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Renesas Electronics Corporation

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1. Overview

1.1 Features

The M32C/87 Group (M32C/87, M32C/87A, M32C/87B) is a single-chip control MCU, fabricated using high-performance silicon gate CMOS technology, embedding the M32C/80 Series CPU core. The M32C/87 Group (M32C/87, M32C/87A, M32C/87B) is housed in 144-pin and 100-pin plastic molded LQFP/QFP packages.

With a 16-Mbyte address space, this MCU combines advanced instruction manipulation capabilities to process complex instructions by less bytes and execute instructions at higher speed.

The M32C/87 Group (M32C/87, M32C/87A, M32C/87B) has a multiplier and DMAC adequate for office automation, communication devices and industrial equipment, and other high-speed processing applications.

1.1.1 Applications

Audio components, cameras, office equipment, communication devices, mobile devices, etc.

1.1.2 Specifications

Tables 1.1 to 1.4 list the specifications of the M32C/87 Group (M32C/87, M32C/87A, M32C/87B).

Table 1.1 Specifications (144-Pin Package) (1/2)

| Item | Function | Specification |
|--------------------------------|--|--|
| CPU | Central processing unit | M32C/80 core (multiplier: 16 bits × 16 bits → 32 bits multiply-addition operation instructions: 16 × 16 + 48 → 48 bits) <ul style="list-style-type: none"> • Basic instructions: 108 • Minimum instruction execution time: 31.3 ns (f(CPU) = 32 MHz, VCC1 = 4.2 to 5.5 V) 41.7 ns (f(CPU) = 24 MHz, VCC1 = 3.0 to 5.5 V) • Operating modes: Single-chip mode, memory expansion mode, and microprocessor mode |
| Memory | ROM, RAM, data flash | See Tables 1.5 to 1.7 Product List . |
| Power Supply Voltage Detection | | Vdet3 detection function, Vdet4 detection function, cold start/warm start determination function |
| External Bus Expansion | Bus/memory expansion function | <ul style="list-style-type: none"> • Address space: 16 Mbytes • External bus interface: 1 to 7 wait states can be inserted, 4 chip select outputs, 3 V and 5 V interfaces • Bus format: Switchable between separate bus and multiplexed bus formats, switchable data bus width (8-bit or 16-bit) |
| Clock | Clock generation circuits | <ul style="list-style-type: none"> • 4 circuits: Main clock, sub clock, on-chip oscillator, PLL frequency synthesizer • Oscillation stop detection: Main clock oscillation stop detection function • Frequency divider circuit: Dividing ratio selectable among 1, 2, 3, 4, 6, 8, 10, 12, 14, 16 • Low power consumption features: Wait mode, stop mode |
| Interrupts | | <ul style="list-style-type: none"> • Interrupt vectors: 70 • External interrupt inputs: 14 ($\overline{\text{NMI}}$, $\overline{\text{INT}} \times 9$, key input × 4) • Interrupt priority levels: 7 |
| Watchdog Timer | | 15-bit × 1 channel (with prescaler) |
| DMA | DMAC | <ul style="list-style-type: none"> • 4 channels, cycle steal method • Trigger sources: 43 • Transfer modes: 2 (single transfer and repeat transfer) |
| | DMACII | <ul style="list-style-type: none"> • Can be activated by all peripheral function interrupt sources • Transfer modes: 2 (single transfer and burst transfer) • Immediate transfer, calculation transfer, and chain transfer functions |
| Timer | Timer A | 16-bit timer × 5 Timer mode, event counter mode, one-shot timer mode, pulse width modulation (PWM) mode, Event counter 2-phase pulse signal processing (2-phase encoder input) × 3 |
| | Timer B | 16-bit timer × 6 Timer mode, event counter mode, pulse period measurement mode, pulse width measurement mode |
| | Timer function for 3-phase motor control | 3-phase inverter control × 1 (using timer A1, timer A2, timer A4, and timer B2) On-chip dead time timer |

Table 1.2 Specifications (144-Pin Package) (2/2)

| Item | Function | Specification |
|------------------------------------|------------------------|---|
| Serial Interface | UART0 to UART4 | Clock synchronous/asynchronous × 5 I ² C bus, special mode 2, GCI mode, SIM mode, IrDA mode ⁽²⁾ , IEBus (optional) ⁽¹⁾⁽³⁾ |
| | UART5, UART6 | Clock synchronous/asynchronous × 2 |
| A/D Converter | | 10-bit resolution × 34 channels (in single-chip mode) 10-bit resolution × 18 channels (in memory expansion mode and microprocessor mode) Including sample and hold function |
| D/A Converter | | 8-bit resolution × 2 channels |
| CRC Calculation Circuit | | CRC-CCITT ($X^{16} + X^{12} + X^5 + 1$) compliant |
| X/Y Converter | | 16 bits × 16 bits |
| Intelligent I/O | | 16-bit timer × 2 <ul style="list-style-type: none"> • Time measurement function (input capture): 8 channels • Waveform generation function (output compare): 16 channels • Communication function: Clock synchronous mode, clock asynchronous mode, HDLC data processing mode, IEBus (optional)⁽¹⁾⁽³⁾ • 2-phase pulse signal processing (2-phase encoder input) × 1 |
| ROM Correction Function | | Address match interrupt × 8 |
| CAN modules | | Supporting CAN 2.0B specification M32C/87: 16 slots × 2 channels, M32C/87A: 16 slots × 1 channel M32C/87B: none |
| I/O Ports | Programmable I/O ports | <ul style="list-style-type: none"> • Input only: 1 • CMOS I/O: 121 with selectable pull-up resistor • N channel open drain ports: 2 |
| Flash Memory | | <ul style="list-style-type: none"> • Erase and program voltage: 3.3 V ± 0.3 V or 5.0 V ± 0.5 V • Erase and program endurance: 100 times (all areas) • Program security: ROM code protect and ID code check • Debug functions: On-chip debug and on-board flash reprogram |
| Operating Frequency/Supply Voltage | | 32 MHz: VCC1 = 4.2 to 5.5 V, VCC2 = 3.0 V to VCC1 24 MHz: VCC1 = 3.0 to 5.5 V, VCC2 = 3.0 V to VCC1 |
| Current Consumption | | 32 mA (32 MHz, VCC1 = VCC2 = 5 V) 23 mA (24 MHz, VCC1 = VCC2 = 3.3 V) 45 μA (approx. 1 MHz, VCC1 = VCC2 = 3.3 V, on-chip oscillator low-power consumption mode → wait mode) 0.8 μA (VCC1 = VCC2 = 3.3 V, stop mode) |
| Operating Ambient Temperature (°C) | | -20 to 85°C, -40 to 85°C (optional) ⁽³⁾ |
| Package | | 144-pin LQFP (PLQP0144KA-A) |

NOTES:

1. IEBus is a registered trademark of NEC Electronics Corporation.
2. Available in UART0.
3. Please contact a Renesas sales office for optional features.

Table 1.3 Specifications (100-Pin Package) (1/2)

| Item | Function | Specification |
|--------------------------------|--|---|
| CPU | Central processing unit | M32C/80 core (multiplier: 16 bits × 16 bits → 32 bits multiply-addition operation instructions: 16 × 16 + 48 → 48 bits) <ul style="list-style-type: none"> • Basic instructions: 108 • Minimum instruction execution time: 31.3 ns (f(CPU) = 32 MHz, VCC1 = 4.2 to 5.5 V) 41.7 ns (f(CPU) = 24 MHz, VCC1 = 3.0 to 5.5 V) • Operating mode: Single-chip mode, memory expansion mode, and microprocessor mode |
| Memory | ROM, RAM, data flash | See Tables 1.5 to 1.7 Product List. |
| Power Supply Voltage Detection | | Vdet3 detection function, Vdet4 detection function, cold start/warm start determination function |
| External Bus Expansion | Bus/memory expansion function | <ul style="list-style-type: none"> • Address space: 16 Mbytes • External bus interface: 1 to 7 wait states can be inserted, 4 chip select outputs, 3 V and 5 V interfaces • Bus format: Switchable between separate bus and multiplexed bus formats, switchable data bus width (8-bit or 16-bit) |
| Clock | Clock generation circuits | <ul style="list-style-type: none"> • 4 circuits: Main clock, sub clock, on-chip oscillator, PLL frequency synthesizer • Oscillation stop detection: Main clock oscillation stop detection function • Frequency divider circuit: Dividing ratio selectable among 1, 2, 3, 4, 6, 8, 10, 12, 14, 16 • Low power consumption features: Wait mode, stop mode |
| Interrupts | | <ul style="list-style-type: none"> • Interrupt vectors: 70 • External interrupt inputs: 11 ($\overline{\text{NMI}}$, $\overline{\text{INT}} \times 6$, key input × 4) • Interrupt priority levels: 7 |
| Watchdog Timer | | 15-bit × 1 channel (with prescaler) |
| DMA | DMAC | <ul style="list-style-type: none"> • 4 channels, cycle steal method • Trigger sources: 43 • Transfer modes: 2 (single transfer and repeat transfer) |
| | DMACII | <ul style="list-style-type: none"> • Can be activated by all peripheral function interrupt sources • Transfer modes: 2 (single transfer and burst transfer) • Immediate transfer, calculation transfer, and chain transfer functions |
| Timer | Timer A | 16-bit timer × 5 Timer mode, event counter mode, one-shot timer mode, pulse width modulation (PWM) mode, Event counter 2-phase pulse signal processing (2-phase encoder input) × 3 |
| | Timer B | 16-bit timer × 6 Timer mode, event counter mode, pulse period measurement mode, pulse width measurement mode |
| | Timer function for 3-phase motor control | 3-phase inverter control × 1 (using timer A1, timer A2, timer A4, and timer B2) On-chip dead time timer |

Table 1.4 Specifications (100-Pin Package) (2/2)

| Item | Function | Specification |
|------------------------------------|---------------------------|--|
| Serial Interface | UART0 to UART4 | Clock synchronous/asynchronous × 5 I ² C bus, special mode 2, GCI mode, SIM mode, IrDA mode ⁽²⁾ , IEBus (optional) ⁽¹⁾⁽³⁾ |
| | UART5 | Clock synchronous/asynchronous × 1 |
| A/D Converter | | 10-bit resolution × 26 channels (in single-chip mode) 10-bit resolution × 10 channels (in memory expansion mode and microprocessor mode) Including sample and hold function |
| D/A Converter | | 8-bit resolution × 2 channels |
| CRC Calculation Circuit | | CRC-CCITT ($X^{16} + X^{12} + X^5 + 1$) compliant |
| X/Y Converter | | 16 bits × 16 bits |
| Intelligent I/O | | 16-bit timer × 2 • Time measurement function (input capture): 8 channels • Waveform generation function (output compare): 10 channels • Communication function: Clock synchronous mode, clock asynchronous mode, HDLC data processing mode, IEBus (optional) ⁽¹⁾⁽³⁾ • 2-phase pulse signal processing (2-phase encoder input) × 1 |
| ROM Correction Function | | Address match interrupt × 8 |
| CAN modules | | Supporting CAN 2.0B specification M32C/87: 16 slots × 2 channels, M32C/87A: 16 slots × 1 channel M32C/87B: none |
| I/O Ports | Programmable I/O ports | • Input only: 1 • CMOS I/O: 85, selectable pull-up resistor • N channel open drain ports: 2 |
| Flash Memory | | • Erase and program voltage: 3.3 V ± 0.3 V or 5.0 V ± 0.5 V • Erase and program endurance: 100 times (all areas) • Program security: ROM code protect and ID code check • Debug functions: On-chip debug and on-board flash reprogram |
| Operating Frequency/Supply Voltage | | 32 MHz: VCC1 = 4.2 to 5.5 V, VCC2 = 3.0 V to VCC1 24 MHz: VCC1 = 3.0 to 5.5 V, VCC2 = 3.0 V to VCC1 |
| Current Consumption | | 32 mA (32 MHz, VCC1 = VCC2 = 5 V) 23 mA (24 MHz, VCC1 = VCC2 = 3.3 V) 45 μA (approx. 1 MHz, VCC1 = VCC2 = 3.3 V, on-chip oscillator low-power consumption mode → wait mode) 0.8 μA (VCC1 = VCC2 = 3.3 V, stop mode) |
| Operating Ambient Temperature (°C) | | -20 to 85°C, -40 to 85°C (optional) ⁽³⁾ |
| Package | | 100-pin LQFP (PLQP0100KB-A) 100-pin QFP (PRQP0100JB-A) |

NOTES:

1. IEBus is a registered trademark of NEC Electronics Corporation.
2. Available in UART0.
3. Please contact a Renesas sales office for optional features.

