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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               | CANbus, I <sup>2</sup> C, LINbus, SIO, SSU, UART/USART                                                                                                                  |
| Peripherals                | POR, Voltage Detect, WDT                                                                                                                                                |
| Number of I/O              | 41                                                                                                                                                                      |
| Program Memory Size        | 48KB (48K x 8)                                                                                                                                                          |
| Program Memory Type        | FLASH                                                                                                                                                                   |
| EEPROM Size                | 2K x 8                                                                                                                                                                  |
| RAM Size                   | 2.5K x 8                                                                                                                                                                |
| Voltage - Supply (Vcc/Vdd) | 2.7V ~ 5.5V                                                                                                                                                             |
| Data Converters            | A/D 12x10b                                                                                                                                                              |
| Oscillator Type            | Internal                                                                                                                                                                |
| Operating Temperature      | -40°C ~ 85°C (TA)                                                                                                                                                       |
| Mounting Type              | Surface Mount                                                                                                                                                           |
| Package / Case             | 48-LQFP                                                                                                                                                                 |
| Supplier Device Package    | 48-LQFP (7x7)                                                                                                                                                           |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f21237jfp">https://www.e-xfl.com/product-detail/renesas-electronics-america/r5f21237jfp</a> |

**Table 1.6 Pin Name Information by Pin Number**

| Pin Number | Control Pin | Port | I/O Pin Functions for of Peripheral Modules |                        |                  |                                               |                                |            |               |
|------------|-------------|------|---------------------------------------------|------------------------|------------------|-----------------------------------------------|--------------------------------|------------|---------------|
|            |             |      | Interrupt                                   | Timer                  | Serial Interface | Clock Synchronous Serial I/O with Chip Select | I <sup>2</sup> C Bus Interface | CAN Module | A/D Converter |
| 1          |             | P3_5 |                                             |                        |                  | SSCK                                          | SCL                            |            |               |
| 2          |             | P3_3 |                                             |                        |                  | SSI                                           |                                |            |               |
| 3          |             | P3_4 |                                             |                        |                  | SCS                                           | SDA                            |            |               |
| 4          | MODE        |      |                                             |                        |                  |                                               |                                |            |               |
| 5          |             | P4_3 |                                             |                        |                  |                                               |                                |            |               |
| 6          |             | P4_4 |                                             |                        |                  |                                               |                                |            |               |
| 7          | RESET       |      |                                             |                        |                  |                                               |                                |            |               |
| 8          | XOUT        | P4_7 |                                             |                        |                  |                                               |                                |            |               |
| 9          | VSS/AVSS    |      |                                             |                        |                  |                                               |                                |            |               |
| 10         | XIN         | P4_6 |                                             |                        |                  |                                               |                                |            |               |
| 11         | VCC/AVCC    |      |                                             |                        |                  |                                               |                                |            |               |
| 12         |             | P2_7 |                                             | TRDIOD1                |                  |                                               |                                |            |               |
| 13         |             | P2_6 |                                             | TRDIOD1                |                  |                                               |                                |            |               |
| 14         |             | P2_5 |                                             | TRDIOD1                |                  |                                               |                                |            |               |
| 15         |             | P2_4 |                                             | TRDIOD1                |                  |                                               |                                |            |               |
| 16         |             | P2_3 |                                             | TRDIOD0                |                  |                                               |                                |            |               |
| 17         |             | P2_2 |                                             | TRDIOD0                |                  |                                               |                                |            |               |
| 18         |             | P2_1 |                                             | TRDIOD0                |                  |                                               |                                |            |               |
| 19         |             | P2_0 |                                             | TRDIOD0/TRDCLK         |                  |                                               |                                |            |               |
| 20         |             | P1_7 | INT1                                        | TRAIO                  |                  |                                               |                                |            |               |
| 21         |             | P1_6 |                                             |                        | CLK0             |                                               |                                |            |               |
| 22         |             | P1_5 | (INT1) <sup>(1)</sup>                       | (TRAIO) <sup>(1)</sup> | RXD0             |                                               |                                |            |               |
| 23         |             | P1_4 |                                             |                        | TXD0             |                                               |                                |            |               |
| 24         |             | P1_3 | KI3                                         |                        |                  |                                               |                                |            | AN11          |
| 25         |             | P4_5 | INT0                                        | INT0                   |                  |                                               |                                |            |               |
| 26         |             | P6_6 | INT2                                        |                        | TXD1             |                                               |                                |            |               |
| 27         |             | P6_7 | INT3                                        |                        | RXD1             |                                               |                                |            |               |
| 28         |             | P1_2 | KI2                                         |                        |                  |                                               |                                |            | AN10          |
| 29         |             | P1_1 | KI1                                         |                        |                  |                                               |                                |            | AN9           |
| 30         |             | P1_0 | KI0                                         |                        |                  |                                               |                                |            | AN8           |
| 31         |             | P3_1 |                                             | TRBO                   |                  |                                               |                                |            |               |
| 32         |             | P3_0 |                                             | TRAIO                  |                  |                                               |                                |            |               |
| 33         |             | P6_5 |                                             |                        |                  |                                               |                                |            |               |
| 34         |             | P6_4 |                                             |                        |                  |                                               |                                |            |               |
| 35         |             | P6_3 |                                             |                        |                  |                                               |                                |            |               |
| 36         |             | P0_7 |                                             |                        |                  |                                               |                                |            | AN0           |
| 37         |             | P0_6 |                                             |                        |                  |                                               |                                |            | AN1           |
| 38         |             | P0_5 |                                             |                        |                  |                                               |                                |            | AN2           |
| 39         |             | P0_4 |                                             |                        |                  |                                               |                                |            | AN3           |
| 40         | VREF        | P4_2 |                                             |                        |                  |                                               |                                |            |               |
| 41         |             | P6_0 |                                             | TREO                   |                  |                                               |                                |            |               |
| 42         |             | P6_2 |                                             |                        |                  |                                               |                                | CRX0       |               |
| 43         |             | P6_1 |                                             |                        |                  |                                               |                                | CTX0       |               |
| 44         |             | P0_3 |                                             |                        |                  |                                               |                                |            | AN4           |
| 45         |             | P0_2 |                                             |                        |                  |                                               |                                |            | AN5           |
| 46         |             | P0_1 |                                             |                        |                  |                                               |                                |            | AN6           |
| 47         |             | P0_0 |                                             |                        |                  |                                               |                                |            | AN7           |
| 48         |             | P3_7 |                                             |                        |                  | SSO                                           |                                |            |               |

NOTE:

1. Can be assigned to the pin in parentheses by a program.

## 2. Central Processing Unit (CPU)

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

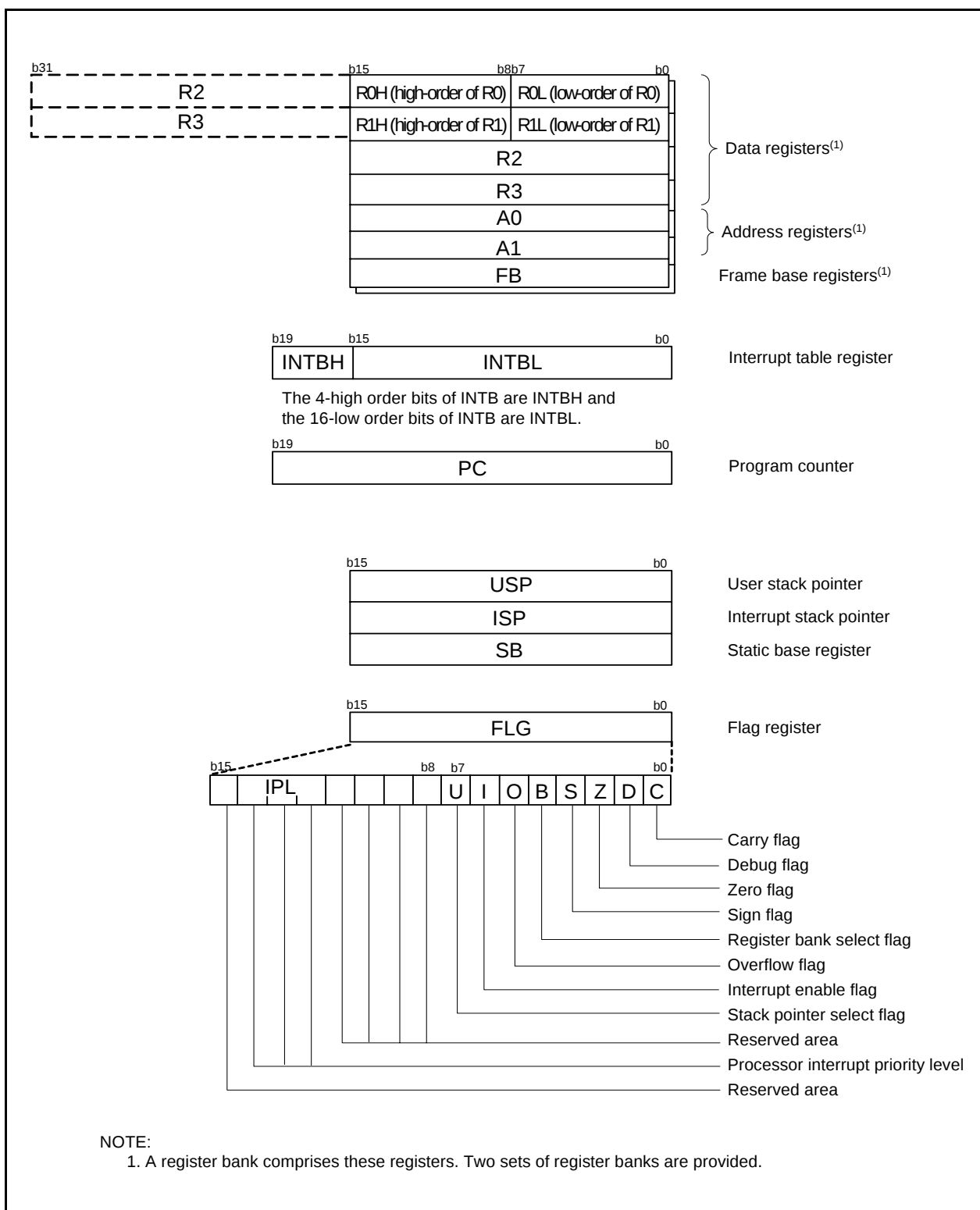


Figure 2.1 CPU Registers

### **2.8.7 Interrupt Enable Flag (I)**

The I flag enables a maskable interrupt.

