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What is "Embedded - Microcontrollers"?

"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	Not For New Designs
Core Processor	RX
Core Size	32-Bit Single-Core
Speed	50MHz
Connectivity	EBI/EMI, I²C, SCI, SPI
Peripherals	DMA, LVD, POR, PWM, WDT
Number of I/O	122
Program Memory Size	512KB (512K x 8)
Program Memory Type	FLASH
EEPROM Size	8K x 8
RAM Size	64K x 8
Voltage - Supply (Vcc/Vdd)	1.62V ~ 5.5V
Data Converters	A/D 16x12b; D/A 2x10b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	144-LQFP
Supplier Device Package	144-LFQFP (20x20)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f52108bdfb-30

Table 1.1 Outline of Specifications (3 / 5)

Classification	Module/Function	Description
Timers	16-bit timer pulse unit (TPUa)	• (16 bits × 6 channels) × 1 unit • Maximum of 16 pulse-input/output possible • Select from among seven or eight counter-input clock signals for each channel • Supports the input capture/output compare function • Output of PWM waveforms in up to 15 phases in PWM mode • Support for buffered operation, phase-counting mode (two-phase encoder input) and cascade-connected operation (32 bits × 2 channels) depending on the channel. • Capable of generating conversion start triggers for the A/D converters • Signals from the input capture pins are input via a digital filter • Clock frequency measuring method (Products with 144 or more pins incorporate a TPU.)
	Multi-function timer pulse unit 2 (MTU2a)	• (16 bits × 6 channels) × 1 unit • Up to 16 pulse-input/output lines and three pulse-input lines are available with six 16-bit timer channels • Select from among eight or seven counter-input clock signals for each channel (PCLK/1, PCLK/4, PCLK/16, PCLK/64, PCLK/256, PCLK/1024, MTCLKA, MTCLKB, MTCLKC, MTCLKD) other than channel 5, for which only four signals are available. • Input capture function • 21 output compare/input capture registers • Pulse output mode • Complementary PWM output mode • Reset synchronous PWM mode • Phase-counting mode • Generation of triggers for A/D converter conversion
	Port output enable 2 (POE2a)	Controls the high-impedance state of the MTU's waveform output pins
	8-bit timer (TMR)	• (8 bits × 2 channels) × 2 units • Select from among seven internal clock signals (PCLK1, PCLK/2, PCLK/8, PCLK/32, PCLK/64, PCLK/1024, PCLK/8192) and one external clock signal • Capable of output of pulse trains with desired duty cycles or of PWM signals • The 2 channels of each unit can be cascaded to create a 16-bit timer • Capable of generating baud-rate clocks for SCI5, SCI6, and SCI12
	Compare match timer (CMT)	• (16 bits × 2 channels) × 2 units • Select from among four clock signals (PCLK/8, PCLK/32, PCLK/128, PCLK/512)
	Watchdog timer (WDTA)	• 14 bits × 1 channel • Select from among six counter-input clock signals (PCLK/4, PCLK/64, PCLK/128, PCLK/512, PCLK/2048, PCLK/8192)
	Independent watchdog timer (IWDTa)	• 14 bits × 1 channel • Counter-input clock: IWDT-dedicated on-chip oscillator Frequency divided by 1, 16, 32, 64, 128, or 256
	Realtime clock (RTCb)	• Clock source: Sub-clock • Time/calendar • Interrupt sources: Alarm interrupt, periodic interrupt, and carry interrupt • Time-capture facility for three values

Table 1.9 List of Pins and Pin Functions (145-Pin TFLGA) (3 / 4)

Pin No.	Power Supply, Clock, System Control	I/O Port	External Bus	Timers (MTU, TMR, POE)	Communications (SCIc, SCId, RSPI, RIIC)	Others
J12		PB2	A10	TIOCC3/TCLKC	CTS4#/RTS4#/SS4#/ CTS6#/RTS6#/SS6#	
J13		PB1	A9	MTIOC0C/MTIOC4C/ TMCI0/TIOCB3	TXD4/SMOSI4/SSDA4/ TXD6/SMOSI6/SSDA6	IRQ4-DS
K1		P27	CS3#	MTIOC2B/TMCI3	SCK1	
K2		P26	CS2#	MTIOC2A/TMO1	TXD1/SMOSI1/SSDA1/ CTS3#/RTS3#/SS3#	
K3		P31		MTIOC4D/TMCI2	CTS1#/RTS1#/SS1#	IRQ1-DS/RTCIC1
K4		P15		MTIOC0B/MTCLKB/ TMCI2/TIOCB2/TCLKB	RXD1/SMISO1/SSCL1/ SCK3	IRQ5
K5		P54	ALE	MTIOC4B/TMCI1	CTS2#/RTS2#/SS2#	
K6	BCLK	P53				
K7		P51	WR1#/BC1#/WAIT#		SCK2	
K8	VCC					
K9		P80		MTIOC3B	SCK10	
K10		P76			RXD11/SMISO11/SSCL11	
K11		PB7	A15	MTIOC3B/TIOCB5	TXD9/SMOSI9/SSDA9	
K12		PB6	A14	MTIOC3D/TIOCA5	RXD9/SMISO9/SSCL9	
K13		PB5	A13	MTIOC2A/MTIOC1B/ TMRI1/POE1#/TIOCB4	SCK9	
L1		P25	CS1#	MTIOC4C/MTCLKB/ TIOCA4	RXD3/SMISO3/SSCL3	ADTRG0#
L2		P23		MTIOC3D/MTCLKD/ TIOCD3	CTS0#/RTS0#/SS0#/ TXD3/SMOSI3/SSDA3	
L3		P16		MTIOC3C/MTIOC3D/ TMO2/TIOCB1/TCLKC	TXD1/SMOSI1/SSDA1/ MOSIA/SCL-DS/RXD3/ SMISO3/SSCL3	IRQ6/RTCOUT/ ADTRG0#
L4		P24	CS0#	MTIOC4A/MTCLKA/ TMRI1/TIOCB4	SCK3	
L5		P13		MTIOC0B/TMO3/ TIOCA5	SDA/TXD2/SMOSI2/ SSDA2	IRQ3
L6		P56		MTIOC3C/TIOCA1		
L7		P52	RD#		RXD2/SMISO2/SSCL2	
L8		P83		MTIOC4C	CTS10#/RTS10#	
L9		PC5	A21/CS2#/WAIT#	MTIOC3B/MTCLKD/ TMRI2	SCK8/RSPCKA	
L10		PC4	A20/CS3#	MTIOC3D/MTCLKC/ TMCI1/POE0#	SCK5/CTS8#/RTS8#/ SS8#/SSLA0	
L11		PC2	A18	MTIOC4B/TCLKA	RXD5/SMISO5/SSCL5/ SSLA3	
L12		P73				
L13		PL0				
M1		P22		MTIOC3B/MTCLKC/ TMO0/TIOCC3	SCK0	
M2		P17		MTIOC3A/MTIOC3B/ TMO1/POE8#/TIOCB0/ TCLKD	SCK1/MISOA/SDA-DS/ TXD3/SMOSI3/SSDA3	IRQ7
M3		P86		TIOCA0		
M4		P12		TMCI1	SCL/RXD2/SMISO2/ SSCL2	IRQ2
M5		PH3		TMCI0		
M6		PH0				CACREF
M7		P50	WR0#/WR#		TXD2/SMOSI2/SSDA2	
M8		PC6	A22/CS1#	MTIOC3C/MTCLKA/ TMCI2	RXD8/SMISO8/SSCL8/ MOSIA	
M9		P81		MTIOC3D	RXD10/SMISO10/SSCL10	
M10		P77			TXD11/SMOSI11/SSDA11	

Table 1.14 List of Pins and Pin Functions (69-Pin WLBGA) (1 / 2)

Pin No.	Power Supply, Clock, System Control	I/O Port	Timers (MTU, TMR, POE)	Communications (SCIc, SCId, RSPI, RIIC)	Others
A1	NC				
A2		PE2	MTIOC4A	RXD12/RXDX12/SMISO12/ SSCL12	IRQ7-DS/AN010/ CVREFB0
A3	VREFL				
A4	VREFH				
A5		P43			AN003
A6	VREFL0				
A7	AVCC0				
A8	AVSS0				
A9	AVSS0				
B1		PE5	MTIOC4C/MTIOC2B		IRQ5/AN013
B2		PE4	MTIOC4D/MTIOC1A		AN012/CMPA2
B3		PE3	MTIOC4B/POE8#	CTS12#/RTS12#/SS12#	AN011/CMPA1
B4		P46			AN006
B5		P44			AN004
B6		P41			AN001
B7	VREFH0				
B8		P05			DA1
B9	VCL				
C1		PA3	MTIOC0D/MTCLKD	RXD5/SMISO5/SSCL5	IRQ6-DS/CMPB1
C2		PA4	MTIC5U/MTCLKA/TMRI0	TXD5/SMOSI5/SSDA5/SSLA0	IRQ5-DS/CVREFB1
C3		PA0	MTIOC4A	SSLA1	CACREF
C4		PE1	MTIOC4C	TXD12/TXDX12/SIOX12/ SMOSI12/SSDA12	AN009/CMPB0
C5		PE0		SCK12	AN008
C6		P42			AN002
C7		P40			AN000
C8		P03			DA0
C9	XCIN				
D1		PA6	MTIC5V/MTCLKB/TMCI3/ POE2#	CTS5#/RTS5#/SS5#/MOSIA	
D2		PB0	MTIC5W	RXD6/SMISO6/SSCL6/ RSPCKA	
D3		PA1	MTIOC0B/MTCLKC	SCK5/SSLA2	CVREFA
D7	MD				FINED
D8	RES#				
D9	XCOUT				
E1	VSS				
E2		PB1	MTIOC0C/MTIOC4C/TMCI0	TXD6/SMOSI6/SSDA6	IRQ4-DS
E8	XTAL	P37			
E9	VSS				
F1	VCC				
F2		PB3	MTIOC0A/MTIOC4A/TMO0/ POE3#	SCK6	
F7		P31	MTIOC4D/TMCI2	CTS1#/RTS1#/SS1#	IRQ1-DS/RTCIC1
F8	EXTAL	P36			
F9	VCC				
G1		PB5	MTIOC2A/MTIOC1B/TMRI1/ POE1#	SCK9	
G2		PB6	MTIOC3D	RXD9/SMISO9/SSCL9	

