

## 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 Outline

Table 1.1. lists the performance outline of this MCU.

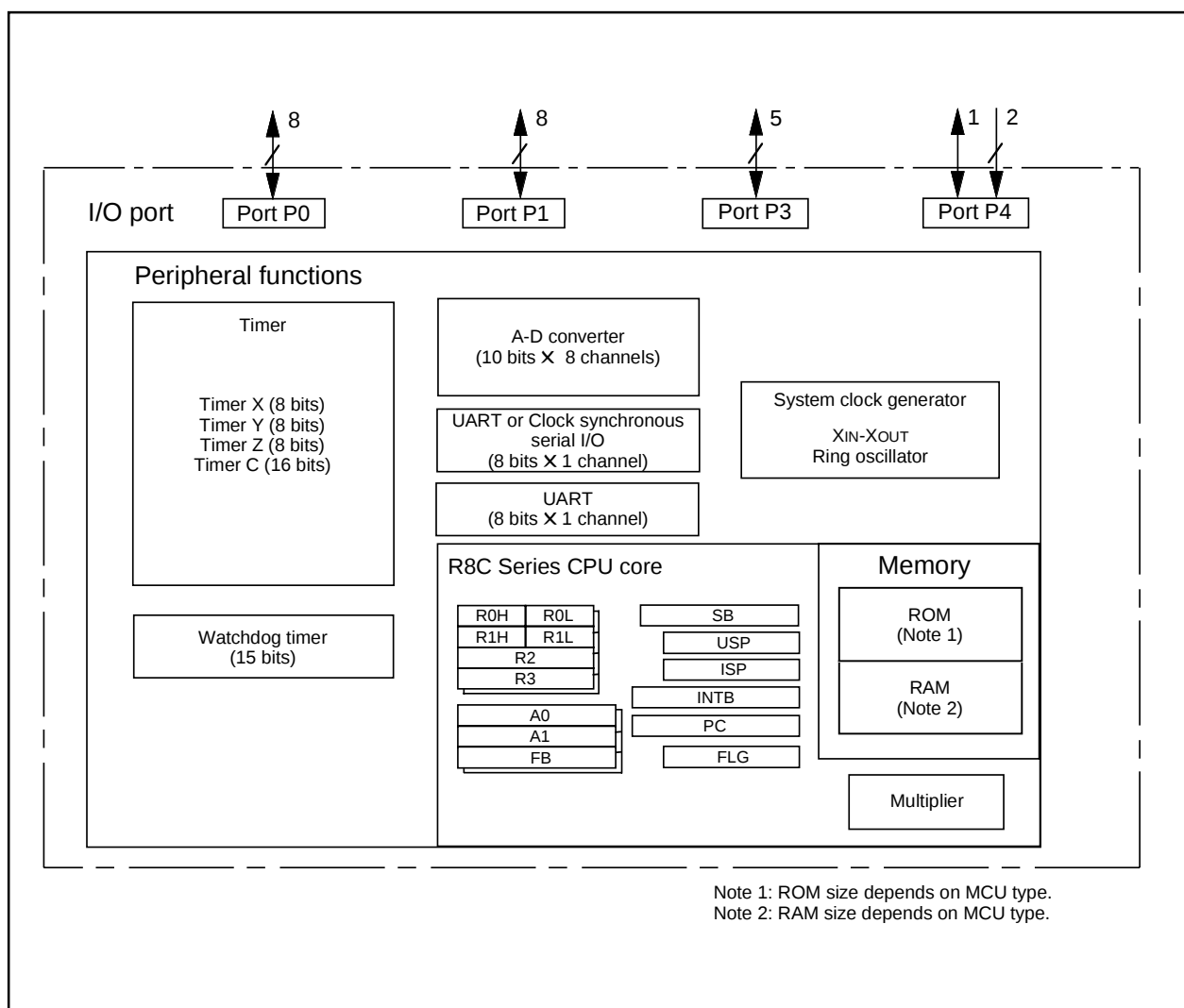
**Table 1.1 Performance outline**

| Item                          |                                     | Performance                                                                                                                                                                                                                                                                 |
|-------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CPU                           | Number of basic instructions        | 89 instructions                                                                                                                                                                                                                                                             |
|                               | Shortest instruction execution time | 62.5 ns ( $f(X_{IN}) = 16$ MHz, $V_{CC} = 3.0$ to 5.5 V)<br>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           | Interrupt                           | Internal: 10 sources, External: 5 sources,<br>Software: 4 sources, Priority level: 7 levels                                                                                                                                                                                 |
|                               | Watchdog timer                      | 15 bits x 1 (with prescaler)                                                                                                                                                                                                                                                |
|                               | 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 I/O                          | •1 channel<br>Clock synchronous, UART<br>•1 channel<br>UART                                                                                                                                                                                                                 |
|                               | A-D converter                       | 10-bit A-D converter: 1 circuit, 8 channels                                                                                                                                                                                                                                 |
|                               | Clock generation circuit            | 2 circuits<br>•Main clock generation circuit (Equipped with a built-in feedback resistor)<br>•Ring oscillator                                                                                                                                                               |
|                               | Oscillation stop detection function | Stop detection of main clock oscillation                                                                                                                                                                                                                                    |
|                               | Port                                | Input/Output: 22 (including LED drive port), Input: 2<br>(LED drive I/O port: 8, max. 20 mA)                                                                                                                                                                                |
| Electrical characteristics    | Power supply voltage                | $V_{CC} = 3.0$ to 5.5 V ( $f(X_{IN}) = 16$ MHz)<br>$V_{CC} = 2.7$ to 5.5 V ( $f(X_{IN}) = 10$ MHz)                                                                                                                                                                          |
|                               | Power consumption                   | Typ. 8 mA ( $V_{CC} = 5.0$ V, ( $f(X_{IN}) = 16$ MHz, High-speed mode)<br>Typ. 5 mA ( $V_{CC} = 3.0$ V, ( $f(X_{IN}) = 10$ MHz, High-speed mode)<br>Typ. 35 $\mu$ A ( $V_{CC} = 3.0$ V, Wait mode, Peripheral clock off)<br>Typ. 0.7 $\mu$ A ( $V_{CC} = 3.0$ V, Stop mode) |
| Flash memory                  | Program/erase voltage               | $V_{CC} = 2.7$ to 5.5 V                                                                                                                                                                                                                                                     |
|                               | Number of program/erase             | 100 times                                                                                                                                                                                                                                                                   |
| Operating ambient temperature |                                     | -20 to 85 °C<br>-40 to 85 °C (option)                                                                                                                                                                                                                                       |
| Package                       |                                     | 32-pin plastic mold LQFP                                                                                                                                                                                                                                                    |

Option: If you require this option, please specify so.

### 1.3 Block Diagram

Figure 1.1 shows this MCU block diagram.



