2SIC, type WO, offset 0xC1C, reset 0x0000.0000 (see page 883) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | RXREIC | | | | TXWEIC | | |

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|---|----|------|----|-------|----|----|----|-------|-------|-------|---------|-----------|-----------------|-------|-------|------|--|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | |
| Controller Area Network (CAN) Module | | | | | | | | | | | | | | | | | |
| CAN0 base: 0x4004.0000 CAN1 base: 0x4004.1000 | | | | | | | | | | | | | | | | | |
| CANCTL, type R/W, offset 0x000, reset 0x0000.0001 (see page 906) | | | | | | | | | | | | | | | | | |
| | | | | | | | | TEST | CCE | DAR | | | EIE | SIE | IE | INIT | |
| CANSTS, type R/W, offset 0x004, reset 0x0000.0000 (see page 908) | | | | | | | | | | | | | | | | | |
| | | | | | | | | BOFF | EWARN | EPASS | RXOK | TXOK | LEC | | | | |
| CANERR, type RO, offset 0x008, reset 0x0000.0000 (see page 911) | | | | | | | | | | | | | | | | | |
| RP | | | | REC | | | | TEC | | | | | | | | | |
| CANBIT, type R/W, offset 0x00C, reset 0x0000.2301 (see page 912) | | | | | | | | | | | | | | | | | |
| TSEG2 | | | | TSEG1 | | | | SJW | | | | BRP | | | | | |
| CANINT, type RO, offset 0x010, reset 0x0000.0000 (see page 913) | | | | | | | | | | | | | | | | | |
| | | | | | | | | INTID | | | | | | | | | |
| CANTST, type R/W, offset 0x014, reset 0x0000.0000 (see page 914) | | | | | | | | | | | | | | | | | |
| | | | | | | | | RX | TX | | LBACK | SILENT | BASIC | | | | |
| CANBRPE, type R/W, offset 0x018, reset 0x0000.0000 (see page 916) | | | | | | | | | | | | | | | | | |
| | | | | | | | | BRPE | | | | | | | | | |
| CANIF1CRQ, type R/W, offset 0x020, reset 0x0000.0001 (see page 917) | | | | | | | | | | | | | | | | | |
| BUSY | | | | | | | | MNUM | | | | | | | | | |
| CANIF2CRQ, type R/W, offset 0x080, reset 0x0000.0001 (see page 917) | | | | | | | | | | | | | | | | | |
| BUSY | | | | | | | | MNUM | | | | | | | | | |
| CANIF1CMSK, type R/W, offset 0x024, reset 0x0000.0000 (see page 918) | | | | | | | | | | | | | | | | | |
| | | | | | | | | WRNRD | MASK | ARB | CONTROL | CLRINTPND | NEWDAT / TXRQST | DATAA | DATAB | | |
| CANIF2CMSK, type R/W, offset 0x084, reset 0x0000.0000 (see page 918) | | | | | | | | | | | | | | | | | |
| | | | | | | | | WRNRD | MASK | ARB | CONTROL | CLRINTPND | NEWDAT / TXRQST | DATAA | DATAB | | |
| CANIF1MSK1, type R/W, offset 0x028, reset 0x0000.FFFF (see page 921) | | | | | | | | | | | | | | | | | |
| | | | | | | | | MSK | | | | | | | | | |
| CANIF2MSK1, type R/W, offset 0x088, reset 0x0000.FFFF (see page 921) | | | | | | | | | | | | | | | | | |
| | | | | | | | | MSK | | | | | | | | | |
| CANIF1MSK2, type R/W, offset 0x02C, reset 0x0000.FFFF (see page 922) | | | | | | | | | | | | | | | | | |
| MXTD | | MDIR | | | | | | MSK | | | | | | | | | |
| CANIF2MSK2, type R/W, offset 0x08C, reset 0x0000.FFFF (see page 922) | | | | | | | | | | | | | | | | | |
| MXTD | | MDIR | | | | | | MSK | | | | | | | | | |
| CANIF1ARB1, type R/W, offset 0x030, reset 0x0000.0000 (see page 924) | | | | | | | | | | | | | | | | | |
| | | | | | | | | ID | | | | | | | | | |

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|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| CANMSG1INT, type RO, offset 0x140, reset 0x0000.0000 (see page 933) | | | | | | | | | | | | | | | |
| INTPND | | | | | | | | | | | | | | | |
| CANMSG2INT, type RO, offset 0x144, reset 0x0000.0000 (see page 933) | | | | | | | | | | | | | | | |
| INTPND | | | | | | | | | | | | | | | |
| CANMSG1VAL, type RO, offset 0x160, reset 0x0000.0000 (see page 934) | | | | | | | | | | | | | | | |
| MSGVAL | | | | | | | | | | | | | | | |
| CANMSG2VAL, type RO, offset 0x164, reset 0x0000.0000 (see page 934) | | | | | | | | | | | | | | | |
| MSGVAL | | | | | | | | | | | | | | | |
| Analog Comparators | | | | | | | | | | | | | | | |
| Base 0x4003.C000 | | | | | | | | | | | | | | | |
| ACMIS, type R/W1C, offset 0x000, reset 0x0000.0000 (see page 942) | | | | | | | | | | | | | | | |
| IN2 IN1 IN0 | | | | | | | | | | | | | | | |
| ACRIS, type RO, offset 0x004, reset 0x0000.0000 (see page 943) | | | | | | | | | | | | | | | |
| IN2 IN1 IN0 | | | | | | | | | | | | | | | |
| ACINTEN, type R/W, offset 0x008, reset 0x0000.0000 (see page 944) | | | | | | | | | | | | | | | |
| IN2 IN1 IN0 | | | | | | | | | | | | | | | |
| ACREFCTL, type R/W, offset 0x010, reset 0x0000.0000 (see page 945) | | | | | | | | | | | | | | | |
| EN RNG VREF | | | | | | | | | | | | | | | |
| ACSTAT0, type RO, offset 0x020, reset 0x0000.0000 (see page 946) | | | | | | | | | | | | | | | |
| OVAL | | | | | | | | | | | | | | | |
| ACSTAT1, type RO, offset 0x040, reset 0x0000.0000 (see page 946) | | | | | | | | | | | | | | | |
| OVAL | | | | | | | | | | | | | | | |
| ACSTAT2, type RO, offset 0x060, reset 0x0000.0000 (see page 946) | | | | | | | | | | | | | | | |
| OVAL | | | | | | | | | | | | | | | |
| ACCTL0, type R/W, offset 0x024, reset 0x0000.0000 (see page 947) | | | | | | | | | | | | | | | |
| TOEN ASRCP TSLVAL TSEN ISLVAL ISEN CINV | | | | | | | | | | | | | | | |
| ACCTL1, type R/W, offset 0x044, reset 0x0000.0000 (see page 947) | | | | | | | | | | | | | | | |
| TOEN ASRCP TSLVAL TSEN ISLVAL ISEN CINV | | | | | | | | | | | | | | | |
| ACCTL2, type R/W, offset 0x064, reset 0x0000.0000 (see page 947) | | | | | | | | | | | | | | | |
| TOEN ASRCP TSLVAL TSEN ISLVAL ISEN CINV | | | | | | | | | | | | | | | |
| Pulse Width Modulator (PWM) | | | | | | | | | | | | | | | |
| PWM0 base: 0x4002.8000 | | | | | | | | | | | | | | | |
| PWMCTL, type R/W, offset 0x000, reset 0x0000.0000 (see page 965) | | | | | | | | | | | | | | | |
| GLOBALSYNC3 GLOBALSYNC2 GLOBALSYNC1 GLOBALSYNC0 | | | | | | | | | | | | | | | |
| PWMSYNC, type R/W, offset 0x004, reset 0x0000.0000 (see page 967) | | | | | | | | | | | | | | | |
| SYNC3 SYNC2 SYNC1 SYNC0 | | | | | | | | | | | | | | | |

