S6E2D5 Series

32-bit Arm® Cortex®-M4F, FM4 Microcontroller

Devices in the S6E2D5 Series are highly integrated 32-bit microcontrollers with high performance and competitive cost. This series is based on the Arm Cortex-M4F Processor with on-chip Flash memory and SRAM. The series has peripheral functions such as graphics engine, display controller, motor control timers, ADCs, and Communication Interfaces (USB, CAN, UART, CSIO, I^2C, LIN). The products that are described in this data sheet are TYPE4-M4 category products. See the FM4 Family Peripheral Manual Main Part (002-04856).

Features

32-bit Arm Cortex-M4F Core

- Processor version: r0p1
- Up to 160 MHz frequency operation
- Built-in FPU
- Supports DSP instructions
- Memory Protection Unit (MPU): improves the reliability of an embedded system
- Integrated Nested Vectored Interrupt Controller (NVIC): 1 NMI (non-maskable interrupt) and 128 peripheral interrupts and 16 priority levels
- 24-bit system timer (Sys Tick): System timer for OS task management

On-Chip Memories

- Flash memory

This series has on-chip flash memory with these features:

  - 384 Kbytes
  - Built-in Flash Accelerator System with 16 Kbytes trace buffer memory
  - Security function for code protection
  - Notes:
    - The read access to flash memory can be achieved without wait-cycle up to operation frequency of 72 MHz.
    - Even at the operation frequency more than 72 MHz, an equivalent access to flash memory can be obtained by Flash Accelerator System.

- SRAM

This is composed of two independent SRAMs (SRAM0 and SRAM2). SRAM0 is connected to I-code bus and D-code bus of Cortex-M4F core. SRAM2 is connected to the system bus of Cortex-M4F core.

  - SRAM0: 32 Kbytes
  - SRAM2: 4 Kbytes

- VRAM

This series is equipped with a SRAM for GDC.

  - Max 512 Kbytes

- VFLASH

S6E2D55GJA is equipped with a Flash for GDC.

  - 2 Mbytes

External Bus Interface

- Supports SRAM, NOR, NAND Flash and SDRAM devices
- Up to two chip selects CS0 and CS8 (CS8 is only for SDRAM)
- 8-/16-bit data width
- Up to 25-bit address bit
- Maximum area size: Up to 256 Mbytes
- Supports address/data multiplexing
- Supports external RDY function
- Supports the scramble function
  - Possible to set the validity/invalidity of the scramble function for the external areas 0x6000_0000 to 0x7FFF_FFFF in 4 Mbytes units.
  - Possible to set two kinds of the scramble key.
  - Note: It is necessary to prepare the dedicated software library to use the scramble function.

USB Interface (One channel)

A USB interface is composed of device and host.

- USB device
  - USB2.0 Full-Speed supported
  - Max 6 EndPoint supported
    - EndPoint 0 is for control transfer
    - EndPoint 1, 2 can be selected for bulk-transfer, interrupt-transfer or isochronous-transfer
    - EndPoint 3 to 5 can select bulk-transfer or interrupt-transfer
  - EndPoint 1 to 5 comprise the double buffer
  - The size of each endpoint is as follows.
    - Endpoint 0, 2 to 5: 64 bytes
    - EndPoint 1: 256 bytes

- USB host
  - USB2.0 Full-Speed / Low-Speed supported
  - Bulk-transfer, interrupt-transfer and isochronous-transfer support
  - USB device connected/disconnected automatically detect
  - In/out token handshake packet automatically accepted
  - Max 256-byte packet-length supported
  - Wake-up function supported

CAN-FD Interface (One channel)

- Compatible with CAN Specification 2.0A/B
- Maximum transfer rate: 5 Mbps
- Message buffer for receiver: Up to 192 messages
- Message buffer for transmitter: Up to 32 messages
- CAN with flexible data rate (non-ISO CAN FD)
- Notes:
  - CAN FD cannot communicate between non-ISO CAN FD and ISO CAN FD, because non-ISO CAN FD and ISO CAN FD are different frame format.
  - About the problem of "non-ISO CAN FD", see the White Paper from CiA(CAN in Automation).
  - http://www.can-newsletter.org/engineering/standardization/141222_can-fd-and-crc-issued_white-paper_bosch

Multi-function Serial Interface (Eight channels)

- 64 bytes with FIFO (the FIFO step numbers vary depending on the settings of the communication mode or bit length.)
- Operation mode is selectable from the following for each channel.
  - UART
  - CSIO
  - LIN
  - I^2C
- UART
  - Full-duplex double buffer
  - Selection with or without parity supported
  - Built-in dedicated baud rate generator
  - External clock available as a serial clock
  - Various error detect functions available (parity errors, framing errors, and overrun errors)
- CSIO
  - Full-duplex double buffer
  - Built-in dedicated baud rate generator
  - Overrun error detect function available
  - Serial chip select function (ch.6 and ch.7 only)
  - Supports High-speed SPI (ch.6 only)
  - Data length 5 to 16-bit
- LIN
  - LIN protocol Rev.2.1 supported
  - Full-duplex double buffer
  - Master/Slave mode supported
  - LIN break field generation (can change to 13 to 16-bit length)
  - LIN break delimiter generation (can change to 1 to 4-bit length)
  - Various error detect functions available (parity errors, framing errors, and overrun errors)
- I^2C
  - Standard mode (Max 100 kbps) / Fast mode (Max 400 kbps) supported
  - Fast mode Plus (Fm+) (Max 1000 kbps, only for ch.4=ch.A) supported

DMA Controller (Eight channels)

The DMA controller has an independent bus for the CPU, so the CPU and the DMA controller can process simultaneously.

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

DSTC (Descriptor System Data Transfer Controller) (128 channels)

The DSTC can transfer data at high-speed without going via the CPU. The DSTC adopts the descriptor system and, following the specified contents of the descriptor that has already been constructed on the memory, can directly access the memory/peripheral device and performs the data transfer operation.

It supports the software activation, the hardware activation, and the chain activation functions.

A/D Converter (24 channels)

- 12-bit A/D Converter
  - Successive Approximation type
  - Built-in 2 units
  - Conversion time: 1.0 µs @ 3.3 V
  - Priority conversion available (priority at two levels)
  - Scanning conversion mode
  - Built-in FIFO for conversion data storage (for SCAN conversion: 16 steps, for priority conversion: four steps)

Base Timer (Eight channels)

Operation mode is selectable from the followings for each channel.

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

General-Purpose I/O Port

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

- Capable of pull-up control per pin
- Capable of reading pin level directly
- Built-in port relocate function
- Up to 98 general-purpose I/O ports @ 120-pin package
- Some I/O pins are 5V tolerant.
  See "4. Pin Descriptions" and "5. I/O Circuit Type" for the corresponding pins.

Multi-Function Timer (One unit)

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

Minimum resolution : 6.25 ns

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

The following functions can be used to achieve motor control.

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

Real-Time Clock (RTC)

The real-time clock can count Year/Month/Day/Hour/Minute/Second/A day of the week from 00 to 99.

- Interrupt function with specifying date and time (Year/Month/Day/Hour/Minute) is available. This function is also available by specifying only Year, Month, Day, Hour or Minute.
- Timer interrupt function after set time or each set time.
- Capable of rewriting the time with continuing the time count.
- Leap year automatic count is available.

Quadrature Position/Revolution Counter (QPRC) (One channel)

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

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

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

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

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

Watch Counter

The watch counter is used for wake up from the low-power consumption mode. It is possible to select the main clock, sub clock, built-in High-speed CR clock or built-in Low-speed CR clock as the clock source.

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

External Interrupt Controller Unit

- External interrupt input pin: 16 pins
- Include one non-maskable interrupt (NMI)

Watchdog Timer (Two channels)

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

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

The hardware watchdog timer is clocked by low-speed internal CR oscillator. Therefore, the hardware watchdog is active in any power saving mode except RTC mode and stop mode.

CRC (Cyclic Redundancy Check) Accelerator

The CRC accelerator helps verify data transmission or storage integrity.

CCITT CRC16 and IEEE-802.3 CRC32 are supported.

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

PRGCRC (Programmable Cyclic Redundancy Check) Accelerator

The CRC accelerator helps verify data transmission or storage integrity.

CCITT CRC16, IEEE-802.3 CRC32 and a generating polynominal are supported.

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

I²S Interface (TX x two channels, RX x two channels)

- Support three transfer protocols
  - I²S
  - Left Justified
  - DSP mode
- Master/Slave Mode selectable
- RX only, TX only or TX and RX simultaneous operation selectable
- Word length is programmable from 7 bits to 32 bits
- RX/TX FIFO integrated (RX: 66 words x 32 bits, TX: 66 words x 32 bits)
- DMA, interrupts, or polling based data transfer supported

GDC Unit

- Controller for external graphics display
- Accelerator for 2D block image transfer (blit) operations
- Embedded SRAM video memory
- High-Speed Quad SPI (Serial Peripheral Interface for external memory extensions)
- SDRAM interface for external memory extensions
- HBI (Hyper Bus Interface) interface for external memory extensions
- Maximum core system clock frequency : 160 MHz

Clock and Reset

- Clocks

Five clock sources (two external oscillators, two internal CR oscillator, and Main PLL) that are dynamically selectable.

  - Main clock: 4 MHz to 20 MHz
  - Sub Clock : 32.768 kHz
  - High-speed internal CR Clock: 4 MHz
  - Low-speed internal CR Clock: 100 kHz
  - Main PLL Clock

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

Clock Super Visor (CSV)

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

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

Low-Voltage Detector (LVD)

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

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

Low-Power Consumption Mode

Six low-power consumption modes are supported.

- Sleep
- Timer
- RTC
- Stop
- Deep standby RTC (selectable from with/without RAM retention)
- Deep standby Stop (selectable from with/without RAM retention)

Peripheral Clock Gating

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

VBAT

The consumption power during the RTC operation can be reduced by supplying the power supply independent from the RTC (calendar circuit)/32 kHz oscillation circuit. The following circuits can also be used.

- RTC
- 32 kHz oscillation circuit
- Power-on circuit
- Back up register : 32 bytes
- Port circuit

Debug

- Serial Wire Debug Port (SWJ-DP)
- Embedded Trace Macrocells (ETM) provide comprehensive debug and trace facilities.

Unique ID

Unique value of the device (41-bit) is set.

Power Supply

- Two Power Supplies
  - Power supply:

    VCC= 2.7 V to 3.6 V (when USB or GDC unit is not used)

    = 3.0 V to 3.6 V (when USB or GDC unit is used)
  - Power supply for VBAT:

    VBAT = 1.65 V to 3.6 V

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1 Product Lineup

Memory Size

Product Name		S6E2D55J0A
On-chip Flash memory		384 Kbytes
On-chip SRAM	SRAM	36 Kbytes
	SRAM0	32 Kbytes
	SRAM2	4 Kbytes
VRAM for GDC		512 Kbytes
VFLASH for GDC		-

Function

Product Name			S6E2D55J0A
Pin count			176
CPU			Cortex-M4F, MPU, NVIC 128ch.
		Freq.	160 MHz
Power supply voltage range			2.7 V to 3.6 V
USB2.0 (Device/Host)			1ch.
CAN-FD (non-ISO CAN FD)			1ch.
DMAC			8ch.
DSTC			128ch.
GDC unit	Graphics・Display controller		1 unit
	High-Speed Quad SPI		1ch.
	Hyper Bus Interface		1 unit
	SDRAM-IF		1ch.
External Bus Interface			Addr:25-bit, Data: 8-/16-bit, CS:2 SRAM, NOR Flash, NAND Flash, SDRAM
Multi-function Serial Interface (UART/CSIO/LIN/I^2C)			8ch.
Base Timer (PWC/Reload timer/PWM/PPG)			8ch.
MF Timer	A/D activation compare	6ch.	1 unit
	Input capture	4ch.	
	Free-run timer	3ch.	
	Output compare	6ch.	
	Waveform generator	3ch.	
	PPG	3ch.	
I^2S			2 units
QPRC			1ch.
Dual Timer			1 unit
Real-Time Clock			1 unit
Watch Counter			1 unit
CRC Accelerator			Yes(Fixed, Programmable)
Watchdog Timer			1ch. (SW) + 1ch. (HW)
External Interrupts			16 pins + NMI × 1
I/O ports			154 pins
12-bit A/D converter			24ch. (2 units)
CSV (Clock Super Visor)			Yes
LVD (Low-Voltage Detector)			2ch.
Built-in CR		High-speed	4 MHz
		Low-speed	100 kHz
Debug Function			SWJ-DP/ETM
Unique ID			Yes

Notes:

- *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 12.4.3 Built-in CR Oscillation Characteristics for the accuracy of the built-in CR.*

2 Packages

Package \ Product Name	S6E2D55J0A
LQFP: LQP176 (0.5 mm pitch)	❍

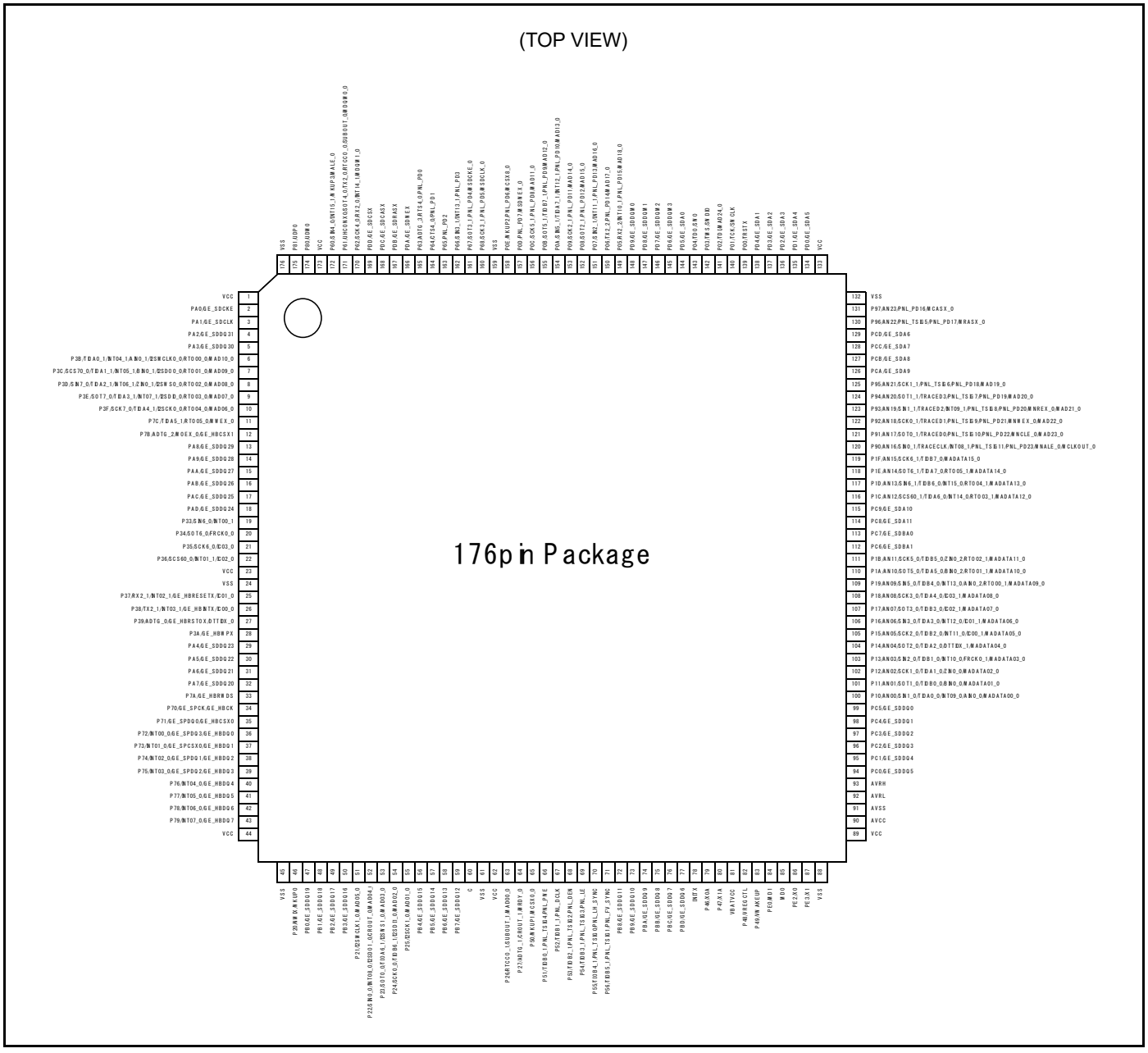
❍: Supported

Note:

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

3 Pin Assignment

LQP176



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.

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. LQFP176	Pin name	I/O circuit type	Pin state type
1	VCC	—	—
2	PA0	K	I
	GE_SDCKE		
3	PA1	K	I
	GE_SDCLK		
4	PA2	L	I
	GE_SDDQ31		
5	PA3	L	I
	GE_SDDQ30		
6	P3B	G	K
	TIOA0_1		
	INT04_1		
	AIN0_1		
	I2SMCLK0_0		
	RTO00_0 (PPG00_0)		
	MAD10_0		
7	P3C	G	K
	SCS70_0		
	TIOA1_1		
	INT05_1		
	BIN0_1		
	I2SDO0_0		
	RTO01_0 (PPG00_0)		
	MAD09_0		
8	P3D	G	K
	SIN7_0		
	TIOA2_1		
	INT06_1		
	ZIN0_1		
	I2SWS0_0		
	RTO02_0 (PPG02_0)		
	MAD08_0		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
9	P3E	G	K
	SOT7_0 (SDA7_0)		
	TIOA3_1		
	INT07_1		
	I2SDI0_0		
	RTO03_0 (PPG02_0)		
	MAD07_0		
10	P3F	G	I
	SCK7_0 (SCL7_0)		
	TIOA4_1		
	I2SCK0_0		
	RTO04_0 (PPG04_0)		
	MAD06_0		
11	P7C	G	I
	TIOA5_1		
	RTO05_0 (PPG04_0)		
	MWEX_0		
12	P7B	K	I
	ADTG_2		
	GE_HBCSX1		
	MOEX_0		
—	P7B	K	I
	ADTG_2		
	MOEX_0		
13	PA8	L	I
	GE_SDDQ29		
14	PA9	L	I
	GE_SDDQ28		
15	PAA	L	I
	GE_SDDQ27		
16	PAB	L	I
	GE_SDDQ26		
17	PAC	L	I
	GE_SDDQ25		
18	PAD	L	I
	GE_SDDQ24		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
19	P33	D	K
	SIN6_0		
	INT00_1		
20	P34	D	I
	SOT6_0 (SDA6_0)		
	FRCK0_0		
21	P35	D	I
	SCK6_0 (SCL6_0)		
	IC03_0		
22	P36	D	K
	SCS60_0		
	INT01_1		
	IC02_0		
23	VCC	–	–
24	VSS	–	–
25	P37	D	K
	RX2_1		
	GE_HBRESETX		
	INT02_1		
	IC01_0		
–	P37	D	K
	RX2_1		
	INT02_1		
	IC01_0		
26	P38	D	K
	TX2_1		
	GE_HBINTX		
	INT03_1		
	IC00_0		
–	P38	D	K
	TX2_1		
	INT03_1		
	IC00_0		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
27	P39	E	I
	ADTG_0		
	GE_HBRSTOX		
	DTTI0X_0		
—	P39	E	I
	ADTG_0		
	DTTI0X_0		
28	P3A	E	I
	GE_HBWPX		
—	P3A	E	I
29	PA4	L	I
	GE_SDDQ23		
30	PA5	L	I
	GE_SDDQ22		
31	PA6	L	I
	GE_SDDQ21		
32	PA7	L	I
	GE_SDDQ20		
33	P7A	K	I
	GE_HBRWDS		
—	(N.C.)	—	—
34	P70	K	I
	GE_SPCK		
	GE_HBCK		
—	(N.C.)	—	—
35	P71	K	I
	GE_SPDQ0		
	GE_HBCSX0		
—	(N.C.)	—	—
36	P72	K	K
	GE_SPDQ3		
	GE_HBDQ0		
	INT00_0		
—	VCC	—	—
37	P73	K	K
	GE_SPCSX0		
	GE_HBDQ1		
	INT01_0		
—	(DNU0)	—	—
38	P74	K	K
	GE_SPDQ1		
	GE_HBDQ2		
	INT02_0		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
—	(DNU1)	—	—
39	P75	K	K
	GE_SPDQ2		
	GE_HBDQ3		
	INT03_0		
—	(N.C.)	—	—
40	P76	K	K
	GE_HBDQ4		
	INT04_0		
—	(N.C.)	—	—
41	P77	K	K
	GE_HBDQ5		
	INT05_0		
—	P77	K	K
	INT05_0		
42	P78	K	K
	GE_HBDQ6		
	INT06_0		
—	P78	K	K
	INT06_0		
43	P79	K	K
	GE_HBDQ7		
	INT07_0		
—	P79	K	K
	INT07_0		
44	VCC	—	—
45	VSS	—	—
46	P20	I	F
	NMIX		
	WKUP0		
47	PB0	L	I
	GE_SDDQ19		
48	PB1	L	I
	GE_SDDQ18		
49	PB2	L	I
	GE_SDDQ17		
50	PB3	L	I
	GE_SDDQ16		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
51	P21	E	I
	I2SMCLK1_0		
	MAD05_0		
52	P22	E	K
	CROUT_0		
	SIN0_0		
	INT08_0		
	I2SDO1_0		
	MAD04_0		
53	P23	E	I
	SOT0_0 (SDA0_0)		
	TIOA6_1		
	I2SWS1_0		
	MAD03_0		
54	P24	E	I
	SCK0_0 (SCL0_0)		
	TIOB6_1		
	I2SDI1_0		
	MAD02_0		
55	P25	E	I
	I2SCK1_0		
	MAD01_0		
56	PB4	L	I
	GE_SDDQ15		
57	PB5	L	I
	GE_SDDQ14		
58	PB6	L	I
	GE_SDDQ13		
59	PB7	L	I
	GE_SDDQ12		
60	C	—	—
61	VSS	—	—
62	VCC	—	—
63	P26	E	I
	RTCCO_1		
	SUBOUT_1		
	MAD00_0		
64	P27	E	I
	ADTG_1		
	CROUT_1		
	MRDY_0		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
65	P50	D	P
	WKUP1		
	MCSX0_0		
66	P51	E	I
	TIOB0_1		
	PNL_PWE		
	PNL_TSIG4		
67	P52	D	I
	TIOB1_1		
	PNL_DCLK		
68	P53	E	I
	TIOB2_1		
	PNL_DEN		
	PNL_TSIG2		
69	P54	E	I
	TIOB3_1		
	PNL_LE		
	PNL_TSIG3		
70	P55	E	I
	TIOB4_1		
	PNL_LH_SYNC		
	PNL_TSIG0		
71	P56	E	I
	TIOB5_1		
	PNL_FV_SYNC		
	PNL_TSIG1		
72	PB8	L	I
	GE_SDDQ11		
73	PB9	L	I
	GE_SDDQ10		
74	PBA	L	I
	GE_SDDQ9		
75	PBB	L	I
	GE_SDDQ8		
76	PBC	L	I
	GE_SDDQ7		
77	PBD	L	I
	GE_SDDQ6		
78	INITX	B	C
79	P46	P	S
	X0A		
80	P47	Q	T
	X1A		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
81	VBAT	—	—
82	P48	O	U
	VREGCTL		
83	P49	O	U
	VWAKEUP		
84	PE0	C	E
	MD1		
85	MD0	J	D
86	PE2	A	A
	X0		
87	PE3	A	B
	X1		
88	VSS	—	—
89	VCC	—	—
90	AVCC	—	—
91	AVSS	—	—
92	AVRL	—	—
93	AVRH	—	—
94	PC0	L	I
	GE_SDDQ5		
95	PC1	L	I
	GE_SDDQ4		
96	PC2	L	I
	GE_SDDQ3		
97	PC3	L	I
	GE_SDDQ2		
98	PC4	L	I
	GE_SDDQ1		
99	PC5	L	I
	GE_SDDQ0		
100	P10	F	M
	AN00		
	SIN1_0		
	TIOA0_0		
	INT09_0		
	AIN0_0		
	MADATA00_0		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
101	P11	F	L
	AN01		
	SOT1_0 (SDA1_0)		
	TIOB0_0		
	BIN0_0		
	MADATA01_0		
102	P12	F	L
	AN02		
	SCK1_0 (SCL1_0)		
	TIOA1_0		
	ZIN0_0		
	MADATA02_0		
103	P13	F	M
	AN03		
	SIN2_0		
	TIOB1_0		
	INT10_0		
	FRCK0_1		
	MADATA03_0		
104	P14	F	L
	AN04		
	SOT2_0 (SDA2_0)		
	TIOA2_0		
	DTTI0X_1		
	MADATA04_0		
105	P15	F	M
	AN05		
	SCK2_0 (SCL2_0)		
	TIOB2_0		
	INT11_0		
	IC00_1		
	MADATA05_0		
106	P16	F	M
	AN06		
	SIN3_0		
	TIOA3_0		
	INT12_0		
	IC01_1		
	MADATA06_0		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
107	P17	F	L
	AN07		
	SOT3_0 (SDA3_0)		
	TIOB3_0		
	IC02_1		
	MADATA07_0		
108	P18	F	L
	AN08		
	SCK3_0 (SCL3_0)		
	TIOA4_0		
	IC03_1		
	MADATA08_0		
109	P19	F	M
	AN09		
	SIN5_0		
	TIOB4_0		
	INT13_0		
	AIN0_2		
	RTO00_1 (PPG00_1)		
	MADATA09_0		
110	P1A	F	L
	AN10		
	SOT5_0 (SDA5_0)		
	TIOA5_0		
	BIN0_2		
	RTO01_1 (PPG00_1)		
	MADATA10_0		
111	P1B	F	L
	AN11		
	SCK5_0 (SCL5_0)		
	TIOB5_0		
	ZIN0_2		
	RTO02_1 (PPG02_1)		
	MADATA11_0		
112	PC6	K	I
	GE_SDBA1		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
113	PC7	K	I
	GE_SDBA0		
114	PC8	K	I
	GE_SDA11		
115	PC9	K	I
	GE_SDA10		
116	P1C	F	M
	AN12		
	SCS60_1		
	TIOA6_0		
	INT14_0		
	RTO03_1 (PPG02_1)		
	MADATA12_0		
117	P1D	F	M
	AN13		
	SIN6_1		
	TIOB6_0		
	INT15_0		
	RTO04_1 (PPG04_1)		
	MADATA13_0		
118	P1E	F	L
	AN14		
	SOT6_1 (SDA6_1)		
	TIOA7_0		
	RTO05_1 (PPG04_1)		
	MADATA14_0		
119	P1F	F	L
	AN15		
	SCK6_1 (SCL6_1)		
	TIOB7_0		
	MADATA15_0		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
120	P90	F	O
	AN16		
	SIN0_1		
	INT08_1		
	PNL_PD23		
	PNL_TSIG11		
	MCLKOUT_0		
	MNALE_0		
	TRACECLK		
121	P91	F	N
	AN17		
	SOT0_1 (SDA0_1)		
	PNL_PD22		
	PNL_TSIG10		
	MAD23_0		
	MNCLE_0		
	TRACED0		
122	P92	F	N
	AN18		
	SCK0_1 (SCL0_1)		
	PNL_PD21		
	PNL_TSIG9		
	MAD22_0		
	MNWEX_0		
	TRACED1		
123	P93	F	O
	AN19		
	SIN1_1		
	INT09_1		
	PNL_PD20		
	PNL_TSIG8		
	MAD21_0		
	MNREX_0		
	TRACED2		
124	P94	F	N
	AN20		
	SOT1_1 (SDA1_1)		
	PNL_PD19		
	PNL_TSIG7		
	MAD20_0		
	TRACED3		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
125	P95	F	L
	AN21		
	SCK1_1 (SCL1_1)		
	PNL_PD18		
	PNL_TSIG6		
	MAD19_0		
126	PCA	K	I
	GE_SDA9		
127	PCB	K	I
	GE_SDA8		
128	PCC	K	I
	GE_SDA7		
129	PCD	K	I
	GE_SDA6		
130	P96	F	L
	AN22		
	PNL_PD17		
	PNL_TSIG5		
	MRASX_0		
131	P97	F	L
	AN23		
	PNL_PD16		
	MCASX_0		
132	VSS	–	–
133	VCC	–	–
134	PD0	K	I
	GE_SDA5		
135	PD1	K	I
	GE_SDA4		
136	PD2	K	I
	GE_SDA3		
137	PD3	K	I
	GE_SDA2		
138	PD4	K	I
	GE_SDA1		
139	P00	E	G
	TRSTX		
140	P01	E	G
	TCK		
	SWCLK		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
141	P02	E	H
	TDI		
	MAD24_0		
142	P03	E	G
	TMS		
	SWDIO		
143	P04	E	G
	TDO		
	SWO		
144	PD5	K	I
	GE_SDA0		
145	PD6	K	I
	GE_SDDQM3		
146	PD7	K	I
	GE_SDDQM2		
147	PD8	K	I
	GE_SDDQM1		
148	PD9	K	I
	GE_SDDQM0		
149	P05	E	K
	RX2_2		
	INT10_1		
	PNL_PD15		
	MAD18_0		
150	P06	E	I
	TX2_2		
	PNL_PD14		
	MAD17_0		
151	P07	E	K
	SIN2_1		
	INT11_1		
	PNL_PD13		
	MAD16_0		
152	P08	E	I
	SOT2_1 (SDA2_1)		
	PNL_PD12		
	MAD15_0		
153	P09	E	I
	SCK2_1 (SCL2_1)		
	PNL_PD11		
	MAD14_0		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
154	P0A	E	K
	SIN5_1		
	TIOA7_1		
	INT12_1		
	PNL_PD10		
	MAD13_0		
155	P0B	E	I
	SOT5_1 (SDA5_1)		
	TIOB7_1		
	PNL_PD9		
	MAD12_0		
156	P0C	E	I
	SCK5_1 (SCL5_1)		
	PNL_PD8		
	MAD11_0		
157	P0D	D	I
	PNL_PD7		
	MSDWEX_0		
158	P0E	D	P
	WKUP2		
	PNL_PD6		
	MCSX8_0		
159	VSS	–	–
160	P68	D	I
	SCK3_1 (SCL3_1)		
	PNL_PD5		
	MSDCLK_0		
161	P67	D	I
	SOT3_1 (SDA3_1)		
	PNL_PD4		
	MSDCKE_0		
162	P66	E	K
	SIN3_1		
	INT13_1		
	PNL_PD3		
163	P65	E	I
	PNL_PD2		
164	P64	E	I
	CTS4_0		
	PNL_PD1		

Pin No. LQFP176	Pin name	I/O circuit type	Pin state type
165	P63	E	I
	ADTG_3		
	RTS4_0		
	PNL_PD0		
166	PDA	K	I
	GE_SDWEX		
167	PDB	K	I
	GE_SDRASX		
168	PDC	K	I
	GE_SDCASX		
169	PDD	K	I
	GE_SDCSX		
170	P62	N	K
	RX2_0		
	SCK4_0 (SCL4_0)		
	INT14_1		
	MDQM1_0		
171	P61	N	I
	UHCONX0		
	RTCCO_0		
	SUBOUT_0		
	TX2_0		
	SOT4_0 (SDA4_0)		
	MDQM0_0		
172	P60	I	Q
	WKUP3		
	SIN4_0		
	INT15_1		
	MALE_0		
173	VCC	—	—
174	P80	H	R
	UDM0		
175	P81	H	R
	UDP0		
176	VSS	—	—
—	VSS	—	—

Signal Description

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

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

Module	Pin Name	Function	Pin No. LQFP176
ADC	ADTG_0	A/D converter external trigger input pin	27
	ADTG_1		64
	ADTG_2		12
	ADTG_3		165
	AN00	A/D converter analog input pin. ANxx describes ADC ch.xx.	100
	AN01		101
	AN02		102
	AN03		103
	AN04		104
	AN05		105
	AN06		106
	AN07		107
	AN08		108
	AN09		109
	AN10		110
	AN11		111
	AN12		116
	AN13		117
	AN14		118
	AN15		119
	AN16		120
	AN17		121
	AN18		122
	AN19		123
	AN20		124
	AN21		125
	AN22		130
	AN23		131
Base Timer 0	TIOA0_0	Base Timer ch.0 TIOA Pin	100
	TIOA0_1		6
	TIOB0_0	Base Timer ch.0 TIOB Pin	101
	TIOB0_1		66
Base Timer 1	TIOA1_0	Base Timer ch.1 TIOA Pin	102
	TIOA1_1		7
	TIOB1_0	Base Timer ch.1 TIOB Pin	103
	TIOB1_1		67
Base Timer 2	TIOA2_0	Base Timer ch.2 TIOA Pin	104
	TIOA2_1		8
	TIOB2_0	Base Timer ch.2 TIOB Pin	105
	TIOB2_1		68

Module	Pin Name	Function	Pin No. LQFP176
Base Timer 3	TIOA3_0	Base Timer ch.3 TIOA Pin	106
	TIOA3_1		9
	TIOB3_0	Base Timer ch.3 TIOB Pin	107
	TIOB3_1		69
Base Timer 4	TIOA4_0	Base Timer ch.4 TIOA Pin	108
	TIOA4_1		10
	TIOB4_0	Base Timer ch.4 TIOB Pin	109
	TIOB4_1		70
Base Timer 5	TIOA5_0	Base Timer ch.5 TIOA Pin	110
	TIOA5_1		11
	TIOB5_0	Base Timer ch.5 TIOB Pin	111
	TIOB5_1		71
Base Timer 6	TIOA6_0	Base Timer ch.6 TIOA Pin	116
	TIOA6_1		53
	TIOB6_0	Base Timer ch.6 TIOB Pin	117
	TIOB6_1		54
Base Timer 7	TIOA7_0	Base Timer ch.7 TIOA Pin	118
	TIOA7_1		154
	TIOB7_0	Base Timer ch.7 TIOB Pin	119
	TIOB7_1		155
CAN (CAN-FD)	TX2_0	CAN-FD interface TX output pin	171
	TX2_1		26
	TX2_2		150
	RX2_0	CAN-FD interface RX input pin	170
	RX2_1		25
	RX2_2		149
Debugger	SWCLK	Serial wire debug interface clock input pin	140
	SWDIO	Serial wire debug interface data input / output pin	142
	SWO	Serial wire viewer output pin	143
	TCK	JTAG test clock input pin	140
	TDI	JTAG test data input pin	141
	TDO	JTAG debug data output pin	143
	TMS	JTAG test mode state output pin	142
	TRACECLK	Trace CLK output pin of ETM	120
	TRACED0	Trace data output pin of ETM	121
	TRACED1		122
	TRACED2		123
	TRACED3		124
	TRSTX	JTAG test reset Input pin	139

Module	Pin Name	Function	Pin No. LQFP176
External Bus	MAD00_0	External bus interface address bus	63
	MAD01_0		55
	MAD02_0		54
	MAD03_0		53
	MAD04_0		52
	MAD05_0		51
	MAD06_0		10
	MAD07_0		9
	MAD08_0		8
	MAD09_0		7
	MAD10_0		6
	MAD11_0		156
	MAD12_0		155
	MAD13_0		154
	MAD14_0		153
	MAD15_0		152
	MAD16_0		151
	MAD17_0		150
	MAD18_0		149
	MAD19_0		125
	MAD20_0		124
	MAD21_0		123
	MAD22_0		122
	MAD23_0		121
	MAD24_0		141
	MCSX0_0	External bus interface chip select output pin	65
	MCSX8_0		158
	MADATA00_0	External bus interface data bus	100
	MADATA01_0		101
	MADATA02_0		102
	MADATA03_0		103
	MADATA04_0		104
	MADATA05_0		105
	MADATA06_0		106
	MADATA07_0		107
	MADATA08_0		108
	MADATA09_0		109
	MADATA10_0		110
	MADATA11_0		111
	MADATA12_0		116
	MADATA13_0		117
	MADATA14_0		118
	MADATA15_0		119

Module	Pin Name	Function	Pin No. LQFP176
External Bus	MDQM0_0	External bus interface byte mask signal output pin	171
	MDQM1_0		170
	MALE_0	External bus interface Address Latch enable output signal for multiplex	172
	MRDY_0	External bus interface external RDY input signal	64
	MCLKOUT_0	External bus interface external clock output pin	120
	MNALE_0	External bus interface ALE signal to control NAND Flash output pin	120
	MNCLE_0	External bus interface CLE signal to control NAND Flash output pin	121
	MNREX_0	External bus interface read enable signal to control NAND Flash output pin	123
	MNWEX_0	External bus interface write enable signal to control NAND Flash output pin	122
	MOEX_0	External bus interface read enable signal for SRAM	12
	MWEX_0	External bus interface write enable signal for SRAM	11
	MSDCLK_0	SDRAM interface SDRAM clock output pin	160
	MSDCKE_0	SDRAM interface SDRAM clock enable pin	161
	MRASX_0	SDRAM interface SDRAM row active strobe pin	130
	MCASX_0	SDRAM interface SDRAM column active strobe pin	131
	MSDWEX_0	SDRAM interface SDRAM write enable pin	157
External Interrupt	INT00_0	External interrupt request 00 input pin	36
	INT00_1		19
	INT01_0	External interrupt request 01 input pin	37
	INT01_1		22
	INT02_0	External interrupt request 02 input pin	38
	INT02_1		25
	INT03_0	External interrupt request 03 input pin	39
	INT03_1		26
	INT04_0	External interrupt request 04 input pin	40
	INT04_1		6
	INT05_0	External interrupt request 05 input pin	41
	INT05_1		7
	INT06_0	External interrupt request 06 input pin	42
	INT06_1		8
	INT07_0	External interrupt request 07 input pin	43
	INT07_1		9
	INT08_0	External interrupt request 08 input pin	52
	INT08_1		120
	INT09_0	External interrupt request 09 input pin	100
	INT09_1		123

Module	Pin Name	Function	Pin No. LQFP176
External Interrupt	INT10_0	External interrupt request 10 input pin	103
	INT10_1		149
	INT11_0	External interrupt request 11 input pin	105
	INT11_1		151
	INT12_0	External interrupt request 12 input pin	106
	INT12_1		154
	INT13_0	External interrupt request 13 input pin	109
	INT13_1		162
	INT14_0	External interrupt request 14 input pin	116
	INT14_1		170
	INT15_0	External interrupt request 15 input pin	117
	INT15_1		172
	NMIX	Non-Maskable Interrupt input pin	46
GPIO	P00	General-purpose I/O port 0	139
	P01		140
	P02		141
	P03		142
	P04		143
	P05		149
	P06		150
	P07		151
	P08		152
	P09		153
	P0A		154
	P0B		155
	P0C		156
	P0D		157
	P0E		158
	P10	General-purpose I/O port 1	100
	P11		101
	P12		102
	P13		103
	P14		104
	P15		105
	P16		106
	P17		107
	P18		108
	P19		109
	P1A		110
	P1B		111
	P1C		116
	P1D		117
	P1E		118
	P1F		119

Module	Pin Name	Function	Pin No. LQFP176
GPIO	P20	General-purpose I/O port 2	46
	P21		51
	P22		52
	P23		53
	P24		54
	P25		55
	P26		63
	P27		64
	P33	General-purpose I/O port 3	19
	P34		20
	P35		21
	P36		22
	P37		25
	P38		26
	P39		27
	P3A		28
	P3B		6
	P3C		7
	P3D		8
	P3E		9
	P3F		10
	P46	General-purpose I/O port 4	79
	P47		80
	P48		82
	P49		83
	P50	General-purpose I/O port 5	65
	P51		66
	P52		67
	P53		68
	P54		69
	P55		70
	P56		71
	P60	General-purpose I/O port 6	172
	P61		171
	P62		170
	P63		165
	P64		164
	P65		163
	P66		162
	P67		161
	P68		160

Module	Pin Name	Function	Pin No. LQFP176
GPIO	P70	General-purpose I/O port 7	34
	P71		35
	P72		36
	P73		37
	P74		38
	P75		39
	P76		40
	P77		41
	P78		42
	P79		43
	P7A		33
	P7B		12
	P7C		11
	P80	General-purpose I/O port 8	174
	P81		175
	P90	General-purpose I/O port 9	120
	P91		121
	P92		122
	P93		123
	P94		124
	P95		125
	P96		130
	P97		131
	PA0	General-purpose I/O port A	2
	PA1		3
	PA2		4
	PA3		5
	PA4		29
	PA5		30
	PA6		31
	PA7		32
	PA8		13
	PA9		14
	PAA		15
	PAB		16
	PAC		17
	PAD		18

Module	Pin Name	Function	Pin No. LQFP176
GPIO	PB0	General-purpose I/O port B	47
	PB1		48
	PB2		49
	PB3		50
	PB4		56
	PB5		57
	PB6		58
	PB7		59
	PB8		72
	PB9		73
	PBA		74
	PBB		75
	PBC		76
	PBD		77
GPIO	PC0	General-purpose I/O port C	94
	PC1		95
	PC2		96
	PC3		97
	PC4		98
	PC5		99
	PC6		112
	PC7		113
	PC8		114
	PC9		115
	PCA		126
	PCB		127
	PCC		128
	PCD		129
	PD0	General-purpose I/O port D	134
	PD1		135
	PD2		136
	PD3		137
	PD4		138
	PD5		144
	PD6		145
	PD7		146
	PD8		147
	PD9		148
	PDA		166
	PDB		167
	PDC		168
	PDD		169

Module	Pin Name	Function	Pin No. LQFP176
GPIO	PE0	General-purpose I/O port E	84
	PE2		86
	PE3		87
Multi-function serial 0	SIN0_0	Multi-function serial interface ch.0 input pin	52
	SIN0_1		120
	SOT0_0 (SDA0_0)	Multi-function serial interface ch.0 output pin. This pin operates as SOT0 when it is used in a UART/CSIO/LIN (operation modes 0 to 3) and as SDA0 when it is used in an I²C (operation mode 4).	53
	SOT0_1 (SDA0_1)		121
	SCK0_0 (SCL0_0)	Multi-function serial interface ch.0 clock I/O pin. This pin operates as SCK0 when it is used in a CSIO (operation mode 2) and as SCL0 when it is used in an I²C (operation mode 4)	54
	SCK0_1 (SCL0_1)		122
Multi-function serial 1	SIN1_0	Multi-function serial interface ch.1 input pin	100
	SIN1_1		123
	SOT1_0 (SDA1_0)	Multi-function serial interface ch.1 output pin. This pin operates as SOT1 when it is used in a UART/CSIO/LIN(operation modes 0 to 3) and as SDA1 when it is used in an I²C (operation mode 4).	101
	SOT1_1 (SDA1_1)		124
	SCK1_0 (SCL1_0)	Multi-function serial interface ch.1 clock I/O pin. This pin operates as SCK1 when it is used in a CSIO (operation mode 2) and as SCL1 when it is used in an I²C (operation mode 4).	102
	SCK1_1 (SCL1_1)		125
Multi-function serial 2	SIN2_0	Multi-function serial interface ch.2 input pin	103
	SIN2_1		151
	SOT2_0 (SDA2_0)	Multi-function serial interface ch.2 output pin. This pin operates as SOT2 when it is used in a UART/CSIO/LIN (operation mode 0 to 3) and as SDA2 when it is used in an I²C (operation mode 4).	104
	SOT2_1 (SDA2_1)		152
	SCK2_0 (SCL2_0)	Multi-function serial interface ch.2 clock I/O Pin. This pin operates as SCK2 when it is used in a CSIO (operation mode 2) and as SCL2 when it is used in an I²C (operation mode 4).	105
	SCK2_1 (SCL2_1)		153
Multi-function serial 3	SIN3_0	Multi-function serial interface ch.3 input pin	106
	SIN3_1		162
	SOT3_0 (SDA3_0)	Multi-function serial interface ch.3 output pin. This pin operates as SOT3 when it is used in a UART/CSIO/LIN (operation modes 0 to 3) and as SDA3 when it is used in an I²C (operation mode 4).	107
	SOT3_1 (SDA3_1)		161
	SCK3_0 (SCL3_0)	Multi-function serial interface ch.3 clock I/O pin. This pin operates as SCK3 when it is used in a CSIO (operation mode 2) and as SCL3 when it is used in an I²C (operation mode 4).	108
	SCK3_1 (SCL3_1)		160

Module	Pin Name	Function	Pin No. LQFP176
Multi-function serial 4	SIN4_0	Multi-function serial interface ch.4 input pin	172
	SOT4_0 (SDA4_0)	Multi-function serial interface ch.4 output pin. This pin operates as SOT4 when it is used in a UART/CSIO/LIN (operation modes 0 to 3) and as SDA4 when it is used in an I²C (operation mode 4).	171
	SCK4_0 (SCL4_0)	Multi-function serial interface ch.4 clock I/O pin. This pin operates as SCK4 when it is used in a CSIO (operation mode 2) and as SCL4 when it is used in an I²C (operation mode 4).	170
	CTS4_0	Multi-function serial interface ch.4 CTS input pin	164
	RTS4_0	Multi-function serial interface ch.4 RTS output pin	165
Multi-function serial 5	SIN5_0	Multi-function serial interface ch.5 input pin	109
	SIN5_1		154
	SOT5_0 (SDA5_0)	Multi-function serial interface ch.5 output pin. This pin operates as SOT5 when it is used in a UART/CSIO/LIN (operation modes 0 to 3) and as SDA5 when it is used in an I²C (operation mode 4).	110
	SOT5_1 (SDA5_1)		155
	SCK5_0 (SCL5_0)	Multi-function serial interface ch.5 clock I/O pin. This pin operates as SCK5 when it is used in a CSIO (operation mode 2) and as SCL5 when it is used in an I²C (operation mode 4).	111
	SCK5_1 (SCL5_1)		156
Multi-function serial 6	SIN6_0	Multi-function serial interface ch.6 input pin	19
	SIN6_1		117
	SOT6_0 (SDA6_0)	Multi-function serial interface ch.6 output pin. This pin operates as SOT6 when it is used in a UART/CSIO/LIN (operation modes 0 to 3) and as SDA6 when it is used in an I²C (operation mode 4).	20
	SOT6_1 (SDA6_1)		118
	SCK6_0 (SCL6_0)	Multi-function serial interface ch.6 clock I/O pin. This pin operates as SCK6 when it is used in a CSIO (operation mode 2) and as SCL6 when it is used in an I²C (operation mode 4).	21
	SCK6_1 (SCL6_1)		119
	SCS60_0	Multi-function serial interface ch.6 chip select 0 input/output pin	22
	SCS60_1		116
Multi-function serial 7	SIN7_0	Multi-function serial interface ch.7 input pin	8
	SOT7_0 (SDA7_0)	Multi-function serial interface ch.7 output pin. This pin operates as SOT7 when it is used in a UART/CSIO/LIN (operation modes 0 to 3) and as SDA7 when it is used in an I²C (operation mode 4).	9
	SCK7_0 (SCL7_0)	Multi-function serial interface ch.7 clock I/O pin. This pin operates as SCK7 when it is used in a CSIO (operation mode 2) and as SCL7 when it is used in an I²C (operation mode 4).	10
	SCS70_0	Multi-function serial interface ch.7 chip select 0 input/output pin	7

Module	Pin Name	Function	Pin No. LQFP176
Multi-function Timer 0	DTTI0X_0	Input signal controlling wave form generator outputs RTO00 to RTO05 of Multi-function timer 0.	27
	DTTI0X_1		104
	FRCK0_0	16-bit free-run timer ch.0 external clock input pin	20
	FRCK0_1		103
	IC00_0	16-bit input capture input pin of Multi-function timer 0. ICxx describes channel number.	26
	IC00_1		105
	IC01_0		25
	IC01_1		106
	IC02_0		22
	IC02_1		107
	IC03_0		21
	IC03_1		108
	RTO00_0 (PPG00_0)	Wave form generator output pin of Multi-function timer 0. This pin operates as PPG00 when it is used in PPG0 output modes.	6
	RTO00_1 (PPG00_1)		109
	RTO01_0 (PPG00_0)	Wave form generator output pin of Multi-function timer 0. This pin operates as PPG00 when it is used in PPG0 output modes.	7
	RTO01_1 (PPG00_1)		110
	RTO02_0 (PPG02_0)	Wave form generator output pin of Multi-function timer 0. This pin operates as PPG02 when it is used in PPG0 output modes.	8
	RTO02_1 (PPG02_1)		111
	RTO03_0 (PPG02_0)	Wave form generator output pin of Multi-function timer 0. This pin operates as PPG02 when it is used in PPG0 output modes.	9
	RTO03_1 (PPG02_1)		116
Multi-function Timer 0	RTO04_0 (PPG04_0)	Wave form generator output pin of Multi-function timer 0. This pin operates as PPG04 when it is used in PPG0 output modes.	10
	RTO04_1 (PPG04_1)		117
	RTO05_0 (PPG04_0)	Wave form generator output pin of Multi-function timer 0. This pin operates as PPG04 when it is used in PPG0 output modes.	11
	RTO05_1 (PPG04_1)		118
Quadrature Position/ Revolution Counter 0	AIN0_0	QPRC ch.0 AIN input pin	100
	AIN0_1		6
	AIN0_2		109
	BIN0_0	QPRC ch.0 BIN input pin	101
	BIN0_1		7
	BIN0_2		110
	ZIN0_0	QPRC ch.0 ZIN input pin	102
	ZIN0_1		8
	ZIN0_2		111
Real-time clock	RTCCO_0	0.5 seconds pulse output pin of Real-time clock	171
	RTCCO_1		63
	SUBOUT_0	Sub clock output pin	171
	SUBOUT_1		63

