



MB9BF116S/T
MB9BF117S/T
MB9BF118S/T

FM3, MB9B110T Series, 32-bit ARM[®] Cortex[®]-M3 based Microcontroller Datasheet

The MB9B110T Series are highly integrated 32-bit microcontrollers dedicated for embedded controllers with high-performance and competitive cost.

These series are based on the ARM Cortex-M3 Processor with on-chip Flash memory and SRAM, and have peripheral functions such as Motor Control Timers, ADCs and Communication Interfaces (UART, CSIO, I²C, LIN).

The products which are described in this data sheet are placed into TYPE2 product categories in "FM3 Family PERIPHERAL MANUAL".

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Features

32-bit ARM Cortex-M3 Core

- Processor version: r2p1
- Up to 144 MHz Frequency Operation
- Memory Protection Unit (MPU): improves 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 1 Mbyte
- Built-in Flash memory Accelerator System with 16 Kbyte trace buffer memory
The read access to Flash memory can be achieved without wait cycle up to the operation frequency of 72MHz. Even at the operation frequency more than 72 MHz, an equivalent access to Flash memory can be obtained by Flash memory Accelerator System.
- Security function for code protection

[SRAM]

This Series on-chip SRAM is composed of two independent SRAMs (SRAM0, SRAM1). SRAM0 is connected to I-code bus and D-code bus of Cortex-M3 core. SRAM1 is connected to System bus.

- SRAM0: Up to 64 Kbytes.
- SRAM1: Up to 64 Kbytes.

External Bus Interface

- Supports SRAM, NOR and NAND Flash memory devices
- Up to 8 chips selected
- 8-/16-bit Data width
- Up to 25-bit Address bit
- Maximum area size: Up to 256 Mbytes
- Supports Address/Data multiplex
- Supports external RDY function

Multi-function Serial Interface (Max 8 channels)

- 4 channels with 16stepsx9-bit FIFO (ch.4 to ch.7), 4 channels without FIFO (ch.0 to ch.3)
- Operation mode is selectable from the followings for each channel.
 - UART
 - CSIO
 - LIN
 - I2C

[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 controls the transmission/reception with CTS/RTS (only for ch.4)
- Various error detection functions available (parity errors, framing errors, and overrun errors)

[CSIO]

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

[LIN]

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

[I²C]

Standard-mode (Max 100 kbps) / Fast-mode (Max 400 kbps) supported

DMA Controller (8 channels)

The DMA Controller has a dedicated bus independent from the 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: 32 bits (4 Gbytes)
- 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 32 channels)
[12-bit A/D Converter]

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

Base Timer (Max 16 channels)

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

This series can use its pins as I/O ports when they are not used for an 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 to.

- Capable of pull-up control per pin
- Capable of reading pin level directly
- Built-in port relocate function
- Up to 154 fast I/O Ports@ 176 pin Package
- Some ports are 5 V tolerant I/O.
See "Pin Assignment" to confirm the corresponding pins.

Multi-function Timer (Max 3 units)

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

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

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

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

Quadrature Position/Revolution Counter (QPRC) (Max 3 channels)

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

- The detection edge of 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 (32-/16-bit 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 low-power consumption mode.

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

External Interrupt Controller Unit

- Up to 32 external interrupt input pins
- One non-maskable interrupt (NMI) pin

Watchdog Timer (2 channels)

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

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

The "Hardware" watchdog timer is operated by the built-in low-speed CR oscillator. Therefore, the "Hardware" watchdog is active in any low-power consumption mode except STOP mode.

CRC (Cyclic Redundancy Check) Accelerator

The CRC accelerator calculates the CRC which has a heavy software processing load, and achieves a reduction of the integrity check processing load for reception data and storage.

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]

Selectable from five clock sources (2 external oscillators, 2 built-in CR oscillators, and Main PLL).

- Main Clock: 4 MHz to 48 MHz
- Sub Clock: 32.768 kHz
- Built-in high-speed CR Clock: 4 MHz
- Built-in low-speed CR Clock: 100 kHz
- Main PLL Clock

[Resets]

- Reset requests from INITX pin
- Power-on reset
- Software reset
- Watchdog timers reset
- Low-voltage detection reset
- Clock supervisor reset

Clock Super Visor (CSV)

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

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

Low-Voltage Detector (LVD)

This Series includes 2-stage monitoring of voltage on the VCC pins. When the voltage falls below the voltage set, Low Voltage Detector generates an interrupt or reset.

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

Low-Power Consumption Mode

Three Low-Power Consumption modes supported.

- Sleep
- Timer
- Stop

Debug

- Serial Wire JTAG Debug Port (SWJ-DP)
- Embedded Trace Macrocells (ETM).

Power Supply

Wide range voltage VCC = 2.7 V to 5.5 V

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1. Product Lineup

1.1 Memory size

| Product name | MB9BF116S/T | MB9BF117S/T | MB9BF118S/T |
|----------------------|-------------|-------------|-------------|
| On-chip Flash memory | 512 Kbytes | 768 Kbytes | 1 Mbytes |
| On-chip SRAM | 64 Kbytes | 96 Kbytes | 128 Kbytes |

1.2 Function

| Product name | | MB9BF116S MB9BF117S MB9BF118S | MB9BF116T MB9BF117T MB9BF118T |
|---|------------------------|--|---|
| Pin count | | 144 | 176/192 |
| CPU | | Cortex-M3 | |
| Freq. | | 144 MHz | |
| Supply voltage range | | 2.7 V to 5.5 V | |
| DMAC | | 8ch | |
| External Bus Interface | | Addr:19-bit (Max) R/Wdata:8-/16-bit (Max) CS: 8 (Max) Support: SRAM, NOR & NAND Flash memory | Addr:25-bit (Max) R/Wdata:8-/16-bit (Max) CS:8 (Max) Support: SRAM, NOR & NAND Flash memory |
| Multi-function Serial Interface (UART/CSIO/LIN/I ² C) | | 8ch. (Max) ch.4 to ch.7: FIFO (16steps x9 bits) ch.0 to ch.3: No FIFO | |
| Base Timer (PWC/ Reload timer/PWM/PPG) | | 16ch. (Max) | |
| MF-Timer | A/D activation compare | 3ch. | 3 units (Max) |
| | Input capture | 4ch. | |
| | Free-run timer | 3ch. | |
| | Output compare | 6ch. | |
| | Waveform generator | 3ch. | |
| | PPG | 3ch. | |
| QPRC | | 3ch. (Max) | |
| Dual Timer | | 1 unit | |
| Watch Counter | | 1 unit | |
| CRC Accelerator | | Yes | |
| Watchdog timer | | 1ch. (SW) + 1ch. (HW) | |
| External Interrupts | | 32 pins (Max) + NMI pinx 1 | |
| I/O ports | | 122 pins (Max) | 154 pins (Max) |
| 12-bit A/D converter | | 24ch. (3 units) | 32ch. (3 units) |
| CSV (Clock Super Visor) | | Yes | |
| LVD (Low-Voltage Detector) | | 2ch. | |
| Built-in CR | High-speed | 4 MHz | |
| | Low-speed | 100 kHz | |
| Debug Function | | SWJ-DP/ETM | |

Note:

- All signals of the peripheral function in each product cannot be allocated due to the pin count restriction of a package. It is necessary to use the port relocate function of the I/O port according to functions use.
- See "Electrical Characteristics 12.4 AC Characteristics 12.4.3 Internal CR Oscillation Characteristics" for accuracy of built-in CR.

2. Packages

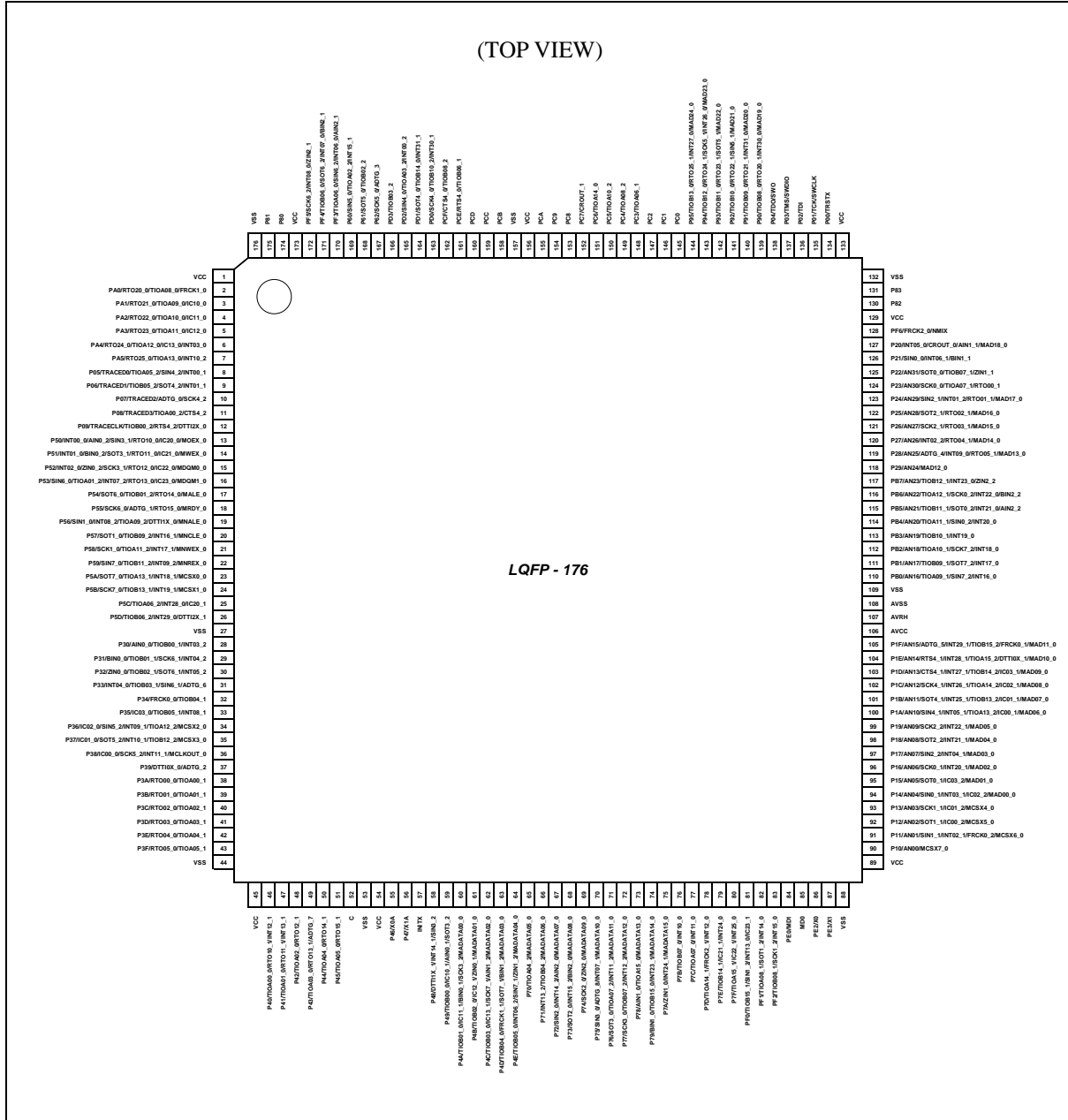
| Product name Package | MB9BF116S MB9BF117S MB9BF118S | MB9BF116T MB9BF117T MB9BF118T |
|-----------------------------------|-------------------------------------|-------------------------------------|
| LQFP: FPT-144P-M08 (0.5 mm pitch) | ○ | - |
| LQFP: FPT-176P-M07 (0.5 mm pitch) | - | ○ |
| BGA: BGA-192P-M06 (0.8 mm pitch) | - | ○ |

○: Supported

Note: See "Package Dimensions" for detailed information on each package.

3. Pin Assignment

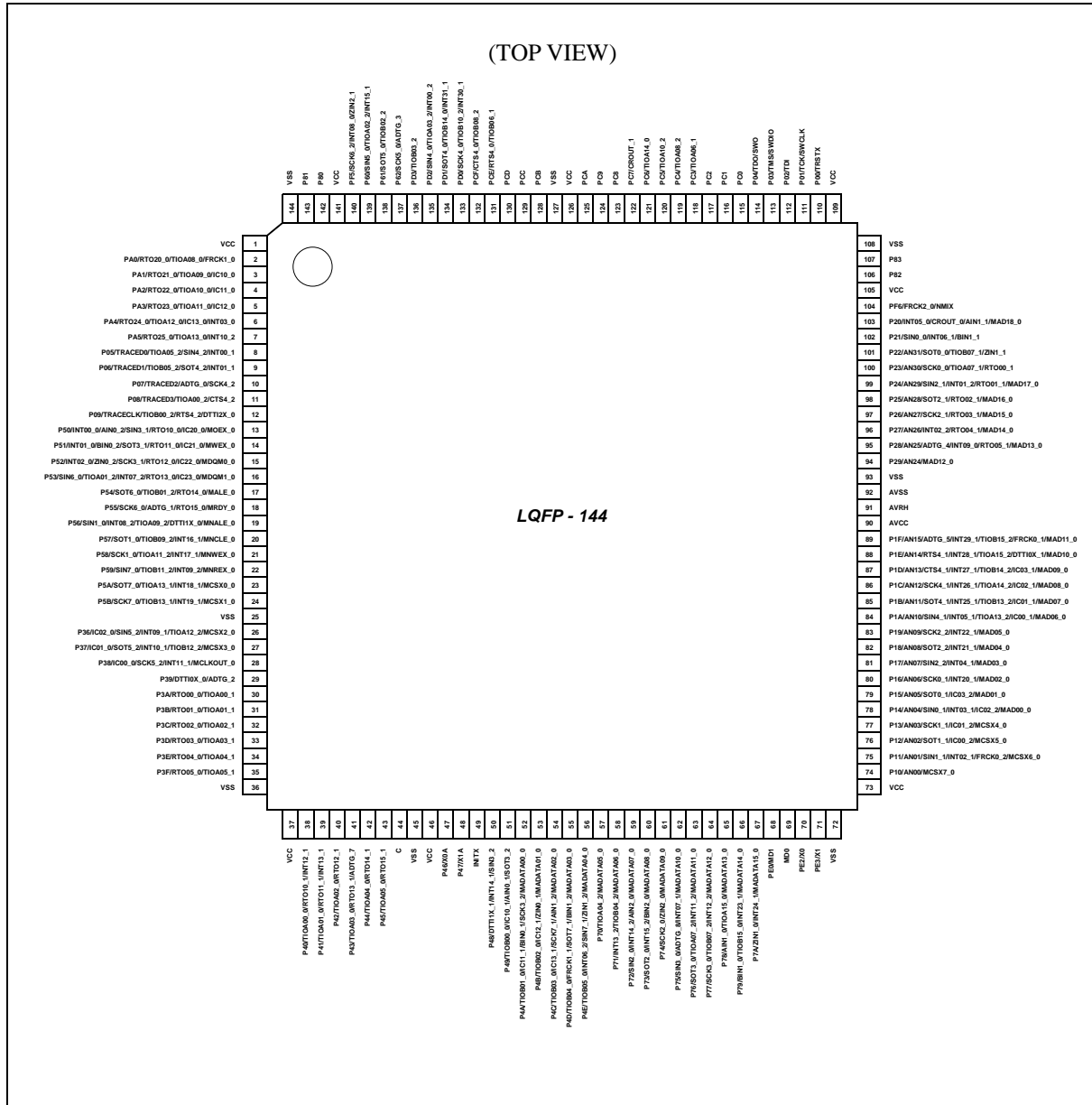
FPT-176P-M07



Note:

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. TIOA09_0, TIOA09_1, and TIOA09_2 cannot be used as the external startup trigger input (TGIN signal) at I/O mode 1 (timer full mode) of the Base Timer. See "7.11 Base Timer" in "Handling Devices" for details.

FPT-144P-M08

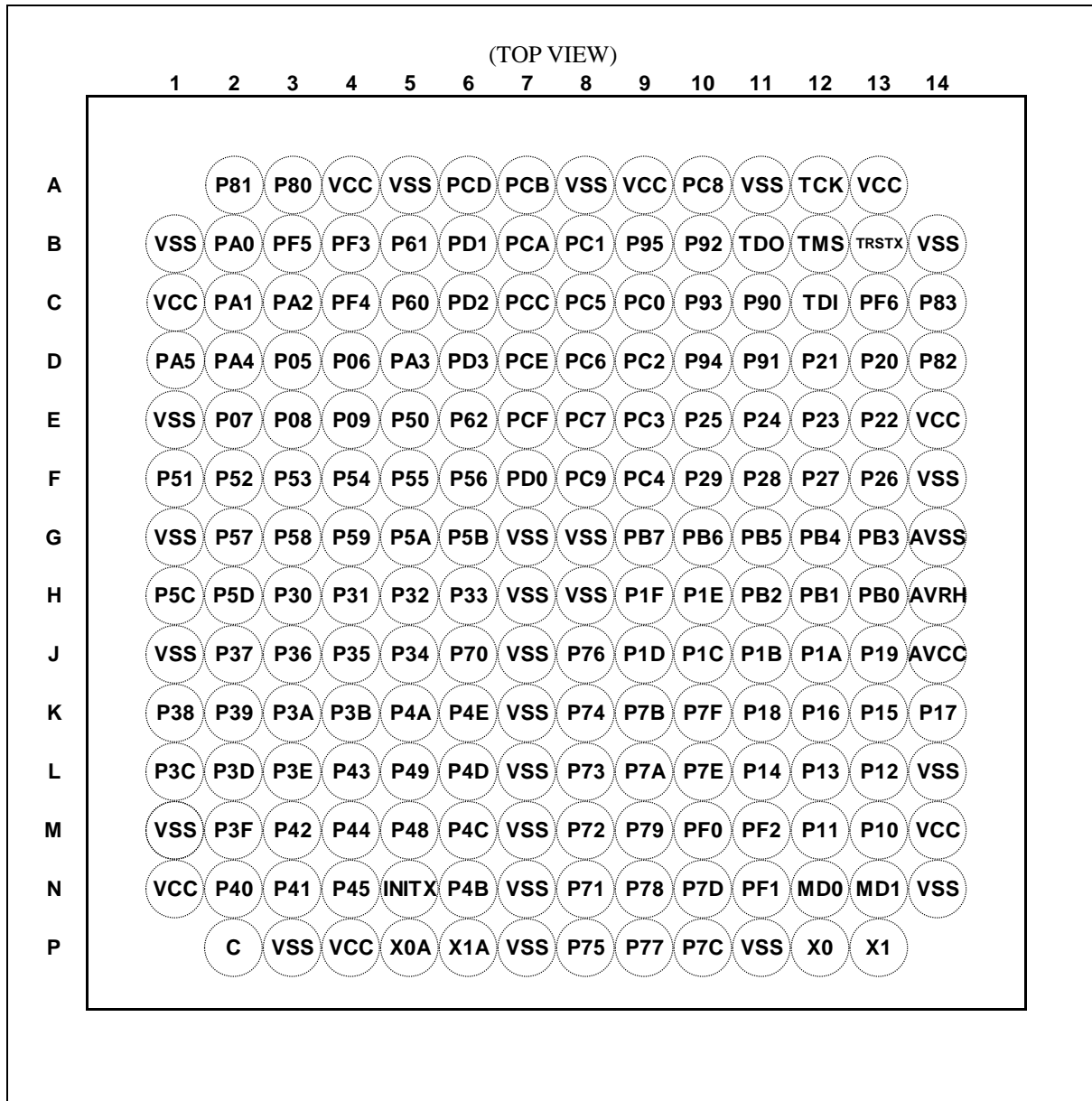


Note:

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.

TIOA09_0, TIOA09_1, and TIOA09_2 cannot be used as the external startup trigger input (TGIN signal) at I/O mode 1 (timer full mode) of the Base Timer. See "7.11 Base Timer" in "Handling Devices" for details.

BGA-192P-M06



Note:

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.

TIOA09_0, TIOA09_1, and TIOA09_2 cannot be used as the external startup trigger input (TGIN signal) at I/O mode 1 (timer full mode) of the Base Timer. See "7.11 Base Timer" in "Handling Devices" for details.

4. List of Pin Functions

4.1 List of pin numbers

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, the same function is provided on 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-176 | LQFP-144 | BGA-192 | | | |
| 1 | 1 | C1 | VCC | - | |
| 2 | 2 | B2 | PA0 | G | I |
| | | | RTO20_0 | | |
| | | | TIOA08_0 | | |
| | | | FRCK1_0 | | |
| 3 | 3 | C2 | PA1 | G | I |
| | | | RTO21_0 | | |
| | | | TIOA09_0 | | |
| | | | IC10_0 | | |
| 4 | 4 | C3 | PA2 | G | I |
| | | | RTO22_0 | | |
| | | | TIOA10_0 | | |
| | | | IC11_0 | | |
| 5 | 5 | D5 | PA3 | G | I |
| | | | RTO23_0 | | |
| | | | TIOA11_0 | | |
| | | | IC12_0 | | |
| 6 | 6 | D2 | PA4 | G | H |
| | | | RTO24_0 | | |
| | | | TIOA12_0 | | |
| | | | IC13_0 | | |
| | | | INT03_0 | | |
| 7 | 7 | D1 | PA5 | G | H |
| | | | RTO25_0 | | |
| | | | TIOA13_0 | | |
| | | | INT10_2 | | |
| 8 | 8 | D3 | P05 | E | F |
| | | | TRACED0 | | |
| | | | TIOA05_2 | | |
| | | | SIN4_2 | | |
| | | | INT00_1 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 9 | 9 | D4 | P06 | E | F |
| | | | TRACED1 | | |
| | | | TIOB05_2 | | |
| | | | SOT4_2 | | |
| | | | INT01_1 | | |
| 10 | 10 | E2 | P07 | E | G |
| | | | TRACED2 | | |
| | | | ADTG_0 | | |
| | | | SCK4_2 | | |
| 11 | 11 | E3 | P08 | E | G |
| | | | TRACED3 | | |
| | | | TIOA00_2 | | |
| | | | CTS4_2 | | |
| 12 | 12 | E4 | P09 | E | G |
| | | | TRACECLK | | |
| | | | TIOB00_2 | | |
| | | | RTS4_2 | | |
| | | | DTTI2X_0 | | |
| 13 | 13 | E5 | P50 | E | H |
| | | | INT00_0 | | |
| | | | AIN0_2 | | |
| | | | SIN3_1 | | |
| | | | RTO10_0 | | |
| | | | IC20_0 | | |
| | | | MOEX_0 | | |
| 14 | 14 | F1 | P51 | E | H |
| | | | INT01_0 | | |
| | | | BIN0_2 | | |
| | | | SOT3_1 | | |
| | | | RTO11_0 | | |
| | | | IC21_0 | | |
| | | | MWEX_0 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 15 | 15 | F2 | P52 | E | H |
| | | | INT02_0 | | |
| | | | ZIN0_2 | | |
| | | | SCK3_1 | | |
| | | | RTO12_0 | | |
| | | | IC22_0 | | |
| | | | MDQM0_0 | | |
| 16 | 16 | F3 | P53 | E | H |
| | | | SIN6_0 | | |
| | | | TIOA01_2 | | |
| | | | INT07_2 | | |
| | | | RTO13_0 | | |
| | | | IC23_0 | | |
| | | | MDQM1_0 | | |
| 17 | 17 | F4 | P54 | E | I |
| | | | SOT6_0 | | |
| | | | TIOB01_2 | | |
| | | | RTO14_0 | | |
| | | | MALE_0 | | |
| 18 | 18 | F5 | P55 | E | I |
| | | | SCK6_0 | | |
| | | | ADTG_1 | | |
| | | | RTO15_0 | | |
| | | | MRDY_0 | | |
| 19 | 19 | F6 | P56 | E | H |
| | | | SIN1_0 | | |
| | | | INT08_2 | | |
| | | | TIOA09_2 | | |
| | | | DTT11X_0 | | |
| | | | MNALE_0 | | |
| 20 | 20 | G2 | P57 | E | H |
| | | | SOT1_0 | | |
| | | | TIOB09_2 | | |
| | | | INT16_1 | | |
| | | | MNCLE_0 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 21 | 21 | G3 | P58 | E | H |
| | | | SCK1_0 | | |
| | | | TIOA11_2 | | |
| | | | INT17_1 | | |
| | | | MNWEX_0 | | |
| 22 | 22 | G4 | P59 | E | H |
| | | | SIN7_0 | | |
| | | | TIOB11_2 | | |
| | | | INT09_2 | | |
| | | | MNREX_0 | | |
| 23 | 23 | G5 | P5A | E | H |
| | | | SOT7_0 | | |
| | | | TIOA13_1 | | |
| | | | INT18_1 | | |
| | | | MCSX0_0 | | |
| 24 | 24 | G6 | P5B | E | H |
| | | | SCK7_0 | | |
| | | | TIOB13_1 | | |
| | | | INT19_1 | | |
| | | | MCSX1_0 | | |
| 25 | - | H1 | P5C | E | H |
| | | | TIOA06_2 | | |
| | | | INT28_0 | | |
| | | | IC20_1 | | |
| 26 | - | H2 | P5D | E | H |
| | | | TIOB06_2 | | |
| | | | INT29_0 | | |
| | | | DTTI2X_1 | | |
| 27 | 25 | J1 | VSS | - | |
| 28 | - | H3 | P30 | E | H |
| | | | AIN0_0 | | |
| | | | TIOB00_1 | | |
| | | | INT03_2 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 29 | - | H4 | P31 | E | H |
| | | | BIN0_0 | | |
| | | | TIOB01_1 | | |
| | | | SCK6_1 | | |
| | | | INT04_2 | | |
| 30 | - | H5 | P32 | E | H |
| | | | ZIN0_0 | | |
| | | | TIOB02_1 | | |
| | | | SOT6_1 | | |
| | | | INT05_2 | | |
| 31 | - | H6 | P33 | E | H |
| | | | INT04_0 | | |
| | | | TIOB03_1 | | |
| | | | SIN6_1 | | |
| | | | ADTG_6 | | |
| 32 | - | J5 | P34 | E | I |
| | | | FRCK0_0 | | |
| | | | TIOB04_1 | | |
| 33 | - | J4 | P35 | E | H |
| | | | IC03_0 | | |
| | | | TIOB05_1 | | |
| | | | INT08_1 | | |
| 34 | 26 | J3 | P36 | E | H |
| | | | IC02_0 | | |
| | | | SIN5_2 | | |
| | | | INT09_1 | | |
| | | | TIOA12_2 | | |
| | | | MCSX2_0 | | |
| 35 | 27 | J2 | P37 | E | H |
| | | | IC01_0 | | |
| | | | SOT5_2 | | |
| | | | INT10_1 | | |
| | | | TIOB12_2 | | |
| | | | MCSX3_0 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|-----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 36 | 28 | K1 | P38 | E | H |
| | | | IC00_0 | | |
| | | | SCK5_2 | | |
| | | | INT11_1 | | |
| | | | MCLKOUT_0 | | |
| 37 | 29 | K2 | P39 | E | I |
| | | | DTTIOX_0 | | |
| | | | ADTG_2 | | |
| 38 | 30 | K3 | P3A | G | I |
| | | | RTO00_0 | | |
| | | | TIOA00_1 | | |
| 39 | 31 | K4 | P3B | G | I |
| | | | RTO01_0 | | |
| | | | TIOA01_1 | | |
| 40 | 32 | L1 | P3C | G | I |
| | | | RTO02_0 | | |
| | | | TIOA02_1 | | |
| 41 | 33 | L2 | P3D | G | I |
| | | | RTO03_0 | | |
| | | | TIOA03_1 | | |
| 42 | 34 | L3 | P3E | G | I |
| | | | RTO04_0 | | |
| | | | TIOA04_1 | | |
| 43 | 35 | M2 | P3F | G | I |
| | | | RTO05_0 | | |
| | | | TIOA05_1 | | |
| 44 | 36 | M1 | VSS | - | |
| 45 | 37 | N1 | VCC | - | |
| 46 | 38 | N2 | P40 | G | H |
| | | | TIOA00_0 | | |
| | | | RTO10_1 | | |
| | | | INT12_1 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 47 | 39 | N3 | P41 | G | H |
| | | | TIOA01_0 | | |
| | | | RTO11_1 | | |
| | | | INT13_1 | | |
| 48 | 40 | M3 | P42 | G | I |
| | | | TIOA02_0 | | |
| | | | RTO12_1 | | |
| 49 | 41 | L4 | P43 | G | I |
| | | | TIOA03_0 | | |
| | | | RTO13_1 | | |
| | | | ADTG_7 | | |
| 50 | 42 | M4 | P44 | G | I |
| | | | TIOA04_0 | | |
| | | | RTO14_1 | | |
| 51 | 43 | N4 | P45 | G | I |
| | | | TIOA05_0 | | |
| | | | RTO15_1 | | |
| 52 | 44 | P2 | C | - | |
| 53 | 45 | P3 | VSS | - | |
| 54 | 46 | P4 | VCC | - | |
| 55 | 47 | P5 | P46 | D | M |
| | | | X0A | | |
| 56 | 48 | P6 | P47 | D | N |
| | | | X1A | | |
| 57 | 49 | N5 | INITX | B | C |
| 58 | 50 | M5 | P48 | E | H |
| | | | DTT1X_1 | | |
| | | | INT14_1 | | |
| | | | SIN3_2 | | |
| 59 | 51 | L5 | P49 | E | I |
| | | | TIOB00_0 | | |
| | | | IC10_1 | | |
| | | | AIN0_1 | | |
| | | | SOT3_2 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|------------|----------|---------|------------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 60 | 52 | K5 | P4A | E | I |
| | | | TIOB01_0 | | |
| | | | IC11_1 | | |
| | | | BIN0_1 | | |
| | | | SCK3_2 | | |
| MADATA00_0 | | | | | |
| 61 | 53 | N6 | P4B | E | I |
| | | | TIOB02_0 | | |
| | | | IC12_1 | | |
| | | | ZIN0_1 | | |
| MADATA01_0 | | | | | |
| 62 | 54 | M6 | P4C | E | I |
| | | | TIOB03_0 | | |
| | | | IC13_1 | | |
| | | | SCK7_1 | | |
| | | | AIN1_2 | | |
| MADATA02_0 | | | | | |
| 63 | 55 | L6 | P4D | E | I |
| | | | TIOB04_0 | | |
| | | | FRCK1_1 | | |
| | | | SOT7_1 | | |
| | | | BIN1_2 | | |
| MADATA03_0 | | | | | |
| 64 | 56 | K6 | P4E | E | H |
| | | | TIOB05_0 | | |
| | | | INT06_2 | | |
| | | | SIN7_1 | | |
| | | | ZIN1_2 | | |
| MADATA04_0 | | | | | |
| 65 | 57 | J6 | P70 | E | I |
| | | | TIOA04_2 | | |
| | | | MADATA05_0 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|------------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 66 | 58 | N8 | P71 | E | H |
| | | | INT13_2 | | |
| | | | TIOB04_2 | | |
| | | | MADATA06_0 | | |
| 67 | 59 | M8 | P72 | E | H |
| | | | SIN2_0 | | |
| | | | INT14_2 | | |
| | | | AIN2_0 | | |
| | | | MADATA07_0 | | |
| 68 | 60 | L8 | P73 | E | H |
| | | | SOT2_0 | | |
| | | | INT15_2 | | |
| | | | BIN2_0 | | |
| | | | MADATA08_0 | | |
| 69 | 61 | K8 | P74 | E | I |
| | | | SCK2_0 | | |
| | | | ZIN2_0 | | |
| | | | MADATA09_0 | | |
| 70 | 62 | P8 | P75 | E | H |
| | | | SIN3_0 | | |
| | | | ADTG_8 | | |
| | | | INT07_1 | | |
| | | | MADATA10_0 | | |
| 71 | 63 | J8 | P76 | E | H |
| | | | SOT3_0 | | |
| | | | TIOA07_2 | | |
| | | | INT11_2 | | |
| | | | MADATA11_0 | | |
| 72 | 64 | P9 | P77 | E | H |
| | | | SCK3_0 | | |
| | | | TIOB07_2 | | |
| | | | INT12_2 | | |
| | | | MADATA12_0 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|------------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 73 | 65 | N9 | P78 | E | I |
| | | | AIN1_0 | | |
| | | | TIOA15_0 | | |
| | | | MADATA13_0 | | |
| 74 | 66 | M9 | P79 | E | H |
| | | | BIN1_0 | | |
| | | | TIOB15_0 | | |
| | | | INT23_1 | | |
| | | | MADATA14_0 | | |
| - | - | E1 | VSS | - | - |
| - | - | G1 | VSS | - | - |
| 75 | 67 | L9 | P7A | E | H |
| | | | ZIN1_0 | | |
| | | | INT24_1 | | |
| | | | MADATA15_0 | | |
| 76 | - | K9 | P7B | E | H |
| | | | TIOB07_0 | | |
| | | | INT10_0 | | |
| 77 | - | P10 | P7C | E | H |
| | | | TIOA07_0 | | |
| | | | INT11_0 | | |
| 78 | - | N10 | P7D | E | H |
| | | | TIOA14_1 | | |
| | | | FRCK2_1 | | |
| | | | INT12_0 | | |
| 79 | - | L10 | P7E | E | H |
| | | | TIOB14_1 | | |
| | | | IC21_1 | | |
| | | | INT24_0 | | |
| 80 | - | K10 | P7F | E | H |
| | | | TIOA15_1 | | |
| | | | IC22_1 | | |
| | | | INT25_0 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 81 | - | M10 | PF0 | I ⁽¹⁾ | H |
| | | | TIOB15_1 | | |
| | | | SIN1_2 | | |
| | | | INT13_0 | | |
| | | | IC23_1 | | |
| 82 | - | N11 | PF1 | I ⁽¹⁾ | H |
| | | | TIOA08_1 | | |
| | | | SOT1_2 | | |
| | | | INT14_0 | | |
| 83 | - | M11 | PF2 | I ⁽¹⁾ | H |
| | | | TIOB08_1 | | |
| | | | SCK1_2 | | |
| | | | INT15_0 | | |
| 84 | 68 | N13 | PE0 | C | P |
| | | | MD1 | | |
| 85 | 69 | N12 | MD0 | J | D |
| 86 | 70 | P12 | PE2 | A | A |
| | | | X0 | | |
| 87 | 71 | P13 | PE3 | A | B |
| | | | X1 | | |
| 88 | 72 | N14 | VSS | - | - |
| 89 | 73 | M14 | VCC | - | - |
| - | - | L7 | VSS | - | - |
| - | - | K7 | VSS | - | - |
| 90 | 74 | M13 | P10 | F | K |
| | | | AN00 | | |
| | | | MCSX7_0 | | |
| 91 | 75 | M12 | P11 | F | L |
| | | | AN01 | | |
| | | | SIN1_1 | | |
| | | | INT02_1 | | |
| | | | FRCK0_2 | | |
| MCSX6_0 | | | | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 92 | 76 | L13 | P12 | F | K |
| | | | AN02 | | |
| | | | SOT1_1 | | |
| | | | IC00_2 | | |
| | | | MCSX5_0 | | |
| 93 | 77 | L12 | P13 | F | K |
| | | | AN03 | | |
| | | | SCK1_1 | | |
| | | | IC01_2 | | |
| | | | MCSX4_0 | | |
| 94 | 78 | L11 | P14 | F | L |
| | | | AN04 | | |
| | | | SIN0_1 | | |
| | | | INT03_1 | | |
| | | | IC02_2 | | |
| | | | MAD00_0 | | |
| 95 | 79 | K13 | P15 | F | K |
| | | | AN05 | | |
| | | | SOT0_1 | | |
| | | | IC03_2 | | |
| | | | MAD01_0 | | |
| 96 | 80 | K12 | P16 | F | L |
| | | | AN06 | | |
| | | | SCK0_1 | | |
| | | | INT20_1 | | |
| | | | MAD02_0 | | |
| 97 | 81 | K14 | P17 | F | L |
| | | | AN07 | | |
| | | | SIN2_2 | | |
| | | | INT04_1 | | |
| | | | MAD03_0 | | |
| - | - | P7 | VSS | - | - |
| - | - | P11 | VSS | - | - |
| - | - | L14 | VSS | - | - |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 98 | 82 | K11 | P18 | F | L |
| | | | AN08 | | |
| | | | SOT2_2 | | |
| | | | INT21_1 | | |
| | | | MAD04_0 | | |
| 99 | 83 | J13 | P19 | F | L |
| | | | AN09 | | |
| | | | SCK2_2 | | |
| | | | INT22_1 | | |
| | | | MAD05_0 | | |
| 100 | 84 | J12 | P1A | F | L |
| | | | AN10 | | |
| | | | SIN4_1 | | |
| | | | INT05_1 | | |
| | | | TIOA13_2 | | |
| | | | IC00_1 | | |
| | | | MAD06_0 | | |
| 101 | 85 | J11 | P1B | F | L |
| | | | AN11 | | |
| | | | SOT4_1 | | |
| | | | INT25_1 | | |
| | | | TIOB13_2 | | |
| | | | IC01_1 | | |
| | | | MAD07_0 | | |
| 102 | 86 | J10 | P1C | F | L |
| | | | AN12 | | |
| | | | SCK4_1 | | |
| | | | INT26_1 | | |
| | | | TIOA14_2 | | |
| | | | IC02_1 | | |
| | | | MAD08_0 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 103 | 87 | J9 | P1D | F | L |
| | | | AN13 | | |
| | | | CTS4_1 | | |
| | | | INT27_1 | | |
| | | | TIOB14_2 | | |
| | | | IC03_1 | | |
| | | | MAD09_0 | | |
| 104 | 88 | H10 | P1E | F | L |
| | | | AN14 | | |
| | | | RTS4_1 | | |
| | | | INT28_1 | | |
| | | | TIOA15_2 | | |
| | | | DTTIOX_1 | | |
| | | | MAD10_0 | | |
| 105 | 89 | H9 | P1F | F | L |
| | | | AN15 | | |
| | | | ADTG_5 | | |
| | | | INT29_1 | | |
| | | | TIOB15_2 | | |
| | | | FRCK0_1 | | |
| | | | MAD11_0 | | |
| 106 | 90 | J14 | AVCC | - | |
| 107 | 91 | H14 | AVRH | - | |
| 108 | 92 | G14 | AVSS | - | |
| 109 | 93 | F14 | VSS | - | |
| 110 | - | H13 | PB0 | F | L |
| | | | AN16 | | |
| | | | TIOA09_1 | | |
| | | | SIN7_2 | | |
| | | | INT16_0 | | |
| 111 | - | H12 | PB1 | F | L |
| | | | AN17 | | |
| | | | TIOB09_1 | | |
| | | | SOT7_2 | | |
| | | | INT17_0 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 112 | - | H11 | PB2 | F | L |
| | | | AN18 | | |
| | | | TIOA10_1 | | |
| | | | SCK7_2 | | |
| | | | INT18_0 | | |
| 113 | - | G13 | PB3 | F | L |
| | | | AN19 | | |
| | | | TIOB10_1 | | |
| | | | INT19_0 | | |
| 114 | - | G12 | PB4 | F | L |
| | | | AN20 | | |
| | | | TIOA11_1 | | |
| | | | SIN0_2 | | |
| | | | INT20_0 | | |
| 115 | - | G11 | PB5 | F | L |
| | | | AN21 | | |
| | | | TIOB11_1 | | |
| | | | SOT0_2 | | |
| | | | INT21_0 | | |
| | | | AIN2_2 | | |
| - | - | G7 | VSS | - | - |
| - | - | J7 | VSS | - | - |
| 116 | - | G10 | PB6 | F | L |
| | | | AN22 | | |
| | | | TIOA12_1 | | |
| | | | SCK0_2 | | |
| | | | INT22_0 | | |
| | | | BIN2_2 | | |
| 117 | - | G9 | PB7 | F | L |
| | | | AN23 | | |
| | | | TIOB12_1 | | |
| | | | INT23_0 | | |
| | | | ZIN2_2 | | |
| 118 | 94 | F10 | P29 | F | K |
| | | | AN24 | | |
| | | | MAD12_0 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 119 | 95 | F11 | P28 | F | L |
| | | | AN25 | | |
| | | | ADTG_4 | | |
| | | | INT09_0 | | |
| | | | RTO05_1 | | |
| | | | MAD13_0 | | |
| 120 | 96 | F12 | P27 | F | L |
| | | | AN26 | | |
| | | | INT02_2 | | |
| | | | RTO04_1 | | |
| | | | MAD14_0 | | |
| 121 | 97 | F13 | P26 | F | K |
| | | | AN27 | | |
| | | | SCK2_1 | | |
| | | | RTO03_1 | | |
| | | | MAD15_0 | | |
| 122 | 98 | E10 | P25 | F | K |
| | | | AN28 | | |
| | | | SOT2_1 | | |
| | | | RTO02_1 | | |
| | | | MAD16_0 | | |
| 123 | 99 | E11 | P24 | F | L |
| | | | AN29 | | |
| | | | SIN2_1 | | |
| | | | INT01_2 | | |
| | | | RTO01_1 | | |
| | | | MAD17_0 | | |
| 124 | 100 | E12 | P23 | F | K |
| | | | AN30 | | |
| | | | SCK0_0 | | |
| | | | TIOA07_1 | | |
| | | | RTO00_1 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 125 | 101 | E13 | P22 | F | K |
| | | | AN31 | | |
| | | | SOT0_0 | | |
| | | | TIOB07_1 | | |
| | | | ZIN1_1 | | |
| 126 | 102 | D12 | P21 | E | H |
| | | | SIN0_0 | | |
| | | | INT06_1 | | |
| | | | BIN1_1 | | |
| 127 | 103 | D13 | P20 | E | H |
| | | | INT05_0 | | |
| | | | CROUT_0 | | |
| | | | AIN1_1 | | |
| | | | MAD18_0 | | |
| 128 | 104 | C13 | PF6 | I ⁽¹⁾ | J |
| | | | FRCK2_0 | | |
| | | | NMIX | | |
| 129 | 105 | E14 | VCC | - | |
| 130 | 106 | D14 | P82 | H | O |
| 131 | 107 | C14 | P83 | H | O |
| 132 | 108 | B14 | VSS | - | |
| 133 | 109 | A13 | VCC | - | |
| 134 | 110 | B13 | P00 | E | E |
| | | | TRSTX | | |
| 135 | 111 | A12 | P01 | E | E |
| | | | TCK | | |
| | | | SWCLK | | |
| 136 | 112 | C12 | P02 | E | E |
| | | | TDI | | |
| 137 | 113 | B12 | P03 | E | E |
| | | | TMS | | |
| | | | SWDIO | | |
| 138 | 114 | B11 | P04 | E | E |
| | | | TDO | | |
| | | | SWO | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 139 | - | C11 | P90 | E | H |
| | | | TIOB08_0 | | |
| | | | RTO20_1 | | |
| | | | INT30_0 | | |
| | | | MAD19_0 | | |
| - | - | A8 | VSS | - | |
| 140 | - | D11 | P91 | E | H |
| | | | TIOB09_0 | | |
| | | | RTO21_1 | | |
| | | | INT31_0 | | |
| | | | MAD20_0 | | |
| 141 | - | B10 | P92 | E | I |
| | | | TIOB10_0 | | |
| | | | RTO22_1 | | |
| | | | SIN5_1 | | |
| | | | MAD21_0 | | |
| 142 | - | C10 | P93 | E | I |
| | | | TIOB11_0 | | |
| | | | RTO23_1 | | |
| | | | SOT5_1 | | |
| | | | MAD22_0 | | |
| 143 | - | D10 | P94 | E | H |
| | | | TIOB12_0 | | |
| | | | RTO24_1 | | |
| | | | SCK5_1 | | |
| | | | INT26_0 | | |
| 144 | - | B9 | P95 | E | H |
| | | | TIOB13_0 | | |
| | | | RTO25_1 | | |
| | | | INT27_0 | | |
| | | | MAD24_0 | | |
| 145 | 115 | C9 | PC0 | K | Q |
| 146 | 116 | B8 | PC1 | K | Q |
| 147 | 117 | D9 | PC2 | K | Q |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 148 | 118 | E9 | PC3 | K | Q |
| | | | TIOA06_1 | | |
| 149 | 119 | F9 | PC4 | K | Q |
| | | | TIOA08_2 | | |
| 150 | 120 | C8 | PC5 | K | Q |
| | | | TIOA10_2 | | |
| - | - | A5 | VSS | - | |
| 151 | 121 | D8 | PC6 | K | Q |
| | | | TIOA14_0 | | |
| 152 | 122 | E8 | PC7 | L | Q |
| | | | CROUT_1 | | |
| 153 | 123 | A10 | PC8 | K | Q |
| 154 | 124 | F8 | PC9 | K | Q |
| 155 | 125 | B7 | PCA | K | Q |
| 156 | 126 | A9 | VCC | - | |
| 157 | 127 | A11 | VSS | - | |
| 158 | 128 | A7 | PCB | L | Q |
| 159 | 129 | C7 | PCC | K | Q |
| 160 | 130 | A6 | PCD | K | Q |
| 161 | 131 | D7 | PCE | L | Q |
| | | | RTS4_0 | | |
| | | | TIOB06_1 | | |
| 162 | 132 | E7 | PCF | L | Q |
| | | | CTS4_0 | | |
| | | | TIOB08_2 | | |
| 163 | 133 | F7 | PD0 | L | R |
| | | | SCK4_0 | | |
| | | | TIOB10_2 | | |
| | | | INT30_1 | | |
| 164 | 134 | B6 | PD1 | L | R |
| | | | SOT4_0 | | |
| | | | TIOB14_0 | | |
| | | | INT31_1 | | |
| - | - | N7 | VSS | - | |
| - | - | G8 | VSS | - | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| - | - | H7 | VSS | - | |
| - | - | H8 | VSS | - | |
| 165 | 135 | C6 | PD2 | L | R |
| | | | SIN4_0 | | |
| | | | TIOA03_2 | | |
| | | | INT00_2 | | |
| 166 | 136 | D6 | PD3 | L | Q |
| | | | TIOB03_2 | | |
| 167 | 137 | E6 | P62 | E | Q |
| | | | SCK5_0 | | |
| | | | ADTG_3 | | |
| 168 | 138 | B5 | P61 | E | I |
| | | | SOT5_0 | | |
| | | | TIOB02_2 | | |
| 169 | 139 | C5 | P60 | E | H |
| | | | SIN5_0 | | |
| | | | TIOA02_2 | | |
| | | | INT15_1 | | |
| 170 | - | B4 | PF3 | I ⁽¹⁾ | H |
| | | | TIOA06_0 | | |
| | | | SIN6_2 | | |
| | | | INT06_0 | | |
| | | | AIN2_1 | | |
| 171 | - | C4 | PF4 | I ⁽¹⁾ | H |
| | | | TIOB06_0 | | |
| | | | SOT6_2 | | |
| | | | INT07_0 | | |
| | | | BIN2_1 | | |
| 172 | 140 | B3 | PF5 | I ⁽¹⁾ | H |
| | | | SCK6_2 | | |
| | | | INT08_0 | | |
| | | | ZIN2_1 | | |

