Renesas Electronics America Inc - R5F524TAADFF#30 Datasheet

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"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

Applications of "Embedded - Microcontrollers"

Details	
Product Status	Discontinued at Digi-Key
Core Processor	RXv2
Core Size	32-Bit Single-Core
Speed	80MHz
Connectivity	I²C, SCI, SPI
Peripherals	DMA, LVD, POR, PWM, WDT
Number of I/O	60
Program Memory Size	256KB (256K x 8)
Program Memory Type	FLASH
EEPROM Size	8K x 8
RAM Size	16K x 8
Voltage - Supply (Vcc/Vdd)	2.7V ~ 5.5V
Data Converters	A/D 17x12b; D/A 1x8b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	80-LQFP
Supplier Device Package	80-LQFP (14x14)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f524taadff-30

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 shows the outline of maximum specifications, and the numbers of peripheral modules and of channels of the modules differ depending on chip version and the pin number on the package. For details, see Table 1.2, Comparison of Functions for Different Packages.

Table 1.1 Outline of Specifications (1/4)

Classification	Module/Function	Description
CPU	CPU	• Maximum operating frequency: 80 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-bit • Barrel shifter: 32 bits • ROM cache: 2 Kbytes (disabled by default)
	FPU	• Single precision (32-bit) floating point • Data types and floating-point exceptions in conformance with the IEEE754 standard
Memory	ROM	• Capacity: 128 K/256 K/384 K/512 Kbytes • Up to 32 MHz, no-wait memory access 32 to 80 MHz: wait states • Off-board programming • Programming/erasing method: Serial programming (asynchronous serial communication), self-programming
	RAM	• Capacity: 16 K/32 Kbytes • 80 MHz, no-wait memory access
	E2 DataFlash	• Capacity: 8 Kbytes • Number of erase/write cycles: 1,000,000 (typ)
MCU operating mode		Single-chip mode
Clock	Clock generation circuit	• Main clock oscillator, low- and high-speed on-chip oscillators, PLL frequency synthesizer, and IWDT-dedicated on-chip oscillator • 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): 80 MHz (at max.) The MTU3 and GPT modules run in synchronization with the PCLKA: 80 MHz (at max.) The peripheral modules other than MTU3 and GPT run in synchronization with the PCLKB: 40 MHz (at max.) ADCLK operated in S12AD runs in synchronization with the PCLKD: 40 MHz (at max.) The flash memory 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 3 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

1.4 Pin Functions

Table 1.4 lists the pin functions.

Table 1.4 Pin Functions (1/4)

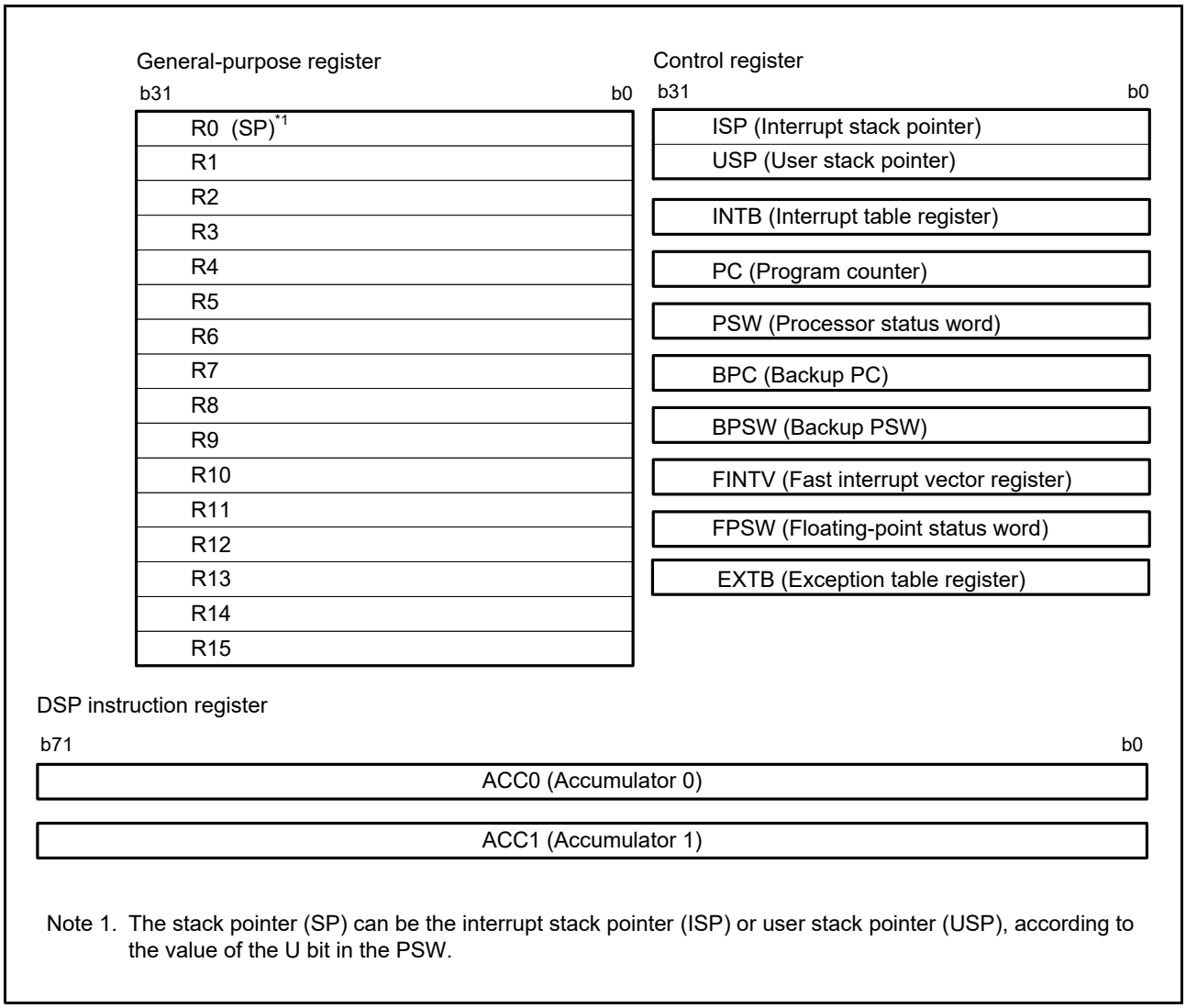
Classifications	Pin Name	I/O	Description
Power supply	VCC	—	Power supply pin. Connect it to the system power supply.
	VCL	—	Connect this pin to the VSS pin via the 4.7 µF smoothing capacitor used to stabilize the internal power supply. Place the capacitor close to the pin.
	VSS	—	Ground pin. Connect 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 IRQ7	Input	Interrupt request pins.
Multi-function timer pulse unit 3 (MTU3d)	MTIOC0A, MTIOC0B, MTIOC0C, MTIOC0D	I/O	The TGRA0 to TGRD0 input capture input/output compare output/PWM output pins.
	MTIOC0A#, MTIOC0B#, MTIOC0C#, MTIOC0D#	I/O	The TGRA0 to TGRD0 input capture inverted input/output compare inverted output/PWM inverted output pins.
	MTIOC1A, MTIOC1B	I/O	The TGRA1 and TGRB1 input capture input/output compare output/PWM output pins.