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

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

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

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

### **2.8.9 Processor Interrupt Priority Level (IPL)**

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

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

### **2.8.10 Reserved Bit**

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

### 3.2 R8C/23 Group

Figure 3.2 shows a Memory Map of R8C/23 Group. The R8C/23 Group has 1 Mbyte of address space from address 00000h to FFFFFFFh.

The internal ROM (program ROM) is allocated lower addresses, beginning with address 0FFFFh. For example, a 48-Kbyte internal ROM is allocated addresses 04000h to 0FFFFh.

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

The internal ROM (data flash) is allocated addresses 02400h to 02BFFh.

The internal RAM is allocated higher addresses, beginning with address 00400h. For example, a 2.5-Kbyte internal RAM is allocated addresses 00400h to 00DFFh. The internal RAM is used not only for storing data but also for calling subroutines and as stacks when interrupt requests are acknowledged.

Special function registers (SFR) are allocated addresses 00000h to 002FFh and 01300h to 0147Fh (SFR area for CAN). The peripheral function control registers are allocated them. All addresses within the SFR, which have nothing allocated are reserved for future use and cannot be accessed by users.

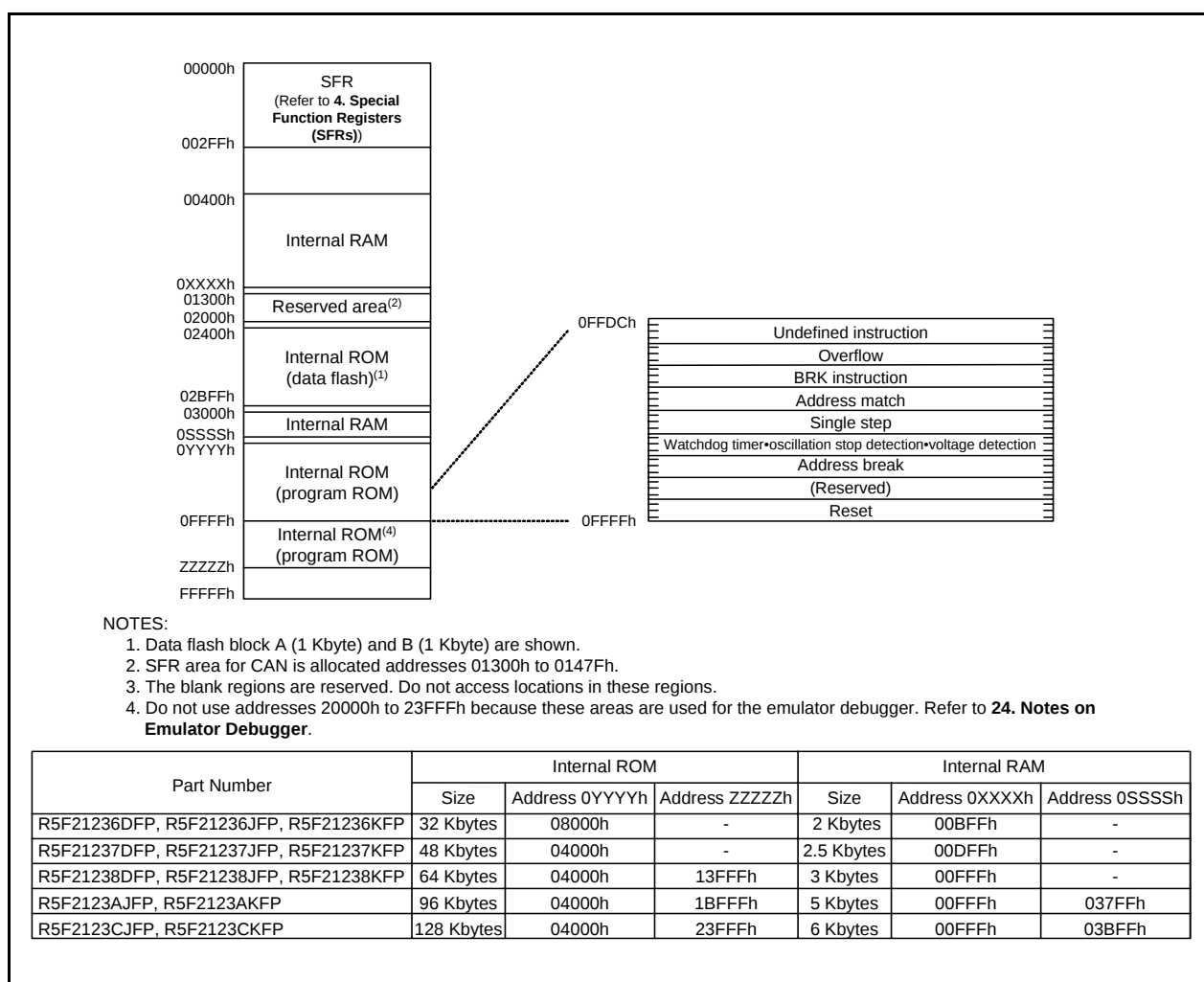


Figure 3.2 Memory Map of R8C/23 Group

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

| Address | Register                                                                         | Symbol      | After reset |
|---------|----------------------------------------------------------------------------------|-------------|-------------|
| 0040h   |                                                                                  |             |             |
| 0041h   |                                                                                  |             |             |
| 0042h   |                                                                                  |             |             |
| 0043h   | CAN0 Wake Up Interrupt Control Register                                          | C01WKIC     | XXXXX000b   |
| 0044h   | CAN0 Successful Reception Interrupt Control Register                             | C0RECIC     | XXXXX000b   |
| 0045h   | CAN0 Successful Transmission Interrupt Control Register                          | C0TRMIC     | XXXXX000b   |
| 0046h   | CAN0 State/Error Interrupt Control Register                                      | C01ERRIC    | XXXXX000b   |
| 0047h   |                                                                                  |             |             |
| 0048h   | Timer RD0 Interrupt Control Register                                             | TRD0IC      | XXXXX000b   |
| 0049h   | Timer RD1 Interrupt Control Register                                             | TRD1IC      | XXXXX000b   |
| 004Ah   | Timer RE Interrupt Control Register                                              | TREIC       | XXXXX000b   |
| 004Bh   |                                                                                  |             |             |
| 004Ch   |                                                                                  |             |             |
| 004Dh   | Key Input Interrupt Control Register                                             | KUPIC       | XXXXX000b   |
| 004Eh   | A/D Conversion Interrupt Control Register                                        | ADIC        | XXXXX000b   |
| 004Fh   | SSU Interrupt Control Register/IIC Bus Interrupt Control Register <sup>(2)</sup> | SSUIC/IICIC | XXXXX000b   |
| 0050h   |                                                                                  |             |             |
| 0051h   | UART0 Transmit Interrupt Control Register                                        | S0TIC       | XXXXX000b   |
| 0052h   | UART0 Receive Interrupt Control Register                                         | S0RIC       | XXXXX000b   |
| 0053h   | UART1 Transmit Interrupt Control Register                                        | S1TIC       | XXXXX000b   |
| 0054h   | UART1 Receive Interrupt Control Register                                         | S1RIC       | XXXXX000b   |
| 0055h   | INT2 Interrupt Control Register                                                  | INT2IC      | XX00X000b   |
| 0056h   | Timer RA Interrupt Control Register                                              | TRAIC       | XXXXX000b   |
| 0057h   |                                                                                  |             |             |
| 0058h   | Timer RB Interrupt Control Register                                              | TRBIC       | XXXXX000b   |
| 0059h   | INT1 Interrupt Control Register                                                  | INT1IC      | XX00X000b   |
| 005Ah   | INT3 Interrupt Control Register                                                  | INT3IC      | XX00X000b   |
| 005Bh   |                                                                                  |             |             |
| 005Ch   |                                                                                  |             |             |
| 005Dh   | INT0 Interrupt Control Register                                                  | INT0IC      | XX00X000b   |
| 005Eh   |                                                                                  |             |             |
| 005Fh   |                                                                                  |             |             |
| 0060h   |                                                                                  |             |             |
| 0061h   |                                                                                  |             |             |
| 0062h   |                                                                                  |             |             |
| 0063h   |                                                                                  |             |             |
| 0064h   |                                                                                  |             |             |
| 0065h   |                                                                                  |             |             |
| 0066h   |                                                                                  |             |             |
| 0067h   |                                                                                  |             |             |
| 0068h   |                                                                                  |             |             |
| 0069h   |                                                                                  |             |             |
| 006Ah   |                                                                                  |             |             |
| 006Bh   |                                                                                  |             |             |
| 006Ch   |                                                                                  |             |             |
| 006Dh   |                                                                                  |             |             |
| 006Eh   |                                                                                  |             |             |
| 006Fh   |                                                                                  |             |             |
| 0070h   |                                                                                  |             |             |
| 0071h   |                                                                                  |             |             |
| 0072h   |                                                                                  |             |             |
| 0073h   |                                                                                  |             |             |
| 0074h   |                                                                                  |             |             |
| 0075h   |                                                                                  |             |             |
| 0076h   |                                                                                  |             |             |
| 0077h   |                                                                                  |             |             |
| 0078h   |                                                                                  |             |             |
| 0079h   |                                                                                  |             |             |
| 007Ah   |                                                                                  |             |             |
| 007Bh   |                                                                                  |             |             |
| 007Ch   |                                                                                  |             |             |
| 007Dh   |                                                                                  |             |             |
| 007Eh   |                                                                                  |             |             |
| 007Fh   |                                                                                  |             |             |

X: Undefined

## NOTES:

1. The blank regions are reserved. Do not access locations in these regions.
2. Selected by the IICSEL bit in the PMR register.