1.2 Product List

Tables 1.5 to 1.7 list product information. Figure 1.1 shows product numbering system.

Table 1.5 M32C/87 Group (1) (M32C/87: 2-channel CAN module) Current as of Jul. 2008

| Part Number | Package Code | ROM Capacity | RAM Capacity | Remarks |
|----------------|-------------------------|---------------------------------|--------------|--------------|
| M3087BFLGP | PLQP0144KA-A (144P6Q-A) | 1 MB + 4 KB ⁽¹⁾ | 48 KB | Flash memory |
| M30879FLFP | PRQP0100JB-A (100P6S-A) | | | |
| M30879FLGP | PLQP0100KB-A (100P6Q-A) | | | |
| M3087BFGGP | PLQP0144KA-A (144P6Q-A) | 768 KB + 4 KB ⁽¹⁾ | | |
| M30879FGGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30878FJGP | PLQP0144KA-A (144P6Q-A) | 512 KB + 4 KB ⁽¹⁾ | 31 KB | |
| M30876FJGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30875FHGP | PLQP0144KA-A (144P6Q-A) | 384 KB + 4 KB ⁽¹⁾ | 24 KB | |
| M30873FHGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30878MJ-XXXGP | PLQP0144KA-A (144P6Q-A) | 512 KB | 31 KB | Mask ROM |
| M30876MJ-XXXFP | PRQP0100JB-A (100P6S-A) | | | |
| M30876MJ-XXXGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30875MH-XXXGP | PLQP0144KA-A (144P6Q-A) | 384 KB | 24 KB | |
| M30873MH-XXXGP | PLQP0100KB-A (100P6Q-A) | | | |

NOTE:

1. Additional 4-Kbyte space is available for data flash memory.

Table 1.6 M32C/87 Group (2) (M32C/87A: 1-channel CAN module) Current as of Jul. 2008

| Part Number | Package Code | ROM Capacity | RAM Capacity | Remarks |
|-----------------|-------------------------|---------------------------------|--------------|--------------|
| M3087BFLAGP | PLQP0144KA-A (144P6Q-A) | 1 MB + 4 KB ⁽¹⁾ | 48 KB | Flash memory |
| M30879FLAFP | PRQP0100JB-A (100P6S-A) | | | |
| M30879FLAGP | PLQP0100KB-A (100P6Q-A) | | | |
| M3087BFGAGP | PLQP0144KA-A (144P6Q-A) | 768 KB + 4 KB ⁽¹⁾ | | |
| M30879FGAGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30878FJAGP | PLQP0144KA-A (144P6Q-A) | 512 KB + 4 KB ⁽¹⁾ | 31 KB | |
| M30876FJAGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30875FHAGP | PLQP0144KA-A (144P6Q-A) | 384 KB + 4 KB ⁽¹⁾ | 24 KB | |
| M30873FHAGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30878MJA-XXXGP | PLQP0144KA-A (144P6Q-A) | 512 KB | 31 KB | Mask ROM |
| M30876MJA-XXXFP | PRQP0100JB-A (100P6S-A) | | | |
| M30876MJA-XXXGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30875MHA-XXXGP | PLQP0144KA-A (144P6Q-A) | 384 KB | 24 KB | |
| M30873MHA-XXXGP | PLQP0100KB-A (100P6Q-A) | | | |

NOTE:

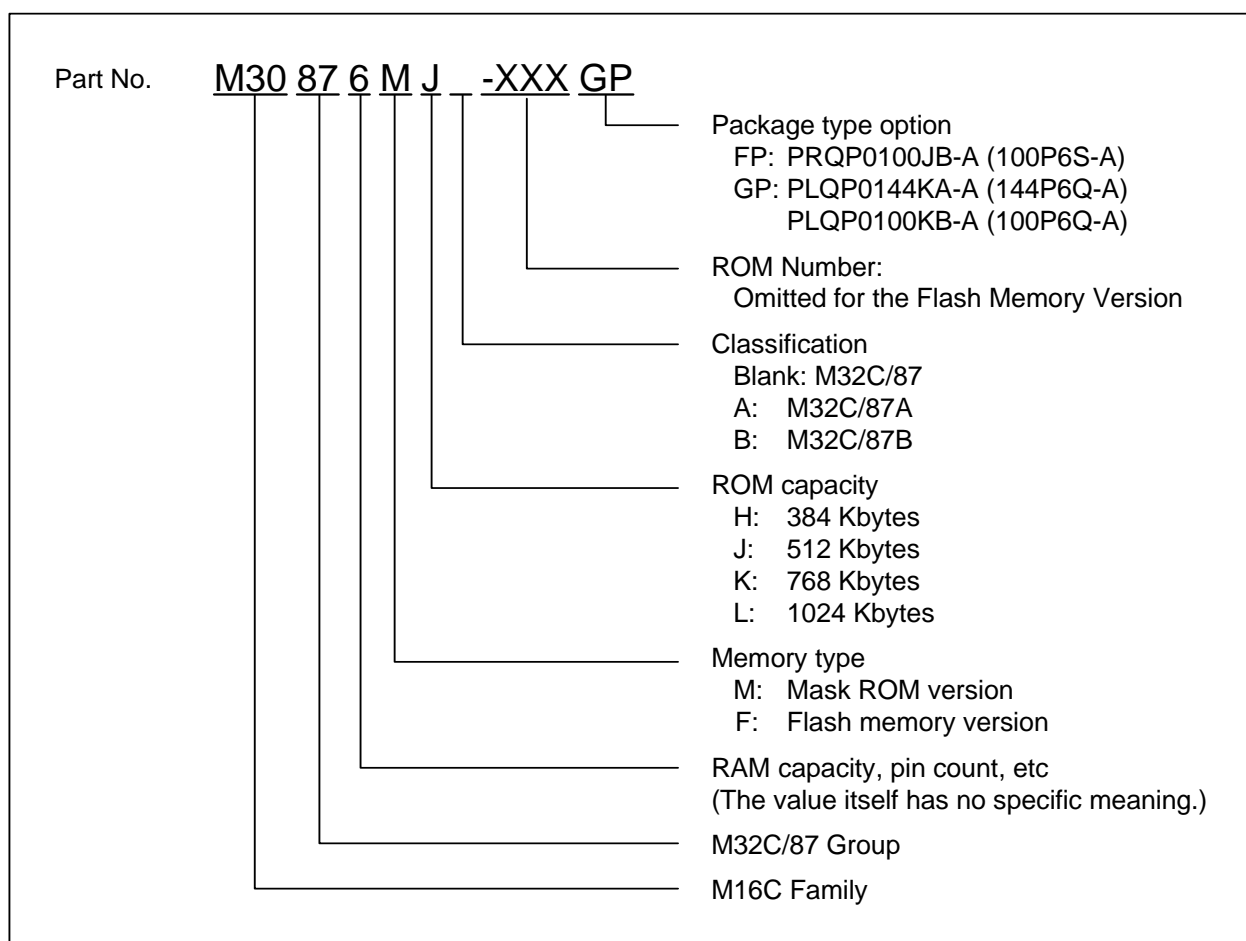
1. Additional 4-Kbyte space is available for data flash memory.

Table 1.7 M32C/87 Group (3) (M32C/87B: no CAN module) Current as of Jul. 2008

| Part Number | Package Code | ROM Capacity | RAM Capacity | Remarks |
|-----------------|-------------------------|---------------------------------|--------------|--------------|
| M3087BFLBGP | PLQP0144KA-A (144P6Q-A) | 1 MB + 4 KB ⁽¹⁾ | 48 KB | Flash memory |
| M30879FLBFP | PRQP0100JB-A (100P6S-A) | | | |
| M30879FLBGP | PLQP0100KB-A (100P6Q-A) | | | |
| M3087BFKBGP | PLQP0144KA-A (144P6Q-A) | 768 KB + 4 KB ⁽¹⁾ | 31 KB | |
| M30879FKBGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30878FJBGP | PLQP0144KA-A (144P6Q-A) | 512 KB + 4 KB ⁽¹⁾ | 31 KB | |
| M30876FJBGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30875FHBGP | PLQP0144KA-A (144P6Q-A) | 384 KB + 4 KB ⁽¹⁾ | 24 KB | |
| M30873FHBGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30878MJB-XXXGP | PLQP0144KA-A (144P6Q-A) | 512 KB | 31 KB | |
| M30876MJB-XXXFP | PRQP0100JB-A (100P6S-A) | | | |
| M30876MJB-XXXGP | PLQP0100KB-A (100P6Q-A) | | | |
| M30875MHB-XXXGP | PLQP0144KA-A (144P6Q-A) | 384 KB | 24 KB | |
| M30873MHB-XXXGP | PLQP0100KB-A (100P6Q-A) | | | |

NOTE:

1. Additional 4-Kbyte space is available for data flash memory.

**Figure 1.1 Product Numbering System**

1.3 Block Diagram

Figure 1.2 shows a block diagram of the M32C/87 Group (M32C/87, M32C/87A, M32C/87B).

