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April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (<http://www.renesas.com>)

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1. Overview

This MCU is built using the high-performance silicon gate CMOS process using a R8C/Tiny Series CPU core and is packaged in a 32-pin plastic molded LQFP. This MCU operates using sophisticated instructions featuring a high level of instruction efficiency. With 1M bytes of address space, it is capable of executing instructions at high speed.

1.1 Applications

Electric household appliance, office equipment, housing equipment (sensor, security), general industrial equipment, audio, etc.

1.2 Performance Overview

Table 1.1. lists the performance outline of this MCU.

Table 1.1 Performance outline

Item		Performance
CPU	Number of basic instructions	89 instructions
	Minimum instruction execution time	62.5 ns ($f(X_{IN}) = 16$ MHz, $V_{CC} = 3.0$ to 5.5 V) 100 ns ($f(X_{IN}) = 10$ MHz, $V_{CC} = 2.7$ to 5.5 V)
	Operating mode	Single-chip
	Address space	1M bytes
	Memory capacity	See Table 1.2 "Product List"
Peripheral function	Port	Input/Output: 22 (including LED drive port), Input: 2
	LED drive port	I/O port: 8
	Timer	Timer X: 8 bits x 1 channel, Timer Y: 8 bits x 1 channel, Timer Z: 8 bits x 1 channel (Each timer equipped with 8-bit prescaler) Timer C: 16 bits x 1 channel (Input capture circuit)
	Serial interface	•1 channel Clock synchronous, UART •1 channel UART
	A/D converter	10-bit A/D converter: 1 circuit, 8 channels
	Watchdog timer	15 bits x 1 (with prescaler)
	Interrupt	Internal: 9 factors, External: 5 factors, Software: 4 factors, Priority level: 7 levels
	Clock generation circuit	2 circuits •Main clock generation circuit (Equipped with a built-in feedback resistor) •On-chip oscillator
	Oscillation stop detection function	Main clock oscillation stop detection function
Electrical characteristics	Supply voltage	$V_{CC} = 3.0$ to 5.5 V ($f(X_{IN}) = 16$ MHz) $V_{CC} = 2.7$ to 5.5 V ($f(X_{IN}) = 10$ MHz)
	Power consumption	Typ. 8mA ($V_{CC} = 5.0$ V, ($f(X_{IN}) = 16$ MHz) Typ. 5mA ($V_{CC} = 3.0$ V, ($f(X_{IN}) = 10$ MHz) Typ. 35 μ A ($V_{CC} = 3.0$ V, Wait mode, Peripheral clock off) Typ. 0.7 μ A ($V_{CC} = 3.0$ V, Stop mode)
Flash memory	Program/erase supply voltage	$V_{CC} = 2.7$ to 5.5 V
	Program/erase endurance	100 times
Operating ambient temperature		-20 to 85 °C -40 to 85 °C (D-version)
Package		32-pin plastic mold LQFP

1.3 Block Diagram

Figure 1.1 shows this MCU block diagram.

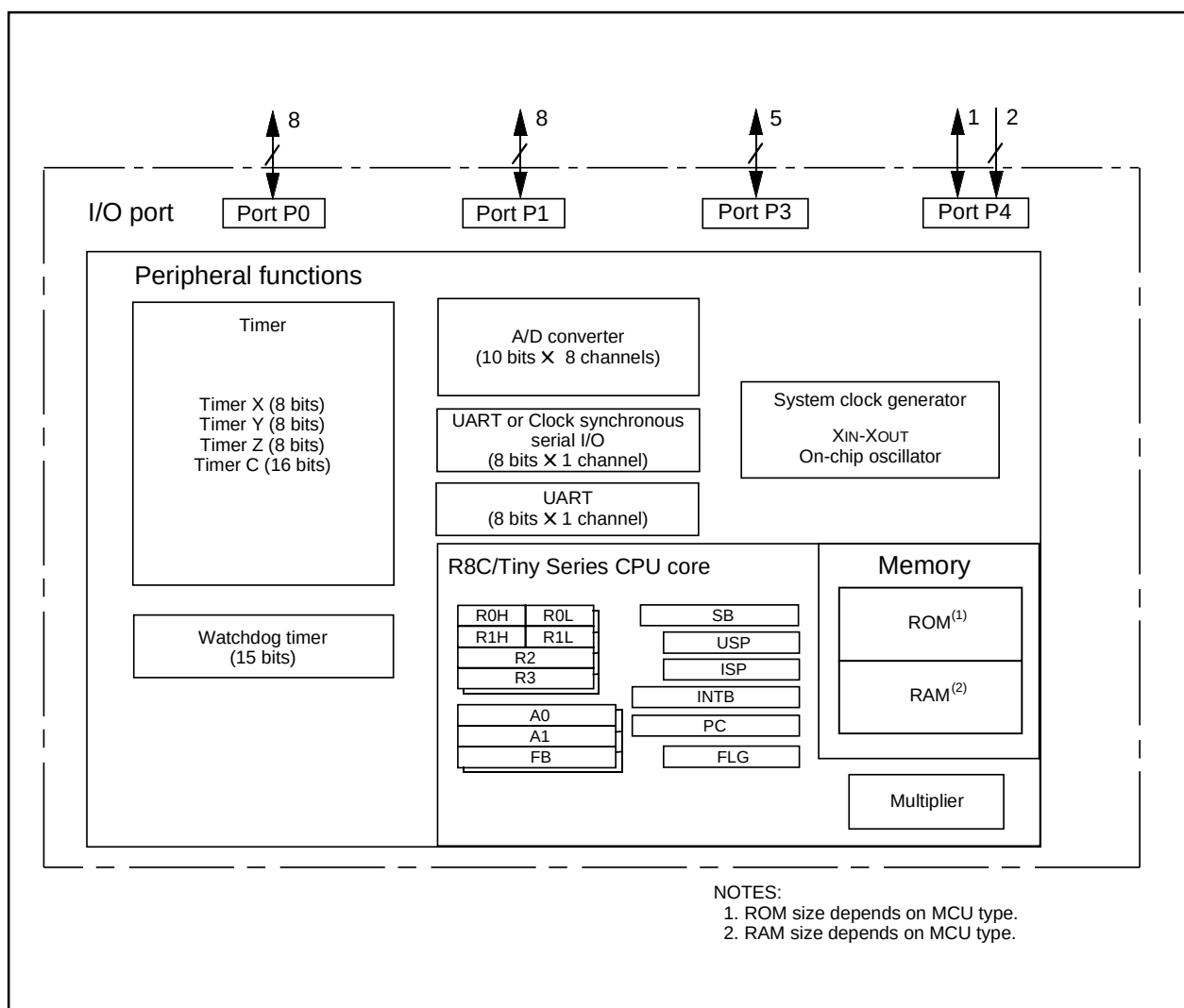


Figure 1.1 Block Diagram

1.4 Product Information

Table 1.2 lists the product information.

Table 1.2 Product Information

As of January 2006

Type No.	ROM capacity	RAM capacity	Package type	Remarks
R5F21102FP	8K bytes	512 bytes	PLQP0032GB-A	Flash memory version
R5F21103FP	12K bytes	768 bytes	PLQP0032GB-A	
R5F21104FP	16K bytes	1K bytes	PLQP0032GB-A	
R5F21102DFP	8K bytes	512 bytes	PLQP0032GB-A	D version
R5F21103DFP	12K bytes	768 bytes	PLQP0032GB-A	
R5F21104DFP	16K bytes	1K bytes	PLQP0032GB-A	

