

*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<sup>2</sup>C, LIN).

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**ARM**™

## ■ 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<sup>2</sup>C

### [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<sup>2</sup>C]

- 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: 1.0 $\mu$ s@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  $\times$  3ch/unit
- Input capture  $\times$  4ch/unit
- Output compare  $\times$  6ch/unit
- A/D activating compare  $\times$  3ch/unit
- Waveform generator  $\times$  3ch/unit
- 16-bit PPG timer  $\times$  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<br>MB9BF505N<br>MB9BF506N                                             | MB9BF504R<br>MB9BF505R<br>MB9BF506R                                                    |
|---------------------------------------------------------|------------------------------|--------------|---------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| Pin count                                               |                              |              | 100                                                                             | 120                                                                                       | 100                                                                             | 120                                                                                    |
| CPU                                                     |                              |              | Cortex-M3                                                                       |                                                                                           |                                                                                 |                                                                                        |
| Freq.                                                   |                              |              | 80MHz                                                                           |                                                                                           |                                                                                 |                                                                                        |
| Power supply voltage range                              |                              |              | 2.7V to 5.5V<br>(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.)<br>Data:8/16 bit<br>CS:5(Max.)<br>Support: SRAM, NOR<br>Flash | Addr:25bit (Max.)<br>Data:8/16 bit<br>CS:8(Max.)<br>Support: SRAM,<br>NOR & NAND<br>Flash | Addr:25bit (Max.)<br>Data:8/16 bit<br>CS:5(Max.)<br>Support: SRAM,<br>NOR Flash | Addr:25bit (Max.)<br>Data:8/16 bit<br>CS:8(Max.)<br>Support: SRAM, NOR<br>& NAND Flash |
| MF Serial Interface<br>(UART/CSIO/LIN/I <sup>2</sup> C) |                              |              | 8ch (Max.)                                                                      |                                                                                           | ←                                                                               |                                                                                        |
| Base Timer<br>(PWC/ Reload timer/PWM/PPG)               |                              |              | 8ch (Max.)                                                                      |                                                                                           | ←                                                                               |                                                                                        |
| MF-<br>Timer                                            | A/D<br>activation<br>compare | 3ch          | 2 units (Max.)                                                                  |                                                                                           | ←                                                                               |                                                                                        |
|                                                         | Input capture                | 4ch          |                                                                                 |                                                                                           |                                                                                 |                                                                                        |
|                                                         | Free-run<br>timer            | 3ch          |                                                                                 |                                                                                           |                                                                                 |                                                                                        |
|                                                         | Output<br>compare            | 6ch          |                                                                                 |                                                                                           |                                                                                 |                                                                                        |
|                                                         | Waveform<br>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<br>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.

# MB9B500 Series

## ■ PACKAGES

| Product name<br>Package | MB9BF500N | MB9BF500R | MB9BF504N<br>MB9BF505N<br>MB9BF506N | MB9BF504R<br>MB9BF505R<br>MB9BF506R |
|-------------------------|-----------|-----------|-------------------------------------|-------------------------------------|
| LQFP: FPT-100P-M20*/M23 | ○         | -         | ○                                   | -                                   |
| LQFP: FPT-120P-M21      | -         | ○         | -                                   | ○                                   |
| BGA: BGA-112P-M04       | -         | -         | ○                                   | -                                   |

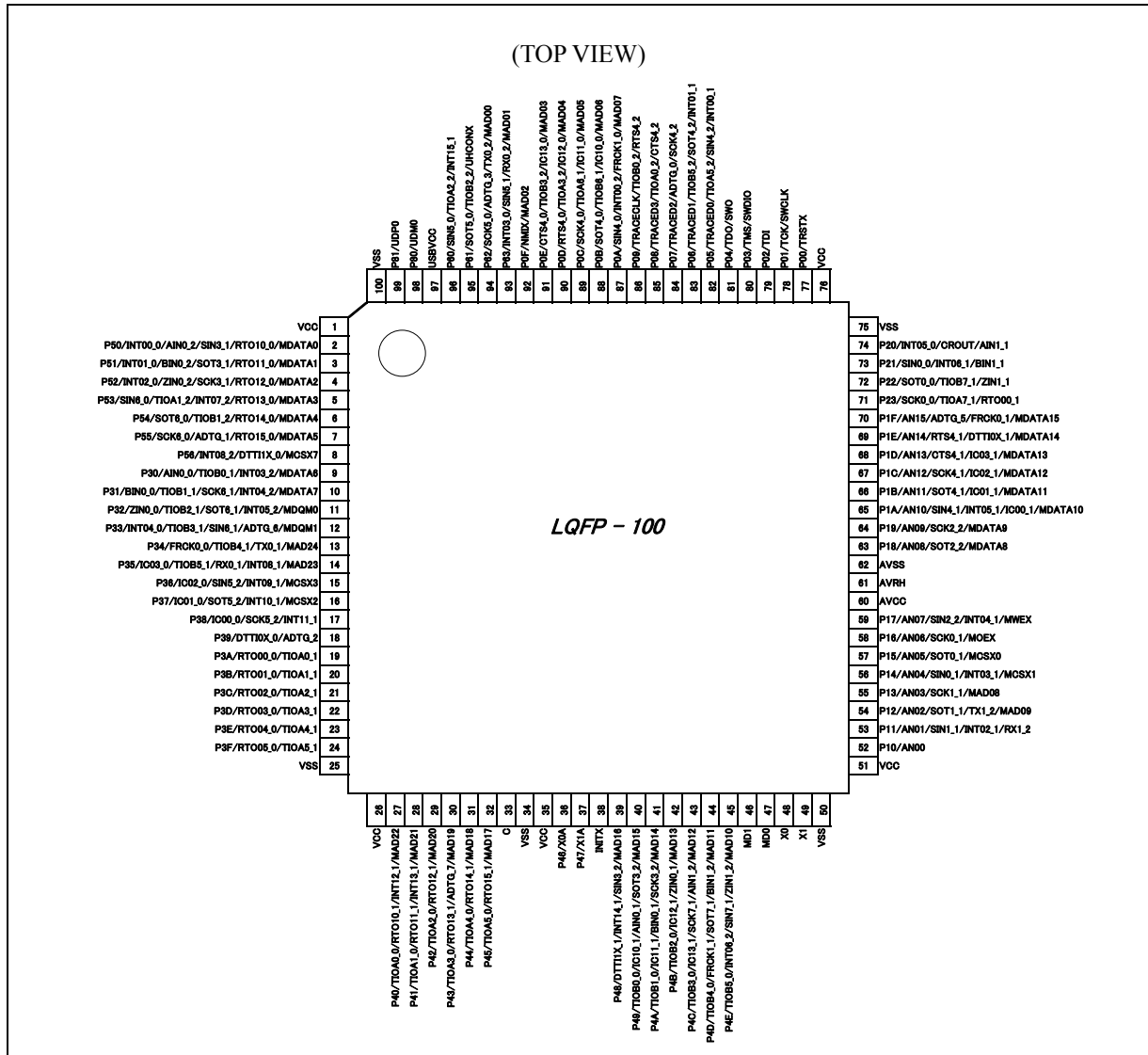
○ : Supported

\* : ES product only

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

## PIN ASSIGNMENT

### FPT-100P-M20/M23

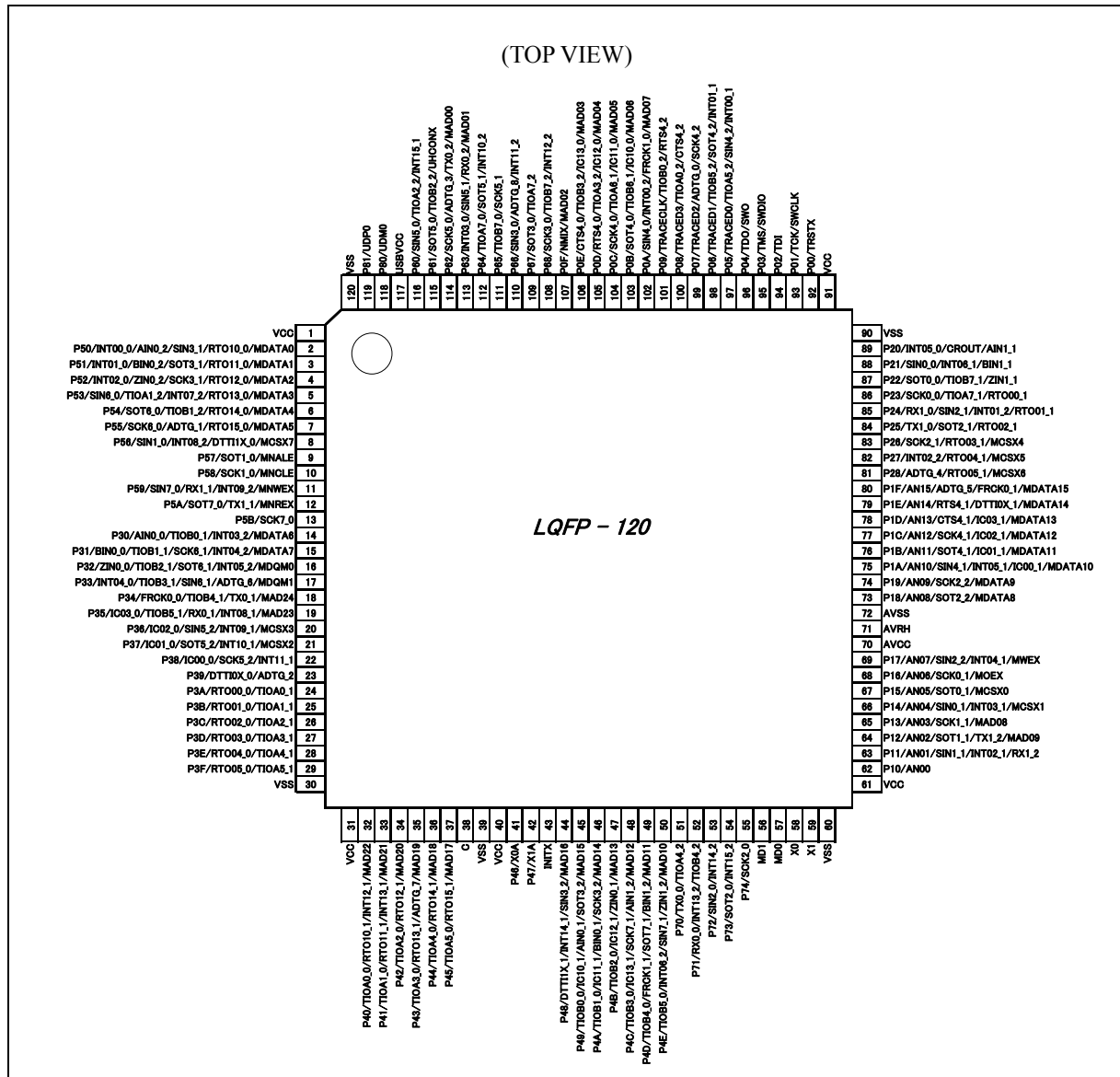


### <Notes>

- 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.

# MB9B500 Series

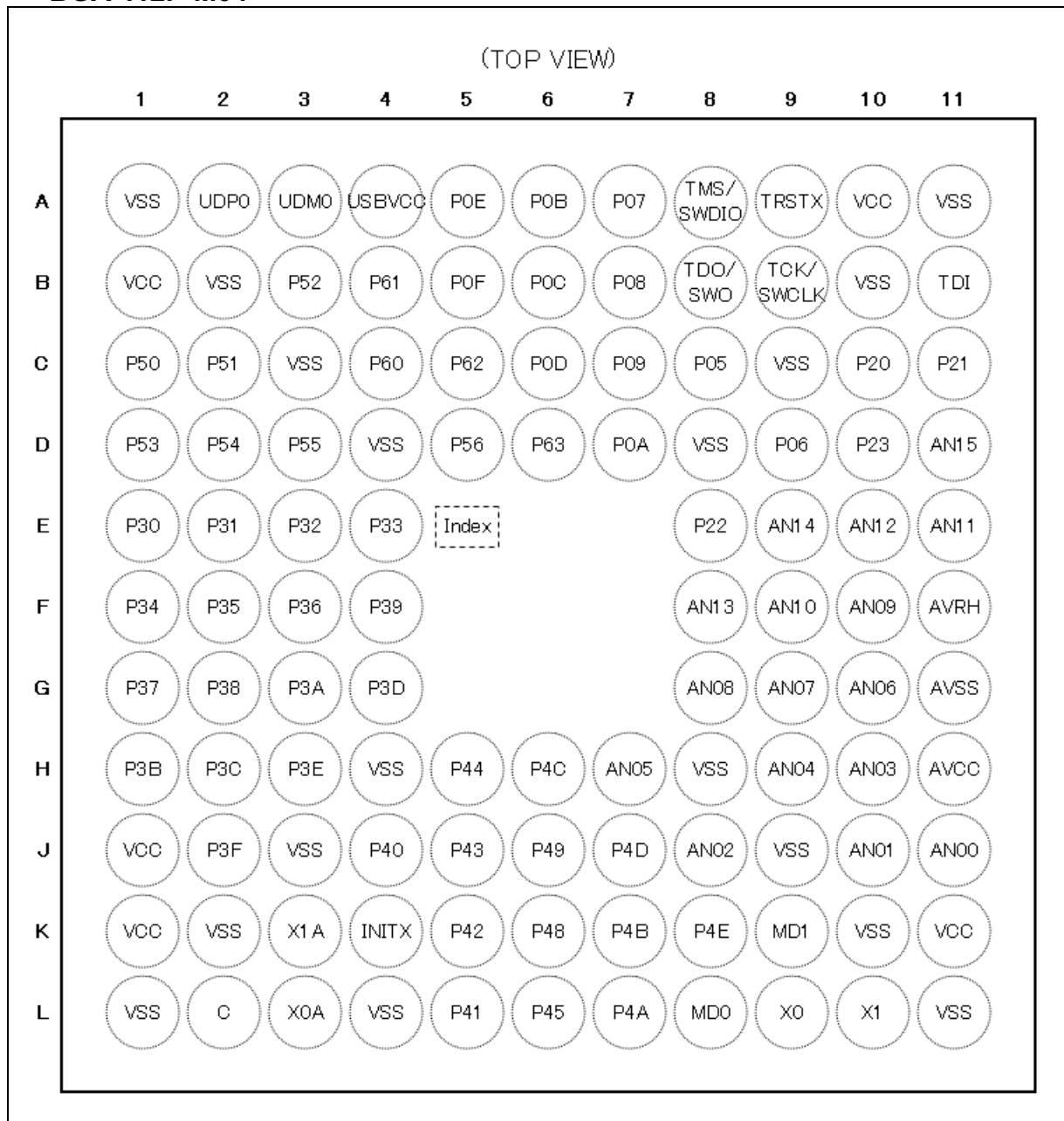
## ● FPT-120P-M21



### <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.

## ● BGA-112P-M04



### <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.

# MB9B500 Series

## ■ 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                  | E                | H              |
|          |         |          | INT00_0              |                  |                |
|          |         |          | AIN0_2               |                  |                |
|          |         |          | SIN3_1               |                  |                |
|          |         |          | RTO10_0<br>(PPG10_0) |                  |                |
|          |         |          | MDATA0               |                  |                |
| 3        | C2      | 3        | P51                  | E                | H              |
|          |         |          | INT01_0              |                  |                |
|          |         |          | BIN0_2               |                  |                |
|          |         |          | SOT3_1<br>(SDA3_1)   |                  |                |
|          |         |          | RTO11_0<br>(PPG10_0) |                  |                |
|          |         |          | MDATA1               |                  |                |
| 4        | B3      | 4        | P52                  | E                | H              |
|          |         |          | INT02_0              |                  |                |
|          |         |          | ZIN0_2               |                  |                |
|          |         |          | SCK3_1<br>(SCL3_1)   |                  |                |
|          |         |          | RTO12_0<br>(PPG12_0) |                  |                |
|          |         |          | MDATA2               |                  |                |
| 5        | D1      | 5        | P53                  | E                | H              |
|          |         |          | SIN6_0               |                  |                |
|          |         |          | TIOA1_2              |                  |                |
|          |         |          | INT07_2              |                  |                |
|          |         |          | RTO13_0<br>(PPG12_0) |                  |                |
|          |         |          | MDATA3               |                  |                |
| 6        | D2      | 6        | P54                  | E                | I              |
|          |         |          | SOT6_0<br>(SDA6_0)   |                  |                |
|          |         |          | TIOB1_2              |                  |                |
|          |         |          | RTO14_0<br>(PPG14_0) |                  |                |
|          |         |          | MDATA4               |                  |                |

# MB9B500 Series

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

# MB9B500 Series

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

# MB9B500 Series

| Pin no.  |         |          | Pin name             | I/O circuit type | Pin state type |
|----------|---------|----------|----------------------|------------------|----------------|
| LQFP-100 | BGA-112 | LQFP-120 |                      |                  |                |
| 17       | G2      | 22       | P38                  | E                | H              |
|          |         |          | IC00_0               |                  |                |
|          |         |          | SCK5_2<br>(SCL5_2)   |                  |                |
|          |         |          | INT11_1              |                  |                |
| 18       | F4      | 23       | P39                  | E                | I              |
|          |         |          | DTTI0X_0             |                  |                |
|          |         |          | ADTG_2               |                  |                |
| 19       | G3      | 24       | P3A                  | G                | I              |
|          |         |          | RTO00_0<br>(PPG00_0) |                  |                |
|          |         |          | TIOA0_1              |                  |                |
| -        | B2      | -        | VSS                  | -                |                |
| 20       | H1      | 25       | P3B                  | G                | I              |
|          |         |          | RTO01_0<br>(PPG00_0) |                  |                |
|          |         |          | TIOA1_1              |                  |                |
| 21       | H2      | 26       | P3C                  | G                | I              |
|          |         |          | RTO02_0<br>(PPG02_0) |                  |                |
|          |         |          | TIOA2_1              |                  |                |
| 22       | G4      | 27       | P3D                  | G                | I              |
|          |         |          | RTO03_0<br>(PPG02_0) |                  |                |
|          |         |          | TIOA3_1              |                  |                |
| 23       | H3      | 28       | P3E                  | G                | I              |
|          |         |          | RTO04_0<br>(PPG04_0) |                  |                |
|          |         |          | TIOA4_1              |                  |                |
| 24       | J2      | 29       | P3F                  | G                | I              |
|          |         |          | RTO05_0<br>(PPG04_0) |                  |                |
|          |         |          | TIOA5_1              |                  |                |
| 25       | L1      | 30       | VSS                  | -                |                |
| 26       | J1      | 31       | VCC                  | -                |                |
| 27       | J4      | 32       | P40                  | G                | H              |
|          |         |          | TIOA0_0              |                  |                |
|          |         |          | RTO10_1<br>(PPG10_1) |                  |                |
|          |         |          | INT12_1              |                  |                |
|          |         |          | MAD22                |                  |                |

# MB9B500 Series

| 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<br>(PPG10_1) |                  |                |
|          |         |          | INT13_1              |                  |                |
|          |         |          | MAD21                |                  |                |
| 29       | K5      | 34       | P42                  | G                | I              |
|          |         |          | TIOA2_0              |                  |                |
|          |         |          | RTO12_1<br>(PPG12_1) |                  |                |
|          |         |          | MAD20                |                  |                |
| 30       | J5      | 35       | P43                  | G                | I              |
|          |         |          | TIOA3_0              |                  |                |
|          |         |          | RTO13_1<br>(PPG12_1) |                  |                |
|          |         |          | ADTG_7               |                  |                |
|          |         |          | MAD19                |                  |                |
| -        | K2      | -        | VSS                  | -                |                |
| -        | J3      | -        | VSS                  | -                |                |
| -        | H4      | -        | VSS                  | -                |                |
| 31       | H5      | 36       | P44                  | G                | I              |
|          |         |          | TIOA4_0              |                  |                |
|          |         |          | RTO14_1<br>(PPG14_1) |                  |                |
|          |         |          | MAD18                |                  |                |
| 32       | L6      | 37       | P45                  | G                | I              |
|          |         |          | TIOA5_0              |                  |                |
|          |         |          | RTO15_1<br>(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                |                  |                |

# MB9B500 Series

| 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<br>(SDA3_2) |                  |                |
|          |         |          | MAD15              |                  |                |
| 41       | L7      | 46       | P4A                | E                | I              |
|          |         |          | TIOB1_0            |                  |                |
|          |         |          | IC11_1             |                  |                |
|          |         |          | BIN0_1             |                  |                |
|          |         |          | SCK3_2<br>(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<br>(SCL7_1) |                  |                |
|          |         |          | AIN1_2             |                  |                |
|          |         |          | MAD12              |                  |                |
| 44       | J7      | 49       | P4D                | E                | I              |
|          |         |          | TIOB4_0            |                  |                |
|          |         |          | FRCK1_1            |                  |                |
|          |         |          | SOT7_1<br>(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            |                  |                |

# MB9B500 Series

| 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<br>(SDA2_0) |                  |                |
|          |         |          | INT15_2            |                  |                |
| -        | -       | 55       | P74                | E                | I              |
|          |         |          | SCK2_0<br>(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<br>(SDA1_1) |                  |                |
|          |         |          | TX1_2              |                  |                |
|          |         |          | MAD09              |                  |                |
| 55       | H10     | 65       | P13                | F                | K              |
|          |         |          | AN03               |                  |                |
|          |         |          | SCK1_1<br>(SCL1_1) |                  |                |
|          |         |          | MAD08              |                  |                |

# MB9B500 Series

| 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<br>(SDA0_1) |                  |                |
|          |         |          | MCSX0              |                  |                |
| 58       | G10     | 68       | P16                | F                | K              |
|          |         |          | AN06               |                  |                |
|          |         |          | SCK0_1<br>(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<br>(SDA2_2) |                  |                |
|          |         |          | MDATA8             |                  |                |
| 64       | F10     | 74       | P19                | F                | K              |
|          |         |          | AN09               |                  |                |
|          |         |          | SCK2_2<br>(SCL2_2) |                  |                |
|          |         |          | MDATA9             |                  |                |
| 65       | F9      | 75       | P1A                | F                | L              |
|          |         |          | AN10               |                  |                |
|          |         |          | SIN4_1             |                  |                |
|          |         |          | INT05_1            |                  |                |
|          |         |          | IC00_1             |                  |                |
|          |         |          | MDATA10            |                  |                |
| -        | H8      | -        | VSS                | -                |                |

# MB9B500 Series

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

# MB9B500 Series

| 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<br>(SDA2_1)   |                  |                |
|          |         |          | RTO02_1<br>(PPG02_1) |                  |                |
| -        | B10     | -        | VSS                  | -                |                |
| -        | C9      | -        | VSS                  | -                |                |
| -        | -       | 85       | P24                  | E                | H              |
|          |         |          | RX1_0                |                  |                |
|          |         |          | SIN2_1               |                  |                |
|          |         |          | INT01_2              |                  |                |
|          |         |          | RTO01_1<br>(PPG00_1) |                  |                |
| 71       | D10     | 86       | P23                  | E                | I              |
|          |         |          | SCK0_0<br>(SCL0_0)   |                  |                |
|          |         |          | TIOA7_1              |                  |                |
|          |         |          | RTO00_1<br>(PPG00_1) |                  |                |
| 72       | E8      | 87       | P22                  | E                | I              |
|          |         |          | SOT0_0<br>(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                  |                  |                |

# MB9B500 Series

| 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             |                  |                |
| 83       | D9      | 98       | INT00_1            | E                | F              |
|          |         |          | VSS                |                  |                |
|          |         |          | P06                |                  |                |
|          |         |          | TRACED1            |                  |                |
| 84       | A7      | 99       | TIOB5_2            | E                | G              |
|          |         |          | SOT4_2<br>(SDA4_2) |                  |                |
|          |         |          | INT01_1            |                  |                |
|          |         |          | P07                |                  |                |
| 85       | B7      | 100      | TRACED2            | E                | G              |
|          |         |          | ADTG_0             |                  |                |
|          |         |          | SCK4_2<br>(SCL4_2) |                  |                |
|          |         |          | P08                |                  |                |
| 86       | C7      | 101      | TRACED3            | E                | G              |
|          |         |          | TIOA0_2            |                  |                |
|          |         |          | CTS4_2             |                  |                |
|          |         |          | P09                |                  |                |
| 87       | D7      | 102      | TRACECLK           | E                | H              |
|          |         |          | TIOB0_2            |                  |                |
|          |         |          | RTS4_2             |                  |                |
|          |         |          | P0A                |                  |                |
| 88       | A6      | 103      | SIN4_0             | E                | I              |
|          |         |          | INT00_2            |                  |                |
|          |         |          | FRCK1_0            |                  |                |
|          |         |          | MAD07              |                  |                |
| 89       | B6      | 104      | P0B                | E                | I              |
|          |         |          | SOT4_0<br>(SDA4_0) |                  |                |
|          |         |          | TIOB6_1            |                  |                |
|          |         |          | IC10_0             |                  |                |
| 90       | C6      | 105      | MAD06              | E                | I              |
|          |         |          | P0C                |                  |                |

# MB9B500 Series

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

# MB9B500 Series

| 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<br>(SCL5_0) |                  |                |
|          |         |          | ADTG_3             |                  |                |
|          |         |          | TX0_2              |                  |                |
|          |         |          | MAD00              |                  |                |
| 95       | B4      | 115      | P61                | E                | I              |
|          |         |          | SOT5_0<br>(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      | A1      | 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.<br>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      |

# MB9B500 Series

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| 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       |

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| 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        |

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| 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       |

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| 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       |

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| 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       |

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| 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 <sup>2</sup> C (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 <sup>2</sup> C (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 <sup>2</sup> C (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 <sup>2</sup> C (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 <sup>2</sup> C (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 <sup>2</sup> C (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 <sup>2</sup> C (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 <sup>2</sup> C (operation mode 4). | -        | -       | 108      |
|                         | SCK3_1 (SCL3_1) |                                                                                                                                                                                                             | 4        | B3      | 4        |
|                         | SCK3_2 (SCL3_2) |                                                                                                                                                                                                             | 41       | L7      | 46       |

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| 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 <sup>2</sup> C (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 <sup>2</sup> C (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 <sup>2</sup> C (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 <sup>2</sup> C (operation mode 4). | 94       | C5      | 114      |
|                         | SCK5_1 (SCL5_1) |                                                                                                                                                                                                             | -        | -       | 111      |
|                         | SCK5_2 (SCL5_2) |                                                                                                                                                                                                             | 17       | G2      | 22       |

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| 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 <sup>2</sup> C (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 <sup>2</sup> C (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 <sup>2</sup> C (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 <sup>2</sup> C (operation mode 4). | -        | -       | 13       |
|                         | SCK7_1 (SCL7_1) |                                                                                                                                                                                                             | 43       | H6      | 48       |

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| 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.<br>ICxx describes channel 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       |

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| 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.<br>ICxx describes channel 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       |

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| 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.<br>Please connect to GND pin if you don't use the USB port (MB9BF500 only). | 98       | A3      | 118      |
|                                           | UDP0     | USB Function / HOST D + pin.<br>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      |

