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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 ( $f(XIN) = 16$ MHz, $VCC = 3.0$ to $5.5$ V)<br>100 ns ( $f(XIN) = 10$ MHz, $VCC = 2.7$ 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,<br>Timer Z: 8 bits x 1 channel<br>(Each timer equipped with 8-bit prescaler)<br>Timer C: 16 bits x 1 channel<br>(Input capture circuit)                     |
|                               | Serial interface                    | •1 channel<br>Clock synchronous, UART<br>•1 channel<br>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,<br>Software: 4 factors, Priority level: 7 levels  |
|                               | Clock generation circuit            | 2 circuits<br>•Main clock generation circuit (Equipped with a built-in feedback resistor)<br>•On-chip oscillator  |
|                               | Oscillation stop detection function | Main clock oscillation stop detection function  |
|                               | Electrical characteristics          | Supply voltage  |
| Power consumption             |                                     | Typ. 8mA ( $VCC = 5.0$ V, ( $f(XIN) = 16$ MHz)<br>Typ. 5mA ( $VCC = 3.0$ V, ( $f(XIN) = 10$ MHz)<br>Typ. 35 $\mu$ A ( $VCC = 3.0$ V, Wait mode, Peripheral clock off)<br>Typ. 0.7 $\mu$ A ( $VCC = 3.0$ V, Stop mode) |
| Flash memory                  | Program/erase supply voltage        | $VCC = 2.7$ to $5.5$ V  |
|                               | Program/erase endurance             | 100 times   |
| Operating ambient temperature |                                     | -20 to 85 °C<br>-40 to 85 °C (D-version)  |
| Package                       |                                     | 32-pin plastic mold LQFP  |

### 1.3 Block Diagram

Figure 1.1 shows this MCU block diagram.

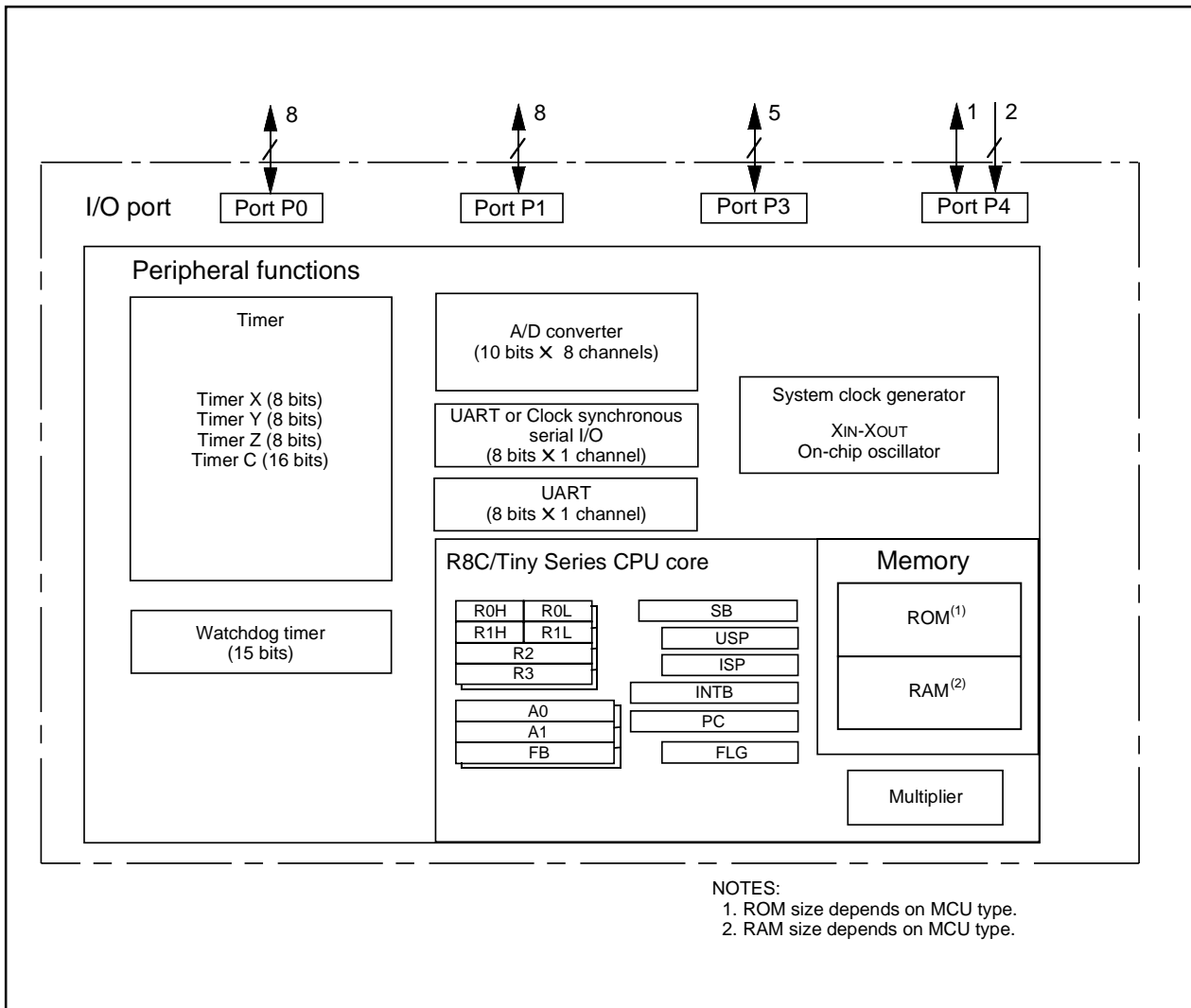


Figure 1.1 Block Diagram

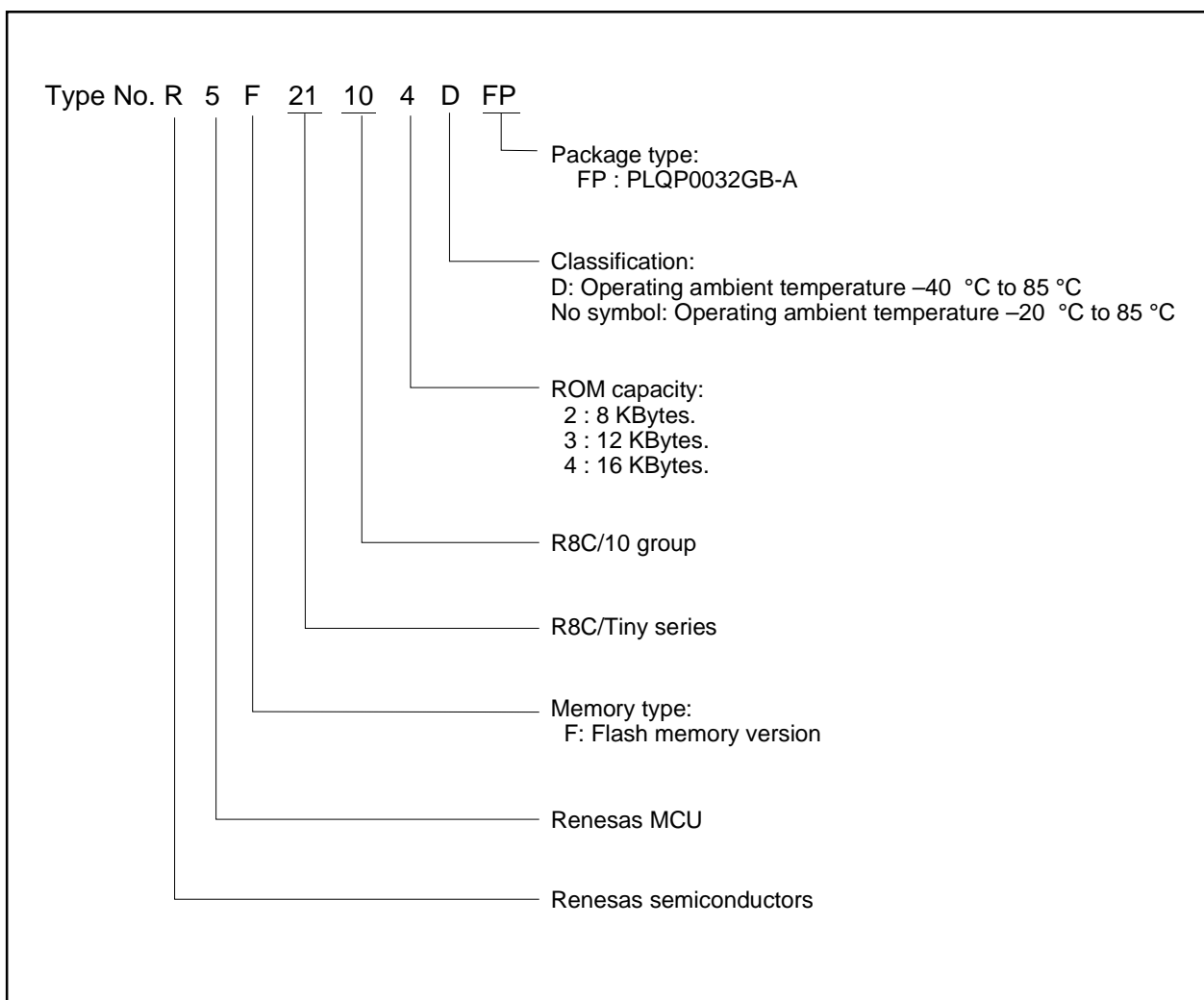
### 1.4 Product Information

Table 1.2 lists the product information.