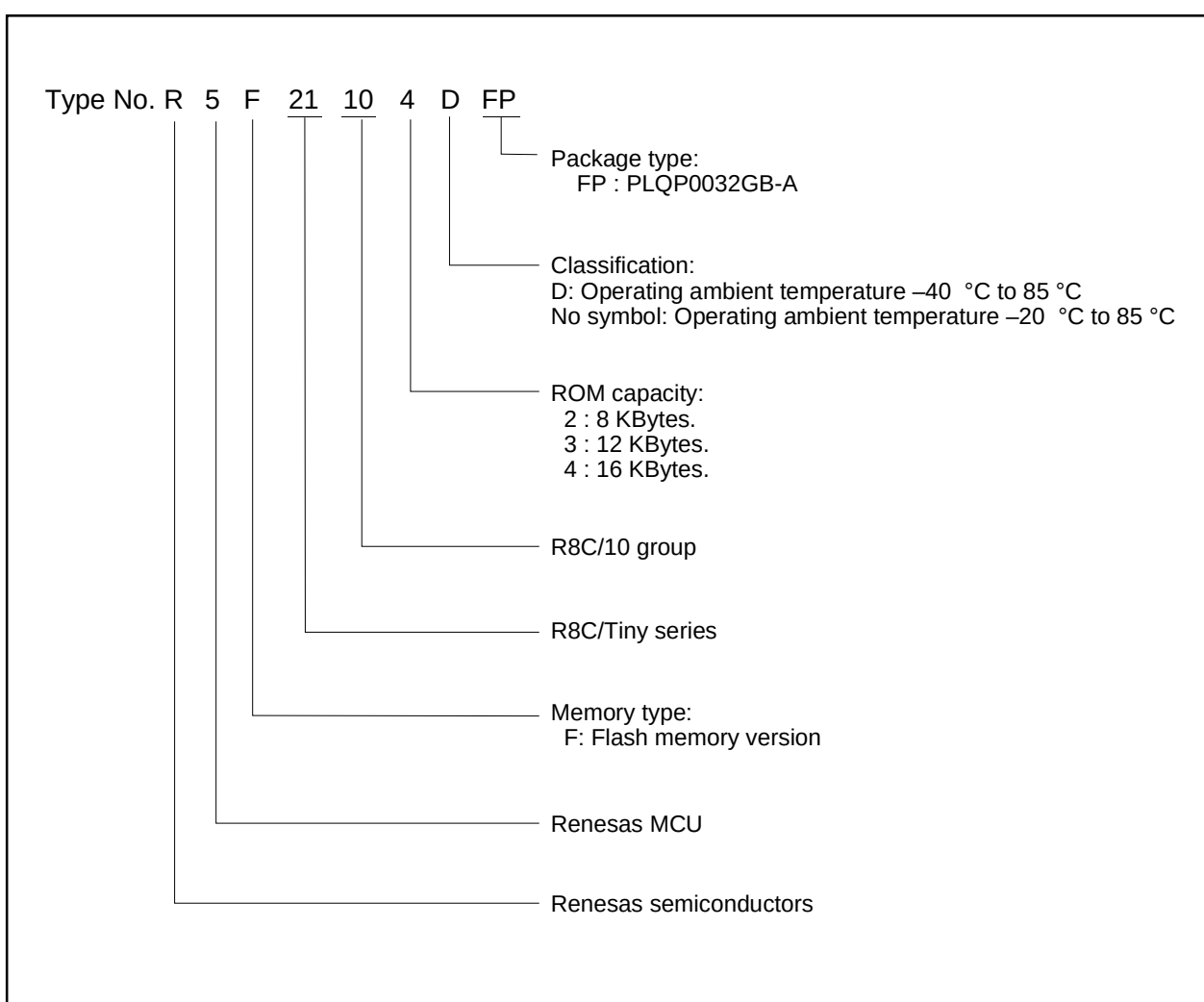


Figure 1.2 Type No., Memory Size, and Package

1.5 Pin Assignment

Figure 1.3 shows the pin Assignments (top view).

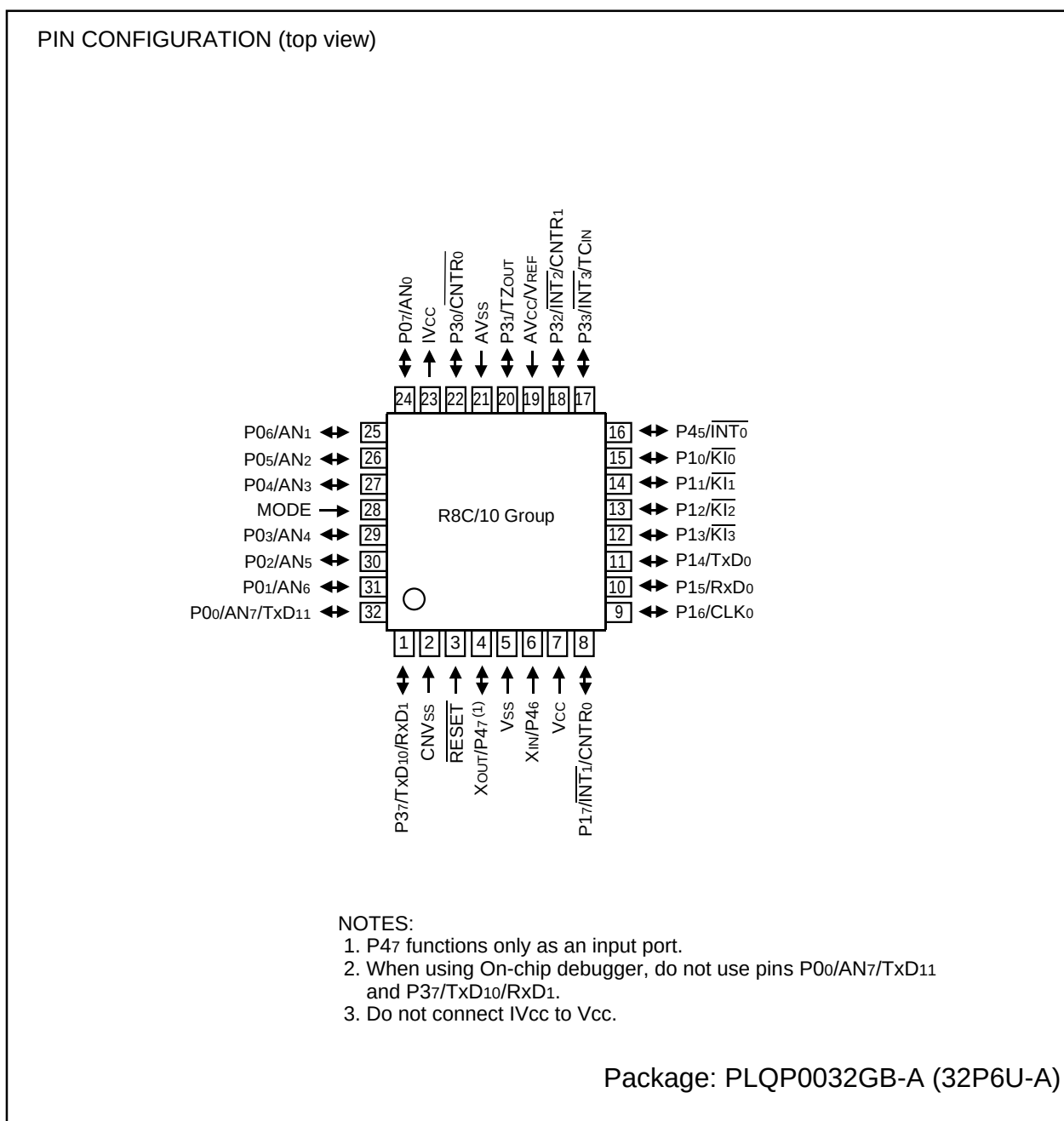


Figure 1.3 Pin Assignments (Top View)

1.6 Pin Description

Table 1.3 shows the pin description

Table 1.3 Pin description

Signal name	Pin name	I/O type	Function
Power supply input	Vcc, Vss	I	Apply 2.7 V to 5.5 V to the Vcc pin. Apply 0 V to the Vss pin.
IVcc	IVcc	O	This pin is to stabilize internal power supply. Connect this pin to Vss via a capacitor (0.1 μ F). Do not connect to Vcc.
Analog power supply input	AVcc, AVss	I	Power supply input pins for A/D converter. Connect the AVcc pin to Vcc. Connect the AVss pin to Vss. Connect a capacitor between pins AVcc and AVss.
Reset input	RESET	I	Input "L" on this pin resets the MCU.
CNVss	CNVss	I	Connect this pin to Vss via a resistor.
MODE	MODE	I	Connect this pin to Vcc via a resistor.
Main clock input	XIN	I	These pins are provided for the main clock generating circuit I/O. Connect a ceramic resonator or a crystal oscillator between the XIN and XOUT pins. To use an externally derived clock, input it to the XIN pin and leave the XOUT pin open.
Main clock output	XOUT	O	
INT interrupt input	INT0 to INT3	I	INT interrupt input pins.
Key input interrupt	KI0 to KI3	I	Key input interrupt pins.
Timer X	CNTR0	I/O	Timer X I/O pin
	CNTR0	O	Timer X output pin
Timer Y	CNTR1	I/O	Timer Y I/O pin
Timer Z	TZOUT	O	Timer Z output pin
Timer C	TCIN	I	Timer C input pin
Serial interface	CLK0	I/O	Transfer clock I/O pin.
	RxD0, RxD1	I	Serial data input pins.
	TxD0, TxD10, TxD11	O	Serial data output pins.
Reference voltage input	VREF	I	Reference voltage input pin for A/D converter. Connect the VREF pin to Vcc.
A/D converter	AN0 to AN7	I	Analog input pins for A/D converter
I/O port	P00 to P07, P10 to P17, P30 to P33, P37, P45	I/O	These are 8-bit CMOS I/O ports. Each port has an I/O select direction register, allowing each pin in that port to be directed for input or output individually. Any port set to input can select whether to use a pull-up resistor or not by program. P10 to P17 also function as LED drive ports.
Input port	P46, P47	I	Port for input-only.

2. Central Processing Unit (CPU)

Figure 2.1 shows the CPU registers. The CPU has 13 registers. Of these, R0, R1, R2, R3, A0, A1 and FB comprise a register bank. Two sets of register banks are provided.