	MTIOC1A#, MTIOC1B#	I/O	The TGRA1 and TGRB1 input capture inverted input/output compare inverted output/PWM inverted output pins.
	MTIOC2A, MTIOC2B	I/O	The TGRA2 and TGRB2 input capture input/output compare output/PWM output pins.
	MTIOC2A#, MTIOC2B#	I/O	The TGRA2 and TGRB2 input capture inverted input/output compare inverted output/PWM inverted output pins.
	MTIOC3A, MTIOC3B, MTIOC3C, MTIOC3D	I/O	The TGRA3 to TGRD3 input capture input/output compare output/PWM output pins.
	MTIOC3A#, MTIOC3B#, MTIOC3C#, MTIOC3D#	I/O	The TGRA3 to TGRD3 input capture inverted input/output compare inverted output/PWM inverted output pins.
	MTIOC4A, MTIOC4B, MTIOC4C, MTIOC4D	I/O	The TGRA4 to TGRD4 input capture input/output compare output/PWM output pins.
	MTIOC4A#, MTIOC4B#, MTIOC4C#, MTIOC4D#	I/O	The TGRA4 to TGRD4 input capture inverted input/output compare inverted output/PWM inverted output pins.
	MTIC5U, MTIC5V, MTIC5W	Input	The TGRU5, TGRV5, and TGRW5 input capture input/external pulse input pins.
	MTIC5U#, MTIC5V#, MTIC5W#	Input	The TGRU5, TGRV5, and TGRW5 input capture inverted input/external pulse inverted input pins.
	MTIOC6A, MTIOC6B, MTIOC6C, MTIOC6D	I/O	The TGRA6 to TGRD6 input capture input/output compare output/PWM output pins.
	MTIOC6A#, MTIOC6B#, MTIOC6C#, MTIOC6D#	I/O	The TGRA6 to TGRD6 input capture inverted input/output compare inverted output/PWM inverted output pins.
	MTIOC7A, MTIOC7B, MTIOC7C, MTIOC7D	I/O	The TGRA7 to TGRD7 input capture input/output compare output/PWM output pins.
	MTIOC7A#, MTIOC7B#, MTIOC7C#, MTIOC7D#	I/O	The TGRA7 to TGRD7 input capture inverted input/output compare inverted output/PWM inverted output pins.
	MTIOC9A, MTIOC9B, MTIOC9C, MTIOC9D	I/O	The TGRA9 to TGRD9 input capture input/output compare output/PWM output pins.

Table 1.6 List of Pins and Pin Functions (100-Pin LFQFP, Chip Version A) (1/2)

Pin No.	Power Supply, Clock, System Control	I/O Port	Timers (MTU, TMR, POE, CAC)	Communications (SCI, RSPI, RIIC)	Others
1		PE5			IRQ0
2		P02	MTIOC9D	CTS1#, RTS1#, SS1#	IRQ5, ADST0
3	VSS				
4		P00			IRQ2, ADST1
5	VCL				
6	MD				FINED
7		P01	POE12#		IRQ4, ADST2
8		PE4	MTCLKC, POE10#		IRQ1
9		PE3	MTCLKD, POE11#		IRQ2
10	RES#				
11	XTAL	P37			
12	VSS				
13	EXTAL	P36			
14	VCC				
15		PE2	POE10#		NMI
16		PE1	MTIOC9D, TMO5	CTS5#, RTS5#, SS5#, SSLA3	
17		PE0	MTIOC9B, TMCI1, TMCI5	SSLA2	
18		PD7	MTIOC9A, TMRI1, TMRI5	SSLA1	
19		PD6	MTIOC9C, TMO1	CTS1#, RTS1#, SS1#, SSLA0	IRQ5, ADST0
20		PD5	TMRI0, TMRI6	RXD1, SMISO1, SSCL1	IRQ3
21		PD4	TMCI0, TMCI6	SCK1	IRQ2
22		PD3	TMO0	TXD1, SMOSI1, SSDA1	
23		PD2	TMCI1, TMO4	SCK5, MOSIA	
24		PD1	TMO2	MISOA	
25		PD0	TMO6	RSPCKA	
26		PB7		SCK5	
27		PB6		RXD5, SMISO5, SSCL5	IRQ5
28		PB5		TXD5, SMOSI5, SSDA5	
29	VCC				
30		PB4	POE8#	CTS5#, RTS5#, SS5#	IRQ3
31	VSS				
32		PB3	MTIOC0A, CACREF	SCK6, RSPCKA	
33		PB2	MTIOC0B, TMRI0, ADSM0	TXD6, SMOSI6, SSDA6, SDA0	
34		PB1	MTIOC0C, TMCI0, ADSM1	RXD6, SMISO6, SSCL6, SCL0	
35		PB0	MTIOC0D, TMO0	TXD6, SMOSI6, SSDA6, MOSIA	ADTRG2#
36		PA5	MTIOC1A, TMCI3	RXD6, SMISO6, SSCL6, MISOA	IRQ1, ADTRG1#
37		PA4	MTIOC1B, TMCI7	SCK6, RSPCKA	ADTRG0#
38		PA3	MTIOC2A, TMRI7	SSLA0	
39		PA2	MTIOC2B, TMO7	CTS6#, RTS6#, SS6#, SSLA1	
40		PA1	MTIOC6A, TMO4	SSLA2	ADTRG0#
41		PA0	MTIOC6C, TMO2	SSLA3	
42	VCC				
43		P96	POE4#		IRQ4
44	VSS				
45		P95	MTIOC6B		
46		P94	MTIOC7A		
47		P93	MTIOC7B		
48		P92	MTIOC6D		
49		P91	MTIOC7C		
50		P90	MTIOC7D		
51		P76	MTIOC4D		
52		P75	MTIOC4C		
53		P74	MTIOC3D		
54		P73	MTIOC4B		

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.

