



# THE DATASHEET OF S6E1A12C0AGV20000

The S6E1A Series is a series of highly integrated 32-bit microcontrollers designed for embedded controllers aiming at low power consumption and low cost.

This series has the Arm Cortex-M0+ Processor with on-chip Flash memory and SRAM, and consists of peripheral functions such as various timers, ADCs and communication interfaces (UART, CSIO, I2C, LIN).

The products which are described in this data sheet are placed into TYPE1-M0+ product categories in "FM0+ Family PERIPHERAL MANUAL".

## Features

### 32-bit Arm Cortex-M0+ Core

- Processor version: r0p1
- Maximum operating frequency: 40 MHz
- Nested Vectored Interrupt Controller (NVIC): 1 NMI (non-maskable interrupt) and 32 peripheral interrupt with 4 selectable interrupt priority levels
- 24-bit System timer (Sys Tick): System timer for OS task management

### Bit Band operation

Compatible with Cortex-M3 bit band operation

### On-Chip Memories

- Flash memory
  - Up to 88 Kbyte
  - Read cycle: 0 wait-cycle
  - Security function for code protection
- SRAM
 

The on-chip SRAM of this series has one independent SRAM.

  - SRAM: 6 Kbyte

### Multi-function Serial Interface (Max 3channels)

- 128 bytes with FIFO in all channels (The number of FIFO steps varies depending on the settings of the communication mode or bit length.)
- The operation mode of each channel can be selected from one of the following.
  - UART
  - CSIO
  - LIN
  - I²C
- UART
  - Full duplex double buffer
  - Parity can be enabled or disabled.
  - Built-in dedicated baud rate generator
  - External clock available as a serial clock
- Various error detection functions (parity errors, framing errors, and overrun errors)

#### ■ CSIO

- Full duplex double buffer
- Built-in dedicated baud rate generator
- Overrun error detection function
- Serial chip select function (ch.1 and ch.3 only)
- Data length: 5 to 16 bits

#### ■ LIN

- LIN protocol Rev.2.1 supported
- Full duplex double buffer
- Master/Slave mode supported
- LIN break field generation function (The length is variable between 13 bits and 16 bits.)
- LIN break delimiter generation function (The length is variable between 1 bit and 4 bits.)
- Various error detection functions available (parity errors, framing errors, and overrun errors)

#### ■ I²C

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

### A/D Converter (Max: 8 channels)

- 12-bit A/D Converter
  - Successive approximation type
  - Conversion time: 0.8  $\mu$ s @ 5 V (S6E1A1xC0A) / 2.0  $\mu$ s (S6E1A1xB0A)
  - Priority conversion available (2 levels of priority)
  - Scan conversion mode
  - Built-in FIFO for conversion data storage (for scan conversion: 16 steps, for priority conversion: 4 steps)

### Base Timer (Max: 4 channels)

The operation mode of each channel can be selected from one of the following.

- 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 pin as a general-purpose I/O port when it is not used for an external bus or a peripheral function. All ports can be set to fast general-purpose I/O ports or slow general-purpose I/O ports. In addition, this series has a port relocate function that can set to which I/O port a peripheral function can be allocated.

- All ports are Fast GPIO which can be accessed by 1cycle
- Capable of controlling the pull-up of each pin
- Capable of reading pin level directly
- Port relocate function
- Up to 37 fast general-purpose I/O ports @48pin package
- Certain ports are 5 V tolerant.

See "3. Pin Assignment" and "5. I/O Circuit Type" for details of such pins.

### Dual Timer (32/16-bit Down Counter)

The Dual Timer consists of two programmable 32/16-bit down counters. The operation mode of each timer channel can be selected from one of the following.

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

### Quadrature Position/Revolution Counter (QPRC)

The Quadrature Position/Revolution Counter (QPRC) is used to measure the position of the position encoder. In addition, it can be used as an up/down counter.

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

### Multi-function Timer

The Multi-function Timer consists of the following blocks.

- 16-bit free-run timer  $\times$  3 channels
- Input capture  $\times$  4 channels
- Output compare  $\times$  6 channels
- ADC start compare  $\times$  6 channel
- Waveform generator  $\times$  3 channels
- 16-bit PPG timer  $\times$  3 channels

IGBT mode is contained.

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
- ADC start function
- DTIF (motor emergency stop) interrupt function

### Real-time Clock (RTC)

The Real-time Clock counts year/month/day/hour/minute/second/day of the week from year 00 to year 99.

- The RTC can generate an interrupt at a specific time (year/month/day/hour/minute) and can also generate an interrupt in a specific year, in a specific month, on a specific day, at a specific hour or at a specific minute.
- It has a timer interrupt function generating an interrupt upon a specific time or at specific intervals.
- It can keep counting while rewriting the time.
- It can count leap years automatically.

### Watch Counter

The Watch Counter wakes up the microcontroller from the low power consumption mode. The clock source can be selected from the main clock, the sub clock, the built-in high-speed CR clock or the built-in low-speed CR clock.

Interval timer: up to 64 s (sub clock: 32.768 kHz)

### External Interrupt Controller Unit

- Up to 8 external interrupt input pins
- Non-maskable interrupt (NMI) input pin: 1

### Watchdog Timer (2 channels)

The watchdog timer generates an interrupt or a reset when the counter reaches a time-out value.

This series consists of two different watchdogs, "hardware" watchdog and "software" watchdog.

The "hardware" watchdog timer is clocked by the built-in low-speed CR oscillator. Therefore, the "hardware" watchdog is active in any low-power consumption modes except RTC mode and STOP mode.

### Clock and Reset

#### ■ Clocks

A clock can be selected from five clock sources (two external oscillators, two built-in CR oscillator, and main PLL).

- |                                                       |                  |
|-------------------------------------------------------|------------------|
| <input type="checkbox"/> Main clock                   | : 4 MHz to 40MHz |
| <input type="checkbox"/> Sub clock                    | : 32.768 kHz     |
| <input type="checkbox"/> Built-in high-speed CR clock | : 4 MHz          |
| <input type="checkbox"/> Built-in low-speed CR clock  | : 100 kHz        |
| <input type="checkbox"/> Main PLL clock               |                  |

#### ■ Resets

- ☐ Reset request from the INITX pin
- ☐ Power on reset
- ☐ Software reset
- ☐ Watchdog timer reset
- ☐ Low-voltage detection reset
- ☐ Clock supervisor reset

### Clock Supervisor (CSV)

The Clock Supervisor monitors the failure of external clocks with a clock generated by a built-in CR oscillator.

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

### Low-voltage Detector (LVD)

This series monitors the voltage on the VCC pin with a 2-stage mechanism. When the voltage falls below a designated voltage, the Low-voltage Detector generates an interrupt or a reset.

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

### Low Power Consumption Mode

This series has four low power consumption modes.

- SLEEP
- TIMER
- RTC
- STOP

### Peripheral Clock Gating

The system can reduce the current consumption of the total system with gating the operation clocks of peripheral functions not used.

### Debug

- Serial Wire Debug Port (SW-DP)
- Micro Trace Buffer (MTB)

### Unique ID

A 41-bit unique value of the device has been set.

### Power Supply

Wide voltage range: VCC = 2.7 V to 5.5 V

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## 1. Product Lineup

### Memory Size

| Product name         | S6E1A11B0A<br>S6E1A11C0A | S6E1A12B0A<br>S6E1A12C0A |
|----------------------|--------------------------|--------------------------|
| On-chip Flash memory | 56 Kbyte                 | 88 Kbyte                 |
| On-chip SRAM         | 6 Kbyte                  | 6 Kbyte                  |

### Function

| Product name                                                 |                    |       | S6E1A11B0A<br>S6E1A12B0A            | S6E1A11C0A<br>S6E1A12C0A |
|--------------------------------------------------------------|--------------------|-------|-------------------------------------|--------------------------|
| Pin count                                                    |                    |       | 32                                  | 48/52                    |
| CPU                                                          |                    |       | Cortex-M0+                          |                          |
| Frequency                                                    |                    |       | 40 MHz                              |                          |
| Power supply voltage range                                   |                    |       | 2.7 V to 5.5 V                      |                          |
| Multi-function Serial Interface (UART/CSIO/I <sup>2</sup> C) |                    |       | 3 ch. (Max)<br>ch.0/ch.1/ch.3: FIFO |                          |
| Base Timer (PWC/Reload timer/PWM/PPG)                        |                    |       | 4 ch. (Max)                         |                          |
| Multi-function Timer                                         | A/D start compare  | 6 ch. | 1 unit                              |                          |
|                                                              | Input capture      | 4 ch. |                                     |                          |
|                                                              | Free-run timer     | 3 ch. |                                     |                          |
|                                                              | Output compare     | 6 ch. |                                     |                          |
|                                                              | Waveform generator | 3 ch. |                                     |                          |
|                                                              | PPG                | 3 ch. |                                     |                          |
| QPRC                                                         |                    |       | 1 ch.                               |                          |
| Dual Timer                                                   |                    |       | 1 unit                              |                          |
| Real-time Clock                                              |                    |       | 1 unit                              |                          |
| Watch Counter                                                |                    |       | 1 unit                              |                          |
| Watchdog timer                                               |                    |       | 1 ch. (SW) + 1 ch. (HW)             |                          |
| External Interrupt                                           |                    |       | 8 pins (Max) + NMI × 1              |                          |
| I/O port                                                     |                    |       | 23 pins (Max)                       | 37 pins (Max)            |
| 12-bit A/D converter                                         |                    |       | 5 ch. (1 unit)                      | 8 ch. (1 unit)           |
| CSV (Clock Supervisor)                                       |                    |       | Yes                                 |                          |
| LVD (Low-voltage Detection)                                  |                    |       | 2 ch.                               |                          |
| Built-in CR                                                  | High-speed         |       | 4 MHz                               |                          |
|                                                              | Low-speed          |       | 100 kHz                             |                          |
| Debug Function                                               |                    |       | SW-DP                               |                          |
| Unique ID                                                    |                    |       | Yes                                 |                          |

### Note:

- All signals of the peripheral function in each product cannot be allocated by limiting the pins of package. It is necessary to use the port relocate function of the I/O port according to your function use.  
See "14. ELECTRICAL CHARACTERISTICS 14.4 AC Characteristics 14.4.3 Built-in CR Oscillation Characteristics" for accuracy of built-in CR.

## 2. Packages

| Product name<br>Package      | S6E1A11B0A<br>S6E1A12B0A | S6E1A11C0A<br>S6E1A12C0A |
|------------------------------|--------------------------|--------------------------|
| LQFP: LQB032 (0.80 mm pitch) | ○                        | -                        |
| QFN: WNU032 (0.50 mm pitch)  | ○                        | -                        |
| LQFP: LQA048 (0.50 mm pitch) | -                        | ○                        |
| QFN: WNY048 (0.50 mm pitch)  | -                        | ○                        |
| LQFP: LQC052 (0.65 mm pitch) | -                        | ○                        |

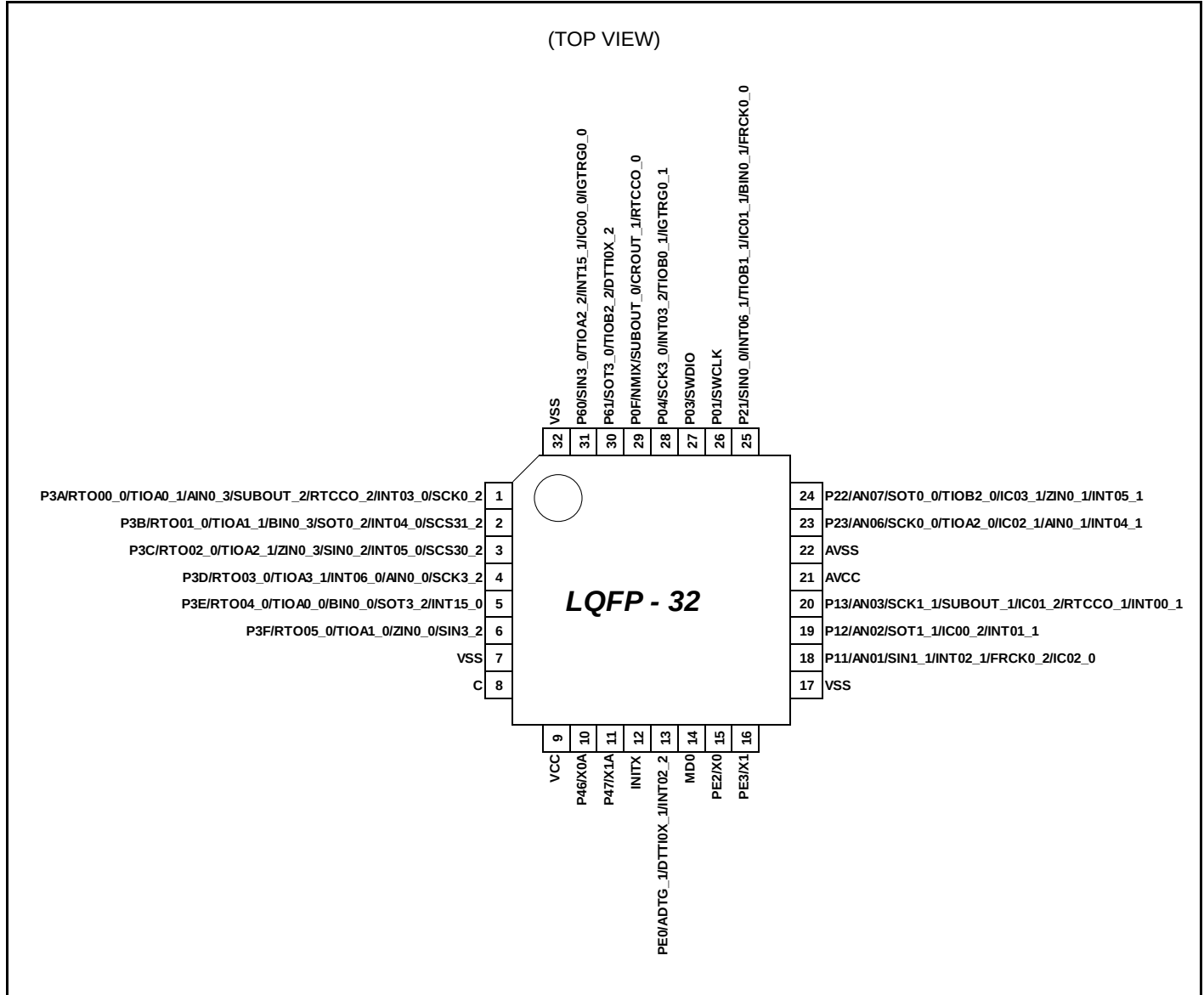
○: Supported

### Note:

- See "14. Package Dimensions" for detailed information on each package.

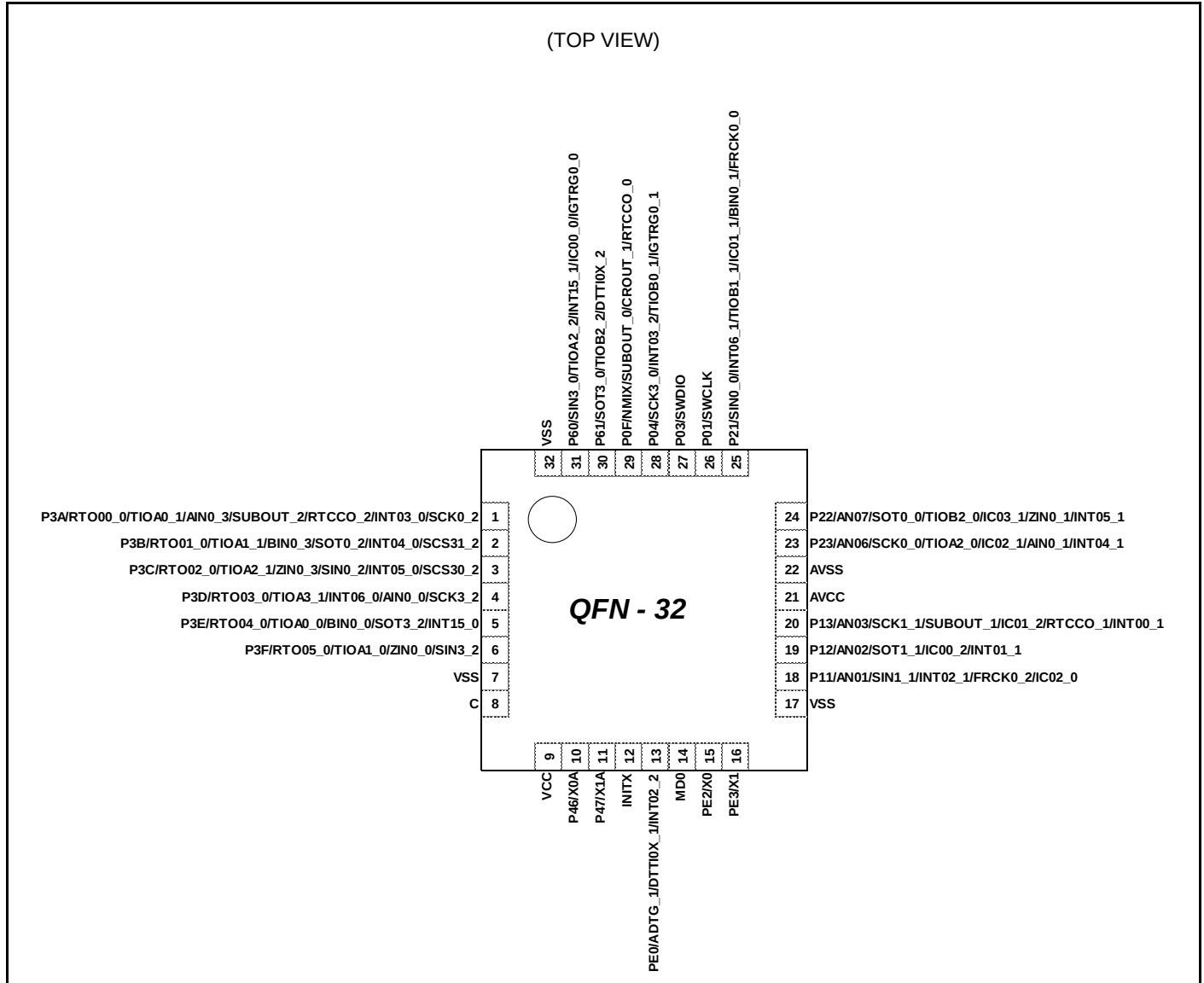
### 3. Pin Assignment

#### LQB032



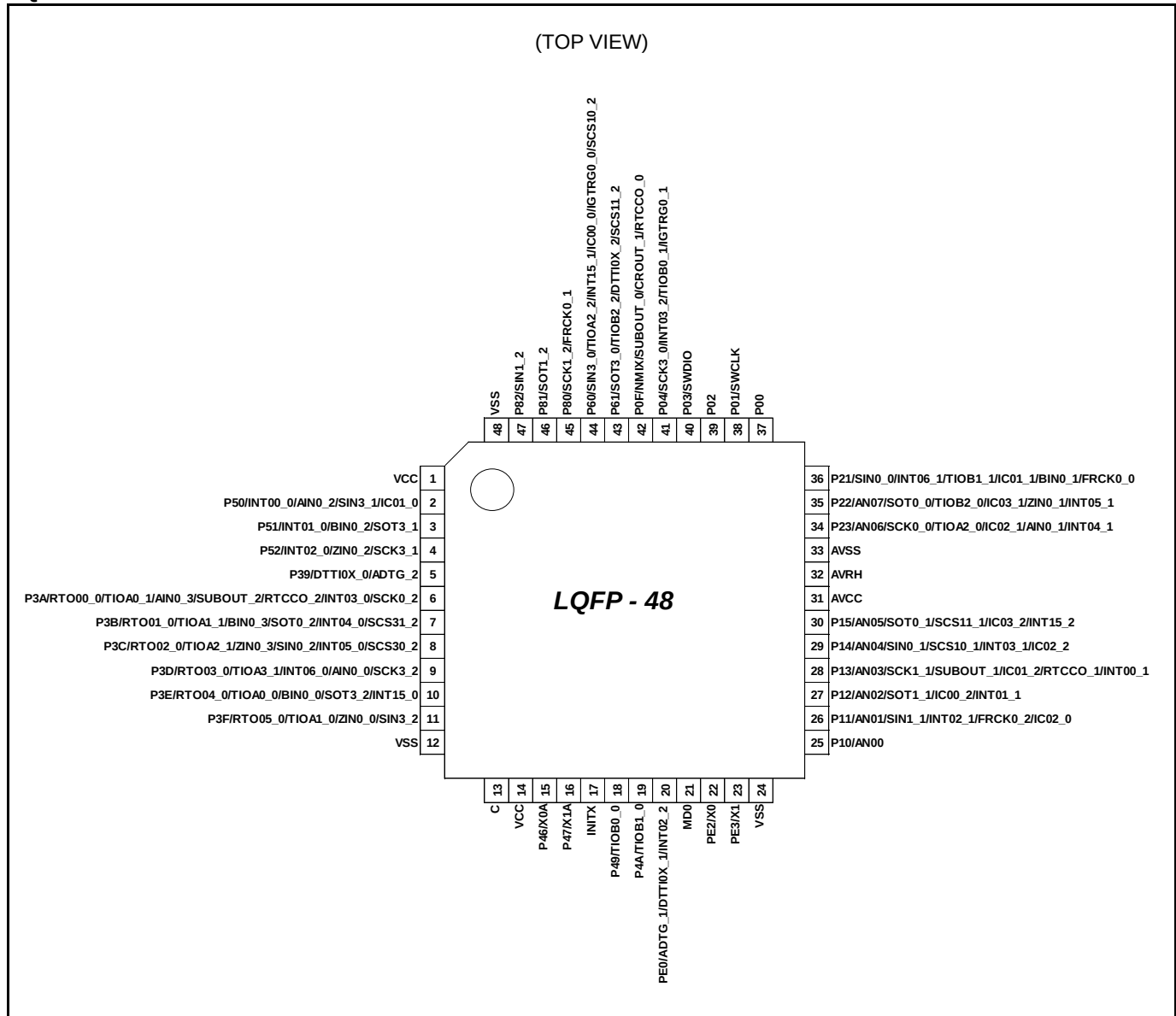
#### Note:

- 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.

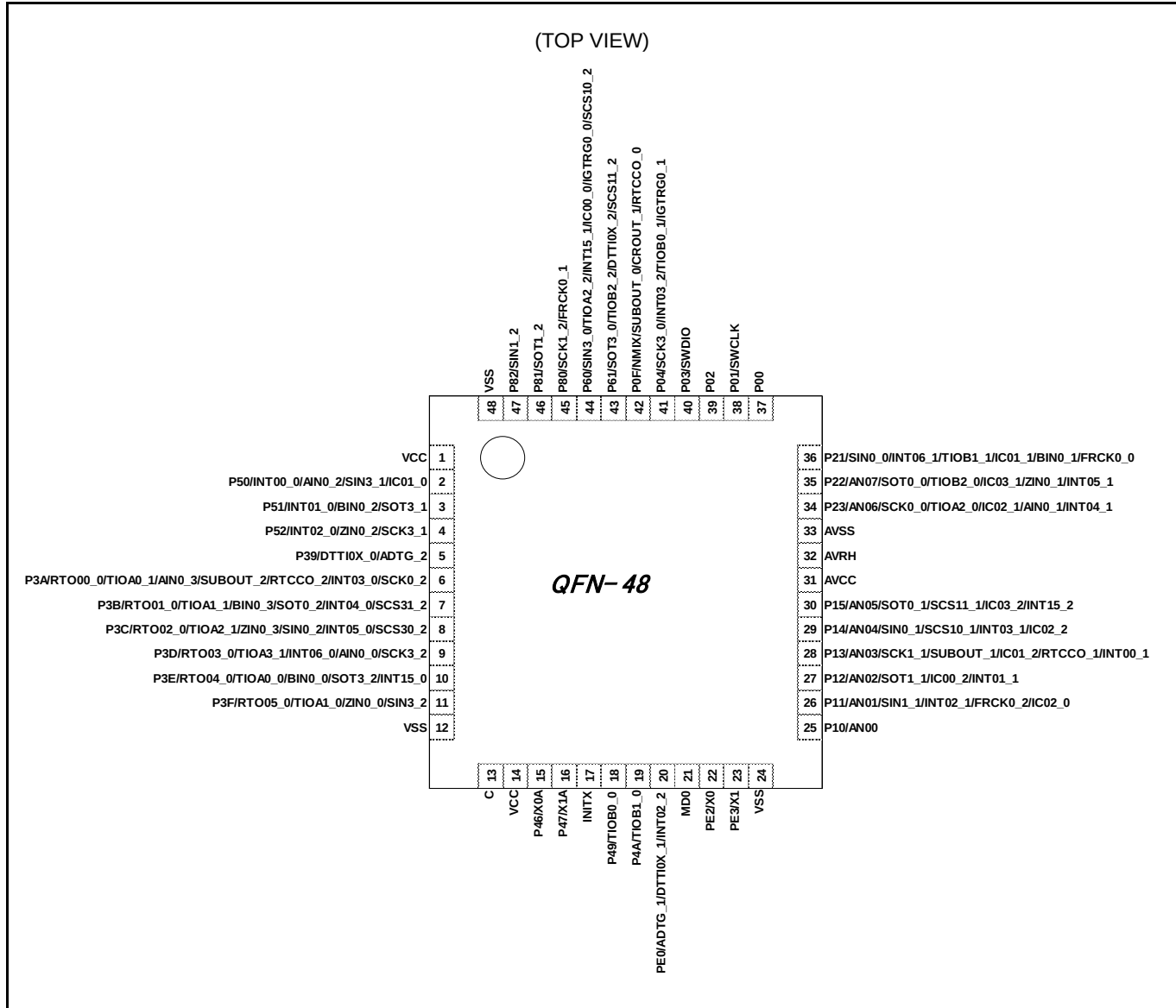
**WNU032**

**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.

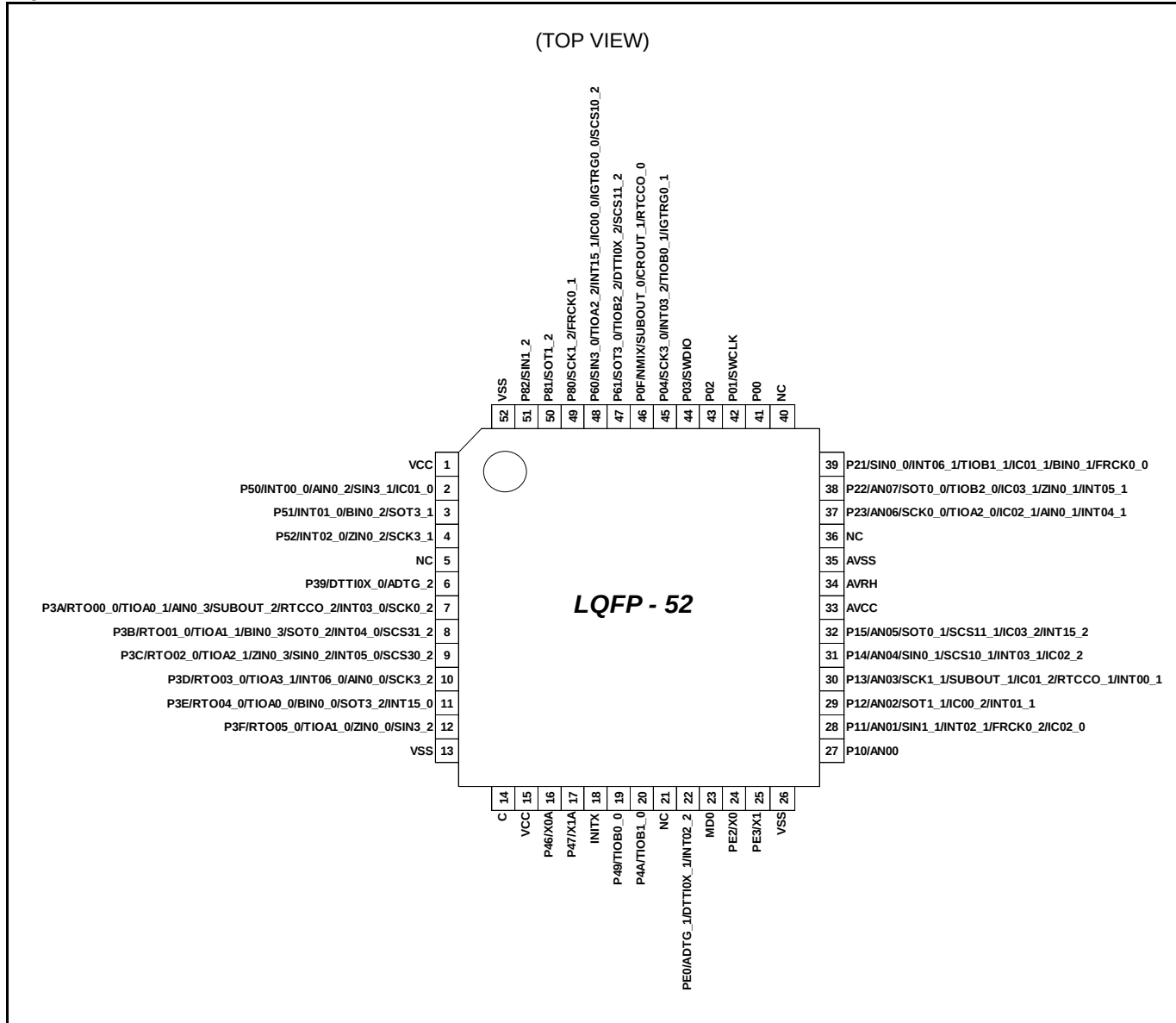
(TOP VIEW)



- 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.

**WNY048**

**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.

**LQC052**

**Note:**

- The number after the underscore ("\_") in a pin name such as XXX\_1 and XXX\_2 indicates the relocated port number. The channel on such pin has multiple functions, each of which has its own pin name. Use the Extended Port Function Register (EPFR) to select the pin to be used.

## 4. Pin Descriptions

### 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, there are multiple pins that provide the same function for the same channel.

Use the extended port function register (EPFR) to select the pin.

| Pin no. |                   |                   | Pin name | I/O circuit type | Pin state type |
|---------|-------------------|-------------------|----------|------------------|----------------|
| LQFP-52 | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |          |                  |                |
| 1       | 1                 | -                 | VCC      | -                |                |
| 2       | 2                 | -                 | P50      | I*               | J              |
|         |                   |                   | INT00_0  |                  |                |
|         |                   |                   | AIN0_2   |                  |                |
|         |                   |                   | SIN3_1   |                  |                |
|         |                   |                   | IC01_0   |                  |                |
| 3       | 3                 | -                 | P51      | I*               | J              |
|         |                   |                   | INT01_0  |                  |                |
|         |                   |                   | BIN0_2   |                  |                |
|         |                   |                   | SOT3_1   |                  |                |
| 4       | 4                 | -                 | P52      | I*               | J              |
|         |                   |                   | INT02_0  |                  |                |
|         |                   |                   | ZIN0_2   |                  |                |
|         |                   |                   | SCK3_1   |                  |                |
| 6       | 5                 | -                 | P39      | E                | I              |
|         |                   |                   | DTTIOX_0 |                  |                |
|         |                   |                   | ADTG_2   |                  |                |
| 7       | 6                 | 1                 | P3A      | F                | J              |
|         |                   |                   | RTO00_0  |                  |                |
|         |                   |                   | TIOA0_1  |                  |                |
|         |                   |                   | AIN0_3   |                  |                |
|         |                   |                   | SUBOUT_2 |                  |                |
|         |                   |                   | RTCCO_2  |                  |                |
|         |                   |                   | INT03_0  |                  |                |
|         |                   |                   | SCK0_2   |                  |                |
| 8       | 7                 | 2                 | P3B      | F                | J              |
|         |                   |                   | RTO01_0  |                  |                |
|         |                   |                   | TIOA1_1  |                  |                |
|         |                   |                   | BIN0_3   |                  |                |
|         |                   |                   | SOT0_2   |                  |                |
|         |                   |                   | INT04_0  |                  |                |
|         |                   |                   | SCS31_2  |                  |                |

| Pin no. |                   |                   | Pin name | I/O circuit type | Pin state type |
|---------|-------------------|-------------------|----------|------------------|----------------|
| LQFP-52 | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |          |                  |                |
| 9       | 8                 | 3                 | P3C      | F                | J              |
|         |                   |                   | RTO02_0  |                  |                |
|         |                   |                   | TIOA2_1  |                  |                |
|         |                   |                   | ZIN0_3   |                  |                |
|         |                   |                   | SIN0_2   |                  |                |
|         |                   |                   | INT05_0  |                  |                |
|         |                   |                   | SCS30_2  |                  |                |
| 10      | 9                 | 4                 | P3D      | F                | J              |
|         |                   |                   | RTO03_0  |                  |                |
|         |                   |                   | TIOA3_1  |                  |                |
|         |                   |                   | INT06_0  |                  |                |
|         |                   |                   | AIN0_0   |                  |                |
|         |                   |                   | SCK3_2   |                  |                |
| 11      | 10                | 5                 | P3E      | F                | J              |
|         |                   |                   | RTO04_0  |                  |                |
|         |                   |                   | TIOA0_0  |                  |                |
|         |                   |                   | BIN0_0   |                  |                |
|         |                   |                   | SOT3_2   |                  |                |
|         |                   |                   | INT15_0  |                  |                |
| 12      | 11                | 6                 | P3F      | F                | I              |
|         |                   |                   | RTO05_0  |                  |                |
|         |                   |                   | TIOA1_0  |                  |                |
|         |                   |                   | ZIN0_0   |                  |                |
|         |                   |                   | SIN3_2   |                  |                |
| 13      | 12                | 7                 | VSS      |                  |                |
| 14      | 13                | 8                 | C        |                  |                |
| 15      | 14                | 9                 | VCC      |                  |                |
| 16      | 15                | 10                | P46      | D                | E              |
|         |                   |                   | X0A      |                  |                |
| 17      | 16                | 11                | P47      | D                | F              |
|         |                   |                   | X1A      |                  |                |
| 18      | 17                | 12                | INITX    | B                | C              |
| 19      | 18                | -                 | P49      | E                | I              |
|         |                   |                   | TIOB0_0  |                  |                |
| 20      | 19                | -                 | P4A      | E                | I              |
|         |                   |                   | TIOB1_0  |                  |                |

| Pin no. |                   |                   | Pin name | I/O circuit type | Pin state type |
|---------|-------------------|-------------------|----------|------------------|----------------|
| LQFP-52 | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |          |                  |                |
| 22      | 20                | 13                | PE0      | C                | J              |
|         |                   |                   | ADTG_1   |                  |                |
|         |                   |                   | DTTI0X_1 |                  |                |
|         |                   |                   | INT02_2  |                  |                |
| 23      | 21                | 14                | MD0      | J                | D              |
| 24      | 22                | 15                | PE2      | A                | A              |
|         |                   |                   | X0       |                  |                |
| 25      | 23                | 16                | PE3      | A                | B              |
|         |                   |                   | X1       |                  |                |
| 26      | 24                | 17                | VSS      | -                |                |
| 27      | 25                | -                 | P10      | G                | K              |
|         |                   |                   | AN00     |                  |                |
| 28      | 26                | 18                | P11      | H*               | L              |
|         |                   |                   | AN01     |                  |                |
|         |                   |                   | SIN1_1   |                  |                |
|         |                   |                   | INT02_1  |                  |                |
|         |                   |                   | FRCK0_2  |                  |                |
|         |                   |                   | IC02_0   |                  |                |
| 29      | 27                | 19                | P12      | H*               | L              |
|         |                   |                   | AN02     |                  |                |
|         |                   |                   | SOT1_1   |                  |                |
|         |                   |                   | IC00_2   |                  |                |
|         |                   |                   | INT01_1  |                  |                |
| 30      | 28                | 20                | P13      | H*               | L              |
|         |                   |                   | AN03     |                  |                |
|         |                   |                   | SCK1_1   |                  |                |
|         |                   |                   | SUBOUT_1 |                  |                |
|         |                   |                   | IC01_2   |                  |                |
|         |                   |                   | RTCCO_1  |                  |                |
|         |                   |                   | INT00_1  |                  |                |
| 31      | 29                | -                 | P14      | H*               | L              |
|         |                   |                   | AN04     |                  |                |
|         |                   |                   | SIN0_1   |                  |                |
|         |                   |                   | SCS10_1  |                  |                |
|         |                   |                   | INT03_1  |                  |                |
|         |                   |                   | IC02_2   |                  |                |

| Pin no. |                   |                   | Pin name | I/O circuit type | Pin state type |
|---------|-------------------|-------------------|----------|------------------|----------------|
| LQFP-52 | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |          |                  |                |
| 32      | 30                | -                 | P15      | H*               | L              |
|         |                   |                   | AN05     |                  |                |
|         |                   |                   | SOT0_1   |                  |                |
|         |                   |                   | SCS11_1  |                  |                |
|         |                   |                   | IC03_2   |                  |                |
|         |                   |                   | INT15_2  |                  |                |
| 33      | 31                | 21                | AVCC     | -                |                |
| 34      | 32                | -                 | AVRH     | -                |                |
| 35      | 33                | 22                | AVSS     | -                |                |
| 37      | 34                | 23                | P23      | G                | L              |
|         |                   |                   | AN06     |                  |                |
|         |                   |                   | SCK0_0   |                  |                |
|         |                   |                   | TIOA2_0  |                  |                |
|         |                   |                   | IC02_1   |                  |                |
|         |                   |                   | AIN0_1   |                  |                |
|         |                   |                   | INT04_1  |                  |                |
| 38      | 35                | 24                | P22      | G                | L              |
|         |                   |                   | AN07     |                  |                |
|         |                   |                   | SOT0_0   |                  |                |
|         |                   |                   | TIOB2_0  |                  |                |
|         |                   |                   | IC03_1   |                  |                |
|         |                   |                   | ZIN0_1   |                  |                |
|         |                   |                   | INT05_1  |                  |                |
| 39      | 36                | 25                | P21      | E                | J              |
|         |                   |                   | SIN0_0   |                  |                |
|         |                   |                   | INT06_1  |                  |                |
|         |                   |                   | TIOB1_1  |                  |                |
|         |                   |                   | IC01_1   |                  |                |
|         |                   |                   | BIN0_1   |                  |                |
|         |                   |                   | FRCK0_0  |                  |                |
| 41      | 37                | -                 | P00      | E                | I              |
| 42      | 38                | 26                | P01      | E                | H              |
|         |                   |                   | SWCLK    |                  |                |
| 43      | 39                | -                 | P02      | E                | I              |
| 44      | 40                | 27                | P03      | E                | H              |
|         |                   |                   | SWDIO    |                  |                |

| Pin no.    |                   |                   | Pin name | I/O circuit type | Pin state type |
|------------|-------------------|-------------------|----------|------------------|----------------|
| LQFP-52    | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |          |                  |                |
| 45         | 41                | 28                | P04      | I*               | J              |
|            |                   |                   | SCK3_0   |                  |                |
|            |                   |                   | INT03_2  |                  |                |
|            |                   |                   | TIOB0_1  |                  |                |
|            |                   |                   | IGTRG0_1 |                  |                |
| 46         | 42                | 29                | P0F      | E                | G              |
|            |                   |                   | NMIX     |                  |                |
|            |                   |                   | SUBOUT_0 |                  |                |
|            |                   |                   | CROUT_1  |                  |                |
|            |                   |                   | RTCCO_0  |                  |                |
| 47         | 43                | 30                | P61      | I*               | I              |
|            |                   |                   | SOT3_0   |                  |                |
|            |                   |                   | TIOB2_2  |                  |                |
|            |                   |                   | DTTIOX_2 |                  |                |
|            |                   | -                 | SCS11_2  |                  |                |
| 48         | 44                | 31                | P60      | I*               | J              |
|            |                   |                   | SIN3_0   |                  |                |
|            |                   |                   | TIOA2_2  |                  |                |
|            |                   |                   | INT15_1  |                  |                |
|            |                   |                   | IC00_0   |                  |                |
|            |                   |                   | IGTRG0_0 |                  |                |
|            |                   | -                 | SCS10_2  |                  |                |
| 49         | 45                | -                 | P80      | K                | I              |
|            |                   |                   | SCK1_2   |                  |                |
|            |                   |                   | FRCK0_1  |                  |                |
| 50         | 46                | -                 | P81      | K                | I              |
|            |                   |                   | SOT1_2   |                  |                |
| 51         | 47                | -                 | P82      | K                | I              |
|            |                   |                   | SIN1_2   |                  |                |
| 52         | 48                | 32                | VSS      | -                |                |
| 5,21,36,40 | -                 | -                 | NC       | -                |                |