**Figure 1.1 Block Diagram**

## 1.4 Product List

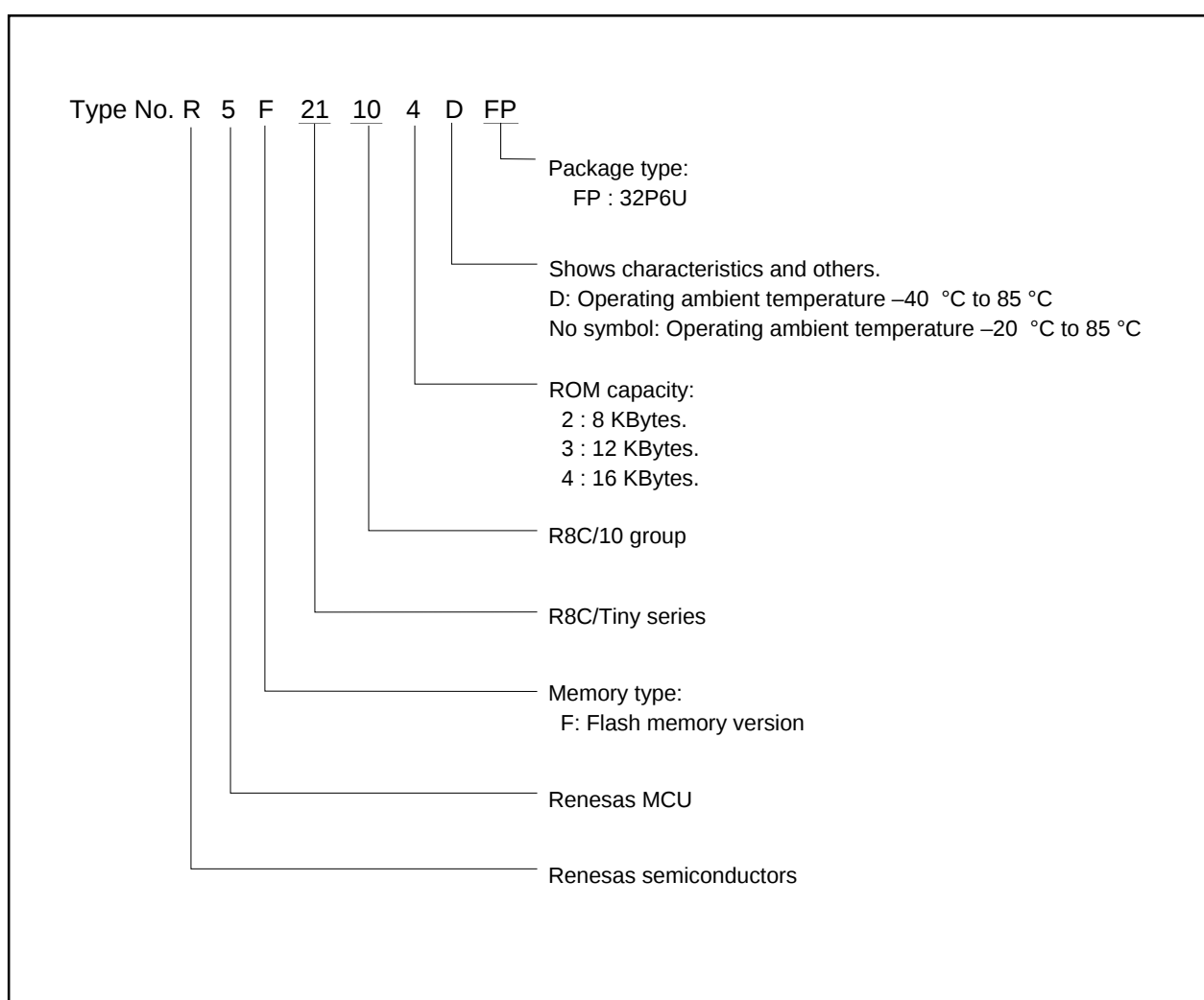
Table 1.2 lists the products.

**Table 1.2 Product List**

As of Oct. 2003

| Type No.    | ROM capacity | RAM capacity | Package type | Remarks              |
|-------------|--------------|--------------|--------------|----------------------|
| R5F21102FP  | 8K bytes     | 512 bytes    | 32P6U-A      | Flash memory version |
| R5F21103FP  | 12K bytes    | 768 bytes    | 32P6U-A      |                      |
| R5F21104FP  | 16K bytes    | 1K bytes     | 32P6U-A      |                      |
| R5F21102DFP | ★★           | 8K bytes     | 512 bytes    | D version            |
| R5F21103DFP | ★★           | 12K bytes    | 768 bytes    |                      |
| R5F21104DFP | ★★           | 16K bytes    | 1K bytes     |                      |
|             |              |              | 32P6U-A      |                      |

★★ : Under development



**Figure 1.2 Type No., Memory Size, and Package**

## 1.5 Pin Configuration

Figure 1.3 shows the pin configuration (top view).

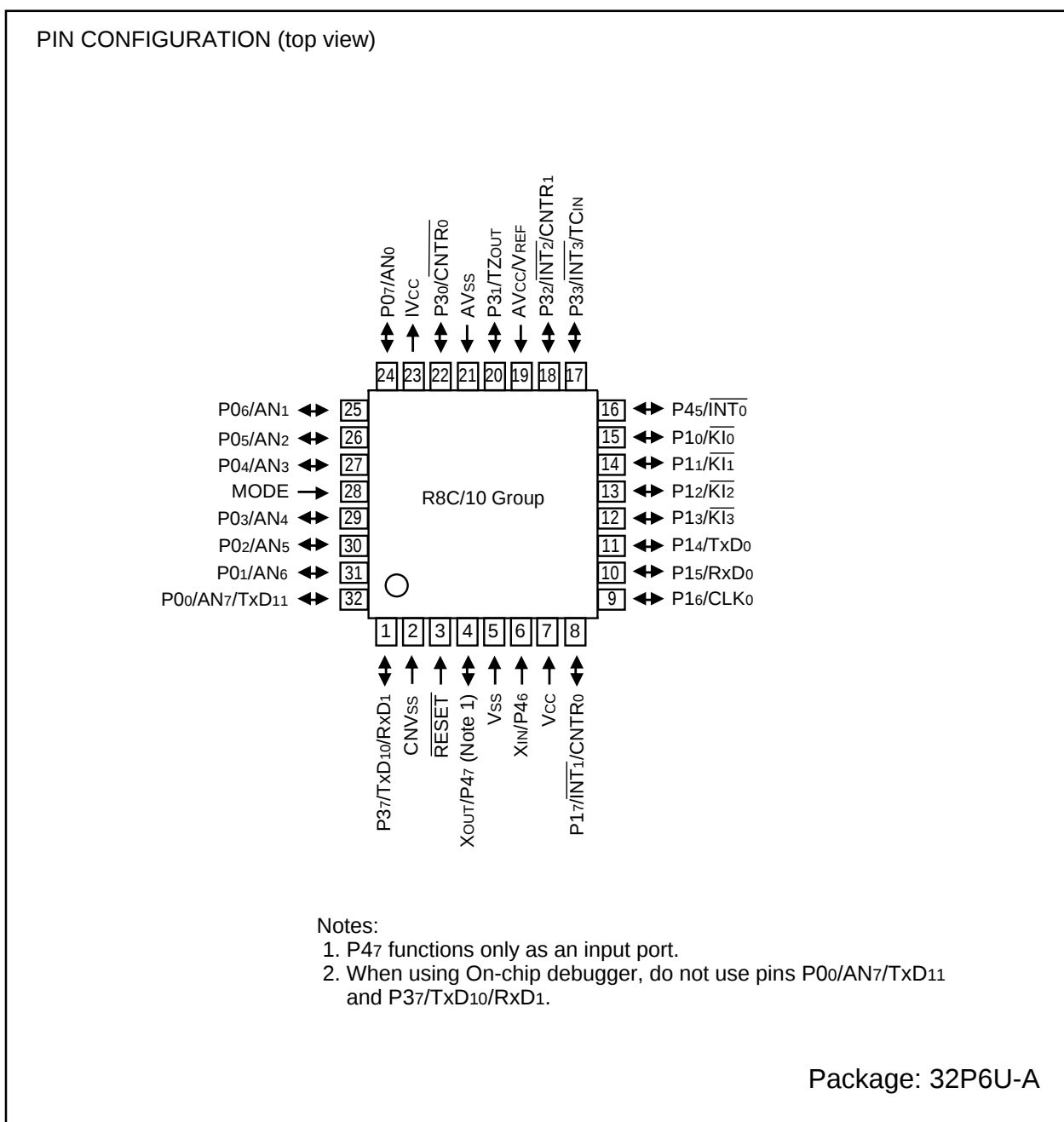


Figure 1.3 Pin Configuration (Top View)

