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### What is "[Embedded - Microcontrollers](#)"?

"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

### Applications of "[Embedded - Microcontrollers](#)"

#### Details

|                            |                                                                                                                                                                                 |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Status             | Not For New Designs                                                                                                                                                             |
| Core Processor             | R8C                                                                                                                                                                             |
| Core Size                  | 16-Bit                                                                                                                                                                          |
| Speed                      | 20MHz                                                                                                                                                                           |
| Connectivity               | I <sup>2</sup> C, LINbus, SIO, SSU, UART/USART                                                                                                                                  |
| Peripherals                | POR, PWM, Voltage Detect, WDT                                                                                                                                                   |
| Number of I/O              | 59                                                                                                                                                                              |
| Program Memory Size        | 32KB (32K x 8)                                                                                                                                                                  |
| Program Memory Type        | FLASH                                                                                                                                                                           |
| EEPROM Size                | 4K x 8                                                                                                                                                                          |
| RAM Size                   | 2.5K x 8                                                                                                                                                                        |
| Voltage - Supply (Vcc/Vdd) | 1.8V ~ 5.5V                                                                                                                                                                     |
| Data Converters            | A/D 12x10b; D/A 2x8b                                                                                                                                                            |
| Oscillator Type            | Internal                                                                                                                                                                        |
| Operating Temperature      | -20°C ~ 85°C (TA)                                                                                                                                                               |
| Mounting Type              | Surface Mount                                                                                                                                                                   |
| Package / Case             | 64-LQFP                                                                                                                                                                         |
| Supplier Device Package    | 64-LFQFP (10x10)                                                                                                                                                                |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f21366cnfp-30">https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f21366cnfp-30</a> |

### 1.1.2 Specifications

Tables 1.1 and 1.2 outline the Specifications for R8C/36C Group.

**Table 1.1 Specifications for R8C/36C Group (1)**

| Item                           | Function                  | Specification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------|---------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CPU                            | Central processing unit   | R8C CPU core <ul style="list-style-type: none"><li>• Number of fundamental instructions: 89</li><li>• Minimum instruction execution time:<ul style="list-style-type: none"><li>50 ns (f(XIN) = 20 MHz, VCC = 2.7 to 5.5 V)</li><li>200 ns (f(XIN) = 5 MHz, VCC = 1.8 to 5.5 V)</li></ul></li><li>• Multiplier: 16 bits × 16 bits → 32 bits</li><li>• Multiply-accumulate instruction: 16 bits × 16 bits + 32 bits → 32 bits</li><li>• Operation mode: Single-chip mode (address space: 1 Mbyte)</li></ul>                                                                                                                                   |
| Memory                         | ROM, RAM, Data flash      | Refer to <b>Table 1.3 Product List for R8C/36C Group</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Power Supply Voltage Detection | Voltage detection circuit | <ul style="list-style-type: none"><li>• Power-on reset</li><li>• Voltage detection 3 (detection level of voltage detection 0 and voltage detection 1 selectable)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| I/O Ports                      | Programmable I/O ports    | <ul style="list-style-type: none"><li>• Input-only: 1 pin</li><li>• CMOS I/O ports: 59, selectable pull-up resistor</li><li>• High current drive ports: 59</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Clock                          | Clock generation circuits | <ul style="list-style-type: none"><li>• 4 circuits: XIN clock oscillation circuit, XCIN clock oscillation circuit (32 kHz), High-speed on-chip oscillator (with frequency adjustment function), Low-speed on-chip oscillator</li><li>• Oscillation stop detection: XIN clock oscillation stop detection function</li><li>• Frequency divider circuit: Dividing selectable 1, 2, 4, 8, and 16</li><li>• Low power consumption modes:<ul style="list-style-type: none"><li>Standard operating mode (high-speed clock, low-speed clock, high-speed on-chip oscillator, low-speed on-chip oscillator), wait mode, stop mode</li></ul></li></ul> |
|                                |                           | Real-time clock (timer RE)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Interrupts                     |                           | <ul style="list-style-type: none"><li>• Interrupt Vectors: 69</li><li>• External: 9 sources (<math>\overline{\text{INT}} \times 5</math>, key input × 4)</li><li>• Priority levels: 7 levels</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Watchdog Timer                 |                           | <ul style="list-style-type: none"><li>• 14 bits × 1 (with prescaler)</li><li>• Reset start selectable</li><li>• Low-speed on-chip oscillator for watchdog timer selectable</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| DTC (Data Transfer Controller) |                           | <ul style="list-style-type: none"><li>• 1 channel</li><li>• Activation sources: 39</li><li>• Transfer modes: 2 (normal mode, repeat mode)</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Timer                          | Timer RA                  | 8 bits × 1 (with 8-bit prescaler)<br>Timer mode (period timer), pulse output mode (output level inverted every period), event counter mode, pulse width measurement mode, pulse period measurement mode                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|                                | Timer RB                  | 8 bits × 1 (with 8-bit prescaler)<br>Timer mode (period timer), programmable waveform generation mode (PWM output), programmable one-shot generation mode, programmable wait one-shot generation mode                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|                                | Timer RC                  | 16 bits × 1 (with 4 capture/compare registers)<br>Timer mode (input capture function, output compare function), PWM mode (output 3 pins), PWM2 mode (PWM output pin)                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                | Timer RD                  | 16 bits × 2 (with 4 capture/compare registers)<br>Timer mode (input capture function, output compare function), PWM mode (output 6 pins), reset synchronous PWM mode (output three-phase waveforms (6 pins), sawtooth wave modulation), complementary PWM mode (output three-phase waveforms (6 pins), triangular wave modulation), PWM3 mode (PWM output 2 pins with fixed period)                                                                                                                                                                                                                                                         |

**Table 1.2 Specifications for R8C/36C Group (2)**

| Item                                        | Function     | Specification                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Timer                                       | Timer RE     | 8 bits × 1<br>Real-time clock mode (count seconds, minutes, hours, days of week), output compare mode                                                                                                                                                                                                                                                                                                         |
|                                             | Timer RF     | 16 bits × 1<br>Input capture mode (input capture circuit), output compare mode (output compare circuit)                                                                                                                                                                                                                                                                                                       |
|                                             | Timer RG     | 16 bits × 1 (with 2 capture/compare registers)<br>Timer mode (input capture function, output compare function), PWM mode (output 1 pin), phase counting mode (available automatic measurement for the counts of 2-phase encoder)                                                                                                                                                                              |
| Serial Interface                            | UART0, UART1 | Clock synchronous serial I/O/UART × 2 channel                                                                                                                                                                                                                                                                                                                                                                 |
|                                             | UART2        | Clock synchronous serial I/O, UART, I <sup>2</sup> C mode (I <sup>2</sup> C bus), multiprocessor communication function                                                                                                                                                                                                                                                                                       |
| Synchronous Serial Communication Unit (SSU) |              | 1 (shared with I <sup>2</sup> C bus)                                                                                                                                                                                                                                                                                                                                                                          |
| I <sup>2</sup> C bus                        |              | 1 (shared with SSU)                                                                                                                                                                                                                                                                                                                                                                                           |
| LIN Module                                  |              | Hardware LIN: 1 (timer RA, UART0)                                                                                                                                                                                                                                                                                                                                                                             |
| A/D Converter                               |              | 10-bit resolution × 12 channels, includes sample and hold function, with sweep mode                                                                                                                                                                                                                                                                                                                           |
| D/A Converter                               |              | 8-bit resolution × 2 circuits                                                                                                                                                                                                                                                                                                                                                                                 |
| Comparator B                                |              | 2 circuits                                                                                                                                                                                                                                                                                                                                                                                                    |
| Flash Memory                                |              | <ul style="list-style-type: none"> <li>• Programming and erasure voltage: VCC = 2.7 to 5.5 V</li> <li>• Programming and erasure endurance: 10,000 times (data flash) 1,000 times (program ROM)</li> <li>• Program security: ROM code protect, ID code check</li> <li>• Debug functions: On-chip debug, on-board flash rewrite function</li> <li>• Background operation (BGO) function (data flash)</li> </ul> |
| Operating Frequency/Supply Voltage          |              | f(XIN) = 20 MHz (VCC = 2.7 to 5.5 V)<br>f(XIN) = 5 MHz (VCC = 1.8 to 5.5 V)                                                                                                                                                                                                                                                                                                                                   |
| Current consumption                         |              | Typ. 7.0 mA (VCC = 5.0 V, f(XIN) = 20 MHz)<br>Typ. 3.5 mA (VCC = 3.0 V, f(XIN) = 10 MHz)<br>Typ. 4.0 μA (VCC = 3.0 V, wait mode (f(XCIN) = 32 kHz))<br>Typ. 2.0 μA (VCC = 3.0 V, stop mode)                                                                                                                                                                                                                   |
| Operating Ambient Temperature               |              | −20 to 85°C (N version)<br>−40 to 85°C (D version) <sup>(1)</sup>                                                                                                                                                                                                                                                                                                                                             |
| Package                                     |              | 64-pin LQFP<br>• Package code: PLQP0064KB-A (previous code: 64P6Q-A)<br>• Package code: PLQP0064GA-A (previous code: 64P6U-A)<br>64-pin TQFP<br>• Package code: PTQP0064LB-A                                                                                                                                                                                                                                  |

Note:

1. Specify the D version if D version functions are to be used.

## 1.2 Product List

Tables 1.3 and 1.4 list Product List for R8C/36C Group. Figure 1.1 shows a Part Number, Memory Size, and Package of R8C/36C Group.