**Table 1.2 Product Information**

As of January 2006

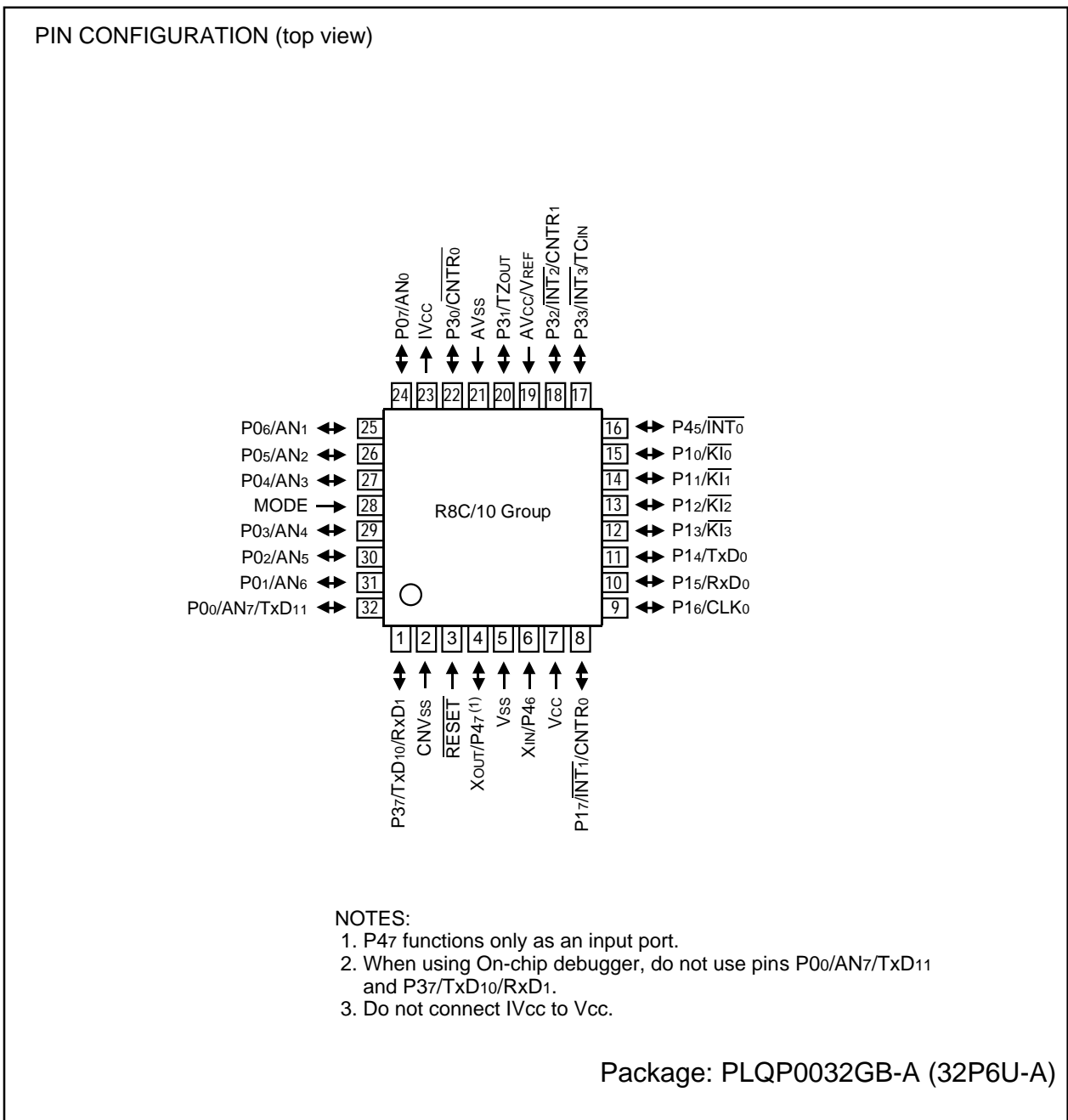
| Type No.    | ROM capacity | RAM capacity | Package type | Remarks              |
|-------------|--------------|--------------|--------------|----------------------|
| R5F21102FP  | 8K bytes     | 512 bytes    | PLQP0032GB-A | Flash memory version |
| R5F21103FP  | 12K bytes    | 768 bytes    | PLQP0032GB-A |                      |
| 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).



**NOTES:**

1. P47 functions only as an input port.
2. When using On-chip debugger, do not use pins P00/AN7/TxD11 and P37/TxD10/RxD1.
3. Do not connect IVcc to Vcc.

**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 $\mu$ 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       | INT $\bar{0}$ to INT $\bar{3}$   | I        | INT interrupt input pins.  |
| Key input interrupt       | KI0 to KI3   | I        | Key input interrupt pins.  |
| Timer X                   | CNTR $\bar{0}$   | I/O      | Timer X I/O pin  |
|                           | CNTR $\bar{0}$   | O        | Timer X output pin   |
| Timer Y                   | CNTR $\bar{1}$   | 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          | CLK $\bar{0}$  | I/O      | Transfer clock I/O pin.  |
|                           | RxD $\bar{0}$ , RxD $\bar{1}$  | I        | Serial data input pins.  |
|                           | TxD $\bar{0}$ , TxD $\bar{10}$ , TxD $\bar{11}$  | 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             | AN $\bar{0}$ to AN $\bar{7}$   | I        | Analog input pins for A/D converter  |
| I/O port                  | P0 $\bar{0}$ to P0 $\bar{7}$ , P1 $\bar{0}$ to P1 $\bar{7}$ , P3 $\bar{0}$ to P3 $\bar{3}$ , P3 $\bar{7}$ , P4 $\bar{5}$ | 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. P1 $\bar{0}$ to P1 $\bar{7}$ also function as LED drive ports. |
| Input port                | P4 $\bar{6}$ , P4 $\bar{7}$  | 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.