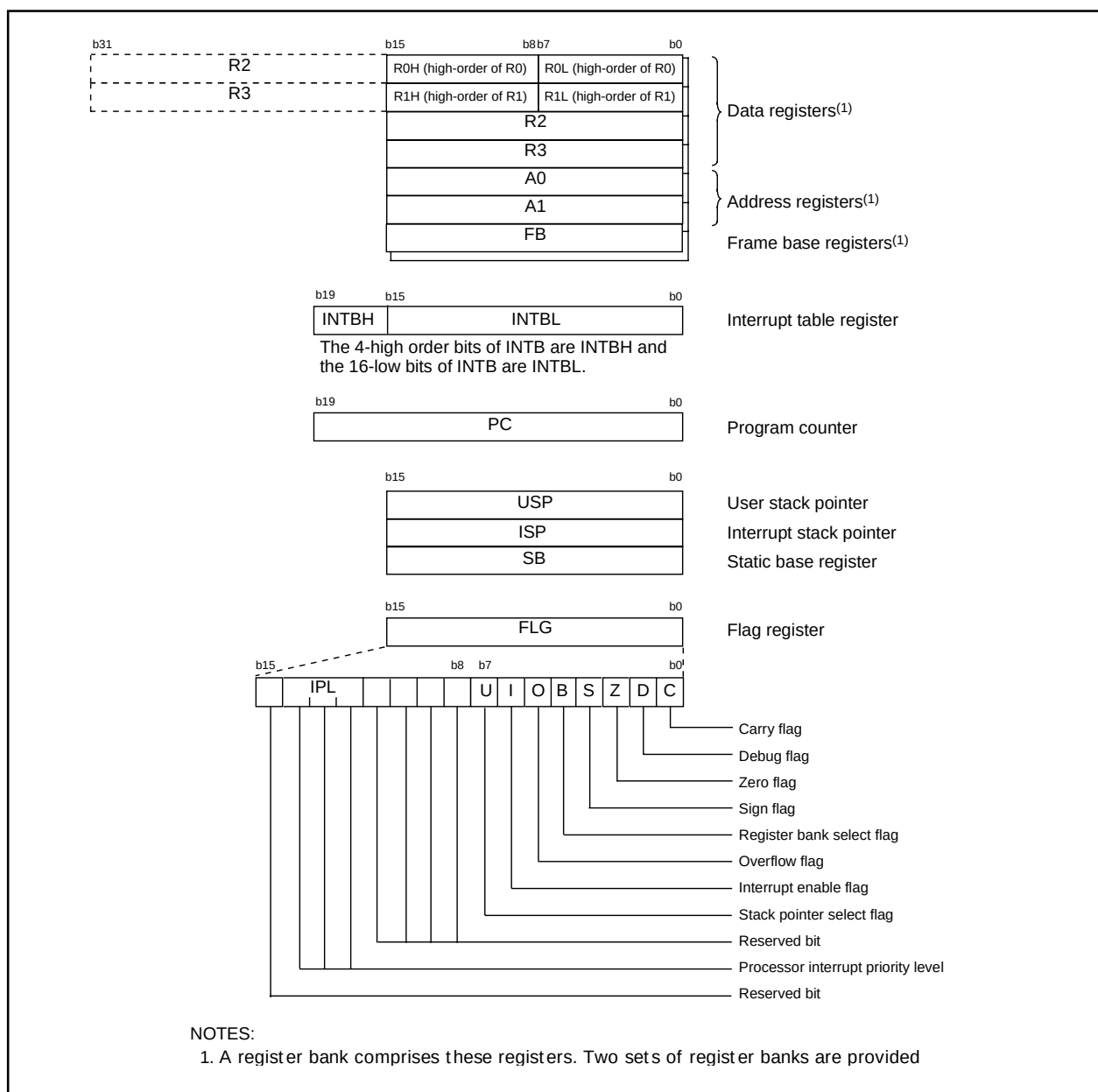


Figure 2.1 CPU Register

2.1 Data Registers (R0, R1, R2 and R3)

R0 is a 16-bit register for transfer, arithmetic and logic operations. The same applies to R1 to R3. The R0 can be split into high-order bit (R0H) and low-order bit (R0L) to be used separately as 8-bit data registers. The same applies to R1H and R1L as R0H and R0L. R2 can be combined with R0 to be used as a 32-bit data register (R2R0). The same applies to R3R1 as R2R0.

2.2 Address Registers (A0 and A1)

A0 is a 16-bit register for address register indirect addressing and address register relative addressing. They also are used for transfer, arithmetic and logic operations. The same applies to A1 as A0. A0 can be combined with A0 to be used as a 32-bit address register (A1A0).

2.3 Frame Base Register (FB)

FB is a 16-bit register for FB relative addressing.

2.4 Interrupt Table Register (INTB)

INTB is a 20-bit register indicates the start address of an interrupt vector table.

2.5 Program Counter (PC)

PC, 20 bits wide, indicates the address of an instruction to be executed.

2.6 User Stack Pointer (USP) and Interrupt Stack Pointer (ISP)

The stack pointer (SP), USP and ISP, are 16 bits wide each. The U flag of FLG is used to switch between USP and ISP.

2.7 Static Base Register (SB)

SB is a 16-bit register for SB relative addressing.

2.8 Flag Register (FLG)

FLG is a 11-bit register indicating the CPU state.

2.8.1 Carry Flag (C)

The C flag retains a carry, borrow, or shift-out bit that has occurred in the arithmetic logic unit.

2.8.2 Debug Flag (D)

The D flag is for debug only. Set to "0".

2.8.3 Zero Flag (Z)

The Z flag is set to "1" when an arithmetic operation resulted in 0; otherwise, "0".

2.8.4 Sign Flag (S)

The S flag is set to "1" when an arithmetic operation resulted in a negative value; otherwise, "0".

2.8.5 Register Bank Select Flag (B)

The register bank 0 is selected when the B flag is "0". The register bank 1 is selected when this flag is set to "1".

2.8.6 Overflow Flag (O)

The O flag is set to "1" when the operation resulted in an overflow; otherwise, "0".

2.8.7 Interrupt Enable Flag (I)

The I flag enables a maskable interrupt.

An interrupt is 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, 3 bits wide, assigns processor interrupt priority levels from level 0 to level 7.

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

2.8.10 Reserved Bit

When write to this bit, set to "0". When read, its content is indeterminate.

3. Memory

Figure 3.1 is a memory map of this MCU. This MCU provides 1-Mbyte address space from addresses 00000₁₆ to FFFFF₁₆.

The internal ROM is allocated lower addresses beginning with address 0C000₁₆. For example, a 16-Kbyte internal ROM is allocated addresses from 0C000₁₆ to 0FFFF₁₆.

The fixed interrupt vector table is allocated addresses 0FFDC₁₆ to 0FFFF₁₆. They store the starting address of each interrupt routine.

The internal RAM is allocated higher addresses beginning with address 00400₁₆. For example, a 1-Kbyte internal RAM is allocated addresses 00400₁₆ to 007FF₁₆. The internal RAM is used not only for storing data, but for calling subroutines and stacks when interrupt request is acknowledged.

Special function registers (SFR) are allocated addresses 00000₁₆ to 002FF₁₆. The peripheral function control registers are located there. All addresses, which have nothing allocated within the SFR, are reserved area and cannot be accessed by users.

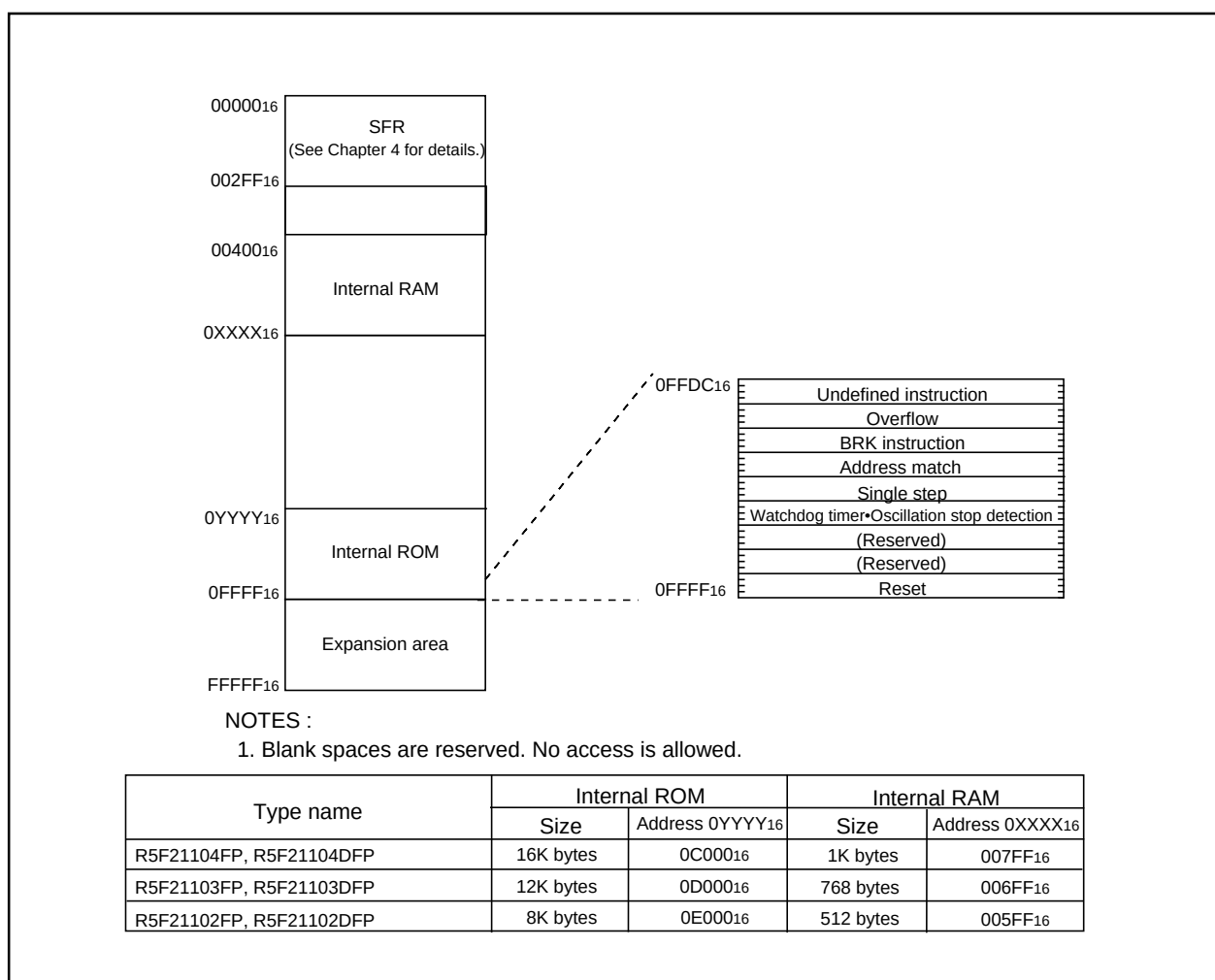


Figure 3.1 Memory Map

4. Special Function Register (SFR)

SFR(Special Function Register) is the control register of peripheral functions. Tables 4.1 to 4.4 list the SFR information

Table 4.1 SFR Information(1)(1)