- 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

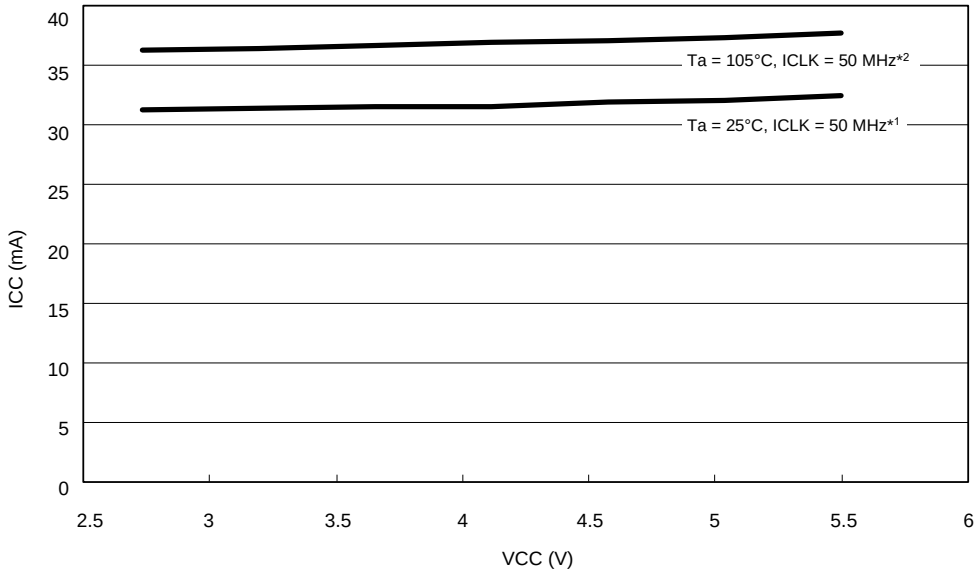
Number of access cycles to I/O registers = Number of bus cycles for internal main bus 1 +
Number of divided clock synchronization cycles +
Number of bus cycles for internal peripheral bus 1 to 6

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 or registers for the external bus control unit (except for bus error related registers) are accessed, the number of divided clock synchronization cycles is added.
The number of divided clock synchronization cycles differs depending on the frequency ratio between ICLK and PCLK (or FCLK, BCLK) or bus access timing.
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.
When the frequency ratio of ICLK is lower than that of PCLK (or FCLK), the subsequent bus access is started from the ICLK cycle following the completion of the access to the peripheral functions. Therefore, the access cycles are described on an ICLK basis.
In the external bus control unit, the sum of the number of bus cycles for internal main bus 1 and the number of divided clock synchronization cycles will be one cycle of BCLK at a maximum. Therefore, one BCLK is 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 instruction fetching to the external memory or bus access from the different bus master (DMAC or DTC).

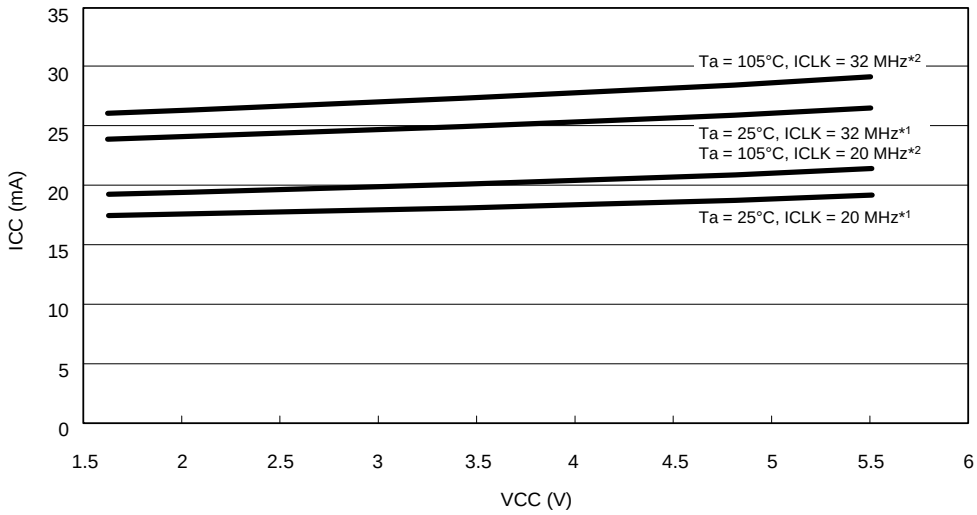
Table 4.1 List of I/O Registers (Address Order) (3 / 29)

Address	Module Symbol	Register Name	Register Symbol	Number of Bits	Access Size	Number of Access Cycles ICLK ≥ PCLK	Number of Access Cycles ICLK < PCLK
0008 3032h	BSC	CS3 mode register	CS3MOD	16	16	1, 2 BCLK	
0008 3034h	BSC	CS3 wait control register 1	CS3WCR1	32	32	1, 2 BCLK	
0008 3038h	BSC	CS3 wait control register 2	CS3WCR2	32	32	1, 2 BCLK	
0008 3802h	BSC	CS0 control register	CS0CR	16	16	1, 2 BCLK	
0008 380Ah	BSC	CS0 recovery cycle register	CS0REC	16	16	1, 2 BCLK	
0008 3812h	BSC	CS1 control register	CS1CR	16	16	1, 2 BCLK	
0008 381Ah	BSC	CS1 recovery cycle register	CS1REC	16	16	1, 2 BCLK	
0008 3822h	BSC	CS2 control register	CS2CR	16	16	1, 2 BCLK	
0008 382Ah	BSC	CS2 recovery cycle register	CS2REC	16	16	1, 2 BCLK	
0008 3832h	BSC	CS3 control register	CS3CR	16	16	1, 2 BCLK	
0008 383Ah	BSC	CS3 recovery cycle register	CS3REC	16	16	1, 2 BCLK	
0008 3880h	BSC	CS recovery cycle insertion enable register	CSRECEN	16	16	1, 2 BCLK	
0008 7010h	ICU	Interrupt request register 016	IR016	8	8	2 ICLK	
0008 7015h	ICU	Interrupt request register 021	IR021	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 703Ah	ICU	Interrupt request register 058	IR058	8	8	2 ICLK	
0008 703Bh	ICU	Interrupt request register 059	IR059	8	8	2 ICLK	
0008 703Fh	ICU	Interrupt request register 063	IR063	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 7046h	ICU	Interrupt request register 070	IR070	8	8	2 ICLK	
0008 7047h	ICU	Interrupt request register 071	IR071	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 705Ch	ICU	Interrupt request register 092	IR092	8	8	2 ICLK	
0008 705Dh	ICU	Interrupt request register 093	IR093	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 706Ah	ICU	Interrupt request register 106	IR106	8	8	2 ICLK	
0008 706Bh	ICU	Interrupt request register 107	IR107	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	



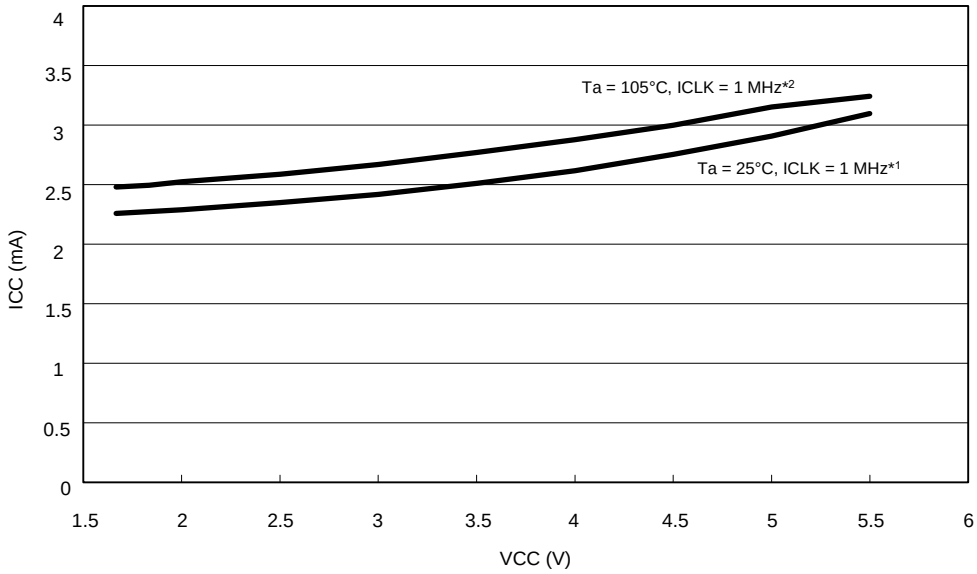
Note 1. All peripheral operation is normal. This does not include BGO operation.
Average value of the tested middle samples during product evaluation.
Note 2. All peripheral operation is maximum. This does not include BGO operation.
Average value of the tested upper-limit samples during product evaluation.