Module	Pin Name	Function	Pin No. LQFP176
USB0	UDM0	USB ch.0 device/host D – pin	174
	UDP0	USB ch.0 device/host D + pin	175
	UHCONX0	USB ch.0 external pull-up control pin	171
Low-Power Consumption Mode	WKUP0	Deep standby mode return signal input pin 0	46
	WKUP1	Deep standby mode return signal input pin 1	65
	WKUP2	Deep standby mode return signal input pin 2	158
	WKUP3	Deep standby mode return signal input pin 3	172
VBAT	VREGCTL	On-board regulator control pin	82
	VWAKEUP	The return signal input pin from a hibernation state	83
I^2S 0	I2SMCLK0_0	I^2S ch.0 external clock pin	6
	I2SDO0_0	I^2S ch.0 serial transition data output pin	7
	I2SWS0_0	I^2S ch.0 frame synchronization signal pin	8
	I2SDI0_0	I^2S ch.0 serial received data input pin	9
	I2SCK0_0	I^2S ch.0 bit clock pin	10
I^2S 1	I2SMCLK1_0	I^2S ch.1 external clock pin	51
	I2SDO1_0	I^2S ch.1 serial transition data output pin	52
	I2SWS1_0	I^2S ch.1 frame synchronization signal pin	53
	I2SDI1_0	I^2S ch.1 serial received data input pin	54
	I2SCK1_0	I^2S ch.1 bit clock pin	55
GDC High-Speed Quad SPI	GE_SPCK	SPI clock output pin	34
	GE_SPDQ0	SPI data input / output pin	35
	GE_SPDQ1		38
	GE_SPDQ2		39
	GE_SPDQ3		36
	GE_SPCSX0	SPI chip select output pin	37
GDC HyperBus I/F	GE_HBCK	HBI clock output pin	34
	GE_HBDQ0	HBI data input / output pin	36
	GE_HBDQ1		37
	GE_HBDQ2		38
	GE_HBDQ3		39
	GE_HBDQ4		40
	GE_HBDQ5		41
	GE_HBDQ6		42
	GE_HBDQ7		43
	GE_HBCSX0	HBI chip select output pin	35
	GE_HBCSX1		12
	GE_HBRWDS	HBI RWDS input / output pin	33
	GE_HBRESETX	HBI hardware reset output pin	25
	GE_HBINTX	HBI interrupt input pin	26
	GE_HBRSTOX	HBI reset input pin	27
	GE_HBWPX	HBI write protect output pin	28

Module	Pin Name	Function	Pin No. LQFP176
GDC Panel	PNL_DCLK	GDC clock output pin	67
	PNL_DEN	GDC data enable output pin (blanking signal)	68
	PNL_PWE	GDC power enable control output pin	66
	PNL_LE	GDC line end output pin	69
	PNL_LH_SYNC	GDC horizontal synchronization output pin	70
	PNL_FV_SYNC	GDC vertical synchronization output pin	71
	PNL_PD0	GDC panel data output pin	165
	PNL_PD1		164
	PNL_PD2		163
	PNL_PD3		162
	PNL_PD4		161
	PNL_PD5		160
	PNL_PD6		158
	PNL_PD7		157
	PNL_PD8		156
	PNL_PD9		155
	PNL_PD10		154
	PNL_PD11		153
	PNL_PD12		152
	PNL_PD13		151
	PNL_PD14		150
	PNL_PD15		149
	PNL_PD16		131
	PNL_PD17		130
	PNL_PD18		125
	PNL_PD19		124
	PNL_PD20		123
	PNL_PD21		122
	PNL_PD22		121
	PNL_PD23		120
	PNL_TSIG0	GDC timing generator for panel control PNL_TSIG signals are customized synchronization signals for direct interfacing to the column and row drivers of most panel types. For more information, refer to Peripheral Manual (GDC Core part).	70
	PNL_TSIG1		71
	PNL_TSIG2		68
	PNL_TSIG3		69
	PNL_TSIG4		66
	PNL_TSIG5		130
	PNL_TSIG6		125
	PNL_TSIG7		124
	PNL_TSIG8		123
	PNL_TSIG9		122
	PNL_TSIG10		121
	PNL_TSIG11		120

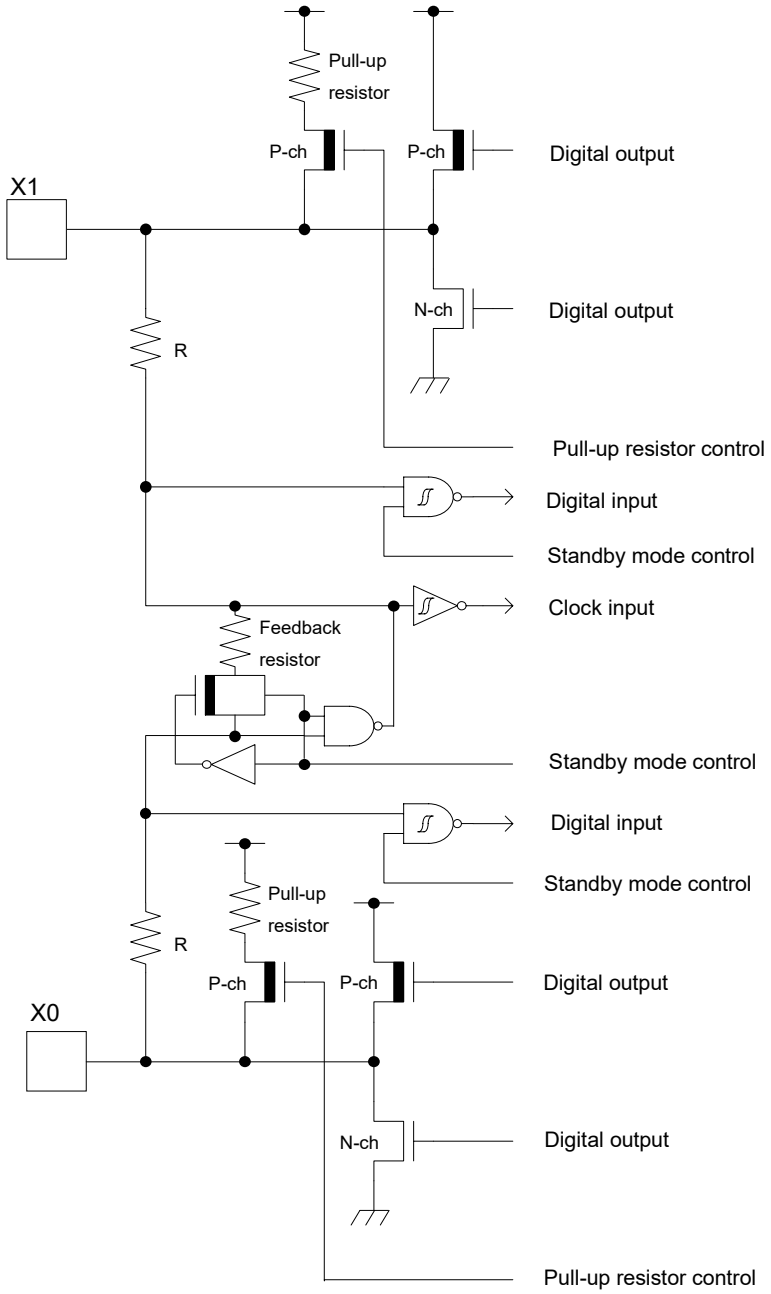
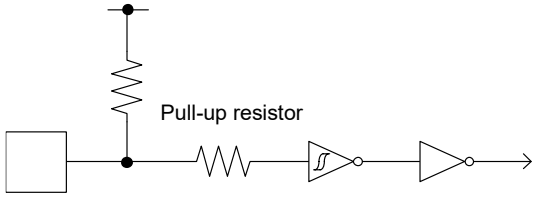
Module	Pin Name	Function	Pin No. LQFP176
GDC SDRAM-IF (176 pin only)	GE_SDA0	SDRAM-IF address output pin	144
	GE_SDA1		138
	GE_SDA2		137
	GE_SDA3		136
	GE_SDA4		135
	GE_SDA5		134
	GE_SDA6		129
	GE_SDA7		128
	GE_SDA8		127
	GE_SDA9		126
	GE_SDA10		115
	GE_SDA11		114
	GE_SDBA0	SDRAM-IF bank address output pin	113
	GE_SDBA1		112
	GE_SDCASX	SDRAM-IF column active output pin	168
	GE_SDRASX	SDRAM-IF row active output pin	167
	GE_SDWEX	SDRAM-IF write enable output pin	166
	GE_SDCKE	SDRAM-IF clock enable output pin	2
	GE_SDCLK	SDRAM-IF clock output pin	3
	GE_SDCSX	SDRAM-IF chip select output pin	169
	GE_SDDQ0	SDRAM-IF data input / output pin	99
	GE_SDDQ1		98
	GE_SDDQ2		97
	GE_SDDQ3		96
	GE_SDDQ4		95
	GE_SDDQ5		94
	GE_SDDQ6		77
	GE_SDDQ7		76
	GE_SDDQ8		75
	GE_SDDQ9		74
	GE_SDDQ10		73
	GE_SDDQ11		72
	GE_SDDQ12		59
	GE_SDDQ13		58
	GE_SDDQ14		57
	GE_SDDQ15		56
	GE_SDDQ16		50
	GE_SDDQ17		49
	GE_SDDQ18		48
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	GE_SDDQ23		29

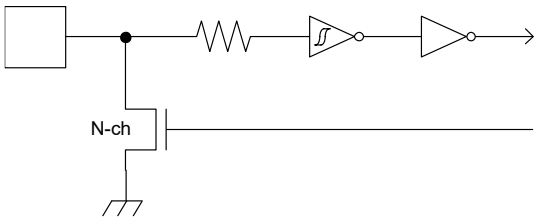
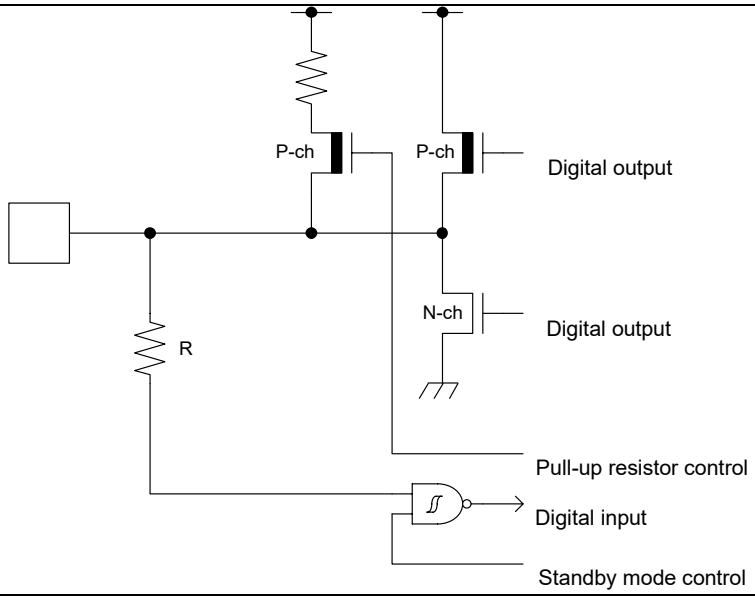
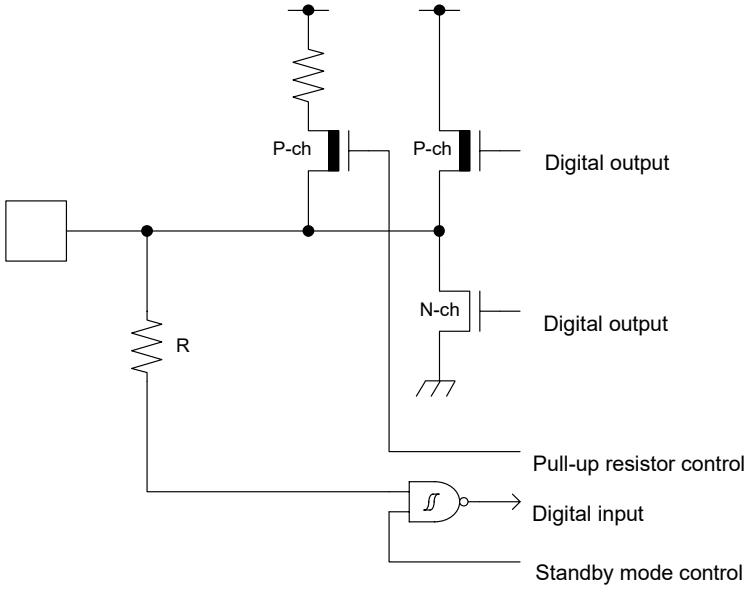
Module	Pin Name	Function	Pin No. LQFP176
GDC SDRAM-IF (176 pin only)	GE_SDDQ24	SDRAM-IF data input / output pin	18
	GE_SDDQ25		17
	GE_SDDQ26		16
	GE_SDDQ27		15
	GE_SDDQ28		14
	GE_SDDQ29		13
	GE_SDDQ30		5
	GE_SDDQ31		4
	GE_SDDQM0	SDRAM-IF input / output mask pin	148
	GE_SDDQM1		147
	GE_SDDQM2		146
	GE_SDDQM3		145
Reset	INITX	External Reset Input pin. A reset is valid when INITX = L.	78
Mode	MD1	Mode 1 pin. During serial programming to Flash memory, MD1 = L must be input.	84
	MD0	Mode 0 pin. During normal operation, MD0 = L must be input. During serial programming to Flash memory, MD0 = H must be input.	85
Power	VCC	Power supply Pin	1
			23
			44
			62
			89
			133
			173
GND	VSS	GND Pin	24
			45
			61
			88
			132
			159
			176
Clock	X0	Main clock (oscillation) input pin	86
	X0A	Sub clock (oscillation) input pin	79
	X1	Main clock (oscillation) I/O pin	87
	X1A	Sub clock (oscillation) I/O pin	80
	CROUT_0	Built-in High-speed CR-osc clock output port	52
	CROUT_1		64
Analog Power	AVCC	A/D converter analog power supply pin	90
	AVRL	A/D converter analog reference voltage input pin	92
	AVRH	A/D converter analog reference voltage input pin	93
VBAT Power	VBAT	VBAT power supply pin. Backup power supply (battery etc.) and system power supply.	81
Analog GND	AVSS	A/D converter GND pin	91
C Pin	C	Power supply stabilization capacity pin	60

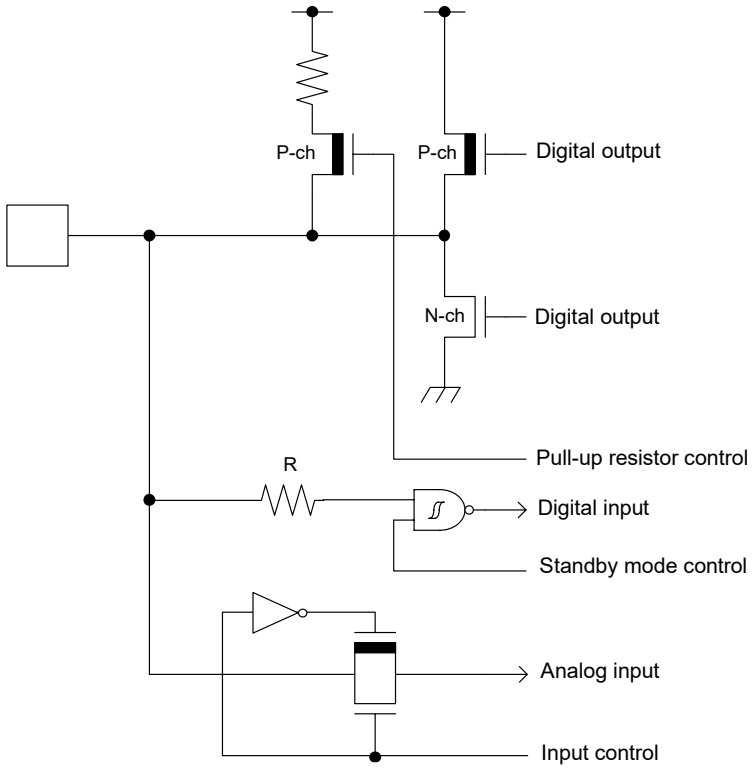
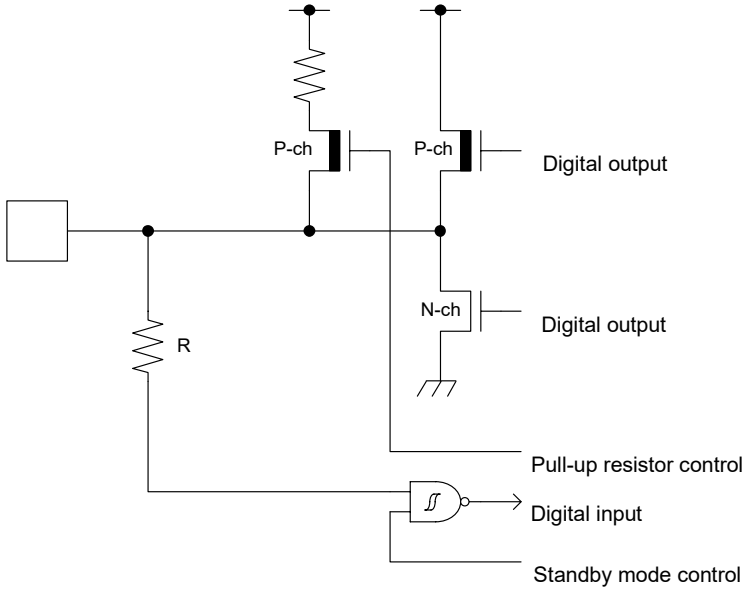
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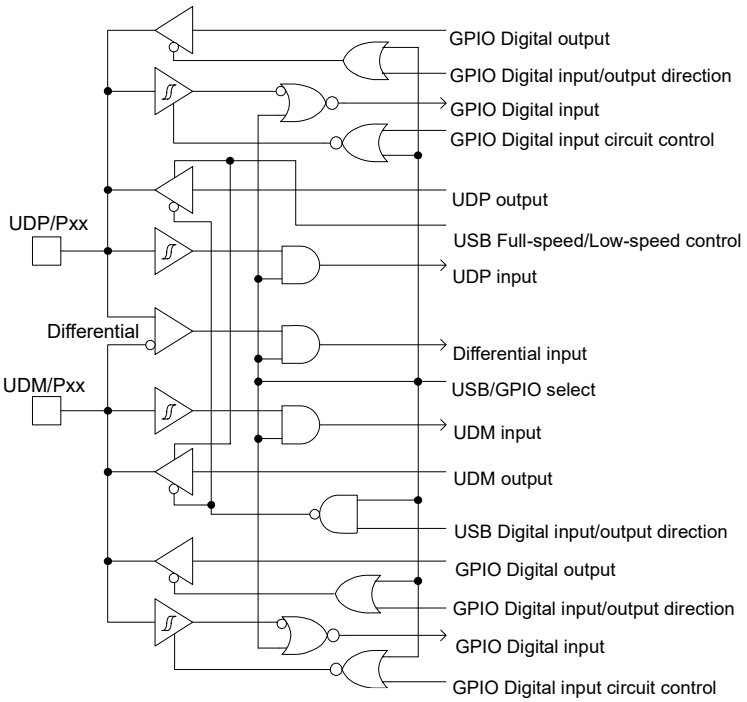
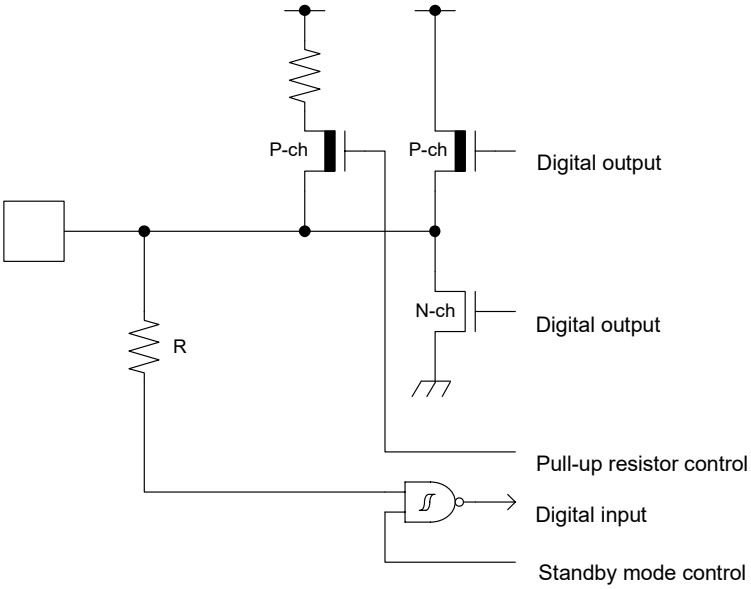
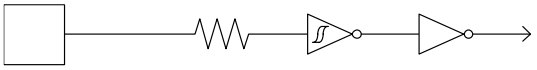
- *While this device contains a Test Access Port (TAP) based on the IEEE 1149.1-2001 JTAG standard, it is not fully compliant to all requirements of that standard. This device may contain a 32-bit device ID that is the same as the 32-bit device ID in other devices with different functionality. The TAP pins may also be configurable for purposes other than access to the TAP controller.*

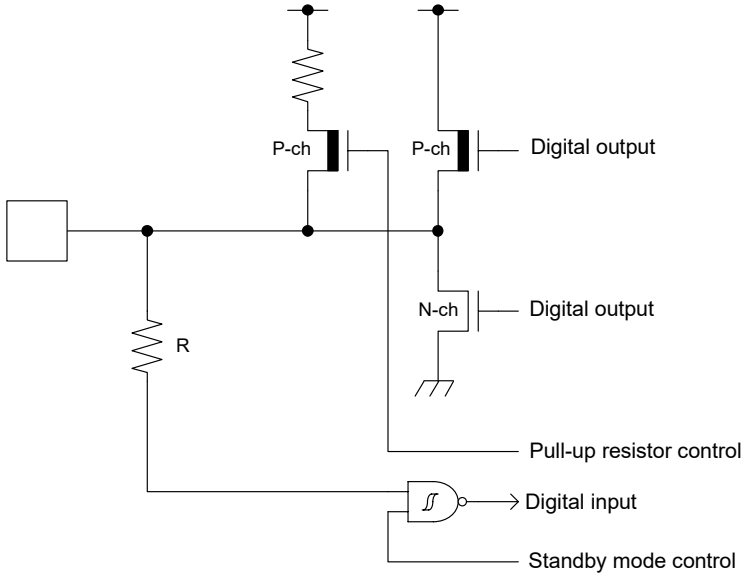
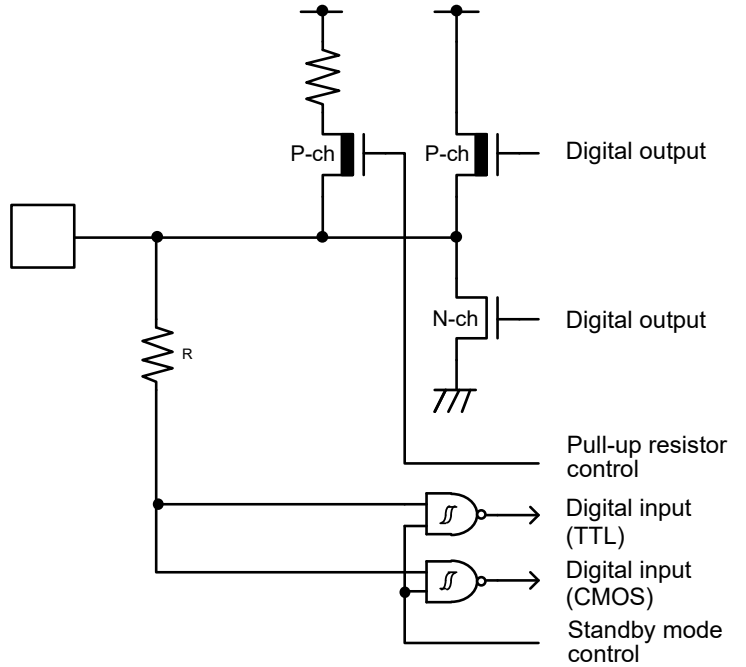
5 I/O Circuit Type

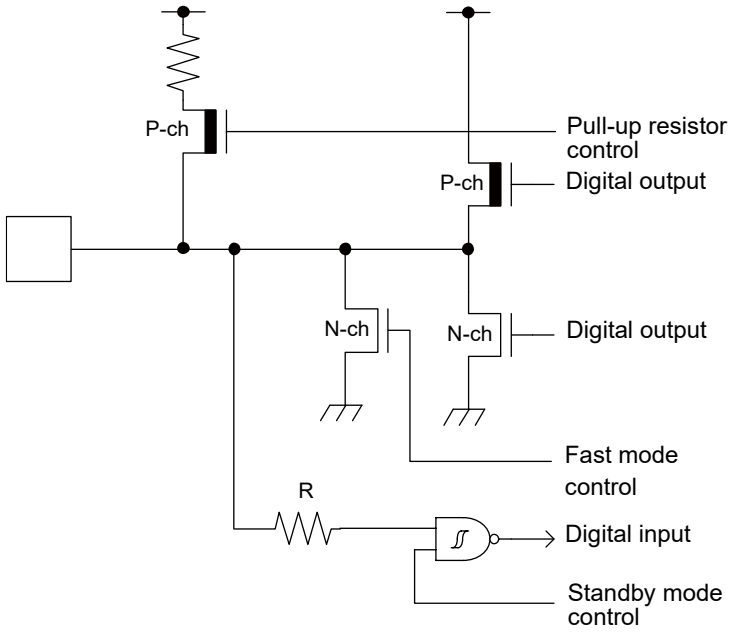
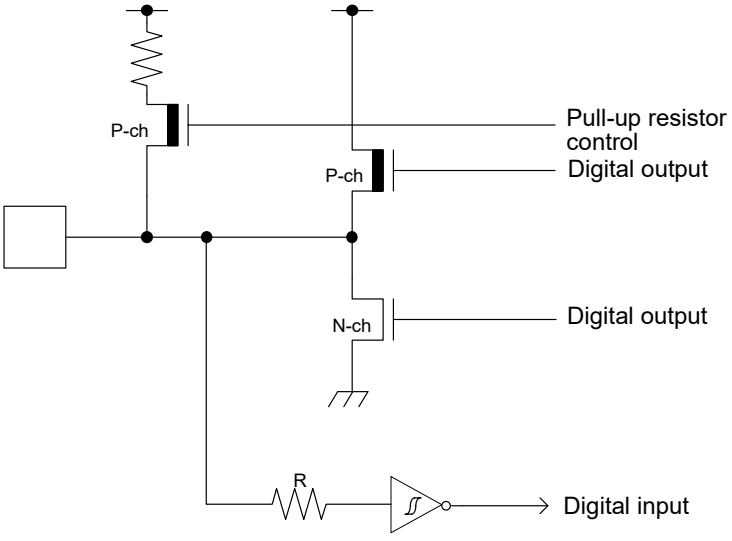
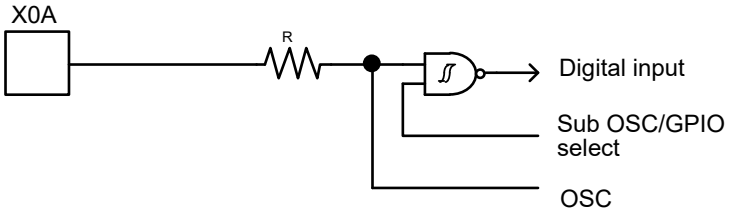
Type	Circuit	Remarks
A		It is possible to select the main oscillation / GPIO function When the main oscillation is selected. ・Oscillation feedback resistor : Approximately 1 MΩ ・With Standby mode control When the GPIO is selected. ・CMOS level output. ・CMOS level hysteresis input ・With pull-up resistor control ・With standby mode control ・Pull-up resistor : Approximately 80 kΩ ・I_{OH} = -2 mA, I_{OL} = 2 mA
B		・CMOS level hysteresis input ・Pull-up resistor : Approximately 80 kΩ

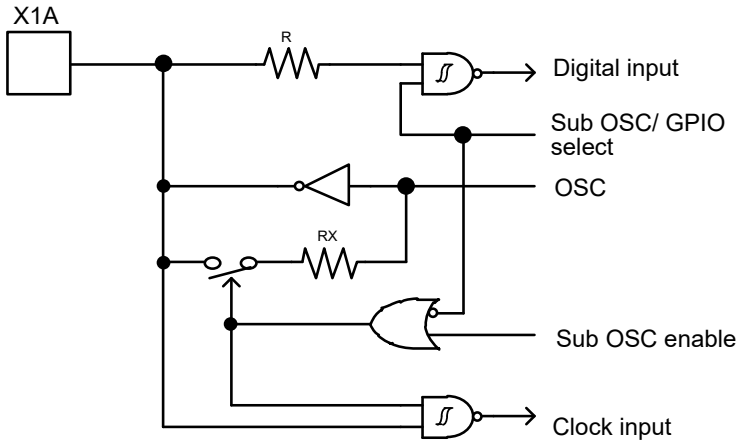
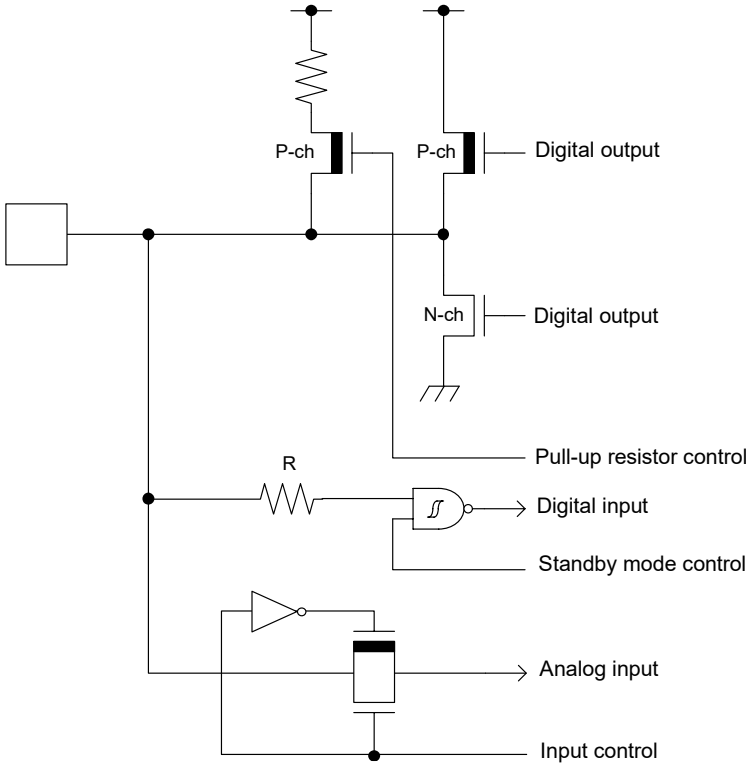
Type	Circuit	Remarks
C		・Open drain output ・CMOS level hysteresis input
D		・CMOS level output ・CMOS level hysteresis input ・With pull-up resistor control ・With standby mode control ・Pull-up resistor : Approximately 80 kΩ ・I_{OH} = -4 mA, I_{OL} = 4 mA ・When this pin is used as an I^2C pin, the digital output P-ch transistor is always off.
E		・CMOS level output ・CMOS level hysteresis input ・With pull-up resistor control ・With standby mode control ・Pull-up resistor : Approximately 80 kΩ ・I_{OH} = -2 mA, I_{OL} = 2 mA ・When this pin is used as an I^2C pin, the digital output P-ch transistor is always off.

Type	Circuit	Remarks
F		・CMOS level output ・CMOS level hysteresis input ・With input control ・Analog input ・With pull-up resistor control ・With standby mode control ・Pull-up resistor : Approximately 80 kΩ ・I_{OH} = -2 mA, I_{OL} = 2 mA ・When this pin is used as an I^2C pin, the digital output P-ch transistor is always off.
G		・CMOS level output ・CMOS level hysteresis input ・With pull-up resistor control ・With standby mode control ・Pull-up resistor : Approximately 80 kΩ ・I_{OH} = -8 mA, I_{OL} = 8 mA ・When this pin is used as an I^2C pin, the digital output P-ch transistor is always off.

Type	Circuit	Remarks
H		It is possible to select the USB I/O / GPIO function. When the USB I/O is selected. ・Full-speed, Low-speed control When the GPIO is selected. ・CMOS level output ・CMOS level hysteresis input ・With standby mode control ・I_{OH} = -20.5 mA, I_{OL} = 18.5 mA
I		・CMOS level output ・CMOS level hysteresis input ・5 V tolerant ・With pull-up resistor control ・With standby mode control ・Pull-up resistor : Approximately 80 kΩ ・I_{OH} = -2 mA, I_{OL} = 2 mA ・Available to control of PZR registers.
J		・CMOS level hysteresis input

Type	Circuit	Remarks
K		・CMOS level output ・CMOS level hysteresis input ・With pull-up resistor control ・With standby mode control ・Pull-up resistor : Approximately 33 kΩ ・I_{OH} = -11 mA, I_{OL} = 11 mA
L		・CMOS level output ・CMOS level hysteresis input ・TTL level hysteresis input :SDRAM-IF Data Input only ・With pull-up resistor control ・With standby mode control ・Pull-up resistor : Approximately 33 kΩ ・I_{OH} = -11 mA, I_{OL} = 11 mA

Type	Circuit	Remarks
N		・CMOS level output ・CMOS level hysteresis input ・5 V tolerant ・With pull-up resistor control ・With standby mode control ・Pull-up resistor : Approximately 80 kΩ ・I_{OH} = -3 mA, I_{OL} = 3 mA (GPIO) ・I_{OL} = 20 mA (Fast Mode Plus) ・Available to control of PZR registers. ・When this pin is used as an I^2C pin, the digital output P-ch transistor is always off
O		・CMOS level output ・CMOS level hysteresis input ・5 V tolerant ・With pull-up resistor control ・Pull-up resistor : Approximately 80 kΩ ・I_{OH} = -2 mA, I_{OL} = 2 mA ・Available to control of PZR registers. ・Please refer to the "VBAT domain" setting of the IO in the “Peripheral Manual main part (002-04856)".
P		・CMOS level hysteresis input ・Please refer to the "VBAT domain" setting of the IO in the “Peripheral Manual main part (002-04856)".

Type	Circuit	Remarks
Q		It is possible to select the sub oscillation / GPIO function When the sub oscillation is selected. ・Oscillation feedback resistor : Approximately 12 MΩ When the GPIO is selected. ・CMOS level hysteresis input ・Please refer to the "VBAT domain" setting of the IO in the “Peripheral Manual main part (002-04856)".
R		・CMOS level output ・CMOS level hysteresis input ・With input control ・Analog input ・With pull-up resistor control ・With standby mode control ・Pull-up resistor : Approximately 80 kΩ ・I_{OH} = -4 mA, I_{OL} = 4 mA

6 Handling Precautions

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

6.1 Precautions for Product Design

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

Absolute Maximum Ratings

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

Recommended Operating Conditions

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

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

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

Processing and Protection of Pins

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

1. Preventing Over-Voltage and Over-Current Conditions

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

2. Protection of Output Pins

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

3. Handling of Unused Input Pins

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

Latch-up

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

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 pins and GND pins of this device at low impedance. It is also advisable that a ceramic capacitor of approximately 0.1 µF be connected as a bypass capacitor between VCC and VSS, between AVCC and AVSS and between AVRH and AVRL near this device.

A malfunction may occur when the power supply voltage fluctuates rapidly even though the fluctuation is within the guaranteed operating range of the VCC power supply voltage. As a rule of voltage stabilization, suppress 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 standard VCC value, and the transient fluctuation rate does not exceed 0.1 V/µs at a momentary fluctuation such as 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

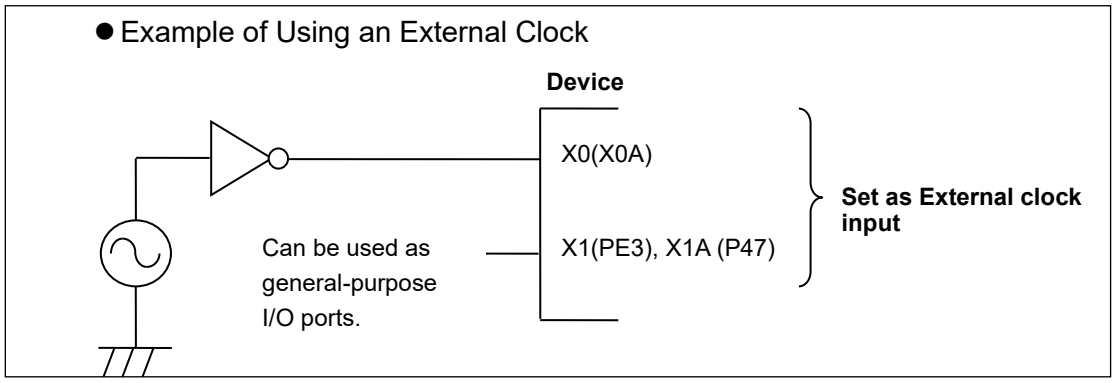
Size:	More than 3.2 mm × 1.5 mm
Load capacitance:	Approximately 6 pF to 7 pF When the Standard setting (CCS/CCB=11001110)
Load capacitance:	Approximately 4 pF to 7 pF When the low power setting (CCS/CCB=00000100)

■Lead type

Load capacitance:	Approximately 6 pF to 7 pF When the Standard setting (CCS/CCB=11001110)
Load capacitance:	Approximately 4 pF to 7 pF When the low power setting (CCS/CCB=00000100)

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.

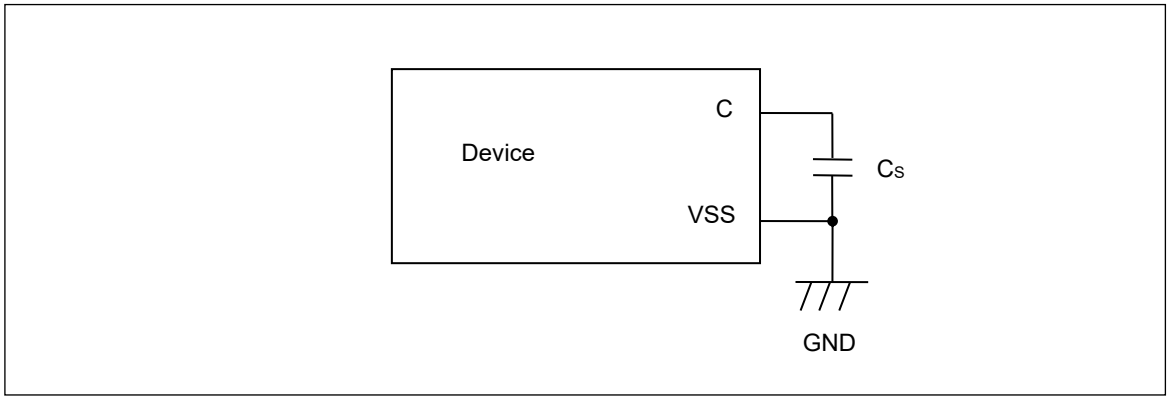


Handling when Using Multi-Function Serial Pin as I²C Pin

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

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 µF 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. The device operates normally after all power on.

VBAT only Power-on is possible when VBAT and VCC turns Power-on and Hibernation control is setting and then turns Power-off. About Hibernation control, see Chapter 7-3: VBAT Domain(B) in FM4 Family Peripheral Manual Main Part (002-04856).

Turning on : VBAT → VCC → AVCC → AVRH
Turning off : AVRH → AVCC → VCC → VBAT

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 5 V Tolerant I/O

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

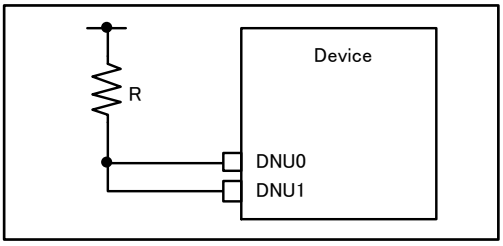
Pin Doubled as Debug Function

Please use as output only regarding the pin doubled as TDO/TMS/TDI/TCK/TRSTX, SWO/SWDIO/SWCLK.
Don't use as input.

S6E2D55GJA

The following must correspond to S6E2D55GJA.

1. Terminal DNU0 / 1 is short-circuited, and the pull-up of about 10kΩ is done.

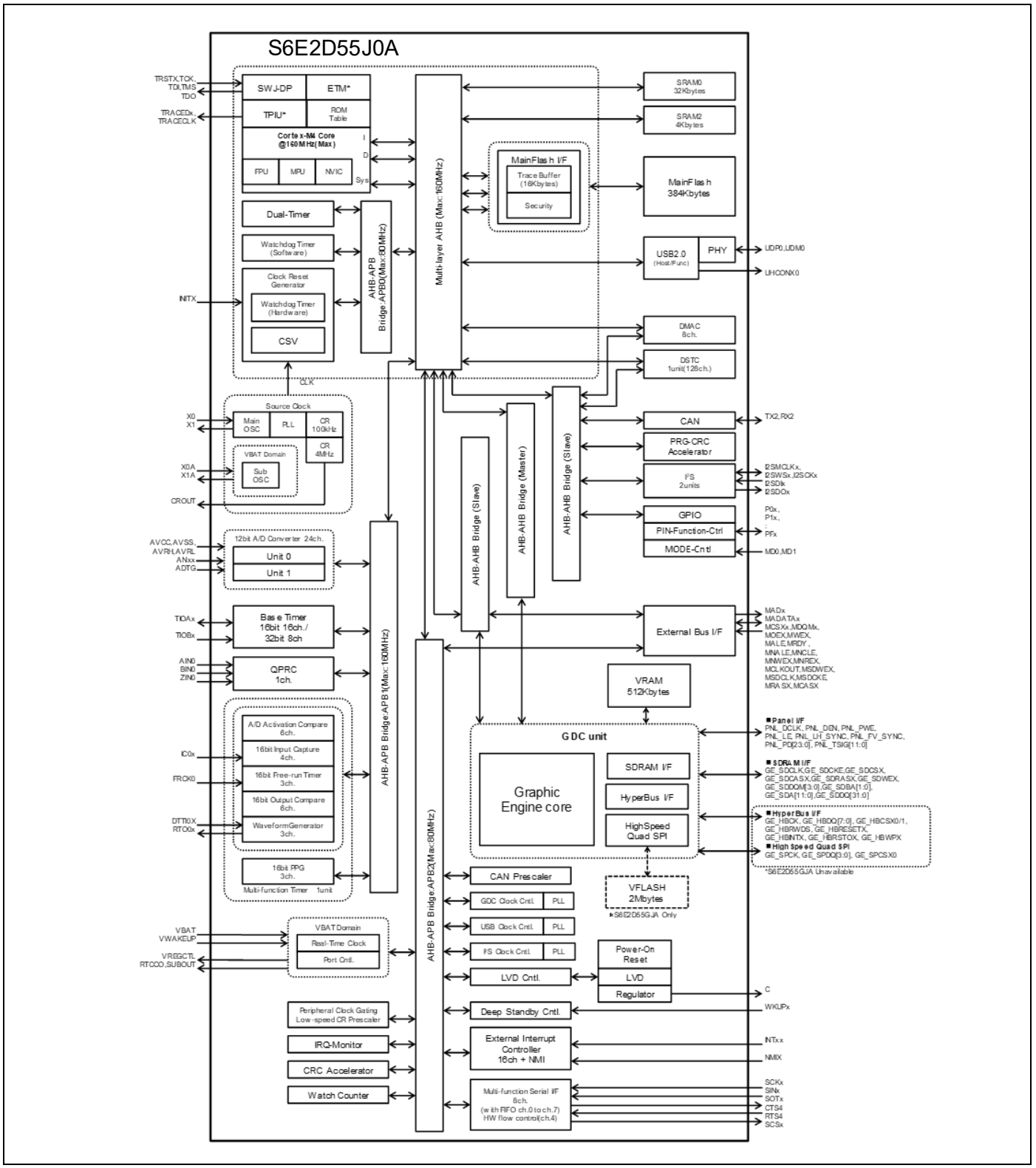


2. Please do not connect the open end NC terminal.
3. Please have the following port settings.

   PFR7: bit6=0, bit10=0
   PDOR7: bit6=0, bit10=0
   DDR7: bit6=1, bit10=1

   See Chapter 12: I/O Port in FM4 Family Peripheral Manual Main Part (002-04856) for more details.
4. Please connect a bypass capacitor as close as possible to GND on the board and VCC in pin number 22.

8 Block Diagram

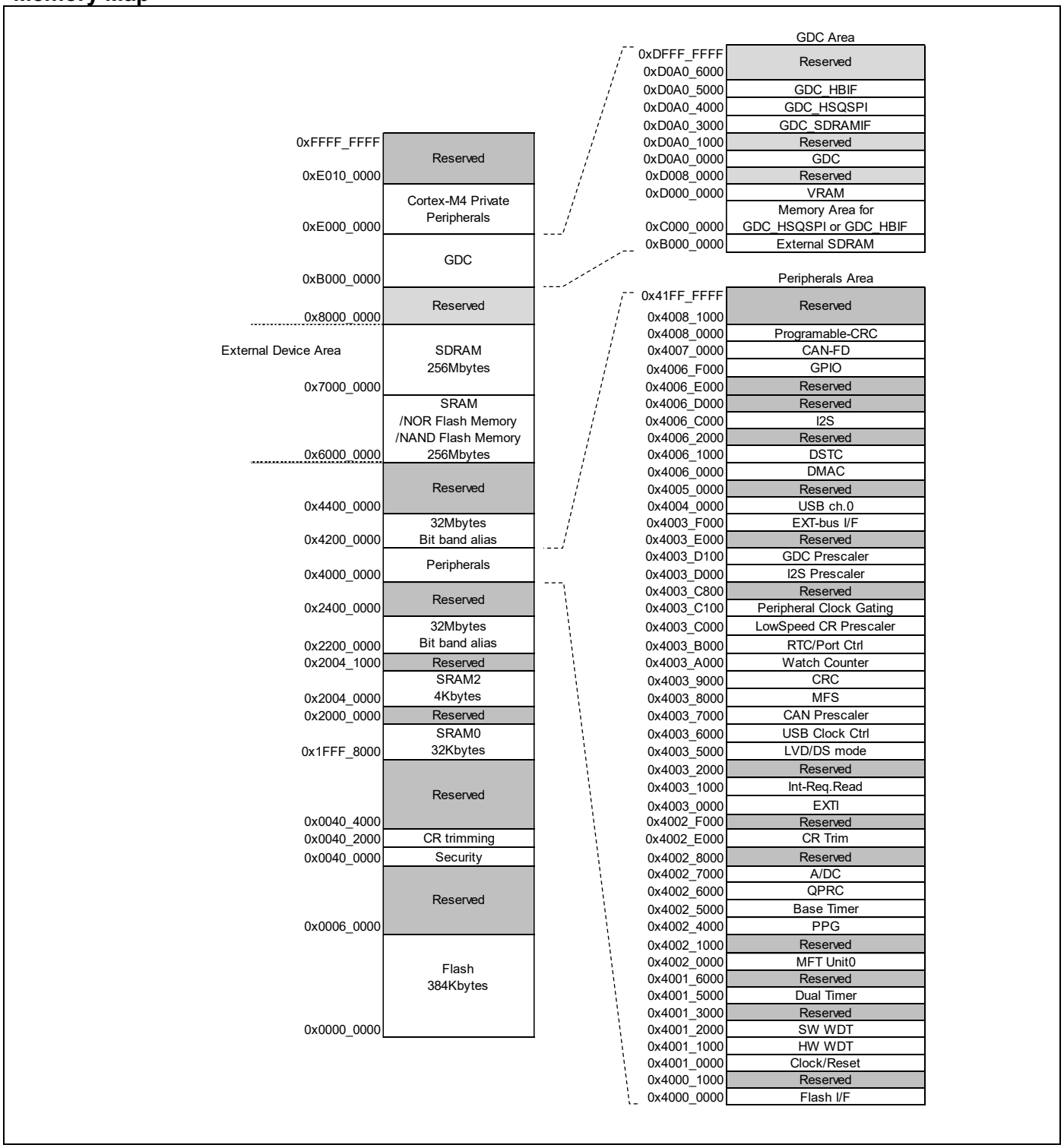


9 Memory Size

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

10 Memory Map

Memory Map



Peripheral Address Map

Start address	End address	Bus	Peripherals
0x4000_0000	0x4000_0FFF	AHB	MainFlash I/F register
0x4000_1000	0x4000_FFFF		Reserved
0x4001_0000	0x4001_0FFF	APB0	Clock/Reset Control
0x4001_1000	0x4001_1FFF		Hardw are Watchdog timer
0x4001_2000	0x4001_2FFF		Softw are 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		Internal CR trimming
0x4002_F000	0x4002_FFFF		Reserved
0x4003_0000	0x4003_0FFF	APB2	External Interrupt Controller
0x4003_1000	0x4003_1FFF		Interrupt Request Batch-Read Function
0x4003_2000	0x4003_4FFF		Reserved
0x4003_5000	0x4003_57FF		Low Voltage Detector
0x4003_5800	0x4003_5FFF		Deep standby mode Controller
0x4003_6000	0x4003_6FFF		USB clock generator
0x4003_7000	0x4003_7FFF		CAN prescaler
0x4003_8000	0x4003_8FFF		Multi-function serial Interface
0x4003_9000	0x4003_9FFF		CRC
0x4003_A000	0x4003_AFFF		Watch Counter
0x4003_B000	0x4003_BFFF		RTC/PortCtrl
0x4003_C000	0x4003_C0FF		Low -speed CR Prescaler
0x4003_C100	0x4003_C7FF		Peripheral Clock Gating
0x4003_C800	0x4003_CFFF		Reserved
0x4003_D000	0x4003_D0FF		I^2S Prescaler
0x4003_D100	0x4003_DFFF		GDC Prescaler
0x4003_E000	0x4003_EFFF		Reserved
0x4003_F000	0x4003_FFFF		External Memory interface
0x4004_0000	0x4004_FFFF	AHB	USB ch.0
0x4005_0000	0x4005_FFFF		Reserved
0x4006_0000	0x4006_0FFF		DMAC register
0x4006_1000	0x4006_1FFF		DSTC register
0x4006_2000	0x4006_BFFF		Reserved
0x4006_C000	0x4006_CFFF		I^2S
0x4006_D000	0x4006_DFFF		Reserved
0x4006_E000	0x4006_EFFF		Reserved
0x4006_F000	0x4006_FFFF		GPIO
0x4007_0000	0x4007_FFFF		CAN-FD
0x4008_0000	0x4008_0FFF		Programmable-CRC
0x4008_1000	0x41FF_FFFF		Reserved
0xB000_0000	0xDFFF_FFFF	AHB	GDC unit

11 Pin Status in Each CPU State

The terms used for pin status have the following meanings.