Address	Register	Symbol	After reset
0000 ₁₆			
0001 ₁₆			
0002 ₁₆			
0003 ₁₆			
0004 ₁₆	Processor mode register 0	PM0	XXXX0X002
0005 ₁₆	Processor mode register 1	PM1	00XXX0X02
0006 ₁₆	System clock control register 0	CM0	011010002
0007 ₁₆	System clock control register 1	CM1	001000002
0008 ₁₆			
0009 ₁₆	Address match interrupt enable register	AIER	XXXXXX002
000A ₁₆	Protect register	PRCR	00XXX0002
000B ₁₆			
000C ₁₆	Oscillation stop detection register	OCD	000001002
000D ₁₆	Watchdog timer reset register	WDTR	XX16
000E ₁₆	Watchdog timer start register	WDTS	XX16
000F ₁₆	Watchdog timer control register	WDC	000111112
0010 ₁₆	Address match interrupt register 0	RMAD0	0016
0011 ₁₆			0016
0012 ₁₆			X016
0013 ₁₆			
0014 ₁₆	Address match interrupt register 1	RMAD1	0016
0015 ₁₆			0016
0016 ₁₆			X016
0017 ₁₆			
0018 ₁₆			
0019 ₁₆			
001A ₁₆			
001B ₁₆			
001C ₁₆			
001D ₁₆			
001E ₁₆	INT0 input filter select register	INT0F	XXXXX0002
001F ₁₆			
0020 ₁₆			
0021 ₁₆			
0022 ₁₆			
0023 ₁₆			
0024 ₁₆			
0025 ₁₆			
0026 ₁₆			
0027 ₁₆			
0028 ₁₆			
0029 ₁₆			
002A ₁₆			
002B ₁₆			
002C ₁₆			
002D ₁₆			
002E ₁₆			
002F ₁₆			
0030 ₁₆			
0031 ₁₆			
0032 ₁₆			
0033 ₁₆			
0034 ₁₆			
0035 ₁₆			
0036 ₁₆			
0037 ₁₆			
0038 ₁₆			
0039 ₁₆			
003A ₁₆			
003B ₁₆			
003C ₁₆			
003D ₁₆			
003E ₁₆			
003F ₁₆			

NOTES:

- Blank spaces are reserved. No access is allowed.

X : Undefined

Table 4.2 SFR Information(2)⁽¹⁾

Address	Register	Symbol	After reset
0040 ₁₆			
0041 ₁₆			
0042 ₁₆			
0043 ₁₆			
0044 ₁₆			
0045 ₁₆			
0046 ₁₆			
0047 ₁₆			
0048 ₁₆			
0049 ₁₆			
004A ₁₆			
004B ₁₆			
004C ₁₆			
004D ₁₆	Key input interrupt control register	KUPIC	XXXXX0002
004E ₁₆	AD conversion interrupt control register	ADIC	XXXXX0002
004F ₁₆			
0050 ₁₆			
0051 ₁₆	UART0 transmit interrupt control register	S0TIC	XXXXX0002
0052 ₁₆	UART0 receive interrupt control register	S0RIC	XXXXX0002
0053 ₁₆	UART1 transmit interrupt control register	S1TIC	XXXXX0002
0054 ₁₆	UART1 receive interrupt control register	S1RIC	XXXXX0002
0055 ₁₆	INT2 interrupt control register	INT2IC	XXXXX0002
0056 ₁₆	Timer X interrupt control register	TXIC	XXXXX0002
0057 ₁₆	Timer Y interrupt control register	TYIC	XXXXX0002
0058 ₁₆	Timer Z interrupt control register	TZIC	XXXXX0002
0059 ₁₆	INT1 interrupt control register	INT1IC	XXXXX0002
005A ₁₆	INT3 interrupt control register	INT3IC	XXXXX0002
005B ₁₆	Timer C interrupt control register	TCIC	XXXXX0002
005C ₁₆			
005D ₁₆	INT0 interrupt control register	INT0IC	XX00X0002
005E ₁₆			
005F ₁₆			
0060 ₁₆			
0061 ₁₆			
0062 ₁₆			
0063 ₁₆			
0064 ₁₆			
0065 ₁₆			
0066 ₁₆			
0067 ₁₆			
0068 ₁₆			
0069 ₁₆			
006A ₁₆			
006B ₁₆			
006C ₁₆			
006D ₁₆			
006E ₁₆			
006F ₁₆			
0070 ₁₆			
0071 ₁₆			
0072 ₁₆			
0073 ₁₆			
0074 ₁₆			
0075 ₁₆			
0076 ₁₆			
0077 ₁₆			
0078 ₁₆			
0079 ₁₆			
007A ₁₆			
007B ₁₆			
007C ₁₆			
007D ₁₆			
007E ₁₆			
007F ₁₆			

NOTES :

- Blank spaces are reserved. No access is allowed.

X : Undefined

Table 4.3 SFR Information(3)(1)

Address	Register	Symbol	After reset
0080 ₁₆	Timer Y, Z mode register	TYZMR	00 ₁₆
0081 ₁₆	Prescaler Y register	PREY	FF ₁₆
0082 ₁₆	Timer Y secondary register	TYSC	FF ₁₆
0083 ₁₆	Timer Y primary register	TYPR	FF ₁₆
0084 ₁₆	Timer Y, Z waveform output control register	PUM	00 ₁₆
0085 ₁₆	Prescaler Z register	PREZ	FF ₁₆
0086 ₁₆	Timer Z secondary register	TZSC	FF ₁₆
0087 ₁₆	Timer Z primary register	TZPR	FF ₁₆
0088 ₁₆			
0089 ₁₆			
008A ₁₆	Timer Y, Z output control register	TYZOC	00 ₁₆
008B ₁₆	Timer X mode register	TXMR	00 ₁₆
008C ₁₆	Prescaler X register	PREX	FF ₁₆
008D ₁₆	Timer X register	TX	FF ₁₆
008E ₁₆	Count source set register	TCSS	00 ₁₆
008F ₁₆			
0090 ₁₆	Timer C register	TC	00 ₁₆
0091 ₁₆			00 ₁₆
0092 ₁₆			
0093 ₁₆			
0094 ₁₆			
0095 ₁₆			
0096 ₁₆	External input enable register	INTEN	00 ₁₆
0097 ₁₆			
0098 ₁₆	Key input enable register	KIEN	00 ₁₆
0099 ₁₆			
009A ₁₆	Timer C control register 0	TCC0	00 ₁₆
009B ₁₆	Timer C control register 1	TCC1	00 ₁₆
009C ₁₆	Capture register	TM0	00 ₁₆
009D ₁₆			00 ₁₆
009E ₁₆			
009F ₁₆			
00A0 ₁₆	UART0 transmit/receive mode register	U0MR	00 ₁₆
00A1 ₁₆	UART0 bit rate generator	U0BRG	XX ₁₆
00A2 ₁₆	UART0 transmit buffer register	U0TB	XX ₁₆
00A3 ₁₆			XX ₁₆
00A4 ₁₆	UART0 transmit/receive control register 0	U0C0	00001000 ₂
00A5 ₁₆	UART0 transmit/receive control register 1	U0C1	00000010 ₂
00A6 ₁₆	UART0 receive buffer register	U0RB	XX ₁₆
00A7 ₁₆			XX ₁₆
00A8 ₁₆	UART1 transmit/receive mode register	U1MR	00 ₁₆
00A9 ₁₆	UART1 bit rate generator	U1BRG	XX ₁₆
00AA ₁₆	UART1 transmit buffer register	U1TB	XX ₁₆
00AB ₁₆			XX ₁₆
00AC ₁₆	UART1 transmit/receive control register 0	U1C0	00001000 ₂
00AD ₁₆	UART1 transmit/receive control register 1	U1C1	00000010 ₂
00AE ₁₆	UART1 receive buffer register	U1RB	XX ₁₆
00AF ₁₆			XX ₁₆
00B0 ₁₆	UART transmit/receive control register 2	UCON	00 ₁₆
00B1 ₁₆			
00B2 ₁₆			
00B3 ₁₆			
00B4 ₁₆			
00B5 ₁₆			
00B6 ₁₆			
00B7 ₁₆			
00B8 ₁₆			
00B9 ₁₆			
00BA ₁₆			
00BB ₁₆			
00BC ₁₆			
00BD ₁₆			
00BE ₁₆			
00BF ₁₆			

NOTES:

1. Blank spaces are reserved. No access is allowed.

X : Undefined

Table 4.4 SFR Information(4)⁽¹⁾

Address	Register	Symbol	After reset
00C0 ₁₆	AD register	AD	XXXXXXXXX2 XXXXXXXXX2
00C1 ₁₆			
00C2 ₁₆			
00C3 ₁₆			
00C4 ₁₆			
00C5 ₁₆			
00C6 ₁₆			
00C7 ₁₆			
00C8 ₁₆			
00C9 ₁₆			
00CA ₁₆			
00CB ₁₆			
00CC ₁₆			
00CD ₁₆			
00CE ₁₆			
00CF ₁₆			
00D0 ₁₆	AD control register 2	ADCON2	0016
00D1 ₁₆			
00D2 ₁₆			
00D3 ₁₆			
00D4 ₁₆			
00D5 ₁₆			
00D6 ₁₆			
00D7 ₁₆			
00D8 ₁₆			
00D9 ₁₆			
00DA ₁₆			
00DB ₁₆			
00DC ₁₆			
00DD ₁₆			
00DE ₁₆			
00DF ₁₆			
00E0 ₁₆	Port P0 register	P0	XX16
00E1 ₁₆	Port P1 register	P1	XX16
00E2 ₁₆	Port P0 direction register	PD0	0016
00E3 ₁₆	Port P1 direction register	PD1	0016
00E4 ₁₆	Port P3 register	P3	XX16
00E5 ₁₆			
00E6 ₁₆	Port P3 direction register	PD3	0016
00E7 ₁₆			
00E8 ₁₆	Port P4 register	P4	XX16
00E9 ₁₆	Port P4 direction register	PD4	0016
00EA ₁₆			
00EB ₁₆			
00EC ₁₆			
00ED ₁₆			
00EE ₁₆			
00EF ₁₆			
00F0 ₁₆			
00F1 ₁₆			
00F2 ₁₆			
00F3 ₁₆			
00F4 ₁₆			
00F5 ₁₆			
00F6 ₁₆			
00F7 ₁₆			
00F8 ₁₆			
00F9 ₁₆			
03FA ₁₆			
00FB ₁₆			
00FC ₁₆	Pull-up control register 0	PUR0	00XX00002
00FD ₁₆	Pull-up control register 1	PUR1	XXXXXXXX0X2
00FE ₁₆	Port P1 drive capacity control register	DRR	0016
00FF ₁₆			
01B3 ₁₆	Flash memory control register 4	FMR4	010000002
01B4 ₁₆	Flash memory control register 1	FMR1	0100XX0X2
01B5 ₁₆			
01B6 ₁₆	Flash memory control register 0	FMR0	000000012
01B7 ₁₆			