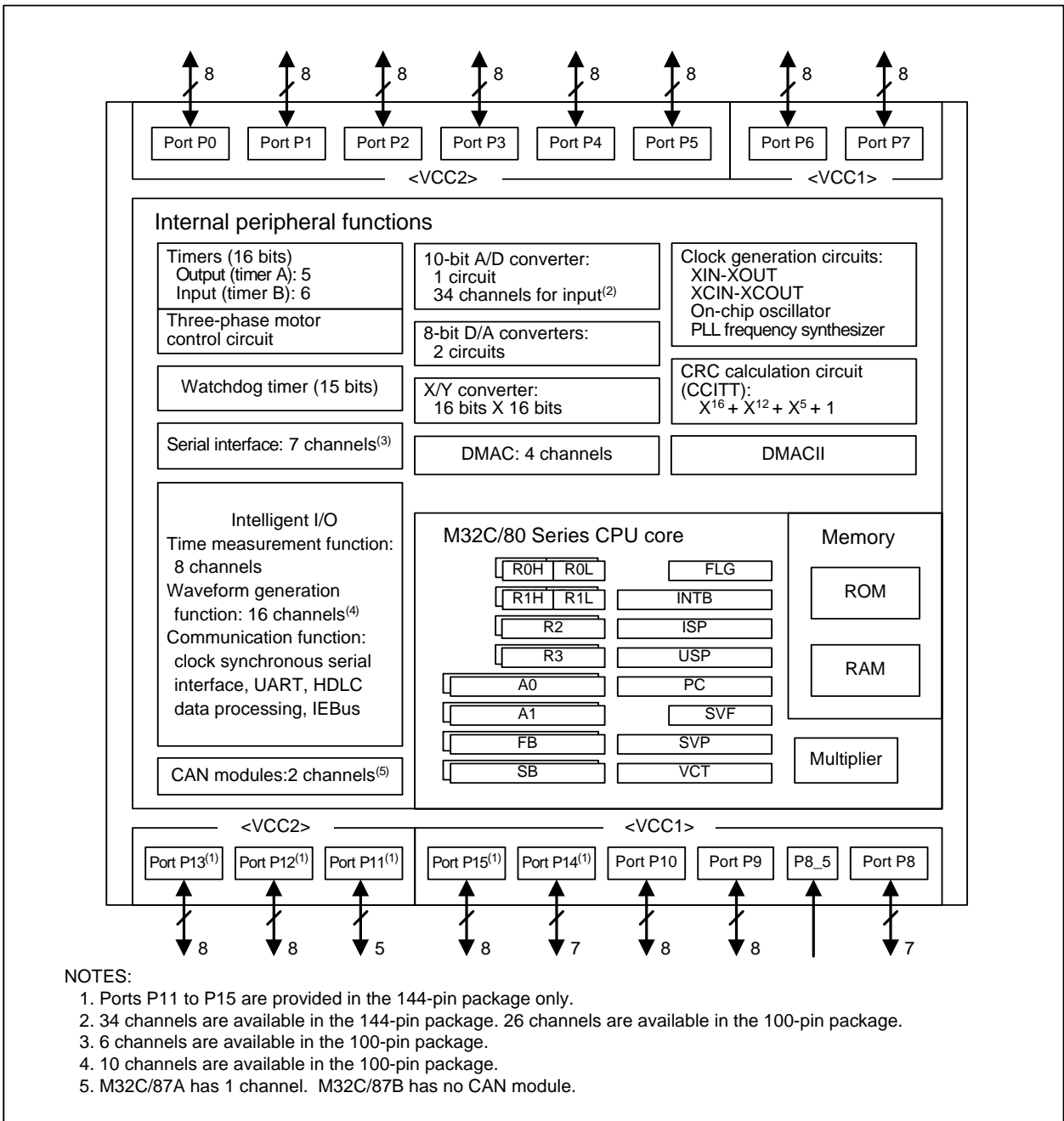


Figure 1.2 M32C/87 Group (M32C/87, M32C/87A, M32C/87B) Block Diagram

1.4 Pin Assignments

Figures 1.3 to 1.5 show pin assignments (top view).



Figure 1.3 Pin Assignment for 144-Pin Package

Table 1.8 144-Pin Package List of Pin Names (1/4)

| Pin No. | Control Pin | Port | Interrupt Pin | Timer Pin | UART/CAN Pin ⁽¹⁾ | Intelligent I/O Pin | Analog Pin | Bus Control Pin |
|---------|---------------------------|-------|--------------------------|---|---|--|------------|-----------------|
| 1 | | P9_6 | | | TXD4/SDA4/SRXD4/ CAN1OUT | | ANEX1 | |
| 2 | | P9_5 | | | CLK4/CAN1IN/ $\overline{\text{CAN1WU}}$ | | ANEX0 | |
| 3 | | P9_4 | | TB4IN | $\overline{\text{CTS4}}/\text{RTS4}/\text{SS4}$ | | DA1 | |
| 4 | | P9_3 | | TB3IN | $\overline{\text{CTS3}}/\text{RTS3}/\text{SS3}$ | | DA0 | |
| 5 | | P9_2 | | TB2IN | TXD3/SDA3/SRXD3 | OUTC2_0/IEOUT/ISTXD2 | | |
| 6 | | P9_1 | | TB1IN | RXD3/SCL3/STXD3 | IEIN/ISRXD2 | | |
| 7 | | P9_0 | | TB0IN | CLK3 | | | |
| 8 | | P14_6 | $\overline{\text{INT8}}$ | | | | | |
| 9 | | P14_5 | $\overline{\text{INT7}}$ | | | | | |
| 10 | | P14_4 | $\overline{\text{INT6}}$ | | | | | |
| 11 | | P14_3 | | | | INPC1_7/OUTC1_7 | | |
| 12 | | P14_2 | | | | INPC1_6/OUTC1_6 | | |
| 13 | | P14_1 | | | | INPC1_5/OUTC1_5 | | |
| 14 | | P14_0 | | | | INPC1_4/OUTC1_4 | | |
| 15 | BYTE | | | | | | | |
| 16 | CNVSS | | | | | | | |
| 17 | XCIN | P8_7 | | | | | | |
| 18 | XCOU | P8_6 | | | | | | |
| 19 | $\overline{\text{RESET}}$ | | | | | | | |
| 20 | XOUT | | | | | | | |
| 21 | VSS | | | | | | | |
| 22 | XIN | | | | | | | |
| 23 | VCC1 | | | | | | | |
| 24 | | P8_5 | $\overline{\text{NMI}}$ | | | | | |
| 25 | | P8_4 | $\overline{\text{INT2}}$ | | | | | |
| 26 | | P8_3 | $\overline{\text{INT1}}$ | | CAN0IN/CAN1IN | | | |
| 27 | | P8_2 | $\overline{\text{INT0}}$ | | CAN0OUT/CAN1OUT | | | |
| 28 | | P8_1 | | TA4IN/ $\overline{\text{U}}$ /RTP2_3 | $\overline{\text{CTS5}}/\text{RTS5}$ | INPC1_5/OUTC1_5 | | |
| 29 | | P8_0 | | TA4OUT/U | RXD5 | ISRXD0 | | |
| 30 | | P7_7 | | TA3IN/RTP2_2 | CLK5/CAN0IN | INPC1_4/OUTC1_4/ ISCLK0 | | |
| 31 | | P7_6 | | TA3OUT | TXD5/CAN0OUT | INPC1_3/OUTC1_3/ ISTXD0 | | |
| 32 | | P7_5 | | TA2IN/ $\overline{\text{W}}$ /RTP2_1 | | INPC1_2/OUTC1_2/ ISRXD1 | | |
| 33 | | P7_4 | | TA2OUT/ $\overline{\text{W}}$ / RTP2_0 | | INPC1_1/OUTC1_1/ ISCLK1 | | |
| 34 | | P7_3 | | TA1IN/ $\overline{\text{V}}$ | $\overline{\text{CTS2}}/\text{RTS2}/\text{SS2}$ | INPC1_0/OUTC1_0/ ISTXD1 | | |
| 35 | | P7_2 | | TA1OUT/ $\overline{\text{V}}$ | CLK2 | | | |
| 36 | | P7_1 | | TA0IN/TB5IN/ RTP0_3 | RXD2/SCL2/STXD2 | INPC1_7/OUTC1_7/ OUTC2_2/ISRXD2/IEIN | | |
| 37 | | P7_0 | | TA0OUT/RTP0_2 | TXD2/SDA2/SRXD2 | INPC1_6/OUTC1_6/ OUTC2_0/ISTXD2/IEOUT | | |
| 38 | | P6_7 | | | TXD1/SDA1/SRXD1 | | | |
| 39 | VCC1 | | | | | | | |
| 40 | | P6_6 | | | RXD1/SCL1/STXD1 | | | |

NOTE:

1. The CAN pins cannot be used in M32C/87B. Only CAN0 pins can be used in M32C/87A.

Table 1.9 144-Pin Package List of Pin Names (2/4)

| Pin No. | Control Pin | Port | Interrupt Pin | Timer Pin | UART/CAN Pin | Intelligent I/O Pin | Analog Pin | Bus Control Pin |
|---------|-------------|-------|---------------|-----------|-----------------------------|--------------------------|------------|-----------------|
| 41 | VSS | | | | | | | |
| 42 | | P6_5 | | | CLK1 | | | |
| 43 | | P6_4 | | | CTS1/RTS1/SS1 | OUTC2_1/ISCLK2 | | |
| 44 | | P6_3 | | | TXD0/SDA0/SRXD0/ IrDAOUT | | | |
| 45 | | P6_2 | | | RXD0/SCL0/STXD0/ IrDAIN | | | |
| 46 | | P6_1 | | RTP0_1 | CLK0 | | | |
| 47 | | P6_0 | | RTP0_0 | CTS0/RTS0/SS0 | | | |
| 48 | | P13_7 | | | | OUTC2_7 | | |
| 49 | | P13_6 | | | | OUTC2_1/ISCLK2 | | |
| 50 | | P13_5 | | | | OUTC2_2/ISRXD2/ IEIN | | |
| 51 | | P13_4 | | | | OUTC2_0/ISTXD2/ IEOUT | | |
| 52 | | P5_7 | | | | | | RDY |
| 53 | | P5_6 | | | | | | ALE |
| 54 | | P5_5 | | | | | | HOLD |
| 55 | | P5_4 | | | | | | HLDA/ALE |
| 56 | | P13_3 | | | | OUTC2_3 | | |
| 57 | VSS | | | | | | | |
| 58 | | P13_2 | | | | OUTC2_6 | | |
| 59 | VCC2 | | | | | | | |
| 60 | | P13_1 | | | | OUTC2_5 | | |
| 61 | | P13_0 | | | | OUTC2_4 | | |
| 62 | CLKOUT | P5_3 | | | | | | BCLK/ALE |
| 63 | | P5_2 | | | | | | RD |
| 64 | | P5_1 | | | | | | WRH/BHE |
| 65 | | P5_0 | | | | | | WRL/WR |
| 66 | | P12_7 | | | | | | |
| 67 | | P12_6 | | | | | | |
| 68 | | P12_5 | | | | | | |
| 69 | | P4_7 | | | | | | CS0/A23 |
| 70 | | P4_6 | | | | | | CS1/A22 |
| 71 | | P4_5 | | | | | | CS2/A21 |
| 72 | | P4_4 | | | | | | CS3/A20 |
| 73 | | P4_3 | | | | | | A19 |
| 74 | VCC2 | | | | | | | |
| 75 | | P4_2 | | | | | | A18 |
| 76 | VSS | | | | | | | |
| 77 | | P4_1 | | | | | | A17 |
| 78 | | P4_0 | | | | | | A16 |
| 79 | | P3_7 | | | | | | A15,[A15/D15] |
| 80 | | P3_6 | | | | | | A14,[A14/D14] |