| Pin No | | | Pin Name | I/O circuit type | Pin state type |
|----------|----------|---------|----------|------------------|----------------|
| LQFP-176 | LQFP-144 | BGA-192 | | | |
| 173 | 141 | A4 | VCC | - | |
| 174 | 142 | A3 | P80 | H | O |
| 175 | 143 | A2 | P81 | H | O |
| 176 | 144 | B1 | VSS | - | |
| - | - | M7 | VSS | - | |

[1]: 5 V tolerant I/O

4.2 List of pin functions

The number after the underscore ("_") in pin names such as XXX_1 and XXX_2 indicates the relocated port number. For these pins, the same function is provided on the same channel. Use the extended port function register (EPFR) to select the pin.

| Module | Pin name | Function | Pin No | | |
|--------|----------|--|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| ADC | ADTG_0 | A/D converter external trigger input pin | 10 | 10 | E2 |
| | ADTG_1 | | 18 | 18 | F5 |
| | ADTG_2 | | 37 | 29 | K2 |
| | ADTG_3 | | 167 | 137 | E6 |
| | ADTG_4 | | 119 | 95 | F11 |
| | ADTG_5 | | 105 | 89 | H9 |
| | ADTG_6 | | 31 | - | H6 |
| | ADTG_7 | | 49 | 41 | L4 |
| | ADTG_8 | | 70 | 62 | P8 |

| Module | Pin name | Function | Pin No | | |
|--------|----------|--|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| ADC | AN00 | A/D converter analog input pin ANxx describes ADC ch.xx | 90 | 74 | M13 |
| | AN01 | | 91 | 75 | M12 |
| | AN02 | | 92 | 76 | L13 |
| | AN03 | | 93 | 77 | L12 |
| | AN04 | | 94 | 78 | L11 |
| | AN05 | | 95 | 79 | K13 |
| | AN06 | | 96 | 80 | K12 |
| | AN07 | | 97 | 81 | K14 |
| | AN08 | | 98 | 82 | K11 |
| | AN09 | | 99 | 83 | J13 |
| | AN10 | | 100 | 84 | J12 |
| | AN11 | | 101 | 85 | J11 |
| | AN12 | | 102 | 86 | J10 |
| | AN13 | | 103 | 87 | J9 |
| | AN14 | | 104 | 88 | H10 |
| | AN15 | | 105 | 89 | H9 |
| | AN16 | | 110 | - | H13 |
| | AN17 | | 111 | - | H12 |
| | AN18 | | 112 | - | H11 |
| | AN19 | | 113 | - | G13 |
| | AN20 | | 114 | - | G12 |
| | AN21 | | 115 | - | G11 |
| | AN22 | | 116 | - | G10 |
| | AN23 | | 117 | - | G9 |
| | AN24 | | 118 | 94 | F10 |
| | AN25 | | 119 | 95 | F11 |
| | AN26 | | 120 | 96 | F12 |
| | AN27 | | 121 | 97 | F13 |
| | AN28 | | 122 | 98 | E10 |
| | AN29 | | 123 | 99 | E11 |
| | AN30 | | 124 | 100 | E12 |
| | AN31 | | 125 | 101 | E13 |

| Module | Pin name | Function | Pin No | | |
|--------------|----------|--------------------------|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Base Timer 0 | TIOA0_0 | Base timer ch.0 TIOA pin | 46 | 38 | N2 |
| | TIOA0_1 | | 38 | 30 | K3 |
| | TIOA0_2 | | 11 | 11 | E3 |
| | TIOB0_0 | Base timer ch.0 TIOB pin | 59 | 51 | L5 |
| | TIOB0_1 | | 28 | - | H3 |
| | TIOB0_2 | | 12 | 12 | E4 |
| Base Timer 1 | TIOA1_0 | Base timer ch.1 TIOA pin | 47 | 39 | N3 |
| | TIOA1_1 | | 39 | 31 | K4 |
| | TIOA1_2 | | 16 | 16 | F3 |
| | TIOB1_0 | Base timer ch.1 TIOB pin | 60 | 52 | K5 |
| | TIOB1_1 | | 29 | - | H4 |
| | TIOB1_2 | | 17 | 17 | F4 |
| Base Timer 2 | TIOA2_0 | Base timer ch.2 TIOA pin | 48 | 40 | M3 |
| | TIOA2_1 | | 40 | 32 | L1 |
| | TIOA2_2 | | 169 | 139 | C5 |
| | TIOB2_0 | Base timer ch.2 TIOB pin | 61 | 53 | N6 |
| | TIOB2_1 | | 30 | - | H5 |
| | TIOB2_2 | | 168 | 138 | B5 |
| Base Timer 3 | TIOA3_0 | Base timer ch.3 TIOA pin | 49 | 41 | L4 |
| | TIOA3_1 | | 41 | 33 | L2 |
| | TIOA3_2 | | 165 | 135 | C6 |
| | TIOB3_0 | Base timer ch.3 TIOB pin | 62 | 54 | M6 |
| | TIOB3_1 | | 31 | - | H6 |
| | TIOB3_2 | | 166 | 136 | D6 |
| Base Timer 4 | TIOA4_0 | Base timer ch.4 TIOA pin | 50 | 42 | M4 |
| | TIOA4_1 | | 42 | 34 | L3 |
| | TIOA4_2 | | 65 | 57 | J6 |
| | TIOB4_0 | Base timer ch.4 TIOB pin | 63 | 55 | L6 |
| | TIOB4_1 | | 32 | - | J5 |
| | TIOB4_2 | | 66 | 58 | N8 |

| Module | Pin name | Function | Pin No | | |
|--------------|----------|--------------------------|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Base Timer 5 | TIOA5_0 | Base timer ch.5 TIOA pin | 51 | 43 | N4 |
| | TIOA5_1 | | 43 | 35 | M2 |
| | TIOA5_2 | | 8 | 8 | D3 |
| | TIOB5_0 | Base timer ch.5 TIOB pin | 64 | 56 | K6 |
| | TIOB5_1 | | 33 | - | J4 |
| | TIOB5_2 | | 9 | 9 | D4 |
| Base Timer 6 | TIOA6_0 | Base timer ch.6 TIOA pin | 170 | - | B4 |
| | TIOA6_1 | | 148 | 118 | E9 |
| | TIOA6_2 | | 25 | - | H1 |
| | TIOB6_0 | Base timer ch.6 TIOB pin | 171 | - | C4 |
| | TIOB6_1 | | 161 | 131 | D7 |
| | TIOB6_2 | | 26 | - | H2 |
| Base Timer 7 | TIOA07_0 | Base timer ch.7 TIOA pin | 77 | - | P10 |
| | TIOA07_1 | | 124 | 100 | E12 |
| | TIOA07_2 | | 71 | 63 | J8 |
| | TIOB07_0 | Base timer ch.7 TIOB pin | 76 | - | K9 |
| | TIOB07_1 | | 125 | 101 | E13 |
| | TIOB07_2 | | 72 | 64 | P9 |
| Base Timer 8 | TIOA08_0 | Base timer ch.8 TIOA pin | 2 | 2 | B2 |
| | TIOA08_1 | | 82 | - | N11 |
| | TIOA08_2 | | 149 | 119 | F9 |
| | TIOB08_0 | Base timer ch.8 TIOB pin | 139 | - | C11 |
| | TIOB08_1 | | 83 | - | M11 |
| | TIOB08_2 | | 162 | 132 | E7 |
| Base Timer 9 | TIOA09_0 | Base timer ch.9 TIOA pin | 3 | 3 | C2 |
| | TIOA09_1 | | 110 | - | H13 |
| | TIOA09_2 | | 19 | 19 | F6 |
| | TIOB09_0 | Base timer ch.9 TIOB pin | 140 | - | D11 |
| | TIOB09_1 | | 111 | - | H12 |
| | TIOB09_2 | | 20 | 20 | G2 |

| Module | Pin name | Function | Pin No | | |
|---------------|----------|---------------------------|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Base Timer 10 | TIOA10_0 | Base timer ch.10 TIOA pin | 4 | 4 | C3 |
| | TIOA10_1 | | 112 | - | H11 |
| | TIOA10_2 | | 150 | 120 | C8 |
| | TIOB10_0 | Base timer ch.10 TIOB pin | 141 | - | B10 |
| | TIOB10_1 | | 113 | - | G13 |
| | TIOB10_2 | | 163 | 133 | F7 |
| Base Timer 11 | TIOA11_0 | Base timer ch.11 TIOA pin | 5 | 5 | D5 |
| | TIOA11_1 | | 114 | - | G12 |
| | TIOA11_2 | | 21 | 21 | G3 |
| | TIOB11_0 | Base timer ch.11 TIOB pin | 142 | - | C10 |
| | TIOB11_1 | | 115 | - | G11 |
| | TIOB11_2 | | 22 | 22 | G4 |
| Base Timer 12 | TIOA12_0 | Base timer ch.12 TIOA pin | 6 | 6 | D2 |
| | TIOA12_1 | | 116 | - | G10 |
| | TIOA12_2 | | 34 | 26 | J3 |
| | TIOB12_0 | Base timer ch.12 TIOB pin | 143 | - | D10 |
| | TIOB12_1 | | 117 | - | G9 |
| | TIOB12_2 | | 35 | 27 | J2 |
| Base Timer 13 | TIOA13_0 | Base timer ch.13 TIOA pin | 7 | 7 | D1 |
| | TIOA13_1 | | 23 | 23 | G5 |
| | TIOA13_2 | | 100 | 84 | J12 |
| | TIOB13_0 | Base timer ch.13 TIOB pin | 144 | - | B9 |
| | TIOB13_1 | | 24 | 24 | G6 |
| | TIOB13_2 | | 101 | 85 | J11 |
| Base Timer 14 | TIOA14_0 | Base timer ch.14 TIOA pin | 151 | 121 | D8 |
| | TIOA14_1 | | 78 | - | N10 |
| | TIOA14_2 | | 102 | 86 | J10 |
| | TIOB14_0 | Base timer ch.14 TIOB pin | 164 | 134 | B6 |
| | TIOB14_1 | | 79 | - | L10 |
| | TIOB14_2 | | 103 | 87 | J9 |

| Module | Pin name | Function | Pin No | | |
|------------------|----------|---|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Base Timer 15 | TIOA15_0 | Base timer ch.15 TIOA pin | 73 | 65 | N9 |
| | TIOA15_1 | | 80 | - | K10 |
| | TIOA15_2 | | 104 | 88 | H10 |
| | TIOB15_0 | Base timer ch.15 TIOB pin | 74 | 66 | M9 |
| | TIOB15_1 | | 81 | - | M10 |
| | TIOB15_2 | | 105 | 89 | H9 |
| Debugger | SWCLK | Serial wire debug interface clock input | 135 | 111 | A12 |
| | SWDIO | Serial wire debug interface data input / output | 137 | 113 | B12 |
| | SWO | Serial wire viewer output | 138 | 114 | B11 |
| | TCK | J-TAG test clock input | 135 | 111 | A12 |
| | TDI | J-TAG test data input | 136 | 112 | C12 |
| | TDO | J-TAG debug data output | 138 | 114 | B11 |
| | TMS | J-TAG test mode state input/output | 137 | 113 | B12 |
| | TRACECLK | Trace CLK output of ETM | 12 | 12 | E4 |
| | TRACED0 | Trace data output of ETM | 8 | 8 | D3 |
| | TRACED1 | | 9 | 9 | D4 |
| | TRACED2 | | 10 | 10 | E2 |
| | TRACED3 | | 11 | 11 | E3 |
| | TRSTX | J-TAG test reset input | 134 | 110 | B13 |

| Module | Pin name | Function | Pin No | | |
|--------------|---|------------------------------------|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| External Bus | MAD00_0 | External bus interface address bus | 94 | 78 | L11 |
| | MAD01_0 | | 95 | 79 | K13 |
| | MAD02_0 | | 96 | 80 | K12 |
| | MAD03_0 | | 97 | 81 | K14 |
| | MAD04_0 | | 98 | 82 | K11 |
| | MAD05_0 | | 99 | 83 | J13 |
| | MAD06_0 | | 100 | 84 | J12 |
| | MAD07_0 | | 101 | 85 | J11 |
| | MAD08_0 | | 102 | 86 | J10 |
| | MAD09_0 | | 103 | 87 | J9 |
| | MAD10_0 | | 104 | 88 | H10 |
| | MAD11_0 | | 105 | 89 | H9 |
| | MAD12_0 | | 118 | 94 | F10 |
| | MAD13_0 | | 119 | 95 | F11 |
| | MAD14_0 | | 120 | 96 | F12 |
| | MAD15_0 | | 121 | 97 | F13 |
| | MAD16_0 | | 122 | 98 | E10 |
| | MAD17_0 | | 123 | 99 | E11 |
| | MAD18_0 | | 127 | 103 | D13 |
| | MAD19_0 | | 139 | - | C11 |
| | MAD20_0 | | 140 | - | D11 |
| | MAD21_0 | | 141 | - | B10 |
| | MAD22_0 | | 142 | - | C10 |
| | MAD23_0 | | 143 | - | D10 |
| MAD24_0 | 144 | - | B9 | | |
| MCSX0_0 | External bus interface chip select output pin | 23 | 23 | G5 | |
| MCSX1_0 | | 24 | 24 | G6 | |
| MCSX2_0 | | 34 | 26 | J3 | |
| MCSX3_0 | | 35 | 27 | J2 | |
| MCSX4_0 | | 93 | 77 | L12 | |
| MCSX5_0 | | 92 | 76 | L13 | |
| MCSX6_0 | | 91 | 75 | M12 | |
| MCSX7_0 | | 90 | 74 | M13 | |

| Module | Pin name | Function | Pin No | | |
|--------------|------------|--|---|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| External Bus | MDQM0_0 | External bus interface byte mask signal output | 15 | 15 | F2 |
| | MDQM1_0 | | 16 | 16 | F3 |
| | MOEX_0 | External bus interface read enable signal for SRAM | 13 | 13 | E5 |
| | MWEX_0 | External bus interface write enable signal for SRAM | 14 | 14 | F1 |
| | MNALE_0 | External bus interface ALE signal to control NAND Flash memory output pin | 19 | 19 | F6 |
| | MNCLE_0 | External bus interface CLE signal to control NAND Flash memory output pin | 20 | 20 | G2 |
| | MNREX_0 | External bus interface read enable signal to control NAND Flash memory | 22 | 22 | G4 |
| | MNWEX_0 | External bus interface write enable signal to control NAND Flash memory | 21 | 21 | G3 |
| | MADATA00_0 | External bus interface data bus (Multiplexed bus to address output for multiplex) | 60 | 52 | K5 |
| | MADATA01_0 | | 61 | 53 | N6 |
| | MADATA02_0 | | 62 | 54 | M6 |
| | MADATA03_0 | | 63 | 55 | L6 |
| | MADATA04_0 | | 64 | 56 | K6 |
| | MADATA05_0 | | 65 | 57 | J6 |
| | MADATA06_0 | | 66 | 58 | N8 |
| | MADATA07_0 | | 67 | 59 | M8 |
| | MADATA08_0 | | 68 | 60 | L8 |
| | MADATA09_0 | | 69 | 61 | K8 |
| | MADATA10_0 | | 70 | 62 | P8 |
| | MADATA11_0 | | 71 | 63 | J8 |
| | MADATA12_0 | | 72 | 64 | P9 |
| | MADATA13_0 | | 73 | 65 | N9 |
| | MADATA14_0 | | 74 | 66 | M9 |
| | MADATA15_0 | | 75 | 67 | L9 |
| | MALE_0 | | Address Latch enable signal for multiplex | 17 | 17 |
| | MRDY_0 | External RDY input signal | 18 | 18 | F5 |
| | MCLKOUT_0 | External bus clock output | 36 | 28 | K1 |

| Module | Pin name | Function | Pin No | | |
|--------------------|---|---|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| External Interrupt | INT00_0 | External interrupt request 00 input pin | 13 | 13 | E5 |
| | INT00_1 | | 8 | 8 | D3 |
| | INT00_2 | | 165 | 135 | C6 |
| | INT01_0 | External interrupt request 01 input pin | 14 | 14 | F1 |
| | INT01_1 | | 9 | 9 | D4 |
| | INT01_2 | | 123 | 99 | E11 |
| | INT02_0 | External interrupt request 02 input pin | 15 | 15 | F2 |
| | INT02_1 | | 91 | 75 | M12 |
| | INT02_2 | | 120 | 96 | F12 |
| | INT03_0 | External interrupt request 03 input pin | 6 | 6 | D2 |
| | INT03_1 | | 94 | 78 | L11 |
| | INT03_2 | | 28 | - | H3 |
| | INT04_0 | External interrupt request 04 input pin | 31 | - | H6 |
| | INT04_1 | | 97 | 81 | K14 |
| | INT04_2 | | 29 | - | H4 |
| | INT05_0 | External interrupt request 05 input pin | 127 | 103 | D13 |
| | INT05_1 | | 100 | 84 | J12 |
| | INT05_2 | | 30 | - | H5 |
| | INT06_0 | External interrupt request 06 input pin | 170 | - | B4 |
| | INT06_1 | | 126 | 102 | D12 |
| | INT06_2 | | 64 | 56 | K6 |
| | INT07_0 | External interrupt request 07 input pin | 171 | - | C4 |
| | INT07_1 | | 70 | 62 | P8 |
| | INT07_2 | | 16 | 16 | F3 |
| | INT08_0 | External interrupt request 08 input pin | 172 | 140 | B3 |
| | INT08_1 | | 33 | - | J4 |
| | INT08_2 | | 19 | 19 | F6 |
| | INT09_0 | External interrupt request 09 input pin | 119 | 95 | F11 |
| | INT09_1 | | 34 | 26 | J3 |
| | INT09_2 | | 22 | 22 | G4 |
| INT10_0 | External interrupt request 10 input pin | 76 | - | K9 | |
| INT10_1 | | 35 | 27 | J2 | |
| INT10_2 | | 7 | 7 | D1 | |

| Module | Pin name | Function | Pin No | | |
|--------------------|---|---|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| | INT11_0 | External interrupt request 11 input pin | 77 | - | P10 |
| | INT11_1 | | 36 | 28 | K1 |
| | INT11_2 | | 71 | 63 | J8 |
| | INT12_0 | External interrupt request 12 input pin | 78 | - | N10 |
| | INT12_1 | | 46 | 38 | N2 |
| | INT12_2 | | 72 | 64 | P9 |
| | INT13_0 | External interrupt request 13 input pin | 81 | - | M10 |
| | INT13_1 | | 47 | 39 | N3 |
| | INT13_2 | | 66 | 58 | N8 |
| | INT14_0 | External interrupt request 14 input pin | 82 | - | N11 |
| | INT14_1 | | 58 | 50 | M5 |
| | INT14_2 | | 67 | 59 | M8 |
| External Interrupt | INT15_0 | External interrupt request 15 input pin | 83 | - | M11 |
| | INT15_1 | | 169 | 139 | C5 |
| | INT15_2 | | 68 | 60 | L8 |
| | INT16_0 | External interrupt request 16 input pin | 110 | - | H13 |
| | INT16_1 | | 20 | 20 | G2 |
| | INT17_0 | External interrupt request 17 input pin | 111 | - | H12 |
| | INT17_1 | | 21 | 21 | G3 |
| | INT18_0 | External interrupt request 18 input pin | 112 | - | H11 |
| | INT18_1 | | 23 | 23 | G5 |
| | INT19_0 | External interrupt request 19 input pin | 113 | - | G13 |
| | INT19_1 | | 24 | 24 | G6 |
| | INT20_0 | External interrupt request 20 input pin | 114 | - | G12 |
| | INT20_1 | | 96 | 80 | K12 |
| | INT21_0 | External interrupt request 21 input pin | 115 | - | G11 |
| | INT21_1 | | 98 | 82 | K11 |
| | INT22_0 | External interrupt request 22 input pin | 116 | - | G10 |
| | INT22_1 | | 99 | 83 | J13 |
| | INT23_0 | External interrupt request 23 input pin | 117 | - | G9 |
| | INT23_1 | | 74 | 66 | M9 |
| | INT24_0 | External interrupt request 24 input pin | 79 | - | L10 |
| INT24_1 | 75 | | 67 | L9 | |
| INT25_0 | External interrupt request 25 input pin | 80 | - | K10 | |
| INT25_1 | | 101 | 85 | J11 | |

| Module | Pin name | Function | Pin No | | |
|--------------------|----------|---|----------------------------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| External Interrupt | INT26_0 | External interrupt request 26 input pin | 143 | - | D10 |
| | INT26_1 | | 102 | 86 | J10 |
| | INT27_0 | External interrupt request 27 input pin | 144 | - | B9 |
| | INT27_1 | | 103 | 87 | J9 |
| | INT28_0 | External interrupt request 28 input pin | 25 | - | H1 |
| | INT28_1 | | 104 | 88 | H10 |
| | INT29_0 | External interrupt request 29 input pin | 26 | - | H2 |
| | INT29_1 | | 105 | 89 | H9 |
| | INT30_0 | External interrupt request 30 input pin | 139 | - | C11 |
| | INT30_1 | | 163 | 133 | F7 |
| | INT31_0 | External interrupt request 31 input pin | 140 | - | D11 |
| | INT31_1 | | 164 | 134 | B6 |
| | NMIX | Non-Maskable Interrupt input | 128 | 104 | C13 |
| | GPIO | P00 | General-purpose I/O port 0 | 134 | 110 |
| P01 | | 135 | | 111 | A12 |
| P02 | | 136 | | 112 | C12 |
| P03 | | 137 | | 113 | B12 |
| P04 | | 138 | | 114 | B11 |
| P05 | | 8 | | 8 | D3 |
| P06 | | 9 | | 9 | D4 |
| P07 | | 10 | | 10 | E2 |
| P08 | | 11 | | 11 | E3 |
| P09 | | 12 | | 12 | E4 |

| Module | Pin name | Function | Pin No | | |
|--------|----------|----------------------------|----------------------------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| GPIO | P10 | General-purpose I/O port 1 | 90 | 74 | M13 |
| | P11 | | 91 | 75 | M12 |
| | P12 | | 92 | 76 | L13 |
| | P13 | | 93 | 77 | L12 |
| | P14 | | 94 | 78 | L11 |
| | P15 | | 95 | 79 | K13 |
| | P16 | | 96 | 80 | K12 |
| | P17 | | 97 | 81 | K14 |
| | P18 | | 98 | 82 | K11 |
| | P19 | | 99 | 83 | J13 |
| | P1A | | 100 | 84 | J12 |
| | P1B | | 101 | 85 | J11 |
| | P1C | | 102 | 86 | J10 |
| | P1D | | 103 | 87 | J9 |
| | P1E | | 104 | 88 | H10 |
| | P1F | | 105 | 89 | H9 |
| | P20 | | General-purpose I/O port 2 | 127 | 103 |
| | P21 | 126 | | 102 | D12 |
| | P22 | 125 | | 101 | E13 |
| | P23 | 124 | | 100 | E12 |
| | P24 | 123 | | 99 | E11 |
| | P25 | 122 | | 98 | E10 |
| | P26 | 121 | | 97 | F13 |
| | P27 | 120 | | 96 | F12 |
| | P28 | 119 | | 95 | F11 |
| | P29 | 118 | | 94 | F10 |

| Module | Pin name | Function | Pin No | | | |
|--------|----------|----------------------------|----------------------------|----------|---------|----|
| | | | LQFP-176 | LQFP-144 | BGA-192 | |
| GPIO | P30 | General-purpose I/O port 3 | 28 | - | H3 | |
| | P31 | | 29 | - | H4 | |
| | P32 | | 30 | - | H5 | |
| | P33 | | 31 | - | H6 | |
| | P34 | | 32 | - | J5 | |
| | P35 | | 33 | - | J4 | |
| | P36 | | 34 | 26 | J3 | |
| | P37 | | 35 | 27 | J2 | |
| | P38 | | 36 | 28 | K1 | |
| | P39 | | 37 | 29 | K2 | |
| | P3A | | 38 | 30 | K3 | |
| | P3B | | 39 | 31 | K4 | |
| | P3C | | 40 | 32 | L1 | |
| | P3D | | 41 | 33 | L2 | |
| | P3E | | 42 | 34 | L3 | |
| | P3F | | 43 | 35 | M2 | |
| | P40 | | General-purpose I/O port 4 | 46 | 38 | N2 |
| | P41 | | | 47 | 39 | N3 |
| | P42 | 48 | | 40 | M3 | |
| | P43 | 49 | | 41 | L4 | |
| | P44 | 50 | | 42 | M4 | |
| | P45 | 51 | | 43 | N4 | |
| | P46 | 55 | | 47 | P5 | |
| | P47 | 56 | | 48 | P6 | |
| | P48 | 58 | | 50 | M5 | |
| | P49 | 59 | | 51 | L5 | |
| | P4A | 60 | | 52 | K5 | |
| | P4B | 61 | | 53 | N6 | |
| | P4C | 62 | | 54 | M6 | |
| | P4D | 63 | | 55 | L6 | |
| | P4E | 64 | 56 | K6 | | |

| Module | Pin name | Function | Pin No | | |
|--------|----------|----------------------------|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| GPIO | P50 | General-purpose I/O port 5 | 13 | 13 | E5 |
| | P51 | | 14 | 14 | F1 |
| | P52 | | 15 | 15 | F2 |
| | P53 | | 16 | 16 | F3 |
| | P54 | | 17 | 17 | F4 |
| | P55 | | 18 | 18 | F5 |
| | P56 | | 19 | 19 | F6 |
| | P57 | | 20 | 20 | G2 |
| | P58 | | 21 | 21 | G3 |
| | P59 | | 22 | 22 | G4 |
| | P5A | | 23 | 23 | G5 |
| | P5B | | 24 | 24 | G6 |
| | P5C | | 25 | - | H1 |
| | P5D | | 26 | - | H2 |
| GPIO | P60 | General-purpose I/O port 6 | 169 | 139 | C5 |
| | P61 | | 168 | 138 | B5 |
| | P62 | | 167 | 137 | E6 |
| | P70 | General-purpose I/O port 7 | 65 | 57 | J6 |
| | P71 | | 66 | 58 | N8 |
| | P72 | | 67 | 59 | M8 |
| | P73 | | 68 | 60 | L8 |
| | P74 | | 69 | 61 | K8 |
| | P75 | | 70 | 62 | P8 |
| | P76 | | 71 | 63 | J8 |
| | P77 | | 72 | 64 | P9 |
| | P78 | | 73 | 65 | N9 |
| | P79 | | 74 | 66 | M9 |
| | P7A | | 75 | 67 | L9 |
| | P7B | | 76 | - | K9 |
| | P7C | | 77 | - | P10 |
| | P7D | | 78 | - | N10 |
| | P7E | | 79 | - | L10 |
| P7F | 80 | - | K10 | | |

| Module | Pin name | Function | Pin No | | |
|--------|----------|----------------------------|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| GPIO | P80 | General-purpose I/O port 8 | 174 | 142 | A3 |
| | P81 | | 175 | 143 | A2 |
| | P82 | | 130 | 106 | D14 |
| | P83 | | 131 | 107 | C14 |
| | P90 | General-purpose I/O port 9 | 139 | - | C11 |
| | P91 | | 140 | - | D11 |
| | P92 | | 141 | - | B10 |
| | P93 | | 142 | - | C10 |
| | P94 | | 143 | - | D10 |
| | P95 | | 144 | - | B9 |
| | PA0 | General-purpose I/O port A | 2 | 2 | B2 |
| | PA1 | | 3 | 3 | C2 |
| | PA2 | | 4 | 4 | C3 |
| | PA3 | | 5 | 5 | D5 |
| | PA4 | | 6 | 6 | D2 |
| | PA5 | | 7 | 7 | D1 |
| | PB0 | General-purpose I/O port B | 110 | - | H13 |
| | PB1 | | 111 | - | H12 |
| | PB2 | | 112 | - | H11 |
| | PB3 | | 113 | - | G13 |
| | PB4 | | 114 | - | G12 |
| | PB5 | | 115 | - | G11 |
| | PB6 | | 116 | - | G10 |
| | PB7 | | 117 | - | G9 |

| Module | Pin name | Function | Pin No | | |
|--------|----------|---|----------------------------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| GPIO | PC0 | General-purpose I/O port C | 145 | 115 | C9 |
| | PC1 | | 146 | 116 | B8 |
| | PC2 | | 147 | 117 | D9 |
| | PC3 | | 148 | 118 | E9 |
| | PC4 | | 149 | 119 | F9 |
| | PC5 | | 150 | 120 | C8 |
| | PC6 | | 151 | 121 | D8 |
| | PC7 | | 152 | 122 | E8 |
| | PC8 | | 153 | 123 | A10 |
| | PC9 | | 154 | 124 | F8 |
| | PCA | | 155 | 125 | B7 |
| | PCB | | 158 | 128 | A7 |
| | PCC | | 159 | 129 | C7 |
| | PCD | | 160 | 130 | A6 |
| | PCE | | 161 | 131 | D7 |
| | PCF | | 162 | 132 | E7 |
| | PD0 | | General-purpose I/O port D | 163 | 133 |
| | PD1 | 164 | | 134 | B6 |
| | PD2 | 165 | | 135 | C6 |
| | PD3 | 166 | | 136 | D6 |
| | PE0 | General-purpose I/O port E | 84 | 68 | N13 |
| | PE2 | | 86 | 70 | P12 |
| | PE3 | | 87 | 71 | P13 |
| | PF0 | General-purpose I/O port F ^[1] | 81 | - | M10 |
| | PF1 | | 82 | - | N11 |
| | PF2 | | 83 | - | M11 |
| | PF3 | | 170 | - | B4 |
| | PF4 | | 171 | - | C4 |
| | PF5 | | 172 | 140 | B3 |
| | PF6 | | 128 | 104 | C13 |

| Module | Pin name | Function | Pin No | | |
|-------------------------|--------------------|---|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Multi-Function Serial 0 | SIN0_0 | Multi-function serial interface ch.0 input pin | 126 | 102 | D12 |
| | SIN0_1 | | 94 | 78 | L11 |
| | SIN0_2 | | 114 | - | G12 |
| | SOT0_0 (SDA0_0) | Multi-function 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 ² C (operation mode 4). | 125 | 101 | E13 |
| | SOT0_1 (SDA0_1) | | 95 | 79 | K13 |
| | SOT0_2 (SDA0_2) | | 115 | - | G11 |
| | SCK0_0 (SCL0_0) | Multi-function 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 ² C (operation mode 4). | 124 | 100 | E12 |
| | SCK0_1 (SCL0_1) | | 96 | 80 | K12 |
| | SCK0_2 (SCL0_2) | | 116 | - | G10 |
| Multi-Function Serial 1 | SIN1_0 | Multi-function serial interface ch.1 input pin | 19 | 19 | F6 |
| | SIN1_1 | | 91 | 75 | M12 |
| | SIN1_2 | | 81 | - | M10 |
| | SOT1_0 (SDA1_0) | Multi-function 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 ² C (operation mode 4). | 20 | 20 | G2 |
| | SOT1_1 (SDA1_1) | | 92 | 76 | L13 |
| | SOT1_2 (SDA1_2) | | 82 | - | N11 |
| | SCK1_0 (SCL1_0) | Multi-function 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 ² C (operation mode 4). | 21 | 21 | G3 |
| | SCK1_1 (SCL1_1) | | 93 | 77 | L12 |
| | SCK1_2 (SCL1_2) | | 83 | - | M11 |