## 1.6 Pin Description

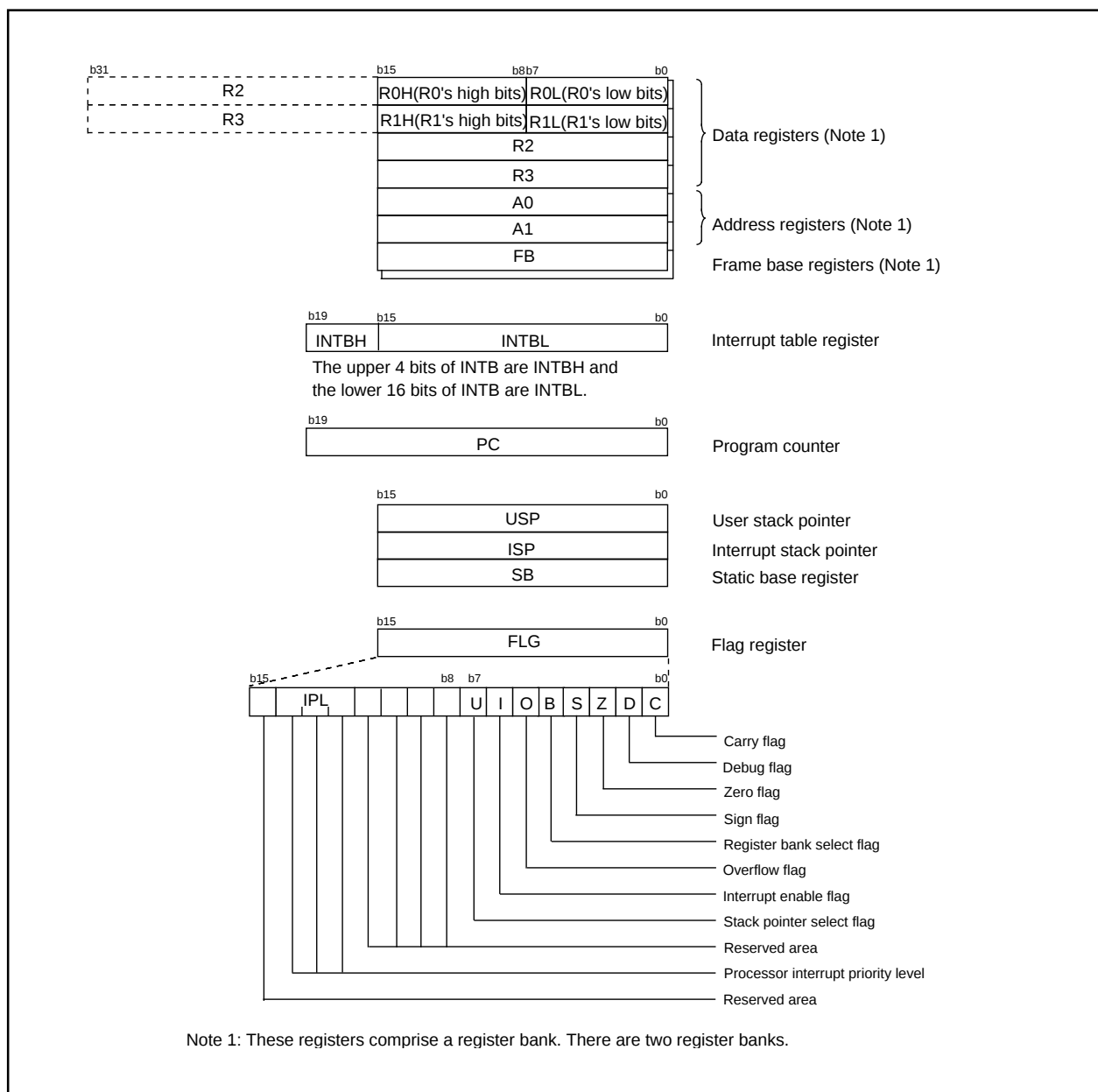
Table 1.3 shows the pin description

**Table 1.3 Pin description**

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

## 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. There are two register banks.



**Figure 2.1 Central Processing Unit Register**

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

The R0 register consists of 16 bits, and is used mainly for transfers and arithmetic/logic operations. R1 to R3 are the same as R0.

The R0 register can be separated between high (R0H) and low (R0L) for use as two 8-bit data registers. R1H and R1L are the same as R0H and R0L. Conversely, R2 and R0 can be combined for use as a 32-bit data register (R2R0). R3R1 is the same as R2R0.

## 2.2 Address Registers (A0 and A1)

The register A0 consists of 16 bits, and is used for address register indirect addressing and address register relative addressing. They also are used for transfers and logic/logic operations. A1 is the same as A0.

In some instructions, registers A1 and A0 can be combined for use as a 32-bit address register (A1A0).

## 2.3 Frame Base Register (FB)

FB is configured with 16 bits, and is used for FB relative addressing.

## 2.4 Interrupt Table Register (INTB)

INTB is configured with 20 bits, indicating the start address of an interrupt vector table.

## 2.5 Program Counter (PC)

PC is configured with 20 bits, indicating the address of an instruction to be executed.

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

Stack pointer (SP) comes in two types: USP and ISP, each configured with 16 bits.

Your desired type of stack pointer (USP or ISP) can be selected by the U flag of FLG.

## 2.7 Static Base Register (SB)

SB is configured with 16 bits, and is used for SB relative addressing.

## 2.8 Flag Register (FLG)

FLG consists of 11 bits, indicating the CPU status.

### 2.8.1 Carry Flag (C Flag)

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

### 2.8.2 Debug Flag (D Flag)

The D flag is used exclusively for debugging purpose. During normal use, it must be set to "0".

### 2.8.3 Zero Flag (Z Flag)

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

### 2.8.4 Sign Flag (S Flag)

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

### 2.8.5 Register Bank Select Flag (B Flag)

Register bank 0 is selected when this flag is "0"; register bank 1 is selected when this flag is "1".

### 2.8.6 Overflow Flag (O Flag)

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

### 2.8.7 Interrupt Enable Flag (I Flag)

This flag enables a maskable interrupt.

Maskable interrupts are disabled when the I flag is "0", and are enabled when the I flag is "1". The I flag is cleared to "0" when the interrupt request is accepted.

### 2.8.8 Stack Pointer Select Flag (U Flag)

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

The U flag is cleared to "0" when a hardware interrupt request is accepted or an INT instruction for software interrupt Nos. 0 to 31 is executed.

### 2.8.9 Processor Interrupt Priority Level (IPL)

IPL is configured with three bits, for specification of up to eight processor interrupt priority levels from level 0 to level 7.

