RX23T Group
Renesas MCUs

R01DS0248EJ0110
Rev.1.10
Jan 13, 2016

40-MHz 32-bit RX MCUs, built-in FPU, 65.6 DMIPS,
12-bit ADC (equipped with three S/H circuits, double data registers, and comparator)
40MHz PWM (three-phase complementary output × 2ch)

Features

■ 32-bit RX CPU core
- Max. operating frequency: 40 MHz
  Capable of 65.6 DMIPS in operation at 40 MHz
- Enhanced DSP: 32-bit multiply-accumulate and 16-bit multiply-subtract instructions supported
- Built-in FPU: 32-bit single-precision floating point (compliant to IEEE754)
- Divider (fastest instruction execution takes two CPU clock cycles)
- Fast interrupt
- CISC Harvard architecture with 5-stage pipeline
- Variable-length instructions, ultra-compact code
- On-chip debugging circuit
- Memory protection unit (MPU) supported

■ Low power design and architecture
- Operation from a single 2.7-V to 5.5-V supply
- Three low power consumption modes

■ On-chip code flash memory, no wait states
- 128-/64-Kbyte capacities
- On-board or off-board user programming

■ On-chip SRAM, no wait states
- 12 Kbytes of SRAM

■ DMA
- DTC: Four transfer modes

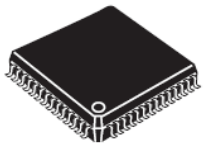
■ Reset and supply management
- Seven types of reset, including the power-on reset (POR)
- Low voltage detection (LVD) with voltage settings

■ Clock functions
- Main clock oscillator frequency: 1 to 20 MHz
- External clock input frequency: Up to 20 MHz
- PLL circuit input: 4 MHz to 12.5 MHz
- On-chip low-speed oscillator, on-chip high-speed oscillator, dedicated on-chip oscillator for the IWDT
- Clock frequency accuracy measurement circuit (CAC)

■ Independent watchdog timer
- 15-kHz on-chip oscillator produces a dedicated clock signal to drive IWDT operation.

■ Useful functions for IEC60730 compliance
- Self-diagnostic and disconnection-detection assistance functions for the A/D converter, clock frequency accuracy measurement circuit, independent watchdog timer, RAM test assistance functions using the DOC, etc.

■ MPC
- Multiple locations are selectable for I/O pins of peripheral functions



PLQP0064KB-C 10 × 10 mm, 0.5 mm pitch
PLQP0052JA-B 10 × 10 mm, 0.65 mm pitch
PLQP0048KB-B 7 × 7 mm, 0.5 mm pitch

■ Up to 4 communications channels
- SCI with many useful functions (2 channels)
  Asynchronous mode, clock synchronous mode, smart card interface mode, simplified SPI, simplified I²C, and extended serial mode.
- I²C bus interface: Transfer at up to 400 kbps (one channel)
- RSPI capable of high speed connection (one channel)

■ Up to 12 extended-function timers
- 16-bit MTU3: 40MHz operation, input capture, output compare, three-phase complementary PWM output, CPU-efficient complementary PWM, phase counting mode (six channels)
- 8-bit TMRs (4 channels),
- 16-bit compare-match timers (4 channels)

■ 12-bit A/D converter: 10ch
- On-chip sample-and-hold circuit: 12bit × up to 3 channels
- Sampling time can be set for each channel
- Self-diagnostic function and analog input disconnection detection assistance function (compliant to IEC60730)
- ADC: three sample-and-hold circuits, double data registers, comparator (3 channels)

■ Register write protection function can protect values in important registers against overwriting.

■ Up to 50 pins for general I/O ports
- 5-V tolerant, open drain, input pull-up

■ Operating temperature range
- –40 to +85°C
- –40 to +105°C

■ Applications
- General industrial and consumer equipment

1. Overview

1.1 Outline of Specifications

Table 1.1 lists the specifications, and Table 1.2 gives a comparison of the functions of the products in different packages.
Table 1.1 is for products with the greatest number of functions, so the number of peripheral modules and channels will differ in accordance with the package type. For details, see Table 1.2, Comparison of Functions for Different Packages.

Table 1.1 Outline of Specifications (1/3)

Classification	Module/Function	Description
CPU	CPU	• Maximum operating frequency: 40 MHz • 32-bit RX CPU (RX v2) • Minimum instruction execution time: One instruction per clock cycle • Address space: 4-Gbyte linear • Register set General purpose: Sixteen 32-bit registers Control: Ten 32-bit registers Accumulator: Two 72-bit registers • Basic instructions: 75 Variable-length instruction format • Floating-point instructions: 11 • DSP instructions: 23 • Addressing modes: 11 • Data arrangement Instructions: Little endian Data: Selectable as little endian or big endian • On-chip 32-bit multiplier: 32-bit × 32-bit → 64-bit • On-chip divider: 32-bit ÷ 32-bit → 32 bits • Barrel shifter: 32 bits • Memory protection unit (MPU)
	FPU	• Single precision (32-bit) floating point • Data types and floating-point exceptions in conformance with the IEEE754 standard
Memory	ROM	• Capacity: 64 K/128 Kbytes • 32 MHz, no-wait memory access 32 to 40 MHz: wait states • Programming/erasing method: Serial programming (asynchronous serial communication), self-programming
	RAM	• Capacity: 12 Kbytes • 40 MHz, no-wait memory access
MCU operating mode		Single-chip mode
Clock	Clock generation circuit	• Main clock oscillator, low-speed and high-speed on-chip oscillator, PLL frequency synthesizer, and IWDT-dedicated on-chip oscillator • Oscillation stop detection: Available • Clock frequency accuracy measurement circuit (CAC): Available • Independent settings for the system clock (ICLK), peripheral module clock (PCLK), and FlashIF clock (FCLK) The CPU and system sections such as other bus masters run in synchronization with the system clock (ICLK): 40 MHz (at max.) MTU3c runs in synchronization with the PCLKA: 40 MHz (at max.) Peripheral modules other than MTU3c run in synchronization with the PCLKB: 40 MHz (at max.) ADCLK operated in S12ADE runs in synchronization with the PCLKD: 40 MHz (at max.) The flash peripheral circuit runs in synchronization with the FCLK: 32 MHz (at max.)
Resets		RES# pin reset, power-on reset, voltage monitoring reset, independent watchdog timer reset, and software reset
Voltage detection	Voltage detection circuit (LVDAb)	• When the voltage on VCC falls below the voltage detection level, an internal reset or internal interrupt is generated. Voltage detection circuit 0 is capable of selecting the detection voltage from 2 levels Voltage detection circuit 1 is capable of selecting the detection voltage from 9 levels Voltage detection circuit 2 is capable of selecting the detection voltage from 4 levels
Low power consumption	Low power consumption functions	• Module stop function • Three low power consumption modes Sleep mode, deep sleep mode, and software standby mode
	Function for lower operating power consumption	• Operating power control modes High-speed operating mode and middle-speed operating mode

Table 1.1 Outline of Specifications (2/3)

Classification	Module/Function	Description
Interrupt	Interrupt controller (ICUb)	• Interrupt vectors: 83 • External interrupts: 7 (NMI, IRQ0 to IRQ5 pins) • Non-maskable interrupts: 5 (NMI pin, oscillation stop detection interrupt, voltage monitoring 1 interrupt, voltage monitoring 2 interrupt, and IWDT interrupt) • 16 levels specifiable for the order of priority
DMA	Data transfer controller (DTCa)	• Transfer modes: Normal transfer, repeat transfer, and block transfer • Activation sources: Interrupts • Chain transfer function
I/O ports	General I/O ports	64-/52-/48-pin • I/O: 50/40/37 • Input: 1/1/1 • Pull-up resistors: 50/40/37 • Open-drain outputs: 42/32/29 • 5-V tolerance: 2/2/2
Multi-function pin controller (MPC)		Capable of selecting the input/output function from multiple pins
Timers	Multi-function timer pulse unit 3 (MTU3c)	• 6 units (16bis × 6 channels) • Provides up to 16 pulse-input/output lines and three pulse-input lines • Select from among fourteen counter-input clock signals for each channel (PCLK/1, PCLK/2, PCLK/4, PCLK/8, PCLK/16, PCLK/32, PCLK/64, PCLK/256, PCLK/1024, MTCLKA, MTCLKB, MTCLKC, MTCLKD, MTIOC1A) other than channel 1/3/4, for which only eleven signals are available, channel 2 for 12, channel 5 for 10 • 26 output compare/input capture registers • Counter clear operation (with compare match- or input capture-sourced simultaneous counter clear capability) • Simultaneous writing to multiple timer counters (TCNT) • Simultaneous register input/output by synchronous counter operation • Buffer operation • Cascaded operation • 28 interrupt sources • Automatic transfer of register data • Pulse output modes: Toggle/PWM/complementary PWM/reset-synchronized PWM • Complementary PWM output mode 3-phase non-overlapping waveform output for inverter control Automatic dead time setting Adjustable PWM duty cycle: from 0 to 100% A/D conversion request delaying function Interrupt at crest/trough can be skipped Double buffer function • Reset-synchronized PWM mode Outputs three phases each for positive and negative PWM waveforms in user-specified duty cycle • Phase counting modes: 16-bit mode (channel 1 and 2)/32-bit mode (channel 1 and 2) • Dead time compensation counter function • A/D converter start trigger can be generated • A/D converter start triggers can be skipped • Signals from the input capture and external counter clock pins are input via a digital filter
	Port output enable 3 (POE3b)	Controls the high-impedance state of the MTU's waveform output pins
	Compare match timer (CMT)	• (16 bits × 2 channels) × 2 units • Select from among four clock signals (PCLK/8, PCLK/32, PCLK/128, PCLK/512)
	Independent watchdog timer (IWDTa)	• 14 bits × 1 channel • Count clock: Dedicated low-speed on-chip oscillator for the IWDT Frequency divided by 1, 16, 32, 64, 128, or 256
	8-bit timer (TMR)	• (8 bits × 2 channels) × 2 units • Seven internal clocks (PCLK/1, PCLK/2, PCLK/8, PCLK/32, PCLK/64, PCLK/1024, and PCLK/8192) and an external clock can be selected • Pulse output and PWM output with any duty cycle are available • Two channels can be cascaded and used as a 16-bit timer • Generates A/D conversion start trigger • Generates baud rate clock for the SCI5

Table 1.1 Outline of Specifications (3/3)

Classification	Module/Function	Description
Communication functions	Serial communications interfaces (SCIg)	• 2 channels (channel 1 and 5: SCIg) • SCIg Serial communications modes: Asynchronous, clock synchronous, and smart-card interface On-chip baud rate generator allows selection of the desired bit rate Choice of LSB-first or MSB-first transfer Average transfer rate clock can be input from TMR timers for SCI5 Simple I^2C Simple SPI 9-bit transfer mode Bit rate modulation
	I^2C bus interface (RIICa)	• 1 channel • Communications formats: I^2C bus format/SMBus format • Master mode or slave mode selectable • Supports fast mode
	Serial peripheral interface (RSPIa)	• 1 channel • Transfer facility Using the MOSI (master out, slave in), MISO (master in, slave out), SSL (slave select), and RSPI clock (RSPCK) signals enables serial transfer through SPI operation (four lines) or clock-synchronous operation (three lines) • Capable of handling serial transfer as a master or slave • Data formats • Choice of LSB-first or MSB-first transfer The number of bits in each transfer can be changed to 8, 9, 10, 11, 12, 13, 14, 15, 16, 20, 24, or 32 bits. 128-bit buffers for transmission and reception Up to four frames can be transmitted or received in a single transfer operation (with each frame having up to 32 bits) • Double buffers for both transmission and reception
12-bit A/D converter (S12ADE)		• 12 bits (10 channels × 1 unit) • 12-bit resolution • Minimum conversion time: 1.0 µs per channel when the ADCLK is operating at 40 MHz • Operating modes Scan mode (single scan mode, continuous scan mode, and group scan mode) Group A priority control (only for group scan mode) • Sampling variable Sampling time can be set up for each channel • Self-diagnostic function • Double trigger mode (A/D conversion data duplicated) • Detection of analog input disconnection • A/D conversion start conditions A software trigger, a trigger from a timer (MTU, TMR), or an external trigger signal
Comparator C (CMPC)		• 3 channels • Function to compare the reference voltage and the analog input voltage • Reference voltage: Select from among two voltages • Analog input voltage: Select from among four voltages
D/A converter (DA) for generating comparator C reference voltage		• 1 channel • 8-bit resolution • Output voltage: 0 to AVCC0 • Reference voltage generation circuit for comparator C
CRC calculator (CRC)		• CRC code generation for arbitrary amounts of data in 8-bit units • Select any of three generating polynomials: $X^8 + X^2 + X + 1$, $X^{16} + X^{15} + X^2 + 1$, or $X^{16} + X^{12} + X^5 + 1$ • Generation of CRC codes for use with LSB-first or MSB-first communications is selectable.
Data operation circuit (DOC)		Comparison, addition, and subtraction of 16-bit data
Power supply voltages/Operating frequencies		VCC = 2.7 to 5.5V: 40MHz
Supply current		15 mA at 40 MHz (typ.)
Operating temperature range		D version: –40 to +85°C, G version: –40 to +105°C
Packages		64-pin LFQFP 0.5mm pitch 52-pin LQFP 0.65mm pitch 48-pin LFQFP 0.5mm pitch
On-chip debugging system		E1 emulator (FINE interface)

Table 1.2 Comparison of Functions for Different Packages

Module/Functions		RX23T Group		
		48 Pins	**52 Pins**	**64 Pins**
Interrupts	External interrupts	NMI, IRQ0 to IRQ5		
DTC	Data transfer controller	Available		
Timers	Multi-function timer pulse unit 3*1	6 channels		
	Port output enable 3	POE0# to POE8#, POE10#		
	8-bit timer	2 channels × 2 units		
	Compare match timer	2 channels × 2 units		
	Independent watchdog timer	Available		
Communication functions	Serial communications interfaces (SCIg) [including simple IIC and simple SPI]	2 channels (SCI1, 5)		
	I^2C bus interface	1 channel		
	Serial peripheral interface	1 channel		
12-bit A/D converter (including high-precision channels)		10 channels (8 channels)		
CRC calculator		Available		
Packages		48-pin LFQFP	52-pin LQFP	64-pin LFQFP

Note 1. For multi-function timer pulse unit 3, the number of pins differs depending on the package. For details, see the "List of Pins and Pin Functions" table for each pin.

1.2 List of Products

Table 1.3 and Table 1.4 are a list of products, and Figure 1.1 shows how to read the product part no., memory capacity, and package type.

Table 1.3 List of Products: D Version (T_a = –40 to +85°C)

Group	Part No.	Package	ROM Capacity	RAM Capacity	Operating Frequency	Operating Temperature
RX23T	R5F523T5ADFL	PLQP0048KB-B	128 Kbytes	12 Kbytes	40MHz	-40 to + 85°C
	R5F523T5ADFD	PLQP0052JA-B				
	R5F523T5ADFM	PLQP0064KB-C				
	R5F523T3ADFL	PLQP0048KB-B	64 Kbytes			
	R5F523T3ADFD	PLQP0052JA-B				
	R5F523T3ADFM	PLQP0064KB-C				

Table 1.4 List of Products: G Version (T_a = –40 to +105°C)

Group	Part No.	Package	ROM Capacity	RAM Capacity	Operating Frequency	Operating Temperature
RX23T	R5F523T5AGFL	PLQP0048KB-B	128 Kbytes	12 Kbytes	40MHz	-40 to +105°C
	R5F523T5AGFD	PLQP0052JA-B				
	R5F523T5AGFM	PLQP0064KB-C				
	R5F523T3AGFL	PLQP0048KB-B	64 Kbytes			
	R5F523T3AGFD	PLQP0052JA-B				
	R5F523T3AGFM	PLQP0064KB-C				

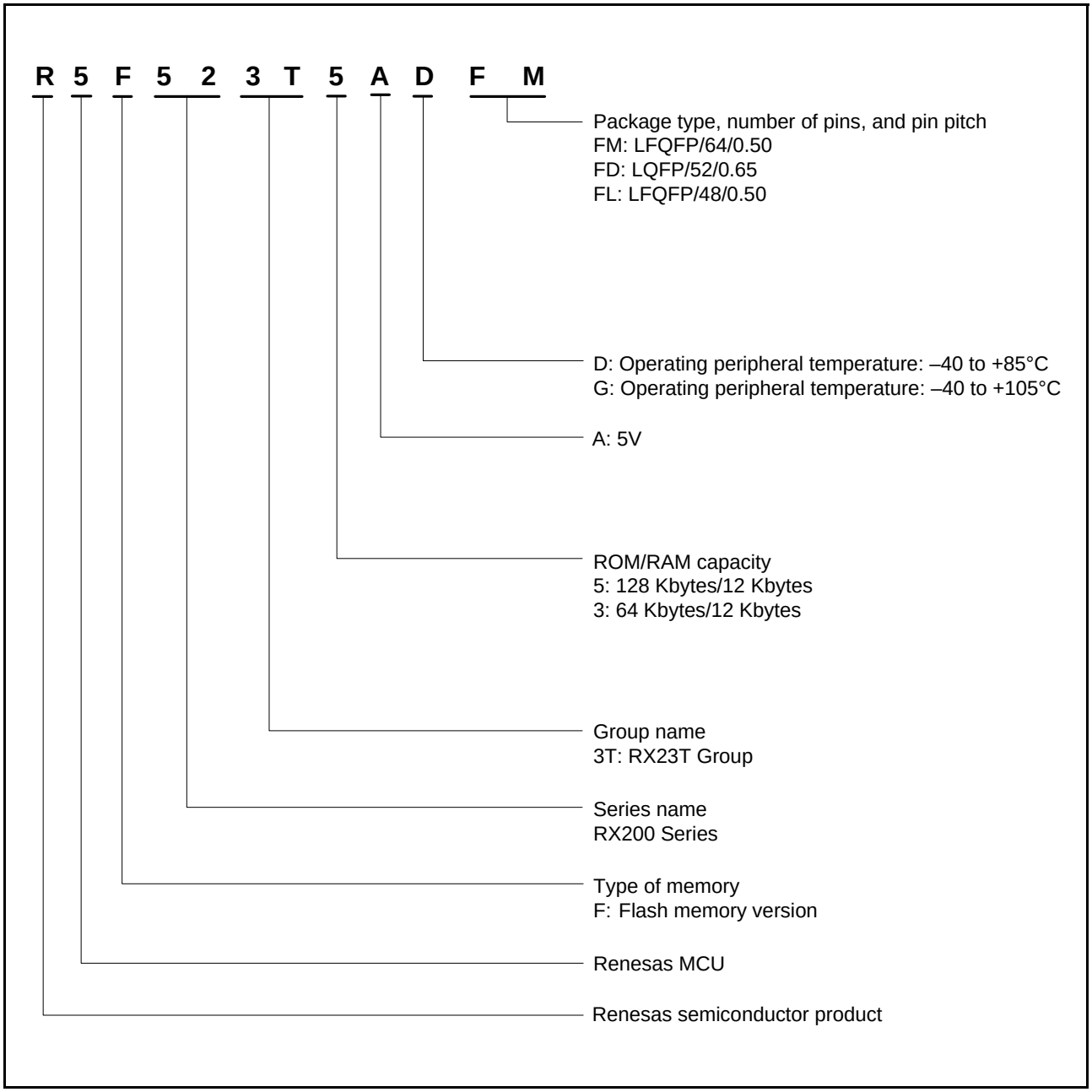


Figure 1.1 How to Read the Product Part Number

1.3 Block Diagram

Figure 1.2 shows a block diagram.

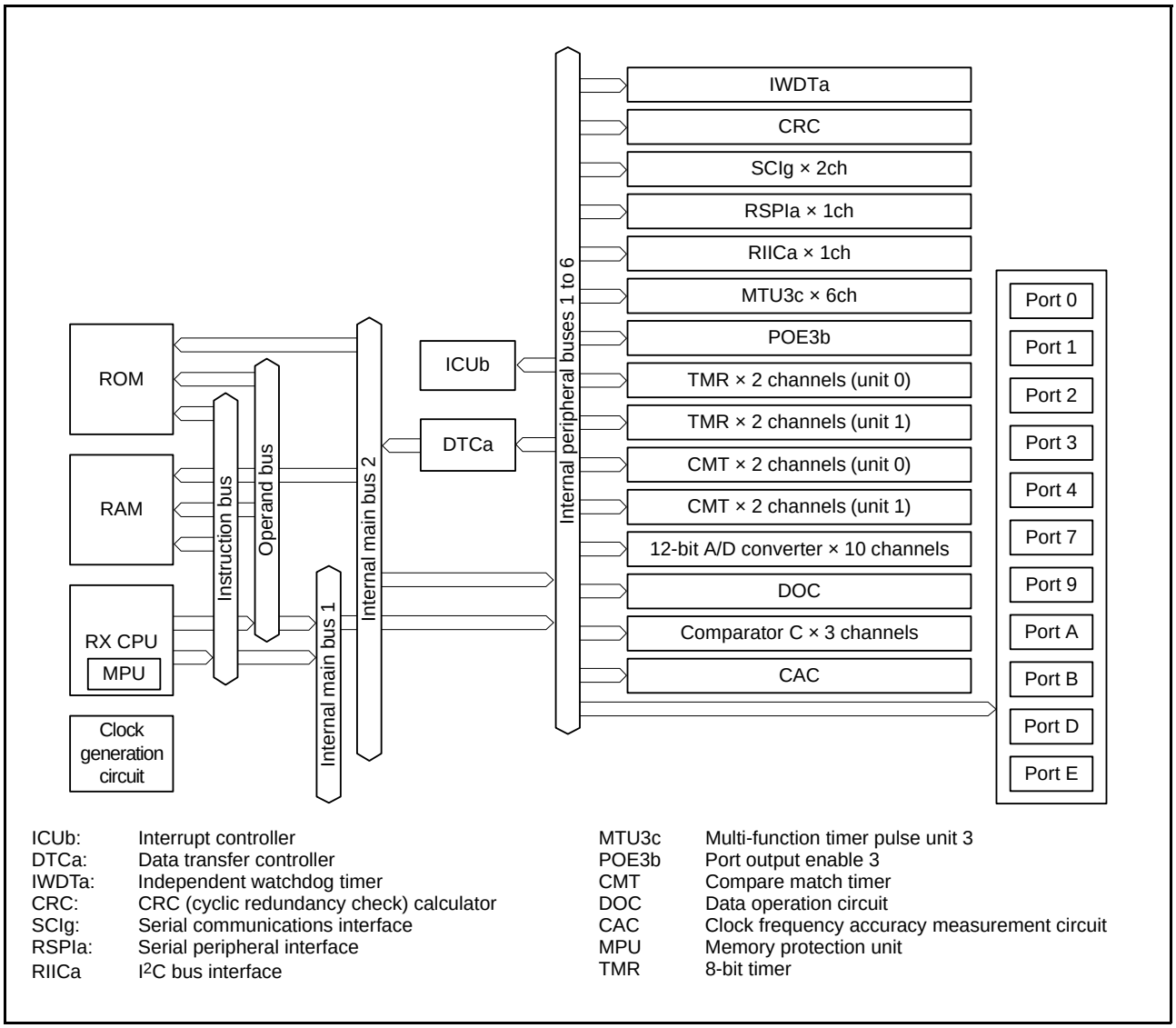


Figure 1.2 Block Diagram

1.4 Pin Functions

Table 1.5 lists the pin functions.

Table 1.5 Pin Functions (1/2)

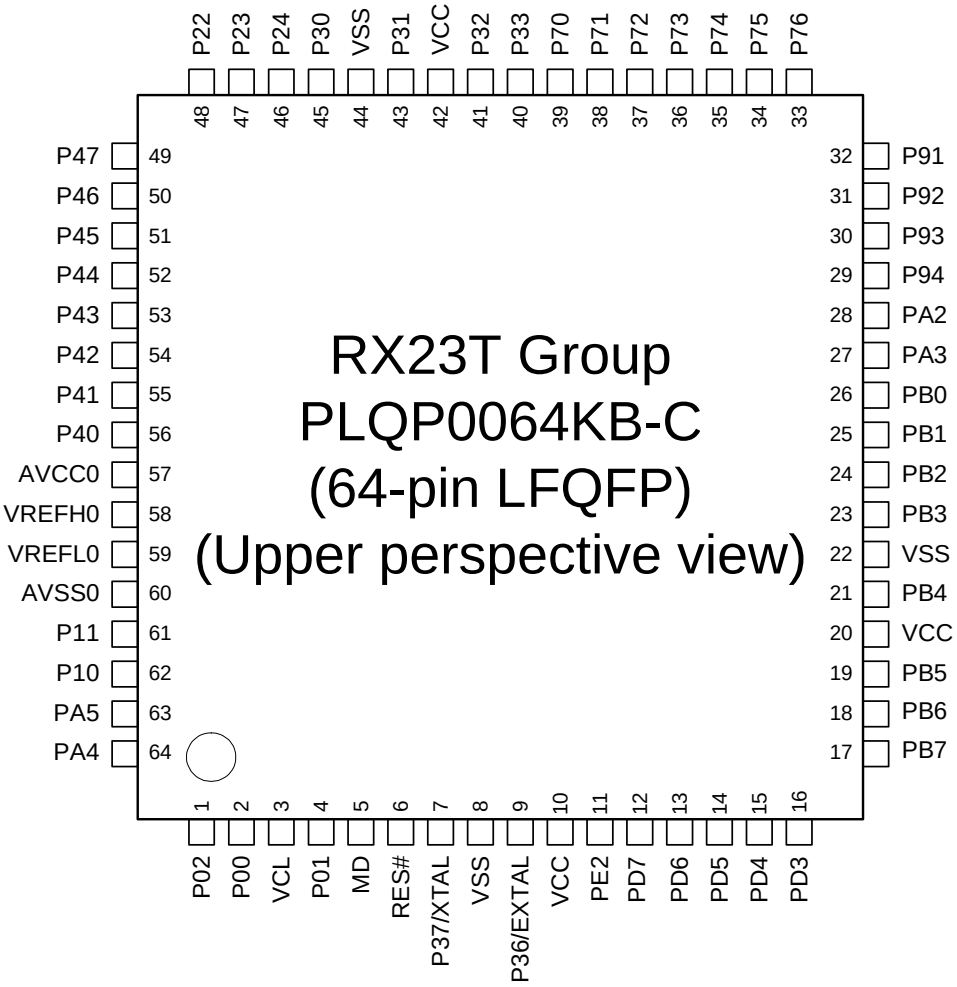
Classifications	Pin Name	I/O	Description
Power supply	VCC	Input	Power supply pin. Connect it to the system power supply.
	VCL	—	Connect this pin to the VSS pin via the 4.7 µF smoothing capacitor used to stabilize the internal power supply. Place the capacitor close to the pin.
	VSS	Input	Ground pin. Connect it to the system power supply (0 V).
Clock	XTAL	Output	Pins for connecting a crystal. An external clock can be input through the EXTAL pin.
	EXTAL	Input	
Operating mode control	MD	Input	Pin for setting the operating mode. The signal levels on this pin must not be changed during operation.
System control	RES#	Input	Reset pin. This MCU enters the reset state when this signal goes low.
CAC	CACREF	Input	Input pin for the clock frequency accuracy measurement circuit.
On-chip emulator	FINED	I/O	FINE interface pin.
Interrupts	NMI	Input	Non-maskable interrupt request pin.
	IRQ0 to IRQ5	Input	Interrupt request pins.
Multi-function timer pulse unit 3	MTIOC0A, MTIOC0B MTIOC0C, MTIOC0D	I/O	The TGRA0 to TGRD0 input capture input/output compare output/PWM output pins.
	MTIOC1A, MTIOC1B	I/O	The TGRA1 and TGRB1 input capture input/output compare output/PWM output pins.
	MTIOC2A, MTIOC2B	I/O	The TGRA2 and TGRB2 input capture input/output compare output/PWM output pins.
	MTIOC3A, MTIOC3B MTIOC3C, MTIOC3D	I/O	The TGRA3 to TGRD3 input capture input/output compare output/PWM output pins.
	MTIOC4A, MTIOC4B MTIOC4C, MTIOC4D	I/O	The TGRA4 to TGRD4 input capture input/output compare output/PWM output pins.
	MTIC5U, MTIC5V, MTIC5W	Input	The TGRU5, TGRV5, and TGRW5 input capture input/external pulse input pins.
	MTCLKA, MTCLKB, MTCLKC, MTCLKD	Input	Input pins for the external clock.
	ADSM0	Output	A/D trigger output pin.
Port output enable 3	POE0#, POE8#, POE10#	Input	Input pins for request signals to place the MTU pins in the high impedance state.
8-bit timer	TMO0 to TMO3	Output	Compare match output pins.
	TMCI0 to TMCI3	Input	Input pins for the external clock to be input to the counter.
	TMRI0 to TMRI3	Input	Counter reset input pins.
Serial communications interface (SCIg)	• Asynchronous mode/clock synchronous mode		
	SCK1, SCK5	I/O	Input/output pins for the clock.
	RXD1, RXD5	Input	Input pins for received data.
	TXD1, TXD5	Output	Output pins for transmitted data.
	CTS1#, CTS5#	Input	Input pins for controlling the start of transmission and reception.
	RTS1#, RTS5#	Output	Output pins for controlling the start of transmission and reception.
	• Simple I^2C mode		
	SSCL1, SSCL5	I/O	Input/output pins for the I^2C clock.
	SSDA1, SSDA5	I/O	Input/output pins for the I^2C data.

Table 1.5 Pin Functions (2/2)

Classifications	Pin Name	I/O	Description
Serial communications interface (SCIg)	• Simple SPI mode		
	SCK1, SCK5	I/O	Input/output pins for the clock.
	SMISO1, SMISO5	I/O	Input/output pins for slave transmit data.
	SMOSI1, SMOSI5	I/O	Input/output pins for master transmit data.
	SS1#, SS5#	Input	Chip-select input pins.
I^2C bus interface	SCL0	I/O	Input/output pin for I^2C bus interface clocks. Bus can be directly driven by the N-channel open drain output.
	SDA0	I/O	Input/output pin for I^2C bus interface data. Bus can be directly driven by the N-channel open drain output.
Serial peripheral interface	RSPCKA	I/O	Input/output pin for the RSPI clock.
	MOSIA	I/O	Input/output pin for transmitting data from the RSPI master.
	MISOA	I/O	Input/output pin for transmitting data from the RSPI slave.
	SSLA0	I/O	Input/output pin to select the slave for the RSPI.
	SSLA1 to SSLA3	Output	Output pins to select the slave for the RSPI.
12-bit A/D converter	AN000 to AN007, AN016, AN017	Input	Input pins for the analog signals to be processed by the A/D converter.
	ADTRG0#	Input	Input pin for the external trigger signals that start the A/D conversion.
	ADST0	Output	Output pin for A/D conversion status.
Comparator C	CMPC00, CMPC01, CMPC02	Input	Analog input pin for CMPC0
	CMPC10, CMPC11, CMPC12	Input	Analog input pin for CMPC1
	CMPC20, CMPC21, CMPC22	Input	Analog input pin for CMPC2
	COMP0 to COMP2	Output	Comparator detection result output pins.
	CVREFC0, CVREFC1	Input	Analog reference voltage supply pins for comparator C.
Analog power supply	AVCC0	Input	Analog voltage supply pin for the 12-bit A/D converter, comparator C, and the 8-bit D/A converter for generating comparator C reference voltage. Connect this pin to VCC when these modules are not used.
	AVSS0	Input	Analog ground pin for the 12-bit A/D converter, comparator C, and the 8-bit D/A converter for generating comparator C reference voltage. Connect this pin to VSS when these modules are not used.
	VREFH0	Input	Analog reference voltage supply pin for the 12-bit A/D converter.
	VREFL0	Input	Analog reference ground pin for the 12-bit A/D converter.
I/O ports	P00 to P02	I/O	3-bit input/output pins.
	P10, P11	I/O	2-bit input/output pins.
	P22 to P24	I/O	3-bit input/output pins.
	P30 to P33, P36, P37	I/O	6-bit input/output pins.
	P40 to P47	I/O	8-bit input/output pins.
	P70 to P76	I/O	7-bit input/output pins.
	P91 to P94	I/O	4-bit input/output pins.
	PA2 to PA5	I/O	4-bit input/output pins.
	PB0 to PB7	I/O	8-bit input/output pins.
	PD3 to PD7	I/O	5-bit input/output pins.
	PE2	Input	1-bit input pin.

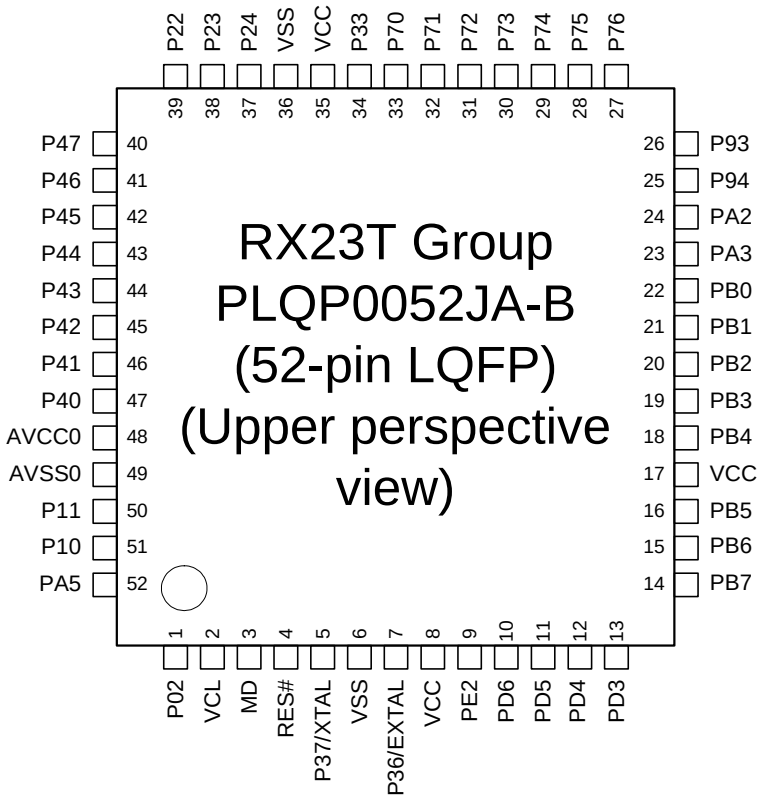
1.5 Pin Assignments

Figure 1.3 to Figure 1.5 show the pin assignments. Table 1.6 to Table 1.8 show the lists of pins and pin functions.



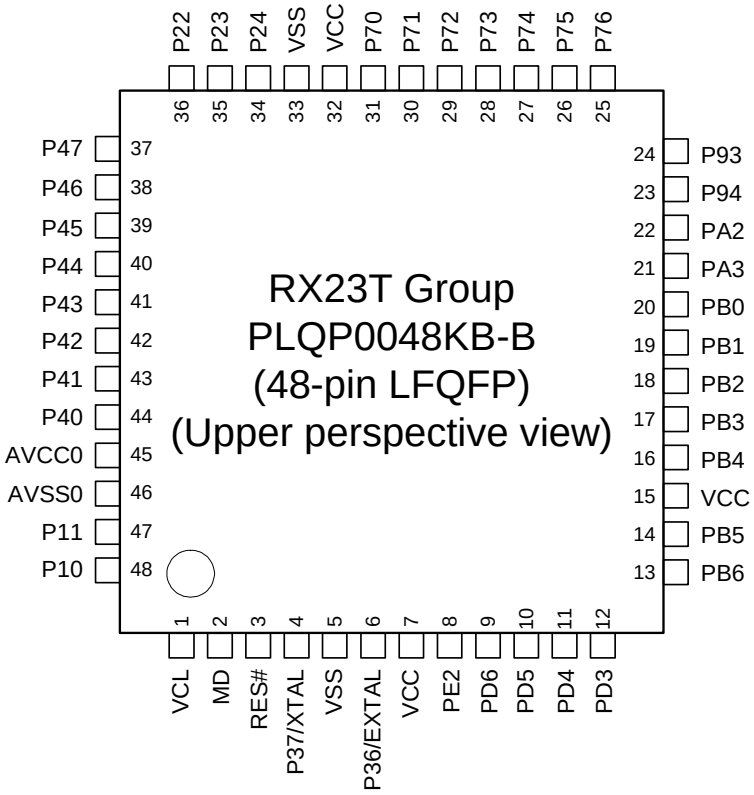
Note: This figure indicates the power supply pins and I/O port pins.
For the pin configuration, see the table “List of Pins and Pin Functions (64-Pin LFQFP)”.

Figure 1.3 Pin Assignments of the 64-Pin LFQFP



Note: This figure indicates the power supply pins and I/O port pins.
For the pin configuration, see the table “List of Pins and Pin Functions (52-Pin LQFP)”.

Figure 1.4 Pin Assignments of the 52-Pin LQFP



Note: This figure indicates the power supply pins and I/O port pins.
For the pin configuration, see the table “List of Pins and Pin Functions (48-Pin LFQFP)”.

Figure 1.5 Pin Assignments of the 48-Pin LFQFP

Table 1.6 List of Pins and Pin Functions (64-Pin LFQFP) (1/2)

Pin No.	Power Supply, Clock, System Control	I/O Port	Timers (MTU, TMR, POE, CAC)	Communications (SCIg, RSPI, RIIC)	Others
1		P02		CTS1#/RTS1#/SS1#	ADST0/IRQ5
2		P00			IRQ2
3	VCL				
4		P01	CACREF		IRQ4
5	MD				FINED
6	RES#				
7	XTAL	P37			
8	VSS				
9	EXTAL	P36			
10	VCC				
11		PE2	POE10#		NMI
12		PD7	TMRI1	SSLA1	
13		PD6	TMO1	SSLA0/CTS1#/RTS1#/SS1#	ADST0/IRQ5
14		PD5	TMRI0	RXD1/SMISO1/SSCL1	IRQ3
15		PD4	TMCI0	SCK1	IRQ2
16		PD3	TMO0	TXD1/SMOSI1/SSDA1	
17		PB7		SCK5	
18		PB6		RXD5/SMISO5/SSCL5	IRQ5
19		PB5		TXD5/SMOSI5/SSDA5	
20	VCC				
21		PB4	POE8#		IRQ3
22	VSS				
23		PB3	MTIOC0A/CACREF	SCK5/RSPCKA	
24		PB2	MTIOC0B/ADSM0	TXD5/SMOSI5/SSDA5/SDA0	
25		PB1	MTIOC0C	RXD5/SMISO5/SSCL5/SCL0	IRQ2
26		PB0	MTIOC0D	MOSIA	
27		PA3	MTIOC2A	SSLA0	
28		PA2	MTIOC2B	CTS5#/RTS5#/SS5#/SSLA1	IRQ4
29		P94	MTIOC0C/TMO1	MISOA	IRQ1
30		P93	MTIOC0B/TMRI1	SCK5/RSPCKA	IRQ0
31		P92	TMCI1	SSLA2	
32		P91		SSLA3	
33		P76	MTIOC4D		
34		P75	MTIOC4C		
35		P74	MTIOC3D		
36		P73	MTIOC4B		
37		P72	MTIOC4A		
38		P71	MTIOC3B		
39		P70	POE0#		IRQ5
40		P33	MTIOC3A/MTCLKA	SSLA3	
41		P32	MTIOC3C/MTCLKB	SSLA2	
42	VCC				
43		P31	MTIOC0A/MTCLKC	SSLA1	
44	VSS				
45		P30	MTIOC0B/MTCLKD	SSLA0	
46		P24	MTIC5U/TMCI2	RSPCKA	COMP0/IRQ3
47		P23	MTIC5V/CACREF/TMO2	MOSIA	COMP1/IRQ4
48		P22	MTIC5W/TMRI2	MISOA	COMP2/IRQ2
49		P47			AN007/CMPC12/ CMPC22
50		P46			AN006/CMPC02
51		P45			AN005/CMPC21
52		P44			AN004/CMPC11
53		P43			AN003/CMPC01

Table 1.6 List of Pins and Pin Functions (64-Pin LFQFP) (2/2)

Pin No.	Power Supply, Clock, System Control	I/O Port	Timers (MTU, TMR, POE, CAC)	Communications (SCIg, RSPI, RIIC)	Others
54		P42			AN002/CMPC20
55		P41			AN001/CMPC10
56		P40			AN000/CMPC00
57	AVCC0				
58	VREFH0				
59	VREFL0				
60	AVSS0				
61		P11	MTIOC3A/MTCLKC/TMO3		IRQ1/AN016/ CVREFC0
62		P10	MTCLKD/TMRI3		IRQ0/AN017/ CVREFC1
63		PA5	MTIOC1A/TMCI3	MISOA	
64		PA4	MTIOC1B	RSPCKA	ADTRG0#

Table 1.7 List of Pins and Pin Functions (52-Pin LQFP)

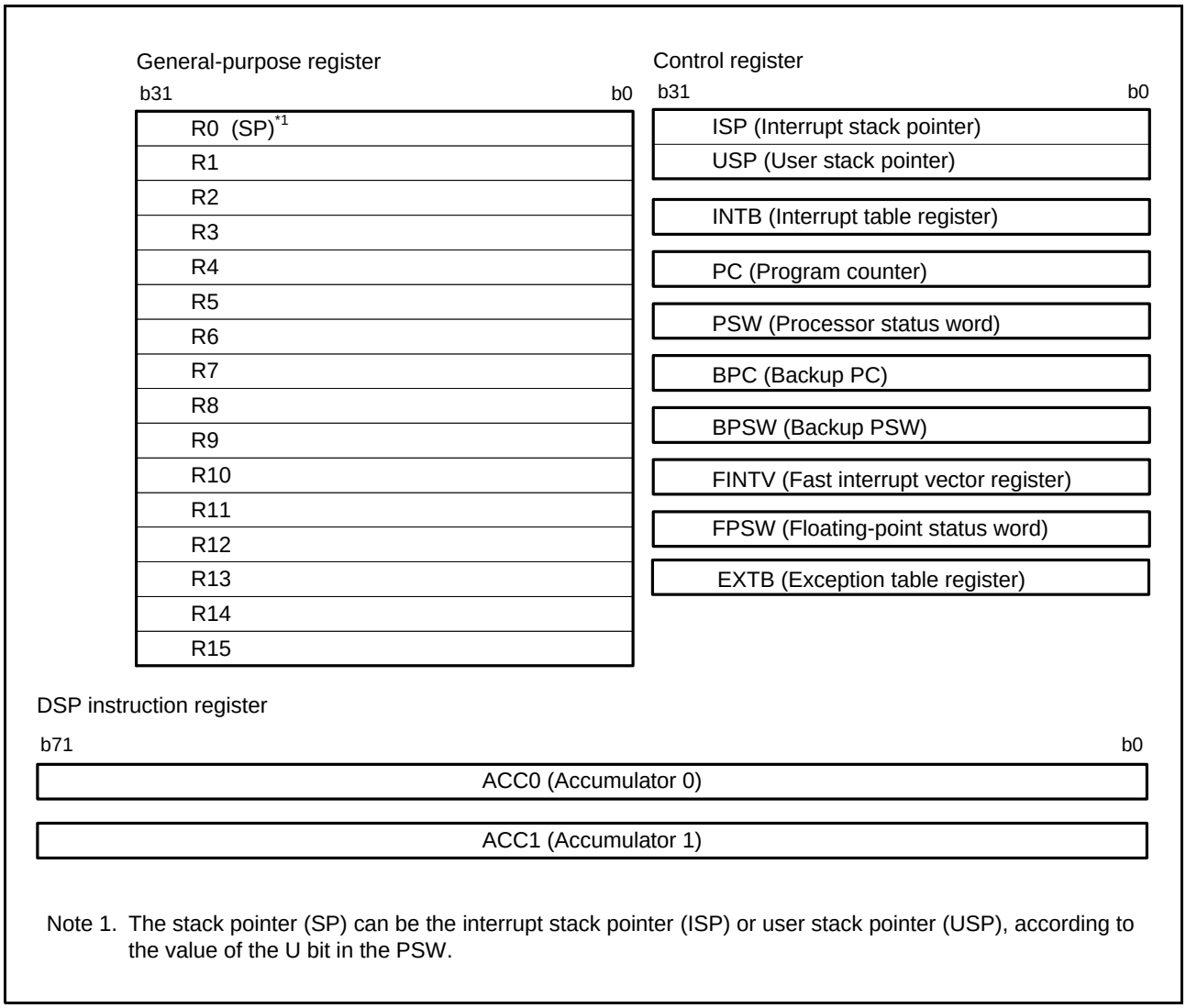
Pin No.	Power Supply, Clock, System Control	I/O Port	Timers (MTU, TMR, POE, CAC)	Communications (SCIg, RSPI, RIIC)	Others
1		P02		CTS1#/RTS1#/SS1#	ADST0/IRQ5
2	VCL				
3	MD				FINED
4	RES#				
5	XTAL	P37			
6	VSS				
7	EXTAL	P36			
8	VCC				
9		PE2	POE10#		NMI
10		PD6	TMO1	SSLA0/CTS1#/RTS1#/SS1#	ADST0/IRQ5
11		PD5	TMRI0	RXD1/SMISO1/SSCL1	IRQ3
12		PD4	TMCI0	SCK1	IRQ2
13		PD3	TMO0	TXD1/SMOSI1/SSDA1	
14		PB7		SCK5	
15		PB6		RXD5/SMISO5/SSCL5	IRQ5
16		PB5		TXD5/SMOSI5/SSDA5	
17	VCC				
18		PB4	POE8#		IRQ3
19		PB3	MTIOC0A/CACREF	SCK5/RSPCKA	
20		PB2	MTIOC0B/ADSM0	TXD5/SMOSI5/SSDA5/SDA0	
21		PB1	MTIOC0C	RXD5/SMISO5/SSCL5/SCL0	IRQ2
22		PB0	MTIOC0D	MOSIA	
23		PA3	MTIOC2A	SSLA0	
24		PA2	MTIOC2B	CTS5#/RTS5#/SS5#/SSLA1	IRQ4
25		P94	MTIOC0C/TMO1	MISOA	IRQ1
26		P93	MTIOC0B/TMRI1	SCK5/RSPCKA	IRQ0
27		P76	MTIOC4D		
28		P75	MTIOC4C		
29		P74	MTIOC3D		
30		P73	MTIOC4B		
31		P72	MTIOC4A		
32		P71	MTIOC3B		
33		P70	POE0#		IRQ5
34		P33	MTIOC3A/MTCLKA	SSLA3	
35	VCC				
36	VSS				
37		P24	MTIC5U/TMCI2	RSPCKA	COMP0/IRQ3
38		P23	MTIC5V/CACREF/TMO2	MOSIA	COMP1/IRQ4
39		P22	MTIC5W/TMRI2	MISOA	COMP2/IRQ2
40		P47			AN007/CMPC12/ CMPC22
41		P46			AN006/CMPC02
42		P45			AN005/CMPC21
43		P44			AN004/CMPC11
44		P43			AN003/CMPC01
45		P42			AN002/CMPC20
46		P41			AN001/CMPC10
47		P40			AN000/CMPC00
48	AVCC0				
49	AVSS0				
50		P11	MTIOC3A/MTCLKC/TMO3		IRQ1/AN016/ CVREFC0
51		P10	MTCLKD/TMRI3		IRQ0/AN017/ CVREFC1
52		PA5	MTIOC1A/TMCI3	MISOA	

Table 1.8 List of Pins and Pin Functions (48-Pin LFQFP)

Pin No.	Power Supply, Clock, System Control	I/O Port	Timers (MTU, TMR, POE, CAC)	Communications (SCIg, RSPI, RIIC)	Others
1	VCL				
2	MD				FINED
3	RES#				
4	XTAL	P37			
5	VSS				
6	EXTAL	P36			
7	VCC				
8		PE2	POE10#		NMI
9		PD6	TMO1	SSLA0/CTS1#/RTS1#/SS1#	ADST0/IRQ5
10		PD5	TMRI0	RXD1/SMISO1/SSCL1	IRQ3
11		PD4	TMCI0	SCK1	IRQ2
12		PD3	TMO0	TXD1/SMOSI1/SSDA1	
13		PB6		RXD5/SMISO5/SSCL5	IRQ5
14		PB5		TXD5/SMOSI5/SSDA5	
15	VCC				
16		PB4	POE8#		IRQ3
17		PB3	MTIOC0A/CACREF	SCK5/RSPCKA	
18		PB2	MTIOC0B/ADSM0	TXD5/SMOSI5/SSDA5/SDA0	
19		PB1	MTIOC0C	RXD5/SMISO5/SSCL5/SCL0	IRQ2
20		PB0	MTIOC0D	MOSIA	
21		PA3	MTIOC2A	SSLA0	
22		PA2	MTIOC2B	CTS5#/RTS5#/SS5#/SSLA1	IRQ4
23		P94	MTIOC0C/TMO1	MISOA	IRQ1
24		P93	MTIOC0B/TMRI1	SCK5/RSPCKA	IRQ0
25		P76	MTIOC4D		
26		P75	MTIOC4C		
27		P74	MTIOC3D		
28		P73	MTIOC4B		
29		P72	MTIOC4A		
30		P71	MTIOC3B		
31		P70	POE0#		IRQ5
32	VCC				
33	VSS				
34		P24	MTIC5U/TMCI2	RSPCKA	COMP0/IRQ3
35		P23	MTIC5V/CACREF/TMO2	MOSIA	COMP1/IRQ4
36		P22	MTIC5W/TMRI2	MISOA	COMP2/IRQ2
37		P47			AN007/CMPC12/ CMPC22
38		P46			AN006/CMPC02
39		P45			AN005/CMPC21
40		P44			AN004/CMPC11
41		P43			AN003/CMPC01
42		P42			AN002/CMPC20
43		P41			AN001/CMPC10
44		P40			AN000/CMPC00
45	AVCC0				
46	AVSS0				
47		P11	MTIOC3A/MTCLKC/TMO3		IRQ1/AN016/ CVREFC0
48		P10	MTCLKD/TMRI3		IRQ0/AN017/ CVREFC1

2. CPU

Figure 2.1 shows register set of the CPU.



