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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	Obsolete
Core Processor	R8C
Core Size	16-Bit
Speed	20MHz
Connectivity	I ² C, LINbus, SIO, SSU, UART/USART
Peripherals	POR, PWM, Voltage Detect, WDT
Number of I/O	27
Program Memory Size	16KB (16K x 8)
Program Memory Type	FLASH
EEPROM Size	4K x 8
RAM Size	1.5K x 8
Voltage - Supply (Vcc/Vdd)	1.8V ~ 5.5V
Data Converters	A/D 12x10b; D/A 2x8b
Oscillator Type	Internal
Operating Temperature	-20°C ~ 85°C (TA)
Mounting Type	Surface Mount
Package / Case	32-LQFP
Supplier Device Package	32-LQFP (7x7)
Purchase URL	https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f21334mnfp-v2

1.2 Product List

Table 1.3 lists Product List for R8C/33M Group, and Figure 1.1 shows a Part Number, Memory Size, and Package of R8C/33M Group.

Table 1.3 Product List for R8C/33M Group

Current of Jun 2011

Part No.	ROM Capacity		RAM Capacity	Package Type	Remarks
	Program ROM	Data flash			
R5F21331MNFP	4 Kbytes	1 Kbyte × 4	512 bytes	PLQP0032GB-A	N version
R5F21332MNFP	8 Kbytes	1 Kbyte × 4	1 Kbyte	PLQP0032GB-A	
R5F21334MNFP	16 Kbytes	1 Kbyte × 4	1.5 Kbytes	PLQP0032GB-A	
R5F21335MNFP	24 Kbytes	1 Kbyte × 4	2 Kbytes	PLQP0032GB-A	
R5F21336MNFP	32 Kbytes	1 Kbyte × 4	2.5 Kbytes	PLQP0032GB-A	
R5F21331MDFP	4 Kbytes	1 Kbyte × 4	512 bytes	PLQP0032GB-A	D version
R5F21332MDFP	8 Kbytes	1 Kbyte × 4	1 Kbyte	PLQP0032GB-A	
R5F21334MDFP	16 Kbytes	1 Kbyte × 4	1.5 Kbytes	PLQP0032GB-A	
R5F21335MDFP	24 Kbytes	1 Kbyte × 4	2 Kbytes	PLQP0032GB-A	
R5F21336MDFP	32 Kbytes	1 Kbyte × 4	2.5 Kbytes	PLQP0032GB-A	

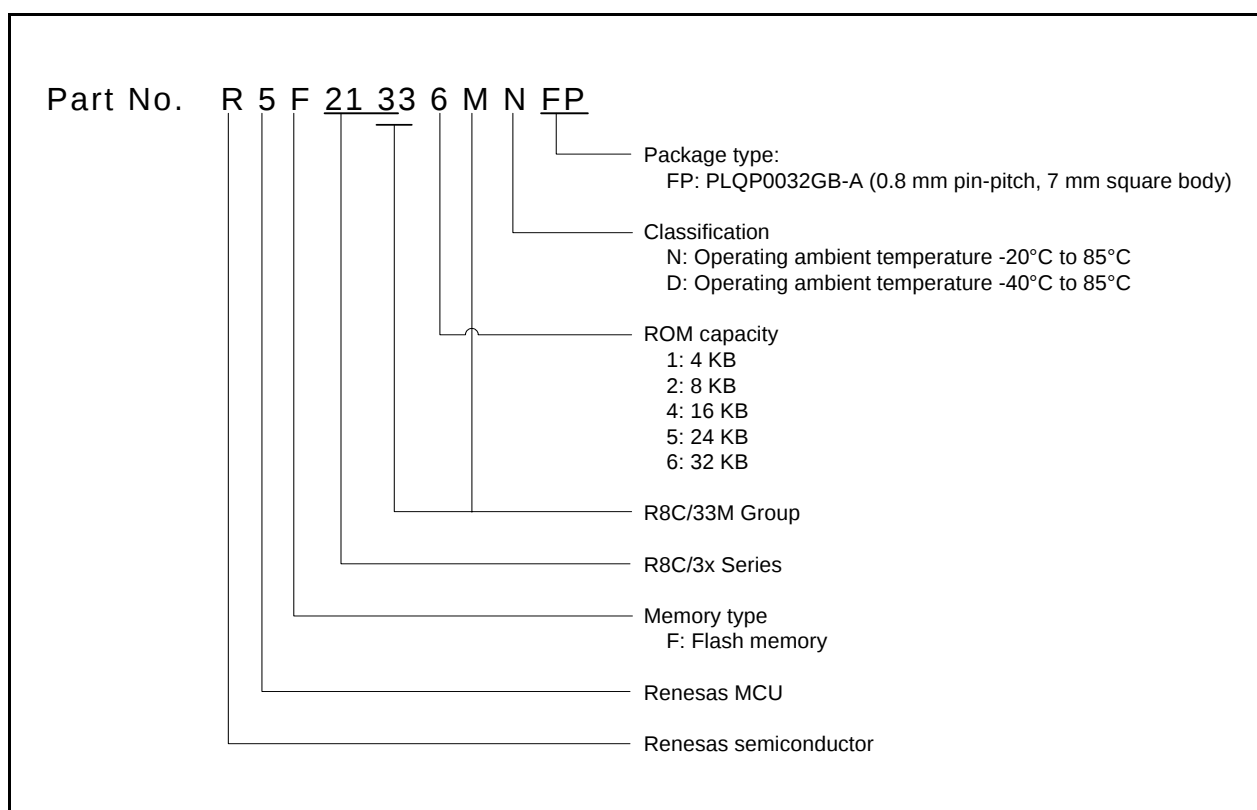


Figure 1.1 Part Number, Memory Size, and Package of R8C/33M Group

1.3 Block Diagram

Figure 1.2 shows a Block Diagram.