**Table 1.3 Product List for R8C/36C Group (1)**

**Current of Nov 2010**

| Part No.            | ROM Capacity |             | RAM Capacity | Package Type | Remarks   |                                            |
|---------------------|--------------|-------------|--------------|--------------|-----------|--------------------------------------------|
|                     | Program ROM  | Data flash  |              |              |           |                                            |
| R5F21364CNFP        | 16 Kbytes    | 1 Kbyte × 4 | 1.5 Kbytes   | PLQP0064KB-A | N version |                                            |
| R5F21365CNFP        | 24 Kbytes    | 1 Kbyte × 4 | 2 Kbytes     | PLQP0064KB-A |           |                                            |
| R5F21366CNFP        | 32 Kbytes    | 1 Kbyte × 4 | 2.5 Kbytes   | PLQP0064KB-A |           |                                            |
| R5F21367CNFP        | 48 Kbytes    | 1 Kbyte × 4 | 4 Kbytes     | PLQP0064KB-A |           |                                            |
| R5F21368CNFP        | 64 Kbytes    | 1 Kbyte × 4 | 6 Kbytes     | PLQP0064KB-A |           |                                            |
| R5F2136ACNFP        | 96 Kbytes    | 1 Kbyte × 4 | 8 Kbytes     | PLQP0064KB-A |           |                                            |
| R5F2136CCNFP        | 128 Kbytes   | 1 Kbyte × 4 | 10 Kbytes    | PLQP0064KB-A |           |                                            |
| R5F21364CNFA        | 16 Kbytes    | 1 Kbyte × 4 | 1.5 Kbytes   | PLQP0064GA-A |           |                                            |
| R5F21365CNFA        | 24 Kbytes    | 1 Kbyte × 4 | 2 Kbytes     | PLQP0064GA-A |           |                                            |
| R5F21366CNFA        | 32 Kbytes    | 1 Kbyte × 4 | 2.5 Kbytes   | PLQP0064GA-A |           |                                            |
| R5F21367CNFA        | 48 Kbytes    | 1 Kbyte × 4 | 4 Kbytes     | PLQP0064GA-A |           |                                            |
| R5F21368CNFA        | 64 Kbytes    | 1 Kbyte × 4 | 6 Kbytes     | PLQP0064GA-A |           |                                            |
| R5F2136ACNFA        | 96 Kbytes    | 1 Kbyte × 4 | 8 Kbytes     | PLQP0064GA-A |           |                                            |
| R5F2136CCNFA        | 128 Kbytes   | 1 Kbyte × 4 | 10 Kbytes    | PLQP0064GA-A |           |                                            |
| R5F21364CNFB (D)    | 16 Kbytes    | 1 Kbyte × 4 | 1.5 Kbytes   | PTQP0064LB-A | N version | Factory programming product <sup>(1)</sup> |
| R5F21365CNFB (D)    | 24 Kbytes    | 1 Kbyte × 4 | 2 Kbytes     | PTQP0064LB-A |           |                                            |
| R5F21366CNFB (D)    | 32 Kbytes    | 1 Kbyte × 4 | 2.5 Kbytes   | PTQP0064LB-A |           |                                            |
| R5F21367CNFB (D)    | 48 Kbytes    | 1 Kbyte × 4 | 4 Kbytes     | PTQP0064LB-A |           |                                            |
| R5F21368CNFB (D)    | 64 Kbytes    | 1 Kbyte × 4 | 6 Kbytes     | PTQP0064LB-A |           |                                            |
| R5F2136ACNFB (D)    | 96 Kbytes    | 1 Kbyte × 4 | 8 Kbytes     | PTQP0064LB-A |           |                                            |
| R5F2136CCNFB (D)    | 128 Kbytes   | 1 Kbyte × 4 | 10 Kbytes    | PTQP0064LB-A |           |                                            |
| R5F21364CNXXXFP     | 16 Kbytes    | 1 Kbyte × 4 | 1.5 Kbytes   | PLQP0064KB-A |           |                                            |
| R5F21365CNXXXFP     | 24 Kbytes    | 1 Kbyte × 4 | 2 Kbytes     | PLQP0064KB-A |           |                                            |
| R5F21366CNXXXFP     | 32 Kbytes    | 1 Kbyte × 4 | 2.5 Kbytes   | PLQP0064KB-A |           |                                            |
| R5F21367CNXXXFP     | 48 Kbytes    | 1 Kbyte × 4 | 4 Kbytes     | PLQP0064KB-A |           |                                            |
| R5F21368CNXXXFP     | 64 Kbytes    | 1 Kbyte × 4 | 6 Kbytes     | PLQP0064KB-A |           |                                            |
| R5F2136ACNXXXFP     | 96 Kbytes    | 1 Kbyte × 4 | 8 Kbytes     | PLQP0064KB-A |           |                                            |
| R5F2136CCNXXXFP     | 128 Kbytes   | 1 Kbyte × 4 | 10 Kbytes    | PLQP0064KB-A |           |                                            |
| R5F21364CNXXXFA     | 16 Kbytes    | 1 Kbyte × 4 | 1.5 Kbytes   | PLQP0064GA-A |           |                                            |
| R5F21365CNXXXFA     | 24 Kbytes    | 1 Kbyte × 4 | 2 Kbytes     | PLQP0064GA-A |           |                                            |
| R5F21366CNXXXFA     | 32 Kbytes    | 1 Kbyte × 4 | 2.5 Kbytes   | PLQP0064GA-A |           |                                            |
| R5F21367CNXXXFA     | 48 Kbytes    | 1 Kbyte × 4 | 4 Kbytes     | PLQP0064GA-A |           |                                            |
| R5F21368CNXXXFA     | 64 Kbytes    | 1 Kbyte × 4 | 6 Kbytes     | PLQP0064GA-A |           |                                            |
| R5F2136ACNXXXFA     | 96 Kbytes    | 1 Kbyte × 4 | 8 Kbytes     | PLQP0064GA-A |           |                                            |
| R5F2136CCNXXXFA     | 128 Kbytes   | 1 Kbyte × 4 | 10 Kbytes    | PLQP0064GA-A |           |                                            |
| R5F21364CNXXXFB (D) | 16 Kbytes    | 1 Kbyte × 4 | 1.5 Kbytes   | PTQP0064LB-A |           |                                            |
| R5F21365CNXXXFB (D) | 24 Kbytes    | 1 Kbyte × 4 | 2 Kbytes     | PTQP0064LB-A |           |                                            |
| R5F21366CNXXXFB (D) | 32 Kbytes    | 1 Kbyte × 4 | 2.5 Kbytes   | PTQP0064LB-A |           |                                            |
| R5F21367CNXXXFB (D) | 48 Kbytes    | 1 Kbyte × 4 | 4 Kbytes     | PTQP0064LB-A |           |                                            |
| R5F21368CNXXXFB (D) | 64 Kbytes    | 1 Kbyte × 4 | 6 Kbytes     | PTQP0064LB-A |           |                                            |
| R5F2136ACNXXXFB (D) | 96 Kbytes    | 1 Kbyte × 4 | 8 Kbytes     | PTQP0064LB-A |           |                                            |
| R5F2136CCNXXXFB (D) | 128 Kbytes   | 1 Kbyte × 4 | 10 Kbytes    | PTQP0064LB-A |           |                                            |

(D): Under development

Note:

1. The user ROM is programmed before shipment.

## 2. Central Processing Unit (CPU)

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

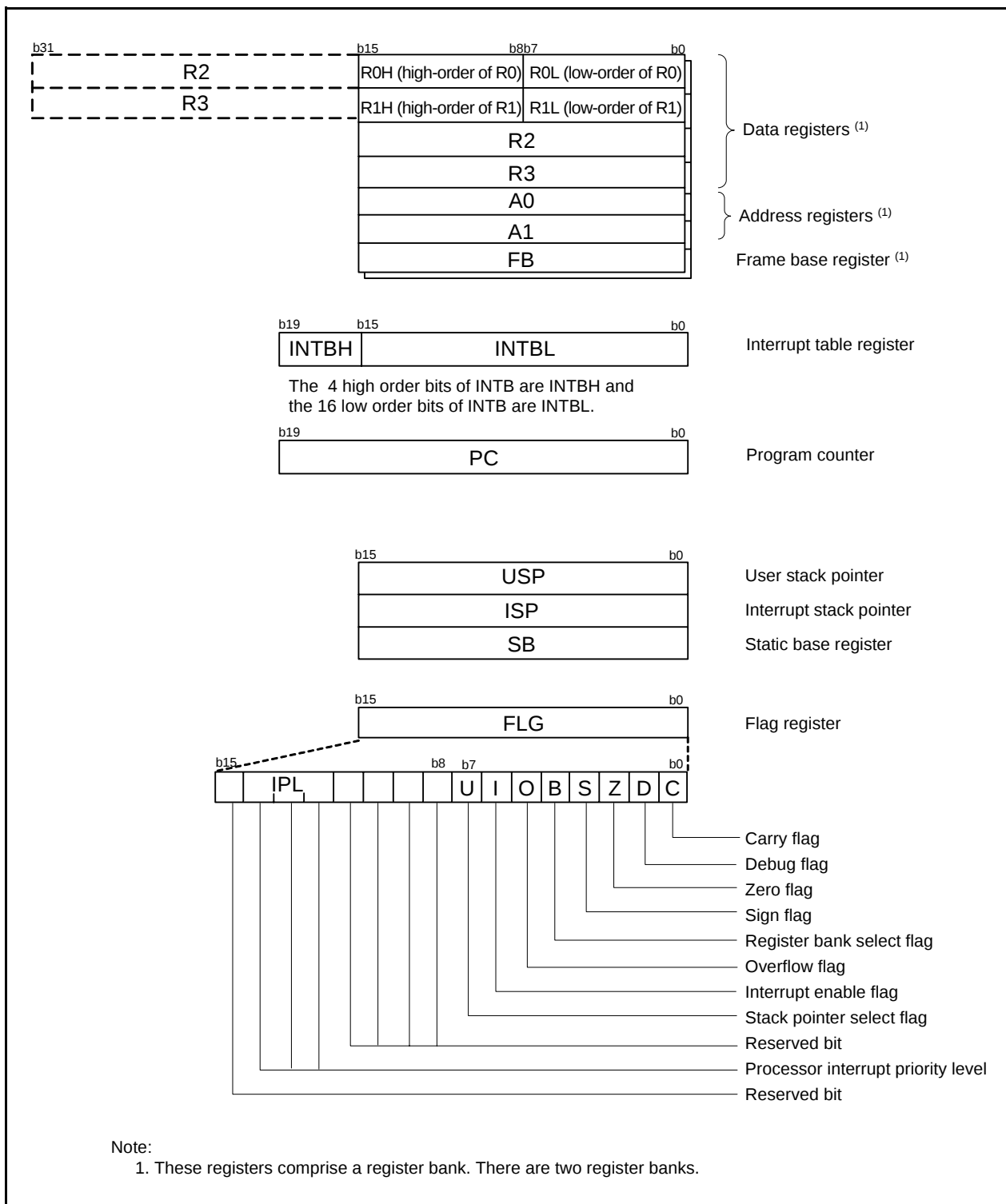
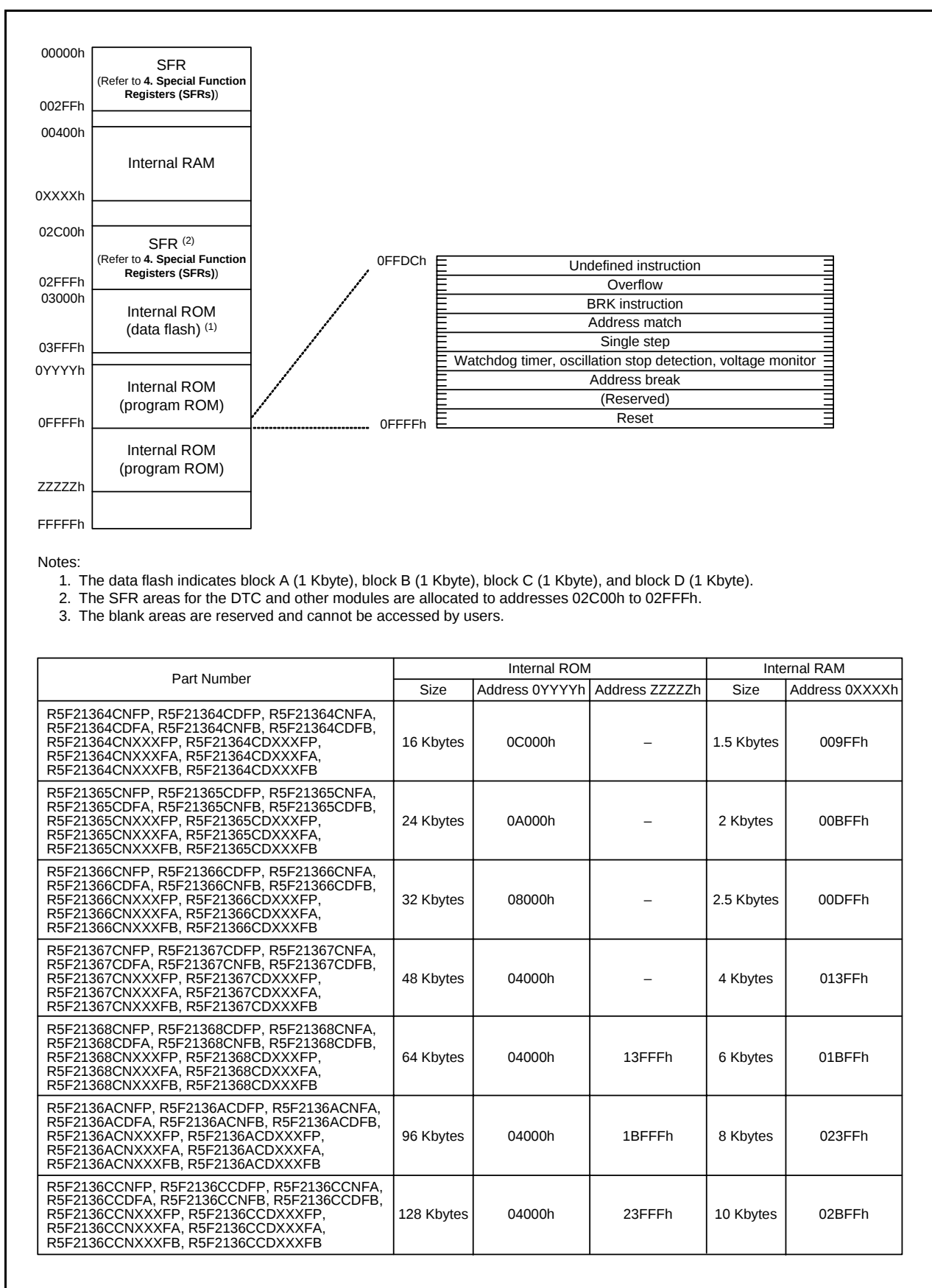


Figure 2.1 CPU Registers



### Figure 3.1 Memory Map of R8C/36C Group

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

| Address | Register                   | Symbol  | After Reset |
|---------|----------------------------|---------|-------------|
| 00C0h   | A/D Register 0             | AD0     | XXh         |
| 00C1h   |                            |         | 000000XXb   |
| 00C2h   |                            |         | XXh         |
| 00C3h   | A/D Register 1             | AD1     | 000000XXb   |
| 00C4h   |                            |         | XXh         |
| 00C5h   |                            |         | 000000XXb   |
| 00C6h   | A/D Register 2             | AD2     | XXh         |
| 00C7h   |                            |         | 000000XXb   |
| 00C8h   |                            |         | XXh         |
| 00C9h   | A/D Register 3             | AD3     | 000000XXb   |
| 00CAh   |                            |         | XXh         |
| 00CBh   |                            |         | 000000XXb   |
| 00CCh   | A/D Register 4             | AD4     | XXh         |
| 00CDh   |                            |         | 000000XXb   |
| 00CEh   |                            |         | XXh         |
| 00CFh   | A/D Register 5             | AD5     | 000000XXb   |
| 00D0h   |                            |         | XXh         |
| 00D1h   |                            |         | 000000XXb   |
| 00D2h   | A/D Register 6             | AD6     | XXh         |
| 00D3h   |                            |         | 000000XXb   |
| 00D4h   |                            |         | XXh         |
| 00D5h   | A/D Register 7             | AD7     | 000000XXb   |
| 00D6h   |                            |         | XXh         |
| 00D7h   |                            |         | 000000XXb   |
| 00D8h   | A/D Mode Register          | ADMOD   | 00h         |
| 00D9h   |                            |         | 11000000b   |
| 00DAh   |                            |         | 00h         |
| 00DBh   | A/D Input Select Register  | ADINSEL | 00h         |
| 00DCh   |                            |         | 00h         |
| 00DDh   |                            |         | 00h         |
| 00DEh   | A/D Control Register 0     | ADCON0  | 00h         |
| 00DFh   |                            |         | 00h         |
| 00E0h   |                            |         | 00h         |
| 00E1h   | A/D Control Register 1     | ADCON1  | 00h         |
| 00E2h   |                            |         | 00h         |
| 00E3h   |                            |         | 00h         |
| 00E4h   | D/A0 Register              | DA0     | 00h         |
| 00E5h   |                            |         | 00h         |
| 00E6h   |                            |         | 00h         |
| 00E7h   | D/A1 Register              | DA1     | 00h         |
| 00E8h   |                            |         | 00h         |
| 00E9h   |                            |         | 00h         |
| 00EAh   | D/A Control Register       | DACON   | 00h         |
| 00EBh   |                            |         | 00h         |
| 00ECh   |                            |         | 00h         |
| 00EDh   | Port P0 Register           | P0      | XXh         |
| 00EEh   |                            |         | XXh         |
| 00EFh   |                            |         | 00h         |
| 00F0h   | Port P1 Register           | P1      | 00h         |
| 00F1h   |                            |         | 00h         |
| 00F2h   |                            |         | 00h         |
| 00F3h   | Port P0 Direction Register | PD0     | 00h         |
| 00F4h   |                            |         | 00h         |
| 00F5h   |                            |         | 00h         |
| 00F6h   | Port P1 Direction Register | PD1     | 00h         |
| 00F7h   |                            |         | 00h         |
| 00F8h   |                            |         | 00h         |
| 00F9h   | Port P2 Register           | P2      | XXh         |
| 00FAh   |                            |         | XXh         |
| 00FBh   |                            |         | 00h         |
| 00FCh   | Port P3 Register           | P3      | 00h         |
| 00FDh   |                            |         | 00h         |
| 00FEh   |                            |         | 00h         |
| 00FFh   | Port P2 Direction Register | PD2     | 00h         |
|         |                            |         | 00h         |
|         |                            |         | 00h         |
|         | Port P3 Direction Register | PD3     | 00h         |
|         |                            |         | 00h         |
|         |                            |         | 00h         |
|         | Port P4 Register           | P4      | XXh         |
|         |                            |         | XXh         |
|         |                            |         | 00h         |
|         | Port P5 Register           | P5      | 00h         |
|         |                            |         | 00h         |
|         |                            |         | 00h         |
|         | Port P4 Direction Register | PD4     | 00h         |
|         |                            |         | 00h         |
|         |                            |         | 00h         |
|         | Port P5 Direction Register | PD5     | 00h         |
|         |                            |         | 00h         |
|         |                            |         | 00h         |
|         | Port P6 Register           | P6      | XXh         |
|         |                            |         | XXh         |
|         |                            |         | 00h         |
|         | Port P6 Direction Register | PD6     | 00h         |
|         |                            |         | 00h         |
|         |                            |         | 00h         |
|         | Port P8 Register           | P8      | XXh         |
|         |                            |         | XXh         |