Note 1. The stack pointer (SP) can be the interrupt stack pointer (ISP) or user stack pointer (USP), according to the value of the U bit in the PSW.

Figure 2.1 Register Set of the CPU

2.1 General-Purpose Registers (R0 to R15)

This CPU has sixteen 32-bit general-purpose registers (R0 to R15). R0 to R15 can be used as data registers or address registers.
R0, a general-purpose register, also functions as the stack pointer (SP).
The stack pointer is switched to operate as the interrupt stack pointer (ISP) or user stack pointer (USP) by the value of the stack pointer select bit (U) in the processor status word (PSW).

2.2 Control Registers

(1) Interrupt stack pointer (ISP) and user stack pointer (USP)

The stack pointer (SP) can be either of two types, the interrupt stack pointer (ISP) or the user stack pointer (USP). Whether the stack pointer operates as the ISP or USP depends on the value of the stack pointer select bit (U) in the processor status word (PSW).
Set the ISP or USP to a multiple of 4 to reduce the number of cycles required to execute interrupt sequences and instructions entailing stack manipulation.

(2) Exception table register (EXTB)

The exception table register (EXTB) specifies the address where the exception vector table starts.
Set the EXTB to a multiple of 4 to reduce the number of cycles required to execute interrupt sequences and instructions entailing stack manipulation.

(3) Interrupt table register (INTB)

The interrupt table register (INTB) specifies the address where the interrupt vector table starts.
Set the INTB to a multiple of 4 to reduce the number of cycles required to execute interrupt sequences and instructions entailing stack manipulation.

(4) Program counter (PC)

The program counter (PC) indicates the address of the instruction being executed.

(5) Processor status word (PSW)

The processor status word (PSW) indicates the results of instruction execution or the state of the CPU.

(6) Backup PC (BPC)

The backup PC (BPC) is provided to speed up response to interrupts.
After a fast interrupt has been generated, the contents of the program counter (PC) are saved in the BPC register.

(7) Backup PSW (BPSW)

The backup PSW (BPSW) is provided to speed up response to interrupts.
After a fast interrupt has been generated, the contents of the processor status word (PSW) are saved in the BPSW. The allocation of bits in the BPSW corresponds to that in the PSW.

(8) Fast interrupt vector register (FINTV)

The fast interrupt vector register (FINTV) is provided to speed up response to interrupts.
The FINTV register specifies a branch destination address when a fast interrupt has been generated.

(9) Floating-point status word (FPSW)

The floating-point status word (FPSW) indicates the results of floating-point operations.
When an exception handling enable bit (Ej) enables the exception handling (Ej = 1), the exception cause can be identified by checking the corresponding Cj flag in the exception handling routine. If the exception handling is masked (Ej = 0), the occurrence of exception can be checked by reading the Fj flag at the end of a series of processing. Once the Fj flag has been set to 1, this value is retained until it is cleared to 0 by software (j = X, U, Z, O, or V).

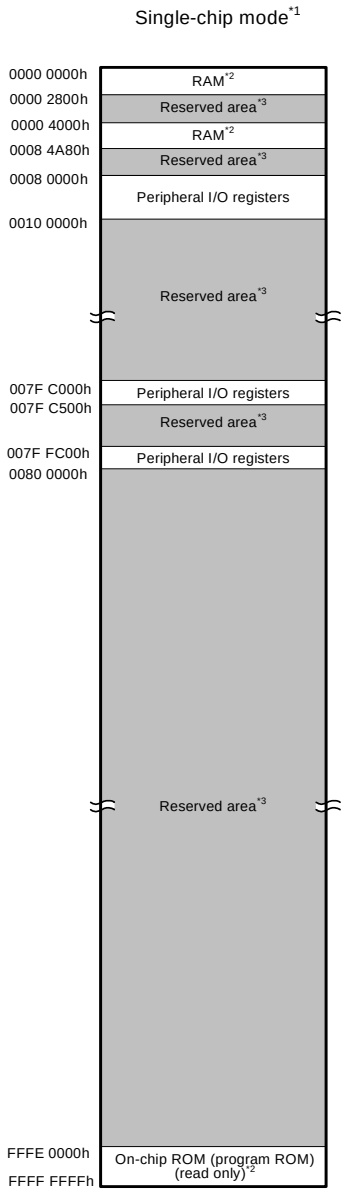
2.3 Accumulator

The accumulator (ACC0 or ACC1) is a 72-bit register used for DSP instructions. The accumulator is handled as a 96-bit register for reading and writing. At this time, when bits 95 to 72 of the accumulator are read, the value where the value of bit 71 is sign extended is read. Writing to bits 95 to 72 of the accumulator is ignored. ACC0 is also used for the multiply and multiply-and-accumulate instructions; EMUL, EMULU, FMUL, MUL, and RMPA, in which case the prior value in ACC0 is modified by execution of the instruction.
Use the MVTACGU, MVTACHI, and MVTACLO instructions for writing to the accumulator. The MVTACGU, MVTACHI, and MVTACLO instructions write data to bits 95 to 64, the higher-order 32 bits (bits 63 to 32), and the lower-order 32 bits (bits 31 to 0), respectively.
Use the MVFACGU, MVFACHI, MVFACMI, and MVFACLO instructions for reading data from the accumulator. The MVFACGU, MVFACHI, MVFACMI, and MVFACLO instructions read data from the guard bits (bits 95 to 64), higher-order 32 bits (bits 63 to 32), the middle 32 bits (bits 47 to 16), and the lower-order 32 bits (bits 31 to 0), respectively.

3. Address Space

3.1 Address Space

This LSI has a 4-Gbyte address space, consisting of the range of addresses from 0000 0000h to FFFF FFFFh. That is, linear access to an address space of up to 4 Gbytes is possible, and this contains both program and data areas.
Figure 3.1 shows the memory maps in the respective operating modes. Accessible areas will differ according to the operating mode and states of control bits.



Note 1. The address space in boot mode is the same as the address space in single-chip mode.
Note 2. The capacity of ROM/RAM differs depending on the products.

ROM (bytes)		RAM (bytes)	
Capacity	**Address**	**Capacity**	**Address**
128 Kbytes	FFFE 0000h to FFFF FFFFh	12 Kbytes	0000 0000h to 0000 27FFh 0000 4000h to 0000 4A7Fh
64 Kbytes	FFFF 0000h to FFFF FFFFh		

Note: See Table 1.3 and Table 1.4 List of Products, for the product type name.

Note 3. Reserved areas should not be accessed.

Figure 3.1 Memory Map in Each Operating Mode

4. I/O Registers

This section provides information on the on-chip I/O register addresses and bit configuration. The information is given as shown below. Notes on writing to registers are also given below.

(1) I/O register addresses (address order)

- Registers are listed from the lower allocation addresses.
- Registers are classified according to module symbols.
- Numbers of cycles for access indicate numbers of cycles of the given base clock.
- Among the internal I/O register area, addresses not listed in the list of registers are reserved. Reserved addresses must not be accessed. Do not access these addresses; otherwise, the operation when accessing these bits and subsequent operations cannot be guaranteed.

(2) Notes on writing to I/O registers

When writing to an I/O register, the CPU starts executing the subsequent instruction before completing I/O register write. This may cause the subsequent instruction to be executed before the post-update I/O register value is reflected on the operation.
As described in the following examples, special care is required for the cases in which the subsequent instruction must be executed after the post-update I/O register value is actually reflected.

[Examples of cases requiring special care]

- The subsequent instruction must be executed while an interrupt request is disabled with the IENj bit in IERn of the ICU (interrupt request enable bit) cleared to 0.
- A WAIT instruction is executed immediately after the preprocessing for causing a transition to the low power consumption state.

In the above cases, after writing to an I/O register, wait until the write operation is completed using the following procedure and then execute the subsequent instruction.

(a) Write to an I/O register.
(b) Read the value from the I/O register to a general register.
(c) Execute the operation using the value read.
(d) Execute the subsequent instruction.

[Instruction examples]

- Byte-size I/O registers

```
MOV.L  #SFR_ADDR, R1
MOV.B  #SFR_DATA, [R1]
CMP    [R1].UB, R1
;; Next process
```

- Word-size I/O registers

```
MOV.L  #SFR_ADDR, R1
MOV.W  #SFR_DATA, [R1]
CMP    [R1].W, R1
;; Next process
```

- Longword-size I/O registers

```
MOV.L  #SFR_ADDR, R1
MOV.L  #SFR_DATA, [R1]
CMP    [R1].L, R1
;; Next process
```

If multiple registers are written to and a subsequent instruction should be executed after the write operations are entirely completed, only read the I/O register that was last written to and execute the operation using the value; it is not necessary to read or execute operation for all the registers that were written to.

(3) Number of Access Cycles to I/O Registers

For numbers of clock cycles for access to I/O registers, see Table 4.1, List of I/O Registers (Address Order).
The number of access cycles to I/O registers is obtained by following equation.*1

Number of access cycles to I/O registers = Number of bus cycles for internal main bus 1 +
Number of divided clock synchronization cycles +
Number of bus cycles for internal peripheral bus 1 to 6

The number of bus cycles of internal peripheral bus 1 to 6 differs according to the register to be accessed.
When peripheral functions connected to internal peripheral bus 2 to 6 are accessed, the number of divided clock synchronization cycles is added.
In the peripheral function unit, when the frequency ratio of ICLK is equal to or greater than that of PCLK (or FCLK), the sum of the number of bus cycles for internal main bus 1 and the number of the divided clock synchronization cycles will be one cycle of PCLK (or FCLK) at a maximum. Therefore, one PCLK (or FCLK) has been added to the number of access cycles shown in Table 4.1.

Note 1. This applies to the number of cycles when the access from the CPU does not conflict with the bus access from the different bus master (DTC).

(4) Restrictions in Relation to RMPA and String-Manipulation Instructions

The allocation of data to be handled by RMPA or string-manipulation instructions to I/O registers is prohibited, and operation is not guaranteed if this restriction is not observed.

(5) Notes on Sleep Mode and Mode Transitions

During sleep mode or mode transitions, do not write to the system control related registers (indicated by 'SYSTEM' in the Module Symbol column in Table 4.1, List of I/O Registers (Address Order)).

4.1 I/O Register Addresses (Address Order)

Table 4.1 List of I/O Registers (Address Order) (1 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
0008 0000h	SYSTEM	Mode Monitor Register	MDMONR	16	16	3 ICLK
0008 0008h	SYSTEM	System Control Register 1	SYSCR1	16	16	3 ICLK
0008 000Ch	SYSTEM	Standby Control Register	SBYCR	16	16	3 ICLK
0008 0010h	SYSTEM	Module Stop Control Register A	MSTPCRA	32	32	3 ICLK
0008 0014h	SYSTEM	Module Stop Control Register B	MSTPCRB	32	32	3 ICLK
0008 0018h	SYSTEM	Module Stop Control Register C	MSTPCRC	32	32	3 ICLK
0008 0020h	SYSTEM	System Clock Control Register	SCKCR	32	32	3 ICLK
0008 0026h	SYSTEM	System Clock Control Register 3	SCKCR3	16	16	3 ICLK
0008 0028h	SYSTEM	PLL Control Register	PLLCR	16	16	3 ICLK
0008 002Ah	SYSTEM	PLL Control Register 2	PLLCR2	8	8	3 ICLK
0008 0031h	SYSTEM	Memory Wait Cycle Setting Register	MEMWAIT	8	8	3 ICLK
0008 0032h	SYSTEM	Main Clock Oscillator Control Register	MOSCCR	8	8	3 ICLK
0008 0034h	SYSTEM	Low-Speed On-Chip Oscillator Control Register	LOCOCR	8	8	3 ICLK
0008 0035h	SYSTEM	IWDT-Dedicated On-Chip Oscillator Control Register	ILOCOCR	8	8	3 ICLK
0008 0036h	SYSTEM	High-Speed On-Chip Oscillator Control Register	HOCOCR	8	8	3ICLK
0008 003Ch	SYSTEM	Oscillation Stabilization Flag Register	OSCOVFSR	8	8	3 ICLK
0008 0040h	SYSTEM	Oscillation Stop Detection Control Register	OSTDCR	8	8	3 ICLK
0008 0041h	SYSTEM	Oscillation Stop Detection Status Register	OSTDSR	8	8	3 ICLK
0008 00A0h	SYSTEM	Operating Power Control Register	OPCCR	8	8	3 ICLK
0008 00A2h	SYSTEM	Main Clock Oscillator Wait Control Register	MOSCWTCR	8	8	3 ICLK
0008 00A5h	SYSTEM	High-Speed On-Chip Oscillator Wait Control Register	HOCOWTCR	8	8	3ICLK
0008 00C0h	SYSTEM	Reset Status Register 2	RSTSR2	8	8	3 ICLK
0008 00C2h	SYSTEM	Software Reset Register	SWRR	16	16	3 ICLK
0008 00E0h	SYSTEM	Voltage Monitoring 1 Circuit Control Register 1	LVD1CR1	8	8	3 ICLK
0008 00E1h	SYSTEM	Voltage Monitoring 1 Circuit Status Register	LVD1SR	8	8	3 ICLK
0008 00E2h	SYSTEM	Voltage Monitoring 2 Circuit Control Register 1	LVD2CR1	8	8	3 ICLK
0008 00E3h	SYSTEM	Voltage Monitoring 2 Circuit Status Register	LVD2SR	8	8	3 ICLK
0008 03FEh	SYSTEM	Protect Register	PRCR	16	16	3 ICLK
0008 1300h	BSC	Bus Error Status Clear Register	BERCLR	8	8	2 ICLK
0008 1304h	BSC	Bus Error Monitoring Enable Register	BEREN	8	8	2 ICLK
0008 1308h	BSC	Bus Error Status Register 1	BERSR1	8	8	2 ICLK
0008 130Ah	BSC	Bus Error Status Register 2	BERSR2	16	16	2 ICLK
0008 1310h	BSC	Bus Priority Control Register	BUSPRI	16	16	2 ICLK
0008 2400h	DTC	DTC Control Register	DTCCR	8	8	2 ICLK
0008 2404h	DTC	DTC Vector Base Register	DTCVBR	32	32	2 ICLK
0008 2408h	DTC	DTC Address Mode Register	DTCADMOD	8	8	2 ICLK
0008 240Ch	DTC	DTC Module Start Register	DTCST	8	8	2 ICLK
0008 240Eh	DTC	DTC Status Register	DTCSTS	16	16	2 ICLK
0008 6400h	MPU	Region-0 Start Page Number Register	RSPAGE0	32	32	1 ICLK
0008 6404h	MPU	Region-0 End Page Number Register	REPAGE0	32	32	1 ICLK
0008 6408h	MPU	Region-1 Start Page Number Register	RSPAGE1	32	32	1 ICLK
0008 640Ch	MPU	Region-1 End Page Number Register	REPAGE1	32	32	1 ICLK
0008 6410h	MPU	Region-2 Start Page Number Register	RSPAGE2	32	32	1 ICLK
0008 6414h	MPU	Region-2 End Page Number Register	REPAGE2	32	32	1 ICLK
0008 6418h	MPU	Region-3 Start Page Number Register	RSPAGE3	32	32	1 ICLK
0008 641Ch	MPU	Region-3 End Page Number Register	REPAGE3	32	32	1 ICLK
0008 6420h	MPU	Region-4 Start Page Number Register	RSPAGE4	32	32	1 ICLK
0008 6424h	MPU	Region-4 End Page Number Register	REPAGE4	32	32	1 ICLK
0008 6428h	MPU	Region-5 Start Page Number Register	RSPAGE5	32	32	1 ICLK

Table 4.1 List of I/O Registers (Address Order) (2 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles ICLK ≥ PCLK
0008 642Ch	MPU	Region-5 End Page Number Register	REPAGE5	32	32	1 ICLK
0008 6430h	MPU	Region-6 Start Page Number Register	RSPAGE6	32	32	1 ICLK
0008 6434h	MPU	Region-6 End Page Number Register	REPAGE6	32	32	1 ICLK
0008 6438h	MPU	Region-7 Start Page Number Register	RSPAGE7	32	32	1 ICLK
0008 643Ch	MPU	Region-7 End Page Number Register	REPAGE7	32	32	1 ICLK
0008 6500h	MPU	Memory-Protection Enable Register	MPEN	32	32	1 ICLK
0008 6504h	MPU	Background Access Control Register	MPBAC	32	32	1 ICLK
0008 6508h	MPU	Memory-Protection Error Status-Clearing Register	MPECLR	32	32	1 ICLK
0008 650Ch	MPU	Memory-Protection Error Status Register	MPESTS	32	32	1 ICLK
0008 6514h	MPU	Data Memory-Protection Error Address Register	MPDEA	32	32	1 ICLK
0008 6520h	MPU	Region Search Address Register	MPSA	32	32	1 ICLK
0008 6524h	MPU	Region Search Operation Register	MPOPS	16	16	1 ICLK
0008 6526h	MPU	Region Invalidation Operation Register	MPOPI	16	16	1 ICLK
0008 6528h	MPU	Instruction-Hit Region Register	MHITI	32	32	1 ICLK
0008 652Ch	MPU	Data-Hit Region Register	MHITD	32	32	1 ICLK
0008 7010h	ICU	Interrupt Request Register 016	IR016	8	8	2 ICLK
0008 7017h	ICU	Interrupt Request Register 023	IR023	8	8	2 ICLK
0008 701Bh	ICU	Interrupt Request Register 027	IR027	8	8	2 ICLK
0008 701Ch	ICU	Interrupt Request Register 028	IR028	8	8	2 ICLK
0008 701Dh	ICU	Interrupt Request Register 029	IR029	8	8	2 ICLK
0008 701Eh	ICU	Interrupt Request Register 030	IR030	8	8	2 ICLK
0008 701Fh	ICU	Interrupt Request Register 031	IR031	8	8	2 ICLK
0008 7020h	ICU	Interrupt Request Register 032	IR032	8	8	2 ICLK
0008 7021h	ICU	Interrupt Request Register 033	IR033	8	8	2 ICLK
0008 7022h	ICU	Interrupt Request Register 034	IR034	8	8	2 ICLK
0008 702Ch	ICU	Interrupt Request Register 044	IR044	8	8	2 ICLK
0008 702Dh	ICU	Interrupt Request Register 045	IR045	8	8	2 ICLK
0008 702Eh	ICU	Interrupt Request Register 046	IR046	8	8	2 ICLK
0008 702Fh	ICU	Interrupt Request Register 047	IR047	8	8	2 ICLK
0008 7039h	ICU	Interrupt Request Register 057	IR057	8	8	2 ICLK
0008 7040h	ICU	Interrupt Request Register 064	IR064	8	8	2 ICLK
0008 7041h	ICU	Interrupt Request Register 065	IR065	8	8	2 ICLK
0008 7042h	ICU	Interrupt Request Register 066	IR066	8	8	2 ICLK
0008 7043h	ICU	Interrupt Request Register 067	IR067	8	8	2 ICLK
0008 7044h	ICU	Interrupt Request Register 068	IR068	8	8	2 ICLK
0008 7045h	ICU	Interrupt Request Register 069	IR069	8	8	2 ICLK
0008 7058h	ICU	Interrupt Request Register 088	IR088	8	8	2 ICLK
0008 7059h	ICU	Interrupt Request Register 089	IR089	8	8	2 ICLK
0008 7066h	ICU	Interrupt Request Register 102	IR102	8	8	2 ICLK
0008 7067h	ICU	Interrupt Request Register 103	IR103	8	8	2 ICLK
0008 706Ch	ICU	Interrupt Request Register 108	IR108	8	8	2 ICLK
0008 706Dh	ICU	Interrupt Request Register 109	IR109	8	8	2 ICLK
0008 706Eh	ICU	Interrupt Request Register 110	IR110	8	8	2 ICLK
0008 7072h	ICU	Interrupt Request Register 114	IR114	8	8	2 ICLK
0008 7073h	ICU	Interrupt Request Register 115	IR115	8	8	2 ICLK
0008 7074h	ICU	Interrupt Request Register 116	IR116	8	8	2 ICLK
0008 7075h	ICU	Interrupt Request Register 117	IR117	8	8	2 ICLK
0008 7076h	ICU	Interrupt Request Register 118	IR118	8	8	2 ICLK
0008 7077h	ICU	Interrupt Request Register 119	IR119	8	8	2 ICLK
0008 7078h	ICU	Interrupt Request Register 120	IR120	8	8	2 ICLK
0008 7079h	ICU	Interrupt Request Register 121	IR121	8	8	2 ICLK
0008 707Ah	ICU	Interrupt Request Register 122	IR122	8	8	2 ICLK

Table 4.1 List of I/O Registers (Address Order) (3 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles ICLK ≥ PCLK
0008 707Bh	ICU	Interrupt Request Register 123	IR123	8	8	2 ICLK
0008 707Ch	ICU	Interrupt Request Register 124	IR124	8	8	2 ICLK
0008 707Dh	ICU	Interrupt Request Register 125	IR125	8	8	2 ICLK
0008 707Eh	ICU	Interrupt Request Register 126	IR126	8	8	2 ICLK
0008 707Fh	ICU	Interrupt Request Register 127	IR127	8	8	2 ICLK
0008 7080h	ICU	Interrupt Request Register 128	IR128	8	8	2 ICLK
0008 7081h	ICU	Interrupt Request Register 129	IR129	8	8	2 ICLK
0008 7082h	ICU	Interrupt Request Register 130	IR130	8	8	2 ICLK
0008 7083h	ICU	Interrupt Request Register 131	IR131	8	8	2 ICLK
0008 7084h	ICU	Interrupt Request Register 132	IR132	8	8	2 ICLK
0008 7085h	ICU	Interrupt Request Register 133	IR133	8	8	2 ICLK
0008 7086h	ICU	Interrupt Request Register 134	IR134	8	8	2 ICLK
0008 7087h	ICU	Interrupt Request Register 135	IR135	8	8	2 ICLK
0008 7088h	ICU	Interrupt Request Register 136	IR136	8	8	2 ICLK
0008 7089h	ICU	Interrupt Request Register 137	IR137	8	8	2 ICLK
0008 708Ah	ICU	Interrupt Request Register 138	IR138	8	8	2 ICLK
0008 708Bh	ICU	Interrupt Request Register 139	IR139	8	8	2 ICLK
0008 708Ch	ICU	Interrupt Request Register 140	IR140	8	8	2 ICLK
0008 708Dh	ICU	Interrupt Request Register 141	IR141	8	8	2 ICLK
0008 70A8h	ICU	Interrupt Request Register 168	IR168	8	8	2 ICLK
0008 70AAh	ICU	Interrupt Request Register 170	IR170	8	8	2 ICLK
0008 70ABh	ICU	Interrupt Request Register 171	IR171	8	8	2 ICLK
0008 70AEh	ICU	Interrupt Request Register 174	IR174	8	8	2 ICLK
0008 70AFh	ICU	Interrupt Request Register 175	IR175	8	8	2 ICLK
0008 70B0h	ICU	Interrupt Request Register 176	IR176	8	8	2 ICLK
0008 70B1h	ICU	Interrupt Request Register 177	IR177	8	8	2 ICLK
0008 70B2h	ICU	Interrupt Request Register 178	IR178	8	8	2 ICLK
0008 70B3h	ICU	Interrupt Request Register 179	IR179	8	8	2 ICLK
0008 70B4h	ICU	Interrupt Request Register 180	IR180	8	8	2 ICLK
0008 70B5h	ICU	Interrupt Request Register 181	IR181	8	8	2 ICLK
0008 70B6h	ICU	Interrupt Request Register 182	IR182	8	8	2 ICLK
0008 70B7h	ICU	Interrupt Request Register 183	IR183	8	8	2 ICLK
0008 70B8h	ICU	Interrupt Request Register 184	IR184	8	8	2 ICLK
0008 70B9h	ICU	Interrupt Request Register 185	IR185	8	8	2 ICLK
0008 70DAh	ICU	Interrupt Request Register 218	IR218	8	8	2 ICLK
0008 70DBh	ICU	Interrupt Request Register 219	IR219	8	8	2 ICLK
0008 70DCh	ICU	Interrupt Request Register 220	IR220	8	8	2 ICLK
0008 70DDh	ICU	Interrupt Request Register 221	IR221	8	8	2 ICLK
0008 70DEh	ICU	Interrupt Request Register 222	IR222	8	8	2 ICLK
0008 70DFh	ICU	Interrupt Request Register 223	IR223	8	8	2 ICLK
0008 70E0h	ICU	Interrupt Request Register 224	IR224	8	8	2 ICLK
0008 70E1h	ICU	Interrupt Request Register 225	IR225	8	8	2 ICLK
0008 70F6h	ICU	Interrupt Request Register 246	IR246	8	8	2 ICLK
0008 70F7h	ICU	Interrupt Request Register 247	IR247	8	8	2 ICLK
0008 70F8h	ICU	Interrupt Request Register 248	IR248	8	8	2 ICLK
0008 70F9h	ICU	Interrupt Request Register 249	IR249	8	8	2 ICLK
0008 711Bh	ICU	DTC Activation Enable Register 027	DTCER027	8	8	2 ICLK
0008 711Ch	ICU	DTC Activation Enable Register 028	DTCER028	8	8	2 ICLK
0008 711Dh	ICU	DTC Activation Enable Register 029	DTCER029	8	8	2 ICLK
0008 711Eh	ICU	DTC Activation Enable Register 030	DTCER030	8	8	2 ICLK
0008 711Fh	ICU	DTC Activation Enable Register 031	DTCER031	8	8	2 ICLK
0008 712Dh	ICU	DTC Activation Enable Register 045	DTCER045	8	8	2 ICLK

Table 4.1 List of I/O Registers (Address Order) (4 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles ICLK ≥ PCLK
0008 712Eh	ICU	DTC Activation Enable Register 046	DTCER046	8	8	2 ICLK
0008 7140h	ICU	DTC Activation Enable Register 064	DTCER064	8	8	2 ICLK
0008 7141h	ICU	DTC Activation Enable Register 065	DTCER065	8	8	2 ICLK
0008 7142h	ICU	DTC Activation Enable Register 066	DTCER066	8	8	2 ICLK
0008 7143h	ICU	DTC Activation Enable Register 067	DTCER067	8	8	2 ICLK
0008 7144h	ICU	DTC Activation Enable Register 068	DTCER068	8	8	2 ICLK
0008 7145h	ICU	DTC Activation Enable Register 069	DTCER069	8	8	2 ICLK
0008 7166h	ICU	DTC Activation Enable Register 102	DTCER102	8	8	2 ICLK
0008 7167h	ICU	DTC Activation Enable Register 103	DTCER103	8	8	2 ICLK
0008 716Ch	ICU	DTC Activation Enable Register 108	DTCER108	8	8	2 ICLK
0008 716Dh	ICU	DTC Activation Enable Register 109	DTCER109	8	8	2 ICLK
0008 716Eh	ICU	DTC Activation Enable Register 110	DTCER110	8	8	2 ICLK
0008 7172h	ICU	DTC Activation Enable Register 114	DTCER114	8	8	2 ICLK
0008 7173h	ICU	DTC Activation Enable Register 115	DTCER115	8	8	2 ICLK
0008 7174h	ICU	DTC Activation Enable Register 116	DTCER116	8	8	2 ICLK
0008 7175h	ICU	DTC Activation Enable Register 117	DTCER117	8	8	2 ICLK
0008 7179h	ICU	DTC Activation Enable Register 121	DTCER121	8	8	2 ICLK
0008 717Ah	ICU	DTC Activation Enable Register 122	DTCER122	8	8	2 ICLK
0008 717Dh	ICU	DTC Activation Enable Register 125	DTCER125	8	8	2 ICLK
0008 717Eh	ICU	DTC Activation Enable Register 126	DTCER126	8	8	2 ICLK
0008 7181h	ICU	DTC Activation Enable Register 129	DTCER129	8	8	2 ICLK
0008 7182h	ICU	DTC Activation Enable Register 130	DTCER130	8	8	2 ICLK
0008 7183h	ICU	DTC Activation Enable Register 131	DTCER131	8	8	2 ICLK
0008 7184h	ICU	DTC Activation Enable Register 132	DTCER132	8	8	2 ICLK
0008 7186h	ICU	DTC Activation Enable Register 134	DTCER134	8	8	2 ICLK
0008 7187h	ICU	DTC Activation Enable Register 135	DTCER135	8	8	2 ICLK
0008 7188h	ICU	DTC Activation Enable Register 136	DTCER136	8	8	2 ICLK
0008 7189h	ICU	DTC Activation Enable Register 137	DTCER137	8	8	2 ICLK
0008 718Ah	ICU	DTC Activation Enable Register 138	DTCER138	8	8	2 ICLK
0008 718Bh	ICU	DTC Activation Enable Register 139	DTCER139	8	8	2 ICLK
0008 718Ch	ICU	DTC Activation Enable Register 140	DTCER140	8	8	2 ICLK
0008 718Dh	ICU	DTC Activation Enable Register 141	DTCER141	8	8	2 ICLK
0008 71AEh	ICU	DTC Activation Enable Register 174	DTCER174	8	8	2 ICLK
0008 71AFh	ICU	DTC Activation Enable Register 175	DTCER175	8	8	2 ICLK
0008 71B1h	ICU	DTC Activation Enable Register 177	DTCER177	8	8	2 ICLK
0008 71B2h	ICU	DTC Activation Enable Register 178	DTCER178	8	8	2 ICLK
0008 71B4h	ICU	DTC Activation Enable Register 180	DTCER180	8	8	2 ICLK
0008 71B5h	ICU	DTC Activation Enable Register 181	DTCER181	8	8	2 ICLK
0008 71B7h	ICU	DTC Activation Enable Register 183	DTCER183	8	8	2 ICLK
0008 71B8h	ICU	DTC Activation Enable Register 184	DTCER184	8	8	2 ICLK
0008 71DBh	ICU	DTC Activation Enable Register 219	DTCER219	8	8	2 ICLK
0008 71DCh	ICU	DTC Activation Enable Register 220	DTCER220	8	8	2 ICLK
0008 71DFh	ICU	DTC Activation Enable Register 223	DTCER223	8	8	2 ICLK
0008 71E0h	ICU	DTC Activation Enable Register 224	DTCER224	8	8	2 ICLK
0008 71F7h	ICU	DTC Activation Enable Register 247	DTCER247	8	8	2 ICLK
0008 71F8h	ICU	DTC Activation Enable Register 248	DTCER248	8	8	2 ICLK
0008 7202h	ICU	Interrupt Request Enable Register 02	IER02	8	8	2 ICLK
0008 7203h	ICU	Interrupt Request Enable Register 03	IER03	8	8	2 ICLK
0008 7204h	ICU	Interrupt Request Enable Register 04	IER04	8	8	2 ICLK
0008 7205h	ICU	Interrupt Request Enable Register 05	IER05	8	8	2 ICLK
0008 7207h	ICU	Interrupt Request Enable Register 07	IER07	8	8	2 ICLK
0008 7208h	ICU	Interrupt Request Enable Register 08	IER08	8	8	2 ICLK

Table 4.1 List of I/O Registers (Address Order) (5 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
0008 720Bh	ICU	Interrupt Request Enable Register 0B	IER0B	8	8	2 ICLK
0008 720Ch	ICU	Interrupt Request Enable Register 0C	IER0C	8	8	2 ICLK
0008 720Dh	ICU	Interrupt Request Enable Register 0D	IER0D	8	8	2 ICLK
0008 720Eh	ICU	Interrupt Request Enable Register 0E	IER0E	8	8	2 ICLK
0008 720Fh	ICU	Interrupt Request Enable Register 0F	IER0F	8	8	2 ICLK
0008 7210h	ICU	Interrupt Request Enable Register 10	IER10	8	8	2 ICLK
0008 7211h	ICU	Interrupt Request Enable Register 11	IER11	8	8	2 ICLK
0008 7215h	ICU	Interrupt Request Enable Register 15	IER15	8	8	2 ICLK
0008 7216h	ICU	Interrupt Request Enable Register 16	IER16	8	8	2 ICLK
0008 7217h	ICU	Interrupt Request Enable Register 17	IER17	8	8	2 ICLK
0008 721Bh	ICU	Interrupt Request Enable Register 1B	IER1B	8	8	2 ICLK
0008 721Ch	ICU	Interrupt Request Enable Register 1C	IER1C	8	8	2 ICLK
0008 721Eh	ICU	Interrupt Request Enable Register 1E	IER1E	8	8	2 ICLK
0008 721Fh	ICU	Interrupt Request Enable Register 1F	IER1F	8	8	2 ICLK
0008 72E0h	ICU	Software Interrupt Activation Register	SWINTR	8	8	2 ICLK
0008 72F0h	ICU	Fast Interrupt Set Register	FIR	16	16	2 ICLK
0008 7300h	ICU	Interrupt Source Priority Register 000	IPR000	8	8	2 ICLK
0008 7302h	ICU	Interrupt Source Priority Register 002	IPR002	8	8	2 ICLK
0008 7303h	ICU	Interrupt Source Priority Register 003	IPR003	8	8	2 ICLK
0008 7304h	ICU	Interrupt Source Priority Register 004	IPR004	8	8	2 ICLK
0008 7305h	ICU	Interrupt Source Priority Register 005	IPR005	8	8	2 ICLK
0008 7306h	ICU	Interrupt Source Priority Register 006	IPR006	8	8	2 ICLK
0008 7307h	ICU	Interrupt Source Priority Register 007	IPR007	8	8	2 ICLK
0008 7320h	ICU	Interrupt Source Priority Register 032	IPR032	8	8	2 ICLK
0008 7321h	ICU	Interrupt Source Priority Register 033	IPR033	8	8	2 ICLK
0008 7322h	ICU	Interrupt Source Priority Register 034	IPR034	8	8	2 ICLK
0008 732Ch	ICU	Interrupt Source Priority Register 044	IPR044	8	8	2 ICLK
0008 7339h	ICU	Interrupt Source Priority Register 057	IPR057	8	8	2 ICLK
0008 7340h	ICU	Interrupt Source Priority Register 064	IPR064	8	8	2 ICLK
0008 7341h	ICU	Interrupt Source Priority Register 065	IPR065	8	8	2 ICLK
0008 7342h	ICU	Interrupt Source Priority Register 066	IPR066	8	8	2 ICLK
0008 7343h	ICU	Interrupt Source Priority Register 067	IPR067	8	8	2 ICLK
0008 7344h	ICU	Interrupt Source Priority Register 068	IPR068	8	8	2 ICLK
0008 7345h	ICU	Interrupt Source Priority Register 069	IPR069	8	8	2 ICLK
0008 7358h	ICU	Interrupt Source Priority Register 088	IPR088	8	8	2 ICLK
0008 7359h	ICU	Interrupt Source Priority Register 089	IPR089	8	8	2 ICLK
0008 7366h	ICU	Interrupt Source Priority Register 102	IPR102	8	8	2 ICLK
0008 7367h	ICU	Interrupt Source Priority Register 103	IPR103	8	8	2 ICLK
0008 736Ch	ICU	Interrupt Source Priority Register 108	IPR108	8	8	2 ICLK
0008 736Dh	ICU	Interrupt Source Priority Register 109	IPR109	8	8	2 ICLK
0008 736Eh	ICU	Interrupt Source Priority Register 110	IPR110	8	8	2 ICLK
0008 7372h	ICU	Interrupt Source Priority Register 114	IPR114	8	8	2 ICLK
0008 7376h	ICU	Interrupt Source Priority Register 118	IPR118	8	8	2 ICLK
0008 7379h	ICU	Interrupt Source Priority Register 121	IPR121	8	8	2 ICLK
0008 737Bh	ICU	Interrupt Source Priority Register 123	IPR123	8	8	2 ICLK
0008 737Dh	ICU	Interrupt Source Priority Register 125	IPR125	8	8	2 ICLK
0008 737Fh	ICU	Interrupt Source Priority Register 127	IPR127	8	8	2 ICLK
0008 7381h	ICU	Interrupt Source Priority Register 129	IPR129	8	8	2 ICLK
0008 7385h	ICU	Interrupt Source Priority Register 133	IPR133	8	8	2 ICLK
0008 7386h	ICU	Interrupt Source Priority Register 134	IPR134	8	8	2 ICLK
0008 738Ah	ICU	Interrupt Source Priority Register 138	IPR138	8	8	2 ICLK
0008 738Bh	ICU	Interrupt Source Priority Register 139	IPR139	8	8	2 ICLK