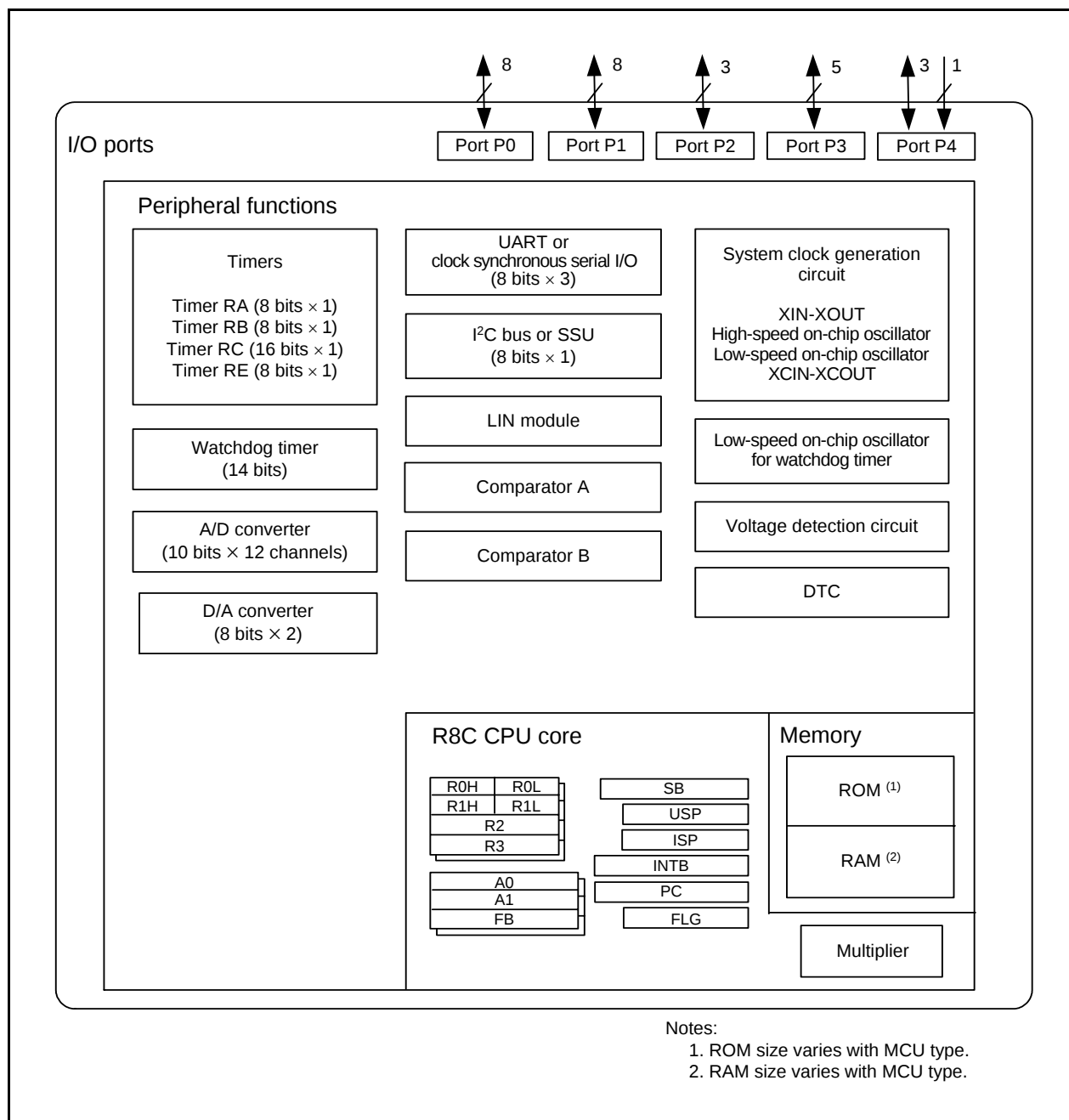


Figure 1.2 Block Diagram

1.5 Pin Functions

Tables 1.5 and 1.6 list Pin Functions.

Table 1.5 Pin Functions (1)

Item	Pin Name	I/O Type	Description
Power supply input	VCC, VSS	–	Apply 1.8 V to 5.5 V to the VCC pin. Apply 0 V to the VSS pin.
Analog power supply input	AVCC, AVSS	–	Power supply for the A/D converter. Connect a capacitor between AVCC and AVSS.
Reset input	$\overline{\text{RESET}}$	I	Input "L" on this pin resets the MCU.
MODE	MODE	I	Connect this pin to VCC via a resistor.
XIN clock input	XIN	I	These pins are provided for XIN clock generation circuit I/O. Connect a ceramic resonator or a crystal oscillator between the XIN and XOUT pins ⁽¹⁾ . To use an external clock, input it to the XOUT pin and leave the XIN pin open.
XIN clock output	XOUT	I/O	
XCIN clock input	XCIN	I	These pins are provided for XCIN clock generation circuit I/O. Connect a crystal oscillator between the XCIN and XCOU pins ⁽¹⁾ . To use an external clock, input it to the XCIN pin and leave the XCOU pin open.
XCIN clock output	XCOU	O	
$\overline{\text{INT}}$ interrupt input	$\overline{\text{INT0}}$, $\overline{\text{INT1}}$, $\overline{\text{INT3}}$	I	$\overline{\text{INT}}$ interrupt input pins. $\overline{\text{INT0}}$ is timer RB, and RC input pin.
Key input interrupt	$\overline{\text{KI0}}$ to $\overline{\text{KI3}}$	I	Key input interrupt input pins
Timer RA	TRAIO	I/O	Timer RA I/O pin
	TRAO	O	Timer RA output pin
Timer RB	TRBO	O	Timer RB output pin
Timer RC	TRCLK	I	External clock input pin
	TRCTR	I	External trigger input pin
	TRCIOA, TRCIOB, TRCIOC, TRCIOD	I/O	Timer RC I/O pins
Timer RE	TREO	O	Divided clock output pin
Serial interface	CLK0, CLK1, CLK2	I/O	Transfer clock I/O pins
	RXD0, RXD1, RXD2	I	Serial data input pins
	TXD0, TXD1, TXD2	O	Serial data output pins
	$\overline{\text{CTS2}}$	I	Transmission control input pin
	$\overline{\text{RTS2}}$	O	Reception control output pin
	SCL2	I/O	I ² C mode clock I/O pin
	SDA2	I/O	I ² C mode data I/O pin
I ² C bus	SCL	I/O	Clock I/O pin
	SDA	I/O	Data I/O pin
SSU	SSI	I/O	Data I/O pin
	$\overline{\text{SCS}}$	I/O	Chip-select signal I/O pin
	SSCK	I/O	Clock I/O pin
	SSO	I/O	Data I/O pin

I: Input O: Output I/O: Input and output

Note:

1. Refer to the oscillator manufacturer for oscillation characteristics.

Table 1.6 Pin Functions (2)

Item	Pin Name	I/O Type	Description
Reference voltage input	VREF	I	Reference voltage input pin to A/D converter and D/A converter
A/D converter	AN0 to AN11	I	Analog input pins to A/D converter
	ADTRG	I	A/D external trigger input pin
D/A converter	DA0, DA1	O	D/A converter output pins
Comparator A	LVCMP1, LVCMP2	I	Comparator A analog voltage input pins
	LVREF	I	Comparator A reference voltage input pin
	LVCOUT1, LVCOUT2	O	Comparator A output pins
Comparator B	IVCMP1, IVCMP3	I	Comparator B analog voltage input pins
	IVREF1, IVREF3	I	Comparator B reference voltage input pins
I/O port	P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_2, P3_1, P3_3 to P3_5, P3_7, P4_5 to P4_7	I/O	CMOS I/O ports. Each port has an I/O select direction register, allowing each pin in the port to be directed for input or output individually. Any port set to input can be set to use a pull-up resistor or not by a program. All ports can be used as LED drive ports.
Input port	P4_2	I	Input-only port

I: Input O: Output I/O: Input and output

2. Central Processing Unit (CPU)

Figure 2.1 shows the CPU Registers. The CPU contains 13 registers. R0, R1, R2, R3, A0, A1, and FB configure a register bank. There are two sets of register bank.