| Module | Pin name | Function | Pin No | | |
|-------------------------|--------------------|---|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Multi-Function Serial 2 | SIN2_0 | Multi-function serial interface ch.2 input pin | 67 | 59 | M8 |
| | SIN2_1 | | 123 | 99 | E11 |
| | SIN2_2 | | 97 | 81 | K14 |
| | SOT2_0 (SDA2_0) | Multi-function 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 ² C (operation mode 4). | 68 | 60 | L8 |
| | SOT2_1 (SDA2_1) | | 122 | 98 | E10 |
| | SOT2_2 (SDA2_2) | | 98 | 82 | K11 |
| | SCK2_0 (SCL2_0) | Multi-function 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 ² C (operation mode 4). | 69 | 61 | K8 |
| | SCK2_1 (SCL2_1) | | 121 | 97 | F13 |
| | SCK2_2 (SCL2_2) | | 99 | 83 | J13 |
| Multi-Function Serial 3 | SIN3_0 | Multi-function serial interface ch.3 input pin | 70 | 62 | P8 |
| | SIN3_1 | | 13 | 13 | E5 |
| | SIN3_2 | | 58 | 50 | M5 |
| | SOT3_0 (SDA3_0) | Multi-function 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 ² C (operation mode 4). | 71 | 63 | J8 |
| | SOT3_1 (SDA3_1) | | 14 | 14 | F1 |
| | SOT3_2 (SDA3_2) | | 59 | 51 | L5 |
| | SCK3_0 (SCL3_0) | Multi-function 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 ² C (operation mode 4). | 72 | 64 | P9 |
| | SCK3_1 (SCL3_1) | | 15 | 15 | F2 |
| | SCK3_2 (SCL3_2) | | 60 | 52 | K5 |

| Module | Pin name | Function | Pin No | | |
|-------------------------|--------------------|---|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Multi-Function Serial 4 | SIN4_0 | Multi-function serial interface ch.4 input pin | 165 | 135 | C6 |
| | SIN4_1 | | 100 | 84 | J12 |
| | SIN4_2 | | 8 | 8 | D3 |
| | SOT4_0 (SDA4_0) | Multi-function 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 ² C (operation mode 4). | 164 | 134 | B6 |
| | SOT4_1 (SDA4_1) | | 101 | 85 | J11 |
| | SOT4_2 (SDA4_2) | | 9 | 9 | D4 |
| | SCK4_0 (SCL4_0) | Multi-function 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 ² C (operation mode 4). | 163 | 133 | F7 |
| | SCK4_1 (SCL4_1) | | 102 | 86 | J10 |
| | SCK4_2 (SCL4_2) | | 10 | 10 | E2 |
| | RTS4_0 | Multi-function serial interface ch.4 RTS output pin | 161 | 131 | D7 |
| | RTS4_1 | | 104 | 88 | H10 |
| | RTS4_2 | | 12 | 12 | E4 |
| | CTS4_0 | Multi-function serial interface ch.4 CTS input pin | 162 | 132 | E7 |
| | CTS4_1 | | 103 | 87 | J9 |
| | CTS4_2 | | 11 | 11 | E3 |
| Multi-Function Serial 5 | SIN5_0 | Multi-function serial interface ch.5 input pin | 169 | 139 | C5 |
| | SIN5_1 | | 141 | - | B10 |
| | SIN5_2 | | 34 | 26 | J3 |
| | SOT5_0 (SDA5_0) | Multi-function 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 ² C (operation mode 4). | 168 | 138 | B5 |
| | SOT5_1 (SDA5_1) | | 142 | - | C10 |
| | SOT5_2 (SDA5_2) | | 35 | 27 | J2 |
| | SCK5_0 (SCL5_0) | Multi-function 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 ² C (operation mode 4). | 167 | 137 | E6 |
| | SCK5_1 (SCL5_1) | | 143 | - | D10 |
| | SCK5_2 (SCL5_2) | | 36 | 28 | K1 |

| Module | Pin name | Function | Pin No | | |
|-------------------------|--------------------|---|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Multi-Function Serial 6 | SIN6_0 | Multi-function serial interface ch.6 input pin | 16 | 16 | F3 |
| | SIN6_1 | | 31 | - | H6 |
| | SIN6_2 | | 170 | - | B4 |
| | SOT6_0 (SDA6_0) | Multi-function 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 ² C (operation mode 4). | 17 | 17 | F4 |
| | SOT6_1 (SDA6_1) | | 30 | - | H5 |
| | SOT6_2 (SDA6_2) | | 171 | - | C4 |
| | SCK6_0 (SCL6_0) | Multi-function 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 ² C (operation mode 4). | 18 | 18 | F5 |
| | SCK6_1 (SCL6_1) | | 29 | - | H4 |
| | SCK6_2 (SCL6_2) | | 172 | 140 | B3 |
| Multi-Function Serial 7 | SIN7_0 | Multi-function serial interface ch.7 input pin | 22 | 22 | G4 |
| | SIN7_1 | | 64 | 56 | K6 |
| | SIN7_2 | | 110 | - | H13 |
| | SOT7_0 (SDA7_0) | Multi-function 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 ² C (operation mode 4). | 23 | 23 | G5 |
| | SOT7_1 (SDA7_1) | | 63 | 55 | L6 |
| | SOT7_2 (SDA7_2) | | 111 | - | H12 |
| | SCK7_0 (SCL7_0) | Multi-function 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 ² C (operation mode 4). | 24 | 24 | G6 |
| | SCK7_1 (SCL7_1) | | 62 | 54 | M6 |
| | SCK7_2 (SCL7_2) | | 112 | - | H11 |

| Module | Pin name | Function | Pin No | | | |
|------------------------|-------------------|---|--|----------|---------|-----|
| | | | LQFP-176 | LQFP-144 | BGA-192 | |
| Multi-Function Timer 0 | DTTIOX_0 | Input signal of waveform generator to control outputs RTO00 to RTO05 of multi-function timer 0. | 37 | 29 | K2 | |
| | DTTIOX_1 | | 104 | 88 | H10 | |
| | FRCK0_0 | 16-bit free-run timer ch.0 external clock input pin | 32 | - | J5 | |
| | FRCK0_1 | | 105 | 89 | H9 | |
| | FRCK0_2 | | 91 | 75 | M12 | |
| | IC00_0 | 16-bit input capture input pin of multi-function timer 0 ICxx describes channel number. | 36 | 28 | K1 | |
| | IC00_1 | | 100 | 84 | J12 | |
| | IC00_2 | | 92 | 76 | L13 | |
| | IC01_0 | | 35 | 27 | J2 | |
| | IC01_1 | | 101 | 85 | J11 | |
| | IC01_2 | | 93 | 77 | L12 | |
| | IC02_0 | | 34 | 26 | J3 | |
| | IC02_1 | | 102 | 86 | J10 | |
| | IC02_2 | | 94 | 78 | L11 | |
| | IC03_0 | | 33 | - | J4 | |
| | IC03_1 | | 103 | 87 | J9 | |
| | IC03_2 | | 95 | 79 | K13 | |
| | RTO00_0 (PPG00_0) | | Waveform generator output of multi-function timer 0 | 38 | 30 | K3 |
| | RTO00_1 (PPG00_1) | | This pin operates as PPG00 when it is used in PPG0 output modes. | 124 | 100 | E12 |
| | RTO01_0 (PPG00_0) | | Waveform generator output of multi-function timer 0 | 39 | 31 | K4 |
| | RTO01_1 (PPG00_1) | This pin operates as PPG00 when it is used in PPG0 output modes. | 123 | 99 | E11 | |
| | RTO02_0 (PPG02_0) | Waveform generator output of multi-function timer 0 | 40 | 32 | L1 | |
| | RTO02_1 (PPG02_1) | This pin operates as PPG02 when it is used in PPG0 output modes. | 122 | 98 | E10 | |
| | RTO03_0 (PPG02_0) | Waveform generator output of multi-function timer 0 | 41 | 33 | L2 | |
| | RTO03_1 (PPG02_1) | This pin operates as PPG02 when it is used in PPG0 output modes. | 121 | 97 | F13 | |
| | RTO04_0 (PPG04_0) | Waveform generator output of multi-function timer 0 | 42 | 34 | L3 | |
| | RTO04_1 (PPG04_1) | This pin operates as PPG04 when it is used in PPG0 output modes. | 120 | 96 | F12 | |
| | RTO05_0 (PPG04_0) | Waveform generator output of multi-function timer 0 | 43 | 35 | M2 | |
| | RTO05_1 (PPG04_1) | This pin operates as PPG04 when it is used in PPG0 output modes. | 119 | 95 | F11 | |

| Module | Pin name | Function | Pin No | | |
|------------------------|--|---|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Multi-Function Timer 1 | DTT1X_0 | Input signal of waveform generator to control outputs RTO10 to RTO15 of multi-function timer 1. | 19 | 19 | F6 |
| | DTT1X_1 | | 58 | 50 | M5 |
| | FRCK1_0 | 16-bit free-run timer ch.1 external clock input pin | 2 | 2 | B2 |
| | FRCK1_1 | | 63 | 55 | L6 |
| | IC10_0 | 16-bit input capture input pin of multi-function timer 1. ICxx describes channel number | 3 | 3 | C2 |
| | IC10_1 | | 59 | 51 | L5 |
| | IC11_0 | | 4 | 4 | C3 |
| | IC11_1 | | 60 | 52 | K5 |
| | IC12_0 | | 5 | 5 | D5 |
| | IC12_1 | | 61 | 53 | N6 |
| | IC13_0 | | 6 | 6 | D2 |
| | IC13_1 | | 62 | 54 | M6 |
| | RTO10_0 (PPG10_0) | Waveform generator output of multi-function timer 1. | 13 | 13 | E5 |
| | RTO10_1 (PPG10_1) | This pin operates as PPG10 when it is used in PPG1 output modes. | 46 | 38 | N2 |
| | RTO11_0 (PPG10_0) | Waveform generator output of multi-function timer 1. | 14 | 14 | F1 |
| | RTO11_1 (PPG10_1) | This pin operates as PPG10 when it is used in PPG1 output modes. | 47 | 39 | N3 |
| | RTO12_0 (PPG12_0) | Waveform generator output of multi-function timer 1. | 15 | 15 | F2 |
| | RTO12_1 (PPG12_1) | This pin operates as PPG12 when it is used in PPG1 output modes. | 48 | 40 | M3 |
| | RTO13_0 (PPG12_0) | Waveform generator output of multi-function timer 1. | 16 | 16 | F3 |
| | RTO13_1 (PPG12_1) | This pin operates as PPG12 when it is used in PPG1 output modes. | 49 | 41 | L4 |
| | RTO14_0 (PPG14_0) | Waveform generator output of multi-function timer 1. | 17 | 17 | F4 |
| | RTO14_1 (PPG14_1) | This pin operates as PPG14 when it is used in PPG1 output modes. | 50 | 42 | M4 |
| | RTO15_0 (PPG14_0) | Waveform generator output of multi-function timer 1. | 18 | 18 | F5 |
| RTO15_1 (PPG14_1) | This pin operates as PPG14 when it is used in PPG1 output modes. | 51 | 43 | N4 | |

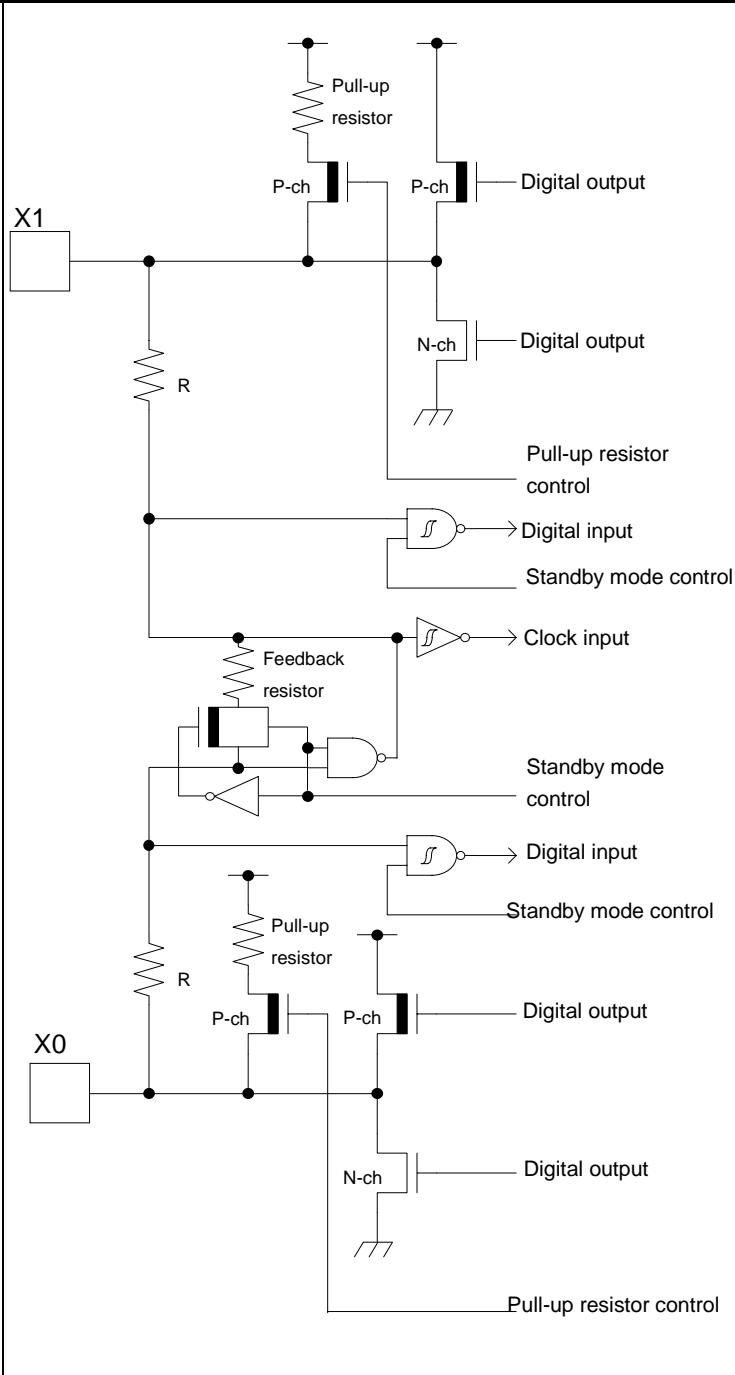
| Module | Pin name | Function | Pin No | | | |
|---------------------------|----------------------|--|--|----------|---------|-----|
| | | | LQFP-176 | LQFP-144 | BGA-192 | |
| Multi-Function Timer 2 | DTTI2X_0 | Input signal of waveform generator to control outputs RTO20 to RTO25 of multi-function timer 2. | 12 | 12 | E4 | |
| | DTTI2X_1 | | 26 | - | H2 | |
| | FRCK2_0 | 16-bit free-run timer ch.2 external clock input pin | 128 | 104 | C13 | |
| | FRCK2_1 | | 78 | - | N10 | |
| | IC20_0 | 16-bit input capture input pin of multi-function timer 2. ICxx describes channel number. | 13 | 13 | E5 | |
| | IC20_1 | | 25 | - | H1 | |
| | IC21_0 | | 14 | 14 | F1 | |
| | IC21_1 | | 79 | - | L10 | |
| | IC22_0 | | 15 | 15 | F2 | |
| | IC22_1 | | 80 | - | K10 | |
| | IC23_0 | | 16 | 16 | F3 | |
| | IC23_1 | | 81 | - | M10 | |
| | RTO20_0 (PPG20_0) | | Waveform generator output of multi-function timer 2. This pin operates as PPG20 when it is used in PPG2 output modes. | 2 | 2 | B2 |
| | RTO20_1 (PPG20_1) | | | 139 | - | C11 |
| | RTO21_0 (PPG20_0) | Waveform generator output of multi-function timer 2. This pin operates as PPG20 when it is used in PPG2 output modes. | 3 | 3 | C2 | |
| | RTO21_1 (PPG20_1) | | 140 | - | D11 | |
| | RTO22_0 (PPG22_0) | Waveform generator output of multi-function timer 2. This pin operates as PPG22 when it is used in PPG2 output modes. | 4 | 4 | C3 | |
| | RTO22_1 (PPG22_1) | | 141 | - | B10 | |
| | RTO23_0 (PPG22_0) | Waveform generator output of multi-function timer 2. This pin operates as PPG22 when it is used in PPG2 output modes. | 5 | 5 | D5 | |
| | RTO23_1 (PPG22_1) | | 142 | - | C10 | |
| | RTO24_0 (PPG24_0) | Waveform generator output of multi-function timer 2. This pin operates as PPG24 when it is used in PPG2 output modes. | 6 | 6 | D2 | |
| | RTO24_1 (PPG24_1) | | 143 | - | D10 | |
| | RTO25_0 (PPG24_0) | Waveform generator output of multi-function timer 2. This pin operates as PPG24 when it is used in PPG2 output modes. | 7 | 7 | D1 | |
| | RTO25_1 (PPG24_1) | | 144 | - | B9 | |

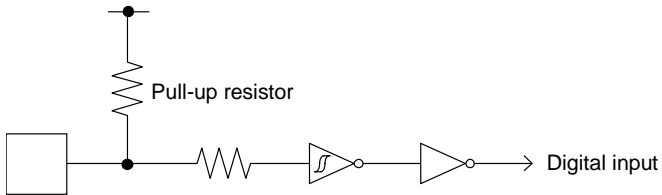
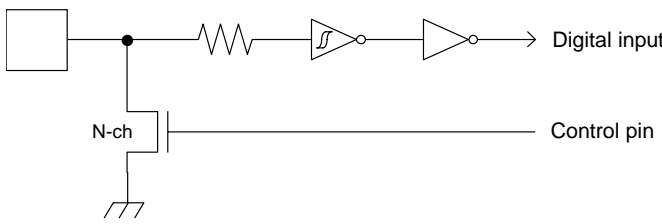
| Module | Pin name | Function | Pin No | | |
|---|----------|--|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Quadrature Position/ Revolution Counter 0 | AIN0_0 | QPRC ch.0 AIN input pin | 28 | - | H3 |
| | AIN0_1 | | 59 | 51 | L5 |
| | AIN0_2 | | 13 | 13 | E5 |
| | BIN0_0 | QPRC ch.0 BIN input pin | 29 | - | H4 |
| | BIN0_1 | | 60 | 52 | K5 |
| | BIN0_2 | | 14 | 14 | F1 |
| | ZIN0_0 | QPRC ch.0 ZIN input pin | 30 | - | H5 |
| | ZIN0_1 | | 61 | 53 | N6 |
| | ZIN0_2 | | 15 | 15 | F2 |
| Quadrature Position/ Revolution Counter 1 | AIN1_0 | QPRC ch.1 AIN input pin | 73 | 65 | N9 |
| | AIN1_1 | | 127 | 103 | D13 |
| | AIN1_2 | | 62 | 54 | M6 |
| | BIN1_0 | QPRC ch.1 BIN input pin | 74 | 66 | M9 |
| | BIN1_1 | | 126 | 102 | D12 |
| | BIN1_2 | | 63 | 55 | L6 |
| | ZIN1_0 | QPRC ch.1 ZIN input pin | 75 | 67 | L9 |
| | ZIN1_1 | | 125 | 101 | E13 |
| | ZIN1_2 | | 64 | 56 | K6 |
| Quadrature Position/ Revolution Counter 2 | AIN2_0 | QPRC ch.2 AIN input pin | 67 | 59 | M8 |
| | AIN2_1 | | 170 | - | B4 |
| | AIN2_2 | | 115 | - | G11 |
| | BIN2_0 | QPRC ch.2 BIN input pin | 68 | 60 | L8 |
| | BIN2_1 | | 171 | - | C4 |
| | BIN2_2 | | 116 | - | G10 |
| | ZIN2_0 | QPRC ch.2 ZIN input pin | 69 | 61 | K8 |
| | ZIN2_1 | | 172 | 140 | B3 |
| | ZIN2_2 | | 117 | - | G9 |
| RESET | INITX | External Reset Input. A reset is valid when INITX="L". | 57 | 49 | N5 |
| Mode | MD0 | Mode 0 Pin. During normal operation, MD0="L" must be input. During serial programming to Flash memory, MD0="H" must be input. | 85 | 69 | N12 |
| | MD1 | Mode 1 Pin. During serial programming to Flash memory, MD1="L" must be input. | 84 | 68 | N13 |

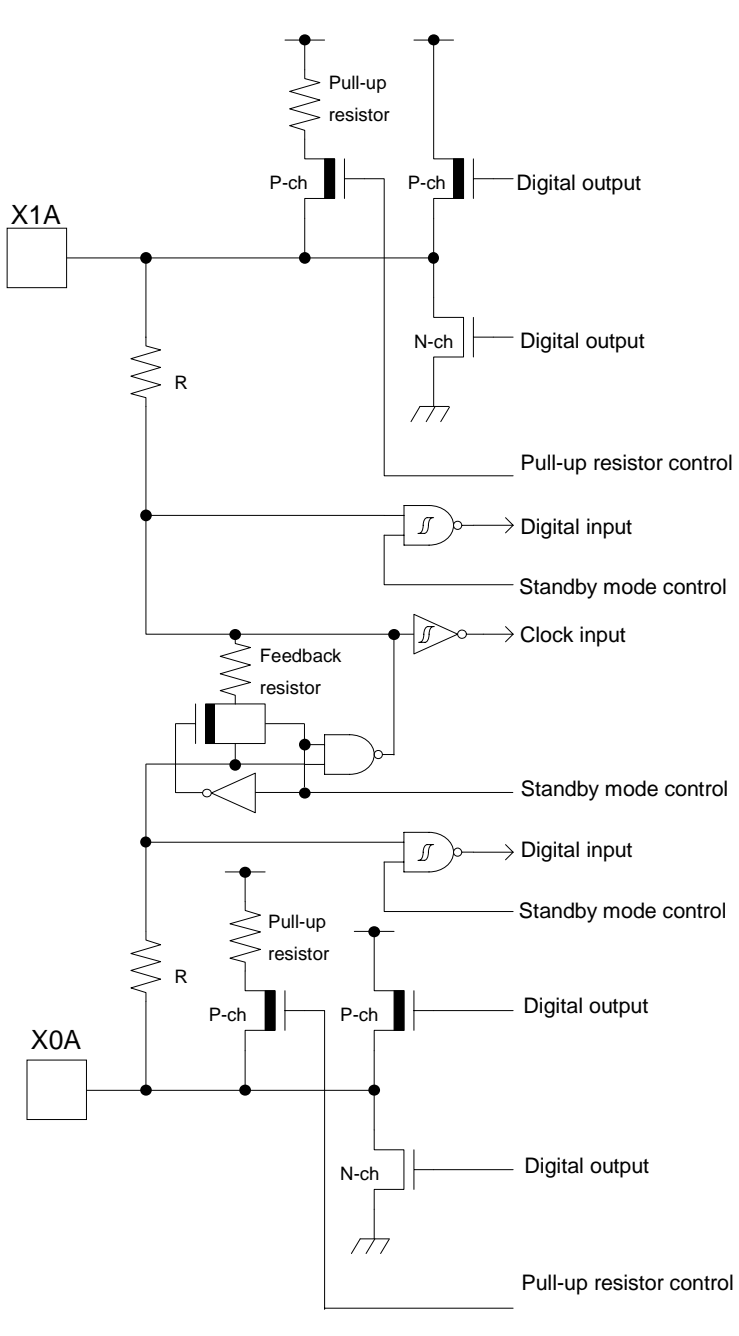
| Module | Pin name | Function | Pin No | | |
|--------|----------|--|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| POWER | VCC | Power supply Pin | 1 | 1 | C1 |
| | VCC | Power supply Pin | 45 | 37 | N1 |
| | VCC | Power supply Pin | 54 | 46 | P4 |
| | VCC | Power supply Pin | 89 | 73 | M14 |
| | VCC | Power supply Pin | 133 | 109 | A13 |
| | VCC | Power supply Pin | 173 | 141 | A4 |
| | VCC | Power supply Pin | 129 | 105 | E14 |
| | VCC | Power supply Pin | 156 | 126 | A9 |
| GND | VSS | GND Pin | 27 | 25 | J1 |
| | VSS | GND Pin | 44 | 36 | M1 |
| | VSS | GND Pin | 53 | 45 | P3 |
| | VSS | GND Pin | 88 | 72 | N14 |
| | VSS | GND Pin | 109 | 93 | F14 |
| | VSS | GND Pin | 132 | 108 | B14 |
| | VSS | GND Pin | 157 | 127 | A11 |
| | VSS | GND Pin | 176 | 144 | B1 |
| | VSS | GND Pin | - | - | E1 |
| | VSS | GND Pin | - | - | G1 |
| | VSS | GND Pin | - | - | P7 |
| | VSS | GND Pin | - | - | P11 |
| | VSS | GND Pin | - | - | L14 |
| | VSS | GND Pin | - | - | A8 |
| | VSS | GND Pin | - | - | A5 |
| | VSS | GND Pin | - | - | N7 |
| | VSS | GND Pin | - | - | M7 |
| | VSS | GND Pin | - | - | L7 |
| | VSS | GND Pin | - | - | K7 |
| | VSS | GND Pin | - | - | J7 |
| | VSS | GND Pin | - | - | G7 |
| | VSS | GND Pin | - | - | H7 |
| VSS | GND Pin | - | - | H8 | |
| VSS | GND Pin | - | - | G8 | |
| CLOCK | X0 | Main clock (oscillation) input pin | 86 | 70 | P12 |
| | X0A | Sub clock (oscillation) input pin | 55 | 47 | P5 |
| | X1 | Main clock (oscillation) I/O pin | 87 | 71 | P13 |
| | X1A | Sub clock (oscillation) I/O pin | 56 | 48 | P6 |
| | CROUT_0 | Built-in high-speed CR oscillation clock output port | 127 | 103 | D13 |
| | CROUT_1 | | 152 | 122 | E8 |

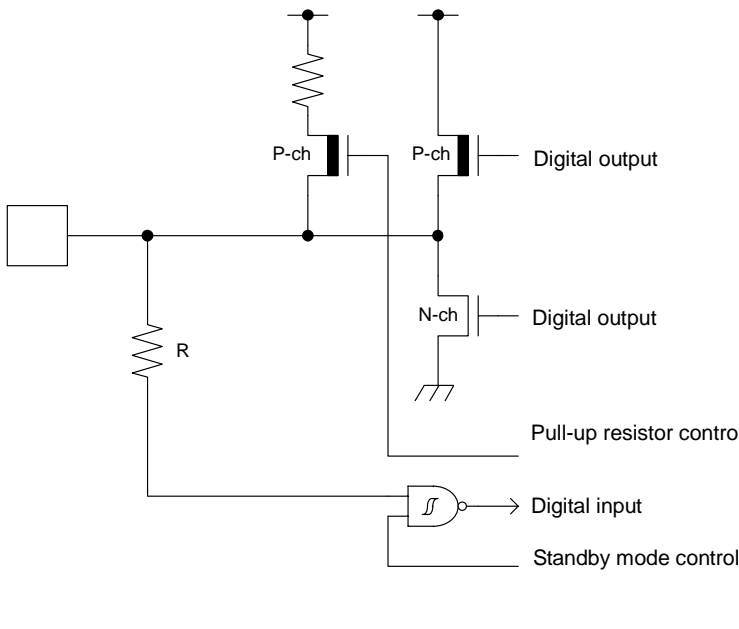
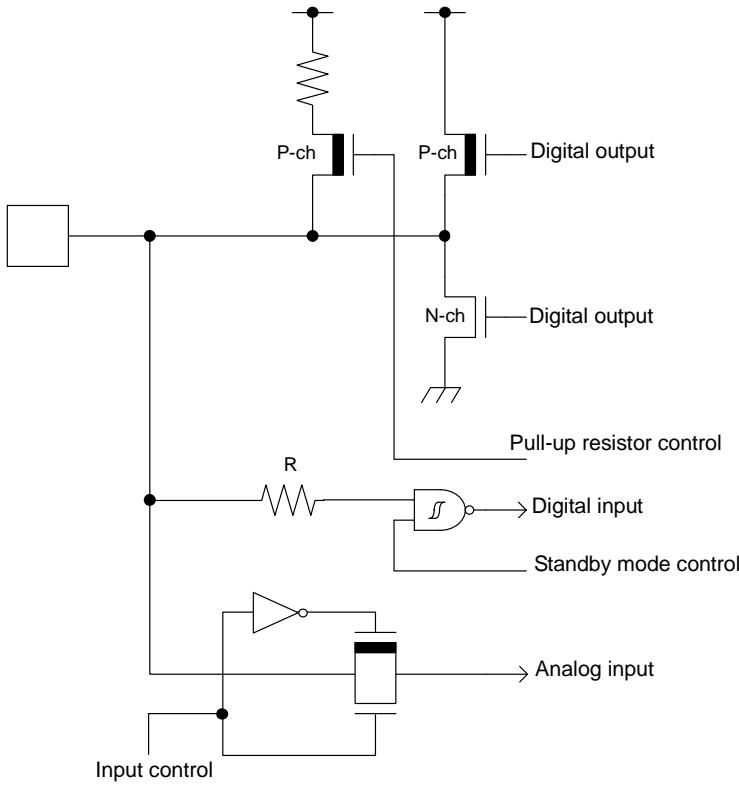
| Module | Pin name | Function | Pin No | | |
|-----------------|----------|--|----------|----------|---------|
| | | | LQFP-176 | LQFP-144 | BGA-192 |
| Analog POWER | AVCC | A/D converter analog power supply pin | 106 | 90 | J14 |
| | AVRH | A/D converter analog reference voltage input pin | 107 | 91 | H14 |
| Analog GND | AVSS | A/D converter GND pin | 108 | 92 | G14 |
| C pin | C | Power supply stabilization capacity pin | 52 | 44 | P2 |

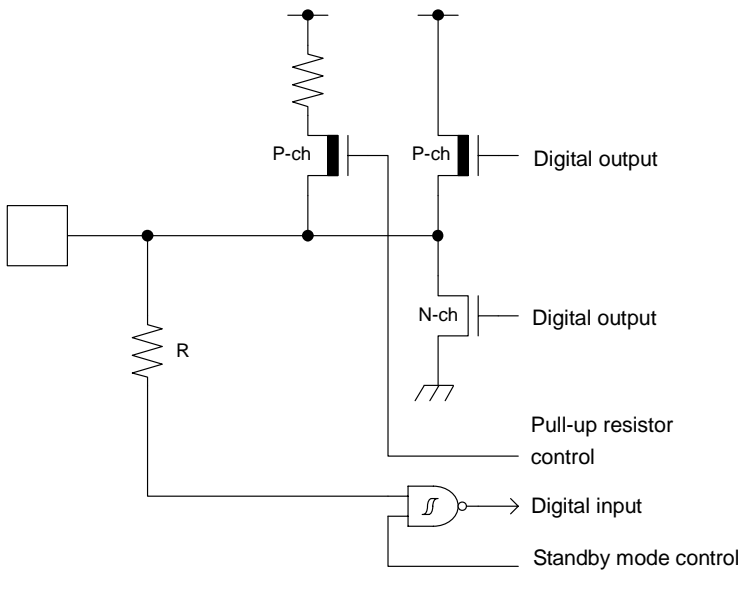
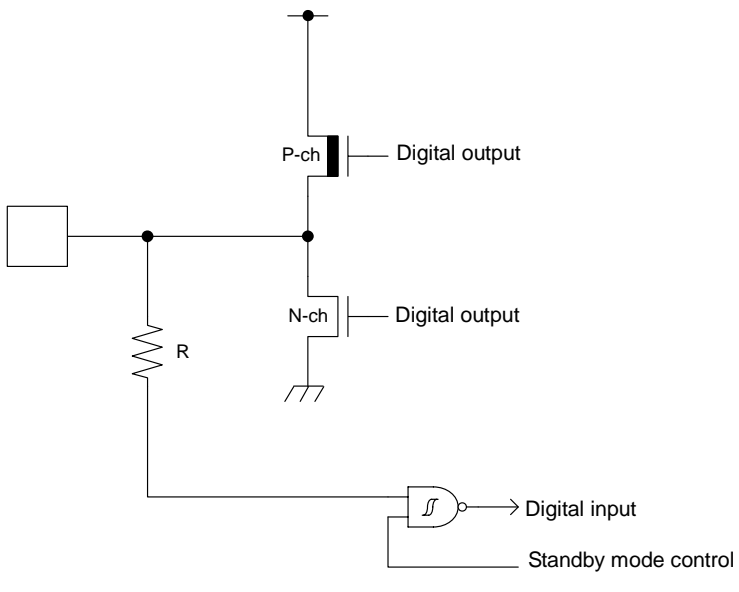
5. I/O Circuit Type

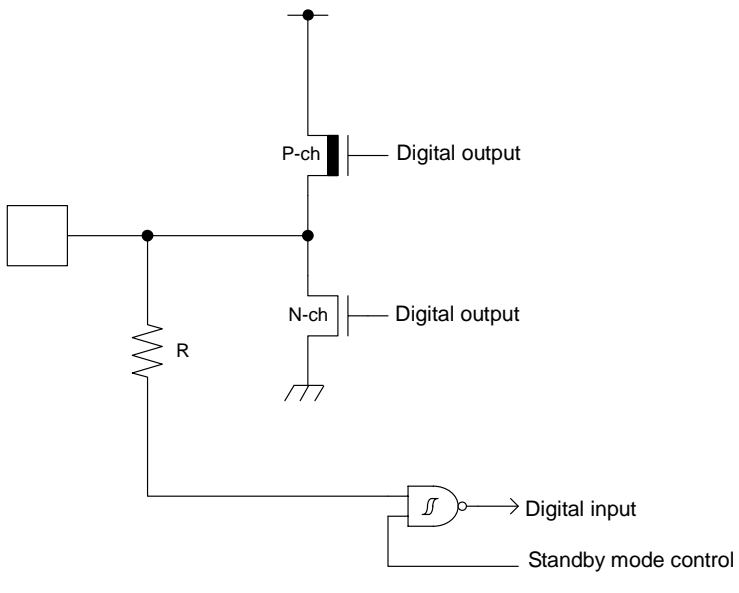
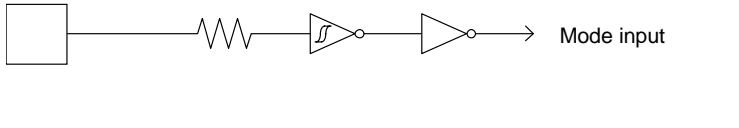
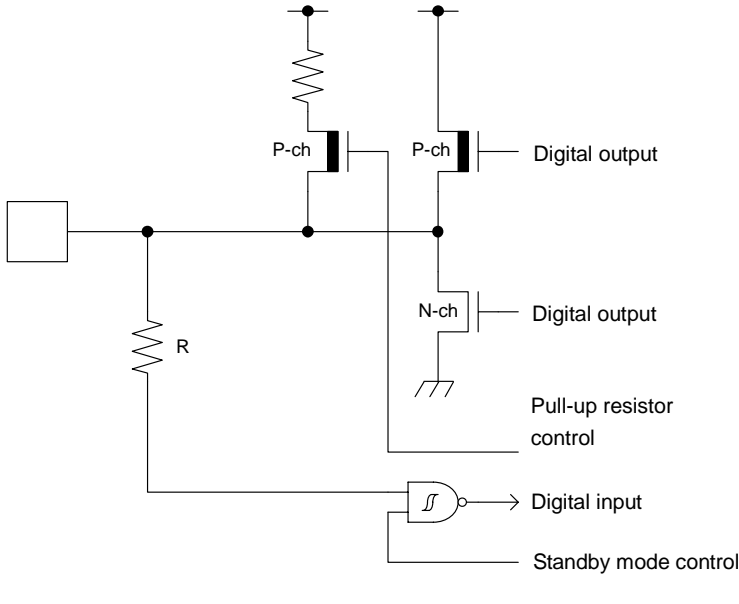
| Type | Circuit | Remarks |
|------|---|--|
| A |  | <p>It is possible to select the main oscillation / GPIO function When the main oscillation is selected.</p> <ul style="list-style-type: none"> ■ Oscillation feedback resistor: Approximately 1 MΩ ■ With Standby mode control When the GPIO is selected. ■ CMOS level output. ■ CMOS level hysteresis input ■ With pull-up resistor control ■ With standby mode control ■ Pull-up resistor: Approximately 50 kΩ ■ I_{OH}= -4 mA, I_{OL}= 4 mA |

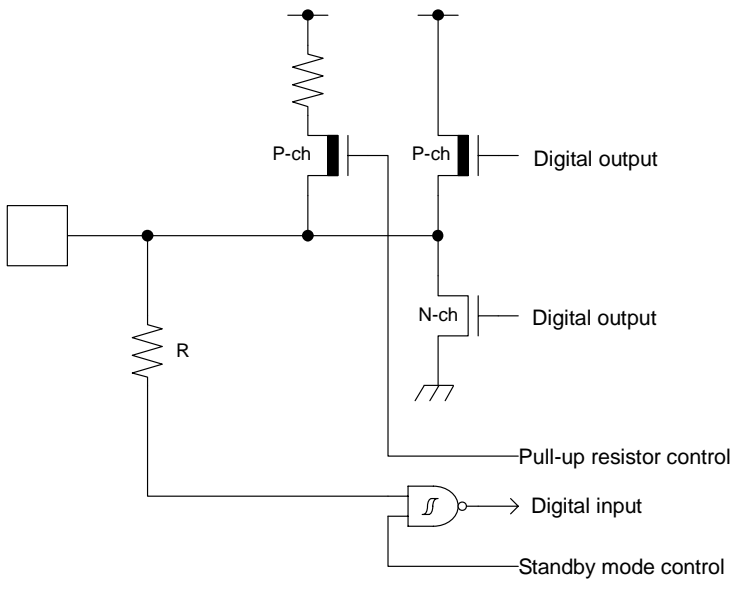
| Type | Circuit | Remarks |
|------|---|--|
| B |  <p style="text-align: center;">Pull-up resistor</p> <p style="text-align: right;">Digital input</p> | <ul style="list-style-type: none"> ■ CMOS level hysteresis input ■ Pull-up resistor: Approximately 50 kΩ |
| C |  <p style="text-align: right;">Digital input</p> <p style="text-align: right;">Control pin</p> <p style="text-align: center;">N-ch</p> | <ul style="list-style-type: none"> ■ Open drain output ■ CMOS level hysteresis input |

| Type | Circuit | Remarks |
|------|---|--|
| D |  <p>The diagram shows two oscillator blocks, X1A and X0A. X1A is connected to a pull-up resistor and a resistor R. Its output is connected to a P-ch MOSFET, which is also connected to a pull-up resistor. The output of X1A is also connected to a Digital output (P-ch), a Digital output (N-ch), and a Pull-up resistor control. X1A is also connected to a Digital input, a Standby mode control, and a Clock input. X0A is connected to a pull-up resistor and a resistor R. Its output is connected to a P-ch MOSFET, which is also connected to a pull-up resistor. The output of X0A is also connected to a Digital output (P-ch), a Digital output (N-ch), and a Pull-up resistor control. X0A is also connected to a Digital input, a Standby mode control, and a Clock input. A Feedback resistor is connected between the Digital input and the Clock input. The Standby mode control is connected to a Digital input and a Standby mode control.</p> | <p>It is possible to select the sub oscillation / GPIO function When the sub oscillation is selected.</p> <ul style="list-style-type: none"> ■ Oscillation feedback resistor: Approximately 5 MΩ ■ With Standby mode control When the GPIO is selected. ■ CMOS level output. ■ CMOS level hysteresis input ■ With pull-up resistor control ■ With standby mode control ■ Pull-up resistor: Approximately 50 kΩ ■ $I_{OH} = -4 \text{ mA}$, $I_{OL} = 4 \text{ mA}$ |

| Type | Circuit | Remarks |
|------|---|--|
| E |  | <ul style="list-style-type: none"> ■ CMOS level output ■ CMOS level hysteresis input ■ With pull-up resistor control ■ With standby mode control ■ Pull-up resistor: Approximately 50 kΩ ■ $I_{OH} = -4 \text{ mA}$, $I_{OL} = 4 \text{ mA}$ ■ When this pin is used as an I²C pin, the digital output P-ch transistor is always off ■ +B input is available |
| F |  | <ul style="list-style-type: none"> ■ CMOS level output ■ CMOS level hysteresis input ■ With input control ■ Analog input ■ With pull-up resistor control ■ With standby mode control ■ Pull-up resistor : Approximately 50 kΩ ■ $I_{OH} = -4 \text{ mA}$, $I_{OL} = 4 \text{ mA}$ ■ When this pin is used as an I²C pin, the digital output P-ch transistor is always off ■ +B input is available |

| Type | Circuit | Remarks |
|------|---|---|
| G |  | <ul style="list-style-type: none"> ■ CMOS level output ■ CMOS level hysteresis input ■ With pull-up resistor control ■ With standby mode control ■ Pull-up resistor: Approximately 50 kΩ ■ $I_{OH} = -12 \text{ mA}$, $I_{OL} = 12 \text{ mA}$ ■ +B input is available |
| H |  | <ul style="list-style-type: none"> ■ CMOS level output ■ CMOS level hysteresis input ■ With standby mode control ■ $I_{OH} = -20.5 \text{ mA}$, $I_{OL} = 18.5 \text{ mA}$ |

| Type | Circuit | Remarks |
|------|--|---|
| I |  | <ul style="list-style-type: none"> ■ CMOS level output ■ CMOS level hysteresis input ■ 5 V tolerant ■ With standby mode control ■ $I_{OH} = -4 \text{ mA}$, $I_{OL} = 4 \text{ mA}$ ■ Available to control PZR registers. ■ When this pin is used as an I²C pin, the digital output P-ch transistor is always off |
| J |  | <p>CMOS level hysteresis input</p> |
| K |  | <ul style="list-style-type: none"> ■ CMOS level output ■ TTL level hysteresis input ■ With pull-up resistor control ■ With standby mode control ■ Pull-up resistor: Approximately 50 kΩ ■ $I_{OH} = -4 \text{ mA}$, $I_{OL} = 4 \text{ mA}$ |

| Type | Circuit | Remarks |
|------|--|--|
| L |  | <ul style="list-style-type: none"> ■ CMOS level output ■ CMOS level hysteresis input ■ With pull-up resistor control ■ With standby mode control ■ Pull-up resistor: Approximately 50 kΩ ■ $I_{OH} = -8 \text{ mA}$, $I_{OL} = 8 \text{ mA}$ ■ When this pin is used as an I2C pin, the digital output P-ch transistor is always off ■ +B input is available |

6. Handling Precautions

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 Cypress semiconductor devices.

