FUJITSU SEMICONDUCTOR
DATA SHEET

DS706-00010-0v01-E

32-bit ARM Cortex-M3™ based Microcontroller

FM3 MB9B500 Series

MB9BF500N/R, MB9BF504N/R, F505N/R, F506N/R

■ DESCRIPTION

The MB9B500 Series are a highly integrated 32-bit microcontroller that target for high-performance and cost-sensitive embedded control applications.
The MB9B500 Series are based on the ARM Cortex-M3 Processor and on-chip Flash memory and SRAM, and peripheral functions, including Motor Control Timers, ADCs and Communication Interfaces (USB, CAN, UART, SIO, I^2C, LIN).

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PRELIMINARY

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■ FEATURES

● 32-bit ARM Cortex-M3™ Core

- Processor version: r2p0
- Up to 80MHz Frequency Operation
- Memory Protection Unit (MPU): improve the reliability of an embedded system
- Integrated Nested Vectored Interrupt Controller (NVIC): 1 NMI (non-maskable interrupt) and 48 peripheral interrupts and 16 priority levels
- 24-bit System timer (Sys Tick): System timer for OS task management

● On-chip Memories

[Flash memory]

- Up to 512 Kbyte
- Read cycle: 0wait-cycle@up to 60MHz, 2wait-cycle(*) above
  *: Instruction pre-fetch buffer is included. So when CPU access continuously, it becomes 0wait-cycle
- Security function for code protection

[SRAM]

MB9B500 Series contain a total of up to 64Kbyte on-chip SRAM memories. This is composed of two independent SRAM for CPU and DMA Controller can process simultaneously.

- Up to 32 Kbyte SRAM for high-performance CPU
- Up to 32 Kbyte SRAM for CPU/DMA Controller

● External Bus Interface

- Supports SRAM, NOR& NAND Flash device
- Up to 8 chip selects
- 8/16-bit Data width
- Up to 25-bit Address bit

● USB Interface

USB interface is composed of Function and Host.

[USB function]

- USB2.0 Full-Speed supported
- Max. 6 EndPoint supported
  - EndPoint 0 is control transfer
  - EndPoint 1 – 5 can be selected bulk-transfer or interrupt-transfer
- EndPoint1-5 is comprised Double Buffer

[USB host]

- USB2.0 Full/Low speed supported
- Bulk-transfer and interrupt-transfer and Isochronous-transfer support (using EndPoint1, EndPoint2)
- USB Device connected/dis-connected automatically detect
- IN/OUT token handshake packet automatically
- Max.256-byte packet-length supported
- Wake-up function supported

● CAN Interface (Max. 2channels)

- Compatible with CAN Specification 2.0A/B
- Maximum transfer rate: 1 Mbps
- Built-in 32 message buffer

● Multi-function Serial Interface (Max. 8channels)

- 4 channels with 16-byte FIFO (ch.4-ch.7), 4 channels without FIFO (ch.0-ch.3)
- Operation mode is selectable from the followings for each channel.
  - UART
  - CSIO
  - LIN
  - I^2C

[UART]

- Full-duplex double buffer
- Selection with or without parity supported
- Built-in dedicated baud rate generator
- External clock available as a serial clock
- Hardware Flow control : Automatically control the transmission by CTS/RTS (only ch.4)
- Various error detect functions available (parity errors, framing errors, and overrun errors)

[CSIO]

- Full-duplex double buffer
- Built-in dedicated baud rate generator
- Overrun error detect function available

[LIN]

- LIN protocol Rev.2.1 supported
- Full-duplex double buffer
- Master/Slave mode supported
- LIN break field generate (can be changed 13-16bit length)
- LIN break delimiter generate (can be changed 1-4bit length)
- Various error detect functions available (parity errors, framing errors, and overrun errors)

[I^2C]

- Standard mode (Max.100kbps) / High-speed mode (Max.400Kbps) supported

● DMA Controller (8channels)

DMA Controller has an independent bus for CPU, so CPU and DMA Controller can process simultaneously.

- 8 independently configured and operated channels
- Transfer can be started by software or request from the built-in peripherals
- Transfer address area: 32bit(4Gbyte)
- Transfer mode: Block transfer/Burst transfer/Demand transfer
- Transfer data type: byte/half-word/word
- Transfer block count: 1 to 16
- Number of transfers: 1 to 65536

● A/D Converter (Max. 16channels)

MB9BF500 built-in 10-bit A/D Converter; MB9BF504/505/506 built-in 12-bit A/D Converter

[10-bit A/D Converter]

- Successive Approximation Register type
- Built-in 3unit
- Conversion time: 1.2µs@5V
- Priority conversion available (priority at 2levels)
- Scanning conversion mode
- Built-in FIFO for conversion data storage (for SCAN conversion: 16steps, for Priority conversion: 4steps)

[12-bit A/D Converter]

- Successive Approximation Register type
- Built-in 3unit
- Conversion time: 1.0µs@5V
- Priority conversion available (priority at 2levels)
- Scanning conversion mode
- Built-in FIFO for conversion data storage (for SCAN conversion: 16steps, for Priority conversion: 4steps)

● Base Timer (Max. 8channels)

Operation mode is selectable from the followings for each channel.

- 16-bit PWM timer
- 16-bit PPG timer
- 16/32-bit reload timer
- 16/32-bit PWC timer

● General Purpose I/O Port

MB9B500 series can use its pins as I/O ports when they are not used for external bus or peripherals. Moreover, the port relocate function is built in. It can set which I/O port the peripheral function can be allocated.

- Capable of pull-up control per pin
- Capable of reading pin level directly
- Built-in the port relocate function
- Up to 100 fast I/O Ports@120pin Package

● Multi-function Timer (Max. 2unit)

The Multi-function timer is composed of the following blocks.

- 16-bit free-run timer × 3ch/unit
- Input capture × 4ch/unit
- Output compare × 6ch/unit
- A/D activating compare × 3ch/unit
- Waveform generator × 3ch/unit
- 16-bit PPG timer × 3ch/unit

The following function can be used to achieve the motor control.

- PWM signal output function
- DC chopper waveform output function
- Dead time function
- Input capture function
- A/D convertor activate function
- DTIF (Motor emergency stop) interrupt function

● Quadrature Position/Revolution Counter (QPRC) (Max. 2unit)

The Quadrature Position/Revolution Counter (QPRC) is used to measure the position of the position encoder. Moreover, it is possible to use up/down counter.

- The detection edge of the three external event input pins AIN, BIN and ZIN is configurable.
- 16-bit position counter
- 16-bit revolution counter
- Two 16-bit compare registers

● Dual Timer (Two 32/16bit Down Counter)

The Dual Timer consists of two programmable 32/16-bit down counters.
Operation mode is selectable from the followings for each channel.

- Free-running
- Periodic (=Reload)
- One-shot

● Watch Counter

The Watch counter is used for wake up from power saving mode.

- Interval timer: up to 64s(Max.)@ Sub Clock : 32.768kHz

● External Interrupt Controller Unit

- Up to 16 external vectors
- Include one non-maskable interrupt(NMI)

● Watch dog Timer (2channels)

A watchdog timer can generate interrupts or a reset when a time-out value is reached.

MB9B500 series consists of two different watchdogs, a "Hardware" watchdog and a "Software" watchdog.

"Hardware" watchdog timer is clocked by low speed CR oscillator. Therefore,"Hardware" watchdog is active in any power saving mode except STOP.

● CRC (Cyclic Redundancy Check) Accelerator

The CRC accelerator helps a verify data transmission or storage integrity.

CCITT CRC16 and IEEE-802.3 CRC32 are supported.

- CCITT CRC16 Generator Polynomial: 0x1021
- IEEE-802.3 CRC32 Generator Polynomial: 0x04C11DB7

● Clock and Reset

[Clocks]

Five clock sources (2 ext. osc, 2 CR osc, and PLL) that are dynamically selectable.

- Main Clock : 4 to 48MHz
- Sub Clock : 32.768kHz
- High-speed CR Clock : 4MHz
- Low-speed CR Clock : 100kHz
- PLL Clock

[Resets]

Reset requests from INITX pins, Power on reset, Software reset, watchdog timers reset, low voltage detector reset and clock supervisor reset.

● Clock Super Visor (CSV)

Clocks generated by CR oscillators are used to supervise abnormality of the external clocks.

- External OSC clock failure (clock stop) is detected, reset is asserted.
- External OSC frequency anomaly is detected, interrupt or reset is asserted.

● Low Voltage Detector (LVD)

MB9B500 Series include 2-stage monitoring of voltage on the VCC. When the voltage falls below the voltage has been set, Low Voltage Detector generates an interrupt or reset.

- LVD1: error reporting via interrupt
- LVD2: auto-reset operation

● Low Power Mode

Three power saving modes supported.

- SLEEP
- TIMER
- STOP

● Debug

- Serial Wire JTAG Debug Port (SWJ-DP)
- Embedded Trace Macrocells (ETM) provide comprehensive debug and trace facilities.
- Trace Port Interface Unit (TPIU) for bridging to a Trace Port Analyzer.

● Power Supply

Two Power Supplies

- VCC = 2.7V to 5.5V: Correspond to the wide range voltage.
- USBVCC = 3.0V to 3.6V: for USB I/O voltage, when USB is used.
  = 2.7V to 5.5V: when GPIO is used(*)

*: MB9BF500N/R cannot use USB I/O for GPIO.

■ PRODUCT LINEUP

● Memory size

Product device	MB9BF500N/R	MB9BF504N/R	MB9BF505N/R	MB9BF506N/R
On-chip Flash	256Kbyte	256Kbyte	384Kbyte	512Kbyte
On-chip RAM	32Kbyte	32Kbyte	48Kbyte	64Kbyte

● Function

Product device			MB9BF500N	MB9BF500R	MB9BF504N MB9BF505N MB9BF506N	MB9BF504R MB9BF505R MB9BF506R
Pin count			100	120	100	120
CPU			Cortex-M3			
	Freq.		80MHz			
Power supply voltage range			2.7V to 5.5V (USBVCC: 3.0V to 3.6V)		2.7V to 5.5V	
USB2.0FS (Function/Host)			1ch		←	
CAN Interface			2ch (Max.)		←	
DMAC			8ch		←	
External Bus Interface			Addr:25bit (Max.) Data:8/16 bit CS:5(Max.) Support: SRAM, NOR Flash	Addr:25bit (Max.) Data:8/16 bit CS:8(Max.) Support: SRAM, NOR & NAND Flash	Addr:25bit (Max.) Data:8/16 bit CS:5(Max.) Support: SRAM, NOR Flash	Addr:25bit (Max.) Data:8/16 bit CS:8(Max.) Support: SRAM, NOR & NAND Flash
MF Serial Interface (UART/CSIO/LIN/I^{2}C)			8ch (Max.)		←	
Base Timer (PWC/ Reload timer/PWM/PPG)			8ch (Max.)		←	
MF-Timer	A/D activation compare	3ch	2 units (Max.)		←	
	Input capture	4ch				
	Free-run timer	3ch				
	Output compare	6ch				
	Waveform generator	3ch				
	PPG	3ch				
QPRC			2ch (Max.)		←	
Dual Timer			1 unit		←	
Watch Counter			1 unit		←	
CRC Accelerator			Yes		←	
Watchdog timer			1ch(SW) + 1ch(HW)		←	
External Interrupts			16pins (Max.)+ NMI × 1		←	
I/O ports			76pins (Max.)	96pins (Max.)	80pins (Max.)	100pins (Max.)
10 bit A/D converter			16ch (3 units)		-	
12 bit A/D converter			-		16ch (3 units)	
CSV (Clock Super Visor)			Yes		←	
LVD (Low Voltage Detector)			2ch		←	
Internal OSC	High-speed		4MHz (± 3%)		4MHz (± 2%)	
	Low-speed		100kHz (Typ)		←	
Debug Function			SWJ-DP/TPIU/ETM		←	

Note: All signals of the peripheral function in each product cannot be allocated by limiting the pins of package. It is necessary to use the port relocate function of the General I/O port according to your function use.

■ PACKAGES

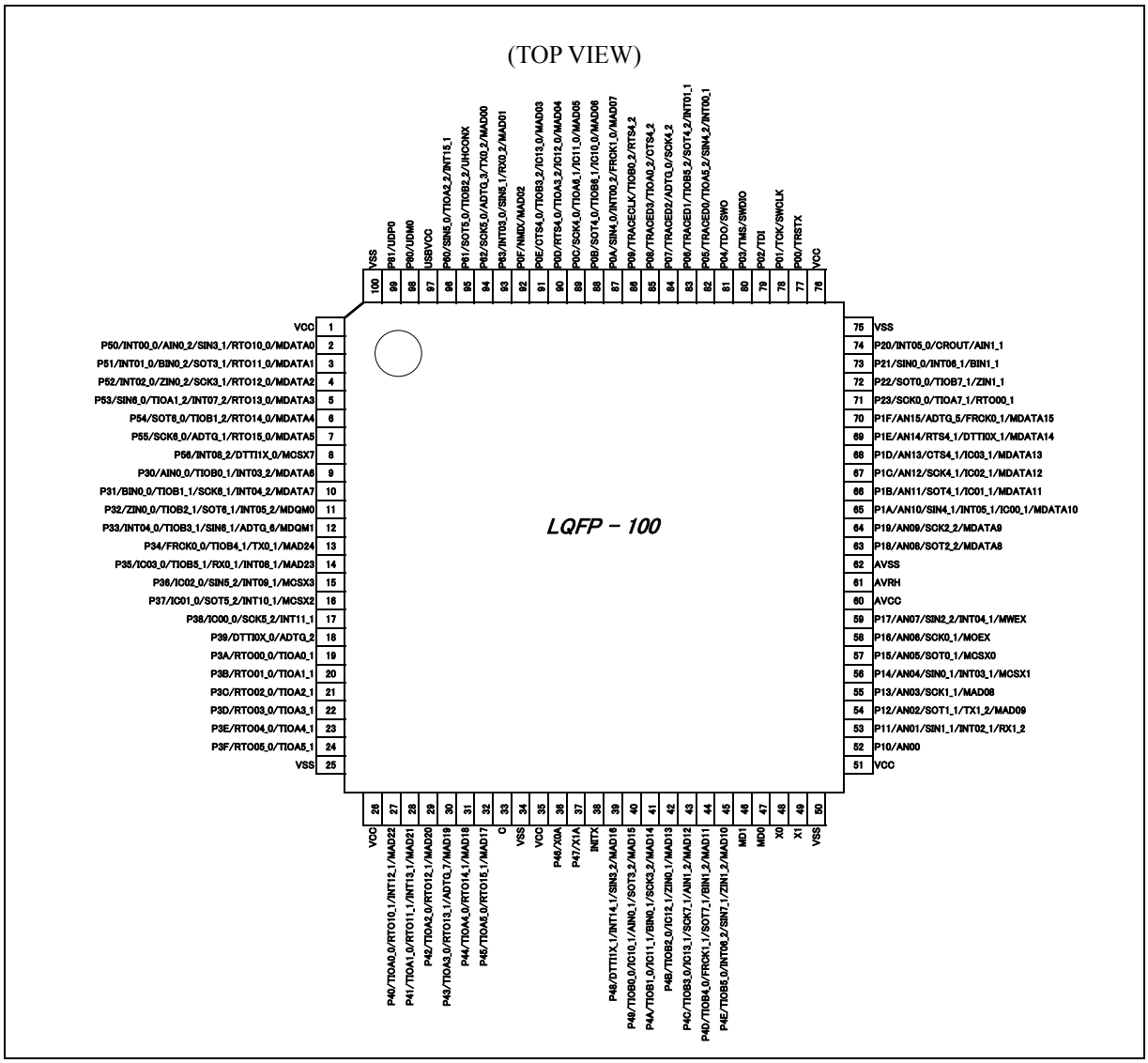
Package \ Product name	MB9BF500N	MB9BF500R	MB9BF504N MB9BF505N MB9BF506N	MB9BF504R MB9BF505R MB9BF506R
LQFP: FPT-100P-M20	❍	-	❍	-
LQFP: FPT-120P-M21	-	❍	-	❍
BGA: BGA-112P-M04	-		❍	-

❍ : Supported

Note : Refer to "■PACKAGE DIMENSIONS" for detailed information on each package.

■ PIN ASSIGNMENT

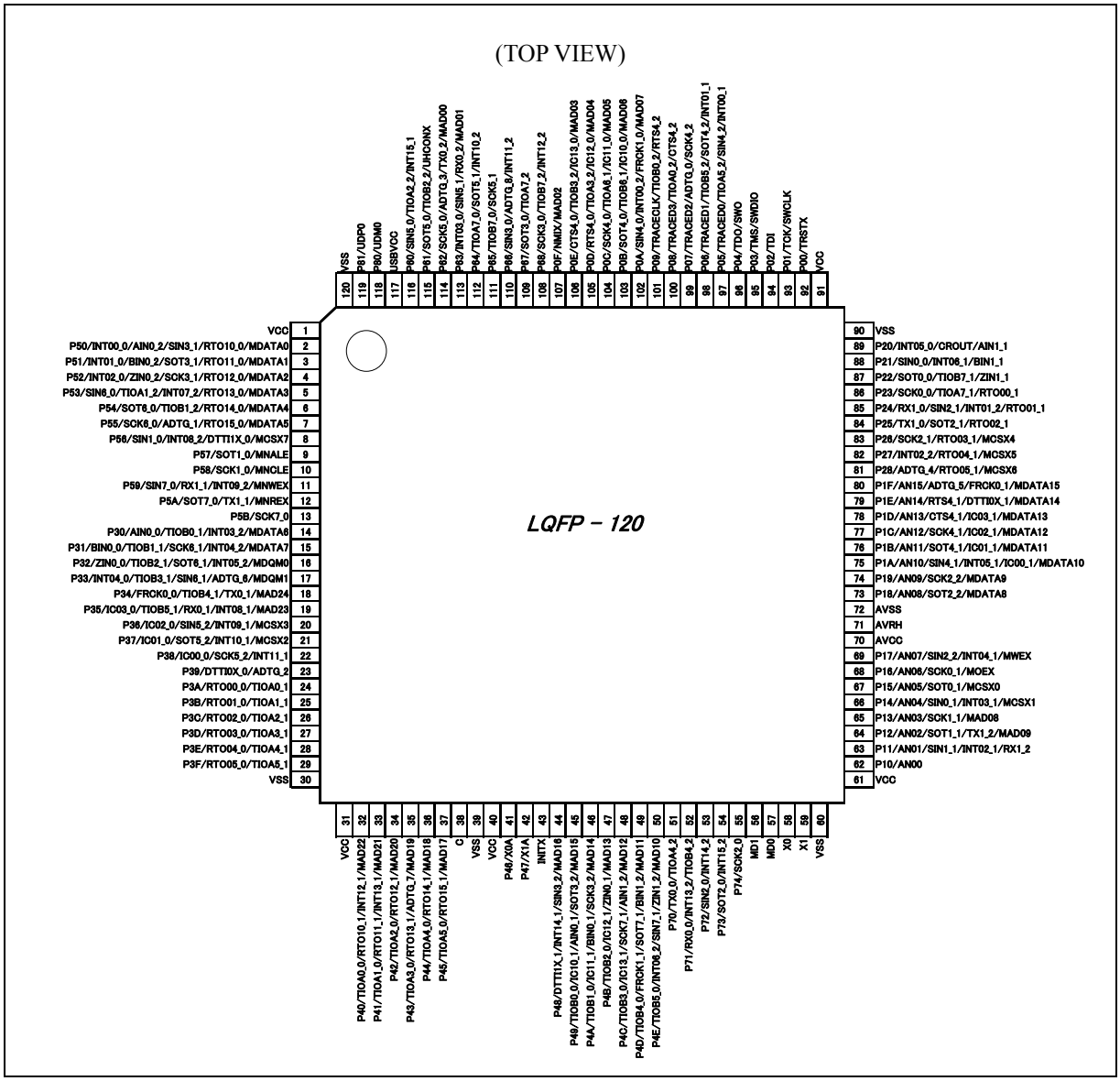
● FPT-100P-M20



<Notes>

- The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.
- In MB9BF500, GPIO function can not be used for P46, P47, P80, and P81.

● **FPT-120P-M21**



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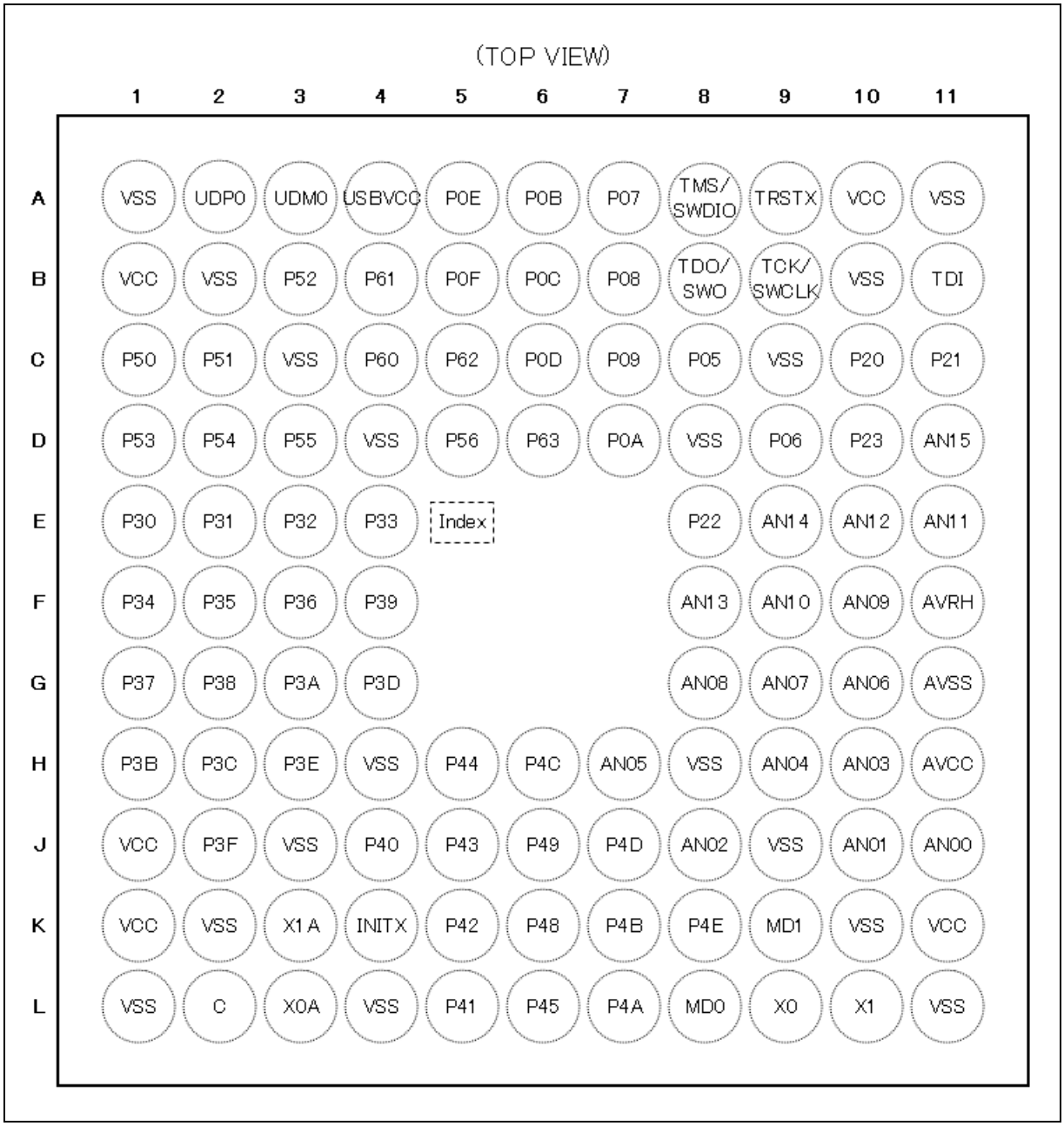
● **BGA-112P-M04**



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■ PIN DESCRIPTION

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
1	B1	1	VCC	-	
2	C1	2	P50 INT00_0 AIN0_2 SIN3_1 RTO10_0 (PPG10_0) MDATA0	E	H
3	C2	3	P51 INT01_0 BIN0_2 SOT3_1 (SDA3_1) RTO11_0 (PPG10_0) MDATA1	E	H
4	B3	4	P52 INT02_0 ZIN0_2 SCK3_1 (SCL3_1) RTO12_0 (PPG12_0) MDATA2	E	H
5	D1	5	P53 SIN6_0 TIOA1_2 INT07_2 RTO13_0 (PPG12_0) MDATA3	E	H
6	D2	6	P54 SOT6_0 (SDA6_0) TIOB1_2 RTO14_0 (PPG14_0) MDATA4	E	I

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
7	D3	7	P55 SCK6_0 (SCL6_0) ADTG_1 RTO15_0 (PPG14_0) MDATA5	E	I
8	D5	8	P56 SIN1_0 (120pin only) INT08_2 DTTI1X_0 MCSX7	E	H
-	-	9	P57 SOT1_0 (SDA1_0) MNALE	E	I
-	-	10	P58 SCK1_0 (SCL1_0) MNCLE	E	I
-	-	11	P59 SIN7_0 RX1_1 INT09_2 MNWEX	E	H
-	-	12	P5A SOT7_0 (SDA7_0) TX1_1 MNREX	E	I
-	-	13	P5B SCK7_0 (SCL7_0)	E	I
9	E1	14	P30 AIN0_0 TIOB0_1 INT03_2 MDATA6	E	H

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
10	E2	15	P31 BIN0_0 TIOB1_1 SCK6_1 (SCL6_1) INT04_2 MDATA7	E	H
11	E3	16	P32 ZIN0_0 TIOB2_1 SOT6_1 (SDA6_1) INT05_2 MDQM0	E	H
12	E4	17	P33 INT04_0 TIOB3_1 SIN6_1 ADTG_6 MDQM1	E	H
13	F1	18	P34 FRCK0_0 TIOB4_1 TX0_1 MAD24	E	I
14	F2	19	P35 IC03_0 TIOB5_1 RX0_1 INT08_1 MAD23	E	H
15	F3	20	P36 IC02_0 SIN5_2 INT09_1 MCSX3	E	H
16	G1	21	P37 IC01_0 SOT5_2 (SDA5_2) INT10_1 MCSX2	E	H

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
17	G2	22	P38 IC00_0 SCK5_2 (SCL5_2) INT11_1	E	H
18	F4	23	P39 DTTI0X_0 ADTG_2	E	I
19	G3	24	P3A RTO00_0 (PPG00_0) TIOA0_1	G	I
-	A1	-	VSS	-	
20	H1	25	P3B RTO01_0 (PPG00_0) TIOA1_1	G	I
21	H2	26	P3C RTO02_0 (PPG02_0) TIOA2_1	G	I
22	G4	27	P3D RTO03_0 (PPG02_0) TIOA3_1	G	I
23	H3	28	P3E RTO04_0 (PPG04_0) TIOA4_1	G	I
24	J2	29	P3F RTO05_0 (PPG04_0) TIOA5_1	G	I
25	L1	30	VSS	-	
26	J1	31	VCC	-	
27	J4	32	P40 TIOA0_0 RTO10_1 (PPG10_1) INT12_1 MAD22	G	H

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
28	L5	33	P41	G	H
			TIOA1_0		
			RTO11_1 (PPG10_1)		
			INT13_1		
			MAD21		
29	K5	34	P42	G	I
			TIOA2_0		
			RTO12_1 (PPG12_1)		
			MAD20		
30	J5	35	P43	G	I
			TIOA3_0		
			RTO13_1 (PPG12_1)		
			ADTG_7		
			MAD19		
-	K2	-	VSS	-	
-	J3	-	VSS	-	
-	H4	-	VSS	-	
31	H5	36	P44	G	I
			TIOA4_0		
			RTO14_1 (PPG14_1)		
			MAD18		
32	L6	37	P45	G	I
			TIOA5_0		
			RTO15_1 (PPG14_1)		
			MAD17		
33	L2	38	C	-	
34	L4	39	VSS	-	
35	K1	40	VCC	-	
36	L3	41	P46	D	M
			X0A		
37	K3	42	P47	D	N
			X1A		
38	K4	43	INITX	B	C
39	K6	44	P48	E	H
			DTTI1X_1		
			INT14_1		
			SIN3_2		
			MAD16		

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
40	J6	45	P49	E	I
			TIOB0_0		
			IC10_1		
			AIN0_1		
			SOT3_2 (SDA3_2)		
			MAD15		
41	L7	46	P4A	E	I
			TIOB1_0		
			IC11_1		
			BIN0_1		
			SCK3_2 (SCL3_2)		
			MAD14		
42	K7	47	P4B	E	I
			TIOB2_0		
			IC12_1		
			ZIN0_1		
			MAD13		
43	H6	48	P4C	E	I
			TIOB3_0		
			IC13_1		
			SCK7_1 (SCL7_1)		
			AIN1_2		
			MAD12		
44	J7	49	P4D	E	I
			TIOB4_0		
			FRCK1_1		
			SOT7_1 (SDA7_1)		
			BIN1_2		
			MAD11		
45	K8	50	P4E	E	I
			TIOB5_0		
			INT06_2		
			SIN7_1		
			ZIN1_2		
			MAD10		
-	-	51	P70	E	I
			TX0_0		
			TIOA4_2		

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
-	-	52	P71	E	H
			RX0_0		
			INT13_2		
			TIOB4_2		
-	-	53	P72	E	H
			SIN2_0		
			INT14_2		
-	-	54	P73	E	H
			SOT2_0 (SDA2_0)		
			INT15_2		
-	-	55	P74	E	I
			SCK2_0 (SCL2_0)		
46	K9	56	MD1	C	D
47	L8	57	MD0	C	D
48	L9	58	X0	A	A
49	L10	59	X1	A	B
50	L11	60	VSS	-	
51	K11	61	VCC	-	
52	J11	62	P10	F	K
			AN00		
53	J10	63	P11	F	L
			AN01		
			SIN1_1		
			INT02_1		
			RX1_2		
-	K10	-	VSS	-	
-	J9	-	VSS	-	
54	J8	64	P12	F	K
			AN02		
			SOT1_1 (SDA1_1)		
			TX1_2		
			MAD09		
55	H10	65	P13	F	K
			AN03		
			SCK1_1 (SCL1_1)		
			MAD08		

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
56	H9	66	P14	F	L
			AN04		
			SIN0_1		
			INT03_1		
			MCSX1		
57	H7	67	P15	F	K
			AN05		
			SOT0_1 (SDA0_1)		
			MCSX0		
58	G10	68	P16	F	K
			AN06		
			SCK0_1 (SCL0_1)		
			MOEX		
59	G9	69	P17	F	L
			AN07		
			SIN2_2		
			INT04_1		
			MWEX		
60	H11	70	AVCC	-	
61	F11	71	AVRH	-	
62	G11	72	AVSS	-	
63	G8	73	P18	F	K
			AN08		
			SOT2_2 (SDA2_2)		
			MDATA8		
64	F10	74	P19	F	K
			AN09		
			SCK2_2 (SCL2_2)		
			MDATA9		
65	F9	75	P1A	F	L
			AN10		
			SIN4_1		
			INT05_1		
			IC00_1		
			MDATA10		
-	H8	-	VSS	-	

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
66	E11	76	P1B AN11 SOT4_1 (SDA4_1) IC01_1 MDATA11	F	K
67	E10	77	P1C AN12 SCK4_1 (SCL4_1) IC02_1 MDATA12	F	K
68	F8	78	P1D AN13 CTS4_1 IC03_1 MDATA13	F	K
69	E9	79	P1E AN14 RTS4_1 DTTI0X_1 MDATA14	F	K
70	D11	80	P1F AN15 ADTG_5 FRCK0_1 MDATA15	F	K
-	-	81	P28 ADTG_4 RTO05_1 (PPG04_1) MCSX6	E	I
-	-	82	P27 INT02_2 RTO04_1 (PPG04_1) MCSX5	E	H
-	-	83	P26 SCK2_1 (SCL2_1) RTO03_1 (PPG02_1) MCSX4	E	I

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
-	-	84	P25	E	I
			TX1_0		
			SOT2_1 (SDA2_1)		
			RTO02_1 (PPG02_1)		
-	B10	-	VSS	-	
-	C9	-	VSS	-	
-	-	85	P24	E	H
			RX1_0		
			SIN2_1		
			INT01_2		
			RTO01_1 (PPG00_1)		
71	D10	86	P23	E	I
			SCK0_0 (SCL0_0)		
			TIOA7_1		
			RTO00_1 (PPG00_1)		
72	E8	87	P22	E	I
			SOT0_0 (SDA0_0)		
			TIOB7_1		
			ZIN1_1		
73	C11	88	P21	E	H
			SIN0_0		
			INT06_1		
			BIN1_1		
74	C10	89	P20	E	H
			INT05_0		
			CROUT		
			AIN1_1		
75	A11	90	VSS	-	
76	A10	91	VCC	-	
77	A9	92	P00	E	E
			TRSTX		
78	B9	93	P01	E	E
			TCK		
			SWCLK		
79	B11	94	P02	E	E
			TDI		