Table 4.1 List of I/O Registers (Address Order) (6 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles ICLK ≥ PCLK
0008 73A8h	ICU	Interrupt Source Priority Register 168	IPR168	8	8	2 ICLK
0008 73AEh	ICU	Interrupt Source Priority Register 174	IPR174	8	8	2 ICLK
0008 73B1h	ICU	Interrupt Source Priority Register 177	IPR177	8	8	2 ICLK
0008 73B4h	ICU	Interrupt Source Priority Register 180	IPR180	8	8	2 ICLK
0008 73B7h	ICU	Interrupt Source Priority Register 183	IPR183	8	8	2 ICLK
0008 73DAh	ICU	Interrupt Source Priority Register 218	IPR218	8	8	2 ICLK
0008 73DEh	ICU	Interrupt Source Priority Register 222	IPR222	8	8	2 ICLK
0008 73F6h	ICU	Interrupt Source Priority Register 246	IPR246	8	8	2 ICLK
0008 73F7h	ICU	Interrupt Source Priority Register 247	IPR247	8	8	2 ICLK
0008 73F8h	ICU	Interrupt Source Priority Register 248	IPR248	8	8	2 ICLK
0008 73F9h	ICU	Interrupt Source Priority Register 249	IPR249	8	8	2 ICLK
0008 7500h	ICU	IRQ Control Register 0	IRQCR0	8	8	2 ICLK
0008 7501h	ICU	IRQ Control Register 1	IRQCR1	8	8	2 ICLK
0008 7502h	ICU	IRQ Control Register 2	IRQCR2	8	8	2 ICLK
0008 7503h	ICU	IRQ Control Register 3	IRQCR3	8	8	2 ICLK
0008 7504h	ICU	IRQ Control Register 4	IRQCR4	8	8	2 ICLK
0008 7505h	ICU	IRQ Control Register 5	IRQCR5	8	8	2 ICLK
0008 7510h	ICU	IRQ Pin Digital Filter Enable Register 0	IRQFLTE0	8	8	2 ICLK
0008 7514h	ICU	IRQ Pin Digital Filter Setting Register 0	IRQFLTC0	16	16	2 ICLK
0008 7580h	ICU	Non-Maskable Interrupt Status Register	NMISR	8	8	2 ICLK
0008 7581h	ICU	Non-Maskable Interrupt Enable Register	NMIER	8	8	2 ICLK
0008 7582h	ICU	Non-Maskable Interrupt Status Clear Register	NMICLR	8	8	2 ICLK
0008 7583h	ICU	NMI Pin Interrupt Control Register	NMICR	8	8	2 ICLK
0008 7590h	ICU	NMI Pin Digital Filter Enable Register	NMIFLTE	8	8	2 ICLK
0008 7594h	ICU	NMI Pin Digital Filter Setting Register	NMIFLTC	8	8	2 ICLK
0008 8000h	CMT	Compare Match Timer Start Register 0	CMSTR0	16	16	2 or 3 PCLKB
0008 8002h	CMT0	Compare Match Timer Control Register	CMCR	16	16	2 or 3 PCLKB
0008 8004h	CMT0	Compare Match Counter	CMCNT	16	16	2 or 3 PCLKB
0008 8006h	CMT0	Compare Match Constant Register	CMCOR	16	16	2 or 3 PCLKB
0008 8008h	CMT1	Compare Match Timer Control Register	CMCR	16	16	2 or 3 PCLKB
0008 800Ah	CMT1	Compare Match Counter	CMCNT	16	16	2 or 3 PCLKB
0008 800Ch	CMT1	Compare Match Constant Register	CMCOR	16	16	2 or 3 PCLKB
0008 8010h	CMT	Compare Match Timer Start Register 1	CMSTR1	16	16	2 or 3 PCLKB
0008 8012h	CMT2	Compare Match Timer Control Register	CMCR	16	16	2 or 3 PCLKB
0008 8014h	CMT2	Compare Match Counter	CMCNT	16	16	2 or 3 PCLKB
0008 8016h	CMT2	Compare Match Constant Register	CMCOR	16	16	2 or 3 PCLKB
0008 8018h	CMT3	Compare Match Timer Control Register	CMCR	16	16	2 or 3 PCLKB
0008 801Ah	CMT3	Compare Match Counter	CMCNT	16	16	2 or 3 PCLKB
0008 801Ch	CMT3	Compare Match Constant Register	CMCOR	16	16	2 or 3 PCLKB
0008 8030h	IWDT	IWDT Refresh Register	IWDTRR	8	8	2 or 3 PCLKB
0008 8032h	IWDT	IWDT Control Register	IWDTCR	16	16	2 or 3 PCLKB
0008 8034h	IWDT	IWDT Status Register	IWDTSR	16	16	2 or 3 PCLKB
0008 8036h	IWDT	IWDT Reset Control Register	IWDTRCR	8	8	2 or 3 PCLKB
0008 8038h	IWDT	IWDT Count Stop Control Register	IWDTCSTPR	8	8	2 or 3 PCLKB
0008 80C0h	DA	D/A Data Register 0	DADR0	16	16	2 or 3 PCLKB
0008 80C4h	DA	D/A Control Register	DACR	8	8	2 or 3 PCLKB
0008 80C5h	DA	DADR0 Format Select Register	DADPR	8	8	2 or 3 PCLKB
0008 8200h	TMR0	Timer Control Register	TCR	8	8	2 or 3 PCLKB
0008 8201h	TMR1	Timer Control Register	TCR	8	8	2 or 3 PCLKB
0008 8202h	TMR0	Timer Control/Status Register	TCSR	8	8	2 or 3 PCLKB
0008 8203h	TMR1	Timer Control/Status Register	TCSR	8	8	2 or 3 PCLKB
0008 8204h	TMR0	Time Constant Register A	TCORA	8	8	2 or 3 PCLKB

Table 4.1 List of I/O Registers (Address Order) (7 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles ICLK ≥ PCLK
0008 8205h	TMR1	Time Constant Register A	TCORA	8	8*1	2 or 3 PCLKB
0008 8206h	TMR0	Time Constant Register B	TCORB	8	8	2 or 3 PCLKB
0008 8207h	TMR1	Time Constant Register B	TCORB	8	8*1	2 or 3 PCLKB
0008 8208h	TMR0	Timer Counter	TCNT	8	8	2 or 3 PCLKB
0008 8209h	TMR1	Timer Counter	TCNT	8	8*1	2 or 3 PCLKB
0008 820Ah	TMR0	Timer Counter Control Register	TCCR	8	8	2 or 3 PCLKB
0008 820Bh	TMR1	Timer Counter Control Register	TCCR	8	8*1	2 or 3 PCLKB
0008 8210h	TMR2	Timer Control Register	TCR	8	8	2 or 3 PCLKB
0008 8211h	TMR3	Timer Control Register	TCR	8	8	2 or 3 PCLKB
0008 8212h	TMR2	Timer Control/Status Register	TCSR	8	8	2 or 3 PCLKB
0008 8213h	TMR3	Timer Control/Status Register	TCSR	8	8	2 or 3 PCLKB
0008 8214h	TMR2	Time Constant Register A	TCORA	8	8	2 or 3 PCLKB
0008 8215h	TMR3	Time Constant Register A	TCORA	8	8*1	2 or 3 PCLKB
0008 8216h	TMR2	Time Constant Register B	TCORB	8	8	2 or 3 PCLKB
0008 8217h	TMR3	Time Constant Register B	TCORB	8	8*1	2 or 3 PCLKB
0008 8218h	TMR2	Timer Counter	TCNT	8	8	2 or 3 PCLKB
0008 8219h	TMR3	Timer Counter	TCNT	8	8*1	2 or 3 PCLKB
0008 821Ah	TMR2	Timer Counter Control Register	TCCR	8	8	2 or 3 PCLKB
0008 821Bh	TMR3	Timer Counter Control Register	TCCR	8	8*1	2 or 3 PCLKB
0008 8280h	CRC	CRC Control Register	CRCCR	8	8	2 or 3 PCLKB
0008 8281h	CRC	CRC Data Input Register	CRCDIR	8	8	2 or 3 PCLKB
0008 8282h	CRC	CRC Data Output Register	CRCDOR	16	16	2 or 3 PCLKB
0008 8300h	RIIC0	I^2C Bus Control Register 1	ICCR1	8	8	2 or 3 PCLKB
0008 8301h	RIIC0	I^2C Bus Control Register 2	ICCR2	8	8	2 or 3 PCLKB
0008 8302h	RIIC0	I^2C Bus Mode Register 1	ICMR1	8	8	2 or 3 PCLKB
0008 8303h	RIIC0	I^2C Bus Mode Register 2	ICMR2	8	8	2 or 3 PCLKB
0008 8304h	RIIC0	I^2C Bus Mode Register 3	ICMR3	8	8	2 or 3 PCLKB
0008 8305h	RIIC0	I^2C Bus Function Enable Register	ICFER	8	8	2 or 3 PCLKB
0008 8306h	RIIC0	I^2C Bus Status Enable Register	ICSER	8	8	2 or 3 PCLKB
0008 8307h	RIIC0	I^2C Bus Interrupt Enable Register	ICIER	8	8	2 or 3 PCLKB
0008 8308h	RIIC0	I^2C Bus Status Register 1	ICSR1	8	8	2 or 3 PCLKB
0008 8309h	RIIC0	I^2C Bus Status Register 2	ICSR2	8	8	2 or 3 PCLKB
0008 830Ah	RIIC0	Slave Address Register L0	SARL0	8	8	2 or 3 PCLKB
0008 830Bh	RIIC0	Slave Address Register U0	SARU0	8	8	2 or 3 PCLKB
0008 830Ch	RIIC0	Slave Address Register L1	SARL1	8	8	2 or 3 PCLKB
0008 830Dh	RIIC0	Slave Address Register U1	SARU1	8	8	2 or 3 PCLKB
0008 830Eh	RIIC0	Slave Address Register L2	SARL2	8	8	2 or 3 PCLKB
0008 830Fh	RIIC0	Slave Address Register U2	SARU2	8	8	2 or 3 PCLKB
0008 8310h	RIIC0	I^2C Bus Bit Rate Low-Level Register	ICBRL	8	8	2 or 3 PCLKB
0008 8311h	RIIC0	I^2C Bus Bit Rate High-Level Register	ICBRH	8	8	2 or 3 PCLKB
0008 8312h	RIIC0	I^2C Bus Transmit Data Register	ICDRT	8	8	2 or 3 PCLKB
0008 8313h	RIIC0	I^2C Bus Receive Data Register	ICDRR	8	8	2 or 3 PCLKB
0008 8380h	RSPI0	RSPI Control Register	SPCR	8	8	2 or 3 PCLKB
0008 8381h	RSPI0	RSPI Slave Select Polarity Register	SSLP	8	8	2 or 3 PCLKB
0008 8382h	RSPI0	RSPI Pin Control Register	SPPCR	8	8	2 or 3 PCLKB
0008 8383h	RSPI0	RSPI Status Register	SPSR	8	8	2 or 3 PCLKB
0008 8384h	RSPI0	RSPI Data Register	SPDR	32	16, 32	2 or 3 PCLKB
0008 8388h	RSPI0	RSPI Sequence Control Register	SPSCR	8	8	2 or 3 PCLKB
0008 8389h	RSPI0	RSPI Sequence Status Register	SPSSR	8	8	2 or 3 PCLKB
0008 838Ah	RSPI0	RSPI Bit Rate Register	SPBR	8	8	2 or 3 PCLKB
0008 838Bh	RSPI0	RSPI Data Control Register	SPDCR	8	8	2 or 3 PCLKB
0008 838Ch	RSPI0	RSPI Clock Delay Register	SPCKD	8	8	2 or 3 PCLKB

Table 4.1 List of I/O Registers (Address Order) (8 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
0008 838Dh	RSPI0	RSPI Slave Select Negation Delay Register	SSLND	8	8	2 or 3 PCLKB
0008 838Eh	RSPI0	RSPI Next-Access Delay Register	SPND	8	8	2 or 3 PCLKB
0008 838Fh	RSPI0	RSPI Control Register 2	SPCR2	8	8	2 or 3 PCLKB
0008 8390h	RSPI0	RSPI Command Register 0	SPCMD0	16	16	2 or 3 PCLKB
0008 8392h	RSPI0	RSPI Command Register 1	SPCMD1	16	16	2 or 3 PCLKB
0008 8394h	RSPI0	RSPI Command Register 2	SPCMD2	16	16	2 or 3 PCLKB
0008 8396h	RSPI0	RSPI Command Register 3	SPCMD3	16	16	2 or 3 PCLKB
0008 8398h	RSPI0	RSPI Command Register 4	SPCMD4	16	16	2 or 3 PCLKB
0008 839Ah	RSPI0	RSPI Command Register 5	SPCMD5	16	16	2 or 3 PCLKB
0008 839Ch	RSPI0	RSPI Command Register 6	SPCMD6	16	16	2 or 3 PCLKB
0008 839Eh	RSPI0	RSPI Command Register 7	SPCMD7	16	16	2 or 3 PCLKB
0008 9000h	S12AD	A/D Control Register	ADCSR	16	16	2 or 3 PCLKB
0008 9004h	S12AD	A/D Channel Select Register A0	ADANSA0	16	16	2 or 3 PCLKB
0008 9006h	S12AD	A/D Channel Select Register A1	ADANSA1	16	16	2 or 3 PCLKB
0008 9008h	S12AD	A/D-Converted Value Addition/Average Function Select Register 0	ADADS0	16	16	2 or 3 PCLKB
0008 900Ah	S12AD	A/D-Converted Value Addition/Average Function Select Register 1	ADADS1	16	16	2 or 3 PCLKB
0008 900Ch	S12AD	A/D-Converted Value Addition/Average Count Select Register	ADADC	8	8	2 or 3 PCLKB
0008 900Eh	S12AD	A/D Control Extended Register	ADCER	16	16	2 or 3 PCLKB
0008 9010h	S12AD	A/D Conversion Start Trigger Select Register	ADSTRGR	16	16	2 or 3 PCLKB
0008 9012h	S12AD	A/D Conversion Extended Input Control Register	ADEXICR	16	16	2 or 3 PCLKB
0008 9014h	S12AD	A/D Channel Select Register B0	ADANSB0	16	16	2 or 3 PCLKB
0008 9016h	S12AD	A/D Channel Select Register B1	ADANSB1	16	16	2 or 3 PCLKB
0008 9018h	S12AD	A/D Data Duplication Register	ADDBLDR	16	16	2 or 3 PCLKB
0008 901Ch	S12AD	A/D Internal Reference Voltage Data Register	ADOCDR	16	16	2 or 3 PCLKB
0008 901Eh	S12AD	A/D Self-Diagnosis Data Register	ADRD	16	16	2 or 3 PCLKB
0008 9020h	S12AD	A/D Data Register 0	ADDR0	16	16	2 or 3 PCLKB
0008 9022h	S12AD	A/D Data Register 1	ADDR1	16	16	2 or 3 PCLKB
0008 9024h	S12AD	A/D Data Register 2	ADDR2	16	16	2 or 3 PCLKB
0008 9026h	S12AD	A/D Data Register 3	ADDR3	16	16	2 or 3 PCLKB
0008 9028h	S12AD	A/D Data Register 4	ADDR4	16	16	2 or 3 PCLKB
0008 902Ah	S12AD	A/D Data Register 5	ADDR5	16	16	2 or 3 PCLKB
0008 902Ch	S12AD	A/D Data Register 6	ADDR6	16	16	2 or 3 PCLKB
0008 902Eh	S12AD	A/D Data Register 7	ADDR7	16	16	2 or 3 PCLKB
0008 9040h	S12AD	A/D Data Register 16	ADDR16	16	16	2 or 3 PCLKB
0008 9042h	S12AD	A/D Data Register 17	ADDR17	16	16	2 or 3 PCLKB
0008 9066h	S12AD	A/D Sample-and-hold Circuit Control Register	ADSHCR	16	16	2 or 3 PCLKB
0008 907Ah	S12AD	A/D Disconnection Detection Control Register	ADDISCR	8	8	2 or 3 PCLKB
0008 9080h	S12AD	A/D Group Scan Priority Control Register	ADGSPCR	16	16	2 or 3 PCLKB
0008 9084h	S12AD	A/D Data Duplication Register A	ADDBLDRA	16	16	2 or 3 PCLKB
0008 9086h	S12AD	A/D Data Duplication Register B	ADDBLDRB	16	16	2 or 3 PCLKB
0008 908Ah	S12AD	A/D High-Side/Low-Side Reference Voltage Control Register	ADHVREFCNT	8	8	2 or 3 PCLKB
0008 90DDh	S12AD	A/D Sampling State Register L	ADSSTRL	8	8	2 or 3 PCLKB
0008 90DFh	S12AD	A/D Sampling State Register O	ADSSTRO	8	8	2 or 3 PCLKB
0008 90E0h	S12AD	A/D Sampling State Register 0	ADSSTR0	8	8	2 or 3 PCLKB
0008 90E1h	S12AD	A/D Sampling State Register 1	ADSSTR1	8	8	2 or 3 PCLKB
0008 90E2h	S12AD	A/D Sampling State Register 2	ADSSTR2	8	8	2 or 3 PCLKB
0008 90E3h	S12AD	A/D Sampling State Register 3	ADSSTR3	8	8	2 or 3 PCLKB
0008 90E4h	S12AD	A/D Sampling State Register 4	ADSSTR4	8	8	2 or 3 PCLKB
0008 90E5h	S12AD	A/D Sampling State Register 5	ADSSTR5	8	8	2 or 3 PCLKB
0008 90E6h	S12AD	A/D Sampling State Register 6	ADSSTR6	8	8	2 or 3 PCLKB

Table 4.1 List of I/O Registers (Address Order) (9 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
0008 90E7h	S12AD	A/D Sampling State Register 7	ADSSTR7	8	8	2 or 3 PCLKB
0008 A020h	SCI1	Serial Mode Register	SMR	8	8	2 or 3 PCLKB
0008 A021h	SCI1	Bit Rate Register	BRR	8	8	2 or 3 PCLKB
0008 A022h	SCI1	Serial Control Register	SCR	8	8	2 or 3 PCLKB
0008 A023h	SCI1	Transmit Data Register	TDR	8	8	2 or 3 PCLKB
0008 A024h	SCI1	Serial Status Register	SSR	8	8	2 or 3 PCLKB
0008 A025h	SCI1	Receive Data Register	RDR	8	8	2 or 3 PCLKB
0008 A026h	SCI1	Smart Card Mode Register	SCMR	8	8	2 or 3 PCLKB
0008 A027h	SCI1	Serial Extended Mode Register	SEMR	8	8	2 or 3 PCLKB
0008 A028h	SCI1	Noise Filter Setting Register	SNFR	8	8	2 or 3 PCLKB
0008 A029h	SCI1	I^2C Mode Register 1	SIMR1	8	8	2 or 3 PCLKB
0008 A02Ah	SCI1	I^2C Mode Register 2	SIMR2	8	8	2 or 3 PCLKB
0008 A02Bh	SCI1	I^2C Mode Register 3	SIMR3	8	8	2 or 3 PCLKB
0008 A02Ch	SCI1	I^2C Status Register	SISR	8	8	2 or 3 PCLKB
0008 A02Dh	SCI1	SPI Mode Register	SPMR	8	8	2 or 3 PCLKB
0008 A02Eh	SCI1	Transmit Data Register HL	TDRHL	16	16	4 or 5 PCLKB
0008 A02Eh	SCI1	Transmit Data Register H	TDRH	8	8	2 or 3 PCLKB
0008 A02Fh	SCI1	Transmit Data Register L	TDRL	8	8	2 or 3 PCLKB
0008 A030h	SCI1	Receive Data Register HL	RDRHL	16	16	4 or 5 PCLKB
0008 A030h	SCI1	Receive Data Register H	RDRH	8	8	2 or 3 PCLKB
0008 A031h	SCI1	Receive Data Register L	RDRL	8	8	2 or 3 PCLKB
0008 A032h	SCI1	Modulation Duty Register	MDDR	8	8	2 or 3 PCLKB
0008 A0A0h	SCI5	Serial Mode Register	SMR	8	8	2 or 3 PCLKB
0008 A0A1h	SCI5	Bit Rate Register	BRR	8	8	2 or 3 PCLKB
0008 A0A2h	SCI5	Serial Control Register	SCR	8	8	2 or 3 PCLKB
0008 A0A3h	SCI5	Transmit Data Register	TDR	8	8	2 or 3 PCLKB
0008 A0A4h	SCI5	Serial Status Register	SSR	8	8	2 or 3 PCLKB
0008 A0A5h	SCI5	Receive Data Register	RDR	8	8	2 or 3 PCLKB
0008 A0A6h	SCI5	Smart Card Mode Register	SCMR	8	8	2 or 3 PCLKB
0008 A0A7h	SCI5	Serial Extended Mode Register	SEMR	8	8	2 or 3 PCLKB
0008 A0A8h	SCI5	Noise Filter Setting Register	SNFR	8	8	2 or 3 PCLKB
0008 A0A9h	SCI5	I^2C Mode Register 1	SIMR1	8	8	2 or 3 PCLKB
0008 A0AAh	SCI5	I^2C Mode Register 2	SIMR2	8	8	2 or 3 PCLKB
0008 A0ABh	SCI5	I^2C Mode Register 3	SIMR3	8	8	2 or 3 PCLKB
0008 A0ACh	SCI5	I^2C Status Register	SISR	8	8	2 or 3 PCLKB
0008 A0ADh	SCI5	SPI Mode Register	SPMR	8	8	2 or 3 PCLKB
0008 A0AEh	SCI5	Transmit Data Register HL	TDRHL	16	16	4 or 5 PCLKB
0008 A0AEh	SCI5	Transmit Data Register H	TDRH	8	8	2 or 3 PCLKB
0008 A0AFh	SCI5	Transmit Data Register L	TDRL	8	8	2 or 3 PCLKB
0008 A0B0h	SCI5	Receive Data Register HL	RDRHL	16	16	4 or 5 PCLKB
0008 A0B0h	SCI5	Receive Data Register H	RDRH	8	8	2 or 3 PCLKB
0008 A0B1h	SCI5	Receive Data Register L	RDRL	8	8	2 or 3 PCLKB
0008 A0B2h	SCI5	Modulation Duty Register	MDDR	8	8	2 or 3 PCLKB
0008 B000h	CAC	CAC Control Register 0	CACR0	8	8	2 or 3 PCLKB
0008 B001h	CAC	CAC Control Register 1	CACR1	8	8	2 or 3 PCLKB
0008 B002h	CAC	CAC Control Register 2	CACR2	8	8	2 or 3 PCLKB
0008 B003h	CAC	CAC Interrupt Request Enable Register	CAICR	8	8	2 or 3 PCLKB
0008 B004h	CAC	CAC Status Register	CASTR	8	8	2 or 3 PCLKB
0008 B006h	CAC	CAC Upper-Limit Value Setting Register	CAULVR	16	16	2 or 3 PCLKB
0008 B008h	CAC	CAC Lower-Limit Value Setting Register	CALLVR	16	16	2 or 3 PCLKB
0008 B00Ah	CAC	CAC Counter Buffer Register	CACNTBR	16	16	2 or 3 PCLKB
0008 B080h	DOC	DOC Control Register	DOCR	8	8	2 or 3 PCLKB

Table 4.1 List of I/O Registers (Address Order) (10 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
0008 B082h	DOC	DOC Data Input Register	DODIR	16	16	2 or 3 PCLKB
0008 B084h	DOC	DOC Data Setting Register	DODSR	16	16	2 or 3 PCLKB
0008 C000h	PORT0	Port Direction Register	PDR	8	8	2 or 3 PCLKB
0008 C001h	PORT1	Port Direction Register	PDR	8	8	2 or 3 PCLKB
0008 C002h	PORT2	Port Direction Register	PDR	8	8	2 or 3 PCLKB
0008 C003h	PORT3	Port Direction Register	PDR	8	8	2 or 3 PCLKB
0008 C004h	PORT4	Port Direction Register	PDR	8	8	2 or 3 PCLKB
0008 C007h	PORT7	Port Direction Register	PDR	8	8	2 or 3 PCLKB
0008 C009h	PORT9	Port Direction Register	PDR	8	8	2 or 3 PCLKB
0008 C00Ah	PORTA	Port Direction Register	PDR	8	8	2 or 3 PCLKB
0008 C00Bh	PORTB	Port Direction Register	PDR	8	8	2 or 3 PCLKB
0008 C00Dh	PORTD	Port Direction Register	PDR	8	8	2 or 3 PCLKB
0008 C020h	PORT0	Port Output Data Register	PODR	8	8	2 or 3 PCLKB
0008 C021h	PORT1	Port Output Data Register	PODR	8	8	2 or 3 PCLKB
0008 C022h	PORT2	Port Output Data Register	PODR	8	8	2 or 3 PCLKB
0008 C023h	PORT3	Port Output Data Register	PODR	8	8	2 or 3 PCLKB
0008 C024h	PORT4	Port Output Data Register	PODR	8	8	2 or 3 PCLKB
0008 C027h	PORT7	Port Output Data Register	PODR	8	8	2 or 3 PCLKB
0008 C029h	PORT9	Port Output Data Register	PODR	8	8	2 or 3 PCLKB
0008 C02Ah	PORTA	Port Output Data Register	PODR	8	8	2 or 3 PCLKB
0008 C02Bh	PORTB	Port Output Data Register	PODR	8	8	2 or 3 PCLKB
0008 C02Dh	PORTD	Port Output Data Register	PODR	8	8	2 or 3 PCLKB
0008 C040h	PORT0	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C041h	PORT1	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C042h	PORT2	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C043h	PORT3	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C044h	PORT4	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C047h	PORT7	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C049h	PORT9	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C04Ah	PORTA	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C04Bh	PORTB	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C04Dh	PORTD	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C04Eh	PORTE	Port Input Data Register	PIDR	8	8	2 or 3 PCLKB
0008 C060h	PORT0	Port Mode Register	PMR	8	8	2 or 3 PCLKB
0008 C061h	PORT1	Port Mode Register	PMR	8	8	2 or 3 PCLKB
0008 C062h	PORT2	Port Mode Register	PMR	8	8	2 or 3 PCLKB
0008 C063h	PORT3	Port Mode Register	PMR	8	8	2 or 3 PCLKB
0008 C067h	PORT7	Port Mode Register	PMR	8	8	2 or 3 PCLKB
0008 C069h	PORT9	Port Mode Register	PMR	8	8	2 or 3 PCLKB
0008 C06Ah	PORTA	Port Mode Register	PMR	8	8	2 or 3 PCLKB
0008 C06Bh	PORTB	Port Mode Register	PMR	8	8	2 or 3 PCLKB
0008 C06Dh	PORTD	Port Mode Register	PMR	8	8	2 or 3 PCLKB
0008 C06Eh	PORTE	Port Mode Register	PMR	8	8	2 or 3 PCLKB
0008 C080h	PORT0	Open Drain Control Register 0	ODR0	8	8, 16	2 or 3 PCLKB
0008 C082h	PORT1	Open Drain Control Register 0	ODR0	8	8, 16	2 or 3 PCLKB
0008 C084h	PORT2	Open Drain Control Register 0	ODR0	8	8, 16	2 or 3 PCLKB
0008 C085h	PORT2	Open Drain Control Register 1	ODR1	8	8, 16	2 or 3 PCLKB
0008 C086h	PORT3	Open Drain Control Register 0	ODR0	8	8, 16	2 or 3 PCLKB
0008 C087h	PORT3	Open Drain Control Register 1	ODR1	8	8, 16	2 or 3 PCLKB
0008 C08Eh	PORT7	Open Drain Control Register 0	ODR0	8	8, 16	2 or 3 PCLKB
0008 C08Fh	PORT7	Open Drain Control Register 1	ODR1	8	8, 16	2 or 3 PCLKB
0008 C092h	PORT9	Open Drain Control Register 0	ODR0	8	8, 16	2 or 3 PCLKB

Table 4.1 List of I/O Registers (Address Order) (11 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
0008 C093h	PORT9	Open Drain Control Register 1	ODR1	8	8, 16	2 or 3 PCLKB
0008 C094h	PORTA	Open Drain Control Register 0	ODR0	8	8, 16	2 or 3 PCLKB
0008 C095h	PORTA	Open Drain Control Register 1	ODR1	8	8, 16	2 or 3 PCLKB
0008 C096h	PORTB	Open Drain Control Register 0	ODR0	8	8, 16	2 or 3 PCLKB
0008 C097h	PORTB	Open Drain Control Register 1	ODR1	8	8, 16	2 or 3 PCLKB
0008 C09Ah	PORTD	Open Drain Control Register 0	ODR0	8	8, 16	2 or 3 PCLKB
0008 C09Bh	PORTD	Open Drain Control Register 1	ODR1	8	8, 16	2 or 3 PCLKB
0008 C0C0h	PORT0	Pull-Up Control Register	PCR	8	8	2 or 3 PCLKB
0008 C0C1h	PORT1	Pull-Up Control Register	PCR	8	8	2 or 3 PCLKB
0008 C0C2h	PORT2	Pull-Up Control Register	PCR	8	8	2 or 3 PCLKB
0008 C0C3h	PORT3	Pull-Up Control Register	PCR	8	8	2 or 3 PCLKB
0008 C0C4h	PORT4	Pull-Up Control Register	PCR	8	8	2 or 3 PCLKB
0008 C0C7h	PORT7	Pull-Up Control Register	PCR	8	8	2 or 3 PCLKB
0008 C0C9h	PORT9	Pull-Up Control Register	PCR	8	8	2 or 3 PCLKB
0008 C0CAh	PORTA	Pull-Up Control Register	PCR	8	8	2 or 3 PCLKB
0008 C0CBh	PORTB	Pull-Up Control Register	PCR	8	8	2 or 3 PCLKB
0008 C0CDh	PORTD	Pull-Up Control Register	PCR	8	8	2 or 3 PCLKB
0008 C0E0h	PORT0	Drive Capacity Control Register	DSCR	8	8	2 or 3 PCLKB
0008 C0E1h	PORT1	Drive Capacity Control Register	DSCR	8	8	2 or 3 PCLKB
0008 C0E2h	PORT2	Drive Capacity Control Register	DSCR	8	8	2 or 3 PCLKB
0008 C0E3h	PORT3	Drive Capacity Control Register	DSCR	8	8	2 or 3 PCLKB
0008 C0E7h	PORT7	Drive Capacity Control Register	DSCR	8	8	2 or 3 PCLKB
0008 C0E9h	PORT9	Drive Capacity Control Register	DSCR	8	8	2 or 3 PCLKB
0008 C0EAh	PORTA	Drive Capacity Control Register	DSCR	8	8	2 or 3 PCLKB
0008 C0EBh	PORTB	Drive Capacity Control Register	DSCR	8	8	2 or 3 PCLKB
0008 C0EDh	PORTD	Drive Capacity Control Register	DSCR	8	8	2 or 3 PCLKB
0008 C11Fh	MPC	Write-Protect Register	PWPR	8	8	2 or 3 PCLKB
0008 C140h	MPC	P00 Pin Function Control Register	P00PFS	8	8	2 or 3 PCLKB
0008 C141h	MPC	P01 Pin Function Control Register	P01PFS	8	8	2 or 3 PCLKB
0008 C142h	MPC	P02 Pin Function Control Register	P02PFS	8	8	2 or 3 PCLKB
0008 C148h	MPC	P10 Pin Function Control Register	P10PFS	8	8	2 or 3 PCLKB
0008 C149h	MPC	P11 Pin Function Control Register	P11PFS	8	8	2 or 3 PCLKB
0008 C152h	MPC	P22 Pin Function Control Register	P22PFS	8	8	2 or 3 PCLKB
0008 C153h	MPC	P23 Pin Function Control Register	P23PFS	8	8	2 or 3 PCLKB
0008 C154h	MPC	P24 Pin Function Control Register	P24PFS	8	8	2 or 3 PCLKB
0008 C158h	MPC	P30 Pin Function Control Register	P30PFS	8	8	2 or 3 PCLKB
0008 C159h	MPC	P31 Pin Function Control Register	P31PFS	8	8	2 or 3 PCLKB
0008 C15Ah	MPC	P32 Pin Function Control Register	P32PFS	8	8	2 or 3 PCLKB
0008 C15Bh	MPC	P33 Pin Function Control Register	P33PFS	8	8	2 or 3 PCLKB
0008 C160h	MPC	P40 Pin Function Control Register	P40PFS	8	8	2 or 3 PCLKB
0008 C161h	MPC	P41 Pin Function Control Register	P41PFS	8	8	2 or 3 PCLKB
0008 C162h	MPC	P42 Pin Function Control Register	P42PFS	8	8	2 or 3 PCLKB
0008 C163h	MPC	P43 Pin Function Control Register	P43PFS	8	8	2 or 3 PCLKB
0008 C164h	MPC	P44 Pin Function Control Register	P44PFS	8	8	2 or 3 PCLKB
0008 C165h	MPC	P45 Pin Function Control Register	P45PFS	8	8	2 or 3 PCLKB
0008 C166h	MPC	P46 Pin Function Control Register	P46PFS	8	8	2 or 3 PCLKB
0008 C167h	MPC	P47 Pin Function Control Register	P47PFS	8	8	2 or 3 PCLKB
0008 C178h	MPC	P70 Pin Function Control Register	P70PFS	8	8	2 or 3 PCLKB
0008 C179h	MPC	P71 Pin Function Control Register	P71PFS	8	8	2 or 3 PCLKB
0008 C17Ah	MPC	P72 Pin Function Control Register	P72PFS	8	8	2 or 3 PCLKB
0008 C17Bh	MPC	P73 Pin Function Control Register	P73PFS	8	8	2 or 3 PCLKB
0008 C17Ch	MPC	P74 Pin Function Control Register	P74PFS	8	8	2 or 3 PCLKB

Table 4.1 List of I/O Registers (Address Order) (12 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
0008 C17Dh	MPC	P75 Pin Function Control Register	P75PFS	8	8	2 or 3 PCLKB
0008 C17Eh	MPC	P76 Pin Function Control Register	P76PFS	8	8	2 or 3 PCLKB
0008 C189h	MPC	P91 Pin Function Control Register	P91PFS	8	8	2 or 3 PCLKB
0008 C18Ah	MPC	P92 Pin Function Control Register	P92PFS	8	8	2 or 3 PCLKB
0008 C18Bh	MPC	P93 Pin Function Control Register	P93PFS	8	8	2 or 3 PCLKB
0008 C18Ch	MPC	P94 Pin Function Control Register	P94PFS	8	8	2 or 3 PCLKB
0008 C192h	MPC	PA2 Pin Function Control Register	PA2PFS	8	8	2 or 3 PCLKB
0008 C193h	MPC	PA3 Pin Function Control Register	PA3PFS	8	8	2 or 3 PCLKB
0008 C194h	MPC	PA4 Pin Function Control Register	PA4PFS	8	8	2 or 3 PCLKB
0008 C195h	MPC	PA5 Pin Function Control Register	PA5PFS	8	8	2 or 3 PCLKB
0008 C198h	MPC	PB0 Pin Function Control Register	PB0PFS	8	8	2 or 3 PCLKB
0008 C199h	MPC	PB1 Pin Function Control Register	PB1PFS	8	8	2 or 3 PCLKB
0008 C19Ah	MPC	PB2 Pin Function Control Register	PB2PFS	8	8	2 or 3 PCLKB
0008 C19Bh	MPC	PB3 Pin Function Control Register	PB3PFS	8	8	2 or 3 PCLKB
0008 C19Ch	MPC	PB4 Pin Function Control Register	PB4PFS	8	8	2 or 3 PCLKB
0008 C19Dh	MPC	PB5 Pin Function Control Register	PB5PFS	8	8	2 or 3 PCLKB
0008 C19Eh	MPC	PB6 Pin Function Control Register	PB6PFS	8	8	2 or 3 PCLKB
0008 C19Fh	MPC	PB7 Pin Function Control Register	PB7PFS	8	8	2 or 3 PCLKB
0008 C1ABh	MPC	PD3 Pin Function Control Register	PD3PFS	8	8	2 or 3 PCLKB
0008 C1ACh	MPC	PD4 Pin Function Control Register	PD4PFS	8	8	2 or 3 PCLKB
0008 C1ADh	MPC	PD5 Pin Function Control Register	PD5PFS	8	8	2 or 3 PCLKB
0008 C1AEh	MPC	PD6 Pin Function Control Register	PD6PFS	8	8	2 or 3 PCLKB
0008 C1AFh	MPC	PD7 Pin Function Control Register	PD7PFS	8	8	2 or 3 PCLKB
0008 C1B2h	MPC	PE2 Pin Function Control Register	PE2PFS	8	8	2 or 3 PCLKB
0008 C290h	SYSTEM	Reset Status Register 0	RSTSR0	8	8	4 or 5 PCLKB
0008 C291h	SYSTEM	Reset Status Register 1	RSTSR1	8	8	4 or 5 PCLKB
0008 C293h	SYSTEM	Main Clock Oscillator Forced Oscillation Control Register	MOFCR	8	8	4 or 5 PCLKB
0008 C297h	SYSTEM	Voltage Monitoring Circuit Control Register	LVCMPCR	8	8	4 or 5 PCLKB
0008 C298h	SYSTEM	Voltage Detection Level Select Register	LVDLVLR	8	8	4 or 5 PCLKB
0008 C29Ah	SYSTEM	Voltage Monitoring 1 Circuit Control Register 0	LVD1CR0	8	8	4 or 5 PCLKB
0008 C29Bh	SYSTEM	Voltage Monitoring 2 Circuit Control Register 0	LVD2CR0	8	8	4 or 5 PCLKB
0008 C4C0h	POE	Input Level Control/Status Register 1	ICSR1	16	8, 16	2 or 3 PCLKB
0008 C4C2h	POE	Output Level Control/Status Register 1	OCSR1	16	8, 16	2 or 3 PCLKB
0008 C4C8h	POE	Input Level Control/Status Register 3	ICSR3	16	8, 16	2 or 3 PCLKB
0008 C4CAh	POE	Software Port Output Enable Register	SPOER	8	8	2 or 3 PCLKB
0008 C4CBh	POE	Port Output Enable Control Register 1	POECR1	8	8	2 or 3 PCLKB
0008 C4CCh	POE	Port Output Enable Control Register 2	POECR2	16	16	2 or 3 PCLKB
0008 C4D0h	POE	Port Output Enable Control Register 4	POECR4	16	16	2 or 3 PCLKB
0008 C4D2h	POE	Port Output Enable Control Register 5	POECR5	16	16	2 or 3 PCLKB
0008 C4D6h	POE	Input Level Control/Status Register 4	ICSR4	16	8, 16	2 or 3 PCLKB
0008 C4DAh	POE	Active Level Setting Register 1	ALR1	16	8, 16	2 or 3 PCLKB
0008 C4DCh	POE	Input Level Control/Status Register 6	ICSR6	16	16	2 or 3 PCLKB
0008 C4E6h	POE	Port Output Enable Comparator Detection Flag Register	POECMPFR	16	16	2 or 3 PCLKB
0008 C4E8h	POE	Port Output Enable Comparator Request Select Register	POECMPSEL	16	16	2 or 3 PCLKB
000A 0C80h	CMPC0	Comparator Control Register 0	CMPCTL	8	8	1 or 2 PCLKB
000A 0C84h	CMPC0	Comparator Input Select Register 0	CMPSEL0	8	8	1 or 2 PCLKB
000A 0C88h	CMPC0	Comparator Reference Voltage Select Register 0	CMPSEL1	8	8	1 or 2 PCLKB
000A 0C8Ch	CMPC0	Comparator Output Monitor Register 0	CMPMON	8	8	1 or 2 PCLKB
000A 0C90h	CMPC0	Comparator External Output Enable Register 0	CMPIOC	8	8	1 or 2 PCLKB
000A 0CA0h	CMPC1	Comparator Control Register 1	CMPCTL	8	8	1 or 2 PCLKB
000A 0CA4h	CMPC1	Comparator Input Select Register 1	CMPSEL0	8	8	1 or 2 PCLKB
000A 0CA8h	CMPC1	Comparator Reference Voltage Select Register 1	CMPSEL1	8	8	1 or 2 PCLKB

Table 4.1 List of I/O Registers (Address Order) (13 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
000A 0CACh	CMPC1	Comparator Output Monitor Register 1	CMPMON	8	8	1 or 2 PCLKB
000A 0CB0h	CMPC1	Comparator External Output Enable Register 1	CMPIOC	8	8	1 or 2 PCLKB
000A 0CC0h	CMPC2	Comparator Control Register 2	CMPCTL	8	8	1 or 2 PCLKB
000A 0CC4h	CMPC2	Comparator Input Select Register 2	CMPSEL0	8	8	1 or 2 PCLKB
000A 0CC8h	CMPC2	Comparator Reference Voltage Select Register 2	CMPSEL1	8	8	1 or 2 PCLKB
000A 0CCCh	CMPC2	Comparator Output Monitor Register 2	CMPMON	8	8	1 or 2 PCLKB
000A 0CD0h	CMPC2	Comparator External Output Enable Register 2	CMPIOC	8	8	1 or 2 PCLKB
000C 1200h	MTU3	Timer Control Register	TCR	8	8, 16, 32	4 or 5 PCLKA
000C 1201h	MTU4	Timer Control Register	TCR	8	8	4 or 5 PCLKA
000C 1202h	MTU3	Timer Mode Register 1	TMDR1	8	8, 16	4 or 5 PCLKA
000C 1203h	MTU4	Timer Mode Register 1	TMDR1	8	8	4 or 5 PCLKA
000C 1204h	MTU3	Timer I/O Control Register H	TIORH	8	8, 16, 32	4 or 5 PCLKA
000C 1205h	MTU3	Timer I/O Control Register L	TIORL	8	8	4 or 5 PCLKA
000C 1206h	MTU4	Timer I/O Control Register H	TIORH	8	8, 16	4 or 5 PCLKA
000C 1207h	MTU4	Timer I/O Control Register L	TIORL	8	8	4 or 5 PCLKA
000C 1208h	MTU3	Timer Interrupt Enable Register	TIER	8	8, 16	4 or 5 PCLKA
000C 1209h	MTU4	Timer Interrupt Enable Register	TIER	8	8	4 or 5 PCLKA
000C 120Ah	MTU	Timer Output Master Enable Register A	TOERA	8	8	4 or 5 PCLKA
000C 120Dh	MTU	Timer Gate Control Register	TGCRA	8	8	4 or 5 PCLKA
000C 120Eh	MTU	Timer Output Control Register 1A	TOCR1A	8	8, 16	4 or 5 PCLKA
000C 120Fh	MTU	Timer Output Control Register 2A	TOCR2A	8	8	4 or 5 PCLKA
000C 1210h	MTU3	Timer Counter	TCNT	16	16, 32	4 or 5 PCLKA
000C 1212h	MTU4	Timer Counter	TCNT	16	16	4 or 5 PCLKA
000C 1214h	MTU	Timer Cycle Data Register A	TCDRA	16	16, 32	4 or 5 PCLKA
000C 1216h	MTU	Timer Dead Time Data Register A	TDDRA	16	16	4 or 5 PCLKA
000C 1218h	MTU3	Timer General Register A	TGRA	16	16, 32	4 or 5 PCLKA
000C 121Ah	MTU3	Timer General Register B	TGRB	16	16	4 or 5 PCLKA
000C 121Ch	MTU4	Timer General Register A	TGRA	16	16, 32	4 or 5 PCLKA
000C 121Eh	MTU4	Timer General Register B	TGRB	16	16	4 or 5 PCLKA
000C 1220h	MTU	Timer Subcounters A	TCNTSA	16	16, 32	4 or 5 PCLKA
000C 1222h	MTU	Timer Cycle Buffer Register A	TCBRA	16	16	4 or 5 PCLKA
000C 1224h	MTU3	Timer General Register C	TGRC	16	16, 32	4 or 5 PCLKA
000C 1226h	MTU3	Timer General Register D	TGRD	16	16	4 or 5 PCLKA
000C 1228h	MTU4	Timer General Register C	TGRC	16	16, 32	4 or 5 PCLKA
000C 122Ah	MTU4	Timer General Register D	TGRD	16	16	4 or 5 PCLKA
000C 122Ch	MTU3	Timer Status Register	TSR	8	8, 16	4 or 5 PCLKA
000C 122Dh	MTU4	Timer Status Register	TSR	8	8	4 or 5 PCLKA
000C 1230h	MTU	Timer Interrupt Skipping Set Register 1A	TITCR1A	8	8, 16	4 or 5 PCLKA
000C 1231h	MTU	Timer Interrupt Skipping Counters 1A	TITCNT1A	8	8	4 or 5 PCLKA
000C 1232h	MTU	Timer Buffer Transfer Set Register A	TBTERA	8	8	4 or 5 PCLKA
000C 1234h	MTU	Timer Dead Time Enable Register A	TDERA	8	8	4 or 5 PCLKA
000C 1236h	MTU	Timer Output Level Buffer Register A	TOLBRA	8	8	4 or 5 PCLKA
000C 1238h	MTU3	Timer Buffer Operation Transfer Mode Register	TBTM	8	8, 16	4 or 5 PCLKA
000C 1239h	MTU4	Timer Buffer Operation Transfer Mode Register	TBTM	8	8	4 or 5 PCLKA
000C 123Ah	MTU	Timer Interrupt Skipping Mode Register A	TITMRA	8	8	4 or 5 PCLKA
000C 123Bh	MTU	Timer Interrupt Skipping Set Register 2A	TITCR2A	8	8	4 or 5 PCLKA
000C 123Ch	MTU	Timer Interrupt Skipping Counters 2A	TITCNT2A	8	8	4 or 5 PCLKA
000C 1240h	MTU4	Timer A/D Converter Start Request Control Register	TADCR	16	16	4 or 5 PCLKA
000C 1244h	MTU4	Timer A/D Converter Start Request Cycle Set Register A	TADCORA	16	16, 32	4 or 5 PCLKA
000C 1246h	MTU4	Timer A/D Converter Start Request Cycle Set Register B	TADCORB	16	16	4 or 5 PCLKA
000C 1248h	MTU4	Timer A/D Converter Start Request Cycle Set Buffer Register A	TADCOBRA	16	16, 32	4 or 5 PCLKA