\*:5V tolerant I/O

**List of pin functions**

The number after the underscore ("\_") in a pin name such as XXX\_1 and XXX\_2 indicates the relocated port number. The channel on such pin has multiple functions, each of which has its own pin name. Use the Extended Port Function Register (EPFR) to select the pin to be used.

| Pin function | Pin name | Function description                                         | Pin no. |                   |                   |
|--------------|----------|--------------------------------------------------------------|---------|-------------------|-------------------|
|              |          |                                                              | LQFP-52 | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |
| ADC          | ADTG_1   | A/D converter external trigger input pin                     | 22      | 20                | 13                |
|              | ADTG_2   |                                                              | 6       | 5                 | -                 |
|              | AN00     | A/D converter analog input pin.<br>ANxx describes ADC ch.xx. | 27      | 25                | -                 |
|              | AN01     |                                                              | 28      | 26                | 18                |
|              | AN02     |                                                              | 29      | 27                | 19                |
|              | AN03     |                                                              | 30      | 28                | 20                |
|              | AN04     |                                                              | 31      | 29                | -                 |
|              | AN05     |                                                              | 32      | 30                | -                 |
|              | AN06     |                                                              | 37      | 34                | 23                |
|              | AN07     |                                                              | 38      | 35                | 24                |
| Base Timer 0 | TIOA0_0  | Base timer ch.0 TIOA pin                                     | 11      | 10                | 5                 |
|              | TIOA0_1  |                                                              | 7       | 6                 | 1                 |
|              | TIOB0_0  | Base timer ch.0 TIOB pin                                     | 19      | 18                | -                 |
|              | TIOB0_1  |                                                              | 45      | 41                | 28                |
| Base Timer 1 | TIOA1_0  | Base timer ch.1 TIOA pin                                     | 12      | 11                | 6                 |
|              | TIOA1_1  |                                                              | 8       | 7                 | 2                 |
|              | TIOB1_0  | Base timer ch.1 TIOB pin                                     | 20      | 19                | -                 |
|              | TIOB1_1  |                                                              | 39      | 36                | 25                |
| Base Timer 2 | TIOA2_0  | Base timer ch.2 TIOA pin                                     | 37      | 34                | 23                |
|              | TIOA2_1  |                                                              | 9       | 8                 | 3                 |
|              | TIOA2_2  |                                                              | 48      | 44                | 31                |
|              | TIOB2_0  | Base timer ch.2 TIOB pin                                     | 38      | 35                | 24                |
|              | TIOB2_2  |                                                              | 47      | 43                | 30                |
| Base Timer 3 | TIOA3_1  | Base timer ch.3 TIOA pin                                     | 10      | 9                 | 4                 |
| Debugger     | SWCLK    | Serial wire debug interface clock input pin                  | 42      | 38                | 26                |
|              | SWDIO    | Serial wire debug interface data input / output pin          | 44      | 40                | 27                |

| Pin function       | Pin name | Function description                    | Pin no. |                   |                   |
|--------------------|----------|-----------------------------------------|---------|-------------------|-------------------|
|                    |          |                                         | LQFP-52 | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |
| External Interrupt | INT00_0  | External interrupt request 00 input pin | 2       | 2                 | -                 |
|                    | INT00_1  |                                         | 30      | 28                | 20                |
|                    | INT01_0  | External interrupt request 01 input pin | 3       | 3                 | -                 |
|                    | INT01_1  |                                         | 29      | 27                | 19                |
|                    | INT02_0  | External interrupt request 02 input pin | 4       | 4                 | -                 |
|                    | INT02_1  |                                         | 28      | 26                | 18                |
|                    | INT02_2  |                                         | 22      | 20                | 13                |
|                    | INT03_0  | External interrupt request 03 input pin | 7       | 6                 | 1                 |
|                    | INT03_1  |                                         | 31      | 29                | -                 |
|                    | INT03_2  |                                         | 45      | 41                | 28                |
|                    | INT04_0  | External interrupt request 04 input pin | 8       | 7                 | 2                 |
|                    | INT04_1  |                                         | 37      | 34                | 23                |
|                    | INT05_0  | External interrupt request 05 input pin | 9       | 8                 | 3                 |
|                    | INT05_1  |                                         | 38      | 35                | 24                |
|                    | INT06_0  | External interrupt request 06 input pin | 10      | 9                 | 4                 |
|                    | INT06_1  |                                         | 39      | 36                | 25                |
|                    | INT15_0  | External interrupt request 15 input pin | 11      | 10                | 5                 |
|                    | INT15_1  |                                         | 48      | 44                | 31                |
|                    | INT15_2  |                                         | 32      | 30                | -                 |
|                    | NMIX     | Non-Maskable Interrupt input pin        | 46      | 42                | 29                |

| Pin function | Pin name | Function description       | Pin no. |                   |                   |
|--------------|----------|----------------------------|---------|-------------------|-------------------|
|              |          |                            | LQFP-52 | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |
| GPIO         | P00      | General-purpose I/O port 0 | 41      | 37                | -                 |
|              | P01      |                            | 42      | 38                | 26                |
|              | P02      |                            | 43      | 39                | -                 |
|              | P03      |                            | 44      | 40                | 27                |
|              | P04      |                            | 45      | 41                | 28                |
|              | P0F      |                            | 46      | 42                | 29                |
|              | P10      | General-purpose I/O port 1 | 27      | 25                | -                 |
|              | P11      |                            | 28      | 26                | 18                |
|              | P12      |                            | 29      | 27                | 19                |
|              | P13      |                            | 30      | 28                | 20                |
|              | P14      |                            | 31      | 29                | -                 |
|              | P15      |                            | 32      | 30                | -                 |
|              | P21      | General-purpose I/O port 2 | 39      | 36                | 25                |
|              | P22      |                            | 38      | 35                | 24                |
|              | P23      |                            | 37      | 34                | 23                |
|              | P39      | General-purpose I/O port 3 | 6       | 5                 | -                 |
|              | P3A      |                            | 7       | 6                 | 1                 |
|              | P3B      |                            | 8       | 7                 | 2                 |
|              | P3C      |                            | 9       | 8                 | 3                 |
|              | P3D      |                            | 10      | 9                 | 4                 |
|              | P3E      |                            | 11      | 10                | 5                 |
|              | P3F      |                            | 12      | 11                | 6                 |
| GPIO         | P46      | General-purpose I/O port 4 | 16      | 15                | 10                |
|              | P47      |                            | 17      | 16                | 11                |
|              | P49      |                            | 19      | 18                | -                 |
|              | P4A      |                            | 20      | 19                | -                 |
|              | P50      | General-purpose I/O port 5 | 2       | 2                 | -                 |
|              | P51      |                            | 3       | 3                 | -                 |
|              | P52      |                            | 4       | 4                 | -                 |
|              | P60      | General-purpose I/O port 6 | 48      | 44                | 31                |
|              | P61      |                            | 47      | 43                | 30                |
|              | P80      | General-purpose I/O port 8 | 49      | 45                | -                 |
|              | P81      |                            | 50      | 46                | -                 |
|              | P82      |                            | 51      | 47                | -                 |
|              | PE0*     | General-purpose I/O port E | 22      | 20                | 13                |
|              | PE2      |                            | 24      | 22                | 15                |
|              | PE3      |                            | 25      | 23                | 16                |

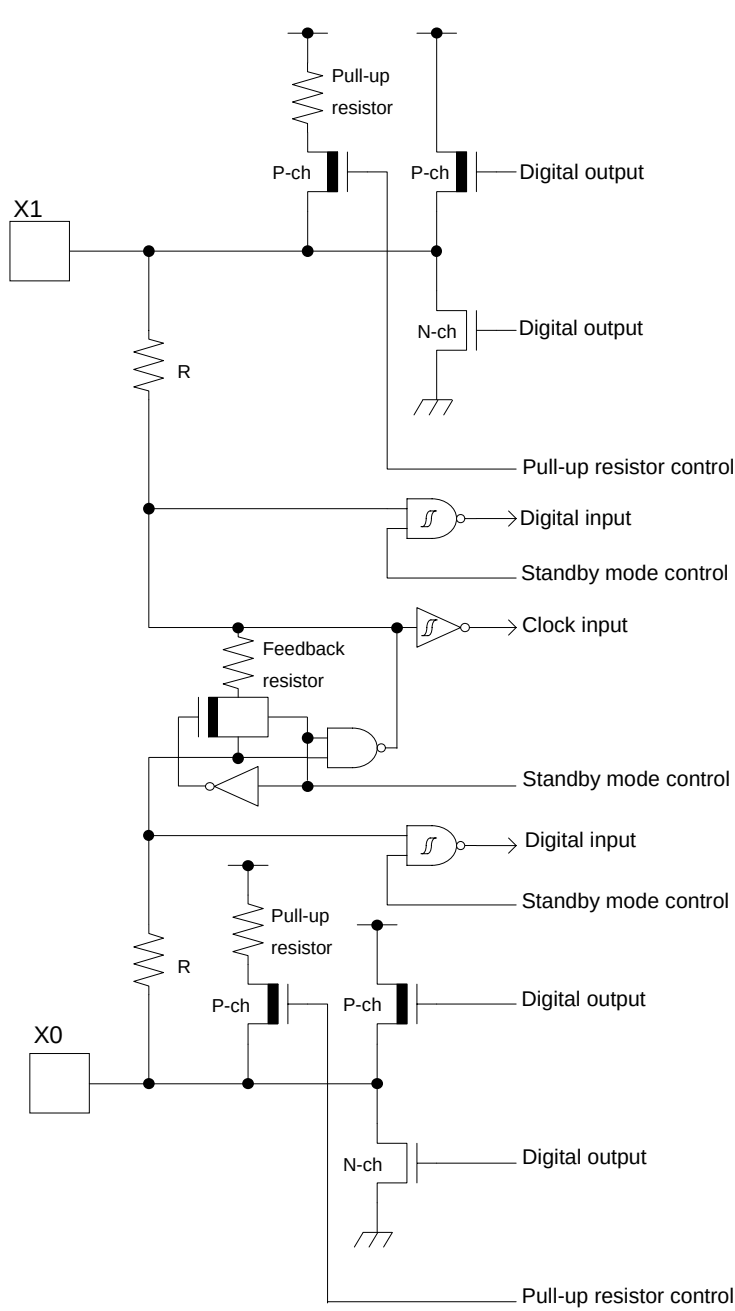
| Pin function            | Pin name        | Function description                                                                                                                                    | Pin no. |                   |                   |
|-------------------------|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-------------------|-------------------|
|                         |                 |                                                                                                                                                         | LQFP-52 | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |
| Multi-function Serial 0 | SIN0_0          | Multi-function serial interface ch.0 input pin                                                                                                          | 39      | 36                | 25                |
|                         | SIN0_1          |                                                                                                                                                         | 31      | 29                | -                 |
|                         | SIN0_2          |                                                                                                                                                         | 9       | 8                 | 3                 |
|                         | SOT0_0 (SDA0_0) | Multi-function serial interface ch.0 output pin.                                                                                                        | 38      | 35                | 24                |
|                         | SOT0_1 (SDA0_1) | This pin operates as SOT0 when used as a UART/CSIO/LIN pin (operation mode 0 to 3) and as SDA0 when used as an I <sup>2</sup> C pin (operation mode 4). | 32      | 30                | -                 |
|                         | SOT0_2 (SDA0_2) |                                                                                                                                                         | 8       | 7                 | 2                 |
|                         | SCK0_0 (SCL0_0) | Multi-function serial interface ch.0 clock I/O pin.                                                                                                     | 37      | 34                | 23                |
|                         | SCK0_2 (SCL0_2) | This pin operates as SCK0 when used as a CSIO pin (operation mode 2) and as SCL0 when used as an I <sup>2</sup> C pin (operation mode 4).               | 7       | 6                 | 1                 |
| Multi-function Serial 1 | SIN1_1          | Multi-function serial interface ch.1 input pin                                                                                                          | 28      | 26                | 18                |
|                         | SIN1_2          |                                                                                                                                                         | 51      | 47                | -                 |
|                         | SOT1_1 (SDA1_1) | Multi-function serial interface ch.1 output pin.                                                                                                        | 29      | 27                | 19                |
|                         | SOT1_2 (SDA1_2) | This pin operates as SOT1 when used as a UART/CSIO/LIN pin (operation mode 0 to 3) and as SDA1 when used as an I <sup>2</sup> C pin (operation mode 4). | 50      | 46                | -                 |
|                         | SCK1_1 (SCL1_1) | Multi-function serial interface ch.1 clock I/O pin.                                                                                                     | 30      | 28                | 20                |
|                         | SCK1_2 (SCL1_2) | This pin operates as SCK1 when used as a CSIO pin (operation mode 2) and as SCL1 when used as an I <sup>2</sup> C pin (operation mode 4).               | 49      | 45                | -                 |
|                         | SCS10_1         | Multi-function serial interface ch.1 serial chip select 0 output/input pin.                                                                             | 31      | 29                | -                 |
|                         | SCS10_2         |                                                                                                                                                         | 48      | 44                | -                 |
|                         | SCS11_1         | Multi-function serial interface ch.1 serial chip select 1 output pin.                                                                                   | 32      | 30                | -                 |
|                         | SCS11_2         |                                                                                                                                                         | 47      | 43                | -                 |
| Multi-function Serial 3 | SIN3_0          | Multi-function serial interface ch.3 input pin                                                                                                          | 48      | 44                | 31                |
|                         | SIN3_1          |                                                                                                                                                         | 2       | 2                 | -                 |
|                         | SIN3_2          |                                                                                                                                                         | 12      | 11                | 6                 |
|                         | SOT3_0 (SDA3_0) | Multi-function serial interface ch.3 output pin.                                                                                                        | 47      | 43                | 30                |
|                         | SOT3_1 (SDA3_1) | This pin operates as SOT3 when used as a UART/CSIO/LIN pin (operation mode 0 to 3) and as SDA3 when used as an I <sup>2</sup> C pin (operation mode 4). | 3       | 3                 | -                 |
|                         | SOT3_2 (SDA3_2) |                                                                                                                                                         | 11      | 10                | 5                 |
|                         | SCK3_0 (SCL3_0) | Multi-function serial interface ch.3 clock I/O pin.                                                                                                     | 45      | 41                | 28                |
|                         | SCK3_1 (SCL3_1) | This pin operates as SCK3 when used as a CSIO (operation mode 2) and as SCL3 when used as an I <sup>2</sup> C pin (operation mode 4).                   | 4       | 4                 | -                 |
|                         | SCK3_2 (SCL3_2) |                                                                                                                                                         | 10      | 9                 | 4                 |
|                         | SCS30_2         | Multi-function serial interface ch.3 serial chip select 0 input/output pin.                                                                             | 9       | 8                 | 3                 |
|                         | SCS31_2         | Multi-function serial interface ch.3 serial chip select 1 output pin.                                                                                   | 8       | 7                 | 2                 |

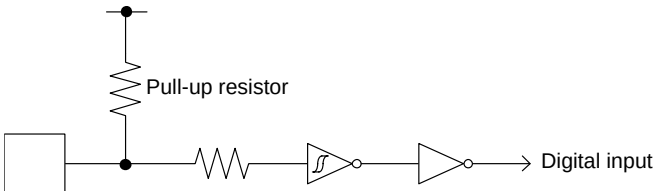
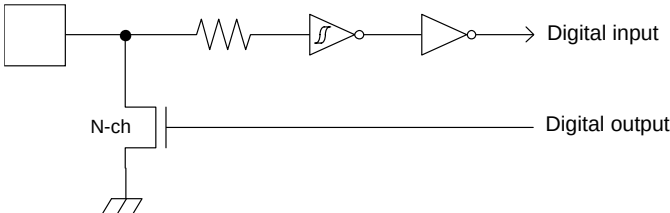
| Pin function              | Pin name             | Function description                                                                                                        | Pin no. |                   |                   |
|---------------------------|----------------------|-----------------------------------------------------------------------------------------------------------------------------|---------|-------------------|-------------------|
|                           |                      |                                                                                                                             | LQFP-52 | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |
| Multi-function<br>Timer 0 | DTTI0X_0             | Input signal of waveform generator controlling RTO00 to RTO05 outputs of Multi-function Timer 0.                            | 6       | 5                 | -                 |
|                           | DTTI0X_1             |                                                                                                                             | 22      | 20                | 13                |
|                           | DTTI0X_2             |                                                                                                                             | 47      | 43                | 30                |
|                           | FRCK0_0              | 16-bit free-run timer ch.0 external clock input pin.                                                                        | 39      | 36                | 25                |
|                           | FRCK0_1              |                                                                                                                             | 49      | 45                | -                 |
|                           | FRCK0_2              |                                                                                                                             | 28      | 26                | 18                |
|                           | IC00_0               | 16-bit input capture input pin of Multi-function timer 0.<br>ICxx describes channel number.                                 | 48      | 44                | 31                |
|                           | IC00_2               |                                                                                                                             | 29      | 27                | 19                |
|                           | IC01_0               |                                                                                                                             | 2       | 2                 | -                 |
|                           | IC01_1               |                                                                                                                             | 39      | 36                | 25                |
|                           | IC01_2               |                                                                                                                             | 30      | 28                | 20                |
|                           | IC02_0               |                                                                                                                             | 28      | 26                | 18                |
|                           | IC02_1               |                                                                                                                             | 37      | 34                | 23                |
|                           | IC02_2               |                                                                                                                             | 31      | 29                | -                 |
|                           | IC03_1               |                                                                                                                             | 38      | 35                | 24                |
|                           | IC03_2               |                                                                                                                             | 32      | 30                | -                 |
|                           | RTO00_0<br>(PPG00_0) | Waveform generator output pin of Multi-function timer 0.<br>This pin operates as PPG00 when it is used in PPG0 output mode. | 7       | 6                 | 1                 |
|                           | RTO01_0<br>(PPG00_0) | Waveform generator output pin of Multi-function timer 0.<br>This pin operates as PPG00 when it is used in PPG0 output mode. | 8       | 7                 | 2                 |
|                           | RTO02_0<br>(PPG02_0) | Waveform generator output pin of Multi-function timer 0.<br>This pin operates as PPG02 when it is used in PPG0 output mode. | 9       | 8                 | 3                 |
|                           | RTO03_0<br>(PPG02_0) | Waveform generator output pin of Multi-function timer 0.<br>This pin operates as PPG02 when it is used in PPG0 output mode. | 10      | 9                 | 4                 |
|                           | RTO04_0<br>(PPG04_0) | Waveform generator output pin of Multi-function timer 0.<br>This pin operates as PPG04 when it is used in PPG0 output mode. | 11      | 10                | 5                 |
|                           | RTO05_0<br>(PPG04_0) | Waveform generator output pin of Multi-function timer 0.<br>This pin operates as PPG04 when it is used in PPG0 output mode. | 12      | 11                | 6                 |
|                           | IGTRG0_0             | PPG IGBT mode external trigger input pin                                                                                    | 48      | 44                | 31                |
|                           | IGTRG0_1             |                                                                                                                             | 45      | 41                | 28                |

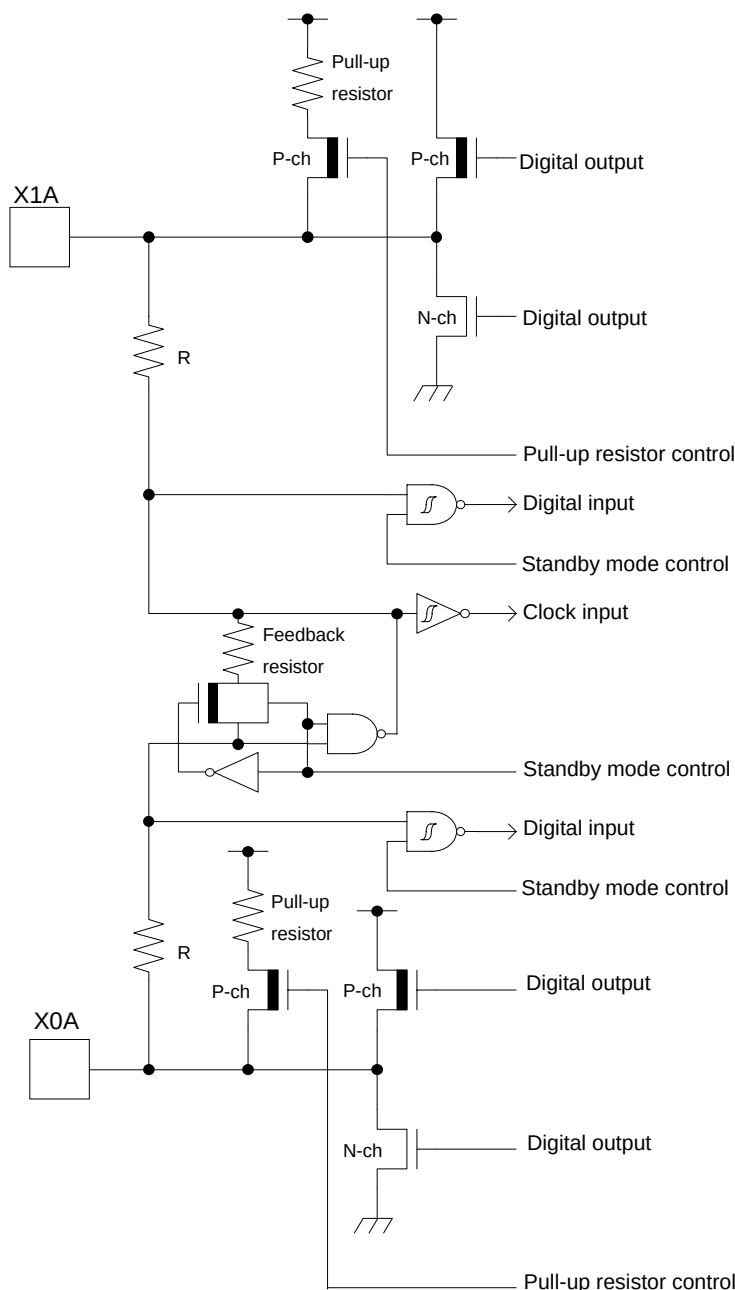
| Pin function                            | Pin name | Function description                                                                                                | Pin no. |                   |                   |
|-----------------------------------------|----------|---------------------------------------------------------------------------------------------------------------------|---------|-------------------|-------------------|
|                                         |          |                                                                                                                     | LQFP-52 | LQFP-48<br>QFN-48 | LQFP-32<br>QFN-32 |
| Quadrature Position/ Revolution Counter | AIN0_0   | QPRC ch.0 AIN input pin                                                                                             | 10      | 9                 | 4                 |
|                                         | AIN0_1   |                                                                                                                     | 37      | 34                | 23                |
|                                         | AIN0_2   |                                                                                                                     | 2       | 2                 | -                 |
|                                         | AIN0_3   |                                                                                                                     | 7       | 6                 | 1                 |
|                                         | BIN0_0   | QPRC ch.0 BIN input pin                                                                                             | 11      | 10                | 5                 |
|                                         | BIN0_1   |                                                                                                                     | 39      | 36                | 25                |
|                                         | BIN0_2   |                                                                                                                     | 3       | 3                 | -                 |
|                                         | BIN0_3   |                                                                                                                     | 8       | 7                 | 2                 |
|                                         | ZIN0_0   | QPRC ch.0 ZIN input pin                                                                                             | 12      | 11                | 6                 |
|                                         | ZIN0_1   |                                                                                                                     | 38      | 35                | 24                |
|                                         | ZIN0_2   |                                                                                                                     | 4       | 4                 | -                 |
|                                         | ZIN0_3   |                                                                                                                     | 9       | 8                 | 3                 |
| Real-time clock                         | RTCCO_0  | 0.5-seconds pulse output pin of Real-time clock                                                                     | 46      | 42                | 29                |
|                                         | RTCCO_1  |                                                                                                                     | 30      | 28                | 20                |
|                                         | RTCCO_2  |                                                                                                                     | 7       | 6                 | 1                 |
|                                         | SUBOUT_0 | Sub clock output pin                                                                                                | 46      | 42                | 29                |
|                                         | SUBOUT_1 |                                                                                                                     | 30      | 28                | 20                |
|                                         | SUBOUT_2 |                                                                                                                     | 7       | 6                 | 1                 |
| RESET                                   | INITX    | External Reset Input pin.<br>A reset is valid when INITX="L".                                                       | 18      | 17                | 12                |
| Mode                                    | MD0      | Mode 0 pin.<br>During normal operation, input MD0="L".<br>During serial programming to Flash memory, input MD0="H". | 23      | 21                | 14                |
| POWER                                   | VCC      | Power supply pin                                                                                                    | 1       | 1                 | -                 |
|                                         | VCC      | Power supply pin                                                                                                    | 15      | 14                | 9                 |
| GND                                     | VSS      | GND pin                                                                                                             | 13      | 12                | 7                 |
|                                         | VSS      | GND pin                                                                                                             | 26      | 24                | 17                |
|                                         | VSS      | GND pin                                                                                                             | 52      | 48                | 32                |
| CLOCK                                   | X0       | Main clock (oscillation) input pin                                                                                  | 24      | 22                | 15                |
|                                         | X0A      | Sub clock (oscillation) input pin                                                                                   | 16      | 15                | 10                |
|                                         | X1       | Main clock (oscillation) I/O pin                                                                                    | 25      | 23                | 16                |
|                                         | X1A      | Sub clock (oscillation) I/O pin                                                                                     | 17      | 16                | 11                |
|                                         | CROUT_1  | Built-in high-speed CR oscillation clock output port                                                                | 46      | 42                | 29                |
| Analog POWER                            | AVCC     | A/D converter analog power supply pin                                                                               | 33      | 31                | 21                |
|                                         | AVRH     | A/D converter analog reference voltage input pin                                                                    | 34      | 32                | -                 |
| Analog GND                              | AVSS     | A/D converter analog reference voltage input pin                                                                    | 35      | 33                | 22                |
| C pin                                   | C        | Power supply stabilization capacitance pin                                                                          | 14      | 13                | 8                 |

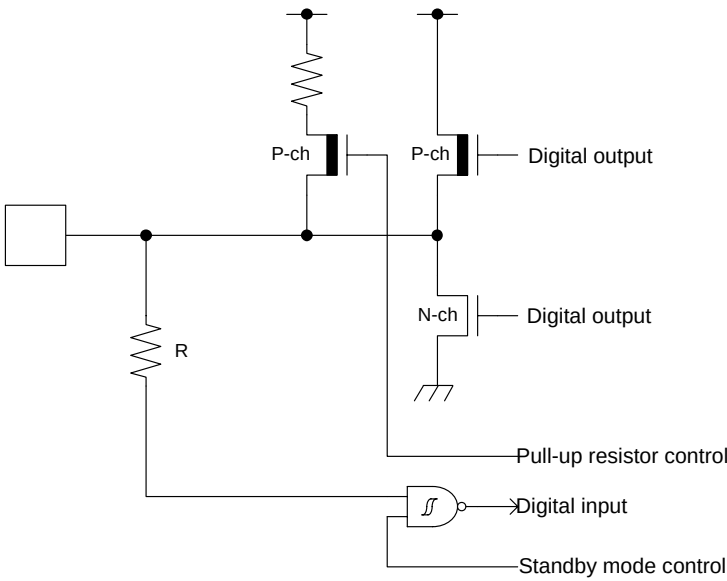
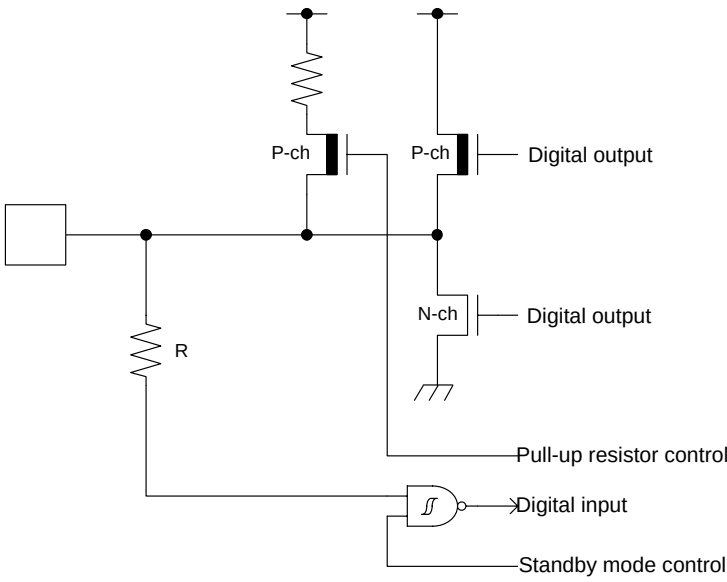
\*: PE0 is an open drain pin, cannot output high.