6.1 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 certain established limits, called absolute maximum ratings. Do not exceed these ratings.

■ Recommended Operating Conditions

Recommended operating conditions are normal operating ranges for the semiconductor device. All the device's electrical characteristics are warranted when operated within these ranges.

Always use semiconductor devices within the recommended operating conditions. 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 sales representative 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.

CAUTION:

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:

1. *Be sure that voltages applied to pins do not exceed the absolute maximum ratings. This should include attention to abnormal noise, surge levels, etc.*
2. *Be sure that abnormal current flows do not occur during the power-on sequence.*

■ Observance of Safety Regulations and Standards

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

■ Fail-Safe Design

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

■ Precautions Related to Usage of Devices

Cypress 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 sales representatives before such use. The company will not be responsible for damages arising from such use without prior approval.

6.2 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 Cypress recommended conditions. For detailed information about mount conditions, contact your 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 Cypress 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. Spansion 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 Cypress ranking of recommended conditions.

■ Lead-Free Packaging

CAUTION:

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:

1. Avoid exposure to rapid temperature changes, which cause moisture to condense inside the product. Store products in locations where temperature changes are slight.
2. 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.
3. When necessary, Cypress 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.
4. 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 Cypress 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:

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

6.3 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

CAUTION:

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 Cypress products in other special environmental conditions should consult with sales representatives.

7. Handling Devices

7.1 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 each Power supply pins and GND pins of this device at low impedance. It is also advisable that a ceramic capacitor of approximately 0.1 μF be connected as a bypass capacitor between each Power supply pins and GND pins, between AVCC pin and AVSS pin near this device.

7.2 Stabilizing power supply voltage

A malfunction may occur when the power supply voltage fluctuates rapidly even though the fluctuation is within the recommended operating conditions of the VCC power supply voltage. As a rule, with voltage stabilization, suppress the voltage fluctuation so that the fluctuation in VCC ripple (peak-to-peak value) at the commercial frequency (50 Hz/60 Hz) does not exceed 10% of the VCC value in the recommended operating conditions, and the transient fluctuation rate does not exceed 0.1 V/ μs when there is a momentary fluctuation on switching the power supply.

7.3 Crystal oscillator circuit

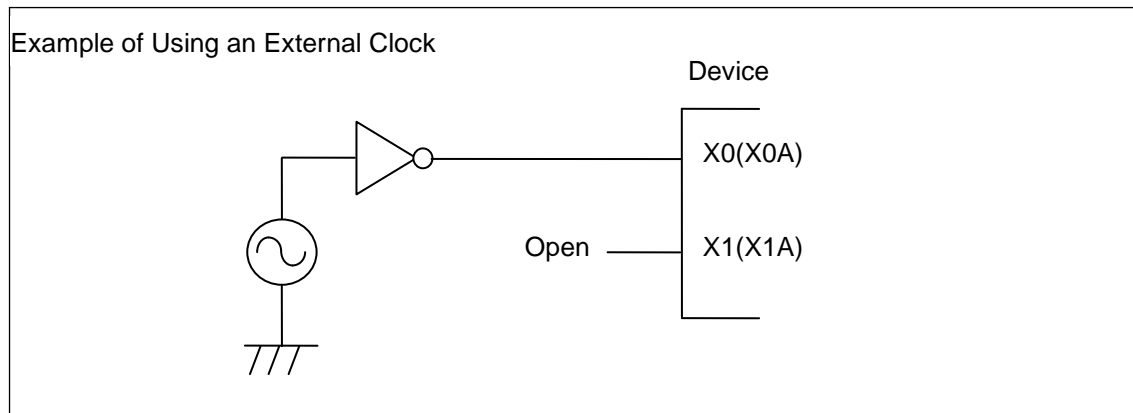
Noise near the X0/X1 and X0A/X1A pins may cause the device to malfunction. Design the printed circuit board so that X0/X1, X0A/X1A pins, the crystal oscillator and the bypass capacitor to ground are located as close to the device as possible.

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.

Evaluate oscillation of your using crystal oscillator by your mount board.

7.4 Using an external clock

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



7.5 Handling when using Multi-function serial pin as I²C pin

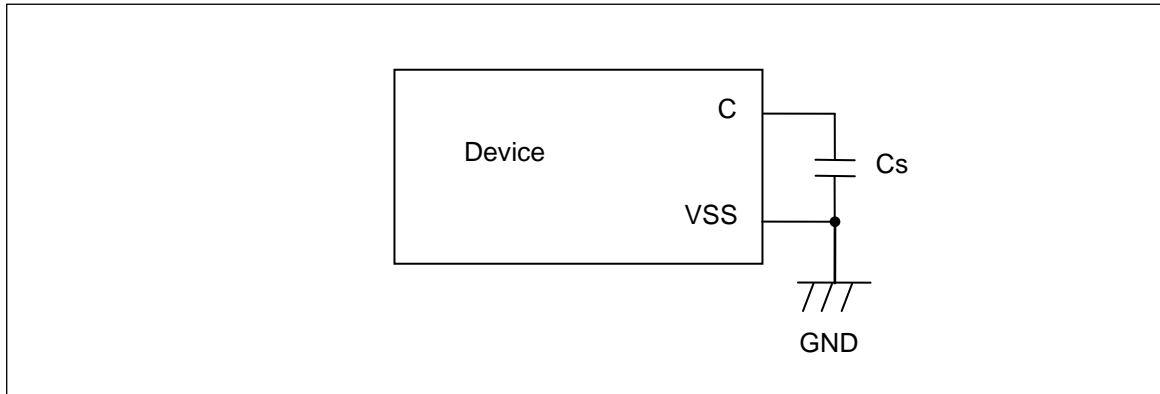
If it is using the multi-function serial pin as I²C pins, P-ch transistor of digital output is always disabled. However, I²C pins need to keep the electrical characteristic like other pins and not to connect to the external I²C bus system with power OFF.

7.6 C Pin

This series contains the regulator. Be sure to connect a smoothing capacitor (C_S) for the regulator between the C pin and the GND pin. Please use a ceramic capacitor or a capacitor of equivalent frequency characteristics as a smoothing capacitor.

However, some laminated ceramic capacitors have the characteristics of capacitance variation due to thermal fluctuation (F characteristics and Y5V characteristics). Please select the capacitor that meets the specifications in the operating conditions to use by evaluating the temperature characteristics of a capacitor.

A smoothing capacitor of about 4.7 μ F would be recommended for this series.



7.7 Mode pins (MD0)

Connect the MD pin (MD0) 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.

7.8 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 → AVCC → AVRH

Turning off : AVRH → AVCC → VCC

7.9 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.

7.10 Differences in features among the products with different memory sizes and between Flash products and MASK products

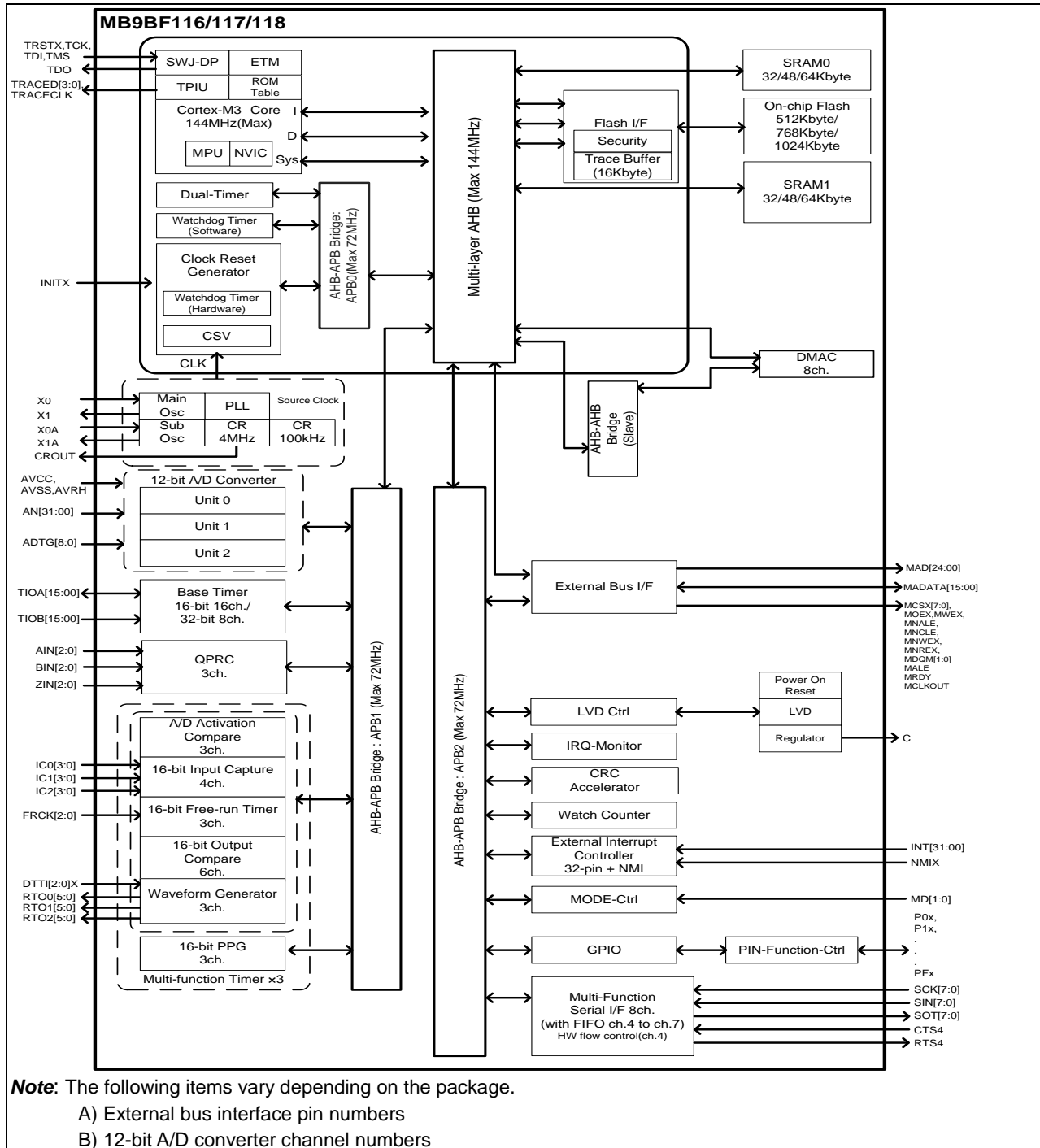
The electric characteristics including power consumption, ESD, latch-up, noise characteristics, and oscillation characteristics among the products with different memory sizes and between Flash products and MASK products are different because chip layout and memory structures are different.

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

7.11 Base Timer

In the case of using ch.8 and ch.9 at I/O mode 1 (timer full mode), the TIOA09 pin cannot be used for external startup trigger input (TGIN). Be sure to use the pin with making ESG1 and ESG2 bits of the Timer Control Register (Ch.9-TMCR) in the Base Timer to be "0b00" in order to disable trigger input.

8. Block Diagram

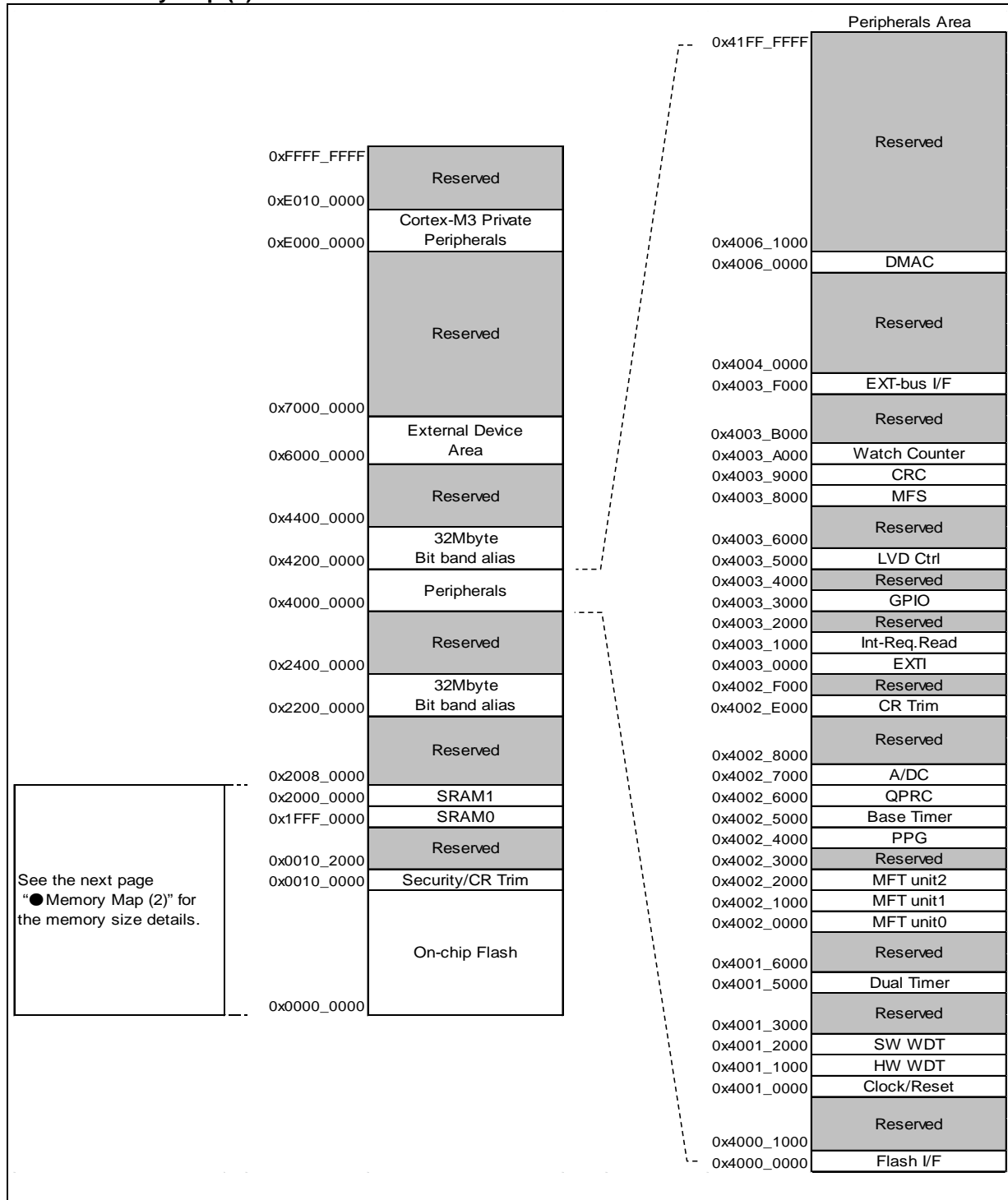


9. Memory Size

See "Memory size" in "Product Lineup" to confirm the memory size.

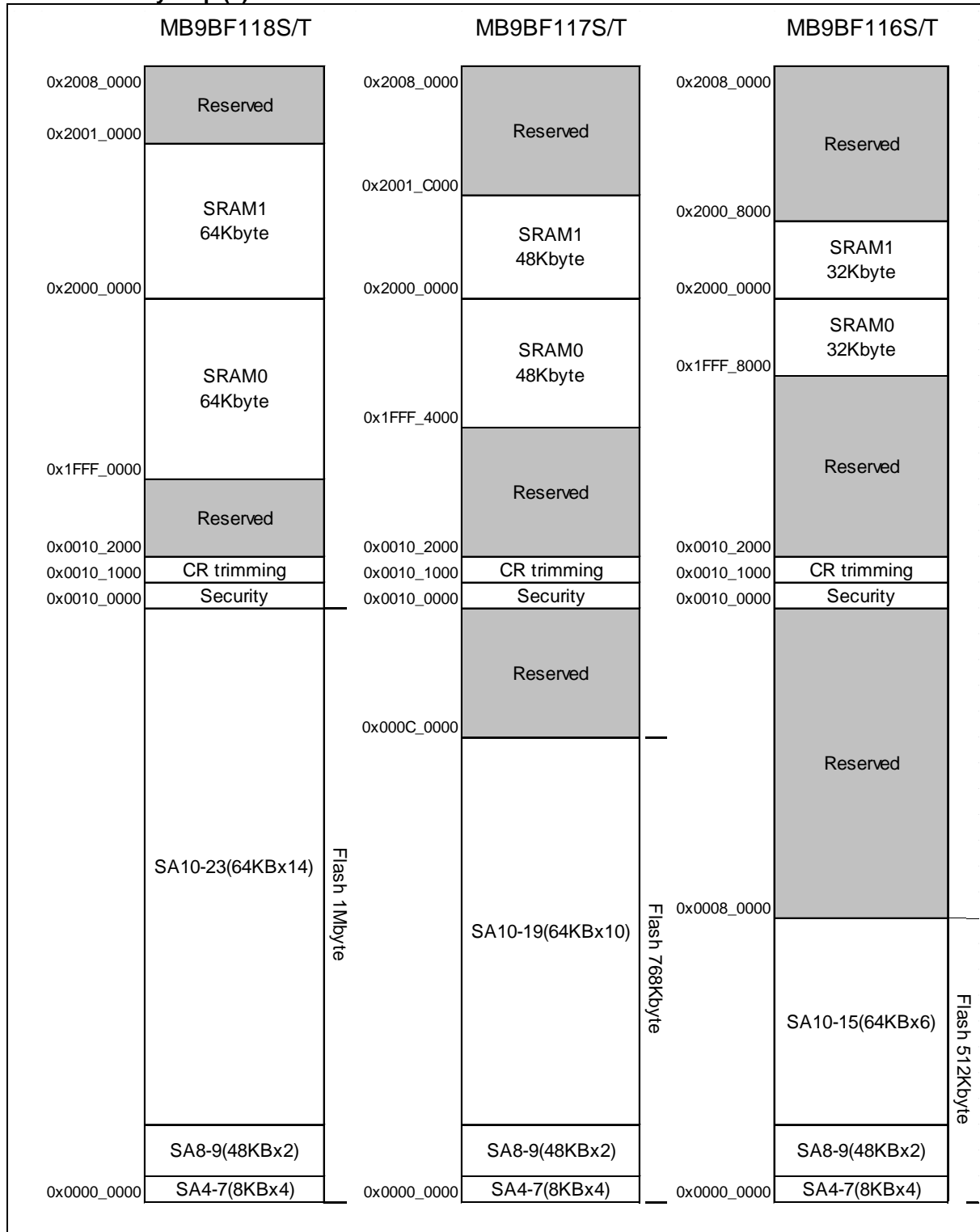
10. Memory Map

10.1 Memory Map (1)



See the next page "●Memory Map (2)" for the memory size details.

10.2 Memory Map (2)



*: See "MB9BD10T/610T/510T/410T/310T/210T/110T Series Flash programming Manual" for sector structure of Flash.

10.3 Peripheral Address Map

| Start address | End address | Bus | Peripherals | |
|---------------|-------------|---|---------------------------------|---------------------------------|
| 0x4000_0000 | 0x4000_0FFF | AHB | Flash memory 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 | Multi-function timer unit2 | | |
| 0x4002_4000 | 0x4002_4FFF | PPG | | |
| 0x4002_5000 | 0x4002_5FFF | Base Timer | | |
| 0x4002_6000 | 0x4002_6FFF | Quadrature Position/Revolution Counter (QPRC) | | |
| 0x4002_7000 | 0x4002_7FFF | A/D Converter | | |
| 0x4002_8000 | 0x4002_DFFF | Reserved | | |
| 0x4002_E000 | 0x4002_EFFF | Built-in CR trimming | | |
| 0x4002_F000 | 0x4002_FFFF | Reserved | | |
| 0x4003_0000 | 0x4003_0FFF | APB2 | | External Interrupt |
| 0x4003_1000 | 0x4003_1FFF | | | Interrupt Source Check Register |
| 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_7FFF | | Reserved | |
| 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 bus interface | |
| 0x4004_0000 | 0x4005_FFFF | | AHB | Reserved |
| 0x4006_0000 | 0x4006_0FFF | DMAC register | | |
| 0x4006_1000 | 0x41FF_FFFF | Reserved | | |

11. 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 the standby pin level setting bit (SPL) in the standby mode control register (STB_CTL) is set to "0".

■ **SPL=1**

This is the status that the standby pin level setting bit (SPL) in the 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 pin 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.

11.1 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 stop 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 | GPIO selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Hi-Z/ Internal input fixed at "0" |
| | Main crystal oscillator input pin | Input enabled | Input enabled | Input enabled | Input enabled | Input enabled | Input enabled |
| B | GPIO selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Hi-Z/ Internal input fixed at "0" |
| | Main crystal oscillator output pin | Hi-Z/ Internal input fixed at "0"/ or Input enable | Hi-Z/ Internal input fixed at "0" | Hi-Z/ Internal input fixed at "0" | Maintain previous state | Maintain previous state/ Hi-Z at oscillation stop ⁽¹⁾ / Internal input fixed at "0" | Maintain previous state/ Hi-Z at oscillation stop ⁽¹⁾ / Internal input fixed at "0" |
| C | INITX input pin | Pull-up/ Input enabled | Pull-up/ Input enabled | Pull-up/ Input enabled | Pull-up/ Input enabled | Pull-up/ Input enabled | Pull-up/ Input enabled |
| D | Mode input pin | Input enabled | Input enabled | Input enabled | Input enabled | Input enabled | Input enabled |
| E | JTAG selected | Hi-Z | Pull-up/ Input enabled | Pull-up/ Input enabled | Maintain previous state | Maintain previous state | Maintain previous state |
| | GPIO selected | Setting disabled | Setting disabled | Setting disabled | | | Hi-Z/ Internal input fixed at "0" |
| F | Trace selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Trace output |
| | External interrupt enabled selected | | | | | | Maintain previous state |
| | GPIO selected, or resource other than above selected | Hi-Z | Hi-Z/ Input enabled | Hi-Z/ Input enabled | | | Hi-Z/ Internal input fixed at "0" |
| G | Trace selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Trace output |
| | GPIO selected, or resource other than above 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 stop 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 |
| H | External interrupt enabled selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Maintain previous state |
| | GPIO selected, or resource other than above selected | Hi-Z | Hi-Z/ Input enabled | Hi-Z/ Input enabled | | | Hi-Z/ Internal input fixed at "0" |
| I | GPIO selected, resource selected | Hi-Z | Hi-Z/ Input enabled | Hi-Z/ Input enabled | Maintain previous state | Maintain previous state | Hi-Z/ Internal input fixed at "0" |
| J | NMIX selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Maintain previous state |
| | GPIO selected, or resource other than above selected | Hi-Z | Hi-Z/ Input enabled | Hi-Z/ Input enabled | | | Hi-Z/ Internal input fixed at "0" |
| K | Analog input selected | Hi-Z | Hi-Z/ Internal input fixed at "0"/ Analog input enabled | Hi-Z/ Internal input fixed at "0"/ Analog input enabled | Hi-Z/ Internal input fixed at "0"/ Analog input enabled | Hi-Z/ Internal input fixed at "0"/ Analog input enabled | Hi-Z/ Internal input fixed at "0"/ Analog input enabled |
| | GPIO selected, or resource other than above selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Hi-Z/ Internal input fixed at "0" |
| L | External interrupt enabled selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Maintain previous state |
| | Analog input selected | Hi-Z | Hi-Z/ Internal input fixed at "0"/ Analog input enabled | Hi-Z/ Internal input fixed at "0"/ Analog input enabled | Hi-Z/ Internal input fixed at "0"/ Analog input enabled | Hi-Z/ Internal input fixed at "0"/ Analog input enabled | Hi-Z/ Internal input fixed at "0"/ Analog input enabled |
| | GPIO selected, or resource other than above selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Hi-Z/ Internal input fixed at "0" |
| M | GPIO selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Hi-Z/ Internal input fixed at "0" |
| | Sub crystal oscillator input pin | Input enabled | Input enabled | Input enabled | Input enabled | Input enabled | Input enabled |

| Pin status type | Function group | Power-on reset or low-voltage detection state | INITX input state | Device internal reset state | Run mode or sleep mode state | Timer mode or stop 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 | GPIO selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Hi-Z/ Internal input fixed at "0" |
| | Sub crystal oscillator output pin | Hi-Z/ Internal input fixed at "0"/ or Input enable | Hi-Z/ Internal input fixed at "0" | Hi-Z/ Internal input fixed at "0" | Maintain previous state | Maintain previous state/ Hi-Z at oscillation stop ^[2] / Internal input fixed at "0" | Maintain previous state/ Hi-Z at oscillation stop ^[2] / Internal input fixed at "0" |
| O | GPIO selected | Hi-Z | Hi-Z/ Input enabled | Hi-Z/ Input enabled | Maintain previous state | Maintain previous state | Hi-Z/ Internal input fixed at "0" |
| P | Mode input pin | Input enabled | Input enabled | Input enabled | Input enabled | Input enabled | Input enabled |
| | GPIO selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Hi-Z/ Input enabled |
| Q | GPIO selected, resource selected | Hi-Z | Hi-Z/ Input enabled | Hi-Z/ Input enabled | Maintain previous state | Maintain previous state | Hi-Z/ Internal input fixed at "0" |
| R | External interrupt enabled selected | Setting disabled | Setting disabled | Setting disabled | Maintain previous state | Maintain previous state | Maintain previous state |
| | GPIO selected, or resource other than above selected | Hi-Z | Hi-Z/ Input enabled | Hi-Z/ Input enabled | | | Hi-Z/ Internal input fixed at "0" |

[1]: Oscillation is stopped at Sub timer mode, Low-speed CR timer mode, and STOP mode.

[2]: Oscillation is stopped at STOP mode.

12. Electrical Characteristics

12.1 Absolute Maximum Ratings

| Parameter | Symbol | Rating | | Unit | Remarks |
|---|------------------------|-----------------------|-------------------------------------|------|-----------------|
| | | Min | Max | | |
| Power supply voltage ^{[1],[2]} | V _{CC} | V _{SS} - 0.5 | V _{SS} + 6.5 | V | |
| Analog power supply voltage ^{[1],[3]} | AV _{CC} | V _{SS} - 0.5 | V _{SS} + 6.5 | V | |
| Analog reference voltage ^{[1],[3]} | AV _{RH} | V _{SS} - 0.5 | V _{SS} + 6.5 | V | |
| Input voltage ^[1] | V _I | V _{SS} - 0.5 | V _{CC} + 0.5 (≤ 6.5V) | V | |
| | | V _{SS} - 0.5 | V _{SS} + 6.5 | V | 5 V tolerant |
| Analog pin input voltage ^[1] | V _{IA} | V _{SS} - 0.5 | AV _{CC} + 0.5 (≤ 6.5 V) | V | |
| Output voltage ^[1] | V _O | V _{SS} - 0.5 | V _{CC} + 0.5 (≤ 6.5 V) | V | |
| Clamp maximum current | I _{CLAMP} | -2 | +2 | mA | [7] |
| Clamp total maximum current | Σ[I _{CLAMP}] | | +20 | mA | [7] |
| "L" level maximum output current ^[4] | I _{OL} | - | 10 | mA | 4 mA type |
| | | | 20 | mA | 8 mA type |
| | | | 20 | mA | 12 mA type |
| | | | 39 | mA | P80,P81,P82,P83 |
| "L" level average output current ^[5] | I _{OLAV} | - | 4 | mA | 4 mA type |
| | | | 8 | mA | 8 mA type |
| | | | 12 | mA | 12 mA type |
| | | | 18.5 | mA | P80,P81,P82,P83 |
| "L" level total maximum output current | ΣI _{OL} | - | 100 | mA | |
| "L" level total average output current ^[6] | ΣI _{OLAV} | - | 50 | mA | |
| "H" level maximum output current ^[4] | I _{OH} | - | - 10 | mA | 4 mA type |
| | | | - 20 | mA | 8 mA type |
| | | | - 20 | mA | 12 mA type |
| | | | - 39 | mA | P80,P81,P82,P83 |
| "H" level average output current ^[5] | I _{OHAV} | - | - 4 | mA | 4 mA type |
| | | | - 8 | mA | 8 mA type |
| | | | - 12 | mA | 12 mA type |
| | | | - 20.5 | mA | P80,P81,P82,P83 |
| "H" level total maximum output current | ΣI _{OH} | - | - 100 | mA | |
| "H" level total average output current ^[6] | ΣI _{OHAV} | - | - 50 | mA | |
| Power consumption | P _D | - | 1000 | mW | |
| Storage temperature | T _{STG} | - 55 | + 150 | °C | |

[1]: These parameters are based on the condition that V_{SS} = AV_{SS} = 0.0 V.

[2]: V_{CC} must not drop below V_{SS} - 0.5 V.

[3]: Ensure that the voltage does not to exceed V_{CC} + 0.5 V, for example, when the power is turned on.

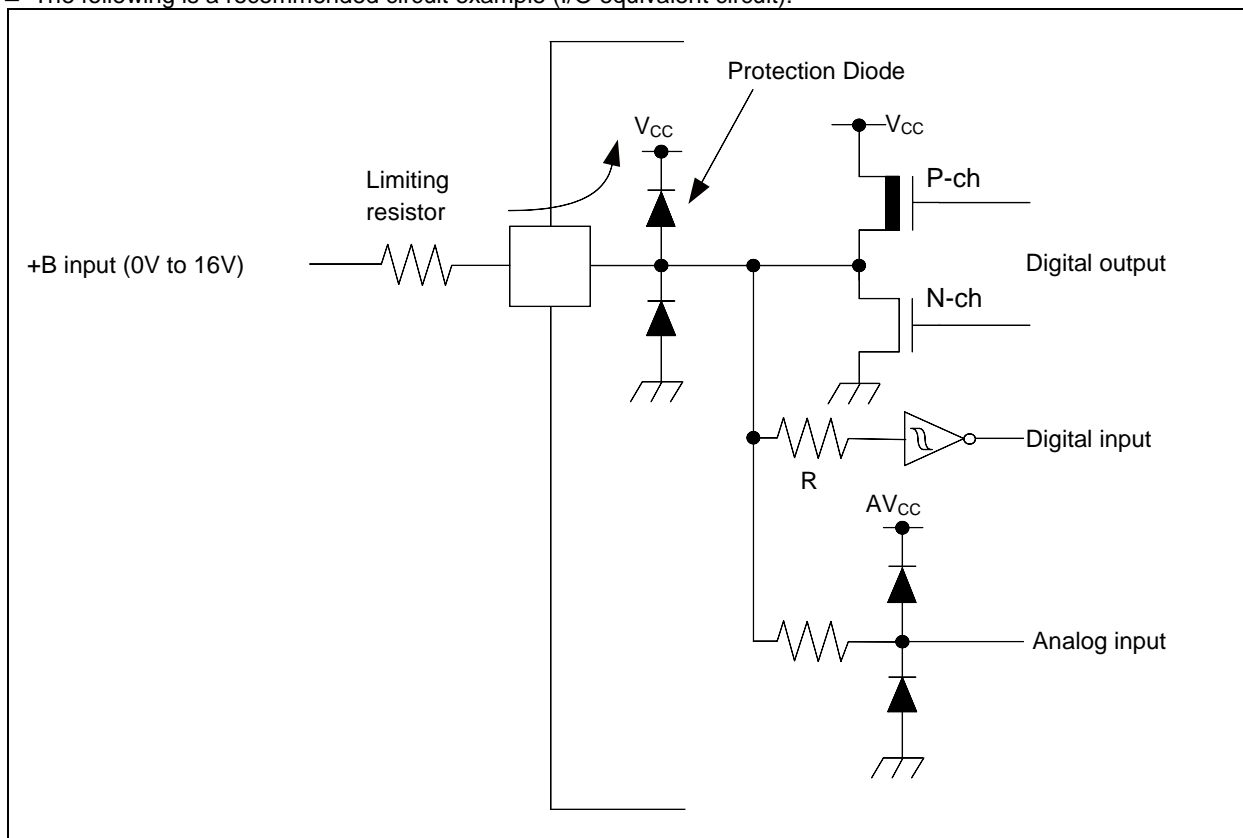
[4]: The maximum output current is the peak value for a single pin.

[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.

[7]:

- See "List of Pin Functions" and "I/O Circuit Type" about +B input available pin.
- Use within recommended operating conditions.
- Use at DC voltage (current) the +B input.
- The +B signal should always be applied a limiting resistance placed between the +B signal and the device.
- The value of the limiting resistance should be set so that when the +B signal is applied the input current to the device pin does not exceed rated values, either instantaneously or for prolonged periods.
- Note that when the device drive current is low, such as in the low-power consumption modes, the +B input potential may pass through the protective diode and increase the potential at the VCC and AVCC pin, and this may affect other devices.
- Note that if a +B signal is input when the device power supply is off (not fixed at 0V), the power supply is provided from the pins, so that incomplete operation may result.
- The following is a recommended circuit example (I/O equivalent circuit).



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.

12.2 Recommended Operating Conditions

(V_{SS} = AV_{SS} = 0.0V)

| Parameter | | Symbol | Conditions | Value | | Unit | Remarks |
|-----------------------------|--|------------------|--------------------------------|--------------------|------------------|------|---------------------------------------|
| | | | | Min | Max | | |
| Power supply voltage | | V _{CC} | - | 2.7 ^[2] | 5.5 | V | |
| Analog power supply voltage | | AV _{CC} | - | 2.7 | 5.5 | V | AV _{CC} = V _{CC} |
| Analog reference voltage | | AV _{RH} | - | 2.7 | AV _{CC} | V | |
| Smoothing capacitor | | C _S | - | 1 | 10 | μF | for built-in regulator ^[1] |
| Operating temperature | FPT-144P-M08, FPT-176P-M07, BGA-192P-M06 | T _a | When mounted on four-layer PCB | - 40 | + 85 | °C | |

[1]: See "7.6 C Pin" in "Handling Devices" for the connection of the smoothing capacitor.

[2]: In between less than the minimum power supply voltage and low voltage reset/interrupt detection voltage or more, instruction execution and low voltage detection function by built-in High-speed CR(including Main PLL is used) or built-in Low-speed CR is possible to operate only.

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.