NOTES:

1. Blank columns, 0100₁₆ to 01B2₁₆ and 01B8₁₆ to 02FF₁₆ are all reserved. No access is allowed.

X : Undefined

5. Electrical Characteristics

Table 5.1 Absolute Maximum Ratings

Symbol	Parameter	Condition	Rated value	Unit
V _{CC}	Supply voltage	V _{CC} =AV _{CC}	-0.3 to 6.5	V
AV _{CC}	Analog supply voltage	V _{CC} =AV _{CC}	-0.3 to 6.5	V
V _I	Input voltage		-0.3 to V _{CC} +0.3	V
V _O	Output voltage		-0.3 to V _{CC} +0.3	V
P _d	Power dissipation	T _{opr} =25 °C	300	mW
T _{opr}	Operating ambient temperature		-20 to 85 / -40 to 85 (D version)	°C
T _{stg}	Storage temperature		-65 to 150	°C

Table 5.2 Recommended Operating Conditions

Symbol	Parameter	Conditions	Standard			Unit
			Min.	Typ.	Max.	
V _{CC}	Supply voltage		2.7	—	5.5	V
AV _{CC}	Analog supply voltage		—	V _{CC} (3)	—	V
V _{SS}	Supply voltage		—	0	—	V
AV _{SS}	Analog supply voltage		—	0	—	V
V _{IH}	"H" input voltage		0.8V _{CC}	—	V _{CC}	V
V _{IL}	"L" input voltage		0	—	0.2V _{CC}	V
I _{OH} (sum)	"H" peak all output currents	Sum of all pins' IOH (peak)	—	—	-60.0	mA
I _{OH} (peak)	"H" peak output current		—	—	-10.0	mA
I _{OH} (avg)	"H" average output current		—	—	-5.0	mA
I _{OL} (sum)	"L" peak all output currents	Sum of all pins' IOL (peak)	—	—	60	mA
I _{OL} (peak)	"L" peak output current	Except P10 to P17	—	—	10	mA
		P10 to P17	—	—	30	mA
		Drive capacity LOW	—	—	10	mA
I _{OL} (avg)	"L" average output current	Except P10 to P17	—	—	5	mA
		P10 to P17	—	—	15	mA
		Drive capacity LOW	—	—	5	mA
f (X _{IN})	Main clock input oscillation frequency	3.0V ≤ V _{CC} ≤ 5.5V	0	—	16	MHz
		2.7V ≤ V _{CC} < 3.0V	0	—	10	MHz

NOTES:

1. V_{CC} = AV_{CC} = 2.7 to 5.5V at T_{opr} = -20 to 85 °C / -40 to 85 °C, unless otherwise specified.
2. The typical values when average output current is 100ms.
3. Hold V_{CC}=AV_{CC}.

Table 5.3 A/D Conversion Characteristics

Symbol	Parameter		Measuring condition	Standard			Unit
				Min.	Typ.	Max.	
—	Resolution		$V_{ref} = V_{CC}$	—	—	10	Bit
—	Absolute accuracy	10 bit mode	$\phi AD = 10 \text{ MHz}$, $V_{ref} = V_{CC} = 5.0 \text{ V}$	—	—	± 3	LSB
		8 bit mode	$\phi AD = 10 \text{ MHz}$, $V_{ref} = V_{CC} = 5.0 \text{ V}$	—	—	± 2	LSB
		10 bit mode	$\phi AD = 10 \text{ MHz}$, $V_{ref} = V_{CC} = 3.3 \text{ V}^{(3)}$	—	—	± 5	LSB
		8 bit mode	$\phi AD = 10 \text{ MHz}$, $V_{ref} = V_{CC} = 3.3 \text{ V}^{(3)}$	—	—	± 2	LSB
R_{LADDER}	Ladder resistance		$V_{REF} = V_{CC}$	10	—	40	k Ω
t_{CONV}	Conversion time	10 bit mode	$\phi AD = 10 \text{ MHz}$, $V_{ref} = V_{CC} = 5.0 \text{ V}$	3.3	—	—	μs
		8 bit mode	$\phi AD = 10 \text{ MHz}$, $V_{ref} = V_{CC} = 5.0 \text{ V}$	2.8	—	—	μs
V_{REF}	Reference voltage			—	$V_{CC}^{(4)}$	—	V
V_{IA}	Analog input voltage			0	—	V_{ref}	V
—	A/D operating clock frequency ⁽²⁾	Without sample & hold		0.25	—	10	MHz
		With sample & hold		1.0	—	10	MHz

NOTES:

1. $V_{CC} = AV_{CC} = 2.7$ to 5.5 V at $T_{opr} = -20$ to $85 \text{ }^{\circ}\text{C}$ / -40 to $85 \text{ }^{\circ}\text{C}$, unless otherwise specified.
2. If f_{AD} exceeds 10 MHz , divide the f_{AD} and hold A/D operating clock frequency (ϕAD) 10 MHz or below.
3. If the AV_{CC} is less than 4.2 V , divide the f_{AD} and hold A/D operating clock frequency (ϕAD) $f_{AD}/2$ or below.
4. Hold $V_{CC} = V_{ref}$.

Table 5.4 Flash Memory Version Electrical Characteristics

Symbol	Parameter	Measuring condition	Standard			Unit
			Min.	Typ.	Max.	
—	Program/erase endurance		100	—	—	times
—	Byte program time		—	50	400	μs
—	Block erase time		—	0.4	9	s
$t_{d(SR-ES)}$	Time delay from suspend request until erase suspend		—	—	8	ms
—	Erase Suspend Request Interval		10	—	—	ms
—	Program, Erase voltage		2.7	—	5.5	V
—	Read voltage		2.7	—	5.5	V
—	Program, Erase temperature		0	—	60	$^{\circ}\text{C}$
—	Data hold time ⁽²⁾	Ambient temperature = $55 \text{ }^{\circ}\text{C}$	20	—	—	year

NOTES:

1. $V_{CC1} = AV_{CC} = 2.7$ to 5.5 V at $T_{opr} = 0$ to $60 \text{ }^{\circ}\text{C}$, unless otherwise specified.
2. The data hold time includes time that the power supply is off or the clock is not supplied.

Table 5.5 Power Circuit Timing Characteristics

Symbol	Parameter	Measuring condition	Standard			Unit
			Min.	Typ.	Max.	
$t_{d(P-R)}$	Time for internal power supply stabilization during powering-on ⁽²⁾		1	—	2000	μs
$t_{d(R-S)}$	STOP release time ⁽³⁾		—	—	150	μs

NOTES:

1. The measuring condition is $V_{CC} = AV_{CC} = 2.7$ to 5.5 V and $T_{opr} = 25 \text{ }^{\circ}\text{C}$.
2. This shows the waiting time until the internal power supply generating circuit is stabilized during powering-on.
3. This shows the time until BCLK starts from the interrupt acknowledgement to cancel stop mode.