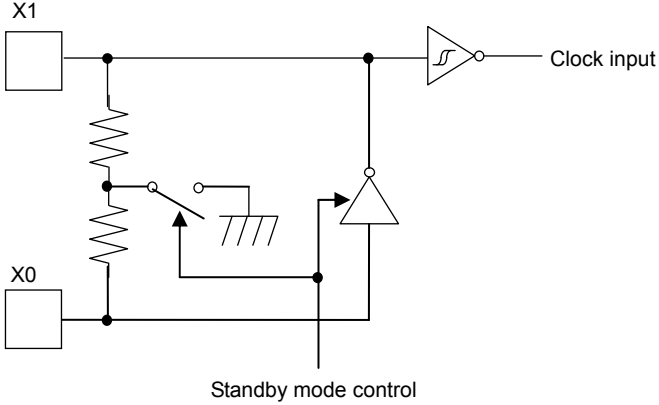
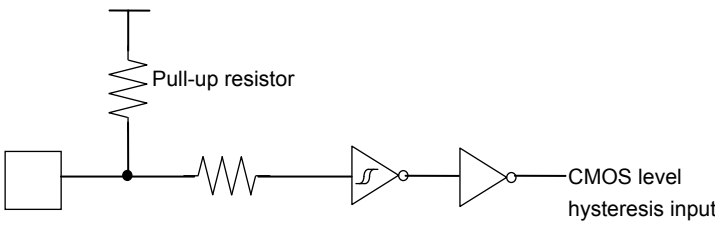
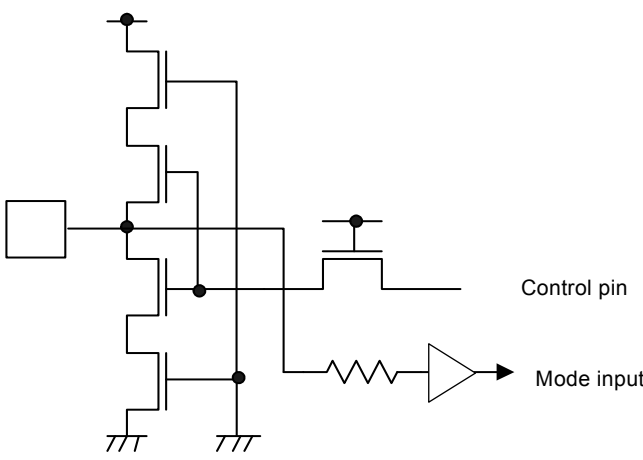
# MB9B500 Series

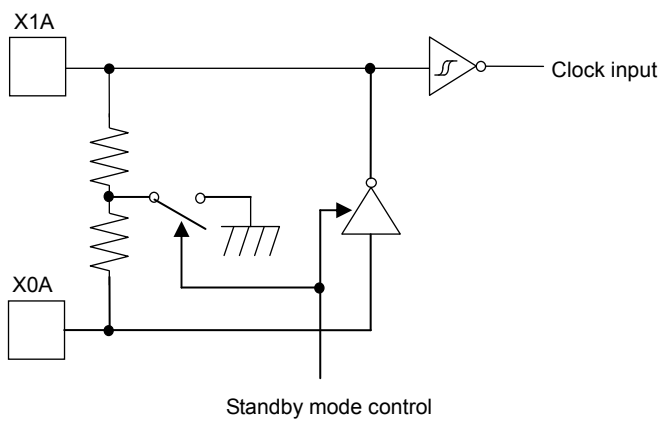
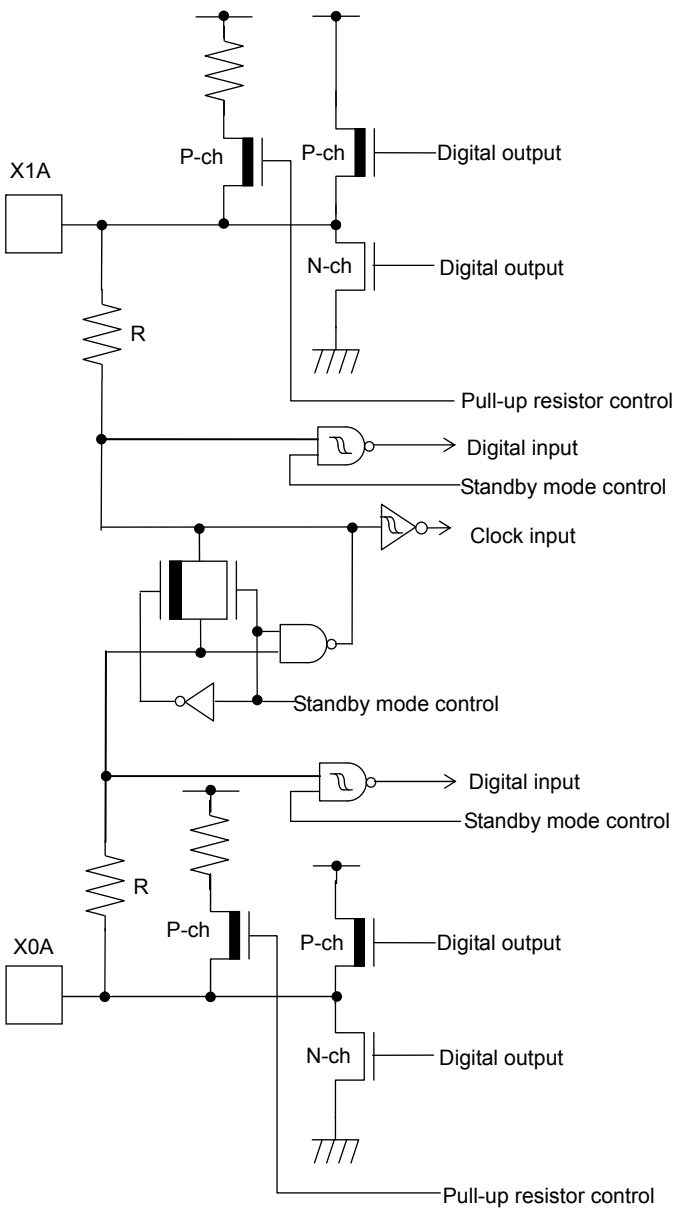
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| Module    | Pin name | Function                                                                                                                        | Pin No.  |         |          |
|-----------|----------|---------------------------------------------------------------------------------------------------------------------------------|----------|---------|----------|
|           |          |                                                                                                                                 | 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.<br>During normal operation, MD0=L must be input.<br>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.<br>Please connect to GND pin if you don't use the USB port (MB9BF500 only).                 | 97       | A4      | 117      |
| GND       | 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      | A1      | 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       |

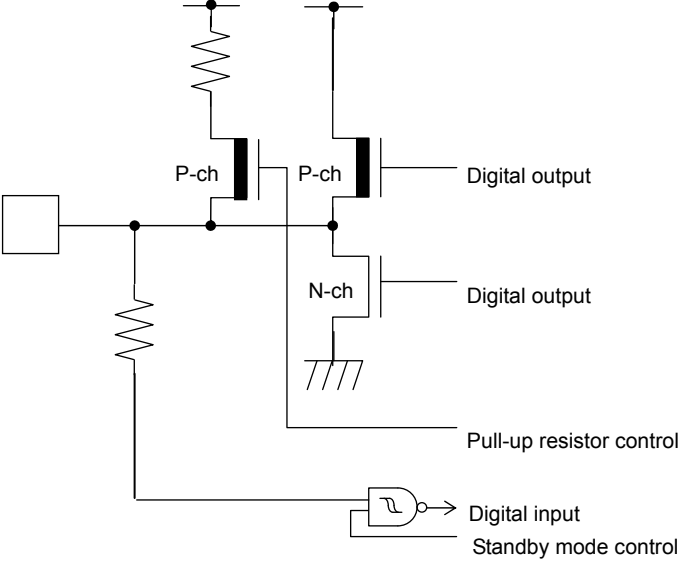
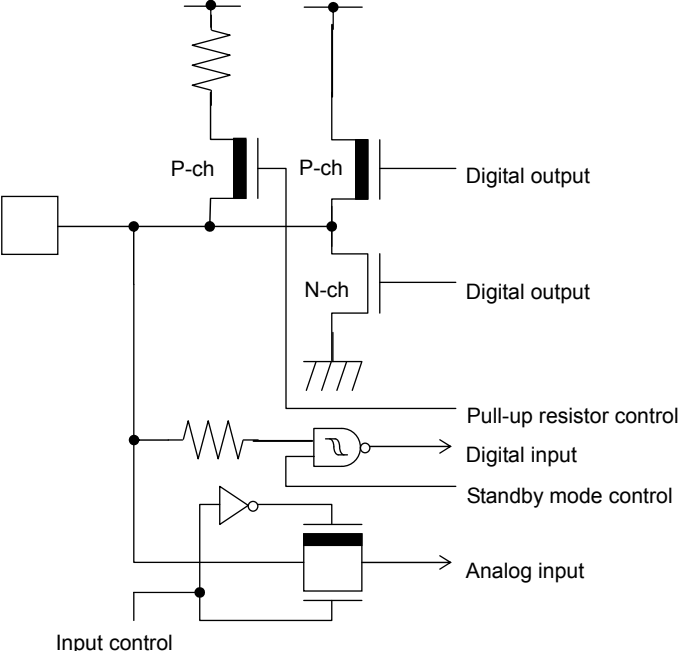
# MB9B500 Series

## I/O CIRCUIT TYPE

| Type | Circuit                                                                                                                                        | Remarks                                                                                                                                 |
|------|------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| A    |  <p>Clock input</p> <p>Standby mode control</p>               | <ul style="list-style-type: none"><li>• Oscillation feedback resistor : Approximately 1MΩ</li><li>• With Standby mode control</li></ul> |
| B    |  <p>Pull-up resistor</p> <p>CMOS level hysteresis input</p> | <ul style="list-style-type: none"><li>• CMOS level hysteresis input</li><li>• pull-up resistor : Approximately 50kΩ</li></ul>           |
| C    |  <p>Control pin</p> <p>Mode input</p>                       | <ul style="list-style-type: none"><li>• CMOS level input</li><li>• With high-voltage control for flash memory test</li></ul>            |

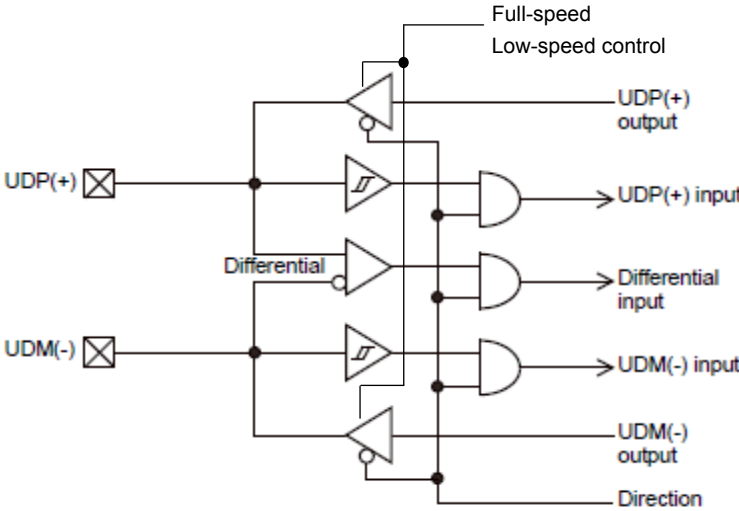
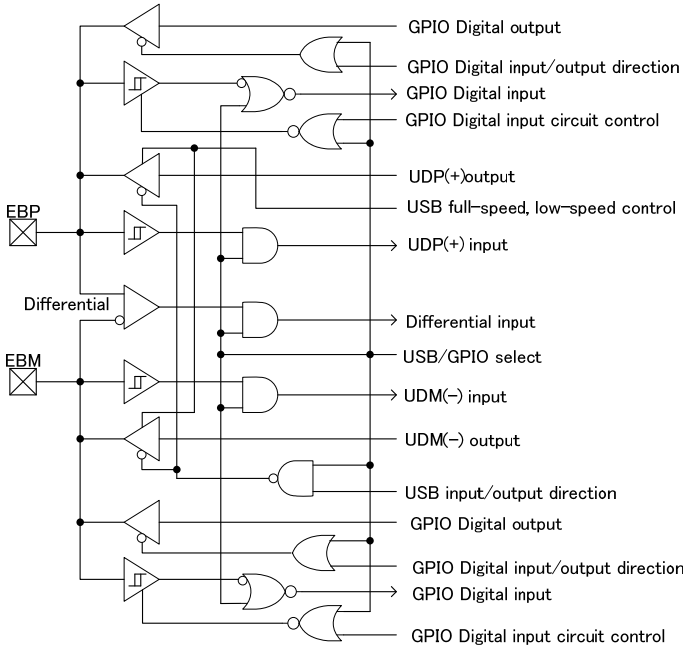
| Type | Circuit                                                                                                       | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|------|---------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| D    |  <p>Standby mode control</p> | <ul style="list-style-type: none"> <li>• Oscillation feedback resistor : Approximately 20MΩ</li> <li>• With Standby mode control (MB9BF500)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|      |                             | <ul style="list-style-type: none"> <li>• It is possible to select the low speed oscillation / GPIO function</li> </ul> <p>When the low speed oscillation is selected.</p> <ul style="list-style-type: none"> <li>• Oscillation feedback resistor : Approximately 20MΩ</li> <li>• With Standby mode control</li> </ul> <p>When the GPIO is selected.</p> <ul style="list-style-type: none"> <li>• CMOS level output.</li> <li>• CMOS level hysteresis input</li> <li>• With pull-up resistor control</li> <li>• With standby mode control</li> <li>• pull-up resistor : Approximately 50kΩ</li> <li>• IOH=-4mA, IOL=4mA (MB9BF504/505/506)</li> </ul> |

# MB9B500 Series

| Type | Circuit                                                                            | Remarks                                                                                                                                                                                                                                                                                                                                 |
|------|------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E    |   | <ul style="list-style-type: none"><li>• CMOS level output</li><li>• CMOS level hysteresis input</li><li>• With pull-up resistor control</li><li>• With standby mode control</li><li>• pull-up resistor : Approximately 50k<math>\Omega</math></li><li>• IOH=-4mA, IOL=4mA</li></ul>                                                     |
| F    |  | <ul style="list-style-type: none"><li>• CMOS level output</li><li>• CMOS level hysteresis input</li><li>• With input control</li><li>• Analog input</li><li>• With pull-up resistor control</li><li>• With standby mode control</li><li>• pull-up resistor : Approximately 50k<math>\Omega</math></li><li>• IOH=-4mA, IOL=4mA</li></ul> |

| Type | Circuit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Remarks                                                                                                                                                                                                                                                                                   |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| G    | <p>The circuit diagram for Type G shows a CMOS output stage. It features a P-channel MOSFET (P-ch) and an N-channel MOSFET (N-ch). The P-ch MOSFET's source is connected to VDD, and its gate is connected to a node that is also connected to a pull-up resistor (represented by a zigzag line) and the output of an AND gate. The N-ch MOSFET's source is connected to ground (represented by a hatched area), and its gate is connected to the same node as the P-ch MOSFET's gate. The drain of the P-ch MOSFET is connected to the output node, which is also connected to a pull-up resistor. The output node is labeled 'Digital output'. The output of the AND gate is labeled 'Digital input Standby mode control'. The pull-up resistor is labeled 'Pull-up resistor control'.</p> | <ul style="list-style-type: none"><li>• CMOS level output</li><li>• CMOS level hysteresis input</li><li>• With pull-up resistor control</li><li>• With standby mode control</li><li>• pull-up resistor<br/>: Approximately 50k<math>\Omega</math></li><li>• IOH=-12mA, IOL=12mA</li></ul> |

# MB9B500 Series

| Type | Circuit                                                                            | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------|------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| H    |  | <ul style="list-style-type: none"><li>• USB IO pin</li><li>• Full-speed, Low-speed control (MB9BF500)</li></ul>                                                                                                                                                                                                                                                                                                               |
|      |  | <ul style="list-style-type: none"><li>• It is possible to select the USB IO / GPIO function.</li></ul> <p>When the USB IO is selected.</p> <ul style="list-style-type: none"><li>• Full-speed, Low-speed control</li></ul> <p>When the GPIO is selected.</p> <ul style="list-style-type: none"><li>• CMOS level output</li><li>• CMOS level hysteresis input</li><li>• With standby mode control (MB9BF504/505/506)</li></ul> |

## ■ 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 PNP 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.

# MB9B500 Series

- 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  $\mu\text{F}$  be connected as a bypass capacitor between VCC and VSS near this device.

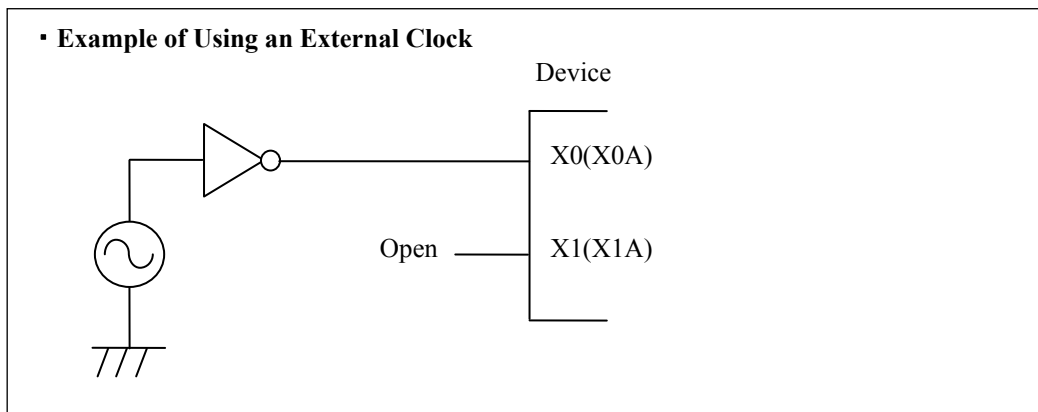
### ● Crystal oscillator circuit

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.

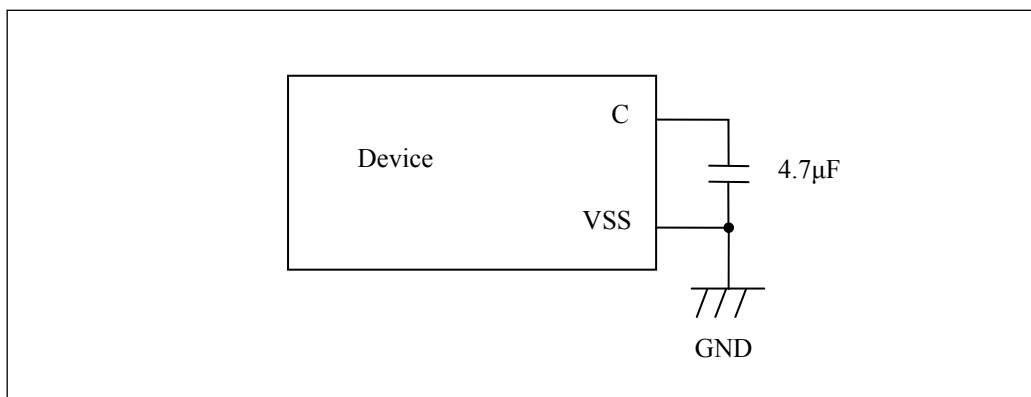


### ● Handling when using Multi function serial pin as I<sup>2</sup>C pin

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

## ● C Pin

As this series includes an internal regulator, always connect a bypass capacitor of approximately 4.7  $\mu\text{F}$  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  $\rightarrow$  USBVCC

VCC  $\rightarrow$  AVCC  $\rightarrow$  AVRH

Turning off : USBVCC  $\rightarrow$  VCC

AVRH  $\rightarrow$  AVCC  $\rightarrow$  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, retransmit the data.

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

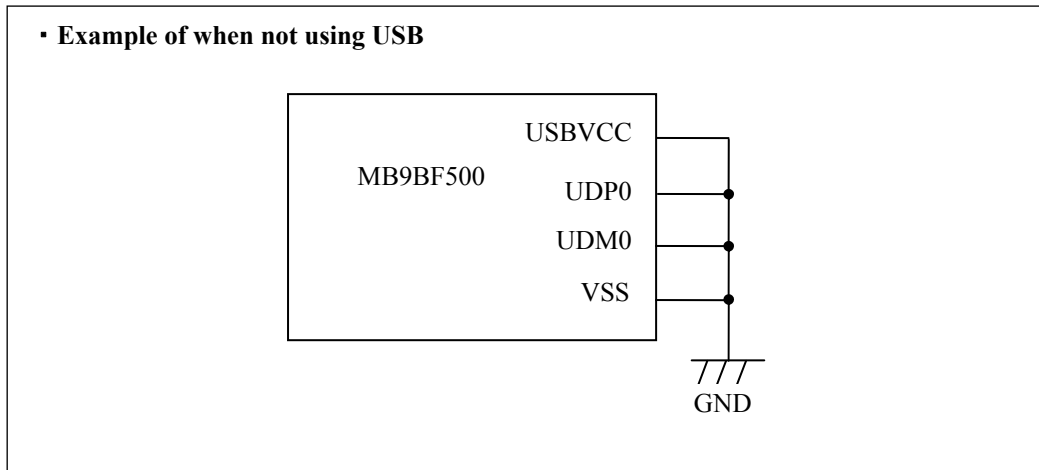
The electric characteristics including power consumption, ESD, latch-up, noise characteristics, and oscillation characteristics among the products with different memory sizes and between FLASH products and MASK products are different because chip layout and memory structures are different.

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.



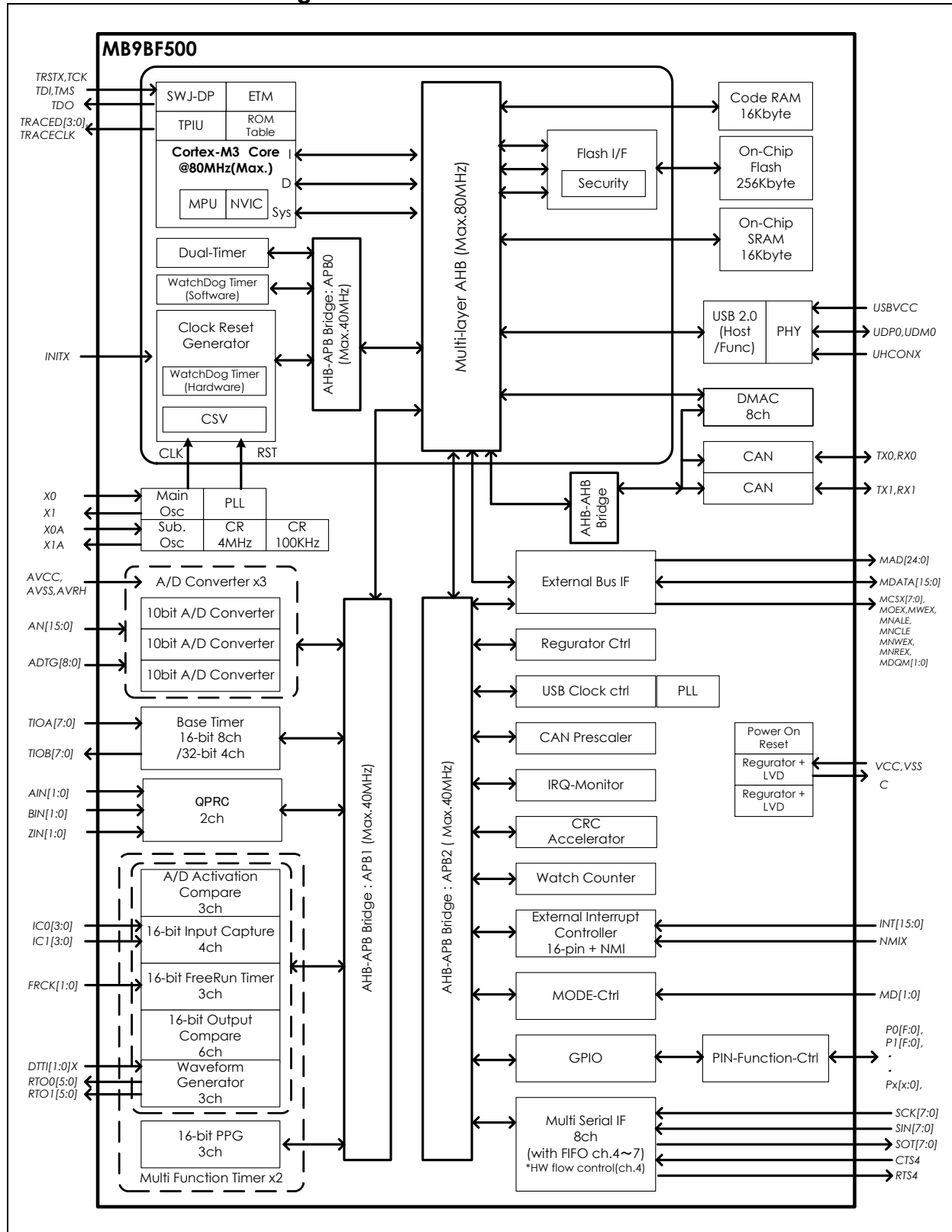
### ● Handling when not using Sub oscillation pin