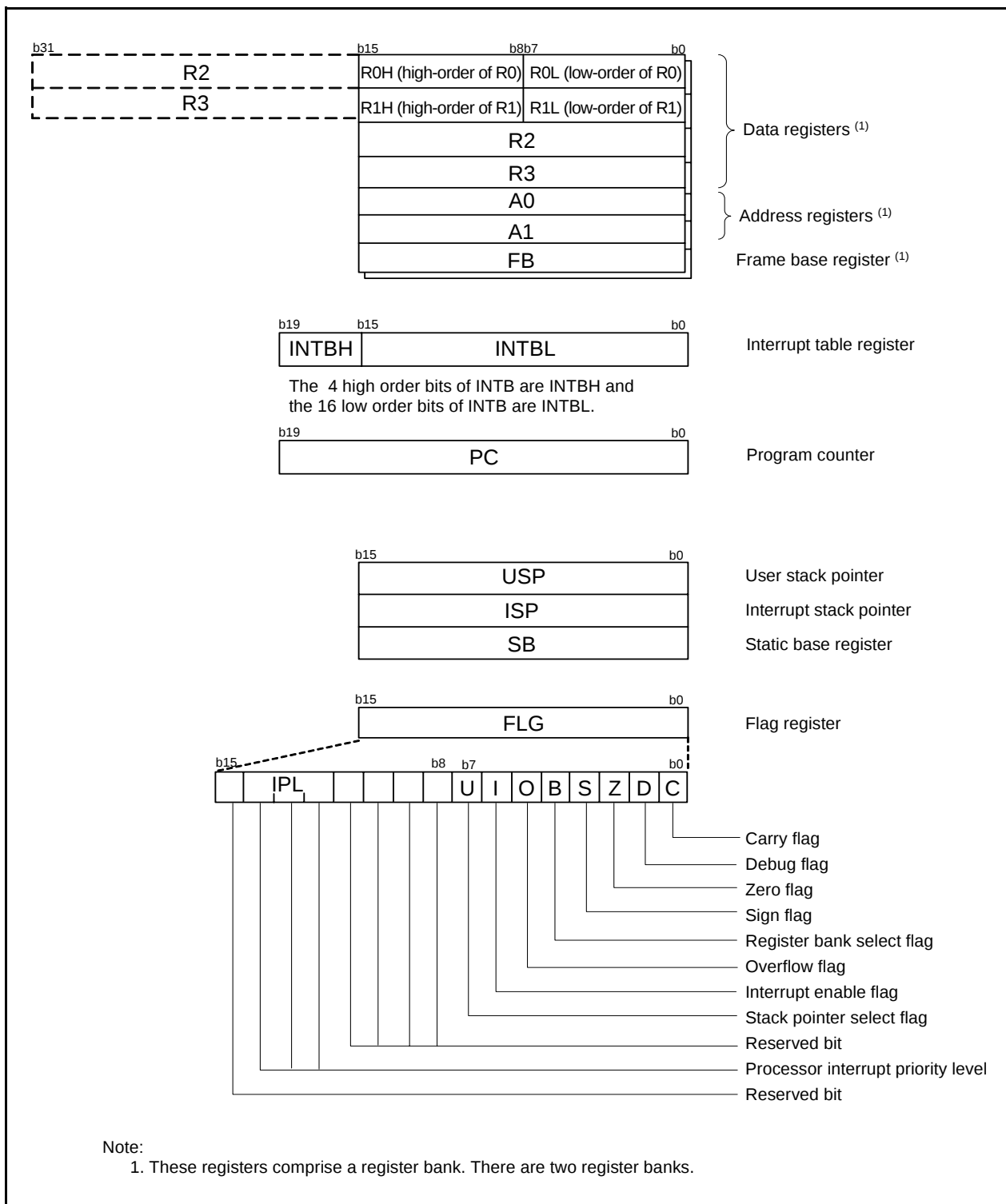


Figure 2.1 CPU Registers

2.8.7 Interrupt Enable Flag (I)

The I flag enables maskable interrupts.

Interrupts are disabled when the I flag is set to 0, and are enabled when the I flag is set to 1. The I flag is set to 0 when an interrupt request is acknowledged.

2.8.8 Stack Pointer Select Flag (U)

ISP is selected when the U flag is set to 0; USP is selected when the U flag is set to 1.

The U flag is set to 0 when a hardware interrupt request is acknowledged or the INT instruction of software interrupt numbers 0 to 31 is executed.

2.8.9 Processor Interrupt Priority Level (IPL)

IPL is 3 bits wide and assigns processor interrupt priority levels from level 0 to level 7.

If a requested interrupt has higher priority than IPL, the interrupt is enabled.

2.8.10 Reserved Bit

If necessary, set to 0. When read, the content is undefined.

Table 4.5 SFR Information (5) (1)

Address	Register	Symbol	After Reset
0100h	Timer RA Control Register	TRACR	00h
0101h	Timer RA I/O Control Register	TRAIOC	00h
0102h	Timer RA Mode Register	TRAMR	00h
0103h	Timer RA Prescaler Register	TRAPRE	FFh
0104h	Timer RA Register	TRA	FFh
0105h	LIN Control Register 2	LINCR2	00h
0106h	LIN Control Register	LINCR	00h
0107h	LIN Status Register	LINST	00h
0108h	Timer RB Control Register	TRBCR	00h
0109h	Timer RB One-Shot Control Register	TRBOCR	00h
010Ah	Timer RB I/O Control Register	TRBIOC	00h
010Bh	Timer RB Mode Register	TRBMR	00h
010Ch	Timer RB Prescaler Register	TRBPPE	FFh
010Dh	Timer RB Secondary Register	TRBSC	FFh
010Eh	Timer RB Primary Register	TRBPR	FFh
010Fh			
0110h			
0111h			
0112h			
0113h			
0114h			
0115h			
0116h			
0117h			
0118h	Timer RE Second Data Register / Counter Data Register	TRESEC	00h
0119h	Timer RE Minute Data Register / Compare Data Register	TREMIN	00h
011Ah	Timer RE Hour Data Register	TREHR	00h
011Bh	Timer RE Day of Week Data Register	TREWK	00h
011Ch	Timer RE Control Register 1	TRECR1	00h
011Dh	Timer RE Control Register 2	TRECR2	00h
011Eh	Timer RE Count Source Select Register	TRECSR	00001000b
011Fh			
0120h	Timer RC Mode Register	TRCMR	01001000b
0121h	Timer RC Control Register 1	TRCCR1	00h
0122h	Timer RC Interrupt Enable Register	TRCIER	01110000b
0123h	Timer RC Status Register	TRCSR	01110000b
0124h	Timer RC I/O Control Register 0	TRCIOR0	10001000b
0125h	Timer RC I/O Control Register 1	TRCIOR1	10001000b
0126h	Timer RC Counter	TRC	00h
0127h			00h
0128h	Timer RC General Register A	TRCGRA	FFh
0129h			FFh
012Ah	Timer RC General Register B	TRCGRB	FFh
012Bh			FFh
012Ch	Timer RC General Register C	TRCGRC	FFh
012Dh			FFh
012Eh	Timer RC General Register D	TRCGRD	FFh
012Fh			FFh
0130h	Timer RC Control Register 2	TRCCR2	00011000b
0131h	Timer RC Digital Filter Function Select Register	TRCDF	00h
0132h	Timer RC Output Master Enable Register	TRCOER	01111111b
0133h	Timer RC Trigger Control Register	TRCADCR	00h
0134h			
0135h			
0136h			
0137h			
0138h			
0139h			
013Ah			
013Bh			
013Ch			
013Dh			
013Eh			
013Fh			

Note:

1. The blank areas are reserved and cannot be accessed by users.

Table 4.6 SFR Information (6) ⁽¹⁾

Address	Register	Symbol	After Reset
0140h			
0141h			
0142h			
0143h			
0144h			
0145h			
0146h			
0147h			
0148h			
0149h			
014Ah			
014Bh			
014Ch			
014Dh			
014Eh			
014Fh			
0150h			
0151h			
0152h			
0153h			
0154h			
0155h			
0156h			
0157h			
0158h			
0159h			
015Ah			
015Bh			
015Ch			
015Dh			
015Eh			
015Fh			
0160h	UART1 Transmit/Receive Mode Register	U1MR	00h
0161h	UART1 Bit Rate Register	U1BRG	XXh
0162h	UART1 Transmit Buffer Register	U1TB	XXh
0163h			XXh
0164h	UART1 Transmit/Receive Control Register 0	U1C0	00001000b
0165h	UART1 Transmit/Receive Control Register 1	U1C1	00000010b
0166h	UART1 Receive Buffer Register	U1RB	XXh
0167h			XXh
0168h			
0169h			
016Ah			
016Bh			
016Ch			
016Dh			
016Eh			
016Fh			
0170h			
0171h			
0172h			
0173h			
0174h			
0175h			
0176h			
0177h			
0178h			
0179h			
017Ah			
017Bh			
017Ch			
017Dh			
017Eh			
017Fh			