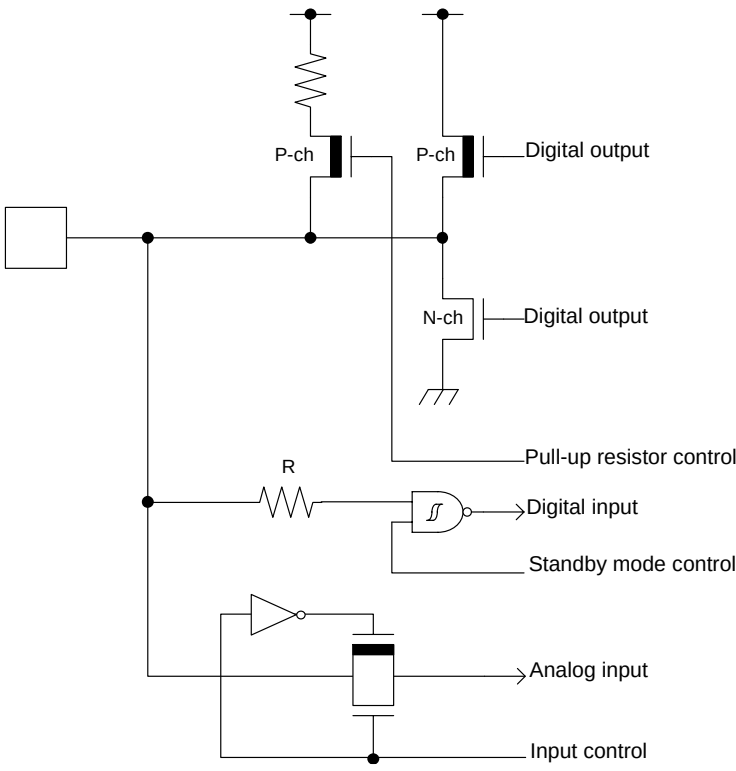
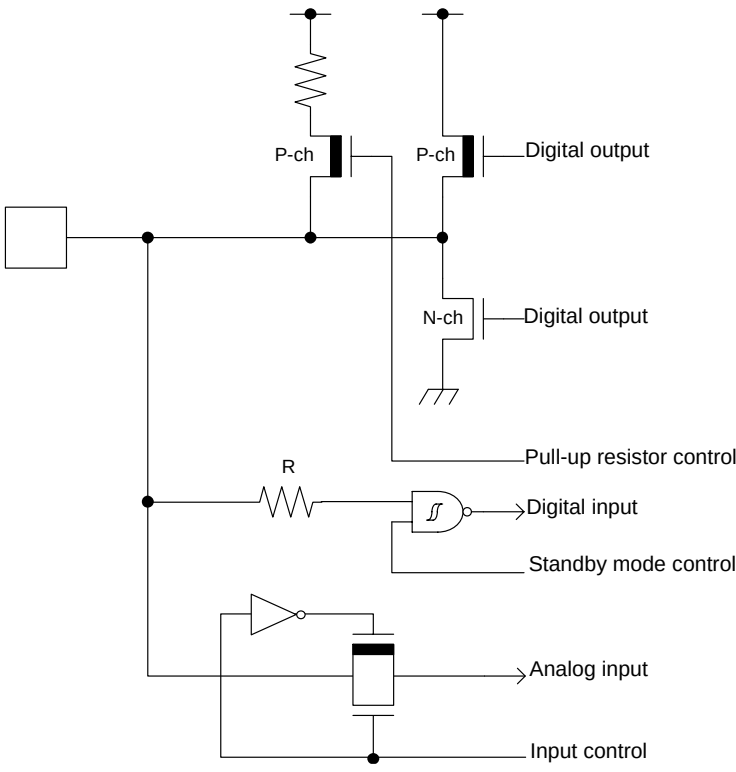
## 5. I/O Circuit Type

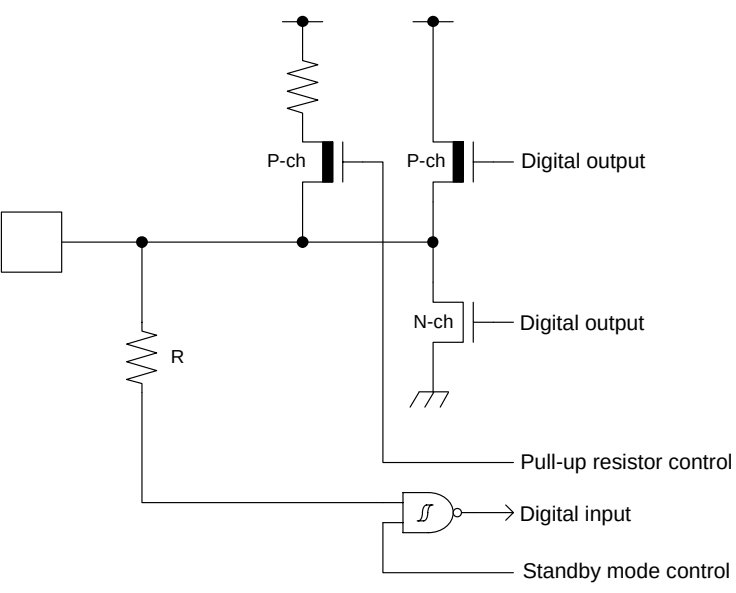
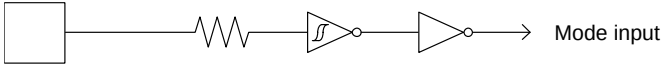
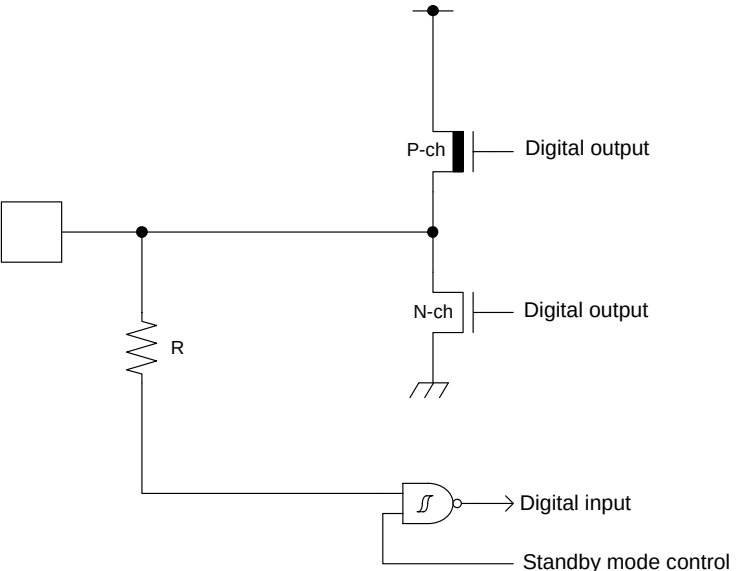
| Type | Circuit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A    |  <p>The diagram illustrates the internal circuitry for I/O Type A. It features two external pins, X1 and X0. X1 is connected to a pull-up resistor, a resistor R, and a feedback resistor. X0 is connected to a pull-up resistor and a resistor R. The circuit includes P-ch and N-ch MOSFETs for digital outputs, pull-up resistors, and logic gates (AND, OR, NOT) for digital inputs and clock inputs. Standby mode control signals are also shown.</p> | <p>It is possible to select the main oscillation / GPIO function</p> <p>When the main oscillation is selected.</p> <ul style="list-style-type: none"> <li>• Oscillation feedback resistor : Approximately 1MΩ</li> <li>• With standby mode control</li> </ul> <p>When the GPIO is selected.</p> <ul style="list-style-type: none"> <li>• CMOS level output.</li> <li>• CMOS level hysteresis input</li> <li>• With pull-up resistor control</li> <li>• With standby mode control</li> <li>• Pull-up resistor : Approximately 50kΩ</li> <li>• <math>I_{OH} = -4\text{mA}</math>, <math>I_{OL} = 4\text{mA}</math></li> </ul> |

| Type | Circuit                                                                                                                                  | Remarks                                                                                                                          |
|------|------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| B    |  <p>Pull-up resistor</p> <p>Digital input</p>           | <ul style="list-style-type: none"> <li>• CMOS level hysteresis input</li> <li>• Pull-up resistor : Approximately 50kΩ</li> </ul> |
| C    |  <p>Digital input</p> <p>N-ch</p> <p>Digital output</p> | <ul style="list-style-type: none"> <li>• Open drain output</li> <li>• CMOS level hysteresis input</li> </ul>                     |

| Type | Circuit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| D    |  <p>The diagram illustrates the internal circuitry of two digital I/O blocks, X1A and X0A. Each block features a pull-up resistor connected to a supply rail. The output stage consists of a P-channel MOSFET (P-ch) and an N-channel MOSFET (N-ch). The P-ch MOSFET's gate is connected to the input signal through a pull-up resistor. The N-ch MOSFET's gate is connected to the input signal through a pull-up resistor. The output of the P-ch MOSFET is connected to the output pin, and the output of the N-ch MOSFET is connected to ground. The input signal is also connected to a digital input pin, which is controlled by a standby mode control signal. A feedback resistor is connected between the output pin and the input signal. The circuit also includes a clock input and a standby mode control signal.</p> | <p>It is possible to select the sub oscillation / GPIO function</p> <p>When the sub oscillation is selected.</p> <ul style="list-style-type: none"> <li>• Oscillation feedback resistor : Approximately 5MΩ</li> <li>• With standby mode control</li> </ul> <p>When the GPIO is selected.</p> <ul style="list-style-type: none"> <li>• CMOS level output.</li> <li>• CMOS level hysteresis input</li> <li>• With pull-up resistor control</li> <li>• With standby mode control</li> <li>• Pull-up resistor : Approximately 50kΩ</li> <li>• <math>I_{OH} = -4mA</math>, <math>I_{OL} = 4mA</math></li> </ul> |

| Type | Circuit                                                                                                                                                                                                                                                                                                                          | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| E    |  <p>           P-ch<br/>           P-ch<br/>           Digital output<br/>           Digital output<br/>           N-ch<br/>           Pull-up resistor control<br/>           Digital input<br/>           Standby mode control         </p>   | <ul style="list-style-type: none"> <li>• CMOS level output</li> <li>• CMOS level hysteresis input</li> <li>• With pull-up resistor control</li> <li>• With standby mode control</li> <li>• Pull-up resistor : Approximately 50kΩ</li> <li>• <math>I_{OH} = -4\text{mA}</math>, <math>I_{OL} = 4\text{mA}</math></li> <li>• When this pin is used as an I<sup>2</sup>C pin, the digital output P-ch transistor is always off</li> </ul>   |
| F    |  <p>           P-ch<br/>           P-ch<br/>           Digital output<br/>           Digital output<br/>           N-ch<br/>           Pull-up resistor control<br/>           Digital input<br/>           Standby mode control         </p> | <ul style="list-style-type: none"> <li>• CMOS level output</li> <li>• CMOS level hysteresis input</li> <li>• With pull-up resistor control</li> <li>• With standby mode control</li> <li>• Pull-up resistor : Approximately 50kΩ</li> <li>• <math>I_{OH} = -12\text{mA}</math>, <math>I_{OL} = 12\text{mA}</math></li> <li>• When this pin is used as an I<sup>2</sup>C pin, the digital output P-ch transistor is always off</li> </ul> |

| Type | Circuit                                                                             | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| G    |   | <ul style="list-style-type: none"> <li>• CMOS level output</li> <li>• CMOS level hysteresis input</li> <li>• With input control</li> <li>• Analog input</li> <li>• With pull-up resistor control</li> <li>• With standby mode control</li> <li>• Pull-up resistor : Approximately 50kΩ</li> <li>• <math>I_{OH} = -4mA</math>, <math>I_{OL} = 4mA</math></li> <li>• When this pin is used as an I<sup>2</sup>C pin, the digital output P-ch transistor is always off</li> </ul>                                                                          |
| H    |  | <ul style="list-style-type: none"> <li>• CMOS level output</li> <li>• CMOS level hysteresis input</li> <li>• With input control</li> <li>• Analog input</li> <li>• 5V tolerant</li> <li>• With pull-up resistor control</li> <li>• With standby mode control</li> <li>• Pull-up resistor : Approximately 50kΩ</li> <li>• <math>I_{OH} = -4mA</math>, <math>I_{OL} = 4mA</math></li> <li>• Available to control of PZR registers.</li> <li>• When this pin is used as an I<sup>2</sup>C pin, the digital output P-ch transistor is always off</li> </ul> |

| Type | Circuit                                                                             | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I    |    | <ul style="list-style-type: none"> <li>• CMOS level output</li> <li>• CMOS level hysteresis input</li> <li>• 5V tolerant</li> <li>• With pull-up resistor control</li> <li>• With standby mode control</li> <li>• Pull-up resistor : Approximately 50kΩ</li> <li>• <math>I_{OH} = -4\text{mA}</math>, <math>I_{OL} = 4\text{mA}</math></li> <li>• Available to control PZR registers</li> <li>• When this pin is used as an I<sup>2</sup>C pin, the digital output P-ch transistor is always off</li> </ul> |
| J    |  | CMOS level hysteresis input                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| K    |  | <ul style="list-style-type: none"> <li>• CMOS level output</li> <li>• CMOS level hysteresis input</li> <li>• With standby mode control</li> <li>• <math>I_{OH} = -4\text{mA}</math>, <math>I_{OL} = 4\text{mA}</math></li> <li>• When this pin is used as an I<sup>2</sup>C pin, the digital output P-ch transistor is always off</li> </ul>                                                                                                                                                                |

## 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.

Code: DS00-00004-2Ea

**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's 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. Cypress 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 MΩ).  
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

### 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 pin and GND pin of this device at low impedance. It is also advisable that a ceramic capacitor of approximately 0.1  $\mu\text{F}$  be connected as a bypass capacitor between each Power supply pin and GND pin near this device.

### Stabilizing 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/ $\mu\text{s}$  when there is a momentary fluctuation on switching the power supply.

### Crystal Oscillator Circuit

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

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

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

### Sub Crystal Oscillator

This series sub oscillator circuit is low gain to keep the low current consumption.

The crystal oscillator to fill the following conditions is recommended for sub crystal oscillator to stabilize the oscillation.

#### ■ Surface mount type

Size: More than 3.2 mm  $\times$  1.5 mm  
Load capacitance: Approximately 6 pF to 7 pF

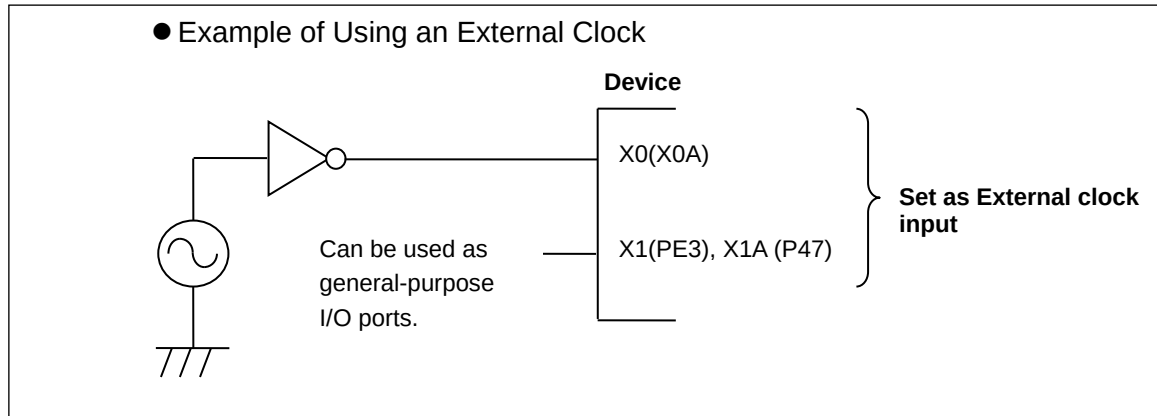
#### ■ Lead type

Load capacitance: Approximately 6 pF to 7 pF

### Using an External Clock

When using an external clock as an input of the main clock, set X0/X1 to the external clock input, and input the clock to X0. X1(PE3) can be used as a general-purpose I/O port.

Similarly, when using an external clock as an input of the sub clock, set X0A/X1A to the external clock input, and input the clock to X0A. X1A (P47) can be used as a general-purpose I/O port.



### Handling when Using Multi-Function Serial Pin as I<sup>2</sup>C Pin

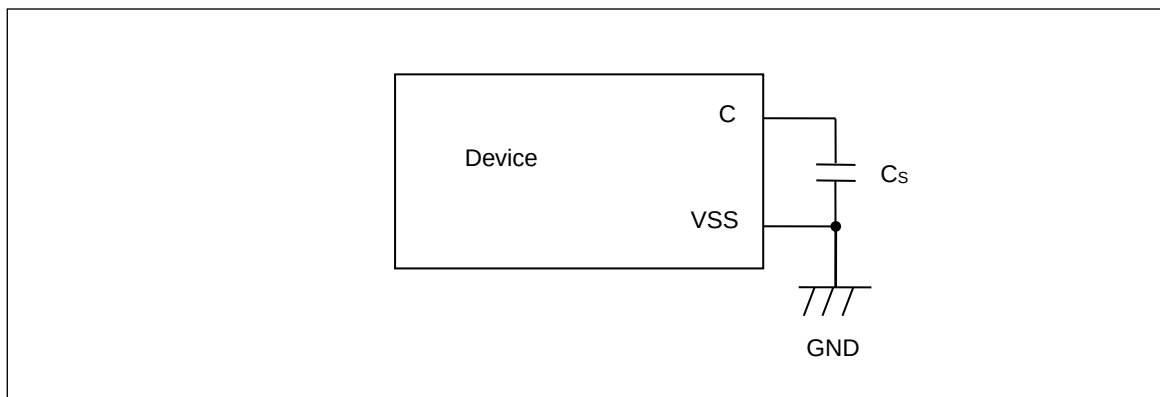
If it is using the multi-function serial pin as I<sup>2</sup>C pins, P-ch transistor of digital output is always disabled.

However, I<sup>2</sup>C pins need to keep the electrical characteristic like other pins and not to connect to the external I<sup>2</sup>C bus system with power OFF.

### 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  $\mu$ F would be recommended for this series.



### 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.

**Notes on Power-on**

Turn power on/off in the following order or at the same time.

Turning on : VCC → AVCC → AVRH

Turning off : AVRH → AVCC → VCC

**Serial Communication**

There is a possibility to receive wrong data due to the noise or other causes on the serial communication.

Therefore, design a printed circuit board so as to avoid noise.

Consider the case of receiving wrong data due to noise, perform error detection such as by applying a checksum of data at the end. If an error is detected, retransmit the data.

**Differences in Features among the Products with Different Memory Sizes and between Flash Products and MASK Products**

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

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

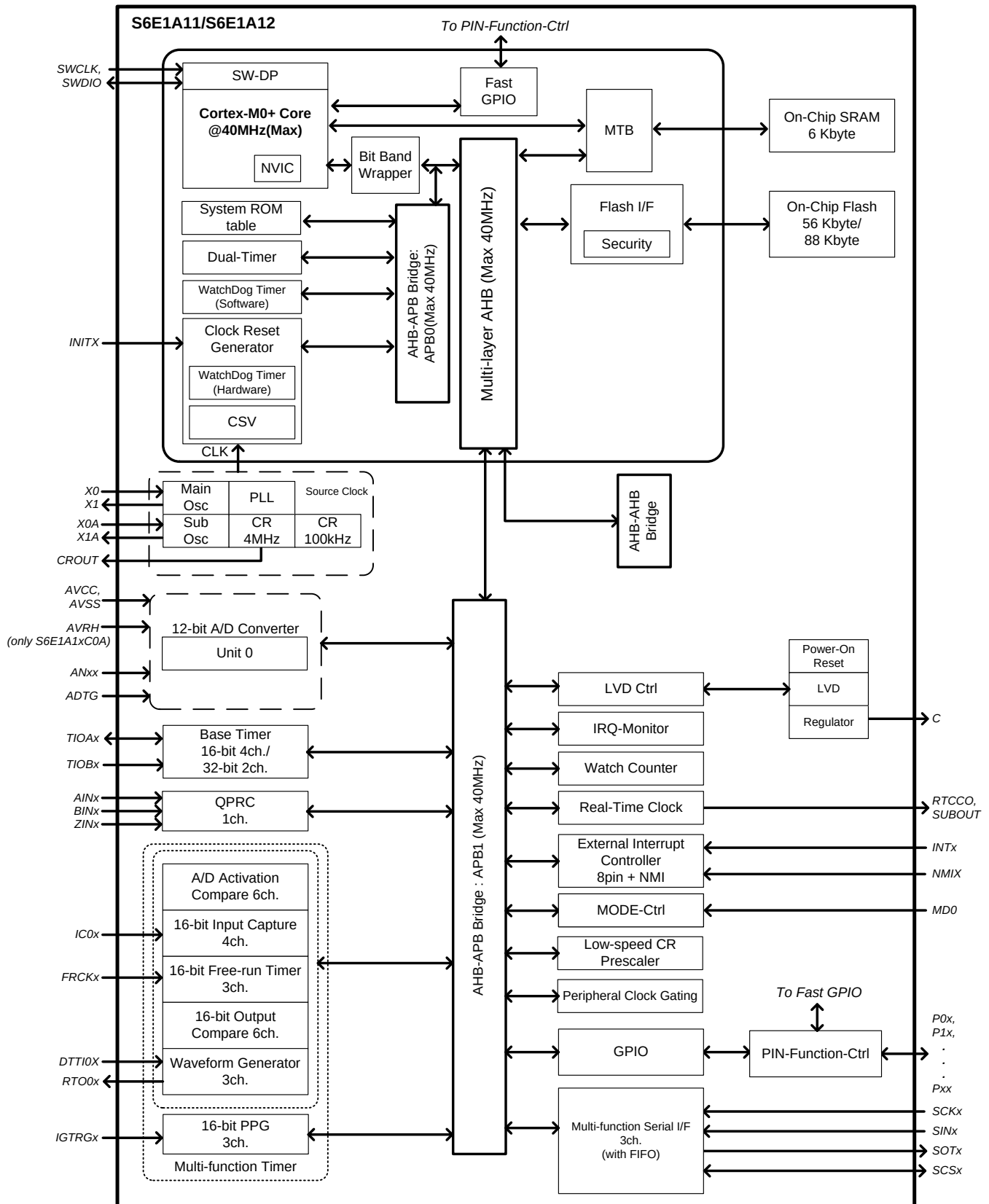
**Pull-Up Function of 5V Tolerant I/O**

Please do not input the signal more than VCC voltage at the time of Pull-Up function use of 5V tolerant I/O.

**Handling when using debug pins**

When debug pins (SWDIO/SWCLK) are set to GPIO or other peripheral functions, only set them as output, do not set them as input.

## 8. Block Diagram

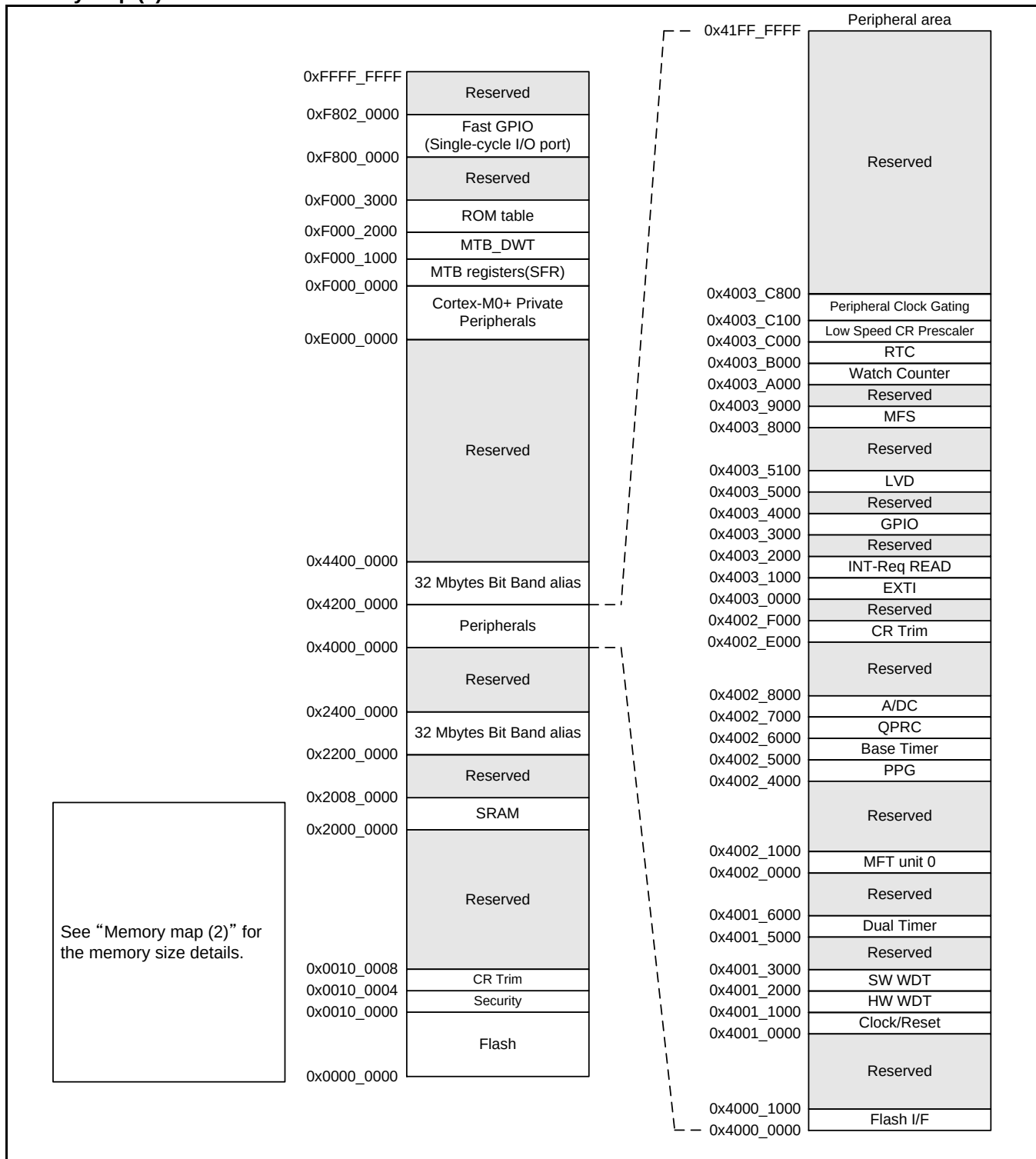


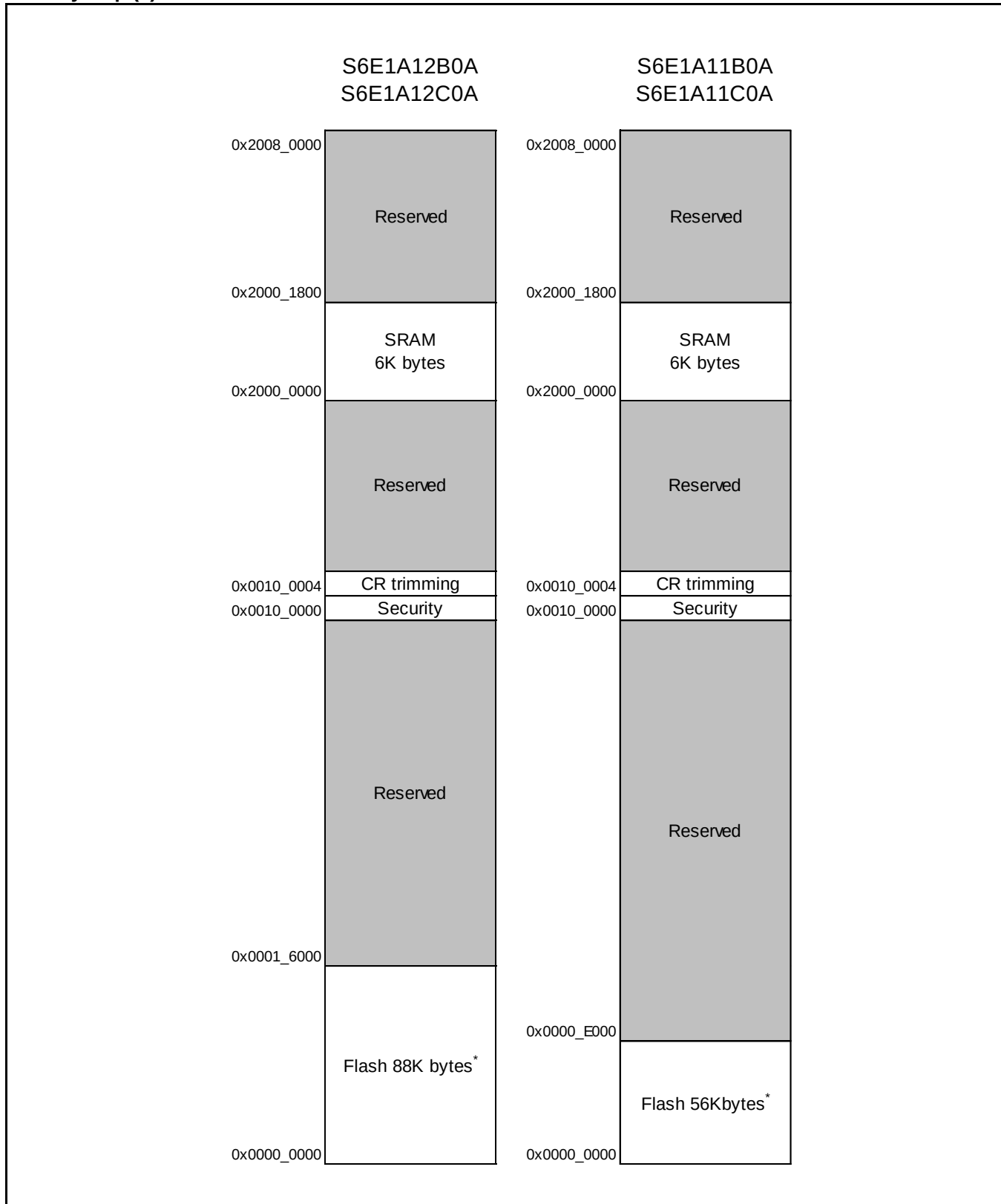
## 9. Memory Size

See Memory size in 1. Product Lineup to confirm the memory size.

## 10. Memory Map

### Memory Map (1)



**Memory Map (2)**


\*: See "S6E1A1 Series Flash Programming Manual" to check details of the flash memory.

**Peripheral Address Map**

| Start address | End address | Bus  | Peripheral                             |
|---------------|-------------|------|----------------------------------------|
| 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_3FFF |      | Reserved                               |
| 0x4002_4000   | 0x4002_4FFF |      | PPG                                    |
| 0x4002_5000   | 0x4002_5FFF |      | Base Timer                             |
| 0x4002_6000   | 0x4002_6FFF |      | Quadrature Position/Revolution Counter |
| 0x4002_7000   | 0x4002_7FFF |      | A/D Converter                          |
| 0x4002_8000   | 0x4002_DFFF |      | Reserved                               |
| 0x4002_E000   | 0x4002_EFFF |      | Built-in CR trimming                   |
| 0x4002_F000   | 0x4002_FFFF |      | Reserved                               |
| 0x4003_0000   | 0x4003_0FFF |      | External Interrupt Controller          |
| 0x4003_1000   | 0x4003_1FFF |      | Interrupt Request Batch-Read Function  |
| 0x4003_2000   | 0x4003_2FFF |      | Reserved                               |
| 0x4003_3000   | 0x4003_3FFF |      | GPIO                                   |
| 0x4003_4000   | 0x4003_4FFF |      | Reserved                               |
| 0x4003_5000   | 0x4003_57FF |      | Low-Voltage Detection                  |
| 0x4003_5800   | 0x4003_7FFF |      | Reserved                               |
| 0x4003_8000   | 0x4003_8FFF |      | Multi-function Serial Interface        |
| 0x4003_9000   | 0x4003_9FFF |      | Reserved                               |
| 0x4003_A000   | 0x4003_AFFF |      | Watch Counter                          |
| 0x4003_B000   | 0x4003_BFFF |      | Real-time clock                        |
| 0x4003_C000   | 0x4003_C0FF |      | Low-speed CR Prescaler                 |
| 0x4003_C100   | 0x4003_C7FF |      | Peripheral Clock Gating                |
| 0x4003_C800   | 0x4003_FFFF |      | Reserved                               |
| 0x4004_0000   | 0x41FF_FFFF | AHB  | 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.

**List of Pin Status**

| Pin status type | Function group                                                           | State upon power-on reset or low-voltage detection   | State at INITX input               | State upon device internal reset   | State in Run mode or SLEEP mode                                                                      | State in TIMER mode, RTC mode, or STOP mode                                                          |                                                                                                      |
|-----------------|--------------------------------------------------------------------------|------------------------------------------------------|------------------------------------|------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
|                 |                                                                          | 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/<br>External main clock input selected | 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"                                                                   |
|                 | External main clock input 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"/<br>Input enabled | Hi-Z / Internal input fixed at "0" | Hi-Z / Internal input fixed at "0" | Maintain previous state/When oscillation stops* <sup>1</sup> ,<br>Hi-Z / Internal input fixed at "0" | Maintain previous state/When oscillation stops* <sup>1</sup> ,<br>Hi-Z / Internal input fixed at "0" | Maintain previous state/When oscillation stops* <sup>1</sup> ,<br>Hi-Z / 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               | 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 /<br>External sub clock input selected  | Input enabled                                        | Input enabled                      | Input enabled                      | Input enabled                                                                                        | Input enabled                                                                                        | Input enabled                                                                                        |

| Pin status type | Function group                         | State upon power-on reset or low-voltage detection | State at INITX input                                      | State upon device internal reset                          | State in Run mode or SLEEP mode                           | State in TIMER mode, RTC mode, or STOP mode                                          |                                                                                      |
|-----------------|----------------------------------------|----------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
|                 |                                        | Power supply unstable                              | Power supply stable                                       |                                                           | Power supply stable                                       | Power supply stable                                                                  |                                                                                      |
|                 |                                        | -                                                  | INITX = 0                                                 | INITX = 1                                                 | INITX = 1                                                 | INITX = 1                                                                            |                                                                                      |
|                 |                                        | -                                                  | -                                                         | -                                                         | -                                                         | SPL = 0                                                                              | SPL = 1                                                                              |
| F               | GPIO selected                          | Setting disabled                                   | Setting disabled                                          | Setting disabled                                          | Maintain previous state                                   | Maintain previous state                                                              | Hi-Z / Internal input fixed at "0"                                                   |
|                 | External sub clock input 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"/ Input enabled  | Hi-Z / Internal input fixed at "0"                        | Hi-Z / Internal input fixed at "0"                        | Maintain previous state                                   | Maintain previous state/When oscillation stops*2, Hi-Z / Internal input fixed at "0" | Maintain previous state/When oscillation stops*2, Hi-Z / Internal input fixed at "0" |
| G               | NMIX selected                          | Setting disabled                                   | Setting disabled                                          | Setting disabled                                          | Maintain previous state                                   | Maintain previous state                                                              | Maintain previous state                                                              |
|                 | Resource other than the above selected | Hi-Z                                               | Hi-Z / Input enabled                                      | Hi-Z / Input enabled                                      |                                                           |                                                                                      | Hi-Z / Internal input fixed at "0"                                                   |
|                 | GPIO selected                          |                                                    |                                                           |                                                           |                                                           |                                                                                      |                                                                                      |
| H               | Serial wire debug 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"                                                   |
| I               | 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"                                                   |
|                 | GPIO selected                          |                                                    |                                                           |                                                           |                                                           |                                                                                      |                                                                                      |
| J               | External interrupt enabled selected    | Setting disabled                                   | Setting disabled                                          | Setting disabled                                          | Maintain previous state                                   | Maintain previous state                                                              | Maintain previous state                                                              |
|                 | Resource other than the above selected | Hi-Z                                               | Hi-Z / Input enabled                                      | Hi-Z / Input enabled                                      |                                                           |                                                                                      | Hi-Z / Internal input fixed at "0"                                                   |
|                 | GPIO selected                          |                                                    |                                                           |                                                           |                                                           |                                                                                      |                                                                                      |
| 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                            |
|                 | Resource other than the above selected | Setting disabled                                   | Setting disabled                                          | Setting disabled                                          | Maintain previous state                                   | Maintain previous state                                                              | Hi-Z / Internal input fixed at "0"                                                   |
|                 | GPIO selected                          |                                                    |                                                           |                                                           |                                                           |                                                                                      |                                                                                      |

| Pin status type | Function group                         | State upon power-on reset or low-voltage detection | State at INITX input                                      | State upon device internal reset                          | State in Run mode or SLEEP mode                           | State in TIMER mode, RTC mode, or STOP mode               |                                                           |
|-----------------|----------------------------------------|----------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|-----------------------------------------------------------|
|                 |                                        | Power supply unstable                              | Power supply stable                                       |                                                           | Power supply stable                                       | Power supply stable                                       |                                                           |
|                 |                                        | -                                                  | INITX = 0                                                 | INITX = 1                                                 | INITX = 1                                                 | INITX = 1                                                 |                                                           |
|                 |                                        | -                                                  | -                                                         | -                                                         | -                                                         | SPL = 0                                                   | SPL = 1                                                   |
| L               | 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 |
|                 | External interrupt enabled selected    | Setting disabled                                   | Setting disabled                                          | Setting disabled                                          | Maintain previous state                                   | Maintain previous state                                   | Maintain previous state                                   |
|                 | Resource other than the above selected |                                                    |                                                           |                                                           |                                                           |                                                           | Hi-Z / Internal input fixed at "0"                        |
|                 | GPIO selected                          |                                                    |                                                           |                                                           |                                                           |                                                           |                                                           |

\*1: Oscillation stops in Sub timer mode, Low-speed CR timer mode, STOP mode, RTC mode.

\*2: Oscillation stops in STOP mode.

## 12. Electrical Characteristics

### 12.1 Absolute Maximum Ratings

| Parameter                                | Symbol             | Rating                |                                  | Unit | Remarks         |
|------------------------------------------|--------------------|-----------------------|----------------------------------|------|-----------------|
|                                          |                    | Min                   | Max                              |      |                 |
| Power supply voltage*1, *2               | V <sub>CC</sub>    | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.5            | V    |                 |
| Analog power supply voltage*1, *3        | AV <sub>CC</sub>   | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.5            | V    |                 |
| Analog reference voltage*1, *3           | AV <sub>RH</sub>   | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.5            | V    | Only S6E1A1xC0A |
| Input voltage*1                          | V <sub>I</sub>     | V <sub>SS</sub> - 0.5 | V <sub>CC</sub> + 0.5 (≤ 6.5 V)  | V    |                 |
|                                          |                    | V <sub>SS</sub> - 0.5 | V <sub>SS</sub> + 6.5            | V    | 5V tolerant     |
| Analog pin input voltage*1               | V <sub>IA</sub>    | V <sub>SS</sub> - 0.5 | AV <sub>CC</sub> + 0.5 (≤ 6.5 V) | V    |                 |
| Output voltage*1                         | V <sub>O</sub>     | V <sub>SS</sub> - 0.5 | V <sub>CC</sub> + 0.5 (≤ 6.5 V)  | V    |                 |
| "L" level maximum output current*4       | I <sub>OL</sub>    | -                     | 10                               | mA   | 4 mA type       |
|                                          |                    |                       | 20                               | mA   | 12 mA type      |
| "L" level average output current*5       | I <sub>OLAV</sub>  | -                     | 4                                | mA   | 4 mA type       |
|                                          |                    |                       | 12                               | mA   | 12 mA type      |
| "L" level total maximum output current   | ∑I <sub>OL</sub>   | -                     | 100                              | mA   |                 |
| "L" level total average output current*6 | ∑I <sub>OLAV</sub> | -                     | 50                               | mA   |                 |
| "H" level maximum output current*4       | I <sub>OH</sub>    | -                     | - 10                             | mA   | 4 mA type       |
|                                          |                    |                       | - 20                             | mA   | 12 mA type      |
| "H" level average output current*5       | I <sub>OHAV</sub>  | -                     | - 4                              | mA   | 4 mA type       |
|                                          |                    |                       | - 12                             | mA   | 12 mA type      |
| "H" level total maximum output current   | ∑I <sub>OH</sub>   | -                     | - 100                            | mA   |                 |
| "H" level total average output current*6 | ∑I <sub>OHAV</sub> | -                     | - 50                             | mA   |                 |
| Power consumption                        | P <sub>D</sub>     | -                     | 200                              | mW   |                 |
| Storage temperature                      | T <sub>STG</sub>   | - 55                  | + 150                            | °C   |                 |

\*1:These parameters are based on the condition that V<sub>SS</sub> = AV<sub>SS</sub> = 0 V.