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

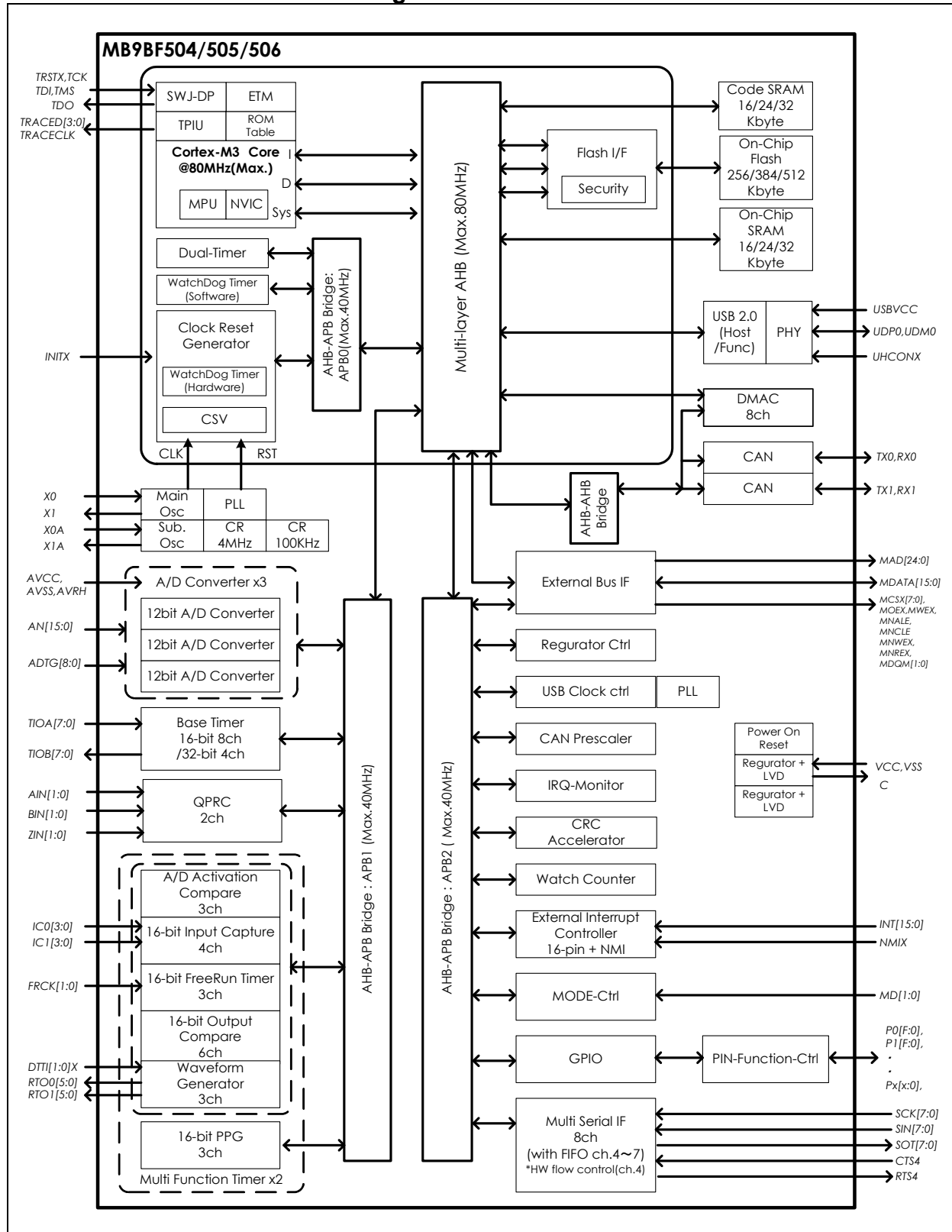
# MB9B500 Series

## ■ BLOCK DIAGRAM

### ● MB9BF500 Block Diagram



## ● MB9BF504/505/506 Block Diagram

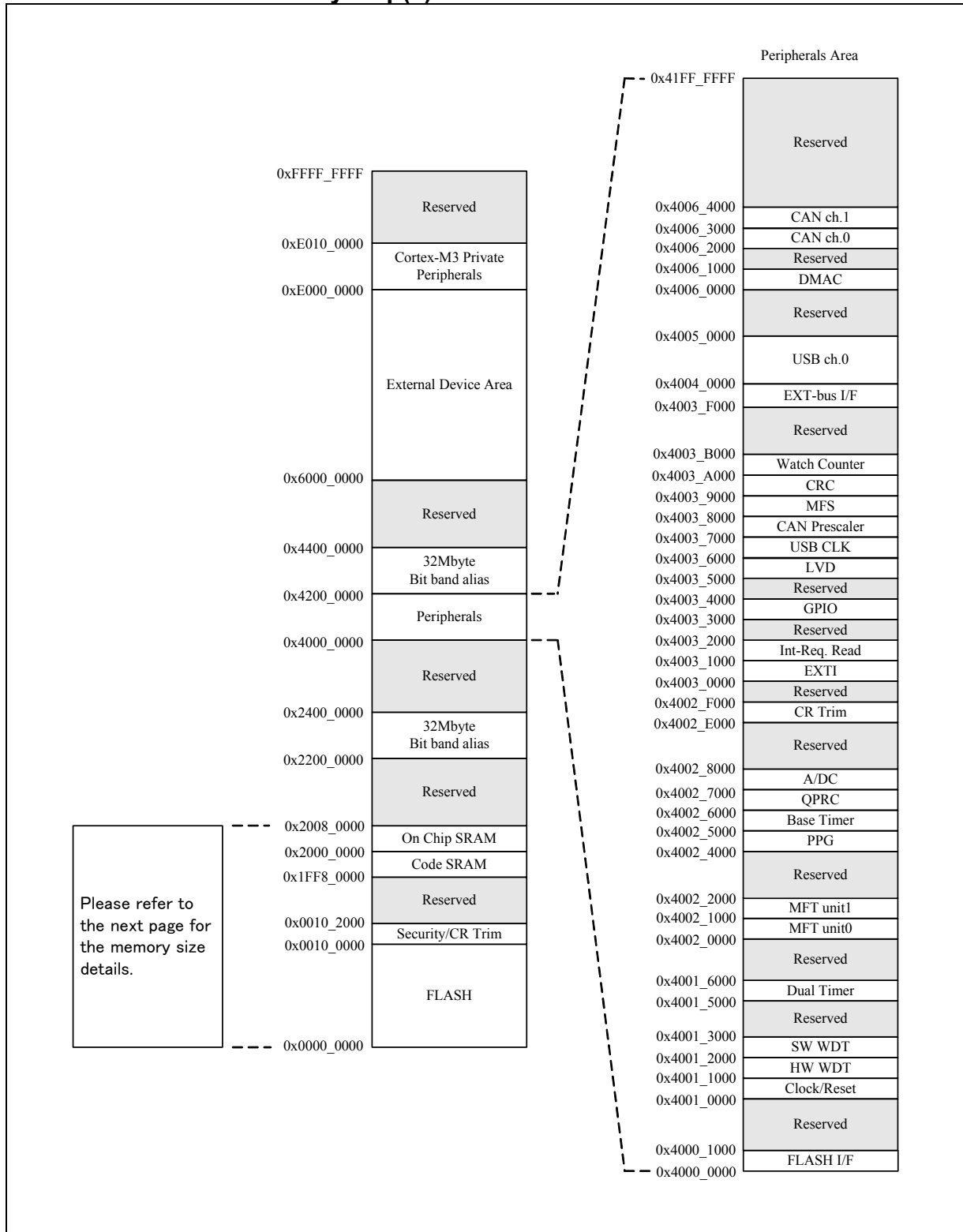


| Product device | MB9BF504 | MB9BF505 | MB9BF506 |
|----------------|----------|----------|----------|
| On-Chip Flash  | 256Kbyte | 384Kbyte | 512Kbyte |
| Code SRAM      | 16Kbyte  | 24Kbyte  | 32Kbyte  |
| On-Chip SRAM   | 16Kbyte  | 24Kbyte  | 32Kbyte  |

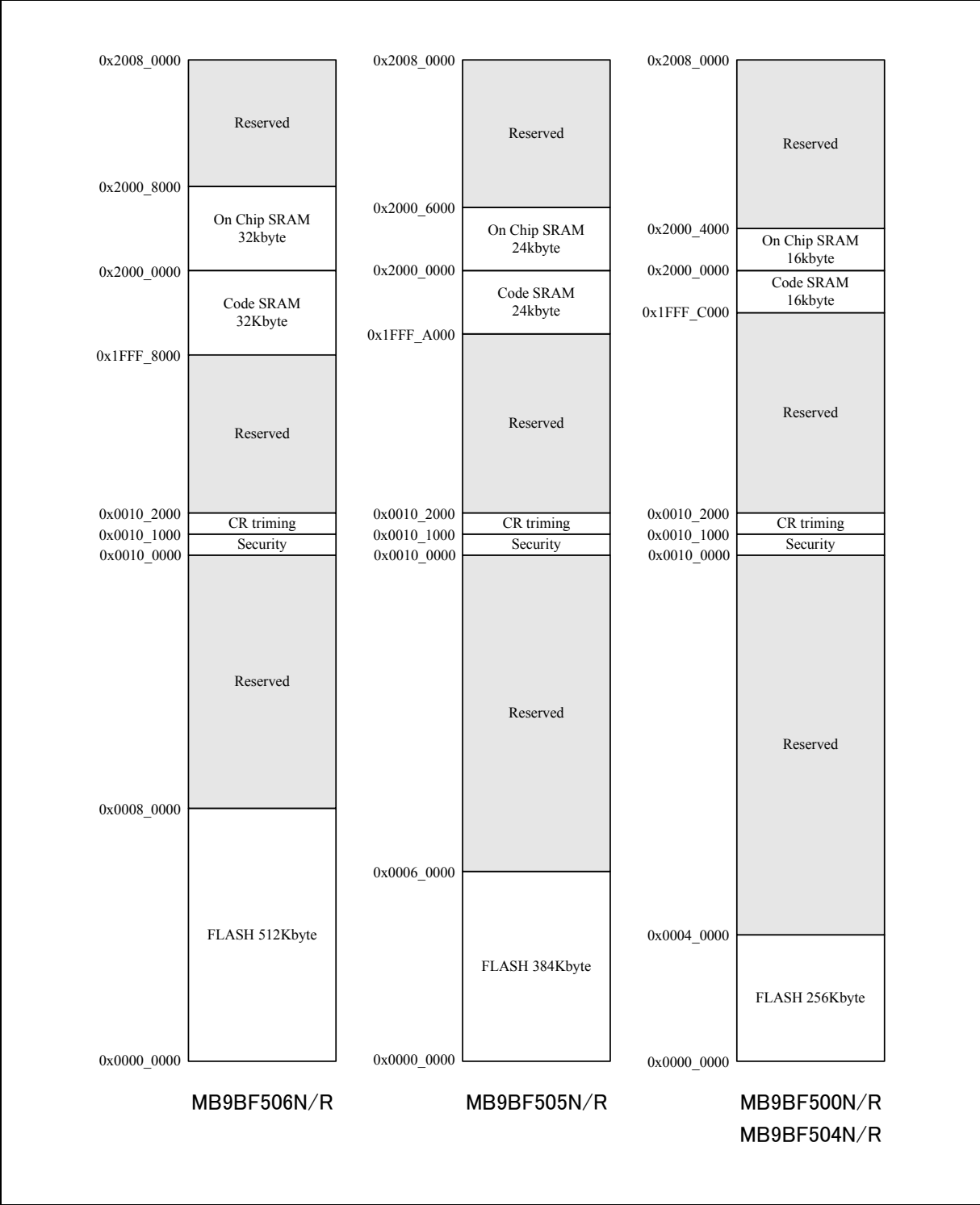
# MB9B500 Series

## ■ MEMORY MAP

### ● MB9B500 Series Memory Map(1)



## ● MB9B500 Series Memory Map(2)



# MB9B500 Series

## ● 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.

# MB9B500 Series

## ● 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/<br>Internal input fixed at "0"/<br>or Input enabled | H output/<br>Internal input fixed at "0" | H output/<br>Internal input fixed at "0" | Maintain previous state/<br>H output at oscillation stop (*1)/<br>Internal input fixed at "0" | Maintain previous state/<br>H output at oscillation stop (*1)/<br>Internal input fixed at "0" | Maintain previous state/<br>H output at oscillation stop (*1)/<br>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/<br>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/<br>Input enabled | Hi-Z/<br>Input enabled      |                              |                                | Hi-Z/<br>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/<br>Input enabled | Hi-Z/<br>Input enabled      |                              |                                | Hi-Z/<br>Internal input fixed at "0"        |
| I               | GPIO selected, resource selected                     | Hi-Z                                          | Hi-Z/<br>Input enabled | Hi-Z/<br>Input enabled      | Maintain previous state      | Maintain previous state        | Output Hi-Z/<br>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/<br>Input enabled | Hi-Z/<br>Input enabled      |                              |                                | Hi-Z/<br>Internal input fixed at "0"        |

# MB9B500 Series

| 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/<br>Internal input fixed at "0"/<br>Analog input enabled | Hi-Z/<br>Internal input fixed at "0"/<br>Analog input enabled | Hi-Z/<br>Internal input fixed at "0"/<br>Analog input enabled | Hi-Z/<br>Internal input fixed at "0"/<br>Analog input enabled | Hi-Z/<br>Internal input fixed at "0"/<br>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/<br>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/<br>Internal input fixed at "0"/<br>Analog input enabled | Hi-Z/<br>Internal input fixed at "0"/<br>Analog input enabled | Hi-Z/<br>Internal input fixed at "0"/<br>Analog input enabled | Hi-Z/<br>Internal input fixed at "0"/<br>Analog input enabled | Hi-Z/<br>Internal input fixed at "0"/<br>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/<br>Internal input fixed at "0"                          |
| M<br>MB9BF500                         | Sub crystal oscillator input pin                     | Input enabled                                 | Input enabled                                                 | Input enabled                                                 | Input enabled                                                 | Input enabled                                                 | Input enabled                                                 |
| M<br>MB9BF504<br>MB9BF505<br>MB9BF506 | GPIO selected                                        | Setting disabled                              | Setting disabled                                              | Setting disabled                                              | Maintain previous state                                       | Maintain previous state                                       | Output<br>Hi-Z/<br>Internal input fixed at "0"                |
|                                       | Sub crystal oscillator input pin                     | Input enabled                                 | Input enabled                                                 | Input enabled                                                 | Input enabled                                                 | Input enabled                                                 | Input enabled                                                 |

# MB9B500 Series

| 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<br>MB9BF500                         | Sub crystal oscillator output pin | Pull-down/<br>Internal input fixed at "0"     | Pull-down/<br>Internal input fixed at "0" | Pull-down/<br>Internal input fixed at "0" | Maintain previous state      | Maintain previous state/<br>Pull-down at oscillation stop (*2)/<br>Internal input fixed at "0" | Maintain previous state/<br>Pull-down at oscillation stop (*2)/<br>Internal input fixed at "0" |
| N<br>MB9BF504<br>MB9BF505<br>MB9BF506 | GPIO selected                     | Setting disabled                              | Setting disabled                          | Setting disabled                          | Maintain previous state      | Maintain previous state                                                                        | Output Hi-Z/<br>Internal input fixed at "0"                                                    |
|                                       | Sub crystal oscillator output pin | Hi-Z/<br>Internal input fixed at "0"          | Hi-Z/<br>Internal input fixed at "0"      | Hi-Z/<br>Internal input fixed at "0"      | Maintain previous state      | Maintain previous state/<br>Hi-Z at oscillation stop (*2)/<br>Internal input fixed at "0"      | Maintain previous state/<br>Hi-Z at oscillation stop (*2)/<br>Internal input fixed at "0"      |
| O<br>MB9BF500                         | USB I/O pin                       | Hi-Z                                          | Hi-Z/<br>Input enabled                    | Hi-Z/<br>Input enabled                    | Maintain previous state      | Output Hi-Z at transmission/<br>Input enabled/<br>Internal input fixed at "0" at reception     | Output Hi-Z at transmission/<br>Input enabled/<br>Internal input fixed at "0" at reception     |
| O<br>MB9BF504<br>MB9BF505<br>MB9BF506 | GPIO selected                     | Hi-Z                                          | Hi-Z/<br>Input enabled                    | Hi-Z/<br>Input enabled                    | Maintain previous state      | Maintain previous state                                                                        | Output Hi-Z/<br>Internal input fixed at "0"                                                    |
|                                       | USB I/O pin                       | Setting disabled                              | Setting disabled                          | Setting disabled                          | Maintain previous state      | Output Hi-Z at transmission/<br>Input enabled/<br>Internal input fixed at "0" at reception     | Output Hi-Z at transmission/<br>Input enabled/<br>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.

# MB9B500 Series

## ■ 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)

(V<sub>SS</sub> = AV<sub>SS</sub> = 0.0V)

| Parameter                                 | Symbol             | Rating                |                                      | Unit | Remarks            |
|-------------------------------------------|--------------------|-----------------------|--------------------------------------|------|--------------------|
|                                           |                    | Min                   | Max                                  |      |                    |
| Power supply voltage*1                    | V <sub>CC</sub>    | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.0                | V    |                    |
| Power supply voltage (for USB) *2         | USBV <sub>CC</sub> | V <sub>SS</sub> - 0.3 | V <sub>SS</sub> + 4.0                | V    |                    |
| Analog power supply voltage *3            | AV <sub>CC</sub>   | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.0                | V    |                    |
| Analog reference voltage *3               | AV <sub>RH</sub>   | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.0                | V    |                    |
| Input voltage                             | V <sub>I</sub>     | V <sub>SS</sub> - 0.3 | V <sub>CC</sub> + 0.3<br>(≤ 6.0V)    | V    | Except for USB pin |
|                                           |                    | V <sub>SS</sub> - 0.3 | USBV <sub>CC</sub> + 0.3<br>(≤ 4.0V) | V    | USB pin            |
| Analog pin input voltage                  | V <sub>IA</sub>    | V <sub>SS</sub> - 0.3 | AV <sub>CC</sub> + 0.3<br>(≤ 6.0V)   | V    |                    |
| Output voltage                            | V <sub>O</sub>     | V <sub>SS</sub> - 0.3 | V <sub>CC</sub> + 0.3<br>(≤ 6.0V)    | V    |                    |
| "L" level maximum output current *4       | I <sub>OL</sub>    | -                     | 10                                   | mA   | 4mA type           |
|                                           |                    |                       | 20                                   | mA   | 12mA type          |
| "L" level average output current *5       | I <sub>OLAV</sub>  | -                     | 4                                    | mA   | 4mA type           |
|                                           |                    |                       | 12                                   | mA   | 12mA type          |
| "L" level total maximum output current    | ∑I <sub>OL</sub>   | -                     | 100                                  | mA   |                    |
| "L" level total average output current *6 | ∑I <sub>OLAV</sub> | -                     | 50                                   | mA   |                    |
| "H" level maximum output current *4       | I <sub>OH</sub>    | -                     | - 10                                 | mA   | 4mA type           |
|                                           |                    |                       | - 20                                 | mA   | 12mA type          |
| "H" level average output current *5       | I <sub>OHAV</sub>  | -                     | - 4                                  | mA   | 4mA type           |
|                                           |                    |                       | - 12                                 | mA   | 12mA type          |
| "H" level total maximum output current    | ∑I <sub>OH</sub>   | -                     | - 100                                | mA   |                    |
| "H" level total average output current *6 | ∑I <sub>OHAV</sub> | -                     | - 50                                 | mA   |                    |
| Power consumption                         | P <sub>D</sub>     | -                     | 800                                  | mW   |                    |
| Storage temperature                       | T <sub>STG</sub>   | - 55                  | + 125                                | °C   |                    |

\*1 : V<sub>CC</sub> must not drop below V<sub>SS</sub> - 0.5V.

\*2 : USBV<sub>CC</sub> must not drop below V<sub>SS</sub> - 0.3V.

\*3 : Be careful not to exceed V<sub>CC</sub> + 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)

(V<sub>SS</sub> = AV<sub>SS</sub> = 0.0V)

| Parameter                                 | Symbol             | Rating                |                                      | Unit | Remarks               |
|-------------------------------------------|--------------------|-----------------------|--------------------------------------|------|-----------------------|
|                                           |                    | Min                   | Max                                  |      |                       |
| Power supply voltage*1                    | V <sub>CC</sub>    | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.5                | V    |                       |
| Power supply voltage (for USB) *2         | USBV <sub>CC</sub> | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.5                | V    |                       |
| Analog power supply voltage *3            | AV <sub>CC</sub>   | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.5                | V    |                       |
| Analog reference voltage *3               | AV <sub>RH</sub>   | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.5                | V    |                       |
| Input voltage                             | V <sub>I</sub>     | V <sub>SS</sub> - 0.5 | V <sub>CC</sub> + 0.5<br>(≤ 6.5V)    | V    | Except for<br>USB pin |
|                                           |                    | V <sub>SS</sub> - 0.5 | USBV <sub>CC</sub> + 0.5<br>(≤ 6.5V) | V    | USB pin               |
| Analog pin input voltage                  | V <sub>IA</sub>    | V <sub>SS</sub> - 0.5 | AV <sub>CC</sub> + 0.5<br>(≤ 6.5V)   | V    |                       |
| Output voltage                            | V <sub>O</sub>     | V <sub>SS</sub> - 0.5 | V <sub>CC</sub> + 0.5<br>(≤ 6.5V)    | V    |                       |
| "L" level maximum output current *4       | I <sub>OL</sub>    | -                     | 10                                   | mA   | 4mA type              |
|                                           |                    |                       | 20                                   | mA   | 12mA type             |
| "L" level average output current *5       | I <sub>OLAV</sub>  | -                     | 4                                    | mA   | 4mA type              |
|                                           |                    |                       | 12                                   | mA   | 12mA type             |
| "L" level total maximum output current    | ΣI <sub>OL</sub>   | -                     | 100                                  | mA   |                       |
| "L" level total average output current *6 | ΣI <sub>OLAV</sub> | -                     | 50                                   | mA   |                       |
| "H" level maximum output current *4       | I <sub>OH</sub>    | -                     | - 10                                 | mA   | 4mA type              |
|                                           |                    |                       | - 20                                 | mA   | 12mA type             |
| "H" level average output current *5       | I <sub>OHAV</sub>  | -                     | - 4                                  | mA   | 4mA type              |
|                                           |                    |                       | - 12                                 | mA   | 12mA type             |
| "H" level total maximum output current    | ΣI <sub>OH</sub>   | -                     | - 100                                | mA   |                       |
| "H" level total average output current *6 | ΣI <sub>OHAV</sub> | -                     | - 50                                 | mA   |                       |
| Power consumption                         | P <sub>D</sub>     | -                     | 800                                  | mW   |                       |
| Storage temperature                       | T <sub>STG</sub>   | - 55                  | + 150                                | °C   |                       |

\*1 : V<sub>CC</sub> must not drop below V<sub>SS</sub> - 0.5V.

\*2 : USBV<sub>CC</sub> must not drop below V<sub>SS</sub> - 0.5V.

\*3 : Be careful not to exceed V<sub>CC</sub> + 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.

# MB9B500 Series

## 3. Recommended Operating Conditions

(V<sub>SS</sub> = AV<sub>SS</sub> = 0.0V)

| Parameter                    |                                                              | Symbol             | Conditions                                    | Value            |                             | Unit | Remarks                            |
|------------------------------|--------------------------------------------------------------|--------------------|-----------------------------------------------|------------------|-----------------------------|------|------------------------------------|
|                              |                                                              |                    |                                               | Min              | Max                         |      |                                    |
| Power supply voltage         |                                                              | V <sub>CC</sub>    | -                                             | 2.7              | 5.5                         | V    |                                    |
| Power supply voltage for USB |                                                              | USBV <sub>CC</sub> | -                                             | 3.0              | 3.6                         | V    | MB9BF500                           |
|                              |                                                              |                    |                                               | 3.0              | 3.6<br>(≤ V <sub>CC</sub> ) |      | MB9BF504/505/506<br>*1             |
|                              |                                                              |                    |                                               | 2.7              | 5.5<br>(≤ V <sub>CC</sub> ) |      | MB9BF504/505/506<br>*2             |
| Analog power supply voltage  |                                                              | AV <sub>CC</sub>   | -                                             | 2.7              | 5.5                         | V    | AV <sub>CC</sub> = V <sub>CC</sub> |
| Analog reference voltage     |                                                              | AV <sub>RH</sub>   | -                                             | AV <sub>SS</sub> | AV <sub>CC</sub>            | V    |                                    |
| Operating Temperature        | FPT-120P-M21<br>FPT-100P-M20<br>FPT-100P-M23<br>BGA-112P-M04 | T <sub>a</sub>     | When mounted on four-layer PCB                | - 40             | + 85                        | °C   |                                    |
|                              |                                                              |                    | When mounted on double-sided single-layer PCB | - 40             | + 85                        | °C   | I <sub>CC</sub> ≤ 100mA            |
|                              |                                                              |                    |                                               | - 40             | + 70                        | °C   | I <sub>CC</sub> > 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,<br>Peripheral : 40MHz,<br>FLASH 2Wait<br>FRWTR.RWT = 10<br>FSYNDN.SD = 000 *1 |
|                      |        |          |                                           | -     | 90  | 110  | mA   | CPU : 60MHz,<br>Peripheral : 30MHz,<br>FLASH 0Wait<br>FRWTR.RWT = 00<br>FSYNDN.SD = 000 *1 |
|                      |        |          |                                           | -     | 80  | 96   | mA   | CPU : 80MHz,<br>Peripheral : 40MHz,<br>FLASH 5Wait<br>FRWTR.RWT = 10<br>FSYNDN.SD = 011 *1 |
|                      |        |          |                                           | -     | 65  | 78   | mA   | CPU : 60MHz,<br>Peripheral : 30MHz,<br>FLASH 3Wait<br>FRWTR.RWT = 00<br>FSYNDN.SD = 011 *1 |
|                      |        |          | Normal operation (built-in high-speed CR) | -     | 7.0 | 10.4 | mA   | CPU/ Peripheral : 4MHz *1, *2<br>FLASH 0Wait<br>FRWTR.RWT = 00<br>FSYNDN.SD = 000          |
|                      |        |          | Normal operation (sub oscillation)        | -     | 0.6 | 2.7  | mA   | CPU/ Peripheral : 32kHz<br>FLASH 0Wait<br>FRWTR.RWT = 00<br>FSYNDN.SD = 000 *1             |
|                      |        |          | Normal operation (built-in low-speed CR)  | -     | 0.8 | 3.0  | mA   | CPU/ Peripheral : 100kHz<br>FLASH 0Wait<br>FRWTR.RWT = 00<br>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                                                                     |

# MB9B500 Series

(Continued)

| Parameter                                                | Symbol                          | Pin name        | Conditions   | Value |     |     | Unit                                  | Remarks                               |
|----------------------------------------------------------|---------------------------------|-----------------|--------------|-------|-----|-----|---------------------------------------|---------------------------------------|
|                                                          |                                 |                 |              | Min   | Typ | Max |                                       |                                       |
| Power supply current                                     | I <sub>CCH</sub>                | V <sub>CC</sub> | STOP mode    | -     | 60  | 200 | μA                                    | Ta = + 25°C,<br>When LVD is off<br>*1 |
|                                                          |                                 |                 |              | -     | -   | 2.0 | mA                                    | Ta = + 85°C,<br>When LVD is off<br>*1 |
|                                                          | TIMER mode<br>(sub oscillation) |                 | -            | 180   | 400 | μA  | Ta = + 25°C,<br>When LVD is off<br>*1 |                                       |
|                                                          |                                 |                 | -            | -     | 3.0 | mA  | Ta = + 85°C,<br>When LVD is off<br>*1 |                                       |
| Low voltage detection circuit (LVD) power supply current | I <sub>CCLVD</sub>              |                 | At operation | -     | 55  | 90  | μA                                    | for occurrence of reset               |
|                                                          |                                 |                 |              | -     | 42  | 70  | μA                                    | for occurrence of interrupt           |

\*1: When all ports are fixed.

\*2: When setting it to 4MHz by trimming.