Table 1.10 144-Pin Package List of Pin Names (3/4)

| Pin No. | Control Pin | Port | Interrupt Pin | Timer Pin | UART/CAN Pin | Intelligent I/O Pin | Analog Pin | Bus Control Pin |
|---------|-------------|-------|---------------|-----------|--------------|----------------------------|------------|-----------------|
| 81 | | P3_5 | | | | | | A13,[A13/D13] |
| 82 | | P3_4 | | | | | | A12,[A12/D12] |
| 83 | | P3_3 | | | | | | A11,[A11/D11] |
| 84 | | P3_2 | | | | | | A10,[A10/D10] |
| 85 | | P3_1 | | | | | | A9,[A9/D9] |
| 86 | | P12_4 | | | | | | |
| 87 | | P12_3 | | | CTS6/RTS6 | | | |
| 88 | | P12_2 | | | RXD6 | | | |
| 89 | | P12_1 | | | CLK6 | | | |
| 90 | | P12_0 | | | TXD6 | | | |
| 91 | VCC2 | | | | | | | |
| 92 | | P3_0 | | | | | | A8,[A8/D8] |
| 93 | VSS | | | | | | | |
| 94 | | P2_7 | | | | | AN2_7 | A7,[A7/D7] |
| 95 | | P2_6 | | | | | AN2_6 | A6,[A6/D6] |
| 96 | | P2_5 | | | | | AN2_5 | A5,[A5/D5] |
| 97 | | P2_4 | | | | | AN2_4 | A4,[A4/D4] |
| 98 | | P2_3 | | | | | AN2_3 | A3,[A3/D3] |
| 99 | | P2_2 | | | | | AN2_2 | A2,[A2/D2] |
| 100 | | P2_1 | | | | | AN2_1 | A1,[A1/D1] |
| 101 | | P2_0 | | | | | AN2_0 | A0,[A0/D0] |
| 102 | | P1_7 | INT5 | | | | | D15 |
| 103 | | P1_6 | INT4 | | | | | D14 |
| 104 | | P1_5 | INT3 | | | | | D13 |
| 105 | | P1_4 | | | | | | D12 |
| 106 | | P1_3 | | | | | | D11 |
| 107 | | P1_2 | | | | | | D10 |
| 108 | | P1_1 | | | | | | D9 |
| 109 | | P1_0 | | | | | | D8 |
| 110 | | P0_7 | | | | | AN0_7 | D7 |
| 111 | | P0_6 | | | | | AN0_6 | D6 |
| 112 | | P0_5 | | | | | AN0_5 | D5 |
| 113 | | P0_4 | | | | | AN0_4 | D4 |
| 114 | | P11_4 | | | | | | |
| 115 | | P11_3 | | | | INPC1_3/OUTC1_3 | | |
| 116 | | P11_2 | | | | INPC1_2/OUTC1_2/ ISRXD1 | | |
| 117 | | P11_1 | | | | INPC1_1/OUTC1_1/ ISCLK1 | | |
| 118 | | P11_0 | | | | INPC1_0/OUTC1_0/ ISTXD1 | | |
| 119 | | P0_3 | | | | | AN0_3 | D3 |
| 120 | | P0_2 | | | | | AN0_2 | D2 |

Table 1.11 144-Pin Package List of Pin Names (4/4)

| Pin No. | Control Pin | Port | Interrupt Pin | Timer Pin | UART/CAN Pin | Intelligent I/O Pin | Analog Pin | Bus Control Pin |
|---------|-------------|-------|---------------|-----------|-----------------|---------------------|------------|-----------------|
| 121 | | P0_1 | | | | | AN0_1 | D1 |
| 122 | | P0_0 | | | | | AN0_0 | D0 |
| 123 | | P15_7 | | | CTS6/RTS6 | | AN15_7 | |
| 124 | | P15_6 | | | CLK6 | | AN15_6 | |
| 125 | | P15_5 | | | RXD6 | | AN15_5 | |
| 126 | | P15_4 | | | TXD6 | | AN15_4 | |
| 127 | | P15_3 | | | CTS5/RTS5 | | AN15_3 | |
| 128 | | P15_2 | | | RXD5 | ISRXD0 | AN15_2 | |
| 129 | | P15_1 | | | CLK5 | ISCLK0 | AN15_1 | |
| 130 | VSS | | | | | | | |
| 131 | | P15_0 | | | TXD5 | ISTXD0 | AN15_0 | |
| 132 | VCC1 | | | | | | | |
| 133 | | P10_7 | KI3 | RTP3_3 | | | AN_7 | |
| 134 | | P10_6 | KI2 | RTP3_2 | | | AN_6 | |
| 135 | | P10_5 | KI1 | RTP3_1 | | | AN_5 | |
| 136 | | P10_4 | KI0 | RTP3_0 | | | AN_4 | |
| 137 | | P10_3 | | RTP1_3 | | | AN_3 | |
| 138 | | P10_2 | | RTP1_2 | | | AN_2 | |
| 139 | | P10_1 | | RTP1_1 | | | AN_1 | |
| 140 | AVSS | | | | | | | |
| 141 | | P10_0 | | RTP1_0 | | | AN_0 | |
| 142 | VREF | | | | | | | |
| 143 | AVCC | | | | | | | |
| 144 | | P9_7 | | | RXD4/SCL4/STXD4 | | ADTRG | |

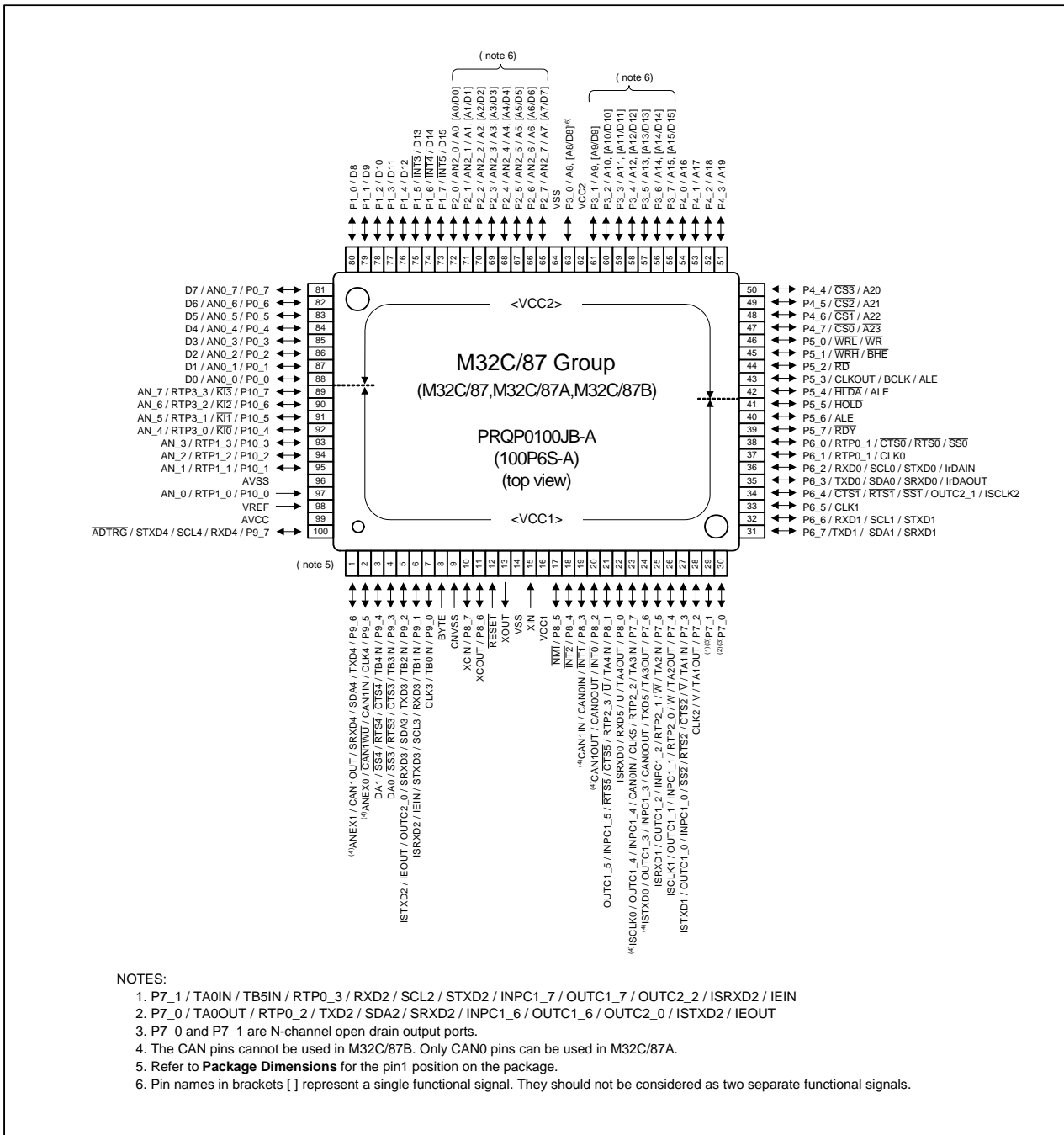


Figure 1.4 Pin Assignment for 100-Pin Package



Figure 1.5 Pin Assignment for 100-Pin Package

Table 1.12 100-Pin Package List of Pin Names (1/3)

| Pin No. | | Control Pin | Port | Interrupt Pin | Timer Pin | UART/CAN Pin ⁽¹⁾ | Intelligent I/O Pin | Analog Pin | Bus Control Pin |
|---------|-----|-------------|------|---------------|-------------------------------|-----------------------------|--|------------|-----------------|
| FP | GP | | | | | | | | |
| 1 | 99 | | P9_6 | | | TXD4/SDA4/SRXD4/ CAN1OUT | | ANEX1 | |
| 2 | 100 | | P9_5 | | | CLK4/CAN1IN/ CAN1WU | | ANEX0 | |
| 3 | 1 | | P9_4 | | TB4IN | CTS4/RTS4/SS4 | | DA1 | |
| 4 | 2 | | P9_3 | | TB3IN | CTS3/RTS3/SS3 | | DA0 | |
| 5 | 3 | | P9_2 | | TB2IN | TXD3/SDA3/SRXD3 | OUTC2_0/IEOUT/ISTXD2 | | |
| 6 | 4 | | P9_1 | | TB1IN | RXD3/SCL3/STXD3 | IEIN/ISRXD2 | | |
| 7 | 5 | | P9_0 | | TB0IN | CLK3 | | | |
| 8 | 6 | BYTE | | | | | | | |
| 9 | 7 | CNVSS | | | | | | | |
| 10 | 8 | XCIN | P8_7 | | | | | | |
| 11 | 9 | XCOU | P8_6 | | | | | | |
| 12 | 10 | RESET | | | | | | | |
| 13 | 11 | XOUT | | | | | | | |
| 14 | 12 | VSS | | | | | | | |
| 15 | 13 | XIN | | | | | | | |
| 16 | 14 | VCC1 | | | | | | | |
| 17 | 15 | | P8_5 | NMI | | | | | |
| 18 | 16 | | P8_4 | INT2 | | | | | |
| 19 | 17 | | P8_3 | INT1 | | CAN0IN/CAN1IN | | | |
| 20 | 18 | | P8_2 | INT0 | | CAN0OUT/CAN1OUT | | | |
| 21 | 19 | | P8_1 | | TA4IN/ \bar{U} /RTP2_3 | CTS5/RTS5 | INPC1_5/OUTC1_5 | | |
| 22 | 20 | | P8_0 | | TA4OUT/ \bar{U} | RXD5 | ISRXD0 | | |
| 23 | 21 | | P7_7 | | TA3IN/RTP2_2 | CLK5/CAN0IN | INPC1_4/OUTC1_4/ ISCLK0 | | |
| 24 | 22 | | P7_6 | | TA3OUT | TXD5/CAN0OUT | INPC1_3/OUTC1_3/ ISTXD0 | | |
| 25 | 23 | | P7_5 | | TA2IN/ \bar{W} /RTP2_1 | | INPC1_2/OUTC1_2 ISRXD1 | | |
| 26 | 24 | | P7_4 | | TA2OUT/ \bar{W} / RTP2_0 | | INPC1_1/OUTC1_1/ ISCLK1 | | |
| 27 | 25 | | P7_3 | | TA1IN/ \bar{V} | CTS2/RTS2/SS2 | INPC1_0/OUTC1_0/ ISTXD1 | | |
| 28 | 26 | | P7_2 | | TA1OUT/ \bar{V} | CLK2 | | | |
| 29 | 27 | | P7_1 | | TA0IN/TB5IN/ RTP0_3 | RXD2/SCL2/STXD2 | INPC1_7/OUTC1_7/ OUTC2_2/ISRXD2/IEIN | | |
| 30 | 28 | | P7_0 | | TA0OUT/RTP0_2 | TXD2/SDA2/SRXD2 | INPC1_6/OUTC1_6/ OUTC2_0/ISTXD2/IEOUT | | |
| 31 | 29 | | P6_7 | | | TXD1/SDA1/SRXD1 | | | |
| 32 | 30 | | P6_6 | | | RXD1/SCL1/STXD1 | | | |
| 33 | 31 | | P6_5 | | | CLK1 | | | |
| 34 | 32 | | P6_4 | | | CTS1/RTS1/SS1 | OUTC2_1/ISCLK2 | | |
| 35 | 33 | | P6_3 | | | TXD0/SDA0/SRXD0/ IrDAOUT | | | |
| 36 | 34 | | P6_2 | | | RXD0/SCL0/STXD0/ IrDAIN | | | |
| 37 | 35 | | P6_1 | | RTP0_1 | CLK0 | | | |
| 38 | 36 | | P6_0 | | RTP0_0 | CTS0/RTS0/SS0 | | | |
| 39 | 37 | | P5_7 | | | | | | RDY |
| 40 | 38 | | P5_6 | | | | | | ALE |