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

### 2.8.10 Reserved Area

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

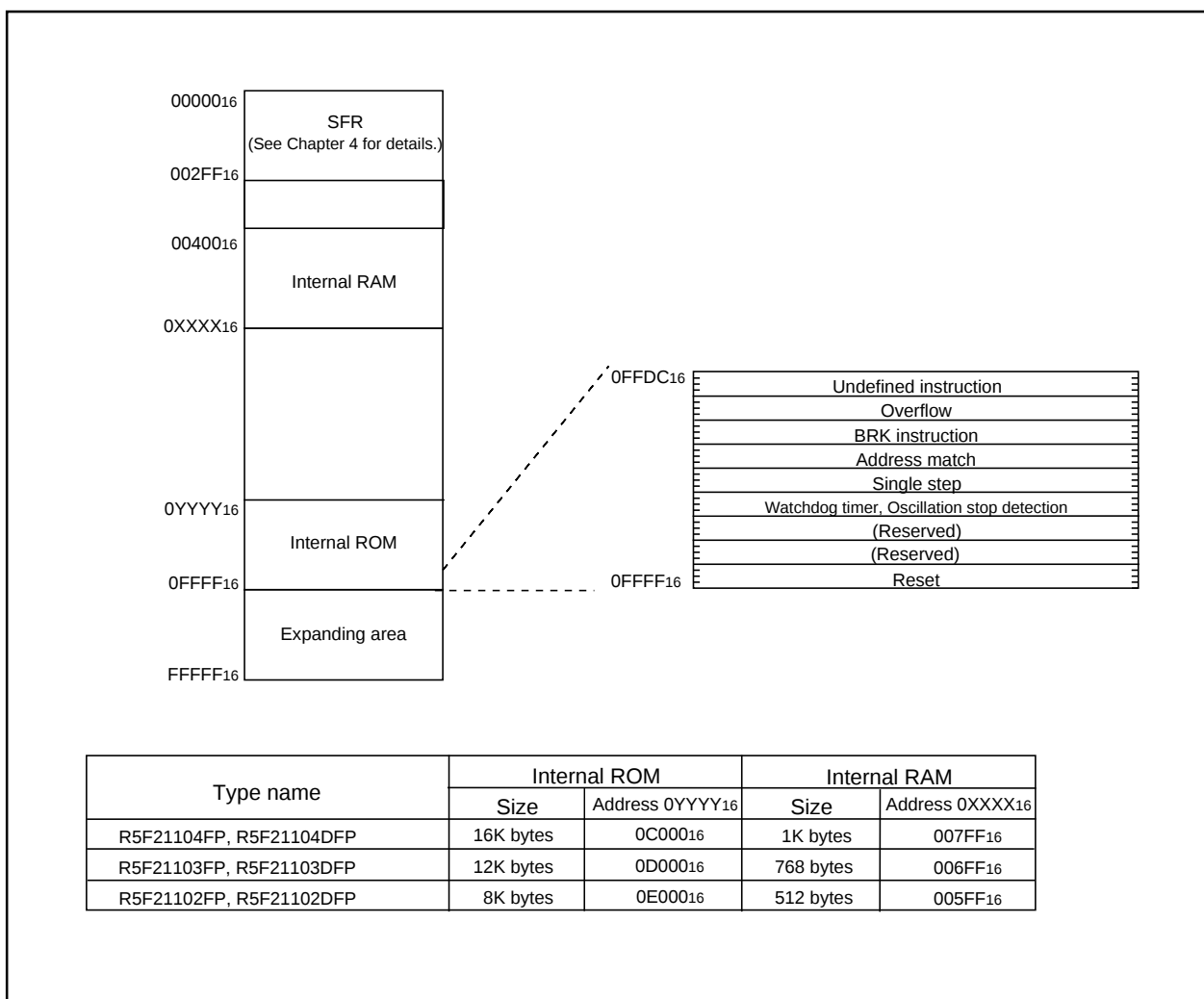
### 3. Memory

Figure 3.1 is a memory map of this MCU. The address space extends the 1M bytes from address 00000<sub>16</sub> to FFFFF<sub>16</sub>.

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

The fixed interrupt vector table is allocated to the addresses from 0FFDC<sub>16</sub> to 0FFFF<sub>16</sub>. Therefore, store the start address of each interrupt routine here.

The internal RAM is allocated in an upper address direction beginning with address 00400<sub>16</sub>. For example, a 1-Kbyte internal RAM is allocated to the addresses from 00400<sub>16</sub> to 007FF<sub>16</sub>. In addition to storing data, the internal RAM also stores the stack used when calling subroutines and when interrupts are generated. Special function registers (SFR) are allocated to the addresses from 00000<sub>16</sub> to 002FF<sub>16</sub>. Peripheral function control registers are located here. Of the SFR, any space which has no functions allocated is reserved for future use and cannot be used by users.



**Figure 3.1 Memory Map**

## 4. Special Function Register (SFR)

| 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    | 0016        |
| 0005 <sub>16</sub> | Processor mode register 1               | PM1    | 0016        |
| 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    | 000XXXXX2   |
| 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> |                                         |        |             |

X : Undefined

Blank columns are all reserved space. No access is allowed.

| 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> | A-D 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> |                                           |        |             |

X : Undefined

Blank columns are all reserved space. No access is allowed.

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

X : Undefined

Blank columns are all reserved space. No access is allowed.

| Address            | Register                             | Symbol | After reset           |
|--------------------|--------------------------------------|--------|-----------------------|
| 00C0 <sub>16</sub> | A-D register                         | AD     | XX <sub>16</sub>      |
| 00C1 <sub>16</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> | A-D control register 2               | ADCON2 | 00 <sub>16</sub>      |
| 00D5 <sub>16</sub> | A-D control register 0               | ADCON0 | 00000XXX <sub>2</sub> |
| 00D6 <sub>16</sub> |                                      |        |                       |
| 00D7 <sub>16</sub> | A-D control register 1               | ADCON1 | 00 <sub>16</sub>      |
| 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    | 00 <sub>16</sub>      |
| 00E3 <sub>16</sub> | Port P1 direction register           | PD1    | 00 <sub>16</sub>      |
| 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    | 00 <sub>16</sub>      |
| 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    | 00 <sub>16</sub>      |
| 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   | XXXXXX0X <sub>2</sub> |
| 00FE <sub>16</sub> | Port P1 drivability control register | DRR    | 00 <sub>16</sub>      |
| 00FF <sub>16</sub> |                                      |        |                       |
| ⋮                  |                                      |        |                       |
| 01B3 <sub>16</sub> | Flash memory control register 4      | FMR4   | 0100000X <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   | XX000001 <sub>2</sub> |

X : Undefined

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## 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                | 5.0             | 5.5                | V    |
| AV <sub>CC</sub>       | Analog supply voltage                  |                                         |                               | —                  | V <sub>CC</sub> | —                  | 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' I <sub>OH</sub> (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' I <sub>OL</sub> (peak) |                               | —                  | —               | 60                 | mA   |
| I <sub>OL</sub> (peak) | "L" peak output current                | Except P10 to P17                       |                               | —                  | —               | 10                 | mA   |
|                        |                                        | P10 to P17                              | Drive ability HIGH            | —                  | —               | 30                 | mA   |
|                        |                                        | P10 to P17                              | Drive ability LOW             | —                  | —               | 10                 | mA   |
| I <sub>OL</sub> (avg)  | "L" average output current             | Except P10 to P17                       |                               | —                  | —               | 5                  | mA   |
|                        |                                        | P10 to P17                              | Drive ability HIGH            | —                  | —               | 15                 | mA   |
|                        |                                        | P10 to P17                              | Drive ability LOW             | —                  | —               | 5                  | mA   |
| f (X <sub>IN</sub> )   | 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  |

**Note**

1: Referenced to 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.

2: The mean output current is the mean value within 100ms.