# MB9B500 Series

(2) MB9BF504/505/506

(V<sub>cc</sub> = AV<sub>cc</sub> = USBV<sub>cc</sub> = 2.7V to 5.5V, V<sub>ss</sub> = AV<sub>ss</sub> = 0V Ta = - 40°C to + 85°C)

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

# MB9B500 Series

(Continued)

Continued

| Parameter                                                | Symbol             | Pin name        | Conditions                      | Value |     |     | Unit | Remarks                               |
|----------------------------------------------------------|--------------------|-----------------|---------------------------------|-------|-----|-----|------|---------------------------------------|
|                                                          |                    |                 |                                 | Min   | Typ | Max |      |                                       |
| Power supply current                                     | I <sub>CCH</sub>   | V <sub>CC</sub> | STOP mode                       | -     | 50  | 200 | μA   | Ta = + 25°C,<br>When LVD is off<br>*1 |
|                                                          |                    |                 |                                 | -     | -   | 2   | mA   | Ta = + 85°C,<br>When LVD is off<br>*1 |
|                                                          | I <sub>CCT</sub>   |                 | Timer mode<br>(sub oscillation) | -     | 110 | 300 | μA   | Ta = + 25°C,<br>When LVD is off<br>*1 |
|                                                          |                    |                 |                                 | -     | -   | 2.2 | mA   | Ta = + 85°C,<br>When LVD is off<br>*1 |
| Low voltage detection circuit (LVD) power supply current | I <sub>CCLVD</sub> |                 | At operation                    | -     | 2   | 10  | μA   | 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 <sub>IHS</sub> | CMOS hysteresis input pin, MD0,1      | -                          | Vcc × 0.8 | -   | Vcc + 0.3 | V    |                  |
| "L" level input voltage (hysteresis input) | V <sub>ILS</sub> | CMOS hysteresis input pin, MD0,1      | -                          | Vss - 0.3 | -   | Vcc × 0.2 | V    |                  |
| "H" level output voltage                   | V <sub>OH</sub>  | 4mA type                              | I <sub>OH</sub> = - 4 mA   | Vcc - 0.5 | -   | Vcc       | V    | MB9BF500         |
|                                            |                  |                                       | Vcc ≥ 4.5 V                |           |     |           |      | MB9BF504/505/506 |
|                                            |                  |                                       | I <sub>OH</sub> = - 4mA    |           |     |           |      |                  |
|                                            |                  |                                       | Vcc < 4.5 V                |           |     |           |      |                  |
|                                            |                  | 12mA type                             | I <sub>OH</sub> = - 12mA   | Vcc - 0.5 | -   | Vcc       | V    |                  |
|                                            |                  |                                       | Vcc < 4.5 V                |           |     |           |      |                  |
|                                            |                  | The pin doubled as USB IO             | I <sub>OH</sub> = - 25.3mA | Vcc - 0.4 | -   | Vcc       | V    | MB9BF504/505/506 |
|                                            |                  |                                       | I <sub>OH</sub> = - 13.4mA |           |     |           |      |                  |
| "L" level output voltage                   | V <sub>OL</sub>  | 4mA type                              | I <sub>OL</sub> = 4 mA     | Vss       | -   | 0.4       | V    | MB9BF500         |
|                                            |                  |                                       | Vcc ≥ 4.5 V                |           |     |           |      | MB9BF504/505/506 |
|                                            |                  |                                       | I <sub>OL</sub> = 4mA      |           |     |           |      |                  |
|                                            |                  |                                       | Vcc < 4.5 V                |           |     |           |      |                  |
|                                            |                  | 12mA type                             | I <sub>OL</sub> = 12mA     | Vss       | -   | 0.4       | V    |                  |
|                                            |                  |                                       | Vcc < 4.5 V                |           |     |           |      |                  |
|                                            |                  | The pin doubled as USB IO             | I <sub>OL</sub> = 19.7mA   | Vss       | -   | 0.4       | V    | MB9BF504/505/506 |
|                                            |                  |                                       | I <sub>OL</sub> = 11.9mA   |           |     |           |      |                  |
| Input leak current                         | I <sub>IL</sub>  | -                                     | -                          | - 5       | -   | 5         | μA   |                  |
| Pull-up resistance value                   | R <sub>PU</sub>  | Pull-up pin                           | Vcc ≥ 4.5 V                | 25        | 50  | 100       | kΩ   |                  |
|                                            |                  |                                       | Vcc < 4.5 V                | 30        | 80  | 200       |      |                  |
| Input capacitance                          | C <sub>IN</sub>  | Other than Vcc, Vss, AVcc, AVss, AVRH | -                          | -         | 5   | 15        | pF   |                  |

# MB9B500 Series

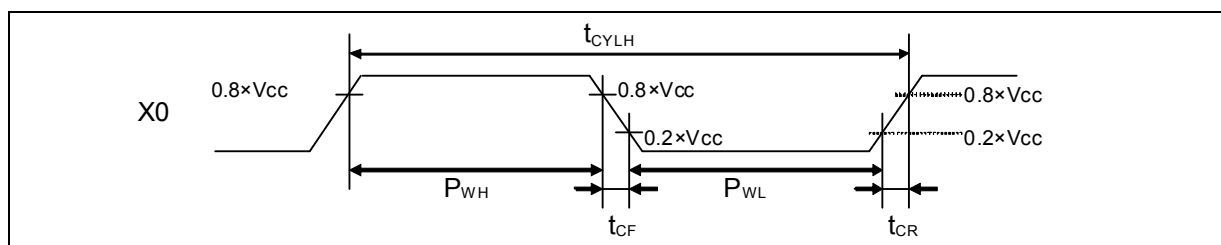
## ● AC Characteristics

The following tables show the AC characteristics.

### (1) Main Clock Input Characteristics

( $V_{CC} = 2.7V$  to  $5.5V$ ,  $V_{SS} = 0V$   $T_a = -40^{\circ}C$  to  $+85^{\circ}C$ )

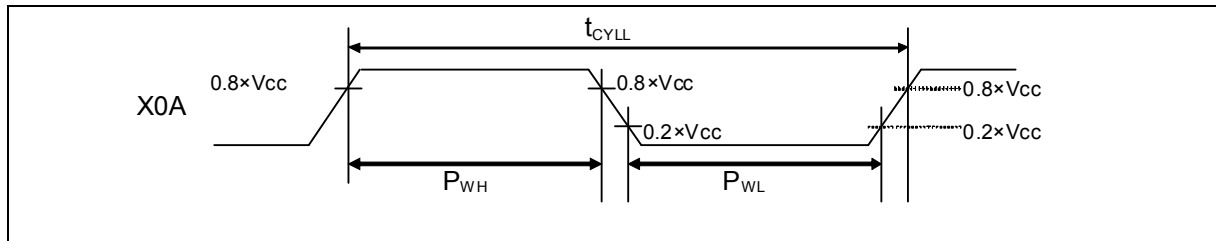
| Parameter                           | Symbol               | Pin name | Conditions                             | Value |     | Unit | Remarks                              |
|-------------------------------------|----------------------|----------|----------------------------------------|-------|-----|------|--------------------------------------|
|                                     |                      |          |                                        | Min   | Max |      |                                      |
| Input frequency                     | $F_{CH}$             | X0<br>X1 | $V_{CC} \geq 4.5V$                     | 4     | 48  | MHz  | When crystal oscillator is connected |
|                                     |                      |          | $V_{CC} < 4.5V$                        | 4     | 20  |      |                                      |
|                                     |                      |          | $V_{CC} \geq 4.5V$                     | 4     | 48  | MHz  | When using external clock            |
|                                     |                      |          | $V_{CC} < 4.5V$                        | 4     | 20  |      |                                      |
| Input clock cycle                   | $t_{CYLH}$           |          | $V_{CC} \geq 4.5V$                     | 20.83 | 250 | ns   | When using external clock            |
|                                     |                      |          | $V_{CC} < 4.5V$                        | 50    | 250 |      |                                      |
| Input clock pulse width             | -                    |          | $P_{WH}/t_{CYLH}$<br>$P_{WL}/t_{CYLH}$ | 45    | 55  | %    | When using external clock            |
| Input clock rise time and fall time | $t_{CF}$<br>$t_{CR}$ |          | -                                      | -     | 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

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

| Parameter               | Symbol            | Pin name   | Conditions                                                               | Value |        |       | Unit | Remarks                              |
|-------------------------|-------------------|------------|--------------------------------------------------------------------------|-------|--------|-------|------|--------------------------------------|
|                         |                   |            |                                                                          | Min   | Typ    | Max   |      |                                      |
| Input frequency         | F <sub>CL</sub>   | X0A<br>X1A | -                                                                        | -     | 32.768 | -     | kHz  | When crystal oscillator is connected |
|                         |                   |            | -                                                                        | 32    | -      | 100   | kHz  | When using external clock            |
| Input clock cycle       | t <sub>CYLL</sub> |            | -                                                                        | 10    | -      | 31.25 | μs   | When using external clock            |
| Input clock pulse width | -                 |            | P <sub>WH</sub> /t <sub>CYLL</sub><br>P <sub>WL</sub> /t <sub>CYLL</sub> | 45    | -      | 55    | %    | When using external clock            |



## (3) Built-in CR Oscillation Characteristics

- Built-in high-speed CR

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

| Parameter       | Symbol           | Conditions            | Value |     |      | Unit | Remarks                          |
|-----------------|------------------|-----------------------|-------|-----|------|------|----------------------------------|
|                 |                  |                       | Min   | Typ | Max  |      |                                  |
| Clock frequency | F <sub>CRH</sub> | Ta = + 25°C           | 3.88  | 4   | 4.12 | MHz  | When trimming (MB9BF500)         |
|                 |                  |                       | 3.92  | 4   | 4.08 |      | When trimming (MB9BF504/505/506) |
|                 |                  | Ta = 0°C to + 70°C    | 3.84  | 4   | 4.16 |      | When trimming                    |
|                 |                  | Ta = - 40°C to + 85°C | 3.8   | 4   | 4.2  |      |                                  |
|                 |                  | Ta = - 40°C to + 85°C | 3     | 4   | 5    |      | When not trimming                |

- Built-in low-speed CR

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

| Parameter       | Symbol           | Conditions | Value |     |     | Unit | Remarks |
|-----------------|------------------|------------|-------|-----|-----|------|---------|
|                 |                  |            | Min   | Typ | Max |      |         |
| Clock frequency | F <sub>CRL</sub> | -          | 50    | 100 | 150 | kHz  |         |

# MB9B500 Series

## (4) Operating Conditions of PLL

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

| Parameter                                               | Symbol            | Value |     |     | Unit     | Remarks          |
|---------------------------------------------------------|-------------------|-------|-----|-----|----------|------------------|
|                                                         |                   | Min   | Typ | Max |          |                  |
| PLL oscillation stabilization wait time (LOCK UP time)* | t <sub>LOCK</sub> | 600   | -   | -   | μs       | MB9BF500         |
|                                                         |                   | 100   | -   | -   |          | MB9BF504/505/506 |
| PLL input clock frequency                               | f <sub>PLL</sub>  | 4     | -   | 30  | MHz      |                  |
| PLL multiple rate                                       | -                 | 4     | -   | 30  | multiple |                  |
| PLL macro oscillation clock frequency                   | f <sub>PLLO</sub> | 60    | -   | 120 | MHz      |                  |

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

## (5) Reset Input Characteristics

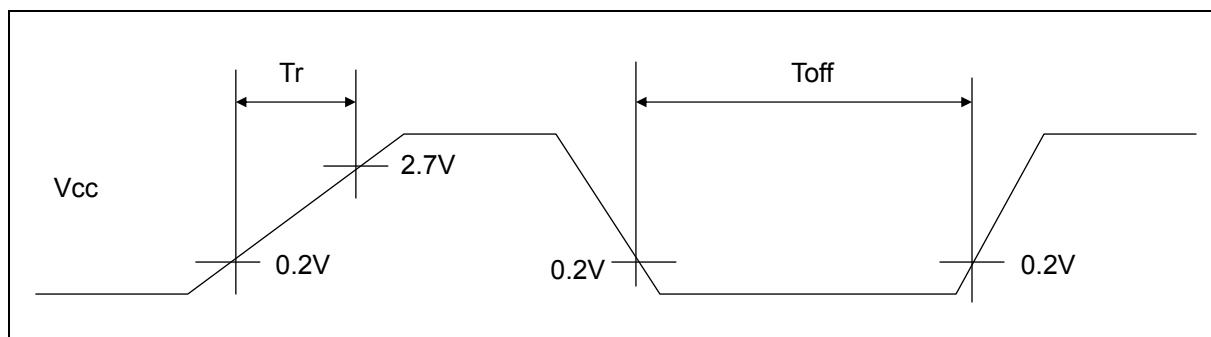
(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

| Parameter        | Symbol             | Pin name | Conditions | Value |     | Unit | Remarks |
|------------------|--------------------|----------|------------|-------|-----|------|---------|
|                  |                    |          |            | Min   | Max |      |         |
| Reset input time | t <sub>INITX</sub> | INITX    | -          | 500   | -   | ns   |         |

## (6) Power-on Reset Timing

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

| Parameter                   | Symbol | Pin name        | Value |     | Unit | Remarks |
|-----------------------------|--------|-----------------|-------|-----|------|---------|
|                             |        |                 | Min   | Max |      |         |
| Power supply rising time    | Tr     | V <sub>CC</sub> | 0     | -   | ms   |         |
| Power supply shut down time | Toff   |                 | 1     | -   | ms   |         |



## (7) External Bus Timing

### • Asynchronous SRAM Mode

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

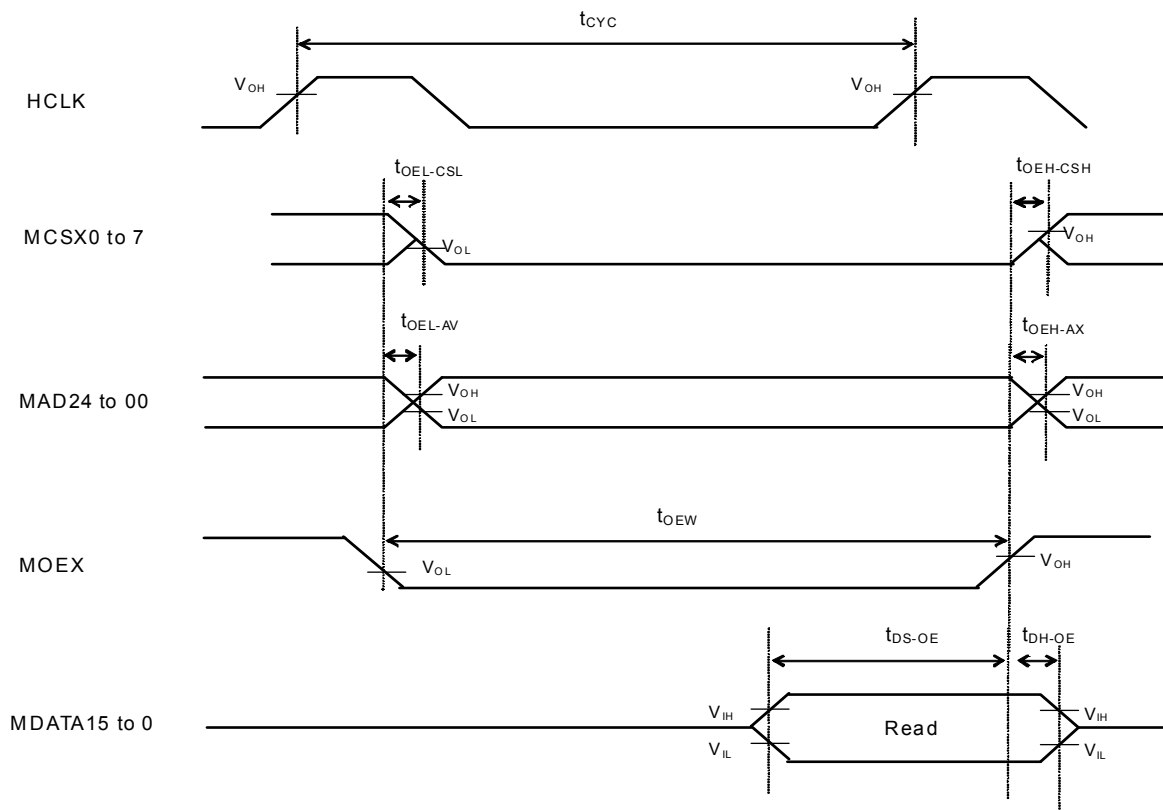
| Parameter                      | Symbol                  | Pin name             | Conditions                                       | Value                                                   |                | Unit | Remarks                        |
|--------------------------------|-------------------------|----------------------|--------------------------------------------------|---------------------------------------------------------|----------------|------|--------------------------------|
|                                |                         |                      |                                                  | Min                                                     | Max            |      |                                |
| MOEX<br>Min pulse width        | t <sub>OE</sub>         | MOEX                 | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | T <sub>HCLK</sub> × 1 - 3                               | -              | ns   |                                |
| MOEX ↓ ⇒<br>Address delay time | t <sub>OEL - AV</sub>   | MOEX<br>MAD24 to 00  | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | 0<br>0                                                  | 10<br>20       | ns   |                                |
| MOEX ↑ ⇒<br>Address delay time | t <sub>OE</sub> - AX    | MOEX<br>MAD24 to 00  | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | 0<br>-10<br>0                                           | 10<br>15<br>20 | ns   | MB9BF-500<br>MB9BF-504/505/506 |
| MOEX ↓ ⇒<br>MCSX ↓ delay time  | t <sub>OEL - CSL</sub>  | MOEX<br>MCSX         | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | 0                                                       | 10             | ns   |                                |
| MOEX ↑ ⇒<br>MCSX ↑ delay time  | t <sub>OE</sub> - CSH   | MOEX<br>MCSX         | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | 0                                                       | 10             | ns   |                                |
| Data set up<br>⇒ MOEX ↑ time   | t <sub>DS - OE</sub>    | MOEX<br>MDATA15 to 0 | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | 20<br>38                                                | -<br>-         | ns   |                                |
| MOEX ↑ ⇒<br>Data hold time     | t <sub>DH - OE</sub>    | MOEX<br>MDATA15 to 0 | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | 0                                                       | -              | ns   |                                |
| MCSX ↓ ⇒<br>MWEX ↓ delay time  | t <sub>CSL - WEL</sub>  | MCSX<br>MWEX         | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | T <sub>HCLK</sub> × 1 - 5<br>T <sub>HCLK</sub> × 1 - 10 | -<br>-         | ns   |                                |
| MWEX ↑ ⇒<br>MCSX ↑ delay time  | t <sub>WEH - CSH</sub>  | MCSX<br>MWEX         | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | T <sub>HCLK</sub> × 1 - 5<br>T <sub>HCLK</sub> × 1 - 10 | -<br>-         | ns   |                                |
| Address ⇒<br>MWEX ↓ delay time | t <sub>AV - WEL</sub>   | MWEX<br>MAD24 to 00  | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | T <sub>HCLK</sub> × 1 - 5<br>T <sub>HCLK</sub> × 1 - 15 | -<br>-         | ns   |                                |
| MWEX ↑ ⇒<br>Address delay time | t <sub>WEH - AX</sub>   | MWEX<br>MAD24 to 00  | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | T <sub>HCLK</sub> × 1 - 5<br>T <sub>HCLK</sub> × 1 - 15 | -<br>-         | ns   |                                |
| MWEX ↓ ⇒<br>MDQM ↓ delay time  | t <sub>WEL - DQML</sub> | MWEX<br>MDQM0 to 1   | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | 0<br>0                                                  | 5<br>10        | ns   |                                |
| MWEX ↑ ⇒<br>MDQM ↑ delay time  | t <sub>WEH - DQMH</sub> | MWEX<br>MDQM0 to 1   | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | 0<br>0                                                  | 5<br>10        | ns   |                                |
| MWEX<br>Min pulse width        | t <sub>WEW</sub>        | MWEX                 | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | T <sub>HCLK</sub> × 1 - 3                               | -              | ns   |                                |
| MWEX ↓ ⇒<br>Data delay time    | t <sub>WEL - DV</sub>   | MWEX<br>MDATA15 to 0 | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | - 5<br>-15                                              | 5<br>15        | ns   |                                |
| MWEX ↑ ⇒<br>Data delay time    | t <sub>WEH - DX</sub>   | MWEX<br>MDATA15 to 0 | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | T <sub>HCLK</sub> × 1 - 5<br>T <sub>HCLK</sub> × 1 - 15 | -<br>-         | ns   |                                |

Note: When the external load capacitance = 50pF.

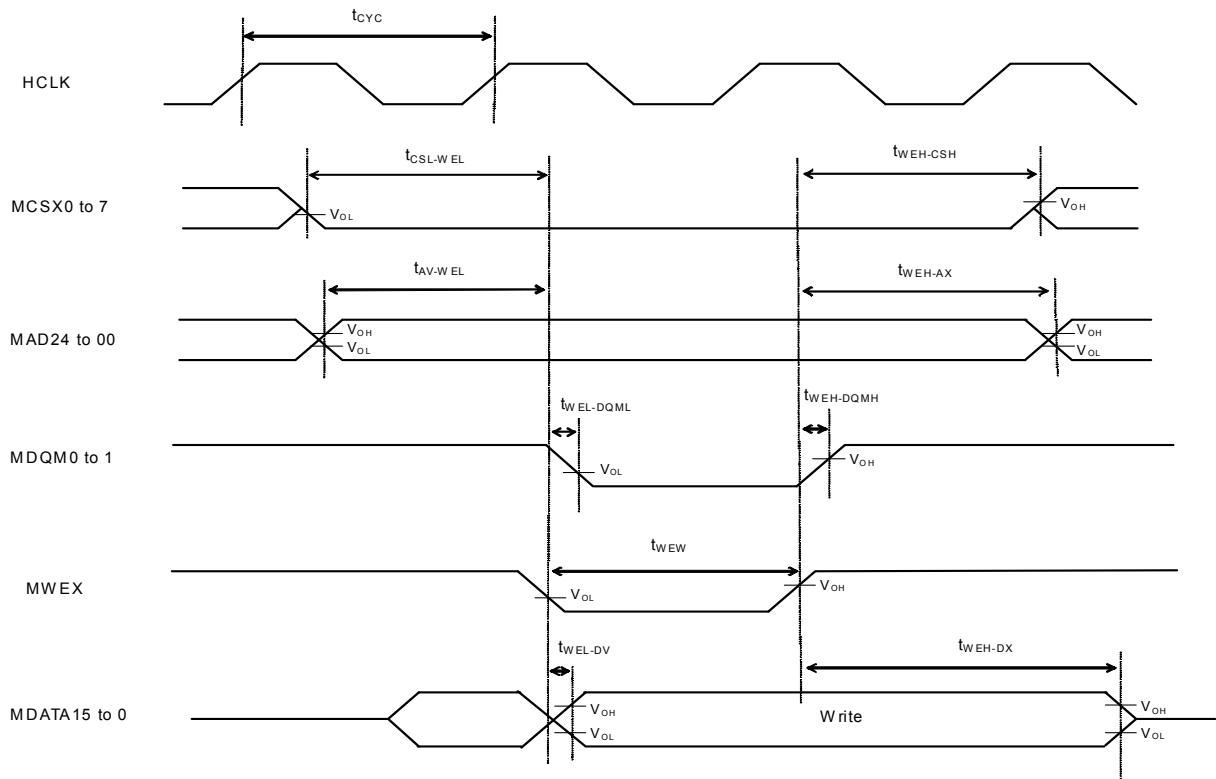
# MB9B500 Series

(Continued)

## SRAM read



## SRAM write



• NAND FLASH mode

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

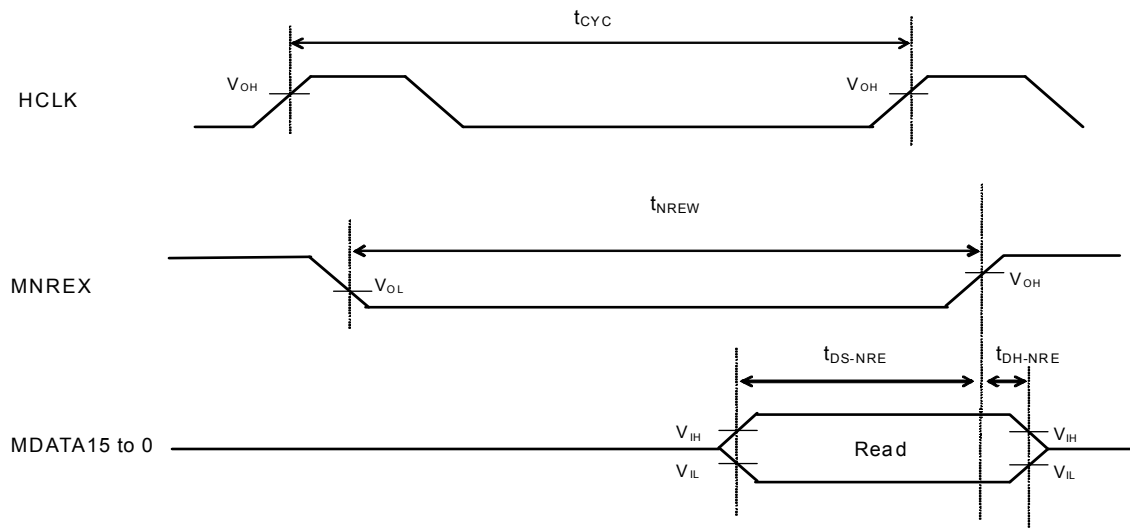
| Parameter                     | Symbol                   | Pin name              | Conditions               | Value                                                 |            | Unit | Remarks |
|-------------------------------|--------------------------|-----------------------|--------------------------|-------------------------------------------------------|------------|------|---------|
|                               |                          |                       |                          | Min                                                   | Max        |      |         |
| MNREX<br>Min pulse width      | t <sub>NREW</sub>        | MNREX                 | Vcc ≥ 4.5V<br>Vcc < 4.5V | T <sub>HCLK</sub> ×1 - 3                              | -          | ns   |         |
| Data set up<br>⇒ MNREX ↑ time | t <sub>DS - NRE</sub>    | MNREX<br>MDATA15 to 0 | Vcc ≥ 4.5V<br>Vcc < 4.5V | 20<br>38                                              | -<br>-     | ns   |         |
| MNREX ↑ ⇒<br>Data hold time   | t <sub>DH - NRE</sub>    | MNREX<br>MDATA15 to 0 | Vcc ≥ 4.5V<br>Vcc < 4.5V | 0<br>0                                                | -<br>-     | ns   |         |
| MNALE ↑ ⇒<br>MNWEX delay time | t <sub>ALEH - NWEL</sub> | MNALE<br>MNWEX        | Vcc ≥ 4.5V<br>Vcc < 4.5V | T <sub>HCLK</sub> ×1 - 5<br>T <sub>HCLK</sub> ×1 - 15 | -<br>-     | ns   |         |
| MNWEX ↑ ⇒<br>MNALE delay time | t <sub>NWEH - ALEL</sub> | MNALE<br>MNWEX        | Vcc ≥ 4.5V<br>Vcc < 4.5V | T <sub>HCLK</sub> ×1 - 5<br>T <sub>HCLK</sub> ×1 - 15 | -<br>-     | ns   |         |
| MNCLE ↑ ⇒<br>MNWEX delay time | t <sub>CLEH - NWEL</sub> | MNCLE<br>MNWEX        | Vcc ≥ 4.5V<br>Vcc < 4.5V | T <sub>HCLK</sub> ×1 - 5<br>T <sub>HCLK</sub> ×1 - 15 | -<br>-     | ns   |         |
| MNWEX ↑ ⇒<br>MNCLE delay time | t <sub>NWEH - CLEL</sub> | MNCLE<br>MNWEX        | Vcc ≥ 4.5V<br>Vcc < 4.5V | T <sub>HCLK</sub> ×1 - 5<br>T <sub>HCLK</sub> ×1 - 15 | -<br>-     | ns   |         |
| MNWEX<br>Min pulse width      | t <sub>NWEW</sub>        | MNWEX                 | Vcc ≥ 4.5V<br>Vcc < 4.5V | T <sub>HCLK</sub> ×1 - 3                              | -          | ns   |         |
| MNWEX ↓ ⇒<br>Data delay time  | t <sub>NWEL - DV</sub>   | MNWEX<br>MDATA15 to 0 | Vcc ≥ 4.5V<br>Vcc < 4.5V | - 5<br>-15                                            | + 5<br>+15 | ns   |         |
| MNWEX ↑ ⇒<br>Data delay time  | t <sub>NWEH - DX</sub>   | MNWEX<br>MDATA15 to 0 | Vcc ≥ 4.5V<br>Vcc < 4.5V | T <sub>HCLK</sub> ×1 - 5<br>T <sub>HCLK</sub> ×1 - 15 | -<br>-     | ns   |         |

Note: when the external load capacitance = 50pF.