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
80	A8	95	P03	E	E
			TMS		
			SWDIO		
81	B8	96	P04	E	E
			TDO		
			SWO		
82	C8	97	P05	E	F
			TRACED0		
			TIOA5_2		
			SIN4_2		
			INT00_1		
-	D8	-	VSS	-	
83	D9	98	P06	E	F
			TRACED1		
			TIOB5_2		
			SOT4_2 (SDA4_2)		
			INT01_1		
84	A7	99	P07	E	G
			TRACED2		
			ADTG_0		
			SCK4_2 (SCL4_2)		
85	B7	100	P08	E	G
			TRACED3		
			TIOA0_2		
			CTS4_2		
86	C7	101	P09	E	G
			TRACECLK		
			TIOB0_2		
			RTS4_2		
87	D7	102	P0A	E	H
			SIN4_0		
			INT00_2		
			FRCK1_0		
			MAD07		
88	A6	103	P0B	E	I
			SOT4_0 (SDA4_0)		
			TIOB6_1		
			IC10_0		
			MAD06		

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
89	B6	104	P0C SCK4_0 (SCL4_0) TIOA6_1 IC11_0 MAD05	E	I
90	C6	105	P0D RTS4_0 TIOA3_2 IC12_0 MAD04	E	I
91	A5	106	P0E CTS4_0 TIOB3_2 IC13_0 MAD03	E	I
-	D4	-	VSS	-	
-	C3	-	VSS	-	
92	B5	107	P0F NMIX MAD02	E	J
-	-	108	P68 SCK3_0 (SCL3_0) TIOB7_2 INT12_2	E	H
-	-	109	P67 SOT3_0 (SDA3_0) TIOA7_2	E	I
-	-	110	P66 SIN3_0 ADTG_8 INT11_2	E	H
-	-	111	P65 TIOB7_0 SCK5_1 (SCL5_1)	E	I
-	-	112	P64 TIOA7_0 SOT5_1 (SDA5_1) INT10_2	E	H

Pin no.			Pin name	I/O circuit type	Pin state type
LQFP-100	BGA-112	LQFP-120			
93	D6	113	P63	E	H
			INT03_0		
			SIN5_1		
			RX0_2		
			MAD01		
94	C5	114	P62	E	I
			SCK5_0 (SCL5_0)		
			ADTG_3		
			TX0_2		
			MAD00		
95	B4	115	P61	E	I
			SOT5_0 (SDA5_0)		
			TIOB2_2		
			UHCONX		
96	C4	116	P60	E	H
			SIN5_0		
			TIOA2_2		
			INT15_1		
97	A4	117	USBVCC	-	
98	A3	118	P80	H	O
			UDM0		
99	A2	119	P81	H	O
			UDP0		
100	B2	120	VSS	-	

■ SIGNAL DESCRIPTION

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
ADC	ADTG_0	A/D converter external trigger input pin.	84	A7	99
	ADTG_1		7	D3	7
	ADTG_2		18	F4	23
	ADTG_3		94	C5	114
	ADTG_4		-	-	81
	ADTG_5		70	D11	80
	ADTG_6		12	E4	17
	ADTG_7		30	J5	35
	ADTG_8		-	-	110
	AN00	A/D converter analog input pin. ANxx describes ADC ch.xx.	52	J11	62
	AN01		53	J10	63
	AN02		54	J8	64
	AN03		55	H10	65
	AN04		56	H9	66
	AN05		57	H7	67
	AN06		58	G10	68
	AN07		59	G9	69
	AN08		63	G8	73
	AN09		64	F10	74
	AN10		65	F9	75
	AN11		66	E11	76
	AN12		67	E10	77
	AN13		68	F8	78
	AN14		69	E9	79
	AN15		70	D11	80
Base Timer 0	TIOA0_0	Base timer ch.0 TIOA pin.	27	J4	32
	TIOA0_1		19	G3	24
	TIOA0_2		85	B7	100
	TIOB0_0	Base timer ch.0 TIOB pin.	40	J6	45
	TIOB0_1		9	E1	14
	TIOB0_2		86	C7	101
Base Timer 1	TIOA1_0	Base timer ch.1 TIOA pin.	28	L5	33
	TIOA1_1		20	H1	25
	TIOA1_2		5	D1	5
	TIOB1_0	Base timer ch.1 TIOB pin.	41	L7	46
	TIOB1_1		10	E2	15
	TIOB1_2		6	D2	6
Base Timer 2	TIOA2_0	Base timer ch.2 TIOA pin.	29	K5	34
	TIOA2_1		21	H2	26
	TIOA2_2		96	C4	116
	TIOB2_0	Base timer ch.2 TIOB pin.	42	K7	47
	TIOB2_1		11	E3	16
	TIOB2_2		95	B4	115

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
Base Timer 3	TIOA3_0	Base timer ch.3 TIOA pin.	30	J5	35
	TIOA3_1		22	G4	27
	TIOA3_2		90	C6	105
	TIOB3_0	Base timer ch.3 TIOB pin.	43	H6	48
	TIOB3_1		12	E4	17
	TIOB3_2		91	A5	106
Base Timer 4	TIOA4_0	Base timer ch.4 TIOA pin.	31	H5	36
	TIOA4_1		23	H3	28
	TIOA4_2		-	-	51
	TIOB4_0	Base timer ch.4 TIOB pin.	44	J7	49
	TIOB4_1		13	F1	18
	TIOB4_2		-	-	52
Base Timer 5	TIOA5_0	Base timer ch.5 TIOA pin.	32	L6	37
	TIOA5_1		24	J2	29
	TIOA5_2		82	C8	97
	TIOB5_0	Base timer ch.5 TIOB pin.	45	K8	50
	TIOB5_1		14	F2	19
	TIOB5_2		83	D9	98
Base Timer 6	TIOA6_1	Base timer ch.6 TIOA pin.	89	B6	104
	TIOB6_1	Base timer ch.6 TIOB pin.	88	A6	103
Base Timer 7	TIOA7_0	Base timer ch.7 TIOA pin.	-	-	112
	TIOA7_1		71	D10	86
	TIOA7_2		-	-	109
	TIOB7_0	Base timer ch.7 TIOB pin.	-	-	111
	TIOB7_1		72	E8	87
	TIOB7_2		-	-	108
CAN 0	TX0_0	CAN interface ch.0 TX output.	-	-	51
	TX0_1		13	F1	18
	TX0_2		94	C5	114
	RX0_0	CAN interface ch.0 RX input.	-	-	52
	RX0_1		14	F2	19
	RX0_2		93	D6	113
CAN 1	TX1_0	CAN interface ch.1 TX output.	-	-	84
	TX1_1		-	-	12
	TX1_2		54	J8	64
	RX1_0	CAN interface ch.1 RX input.	-	-	85
	RX1_1		-	-	11
	RX1_2		53	J10	63

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
Debugger	SWCLK	Serial wire debug interface clock input.	78	B9	93
	SWDIO	Serial wire debug interface data input / output.	80	A8	95
	SWO	Serial wire viewer output.	81	B8	96
	TCK	J-TAG test clock input.	78	B9	93
	TDI	J-TAG test data input.	79	B11	94
	TDO	J-TAG debug data output.	81	B8	96
	TMS	J-TAG test mode state input/output.	80	A8	95
	TRACECLK	Trace CLK output of ETM.	86	C7	101
	TRACED0	Trace data output of ETM.	82	C8	97
	TRACED1		83	D9	98
	TRACED2		84	A7	99
	TRACED3		85	B7	100
	TRSTX	J-TAG test reset Input.	77	A9	92
External Bus	MAD00	External bus interface address bus.	94	C5	114
	MAD01		93	D6	113
	MAD02		92	B5	107
	MAD03		91	A5	106
	MAD04		90	C6	105
	MAD05		89	B6	104
	MAD06		88	A6	103
	MAD07		87	D7	102
	MAD08		55	H10	65
	MAD09		54	J8	64
	MAD10		45	K8	50
	MAD11		44	J7	49
	MAD12		43	H6	48
	MAD13		42	K7	47
	MAD14		41	L7	46
	MAD15		40	J6	45
	MAD16		39	K6	44
	MAD17		32	L6	37
	MAD18		31	H5	36
	MAD19		30	J5	35
	MAD20		29	K5	34
	MAD21		28	L5	33
	MAD22		27	J4	32
	MAD23		14	F2	19
	MAD24		13	F1	18
	MCSX0	External bus interface chip select output pin.	57	H7	67
	MCSX1		56	H9	66
	MCSX2		16	G1	21
	MCSX3		15	F3	20
	MCSX4		-	-	83
	MCSX5		-	-	82
	MCSX6		-	-	81
	MCSX7		8	D5	8

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
External Bus	MDATA0	External bus interface data bus.	2	C1	2
	MDATA1		3	C2	3
	MDATA2		4	B3	4
	MDATA3		5	D1	5
	MDATA4		6	D2	6
	MDATA5		7	D3	7
	MDATA6		9	E1	14
	MDATA7		10	E2	15
	MDATA8		63	G8	73
	MDATA9		64	F10	74
	MDATA10		65	F9	75
	MDATA11		66	E11	76
	MDATA12		67	E10	77
	MDATA13		68	F8	78
	MDATA14		69	E9	79
	MDATA15		70	D11	80
	MDQM0	External bus interface byte mask signal output.	11	E3	16
	MDQM1		12	E4	17
	MNALE	External bus interface ALE signal to control NAND Flash output pin.	-	-	9
	MNCLE	External bus interface CLE signal to control NAND Flash output pin.	-	-	10
	MNREX	External bus interface read enable signal to control NAND Flash.	-	-	12
	MNWEX	External bus interface write enable signal to control NAND Flash.	-	-	11
	MOEX	External bus interface read enable signal for SRAM.	58	G10	68
	MWEX	External bus interface write enable signal for SRAM.	59	G9	69

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
External Interrupt	INT00_0	External interrupt request 00 input pin.	2	C1	2
	INT00_1		82	C8	97
	INT00_2		87	D7	102
	INT01_0	External interrupt request 01 input pin.	3	C2	3
	INT01_1		83	D9	98
	INT01_2		-	-	85
	INT02_0	External interrupt request 02 input pin.	4	B3	4
	INT02_1		53	J10	63
	INT02_2		-	-	82
	INT03_0	External interrupt request 03 input pin.	93	D6	113
	INT03_1		56	H9	66
	INT03_2		9	E1	14
	INT04_0	External interrupt request 04 input pin.	12	E4	17
	INT04_1		59	G9	69
	INT04_2		10	E2	15
	INT05_0	External interrupt request 05 input pin.	74	C10	89
	INT05_1		65	F9	75
	INT05_2		11	E3	16
	INT06_1	External interrupt request 06 input pin.	73	C11	88
	INT06_2		45	K8	50
	INT07_2	External interrupt request 07 input pin.	5	D1	5
	INT08_1	External interrupt request 08 input pin.	14	F2	19
	INT08_2		8	D5	8
	INT09_1	External interrupt request 09 input pin.	15	F3	20
	INT09_2		-	-	11
	INT10_1	External interrupt request 10 input pin.	16	G1	21
	INT10_2		-	-	112
	INT11_1	External interrupt request 11 input pin.	17	G2	22
	INT11_2		-	-	110
	INT12_1	External interrupt request 12 input pin.	27	J4	32
	INT12_2		-	-	108
	INT13_1	External interrupt request 13 input pin.	28	L5	33
	INT13_2		-	-	52
	INT14_1	External interrupt request 14 input pin.	39	K6	44
	INT14_2		-	-	53
	INT15_1	External interrupt request 15 input pin.	96	C4	116
	INT15_2		-	-	54
	NMIX	Non-Maskable Interrupt input.	92	B5	107

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Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
GPIO	P00	General-purpose I/O port 0.	77	A9	92
	P01		78	B9	93
	P02		79	B11	94
	P03		80	A8	95
	P04		81	B8	96
	P05		82	C8	97
	P06		83	D9	98
	P07		84	A7	99
	P08		85	B7	100
	P09		86	C7	101
	P0A		87	D7	102
	P0B		88	A6	103
	P0C		89	B6	104
	P0D		90	C6	105
	P0E		91	A5	106
	P0F		92	B5	107
	P10	General-purpose I/O port 1.	52	J11	62
	P11		53	J10	63
	P12		54	J8	64
	P13		55	H10	65
	P14		56	H9	66
	P15		57	H7	67
	P16		58	G10	68
	P17		59	G9	69
	P18		63	G8	73
	P19		64	F10	74
	P1A		65	F9	75
	P1B		66	E11	76
	P1C		67	E10	77
	P1D		68	F8	78
	P1E		69	E9	79
	P1F		70	D11	80
	P20	General-purpose I/O port 2.	74	C10	89
	P21		73	C11	88
	P22		72	E8	87
	P23		71	D10	86
	P24		-	-	85
	P25		-	-	84
	P26		-	-	83
	P27		-	-	82
	P28		-	-	81

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
GPIO	P30	General-purpose I/O port 3.	9	E1	14
	P31		10	E2	15
	P32		11	E3	16
	P33		12	E4	17
	P34		13	F1	18
	P35		14	F2	19
	P36		15	F3	20
	P37		16	G1	21
	P38		17	G2	22
	P39		18	F4	23
	P3A		19	G3	24
	P3B		20	H1	25
	P3C		21	H2	26
	P3D		22	G4	27
	P3E		23	H3	28
	P3F		24	J2	29
	P40	General-purpose I/O port 4.	27	J4	32
	P41		28	L5	33
	P42		29	K5	34
	P43		30	J5	35
	P44		31	H5	36
	P45		32	L6	37
	P46		36	L3	41
	P47		37	K3	42
	P48		39	K6	44
	P49		40	J6	45
	P4A		41	L7	46
	P4B		42	K7	47
	P4C		43	H6	48
	P4D		44	J7	49
	P4E		45	K8	50
	P50	General-purpose I/O port 5.	2	C1	2
	P51		3	C2	3
	P52		4	B3	4
	P53		5	D1	5
	P54		6	D2	6
	P55		7	D3	7
	P56		8	D5	8
	P57		-	-	9
	P58		-	-	10
	P59		-	-	11
	P5A		-	-	12
	P5B		-	-	13

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
GPIO	P60	General-purpose I/O port 6.	96	C4	116
	P61		95	B4	115
	P62		94	C5	114
	P63		93	D6	113
	P64		-	-	112
	P65		-	-	111
	P66		-	-	110
	P67		-	-	109
	P68		-	-	108
	P70	General-purpose I/O port 7.	-	-	51
	P71		-	-	52
	P72		-	-	53
	P73		-	-	54
	P74		-	-	55
	P80	General-purpose I/O port 8.	98	A3	118
	P81		99	A2	119
Multi Function Serial 0	SIN0_0	Multifunction serial interface ch.0 input pin.	73	C11	88
	SIN0_1		56	H9	66
	SOT0_0 (SDA0_0)	Multifunction serial interface ch.0 output pin. This pin operates as SOT0 when it is used in a UART/CSIO (operation modes 0 to 2) and as SDA0 when it is used in an I^2C (operation mode 4).	72	E8	87
	SOT0_1 (SDA0_1)		57	H7	67
	SCK0_0 (SCL0_0)	Multifunction serial interface ch.0 clock I/O pin. This pin operates as SCK0 when it is used in a UART/CSIO (operation modes 0 to 2) and as SCL0 when it is used in an I^2C (operation mode 4).	71	D10	86
	SCK0_1 (SCL0_1)		58	G10	68
Multi Function Serial 1	SIN1_0	Multifunction serial interface ch.1 input pin.	-	-	8
	SIN1_1		53	J10	63
	SOT1_0 (SDA1_0)	Multifunction serial interface ch.1 output pin. This pin operates as SOT1 when it is used in a UART/CSIO (operation modes 0 to 2) and as SDA1 when it is used in an I^2C (operation mode 4).	-	-	9
	SOT1_1 (SDA1_1)		54	J8	64
	SCK1_0 (SCL1_0)	Multifunction serial interface ch.1 clock I/O pin. This pin operates as SCK1 when it is used in a UART/CSIO (operation modes 0 to 2) and as SCL1 when it is used in an I^2C (operation mode 4).	-	-	10
	SCK1_1 (SCL1_1)		55	H10	65

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
Multi Function Serial 2	SIN2_0	Multifunction serial interface ch.2 input pin.	-	-	53
	SIN2_1		-	-	85
	SIN2_2		59	G9	69
	SOT2_0 (SDA2_0)	Multifunction serial interface ch.2 output pin. This pin operates as SOT2 when it is used in a UART/CSIO (operation modes 0 to 2) and as SDA2 when it is used in an I^2C (operation mode 4).	-	-	54
	SOT2_1 (SDA2_1)		-	-	84
	SOT2_2 (SDA2_2)		63	G8	73
	SCK2_0 (SCL2_0)	Multifunction serial interface ch.2 clock I/O pin. This pin operates as SCK2 when it is used in a UART/CSIO (operation modes 0 to 2) and as SCL2 when it is used in an I^2C (operation mode 4).	-	-	55
	SCK2_1 (SCL2_1)		-	-	83
	SCK2_2 (SCL2_2)		64	F10	74
Multi Function Serial 3	SIN3_0	Multifunction serial interface ch.3 input pin.	-	-	110
	SIN3_1		2	C1	2
	SIN3_2		39	K6	44
	SOT3_0 (SDA3_0)	Multifunction serial interface ch.3 output pin. This pin operates as SOT3 when it is used in a UART/CSIO (operation modes 0 to 2) and as SDA3 when it is used in an I^2C (operation mode 4).	-	-	109
	SOT3_1 (SDA3_1)		3	C2	3
	SOT3_2 (SDA3_2)		40	J6	45
	SCK3_0 (SCL3_0)	Multifunction serial interface ch.3 clock I/O pin. This pin operates as SCK3 when it is used in a UART/CSIO (operation modes 0 to 2) and as SCL3 when it is used in an I^2C (operation mode 4).	-	-	108
	SCK3_1 (SCL3_1)		4	B3	4
	SCK3_2 (SCL3_2)		41	L7	46

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
Multi Function Serial 4	SIN4_0	Multifunction serial interface ch.4 input pin.	87	D7	102
	SIN4_1		65	F9	75
	SIN4_2		82	C8	97
	SOT4_0 (SDA4_0)	Multifunction serial interface ch.4 output pin. This pin operates as SOT4 when it is used in a UART/CSIO (operation modes 0 to 2) and as SDA4 when it is used in an I^2C (operation mode 4).	88	A6	103
	SOT4_1 (SDA4_1)		66	E11	76
	SOT4_2 (SDA4_2)		83	D9	98
	SCK4_0 (SCL4_0)	Multifunction serial interface ch.4 clock I/O pin. This pin operates as SCK4 when it is used in a UART/CSIO (operation modes 0 to 2) and as SCL4 when it is used in an I^2C (operation mode 4).	89	B6	104
	SCK4_1 (SCL4_1)		67	E10	77
	SCK4_2 (SCL4_2)		84	A7	99
	RTS4_0	Multifunction serial interface ch.4 RTS output pin.	90	C6	105
	RTS4_1		69	E9	79
	RTS4_2		86	C7	101
	CTS4_0	Multifunction serial interface ch.4 CTS input pin.	91	A5	106
	CTS4_1		68	F8	78
	CTS4_2		85	B7	100
Multi Function Serial 5	SIN5_0	Multifunction serial interface ch.5 input pin.	96	C4	116
	SIN5_1		93	D6	113
	SIN5_2		15	F3	20
	SOT5_0 (SDA5_0)	Multifunction serial interface ch.5 output pin. This pin operates as SOT5 when it is used in a UART/CSIO (operation modes 0 to 2) and as SDA5 when it is used in an I^2C (operation mode 4).	95	B4	115
	SOT5_1 (SDA5_1)		-	-	112
	SOT5_2 (SDA5_2)		16	G1	21
	SCK5_0 (SCL5_0)	Multifunction serial interface ch.5 clock I/O pin. This pin operates as SCK5 when it is used in a UART/CSIO (operation modes 0 to 2) and as SCL5 when it is used in an I^2C (operation mode 4).	94	C5	114
	SCK5_1 (SCL5_1)		-	-	111
	SCK5_2 (SCL5_2)		17	G2	22

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
Multi Function Serial 6	SIN6_0	Multifunction serial interface ch.6 input pin.	5	D1	5
	SIN6_1		12	E4	17
	SOT6_0 (SDA6_0)	Multifunction serial interface ch.6 output pin. This pin operates as SOT6 when it is used in a UART/CSIO (operation modes 0 to 2) and as SDA6 when it is used in an I^2C (operation mode 4).	6	D2	6
	SOT6_1 (SDA6_1)		11	E3	16
	SCK6_0 (SCL6_0)	Multifunction serial interface ch.6 clock I/O pin. This pin operates as SCK6 when it is used in a UART/CSIO (operation modes 0 to 2) and as SCL6 when it is used in an I^2C (operation mode 4).	7	D3	7
	SCK6_1 (SCL6_1)		10	E2	15
Multi Function Serial 7	SIN7_0	Multifunction serial interface ch.7 input pin.	-	-	11
	SIN7_1		45	K8	50
	SOT7_0 (SDA7_0)	Multifunction serial interface ch.7 output pin. This pin operates as SOT7 when it is used in a UART/CSIO (operation modes 0 to 2) and as SDA7 when it is used in an I^2C (operation mode 4).	-	-	12
	SOT7_1 (SDA7_1)		44	J7	49
	SCK7_0 (SCL7_0)	Multifunction serial interface ch.7 clock I/O pin. This pin operates as SCK7 when it is used in a UART/CSIO (operation modes 0 to 2) and as SCL7 when it is used in an I^2C (operation mode 4).	-	-	13
	SCK7_1 (SCL7_1)		43	H6	48

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
Multi Function Timer 0	DTTI0X_0	Input signal controlling wave form generator outputs RTO00 to RTO05 of multi-function timer 0.	18	F4	23
	DTTI0X_1		69	E9	79
	FRCK0_0	16-bit free-run timer ch.0 external clock input pin.	13	F1	18
	FRCK0_1		70	D11	80
	IC00_0	16-bit input capture ch.0 input pin of multi-function timer 0. ICxx desicribes chanel number.	17	G2	22
	IC00_1		65	F9	75
	IC01_0		16	G1	21
	IC01_1		66	E11	76
	IC02_0		15	F3	20
	IC02_1		67	E10	77
	IC03_0		14	F2	19
	IC03_1		68	F8	78
	RTO00_0 (PPG00_0)	Wave form generator output of multi-function timer 0. This pin operates as PPG00 when it is used in PPG 0 output modes.	19	G3	24
	RTO00_1 (PPG00_1)		71	D10	86
	RTO01_0 (PPG00_0)	Wave form generator output of multi-function timer 0. This pin operates as PPG00 when it is used in PPG 0 output modes.	20	H1	25
	RTO01_1 (PPG00_1)		-	-	85
	RTO02_0 (PPG02_0)	Wave form generator output of multi-function timer 0. This pin operates as PPG02 when it is used in PPG 0 output modes.	21	H2	26
	RTO02_1 (PPG02_1)		-	-	84
	RTO03_0 (PPG02_0)	Wave form generator output of multi-function timer 0. This pin operates as PPG02 when it is used in PPG 0 output modes.	22	G4	27
	RTO03_1 (PPG02_1)		-	-	83
	RTO04_0 (PPG04_0)	Wave form generator output of multi-function timer 0. This pin operates as PPG04 when it is used in PPG 0 output modes.	23	H3	28
	RTO04_1 (PPG04_1)		-	-	82
	RTO05_0 (PPG04_0)	Wave form generator output of multi-function timer 0. This pin operates as PPG04 when it is used in PPG 0 output modes.	24	J2	29
	RTO05_1 (PPG04_1)		-	-	81

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
Multi Function Timer 1	DTTI1X_0	Input signal controlling wave form generator outputs RTO10 to RTO15 of multi-function timer 1.	8	D5	8
	DTTI1X_1		39	K6	44
	FRCK1_0	16-bit free-run timer ch.1 external clock input pin.	87	D7	102
	FRCK1_1		44	J7	49
	IC10_0	16-bit input capture ch.0 input pin of multi-function timer 1. ICxx desicribes chanel number.	88	A6	103
	IC10_1		40	J6	45
	IC11_0		89	B6	104
	IC11_1		41	L7	46
	IC12_0		90	C6	105
	IC12_1		42	K7	47
	IC13_0		91	A5	106
	IC13_1		43	H6	48
	RTO10_0 (PPG10_0)	Wave form generator output of multi-function timer 1. This pin operates as PPG10 when it is used in PPG 1 output modes.	2	C1	2
	RTO10_1 (PPG10_1)		27	J4	32
	RTO11_0 (PPG10_0)	Wave form generator output of multi-function timer 1. This pin operates as PPG10 when it is used in PPG 1 output modes.	3	C2	3
	RTO11_1 (PPG10_1)		28	L5	33
	RTO12_0 (PPG12_0)	Wave form generator output of multi-function timer 1. This pin operates as PPG12 when it is used in PPG 1 output modes.	4	B3	4
	RTO12_1 (PPG12_1)		29	K5	34
	RTO13_0 (PPG12_0)	Wave form generator output of multi-function timer 1. This pin operates as PPG12 when it is used in PPG 1 output modes.	5	D1	5
	RTO13_1 (PPG12_1)		30	J5	35
	RTO14_0 (PPG14_0)	Wave form generator output of multi-function timer 1. This pin operates as PPG14 when it is used in PPG 1 output modes.	6	D2	6
	RTO14_1 (PPG14_1)		31	H5	36
	RTO15_0 (PPG14_0)	Wave form generator output of multi-function timer 1. This pin operates as PPG14 when it is used in PPG 1 output modes.	7	D3	7
	RTO15_1 (PPG14_1)		32	L6	37

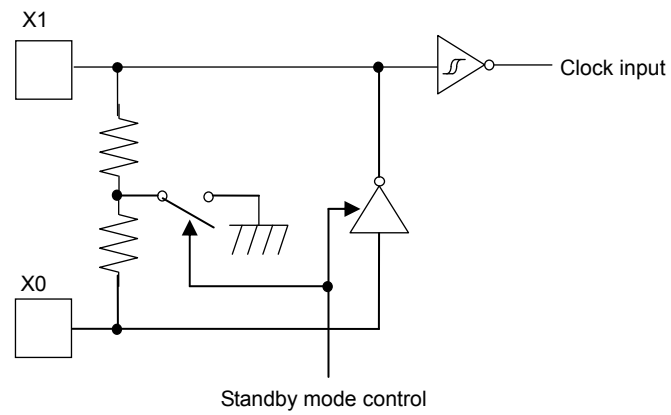
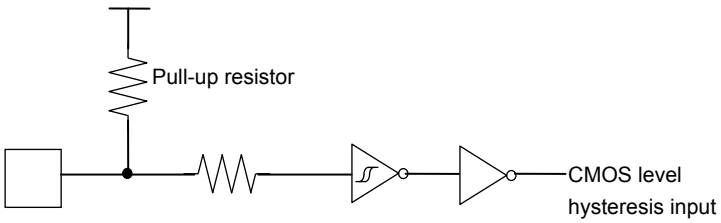
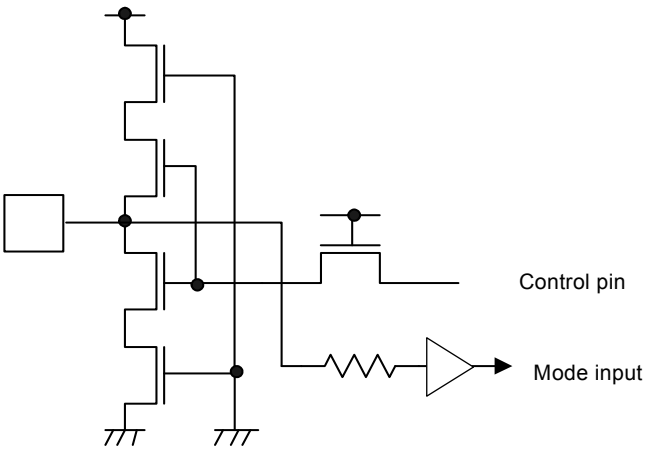
The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

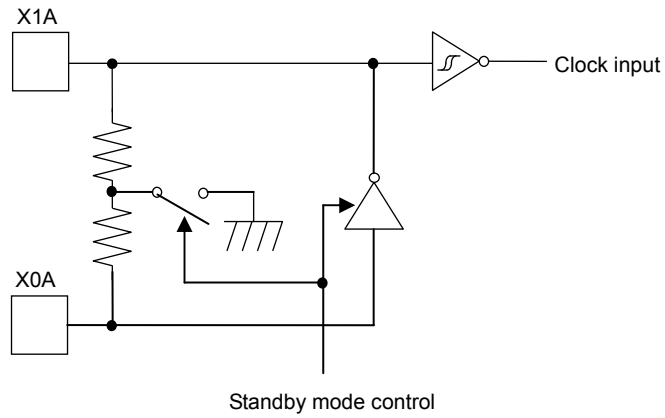
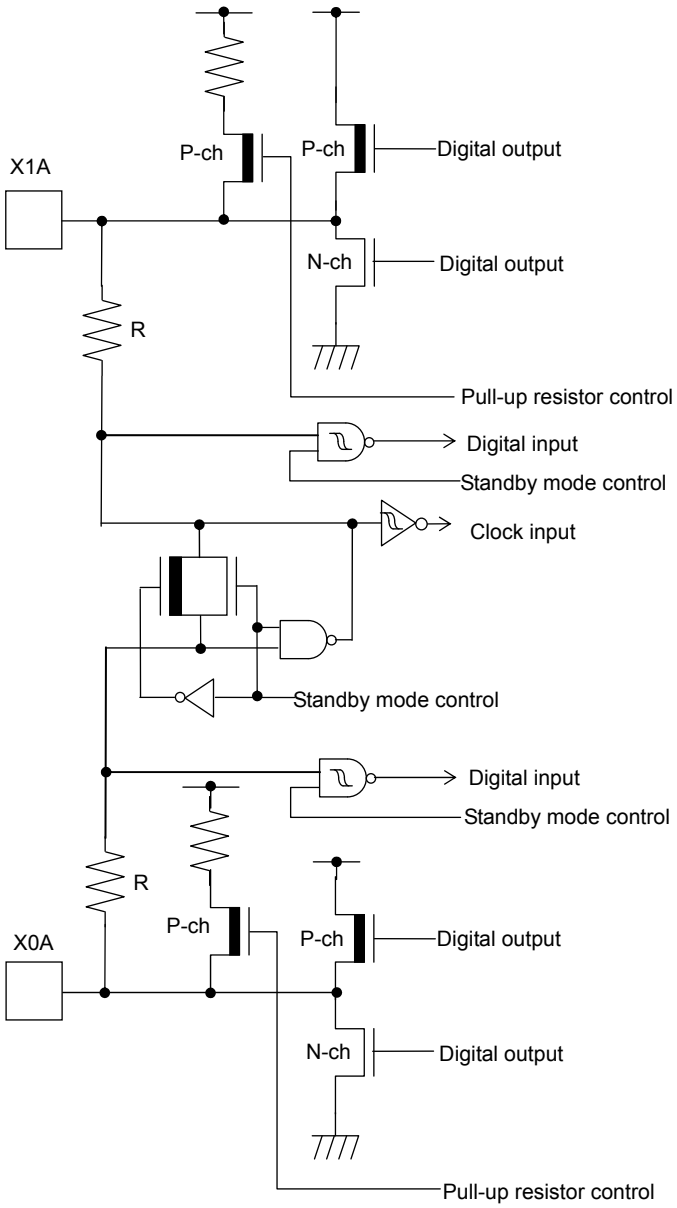
Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
Quadrature Position/ Revolution Counter 0	AIN0_0	QPRC ch.0 AIN input pin.	9	E1	14
	AIN0_1		40	J6	45
	AIN0_2		2	C1	2
	BIN0_0	QPRC ch.0 BIN input pin.	10	E2	15
	BIN0_1		41	L7	46
	BIN0_2		3	C2	3
	ZIN0_0	QPRC ch.0 ZIN input pin.	11	E3	16
	ZIN0_1		42	K7	47
	ZIN0_2		4	B3	4
Quadrature Position/ Revolution Counter 1	AIN1_1	QPRC ch.1 AIN input pin.	74	C10	89
	AIN1_2		43	H6	48
	BIN1_1	QPRC ch.1 BIN input pin.	73	C11	88
	BIN1_2		44	J7	49
	ZIN1_1	QPRC ch.1 ZIN input pin.	72	E8	87
	ZIN1_2		45	K8	50
USB	UDM0	USB Function / HOST D – pin. Please connect to GND pin if you don't use the USB port (MB9BF500 only).	98	A3	118
	UDP0	USB Function / HOST D + pin. Please connect to GND pin if you don't use the USB port (MB9BF500 only).	99	A2	119
	UHCONX	USB external pull-up control pin.	95	B4	115

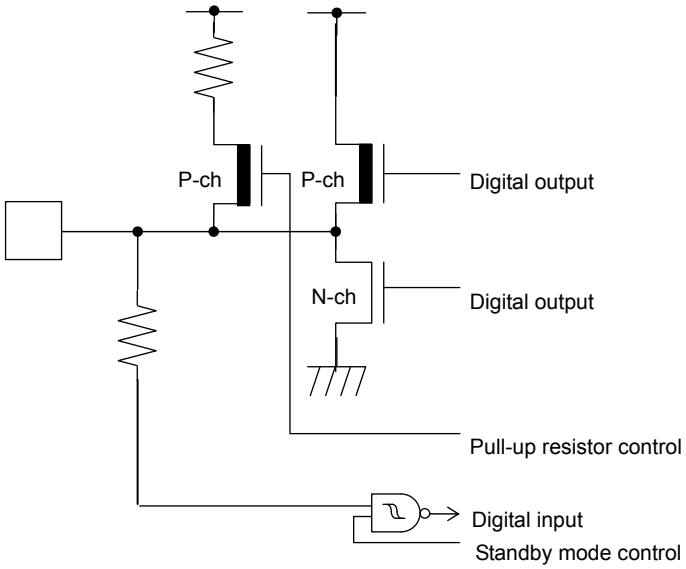
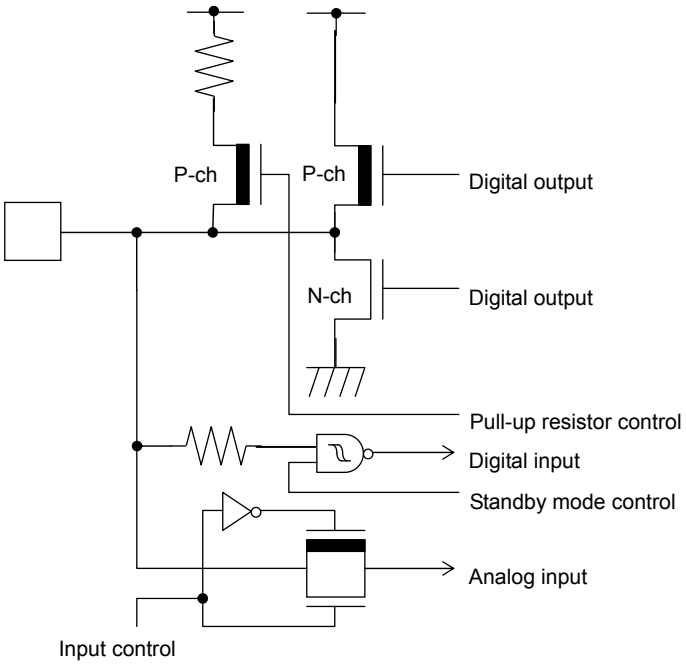
The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, there are multiple pins that provide the same function for the same channel. Use the extended port function register (EPFR) to select the pin.