X: Undefined

Note:

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

**Table 4.6 SFR Information (6) (1)**

| Address | Register                                          | Symbol   | After Reset |
|---------|---------------------------------------------------|----------|-------------|
| 0140h   | Timer RD Control Register 0                       | TRDCR0   | 00h         |
| 0141h   | Timer RD I/O Control Register A0                  | TRDIORA0 | 10001000b   |
| 0142h   | Timer RD I/O Control Register C0                  | TRDIORC0 | 10001000b   |
| 0143h   | Timer RD Status Register 0                        | TRDSR0   | 11100000b   |
| 0144h   | Timer RD Interrupt Enable Register 0              | TRDIER0  | 11100000b   |
| 0145h   | Timer RD PWM Mode Output Level Control Register 0 | TRDPOCR0 | 11111000b   |
| 0146h   | Timer RD Counter 0                                | TRD0     | 00h         |
| 0147h   |                                                   |          | 00h         |
| 0148h   | Timer RD General Register A0                      | TRDGRA0  | FFh         |
| 0149h   |                                                   |          | FFh         |
| 014Ah   | Timer RD General Register B0                      | TRDGRB0  | FFh         |
| 014Bh   |                                                   |          | FFh         |
| 014Ch   | Timer RD General Register C0                      | TRDGRC0  | FFh         |
| 014Dh   |                                                   |          | FFh         |
| 014Eh   | Timer RD General Register D0                      | TRDGRD0  | FFh         |
| 014Fh   |                                                   |          | FFh         |
| 0150h   | Timer RD Control Register 1                       | TRDCR1   | 00h         |
| 0151h   | Timer RD I/O Control Register A1                  | TRDIORA1 | 10001000b   |
| 0152h   | Timer RD I/O Control Register C1                  | TRDIORC1 | 10001000b   |
| 0153h   | Timer RD Status Register 1                        | TRDSR1   | 11000000b   |
| 0154h   | Timer RD Interrupt Enable Register 1              | TRDIER1  | 11100000b   |
| 0155h   | Timer RD PWM Mode Output Level Control Register 1 | TRDPOCR1 | 11111000b   |
| 0156h   | Timer RD Counter 1                                | TRD1     | 00h         |
| 0157h   |                                                   |          | 00h         |
| 0158h   | Timer RD General Register A1                      | TRDGRA1  | FFh         |
| 0159h   |                                                   |          | FFh         |
| 015Ah   | Timer RD General Register B1                      | TRDGRB1  | FFh         |
| 015Bh   |                                                   |          | FFh         |
| 015Ch   | Timer RD General Register C1                      | TRDGRC1  | FFh         |
| 015Dh   |                                                   |          | FFh         |
| 015Eh   | Timer RD General Register D1                      | TRDGRD1  | FFh         |
| 015Fh   |                                                   |          | FFh         |
| 0160h   | UART1 Transmit/Receive Mode Register              | U1MR     | 00h         |
| 0161h   | UART1 Bit Rate Register                           | U1BRG    | XXh         |
| 0162h   | UART1 Transmit Buffer Register                    | U1TB     | XXh         |
| 0163h   |                                                   |          | XXh         |
| 0164h   | UART1 Transmit/Receive Control Register 0         | U1C0     | 00001000b   |
| 0165h   | UART1 Transmit/Receive Control Register 1         | U1C1     | 00000010b   |
| 0166h   | UART1 Receive Buffer Register                     | U1RB     | XXh         |
| 0167h   |                                                   |          | XXh         |
| 0168h   |                                                   |          |             |
| 0169h   |                                                   |          |             |
| 016Ah   |                                                   |          |             |
| 016Bh   |                                                   |          |             |
| 016Ch   |                                                   |          |             |
| 016Dh   |                                                   |          |             |
| 016Eh   |                                                   |          |             |
| 016Fh   |                                                   |          |             |
| 0170h   | Timer RG Mode Register                            | TRGMR    | 01000000b   |
| 0171h   | Timer RG Count Control Register                   | TRGCNTC  | 00h         |
| 0172h   | Timer RG Control Register                         | TRGCR    | 10000000b   |
| 0173h   | Timer RG Interrupt Enable Register                | TRGIER   | 11110000b   |
| 0174h   | Timer RG Status Register                          | TRGSR    | 11100000b   |
| 0175h   | Timer RG I/O Control Register                     | TRGIOR   | 00h         |
| 0176h   | Timer RG Counter                                  | TRG      | 00h         |
| 0177h   |                                                   |          | 00h         |
| 0178h   | Timer RG General Register A                       | TRGGRA   | FFh         |
| 0179h   |                                                   |          | FFh         |
| 017Ah   | Timer RG General Register B                       | TRGGRB   | FFh         |
| 017Bh   |                                                   |          | FFh         |
| 017Ch   | Timer RG General Register C                       | TRGGRC   | FFh         |
| 017Dh   |                                                   |          | FFh         |
| 017Eh   | Timer RG General Register D                       | TRGGRD   | FFh         |
| 017Fh   |                                                   |          | FFh         |

X: Undefined

Note:

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

**Table 5.3 A/D Converter Characteristics**

| Symbol | Parameter                 |             | Conditions                           |                                        | Standard |      |      | Unit |
|--------|---------------------------|-------------|--------------------------------------|----------------------------------------|----------|------|------|------|
|        |                           |             |                                      |                                        | Min.     | Typ. | Max. |      |
| —      | Resolution                |             | Vref = AVCC                          |                                        | —        | —    | 10   | Bit  |
| —      | Absolute accuracy         | 10-bit mode | Vref = AVCC = 5.0 V                  | AN0 to AN7 input,<br>AN8 to AN11 input | —        | —    | ±3   | LSB  |
|        |                           |             | Vref = AVCC = 3.3 V                  | AN0 to AN7 input,<br>AN8 to AN11 input | —        | —    | ±5   | LSB  |
|        |                           |             | Vref = AVCC = 3.0 V                  | AN0 to AN7 input,<br>AN8 to AN11 input | —        | —    | ±5   | LSB  |
|        |                           |             | Vref = AVCC = 2.2 V                  | AN0 to AN7 input,<br>AN8 to AN11 input | —        | —    | ±5   | LSB  |
|        |                           | 8-bit mode  | Vref = AVCC = 5.0 V                  | AN0 to AN7 input,<br>AN8 to AN11 input | —        | —    | ±2   | LSB  |
|        |                           |             | Vref = AVCC = 3.3 V                  | AN0 to AN7 input,<br>AN8 to AN11 input | —        | —    | ±2   | LSB  |
|        |                           |             | Vref = AVCC = 3.0 V                  | AN0 to AN7 input,<br>AN8 to AN11 input | —        | —    | ±2   | LSB  |
|        |                           |             | Vref = AVCC = 2.2 V                  | AN0 to AN7 input,<br>AN8 to AN11 input | —        | —    | ±2   | LSB  |
| φAD    | A/D conversion clock      |             | 4.0 V ≤ Vref = AVCC ≤ 5.5 V (2)      |                                        | 2        | —    | 20   | MHz  |
|        |                           |             | 3.2 V ≤ Vref = AVCC ≤ 5.5 V (2)      |                                        | 2        | —    | 16   | MHz  |
|        |                           |             | 2.7 V ≤ Vref = AVCC ≤ 5.5 V (2)      |                                        | 2        | —    | 10   | MHz  |
|        |                           |             | 2.2 V ≤ Vref = AVCC ≤ 5.5 V (2)      |                                        | 2        | —    | 5    | MHz  |
| —      | Tolerance level impedance |             |                                      |                                        | —        | 3    | —    | kΩ   |
| tCONV  | Conversion time           | 10-bit mode | Vref = AVCC = 5.0 V, φAD = 20 MHz    |                                        | 2.2      | —    | —    | μs   |
|        |                           | 8-bit mode  | Vref = AVCC = 5.0 V, φAD = 20 MHz    |                                        | 2.2      | —    | —    | μs   |
| tsAMP  | Sampling time             |             | φAD = 20 MHz                         |                                        | 0.8      | —    | —    | μs   |
| Ivref  | Vref current              |             | Vcc = 5.0 V, XIN = f1 = φAD = 20 MHz |                                        | —        | 45   | —    | μA   |
| Vref   | Reference voltage         |             |                                      |                                        | 2.2      | —    | AVCC | V    |
| VIA    | Analog input voltage (3)  |             |                                      |                                        | 0        | —    | Vref | V    |
| OCVREF | On-chip reference voltage |             | 2 MHz ≤ φAD ≤ 4 MHz                  |                                        | 1.19     | 1.34 | 1.49 | V    |

Notes:

- $V_{CC}/AV_{CC} = V_{ref} = 2.2\text{ to }5.5\text{ V}$ ,  $V_{SS} = 0\text{ V}$ , and  $T_{opr} = -20\text{ to }85\text{ }^{\circ}\text{C}$  (N version)/ $-40\text{ to }85\text{ }^{\circ}\text{C}$  (D version), unless otherwise specified.
- The A/D conversion result will be undefined in wait mode, stop mode, when the flash memory stops, and in low-current-consumption mode. Do not perform A/D conversion in these states or transition to these states during A/D conversion.
- When the analog input voltage is over the reference voltage, the A/D conversion result will be 3FFh in 10-bit mode and FFh in 8-bit mode.