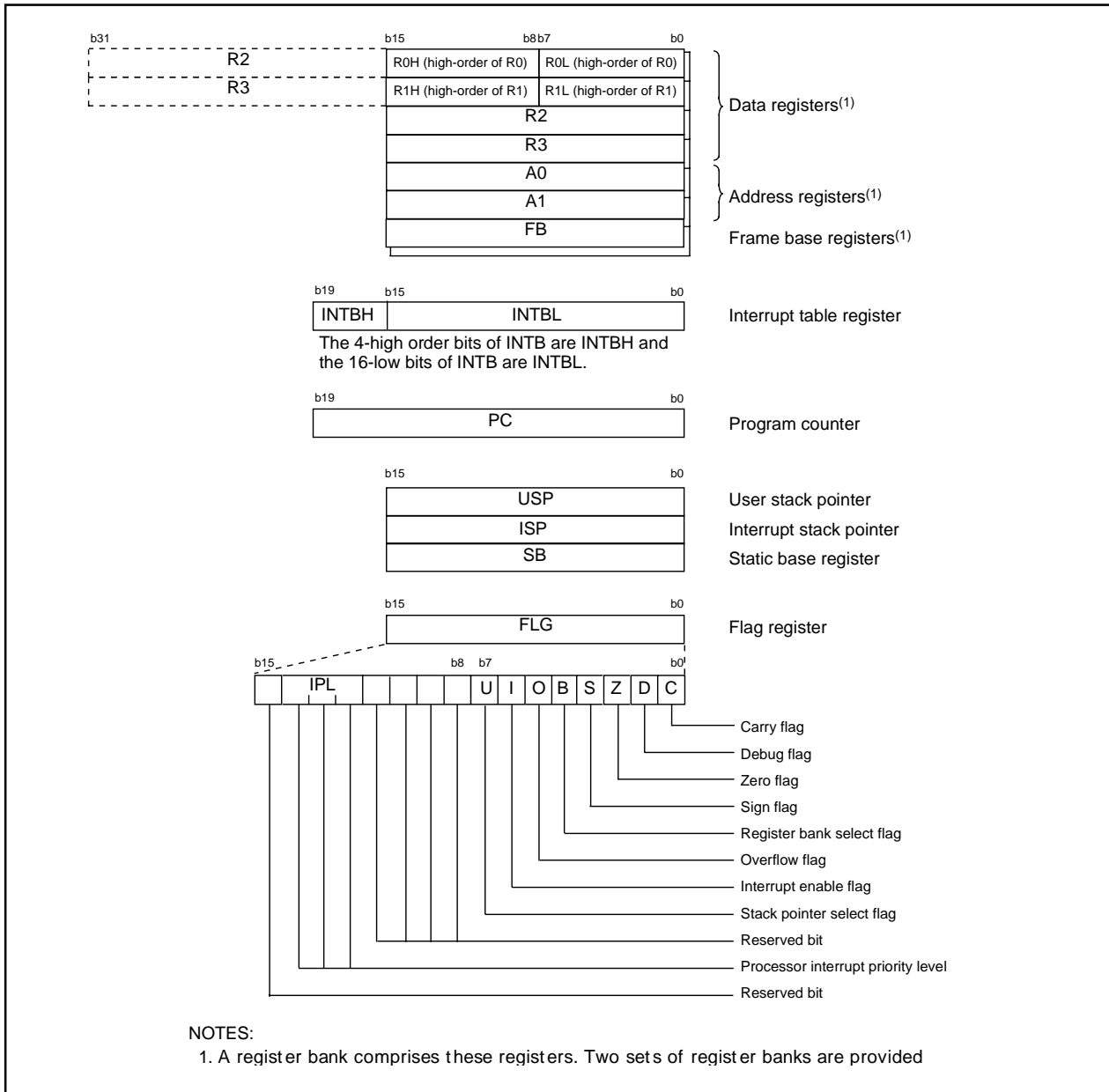


Figure 2.1 CPU Register

### 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 A1 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 00000<sub>16</sub> to FFFFF<sub>16</sub>.

The internal ROM is allocated lower addresses beginning with address 0FFFF<sub>16</sub>. For example, a 16-Kbyte internal ROM is allocated addresses from 0C000<sub>16</sub> to 0FFFF<sub>16</sub>.

The fixed interrupt vector table is allocated addresses 0FFDC<sub>16</sub> to 0FFFF<sub>16</sub>. They store the starting address of each interrupt routine.

The internal RAM is allocated higher addresses beginning with address 00400<sub>16</sub>. For example, a 1-Kbyte internal RAM is allocated addresses 00400<sub>16</sub> to 007FF<sub>16</sub>. 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 00000<sub>16</sub> to 002FF<sub>16</sub>. 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.

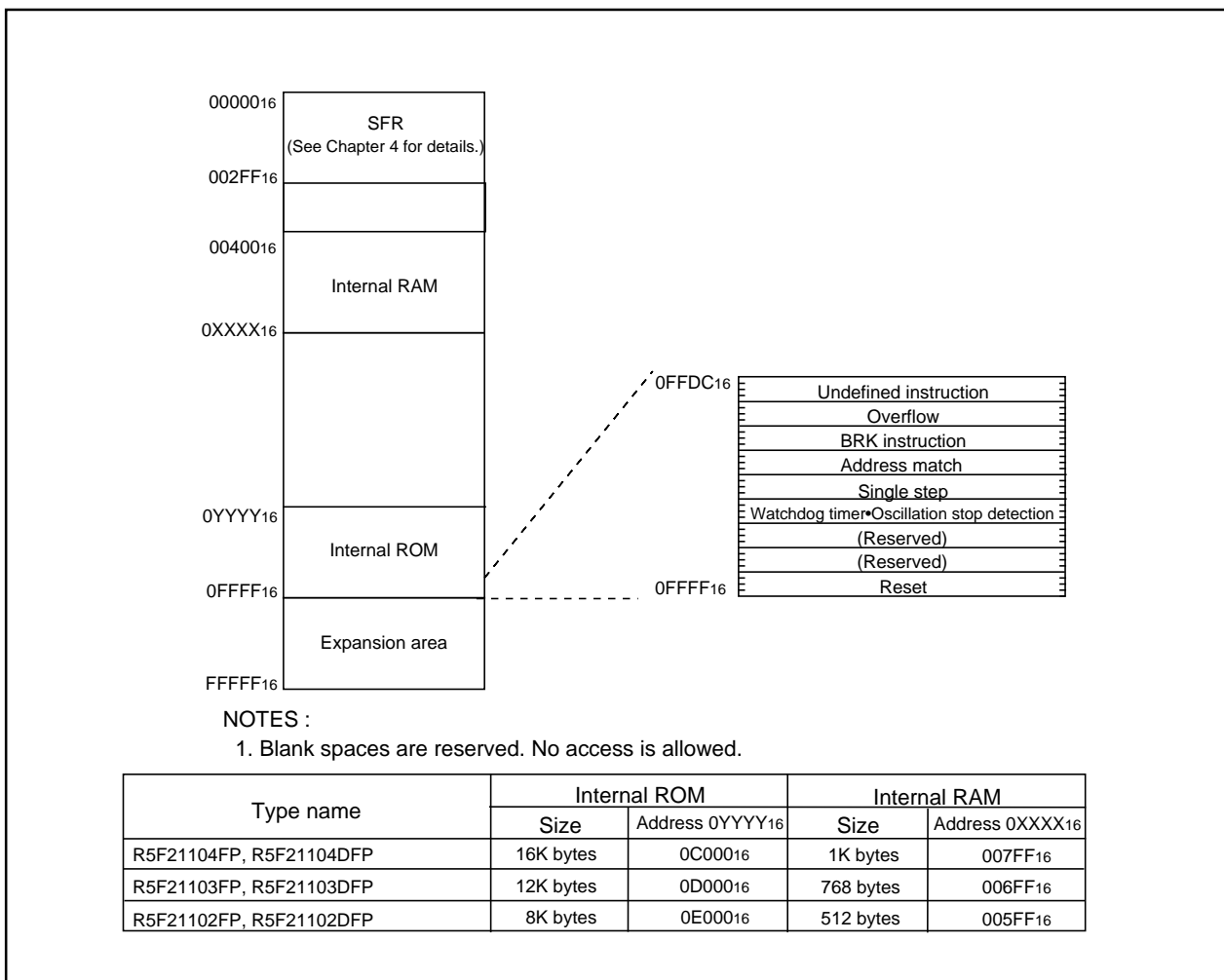


Figure 3.1 Memory Map

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

**NOTES:**

- Blank spaces are reserved. No access is allowed.

X : Undefined

**Table 4.2 SFR Information(2)<sup>(1)</sup>**

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

## NOTES :

- Blank spaces are reserved. No access is allowed.