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

\*3:Ensure that the voltage does not to exceed V<sub>CC</sub> + 0.5 V at power-on.

\*4:The maximum output current is the peak value for a single pin.

\*5:The average output is the average current for a single pin over a period of 100 ms.

\*6:The total average output current is the average current for all pins over a period of 100 ms.

### Warning

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

## 12.2 Recommended Operating Conditions

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

| Parameter                   | Symbol           | Conditions | Value             |                  | Unit | Remarks                            |
|-----------------------------|------------------|------------|-------------------|------------------|------|------------------------------------|
|                             |                  |            | Min               | Max              |      |                                    |
| Power supply voltage        | V <sub>CC</sub>  | -          | 2.7* <sup>2</sup> | 5.5              | V    |                                    |
| Analog power supply voltage | AV <sub>CC</sub> | -          | 2.7               | 5.5              | V    | AV <sub>CC</sub> = V <sub>CC</sub> |
| Analog reference voltage    | AVRH             | -          | 2.7               | AV <sub>CC</sub> | V    | Only S6E1A1xC0A                    |
| Smoothing capacitor         | C <sub>S</sub>   | -          | 1                 | 10               | μF   | For regulator* <sup>1</sup>        |
| Operating temperature       | T <sub>a</sub>   | -          | - 40              | + 105            | °C   |                                    |

\*1: See "C Pin" in "6. Handling Precautions" 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

1. 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.
2. Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.
3. No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet.
4. Users considering application outside the listed conditions are advised to contact their representatives beforehand.

## 12.3 DC Characteristics

### 12.3.1 Current Rating

| Symbol<br>(Pin name)      | Conditions                               |                                                                                                                                           | HCLK<br>Frequency<br>*4 | Value |       | Unit | Remarks  |
|---------------------------|------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|-------|-------|------|----------|
|                           |                                          |                                                                                                                                           |                         | Typ*1 | Max*2 |      |          |
| I <sub>CC</sub><br>(VCC)  | Run mode,<br>code executed<br>from Flash | 4MHz external clock input, PLL<br>ON*8<br>NOP code executed<br>Built-in high speed CR stopped<br>All peripheral clock stopped by<br>CKENx | 4MHz                    | 0.7   | 1.5   | mA   | *3       |
|                           |                                          |                                                                                                                                           | 8MHz                    | 1.3   | 2.3   |      |          |
|                           |                                          |                                                                                                                                           | 20MHz                   | 2.8   | 4.0   |      |          |
|                           |                                          |                                                                                                                                           | 40MHz                   | 5.7   | 7.3   |      |          |
|                           |                                          | 4MHz external clock input, PLL<br>ON*8<br>Benchmark code executed<br>Built-in high speed CR stopped<br>PCLK1 stopped                      | 4MHz                    | 0.6   | 1.4   | mA   | *3       |
|                           |                                          |                                                                                                                                           | 8MHz                    | 1.2   | 2.1   |      |          |
|                           |                                          |                                                                                                                                           | 20MHz                   | 2.6   | 3.7   |      |          |
|                           |                                          |                                                                                                                                           | 40MHz                   | 4.8   | 6.3   |      |          |
|                           |                                          | 4MHz crystal oscillation, PLL ON*8<br>NOP code executed<br>Built-in high speed CR stopped<br>All peripheral clock stopped by<br>CKENx     | 4MHz                    | 1.0   | 2.9   | mA   | *3       |
|                           |                                          |                                                                                                                                           | 8MHz                    | 1.7   | 3.6   |      |          |
|                           |                                          |                                                                                                                                           | 20MHz                   | 3.4   | 5.6   |      |          |
|                           |                                          |                                                                                                                                           | 40MHz                   | 5.7   | 8.2   |      |          |
|                           | Run mode,<br>code executed<br>from RAM   | 4MHz external clock input, PLL<br>ON*8<br>NOP code executed<br>Built-in high speed CR stopped<br>All peripheral clock stopped by<br>CKENx | 4MHz                    | 0.5   | 1.2   | mA   | *3       |
|                           |                                          |                                                                                                                                           | 8MHz                    | 0.9   | 1.8   |      |          |
|                           |                                          |                                                                                                                                           | 20MHz                   | 2.0   | 2.9   |      |          |
|                           |                                          |                                                                                                                                           | 40MHz                   | 3.7   | 4.8   |      |          |
|                           | Run mode,<br>code executed<br>from Flash | 4MHz external clock input, PLL<br>ON<br>NOP code executed<br>Built-in high speed CR stopped<br>PCLK1 stopped                              | 40MHz                   | 2.8   | 3.7   | mA   | *3,*6,*7 |
|                           | Run mode,<br>code executed<br>from Flash | Built-in high speed CR*5<br>NOP code executed<br>All peripheral clock stopped by<br>CKENx                                                 | 4MHz                    | 0.8   | 1.5   | mA   | *3       |
|                           |                                          | 32kHz crystal oscillation<br>NOP code executed<br>All peripheral clock stopped by<br>CKENx                                                | 32kHz                   | 65    | 900   | μA   | *3       |
|                           |                                          | Built-in low speed CR<br>NOP code executed<br>All peripheral clock stopped by<br>CKENx                                                    | 100kHz                  | 73    | 920   | μA   | *3       |
| I <sub>CCS</sub><br>(VCC) | SLEEP operation                          | 4MHz external clock input, PLL<br>ON*8<br>All peripheral clock stopped by<br>CKENx                                                        | 4MHz                    | 0.4   | 1.2   | mA   | *3       |
|                           |                                          |                                                                                                                                           | 8MHz                    | 0.7   | 1.6   |      |          |
|                           |                                          |                                                                                                                                           | 20MHz                   | 1.5   | 2.4   |      |          |
|                           |                                          |                                                                                                                                           | 40MHz                   | 2.7   | 3.7   |      |          |
|                           |                                          | Built-in high speed CR*5<br>All peripheral clock stopped by<br>CKENx                                                                      | 4MHz                    | 0.5   | 1.2   | mA   | *3       |
|                           |                                          | 32kHz crystal oscillation<br>All peripheral clock stopped by<br>CKENx                                                                     | 32kHz                   | 63    | 880   | μA   | *3       |
|                           |                                          | Built-in low speed CR<br>All peripheral clock stopped by<br>CKENx                                                                         | 100kHz                  | 66    | 890   | μA   | *3       |
|                           |                                          |                                                                                                                                           |                         |       |       |      |          |

- \*1 : Ta=+25°C, Vcc=3.0V  
 \*2 : Ta=+105°C, Vcc=5.5V  
 \*3 : All ports are fixed  
 \*4 : PCLK0=HCLK/8  
 \*5 : The frequency is set to 4MHz by trimming  
 \*6 : Flash sync down is set to FRWTR.RWT = 11 and FSYNDN.SD = 1111  
 \*7 : Vcc=2.7V  
 \*8 : When HCLK=4MHz, PLL OFF

| Symbol<br>(Pin name)      | Conditions     |                                                              | Value |     | Unit | Remarks |
|---------------------------|----------------|--------------------------------------------------------------|-------|-----|------|---------|
|                           |                |                                                              | Typ   | Max |      |         |
| I <sub>CCH</sub><br>(VCC) | STOP mode      | Ta=25°C<br>Vcc=3.0V<br>LVD off                               | 5.6   | 28  | μA   | *1      |
|                           |                | Ta=25°C<br>Vcc=5.0V<br>LVD off                               | 6.7   | 30  | μA   | *1      |
|                           |                | Ta=105°C<br>Vcc=5.5V<br>LVD off                              | -     | 540 | μA   | *1      |
| I <sub>CCT</sub><br>(VCC) | Sub timer mode | Ta=25°C<br>Vcc=3.0V<br>32kHz crystal oscillation<br>LVD off  | 12    | 42  | μA   | *1      |
|                           |                | Ta=25°C<br>Vcc=5.0V<br>32kHz crystal oscillation<br>LVD off  | 13    | 44  | μA   | *1      |
|                           |                | Ta=105°C<br>Vcc=5.5V<br>32kHz crystal oscillation<br>LVD off | -     | 730 | μA   | *1      |
| I <sub>CCR</sub><br>(VCC) | RTC mode       | Ta=25°C<br>Vcc=3.0V<br>32kHz crystal oscillation<br>LVD off  | 9     | 36  | μA   | *1      |
|                           |                | Ta=25°C<br>Vcc=5.0V<br>32kHz crystal oscillation<br>LVD off  | 10    | 38  | μA   | *1      |
|                           |                | Ta=105°C<br>Vcc=5.5V<br>32kHz crystal oscillation<br>LVD off | -     | 570 | μA   | *1      |

\*1: All ports are fixed.

**LVD current**
 $(V_{CC} = 2.7V \text{ to } 5.5V, V_{SS} = AV_{SS} = 0V, T_a = -40^{\circ}C \text{ to } +105^{\circ}C)$ 

| Parameter                                                | Symbol              | Pin name | Conditions   | Value |     | Unit | Remarks                     |
|----------------------------------------------------------|---------------------|----------|--------------|-------|-----|------|-----------------------------|
|                                                          |                     |          |              | Typ   | Max |      |                             |
| Low-Voltage detection circuit (LVD) power supply current | I <sub>CC</sub> LVD | VCC      | At operation | 0.13  | 0.3 | μA   | For occurrence of reset     |
|                                                          |                     |          |              | 0.13  | 0.3 | μA   | For occurrence of interrupt |

**Flash memory current**
 $(V_{CC} = 2.7V \text{ to } 5.5V, V_{SS} = AV_{SS} = 0V, T_a = -40^{\circ}C \text{ to } +105^{\circ}C)$ 

| Parameter                        | Symbol                | Pin name | Conditions     | Value |      | Unit | Remarks |
|----------------------------------|-----------------------|----------|----------------|-------|------|------|---------|
|                                  |                       |          |                | Typ   | Max  |      |         |
| Flash memory write/erase current | I <sub>CC</sub> FLASH | VCC      | At Write/Erase | 9.5   | 11.2 | mA   |         |

**A/D convertor current (S6E1A1xC0A)**
 $(V_{CC} = 2.7V \text{ to } 5.5V, V_{SS} = AV_{SS} = 0V, T_a = -40^{\circ}C \text{ to } +105^{\circ}C)$ 

| Parameter                             | Symbol               | Pin name | Conditions   | Value |      | Unit | Remarks   |
|---------------------------------------|----------------------|----------|--------------|-------|------|------|-----------|
|                                       |                      |          |              | Typ   | Max  |      |           |
| Power supply current                  | I <sub>CC</sub> AD   | AVCC     | At operation | 0.7   | 0.9  | mA   |           |
|                                       |                      |          | At stop      | 0.13  | 13   | μA   |           |
| Reference power supply current (AVRH) | I <sub>CC</sub> AVRH | AVRH     | At operation | 1.1   | 1.97 | mA   | AVRH=5.5V |
|                                       |                      |          | At stop      | 0.1   | 1.7  | μA   |           |

**A/D convertor current (S6E1A1xB0A)**
 $(V_{CC} = 2.7V \text{ to } 5.5V, V_{SS} = AV_{SS} = 0V, T_a = -40^{\circ}C \text{ to } +105^{\circ}C)$ 

| Parameter            | Symbol             | Pin name | Conditions   | Value |      | Unit | Remarks |
|----------------------|--------------------|----------|--------------|-------|------|------|---------|
|                      |                    |          |              | Typ   | Max  |      |         |
| Power supply current | I <sub>CC</sub> AD | AVCC     | At operation | 1.8   | 2.87 | mA   |         |
|                      |                    |          | At stop      | 0.23  | 14.7 | μA   |         |

**Peripheral current dissipation**

| Clock system | Peripheral                             | Conditions             | Frequency (MHz) |      |      |      | Unit | Remarks |
|--------------|----------------------------------------|------------------------|-----------------|------|------|------|------|---------|
|              |                                        |                        | 4               | 8    | 20   | 40   |      |         |
| HCLK         | GPIO                                   | At all ports operation | 0.11            | 0.22 | 0.55 | 1.10 | mA   |         |
| PCLK1        | Base timer                             | At 4ch operation       | 0.03            | 0.05 | 0.15 | 0.30 | mA   |         |
|              | Multi-functional timer/PPG             | At 1unit/4ch operation | 0.14            | 0.28 | 0.68 | 1.38 |      |         |
|              | Quadrature position/Revolution counter | At 1unit operation     | 0.02            | 0.04 | 0.11 | 0.22 |      |         |
|              | ADC                                    | At 1unit operation     | 0.07            | 0.14 | 0.37 | 0.73 |      |         |
|              | Multi-function serial                  | At 1ch operation       | 0.15            | 0.31 | 0.77 | 1.54 |      |         |

**12.3.2 Pin Characteristics**
 $(V_{CC} = AV_{CC} = 2.7 \text{ V to } 5.5 \text{ V}, V_{SS} = AV_{SS} = 0 \text{ V}, T_a = -40^\circ\text{C to } +105^\circ\text{C})$ 

| Parameter                                     | Symbol    | Pin name                              | Conditions                                           | Value               |     |                     | Unit          | Remarks |
|-----------------------------------------------|-----------|---------------------------------------|------------------------------------------------------|---------------------|-----|---------------------|---------------|---------|
|                                               |           |                                       |                                                      | Min                 | Typ | Max                 |               |         |
| "H" level input voltage<br>(hysteresis input) | $V_{IHS}$ | CMOS hysteresis input pin, MD0, PE0   | -                                                    | $V_{CC} \times 0.8$ | -   | $V_{CC} + 0.3$      | V             |         |
|                                               |           | 5V tolerant input pin                 | -                                                    | $V_{CC} \times 0.8$ | -   | $V_{SS} + 5.5$      | V             |         |
| "L" level input voltage<br>(hysteresis input) | $V_{ILS}$ | CMOS hysteresis input pin, MD0, PE0   | -                                                    | $V_{SS} - 0.3$      | -   | $V_{CC} \times 0.2$ | V             |         |
|                                               |           | 5V tolerant input pin                 | -                                                    | $V_{SS} - 0.3$      | -   | $V_{CC} \times 0.2$ | V             |         |
| "H" level output voltage                      | $V_{OH}$  | 4 mA type                             | $V_{CC} \geq 4.5 \text{ V}, I_{OH} = -4 \text{ mA}$  | $V_{CC} - 0.5$      | -   | $V_{CC}$            | V             |         |
|                                               |           |                                       | $V_{CC} < 4.5 \text{ V}, I_{OH} = -2 \text{ mA}$     |                     |     |                     |               |         |
|                                               |           | 12 mA type                            | $V_{CC} \geq 4.5 \text{ V}, I_{OH} = -12 \text{ mA}$ | $V_{CC} - 0.5$      | -   | $V_{CC}$            | V             |         |
|                                               |           |                                       | $V_{CC} < 4.5 \text{ V}, I_{OH} = -8 \text{ mA}$     |                     |     |                     |               |         |
| "L" level output voltage                      | $V_{OL}$  | 4 mA type                             | $V_{CC} \geq 4.5 \text{ V}, I_{OL} = 4 \text{ mA}$   | $V_{SS}$            | -   | 0.4                 | V             |         |
|                                               |           |                                       | $V_{CC} < 4.5 \text{ V}, I_{OL} = 2 \text{ mA}$      |                     |     |                     |               |         |
|                                               |           | 12 mA type                            | $V_{CC} \geq 4.5 \text{ V}, I_{OL} = 12 \text{ mA}$  | $V_{SS}$            | -   | 0.4                 | V             |         |
|                                               |           |                                       | $V_{CC} < 4.5 \text{ V}, I_{OL} = 8 \text{ mA}$      |                     |     |                     |               |         |
| Input leak current                            | $I_{IL}$  | -                                     | -                                                    | - 5                 | -   | + 5                 | $\mu\text{A}$ |         |
| Pull-up resistance value                      | $R_{PU}$  | Pull-up pin                           | $V_{CC} \geq 4.5 \text{ V}$                          | 33                  | 50  | 90                  | k $\Omega$    |         |
|                                               |           |                                       | $V_{CC} < 4.5 \text{ V}$                             | -                   | -   | 180                 |               |         |
| Input capacitance                             | $C_{IN}$  | Other than VCC, VSS, AVCC, AVSS, AVRH | -                                                    | -                   | 5   | 15                  | pF            |         |

## 12.4 AC Characteristics

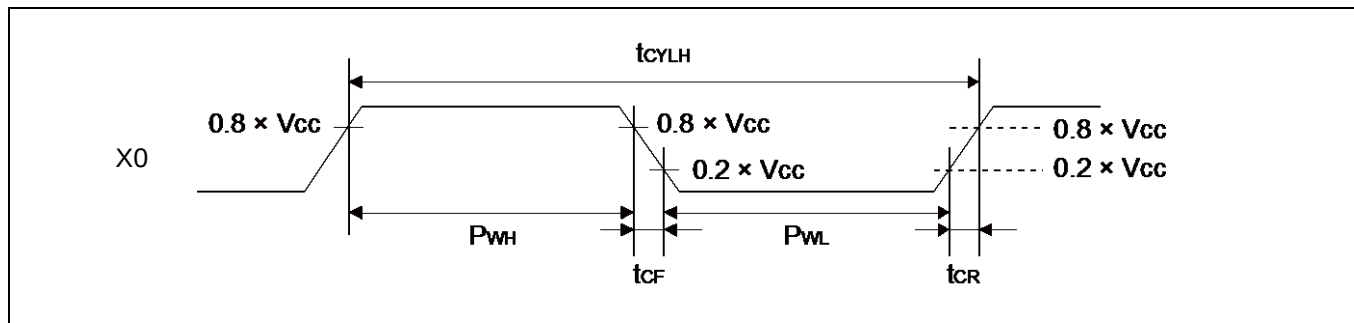
### 12.4.1 Main Clock Input Characteristics

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

| Parameter                                         | Symbol                 | Pin name  | Conditions                               | Value |      | Unit | Remarks                                  |
|---------------------------------------------------|------------------------|-----------|------------------------------------------|-------|------|------|------------------------------------------|
|                                                   |                        |           |                                          | Min   | Max  |      |                                          |
| Input frequency                                   | $F_{CH}$               | X0,<br>X1 | $V_{CC} \geq 4.5\text{ V}$               | 4     | 40   | MHz  | When the crystal oscillator is connected |
|                                                   |                        |           | $V_{CC} < 4.5\text{ V}$                  | 4     | 20   |      |                                          |
|                                                   |                        |           | -                                        | 4     | 40   | MHz  | When the external clock is used          |
| Input clock cycle                                 | $t_{CYLH}$             |           | -                                        | 25    | 250  | ns   | When the external clock is used          |
| Input clock pulse width                           | -                      |           | $P_{WH}/t_{CYLH}$ ,<br>$P_{WL}/t_{CYLH}$ | 45    | 55   | %    | When the external clock is used          |
| Input clock rising time and falling time          | $t_{CF}$ ,<br>$t_{CR}$ |           | -                                        | -     | 5    | ns   | When the external clock is used          |
| Internal operating clock <sup>*1</sup> frequency  | $F_{CM}$               | -         | -                                        | -     | 41.2 | MHz  | Master clock                             |
|                                                   | $F_{CC}$               | -         | -                                        | -     | 41.2 | MHz  | Base clock (HCLK/FCLK)                   |
|                                                   | $F_{CP0}$              | -         | -                                        | -     | 41.2 | MHz  | APB0 bus clock <sup>*2</sup>             |
|                                                   | $F_{CP1}$              | -         | -                                        | -     | 41.2 | MHz  | APB1 bus clock <sup>*2</sup>             |
| Internal operating clock <sup>*1</sup> cycle time | $t_{CYCC}$             | -         | -                                        | 24.27 | -    | ns   | Base clock (HCLK/FCLK)                   |
|                                                   | $t_{CYCP0}$            | -         | -                                        | 24.27 | -    | ns   | APB0 bus clock <sup>*2</sup>             |
|                                                   | $t_{CYCP1}$            | -         | -                                        | 24.27 | -    | ns   | APB1 bus clock <sup>*2</sup>             |

\*1: For details of each internal operating clock, refer to "CHAPTER: Clock" in "FM0+ Family PERIPHERAL MANUAL".

\*2: For details of the APB bus to which a peripheral is connected, see "8. Block Diagram".

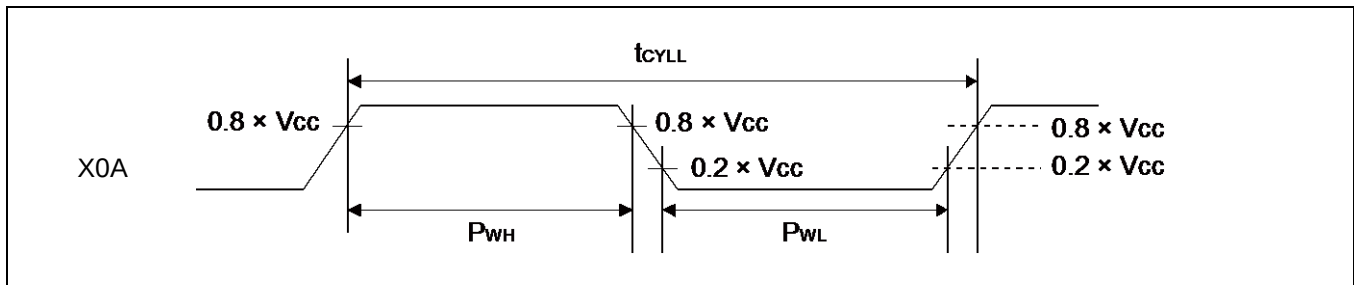


### 12.4.2 Sub Clock Input Characteristics

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

| Parameter               | Symbol       | Pin name    | Conditions                               | Value |        |       | Unit          | Remarks                                  |
|-------------------------|--------------|-------------|------------------------------------------|-------|--------|-------|---------------|------------------------------------------|
|                         |              |             |                                          | Min   | Typ    | Max   |               |                                          |
| Input frequency         | $1/t_{CYLL}$ | X0A,<br>X1A | -                                        | -     | 32.768 | -     | kHz           | When the crystal oscillator is connected |
|                         |              |             | -                                        | 32    | -      | 100   | kHz           | When the external clock is used          |
| Input clock cycle       | $t_{CYLL}$   |             | -                                        | 10    | -      | 31.25 | $\mu\text{s}$ | When the external clock is used          |
| Input clock pulse width | -            |             | $P_{WH}/t_{CYLL}$ ,<br>$P_{WL}/t_{CYLL}$ | 45    | -      | 55    | %             | When the external clock is used          |

\*: See "Sub crystal oscillator" in "7. Handling Devices" for the crystal oscillator used.



### 12.4.3 Built-in CR Oscillation Characteristics

#### Built-in high-speed CR

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

| Parameter                    | Symbol     | Conditions                                                                                          | Value |     |      | Unit          | Remarks                       |
|------------------------------|------------|-----------------------------------------------------------------------------------------------------|-------|-----|------|---------------|-------------------------------|
|                              |            |                                                                                                     | Min   | Typ | Max  |               |                               |
| Clock frequency              | $F_{CRH}$  | $T_a = +25^{\circ}\text{C}$ ,<br>$3.6\text{V} < V_{CC} \leq 5.5\text{V}$                            | 3.92  | 4   | 4.08 | MHz           | During trimming* <sup>1</sup> |
|                              |            | $T_a = 0^{\circ}\text{C to }+85^{\circ}\text{C}$ ,<br>$3.6\text{V} < V_{CC} \leq 5.5\text{V}$       | 3.9   | 4   | 4.1  |               |                               |
|                              |            | $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ ,<br>$3.6\text{V} < V_{CC} \leq 5.5\text{V}$    | 3.88  | 4   | 4.12 |               |                               |
|                              |            | $T_a = +25^{\circ}\text{C}$ ,<br>$2.7\text{V} \leq V_{CC} \leq 3.6\text{V}$                         | 3.94  | 4   | 4.06 |               |                               |
|                              |            | $T_a = -20^{\circ}\text{C to }+85^{\circ}\text{C}$ ,<br>$2.7\text{V} \leq V_{CC} \leq 3.6\text{V}$  | 3.92  | 4   | 4.08 |               |                               |
|                              |            | $T_a = -20^{\circ}\text{C to }+105^{\circ}\text{C}$ ,<br>$2.7\text{V} \leq V_{CC} \leq 3.6\text{V}$ | 3.9   | 4   | 4.1  |               |                               |
|                              |            | $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ ,<br>$2.7\text{V} \leq V_{CC} \leq 3.6\text{V}$ | 3.88  | 4   | 4.12 |               |                               |
|                              |            | $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$                                                 | 2.8   | 4   | 5.2  |               | Not during trimming           |
| Frequency stabilization time | $t_{CRWT}$ | -                                                                                                   | -     | -   | 30   | $\mu\text{s}$ | * <sup>2</sup>                |

\*1: In the case of using the values in CR trimming area of Flash memory at shipment for frequency trimming/temperature trimming.

\*2: This is time from the trim value setting to stable of the frequency of the High-speed CR clock. After setting the trim value, the period when the frequency stability time passes can use the High-speed CR clock as a source clock.

#### Built-in low-speed CR

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

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

#### 12.4.4 Operating Conditions of Main PLL

(In the case of using the main clock as the input clock of the PLL)

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

| Parameter                                                               | Symbol              | Value |     |     | Unit          | Remarks |
|-------------------------------------------------------------------------|---------------------|-------|-----|-----|---------------|---------|
|                                                                         |                     | Min   | Typ | Max |               |         |
| PLL oscillation stabilization wait time* <sup>1</sup><br>(LOCK UP time) | $t_{\text{LOCK}}$   | 100   | -   | -   | $\mu\text{s}$ |         |
| PLL input clock frequency                                               | $F_{\text{PLLI}}$   | 4     | -   | 16  | MHz           |         |
| PLL multiple rate                                                       | -                   | 5     | -   | 37  | multiple      |         |
| PLL macro oscillation clock frequency                                   | $F_{\text{PLLO}}$   | 75    | -   | 150 | MHz           |         |
| Main PLL clock frequency* <sup>2</sup>                                  | $F_{\text{CLKPLL}}$ | -     | -   | 40  | MHz           |         |

\*1: The wait time is the time it takes for PLL oscillation to stabilize.

\*2: For details of the main PLL clock (CLKPLL), refer to "CHAPTER: Clock" in "FM0+ Family PERIPHERAL MANUAL".

#### 12.4.5 Operating Conditions of Main PLL

(In the case of using the built-in high-speed CR clock as the input clock of the main PLL)

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

| Parameter                                                               | Symbol              | Value |     |      | Unit          | Remarks |
|-------------------------------------------------------------------------|---------------------|-------|-----|------|---------------|---------|
|                                                                         |                     | Min   | Typ | Max  |               |         |
| PLL oscillation stabilization wait time* <sup>1</sup><br>(LOCK UP time) | $t_{\text{LOCK}}$   | 100   | -   | -    | $\mu\text{s}$ |         |
| PLL input clock frequency                                               | $F_{\text{PLLI}}$   | 3.88  | 4   | 4.12 | MHz           |         |
| PLL multiple rate                                                       | -                   | 19    | -   | 35   | multiple      |         |
| PLL macro oscillation clock frequency                                   | $F_{\text{PLLO}}$   | 72    | -   | 150  | MHz           |         |
| Main PLL clock frequency* <sup>2</sup>                                  | $F_{\text{CLKPLL}}$ | -     | -   | 41.2 | MHz           |         |

\*1: The wait time is the time it takes for PLL oscillation to stabilize.

\*2: For details of the main PLL clock (CLKPLL), refer to "CHAPTER: Clock" in "FM0+ Family PERIPHERAL MANUAL".

#### Note:

For the main PLL source clock, input the high-speed CR clock (CLKHC) whose frequency has been trimmed.

#### 12.4.6 Reset Input Characteristics

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

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

#### 12.4.7 Power-on Reset Timing

( $V_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

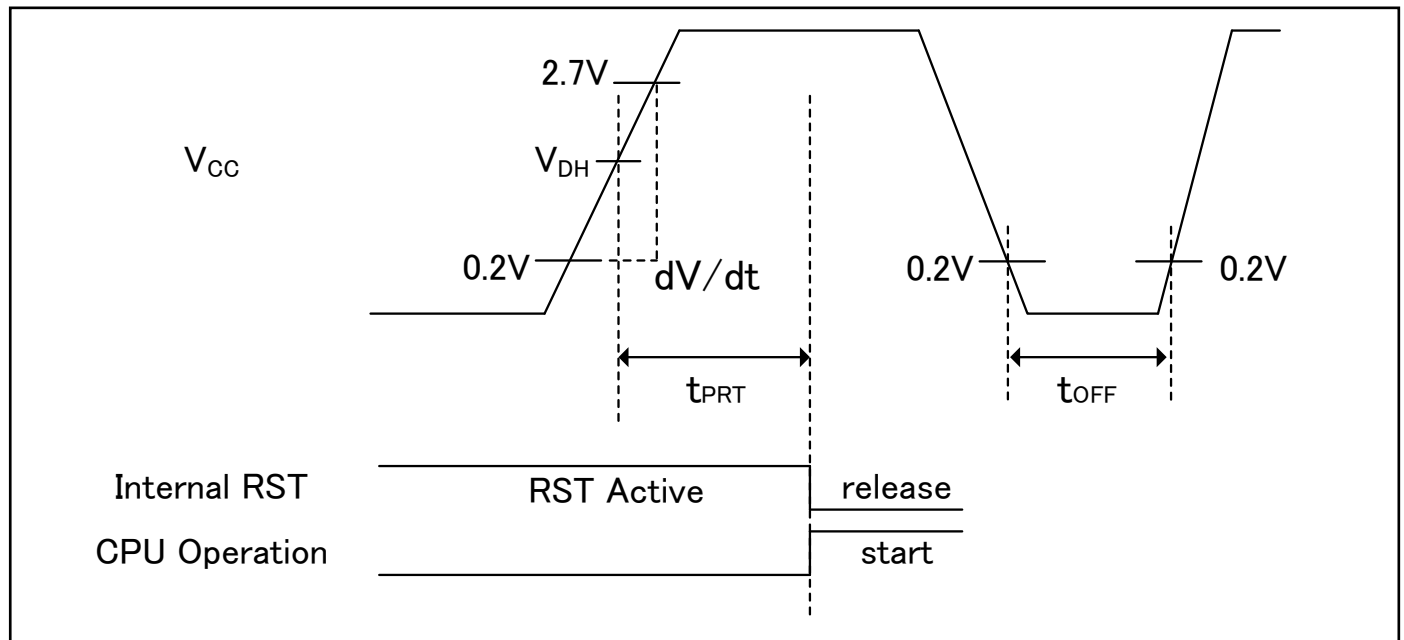
| Parameter                           | Symbol    | Pin name | Conditions                              | Value |     |      | Unit              | Remark |
|-------------------------------------|-----------|----------|-----------------------------------------|-------|-----|------|-------------------|--------|
|                                     |           |          |                                         | Min   | Typ | Max  |                   |        |
| Power supply shut down time         | $t_{OFF}$ | VCC      |                                         | 1     | -   | -    | ms                | *1     |
| Power ramp rate                     | $dV/dt$   |          | $V_{CC}: 0.2\text{ V to }2.70\text{ V}$ | 1.0   | -   | 1000 | mV/ $\mu\text{s}$ | *2     |
| Time until releasing Power-on reset | $t_{PRT}$ |          |                                         | 0.43  | -   | 3.4  | ms                |        |

\*1: VCC must be held below 0.2V for minimum period of  $t_{OFF}$ . Improper initialization may occur if this condition is not met.

\*2: This  $dV/dt$  characteristic is applied at the power-on of cold start ( $t_{OFF} > 1\text{ ms}$ ).

**Note:**

- If  $t_{OFF}$  cannot be satisfied designs must assert external reset(INITX) at power-up and at any brownout event per 12.4.6.



**Glossary**

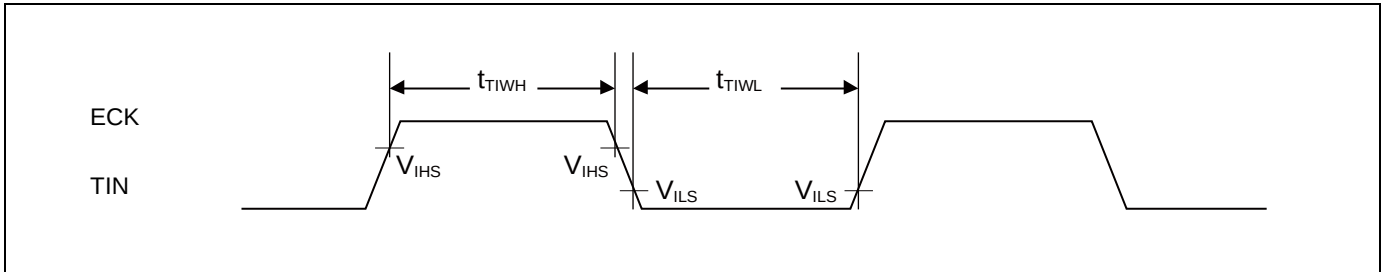
- VDH: detection voltage of Low Voltage detection reset. See "12.6. Low-Voltage Detection Characteristics".

### 12.4.8 Base Timer Input Timing

#### Timer input timing

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

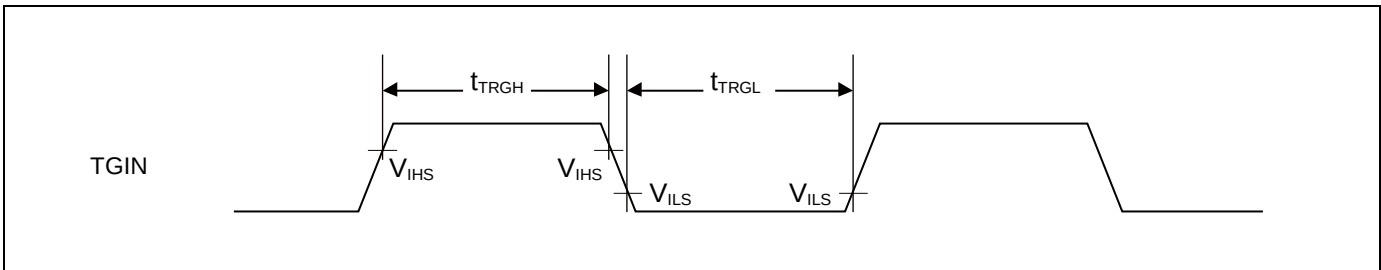
| Parameter         | Symbol                  | Pin name                                   | Conditions | Value         |     | Unit | Remarks |
|-------------------|-------------------------|--------------------------------------------|------------|---------------|-----|------|---------|
|         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



#### Trigger input timing

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

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



#### Note:

- $t_{CYCP}$  indicates the APB bus clock cycle time.  
For the number of the APB bus to which the Base Timer has been connected, see "8. Block Diagram".