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
```

Table 4.1 List of I/O Registers (Address Order) (32/37)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles ICLK ≥ PCLK
000C 1A4Dh	MTU7	Timer Control Register 2	TCR2	8	8	4 or 5 PCLKA
000C 1A50h	MTU6	Timer Synchronous Clear Register	TSYCR	8	8	4 or 5 PCLKA
000C 1A60h	MTU	Timer Waveform Control Register B	TWCRB	8	8	4 or 5 PCLKA
000C 1A70h	MTU	Timer Mode Register 2B	TMDR2B	8	8	4 or 5 PCLKA
000C 1A72h	MTU6	Timer General Register E	TGRE	16	16	4 or 5 PCLKA
000C 1A74h	MTU7	Timer General Register E	TGRE	16	16	4 or 5 PCLKA
000C 1A76h	MTU7	Timer General Register F	TGRF	16	16	4 or 5 PCLKA
000C 1A80h	MTU	Timer Start Register B	TSTRB	8	8, 16	4 or 5 PCLKA
000C 1A81h	MTU	Timer Synchronous Register B	TSYRB	8	8	4 or 5 PCLKA
000C 1A84h	MTU	Timer Read/Write Enable Register B	TRWERB	8	8	4 or 5 PCLKA
000C 1A93h	MTU6	Noise Filter Control Register 6	NFCR6	8	8	4 or 5 PCLKA
000C 1A94h	MTU7	Noise Filter Control Register 7	NFCR7	8	8	4 or 5 PCLKA
000C 1A95h	MTU5	Noise Filter Control Register 5	NFCR5	8	8	4 or 5 PCLKA
000C 1C80h	MTU5	Timer Counter U	TCNTU	16	16, 32	4 or 5 PCLKA
000C 1C82h	MTU5	Timer General Register U	TGRU	16	16	4 or 5 PCLKA
000C 1C84h	MTU5	Timer Control Register U	TCRU	8	8	4 or 5 PCLKA
000C 1C85h	MTU5	Timer Control Register 2U	TCR2U	8	8	4 or 5 PCLKA
000C 1C86h	MTU5	Timer I/O Control Register U	TIORU	8	8	4 or 5 PCLKA
000C 1C90h	MTU5	Timer Counter V	TCNTV	16	16, 32	4 or 5 PCLKA
000C 1C92h	MTU5	Timer General Register V	TGRV	16	16	4 or 5 PCLKA
000C 1C94h	MTU5	Timer Control Register V	TCRV	8	8	4 or 5 PCLKA
000C 1C95h	MTU5	Timer Control Register 2V	TCR2V	8	8	4 or 5 PCLKA
000C 1C96h	MTU5	Timer I/O Control Register V	TIORV	8	8	4 or 5 PCLKA
000C 1CA0h	MTU5	Timer Counter W	TCNTW	16	16, 32	4 or 5 PCLKA
000C 1CA2h	MTU5	Timer General Register W	TGRW	16	16	4 or 5 PCLKA
000C 1CA4h	MTU5	Timer Control Register W	TCRW	8	8	4 or 5 PCLKA
000C 1CA5h	MTU5	Timer Control Register 2W	TCR2W	8	8	4 or 5 PCLKA
000C 1CA6h	MTU5	Timer I/O Control Register W	TIORW	8	8	4 or 5 PCLKA
000C 1CB2h	MTU5	Timer Interrupt Enable Register	TIER	8	8	4 or 5 PCLKA
000C 1CB4h	MTU5	Timer Start Register	TSTR	8	8	4 or 5 PCLKA
000C 1CB6h	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
000C 1D32h	MTU	A/D Conversion Start Request Select Register 1	TADSTRGR1	8	8	4 or 5 PCLKA
000C 2000h	GPT	General PWM Timer Software Start Register*2	GTSTR	16	8, 16, 32	4 or 5 PCLKA
000C 2002h	GPT	Noise Filter Control Register*2	NFCR	16	16, 32	4 or 5 PCLKA
000C 2004h	GPT	General PWM Timer Hardware Source Start/Stop Control Register 0*2	GTHSCR	16	8, 16, 32	4 or 5 PCLKA
000C 2006h	GPT	General PWM Timer Hardware Source Clear Control Register*2	GTHCCR	16	8, 16, 32	4 or 5 PCLKA
000C 2008h	GPT	General PWM Timer Hardware Start Source Select Register*2	GTHSSR	16	8, 16, 32	4 or 5 PCLKA
000C 200Ah	GPT	General PWM Timer Hardware Stop/Clear Source Select Register*2	GTHPSR	16	8, 16, 32	4 or 5 PCLKA
000C 200Ch	GPT	General PWM Timer Write-Protection Register*2	GTWP	16	8, 16, 32	4 or 5 PCLKA
000C 200Eh	GPT	General PWM Timer Sync Register*2	GTSYNC	16	8, 16, 32	4 or 5 PCLKA
000C 2010h	GPT	General PWM Timer External Trigger Input Interrupt Register*2	GTETINT	16	8, 16, 32	4 or 5 PCLKA
000C 2014h	GPT	General PWM Timer Buffer Operation Disable Register*2	GTBDR	16	8, 16, 32	4 or 5 PCLKA
000C 2018h	GPT	General PWM Timer Start Write-Protection Register*2	GTSWP	16	8, 16, 32	4 or 5 PCLKA
000C 201Ch	GPT	General PWM Timer Clearing Write-Protection Register*2	GTCWP	16	8, 16, 32	4 or 5 PCLKA
000C 2020h	GPT	General PWM Timer Common Register Write-Protection Register*2	GTCMNWP	16	8, 16, 32	4 or 5 PCLKA
000C 2024h	GPT	General PWM Timer Mode Register*2	GTMDR	16	8, 16, 32	4 or 5 PCLKA
000C 2028h	GPT	General PWM Timer External Clock Noise Filter Control Register*2	GTECNFCR	32	8, 16, 32	4 or 5 PCLKA

Table 4.1 List of I/O Registers (Address Order) (34/37)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles ICLK ≥ PCLK
000C 21A0h	GPT1	General PWM Timer Period Setting Double Buffer Register*2	GTPDBR	16	16, 32	4 or 5 PCLKA
000C 21A4h	GPT1	A/D Converter Start Request Timing Register A*2	GTADTRA	16	16, 32	4 or 5 PCLKA
000C 21A6h	GPT1	A/D Converter Start Request Timing Buffer Register A*2	GTADTBRA	16	16, 32	4 or 5 PCLKA
000C 21A8h	GPT1	A/D Converter Start Request Timing Double Buffer Register A*2	GTADTDBRA	16	16, 32	4 or 5 PCLKA
000C 21ACh	GPT1	A/D Converter Start Request Timing Register B*2	GTADTRB	16	16, 32	4 or 5 PCLKA
000C 21AEh	GPT1	A/D Converter Start Request Timing Buffer Register B*2	GTADTBRB	16	16, 32	4 or 5 PCLKA
000C 21B0h	GPT1	A/D Converter Start Request Timing Double Buffer Register B*2	GTADTDBRB	16	16, 32	4 or 5 PCLKA
000C 21B4h	GPT1	General PWM Timer Output Negate Control Register*2	GTONCR	16	16, 32	4 or 5 PCLKA
000C 21B6h	GPT1	General PWM Timer Dead Time Control Register*2	GTDTCR	16	16, 32	4 or 5 PCLKA
000C 21B8h	GPT1	General PWM Timer Dead Time Value Register U*2	GTDVU	16	16, 32	4 or 5 PCLKA
000C 21BAh	GPT1	General PWM Timer Dead Time Value Register D*2	GTDVD	16	16, 32	4 or 5 PCLKA
000C 21BCh	GPT1	General PWM Timer Dead Time Buffer Register U*2	GTDBU	16	16, 32	4 or 5 PCLKA
000C 21BEh	GPT1	General PWM Timer Dead Time Buffer Register D*2	GTDBD	16	16, 32	4 or 5 PCLKA