- INITX=0

  This is the period when the INITX pin is the L level.

- INITX=1

  This is the period when the INITX pin is the H level.

- SPL=0

  This is the status that the standby pin level setting bit (SPL) in the standby mode control register (STB_CTL) is set to 0.

- SPL=1

  This is the status that the standby pin level setting bit (SPL) in the standby mode control register (STB_CTL) is set to 1.

- Input enabled

  Indicates that the input function can be used.

- Internal input fixed at 0

  This is the status that the input function cannot be used. Internal input is fixed at L.

- Hi-Z

  Indicates that the pin drive transistor is disabled and the pin is put in the Hi-Z state.

- Setting disabled

  Indicates that the setting is disabled.

- Maintain previous state

  Maintains the state that was immediately prior to entering the current mode.
  If a built-in peripheral function is operating, the output follows the peripheral function.
  If the pin is being used as a port, that output is maintained.

- Analog input is enabled

  Indicates that the analog input is enabled.

- Trace output

  Indicates that the trace function can be used.

- GPIO selected

  In Deep standby mode, pins switch to the general-purpose I/O port.

- Setting prohibition

  Prohibition of a setting by specification limitation.

List of Pin Status

Pin status Type	Function Group	Power-on Reset or Low-Voltage Detection State	INITX Input State	Device Internal Reset State	Run Mode or Sleep Mode State	Timer Mode RTC Mode or Stop Mode State		Deep Standby RTC Mode or Deep Standby Stop Mode State		Return from Deep Standby Mode State
		Power Supply Unstable	Power Supply Stable		Power Supply Stable	Power Supply Stable		Power Supply Stable		Power Supply Stable
		-	INITX=0	INITX=1	INITX=1	INITX=1		INITX=1		INITX=1
		-	-	-	-	SPL=0	SPL=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	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	Main crystal oscillator input pin/ External main clock input selected	Input enabled	Input enabled	Input enabled	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	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	External main clock input selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Hi-Z / Internal input fixed at 0	Maintain previous state	Hi-Z / Internal input fixed at 0	Maintain previous state
	Main crystal oscillator output pin	Hi-Z / Internal input fixed at 0/ or Input enable	Hi-Z / Internal input fixed at 0	Hi-Z / Internal input fixed at 0	Maintain previous state/ When oscillation stops*1,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	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	Input enabled	Input enabled	Input enabled

Pin status Type	Function Group	Power-on Reset or Low-Voltage Detection State	INITX Input State	Device Internal Reset State	Run Mode or Sleep Mode State	Timer Mode RTC Mode or Stop Mode State		Deep Standby RTC Mode or Deep Standby Stop Mode State		Return from Deep Standby Mode State
		Power Supply Unstable	Power Supply Stable		Power Supply Stable	Power Supply Stable		Power Supply Stable		Power Supply Stable
		-	INITX=0	INITX=1	INITX=1	INITX=1		INITX=1		INITX=1
		-	-	-	-	SPL=0	SPL=1	SPL=0	SPL=1	-
E	Mode input pin	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled
	GPIO selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Hi-Z / input enabled	GPIO selected	Hi-Z / input enabled	GPIO selected
F	NMIX selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Maintain previous state	WKUP input enabled	Hi-Z / WKUP input enabled	Maintain previous state
	Resource other than above selected	Hi-Z	Hi-Z / input enabled	Hi-Z / input enabled			Hi-Z / Internal input fixed at 0			GPIO selected
	GPIO selected									
G	JTAG selected	Hi-Z	Pull-up / Input enabled	Pull-up / Input enabled	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state
	GPIO selected	Setting disabled	Setting disabled	Setting disabled			Hi-Z / Internal input fixed at 0	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
H	JTAG selected	Hi-Z	Pull-up / Input enabled	Pull-up / Input enabled	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state
	Resource other than above selected	Setting disabled	Setting disabled	Setting disabled			Hi-Z / Internal input fixed at 0	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	GPIO selected									
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 Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	GPIO selected									

Pin status Type	Function Group	Power-on Reset or Low-Voltage Detection State	INITX Input State	Device Internal Reset State	Run Mode or Sleep Mode State	Timer Mode RTC Mode or Stop Mode State		Deep Standby RTC Mode or Deep Standby Stop Mode State		Return from Deep Standby Mode State
		Power Supply Unstable	Power Supply Stable		Power Supply Stable	Power Supply Stable		Power Supply Stable		Power Supply Stable
		-	INITX=0	INITX=1	INITX=1	INITX=1		INITX=1		INITX=1
		-	-	-	-	SPL=0	SPL=1	SPL=0	SPL=1	-
K	External interrupt enabled selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Maintain previous state	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	Resource other than above selected	Hi-Z	Hi-Z / input enabled	Hi-Z / input enabled			Hi-Z / Internal input fixed at 0			
	GPIO selected									
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	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 above selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Hi-Z / Internal input fixed at 0	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	GPIO selected									

Pin status Type	Function Group	Power-on Reset or Low-Voltage Detection State	INITX Input State	Device Internal Reset State	Run Mode or Sleep Mode State	Timer Mode RTC Mode or Stop Mode State		Deep Standby RTC Mode or Deep Standby Stop Mode State		Return from Deep Standby Mode State
		Power Supply Unstable	Power Supply Stable		Power Supply Stable	Power Supply Stable		Power Supply Stable		Power Supply Stable
		-	INITX=0	INITX=1	INITX=1	INITX=1		INITX=1		INITX=1
		-	-	-	-	SPL=0	SPL=1	SPL=0	SPL=1	-
M	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	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	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	Resource other than above selected						Hi-Z / Internal input fixed at 0			
	GPIO selected									
N	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	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
	Trace selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Trace output	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	Resource other than above selected						Hi-Z / Internal input fixed at 0			
	GPIO selected									

Pin status Type	Function Group	Power-on Reset or Low-Voltage Detection State	INITX Input State	Device Internal Reset State	Run Mode or Sleep Mode State	Timer Mode RTC Mode or Stop Mode State		Deep Standby RTC Mode or Deep Standby Stop Mode State		Return from Deep Standby Mode State
		Power Supply Unstable	Power Supply Stable		Power Supply Stable	Power Supply Stable		Power Supply Stable		Power Supply Stable
		-	INITX=0	INITX=1	INITX=1	INITX=1		INITX=1		INITX=1
		-	-	-	-	SPL=0	SPL=1	SPL=0	SPL=1	-
O	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	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
	Trace selected	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Trace output	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	External interrupt enabled selected						Maintain previous state			
	Resource other than above selected						Hi-Z / Internal input fixed at 0			
	GPIO selected									
P	WKUP enabled	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Maintain previous state	WKUP input enabled	Hi-Z / WKUP input enabled	GPIO selected
	Resource other than above selected						Hi-Z / Internal input fixed at 0	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	
	GPIO selected									

Pin status Type	Function Group	Power-on Reset or Low-Voltage Detection State	INITX Input State	Device Internal Reset State	Run Mode or Sleep Mode State	Timer Mode RTC Mode or Stop Mode State		Deep Standby RTC Mode or Deep Standby Stop Mode State		Return from Deep Standby Mode State
		Power Supply Unstable	Power Supply Stable		Power Supply Stable	Power Supply Stable		Power Supply Stable		Power Supply Stable
		-	INITX=0	INITX=1	INITX=1	INITX=1		INITX=1		INITX=1
		-	-	-	-	SPL=0	SPL=1	SPL=0	SPL=1	-
Q	WKUP enabled	Setting disabled	Setting disabled	Setting disabled	Maintain previous state	Maintain previous state	Maintain previous state	WKUP input enabled	Hi-Z / WKUP input enabled	WKUP input enabled
	External interrupt enabled selected							GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	Resource other than above selected	Hi-Z	Hi-Z / input enabled	Hi-Z / input enabled			Hi-Z / Internal input fixed at 0			
	GPIO selected									
R	GPIO selected	Hi-Z	Hi-Z / input enabled	Hi-Z / input enabled	Maintain previous state	Maintain previous state	Hi-Z / Internal input fixed at 0	GPIO selected Internal input fixed at 0	Hi-Z / Internal input fixed at 0	GPIO selected
	USB I/O pin	Setting disabled	Setting disabled	Setting disabled	Hi-Z at trans-mission/ Internal input fixed at 0 at reception	Hi-Z at trans-mission/ Internal input fixed at 0 at reception	Hi-Z / input enabled	Hi-Z / input enabled	Hi-Z / input enabled	Hi-Z / input enabled

*1: Oscillation is stopped at Sub timer mode, low-speed CR timer mode, RTC mode, Stop mode, Deep standby RTC mode, and Deep standby Stop mode.

List of VBAT Domain Pin Status

VBAT Pin Status Type	Function Group	Power-on Reset*1	INITX Input State	Device Internal Reset State	Run Mode or Sleep Mode State	Timer Mode RTC Mode or Stop Mode State		Deep Standby RTC Mode or Deep Standby Stop Mode State		Return from Deep Standby Mode State	VBAT RTC Mode State	Return from VBAT RTC Mode State
		Power Supply Unstable	Power Supply Stable		Power Supply Stable	Power Supply Stable		Power Supply Stable		Power Supply Stable	Power Supply Stable	Power Supply Sable
		-	INITX=0	INITX=1	INITX=1	INITX=1		INITX=1		INITX=1	-	-
		-	-	-	-	SPL=0	SPL=1	SPL=0	SPL=1	-	-	-
S	GPIO selected	Setting disabled	Internal input fixed at 0	Internal input fixed at 0	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Setting prohibition	-
	Sub crystal oscillator input pin / External sub clock input selected	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Maintain previous state	Maintain previous state
T	GPIO selected	Setting disabled	Internal input fixed at 0	Internal input fixed at 0	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled	Setting prohibition	-
	External sub clock input selected	Setting disabled	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state
	Sub crystal oscillator output pin	Hi-Z/ Internal input fixed at 0 or input enabled	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state / When oscillation stops, Hi-Z*2	Maintain previous state / When oscillation stops, Hi-Z*2	Maintain previous state / When oscillation stops, Hi-Z*2	Maintain previous state / When oscillation stops, Hi-Z*2	Maintain previous state	Maintain previous state	Maintain previous state
U	Resource selected / GPIO selected	Hi-Z	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state	Maintain previous state

*1: When VBAT and VCC power on.

*2: When the SOSCNTL bit in the WTOSCCNT register is 0, Sub crystal oscillator output pin maintains the previous state. When the SOSCNTL bit in the WTOSCCNT register is 1, Oscillation is stopped at Stop mode and Deep standby Stop mode

12 Electrical Characteristics

12.1 Absolute Maximum Ratings

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power supply voltage *1, *2	V_{CC}	V_{SS} - 0.5	V_{SS} + 4.6	V	
Power supply voltage (VBAT) *1 ,*3	V_{BAT}	V_{SS} - 0.5	V_{SS} + 4.6	V	
Analog power supply voltage *1 ,*4	AV_{CC}	V_{SS} - 0.5	V_{SS} + 4.6	V	
Analog reference voltage *1 ,*4	AVRH	V_{SS} - 0.5	V_{SS} + 4.6	V	
Input voltage *1	V_I	V_{SS} - 0.5	V_{CC} + 0.5 (≤ 4.6 V)	V	
		V_{SS} - 0.5	V_{SS} + 6.5	V	5 V tolerant
Analog pin input voltage *1	V_{IA}	V_{SS} - 0.5	AV_{CC} + 0.5 (≤ 4.6 V)	V	
Output voltage *1	V_O	V_{SS} - 0.5	V_{CC} + 0.5 (≤ 4.6 V)	V	
L level maximum output current *5	I_{OL}	-	10	mA	2 mA type
			20	mA	4 mA type
			20	mA	8 mA type
			20	mA	11 mA type
			22.4	mA	I^2C Fm+
L level average output current *6	I_{OLAV}	-	2	mA	2 mA type
			4	mA	4 mA type
			8	mA	8 mA type
			11	mA	11 mA type
			20	mA	I^2C Fm+
L level total maximum output current	$\sum I_{OL}$	-	100	mA	
L level total average output current *7	$\sum I_{OLAV}$	-	50	mA	
H level maximum output current *5	I_{OH}	-	- 10	mA	2 mA type
			-20	mA	4 mA type
			- 20	mA	8 mA type
			- 20	mA	11 mA type
H level average output current *6	I_{OHAV}	-	- 2	mA	2 mA type
			-4	mA	4 mA type
			- 8	mA	8 mA type
			- 11	mA	11 mA type
H level total maximum output current	$\sum I_{OH}$	-	- 100	mA	
H level total average output current *7	$\sum I_{OHAV}$	-	- 50	mA	
Storage temperature	T_{STG}	- 55	+ 150	°C	

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

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

*3: V_{BAT} must not drop below V_{SS} - 0.5 V.

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

*5: The maximum output current is defined as the value of the peak current flowing through any one of the corresponding pins.

*6: The average output current is defined as the average current value flowing through any one of the corresponding pins for a 100 ms period.

*7: The total average output current is defined as the average current value flowing through all of corresponding pins for a 100 ms.

WARNING:

- *Semiconductor devices may be permanently damaged by application of stress (including, without limitation, voltage, current or temperature) in excess of absolute maximum ratings. Do not exceed any of these ratings.*

12.2 Recommended Operating Conditions

Parameter		Symbol	Conditions	Value		Unit	Remarks
				Min	Max		
Power supply voltage		V_{CC}	-	3.0	3.6	V	*1
				2.7 *5	3.6		*2
Power supply voltage (VBAT)		V_{BAT}	-	1.65	3.6	V	
Analog power supply voltage		AV_{CC}	-	2.7	3.6	V	$AV_{CC} = V_{CC}$
Analog reference voltage		AVRH	-	*4	AV_{CC}	V	
		AVRL	-	AVss	AVss	V	
Smoothing capacitor		C_S	-	1	10	µF	for built-in regulator *6
Operating temperature	Junction temperature	T_J	-	-40	+ 125	°C	
	Ambient temperature	T_A	-	-40	*3	°C	

*1: When using the GDC part .

When P81/UDP0 and P80/UDM0 pins are used as USB (UDP0, UDM0).

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

*3: The maximum temperature of the ambient temperature (T_A) can guarantee a range that does not exceed the junction temperature (T_J).
The calculation formula of the ambient temperature (T_A) is shown below.

$$T_A(Max) = T_J(Max) - Pd(Max) \times \theta_{JA}$$

Pd: Power dissipation (W)
θ_{JA}: Package thermal resistance (°C/W)

$$Pd\ (Max) = V_{CC} \times I_{CC}\ (Max) + \Sigma\ (I_{OL} \times V_{OL}) + \Sigma\ ((V_{CC} - V_{OH}) \times (-I_{OH}))$$

I_{OL}: L level output current
I_{OH}: H level output current
V_{OL}: L level output voltage
V_{OH}: H level output voltage

*4: The minimum value of Analog reference voltage depends on the value of compare clock cycle (t_{CCK}). See 14.5 12-bit A/D Converter for the details.

*5: 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.

*6: See "C pin" in "7. Handling Devices" for the connection of the smoothing capacitor.

Package thermal resistance and maximum permissible power for each package are shown below.
The operation is guaranteed maximum permissible power or less for semiconductor devices.

Table 12-1 Table for Package Thermal Resistance and Maximum Permissible Power

Package	Printed Circuit Board	Thermal Resistance θ_{JA} (°C/W)	Maximum Permissible Power (mW)	
			T_A= +85°C	T_A= +105°C
LQFP: LQM120 (0.5 mm pitch)	4 layers	38	1053	526
LQFP: LQM120 *1 (0.5 mm pitch)	4 layers	39	1026	513
LQFP: LQP176 (0.5 mm pitch)	4 layers	35	1143	571
FBGA: FDJ161 (0.5 mm pitch)	4 layers	35	1143	571
Ex-LQFP: LEM120 (0.5 mm pitch)	4 layers	18*2	2222	1111

*1: When S6E2D55GJA product.
*2: This is a case where the connection process was carried out back exposed die pad foundation. Please connect directly to GND back exposed die pad.

Notes:

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.*

Calculation Method of Power Dissipation (Pd)

The power dissipation is shown in the following formula.

$$Pd = V_{CC} \times I_{CC} + \Sigma (I_{OL} \times V_{OL}) + \Sigma ((V_{CC}-V_{OH}) \times (-I_{OH}))$$

I_{OL}: L level output current
I_{OH}: H level output current
V_{OL}: L level output voltage
V_{OH}: H level output voltage

I_{CC} is a current consumed in device.
It can be analyzed as follows.

$$I_{CC} = I_{CC}(INT) + \Sigma I_{CC}(IO)$$

I_{CC}(INT): Current consumed in internal logic and memory, etc. through regulator
ΣI_{CC}(IO): Sum of current (I/O switching current) consumed in output pin

For I_{CC} (INT), it can be anticipated by "(1) Current Rating" in "3. DC Characteristics" (This rating value does not include I_{CC} (IO) for a value at pin fixed).
For Icc (IO), it depends on system used by customers.
The calculation formula is shown below.

$$I_{CC}(IO) = (C_{INT} + C_{EXT}) \times V_{CC} \times fsw$$

C_{INT}: Pin internal load capacitance
C_{EXT}: External load capacitance of output pin
f_{SW}: Pin switching frequency

Parameter	Symbol	Conditions	Capacitance Value
Pin internal load capacitance	C_{INT}	2 mA type	1.93 pF
		4 mA type	3.45 pF
		8 mA type	3.42 pF

Calculate I_{CC} (Max) as follows when the power dissipation can be evaluated by yourself.

(1) Measure current value I_{CC} (Typ) at normal temperature (+25°C).

(2) Add maximum leak current value I_{CC} (leak_max) at operating on a value in (1).

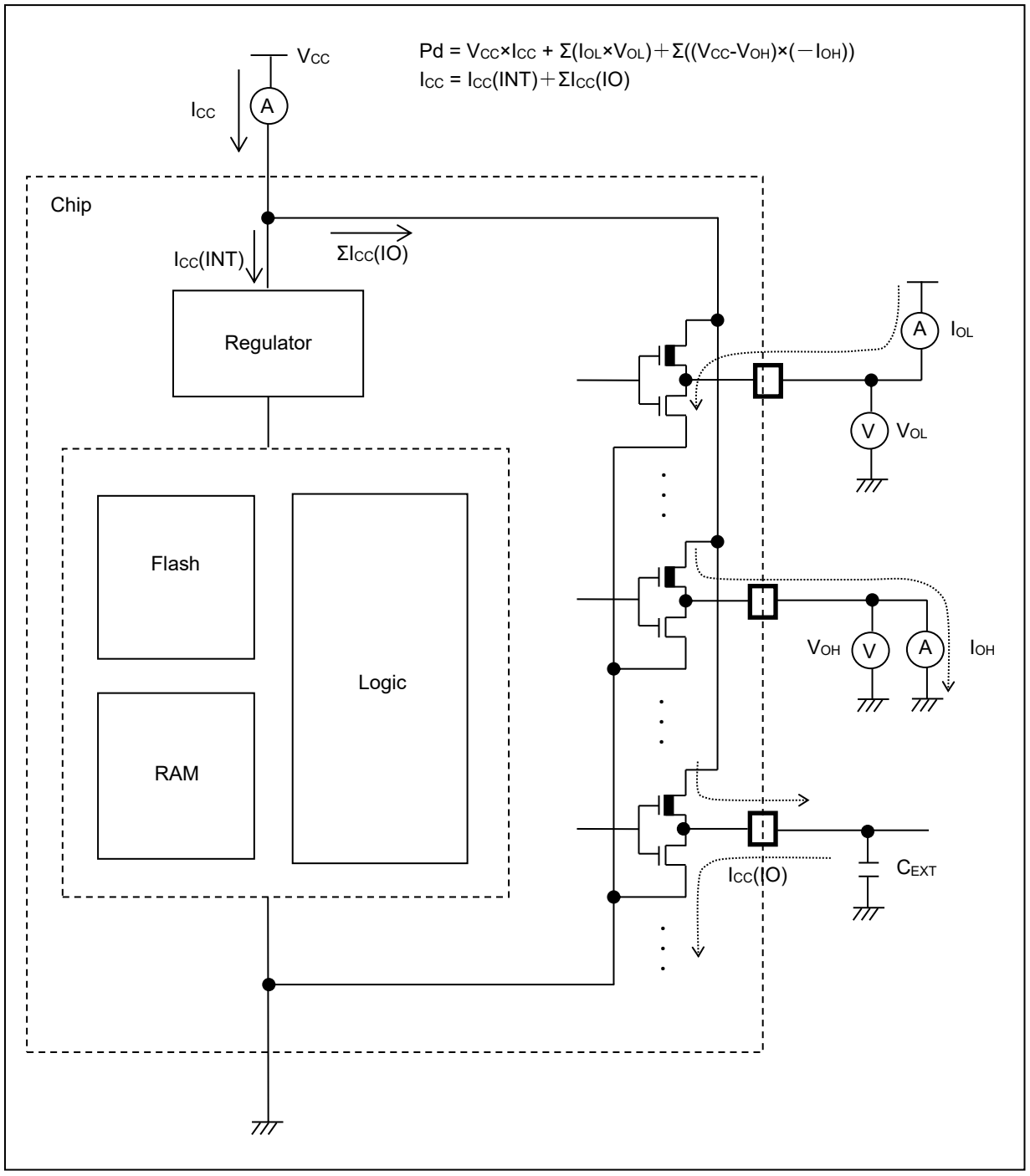
$$I_{CC}(Max) = I_{CC}(Typ) + I_{CC}(leak_max)$$

Parameter	Symbol	Conditions	Current Value
Maximum leak current at operating	I_{CC}(leak_max)	T_J = +125 °C	66.8 mA
		T_J = +105 °C	33.7 mA
		T_J = +85 °C	22.8 mA

Note:

− *VFLASH of current is not included*

Current Explanation Diagram



12.3 DC Characteristics

12.3.1 Current Rating

Table 12-2 Typical and Maximum Current Consumption in Normal Operation (PLL), Code Running from Flash Memory (Flash Accelerator Mode and Trace Buffer Function Enabled)

Parameter	Symbol	Pin Name	Conditions		Frequency*4 (MHz)	Value		Unit	Remarks
						Typ*1	Max*2		
Power supply current	I_{CC}	VCC	Normal operation *6,*7 (PLL)	*5	160 MHz	182	279	mA	*3 When all peripheral clocks are ON GDC clock 160 MHz
					144 MHz	176	270	mA	
					120 MHz	167	256	mA	
					100 MHz	159	244	mA	
					80 MHz	151	233	mA	
					60 MHz	143	221	mA	
					40 MHz	136	210	mA	
					20 MHz	128	199	mA	
					8 MHz	123	191	mA	
					4 MHz	122	190	mA	
			Normal operation , *6,*7 (PLL)	*5	160 MHz	43	117	mA	*3 When all peripheral clocks are OFF
					144 MHz	39	112	mA	
					120 MHz	34	106	mA	
					100 MHz	29	100	mA	
					80 MHz	24	95	mA	
					60 MHz	20	90	mA	
					40 MHz	15	84	mA	
					20 MHz	10	78	mA	
					8 MHz	7	74	mA	
					4 MHz	6	73	mA	

*1: T_A=+25°C, V_{CC}=3.3 V

*2: T_J=+125°C, V_{CC}=3.6 V

*3: When all ports are fixed.

*4: Frequency is a value of HCLK. PCLK0=PCLK1=PCLK2=HCLK/2

*5: When operating flash accelerator mode and trace buffer function (FRWTR.RWT = 10, FBFCR.BE = 1)

*6: Data access is nothing to main flash memory and VFLASH memory

*7: When using the crystal oscillator of 4 MHz (including the current consumption of the oscillation circuit)

Table 12-3 Typical and Maximum Current Consumption in Normal Operation (PLL), Code with Data Accessing Running from Flash Memory (Flash Accelerator Mode and Trace Buffer Function Disabled)

Parameter	Symbol	Pin Name	Conditions		Frequency*4 (MHz)	Value		Unit	Remarks
						Typ*1	Max*2		
Power supply current	I_{CC}	VCC	Normal operation *6,*7,*8 (PLL)	*5	160 MHz	185	285	mA	*3 When all peripheral clocks are ON GDC clock 160 MHz
					144 MHz	179	276	mA	
					120 MHz	169	261	mA	
					100 MHz	161	250	mA	
					80 MHz	154	239	mA	
					60 MHz	146	227	mA	
					40 MHz	138	215	mA	
					20 MHz	130	204	mA	
					8 MHz	125	196	mA	
					4 MHz	124	195	mA	
			Normal operation *6,*7,*8 (PLL)	*5	160 MHz	45	122	mA	*3 When all peripheral clocks are OFF
					144 MHz	41	117	mA	
					120 MHz	36	111	mA	
					100 MHz	31	105	mA	
					80 MHz	26	99	mA	
					60 MHz	22	94	mA	
					40 MHz	17	89	mA	
					20 MHz	12	83	mA	
					8 MHz	10	80	mA	
					4 MHz	9	79	mA	

*1: T_A=+25°C, V_{CC}=3.3 V

*2: T_J=+125°C, V_{CC}=3.6 V

*3: When all ports are fixed.

*4: Frequency is a value of HCLK. PCLK0=PCLK2=HCLK/2, PCLK1=HCLK

*5: When not operating flash accelerator mode and trace buffer function (FRWTR.RWT = 10, FBFCR.BE = 0)

*6: With data access to a main flash memory.

*7: When using the crystal oscillator of 4 MHz (including the current consumption of the oscillation circuit)

*8: Data access is nothing to VFLASH memory

Table 12-4 Typical and Maximum Current Consumption in Normal Operation (PLL), Code with Data Accessing Running from Flash Memory (Flash 0 Wait-cycle Mode and Read Access 0 Wait)

Parameter	Symbol	Pin Name	Conditions		Frequency*4 (MHz)	Value		Unit	Remarks
						Typ*1	Max*2		
Power supply current	I_{CC}	VCC	Normal operation , *6,*7,*8 (PLL)	*5	72 MHz	168	251	mA	*3 When all peripheral clocks are ON GDC clock 160 MHz
					60 MHz	161	242	mA	
					48 MHz	154	233	mA	
					36 MHz	147	224	mA	
					24 MHz	140	214	mA	
					12 MHz	133	205	mA	
					8 MHz	131	202	mA	
					4 MHz	128	199	mA	
				*5	72 MHz	41	114	mA	*3 When all peripheral clocks are OFF
					60 MHz	36	108	mA	
					48 MHz	32	104	mA	
					36 MHz	27	98	mA	
					24 MHz	23	94	mA	
					12 MHz	18	88	mA	
					8 MHz	17	87	mA	
					4 MHz	15	85	mA	

*1: T_A=+25°C, V_{CC}=3.3 V

*2: T_J=+125°C, V_{CC}=3.6 V

*3: When all ports are fixed.

*4: Frequency is a value of HCLK. PCLK0=PCLK1=PCLK2=HCLK

*5: When operating flash 0 wait-cycle mode and read access 0 wait (FRWTR.RWT = 00, FSYNDN.SD = 000)

*6: With data access to a main flash memory.

*7: When using the crystal oscillator of 4 MHz (including the current consumption of the oscillation circuit)

*8: Data access is nothing to VFLASH memory

Table 12-5 Typical and Maximum Current Consumption in Normal Operation (other than PLL), Code with Data Accessing Running from Flash Memory (Flash 0 Wait-cycle Mode and Read Access 0 Wait)

Parameter	Symbol	Pin Name	Conditions		Frequency*4 (MHz)	Value		Unit	Remarks
						Typ*1	Max*2		
Power supply current	I_{CC}	VCC	Normal operation, *6,*8 (built-in High-speed CR)	*5	4 MHz	110	181	mA	*3 When all peripheral clocks are ON GDC clock 160 MHz
						4.1	74	mA	*3 When all peripheral clocks are OFF
			Normal operation , *6,*7,*8 (Sub oscillation)	*5	32 kHz	0.7	76.65	mA	*3 When all peripheral clocks are ON
						0.69	71.65	mA	*3 When all peripheral clocks are OFF
			Normal operation , *6,*8 (built-in Low-speed CR)	*5	100 kHz	0.74	88.65	mA	*3 When all peripheral clocks are ON
						0.73	74.65	mA	*3 When all peripheral clocks are OFF

*1: T_A=+25°C, V_{CC}=3.3 V

*2: T_J=+125°C, V_{CC}=3.6 V

*3: When all ports are fixed.

*4: Frequency is a value of HCLK. PCLK0=PCLK1=PCLK2=HCLK/2

*5: When operating flash 0 wait-cycle mode and read access 0 wait (FRWTR.RWT = 00, FSYNDN.SD = 000)

*6: With data access to a main flash memory.

*7: When using the crystal oscillator of 32 kHz (including the current consumption of the oscillation circuit)

*8: Data access is nothing to VFLASH memory

Table 12-6 Typical and Maximum Current Consumption in Sleep Operation (PLL), when PCLK0 = PCLK1 = PCLK2 = HCLK/2

Parameter	Symbol	Pin Name	Conditions	Frequency*4 (MHz)	Value		Unit	Remarks
					Typ*1	Max*2		
Power supply current	I_{CCS}	VCC	Sleep *5,*6 operation (PLL)	160 MHz	103	181	mA	*3 When all peripheral clocks are ON GDC clock 160 MHz
				144 MHz	98	175	mA	
				120 MHz	91	168	mA	
				100 MHz	86	162	mA	
				80 MHz	80	155	mA	
				60 MHz	74	149	mA	
				40 MHz	69	143	mA	
				20 MHz	63	137	mA	
				8 MHz	59	132	mA	
				4 MHz	58	131	mA	
			Sleep *5,*6 operation (PLL)	160 MHz	24	91	mA	*3 When all peripheral clocks are OFF
				144 MHz	22	89	mA	
				120 MHz	19	86	mA	
				100 MHz	16	83	mA	
				80 MHz	14	81	mA	
				60 MHz	11	78	mA	
				40 MHz	9	76	mA	
				20 MHz	6	73	mA	
				8 MHz	5	72	mA	
				4 MHz	4	71	mA	

*1: T_A=+25°C, V_{CC}=3.3 V

*2: T_J=+125°C, V_{CC}=3.6 V

*3: When all ports are fixed.

*4: Frequency is a value of HCLK. PCLK0=PCLK1=PCLK2=HCLK/2

*5: When using the crystal oscillator of 4 MHz (including the current consumption of the oscillation circuit)

*6: Data access is nothing to VFLASH memory

Table 12-7 Typical and Maximum Current Consumption in Sleep Operation (PLL), when PCLK0 = PCLK1 = PCLK2 = HCLK

Parameter	Symbol	Pin Name	Conditions	Frequency*4 (MHz)	Value		Unit	Remarks
					Typ*1	Max*2		
Power supply current	I_{CCS}	VCC	Sleep *5,*6 operation (PLL)	72 MHz	84	160	mA	*3 When all peripheral clocks are ON GDC clock 160 MHz
				60 MHz	80	155	mA	
				48 MHz	75	150	mA	
				36 MHz	71	145	mA	
				24 MHz	67	141	mA	
				12 MHz	63	137	mA	
				8 MHz	61	134	mA	
				4 MHz	60	133	mA	
				72 MHz	15	82	mA	*3 When all peripheral clocks are OFF
				60 MHz	13	80	mA	
				48 MHz	12	79	mA	
				36 MHz	10	77	mA	
				24 MHz	8	75	mA	
				12 MHz	7	74	mA	
				8 MHz	6	73	mA	
				4 MHz	5	72	mA	

*1: T_A=+25°C, V_{CC}=3.3 V

*2: T_J=+125°C, V_{CC}=3.6 V

*3: When all ports are fixed.

*4: Frequency is a value of HCLK. PCLK0=PCLK1=PCLK2=HCLK

*5: When using the crystal oscillator of 4 MHz (including the current consumption of the oscillation circuit)

*6: Data access is nothing to VFLASH memory

Table 12-8 Typical and Maximum Current Consumption in Sleep Operation (other than PLL), when PCLK0 = PCLK1 = PCLK2 = HCLK/2

Parameter	Symbol	Pin Name	Conditions	Frequency*4 (MHz)	Value		Unit	Remarks
					Typ*1	Max*2		
Power supply current	I_{CCS}	VCC	Sleep *6 operation (built-in High-speed CR)	4 MHz	56	126	mA	*3 When all peripheral clocks are ON GDC clock 160 MHz
					2	72	mA	*3 When all peripheral clocks are OFF
			Sleep *5,*6 operation (Sub oscillation)	32 kHz	0.52	69.65	mA	*3 When all peripheral clocks are ON
					0.51	69.65	mA	*3 When all peripheral clocks are OFF
			Sleep *6 operation (built-in Low-speed CR)	100 kHz	0.54	70.65	mA	*3 When all peripheral clocks are ON
					0.52	69.65	mA	*3 When all peripheral clocks are OFF

*1: T_A=+25°C, V_{CC}=3.3 V

*2: T_J=+125°C, V_{CC}=3.6 V

*3: When all ports are fixed.

*4: Frequency is a value of HCLK. PCLK0=PCLK1=PCLK2=HCLK/2

*5: When using the crystal oscillator of 32 kHz (including the current consumption of the oscillation circuit)

*6: Data access is nothing to VFLASH memory

Table 12-9 Typical and Maximum Current Consumption in Stop Mode, Timer Mode and RTC Mode

Parameter	Symbol	Pin Name	Conditions	Frequency (MHz)	Value		Unit	Remarks
					Typ*1	Max*2		
Power supply current	I_{CCH}	VCC	Stop mode	-	0.41	2.07	mA	*3, *4 T_A=+25°C
					-	21.35	mA	*3, *4 T_A=+85°C
					-	30.57	mA	*3, *4 T_A=+105°C
	I_{CCT}		Timer mode (built-in High-speed CR)	4 MHz	1.14	2.8	mA	*3, *4 T_A=+25°C
					-	22.08	mA	*3, *4 T_A=+85°C
					-	31.3	mA	*3, *4 T_A=+105°C
			Timer mode *5 (Sub oscillation)	32 kHz	0.43	2.09	mA	*3, *4 T_A=+25°C
					-	21.37	mA	*3, *4 T_A=+85°C
					-	30.59	mA	*3, *4 T_A=+105°C
			Timer mode (built-in Low-speed CR)	100 kHz	0.43	2.09	mA	*3, *4 T_A=+25°C
					-	21.37	mA	*3, *4 T_A=+85°C
					-	30.59	mA	*3, *4 T_A=+105°C
	I_{CCR}		RTC mode (Sub oscillation)	32 kHz	0.41	2.07	mA	*3, *4 T_A=+25°C
					-	21.35	mA	*3, *4 T_A=+85°C
					-	30.57	mA	*3, *4 T_A=+105°C

*1: V_{CC}=3.3 V

*2: V_{CC}=3.6 V

*3: When all ports are fixed.

*4: When LVD is OFF

*5: When using the crystal oscillator of 32 kHz (including the current consumption of the oscillation circuit)

Table 12-10 Typical and Maximum Current Consumption in Deep Standby Stop Mode, Deep Standby RTC Mode and VBAT

Parameter	Symbol	Pin Name	Conditions	Frequency (MHz)	Value		Unit	Remarks
					Typ*1	Max*2		
Power supply current	I_{CCHD}	VCC	Deep Standby Stop mode (When RAM is OFF)	-	108	173	µA	*3, *4 T_A=+25°C
					-	1774	µA	*3, *4 T_A=+85°C
					-	2208	µA	*3, *4 T_A=+105°C
			Deep Standby Stop mode (When RAM is ON)	-	112	177	µA	*3, *4 T_A=+25°C
					-	1778	µA	*3, *4 T_A=+85°C
					-	2212	µA	*3, *4 T_A=+105°C
	I_{CCRD}		Deep Standby RTC mode (When RAM is OFF)	32 kHz	109	174	µA	*3, *4 T_A=+25°C
					-	1771	µA	*3, *4 T_A=+85°C
					-	2205	µA	*3, *4 T_A=+105°C
			Deep Standby RTC mode (When RAM is ON)		113	178	µA	*3, *4 T_A=+25°C
					-	1775	µA	*3, *4 T_A=+85°C
					-	2209	µA	*3, *4 T_A=+105°C
	I_{CCVBAT}	VBAT	RTC stop *8	-	0.009	0.032	µA	*3, *4, *5 T_A=+25°C
					-	0.994	µA	*3, *4, *5 T_A=+85°C
					-	1.491	µA	*3, *4, *5 T_A=+105°C
			RTC *6, *8 operation		1.0	1.636	µA	*3, *4 T_A=+25°C
					-	2.828	µA	*3, *4 T_A=+85°C
					-	4.242	µA	*3, *4 T_A=+105°C
			RTC *7, *8 operation		0.7	1.153	µA	*3, *4 T_A=+25°C
					-	2.277	µA	*3, *4 T_A=+85°C
					-	3.416	µA	*3, *4 T_A=+105°C

*1: V_{CC}=3.3 V

*2: V_{CC}=3.6 V

*3: When all ports are fixed.

*4: When LVD is OFF

*5: When sub oscillation is OFF

*6: When using the crystal oscillator of 32 kHz (including the current consumption of the oscillation circuit)
When the Standard setting (CCS/CCB=11001110)

*7: When using the crystal oscillator of 32 kHz (including the current consumption of the oscillation circuit)
When the low power setting (CCS/CCB=00000100)

*8: In the case of setting RTC after VCC power on

Table 12-11 Typical and Maximum Current Consumption in Low-voltage Detection Circuit, Main Flash Memory Write/erase, VFLASH Memory

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Low-voltage detection circuit (LVD) power supply current	I_{CCLVD}	VCC	At operation	-	4	7	µA	For occurrence of interrupt
Main flash memory write/erase current	$I_{CCFLASH}$		At Write/Erase	-	13.4	15.8	mA	
VFLASH memory Standby current	$I_{CCVFLASH}$		At Standby	-	15	35	µA	
VFLASH memory Read current			At Read	-	9	14	mA	40MHz
					13	20		80MHz
VFLASH memory write/erase current			At Write/Erase	-	20	25	mA	

Peripheral Current Dissipation

Clock system	Peripheral		Unit	Frequency (MHz)			Unit	Remarks
				40	80	160		
HCLK	GPIO		All ports	0.30	0.60	1.19	mA	T_A=+25°C, V_{CC}=3.3 V
	DMAC		-	0.99	1.95	3.82		
	DSTC		-	0.41	0.83	1.61		
	External bus I/F		-	0.18	0.35	0.70		
	CAN-FD		1ch.	0.54	1.07	2.13		
	USB		1ch.	0.47	0.93	1.85		
	I^2S		1 unit	0.36	0.71	1.42		
	Programmable CRC		-	0.04	0.09	0.18		
PCLK1	Base timer		4ch.	0.20	0.39	0.76	mA	T_A=+25°C, V_{CC}=3.3 V
	Multi-functional timer/PPG		1unit/4ch.	0.61	1.21	2.40		
	Quadrature position/Revolution counter		1ch.	0.04	0.09	0.18		
	A/DC		1 unit	0.25	0.50	1.00		
PCLK2	Multi-function serial		1ch.	0.44	0.88	-	mA	T_A=+25°C, V_{CC}=3.3 V
GECLK	GDC unit	GDC	1 unit	31	57	109	mA	T_A=+25°C, V_{CC}=3.3 V
		High-Speed Quad SPI	1ch.	1.1	2.3	-		
		HyperBus I/F	1 unit	0.6	1.2	-		
		SDRAM-IF	1ch.	2.3	4.6	-		

12.3.2 Pin Characteristics

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
H level input voltage (hysteresis input)	V_{IHS}	CMOS hysteresis input pin, MD0, MD1	-	V_{CC}×0.8	-	V_{CC} + 0.3	V	
		5 V tolerant input pin	-	V_{CC}×0.8	-	V_{SS} + 5.5	V	
		Input pin doubled as I^2C Fm+	-	V_{CC}×0.7	-	V_{SS} + 5.5	V	
		TTL Schmitt input pin	-	2.0	-	V_{CC}+0.3	V	
L level input voltage (hysteresis input)	V_{ILS}	CMOS hysteresis input pin, MD0, MD1	-	V_{SS} - 0.3	-	V_{CC}×0.2	V	
		5 V tolerant input pin	-	V_{SS} - 0.3	-	V_{CC}×0.2	V	
		Input pin doubled as I^2C Fm+	-	V_{SS}	-	V_{CC}×0.3	V	
		TTL Schmitt input pin	-	V_{SS} - 0.3	-	0.8	V	
H level output voltage	V_{OH}	2 mA type	I_{OH} = - 2 mA	V_{CC} - 0.5	-	V_{CC}	V	
		4 mA type	I_{OH} = - 4 mA	V_{CC} - 0.5	-	V_{CC}	V	
		8 mA type	I_{OH} = - 8 mA	V_{CC} - 0.5	-	V_{CC}	V	
		11 mA type	I_{OH} = - 11 mA	V_{CC} - 0.5	-	V_{CC}	V	High-speed IO
		The pin doubled as USB I/O	I_{OH} = - 13.0 mA	V_{CC} - 0.4	-	V_{CC}	V	
		The pin doubled as I^2C Fm+	I_{OH} = - 3 mA	V_{CC} - 0.5	-	V_{CC}	V	At GPIO
L level output voltage	V_{OL}	2 mA type	I_{OL} = 2 mA	V_{SS}	-	0.4	V	
		4 mA type	I_{OL} = 4 mA	V_{SS}	-	0.4	V	
		8 mA type	I_{OL} = 8 mA	V_{SS}	-	0.4	V	
		11 mA type	I_{OL} = 11 mA	V_{SS}	-	0.4	V	
		The pin doubled as USB I/O	I_{OL} = 10.5 mA	V_{SS}	-	0.4	V	
		The pin doubled as I^2C Fm+	I_{OL} = 3 mA	V_{SS}	-	0.4	V	At GPIO
			I_{OL} = 20 mA					At I^2C Fm+
Input leak current	I_{IL}	-	-	- 5	-	+ 5	µA	
Pull-up resistor value	R_{PU}	Pull-up pin	-	30	80	200	kΩ	
			-	15	33	70		High-speed IO
Input capacitance	C_{IN}	Other than VCC, VBAT, VSS, AVCC, AVSS, AVRH	-	-	5	15	pF	

12.4 AC Characteristics

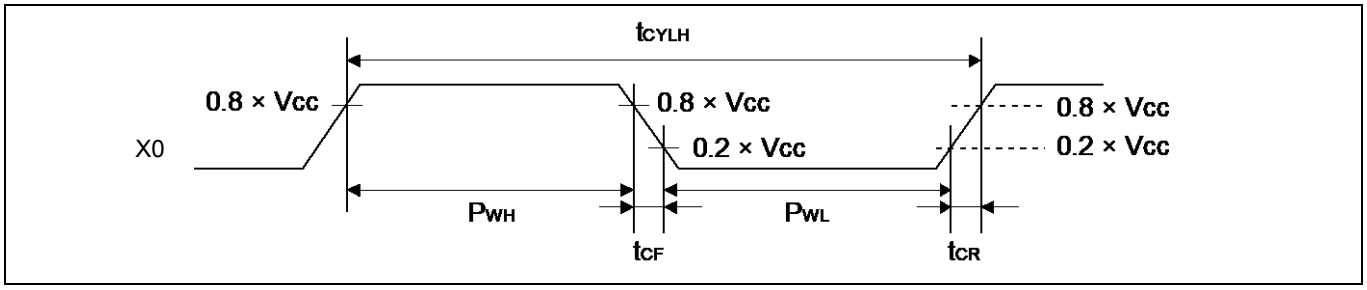
12.4.1 Main Clock Input Characteristics

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Input frequency	f_{CH}	X0, X1	-	4	20	MHz	When crystal oscillator is connected
			-	4	20	MHz	When using external clock
Input clock cycle	t_{CYLH}		-	50	250	ns	When using external clock
Input clock pulse width	-		P_{WH}/t_{CYLH}, P_{WL}/t_{CYLH}	45	55	%	When using external clock
Input clock rising time and falling time	t_{CF}, t_{CR}		-	-	5	ns	When using external clock
Internal operating clock*1 frequency	f_{CM}	-	-	-	160	MHz	Master clock
	f_{CC}	-	-	-	160	MHz	Base clock (HCLK/FCLK)
	f_{CP0}	-	-	-	80	MHz	APB0 bus clock*2
	f_{CP1}	-	-	-	160	MHz	APB1 bus clock*2
	f_{CP2}	-	-	-	80	MHz	APB2 bus clock*2
Internal operating clock*1 cycle time	t_{CYCC}	-	-	5	-	ns	Base clock (HCLK/FCLK)
	t_{CYCP0}	-	-	10	-	ns	APB0 bus clock*2
	t_{CYCP1}	-	-	5	-	ns	APB1 bus clock*2
	t_{CYCP2}	-	-	10	-	ns	APB2 bus clock*2

*1: For more information about each internal operating clock, see Chapter 2-1: Clock in FM4 Family Peripheral Manual Main part (002-04856).

*2: For about each APB bus which each peripheral is connected to, see Block Diagram in this data sheet.

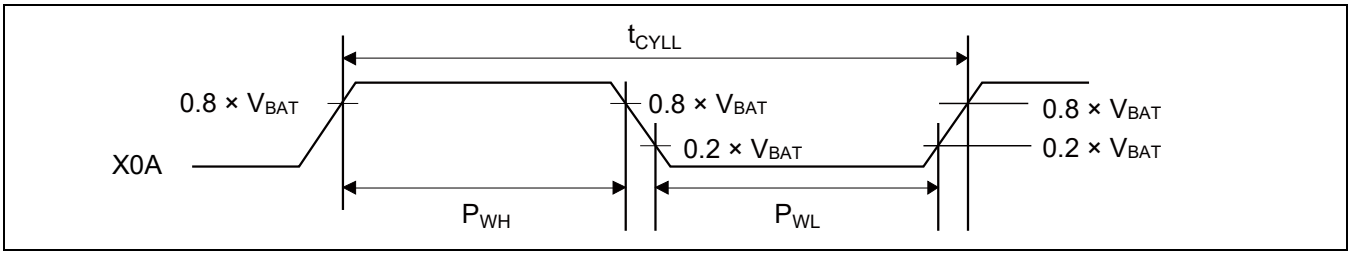


12.4.2 Sub Clock Input Characteristics

(V_{BAT} = 1.65V to 3.6V, V_{SS} = 0V)

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

*: For more information about crystal oscillators, see Sub crystal oscillator in 9. Handling Devices.



12.4.3 Built-in CR Oscillation Characteristics

Built-in High-speed CR

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Conditions	Value			Unit	Remarks
			Min	Typ	Max		
Clock frequency	f_{CRH}	T_J = - 20 °C to + 105 °C	3.92	4	4.08	MHz	When trimming *1
		T_J = - 40 °C to + 125 °C	3.88	4	4.12		
		T_J = - 40 °C to + 125 °C	2.9	4	5		When not trimming
Frequency stabilization time	t_{CRWT}	-	-	-	30	µs	*2

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

*2: This is the time to stabilize the frequency of High-speed CR clock after setting trimming value. This period is able to use High-speed CR clock as source clock.

Built-in Low-speed CR

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Condition	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 Main Clock for Input Clock of PLL)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
PLL oscillation stabilization wait time*1 (LOCK UP time)	t_{LOCK}	100	-	-	µs	-
PLL input clock frequency	f_{PLLI}	4	-	16	MHz	-
PLL multiplication rate	-	13	-	100	multiplier	-
PLL macro oscillation clock frequency	f_{PLLO}	200	-	400	MHz	-
Main PLL clock frequency*2	f_{CLKPLL}	-	-	200	MHz	-

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

*2: For more information about Main PLL clock (CLKPLL), see Chapter 2-1: Clock in FM4 Family Peripheral Manual Main part (002-04856).

12.4.5 Operating Conditions of USB/I²S/GDC PLL (In the Case of Using Main Clock for Input Clock of PLL)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
PLL oscillation stabilization wait time*1 (LOCK UP time)	t_{LOCK}	100	-	-	µs	-
PLL input clock frequency	f_{PLLI}	4	-	16	MHz	-
PLL multiplication rate	-	13	-	100	multiplier	-
PLL macro oscillation clock frequency	f_{PLLO}	200	-	400	MHz	USB/GDC
				384	MHz	I²S
USB clock frequency *2	f_{CLKPLL}	-	-	50	MHz	After the M frequency division
I²S clock frequency *3	f_{CLKPLL}	-	-	12.288	MHz	After the M frequency division
GDC clock frequency *4	f_{CLKPLL}	-	-	160	MHz	After divided by GDC part

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

*2: For more information about USB clock, see Chapter 2-2: USB Clock Generation in FM4 Family Peripheral Manual Communication Macro part (002-04862).

*3: For more information about I²S clock, see Chapter 7-1: I²S Clock Generation in FM4 Family Peripheral Manual Communication Macro part (002-04862).

*4: For more information about GDC clock, see FM4 Family Peripheral Manual GDC part (002-04917).