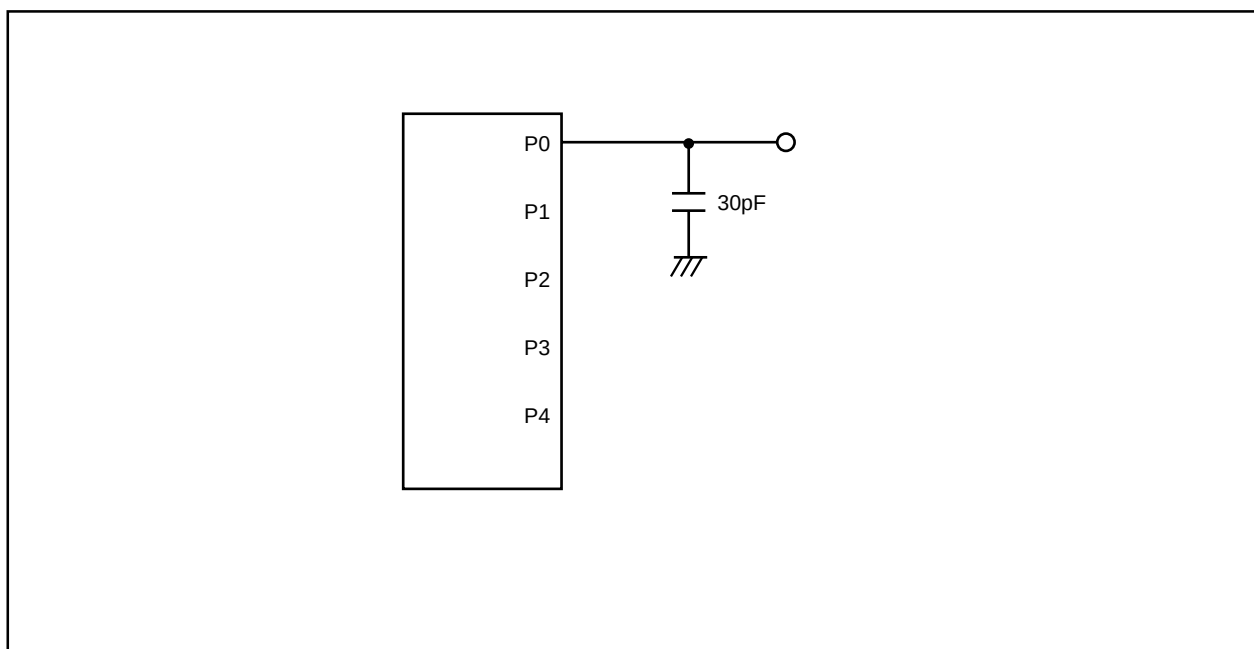
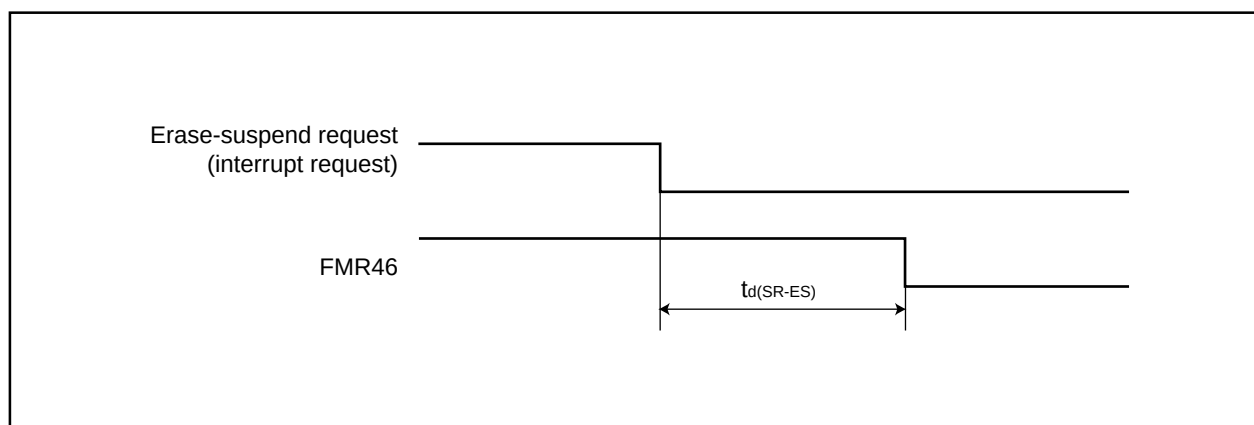
**Figure 5.1 Port P0 to P4 measurement circuit****Figure 5.2 Time delay from Suspend Request until Erase Suspend**

Table 5.6 Electrical Characteristics (1) [Vcc=5V]

Symbol	Parameter		Measuring condition	Standard			Unit
				Min.	Typ.	Max.	
VOH	"H" output voltage	Except XOUT	IOH=-5mA	Vcc-2.0		Vcc	V
			IOH=-200μA	Vcc-0.3		Vcc	V
	XOUT		Drive capacity HIGH IOH=-1 mA	Vcc-2.0		Vcc	V
			Drive capacity LOW IOH=-500μA	Vcc-2.0		Vcc	V
VOL	"L" output voltage	Except P10 to P17, XOUT	IOL= 5 mA			2.0	V
			IOL= 200 μA			0.45	V
	P10 to P17		Drive capacity HIGH IOL= 15 mA			2.0	V
			Drive capacity LOW IOL= 5 mA			2.0	V
			Drive capacity LOW IOL= 200 μA			0.45	V
	XOUT		Drive capacity HIGH IOL= 1 mA			2.0	V
			Drive capacity LOW IOL=500μA			2.0	V
VT+-VT-	Hysteresis	INT0, INT1, INT2, INT3, KI0, KI1, KI2, KI3, CNTR0, CNTR1, TCIN, RxD0, RxD1, P45		0.2		1.0	V
		RESET		0.2		2.2	V
IiH	"H" input current		Vi=5V			5.0	μA
IiL	"L" input current		Vi=0V			-5.0	μA
RPULLUP	Pull-up resistance		Vi=0V	30	50	167	kΩ
RtXIN	Feedback resistance	XIN			1.0		MΩ
fRING	On-chip oscillator frequency			40	125	250	kHz
V _{RAM}	RAM retention voltage		At stop mode	2.0			V

NOTES:

1. Referenced to Vcc=AVcc=4.2 to 5.5V at Topr = -20 to 85 °C / -40 to 85 °C, f(XIN)=20MHz unless otherwise specified.

Table 5.7 Electrical Characteristics (2) [Vcc=5V]

Symbol	Parameter	Measuring condition	Standard			Unit
			Min.	Typ.	Max.	
I _{CC}	Power supply current (V _{CC} =3.3 to 5.5V) In single-chip mode, the output pins are open and other pins are V _{SS}	High-speed mode X _{IN} =16 MHz (square wave) On-chip oscillator on=125 kHz No division	—	8	14	mA
		X _{IN} =10 MHz (square wave) On-chip oscillator on=125 kHz No division	—	5	—	mA
		Medium-speed mode X _{IN} =16 MHz (square wave) On-chip oscillator on=125 kHz Division by 8	—	3	—	mA
		X _{IN} =10 MHz (square wave) On-chip oscillator on=125 kHz Division by 8	—	2	—	mA
		On-chip oscillator mode Main clock off On-chip oscillator on=125 kHz Division by 8	—	470	900	μA
		Wait mode Main clock off On-chip oscillator on=125 kHz When a WAIT instruction is executed ⁽¹⁾ Peripheral clock operation	—	40	80	μA
		Wait mode Main clock off On-chip oscillator on=125 kHz When a WAIT instruction is executed ⁽¹⁾ Peripheral clock off	—	38	76	μA
		Stop mode Main clock off, T _{opr} = 25 °C On-chip oscillator off CM10="1" Peripheral clock off	—	0.8	3.0	μA

NOTES:

1. Timer Y is operated with timer mode.

2. Referenced to V_{CC} = AV_{CC} = 4.2 to 5.5V at T_{opr} = -20 to 85 °C / -40 to 85 °C, f(X_{IN})=20MHz unless otherwise specified.

Timing requirements (Unless otherwise noted: $V_{CC} = 5V$, $V_{SS} = 0V$ at $T_{opr} = 25^\circ C$) [$V_{CC}=5V$]**Table 5.8 XIN input**

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_c(XIN)$	XIN input cycle time	62.5	—	ns
$t_{WH}(XIN)$	XIN input HIGH pulse width	30	—	ns
$t_{WL}(XIN)$	XIN input LOW pulse width	30	—	ns

Table 5.9 CNTR0 input, CNTR1 input, $\overline{INT2}$ input

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_c(CNTR0)$	CNTR0 input cycle time	100	—	ns
$t_{WH}(CNTR0)$	CNTR0 input HIGH pulse width	40	—	ns
$t_{WL}(CNTR0)$	CNTR0 input LOW pulse width	40	—	ns

Table 5.10 TCIN input, $\overline{INT3}$ input

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_c(TCIN)$	TCIN input cycle time	400 ⁽¹⁾	—	ns
$t_{WH}(TCIN)$	TCIN input HIGH pulse width	200 ⁽²⁾	—	ns
$t_{WL}(TCIN)$	TCIN input LOW pulse width	200 ⁽²⁾	—	ns

NOTES:

1. When using the Timer C capture function, adjust the cycle time above (1/ Timer C count source frequency x 3).
2. When using the Timer C capture function, adjust the pulse width above (1/ Timer C count source frequency x 1.5).

Table 5.11 Serial Interface

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_c(CK)$	CLKi input cycle time	200	—	ns
$t_w(CKH)$	CLKi input HIGH pulse width	100	—	ns
$t_w(CKL)$	CLKi input LOW pulse width	100	—	ns
$t_d(C-Q)$	TxDi output delay time	—	80	ns
$t_h(C-Q)$	TxDi hold time	0	—	ns
$t_{su}(D-C)$	RxDi input setup time	35	—	ns
$t_h(C-D)$	RxDi input hold time	90	—	ns

Table 5.12 External interrupt $\overline{INT0}$ input

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_w(\overline{INH})$	$\overline{INT0}$ input HIGH pulse width	250 ⁽¹⁾	—	ns
$t_w(\overline{INL})$	$\overline{INT0}$ input LOW pulse width	250 ⁽²⁾	—	ns

NOTES:

1. When selecting the digital filter by the $\overline{INT0}$ input filter select bit, use the $\overline{INT0}$ input HIGH pulse width to the greater value, either (1/ digital filter clock frequency x 3) or the minimum value of standard.
2. When selecting the digital filter by the $\overline{INT0}$ input filter select bit, use the $\overline{INT0}$ input LOW pulse width to the greater value, either (1/ digital filter clock frequency x 3) or the minimum value of standard.