000C 21C0h	GPT1	General PWM Timer Output Protection Function Status Register*2	GTSOS	16	16, 32	4 or 5 PCLKA
000C 21C2h	GPT1	General PWM Timer Output Protection Function Temporary Release Register*2	GTSOTR	16	16, 32	4 or 5 PCLKA
000C 2200h	GPT2	General PWM Timer I/O Control Register*2	GTIOR	16	8, 16, 32	4 or 5 PCLKA
000C 2202h	GPT2	General PWM Timer Interrupt Output Setting Register*2	GTINTAD	16	8, 16, 32	4 or 5 PCLKA
000C 2204h	GPT2	General PWM Timer Control Register*2	GTCR	16	8, 16, 32	4 or 5 PCLKA
000C 2206h	GPT2	General PWM Timer Buffer Enable Register*2	GTBER	16	8, 16, 32	4 or 5 PCLKA
000C 2208h	GPT2	General PWM Timer Count Direction Register*2	GTUDC	16	8, 16, 32	4 or 5 PCLKA
000C 220Ah	GPT2	General PWM Timer Interrupt and A/D Converter Start Request Skipping Setting Register*2	GTITC	16	8, 16, 32	4 or 5 PCLKA
000C 220Ch	GPT2	General PWM Timer Status Register*2	GTST	16	8, 16, 32	4 or 5 PCLKA
000C 220Eh	GPT2	General PWM Timer Counter*2	GTCNT	16	16	4 or 5 PCLKA
000C 2210h	GPT2	General PWM Timer Compare Capture Register A*2	GTCCRA	16	16, 32	4 or 5 PCLKA
000C 2212h	GPT2	General PWM Timer Compare Capture Register B*2	GTCCRB	16	16, 32	4 or 5 PCLKA
000C 2214h	GPT2	General PWM Timer Compare Capture Register C*2	GTCCRC	16	16, 32	4 or 5 PCLKA
000C 2216h	GPT2	General PWM Timer Compare Capture Register D*2	GTCCRD	16	16, 32	4 or 5 PCLKA
000C 2218h	GPT2	General PWM Timer Compare Capture Register E*2	GTCCRE	16	16, 32	4 or 5 PCLKA
000C 221Ah	GPT2	General PWM Timer Compare Capture Register F*2	GTCCRF	16	16, 32	4 or 5 PCLKA
000C 221Ch	GPT2	General PWM Timer Period Setting Register*2	GTPR	16	16, 32	4 or 5 PCLKA
000C 221Eh	GPT2	General PWM Timer Period Setting Buffer Register*2	GTPBR	16	16, 32	4 or 5 PCLKA
000C 2220h	GPT2	General PWM Timer Period Setting Double Buffer Register*2	GTPDBR	16	16, 32	4 or 5 PCLKA
000C 2224h	GPT2	A/D Converter Start Request Timing Register A*2	GTADTRA	16	16, 32	4 or 5 PCLKA
000C 2226h	GPT2	A/D Converter Start Request Timing Buffer Register A*2	GTADTBRA	16	16, 32	4 or 5 PCLKA
000C 2228h	GPT2	A/D Converter Start Request Timing Double Buffer Register A*2	GTADTDBRA	16	16, 32	4 or 5 PCLKA
000C 222Ch	GPT2	A/D Converter Start Request Timing Register B*2	GTADTRB	16	16, 32	4 or 5 PCLKA
000C 222Eh	GPT2	A/D Converter Start Request Timing Buffer Register B*2	GTADTBRB	16	16, 32	4 or 5 PCLKA
000C 2230h	GPT2	A/D Converter Start Request Timing Double Buffer Register B*2	GTADTDBRB	16	16, 32	4 or 5 PCLKA
000C 2234h	GPT2	General PWM Timer Output Negate Control Register*2	GTONCR	16	16, 32	4 or 5 PCLKA
000C 2236h	GPT2	General PWM Timer Dead Time Control Register*2	GTDTCR	16	16, 32	4 or 5 PCLKA
000C 2238h	GPT2	General PWM Timer Dead Time Value Register U*2	GTDVU	16	16, 32	4 or 5 PCLKA
000C 223Ah	GPT2	General PWM Timer Dead Time Value Register D*2	GTDVD	16	16, 32	4 or 5 PCLKA
000C 223Ch	GPT2	General PWM Timer Dead Time Buffer Register U*2	GTDBU	16	16, 32	4 or 5 PCLKA
000C 223Eh	GPT2	General PWM Timer Dead Time Buffer Register D*2	GTDBD	16	16, 32	4 or 5 PCLKA
000C 2240h	GPT2	General PWM Timer Output Protection Function Status Register*2	GTSOS	16	16, 32	4 or 5 PCLKA
000C 2242h	GPT2	General PWM Timer Output Protection Function Temporary Release Register*2	GTSOTR	16	16, 32	4 or 5 PCLKA

Table 5.4 DC Characteristics (2)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V, T_a = –40 to +85°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, port 5, port 6	$\lvert I_{TSI} \rvert$	—	—	1.0	µA	V_{in} = 0 V, VREF
	Ports except for 5-V tolerant ports and port 4, port 5, port 6		—	—	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 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V, T_a = –40 to +85°C

Item					Symbol	Chip Version A		Chip Version B		Unit	Test Conditions
						Typ. *7	Max.	Typ. *7	Max.		
Supply current *1	High-speed operating mode	Normal operating mode	No peripheral operation*2	ICLK = 80 MHz	I_{CC}	26.0	—	26.0	—	mA	
				ICLK = 64 MHz		20.7	—	20.7	—		
				ICLK = 32 MHz		11.8	—	11.8	—		
				ICLK = 16 MHz		7.0	—	7.0	—		
				ICLK = 8 MHz		4.7	—	4.7	—		
			All peripheral operation: Normal	ICLK = 80 MHz*3		35.0	—	40.5	—		
				ICLK = 64 MHz*4		28.5	—	32.5	—		
				ICLK = 32 MHz*5		18.5	—	20.9	—		
				ICLK = 16 MHz*5		10.5	—	11.7	—		
				ICLK = 8 MHz*5		6.4	—	7.0	—		
			All peripheral operation: Max.	ICLK = 80 MHz*3		—	70.0	—	80.0		
				ICLK = 64 MHz*4		—	60.0	—	70.0		
				ICLK = 32 MHz*5		—	40.0	—	45.0		
		Sleep mode	No peripheral operation*2	ICLK = 80 MHz		7.2	—	7.2	—		
				ICLK = 64 MHz		6.1	—	6.1	—		
				ICLK = 32 MHz		4.4	—	4.4	—		
				ICLK = 16 MHz		3.4	—	3.4	—		
				ICLK = 8 MHz		2.9	—	2.9	—		
			All peripheral operation: Normal	ICLK = 80 MHz*3		22.4	—	26.9	—		
				ICLK = 64 MHz*4		18.4	—	21.9	—		
				ICLK = 32 MHz*5		13.5	—	15.5	—		
				ICLK = 16 MHz*5		8.0	—	9.0	—		
				ICLK = 8 MHz*5		5.2	—	5.7	—		

Table 5.6 DC Characteristics (4)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V, T_a = –40 to +85°C

Item			Symbol	Chip Version A		Chip Version B		Unit	Test Conditions
				Typ.*3	Max.	Typ.*3	Max.		
Supply current*1	Software standby mode*2	T_a = 25°C	I_{CC}	1.0	55.0	1.5	15.0	µA	
		T_a = 55°C		1.5	60.0	3.0	38.0		
		T_a = 85°C		5.5	260.0	13.0	135.0		

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.