### 12.4.9 CSIO/UART Timing

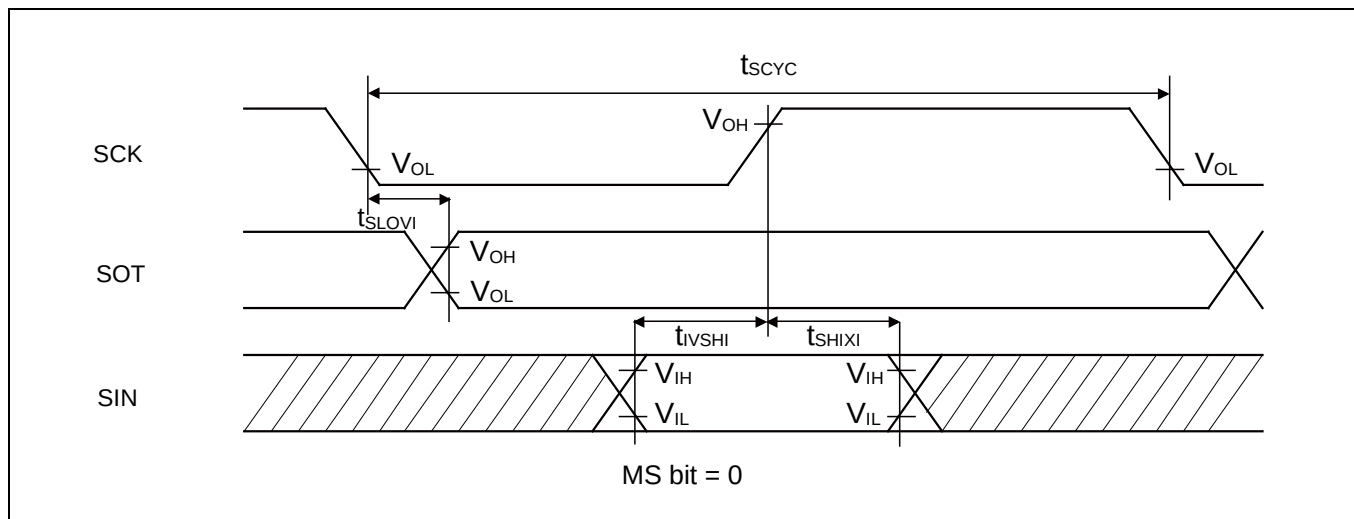
#### Synchronous serial (SPI = 0, SCINV = 0)

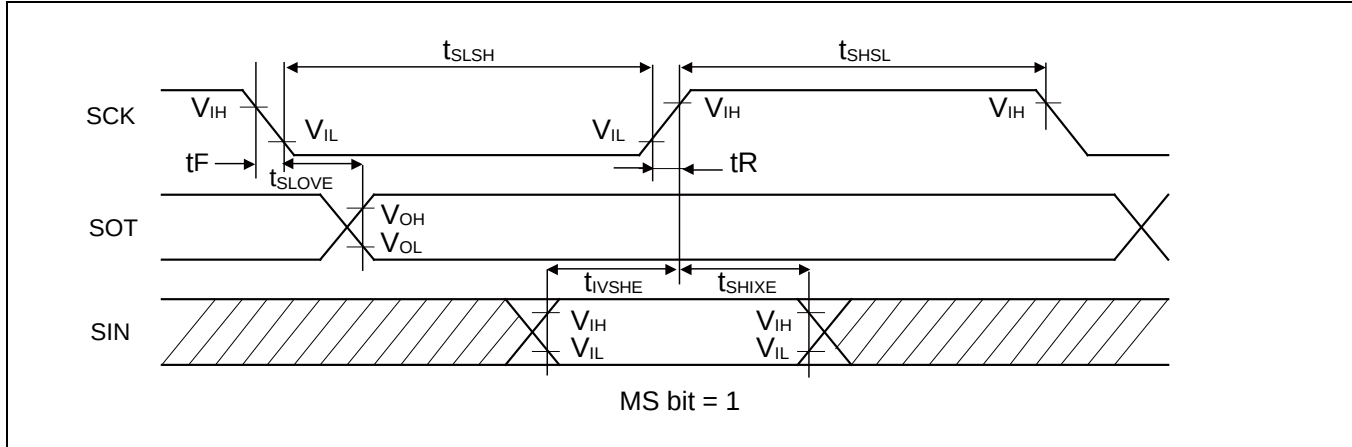
( $V_{CC} = AV_{CC} = 2.7 \text{ V to } 5.5 \text{ V}$ ,  $V_{SS} = AV_{SS} = 0 \text{ V}$ ,  $T_a = -40^\circ\text{C to } +105^\circ\text{C}$ )

| Parameter                                   | Symbol      | Pin name   | Conditions                     | $V_{CC} < 4.5 \text{ V}$ |      | $V_{CC} \geq 4.5 \text{ V}$ |      | Unit |
|---------------------------------------------|-------------|------------|--------------------------------|--------------------------|------|-----------------------------|------|------|
|                                             |             |            |                                | Min                      | Max  | Min                         | Max  |      |
| Baud rate                                   | -           | -          | -                              | -                        | 8    | -                           | 8    | Mbps |
| Serial clock cycle time                     | $t_{SCYC}$  | SCKx       | Internal shift clock operation | $4 t_{CYCP}$             | -    | $4 t_{CYCP}$                | -    | ns   |
| SCK $\downarrow \rightarrow$ SOT delay time | $t_{SLOVI}$ | SCKx, SOTx |                                | - 30                     | + 30 | - 20                        | + 20 | ns   |
| SIN $\rightarrow$ SCK $\uparrow$ setup time | $t_{IVSHI}$ | SCKx, SINx |                                | 50                       | -    | 30                          | -    | ns   |
| SCK $\uparrow \rightarrow$ SIN hold time    | $t_{SHIXI}$ | SCKx, SINx |                                | 0                        | -    | 0                           | -    | ns   |
| Serial clock "L" pulse width                | $t_{LSLH}$  | SCKx       | External shift clock operation | $2 t_{CYCP} - 10$        | -    | $2 t_{CYCP} - 10$           | -    | ns   |
| Serial clock "H" pulse width                | $t_{HSL}$   | SCKx       |                                | $t_{CYCP} + 10$          | -    | $t_{CYCP} + 10$             | -    | ns   |
| SCK $\downarrow \rightarrow$ SOT delay time | $t_{SLOVE}$ | SCKx, SOTx |                                | -                        | 50   | -                           | 30   | ns   |
| SIN $\rightarrow$ SCK $\uparrow$ setup time | $t_{IVSHE}$ | SCKx, SINx |                                | 10                       | -    | 10                          | -    | ns   |
| SCK $\uparrow \rightarrow$ SIN hold time    | $t_{SHIXE}$ | SCKx, SINx |                                | 20                       | -    | 20                          | -    | ns   |
| SCK falling time                            | $t_F$       | SCKx       |                                | -                        | 5    | -                           | 5    | ns   |
| SCK rising time                             | $t_R$       | SCKx       |                                | -                        | 5    | -                           | 5    | ns   |

#### Notes:

- The above AC characteristics are for CLK synchronous mode.
- $t_{CYCP}$  represents the APB bus clock cycle time.  
For the number of the APB bus to which Multi-function Serial has been connected, see "8. Block Diagram".
- The characteristics are only applicable when the relocate port numbers are the same.  
For instance, they are not applicable for the combination of SCKx\_0 and SOTx\_1.
- External load capacitance  $C_L = 30 \text{ pF}$



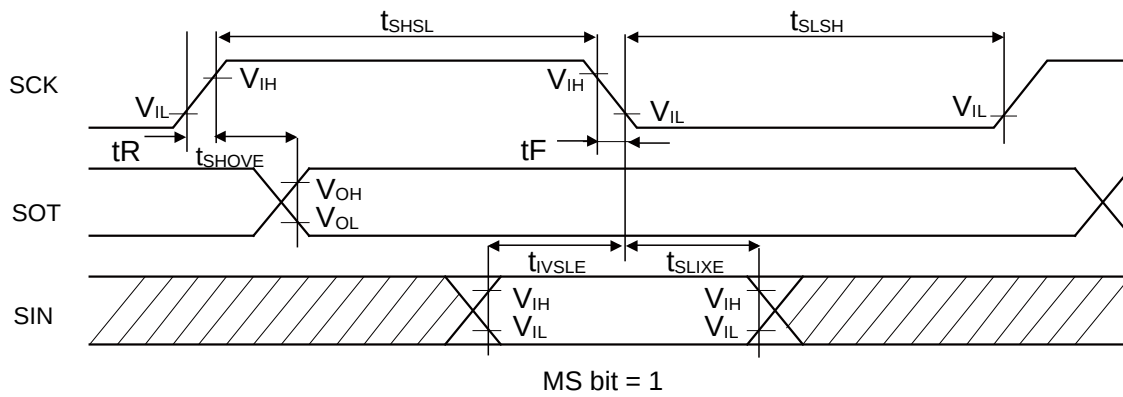
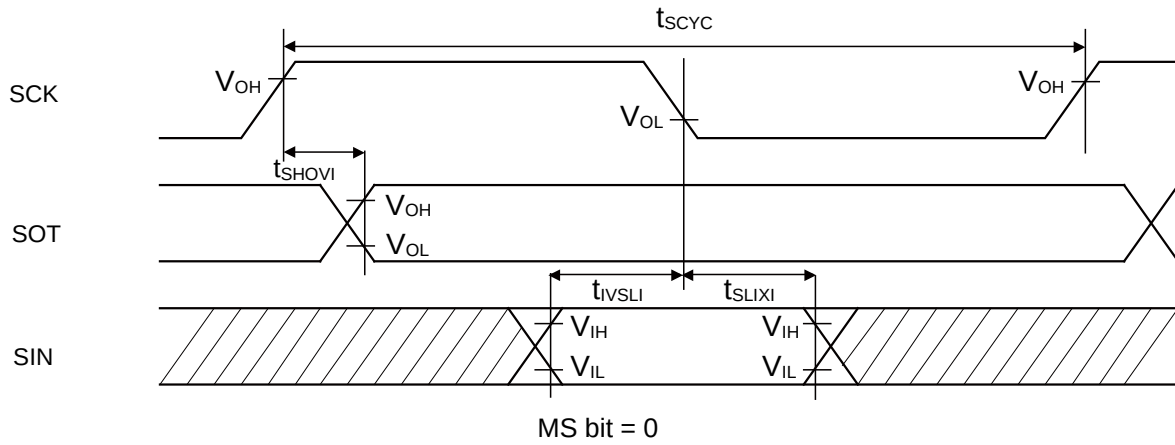

**Synchronous serial (SPI = 0, SCINV = 1)**

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

| Parameter                                     | Symbol      | Pin name   | Conditions                     | $V_{CC} < 4.5\text{V}$ |      | $V_{CC} \geq 4.5\text{V}$ |      | Unit |
|-----------------------------------------------|-------------|------------|--------------------------------|------------------------|------|---------------------------|------|------|
|                                               |             |            |                                | Min                    | Max  | Min                       | Max  |      |
| Baud rate                                     | -           | -          | -                              | -                      | 8    | -                         | 8    | Mbps |
| Serial clock cycle time                       | $t_{SCYC}$  | SCKx       | Internal shift clock operation | $4 t_{CYCP}$           | -    | $4 t_{CYCP}$              | -    | ns   |
| SCK $\uparrow \rightarrow$ SOT delay time     | $t_{SHOVI}$ | SCKx, SOTx |                                | - 30                   | + 30 | - 20                      | + 20 | ns   |
| SIN $\rightarrow$ SCK $\downarrow$ setup time | $t_{IVSLI}$ | SCKx, SINx |                                | 50                     | -    | 30                        | -    | ns   |
| SCK $\downarrow \rightarrow$ SIN hold time    | $t_{SLIXI}$ | SCKx, SINx |                                | 0                      | -    | 0                         | -    | ns   |
| Serial clock "L" pulse width                  | $t_{SLSH}$  | SCKx       | External shift clock operation | $2 t_{CYCP} - 10$      | -    | $2 t_{CYCP} - 10$         | -    | ns   |
| Serial clock "H" pulse width                  | $t_{SHSL}$  | SCKx       |                                | $t_{CYCP} + 10$        | -    | $t_{CYCP} + 10$           | -    | ns   |
| SCK $\uparrow \rightarrow$ SOT delay time     | $t_{SHOVE}$ | SCKx, SOTx |                                | -                      | 50   | -                         | 30   | ns   |
| SIN $\rightarrow$ SCK $\downarrow$ setup time | $t_{IVSLE}$ | SCKx, SINx |                                | 10                     | -    | 10                        | -    | ns   |
| SCK $\downarrow \rightarrow$ SIN hold time    | $t_{SLIXE}$ | SCKx, SINx |                                | 20                     | -    | 20                        | -    | ns   |
| SCK falling time                              | $t_F$       | SCKx       |                                | -                      | 5    | -                         | 5    | ns   |
| SCK rising time                               | $t_R$       | SCKx       |                                | -                      | 5    | -                         | 5    | ns   |

**Notes:**

- The above AC characteristics are for CLK synchronous mode.
- $t_{CYCP}$  represents the APB bus clock cycle time.  
For the number of the APB bus to which Multi-function Serial has been connected, see "8. Block Diagram".
- The characteristics are only applicable when the relocate port numbers are the same.  
For instance, they are not applicable for the combination of SCKx\_0 and SOTx\_1.
- External load capacitance  $C_L = 30\text{ pF}$

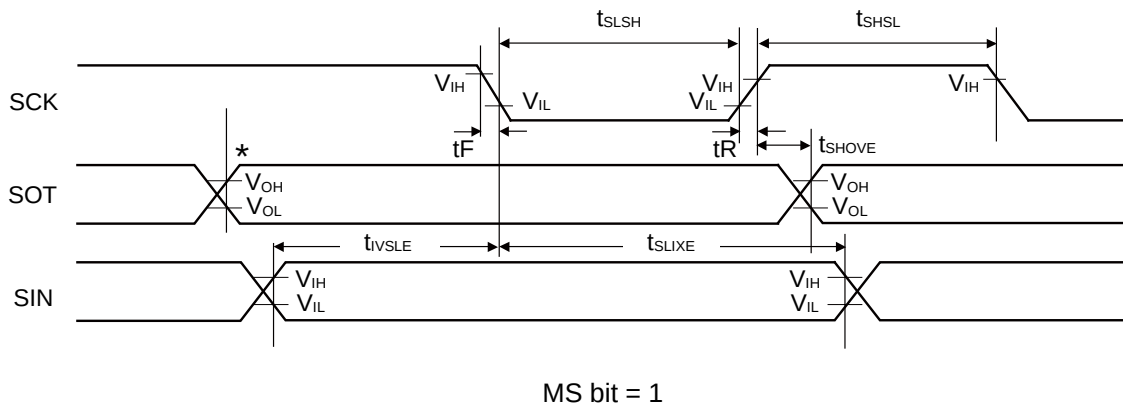
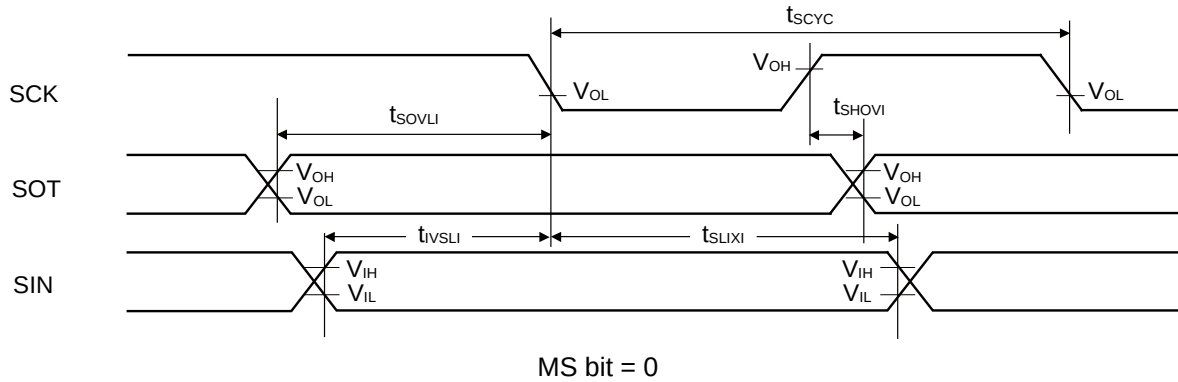


**Synchronous serial (SPI = 1, SCINV = 0)**
 $(V_{CC} = AV_{CC} = 2.7 \text{ V to } 5.5 \text{ V}, V_{SS} = AV_{SS} = 0 \text{ V}, T_a = -40^\circ\text{C to } +105^\circ\text{C})$ 

| Parameter                                     | Symbol      | Pin name   | Conditions                     | $V_{CC} < 4.5 \text{ V}$ |      | $V_{CC} \geq 4.5 \text{ V}$ |      | Unit |
|-----------------------------------------------|-------------|------------|--------------------------------|--------------------------|------|-----------------------------|------|------|
|                                               |             |            |                                | Min                      | Max  | Min                         | Max  |      |
| Baud rate                                     | -           | -          | -                              | -                        | 8    | -                           | 8    | Mbps |
| Serial clock cycle time                       | $t_{SCYC}$  | SCKx       | Internal shift clock operation | $4 t_{CYCP}$             | -    | $4 t_{CYCP}$                | -    | ns   |
| SCK $\uparrow \rightarrow$ SOT delay time     | $t_{SHOVI}$ | SCKx, SOTx |                                | - 30                     | + 30 | - 20                        | + 20 | ns   |
| SIN $\rightarrow$ SCK $\downarrow$ setup time | $t_{IVSLI}$ | SCKx, SINx |                                | 50                       | -    | 30                          | -    | ns   |
| SCK $\downarrow \rightarrow$ SIN hold time    | $t_{SLIXI}$ | SCKx, SINx |                                | 0                        | -    | 0                           | -    | ns   |
| SOT $\rightarrow$ SCK $\downarrow$ delay time | $t_{SOVLI}$ | SCKx, SOTx |                                | $2 t_{CYCP} - 30$        | -    | $2 t_{CYCP} - 30$           | -    | ns   |
| Serial clock "L" pulse width                  | $t_{LSLH}$  | SCKx       | External shift clock operation | $2 t_{CYCP} - 10$        | -    | $2 t_{CYCP} - 10$           | -    | ns   |
| Serial clock "H" pulse width                  | $t_{HSL}$   | SCKx       |                                | $t_{CYCP} + 10$          | -    | $t_{CYCP} + 10$             | -    | ns   |
| SCK $\uparrow \rightarrow$ SOT delay time     | $t_{SHOVE}$ | SCKx, SOTx |                                | -                        | 50   | -                           | 30   | ns   |
| SIN $\rightarrow$ SCK $\downarrow$ setup time | $t_{IVSLE}$ | SCKx, SINx |                                | 10                       | -    | 10                          | -    | ns   |
| SCK $\downarrow \rightarrow$ SIN hold time    | $t_{SLIXE}$ | SCKx, SINx |                                | 20                       | -    | 20                          | -    | ns   |
| SCK falling time                              | $t_F$       | SCKx       |                                | -                        | 5    | -                           | 5    | ns   |
| SCK rising time                               | $t_R$       | SCKx       |                                | -                        | 5    | -                           | 5    | ns   |

**Notes:**

- The above AC characteristics are for CLK synchronous mode.
- $t_{CYCP}$  represents the APB bus clock cycle time.  
For the number of the APB bus to which Multi-function Serial has been connected, see "8. Block Diagram".
- The characteristics are only applicable when the relocate port numbers are the same.  
For instance, they are not applicable for the combination of SCKx\_0 and SOTx\_1.
- External load capacitance  $C_L = 30 \text{ pF}$



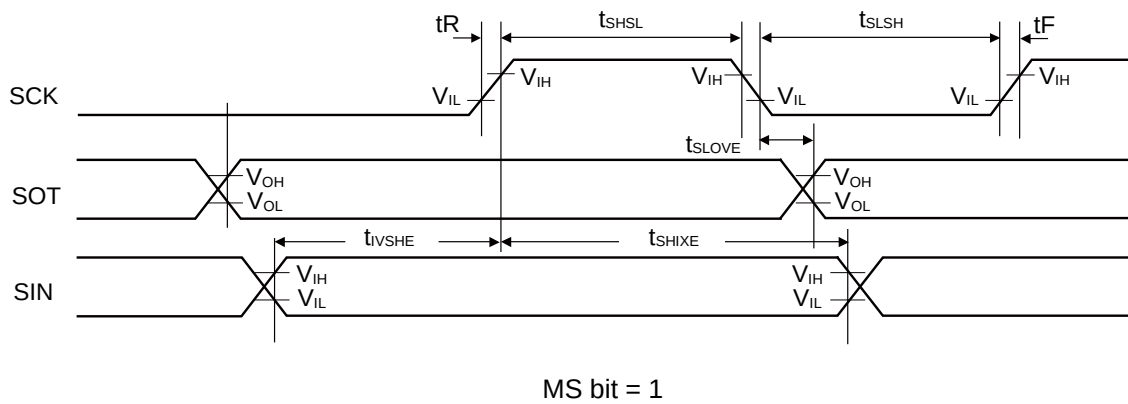
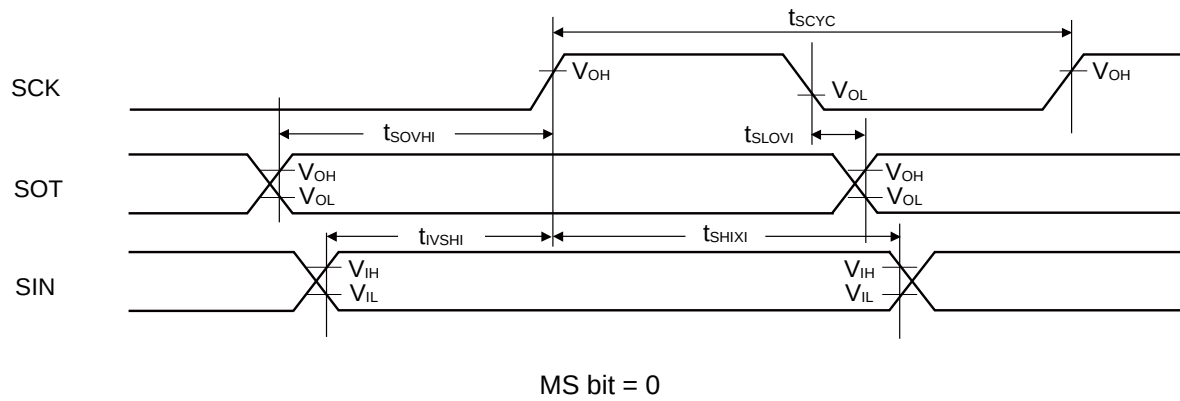
\*: This changes as data is written to the TDR register.

**Synchronous serial (SPI = 1, SCINV = 1)**
 $(V_{CC} = AV_{CC} = 2.7 \text{ V to } 5.5 \text{ V}, V_{SS} = AV_{SS} = 0 \text{ V}, T_a = -40^\circ\text{C to } +105^\circ\text{C})$ 

| Parameter                    | Symbol      | Pin name   | Conditions                     | $V_{CC} < 4.5 \text{ V}$ |      | $V_{CC} \geq 4.5 \text{ V}$ |      | Unit |
|------------------------------|-------------|------------|--------------------------------|--------------------------|------|-----------------------------|------|------|
|                              |             |            |                                | Min                      | Max  | Min                         | Max  |      |
| Baud rate                    | -           | -          | -                              | -                        | 8    | -                           | 8    | Mbps |
| Serial clock cycle time      | $t_{SCYC}$  | SCKx       | Internal shift clock operation | $4 t_{CYCP}$             | -    | $4 t_{CYCP}$                | -    | 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   |
| SOT → SCK ↑ delay time       | $t_{SOVHI}$ | SCKx, SOTx |                                | $2 t_{CYCP} - 30$        | -    | $2 t_{CYCP} - 30$           | -    | ns   |
| Serial clock "L" pulse width | $t_{LSH}$   | SCKx       | External shift clock operation | $2 t_{CYCP} - 10$        | -    | $2 t_{CYCP} - 10$           | -    | ns   |
| Serial clock "H" pulse width | $t_{HSL}$   | 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 falling time             | $t_F$       | SCKx       |                                | -                        | 5    | -                           | 5    | ns   |
| SCK rising time              | $t_R$       | SCKx       |                                | -                        | 5    | -                           | 5    | ns   |

**Notes:**

- The above AC characteristics are for CLK synchronous mode.
- $t_{CYCP}$  represents the APB bus clock cycle time.  
For the number of the APB bus to which Multi-function Serial has been connected, see "8. Block Diagram".
- The characteristics are only applicable when the relocate port numbers are the same.  
For instance, they are not applicable for the combination of SCKx\_0 and SOTx\_1.
- External load capacitance  $C_L = 30 \text{ pF}$



**When using synchronous serial chip select (SCINV = 0, CSLVL=1)**

 (V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V)

| Parameter            | Symbol            | Conditions                     | V <sub>CC</sub> < 4.5V         |                                | V <sub>CC</sub> ≥ 4.5V         |                                | Unit |
|----------------------|-------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|------|
|                      |                   |                                | Min                            | Max                            | Min                            | Max                            |      |
| SCS↓→SCK↓ setup time | t <sub>CSSI</sub> | Internal shift clock operation | (*1)-50                        | (*1)+0                         | (*1)-50                        | (*1)+0                         | ns   |
| SCK↑→SCS↑ hold time  | t <sub>CSHI</sub> |                                | (*2)+0                         | (*2)+50                        | (*2)+0                         | (*2)+50                        | ns   |
| SCS deselect time    | t <sub>CSDI</sub> |                                | (*3)-50<br>+5t <sub>CYCP</sub> | (*3)+50<br>+5t <sub>CYCP</sub> | (*3)-50<br>+5t <sub>CYCP</sub> | (*3)+50<br>+5t <sub>CYCP</sub> | ns   |
| SCS↓→SCK↓ setup time | t <sub>CSSE</sub> | External shift clock operation | 3t <sub>CYCP</sub> +30         | -                              | 3t <sub>CYCP</sub> +30         | -                              | ns   |
| SCK↑→SCS↑ hold time  | t <sub>CSHE</sub> |                                | 0                              | -                              | 0                              | -                              | ns   |
| SCS deselect time    | t <sub>CSE</sub>  |                                | 3t <sub>CYCP</sub> +30         | -                              | 3t <sub>CYCP</sub> +30         | -                              | ns   |
| SCS↓→SUT delay time  | t <sub>DSE</sub>  |                                | -                              | 40                             | -                              | 40                             | ns   |
| SCS↑→SUT delay time  | t <sub>DEE</sub>  |                                | 0                              | -                              | 0                              | -                              | ns   |

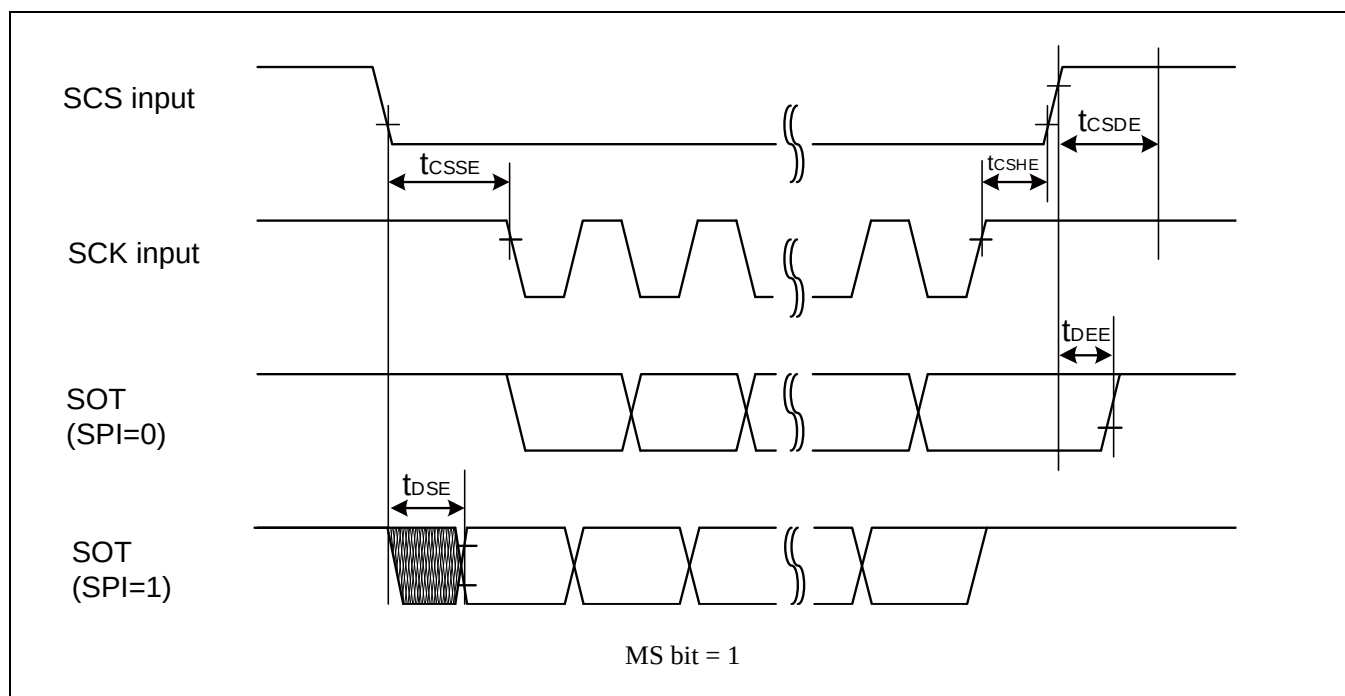
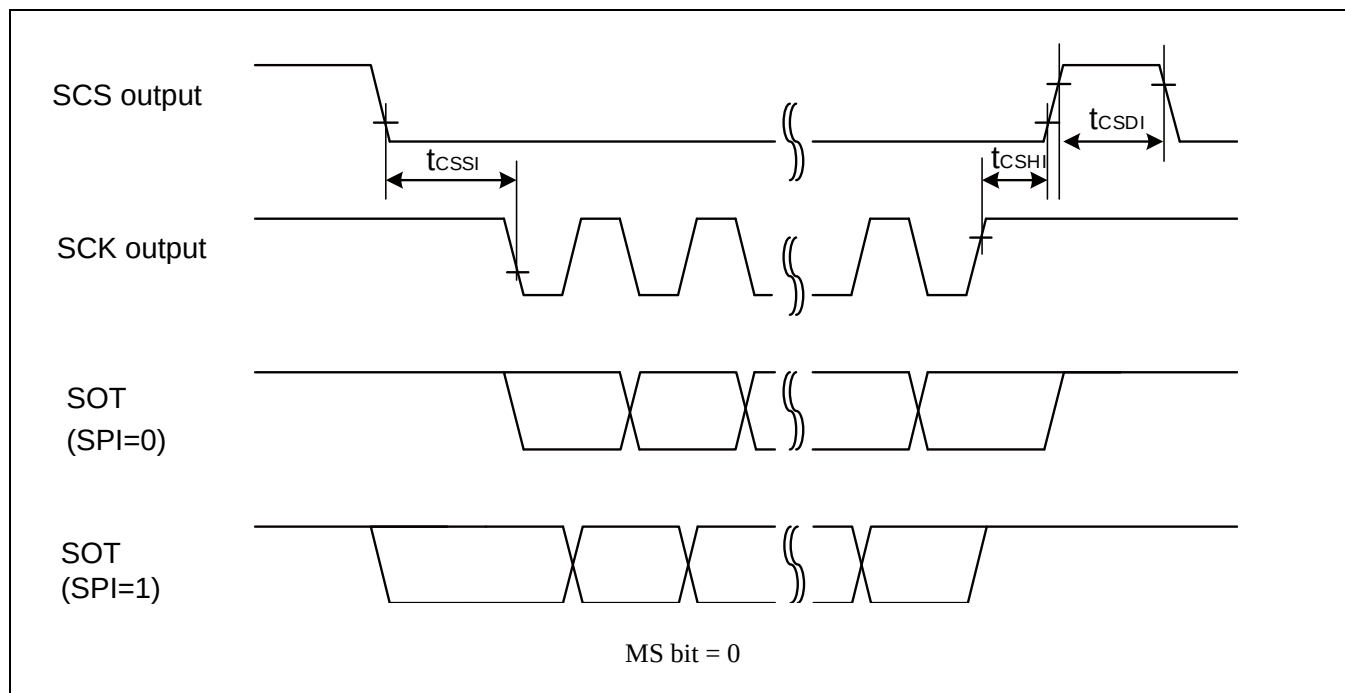
(\*1): CSSU bit value × serial chip select timing operating clock cycle [ns]

(\*2): CSHD bit value × serial chip select timing operating clock cycle [ns]

(\*3): CSDS bit value × serial chip select timing operating clock cycle [ns]

**Notes:**

- t<sub>CYCP</sub> indicates the APB bus clock cycle time.  
About the APB bus number which Multi-function Serial is connected to, see "8. Block Diagram".
- About CSSU, CSHD, CSDS, serial chip select timing operating clock, see "FM0+ Family PERIPHERAL MANUAL".
- The characteristics are only applicable when the relocate port numbers are the same.  
For instance, they are not applicable for the combination of SCKx\_0 and SCSx0\_1.
- When the external load capacitance C<sub>L</sub> = 30pF.