Figure 5.1 Voltage Dependency in High-Speed Operating Mode (Reference Data) for Chip Version A



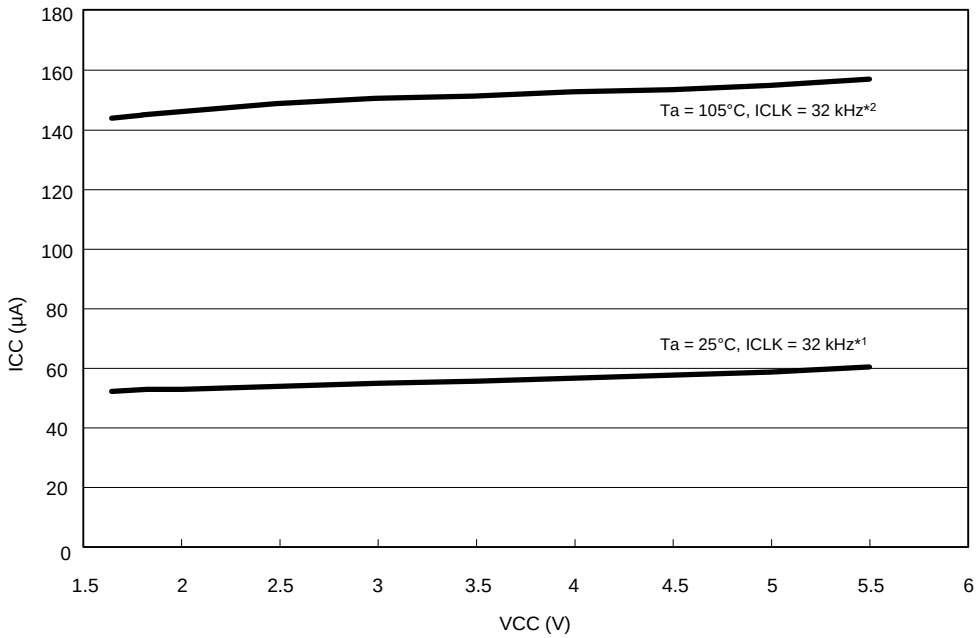
Note 1. All peripheral operation is normal. This does not include BGO operation.
Average value of the tested middle samples during product evaluation.
Note 2. All peripheral operation is maximum. This does not include BGO operation.
Average value of the tested upper-limit samples during product evaluation.

Figure 5.2 Voltage Dependency in Middle-Speed Operating Modes 1A and 1B (Reference Data) for Chip Version A



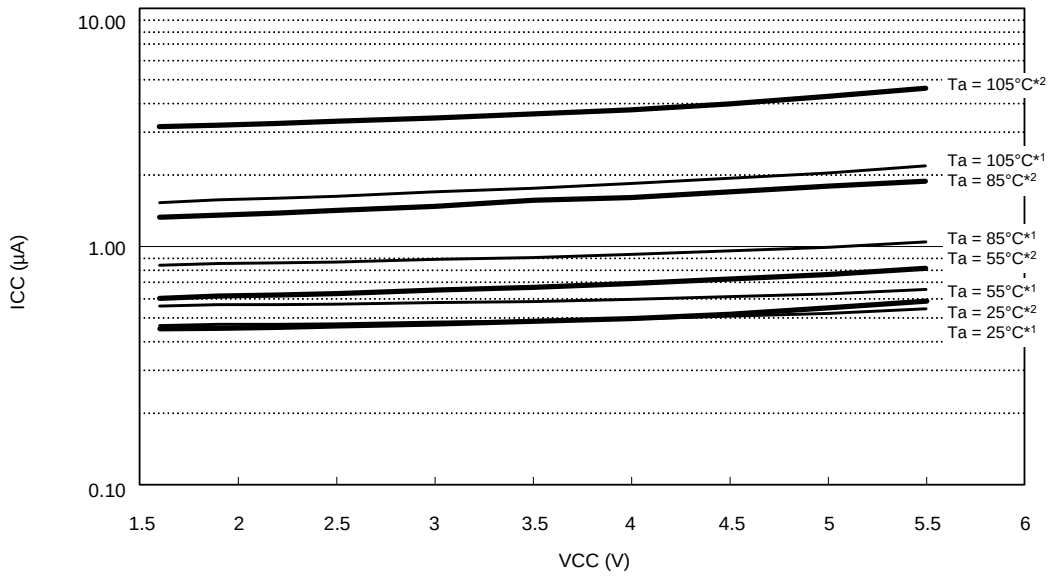
Note 1. All peripheral operation is normal.
Average value of the tested middle samples during product evaluation.
Note 2. All peripheral operation is maximum.
Average value of the tested upper-limit samples during product evaluation.

Figure 5.3 Voltage Dependency in Low-Speed Operating Mode 1 (Reference Data) for Chip Version A



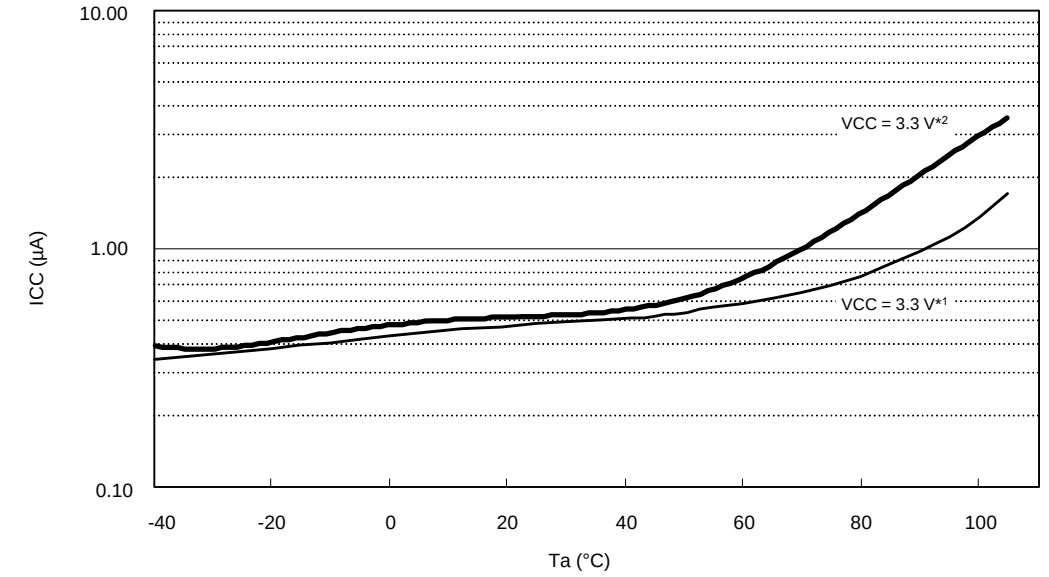
Note 1. All peripheral operation is normal.
Average value of the tested middle samples during product evaluation.
Note 2. All peripheral operation is maximum.
Average value of the tested upper-limit samples during product evaluation.

Figure 5.4 Voltage Dependency in Low-Speed Operating Mode 2 (Reference Data) for Chip Version A



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 5.15 Voltage Dependency in Deep Software Standby Mode (DEEPCUT1 Bit = 1) (Reference Data) for Chip Version C



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.