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|---|-----------|----------|----------|---------|---------|-----------|-----------|---------|---------|----------|----------|-----------|-----------|------------|------------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| PWMENABLE , type R/W, offset 0x008, reset 0x0000.0000 (see page 968) | | | | | | | | | | | | | | | |
| | | | | | | | | PWM7EN | PWM6EN | PWM5EN | PWM4EN | PWM3EN | PWM2EN | PWM1EN | PWM0EN |
| PWMINVERT , type R/W, offset 0x00C, reset 0x0000.0000 (see page 970) | | | | | | | | | | | | | | | |
| | | | | | | | | PWM7INV | PWM6INV | PWM5INV | PWM4INV | PWM3INV | PWM2INV | PWM1INV | PWM0INV |
| PWMFAULT , type R/W, offset 0x010, reset 0x0000.0000 (see page 972) | | | | | | | | | | | | | | | |
| | | | | | | | | FAULT7 | FAULT6 | FAULT5 | FAULT4 | FAULT3 | FAULT2 | FAULT1 | FAULT0 |
| PWMINTEN , type R/W, offset 0x014, reset 0x0000.0000 (see page 974) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INTFAULT3 | INTFAULT2 | INTFAULT1 | INTFAULT0 |
| | | | | | | | | | | | | INTPWM3 | INTPWM2 | INTPWM1 | INTPWM0 |
| PWMRIS , type RO, offset 0x018, reset 0x0000.0000 (see page 976) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INTFAULT3 | INTFAULT2 | INTFAULT1 | INTFAULT0 |
| | | | | | | | | | | | | INTPWM3 | INTPWM2 | INTPWM1 | INTPWM0 |
| PWMISC , type R/W1C, offset 0x01C, reset 0x0000.0000 (see page 979) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INTFAULT3 | INTFAULT2 | INTFAULT1 | INTFAULT0 |
| | | | | | | | | | | | | INTPWM3 | INTPWM2 | INTPWM1 | INTPWM0 |
| PWMSTATUS , type RO, offset 0x020, reset 0x0000.0000 (see page 982) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FAULT3 | FAULT2 | FAULT1 | FAULT0 |
| PWMFAULTVAL , type R/W, offset 0x024, reset 0x0000.0000 (see page 984) | | | | | | | | | | | | | | | |
| | | | | | | | | PWM7 | PWM6 | PWM5 | PWM4 | PWM3 | PWM2 | PWM1 | PWM0 |
| PWMENUPD , type R/W, offset 0x028, reset 0x0000.0000 (see page 986) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | ENUPD7 | ENUPD6 | ENUPD5 | ENUPD4 | ENUPD3 | ENUPD2 | ENUPD1 | ENUPD0 | | | | | | | |
| PWM0CTL , type R/W, offset 0x040, reset 0x0000.0000 (see page 990) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | LATCH | MINFLTPER | FLTSRC |
| | DBFALLUPD | DRISEUPD | DBCTLUPD | GENBUPD | GENAUPD | CMPBUPD | CMPAUPD | LOADUPD | DEBUG | MODE | ENABLE | | | | |
| PWM1CTL , type R/W, offset 0x080, reset 0x0000.0000 (see page 990) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | LATCH | MINFLTPER | FLTSRC |
| | DBFALLUPD | DRISEUPD | DBCTLUPD | GENBUPD | GENAUPD | CMPBUPD | CMPAUPD | LOADUPD | DEBUG | MODE | ENABLE | | | | |
| PWM2CTL , type R/W, offset 0x0C0, reset 0x0000.0000 (see page 990) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | LATCH | MINFLTPER | FLTSRC |
| | DBFALLUPD | DRISEUPD | DBCTLUPD | GENBUPD | GENAUPD | CMPBUPD | CMPAUPD | LOADUPD | DEBUG | MODE | ENABLE | | | | |
| PWM3CTL , type R/W, offset 0x100, reset 0x0000.0000 (see page 990) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | LATCH | MINFLTPER | FLTSRC |
| | DBFALLUPD | DRISEUPD | DBCTLUPD | GENBUPD | GENAUPD | CMPBUPD | CMPAUPD | LOADUPD | DEBUG | MODE | ENABLE | | | | |
| PWM0INTEN , type R/W, offset 0x044, reset 0x0000.0000 (see page 995) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | TRCMPBD | TRCMPBU | TRCMPAD | TRCMPAU | TRCNTLOAD | TRCNTZERO | | | INTCMPBD | INTCMPBU | INTCMPAD | INTCMPAU | INTCNTLOAD | INTCNTZERO |
| PWM1INTEN , type R/W, offset 0x084, reset 0x0000.0000 (see page 995) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | TRCMPBD | TRCMPBU | TRCMPAD | TRCMPAU | TRCNTLOAD | TRCNTZERO | | | INTCMPBD | INTCMPBU | INTCMPAD | INTCMPAU | INTCNTLOAD | INTCNTZERO |
| PWM2INTEN , type R/W, offset 0x0C4, reset 0x0000.0000 (see page 995) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | TRCMPBD | TRCMPBU | TRCMPAD | TRCMPAU | TRCNTLOAD | TRCNTZERO | | | INTCMPBD | INTCMPBU | INTCMPAD | INTCMPAU | INTCNTLOAD | INTCNTZERO |
| PWM3INTEN , type R/W, offset 0x104, reset 0x0000.0000 (see page 995) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| | | TRCMPBD | TRCMPBU | TRCMPAD | TRCMPAU | TRCNTLOAD | TRCNTZERO | | | INTCMPBD | INTCMPBU | INTCMPAD | INTCMPAU | INTCNTLOAD | INTCNTZERO |