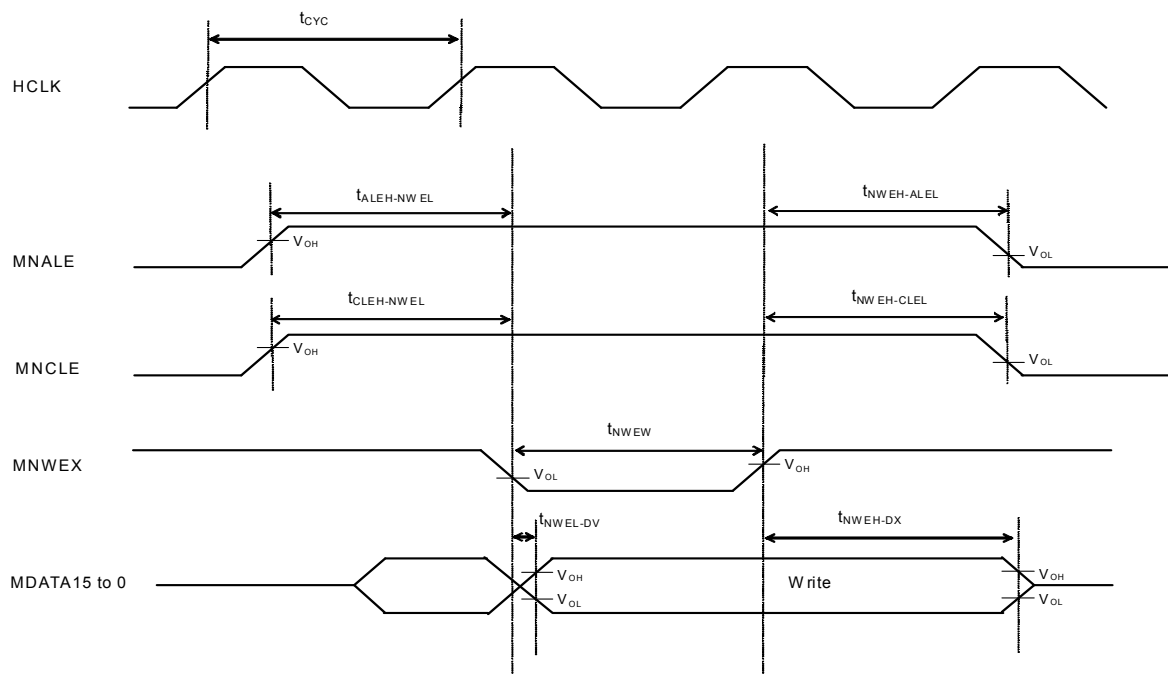
# MB9B500 Series

(Continued)

## NAND FLASH read



## NAND FLASH write

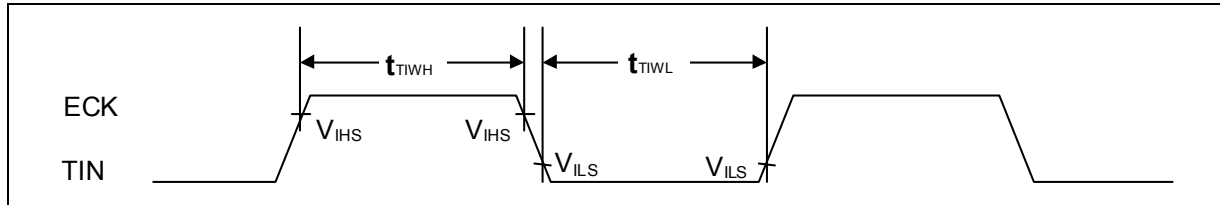


## (8) Base Timer Input Timing

### • Timer input timing

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

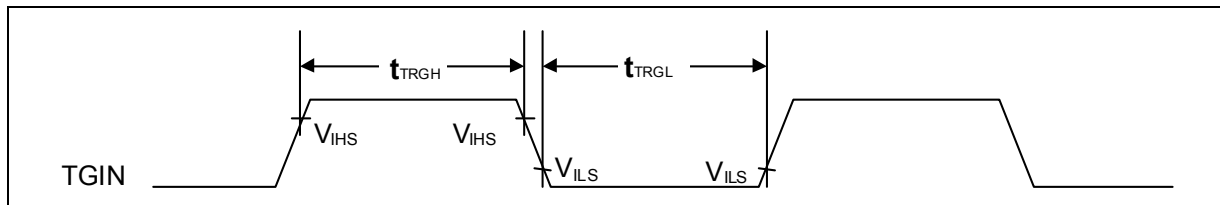
| Parameter         | Symbol                   | Pin name                                  | Conditions | Value       |     | Unit | Remarks |
|-------------------|--------------------------|-------------------------------------------|------------|-------------|-----|------|---------|
|             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



### • Trigger input timing

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

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



# MB9B500 Series

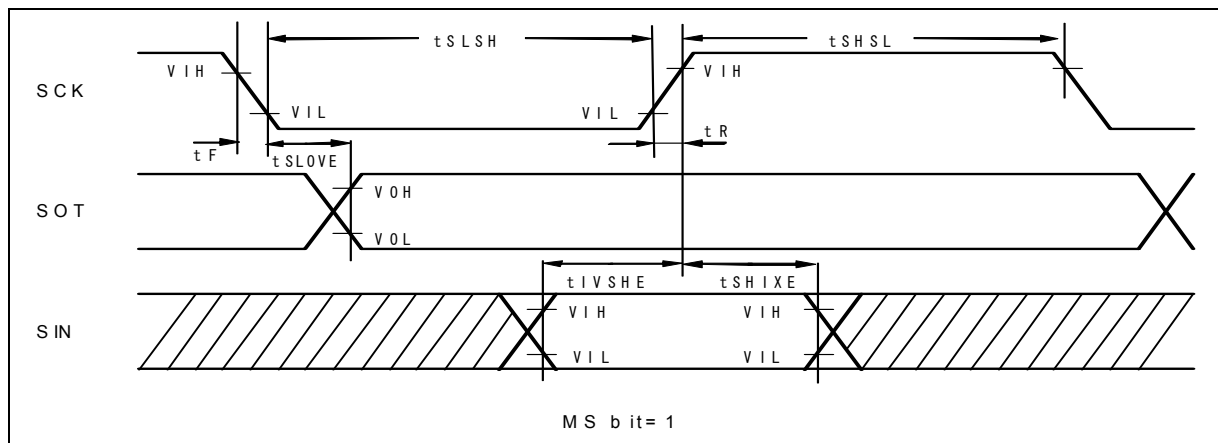
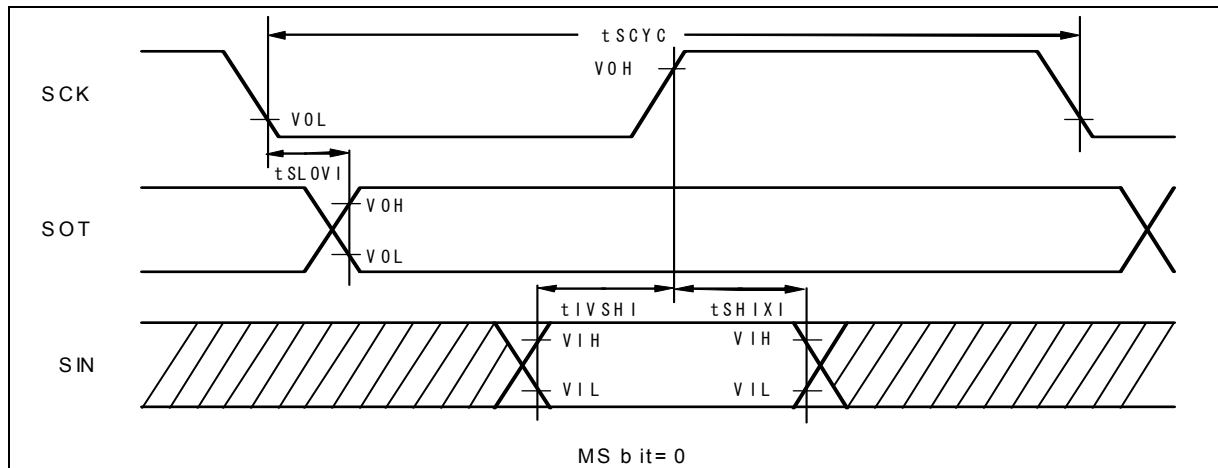
## (9) UART Timing

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

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

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

- Notes:
- The above characteristics apply to CLK synchronous mode.
  - t<sub>CYCP</sub> indicates the peripheral clock cycle time.
  - These characteristics only guarantee the same relocate port number.  
For example, the combination of SCLK<sub>x\_0</sub> and SOT<sub>x\_1</sub> is not guaranteed.
  - When the external load capacitance = 50pF.



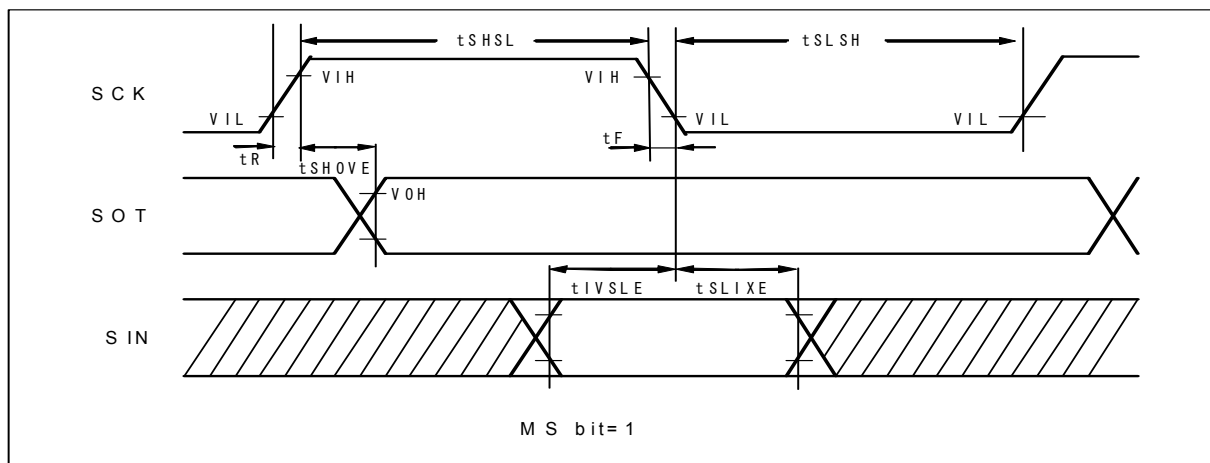
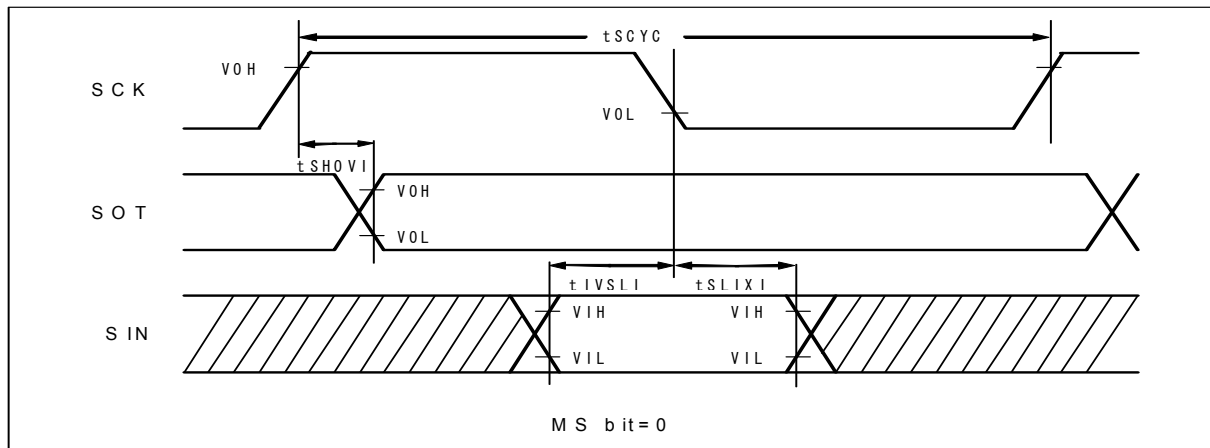
# MB9B500 Series

- 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.
  - tcycp 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.



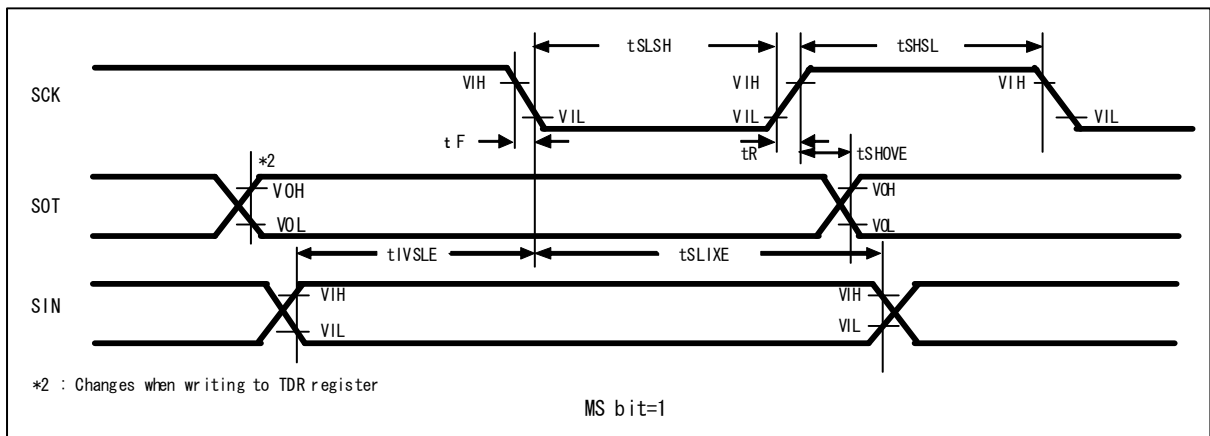
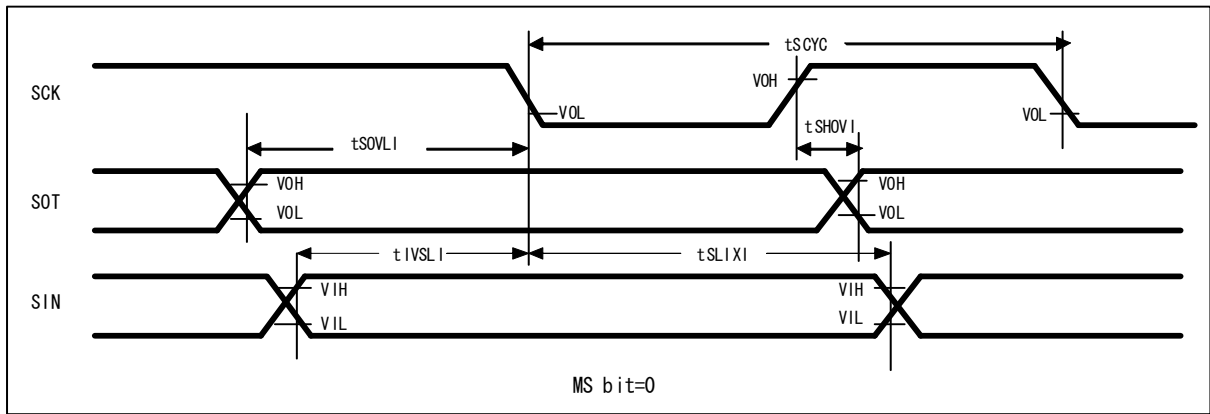
# MB9B500 Series

- 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<br>SOTx |                                | -30            | +30 | - 20           | + 20 | ns   |
| SIN → SCK ↓ setup time       | tIVSLI | SCKx<br>SINx |                                | 50             | -   | 30             | -    | ns   |
| SCK ↓ → SIN hold time        | tSLIXI | SCKx<br>SINx |                                | 0              | -   | 0              | -    | ns   |
| SOT → SCK ↓ delay time       | tSOVLI | SCKx<br>SOTx |                                | 2tcycp<br>- 30 | -   | 2tcycp -<br>30 | -    | ns   |
| Serial clock "L" pulse width | tSLSH  | SCKx         | External shift clock operation | 2tcycp<br>- 10 | -   | 2tcycp -<br>10 | -    | ns   |
| Serial clock "H" pulse width | tSHSL  | SCKx         |                                | tcycp +<br>10  | -   | tcycp +<br>10  | -    | ns   |
| SCK ↑ → SOT delay time       | tSHOVE | SCKx<br>SOTx |                                | -              | 50  | -              | 30   | ns   |
| SIN → SCK ↓ setup time       | tIVSLE | SCKx<br>SINx |                                | 10             | -   | 10             | -    | ns   |
| SCK ↓ → SIN hold time        | tSLIXE | SCKx<br>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.
  - tcycp 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.



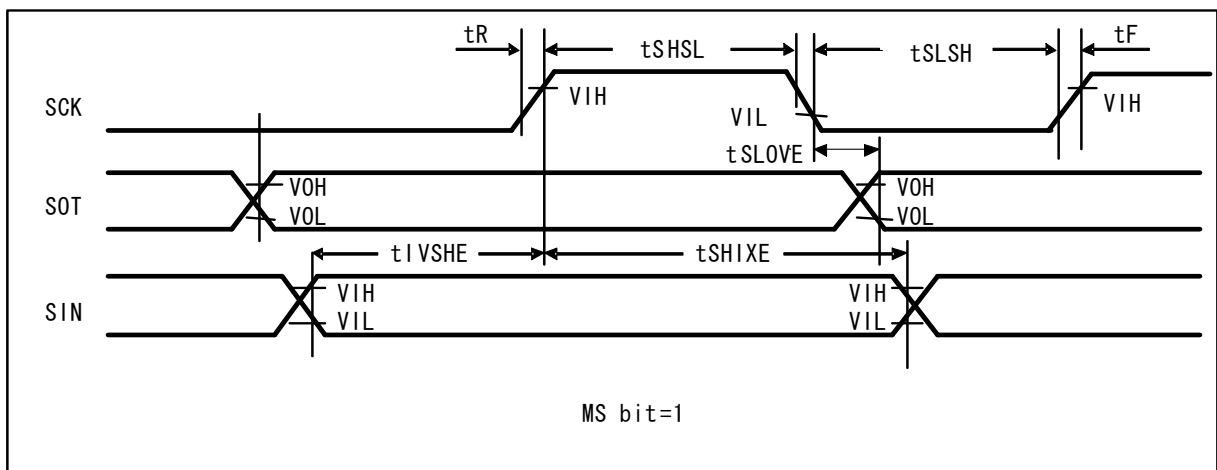
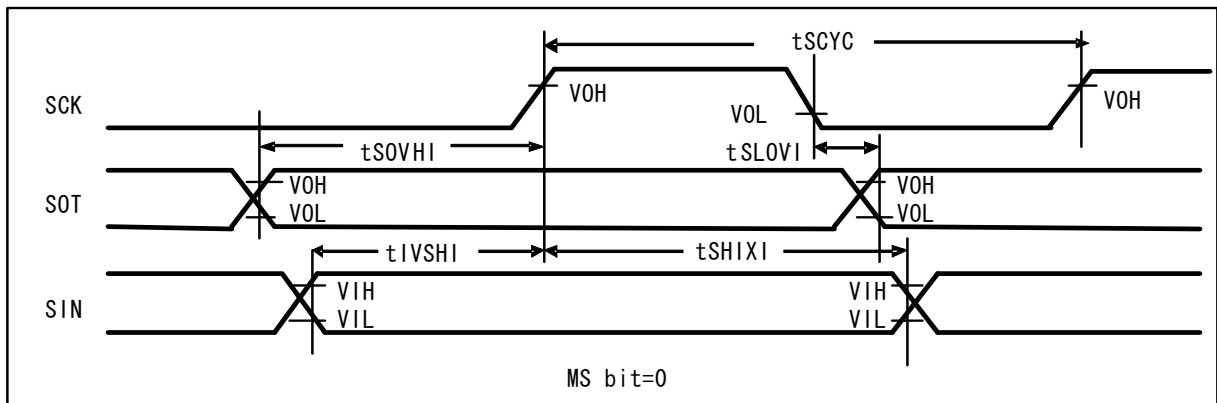
# MB9B500 Series

- 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<br>SOTx |                                | -30         | +30 | - 20        | + 20 | ns   |
| SIN → SCK ↑ setup time       | tIVSHI | SCKx<br>SINx |                                | 50          | -   | 30          | -    | ns   |
| SCK ↑ → SIN hold time        | tSHIXI | SCKx<br>SINx |                                | 0           | -   | 0           | -    | ns   |
| SOT → SCK ↑ delay time       | tSOVHI | SCKx<br>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<br>SOTx |                                | -           | 50  | -           | 30   | ns   |
| SIN → SCK ↑ setup time       | tIVSHE | SCKx<br>SINx |                                | 10          | -   | 10          | -    | ns   |
| SCK ↑ → SIN hold time        | tSHIXE | SCKx<br>SINx |                                | 20          | -   | 20          | -    | ns   |
| SCK fall time                | tF     | SCKx         |                                | -           | 5   | -           | 5    | ns   |
| SCK rise time                | tR     | SCKx         |                                | -           | 5   | -           | 5    | ns   |

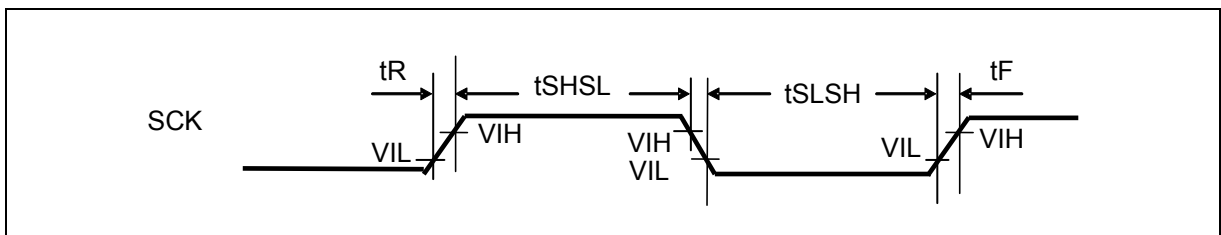
- Notes:
- The above characteristics apply to CLK synchronous mode.
  - tcycp indicates the peripheral clock cycle time.
  - These characteristics only guarantee the same relocate port number.  
For example, the combination of SCLKx\_0 and SOTx\_1 is not guaranteed.
  - When the external load capacitance = 50pF.



• External clock(EXT = 1) : asynchronous only

( $V_{CC} = 2.7V$  to  $5.5V$ ,  $V_{SS} = 0V$   $T_a = -40^{\circ}C$  to  $+85^{\circ}C$ )

| Parameter                    | Symbol     | Conditions  | Min             | Max | Unit | Remarks |
|------------------------------|------------|-------------|-----------------|-----|------|---------|
| Serial clock "L" pulse width | $t_{SLSH}$ | $CL = 50pF$ | $t_{cycp} + 10$ | -   | ns   |         |
| Serial clock "H" pulse width | $t_{SHSL}$ |             | $t_{cycp} + 10$ | -   | ns   |         |
| SCK fall time                | $t_F$      |             | -               | 5   | ns   |         |
| SCK rise time                | $t_R$      |             | -               | 5   | ns   |         |



# MB9B500 Series

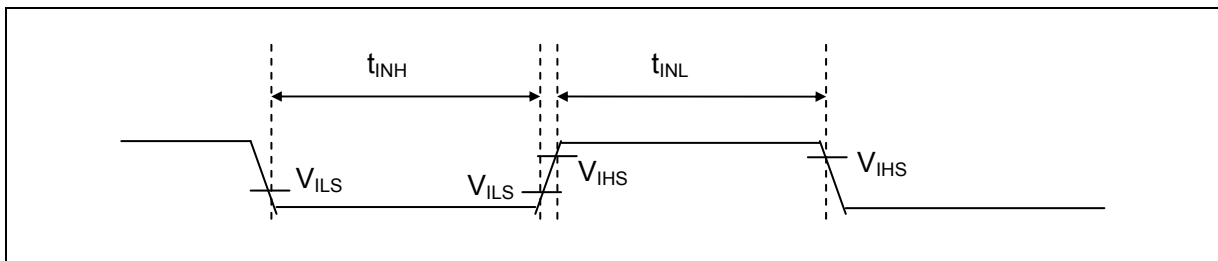
## (10) External input timing

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

| Parameter         | Symbol                 | Pin name             | Conditions | Value                |     | Unit | Remarks                     |
|-------------------|------------------------|----------------------|------------|----------------------|-----|------|-----------------------------|
|                   |                        |                      |            | Min                  | Max |      |                             |
| Input pulse width | $t_{INH}$<br>$t_{INL}$ | ADTG                 | -          | $2t_{CYCP} *1$       | -   | ns   | A/D converter trigger input |
|                   |                        | FRCK <sub>x</sub>    |            |                      |     |      | Free-run timer input clock  |
|                   |                        | IC <sub>xx</sub>     |            |                      |     |      | Input capture               |
|                   |                        | DTTi <sub>xX</sub>   | -          | $2t_{CYCP} *1$       | -   | 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.