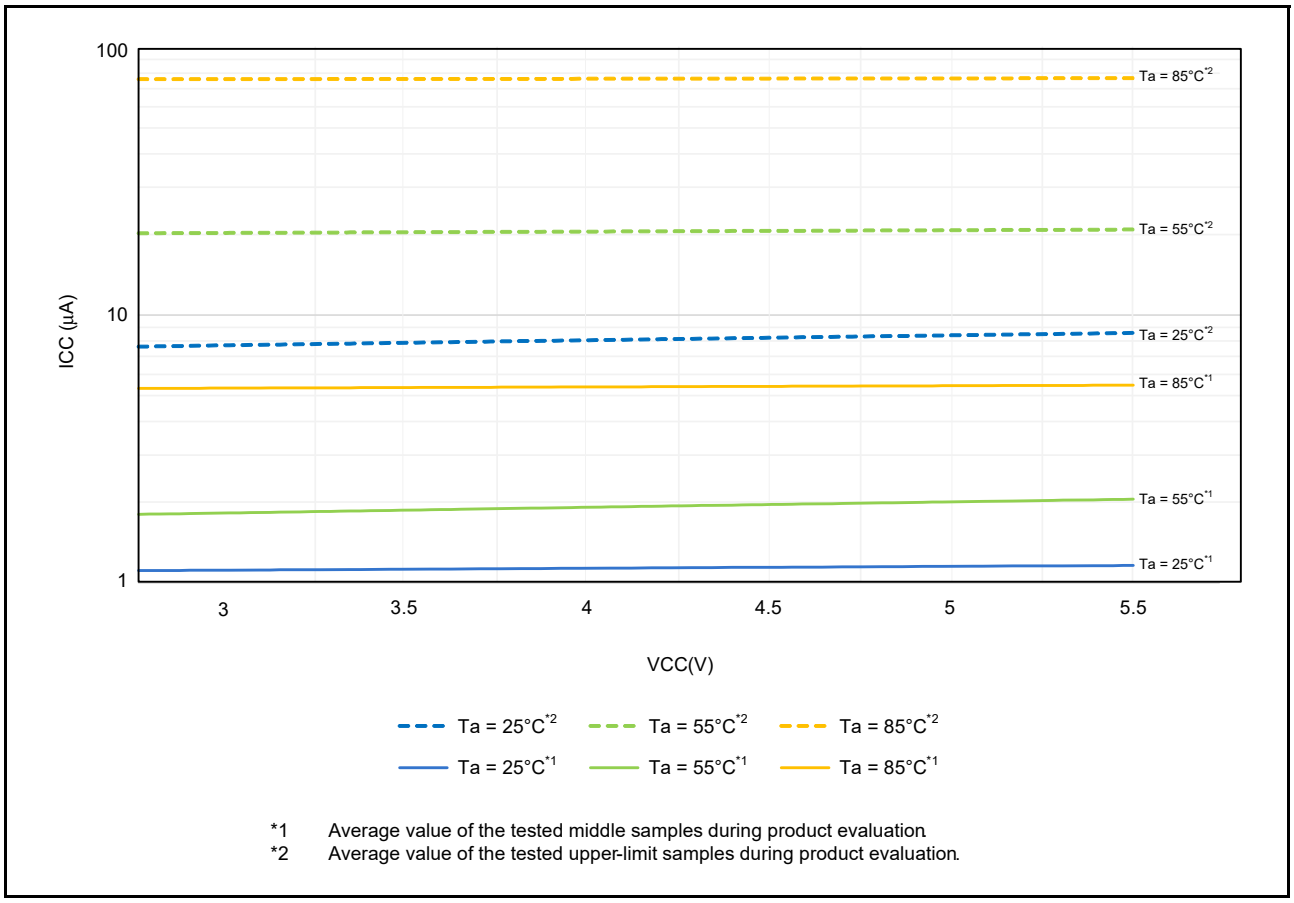


Figure 5.1 Voltage Dependency in Software Standby Mode (Chip Version A) (Reference Data)

Table 5.10 DC Characteristics (8)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V, T_a = –40 to +85°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 5.5 $V_{r\,(VCC)} \leq VCC \times 0.2$
		—	—	1	MHz	Figure 5.5 $V_{r\,(VCC)} \leq VCC \times 0.08$
		—	—	10	MHz	Figure 5.5 $V_{r\,(VCC)} \leq VCC \times 0.06$
Allowable voltage change rising/falling gradient	dt/dVCC	1.0	—	—	ms/V	When VCC change exceeds VCC ±10%

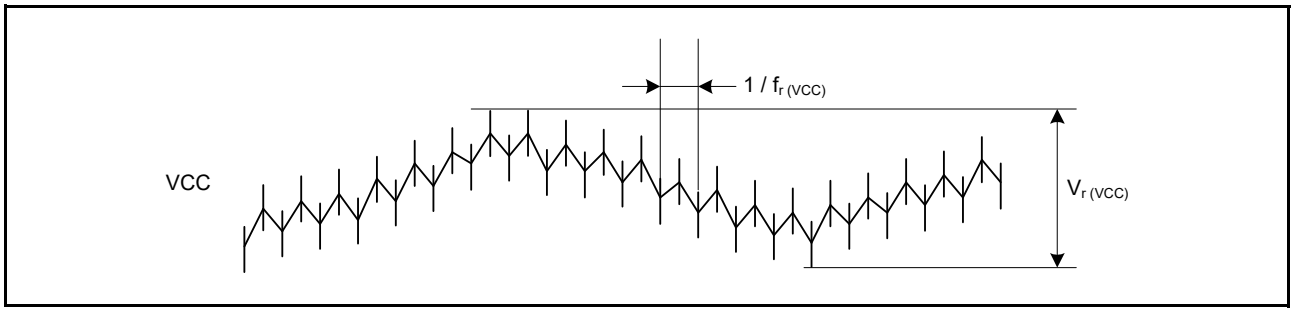


Figure 5.5 Ripple Waveform

Table 5.11 DC Characteristics (9)

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V, T_a = –40 to +85°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.