**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           | $f(XIN) = \phi AD = 10 \text{ MHz}$ , $V_{ref} = V_{CC} = 5.0V$ |          |      | $\pm 3$   | LSB        |
|              |                                            | 8 bit mode            | $f(XIN) = \phi AD = 10 \text{ MHz}$ , $V_{ref} = V_{CC} = 5.0V$ |          |      | $\pm 2$   | LSB        |
|              |                                            | 10 bit mode           | $f(XIN) = \phi AD = 10 \text{ MHz}$ , $V_{ref} = V_{CC} = 3.3V$ |          |      | $\pm 5$   | LSB        |
|              |                                            | 8 bit mode            | $f(XIN) = \phi AD = 10 \text{ MHz}$ , $V_{ref} = V_{CC} = 3.3V$ |          |      | $\pm 2$   | LSB        |
| $R_{LADDER}$ | Ladder resistance                          |                       | $V_{REF} = V_{CC}$                                              | 10       |      | 40        | k $\Omega$ |
| $t_{CONV}$   | Conversion time                            | 10 bit mode           | $f(XIN) = \phi AD = 10 \text{ MHz}$ , $V_{ref} = V_{CC} = 5.0V$ | 3.3      |      |           | $\mu s$    |
|              |                                            | 8 bit mode            | $f(XIN) = \phi AD = 10 \text{ MHz}$ , $V_{ref} = V_{CC} = 5.0V$ | 2.8      |      |           | $\mu s$    |
| $V_{REF}$    | Reference voltage                          |                       |                                                                 | 2.0      |      | $V_{CC}$  | V          |
| $V_{IA}$     | Analog input voltage                       |                       |                                                                 | 0        |      | $V_{ref}$ | V          |
| —            | A-D operation clock frequency <sup>2</sup> | Without sample & hold |                                                                 | 0.25     |      | 10        | MHz        |
|              |                                            | With sample & hold    |                                                                 | 1.0      |      | 10        | MHz        |

Note

- 1: Referenced to  $V_{CC} = AV_{CC} = 2.7$  to  $5.5V$  at  $T_{opr} = -20$  to  $85^\circ C$  /  $-40$  to  $85^\circ C$  unless otherwise specified.
- 2: When  $f_{AD}$  is 10 MHz more, divide the  $f_{AD}$  and make A-D operation clock frequency ( $\phi AD$ ) lower than 10 MHz.
- 3: When the  $V_{CC}$  is less than 4.2V, divide the  $f_{AD}$  and make A-D operation clock frequency ( $\phi AD$ ) lower than  $f_{AD}/2$ .

**Table 5.4 Flash Memory Version Electrical Characteristics**

| Symbol | Parameter                                           | Measuring condition                      | Standard |      |      | Unit       |
|--------|-----------------------------------------------------|------------------------------------------|----------|------|------|------------|
|        |                                                     |                                          | Min.     | Typ. | Max. |            |
| —      | Program/erase cycle                                 |                                          | 100      | —    | —    | cycle      |
| —      | Byte program time                                   | $V_{CC} = 5.0V$ , $T_{opr} = 25^\circ C$ | —        | 50   | 400  | $\mu s$    |
| —      | Block erase time                                    | $V_{CC} = 5.0V$ , $T_{opr} = 25^\circ C$ | —        | 0.4  | 9    | s          |
| —      | Time delay from suspend request until erase suspend |                                          | —        | —    | 8    | ms         |
| —      | Program, Erase voltage                              |                                          | 2.7      | —    | 5.5  | V          |
| —      | Read voltage                                        |                                          | 2.7      | —    | 5.5  | V          |
| —      | Program, Erase temperature                          |                                          | 0        | —    | 60   | $^\circ C$ |
| —      | Data-retention duration                             | $T_{opr} = 55^\circ C$                   | —        | —    | 20   | year       |

Note

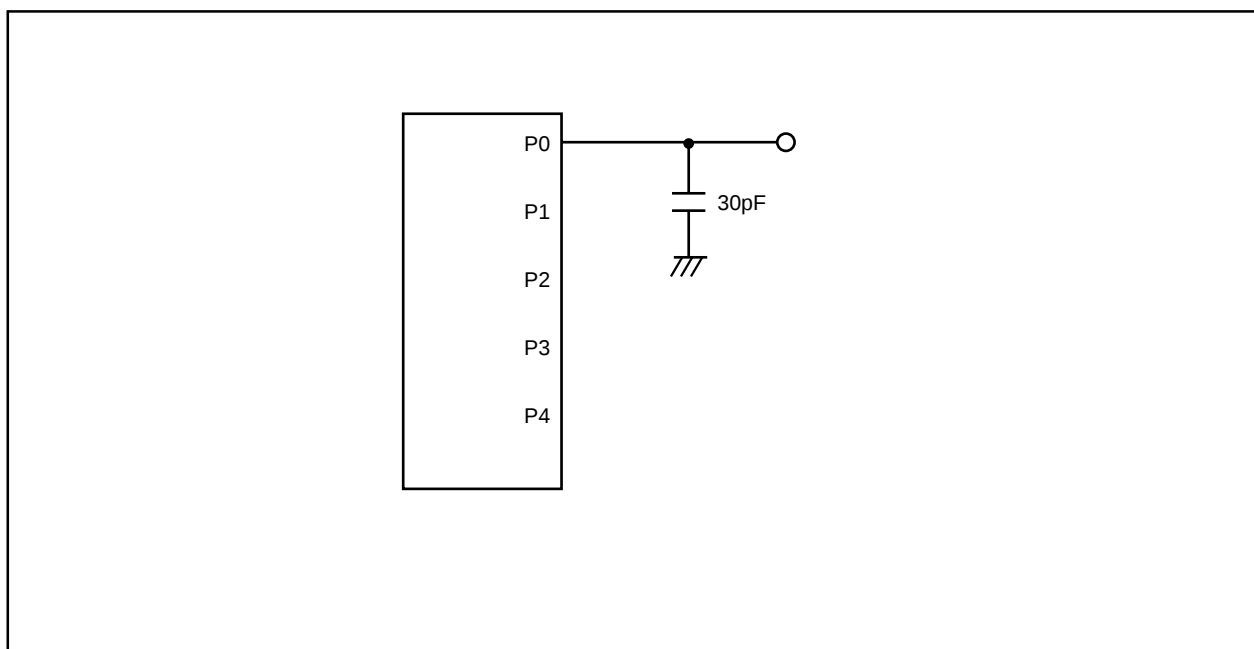
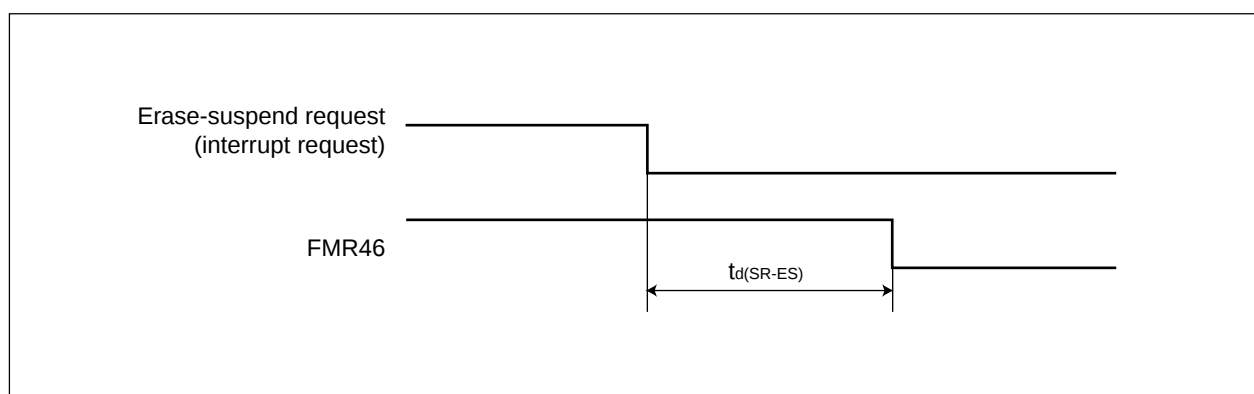
- 1: Referenced to  $V_{CC1} = AV_{CC} = 2.7$  to  $5.5V$  at  $T_{opr} = 0$  to  $60^\circ C$  unless otherwise specified.