**Table 5.4 D/A Converter Characteristics**

| Symbol     | Parameter                     | Condition | Standard |      |      | Unit      |
|------------|-------------------------------|-----------|----------|------|------|-----------|
|            |                               |           | Min.     | Typ. | Max. |           |
| —          | Resolution                    |           | —        | —    | 8    | Bit       |
| —          | Absolute accuracy             |           | —        | —    | 2.5  | LSB       |
| $t_{su}$   | Setup time                    |           | —        | —    | 3    | $\mu s$   |
| $R_o$      | Output resistor               |           | —        | 6    | —    | $k\Omega$ |
| $I_{vref}$ | Reference power input current | (Note 2)  | —        | —    | 1.5  | mA        |

Notes:

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

**Table 5.5 Comparator B Electrical Characteristics**

| Symbol    | Parameter                                   | Condition                  | Standard |      |                | Unit    |
|-----------|---------------------------------------------|----------------------------|----------|------|----------------|---------|
|           |                                             |                            | Min.     | Typ. | Max.           |         |
| $V_{ref}$ | IVREF1, IVREF3 input reference voltage      |                            | 0        | —    | $V_{CC} - 1.4$ | V       |
| $V_i$     | IVCMP1, IVCMP3 input voltage                |                            | $-0.3$   | —    | $V_{CC} + 0.3$ | V       |
| —         | Offset                                      |                            | —        | 5    | 100            | mV      |
| $t_d$     | Comparator output delay time <sup>(2)</sup> | $V_i = V_{ref} \pm 100$ mV | —        | 0.1  | —              | $\mu s$ |
| $I_{CMP}$ | Comparator operating current                | $V_{CC} = 5.0$ V           | —        | 17.5 | —              | $\mu A$ |

Notes:

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

**Table 5.15 Timing Requirements of Synchronous Serial Communication Unit (SSU)**

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

Notes:

1. Vcc = 1.8 to 5.5 V, Vss = 0 V, and T<sub>opr</sub> = −20 to 85 °C (N version)/−40 to 85 °C (D version), unless otherwise specified.
2. 1tcyc = 1/f1(s)

**Table 5.17 Electrical Characteristics (1) [4.2 V ≤ V<sub>CC</sub> ≤ 5.5 V]**

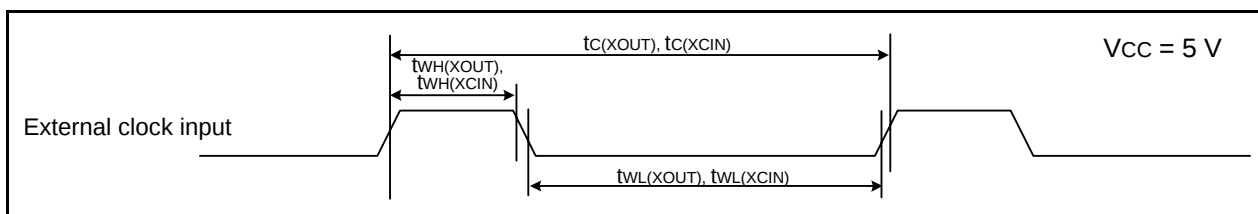
| Symbol                           | Parameter           |                                                                                                                                                                                                                                                                             | Condition                                     |                           | Standard              |      |                 | Unit |
|----------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|---------------------------|-----------------------|------|-----------------|------|
|                                  |                     |                                                                                                                                                                                                                                                                             |                                               |                           | Min.                  | Typ. | Max.            |      |
| V <sub>OH</sub>                  | Output "H" voltage  | Other than XOUT                                                                                                                                                                                                                                                             | Drive capacity High V <sub>CC</sub> = 5 V     | I <sub>OH</sub> = −20 mA  | V <sub>CC</sub> − 2.0 | —    | V <sub>CC</sub> | V    |
|                                  |                     |                                                                                                                                                                                                                                                                             | Drive capacity Low V <sub>CC</sub> = 5 V      | I <sub>OH</sub> = −5 mA   | V <sub>CC</sub> − 2.0 | —    | V <sub>CC</sub> | V    |
|                                  |                     | XOUT                                                                                                                                                                                                                                                                        | V <sub>CC</sub> = 5 V                         | I <sub>OH</sub> = −200 μA | 1.0                   | —    | V <sub>CC</sub> | V    |
| V <sub>OL</sub>                  | Output "L" voltage  | Other than XOUT                                                                                                                                                                                                                                                             | Drive capacity High V <sub>CC</sub> = 5 V     | I <sub>OL</sub> = 20 mA   | —                     | —    | 2.0             | V    |
|                                  |                     |                                                                                                                                                                                                                                                                             | Drive capacity Low V <sub>CC</sub> = 5 V      | I <sub>OL</sub> = 5 mA    | —                     | —    | 2.0             | V    |
|                                  |                     | XOUT                                                                                                                                                                                                                                                                        | V <sub>CC</sub> = 5 V                         | I <sub>OL</sub> = 200 μA  | —                     | —    | 0.5             | V    |
| V <sub>T+</sub> –V <sub>T–</sub> | Hysteresis          | INT0, INT1, INT2, INT3, INT4, KI0, KI1, KI2, KI3, TRAIO, TRBO, TRCIOA, TRCIOB, TRCIOC, TRCIOD, TRDIOA0, TRDIOB0, TRDIOC0, TRDIOD0, TRDIOA1, TRDIOB1, TRDIOC1, TRDIOD1, TRCTRIG, TRCCLK, TRFI, TRGIOA, TRGIOB, ADTRG, RXD0, RXD1, RXD2, CLK0, CLK1, CLK2, SSI, SCL, SDA, SSO |                                               |                           | 0.1                   | 1.2  | —               | V    |
|                                  |                     | RESET                                                                                                                                                                                                                                                                       |                                               |                           | 0.1                   | 1.2  | —               | V    |
| I <sub>IH</sub>                  | Input "H" current   |                                                                                                                                                                                                                                                                             | V <sub>I</sub> = 5 V, V <sub>CC</sub> = 5.0 V |                           | —                     | —    | 5.0             | μA   |
| I <sub>IL</sub>                  | Input "L" current   |                                                                                                                                                                                                                                                                             | V <sub>I</sub> = 0 V, V <sub>CC</sub> = 5.0 V |                           | —                     | —    | −5.0            | μA   |
| R <sub>PULLUP</sub>              | Pull-up resistance  |                                                                                                                                                                                                                                                                             | V <sub>I</sub> = 0 V, V <sub>CC</sub> = 5.0 V |                           | 25                    | 50   | 100             | kΩ   |
| R <sub>IXIN</sub>                | Feedback resistance | XIN                                                                                                                                                                                                                                                                         |                                               |                           | —                     | 0.3  | —               | MΩ   |
| R <sub>IXCIN</sub>               | Feedback resistance | XCIN                                                                                                                                                                                                                                                                        |                                               |                           | —                     | 8    | —               | MΩ   |
| V <sub>RAM</sub>                 | RAM hold voltage    |                                                                                                                                                                                                                                                                             | During stop mode                              |                           | 1.8                   | —    | —               | V    |

Note:

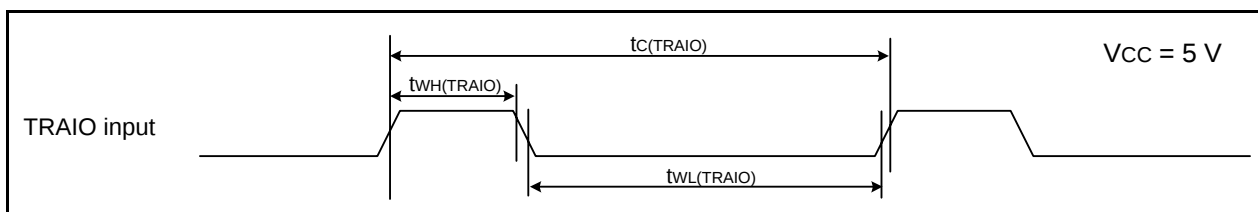
- 4.2 V ≤ V<sub>CC</sub> ≤ 5.5 V, T<sub>opr</sub> = −20 to 85 °C (N version)/−40 to 85 °C (D version), and f(XIN) = 20 MHz, unless otherwise specified.