NOTE:

1. The CAN pins cannot be used in M32C/87B. Only CAN0 pins can be used in M32C/87A.

Table 1.13 100-Pin Package List of Pin Names (2/3)

| Pin No. | | Control Pin | Port | Interrupt Pin | Timer Pin | UART/CAN Pin | Intelligent I/O Pin | Analog Pin | Bus Control Pin |
|---------|----|-------------|------|---------------|-----------|--------------|---------------------|------------|--------------------------|
| FP | GP | | | | | | | | |
| 41 | 39 | | P5_5 | | | | | | HOLD |
| 42 | 40 | | P5_4 | | | | | | HLD \bar{A} /ALE |
| 43 | 41 | CLKOUT | P5_3 | | | | | | BCLK/ALE |
| 44 | 42 | | P5_2 | | | | | | $\bar{R}D$ |
| 45 | 43 | | P5_1 | | | | | | $\bar{W}R$ /BHE |
| 46 | 44 | | P5_0 | | | | | | $\bar{W}R$ L/ $\bar{W}R$ |
| 47 | 45 | | P4_7 | | | | | | CS0/A23 |
| 48 | 46 | | P4_6 | | | | | | CS1/A22 |
| 49 | 47 | | P4_5 | | | | | | CS2/A21 |
| 50 | 48 | | P4_4 | | | | | | CS3/A20 |
| 51 | 49 | | P4_3 | | | | | | A19 |
| 52 | 50 | | P4_2 | | | | | | A18 |
| 53 | 51 | | P4_1 | | | | | | A17 |
| 54 | 52 | | P4_0 | | | | | | A16 |
| 55 | 53 | | P3_7 | | | | | | A15,[A15/D15] |
| 56 | 54 | | P3_6 | | | | | | A14,[A14/D14] |
| 57 | 55 | | P3_5 | | | | | | A13,[A13/D13] |
| 58 | 56 | | P3_4 | | | | | | A12,[A12/D12] |
| 59 | 57 | | P3_3 | | | | | | A11,[A11/D11] |
| 60 | 58 | | P3_2 | | | | | | A10,[A10/D10] |
| 61 | 59 | | P3_1 | | | | | | A9,[A9/D9] |
| 62 | 60 | VCC2 | | | | | | | |
| 63 | 61 | | P3_0 | | | | | | A8,[A8/D8] |
| 64 | 62 | VSS | | | | | | | |
| 65 | 63 | | P2_7 | | | | AN2_7 | | A7,[A7/D7] |
| 66 | 64 | | P2_6 | | | | AN2_6 | | A6,[A6/D6] |
| 67 | 65 | | P2_5 | | | | AN2_5 | | A5,[A5/D5] |
| 68 | 66 | | P2_4 | | | | AN2_4 | | A4,[A4/D4] |
| 69 | 67 | | P2_3 | | | | AN2_3 | | A3,[A3/D3] |
| 70 | 68 | | P2_2 | | | | AN2_2 | | A2,[A2/D2] |
| 71 | 69 | | P2_1 | | | | AN2_1 | | A1,[A1/D1] |
| 72 | 70 | | P2_0 | | | | AN2_0 | | A0,[A0/D0] |

Table 1.14 100-Pin Package List of Pin Names (3/3)

| Pin No. | | Control Pin | Port | Interrupt Pin | Timer Pin | UART/CAN Pin | Intelligent I/O Pin | Analog Pin | Bus Control Pin |
|---------|----|-------------|-------|--------------------------|-----------|-----------------|---------------------|---------------------------|-----------------|
| FP | GP | | | | | | | | |
| 73 | 71 | | P1_7 | $\overline{\text{INT5}}$ | | | | | D15 |
| 74 | 72 | | P1_6 | $\overline{\text{INT4}}$ | | | | | D14 |
| 75 | 73 | | P1_5 | $\overline{\text{INT3}}$ | | | | | D13 |
| 76 | 74 | | P1_4 | | | | | | D12 |
| 77 | 75 | | P1_3 | | | | | | D11 |
| 78 | 76 | | P1_2 | | | | | | D10 |
| 79 | 77 | | P1_1 | | | | | | D9 |
| 80 | 78 | | P1_0 | | | | | | D8 |
| 81 | 79 | | P0_7 | | | | | AN0_7 | D7 |
| 82 | 80 | | P0_6 | | | | | AN0_6 | D6 |
| 83 | 81 | | P0_5 | | | | | AN0_5 | D5 |
| 84 | 82 | | P0_4 | | | | | AN0_4 | D4 |
| 85 | 83 | | P0_3 | | | | | AN0_3 | D3 |
| 86 | 84 | | P0_2 | | | | | AN0_2 | D2 |
| 87 | 85 | | P0_1 | | | | | AN0_1 | D1 |
| 88 | 86 | | P0_0 | | | | | AN0_0 | D0 |
| 89 | 87 | | P10_7 | $\overline{\text{KI3}}$ | RTP3_3 | | | AN_7 | |
| 90 | 88 | | P10_6 | $\overline{\text{KI2}}$ | RTP3_2 | | | AN_6 | |
| 91 | 89 | | P10_5 | $\overline{\text{KI1}}$ | RTP3_1 | | | AN_5 | |
| 92 | 90 | | P10_4 | $\overline{\text{KI0}}$ | RTP3_0 | | | AN_4 | |
| 93 | 91 | | P10_3 | | RTP1_3 | | | AN_3 | |
| 94 | 92 | | P10_2 | | RTP1_2 | | | AN_2 | |
| 95 | 93 | | P10_1 | | RTP1_1 | | | AN_1 | |
| 96 | 94 | AVSS | | | | | | | |
| 97 | 95 | | P10_0 | | RTP1_0 | | | AN_0 | |
| 98 | 96 | VREF | | | | | | | |
| 99 | 97 | AVCC | | | | | | | |
| 100 | 98 | | P9_7 | | | RXD4/SCL4/STXD4 | | $\overline{\text{ADTRG}}$ | |

1.5 Pin Functions

Table 1.15 Pin Functions (100-Pin and 144-Pin Packages) (1/4)

| Type | Symbol | I/O Type | Supply Voltage | Description |
|--------------------------------------|---|----------|--|---|
| Power supply | VCC1, VCC2 VSS | – | – | Apply 3.0 to 5.5 V to pins VCC1 and VCC2, and 0 V to the VSS pin. The input condition of $VCC1 \geq VCC2$ must be met. |
| Analog power supply input | AVCC AVSS | – | VCC1 | Power supply input pins to the A/D converter and D/A converter. Connect the AVCC pin to VCC1, and the AVSS pin to VSS. |
| Reset input | $\overline{\text{RESET}}$ | I | VCC1 | The MCU is placed in the reset state while applying an “L” signal to the $\overline{\text{RESET}}$ pin. |
| CNVSS | CNVSS | I | VCC1 | This pin switches processor mode. Apply an “L” to the CNVSS pin to start up in single-chip mode, or an “H” to start up in microprocessor mode (mask ROM, flash memory version) and boot mode (flash memory version). |
| External data bus width select input | BYTE | I | VCC1 | This pin switches a data bus width in external memory space 3. A data bus is 16 bits wide when the BYTE pin is held “L” and 8 bits wide when it is held “H”. Fix to either “L” or “H”. Apply an “L” to the BYTE pin in single-chip mode. |
| Bus control Pins | D0 to D7 | I/O | VCC2 | Data (D0 to D7) input/output pins while accessing an external memory space with separate bus. |
| | D8 to D15 | I/O | VCC2 | Data (D8 to D15) input/output pins while accessing an external memory space with 16-bit separate bus. |
| | A0 to A22 | O | VCC2 | Address bits (A0 to A22) output pins. |
| | $\overline{\text{A23}}$ | O | VCC2 | Inverted address bit ($\overline{\text{A23}}$) output pin. |
| | A0/D0 to A7/D7 | I/O | VCC2 | Data (D0 to D7) input/output and 8 low-order address bits (A0 to A7) output are performed by time-sharing these pins while accessing an external memory space with multiplexed bus. |
| | A8/D8 to A15/D15 | I/O | VCC2 | Data (D8 to D15) input/output and 8 middle-order address bits (A8 to A15) output are performed by time-sharing these pins while accessing an external memory space with 16-bit multiplexed bus. |
| | $\overline{\text{CS0}}$ to $\overline{\text{CS3}}$ | O | VCC2 | Chip-select signal output pins used to specify external devices. |
| | $\overline{\text{WRL}}/\overline{\text{WR}}$ $\overline{\text{WRH}}/\overline{\text{BHE}}$ $\overline{\text{RD}}$ | O | VCC2 | $\overline{\text{WRL}}$, $\overline{\text{WRH}}$, ($\overline{\text{WR}}$, $\overline{\text{BHE}}$) and $\overline{\text{RD}}$ signal output pins. $\overline{\text{WRL}}$ and $\overline{\text{WRH}}$ can be switched with $\overline{\text{WR}}$ and $\overline{\text{BHE}}$ by a program. <ul style="list-style-type: none"> • $\overline{\text{WRL}}$, $\overline{\text{WRH}}$ and $\overline{\text{RD}}$ are selected: If external data bus is 16 bits wide, data is written to an even address in external memory space while an “L” is output from the $\overline{\text{WRL}}$ pin. Data is written to an odd address while an “L” is output from the $\overline{\text{WRH}}$ pin. Data is read while an “L” is output from the $\overline{\text{RD}}$ pin. • $\overline{\text{WR}}$, $\overline{\text{BHE}}$ and $\overline{\text{RD}}$ are selected: Data is written while an “L” is output from the $\overline{\text{WR}}$ pin. Data is read while an “L” is output from the $\overline{\text{RD}}$ pin. Data in odd address is accessed while an “L” is output from the $\overline{\text{BHE}}$ pin. Select $\overline{\text{WR}}$, $\overline{\text{BHE}}$ and $\overline{\text{RD}}$ when an external data bus is 8 bits wide. |
| | ALE | O | VCC2 | ALE signal is used for the external devices to latch address signals when the multiplexed bus is selected. |
| | $\overline{\text{HOLD}}$ | I | VCC2 | The MCU is placed in a hold state while an “L” signal is applied to the $\overline{\text{HOLD}}$ pin. |
| $\overline{\text{HLDA}}$ | O | VCC2 | The $\overline{\text{HLDA}}$ pin outputs an “L” while the MCU is placed in a hold state. | |
| $\overline{\text{RDY}}$ | I | VCC2 | Bus is placed in a wait state while an “L” signal is applied to the $\overline{\text{RDY}}$ pin. | |