X : Undefined

**Table 4.3 SFR Information(3)<sup>(1)</sup>**

| Address            | Register                                    | Symbol | After reset |
|--------------------|---|--------|-------------|
| 0080 <sub>16</sub> | Timer Y, Z mode register                    | TYZMR  | 0016        |
| 0081 <sub>16</sub> | Prescaler Y register                        | PREY   | FF16        |
| 0082 <sub>16</sub> | Timer Y secondary register                  | TYSC   | FF16        |
| 0083 <sub>16</sub> | Timer Y primary register                    | TYPR   | FF16        |
| 0084 <sub>16</sub> | Timer Y, Z waveform output control register | PUM    | 0016        |
| 0085 <sub>16</sub> | Prescaler Z register                        | PREZ   | FF16        |
| 0086 <sub>16</sub> | Timer Z secondary register                  | TZSC   | FF16        |
| 0087 <sub>16</sub> | Timer Z primary register                    | TZPR   | FF16        |
| 0088 <sub>16</sub> |   |        |             |
| 0089 <sub>16</sub> |   |        |             |
| 008A <sub>16</sub> | Timer Y, Z output control register          | TYZOC  | 0016        |
| 008B <sub>16</sub> | Timer X mode register                       | TXMR   | 0016        |
| 008C <sub>16</sub> | Prescaler X register                        | PREX   | FF16        |
| 008D <sub>16</sub> | Timer X register                            | TX     | FF16        |
| 008E <sub>16</sub> | Count source set register                   | TCSS   | 0016        |
| 008F <sub>16</sub> |   |        |             |
| 0090 <sub>16</sub> | Timer C register                            | TC     | 0016        |
| 0091 <sub>16</sub> |   |        | 0016        |
| 0092 <sub>16</sub> |   |        |             |
| 0093 <sub>16</sub> |   |        |             |
| 0094 <sub>16</sub> |   |        |             |
| 0095 <sub>16</sub> |   |        |             |
| 0096 <sub>16</sub> | External input enable register              | INTEN  | 0016        |
| 0097 <sub>16</sub> |   |        |             |
| 0098 <sub>16</sub> | Key input enable register                   | KIEN   | 0016        |
| 0099 <sub>16</sub> |   |        |             |
| 009A <sub>16</sub> | Timer C control register 0                  | TCC0   | 0016        |
| 009B <sub>16</sub> | Timer C control register 1                  | TCC1   | 0016        |
| 009C <sub>16</sub> | Capture register                            | TM0    | 0016        |
| 009D <sub>16</sub> |   |        | 0016        |
| 009E <sub>16</sub> |   |        |             |
| 009F <sub>16</sub> |   |        |             |
| 00A0 <sub>16</sub> | UART0 transmit/receive mode register        | U0MR   | 0016        |
| 00A1 <sub>16</sub> | UART0 bit rate generator                    | U0BRG  | XX16        |
| 00A2 <sub>16</sub> | UART0 transmit buffer register              | U0TB   | XX16        |
| 00A3 <sub>16</sub> |   |        | XX16        |
| 00A4 <sub>16</sub> | UART0 transmit/receive control register 0   | U0C0   | 000010002   |
| 00A5 <sub>16</sub> | UART0 transmit/receive control register 1   | U0C1   | 000000102   |
| 00A6 <sub>16</sub> | UART0 receive buffer register               | U0RB   | XX16        |
| 00A7 <sub>16</sub> |   |        | XX16        |
| 00A8 <sub>16</sub> | UART1 transmit/receive mode register        | U1MR   | 0016        |
| 00A9 <sub>16</sub> | UART1 bit rate generator                    | U1BRG  | XX16        |
| 00AA <sub>16</sub> | UART1 transmit buffer register              | U1TB   | XX16        |
| 00AB <sub>16</sub> |   |        | XX16        |
| 00AC <sub>16</sub> | UART1 transmit/receive control register 0   | U1C0   | 000010002   |
| 00AD <sub>16</sub> | UART1 transmit/receive control register 1   | U1C1   | 000000102   |
| 00AE <sub>16</sub> | UART1 receive buffer register               | U1RB   | XX16        |
| 00AF <sub>16</sub> |   |        | XX16        |
| 00B0 <sub>16</sub> | UART transmit/receive control register 2    | UCON   | 0016        |
| 00B1 <sub>16</sub> |   |        |             |
| 00B2 <sub>16</sub> |   |        |             |
| 00B3 <sub>16</sub> |   |        |             |
| 00B4 <sub>16</sub> |   |        |             |
| 00B5 <sub>16</sub> |   |        |             |
| 00B6 <sub>16</sub> |   |        |             |
| 00B7 <sub>16</sub> |   |        |             |
| 00B8 <sub>16</sub> |   |        |             |
| 00B9 <sub>16</sub> |   |        |             |
| 00BA <sub>16</sub> |   |        |             |
| 00BB <sub>16</sub> |   |        |             |
| 00BC <sub>16</sub> |   |        |             |
| 00BD <sub>16</sub> |   |        |             |
| 00BE <sub>16</sub> |   |        |             |
| 00BF <sub>16</sub> |   |        |             |

## NOTES:

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

X : Undefined

Table 4.4 SFR Information(4)<sup>(1)</sup>

| Address            | Register                                | Symbol | After reset           |
|--------------------|---|--------|-----------------------|
| 00C0 <sub>16</sub> | AD register                             | AD     | XXXXXXXX <sub>2</sub> |
| 00C1 <sub>16</sub> |   |        | XXXXXXXX <sub>2</sub> |
| 00C2 <sub>16</sub> |   |        |                       |
| 00C3 <sub>16</sub> |   |        |                       |
| 00C4 <sub>16</sub> |   |        |                       |
| 00C5 <sub>16</sub> |   |        |                       |
| 00C6 <sub>16</sub> |   |        |                       |
| 00C7 <sub>16</sub> |   |        |                       |
| 00C8 <sub>16</sub> |   |        |                       |
| 00C9 <sub>16</sub> |   |        |                       |
| 00CA <sub>16</sub> |   |        |                       |
| 00CB <sub>16</sub> |   |        |                       |
| 00CC <sub>16</sub> |   |        |                       |
| 00CD <sub>16</sub> |   |        |                       |
| 00CE <sub>16</sub> |   |        |                       |
| 00CF <sub>16</sub> |   |        |                       |
| 00D0 <sub>16</sub> |   |        |                       |
| 00D1 <sub>16</sub> |   |        |                       |
| 00D2 <sub>16</sub> |   |        |                       |
| 00D3 <sub>16</sub> |   |        |                       |
| 00D4 <sub>16</sub> | AD control register 2                   | ADCON2 | 0016                  |
| 00D5 <sub>16</sub> |   |        |                       |
| 00D6 <sub>16</sub> | AD control register 0                   | ADCON0 | 00000XXX <sub>2</sub> |
| 00D7 <sub>16</sub> | AD control register 1                   | ADCON1 | 0016                  |
| 00D8 <sub>16</sub> |   |        |                       |
| 00D9 <sub>16</sub> |   |        |                       |
| 00DA <sub>16</sub> |   |        |                       |
| 00DB <sub>16</sub> |   |        |                       |
| 00DC <sub>16</sub> |   |        |                       |
| 00DD <sub>16</sub> |   |        |                       |
| 00DE <sub>16</sub> |   |        |                       |
| 00DF <sub>16</sub> |   |        |                       |
| 00E0 <sub>16</sub> | Port P0 register                        | P0     | XX <sub>16</sub>      |
| 00E1 <sub>16</sub> | Port P1 register                        | P1     | XX <sub>16</sub>      |
| 00E2 <sub>16</sub> | Port P0 direction register              | PD0    | 0016                  |
| 00E3 <sub>16</sub> | Port P1 direction register              | PD1    | 0016                  |
| 00E4 <sub>16</sub> |   |        |                       |
| 00E5 <sub>16</sub> | Port P3 register                        | P3     | XX <sub>16</sub>      |
| 00E6 <sub>16</sub> |   |        |                       |
| 00E7 <sub>16</sub> | Port P3 direction register              | PD3    | 0016                  |
| 00E8 <sub>16</sub> | Port P4 register                        | P4     | XX <sub>16</sub>      |
| 00E9 <sub>16</sub> |   |        |                       |
| 00EA <sub>16</sub> | Port P4 direction register              | PD4    | 0016                  |
| 00EB <sub>16</sub> |   |        |                       |
| 00EC <sub>16</sub> |   |        |                       |
| 00ED <sub>16</sub> |   |        |                       |
| 00EE <sub>16</sub> |   |        |                       |
| 00EF <sub>16</sub> |   |        |                       |
| 00F0 <sub>16</sub> |   |        |                       |
| 00F1 <sub>16</sub> |   |        |                       |
| 00F2 <sub>16</sub> |   |        |                       |
| 00F3 <sub>16</sub> |   |        |                       |
| 00F4 <sub>16</sub> |   |        |                       |
| 00F5 <sub>16</sub> |   |        |                       |
| 00F6 <sub>16</sub> |   |        |                       |
| 00F7 <sub>16</sub> |   |        |                       |
| 00F8 <sub>16</sub> |   |        |                       |
| 00F9 <sub>16</sub> |   |        |                       |
| 03FA <sub>16</sub> |   |        |                       |
| 00FB <sub>16</sub> |   |        |                       |
| 00FC <sub>16</sub> | Pull-up control register 0              | PUR0   | 00XX0000 <sub>2</sub> |
| 00FD <sub>16</sub> | Pull-up control register 1              | PUR1   | XXXXXXXX <sub>2</sub> |
| 00FE <sub>16</sub> | Port P1 drive capacity control register | DRR    | 0016                  |
| 00FF <sub>16</sub> |   |        |                       |
| 01B3 <sub>16</sub> | Flash memory control register 4         | FMR4   | 01000000 <sub>2</sub> |
| 01B4 <sub>16</sub> |   |        |                       |
| 01B5 <sub>16</sub> | Flash memory control register 1         | FMR1   | 0100XX0X <sub>2</sub> |
| 01B6 <sub>16</sub> |   |        |                       |
| 01B7 <sub>16</sub> | Flash memory control register 0         | FMR0   | 00000012              |