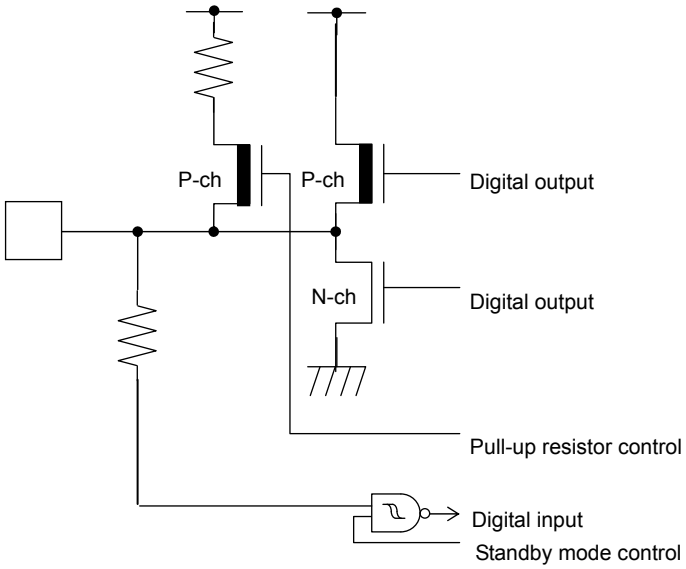
Module	Pin name	Function	Pin No.		
			LQFP-100	BGA-112	LQFP-120
RESET	INITX	External Reset Input. A reset is valid when INITX=L.	38	K4	43
Mode	MD0	Mode 0 pin. During normal operation, MD0=L must be input. During serial programming to flash memory, MD0=H must be input.	47	L8	57
	MD1	Mode 1 pin. Input must always be at the "L" level.	46	K9	56
POWER	VCC	Power Pin.	1	B1	1
	VCC	Power Pin.	26	J1	31
	VCC	Power pin.	35	K1	40
	VCC	Power pin.	51	K11	61
	VCC	Power pin.	76	A10	91
	USBVCC	3.3V Power supply port for USB I/O. Please connect to GND pin if you don't use the USB port (MB9BF500 only).	97	A4	117
GND	VSS	GND Pin.	-	A1	-
	VSS	GND pin.	-	B2	-
	VSS	GND pin.	25	L1	30
	VSS	GND pin.	-	K2	-
	VSS	GND pin.	-	J3	-
	VSS	GND pin.	-	H4	-
	VSS	GND pin.	34	L4	39
	VSS	GND pin.	50	L11	60
	VSS	GND pin.	-	K10	-
	VSS	GND pin.	-	J9	-
	VSS	GND pin.	-	H8	-
	VSS	GND pin.	-	B10	-
	VSS	GND pin.	-	C9	-
	VSS	GND pin.	75	A11	90
	VSS	GND pin.	-	D8	-
	VSS	GND pin.	-	D4	-
	VSS	GND pin.	-	C3	-
	VSS	GND pin.	100	B2	120
CLOCK	X0	Main clock (oscillation) input pin.	48	L9	58
	X0A	Sub clock (oscillation) input pin.	36	L3	41
	X1	Main clock (oscillation) I/O pin.	49	L10	59
	X1A	Sub clock (oscillation) I/O pin.	37	K3	42
	CROUT	Internal CR-osc clock output port.	74	C10	89
ADC POWER	AVCC	A/D converter analog power pin.	60	H11	70
	AVRH	A/D converter analog reference voltage input pin.	61	F11	71
ADC GND	AVSS	A/D converter GND pin.	62	G11	72
C-pin	C	Power stabilization capacity pin.	33	L2	38

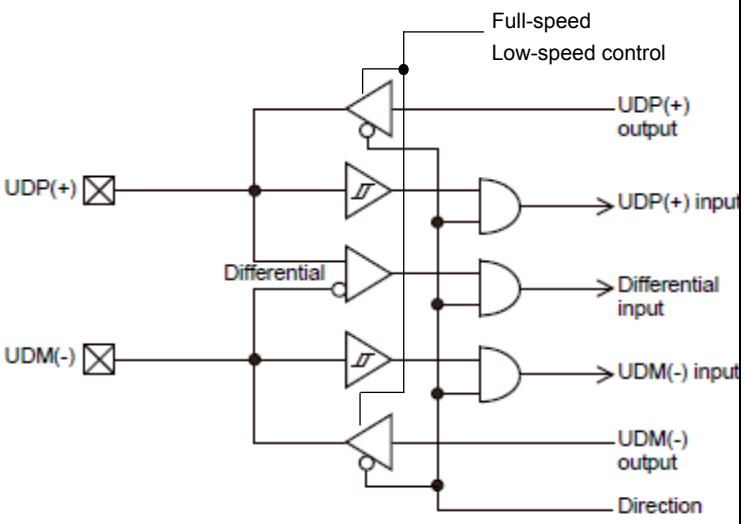
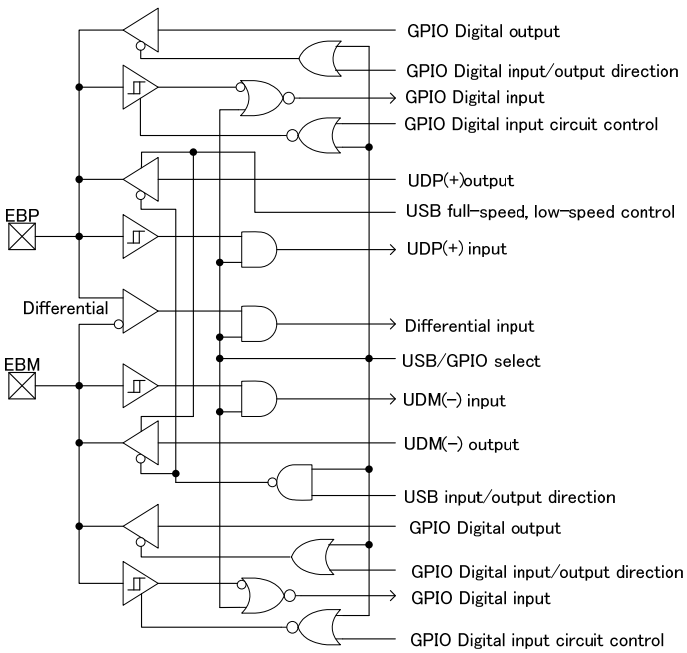
■ I/O CIRCUIT TYPE

Type	Circuit	Remarks
A		・Oscillation feedback resistor : Approximately 1MΩ ・With Standby mode control
B		・CMOS level hysteresis input ・pull-up resistor : Approximately 50kΩ
C		・CMOS level input ・With high-voltage control for flash memory test

Type	Circuit	Remarks
D		・Oscillation feedback resistor : Approximately 20MΩ ・With Standby mode control (MB9BF500)
		・It is possible to select the low speed oscillation / GPIO function When the low speed oscillation is selected. ・Oscillation feedback resistor : Approximately 20MΩ ・With Standby mode control When the GPIO is selected. ・CMOS level output. ・CMOS level hysteresis input ・With pull-up resistor control ・With standby mode control ・pull-up resistor : Approximately 50kΩ ・IOH=-4mA, IOL=4mA (MB9BF504/505/506)

Type	Circuit	Remarks
E		・CMOS level output ・CMOS level hysteresis input ・With pull-up resistor control ・With standby mode control ・pull-up resistor : Approximately 50kΩ ・IOH=-4mA, IOL=4mA
F		・CMOS level output ・CMOS level hysteresis input ・With input control ・Analog input ・With pull-up resistor control ・With standby mode control ・pull-up resistor : Approximately 50kΩ ・IOH=-4mA, IOL=4mA

Type	Circuit	Remarks
G		・CMOS level output ・CMOS level hysteresis input ・With pull-up resistor control ・With standby mode control ・pull-up resistor : Approximately 50kΩ ・IOH=-12mA, IOL=12mA

Type	Circuit	Remarks
H		・USB IO pin ・Full-speed, Low-speed control (MB9BF500)
		・It is possible to select the USB IO / GPIO function. When the USB IO is selected. ・Full-speed, Low-speed control When the GPIO is selected. ・CMOS level output ・CMOS level hysteresis input ・With standby mode control (MB9BF504/505/506)

■ PRECAUTIONS FOR HANDLING THE DEVICES

Any semiconductor devices have inherently a certain rate of failure. The possibility of failure is greatly affected by the conditions in which they are used (circuit conditions, environmental conditions, etc.). This page describes precautions that must be observed to minimize the chance of failure and to obtain higher reliability from your FUJITSU semiconductor devices.

● Precautions for Product Design

This section describes precautions when designing electronic equipment using semiconductor devices.

・ Absolute Maximum Ratings

Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

・ Recommended Operating Conditions

The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

・ Processing and Protection of Pins

These precautions must be followed when handling the pins which connect semiconductor devices to power supply and input/output functions.

1. Preventing Over-Voltage and Over-Current Conditions

Exposure to voltage or current levels in excess of maximum ratings at any pin is likely to cause deterioration within the device, and in extreme cases leads to permanent damage of the device. Try to prevent such overvoltage or over-current conditions at the design stage.

2. Protection of Output Pins

Shorting of output pins to supply pins or other output pins, or connection to large capacitance can cause large current flows. Such conditions if present for extended periods of time can damage the device.
Therefore, avoid this type of connection.

3. Handling of Unused Input Pins

Unconnected input pins with very high impedance levels can adversely affect stability of operation. Such pins should be connected through an appropriate resistance to a power supply pin or ground pin.

・ Latch-up

Semiconductor devices are constructed by the formation of P-type and N-type areas on a substrate. When subjected to abnormally high voltages, internal parasitic PNPN junctions (called thyristor structures) may be formed, causing large current levels in excess of several hundred mA to flow continuously at the power supply pin. This condition is called latch-up.

Note: The occurrence of latch-up not only causes loss of reliability in the semiconductor device, but can cause injury or damage from high heat, smoke or flame. To prevent this from happening, do the following:
(a) Be sure that voltages applied to pins do not exceed the absolute maximum ratings. This should include attention to abnormal noise, surge levels, etc.
(b) Be sure that abnormal current flows do not occur during the power-on sequence.

- Observance of Safety Regulations and Standards
  Most countries in the world have established standards and regulations regarding safety, protection from electromagnetic interference, etc. Customers are requested to observe applicable regulations and standards in the design of products.

- Fail-Safe Design
  Any semiconductor devices have inherently a certain rate of failure. You must protect against injury, damage or loss from such failures by incorporating safety design measures into your facility and equipment such as redundancy, fire protection, and prevention of over-current levels and other abnormal operating conditions.

- Precautions Related to Usage of Devices
  FUJITSU semiconductor devices are intended for use in standard applications (computers, office automation and other office equipment, industrial, communications, and measurement equipment, personal or household devices, etc.).

  CAUTION: Customers considering the use of our products in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage, or where extremely high levels of reliability are demanded (such as aerospace systems, atomic energy controls, sea floor repeaters, vehicle operating controls, medical devices for life support, etc.) are requested to consult with FUJITSU sales representatives before such use. The company will not be responsible for damages arising from such use without prior approval.

● Precautions for Package Mounting

Package mounting may be either lead insertion type or surface mount type. In either case, for heat resistance during soldering, you should only mount under FUJITSU's recommended conditions. For detailed information about mount conditions, contact your FUJITSU sales representative.

・Lead Insertion Type

Mounting of lead insertion type packages onto printed circuit boards may be done by two methods: direct soldering on the board, or mounting by using a socket.

Direct mounting onto boards normally involves processes for inserting leads into through-holes on the board and using the flow soldering (wave soldering) method of applying liquid solder.

In this case, the soldering process usually causes leads to be subjected to thermal stress in excess of the absolute ratings for storage temperature. Mounting processes should conform to FUJITSU recommended mounting conditions.

If socket mounting is used, differences in surface treatment of the socket contacts and IC lead surfaces can lead to contact deterioration after long periods. For this reason it is recommended that the surface treatment of socket contacts and IC leads be verified before mounting.

・Surface Mount Type

Surface mount packaging has longer and thinner leads than lead-insertion packaging, and therefore leads are more easily deformed or bent. The use of packages with higher pin counts and narrower pin pitch results in increased susceptibility to open connections caused by deformed pins, or shorting due to solder bridges.

You must use appropriate mounting techniques. FUJITSU recommends the solder reflow method, and has established a ranking of mounting conditions for each product. Users are advised to mount packages in accordance with FUJITSU ranking of recommended conditions.

・Lead-Free Packaging

Note: When ball grid array (BGA) packages with Sn-Ag-Cu balls are mounted using Sn-Pb eutectic soldering, junction strength may be reduced under some conditions of use.

・Storage of Semiconductor Devices

Because plastic chip packages are formed from plastic resins, exposure to natural environmental conditions will cause absorption of moisture. During mounting, the application of heat to a package that has absorbed moisture can cause surfaces to peel, reducing moisture resistance and causing packages to crack. To prevent, do the following:

- Avoid exposure to rapid temperature changes, which cause moisture to condense inside the product. Store products in locations where temperature changes are slight.
- Use dry boxes for product storage. Products should be stored below 70% relative humidity, and at temperatures between 5 °C and 30 °C When you open Dry Package that recommends humidity 40% to 70% relative humidity.
- When necessary, FUJITSU packages semiconductor devices in highly moisture-resistant aluminum laminate bags, with a silica gel desiccant. Devices should be sealed in their aluminum laminate bags for storage.
- Avoid storing packages where they are exposed to corrosive gases or high levels of dust.

・Baking

Packages that have absorbed moisture may be de-moisturized by baking (heat drying). Follow the FUJITSU recommended conditions for baking.

Condition:+125 °C/24 h

・ Static Electricity

Because semiconductor devices are particularly susceptible to damage by static electricity, you must take the following precautions:

- Maintain relative humidity in the working environment between 40% and 70%. Use of an apparatus for ion generation may be needed to remove electricity.
- Electrically ground all conveyors, solder vessels, soldering irons and peripheral equipment.
- Eliminate static body electricity by the use of rings or bracelets connected to ground through high resistance (on the level of 1 MΩ). Wearing of conductive clothing and shoes, use of conductive floor mats and other measures to minimize shock loads is recommended.
- Ground all fixtures and instruments, or protect with anti-static measures.
- Avoid the use of styrofoam or other highly static-prone materials for storage of completed board assemblies.

・ Precautions for Use Environment

Reliability of semiconductor devices depends on ambient temperature and other conditions as described above.

For reliable performance, do the following:

1. Humidity

   Prolonged use in high humidity can lead to leakage in devices as well as printed circuit boards. If high humidity levels are anticipated, consider anti-humidity processing.

2. Discharge of Static Electricity

   When high-voltage charges exist close to semiconductor devices, discharges can cause abnormal operation.
   In such cases, use anti-static measures or processing to prevent discharges.

3. Corrosive Gases, Dust, or Oil

   Exposure to corrosive gases or contact with dust or oil may lead to chemical reactions that will adversely affect the device. If you use devices in such conditions, consider ways to prevent such exposure or to protect the devices.

4. Radiation, Including Cosmic Radiation

   Most devices are not designed for environments involving exposure to radiation or cosmic radiation. Users should provide shielding as appropriate.

5. Smoke, Flame

   Note: Plastic molded devices are flammable, and therefore should not be used near combustible substances.
   If devices begin to smoke or burn, there is danger of the release of toxic gases.

Customers considering the use of FUJITSU products in other special environmental conditions should consult with FUJITSU sales representatives.

Please check the latest handling precautions at the following URL.
http://edevice.fujitsu.com/fj/handling-e.pdf

■ HANDLING DEVICES

● Power supply pins

In products with multiple VCC and VSS pins, respective pins at the same potential are interconnected within the device in order to prevent malfunctions such as latch-up. However, all of these pins should be connected externally to the power supply or ground lines in order to reduce electromagnetic emission levels, to prevent abnormal operation of strobe signals caused by the rise in the ground level, and to conform to the total output current rating.

Moreover, connect the current supply source with the VCC and VSS pins of this device at low impedance. It is also advisable that a ceramic capacitor of approximately 0.1 µF be connected as a bypass capacitor between VCC and VSS near this device.

● Crystal oscillator circuit

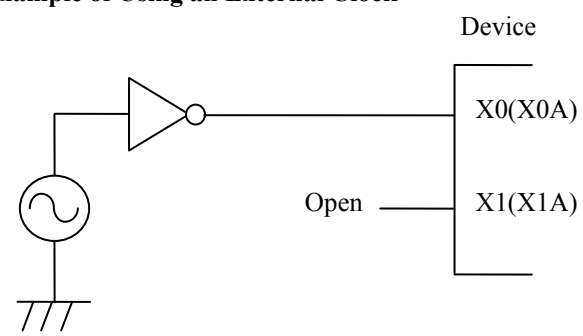
Noise near the X0/X1 and X0A/X1A pins may cause the device to malfunction. Design the printed circuit board so that X0/X1, X0A/X1A pins, the crystal oscillator (or ceramic oscillator), and the bypass capacitor to ground are located as close to the device as possible.

It is strongly recommended that the PC board artwork be designed such that the X0/X1 and X0A/X1A pins are surrounded by ground plane as this is expected to produce stable operation.

● Using an external clock

When using an external clock, the clock signal should be input to the X0,X0A pin only and the X1,X1A pin should be kept open.

・Example of Using an External Clock

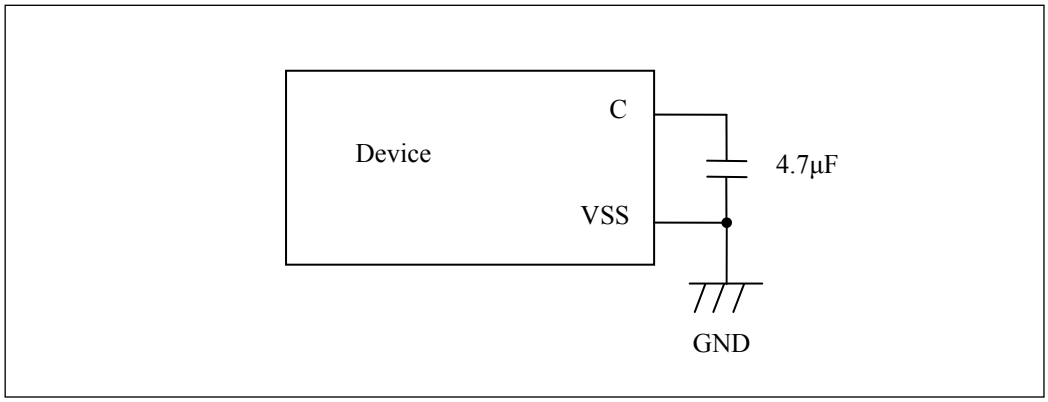


● Handling when using Multi function serial pin as I^2C pin

If it is using multi function serial pin as I^2C pins, P-ch transistor of digital output is always disable. However, I^2C pins need to keep the electrical characteristic like other pins and not to connect to external I^2C bus system with power OFF.

● C Pin

As this series includes an internal regulator, always connect a bypass capacitor of approximately 4.7 µF to the C pin for use by the regulator.



● Mode pins (MD0, MD1)

Connect the MD pin (MD0, MD1) directly to VCC or VSS pins. Design the printed circuit board such that the pull-up/down resistance stays low, as well as the distance between the mode pins and VCC pins or VSS pins is as short as possible and the connection impedance is low, when the pins are pulled-up/down such as for switching the pin level and rewriting the Flash memory data. It is because of preventing the device erroneously switching to test mode due to noise.

● Notes on power-on

Turn power on/off in the following order or at the same time.
If not using the A/D converter, connect AVCC =VCC and AVSS = VSS.

Turning on : VCC → USBVCC

VCC → AVCC → AVRH

Turning off : USBVCC → VCC

AVRH → AVCC → VCC

● Serial Communication

There is a possibility to receive wrong data due to the noise or other causes on the serial communication. Therefore, design a printed circuit board so as to avoid noise.
Consider the case of receiving wrong data due to noise, perform error detection such as by applying a checksum of data at the end. If an error is detected, restransmit the data.

● Differences in features among the products with different memory sizes and between FLASH products and MASK products

The electric characteristics including power consumption, ESD, latch-up, noise characteristics, and oscillation characteristics among the products with different memory sizes and between FLASH products and MASK products are different because chip layout and memory structures are different.

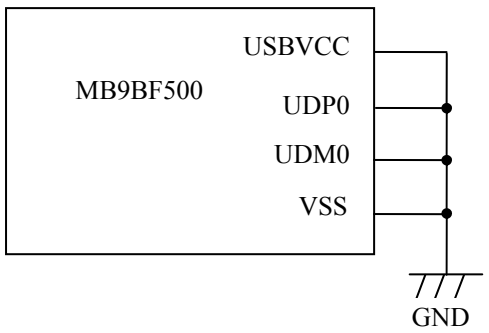
If you are switching to use a different product of the same series, please make sure to evaluate the electric characteristics.

■ HANDLING MB9BF500

● Handling when not using USB

If it is not using USB of MB9BF500, be sure to-connect USBVCC power-supply pin, UDP0, and UDM0 pin to GND.

・Example of when not using USB

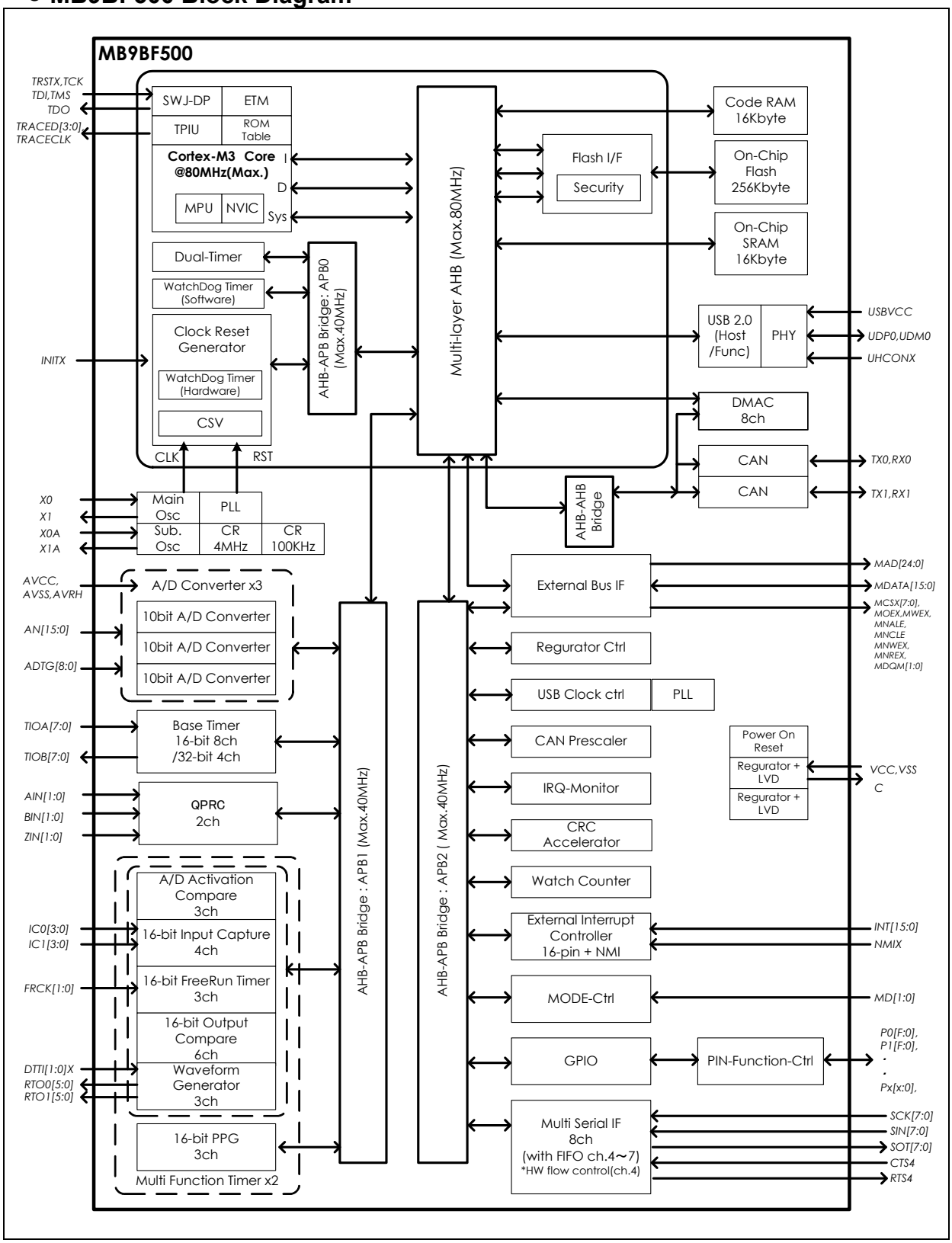


● Handling when not using Sub oscillation pin

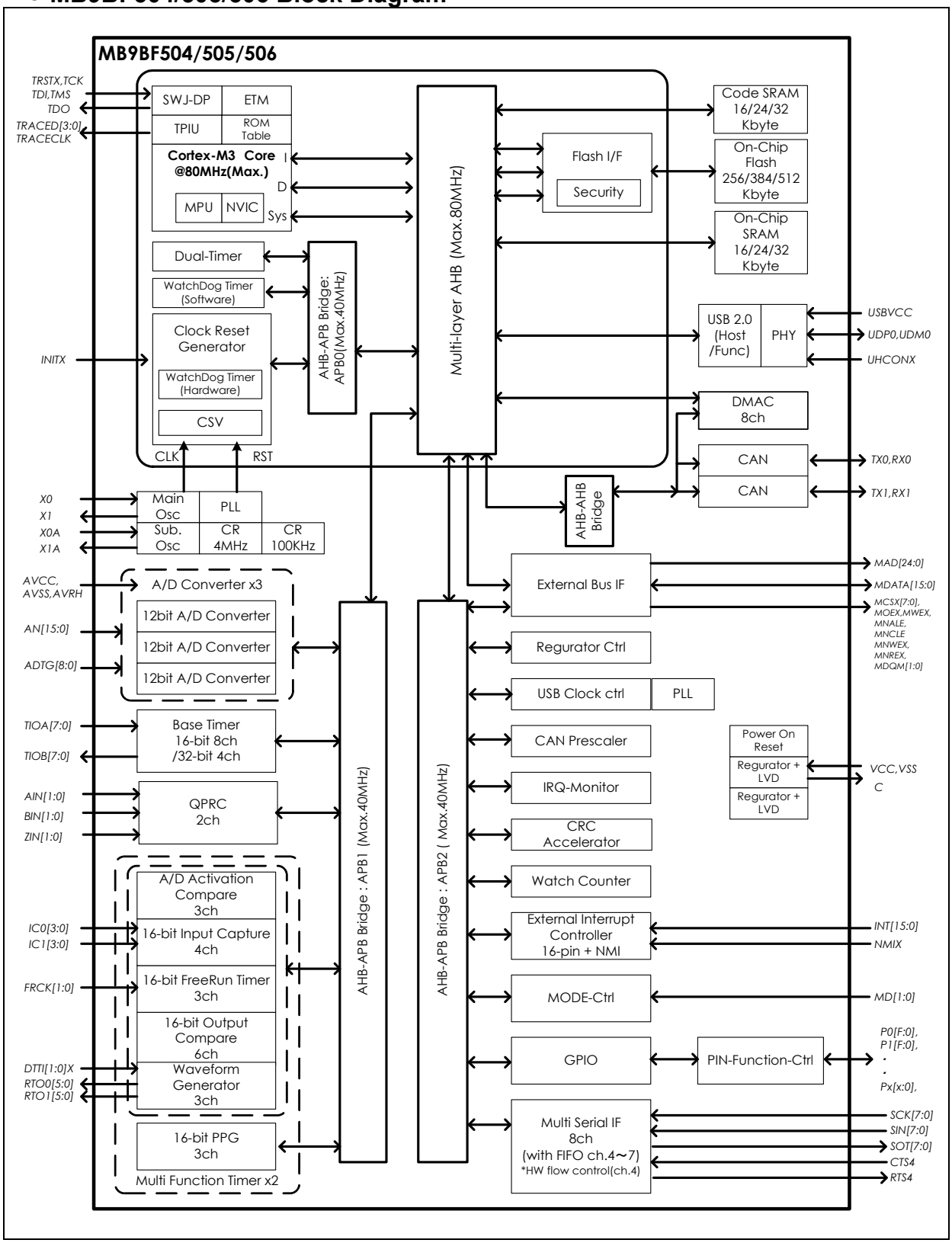
If it is not using X0A and X1A (sub oscillation) pins of MB9BF500, use it with X0A = GND : X1A = OPEN.