12.4.6 Operating Conditions of Main PLL (In the Case of Using Built-in High-Speed CR Clock for Input Clock of Main PLL)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
PLL oscillation stabilization wait time*1 (LOCK UP time)	t_{LOCK}	100	-	-	µs	
PLL input clock frequency	f_{PLLI}	3.8	4	4.2	MHz	
PLL multiplication rate	-	50	-	95	multiplier	
PLL macro oscillation clock frequency	f_{PLLO}	190	-	400	MHz	
Main PLL clock frequency*2	f_{CLKPLL}	-	-	160	MHz	

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

*2: For more information about Main PLL clock (CLKPLL), see Chapter 2-1: Clock in FM4 Family Peripheral Manual Main part (002-04856).

Note:

- *The High-speed CR clock (CLKHC) should be set with frequency/temperature trimming to act as the source clock of the Main PLL.*

12.4.7 Reset Input Characteristics

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

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

12.4.8 Power-on Reset Timing

(V_{SS} = 0V)

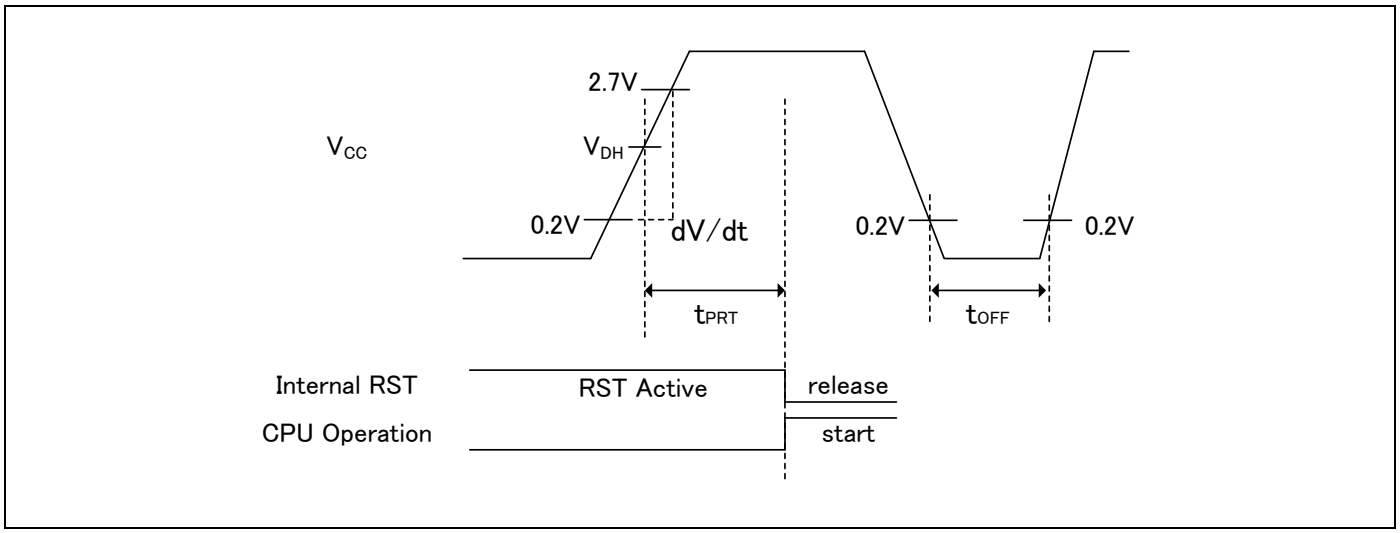
Parameter	Symbol	Pin Name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Power supply shut down time	t_{OFF}	VCC	-	1	-	-	ms	*1
Power ramp rate	dV/dt		V_{CC}: 0.2V to 2.70V	0.6	-	1000	mV/µs	*2
Time until releasing Power-on reset	t_{PRT}		-	0.33	-	0.60	ms	

*1: V_{CC} must be held below 0.2V for a 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}>1ms).

Note:

- *If t_{OFF} cannot be satisfied designs must assert external reset(INITX) at power-up and at any brownout event per 12. 4. 7.*



Glossary

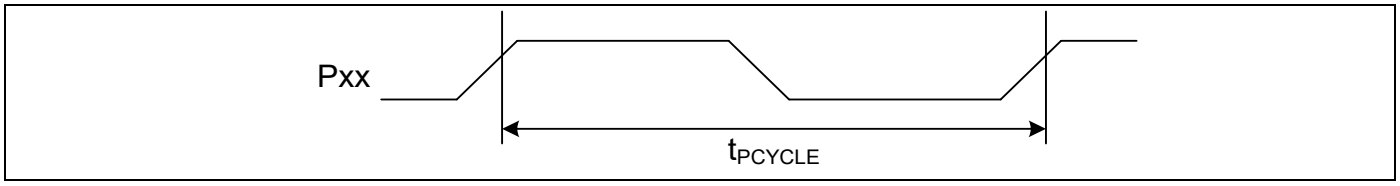
□ VDH: detection voltage of Low Voltage detection reset. See “12.7. Low-Voltage Detection Characteristics”.

12.4.9 GPIO Output Characteristics

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Output frequency	t_{PCYCLE}	Pxx*	-	-	32	MHz	

*: GPIO is a target.



12.4.10 External Bus Timing

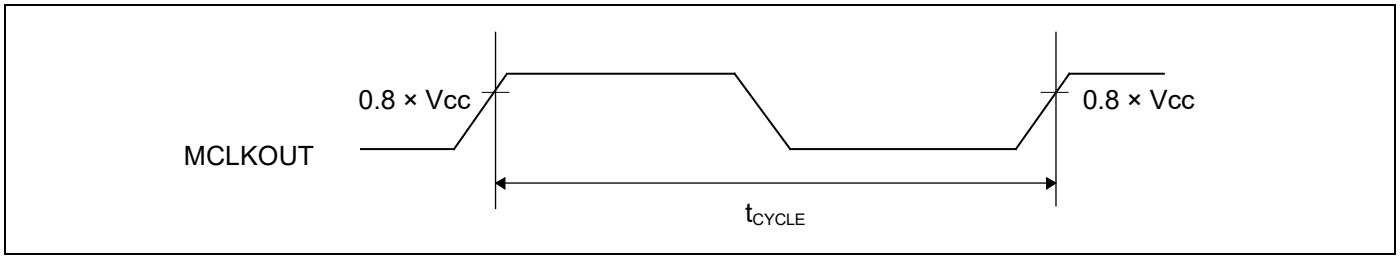
External Bus Clock Output Characteristics

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Output frequency	t_{CYCLE}	MCLKOUT*1		-	50*2	MHz	

*1: The external bus clock (MCLKOUT) is a divided clock of HCLK.
For more information about setting of clock divider, see Chapter 14: External Bus Interface in FM4 Family Peripheral Manual Main part (002-04856).

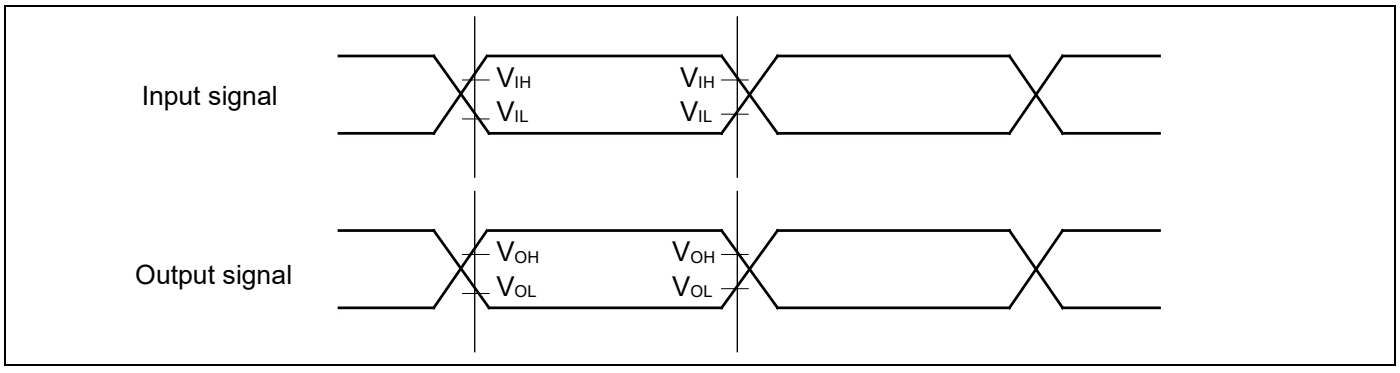
*2: Generate MCLKOUT at setting more than 4 divisions when the AHB bus clock exceeds 100 MHz.



External Bus Signal Input/output Characteristics

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

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



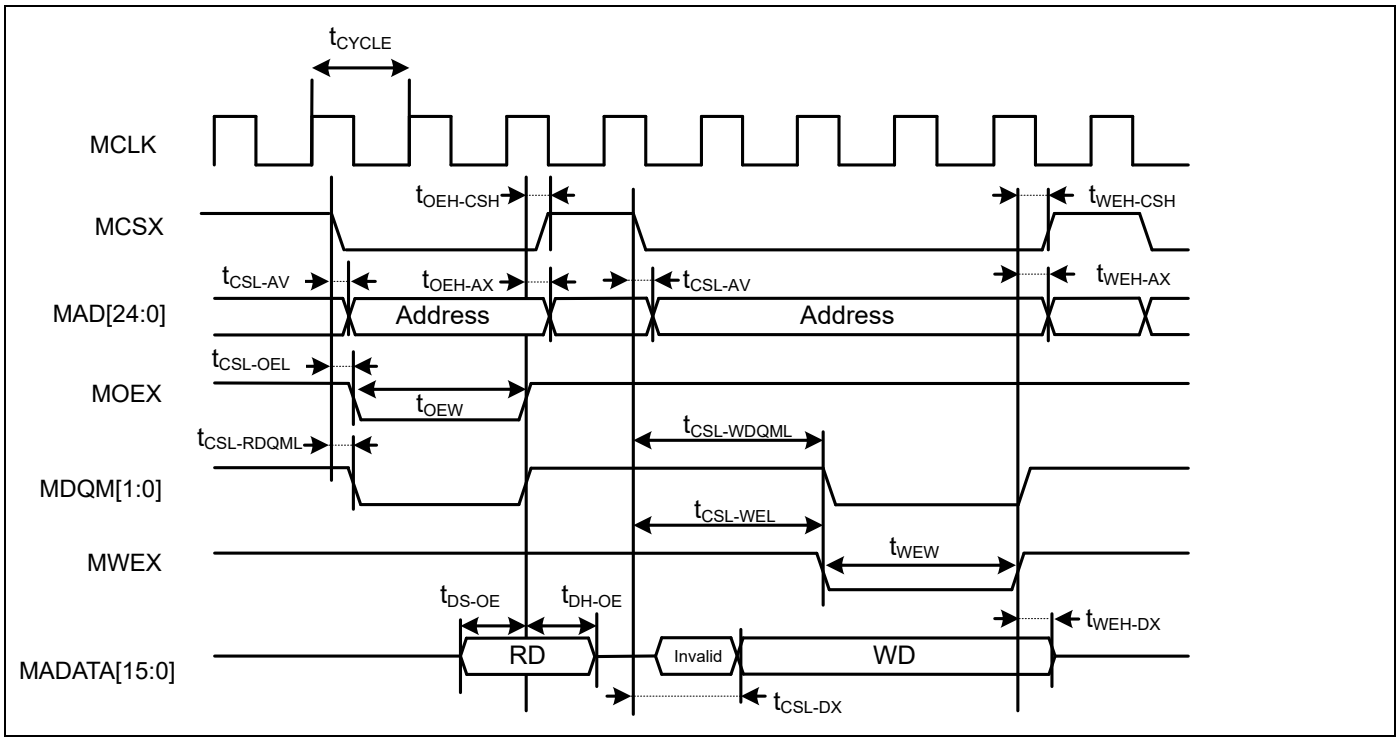
Separate Bus Access Asynchronous SRAM Mode

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
MOEX Minimum pulse width	t_{OEW}	MOEX	-	MCLK×n-3	-	ns	
MCSX↓→Address output delay time	t_{CSL-AV}	MCSX, MAD[24:0]	-	-9	+9	ns	
MOEX↑→Address hold time	t_{OEH-AX}	MOEX, MAD[24:0]	-	0	MCLK×m+9	ns	
MCSX↓→ MOEX↓delay time	$t_{CSL-OEL}$	MOEX, MCSX	-	MCLK×m-9	MCLK×m+9	ns	
MOEX↑→ MCSX↑time	$t_{OEH-CSH}$		-	0	MCLK×m+9	ns	
MCSX↓→ MDQM↓delay time	$t_{CSL-RDQML}$	MCSX, MDQM[1:0]	-	MCLK×m-9	MCLK×m+9	ns	
Data setup→ MOEX↑time	t_{DS-OE}	MOEX, MADATA[15:0]	-	20	-	ns	
MOEX↑→ Data hold time	t_{DH-OE}	MOEX, MADATA[15:0]	-	0	-	ns	
MWEX Mininum pulse width	t_{WEW}	MWEX	-	MCLK×n-3	-	ns	
MWEX↑→Address output delay time	t_{WEH-AX}	MWEX, MAD[24:0]	-	0	MCLK×m+9	ns	
MCSX↓→ MWEX↓delay time	$t_{CSL-WEL}$	MWEX, MCSX	-	MCLK×n-9	MCLK×n+9	ns	
MWEX↑→ MCSX↑delay time	$t_{WEH-CSH}$		-	0	MCLK×m+9	ns	
MCSX↓→ MDQM↓delay time	$t_{CSL-WDQML}$	MCSX, MDQM[1:0]	-	MCLK×n-9	MCLK×n+9	ns	
MCSX↓→ Data output time	t_{CSL-DX}	MCSX, MADATA[15:0]	-	MCLK-9	MCLK+9	ns	
MWEX↑→ Data hold time	t_{WEH-DX}	MWEX, MADATA[15:0]	-	0	MCLK×m+9	ns	

Note:

- *When the external load capacitance C_L = 30 pF (m=0 to 15, n=1 to 16)*



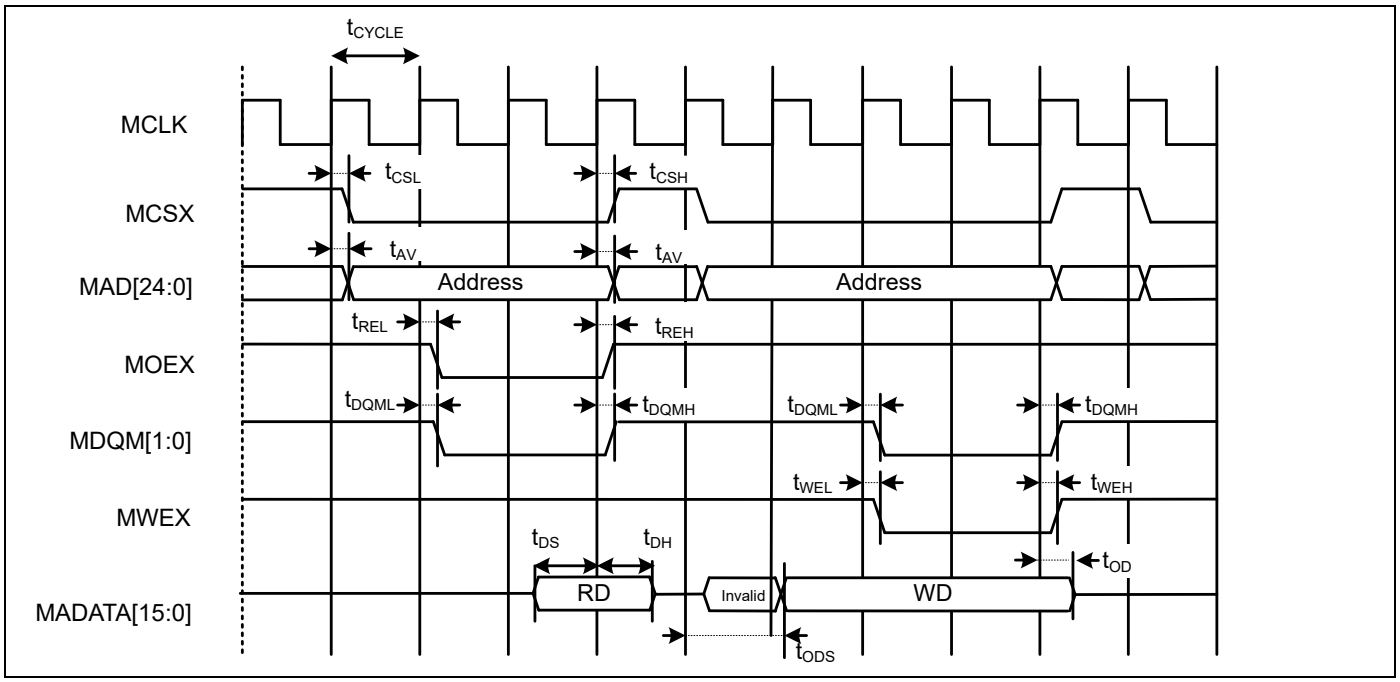
Separate Bus Access Synchronous SRAM Mode

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Address delay time	t_{AV}	MCLK, MAD[24:0]	-	1	9	ns	
MCSX delay time	t_{CSL}	MCLK, MCSX	-	1	9	ns	
	t_{CSH}		-	1	9	ns	
MOEX delay time	t_{REL}	MCLK, MOEX	-	1	9	ns	
	t_{REH}		-	1	9	ns	
Data set up →MCLK ↑ time	t_{DS}	MCLK, MADATA[15:0]	-	19	-	ns	
MCLK ↑ → Data hold time	t_{DH}	MCLK, MADATA[15:0]	-	0	-	ns	
MWEX delay time	t_{WEL}	MCLK, MWEX	-	1	9	ns	
	t_{WEH}		-	1	9	ns	
MDQM[1:0] delay time	t_{DQML}	MCLK, MDQM[1:0]	-	1	9	ns	
	t_{DQMH}		-	1	9	ns	
MCLK ↑ → Data output time	t_{ODS}	MCLK, MADATA[15:0]	-	MCLK+1	MCLK+18	ns	
MCLK ↑ → Data hold time	t_{OD}	MCLK, MADATA[15:0]	-	1	18	ns	

Note:

- *When the external load capacitance C_L = 30 pF*



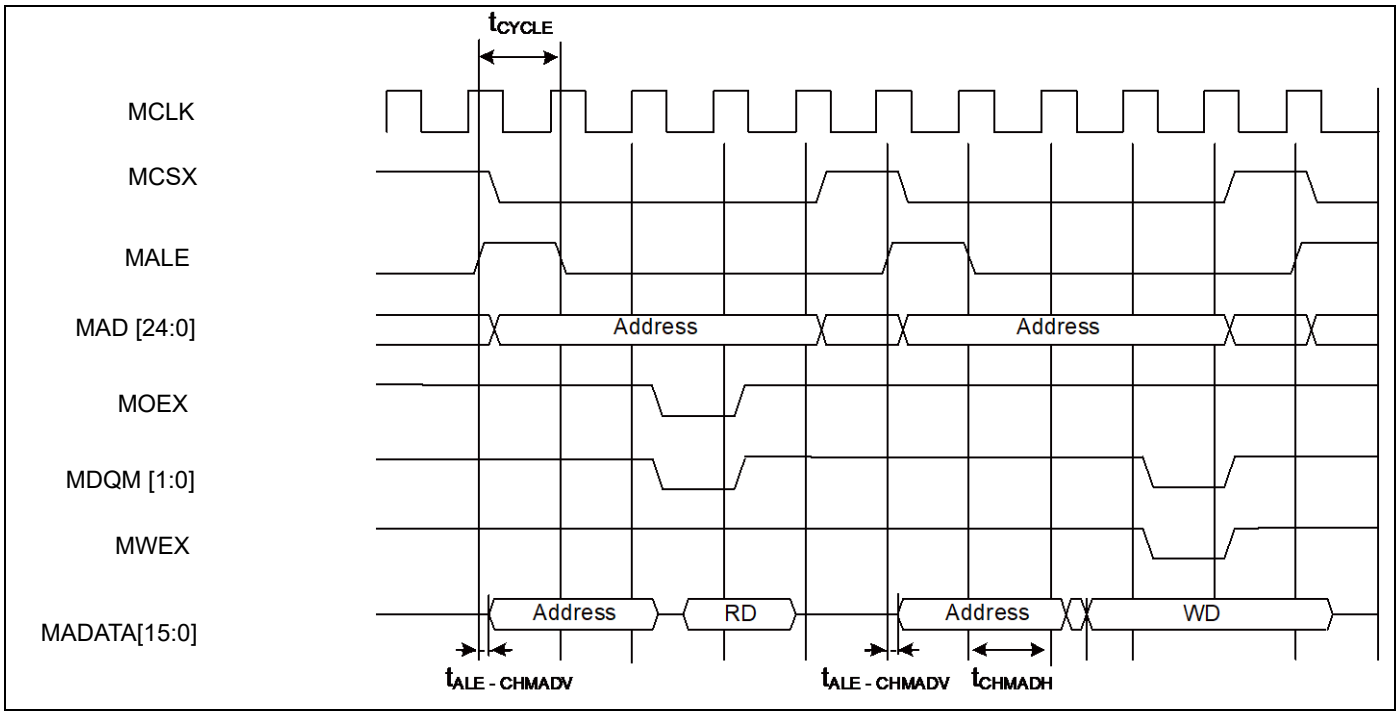
Multiplexed Bus Access Asynchronous SRAM Mode

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Multiplexed address delay time	$t_{ALE-CHMADV}$	MALE, MAD[24:0]	-	0	10	ns	
Multiplexed address hold time	t_{CHMADH}		-	MCLK×n+0	MCLK×n+10	ns	

Note:

− *When the external load capacitance C_L = 30 pF (m=0 to 15, n=1 to 16)*



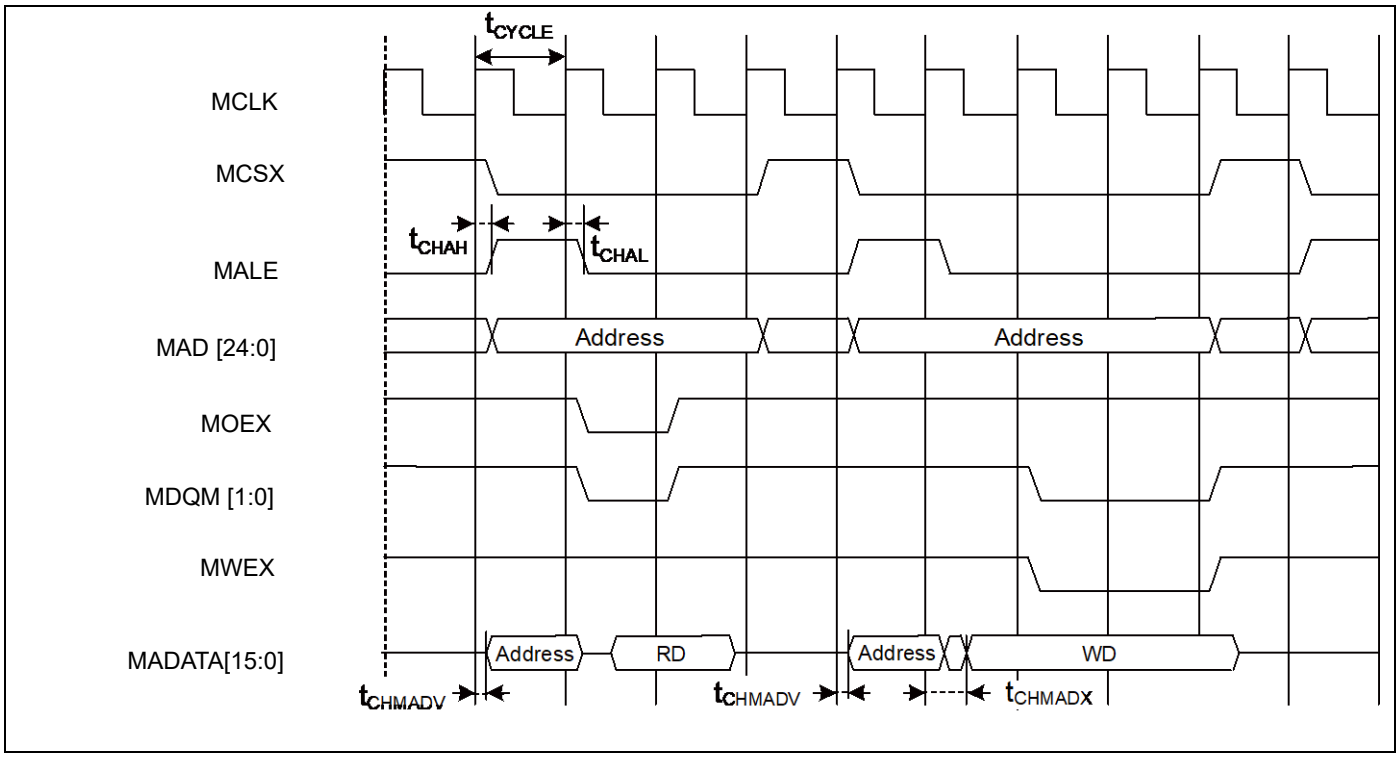
Multiplexed Bus Access Synchronous SRAM Mode

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
MALE delay time	t_{CHAL}	MCLK, MALE	-	1	9	ns	
	t_{CHAH}		-	1	9	ns	
MCLK ↑ →Multiplexed address delay time	t_{CHMADV}	MCLK, MADATA[15:0]	-	1	t_{OD}	ns	
MCLK ↑ →Multiplexed data output time	t_{CHMADX}		-	1	t_{OD}	ns	

Note:

− *When the external load capacitance C_L = 30 pF*



NAND Flash Mode

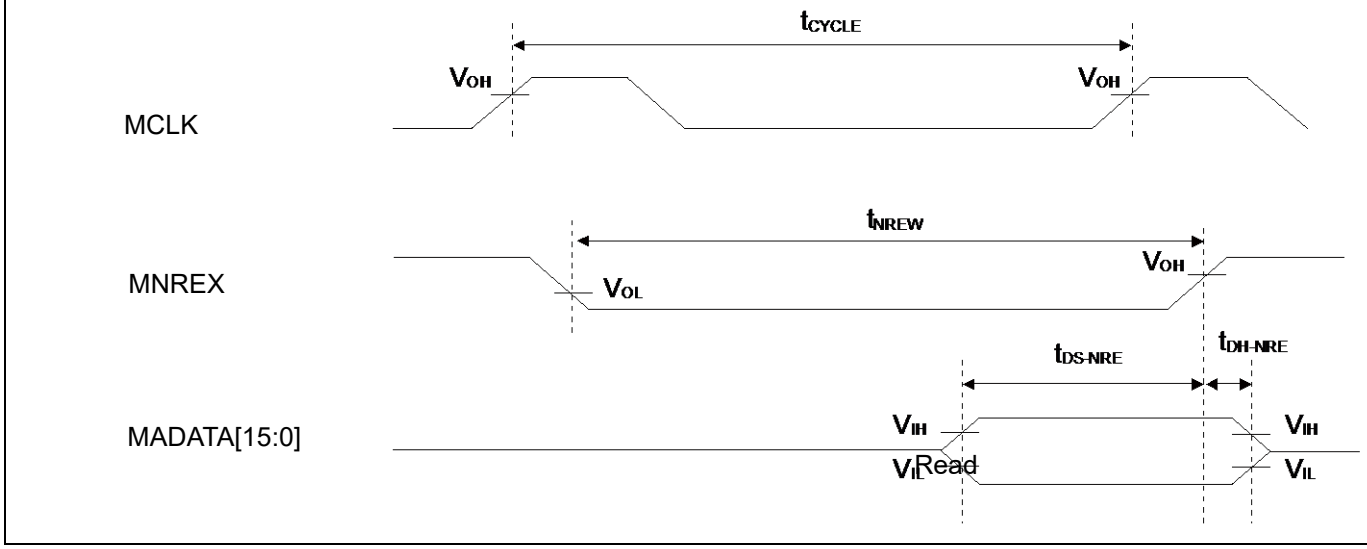
(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
MNREX Min pulse width	t_{NREW}	MNREX	-	MCLK×n-3	-	ns	
Data set up →MNREX ↑ time	t_{DS-NRE}	MNREX, MADATA[15:0]	-	20	-	ns	
MNREX ↑ → Data hold time	t_{DH-NRE}	MNREX, MADATA[15:0]	-	0	-	ns	
MNALE ↑ → MNWEX delay time	$t_{ALEH-NWEL}$	MNALE, MNWEX	-	MCLK×m-9	MCLK×m+9	ns	
MNALE ↓ → MNWEX delay time	$t_{ALEL-NWEL}$	MNALE, MNWEX	-	MCLK×m-9	MCLK×m+9	ns	
MNCLE ↑ → MNWEX delay time	$t_{CLEH-NWEL}$	MNCLE, MNWEX	-	MCLK×m-9	MCLK×m+9	ns	
MNWEX ↑ → MNCLE delay time	$t_{NWEH-CLEL}$	MNCLE, MNWEX	-	0	MCLK×m+9	ns	
MNWEX Min pulse width	t_{NWEW}	MNWEX	-	MCLK×n-3	-	ns	
MNWEX ↓ → Data output time	$t_{NWEL-DV}$	MNWEX, MADATA[15:0]	-	-9	9	ns	
MNWEX ↑ → Data hold time	$t_{NWEH-DX}$	MNWEX, MADATA[15:0]	-	0	MCLK×m+9	ns	

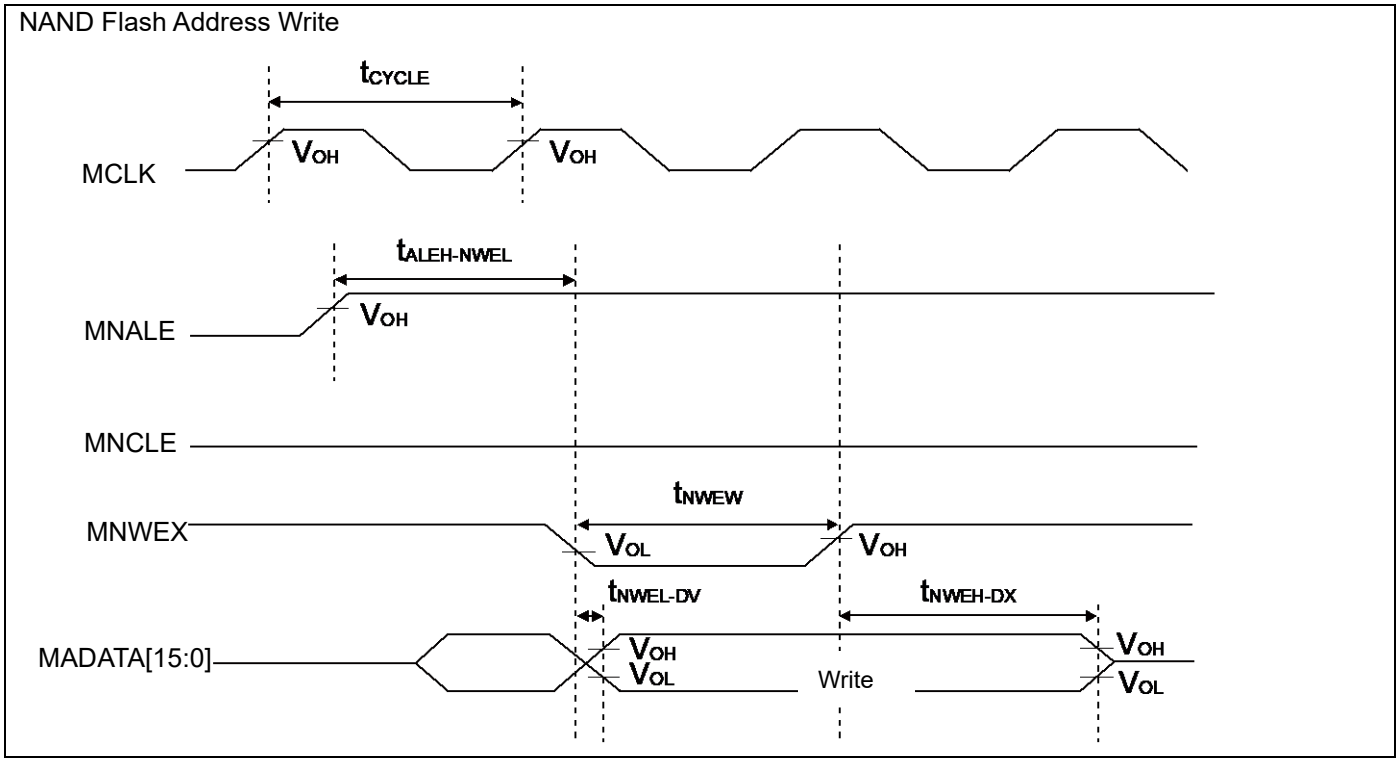
Note:

- *When the external load capacitance C_L = 30 pF (m=0 to 15, n=1 to 16)*

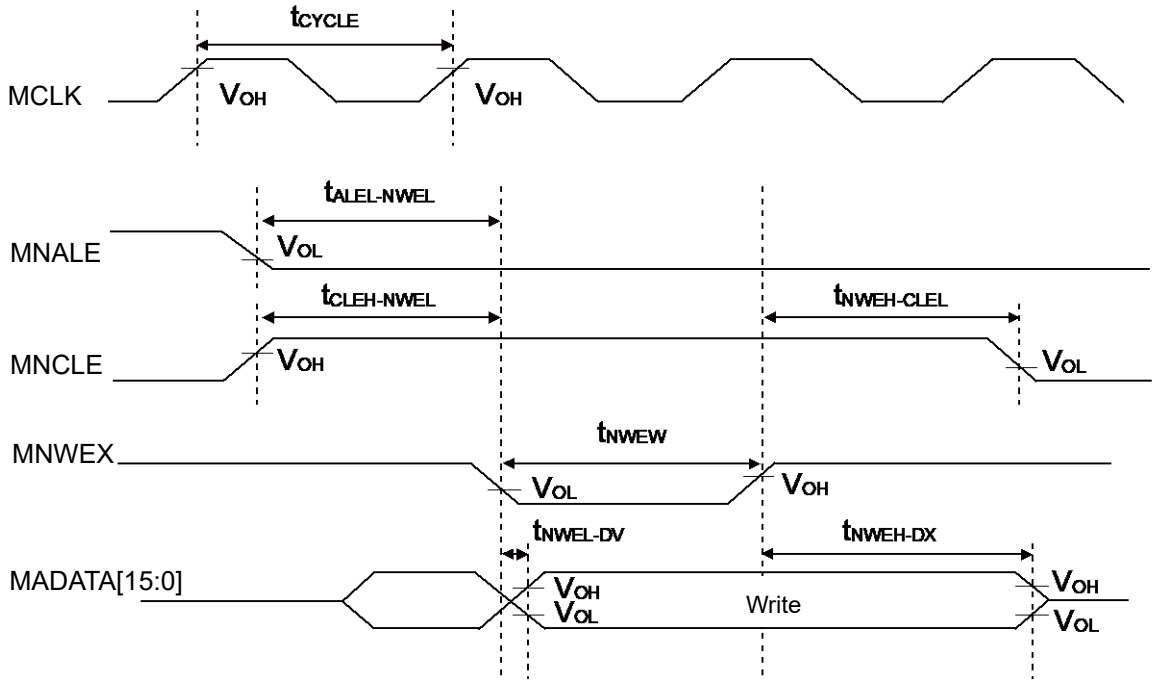
NAND Flash Read



NAND Flash Address Write



NAND Flash Command Write

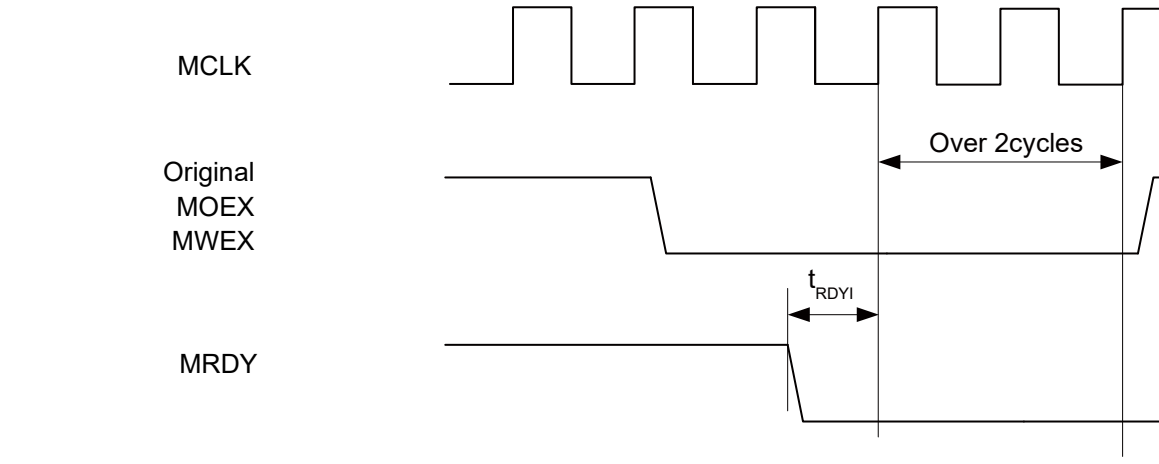


External Ready Input Timing

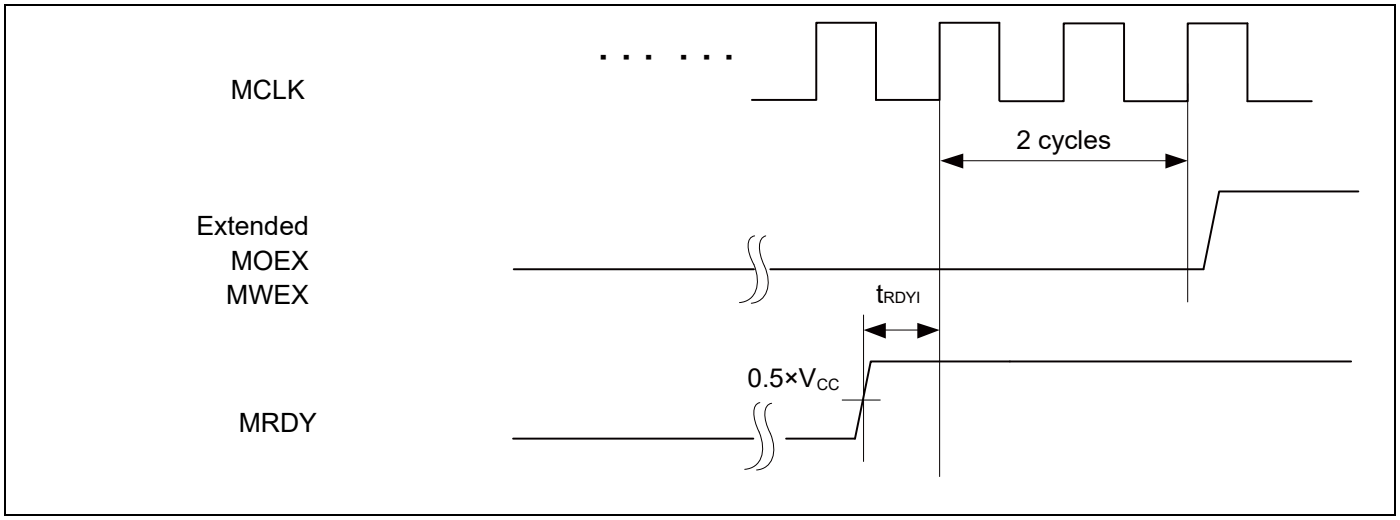
(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
MCLK↑ MRDY input setup time	t_{RDYI}	MCLK, MRDY	-	19	-	ns	

■When RDY is input



■When RDY is released



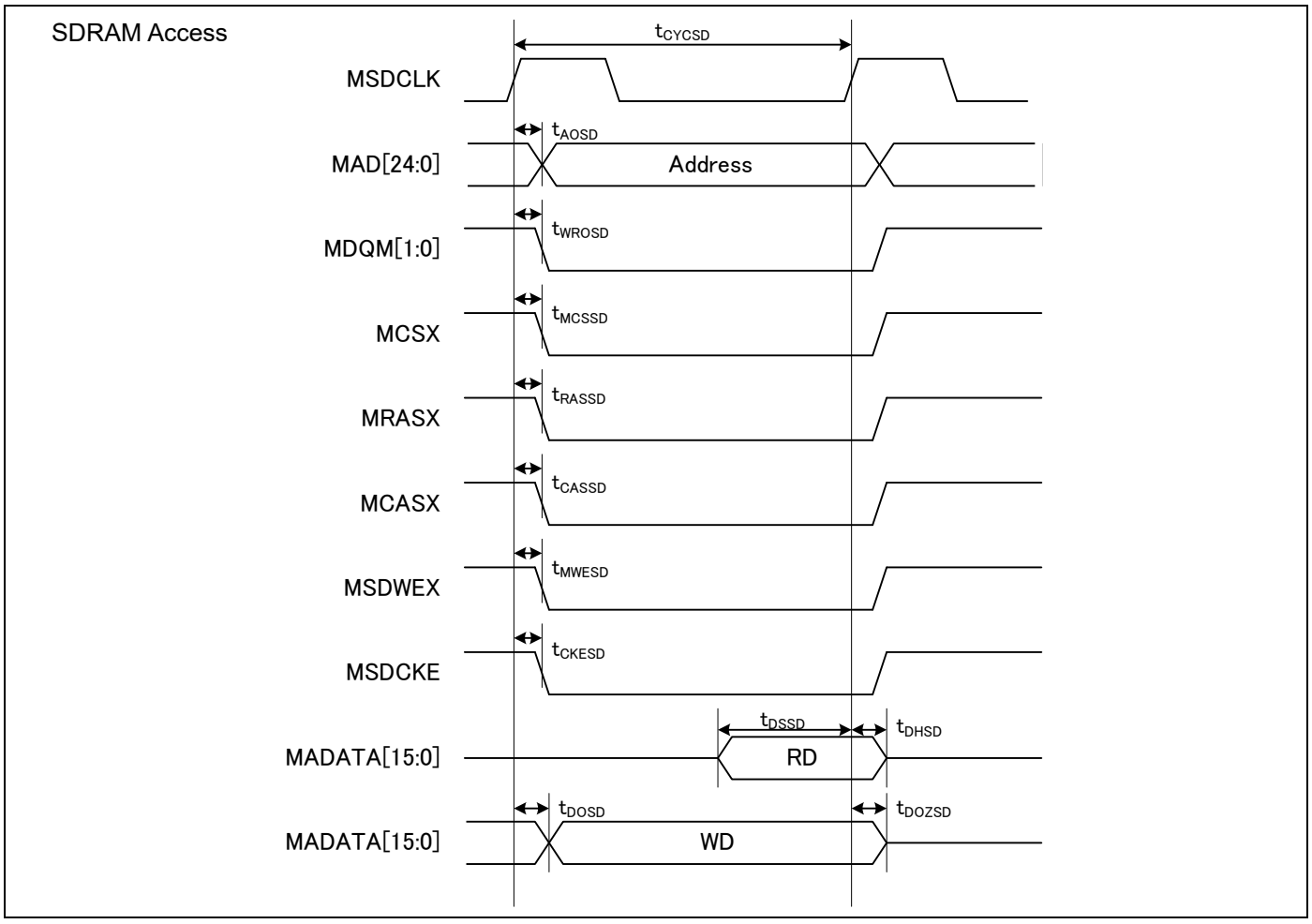
SDRAM Mode

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Value	Unit		Unit	Remarks
				Min	Max		
Output frequency	t_{CYCSD}	MSDCLK	-	-	50	MHz	
Address delay time	t_{AOSD}	MSDCLK, MAD[15:0]	-	2	12	ns	
MSDCLK ↑ → Data output delay time	t_{DOSD}	MSDCLK, MADATA[15:0]	-	2	12	ns	
MSDCLK ↑ → Data output Hi-Z time	t_{DOZSD}	MSDCLK, MADATA[15:0]	-	2	19.5	ns	
MDQM[1:0] delay time	t_{WROSD}	MSDCLK, MDQM[1:0]	-	1	12	ns	
MCSX delay time	t_{MCSSD}	MSDCLK, MCSX8	-	2	12	ns	
MRASX delay time	t_{RASSD}	MSDCLK, MRASX	-	2	12	ns	
MCASX delay time	t_{CASSD}	MSDCLK, MCASX	-	2	12	ns	
MSDWEX delay time	t_{MWESD}	MSDCLK, MSDWEX	-	2	12	ns	
MSDCKE delay time	t_{CKESD}	MSDCLK, MSDCKE	-	2	12	ns	
Data setup time	t_{DSSD}	MSDCLK, MADATA[15:0]	-	19	-	ns	
Data hold time	t_{DHSD}	MSDCLK, MADATA[15:0]	-	0	-	ns	

Note:

– *When the external load capacitance C_L = 30 pF*

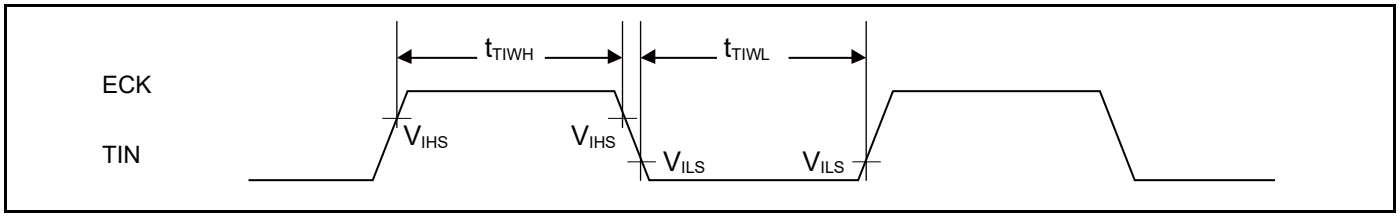


12.4.11 Base Timer Input Timing

Timer Input Timing

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

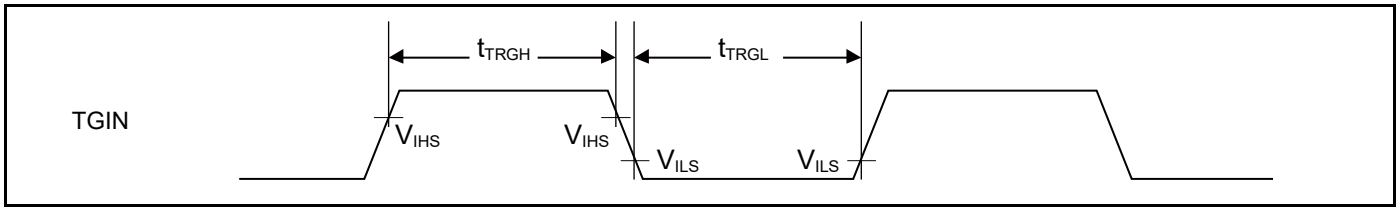
Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TIWH}, t_{TIWL}	TIOAn/TIOBn (when using as ECK, TIN)	-	$2t_{CYCP}$	-	ns	



Trigger Input Timing

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

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



Note:

- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which the Base Timer is connected to, see 8. Block Diagram in this data sheet.