I: Input O: Output I/O: Input and output

Table 1.16 Pin Functions (100-Pin and 144-Pin Packages) (2/4)

| Type | Symbol | I/O Type | Supply Voltage | Description |
|---|--|----------|----------------|--|
| Main clock input | XIN | I | VCC1 | Input/output pins for the main clock oscillation circuit. Connect a ceramic resonator or crystal oscillator between XIN and XOUT. To apply an external clock, apply it to XIN and leave XOUT open. |
| Main clock output | XOUT | O | VCC1 | |
| Sub clock input | XCIN | I | VCC1 | Input/output pins for the sub clock oscillation circuit. Connect a crystal oscillator between XCIN and XCOU. To apply an external clock, apply it to XCIN and leave XCOU open. |
| Sub clock output | XCOU | O | VCC1 | |
| BCLK output | BCLK | O | VCC2 | Bus clock output pin. |
| Clock output | CLKOUT | O | VCC2 | The CLKOUT pin outputs the clock having the same frequency as f _C , f ₈ , or f ₃₂ . |
| $\overline{\text{INT}}$ interrupt input | $\overline{\text{INT}}_0$ to $\overline{\text{INT}}_2$ | I | VCC1 | $\overline{\text{INT}}$ interrupt input pins. |
| | $\overline{\text{INT}}_3$ to $\overline{\text{INT}}_5$ | I | VCC2 | |
| $\overline{\text{NMI}}$ interrupt input | $\overline{\text{NMI}}$ | I | VCC1 | $\overline{\text{NMI}}$ interrupt input pin. Connect the $\overline{\text{NMI}}$ pin to VCC1 via a resistor when the $\overline{\text{NMI}}$ interrupt is not used. |
| Timer A | TA0OUT to TA4OUT | I/O | VCC1 | Timer A0 to A4 input/output pins. (TA0OUT is N-channel open drain output.) |
| | TA0IN to TA4IN | I | VCC1 | Timer A0 to A4 input pins. |
| Timer B | TB0IN to TB5IN | I | VCC1 | Timer B0 to B5 input pins. |
| Three-phase motor control timer output | U, $\overline{\text{U}}$, V, $\overline{\text{V}}$, W, $\overline{\text{W}}$ | O | VCC1 | Three-phase motor control timer output pins. |
| Serial interface | $\overline{\text{CTS}}_0$ to $\overline{\text{CTS}}_5$ | I | VCC1 | Input pins to control data transmission. |
| | $\overline{\text{RTS}}_0$ to $\overline{\text{RTS}}_5$ | O | VCC1 | Output pins to control data reception. |
| | CLK0 to CLK5 | I/O | VCC1 | Serial clock input/output pins. |
| | RXD0 to RXD5 | I | VCC1 | Serial data input pins. |
| | TXD0 to TXD5 | O | VCC1 | Serial data output pins. (TXD2 is N-channel open drain output.) |
| I ² C mode | SDA0 to SDA4 | I/O | VCC1 | Serial data input/output pins. (SDA2 is N-channel open drain output.) |
| | SCL0 to SCL4 | I/O | VCC1 | Serial clock input/output pins. (SCL2 is N-channel open drain output.) |
| Serial interface special function | STXD0 to STXD4 | O | VCC1 | Serial data output pins when slave mode is selected. (STXD2 is N-channel open drain output.) |
| | SRXD0 to SRXD4 | I | VCC1 | Serial data input pins when slave mode is selected. |
| | $\overline{\text{SS}}_0$ to $\overline{\text{SS}}_4$ | I | VCC1 | Control input pins used in the serial interface special mode. |
| IrDA | IrDAIN | I | VCC1 | IrDA serial data input pin. |
| | IrDAOUT | O | VCC1 | IrDA serial data output pin. |
| CAN ⁽¹⁾ | CAN0IN, CAN1IN | I | VCC1 | Received data input pins for the CAN communication function. |
| | CAN0OUT, CAN1OUT | O | VCC1 | Transmit data output pins for the CAN communication function. |
| | $\overline{\text{CAN}}_1\text{WU}$ | I | VCC1 | CAN wake-up interrupt input pin. |

I: Input O: Output I/O: Input and output

NOTE:

1. The CAN pins cannot be used in M32C/87B. Only CAN0 pins can be used in M32C/87A.

Table 1.17 Pin Functions (100-Pin and 144-Pin Package) (3/4)

| Type | Symbol | I/O Type | Supply Voltage | Description |
|-------------------------|--|----------|------------------|---|
| Intelligent I/O | INPC1_0 to INPC1_3 | I | VCC1/ VCC2(1) | Input pins for the time measurement function. |
| | INPC1_4 to INPC1_7 | I | VCC1 | |
| | OUTC1_0 to OUTC1_3 | O | VCC1/ VCC2(1) | Output pins for the waveform generation function. (OUTC1_6/OUTC2_0 and OUTC1_7/OUTC2_2 assigned to ports 7_0 and 7_1 are N-channel open drain output.) |
| | OUTC1_4 to OUTC1_7 | O | VCC1 | |
| | OUTC2_0 to OUTC2_2 | O | VCC1/ VCC2(1) | |
| | ISCLK0 | I/O | VCC1 | Clock input/output pins for the intelligent I/O communication function. |
| | ISCLK1, ISCLK2 | I/O | VCC1/ VCC2(1) | |
| | ISRXD0 | I | VCC1 | Data input pins for the intelligent I/O communication function. |
| | ISRXD1, ISRXD2 | I | VCC1/ VCC2(1) | |
| | ISTXD0 | O | VCC1 | Data output pins for the intelligent I/O communication function. (ISTXD2 assigned to port 7_0 is N-channel open drain output.) |
| | ISTXD1, ISTXD2 | O | VCC1/ VCC2(1) | |
| | IEIN | I | VCC1/ VCC2(1) | Data input pin for the intelligent I/O communication function. |
| | IEOUT | O | VCC1/ VCC2(1) | Data output pin for the intelligent I/O communication function. (IEOUT assigned to port 7_0 is N-channel open drain output.) |
| Reference voltage input | VREF | I | – | The VREF pin supplies the reference voltage to the A/D converter and D/A converter. |
| A/D converter | AN_0 to AN_7 | I | VCC1 | Analog input pins for the A/D converter. |
| | AN0_0 to AN0_7, AN2_0 to AN2_7 | I | VCC2 | |
| | ADTRG | I | VCC1 | External trigger input pin for the A/D converter. |
| | ANEX0 | I/O | VCC1 | Extended analog input pin for the A/D converter or output pin in external op-amp connection mode. |
| | ANEX1 | I | VCC1 | Extended analog input pin for the A/D converter. |
| D/A converter | DA0, DA1 | O | VCC1 | Output pins for the D/A converter. |
| Real-time port | RTP0_0 to RTP0_3 RTP1_0 to RTP1_3 RTP2_0 to RTP2_3 RTP3_0 to RTP3_3 | O | VCC1 | These pins function as real-time ports. (RTP0_2 and RTP0_3 are N-channel open drain output.) |

I: Input O: Output I/O: Input and output

NOTE:

1. Only VCC1 can be used in the 100-pin package.

Table 1.18 Pin Functions (100-Pin and 144-Pin Package) (4/4)

| Type | Symbol | I/O Type | Supply Voltage | Description |
|------------------------------|---|----------|----------------|--|
| I/O port | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7 | I/O | VCC2 | 8-bit CMOS I/O ports. The Port Pi Direction Register (i = 0 to 15) determines if each pin is used as an input port or an output port. The Pull-Up Control Registers determine if the input ports, divided into groups of four, are pulled up or not. |
| | P6_0 to P6_7, P7_0 to P7_7, P9_0 to P9_7, P10_0 to P10_7 | I/O | VCC1 | These 8-bit I/O ports are functionally equivalent to P0. (P7_0 and P7_1 are N-channel open drain output.) |
| | P8_0 to P8_4 P8_6, P8_7 | I/O | VCC1 | These I/O ports are functionally equivalent to P0. |
| Input port | P8_5 | I | VCC1 | Shares the pin with $\overline{\text{NMI}}$. Input port to read $\overline{\text{NMI}}$ pin level. |
| Key input interrupt input | $\overline{\text{KI0}}$ to $\overline{\text{KI3}}$ | I | VCC1 | Key input interrupt input pins. |

I: Input O: Output I/O: Input and output

Table 1.19 Pin Functions (144-Pin Package Only)

| Type | Symbol | I/O Type | Supply Voltage | Description |
|--|---|----------|----------------|--|
| $\overline{\text{INT}}$ Interrupt Input | $\overline{\text{INT6}}$ to $\overline{\text{INT8}}$ | I | VCC1 | $\overline{\text{INT}}$ interrupt input pins. |
| Serial interface | CTS6 | I | VCC1/ VCC2 | Input pin to control data transmission. |
| | RTS6 | O | VCC1/ VCC2 | Output pin to control data reception. |
| | CLK6 | I/O | VCC1/ VCC2 | Serial clock input/output pin. |
| | RXD6 | I | VCC1/ VCC2 | Serial data input pin. |
| | TXD6 | O | VCC1/ VCC2 | Serial data output pin. |
| Intelligent I/O | OUTC2_3 to OUTC2_7 | O | VCC2 | Output pins for the waveform generation function. |
| A/D converter | AN15_0 to AN15_7 | I | VCC1 | Analog input pins for the A/D converter. |
| I/O port | P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7 | I/O | VCC2 | These I/O ports are functionally equivalent to P0. |
| | P14_0 to P14_6, P15_0 to P15_7 | I/O | VCC1 | These I/O ports are functionally equivalent to P0. |

I: Input O: Output I/O: Input and output

2. Central Processing Unit (CPU)

Figure 2.1 shows the CPU registers.

The register bank is comprised of eight registers (R0, R1, R2, R3, A0, A1, SB, and FB) out of 28 CPU registers. There are two sets of register banks.



Figure 2.1 CPU Register

2.1 General Registers

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

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

2.1.2 Address Registers (A0 and A1)

A0 and A1 are 24-bit registers used for A0-/A1-indirect addressing, A0-/A1-relative addressing, transfer, arithmetic and logic operations.

2.1.3 Static Base Register (SB)

SB is a 24-bit register used for SB-relative addressing.

2.1.4 Frame Base Register (FB)

FB is a 24-bit register used for FB-relative addressing.

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

The stack pointers (SP), USP and ISP, are 24 bits wide each. The U flag is used to switch between USP and ISP. Refer to **2.1.8 Flag Register (FLG)** for details on the U flag. Set USP and ISP to even addresses to execute an interrupt sequence efficiently.

2.1.6 Interrupt Table Register (INTB)

INTB is a 24-bit register indicating the starting address of a relocatable interrupt vector table.

2.1.7 Program Counter (PC)

PC is 24 bits wide and indicates the address of the next instruction to be executed.

2.1.8 Flag Register (FLG)

FLG is a 16-bit register indicating the CPU state.

2.1.8.1 Carry Flag (C)

The C flag indicates whether or not carry or borrow has been generated after executing an instruction.