## NOTES:

1. Blank columns, 0100<sub>16</sub> to 01B2<sub>16</sub> and 01B8<sub>16</sub> to 02FF<sub>16</sub> 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 <sub>cc</sub>  | Supply voltage                | V <sub>cc</sub> =AV <sub>cc</sub> | -0.3 to 6.5                       | V    |
| AV <sub>cc</sub> | Analog supply voltage         | V <sub>cc</sub> =AV <sub>cc</sub> | -0.3 to 6.5                       | V    |
| V <sub>i</sub>   | Input voltage                 |                                   | -0.3 to V <sub>cc</sub> +0.3      | V    |
| V <sub>o</sub>   | Output voltage                |                                   | -0.3 to V <sub>cc</sub> +0.3      | V    |
| P <sub>d</sub>   | Power dissipation             | T <sub>opr</sub> =25 °C           | 300                               | mW   |
| T <sub>opr</sub> | Operating ambient temperature |                                   | -20 to 85 / -40 to 85 (D version) | °C   |
| T <sub>stg</sub> | Storage temperature           |                                   | -65 to 150                        | °C   |

**Table 5.2 Recommended Operating Conditions**

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

**NOTES:**

- V<sub>cc</sub> = AV<sub>cc</sub> = 2.7 to 5.5V at T<sub>opr</sub> = -20 to 85 °C / -40 to 85 °C, unless otherwise specified.
- The typical values when average output current is 100ms.
- Hold V<sub>cc</sub>=AV<sub>cc</sub>.



**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           | $\phi_{AD}=10$ MHz, $V_{ref}=V_{CC}=5.0$ V                | —        | —                       | $\pm 3$   | LSB        |
|              |  | 8 bit mode            | $\phi_{AD}=10$ MHz, $V_{ref}=V_{CC}=5.0$ V                | —        | —                       | $\pm 2$   | LSB        |
|              |  | 10 bit mode           | $\phi_{AD}=10$ MHz, $V_{ref}=V_{CC}=3.3$ V <sup>(3)</sup> | —        | —                       | $\pm 5$   | LSB        |
|              |  | 8 bit mode            | $\phi_{AD}=10$ MHz, $V_{ref}=V_{CC}=3.3$ V <sup>(3)</sup> | —        | —                       | $\pm 2$   | LSB        |
| $R_{LADDER}$ | Ladder resistance                            |                       | $V_{REF}=V_{CC}$  | 10       | —                       | 40        | k $\Omega$ |
| $t_{CONV}$   | Conversion time                              | 10 bit mode           | $\phi_{AD}=10$ MHz, $V_{ref}=V_{CC}=5.0$ V                | 3.3      | —                       | —         | $\mu$ s    |
|              |  | 8 bit mode            | $\phi_{AD}=10$ MHz, $V_{ref}=V_{CC}=5.0$ V                | 2.8      | —                       | —         | $\mu$ s    |
| $V_{REF}$    | Reference voltage                            |                       |   | —        | $V_{CC}$ <sup>(4)</sup> | —         | V          |
| $V_{IA}$     | Analog input voltage                         |                       |   | 0        | —                       | $V_{ref}$ | V          |
| —            | A/D operating clock frequency <sup>(2)</sup> | 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  $85$  °C /  $-40$  to  $85$  °C, unless otherwise specified.
2. If  $f_{AD}$  exceeds 10 MHz, divide the  $f_{AD}$  and hold A/D operating clock frequency ( $\phi_{AD}$ ) 10 MHz or below.
3. If the  $AV_{CC}$  is less than 4.2V, divide the  $f_{AD}$  and hold A/D operating clock frequency ( $\phi_{AD}$ )  $f_{AD}/2$  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  | $\mu$ s |
| —              | 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   | °C      |
| —              | Data hold time <sup>(2)</sup>                       | Ambient temperature= $55$ °C | 20       | —    | —    | year    |

## NOTES:

1.  $V_{CC1}=AV_{CC}=2.7$  to  $5.5$ V at  $T_{opr} = 0$  to  $60$  °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 <sup>(2)</sup> |                     | 1        | —    | 2000 | $\mu$ s |
| $t_{d(R-S)}$ | STOP release time <sup>(3)</sup>   |                     | —        | —    | 150  | $\mu$ s |

## NOTES:

1. The measuring condition is  $V_{CC}=AV_{CC}=2.7$  to  $5.5$  V and  $T_{opr}=25$  °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.