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
|--|----|----|----|----------|----|----------|----|----------|----|----------|----|---------|----|---------|----|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| PWM1CMPA, type R/W, offset 0x098, reset 0x0000.0000 (see page 1004) | | | | | | | | | | | | | | | |
| COMPA | | | | | | | | | | | | | | | |
| PWM2CMPA, type R/W, offset 0x0D8, reset 0x0000.0000 (see page 1004) | | | | | | | | | | | | | | | |
| COMPA | | | | | | | | | | | | | | | |
| PWM3CMPA, type R/W, offset 0x118, reset 0x0000.0000 (see page 1004) | | | | | | | | | | | | | | | |
| COMPA | | | | | | | | | | | | | | | |
| PWM0CMPB, type R/W, offset 0x05C, reset 0x0000.0000 (see page 1005) | | | | | | | | | | | | | | | |
| COMPB | | | | | | | | | | | | | | | |
| PWM1CMPB, type R/W, offset 0x09C, reset 0x0000.0000 (see page 1005) | | | | | | | | | | | | | | | |
| COMPB | | | | | | | | | | | | | | | |
| PWM2CMPB, type R/W, offset 0x0DC, reset 0x0000.0000 (see page 1005) | | | | | | | | | | | | | | | |
| COMPB | | | | | | | | | | | | | | | |
| PWM3CMPB, type R/W, offset 0x11C, reset 0x0000.0000 (see page 1005) | | | | | | | | | | | | | | | |
| COMPB | | | | | | | | | | | | | | | |
| PWM0GENA, type R/W, offset 0x060, reset 0x0000.0000 (see page 1006) | | | | | | | | | | | | | | | |
| | | | | ACTCMPBD | | ACTCMPBU | | ACTCMPAD | | ACTCMPAU | | ACTLOAD | | ACTZERO | |
| PWM1GENA, type R/W, offset 0x0A0, reset 0x0000.0000 (see page 1006) | | | | | | | | | | | | | | | |
| | | | | ACTCMPBD | | ACTCMPBU | | ACTCMPAD | | ACTCMPAU | | ACTLOAD | | ACTZERO | |
| PWM2GENA, type R/W, offset 0x0E0, reset 0x0000.0000 (see page 1006) | | | | | | | | | | | | | | | |
| | | | | ACTCMPBD | | ACTCMPBU | | ACTCMPAD | | ACTCMPAU | | ACTLOAD | | ACTZERO | |
| PWM3GENA, type R/W, offset 0x120, reset 0x0000.0000 (see page 1006) | | | | | | | | | | | | | | | |
| | | | | ACTCMPBD | | ACTCMPBU | | ACTCMPAD | | ACTCMPAU | | ACTLOAD | | ACTZERO | |
| PWM0GENB, type R/W, offset 0x064, reset 0x0000.0000 (see page 1009) | | | | | | | | | | | | | | | |
| | | | | ACTCMPBD | | ACTCMPBU | | ACTCMPAD | | ACTCMPAU | | ACTLOAD | | ACTZERO | |
| PWM1GENB, type R/W, offset 0x0A4, reset 0x0000.0000 (see page 1009) | | | | | | | | | | | | | | | |
| | | | | ACTCMPBD | | ACTCMPBU | | ACTCMPAD | | ACTCMPAU | | ACTLOAD | | ACTZERO | |
| PWM2GENB, type R/W, offset 0x0E4, reset 0x0000.0000 (see page 1009) | | | | | | | | | | | | | | | |
| | | | | ACTCMPBD | | ACTCMPBU | | ACTCMPAD | | ACTCMPAU | | ACTLOAD | | ACTZERO | |
| PWM3GENB, type R/W, offset 0x124, reset 0x0000.0000 (see page 1009) | | | | | | | | | | | | | | | |
| | | | | ACTCMPBD | | ACTCMPBU | | ACTCMPAD | | ACTCMPAU | | ACTLOAD | | ACTZERO | |
| PWM0DBCTL, type R/W, offset 0x068, reset 0x0000.0000 (see page 1012) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | ENABLE | |
| PWM1DBCTL, type R/W, offset 0x0A8, reset 0x0000.0000 (see page 1012) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | ENABLE | |

| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 | |
|--|----|----|----|----|----|----|----|-------|-------|-------|-------|-------|--------|--------|-----------|--------|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| PWM2DBCTL, type R/W, offset 0x0E8, reset 0x0000.0000 (see page 1012) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | ENABLE | |
| PWM3DBCTL, type R/W, offset 0x128, reset 0x0000.0000 (see page 1012) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | ENABLE | |
| PWM0DBRISE, type R/W, offset 0x06C, reset 0x0000.0000 (see page 1013) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | RISEDELAY | |
| PWM1DBRISE, type R/W, offset 0x0AC, reset 0x0000.0000 (see page 1013) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | RISEDELAY | |
| PWM2DBRISE, type R/W, offset 0x0EC, reset 0x0000.0000 (see page 1013) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | RISEDELAY | |
| PWM3DBRISE, type R/W, offset 0x12C, reset 0x0000.0000 (see page 1013) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | RISEDELAY | |
| PWM0DBFALL, type R/W, offset 0x070, reset 0x0000.0000 (see page 1014) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | FALLDELAY | |
| PWM1DBFALL, type R/W, offset 0x0B0, reset 0x0000.0000 (see page 1014) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | FALLDELAY | |
| PWM2DBFALL, type R/W, offset 0x0F0, reset 0x0000.0000 (see page 1014) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | FALLDELAY | |
| PWM3DBFALL, type R/W, offset 0x130, reset 0x0000.0000 (see page 1014) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | FALLDELAY | |
| PWM0FLTSRC0, type R/W, offset 0x074, reset 0x0000.0000 (see page 1015) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | FAULT3 | FAULT2 | FAULT1 | FAULT0 |
| PWM1FLTSRC0, type R/W, offset 0x0B4, reset 0x0000.0000 (see page 1015) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | FAULT3 | FAULT2 | FAULT1 | FAULT0 |
| PWM2FLTSRC0, type R/W, offset 0x0F4, reset 0x0000.0000 (see page 1015) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | FAULT3 | FAULT2 | FAULT1 | FAULT0 |
| PWM3FLTSRC0, type R/W, offset 0x134, reset 0x0000.0000 (see page 1015) | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | FAULT3 | FAULT2 | FAULT1 | FAULT0 |
| PWM0FLTSRC1, type R/W, offset 0x078, reset 0x0000.0000 (see page 1017) | | | | | | | | | | | | | | | | |
| | | | | | | | | DCMP7 | DCMP6 | DCMP5 | DCMP4 | DCMP3 | DCMP2 | DCMP1 | DCMP0 | |
| PWM1FLTSRC1, type R/W, offset 0x0B8, reset 0x0000.0000 (see page 1017) | | | | | | | | | | | | | | | | |
| | | | | | | | | DCMP7 | DCMP6 | DCMP5 | DCMP4 | DCMP3 | DCMP2 | DCMP1 | DCMP0 | |
| PWM2FLTSRC1, type R/W, offset 0x0F8, reset 0x0000.0000 (see page 1017) | | | | | | | | | | | | | | | | |
| | | | | | | | | DCMP7 | DCMP6 | DCMP5 | DCMP4 | DCMP3 | DCMP2 | DCMP1 | DCMP0 | |

| | | | | | | | | | | | | | | | |
|---|----|--------|---------|------|------|------|--------|----|----|-------|---------|-----------|---------|----------|----------|
| 31 | 30 | 29 | 28 | 27 | 26 | 25 | 24 | 23 | 22 | 21 | 20 | 19 | 18 | 17 | 16 |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Quadrature Encoder Interface (QEI) | | | | | | | | | | | | | | | |
| QEI0 base: 0x4002.C000 | | | | | | | | | | | | | | | |
| QEI1 base: 0x4002.D000 | | | | | | | | | | | | | | | |
| QEICTL, type R/W, offset 0x000, reset 0x0000.0000 (see page 1034) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | FILCNT | | | |
| | | FILTEN | STALLEN | INVI | INVB | INVA | VELDIV | | | VELEN | RESMODE | CAPMODE | SIGMODE | SWAP | ENABLE |
| QEISTAT, type RO, offset 0x004, reset 0x0000.0000 (see page 1037) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | DIRECTION | | ERROR | |
| QEIPOS, type R/W, offset 0x008, reset 0x0000.0000 (see page 1038) | | | | | | | | | | | | | | | |
| POSITION | | | | | | | | | | | | | | | |
| POSITION | | | | | | | | | | | | | | | |
| QEIMAXPOS, type R/W, offset 0x00C, reset 0x0000.0000 (see page 1039) | | | | | | | | | | | | | | | |
| MAXPOS | | | | | | | | | | | | | | | |
| MAXPOS | | | | | | | | | | | | | | | |
| QEILOAD, type R/W, offset 0x010, reset 0x0000.0000 (see page 1040) | | | | | | | | | | | | | | | |
| LOAD | | | | | | | | | | | | | | | |
| LOAD | | | | | | | | | | | | | | | |
| QEITIME, type RO, offset 0x014, reset 0x0000.0000 (see page 1041) | | | | | | | | | | | | | | | |
| TIME | | | | | | | | | | | | | | | |
| TIME | | | | | | | | | | | | | | | |
| QEICOUNT, type RO, offset 0x018, reset 0x0000.0000 (see page 1042) | | | | | | | | | | | | | | | |
| COUNT | | | | | | | | | | | | | | | |
| COUNT | | | | | | | | | | | | | | | |
| QEISPEED, type RO, offset 0x01C, reset 0x0000.0000 (see page 1043) | | | | | | | | | | | | | | | |
| SPEED | | | | | | | | | | | | | | | |
| SPEED | | | | | | | | | | | | | | | |
| QEINTEN, type R/W, offset 0x020, reset 0x0000.0000 (see page 1044) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INTERROR | INTDIR | INTTIMER | INTINDEX |
| QEIRIS, type RO, offset 0x024, reset 0x0000.0000 (see page 1046) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INTERROR | INTDIR | INTTIMER | INTINDEX |
| QEIISC, type R/W1C, offset 0x028, reset 0x0000.0000 (see page 1048) | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | INTERROR | INTDIR | INTTIMER | INTINDEX |

B Ordering and Contact Information

B.1 Ordering Information

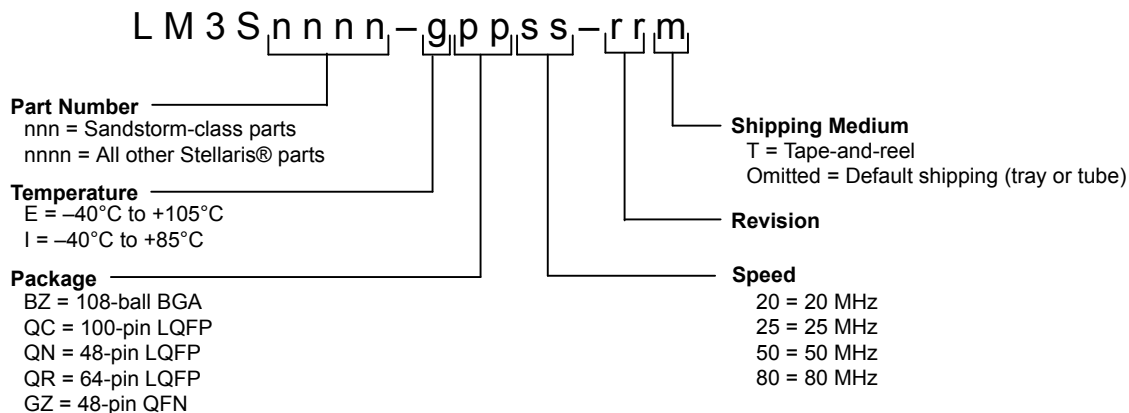


Table B-1. Part Ordering Information

| Orderable Part Number | Description |
|-----------------------|--|
| LM3S2U93-IQC80-A2 | Stellaris® LM3S2U93 Microcontroller Industrial Temperature 100-pin LQFP |
| LM3S2U93-IBZ80-A2 | Stellaris LM3S2U93 Microcontroller Industrial Temperature 108-ball BGA |
| LM3S2U93-IQC80-A2T | Stellaris LM3S2U93 Microcontroller Industrial Temperature 100-pin LQFP Tape-and-reel |
| LM3S2U93-IBZ80-A2T | Stellaris LM3S2U93 Microcontroller Industrial Temperature 108-ball BGA Tape-and-reel |