2.1.8.2 Debug Flag (D)

The D flag is for debugging only. Set it to 0.

2.1.8.3 Zero Flag (Z)

The Z flag becomes 1 when an arithmetic operation results in 0; otherwise becomes 0.

2.1.8.4 Sign Flag (S)

The S flag becomes 1 when an arithmetic operation results in a negative value; otherwise becomes 0.

2.1.8.5 Register Bank Select Flag (B)

Register bank 0 is selected when the B flag is set to 0. Register bank 1 is selected when this flag is set to 1.

2.1.8.6 Overflow Flag (O)

The O flag becomes 1 when an arithmetic operation results in an overflow; otherwise becomes 0.

2.1.8.7 Interrupt Enable Flag (I)

The I flag enables maskable interrupts.

Interrupts are disabled when the I flag is set to 0 and enabled when it is set to 1. The I flag becomes 0 when an interrupt request is acknowledged.

2.1.8.8 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 becomes 0 when a hardware interrupt request is acknowledged or the INT instruction specifying software interrupt numbers 0 to 31 is executed.

2.1.8.9 Processor Interrupt Priority Level (IPL)

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

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

2.1.8.10 Reserved Space

Only write 0 to bits assigned to the reserved space. When read, the bits return undefined values.

2.2 High-Speed Interrupt Registers

Registers associated with the high-speed interrupt are as follows:

- Flag save register (SVF)
- PC save register (SVP)
- Vector register (VCT)

2.3 DMAC-Associated Registers

Registers associated with the DMAC are as follows:

- DMA mode register (DMD0, DMD1)
- DMA transfer count register (DCT0, DCT1)
- DMA transfer count reload register (DRC0, DRC1)
- DMA memory address register (DMA0, DMA1)
- DMA memory address reload register (DRA0, DRA1)
- DMA SFR address register (DSA0, DSA1)

3. Memory

Figure 3.1 shows a memory map of the M32C/87 Group (M32C/87, M32C/87A, M32C/87B).

The M32C/87 Group (M32C/87, M32C/87A, M32C/87B) has 16-Mbyte address space from addresses 000000h to FFFFFFFh.

The internal ROM is allocated in lower addresses, beginning with address FFFFFFFh. For example, a 512-Kbyte internal ROM area is allocated in addresses F80000h to FFFFFFFh.

The fixed interrupt vectors are allocated in addresses FFFFDCh to FFFFFFFh. They store the starting address of each interrupt routine.

The internal RAM is allocated higher addresses, beginning with address 000400h. For example, a 48-Kbyte internal RAM area is allocated in addresses 000400h to 00C3FFh. The internal RAM is used not only for storing data but for the stacks when subroutines are called or when interrupt requests are acknowledged.

SFRs are allocated in addresses 000000h to 0003FFh. The peripheral function control registers such as for I/O ports, A/D converters, serial interfaces, timers are allocated here. All blank spaces within SFRs are reserved and cannot be accessed by users.

The special page vectors are allocated addresses FFFE00h to FFFFDBh. They are used for the JMPS instruction and JSRS instruction. Refer to the Renesas publication **M32C/80 Series Software Manual** for details.



Figure 3.1 Memory Map

4. Special Function Registers (SFRs)

Special Function Registers (SFRs) are the control registers of peripheral functions. Tables 4.1 to 4.20 list SFR address maps.

Table 4.1 SFR Address Map (1/20)

| Address | Register | Symbol | After Reset |
|---------|--|--------|--|
| 0000h | | | |
| 0001h | | | |
| 0002h | | | |
| 0003h | | | |
| 0004h | Processor Mode Register 0 ⁽¹⁾ | PM0 | 1000 0000b(CNVSS="L") 0000 0011b(CNVSS="H") |
| 0005h | Processor Mode Register 1 | PM1 | 00h |
| 0006h | System Clock Control Register 0 | CM0 | 0000 1000b |
| 0007h | System Clock Control Register 1 | CM1 | 0010 0000b |
| 0008h | | | |
| 0009h | Address Match Interrupt Enable Register | AIER | 00h |
| 000Ah | Protect Register | PRCR | XXXX 0000b |
| 000Bh | External Data Bus Width Control Register | DS | XXXX 1000b(BYTE="L") XXXX 0000b(BYTE="H") |
| 000Ch | Main Clock Division Register | MCD | XXX0 1000b |
| 000Dh | Oscillation Stop Detection Register | CM2 | 00h |
| 000Eh | Watchdog Timer Start Register | WDTS | XXh |
| 000Fh | Watchdog Timer Control Register | WDC | 00XX XXXXb |
| 0010h | | | |
| 0011h | Address Match Interrupt Register 0 | RMAD0 | 000000h |
| 0012h | | | |
| 0013h | Processor Mode Register 2 | PM2 | 00h |
| 0014h | Address Match Interrupt Register 1 | RMAD1 | 000000h |
| 0015h | | | |
| 0016h | | | |
| 0017h | Voltage Detection Register 2 | VCR2 | 00h |
| 0018h | Address Match Interrupt Register 2 | RMAD2 | 000000h |
| 0019h | | | |
| 001Ah | | | |
| 001Bh | Voltage Detection Register 1 | VCR1 | 0000 1000b |
| 001Ch | Address Match Interrupt Register 3 | RMAD3 | 000000h |
| 001Dh | | | |
| 001Eh | | | |
| 001Fh | | | |
| 0020h | | | |
| 0021h | | | |
| 0022h | | | |
| 0023h | | | |
| 0024h | | | |
| 0025h | | | |
| 0026h | PLL Control Register 0 | PLC0 | 0001 X010b |
| 0027h | PLL Control Register 1 | PLC1 | 000X 0000b |
| 0028h | Address Match Interrupt Register 4 | RMAD4 | 000000h |
| 0029h | | | |
| 002Ah | | | |
| 002Bh | | | |
| 002Ch | Address Match Interrupt Register 5 | RMAD5 | 000000h |
| 002Dh | | | |
| 002Eh | | | |
| 002Fh | Vdet4 Detection Interrupt Register | D4INT | XX00 0000b |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTE:

1. Bits PM01 and PM00 in the PM0 register maintain values set before reset, even after software reset or watchdog timer reset has been performed.

Table 4.2 SFR Address Map (2/20)

| Address | Register | Symbol | After Reset |
|---------|--|--------|--|
| 0030h | | | |
| 0031h | | | |
| 0032h | | | |
| 0033h | | | |
| 0034h | | | |
| 0035h | | | |
| 0036h | | | |
| 0037h | | | |
| 0038h | | | |
| 0039h | Address Match Interrupt Register 6 | RMAD6 | 000000h |
| 003Ah | | | |
| 003Bh | | | |
| 003Ch | | | |
| 003Dh | Address Match Interrupt Register 7 | RMAD7 | 000000h |
| 003Eh | | | |
| 003Fh | | | |
| 0040h | | | |
| 0041h | | | |
| 0042h | | | |
| 0043h | | | |
| 0044h | | | |
| 0045h | | | |
| 0046h | | | |
| 0047h | | | |
| 0048h | External Space Wait Control Register 0 | EWCR0 | X0X0 0011b |
| 0049h | External Space Wait Control Register 1 | EWCR1 | X0X0 0011b |
| 004Ah | External Space Wait Control Register 2 | EWCR2 | X0X0 0011b |
| 004Bh | External Space Wait Control Register 3 | EWCR3 | X0X0 0011b |
| 004Ch | | | |
| 004Dh | | | |
| 004Eh | | | |
| 004Fh | | | |
| 0050h | | | |
| 0051h | | | |
| 0052h | | | |
| 0053h | | | |
| 0054h | | | |
| 0055h | Flash Memory Control Register 1 | FMR1 | 0000 0X0Xb |
| 0056h | | | |
| 0057h | Flash Memory Control Register 0 | FMR0 | 0000 0001b(Flash Memory) XXXX XXX0b(Mask ROM) |
| 0058h | | | |
| 0059h | | | |
| 005Ah | | | |
| 005Bh | | | |
| 005Ch | | | |
| 005Dh | | | |
| 005Eh | | | |
| 005Fh | | | |

X: Undefined
 Blank spaces are all reserved. No access is allowed.

Table 4.3 SFR Address Map (3/20)

| Address | Register | Symbol | After Reset |
|---------|---|----------------|-------------|
| 0060h | | | |
| 0061h | | | |
| 0062h | | | |
| 0063h | | | |
| 0064h | | | |
| 0065h | | | |
| 0066h | | | |
| 0067h | | | |
| 0068h | DMA0 Interrupt Control Register | DM0IC | XXXX X000b |
| 0069h | Timer B5 Interrupt Control Register | TB5IC | XXXX X000b |
| 006Ah | DMA2 Interrupt Control Register | DM2IC | XXXX X000b |
| 006Bh | UART2 Receive/ACK Interrupt Control Register | S2RIC | XXXX X000b |
| 006Ch | Timer A0 Interrupt Control Register | TA0IC | XXXX X000b |
| 006Dh | UART3 Receive/ACK Interrupt Control Register | S3RIC | XXXX X000b |
| 006Eh | Timer A2 Interrupt Control Register | TA2IC | XXXX X000b |
| 006Fh | UART4 Receive/ACK Interrupt Control Register | S4RIC | XXXX X000b |
| 0070h | Timer A4 Interrupt Control Register | TA4IC | XXXX X000b |
| 0071h | UART0/UART3 Bus Conflict Detection Interrupt Control Register | BCN0IC/BCN3IC | XXXX X000b |
| 0072h | UART0 Receive/ACK Interrupt Control Register | S0RIC | XXXX X000b |
| 0073h | A/D0 Conversion Interrupt Control Register | AD0IC | XXXX X000b |
| 0074h | UART1 Receive/ACK Interrupt Control Register | S1RIC | XXXX X000b |
| 0075h | I/O Interrupt Control Register 0 / CAN1 interrupt Control Register 0 | IIO0IC/CAN3IC | XXXX X000b |
| 0076h | Timer B1 Interrupt Control Register | TB1IC | XXXX X000b |
| 0077h | I/O Interrupt Control Register 2 | IIO2IC | XXXX X000b |
| 0078h | Timer B3 Interrupt Control Register | TB3IC | XXXX X000b |
| 0079h | I/O Interrupt Control Register 4 | IIO4IC | XXXX X000b |
| 007Ah | INT5 Interrupt Control Register | INT5IC | XX00 X000b |
| 007Bh | I/O Interrupt Control Register 6 | IIO6IC | XXXX X000b |
| 007Ch | INT3 Interrupt Control Register | INT3IC | XX00 X000b |
| 007Dh | I/O Interrupt Control Register 8 | IIO8IC | XXXX X000b |
| 007Eh | INT1 Interrupt Control Register | INT1IC | XX00 X000b |
| 007Fh | I/O Interrupt Control Register 10 / CAN0 Interrupt Control Register 1 | IIO10IC/CAN1IC | XXXX X000b |
| 0080h | | | |
| 0081h | I/O Interrupt Control Register 11 / CAN0 Interrupt Control Register 2 | IIO11IC/CAN2IC | XXXX X000b |
| 0082h | | | |
| 0083h | | | |
| 0084h | | | |
| 0085h | | | |
| 0086h | | | |
| 0087h | | | |
| 0088h | DMA1 Interrupt Control Register | DM1IC | XXXX X000b |
| 0089h | UART2 Transmit/NACK Interrupt Control Register | S2TIC | XXXX X000b |
| 008Ah | DMA3 Interrupt Control Register | DM3IC | XXXX X000b |
| 008Bh | UART3 Transmit/NACK Interrupt Control Register | S3TIC | XXXX X000b |
| 008Ch | Timer A1 Interrupt Control Register | TA1IC | XXXX X000b |
| 008Dh | UART4 Transmit/NACK Interrupt Control Register | S4TIC | XXXX X000b |
| 008Eh | Timer A3 Interrupt Control Register | TA3IC | XXXX X000b |
| 008Fh | UART2 Bus Conflict Detection Interrupt Control Register | BCN2IC | XXXX X000b |

X: Undefined

Blank spaces are all reserved. No access is allowed.