Table 4.1 List of I/O Registers (Address Order) (14 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
000C 124Ah	MTU4	Timer A/D Converter Start Request Cycle Set Buffer Register B	TADCOBRB	16	16	4 or 5 PCLKA
000C 124Ch	MTU3	Timer Control Register 2	TCR2	8	8	4 or 5 PCLKA
000C 124Dh	MTU4	Timer Control Register 2	TCR2	8	8	4 or 5 PCLKA
000C 1260h	MTU	Timer Waveform Control Register A	TWCRA	8	8	4 or 5 PCLKA
000C 1270h	MTU	Timer Mode Register 2A	TMDR2A	8	8	4 or 5 PCLKA
000C 1272h	MTU3	Timer General Register E	TGRE	16	16	4 or 5 PCLKA
000C 1274h	MTU4	Timer General Register E	TGRE	16	16	4 or 5 PCLKA
000C 1276h	MTU4	Timer General Register F	TGRF	16	16	4 or 5 PCLKA
000C 1280h	MTU	Timer Start Register A	TSTRA	8	8, 16	4 or 5 PCLKA
000C 1281h	MTU	Timer Synchronous Register A	TSYRA	8	8	4 or 5 PCLKA
000C 1282h	MTU	Timer Counter Synchronous Start Register	TCSYSTR	8	8	4 or 5 PCLKA
000C 1284h	MTU	Timer Read/Write Enable Register A	TRWERA	8	8	4 or 5 PCLKA
000C 1290h	MTU0	Noise Filter Control Register 0	NFCR0	8	8	4 or 5 PCLKA
000C 1291h	MTU1	Noise Filter Control Register 1	NFCR1	8	8	4 or 5 PCLKA
000C 1292h	MTU2	Noise Filter Control Register 2	NFCR2	8	8	4 or 5 PCLKA
000C 1293h	MTU3	Noise Filter Control Register 3	NFCR3	8	8	4 or 5 PCLKA
000C 1294h	MTU4	Noise Filter Control Register 4	NFCR4	8	8	4 or 5 PCLKA
000C 1299h	MTU0	Noise Filter Control Register C	NFCRC	8	8	4 or 5 PCLKA
000C 1300h	MTU0	Timer Control Register	TCR	8	8, 16, 32	4 or 5 PCLKA
000C 1301h	MTU0	Timer Mode Register 1	TMDR1	8	8	4 or 5 PCLKA
000C 1302h	MTU0	Timer I/O Control Register H	TIORH	8	8, 16	4 or 5 PCLKA
000C 1303h	MTU0	Timer I/O Control Register L	TIORL	8	8	4 or 5 PCLKA
000C 1304h	MTU0	Timer Interrupt Enable Register	TIER	8	8, 16, 32	4 or 5 PCLKA
000C 1306h	MTU0	Timer Counter	TCNT	16	16	4 or 5 PCLKA
000C 1308h	MTU0	Timer General Register A	TGRA	16	16, 32	4 or 5 PCLKA
000C 130Ah	MTU0	Timer General Register B	TGRB	16	16	4 or 5 PCLKA
000C 130Ch	MTU0	Timer General Register C	TGRC	16	16, 32	4 or 5 PCLKA
000C 130Eh	MTU0	Timer General Register D	TGRD	16	16	4 or 5 PCLKA
000C 1320h	MTU0	Timer General Register E	TGRE	16	16, 32	4 or 5 PCLKA
000C 1322h	MTU0	Timer General Register F	TGRF	16	16	4 or 5 PCLKA
000C 1324h	MTU0	Timer Interrupt Enable Register 2	TIER2	8	8, 16	4 or 5 PCLKA
000C 1326h	MTU0	Timer Buffer Operation Transfer Mode Register	TBTM	8	8	4 or 5 PCLKA
000C 1328h	MTU0	Timer Control Register 2	TCR2	8	8	4 or 5 PCLKA
000C 1380h	MTU1	Timer Control Register	TCR	8	8, 16	4 or 5 PCLKA
000C 1381h	MTU1	Timer Mode Register 1	TMDR1	8	8	4 or 5 PCLKA
000C 1382h	MTU1	Timer I/O Control Register	TIOR	8	8	4 or 5 PCLKA
000C 1384h	MTU1	Timer Interrupt Enable Register	TIER	8	8, 16, 32	4 or 5 PCLKA
000C 1385h	MTU1	Timer Status Register	TSR	8	8	4 or 5 PCLKA
000C 1386h	MTU1	Timer Counter	TCNT	16	16	4 or 5 PCLKA
000C 1388h	MTU1	Timer General Register A	TGRA	16	16, 32	4 or 5 PCLKA
000C 138Ah	MTU1	Timer General Register B	TGRB	16	16	4 or 5 PCLKA
000C 1390h	MTU1	Timer Input Capture Control Register	TICCR	8	8	4 or 5 PCLKA
000C 1391h	MTU1	Timer Mode Register 3	TMDR3	8	8	4 or 5 PCLKA
000C 1394h	MTU1	Timer Control Register 2	TCR2	8	8	4 or 5 PCLKA
000C 13A0h	MTU1	Timer Longword Counter	TCNTLW	32	32	4 or 5 PCLKA
000C 13A4h	MTU1	Timer Longword General Register	TGRALW	32	32	4 or 5 PCLKA
000C 13A8h	MTU1	Timer Longword General Register	TGRBLW	32	32	4 or 5 PCLKA
000C 1400h	MTU2	Timer Control Register	TCR	8	8, 16	4 or 5 PCLKA
000C 1401h	MTU2	Timer Mode Register 1	TMDR1	8	8	4 or 5 PCLKA
000C 1402h	MTU2	Timer I/O Control Register	TIOR	8	8	4 or 5 PCLKA
000C 1404h	MTU2	Timer Interrupt Enable Register	TIER	8	8, 16, 32	4 or 5 PCLKA

Table 4.1 List of I/O Registers (Address Order) (15 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
000C 1405h	MTU2	Timer Status Register	TSR	8	8	4 or 5 PCLKA
000C 1406h	MTU2	Timer Counter	TCNT	16	16	4 or 5 PCLKA
000C 1408h	MTU2	Timer General Register A	TGRA	16	16, 32	4 or 5 PCLKA
000C 140Ah	MTU2	Timer General Register B	TGRB	16	16	4 or 5 PCLKA
000C 140Ch	MTU2	Timer Control Register 2	TCR2	8	8	4 or 5 PCLKA
000C 1480h	MTU5	Timer Counter U	TCNTU	16	16, 32	4 or 5 PCLKA
000C 1482h	MTU5	Timer General Register U	TGRU	16	16	4 or 5 PCLKA
000C 1484h	MTU5	Timer Control Register U	TCRU	8	8	4 or 5 PCLKA
000C 1485h	MTU5	Timer Control Register 2U	TCR2U	8	8	4 or 5 PCLKA
000C 1486h	MTU5	Timer I/O Control Register U	TIORU	8	8	4 or 5 PCLKA
000C 1490h	MTU5	Timer Counter V	TCNTV	16	16, 32	4 or 5 PCLKA
000C 1492h	MTU5	Timer General Register V	TGRV	16	16	4 or 5 PCLKA
000C 1494h	MTU5	Timer Control Register V	TCRV	8	8	4 or 5 PCLKA
000C 1495h	MTU5	Timer Control Register 2V	TCR2V	8	8	4 or 5 PCLKA
000C 1496h	MTU5	Timer I/O Control Register V	TIORV	8	8	4 or 5 PCLKA
000C 14A0h	MTU5	Timer Counter W	TCNTW	16	16, 32	4 or 5 PCLKA
000C 14A2h	MTU5	Timer General Register W	TGRW	16	16	4 or 5 PCLKA
000C 14A4h	MTU5	Timer Control Register W	TCRW	8	8	4 or 5 PCLKA
000C 14A5h	MTU5	Timer Control Register 2W	TCR2W	8	8	4 or 5 PCLKA
000C 14A6h	MTU5	Timer I/O Control Register W	TIORW	8	8	4 or 5 PCLKA
000C 14B2h	MTU5	Timer Interrupt Enable Register	TIER	8	8	4 or 5 PCLKA
000C 14B4h	MTU5	Timer Start Register	TSTR	8	8	4 or 5 PCLKA
000C 14B6h	MTU5	Timer Compare Match Clear Register	TCNTCMPCLR	8	8	4 or 5 PCLKA
000C 1D30h	MTU	A/D Conversion Start Request Select Register 0	TADSTRGR0	8	8	4 or 5 PCLKA
007F C100h	FLASH	Flash P/E Mode Control Register	FPMCR	8	8	2 or 3 FCLK
007F C104h	FLASH	Flash Area Select Register	FASR	8	8	2 or 3 FCLK
007F C108h	FLASH	Flash Processing Start Address Register L	FSARL	16	16	2 or 3 FCLK
007F C110h	FLASH	Flash Processing Start Address Register H	FSARH	16	16	2 or 3 FCLK
007F C114h	FLASH	Flash Control Register	FCR	8	8	2 or 3 FCLK
007F C118h	FLASH	Flash Processing End Address Register L	FEARL	16	16	2 or 3 FCLK
007F C120h	FLASH	Flash Processing End Address Register H	FEARH	16	16	2 or 3 FCLK
007F C124h	FLASH	Flash Reset Register	FRESETR	8	8	2 or 3 FCLK
007F C12Ch	FLASH	Flash Status Register 1	FSTATR1	8	8	2 or 3 FCLK
007F C130h	FLASH	Flash Write Buffer Register 0	FWB0	16	16	2 or 3 FCLK
007F C138h	FLASH	Flash Write Buffer Register 1	FWB1	16	16	2 or 3 FCLK
007F C140h	FLASH	Flash Write Buffer Register 2	FWB2	16	16	2 or 3 FCLK
007F C144h	FLASH	Flash Write Buffer Register 3	FWB3	16	16	2 or 3 FCLK
007F C180h	FLASH	Protection Unlock Register	FPR	8	8	2 or 3 FCLK
007F C184h	FLASH	Protection Unlock Status Register	FPSR	8	8	2 or 3 FCLK
007F C1C0h	FLASH	Flash Start-Up Setting Monitor Register	FSCMR	16	16	2 or 3 FCLK
007F C1C8h	FLASH	Flash Access Window Start Address Monitor Register	FAWSMR	16	16	2 or 3 FCLK
007F C1D0h	FLASH	Flash Access Window End Address Monitor Register	FAWEMR	16	16	2 or 3 FCLK
007F C1D8h	FLASH	Flash Initial Setting Register	FISR	8	8	2 or 3 FCLK
007F C1DCh	FLASH	Flash Extra Area Control Register	FEXCR	8	8	2 or 3 FCLK
007F C1E0h	FLASH	Flash Error Address Monitor Register L	FEAML	16	16	2 or 3 FCLK
007F C1E8h	FLASH	Flash Error Address Monitor Register H	FEAMH	16	16	2 or 3 FCLK
007F C1F0h	FLASH	Flash Status Register 0	FSTATR0	8	8	2 or 3 FCLK
007F C350h	FLASHCONST	Unique ID Register 0	UIDR0	32	32	2 or 3 FCLK
007F C354h	FLASHCONST	Unique ID Register 1	UIDR1	32	32	2 or 3 FCLK
007F C358h	FLASHCONST	Unique ID Register 2	UIDR2	32	32	2 or 3 FCLK

Table 4.1 List of I/O Registers (Address Order) (16 / 16)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles
						ICLK ≥ PCLK
007F C35Ch	FLASHCONST	Unique ID Register 3	UIDR3	32	32	2 or 3 FCLK
007F FFB2h	FLASH	Flash P/E Mode Entry Register	FENTRYR	16	16	2 or 3 FCLK

Note 1. Odd addresses cannot be accessed in 16-bit units. When accessing a register in 16-bit units, access the address of the TMR0 or TMR2 register. Table 22.4 lists register allocation for 16-bit access in the User's Manual: Hardware.

5. Electrical Characteristics

5.1 Absolute Maximum Ratings

Table 5.1 Absolute Maximum Ratings

Conditions: VSS = AVSS0 = VREFL0 = 0 V

Item		Symbol	Value	Unit
Power supply voltage		VCC	–0.3 to +6.5	V
Input voltage	Port 4	V_{in}	-0.3 to AVCC0+0.3	V
	Except for port 4 and ports for 5 V tolerant*1		–0.3 to VCC+0.3	V
	Ports for 5 V tolerant*1		–0.3 to +6.5	V
Reference power supply voltage		VREFH0	–0.3 to AVCC0+0.3	V
Analog power supply voltage		AVCC0	–0.3 to +6.5	V
Analog input voltage	When AN000 to AN007 used	V_{AN}	–0.3 to AVCC0+0.3	V
	When AN016 and AN017 used		–0.3 to VCC+0.3	
Operating temperature*2		T_{opr}	–40 to +85 –40 to +105	°C
Storage temperature		T_{stg}	–55 to +125	°C

Caution: Permanent damage to the MCU may result if absolute maximum ratings are exceeded.

To preclude any malfunctions due to noise interference, insert capacitors of high frequency characteristics between the VCC and VSS pins, between the AVCC0 and AVSS0 pins, between the VREFH0 and VREFL0 pins. Place capacitors of about 0.1 µF as close as possible to every power supply pin and use the shortest and heaviest possible traces.

Connect the VCL pin to a VSS pin via a 4.7 µF capacitor. The capacitor must be placed close to the pin.

Do not input signals or an I/O pull-up power supply to ports other than 5-V tolerant ports while the device is not powered.

The current injection that results from input of such a signal or I/O pull-up may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements.

Even if –0.3 to +6.5 V is input to 5-V tolerant ports, it will not cause problems such as damage to the MCU.

Note 1. Ports B1 and B2 are 5 V tolerant.

Note 2. The upper limit of operating temperature is 85°C or 105°C, depending on the product. For details, refer to section 1.2, List of Products.

Table 5.2 Recommended Operating Voltage Conditions

Item	Symbol	Conditions	Min.	Typ.	Max.	Unit
Power supply voltages	VCC*1, *2		2.7	—	5.5	V
	VSS		—	0	—	
Analog power supply voltages	AVCC0*1, *2		VCC	—	5.5	V
	VREFH0*1, *2		—	AVCC0	—	
	AVSS0, VREFL0		—	0	—	

Note 1. AVCC0/VREFH0 and VCC can be set individually within the operating range.

Note 2. When powering on the VCC and AVCC0/VREFH0 pins, power them on at the same time or the VCC pin first and then the AVCC0/VREFH0 pin.

5.2 DC Characteristics

Table 5.3 DC Characteristics (1)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Schmitt trigger input voltage	RIIC input pin (except for SMBus, 5 V tolerant)	V_{IH}	VCC × 0.7	—	5.8	V	
	Ports B1 and B2 (5 V tolerant)		VCC × 0.8	—	5.8		
	Ports 00 to 02, 10, 11 Ports 22 to 24 Ports 30 to 33, 36, 37 Ports 70 to 76 Ports 91 to 94 Ports A2 to A5 Ports B0, B3 to B7 Ports D3 to D7 Port E2 Port RES#		VCC × 0.8	—	VCC + 0.3		
	Ports 40 to 47		AVCC0 × 0.8	—	AVCC0 + 0.3		
	RIIC input pin (except for SMBus)	V_{IL}	–0.3	—	VCC × 0.3		
	Ports 40 to 47		–0.3	—	AVCC0 × 0.2		
	Other than RIIC input pin or ports 40 to 47		–0.3	—	VCC × 0.2		
	RIIC input pin (except for SMBus)	ΔV_T	VCC × 0.05	—	—		
	Ports 40 to 47		AVCC0 × 0.1	—	—		
	Other than RIIC input pin or ports 40 to 47		VCC × 0.1	—	—		
Input level voltage (except for Schmitt trigger input pins)	MD	V_{IH}	VCC × 0.9	—	VCC + 0.3	V	
	EXTAL (external clock input)		VCC × 0.8	—	VCC + 0.3		
	RIIC input pin (SMBus)		2.1	—	VCC + 0.3		
	MD	V_{IL}	–0.3	—	VCC × 0.1		
	EXTAL (external clock input)		–0.3	—	VCC × 0.2		
	RIIC input pin (SMBus)		–0.3	—	0.8		

Table 5.4 DC Characteristics (2)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Input leakage current	RES#, MD, port E2	$\lvert I_{in} \rvert$	—	—	1.0	µA	V_{in} = 0 V, VCC
Three-state leakage current (off-state)	Port 4	$\lvert I_{TSI} \rvert$	—	—	1.0	µA	V_{in} = 0 V, AVCC0
	Ports except for 5-V tolerant ports and port 4		—	—	0.2		V_{in} = 0 V, VCC
	Ports for 5 V tolerant		—	—	1.0		V_{in} = 0 V, 5.8 V
Input capacitance	All input pins	C_{in}	—	4	15	pF	V_{in} = 0 mV, f = 1 MHz, T_a = 25°C
Input pull-up resistor	All ports (except for port E2)	R_U	10	20	50	kΩ	V_{in} = 0 V

Table 5.5 DC Characteristics (3)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item					Symbol	Typ.	Max.	Unit	Test Conditions
Supply current *1	High-speed operating mode	Normal operating mode	No peripheral operation*2	ICLK = 40 MHz	I_{CC}	4.6	—	mA	
				ICLK = 32 MHz		3.9	—		
				ICLK = 16 MHz		2.8	—		
				ICLK = 8 MHz		2.2	—		
			All peripheral operation: Normal	ICLK = 40 MHz*3		15.0	—		
				ICLK = 32 MHz*4		12.4	—		
				ICLK = 16 MHz*4		7.2	—		
				ICLK = 8 MHz*4		4.6	—		
			All peripheral operation: Max.	ICLK = 40 MHz*3		—	33.0		
				ICLK = 32 MHz*4		—	24.5		
		Sleep mode	No peripheral operation*2	ICLK = 40 MHz		2.7	—		
				ICLK = 32 MHz		2.3	—		
				ICLK = 16 MHz		1.9	—		
				ICLK = 8 MHz		1.6	—		
			All peripheral operation: Normal	ICLK = 40 MHz*3		6.8	—		
				ICLK = 32 MHz*4		5.7	—		
				ICLK = 16 MHz*4		3.6	—		
				ICLK = 8 MHz*4		2.5	—		
		Deep sleep mode	No peripheral operation*2	ICLK = 40 MHz		1.7	—		
				ICLK = 32 MHz		1.5	—		
				ICLK = 16 MHz		1.3	—		
				ICLK = 8 MHz		1.3	—		
			All peripheral operation: Normal	ICLK = 40 MHz*3		5.3	—		
				ICLK = 32 MHz*4		4.4	—		
				ICLK = 16 MHz*4		2.8	—		
				ICLK = 8 MHz*4		2.0	—		
	Middle-speed operating modes	Normal operating mode	No peripheral operation*6	ICLK = 12 MHz	I_{CC}	2.6	—	mA	
				ICLK = 8 MHz		1.9	—		
				ICLK = 1 MHz		1.3	—		
			All peripheral operation: Normal*7	ICLK = 12 MHz		5.5	—		
				ICLK = 8 MHz		4.2	—		
				ICLK = 1 MHz		1.6	—		
			All peripheral operation: Max.*7	ICLK = 12 MHz		—	11.0		

Item					Symbol	Typ.	Max.	Unit	Test Conditions
Supply current *1	Middle-speed operating modes	Sleep mode	No peripheral operation*6	ICLK = 12 MHz	I_{CC}	2.0	—	mA	
				ICLK = 8 MHz		1.4	—		
				ICLK = 1 MHz		1.2	—		
			All peripheral operation: Normal*7	ICLK = 12 MHz		2.8	—		
				ICLK = 8 MHz		2.3	—		
				ICLK = 1 MHz		1.3	—		
		Deep sleep mode	No peripheral operation*6	ICLK = 12 MHz		1.5	—		
				ICLK = 8 MHz		1.2	—		
				ICLK = 1 MHz		1.1	—		
			All peripheral operation: Normal*7	ICLK = 12 MHz		2.8	—		
				ICLK = 8 MHz		2.3	—		
				ICLK = 1 MHz		1.1	—		

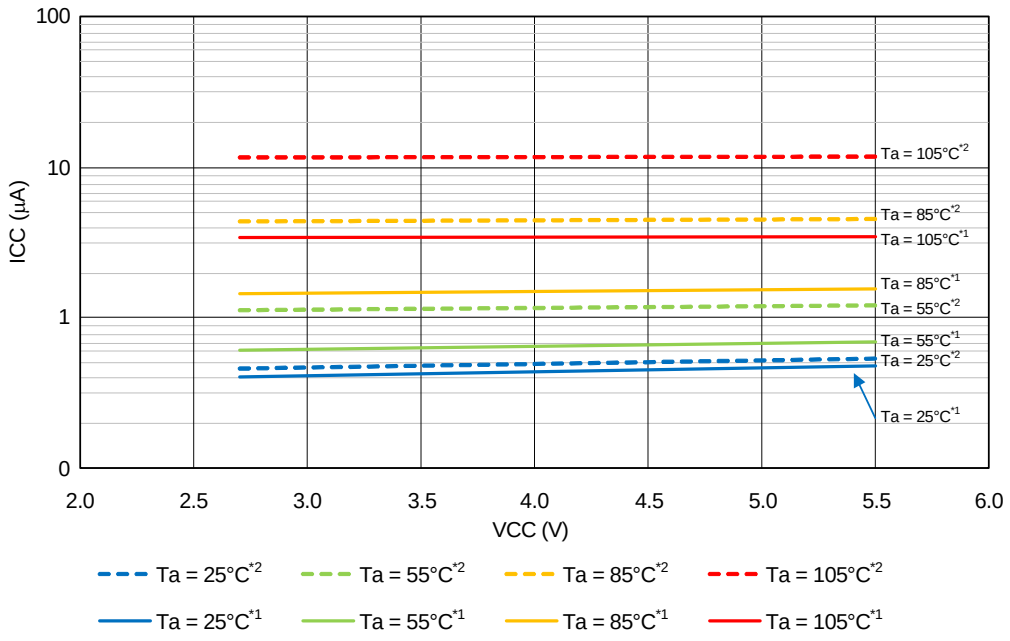
Note 1. Supply current values do not include output charge/discharge current from all pins. The values apply when internal pull-up MOSs are in the off state.
Note 2. Supply of the clock signal to peripheral modules is stopped in this state. The clock source is PLL. FCLK and PCLK are division by 64.
Note 3. The clock signal to peripheral modules is supplied in this state. The clock source is PLL. FCLK is division by 2. The frequency of PCLK is same as ICLK.
Note 4. The clock signal to peripheral modules is supplied in this state. The clock source is PLL. The frequencies of FCLK and PCLK are same as ICLK.
Note 5. Values when VCC = 5 V.
Note 6. Supply of the clock signal to peripheral modules is stopped in this state. The clock source is PLL. FCLK and PCLK are division by 64.
Note 7. Supply of the clock signal to peripheral modules is stopped in this state. The clock source is PLL. The frequencies of FCLK and PCLK are same as ICLK.

Table 5.6 DC Characteristics (4)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item			Symbol	Typ.*3	Max.	Unit	Test Conditions
Supply current*1	Software standby mode*2	T_a = 25°C	I_{CC}	0.45	0.91	µA	
		T_a = 55°C		0.66	2.23		
		T_a = 85°C		1.50	9.14		
		T_a = 105°C		3.42	23.94		

Note 1. Supply current values are with all output pins unloaded and all input pull-up MOSs in the off state.
Note 2. The IWDT and LVD are stopped.
Note 3. VCC = 5 V.



Note 1. Average value of the tested middle samples during product evaluation
Note 2. Average value of the tested upper-limit samples during product evaluation

Figure 5.1 Voltage Dependency in Software Standby Mode (Reference Data)

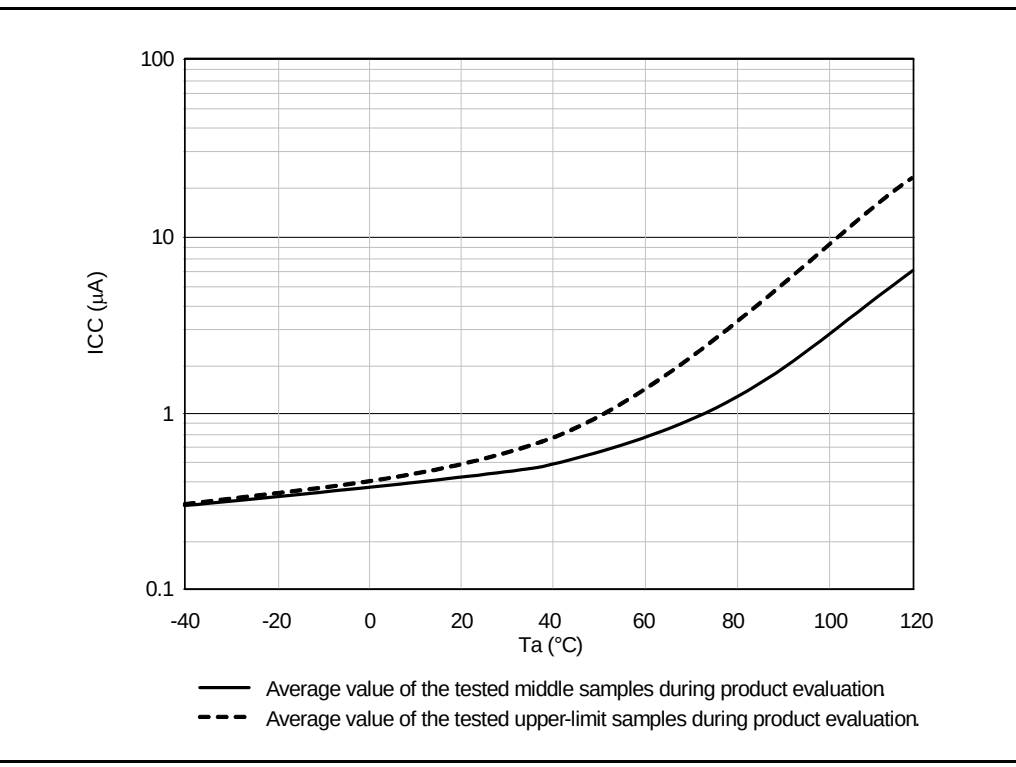


Figure 5.2 Temperature Dependency in Software Standby Mode (Reference Data)

Table 5.7 DC Characteristics (5)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item	Symbol	Typ.	Max.	Unit	Test Conditions
Permissible total consumption power*1	Pd	—	300	mW	D-version product
Permissible total consumption power*1	Pd	—	125	mW	G-version product

Note: Please contact a Renesas Electronics sales office for information on the derating of the G-version product. Derating is the systematic reduction of load for the sake of improved reliability.

Note 1. Total power dissipated by the entire chip (including output currents)

Table 5.8 DC Characteristics (6)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	Min.	Typ.*2	Max.	Unit	Test Conditions
Analog power supply current	During A/D conversion (Sample-and-hold circuits in use)	I_{AVCC}	—	3.1	5.2	mA	
	During A/D conversion (Sample-and-hold circuits not in use)		—	0.9	1.8		
	During D/A conversion*1		—	0.4	0.9		
	Waiting for A/D and D/A conversion (all units)		—	—	0.4	µA	
Reference power supply current	During A/D conversion	I_{REFH0}	—	80	130	µA	
	Waiting for A/D conversion (all units)		—	—	60	nA	
Comparator C operating current*3	Comparator enabled (per channel)	I_{CMP}	—	40	60	µA	

Note 1. The value of the D/A converter is the value of the power supply current including the reference current.

Note 2. When VCC = AVCC0 = 5 V.

Note 3. Current consumed only by the comparator C module.

Table 5.9 DC Characteristics (7)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Power-on VCC rising gradient	At normal startup	SrVCC	0.02	—	20	ms/V	
	Voltage monitoring 0 reset enabled at startup*1, *2		0.02	—	—		

Note 1. When OFS1.LVDAS = 0.

Note 2. Turn on the power supply voltage according to the normal startup rising gradient because the register settings set by OFS1 are not read in boot mode.

Table 5.10 DC Characteristics (8)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

The ripple voltage must meet the allowable ripple frequency $f_{r\,(VCC)}$ within the range between the VCC upper limit (5.5 V) and lower limit (2.7 V). When VCC change exceeds VCC ±10%, the allowable voltage change rising/falling gradient dt/dVCC must be met.

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Allowable ripple frequency	$f_{r\,(VCC)}$	—	—	10	kHz	Figure 5.3 $V_{r\,(VCC)} \leq VCC \times 0.2$
		—	—	1	MHz	Figure 5.3 $V_{r\,(VCC)} \leq VCC \times 0.08$
		—	—	10	MHz	Figure 5.3 $V_{r\,(VCC)} \leq VCC \times 0.06$
Allowable voltage change rising/falling gradient	dt/dVCC	1.0	—	—	ms/V	When VCC change exceeds VCC ±10%

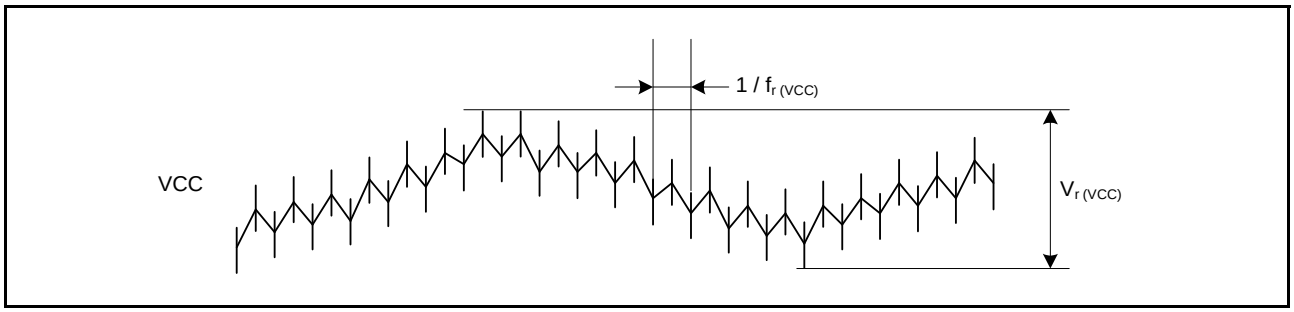


Figure 5.3 Ripple Waveform

Table 5.11 DC Characteristics (9)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Permissible error of VCL pin external capacitance	C_{VCL}	3.3	4.7	6.1	µF	

Note: The recommended capacitance is 4.7 µF. Variations in connected capacitors should be within the above range.

Table 5.12 Permissible Output Currents

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item			Symbol	Max.	Unit
Permissible output low current	Large current ports (Ports 71 to 76, port B5, port D3)		I_{OL}	10.0	mA
	RIIC pins			6.0	
	Ports other than above	Normal output mode		4.0	
		High-drive output mode		8.0	
Permissible output low current	Total of large current ports		ΣI_{OL}	50	
	Total of all output pins			110	
Permissible output high current	Large current ports (Ports 71 to 76, port B5, port D3)		I_{OH}	–5.0	
	Ports other than above	Normal output mode		–4.0	
		High-drive output mode		–8.0	
Permissible output high current	Total of large current ports		ΣI_{OH}	–25	
	Total of all output pins			–35	

Note: Do not exceed the permissible total supply current.

Table 5.13 Output Values of Voltage

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item			Symbol	Min.	Max.	Unit	Test Conditions
Output low	Large current ports (Ports 71 to 76, port B5, port D3)		V_{OL}	—	0.8	V	I_{OL} = 10.0mA
	RIIC pins	Standard mode		—	0.4		I_{OL} = 3.0mA
		Fast mode		—	0.6		I_{OL} = 6.0mA
	Ports other than above	Normal output mode		—	0.8		I_{OL} = 1.0mA
		High-drive output mode		—	0.8		I_{OL} = 2.0mA
Output high	Large current ports (Ports 71 to 76, port B5, port D3)		V_{OH}	VCC – 0.8	—	V	I_{OH} = –5.0mA
	Ports 40 to 47			AVCC0 – 0.8	—		I_{OH} = –2.0mA
	Ports other than above	Normal output mode		VCC – 0.8	—		I_{OH} = –2.0mA
		High-drive output mode		VCC – 0.8	—		I_{OH} = –4.0mA

5.2.1 Normal I/O Pin Output Characteristics (1)

Figure 5.4 to Figure 5.7 show the characteristics when normal output is selected by the drive capacity control register.

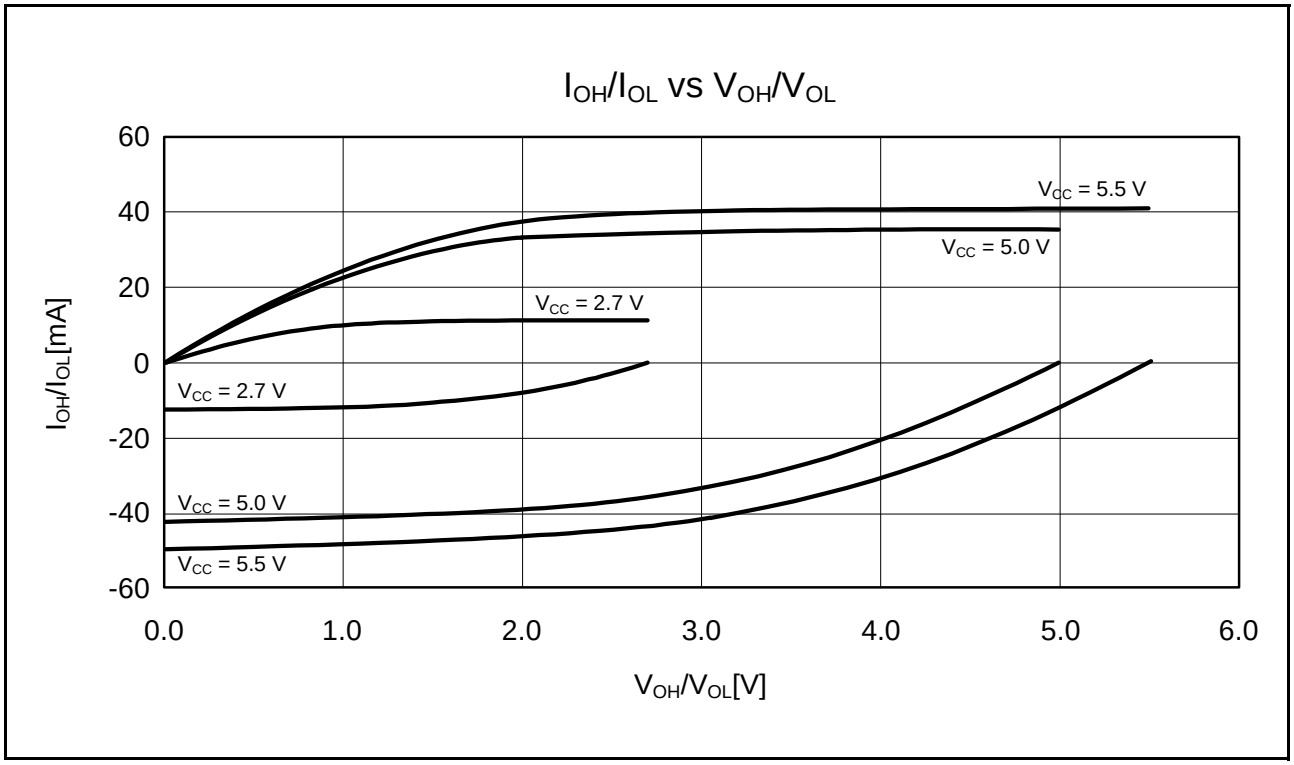


Figure 5.4 V_{OH}/V_{OL} and I_{OH}/I_{OL} Voltage Characteristics at T_a = 25°C When Normal Output is Selected (Reference Data)

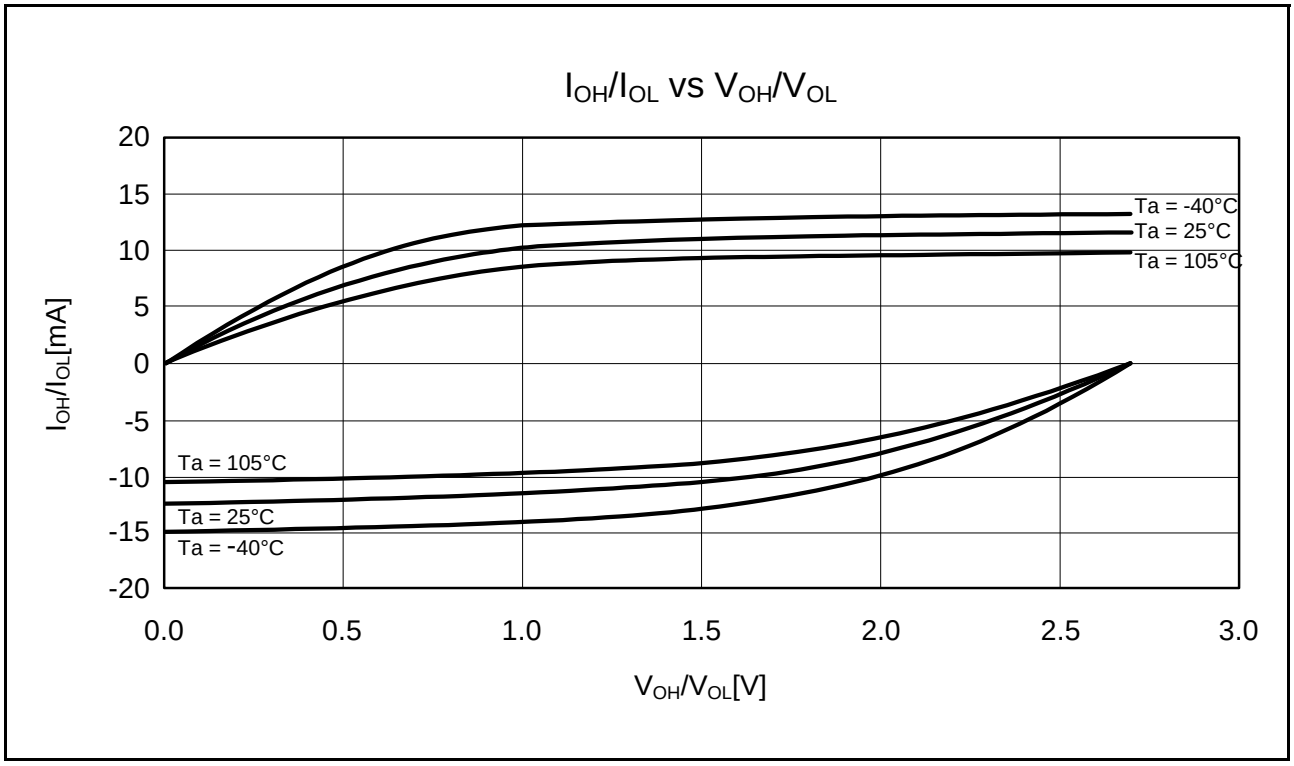


Figure 5.5 **V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics at VCC = 2.7 V when Normal Output is Selected (Reference Data)**

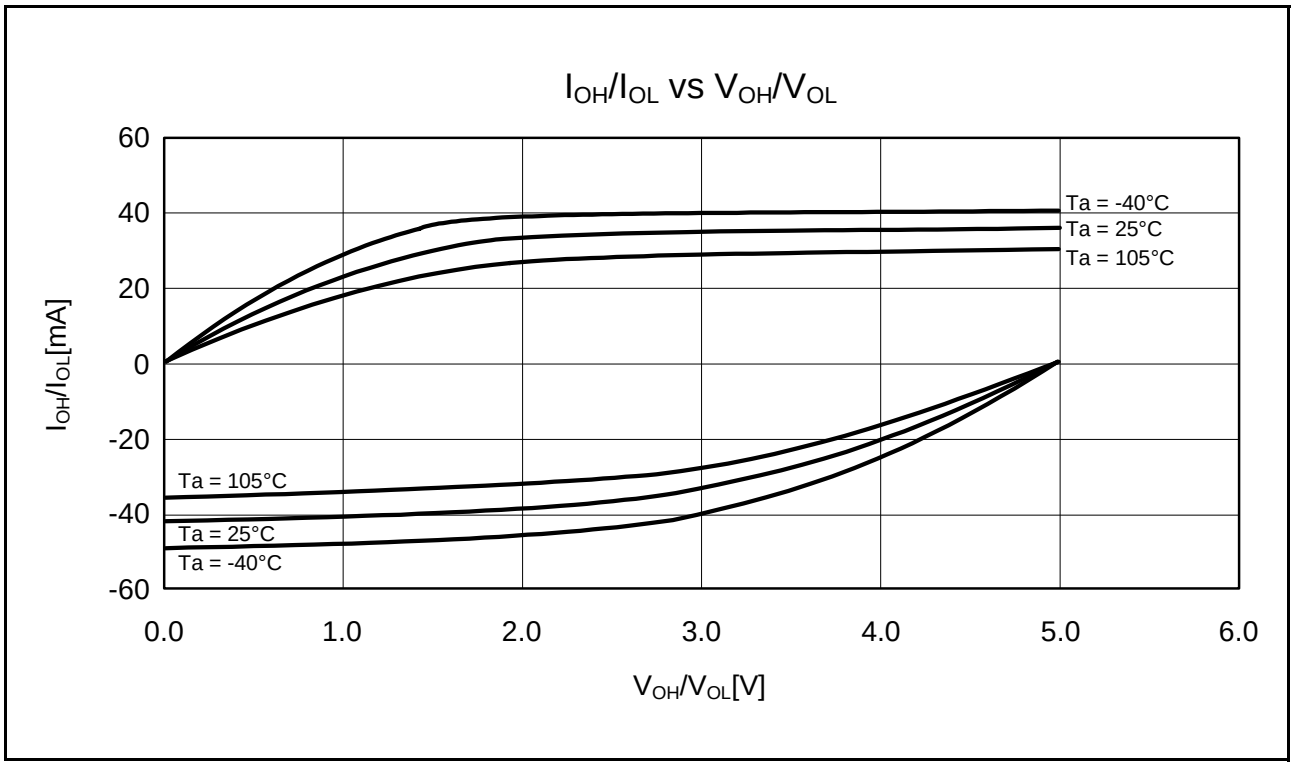


Figure 5.6 **V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics at VCC = 5.0 V when Normal Output is Selected (Reference Data)**

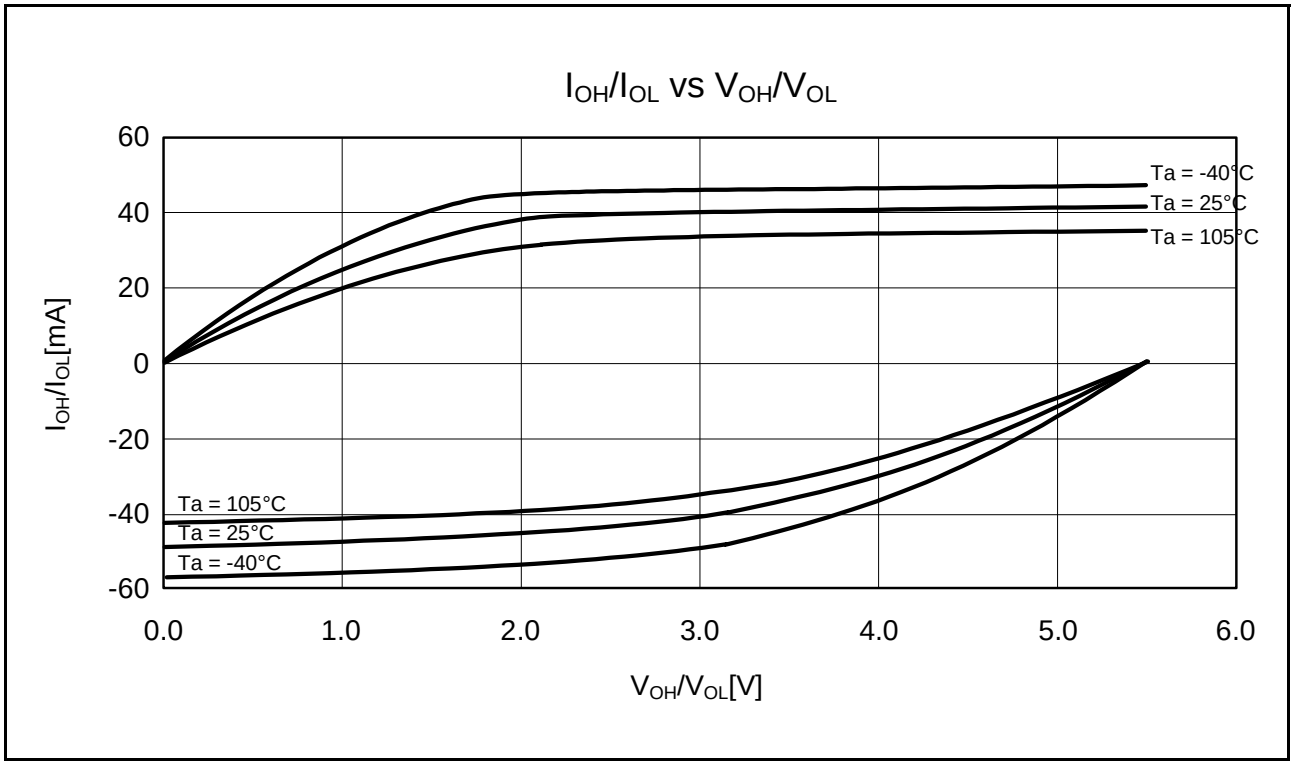


Figure 5.7 **V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics at VCC = 5.5 V when Normal Output is Selected (Reference Data)**

5.2.2 Standard I/O Pin Output Characteristics (2)

Figure 5.8 to Figure 5.11 show the characteristics when high-drive output is selected by the drive capacity control register.