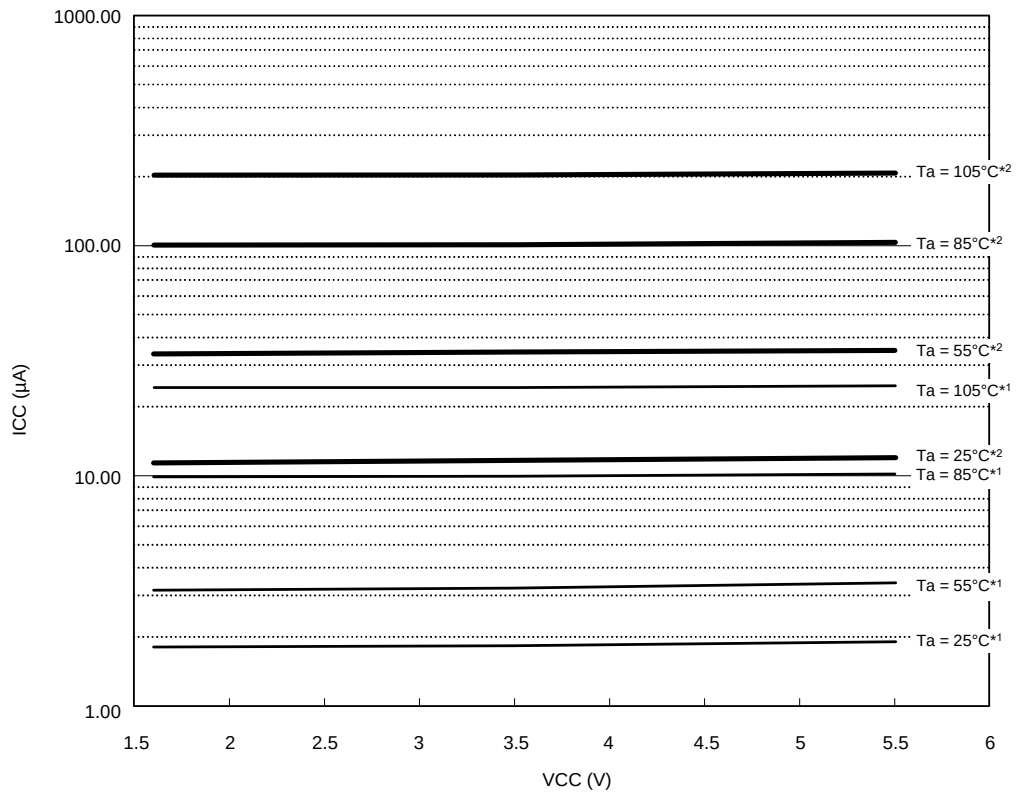
Figure 5.16 Temperature Dependency in Deep Software Standby Mode (DEEPCUT1 Bit = 1) (Reference Data) for Chip Version C

[Chip version B with 256 Kbytes or less of flash memory and 48 to 100 pins]

Table 5.13 DC Characteristics (12)

Conditions: VCC = AVCC0 = 1.62 to 5.5 V, VSS = AVSS0 = VREFL = VREFL0 = 0 V, T_a = –40 to +105°C

Item					Symbol	Typ.	Max.	Unit	Test Conditions
Supply current*1	Middle-speed operating modes 1A and 1B	Normal operating mode	No peripheral operation	ICLK = 32 MHz*2	I_{CC}	5.3	—	mA	
				ICLK = 20 MHz*3		4.6	—		
			All peripheral operation: Normal	ICLK = 32 MHz*4		20.1	—		
				ICLK = 20 MHz*5		14.3	—		
			All peripheral operation: Max.	ICLK = 32 MHz*4		—	35		
				ICLK = 20 MHz*5		—	—		
		Sleep mode	No peripheral operation	ICLK = 32 MHz		3.4	—		
				ICLK = 20 MHz		3.3	—		
			All peripheral operation: Normal	ICLK = 32 MHz		11.5	—		
				ICLK = 20 MHz		9	—		
		All-module clock stop mode		ICLK = 32 MHz		3	—		
				ICLK = 20 MHz		3	—		
		Increase during BGO operation*6	Middle-speed operating mode 1A			17	—		
			Middle-speed operating mode 1B			17	—		
	Middle-speed operating modes 2A and 2B	Normal operating mode	No peripheral operation*2	ICLK = 32 MHz		4.7	—		
				ICLK = 16 MHz		3.4	—		
				ICLK = 8 MHz		2.7	—		
			All peripheral operation: Normal*4	ICLK = 32 MHz		19.6	—		
				ICLK =16 MHz		11.3	—		
				ICLK = 8 MHz		7.2	—		
			All peripheral operation: Max.*4	ICLK = 32 MHz		—	34		
				ICLK = 16 MHz		—	—		
				ICLK = 8 MHz		—	—		
		Sleep mode	No peripheral operation	ICLK = 32 MHz		2.8	—		
				ICLK = 16 MHz		2.5	—		
				ICLK = 8 MHz		2.2	—		
			All peripheral operation: Normal	ICLK = 32 MHz		11	—		
				ICLK = 16 MHz		7.2	—		
				ICLK = 8 MHz		5.3	—		
		All-module clock stop mode		ICLK = 32 MHz		2.4	—		
				ICLK = 16 MHz		2.2	—		
				ICLK = 8 MHz		2.1	—		
		Increase during BGO operation*6	Middle-speed operating mode 1A			17	—		
			Middle-speed operating mode 1B			17	—		



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 5.31 Voltage Dependency in Software Standby Mode (SOFTCUT[2:0] Bits = 110b) (Reference Data) for Chip Version B with 768 Kbytes/1 Mbyte of Flash Memory and 100 to 145 Pins

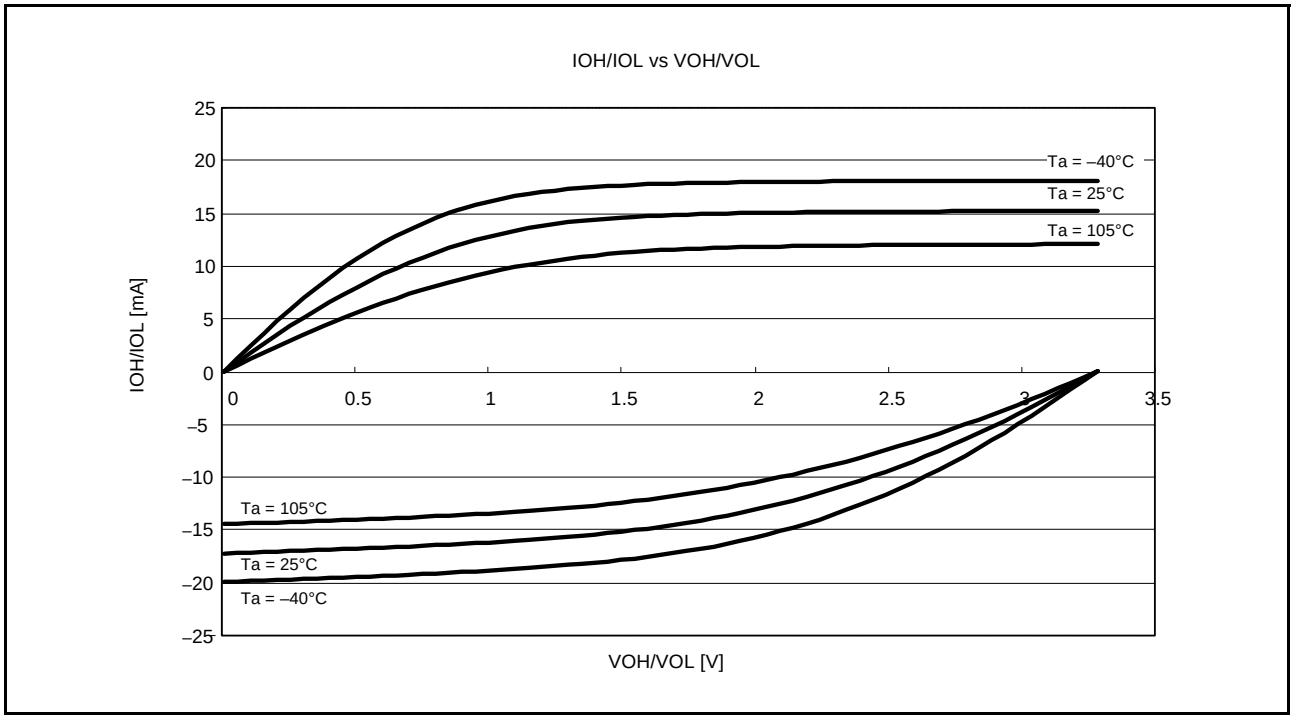


Figure 5.48 VOH/VOL and IOH/IOL Temperature Characteristics at VCC = 3.3 V when Normal Output is Selected (Reference Data)