12.3 DC Characteristics

12.3.1 Current Rating

(V_{CC} = AV_{CC} = 2.7V to 5.5V, V_{SS} = AV_{SS} = 0V, Ta = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit | Remarks |
|--------------------|------------------|----------|---|--------------------|--------------------|------|----------|
| | | | | Typ ^[3] | Max ^[4] | | |
| RUN mode current | I _{CC} | VCC | PLL RUN mode CPU : 144 MHz, Peripheral : 72 MHz, Flash 2 Wait, TraceBuffer : ON, FRWTR.RWT = 10, FSYNDN.SD = 000, FBFCR.BE = 1 | 100 | 180 | mA | [1],[5] |
| | | | PLL RUN mode CPU : 72 MHz, Peripheral : 72 MHz,Flash 0 Wait, TraceBuffer : OFF, FRWTR.RWT = 00, FSYNDN.SD = 000, FBFCR.BE = 0 | 65 | 135 | mA | [1],[5] |
| | | | High-speed CR RUN mode CPU/ Peripheral : 4 MHz ^[2] , Flash 0 Wait, FRWTR.RWT = 00, FSYNDN.SD = 000 | 6 | 57.8 | mA | [1] |
| | | | Sub RUN mode CPU/ Peripheral : 32 kHz, Flash 0 Wait, FRWTR.RWT = 00, FSYNDN.SD = 000 | 1.3 | 51.7 | mA | [1], [6] |
| | | | Low-speed CR RUN mode CPU/ Peripheral : 100 kHz, Flash 0 Wait, FRWTR.RWT = 00, FSYNDN.SD = 000 | 1.3 | 51.7 | mA | [1] |
| SLEEP mode current | I _{CCS} | VCC | PLL SLEEP mode Peripheral : 72 MHz | 30 | 89 | mA | [1],[5] |
| | | | High-speed CR SLEEP mode Peripheral : 4 MHz ^[2] | 4.5 | 55.9 | mA | [1] |
| | | | Sub SLEEP mode Peripheral : 32 kHz | 1.2 | 51.6 | mA | [1], [6] |
| | | | Low-speed CR SLEEP mode Peripheral : 100 kHz | 1.2 | 51.6 | mA | [1] |

[1]: When all ports are fixed.

[2]: When setting it to 4 MHz by trimming.

[3]: Ta = + 25°C, V_{CC} = 5.5 V

[4]: Ta = + 85°C, V_{CC} = 5.5 V

[5]: When using the crystal oscillator of 4 MHz(Including the current consumption of the oscillation circuit)

[6]: When using the crystal oscillator of 32 kHz(Including the current consumption of the oscillation circuit)

(V_{CC} = AV_{CC} = 2.7V to 5.5V, V_{SS} = AV_{SS} = 0V, Ta = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit | Remarks | |
|--------------------|-------------------|-----------|---------------------------------|---------------------------------|--------------------|------|---------|---------|
| | | | | Typ ^[2] | Max ^[2] | | | |
| TIMER mode current | I _{CC} T | VCC | Main TIMER mode | Ta = + 25°C, When LVD is off | 4 | 10 | mA | [1],[3] |
| | | | | Ta = + 85°C, When LVD is off | - | 55 | mA | [1],[3] |
| | | | Sub TIMER mode | Ta = + 25°C, When LVD is off | 1.1 | 5 | mA | [1],[4] |
| | | | | Ta = + 85°C, When LVD is off | - | 50 | mA | [1],[4] |
| STOP mode current | I _{CC} H | STOP mode | Ta = + 25°C, When LVD is off | 1 | 5 | mA | [1] | |
| | | | Ta = + 85°C, When LVD is off | - | 50 | mA | [1] | |

[1]: When all ports are fixed.

[2]: V_{CC} = 5.5 V

[3]: When using the crystal oscillator of 4 MHz(Including the current consumption of the oscillation circuit)

[4]: When using the crystal oscillator of 32 kHz(Including the current consumption of the oscillation circuit)

12.3.1.1 Low-Voltage Detection Current

(V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, Ta = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit | Remarks |
|--|---------------------|----------|----------------------------|-------|-----|------|---------------|
| | | | | Typ | Max | | |
| Low-voltage detection circuit (LVD) power supply current | I _{CC} LVD | VCC | At operation for interrupt | 4 | 7 | μA | At not detect |

12.3.1.2 Flash Memory Current

(V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, Ta = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit | Remarks |
|----------------------------------|-----------------------|----------|----------------|-------|-----|------|---------|
| | | | | Typ | Max | | |
| Flash memory write/erase current | I _{CC} FLASH | VCC | At Write/Erase | 12 | 14 | mA | |

12.3.1.3 A/D Converter Current

(V_{CC} = AV_{CC} = 2.7V to 5.5V, V_{SS} = AV_{SS} = AV_{RL} = 0V, Ta = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit | Remarks |
|--------------------------------|----------------------|----------|----------------------------------|-------|------|------|---------|
| | | | | Typ | Max | | |
| Power supply current | I _{CC} AD | AVCC | At 1unit operation | 0.57 | 0.72 | mA | |
| | | | At stop | 0.06 | 35 | μA | |
| Reference power supply current | I _{CC} AVRH | AVRH | At 1unit operation AVRH=5.5 V | 1.1 | 1.96 | mA | |
| | | | At stop | 0.06 | 4 | μA | |

12.3.2 Pin Characteristics

 (V_{cc} = AV_{cc} = 2.7V to 5.5V, V_{ss} = AV_{ss} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | | Unit | Remarks |
|--|------------------|-------------------------------------|--|-----------------------|-----|-----------------------|------|---------|
| | | | | Min | Typ | Max | | |
| "H" level input voltage (hysteresis input) | V _{IHS} | CMOS hysteresis input pin, MD0, MD1 | - | V _{cc} × 0.8 | - | V _{cc} + 0.3 | V | [1] |
| | | 5 V tolerant input pin | - | V _{cc} × 0.8 | - | V _{ss} + 5.5 | V | |
| | | TTL Schmitt input pin | - | 2.0 | - | V _{cc} + 0.3 | V | |
| "L" level input voltage (hysteresis input) | V _{ILS} | CMOS hysteresis input pin, MD0, MD1 | - | V _{ss} - 0.3 | - | V _{cc} × 0.2 | V | [1] |
| | | 5 V tolerant input pin | - | V _{ss} - 0.3 | - | V _{cc} × 0.2 | V | |
| | | TTL Schmitt input pin | - | V _{ss} - 0.3 | - | 0.8 | V | |
| "H" level output voltage | V _{OH} | 4 mA type | V _{cc} ≥ 4.5 V, I _{OH} = - 4 mA | V _{cc} - 0.5 | - | V _{cc} | V | [1] |
| | | | V _{cc} < 4.5 V, I _{OH} = - 2 mA | | | | | |
| | | 8 mA type | V _{cc} ≥ 4.5 V, I _{OH} = - 8 mA | V _{cc} - 0.5 | - | V _{cc} | V | [1] |
| | | | V _{cc} < 4.5 V, I _{OH} = - 4 mA | | | | | |
| | | 12 mA type | V _{cc} ≥ 4.5 V, I _{OH} = - 12 mA | V _{cc} - 0.5 | - | V _{cc} | V | |
| | | | V _{cc} < 4.5 V, I _{OH} = - 8 mA | | | | | |
| | | P80, P81, P82, P83 | V _{cc} ≥ 4.5 V, I _{OH} = - 20.5 mA | V _{cc} - 0.4 | - | V _{cc} | V | [2] |
| | | | V _{cc} < 4.5 V, I _{OH} = - 13.0 mA | | | | | |

| Parameter | Symbol | Pin name | Conditions | Value | | | Unit | Remarks |
|--------------------------|----------|---|--|-------|-----|-----|------------|---------|
| | | | | Min | Typ | Max | | |
| "L" level output voltage | V_{OL} | 4 mA type | $V_{CC} \geq 4.5 V,$ $I_{OL} = 4 mA$ | Vss | - | 0.4 | V | [1] |
| | | | $V_{CC} < 4.5 V,$ $I_{OL} = 2 mA$ | | | | | |
| | | 8 mA type | $V_{CC} \geq 4.5 V,$ $I_{OL} = 8 mA$ | Vss | - | 0.4 | V | [1] |
| | | | $V_{CC} < 4.5 V,$ $I_{OL} = 4 mA$ | | | | | |
| | | 12 mA type | $V_{CC} \geq 4.5 V,$ $I_{OL} = 12 mA$ | Vss | - | 0.4 | V | |
| | | | $V_{CC} < 4.5 V,$ $I_{OL} = 8 mA$ | | | | | |
| | | P80, P81, P82, P83 | $V_{CC} \geq 4.5 V,$ $I_{OL} = 18.5 mA$ | Vss | - | 0.4 | V | [2] |
| | | | $V_{CC} < 4.5 V,$ $I_{OL} = 10.5 mA$ | | | | | |
| Input leak current | I_{IL} | - | - | - 5 | - | + 5 | μA | |
| Pull-up resistance value | R_{PU} | Pull-up pin | $V_{CC} \geq 4.5 V$ | 25 | 50 | 100 | k Ω | |
| | | | $V_{CC} < 4.5 V$ | 30 | 80 | 200 | | |
| Input capacitance | C_{IN} | Other than VCC, VSS, AVCC, AVSS, AVRH | - | - | 5 | 15 | pF | |

12.4 AC Characteristics

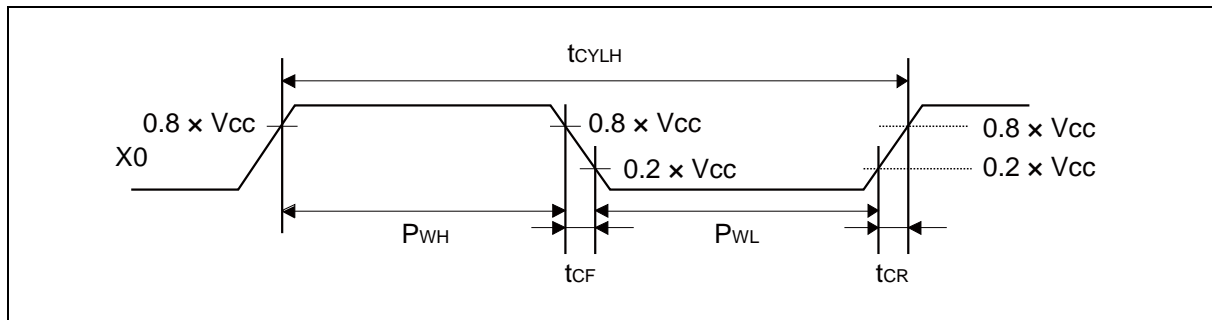
12.4.1 Main Clock Input Characteristics

($V_{CC} = 2.7V$ 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, 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 | - | | | PWH/t_{CYLH} , PWL/t_{CYLH} | 45 | 55 | % | When using external clock |
| Input clock rise time and fall time | t_{CF} | | | - | - | 5 | ns | When using external clock |
| | t_{CR} | | - | - | | | | |
| Internal operating clock ^[1] frequency | F_{CM} | - | - | - | 144 | MHz | Master clock | |
| | F_{CC} | - | - | - | 144 | MHz | Base clock (HCLK/FCLK) | |
| | F_{CP0} | - | - | - | 72 | MHz | APB0 bus clock ^[2] | |
| | F_{CP1} | - | - | - | 72 | MHz | APB1 bus clock ^[2] | |
| | F_{CP2} | - | - | - | 72 | MHz | APB2 bus clock ^[2] | |
| Internal operating clock ^[1] cycle time | t_{CYCC} | - | - | 6.94 | - | ns | Base clock (HCLK/FCLK) | |
| | t_{CYCP0} | - | - | 13.8 | - | ns | APB0 bus clock ^[2] | |
| | t_{CYCP1} | - | - | 13.8 | - | ns | APB1 bus clock ^[2] | |
| | t_{CYCP2} | - | - | 13.8 | - | ns | APB2 bus clock ^{[2]2} | |

[1]: For more information about each internal operating clock, see "CHAPTER 2-1: Clock" in "FM3 Family PERIPHERAL MANUAL".

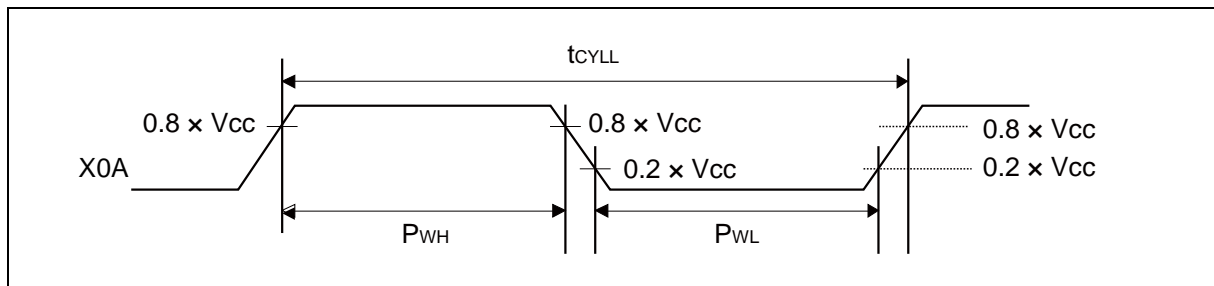
[2]: For about each APB bus which each peripheral is connected to, see "Block Diagram" in this datasheet.



12.4.2 Sub Clock Input Characteristics

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

| Parameter | Symbol | Pin name | Conditions | Value | | | Unit | Remarks |
|-------------------------|---------------------|-------------|--|-------|--------|-------|------|--------------------------------------|
| | | | | Min | Typ | Max | | |
| Input frequency | 1/t _{CYLL} | X0A, X1A | - | - | 32.768 | - | kHz | When crystal oscillator is connected |
| | | | - | 32 | - | 100 | | kHz |
| Input clock cycle | t _{CYLL} | | - | 10 | - | 31.25 | μs | When using external clock |
| Input clock pulse width | - | | P _{WH} /t _{CYLL} , P _{WL} /t _{CYLL} | 45 | - | 55 | % | When using external clock |


12.4.3 Internal CR Oscillation Characteristics
12.4.3.1 High-speed Internal CR

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

| Parameter | Symbol | Conditions | Value | | | Unit | Remarks |
|--------------------------|-------------------|-----------------------------------|-------|-----|------|------|------------------------------|
| | | | Min | Typ | Max | | |
| Clock frequency | F _{CRH} | T _a = + 25°C | 3.96 | 4 | 4.04 | MHz | When trimming ^[1] |
| | | T _a = 0°C to + 70°C | 3.84 | 4 | 4.16 | | |
| | | T _a = - 40°C to + 85°C | 3.8 | 4 | 4.2 | | |
| | | T _a = - 40°C to + 85°C | 3 | 4 | 5 | | When not trimming |
| Frequency stability time | t _{CRWT} | - | - | - | 90 | μs | [2] |

[1]: In the case of using the values in CR trimming area of Flash memory at shipment for frequency trimming.

[2]: Frequency stable time is time to stable of the frequency of the High-speed CR.clock after the trim value is set. After setting the trim value, the period when the frequency stability time passes can use the High-speed CR clock as a source clock.

12.4.3.2 Low-speed Internal CR
(V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Conditions | Value | | | Unit | Remarks |
|-----------------|-------------------|------------|-------|-----|-----|------|---------|
| | | | Min | Typ | Max | | |
| Clock frequency | F _{CR_L} | - | 50 | 100 | 150 | kHz | |

12.4.4 Operating Conditions of Main and USB PLL
12.4.4.1 Operating Conditions of Main PLL (In the case of using main clock for input of PLL)
(V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Value | | | Unit | Remarks |
|--|---------------------|-------|-----|-----|----------|---------|
| | | Min | Typ | Max | | |
| PLL oscillation stabilization wait time ^[1] (LOCK UP time) | t _{LOCK} | 100 | - | - | μs | |
| PLL input clock frequency | F _{PLLI} | 4 | - | 16 | MHz | |
| PLL multiple rate | - | 13 | - | 75 | multiple | |
| PLL macro oscillation clock frequency | F _{PLLO} | 200 | - | 300 | MHz | |
| Main PLL clock frequency ^[2] | F _{CLKPLL} | - | - | 144 | MHz | |

[1]: Time from when the PLL starts operating until the oscillation stabilizes.

[2]: For more information about Main PLL clock (CLKPLL), see "CHAPTER 2-1: Clock" in "FM3 Family PERIPHERAL MANUAL".

12.4.4.2 Operating Conditions of Main PLL (In the case of using high-speed internal CR)
(V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

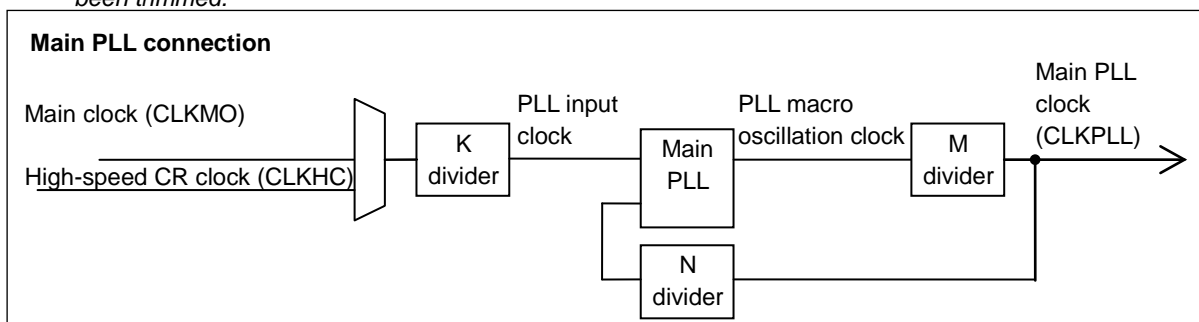
| Parameter | Symbol | Value | | | Unit | Remarks |
|--|---------------------|-------|-----|-----|----------|---------|
| | | Min | Typ | Max | | |
| PLL oscillation stabilization wait time ^[1] (LOCK UP time) | t _{LOCK} | 100 | - | - | μs | |
| PLL input clock frequency | F _{PLLI} | 3.8 | 4 | 4.2 | MHz | |
| PLL multiple rate | - | 50 | - | 71 | multiple | |
| PLL macro oscillation clock frequency | F _{PLLO} | 190 | - | 300 | MHz | |
| Main PLL clock frequency ^[2] | F _{CLKPLL} | - | - | 144 | MHz | |

[1]: Time from when the PLL starts operating until the oscillation stabilizes.

[2]: For more information about Main PLL clock (CLKPLL), see "CHAPTER 2-1: Clock" in "FM3 Family PERIPHERAL MANUAL".

Note:

Make sure to input to the main PLL source clock, the high-speed CR clock (CLKHC) that the frequency has been trimmed.



12.4.5 Reset Input Characteristics

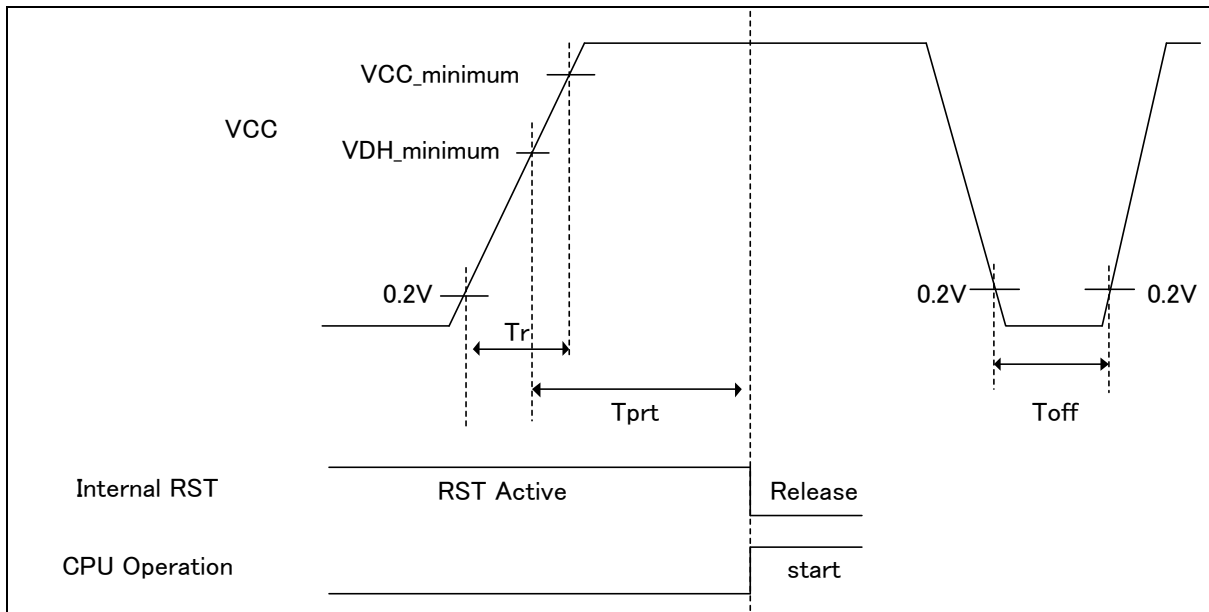
 (V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

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

12.4.6 Power-on Reset Timing

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

| Parameter | Symbol | Pin name | Value | | Unit | Remarks |
|-------------------------------------|--------|----------|-------|------|------|---------|
| | | | Min | Max | | |
| Power supply rising time | Tr | VCC | 0 | - | ms | |
| Power supply shut down time | Toff | | 1 | - | ms | |
| Time until releasing Power-on reset | Tprt | | 0.46 | 0.76 | ms | |


Glossary

- VCC_{minimum}: Minimum V_{CC} of recommended operating conditions
- VDH_{minimum}: Minimum release voltage of Low-Voltage detection reset. See "12.5.3 Low-Voltage Detection Characteristics"

12.4.7 External Bus Timing
12.4.7.1 External bus clock output 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 |
|------------------|-------------|------------------------|--------------------|-------|-------------------|------|
| | | | | Min | Max | |
| Output frequency | t_{CYCLE} | MCLKOUT ^[1] | $V_{CC} \geq 4.5V$ | - | 50 ^[2] | MHz |
| | | | $V_{CC} < 4.5V$ | - | 32 ^[3] | MHz |

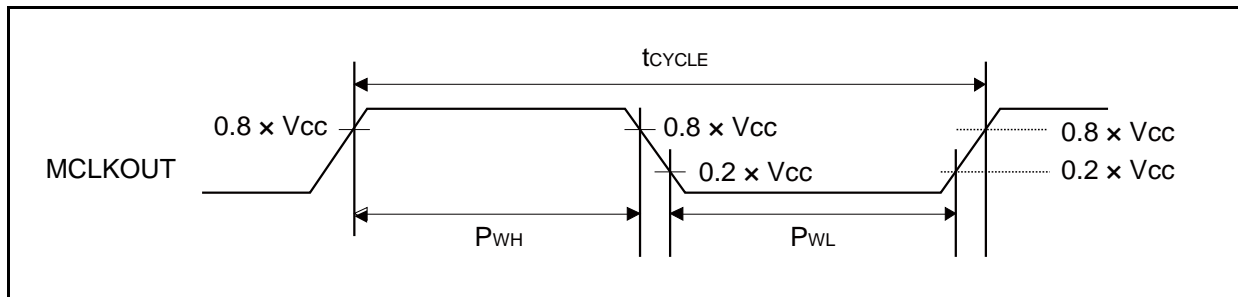
[1]: External bus clock (MCLKOUT) is divided clock of HCLK.

For more information about setting of clock divider, see "CHAPTER 12: External Bus Interface" in "FM3 Family PERIPHERAL MANUAL".

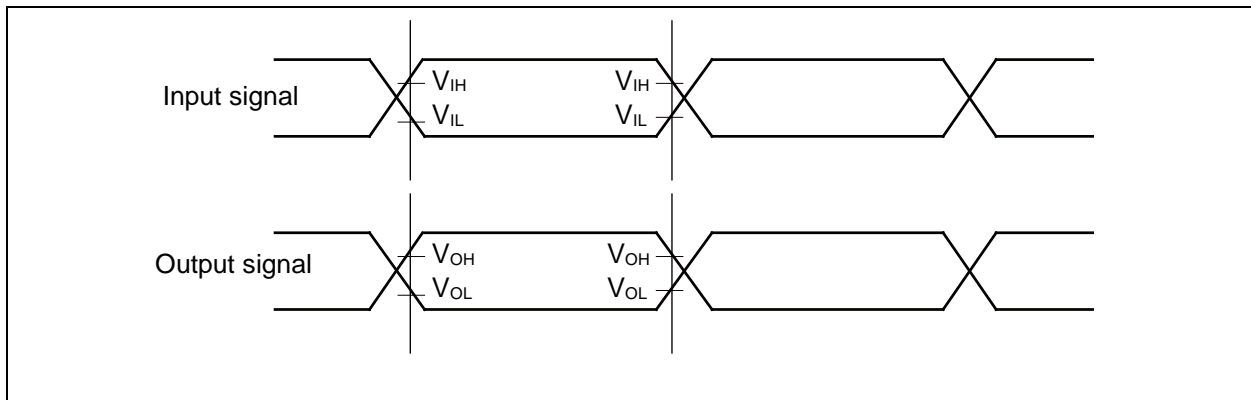
When external bus clock is not output, this characteristic does not give any effect on external bus operation.

[2]: When AHB bus clock frequency is more than 100 MHz, the divider setting for MCLKOUT must be more than 4.

[3]: When AHB bus clock frequency is more than 64 MHz, the divider setting for MCLKOUT must be more than 4.


12.4.7.2 External bus signal input/output characteristics
 ($V_{CC} = 2.7V$ to $5.5V$, $V_{SS} = 0V$, $T_a = -40^{\circ}C$ to $+85^{\circ}C$)

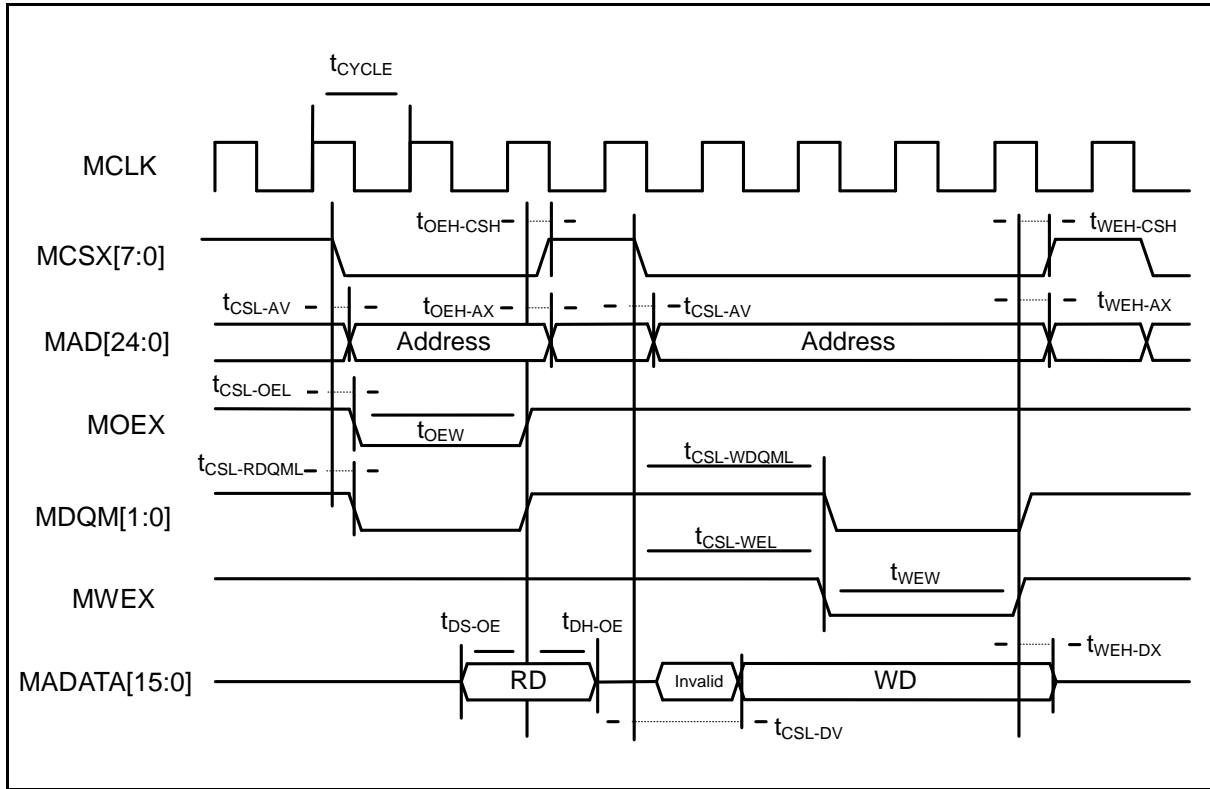
| Parameter | Symbol | Conditions | Value | Unit | Remarks |
|-------------------------------|----------|------------|---------------------|------|---------|
| Signal input characteristics | V_{IH} | - | $0.8 \times V_{CC}$ | V | |
| | V_{IL} | | $0.2 \times V_{CC}$ | V | |
| Signal output characteristics | V_{OH} | | $0.8 \times V_{CC}$ | V | |
| | V_{OL} | | $0.2 \times V_{CC}$ | V | |



12.4.7.3 *Separate Bus Access Asynchronous SRAM Mode*
 (V_{cc} = 2.7V to 5.5V, V_{ss} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit |
|---------------------------------------|--------------------------|-------------------------|--|-----------------------|-----------------------|------|
| | | | | Min | Max | |
| MOEX Min pulse width | t _{OEw} | MOEX | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxn-3 | - | ns |
| MCSX ↓ → Address output delay time | t _{CSL - AV} | MCSX[7:0], MAD[24:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | -9 -12 | +9 +12 | ns |
| MOEX ↑ → Address hold time | t _{OEh - AX} | MOEX, MAD[24:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 0 | MCLKxm+9 MCLKxm+12 | ns |
| MCSX ↓ → MOEX ↓ delay time | t _{CSL - OEL} | MOEX, MCSX[7:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxm-9 MCLKxm-12 | MCLKxm+9 MCLKxm+12 | ns |
| MOEX ↑ → MCSX ↑ time | t _{OEh - CSH} | | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 0 | MCLKxm+9 MCLKxm+12 | ns |
| MCSX ↓ → MDQM ↓ delay time | t _{CSL - RDQML} | MCSX, MDQM[1:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxm-9 MCLKxm-12 | MCLKxm+9 MCLKxm+12 | ns |
| Data set up → MOEX ↑ time | t _{DS - OE} | MOEX, MADATA[15:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 20 38 | - - | ns |
| MOEX ↑ → Data hold time | t _{DH - OE} | MOEX, MADATA[15:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 0 | - | ns |
| MWEX Min pulse width | t _{WEw} | MWEX | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxn-3 | - | ns |
| MWEX ↑ → Address output delay time | t _{WEh - AX} | MWEX, MAD[24:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 0 | MCLKxm+9 MCLKxm+12 | ns |
| MCSX ↓ → MWEX ↓ delay time | t _{CSL - WEL} | MWEX, MCSX[7:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxn-9 MCLKxn-12 | MCLKxn+9 MCLKxn+12 | ns |
| MWEX ↑ → MCSX ↑ delay time | t _{WEh - CSH} | | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 0 | MCLKxm+9 MCLKxm+12 | ns |
| MCSX ↓ → MDQM ↓ delay time | t _{CSL - WDQML} | MCSX, MDQM[1:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxn-9 MCLKxn-12 | MCLKxn+9 MCLKxn+12 | ns |
| MCSX ↓ → Data output time | t _{CSL - DV} | MCSX, MADATA[15:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLK-9 MCLK-12 | MCLK+9 MCLK+12 | ns |
| MWEX ↑ → Data hold time | t _{WEh - DX} | MWEX, MADATA[15:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 0 | MCLKxm+9 MCLKxm+12 | ns |

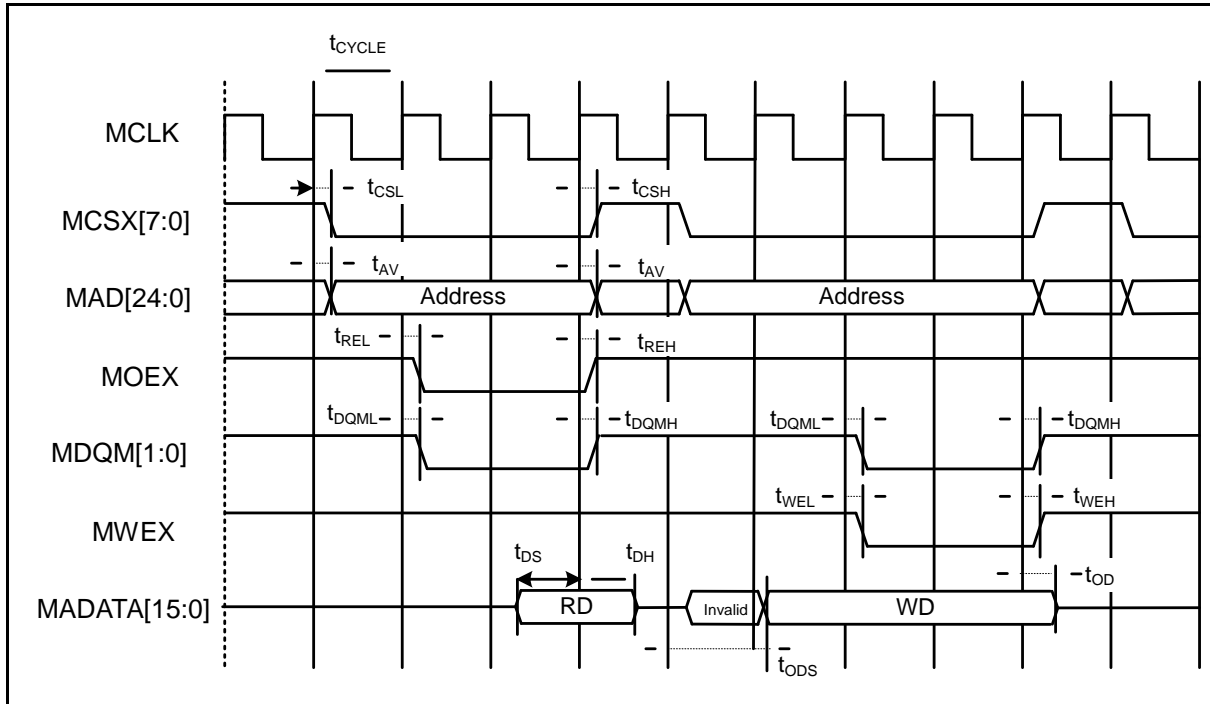
Note: When the external load capacitance = 30 pF. (m = 0 to 15, n = 1 to 16)



12.4.7.4 Separate Bus Access Synchronous SRAM Mode
 (V_{cc} = 2.7V to 5.5V, V_{ss} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit |
|---------------------------|-------------------|-----------------------|-------------------------|--------|---------|------|
| | | | | Min | Max | |
| Address delay time | t _{AV} | MCLK, MAD[24:0] | V _{cc} ≥ 4.5 V | 1 | 9 | ns |
| | | | V _{cc} < 4.5 V | | 12 | |
| MCSX delay time | t _{CSL} | MCLK, MCSX[7:0] | V _{cc} ≥ 4.5 V | 1 | 9 | ns |
| | | | V _{cc} < 4.5 V | | 12 | |
| | t _{CSH} | | V _{cc} ≥ 4.5 V | 1 | 9 | ns |
| | | | V _{cc} < 4.5 V | | 12 | |
| MOEX delay time | t _{REL} | MCLK, MOEX | V _{cc} ≥ 4.5 V | 1 | 9 | ns |
| | | | V _{cc} < 4.5 V | | 12 | |
| | t _{REH} | | V _{cc} ≥ 4.5 V | 1 | 9 | ns |
| | | | V _{cc} < 4.5 V | | 12 | |
| Data set up → MCLK ↑ time | t _{DS} | MCLK, MADATA[15:0] | V _{cc} ≥ 4.5 V | 19 | - | ns |
| | | | V _{cc} < 4.5 V | 37 | | |
| MCLK ↑ → Data hold time | t _{DH} | MCLK, MADATA[15:0] | V _{cc} ≥ 4.5 V | 0 | - | ns |
| | | | V _{cc} < 4.5 V | | | |
| MWEX delay time | t _{WEL} | MCLK, MWEX | V _{cc} ≥ 4.5 V | 1 | 9 | ns |
| | | | V _{cc} < 4.5 V | | 12 | |
| | t _{WEH} | | V _{cc} ≥ 4.5 V | 1 | 9 | ns |
| | | | V _{cc} < 4.5 V | | 12 | |
| MDQM[1:0] delay time | t _{DQML} | MCLK, MDQM[1:0] | V _{cc} ≥ 4.5 V | 1 | 9 | ns |
| | | | V _{cc} < 4.5 V | | 12 | |
| | t _{DQMH} | | V _{cc} ≥ 4.5 V | 1 | 9 | ns |
| | | | V _{cc} < 4.5 V | | 12 | |
| MCLK ↑ → Data output time | t _{OD} | MCLK, MADATA[15:0] | V _{cc} ≥ 4.5 V | MCLK+1 | MCLK+18 | ns |
| | | | V _{cc} < 4.5 V | | MCLK+24 | |
| MCLK ↑ → Data hold time | t _{OD} | MCLK, MADATA[15:0] | V _{cc} ≥ 4.5 V | 1 | 18 | ns |
| | | | V _{cc} < 4.5 V | | 24 | |

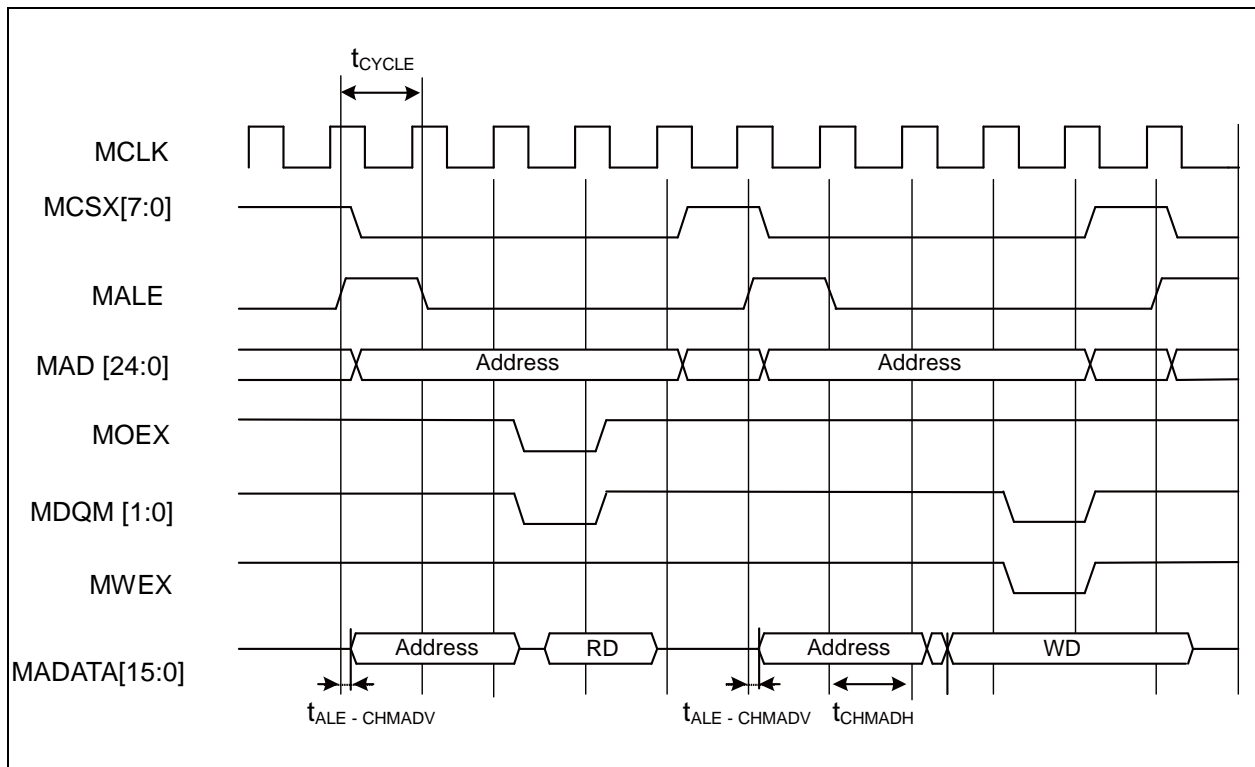
Note: When the external load capacitance = 30 pF.