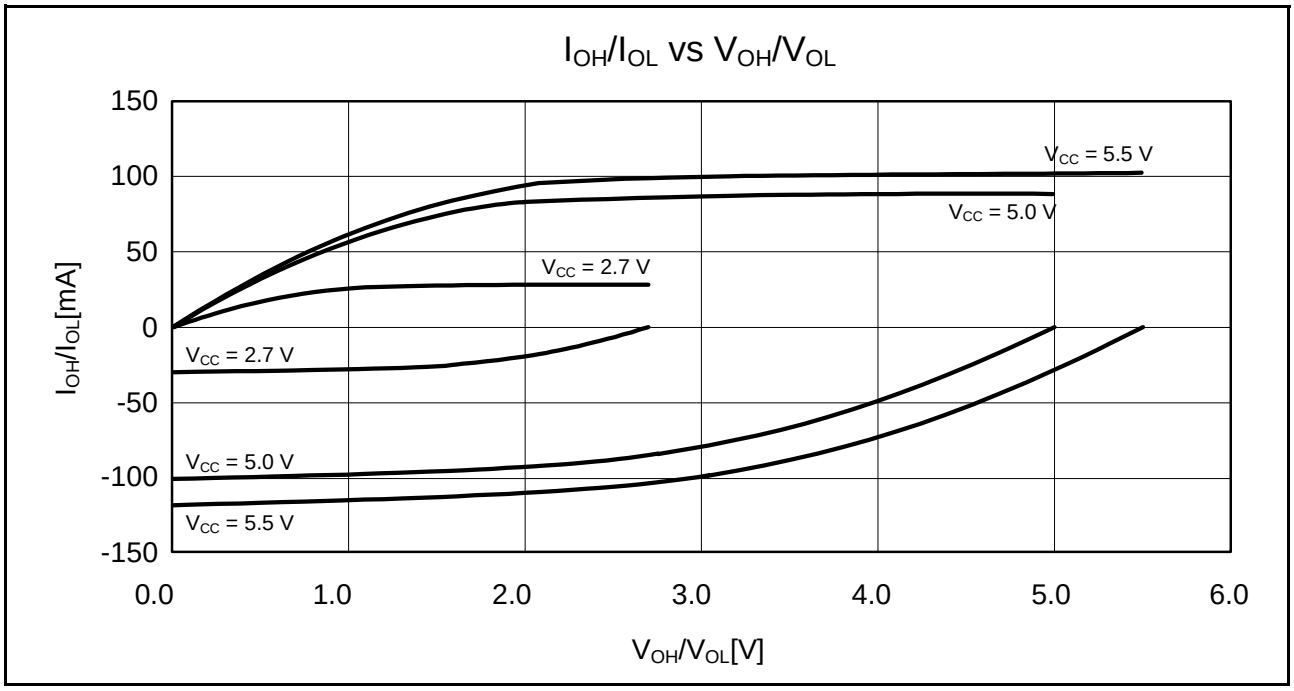


Figure 5.8 V_{OH}/V_{OL} and I_{OH}/I_{OL} Voltage Characteristics at T_a = 25°C When Normal Output is Selected (Reference Data)

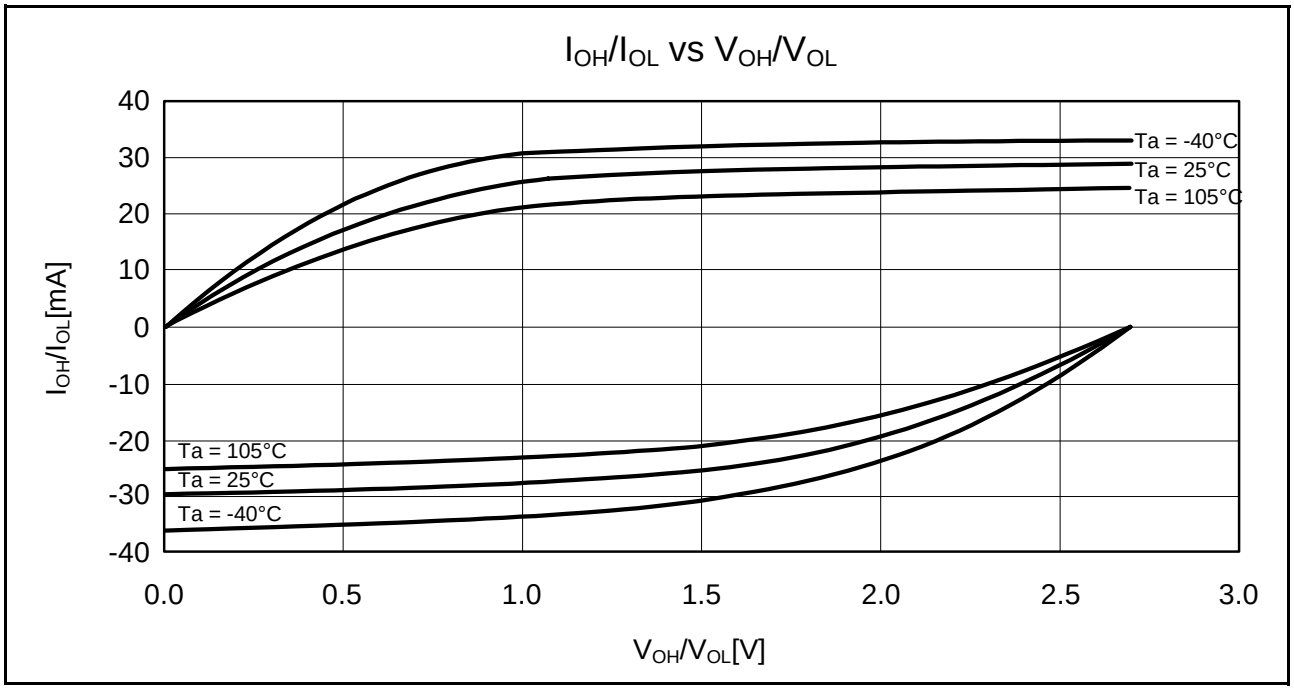


Figure 5.9 V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics at VCC = 2.7 V when Normal Output is Selected (Reference Data)

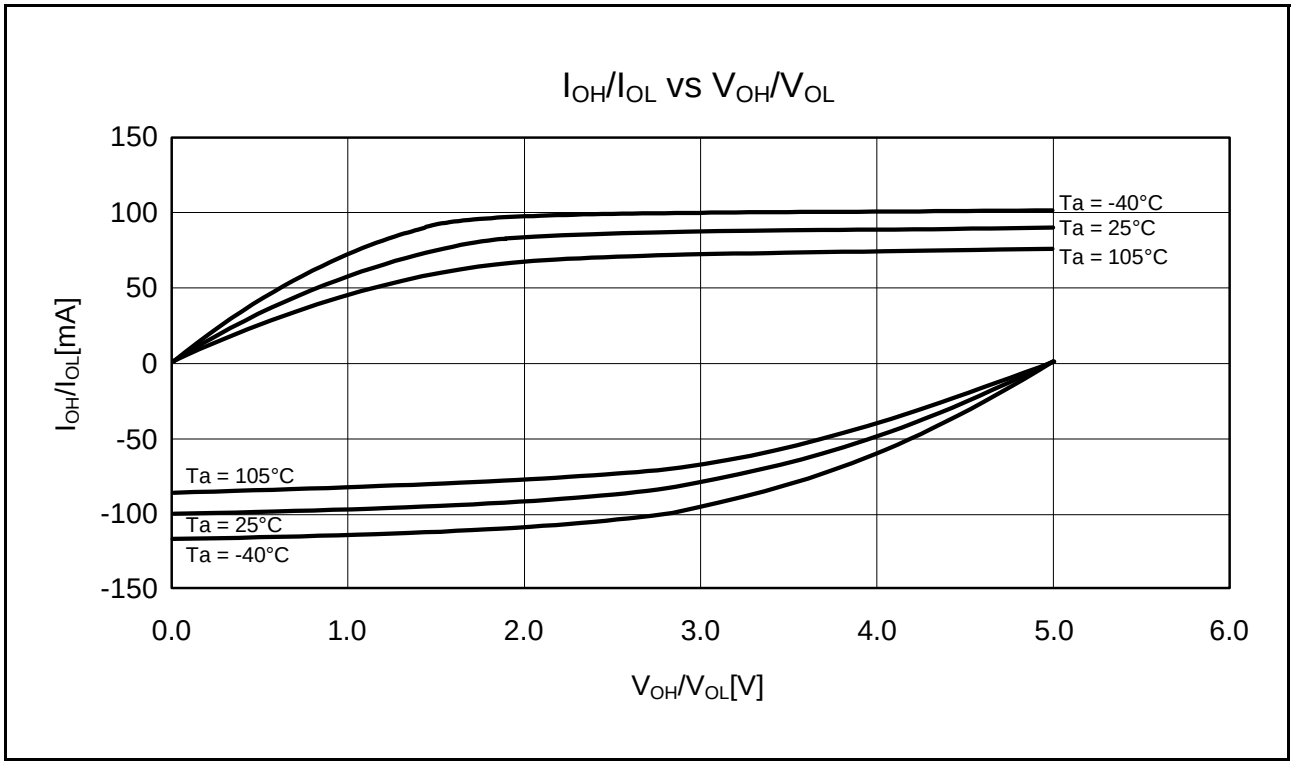


Figure 5.10 V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics at VCC = 5.0 V when Normal Output is Selected (Reference Data)

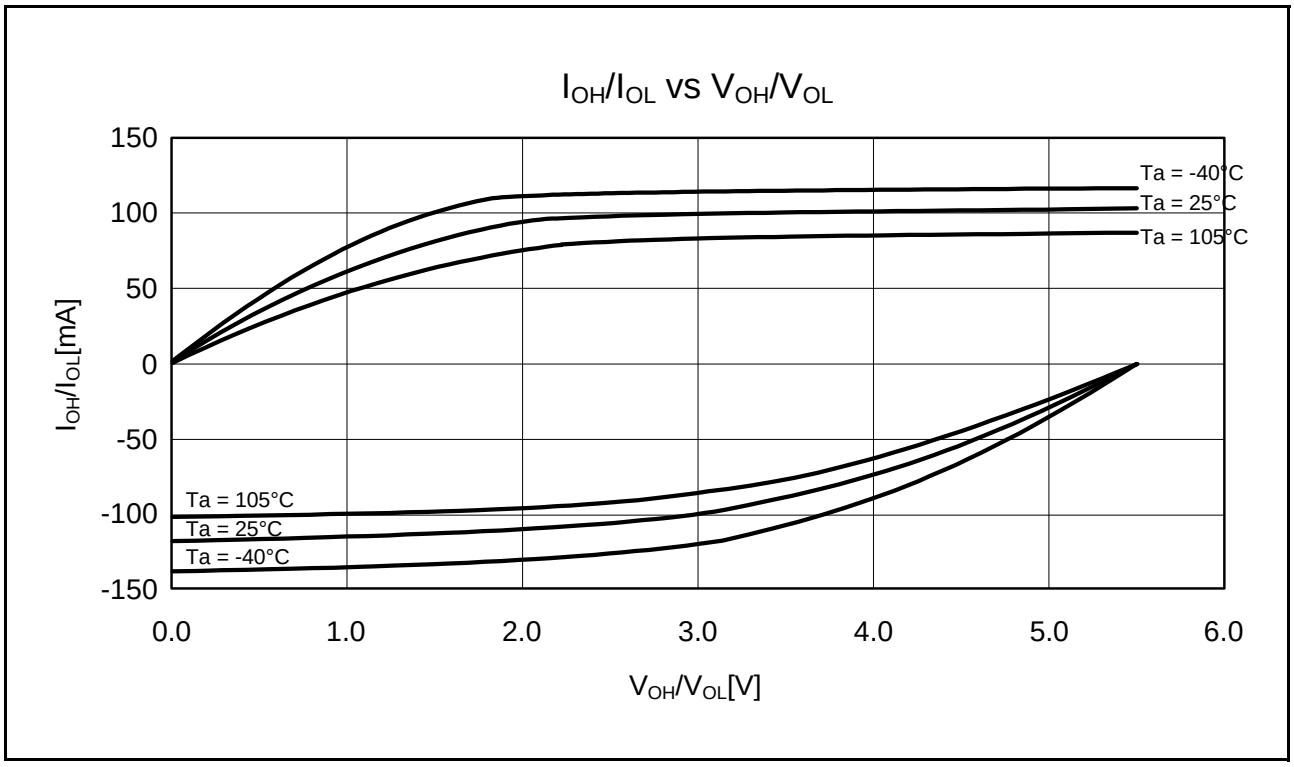


Figure 5.11 V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics at VCC = 5.5 V when Normal Output is Selected (Reference Data)

5.2.3 Standard I/O Pin Output Characteristics (3)

Figure 5.12 to Figure 5.15 show the output characteristics of the large current ports (ports 71 to 76, port B5, port D3).

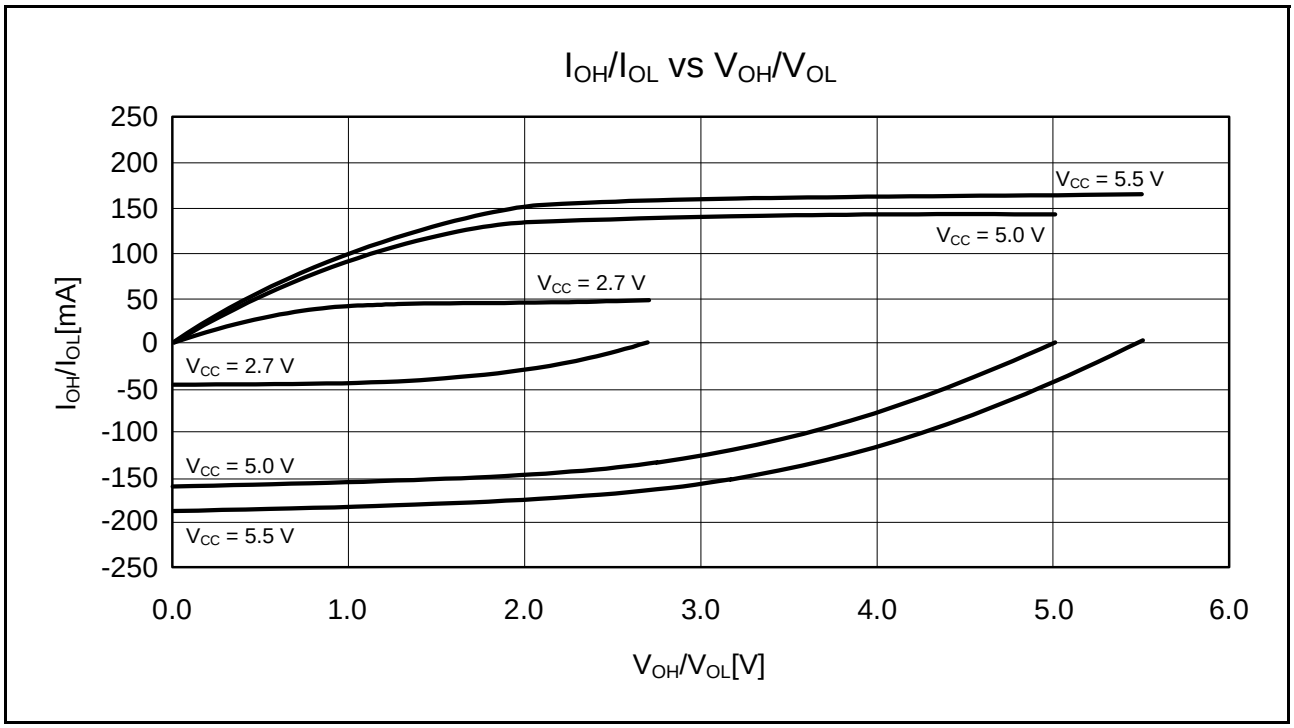


Figure 5.12 V_{OH}/V_{OL} and I_{OH}/I_{OL} Voltage Characteristics of Large Current Ports (Ports 71 to 76, Port B5, Port D3) at T_a = 25°C (Reference Data)

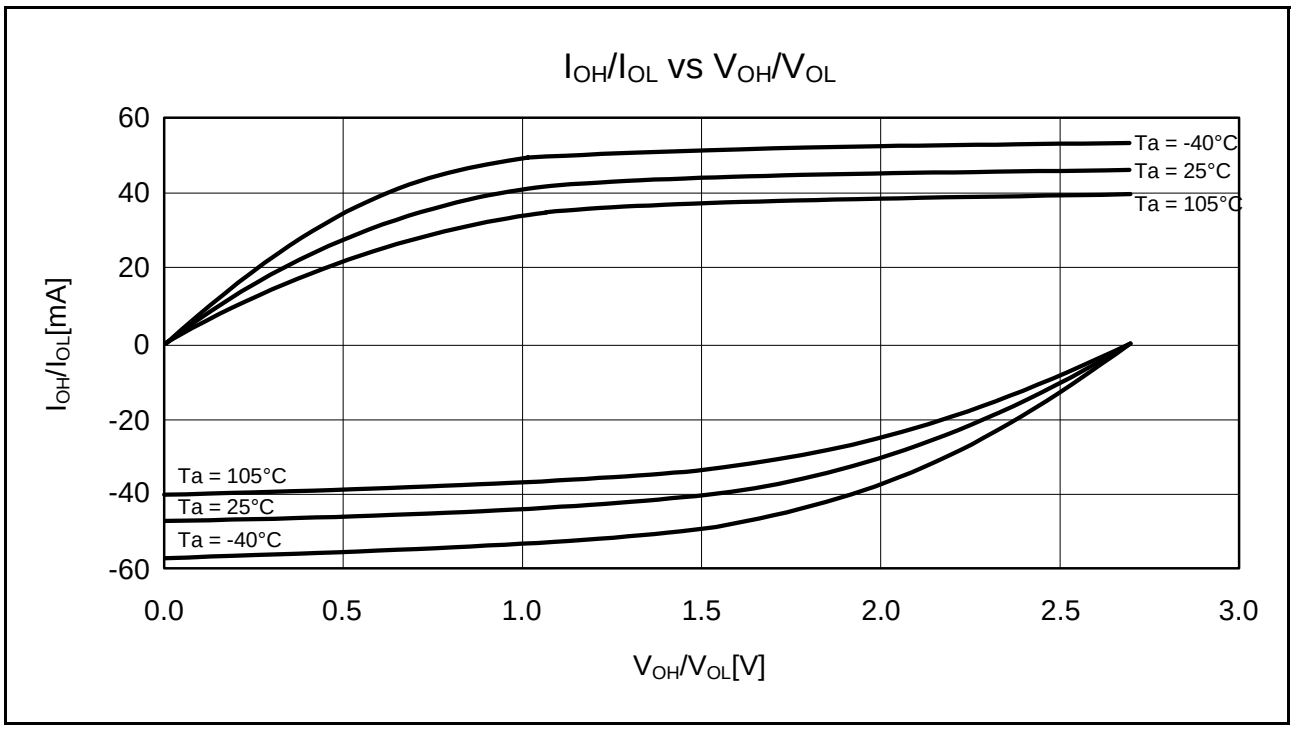


Figure 5.13 V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics of Large Current Ports (Ports 71 to 76, Port B5, Port D3) at VCC = 2.7 V (Reference Data)

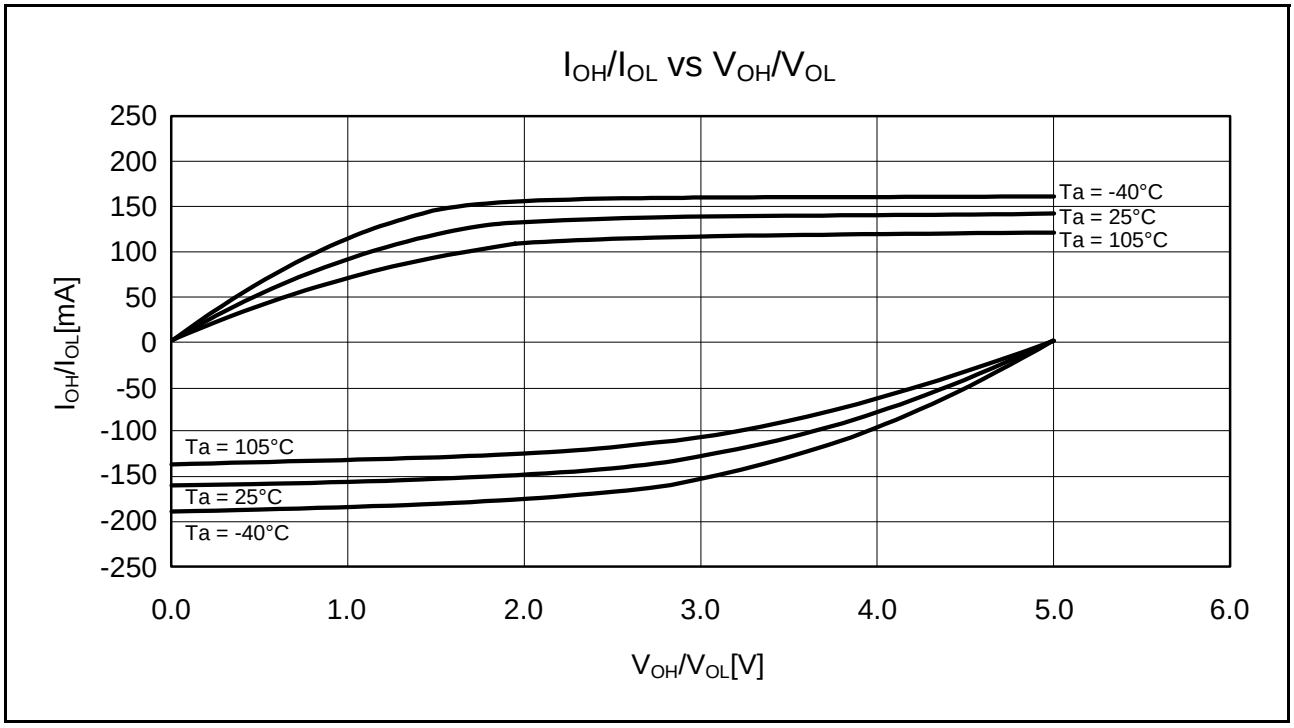


Figure 5.14 **V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics of Large Current Ports (Ports 71 to 76, Port B5, Port D3) at VCC = 5.0 V (Reference Data)**

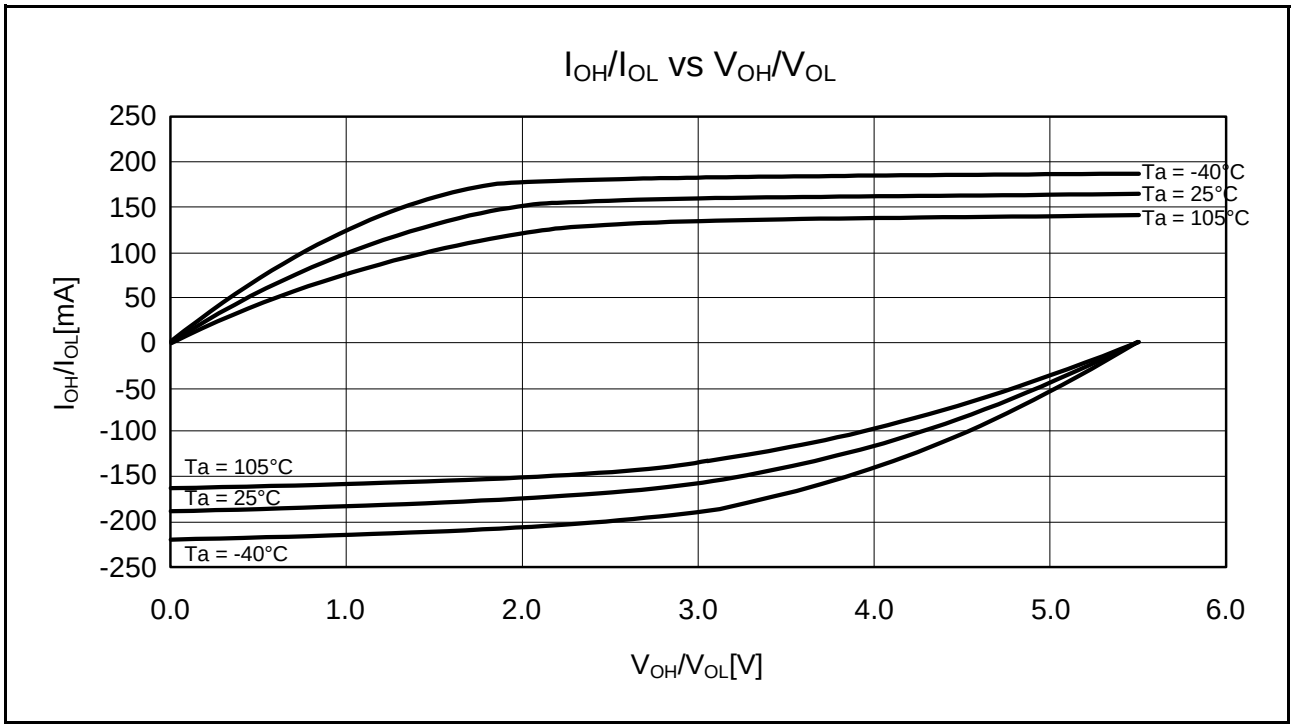


Figure 5.15 **V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics of Large Current Ports (Ports 71 to 76, Port B5, Port D3) at VCC = 5.5 V (Reference Data)**

5.2.4 RIIC Pin Output Characteristics

Figure 5.16 to Figure 5.19 show the output characteristics of the RIIC pin.

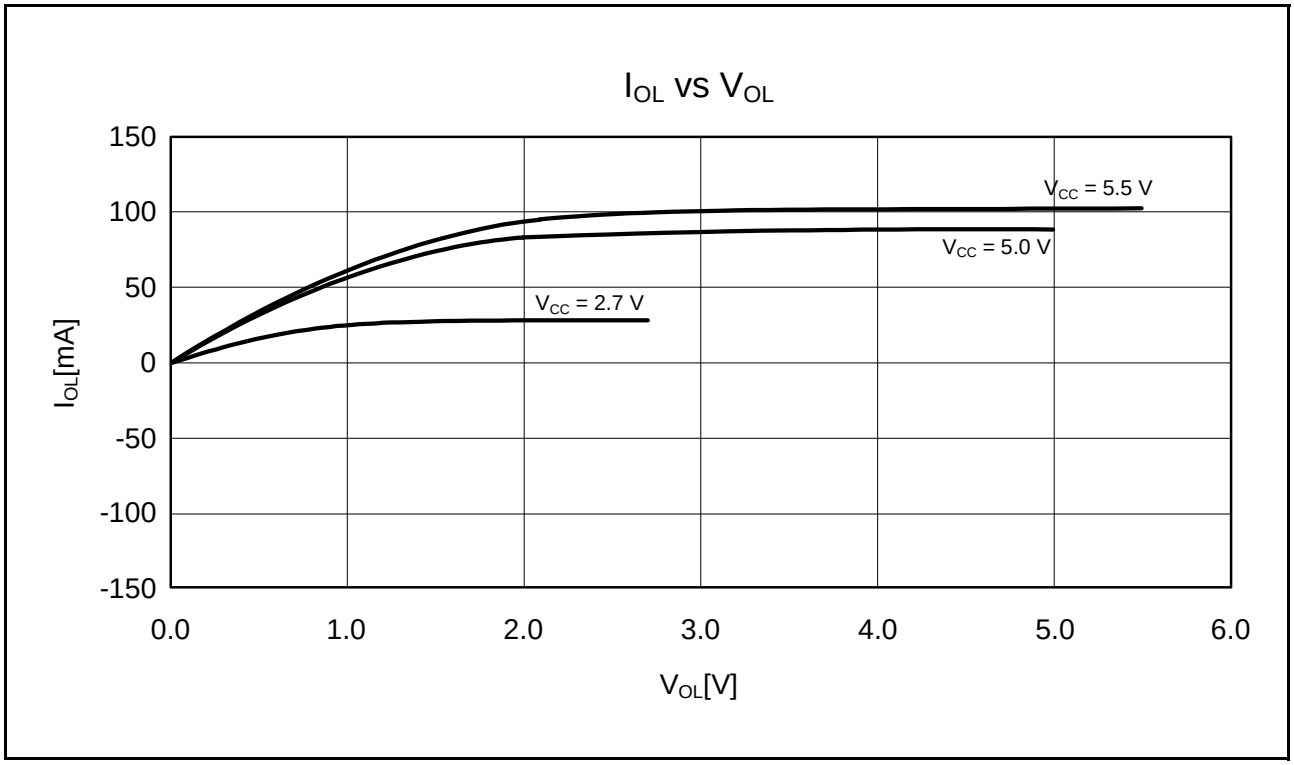


Figure 5.16 V_{OL} and I_{OL} Voltage Characteristics of RIIC Output Pin at T_a = 25°C (Reference Data)

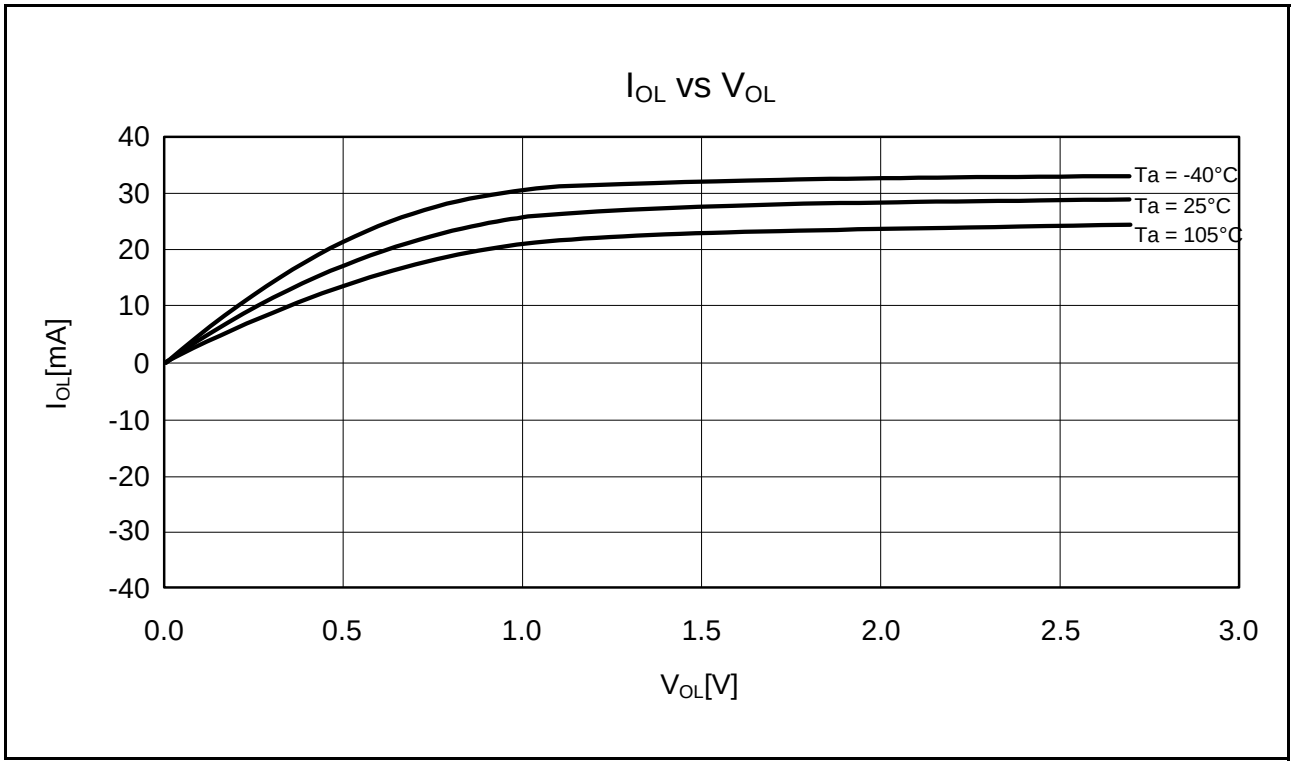


Figure 5.17 V_{OL} and I_{OL} Temperature Characteristics of RIIC Output Pin at VCC = 2.7 V (Reference Data)

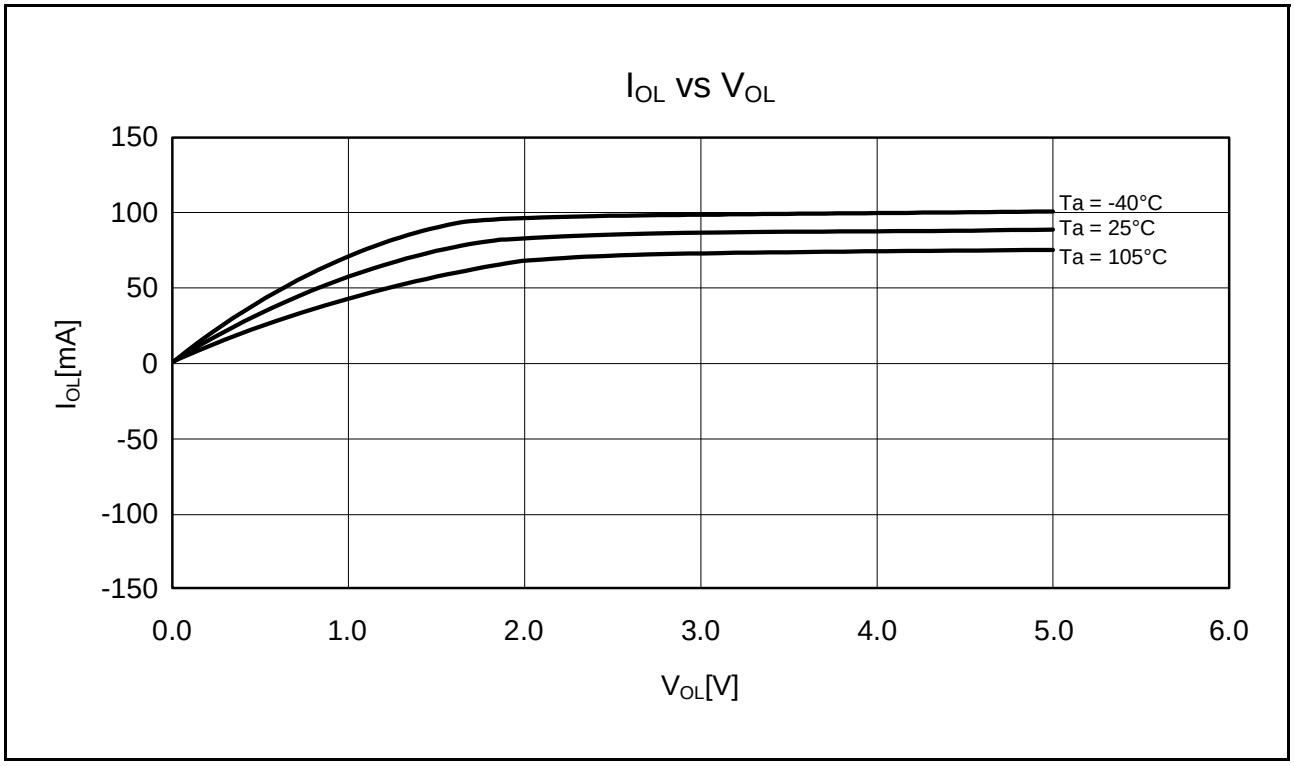


Figure 5.18 V_{OL} and I_{OL} Temperature Characteristics of RIIC Output Pin at VCC = 5.0 V (Reference Data)

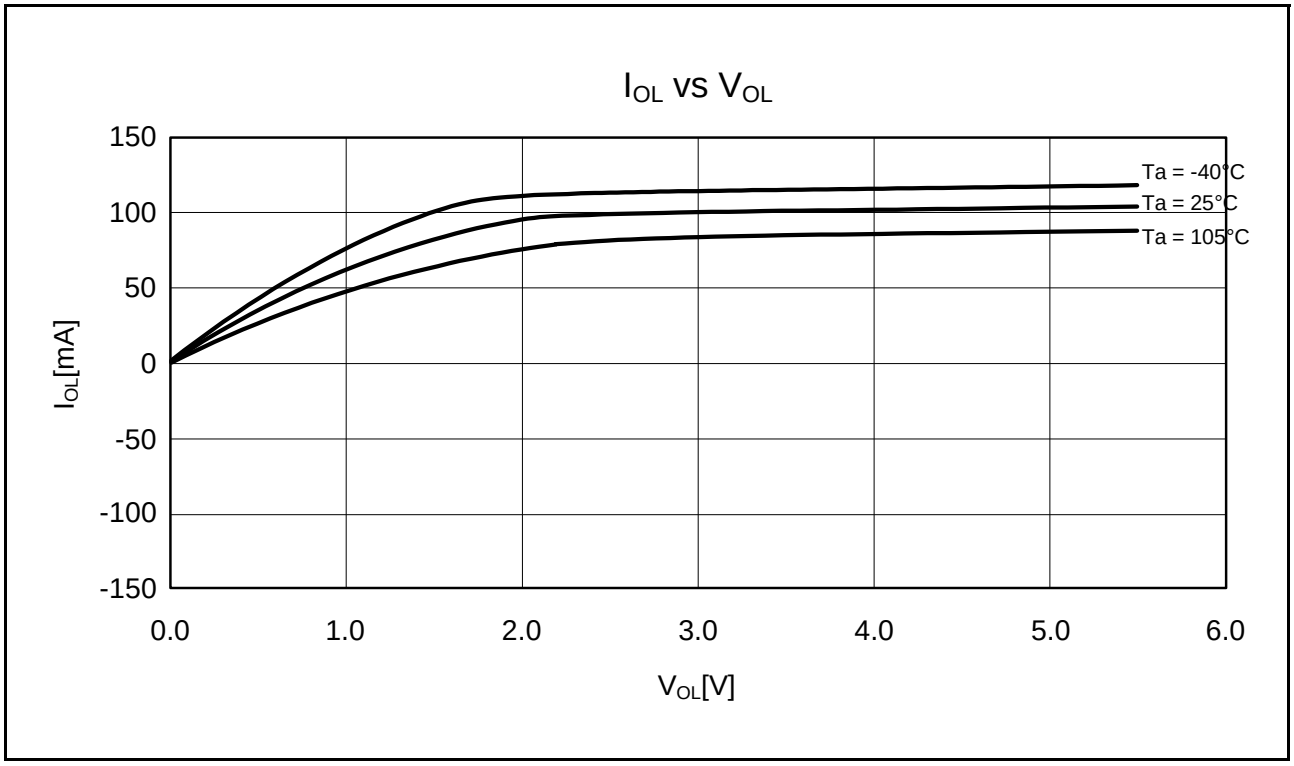


Figure 5.19 V_{OL} and I_{OL} Temperature Characteristics of RIIC Output Pin at VCC = 5.5 V (Reference Data)

5.3 AC Characteristics

5.3.1 Clock Timing

Table 5.14 Operating Frequency Value (High-Speed Operating Mode)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	min.	typ.	max.	Unit
Maximum operating frequency	System clock (ICLK)	f_{max}	—	—	40	MHz
	FlashIF clock (FCLK)*1, *2		—	—	32	
	Peripheral module clock (PCLKA)		—	—	40	
	Peripheral module clock (PCLKB)		—	—	40	
	Peripheral module clock (PCLKD)		—	—	40	

Note 1. The lower-limit frequency of FCLK is 1 MHz during programming or erasing of the flash memory. When using FCLK at below 4 MHz, the frequency can be set to 1 MHz, 2 MHz, or 3 MHz. A non-integer frequency such as 1.5 MHz cannot be set.
Note 2. The frequency accuracy of FCLK should be ±3.5%.

Table 5.15 Operating Frequency Value (Middle-Speed Operating Mode)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	min.	typ.	max.	Unit
Maximum operating frequency	System clock (ICLK)	f_{max}	—	—	12	MHz
	FlashIF clock (FCLK)*1, *2		—	—	12	
	Peripheral module clock (PCLKA)		—	—	12	
	Peripheral module clock (PCLKB)		—	—	12	
	Peripheral module clock (PCLKD)		—	—	12	

Note 1. The lower-limit frequency of FCLK is 1 MHz during programming or erasing of the flash memory. When using FCLK at below 4 MHz, the frequency can be set to 1 MHz, 2 MHz, or 3 MHz. A non-integer frequency such as 1.5 MHz cannot be set.
Note 2. The frequency accuracy of FCLK should be ±3.5%.

Table 5.16 Clock Timing

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
EXTAL external clock input cycle time	t_{Xcyc}	50	—	—	ns	Figure 5.20
EXTAL external clock input high pulse width	t_{XH}	20	—	—	ns	
EXTAL external clock input low pulse width	t_{XL}	20	—	—	ns	
EXTAL external clock rise time	t_{Xr}	—	—	5	ns	
EXTAL external clock fall time	t_{Xf}	—	—	5	ns	
EXTAL external clock input wait time*1	t_{EXWT}	0.5	—	—	μs	
Main clock oscillator oscillation frequency*2	f_{MAIN}	1	—	20	MHz	
Main clock oscillation stabilization time (crystal)*2	$t_{MAINOSC}$	—	3	—	ms	Figure 5.21
Main clock oscillation stabilization time (ceramic resonator)*2	$t_{MAINOSC}$	—	50	—	μs	
LOCO clock oscillation frequency	f_{LOCO}	3.44	4.0	4.56	MHz	
LOCO clock oscillation stabilization time	t_{LOCO}	—	—	0.5	μs	Figure 5.22
IWDT-dedicated clock oscillation frequency	f_{ILOCO}	12.75	15	17.25	kHz	
IWDT-dedicated clock oscillation stabilization time	t_{ILOCO}	—	—	50	μs	Figure 5.23
HOCO clock oscillation frequency	f_{HOCO}	31.52	32	32.48	MHz	T_a = –40 to +85°C
		31.68	32	32.32		T_a = –20 to +85°C
		31.36	32	32.64		T_a = –40 to +105°C
HOCO clock oscillation stabilization time	t_{HOCO}	—	—	30	μs	Figure 5.25
PLL circuit oscillation frequency	f_{PLL}	24	—	40	MHz	
PLL clock oscillation stabilization time	t_{PLL}	—	—	50	μs	Figure 5.26
PLL free-running oscillation frequency	f_{PLLFR}	—	8	—	MHz	

Note 1. Time until the clock can be used after the main clock oscillator stop bit (MOSCCR.MOSTP) is set to 0 (operating) when the external clock is stable.

Note 2. Reference values when an 8-MHz resonator is used.
When specifying the main clock oscillator stabilization time, set the MOSCWTCR register with a stabilization time value that is equal to or greater than the resonator-manufacturer-recommended value.
After changing the setting of the MOSCCR.MOSTP bit so that the main clock oscillator operates, read the OSCOVFSR.MOOVF flag to confirm that is has become 1, and then start using the main clock.