B.2 Part Markings

The Stellaris microcontrollers are marked with an identifying number. This code contains the following information:

- The first line indicates the part number, for example, LM3S9B90.
- In the second line, the first eight characters indicate the temperature, package, speed, revision, and product status. For example in the figure below, IQC80C0X indicates an Industrial temperature (I), 100-pin LQFP package (QC), 80-MHz (80), revision C0 (C0) device. The letter immediately following the revision indicates product status. An X indicates experimental and requires a waiver; an S indicates the part is fully qualified and released to production.
- The remaining characters contain internal tracking numbers.



B.3 Kits

The Stellaris Family provides the hardware and software tools that engineers need to begin development quickly.

- Reference Design Kits accelerate product development by providing ready-to-run hardware and comprehensive documentation including hardware design files
- Evaluation Kits provide a low-cost and effective means of evaluating Stellaris microcontrollers before purchase
- Development Kits provide you with all the tools you need to develop and prototype embedded applications right out of the box

See the website at www.ti.com/stellaris for the latest tools available, or ask your distributor.

B.4 Support Information

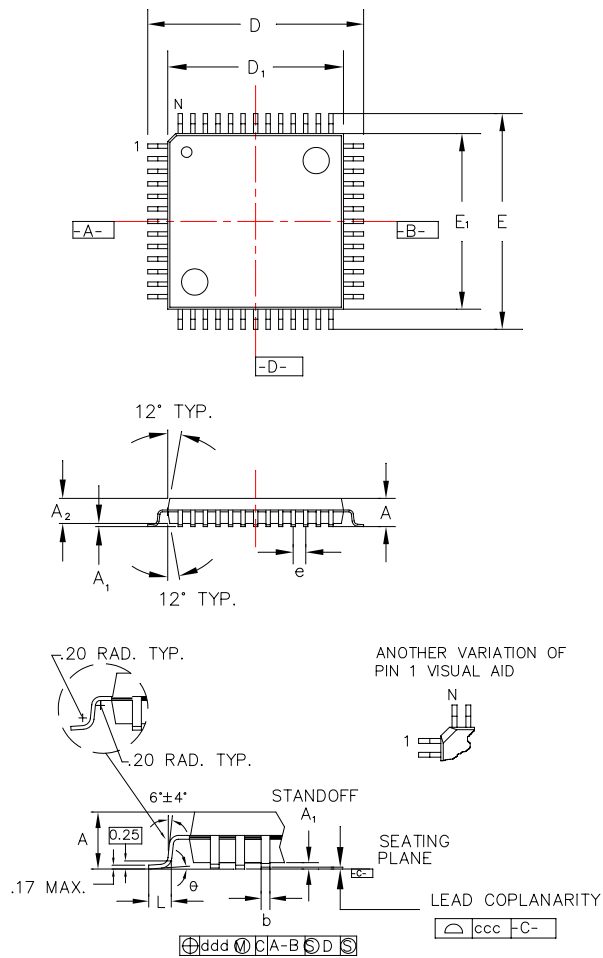
For support on Stellaris products, contact the TI Worldwide Product Information Center nearest you: <http://www-k.ext.ti.com/sc/technical-support/product-information-centers.htm>.

C Package Information

C.1 100-Pin LQFP Package

C.1.1 Package Dimensions

Figure C-1. Stellaris LM3S2U93 100-Pin LQFP Package Dimensions



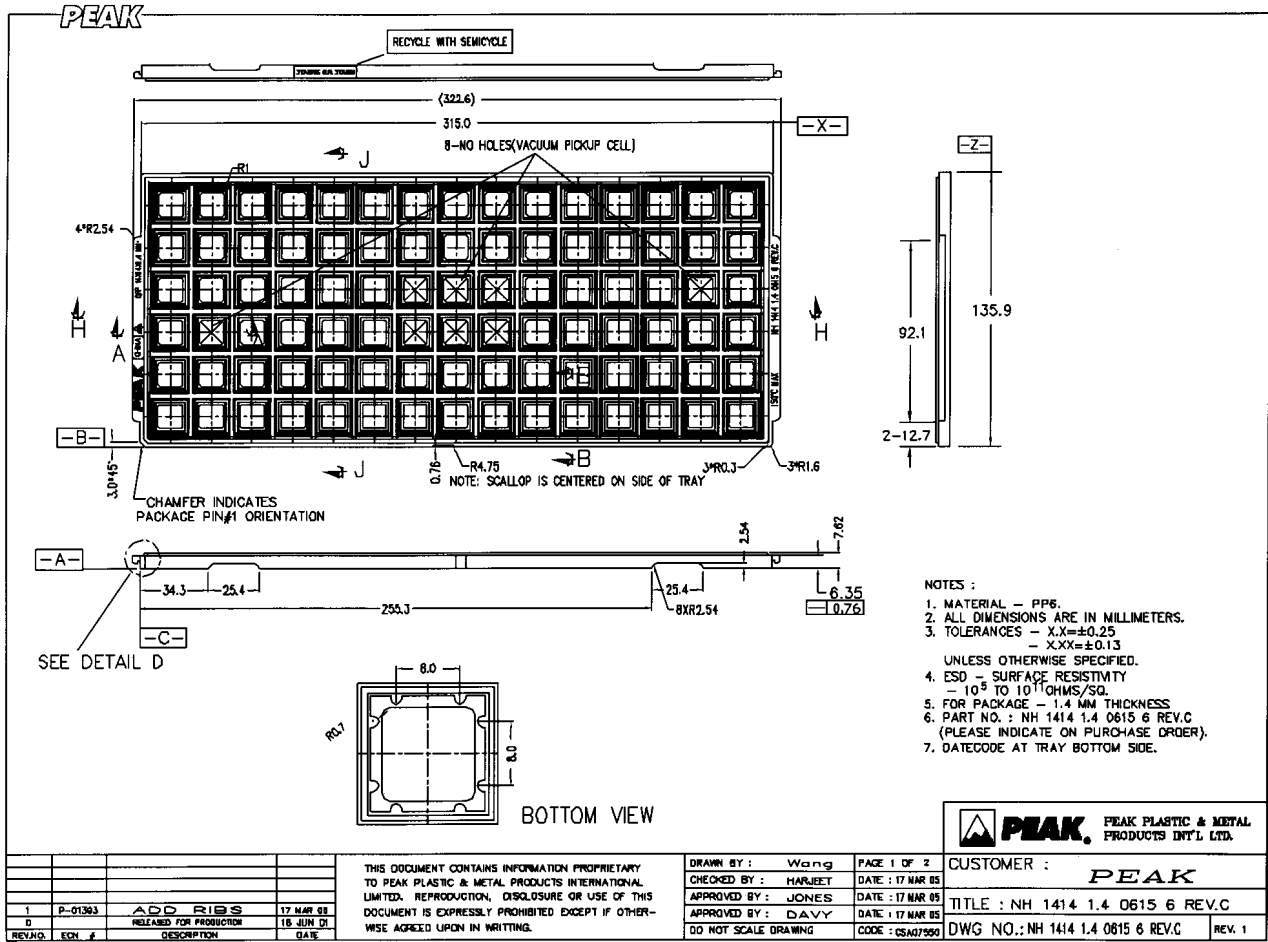
Note: The following notes apply to the package drawing.