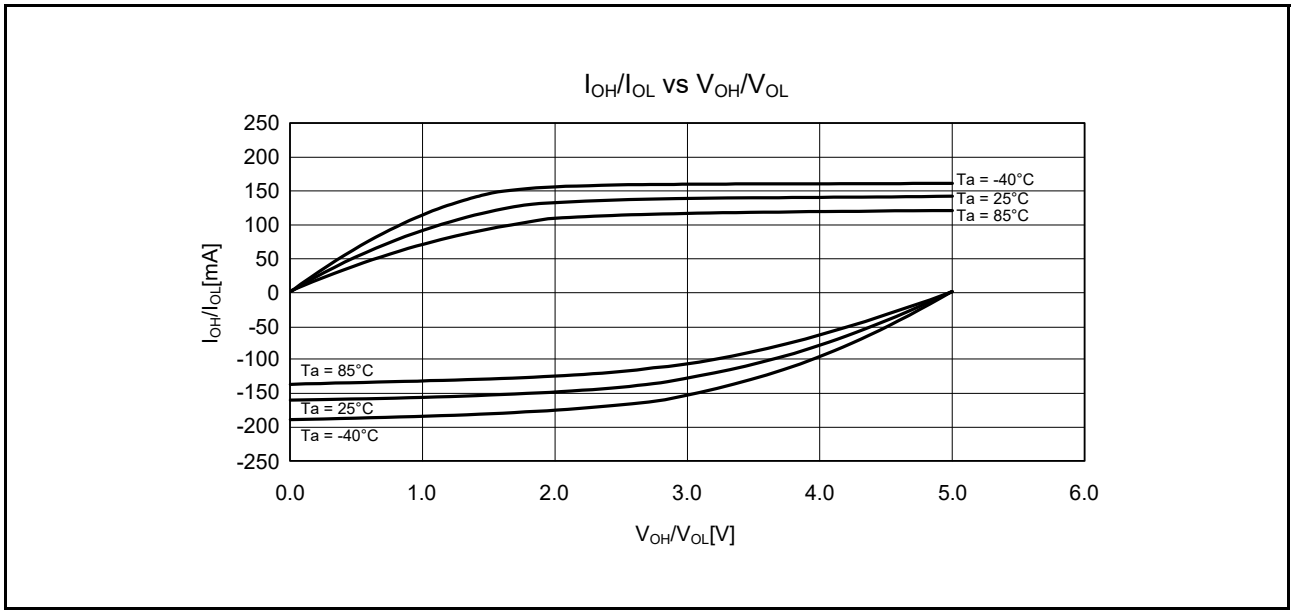


Figure 5.16 V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics of Large Current Ports at VCC = 5.0 V (Reference Data)

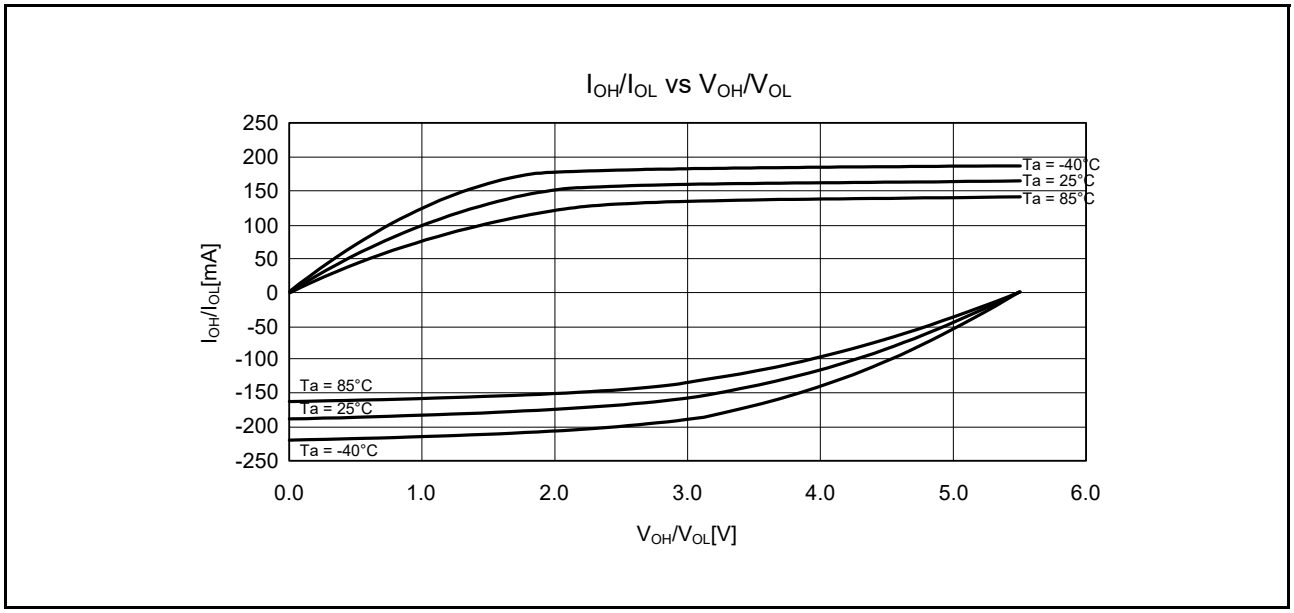


Figure 5.17 V_{OH}/V_{OL} and I_{OH}/I_{OL} Temperature Characteristics of Large Current Ports at VCC = 5.5 V (Reference Data)

Table 5.16 Clock Timing

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V, T_a = –40 to +85°C

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
EXTAL external clock input cycle time	t_{Xcyc}	50	—	—	ns	Figure 5.22
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_{XWT}	0.5	—	—	μs	
Main clock oscillator oscillation frequency	f_{MAIN}	1	—	20	MHz	
Main clock oscillation stabilization time (crystal)*2	$t_{MAINOSC}$	—	3	—	ms	Figure 5.23
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 5.24
HOCO clock oscillation frequency	f_{HOCO} (32MHz)	31.52	32	32.48	MHz	T_a = –40 to –20°C
		31.68	32	32.32	MHz	T_a = –20 to +75°C
		31.52	32	32.48	MHz	T_a = +75 to +85°C
	f_{HOCO} (64MHz)	63.04	64	64.96	MHz	T_a = –40 to –20°C
		63.36	64	64.64	MHz	T_a = –20 to +75°C
		63.04	64	64.96	MHz	T_a = +75 to +85°C
HOCO clock oscillation stabilization time	t_{HOCO} (32MHz)	—	—	37.1	μs	Figure 5.26
	t_{HOCO} (64MHz)	—	—	80.6	μs	Figure 5.26
IWDT-dedicated clock oscillation frequency	f_{ILOCO}	12.75	15	17.25	kHz	
IWDT-dedicated clock oscillation stabilization time	t_{ILOCO}	—	—	50	μs	Figure 5.27
PLL circuit oscillation frequency	f_{PLL}	40	—	80	MHz	
PLL clock oscillation stabilization time	t_{PLL}	—	—	50	μs	Figure 5.28
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.

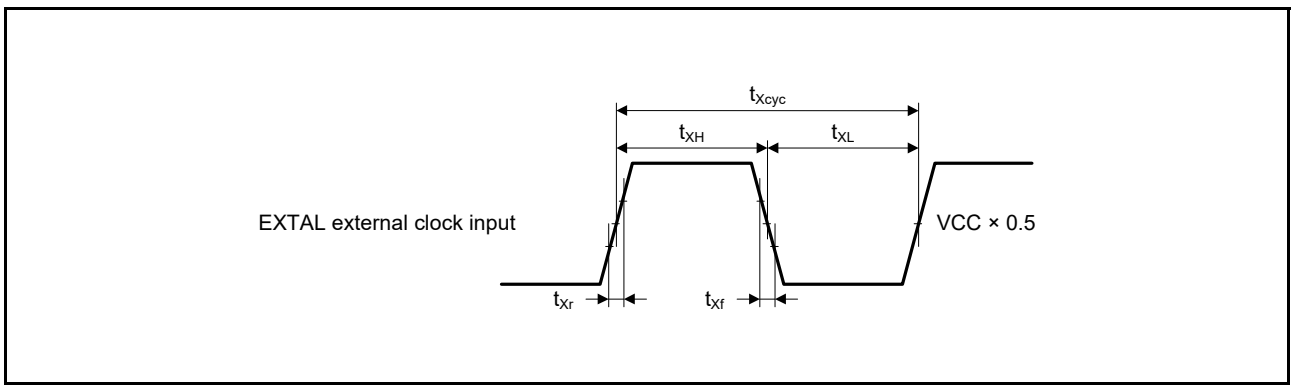


Figure 5.22 EXTAL External Clock Input Timing

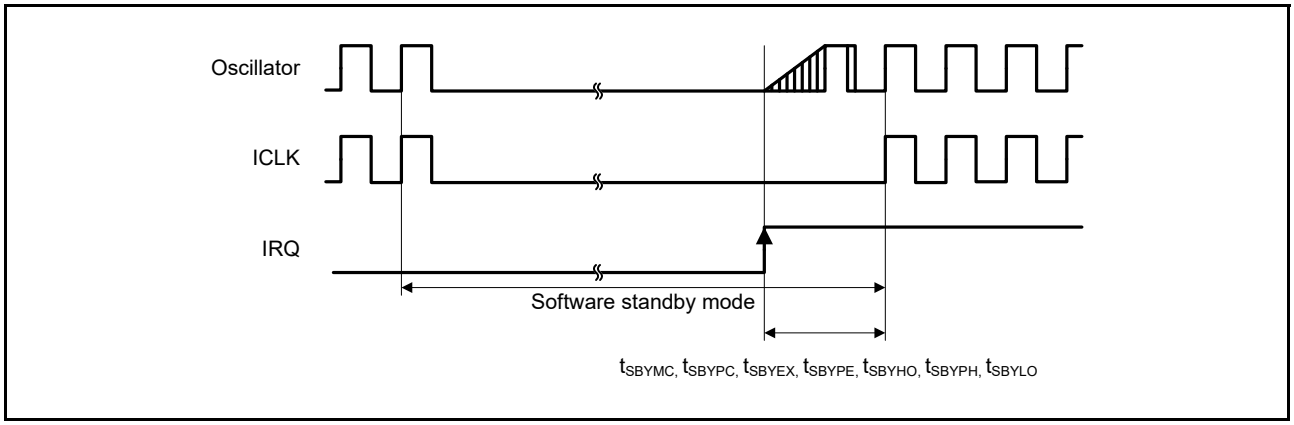


Figure 5.32 Software Standby Mode Recovery Timing

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

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V, T_a = –40 to +85°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 5.33
	Middle-speed mode*3	t_{DSLP}	—	3	4	µs	

Note 1. Oscillators continue oscillating in deep sleep mode.