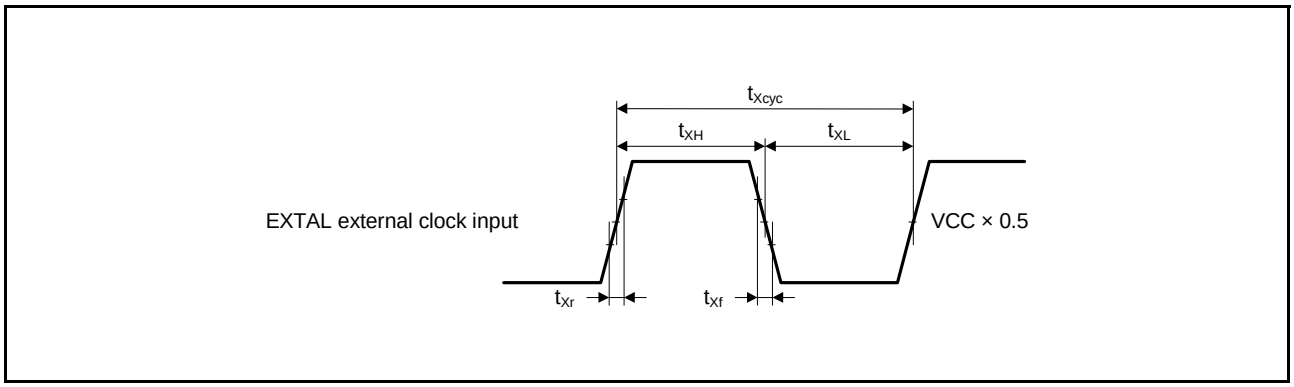


Figure 5.20 EXTAL External Clock Input Timing

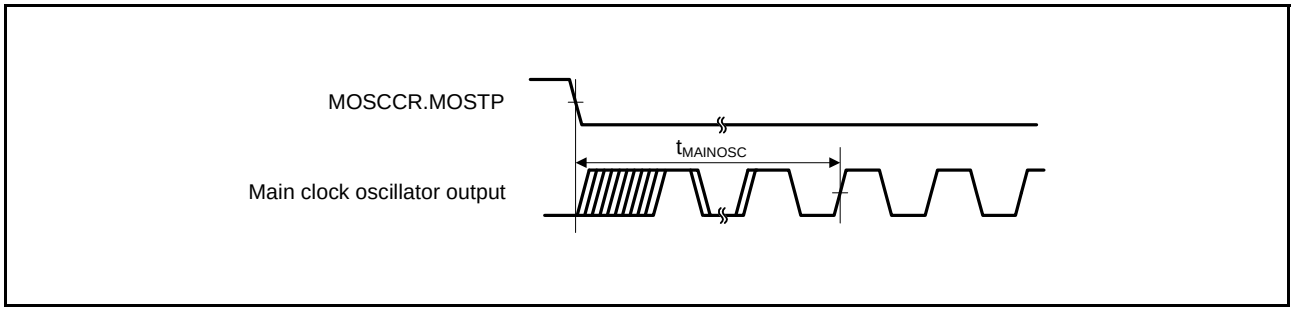


Figure 5.21 Main Clock Oscillation Start Timing

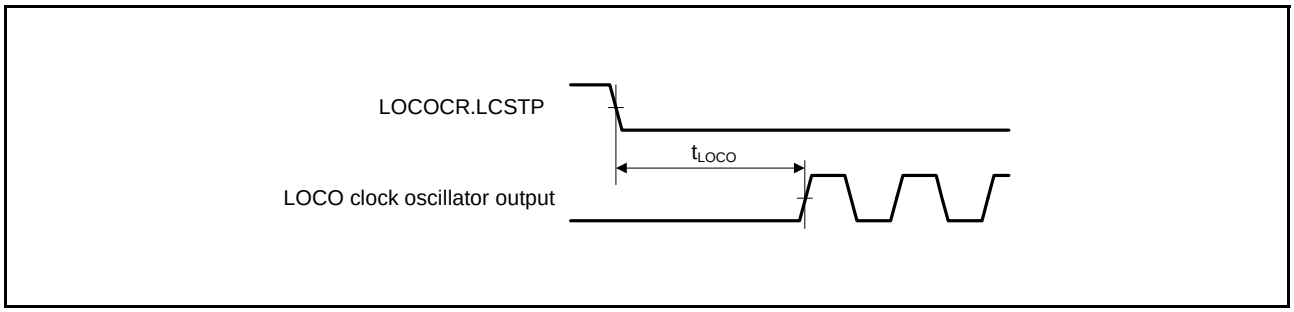


Figure 5.22 LOCO Clock Oscillation Start Timing

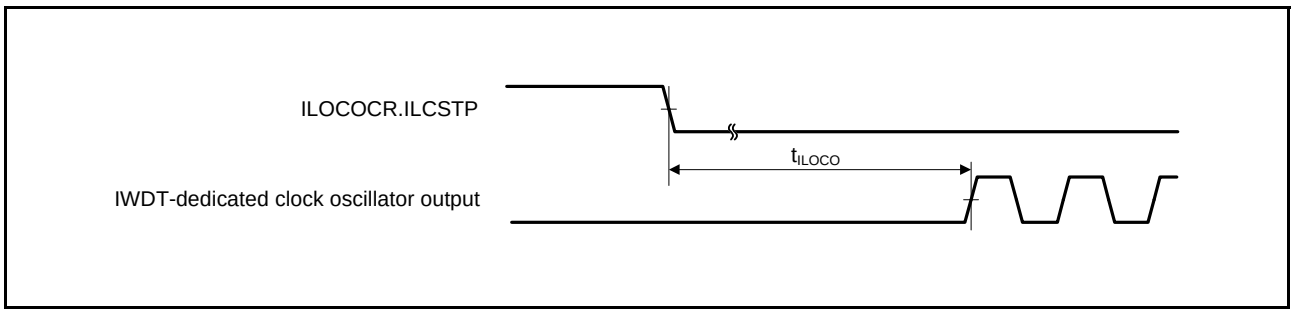


Figure 5.23 IWDT-Dedicated Clock Oscillation Start Timing

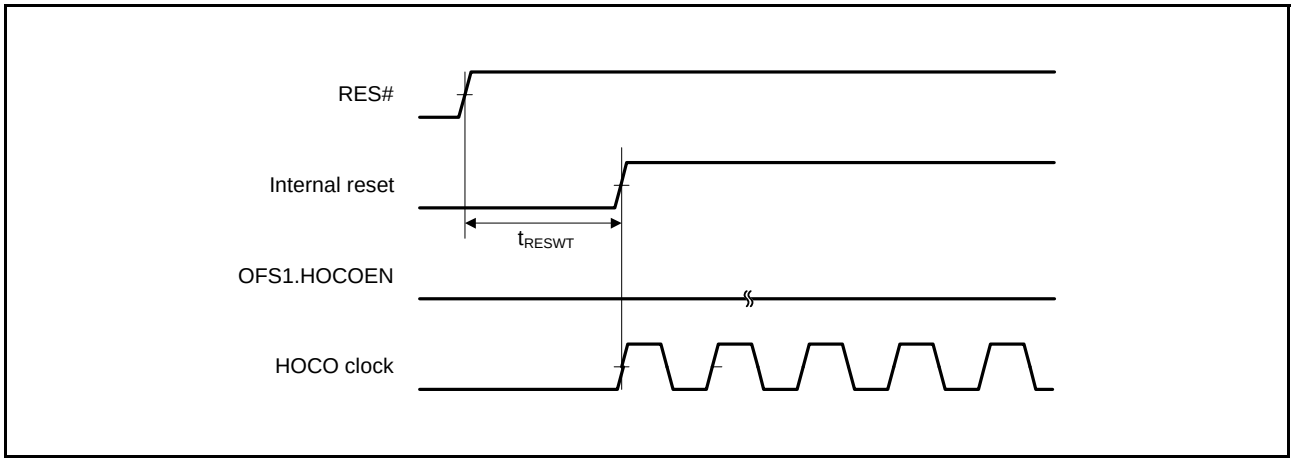


Figure 5.24 HOCO Clock Oscillation Start Timing (After Reset is Canceled by Setting OFS1.HOCOEN Bit to 0)

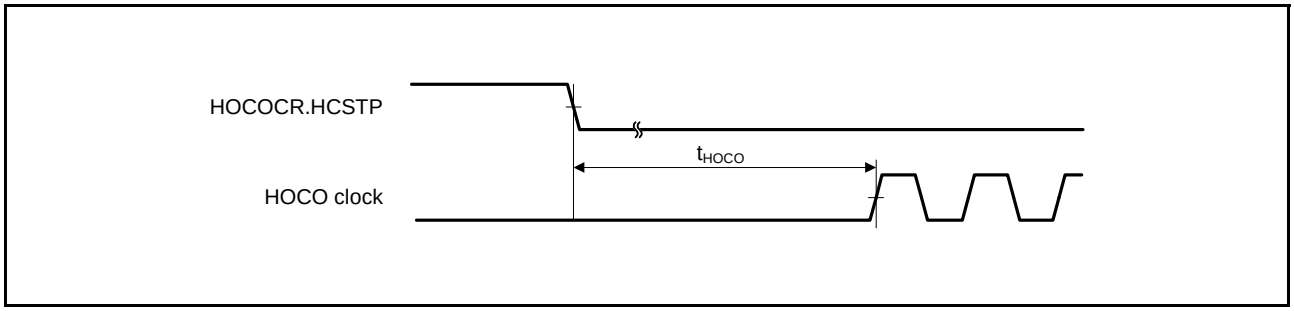


Figure 5.25 HOCO Clock Oscillation Start Timing (Oscillation is Started by Setting HOCOCR.HCSTP Bit)

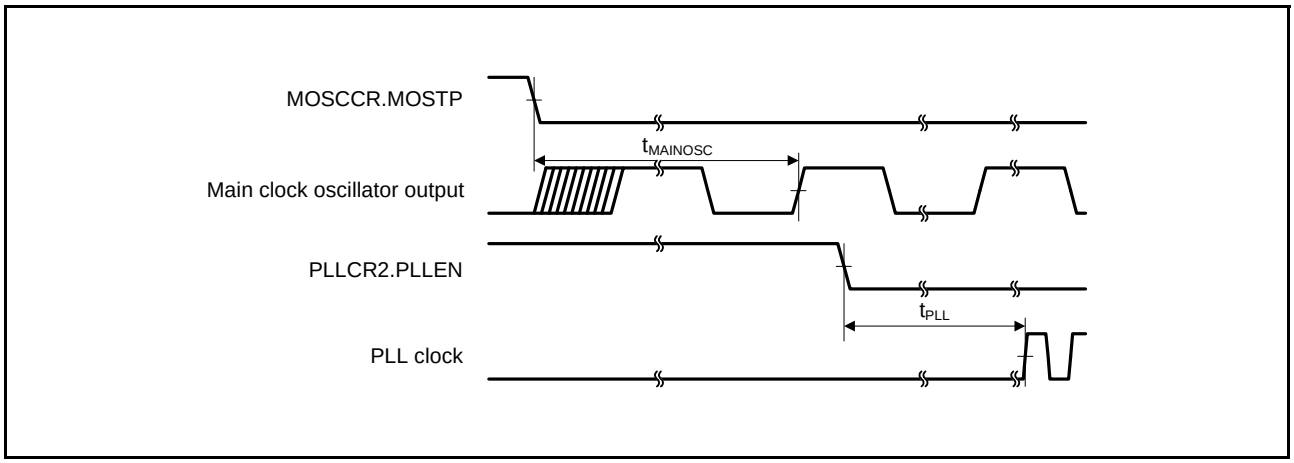


Figure 5.26 PLL Clock Oscillation Start Timing (PLL is Operated after Main Clock Oscillation Has Settled)

5.3.2 Reset Timing

Table 5.17 Reset Timing

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	Min.	Typ.	Max.	Unit	Test Conditions
RES# pulse width	At power-on	t_{RESWP}	3	—	—	ms	Figure 5.27
	Other than above	t_{RESW}	30	—	—	µs	Figure 5.28
Wait time after RES# cancellation (at power-on)		t_{RESWT}	—	27.5	—	ms	Figure 5.27
Wait time after RES# cancellation (during powered-on state)		t_{RESWT}	—	114	—	µs	Figure 5.28
Independent watchdog timer reset period		t_{RESWIW}	—	1	—	IWDT clock cycle	Figure 5.29
Software reset period		t_{RESWSW}	—	1	—	ICLK cycle	
Wait time after independent watchdog timer reset cancellation*1		t_{RESW2}	—	300	—	µs	
Wait time after software reset cancellation		t_{RESW2}	—	168	—	µs	

Note 1. When IWDTCR.CKS[3:0] = 0000b.

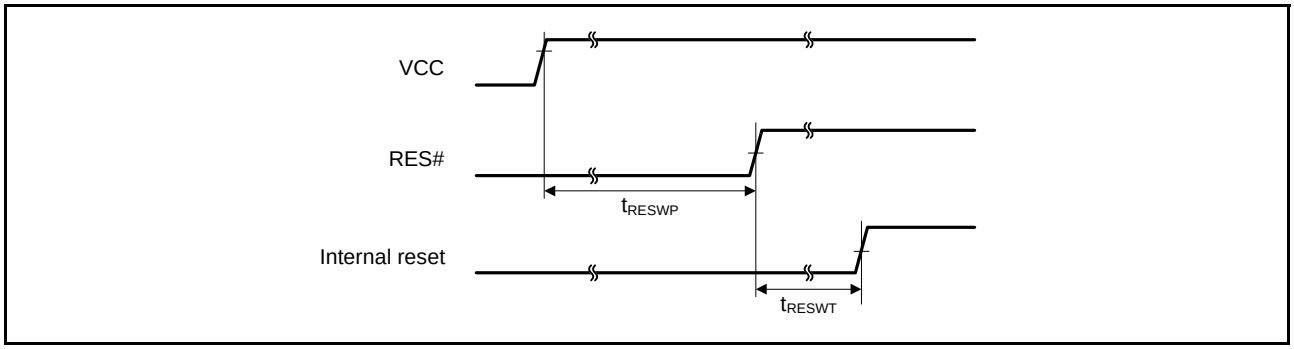


Figure 5.27 Reset Input Timing at Power-On

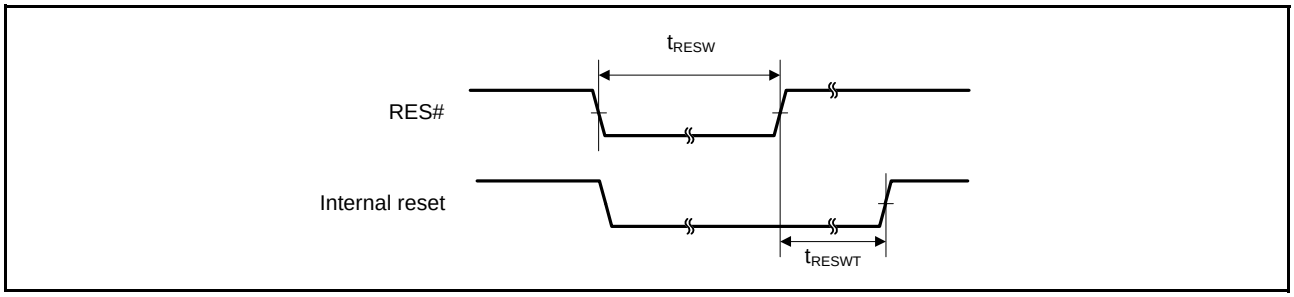


Figure 5.28 Reset Input Timing (1)

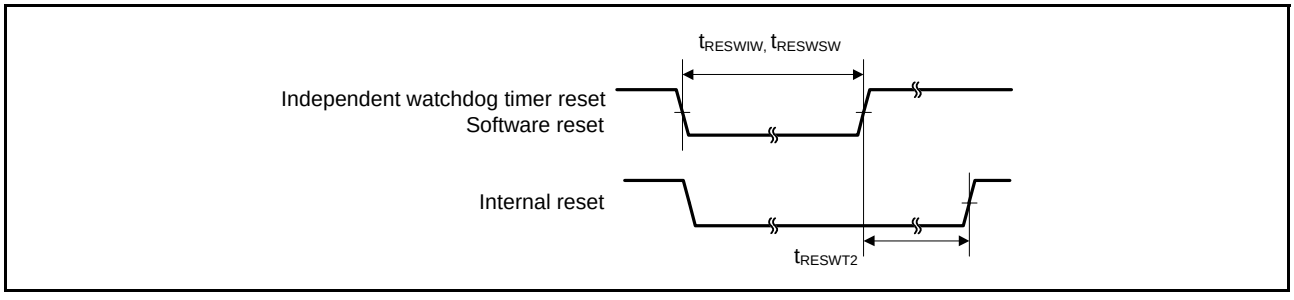


Figure 5.29 Reset Input Timing (2)

5.3.3 Timing of Recovery from Low Power Consumption Modes

Table 5.18 Timing of Recovery from Low Power Consumption Modes (1)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item				Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Recovery time from software standby mode*1	High-speed mode	Crystal connected to main clock oscillator	Main clock oscillator operating*2	t_{SBYMC}	—	2	3	ms	Figure 5.30
		External clock input to main clock oscillator	Main clock oscillator operating*3	t_{SBYEX}	—	35	50	µs	
			Main clock oscillator and PLL circuit operating*4	t_{SBYPE}	—	70	95	µs	
		LOCO clock oscillator operating		t_{SBYLO}	—	40	55	µs	

Note 1. The recovery time varies depending on the state of each oscillator when the WAIT instruction is executed. The recovery time when multiple oscillators are operating varies depending on the operating state of the oscillators that are not selected as the system clock source. The above table applies when only the corresponding clock is operating.
Note 2. When the frequency of crystal is 20 MHz.
When the main clock oscillator wait control register (MOSCWTCR) is set to 04h.
Note 3. When the frequency of the external clock is 20 MHz.
When the main clock oscillator wait control register (MOSCWTCR) is set to 00h.
Note 4. When the frequency of PLL is 40 MHz.
When the main clock oscillator wait control register (MOSCWTCR) is set to 00h.

Table 5.19 Timing of Recovery from Low Power Consumption Modes (2)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item				Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Recovery time from software standby mode*1	Middle-speed mode	Crystal connected to main clock oscillator	Main clock oscillator operating*2	t_{SBYMC}	—	2	3	ms	Figure 5.30
		External clock input to main clock oscillator	Main clock oscillator operating*3	t_{SBYEX}	—	3	4	µs	
			Main clock oscillator and PLL circuit operating*4	t_{SBYPE}	—	65	85	µs	
		LOCO clock oscillator operating		t_{SBYLO}	—	5	7	µs	

Note 1. The recovery time varies depending on the state of each oscillator when the WAIT instruction is executed. The recovery time when multiple oscillators are operating varies depending on the operating state of the oscillators that are not selected as the system clock source. The above table applies when only the corresponding clock is operating.
Note 2. When the frequency of the crystal is 12 MHz.
When the main clock oscillator wait control register (MOSCWTCR) is set to 04h.
Note 3. When the frequency of the external clock is 12 MHz.
When the main clock oscillator wait control register (MOSCWTCR) is set to 00h.
Note 4. When the frequency of PLL is 12 MHz.
When the main clock oscillator wait control register (MOSCWTCR) is set to 00h.

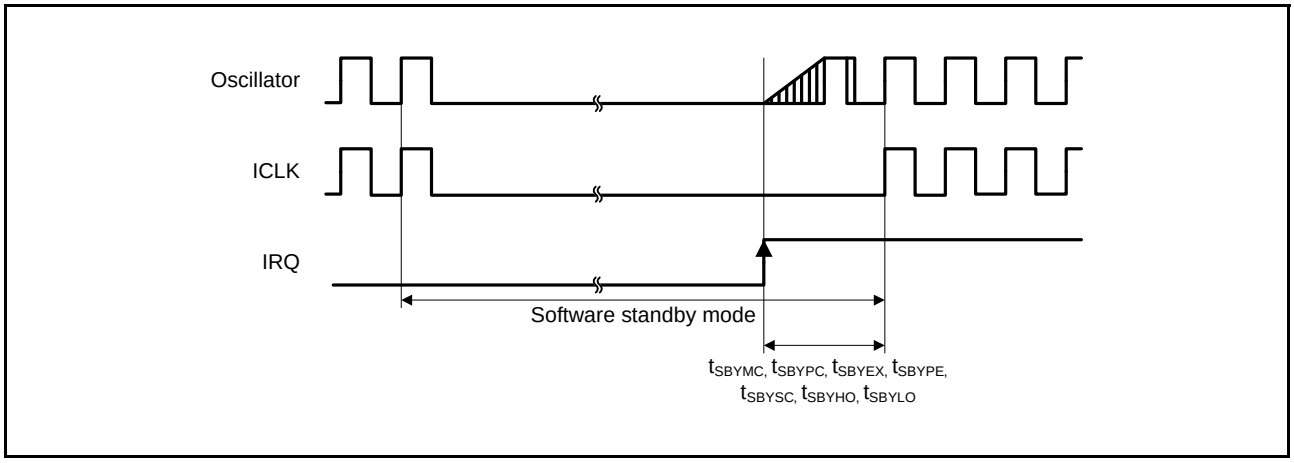


Figure 5.30 Software Standby Mode Recovery Timing

Table 5.20 Timing of Recovery from Low Power Consumption Modes (3)

Conditions: VCC = 2.7 V to AVCC0, AVCC0 = VREFH0 = 2.7 V to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Recovery time from deep sleep mode*1	High-speed mode*2	t_{DSLP}	—	2	3.5	µs	Figure 5.31
	Middle-speed mode*3	t_{DSLP}	—	3	4	µs	

Note 1. Oscillators continue oscillating in deep sleep mode.
Note 2. When the frequency of the system clock is 32 MHz.
Note 3. When the frequency of the system clock is 12 MHz.

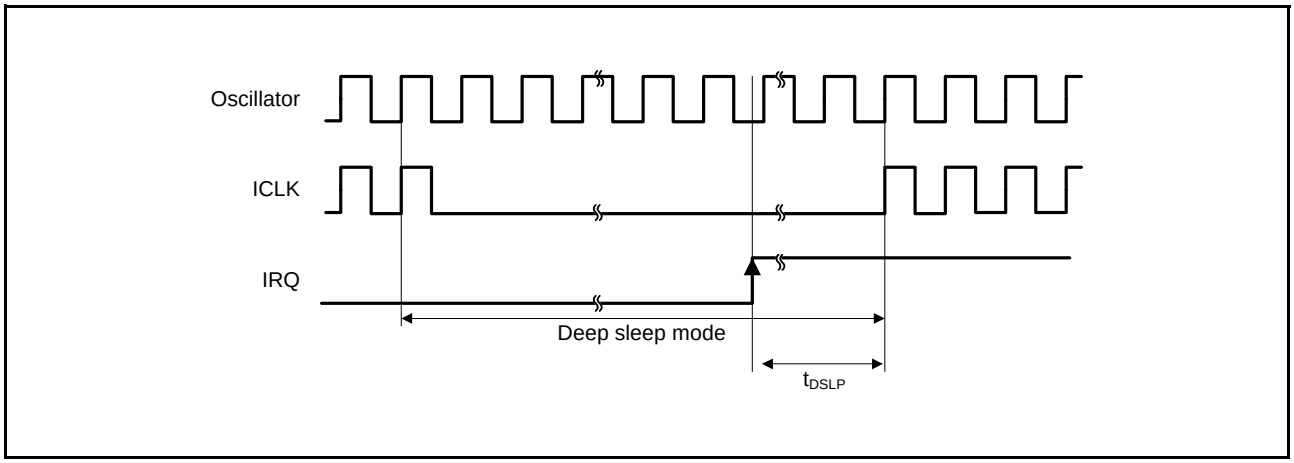


Figure 5.31 Deep Sleep Mode Recovery Timing

Table 5.21 Operating Mode Transition Time

Conditions: VCC = 2.7 V to AVCC0, AVCC0 = VREFH0 = 2.7 V to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Mode before Transition	Mode after Transition	ICLK Frequency	Transition Time			Unit
			Min.	Typ.	Max.	
High-speed operating mode	Middle-speed operating modes	8 MHz	—	10	—	µs
Middle-speed operating modes	High-speed operating mode	8 MHz	—	37.5	—	µs

Note: Values when the frequencies of PCLKB, PCLKD, and FCLK are not divided.

5.3.4 Control Signal Timing

Table 5.22 Control Signal Timing

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions	
NMI pulse width	t_{NMIW}	200	—	—	ns	NMI digital filter disabled (NMIFLTE.NFLTEN = 0)	$t_{Pcyc} \times 2 \leq 200$ ns
		$t_{Pcyc} \times 2$*1	—	—			$t_{Pcyc} \times 2 > 200$ ns
		200	—	—		NMI digital filter enabled (NMIFLTE.NFLTEN = 1)	$t_{NMICK} \times 3 \leq 200$ ns
		$t_{NMICK} \times 3.5$*2	—	—			$t_{NMICK} \times 3 > 200$ ns
IRQ pulse width	t_{IRQW}	200	—	—	ns	IRQ digital filter disabled (IRQFLTE0.FLTENi = 0)	$t_{Pcyc} \times 2 \leq 200$ ns
		$t_{Pcyc} \times 2$*1	—	—			$t_{Pcyc} \times 2 > 200$ ns
		200	—	—		IRQ digital filter enabled (IRQFLTE0.FLTENi = 1)	$t_{IRQCK} \times 3 \leq 200$ ns
		$t_{IRQCK} \times 3.5$*3	—	—			$t_{IRQCK} \times 3 > 200$ ns

Note: 200 ns minimum in software standby mode.
Note 1. t_{Pcyc} indicates the cycle of PCLKB.
Note 2. t_{NMICK} indicates the cycle of the NMI digital filter sampling clock.
Note 3. t_{IRQCK} indicates the cycle of the IRQi digital filter sampling clock (i = 0 to 5).

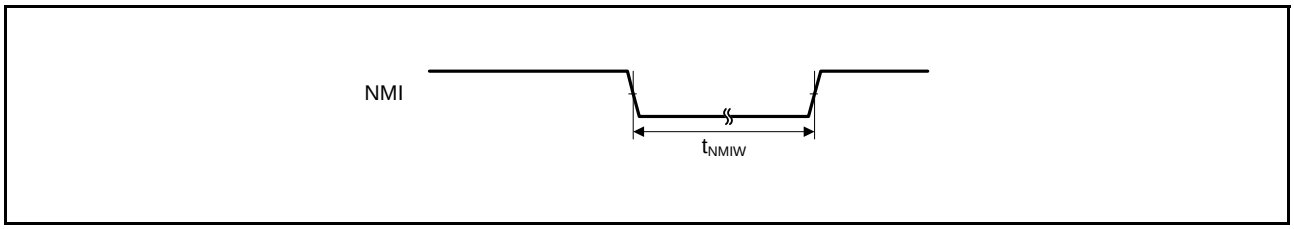


Figure 5.32 NMI Interrupt Input Timing

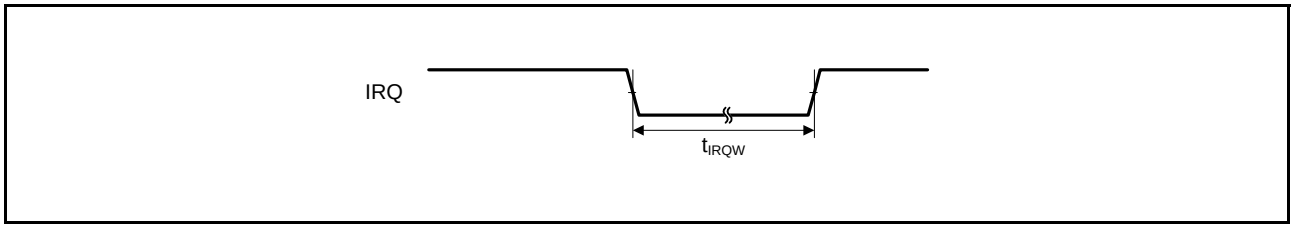


Figure 5.33 IRQ Interrupt Input Timing

5.3.5 Timing of On-Chip Peripheral Modules

Table 5.23 Timing of On-Chip Peripheral Modules (1)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item				Symbol	Min.	Max.	Unit *1	Test Conditions
I/O ports	Input data pulse width			t_{PRW}	1.5	—	t_{Pcyc}	Figure 5.34
MTU3	Input capture input pulse width		Single-edge setting	t_{TICW}	3	—	t_{PAcyc}	Figure 5.35
			Both-edge setting		5	—		
	Timer clock pulse width		Single-edge setting	t_{TCKWH}, t_{TCKWL}	3	—	t_{PAcyc}	Figure 5.36
			Both-edge setting		5	—		
			Phase counting mode		5	—		
POE3	POE# input pulse width			t_{POEW}	1.5	—	t_{Pcyc}	Figure 5.37
TMR	Timer clock pulse width		Single-edge setting	t_{TMCWH}, t_{TMCWL}	1.5	—	t_{Pcyc}	Figure 5.38
			Both-edge setting		2.5	—		
SCI	Input clock cycle		Asynchronous	t_{Scyc}	4	—	t_{Pcyc}	Figure 5.39
			Clock synchronous		6	—		
	Input clock pulse width			t_{SCKW}	0.4	0.6	t_{Scyc}	
	Input clock rise time			t_{SCKr}	—	20	ns	
	Input clock fall time			t_{SCKf}	—	20	ns	
	Output clock cycle		Asynchronous	t_{Scyc}	16	—	t_{Pcyc}	Figure 5.40
			Clock synchronous		4	—		
	Output clock pulse width			t_{SCKW}	0.4	0.6	t_{Scyc}	
	Output clock rise time			t_{SCKr}	—	20	ns	
	Output clock fall time			t_{SCKf}	—	20	ns	
	Transmit data delay time (master)	Clock synchronous		t_{TXD}	—	40	ns	
	Transmit data delay time (slave)	Clock synchronous	VCC = 4.0 V or above		—	40	ns	
			VCC = 2.7 V or above		—	65	ns	
	Receive data setup time (master)	Clock synchronous	VCC = 4.0 V or above	t_{RXS}	40	—	ns	
			VCC = 2.7 V or above		65	—	ns	
	Receive data setup time (slave)	Clock synchronous			40	—	ns	
	Receive data hold time	Clock synchronous		t_{RXH}	40	—	ns	
A/D converter	Trigger input pulse width			t_{TRGW}	1.5	—	t_{Pcyc}	Figure 5.41
CAC	CACREF input pulse width		$t_{Pcyc} \le t_{cac}$ *2	t_{CACREF}	4.5 t_{cac} + 3 t_{Pcyc}	—	ns	
			$t_{Pcyc} > t_{cac}$ *2		5 t_{cac} + 6.5 t_{Pcyc}			

Note 1. t_{Pcyc}: PCLK cycle, t_{PAcyc}: PCLKA cycle
Note 2. t_{cac}: CAC count clock source cycle

Table 5.24 Timing of On-Chip Peripheral Modules (2)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C, C = 30pF

Item				Symbol	Min.	Max.	Unit	Test Conditions
RSPI	RSPCK clock cycle	Master		t_{SPcyc}	2	4096	t_{Pcyc}*1	Figure 5.42
		Slave			8	4096		
	RSPCK clock high pulse width	Master	VCC = 4.0 V or above	t_{SPCKWH}	$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2 - 5$	—	ns	
			VCC = 2.7 V or above		$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2 - 8$	—		
		Slave			$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2$	—		
	RSPCK clock low pulse width	Master	VCC = 4.0 V or above	t_{SPCKWL}	$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2 - 5$	—	ns	
			VCC = 2.7 V or above		$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2 - 8$	—		
		Slave			$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2$	—		
	RSPCK clock rise/fall time	Output	VCC = 4.0 V or above	t_{SPCKr}, t_{SPCKf}	—	6	ns	
			VCC = 2.7 V or above		—	10		
		Input			—	0.1	μs/V	
	Data input setup time	Master	VCC = 4.0 V or above	t_{SU}	10	—	ns	Figure 5.43 to Figure 5.46
			VCC = 2.7 V or above		26	—		
		Slave			$25 - t_{Pcyc}$	—		
	Data input hold time	Master	RSPCK set to a division ratio other than PCLKB divided by 2	t_H	t_{Pcyc}	—	ns	
			RSPCK set to PCLKB divided by 2	t_{HF}	0	—		
		Slave		t_H	$20 + 2 \times t_{Pcyc}$	—		
	SSL setup time	Master		t_{LEAD}	$-30 + N^{*2} \times t_{SPcyc}$	—	ns	
		Slave			2	—	t_{Pcyc}	
	SSL hold time	Master		t_{LAG}	$-30 + N^{*3} \times t_{SPcyc}$	—	ns	
		Slave			2	—	t_{Pcyc}	
	Data output delay time	Master	VCC = 4.0 V or above	t_{OD}	—	10	ns	
			VCC = 2.7 V or above		—	14		
		Slave			—	$3 \times t_{Pcyc} + 65$		
	Data output hold time	Master	2.7 V or above	t_{OH}	0	—	ns	
		Slave			0	—		
	Successive transmission delay time	Master		t_{TD}	$t_{SPcyc} + 2 \times t_{Pcyc}$	$8 \times t_{SPcyc} + 2 \times t_{Pcyc}$	ns	
		Slave			$4 \times t_{Pcyc}$	—		
	MOSI and MISO rise/fall time	Output		t_{Dr}, t_{Df}	—	10	ns	
		Input			—	1	μs	
	SSL rise/fall time	Output		t_{SSLr}, t_{SSLf}	—	10	ns	
		Input			—	1	μs	
	Slave access time			t_{SA}	—	6	t_{Pcyc}	Figure 5.45, Figure 5.46
	Slave output release time			t_{REL}	—	5	t_{Pcyc}	

Note 1. t_{Pcyc}: PCLK cycle
Note 2. N: An integer from 1 to 8 that can be set by the RSPI clock delay register (SPCKD)
Note 3. N: An integer from 1 to 8 that can be set by the RSPI slave select negation delay register (SSLND)

Table 5.25 Timing of On-Chip Peripheral Modules (3)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C, C = 30pF

Item			Symbol	Min.	Max.	Unit*1	Test Conditions
Simple SPI	SCK clock cycle output (master)		t_{SPcyc}	4	65536	t_{Pcyc}	Figure 5.42
	SCK clock cycle input (slave)			6	65536	t_{Pcyc}	
	SCK clock high pulse width		t_{SPCKWH}	0.4	0.6	t_{SPcyc}	
	SCK clock low pulse width		t_{SPCKWL}	0.4	0.6	t_{SPcyc}	
	SCK clock rise/fall time		t_{SPCKr}, t_{SPCKf}	—	20	ns	
	Data input setup time (master)	VCC = 4.0 V or above	t_{SU}	40	—	ns	Figure 5.43, Figure 5.44
		VCC = 2.7 V or above		65	—		
	Data input setup time (slave)			40	—		
	Data input hold time		t_H	40	—	ns	
	SS input setup time		t_{LEAD}	3	—	t_{SPcyc}	
	SS input hold time		t_{LAG}	3	—	t_{SPcyc}	
	Data output delay time (master)		t_{OD}	—	40	ns	
	Data output delay time (slave)	VCC = 4.0 V or above		—	40		
		VCC = 2.7 V or above		—	65		
	Data output hold time (master)	Master	t_{OH}	–10	—	ns	
		Slave		–10	—		
	Data rise/fall time		t_{Dr}, t_{Df}	—	20	ns	
	SS input rise/fall time		t_{SSLr}, t_{SSLf}	—	20	ns	
	Slave access time		t_{SA}	—	6	t_{Pcyc}	Figure 5.45, Figure 5.46
	Slave output release time		t_{REL}	—	6	t_{Pcyc}	

Note 1. t_{Pcyc}: PCLK cycle

Table 5.26 Timing of On-Chip Peripheral Modules (4)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	Min.*1, *2	Max.	Unit	Test Conditions
RIIC (Standard mode, SMBus)	SCL cycle time	t_{SCL}	6 (12) × t_{IICcyc} + 1300	—	ns	Figure 5.47
	SCL high pulse width	t_{SCLH}	3 (6) × t_{IICcyc} + 300	—	ns	
	SCL low pulse width	t_{SCLL}	3 (6) × t_{IICcyc} + 300	—	ns	
	SCL, SDA rise time	t_{Sr}	—	1000	ns	
	SCL, SDA fall time	t_{Sf}	—	300	ns	
	SCL, SDA spike pulse removal time	t_{SP}	0	1 (4) × t_{IICcyc}	ns	
	SDA bus free time	t_{BUF}	3 (6) × t_{IICcyc} + 300	—	ns	
	START condition hold time	t_{STAH}	t_{IICcyc} + 300	—	ns	
	Repeated START condition setup time	t_{STAS}	1000	—	ns	
	STOP condition setup time	t_{STOS}	1000	—	ns	
	Data setup time	t_{SDAS}	t_{IICcyc} + 50	—	ns	
	Data hold time	t_{SDAH}	0	—	ns	
	SCL, SDA capacitive load	C_b	—	400	pF	
RIIC (Fast mode)	SCL cycle time	t_{SCL}	6 (12) × t_{IICcyc} + 600	—	ns	Figure 5.47
	SCL high pulse width	t_{SCLH}	3 (6) × t_{IICcyc} + 300	—	ns	
	SCL low pulse width	t_{SCLL}	3 (6) × t_{IICcyc} + 300	—	ns	
	SCL, SDA rise time	t_{Sr}	—	300	ns	
	SCL, SDA fall time	t_{Sf}	—	300	ns	
	SCL, SDA spike pulse removal time	t_{SP}	0	1 (4) × t_{IICcyc}	ns	
	SDA bus free time	t_{BUF}	3 (6) × t_{IICcyc} + 300	—	ns	
	START condition hold time	t_{STAH}	t_{IICcyc} + 300	—	ns	
	Repeated START condition setup time	t_{STAS}	300	—	ns	
	STOP condition setup time	t_{STOS}	300	—	ns	
	Data setup time	t_{SDAS}	t_{IICcyc} + 50	—	ns	
	Data hold time	t_{SDAH}	0	—	ns	
	SCL, SDA capacitive load	C_b	—	400	pF	

Note 1. t_{IICcyc}: RIIC internal reference count clock (IICφ) cycle

Note 2. The value in parentheses is used when the ICMR3.NF[1:0] bits are set to 11b while a digital filter is enabled with the ICFER.NFE bit = 1.

Table 5.27 Timing of On-Chip Peripheral Modules (5)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	Min.*2	Max.	Unit	Test Conditions
Simple I²C (Standard mode)	SDA rise time	t_{Sr}	—	1000	ns	Figure 5.47
	SDA fall time	t_{Sf}	—	300	ns	
	SDA spike pulse removal time	t_{SP}	0	4 × t_{pcyc}*1	ns	
	Data setup time	t_{SDAS}	250	—	ns	
	Data hold time	t_{SDAH}	0	—	ns	
	SCL, SDA capacitive load	C_b	—	400	pF	
Simple I²C (Fast mode)	SDA rise time	t_{Sr}	—	300	ns	Figure 5.47
	SDA fall time	t_{Sf}	—	300	ns	
	SDA spike pulse removal time	t_{SP}	0	4 × t_{pcyc}*1	ns	
	Data setup time	t_{SDAS}	100	—	ns	
	Data hold time	t_{SDAH}	0	—	ns	
	SCL, SDA capacitive load	C_b	—	400	pF	

Note 1. t_{Pcyc}: PCLK cycle
Note 2. C_b is the total capacitance of the bus lines.