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

| Address | Register                                                                | Symbol      | After reset   |
|---------|-------------------------------------------------------------------------|-------------|---------------|
| 0080h   |                                                                         |             |               |
| 0081h   |                                                                         |             |               |
| 0082h   |                                                                         |             |               |
| 0083h   |                                                                         |             |               |
| 0084h   |                                                                         |             |               |
| 0085h   |                                                                         |             |               |
| 0086h   |                                                                         |             |               |
| 0087h   |                                                                         |             |               |
| 0088h   |                                                                         |             |               |
| 0089h   |                                                                         |             |               |
| 008Ah   |                                                                         |             |               |
| 008Bh   |                                                                         |             |               |
| 008Ch   |                                                                         |             |               |
| 008Dh   |                                                                         |             |               |
| 008Eh   |                                                                         |             |               |
| 008Fh   |                                                                         |             |               |
| 0090h   |                                                                         |             |               |
| 0091h   |                                                                         |             |               |
| 0092h   |                                                                         |             |               |
| 0093h   |                                                                         |             |               |
| 0094h   |                                                                         |             |               |
| 0095h   |                                                                         |             |               |
| 0096h   |                                                                         |             |               |
| 0097h   |                                                                         |             |               |
| 0098h   |                                                                         |             |               |
| 0099h   |                                                                         |             |               |
| 009Ah   |                                                                         |             |               |
| 009Bh   |                                                                         |             |               |
| 009Ch   |                                                                         |             |               |
| 009Dh   |                                                                         |             |               |
| 009Eh   |                                                                         |             |               |
| 009Fh   |                                                                         |             |               |
| 00A0h   | UART0 Transmit/Receive Mode Register                                    | U0MR        | 00h           |
| 00A1h   | UART0 Bit Rate Register                                                 | U0BRG       | XXh           |
| 00A2h   | UART0 Transmit Buffer Register                                          | U0TB        | XXh           |
| 00A3h   |                                                                         |             | XXh           |
| 00A4h   | UART0 Transmit/Receive Control Register 0                               | U0C0        | 00001000b     |
| 00A5h   | UART0 Transmit/Receive Control Register 1                               | U0C1        | 00000010b     |
| 00A6h   | UART0 Receive Buffer Register                                           | U0RB        | XXh           |
| 00A7h   |                                                                         |             | XXh           |
| 00A8h   | UART1 Transmit/Receive Mode Register                                    | U1MR        | 00h           |
| 00A9h   | UART1 Bit Rate Register                                                 | U1BRG       | XXh           |
| 00AAh   | UART1 Transmit Buffer Register                                          | U1TB        | XXh           |
| 00ABh   |                                                                         |             | XXh           |
| 00ACh   | UART1 Transmit/Receive Control Register 0                               | U1C0        | 00001000b     |
| 00ADh   | UART1 Transmit/Receive Control Register 1                               | U1C1        | 00000010b     |
| 00AEh   | UART1 Receive Buffer Register                                           | U1RB        | XXh           |
| 00AFh   |                                                                         |             | XXh           |
| 00B0h   |                                                                         |             |               |
| 00B1h   |                                                                         |             |               |
| 00B2h   |                                                                         |             |               |
| 00B3h   |                                                                         |             |               |
| 00B4h   |                                                                         |             |               |
| 00B5h   |                                                                         |             |               |
| 00B6h   |                                                                         |             |               |
| 00B7h   |                                                                         |             |               |
| 00B8h   | SS Control Register H/IIC Bus Control Register 1 <sup>(2)</sup>         | SSCRH/ICCR1 | 00h           |
| 00B9h   | SS Control Register L/IIC Bus Control Register 2 <sup>(2)</sup>         | SSCRL/ICCR2 | 01111101b     |
| 00BAh   | SS Mode Register/IIC Bus Mode Register 1 <sup>(2)</sup>                 | SSMR/ICMR   | 00011000b     |
| 00BBh   | SS Enable Register/IIC Bus Interrupt Enable Register <sup>(2)</sup>     | SSER/ICIER  | 00h           |
| 00BCh   | SS Status Register/IIC Bus Status Register <sup>(2)</sup>               | SSSR/ICSR   | 00h/0000X000b |
| 00BDh   | SS Mode Register 2/Slave Address Register <sup>(2)</sup>                | SSMR2/SAR   | 00h           |
| 00BEh   | SS Transmit Data Register/IIC Bus Transmit Data Register <sup>(2)</sup> | SSTDR/ICDRT | FFh           |
| 00BFh   | SS Receive Data Register/IIC Bus Receive Data Register <sup>(2)</sup>   | SSRDR/ICDRR | FFh           |

X: Undefined

NOTES:

1. The blank regions are reserved. Do not access locations in these regions.
2. Selected by the IICSEL bit in the PMR register.

**Table 4.5 SFR Information (5)<sup>(1)</sup>**

| Address | Register                                           | Symbol  | After reset |
|---------|----------------------------------------------------|---------|-------------|
| 0100h   | Timer RA Control Register                          | TRACR   | 00h         |
| 0101h   | Timer RA I/O Control Register                      | TRAIOC  | 00h         |
| 0102h   | Timer RA Mode Register                             | TRAMR   | 00h         |
| 0103h   | Timer RA Prescaler Register                        | TRAPRE  | FFh         |
| 0104h   | Timer RA Register                                  | TRA     | FFh         |
| 0105h   |                                                    |         |             |
| 0106h   | LIN Control Register                               | LINCR   | 00h         |
| 0107h   | LIN Status Register                                | LINST   | 00h         |
| 0108h   | Timer RB Control Register                          | TRBCR   | 00h         |
| 0109h   | Timer RB One-Shot Control Register                 | TRBOCR  | 00h         |
| 010Ah   | Timer RB I/O Control Register                      | TRBIOC  | 00h         |
| 010Bh   | Timer RB Mode Register                             | TRBMR   | 00h         |
| 010Ch   | Timer RB Prescaler Register                        | TRBPRES | FFh         |
| 010Dh   | Timer RB Secondary Register                        | TRBSC   | FFh         |
| 010Eh   | Timer RB Primary                                   | TRBPR   | FFh         |
| 010Fh   |                                                    |         |             |
| 0110h   |                                                    |         |             |
| 0111h   |                                                    |         |             |
| 0112h   |                                                    |         |             |
| 0113h   |                                                    |         |             |
| 0114h   |                                                    |         |             |
| 0115h   |                                                    |         |             |
| 0116h   |                                                    |         |             |
| 0117h   |                                                    |         |             |
| 0118h   | Timer RE Counter Data Register                     | TRESEC  | 00h         |
| 0119h   | Timer RE Compare Data Register                     | TREMIN  | 00h         |
| 011Ah   |                                                    |         |             |
| 011Bh   |                                                    |         |             |
| 011Ch   | Timer RE Control Register 1                        | TRECR1  | 00h         |
| 011Dh   | Timer RE Control Register 2                        | TRECR2  | 00h         |
| 011Eh   | Timer RE Count Source Select Register              | TRECSR  | 00001000b   |
| 011Fh   |                                                    |         |             |
| 0120h   |                                                    |         |             |
| 0121h   |                                                    |         |             |
| 0122h   |                                                    |         |             |
| 0123h   |                                                    |         |             |
| 0124h   |                                                    |         |             |
| 0125h   |                                                    |         |             |
| 0126h   |                                                    |         |             |
| 0127h   |                                                    |         |             |
| 0128h   |                                                    |         |             |
| 0129h   |                                                    |         |             |
| 012Ah   |                                                    |         |             |
| 012Bh   |                                                    |         |             |
| 012Ch   |                                                    |         |             |
| 012Dh   |                                                    |         |             |
| 012Eh   |                                                    |         |             |
| 012Fh   |                                                    |         |             |
| 0130h   |                                                    |         |             |
| 0131h   |                                                    |         |             |
| 0132h   |                                                    |         |             |
| 0133h   |                                                    |         |             |
| 0134h   |                                                    |         |             |
| 0135h   |                                                    |         |             |
| 0136h   |                                                    |         |             |
| 0137h   | Timer RD Start Register                            | TRDSTR  | 11111100b   |
| 0138h   | Timer RD Mode Register                             | TRDMR   | 00001110b   |
| 0139h   | Timer RD PWM Mode Register                         | TRDPMR  | 10001000b   |
| 013Ah   | Timer RD Function Control Register                 | TRDFCR  | 10000000b   |
| 013Bh   | Timer RD Output Master Enable Register 1           | TRDOER1 | FFh         |
| 013Ch   | Timer RD Output Master Enable Register 2           | TRDOER2 | 01111111b   |
| 013Dh   | Timer RD Output Control Register                   | TRDOCR  | 00h         |
| 013Eh   | Timer RD Digital Filter Function Select Register 0 | TRDDF0  | 00h         |
| 013Fh   | Timer RD Digital Filter Function Select Register 1 | TRDDF1  | 00h         |

X: Undefined

NOTE:

1. The blank regions are reserved. Do not access locations in these regions.

**Table 4.7 SFR Information (7)<sup>(1)</sup>**

| Address | Register                        | Symbol | After reset |
|---------|---------------------------------|--------|-------------|
| 0180h   |                                 |        |             |
| 0181h   |                                 |        |             |
| 0182h   |                                 |        |             |
| 0183h   |                                 |        |             |
| 0184h   |                                 |        |             |
| 0185h   |                                 |        |             |
| 0186h   |                                 |        |             |
| 0187h   |                                 |        |             |
| 0188h   |                                 |        |             |
| 0189h   |                                 |        |             |
| 018Ah   |                                 |        |             |
| 018Bh   |                                 |        |             |
| 018Ch   |                                 |        |             |
| 018Dh   |                                 |        |             |
| 018Eh   |                                 |        |             |
| 018Fh   |                                 |        |             |
| 0190h   |                                 |        |             |
| 0191h   |                                 |        |             |
| 0192h   |                                 |        |             |
| 0193h   |                                 |        |             |
| 0194h   |                                 |        |             |
| 0195h   |                                 |        |             |
| 0196h   |                                 |        |             |
| 0197h   |                                 |        |             |
| 0198h   |                                 |        |             |
| 0199h   |                                 |        |             |
| 019Ah   |                                 |        |             |
| 019Bh   |                                 |        |             |
| 019Ch   |                                 |        |             |
| 019Dh   |                                 |        |             |
| 019Eh   |                                 |        |             |
| 019Fh   |                                 |        |             |
| 01A0h   |                                 |        |             |
| 01A1h   |                                 |        |             |
| 01A2h   |                                 |        |             |
| 01A3h   |                                 |        |             |
| 01A4h   |                                 |        |             |
| 01A5h   |                                 |        |             |
| 01A6h   |                                 |        |             |
| 01A7h   |                                 |        |             |
| 01A8h   |                                 |        |             |
| 01A9h   |                                 |        |             |
| 01AAh   |                                 |        |             |
| 01ABh   |                                 |        |             |
| 01ACh   |                                 |        |             |
| 01ADh   |                                 |        |             |
| 01AEh   |                                 |        |             |
| 01AFh   |                                 |        |             |
| 01B0h   |                                 |        |             |
| 01B1h   |                                 |        |             |
| 01B2h   |                                 |        |             |
| 01B3h   | Flash Memory Control Register 4 | FMR4   | 01000000b   |
| 01B4h   |                                 |        |             |
| 01B5h   | Flash Memory Control Register 1 | FMR1   | 1000000Xb   |
| 01B6h   |                                 |        |             |
| 01B7h   | Flash Memory Control Register 0 | FMR0   | 00000001b   |
| 01B8h   |                                 |        |             |
| 01B9h   |                                 |        |             |
| 01BAh   |                                 |        |             |
| 01BBh   |                                 |        |             |
| 01FDh   |                                 |        |             |
| 01FEh   |                                 |        |             |
| 01FFh   |                                 |        |             |