1. All dimensions shown in mm.
2. Dimensions shown are nominal with tolerances indicated.
3. Foot length 'L' is measured at gage plane 0.25 mm above seating plane.

| Body +2.00 mm Footprint, 1.4 mm package thickness | | |
|---|-------------|---------------------|
| Symbols | Leads | 100L |
| A | Max. | 1.60 |
| A ₁ | - | 0.05 Min./0.15 Max. |
| A ₂ | ±0.05 | 1.40 |
| D | ±0.20 | 16.00 |
| D ₁ | ±0.05 | 14.00 |
| E | ±0.20 | 16.00 |
| E ₁ | ±0.05 | 14.00 |
| L | +0.15/-0.10 | 0.60 |
| e | Basic | 0.50 |
| b | +0.05 | 0.22 |
| θ | - | 0°-7° |
| ddd | Max. | 0.08 |
| ccc | Max. | 0.08 |
| JEDEC Reference Drawing | | MS-026 |
| Variation Designator | | BED |

C.1.2 Tray Dimensions

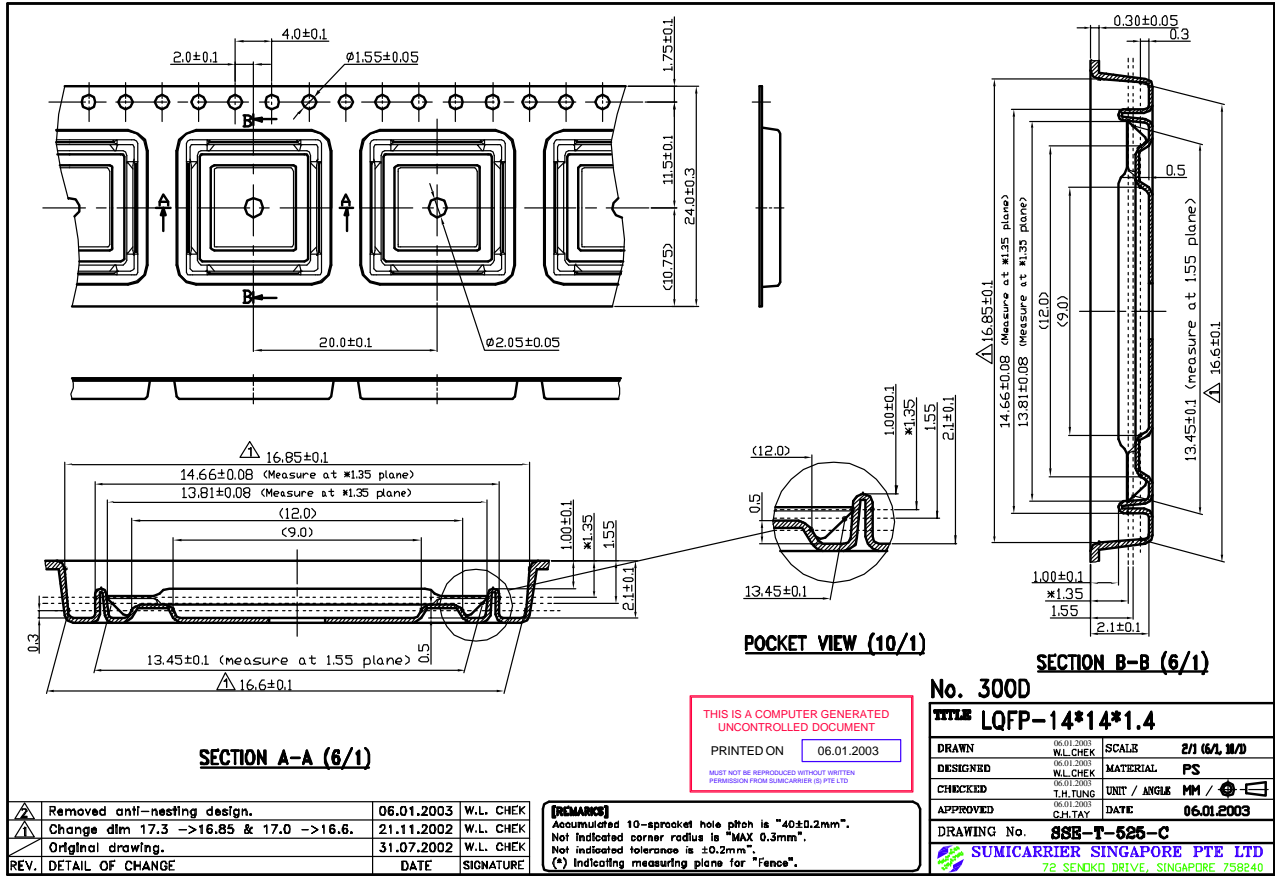
Figure C-2. 100-Pin LQFP Tray Dimensions



C.1.3 Tape and Reel Dimensions

Note: In the figure that follows, pin 1 is located in the top right corner of the device.