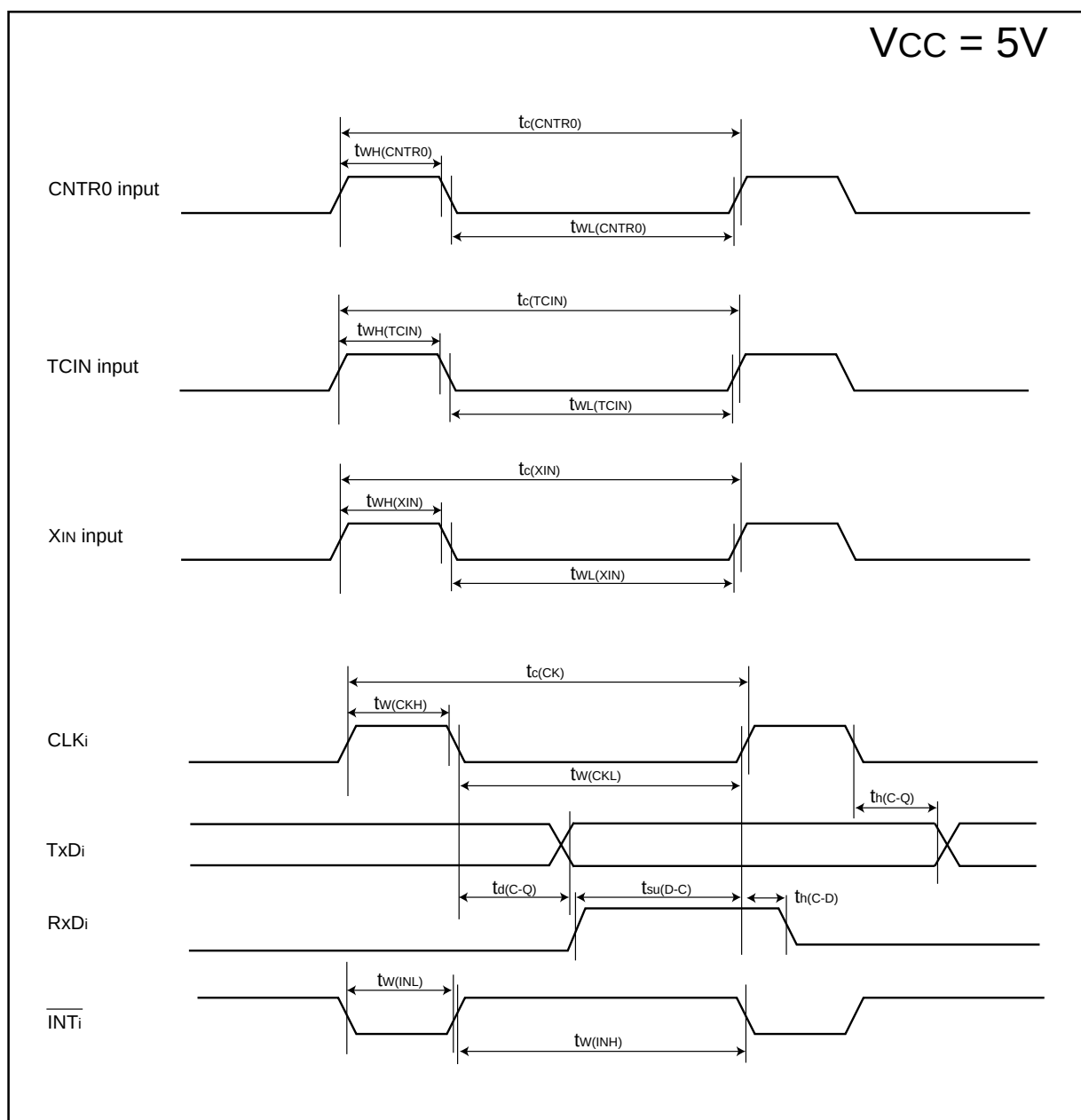
Figure 5.3 $V_{CC}=5V$ timing diagram

Table 5.13 Electrical Characteristics (3) [Vcc=3V]

Symbol	Parameter		Measuring condition		Standard			Unit
					Min.	Typ.	Max.	
V _{OH}	"H" output voltage	Except X _{OUT}	I _{OH} =-1mA		V _{CC} -0.5	—	V _{CC}	V
		X _{OUT}	Drive capacity HIGH	I _{OH} =-0.1 mA	V _{CC} -0.5	—	V _{CC}	V
			Drive capacity LOW	I _{OH} =-50 μA	V _{CC} -0.5	—	V _{CC}	V
V _{OL}	"L" output voltage	Except P10 to P17, X _{OUT}	I _{OL} = 1 mA		—	—	0.5	V
		P10 to P17	Drive capacity HIGH	I _{OL} = 2 mA	—	—	0.5	V
			Drive capacity LOW	I _{OL} = 1 mA	—	—	0.5	V
		X _{OUT}	Drive capacity HIGH	I _{OL} = 0.1 mA	—	—	0.5	V
			Drive capacity LOW	I _{OL} =50 μA	—	—	0.5	V
V _{T+} -V _{T-}	Hysteresis	INT0, INT1, INT2, INT3, KI0, KI1, KI2, KI3, CNTR0, CNTR1, TCIN, RxD0, RxD1, P45			0.2	—	0.8	V
		RESET			0.2	—	1.8	V
I _{IH}	"H" input current		V _I =3V		—	—	4.0	μA
I _{IL}	"L" input current		V _I =0V		—	—	-4.0	μA
R _{PULLUP}	Pull-up resistance		V _I =0V		66	160	500	kΩ
R _{XIN}	Feedback resistance	X _{IN}			—	3.0	—	MΩ
f _{RING}	On-chip oscillator frequency				40	125	250	kHz
V _{RAM}	RAM retention voltage		At stop mode		2.0	—	—	V

NOTES:

1. Referenced to V_{CC}=AV_{CC}=2.7 to 3.3V at T_{opr} = -20 to 85 °C / -40 to 85 °C, f(X_{IN})=10MHz unless otherwise specified.

Table 5.14 Electrical Characteristics (4) [Vcc=3V]

Symbol	Parameter	Measuring condition		Standard			Unit
				Min.	Typ.	Max.	
I _{CC}	Power supply current (V _{CC1} =2.7 to 3.3V) In single-chip mode, the output pins are open and other pins are V _{SS}	High-speed mode	X _{IN} =16 MHz (square wave) On-chip oscillator on=125 kHz No division	—	7	12	mA
			X _{IN} =10 MHz (square wave) On-chip oscillator on=125 kHz No division	—	5	—	mA
		Medium-speed mode	X _{IN} =16 MHz (square wave) On-chip oscillator on=125 kHz Division by 8	—	2.5	—	mA
			X _{IN} =10 MHz (square wave) On-chip oscillator on=125 kHz Division by 8	—	1.6	—	mA
		On-chip oscillator mode	Main clock off On-chip oscillator on=125 kHz Division by 8	—	420	800	μA
		Wait mode	Main clock off On-chip oscillator on=125 kHz When a WAIT instruction is executed ⁽¹⁾ Peripheral clock operation	—	37	74	μA
		Wait mode	Main clock off On-chip oscillator on=125 kHz When a WAIT instruction is executed ⁽¹⁾ Peripheral clock off	—	35	70	μA
		Stop mode	Main clock off, T _{opr} = 25 °C On-chip oscillator off CM10="1" Peripheral clock off	—	0.7	3.0	μA

NOTES:

1. Timer Y is operated with timer mode.

2. Referenced to V_{CC}=AV_{CC}=2.7 to 3.3V at T_{opr} = -20 to 85 °C / -40 to 85 °C, f(X_{IN})=10MHz unless otherwise specified.

Timing requirements (Unless otherwise noted: $V_{CC} = 3V$, $V_{SS} = 0V$ at $T_{opr} = 25\text{ }^{\circ}C$) [$V_{CC}=3V$]**Table 5.15 X_{IN} input**

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_C(X_{IN})$	X_{IN} input cycle time	100	—	ns
$t_{WH}(X_{IN})$	X_{IN} input HIGH pulse width	40	—	ns
$t_{WL}(X_{IN})$	X_{IN} input LOW pulse width	40	—	ns

Table 5.16 CNTR0 input, CNTR1 input, $\overline{INT2}$ input

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_C(CNTR0)$	CNTR0 input cycle time	300	—	ns
$t_{WH}(CNTR0)$	CNTR0 input HIGH pulse width	120	—	ns
$t_{WL}(CNTR0)$	CNTR0 input LOW pulse width	120	—	ns

Table 5.17 TCIN input, $\overline{INT3}$ input

Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_C(TCIN)$	TCIN input cycle time	1200 ⁽¹⁾	—	ns
$t_{WH}(TCIN)$	TCIN input HIGH pulse width	600 ⁽²⁾	—	ns
$t_{WL}(TCIN)$	TCIN input LOW pulse width	600 ⁽²⁾	—	ns

NOTES:

1. When using the Timer C capture function, adjust the cycle time above (1/ Timer C count source frequency x 3).
2. When using the Timer C capture function, adjust the pulse width above (1/ Timer C count source frequency x 1.5).