X: Undefined

Note:

1. The blank areas are reserved and cannot be accessed by users.

Table 4.9 SFR Information (9) ⁽¹⁾

Address	Register	Symbol	After Reset
2C00h	DTC Transfer Vector Area		XXh
2C01h	DTC Transfer Vector Area		XXh
2C02h	DTC Transfer Vector Area		XXh
2C03h	DTC Transfer Vector Area		XXh
2C04h	DTC Transfer Vector Area		XXh
2C05h	DTC Transfer Vector Area		XXh
2C06h	DTC Transfer Vector Area		XXh
2C07h	DTC Transfer Vector Area		XXh
2C08h	DTC Transfer Vector Area		XXh
2C09h	DTC Transfer Vector Area		XXh
2C0Ah	DTC Transfer Vector Area		XXh
:	DTC Transfer Vector Area		XXh
:	DTC Transfer Vector Area		XXh
2C3Ah	DTC Transfer Vector Area		XXh
2C3Bh	DTC Transfer Vector Area		XXh
2C3Ch	DTC Transfer Vector Area		XXh
2C3Dh	DTC Transfer Vector Area		XXh
2C3Eh	DTC Transfer Vector Area		XXh
2C3Fh	DTC Transfer Vector Area		XXh
2C40h	DTC Control Data 0	DTCD0	XXh
2C41h			XXh
2C42h			XXh
2C43h			XXh
2C44h			XXh
2C45h			XXh
2C46h			XXh
2C47h			XXh
2C48h	DTC Control Data 1	DTCD1	XXh
2C49h			XXh
2C4Ah			XXh
2C4Bh			XXh
2C4Ch			XXh
2C4Dh			XXh
2C4Eh			XXh
2C4Fh			XXh
2C50h	DTC Control Data 2	DTCD2	XXh
2C51h			XXh
2C52h			XXh
2C53h			XXh
2C54h			XXh
2C55h			XXh
2C56h			XXh
2C57h			XXh
2C58h	DTC Control Data 3	DTCD3	XXh
2C59h			XXh
2C5Ah			XXh
2C5Bh			XXh
2C5Ch			XXh
2C5Dh			XXh
2C5Eh			XXh
2C5Fh			XXh
2C60h	DTC Control Data 4	DTCD4	XXh
2C61h			XXh
2C62h			XXh
2C63h			XXh
2C64h			XXh
2C65h			XXh
2C66h			XXh
2C67h			XXh
2C68h	DTC Control Data 5	DTCD5	XXh
2C69h			XXh
2C6Ah			XXh
2C6Bh			XXh
2C6Ch			XXh
2C6Dh			XXh
2C6Eh			XXh
2C6Fh			XXh

X: Undefined

Note:

1. The blank areas are reserved and cannot be accessed by users.

Table 4.11 SFR Information (11) ⁽¹⁾

Address	Register	Symbol	After Reset
2CB0h	DTC Control Data 14	DTCD14	XXh
2CB1h			XXh
2CB2h			XXh
2CB3h			XXh
2CB4h			XXh
2CB5h			XXh
2CB6h			XXh
2CB7h			XXh
2CB8h	DTC Control Data 15	DTCD15	XXh
2CB9h			XXh
2CBAh			XXh
2CBBh			XXh
2CBCh			XXh
2CBDh			XXh
2CBEh			XXh
2CBFh			XXh
2CC0h	DTC Control Data 16	DTCD16	XXh
2CC1h			XXh
2CC2h			XXh
2CC3h			XXh
2CC4h			XXh
2CC5h			XXh
2CC6h			XXh
2CC7h			XXh
2CC8h	DTC Control Data 17	DTCD17	XXh
2CC9h			XXh
2CCAh			XXh
2CCBh			XXh
2CCCh			XXh
2CCDh			XXh
2CCEh			XXh
2CCFh			XXh
2CD0h	DTC Control Data 18	DTCD18	XXh
2CD1h			XXh
2CD2h			XXh
2CD3h			XXh
2CD4h			XXh
2CD5h			XXh
2CD6h			XXh
2CD7h			XXh
2CD8h	DTC Control Data 19	DTCD19	XXh
2CD9h			XXh
2CDAh			XXh
2CDBh			XXh
2CDCh			XXh
2CDDh			XXh
2CDEh			XXh
2CDFh			XXh
2CE0h	DTC Control Data 20	DTCD20	XXh
2CE1h			XXh
2CE2h			XXh
2CE3h			XXh
2CE4h			XXh
2CE5h			XXh
2CE6h			XXh
2CE7h			XXh
2CE8h	DTC Control Data 21	DTCD21	XXh
2CE9h			XXh
2CEAh			XXh
2CEBh			XXh
2CECh			XXh
2CEDh			XXh
2CEEh			XXh
2CEFh			XXh

X: Undefined

Note:

1. The blank areas are reserved and cannot be accessed by users.

Table 4.12 SFR Information (12) (1)

Address	Register	Symbol	After Reset
2CF0h	DTC Control Data 22	DTCD22	XXh
2CF1h			XXh
2CF2h			XXh
2CF3h			XXh
2CF4h			XXh
2CF5h			XXh
2CF6h			XXh
2CF7h			XXh
2CF8h	DTC Control Data 23	DTCD23	XXh
2CF9h			XXh
2CFAh			XXh
2CFBh			XXh
2CFCh			XXh
2CFDh			XXh
2CFEh			XXh
2CFFh			XXh
2D00h			
2FFFh			

X: Undefined

Note:

1. The blank areas are reserved and cannot be accessed by users.

Table 4.13 ID Code Areas and Option Function Select Area

Address	Area Name	Symbol	After Reset
FFDBh	Option Function Select Register 2	OFS2	(Note 1)
FFDFh	ID1		(Note 2)
FFE3h	ID2		(Note 2)
FFEBh	ID3		(Note 2)
FFEFh	ID4		(Note 2)
FFF3h	ID5		(Note 2)
FFF7h	ID6		(Note 2)
FFFBh	ID7		(Note 2)
FFFFh	Option Function Select Register	OFS	(Note 1)

Notes:

1. The option function select area is allocated in the flash memory, not in the SFRs. Set appropriate values as ROM data by a program. Do not write additions to the option function select area. If the block including the option function select area is erased, the option function select area is set to FFh.
When blank products are shipped, the option function select area is set to FFh. It is set to the written value after written by the user.
When factory-programming products are shipped, the value of the option function select area is the value programmed by the user.
2. The ID code areas are allocated in the flash memory, not in the SFRs. Set appropriate values as ROM data by a program. Do not write additions to the ID code areas. If the block including the ID code areas is erased, the ID code areas are set to FFh.
When blank products are shipped, the ID code areas are set to FFh. They are set to the written value after written by the user.
When factory-programming products are shipped, the value of the ID code areas is the value programmed by the user.