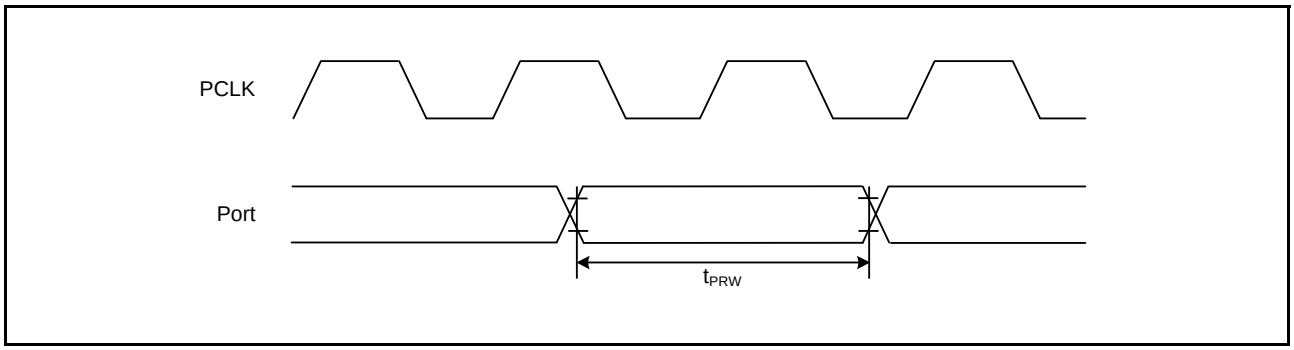


Figure 5.34 I/O Port Input Timing

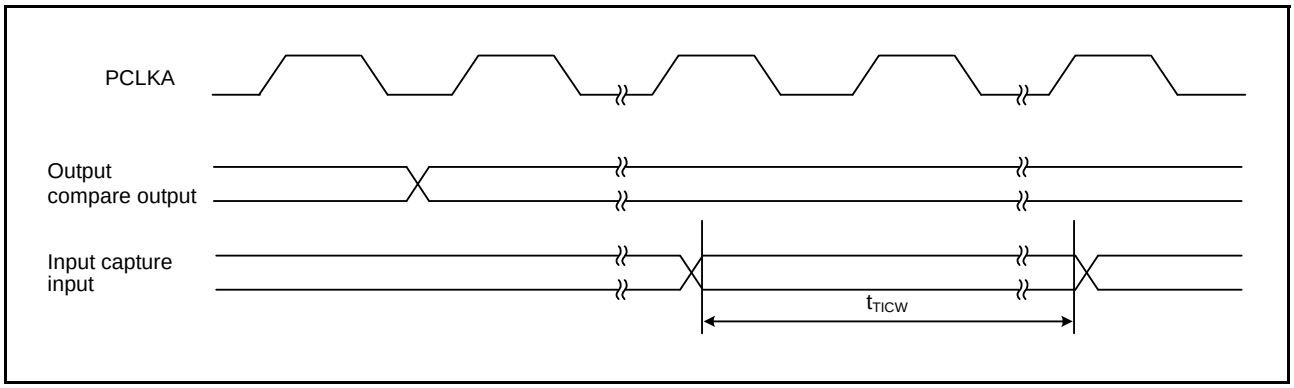


Figure 5.35 MTU3 Input/Output Timing

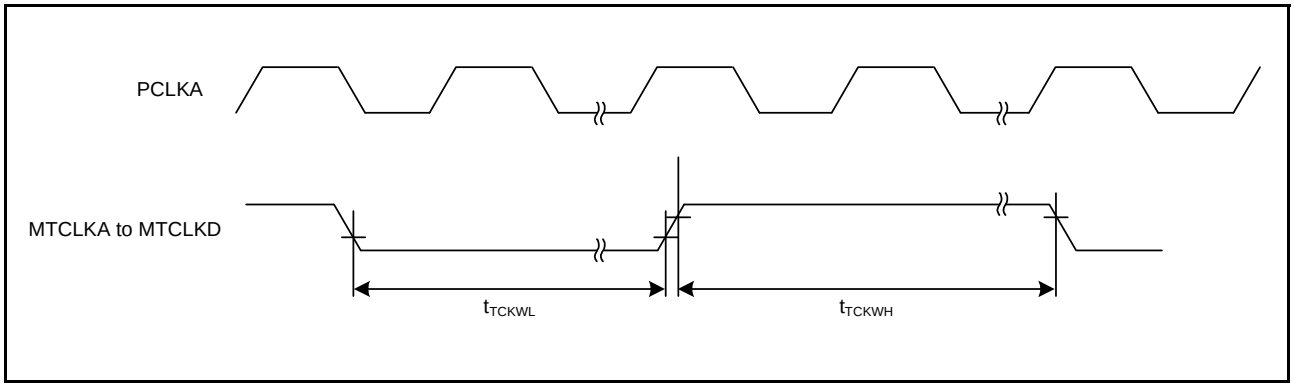


Figure 5.36 MTU3 Clock Input Timing

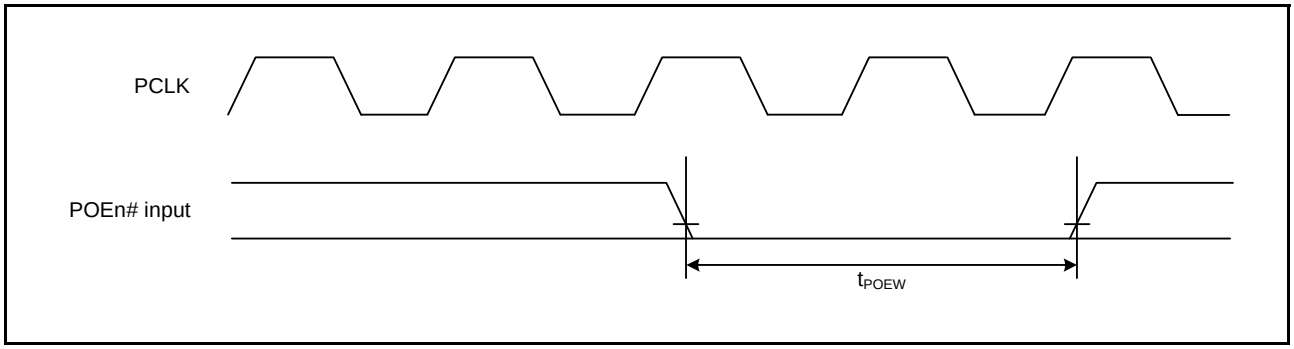


Figure 5.37 POE# Input Timing

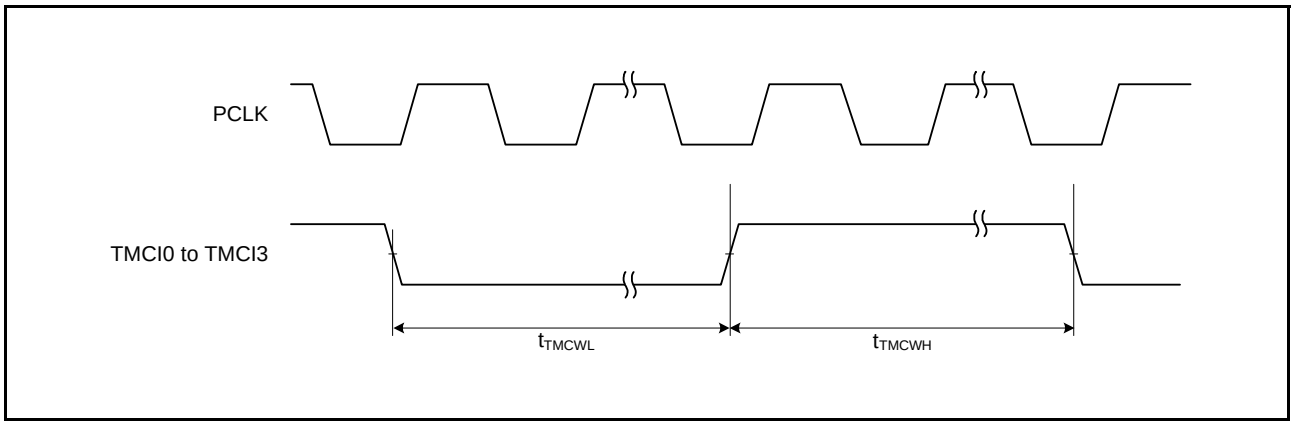


Figure 5.38 TMR Clock Input Timing

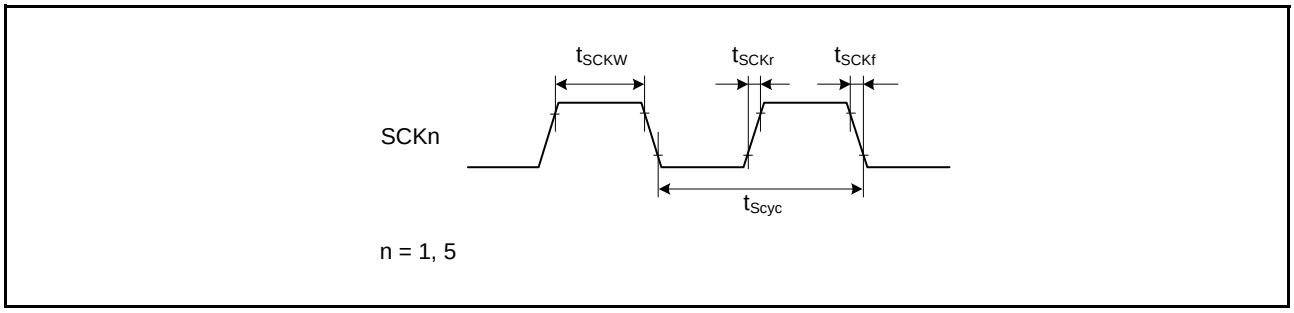


Figure 5.39 SCK Clock Input Timing

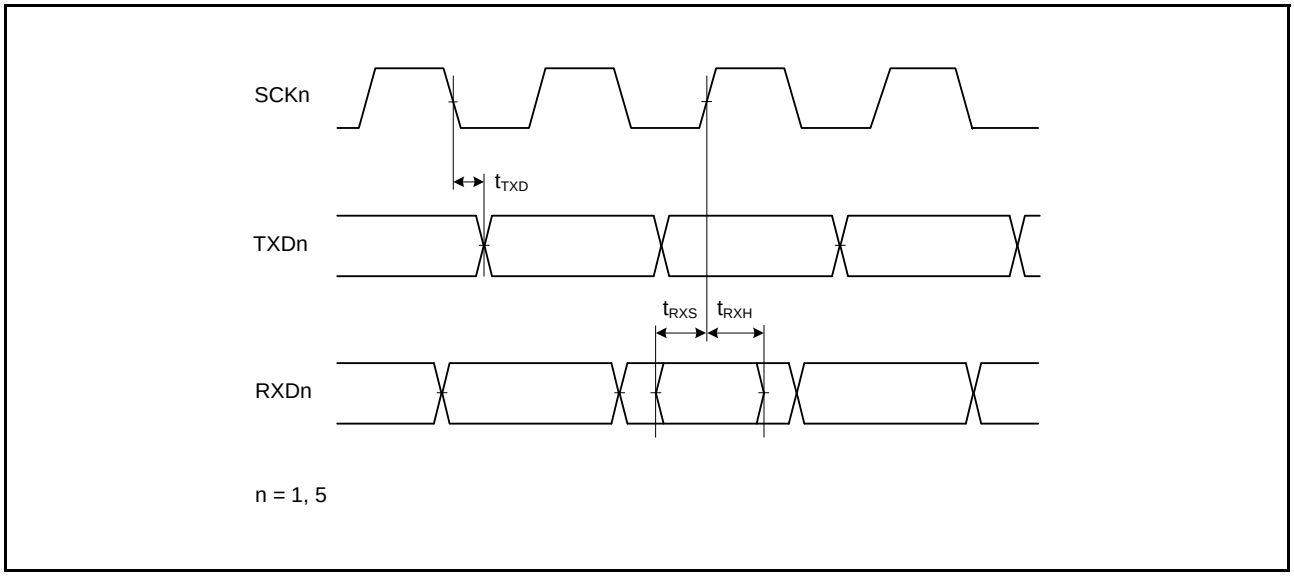


Figure 5.40 SCI Input/Output Timing: Clock Synchronous Mode

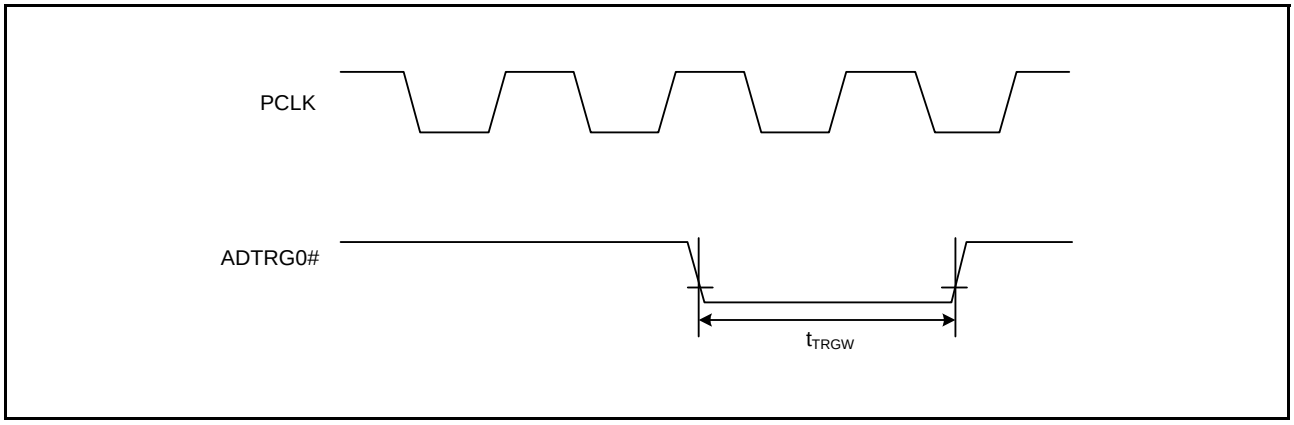


Figure 5.41 A/D Converter External Trigger Input Timing

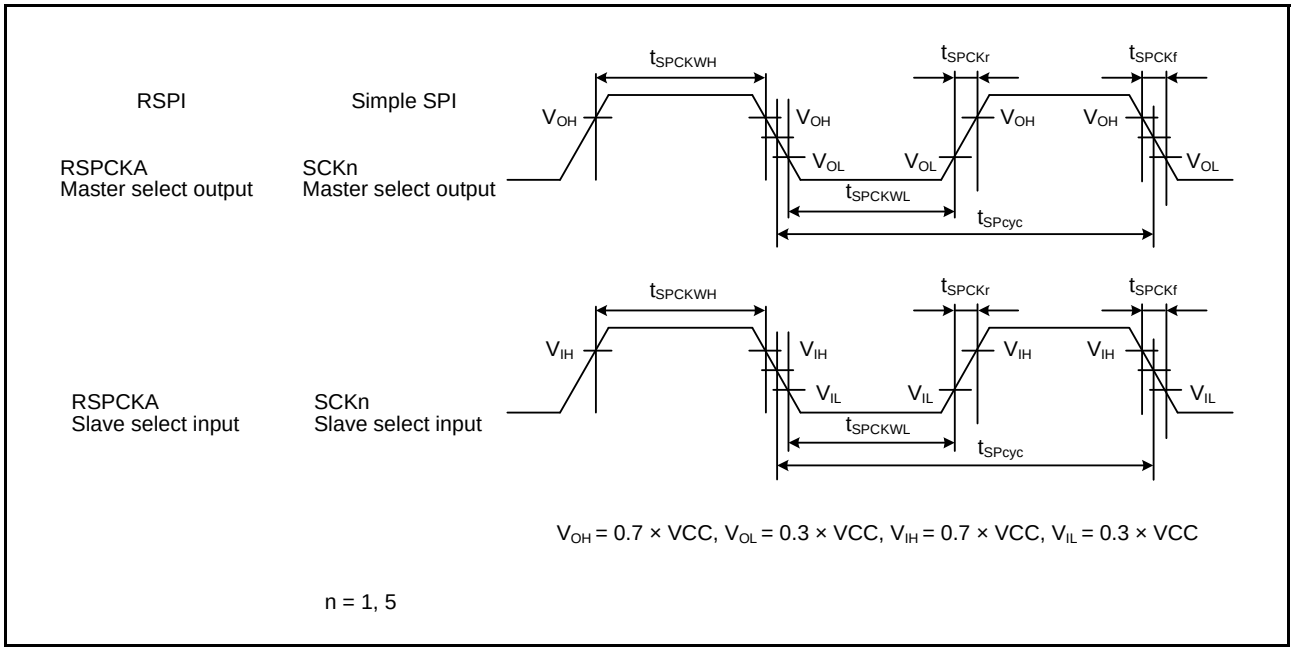


Figure 5.42 RSPI Clock Timing and Simple SPI Clock Timing

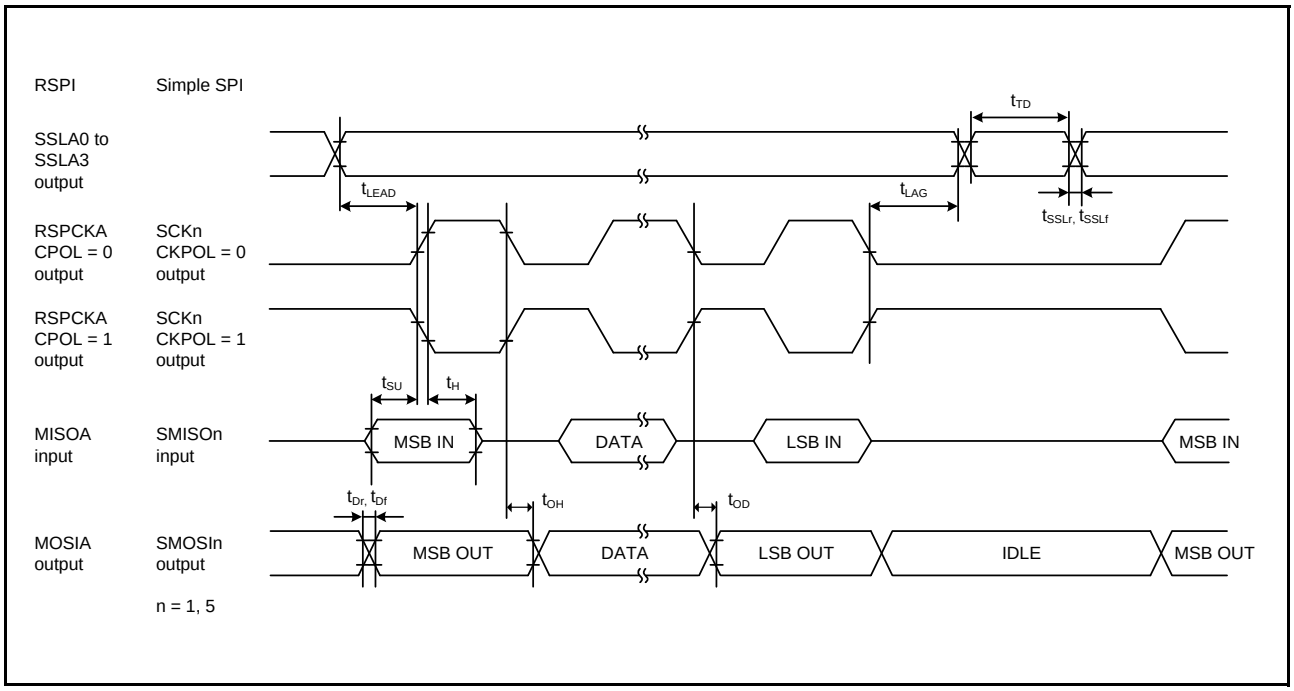


Figure 5.43 RSPI Timing (Master, CPHA = 0) and Simple SPI Clock Timing (Master, CKPH = 1)

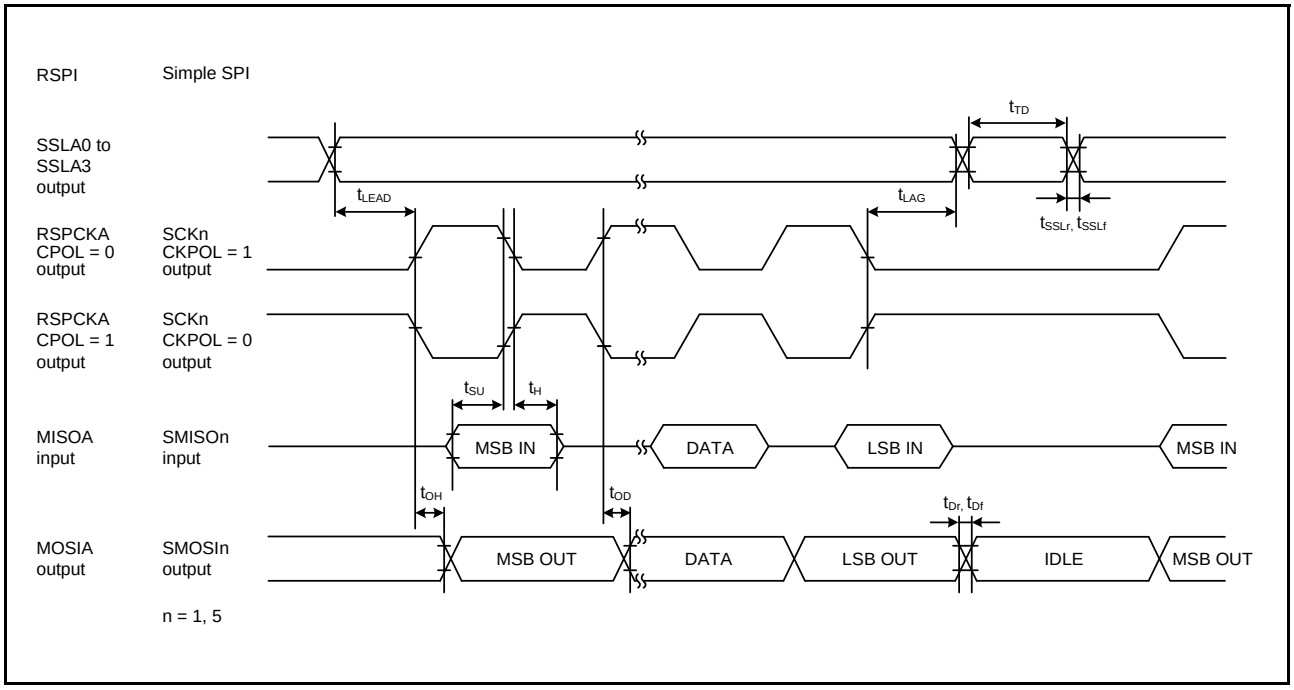


Figure 5.44 RSPI Timing (Master, CPHA = 1) and Simple SPI Clock Timing (Master, CKPH = 0)

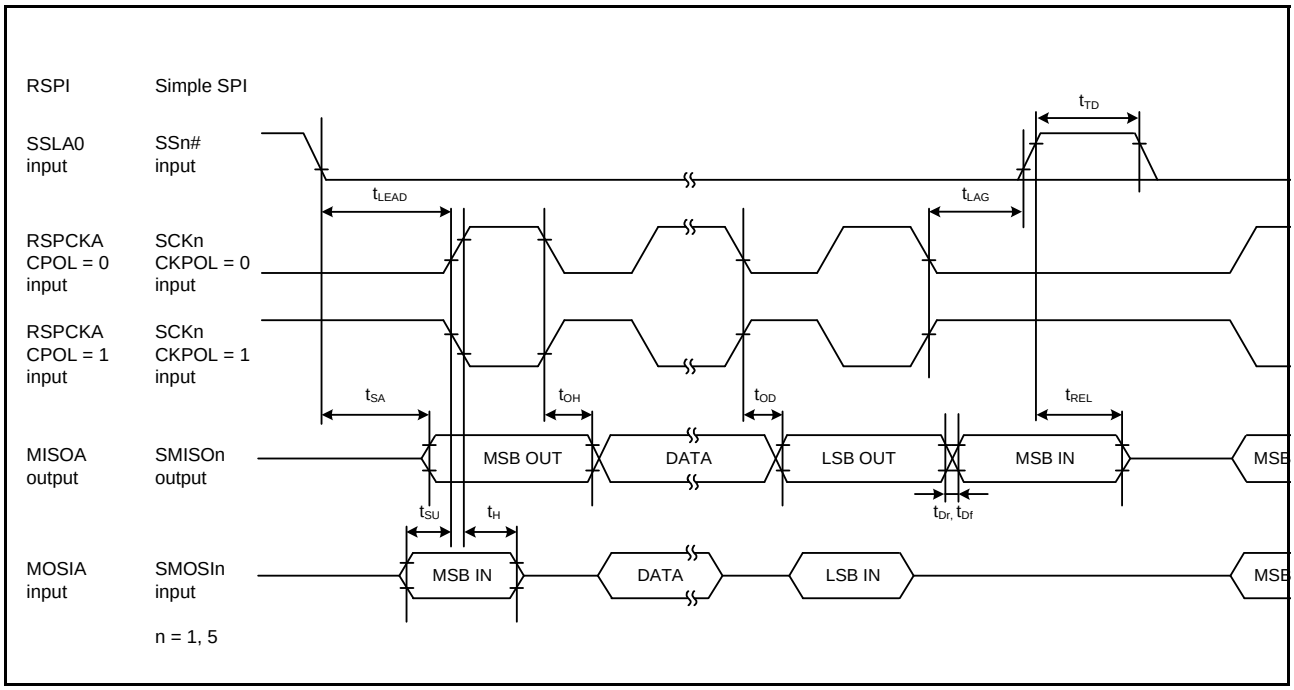


Figure 5.45 RSPI Timing (Slave, CPHA = 0) and Simple SPI Clock Timing (Slave, CKPH = 1)

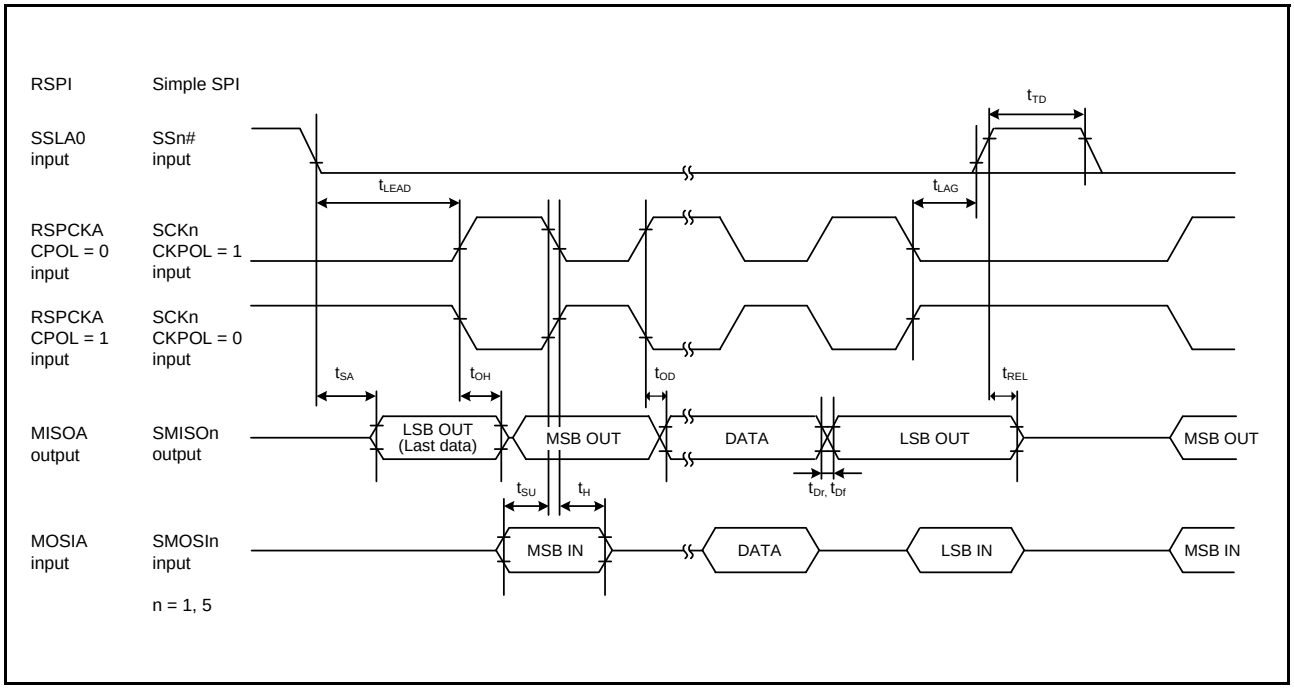


Figure 5.46 RSPI Timing (Slave, CPHA = 1) and Simple SPI Clock Timing (Slave, CKPH = 0)

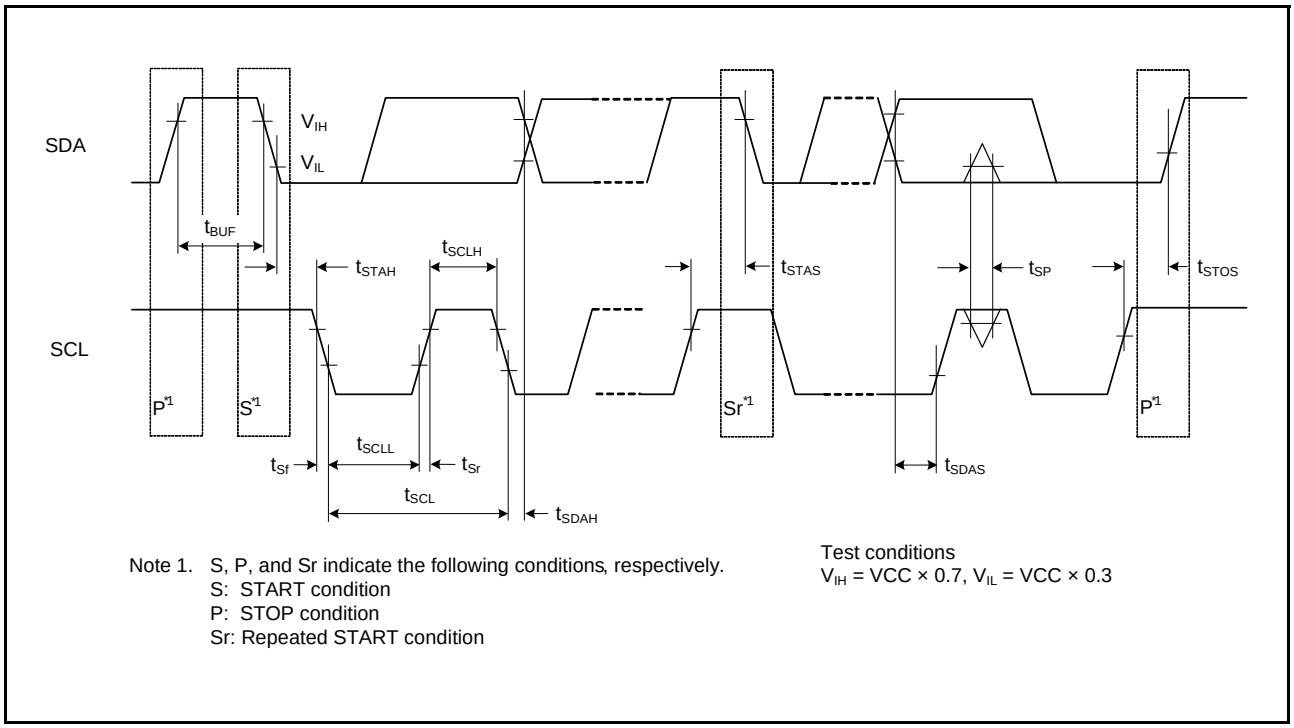


Figure 5.47 RIIC Bus Interface Input/Output Timing and Simple I²C Bus Interface Input/Output Timing

5.4 A/D Conversion Characteristics

Table 5.28 A/D Conversion Characteristics (1)

Conditions: VCC = 4.5 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Min.	Typ.	Max.	Unit	Test Conditions
Frequency		1	—	40	MHz	
Resolution		—	—	12	Bit	
Conversion time*1 (Operation at PCLKD = 40 MHz)	Permissible signal source impedance (Max.) = 1.0 kΩ Sample-and-hold circuit not in use	1.00	—	—	µs	High-precision channel ADSSTRn.SST[7:0] bits = 08h
		1.25	—	—	µs	Normal-precision channel ADSSTRn.SST[7:0] bits = 12h
	Permissible signal source impedance (Max.) = 1.0 kΩ / Sample-and-hold circuit in use	1.65	—	—	µs	High-precision channel ADSSTRn.SST[7:0] bits = 08h ADSHCR.SSTSH[7:0] bits = 0Dh AN000 to AN002 = 0.25 V to VREFH0 – 0.25 V
Analog input capacitance		—	—	12	pF	
Offset error		—	—	±6.5	LSB	
Full-scale error		—	—	±6.5	LSB	
Quantization error		—	±0.5	—	LSB	
Absolute accuracy		—	—	±8.0	LSB	
DNL differential nonlinearity error		—	±0.5	±1.5	LSB	
INL integral nonlinearity error		—	±2.0	±4.0	LSB	

Note: The characteristics apply when no pin functions other than A/D converter input are used. Absolute accuracy includes quantization errors. Offset error, full-scale error, DNL differential nonlinearity error, and INL integral nonlinearity error do not include quantization errors.

Note 1. The conversion time is the sum of the sampling time and the comparison time. As the test conditions, the number of sampling states is indicated.

Table 5.29 A/D Conversion Characteristics (2)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Min.	Typ.	Max.	Unit	Test Conditions
Frequency		1	—	40	MHz	
Resolution		—	—	12	Bit	
Conversion time*1 (Operation at PCLKD = 40 MHz)	Permissible signal source impedance (Max.) = 1.0 kΩ Sample-and-hold circuit not in use	1.15	—	—	µs	High-precision channel ADSSTRn.SST[7:0] bits = 0Eh
		1.30	—	—	µs	Normal-precision channel ADSSTRn.SST[7:0] bits = 14h
	Permissible signal source impedance (Max.) = 1.0 kΩ Sample-and-hold circuit in use	1.90	—	—	µs	High-precision channel ADSSTRn.SST[7:0] bits = 0Eh ADSHCR.SSTSH[7:0] bits = 11h AN000 to AN002 = 0.25 V to VREFH0 – 0.25 V
Analog input capacitance		—	—	12	pF	
Offset error		—	—	±6.5	LSB	
Full-scale error		—	—	±6.5	LSB	
Quantization error		—	±0.5	—	LSB	
Absolute accuracy		—	—	±8.0	LSB	
DNL differential nonlinearity error		—	±0.5	±1.5	LSB	
INL integral nonlinearity error		—	±2.0	±4.0	LSB	

Note: The characteristics apply when no pin functions other than A/D converter input are used. Absolute accuracy includes quantization errors. Offset error, full-scale error, DNL differential nonlinearity error, and INL integral nonlinearity error do not include quantization errors.

Note 1. The conversion time is the sum of the sampling time and the comparison time. As the test conditions, the number of sampling states is indicated.

Table 5.30 A/D Converter Channel Classification

Classification	Channel	Conditions	Remarks
High-precision channel	AN000 to AN007	AVCC0 = 2.7 to 5.5 V	Pins AN000 to AN007 cannot be used as digital outputs when the A/D converter is in use.
Normal-precision channel	AN016, AN017	VCC = AVCC0 = 2.7 to 5.5 V	
Internal reference voltage input channel	Internal reference voltage	AVCC0 = 2.7 to 5.5 V	

Table 5.31 A/D Internal Reference Voltage Characteristics

Conditions: VCC = 2.7 V to AVCC0, AVCC0 = VREFH0 = 2.7 V to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item	Min.	Typ.	Max.	Unit	Test Conditions
Internal reference voltage input channel*1	1.36	1.43	1.50	V	

Note 1. The A/D internal reference voltage indicates the voltage when the internal reference voltage is input to the A/D converter.

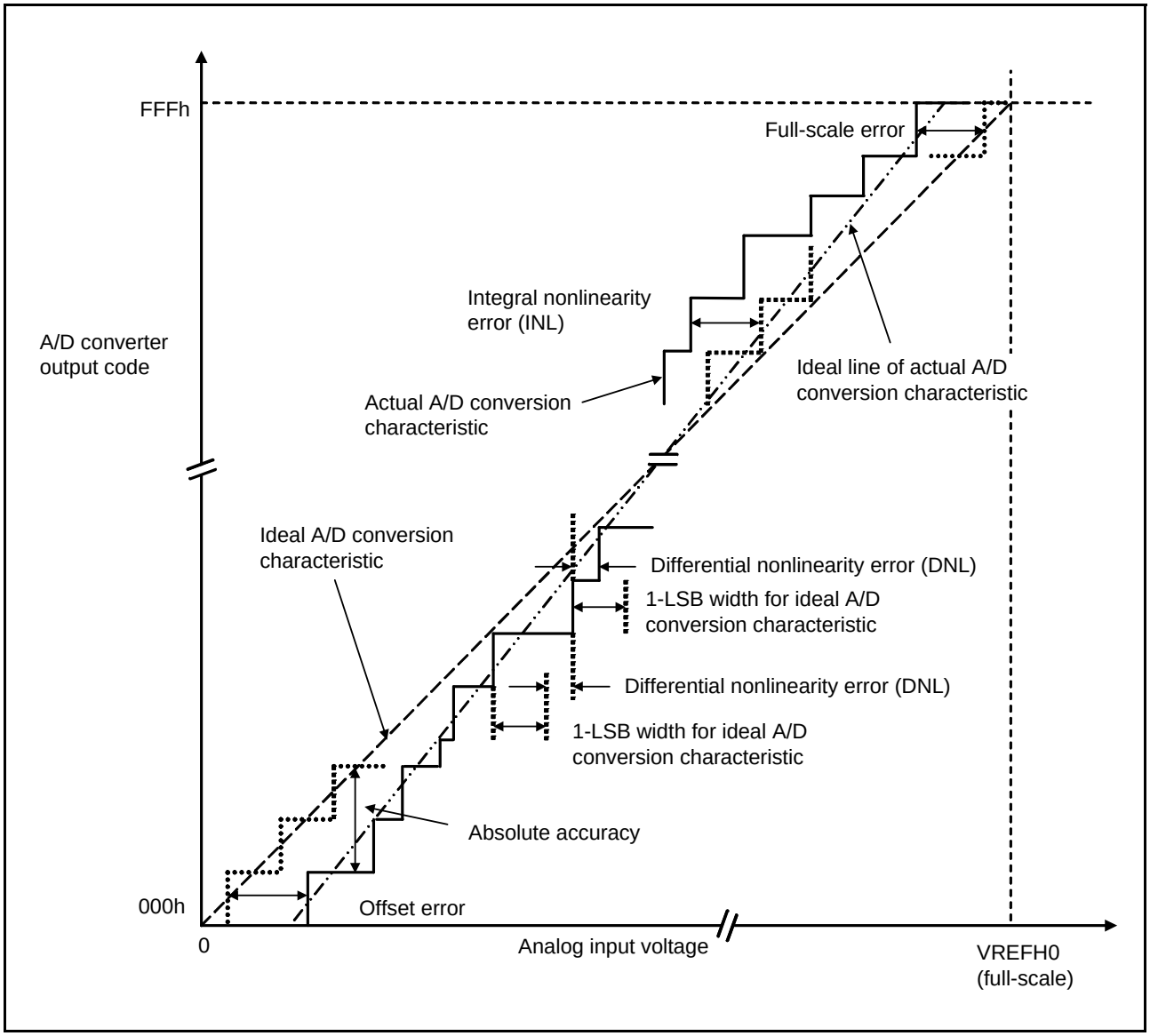


Figure 5.48 Illustration of A/D Converter Characteristic Terms

Absolute accuracy

Absolute accuracy is the difference between output code based on the theoretical A/D conversion characteristics, and the actual A/D conversion result. When measuring absolute accuracy, the voltage at the midpoint of the width of analog input voltage (1-LSB width), that can meet the expectation of outputting an equal code based on the theoretical A/D conversion characteristics, is used as an analog input voltage. For example, if 12-bit resolution is used and if reference voltage (VREFH0 = 3.072 V), then 1-LSB width becomes 0.75 mV, and 0 mV, 0.75 mV, 1.5 mV, ... are used as analog input voltages.

If analog input voltage is 6 mV, absolute accuracy = ±5 LSB means that the actual A/D conversion result is in the range of 003h to 00Dh though an output code, 008h, can be expected from the theoretical A/D conversion characteristics.

Integral nonlinearity error (INL)

Integral nonlinearity error is the maximum deviation between the ideal line when the measured offset and full-scale errors are zeroed, and the actual output code.

Differential nonlinearity error (DNL)

Differential nonlinearity error is the difference between 1-LSB width based on the ideal A/D conversion characteristics and the width of the actual output code.

Offset error

Offset error is the difference between a transition point of the ideal first output code and the actual first output code.

Full-scale error

Full-scale error is the difference between a transition point of the ideal last output code and the actual last output code.

5.5 Comparator Characteristics

Table 5.32 Comparator Characteristics

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Offset voltage	V_{cioff}	—	—	40	mV	
Reference input voltage range	V_{cref}	0	—	AVCC0	V	
Response time	t_{cr}	—	—	200	ns	VOD = 100 mV CMPCTL.CDFS = 0
	t_{cf}	—	—	200	ns	
Stabilization wait time for input selection	t_{cwait}	300	—	—	ns	
Operation stabilization wait time	t_{cmp}		—	1	µs	

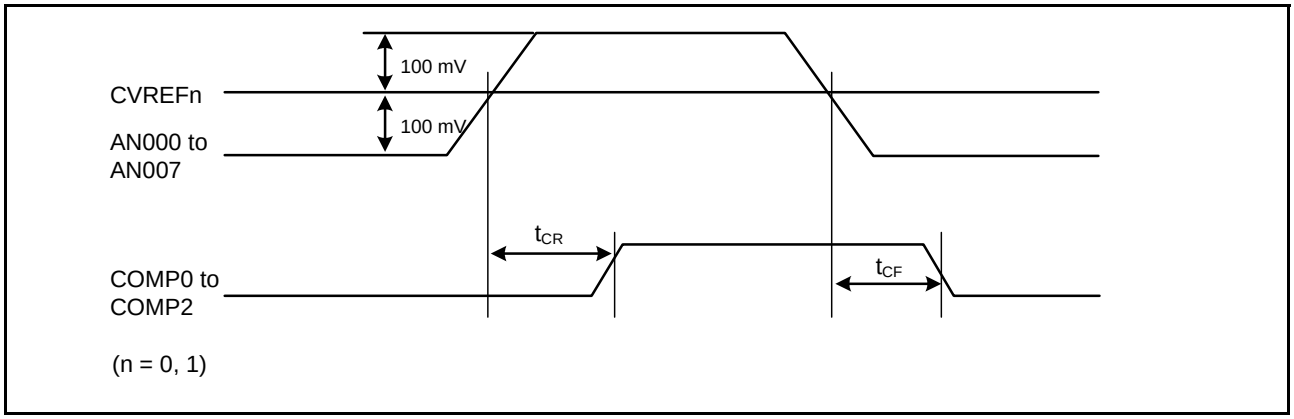


Figure 5.49 Comparator Response Time

5.6 D/A Conversion Characteristics

Table 5.33 D/A Conversion Characteristics

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Resolution	—	—	—	8	Bit	
Conversion time	t_{DCONV}	—	—	3.0	µs	
Absolute accuracy	—	—	±1.0	±3.0	LSB	

5.7 Power-On Reset Circuit and Voltage Detection Circuit Characteristics

Table 5.34 Power-On Reset Circuit and Voltage Detection Circuit Characteristics (1)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Item		Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Voltage detection level	Power-on reset (POR)	V_{POR}	1.35	1.50	1.65	V	Figure 5.50, Figure 5.51
	Voltage detection circuit (LVD0)*1	V_{det0_0}	3.67	3.84	3.97	V	
		V_{det0_2}	2.37	2.51	2.67		
	Voltage detection circuit (LVD1)*2	V_{det1_0}	4.12	4.29	4.42	V	Figure 5.53 At falling edge VCC
		V_{det1_1}	3.98	4.14	4.28		
		V_{det1_2}	3.86	4.02	4.16		
		V_{det1_3}	3.68	3.84	3.98		
		V_{det1_4}	2.99	3.10	3.29		
		V_{det1_5}	2.89	3.00	3.19		
		V_{det1_6}	2.79	2.90	3.09		
		V_{det1_7}	2.68	2.79	2.98		
		V_{det1_8}	2.57	2.68	2.87		
	Voltage detection circuit (LVD2)*1	V_{det2_0}*2	4.08	4.29	4.48		Figure 5.54 At falling edge VCC
		V_{det2_1}	3.95	4.14	4.35		
		V_{det2_2}	3.82	4.02	4.22		
		V_{det2_3}	3.62	3.84	4.02		

Note: These characteristics apply when noise is not superimposed on the power supply. When a setting is made so that the voltage detection level overlaps with that of the voltage detection circuit (LVD2), it cannot be specified which of LVD1 and LVD2 is used for voltage detection.

Note 1. n in the symbol Vdet0_n denotes the value of the LVDS0[1:0] bits.

Note 2. n in the symbol Vdet1_n denotes the value of the LVDLVLR.LVD1LVL[3:0] bits.

Note 3. n in the symbol Vdet2_n denotes the value of the LVDLVLR.LVD2LVL[3:0] bits.

Table 5.35 Power-On Reset Circuit and Voltage Detection Circuit Characteristics (2)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, Ta = –40 to +105°C

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Wait time after power-on reset cancellation	t_{POR}	—	28.4	—	ms	Figure 5.51
Wait time after voltage monitoring 0 reset cancellation	t_{LVD0}	—	568	—	µs	Figure 5.52
Wait time after voltage monitoring 1 reset cancellation	t_{LVD1}	—	100	—	µs	Figure 5.53
Wait time after voltage monitoring 2 reset cancellation	t_{LVD2}	—	100	—	µs	Figure 5.54
Response delay time	t_{det}	—	—	350	µs	Figure 5.50
Minimum VCC down time*1	t_{VOFF}	350	—	—	µs	Figure 5.50, VCC = 1.0 V or above
Power-on reset enable time	$t_{W(POR)}$	1	—	—	ms	Figure 5.51, VCC = below 1.0 V
LVD operation stabilization time (after LVD is enabled)	$Td_{(E-A)}$	—	—	300	µs	Figure 5.53, Figure 5.54
Hysteresis width (LVD1 and LVD2)	V_{LVH}	—	70	—	mV	Vdet1_0 to 4 selected
		—	60	—		Vdet1_5 to 8, LVD2 selected

Note: These characteristics apply when noise is not superimposed on the power supply. When a setting is made so that the voltage detection level overlaps with that of the voltage detection circuit (LVD1), it cannot be specified which of LVD1 and LVD2 is used for voltage detection.

Note 1. The minimum VCC down time indicates the time when VCC is below the minimum value of voltage detection levels V_{POR}, V_{det1}, and V_{det2} for the POR/LVD.

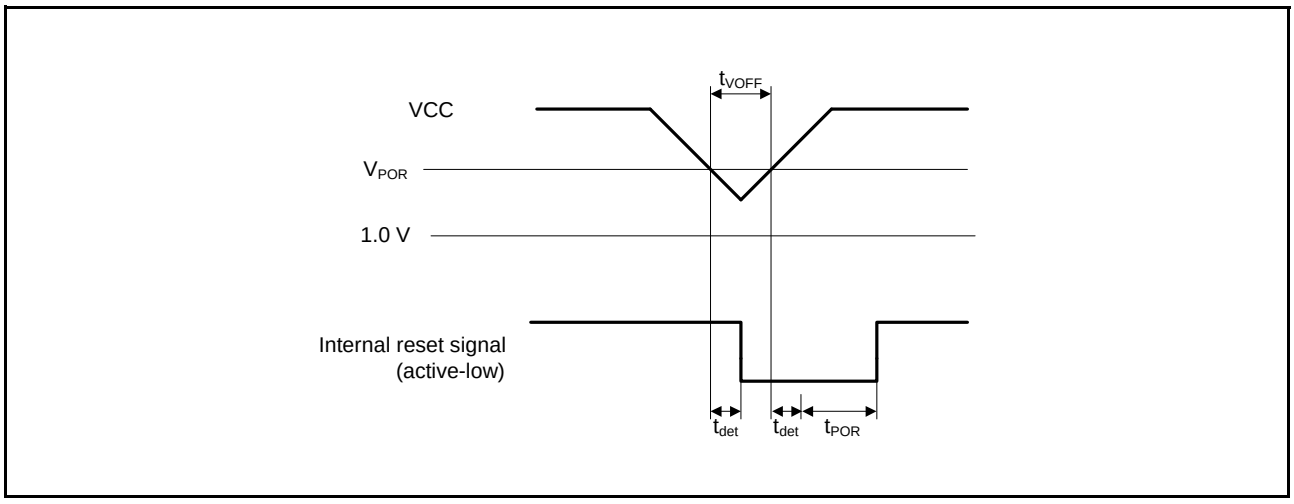
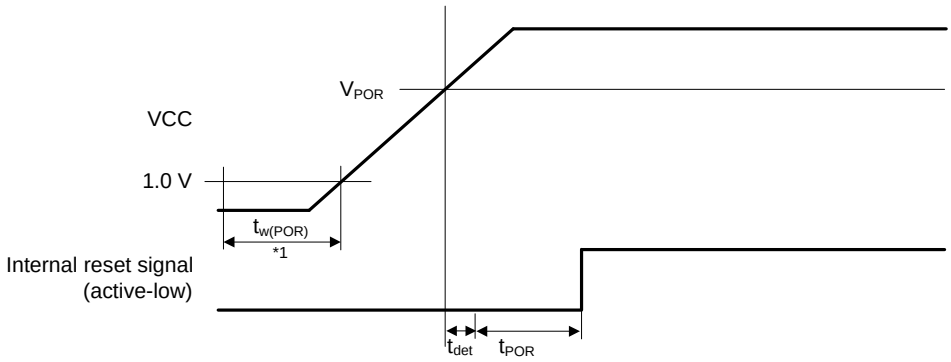


Figure 5.50 Voltage Detection Reset Timing



Note 1. $t_{w(POR)}$ is the time required for a power-on reset to be enabled while the external power VCC is being held below the valid voltage (1.0 V).
When VCC turns on, maintain $t_{w(POR)}$ for 1.0 ms or more.