12.4.7.5 Multiplexed Bus Access Asynchronous SRAM Mode
 (V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit |
|--------------------------------|-------------------------|-----------------------|-------------------------|----------------------|-----------------------|------|
| | | | | Min | Max | |
| Multiplexed address delay time | t _{ALE-CHMADV} | MALE, MADATA[15:0] | V _{CC} ≥ 4.5 V | 0 | 10 | ns |
| | | | V _{CC} < 4.5 V | | 20 | |
| Multiplexed address hold time | t _{CHMADH} | MALE, MADATA[15:0] | V _{CC} ≥ 4.5 V | MCLK _{xn+0} | MCLK _{xn+10} | ns |
| | | | V _{CC} < 4.5 V | MCLK _{xn+0} | MCLK _{xn+20} | |

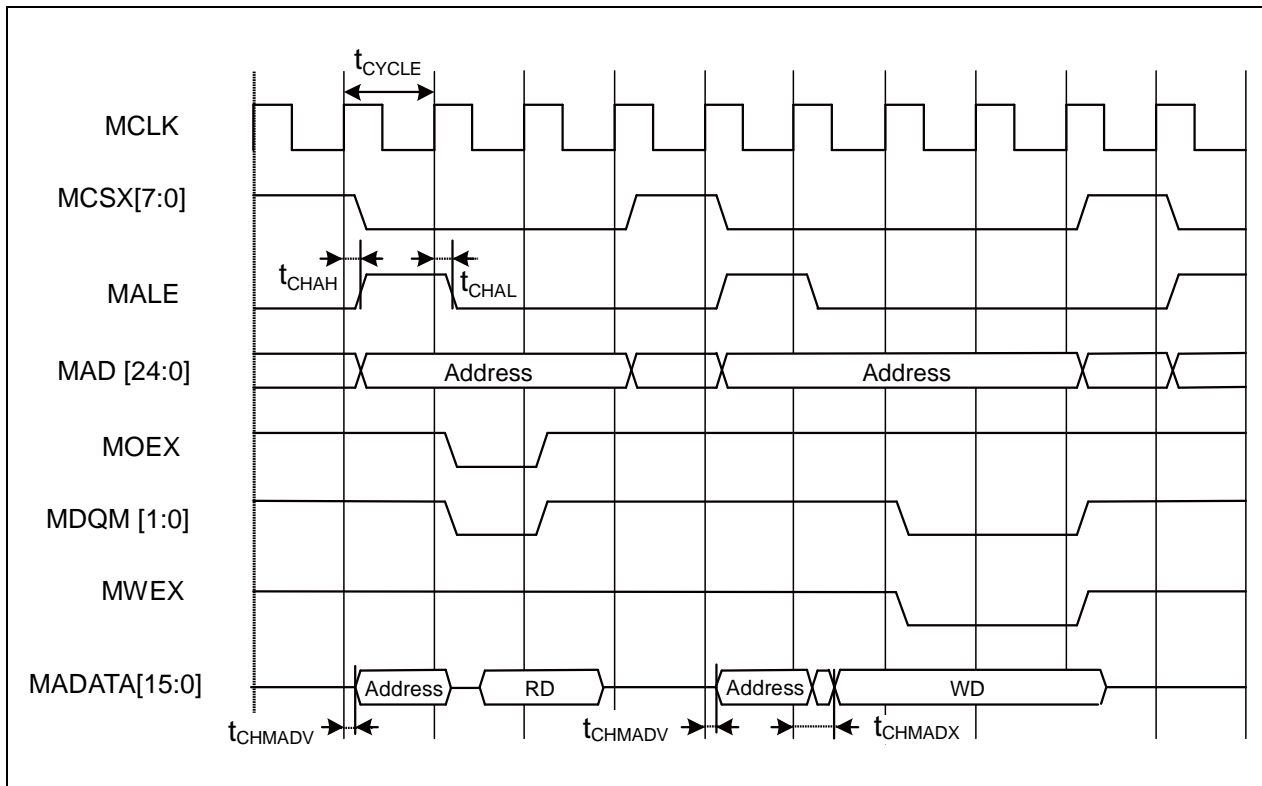
Note: When the external load capacitance = 30 pF. (m = 0 to 15, n = 1 to 16)



12.4.7.6 Multiplexed Bus Access Synchronous SRAM Mode
 (V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit | Remarks |
|---|---------------------|-----------------------|-------------------------|-------|-----------------|------|---------|
| | | | | Min | Max | | |
| MALE delay time | t _{CHAL} | MCLK, ALE | V _{CC} ≥ 4.5 V | 1 | 9 | ns | |
| | | | V _{CC} < 4.5 V | | 12 | | |
| | t _{CHAH} | | V _{CC} ≥ 4.5 V | 1 | 9 | ns | |
| | | | V _{CC} < 4.5 V | | 12 | | |
| MCLK ↑ → Multiplexed Address delay time | t _{CHMADV} | MCLK, MADATA[15:0] | V _{CC} ≥ 4.5 V | 1 | t _{OD} | ns | |
| | | | V _{CC} < 4.5 V | | | | |
| MCLK ↑ → Multiplexed Data output time | t _{CHMADX} | MCLK, MADATA[15:0] | V _{CC} ≥ 4.5 V | 1 | t _{OD} | ns | |
| | | | V _{CC} < 4.5 V | | | | |

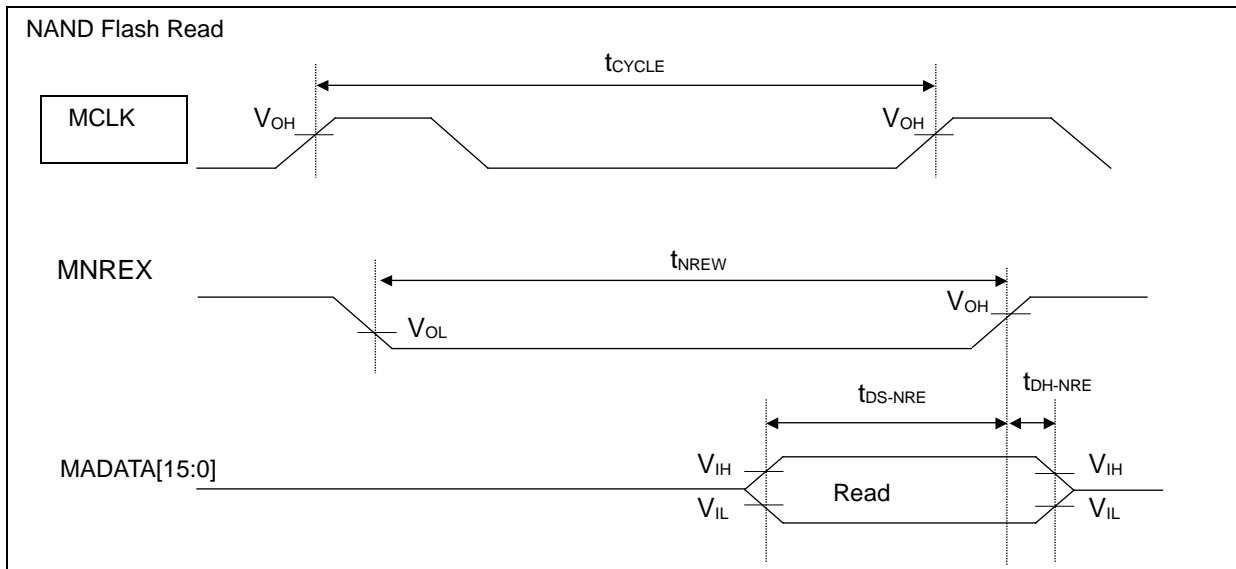
Note: When the external load capacitance = 30 pF.

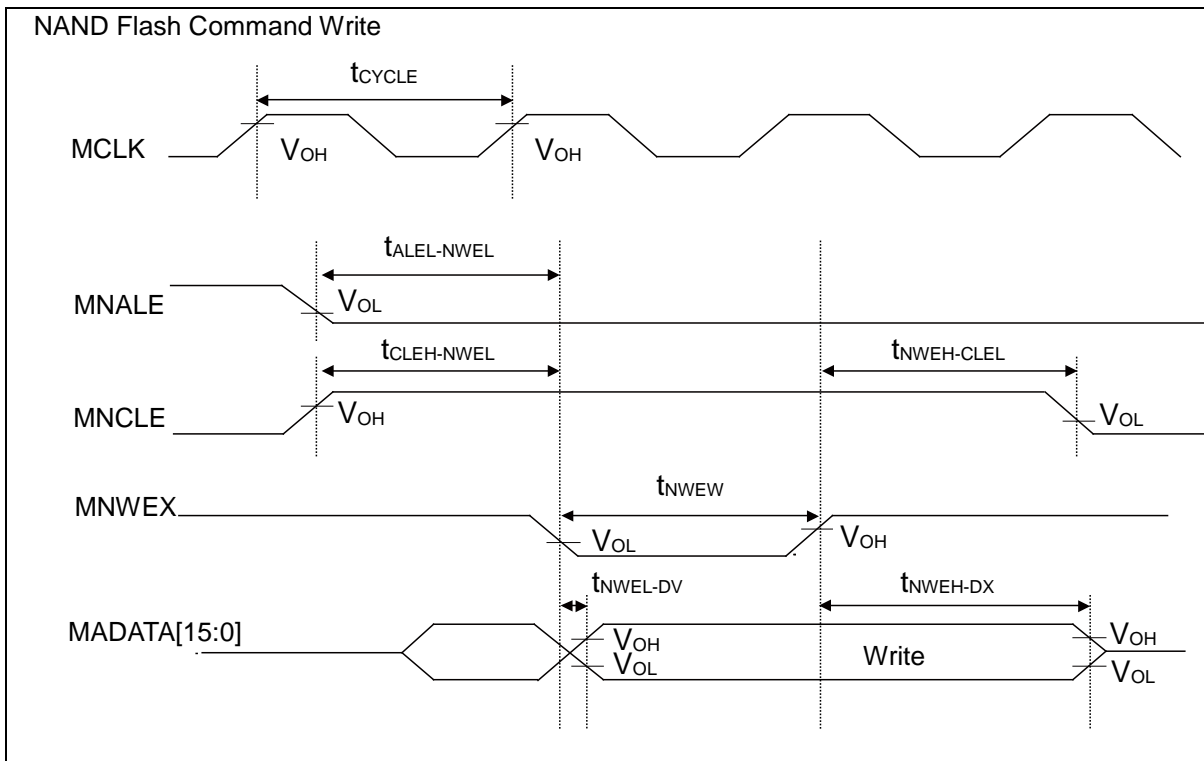
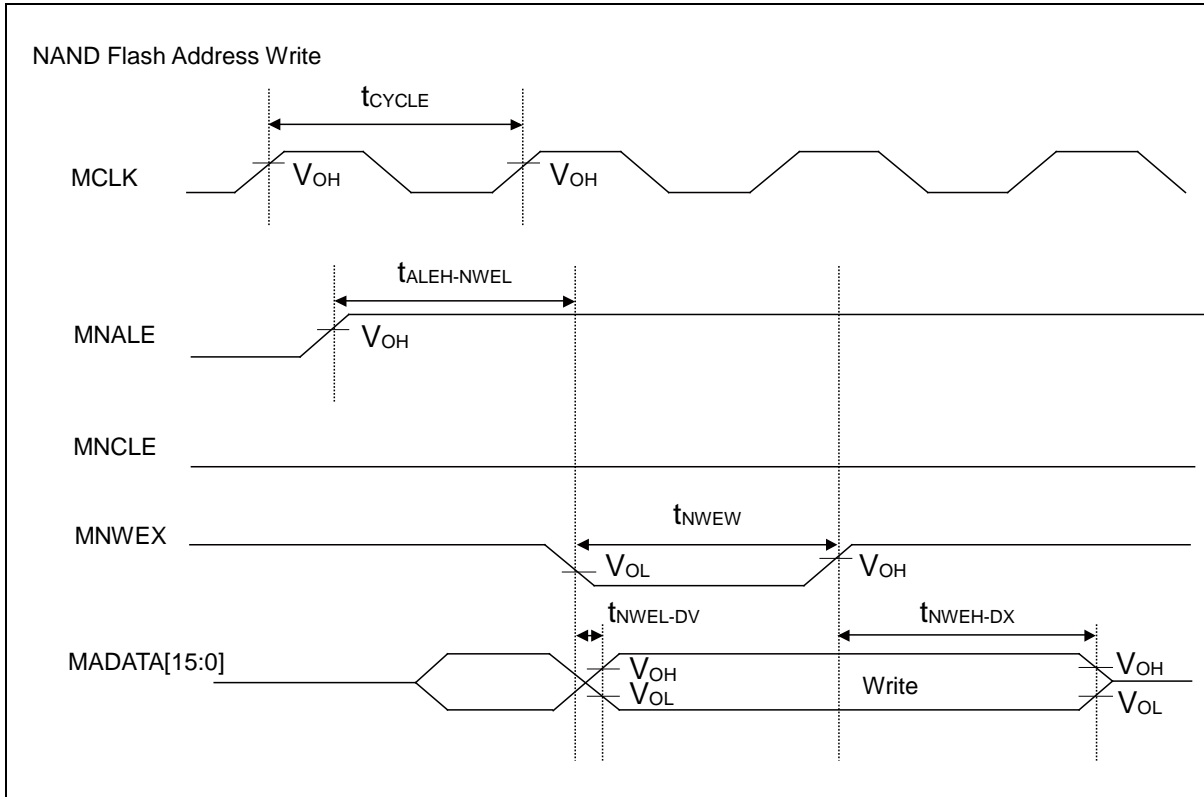


12.4.7.7 NAND Flash Mode

 (V_{cc} = 2.7V to 5.5V, V_{ss} = 0V, Ta = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit |
|--------------------------|------------------------|------------------------|--|-----------------------|-----------------------|------|
| | | | | Min | Max | |
| MNREX Min pulse width | t _{NREW} | MNREX | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxn-3 | - | ns |
| Data setup → MNREX↑time | t _{DS-NRE} | MNREX, MADATA[15:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 20 38 | - | ns |
| MNREX↑→ Data hold time | t _{DH-NRE} | MNREX, MADATA[15:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 0 | - | ns |
| MNALE↑→ MNWEX delay time | t _{ALEH-NWEL} | MNALE, MNWEX | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxm-9 MCLKxm-12 | MCLKxm+9 MCLKxm+12 | ns |
| MNALE↓→ MNWEX delay time | t _{ALEL-NWEL} | MNALE, MNWEX | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxm-9 MCLKxm-12 | MCLKxm+9 MCLKxm+12 | ns |
| MNCLE↑→ MNWEX delay time | t _{CLEH-NWEL} | MNCLE, MNWEX | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxm-9 MCLKxm-12 | MCLKxm+9 MCLKxm+12 | ns |
| MNWEX↑→ MNCLE delay time | t _{NWEH-CLEL} | MNCLE, MNWEX | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 0 | MCLKxm+9 MCLKxm+12 | ns |
| MNWEX Min pulse width | t _{NWEW} | MNWEX | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | MCLKxn-3 | - | ns |
| MNWEX↓→ Data output time | t _{NWEL-DV} | MNWEX, MADATA[15:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | -9 -12 | +9 +12 | ns |
| MNWEX↑→ Data hold time | t _{NWEH-DX} | MNWEX, MADATA[15:0] | V _{cc} ≥ 4.5 V V _{cc} < 4.5 V | 0 | MCLKxm+9 MCLKxm+12 | ns |

Note: When the external load capacitance = 30 pF. (m=0 to 15, n=1 to 16)


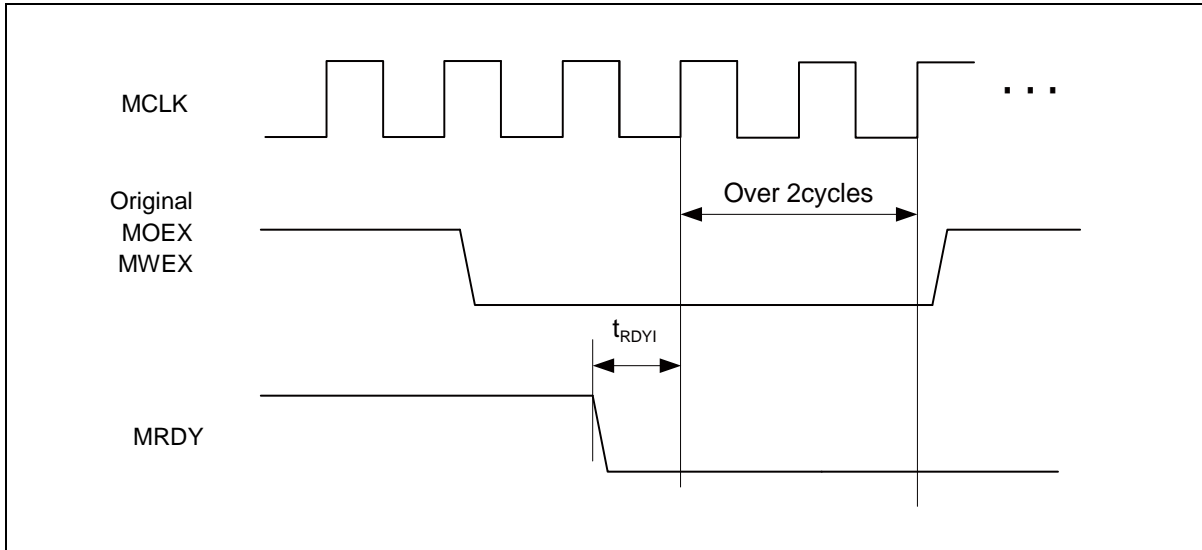


12.4.7.8 External Ready Input Timing

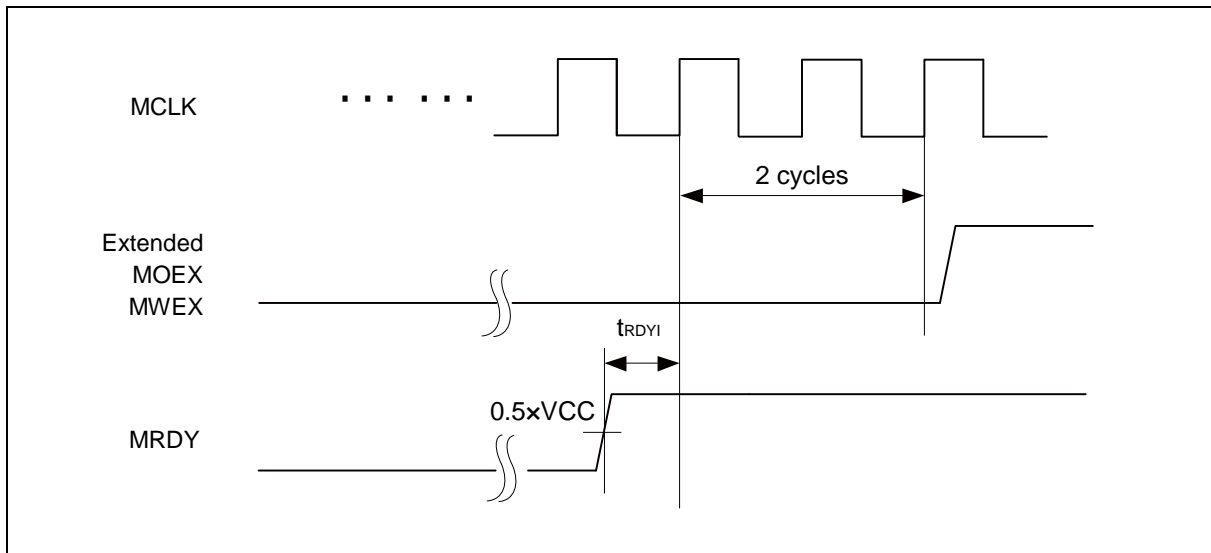
(V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | Value | | Unit | Remarks |
|------------------------------|-------------------|------------|-------------------------|-------|-----|------|---------|
| | | | | Min | Max | | |
| MCLK ↑ MRDY input setup time | t _{RDYI} | MCLK, MRDY | V _{CC} ≥ 4.5 V | 19 | - | ns | |
| | | | V _{CC} < 4.5 V | 37 | | | |

When RDY is input



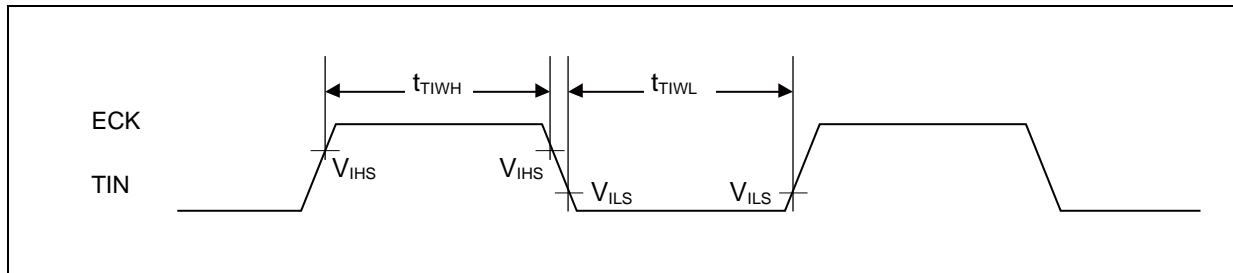
When RDY is released



12.4.8 Base Timer Input Timing
12.4.8.1 Timer input timing

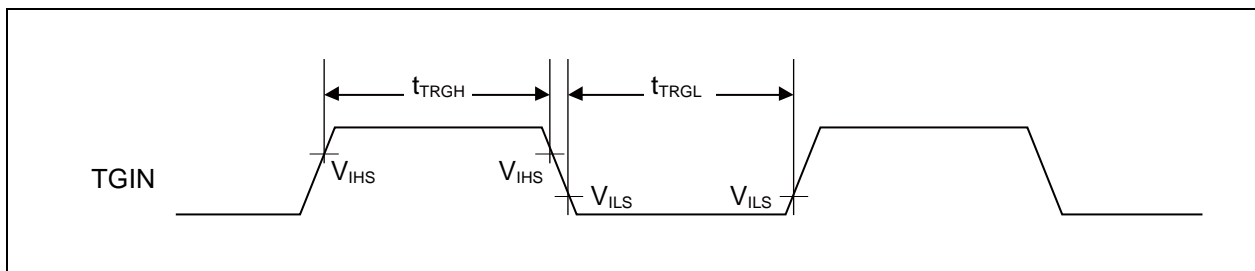
 (V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

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


12.4.8.2 Trigger input timing

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

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


Note:

 t_{CYCP} indicates the APB bus clock cycle time.

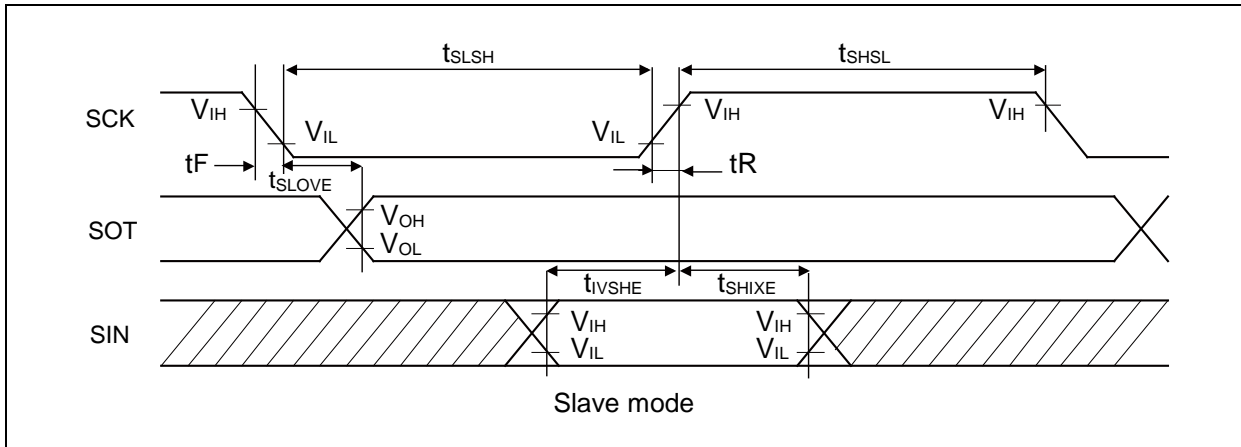
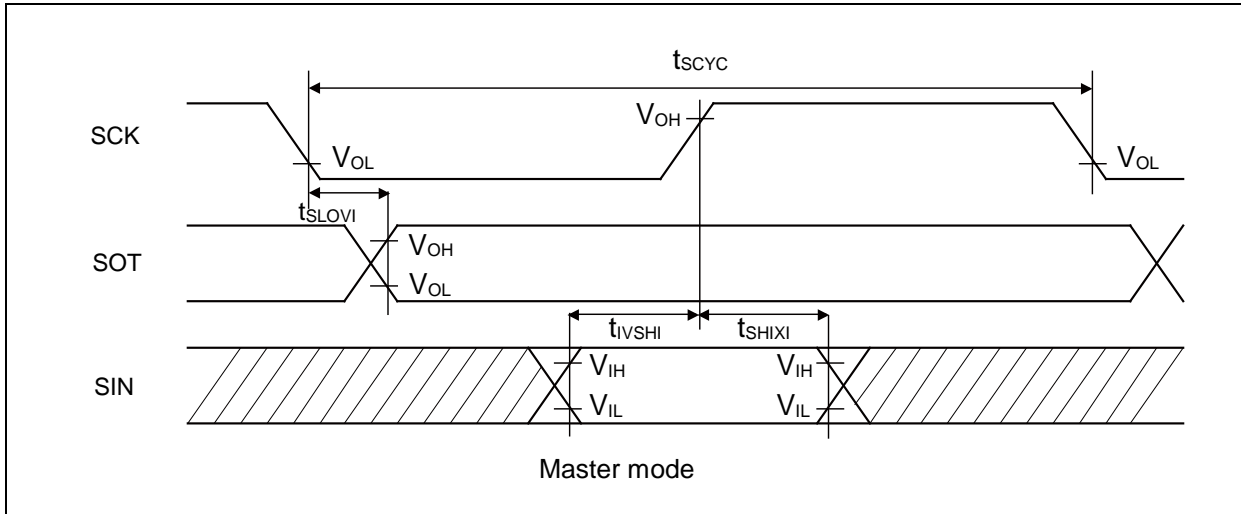
 About the APB bus number which Base Timer is connected to, see "[Block Diagram](#)" in this data sheet.

12.4.9 CSIO/UART Timing

12.4.9.1 CSIO (SPI = 0, SCINV = 0)
(V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | V _{CC} < 4.5 V | | V _{CC} ≥ 4.5 V | | Unit |
|------------------------------|--------------------|---------------|-------------|-------------------------|------|-------------------------|------|------|
| | | | | Min | Max | Min | Max | |
| Serial clock cycle time | t _{SCYC} | SCKx | Master mode | 4t _{CYCP} | - | 4t _{CYCP} | - | ns |
| SCK ↓ → SOT delay time | t _{SLOVI} | SCKx, SOTx | | - 30 | + 30 | - 20 | + 20 | ns |
| SIN → SCK ↑ setup time | t _{IVSHI} | SCKx, SINx | | 50 | - | 30 | - | ns |
| SCK ↑ → SIN hold time | t _{SHIXI} | SCKx, SINx | | 0 | - | 0 | - | ns |
| Serial clock "L" pulse width | t _{SLSH} | SCKx | Slave mode | 2t _{CYCP} - 10 | - | 2t _{CYCP} - 10 | - | ns |
| Serial clock "H" pulse width | t _{SHSL} | SCKx | | t _{CYCP} + 10 | - | t _{CYCP} + 10 | - | ns |
| SCK ↓ → SOT delay time | t _{SLOVE} | SCKx, SOTx | | - | 50 | - | 30 | ns |
| SIN → SCK ↑ setup time | t _{IVSHE} | SCKx, SINx | | 10 | - | 10 | - | ns |
| SCK ↑ → SIN hold time | t _{SHIXE} | SCKx, SINx | | 20 | - | 20 | - | ns |
| SCK fall time | t _F | SCKx | | - | 5 | - | 5 | ns |
| SCK rise time | t _R | SCKx | | - | 5 | - | 5 | ns |

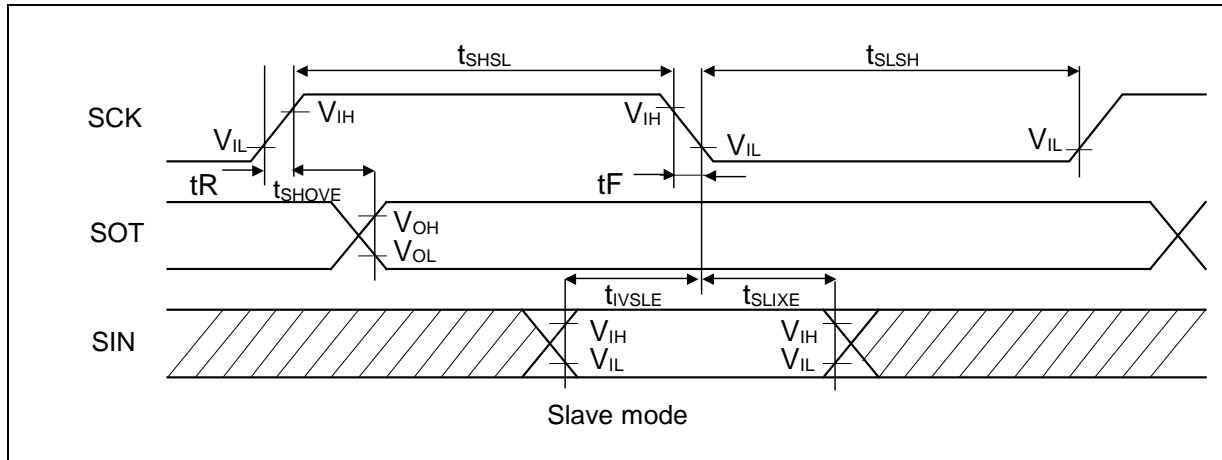
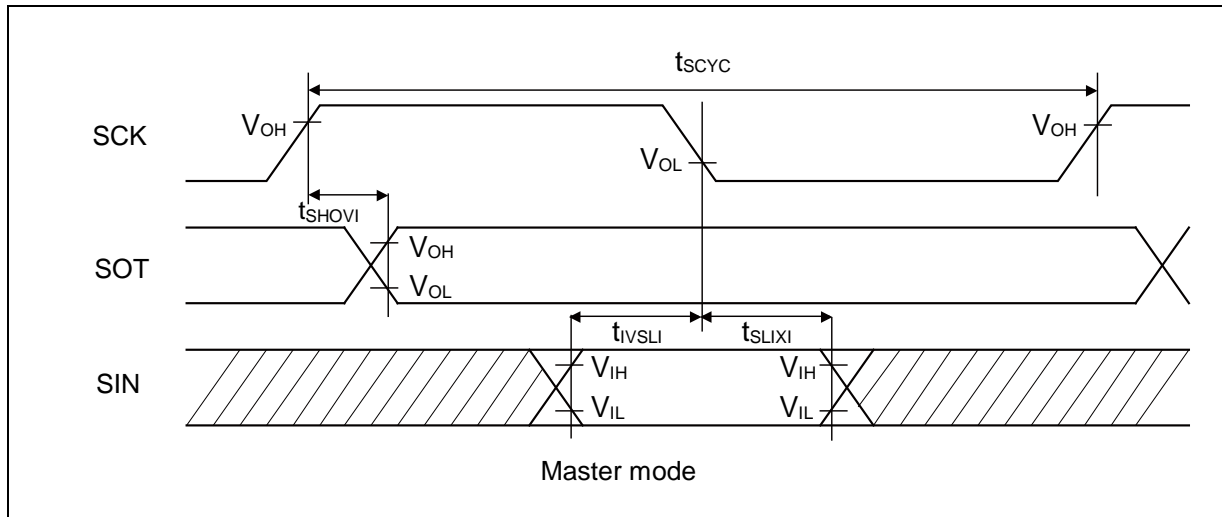
- Notes:**
- The above characteristics apply to CLK synchronous mode.
 - t_{CYCP} indicates the APB bus clock cycle time. About the APB bus number which Multi-function Serial is connected to, see "Block Diagram" in this data sheet.
 - These characteristics only guarantee the same relocate port number. For example, the combination of SCKx_0 and SOTx_1 is not guaranteed.
 - When the external load capacitance = 30 pF.



12.4.9.2 CSIO (SPI = 0, SCINV = 1)
(V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | V _{CC} < 4.5 V | | V _{CC} ≥ 4.5 V | | Unit |
|------------------------------|--------------------|---------------|------------------------|-------------------------|------------------------|-------------------------|------|------|
| | | | | Min | Max | Min | Max | |
| Serial clock cycle time | t _{SCYC} | SCKx | Master mode | 4t _{CYCP} | - | 4t _{CYCP} | - | ns |
| SCK ↑ → SOT delay time | t _{SHOVI} | SCKx, SOTx | | - 30 | + 30 | - 20 | + 20 | ns |
| SIN → SCK ↓ setup time | t _{IVSLI} | SCKx, SINx | | 50 | - | 30 | - | ns |
| SCK ↓ → SIN hold time | t _{SLIXI} | SCKx, SINx | | 0 | - | 0 | - | ns |
| Serial clock "L" pulse width | t _{SLSH} | SCKx | | 2t _{CYCP} - 10 | - | 2t _{CYCP} - 10 | - | ns |
| Serial clock "H" pulse width | t _{SHSL} | SCKx | t _{CYCP} + 10 | - | t _{CYCP} + 10 | - | ns | |
| SCK ↑ → SOT delay time | t _{SHOVE} | SCKx, SOTx | Slave mode | - | 50 | - | 30 | ns |
| SIN → SCK ↓ setup time | t _{IVSLE} | SCKx, SINx | | 10 | - | 10 | - | ns |
| SCK ↓ → SIN hold time | t _{SLIXE} | SCKx, SINx | | 20 | - | 20 | - | ns |
| SCK fall time | t _F | SCKx | | - | 5 | - | 5 | ns |
| SCK rise time | t _R | SCKx | | - | 5 | - | 5 | ns |

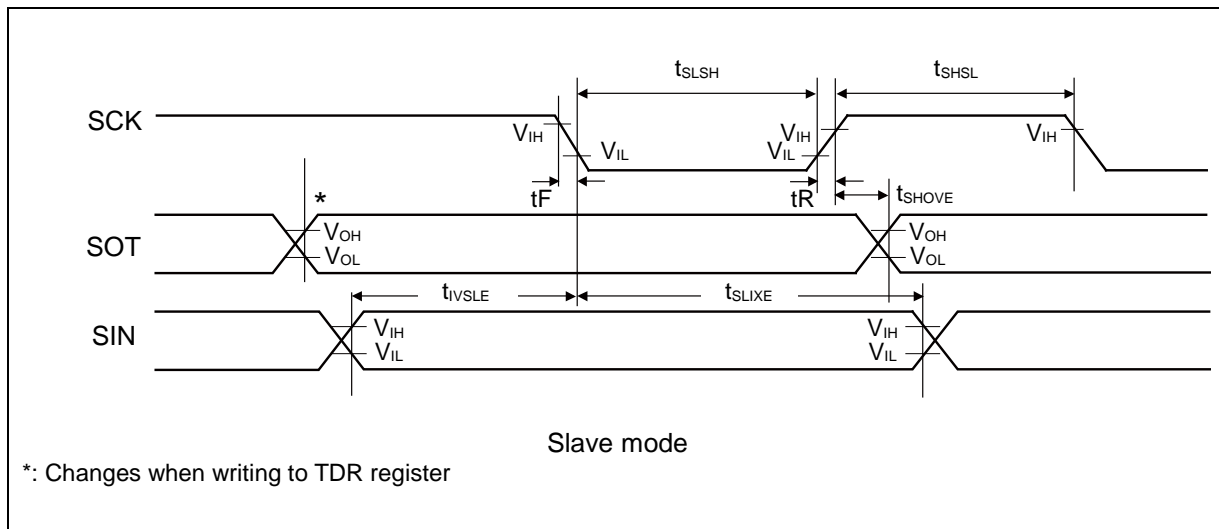
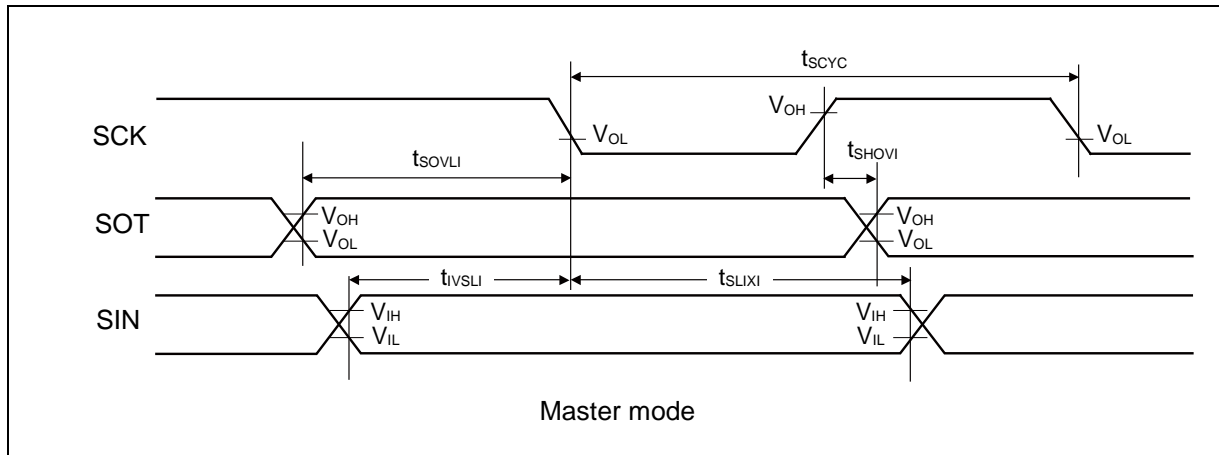
- Notes:**
- The above characteristics apply to CLK synchronous mode.
 - t_{CYCP} indicates the APB bus clock cycle time. About the APB bus number which Multi-function Serial is connected to, see "Block Diagram" in this data sheet.
 - These characteristics only guarantee the same relocate port number. For example, the combination of SCKx_0 and SOTx_1 is not guaranteed.
 - When the external load capacitance = 30 pF.