■ BLOCK DIAGRAM

● MB9BF500 Block Diagram



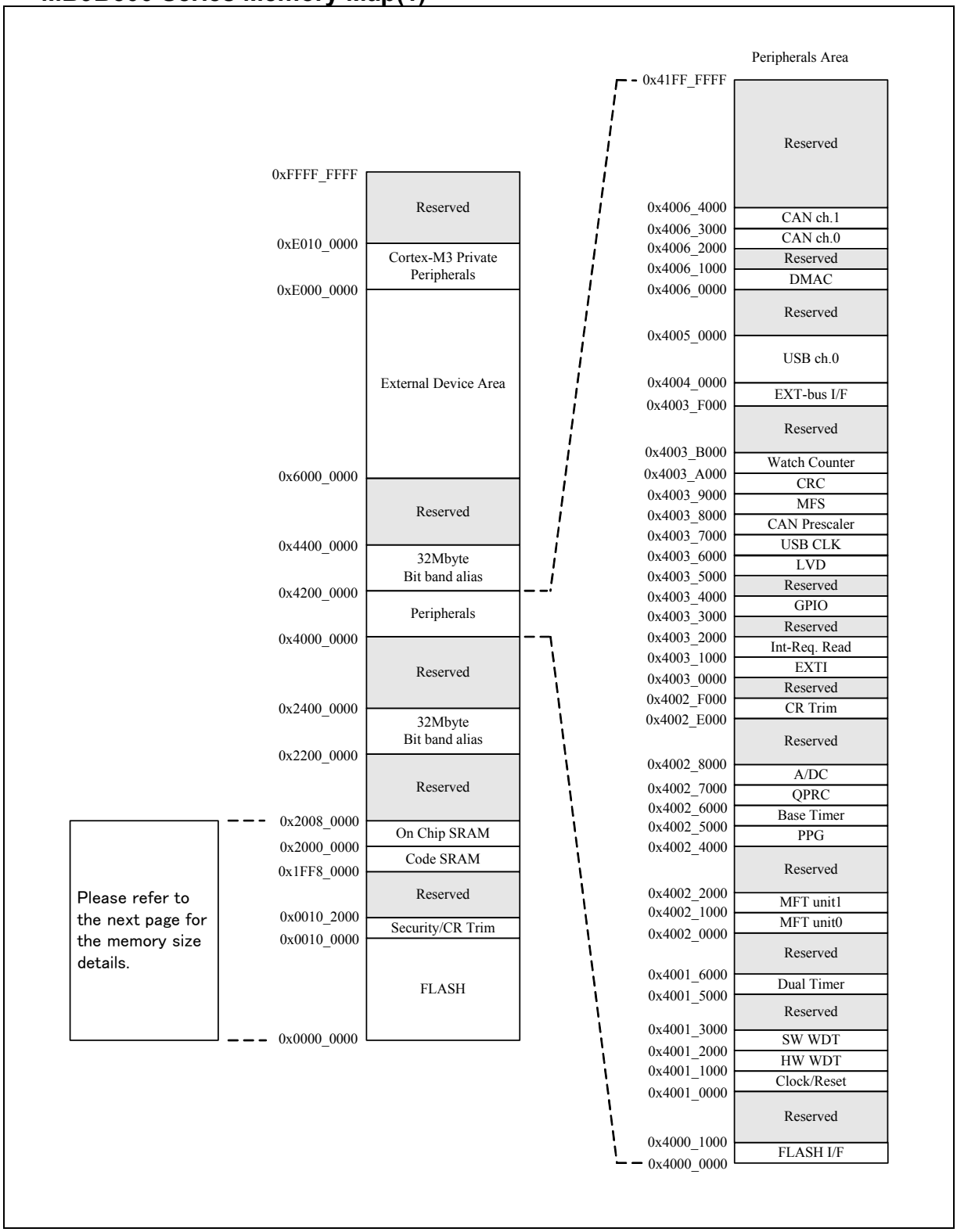
● MB9BF504/505/506 Block Diagram



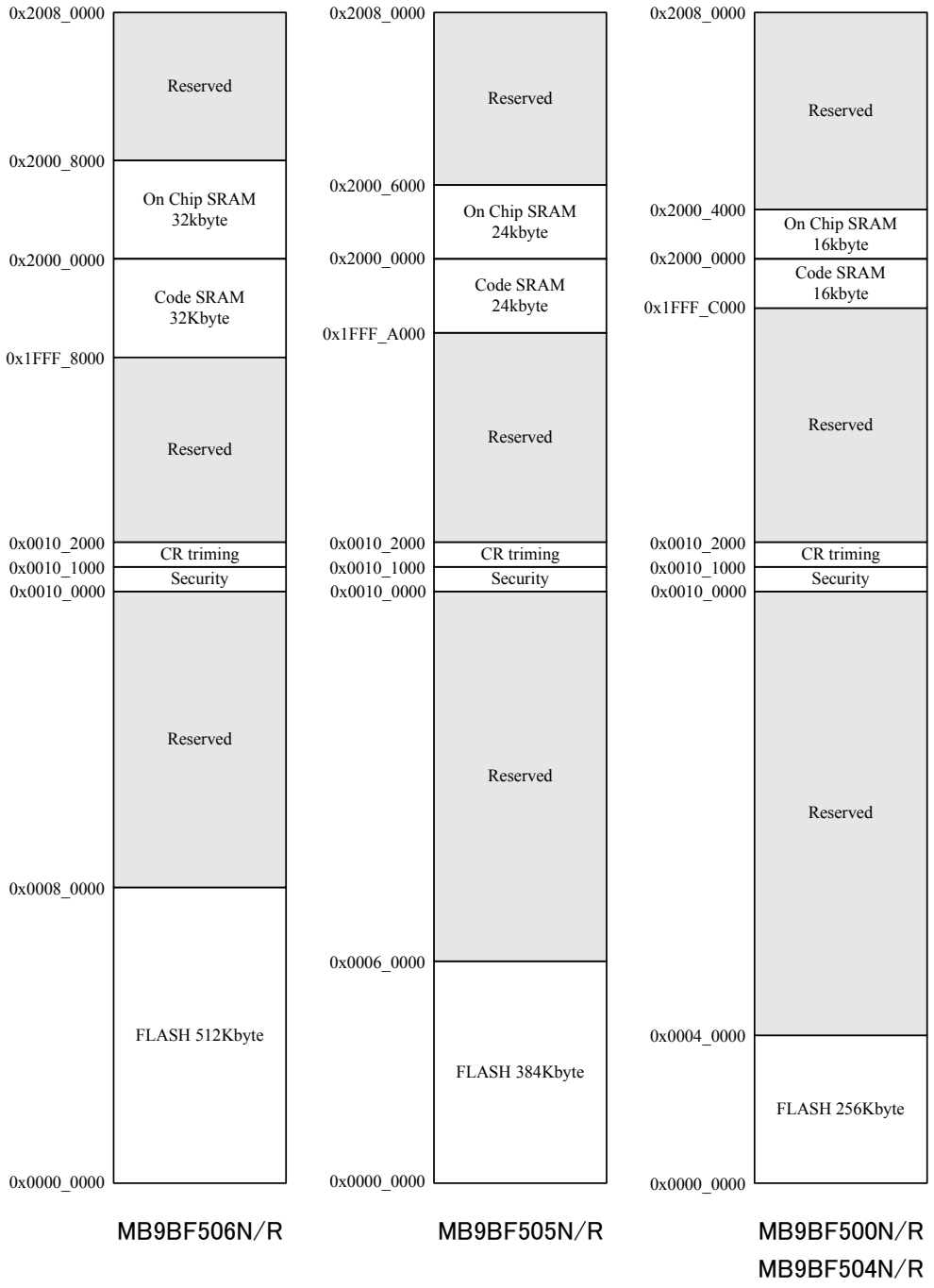
Product device	MB9BF504	MB9BF505	MB9BF506
On-Chip Flash	256Kbyte	384Kbyte	512Kbyte
Code SRAM	16Kbyte	24Kbyte	32Kbyte
On-Chip SRAM	16Kbyte	24Kbyte	32Kbyte

■ MEMORY MAP

● MB9B500 Series Memory Map(1)



● MB9B500 Series Memory Map(2)



● Peripheral Address Map

Start address	End address	Bus	Peripherals
0x4000_0000	0x4000_0FFF	AHB	Flash I/F register
0x4000_1000	0x4000_FFFF		Reserved
0x4001_0000	0x4001_0FFF	APB0	Clock/Reset Control
0x4001_1000	0x4001_1FFF		Hardware Watchdog timer
0x4001_2000	0x4001_2FFF		Software Watchdog timer
0x4001_3000	0x4001_4FFF		Reserved
0x4001_5000	0x4001_5FFF		Dual-Timer
0x4001_6000	0x4001_FFFF		Reserved
0x4002_0000	0x4002_0FFF	APB1	Multi-function timer unit0
0x4002_1000	0x4002_1FFF		Multi-function timer unit1
0x4002_2000	0x4002_3FFF		Reserved
0x4002_4000	0x4002_4FFF		PPG
0x4002_5000	0x4002_5FFF		Base Timer
0x4002_6000	0x4002_6FFF		Quadrature Position/Revolution Counter
0x4002_7000	0x4002_7FFF		A/D Converter
0x4002_8000	0x4002_DFFF		Reserved
0x4002_E000	0x4002_EFFF		Internal CR trimming
0x4002_F000	0x4002_FFFF		Reserved
0x4003_0000	0x4003_0FFF	APB2	External Interrupt Controller
0x4003_1000	0x4003_1FFF		Interrupt Request Batch-Read Function
0x4003_2000	0x4003_2FFF		Reserved
0x4003_3000	0x4003_3FFF		GPIO
0x4003_4000	0x4003_4FFF		Reserved
0x4003_5000	0x4003_5FFF		Low Voltage Detector
0x4003_6000	0x4003_6FFF		USB clock generator
0x4003_7000	0x4003_7FFF		CAN prescaler
0x4003_8000	0x4003_8FFF		Multi-function serial Interface
0x4003_9000	0x4003_9FFF		CRC
0x4003_A000	0x4003_AFFF		Watch Counter
0x4003_B000	0x4003_EFFF		Reserved
0x4003_F000	0x4003_FFFF		External Memory interface
0x4004_0000	0x4004_FFFF	AHB	USB ch.0
0x4005_0000	0x4005_FFFF		Reserved
0x4006_0000	0x4006_0FFF		DMAC register
0x4006_1000	0x4006_1FFF		Reserved
0x4006_2000	0x4006_2FFF		CAN ch.0
0x4006_3000	0x4006_3FFF		CAN ch.1
0x4006_4000	0x41FF_FFFF		Reserved

■ PIN STATUS IN EACH CPU STATE

The terms used for pin status have the following meanings.

- INITX=0
  This is the period when the INITX pin is the "L" level.
- INITX=1
  This is the period when the INITX pin is the "H" level.
- SPL=0
  This is the status that standby pin level setting bit (SPL) in standby mode control register (STB_CTL) is set to "0".
- SPL=1
  This is the status that standby pin level setting bit (SPL) in standby mode control register (STB_CTL) is set to "1".
- Input enabled
  Indicates that the input function can be used.
- Internal input fixed at "0"
  This is the status that the input function cannot be used. Internal input is fixed at "L".
- Hi-Z
  Indicates that the output drive transistor is disabled and the pin is put in the Hi-Z state.
- Setting disabled
  Indicates that the setting is disabled.
- Maintain previous state
  Maintains the state that was immediately prior to entering the current mode.
  If a built-in peripheral function is operating, the output follows the peripheral function.
  If the pin is being used as a port, that output is maintained.
- Analog input is enabled
  Indicates that the analog input is enabled.
- Trace output
  Indicates that the trace function can be used.

● LIST OF PIN STATUS

Pin status type	Function group	Power-on reset or low voltage detection state	INITX input state	Device internal reset state	Run mode or sleep mode state	Timer mode or sleep mode state	
		Power supply unstable	Power supply stable		Power supply stable	Power supply stable	
		-	INITX=0	INITX=1	INITX=1	INITX=1	
		-	-	-	-	SPL=0	SPL=1
A	Main crystal oscillator input pin	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled
B	Main crystal oscillator output pin	H output/ Internal input fixed at "0"/ or Input enabled	H output/ Internal input fixed at "0"	H output/ Internal input fixed at "0"	Maintain previous state/ H output at oscillation stop (*1)/ Internal input fixed at "0"	Maintain previous state/ H output at oscillation stop (*1)/ Internal input fixed at "0"	Maintain previous state/ H output at oscillation stop (*1)/ Internal input fixed at "0"
C	INITX input pin	Pull-up/ Input enabled	Pull-up/ Input enabled	Pull-up/ Input enabled	Pull-up/ Input enabled	Pull-up/ Input enabled	Pull-up/ Input enabled
D	Mode input pin	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled
E	JTAG selected	Hi-Z	Pull-up/ Input enabled	Pull-up/ Input enabled	Maintain previous state	Maintain previous state	Maintain previous state
	GPIO selected	Setting disabled	Setting disabled	Setting disabled			Output Hi-Z/ Internal input fixed at "0"
F	Trace selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Trace output
	External interrupt enabled selected						Maintain previous state
	GPIO selected, or other than above resource selected	Hi-Z	Hi-Z/ Input enabled	Hi-Z/ Input enabled			Hi-Z/ Internal input fixed at "0"

Pin status type	Function group	Power-on reset or low voltage detection state	INITX input state	Device internal reset state	Run mode or sleep mode state	Timer mode or sleep mode state	
		Power supply unstable	Power supply stable		Power supply stable	Power supply stable	
		-	INITX=0	INITX=1	INITX=1	INITX=1	
		-	-	-	-	SPL=0	SPL=1
G	Trace selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Trace output
	GPIO selected, or other than above resource selected	Hi-Z	Hi-Z/ Input enabled	Hi-Z/ Input enabled			Hi-Z/ Internal input fixed at "0"
H	External interrupt enabled selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Maintain previous state
	GPIO selected, or other than above resource selected	Hi-Z	Hi-Z/ Input enabled	Hi-Z/ Input enabled			Hi-Z/ Internal input fixed at "0"
I	GPIO selected, resource selected	Hi-Z	Hi-Z/ Input enabled	Hi-Z/ Input enabled	Maintain previous state	Maintain previous state	Output Hi-Z/ Internal input fixed at "0"
J	NMIX selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Maintain previous state
	GPIO selected, or other than above resource selected	Hi-Z	Hi-Z/ Input enabled	Hi-Z/ Input enabled			Hi-Z/ Internal input fixed at "0"

Pin status type	Function group	Power-on reset or low voltage detection state	INITX input state	Device internal reset state	Run mode or sleep mode state	Timer mode or sleep mode state	
		Power supply unstable	Power supply stable		Power supply stable	Power supply stable	
		-	INITX=0	INITX=1	INITX=1	INITX=1	
		-	-	-	-	SPL=0	SPL=1
K	Analog input selected	Hi-Z	Hi-Z/ Internal input fixed at "0"/ Analog input enabled	Hi-Z/ Internal input fixed at "0"/ Analog input enabled	Hi-Z/ Internal input fixed at "0"/ Analog input enabled	Hi-Z/ Internal input fixed at "0"/ Analog input enabled	Hi-Z/ Internal input fixed at "0"/ Analog input enabled
	GPIO selected, or other than above resource selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Hi-Z/ Internal input fixed at "0"
L	External interrupt enabled selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Maintain previous state
	Analog input selected	Hi-Z	Hi-Z/ Internal input fixed at "0"/ Analog input enabled	Hi-Z/ Internal input fixed at "0"/ Analog input enabled	Hi-Z/ Internal input fixed at "0"/ Analog input enabled	Hi-Z/ Internal input fixed at "0"/ Analog input enabled	Hi-Z/ Internal input fixed at "0"/ Analog input enabled
	GPIO selected, or other than above resource selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Hi-Z/ Internal input fixed at "0"
M MB9BF500	Sub crystal oscillator input pin	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled
M MB9BF504 MB9BF505 MB9BF506	GPIO selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Output Hi-Z/ Internal input fixed at "0"
	Sub crystal oscillator input pin	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled

Pin status type	Function group	Power-on reset or low voltage detection state	INITX input state	Device internal reset state	Run mode or sleep mode state	Timer mode or sleep mode state	
		Power supply unstable	Power supply stable		Power supply stable	Power supply stable	
		-	INITX=0	INITX=1	INITX=1	INITX=1	
		-	-	-	-	SPL=0	SPL=1
N MB9BF500	Sub crystal oscillator output pin	Pull-down/ Internal input fixed at "0"	Pull-down/ Internal input fixed at "0"	Pull-down/ Internal input fixed at "0"	Maintain previous state	Maintain previous state/ Pull-down at oscillation stop (*2)/ Internal input fixed at "0"	Maintain previous state/ Pull-down at oscillation stop (*2)/ Internal input fixed at "0"
N MB9BF504 MB9BF505 MB9BF506	GPIO selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Output Hi-Z/ Internal input fixed at "0"
	Sub crystal oscillator output pin	Hi-Z/ Internal input fixed at "0"	Hi-Z/ Internal input fixed at "0"	Hi-Z/ Internal input fixed at "0"	Maintain previous state	Maintain previous state/ Hi-Z at oscillation stop (*2)/ Internal input fixed at "0"	Maintain previous state/ Hi-Z at oscillation stop (*2)/ Internal input fixed at "0"
O MB9BF500	USB I/O pin	Hi-Z	Hi-Z/ Input enabled	Hi-Z/ Input enabled	Maintain previous state	Output Hi-Z at transmission/ Input enabled/ Internal input fixed at "0" at reception	Output Hi-Z at transmission/ Input enabled/ Internal input fixed at "0" at reception
O MB9BF504 MB9BF505 MB9BF506	GPIO selected	Hi-Z	Hi-Z/ Input enabled	Hi-Z/ Input enabled	Maintain previous state	Maintain previous state	Output Hi-Z/ Internal input fixed at "0"
	USB I/O pin	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Output Hi-Z at transmission/ Input enabled/ Internal input fixed at "0" at reception	Output Hi-Z at transmission/ Input enabled/ Internal input fixed at "0" at reception

*1 : Oscillation is stopped at sub timer, sub CR timer mode, and stop mode.
*2 : Oscillation is stopped at stop mode.

■ ELECTRICAL CHARACTERISTICS

This section describes the electrical characteristics of MB9B500 series.

● Absolute Maximum Ratings / Recommended Operating Conditions

The following tables show the absolute maximum ratings and recommended operating conditions.

1. Absolute Maximum Ratings (MB9BF500)

(Vss = AVss = 0.0V)

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power supply voltage*1	Vcc	Vss - 0.5	Vss + 6.0	V	
Power supply voltage (for USB) *2	USBVcc	Vss - 0.3	Vss + 4.0	V	
Analog power supply voltage *3	AVcc	Vss - 0.5	Vss + 6.0	V	
Analog reference voltage *3	AVRH	Vss - 0.5	Vss + 6.0	V	
Input voltage	V_I	Vss - 0.3	Vcc + 0.3 (≦ 6.0V)	V	Except for USB pin
		Vss - 0.3	USBVcc + 0.3 (≦ 4.0V)	V	USB pin
Analog pin input voltage	V_{IA}	Vss - 0.3	AVcc + 0.3 (≦ 6.0V)	V	
Output voltage	V_O	Vss - 0.3	Vcc + 0.3 (≦ 6.0V)	V	
"L" level maximum output current *4	I_{OL}	-	10	mA	4mA type
			20	mA	12mA type
"L" level average output current *5	I_{OLAV}	-	4	mA	4mA type
			12	mA	12mA type
"L" level total maximum output current	$\sum I_{OL}$	-	100	mA	
"L" level total average output current *6	$\sum I_{OLAV}$	-	50	mA	
"H" level maximum output current *4	I_{OH}	-	- 10	mA	4mA type
			- 20	mA	12mA type
"H" level average output current *5	I_{OHAV}	-	- 4	mA	4mA type
			- 12	mA	12mA type
"H" level total maximum output current	$\sum I_{OH}$	-	- 100	mA	
"H" level total average output current *6	$\sum I_{OHAV}$	-	- 50	mA	
Power consumption	P_D	-	800	mW	
Storage temperature	T_{STG}	- 55	+ 125	°C	

*1 : Vcc must not drop below Vss - 0.5V.
*2 : USBVcc must not drop below Vss - 0.3V.
*3 : Be careful not to exceed Vcc + 0.3 V, for example, when the power is turned on.
*4 : The maximum output current is the peak value for a single pin.
*5 : The average output is the average current for a single pin over a period of 100 ms.
*6 : The total average output current is the average current for all pins over a period of 100 ms.

<WARNING>

Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

2. Absolute Maximum Ratings (MB9BF504/505/506)

(Vss = AVss = 0.0V)

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power supply voltage*1	Vcc	Vss - 0.5	Vss + 6.5	V	
Power supply voltage (for USB) *2	USBVcc	Vss - 0.5	Vss + 6.5	V	
Analog power supply voltage *3	AVcc	Vss - 0.5	Vss + 6.5	V	
Analog reference voltage *3	AVRH	Vss - 0.5	Vss + 6.5	V	
Input voltage	V_I	Vss - 0.5	Vcc + 0.5 (≦ 6.5V)	V	Except for USB pin
		Vss - 0.5	USBVcc + 0.5 (≦ 6.5V)	V	USB pin
Analog pin input voltage	V_{IA}	Vss - 0.5	AVcc + 0.5 (≦ 6.5V)	V	
Output voltage	V_O	Vss - 0.5	Vcc + 0.5 (≦ 6.5V)	V	
"L" level maximum output current *4	I_{OL}	-	10	mA	4mA type
			20	mA	12mA type
"L" level average output current *5	I_{OLAV}	-	4	mA	4mA type
			12	mA	12mA type
"L" level total maximum output current	$\sum I_{OL}$	-	100	mA	
"L" level total average output current *6	$\sum I_{OLAV}$	-	50	mA	
"H" level maximum output current *4	I_{OH}	-	- 10	mA	4mA type
			- 20	mA	12mA type
"H" level average output current *5	I_{OHAV}	-	- 4	mA	4mA type
			- 12	mA	12mA type
"H" level total maximum output current	$\sum I_{OH}$	-	- 100	mA	
"H" level total average output current *6	$\sum I_{OHAV}$	-	- 50	mA	
Power consumption	P_D	-	800	mW	
Storage temperature	T_{STG}	- 55	+ 150	°C	

*1 : Vcc must not drop below Vss - 0.5V.
*2 : USBVcc must not drop below Vss - 0.5V.
*3 : Be careful not to exceed Vcc + 0.5 V, for example, when the power is turned on.
*4 : The maximum output current is the peak value for a single pin.
*5 : The average output is the average current for a single pin over a period of 100 ms.
*6 : The total average output current is the average current for all pins over a period of 100 ms.

<WARNING>

Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

3. Recommended Operating Conditions

(Vss = AVss = 0.0V)

Parameter		Symbol	Conditions	Value		Unit	Remarks
				Min	Max		
Power supply voltage		Vcc	-	2.7	5.5	V	
Power supply voltage for USB		USBVcc	-	3.0	3.6	V	MB9BF500
				3.0	3.6 (≦ Vcc)		MB9BF504/505/506 *1
				2.7	5.5 (≦ Vcc)		MB9BF504/505/506 *2
Analog power supply voltage		AVcc	-	2.7	5.5	V	AVcc = Vcc
Analog reference voltage		AVRH	-	AVss	AVcc	V	
Operating Temperature	FPT-120P-M21 FPT-100P-M20 BGA-112P-M04	Ta	When mounted on four-layer PCB	- 40	+ 85	°C	
			When mounted on double-sided single-layer PCB	- 40	+ 85	°C	Icc ≦ 100mA
				- 40	+ 70	°C	Icc > 100mA

*1: When P81/UDP0 and P80/UDM0 pin are used as USB(UDP0, UDM0).
*2: When P81/UDP0 and P80/UDM0 pin are used as GPIO(P81, P80).

<WARNING>

The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.
Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure. No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their representatives beforehand.

● DC Characteristics

The following tables show the DC characteristics.

1. Current rating

(1) MB9BF500

(Vcc = AVcc = 2.7V to 5.5V,USBVcc = 3.0V to 3.6V, Vss = AVss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Power supply current	Icc	Vcc	Normal operation (PLL)	-	120	145	mA	CPU : 80MHz, Peripheral : 40MHz, FLASH 2Wait FRWTR.RWT = 10 FSYNDN.SD = 000 *1
				-	90	110	mA	CPU : 60MHz, Peripheral : 30MHz, FLASH 0Wait FRWTR.RWT = 00 FSYNDN.SD = 000 *1
				-	80	96	mA	CPU : 80MHz, Peripheral : 40MHz, FLASH 5Wait FRWTR.RWT = 10 FSYNDN.SD = 011 *1
				-	65	78	mA	CPU : 60MHz, Peripheral : 30MHz, FLASH 3Wait FRWTR.RWT = 00 FSYNDN.SD = 011 *1
			Normal operation (built-in high-speed CR)	-	7.0	10.4	mA	CPU/ Peripheral : 4MHz *1, *2 FLASH 0Wait FRWTR.RWT = 00 FSYNDN.SD = 000
			Normal operation (sub oscillation)	-	0.6	2.7	mA	CPU/ Peripheral : 32kHz FLASH 0Wait FRWTR.RWT = 00 FSYNDN.SD = 000 *1
			Normal operation (built-in low-speed CR)	-	0.8	3.0	mA	CPU/ Peripheral : 100kHz FLASH 0Wait FRWTR.RWT = 00 FSYNDN.SD = 000 *1
	Iccs		SLEEP operation (PLL)	-	55	68	mA	Peripheral : 40MHz *1
			SLEEP operation (built-in high-speed CR)	-	5.0	8.0	mA	Peripheral : 4MHz *1, *2
			SLEEP operation (sub oscillation)	-	0.6	2.7	mA	Peripheral : 32kHz *1
			SLEEP operation (built in low-speed CR)	-	0.8	3.0	mA	Peripheral : 100kHz *1

(Continued)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Power supply current	I_{CCH}	Vcc	STOP mode	-	0.06	0.2	mA	Ta = + 25°C, When LVD is off *1
				-	-	2.0	mA	Ta = + 85°C, When LVD is off *1
	I_{CCT}		TIMER mode (sub oscillation)	-	0.18	0.4	mA	Ta = + 25°C, When LVD is off *1
				-	-	3.0	mA	Ta = + 85°C, When LVD is off *1
Low voltage detection circuit (LVD) power supply current	I_{CCLVD}		At operation	-	0.055	0.09	mA	for occurrence of reset
				-	0.042	0.07	mA	for occurrence of interrupt

*1:When all ports are fixed.
*2: When setting it to 4MHz by trimming.

(2) MB9BF504/505/506

(Vcc = AVcc =USBVcc= 2.7V to 5.5V, Vss = AVss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Power supply current	Icc	Vcc	Normal operation (PLL)	-	96	118	mA	CPU : 80MHz, Peripheral : 40MHz, FLASH 2Wait FRWTR.RWT = 10 FSYNDN.SD = 000 *1
				-	76	94	mA	CPU : 60MHz, Peripheral : 30MHz, FLASH 0Wait FRWTR.RWT = 00 FSYNDN.SD = 000 *1
				-	66	82	mA	CPU : 80MHz, Peripheral : 40MHz, FLASH 5Wait FRWTR.RWT = 10 FSYNDN.SD = 011 *1
				-	52	65	mA	CPU : 60MHz, Peripheral : 30MHz, FLASH 3Wait FRWTR.RWT = 00 FSYNDN.SD = 011 *1
			Normal operation (built-in high-speed CR)	-	6.0	9.2	mA	CPU/ Peripheral : 4MHz *1, *2 FLASH 0Wait FRWTR.RWT = 00 FSYNDN.SD = 000
			Normal operation (sub oscillation)	-	0.2	2.24	mA	CPU/ Peripheral : 32kHz FLASH 0Wait FRWTR.RWT = 00 FSYNDN.SD = 000 *1
			Normal operation (built-in low-speed CR)	-	0.3	2.36	mA	CPU/ Peripheral : 100kHz FLASH 0Wait FRWTR.RWT = 00 FSYNDN.SD = 000 *1
	Iccs		SLEEP operation (PLL)	-	43	54	mA	Peripheral : 40MHz *1
			SLEEP operation (built-in high-speed CR)	-	3.5	6.2	mA	Peripheral : 4MHz *1, *2
			SLEEP operation (sub oscillation)	-	0.15	2.18	mA	Peripheral : 32kHz *1
			SLEEP operation (built in low-speed CR)	-	0.22	2.27	mA	Peripheral : 100kHz *1

(Continued)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Power supply current	I_{CCH}	Vcc	STOP mode	-	0.05	0.2	mA	Ta = + 25°C, When LVD is off *1
				-	-	2	mA	Ta = + 85°C, When LVD is off *1
	I_{CCT}		Timer mode (sub oscillation)	-	0.11	0.3	mA	Ta = + 25°C, When LVD is off *1
				-	-	2.2	mA	Ta = + 85°C, When LVD is off *1
Low voltage detection circuit (LVD) power supply current	I_{CCLVD}		At operation	-	0.002	0.01	mA	for occurrence of interrupt

*1:When all ports are fixed.
*2: When setting it to 4MHz by trimming.

2. Pin Characteristics

(Vcc = AVcc = 2.7V to 5.5V, Vss = AVss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
"H" level input voltage (hysteresis input)	V_{IHS}	CMOS hysteresis input pin, MD0,1	-	Vcc × 0.8	-	Vcc + 0.3	V	
"L" level input voltage (hysteresis input)	V_{ILS}	CMOS hysteresis input pin, MD0,1	-	Vss - 0.3	-	Vcc × 0.2	V	
"H" level output voltage	V_{OH}	4mA type	I_{OH} = - 4 mA	Vcc - 0.5	-	Vcc	V	MB9BF500
			Vcc ≧ 4.5 V I_{OH} = - 4mA					MB9BF504/505/506
			Vcc < 4.5 V I_{OH} = - 2mA					
		12mA type	Vcc ≧ 4.5 V I_{OH} = - 12mA	Vcc - 0.5	-	Vcc	V	
			Vcc < 4.5 V I_{OH} = - 8mA					
		The pin doubled as USB IO	Vcc ≧ 4.5 V I_{OH} = - 25.3mA	Vcc - 0.4	-	Vcc	V	MB9BF504/505/506
			Vcc < 4.5 V I_{OH} = - 13.4mA					
"L" level output voltage	V_{OL}	4mA type	I_{OH} = 4 mA	Vss	-	0.4	V	MB9BF500
			Vcc ≧ 4.5 V I_{OH} = 4mA					MB9BF504/505/506
			Vcc < 4.5 V I_{OH} = 2mA					
		12mA type	Vcc ≧ 4.5 V I_{OH} = 12mA	Vss	-	0.4	V	
			Vcc < 4.5 V I_{OH} = 8mA					
		The pin doubled as USB IO	Vcc ≧ 4.5 V I_{OH} = 19.7mA	Vss	-	0.4	V	MB9BF504/505/506
			Vcc < 4.5 V I_{OH} = 11.9mA					
Input leak current	I_{IL}	-	-	- 5	-	5	µA	
Pull-up resistance value	R_{PU}	Pull-up pin	Vcc ≧ 4.5 V	25	50	100	kΩ	
			Vcc < 4.5 V	30	80	200		
Input capacitance	C_{IN}	Other than Vcc, Vss, AVcc, AVss, AVRH	-	-	5	15	pF	

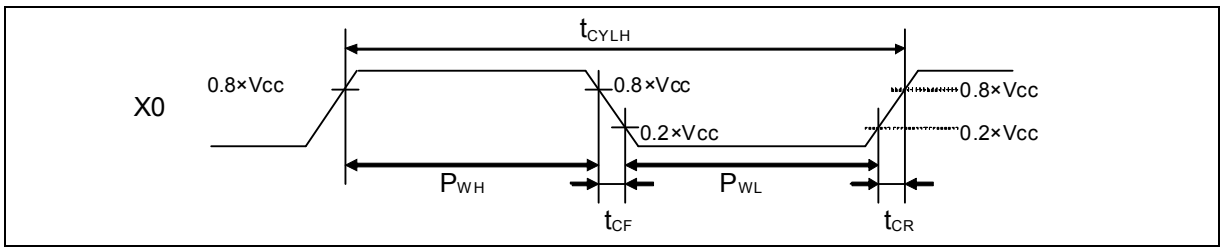
● AC Characteristics

The following tables show the AC characteristics.

(1) Main Clock Input Characteristics

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

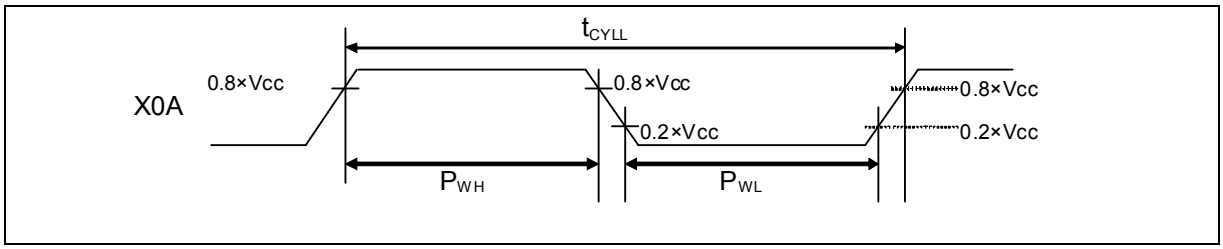
Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Input frequency	F_{CH}	X0 X1	Vcc ≧ 4.5V	4	48	MHz	When crystal oscillator is connected
			Vcc < 4.5V	4	20		
			Vcc ≧ 4.5V	4	48	MHz	When using external clock
			Vcc < 4.5V	4	20		
Input clock cycle	t_{CYLH}		Vcc ≧ 4.5V	20.83	250	ns	When using external clock
			Vcc < 4.5V	50	250		
Input clock pulse width	-		P_{WH}/t_{CYLH} P_{WL}/t_{CYLH}	45	55	%	When using external clock
Input clock rise time and fall time	t_{CF} t_{CR}		-	-	5	ns	When using external clock
Internal operating clock frequency	F_{CC}	-	-	-	80	MHz	CPU/AHB bus clock
	F_{CP0}	-	-	-	40	MHz	Peripheral bus clock 0 (APB0)
	F_{CP1}	-	-	-	40	MHz	Peripheral bus clock 1 (APB1)
	F_{CP2}	-	-	-	40	MHz	Peripheral bus clock 1 (APB2)
Internal operating clock cycle time	t_{CYCC}	-	-	12.5	-	ns	CPU/AHB bus clock
	t_{CYCP0}	-	-	25	-	ns	Peripheral bus clock 0 (APB0)
	t_{CYCP1}	-	-	25	-	ns	Peripheral bus clock 1 (APB1)
	t_{CYCP2}	-	-	25	-	ns	Peripheral bus clock 1 (APB2)



(2) Sub Clock Input Characteristics

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Input frequency	F_{CL}	X0A X1A	-	-	32.768	-	kHz	When crystal oscillator is connected
			-	32	-	100	kHz	When using external clock
Input clock cycle	t_{CYLL}		-	10	-	31.25	µs	When using external clock
Input clock pulse width	-		P_{WH}/t_{CYLL} P_{WL}/t_{CYLL}	45	-	55	%	When using external clock



(3) Built-in CR Oscillation Characteristics

・ Built-in high-speed CR

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Conditions	Value			Unit	Remarks
			Min	Typ	Max		
Clock frequency	F_{CRH}	Ta = + 25°C	3.88	4	4.12	MHz	When trimming (MB9BF500)
			3.92	4	4.08		When trimming (MB9BF504/505/506)
		Ta = - 40°C to + 85°C	TBD	4	TBD		When trimming
		Ta = - 40°C to + 85°C	2.8	4	6		When not trimming

・ Built-in low-speed CR

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Conditions	Value			Unit	Remarks
			Min	Typ	Max		
Clock frequency	F_{CRL}	-	50	100	150	kHz	

(4) Operating Conditions of PLL

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
PLL oscillation stabilization wait time (LOCK UP time)*	t_{LOCK}	600	-	-	µs	MB9BF500
		100	-	-		MB9BF504/505/506
PLL input clock frequency	f_{PLLI}	4	-	30	MHz	
PLL multiple rate	-	4	-	30	multiple	
PLL macro oscillation clock frequency	f_{PLLO}	60	-	120	MHz	

*: Time from when the PLL starts operating until the oscillation stabilizes.