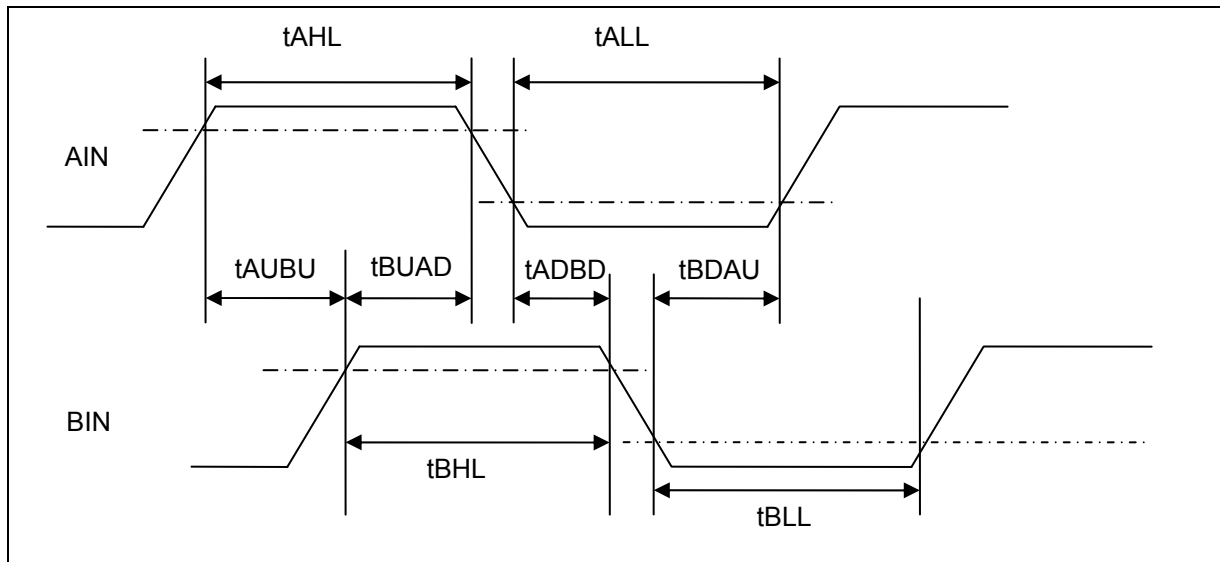


## (11) Quadrature Position/Revolution Counter timing

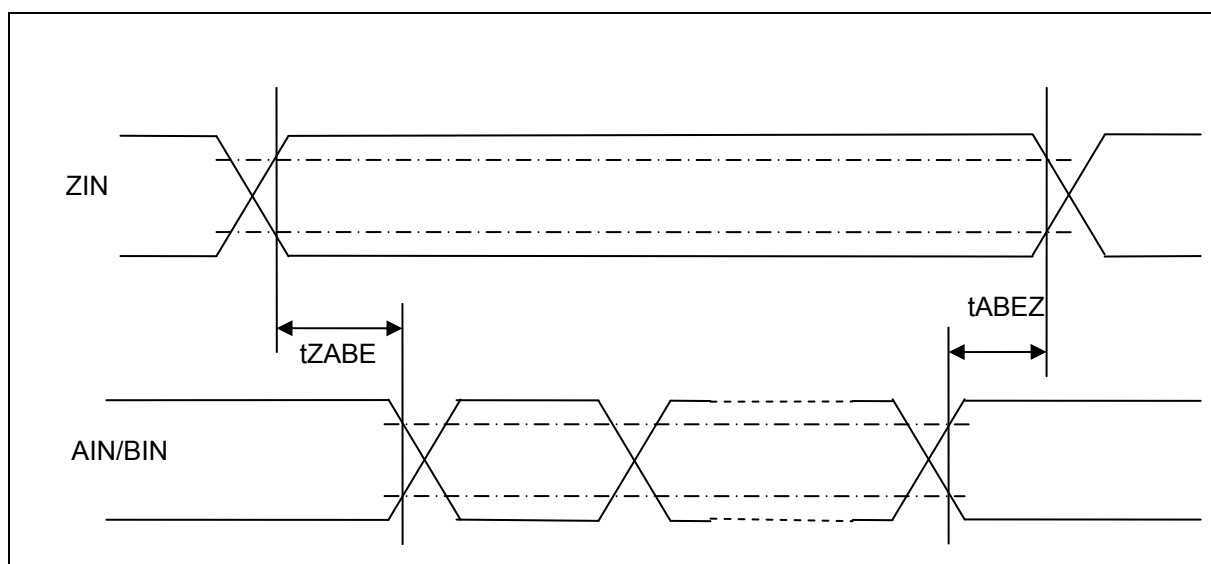
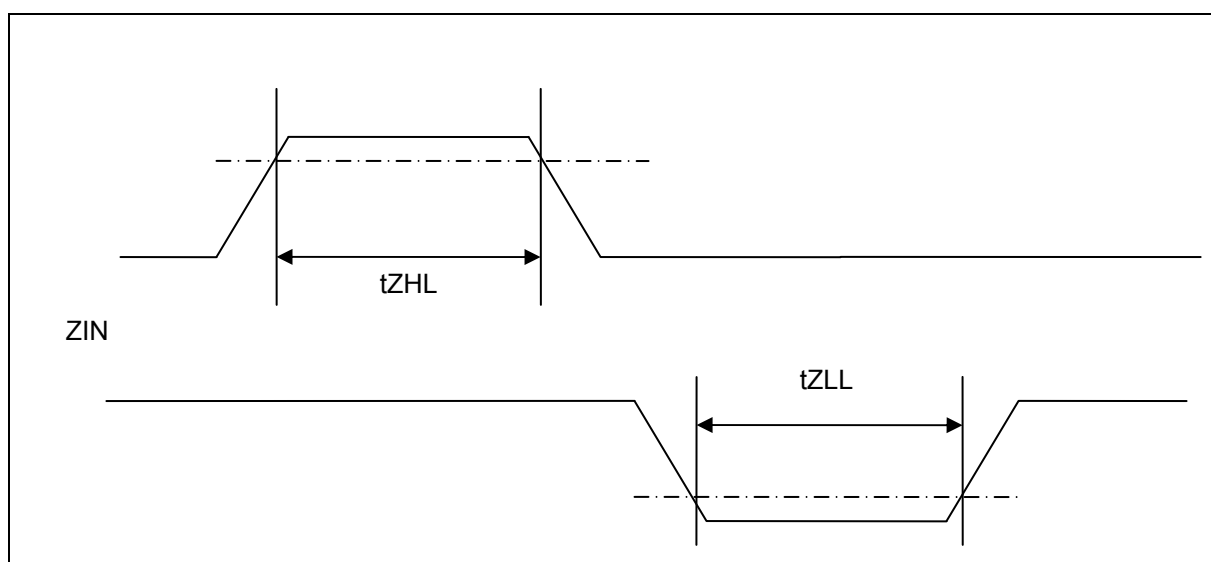
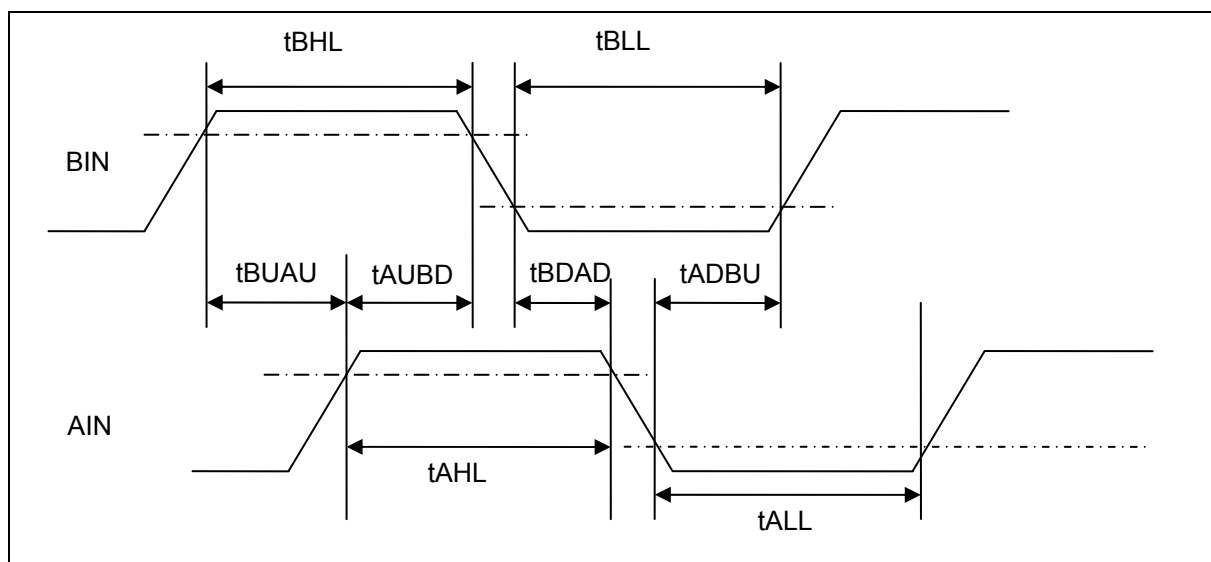
(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

| Parameter                                            | Symbol | Conditions           | Value                |     | Unit |
|------------------------------------------------------|--------|----------------------|----------------------|-----|------|
|                                                      |        |                      | Min                  | Max |      |
| AIN pin "H" width                                    | tAHL   | -                    | 2t <sub>CYCP</sub> * | -   | 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<sub>CYCP</sub> indicates the peripheral clock cycle time except stop when in stop mode.



# MB9B500 Series



## (12) I<sup>2</sup>C timing

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

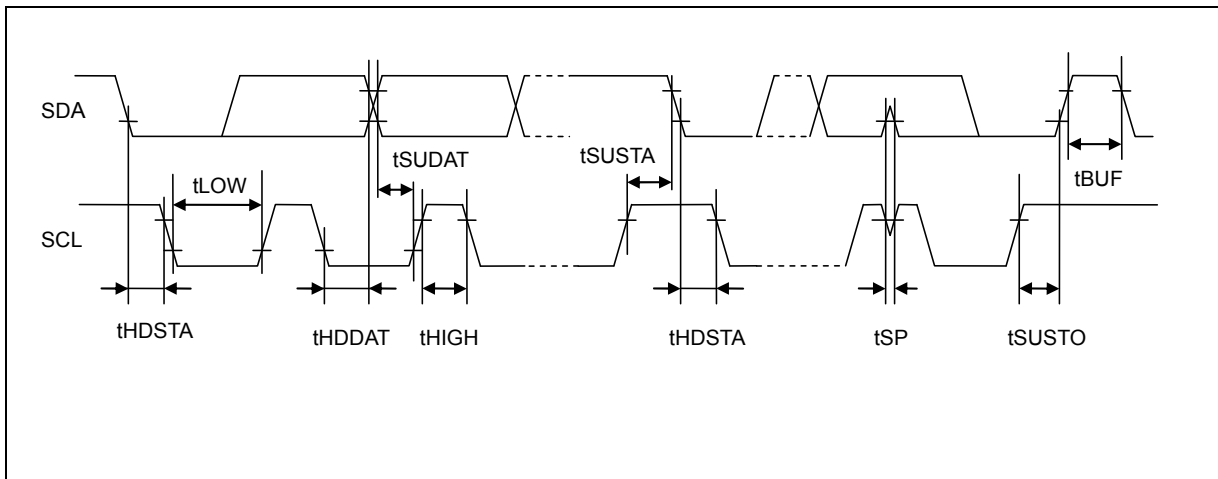
| Parameter                                                          | Symbol | Conditions                                                   | Typical mode                |              | High-speed mode             |             | Unit | Remarks |
|--------------------------------------------------------------------|--------|------------------------------------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

\*1 : R and C represent the pull-up resistance and load capacitance of the SCL and SDA lines, respectively. V<sub>p</sub> indicates the power supply voltage of the pull-up resistance and I<sub>OL</sub> indicates V<sub>OL</sub> 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<sup>2</sup>C bus device can be used on a standard mode I<sup>2</sup>C bus system as long as the device satisfies the requirement of "tSUDAT ≥ 250 ns".

\*4 : t<sub>CYCP</sub> is the peripheral clock cycle time. To use I<sup>2</sup>C, set the peripheral bus clock at 8 MHz or more.



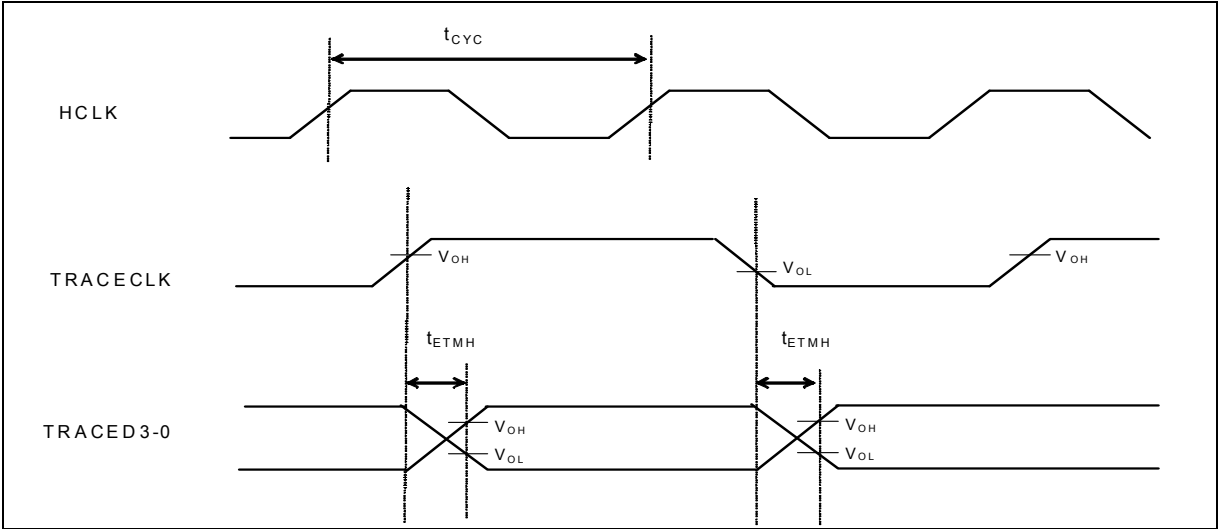
# MB9B500 Series

## (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 <sub>ETMH</sub> | TRACECLK<br>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.

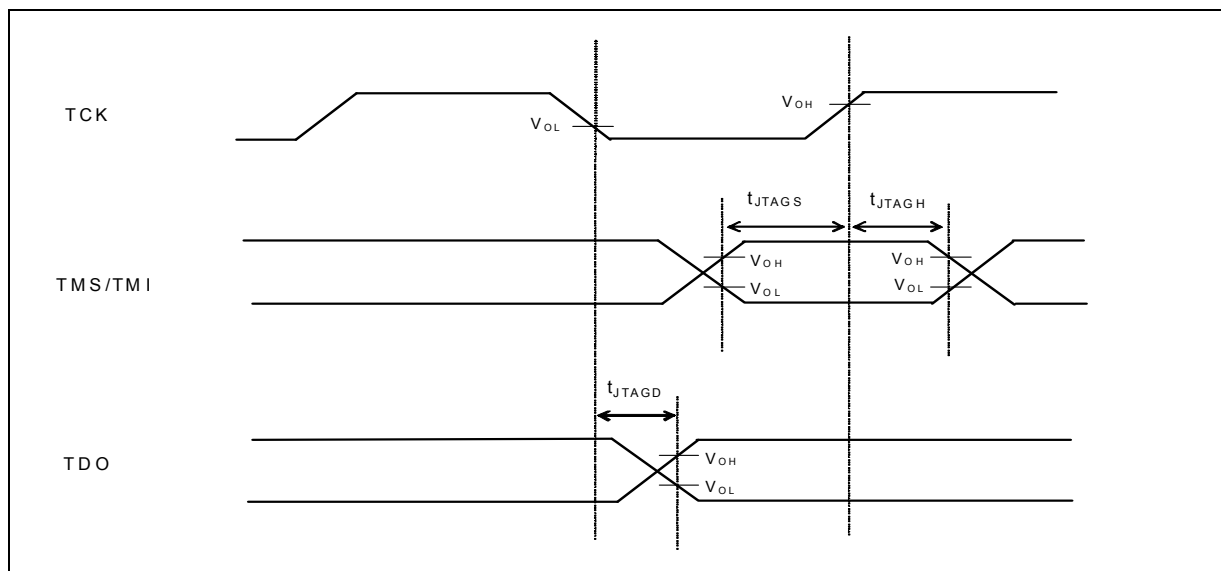


## (14) JTAG timing

(V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V Ta = - 40°C to + 85°C)

| Parameter          | Symbol             | Pin name       | Conditions                                       | Value |     | Unit | Remarks          |
|--------------------|--------------------|----------------|--------------------------------------------------|-------|-----|------|------------------|
|                    |                    |                |                                                  | Min   | Max |      |                  |
| TMS,TDI setup time | t <sub>JTAGS</sub> | TCK<br>TMS,TDI | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | 15    | -   | ns   |                  |
| TMS,TDI hold time  | t <sub>JTAGH</sub> | TCK<br>TMS,TDI | V <sub>CC</sub> ≥ 4.5V<br>V <sub>CC</sub> < 4.5V | 15    | -   | ns   |                  |
| TDO delay time     | t <sub>JTAGD</sub> | TCK<br>TDO     | V <sub>CC</sub> ≥ 4.5V                           | -     | 25  | ns   |                  |
|                    |                    |                | V <sub>CC</sub> < 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.

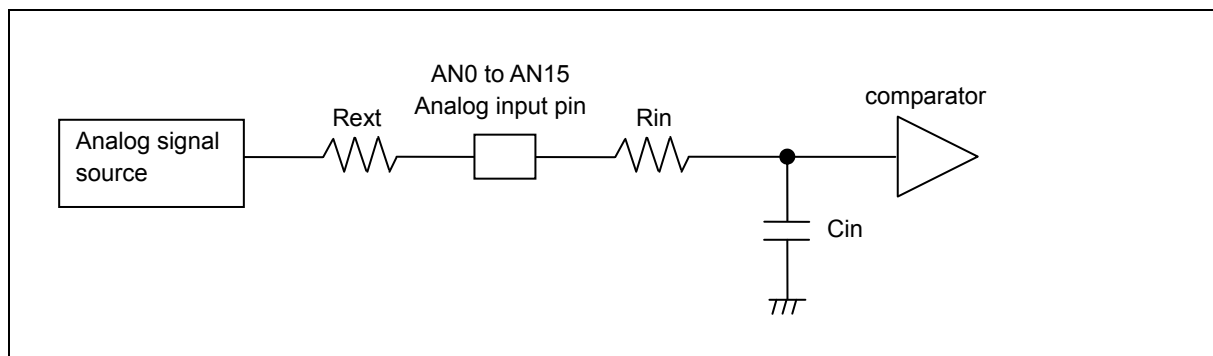
( $V_{CC} = AV_{CC} = 2.7V$  to  $5.5V$ ,  $V_{SS} = AV_{SS} = 0V$   $T_a = -40^{\circ}C$  to  $+85^{\circ}C$ )

| 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 (*)    | -          | -          | $\mu s$ | $AV_{CC} \geq 4.5V$ , PCLK = 30MHz      |
|                                                       |             | 3.1 (*)    | -          | -          | $\mu s$ | $AV_{CC} < 4.5V$ , PCLK = 30MHz         |
| Power supply current (analog + digital)               | AVCC        | -          | 5.7        | 11.1       | mA      | A/D 3unit operation                     |
|                                                       |             | -          | -          | 15         | $\mu A$ | 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         | $\mu A$ | 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          | $\mu A$ |                                         |
| 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: 0.4 $\mu s$ , external impedance: 4.1 k $\Omega$  or less and compare time: 0.8 $\mu s$  ( $AV_{CC} \geq 4.5V$ )



(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  $T_s$  calculated from the following equation.

(Equation 1)

$$T_s = (R_{in} + R_{ext}) \times C_{in} \times 7$$

$T_s$  : Sampling time

$R_{in}$  : input resistance of A/D =  $2.6\text{k}\Omega$   $4.5 \leq AVCC \leq 5.5$

input resistance of A/D =  $12.1\text{k}\Omega$   $2.7 \leq AVCC < 4.5$

$C_{in}$  : input capacity of A/D =  $8.5\text{pF}$

$R_{ext}$  : Output impedance of external circuit

If the sampling time is set as  $400\text{ns}$  (when  $4.5 \leq AVCC \leq 5.5$ ),

$$400\text{ns} \geq (2.6\text{k}\Omega + R_{ext}) \times 8.5\text{pF} \times 7$$

$$\therefore R_{ext} \leq 4.1\text{k}\Omega$$

And the impedance of the external circuit therefore needs to be  $4.1\text{k}\Omega$  or less.

# MB9B500 Series

• 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<br>STx5 to STx0 | Sampling Time [μs] |                 |                 |                 | Maximum External Impedance [kΩ] |                 |                 |                 |
|--------------------------------|--------------------|-----------------|-----------------|-----------------|---------------------------------|-----------------|-----------------|-----------------|
|                                | PCLK =<br>20MHz    | PCLK =<br>30MHz | PCLK =<br>33MHz | PCLK =<br>40MHz | PCLK =<br>20MHz                 | PCLK =<br>30MHz | PCLK =<br>33MHz | PCLK =<br>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

# MB9B500 Series

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

| Register Value<br>STx5 to STx0 | Sampling Time [ $\mu$ s] |                 |                 |                 | Maximum External Impedance [ $k\Omega$ ] |                 |                 |                 |
|--------------------------------|--------------------------|-----------------|-----------------|-----------------|------------------------------------------|-----------------|-----------------|-----------------|
|                                | PCLK =<br>20MHz          | PCLK =<br>30MHz | PCLK =<br>33MHz | PCLK =<br>40MHz | PCLK =<br>20MHz                          | PCLK =<br>30MHz | PCLK =<br>33MHz | PCLK =<br>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

# MB9B500 Series

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

| Register Value<br>STx5 to STx0 | Sampling Time [ $\mu$ s] |                 |                 |                 | Maximum External Impedance [k $\Omega$ ] |                 |                 |                 |
|--------------------------------|--------------------------|-----------------|-----------------|-----------------|------------------------------------------|-----------------|-----------------|-----------------|
|                                | PCLK =<br>20MHz          | PCLK =<br>30MHz | PCLK =<br>33MHz | PCLK =<br>40MHz | PCLK =<br>20MHz                          | PCLK =<br>30MHz | PCLK =<br>33MHz | PCLK =<br>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

# MB9B500 Series

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

| Register Value<br>STx5 to STx0 | Sampling Time [ $\mu$ s] |                 |                 |                 | Maximum External Impedance [k $\Omega$ ] |                 |                 |                 |
|--------------------------------|--------------------------|-----------------|-----------------|-----------------|------------------------------------------|-----------------|-----------------|-----------------|
|                                | PCLK =<br>20MHz          | PCLK =<br>30MHz | PCLK =<br>33MHz | PCLK =<br>40MHz | PCLK =<br>20MHz                          | PCLK =<br>30MHz | PCLK =<br>33MHz | PCLK =<br>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

# MB9B500 Series

• Setting examples of compare time at  $AV_{CC} \geq 4.5V$

| Register Value<br>CT2 to CT0 | Compare Time [ $\mu s$ ] |              |              |              |
|------------------------------|--------------------------|--------------|--------------|--------------|
|                              | 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  $2.7V \leq AV_{CC} < 4.5V$

| Register Value<br>CT2 to CT0 | Compare Time [ $\mu s$ ] |              |              |              |
|------------------------------|--------------------------|--------------|--------------|--------------|
|                              | 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        |

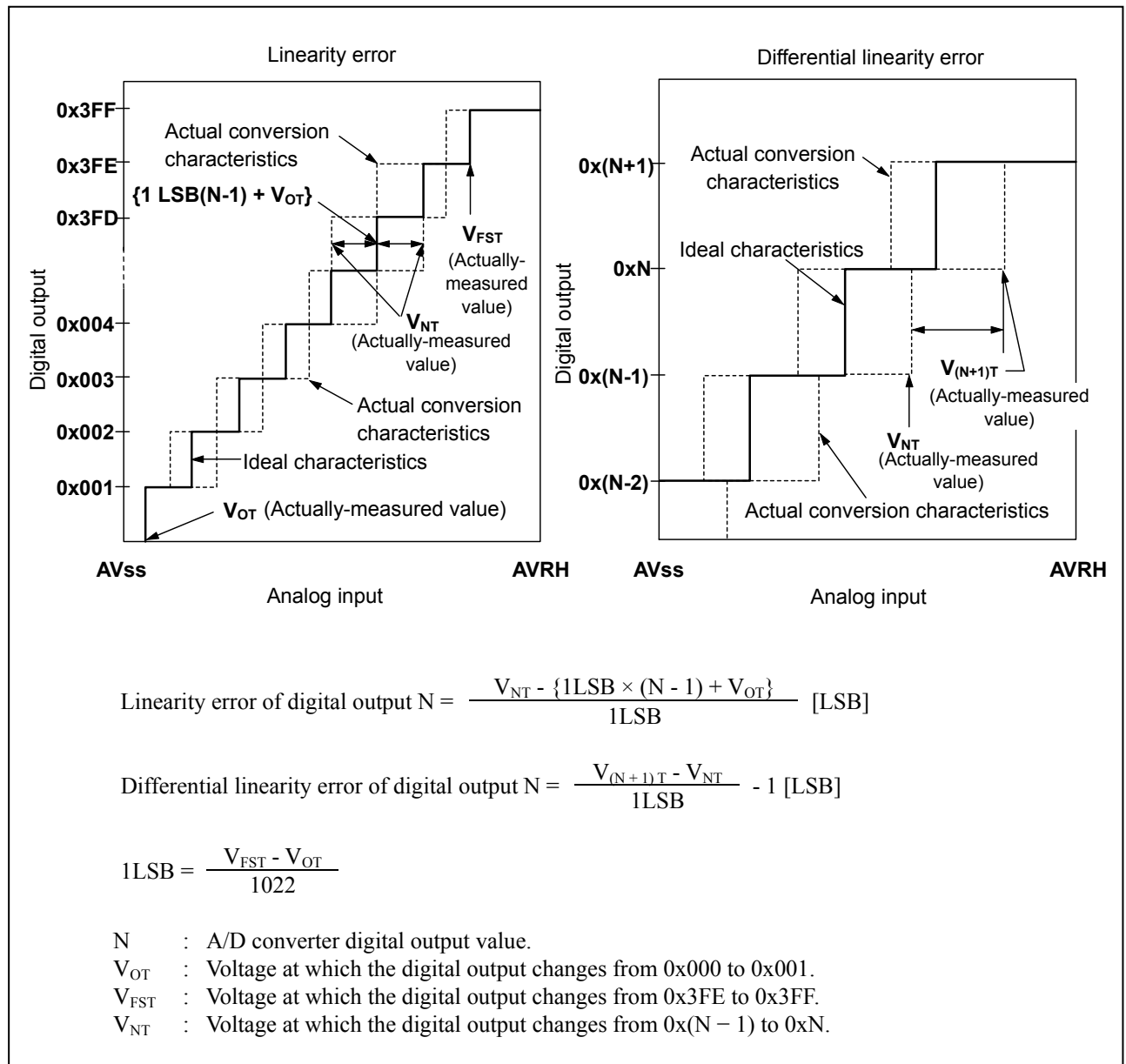
PCLK : peripheral clock (PCLK) frequency

- : Setting prohibited

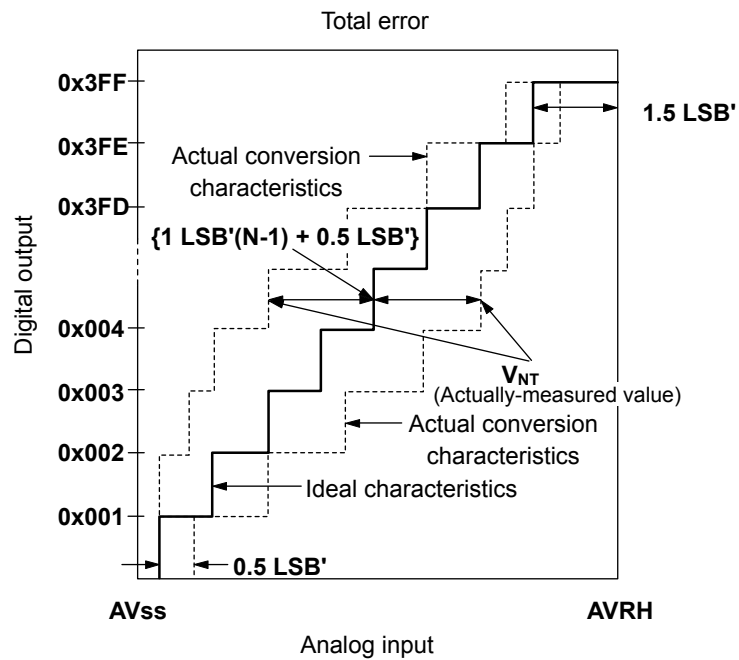
\* This table covers only compare time data.