Table 5.18 Serial Interface

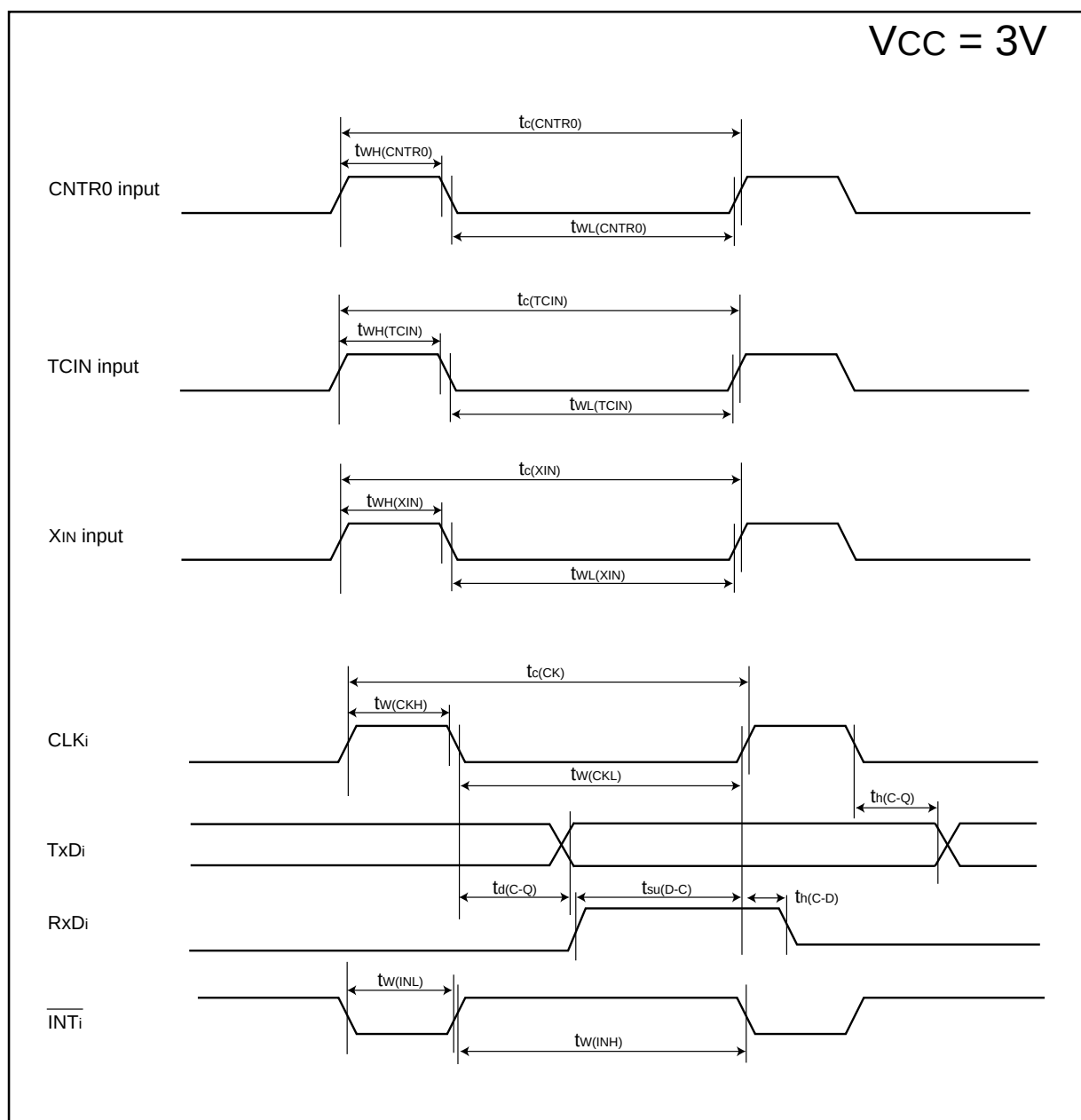
Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_C(CK)$	CLKi input cycle time	300	—	ns
$t_W(CKH)$	CLKi input HIGH pulse width	150	—	ns
$t_W(CKL)$	CLKi input LOW pulse width	150	—	ns
$t_d(C-Q)$	TxDi output delay time	—	160	ns
$t_h(C-Q)$	TxDi hold time	0	—	ns
$t_{su}(D-C)$	RxDi input setup time	55	—	ns
$t_h(C-D)$	RxDi input hold time	90	—	ns

Table 5.19 External interrupt $\overline{INT0}$ input

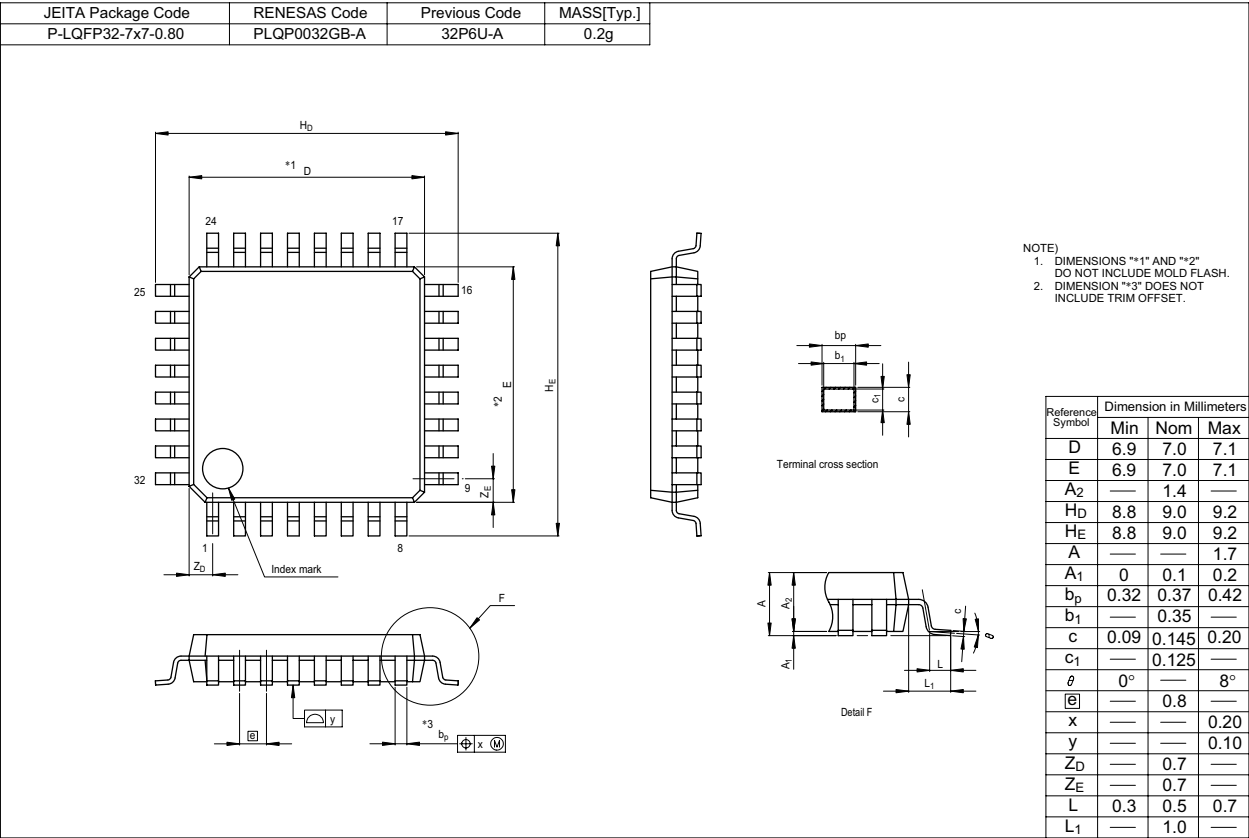
Symbol	Parameter	Standard		Unit
		Min.	Max.	
$t_W(INH)$	$\overline{INT0}$ input HIGH pulse width	380 ⁽¹⁾	—	ns
$t_W(INL)$	$\overline{INT0}$ input LOW pulse width	380 ⁽²⁾	—	ns

NOTES:

1. When selecting the digital filter by the $\overline{INT0}$ input filter select bit, use the $\overline{INT0}$ input HIGH pulse width to the greater value, either (1/ digital filter clock frequency x 3) or the minimum value of standard.
2. When selecting the digital filter by the $\overline{INT0}$ input filter select bit, use the $\overline{INT0}$ input LOW pulse width to the greater value, either (1/ digital filter clock frequency x 3) or the minimum value of standard.

Figure 5.4 $V_{CC}=3V$ timing diagram

Package Dimensions



REVISION HISTORY	R8C/10 Group Datasheet
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Rev.	Date	Description	
		Page	Summary
1.00	Jun. 19, 2003		First edition issued
1.10	Sep. 08, 2003	2 5 6 12 14	Table 1.1: Shortest instruction execution time and $f(X_{IN})$ changed Figure 1.3: Pin name changed from TXOUT to $\overline{CNTR0}$ Table 1.3: Pin name changed from TXOUT to $\overline{CNTR0}$ The value of Time C register after reset changed Chapter "5. Electrical Characteristics" added
1.20	Oct. 31, 2003	2 6 14 15 16 18 19 20 21 22 23 24	Table 1.1: Power consumption values added Table 1.3: Resistor value for CNVss and MODE deleted Table 5.2: Note 3 and Note 4 deleted tsamp in Table 5.3 deleted Figure 5.1 added Table 5.7: Vcc changed from "4.2 to 5.5V" to "3.3V to 5.5V", on-chip oscillator changed from "on 100kHz" to "125kHz", $X_{IN}=5\text{MHz}$ deleted and $X_{IN}=10\text{MHz}$ added in high-speed mode and medium-speed mode, data added and modified Table 5.8 to Table 5.12 added Figure 5.2 added Table 5.13: Note 1, $f(BCLK)=5\text{ MHz}$ changed to 10 MHz Table 5.14: on-chip oscillator changed from "on 100kHz" to "125kHz", $X_{IN}=5\text{MHz}$ deleted and $X_{IN}=10\text{MHz}$ added in high-speed mode and medium-speed mode, data added and modified Table 5.15 to Table 5.19 added Figure 5.3 added
1.30	Dec 05, 2003	4 15	Table 1.2 : ** deleted Table 5.4 revised
1.40	Sep 30, 2004	All pages 2 5 6 10-13 12 14 15 17 18 19 21 22 23	Words standardized (on-chip oscillator, serial interface, A/D) Table 1.1 revised Figure 1.3, NOTES 3 added Table 1.3 revised One body sentence in chapter 4 added ; Titles 4.1 to 4.4 added Table 4.3 revised ; Table 4.4 revised Table 5.2 revised Table 5.3 revised ; Table 5.4 revised Table 5.6 revised Table 5.7 revised Table 5.8 revised ; Table 5.12 revised Table 5.13 revised Table 5.14 revised Table 5.15 revised ; Table 5.17 revised ; Table 5.19 revised
1.50	Apr.27.2005	4 5 10	Table 1.2, Figure 1.2 package name revised Figure 1.3 package name revised Table 4.1 revised

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