X: Undefined

NOTE:

1. The blank regions are reserved. Do not access locations in these regions.

**Table 4.8 SFR Information (8)<sup>(1)</sup>**

| Address | Register                           | Symbol   | After reset |
|---------|------------------------------------|----------|-------------|
| 1300h   | CAN0 Message Control Register 0    | C0MCTL0  | 00h         |
| 1301h   | CAN0 Message Control Register 1    | C0MCTL1  | 00h         |
| 1302h   | CAN0 Message Control Register 2    | C0MCTL2  | 00h         |
| 1303h   | CAN0 Message Control Register 3    | C0MCTL3  | 00h         |
| 1304h   | CAN0 Message Control Register 4    | C0MCTL4  | 00h         |
| 1305h   | CAN0 Message Control Register 5    | C0MCTL5  | 00h         |
| 1306h   | CAN0 Message Control Register 6    | C0MCTL6  | 00h         |
| 1307h   | CAN0 Message Control Register 7    | C0MCTL7  | 00h         |
| 1308h   | CAN0 Message Control Register 8    | C0MCTL8  | 00h         |
| 1309h   | CAN0 Message Control Register 9    | C0MCTL9  | 00h         |
| 130Ah   | CAN0 Message Control Register 10   | C0MCTL10 | 00h         |
| 130Bh   | CAN0 Message Control Register 11   | C0MCTL11 | 00h         |
| 130Ch   | CAN0 Message Control Register 12   | C0MCTL12 | 00h         |
| 130Dh   | CAN0 Message Control Register 13   | C0MCTL13 | 00h         |
| 130Eh   | CAN0 Message Control Register 14   | C0MCTL14 | 00h         |
| 130Fh   | CAN0 Message Control Register 15   | C0MCTL15 | 00h         |
| 1310h   | CAN0 Control Register              | C0CTLR   | X0000001b   |
| 1311h   |                                    |          | XX0X0000b   |
| 1312h   | CAN0 Status Register               | C0STR    | 00h         |
| 1313h   |                                    |          | X0000001b   |
| 1314h   | CAN0 Slot Status Register          | C0SSTR   | 00h         |
| 1315h   |                                    |          | 00h         |
| 1316h   | CAN0 Interrupt Control Register    | C0ICR    | 00h         |
| 1317h   |                                    |          | 00h         |
| 1318h   | CAN0 Extended ID Register          | C0IDR    | 00h         |
| 1319h   |                                    |          | 00h         |
| 131Ah   | CAN0 Configuration Register        | C0CONR   | XXh         |
| 131Bh   |                                    |          | XXh         |
| 131Ch   | CAN0 Receive Error Count Register  | C0RECR   | 00h         |
| 131Dh   | CAN0 Transmit Error Count Register | C0TECR   | 00h         |
| 131Eh   |                                    |          |             |
| 131Fh   |                                    |          |             |
| 1320h   |                                    |          |             |
| 1321h   |                                    |          |             |
| 1322h   |                                    |          |             |
| 1323h   |                                    |          |             |
| 1324h   |                                    |          |             |
| 1325h   |                                    |          |             |
| 1326h   |                                    |          |             |
| 1327h   |                                    |          |             |
| 1328h   |                                    |          |             |
| 1329h   |                                    |          |             |
| 132Ah   |                                    |          |             |
| 132Bh   |                                    |          |             |
| 132Ch   |                                    |          |             |
| 132Dh   |                                    |          |             |
| 132Eh   |                                    |          |             |
| 132Fh   |                                    |          |             |
| 1330h   |                                    |          |             |
| 1331h   |                                    |          |             |
| 1332h   |                                    |          |             |
| 1333h   |                                    |          |             |
| 1334h   |                                    |          |             |
| 1335h   |                                    |          |             |
| 1336h   |                                    |          |             |
| 1337h   |                                    |          |             |
| 1338h   |                                    |          |             |
| 1339h   |                                    |          |             |
| 133Ah   |                                    |          |             |
| 133Bh   |                                    |          |             |
| 133Ch   |                                    |          |             |
| 133Dh   |                                    |          |             |
| 133Eh   |                                    |          |             |
| 133Fh   |                                    |          |             |

X: Undefined

NOTE:

1. The blank regions are reserved. Do not access locations in these regions.

**Table 4.9 SFR Information (9)<sup>(1)</sup>**

| Address | Register                                | Symbol | After reset |
|---------|-----------------------------------------|--------|-------------|
| 1340h   |                                         |        |             |
| 1341h   |                                         |        |             |
| 1342h   | CAN0 Acceptance Filter Support Register | C0AFS  | XXh         |
| 1343h   |                                         |        | XXh         |
| 1344h   |                                         |        |             |
| 1345h   |                                         |        |             |
| 1346h   |                                         |        |             |
| 1347h   |                                         |        |             |
| 1348h   |                                         |        |             |
| 1349h   |                                         |        |             |
| 134Ah   |                                         |        |             |
| 134Bh   |                                         |        |             |
| 134Ch   |                                         |        |             |
| 134Dh   |                                         |        |             |
| 134Eh   |                                         |        |             |
| 134Fh   |                                         |        |             |
| 1350h   |                                         |        |             |
| 1351h   |                                         |        |             |
| 1352h   |                                         |        |             |
| 1353h   |                                         |        |             |
| 1354h   |                                         |        |             |
| 1355h   |                                         |        |             |
| 1356h   |                                         |        |             |
| 1357h   |                                         |        |             |
| 1358h   |                                         |        |             |
| 1359h   |                                         |        |             |
| 135Ah   |                                         |        |             |
| 135Bh   |                                         |        |             |
| 135Ch   |                                         |        |             |
| 135Dh   |                                         |        |             |
| 135Eh   |                                         |        |             |
| 135Fh   | CAN0 Clock Select Register              | CCLKR  | 00h         |
| 1360h   | CAN0 Slot 0: Identifier/DLC             |        | XXh         |
| 1361h   |                                         |        | XXh         |
| 1362h   |                                         |        | XXh         |
| 1363h   |                                         |        | XXh         |
| 1364h   |                                         |        | XXh         |
| 1365h   |                                         |        | XXh         |
| 1366h   | CAN0 Slot 0: Data Field                 |        | XXh         |
| 1367h   |                                         |        | XXh         |
| 1368h   |                                         |        | XXh         |
| 1369h   |                                         |        | XXh         |
| 136Ah   |                                         |        | XXh         |
| 136Bh   |                                         |        | XXh         |
| 136Ch   |                                         |        | XXh         |
| 136Dh   |                                         |        | XXh         |
| 136Eh   | CAN0 Slot 0: Time Stamp                 |        | XXh         |
| 136Fh   |                                         |        | XXh         |
| 1370h   | CAN0 Slot 1: Identifier/DLC             |        | XXh         |
| 1371h   |                                         |        | XXh         |
| 1372h   |                                         |        | XXh         |
| 1373h   |                                         |        | XXh         |
| 1374h   |                                         |        | XXh         |
| 1375h   |                                         |        | XXh         |
| 1376h   | CAN0 Slot 1: Data Field                 |        | XXh         |
| 1377h   |                                         |        | XXh         |
| 1378h   |                                         |        | XXh         |
| 1379h   |                                         |        | XXh         |
| 137Ah   |                                         |        | XXh         |
| 137Bh   |                                         |        | XXh         |
| 137Ch   |                                         |        | XXh         |
| 137Dh   |                                         |        | XXh         |
| 137Eh   | CAN0 Slot 1: Time Stamp                 |        | XXh         |
| 137Fh   |                                         |        | XXh         |

X: Undefined

NOTE:

1. The blank regions are reserved. Do not access locations in these regions.

**Table 4.12 SFR Information (12)<sup>(1)</sup>**

| Address | Register                     | Symbol | After reset |
|---------|------------------------------|--------|-------------|
| 1400h   | CAN0 Slot 10: Identifier/DLC |        | XXh         |
| 1401h   |                              |        | XXh         |
| 1402h   |                              |        | XXh         |
| 1403h   |                              |        | XXh         |
| 1404h   |                              |        | XXh         |
| 1405h   |                              |        | XXh         |
| 1406h   | CAN0 Slot 10: Data Field     |        | XXh         |
| 1407h   |                              |        | XXh         |
| 1408h   |                              |        | XXh         |
| 1409h   |                              |        | XXh         |
| 140Ah   |                              |        | XXh         |
| 140Bh   |                              |        | XXh         |
| 140Ch   |                              |        | XXh         |
| 140Dh   |                              |        | XXh         |
| 140Eh   | CAN0 Slot 10: Time Stamp     |        | XXh         |
| 140Fh   |                              |        | XXh         |
| 1410h   | CAN0 Slot 11: Identifier/DLC |        | XXh         |
| 1411h   |                              |        | XXh         |
| 1412h   |                              |        | XXh         |
| 1413h   |                              |        | XXh         |
| 1414h   |                              |        | XXh         |
| 1415h   |                              |        | XXh         |
| 1416h   | CAN0 Slot 11: Data Field     |        | XXh         |
| 1417h   |                              |        | XXh         |
| 1418h   |                              |        | XXh         |
| 1419h   |                              |        | XXh         |
| 141Ah   |                              |        | XXh         |
| 141Bh   |                              |        | XXh         |
| 141Ch   |                              |        | XXh         |
| 141Dh   |                              |        | XXh         |
| 141Eh   | CAN0 Slot 11: Time Stamp     |        | XXh         |
| 141Fh   |                              |        | XXh         |
| 1420h   | CAN0 Slot 12: Identifier/DLC |        | XXh         |
| 1421h   |                              |        | XXh         |
| 1422h   |                              |        | XXh         |
| 1423h   |                              |        | XXh         |
| 1424h   |                              |        | XXh         |
| 1425h   |                              |        | XXh         |
| 1426h   | CAN0 Slot 12: Data Field     |        | XXh         |
| 1427h   |                              |        | XXh         |
| 1428h   |                              |        | XXh         |
| 1429h   |                              |        | XXh         |
| 142Ah   |                              |        | XXh         |
| 142Bh   |                              |        | XXh         |
| 142Ch   |                              |        | XXh         |
| 142Dh   |                              |        | XXh         |
| 142Eh   | CAN0 Slot 12: Time Stamp     |        | XXh         |
| 142Fh   |                              |        | XXh         |
| 1430h   | CAN0 Slot 13: Identifier/DLC |        | XXh         |
| 1431h   |                              |        | XXh         |
| 1432h   |                              |        | XXh         |
| 1433h   |                              |        | XXh         |
| 1434h   |                              |        | XXh         |
| 1435h   |                              |        | XXh         |
| 1436h   | CAN0 Slot 13: Data Field     |        | XXh         |
| 1437h   |                              |        | XXh         |
| 1438h   |                              |        | XXh         |
| 1439h   |                              |        | XXh         |
| 143Ah   |                              |        | XXh         |
| 143Bh   |                              |        | XXh         |
| 143Ch   |                              |        | XXh         |
| 143Dh   |                              |        | XXh         |
| 143Eh   | CAN0 Slot 13: Time Stamp     |        | XXh         |
| 143Fh   |                              |        | XXh         |

X: Undefined

NOTE:

1. The blank regions are reserved. Do not access locations in these regions.

## 5. Electrical Characteristics

**Table 5.1 Absolute Maximum Ratings**

| Symbol                            | Parameter                     | Condition           | Rated value                                          | Unit |
|-----------------------------------|-------------------------------|---------------------|------------------------------------------------------|------|
| V <sub>CC</sub> /AV <sub>CC</sub> | Supply voltage                |                     | -0.3 to 6.5                                          | V    |
| V <sub>I</sub>                    | Input voltage                 |                     | -0.3 to V <sub>CC</sub> +0.3                         | V    |
| V <sub>O</sub>                    | Output voltage                |                     | -0.3 to V <sub>CC</sub> +0.3                         | V    |
| P <sub>d</sub>                    | Power dissipation             | -40°C ≤ Topr ≤ 85°C | 300                                                  | mW   |
|                                   |                               | 85°C < Topr ≤ 125°C | 125                                                  | mW   |
| Topr                              | Operating ambient temperature |                     | -40 to 85 (D, J version) /<br>-40 to 125 (K version) | °C   |
| Tstg                              | Storage temperature           |                     | -65 to 150                                           | °C   |

**Table 5.2 Recommended Operating Conditions**

| Symbol                            | Parameter                             |                                                        | Conditions                                                                                                                   | Standard           |      |                    | Unit |
|-----------------------------------|---------------------------------------|--------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|--------------------|------|--------------------|------|
|                                   |                                       |                                                        |                                                                                                                              | Min.               | Typ. | Max.               |      |
| V <sub>CC</sub> /AV <sub>CC</sub> | Supply voltage                        |                                                        |                                                                                                                              | 2.7                | –    | 5.5                | V    |
| V <sub>SS</sub> /AV <sub>SS</sub> | Supply voltage                        |                                                        |                                                                                                                              | –                  | 0    | –                  | V    |
| V <sub>IH</sub>                   | Input “H” voltage                     |                                                        |                                                                                                                              | 0.8V <sub>CC</sub> | –    | V <sub>CC</sub>    | V    |
| V <sub>IL</sub>                   | Input “L” voltage                     |                                                        |                                                                                                                              | 0                  | –    | 0.2V <sub>CC</sub> | V    |
| I <sub>OH</sub> (sum)             | Peak sum output “H” current           | Sum of all Pins I <sub>OH</sub> (peak)                 |                                                                                                                              | –                  | –    | -60                | mA   |
| I <sub>OH</sub> (peak)            | Peak output “H” current               |                                                        |                                                                                                                              | –                  | –    | -10                | mA   |
| I <sub>OH</sub> (avg)             | Average output “H” current            |                                                        |                                                                                                                              | –                  | –    | -5                 | mA   |
| I <sub>OL</sub> (sum)             | Peak sum output “L” currents          | Sum of all Pins I <sub>OL</sub> (peak)                 |                                                                                                                              | –                  | –    | 60                 | mA   |
| I <sub>OL</sub> (peak)            | Peak output “L” currents              |                                                        |                                                                                                                              | –                  | –    | 10                 | mA   |
| I <sub>OL</sub> (avg)             | Average output “L” current            |                                                        |                                                                                                                              | –                  | –    | 5                  | mA   |
| f <sub>(XIN)</sub>                | XIN clock input oscillation frequency |                                                        | 3.0 V ≤ V <sub>CC</sub> ≤ 5.5 V<br>-40°C ≤ Topr ≤ 85°C                                                                       | 0                  | –    | 20                 | MHz  |
|                                   |                                       |                                                        | 3.0 V ≤ V <sub>CC</sub> ≤ 5.5 V<br>-40°C ≤ Topr ≤ 125°C                                                                      | 0                  | –    | 16                 | MHz  |
|                                   |                                       |                                                        | 2.7 V ≤ V <sub>CC</sub> < 3.0 V                                                                                              | 0                  | –    | 10                 | MHz  |
| –                                 | System clock                          | OCD2 = 0<br>When XIN clock is selected.                | 3.0 V ≤ V <sub>CC</sub> ≤ 5.5 V<br>-40°C ≤ Topr ≤ 85°C                                                                       | 0                  | –    | 20                 | MHz  |
|                                   |                                       |                                                        | 3.0 V ≤ V <sub>CC</sub> ≤ 5.5 V<br>-40°C ≤ Topr ≤ 125°C                                                                      | 0                  | –    | 16                 | MHz  |
|                                   |                                       |                                                        | 2.7 V ≤ V <sub>CC</sub> < 3.0 V                                                                                              | 0                  | –    | 10                 | MHz  |
|                                   |                                       | OCD2 = 1<br>When on-chip oscillator clock is selected. | FRA01 = 0<br>When low-speed on-chip oscillator clock is selected.                                                            | –                  | 125  | –                  | kHz  |
|                                   |                                       |                                                        | FRA01 = 1<br>When high-speed on-chip oscillator clock is selected.<br>3.0 V ≤ V <sub>CC</sub> ≤ 5.5 V<br>-40°C ≤ Topr ≤ 85°C | –                  | –    | 20                 | MHz  |
|                                   |                                       |                                                        | FRA01 = 1<br>When high-speed on-chip oscillator clock is selected.                                                           | –                  | –    | 10                 | MHz  |

**NOTES:**

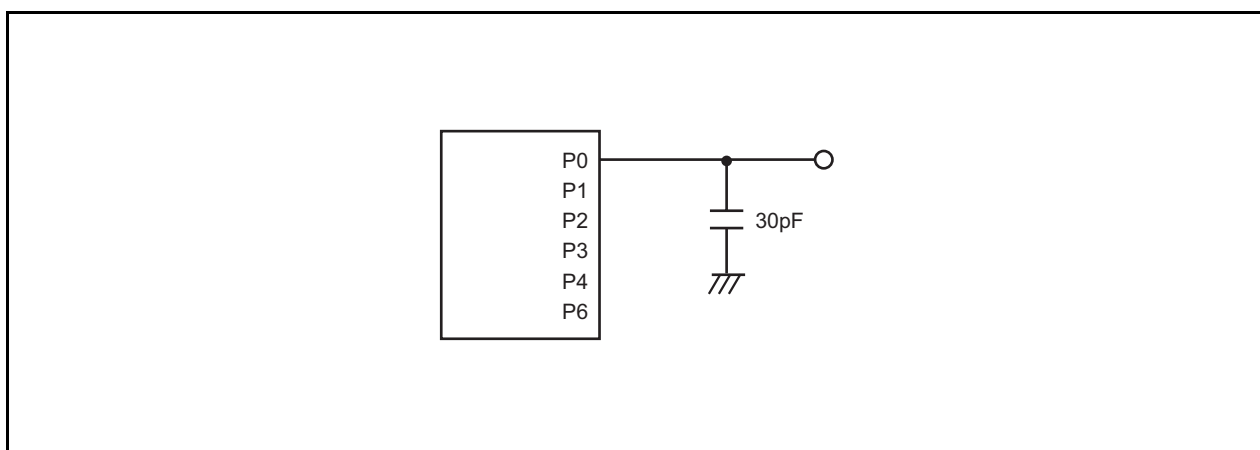
- V<sub>CC</sub> = 2.7 to 5.5 V at Topr = -40 to 85°C (D, J version) / -40 to 125°C (K version), unless otherwise specified.
- The average output current indicates the average value of current measured during 100 ms.