## • 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 $\longleftrightarrow$ 0b0000000001) and the full-scale transition point (0b1111111110 $\longleftrightarrow$ 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.



(Continued)



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

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

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) =  $\text{AV}_{\text{SS}} + 0.5\text{LSB}'[\text{V}]$

$V_{FST}'$  (Ideal value) =  $\text{AVRH} - 1.5\text{LSB}'[\text{V}]$

## ● 12bit A/D Converter

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

### 1. Electrical characteristics for the A/D converter.

( $V_{CC} = AV_{CC} = 2.7V$  to  $5.5V$ ,  $V_{SS} = AV_{SS} = 0V$   $T_a = -40^{\circ}C$  to  $+85^{\circ}C$ )

| 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        | 55.5     | -    | 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           |
|                                                       |             | -        | 0.1  | 2     | μA   | When XSTB is 0 (3unit)        |
| Reference power supply current (between AVRH to AVSS) | AVRH        | -        | 2.2  | 3.0   | mA   | A/D 1unit operation AVRH=5.5V |
|                                                       |             | -        | 0.03 | 0.6   | μA   | When XSTB is 0 (3unit)        |
| 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"

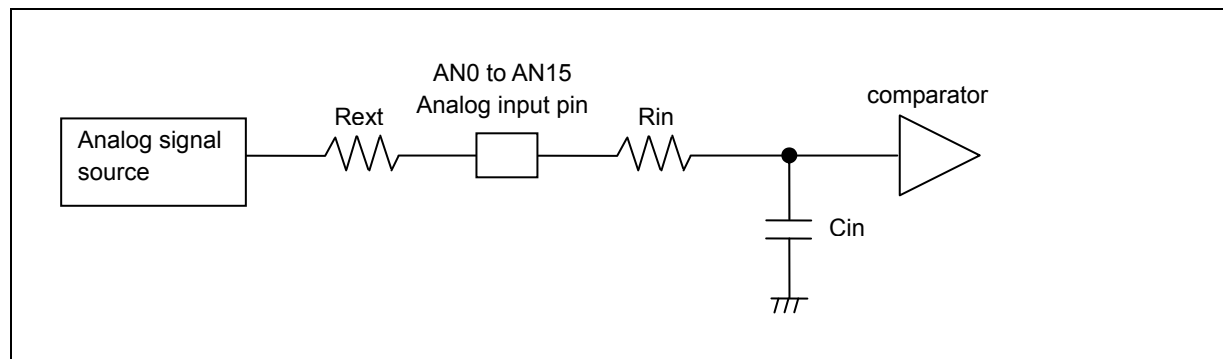
\*2: A necessary sampling time changes by external impedance.

Ensure that it set the sampling time to satisfy (Equation 1)

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

# MB9B500 Series

(Continued)



$$(\text{Equation 1}) \quad T_s \geq (R_{in} + R_{ext}) \times C_{in} \times 9$$

Ts : Sampling time

Rin : input resistance of A/D = 0.93kΩ      $4.5 \leq AVCC \leq 5.5$

input resistance of A/D = 2.04k $\Omega$       2.7  $\leq$  AVCC < 4.5

Cin : input capacity of A/D = 14.5pF       $2.7 \leq AVCC \leq 5.5$

Rest : Output impedance of external circuit

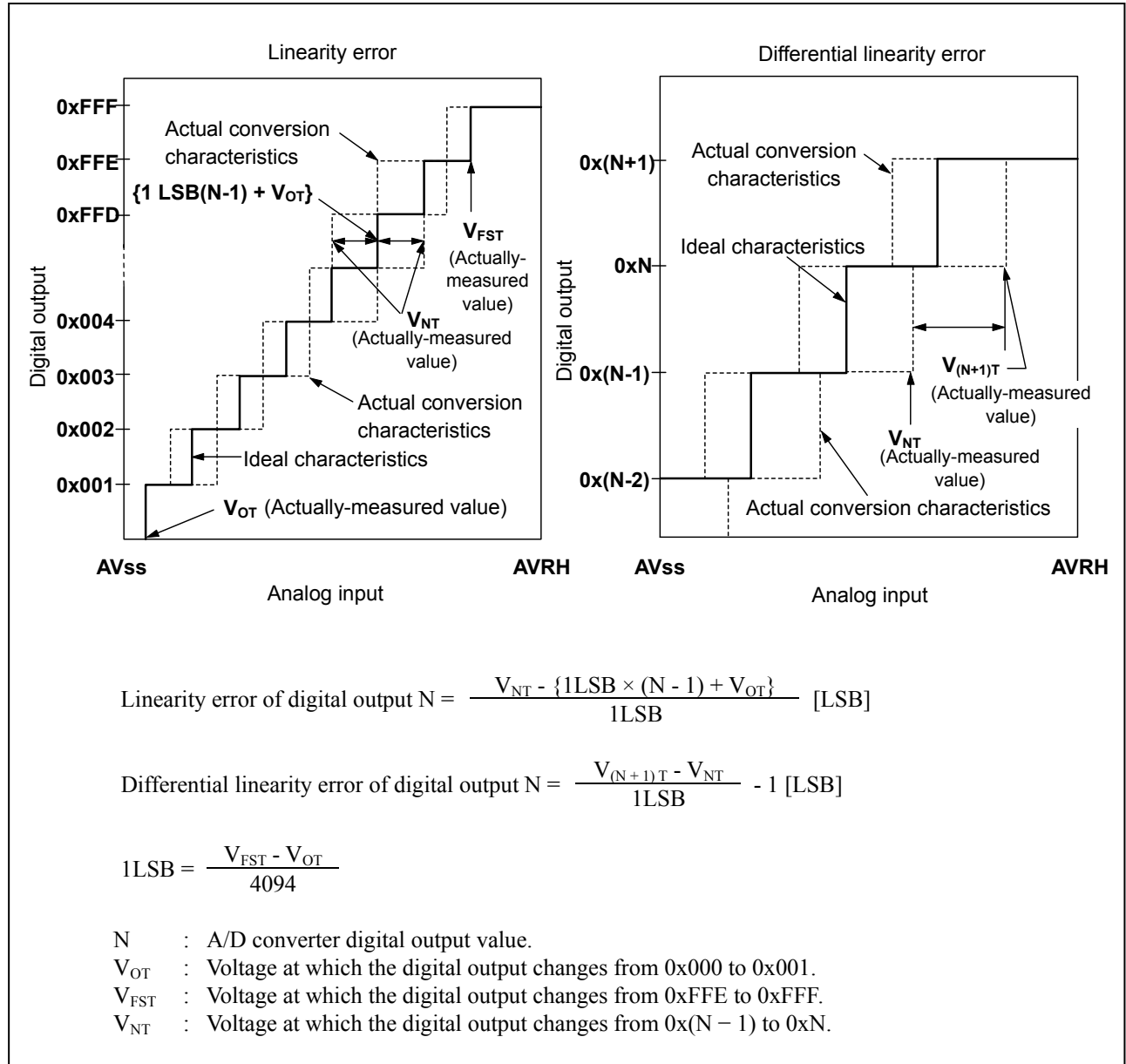
(Equation 2)  $T_c = T_{cck} \times 14$

Tc : Compare time

Tck : 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 $\longleftrightarrow$ 0b000000000001) and the full-scale transition point (0b111111111110 $\longleftrightarrow$ 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.



# MB9B500 Series

## ● USB characteristics

(V<sub>cc</sub> = 2.7V to 5.5V, USBV<sub>cc</sub> = 3.0V to 3.6V, V<sub>ss</sub> = 0V Ta = - 40°C to + 85°C)

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

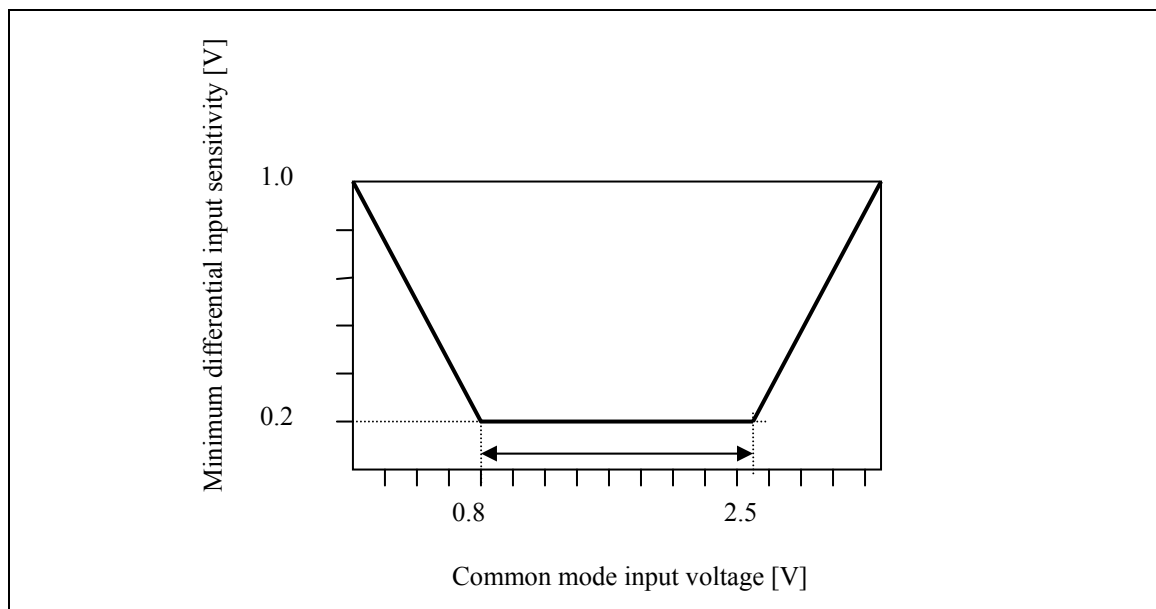
\*1 : The switching threshold voltage of Single-End-Receiver of USB I/O buffer is set as within V<sub>IL</sub> (Max) = 0.8V, V<sub>IH</sub> (Min) = 2.0 V (TTL input standard).

There are some hystereses to lower noise sensitivity.

\*2 : Use differential-Receiver to receive USB differential data signal.

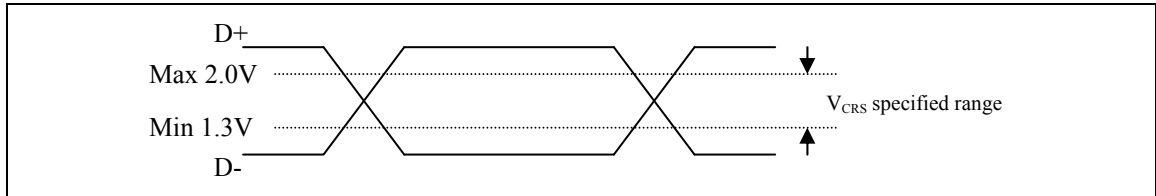
Differential-Receiver has 200 mV of differential input sensitivity when the differential data input is within 0.8 V to 2.5 V to the local ground reference level.

Above voltage range is the common mode input voltage range.

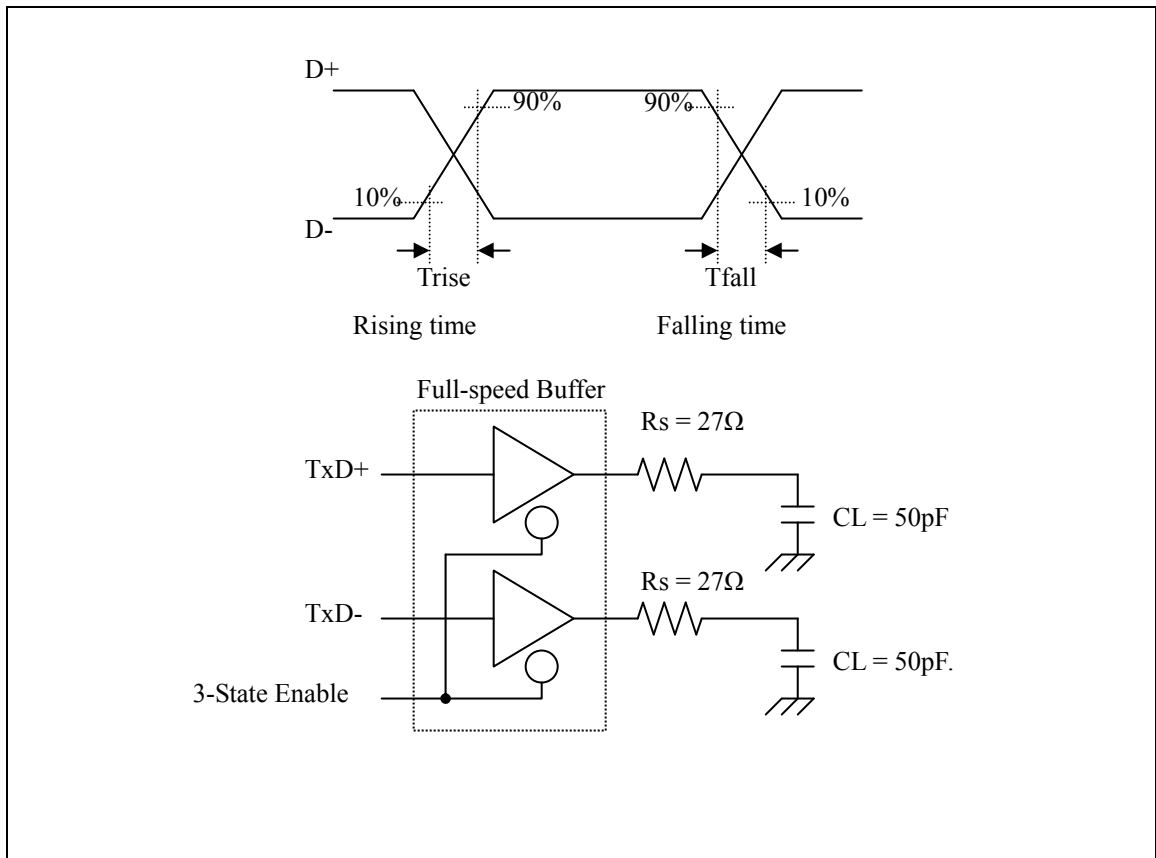


\*3 : The output drive capability of the driver is below 0.3 V at Low-State ( $V_{OL}$ ) (to 3.6 V and 1.5 k $\Omega$  load), and 2.8 V or above (to the VSS and 1.5 k $\Omega$  load) at High-State ( $V_{OH}$ ).

\*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 ( $T_{rise}$ ) and fall time ( $T_{fall}$ ) 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,  $T_r/T_f$  ratio is regulated as within  $\pm 10\%$  to minimize RFI emission.

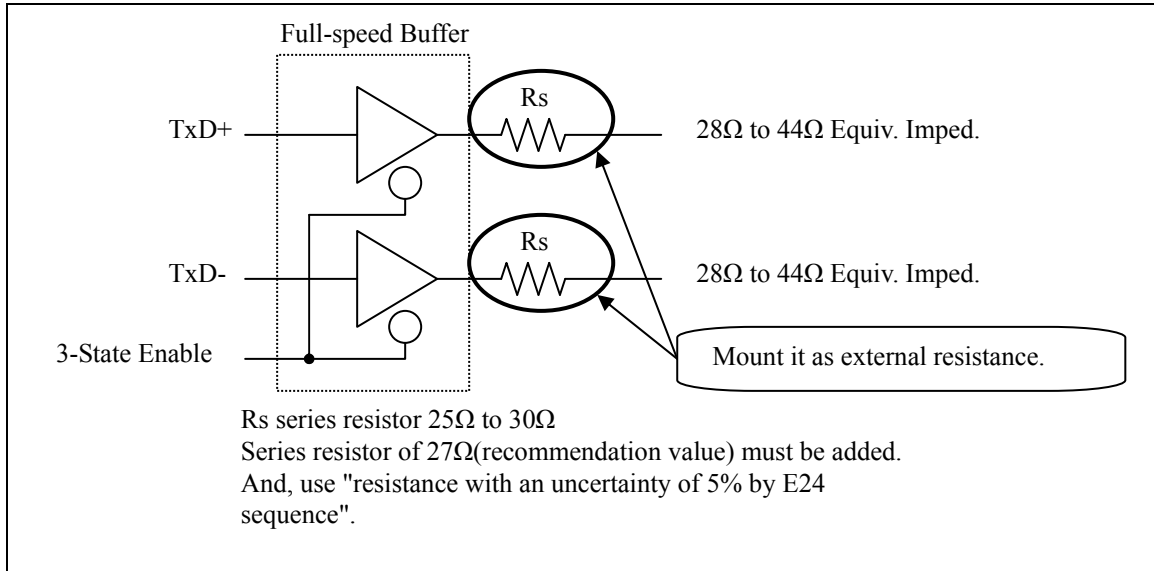


# MB9B500 Series

\*6 : USB Full-speed connection is performed via twist pair cable shield with  $90\Omega \pm 15\%$  characteristic impedance(Differential Mode).

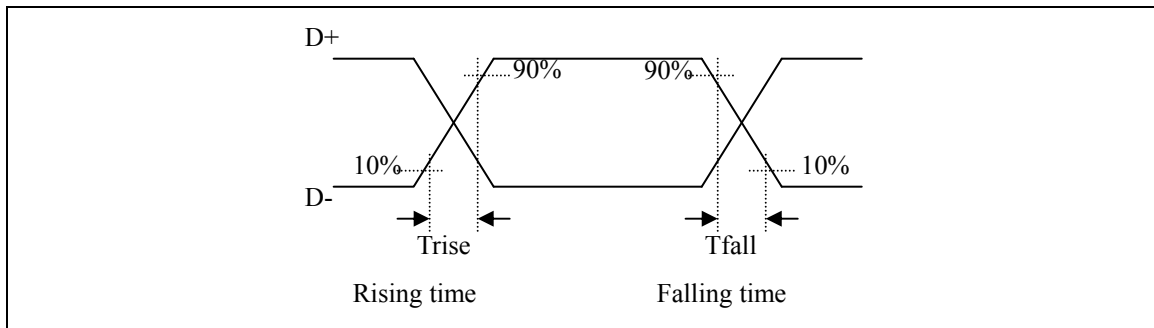
USB standard defines that output impedance of USB driver must be in range from  $28\Omega$  to  $44\Omega$ . So, discrete series resistor ( $R_s$ ) addition is defined in order to satisfy the above definition and keep balance.

When using this USB FLS I/O, use it with  $25\Omega$  to  $30\Omega$ (recommendation value  $27\Omega$ )series resistor  $R_s$ .



\*7 : They indicate rise time ( $T_{rise}$ ) and fall time ( $T_{fall}$ ) 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

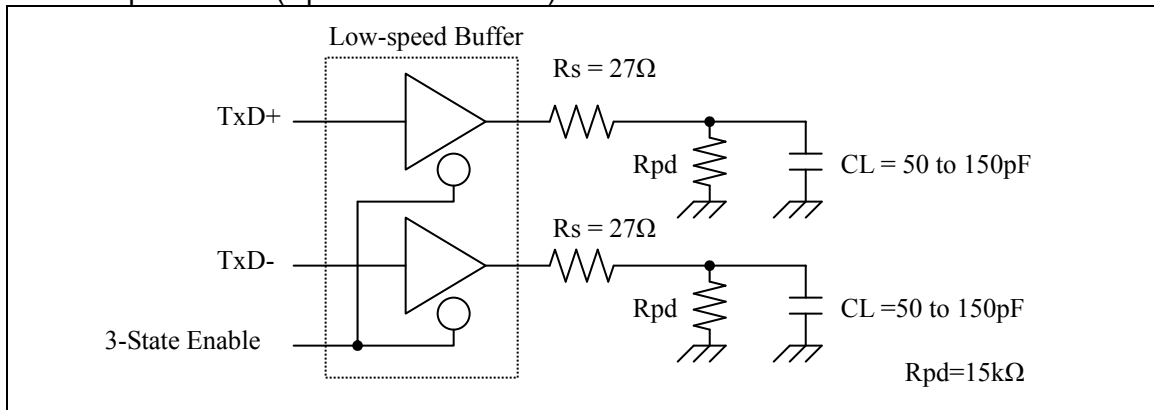


Figure 2 Low-Speed Load (Downstream Port Load) - Reference 2

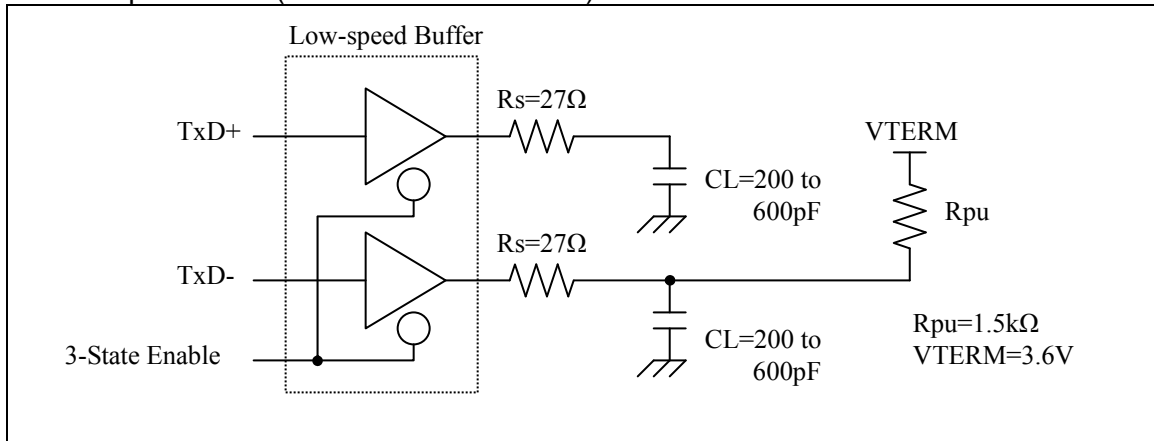
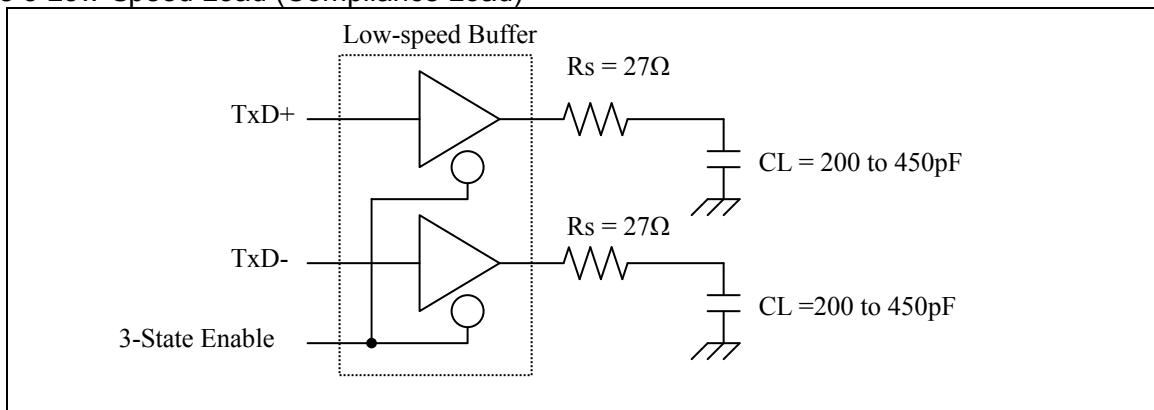


Figure 3 Low-Speed Load (Compliance Load)



# MB9B500 Series

## ● 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 <sub>LVDW</sub> | -          | -     | -    | 4500 × tcycp * | μs   | MB9BF500           |

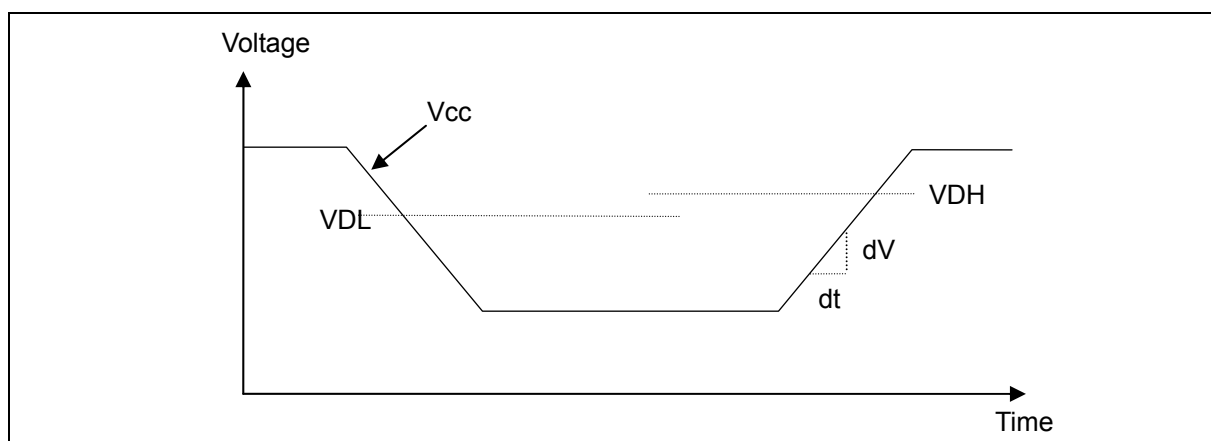
\* : tcycp indicates the peripheral clock cycle time.