**When using synchronous serial chip select (SCINV = 1, CSLVL=1)**

 (V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V)

| Parameter            | Symbol            | Conditions                     | V <sub>CC</sub> < 4.5V         |                                | V <sub>CC</sub> ≥ 4.5V         |                                | Unit |
|----------------------|-------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|------|
|                      |                   |                                | Min                            | Max                            | Min                            | Max                            |      |
| SCS↓→SCK↑ setup time | t <sub>CSSI</sub> | Internal shift clock operation | (*1)-50                        | (*1)+0                         | (*1)-50                        | (*1)+0                         | ns   |
| SCK↓→SCS↑ hold time  | t <sub>CSHI</sub> |                                | (*2)+0                         | (*2)+50                        | (*2)+0                         | (*2)+50                        | ns   |
| SCS deselect time    | t <sub>CSDI</sub> |                                | (*3)-50<br>+5t <sub>CYCP</sub> | (*3)+50<br>+5t <sub>CYCP</sub> | (*3)-50<br>+5t <sub>CYCP</sub> | (*3)+50<br>+5t <sub>CYCP</sub> | ns   |
| SCS↓→SCK↑ setup time | t <sub>CSSE</sub> | External shift clock operation | 3t <sub>CYCP</sub> +30         | -                              | 3t <sub>CYCP</sub> +30         | -                              | ns   |
| SCK↓→SCS↑ hold time  | t <sub>CSHE</sub> |                                | 0                              | -                              | 0                              | -                              | ns   |
| SCS deselect time    | t <sub>CSDE</sub> |                                | 3t <sub>CYCP</sub> +30         | -                              | 3t <sub>CYCP</sub> +30         | -                              | ns   |
| SCS↓→SOT delay time  | t <sub>DSE</sub>  |                                | -                              | 40                             | -                              | 40                             | ns   |
| SCS↑→SOT delay time  | t <sub>DEE</sub>  |                                | 0                              | -                              | 0                              | -                              | ns   |

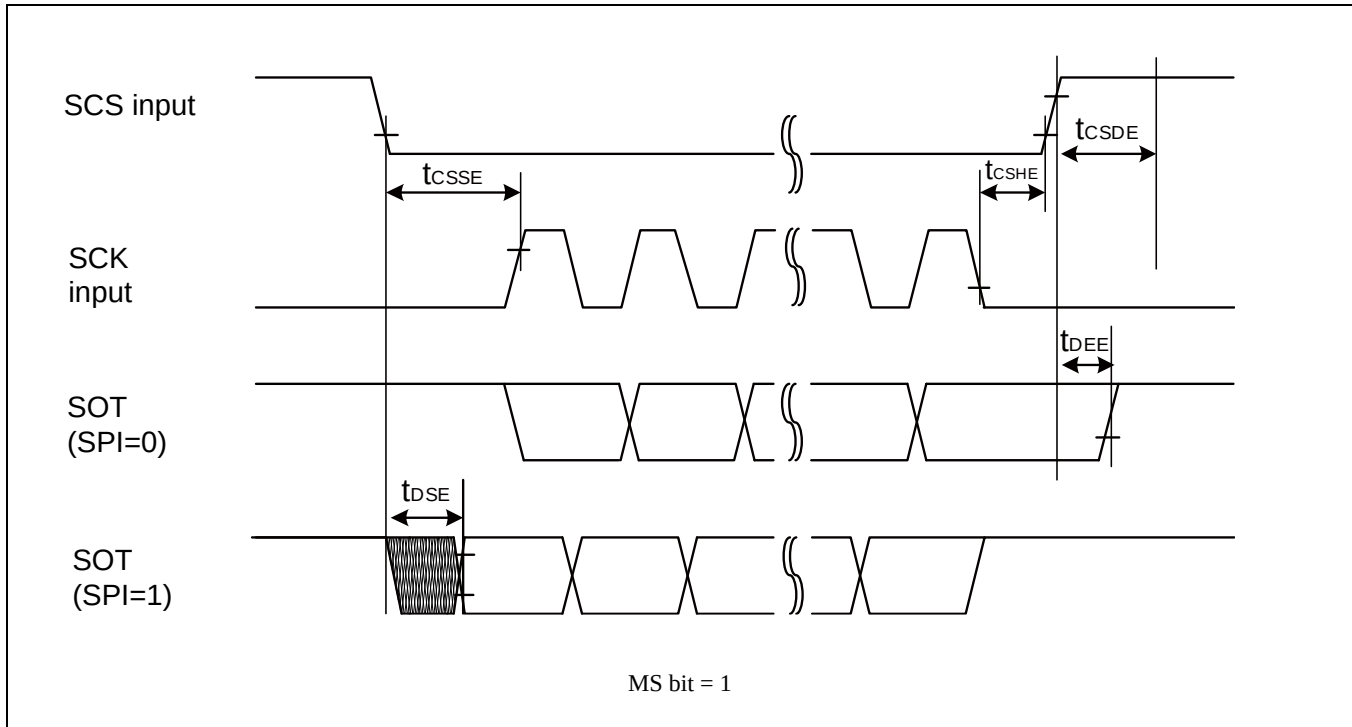
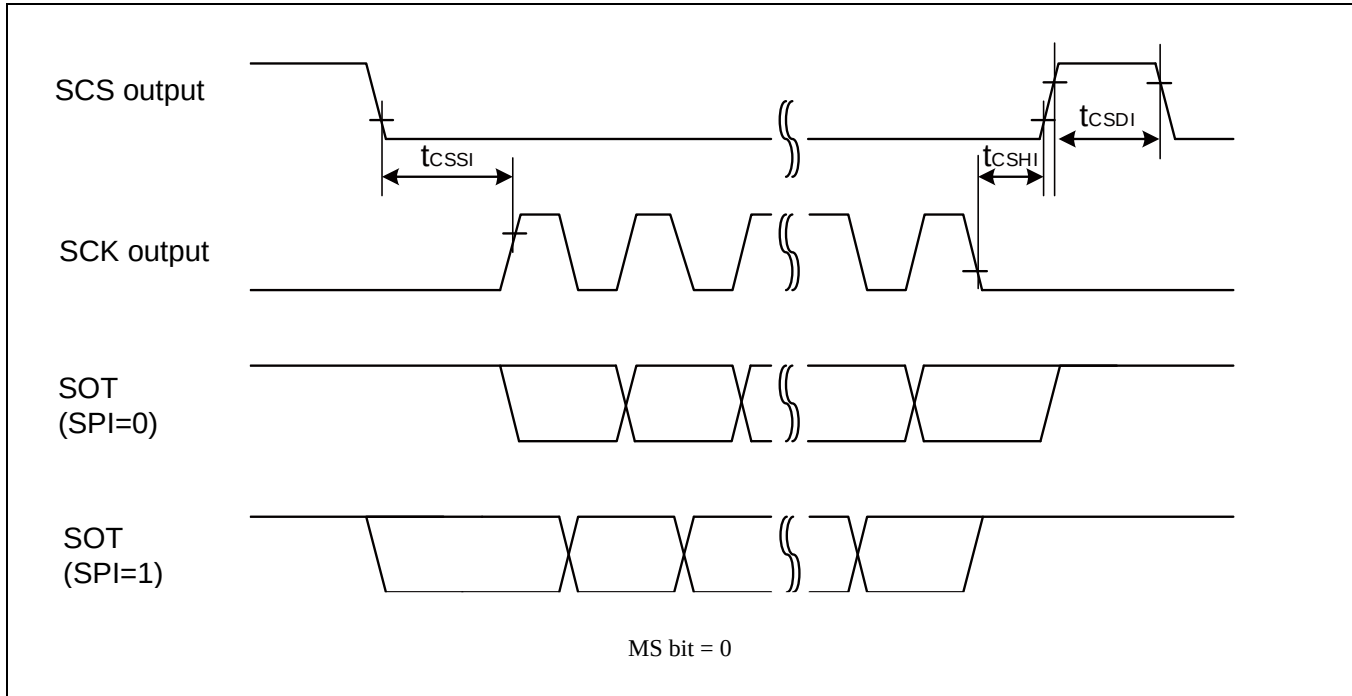
(\*1): CSSU bit value × serial chip select timing operating clock cycle [ns]

(\*2): CSHD bit value × serial chip select timing operating clock cycle [ns]

(\*3): CSDS bit value × serial chip select timing operating clock cycle [ns]

**Notes:**

- t<sub>CYCP</sub> indicates the APB bus clock cycle time.  
About the APB bus number which Multi-function Serial is connected to, see "8. Block Diagram".
- About CSSU, CSHD, CSDS, serial chip select timing operating clock, see "FM0+ Family PERIPHERAL MANUAL".
- The characteristics are only applicable when the relocate port numbers are the same.  
For instance, they are not applicable for the combination of SCKx\_0 and SCSx0\_1.
- When the external load capacitance C<sub>L</sub> = 30pF.



**When using synchronous serial chip select (SCINV = 0, CSLVL=0)**

 (V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V)

| Parameter            | Symbol            | Conditions                     | V <sub>CC</sub> < 4.5V         |                                | V <sub>CC</sub> ≥ 4.5V         |                                | Unit |
|----------------------|-------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|------|
|                      |                   |                                | Min                            | Max                            | Min                            | Max                            |      |
| SCS↑→SCK↓ setup time | t <sub>CSSI</sub> | Internal shift clock operation | (*1)-50                        | (*1)+0                         | (*1)-50                        | (*1)+0                         | ns   |
| SCK↑→SCS↓ hold time  | t <sub>CSHI</sub> |                                | (*2)+0                         | (*2)+50                        | (*2)+0                         | (*2)+50                        | ns   |
| SCS deselect time    | t <sub>CSDI</sub> |                                | (*3)-50<br>+5t <sub>CYCP</sub> | (*3)+50<br>+5t <sub>CYCP</sub> | (*3)-50<br>+5t <sub>CYCP</sub> | (*3)+50<br>+5t <sub>CYCP</sub> | ns   |
| SCS↑→SCK↓ setup time | t <sub>CSSE</sub> | External shift clock operation | 3t <sub>CYCP</sub> +30         | -                              | 3t <sub>CYCP</sub> +30         | -                              | ns   |
| SCK↑→SCS↓ hold time  | t <sub>CSHE</sub> |                                | 0                              | -                              | 0                              | -                              | ns   |
| SCS deselect time    | t <sub>CSDE</sub> |                                | 3t <sub>CYCP</sub> +30         | -                              | 3t <sub>CYCP</sub> +30         | -                              | ns   |
| SCS↑→SOT delay time  | t <sub>DSE</sub>  |                                | -                              | 40                             | -                              | 40                             | ns   |
| SCS↓→SOT delay time  | t <sub>DSE</sub>  |                                | 0                              | -                              | 0                              | -                              | ns   |

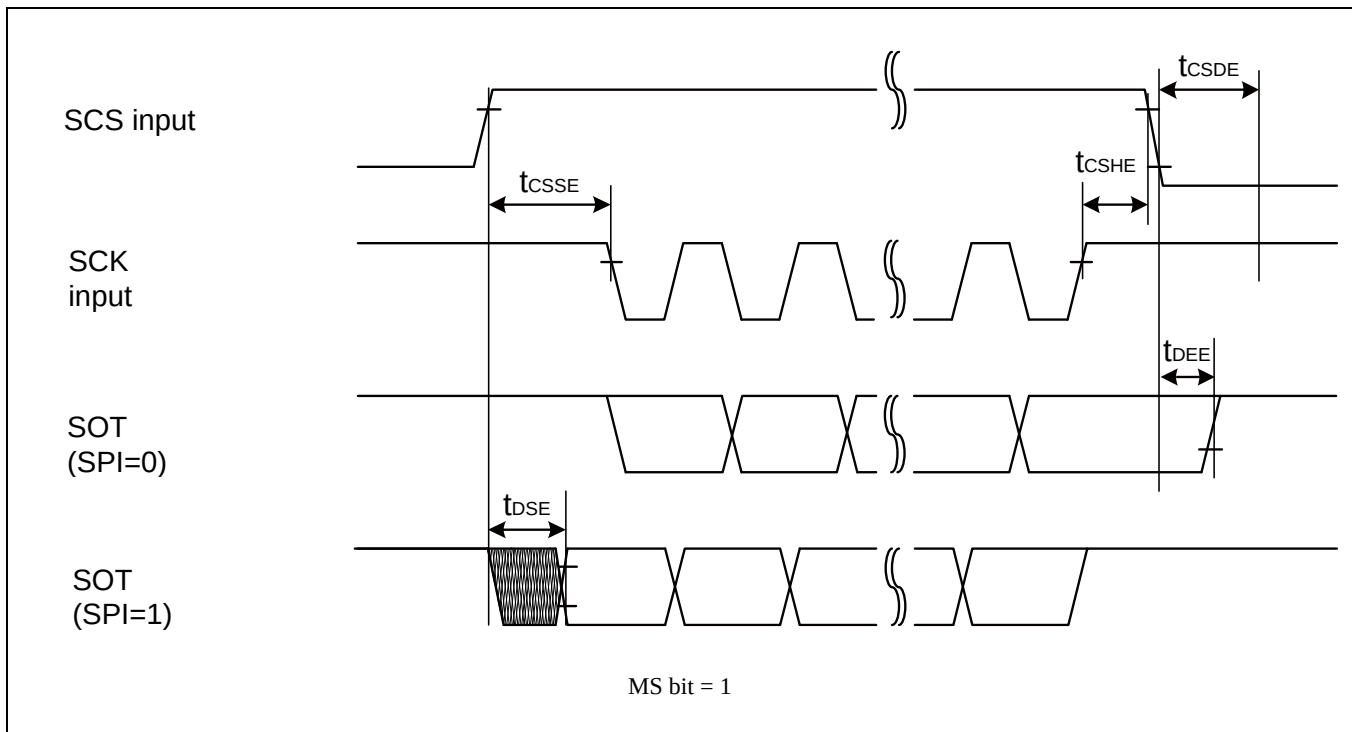
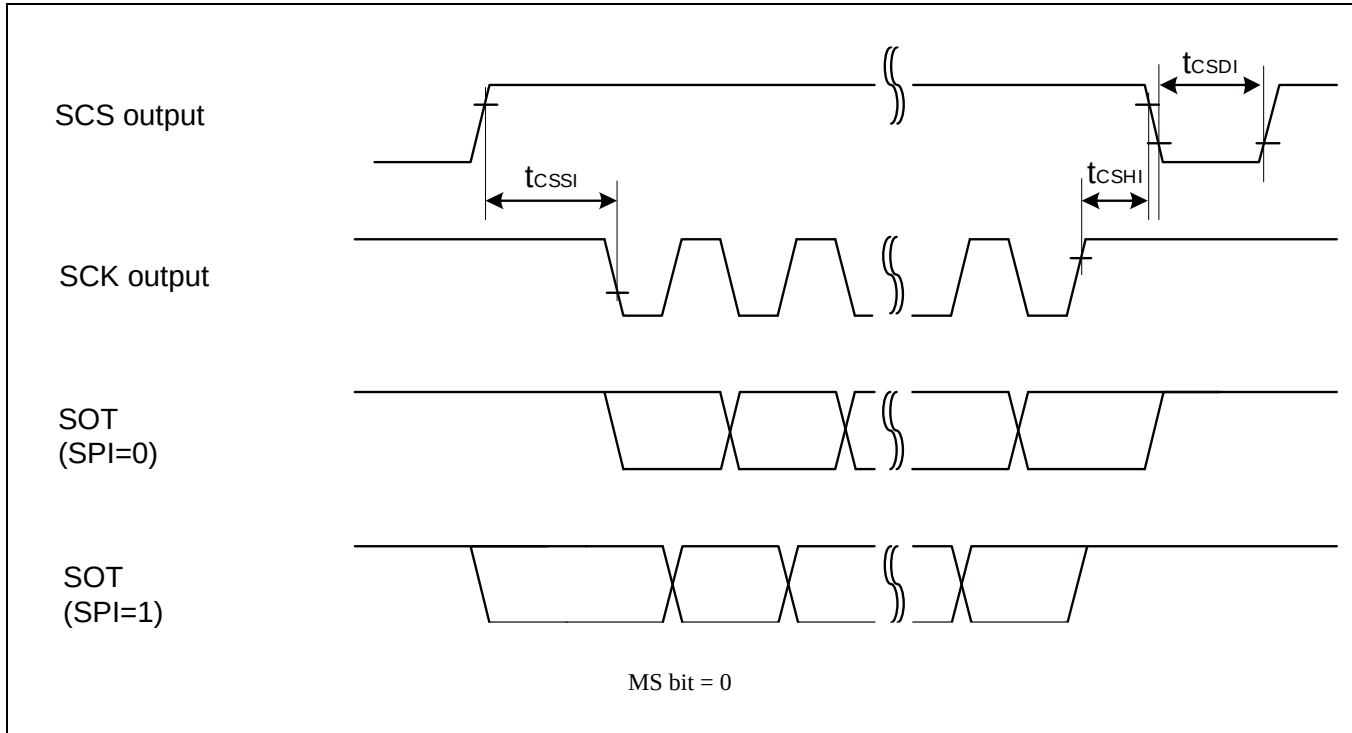
(\*1): CSSU bit value × serial chip select timing operating clock cycle [ns]

(\*2): CSHD bit value × serial chip select timing operating clock cycle [ns]

(\*3): CSDS bit value × serial chip select timing operating clock cycle [ns]

**Notes:**

- t<sub>CYCP</sub> indicates the APB bus clock cycle time.  
About the APB bus number which Multi-function Serial is connected to, see "8. Block Diagram".
- About CSSU, CSHD, CSDS, serial chip select timing operating clock, see "FM0+ Family PERIPHERAL MANUAL".
- The characteristics are only applicable when the relocate port numbers are the same.  
For instance, they are not applicable for the combination of SCKx\_0 and SCSx0\_1.
- When the external load capacitance C<sub>L</sub> = 30pF.



**When using synchronous serial chip select (SCINV = 1, CSLVL=0)**

 (V<sub>CC</sub> = 2.7V to 5.5V, V<sub>SS</sub> = 0V)

| Parameter            | Symbol            | Conditions                     | V <sub>CC</sub> < 4.5V         |                                | V <sub>CC</sub> ≥ 4.5V         |                                | Unit |
|----------------------|-------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|------|
|                      |                   |                                | Min                            | Max                            | Min                            | Max                            |      |
| SCS↑→SCK↑ setup time | t <sub>CSSI</sub> | Internal shift clock operation | (*1)-50                        | (*1)+0                         | (*1)-50                        | (*1)+0                         | ns   |
| SCK↓→SCS↓ hold time  | t <sub>CSHI</sub> |                                | (*2)+0                         | (*2)+50                        | (*2)+0                         | (*2)+50                        | ns   |
| SCS deselect time    | t <sub>CSDI</sub> |                                | (*3)-50<br>+5t <sub>CYCP</sub> | (*3)+50<br>+5t <sub>CYCP</sub> | (*3)-50<br>+5t <sub>CYCP</sub> | (*3)+50<br>+5t <sub>CYCP</sub> | ns   |
| SCS↑→SCK↑ setup time | t <sub>CSSE</sub> | External shift clock operation | 3t <sub>CYCP</sub> +30         | -                              | 3t <sub>CYCP</sub> +30         | -                              | ns   |
| SCK↓→SCS↓ hold time  | t <sub>CSHE</sub> |                                | 0                              | -                              | 0                              | -                              | ns   |
| SCS deselect time    | t <sub>CSDE</sub> |                                | 3t <sub>CYCP</sub> +30         | -                              | 3t <sub>CYCP</sub> +30         | -                              | ns   |
| SCS↑→SOT delay time  | t <sub>DSE</sub>  |                                | -                              | 40                             | -                              | 40                             | ns   |
| SCS↓→SOT delay time  | t <sub>DSE</sub>  |                                | 0                              | -                              | 0                              | -                              | ns   |

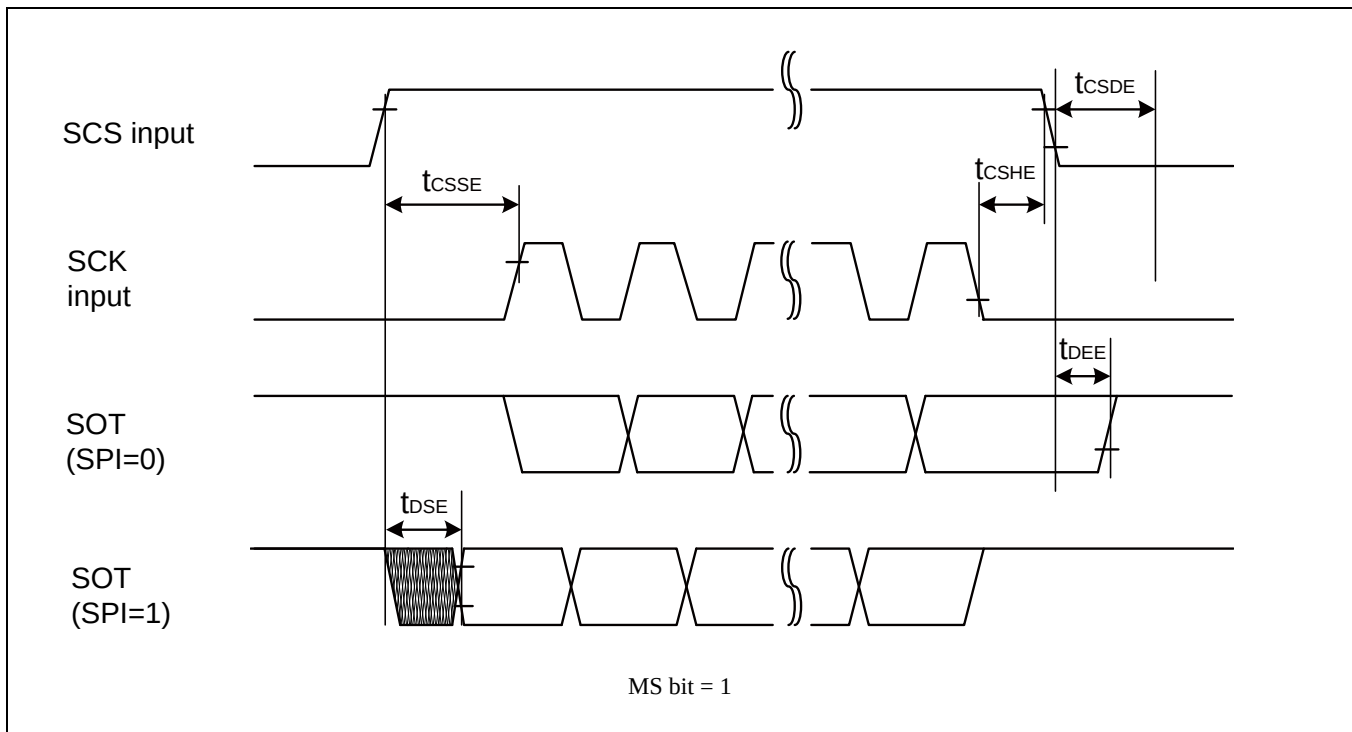
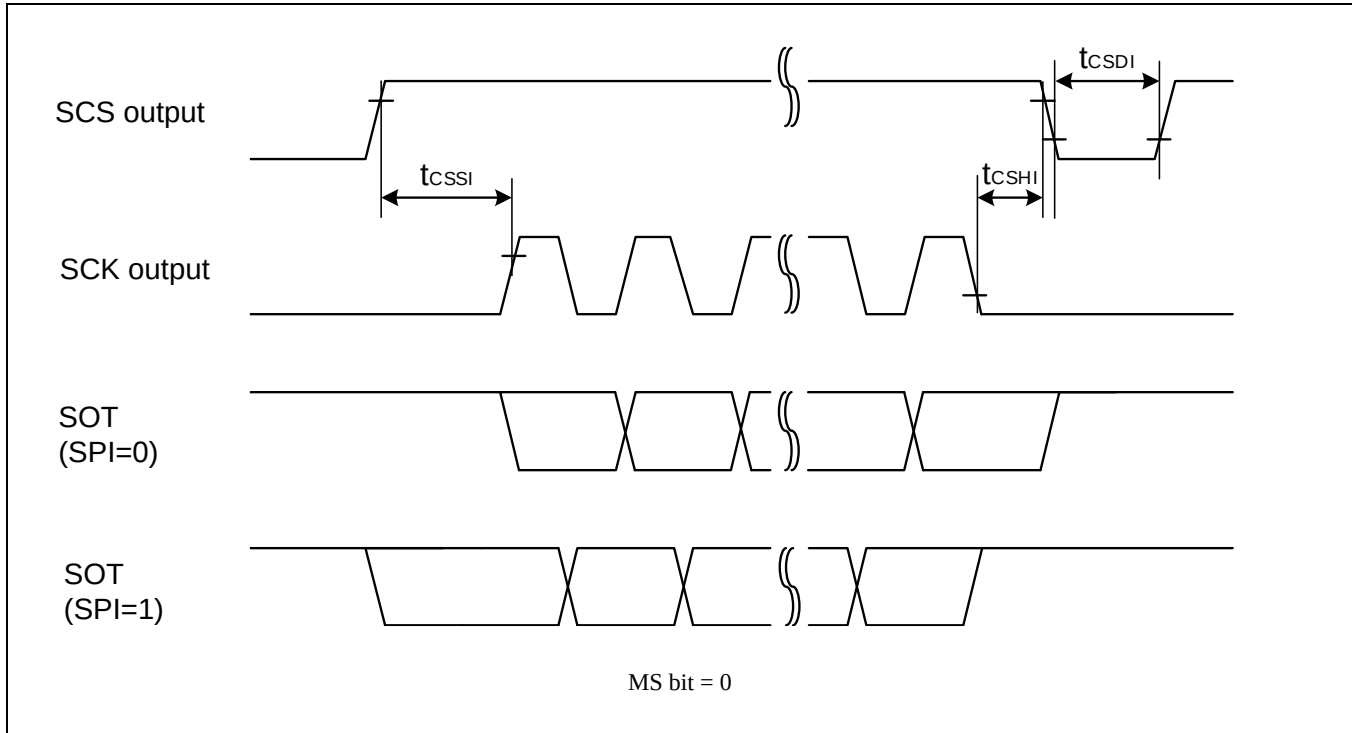
(\*1): CSSU bit value × serial chip select timing operating clock cycle [ns]

(\*2): CSHD bit value × serial chip select timing operating clock cycle [ns]

(\*3): CSDS bit value × serial chip select timing operating clock cycle [ns]

**Notes:**

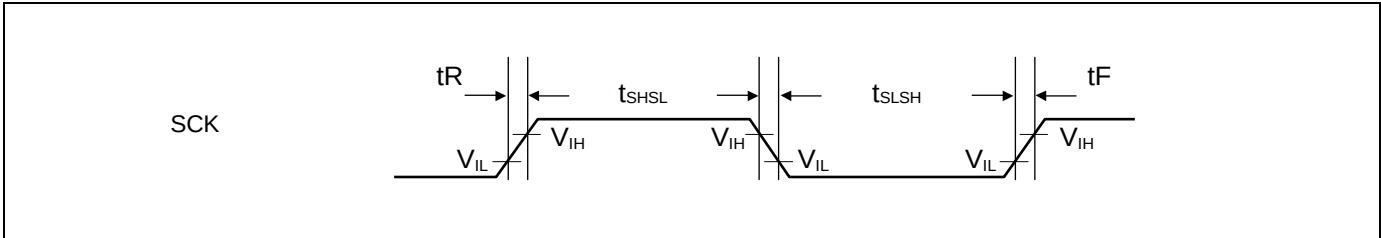
- t<sub>CYCP</sub> indicates the APB bus clock cycle time.  
About the APB bus number which Multi-function Serial is connected to, see "8. Block Diagram".
- About CSSU, CSHD, CSDS, serial chip select timing operating clock, see "FM0+ Family PERIPHERAL MANUAL".
- The characteristics are only applicable when the relocate port numbers are the same.  
For instance, they are not applicable for the combination of SCKx\_0 and SCSx0\_1.
- When the external load capacitance C<sub>L</sub> = 30pF.



**External clock (EXT = 1): asynchronous only**

 ( $V_{CC} = AV_{CC} = 2.7 \text{ V to } 5.5 \text{ V}$ ,  $V_{SS} = AV_{SS} = 0 \text{ V}$ ,  $T_a = -40^{\circ}\text{C to } +105^{\circ}\text{C}$ )

| Parameter                    | Symbol     | Conditions            | Value           |     | Unit | Remarks |
|------------------------------|------------|-----------------------|-----------------|-----|------|---------|
|                              |            |                       | Min             | Max |      |         |
| Serial clock "L" pulse width | $t_{SLSH}$ | $C_L = 30 \text{ pF}$ | $t_{CYCP} + 10$ | -   | ns   |         |
| Serial clock "H" pulse width | $t_{SHSL}$ |                       | $t_{CYCP} + 10$ | -   | ns   |         |
| SCK falling time             | $t_F$      |                       | -               | 5   | ns   |         |
| SCK rising time              | $t_R$      |                       | -               | 5   | ns   |         |



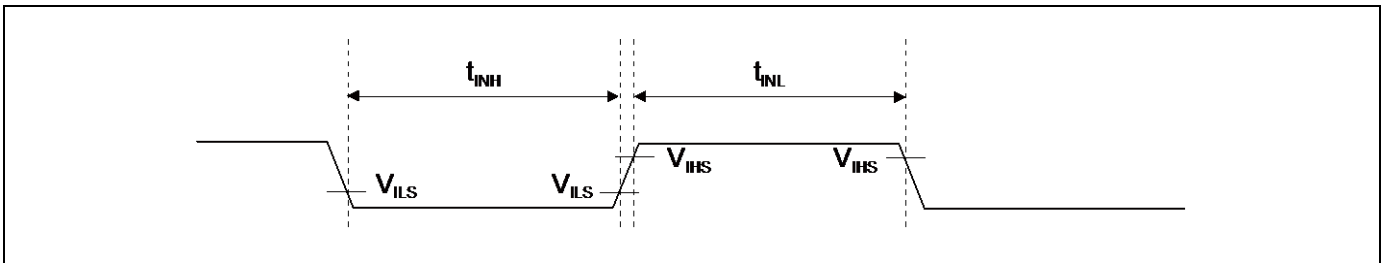
#### 12.4.10 External Input Timing

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

| Parameter         | Symbol                | Pin name    | Conditions | Value                   |     | Unit | Remarks                     |
|-------------------|-----------------------|-------------|------------|-------------------------|-----|------|-----------------------------|
|                   |                       |             |            | Min                     | Max |      |                             |
| Input pulse width | $t_{INH}$ , $t_{INL}$ | ADTGx       | -          | $2 t_{CYCP}^{*1}$       | -   | ns   | A/D converter trigger input |
|                   |                       | FRCKx       |            |                         |     |      | Free-run timer input clock  |
|                   |                       | ICxx        |            |                         |     |      | Input capture               |
|                   |                       | DTTlxX      | -          | $2 t_{CYCP}^{*1}$       | -   | ns   | Wave form generator         |
|                   |                       | INTxx, NMIX | -          | $2 t_{CYCP} + 100^{*1}$ | -   | ns   | External interrupt, NMI     |
|                   |                       |             |            | 500 <sup>*2</sup>       | -   | ns   |                             |

\*1:  $t_{CYCP}$  represents the APB bus clock cycle time except when the APB bus clock stops in STOP mode or in TIMER mode. For the number of the APB bus to which the Multi-function Timer is connected and that of the APB bus to which the External Interrupt Controller is connected, see "8. Block Diagram".

\*2: In STOP mode and TIMER mode

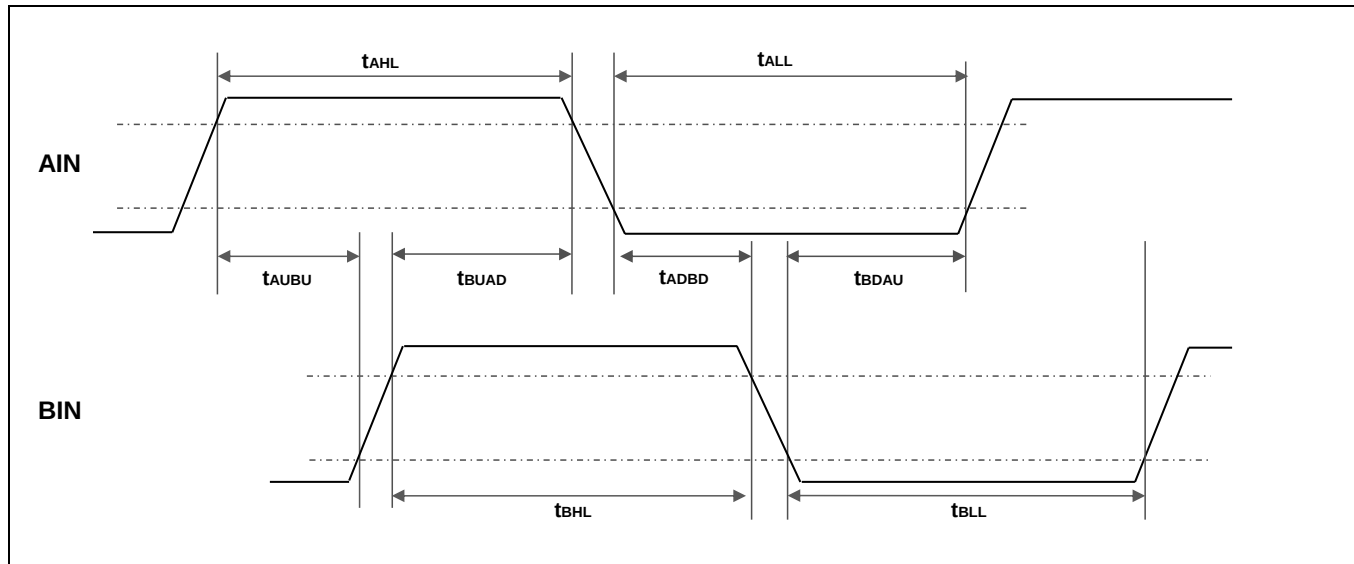


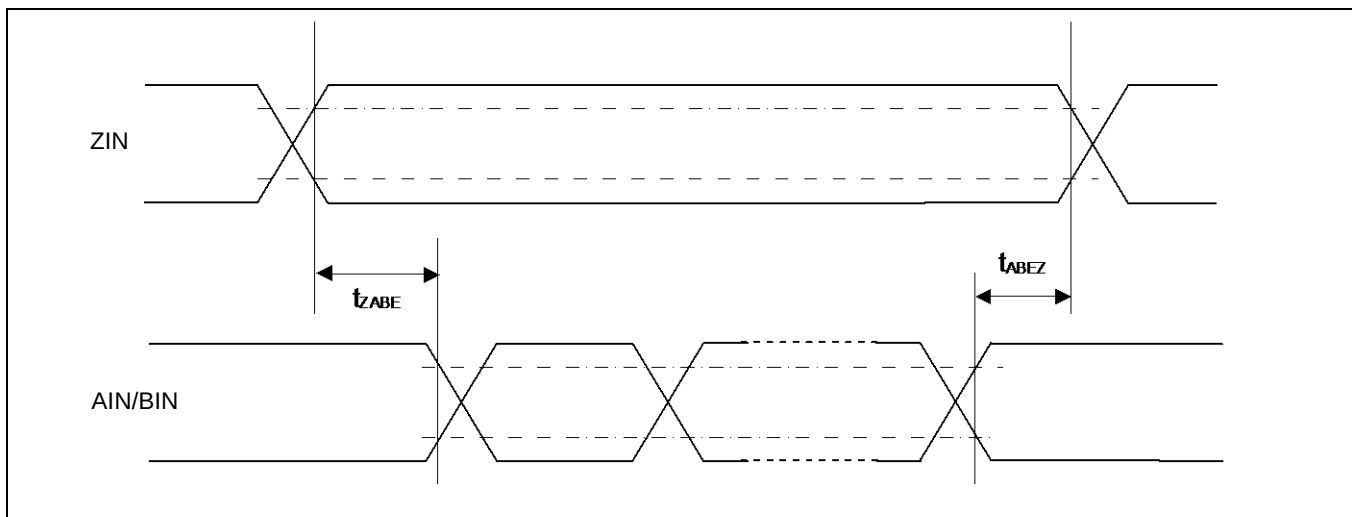
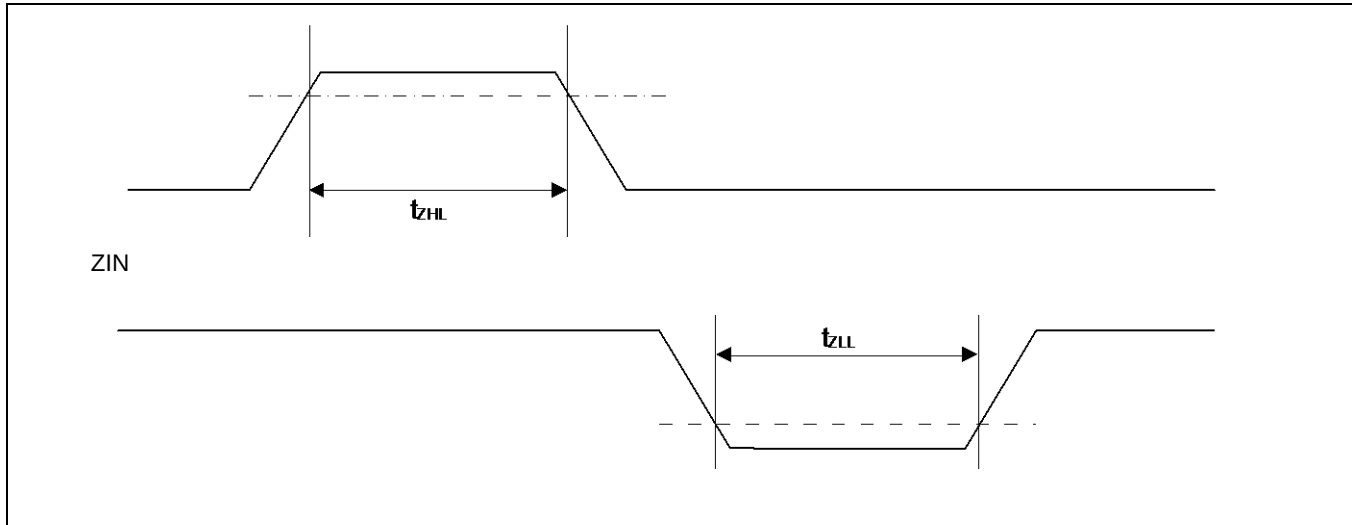
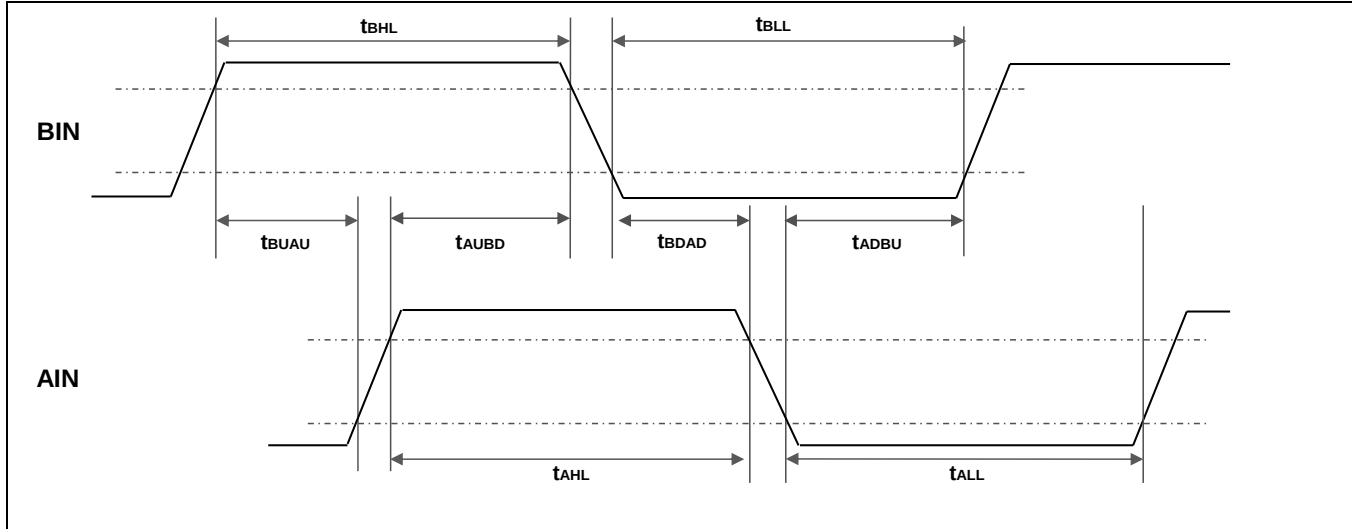
### 12.4.11 QPRC Timing

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

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

\*:  $t_{CYCP}$  represents the APB bus clock cycle time except when the APB bus clock stops in STOP mode or in TIMER mode. For the number of the APB bus to which the QPRC is connected, see "8. Block Diagram".