Figure C-3. 100-Pin LQFP Tape and Reel Dimensions



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| REV. | DETAIL OF CHANGE | DATE | SIGNATURE |
|------|--|------------|-----------|
| 1 | Removed anti-nesting design. | 06.01.2003 | W.L. CHEK |
| 2 | Change dim 17.3 ->16.85 & 17.0 ->16.6. | 21.11.2002 | W.L. CHEK |
| 3 | Original drawing. | 31.07.2002 | W.L. CHEK |

REMARKS
 Accumulated 10-sprocket hole pitch is "40±0.2mm".
 Not indicated corner radius is "MAX 0.3mm".
 Not indicated tolerance is ±0.2mm".
 (*) Indicating measuring plane for "Fence".

No. 300D

| TITLE LQFP-14*14*1.4 | | |
|--|-------------------------|----------------------|
| DRAWN | 06.01.2003 W.L. CHEK | SCALE 2/1 (6/1, M/D) |
| DESIGNED | 06.01.2003 W.L. CHEK | MATERIAL PS |
| CHECKED | 06.01.2003 T.H. TUNG | UNIT / ANGLE MM / ° |
| APPROVED | 06.01.2003 C.H. TAY | DATE 06.01.2003 |
| DRAWING No. 888-T-525-C | | |
| SUMICARRIER SINGAPORE PTE LTD 72 SENKID DRIVE, SINGAPORE 758240 | | |

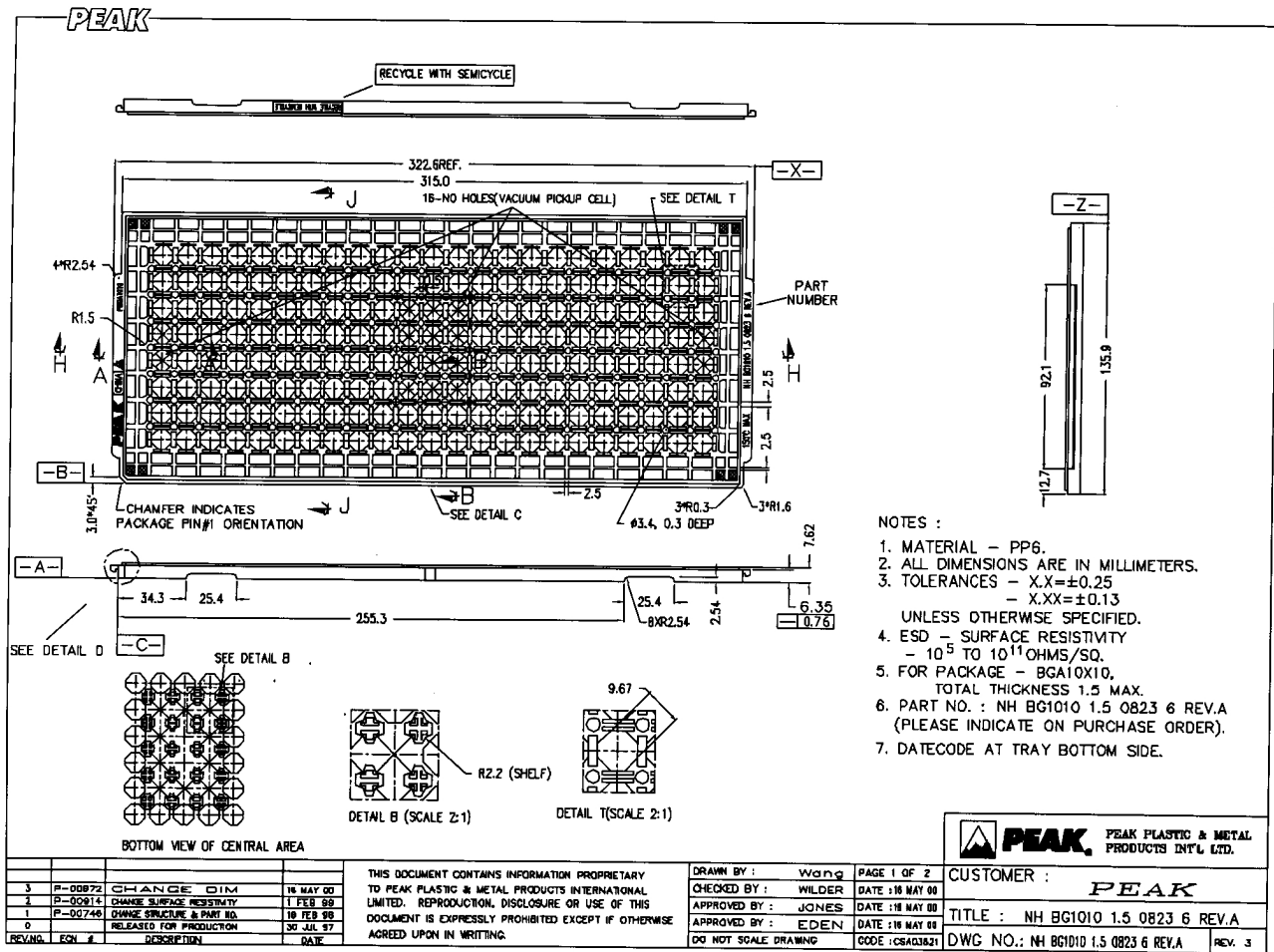
Note: The following notes apply to the package drawing.