**Timing Requirements** (Unless Otherwise Specified:  $V_{CC} = 5\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_{opr} = 25\text{ }^{\circ}\text{C}$ )**Table 5.19 External Clock Input (XOUT, XCIN)**

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

**Figure 5.8 External Clock Input Timing Diagram when  $V_{CC} = 5\text{ V}$** **Table 5.20 TRAIO Input**

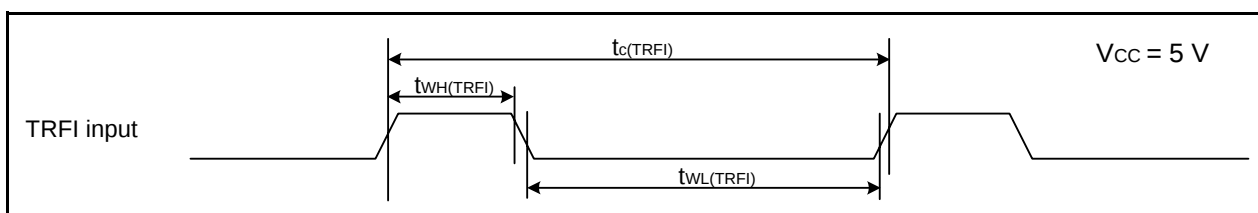
| Symbol          | Parameter              | Standard |      | Unit |
|-----------------|------------------------|----------|------|------|
|                 |                        | Min.     | Max. |      |
| $t_{c(TRAIO)}$  | TRAIO input cycle time | 100      | —    | ns   |
| $t_{WH(TRAIO)}$ | TRAIO input "H" width  | 40       | —    | ns   |
| $t_{WL(TRAIO)}$ | TRAIO input "L" width  | 40       | —    | ns   |

**Figure 5.9 TRAIO Input Timing Diagram when  $V_{CC} = 5\text{ V}$** **Table 5.21 TRFI Input**

| Symbol         | Parameter             | Standard |      | Unit |
|----------------|-----------------------|----------|------|------|
|                |                       | Min.     | Max. |      |
| $t_{c(TRFI)}$  | TRFI input cycle time | 400 (1)  | —    | ns   |
| $t_{WH(TRFI)}$ | TRFI input "H" width  | 200 (2)  | —    | ns   |
| $t_{WL(TRFI)}$ | TRFI input "L" width  | 200 (2)  | —    | ns   |

Notes:

1. When using timer RF input capture mode, adjust the cycle time to  $(1/\text{timer RF count source frequency} \times 3)$  or above.
2. When using timer RF input capture mode, adjust the pulse width to  $(1/\text{timer RF count source frequency} \times 1.5)$  or above.

**Figure 5.10 TRFI Input Timing Diagram when  $V_{CC} = 5\text{ V}$**

**Table 5.24 Electrical Characteristics (3) [ $2.7\text{ V} \leq V_{CC} < 4.2\text{ V}$ ]**

| Symbol                           | Parameter           |                                                                                                                                                                                                                                                                                                                         | Condition                                     |                                | Standard              |      |                 | Unit       |
|----------------------------------|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------|--------------------------------|-----------------------|------|-----------------|------------|
|                                  |                     |                                                                                                                                                                                                                                                                                                                         |                                               |                                | Min.                  | Typ. | Max.            |            |
| V <sub>OH</sub>                  | Output "H" voltage  | Other than XOUT                                                                                                                                                                                                                                                                                                         | Drive capacity High                           | I <sub>OH</sub> = -5 mA        | V <sub>CC</sub> - 0.5 | —    | V <sub>CC</sub> | V          |
|                                  |                     |                                                                                                                                                                                                                                                                                                                         | Drive capacity Low                            | I <sub>OH</sub> = -1 mA        | V <sub>CC</sub> - 0.5 | —    | V <sub>CC</sub> | V          |
|                                  |                     | XOUT                                                                                                                                                                                                                                                                                                                    |                                               | I <sub>OH</sub> = -200 $\mu$ A | 1.0                   | —    | V <sub>CC</sub> | V          |
| V <sub>OL</sub>                  | Output "L" voltage  | Other than XOUT                                                                                                                                                                                                                                                                                                         | Drive capacity High                           | I <sub>OL</sub> = 5 mA         | —                     | —    | 0.5             | V          |
|                                  |                     |                                                                                                                                                                                                                                                                                                                         | Drive capacity Low                            | I <sub>OL</sub> = 1 mA         | —                     | —    | 0.5             | V          |
|                                  |                     | XOUT                                                                                                                                                                                                                                                                                                                    |                                               | I <sub>OL</sub> = 200 $\mu$ A  | —                     | —    | 0.5             | V          |
| V <sub>T+</sub> -V <sub>T-</sub> | Hysteresis          | INT0, INT1, INT2,<br>INT3, INT4,<br>KI0, KI1, KI2, KI3,<br>TRAIO, TRBO,<br>TRCIOA, TRCIOB,<br>TRCIOC, TRCIOD,<br>TRDIOA0, TRDIOB0,<br>TRDIOC0, TRDIOD0,<br>TRDIOA1, TRDIOB1,<br>TRDIOC1, TRDIOD1,<br>TRCTRG, TRCCLK,<br>TRFI, TRGIOA,<br>TRGIOB, ADTRG,<br>RXD0, RXD1, RXD2,<br>CLK0, CLK1, CLK2,<br>SSI, SCL, SDA, SSO | V <sub>CC</sub> = 3.0 V                       |                                | 0.1                   | 0.4  | —               | V          |
|                                  |                     | RESET                                                                                                                                                                                                                                                                                                                   | V <sub>CC</sub> = 3.0 V                       |                                | 0.1                   | 0.5  | —               | V          |
| I <sub>IH</sub>                  | Input "H" current   |                                                                                                                                                                                                                                                                                                                         | V <sub>I</sub> = 3 V, V <sub>CC</sub> = 3.0 V |                                | —                     | —    | 4.0             | $\mu$ A    |
| I <sub>IL</sub>                  | Input "L" current   |                                                                                                                                                                                                                                                                                                                         | V <sub>I</sub> = 0 V, V <sub>CC</sub> = 3.0 V |                                | —                     | —    | -4.0            | $\mu$ A    |
| R <sub>PULLUP</sub>              | Pull-up resistance  |                                                                                                                                                                                                                                                                                                                         | V <sub>I</sub> = 0 V, V <sub>CC</sub> = 3.0 V |                                | 42                    | 84   | 168             | k $\Omega$ |
| R <sub>IXIN</sub>                | Feedback resistance | XIN                                                                                                                                                                                                                                                                                                                     |                                               |                                | —                     | 0.3  | —               | M $\Omega$ |
| R <sub>IXCIN</sub>               | Feedback resistance | XCIN                                                                                                                                                                                                                                                                                                                    |                                               |                                | —                     | 8    | —               | M $\Omega$ |
| V <sub>RAM</sub>                 | RAM hold voltage    |                                                                                                                                                                                                                                                                                                                         | During stop mode                              |                                | 1.8                   | —    | —               | V          |

Note:

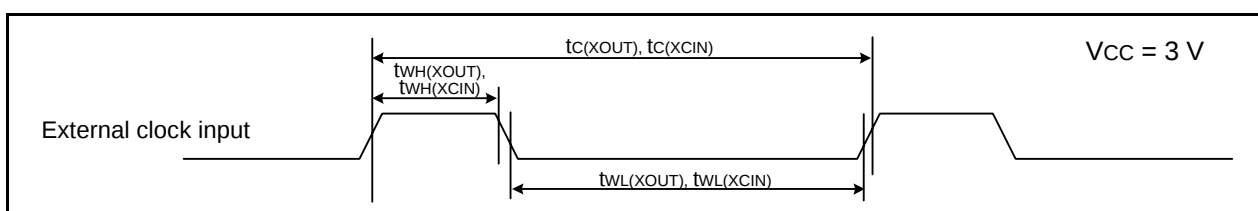
1.  $2.7\text{ V} \leq V_{CC} < 4.2\text{ V}$ , T<sub>opr</sub> = -20 to 85 °C (N version)/-40 to 85 °C (D version), and f(XIN) = 10 MHz, unless otherwise specified.

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

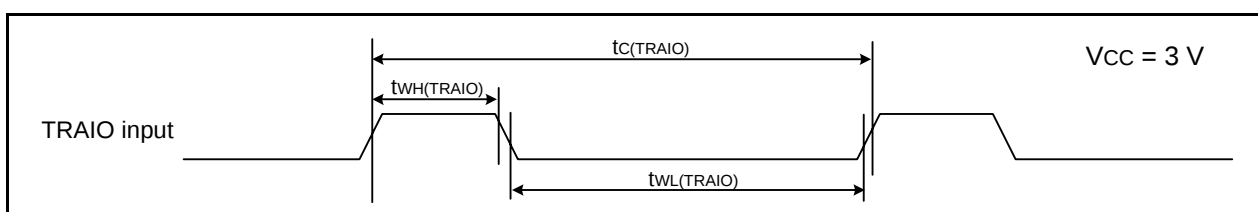
| Symbol          | Parameter                                                                                                                             | Condition                          |                                                                                                            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