### 12.4.12 I<sup>2</sup>C Timing

(V<sub>CC</sub> = AV<sub>CC</sub> = 2.7 V to 5.5 V, V<sub>SS</sub> = AV<sub>SS</sub> = 0 V, Ta = - 40°C to + 105°C)

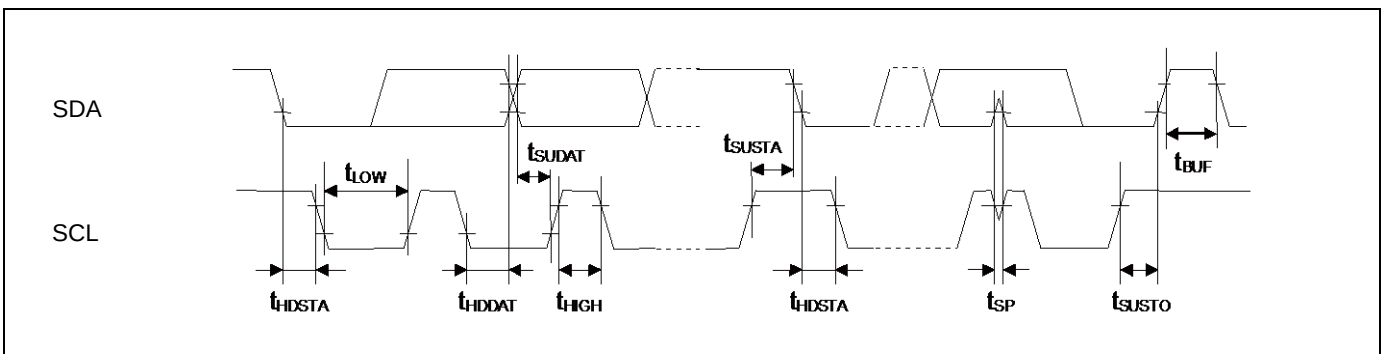
| Parameter                                                    | Symbol             | Conditions                                                                      | Standard-mode                      |                    | Fast-mode                          |                   | Unit | Remarks |
|--------------------------------------------------------------|--------------------|---------------------------------------------------------------------------------|------------------------------------|--------------------|------------------------------------|-------------------|------|---------|
|                                                              |                    |                                                                                 | Min                                | Max                | Min                                | Max               |      |         |
| SCL clock frequency                                          | F <sub>SCL</sub>   | C <sub>L</sub> = 30 pF,<br>R = (V <sub>p</sub> /I <sub>OL</sub> )* <sup>1</sup> | 0                                  | 100                | 0                                  | 400               | kHz  |         |
| (Repeated) START condition hold time<br>SDA ↓ → SCL ↓        | t <sub>HDSTA</sub> |                                                                                 | 4.0                                | -                  | 0.6                                | -                 | μs   |         |
| SCL clock "L" width                                          | t <sub>LOW</sub>   |                                                                                 | 4.7                                | -                  | 1.3                                | -                 | μs   |         |
| SCL clock "H" width                                          | t <sub>HIGH</sub>  |                                                                                 | 4.0                                | -                  | 0.6                                | -                 | μs   |         |
| (Repeated) START setup time<br>SCL ↑ → SDA ↓                 | t <sub>SUSTA</sub> |                                                                                 | 4.7                                | -                  | 0.6                                | -                 | μs   |         |
| Data hold time<br>SCL ↓ → SDA ↓ ↑                            | t <sub>HDDAT</sub> |                                                                                 | 0                                  | 3.45* <sup>2</sup> | 0                                  | 0.9* <sup>3</sup> | μs   |         |
| Data setup time<br>SDA ↓ ↑ → SCL ↑                           | t <sub>SUDAT</sub> |                                                                                 | 250                                | -                  | 100                                | -                 | ns   |         |
| STOP condition setup time<br>SCL ↑ → SDA ↑                   | t <sub>SUSTO</sub> |                                                                                 | 4.0                                | -                  | 0.6                                | -                 | μs   |         |
| Bus free time between "STOP condition" and "START condition" | t <sub>BUF</sub>   |                                                                                 | 4.7                                | -                  | 1.3                                | -                 | μs   |         |
| Noise filter                                                 | t <sub>SP</sub>    | -                                                                               | 2 t <sub>CYCP</sub> * <sup>4</sup> | -                  | 2 t <sub>CYCP</sub> * <sup>4</sup> | -                 | ns   |         |

\*1: R represents the pull-up resistance of the SCL and SDA lines, and C<sub>L</sub> the load capacitance of the SCL and SDA lines. V<sub>p</sub> represents the power supply voltage of the pull-up resistance, and I<sub>OL</sub> the V<sub>OL</sub> guaranteed current.

\*2: The maximum t<sub>HDDAT</sub> must satisfy at least the condition that the period during which the device is holding the SCL signal at "L" (t<sub>LOW</sub>) does not extend.

\*3: A Fast-mode I<sup>2</sup>C bus device can be used in a Standard-mode I<sup>2</sup>C bus system, provided that the condition of "t<sub>SUDAT</sub> ≥ 250 ns" is fulfilled.

\*4: t<sub>CYCP</sub> represents the APB bus clock cycle time.  
 For the number of the APB bus to which the I<sup>2</sup>C is connected, see "8. Block Diagram".  
 To use Standard-mode, set the APB bus clock at 2MHz or more.  
 To use Fast-mode, set the APB bus clock at 8 MHz or more.



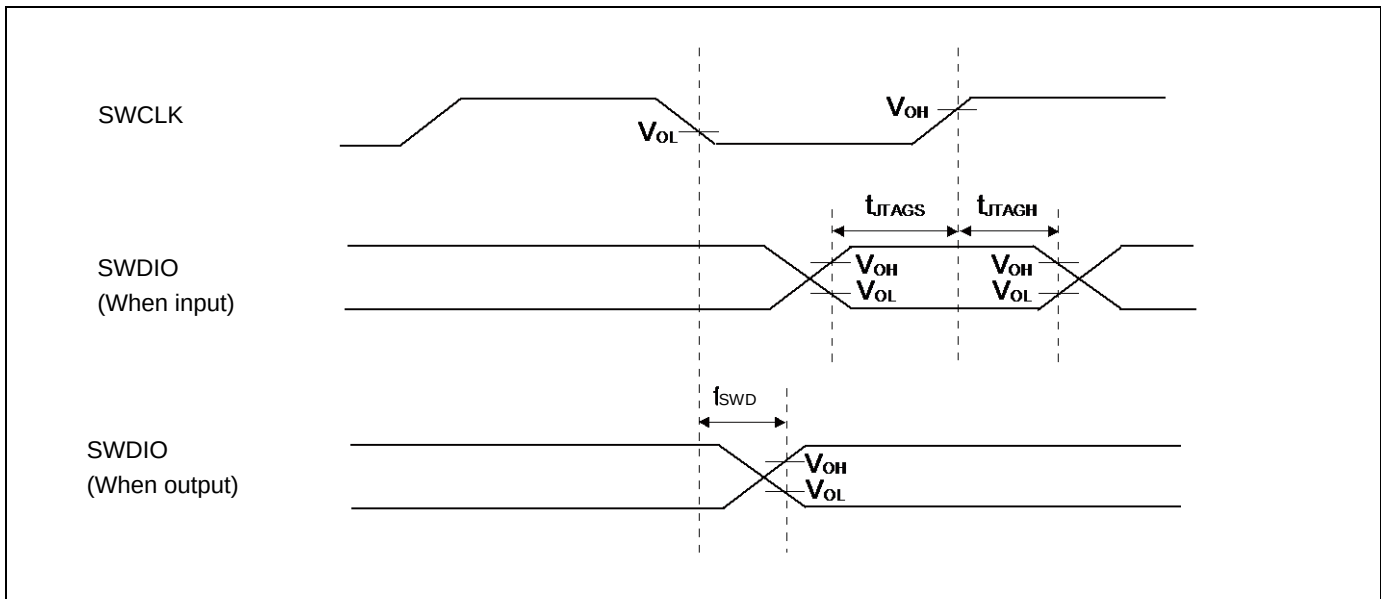
### 12.4.13 SW-DP Timing

( $V_{CC} = AV_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

| Parameter        | Symbol    | Pin name        | Conditions | Value |     | Unit | Remarks |
|------------------|-----------|-----------------|------------|-------|-----|------|---------|
|                  |           |                 |            | Min   | Max |      |         |
| SWDIO setup time | $t_{SWS}$ | SWCLK,<br>SWDIO | -          | 15    | -   | ns   |         |
| SWDIO hold time  | $t_{SWH}$ | SWCLK,<br>SWDIO | -          | 15    | -   | ns   |         |
| SWDIO delay time | $t_{SWD}$ | SWCLK,<br>SWDIO | -          | -     | 45  | ns   |         |

#### Note:

- External load capacitance  $C_L = 30\text{ pF}$



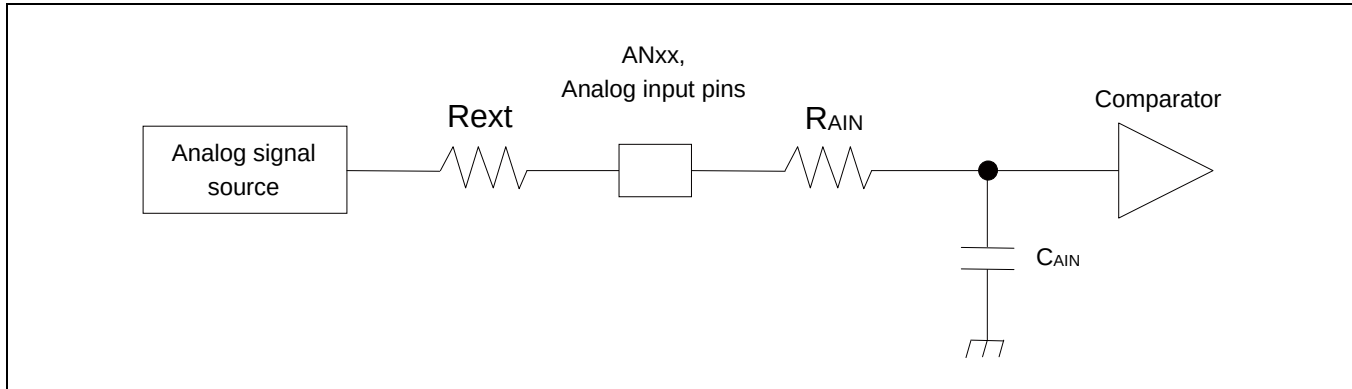
## 12.5 12-bit A/D Converter

### Electrical characteristics of A/D Converter

( $V_{CC} = AV_{CC} = 2.7\text{ V}$  to  $5.5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -40^{\circ}\text{C}$  to  $+105^{\circ}\text{C}$ )

| Parameter                                     | Symbol           | Pin name | Value                |     |                      | Unit          | Remarks                                    |
|-----------------------------------------------|------------------|----------|----------------------|-----|----------------------|---------------|--------------------------------------------|
|                                               |                  |          | Min                  | Typ | Max                  |               |                                            |
| Resolution                                    | -                | -        | -                    | -   | 12                   | bit           |                                            |
| Integral Nonlinearity                         | -                | -        | - 4.5                | -   | 4.5                  | LSB           |                                            |
| Differential Nonlinearity                     | -                | -        | - 2.5                | -   | + 2.5                | LSB           |                                            |
| Zero transition voltage                       | $V_{ZT}$         | ANxx     | - 20                 | -   | + 20                 | mV            |                                            |
| Full-scale transition voltage                 | $V_{FST}$        | ANxx     | AVRH - 20            | -   | AVRH+ 20             | mV            | S6E1A1xC0A                                 |
|                                               |                  |          | AV <sub>CC</sub> -20 | -   | AV <sub>CC</sub> +20 |               | S6E1A1xB0A                                 |
| Conversion time                               | -                | -        | 0.8* <sup>1</sup>    | -   | -                    | $\mu\text{s}$ | S6E1A1xC0A<br>AV <sub>CC</sub> $\geq$ 4.5V |
|                                               |                  |          | 2.0* <sup>1</sup>    | -   | -                    |               | S6E1A1xB0A                                 |
| Sampling time* <sup>2</sup>                   | Ts               | -        | 0.24                 | -   | 10                   | $\mu\text{s}$ | S6E1A1xC0A<br>AV <sub>CC</sub> $\geq$ 4.5V |
|                                               |                  |          | 0.3                  |     |                      |               | S6E1A1xC0A<br>AV <sub>CC</sub> < 4.5V      |
|                                               |                  |          | 0.6                  |     |                      |               | S6E1A1xB0A                                 |
| Compare clock cycle* <sup>3</sup>             | Tcck             | -        | 40                   | -   | 1000                 | ns            | S6E1A1xC0A<br>AV <sub>CC</sub> $\geq$ 4.5V |
|                                               |                  |          | 50                   |     |                      |               | S6E1A1xC0A<br>AV <sub>CC</sub> < 4.5V      |
|                                               |                  |          | 100                  |     |                      |               | S6E1A1xB0A                                 |
| State transition time to operation permission | Tstt             | -        | -                    | -   | 1.0                  | $\mu\text{s}$ |                                            |
| Analog input capacity                         | C <sub>AIN</sub> | -        | -                    | -   | 9.7                  | pF            |                                            |
| Analog input resistance                       | R <sub>AIN</sub> | -        | -                    | -   | 1.6                  | k $\Omega$    | AV <sub>CC</sub> $\geq$ 4.5V               |
|                                               |                  |          |                      |     | 2.3                  |               | AV <sub>CC</sub> < 4.5V                    |
| Interchannel disparity                        | -                | -        | -                    | -   | 4                    | LSB           |                                            |
| Analog port input current                     | -                | ANxx     | -                    | -   | 5                    | $\mu\text{A}$ |                                            |
| Analog input voltage                          | -                | ANxx     | AV <sub>SS</sub>     | -   | AVRH                 | V             | S6E1A1xC0A                                 |
|                                               |                  |          | AV <sub>SS</sub>     | -   | AV <sub>CC</sub>     |               | S6E1A1xB0A                                 |
| Reference voltage                             | -                | AVRH     | 2.7                  | -   | AV <sub>CC</sub>     | V             | Only S6E1A1xB0A                            |

- \*1: The conversion time is the value of "sampling time (Ts) + compare time (Tc)".  
 The minimum conversion time is computed according to the following conditions: sampling time = 240 ns, compare time = 560 ns (AV<sub>CC</sub>  $\geq$  4.5 V). Must be set 25MHz to the Base clock (HCLK).  
 Ensure that the conversion time satisfies the specifications of the sampling time (Ts) and compare clock cycle (Tcck).  
 For details of the settings of the sampling time and compare clock cycle, refer to "CHAPTER: A/D Converter" in "FM0+ Family PERIPHERAL MANUAL Analog Macro Part".  
 The register settings of the A/D Converter are reflected in the operation according to the APB bus clock timing.  
 For the number of the APB bus to which the A/D Converter is connected, see "8. Block Diagram".  
 The base clock (HCLK) is used to generate the sampling time and the compare clock cycle.
- \*2: The required sampling time varies according to the external impedance.  
 Set a sampling time that satisfies (Equation 1).
- \*3: The compare time (Tc) is the result of (Equation 2).



(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 Converter = 1.6 k $\Omega$  with 4.5 < AVCC < 5.5 ch.1 to ch.5  
 Input resistance of A/D Converter = 1.4 k $\Omega$  with 4.5 < AVCC < 5.5 ch.0, ch.6, ch.7  
 Input resistance of A/D Converter = 2.3 k $\Omega$  with 2.7 < AVCC < 4.5 ch.1 to ch.5  
 Input resistance of A/D Converter = 2.0 k $\Omega$  with 2.7 < AVCC < 4.5 ch.0, ch.6, ch.7

$C_{AIN}$ : Input capacitance of A/D Converter = 9.7 pF with 2.7 < AVCC < 5.5

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

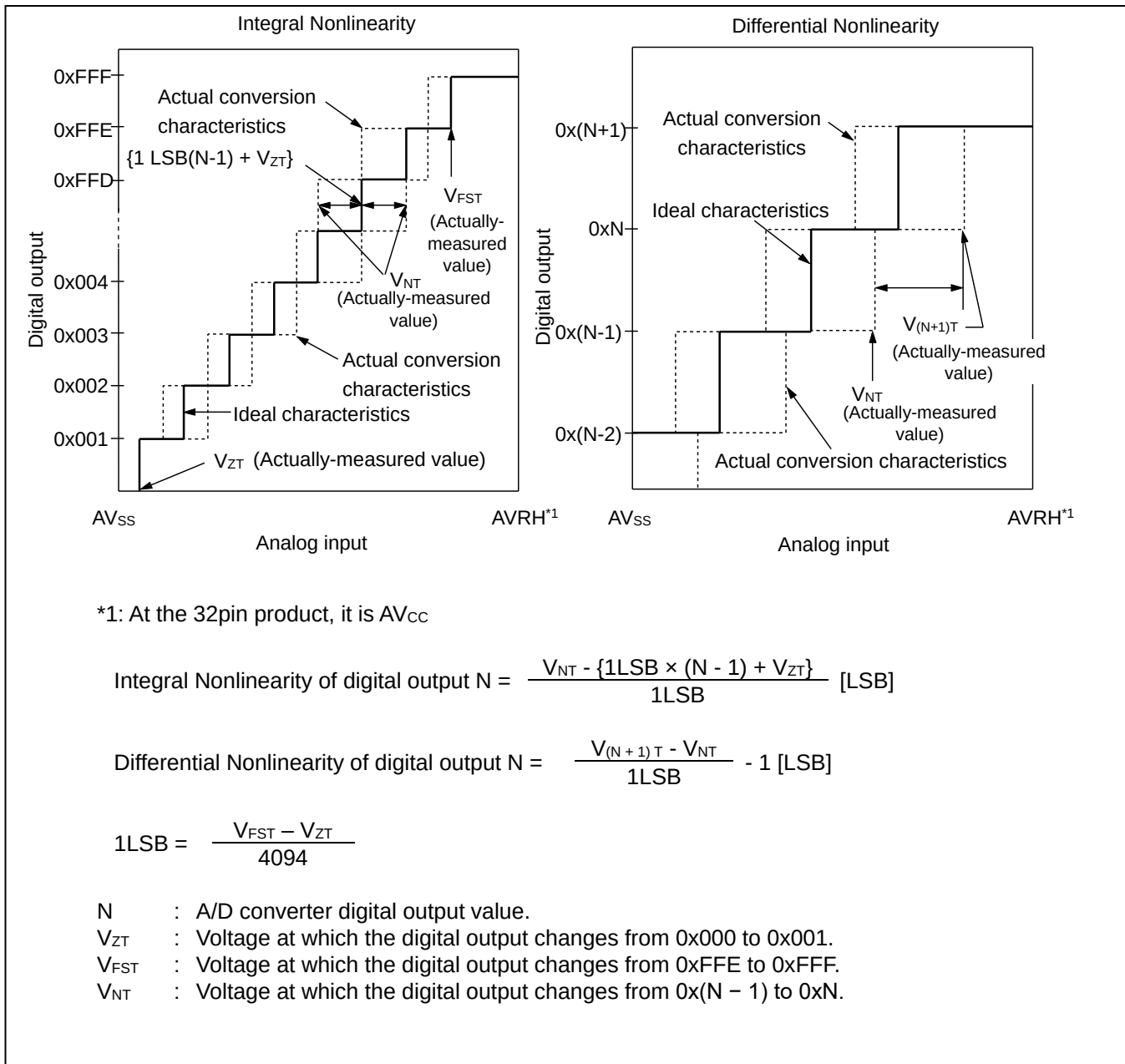
(Equation 2)  $T_c = T_{cck} \times 14$

$T_c$ : Compare time

$T_{cck}$ : Compare clock cycle

## Definitions 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 + 105°C)

| Parameter                   | Symbol            | Conditions           | Value                      |      |                                        | Unit | Remarks            |
|-----------------------------|-------------------|----------------------|----------------------------|------|----------------------------------------|------|--------------------|
|                             |                   |                      | Min                        | Typ  | Max                                    |      |                    |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 2.25                       | 2.45 | 2.65                                   | V    | When voltage drops |
| Released voltage            | VDH               | 00000                | 2.30                       | 2.50 | 2.70                                   | V    | When voltage rises |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 2.39                       | 2.60 | 2.81                                   | V    | When voltage drops |
| Released voltage            | VDH               | 00001                | Same as SVHR = 00000 value |      |                                        | V    | When voltage rises |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 2.48                       | 2.70 | 2.92                                   | V    | When voltage drops |
| Released voltage            | VDH               | 00010                | Same as SVHR = 00000 value |      |                                        | V    | When voltage rises |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 2.58                       | 2.80 | 3.02                                   | V    | When voltage drops |
| Released voltage            | VDH               | 00011                | Same as SVHR = 00000 value |      |                                        | V    | When voltage rises |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 2.76                       | 3.00 | 3.24                                   | V    | When voltage drops |
| Released voltage            | VDH               | 00100                | Same as SVHR = 00000 value |      |                                        | V    | When voltage rises |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 2.94                       | 3.20 | 3.46                                   | V    | When voltage drops |
| Released voltage            | VDH               | 00101                | Same as SVHR = 00000 value |      |                                        | V    | When voltage rises |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 3.31                       | 3.60 | 3.89                                   | V    | When voltage drops |
| Released voltage            | VDH               | 00110                | Same as SVHR = 00000 value |      |                                        | V    | When voltage rises |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 3.40                       | 3.70 | 4.00                                   | V    | When voltage drops |
| Released voltage            | VDH               | 00111                | Same as SVHR = 00000 value |      |                                        | V    | When voltage rises |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 3.68                       | 4.00 | 4.32                                   | V    | When voltage drops |
| Released voltage            | VDH               | 01000                | Same as SVHR = 00000 value |      |                                        | V    | When voltage rises |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 3.77                       | 4.10 | 4.43                                   | V    | When voltage drops |
| Released voltage            | VDH               | 01001                | Same as SVHR = 00000 value |      |                                        | V    | When voltage rises |
| Detected voltage            | VDL               | SVHR <sup>*1</sup> = | 3.86                       | 4.20 | 4.54                                   | V    | When voltage drops |
| Released voltage            | VDH               | 01010                | Same as SVHR = 00000 value |      |                                        | V    | When voltage rises |
| LVD stabilization wait time | T <sub>LVDW</sub> | -                    | -                          | -    | 8160 × t <sub>CYCP</sub> <sup>*2</sup> | μs   |                    |
| LVD detection delay time    | T <sub>LVDL</sub> | -                    | -                          | -    | 200                                    | μs   |                    |

\*1: SVHR bit of Low-Voltage Detection Voltage Control Register (LVD\_CTL) is reset to SVHR = 00000 by low voltage detection reset.

\*2: t<sub>CYCP</sub> indicates the APB1 bus clock cycle time.

**12.6.2 Low-voltage Detection Interrupt**

(Ta = - 40°C to + 105°C)

| Parameter                   | Symbol            | Conditions   | Value |      |                            | Unit | Remarks            |
|-----------------------------|-------------------|--------------|-------|------|----------------------------|------|--------------------|
|                             |                   |              | Min   | Typ  | Max                        |      |                    |
| Detected voltage            | VDL               | SVHI = 00011 | 2.58  | 2.80 | 3.02                       | V    | When voltage drops |
| Released voltage            | VDH               |              | 2.67  | 2.90 | 3.13                       | V    | When voltage rises |
| Detected voltage            | VDL               | SVHI = 00100 | 2.76  | 3.00 | 3.24                       | V    | When voltage drops |
| Released voltage            | VDH               |              | 2.85  | 3.10 | 3.35                       | V    | When voltage rises |
| Detected voltage            | VDL               | SVHI = 00101 | 2.94  | 3.20 | 3.46                       | V    | When voltage drops |
| Released voltage            | VDH               |              | 3.04  | 3.30 | 3.56                       | V    | When voltage rises |
| Detected voltage            | VDL               | SVHI = 00110 | 3.31  | 3.60 | 3.89                       | V    | When voltage drops |
| Released voltage            | VDH               |              | 3.40  | 3.70 | 4.00                       | V    | When voltage rises |
| Detected voltage            | VDL               | SVHI = 00111 | 3.40  | 3.70 | 4.00                       | V    | When voltage drops |
| Released voltage            | VDH               |              | 3.50  | 3.80 | 4.10                       | V    | When voltage rises |
| Detected voltage            | VDL               | SVHI = 01000 | 3.68  | 4.00 | 4.32                       | V    | When voltage drops |
| Released voltage            | VDH               |              | 3.77  | 4.10 | 4.43                       | V    | When voltage rises |
| Detected voltage            | VDL               | SVHI = 01001 | 3.77  | 4.10 | 4.43                       | V    | When voltage drops |
| Released voltage            | VDH               |              | 3.86  | 4.20 | 4.54                       | V    | When voltage rises |
| Detected voltage            | VDL               | SVHI = 01010 | 3.86  | 4.20 | 4.54                       | V    | When voltage drops |
| Released voltage            | VDH               |              | 3.96  | 4.30 | 4.64                       | V    | When voltage rises |
| LVD stabilization wait time | T <sub>LVDW</sub> | -            | -     | -    | 8160 × t <sub>CYCP</sub> * | μs   |                    |
| LVD detection delay time    | T <sub>LVDL</sub> | -            | -     | -    | 200                        | μs   |                    |

 \*:t<sub>CYCP</sub> represents the APB1 bus clock cycle time.

## 12.7 Flash Memory Write/Erase Characteristics

( $V_{CC} = 2.7\text{ V to }5.5\text{ V}$ ,  $T_a = -40^{\circ}\text{C to }+105^{\circ}\text{C}$ )

| Parameter                    |              | Value |     |     | Unit | Remarks                                                                     |
|------------------------------|--------------|-------|-----|-----|------|-----------------------------------------------------------------------------|
|                              |              | Min   | Typ | Max |      |                                                                             |
| Sector erase time            | Large sector | -     | 0.7 | 2.2 | s    | The sector erase time includes the time of writing prior to internal erase. |
|                              | Small sector | -     | 0.3 | 0.9 |      |                                                                             |
| Halfword (16-bit) write time |              | -     | 30  | 528 | μs   | The halfword (16-bit) write time excludes the system-level overhead.        |
| Chip erase time              |              | -     | 2.6 | 8   | s    | The chip erase time includes the time of writing prior to internal erase.   |

### Write/erase cycle and data hold time

| Write/erase cycle | Data hold time (year) | Remarks |
|-------------------|-----------------------|---------|
| 1,000             | 20*                   |         |
| 10,000            | 10*                   |         |

\*: This value was converted from the result of a technology reliability assessment. (This value was converted from the result of a high temperature accelerated test using the Arrhenius equation with the average temperature value being + 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.

#### Return Count Time

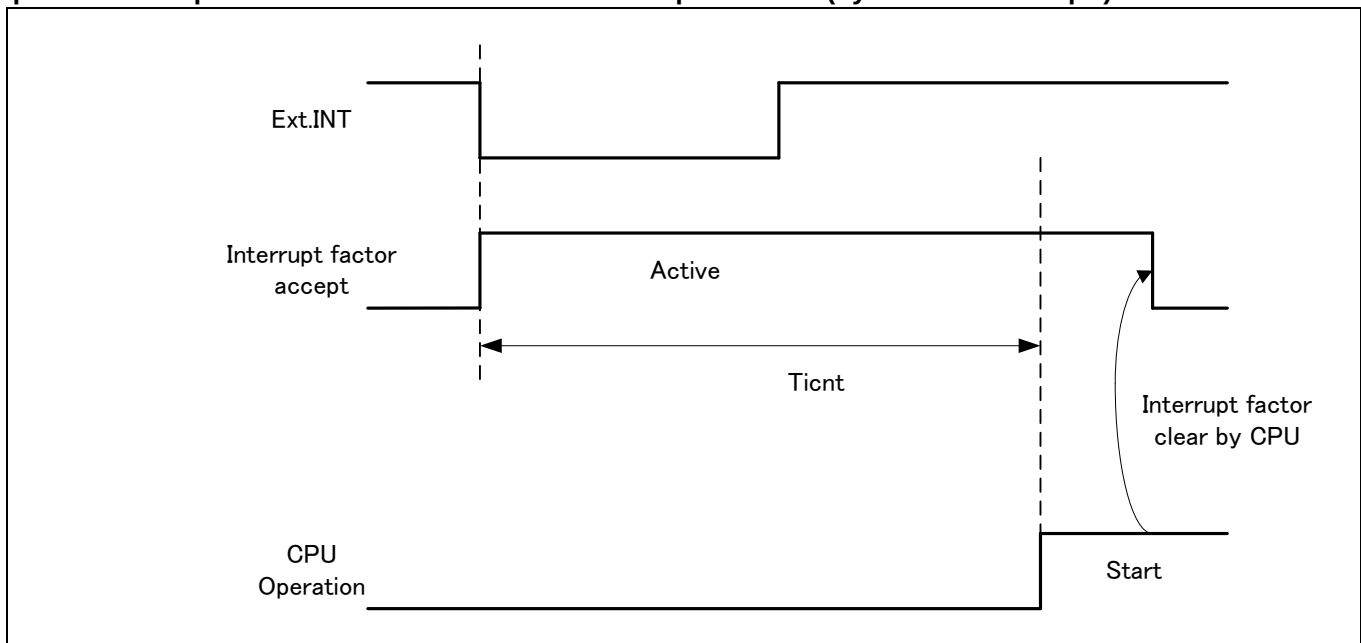
( $V_{CC} = 2.7V$  to  $5.5V$ ,  $T_a = -40^{\circ}C$  to  $+105^{\circ}C$ )

| Parameter                                                       | Symbol | Value*                    |                           | Unit | Remarks |
|-----------------------------------------------------------------|--------|---------------------------|---------------------------|------|---------|
|                                                                 |        | Typ                       | Max                       |      |         |
| SLEEP mode                                                      | Ticnt  | t <sub>cycc</sub>         |                           | μs   |         |
| High-speed CR TIMER mode,<br>Main TIMER mode,<br>PLL TIMER mode |        | $40 + 17 \times t_{cycc}$ | $80 + 17 \times t_{cycc}$ | μs   |         |
| Low-speed CR TIMER mode                                         |        | 360                       | 720                       | μs   |         |
| Sub TIMER mode                                                  |        | 191                       | 381                       | μs   |         |
| RTC mode,<br>STOP mode                                          |        | 819                       | 1090                      | μs   |         |

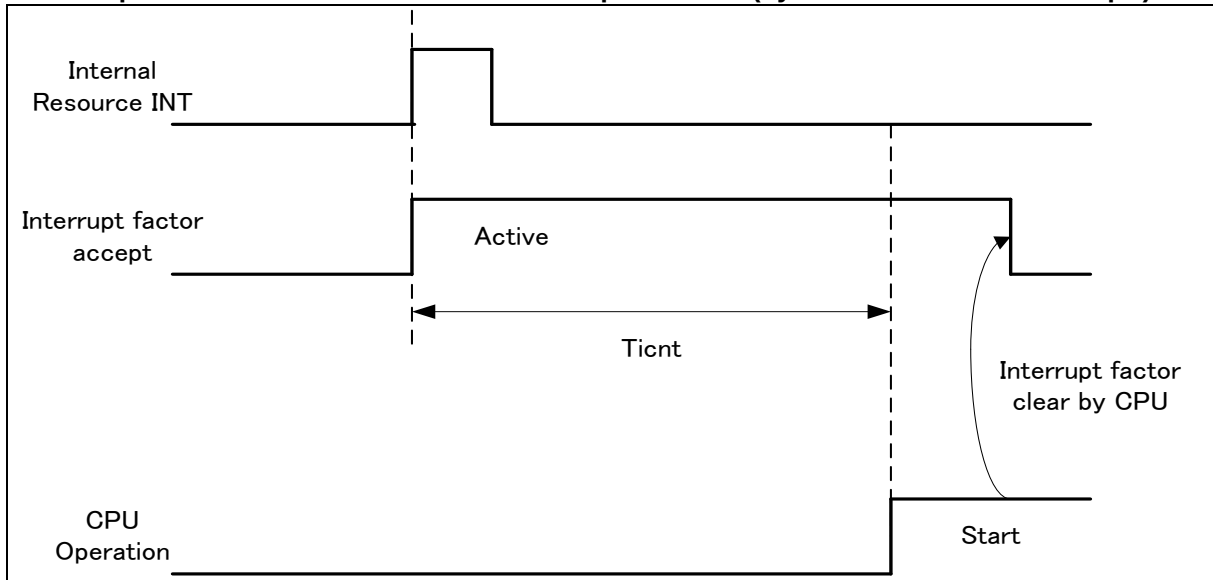
\*: The value depends on the accuracy of built-in CR.

The stabilization time of Main clock/Sub clock/Main PLL clock is not included.

#### Operation example of return from Low-Power consumption mode (by external interrupt\*)



\*: External interrupt is set to detecting fall edge.

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


\*: 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: Low Power Consumption Mode" and "Operations of Standby Modes" in FM0+ 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: Low Power Consumption Mode" in "FM0+ 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.