(5) Reset Input Characteristics

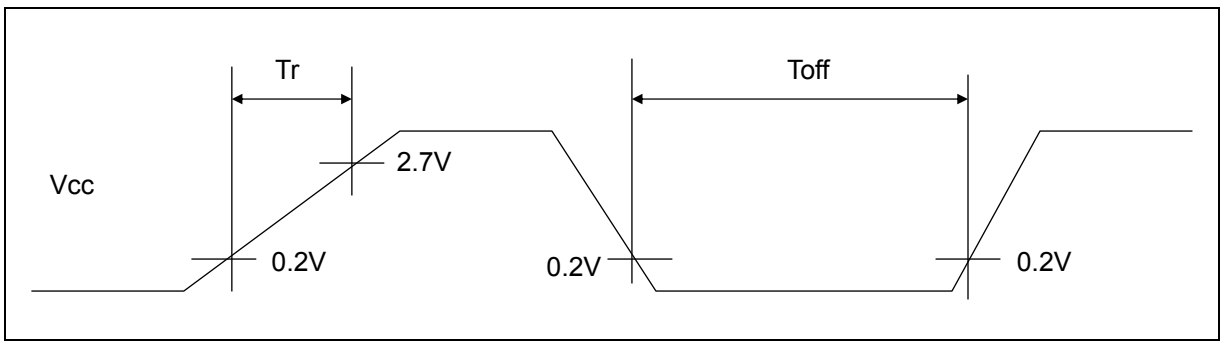
(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Reset input time	t_{INITX}	INITX	-	500	-	ns	

(6) Power-on Reset Timing

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Value		Unit	Remarks
			Min	Max		
Power supply rising time	Tr	Vcc	0	-	ms	
Power supply shut down time	Toff		1	-	ms	



(7) External Bus Timing

・ Asynchronous SRAM Mode

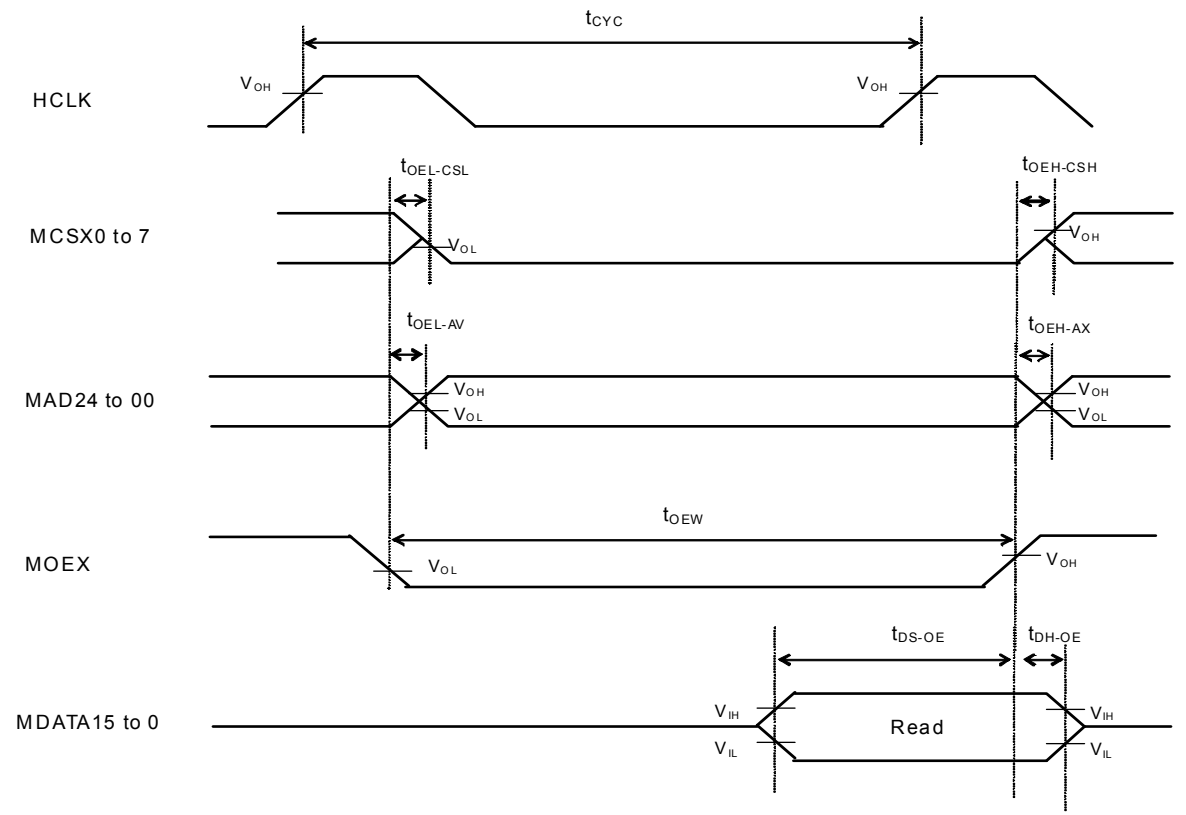
(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
MOEX Min pulse width	t_{OEW}	MOEX	Vcc ≧ 4.5V	T_{HCLK}×1 - 3	-	ns	
			Vcc < 4.5V				
MOEX ↓ ⇒ Address delay time	$t_{OEL - AV}$	MOEX MAD24 to 00	Vcc ≧ 4.5V	0	10	ns	
			Vcc < 4.5V	0	20		
MOEX ↑ ⇒ Address delay time	$t_{OEH - AX}$	MOEX MAD24 to 00	Vcc ≧ 4.5V	0	10	ns	
			Vcc < 4.5V	-10	15		MB9BF-500
				0	20		MB9BF-504/505/506
MOEX ↓ ⇒ MCSX ↓ delay time	$t_{OEL - CSL}$	MOEX MCSX	Vcc ≧ 4.5V	0	10	ns	
			Vcc < 4.5V				
MOEX ↑ ⇒ MCSX ↑ delay time	$t_{OEH - CSH}$	MOEX MCSX	Vcc ≧ 4.5V	0	10	ns	
			Vcc < 4.5V				
Data set up ⇒MOEX ↑ time	$t_{DS - OE}$	MOEX MDATA15 to 0	Vcc ≧ 4.5V	20	-	ns	
			Vcc < 4.5V	38	-		
MOEX ↑ ⇒ Data hold time	$t_{DH - OE}$	MOEX MDATA15 to 0	Vcc ≧ 4.5V	0	-	ns	
			Vcc < 4.5V				
MCSX ↓ ⇒ MWEX ↓ delay time	$t_{CSL - WEL}$	MCSX MWEX	Vcc ≧ 4.5V	T_{HCLK}×1 - 5	-	ns	
			Vcc < 4.5V	T_{HCLK}×1 - 10	-		
MWEX ↑ ⇒ MCSX ↑ delay time	$t_{WEH - CSH}$	MCSX MWEX	Vcc ≧ 4.5V	T_{HCLK}×1 - 5	-	ns	
			Vcc < 4.5V	T_{HCLK}×1 - 10	-		
Address ⇒ MWEX ↓ delay time	$t_{AV - WEL}$	MWEX MAD24 to 00	Vcc ≧ 4.5V	T_{HCLK}×1 - 5	-	ns	
			Vcc < 4.5V	T_{HCLK}×1 - 15	-		
MWEX ↑ ⇒ Address delay time	$t_{WEH - AX}$	MWEX MAD24 to 00	Vcc ≧ 4.5V	T_{HCLK}×1 - 5	-	ns	
			Vcc < 4.5V	T_{HCLK}×1 - 15	-		
MWEX ↓ ⇒ MDQM ↓ delay time	$t_{WEL - DQML}$	MWEX MDQM0 to 1	Vcc ≧ 4.5V	0	5	ns	
			Vcc < 4.5V	0	10		
MWEX ↑ ⇒ MDQM ↑ delay time	$t_{WEH - DQMH}$	MWEX MDQM0 to 1	Vcc ≧ 4.5V	0	5	ns	
			Vcc < 4.5V	0	10		
MWEX Min pulse width	t_{WEW}	MWEX	Vcc ≧ 4.5V	T_{HCLK}×1 - 3	-	ns	
			Vcc < 4.5V				
MWEX ↓ ⇒ Data delay time	$t_{WEL - DV}$	MWEX MDATA15 to 0	Vcc ≧ 4.5V	- 5	5	ns	
			Vcc < 4.5V	-15	15		
MWEX ↑ ⇒ Data delay time	$t_{WEH - DX}$	MWEX MDATA15 to 0	Vcc ≧ 4.5V	T_{HCLK}×1 - 5	-	ns	
			Vcc < 4.5V	T_{HCLK}×1 - 15	-		

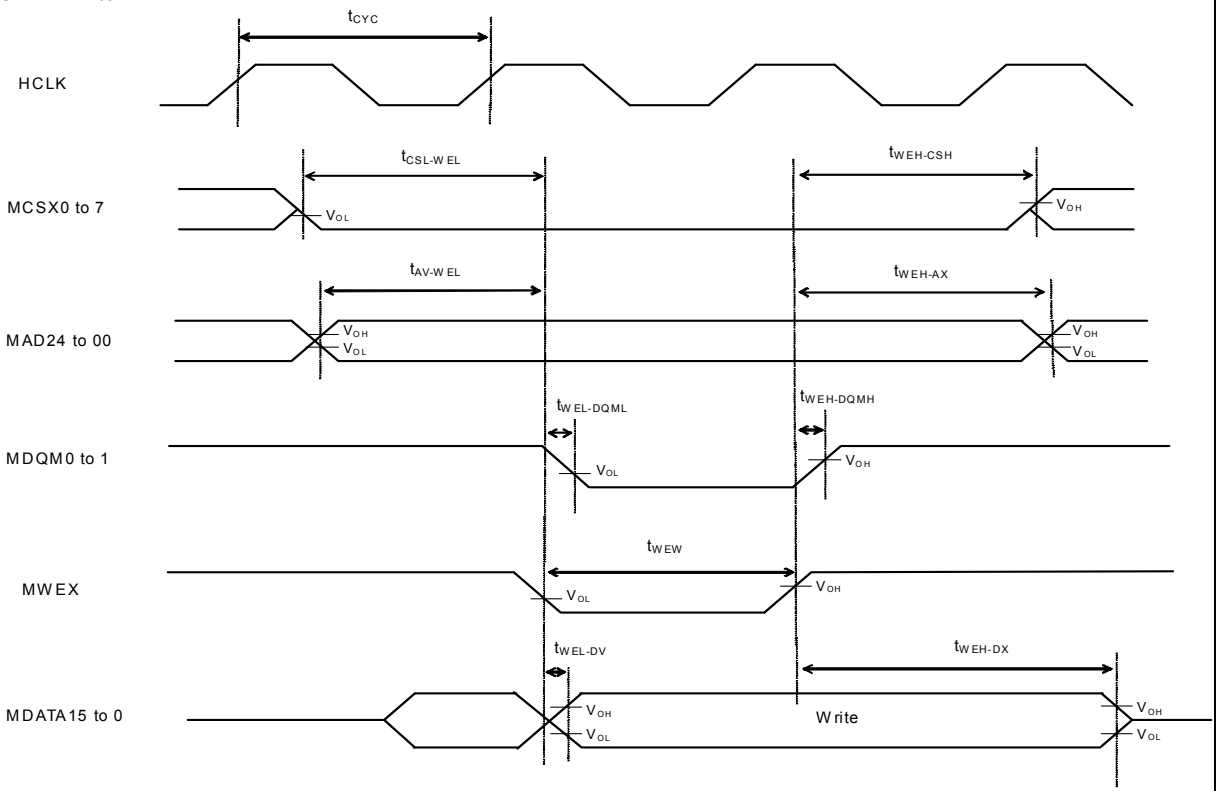
Note: When the external load capacitance = 50pF.

(Continued)

SRAM read



SRAM write



・ NAND FLASH mode

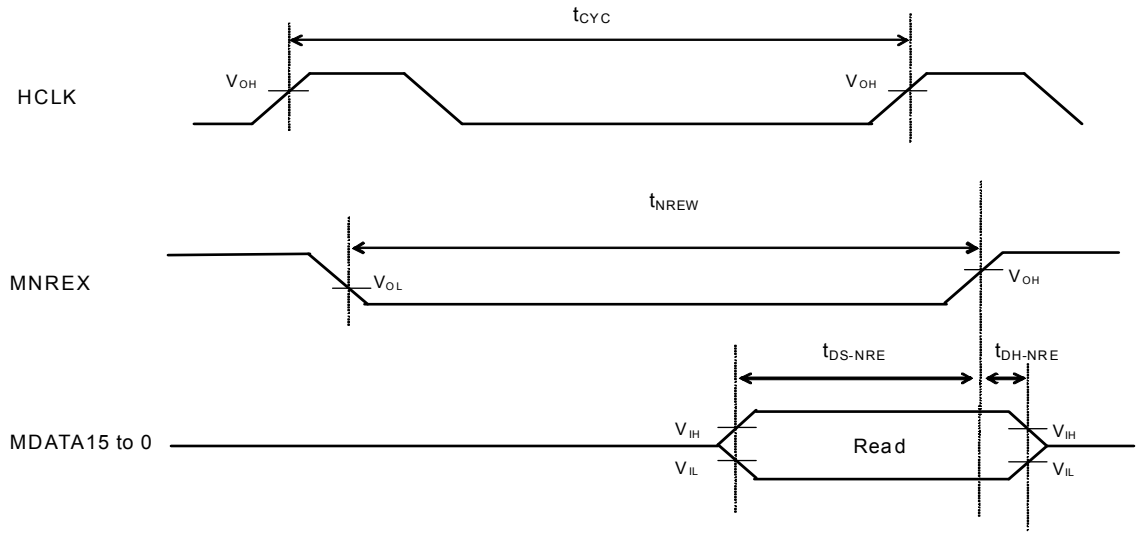
(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
MNREX Min pulse width	t_{NREW}	MNREX	Vcc ≧ 4.5V	T_{HCLK}×1 - 3	-	ns	
			Vcc < 4.5V				
Data set up ⇒ MNREX ↑ tiime	$t_{DS - NRE}$	MNREX MDATA15 to 0	Vcc ≧ 4.5V	20	-	ns	
			Vcc < 4.5V	38	-		
MNREX ↑ ⇒ Data hold time	$t_{DH - NRE}$	MNREX MDATA15 to 0	Vcc ≧ 4.5V	0	-	ns	
			Vcc < 4.5V	0	-		
MNALE ↑ ⇒ MNWEX delay time	$t_{ALEH - NWEL}$	MNALE MNWEX	Vcc ≧ 4.5V	T_{HCLK}×1 - 5	-	ns	
			Vcc < 4.5V	T_{HCLK}×1 - 15	-		
MNWEX ↑ ⇒ MNALE delay time	$t_{NWEH - ALEL}$	MNALE MNWEX	Vcc ≧ 4.5V	T_{HCLK}×1 - 5	-	ns	
			Vcc < 4.5V	T_{HCLK}×1 - 15	-		
MNCLE ↑ ⇒ MNWEX delay time	$t_{CLEH - NWEL}$	MNCLE MNWEX	Vcc ≧ 4.5V	T_{HCLK}×1 - 5	-	ns	
			Vcc < 4.5V	T_{HCLK}×1 - 15	-		
MNWEX ↑ ⇒ MNCLE delay time	$t_{NWEH - CLEL}$	MNCLE MNWEX	Vcc ≧ 4.5V	T_{HCLK}×1 - 5	-	ns	
			Vcc < 4.5V	T_{HCLK}×1 - 15	-		
MNWEX Min pulse width	t_{NWEW}	MNWEX	Vcc ≧ 4.5V	T_{HCLK}×1 - 3	-	ns	
			Vcc < 4.5V				
MNWEX ↓ ⇒ Data delay time	$t_{NWEL - DV}$	MNWEX MDATA15 to 0	Vcc ≧ 4.5V	- 5	+ 5	ns	
			Vcc < 4.5V	-15	+15		
MNWEX ↑ ⇒ Data delay time	$t_{NWEH - DX}$	MNWEX MDATA15 to 0	Vcc ≧ 4.5V	T_{HCLK}×1 - 5	-	ns	
			Vcc < 4.5V	T_{HCLK}×1 - 15	-		

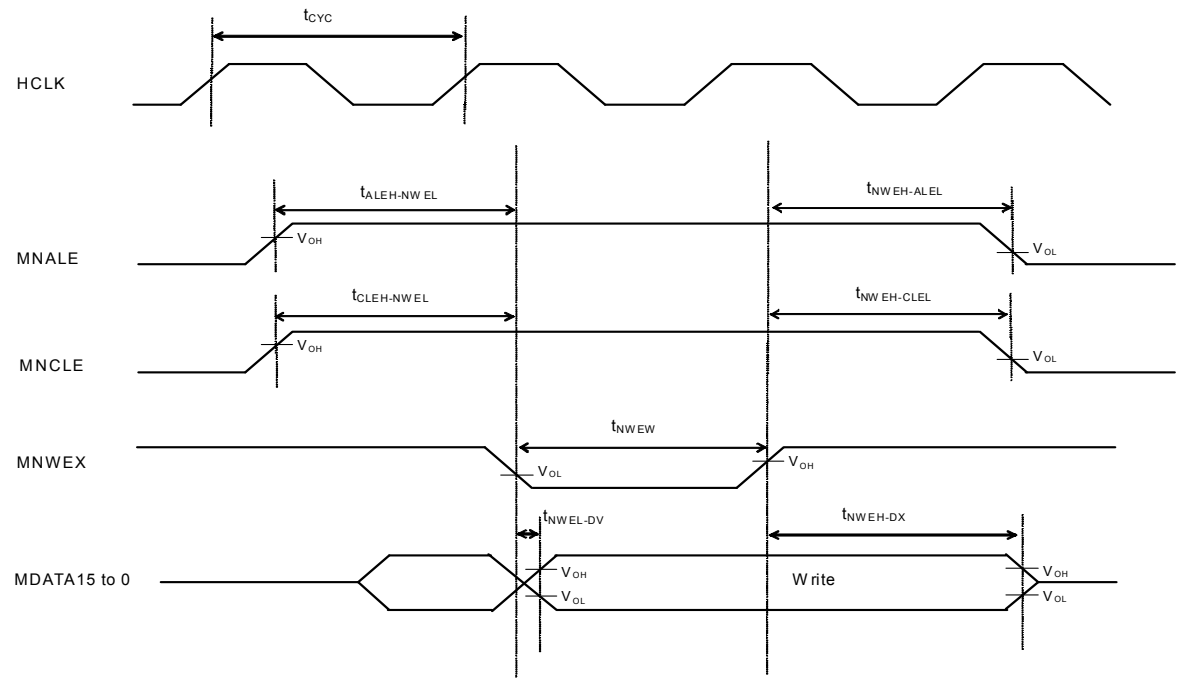
Note: when the external load capacitance = 50pF.

(Continued)

NAND FLASH read



NAND FLASH write

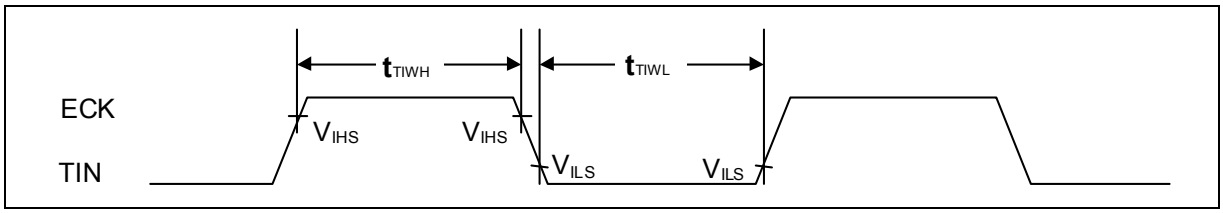


(8) Base Timer Input Timing

・ Timer input timing

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

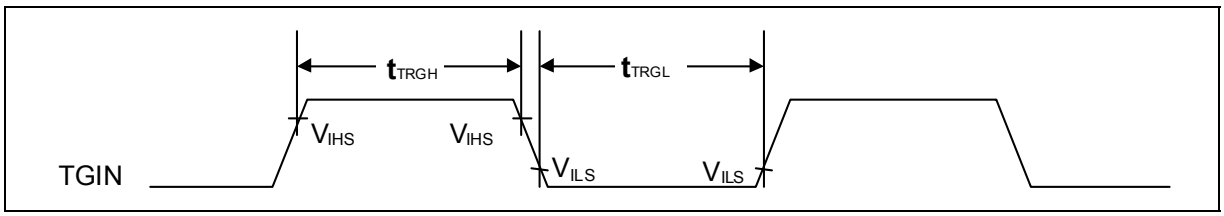
Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TIWH} t_{TIWL}	TIOAn/TIOBn (when using as ECK,TIN)	-	$2t_{CYCP}$	-	ns	



・ Trigger input timing

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TRGH} t_{TRGL}	TIOAn/TIOBn (when using as TGIN)	-	$2t_{CYCP}$	-	ns	



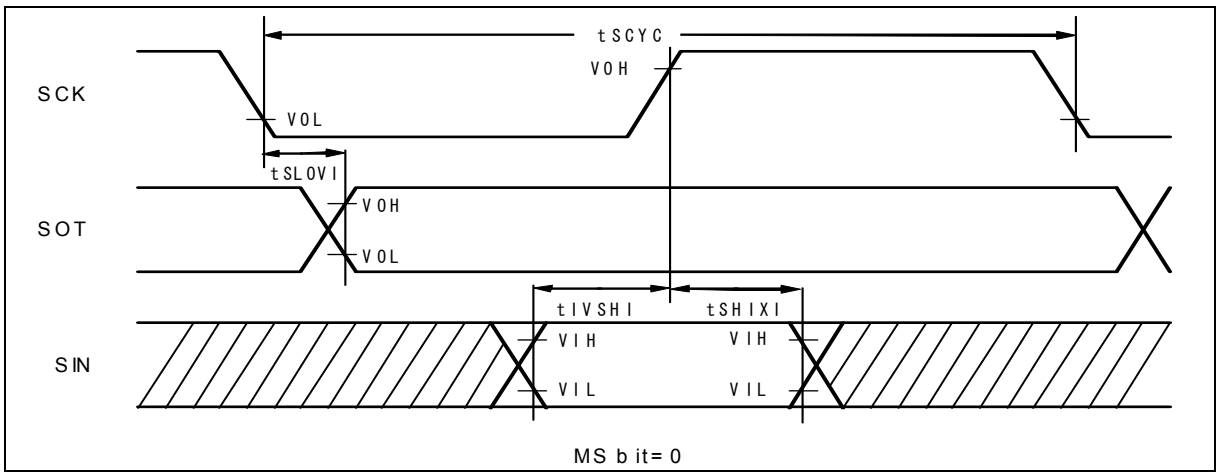
(9) UART Timing

・ Synchronous serial (SPI = 0, SCINV = 0)

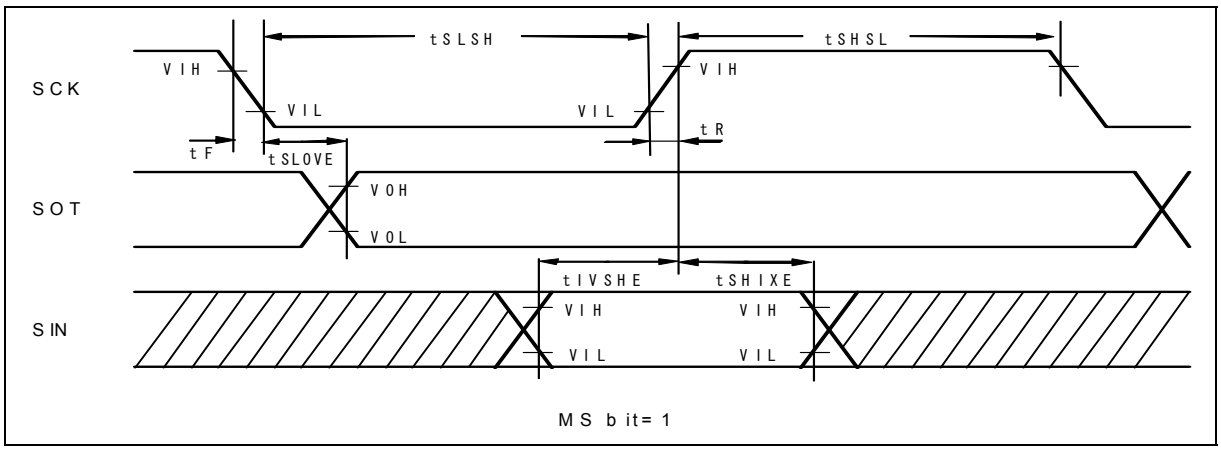
(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Vcc < 4.5V		Vcc ≧ 4.5V		Unit
				Min	Max	Min	Max	
Serial clock cycle time	tSCYC	SCKx	Internal shift clock operation	4tcycp	-	4tcycp	-	ns
SCK ↓ → SOT delay time	tSLOVI	SCKx SOTx		-30	+30	- 20	+ 20	ns
SIN → SCK ↑ setup time	tIVSHI	SCKx SINx		50	-	30	-	ns
SCK ↑ → SIN hold time	tSHIXI	SCKx SINx		0	-	0	-	ns
Serial clock "L" pulse width	tSLSH	SCKx	External shift clock operation	2tcycp - 10	-	2tcycp - 10	-	ns
Serial clock "H" pulse width	tSHSL	SCKx		tcycp + 10	-	tcycp + 10	-	ns
SCK ↓ → SOT delay time	tSLOVE	SCKx SOTx		-	50	-	30	ns
SIN → SCK ↑ setup time	tIVSHE	SCKx SINx		10	-	10	-	ns
SCK ↑ → SIN hold time	tSHIXE	SCKx SINx		20	-	20	-	ns
SCK fall time	tF	SCKx		-	5	-	5	ns
SCK rise time	tR	SCKx		-	5	-	5	ns

Notes:
- The above characteristics apply to CLK synchronous mode.
- t_{CYCP} indicates the peripheral clock cycle time.
- These characteristics only guarantee the same relocate port number.
  For example, the combination of SCLKx_0 and SOTx_1 is not guaranteed.
- When the external load capacitance = 50pF.



MS bit= 0



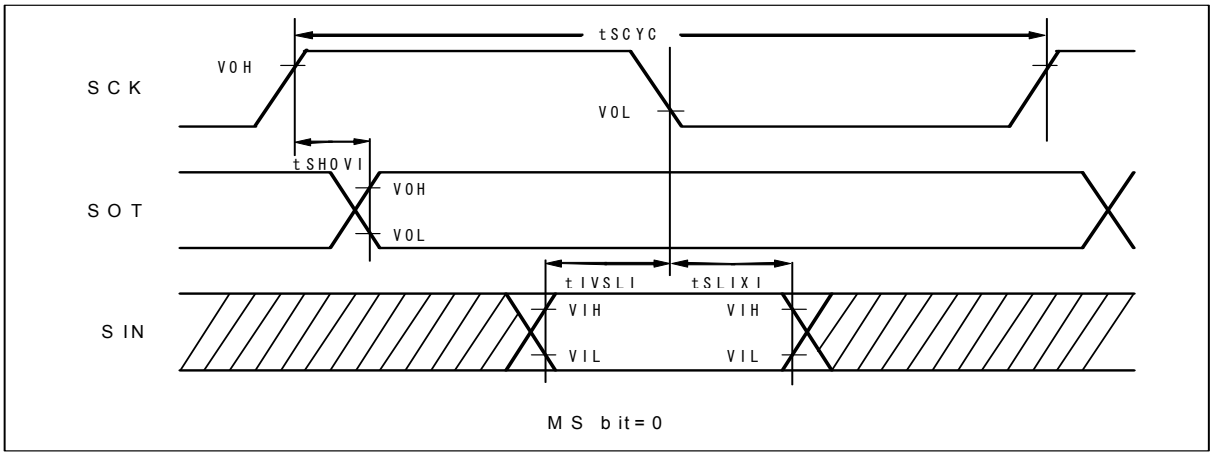
MS bit= 1

・ Synchronous serial(SPI = 0, SCINV = 1)

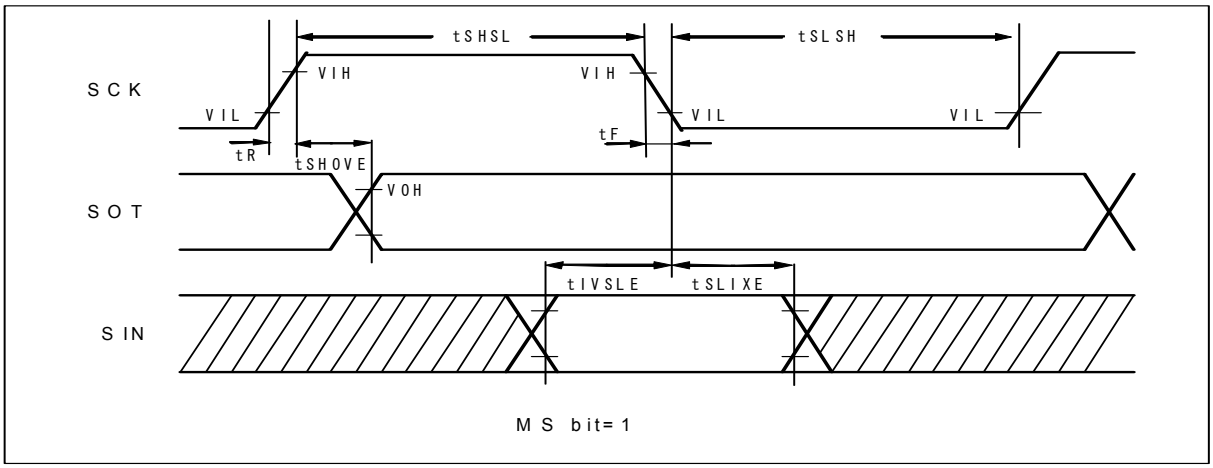
(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Vcc < 4.5V		Vcc ≧ 4.5V		Unit
				Min	Max	Min	Max	
Serial clock cycle time	tSCYC	SCKx	Internal shift clock operation	4tcycp	-	4tcycp	-	ns
SCK ↑ → SOT delay time	tSHOVI	SCKx SOTx		-30	+30	- 20	+ 20	ns
SIN → SCK ↓ setup time	tIVSLI	SCKx SINx		50	-	30	-	ns
SCK ↓ → SIN hold time	tSLIXI	SCKx SINx		0	-	0	-	ns
Serial clock "L" pulse width	tSLSH	SCKx	External shift clock operation	2tcycp - 10	-	2tcycp - 10	-	ns
Serial clock "H" pulse width	tSHSL	SCKx		tcycp + 10	-	tcycp + 10	-	ns
SCK ↑ → SOT delay time	tSHOVE	SCKx SOTx		-	50	-	30	ns
SIN → SCK ↓ setup time	tIVSLE	SCKx SINx		10	-	10	-	ns
SCK ↓ → SIN hold time	tSLIXE	SCKx SINx		20	-	20	-	ns
SCK fall time	tF	SCKx		-	5	-	5	ns
SCK rise time	tR	SCKx		-	5	-	5	ns

Notes:
- The above characteristics apply to CLK synchronous mode.
- t_{CYCP} indicates the peripheral clock cycle time.
- These characteristics only guarantee the same relocate port number.
  For example, the combination of SCLKx_0 and SOTx_1 is not guaranteed.
- When the external load capacitance = 50pF.