12.4.12 CSIO Timing

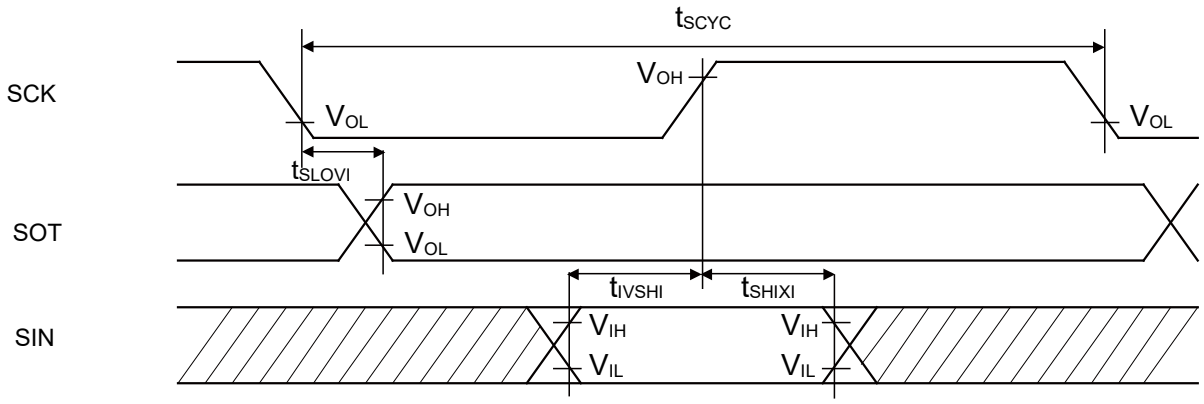
Synchronous Serial (SPI = 0, SCINV = 0)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

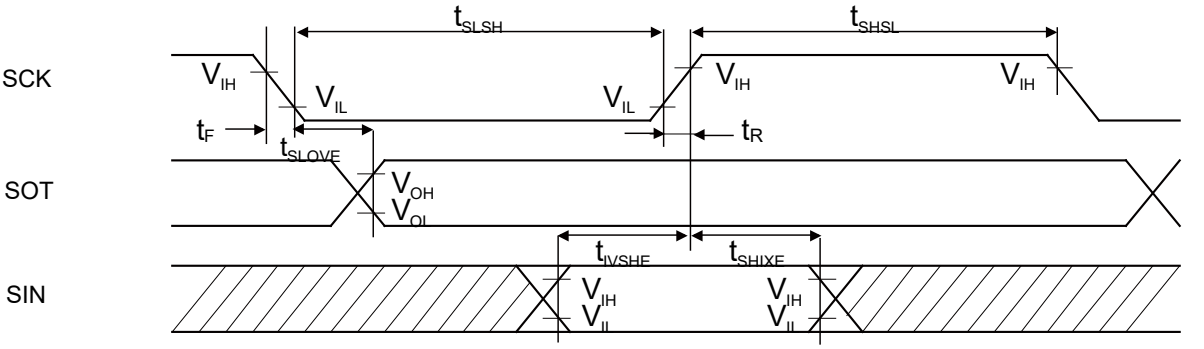
Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Baud rate	-	-		-	8	Mbps
Serial clock cycle time	t_{SCYC}	SCKx	Internal shift clock operation	$4t_{CYCP}$	-	ns
SCK↓→SOT delay time	t_{SLOVI}	SCKx, SOTx		- 30	+ 30	ns
SIN→SCK↑ setup time	t_{IVSHI}	SCKx, SINx		50	-	ns
SCK↑→SIN hold time	t_{SHIXI}	SCKx, SINx		0	-	ns
Serial clock L pulse width	t_{SLSH}	SCKx	External shift clock operation	$2t_{CYCP}$ - 10	-	ns
Serial clock H pulse width	t_{SHSL}	SCKx		t_{CYCP} + 10	-	ns
SCK↓→SOT delay time	t_{SLOVE}	SCKx, SOTx		-	50	ns
SIN→SCK↑ setup time	t_{IVSHE}	SCKx, SINx		10	-	ns
SCK↑→SIN hold time	t_{SHIXE}	SCKx, SINx		20	-	ns
SCK falling time	t_F	SCKx		-	5	ns
SCK rising time	t_R	SCKx		-	5	ns

Notes:

- *The above characteristics apply to CLK synchronous mode.*
- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *These characteristics only guarantee the same relocate port number.*
  For example, the combination of SCKx_0 and SOTx_1 is not guaranteed.
- *When the external load capacitance C_L = 30 pF.*



MS bit = 0



MS bit = 1

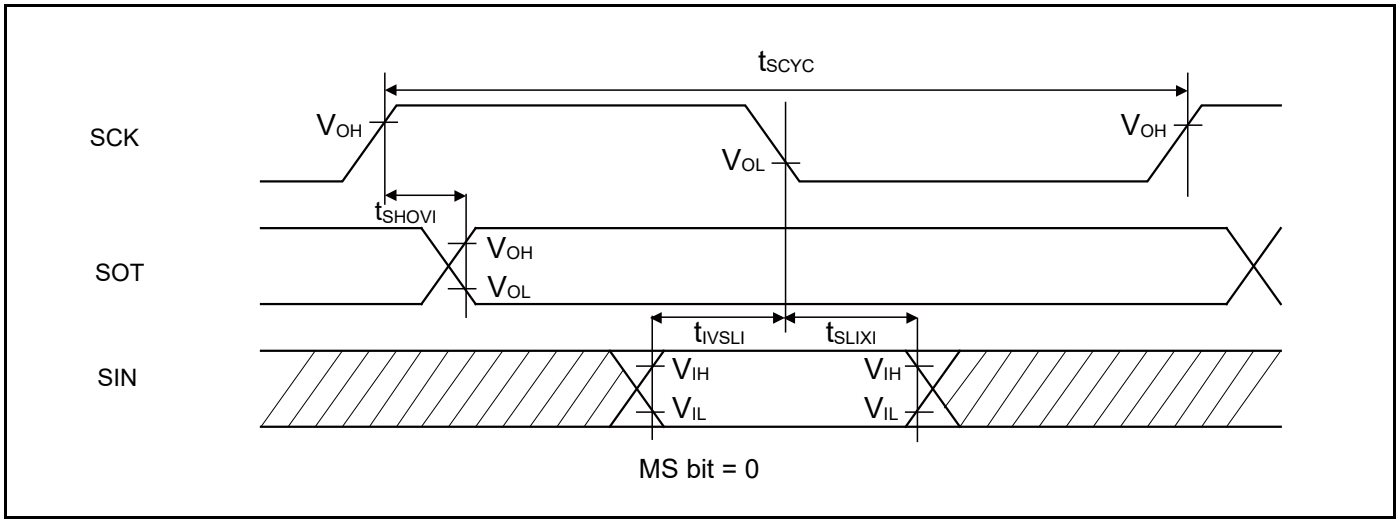
Synchronous Serial (SPI = 0, SCINV = 1)

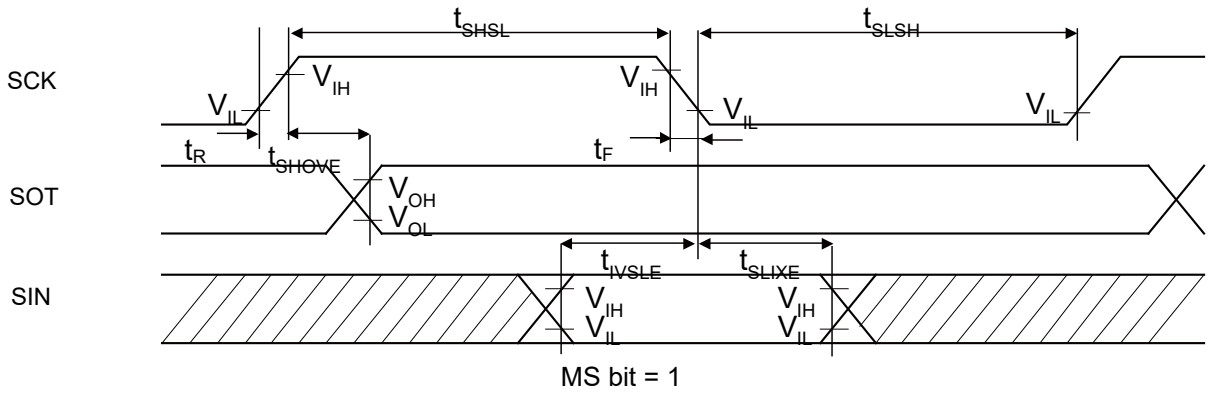
(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Baud rate	-	-	-	-	8	Mbps
Serial clock cycle time	t_{SCYC}	SCKx	Internal shift clock operation	$4t_{CYCP}$	-	ns
SCK↑→SOT delay time	t_{SHOVI}	SCKx, SOTx		- 30	+ 30	ns
SIN→SCK↓ setup time	t_{IVSLI}	SCKx, SINx		50	-	ns
SCK↓→SIN hold time	t_{SLIXI}	SCKx, SINx		0	-	ns
Serial clock L pulse width	t_{SLSH}	SCKx	External shift clock operation	$2t_{CYCP}$ - 10	-	ns
Serial clock H pulse width	t_{SHSL}	SCKx		t_{CYCP} + 10	-	ns
SCK↑→SOT delay time	t_{SHOVE}	SCKx, SOTx		-	50	ns
SIN→SCK↓ setup time	t_{IVSLE}	SCKx, SINx		10	-	ns
SCK↓→SIN hold time	t_{SLIXE}	SCKx, SINx		20	-	ns
SCK falling time	t_F	SCKx		-	5	ns
SCK rising time	t_R	SCKx		-	5	ns

Notes:

- *The above characteristics apply to CLK synchronous mode.*
- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *These characteristics only guarantee the same relocate port number.*
  For example, the combination of SCKx_0 and SOTx_1 is not guaranteed.
- *When the external load capacitance C_L = 30 pF.*





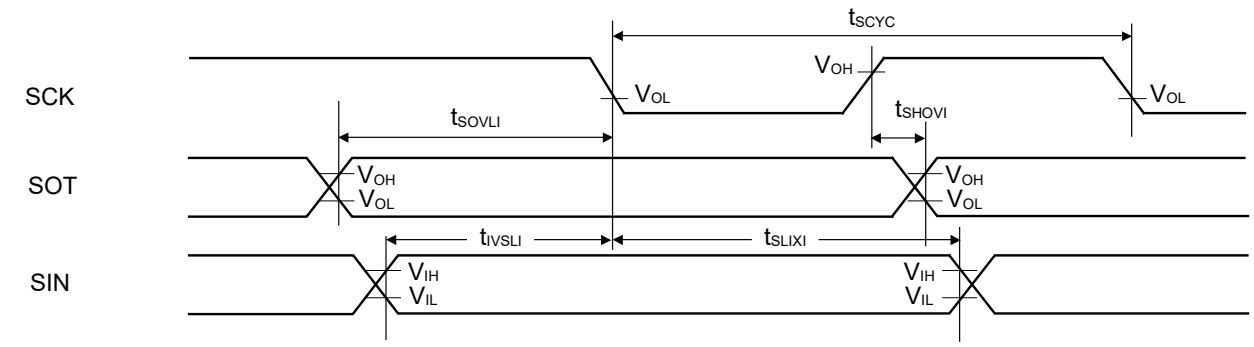
Synchronous Serial (SPI = 1, SCINV = 0)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

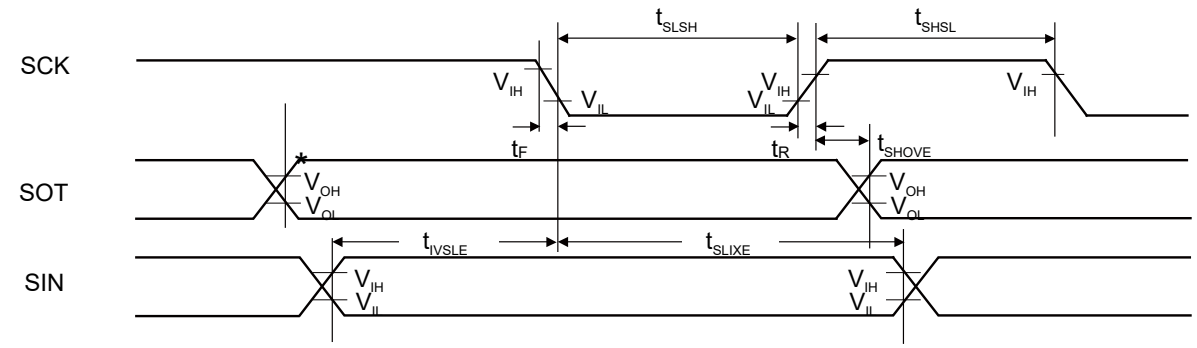
Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Baud rate	-	-	-	-	8	Mbps
Serial clock cycle time	t_{SCYC}	SCKx	Internal shift clock operation	$4t_{CYCP}$	-	ns
SCK↑→SOT delay time	t_{SHOVI}	SCKx, SOTx		- 30	+ 30	ns
SIN→SCK↓ setup time	t_{IVSLI}	SCKx, SINx		50	-	ns
SCK↓→SIN hold time	t_{SLIXI}	SCKx, SINx		0	-	ns
SOT→SCK↓ delay time	t_{SOVLI}	SCKx, SOTx		$2t_{CYCP}$ - 30	-	ns
Serial clock L pulse width	t_{SLSH}	SCKx	External shift clock operation	$2t_{CYCP}$ - 10	-	ns
Serial clock H pulse width	t_{SHSL}	SCKx		t_{CYCP} + 10	-	ns
SCK↑→SOT delay time	t_{SHOVE}	SCKx, SOTx		-	50	ns
SIN→SCK↓ setup time	t_{IVSLE}	SCKx, SINx		10	-	ns
SCK↓→SIN hold time	t_{SLIXE}	SCKx, SINx		20	-	ns
SCK falling time	t_F	SCKx		-	5	ns
SCK rising time	t_R	SCKx		-	5	ns

Notes:

- *The above characteristics apply to CLK synchronous mode.*
- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *These characteristics only guarantee the same relocate port number.*
  For example, the combination of SCKx_0 and SOTx_1 is not guaranteed.
- *When the external load capacitance C_L = 30 pF.*



MS bit = 0



MS bit = 1

*: Changes when writing to TDR register

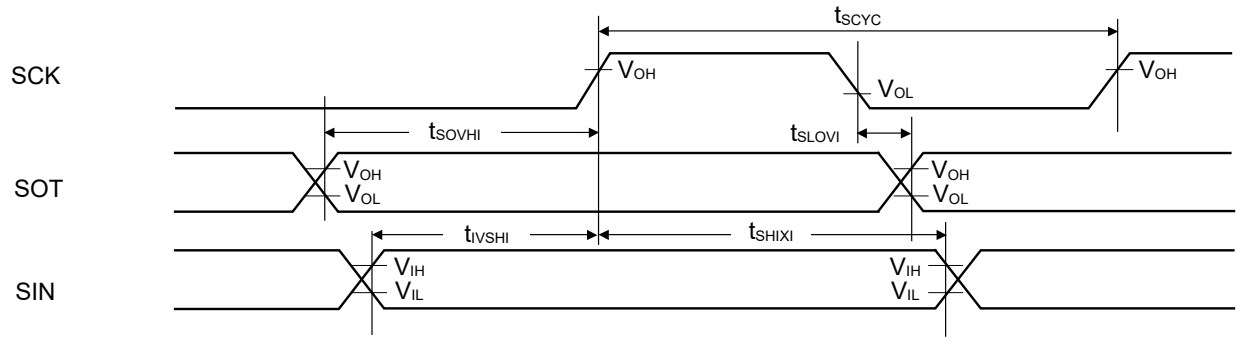
Synchronous Serial (SPI = 1, SCINV = 1)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

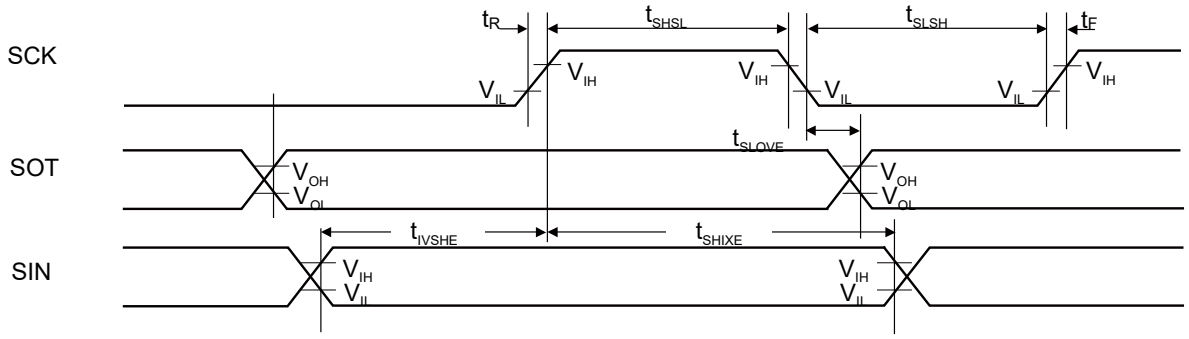
Parameter	Symbol	Pin name	Conditions	Value		Unit
				Min	Max	
Baud rate	-	-	-	-	8	Mbps
Serial clock cycle time	t_{SCYC}	SCKx	Internal shift clock operation	$4t_{CYCP}$	-	ns
SCK↓→SOT delay time	t_{SLOVI}	SCKx, SOTx		- 30	+ 30	ns
SIN→SCK↑ setup time	t_{IVSHI}	SCKx, SINx		50	-	ns
SCK↑→SIN hold time	t_{SHIXI}	SCKx, SINx		0	-	ns
SOT→SCK↑ delay time	t_{SOVHI}	SCKx, SOTx		$2t_{CYCP}$ - 30	-	ns
Serial clock L pulse width	t_{SLSH}	SCKx	External shift clock operation	$2t_{CYCP}$ - 10	-	ns
Serial clock H pulse width	t_{SHSL}	SCKx		t_{CYCP} + 10	-	ns
SCK↓→SOT delay time	t_{SLOVE}	SCKx, SOTx		-	50	ns
SIN→SCK↑ setup time	t_{IVSHE}	SCKx, SINx		10	-	ns
SCK↑→SIN hold time	t_{SHIXE}	SCKx, SINx		20	-	ns
SCK falling time	t_F	SCKx		-	5	ns
SCK rising time	t_R	SCKx		-	5	ns

Notes:

- *The above characteristics apply to CLK synchronous mode.*
- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *These characteristics only guarantee the same relocate port number.*
  For example, the combination of SCKx_0 and SOTx_1 is not guaranteed.
- *When the external load capacitance C_L = 30 pF.*



MS bit = 0



When Using Synchronous Serial Chip Select (SCINV = 0, CSLVL=1)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
SCS↓→SCK↓ setup time	t_{CSSI}	Internal shift clock operation	(*1)-50	(*1)+0	ns
SCK↑→SCS↑ hold time	t_{CSHI}		(*2)+0	(*2)+50	ns
SCS deselect time	t_{CSDI}		(*3)-50+5t_{CYCP}	(*3)+50+5t_{CYCP}	ns
SCS↓→SCK↓ setup time	t_{CSSE}	External shift clock operation	3t_{CYCP}+30	-	ns
SCK↑→SCS↑ hold time	t_{CSHE}		0	-	ns
SCS deselect time	t_{CSDE}		3t_{CYCP}+30	-	ns
SCS↓→SOT delay time	t_{DSE}		-	40	ns
SCS↑→SOT delay time	t_{DEE}		0	-	ns

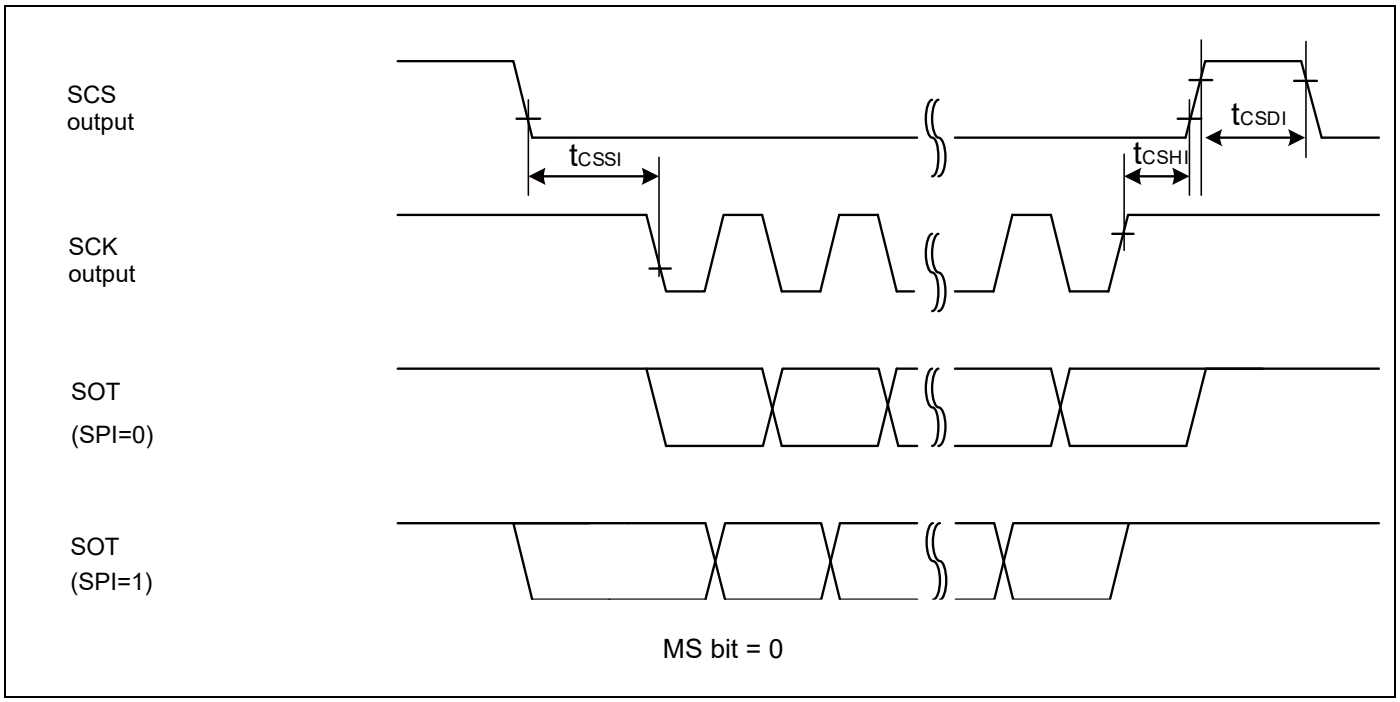
(*1): CSSU bit value×serial chip select timing operating clock cycle [ns]

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

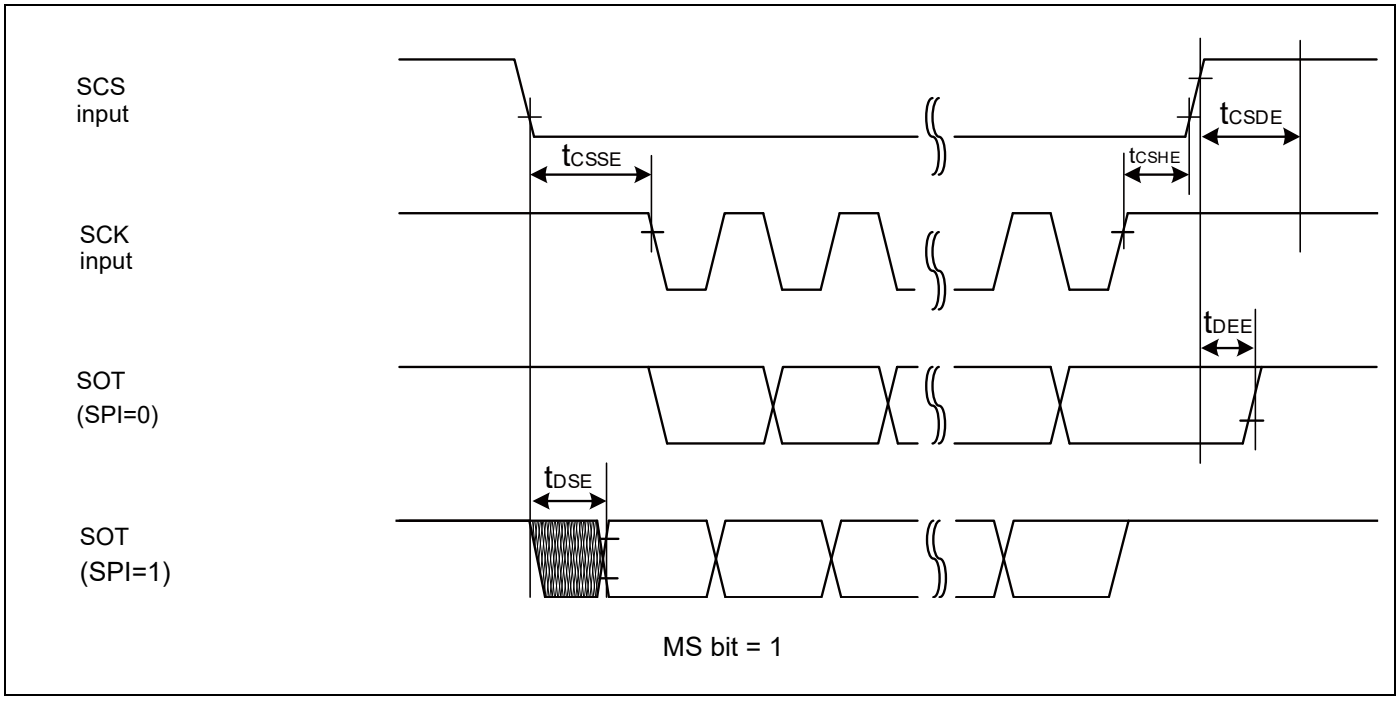
(*3): CSDS bit value×serial chip select timing operating clock cycle [ns]

Notes:

- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *About CSSU, CSHD, CSDS, serial chip select timing operating clock, see FM4 Family Peripheral Manual Main part (002-04856).*
- *When the external load capacitance C_L = 30 pF.*



MS bit = 0



MS bit = 1

When Using Synchronous Serial Chip Select (SCINV = 1, CSLVL=1)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
SCS↓→SCK↑ setup time	t_{CSSI}	Internal shift clock operation	(*1)-50	(*1)+0	ns
SCK↓→SCS↑ hold time	t_{CSHI}		(*2)+0	(*2)+50	ns
SCS deselect time	t_{CSDI}		(*3)-50+5t_{CYCP}	(*3)+50+5t_{CYCP}	ns
SCS↓→SCK↑ setup time	t_{CSSE}	External shift clock operation	3t_{CYCP}+30	-	ns
SCK↓→SCS↑ hold time	t_{CSHE}		0	-	ns
SCS deselect time	t_{CSDE}		3t_{CYCP}+30	-	ns
SCS↓→SOT delay time	t_{DSE}		-	40	ns
SCS↑→SOT delay time	t_{DEE}		0	-	ns

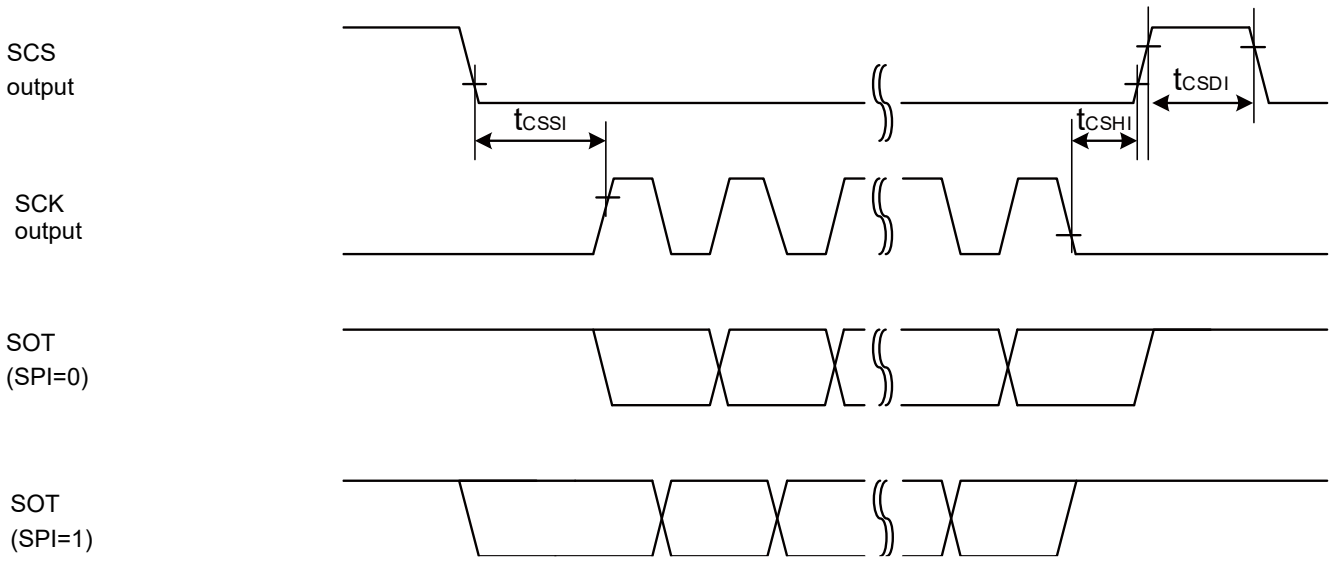
(*1): CSSU bit value×serial chip select timing operating clock cycle [ns]

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

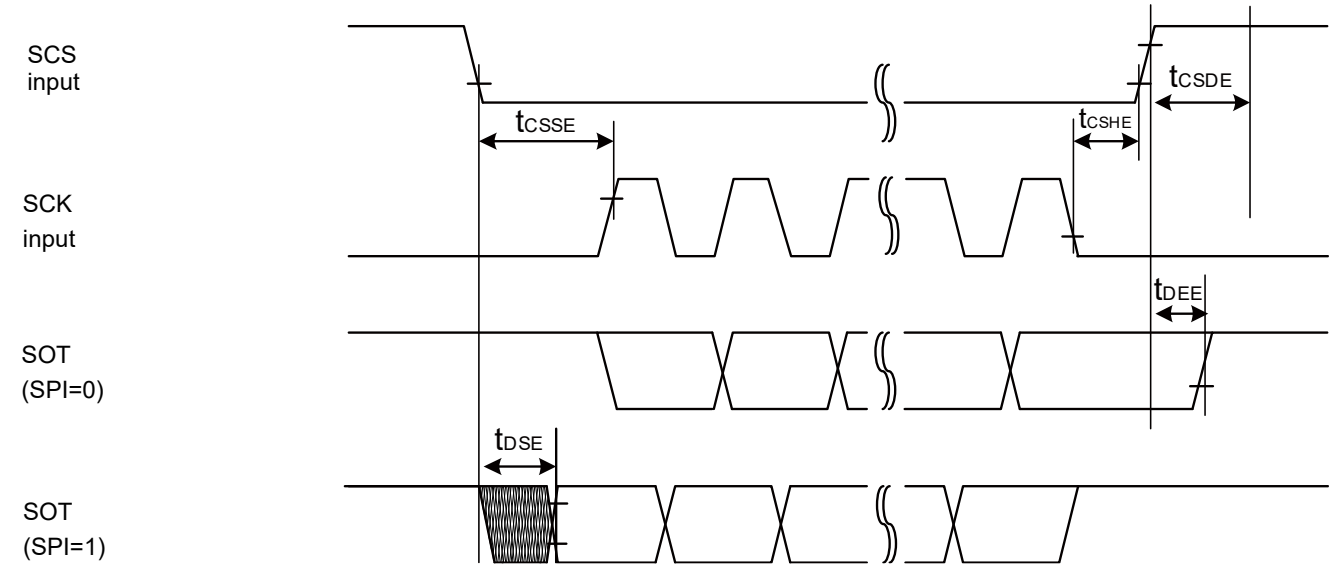
(*3): CSDS bit value×serial chip select timing operating clock cycle [ns]

Notes:

- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *About CSSU, CSHD, CSDS, serial chip select timing operating clock, see FM4 Family Peripheral Manual Main part (002-04856).*
- *When the external load capacitance C_L = 30 pF.*



MS bit = 0



MS bit = 1

When Using Synchronous Serial Chip Select (SCINV = 0, CSLVL=0)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
SCS↑→SCK↓ setup time	t_{CSSI}	Internal shift clock operation	(*1)-50	(*1)+0	ns
SCK↑→SCS↓ hold time	t_{CSHI}		(*2)+0	(*2)+50	ns
SCS deselect time	t_{CSDI}		(*3)-50+5t_{CYCP}	(*3)+50+5t_{CYCP}	ns
SCS↑→SCK↓ setup time	t_{CSSE}	External shift clock operation	3t_{CYCP}+30	-	ns
SCK↑→SCS↓ hold time	t_{CSHE}		0	-	ns
SCS deselect time	t_{CSDE}		3t_{CYCP}+30	-	ns
SCS↑→SOT delay time	t_{DSE}		-	40	ns
SCS↓→SOT delay time	t_{DEE}		0	-	ns

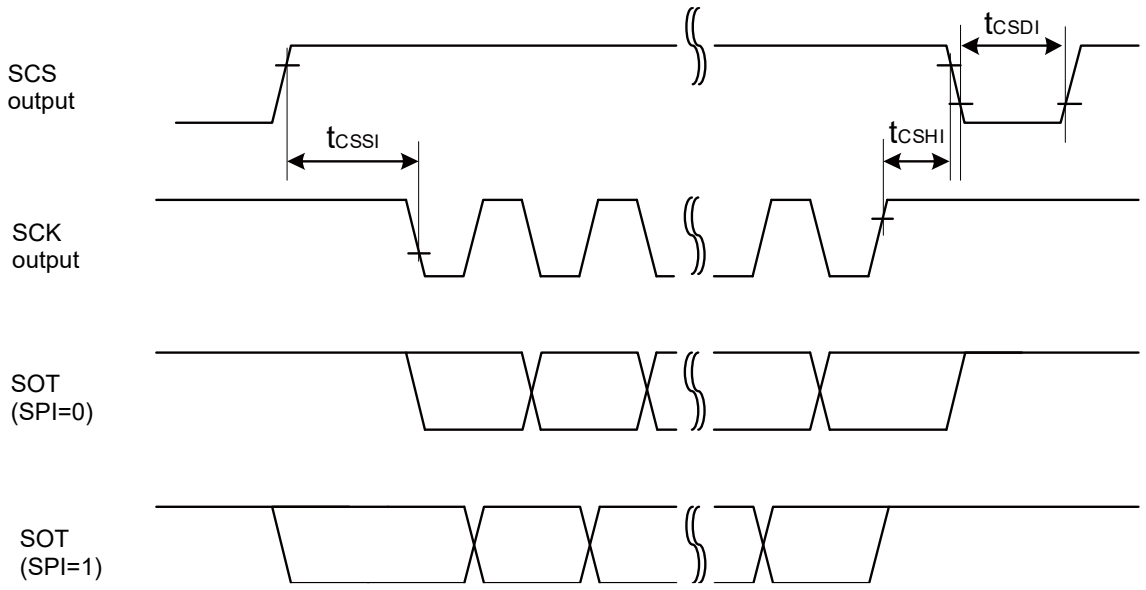
(*1): CSSU bit value×serial chip select timing operating clock cycle [ns]

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

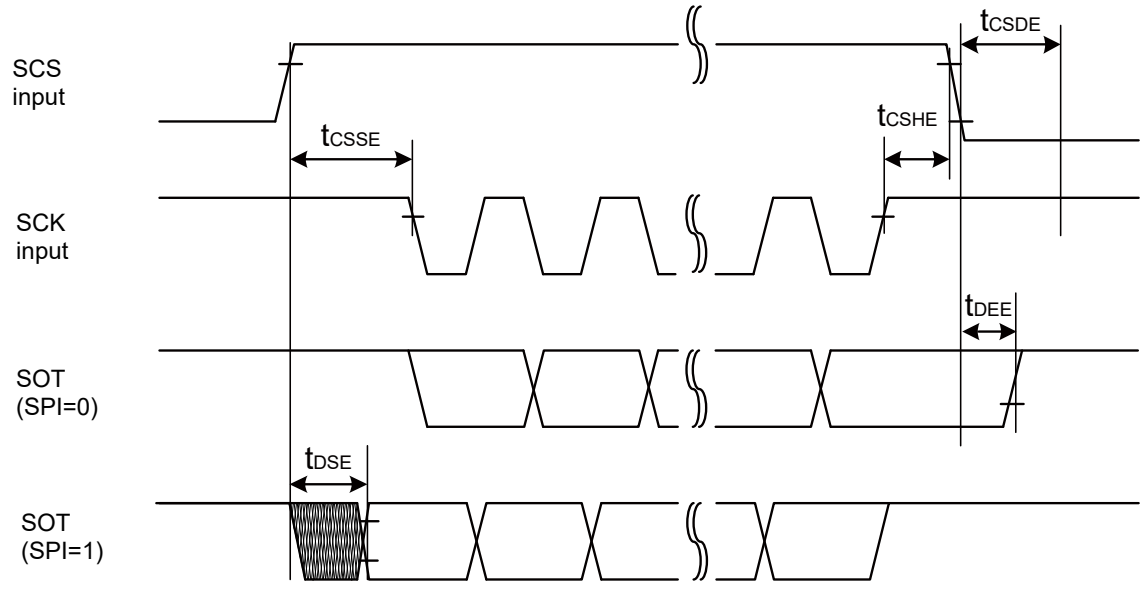
(*3): CSDS bit value×serial chip select timing operating clock cycle [ns]

Notes:

- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *About CSSU, CSHD, CSDS, serial chip select timing operating clock, see FM4 Family Peripheral Manual Main part (002-04856).*
- *When the external load capacitance C_L = 30 pF.*



MS bit = 0



MS bit = 1

When Using Synchronous Serial Chip Select (SCINV = 1, CSLVL=0)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
SCS↑→SCK↑ setup time	t_{CSSI}	Internal shift clock operation	(*1)-50	(*1)+0	ns
SCK↓→SCS↓ hold time	t_{CSHI}		(*2)+0	(*2)+50	ns
SCS deselect time	t_{CSDI}		(*3)-50+5t_{CYCP}	(*3)+50+5t_{CYCP}	ns
SCS↑→SCK↑ setup time	t_{CSSE}	External shift clock operation	3t_{CYCP}+30	-	ns
SCK↓→SCS↓ hold time	t_{CSHE}		0	-	ns
SCS deselect time	t_{CSDE}		3t_{CYCP}+30	-	ns
SCS↑→SOT delay time	t_{DSE}		-	40	ns
SCS↓→SOT delay time	t_{DEE}		0	-	ns

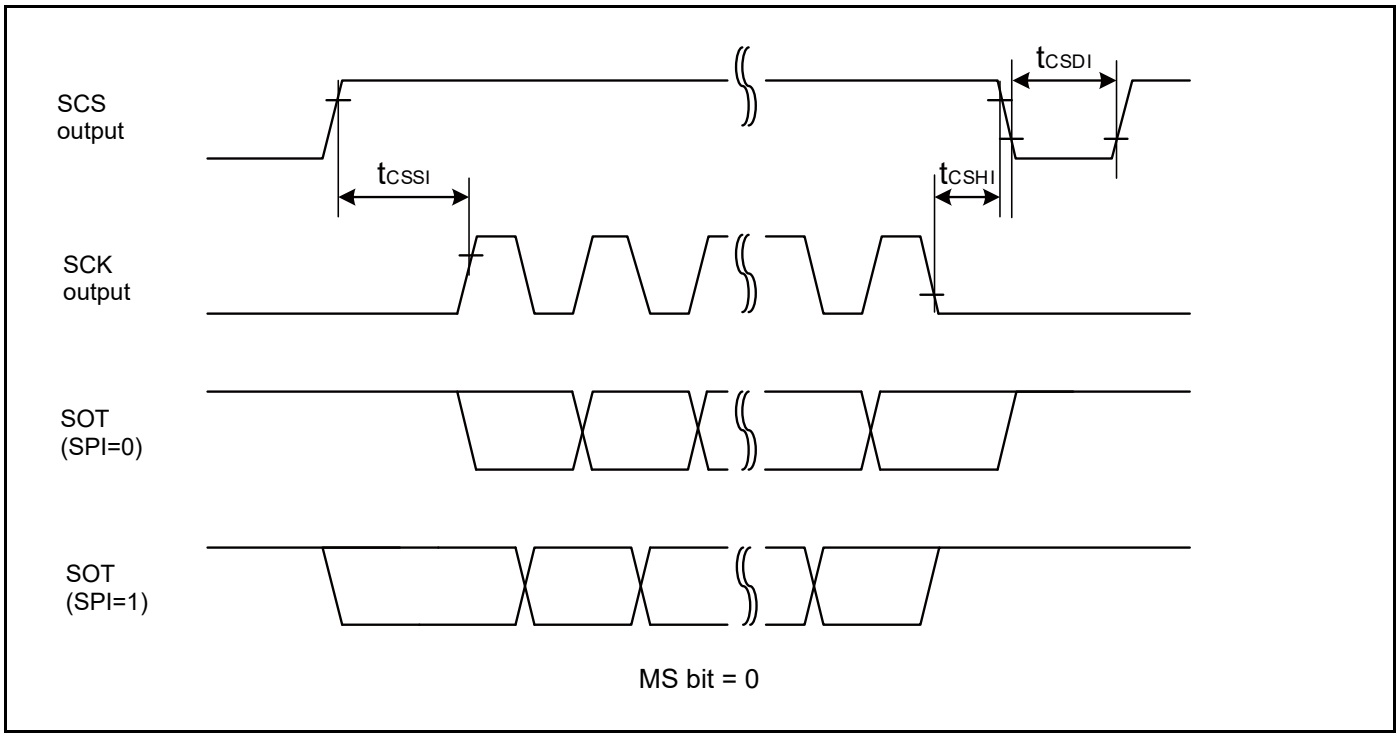
(*1): CSSU bit value×serial chip select timing operating clock cycle [ns]

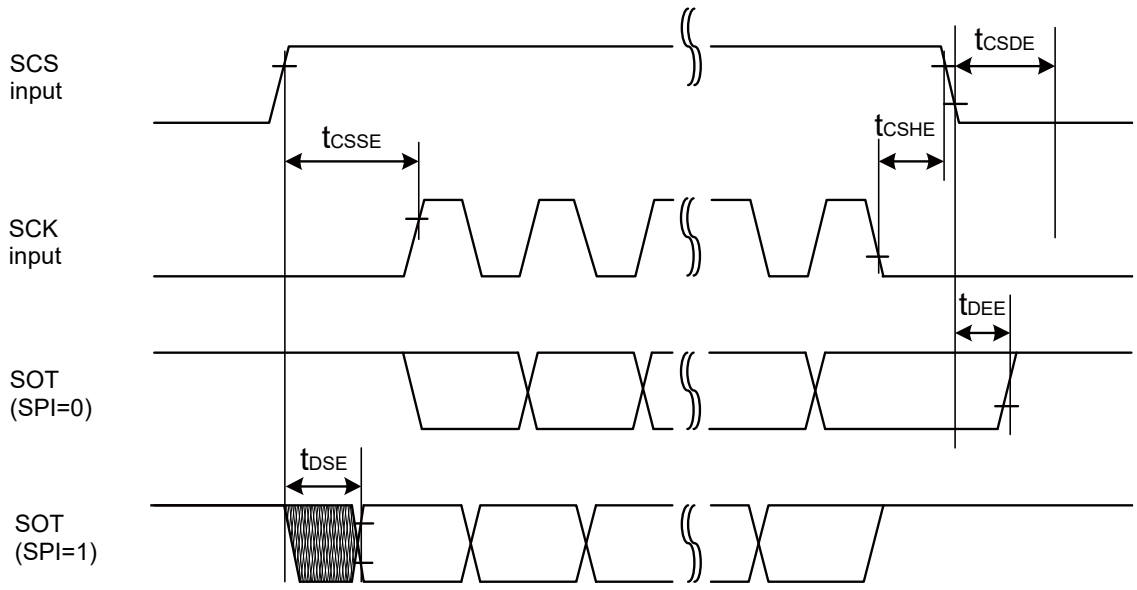
(*2): CSHD bit value×serial chip select timing operating clock cycle [ns]

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

Notes:

- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *About CSSU, CSHD, CSDS, serial chip select timing operating clock, see FM4 Family Peripheral Manual Main part (002-04856).*
- *When the external load capacitance C_L = 30 pF.*




SCS
input
SCK
input
SOT
(SPI=0)
SOT
(SPI=1)
tCSSE
tCSHE
tCSDE
tDEE
tDSE

MS bit = 1

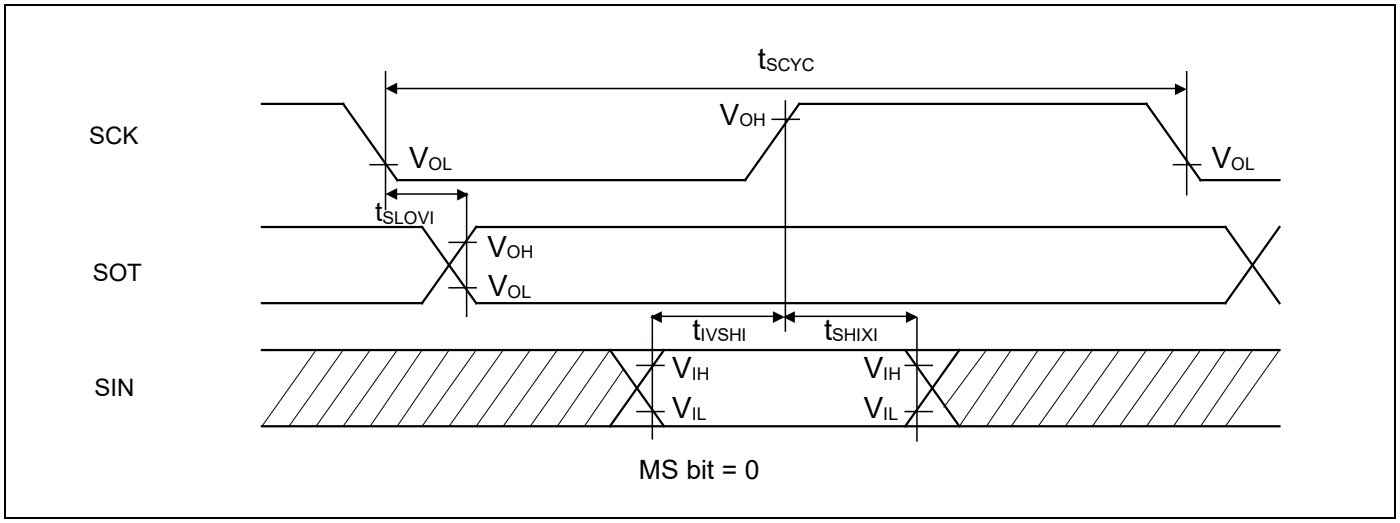
High-Speed Synchronous Serial (SPI = 0, SCINV = 0)

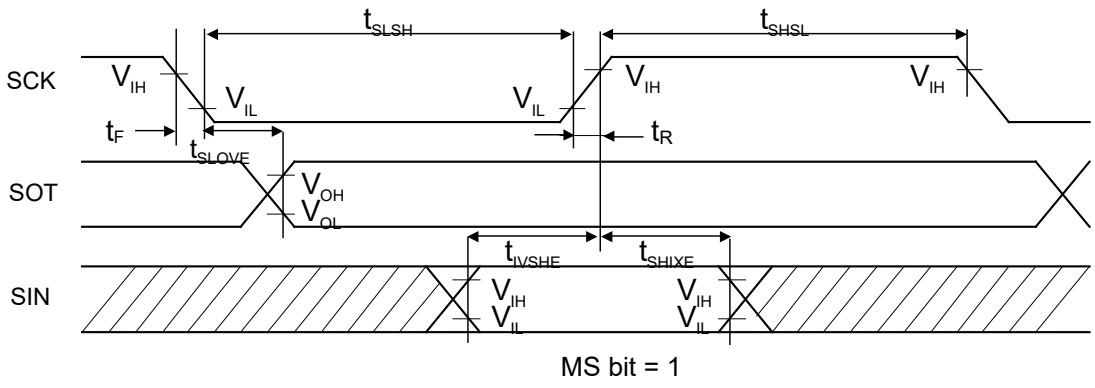
(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCKx	Internal shift clock operation	$4t_{CYCP}$	-	ns
SCK↓→SOT delay time	t_{SLOVI}	SCKx, SOTx		- 10	+ 10	ns
SIN→SCK↑ setup time	t_{IVSHI}	SCKx, SINx		14 12.5*	-	ns
SCK↑→SIN hold time	t_{SHIXI}	SCKx, SINx		5	-	ns
Serial clock L pulse width	t_{SLSH}	SCKx	External shift clock operation	$2t_{CYCP}$ - 5	-	ns
Serial clock H pulse width	t_{SHSL}	SCKx		t_{CYCP} + 10	-	ns
SCK↓→SOT delay time	t_{SLOVE}	SCKx, SOTx		-	15	ns
SIN→SCK↑ setup time	t_{IVSHE}	SCKx, SINx		5	-	ns
SCK↑→SIN hold time	t_{SHIXE}	SCKx, SINx		5	-	ns
SCK falling time	t_F	SCKx		-	5	ns
SCK rising time	t_R	SCKx		-	5	ns

Notes:

- *The above characteristics apply to CLK synchronous mode.*
- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *These characteristics only guarantee the following pins.*
  SIN6_0, SOT6_0, SCK6_0, SCS60_0
- *When the external load capacitance C_L = 30 pF. (For *, when C_L = 10 pF)*





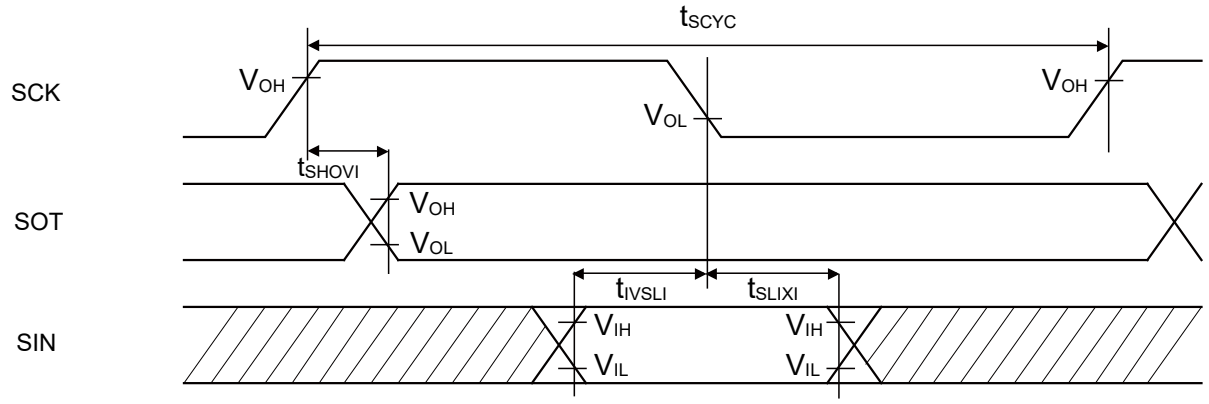
High-Speed Synchronous Serial (SPI = 0, SCINV = 1)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