12.4.9.3 CSIO (SPI = 1, SCINV = 0)
(V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

| Parameter | Symbol | Pin name | Conditions | V _{CC} < 4.5 V | | V _{CC} ≥ 4.5 V | | Unit |
|------------------------------|--------------------|---------------|------------------------|-------------------------|------------------------|-------------------------|------|------|
| | | | | Min | Max | Min | Max | |
| Serial clock cycle time | t _{SCYC} | SCKx | Master mode | 4t _{CYCP} | - | 4t _{CYCP} | - | ns |
| SCK ↑ → SOT delay time | t _{SHOVI} | SCKx, SOTx | | - 30 | + 30 | - 20 | + 20 | ns |
| SIN → SCK ↓ setup time | t _{IVSLI} | SCKx, SINx | | 50 | - | 30 | - | ns |
| SCK ↓ → SIN hold time | t _{SLIXI} | SCKx, SINx | | 0 | - | 0 | - | ns |
| SOT → SCK ↓ delay time | t _{SOVLI} | SCKx, SOTx | | 2t _{CYCP} - 30 | - | 2t _{CYCP} - 30 | - | ns |
| Serial clock "L" pulse width | t _{SLSH} | SCKx | | 2t _{CYCP} - 10 | - | 2t _{CYCP} - 10 | - | ns |
| Serial clock "H" pulse width | t _{SHSL} | SCKx | t _{CYCP} + 10 | - | t _{CYCP} + 10 | - | ns | |
| SCK ↑ → SOT delay time | t _{SHOVE} | SCKx, SOTx | Slave mode | - | 50 | - | 30 | ns |
| SIN → SCK ↓ setup time | t _{IVSLE} | SCKx, SINx | | 10 | - | 10 | - | ns |
| SCK ↓ → SIN hold time | t _{SLIXE} | SCKx, SINx | | 20 | - | 20 | - | ns |
| SCK fall time | t _F | SCKx | | - | 5 | - | 5 | ns |
| SCK rise time | t _R | SCKx | | - | 5 | - | 5 | ns |

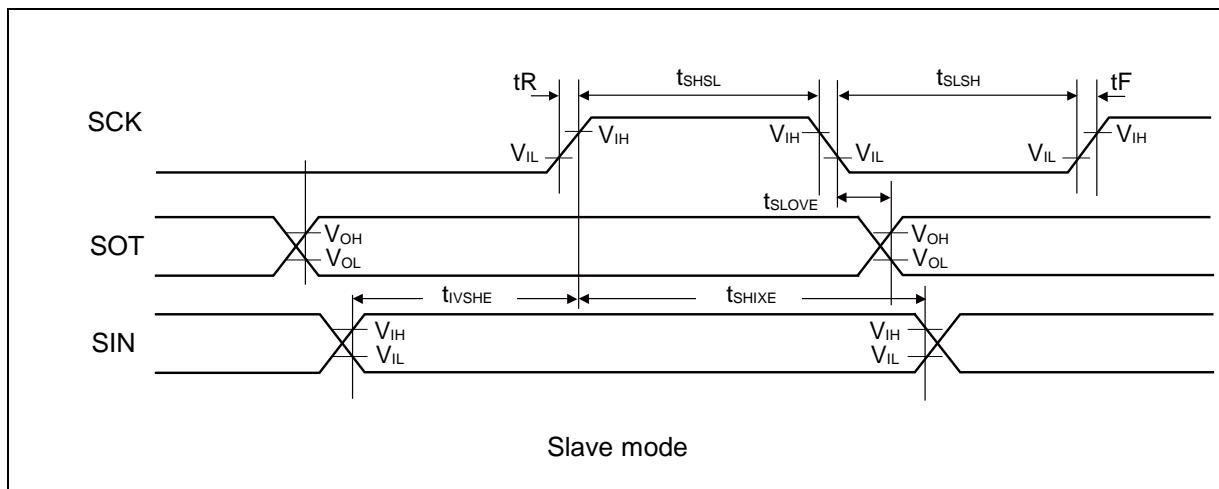
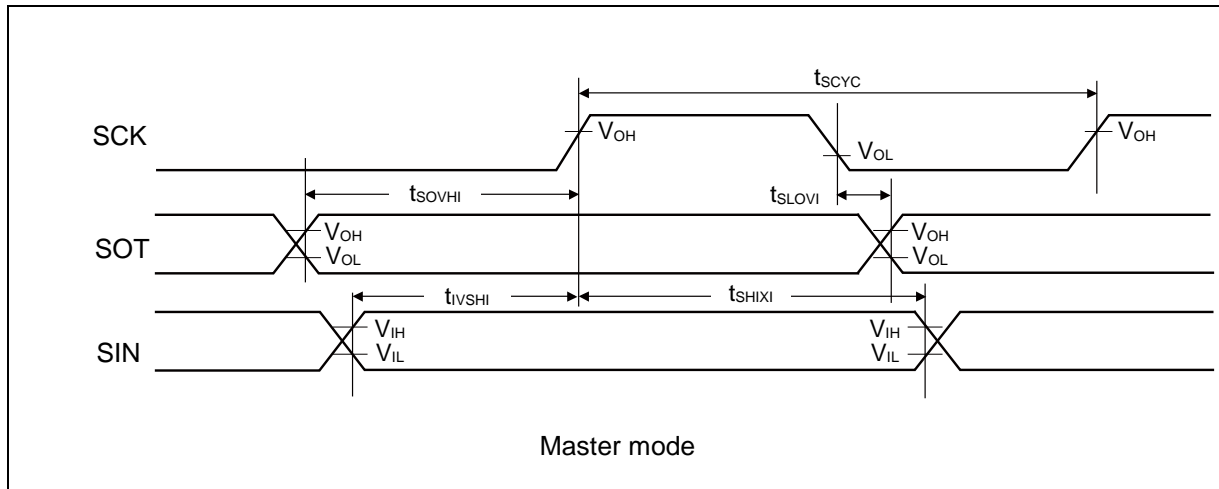
- Notes:**
- The above characteristics apply to CLK synchronous mode.
 - t_{CYCP} indicates the APB bus clock cycle time. About the APB bus number which Multi-function Serial is connected to, see "Block Diagram" in this data sheet.
 - These characteristics only guarantee the same relocate port number. For example, the combination of SCKx_0 and SOTx_1 is not guaranteed.
 - When the external load capacitance = 30 pF.



12.4.9.4 CSIO (SPI = 1, SCINV = 1)
(V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = - 40°C to + 85°C)

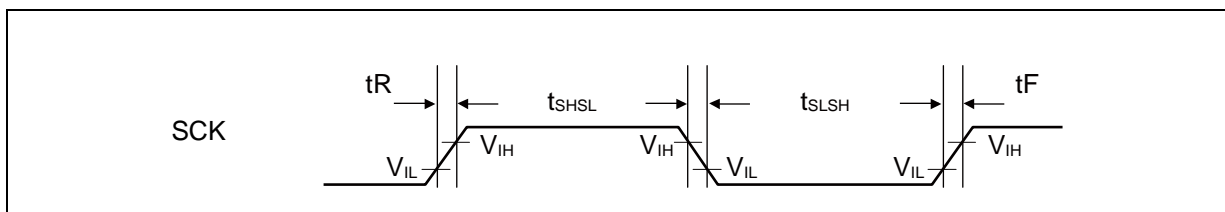
| Parameter | Symbol | Pin name | Conditions | V _{CC} < 4.5 V | | V _{CC} ≥ 4.5 V | | Unit |
|------------------------------|--------------------|-------------------------------------|-------------|-------------------------|------|-------------------------|------|------|
| | | | | Min | Max | Min | Max | |
| Serial clock cycle time | t _{SCYC} | SCK _X | Master mode | 4t _{CYCP} | - | 4t _{CYCP} | - | ns |
| SCK ↓ → SOT delay time | t _{SLOVI} | SCK _X , SOT _X | | - 30 | + 30 | - 20 | + 20 | ns |
| SIN → SCK ↑ setup time | t _{IVSHI} | SCK _X , SIN _X | | 50 | - | 30 | - | ns |
| SCK ↑ → SIN hold time | t _{SHIXI} | SCK _X , SIN _X | | 0 | - | 0 | - | ns |
| SOT → SCK ↑ delay time | t _{SOVHI} | SCK _X , SOT _X | | 2t _{CYCP} - 30 | - | 2t _{CYCP} - 30 | - | ns |
| Serial clock "L" pulse width | t _{SLSH} | SCK _X | Slave mode | 2t _{CYCP} - 10 | - | 2t _{CYCP} - 10 | - | ns |
| Serial clock "H" pulse width | t _{SHSL} | SCK _X | | t _{CYCP} + 10 | - | t _{CYCP} + 10 | - | ns |
| SCK ↓ → SOT delay time | t _{SLOVE} | SCK _X , SOT _X | | - | 50 | - | 30 | ns |
| SIN → SCK ↑ setup time | t _{IVSHE} | SCK _X , SIN _X | | 10 | - | 10 | - | ns |
| SCK ↑ → SIN hold time | t _{SHIXE} | SCK _X , SIN _X | | 20 | - | 20 | - | ns |
| SCK fall time | t _F | SCK _X | | - | 5 | - | 5 | ns |
| SCK rise time | t _R | SCK _X | | - | 5 | - | 5 | ns |

- Notes:**
- The above characteristics apply to CLK synchronous mode.
 - t_{CYCP} indicates the APB bus clock cycle time. About the APB bus number which Multi-function Serial is connected to, see "Block Diagram" in this data sheet.
 - These characteristics only guarantee the same relocate port number. For example, the combination of SCK_{X_0} and SOT_{X_1} is not guaranteed.
 - When the external load capacitance = 30 pF.



12.4.9.5 UART external clock input (EXT = 1)
 (V_{CC} = 2.7V to 5.5V, V_{SS} = 0V, T_a = -40°C to +85°C)

| Parameter | Symbol | Conditions | Value | | Unit | Remarks |
|------------------------------|-------------------|------------------------|------------------------|-----|------|---------|
| | | | Min | Max | | |
| Serial clock "L" pulse width | t _{SLSH} | C _L = 30 pF | 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 | |

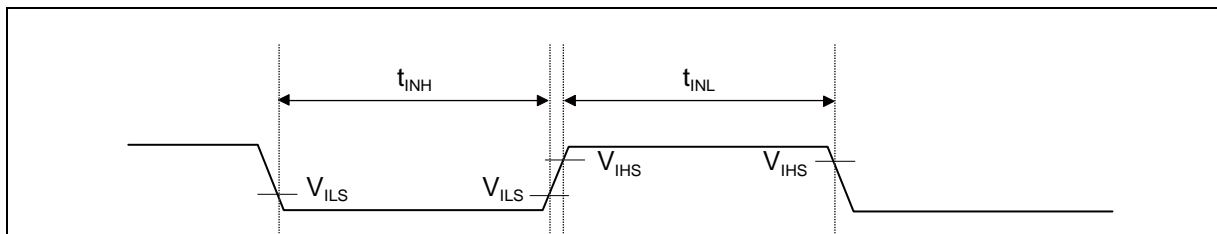


12.4.10 External Input Timing

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

| Parameter | Symbol | Pin name | Conditions | Value | | Unit | Remarks |
|-------------------|--|----------------|---------------------------------|---|-----|------|-----------------------------|
| | | | | Min | Max | | |
| Input pulse width | t _{INH} , t _{INL} | ADTG | - | 2t _{CYCP} ^[1] | - | ns | A/D converter trigger input |
| | | FRCKx | | | | | Free-run timer input clock |
| | | ICxx | | | | | Input capture |
| | | DTTlxX | - | 2t _{CYCP} ^[1] | - | ns | Wave form generator |
| | | INTxx, NMIX | Except Timer mode, Stop mode | 2t _{CYCP} + 100 ^[1] | - | ns | External interrupt NMI |
| | Timer mode, Stop mode | 500 | - | ns | | | |

[1]: t_{CYCP} indicates the APB bus clock cycle time. About the APB bus number which the A/D converter, Multi-function Timer, External interrupt are connected to, see "Block Diagram" in this data sheet.

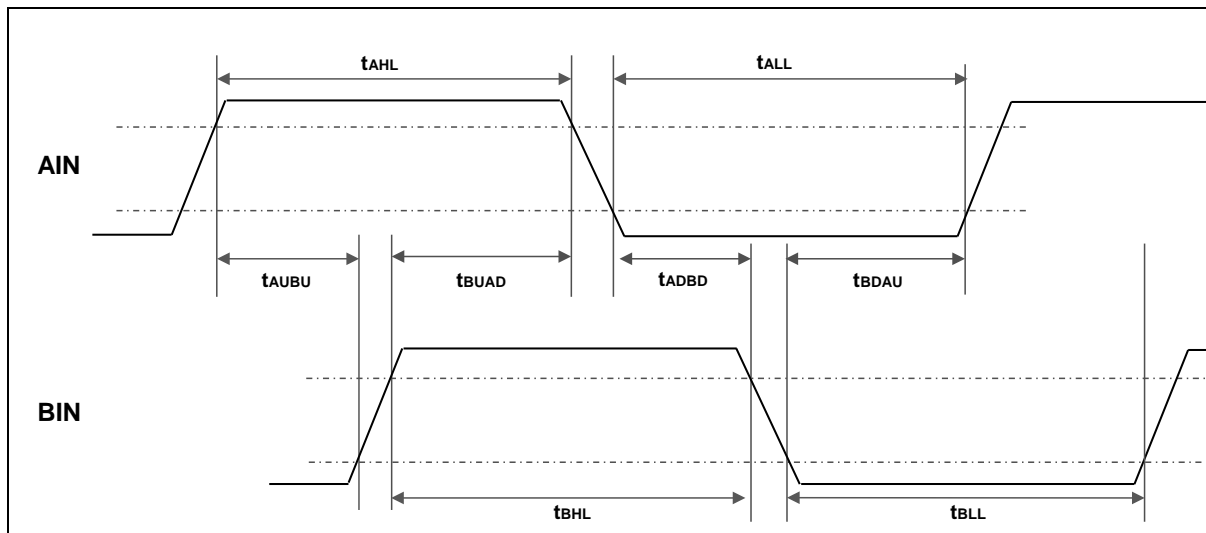


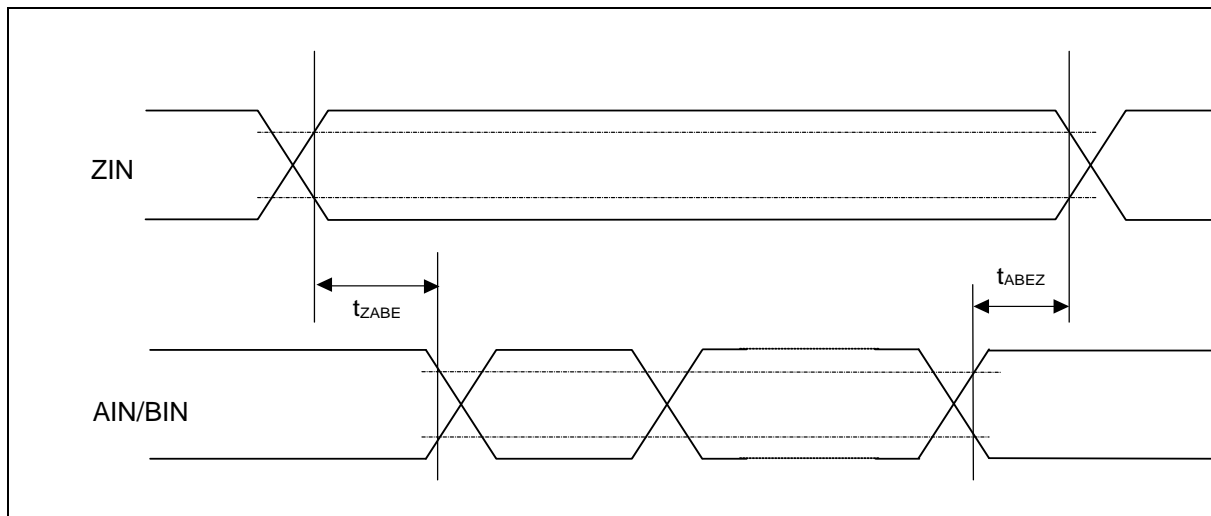
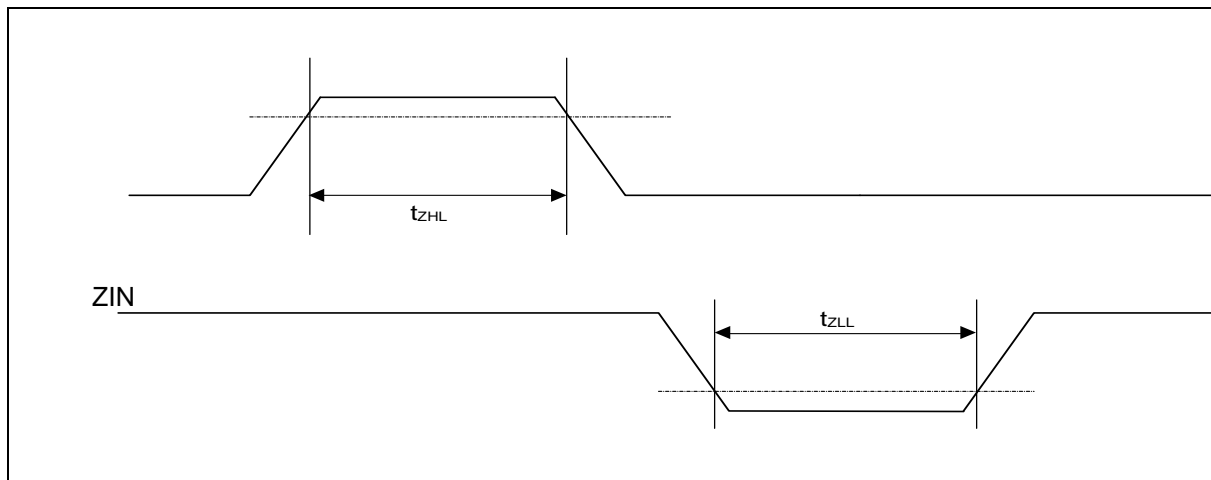
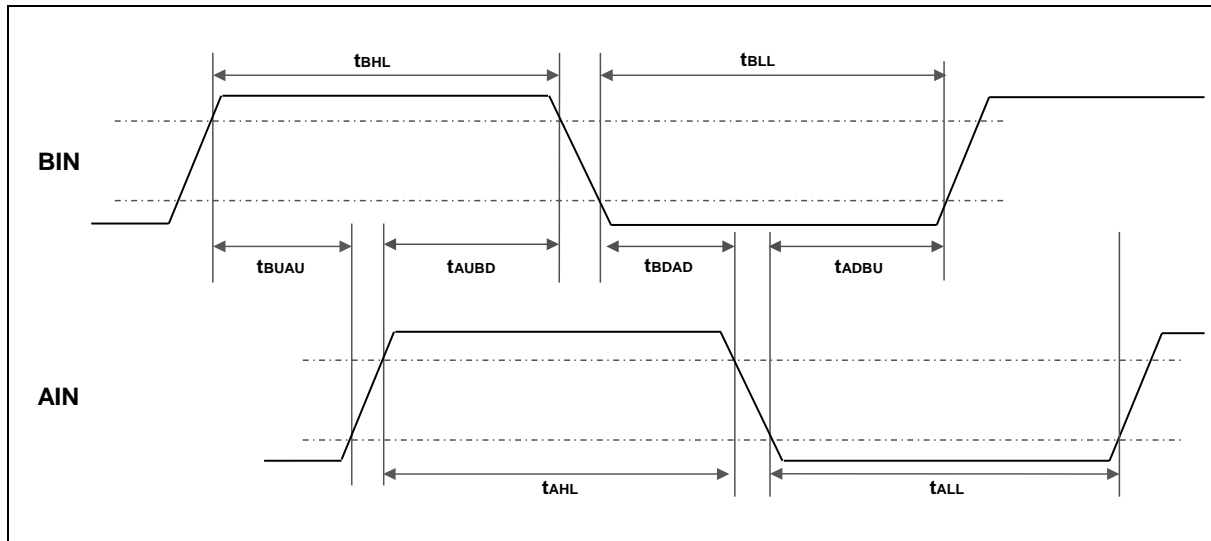
12.4.11 Quadrature Position/Revolution Counter timing

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

| Parameter | Symbol | Conditions | Value | | Unit | | | |
|--|-------------------|----------------------|-----------------------------------|-----|------|--|--|--|
| | | | Min | Max | | | | |
| AIN pin "H" width | t _{AHL} | - | 2t _{CYCP} ^[1] | - | ns | | | |
| AIN pin "L" width | t _{ALL} | - | | | | | | |
| BIN pin "H" width | t _{BHL} | - | | | | | | |
| BIN pin "L" width | t _{BLL} | - | | | | | | |
| BIN rise time from AIN pin "H" level | t _{AUBU} | PC_Mode2 or PC_Mode3 | | | | | | |
| AIN fall time from BIN pin "H" level | t _{BUAD} | PC_Mode2 or PC_Mode3 | | | | | | |
| BIN fall time from AIN pin "L" level | t _{ADBD} | PC_Mode2 or PC_Mode3 | | | | | | |
| AIN rise time from BIN pin "L" level | t _{BDAU} | PC_Mode2 or PC_Mode3 | | | | | | |
| AIN rise time from BIN pin "H" level | t _{BUAU} | PC_Mode2 or PC_Mode3 | | | | | | |
| BIN fall time from AIN pin "H" level | t _{AUBD} | PC_Mode2 or PC_Mode3 | | | | | | |
| AIN fall time from BIN pin "L" level | t _{BDAD} | PC_Mode2 or PC_Mode3 | | | | | | |
| BIN rise time from AIN pin "L" level | t _{ADBU} | PC_Mode2 or PC_Mode3 | | | | | | |
| ZIN pin "H" width | t _{ZHL} | QCR:CGSC="0" | | | | | | |
| ZIN pin "L" width | t _{ZLL} | QCR:CGSC="0" | | | | | | |
| AIN/BIN rise and fall time from determined ZIN level | t _{ZABE} | QCR:CGSC="1" | | | | | | |
| Determined ZIN level from AIN/BIN rise and fall time | t _{ABEZ} | QCR:CGSC="1" | | | | | | |

[1]: t_{CYCP} indicates the APB bus clock cycle time. About the APB bus number which Quadrature Position/Revolution Counter is connected to, see "Block Diagram" in this data sheet.





12.4.12 I²C Timing

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

| Parameter | Symbol | Conditions | Standard-mode | | Fast-mode | | Unit | Remarks |
|--|--------------------|--|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------|---------|
| | | | Min | Max | Min | Max | | |
| SCL clock frequency | F _{SCL} | C _L = 30 pF, R = (V _p /I _{OL}) ^[1] | 0 | 100 | 0 | 400 | kHz | |
| (Repeated) START condition hold time SDA ↓ → SCL ↓ | t _{HDSTA} | | 4.0 | - | 0.6 | - | μs | |
| SCLclock "L" width | t _{LOW} | | 4.7 | - | 1.3 | - | μs | |
| SCLclock "H" width | t _{HIGH} | | 4.0 | - | 0.6 | - | μs | |
| (Repeated) START setup time SCL ↑ → SDA ↓ | t _{SUSTA} | | 4.7 | - | 0.6 | - | μs | |
| Data hold time SCL ↓ → SDA ↓ ↑ | t _{HDDAT} | | 0 | 3.45 ^[2] | 0 | 0.9 ^[3] | μs | |
| Data setup time SDA ↓ ↑ → SCL ↑ | t _{SUDAT} | | 250 | - | 100 | - | ns | |
| STOP condition setup time SCL ↑ → SDA ↑ | t _{SUSTO} | | 4.0 | - | 0.6 | - | μs | |
| Bus free time between "STOP condition" and "START condition" | t _{BUF} | | 4.7 | - | 1.3 | - | μs | |
| Noise filter | t _{SP} | | 8 MHz ≤ t _{CYCP} ≤ 40 Hz | 2 t _{CYCP} ^[4] | - | 2 t _{CYCP} ^[4] | - | ns |
| | | 40 MHz < t _{CYCP} ≤ 60 Hz | 3 t _{CYCP} ^[4] | - | 3 t _{CYCP} ^[4] | - | ns | [5] |
| | | 60 MHz < t _{CYCP} ≤ 72 Hz | 4 t _{CYCP} ^[4] | - | 4 t _{CYCP} ^[4] | - | ns | [5] |

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

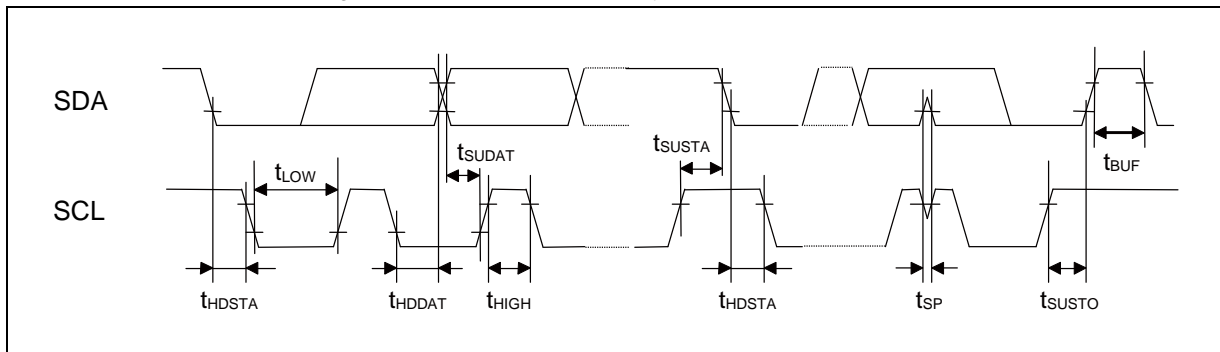
[2]: The maximum t_{HDDAT} must satisfy that it does not extend at least "L" period (t_{LOW}) of device's SCL signal.

[3]: A Fast-mode I²C bus device can be used on a Standard-mode I²C bus system as long as the device satisfies the requirement of "t_{SUDAT} ≥ 250 ns".

[4]: t_{CYCP} is the APB bus clock cycle time. About the APB bus number which I²C is connected to, see "Block Diagram" in this data sheet.

To use Standard-mode, set the APB bus clock at 2 MHz or more. To use Fast-mode, set the APB bus clock at 8 MHz or more.

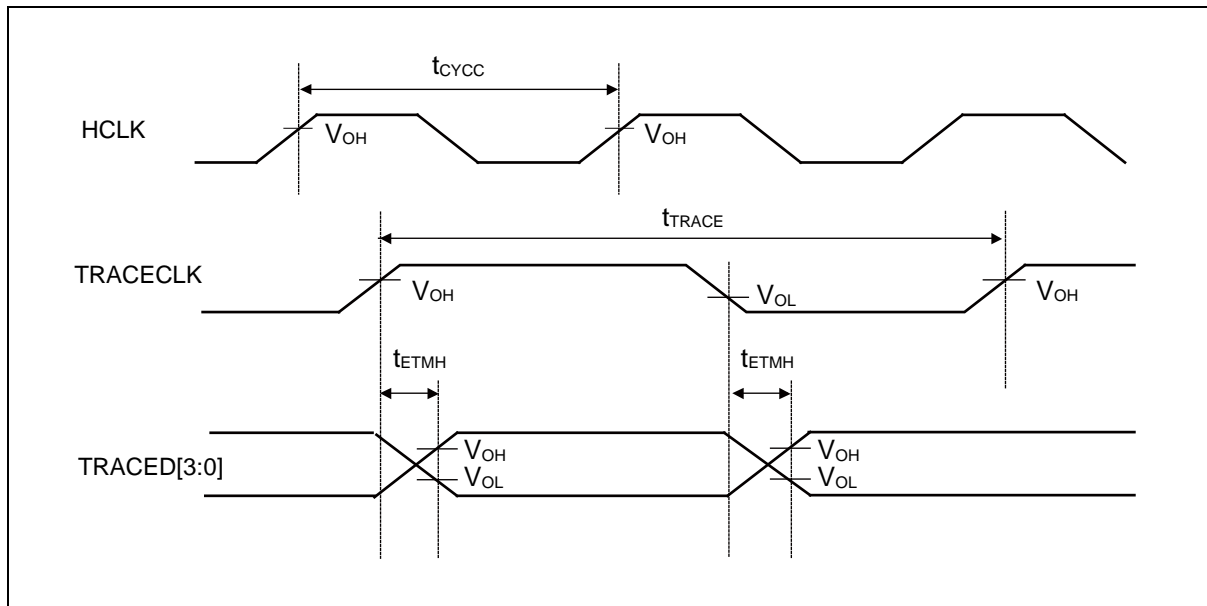
[5]: The number of steps of the noise filter can be changed with register settings. Change the number of the noise filter steps according to APB2 bus clock frequency.



12.4.13 ETM Timing

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

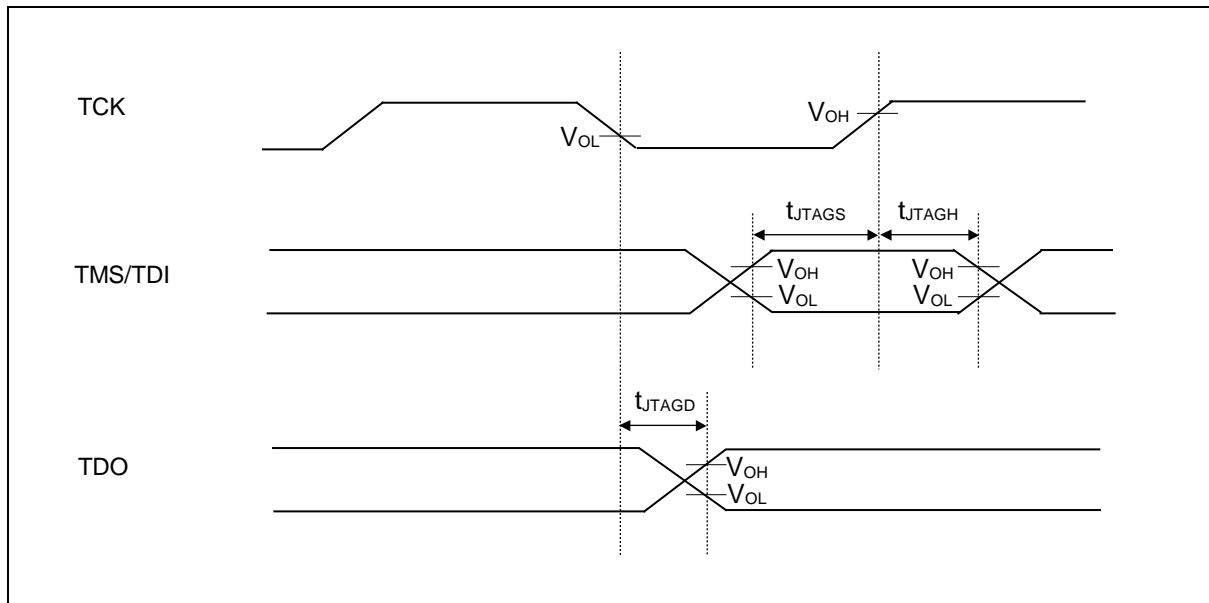
| Parameter | Symbol | Pin name | Conditions | Value | | Unit | Remarks |
|---------------------|-----------------------|--------------------------|-------------------------|-------|-----|------|---------|
| | | | | Min | Max | | |
| Data hold | t _{ETMH} | TRACECLK, TRACED[3:0] | V _{CC} ≥ 4.5 V | 2 | 9 | ns | |
| | | | V _{CC} < 4.5 V | 2 | 15 | | |
| TRACECLK frequency | 1/ t _{TRACE} | TRACECLK | V _{CC} ≥ 4.5 V | - | 50 | MHz | |
| | | | V _{CC} < 4.5 V | - | 32 | MHz | |
| TRACECLK cycle time | t _{TRACE} | | V _{CC} ≥ 4.5 V | 20 | - | ns | |
| | | | V _{CC} < 4.5 V | 31.25 | - | ns | |

Note: When the external load capacitance = 30 pF.


12.4.14 JTAG Timing

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

| Parameter | Symbol | Pin name | Conditions | Value | | Unit | Remarks |
|---------------------|--------------------|------------------|-------------------------|-------|-----|------|---------|
| | | | | Min | Max | | |
| TMS, TDI setup time | t _{JTAGS} | TCK, TMS, TDI | V _{CC} ≥ 4.5 V | 15 | - | ns | |
| | | | V _{CC} < 4.5 V | | | | |
| TMS, TDI hold time | t _{JTAGH} | TCK, TMS, TDI | V _{CC} ≥ 4.5 V | 15 | - | ns | |
| | | | V _{CC} < 4.5 V | | | | |
| TDO delay time | t _{JTAGD} | TCK, TDO | V _{CC} ≥ 4.5 V | - | 25 | ns | |
| | | | V _{CC} < 4.5 V | - | 45 | | |

Note: When the external load capacitance = 30 pF.


12.5 12-bit A/D Converter

12.5.1 Electrical characteristics for the A/D converter

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

| Parameter | Symbol | Pin name | Value | | | Unit | Remarks |
|---|------------------|----------|--------------------|-----|------------------|------|--------------------------|
| | | | Min | Typ | Max | | |
| Resolution | - | - | - | - | 12 | bit | |
| Integral Nonlinearity | - | - | - | - | ± 4.5 | LSB | AVRH = 2.7 V to 5.5 V |
| Differential Nonlinearity | - | - | - | - | ± 2.5 | LSB | |
| Zero transition voltage | V _{ZT} | ANxx | - | - | ± 15 | mV | |
| Full-scale transition voltage | V _{FST} | ANxx | - | - | AVRH ± 15 | mV | |
| Conversion time | - | - | 1.0 ^[1] | - | - | μs | AV _{CC} ≥ 4.5 V |
| | | | 1.2 ^[1] | - | - | | AV _{CC} < 4.5 V |
| Sampling time | T _s | - | ^[2] | - | - | ns | AV _{CC} ≥ 4.5 V |
| | | | ^[2] | - | - | | AV _{CC} < 4.5 V |
| Compare clock cycle ^{*3} | T _{ck} | - | 50 | - | 2000 | ns | |
| State transition time to operation permission | T _{stt} | - | - | - | 1.0 | μs | |
| Analog input capacity | C _{AIN} | - | - | - | 12.9 | pF | |
| Analog input resistance | R _{AIN} | - | - | - | 2 | kΩ | AV _{CC} ≥ 4.5 V |
| | | | | | 3.8 | | AV _{CC} < 4.5 V |
| Interchannel disparity | - | - | - | - | 4 | LSB | |
| Analog port input current | - | ANxx | - | - | 5 | μA | |
| Analog input voltage | - | ANxx | AV _{SS} | - | AVRH | V | |
| Reference voltage | - | AVRH | 2.7 | - | AV _{CC} | V | |

[1]: The Conversion time is the value of sampling time (T_s) + compare time (T_c).

The condition of the minimum conversion time is the following.

AV_{CC} ≥ 4.5 V, HCLK=120 MHz sampling time: 300 ns compare time: 700 ns
 AV_{CC} < 4.5 V, HCLK=120 MHz sampling time: 500 ns compare time: 700 ns

Ensure that it satisfies the value of the sampling time (T_s) and compare clock cycle (T_{ck}).

For setting of the sampling time and compare clock cycle, see "CHAPTER 1-1: A/D Converter" in "FM3 Family PERIPHERAL MANUAL Analog Macro Part".

The registers setting of the A/D Converter are reflected in the operation according to the APB bus clock timing.

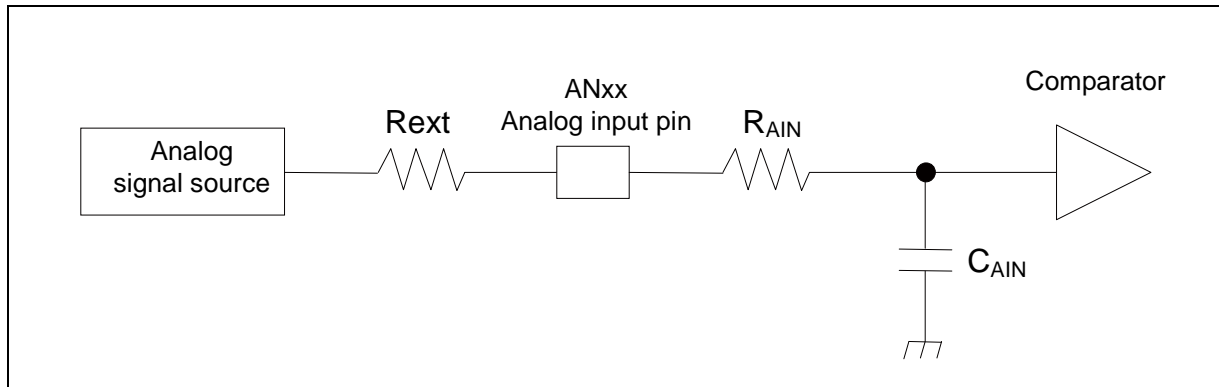
The sampling clock and compare clock is generated from the Base clock (HCLK).

About the APB bus number which the A/D Converter is connected to, see "Block Diagram" in this data sheet.

[2]: A necessary sampling time changes by external impedance.

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

[3]: Compare time (T_c) is the value of (Equation 2).