**Table 5.5 Power Circuit Timing Characteristics**

| Symbol     | Parameter                                                                    | Measuring condition | Min. | Standard |      | Unit    |
|------------|------------------------------------------------------------------------------|---------------------|------|----------|------|---------|
|            |                                                                              |                     |      | Typ.     | Max. |         |
| $t_d(P-R)$ | Time for internal power supply stabilization during powering-on <sup>2</sup> |                     |      |          | 2    | ms      |
| $t_d(R-S)$ | STOP release time <sup>3</sup>                                               |                     |      |          | 150  | $\mu s$ |

Note

- 1: The measuring condition is  $V_{CC} = AV_{CC} = 2.7$  to  $5.5V$  and  $T_{opr} = 25^\circ C$ .
- 2: This shows the waiting time till the internal power supply generating circuit is stabilized during powering-on.
- 3: This shows the time till 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 ability HIGH IOH=-1 mA  | Vcc-2.0  |      | Vcc  | V    |
|                  |                           |                                                                                  | Drive ability LOW IOH=-500μA  | Vcc-2.0  |      | Vcc  | V    |
| VOL              | "L" output voltage        | P10 to P17<br>Except XOUT                                                        | IOH= 5 mA                     |          |      | 2.0  | V    |
|                  |                           |                                                                                  | IOH= 200 μA                   |          |      | 0.45 | V    |
|                  | P10 to P17                |                                                                                  | Drive ability HIGH IOH= 10 mA |          |      | 2.0  | V    |
|                  |                           |                                                                                  | Drive ability LOW IOH= 5 mA   |          |      | 2.0  | V    |
|                  | XOUT                      |                                                                                  | Drive ability HIGH IOH= 1 mA  |          |      | 2.0  | V    |
|                  |                           |                                                                                  | Drive ability LOW IOH=500μA   |          |      | 2.0  | V    |
| VT+-VT-          | Hysteresis                | INT0, INT1, INT2, INT3, KI0, KI1,<br>KI2, KI3, CNTR0, CNTR1, TCIN,<br>RxD0, RxD1 |                               | 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   |
| RiXIN            | Feedback resistance       | XIN                                                                              |                               |          | 1.0  |      | MΩ   |
| fRING            | Ring oscillator frequency |                                                                                  |                               | 40       | 125  | 250  | kHz  |
| V <sub>RAM</sub> | RAM retention voltage     |                                                                                  | At stop mode                  | 2.0      |      |      | V    |

**Note**

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

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

| Symbol          | Parameter                                                                                                                                  | Measuring condition  | Min.                                                                                                                           | Standard Typ. | Max. | Unit |
|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------------------------------------------------------------------------------------------------------------|---------------|------|------|
|                 |                                                                                                                                            |                      |                                                                                                                                |               |      |      |
| 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      | X <sub>IN</sub> =16 MHz (square wave)<br>Ring oscillator on=125 kHz<br>No division                                             | 8             | 14   | mA   |
|                 |                                                                                                                                            |                      | X <sub>IN</sub> =10 MHz (square wave)<br>Ring oscillator on=125 kHz<br>No division                                             | 5             |      | mA   |
|                 |                                                                                                                                            | Medium-speed mode    | X <sub>IN</sub> =16 MHz (square wave)<br>Ring oscillator on=125 kHz<br>Division by 8                                           | 3             |      | mA   |
|                 |                                                                                                                                            |                      | X <sub>IN</sub> =10 MHz (square wave)<br>Ring oscillator on=125 kHz<br>Division by 8                                           | 2             |      | mA   |
|                 |                                                                                                                                            | Ring oscillator mode | Main clock off<br>Ring oscillator on=125 kHz<br>Division by 8                                                                  | 0.4           | 2.0  | mA   |
|                 |                                                                                                                                            | Wait mode            | Main clock off<br>Ring oscillator on=125 kHz<br>When a WAIT instruction is executed <sup>2</sup><br>Peripheral clock operation | 40            | 80   | μA   |
|                 |                                                                                                                                            | Wait mode            | Main clock off<br>Ring oscillator on=125 kHz<br>When a WAIT instruction is executed <sup>2</sup><br>Peripheral clock off       | 38            | 76   | μA   |
|                 |                                                                                                                                            | Stop mode            | Main clock off<br>Ring oscillator off<br>CM10="1"<br>Peripheral clock off                                                      | 0.8           | 3.0  | μA   |

## Note

- 1: The power supply current measuring is executed using the measuring program on flash memory.  
 2: Timer Y is operated with timer mode.

**Timing requirements (Unless otherwise noted:  $V_{CC} = 5V$ ,  $V_{SS} = 0V$  at  $T_a = 25^\circ C$ ) [ $V_{CC}=5V$ ]****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 <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   |

Note

1 : Use the greater value, either (  $1 / \text{digital filter clock frequency} \times 6$  ) or min. value.2 : Use the greater value, either (  $1 / \text{digital filter clock frequency} \times 3$  ) or min. value.**Table 5.11 Serial I/O**

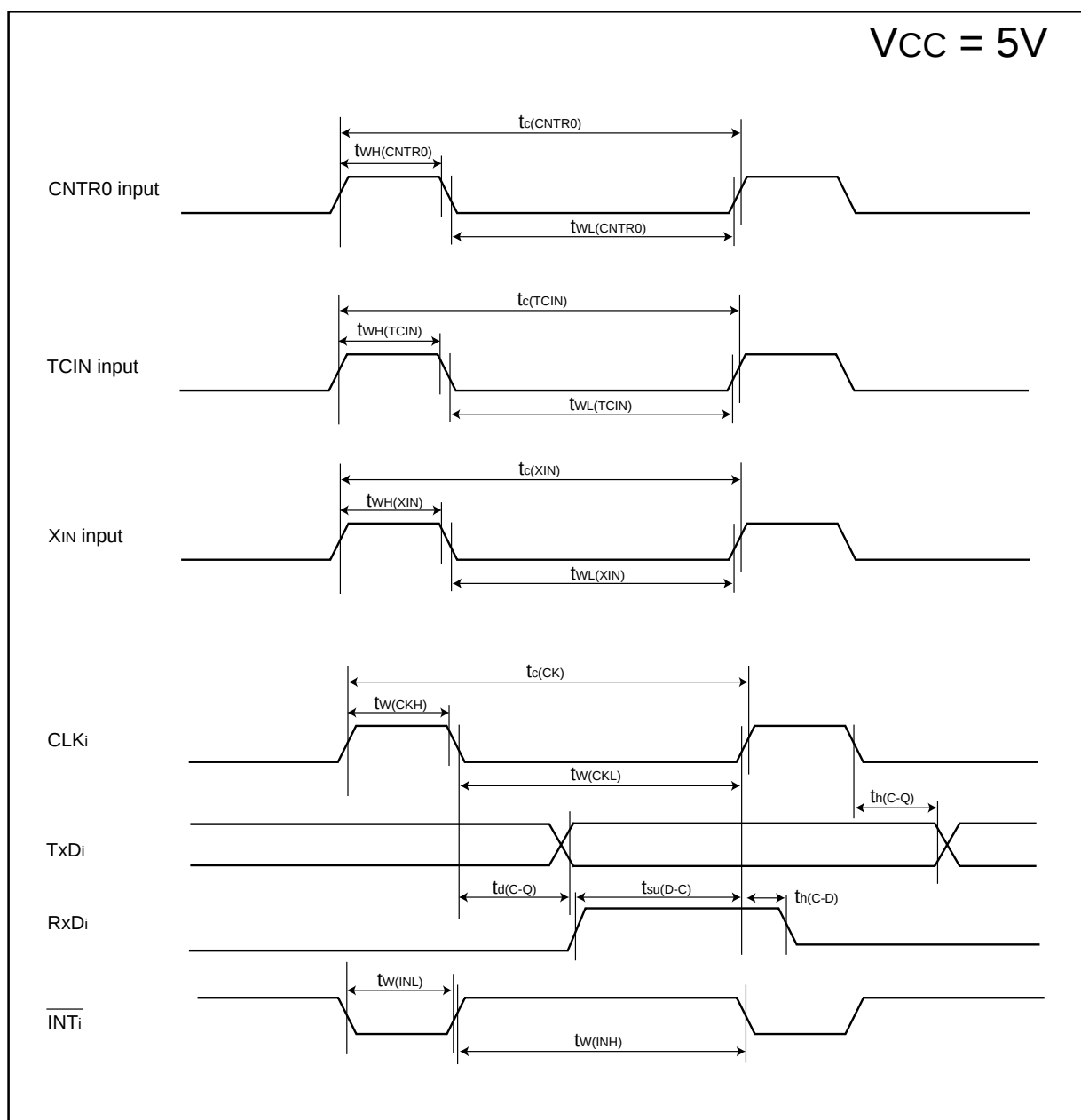
| Symbol        | Parameter                   | Standard |      | Unit |
|---------------|-----------------------------|----------|------|------|
|               |                             | Min.     | Max. |      |
| $t_c(CLK)$    | CLKi input cycle time       | 200      |      | ns   |
| $t_{W}(CLKH)$ | CLKi input HIGH pulse width | 100      |      | ns   |
| $t_{W}(CLKL)$ | 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   |