Figure 5.51 Power-On Reset Timing

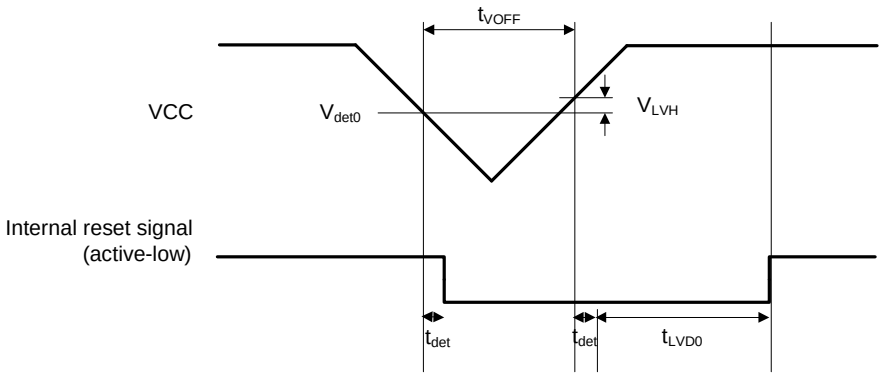


Figure 5.52 Voltage Detection Circuit Timing (Vdet0)

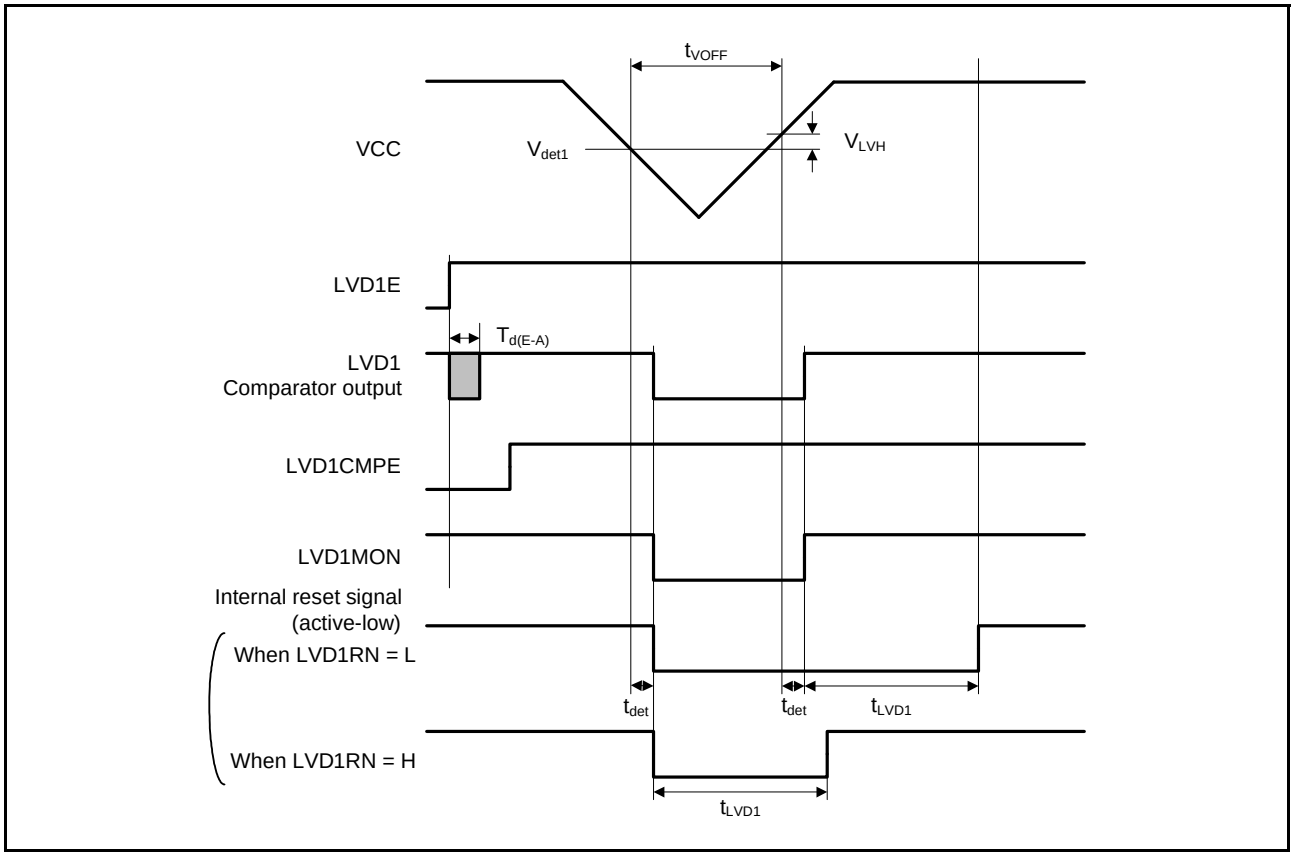


Figure 5.53 Voltage Detection Circuit Timing (V_{det1})

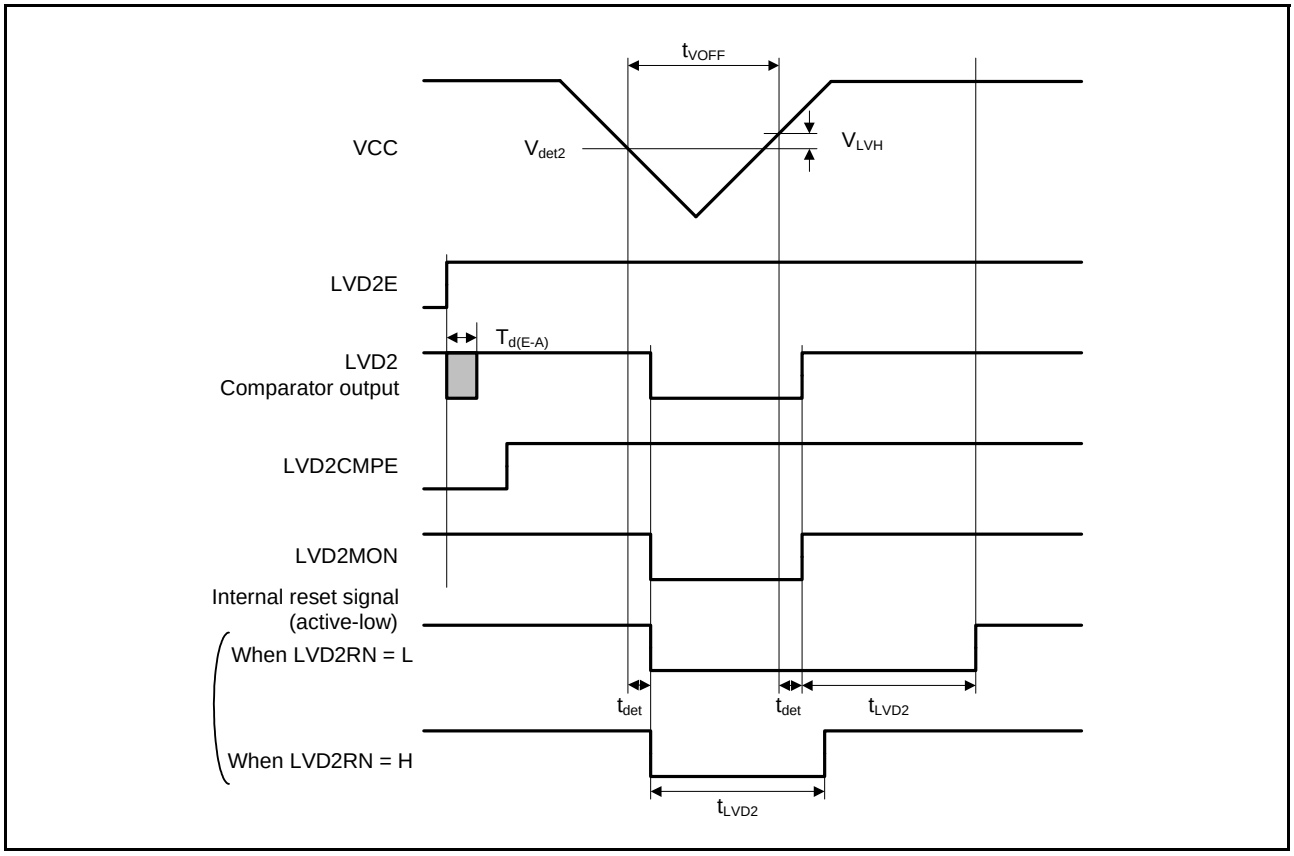


Figure 5.54 Voltage Detection Circuit Timing (V_{det2})

5.8 Oscillation Stop Detection Timing

Table 5.36 Oscillation Stop Detection Timing

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, Ta = –40 to +105°C

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Detection time	t_{dr}	—	—	1	ms	Figure 5.55

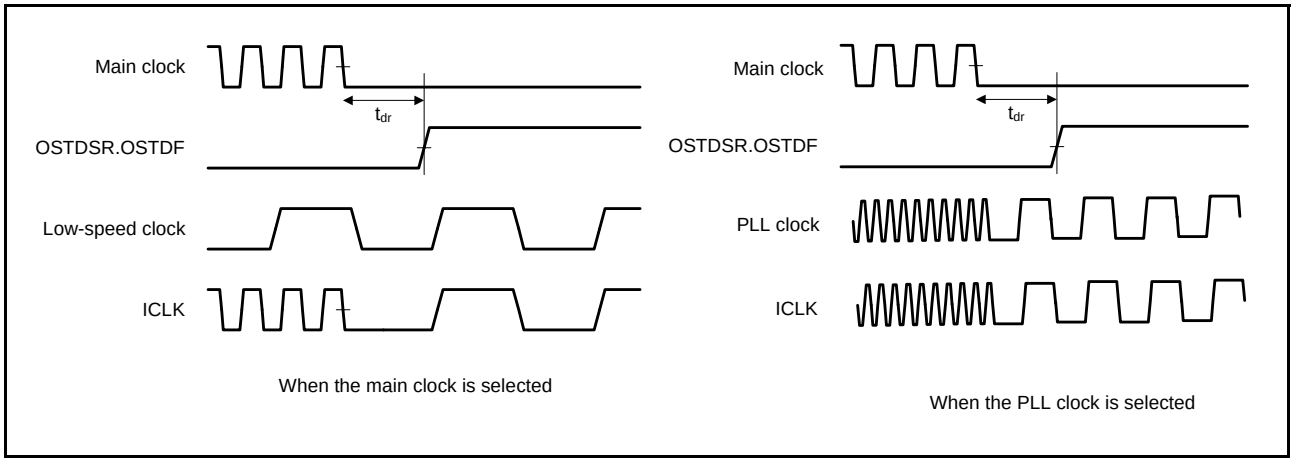


Figure 5.55 Oscillation Stop Detection Timing

5.9 ROM (Flash Memory for Code Storage) Characteristics

Table 5.37 ROM (Flash Memory for Code Storage) Characteristics (1)

Item		Symbol	Min.	Typ.	Max.	Unit	Conditions
Reprogramming/erasure cycle*1		N_{PEC}	1000	—	—	Times	
Data hold time	After 1000 times of N_{PEC}	t_{DRP}	20*2, *3	—	—	Year	T_a = +85°C

Note 1. Definition of reprogram/erase cycle: The reprogram/erase cycle is the number of erasing for each block. When the reprogram/erase cycle is n times (n = 1000), erasing can be performed n times for each block. For instance, when 4-byte programming is performed 256 times for different addresses in 1-Kbyte block and then the entire block is erased, the reprogram/erase cycle is counted as one. However, programming the same address for several times as one erasing is not enabled (overwriting is prohibited).
Note 2. Characteristic when using the flash memory programmer and the self-programming library provided from Renesas Electronics.
Note 3. This result is obtained from reliability testing.

Table 5.38 ROM (Flash Memory for Code Storage) Characteristics (2): High-Speed Operating Mode

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C
Temperature range for the programming/erasure operation: T_a = –40 to +85°C

Item		Symbol	FCLK = 1 MHz			FCLK = 32 MHz			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Programming time	8-byte	t_{P8}	—	112.0	967.0	—	52.3	490.5	µs
Erasure time	2-Kbyte	t_{E2K}	—	8.7	278.1	—	5.5	214.6	ms
	128-Kbyte (when block erase command used)		—	239.7	5111.4	—	25.9	734.3	ms
	128-Kbyte (when all-block erase command used)	t_{E128K}	—	234.5	4906.8	—	20.6	524.6	ms
Blank check time	8-byte	t_{BC8}	—	—	55.0	—	—	16.1	µs
	2-Kbyte	t_{BC2K}	—	—	1840.0	—	—	135.7	µs
Erase operation forcible stop time		t_{SED}	—	—	18.0	—	—	10.7	µs
Start-up area switching setting time		t_{SAS}	—	12.3	566.5	—	6.2	433.5	ms
Access window time		t_{AWS}	—	12.3	566.5	—	6.2	433.5	ms
ROM mode transition wait time 1		t_{DIS}	2.0	—	—	2.0	—	—	µs
ROM mode transition wait time 2		t_{MS}	5.0	—	—	5.0	—	—	µs

Note: Does not include the time until each operation of the flash memory is started after instructions are executed by software.
Note: The lower-limit frequency of FCLK is 1 MHz during programming or erasing of the flash memory. When using FCLK at below 4 MHz, the frequency can be set to 1 MHz, 2 MHz, or 3 MHz. A non-integer frequency such as 1.5 MHz cannot be set.
Note: The frequency accuracy of FCLK should be ±3.5%.

Table 5.39 ROM (Flash Memory for Code Storage) Characteristics (3): Middle-Speed Operating Mode

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = VREFH0 = VCC to 5.5 V, VSS = AVSS0 = VREFL0 = 0 V, T_a = –40 to +105°C

Temperature range for the programming/erasure operation: T_a = –40 to +85°C

Item		Symbol	FCLK = 1 MHz			FCLK = 8 MHz			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Programming time	8-byte	t_{P8}	—	152.0	1367.0	—	97.9	936.0	µs
Erasure time	2-Kbyte	t_{E2K}	—	8.8	279.7	—	5.9	220.8	ms
	128-Kbyte (when block erase command used)		—	239.8	5114.7	—	55.5	1336.4	ms
	128-Kbyte (when all-block erase command used)	t_{E128K}	—	234.6	4908.5	—	50.3	1130.1	ms
Blank check time	8-byte	t_{BC8}	—	—	85.0	—	—	50.9	µs
	2-Kbyte	t_{BC2K}	—	—	1870.0	—	—	401.5	µs
Erase operation forcible stop time		t_{SED}	—	—	28.0	—	—	21.3	µs
Start-up area switching setting time		t_{SAS}	—	13.0	573.3	—	7.7	450.1	ms
Access window time		t_{AWS}	—	13.0	573.3	—	7.7	450.1	ms
ROM mode transition wait time 1		t_{DIS}	2.0	—	—	2.0	—	—	µs
ROM mode transition wait time 2		t_{MS}	3.0	—	—	3.0	—	—	µs

Note: Does not include the time until each operation of the flash memory is started after instructions are executed by software.

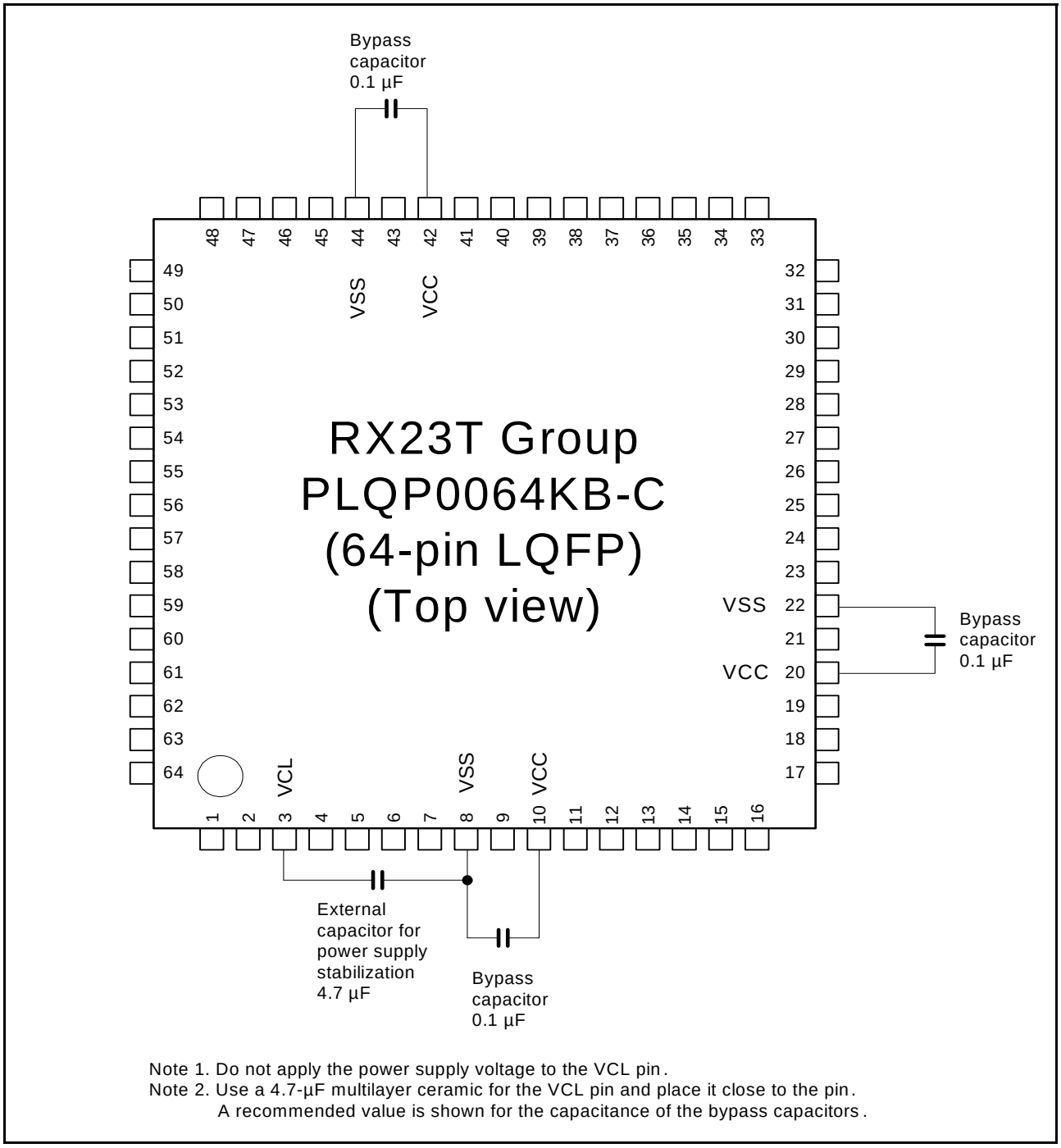
Note: The lower-limit frequency of FCLK is 1 MHz during programming or erasing of the flash memory. When using FCLK at below 4 MHz, the frequency can be set to 1 MHz, 2 MHz, or 3 MHz. A non-integer frequency such as 1.5 MHz cannot be set.

Note: The frequency accuracy of FCLK should be ±3.5%.

5.10 Usage Notes

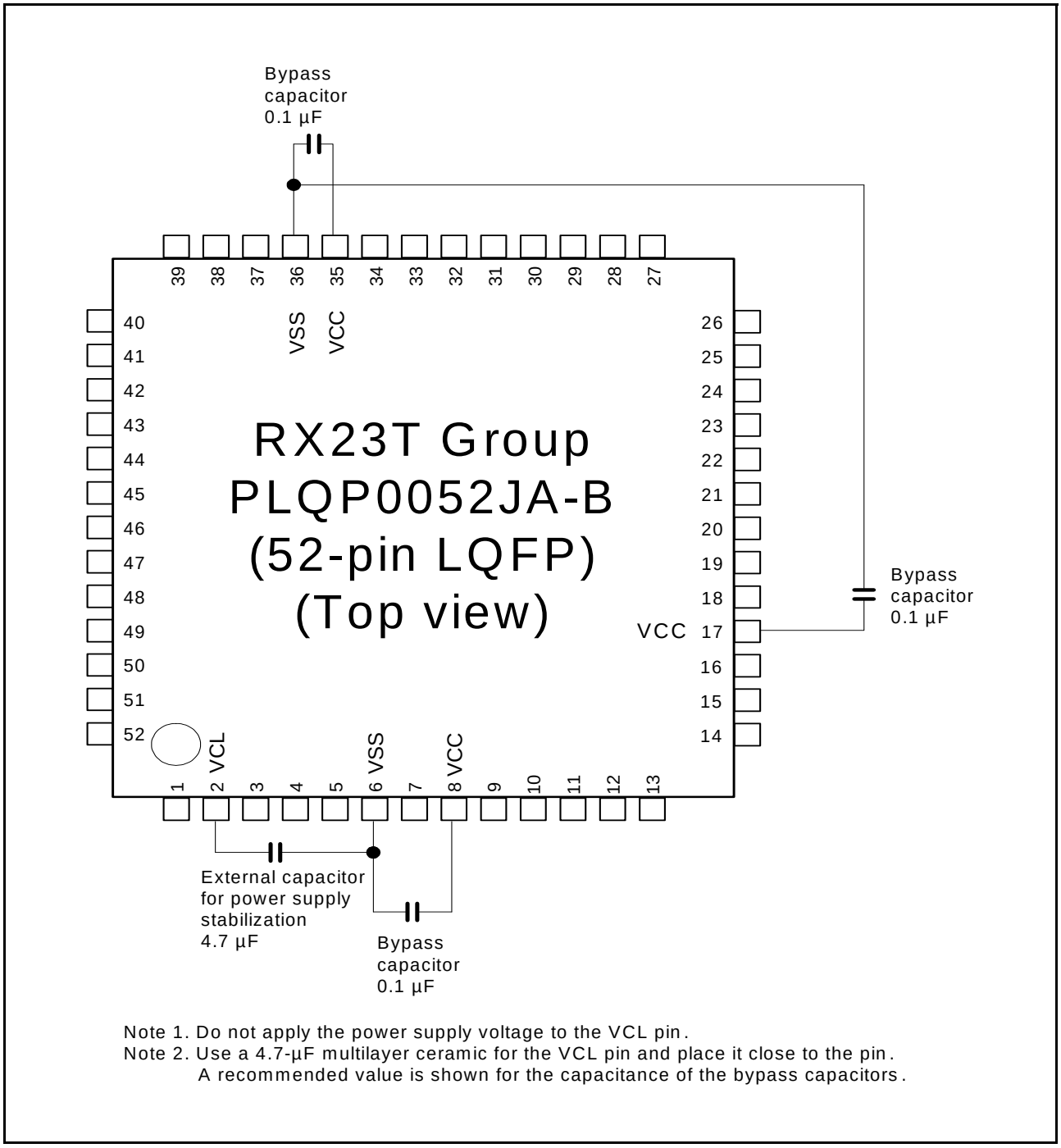
5.10.1 Connecting VCL Capacitor and Bypass Capacitors

This MCU integrates an internal voltage-down circuit, which is used for lowering the power supply voltage in the internal MCU to adjust automatically to the optimum level. A 4.7-µF capacitor needs to be connected between this internal voltage-down power supply (VCL pin) and VSS pin. Figure 5.56 to Figure 5.58 shows how to connect external capacitors. Place an external capacitor close to the pins. Do not apply the power supply voltage to the VCL pin. Insert a multilayer ceramic capacitor as a bypass capacitor between each pair of the power supply pins. Implement a bypass capacitor to the MCU power supply pins as close as possible. Use a recommended value of 0.1 µF as the capacitance of the capacitors. For the capacitors related to crystal oscillation, see section 9, Clock Generation Circuit in the User's Manual: Hardware. For the capacitors related to analog modules, also see section 29, 12-Bit A/D Converter (S12ADE) in the User's Manual: Hardware.
For notes on designing the printed circuit board, see the descriptions of the application note "Hardware Design Guide" (R01AN1411EJ). The latest version can be downloaded from Renesas Electronics Website.



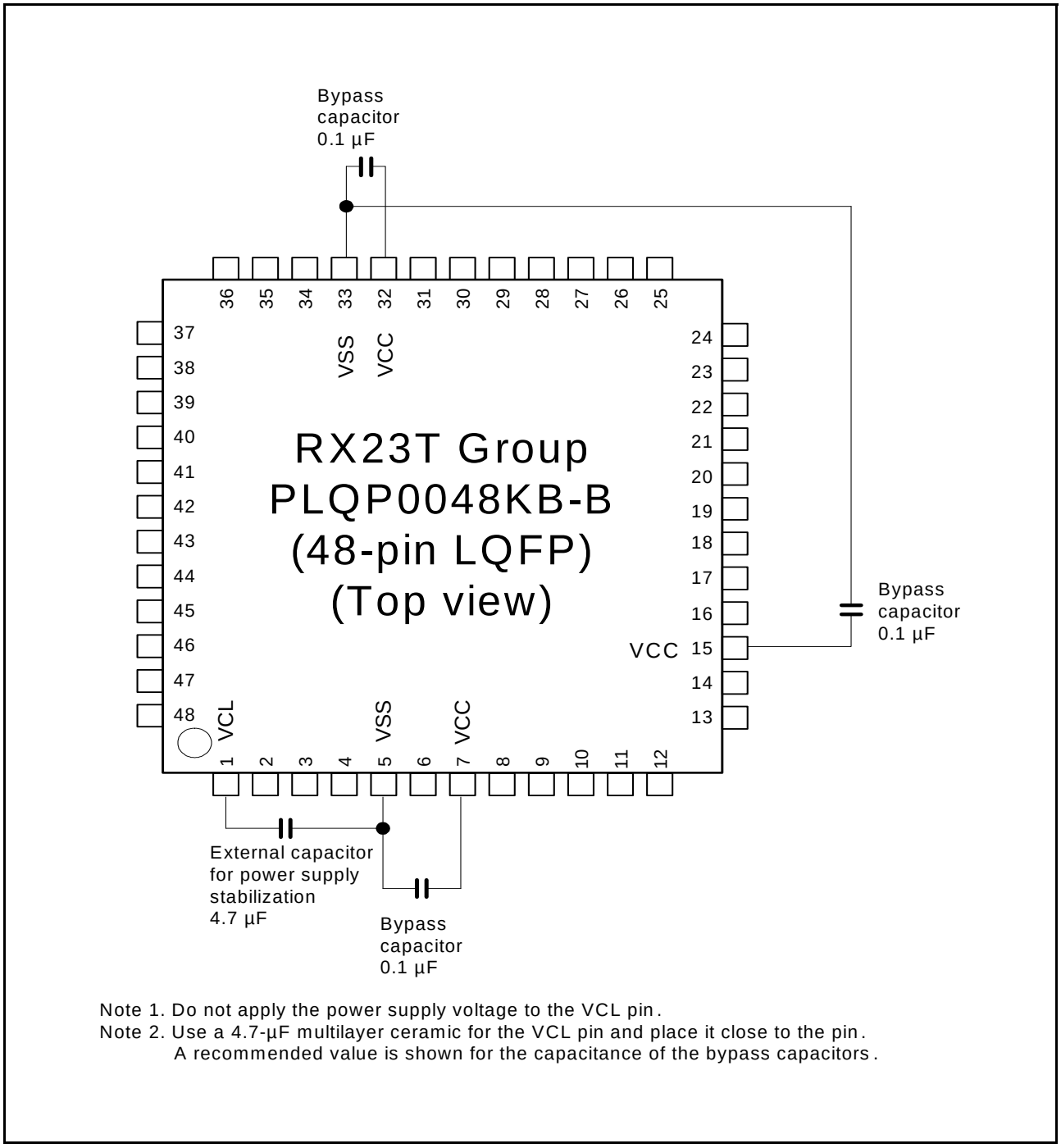
Note 1. Do not apply the power supply voltage to the VCL pin.
Note 2. Use a 4.7-µF multilayer ceramic for the VCL pin and place it close to the pin.
A recommended value is shown for the capacitance of the bypass capacitors.

Figure 5.56 Connecting Capacitors (64 Pins)



Note 1. Do not apply the power supply voltage to the VCL pin.
Note 2. Use a 4.7-µF multilayer ceramic for the VCL pin and place it close to the pin.
A recommended value is shown for the capacitance of the bypass capacitors.

Figure 5.57 Connecting Capacitors (52 Pins)



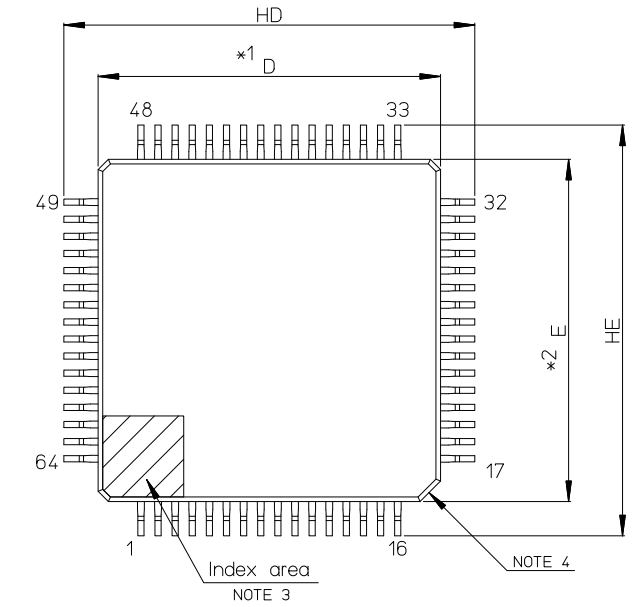
Note 1. Do not apply the power supply voltage to the VCL pin.
Note 2. Use a 4.7-µF multilayer ceramic for the VCL pin and place it close to the pin.
A recommended value is shown for the capacitance of the bypass capacitors.

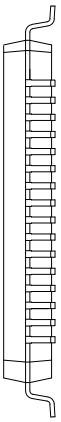
Figure 5.58 Connecting Capacitors (48 Pins)

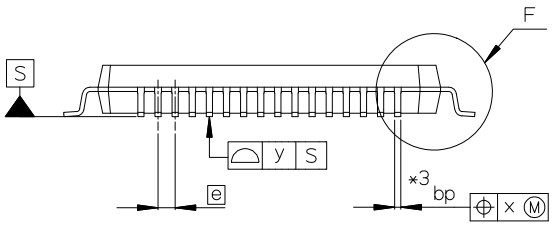
Appendix 1. Package Dimensions

Information on the latest version of the package dimensions or mountings has been displayed in “Packages” on Renesas Electronics Corporation website.

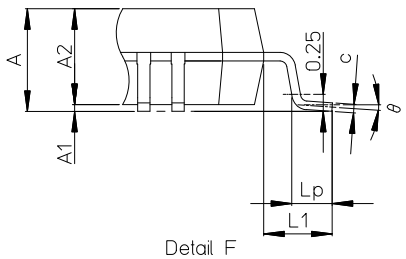
JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-LFQFP64-10x10-0.50	PLQP0064KB-C	——	0.3g







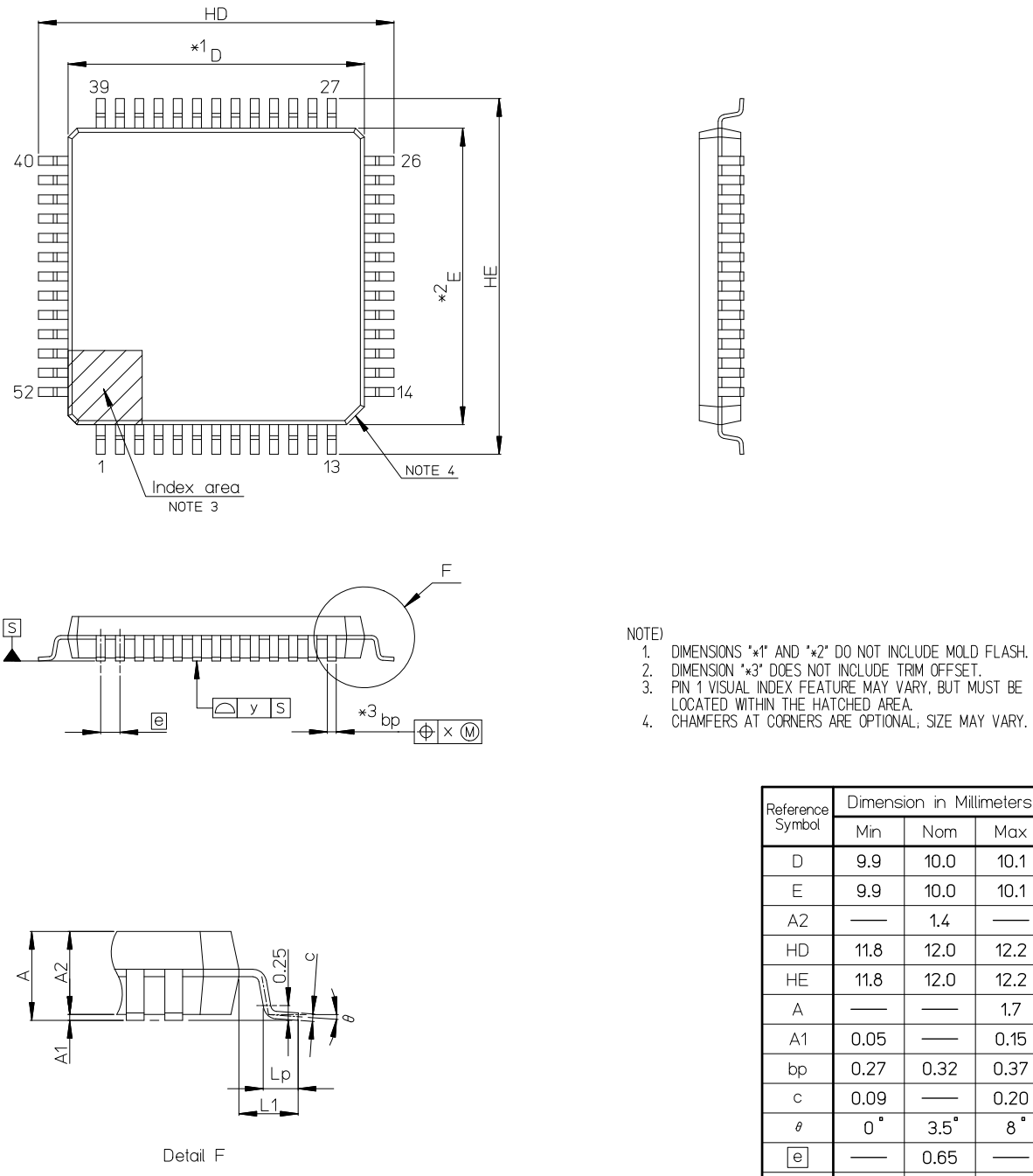
NOTE)
1. DIMENSIONS "*1" AND "*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION "*3" DOES NOT INCLUDE TRIM OFFSET.
3. PIN 1 VISUAL INDEX FEATURE MAY VARY, BUT MUST BE LOCATED WITHIN THE HATCHED AREA.
4. CHAMFERS AT CORNERS ARE OPTIONAL; SIZE MAY VARY.



Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	9.9	10.0	10.1
E	9.9	10.0	10.1
A2	——	1.4	——
HD	11.8	12.0	12.2
HE	11.8	12.0	12.2
A	——	——	1.7
A1	0.05	——	0.15
bp	0.15	0.20	0.27
c	0.09	——	0.20
θ	0°	3.5°	8°
e	——	0.5	——
x	——	——	0.08
y	——	——	0.08
Lp	0.45	0.6	0.75
L1	——	1.0	——

Figure A 64-Pin LFQFP (PLQP0064KB-C)

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-LQFP52-10x10-0.65	PLQP0052JA-B	——	0.3g

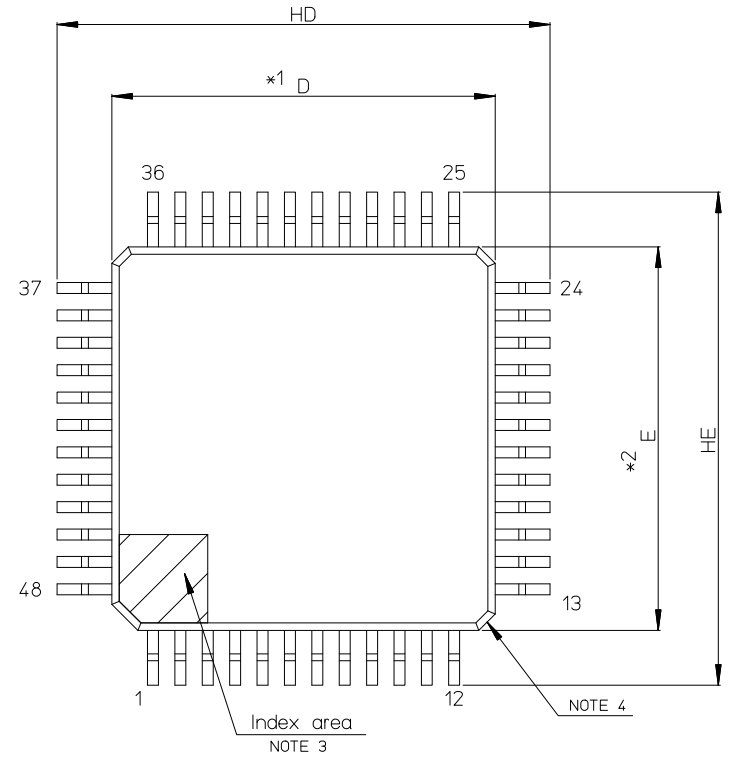


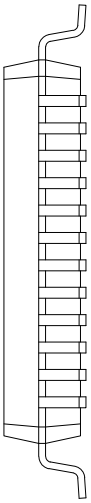
NOTE)
1. DIMENSIONS "*1" AND "*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION "*3" DOES NOT INCLUDE TRIM OFFSET.
3. PIN 1 VISUAL INDEX FEATURE MAY VARY, BUT MUST BE LOCATED WITHIN THE HATCHED AREA.
4. CHAMFERS AT CORNERS ARE OPTIONAL; SIZE MAY VARY.

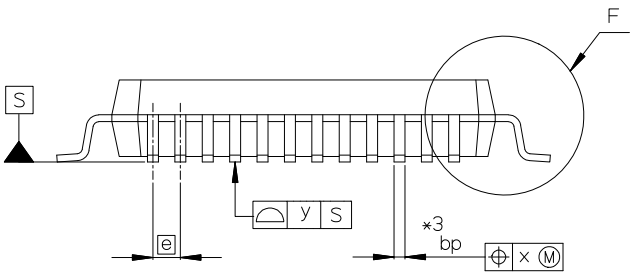
Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	9.9	10.0	10.1
E	9.9	10.0	10.1
A2	——	1.4	——
HD	11.8	12.0	12.2
HE	11.8	12.0	12.2
A	——	——	1.7
A1	0.05	——	0.15
bp	0.27	0.32	0.37
c	0.09	——	0.20
θ	0°	3.5°	8°
e	——	0.65	——
x	——	——	0.13
y	——	——	0.10
Lp	0.45	0.6	0.75
L1	——	1.0	——

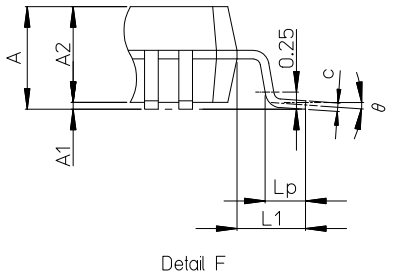
Figure B 52-Pin LQFP (PLQP0052JA-B)

JEITA Package Code	RENESAS Code	Previous Code	MASS[Typ.]
P-LFQFP48-7x7-0.50	PLQP0048KB-B	——	0.2g









NOTE)
1. DIMENSIONS "*1" AND "*2" DO NOT INCLUDE MOLD FLASH.
2. DIMENSION "*3" DOES NOT INCLUDE TRIM OFFSET.
3. PIN 1 VISUAL INDEX FEATURE MAY VARY, BUT MUST BE LOCATED WITHIN THE HATCHED AREA.
4. CHAMFERS AT CORNERS ARE OPTIONAL, SIZE MAY VARY.

Reference Symbol	Dimension in Millimeters		
	Min	Nom	Max
D	6.9	7.0	7.1
E	6.9	7.0	7.1
A2	——	1.4	——
HD	8.8	9.0	9.2
HE	8.8	9.0	9.2
A	——	——	1.7
A1	0.05	——	0.15
bp	0.17	0.20	0.27
c	0.09	——	0.20
θ	0°	3.5°	8°
e	——	0.5	——
x	——	——	0.08
y	——	——	0.08
Lp	0.45	0.6	0.75
L1	——	1.0	——

Figure C 48 -Pin LFQFP (PLQP0048KB-B)

REVISION HISTORY	RX23T Group Datasheet

Classifications

- Items with Technical Update document number: Changes according to the corresponding issued Technical Update
- Items without Technical Update document number: Minor changes that do not require Technical Update to be issued

Rev.	Date	Description		Classification
		Page	Summary	
1.00	Mar 31, 2015	—	First edition, issued	
1.10	Oct 30, 2015	Features		
		1	Features changed	
		1. Overview		
		2, 3	Table 1.1 Outline of Specifications (1/3) (2/3) changed	
		6	Table 1.3 List of Products: D Version (Ta = –40 to +85°C) changed	
		6	Table 1.4 List of Products: G Version (Ta = –40 to +105°C) changed	
		7	Figure 1.1 How to Read the Product Part Number changed	
		10	Table 1.5 Pin Functions (2/2) changed	
		11	Figure 1.3 Pin Assignments of the 64-Pin LFQFP changed	
		12	Figure 1.4 Pin Assignments of the 52-Pin LQFP changed	
		13	Figure 1.5 Pin Assignments of the 48-Pin LFQFP changed	
		14	Table 1.6 List of Pins and Pin Functions (64-Pin LFQFP) (1/2) changed	
		16	Table 1.7 List of Pins and Pin Functions (52-Pin LQFP) changed	
		17	Table 1.8 List of Pins and Pin Functions (48-Pin LFQFP) changed	
		3. Address Space		
		22	Figure 3.1 Memory Map in Each Operating Mode changed	
		4. I/O Registers		
		25	Table 4.1 List of I/O Registers (Address Order) (1 / 16) Address: 0008 0036h High-Speed On-Chip Oscillator Control Register (HOCOCR), Address: 0008 00A5h High-Speed On-Chip Oscillator Wait Control Register (HOCOWTCR) added	
		34	Table 4.1 List of I/O Registers (Address Order) (10 / 16) Address: 0008 C087h Open Drain Control Register 1 (ODR1) added	
		5. Electrical Characteristics		
		42	Table 5.3 DC Characteristics (1) changed	
		57	Table 5.14 Operating Frequency Value (High-Speed Operating Mode), Table 5.15 Operating Frequency Value (Middle-Speed Operating Mode) changed	
		58	Table 5.16 Clock Timing, Figure 5.20 EXTAL External Clock Input Timing changed	
		59, 60	Figure 5.24 HOCO Clock Oscillation Start Timing (After Reset is Canceled by Setting OFS1.HOCOEN Bit to 0), Figure 5.25 HOCO Clock Oscillation Start Timing (Oscillation is Started by Setting HOCOCR.HCSTP Bit) added	
		79	Table 5.32 Comparator Characteristics changed	
		80	Table 5.33 D/A Conversion Characteristics symbol added	
		82	Table 5.35 Power-On Reset Circuit and Voltage Detection Circuit Characteristics (2) changed	
		83	Figure 5.52 Voltage Detection Circuit Timing (Vdet0) changed	
		89	Figure 5.56 Connecting Capacitors (64 Pins) changed	
		90	Figure 5.57 Connecting Capacitors (52 Pins) changed	
		91	Figure 5.58 Connecting Capacitors (48 Pins) changed	
		Appendix 1. Package Dimensions		
		92	Figure A 64-Pin LFQFP (PLQP0064KB-C) changed	
		93	Figure B 52-Pin LQFP (PLQP0052JA-B) changed	
		94	Figure C 48 -Pin LFQFP (PLQP0048KB-B) changed	

NOTES FOR CMOS DEVICES

(1) VOLTAGE APPLICATION WAVEFORM AT INPUT PIN: Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between VIL (MAX) and VIH (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between VIL (MAX) and VIH (MIN).

(2) HANDLING OF UNUSED INPUT PINS: Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to VDD or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

(3) PRECAUTION AGAINST ESD: A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

(4) STATUS BEFORE INITIALIZATION: Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

(5) POWER ON/OFF SEQUENCE: In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current. The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

(6) INPUT OF SIGNAL DURING POWER OFF STATE : Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

   Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

   — The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

   The state of the product is undefined at the moment when power is supplied.

   — The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.
   In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.
   In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

   Access to reserved addresses is prohibited.

   — The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

   After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

   — When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

   Before changing from one product to another, i.e. to a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of an MPU or MCU in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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