**Table 5.3 A/D Converter Characteristics**

| Symbol       | Parameter                           |                       | Conditions                                                         | Standard |      |           | Unit          |
|--------------|-------------------------------------|-----------------------|--------------------------------------------------------------------|----------|------|-----------|---------------|
|              |                                     |                       |                                                                    | Min.     | Typ. | Max.      |               |
| —            | Resolution                          |                       | $V_{ref} = AV_{CC}$                                                | —        | —    | 10        | Bits          |
| —            | Absolute Accuracy                   | 10-bit mode           | $\phi_{AD} = 10 \text{ MHz}$ , $V_{ref} = AV_{CC} = 5.0 \text{ V}$ | —        | —    | $\pm 3$   | LSB           |
|              |                                     | 8-bit mode            | $\phi_{AD} = 10 \text{ MHz}$ , $V_{ref} = AV_{CC} = 5.0 \text{ V}$ | —        | —    | $\pm 2$   | LSB           |
|              |                                     | 10-bit mode           | $\phi_{AD} = 10 \text{ MHz}$ , $V_{ref} = AV_{CC} = 3.3 \text{ V}$ | —        | —    | $\pm 5$   | LSB           |
|              |                                     | 8-bit mode            | $\phi_{AD} = 10 \text{ MHz}$ , $V_{ref} = AV_{CC} = 3.3 \text{ V}$ | —        | —    | $\pm 2$   | LSB           |
| $R_{ladder}$ | Resistor ladder                     |                       | $V_{ref} = AV_{CC}$                                                | 10       | —    | 40        | $k\Omega$     |
| $t_{conv}$   | Conversion time                     | 10-bit mode           | $\phi_{AD} = 10 \text{ MHz}$ , $V_{ref} = AV_{CC} = 5.0 \text{ V}$ | 3.3      | —    | —         | $\mu\text{s}$ |
|              |                                     | 8-bit mode            | $\phi_{AD} = 10 \text{ MHz}$ , $V_{ref} = AV_{CC} = 5.0 \text{ V}$ | 2.8      | —    | —         | $\mu\text{s}$ |
| $V_{ref}$    | Reference voltage                   |                       |                                                                    | 2.7      | —    | $AV_{CC}$ | V             |
| $V_{IA}$     | Analog input voltage <sup>(2)</sup> |                       |                                                                    | 0        | —    | $AV_{CC}$ | V             |
| —            | A/D operating clock frequency       | Without sample & hold |                                                                    | 0.25     | —    | 10        | MHz           |
|              |                                     | With sample & hold    |                                                                    | 1        | —    | 10        | MHz           |

## NOTES:

1.  $V_{CC} = AV_{CC} = 2.7$  to  $5.5 \text{ V}$  at  $T_{opr} = -40$  to  $85^\circ\text{C}$  (D, J version) /  $-40$  to  $125^\circ\text{C}$  (K version), unless otherwise specified.
2. When analog input voltage exceeds reference voltage, A/D conversion result is 3FFh in 10-bit mode, FFh in 8-bit mode.

**Figure 5.1 Ports P0 to P4, P6 Timing Measurement Circuit**

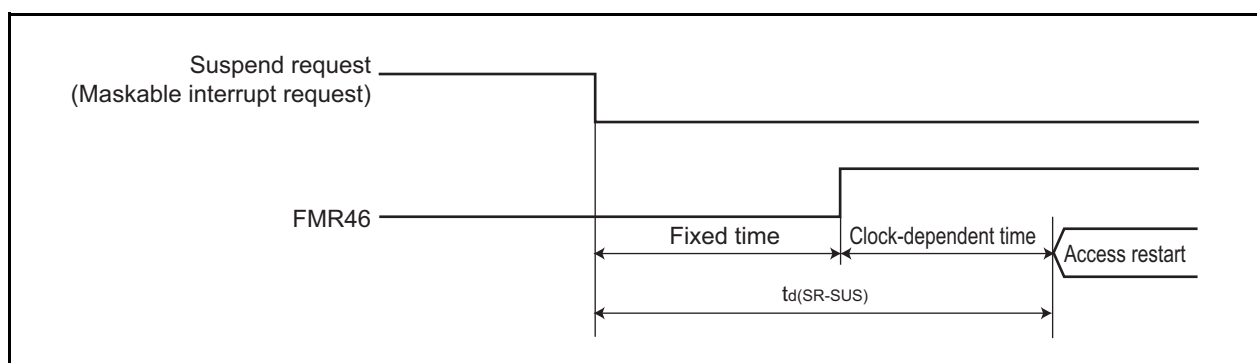


Figure 5.2 Time delay until Suspend

Table 5.6 Voltage Detection 1 Circuit Electrical Characteristics

| Symbol                                | Parameter                                                                    | Condition                          | Standard |      |      | Unit |
|---------------------------------------|------------------------------------------------------------------------------|------------------------------------|----------|------|------|------|
|                                       |                                                                              |                                    | Min.     | Typ. | Max. |      |
| V <sub>det1</sub>                     | Voltage detection level <sup>(3, 4)</sup>                                    |                                    | 2.70     | 2.85 | 3.00 | V    |
| t <sub>d</sub> (V <sub>det1</sub> -A) | Voltage monitor 1 reset generation time <sup>(5)</sup>                       |                                    | –        | 40   | 200  | μs   |
| –                                     | Voltage detection circuit self power consumption                             | VCA26 = 1, V <sub>CC</sub> = 5.0 V | –        | 0.6  | –    | μA   |
| t <sub>d</sub> (E-A)                  | Waiting time until voltage detection circuit operation starts <sup>(2)</sup> |                                    | –        | –    | 100  | μs   |
| V <sub>ccmin</sub>                    | MCU operating voltage minimum value                                          |                                    | 2.70     | –    | –    | V    |

## NOTES:

1. The measurement condition is V<sub>CC</sub> = 2.7 V to 5.5 V and Topr = -40°C to 85°C (D, J version) / -40°C to 125°C (K version).
2. Necessary time until the voltage detection circuit operates when setting to 1 again after setting the VCA26 bit in the VCA2 register to 0.
3. Hold V<sub>det2</sub> > V<sub>det1</sub>.
4. This parameter shows the voltage detection level when the power supply drops. The voltage detection level when the power supply rises is higher than the voltage detection level when the power supply drops by approximately 0.1 V.
5. Time until the voltage monitor 1 reset is generated after the voltage passes V<sub>det1</sub> when V<sub>CC</sub> falls. When using the digital filter, its sampling time is added to t<sub>d</sub>(V<sub>det1</sub>-A). When using the voltage monitor 1 reset, maintain this time until V<sub>CC</sub> = 2.0 V after the voltage passes V<sub>det1</sub> when the power supply falls.

Table 5.7 Voltage Detection 2 Circuit Electrical Characteristics

| Symbol                                | Parameter                                                                    | Condition                         | Standard |      |      | Unit |
|---------------------------------------|------------------------------------------------------------------------------|-----------------------------------|----------|------|------|------|
|                                       |                                                                              |                                   | Min.     | Typ. | Max. |      |
| V <sub>det2</sub>                     | Voltage detection level <sup>(4)</sup>                                       |                                   | 3.3      | 3.6  | 3.9  | V    |
| t <sub>d</sub> (V <sub>det2</sub> -A) | Voltage monitor 2 reset/interrupt request generation time <sup>(2, 5)</sup>  |                                   | –        | 40   | 200  | μs   |
| –                                     | Voltage detection circuit self power consumption                             | VCA27 = 1, V <sub>CC</sub> = 5.0V | –        | 0.6  | –    | μA   |
| t <sub>d</sub> (E-A)                  | Waiting time until voltage detection circuit operation starts <sup>(3)</sup> |                                   | –        | –    | 100  | μs   |

## NOTES:

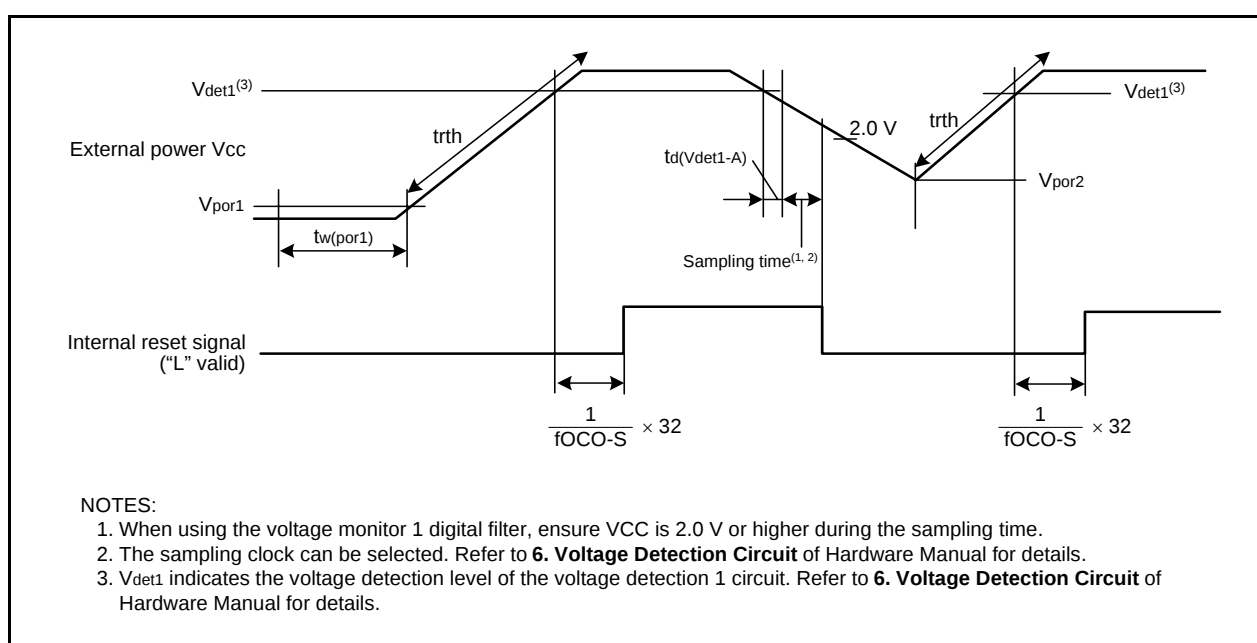
1. The measurement condition is V<sub>CC</sub> = 2.7 V to 5.5 V and Topr = -40°C to 85°C (D, J version) / -40°C to 125°C (K version).
2. Time until the voltage monitor 2 reset/interrupt request is generated since the voltage passes V<sub>det2</sub>.
3. Necessary time until the voltage detection circuit operates when setting to 1 again after setting the VCA27 bit in the VCA2 register to 0.
4. Hold V<sub>det2</sub> > V<sub>det1</sub>.
5. When using the digital filter, its sampling time is added to t<sub>d</sub>(V<sub>det2</sub>-A). When using the voltage monitor 2 reset, maintain this time until V<sub>CC</sub> = 2.0 V after the voltage passes V<sub>det2</sub> when the power supply falls.