Table 5.4 D/A Converter Characteristics

Symbol	Parameter	Condition	Standard			Unit
			Min.	Typ.	Max.	
–	Resolution		–	–	8	Bit
–	Absolute accuracy		–	–	2.5	LSB
t _{su}	Setup time		–	–	3	μs
R _o	Output resistor		–	6	–	kΩ
I _{vref}	Reference power input current	(Note 2)	–	–	1.5	mA

Notes:

1. V_{CC}/AV_{CC} = V_{ref} = 2.7 to 5.5 V and T_{opr} = –20 to 85°C (N version) / –40 to 85°C (D version), unless otherwise specified.
2. This applies when one D/A converter is used and the value of the DA_i register (i = 0 or 1) for the unused D/A converter is 00h. The resistor ladder of the A/D converter is not included.

Table 5.5 Comparator A Electrical Characteristics

Symbol	Parameter	Condition	Standard			Unit
			Min.	Typ.	Max.	
LVREF	External reference voltage input range		1.4	–	V _{CC}	V
LVCMP1, LVCMP2	External comparison voltage input range		–0.3	–	V _{CC} + 0.3	V
–	Offset		–	50	200	mV
–	Comparator output delay time ⁽²⁾	At falling, V _I = V _{ref} – 100 mV	–	3	–	μs
		At falling, V _I = V _{ref} – 1 V or below	–	1.5	–	μs
		At rising, V _I = V _{ref} + 100 mV	–	2	–	μs
		At rising, V _I = V _{ref} + 1 V or above	–	0.5	–	μs
–	Comparator operating current	V _{CC} = 5.0 V	–	0.5	–	μA

Notes:

1. V_{CC} = 2.7 to 5.5 V, T_{opr} = –20 to 85°C (N version) / –40 to 85°C (D version), unless otherwise specified.
2. When the digital filter is disabled.

Table 5.6 Comparator B Electrical Characteristics

Symbol	Parameter	Condition	Standard			Unit
			Min.	Typ.	Max.	
V _{ref}	IVREF1, IVREF3 input reference voltage		0	–	V _{CC} – 1.4	V
V _i	IVCMP1, IVCMP3 input voltage		–0.3	–	V _{CC} + 0.3	V
–	Offset		–	5	100	mV
t _d	Comparator output delay time ⁽²⁾	V _I = V _{ref} ± 100 mV	–	0.1	–	μs
I _{CMP}	Comparator operating current	V _{CC} = 5.0 V	–	17.5	–	μA

Notes:

1. V_{CC} = 2.7 to 5.5 V, T_{opr} = –20 to 85°C (N version) / –40 to 85°C (D version), unless otherwise specified.
2. When the digital filter is disabled.

Table 5.16 Timing Requirements of Synchronous Serial Communication Unit (SSU) (1)

Symbol	Parameter		Conditions	Standard			Unit
				Min.	Typ.	Max.	
tsucyc	SSCK clock cycle time			4	–	–	tcyc (2)
tHI	SSCK clock "H" width			0.4	–	0.6	tsucyc
tLO	SSCK clock "L" width			0.4	–	0.6	tsucyc
trISE	SSCK clock rising time	Master		–	–	1	tcyc (2)
		Slave		–	–	1	μs
tFALL	SSCK clock falling time	Master		–	–	1	tcyc (2)
		Slave		–	–	1	μs
tsu	SSO, SSI data input setup time			100	–	–	ns
tH	SSO, SSI data input hold time			1	–	–	tcyc (2)
tLEAD	SCS setup time	Slave		1tcyc + 50	–	–	ns
tLAG	SCS hold time	Slave		1tcyc + 50	–	–	ns
tOD	SSO, SSI data output delay time			–	–	1	tcyc (2)
tsA	SSI slave access time		$2.7\text{ V} \leq V_{CC} \leq 5.5\text{ V}$	–	–	$1.5tcyc + 100$	ns
			$1.8\text{ V} \leq V_{CC} < 2.7\text{ V}$	–	–	$1.5tcyc + 200$	ns
toR	SSI slave out open time		$2.7\text{ V} \leq V_{CC} \leq 5.5\text{ V}$	–	–	$1.5tcyc + 100$	ns
			$1.8\text{ V} \leq V_{CC} < 2.7\text{ V}$	–	–	$1.5tcyc + 200$	ns

Notes:

1. $V_{CC} = 1.8$ to 5.5 V , $V_{SS} = 0\text{ V}$ and $T_{opr} = -20$ to 85°C (N version) / -40 to 85°C (D version), unless otherwise specified.
2. $1tcyc = 1/f_1(s)$

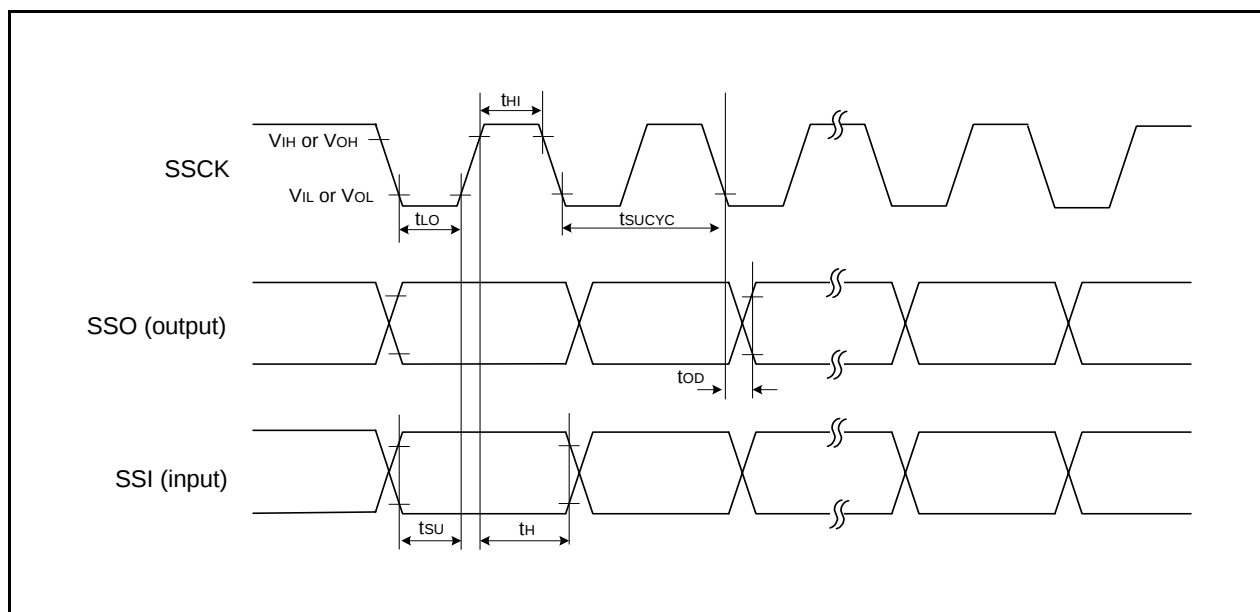


Figure 5.6 I/O Timing of Synchronous Serial Communication Unit (SSU) (Clock Synchronous Communication Mode)