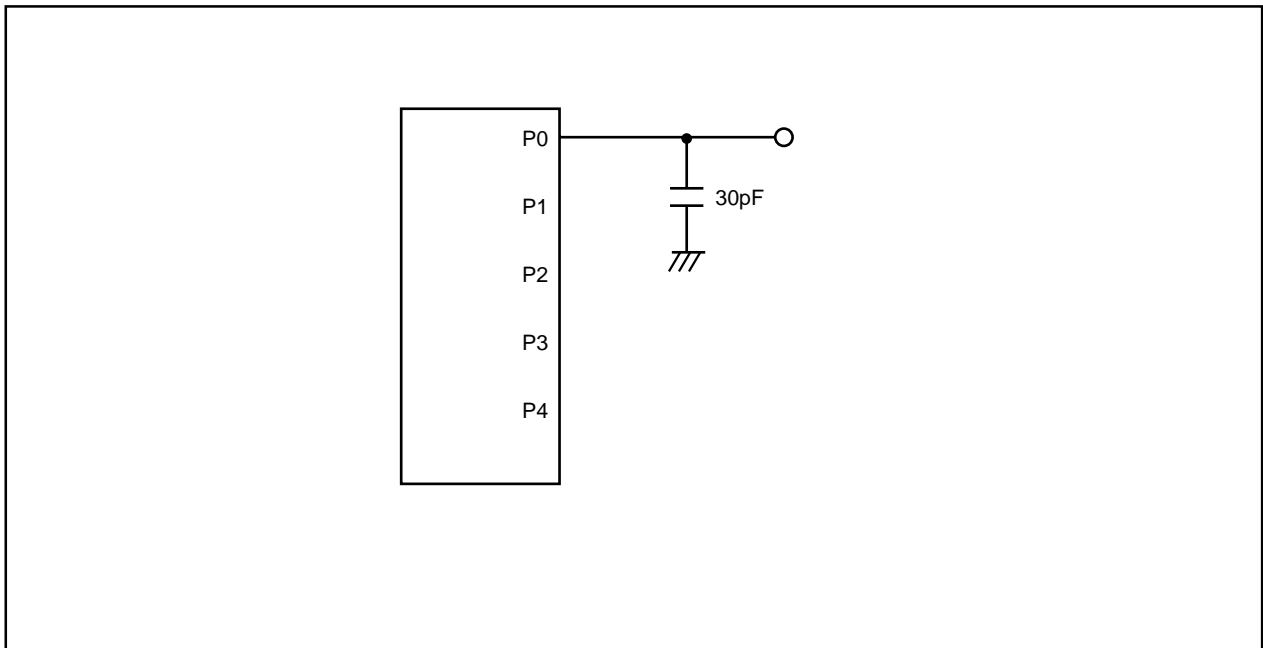


Figure 5.1 Port P0 to P4 measurement circuit

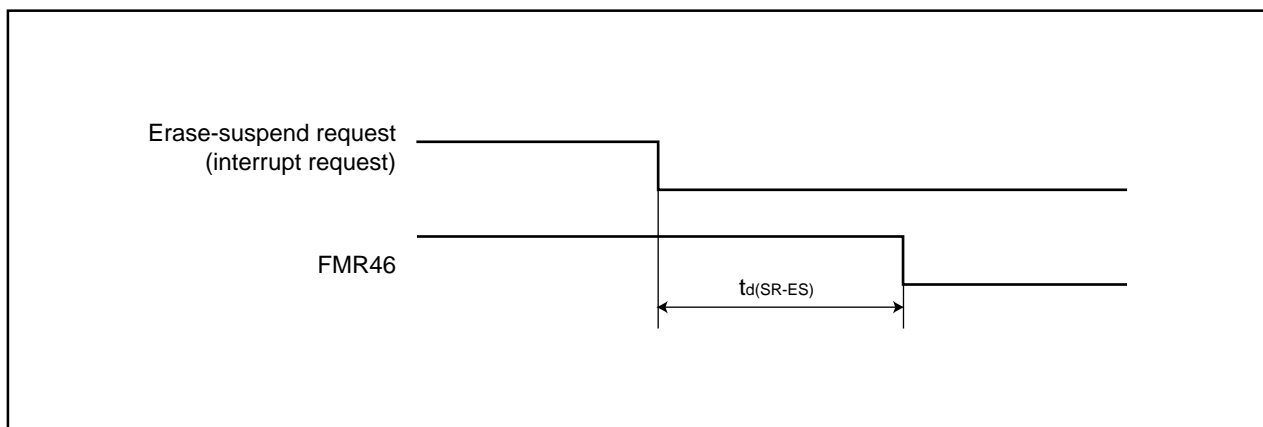


Figure 5.2 Time delay from Suspend Request until Erase Suspend

**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<br>RESET |                                | 0.2      |      | 1.0  | V    |
|                              |                              |  |                                | 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   |
| RiXIN                        | Feedback resistance          | XIN  |                                |          | 1.0  |      | MΩ   |
| fRING                        | On-chip oscillator frequency |  |                                | 40       | 125  | 250  | kHz  |
| V <sub>RAM</sub>             | 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) [V<sub>CC</sub>=5V]

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

## NOTES:

1. Timer Y is operated with timer mode.
2. Referenced to V<sub>CC</sub> = AV<sub>CC</sub> = 4.2 to 5.5V at T<sub>opr</sub> = -20 to 85 °C / -40 to 85 °C, f(X<sub>IN</sub>)=20MHz unless otherwise specified.

**Timing requirements (Unless otherwise noted:  $V_{CC} = 5V$ ,  $V_{SS} = 0V$  at  $T_{opr} = 25\text{ }^{\circ}C$ ) [ $V_{CC}=5V$ ]****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 <sup>(1)</sup> | –    | ns   |
| $t_{WH}(TCIN)$ | TCIN input HIGH pulse width | 200 <sup>(2)</sup> | –    | ns   |
| $t_{WL}(TCIN)$ | TCIN input LOW pulse width  | 200 <sup>(2)</sup> | –    | 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. |      |
| $t_W(INH)$ | $\overline{INT0}$ input HIGH pulse width | 250 <sup>(1)</sup> | –    | ns   |
| $t_W(INL)$ | $\overline{INT0}$ input LOW pulse width  | 250 <sup>(2)</sup> | –    | 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.

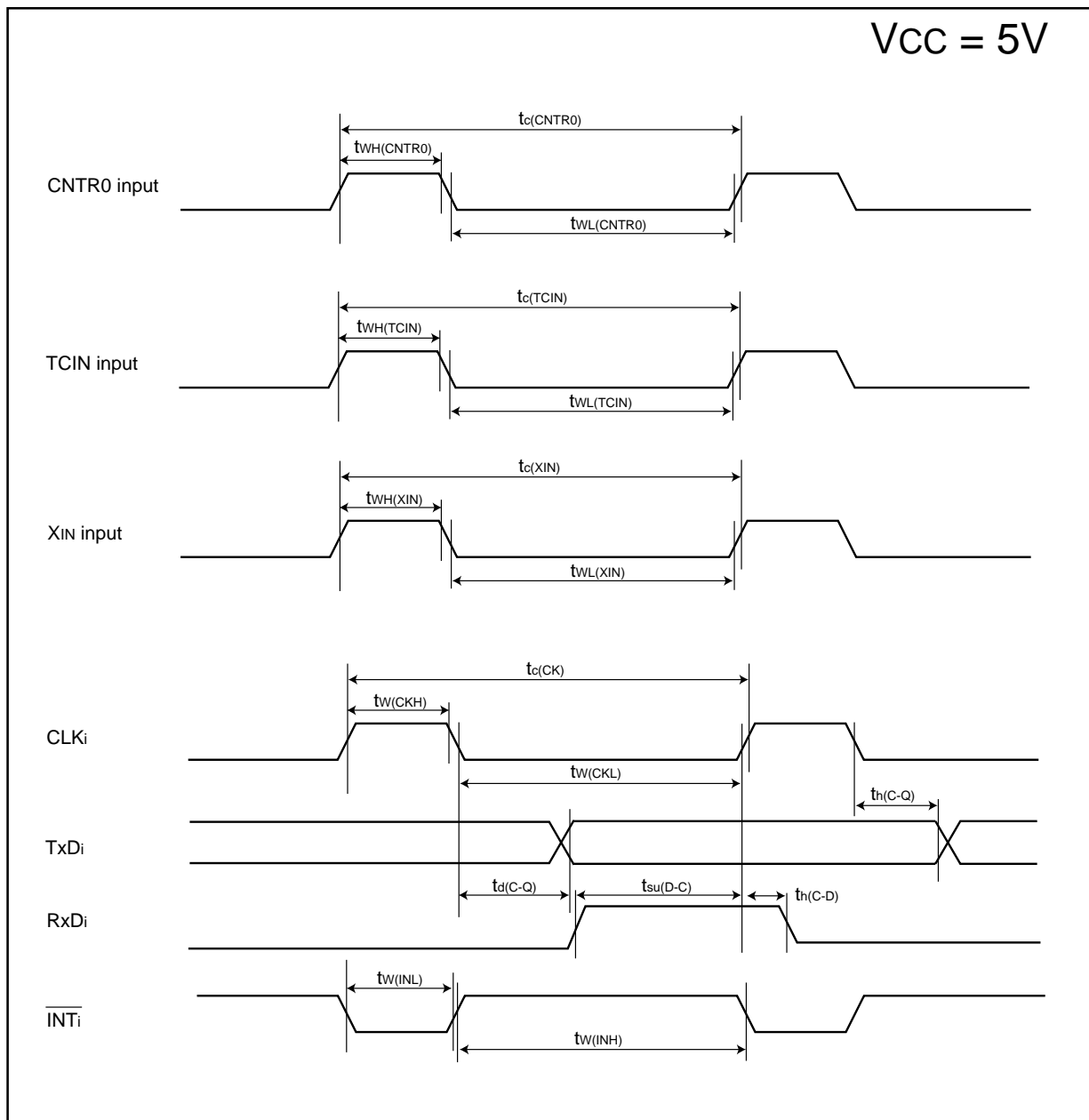


Figure 5.3  $V_{CC}=5V$  timing diagram

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

| Symbol              | Parameter                    |   | Measuring condition |              | Standard |      |      | Unit |
|---------------------|------------------------------|---|---------------------|--------------|----------|------|------|------|
|                     |                              |   |                     |              | Min.     | Typ. | Max. |      |
| VOH                 | "H" output voltage           | Except XOUT   | IOH=-1mA            |              | Vcc-0.5  | —    | Vcc  | V    |
|                     |                              | XOUT  | Drive capacity HIGH | IOH=0.1 mA   | Vcc-0.5  | —    | Vcc  | v    |
|                     |                              |   | Drive capacity LOW  | IOH=50 μA    | Vcc-0.5  | —    | Vcc  | v    |
| VOL                 | "L" output voltage           | Except P10 to P17, XOUT   | IOL= 1 mA           |              | —        | —    | 0.5  | V    |
|                     |                              | P10 to P17  | Drive capacity HIGH | IOL= 2 mA    | —        | —    | 0.5  | V    |
|                     |                              |   | Drive capacity LOW  | IOL= 1 mA    | —        | —    | 0.5  | v    |
|                     |                              | XOUT  | Drive capacity HIGH | IOL= 0.1 mA  | —        | —    | 0.5  | V    |
|                     |                              |   | Drive capacity LOW  | IOL=50 μA    | —        | —    | 0.5  | V    |
| VT+·VT-             | 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 <sub>IH</sub>     | "H" input current            |   |                     | VI=3V        | —        | —    | 4.0  | μA   |
| I <sub>IL</sub>     | "L" input current            |   |                     | VI=0V        | —        | —    | -4.0 | μA   |
| R <sub>PULLUP</sub> | Pull-up resistance           |   |                     | VI=0V        | 66       | 160  | 500  | kΩ   |
| R <sub>XIN</sub>    | Feedback resistance          | XIN   |                     |              | —        | 3.0  | —    | MΩ   |
| f <sub>RING</sub>   | On-chip oscillator frequency |   |                     |              | 40       | 125  | 250  | kHz  |
| V <sub>RAM</sub>    | RAM retention voltage        |   |                     | At stop mode | 2.0      | —    | —    | V    |