Note

1 : When the  $\overline{INT0}$  input filter select bit selects the digital filter, use the  $\overline{INT0}$  input HIGH pulse width to the greater value, either (  $1 / \text{digital filter clock frequency} \times 3$  ) or min. value.2 : When the  $\overline{INT0}$  input filter select bit selects the digital filter, use the  $\overline{INT0}$  input LOW pulse width to the greater value, either (  $1 / \text{digital filter clock frequency} \times 3$  ) or min. value.

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 ability HIGH IOH=-0.1 mA | Vcc-0.5  |      | Vcc  | V    |
|         |                           |                                                                                  | Drive ability LOW IOH=-50 μA   | Vcc-0.5  |      | Vcc  | V    |
| VOL     | "L" output voltage        | P10 to P17<br>Except XOUT                                                        | IOH= 1 mA                      |          |      | 0.5  | V    |
|         |                           | P10 to P17                                                                       | Drive ability HIGH IOH= 2 mA   |          |      | 0.5  | V    |
|         |                           |                                                                                  | Drive ability LOW IOH= 1 mA    |          |      | 0.5  | V    |
|         |                           | XOUT                                                                             | Drive ability HIGH IOH= 0.1 mA |          |      | 0.5  | V    |
|         |                           |                                                                                  | Drive ability LOW IOH=50 μA    |          |      | 0.5  | V    |
| VT+-VT- | Hysteresis                | INT0, INT1, INT2, INT3, KI0, KI1,<br>KI2, KI3, CNTR0, CNTR1, TCIN,<br>RXD0, RXD1 |                                | 0.2      |      | 0.8  | V    |
|         |                           | RESET                                                                            |                                | 0.2      |      | 1.8  | V    |
| IiH     | "H" input current         |                                                                                  | Vi=3V                          |          |      | 4.0  | μA   |
| IiL     | "L" input current         |                                                                                  | Vi=0V                          |          |      | -4.0 | μA   |
| RPULLUP | Pull-up resistance        |                                                                                  | Vi=0V                          | 66       | 160  | 500  | kΩ   |
| RiXIN   | Feedback resistance       | XIN                                                                              |                                |          | 3.0  |      | MΩ   |
| fRING   | Ring oscillator frequency |                                                                                  |                                | 40       | 125  | 250  | kHz  |
| VRAM    | RAM retention voltage     |                                                                                  | At stop mode                   | 2.0      |      |      | V    |

**Note**

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

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

| Symbol          | Parameter                                                                                                                                         | Measuring condition     |                                                                                                                                | Min. | Standard<br>Typ. | Max. | Unit |
|-----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------------------------------------------------------------------------------------------------------|------|------------------|------|------|
| I <sub>CC</sub> | Power supply current<br>(V <sub>CC1</sub> =2.7 to 3.3V)<br>In single-chip mode, the output<br>pins are open and other pins<br>are V <sub>SS</sub> | High-speed<br>mode      | X <sub>IN</sub> =16 MHz (square wave)<br>Ring oscillator on=125 kHz<br>No division                                             |      | 7                | 12   | mA   |
|                 |                                                                                                                                                   |                         | X <sub>IN</sub> =10 MHz (square wave)<br>Ring oscillator on=125 kHz<br>No division                                             |      | 5                |      | mA   |
|                 |                                                                                                                                                   | Medium-speed<br>mode    | X <sub>IN</sub> =16 MHz (square wave)<br>Ring oscillator on=125 kHz<br>Division by 8                                           |      | 2.5              |      | mA   |
|                 |                                                                                                                                                   |                         | X <sub>IN</sub> =10 MHz (square wave)<br>Ring oscillator on=125 kHz<br>Division by 8                                           |      | 1.6              |      | mA   |
|                 |                                                                                                                                                   | Ring oscillator<br>mode | Main clock off<br>Ring oscillator on=125 kHz<br>Division by 8                                                                  |      | 0.4              | 2.0  | mA   |
|                 |                                                                                                                                                   | Wait mode               | Main clock off<br>Ring oscillator on=125 kHz<br>When a WAIT instruction is executed <sup>2</sup><br>Peripheral clock operation |      | 37               | 74   | μA   |
|                 |                                                                                                                                                   | Wait mode               | Main clock off<br>Ring oscillator on=125 kHz<br>When a WAIT instruction is executed <sup>2</sup><br>Peripheral clock off       |      | 35               | 70   | μA   |
|                 |                                                                                                                                                   | Stop mode               | Main clock off<br>Ring oscillator off<br>CM10="1"<br>Peripheral clock off                                                      |      | 0.7              | 3.0  | μA   |

**Note**

- 1: The power supply current measuring is executed using the measuring program on frash memory.  
 2: Timer Y is operated with timer mode.

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

| Symbol           | Parameter                       | Standard |      | Unit |
|------------------|---------------------------------|----------|------|------|
|                  |                                 | Min.     | Max. |      |
| $t_C(X_{IN})$    | $X_{IN}$ input cycle time       | 143      |      | ns   |
| $t_{WH}(X_{IN})$ | $X_{IN}$ input HIGH pulse width | 70       |      | ns   |
| $t_{WL}(X_{IN})$ | $X_{IN}$ input LOW pulse width  | 70       |      | 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 <sup>1</sup> |      | ns   |
| $t_{WH}(TCIN)$ | TCIN input HIGH pulse width | 600 <sup>2</sup>  |      | ns   |
| $t_{WL}(TCIN)$ | TCIN input LOW pulse width  | 600 <sup>2</sup>  |      | ns   |

Note

1 : Use the greater value, either ( 1/ digital filter clock frequency x 6 ) or min. value.

2 : Use the greater value, either ( 1/ digital filter clock frequency x 3 ) or min. value.