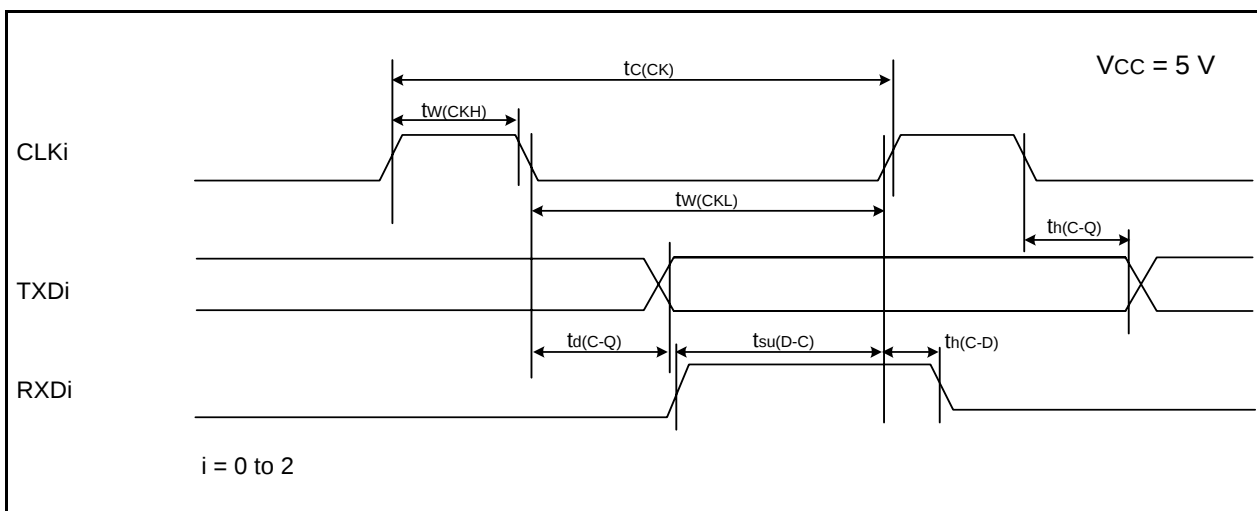
Table 5.22 Serial Interface

Symbol	Parameter		Standard		Unit
			Min.	Max.	
$t_{c(CK)}$	CLKi input cycle time	When external clock is selected	200	–	ns
$t_{w(CKH)}$	CLKi input “H” width		100	–	ns
$t_{w(CKL)}$	CLKi input “L” width		100	–	ns
$t_{d(C-Q)}$	TXDi output delay time		–	90	ns
$t_{h(C-Q)}$	TXDi hold time	When internal clock is selected	0	–	ns
$t_{su(D-C)}$	RXDi input setup time		10	–	ns
$t_{h(C-D)}$	RXDi input hold time		90	–	ns
$t_{d(C-Q)}$	TXDi output delay time		–	10	ns
$t_{su(D-C)}$	RXDi input setup time		90	–	ns
$t_{h(C-D)}$	RXDi input hold time		90	–	ns

i = 0 to 2

Note:

1. $V_{CC} = 5\text{ V}$ and $T_{opr} = -20\text{ to }85\text{ }^{\circ}\text{C}$ (N version)/ $-40\text{ to }85\text{ }^{\circ}\text{C}$ (D version), unless otherwise specified.

**Figure 5.10 Serial Interface Timing Diagram when $V_{CC} = 5\text{ V}$** **Table 5.23 External Interrupt $\overline{INTi}$ (i = 0, 1, 3) Input, Key Input Interrupt $\overline{Kli}$ (i = 0 to 3)**

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{w(INH)}$	$\overline{INTi}$ input “H” width, $\overline{Kli}$ input “H” width	250 ⁽¹⁾	–	ns
$t_{w(INL)}$	$\overline{INTi}$ input “L” width, $\overline{Kli}$ input “L” width	250 ⁽²⁾	–	ns

Notes:

1. When selecting the digital filter by the $\overline{INTi}$ input filter select bit, use an $\overline{INTi}$ input HIGH width of either (1/digital filter clock frequency $\times$ 3) or the minimum value of standard, whichever is greater.
2. When selecting the digital filter by the $\overline{INTi}$ input filter select bit, use an $\overline{INTi}$ input LOW width of either (1/digital filter clock frequency $\times$ 3) or the minimum value of standard, whichever is greater.

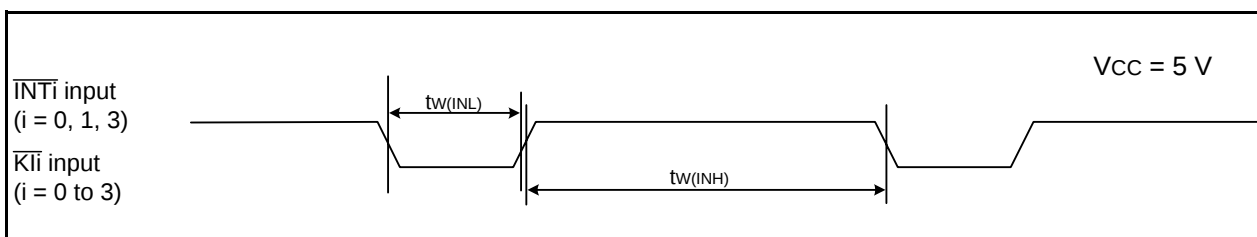
**Figure 5.11 Input Timing Diagram for External Interrupt $\overline{INTi}$ and Key Input Interrupt $\overline{Kli}$ when $V_{CC} = 5\text{ V}$**

Table 5.24 Electrical Characteristics (3) [2.7 V ≤ V_{CC} < 4.2 V]

Symbol	Parameter		Condition		Standard			Unit
					Min.	Typ.	Max.	
V _{OH}	Output "H" voltage	Other than XOUT	Drive capacity High	I _{OH} = −5 mA	V _{CC} − 0.5	–	V _{CC}	V
			Drive capacity Low	I _{OH} = −1 mA	V _{CC} − 0.5	–	V _{CC}	V
		XOUT		I _{OH} = −200 μA	1.0	–	V _{CC}	V
V _{OL}	Output "L" voltage	Other than XOUT	Drive capacity High	I _{OL} = 5 mA	–	–	0.5	V
			Drive capacity Low	I _{OL} = 1 mA	–	–	0.5	V
		XOUT		I _{OL} = 200 μA	–	–	0.5	V
V _{T+} –V _{T–}	Hysteresis	INT0, INT1, INT3, KI0, KI1, KI2, KI3, TRAI0, TRCIOA, TRCIOB, TRCIOC, TRCIOD, TRCTRG, TRCCLK, ADTRG, RXD0, RXD1, RXD2, CLK0, CLK1, CLK2, SSI, SCL, SDA, SSO	V _{CC} = 3.0 V		0.1	0.4	–	V
		RESET	V _{CC} = 3.0 V		0.1	0.5	–	V
I _{IH}	Input "H" current		V _I = 3 V, V _{CC} = 3.0 V		–	–	4.0	μA
I _{IL}	Input "L" current		V _I = 0 V, V _{CC} = 3.0 V		–	–	−4.0	μA
R _{PULLUP}	Pull-up resistance		V _I = 0 V, V _{CC} = 3.0 V		42	84	168	kΩ
R _{IXIN}	Feedback resistance	XIN			–	0.3	–	MΩ
R _{IXCIN}	Feedback resistance	XCIN			–	8	–	MΩ
V _{RAM}	RAM hold voltage		During stop mode		1.8	–	–	V

Note:

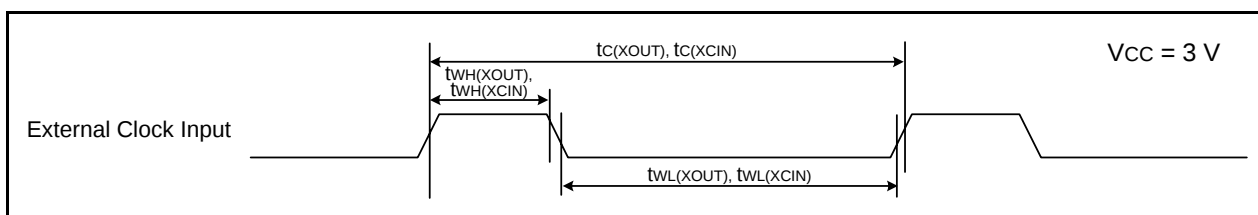
1. 2.7 V ≤ V_{CC} < 4.2 V and T_{opr} = −20 to 85°C (N version) / −40 to 85°C (D version), f(XIN) = 10 MHz, unless otherwise specified.