MS bit=0



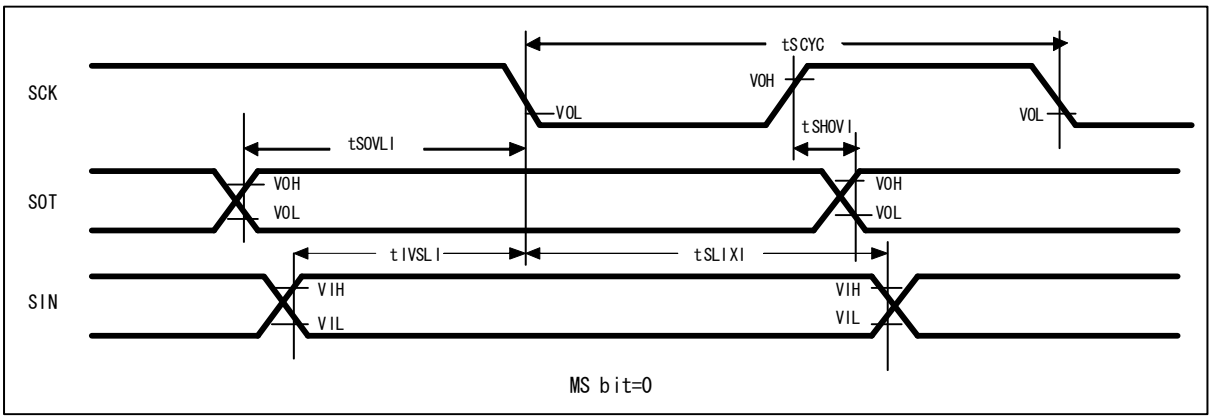
MS bit=1

・ Synchronous serial(SPI = 1, SCINV = 0)

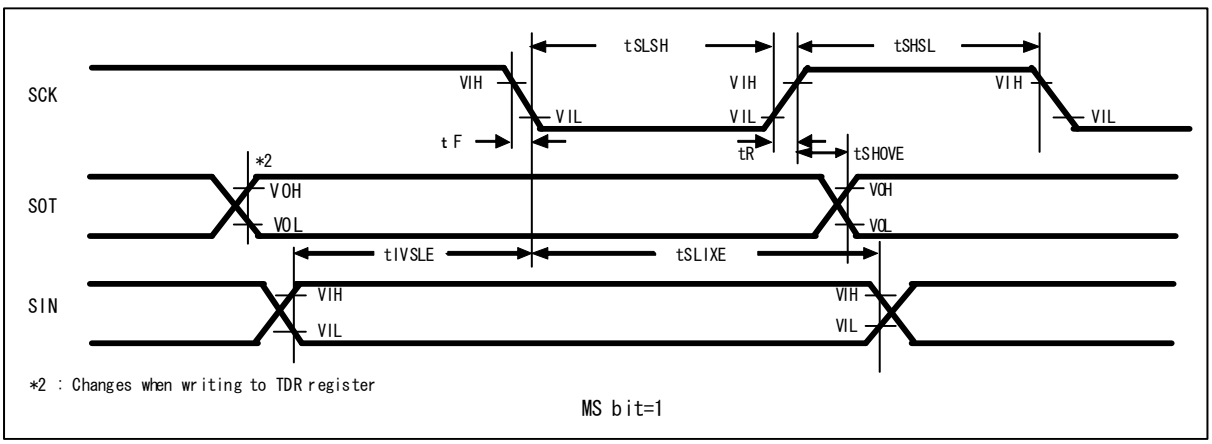
(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Vcc < 4.5V		Vcc ≧ 4.5V		Unit
				Min	Max	Min	Max	
Serial clock cycle time	tSCYC	SCKx	Internal shift clock operation	4tcycp	-	4tcycp	-	ns
SCK ↑ → SOT delay time	tSHOVI	SCKx SOTx		-30	+30	- 20	+ 20	ns
SIN → SCK ↓ setup time	tIVSLI	SCKx SINx		50	-	30	-	ns
SCK ↓ → SIN hold time	tSLIXI	SCKx SINx		0	-	0	-	ns
SOT → SCK ↓ delay time	tSOVLI	SCKx SOTx		2tcycp - 30	-	2tcycp - 30	-	ns
Serial clock "L" pulse width	tSLSH	SCKx	External shift clock operation	2tcycp - 10	-	2tcycp - 10	-	ns
Serial clock "H" pulse width	tSHSL	SCKx		tcycp + 10	-	tcycp + 10	-	ns
SCK ↑ → SOT delay time	tSHOVE	SCKx SOTx		-	50	-	30	ns
SIN → SCK ↓ setup time	tIVSLE	SCKx SINx		10	-	10	-	ns
SCK ↓ → SIN hold time	tSLIXE	SCKx SINx		20	-	20	-	ns
SCK fall time	tF	SCKx		-	5	-	5	ns
SCK rise time	tR	SCKx		-	5	-	5	ns

Notes:
- The above characteristics apply to CLK synchronous mode.
- t_{CYCP} indicates the peripheral clock cycle time.
- These characteristics only guarantees the same relocate port number.
  For example, the combination of SCLKx_0 and SOTx_1 is not guaranteed.
- When the external load capacitance = 50pF.



MS bit=0



*2 : Changes when writing to TDR register

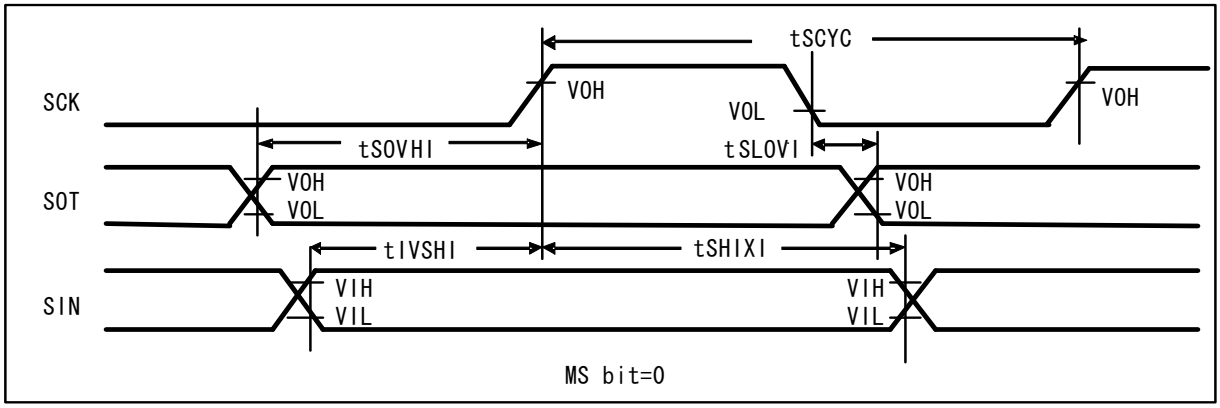
MS bit=1

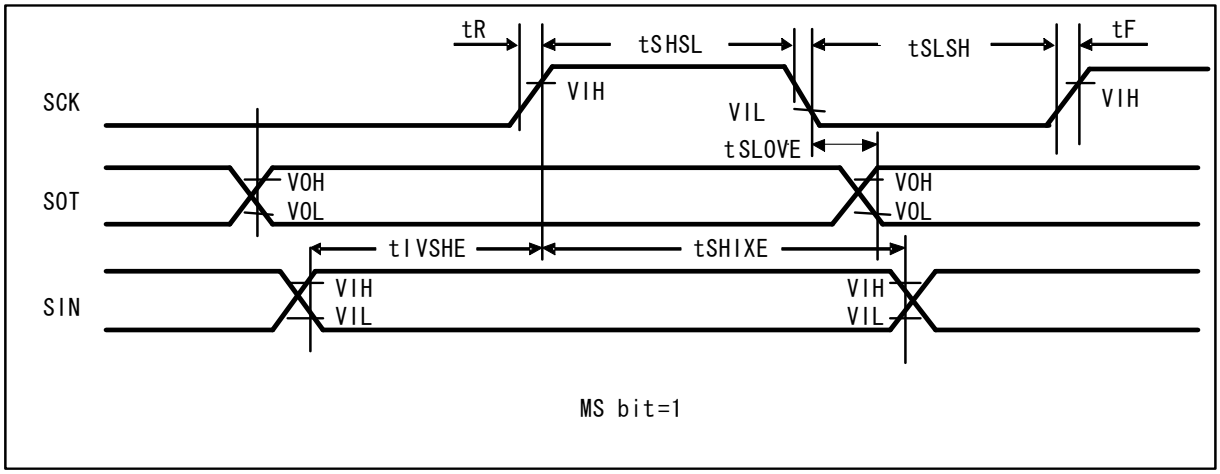
・ Synchronous serial(SPI = 1, SCINV = 1)

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Vcc < 4.5V		Vcc ≧ 4.5V		Unit
				Min	Max	Min	Max	
Serial clock cycle time	tSCYC	SCKx	Internal shift clock operation	4tcycp	-	4tcycp	-	ns
SCK ↓ → SOT delay time	tSLOVI	SCKx SOTx		-30	+30	- 20	+ 20	ns
SIN → SCK ↑ setup time	tIVSHI	SCKx SINx		50	-	30	-	ns
SCK ↑ → SIN hold time	tSHIXI	SCKx SINx		0	-	0	-	ns
SOT → SCK ↑ delay time	tSOVHI	SCKx SOTx		2tcycp - 30	-	2tcycp - 30	-	ns
Serial clock "L" pulse width	tSLSH	SCKx	External shift clock operation	2tcycp - 10	-	2tcycp - 10	-	ns
Serial clock "H" pulse width	tSHSL	SCKx		tcycp + 10	-	tcycp + 10	-	ns
SCK ↓ → SOT delay time	tSLOVE	SCKx SOTx		-	50	-	30	ns
SIN → SCK ↑ setup time	tIVSHE	SCKx SINx		10	-	10	-	ns
SCK ↑ → SIN hold time	tSHIXE	SCKx SINx		20	-	20	-	ns
SCK fall time	tF	SCKx		-	5	-	5	ns
SCK rise time	tR	SCKx		-	5	-	5	ns

Notes:
- The above characteristics apply to CLK synchronous mode.
- t_{CYCP} indicates the peripheral clock cycle time.
- These characteristics only guarantee the same relocate port number.
  For example, the combination of SCLKx_0 and SOTx_1 is not guaranteed.
- When the external load capacitance = 50pF.

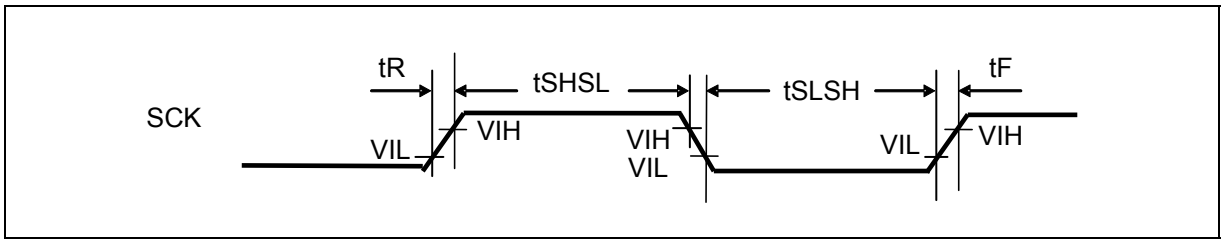




・ External clock(EXT = 1) : asynchronous only

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Conditions	Min	Max	Unit	Remarks
Serial clock "L" pulse width	tSLSH	CL = 50pF	tcycp + 10	-	ns	
Serial clock "H" pulse width	tSHSL		tcycp + 10	-	ns	
SCK fall time	tF		-	5	ns	
SCK rise time	tR		-	5	ns	

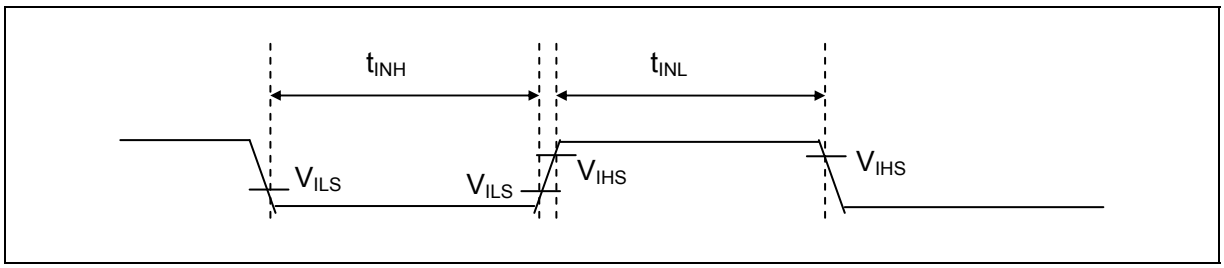


(10) External input timing

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{INH} t_{INL}	ADTG	-	$2t_{CYCP}$ *1	-	ns	A/D converter trigger input
		FRCKx					Free-run timer input clock
		ICxx					Input capture
		DTTIxX	-	$2t_{CYCP}$ *1	-	ns	Wave form generator
		INT00 to INT15, NMIX	-	$2t_{CYCP}$ + 100 *1	-	ns	External interrupt NMI
				500 *2	-	ns	

*1 : t_{CYCP} indicates the peripheral clock cycle time except stop when in stop mode.
*2 : When in stop mode, in timer mode.

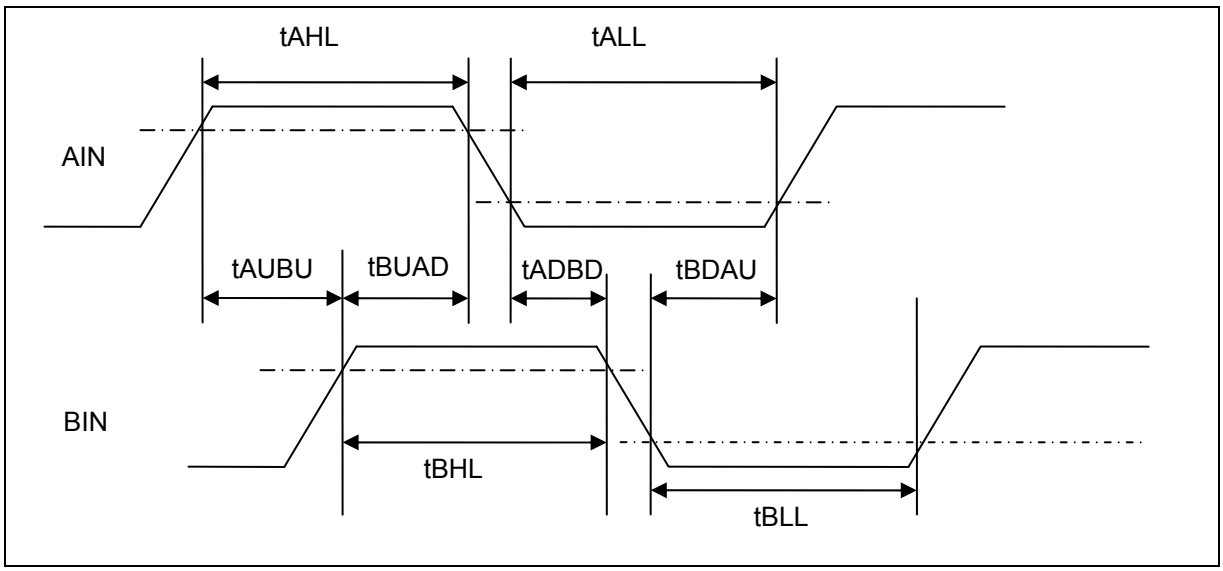


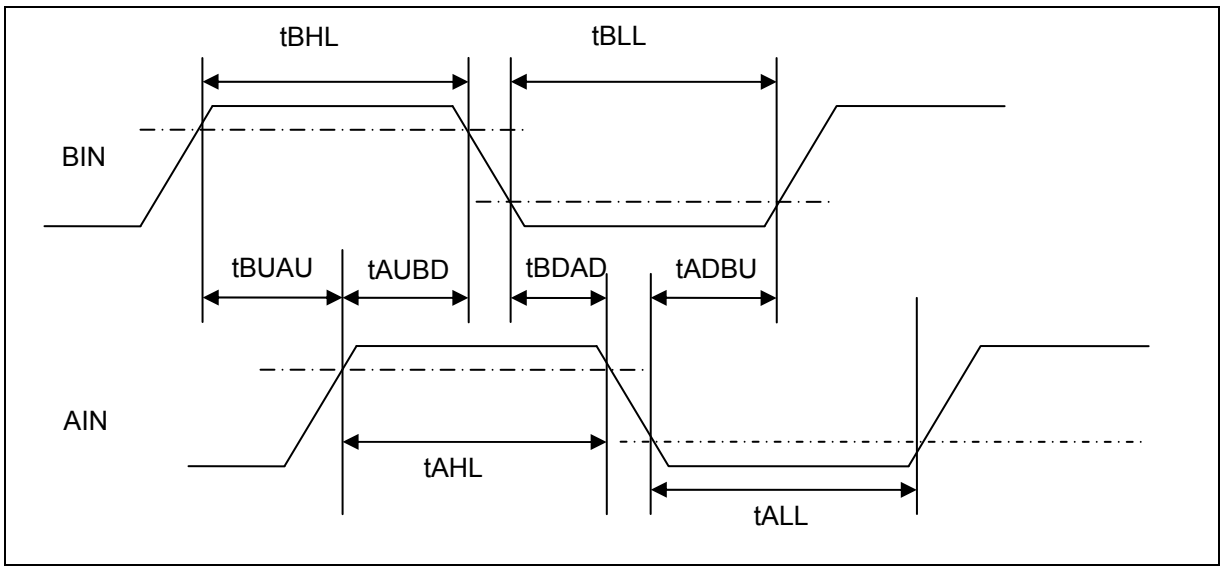
(11) Quadrature Position/Revolution Counter timing

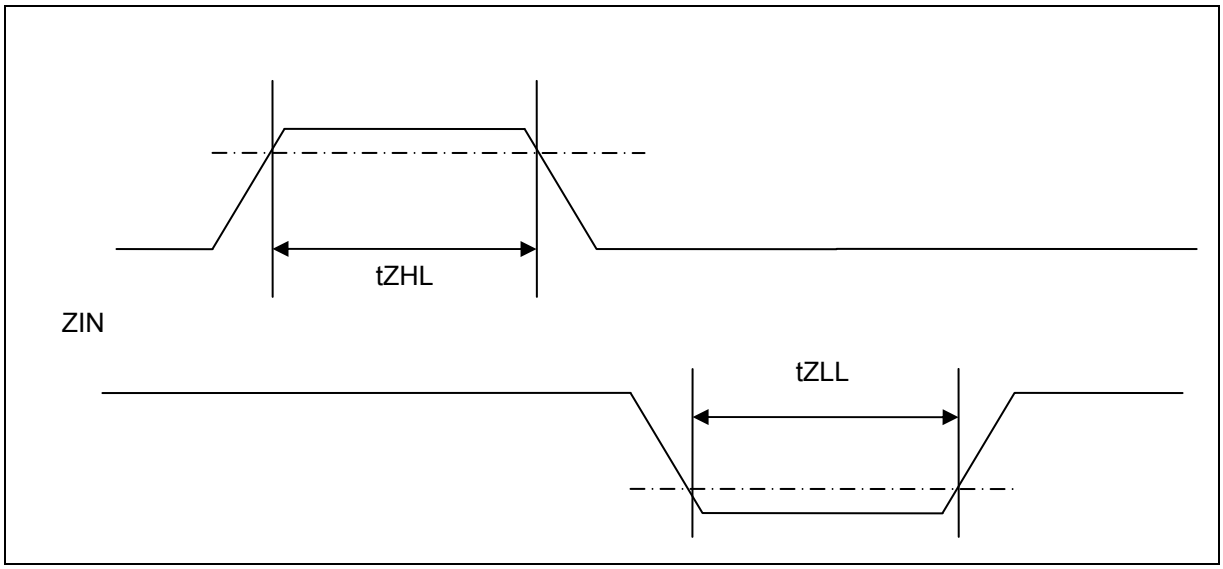
(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

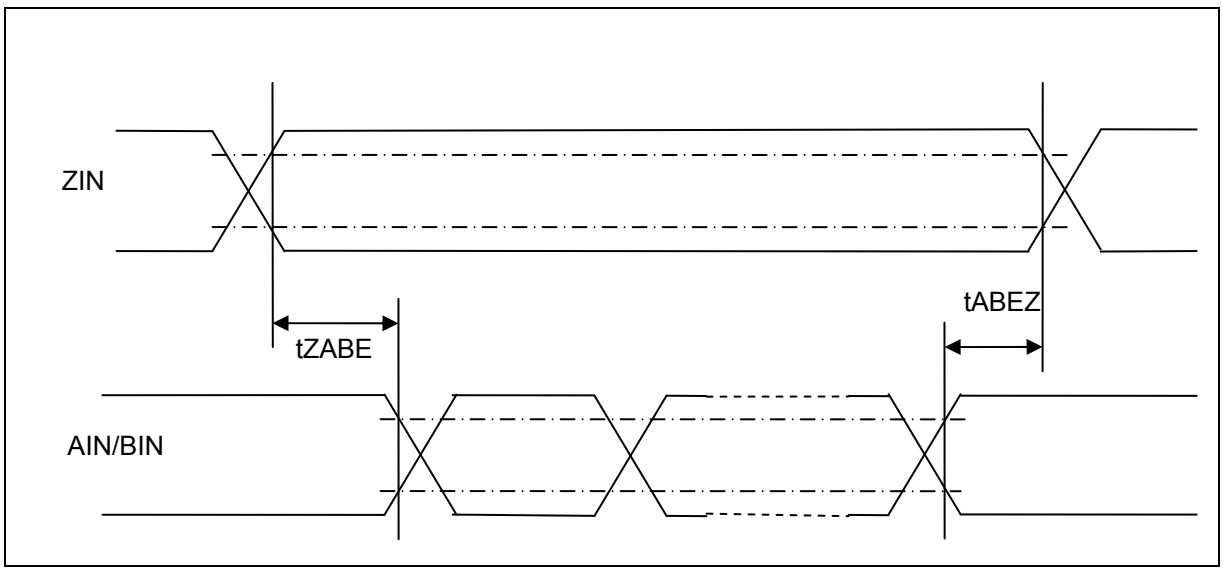
Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
AIN pin "H" width	tAHL	-	$2t_{CYCP}$ *	-	ns
AIN pin "L" width	tALL	-			
BIN pin "H" width	tBHL	-			
BIN pin "L" width	tBLL	-			
BIN rise time from AIN pin "H" level	tAUBU	PC_Mode2 or PC_Mode3			
AIN fall time from BIN pin "H" level	tBUAD	PC_Mode2 or PC_Mode3			
BIN fall time from AIN pin "L" level	tADBD	PC_Mode2 or PC_Mode3			
AIN rise time from BIN pin "L" level	tBDAU	PC_Mode2 or PC_Mode3			
AIN rise time from BIN pin "H" level	tBUAU	PC_Mode2 or PC_Mode3			
BIN fall time from AIN pin "H" level	tAUBD	PC_Mode2 or PC_Mode3			
AIN fall time from BIN pin "L" level	tBDAD	PC_Mode2 or PC_Mode3			
BIN rise time from AIN pin "L" level	tADBU	PC_Mode2 or PC_Mode3			
ZIN pin "H" width	tZHL	QCR:CGSC="0"			
ZIN pin "L" width	tZLL	QCR:CGSC="0"			
AIN/BIN rise and fall time from determined ZIN level	tZABE	QCR:CGSC="1"			
Determined ZIN level from AIN/BIN rise and fall time	tABEZ	QCR:CGSC="1"			

* : t_{CYCP} indicates the peripheral clock cycle time except stop when in stop mode.




tBHL
tBLL
BIN
tBUAU
tAUBD
tBDAD
tADBU
AIN
tAHL
tALL


tZHL
ZIN
tZLL


ZIN
tABEZ
tZABE
AIN/BIN

(12) I^2C timing

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

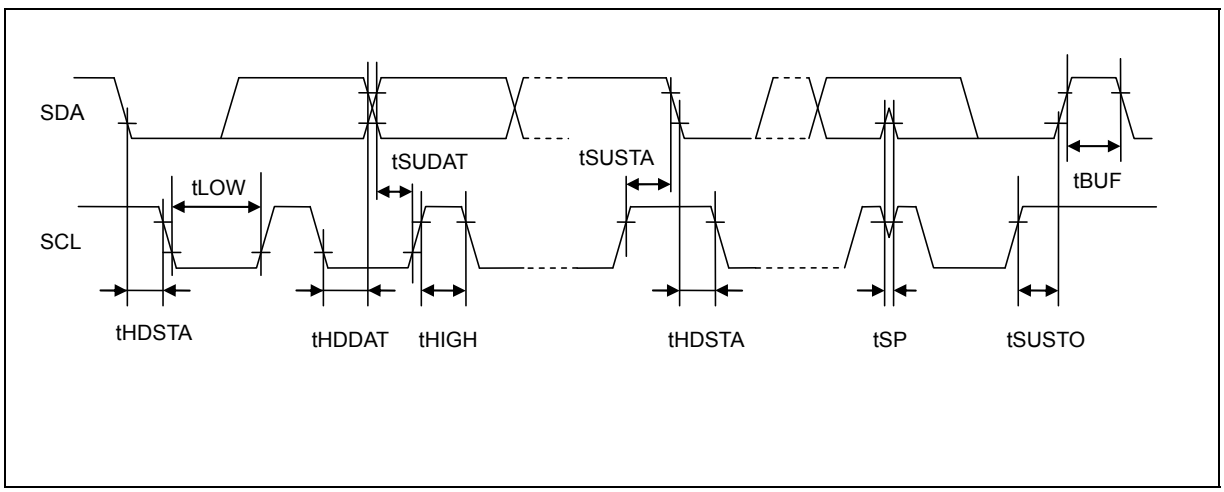
Parameter	Symbol	Conditions	Typical mode		High-speed mode		Unit	Remarks
			Min	Max	Min	Max		
SCL clock frequency	fSCL	CL = 50pF, R = (Vp/I_{OL}) (*1)	0	100	0	400	kHz	
(Repeated) START condition hold time SDA ↓ → SCL ↓	tHDSTA		4.0	-	0.6	-	µs	
SCLclock "L" width	tLOW		4.7	-	1.3	-	µs	
SCLclock "H" width	tHIGH		4.0	-	0.6	-	µs	
(Repeated) START setup time SCL ↑ → SDA ↓	tSUSTA		4.7	-	0.6	-	µs	
Data hold time SCL ↓ → SDA ↓ ↑	tHDDAT		0	3.45 (*2)	0	0.9 (*3)	µs	
Data setup time SDA ↓ ↑ → SCL ↑	tSUDAT		250	-	100	-	ns	
STOP condition setup time SCL ↑ → SDA ↑	tSUSTO		4.0	-	0.6	-	µs	
Bus free time between "STOP condition" and "START condition"	tBUF		4.7	-	1.3	-	µs	
Noise filter	tSP	-	2 t_{CYCP} (*4)	-	2 t_{CYCP} (*4)	-	ns	

*1 : R and C represent the pull-up resistance and load capacitance of the SCL and SDA lines, respectively. Vp indicates the power supply voltage of the pull-up resistance and I_{OL} indicates V_{OL} guaranteed current.

*2 : The maximum tHDDAT must satisfy that it doesn't extend at least "L" period (tLOW) of device's SCL signal.

*3 : A high-speed mode I^2C bus device can be used on a standard mode I^2C bus system as long as the device satisfies the requirement of "tSUDAT ≥ 250 ns".

*4 : t_{CYCP} is the peripheral clock cycle time. To use I^2C, set the peripheral bus clock at 8 MHz or more.

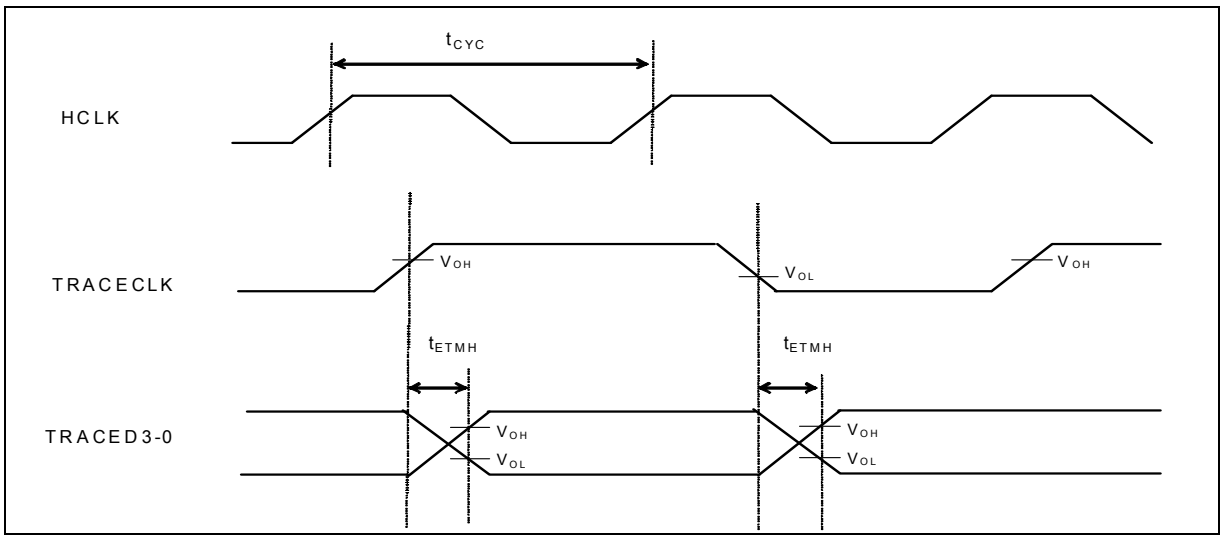


(13) ETM timing

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Data hold	t_{ETMH}	TRACECLK TRACED3 - 0	Vcc ≧ 4.5V	2	9	ns	
			Vcc < 4.5V	-4	15		MB9BF500
				2	15		MB9BF504/505/506

Note: When the external load capacitance = 50pF.

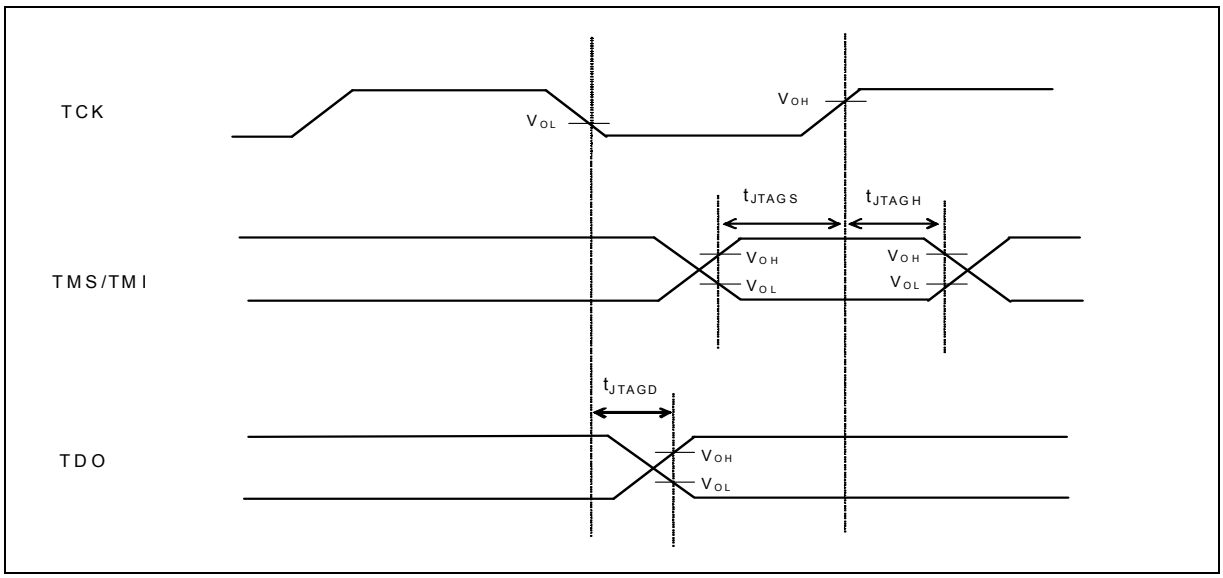


(14) JTAG timing

(Vcc = 2.7V to 5.5V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
TMS,TDI setup time	t_{JTAGS}	TCK TMS,TDI	Vcc ≧ 4.5V	15	-	ns	
			Vcc < 4.5V				
TMS,TDI hold time	t_{JTAGH}	TCK TMS,TDI	Vcc ≧ 4.5V	15	-	ns	
			Vcc < 4.5V				
TDO delay time	t_{JTAGD}	TCK TDO	Vcc ≧ 4.5V	-	25	ns	
			Vcc < 4.5V	-	55		MB9BF500
					45		MB9BF504/505/506

Note: When the external load capacitance = 50pF.



● 10bit A/D Converter

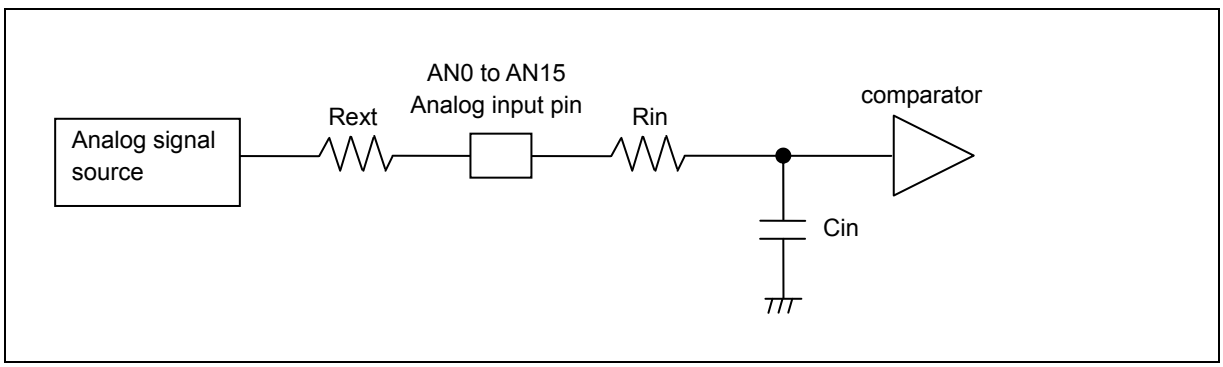
This chapter shows the electrical characteristics for the A/D converter.