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

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

**Figure 5.13 External Clock Input Timing Diagram when  $V_{CC} = 3\text{ V}$** **Table 5.27 TRAIO Input**

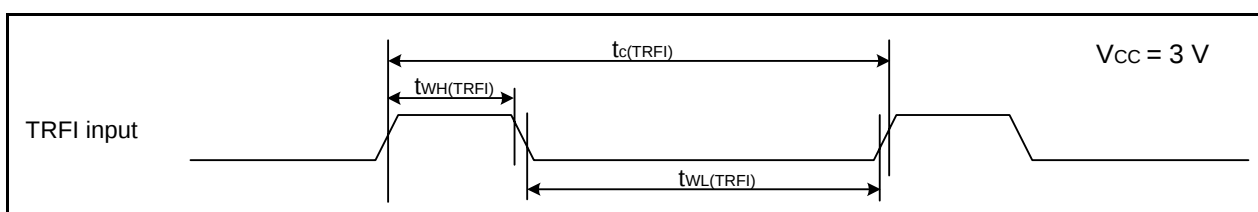
| Symbol          | Parameter              | Standard |      | Unit |
|-----------------|------------------------|----------|------|------|
|                 |                        | Min.     | Max. |      |
| $t_c(TRAIO)$    | TRAIO input cycle time | 300      | —    | ns   |
| $t_{WH}(TRAIO)$ | TRAIO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

**Figure 5.14 TRAIO Input Timing Diagram when  $V_{CC} = 3\text{ V}$** **Table 5.28 TRFI Input**

| Symbol         | Parameter             | Standard |      | Unit |
|----------------|-----------------------|----------|------|------|
|                |                       | Min.     | Max. |      |
| $t_c(TRFI)$    | TRFI input cycle time | 1200 (1) | —    | ns   |
| $t_{WH}(TRFI)$ | TRFI input "H" width  | 600 (2)  | —    | ns   |
| $t_{WL}(TRFI)$ | TRFI input "L" width  | 600 (2)  | —    | ns   |

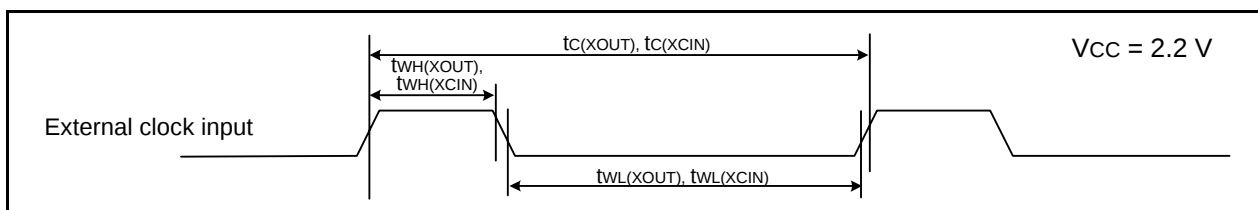
**Notes:**

1. When using timer RF input capture mode, adjust the cycle time to  $(1/\text{timer RF count source frequency} \times 3)$  or above.
2. When using timer RF input capture mode, adjust the pulse width to  $(1/\text{timer RF count source frequency} \times 1.5)$  or above.

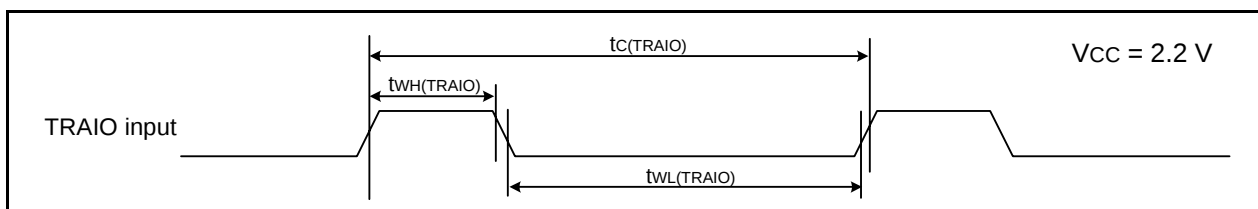
**Figure 5.15 TRFI Input Timing Diagram when  $V_{CC} = 3\text{ V}$**

**Timing requirements** (Unless Otherwise Specified:  $V_{CC} = 2.2\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_{opr} = 25\text{ }^{\circ}\text{C}$ )**Table 5.33 External Clock Input (XOUT, XCIN)**

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

**Figure 5.18 External Clock Input Timing Diagram when  $V_{CC} = 2.2\text{ V}$** **Table 5.34 TRAIO Input**

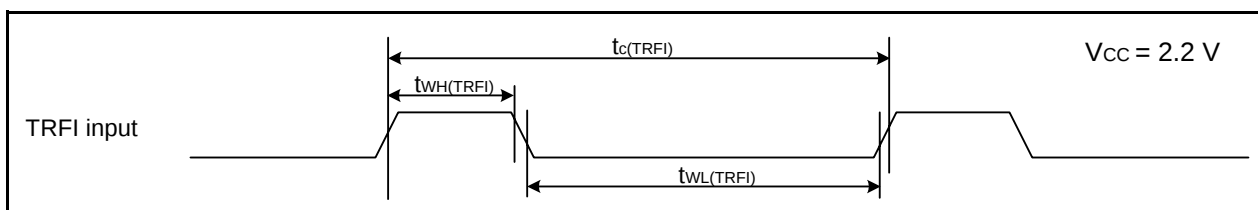
| Symbol          | Parameter              | Standard |      | Unit |
|-----------------|------------------------|----------|------|------|
|                 |                        | Min.     | Max. |      |
| $t_c(TRAIO)$    | TRAIO input cycle time | 500      | —    | ns   |
| $t_{WH}(TRAIO)$ | TRAIO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

**Figure 5.19 TRAIO Input Timing Diagram when  $V_{CC} = 2.2\text{ V}$** **Table 5.35 TRFI Input**

| Symbol         | Parameter             | Standard |      | Unit |
|----------------|-----------------------|----------|------|------|
|                |                       | Min.     | Max. |      |
| $t_c(TRFI)$    | TRFI input cycle time | 2000 (1) | —    | ns   |
| $t_{WH}(TRFI)$ | TRFI input "H" width  | 1000 (2) | —    | ns   |
| $t_{WL}(TRFI)$ | TRFI input "L" width  | 1000 (2) | —    | ns   |

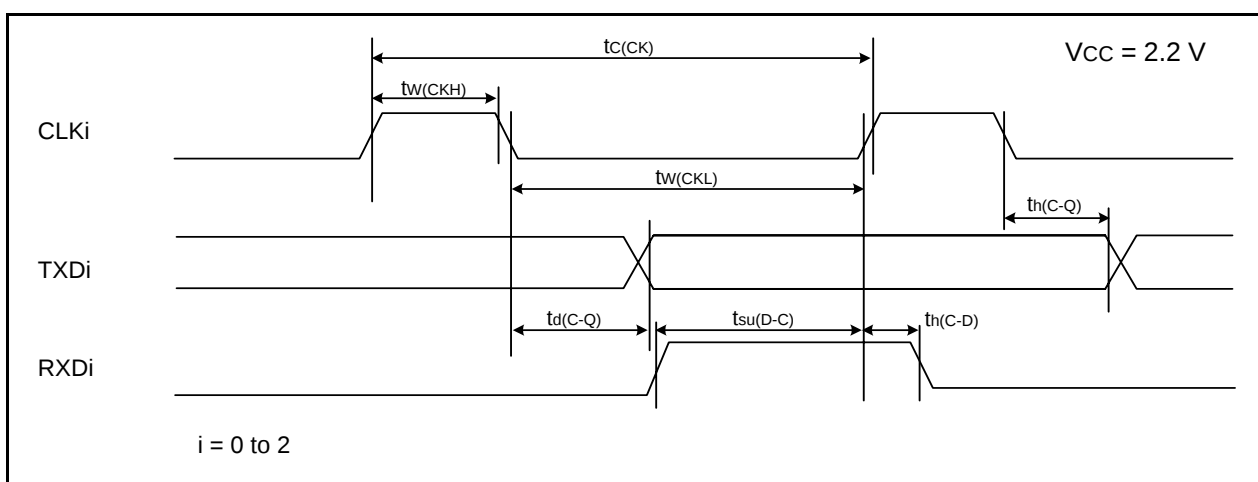
**Notes:**

1. When using timer RF input capture mode, adjust the cycle time to  $(1/\text{timer RF count source frequency} \times 3)$  or above.
2. When using timer RF input capture mode, adjust the pulse width to  $(1/\text{timer RF count source frequency} \times 1.5)$  or above.