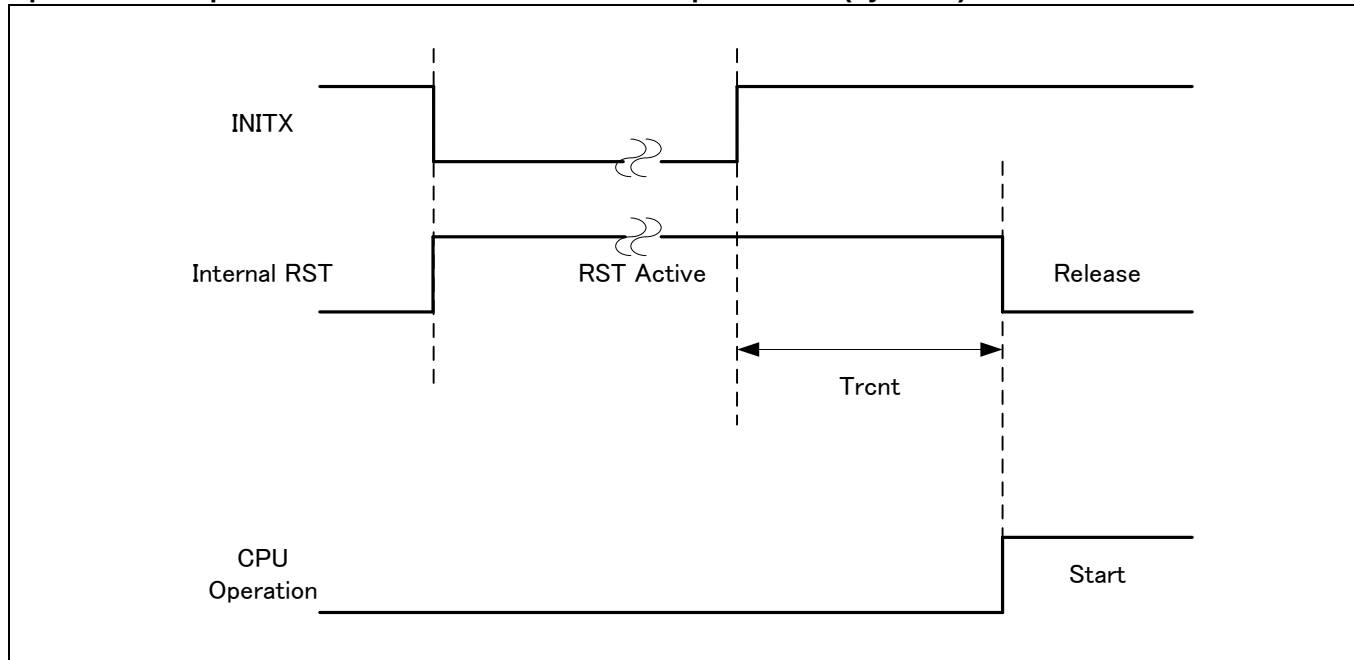
#### Return Count Time

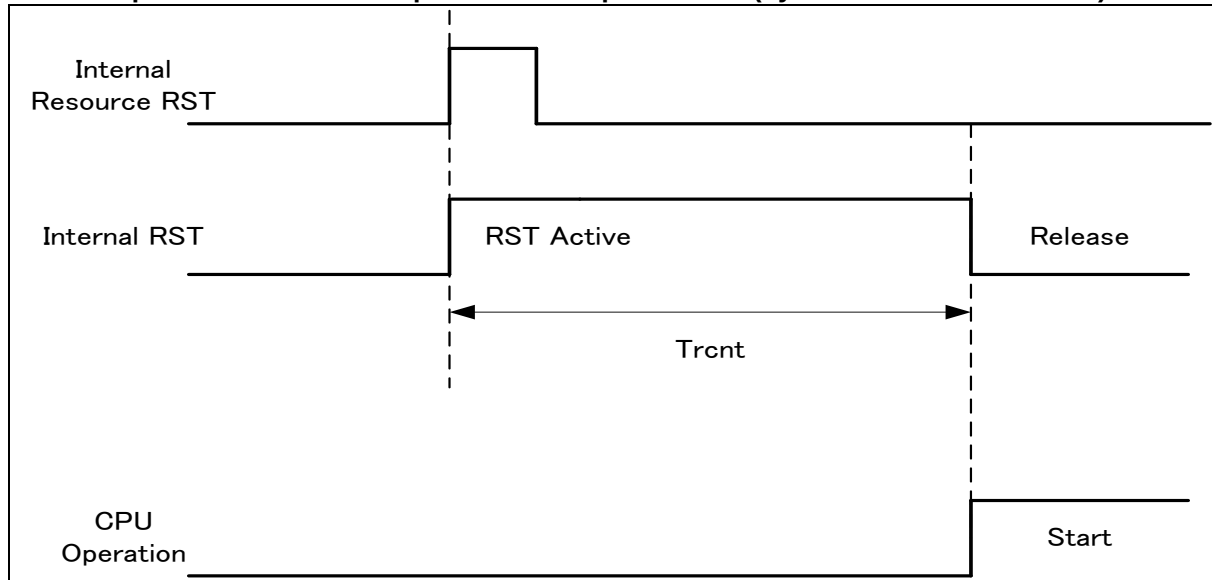
( $V_{CC} = 2.7V$  to  $5.5V$ ,  $T_a = -40^{\circ}C$  to  $+105^{\circ}C$ )

| Parameter                                                       | Symbol | Value |      | Unit | Remarks |
|-----------------------------------------------------------------|--------|-------|------|------|---------|
|                                                                 |        | Typ   | Max* |      |         |
| SLEEP mode                                                      | Trcnt  | 208   | 378  | μs   |         |
| High-speed CR TIMER mode,<br>Main TIMER mode,<br>PLL TIMER mode |        | 208   | 378  | μs   |         |
| Low-speed CR TIMER mode                                         |        | 398   | 758  | μs   |         |
| Sub TIMER mode                                                  |        | 490   | 849  | μs   |         |
| RTC/STOP mode                                                   |        | 288   | 538  | μs   |         |

\*: The maximum value depends on the accuracy of built-in CR.

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



**Operation example of return from low power consumption mode (by internal resource reset\*)**


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

**Notes:**

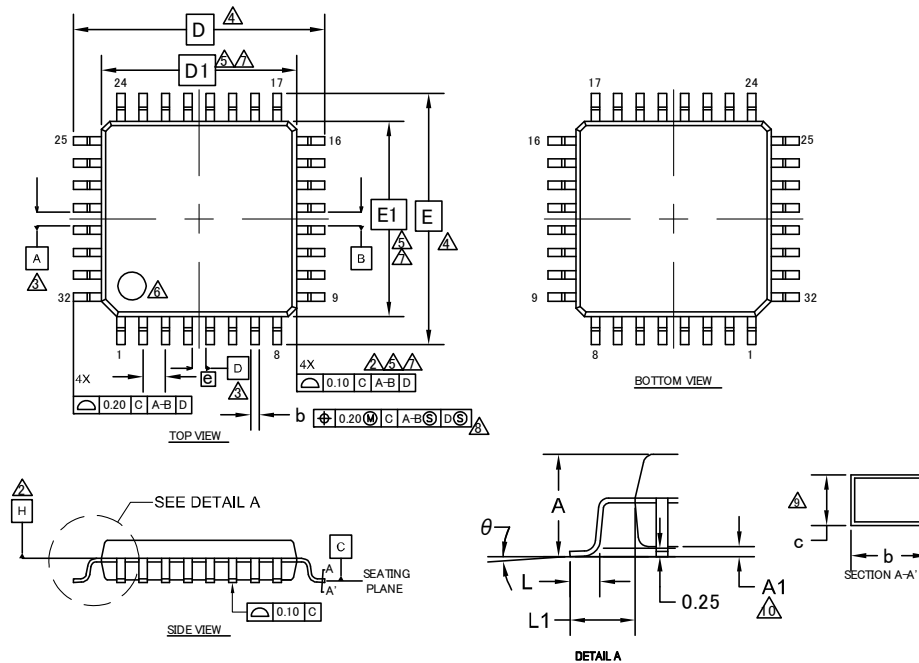
- The return factor is different in each Low-Power consumption modes.  
See "Chapter: Low Power Consumption Mode" and "Operations of Standby Modes" in FM0+ Family PERIPHERAL MANUAL.
- When interrupt recovers, the operation mode that CPU recovers depends on the state before the Low-Power consumption mode transition. See "CHAPTER: Low Power Consumption Mode" in "FM0+ Family PERIPHERAL MANUAL".
- The time during the power-on reset/low-voltage detection reset is excluded. See "12.4.7 Power-on Reset Timing " 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 |
|-------------------|----------------------|--------------|------------------------------------------------|---------|
| S6E1A11B0AGP20000 | 56Kbyte              | 6Kbyte       | Plastic • LQFP (0.80mm pitch), 32pins (LQB032) | Tray    |
| S6E1A12B0AGP20000 | 88Kbyte              | 6Kbyte       |                                                |         |
| S6E1A11B0AGN20000 | 56Kbyte              | 6Kbyte       | Plastic • QFN (0.50mm pitch), 32pins (WNU032)  | Tray    |
| S6E1A12B0AGN20000 | 88Kbyte              | 6Kbyte       |                                                | Taping  |
| S6E1A11B0AGN2B000 | 56Kbyte              | 6Kbyte       |                                                |         |
| S6E1A12B0AGN2B000 | 88Kbyte              | 6Kbyte       |                                                |         |
| S6E1A11C0AGV20000 | 56Kbyte              | 6Kbyte       | Plastic • LQFP (0.50mm pitch), 48pins (LQA048) | Tray    |
| S6E1A12C0AGV20000 | 88Kbyte              | 6Kbyte       |                                                |         |
| S6E1A11C0AGN20000 | 56Kbyte              | 6Kbyte       | Plastic • QFN (0.50mm pitch), 48pins (WNY048)  | Tray    |
| S6E1A12C0AGN20000 | 88Kbyte              | 6Kbyte       |                                                | Taping  |
| S6E1A11C0AGN2B000 | 56Kbyte              | 6Kbyte       |                                                |         |
| S6E1A12C0AGN2B000 | 88Kbyte              | 6Kbyte       |                                                |         |
| S6E1A11C0AGF20000 | 56Kbyte              | 6Kbyte       | Plastic • LQFP (0.65mm pitch), 52pins (LQC052) | Tray    |
| S6E1A12C0AGF20000 | 88Kbyte              | 6Kbyte       |                                                |         |

## 14. Package Dimensions

| Package Type | Package Code |
|--------------|--------------|
| LQFP 32      | LQB032       |



| SYMBOL | DIMENSIONS |      |      |
|--------|------------|------|------|
|        | MIN.       | NOM. | MAX. |
| A      | —          | —    | 1.60 |
| A1     | 0.05       | —    | 0.15 |
| b      | 0.32       | 0.35 | 0.43 |
| c      | 0.13       | —    | 0.18 |
| D      | 9.00 BSC   |      |      |
| D1     | 7.00 BSC   |      |      |
| e      | 0.80 BSC   |      |      |
| E      | 9.00 BSC   |      |      |
| E1     | 7.00 BSC   |      |      |
| L      | 0.45       | 0.60 | 0.75 |
| L1     | 0.30       | 0.50 | 0.70 |
| θ      | 0°         | —    | 8°   |

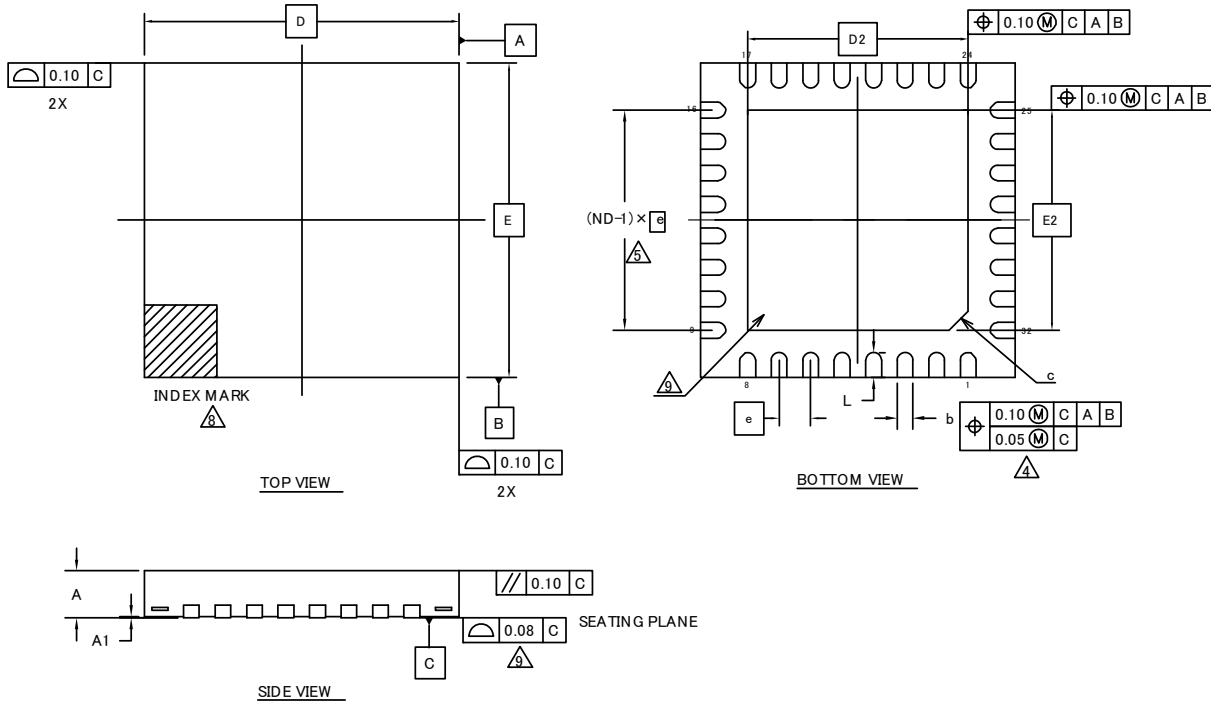
### NOTES

- ALL DIMENSIONS ARE IN MILLIMETERS.
- DATUM PLANE H IS LOCATED AT THE BOTTOM OF THE MOLD PARTING LINE COINCIDENT WITH WHERE THE LEAD EXITS THE BODY.
- DATUMS A-B AND D TO BE DETERMINED AT DATUM PLANE H.
- TO BE DETERMINED AT SEATING PLANE C.
- DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25mm PRE SIDE. DIMENSIONS D1 AND E1 INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
- DETAILS OF PIN 1 IDENTIFIER ARE OPTIONAL BUT MUST BE LOCATED WITHIN THE ZONE INDICATED.
- REGARDLESS OF THE RELATIVE SIZE OF THE UPPER AND LOWER BODY SECTIONS. DIMENSIONS D1 AND E1 ARE DETERMINED AT THE LARGEST FEATURE OF THE BODY EXCLUSIVE OF MOLD FLASH AND GATE BURRS. BUT INCLUDING ANY MISMATCH BETWEEN THE UPPER AND LOWER SECTIONS OF THE MOLDER BODY.
- DIMENSION b DOES NOT INCLUDE DAMBAR PROTRUSION. THE DAMBAR PROTRUSION (S) SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED b MAXIMUM BY MORE THAN 0.08mm. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE LEAD FOOT.
- THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.10mm AND 0.25mm FROM THE LEAD TIP.
- A1 IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT OF THE PACKAGE BODY.

002-13879 \*\*

PACKAGE OUTLINE, 32 LEAD LQFP  
 7.0X7.0X1.6 MM LQB032 REV\*\*

| Package Type | Package Code |
|--------------|--------------|
| QFN 32       | WNU032       |



| SYMBOL | DIMENSIONS |      |      |
|--------|------------|------|------|
|        | MIN.       | NOM. | MAX. |
| A      | —          | —    | 0.80 |
| A1     | 0.00       | —    | 0.05 |
| D      | 5.00 BSC   |      |      |
| E      | 5.00 BSC   |      |      |
| b      | 0.20       | 0.25 | 0.30 |
| D2     | 3.20 BSC   |      |      |
| E2     | 3.20 BSC   |      |      |
| e      | 0.50 BSC   |      |      |
| c      | 0.25 REF   |      |      |
| L      | 0.35       | 0.40 | 0.45 |

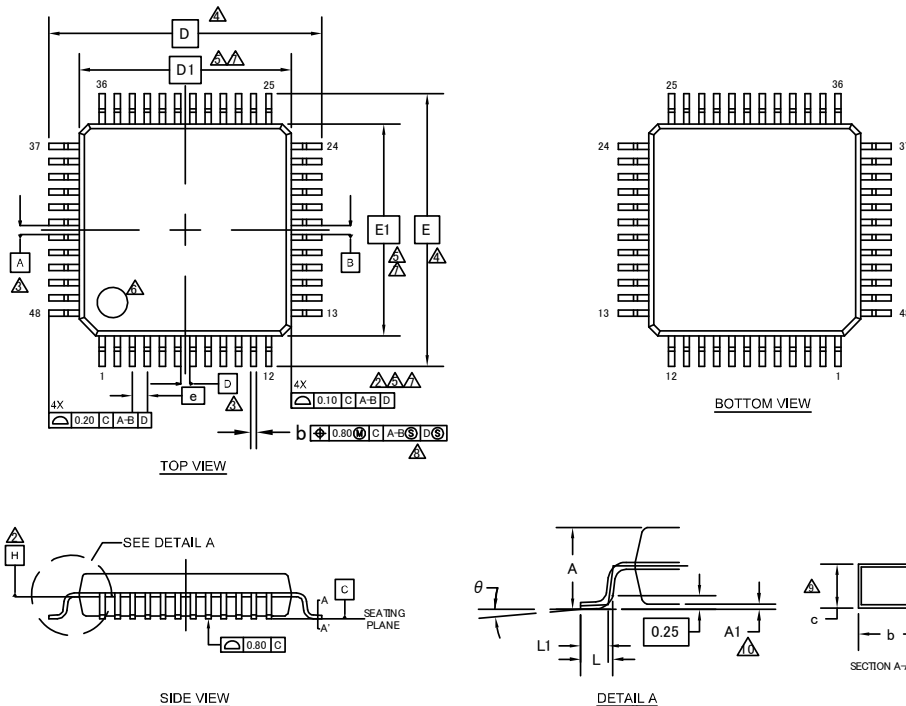
#### NOTE

- ALL DIMENSIONS ARE IN MILLIMETERS.
- DIMENSIONING AND TOLERANCING C CONFORMS TO ASME Y14.5-1994.
- N IS THE TOTAL NUMBER OF TERMINALS.
- DIMENSION "b" APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm FROM TERMINAL TIP. IF THE TERMINAL HAS THE OPTIONAL RADIUS ON THE OTHER END OF THE TERMINAL THE DIMENSION "b" SHOULD NOT BE MEASURED IN THAT RADIUS AREA.
- ND REFER TO THE NUMBER OF TERMINALS ON D OR E SIDE.
- MAX. PACKAGE WARPAGE IS 0.05mm.
- MAXIMUM ALLOWABLE BURRS IS 0.076mm IN ALL DIRECTIONS.
- PIN #1 ID ON TOP WILL BE LOCATED WITHIN INDICATED ZONE.
- BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
- JEDEC SPECIFICATION NO. REF : N/A

002-15907 \*\*

PACKAGE OUTLINE, 32 LEAD QFN  
 5.00X5.00X0.80 MM WNU032 3.20X2.00 MM EPAD (SAWN) REV\*\*

| Package Type | Package Code |
|--------------|--------------|
| LQFP 48      | LQA048       |



| SYMBOL | DIMENSIONS |      |      |
|--------|------------|------|------|
|        | MIN.       | NOM. | MAX. |
| A      | —          | —    | 1.70 |
| A1     | 0.00       | —    | 0.20 |
| b      | 0.15       | —    | 0.27 |
| c      | 0.09       | —    | 0.20 |
| D      | 9.00 BSC   |      |      |
| D1     | 7.00 BSC   |      |      |
| e      | 0.50 BSC   |      |      |
| E      | 9.00 BSC   |      |      |
| E1     | 7.00 BSC   |      |      |
| L      | 0.45       | 0.60 | 0.75 |
| L1     | 0.30       | 0.50 | 0.70 |
| θ      | 0°         | —    | 8°   |

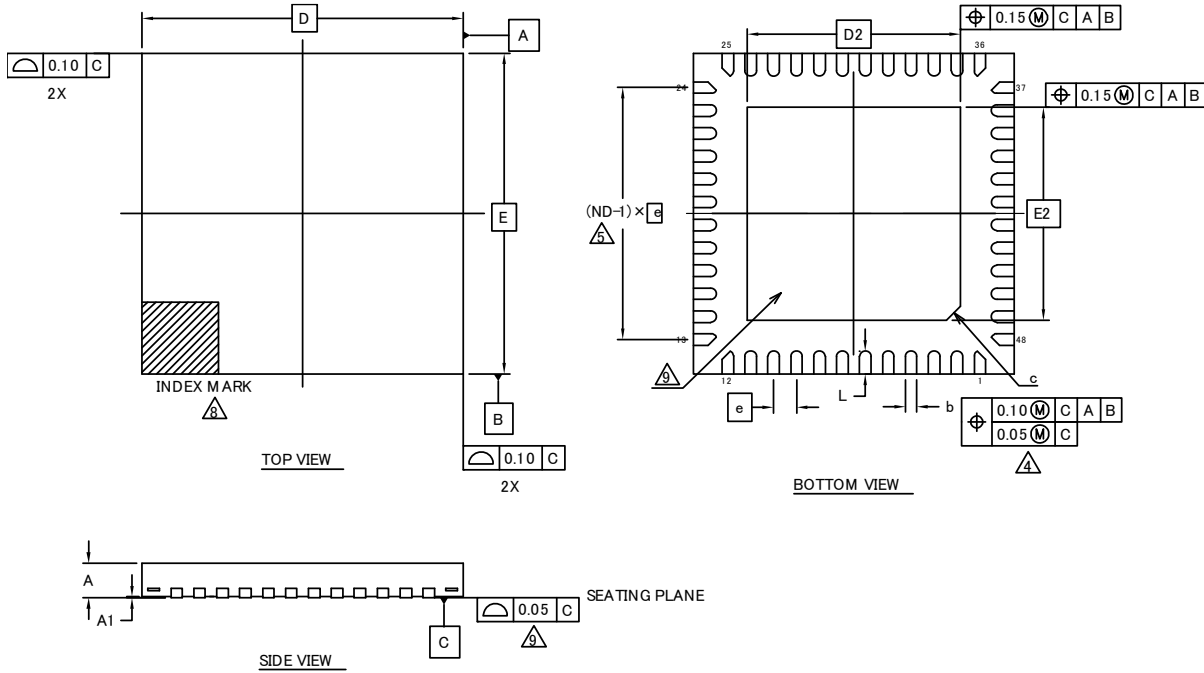
### NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DATUM PLANE H IS LOCATED AT THE BOTTOM OF THE MOLD PARTING LINE COINCIDENT WITH WHERE THE LEAD EXITS THE BODY.
3. DATUMS A-B AND D TO BE DETERMINED AT DATUM PLANE H.
4. TO BE DETERMINED AT SEATING PLANE C.
5. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25mm PRE SIDE. DIMENSIONS D1 AND E1 INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
6. DETAILS OF PIN 1 IDENTIFIER ARE OPTIONAL BUT MUST BE LOCATED WITHIN THE ZONE INDICATED.
7. REGARDLESS OF THE RELATIVE SIZE OF THE UPPER AND LOWER BODY SECTIONS. DIMENSIONS D1 AND E1 ARE DETERMINED AT THE LARGEST FEATURE OF THE BODY EXCLUSIVE OF MOLD FLASH AND GATE BURRS. BUT INCLUDING ANY MISMATCH BETWEEN THE UPPER AND LOWER SECTIONS OF THE MOLDER BODY.
8. DIMENSION b DOES NOT INCLUDE DAMBER PROTRUSION. THE DAMBER PROTRUSION (S) SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED b MAXIMUM BY MORE THAN 0.08mm. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE LEAD FOOT.
9. THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.10mm AND 0.25mm FROM THE LEAD TIP.
10. A1 IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT OF THE PACKAGE BODY.

002-13731 \*\*

PACKAGE OUTLINE, 48 LEAD LQFP  
 7.0X7.0X1.7 MM LQA048 REV\*\*

| Package Type | Package Code |
|--------------|--------------|
| QFN 48       | WNY048       |



| SYMBOL | DIMENSIONS |      |      |
|--------|------------|------|------|
|        | MIN.       | NOM. | MAX. |
| A      | —          | —    | 0.80 |
| A1     | 0.00       | —    | 0.05 |
| D      | 7.00 BSC   |      |      |
| E      | 7.00 BSC   |      |      |
| b      | 0.18       | 0.25 | 0.30 |
| D2     | 4.65 BSC   |      |      |
| E2     | 4.65 BSC   |      |      |
| e      | 0.50 BSC   |      |      |
| c      | 0.30 REF   |      |      |
| L      | 0.45       | 0.50 | 0.55 |

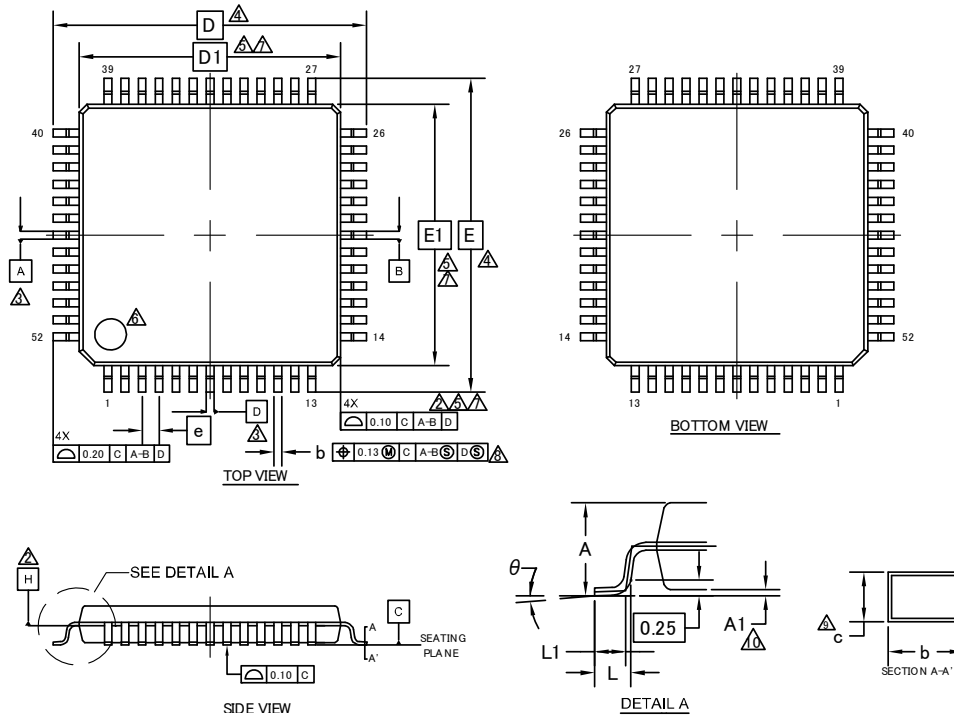
#### NOTE

- ALL DIMENSIONS ARE IN MILLIMETERS.
- DIMENSIONING AND TOLERANCING CONFORMS TO ASME Y14.5-1994.
- N IS THE TOTAL NUMBER OF TERMINALS.
- DIMENSION "b" APPLIES TO METALLIZED TERMINAL AND IS MEASURED BETWEEN 0.15 AND 0.30mm FROM TERMINAL TIP. IF THE TERMINAL HAS THE OPTIONAL RADIUS ON THE OTHER END OF THE TERMINAL THE DIMENSION "b" SHOULD NOT BE MEASURED IN THAT RADIUS AREA.
- ND REFER TO THE NUMBER OF TERMINAL ON D OR E SIDE.
- MAX. PACKAGE WARPAGE IS 0.05mm.
- MAXIMUM ALLOWABLE BURRS IS 0.076mm IN ALL DIRECTIONS.
- PIN #1 ID ON TOP WILL BE LOCATED WITHIN INDICATED ZONE.
- BILATERAL COPLANARITY ZONE APPLIES TO THE EXPOSED HEAT SINK SLUG AS WELL AS THE TERMINALS.
- JEDEC SPECIFICATION NO. REF: N/A

002-16422 \*\*

PACKAGE OUTLINE, 48 LEAD QFN  
 7.00X7.00X0.80 MM WNY048 4.65X4.65 MM EPAD (SAWN) REV\*

| Package Type | Package Code |
|--------------|--------------|
| LQFP 52      | LQC052       |



| SYMBOL   | DIMENSION |      |       |
|----------|-----------|------|-------|
|          | MIN.      | NOM. | MAX.  |
| A        | —         | —    | 1.70  |
| A1       | 0.00      | —    | 0.20  |
| b        | 0.265     | 0.30 | 0.365 |
| c        | 0.09      | —    | 0.20  |
| D        | 12.00 BSC |      |       |
| D1       | 10.00 BSC |      |       |
| e        | 0.65 BSC  |      |       |
| E        | 12.00 BSC |      |       |
| E1       | 10.00 BSC |      |       |
| L        | 0.45      | 0.60 | 0.75  |
| L1       | 0.30      | 0.50 | 0.70  |
| $\theta$ | 0°        | —    | 8°    |

### NOTES

- ALL DIMENSIONS ARE IN MILLIMETERS.
- DATUM PLANE H IS LOCATED AT THE BOTTOM OF THE MOLD PARTING LINE COINCIDENT WITH WHERE THE LEAD EXITS THE BODY.
- DATUMS A-B AND D TO BE DETERMINED AT DATUM PLANE H.
- TO BE DETERMINED AT SEATING PLANE C.
- DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25mm PRE SIDE. DIMENSIONS D1 AND E1 INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
- DETAILS OF PIN 1 IDENTIFIER ARE OPTIONAL BUT MUST BE LOCATED WITHIN THE ZONE INDICATED.
- REGARDLESS OF THE RELATIVE SIZE OF THE UPPER AND LOWER BODY SECTIONS. DIMENSIONS D1 AND E1 ARE DETERMINED AT THE LARGEST FEATURE OF THE BODY EXCLUSIVE OF MOLD FLASH AND GATE BURRS. BUT INCLUDING ANY MISMATCH BETWEEN THE UPPER AND LOWER SECTIONS OF THE MOLDER BODY.
- DIMENSION b DOES NOT INCLUDE DAMBER PROTRUSION. THE DAMBER PROTRUSION (S) SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED b MAXIMUM BY MORE THAN 0.08mm. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE LEAD FOOT.
- THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.10mm AND 0.25mm FROM THE LEAD TIP.
- A1 IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT OF THE PACKAGE BODY.

002-13880 \*\*

PACKAGE OUTLINE, 52 LEAD LQFP  
 10.0X10.0X1.7 MM LQC052 REV\*\*

## 15. Major Changes

Spanion Publication Number: S6E1A1\_DS710-00001

| Page                        | Section                                                                                                                                                                                        | Change Results                                                                                                                                                                                                                                    |
|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision 0.1                |                                                                                                                                                                                                |                                                                                                                                                                                                                                                   |
| -                           | -                                                                                                                                                                                              | Initial release                                                                                                                                                                                                                                   |
| Revision 1.0 [July 16,2014] |                                                                                                                                                                                                |                                                                                                                                                                                                                                                   |
| -                           | -                                                                                                                                                                                              | Revised from "Preliminary" to "Full Production"                                                                                                                                                                                                   |
| 3                           | 1. Description                                                                                                                                                                                 | Revised from "TYPE1" product to "TYPE1-M0+" product                                                                                                                                                                                               |
| 5                           | 2. Features                                                                                                                                                                                    | Revised "Processor version"                                                                                                                                                                                                                       |
| 6                           | 2. Features                                                                                                                                                                                    | Revised "Conversion time" of 12-bit A/D converter                                                                                                                                                                                                 |
| 9                           | 3. Product Lineup                                                                                                                                                                              | Added "Note" for accuracy of built-in CR                                                                                                                                                                                                          |
| 21,22,23<br>,<br>24,25      | 6. List of Pin Functions<br>List of pin functions                                                                                                                                              | Revised Pin number 30 and 31 of LQFP-32 and QFN-32                                                                                                                                                                                                |
| 23                          | 6. List of Pin Functions<br>List of pin functions                                                                                                                                              | Revised Function description of SOT1_x(SDA1_x)                                                                                                                                                                                                    |
| 40                          | 12. Memory Map<br>Memory map (1)                                                                                                                                                               | Revised from "MTB resister" to "MTB resister(SFR)"                                                                                                                                                                                                |
| 41                          | 12. Memory Map<br>Memory map (2)                                                                                                                                                               | Revised product name and RAM address                                                                                                                                                                                                              |
| 46                          | 14. Electrical Characteristics<br>14.1 Absolute Maximum Ratings                                                                                                                                | Revised Analog pin input voltage                                                                                                                                                                                                                  |
| 47                          | 14. Electrical Characteristics<br>14.2 Recommended Operating Conditions                                                                                                                        | Added note "*2"                                                                                                                                                                                                                                   |
| 48,49,50                    | 14. Electrical Characteristics<br>14.3 DC Characteristics<br>14.3.1 Current Rating                                                                                                             | <ul style="list-style-type: none"> <li>• Revised and added "Conditions"</li> <li>• Revised the value of "TBD"</li> </ul>                                                                                                                          |
| 52                          | 14. Electrical Characteristics<br>14.4 AC Characteristics<br>14.4.1 Main Clock Input Characteristics                                                                                           | Revised the value of "Internal operating clock frequency" and "Internal operating clock cycle time"                                                                                                                                               |
| 54                          | 14. Electrical Characteristics<br>14.4 AC Characteristics<br>14.4.3 Built-in CR Oscillation Characteristics                                                                                    | Revised the value of "TBD"                                                                                                                                                                                                                        |
| 55                          | 14. Electrical Characteristics<br>14.4 AC Characteristics<br>14.4.5 Operating Conditions of Main PLL(In the case of using the built-in high-speed CR clock as the input clock of the main PLL) | <ul style="list-style-type: none"> <li>• Revised the value of "TBD"</li> <li>• Revised the maximum value of "Main PLL clock frequency"</li> </ul>                                                                                                 |
| 56                          | 14. Electrical Characteristics<br>14.4 AC Characteristics<br>14.4.7 Power-on Reset Timing                                                                                                      | <ul style="list-style-type: none"> <li>• Revised the value of "TBD"</li> <li>• Revised from "LVDL_minimum" to "VDH_minimum"</li> </ul>                                                                                                            |
| 78                          | 14. Electrical Characteristics<br>14.4 AC Characteristics<br>14.4.12 I2C Timing                                                                                                                | <ul style="list-style-type: none"> <li>• Revised the condition of "Noise filter"</li> <li>• Revised the note for noise filter</li> </ul>                                                                                                          |
| 80                          | 14. Electrical Characteristics<br>14.5 12-bit A/D Converter                                                                                                                                    | <ul style="list-style-type: none"> <li>• Revised the value of "Conversion time", "Sampling time" and "Compare clock cycle"</li> <li>• Revised the value of "State transition time to operation permission"</li> <li>• Revised the note</li> </ul> |
| 83,84                       | 14. Electrical Characteristics<br>14.6 Low-voltage Detection Characteristics                                                                                                                   | Revised the value of SVHR and SVHI                                                                                                                                                                                                                |
| 85                          | 14. Electrical Characteristics<br>14.7 Flash Memory Write/Erase Characteristics                                                                                                                | <ul style="list-style-type: none"> <li>• Revised the value of "TBD"</li> <li>• Revised the value of typical</li> </ul>                                                                                                                            |

| Page  | Section                                                                            | Change Results                              |
|-------|------------------------------------------------------------------------------------|---------------------------------------------|
| 86,88 | 14. Electrical Characteristics<br>14.8 Return Time from Low-Power Consumption Mode | Revised the value of "TBD"                  |
| 90    | 15. Ordering Information                                                           | Revised from "LCC-52P-M02" to "FPT-52P-M02" |

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

## Document History

Document Title: S6E1A Series, 32-bit Arm® Cortex®-M0+ FM0+ Microcontroller

Document Number: 002-05091

| Revision | ECN     | Orig. of Change | Submission Date | Description of Change                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------|---------|-----------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **       | -       | AKIH            | 07/16/2014      | Migrated to Cypress and assigned document number 002-05091.<br>No change to document contents or format.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| *A       | 5131394 | AKIH            | 02/10/2016      | Updated to Cypress template.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| *B       | 5626717 | HTER            | 04/13/2017      | <ul style="list-style-type: none"> <li>Modified RTC description in “Features, Real-Time Clock(RTC)”. Changed starting count value from 01 to 00. Deleted “second, or day of the week” in the Interrupt function (<a href="#">Page 2</a>)</li> <li>Updated Package code and dimensions as follows (<a href="#">Page 7-12, 87-92</a>)               <ul style="list-style-type: none"> <li>FPT-32P-M30 -&gt; LQB032</li> <li>FPT-48P-M49 -&gt; LQA048</li> <li>FPT-52P-M02 -&gt; LQC052</li> <li>LCC-32P-M73 -&gt; WNU032</li> <li>LCC-48P-M74 -&gt; WNY048</li> </ul> </li> <li>Updated “12.4.7 Power-on Reset Timing”. Changed parameter from “Power Supply rise time (Tr) [ms]” to “Power ramp rate (dV/dt) [mV/us]” and add some comments (<a href="#">Page 54</a>)</li> <li>Modified the Chapter name “12.4.9 CSIO Timing” to “12.4.9 CSIO/UART Timing”. (<a href="#">Page 56</a>)</li> <li>Added the Baud rate spec in “12.4.9 CSIO Timing”. (<a href="#">Page 56-61</a>)</li> <li>Modified “12.4.9 CSIO Timing”. Deleted “SPI=1, MS=0” in the titles and added MS=0,1 in the schematic (<a href="#">Page 63-70</a>)</li> <li>Deleted the DMAC description. (<a href="#">Page 1, 6, 36-39, 48</a>)</li> </ul> <p>Modified according to the Datasheet Errata (002-05092 Rev. **) as below.</p> <ul style="list-style-type: none"> <li>Deleted the Pin name of no available. (<a href="#">Page 8-9, 17, 21</a>)</li> <li>Fixed typo from SCLKx_0 to SCKx_0. (<a href="#">Page 56-61</a>)</li> <li>Added the note. (<a href="#">Page 63-69</a>)</li> <li>Corrected the Ordering Information table. (<a href="#">Page 87</a>)</li> </ul> |
| *C       | 6062224 | HUAL            | 02/07/2018      | <ul style="list-style-type: none"> <li>Updated Figure of I/O Circuit type A and type D</li> <li>Modified the A/D Converter value in the table 12.5<br/>the changed sampling time is for min value when AVcc &lt; 4.5V for S6E1AxCOA part and this value is changed from 0.5 to 0.3.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| *D       | 6602393 | XITO            | 06/24/2019      | Updated to new template.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

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