1. Electrical characteristics for the A/D converter.

(Vcc = AVcc = 2.7V to 5.5V, Vss = AVss = 0V Ta = - 40°C to + 85°C)

Parameter	Pin name	Value			Unit	Remarks
		Min	Typ	Max		
Resolution	-	-	-	10	bit	
Total error	-	- 4.0	-	+ 4.0	LSB	AVRH = 2.7V to 5.5V
Linearity error	-	- 3.5	-	+ 3.5	LSB	
Differential linearity error	-	- 3.0	-	+ 3.0	LSB	
Zero transition voltage	AN0 to AN15	- 1.5	+ 0.5	+ 3.5	LSB	
Full transition voltage	AN0 to AN15	AVRH - 4.5	AVRH - 1.5	AVRH + 0.5	LSB	
Conversion time	-	1.2 (*)	-	-	µs	AVcc ≧ 4.5V, PCLK = 30MHz
		3.1 (*)	-	-	µs	AVcc < 4.5V, PCLK = 30MHz
Power supply current (analog + digital)	AVCC	-	5.7	11.1	mA	A/D 3unit operation
		-	-	15	µA	When A/D converter is not in operation.
Reference power supply current (between AVRH to AVSS)	AVRH	-	1.56	2.43	mA	A/D 3unit operation
		-	-	15	µA	When A/D converter is not in operation.
Analog input capacity	-	-	-	8.5	pF	
Interchannel disparity	-	-	-	4	LSB	
Analog port input current	AN0 to AN15	-	-	5	µA	
Analog input voltage	AN0 to AN15	AVSS	-	AVRH	V	
Reference voltage	AVRH	AVSS	-	AVCC	V	

* : Depending on the clock cycle supplied to peripheral resources.
Ensure that it satisfies the value; PCLK cycle more than 4 + the value calculated from (Equation 1).
The condition of the minimum conversion time is when PCLK = 30 MHz, the value of sampling time: 0.4µs, external impedance: 4.1 kΩ or less and compare time: 0.8µs (AVcc ≧ 4.5V)



(Continued)

The output impedance of the external circuit connected to the analog input affects the sampling time of the A/D converter. Design the output impedance of the output circuit such that the required sampling time is less than the value of Ts calculated from the following equation.

(Equation 1)

$Ts = (Rin + Rext) \times Cin \times 7$

Ts : Sampling time
Rin : input resistance of A/D = 2.6kΩ 4.5 ≦ AVCC ≦ 5.5
input resistance of A/D = 12.1kΩ 2.7 ≦ AVCC < 4.5
Cin : input capacity of A/D = 8.5pF
Rext : Output impedance of external circuit

If the sampling time is set as 400ns (when 4.5 ≦ AVCC ≦ 5.5),

$400ns \geqq (2.6k\Omega + Rext) \times 8.5pF \times 7$

$\therefore Rext \leqq 4.1k\Omega$

And the impedance of the external circuit therefore needs to be 4.1kΩor less.

・Setting examples of sampling time and compare time

・Setting examples of sampling time (for STX01, STX00/STX11, STX10 bits = "00" at AVcc ≧ 4.5V)

Register Value STx5 to STx0	Sampling Time [µs]				Maximum External Impedance [kΩ]			
	PCLK = 20MHz	PCLK = 30MHz	PCLK = 33MHz	PCLK = 40MHz	PCLK = 20MHz	PCLK = 30MHz	PCLK = 33MHz	PCLK = 40MHz
0	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	0.400	-	-	-	4.123	-	-	-
8	0.450	-	-	-	4.963	-	-	-
9	0.500	-	-	-	5.803	-	-	-
10	0.550	-	-	-	6.644	-	-	-
11	0.600	0.400	-	-	7.484	4.123	-	-
12	0.650	0.433	-	-	8.324	4.683	-	-
13	0.700	0.467	0.424	-	9.165	5.243	4.530	-
14	0.750	0.500	0.455	-	10.005	5.803	5.039	-
15	0.800	0.533	0.485	0.400	10.845	6.364	5.549	4.123
16	0.850	0.567	0.515	0.425	11.686	6.924	6.058	4.543
17	0.900	0.600	0.545	0.450	12.526	7.484	6.567	4.963
18	0.950	0.633	0.576	0.475	13.366	8.044	7.077	5.383
19	1.000	0.667	0.606	0.500	14.207	8.604	7.586	5.803
20	1.050	0.700	0.636	0.525	15.047	9.165	8.095	6.224
21	1.100	0.733	0.667	0.550	15.887	9.725	8.604	6.644
22	1.150	0.767	0.697	0.575	16.728	10.285	9.114	7.064
23	1.200	0.800	0.727	0.600	17.568	10.845	9.623	7.484
24	1.250	0.833	0.758	0.625	18.408	11.406	10.132	7.904
25	1.300	0.867	0.788	0.650	19.249	11.966	10.642	8.324
26	1.350	0.900	0.818	0.675	20.089	12.526	11.151	8.745
27	1.400	0.933	0.848	0.700	20.929	13.086	11.660	9.165
28	1.450	0.967	0.879	0.725	21.770	13.646	12.170	9.585
29	1.500	1.000	0.909	0.750	22.610	14.207	12.679	10.005
30	1.550	1.033	0.939	0.775	23.450	14.767	13.188	10.425
31	1.600	1.067	0.970	0.800	24.291	15.327	13.697	10.845
32	1.650	1.100	1.000	0.825	25.131	15.887	14.207	11.266
33	1.700	1.133	1.030	0.850	25.971	16.448	14.716	11.686
34	1.750	1.167	1.061	0.875	26.812	17.008	15.225	12.106
35	1.800	1.200	1.091	0.900	27.652	17.568	15.735	12.526
36	1.850	1.233	1.121	0.925	28.492	18.128	16.244	12.946
37	1.900	1.267	1.152	0.950	29.333	18.689	16.753	13.366
38	1.950	1.300	1.182	0.975	30.173	19.249	17.262	13.787
39	2.000	1.333	1.212	1.000	31.013	19.809	17.772	14.207
...	...	...	...	...	...	...	...	...
62	3.150	2.100	1.909	1.575	50.341	32.694	29.486	23.871
63	3.200	2.133	1.939	1.600	51.182	33.254	29.995	24.291

PCLK : peripheral clock (PCLK) frequency

- : Setting prohibited

・ Setting examples of sampling time (for STX01, STX00/STX11, STX10 bits = "10" at AVcc ≧ 4.5V)

Register Value STx5 to STx0	Sampling Time [µs]				Maximum External Impedance [kΩ]			
	PCLK = 20MHz	PCLK = 30MHz	PCLK = 33MHz	PCLK = 40MHz	PCLK = 20MHz	PCLK = 30MHz	PCLK = 33MHz	PCLK = 40MHz
0	0.400	-	-	-	4.123	-	-	-
1	0.800	0.533	0.485	0.400	10.845	6.364	5.549	4.123
2	1.200	0.800	0.727	0.600	17.568	10.845	9.623	7.484
3	1.600	1.067	0.970	0.800	24.291	15.327	13.697	10.845
4	2.000	1.333	1.212	1.000	31.013	19.809	17.772	14.207
5	2.400	1.600	1.455	1.200	37.736	24.291	21.846	17.568
6	2.800	1.867	1.697	1.400	44.459	28.773	25.920	20.929
7	3.200	2.133	1.939	1.600	51.182	33.254	29.995	24.291
8	3.600	2.400	2.182	1.800	57.904	37.736	34.069	27.652
9	4.000	2.667	2.424	2.000	64.627	42.218	38.144	31.013
10	4.400	2.933	2.667	2.200	71.350	46.700	42.218	34.375
11	4.800	3.200	2.909	2.400	78.072	51.182	46.292	37.736
12	5.200	3.467	3.152	2.600	84.795	55.663	50.367	41.097
13	5.600	3.733	3.394	2.800	91.518	60.145	54.441	44.459
14	6.000	4.000	3.636	3.000	98.240	64.627	58.515	47.820
15	6.400	4.267	3.879	3.200	104.963	69.109	62.590	51.182
16	6.800	4.533	4.121	3.400	111.686	73.590	66.664	54.543
17	7.200	4.800	4.364	3.600	118.408	78.072	70.738	57.904
18	7.600	5.067	4.606	3.800	125.131	82.554	74.813	61.266
19	8.000	5.333	4.848	4.000	131.854	87.036	78.887	64.627
20	8.400	5.600	5.091	4.200	138.576	91.518	82.961	67.988
21	8.800	5.867	5.333	4.400	145.299	95.999	87.036	71.350
22	9.200	6.133	5.576	4.600	152.022	100.481	91.110	74.711
23	9.600	6.400	5.818	4.800	158.745	104.963	95.185	78.072
24	10.000	6.667	6.061	5.000	165.467	109.445	99.259	81.434
25	10.400	6.933	6.303	5.200	172.190	113.927	103.333	84.795
26	10.800	7.200	6.545	5.400	178.913	118.408	107.408	88.156
27	11.200	7.467	6.788	5.600	185.635	122.890	111.482	91.518
28	11.600	7.733	7.030	5.800	192.358	127.372	115.556	94.879
29	12.000	8.000	7.273	6.000	199.081	131.854	119.631	98.240
30	12.400	8.267	7.515	6.200	205.803	136.336	123.705	101.602
31	12.800	8.533	7.758	6.400	212.526	140.817	127.779	104.963
32	13.200	8.800	8.000	6.600	219.249	145.299	131.854	108.324
33	13.600	9.067	8.242	6.800	225.971	149.781	135.928	111.686
34	14.000	9.333	8.485	7.000	232.694	154.263	140.002	115.047
35	14.400	9.600	8.727	7.200	239.417	158.745	144.077	118.408
36	14.800	9.867	8.970	7.400	246.139	163.226	148.151	121.770
37	15.200	10.133	9.212	7.600	252.862	167.708	152.226	125.131
38	15.600	10.400	9.455	7.800	259.585	172.190	156.300	128.492
39	16.000	10.667	9.697	8.000	266.308	176.672	160.374	131.854
...	...	...	...	...	...	...	...	...
62	25.200	16.800	15.273	12.600	420.929	279.753	254.084	209.165
63	25.600	17.067	15.515	12.800	427.652	284.235	258.159	212.526

PCLK : peripheral clock (PCLK) frequency

- : Setting prohibited

・ Setting examples of sampling time (for STX01, STX00/STX11, STX10 bits = "00" at AVcc < 4.5V)

Register Value STx5 to STx0	Sampling Time [µs]				Maximum External Impedance [kΩ]			
	PCLK = 20MHz	PCLK = 30MHz	PCLK = 33MHz	PCLK = 40MHz	PCLK = 20MHz	PCLK = 30MHz	PCLK = 33MHz	PCLK = 40MHz
0	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-
11	-	-	-	-	-	-	-	-
12	-	-	-	-	-	-	-	-
13	-	-	-	-	-	-	-	-
14	-	-	-	-	-	-	-	-
15	-	-	-	-	-	-	-	-
16	-	-	-	-	-	-	-	-
17	-	-	-	-	-	-	-	-
18	-	-	-	-	-	-	-	-
19	1.000	-	-	-	4.707	-	-	-
20	1.050	-	-	-	5.547	-	-	-
21	1.100	-	-	-	6.387	-	-	-
22	1.150	-	-	-	7.228	-	-	-
23	1.200	-	-	-	8.068	-	-	-
24	1.250	-	-	-	8.908	-	-	-
25	1.300	-	-	-	9.749	-	-	-
26	1.350	-	-	-	10.589	-	-	-
27	1.400	-	-	-	11.429	-	-	-
28	1.450	-	-	-	12.270	-	-	-
29	1.500	1.000	-	-	13.110	4.707	-	-
30	1.550	1.033	-	-	13.950	5.267	-	-
31	1.600	1.067	-	-	14.791	5.827	-	-
32	1.650	1.100	1.000	-	15.631	6.387	4.707	-
33	1.700	1.133	1.030	-	16.471	6.948	5.216	-
34	1.750	1.167	1.061	-	17.312	7.508	5.725	-
35	1.800	1.200	1.091	-	18.152	8.068	6.235	-
36	1.850	1.233	1.121	-	18.992	8.628	6.744	-
37	1.900	1.267	1.152	-	19.833	9.189	7.253	-
38	1.950	1.300	1.182	-	20.673	9.749	7.762	-
39	2.000	1.333	1.212	1.000	21.513	10.309	8.272	4.707
...	...	...	...	...	...	...	...	...
62	3.150	2.100	1.909	1.575	40.841	23.194	19.986	14.371
63	3.200	2.133	1.939	1.600	41.682	23.754	20.495	14.791

PCLK : peripheral clock (PCLK) frequency

- : Setting prohibited

・ Setting examples of sampling time (for STX01, STX00/STX11, STX10 bits = "10" at AVcc < 4.5V)

Register Value STx5 to STx0	Sampling Time [µs]				Maximum External Impedance [kΩ]			
	PCLK = 20MHz	PCLK = 30MHz	PCLK = 33MHz	PCLK = 40MHz	PCLK = 20MHz	PCLK = 30MHz	PCLK = 33MHz	PCLK = 40MHz
0	-	-	-	-	-	-	-	-
1	-	-	-	-	-	-	-	-
2	1.200	-	-	-	8.068	-	-	-
3	1.600	1.067	-	-	14.791	5.827	-	-
4	2.000	1.333	1.212	1.000	21.513	10.309	8.272	4.707
5	2.400	1.600	1.455	1.200	28.236	14.791	12.346	8.068
6	2.800	1.867	1.697	1.400	34.959	19.273	16.420	11.429
7	3.200	2.133	1.939	1.600	41.682	23.754	20.495	14.791
8	3.600	2.400	2.182	1.800	48.404	28.236	24.569	18.152
9	4.000	2.667	2.424	2.000	55.127	32.718	28.644	21.513
10	4.400	2.933	2.667	2.200	61.850	37.200	32.718	24.875
11	4.800	3.200	2.909	2.400	68.572	41.682	36.792	28.236
12	5.200	3.467	3.152	2.600	75.295	46.163	40.867	31.597
13	5.600	3.733	3.394	2.800	82.018	50.645	44.941	34.959
14	6.000	4.000	3.636	3.000	88.740	55.127	49.015	38.320
15	6.400	4.267	3.879	3.200	95.463	59.609	53.090	41.682
16	6.800	4.533	4.121	3.400	102.186	64.090	57.164	45.043
17	7.200	4.800	4.364	3.600	108.908	68.572	61.238	48.404
18	7.600	5.067	4.606	3.800	115.631	73.054	65.313	51.766
19	8.000	5.333	4.848	4.000	122.354	77.536	69.387	55.127
20	8.400	5.600	5.091	4.200	129.076	82.018	73.461	58.488
21	8.800	5.867	5.333	4.400	135.799	86.499	77.536	61.850
22	9.200	6.133	5.576	4.600	142.522	90.981	81.610	65.211
23	9.600	6.400	5.818	4.800	149.245	95.463	85.685	68.572
24	10.000	6.667	6.061	5.000	155.967	99.945	89.759	71.934
25	10.400	6.933	6.303	5.200	162.690	104.427	93.833	75.295
26	10.800	7.200	6.545	5.400	169.413	108.908	97.908	78.656
27	11.200	7.467	6.788	5.600	176.135	113.390	101.982	82.018
28	11.600	7.733	7.030	5.800	182.858	117.872	106.056	85.379
29	12.000	8.000	7.273	6.000	189.581	122.354	110.131	88.740
30	12.400	8.267	7.515	6.200	196.303	126.836	114.205	92.102
31	12.800	8.533	7.758	6.400	203.026	131.317	118.279	95.463
32	13.200	8.800	8.000	6.600	209.749	135.799	122.354	98.824
33	13.600	9.067	8.242	6.800	216.471	140.281	126.428	102.186
34	14.000	9.333	8.485	7.000	223.194	144.763	130.502	105.547
35	14.400	9.600	8.727	7.200	229.917	149.245	134.577	108.908
36	14.800	9.867	8.970	7.400	236.639	153.726	138.651	112.270
37	15.200	10.133	9.212	7.600	243.362	158.208	142.726	115.631
38	15.600	10.400	9.455	7.800	250.085	162.690	146.800	118.992
39	16.000	10.667	9.697	8.000	256.808	167.172	150.874	122.354
...	...	...	...	...	...	...	...	...
62	25.200	16.800	15.273	12.600	411.429	270.253	244.584	199.665
63	25.600	17.067	15.515	12.800	418.152	274.735	248.659	203.026

PCLK : peripheral clock (PCLK) frequency

- : Setting prohibited

・ Setting examples of compare time at AVcc ≧ 4.5V

Register Value CT2 to CT0	Compare Time [µs]			
	PCLK = 20MHz	PCLK = 30MHz	PCLK = 33MHz	PCLK = 40MHz
0	-	-	-	-
1	1.200	0.800	0.727	-
2	1.700	1.133	1.030	0.850
3	2.200	1.467	1.333	1.100
4	2.700	1.800	1.636	1.350
5	3.200	2.133	1.939	1.600
6	3.700	2.467	2.242	1.850
7 (initial value)	4.200	2.800	2.545	2.100

PCLK : peripheral clock (PCLK) frequency
- : Setting prohibited
* This table covers only compare time data.

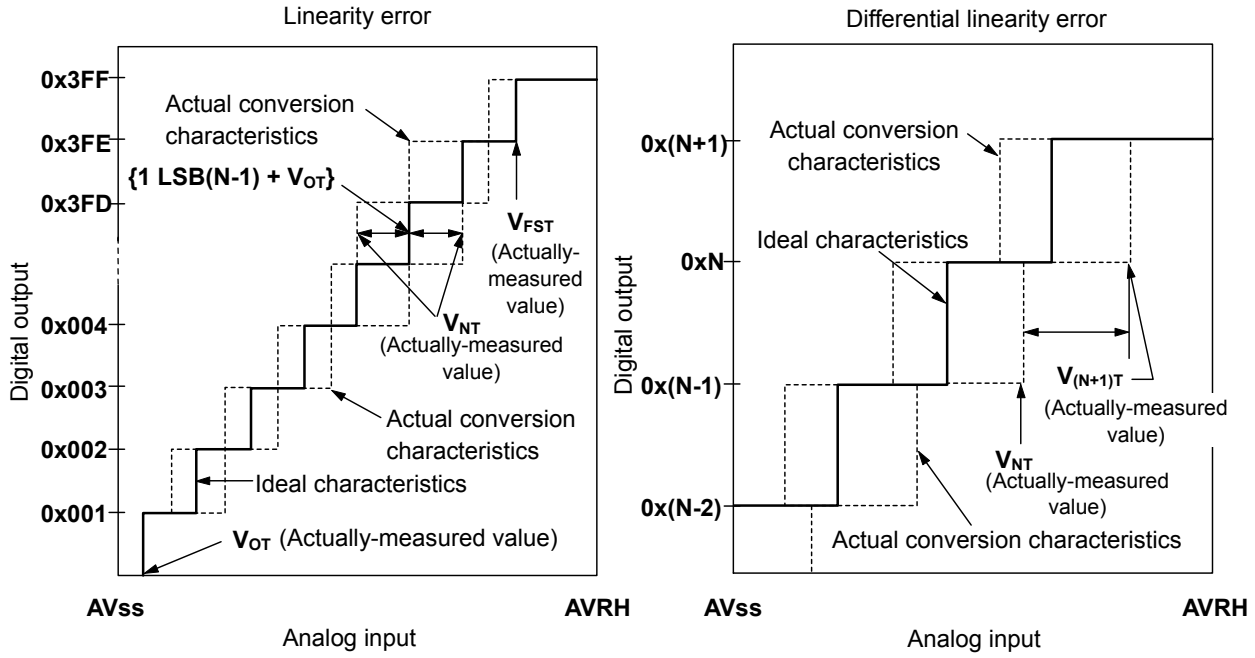
・ Setting examples of compare time at 2.7V ≦ AVcc < 4.5V

Register Value CT2 to CT0	Compare Time [µs]			
	PCLK = 20MHz	PCLK = 30MHz	PCLK = 33MHz	PCLK = 40MHz
0	-	-	-	-
1	-	-	-	-
2	-	-	-	-
3	2.200	-	-	-
4	2.700	-	-	-
5	3.200	2.133	-	-
6	3.700	2.467	2.242	-
7 (initial value)	4.200	2.800	2.545	2.100

PCLK : peripheral clock (PCLK) frequency
- : Setting prohibited
* This table covers only compare time data.

・Definition of 10-bit A/D Converter Terms

- ・Resolution : Analog variation that is recognized by an A/D converter.
- ・Linearity error : Deviation of the line between the zero-transition point (0b0000000000←→0b0000000001) and the full-scale transition point (0b1111111110←→0b1111111111) from the actual conversion characteristics.
- ・Differential linearity error : Deviation from the ideal value of the input voltage that is required to change the output code by 1 LSB.
- ・Total error : Difference between the actual value and the theoretical value. The total error includes zero transition error, full-scale transition error, and linearity error.



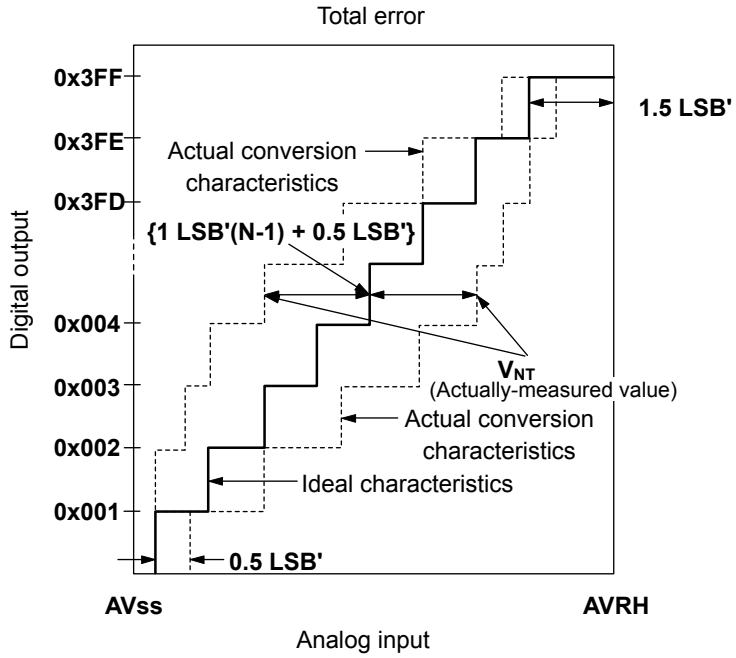
$$\text{Linearity error of digital output N} = \frac{V_{NT} - \{1LSB \times (N - 1) + V_{OT}\}}{1LSB} \text{ [LSB]}$$

$$\text{Differential linearity error of digital output N} = \frac{V_{(N+1)T} - V_{NT}}{1LSB} - 1 \text{ [LSB]}$$

$$1LSB = \frac{V_{FST} - V_{OT}}{1022}$$

N : A/D converter digital output value.
V_{OT} : Voltage at which the digital output changes from 0x000 to 0x001.
V_{FST} : Voltage at which the digital output changes from 0x3FE to 0x3FF.
V_{NT} : Voltage at which the digital output changes from 0x(N − 1) to 0xN.

(Continued)



$$1LSB' \text{ (Ideal value)} = \frac{AVRH - AV_{SS}}{1024} \text{ [V]}$$

$$\text{Total error of digital output N} = \frac{V_{NT} - \{1LSB' \times (N - 1) + 0.5LSB'\}}{1LSB'}$$

N : A/D converter digital output value.
V_{NT} : Voltage at which the digital output changes from 0x(N + 1) to 0xN.
V_{OT}' (Ideal value) = AV_{SS} + 0.5LSB[V]
V_{FST}' (Ideal value) = AVRH - 1.5LSB[V]

● 12bit A/D Converter

This chapter shows the electrical characteristics for the A/D converter.

1. Electrical characteristics for the A/D converter.(Provisional value)

(Vcc = AVcc = 2.7V to 5.5V, Vss = AVss = 0V Ta = - 40°C to + 85°C)

Parameter	Pin name	Value			Unit	Remarks
		Min	Typ	Max		
Resolution	-	-	-	12	bit	
Linearity error	-	- 4.5	-	+ 4.5	LSB	AVRH = 2.7V to 5.5V
Differential linearity error	-	-2.5	-	+ 2.5	LSB	
Zero transition voltage	AN0 to AN15	- 20	-	+ 20	mV	
Full transition voltage	AN0 to AN15	- 20	-	+ 20	mV	
Conversion time	-	1.0 (*1)	-	-	µs	AVcc ≧ 4.5V
Sampling time	Ts	*2	-	-	ns	AVcc ≧ 4.5V
		*2	-	-		AVcc < 4.5V
Compare clock cycle *3	Tcck	55.6	-	10000	ns	AVcc ≧ 4.5V
		166.7				AVcc < 4.5V
State transition time to operation permission	Tstt	2.5	-	-	µs	
Power supply current (analog + digital)	AVCC	-	2.3	3.6	mA	A/D 1unit operation
		-	0.01	0.3	µA	When XSTB is 0 (1unit)
Reference power supply current (between AVRH to AVSS)	AVRH	-	2.2	3.0	mA	A/D 1unit operation AVRH=5.5V
		-	0.01	0.2	µA	When XSTB is 0 (1unit)
Analog input capacity	Cin	-	-	14.5	pF	
Analog input resistance	Rin	-	-	0.93	kΩ	AVcc ≧ 4.5V
				2.04		AVcc < 4.5V
Interchannel disparity	-	-	-	4	LSB	
Analog port input current	AN0 to AN15	-	-	5	µA	
Analog input voltage	AN0 to AN15	AVSS	-	AVRH	V	
Reference voltage	AVRH	AVSS	-	AVCC	V	

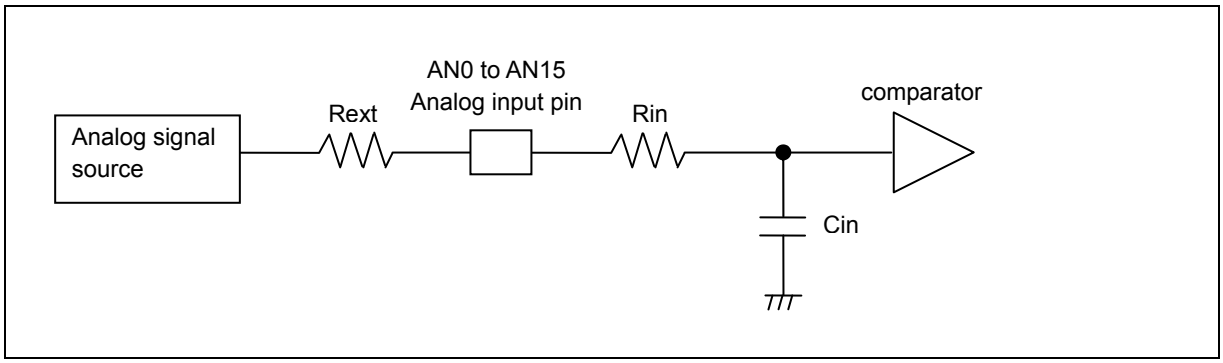
*1: Conversion time is the value of sampling time(Ts) + compare time(Tc).
The condition of the minimum conversion time is when HCLK=72MHz, the value of sampling time: 0.222µs, the value of sampling time: 778ns (AVcc ≧ 4.5V)

Ensure that it satisfies the value of sampling time(Ts) and compare clock cycle (Tcck).
For setting of sampling time and compare clock cycle, see chapter "12-bit A/D Converter" in "Peripheral Manual"

*2: A necessary sampling time changes by external impedance.
Ensure that it set the sampling time to satisfy (Equation 1)

*3: Compare time (Tc) is the value of (Equation 2)

(Continued)



(Equation 1) $Ts \geqq (Rin + Rext) \times Cin \times 9$

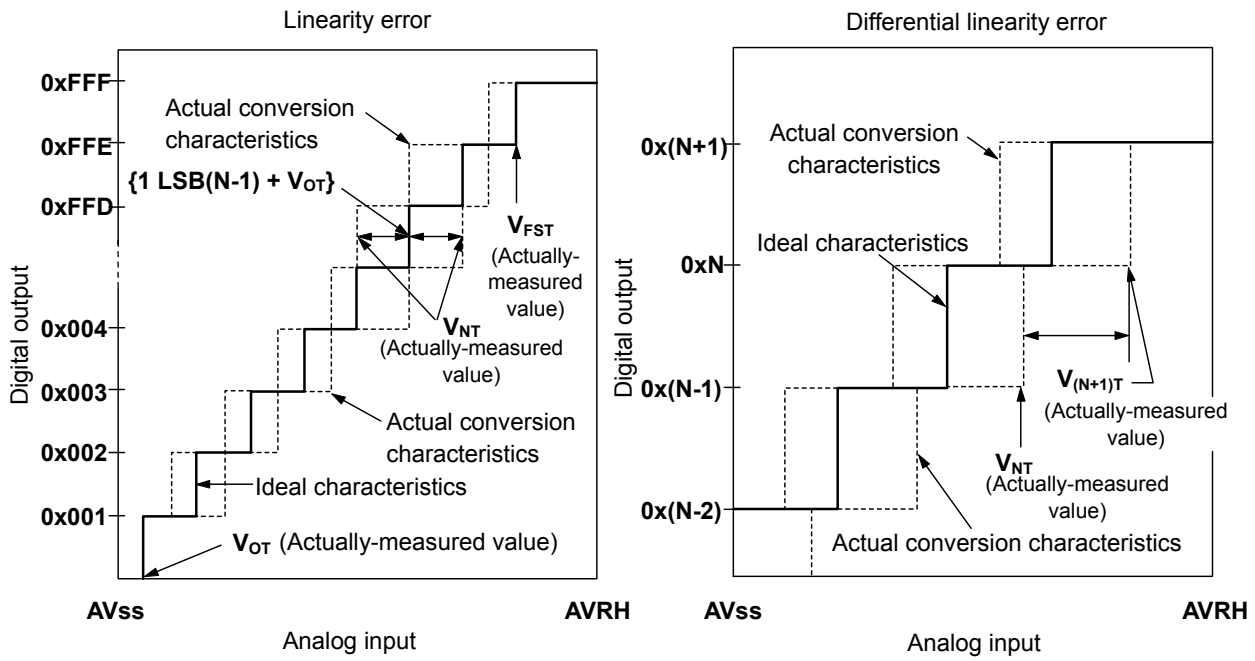
Ts : Sampling time
Rin : input resistance of A/D = 0.93kΩ 4.5 ≦ AVCC ≦ 5.5
input resistance of A/D = 2.04kΩ 2.7 ≦ AVCC < 4.5
Cin : input capacity of A/D = 14.5pF 2.7 ≦ AVCC ≦ 5.5
Rext : Output impedance of external circuit

(Equation 2) $Tc = Tcck \times 14$

Tc : Compare time
Tcck : Comrare clock cycle

・Definition of 12-bit A/D Converter Terms

- ・Resolution : Analog variation that is recognized by an A/D converter.
- ・Linearity error : Deviation of the line between the zero-transition point (0b000000000000←→0b000000000001) and the full-scale transition point (0b111111111110←→0b111111111111) from the actual conversion characteristics.
- ・Differential linearity error : Deviation from the ideal value of the input voltage that is required to change the output code by 1 LSB.



$$\text{Linearity error of digital output N} = \frac{V_{NT} - \{1LSB \times (N - 1) + V_{OT}\}}{1LSB} \text{ [LSB]}$$

$$\text{Differential linearity error of digital output N} = \frac{V_{(N+1)T} - V_{NT}}{1LSB} - 1 \text{ [LSB]}$$

$$1LSB = \frac{V_{FST} - V_{OT}}{4094}$$

N : A/D converter digital output value.
V_{OT} : Voltage at which the digital output changes from 0x000 to 0x001.
V_{FST} : Voltage at which the digital output changes from 0xFFE to 0xFFF.
V_{NT} : Voltage at which the digital output changes from 0x(N − 1) to 0xN.