Table 5.25 Electrical Characteristics (4) [$2.7\text{ V} \leq V_{CC} < 3.3\text{ V}$]
($T_{opr} = -20\text{ to }85^{\circ}\text{C}$ (N version) / $-40\text{ to }85^{\circ}\text{C}$ (D version), unless otherwise specified.)

Symbol	Parameter	Condition		Standard			Unit
				Min.	Typ.	Max.	
Icc	Power supply current (Vcc = 2.7 to 3.3 V) Single-chip mode, output pins are open, other pins are Vss	High-speed clock mode	XIN = 10 MHz (square wave) High-speed on-chip oscillator off Low-speed on-chip oscillator on = 125 kHz No division	–	3.5	10	mA
			XIN = 10 MHz (square wave) High-speed on-chip oscillator off Low-speed on-chip oscillator on = 125 kHz Divide-by-8	–	1.5	7.5	mA
		High-speed on-chip oscillator mode	XIN clock off High-speed on-chip oscillator on fOCO-F = 20 MHz Low-speed on-chip oscillator on = 125 kHz No division	–	7.0	15	mA
			XIN clock off High-speed on-chip oscillator on fOCO-F = 20 MHz Low-speed on-chip oscillator on = 125 kHz Divide-by-8	–	3.0	–	mA
			XIN clock off High-speed on-chip oscillator on fOCO-F = 10 MHz Low-speed on-chip oscillator on = 125 kHz No division	–	4.0	–	mA
			XIN clock off High-speed on-chip oscillator on fOCO-F = 10 MHz Low-speed on-chip oscillator on = 125 kHz Divide-by-8	–	1.5	–	mA
			XIN clock off High-speed on-chip oscillator on fOCO-F = 4 MHz Low-speed on-chip oscillator on = 125 kHz Divide-by-16 MSTIIC = MSTTRD = MSTTRC = 1	–	1	–	mA
			Low-speed on-chip oscillator mode	XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator on = 125 kHz Divide-by-8, FMR27 = 1, VCA20 = 0	–	90	390
		Low-speed clock mode	XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator off XCIN clock oscillator on = 32 kHz No division FMR27 = 1, VCA20 = 0	–	80	400	μA
			XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator off XCIN clock oscillator on = 32 kHz No division	–	40	–	μA
			Program operation on RAM Flash memory off, FMSTP = 1, VCA20 = 0				
		Wait mode	XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator on = 125 kHz While a WAIT instruction is executed Peripheral clock operation VCA27 = VCA26 = VCA25 = 0, VCA20 = 1	–	15	90	μA
			XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator on = 125 kHz While a WAIT instruction is executed Peripheral clock off VCA27 = VCA26 = VCA25 = 0, VCA20 = 1	–	4	80	μA
			XIN clock off High-speed on-chip oscillator off Low-speed on-chip oscillator off XCIN clock oscillator on = 32 kHz (peripheral clock off) While a WAIT instruction is executed VCA27 = VCA26 = VCA25 = 0, VCA20 = 1	–	3.5	–	μA
		Stop mode	XIN clock off, Topr = 25°C High-speed on-chip oscillator off Low-speed on-chip oscillator off CM10 = 1 Peripheral clock off VCA27 = VCA26 = VCA25 = 0	–	2.0	5.0	μA
			XIN clock off, Topr = 85°C High-speed on-chip oscillator off Low-speed on-chip oscillator off CM10 = 1 Peripheral clock off VCA27 = VCA26 = VCA25 = 0	–	5.0	–	μA

Timing requirements**(Unless Otherwise Specified: $V_{CC} = 3\text{ V}$, $V_{SS} = 0\text{ V}$ at $T_{opr} = 25^{\circ}\text{C}$)****Table 5.26 External Clock Input (XOUT, XCIN)**

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_c(\text{XOUT})$	XOUT input cycle time	50	—	ns
$t_{WH}(\text{XOUT})$	XOUT input "H" width	24	—	ns
$t_{WL}(\text{XOUT})$	XOUT input "L" width	24	—	ns
$t_c(\text{XCIN})$	XCIN input cycle time	14	—	μs
$t_{WH}(\text{XCIN})$	XCIN input "H" width	7	—	μs
$t_{WL}(\text{XCIN})$	XCIN input "L" width	7	—	μs

**Figure 5.12 External Clock Input Timing Diagram when $V_{CC} = 3\text{ V}$** **Table 5.27 TRAIO Input**

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_c(\text{TRAIO})$	TRAIO input cycle time	300	—	ns
$t_{WH}(\text{TRAIO})$	TRAIO input "H" width	120	—	ns
$t_{WL}(\text{TRAIO})$	TRAIO input "L" width	120	—	ns

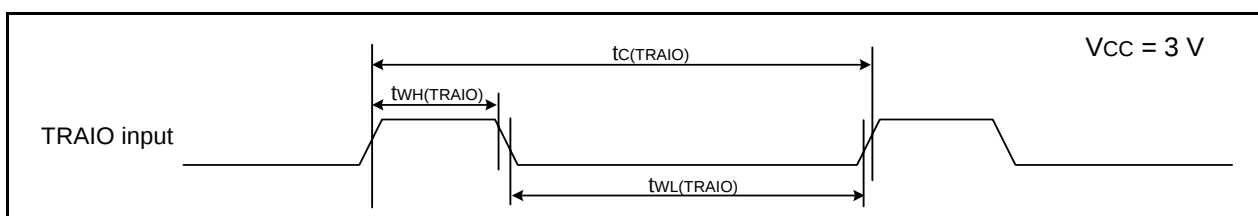
**Figure 5.13 TRAIO Input Timing Diagram when $V_{CC} = 3\text{ V}$**