**Table 5.8 Power-on Reset Circuit, Voltage Monitor 1 Reset Circuit Electrical Characteristics<sup>(3)</sup>**

| Symbol            | Parameter                                         | Condition               | Standard          |      |                   | Unit    |
|-------------------|---------------------------------------------------|-------------------------|-------------------|------|-------------------|---------|
|                   |                                                   |                         | Min.              | Typ. | Max.              |         |
| V <sub>por1</sub> | Power-on reset valid voltage <sup>(4)</sup>       |                         | –                 | –    | 0.1               | V       |
| V <sub>por2</sub> | Power-on reset or voltage monitor 1 valid voltage |                         | 0                 | –    | V <sub>det1</sub> | V       |
| trth              | External power V <sub>CC</sub> rise gradient      | V <sub>CC</sub> ≤ 3.6 V | 20 <sup>(2)</sup> | –    | –                 | mV/msec |
|                   |                                                   | V <sub>CC</sub> > 3.6 V | 20 <sup>(2)</sup> | –    | 2,000             | mV/msec |

## NOTES:

1. Topr = -40°C to 85°C (D, J version) / -40°C to 125°C (K version), unless otherwise specified.
2. This condition (the minimum value of external power V<sub>CC</sub> rise gradient) does not apply if V<sub>por2</sub> ≥ 1.0 V.
3. To use the power-on reset function, enable voltage monitor 1 reset by setting the LVD1ON bit in the OFS register to 0, the VW1C0 and VW1C6 bits in the VW1C register to 1 respectively, and the VCA26 bit in the VCA2 register to 1.
4. t<sub>w(por1)</sub> indicates the duration the external power V<sub>CC</sub> must be held below the effective voltage (V<sub>por1</sub>) to enable a power on reset. When turning on the power for the first time, maintain t<sub>w(por1)</sub> for 30s or more if -20°C ≤ Topr ≤ 125°C, maintain t<sub>w(por1)</sub> for 3,000s or more if -40°C ≤ Topr < -20°C.

**Figure 5.3 Power-on Reset Circuit Electrical Characteristics**

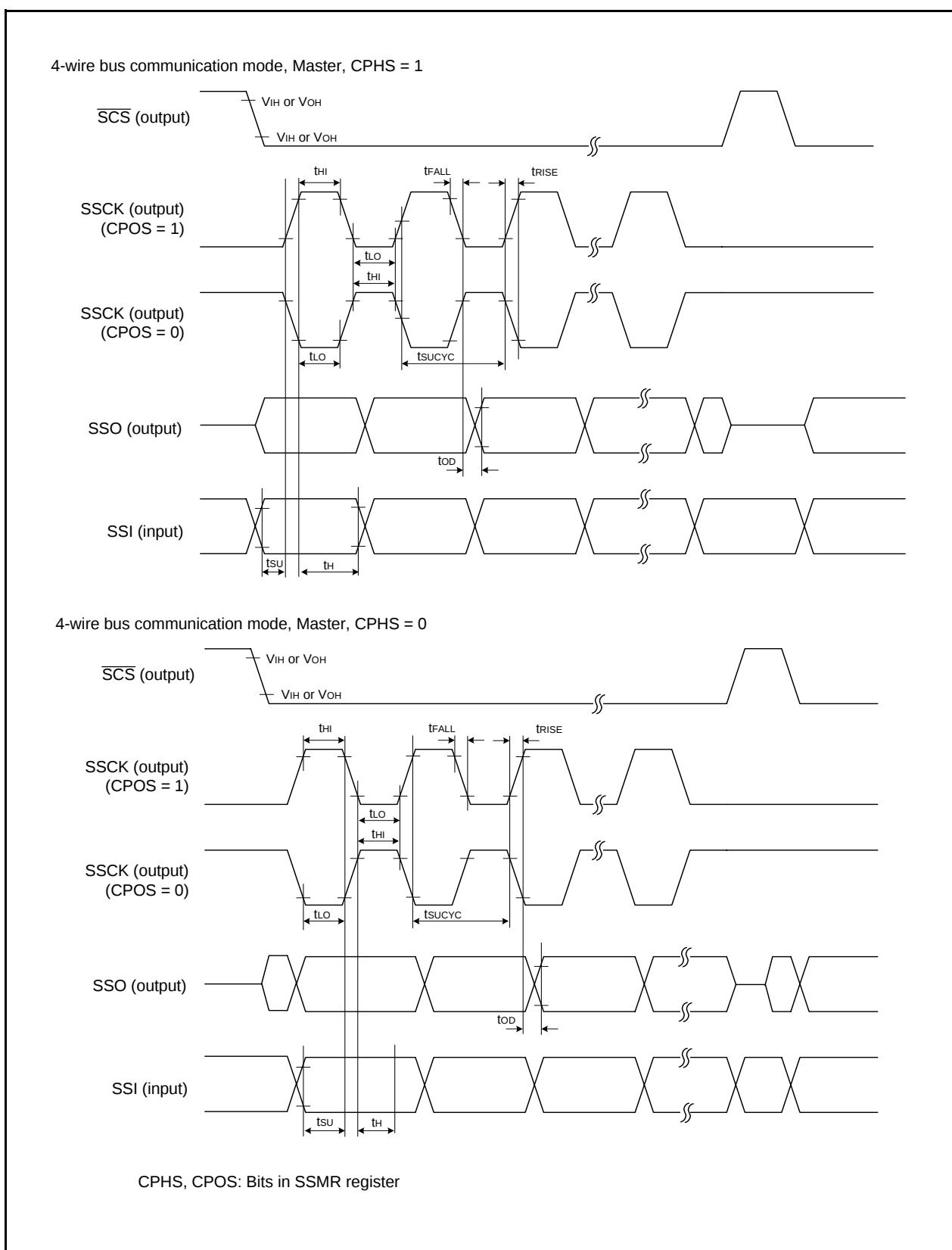


Figure 5.4 I/O Timing of Clock Synchronous Serial I/O with Chip Select (Master)

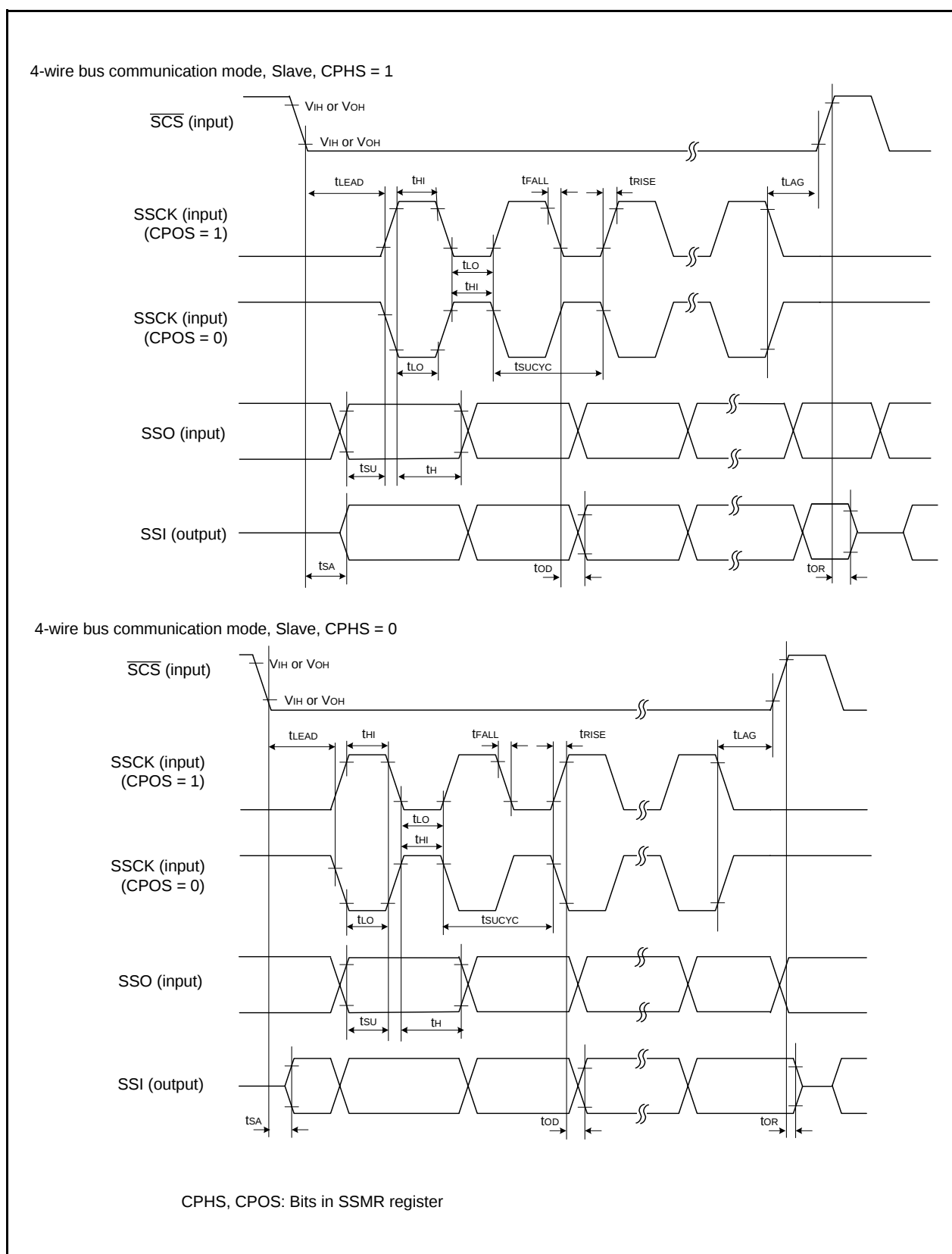
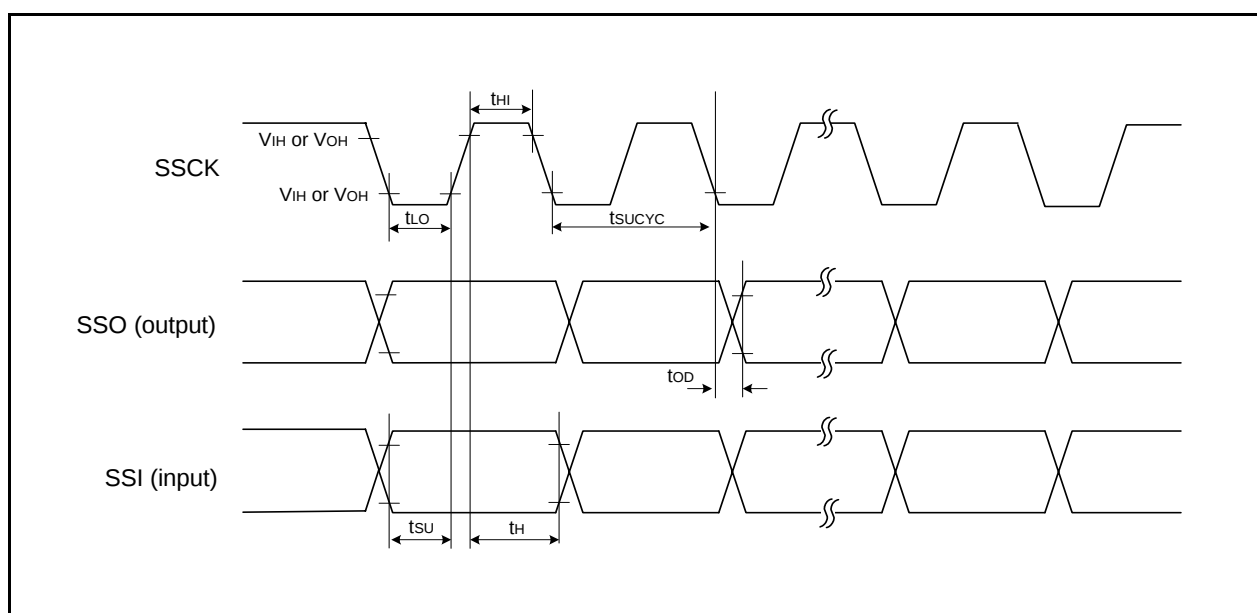