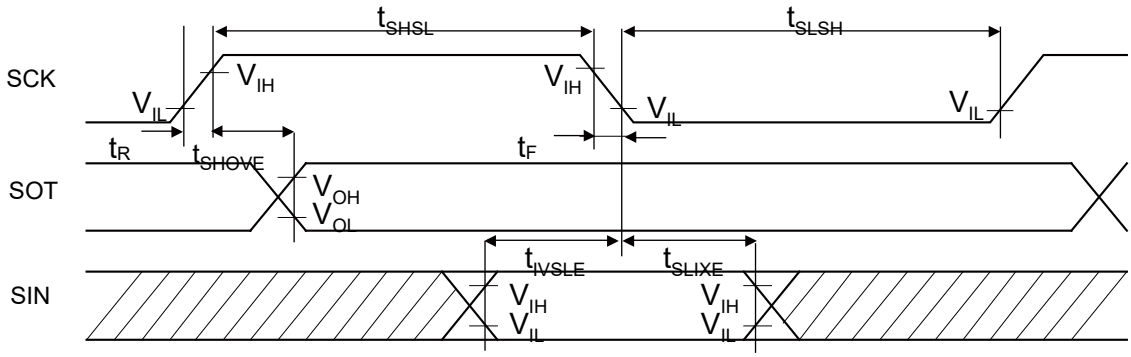
Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCKx	Internal shift clock operation	$4t_{CYCP}$	-	ns
SCK↑→SOT delay time	t_{SHOVI}	SCKx, SOTx		- 10	+ 10	ns
SIN→SCK↓ setup time	t_{IVSLI}	SCKx, SINx		14 12.5*	-	ns
SCK↓→SIN hold time	t_{SLIXI}	SCKx, SINx		5	-	ns
Serial clock L pulse width	t_{SLSH}	SCKx	External shift clock operation	$2t_{CYCP}$ - 5	-	ns
Serial clock H pulse width	t_{SHSL}	SCKx		t_{CYCP} + 10	-	ns
SCK↑→SOT delay time	t_{SHOVE}	SCKx, SOTx		-	15	ns
SIN→SCK↓ setup time	t_{IVSLE}	SCKx, SINx		5	-	ns
SCK↓→SIN hold time	t_{SLIXE}	SCKx, SINx		5	-	ns
SCK falling time	t_F	SCKx		-	5	ns
SCK rising time	t_R	SCKx		-	5	ns

Notes:

- *The above characteristics apply to CLK synchronous mode.*
- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *These characteristics only guarantee the following pins.*
  SIN6_0, SOT6_0, SCK6_0, SCS60_0
- *When the external load capacitance C_L = 30 pF. (For *, when C_L = 10 pF)*



MS bit = 0



MS bit = 1

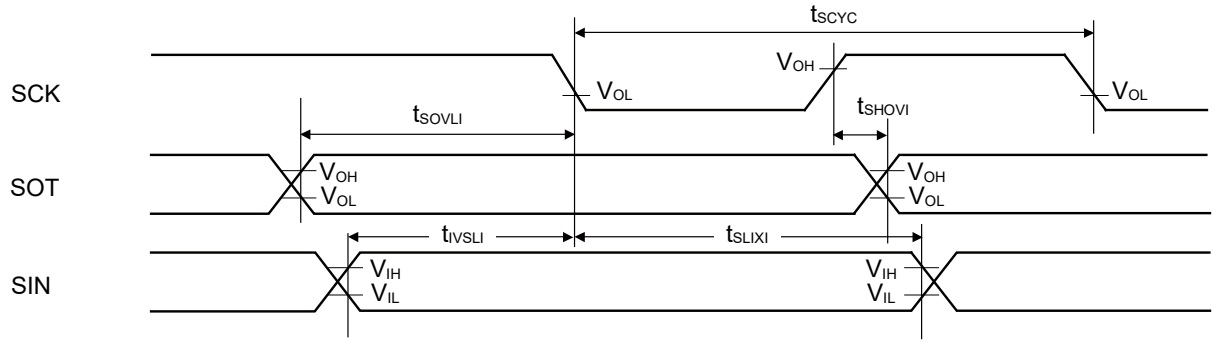
High-Speed Synchronous Serial (SPI = 1, SCINV = 0)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

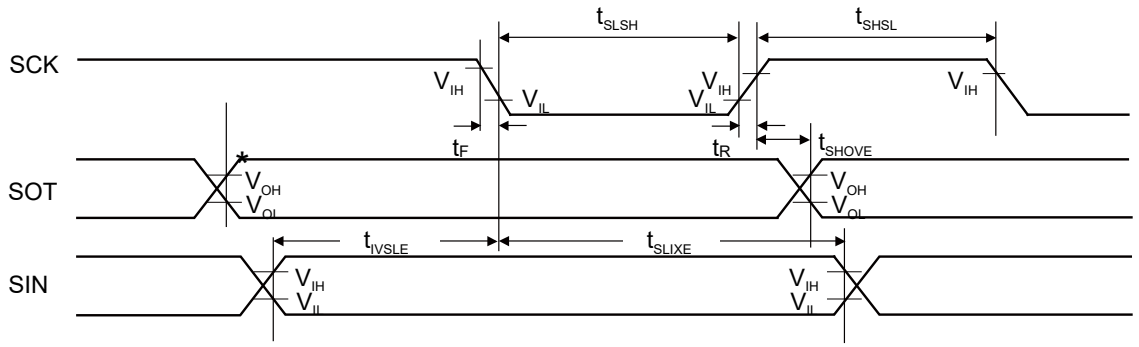
Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCKx	Internal shift clock operation	$4t_{CYCP}$	-	ns
SCK↑→SOT delay time	t_{SHOVI}	SCKx, SOTx		- 10	+ 10	ns
SIN→SCK↓ setup time	t_{IVSLI}	SCKx, SINx		14 12.5*	-	ns
SCK↓→SIN hold time	t_{SLIXI}	SCKx, SINx		5	-	ns
SOT→SCK↓ delay time	t_{SOVLI}	SCKx, SOTx		$2t_{CYCP}$ - 10	-	ns
Serial clock L pulse width	t_{SLSH}	SCKx	External shift clock operation	$2t_{CYCP}$ - 5	-	ns
Serial clock H pulse width	t_{SHSL}	SCKx		t_{CYCP} + 10	-	ns
SCK↑→SOT delay time	t_{SHOVE}	SCKx, SOTx		-	15	ns
SIN→SCK↓ setup time	t_{IVSLE}	SCKx, SINx		5	-	ns
SCK↓→SIN hold time	t_{SLIXE}	SCKx, SINx		5	-	ns
SCK falling time	t_F	SCKx		-	5	ns
SCK rising time	t_R	SCKx		-	5	ns

Notes:

- *The above characteristics apply to CLK synchronous mode.*
- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *These characteristics only guarantee the following pins.*
  SIN6_0, SOT6_0, SCK6_0, SCS60_0
- *When the external load capacitance C_L = 30 pF. (For *, when C_L = 10 pF)*



MS bit = 0



MS bit = 1

*: Changes when writing to TDR register

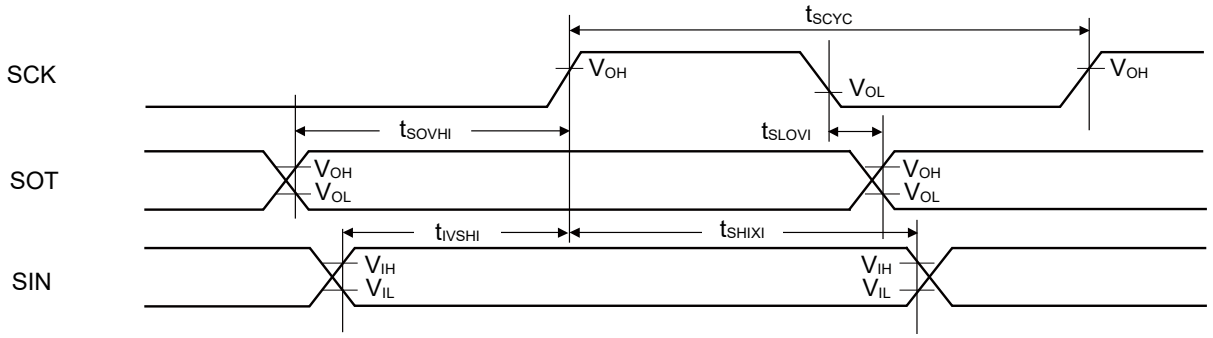
High-Speed Synchronous Serial (SPI = 1, SCINV = 1)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

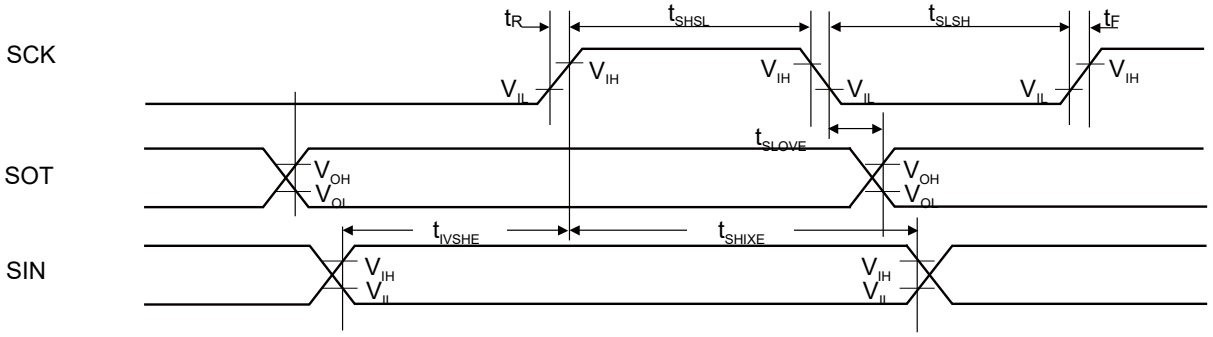
Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCKx	Internal shift clock operation	$4t_{CYCP}$	-	ns
SCK↓→SOT delay time	t_{SLOVI}	SCKx, SOTx		- 10	+ 10	ns
SIN→SCK↑ setup time	t_{IVSHI}	SCKx, SINx		14	-	ns
				12.5*		
SCK↑→SIN hold time	t_{SHIXI}	SCKx, SINx		5	-	ns
SOT→SCK↑ delay time	t_{SOVHI}	SCKx, SOTx		$2t_{CYCP}$ - 10	-	ns
Serial clock L pulse width	t_{SLSH}	SCKx	External shift clock operation	$2t_{CYCP}$ - 5	-	ns
Serial clock H pulse width	t_{SHSL}	SCKx		t_{CYCP} + 10	-	ns
SCK↓→SOT delay time	t_{SLOVE}	SCKx, SOTx		-	15	ns
SIN→SCK↑ setup time	t_{IVSHE}	SCKx, SINx		5	-	ns
SCK↑→SIN hold time	t_{SHIXE}	SCKx, SINx		5	-	ns
SCK falling time	t_F	SCKx		-	5	ns
SCK rising time	t_R	SCKx		-	5	ns

Notes:

- *The above characteristics apply to CLK synchronous mode.*
- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *These characteristics only guarantee the following pins.*
  SIN6_0, SOT6_0, SCK6_0, SCS60_0
- *When the external load capacitance C_L = 30 pF. (For *, when C_L = 10 pF)*



MS bit = 0



MS bit = 1

When Using High-Speed Synchronous Serial Chip Select (SCINV = 0, CSLVL=1)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
SCS↓→SCK↓ setup time	t_{CSSI}	Internal shift clock operation	(*1)-20	(*1)+0	ns
SCK↑→SCS↑ hold time	t_{CSHI}		(*2)+0	(*2)+20	ns
SCS deselect time	t_{CSDI}		(*3)-20+5t_{CYCP}	(*3)+20+5t_{CYCP}	ns
SCS↓→SCK↓ setup time	t_{CSSE}	External shift clock operation	3t_{CYCP}+15	-	ns
SCK↑→SCS↑ hold time	t_{CSHE}		0	-	ns
SCS deselect time	t_{CSDE}		3t_{CYCP}+15	-	ns
SCS↓→SOT delay time	t_{DSE}		-	25	ns
SCS↑→SOT delay time	t_{DEE}		0	-	ns

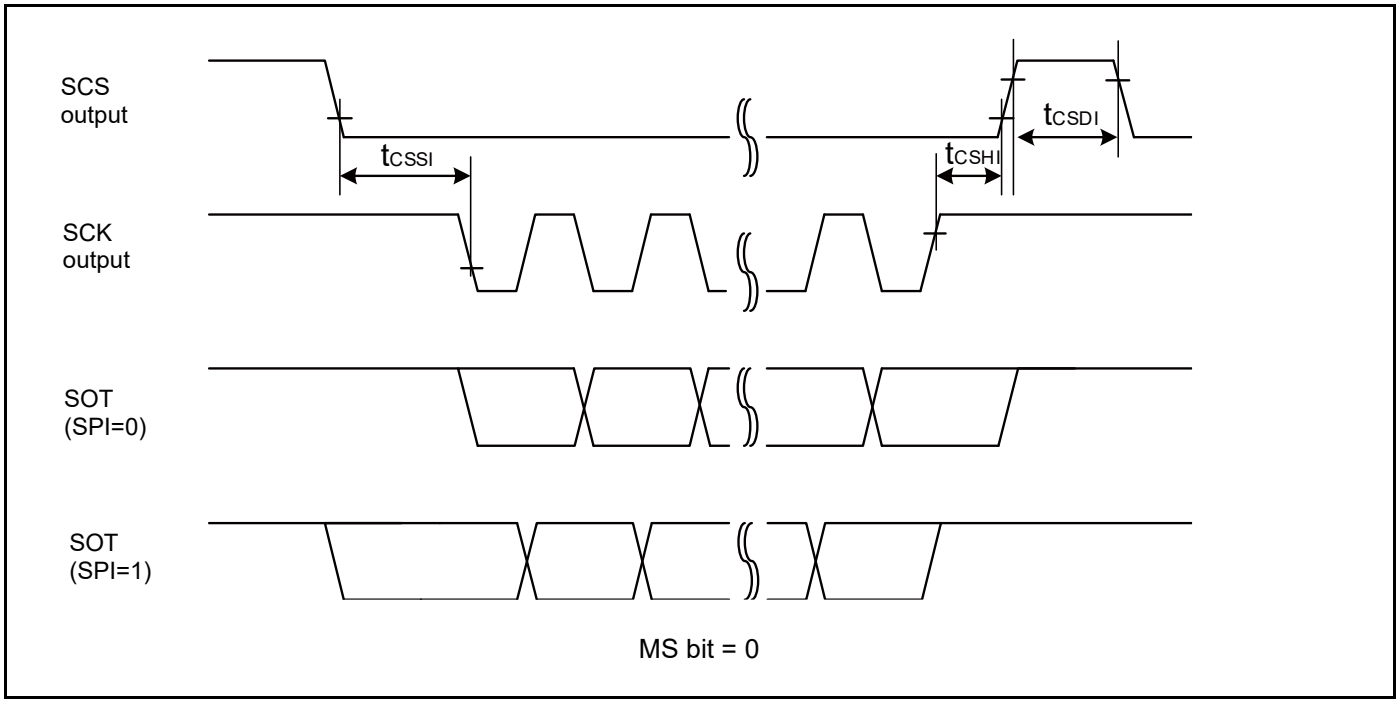
(*1): CSSU bit value×serial chip select timing operating clock cycle [ns]

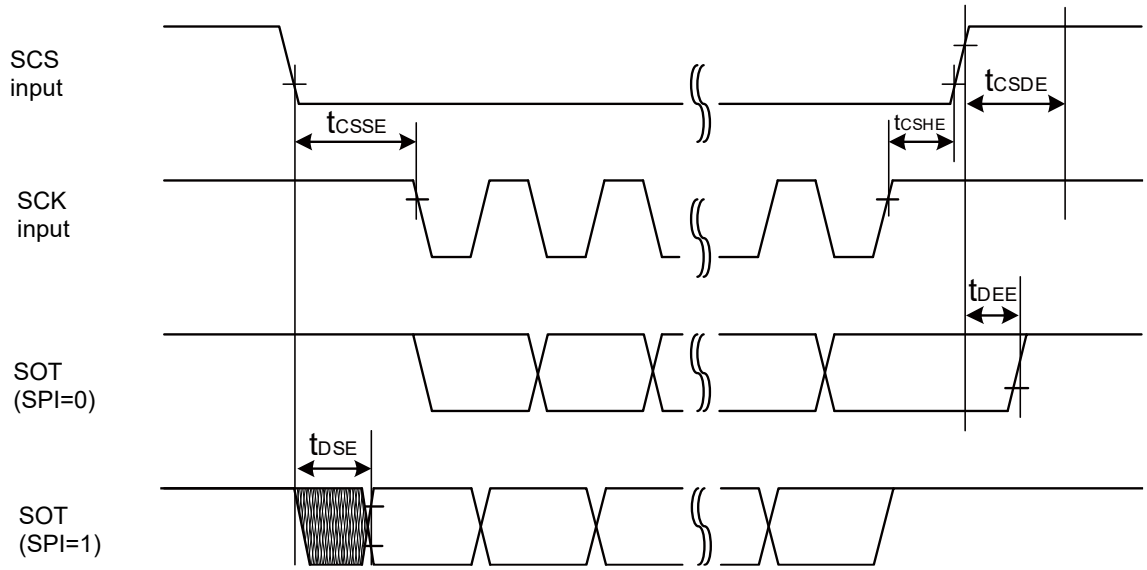
(*2): CSHD bit value×serial chip select timing operating clock cycle [ns]

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

Notes:

- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *About CSSU, CSHD, CSDS, serial chip select timing operating clock, see FM4 Family Peripheral Manual Main part (002-04856).*
- *When the external load capacitance C_L = 30 pF.*





When Using High-Speed Synchronous Serial Chip Select (SCINV = 1, CSLVL=1)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
SCS↓→SCK↑ setup time	t_{CSSI}	Internal shift clock operation	(*1)-20	(*1)+0	ns
SCK↓→SCS↑ hold time	t_{CSHI}		(*2)+0	(*2)+20	ns
SCS deselect time	t_{CSDI}		(*3)-20+5t_{CYCP}	(*3)+20+5t_{CYCP}	ns
SCS↓→SCK↑ setup time	t_{CSSE}	External shift clock operation	3t_{CYCP}+15	-	ns
SCK↓→SCS↑ hold time	t_{CSHE}		0	-	ns
SCS deselect time	t_{CSDE}		3t_{CYCP}+15	-	ns
SCS↓→SOT delay time	t_{DSE}		-	25	ns
SCS↑→SOT delay time	t_{DEE}		0	-	ns

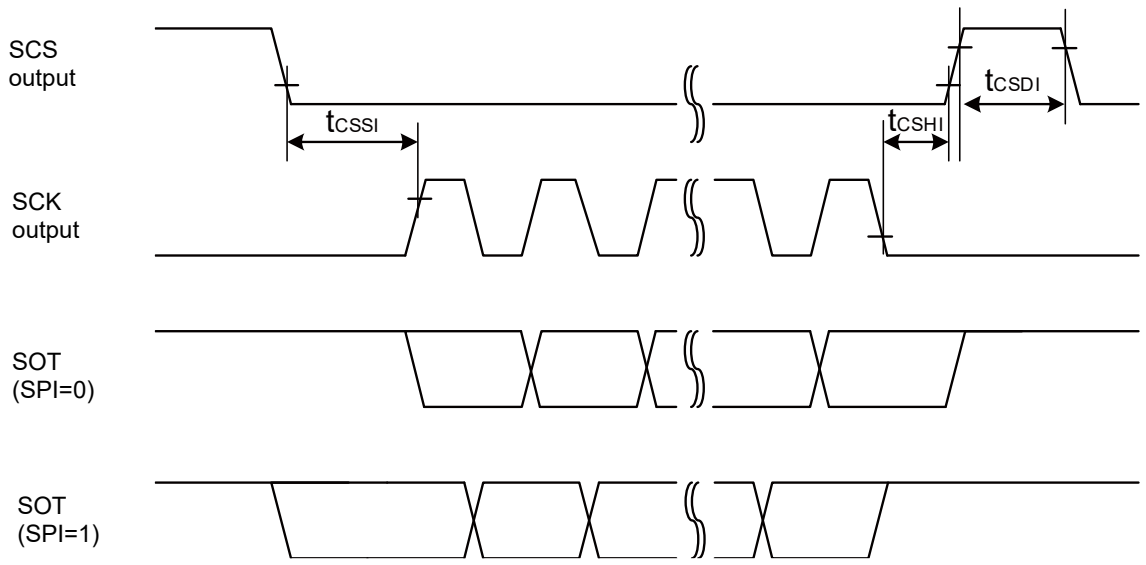
(*1): CSSU bit value×serial chip select timing operating clock cycle [ns]

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

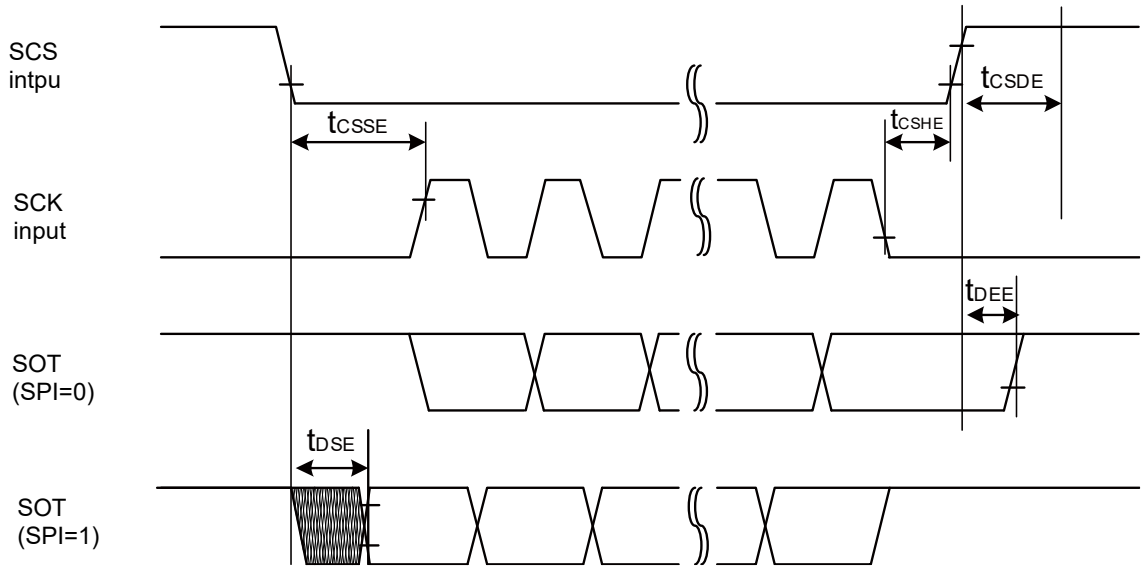
(*3): CSDS bit value×serial chip select timing operating clock cycle [ns]

Notes:

- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *About CSSU, CSHD, CSDS, serial chip select timing operating clock, see FM4 Family Peripheral Manual Main part (002-04856).*
- *When the external load capacitance C_L = 30 pF.*



MS bit = 0



MS bit = 1

When Using High-Speed Synchronous Serial Chip Select (SCINV = 0, CSLVL=0)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
SCS↑→SCK↓ setup time	t_{CSSI}	Internal shift clock operation	(*1)-20	(*1)+0	ns
SCK↑→SCS↓ hold time	t_{CSHI}		(*2)+0	(*2)+20	ns
SCS deselect time	t_{CSDI}		(*3)-20+5t_{CYCP}	(*3)+20+5t_{CYCP}	ns
SCS↑→SCK↓ setup time	t_{CSSE}	External shift clock operation	3t_{CYCP}+15	-	ns
SCK↑→SCS↓ hold time	t_{CSHE}		0	-	ns
SCS deselect time	t_{CSDE}		3t_{CYCP}+15	-	ns
SCS↑→SOT delay time	t_{DSE}		-	25	ns
SCS↓→SOT delay time	t_{DEE}		0	-	ns

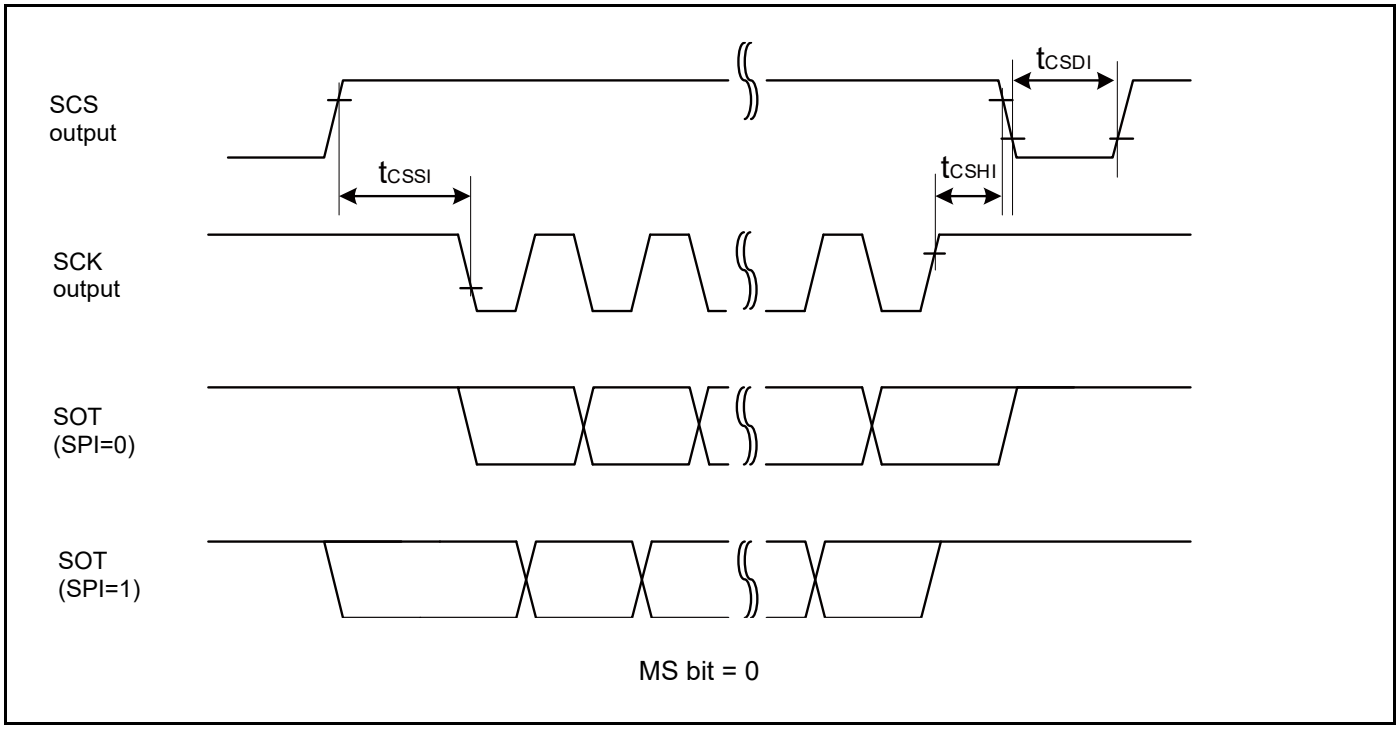
(*1): CSSU bit value×serial chip select timing operating clock cycle [ns]

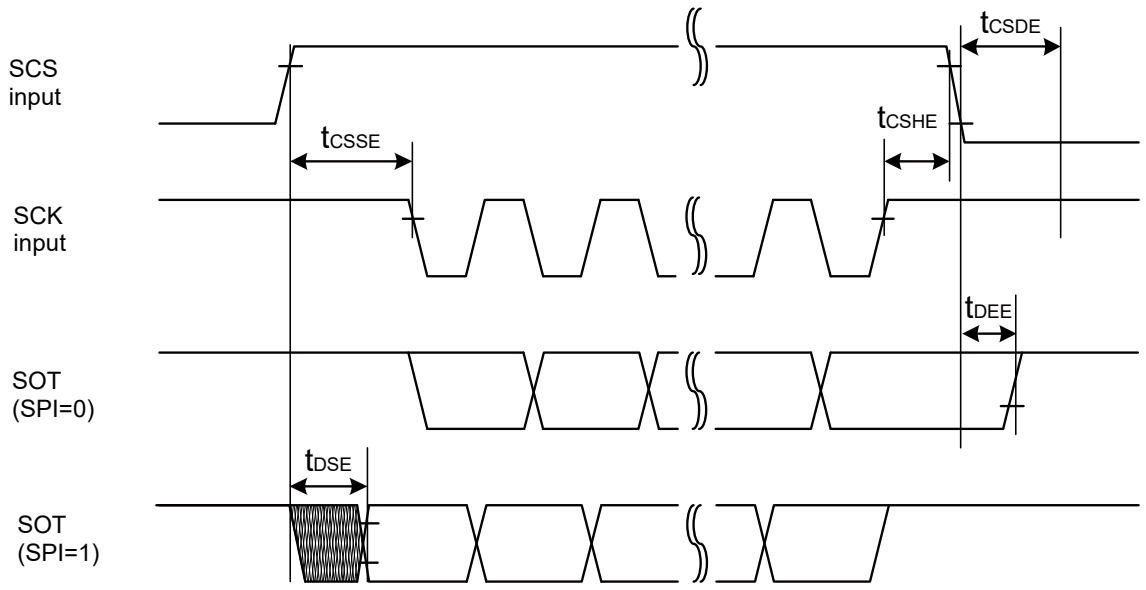
(*2): CSHD bit value×serial chip select timing operating clock cycle [ns]

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

Notes:

- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *About CSSU, CSHD, CSDS, serial chip select timing operating clock, see FM4 Family Peripheral Manual Main part (002-04856).*
- *When the external load capacitance C_L = 30 pF.*





When Using Synchronous Serial Chip Select (SCINV = 1, CSLVL=0)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
SCS↑→SCK↑ setup time	t_{CSSI}	Internal shift clock operation	(*1)-20	(*1)+0	ns
SCK↑→SCS↓ hold time	t_{CSHI}		(*2)+0	(*2)+20	ns
SCS deselect time	t_{CSDI}		(*3)-20+5t_{CYCP}	(*3)+20+5t_{CYCP}	ns
SCS↑→SCK↑ setup time	t_{CSSE}	External shift clock operation	3t_{CYCP}+15	-	ns
SCK↓→SCS↓ hold time	t_{CSHE}		0	-	ns
SCS deselect time	t_{CSDE}		3t_{CYCP}+15	-	ns
SCS↑→SOT delay time	t_{DSE}		-	40	ns
SCS↓→SOT delay time	t_{DEE}		0	-	ns

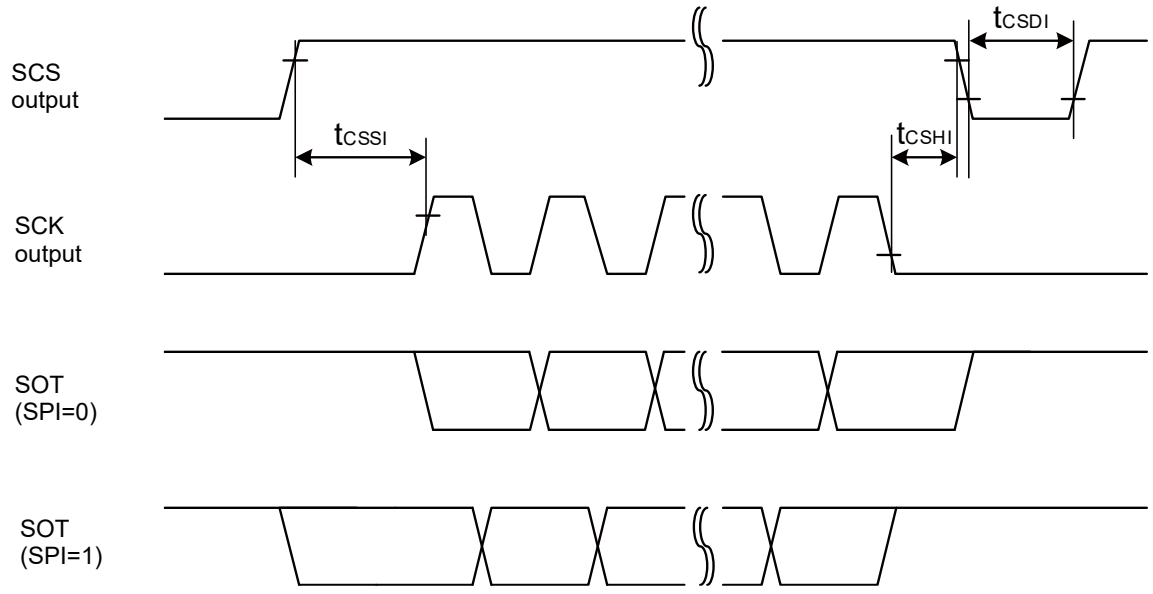
(*1): CSSU bit value×serial chip select timing operating clock cycle [ns]

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

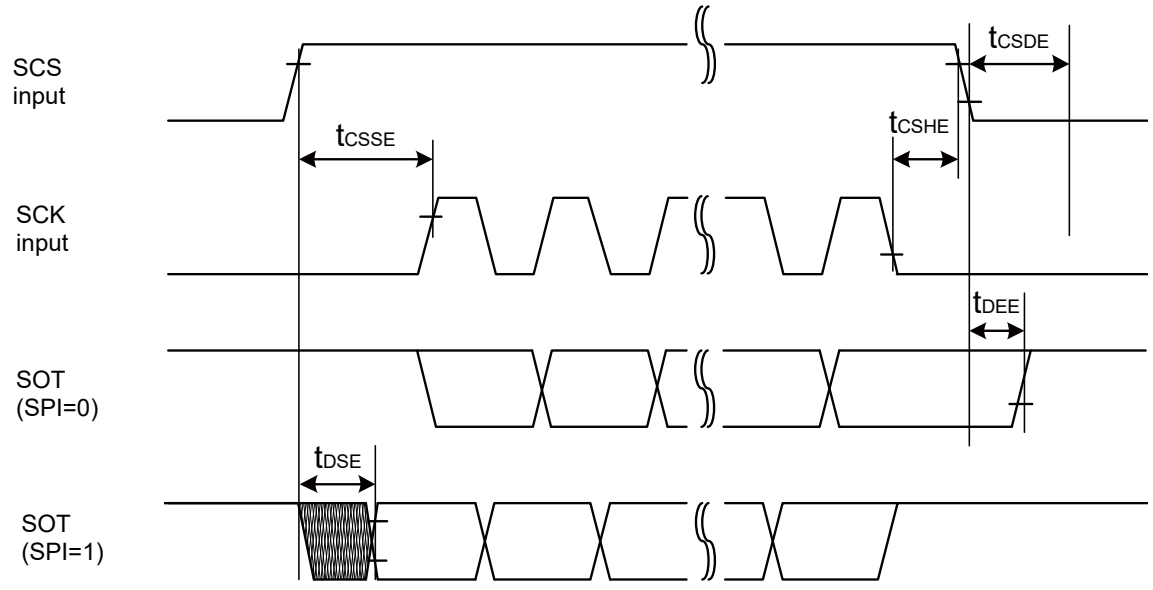
(*3): CSDS bit value×serial chip select timing operating clock cycle [ns]

Notes:

- *t_{CYCP} indicates the APB bus clock cycle time.*
  About the APB bus number which multi-function serial is connected to, see 8. Block Diagram in this data sheet.
- *About CSSU, CSHD, CSDS, serial chip select timing operating clock, see FM4 Family Peripheral Manual Main part (002-04856).*
- *When the external load capacitance C_L = 30 pF.*



MS bit = 0



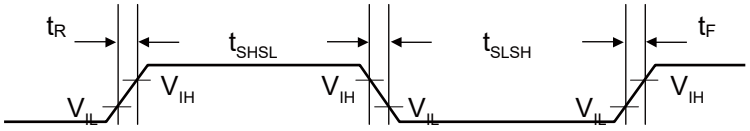
MS bit = 1

External Clock (EXT = 1): when in Asynchronous Mode Only

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

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

SCK



12.4.13 External Input Timing

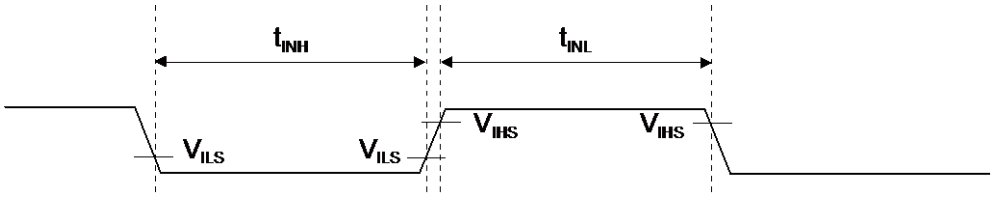
(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{INH}, t_{INL}	ADTG	-	$2t_{CYCP}$*1	-	ns	A/D converter trigger input
		FRCK0					Free-run timer input clock
		IC0x					Input capture
		DTTI0X	-	$2t_{CYCP}$*1	-	ns	Waveform generator
		INTxx, NMIX	-	$2t_{CYCP}$ + 100(*1)	-	ns	External interrupt, NMI
				500(*2)	-	ns	
		WKUPx	-	500(*3)	-	ns	Deep standby wake up

(*1): t_{CYCP} indicates the APB bus clock cycle time except stop when in Stop mode, in timer mode. About the APB bus number which the Multi-function Timer and External interrupt are connected to, see 8. Block Diagram in this data sheet.

(*2): When in Stop mode, in timer mode.

(*3): When in deep standby RTC mode, in deep standby Stop mode.

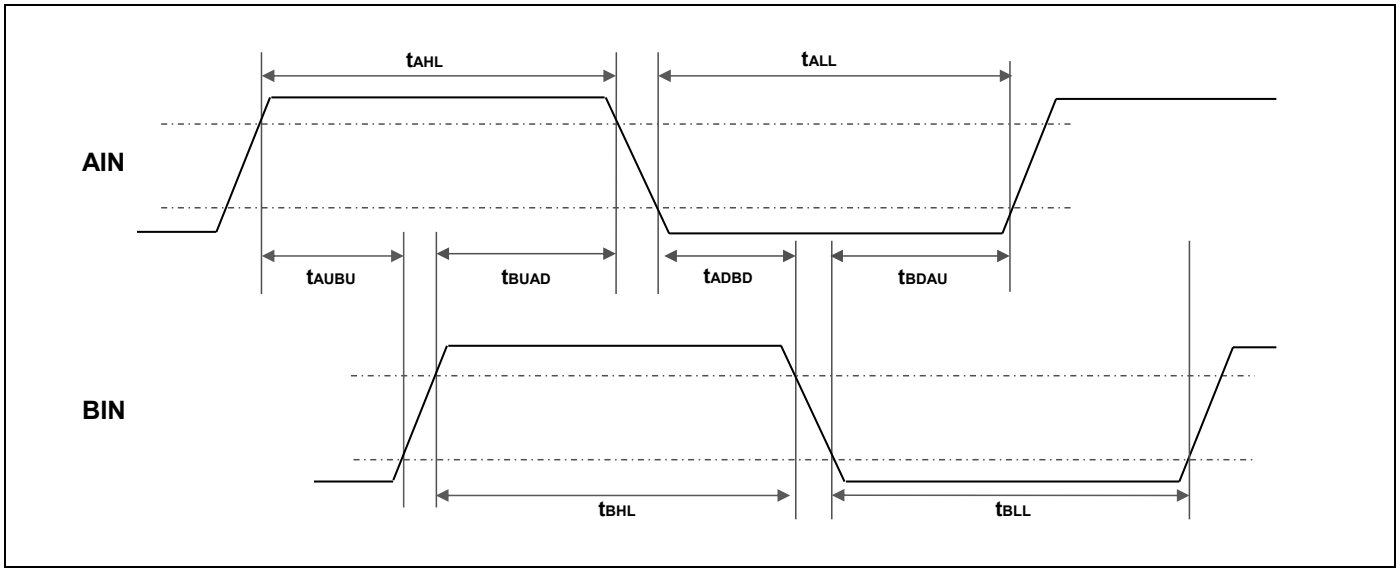


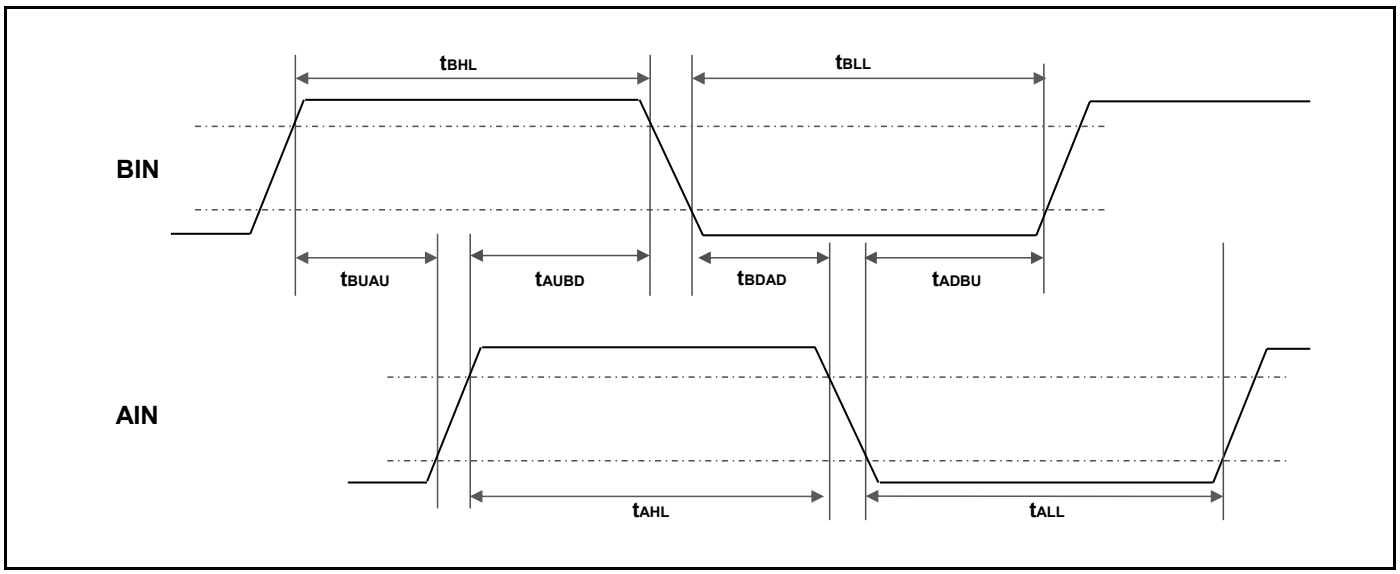
12.4.14 Quadrature Position/Revolution Counter Timing

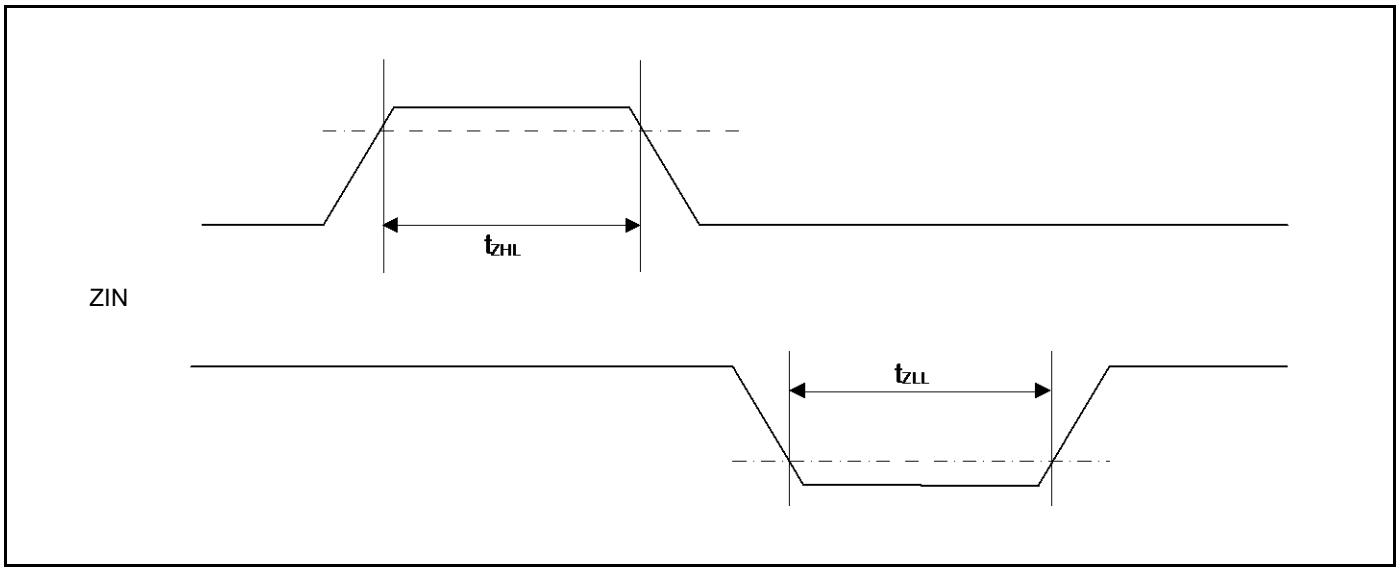
(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

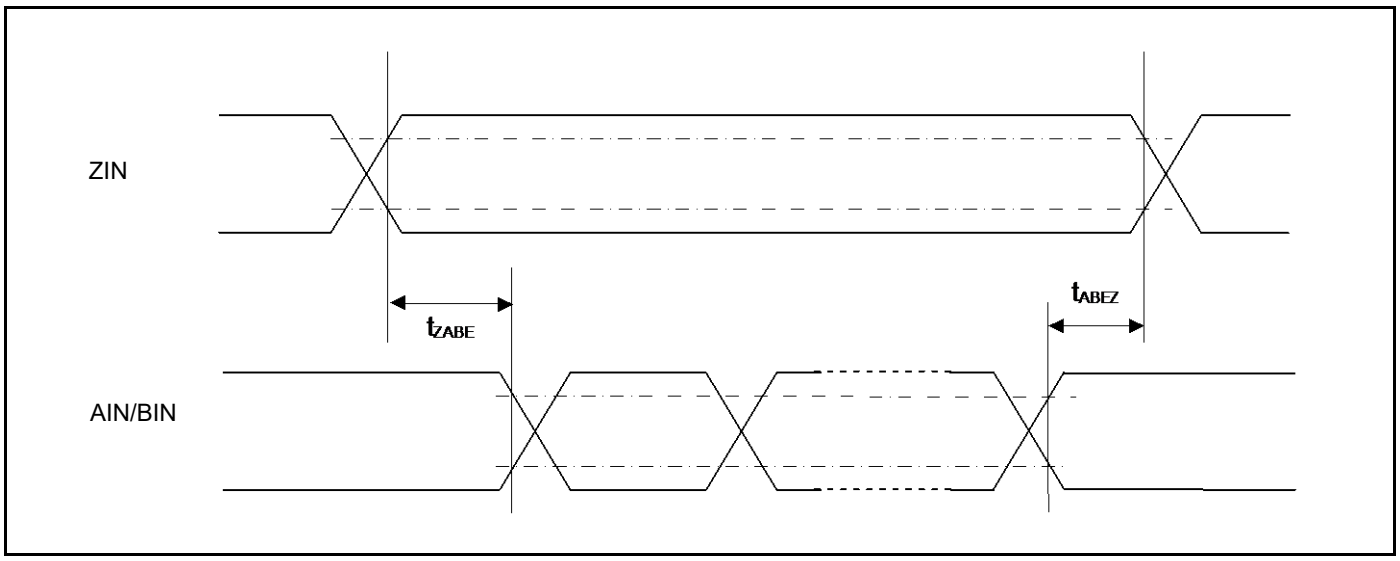
Parameter	Symbol	Conditions	Value		Unit
			Min	Max	
AIN pin H width	t_{AHL}	-	$2t_{CYCP}$*	-	ns
AIN pin L width	t_{ALL}	-			
BIN pin H width	t_{BHL}	-			
BIN pin L width	t_{BLL}	-			
BIN rising time from AIN pin H level	t_{AUBU}	PC_Mode2 or PC_Mode3			
AIN falling time from BIN pin H level	t_{BUAD}	PC_Mode2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

*: t_{CYCP} indicates the APB bus clock cycle time except when in Stop mode, in timer mode.
About the APB bus number which Quadrature Position/Revolution Counter is connected to, see 8. Block Diagram in this data sheet.




BIN
AIN
tBHL
tBLL
tBUAU
tAUBD
tBDAD
tADBU
tAHL
tALL


ZIN
tZHL
tZLL


ZIN
AIN/BIN
tZABE
tABEZ

12.4.15 I²C Timing

Standard Mode, Fast Mode

(V_{CC} = 2.7V to 3.6, V_{SS} = 0V)

Parameter	Symbol	Conditions	Standard Mode		Fast Mode		Unit	Remarks
			Min	Max	Min	Max		
SCL clock frequency	f_{SCL}	C_L = 30 pF, R = (Vp/I_{OL})*1	0	100	0	400	kHz	
(Repeated) START condition hold time SDA ↓ → SCL ↓	t_{HDSTA}		4.0	-	0.6	-	µs	
SCL clock L width	t_{LOW}		4.7	-	1.3	-	µs	
SCL clock H width	t_{HIGH}		4.0	-	0.6	-	µs	
(Repeated) Start condition setup time SCL ↑ → SDA ↓	t_{SUSTA}		4.7	-	0.6	-	µs	
Data hold time SCL ↓ → SDA ↓ ↑	t_{HDDAT}		0	3.45*2	0	0.9*3	µs	
Data setup time SDA ↓ ↑ → SCL ↑	t_{SUDAT}		250	-	100	-	ns	
STOP condition setup time SCL ↑ → SDA ↑	t_{SUSTO}		4.0	-	0.6	-	µs	
Bus free time between Stop condition and Start condition	t_{BUF}		4.7	-	1.3	-	µs	
Noise filter	t_{SP}	2 MHz ≤ t_{CYCP} < 40 MHz	2 t_{CYCP}*4	-	2 t_{CYCP}*4	-	ns	*5
		40 MHz ≤ t_{CYCP} < 60 MHz	4 t_{CYCP}*4	-	4 t_{CYCP}*4	-	ns	
		60 MHz ≤ t_{CYCP} < 80 MHz	6 t_{CYCP}*4	-	6 t_{CYCP}*4	-	ns	
		80 MHz ≤ t_{CYCP} ≤ 100 MHz	8 t_{CYCP}*4	-	8 t_{CYCP}*4	-	ns	

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

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

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

*4: t_{CYCP} is the APB bus clock cycle time.

About the APB bus number that I²C is connected to, see 8. Block Diagram in this data sheet.

When the standard mode is used, please set to 2 MHz or more peripheral bus clock.