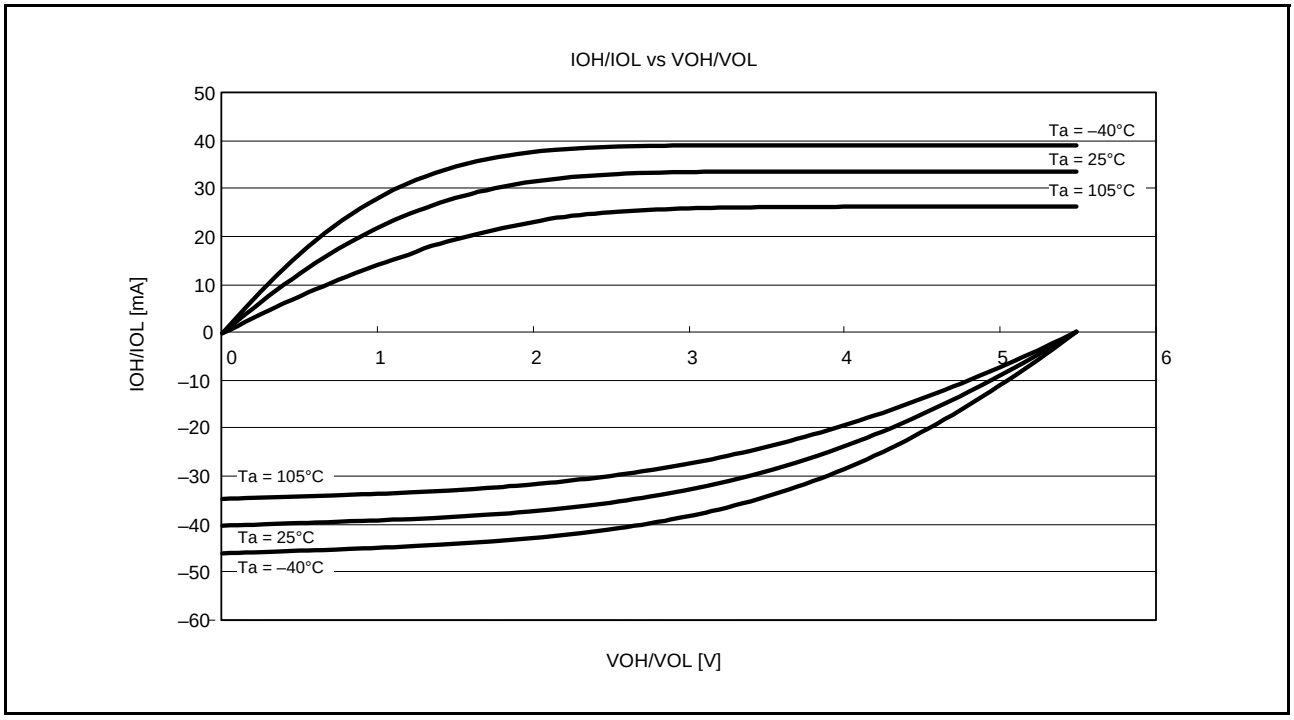


Figure 5.49 VOH/VOL and IOH/IOL Temperature Characteristics at VCC = 5.5 V when Normal Output is Selected (Reference Data)

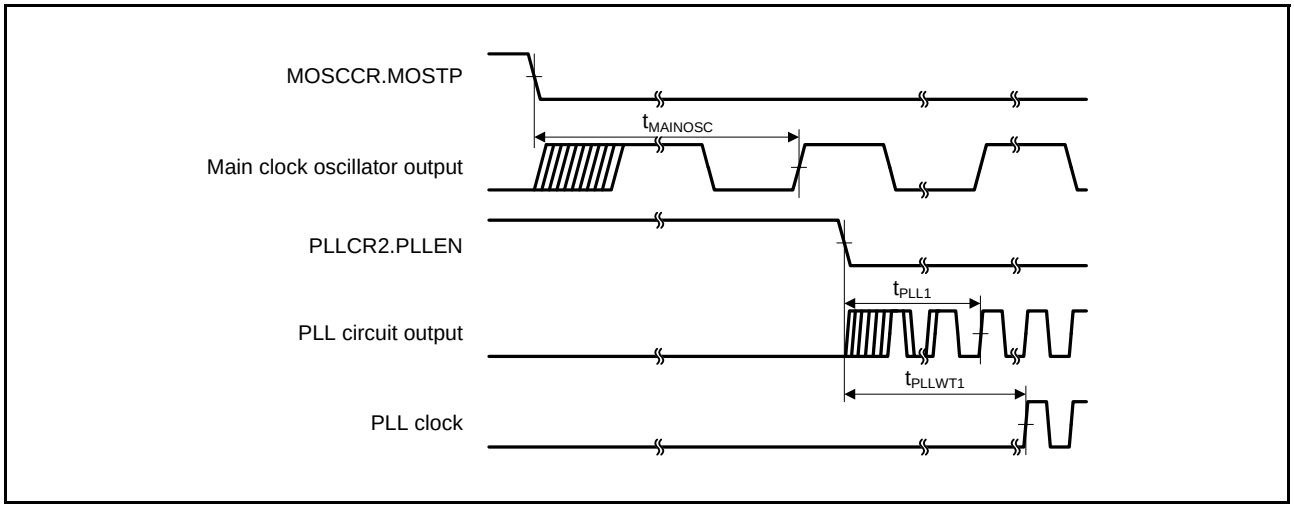


Figure 5.66 PLL Clock Oscillation Start Timing (PLL is Operated after Main Clock Oscillation Has Settled)

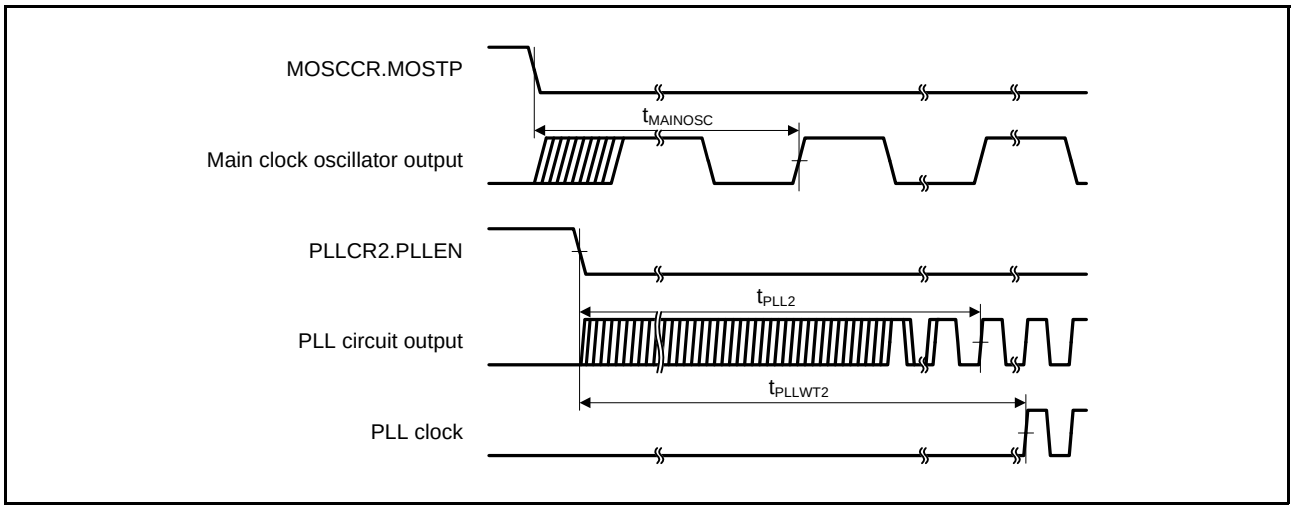


Figure 5.67 PLL Clock Oscillation Start Timing (PLL is Operated before Main Clock Oscillation Has Settled)

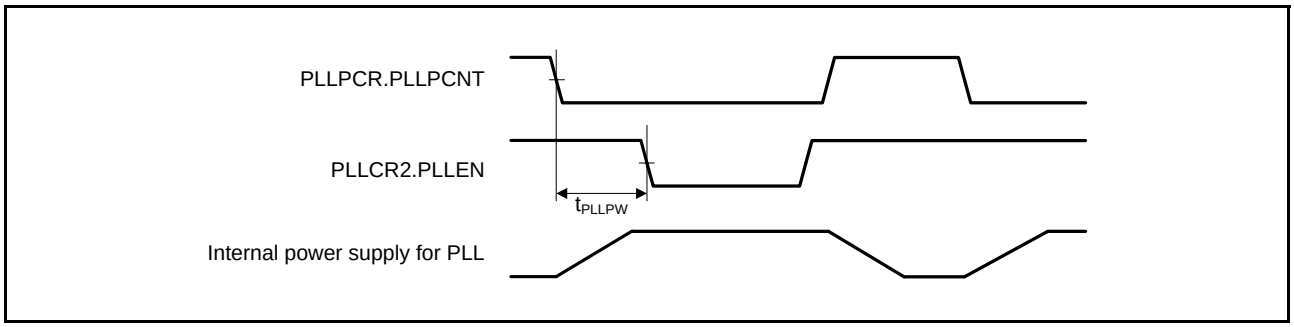


Figure 5.68 PLL Power Control Timing

5.3.3 Timing of Recovery from Low Power Consumption Modes

[Chip versions A and C]

Table 5.46 Timing of Recovery from Low Power Consumption Modes

Conditions: VCC = AVCC0 = 1.62 to 5.5 V, VSS = AVSS0 = VREFL = VREFL0 = 0 V, T_a = –40 to +105°C