Figure 5.5 I/O Timing of Clock Synchronous Serial I/O with Chip Select (Slave)



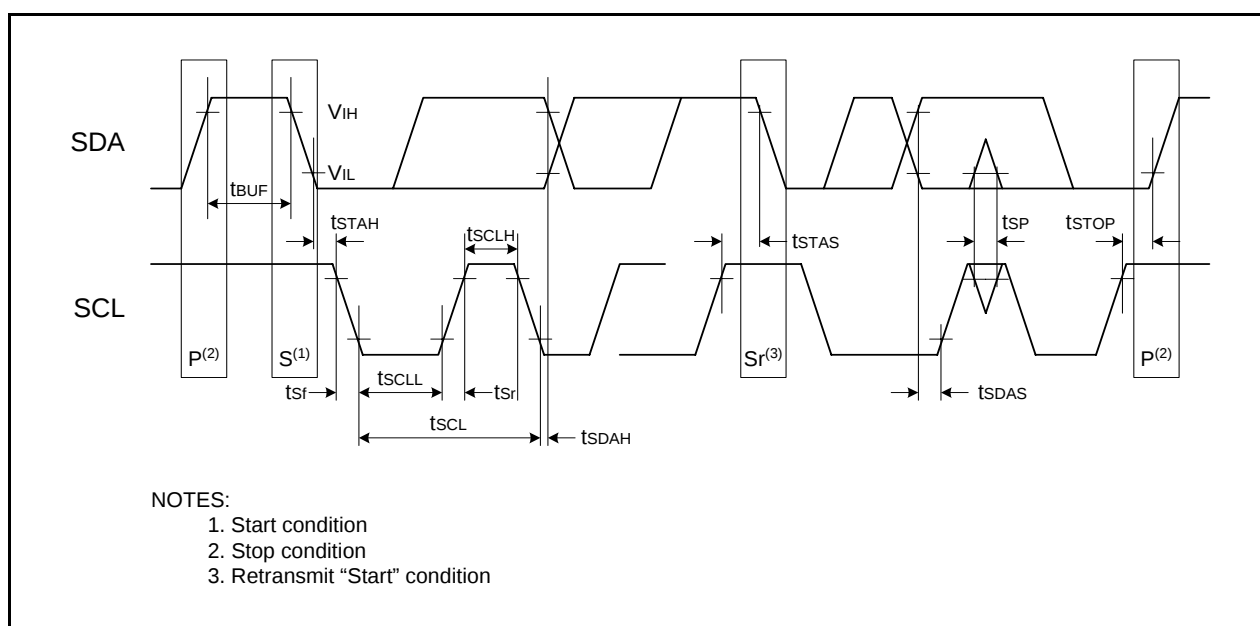
**Figure 5.6 I/O Timing of Clock Synchronous Serial I/O with Chip Select  
(Clock Synchronous Communication Mode)**

**Table 5.13 Timing Requirements of I<sup>2</sup>C Bus Interface<sup>(1)</sup>**

| Symbol            | Parameter                                   | Conditions | Standard                                |      |                                  | Unit |
|-------------------|---------------------------------------------|------------|-----------------------------------------|------|----------------------------------|------|
|                   |                                             |            | Min.                                    | Typ. | Max.                             |      |
| t <sub>SCL</sub>  | SCL input cycle time                        |            | 12t <sub>CYC</sub> + 600 <sup>(2)</sup> | —    | —                                | ns   |
| t <sub>SCLH</sub> | SCL input "H" width                         |            | 3t <sub>CYC</sub> + 300 <sup>(2)</sup>  | —    | —                                | ns   |
| t <sub>SCLL</sub> | SCL input "L" width                         |            | 5t <sub>CYC</sub> + 500 <sup>(2)</sup>  | —    | —                                | ns   |
| t <sub>sf</sub>   | SCL, SDA input falling time                 |            | —                                       | —    | 300                              | ns   |
| t <sub>SP</sub>   | SCL, SDA input spike pulse rejection time   |            | —                                       | —    | 1t <sub>CYC</sub> <sup>(2)</sup> | ns   |
| t <sub>BUF</sub>  | SDA input bus-free time                     |            | 5t <sub>CYC</sub> <sup>(2)</sup>        | —    | —                                | ns   |
| t <sub>STAH</sub> | Start condition input hold time             |            | 3t <sub>CYC</sub> <sup>(2)</sup>        | —    | —                                | ns   |
| t <sub>STAS</sub> | Retransmit start condition input setup time |            | 3t <sub>CYC</sub> <sup>(2)</sup>        | —    | —                                | ns   |
| t <sub>STOP</sub> | Stop condition input setup time             |            | 3t <sub>CYC</sub> <sup>(2)</sup>        | —    | —                                | ns   |
| t <sub>SOAS</sub> | Data input setup time                       |            | 1t <sub>CYC</sub> + 20 <sup>(2)</sup>   | —    | —                                | ns   |
| t <sub>SDAH</sub> | Data input hold time                        |            | 0                                       | —    | —                                | ns   |

## NOTES:

1. V<sub>CC</sub> = 2.7 to 5.5 V, V<sub>SS</sub> = 0V at Topr = -40 to 85°C (D, J version) / -40 to 125°C (K version), unless otherwise specified.
2. 1t<sub>CYC</sub> = 1/f<sub>1</sub>(s)

**Figure 5.7 I/O Timing of I<sup>2</sup>C Bus Interface**

**Table 5.20 Electrical Characteristics (3) [Vcc = 3 V]**

| Symbol  | Parameter           |                                                                                         | Condition           |                   | Standard  |      |      | Unit       |
|---------|---------------------|-----------------------------------------------------------------------------------------|---------------------|-------------------|-----------|------|------|------------|
|         |                     |                                                                                         |                     |                   | Min.      | Typ. | Max. |            |
| VOH     | Output "H" voltage  | Except XOUT                                                                             | IOH = -1 mA         |                   | Vcc - 0.5 | —    | Vcc  | V          |
|         |                     | XOUT                                                                                    | Drive capacity HIGH | IOH = -0.1 mA     | Vcc - 0.5 | —    | Vcc  | V          |
|         |                     |                                                                                         | Drive capacity LOW  | IOH = -50 $\mu$ A | Vcc - 0.5 | —    | Vcc  | V          |
| VOL     | Output "L" voltage  | Except XOUT                                                                             | IOL = 1 mA          |                   | —         | —    | 0.5  | V          |
|         |                     | XOUT                                                                                    | Drive capacity HIGH | IOL = 0.1 mA      | —         | —    | 0.5  | V          |
|         |                     |                                                                                         | Drive capacity LOW  | IOL = 50 $\mu$ A  | —         | —    | 0.5  | V          |
| VT+-VT- | Hysteresis          | INT0, INT1, INT2, INT3, KI0, KI1, KI2, KI3, TRAIO, RXD0, RXD1, CLK0, SSI, SCL, SDA, SSO |                     |                   | 0.1       | 0.3  | —    | V          |
|         |                     | RESET                                                                                   |                     |                   | 0.1       | 0.4  | —    | V          |
| IiH     | Input "H" current   |                                                                                         | VI = 3 V, Vcc = 3 V |                   | —         | —    | 4.0  | $\mu$ A    |
| IiL     | Input "L" current   |                                                                                         | VI = 0 V, Vcc = 3 V |                   | —         | —    | -4.0 | $\mu$ A    |
| RPULLUP | Pull-up resistance  |                                                                                         | VI = 0 V, Vcc = 3 V |                   | 66        | 160  | 500  | k $\Omega$ |
| RfXIN   | Feedback resistance | XIN                                                                                     |                     |                   | —         | 3.0  | —    | M $\Omega$ |
| VRAM    | RAM hold voltage    |                                                                                         | During stop mode    |                   | 2.0       | —    | —    | V          |

## NOTE:

- Vcc = 2.7 to 3.3 V at Topr = -40 to 85°C (D, J version) / -40 to 125°C (K version), f(XIN) = 10 MHz, unless otherwise specified.