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

T_s : Sampling time

R_{AIN} : input resistance of A/D = 2 k Ω at $4.5 \leq AV_{CC} \leq 5.5$

input resistance of A/D = 3.8 k Ω at $2.7 \leq AV_{CC} < 4.5$

C_{AIN} : input capacity of A/D = 12.9 pF at $2.7 \leq AV_{CC} \leq 5.5$

R_{ext} : Output impedance of external circuit

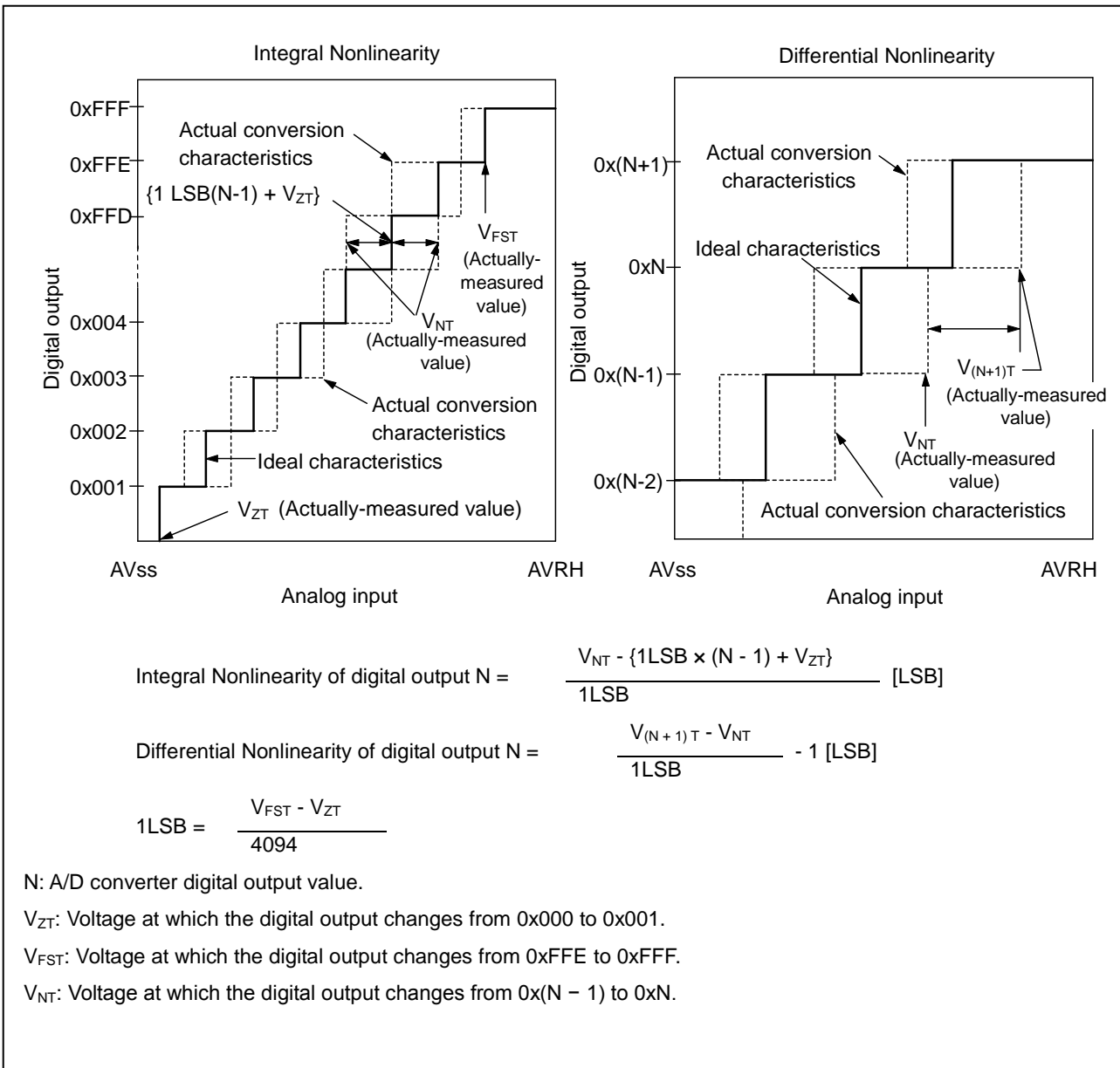
$$\text{(Equation 2) } T_c = T_{ck} \times 14$$

T_c : Compare time

T_{ck} : Compare clock cycle

12.5.2 Definition of 12-bit A/D Converter Terms

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



12.6 Low-Voltage Detection Characteristics

12.6.1 Low-Voltage Detection Reset

(Ta = - 40°C to + 85°C)

| Parameter | Symbol | Conditions | Value | | | Unit | Remarks |
|------------------|--------|------------|-------|------|------|------|--------------------|
| | | | Min | Typ | Max | | |
| Detected voltage | VDL | - | 2.25 | 2.45 | 2.65 | V | When voltage drops |
| Released voltage | VDH | - | 2.30 | 2.50 | 2.70 | V | When voltage rises |

12.6.2 Interrupt of Low-Voltage Detection

(Ta = - 40°C to + 85°C)

| Parameter | Symbol | Conditions | Value | | | Unit | Remarks |
|-----------------------------|-------------------|-------------|-------|-----|---|------|--------------------|
| | | | Min | Typ | Max | | |
| Detected voltage | VDL | SVHI = 0000 | 2.58 | 2.8 | 3.02 | V | When voltage drops |
| Released voltage | VDH | | 2.67 | 2.9 | 3.13 | V | When voltage rises |
| Detected voltage | VDL | SVHI = 0001 | 2.76 | 3.0 | 3.24 | V | When voltage drops |
| Released voltage | VDH | | 2.85 | 3.1 | 3.34 | V | When voltage rises |
| Detected voltage | VDL | SVHI = 0010 | 2.94 | 3.2 | 3.45 | V | When voltage drops |
| Released voltage | VDH | | 3.04 | 3.3 | 3.56 | V | When voltage rises |
| Detected voltage | VDL | SVHI = 0011 | 3.31 | 3.6 | 3.88 | V | When voltage drops |
| Released voltage | VDH | | 3.40 | 3.7 | 3.99 | V | When voltage rises |
| Detected voltage | VDL | SVHI = 0100 | 3.40 | 3.7 | 3.99 | V | When voltage drops |
| Released voltage | VDH | | 3.50 | 3.8 | 4.10 | V | When voltage rises |
| Detected voltage | VDL | SVHI = 0111 | 3.68 | 4.0 | 4.32 | V | When voltage drops |
| Released voltage | VDH | | 3.77 | 4.1 | 4.42 | V | When voltage rises |
| Detected voltage | VDL | SVHI = 1000 | 3.77 | 4.1 | 4.42 | V | When voltage drops |
| Released voltage | VDH | | 3.86 | 4.2 | 4.53 | V | When voltage rises |
| Detected voltage | VDL | SVHI = 1001 | 3.86 | 4.2 | 4.53 | V | When voltage drops |
| Released voltage | VDH | | 3.96 | 4.3 | 4.64 | V | When voltage rises |
| LVD stabilization wait time | T _{LVDW} | - | - | - | 4032 × t _{CYCP} ^[1] | μs | |

[1]: t_{CYCP} indicates the APB2 bus clock cycle time.

12.7 Flash Memory Write/Erase Characteristics

12.7.1 Write / Erase time

(V_{cc} = 2.7V to 5.5V, T_a = - 40°C to + 85°C)

| Parameter | | Value | | Unit | Remarks |
|-------------------------------|--------------|--------------------|--------------------|------|---|
| | | Typ ^[1] | Max ^[1] | | |
| Sector erase time | Large Sector | 0.7 | 3.7 | s | Includes write time prior to internal erase |
| | Small Sector | 0.3 | 1.1 | | |
| Half word (16-bit) write time | | 12 | 384 | μs | Not including system-level overhead time. |
| Chip erase time | | 13.6 | 68 | s | Includes write time prior to internal erase |

[1]: The typical value is immediately after shipment, the maximum value is guarantee value under 100,000 cycle of erase/write.

12.7.2 Write cycles and data hold time

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

[1]: At average + 85°C

12.8 Return Time from Low-Power Consumption Mode

12.8.1 Return Factor: Interrupt

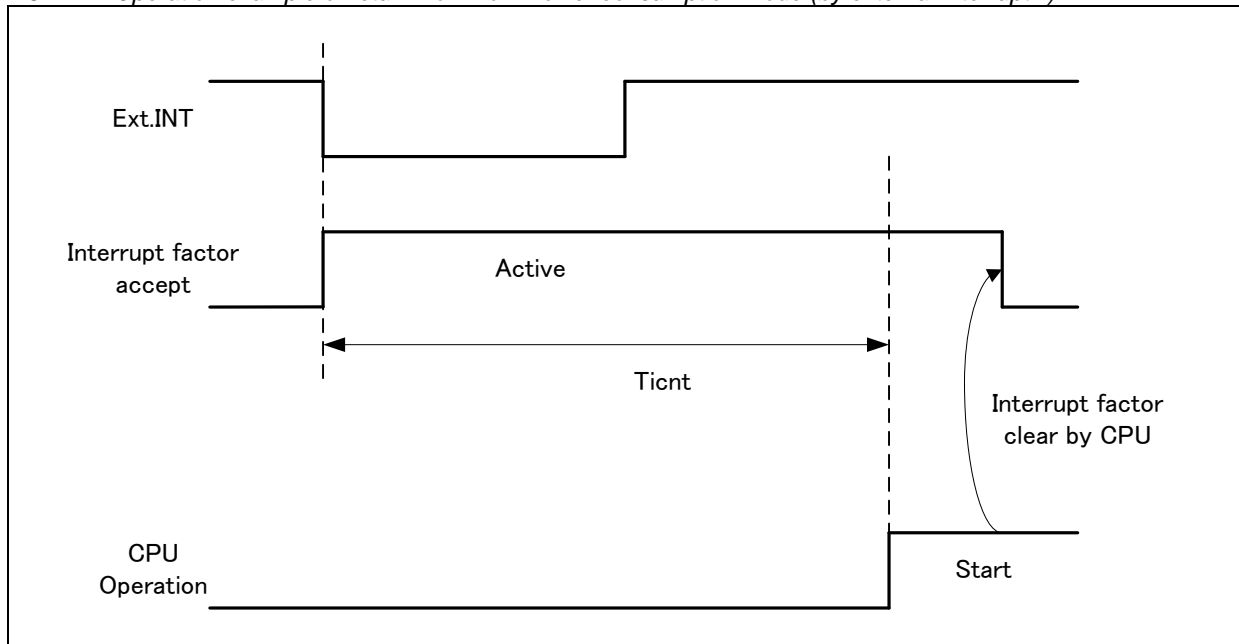
The return time from Low-Power consumption mode is indicated as follows. It is from receiving the return factor to starting the program operation.

12.8.1.1 Return Count Time
($V_{CC} = 2.7V$ to $5.5V$, $T_a = -40^{\circ}C$ to $+85^{\circ}C$)

| Parameter | Symbol | Value | | Unit | Remarks |
|---|--------|-------------------|--------------------|------|---------|
| | | Typ | Max ^[1] | | |
| SLEEP mode | Ticnt | t _{cycc} | | ns | |
| High-speed CR TIMER mode, Main TIMER mode, PLL TIMER mode | | 40 | 80 | μs | |
| Low-speed CR TIMER mode | | 453 | 737 | μs | |
| Sub TIMER mode | | 453 | 737 | μs | |
| STOP mode | | 453 | 737 | μs | |

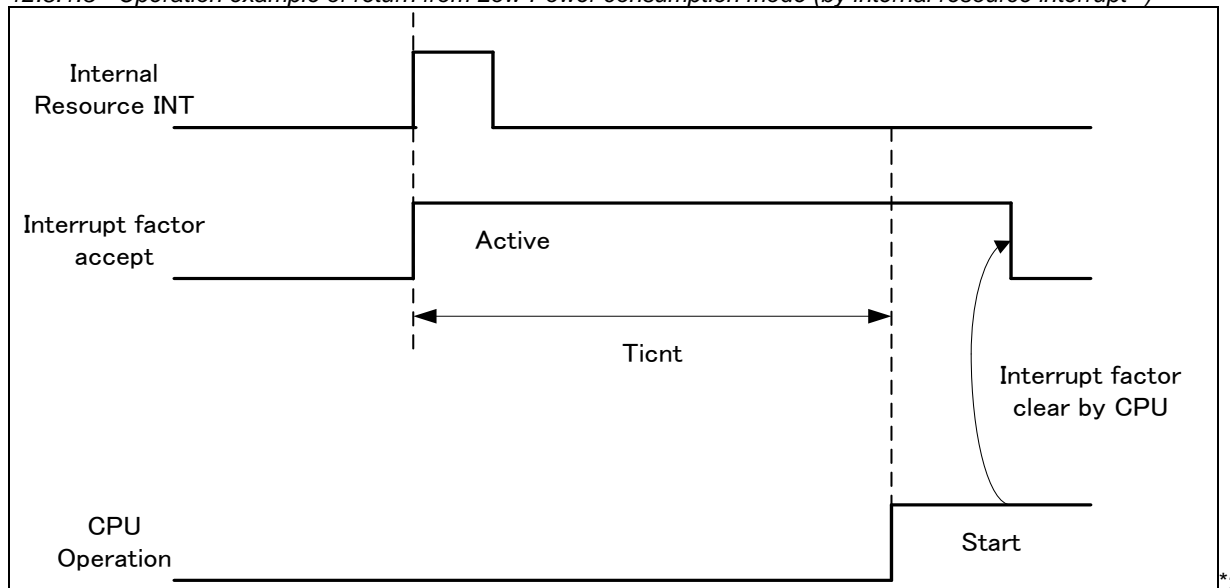
[1]: The maximum value depends on the accuracy of built-in CR.

12.8.1.2 Operation example of return from Low-Power consumption mode (by external interrupt^[1])



[1]: External interrupt is set to detecting fall edge.

12.8.1.3 Operation example of return from Low-Power consumption mode (by internal resource interrupt⁽¹⁾)



Internal resource interrupt is not included in return factor by the kind of Low-Power consumption mode.

- Notes:**
- The return factor is different in each Low-Power consumption modes. See "CHAPTER 6: Low Power Consumption Mode" and "Operations of Standby Modes" in [FM3 FAMILY PERIPHERAL MANUAL](#) about the return factor from Low-Power consumption mode.
 - When interrupt recovers, the operation mode that CPU recovers depends on the state before the Low-Power consumption mode transition. See "CHAPTER 6: Low Power Consumption Mode" in ["FM3 FAMILY PERIPHERAL MANUAL"](#).

12.8.2 Return Factor: Reset

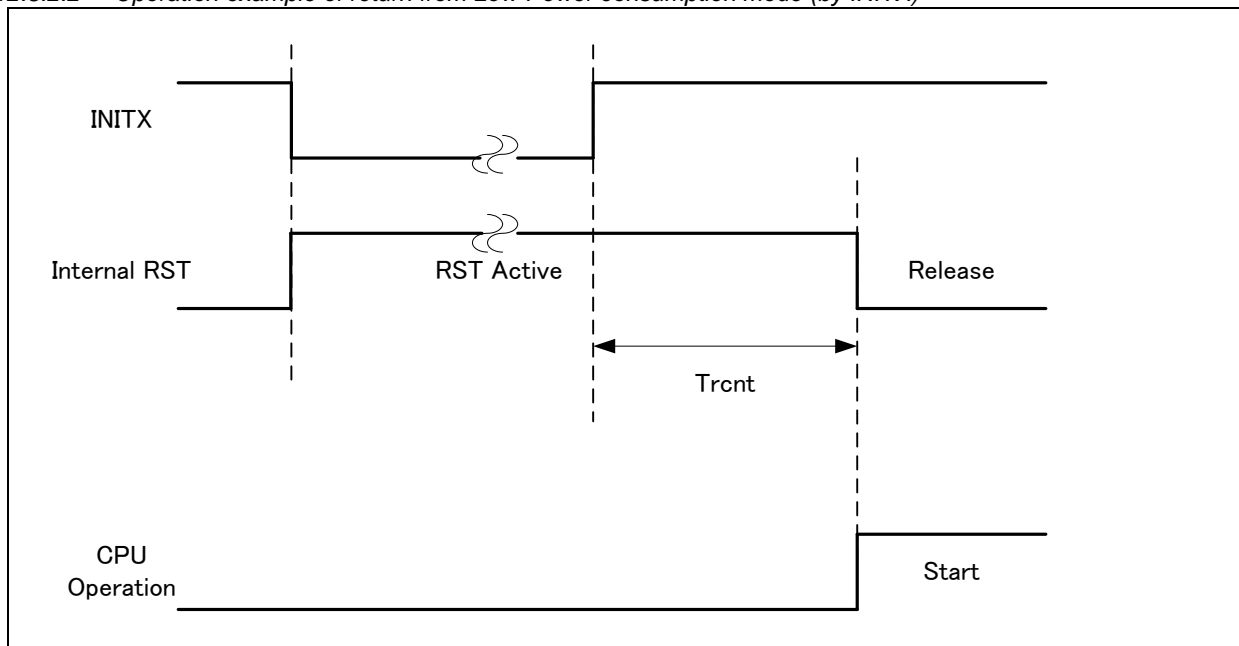
The return time from Low-Power consumption mode is indicated as follows. It is from releasing reset to starting the program operation.

12.8.2.1 Return Count Time

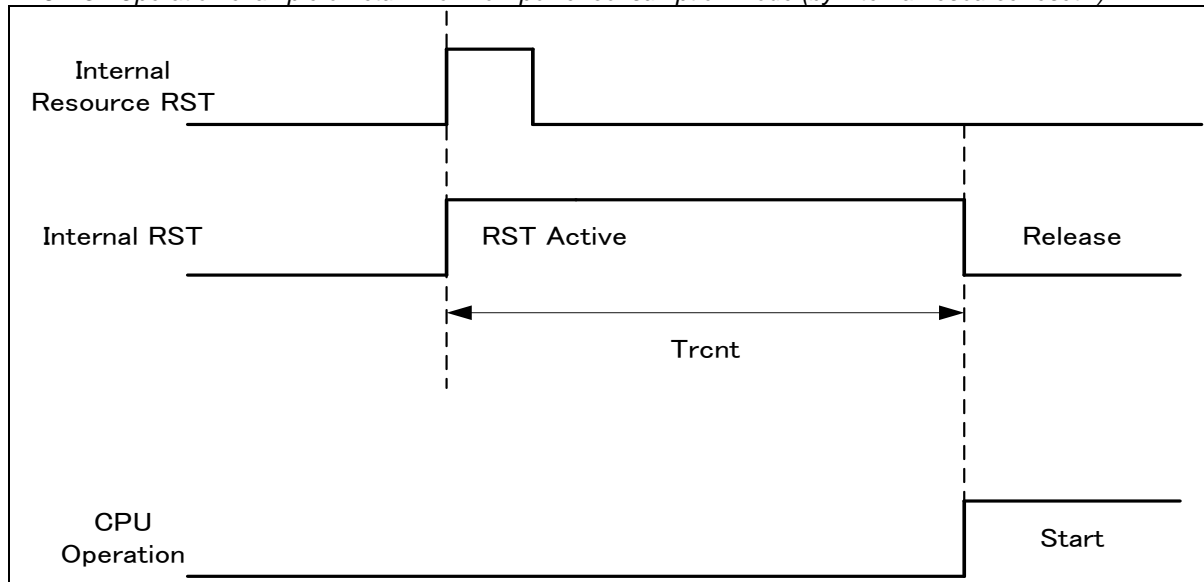
($V_{CC} = 2.7V$ to $5.5V$, $T_a = -40^{\circ}C$ to $+85^{\circ}C$)

| Parameter | Symbol | Value | | Unit | Remarks |
|---|--------|-------|--------------------|---------|---------|
| | | Typ | Max ^[1] | | |
| SLEEP mode | Trcnt | 321 | 461 | μs | |
| High-speed CR TIMER mode, Main TIMER mode, PLL TIMER mode | | 321 | 461 | μs | |
| Low-speed CR TIMER mode | | 441 | 701 | μs | |
| Sub TIMER mode | | 441 | 701 | μs | |
| STOP mode | | 441 | 701 | μs | |

[1]: The maximum value depends on the accuracy of built-in CR.

12.8.2.2 Operation example of return from Low-Power consumption mode (by INITX)


12.8.2.3 Operation example of return from low power consumption mode (by internal resource reset^[1])



[1] : Internal resource reset is not included in return factor by the kind of Low-Power consumption mode.

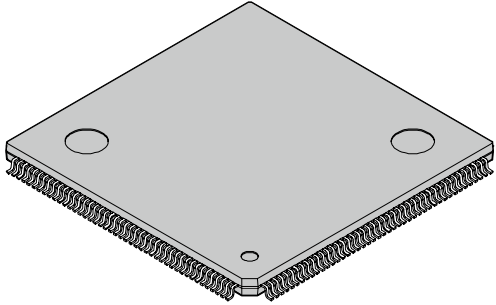
Notes:

- The return factor is different in each Low-Power consumption modes. See "CHAPTER 6: Low Power Consumption Mode" and "Operations of Standby Modes" in [FM3 Family PERIPHERAL MANUAL](#).
- When interrupt recovers, the operation mode that CPU recovers depends on the state before the Low-Power consumption mode transition. See "CHAPTER 6: Low Power Consumption Mode" in ["FM3 Family PERIPHERAL MANUAL"](#).
- The time during the power-on reset/low-voltage detection reset is excluded. See "12.4.6 Power-on Reset Timing in 12.4 AC Characteristics in [Electrical Characteristics](#)" for the detail on the time during the power-on reset/low -voltage detection reset.
- When in recovery from reset, CPU changes to the high-speed CR run mode. When using the main clock or the PLL clock, it is necessary to add the main clock oscillation stabilization wait time or the main PLL clock stabilization wait time.
- The internal resource reset means the watchdog reset and the CSV reset.

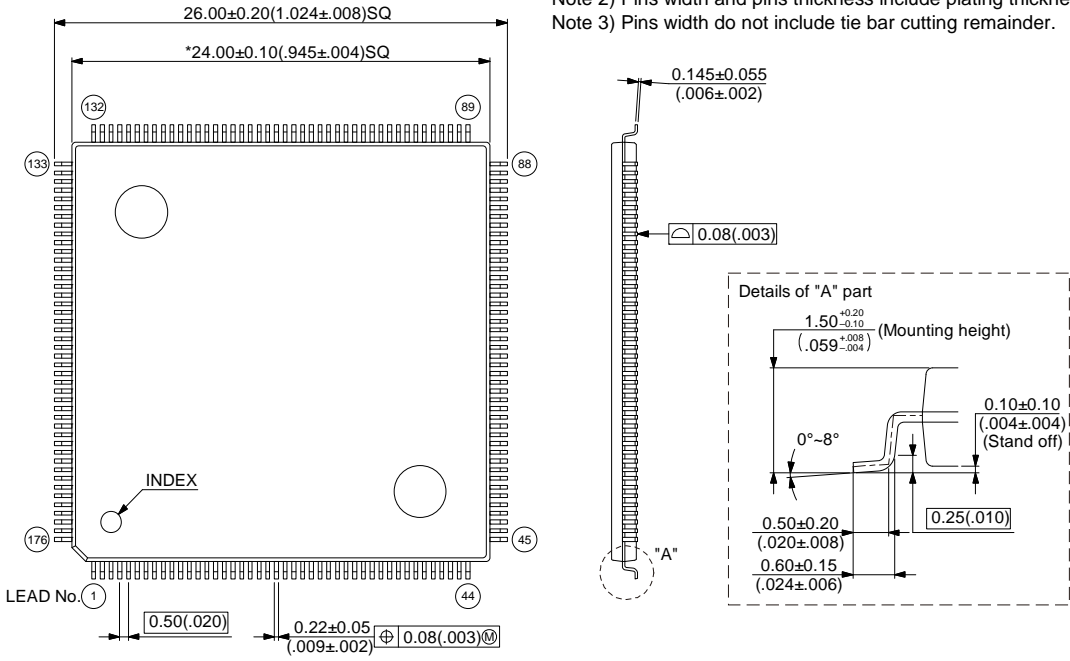
13. Ordering Information

| Part number | On-chip Flash memory | On-chip SRAM | Package | Packing |
|------------------|----------------------|--------------|---|---------|
| MB9BF116SPMC-GE1 | 512 Kbyte | 64 Kbyte | Plastic • LQFP 144-pin (0.5 mm pitch), (FPT-144P-M08) | Tray |
| MB9BF117SPMC-GE1 | 768 Kbyte | 96 Kbyte | | |
| MB9BF118SPMC-GE1 | 1 Mbyte | 128 Kbyte | | |
| MB9BF116TPMC-GE1 | 512 Kbyte | 64 Kbyte | Plastic • LQFP 176-pin (0.5 mm pitch), (FPT-176P-M07) | |
| MB9BF117TPMC-GE1 | 768 Kbyte | 96 Kbyte | | |
| MB9BF118TPMC-GE1 | 1 Mbyte | 128 Kbyte | | |
| MB9BF116TBGL-GE1 | 512 Kbyte | 64 Kbyte | Plastic • PFBGA 192-pin (0.8 mm pitch), (BGA-192P-M06) | |
| MB9BF117TBGL-GE1 | 768 Kbyte | 96 Kbyte | | |
| MB9BF118TBGL-GE1 | 1 Mbyte | 128 Kbyte | | |

14. Package Dimensions

| | | |
|---|--------------------------------|-----------------------|
| <p>176-pin plastic LQFP</p>  <p>(FPT-176P-M07)</p> | Lead pitch | 0.50 mm |
| | Package width × package length | 24.0 × 24.0 mm |
| | Lead shape | Gullwing |
| | Sealing method | Plastic mold |
| | Mounting height | 1.70 mm MAX |
| | Code (Reference) | P-LQFP-0176-2424-0.50 |
| | | |

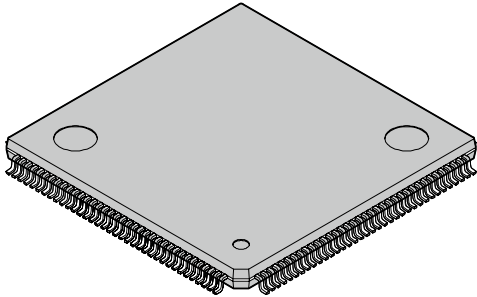
176-pin plastic LQFP (FPT-176P-M07)



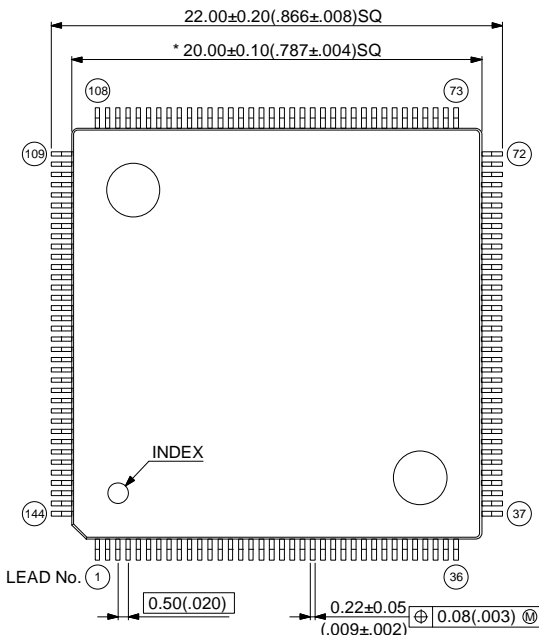
Note 1) * : Values do not include resin protrusion.
Resin protrusion is +0.25(.010)Max(each side).
Note 2) Pins width and pins thickness include plating thickness
Note 3) Pins width do not include tie bar cutting remainder.

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

| | | |
|---|--------------------------------|-----------------------|
| <p style="text-align: center;">144-pin plastic LQFP</p>  <p style="text-align: center;">(FPT-144P-M08)</p> | Lead pitch | 0.50 mm |
| | Package width × package length | 20.0 × 20.0 mm |
| | Lead shape | Gullwing |
| | Sealing method | Plastic mold |
| | Mounting height | 1.70 mm MAX |
| | Weight | 1.20 g |
| | Code (Reference) | P-LFQFP144-20×20-0.50 |

144-pin plastic LQFP (FPT-144P-M08)



LEAD No. 1

INDEX

0.50(.020)

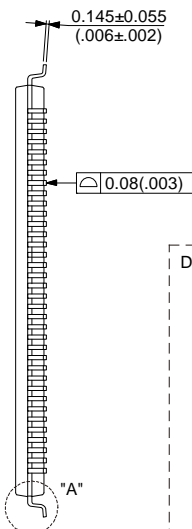
0.22±0.05
(.009±.002)

0.08(.003) Ⓜ

Note 1) *:Values do not include resin protrusion.
Resin protrusion is +0.25(.010)Max(each side).

Note 2) Pins width and pins thickness include plating thickness.

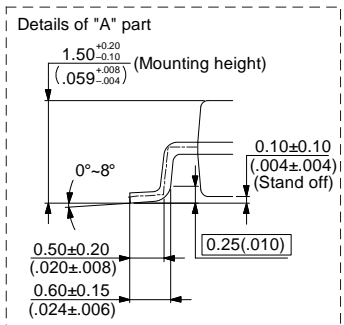
Note 3) Pins width do not include tie bar cutting remainder.



0.145±0.055
(.006±.002)

0.08(.003)

Details of "A" part



1.50^{+0.20}_{-0.10}
(.059^{+0.008}_{-0.004}) (Mounting height)

0°-8°

0.10±0.10
(.004±.004) (Stand off)

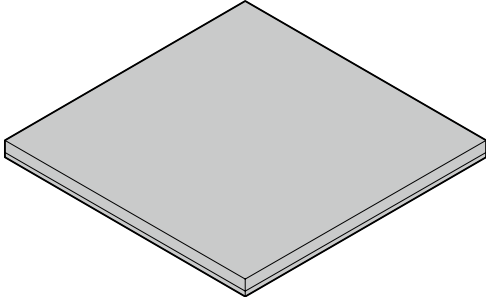
0.50±0.20
(.020±.008)

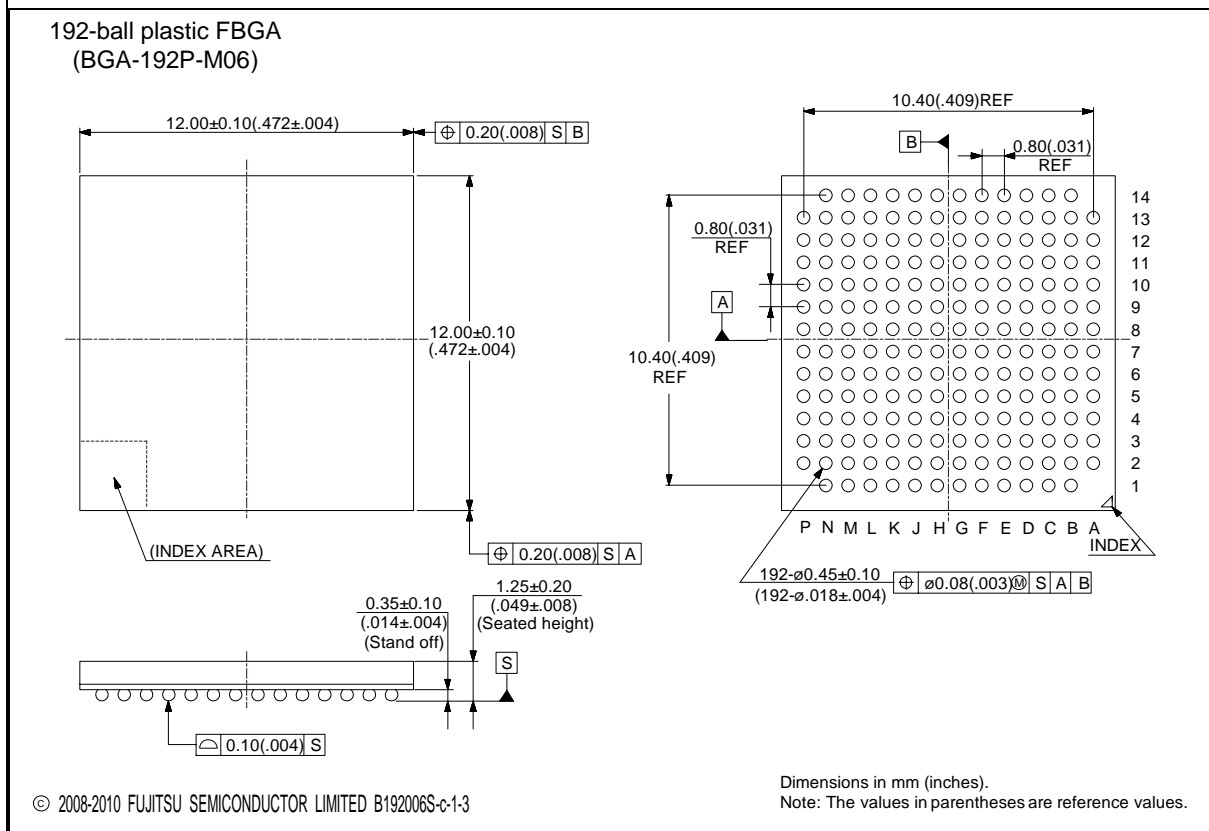
0.60±0.15
(.024±.006)

0.25(.010)

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

| | | |
|--|--------------------------------|---------------------|
| <p>192-ball plastic FBGA</p>  <p>(BGA-192P-M06)</p> | Ball pitch | 0.80 mm |
| | Package width × package length | 12.00 mm × 12.00 mm |
| | Lead shape | Ball |
| | Sealing method | Plastic mold |
| | Mounting height | 1.45 mm Max. |
| | Weight | 0.34 g |
| | | |



15. Major Changes

| Page | Section | Change Results |
|--------------|--|---|
| Revision 1.0 | | |
| - | - | Initial release |
| Revision 2.0 | | |
| 9 to 11 | Pin Assignment | Added the description of "Note". |
| 70, 71 | Handling Devices | <ul style="list-style-type: none"> ■ Revised the description of "•C pin". ■ Added the description of "•Base Timer". |
| 72 | Block Diagram | Corrected the figure. <ul style="list-style-type: none"> ■ TIOA: input → input/output ■ TIOB: output → input |
| 82 | Electrical Characteristics 12.2. Recommended Operating Conditions | <ul style="list-style-type: none"> ■ Added the "Smoothing capacitor (C_S)". ■ Added the footnote. |
| 87 | 12.4. AC Characteristics 12.4.1. Main Clock Input Characteristics | Added "Internal operating clock frequency (F _{CM}): Master Clock". |
| 89 | 12.4.4.1 Operating Conditions of Main PLL (In the case of using main clock for input of PLL) | Added "Main PLL clock frequency (F _{CLKPLL})". |
| | 12.4.4.2 Operating Conditions of Main PLL (In the case of using built-in high-speed CR clock for the input clock of the main PLL) | |
| 116 | 12.5. 12-bit A/D Converter 12.5.1 Electrical Characteristics for the A/D Converter | <ul style="list-style-type: none"> ■ • Added the Symbol. ■ • Deleted the following Pin name. <ul style="list-style-type: none"> □ "Sampling time" □ "Compare clock cycle" □ "State transition time to operation permission" □ "Analog input capacity" □ "Analog input resistance" ■ Corrected the value of "Compare clock cycle (T_{ck})". Max: 10000 → 2000 |
| Revision 2.1 | | |
| - | - | Company name and layout design change |
| Revision 3.0 | | |
| 1 | Features External Bus Interface | Added the description of Maximum area size |
| 9, 10 | Pin Assignment | Added SWCLK and SWDIO and SWO |
| 58 to 64 | I/O Circuit Type | <ul style="list-style-type: none"> ■ Added the description of I²C to the type of E, F, I, ■ Added about +B input |
| 69 | Handling Devices | Added "7.2 Stabilizing power supply voltage" |
| 69 | Handling Devices 7.3 Crystal oscillator circuit | Added the following description "Evaluate oscillation of your using crystal oscillator by your mount board." |
| 70 | Handling Devices 7.6 C Pin | Changed the description |
| 72 | Block Diagram | Modified the block diagram |
| 73 | Memory Map 10.1 Memory map(1) | Modified the area of "External Device Area" |

| Page | Section | Change Results |
|------------|---|--|
| 74 | Memory Map 10.2 Memory map(2) | Added the summary of Flash memory sector and the note |
| 80, 81 | Electrical Characteristics 12.1 Absolute Maximum Ratings | <ul style="list-style-type: none"> ■ Added the Clamp maximum current ■ Added the output current of P80, P81, P82, P83 ■ Added about +B input |
| 82 | Electrical Characteristics 12.2. Recommended Operation Conditions | <ul style="list-style-type: none"> ■ Modified the minimum value of Analog reference voltage ■ Added Smoothing capacitor ■ Added the note about less than the minimum power supply voltage |
| 83, 48 | Electrical Characteristics 12.3. DC Characteristics 12.3.1 Current rating | <ul style="list-style-type: none"> ■ Changed the table format ■ Added Main TIMER mode current ■ Added Flash Memory Current ■ Moved A/D Converter Current |
| 88 | Electrical Characteristics 12.4. AC Characteristics 12.4.3 Built to in CR Oscillation Characteristics | Added Frequency stability time at Built to in high to speed CR |
| 90 | Electrical Characteristics 12.4. AC Characteristics 12.4.6 Power to on Reset Timing | <ul style="list-style-type: none"> ■ Added Time until releasing Power to on reset ■ Changed the figure of timing |
| 91 | Electrical Characteristics 12.4. AC Characteristics 12.4.7 External Bus Timing | Modified Data output time |
| 106-109 | Electrical Characteristics 12.4. AC Characteristics 12.4.9 CSIO/UART Timing | <ul style="list-style-type: none"> ■ Modified from UART Timing to CSIO/UART Timing ■ Changed from Internal shift clock operation to Master mode ■ Changed from External shift clock operation to Slave mode |
| 116 | Electrical Characteristics 12.5. 12bit A/D Converter | <ul style="list-style-type: none"> ■ Added the typical value of Integral Nonlinearity, Differential Nonlinearity, Zero transition voltage and Full to scale transition voltage ■ Added Conversion time at AVcc < 4.5 V ■ Modified Stage transition time to operation permission ■ Modified the minimum value of Reference voltage |
| 123 to 124 | Electrical Characteristics 12.8. Return Time from Low to Power Consumption Mode | Added Return Time from Low to Power Consumption Mode |
| 125 | Ordering Information | Change to full part number |

NOTE: Please see “Document History” for later revised information.

Document History

Document Title: MB9BF116S/T, MB9BF117S/T, MB9BF118S/T, FM3, MB9B110T Series, 32-bit ARM®
 Cortex®-M3 based Microcontroller Datasheet

Document Number: 002-04683

| Revision | ECN | Orig. of Change | Submission Date | Description of Change |
|----------|---------|-----------------|-----------------|--|
| ** | — | TOYO | 02/10/2015 | Migrated to Cypress and assigned document number 002-04683. No change to document contents or format. |
| *A | 5200957 | TOYO | 04/07/2016 | Updated to Cypress template |

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