1. ALL DIMENSIONS ARE IN MILLIMETERS.
 2. 'e' REPRESENTS THE BASIC SOLDER BALL GRID PITCH.
 3. 'M' REPRESENTS THE BASIC SOLDER BALL MATRIX SIZE.
AND SYMBOL 'N' IS THE NUMBER OF BALLS AFTER DEPOPULATING.
 4. 'b' IS MEASURABLE AT THE MAXIMUM SOLDER BALL DIAMETER AFTER REFLOW
PARALLEL TO PRIMARY DATUM [C].
 5. DIMENSION 'ccc' IS MEASURED PARALLEL TO PRIMARY DATUM [C].
 6. PRIMARY DATUM [C] AND SEATING PLANE ARE DEFINED BY THE SPHERICAL
CROWNS OF THE SOLDER BALLS.
 7. PACKAGE SURFACE SHALL BE MATTE FINISH CHARMILLES 24 TO 27.
 8. SUBSTRATE MATERIAL BASE IS BT RESIN.
 9. THE OVERALL PACKAGE THICKNESS "A" ALREADY CONSIDERS COLLAPSE BALLS
 10. DIMENSIONING AND TOLERANCING PER ASME Y14.5M 1994.
- EXCEPT DIMENSION b.

| Symbols | MIN | NOM | MAX |
|--------------------|----------|-------|-------|
| A | 1.22 | 1.36 | 1.50 |
| A1 | 0.29 | 0.34 | 0.39 |
| A3 | 0.65 | 0.70 | 0.75 |
| c | 0.28 | 0.32 | 0.36 |
| D | 9.85 | 10.00 | 10.15 |
| D1 | 8.80 BSC | | |
| E | 9.85 | 10.00 | 10.15 |
| E1 | 8.80 BSC | | |
| b | 0.43 | 0.48 | 0.53 |
| bbb | .20 | | |
| ddd | .12 | | |
| e | 0.80 BSC | | |
| f | - | 0.60 | - |
| M | 12 | | |
| n | 108 | | |
| REF: JEDEC MO-219F | | | |

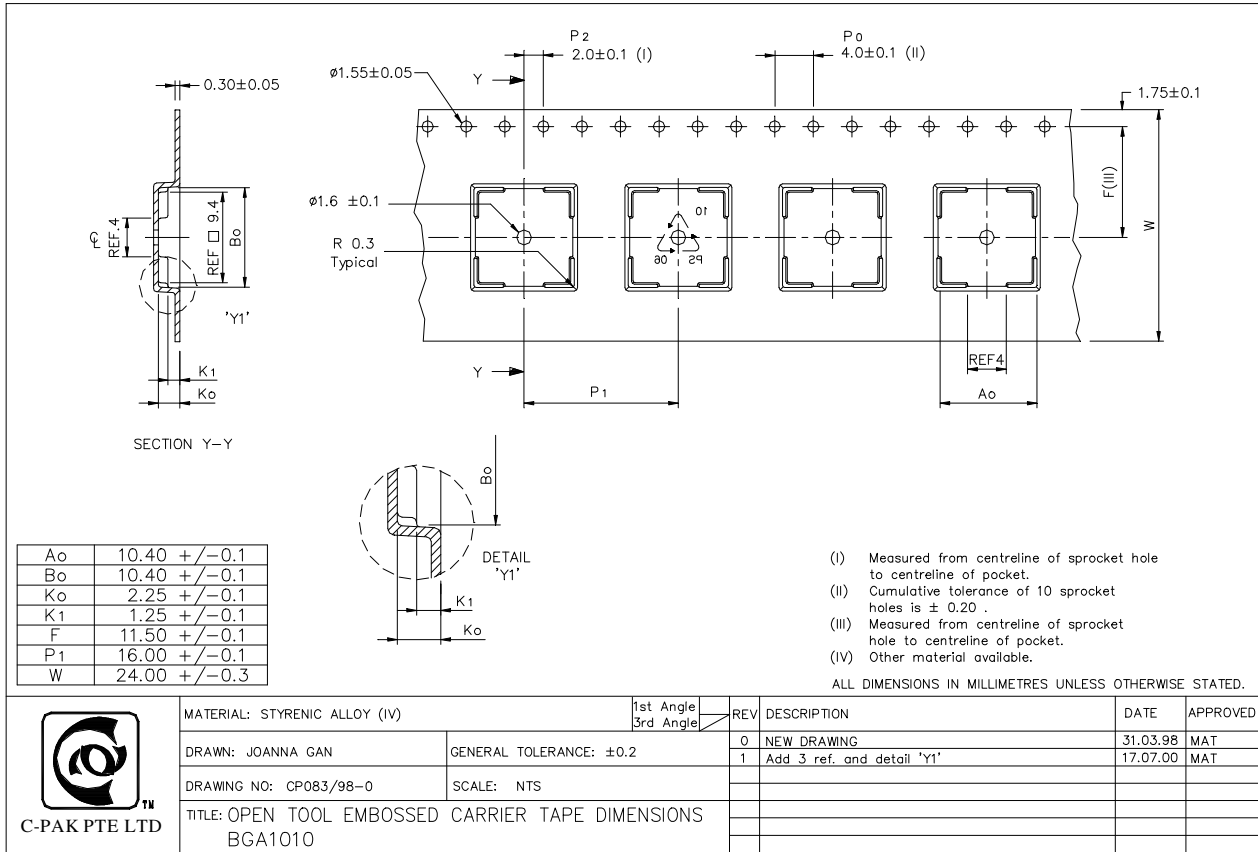
C.2.2 Tray Dimensions

Figure C-5. 108-Ball BGA Tray Dimensions



C.2.3 Tape and Reel Dimensions

Figure C-6. 108-Ball BGA Tape and Reel Dimensions



THIS DRAWING CONTAINS INFORMATION THAT IS PROPRIETARY TO C-PAK PTE.LTD.

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/ Ball Finish | MSL Peak Temp ⁽³⁾ | Samples (Requires Login) |
|--------------------|-----------------------|--------------|-----------------|------|-------------|----------------------------|----------------------|------------------------------|-----------------------------|
| LM3S2U93-IBZ80-A2 | ACTIVE | NFBGA | ZCR | 108 | 184 | Green (RoHS & no Sb/Br) | SNAGCU | Level-3-260C-168 HR | |
| LM3S2U93-IBZ80-A2T | ACTIVE | NFBGA | ZCR | 108 | 1500 | Green (RoHS & no Sb/Br) | SNAGCU | Level-3-260C-168 HR | |
| LM3S2U93-IQC80-A2 | ACTIVE | LQFP | PZ | 100 | 90 | Green (RoHS & no Sb/Br) | | Level-3-260C-168 HR | |
| LM3S2U93-IQC80-A2T | ACTIVE | LQFP | PZ | 100 | 1000 | Green (RoHS & no Sb/Br) | | Level-3-260C-168 HR | |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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