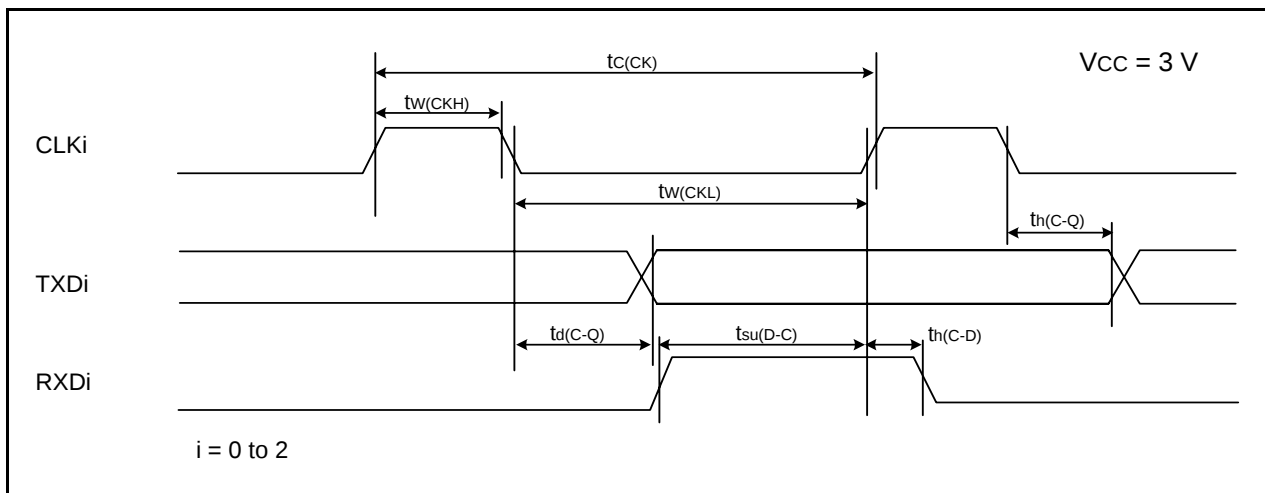
Table 5.28 Serial Interface

Symbol	Parameter		Standard		Unit
			Min.	Max.	
$t_{c(CK)}$	CLKi input cycle time	When external clock is selected	300	–	ns
$t_{w(CKH)}$	CLKi input "H" width		150	–	ns
$t_{w(CKL)}$	CLKi Input "L" width		150	–	ns
$t_{d(C-Q)}$	TXDi output delay time		–	120	ns
$t_{h(C-Q)}$	TXDi hold time	When internal clock is selected	0	–	ns
$t_{su(D-C)}$	RXDi input setup time		30	–	ns
$t_{h(C-D)}$	RXDi input hold time		90	–	ns
$t_{d(C-Q)}$	TXDi output delay time		–	30	ns
$t_{su(D-C)}$	RXDi input setup time		120	–	ns
$t_{h(C-D)}$	RXDi input hold time		90	–	ns

$i = 0$ to 2

Note:

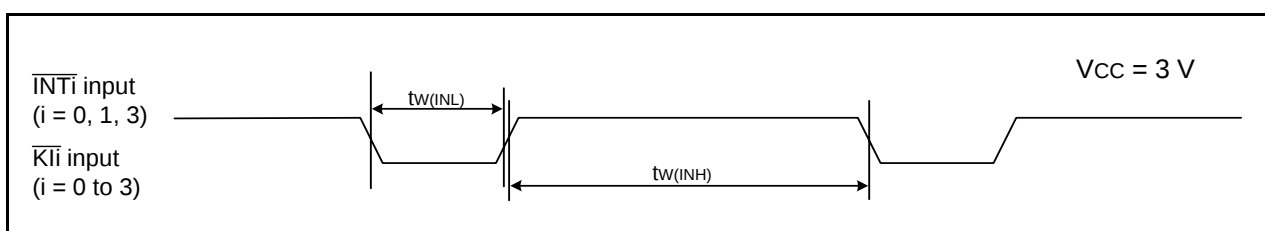
1. $V_{CC} = 3\text{ V}$ and $T_{opr} = -20$ to $85\text{ }^{\circ}\text{C}$ (N version)/ -40 to $85\text{ }^{\circ}\text{C}$ (D version), unless otherwise specified.

**Figure 5.14 Serial Interface Timing Diagram when $V_{CC} = 3\text{ V}$** **Table 5.29 External Interrupt $\overline{INTi}$ ($i = 0, 1, 3$) Input, Key Input Interrupt $\overline{Kli}$ ($i = 0$ to 3)**

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_{w(INH)}$	$\overline{INTi}$ input "H" width, $\overline{Kli}$ input "H" width	380 (1)	–	ns
$t_{w(INL)}$	$\overline{INTi}$ input "L" width, $\overline{Kli}$ input "L" width	380 (2)	–	ns

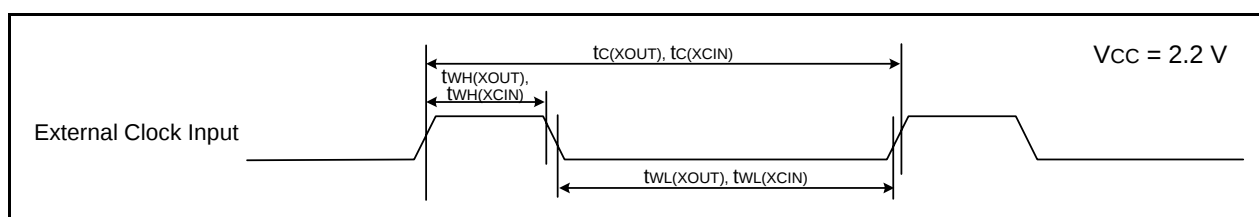
Notes:

1. When selecting the digital filter by the $\overline{INTi}$ input filter select bit, use an $\overline{INTi}$ input HIGH width of either (1/digital filter clock frequency $\times 3$) or the minimum value of standard, whichever is greater.
2. When selecting the digital filter by the $\overline{INTi}$ input filter select bit, use an $\overline{INTi}$ input LOW width of either (1/digital filter clock frequency $\times 3$) or the minimum value of standard, whichever is greater.

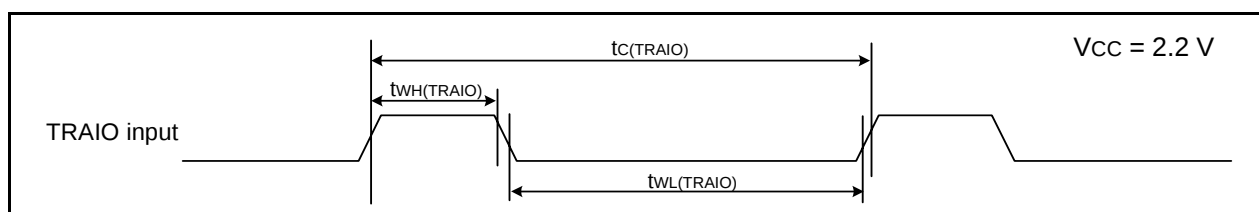
**Figure 5.15 Input Timing Diagram for External Interrupt $\overline{INTi}$ and Key Input Interrupt $\overline{Kli}$ when $V_{CC} = 3\text{ V}$**

Timing requirements**(Unless Otherwise Specified: $V_{CC} = 2.2\text{ V}$, $V_{SS} = 0\text{ V}$ at $T_{opr} = 25^{\circ}\text{C}$)****Table 5.32 External Clock Input (XOUT, XCIN)**

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_c(\text{XOUT})$	XOUT input cycle time	200	—	ns
$t_{WH}(\text{XOUT})$	XOUT input "H" width	90	—	ns
$t_{WL}(\text{XOUT})$	XOUT input "L" width	90	—	ns
$t_c(\text{XCIN})$	XCIN input cycle time	14	—	μs
$t_{WH}(\text{XCIN})$	XCIN input "H" width	7	—	μs
$t_{WL}(\text{XCIN})$	XCIN input "L" width	7	—	μs

**Figure 5.16 External Clock Input Timing Diagram when $V_{CC} = 2.2\text{ V}$** **Table 5.33 TRAIO Input**

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_c(\text{TRAIO})$	TRAIO input cycle time	500	—	ns
$t_{WH}(\text{TRAIO})$	TRAIO input "H" width	200	—	ns
$t_{WL}(\text{TRAIO})$	TRAIO input "L" width	200	—	ns

**Figure 5.17 TRAIO Input Timing Diagram when $V_{CC} = 2.2\text{ V}$**