When fast mode is used, please set to 8MHz or more peripheral bus clock.

*5: The noise filter time can be changed by register settings.

Change the number of the noise filter steps according to APB bus clock frequency.

Fast Mode Plus (Fm+)

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Conditions	Fast Mode Plus (Fm+)*6		Unit	Remarks
			Min	Max		
SCL clock frequency	f_{SCL}	C_L = 30 pF, R = (V_p/I_{OL})*1	0	1000	kHz	
(Repeated) Start condition hold time SDA ↓ → SCL ↓	t_{HDSTA}		0.26	-	µs	
SCL clock L width	t_{LOW}		0.5	-	µs	
SCL clock H width	t_{HIGH}		0.26	-	µs	
(Repeated) Start condition setup time SCL ↑ → SDA ↓	t_{SUSTA}		0.26	-	µs	
Data hold time SCL ↓ → SDA ↓ ↑	t_{HDDAT}		0	0.45*2, *3	µs	
Data setup time SDA ↓ ↑ → SCL ↑	t_{SUDAT}		50	-	ns	
Stop condition setup time SCL ↑ → SDA ↑	t_{SUSTO}		0.26	-	µs	
Bus free time between Stop condition and Start condition	t_{BUF}		0.5	-	µs	
Noise filter	t_{SP}	60 MHz ≤ t_{CYCP} < 80 MHz	6 t_{CYCP}*4	-	ns	*5
		80 MHz ≤ t_{CYCP} ≤100 MHz	8 t_{CYCP}*4	-	ns	

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

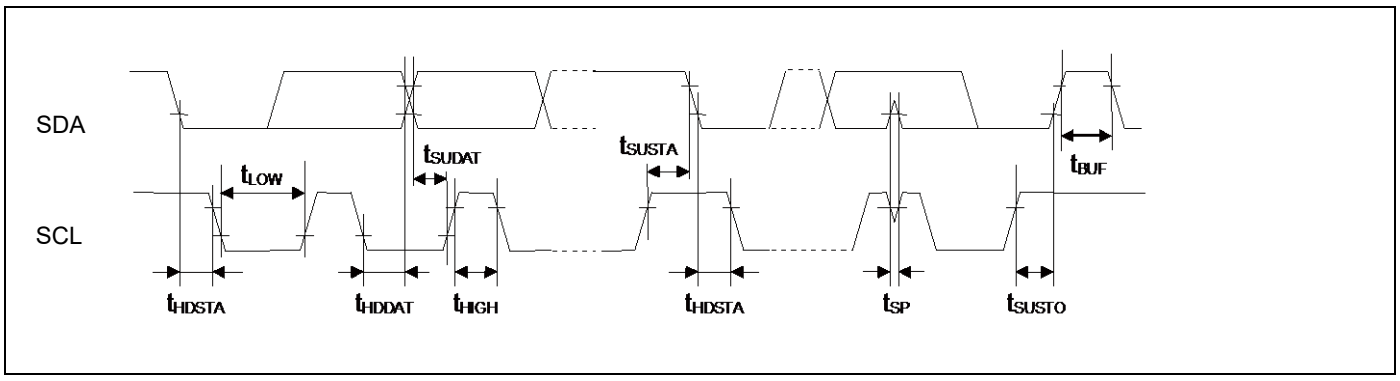
*2: The maximum t_{HDDAT} must satisfy that it does not extend at least L period (t_{LOW}) of device's SCL signal.

*3: A Fast mode I^2C bus device can be used on a Standard mode I^2C bus system as long as the device satisfies the requirement of "t_{SUDAT} ≥ 250 ns".

*4: t_{CYCP} is the APB bus clock cycle time.
About the APB bus number that I^2C is connected to, see 8. Block Diagram in this data sheet.
To use fast mode plus (Fm+), set the peripheral bus clock at 64 MHz or more.

*5: The noise filter time can be changed by register settings.
Change the number of the noise filter steps according to APB bus clock frequency.

*6: When using fast mode plus (Fm+), set the I/O pin to the mode corresponding to I^2C Fm+ in the EPFR register. See Chapter 12 : I/O Port in "FM4 Family Peripheral Manual Main part (002-04856)" for the details.



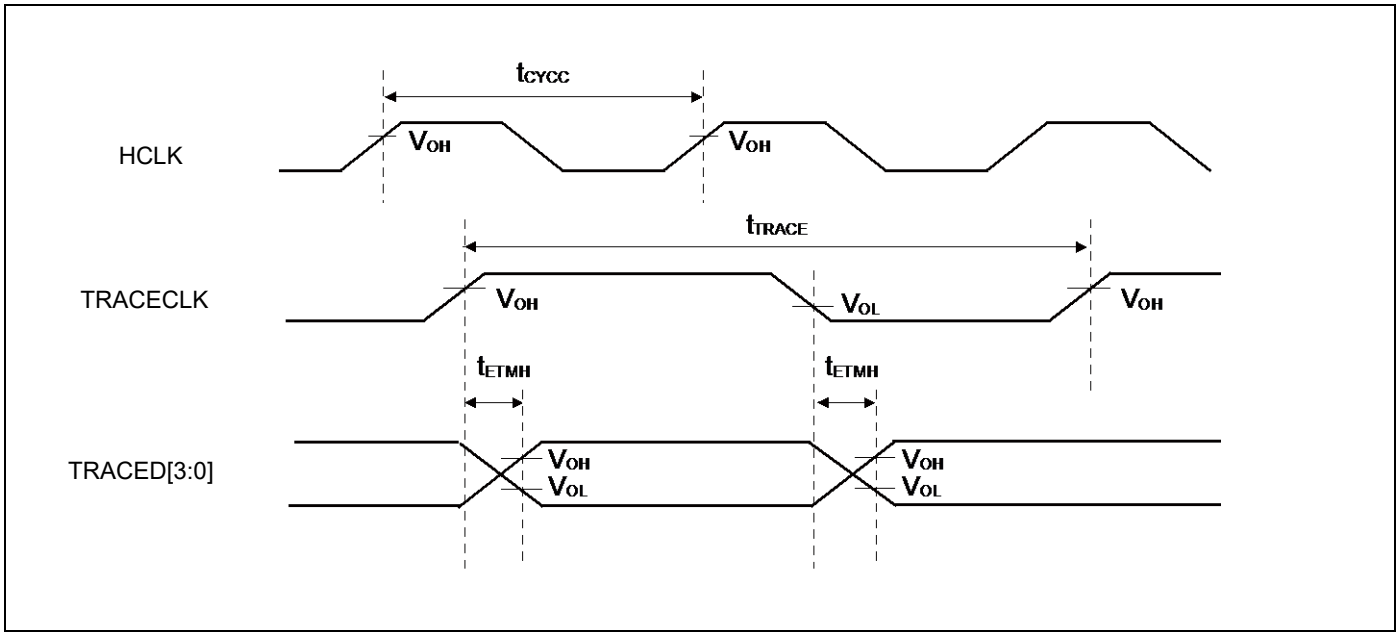
12.4.16 ETM Timing

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Data hold	t_{ETMH}	TRACECLK, TRACED[3:0]	-	2	15	ns	
TRACECLK frequency	$1/t_{TRACE}$	TRACECLK	-		32	MHz	
TRACECLK clock cycle	t_{TRACE}		-	31.25	-	ns	

Note:

– *When the external load capacitance C_L= 30 pF.*



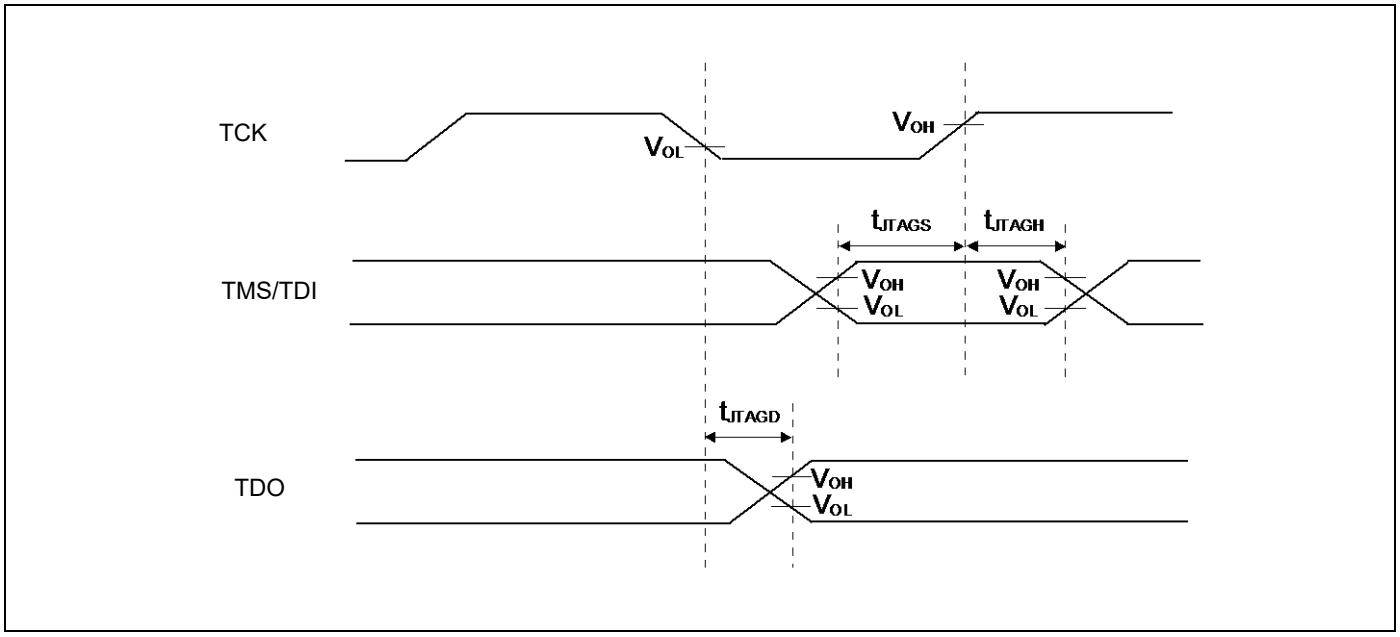
12.4.17 JTAG Timing

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
TMS, TDI setup time	t_{JTAGS}	TCK, TMS, TDI	-	15	-	ns	
TMS, TDI hold time	t_{JTAGH}	TCK, TMS, TDI	-	15	-	ns	
TDO delay time	t_{JTAGD}	TCK, TDO	-	-	45	ns	

Note:

– *When the external load capacitance C_L= 30 pF.*



12.4.18 I²S Timing

Master Mode Timing

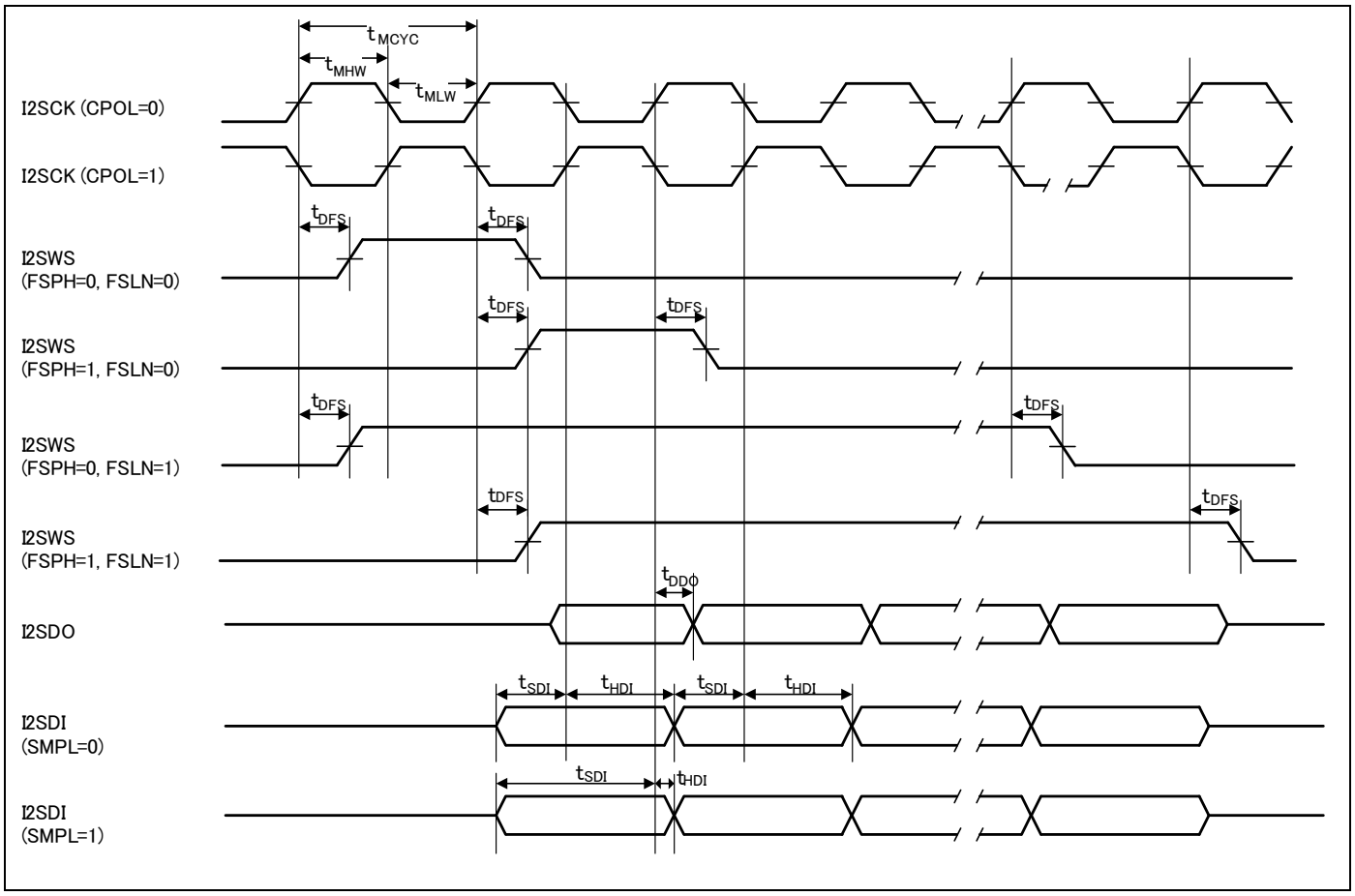
(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Output frequency	t_{MCYC}	I2SCK	-	-	12.288	MHz	
Output clock pulse width	t_{MHW}	I2SCK	-	45	55	%	
	t_{MLW}			45	55	%	
I2SCK→I2SWS delay time	t_{DFS}	I2SCK, I2SWS	-	0	24.0	ns	
I2SCK→I2SDO delay time*	t_{DDO}	I2SCK, I2SDO	-	0	24.0	ns	
I2SDI→I2SCK setup time	t_{HSDI}	I2SCK, I2SDI	-	25.0	-	ns	
I2SDI→I2SCK hold time	t_{HDI}		-	0	-	ns	
Input signal rising time	t_{RI}	I2SDI	-	-	5	ns	
Input signal falling time	t_{FI}		-	-	5	ns	

*: Except for the first bit of transmission frame

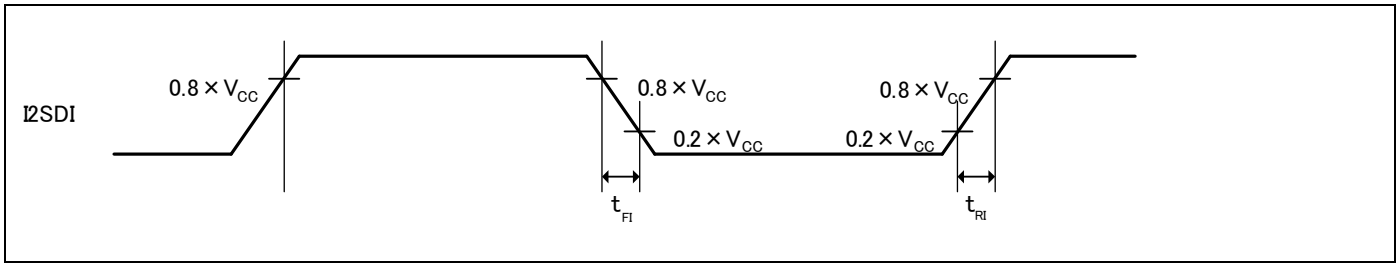
Notes:

- *When the external load capacitance C_L = 20 pF*
- *When I2SWS=48 kHz, I2MCLK=256 × I2SWS*
  Frame synchronization signal (I2SWS) is settable to 48 kHz, 32 kHz, 16 kHz.
  See Chapter 7-2: I²S(Inter-IC Sound bus) Interface in FM4 Family Peripheral Manual Communication part (002-04862) for the details.



Note:

– *See Chapter 7-2: I²S(Inter-IC Sound bus)Interface in FM4 Family Peripheral Manual Communication part (002-04862) for the details of CPOL, FSPH, FSLIN, SMPL .*



Slave Mode Timing

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

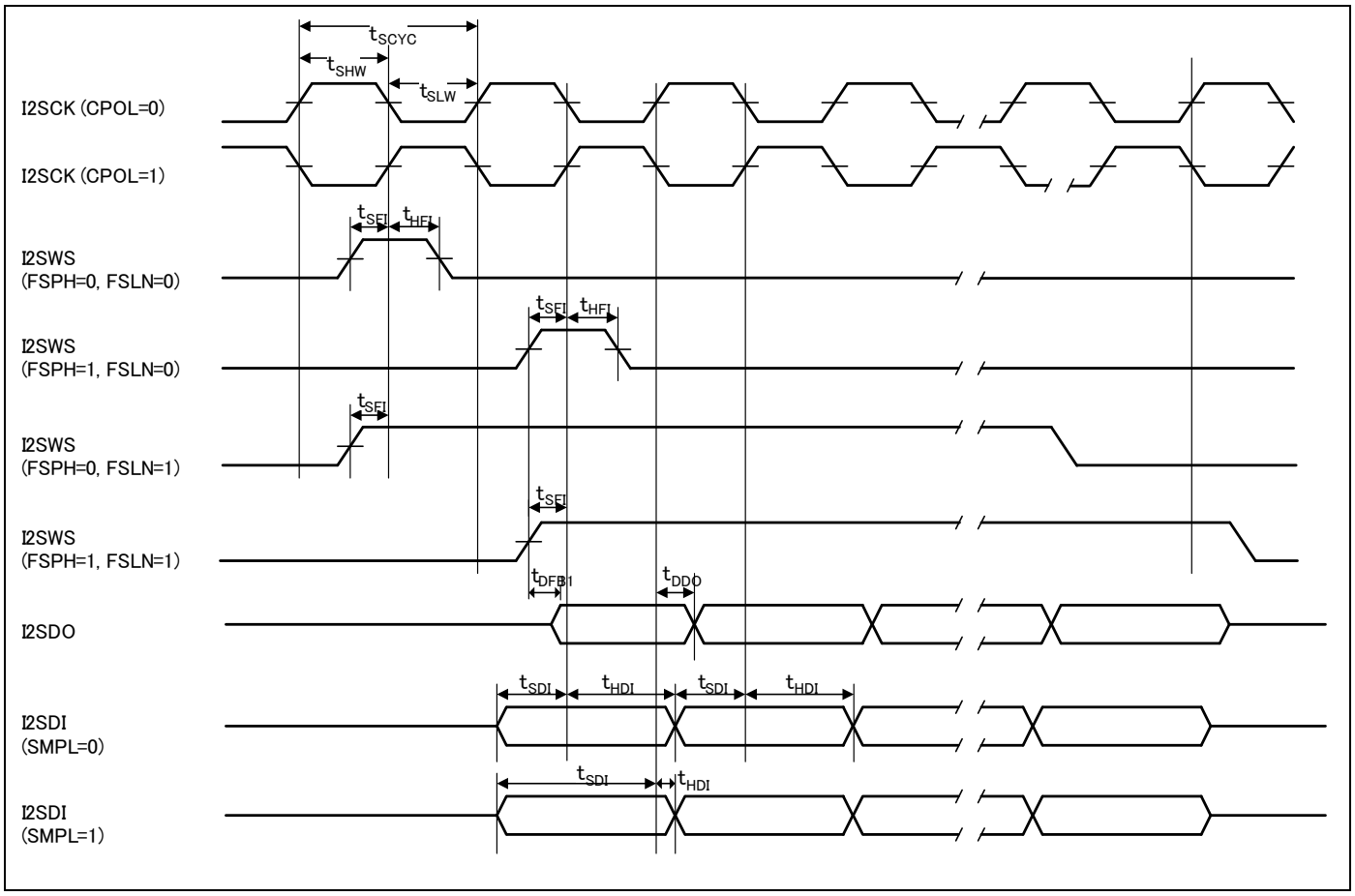
Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Input frequency	t_{SCYC}	I2SCK	-	-	12.288	MHz	
Input clock pulse width	t_{SHW}	I2SCK	-	45	55	%	
	t_{SLW}			45	55	%	
I2SWS→I2SCK Setup time	t_{SFI}	I2SCK, I2SWS	-	8	-	ns	
I2SWS→I2SCK Hold time	t_{HFI}	I2SCK, I2SWS	-	0	-	ns	
I2SCK↑→I2SDO Delay time*1	t_{DDO}	I2SCK, I2SDO	-	0	32	ns	
I2SCK↑→I2SDO Delay Time*2	t_{DFB1}		-	0	32	ns	
I2SDI→I2SCK↓ Setup time	t_{SDI}	I2SCK, I2SDI	-	8	-	ns	
I2SDI→I2SCK↓ Hold time	t_{HDI}		-	0	-	ns	
Input signal rising time	t_{RI}	I2SCK, I2SWS,I2SDI	-	-	5	ns	
Input signal falling time	t_{FI}		-	-	5	ns	

*1: Except for the first bit of transmission frame

*2: When FSPH register 1.

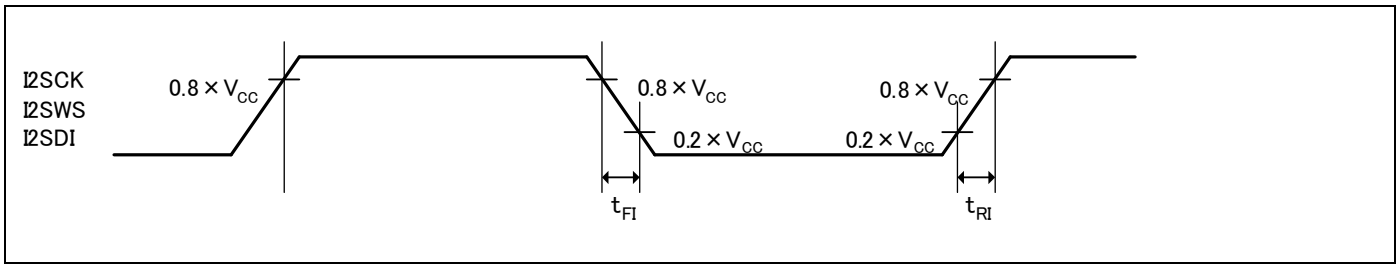
Notes:

- *When the external load capacitance C_L = 20 pF*
- *When I2SWS=48 kHz, I2MCLK=256 × I2SWS*
  Frame synchronization signal (I2SWS) is settable to 48 kHz, 32 kHz, 16 kHz.
  See Chapter 7-2: I^2S(Inter-IC Sound bus)Interface in FM4 Family Peripheral Manual Communication part (002-04862) for the details.



Notes:

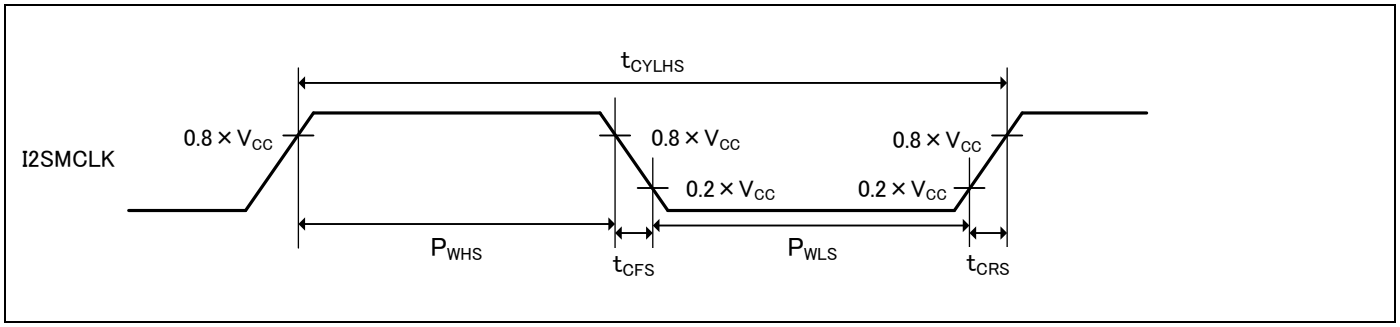
- *See Chapter 7-2: I²S(Inter-IC Sound bus)Interface in FM4 Family Peripheral Manual Communication part (002-04862) for the details of FSPH, FSLN, SMPL*
- *I2SCK input is selectable polarity by CPOL bit of CNTREG register*



▪ I2SMCLK Input Characteristics

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Input frequency	f_{CHS}	I2SCK	-	-	25	MHz	
Input clock cycle	t_{CYLHS}	-	-	40	-	ns	
Input clock pulse width	-	-	P_{WHS}/t_{CYLHS} P_{WLS}/t_{CYLHS}	45	55	%	When using external clock
Input clock rising time and falling time	t_{CFS} t_{CRS}	-	-	-	5	ns	When using external clock



▪ I2SMCLK Output Characteristics

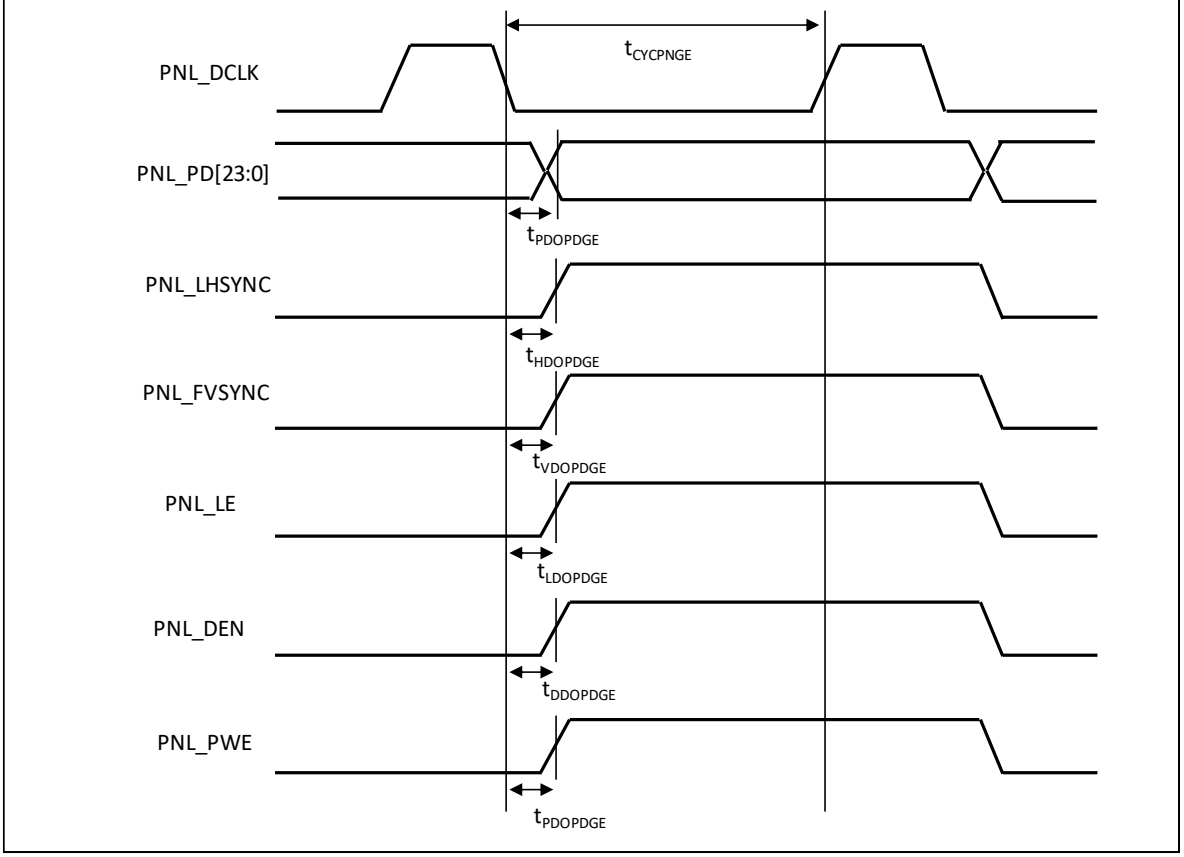
(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit	Remarks
				Min	Max		
Input frequency	f_{CHS}	I2SCK	-	-	12.288	MHz	

12.4.19 GDC: Panel Output Timing

(V_{CC} = 3.0V to 3.6V, V_{SS} = 0V)

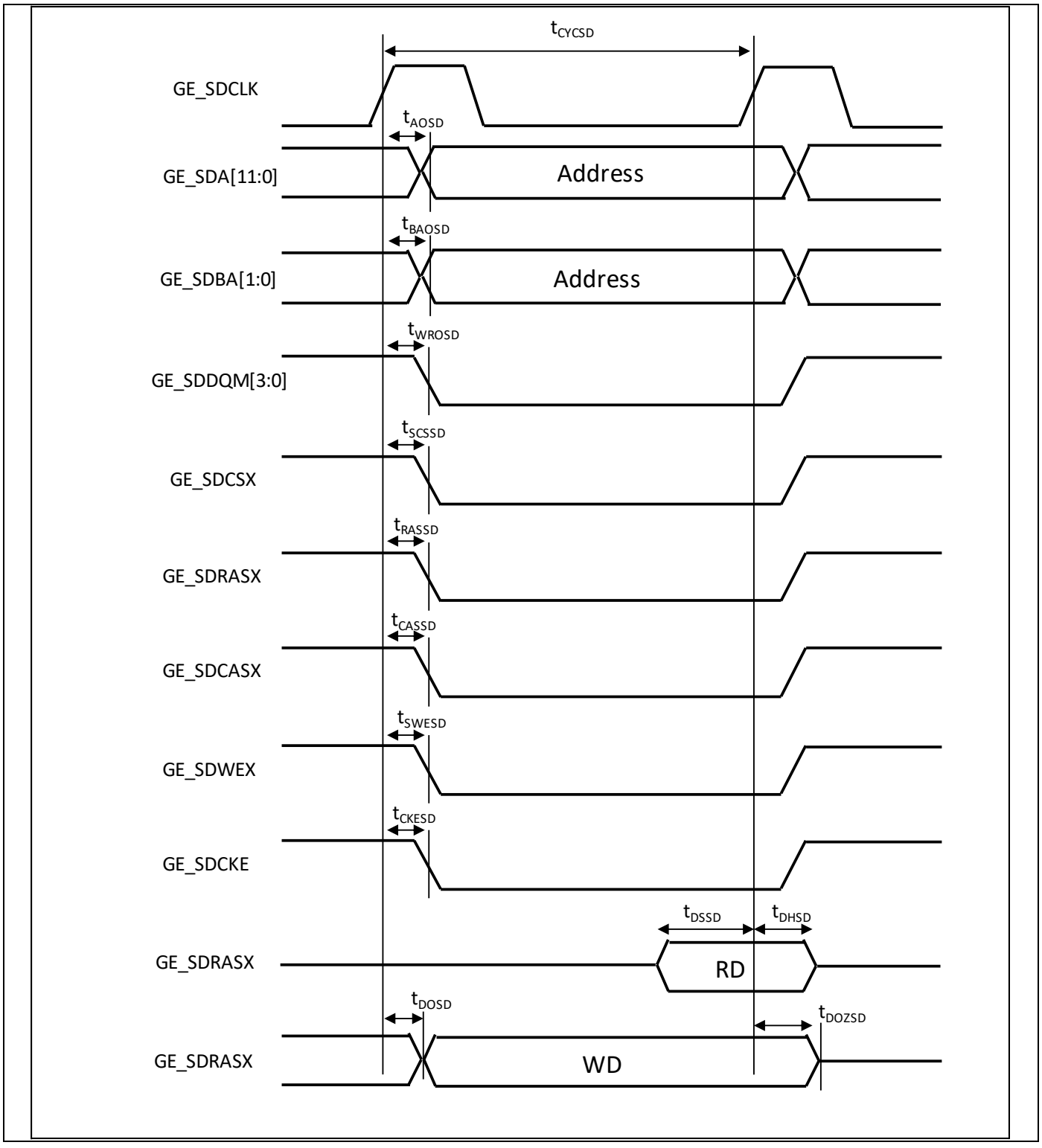
Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Output frequency	$t_{CYCPNGE}$	PNL_DCLK	-	-	40	MHz
PNL_DCLK↓→PNL_PD[23:0] Output delay time	$t_{PDOPDGE}$	PNL_PD[23:0]	-	-4.5	4.5	ns
PNL_DCLK↓→PNL_LH_SYNC Output delay time	$t_{HDOPDGE}$	PNL_LH_SYNC	-	-4.5	4.5	ns
PNL_DCLK↓→PNL_FV_SYNC Output delay time	$t_{VDOPDGE}$	PNL_FV_SYNC	-	-4.5	4.5	ns
PNL_DCLK↓→PNL_LE Output delay time	$t_{LDOPDGE}$	PNL_LE	-	-4.5	4.5	ns
PNL_DCLK↓→PNL_DEN Output delay time	$t_{DDOPDGE}$	PNL_DEN	-	-4.5	4.5	ns
PNL_DCLK↓→PNL_PWE Output delay time	$t_{PDOPDGE}$	PNL_PWE		-4.5	4.5	ns



12.4.20 GDC: SDRAM-IF Timing

(V_{CC} = 3.0V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Value		Unit
			Min	Max	
Output frequency	t_{CYCSD}	GE_SDCLK	-	80	MHz
Address delay time	t_{AOSD}	GE_SDCLK GE_SDA[11:0]	1	5	ns
Bank address delay time	t_{BAOSD}	GE_SDCLK GE_SDBA[1:0]	1	5	ns
GE_SDCLK↑→ Data output delay time	t_{DOSD}	GE_SDCLK GE_SDDQ[31:0]	1	5	ns
GE_SDCLK↑→ Data output Hi-Z time	t_{DOZSD}	GE_SDCLK GE_SDDQ[31:0]	1	5	ns
GE_SDDQM[3:0] delay time	t_{WROSD}	GE_SDCLK GE_SDDQM[3:0]	1	5	ns
GE_SDCSX delay time	t_{SCSSD}	GE_SDCLK GE_SDCSX	1	5	ns
GE_SDRASX delay time	t_{RASSD}	GE_SDCLK GE_SDRASX	1	5	ns
GE_SDCASX delay time	t_{CASSD}	GE_SDCLK GE_SDCASX	1	5	ns
GE_SDWEX delay time	t_{SWESD}	GE_SDCLK GE_SDWEX	1	5	ns
GE_SDCKE delay time	t_{CKESD}	GE_SDCLK GE_SDCKE	1	5	ns
Data setup time	t_{DSSD}	GE_SDCLK GE_SDDQ[31:0]	4	-	ns
Data hold time	t_{DHSD}	GE_SDCLK GE_SDDQ[31:0]	0	-	ns


tCYCSD
GE_SDCLK
tAOSD
GE_SDA[11:0]
Address
tBAOSD
GE_SDBA[1:0]
Address
tWROSD
GE_SDDQM[3:0]
tSCSSD
GE_SDCSX
tRASSD
GE_SDRASX
tCASSD
GE_SDCASX
tSWESD
GE_SDWEX
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tDOZSD
GE_SDRASX
WD

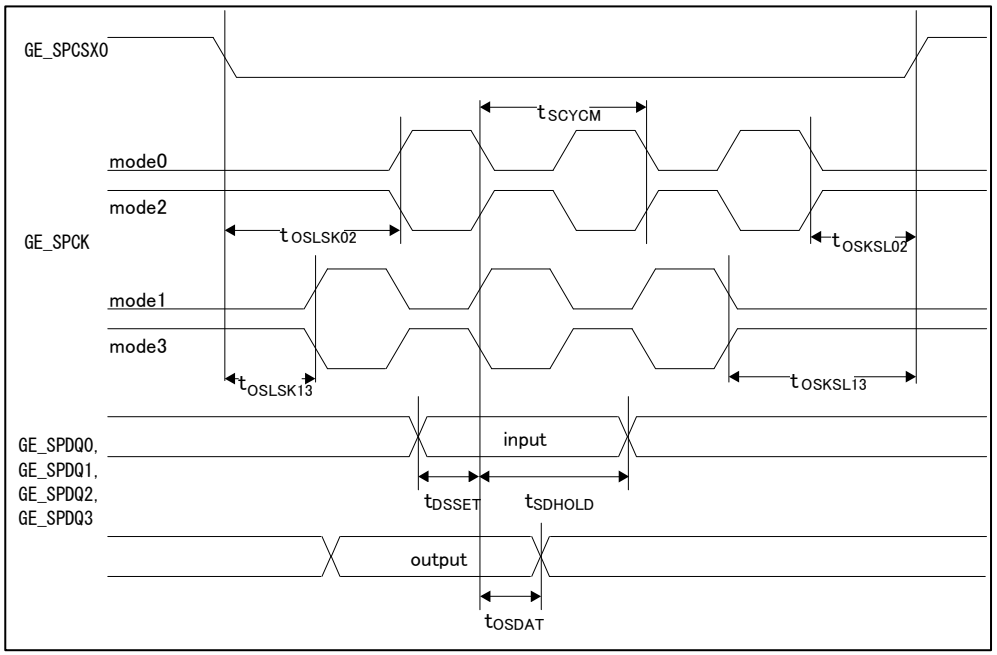
12.4.21 GDC: High-Speed Quad SPI Timing

(V_{CC} = 3.0V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Serial clock frequency	t_{SCYCM}	GE_SPCK	C_L=20 pF	-	80	MHz
Enabled CS→ CLK Starting Time (mode0/mode2)	$t_{OSLSK02}$	GE_SPCK, GE_SPCSX0		$1.5 \times t_{SCYCM} - 4.25$	-	ns
Enabled CS→ CLK Starting Time (mode1/mode3)	$t_{OSLSK13}$			$t_{SCYCM} - 4.25$	-	ns
CLK Last→ Disabled CS Time (mode0/mode2)	$t_{OSKSL02}$			t_{SCYCM}	-	ns
CLK Last→ Disabled CS Time (mode1/mode3)	$t_{OSKSL13}$			$1.5 \times t_{SCYCM}$	-	ns
SIO Data output time	t_{OSDAT}	GE_SPCK, GE_SPDQ0, GE_SPDQ1, GE_SPDQ2, GE_SPDQ3		-1.25	4.25	ns
SIO Setup	t_{DSSET}			4	-	ns
SIO Hold	t_{SDHOLD}			$0.5 \times t_{SCYCM}$	-	ns

Note:

– *See Chapter 8-3: High-Speed Quad SPI controller in FM4 Family Peripheral Manual Communication part (002-04862) for the detail of RTM mode.*

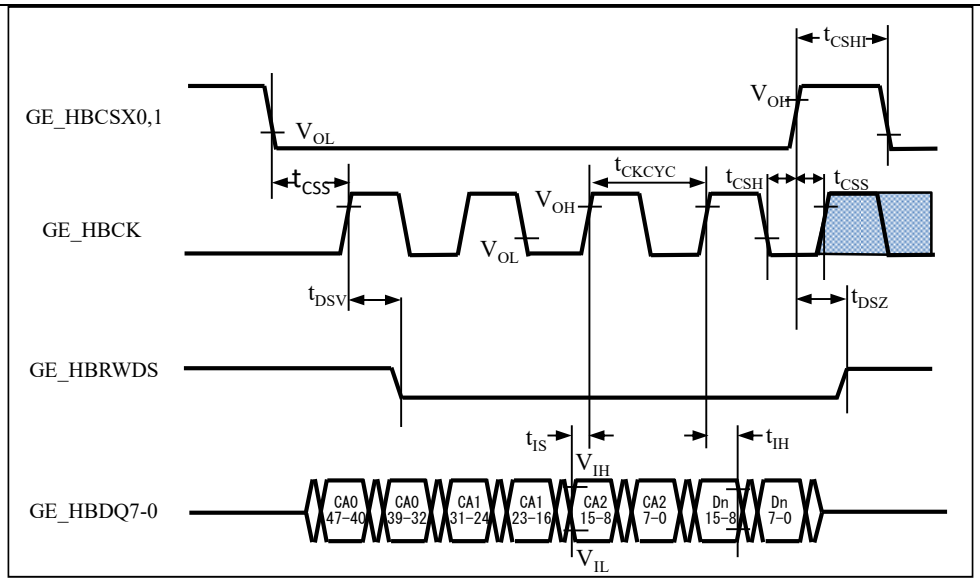

GE_SPCSX0
tSCYCM
mode0
mode2
GE_SPCK
tOSLSK02
tOSKSL02
mode1
mode3
tOSLSK13
tOSKSL13
GE_SPDQ0,
GE_SPDQ1,
GE_SPDQ2,
GE_SPDQ3
input
tDSSET
tSDHOLD
output
tOSDAT

12.4.22 GDC: HyperBus I/F Timing

HyperFlash Write

(V_{CC} = 3.0V to 3.6V, V_{SS} = 0V)

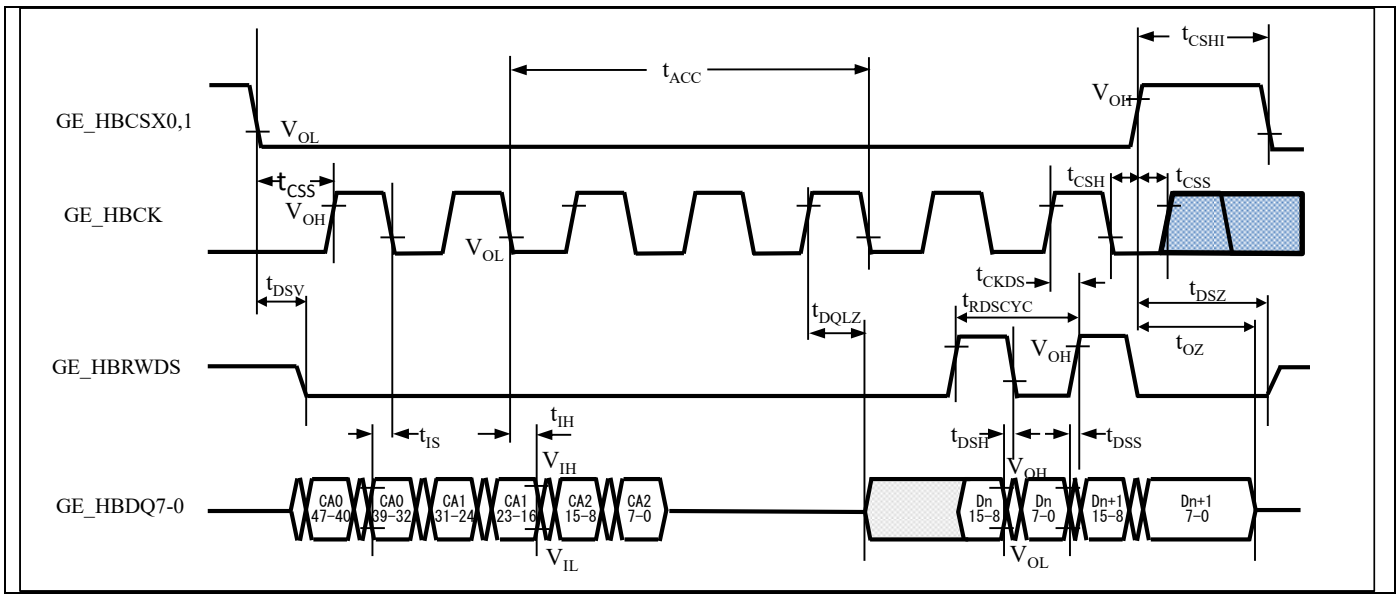
Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Hyper Bus clock cycle	t_{CKCYC}	GE_HBCK	C_L=30 pF	10	-	ns
CS ↑ ↓ →CK ↑ Chip Select setup time	t_{CSS}	GE_HBCSX1 GE_HBCSX0		3	-	ns
CS ↓ →RDS ↓ Chip select active to RDS valid(Low)	t_{DSV}	GE_HBRWDS		-	8	ns
DQ → CK ↑ ↓ Input setup time	t_{IS}	GE_HBDQ7- GE_HBDQ0		0.8	-	ns
CK ↑ ↓ → DQ Input hold time	t_{IH}	GE_HBDQ7- GE_HBDQ0		0.8	-	ns
CK ↓ → CS ↑ Chip select hold time	t_{CSH}	GE_HBCSX1 GE_HBCSX0		0	-	ns
CS ↑ → RDS(Hi-z) Chip select Inactive to RDS High-Z	t_{DSZ}	GE_HBCSX1 GE_HBCSX0		-	7	ns
CS ↑ → CS ↓ Chip select HIGH between operation	t_{CSHI}	GE_HBCSX1 GE_HBCSX0		8	-	ns



HyperFlash Read

(V_{CC} = 3.0V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Pin Name	Conditions	Value		Unit
				Min	Max	
Hyper Bus clock cycle	t_{RDSCYC}	GE_HBCK	C_L=30pF	10	-	ns
Read initial Access Time	t_{ACC}	GE_HBCK		-	120	ns
CS ↑ ↓→CK ↑ Chip Select setup time	t_{CSS}	GE_HBCSX1 GE_HBCSX0		3	-	ns
CS ↓ → RDS ↓ Chip select active to RDS valid (Low)	t_{DSV}	GE_HBRWDS		-	8	ns
DQ → CK ↑ ↓ Input setup time	t_{IS}	GE_HBDQ7- GE_HBDQ0		0.8	-	ns
CK ↑ ↓→ DQ Input hold time	t_{IH}	GE_HBDQ7- GE_HBDQ0		0.8	-	ns
CK ↓ → CS ↑ Chip select hold time	t_{CSH}	GE_HBCSX1 GE_HBCSX0		0	-	ns
CS ↑ → RDS(Hi-Z) Chip select Inactive to RDS High-Z	t_{DSZ}	GE_HBRWDS		-	7	ns
CK ↑ ↓ → DQ (Low Z) Clock to DQs Low Z	t_{DQLZ}	GE_HBDQ7- GE_HBDQ0		0	-	ns
RDS ↑ ↓→ DQ (valid) RDS transition to DQ valid	t_{DSS}	GE_HBDQ7- GE_HBDQ0		-0.8	+0.8	ns
RDS ↑ ↓→ DQ (invalid) RDS transition to DQ invalid	t_{DSH}	GE_HBDQ7- GE_HBDQ0		-0.8	+0.8	ns
CS ↑→ DQ (Hi-Z) Chip select Inactive to DQs High-Z	t_{OZ}	GE_HBDQ7- GE_HBDQ0		-	7	ns
CK ↑ ↓→ RDS ↑ ↓ CK transition to RDS transition	t_{CKDS}	GE_HBRWDS		1	7	ns
CS ↑→ CS ↓ Chip select HIGH between Operation	t_{CSHI}	GE_HBCSX1 GE_HBCSX0		8	-	ns



12.5 12-bit A/D Converter

Electrical Characteristics for the A/D Converter

(V_{CC} = AV_{CC} = 2.7V to 3.6V, V_{SS} = AV_{SS} = AVRL = 0V)

Parameter	Symbol	Pin Name	Value			Unit	Remarks
			Min	Typ	Max		
Resolution	-	-	-	-	12	bit	
Integral Nonlinearity	-	-	-	-	± 4.5	LSB	AVRH=2.7 V to 3.6 V Offset calibration when used
Differential Nonlinearity	-	-	-	-	± 2.5	LSB	
Zero transition voltage	V_{ZT}	ANxx	-	± 2	± 7	LSB	
Full-scale transition voltage	V_{FST}	ANxx	-	AVRH ± 2	AVRH ± 7	LSB	
Total error	-	-	-	± 3	± 8	LSB	
Conversion time	-	-	1.0*1	-	-	µs	
Sampling time *2	t_S	-	0.3	-	10	µs	
Compare clock cycle*3	t_{CCK}	-	50	-	1000	ns	
State transition time to operation permission	t_{STT}	-	-	-	1.0	µs	
Power supply current (analog + digital)	-	AV_{CC}	-	0.30	0.45	mA	A/D 1unit operation
			-	0.1	9.5	µA	When A/D stop
Reference power supply current(AVRH)	-	AVRH	-	0.66	1.18	mA	A/D 1unit operation AVRH=3.3 V
			-	0.2	3.2	µA	When A/D stop
Analog input capacity	C_{AIN}	-	-	-	12.05	pF	
Analog input resistance	R_{AIN}	-	-	-	1.8	kΩ	
Interchannel disparity	-	-	-	-	4	LSB	
Analog port input leak current	-	ANxx	-	-	5	µA	
Analog input voltage	-	ANxx	AV_{SS}	-	AVRH	V	
			AV_{SS}	-	AV_{CC}	V	
Reference voltage	-	AVRH	2.7	-	AV_{CC}	V	t_{CCK} ≥ 50 ns
	-	AVRL	AV_{SS}	-	AV_{SS}	V	

*1: The conversion time is the value of sampling time (t_S) + compare time (t_C).

Ensure that it satisfies the value of sampling time (t_S) and compare clock cycle (t_{CCK}).