**Figure 5.20 TRFI Input Timing Diagram when  $V_{CC} = 2.2\text{ V}$**

**Table 5.36 Serial Interface**

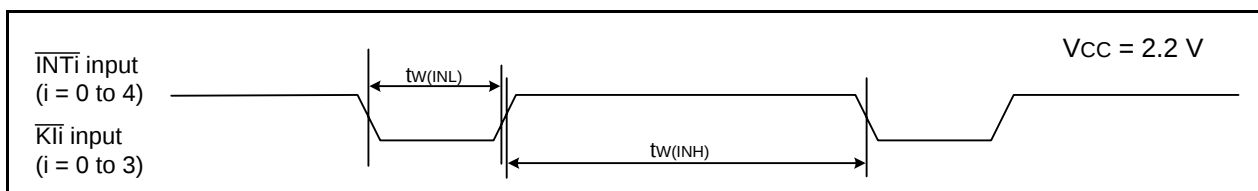
| Symbol        | Parameter              | Standard |      | Unit |
|---------------|------------------------|----------|------|------|
|               |                        | Min.     | Max. |      |
| $t_{c(CK)}$   | CLKi input cycle time  | 800      | —    | ns   |
| $t_{w(CKH)}$  | CLKi input "H" width   | 400      | —    | ns   |
| $t_{w(CKL)}$  | CLKi input "L" width   | 400      | —    | ns   |
| $t_{d(C-Q)}$  | TXDi output delay time | —        | 200  | ns   |
| $t_{h(C-Q)}$  | TXDi hold time         | 0        | —    | ns   |
| $t_{su(D-C)}$ | RXDi input setup time  | 150      | —    | ns   |
| $t_{h(C-D)}$  | RXDi input hold time   | 90       | —    | ns   |

 $i = 0 \text{ to } 2$ **Figure 5.21 Serial Interface Timing Diagram when Vcc = 2.2 V****Table 5.37 External Interrupt  $\overline{INTi}$  ( $i = 0 \text{ to } 4$ ) Input, Key Input Interrupt  $\overline{Kli}$  ( $i = 0 \text{ to } 3$ )**

| Symbol       | Parameter                                                           | Standard |      | Unit |
|--------------|---------------------------------------------------------------------|----------|------|------|
|              |                                                                     | Min.     | Max. |      |
| $t_{w(INH)}$ | $\overline{INTi}$ input "H" width, $\overline{Kli}$ input "H" width | 1000 (1) | —    | ns   |
| $t_{w(INL)}$ | $\overline{INTi}$ input "L" width, $\overline{Kli}$ input "L" width | 1000 (2) | —    | ns   |

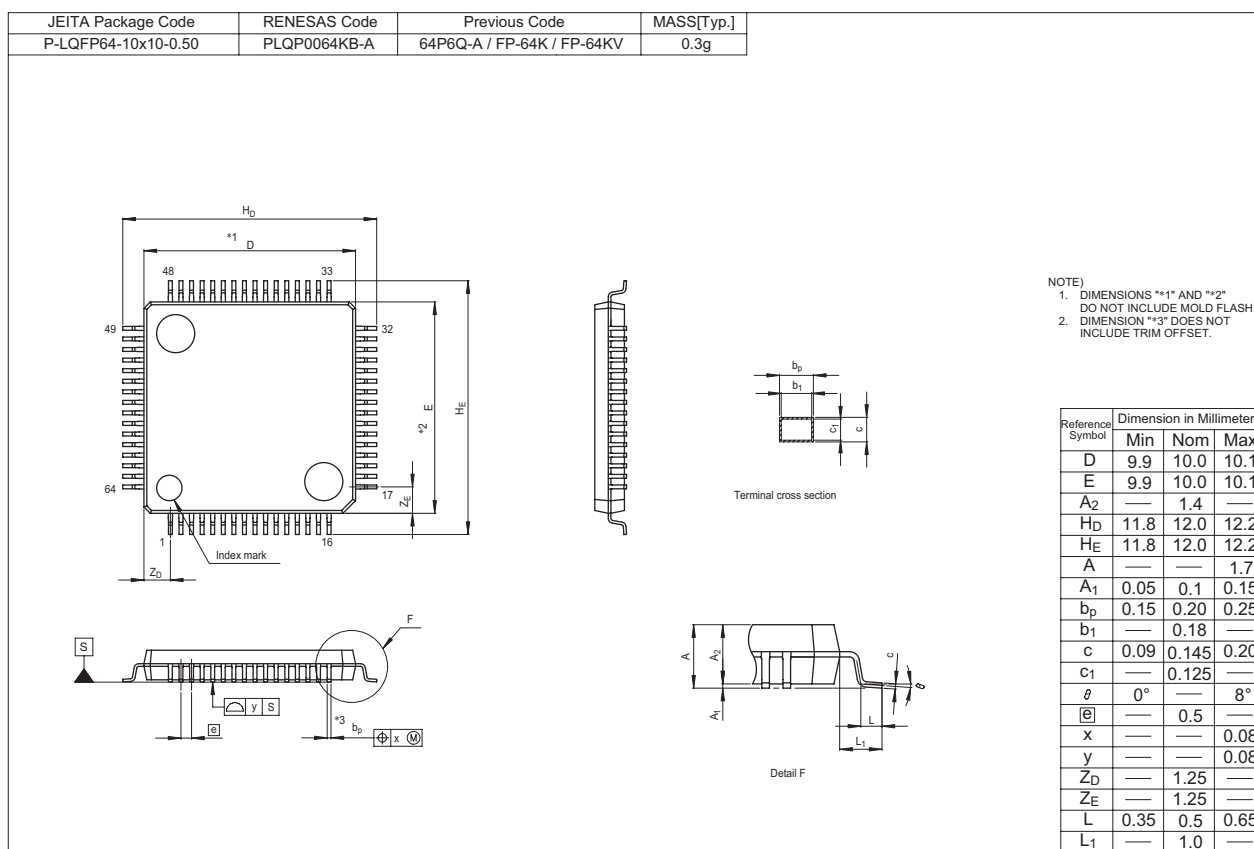
Notes:

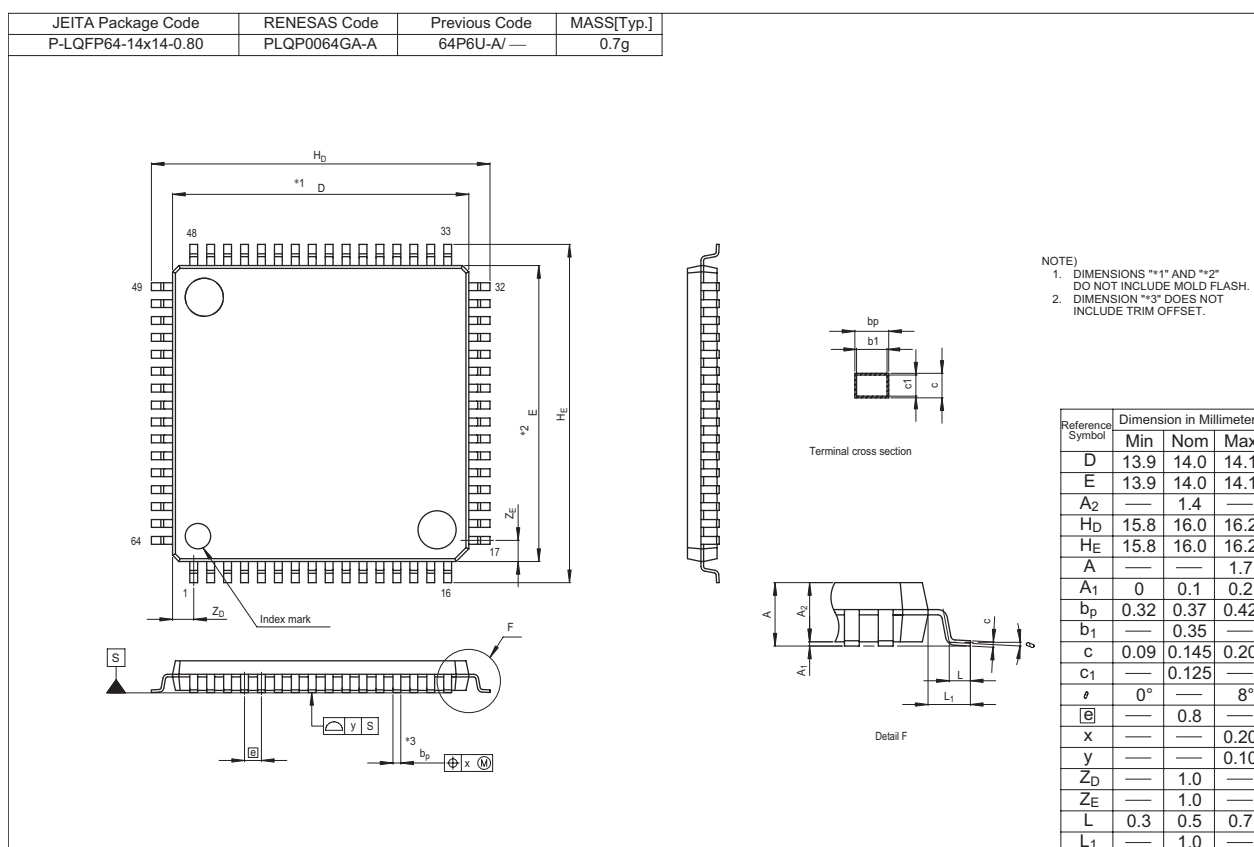
1. When selecting the digital filter by the  $\overline{INTi}$  input filter select bit, use an  $\overline{INTi}$  input HIGH width of either (1/digital filter clock frequency  $\times 3$ ) or the minimum value of standard, whichever is greater.
2. When selecting the digital filter by the  $\overline{INTi}$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

**Figure 5.22 Input Timing Diagram for External Interrupt  $\overline{INTi}$  and Key Input Interrupt  $\overline{Kli}$  when Vcc = 2.2 V**

## Package Dimensions

Diagrams showing the latest package dimensions and mounting information are available in the “Packages” section of the Renesas Electronics website.





## General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

### 1. Handling of Unused Pins

Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

- The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

### 2. Processing at Power-on

The state of the product is undefined at the moment when power is supplied.

- The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

### 3. Prohibition of Access to Reserved Addresses

Access to reserved addresses is prohibited.

- The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

### 4. Clock Signals

After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

- When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

### 5. Differences between Products

Before changing from one product to another, i.e. to one with a different part number, confirm that the change will not lead to problems.

- The characteristics of MPU/MCU in the same group but having different part numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different part numbers, implement a system-evaluation test for each of the products.