**Table 5.18 Serial I/O**

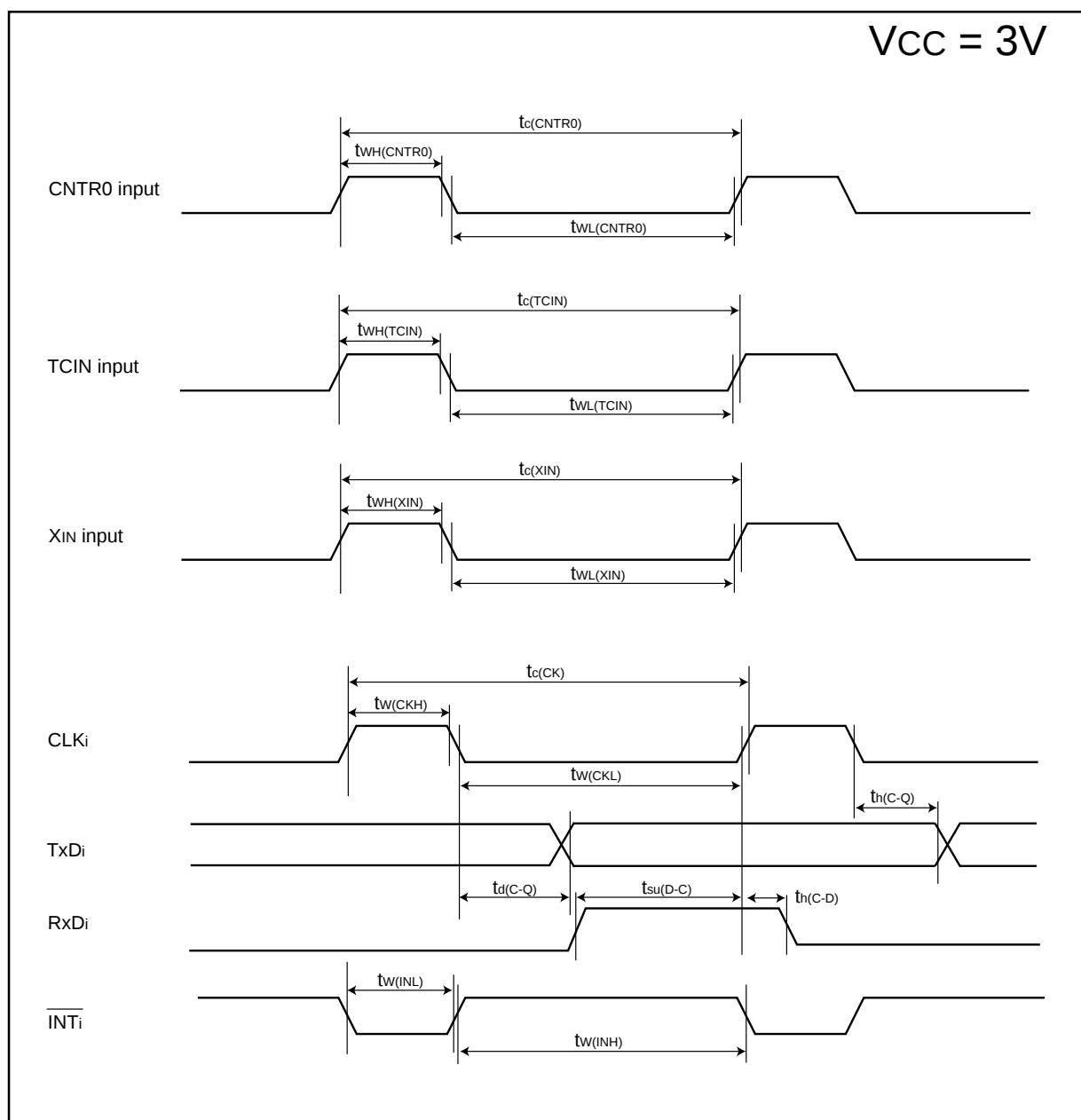
| Symbol        | Parameter                   | Standard |      | Unit |
|---------------|-----------------------------|----------|------|------|
|               |                             | Min.     | Max. |      |
| $t_C(CLK)$    | CLKi input cycle time       | 300      |      | ns   |
| $t_{W}(CLKH)$ | CLKi input HIGH pulse width | 150      |      | ns   |
| $t_{W}(CLKL)$ | 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 <sup>1</sup> |      | ns   |
| $t_{W}(INL)$ | $\overline{INT0}$ input LOW pulse width  | 380 <sup>2</sup> |      | ns   |

Note

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

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

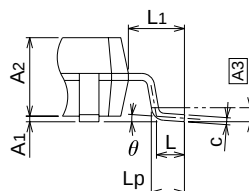
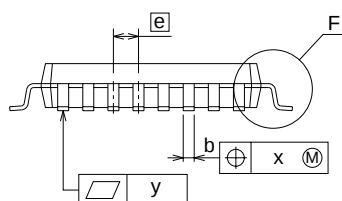
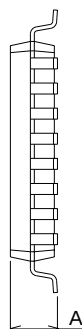
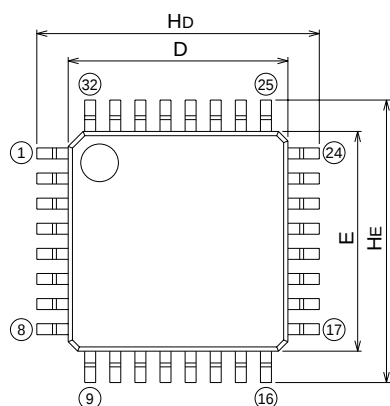
## Package Dimensions

### 32P6U-A

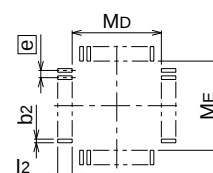
(MMP)

Plastic 32pin 7X7mm body LQFP

| EIAJ Package Code  | JEDEC Code | Weight(g) | Lead Material |
|--------------------|------------|-----------|---------------|
| LQFP32-P-0707-0.80 | —          |           | Cu Alloy      |



Detail F



Recommended Mount Pad

| Symbol   | Dimension in Millimeters |       |       |
|----------|--------------------------|-------|-------|
|          | Min                      | Nom   | Max   |
| A        | —                        | —     | 1.7   |
| A1       | 0                        | 0.1   | 0.2   |
| A2       | —                        | 1.4   | —     |
| b        | 0.32                     | 0.37  | 0.45  |
| c        | 0.105                    | 0.125 | 0.175 |
| D        | 6.9                      | 7.0   | 7.1   |
| E        | 6.9                      | 7.0   | 7.1   |
| e        | —                        | 0.8   | —     |
| Hb       | 8.8                      | 9.0   | 9.2   |
| HE       | 8.8                      | 9.0   | 9.2   |
| L        | 0.3                      | 0.5   | 0.7   |
| L1       | —                        | 1.0   | —     |
| Lp       | 0.45                     | 0.6   | 0.75  |
| A3       | —                        | 0.25  | —     |
| x        | —                        | —     | 0.2   |
| y        | —                        | —     | 0.1   |
| $\theta$ | 0°                       | —     | 10°   |
| b2       | —                        | 0.5   | —     |
| l2       | 1.0                      | —     | —     |
| Md       | —                        | 7.4   | —     |
| ME       | —                        | 7.4   | —     |

|                  |                         |
|------------------|-------------------------|
| REVISION HISTORY | R8C/10 Group Data Sheet |
|------------------|-------------------------|

| 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 $f(X_{IN})$ changed<br>Figure 1.3: Pin name changed from TXOUT to $\overline{CNTR0}$<br>Table 1.3: Pin name changed from TXOUT to $\overline{CNTR0}$<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", ring 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<br>Table 5.8 to Table 5.12 added<br>Figure 5.2 added<br>Table 5.13: Note 1, $f(BCLK)=5\text{ MHz}$ changed to 10 MHz<br>Table 5.14: ring 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<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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| 1.30 | Dec 05, 2003  | 15<br>16                                                                   | Table 5.4 revised<br>Figure 5.2 added                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

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