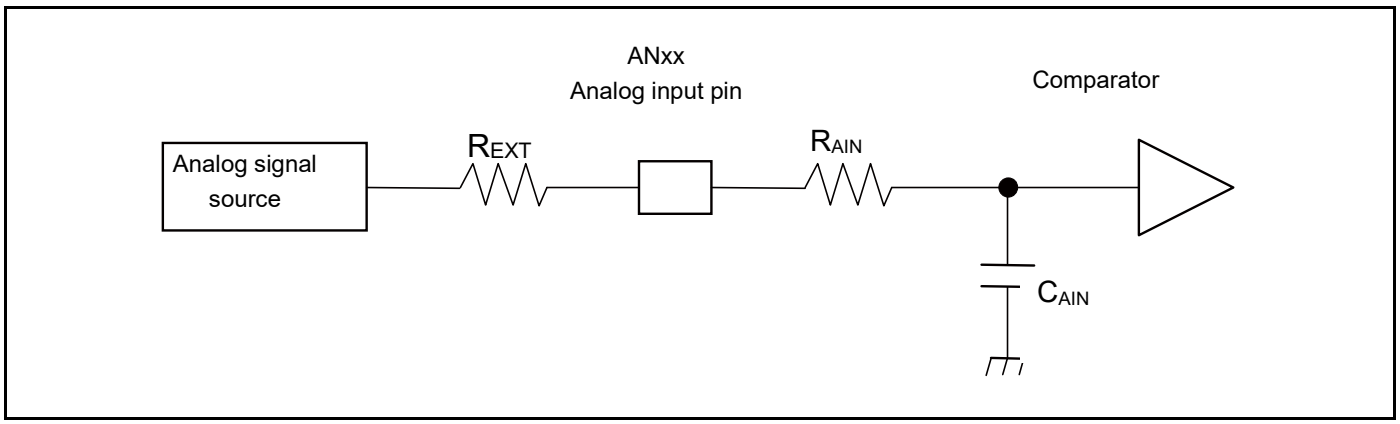
For setting of sampling time and compare clock cycle, see Chapter 1-1: A/D Converter in FM4 Family Peripheral Manual Analog Macro Part (002-04860). The register setting of the A/D converter is reflected by the APB bus clock timing.

For more information about the APB bus signal to which the A/D converter is connected, see 10. Block Diagram in this data sheet.

The sampling clock and compare clock are set at base clock (HCLK).

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

*3: The compare time (t_C) is the value 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 = 1.8 kΩ

C_{AIN}: Input capacity of A/D = 12.05 pF

R_{EXT}: Output impedance of external circuit

(Equation 2) $t_C = t_{CCK} \times 14$

t_C: Compare time

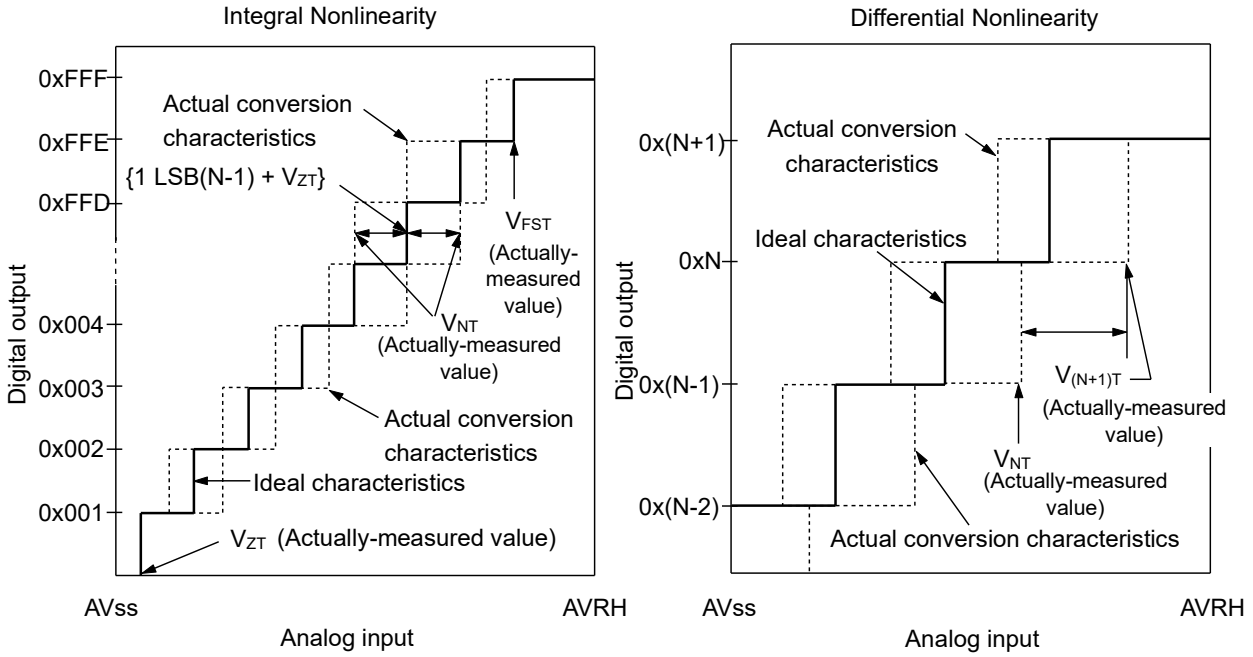
t_{CCK}: Compare clock cycle

Definition of 12-bit A/D Converter Terms

■Resolution: Analog variation that is recognized by an A/D converter.

■Integral Nonlinearity: Deviation of the line between the zero-transition point (0b000000000000 ⟷ 0b000000000001) and the full-scale transition point (0b111111111110 ⟷ 0b111111111111) from the actual conversion characteristics.

■Differential Nonlinearity: Deviation from the ideal value of the input voltage that is required to change the output code by 1 LSB.



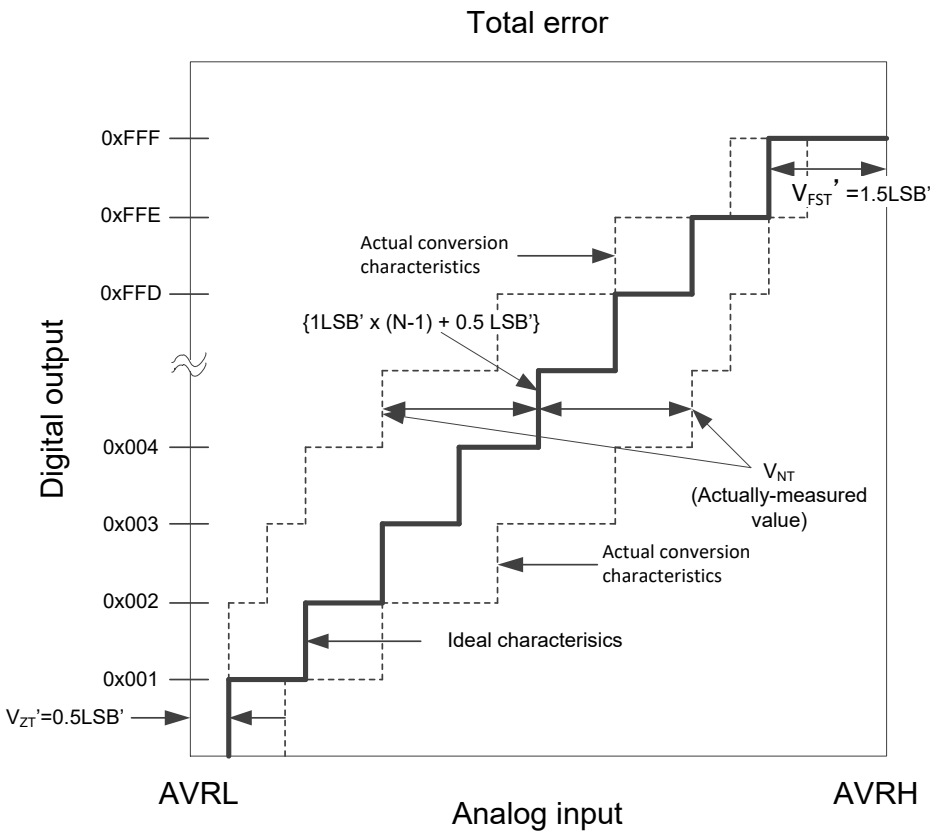
$$\text{Integral Nonlinearity of digital output N} = \frac{V_{NT} - \{1LSB \times (N - 1) + V_{ZT}\}}{1LSB} \text{ [LSB]}$$

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

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

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

■Total error: A difference between actual value and theoretical value.
The overall error includes zero-transition voltage, full-scale transition voltage and linearity error.



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

$$1\ LSB'\ (\text{ideal value}) = \frac{AVRH - AVRL}{4096} \quad [V]$$

V_{ZT}' (ideal value) = AVRL + 0.5 LSB' [V]

V_{FST}' (ideal value) = AVRH - 1.5 LSB' [V]

V_{NT}' : A voltage for causing transition of digital output from (N-1) to N

12.6 USB Characteristics

(V_{CC} = 3.0V to 3.6V, V_{SS} = 0V)

Parameter		Symbol	Pin Name	Conditions	Value		Unit	Remarks
					Min	Max		
Input characteristics	Input H level voltage	V_{IH}	UDP0/ UDM0	-	2.0	V_{CC} + 0.3	V	*1
	Input L level voltage	V_{IL}		-	V_{SS} - 0.3	0.8	V	*1
	Differential input sensitivity	V_{DI}		-	0.2	-	V	*2
	Different common mode range	V_{CM}		-	0.8	2.5	V	*2
Output characteristics	Output H level voltage	V_{OH}		External pull-up resistance = 15kΩ	2.8	3.6	V	*3
	Output L level voltage	V_{OL}		External pull-up resistance = 15kΩ	0.0	0.3	V	*3
	Crossover voltage	V_{CRS}		-	1.3	2.0	V	*4
	Rising time	t_{FR}		Full-Speed	4	20	ns	*5
	Falling time	t_{FF}		Full-Speed	4	20	ns	*5
	Rising/falling time matching	t_{FRFM}		Full-Speed	90	111.11	%	*5
	Output impedance	Z_{DRV}		Full-Speed	28	44	Ω	*6
	Rising time	t_{LR}		Low-Speed	75	300	ns	*7
	Falling time	t_{LF}		Low-Speed	75	300	ns	*7
	Rising/falling time matching	t_{LRFM}		Low-Speed	80	125	%	*7

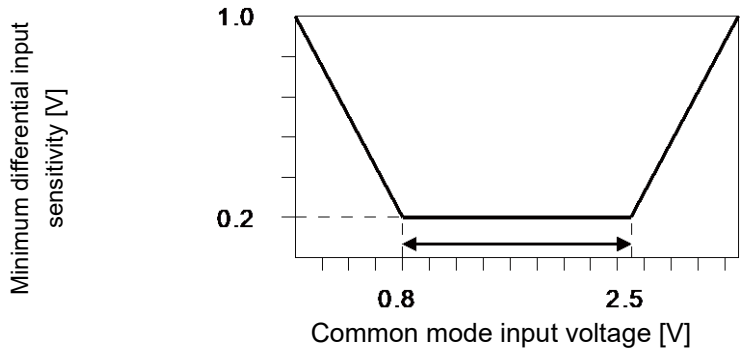
*1: The switching threshold voltage of Single-end-receiver of USB I/O buffer is set as within V_{IL} (Max) = 0.8 V, V_{IH} (Min) = 2.0 V (TTL input standard).

There are some hysteresis to lower noise sensitivity.

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

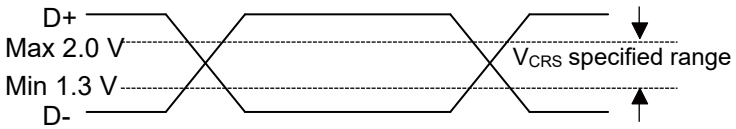
Differential-receiver has 200 mV of differential input sensitivity when the differential data input is within 0.8 V to 2.5 V to the local ground reference level.

Above voltage range is the common mode input voltage range.

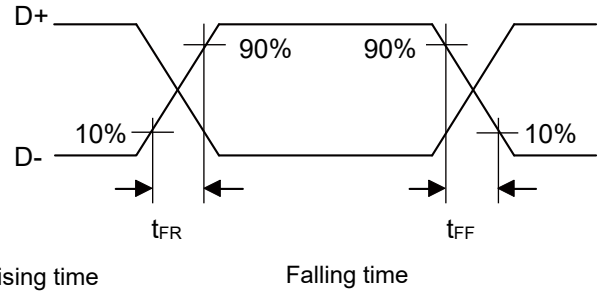


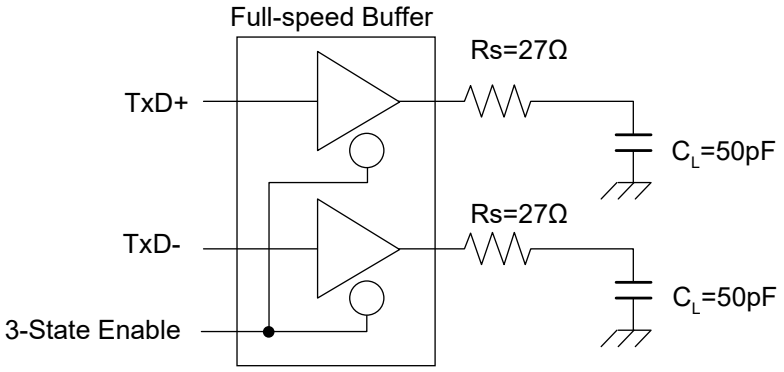
*3: The output drive capability of the driver is below 0.3 V at Low-state (V_{OL}) (to 3.6 V and 1.5 kΩ load), and 2.8 V or above (to the V_{SS} and 15 kΩ load) at High-State (V_{OH}).

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

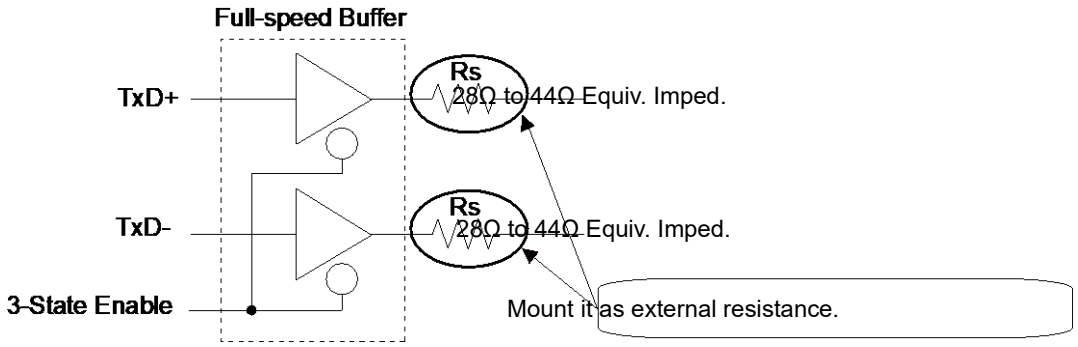


*5: They indicate Rising time (t_{FR}) and Falling time (t_{FF}) of the Full-speed differential data signal.
They are defined by the time between 10 % and 90 % of the output signal voltage.
For Full-speed buffer, t_{FR}/t_{FF} ratio is regulated as within ± 10 % to minimize RFI emission.



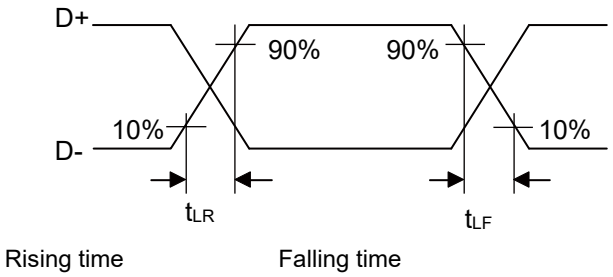


*6: USB Full-speed connection is performed via twist pair cable shield with 90 Ω ± 15 % characteristic impedance (Differential Mode).
USB standard defines that output impedance of USB driver must be in range from 28 Ω to 44 Ω. So, discrete series resistor (Rs) addition is defined in order to satisfy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



Rs series resistor 25 Ω to 30 Ω
Series resistor of 27 Ω (recommendation value) must be added.
And, use "resistance with an uncertainty of 5% by E24 sequence".

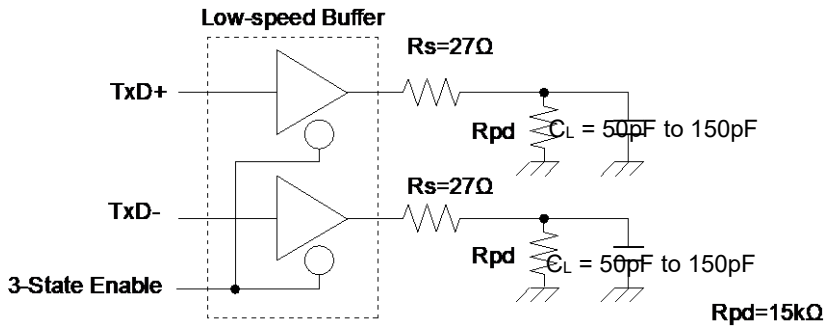
*7: They indicate rising time (t_{LR}) and Falling time (t_{LF}) of the Low-speed differential data signal.
They are defined by the time between 10 % and 90 % of the output signal voltage.



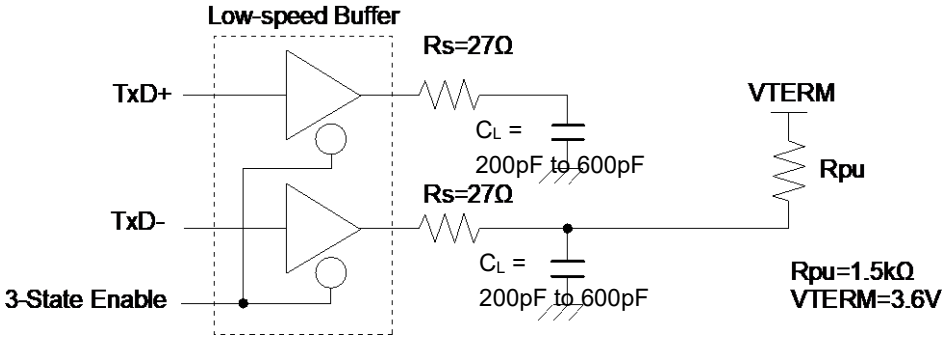
Note:

- *See Low-speed load (Compliance load) for conditions of external load.*

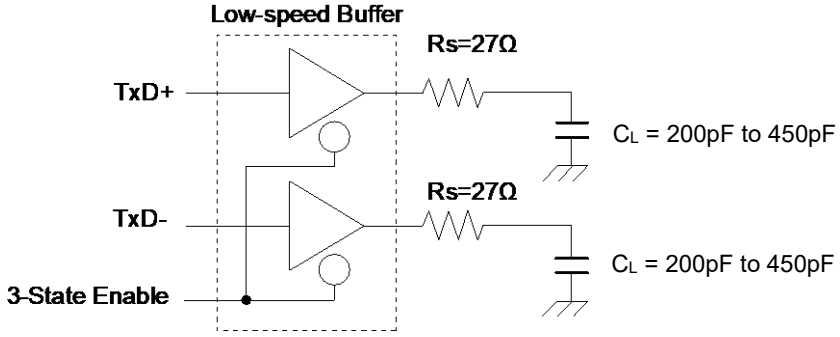
■Low-speed load (Upstream port load) - Reference 1



■Low-speed load (Downstream port load) - Reference 2



■Low-speed load (Compliance load)



12.7 Low-Voltage Detection Characteristics

12.7.1 Low-Voltage Detection Reset

Parameter	Symbol	Conditions	Value			Unit	Remarks
			Min	Typ	Max		
Detected voltage	VDL	-	2.46	2.55	2.64	V	When voltage drops
Released voltage	VDH	-	2.51	2.60	2.69	V	When voltage rises

12.7.2 Interrupt of Low-Voltage Detection

Parameter	Symbol	Conditions	Value			Unit	Remarks
			Min	Typ	Max		
Detected voltage	VDL	SVHI = 00111	2.80	2.90	3.00	V	When voltage drops
Released voltage	VDH		2.90	3.00	3.11	V	When voltage rises
Detected voltage	VDL	SVHI = 00100	2.99	3.10	3.21	V	When voltage drops
Released voltage	VDH		3.09	3.20	3.31	V	When voltage rises
Detected voltage	VDL	SVHI = 01100	3.18	3.30	3.42	V	When voltage drops
Released voltage	VDH		3.28	3.40	3.52	V	When voltage rises
LVD stabilization wait time	t_{LVDW}	-	-	-	$4800 \times t_{CYCP}$*	µs	

*: t_{CYCP} indicates the APB2 bus clock cycle time.

12.8 MainFlash Memory Write/Erase Characteristics

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter		Value			Unit	Remarks
		Min	Typ	Max		
Sector erase time	Large Sector	-	0.7	3.7	s	Includes write time prior to internal erase
	Small Sector	-	0.3	1.1	s	
Half word (16-bit) write time	Write cycles ≤ 100 times	-	12	100	µs	Not including system-level overhead time
	Write cycles > 100 times			200		
Chip erase time		-	6.6	31	s	Includes write time prior to internal erase

Write Cycles and Data Hold Time

Erase/Write Cycles (cycle)	Data Hold Time (year)
1,000	20*
10,000	10*
100,000	5*

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

12.9 VFLASH Memory Write/Erase Characteristics

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Value			Unit	Remarks
	Min	Typ	Max		
Sector erase time (4 KB)	-	50	450	ms	
Block Erase Time (64 KB)	-	500	2000	ms	
Page Program Time	-	0.7	3	ms	
Chip erase time	-	11.2	64	s	

Erase Endurance

Parameter	Value			Unit	Remarks
	Min	Typ	Max		
Erase per sector	100k	-	-	cycle	

*: Data retention of 20 years is based on 1k erase cycle or less.

12.10 Standby Recovery Time

12.10.1 Recovery Cause: Interrupt/WKUP

The time from recovery cause reception of the internal circuit to the program operation start is shown.

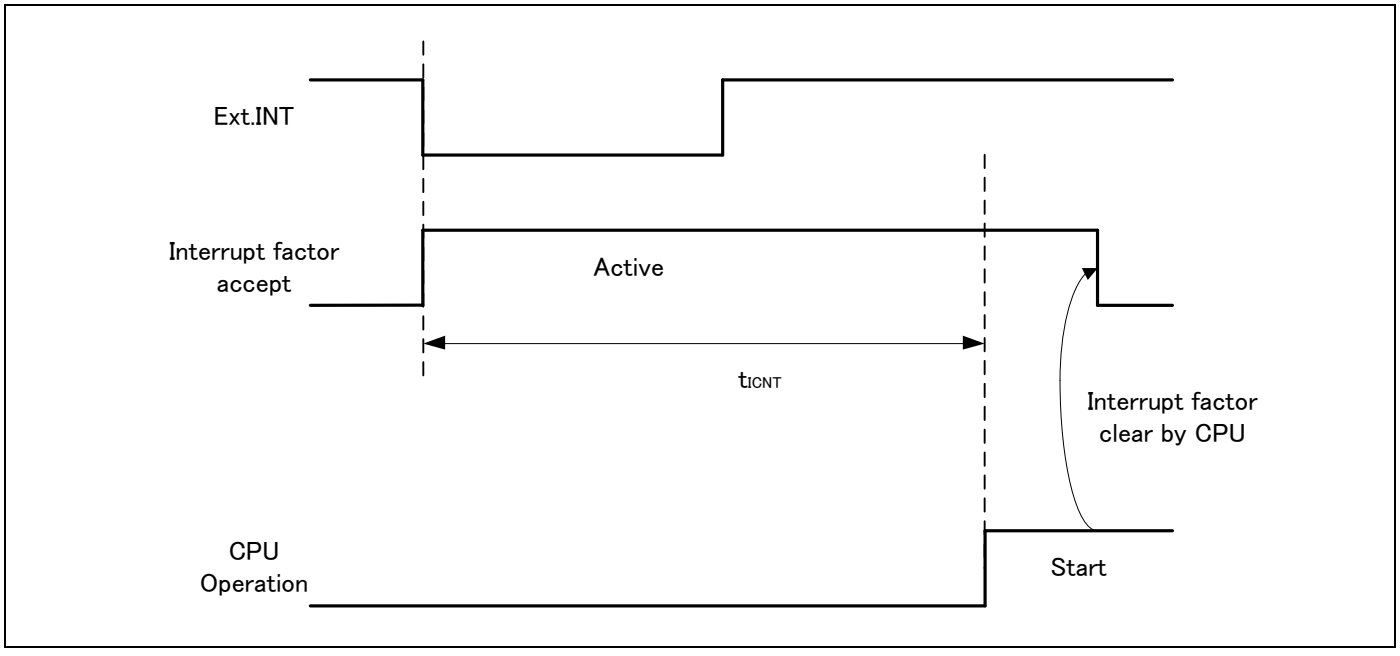
Recovery Count Time

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

Parameter	Symbol	Value		Unit	Remarks
		Typ	Max*		
Sleep mode	t_{ICNT}	HCLK×1		µs	
High-speed CR Timer mode Main Timer mode PLL Timer mode		40	80	µs	
Low-speed CR timer mode		450	900	µs	
Sub timer mode		896	1136	µs	
RTC mode Stop mode (High-speed CR /Main/PLL run mode return)		316	581	µs	
RTC mode Stop mode (Low-speed CR/sub run mode return)		270	540	µs	
Deep standby RTC mode		365	667	µs	without RAM retention
Deep standby Stop mode		365	667	µs	with RAM retention

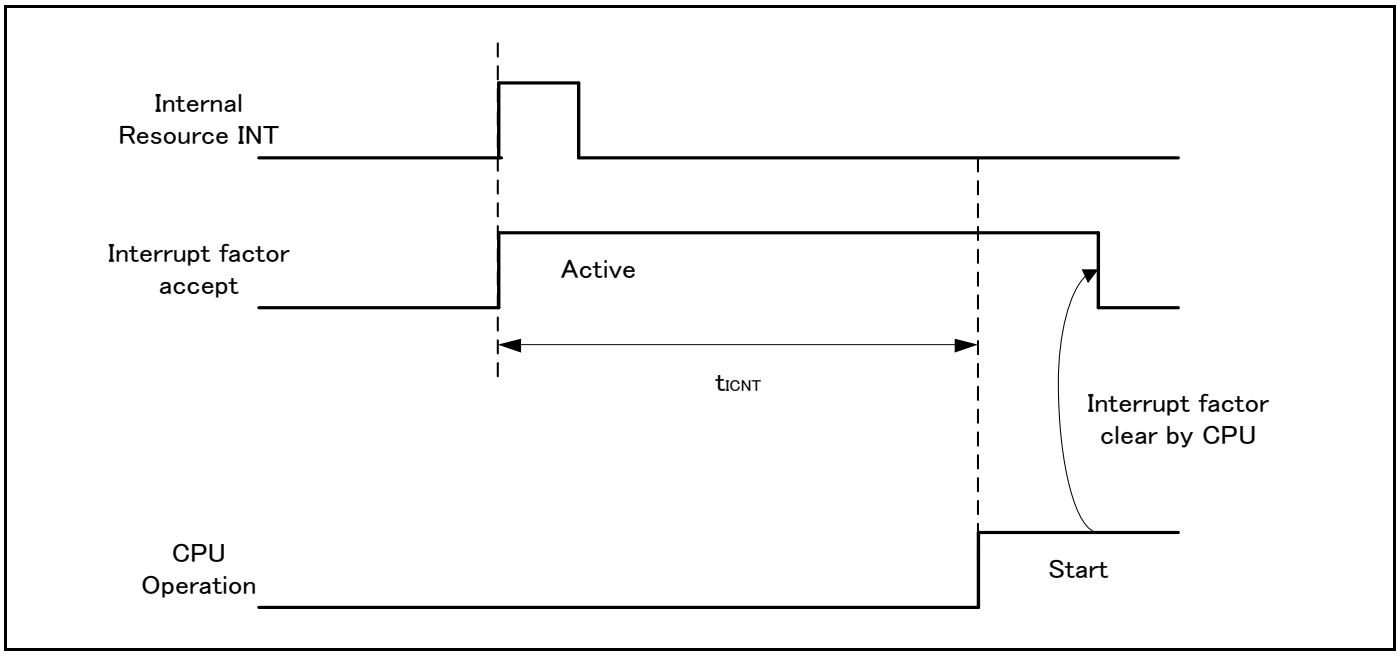
*: The maximum value depends on the built-in CR accuracy.

Example of standby recovery operation (when in external interrupt recovery*)



*: External interrupt is set to detecting fall edge.

Example of Standby Recovery Operation (when in Internal Resource Interrupt Recovery*)



*: Depending on the standby mode, interrupt from the internal resource is not included in the recovery cause.

Notes:

- *The return factor is different in each Low-Power consumption modes. See Chapter 6: The return factor from each low power consumption modes in "FM4 Family Peripheral Manual Main Part (002-04856).*
- *When interrupt recoveries, the operation mode that CPU recoveries depends on the state before the Low-Power consumption mode transition. See Chapter 6: Low Power Consumption Mode" in "FM4 Family Peripheral Manual Main part (002-04856).*

12.10.2 Recovery Cause: Reset

The time from reset release to the program operation start is shown.

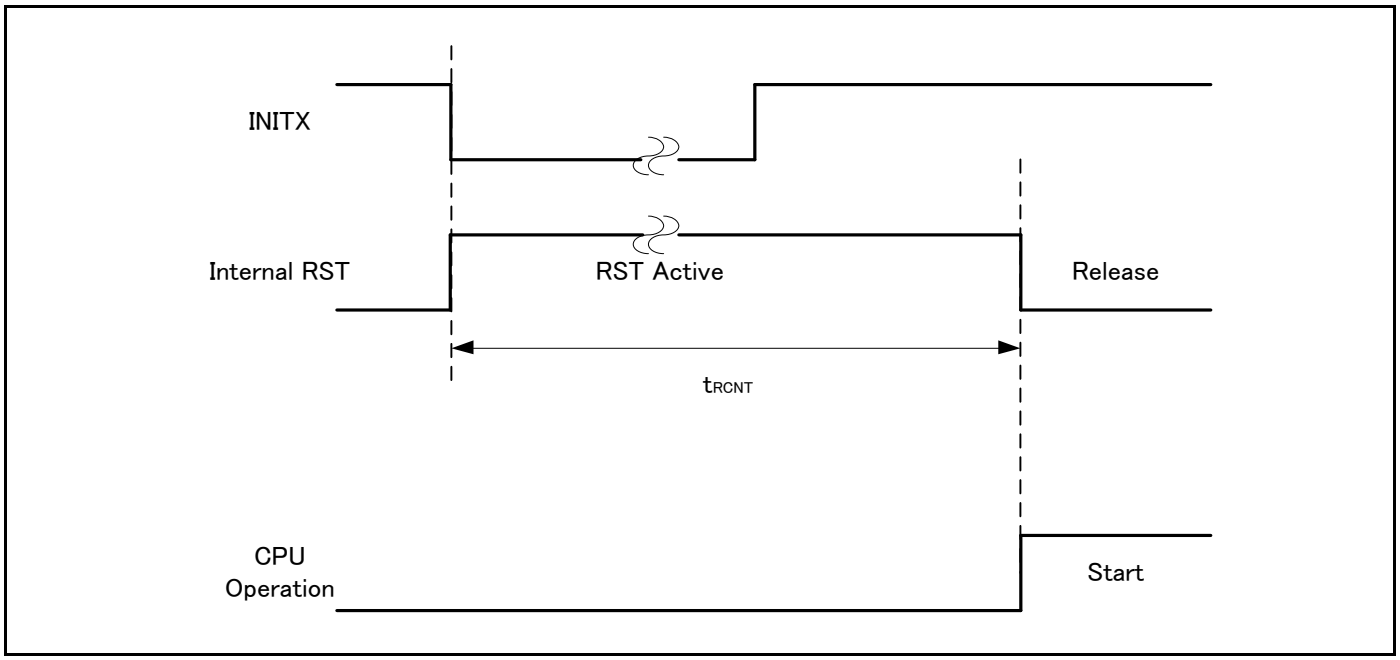
Recovery Count Time

(V_{CC} = 2.7V to 3.6V, V_{SS} = 0V)

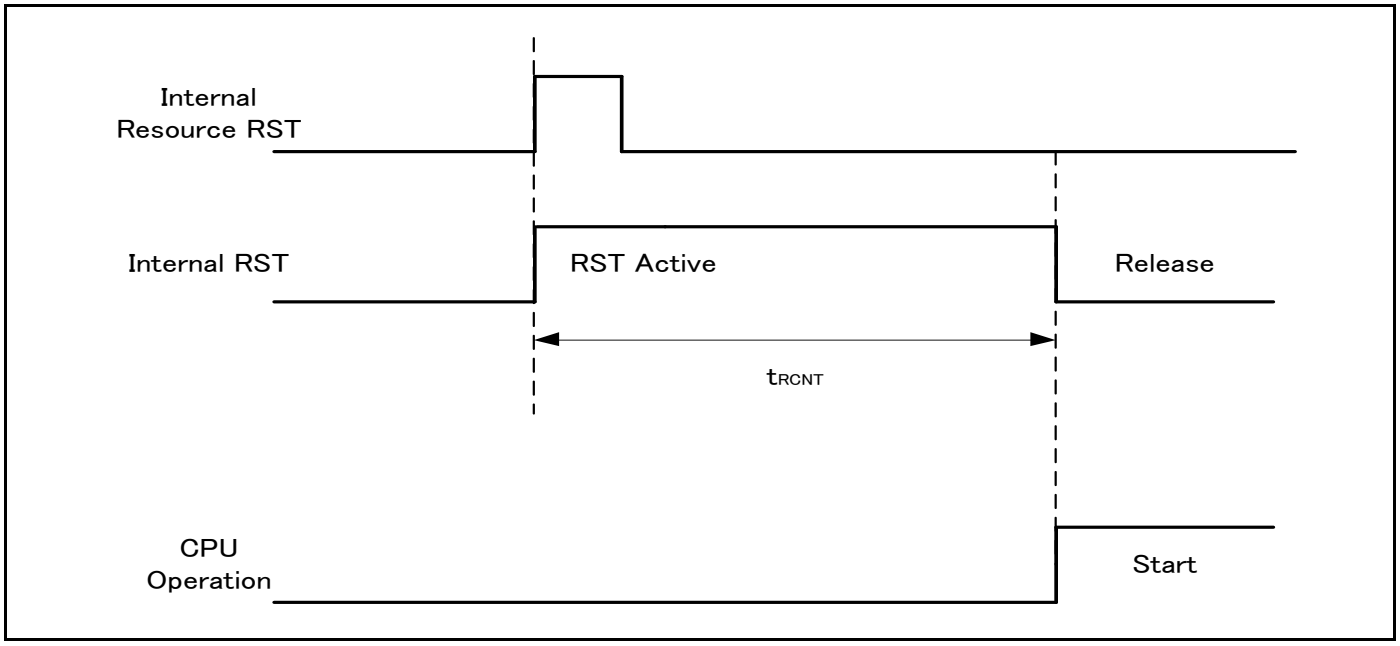
Parameter	Symbol	Value		Unit	Remarks
		Typ	Max*		
Sleep mode	t_{RCNT}	155	266	µs	
High-speed CR Timer mode Main Timer mode PLL Timer mode		155	266	µs	
Low-speed CR timer mode		315	567	µs	
Sub timer mode		315	567	µs	
RTC mode Stop mode		315	567	µs	
Deep standby RTC mode Deep standby Stop mode		336	667	µs	without RAM retention
		336	667	µs	with RAM retention

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

Example of Standby Recovery Operation (when in INITX Recovery)



Example of Standby Recovery Operation (when in Internal Resource Reset Recovery*)



*: Depending on the Low-Power consumption mode, the reset issue from the internal resource is not included in the recovery cause.

Notes:

- *The return factor is different in each low power consumption mode.*
  See Chapter 6: The return factor from each low power consumption modes in "FM4 Family Peripheral Manual Main Part (002-04856).
- *The recovery process is unique for each operating mode. See Chapter 6: Low Power Consumption mode in FM4 Family Peripheral Manual Main Part (002-04856)*

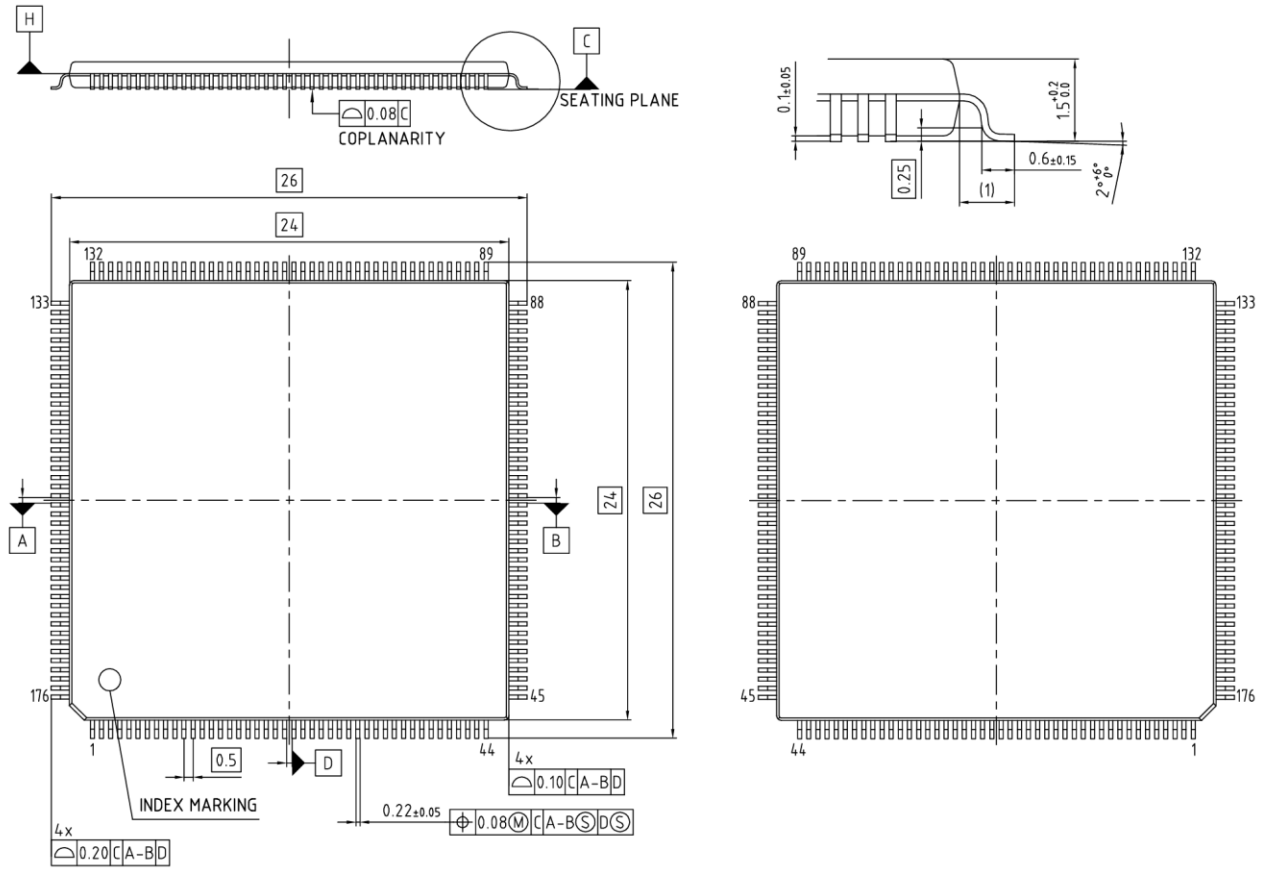
- *When the power-on reset/low-voltage detection reset, they are not included in the return factor. See 12.4.8 Power-on Reset Timing.*
- *In recovering from reset, CPU changes to High-speed Run mode. In the case of using the main clock and PLL clock, they need further main clock oscillation stabilization wait time and oscillation stabilization wait time of Main PLL clock.*
- *Internal resource reset indicates Watchdog reset and CSV reset.*

13 Ordering Information

Part Number	Package
S6E2D55J0AGV2000A	Plastic・LQFP (0.5 mm pitch), 176 pin (LQP176)

14 Package Dimensions

Package Type	Package Code
LQFP 176	LQP 176



1) DOES NOT INCLUDE PLASTIC OR METAL PROTRUSION OF 0.25 MAX. PER SIDE
2) DOES NOT INCLUDE DAMBAR PROTRUSION OF 0.08 MAX. PER SIDE AT MAX. MATERIAL CONDITION

Z8B00252086 v01

15 Errata

This chapter describes the errata for S6E2D5 series. Details include errata trigger conditions, scope of impact, available workaround, and silicon revision applicability. Contact your local Cypress Sales Representative if you have questions.

15.1 Part Numbers Affected

Part Number
S6E2D55J0AGV20000, S6E2D55J0AGV2000A

15.2 Qualification Status

Product Status: In Production

15.3 Errata Summary

This table defines the errata applicability to available devices.

Items	Part Number	Silicon Revision	Fix Status
SDRAM cannot be used as destination buffer of the GDC	Refer to 15.1	Rev A	No silicon fix planned. Workaround required.

SDRAM cannot be used as destination buffer of the GDC

1. PROBLEM DEFINITION

   Unnecessary data is written before and after the correct addresses if the GDC writes data to the external SDRAM, the CPU’s internal SRAM0, SRAM2, or any memory devices connected to the External Bus Interface.

2. PARAMETERS AFFECTED

   N/A

3. TRIGGER CONDITION(S)

   The GDC generates either write data that is NOT size of multiples of 8 bytes multiplied by Burst Length or write address that is NOT aligned with 8 bytes multiplied by Burst Length to the external SDRAM, the CPU's internal SRAM0, SRAM2, or any memory devices connected to the External Bus Interface. The Burst Length means length of write burst transaction, and you can set it as 2 (16 bytes), or 4 (32 bytes).

4. SCOPE OF IMPACT

   The external SDRAM, the CPU’s internal SRAM0, SRAM2, or any memory devices connected to the External Bus Interface cannot be used as destination buffer of the GDC.

5. WORKAROUND

Keep Write data size and Base address according as following table when the GDC writes to the external SDRAM, the CPU's internal SRAM0, SRAM2, or any memory devices connected to the External Bus Interface.

Burst Length for write access	Write data size	Base address alignment for write data
2	Multiples of 16 bytes	16 bytes aligned address. E.g. 0xB000_0010, 0xB000_0020.
4	Multiples of 32 bytes	32 bytes aligned address. E.g. 0xB000_0020, 0xB000_0040.

6. FIX STATUS

There is no fix planned. The workaround listed above should be used.

16 Major Changes

Spansion Publication Number: DS709-00021

Page	Section	Change Results
Revision 0.1		
-	-	Initial release
Revision 1.0		
1, 3 13, 14 15 176	Title 3. Product Lineup 4. Packages 15. Ordering Information	Deleted the following products. S6E2D55JAA/ S6E2D55GAA
6	2. Features External Bus Interface	Added the following description: ■ Maximum area size : Up to 256 Mbytes ■Modified the following description: ■ 0x6000_0000 to 0xDFFF_FFFF to 0x6000_0000 to 0x7FFF_FFFF
7 13	2. Features 3. Product Lineup	Added that CAN-FD Interface supported non-CAN FD.
8	2. Features	Modified the ch. Number of I^2C (ch.7→ch.4)
15 16 20 to 52 81 176	4. Packages 5. Pin Assignment 6. Pin Descriptions 14.2. Recommended Operating 15. Ordering Information	Added the Ex-LQFP(TEQFP)(LEM120)
53	7. I/O Circuit Type	Modified the Type-A Circuit
54,55,58	7. I/O Circuit Type	Added the comment in TypeD/E/F/G/N
59	7. I/O Circuit Type	■Modified theType-Q Remarks CMOS level output → CMOS level hysteresis input
67	10. Block Diagram	Deleted the following products. ■S6E2D55JAA/ S6E2D55GAA
68	12. Memory Map	Modified the External Device Area / GDC Area
80 163	14.2. Recommended Operating 14.5 12-bit A/D Converter	Added the AVRL in Analog reference voltage.
82	14.2. Recommended Operating	Modified the TBD in Current Value Added the Note
84 to 93	14.3.1 Current Rating	Modified the TBD in Max spec Added the comment of VFLASH memory
93	14.3.1 Current Rating Table 14-11	Added the VFLASH memory current
95	14.4 AC Characteristics 14.4.1 Main Clock Input	Added the Master clock
97	14.4 AC Characteristics 14.4.5 Operating Conditions	Modified the I^2S PLL frequency (307.2→384) Modified the GDC clock frequency (400→160)
163	14.5 12-bit A/D Converter	Modified the Spec Modified the comment of Conversion time
170	14.7.2 Interrupt of Low-Voltage Detection	Modified the max value in LVD stabilization wait time. (6000→4800)
171	14.9 VFLASH Memory	Added the new
176	15. Ordering Information	Modified the Part Number (S6E2D55G0AGB10000→ S6E2D55G0AGB30000) Added the Package (Ex_LQFP)
179, 180	16. Package Dimensions	Added the FDJ161/LEM120
2	17.Feature	Deleted Max
7	18.Product Lineup	Deleted Max

69	19. Electrical Characteristics	Deleted the power consumption item due to an error in the Absolute Maximum Ratings under the Electrical Characteristics.

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

Document History

Document Title: S6E2D5 Series 32-bit Arm® Cortex®-M4F, FM4 Microcontroller
Document Number: 002-03982

Revision	ECN	Submission Date	Description of Change
**	—	04/21/2015	New spec.
*A	5040094	01/14/2016	Updated to Cypress template.
*B	5123103	03/04/2016	Added CCS/CCB settings in 7. HandlingDevices (Page58) and Table 12-10 Typical…*6,*7 (page 85). Changed PN: S6E2DH5G0AGZ20000 to S6E2DH5G0AGE20000 in 13. Ordering… (Page 172). Changed “GE_SPCSX_0” to “GE_SPCSX0” in 3. PinAssignment (Page 9, 11), 4. PinDescriptions (Page16, 42), 8. BlockDiagram (Page 61) and 12.4.21 GDC: … (Page 154,155) Changed “GE_HBCSX_0” to “GE_HBCSX0” in 3. PinAssignment (Page 9, 11), 4. PinDescriptions (Page 16, 42) , 8. BlockDiagram (Page 61) and 12.4.22 GDC: ... (Page 156,157) Changed “GE_HBCSX_1” to “GE_HBCSX1” in 3. PinAssignment (Page 9, 11), 4. PinDescriptions (Page 14, 42), 8. BlockDiagram (Page 61) and 12.4.22 GDC: … (Page 156,157) Updated VFLASH memory Standby current value to 35uA in Table 12-11 Typical… (Page 86). Changed “Ex_LQFP” to “Ex-LQFP” in 2. Packages (Page 8), 4. Pin Descriptions (Page 13 to 46), 12.2 Recommended… (Page 74) and 13. Ordering… (Page 172). Changed “VMAKEUP” to “VWAKEUP” in 8. BlockDiagram (Page 61). Changed “HW flow control (ch. 4, 5)” to “HW flow control (ch. 4)” in 8. BlockDiagram (Page 61). Added “(N.C.): Do not connect anything” in 3. Pin Assignment (Page 10). Added the Note in 4. Pin Descriptions (Page 46). Added Function of PNL_TSIG in 4. Pin Descriptions (Page 43). Changed “PFBGA” to “FBGA” in 12.2 Recommended… (Page 74) and 13. Ordering… (Page 172). New added errata in 15. Errata (Page 177 to 178).
*C	5634638	02/21/2017	Changed an explanation from “from 01 to 99” to “from 00 to 99” in Real-Time Clock (RTC) (Page 3) of Features. Added an explanation in Notes on Power-on (Page 60) of 7. Handling Devices. Changed “VBAT Power-on Reset” to “Power-on Reset” in List of VBAT Domain Pin Status (Page 71) of 11. Pin Status in Each CPU State, and Added Remark *1. Added Remark *8 in Table 12-10 Typical and Maximum Current Consumption in Deep Standby Stop Mode, Deep Standby RTC Mode and VBAT (Page 85). Changed Parameter “Power supply rising time (t_{VCCR})” to “Power ramp rate (dV/dt)” in 12.4.8 Power-on Reset Timing (Page 92), Changed the minimum to 0.6mV/µs, Changed the maximum to 1000mV/µs, and Added Remarks and Note. Deleted setting value “SPI=1” and “MS=0” at using chip select in 12.4.12 CSIO Timing, and Added “MS bit = 0” and “MS bit = 1” on the Figure (P113-120, P129-136). Deleted following Part Numbers from 13. Ordering Information (Page 172).

Revision	ECN	Submission Date	Description of Change
			S6E2D55J0AGV20000, S6E2D55G0AGB30000 Added following Part Numbers to 13. Ordering Information (Page 172). S6E2D55J0AGV2000A, S6E2D55G0AGB3000A Updated figures in 14.Package Dimensions (Page 173 to 176). Added following Part Numbers to 15. Errata (Page 177). S6E2D55J0AGV2000A Deleted Baud rate spec for High-Speed Synchronous Serial in “12.4.12 CSIO Timing”(Page 121-127)
*D	6579846	05/23/2019	Updated Package Dimensions: Spec 002-12611 – Changed revision from ** to *A. Updated to new template.
*E	7156460	06/14/2021	Deleted following obsolete Part Numbers from 13. Ordering Information (Page 172): S6E2D55G0AGV20000 S6E2D55GJAMV20000 S6E2D55G0AGE2000 Corrected some typos. Completing Sunset Review.
*F	8097948	01/07/2025	Updated the Product Lineup, Packages, Pin Assignment, Pin Descriptions, Block Diagram, and Ordering Information. Replaced package diagram spec 002-15150 by Z8B00252086. Completing ECN Sunset review.
*G	8185793	07/22/2026	Deleted the power consumption item due to an error in the Absolute Maximum Ratings under the Electrical Characteristics.

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