Item			Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Recovery time after cancellation of software standby mode (flash memory, HOCO power supplied) (SOFTCUT[2:0] bits = 000b)*1	Crystal resonator connected to main clock oscillator*2	Main clock oscillator operating	t_{SBYMC}	—	3	—	ms	Figure 5.72
		Main clock oscillator and PLL circuit operating	t_{SBYPC}	—	3.5	—	ms	
	External clock input to main clock oscillator	Main clock oscillator operating	t_{SBYEX}	10	—	—	µs	
		Main clock oscillator and PLL circuit operating	t_{SBYPE}	0.5	—	—	ms	
	Sub-clock oscillator operating		t_{SBYSC}	2*3	—	—	s	
	HOCO clock oscillator operating		t_{SBYHO}	—	—	500	µs	
	LOCO clock oscillator operating		t_{SBYLO}	—	—	90	µs	
Recovery time after cancellation of software standby mode (flash memory power supplied, HOCO power not supplied) (SOFTCUT[2:0] bits = 110b)*1	Crystal resonator connected to main clock oscillator*2	Main clock oscillator operating	t_{SBYMC}	—	3	—	ms	Figure 5.72
		Main clock oscillator and PLL circuit operating	t_{SBYPC}	—	3.5	—	ms	
	External clock input to main clock oscillator	Main clock oscillator operating	t_{SBYEX}	40	—	—	µs	
		Main clock oscillator and PLL circuit operating	t_{SBYPE}	0.5	—	—	ms	
	Sub-clock oscillator operating		t_{SBYSC}	2*3	—	—	s	
	HOCO clock oscillator operating		t_{SBYHO}	—	—	1.2	ms	
	LOCO clock oscillator operating		t_{SBYLO}	—	—	90	µs	
Recovery time after cancellation of software standby mode (flash memory, HOCO power not supplied) (SOFTCUT[2:0] bits = 111b)*1	Crystal resonator connected to main clock oscillator*2	Main clock oscillator operating	t_{SBYMC}	—	3	—	ms	Figure 5.72
		Main clock oscillator and PLL circuit operating	t_{SBYPC}	—	3.5	—	ms	
	External clock input to main clock oscillator	Main clock oscillator operating	t_{SBYEX}	100	—	—	µs	
		Main clock oscillator and PLL circuit operating	t_{SBYPE}	0.5	—	—	ms	
	Sub-clock oscillator operating		t_{SBYSC}	2*4	—	—	s	
	HOCO clock oscillator operating		t_{SBYHO}	—	—	1.2	ms	
	LOCO clock oscillator operating		t_{SBYLO}	—	—	10	ms	
Recovery time after cancellation of deep software standby mode			t_{DSBY}	—	—	8	ms	Figure 5.73
Wait time after cancellation of deep software standby mode			t_{DSBYWT}	—	—	0.8	ms	

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, and depends on the time set in the wait control registers corresponding to the oscillators.
Note 2. The indicated value is measured for an 8 MHz crystal resonator.
Note 3. When RCR3.RTCEN = 1, the time will be the time set in the SOSCWTCR register minus 2 s.
Note 4. When RCR3.RTCEN = 1, the time will be the time set in the SOSCWTCR register minus 2 s and plus 31.25 ms.

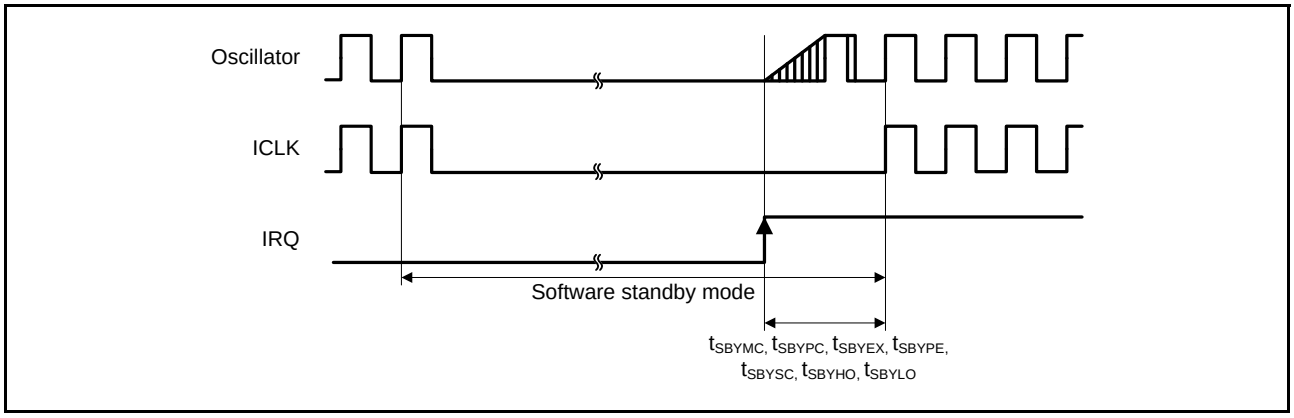


Figure 5.72 Software Standby Mode Cancellation Timing

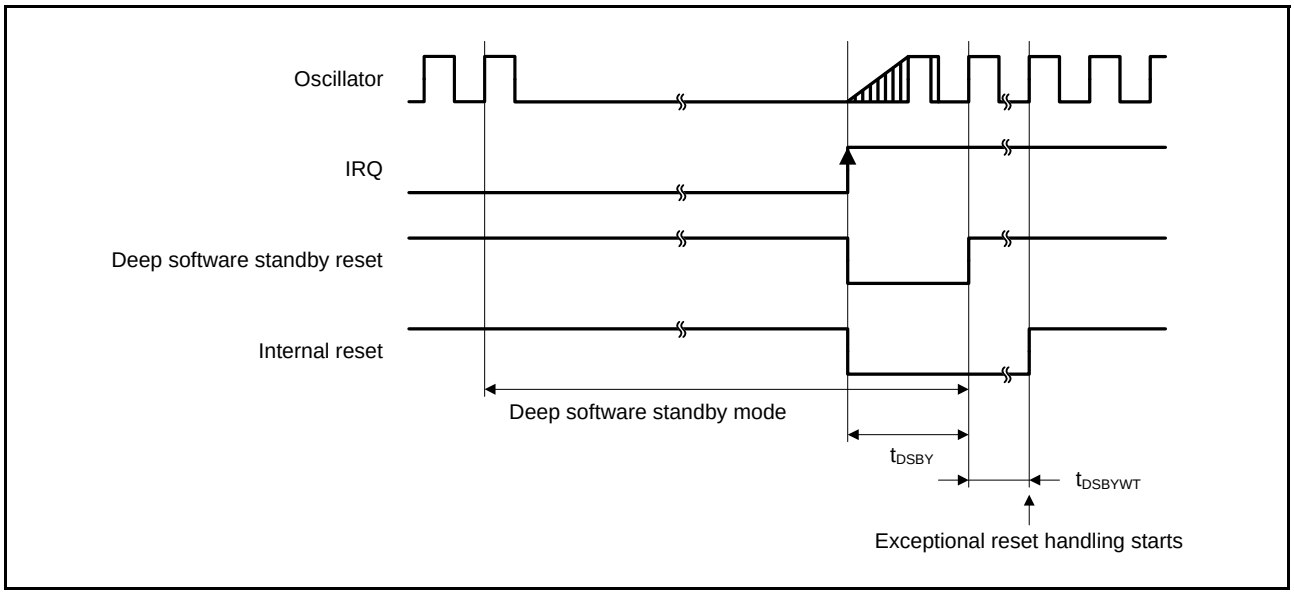


Figure 5.73 Deep Software Standby Mode Cancellation Timing

5.3.6 Timing of On-Chip Peripheral Modules

Table 5.55 Timing of On-Chip Peripheral Modules (1)

Conditions: VCC = AVCC0 = 1.62 to 5.5 V, VSS = AVSS0 = VREFL = VREFL0 = 0 V, T_a = –40 to +105°C
When high-drive output is selected by the drive capacity register

Item				Symbol	Min.	Max.	Unit	Test Conditions
I/O ports	Input data pulse width			t_{PRW}	1.5	—	t_{Pcyc}	Figure 5.83
MTU/ TPU	Input capture input pulse width		Single-edge setting	t_{TICW}	1.5	—	t_{Pcyc}	Figure 5.84
			Both-edge setting		2.5	—		
	Timer clock pulse width		Single-edge setting	t_{TCKWH}, t_{TCKWL}	1.5	—	t_{Pcyc}	Figure 5.85
			Both-edge setting		2.5	—		
			Phase counting mode		2.5	—		
POE	POE# input pulse width			t_{POEW}	1.5	—	t_{Pcyc}	Figure 5.86
8-bit timer	Timer clock pulse width		Single-edge setting	t_{TMCWH}, t_{TMCWL}	1.5	—	t_{Pcyc}	Figure 5.87
			Both-edge setting		2.5	—		
SCI	Input clock cycle		Asynchronous	t_{Scyc}	4	—	t_{Pcyc}	Figure 5.88
			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}	C = 30 pF Figure 5.89
			Clock synchronous		4	—		
	Output clock pulse width		2.7 V ≤ VCC ≤ 5.5 V	t_{SCKW}	0.4	0.6	t_{Scyc}	
			1.8 V ≤ VCC < 2.7 V		0.35	0.65		
			1.62 V ≤ VCC < 1.8 V		0.35	0.65		
	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	2.7 V ≤ VCC ≤ 5.5 V		—	65	ns	
			1.8 V ≤ VCC < 2.7 V		—	85	ns	
			1.62 V ≤ VCC < 1.8 V		—	95	ns	
	Receive data setup time (master)	Clock synchronous	2.7 V ≤ VCC ≤ 5.5 V	t_{RXS}	65	—	ns	
			1.8 V ≤ VCC < 2.7 V		75	—	ns	
			1.62 V ≤ VCC < 1.8 V		80	—	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 5.90
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
Note 2. t_{cac}: CAC count clock source cycle