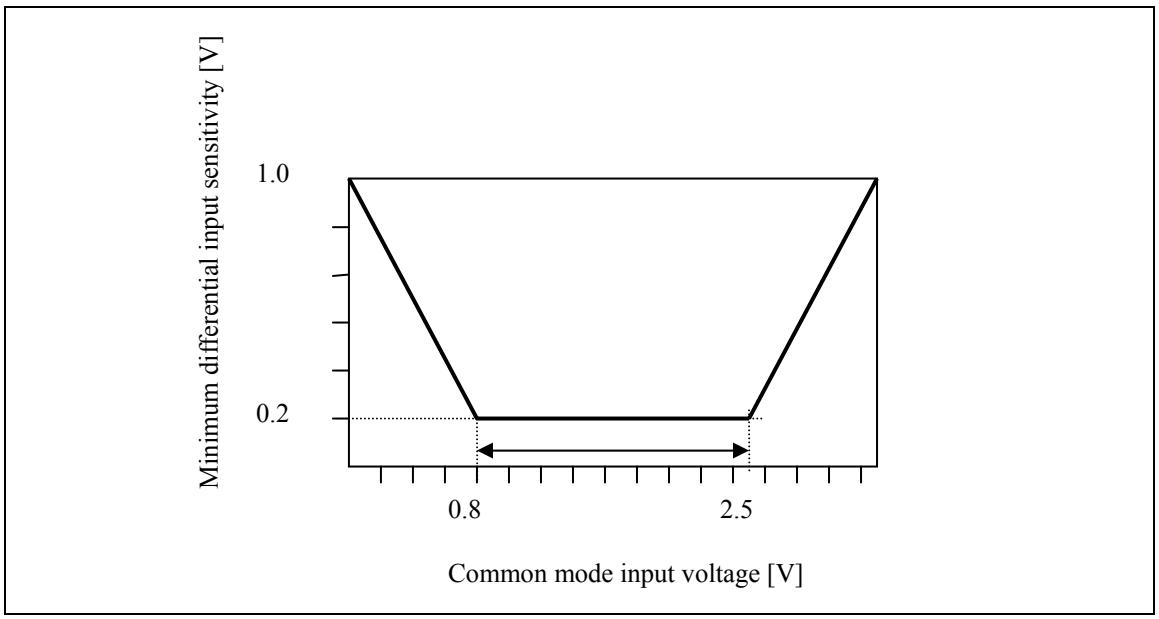
● USB characteristics

(Vcc = 2.7V to 5.5V,USBVcc = 3.0V to 3.6V, Vss = 0V Ta = - 40°C to + 85°C)

Parameter		Symbol	Pin name	Conditions	Value		Unit	Remarks
					MIN	MAX		
Input characteristics	Input High level voltage	V_{IH}	UDP0, UDM0	-	2.0	USBVcc + 0.3	V	*1
	Input Low level voltage	V_{IL}		-	Vss - 0.3	0.8	V	*1
	Differential input sensitivity	V_{DI}		-	0.2	-	V	*2
	Different common mode input voltage	V_{CM}		-	0.8	2.5	V	*2
Output characteristics	Output High level voltage	V_{OH}		External pull-down resistance = 15kΩ	2.8	3.6	V	*3
	Output Low level voltage	V_{OL}		External pull-up resistance = 1.5kΩ	0.0	0.3	V	*3
	Crossover voltage	V_{CRS}		-	1.3	2.0	V	*4
	Rise time	t_{FR}		Full Speed	4	20	ns	*5
	Fall time	t_{FF}		Full Speed	4	20	ns	*5
	Rise/ fall time matching	t_{FRFM}		Full Speed	90	111.11	%	*5
	Output impedance	Z_{DRV}		Full Speed	28	44	Ω	*6
	Rise time	t_{LR}		Low Speed	75	300	ns	*7
	Fall time	t_{LF}		Low Speed	75	300	ns	*7
	Rise/ fall time matching	t_{LRFM}		Low Speed	80	125	%	*7

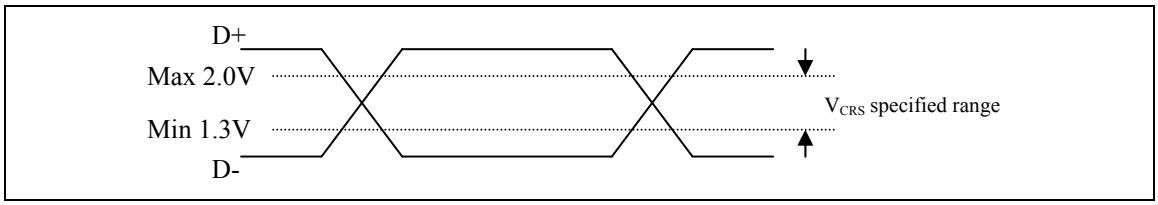
*1 : The switching threshold voltage of Single-End-Receiver of USB I/O buffer is set as within V_{IL} (Max) = 0.8V, V_{IH} (Min) = 2.0 V (TTL input standard).
There are some hystereses to lower noise sensitivity.

*2 : Use differential-Receiver to receive USB differential data signal.
Differential-Receiver has 200 mV of differential input sensitivity when the differential data input is within 0.8 V to 2.5 V to the local ground reference level.
Above voltage range is the common mode input voltage range.

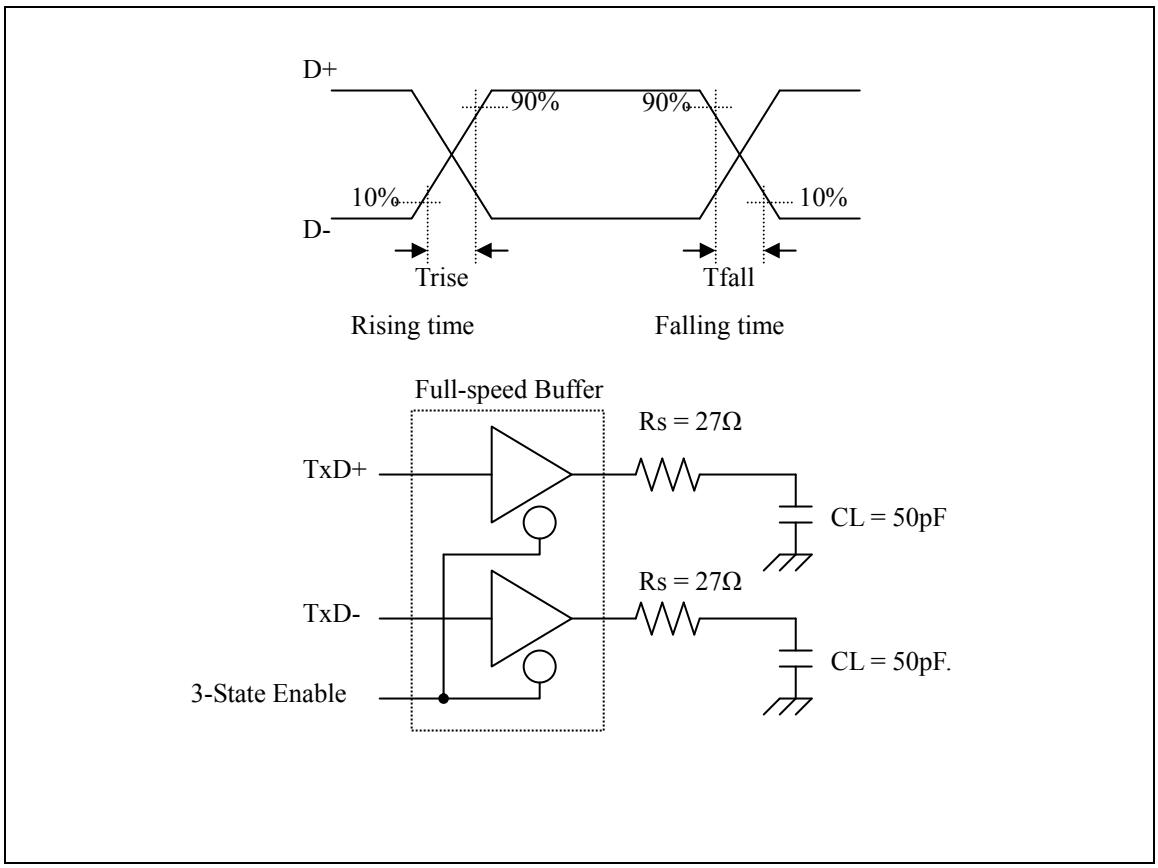


*3 : The output drive capability of the driver is below 0.3 V at Low-State (V_{OL}) (to 3.6 V and 1.5 kΩ load), and 2.8 V or above (to the VSS and 1.5 kΩ load) at High-State (V_{OH}).

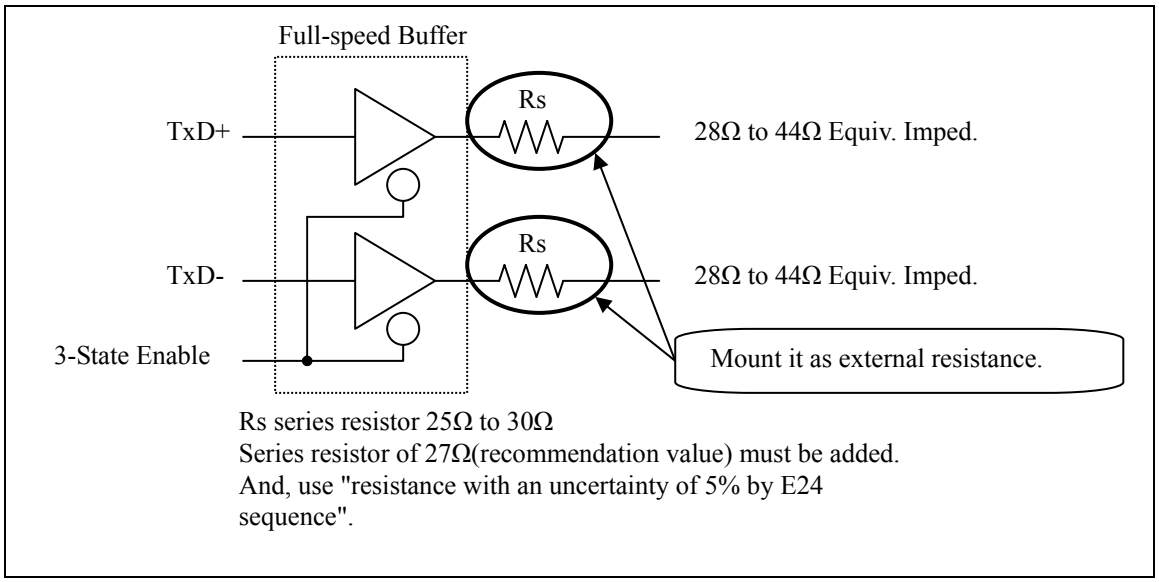
*4 : The cross voltage of the external differential output signal (D + /D −) of USB I/O buffer is within 1.3 V to 2.0 V.



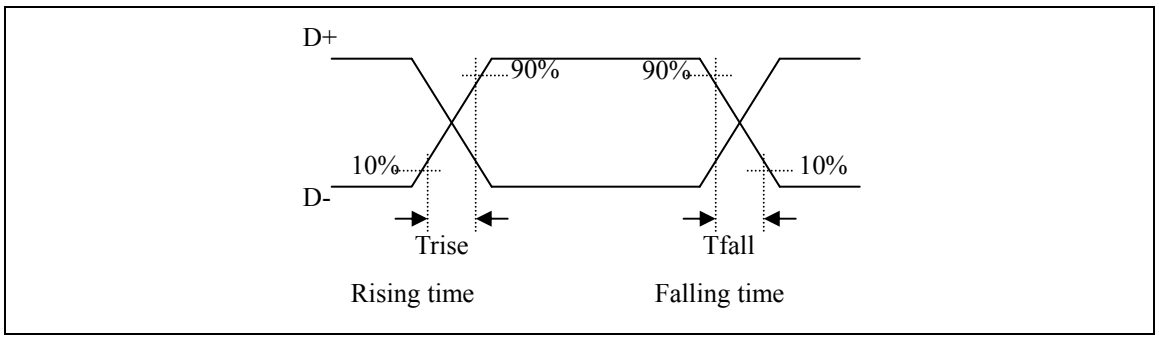
*5 : They indicate rise time (Trise) and fall time (Tfall) of the full-speed differential data signal.
They are defined by the time between 10% and 90% of the output signal voltage.
For full-speed buffer, Tr/Tf ratio is regulated as within ± 10% to minimize RFI emission.



*6 : USB Full-speed connection is performed via twist pair cable shield with 90Ω ± 15% characteristic impedance(Differential Mode).
USB standard defines that output impedance of USB driver must be in range from 28Ωto 44Ω. So, discrete series resistor (Rs) addition is defined in order to satisfy the above definition and keep balance.
When using this USB FLS I/O, use it with 25Ω to 30Ω(recommendation value 27Ω)series resistor Rs.



*7 : They indicate rise time (Trise) and fall time (Tfall) of the low-speed differential data signal.
They are defined by the time between 10% and 90% of the output signal voltage.



See Figure 3 Low-Speed Load (Compliance Load) for conditions of external load.

(Continued)

Figure 1 Low-Speed Load (Upstream Port Load) - Reference 1

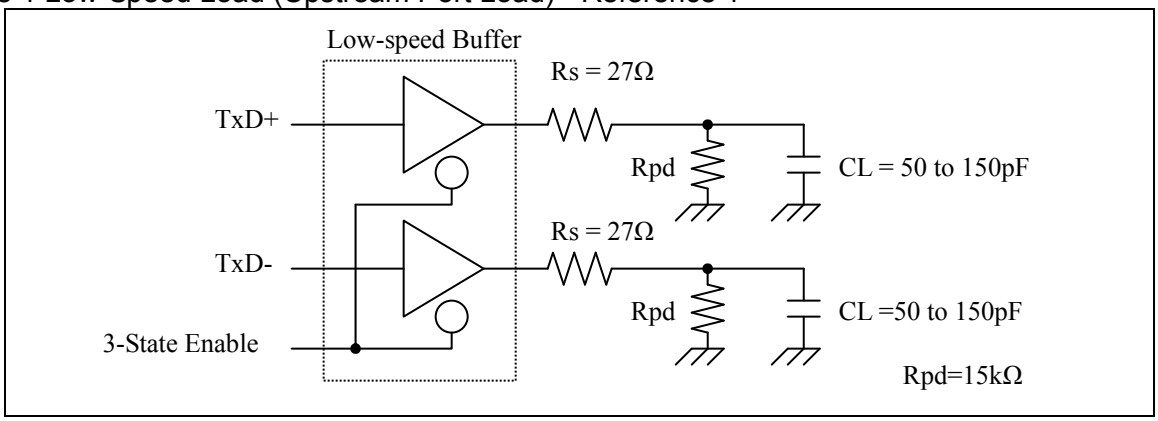


Figure 2 Low-Speed Load (Downstream Port Load) - Reference 2

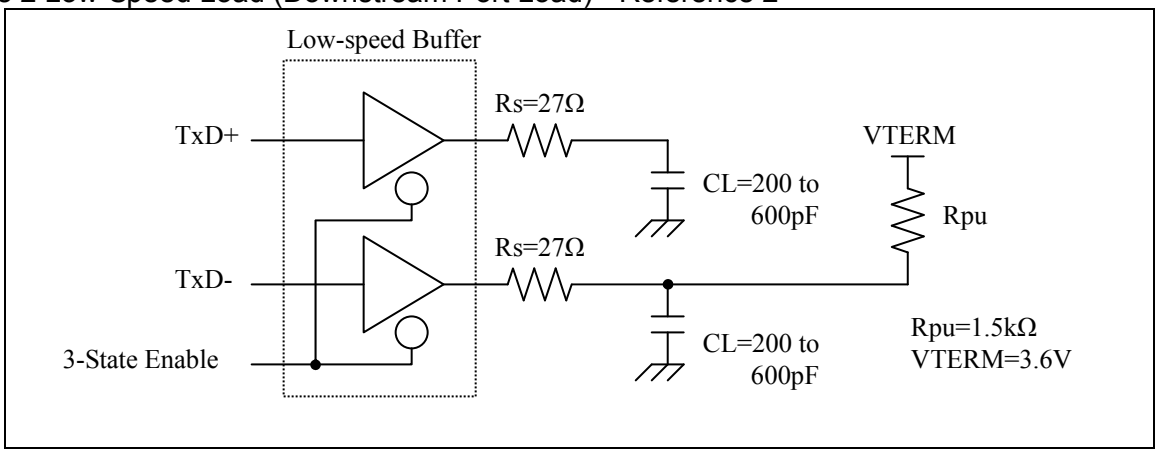
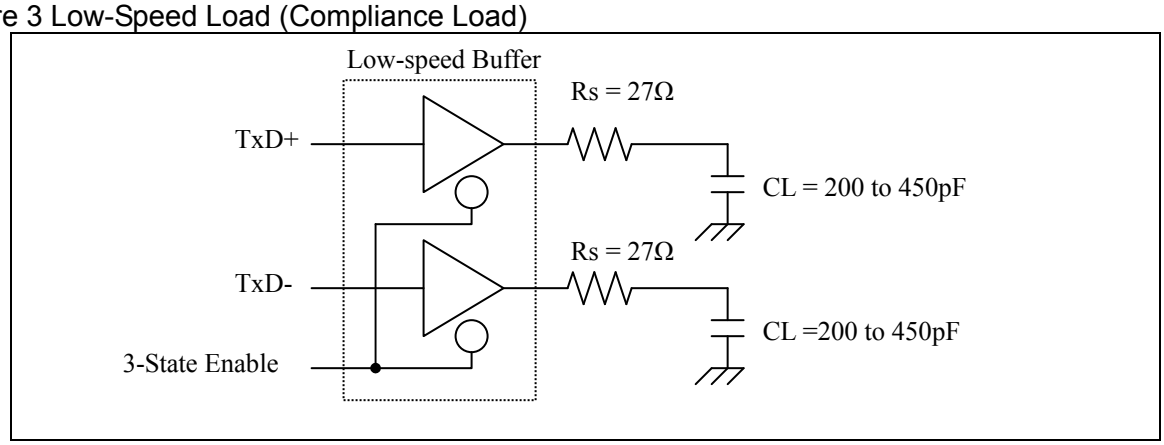


Figure 3 Low-Speed Load (Compliance Load)



● Low voltage detection characteristics

1. Low voltage detection reset

(Ta = - 40°C to + 85°C)

Parameter	Symbol	Conditions	Value			Unit	Remarks
			Min	Typ	Max		
Detected voltage	VDL	-	2.20	2.40	2.60	V	When voltage drops
Released voltage	VDH	-	2.30	2.50	2.70	V	When voltage rises
LVD stabilization wait time	T_{LVDW}	-	-	-	4500 × tcycp *	µs	MB9BF500

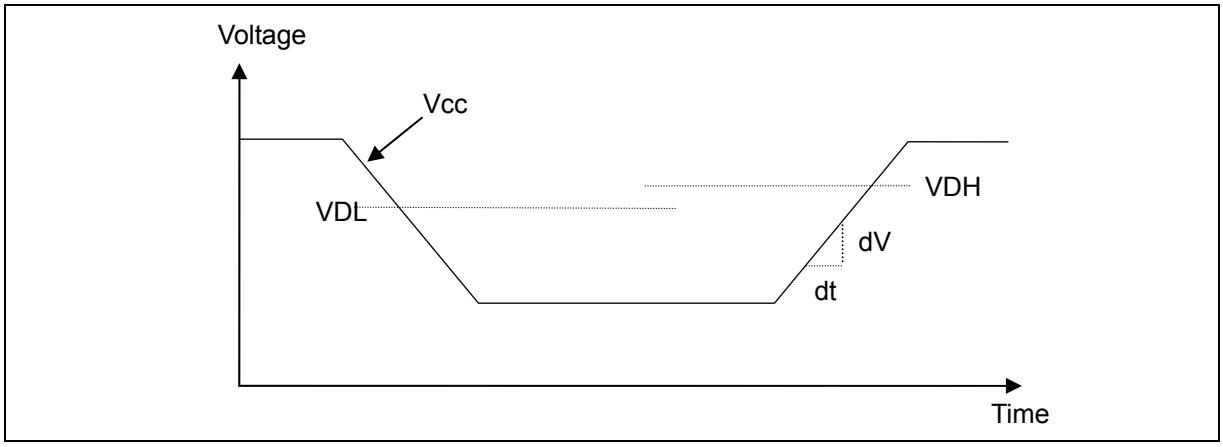
* : t_{CYCP} indicates the peripheral clock cycle time.

2. Interrupt of low voltage detection

(Ta = - 40°C to + 85°C)

Parameter	Symbol	Conditions	Value			Unit	Remarks
			Min	Typ	Max		
Detected voltage	VDL	SVHI = 0000	2.58	2.8	3.02	V	When voltage drops
Released voltage	VDH		2.67	2.9	3.13	V	When voltage rises
Detected voltage	VDL	SVHI = 0001	2.76	3.0	3.24	V	When voltage drops
Released voltage	VDH		2.85	3.1	3.34	V	When voltage rises
Detected voltage	VDL	SVHI = 0010	2.94	3.2	3.45	V	When voltage drops
Released voltage	VDH		3.04	3.3	3.56	V	When voltage rises
Detected voltage	VDL	SVHI = 0011	3.31	3.6	3.88	V	When voltage drops
Released voltage	VDH		3.40	3.7	3.99	V	When voltage rises
Detected voltage	VDL	SVHI = 0100	3.40	3.7	3.99	V	When voltage drops
Released voltage	VDH		3.50	3.8	4.10	V	When voltage rises
Detected voltage	VDL	SVHI = 0111	3.68	4.0	4.32	V	When voltage drops
Released voltage	VDH		3.77	4.1	4.42	V	When voltage rises
Detected voltage	VDL	SVHI = 1000	3.77	4.1	4.42	V	When voltage drops
Released voltage	VDH		3.86	4.2	4.53	V	When voltage rises
Detected voltage	VDL	SVHI = 1001	3.86	4.2	4.53	V	When voltage drops
Released voltage	VDH		3.96	4.3	4.64	V	When voltage rises
LVD stabilization wait time	T_{LVDW}	-	-	-	4500 × tcycp *	µs	MB9BF500
					2040 × tcycp *		MB9BF504/505/506

* : t_{CYCP} indicates the peripheral clock cycle time.



● Flash Memory Write/Erase Characteristics

1. MB9BF500

(Vcc = 2.7V to 5.5V, Ta = - 40°C to + 85°C)

Parameter	Value			Unit	Remarks
	Min	Typ	Max		
Sector erase time	-	0.2	6.4	s	Excludes write time prior to internal erase
Half word (16 bit) write time	-	100	1600	µs	Not including system-level overhead time.
Chip erase time	-	2.4	76.8	s	Excludes write time prior to internal erase
Erase/write cycles	1000	-	-	cycle	
	10,000	-	-		When Ta= + 25°C
Flash memory data hold time	20 *	-	-	year	When Erase/write cycle is 1000 cycles or less.

*: This value comes from the technology qualification (using Arrhenius equation to translate high temperature measurements into normalized value at + 85°C) .

2. MB9BF504/505/506

(Vcc = 2.7V to 5.5V, Ta = - 40°C to + 85°C)

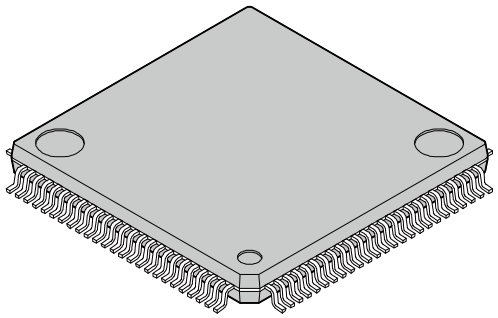
Parameter		Value			Value	Remarks
		Min	Typ	Max		
Sector erase time	Large Sector	-	0.6	3.1	s	Excludes write time prior to internal erase
	Small Sector		0.3	1.6		
Half word (16 bit) write time		-	25	400	µs	Not including system-level overhead time.
Chip erase time		-	7.2	37.6	s	Excludes write time prior to internal erase

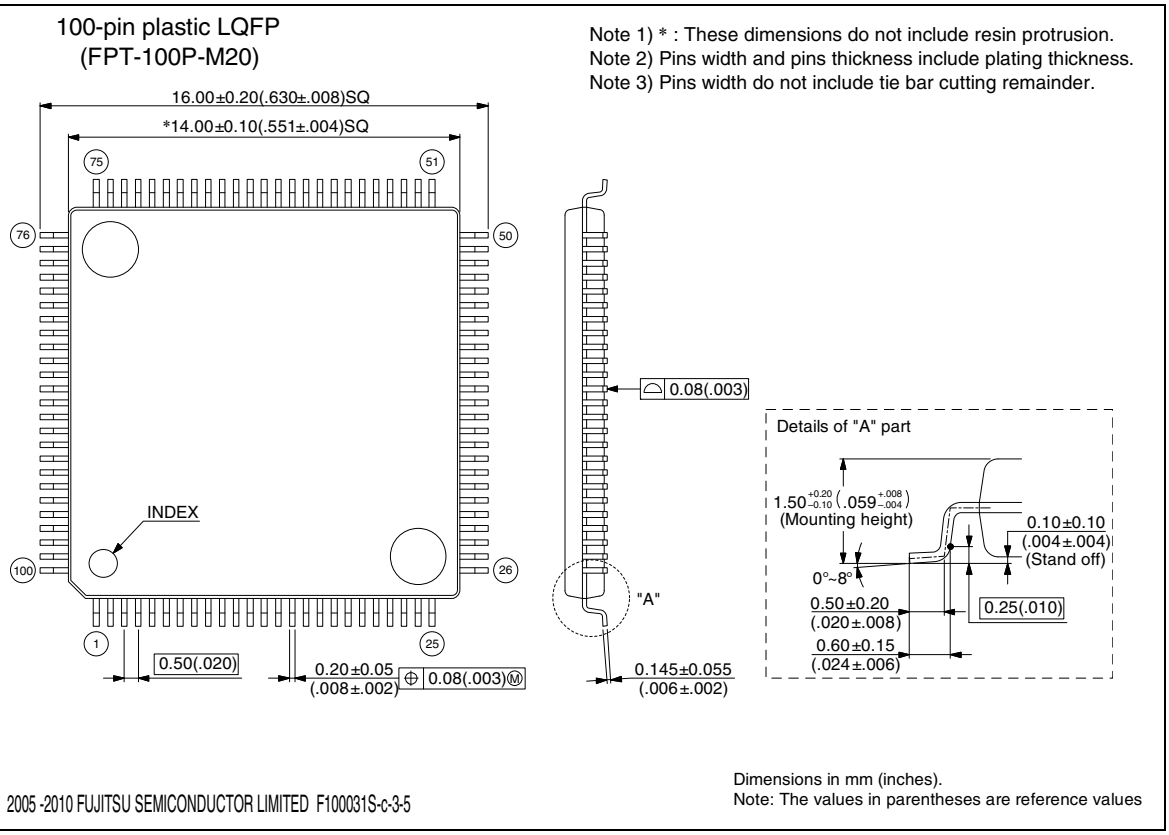
Erase/write cycles and data hold time (targeted value)

Erase/write cycles (cycle)	Data hold time (year)	Remarks
1,000	20 *	
10,000	10 *	
100,000	5 *	

*: This value comes from the technology qualification (using Arrhenius equation to translate high temperature measurements into normalized value at + 85°C) .

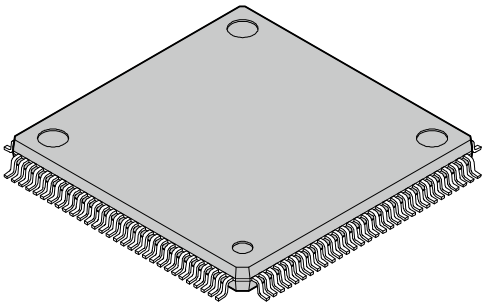
■ PACKAGE DIMENSIONS

100-pin plastic LQFP		
	Lead pitch	0.50 mm
	Package width × package length	14.0 mm × 14.0 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.70 mm Max
	Weight	0.65 g
(FPT-100P-M20)	Code (Reference)	P-LFQFP100-14×14-0.50



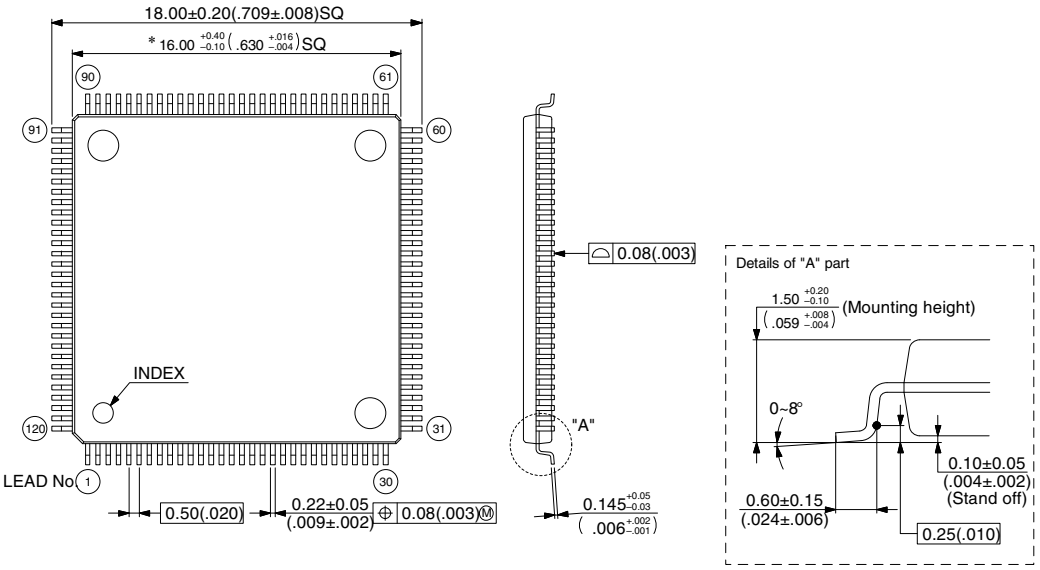
Please check the latest package dimension at the following URL.
http://edevice.fujitsu.com/package/en-search/

(Continued)

120-pin plastic LQFP		
	Lead pitch	0.50 mm
	Package width × package length	16.0 × 16.0 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.70 mm MAX
	Weight	0.88 g
(FPT-120P-M21)	Code (Reference)	P-LFQFP120-16×16-0.50

120-pin plastic LQFP
(FPT-120P-M21)

Note 1) * : These dimensions do not include resin protrusion.
Resin protrusion is +0.25(.010) MAX(each side).
Note 2) Pins width and pins thickness include plating thickness.
Note 3) Pins width do not include tie bar cutting remainder.



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Dimensions in mm (inches).
Note: The values in parentheses are reference values.

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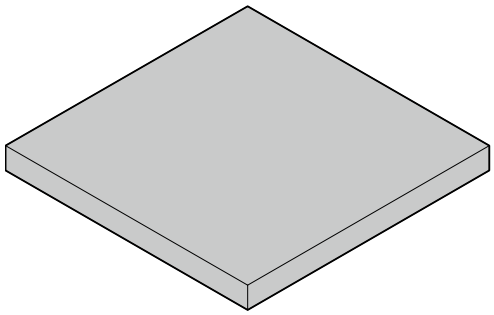
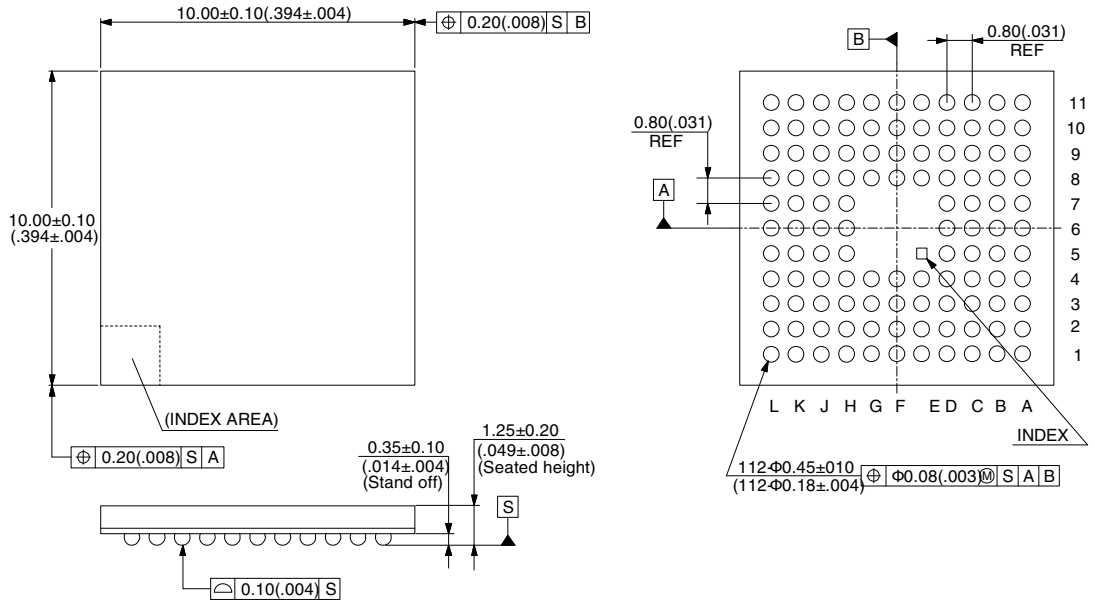
(Continued)

112-ball plastic PFBGA		
	Ball pitch	0.80 mm
	Package width × package length	10.00 × 10.00 mm
	Lead shape	Soldering ball
	Sealing method	Plastic mold
	Ball size	Φ 0.45 mm
	Mounting height	1.45 mm Max.
(BGA-112P-M04)	Weight	0.22 g

112-ball plastic PFBGA
(BGA-112P-M04)



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Dimensions in mm (inches).
Note: The values in parentheses are reference values.

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http://edevice.fujitsu.com/package/en-search/

■ MAJOR CHANGES IN THIS EDITION

Page	Section	Change Results
-	All	Added the information of MB9BF504/505.
71	AC Characteristics (3) Built-in CR Oscillation Characteristics	Changed "・Built-in high-speed CR".
91	(14) JTAG timing	Corrected the value of the setup time and hold time.
101, 102	12bit A/D Converter	Changed the value of Electrical characteristics.
104		Added the definition of the term of 12 bit A/D converter.
108	Low voltage detection characteristics 1. Low voltage detection reset	Deleted the information of MB9BF506.

In the previous revision, the number at the upper-right of the page is DS07-17301-3E.

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