## NOTES:

1. Referenced to Vcc=AVcc=2.7 to 3.3V at Topr = -20 to 85 °C / -40 to 85 °C, f(XIN)=10MHz unless otherwise specified.

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

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

## NOTES:

1. Timer Y is operated with timer mode.
2. Referenced to V<sub>CC</sub>=AV<sub>CC</sub>=2.7 to 3.3V at Topr = -20 to 85 °C / -40 to 85 °C, f(X<sub>IN</sub>)=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 XIN input**

| Symbol   | Parameter                  | Standard |      | Unit |
|----------|----------------------------|----------|------|------|
|          |                            | Min.     | Max. |      |
| tC(XIN)  | XIN input cycle time       | 100      | –    | ns   |
| tWH(XIN) | XIN input HIGH pulse width | 40       | –    | ns   |
| tWL(XIN) | XIN input LOW pulse width  | 40       | –    | ns   |

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

| Symbol     | Parameter                    | Standard |      | Unit |
|------------|------------------------------|----------|------|------|
|            |                              | Min.     | Max. |      |
| tC(CNTR0)  | CNTR0 input cycle time       | 300      | –    | ns   |
| tWH(CNTR0) | CNTR0 input HIGH pulse width | 120      | –    | ns   |
| tWL(CNTR0) | CNTR0 input LOW pulse width  | 120      | –    | ns   |

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

| Symbol    | Parameter                   | Standard            |      | Unit |
|-----------|-----------------------------|---------------------|------|------|
|           |                             | Min.                | Max. |      |
| tC(TCIN)  | TCIN input cycle time       | 1200 <sup>(1)</sup> | –    | ns   |
| tWH(TCIN) | TCIN input HIGH pulse width | 600 <sup>(2)</sup>  | –    | ns   |
| tWL(TCIN) | TCIN input LOW pulse width  | 600 <sup>(2)</sup>  | –    | 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. |      |
| tC(CK)   | CLKi input cycle time       | 300      | –    | ns   |
| tW(CKH)  | CLKi input HIGH pulse width | 150      | –    | ns   |
| tW(CKL)  | CLKi input LOW pulse width  | 150      | –    | ns   |
| td(C-Q)  | TxDi output delay time      | –        | 160  | ns   |
| th(C-Q)  | TxDi hold time              | 0        | –    | ns   |
| tsu(D-C) | RxDi input setup time       | 55       | –    | ns   |
| th(C-D)  | RxDi input hold time        | 90       | –    | ns   |

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

| Symbol  | Parameter                                | Standard           |      | Unit |
|---------|--|--------------------|------|------|
|         |  | Min.               | Max. |      |
| tW(INH) | $\overline{INT0}$ input HIGH pulse width | 380 <sup>(1)</sup> | –    | ns   |
| tW(INL) | $\overline{INT0}$ input LOW pulse width  | 380 <sup>(2)</sup> | –    | 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.

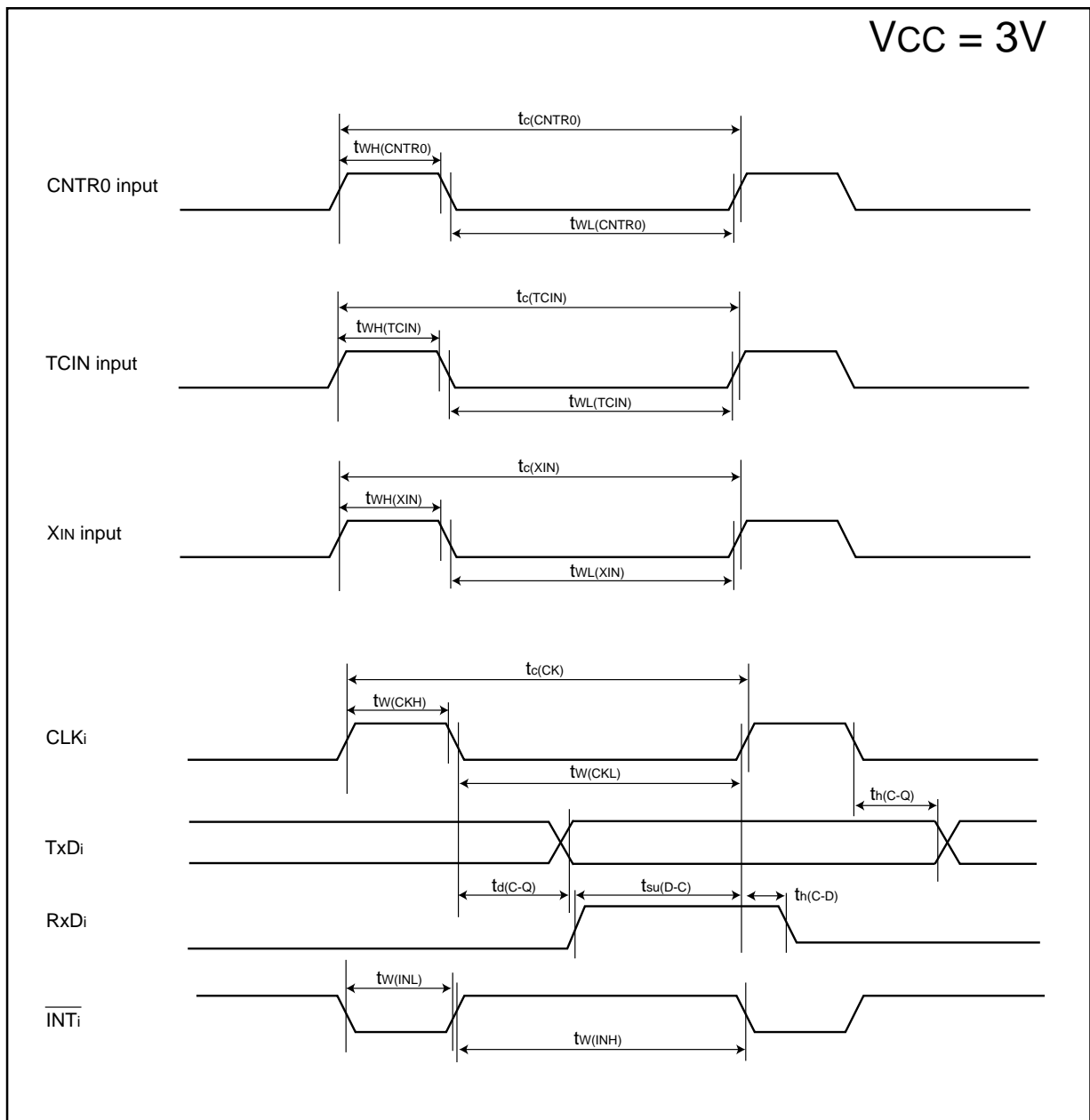
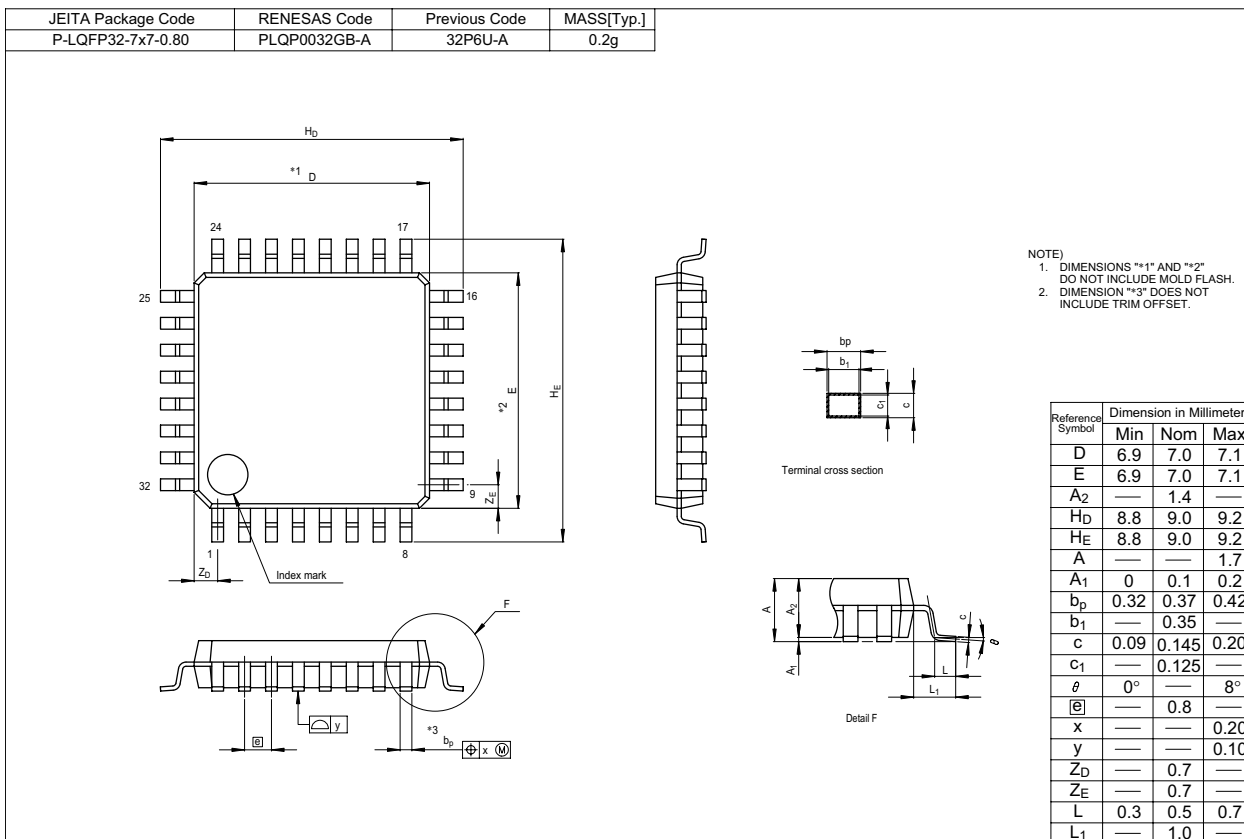