### 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 <sub>LVDW</sub> | -           | -     | -   | 4500 × tcycp * | μs   | MB9BF500           |
|                             |                   |             |       |     | 2040 × tcycp * |      | MB9BF504/505/506   |

\* : tcycp indicates the peripheral clock cycle time.



## ● Flash Memory Write/Erase Characteristics

### 1. MB9BF500

(V<sub>cc</sub> = 2.7V to 5.5V, T<sub>a</sub> = - 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 | When T <sub>a</sub> = + 25°C                   |
|                               | 10,000 | -   | -    |       |                                                |
| 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

(V<sub>cc</sub> = 2.7V to 5.5V, T<sub>a</sub> = - 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 |

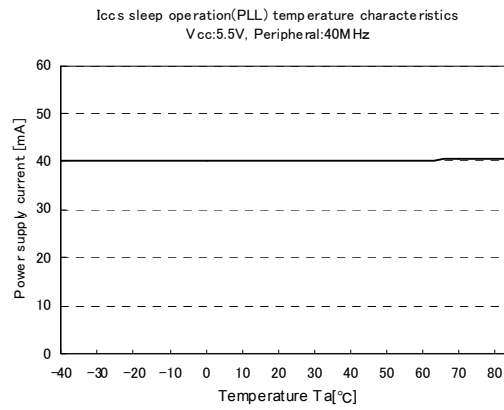
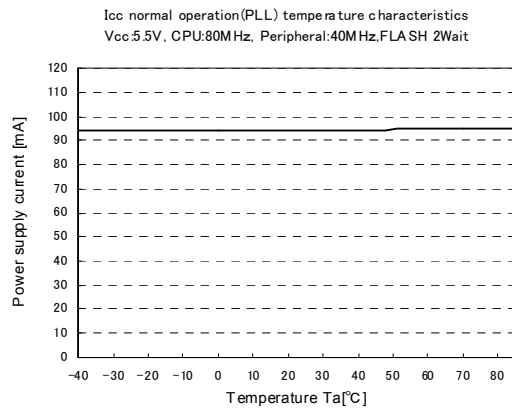
Erase/write cycles and data hold time

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

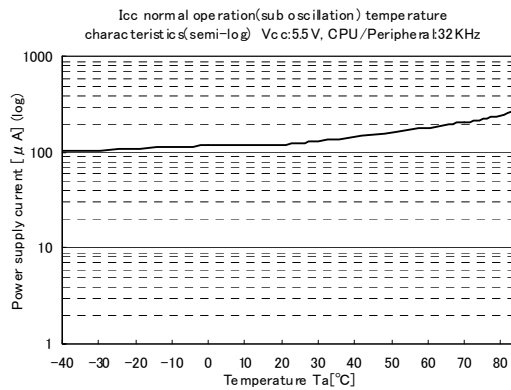
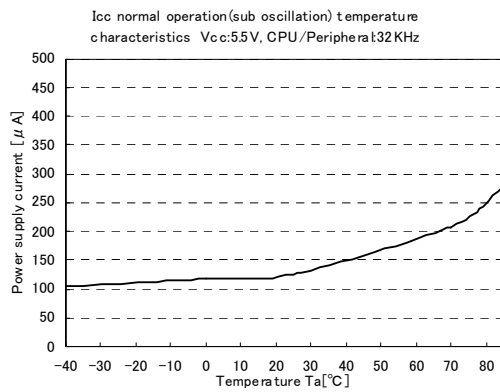
\*: This value comes from the technology qualification (using Arrhenius equation to translate high temperature measurements into normalized value at + 85°C) .

## ■ EXAMPLE OF CHARACTERISTIC

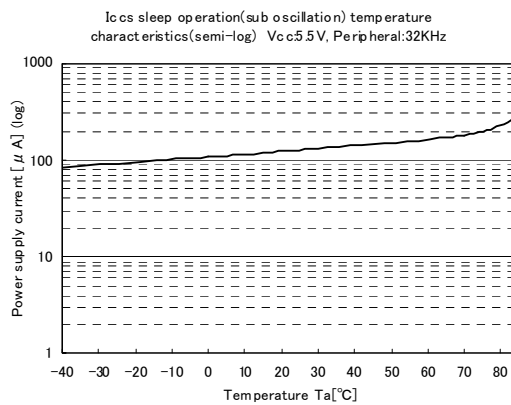
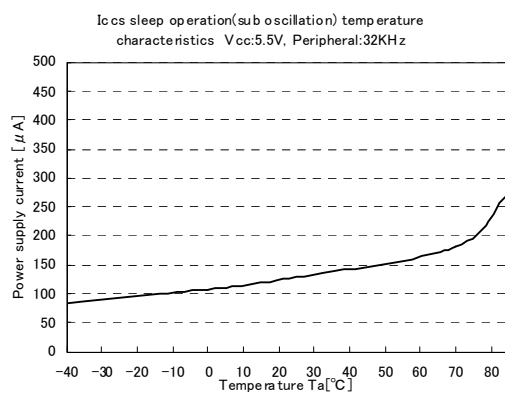
### Power supply current (PLL run mode, PLL sleep mode)



### Power supply current (Sub run mode)

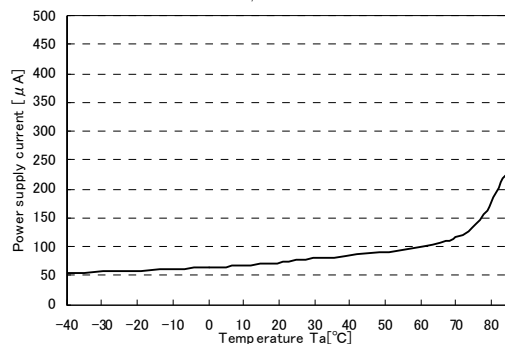


### Power supply current (Sub sleep mode)

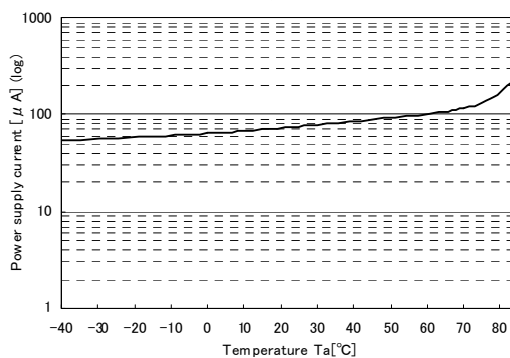


## Power supply current (Sub timer mode)

$I_{CC1}$  timer mode(sub oscillation) temperature characteristics  
Vcc:5.5V, LVD is Off

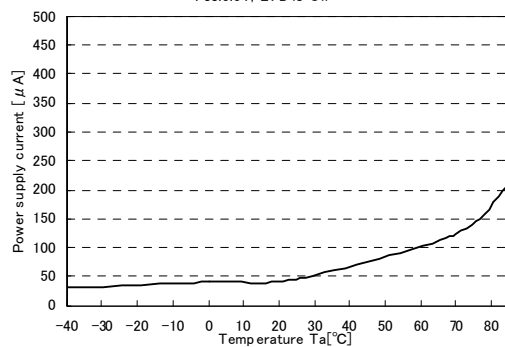


$I_{CC1}$  timer mode(sub oscillation) temperature characteristics(semi-log) Vcc:5.5V, LVD is Off

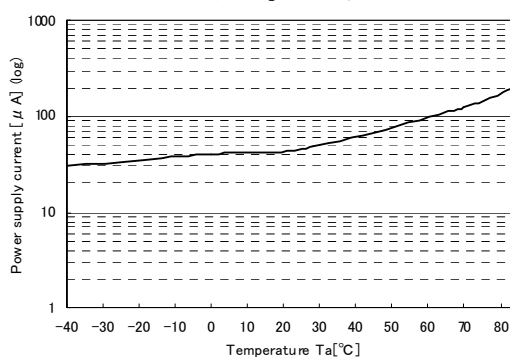


## Power supply current (Stop mode)

$I_{CC1}$  stop mode (sub oscillation) temperature characteristics  
Vcc:5.5V, LVD is Off



$I_{CC1}$  stop mode (sub oscillation) temperature characteristics(semi-log) Vcc:5.5V, LVD is Off



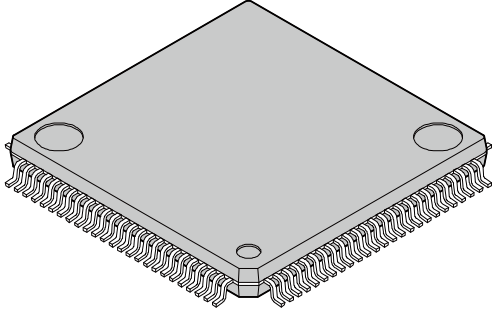
# MB9B500 Series

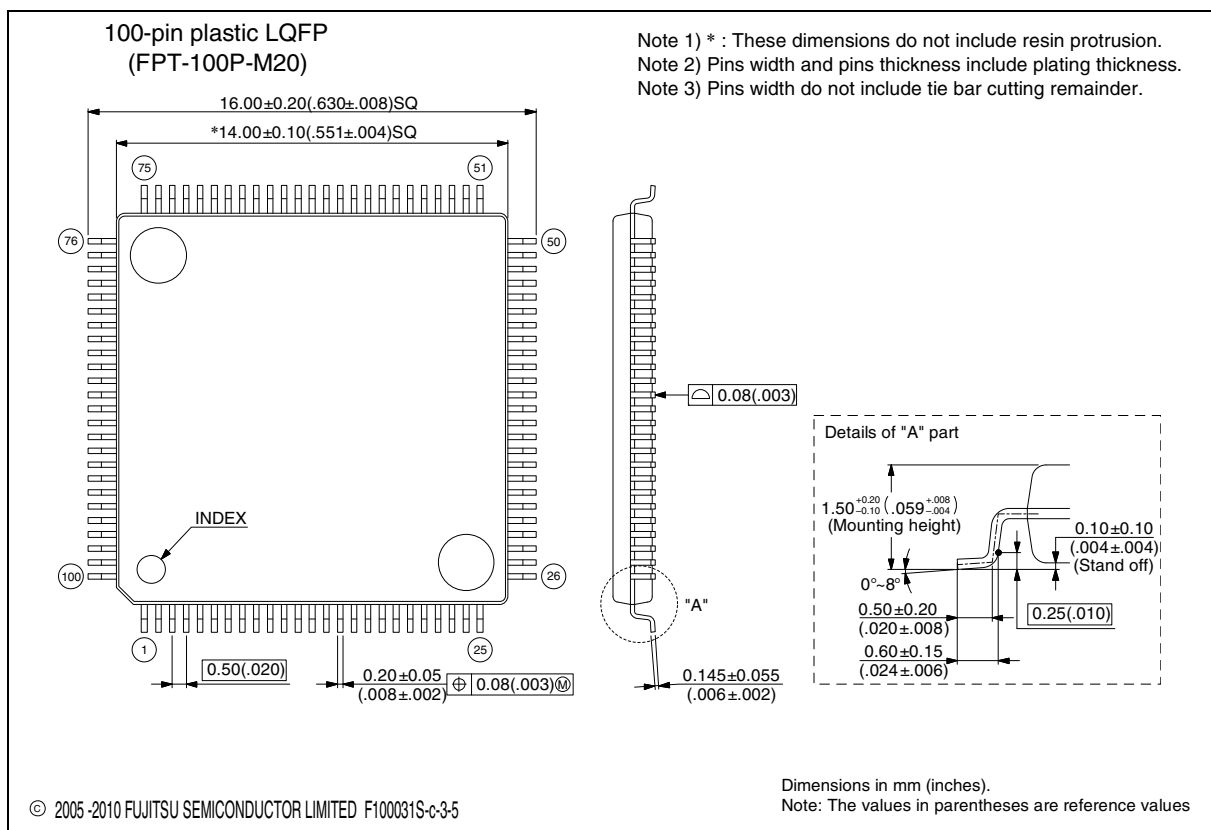
## ■ ORDERING INFORMATION

| Part number  | Package                                                    |
|--------------|------------------------------------------------------------|
| MB9BF504NPMC | Plastic • LQFP(0.5mm pitch),100-pin<br>(FPT-100P-M20*/M23) |
| MB9BF505NPMC | Plastic • LQFP(0.5mm pitch),100-pin<br>(FPT-100P-M20*/M23) |
| MB9BF506NPMC | Plastic • LQFP(0.5mm pitch),100-pin<br>(FPT-100P-M20*/M23) |
| MB9BF504RPMC | Plastic • LQFP(0.5mm pitch),120-pin<br>(FPT-120P-M21)      |
| MB9BF505RPMC | Plastic • LQFP(0.5mm pitch),120-pin<br>(FPT-120P-M21)      |
| MB9BF506RPMC | Plastic • LQFP(0.5mm pitch),120-pin<br>(FPT-120P-M21)      |
| MB9BF504NBGL | Plastic • PFBGA(0.8mm pitch),112-pin<br>(BGA-112P-M04)     |
| MB9BF505NBGL | Plastic • PFBGA(0.8mm pitch),112-pin<br>(BGA-112P-M04)     |
| MB9BF506NBGL | Plastic • PFBGA(0.8mm pitch),112-pin<br>(BGA-112P-M04)     |

\* : ES product only

## ■ PACKAGE DIMENSIONS

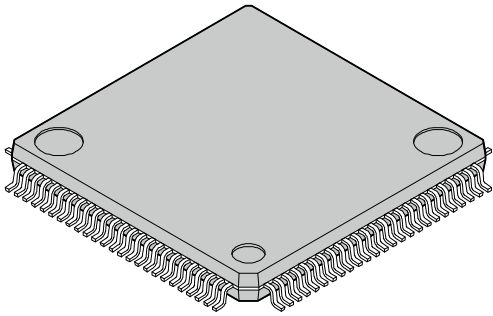
|                                                                                                                                     |                                |                       |
|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-----------------------|
|  <p>100-pin plastic LQFP</p> <p>(FPT-100P-M20)</p> | 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                |
|                                                                                                                                     | Code (Reference)               | P-LFQFP100-14×14-0.50 |

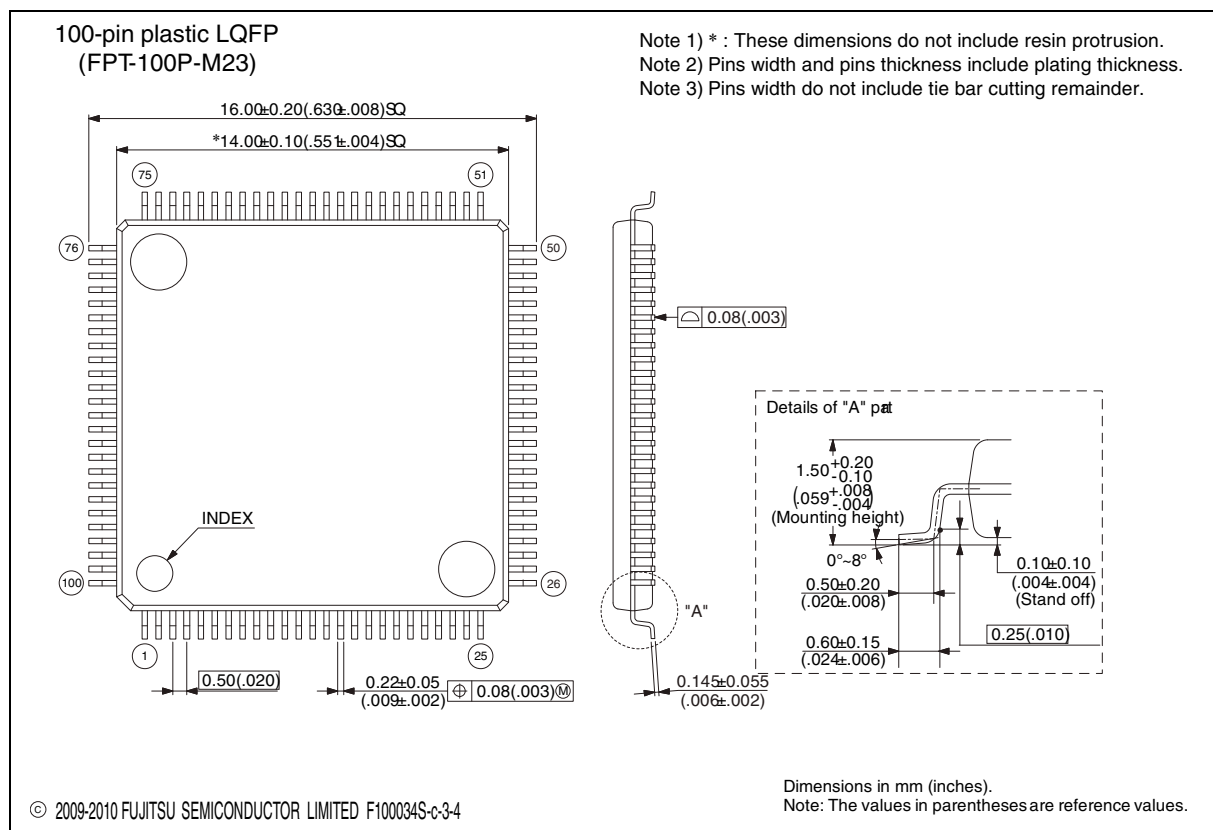


Please check the latest package dimension at the following URL.  
<http://edevic.fujitsu.com/package/en-search/>

# MB9B500 Series

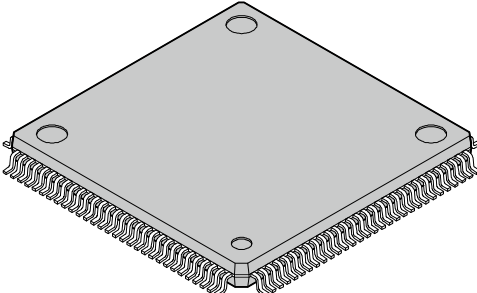
(Continued)

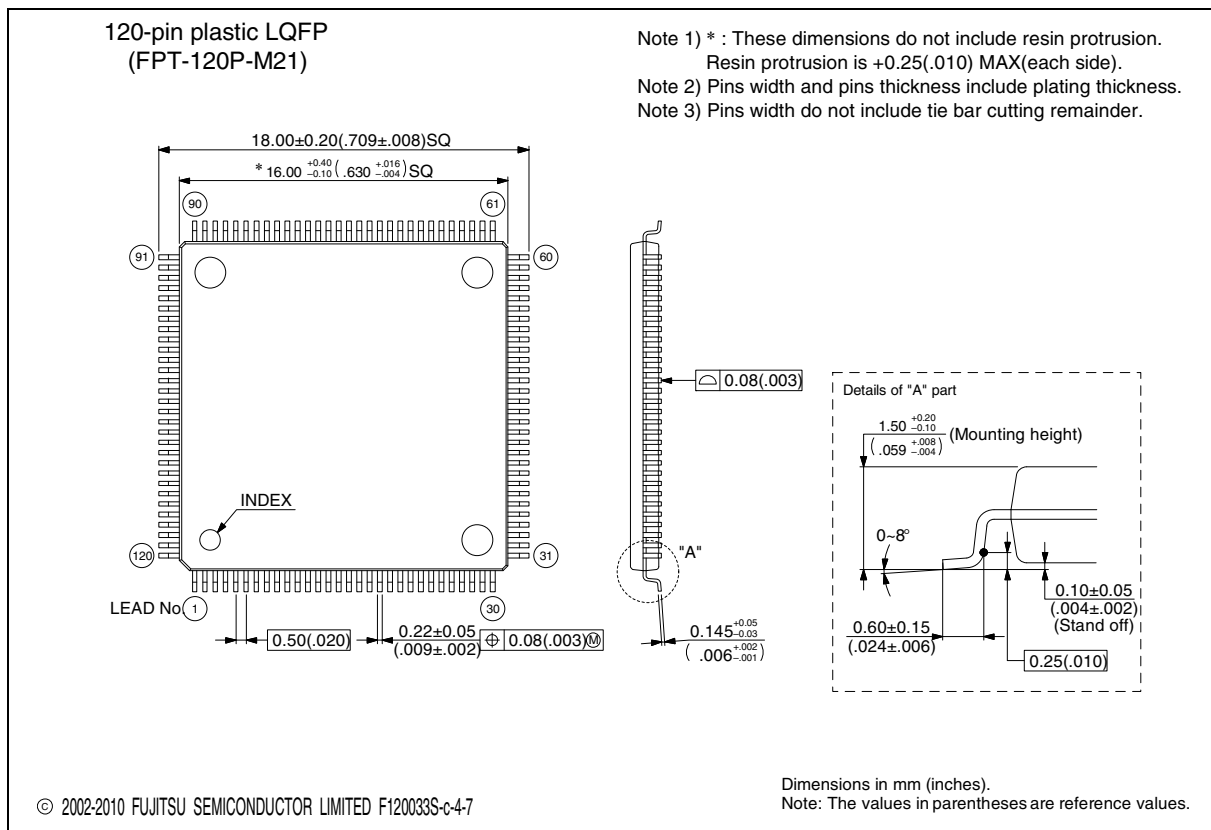
|                                                                                                                                     |                                |                     |
|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|---------------------|
|  <p>100-pin plastic LQFP</p> <p>(FPT-100P-M23)</p> | Lead pitch                     | 0.50 mm             |
|                                                                                                                                     | Package width × package length | 14.00 mm × 14.00 mm |
|                                                                                                                                     | Lead shape                     | Gullwing            |
|                                                                                                                                     | Lead bend direction            | Normal bend         |
|                                                                                                                                     | Sealing method                 | Plastic mold        |
|                                                                                                                                     | Mounting height                | 1.70 mm MAX         |
|                                                                                                                                     | Weight                         | 0.65 g              |



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

(Continued)

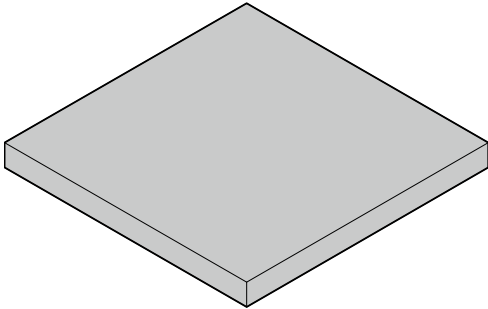
|                                                                                                                                     |                                |                       |
|-------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|-----------------------|
| <p>120-pin plastic LQFP</p>  <p>(FPT-120P-M21)</p> | 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                |
|                                                                                                                                     | Code (Reference)               | P-LFQFP120-16×16-0.50 |

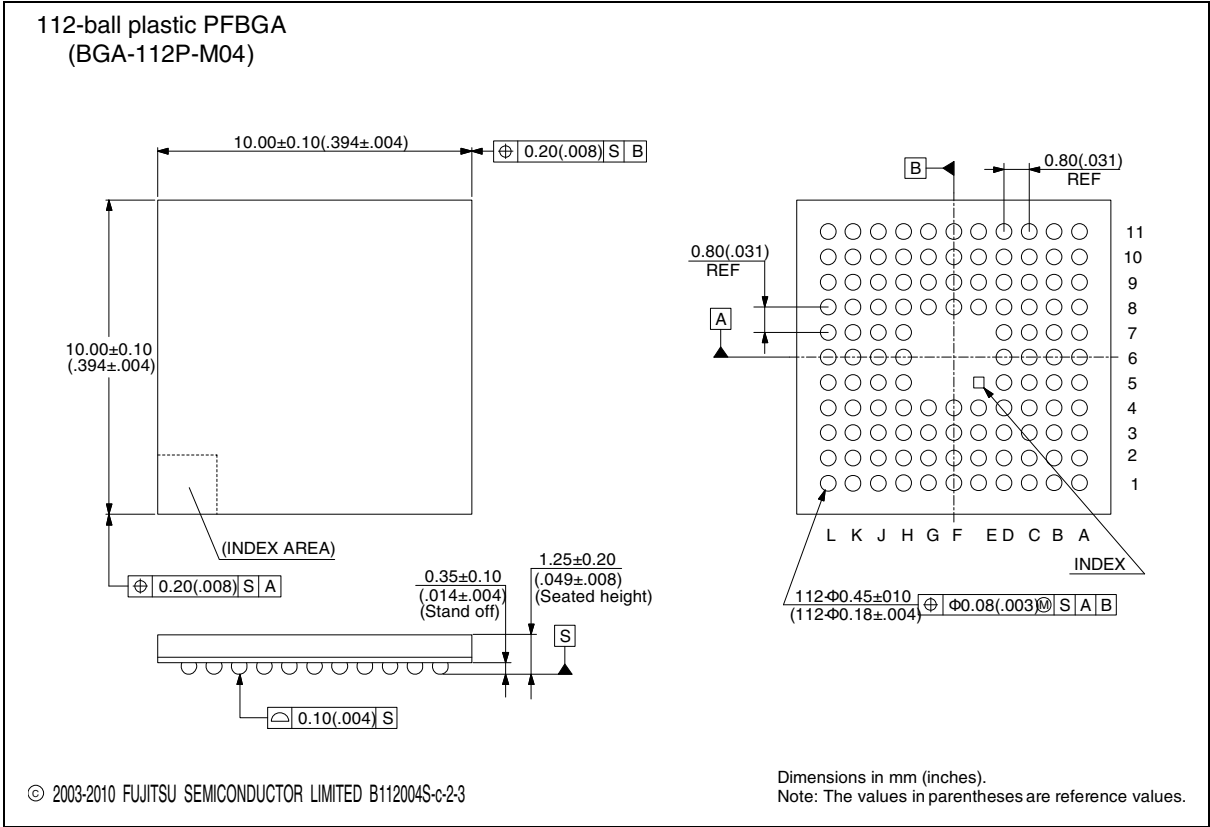


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<http://edevic.fujitsu.com/package/en-search/>

# MB9B500 Series

(Continued)

|                                                                                                                                               |                                |                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|------------------|
| <div>112-ball plastic PFBGA</div>  <div>(BGA-112P-M04)</div> | 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.     |
|                                                                                                                                               | Weight                         | 0.22 g           |



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

## ■ MAJOR CHANGES IN THIS EDITION

| Page        | Section                                                                                           | Change Results                                                              |
|-------------|---------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| -           | All                                                                                               | Added package : LQFP100(FPT-100P-M23).                                      |
| 71          | ■ELECTRICAL CHARACTERISTICS<br>●AC Characteristics<br>(3) Built-in CR Oscillation Characteristics | Changed the value of " • Built-in high-speed CR".<br>(TBD → Fixed value)    |
| 101         | ●12bit A/D Converter                                                                              | Changed the value and remarks of T <sub>ck</sub> , AVCC, AVR <sub>H</sub> . |
| 110,<br>111 | ■EXAMPLE OF CHARACTERISTIC                                                                        | Added a new section.                                                        |
| 112         | ■ORDERING INFORMATION                                                                             | Added a new section.                                                        |

In the previous revision, the number at the upper-right of the page is DS706-00010-0v01-E.

**MEMO**

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