[512 Kbytes or less of flash memory and 48 to 100 pins]

Table 5.56 Timing of On-Chip Peripheral Modules (2)

Conditions: VCC = AVCC0 = 1.62 to 5.5 V, VSS = AVSS0 = VREFL = VREFL0 = 0 V, T_a = –40 to +105°C
When high-drive output is selected by the drive capacity register

Item				Symbol	Min.	Max.	Unit*1	Test Conditions
RSPI	RSPCK clock cycle	Master		t_{SPcyc}	2	4096	t_{Pcyc}	C = 30 pF Figure 5.91
					125	—	ns	
		Slave			8	4096	t_{Pcyc}	
	RSPCK clock high pulse width	Master	2.7 V ≤ VCC ≤ 5.5 V	t_{SPCKWH}	$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2 - 3$	—	ns	
			1.8 V ≤ VCC < 2.7 V		$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2 - 3$	—		
			1.62 V ≤ VCC < 1.8 V		$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2 - 10$	—		
		Slave			$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2$	—		
	RSPCK clock low pulse width	Master	2.7 V ≤ VCC ≤ 5.5 V	t_{SPCKWL}	$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2 - 3$	—	ns	
			1.8 V ≤ VCC < 2.7 V		$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2 - 3$	—		
			1.62 V ≤ VCC < 1.8 V		$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2 - 10$	—		
		Slave			$(t_{SPcyc} - t_{SPCKr} - t_{SPCKf})/2$	—		
	RSPCK clock rise/fall time	Output	2.7 V ≤ VCC ≤ 5.5 V	t_{SPCKr}, t_{SPCKf}	—	10	ns	
			1.8 V ≤ VCC < 2.7 V		—	15		
			1.62 V ≤ VCC < 1.8 V		—	20		
		Input			—	1	µs	
	Data input setup time	Master	2.7 V ≤ VCC ≤ 5.5 V	t_{SU}	50	—	ns	C = 30 pF Figure 5.92 to Figure 5.97
			1.8 V ≤ VCC < 2.7 V		65	—		
			1.62 V ≤ VCC < 1.8 V		75	—		
		Slave			$25 - t_{Pcyc}$	—		
	Data input hold time	Master		t_H	t_{Pcyc}	—	ns	
		Slave			$20 + 2 \times t_{Pcyc}$	—		
	SSL setup time	Master		t_{LEAD}	1	8	t_{SPcyc}	
		Slave			4	—	t_{Pcyc}	
	SSL hold time	Master		t_{LAG}	1	8	t_{SPcyc}	
		Slave			4	—	t_{Pcyc}	
	Data output delay time	Master	2.7 V ≤ VCC ≤ 5.5 V	t_{OD}	—	50	ns	
			1.8 V ≤ VCC < 2.7 V		—	55		
			1.62 V ≤ VCC < 1.8 V		—	60		
		Slave	2.7 V ≤ VCC ≤ 5.5 V		—	$3 \times t_{Pcyc} + 65$		
			1.8 V ≤ VCC < 2.7 V		—	$3 \times t_{Pcyc} + 85$		
			1.62 V ≤ VCC < 1.8 V		—	$3 \times t_{Pcyc} + 95$		
	Data output hold time	Master		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			$4 \times t_{Pcyc}$	—		

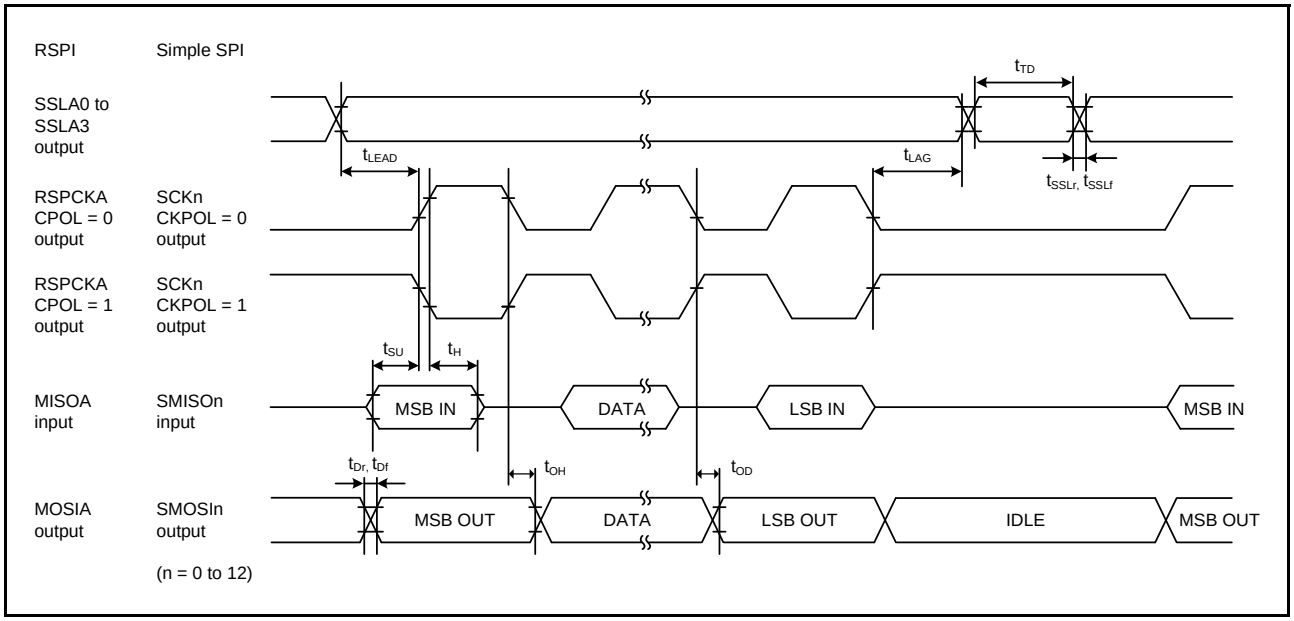


Figure 5.92 RSPI Timing (Master, CPHA = 0) (Bit Rate: PCLKB Set to Division Ratio Other Than Divided by 2) and Simple SPI Timing (Master, CKPH = 1)

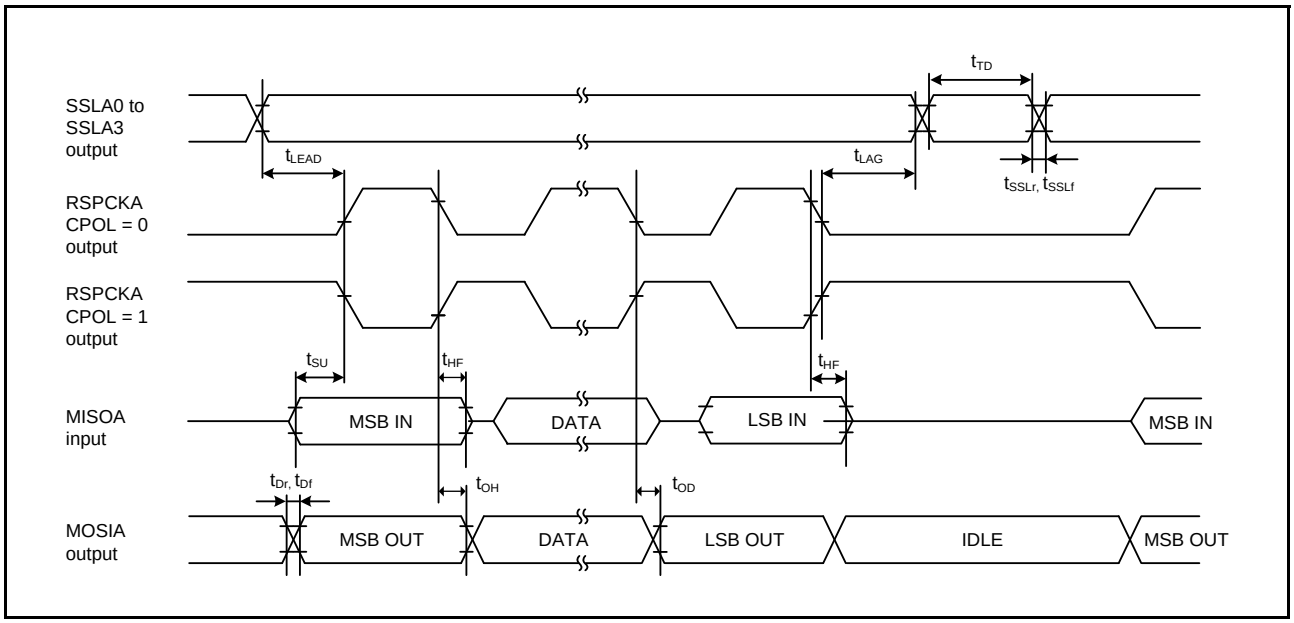


Figure 5.93 RSPI Timing (Master, CPHA = 0) (Bit Rate: PCLKB Set to Divided by 2)