Note 2. When the frequencies of ICLK, FCLK, PCLKA, PCLKB, and PCLKD are 32 MHz.
Note 3. When the frequencies of ICLK, FCLK, PCLKA, PCLKB, and PCLKD are 12 MHz.

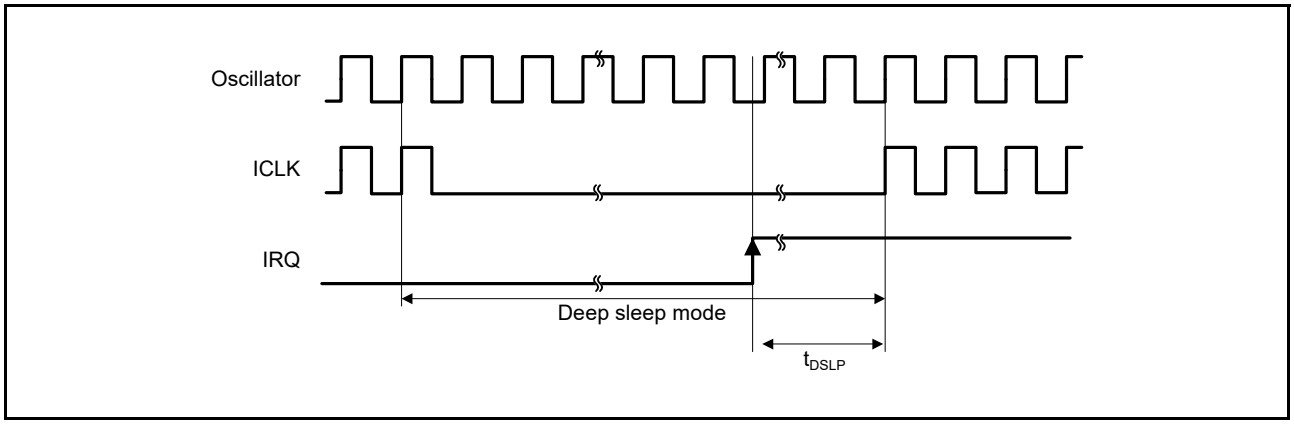


Figure 5.33 Deep Sleep Mode Recovery Timing

Table 5.21 Operating Mode Transition Time

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V, T_a = –40 to +85°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 PCLKA, PCLKB, PCLKD, and FCLK are not divided.

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

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V, T_a = –40 to +85°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 5.52
	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 5.52
	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.

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_{det0}, V_{det1}, and V_{det2} for the POR/LVD.

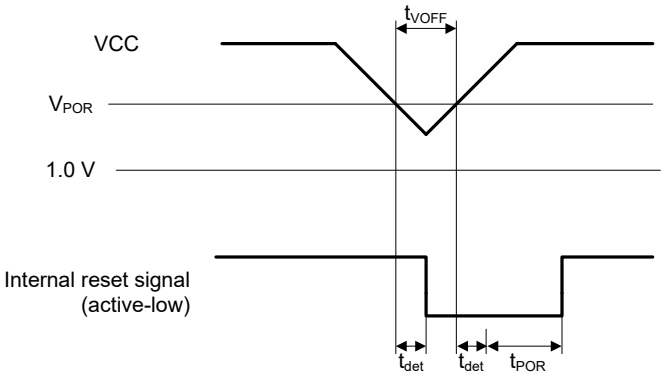
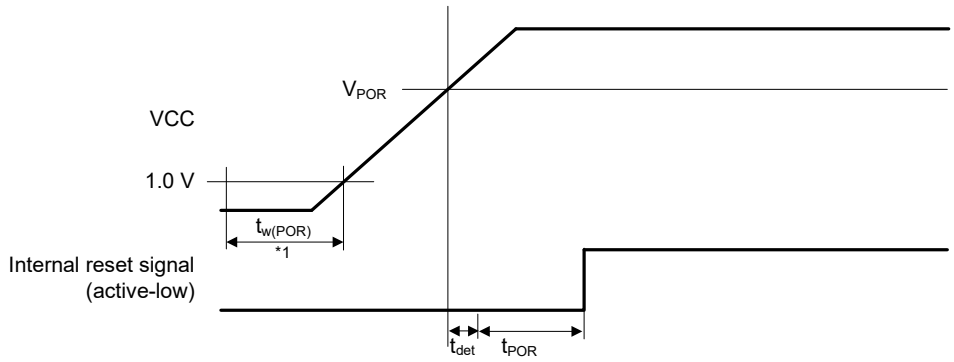


Figure 5.55 Voltage Detection Reset Timing



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 5.56 Power-On Reset Timing

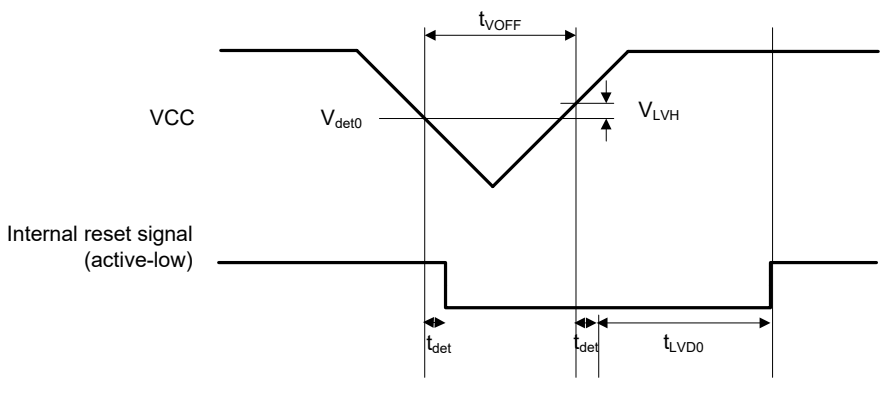


Figure 5.57 Voltage Detection Circuit Timing (Vdet0)

Table 5.41 ROM (Flash Memory for Code Storage) Characteristics (3): Middle-Speed Operating Mode

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V

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
	256-Kbyte (when block erase command used)	t_{E256K}	—	469.2	9816.9	—	100.5	2260.1	ms
	256-Kbyte (when all-block erase command used)	t_{EA256K}	—	464.0	9610.7	—	95.3	2053.7	ms
	512-Kbyte (when block erase command used)	t_{E512K}	—	928.0	19221.2	—	190.6	4107.3	ms
	512-Kbyte (when all-block erase command used)	t_{EA512K}	—	922.7	19015.0	—	185.4	3901.0	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%.