Figure 5.4  $V_{CC}=3V$  timing diagram

### Package Dimensions



REVISION HISTORY

R8C/10 Group Datasheet

| Rev. | Date          | Description   |  |
|------|---------------|---|--|
|      |               | Page  | Summary  |
| 1.00 | Jun. 19, 2003 |   | First edition issued   |
| 1.10 | Sep. 08, 2003 | 2<br>5<br>6<br>12<br>14   | Table 1.1: Shortest instruction execution time and f(XIN) changed<br>Figure 1.3: Pin name changed from TXOUT to CNTR $\bar{0}$<br>Table 1.3: Pin name changed from TXOUT to CNTR $\bar{0}$<br>The value of Time C register after reset changed<br>Chapter "5. Electrical Characteristics" added  |
| 1.20 | Oct. 31, 2003 | 2<br>6<br>14<br>15<br>16<br>18<br><br>19<br>20<br>21<br>22<br><br>23<br>24              | Table 1.1: Power consumption values added<br>Table 1.3: Resistor value for CNVss and MODE deleted<br>Table 5.2: Note 3 and Note 4 deleted<br>tsamp in Table 5.3 deleted<br>Figure 5.1 added<br>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", XIN=5MHz deleted and XIN=10MHz added in high-speed mode and medium-speed mode, data added and modified<br>Table 5.8 to Table 5.12 added<br>Figure 5.2 added<br>Table 5.13: Note 1, f(BCLK)=5 MHz changed to 10 MHz<br>Table 5.14: on-chip oscillator changed from "on 100kHz" to "125kHz", XIN=5MHz deleted and XIN=10MHz added in high-speed mode and medium-speed mode, data added and modified<br>Table 5.15 to Table 5.19 added<br>Figure 5.3 added |
| 1.30 | Dec 05, 2003  | 4<br>15   | Table 1.2 : ** deleted<br>Table 5.4 revised  |
| 1.40 | Sep 30, 2004  | All pages<br>2<br>5<br>6<br>10-13<br>12<br>14<br>15<br>17<br>18<br>19<br>21<br>22<br>23 | Words standardized (on-chip oscillator, serial interface, A/D)<br>Table 1.1 revised<br>Figure 1.3, NOTES 3 added<br>Table 1.3 revised<br>One body sentence in chapter 4 added ; Titles 4.1 to 4.4 added<br>Table 4.3 revised ; Table 4.4 revised<br>Table 5.2 revised<br>Table 5.3 revised ; Table 5.4 revised<br>Table 5.6 revised<br>Table 5.7 revised<br>Table 5.8 revised ; Table 5.12 revised<br>Table 5.13 revised<br>Table 5.14 revised<br>Table 5.15 revised ; Table 5.17 revised ; Table 5.19 revised   |
| 1.50 | Apr.27.2005   | 4<br>5<br>10  | Table 1.2, Figure 1.2 package name revised<br>Figure 1.3 package name revised<br>Table 4.1 revised   |

REVISION HISTORY

R8C/10 Group Datasheet

| Rev. | Date  | Description |   |
|------|---|-------------|---|
|      |   | Page        | Summary   |
| 1.50 | Apr.27.2005   | 12          | Table 4.3 revised   |
|      |   | 15          | Table 5.3 partly revised<br>Table 5.4 partly added<br>Table 5.5 partly revised  |
|      |   | 17          | Table 5.6 partly revised  |
|      |   | 21          | Table 5.13 partly revised   |
|      |   | 25          | Package Dimensions revised  |
|      |   |             |   |
| 1.60 | Jan.27.2006   | 2           | Table 1.1 Performance outline revised   |
|      |   | 3           | Figure 1.1 Block diagram partly revised   |
|      |   | 4           | 1.4 Product Information, title of Table 1.2<br>"Product List" → "Product Informaton" revised  |
|      |   | 6           | Figure 1.2 Type No., Memory Size, and Package partly revised  |
|      |   | 7-8         | Table 1.3 Pin description revised<br>2 Central Processing Unit (CPU) revised<br>Figure 2.1 CPU register revised   |
|      |   | 10          | Table 4.1 SFR Information(1) NOTES:1 revised  |
|      |   | 11          | Table 4.2 SFR Information(2) NOTES:1 revised  |
|      |   | 12          | Table 4.3 SFR Information(3);<br>0081 <sub>16</sub> : "Prescaler Y" → "Prescaler Y Register"<br>0082 <sub>16</sub> : "Timer Y Secondary" → "Timer Y Secondary Register"<br>0083 <sub>16</sub> : "Timer Y Primary" → "Timer Y Primary Register"<br>0085 <sub>16</sub> : "Prescaler Z" → "Prescaler Z Register"<br>0086 <sub>16</sub> : "Timer Z Secondary" → "Timer Z Secondary Register"<br>0087 <sub>16</sub> : "Timer Z Primary" → "Timer Z Primary Register"<br>008C <sub>16</sub> : "Prescaler X" → "Prescaler X Register" revised<br>NOTES:1 revised |
|      |   | 13          | Table 4.4 SFR Information(4) NOTES:1 revised  |
|      |   | 14          | Table 5.2 Recommended Operating Conditions; NOTES: 1, 2, 3 revised  |
|      |   | 15          | Table 5.3 A/D Conversion Characteristics;<br>"A/D operation clock frequency" → "A/D operating clock frequency" revised<br>NOTES: 1, 2, 3, 4 revised<br>Table 5.4 Flash Memory (Program ROM) Electrical Characteristics;<br>"Data retention duration" → "Data hold time" revised<br>"Topr" → "Ambient temperature" revised<br>NOTES: 2 added<br>Measuring condition of byte program time and block erase time deleted  |
|      |   | 17          | Table 5.6 Electrical Characteristics (1) [V <sub>CC</sub> =5V];<br>"P1 <sub>0</sub> to P1 <sub>7</sub> Except X <sub>OUT</sub> " → "Except P1 <sub>0</sub> to P1 <sub>7</sub> , X <sub>OUT</sub> " revised  |
|      |   | 18          | Table 5.7 Electrical Characteristics (2) [V <sub>CC</sub> =5V]<br>NOTES: 1, 2 revised<br>Measuring condition: Stop mode "Topr = 25 °C"  |
|      |   | 21          | Table 5.13 Electrical Characteristics (3) [V <sub>CC</sub> =3V]<br>"P1 <sub>0</sub> to P1 <sub>7</sub> Except X <sub>OUT</sub> " → "Except P1 <sub>0</sub> to P1 <sub>7</sub> , X <sub>OUT</sub> " revised  |
| 22   | Table 5.14 Electrical Characteristics (4) [V <sub>CC</sub> =3V]<br>NOTES: 1, 2 revised<br>Measuring condition: Stop mode "Topr = 25 °C" |             |   |
|      |   |             |   |

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- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «JONHON», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «FORSTAR».



## JONHON

«JONHON» (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

«FORSTAR» (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).



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