5.9 Oscillation Stop Detection Timing

Table 5.73 Oscillation Stop Detection Circuit Characteristics

Conditions: VCC = AVCC0 = 1.62 to 5.5 V, VSS = AVSS0 = VREFL = VREFL0 = 0 V, T_a = –40 to +105°C

Item	Symbol	Min.	Typ.	Max.	Unit	Test Conditions
Detection time	t_{dr}	—	—	1	ms	Figure 5.108

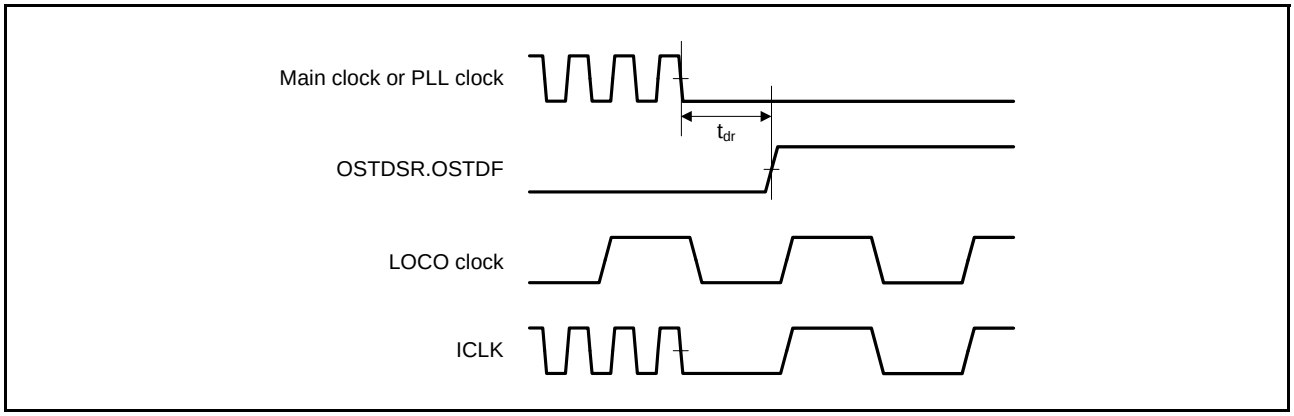


Figure 5.108 Oscillation Stop Detection Timing

[Chip version B]

Table 5.79 ROM (Flash Memory for Code Storage) Characteristics (6) : middle-speed operating modes 1B and 2B

Conditions: VCC = AVCC0 = 1.62 to 3.6 V, VREFH = VREFH0 = AVCC0, VSS = AVSS0 = VREFL = VREFL0 = 0 V
Temperature range for the programming/erasure operation: T_a = –40 to +105°C

Item		Symbol	FCLK = 4 MHz			FCLK = 32 MHz*1			Unit
			Min.	Typ.	Max.	Min.	Typ.	Max.	
Programming time when N_{PEC} ≤ 100 times	2 bytes	t_{P2}	—	0.25	5.0	—	0.21	2.8	ms
	8 bytes	t_{P8}	—	0.25	5.3	—	0.21	3.0	
	128 bytes	t_{P128}	—	0.92	14.0	—	0.65	8.3	
Programming time when N_{PEC} > 100 times	2 bytes	t_{P2}	—	0.31	6.2	—	0.26	3.5	ms
	8 bytes	t_{P8}	—	0.31	6.6	—	0.26	3.7	
	128 bytes	t_{P128}	—	1.09	17.5	—	0.77	10.0	
Erasure time when N_{PEC} ≤ 100 times	2 Kbytes	t_{E2K}	—	21.0	113.7	—	18.5	46	ms
Erasure time when N_{PEC} > 100 times	2 Kbytes	t_{E2K}	—	25.6	220.6	—	22.5	90 (1000 times ≥ N_{PEC} > 100 times), 98 (10000 times ≥ N_{PEC} > 1000 times)	ms
Suspend delay time during programming (in programming/erasure priority mode)		t_{SPD}	—	—	1.7	—	—	1.6	ms
First suspend delay time during programming (in suspend priority mode)		t_{SPSD1}	—	—	220	—	—	120	µs
Second suspend delay time during programming (in suspend priority mode)		t_{SPSD2}	—	—	1.7	—	—	1.6	ms
Suspend delay time during erasing (in programming/erasure priority mode)		t_{SED}	—	—	1.7	—	—	1.6	ms
First suspend delay time during erasing (in suspend priority mode)		t_{SESD1}	—	—	220	—	—	120	µs
Second suspend delay time during erasing (in suspend priority mode)		t_{SESD2}	—	—	1.7	—	—	1.6	ms
FCU reset time		t_{FCUR}	20 µs or longer and FCLK × 6 or greater	—	—	20 µs or longer and FCLK × 6 or greater	—	—	µs

Note 1. The operating frequency is 20 MHz (max.) when the voltage is in the range from 1.62 V to less than 1.8 V.

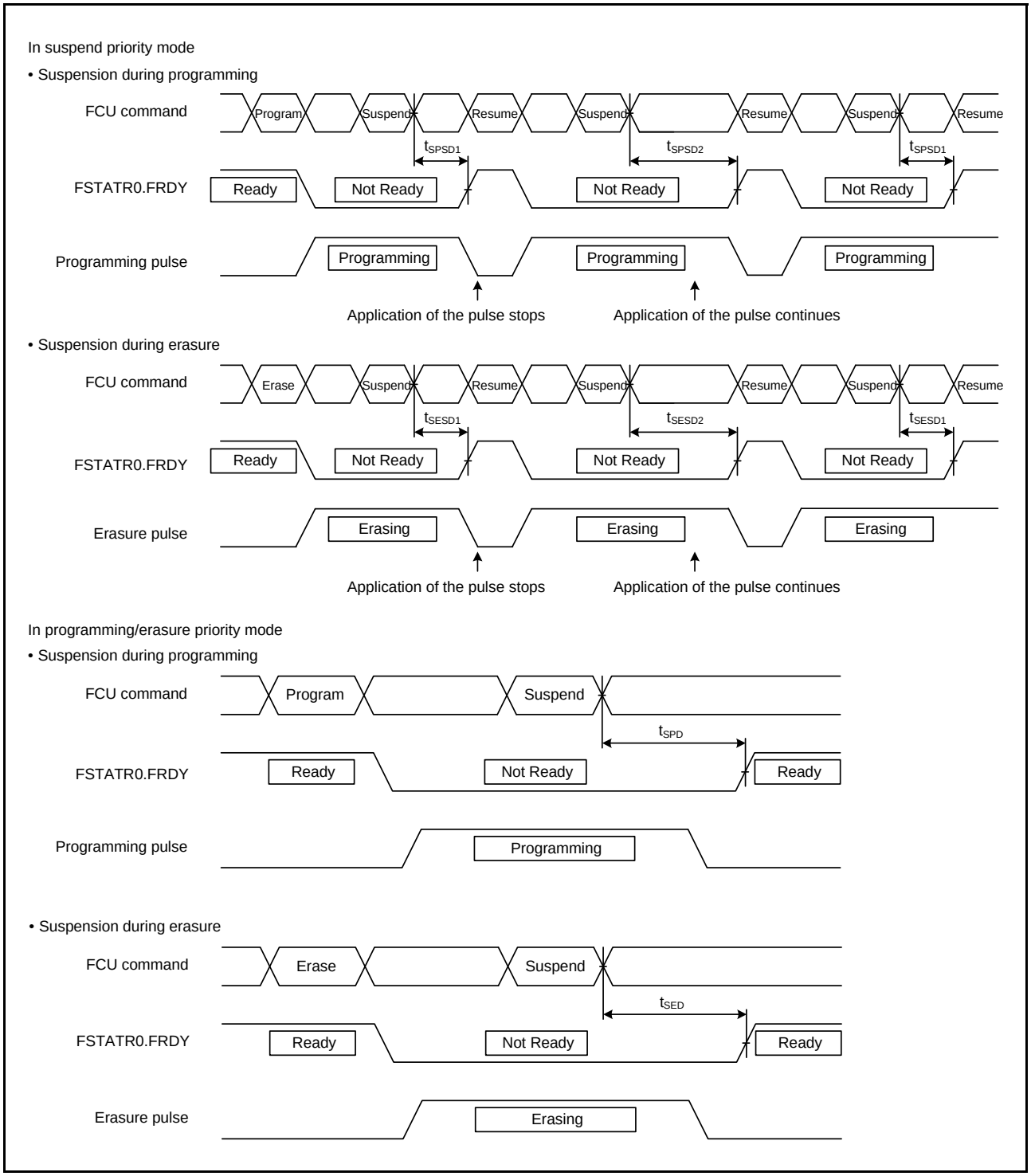


Figure 5.109 Flash Memory Program/Erase Suspend Timing