5.11 E2 DataFlash Characteristics

Table 5.42 E2 DataFlash Characteristics (1)

Item		Symbol	Min.	Typ.	Max.	Unit	Conditions
Reprogramming/erasure cycle*1		N_{DPEC}	100000	1000000	—	Times	
Data hold time	After 10000 times of N_{DPEC}	t_{DDRP}	20*2, *3	—	—	Year	T_a = +85°C
	After 100000 times of N_{DPEC}		5*2, *3	—	—	Year	
	After 1000000 times of N_{DPEC}		—	1*2, *3	—	Year	T_a = +25°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 = 100000), erasing can be performed n times for each block. For instance, when 1-byte programming is performed 1000 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 5.43 E2 DataFlash Characteristics (2): High-Speed Operating Mode

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V,
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	1-byte	t_{Dp1}	—	95.0	797.0	—	40.8	375.5	µs
Erasure time	1-Kbyte	t_{DE1K}	—	19.5	498.5	—	6.2	229.4	ms
	8-Kbyte	t_{DE8K}	—	119.8	2555.7	—	12.9	367.2	ms
Blank check time	1-byte	t_{DBC1}	—	—	55.0	—	—	16.1	µs
	1-Kbyte	t_{DBC1K}	—	—	7216.0	—	—	495.7	µs
Erase operation forcible stop time		t_{DSED}	—	—	16.0	—	—	10.7	µs
Data flash-module stop release time		t_{DSTOP}	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 5.44 E2 DataFlash Characteristics (3): Middle-Speed Operating Mode

Conditions: VCC = 2.7 V to 5.5 V, AVCC0 = AVCC1 = AVCC2 = VREF = VCC to 5.5 V, VSS = AVSS0 = AVSS1 = AVSS2 = 0 V,
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	1-byte	t_{Dp1}	—	135.0	1197.0	—	86.5	822.5	µs
Erasure time	1-Kbyte	t_{DE1K}	—	19.6	500.1	—	8.0	264.1	ms
	8-Kbyte	t_{DE8K}	—	119.9	2557.4	—	27.7	668.2	ms
Blank check time	1-byte	t_{DBC1}	—	—	85.0	—	—	50.9	µs
	1-Kbyte	t_{DBC1K}	—	—	7246.0	—	—	1457.5	µs
Erase operation forcible stop time		t_{DSED}	—	—	28.0	—	—	21.3	µs
Data flash-module stop release time		t_{DSTOP}	0.72	—	—	0.72	—	—	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%.

5.12 Usage Notes

5.12.1 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 5.61 to Figure 5.63 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 31, 12-Bit A/D Converter (S12ADF) 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.

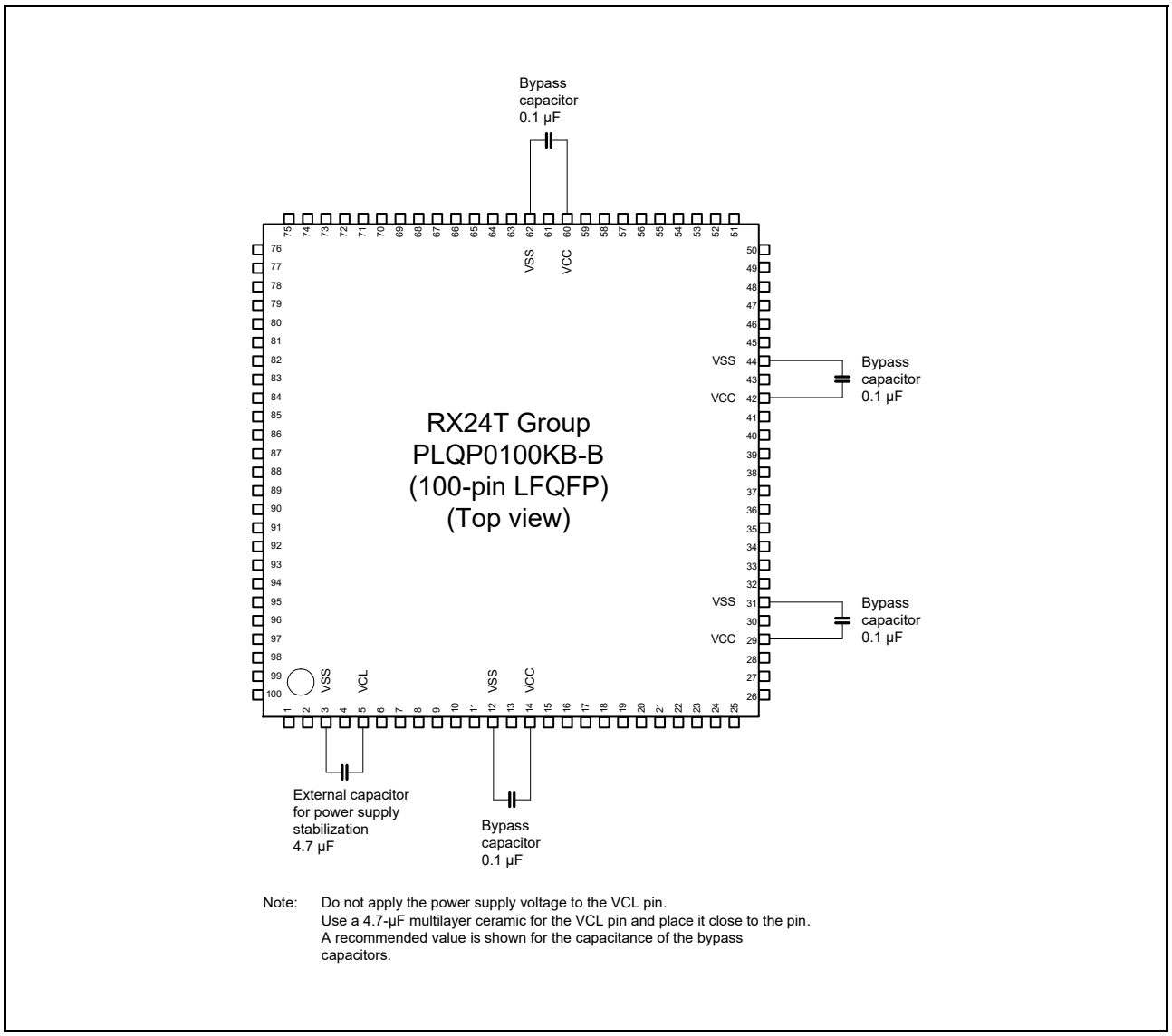


Figure 5.61 Connecting Capacitors (100 Pins)

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