Table 4.4 SFR Address Map (4/20)

| Address | Register | Symbol | After Reset |
|----------------------|--|---------------|-------------|
| 0090h | UART0 Transmit/NACK Interrupt Control Register | S0TIC | XXXX X000b |
| 0091h | UART1/UART4 Bus Conflict Detection Interrupt Control Register | BCN1IC/BCN4IC | XXXX X000b |
| 0092h | UART1 Transmit/NACK Interrupt Control Register | S1TIC | XXXX X000b |
| 0093h | Key Input Interrupt Control Register | KUPIC | XXXX X000b |
| 0094h | Timer B0 Interrupt Control Register | TB0IC | XXXX X000b |
| 0095h | I/O Interrupt Control Register 1 / CAN1 Interrupt Control Register 1 | IIO1IC/CAN4IC | XXXX X000b |
| 0096h | Timer B2 Interrupt Control Register | TB2IC | XXXX X000b |
| 0097h | I/O Interrupt Control Register 3 | IIO3IC | XXXX X000b |
| 0098h | Timer B4 Interrupt Control Register | TB4IC | XXXX X000b |
| 0099h | I/O Interrupt Control Register 5 / CAN1 Interrupt Control Register 2 | IIO5IC/CAN5IC | XXXX X000b |
| 009Ah | $\overline{\text{INT4}}$ Interrupt Control Register | INT4IC | XX00 X000b |
| 009Bh | I/O Interrupt Control Register 7 | IIO7IC | XXXX X000b |
| 009Ch | $\overline{\text{INT2}}$ Interrupt Control Register | INT2IC | XX00 X000b |
| 009Dh | I/O Interrupt Control Register 9 / CAN0 Interrupt Control Register 0 | IIO9IC/CAN0IC | XXXX X000b |
| 009Eh | $\overline{\text{INT0}}$ Interrupt Control Register | INT0IC | XX00 X000b |
| 009Fh | Exit Priority Register | RLVL | XXXX 0000b |
| 00A0h | Interrupt Request Register 0 | IIO0IR | 0000 000Xb |
| 00A1h | Interrupt Request Register 1 | IIO1IR | 0000 000Xb |
| 00A2h | Interrupt Request Register 2 | IIO2IR | 0000 000Xb |
| 00A3h | Interrupt Request Register 3 | IIO3IR | 0000 000Xb |
| 00A4h | Interrupt Request Register 4 | IIO4IR | 0000 000Xb |
| 00A5h | Interrupt Request Register 5 | IIO5IR | 0000 000Xb |
| 00A6h | Interrupt Request Register 6 | IIO6IR | 0000 000Xb |
| 00A7h | Interrupt Request Register 7 | IIO7IR | 0000 000Xb |
| 00A8h | Interrupt Request Register 8 | IIO8IR | 0000 000Xb |
| 00A9h | Interrupt Request Register 9 | IIO9IR | 0000 000Xb |
| 00AAh | Interrupt Request Register 10 | IIO10IR | 0000 000Xb |
| 00ABh | Interrupt Request Register 11 | IIO11IR | 0000 000Xb |
| 00ACh | | | |
| 00ADh | | | |
| 00AEh | | | |
| 00AFh | | | |
| 00B0h | Interrupt Enable Register 0 | IIO0IE | 00h |
| 00B1h | Interrupt Enable Register 1 | IIO1IE | 00h |
| 00B2h | Interrupt Enable Register 2 | IIO2IE | 00h |
| 00B3h | Interrupt Enable Register 3 | IIO3IE | 00h |
| 00B4h | Interrupt Enable Register 4 | IIO4IE | 00h |
| 00B5h | Interrupt Enable Register 5 | IIO5IE | 00h |
| 00B6h | Interrupt Enable Register 6 | IIO6IE | 00h |
| 00B7h | Interrupt Enable Register 7 | IIO7IE | 00h |
| 00B8h | Interrupt Enable Register 8 | IIO8IE | 00h |
| 00B9h | Interrupt Enable Register 9 | IIO9IE | 00h |
| 00BAh | Interrupt Enable Register 10 | IIO10IE | 00h |
| 00BBh | Interrupt Enable Register 11 | IIO11IE | 00h |
| 00BCh | | | |
| 00BDh | | | |
| 00BEh | | | |
| 00BFh to 00DFh | | | |

X: Undefined

Blank spaces are all reserved. No access is allowed.

Table 4.5 SFR Address Map (5/20)

| Address | Register | Symbol | After Reset |
|---------|---|-------------|-------------|
| 00E0h | | | |
| 00E1h | | | |
| 00E2h | | | |
| 00E3h | | | |
| 00E4h | | | |
| 00E5h | | | |
| 00E6h | | | |
| 00E7h | | | |
| 00E8h | Group 0 SI/O Receive Buffer Register | G0RB | XXXX XXXXb |
| 00E9h | | | XXX0 XXXXb |
| 00EAh | Group 0 Transmit Buffer/Receive Data Register | G0TB/G0DR | XXh |
| 00EBh | | | |
| 00ECh | Group 0 Receive Input Register | G0RI | XXh |
| 00EDh | Group 0 SI/O Communication Mode Register | G0MR | 00h |
| 00EEh | Group 0 Transmit Output Register | G0TO | XXh |
| 00EFh | Group 0 SI/O Communication Control Register | G0CR | 0000 X011b |
| 00F0h | Group 0 Data Compare Register 0 | G0CMP0 | XXh |
| 00F1h | Group 0 Data Compare Register 1 | G0CMP1 | XXh |
| 00F2h | Group 0 Data Compare Register 2 | G0CMP2 | XXh |
| 00F3h | Group 0 Data Compare Register 3 | G0CMP3 | XXh |
| 00F4h | Group 0 Data Mask Register 0 | G0MSK0 | XXh |
| 00F5h | Group 0 Data Mask Register 1 | G0MSK1 | XXh |
| 00F6h | Communication Clock Select Register | CCS | XXXX 0000b |
| 00F7h | | | |
| 00F8h | Group 0 Receive CRC Code Register | G0RCRC | XXXXh |
| 00F9h | | | |
| 00FAh | Group 0 Transmit CRC Code Register | G0TCRC | 0000h |
| 00FBh | | | |
| 00FCh | Group 0 SI/O Expansion Mode Register | G0EMR | 00h |
| 00FDh | Group 0 SI/O Extended Receive Control Register | G0ERC | 00h |
| 00FEh | Group 0 SI/O Special Communication Interrupt Detection Register | G0IRF | 0000 XXXXb |
| 00FFh | Group 0 SI/O Extended Transmit Control Register | G0ETC | 0000 0XXXb |
| 0100h | Group 1 Time Measurement/Waveform Generation Register 0 | G1TM0/G1PO0 | XXXXh |
| 0101h | | | |
| 0102h | Group 1 Time Measurement/Waveform Generation Register 1 | G1TM1/G1PO1 | XXXXh |
| 0103h | | | |
| 0104h | Group 1 Time Measurement/Waveform Generation Register 2 | G1TM2/G1PO2 | XXXXh |
| 0105h | | | |
| 0106h | Group 1 Time Measurement/Waveform Generation Register 3 | G1TM3/G1PO3 | XXXXh |
| 0107h | | | |
| 0108h | Group 1 Time Measurement/Waveform Generation Register 4 | G1TM4/G1PO4 | XXXXh |
| 0109h | | | |
| 010Ah | Group 1 Time Measurement/Waveform Generation Register 5 | G1TM5/G1PO5 | XXXXh |
| 010Bh | | | |
| 010Ch | Group 1 Time Measurement/Waveform Generation Register 6 | G1TM6/G1PO6 | XXXXh |
| 010Dh | | | |
| 010Eh | Group 1 Time Measurement/Waveform Generation Register 7 | G1TM7/G1PO7 | XXXXh |
| 010Fh | | | |
| 0110h | Group 1 Waveform Generation Control Register 0 | G1POCR0 | 0000 X000b |
| 0111h | Group 1 Waveform Generation Control Register 1 | G1POCR1 | 0X00 X000b |
| 0112h | Group 1 Waveform Generation Control Register 2 | G1POCR2 | 0X00 X000b |
| 0113h | Group 1 Waveform Generation Control Register 3 | G1POCR3 | 0X00 X000b |
| 0114h | Group 1 Waveform Generation Control Register 4 | G1POCR4 | 0X00 X000b |
| 0115h | Group 1 Waveform Generation Control Register 5 | G1POCR5 | 0X00 X000b |
| 0116h | Group 1 Waveform Generation Control Register 6 | G1POCR6 | 0X00 X000b |
| 0117h | Group 1 Waveform Generation Control Register 7 | G1POCR7 | 0X00 X000b |
| 0118h | Group 1 Time Measurement Control Register 0 | G1TMCR0 | 00h |
| 0119h | Group 1 Time Measurement Control Register 1 | G1TMCR1 | 00h |

X: Undefined

Blank spaces are all reserved. No access is allowed.

Table 4.6 SFR Address Map (6/20)

| Address | Register | Symbol | After Reset |
|---------|---|-----------|-------------|
| 011Ah | Group 1 Time Measurement Control Register 2 | G1TMCR2 | 00h |
| 011Bh | Group 1 Time Measurement Control Register 3 | G1TMCR3 | 00h |
| 011Ch | Group 1 Time Measurement Control Register 4 | G1TMCR4 | 00h |
| 011Dh | Group 1 Time Measurement Control Register 5 | G1TMCR5 | 00h |
| 011Eh | Group 1 Time Measurement Control Register 6 | G1TMCR6 | 00h |
| 011Fh | Group 1 Time Measurement Control Register 7 | G1TMCR7 | 00h |
| 0120h | Group 1 Base Timer Register | G1BT | XXXXh |
| 0121h | | | |
| 0122h | Group 1 Base Timer Control Register 0 | G1BCR0 | 00h |
| 0123h | Group 1 Base Timer Control Register 1 | G1BCR1 | X000 000Xb |
| 0124h | Group 1 Time Measurement Prescaler Register 6 | G1TPR6 | 00h |
| 0125h | Group 1 Time Measurement Prescaler Register 7 | G1TPR7 | 00h |
| 0126h | Group 1 Function Enable Register | G1FE | 00h |
| 0127h | Group 1 Function Select Register | G1FS | 00h |
| 0128h | Group 1 SI/O Receive Buffer Register | G1RB | XXXX XXXXb |
| 0129h | | | X000 XXXXb |
| 012Ah | Group 1 Transmit Buffer/Receive Data Register | G1TB/G1DR | XXh |
| 012Bh | | | |
| 012Ch | Group 1 Receive Input Register | G1RI | XXh |
| 012Dh | Group 1 SI/O Communication Mode Register | G1MR | 00h |
| 012Eh | Group 1 Transmit Output Register | G1TO | XXh |
| 012Fh | Group 1 SI/O Communication Control Register | G1CR | 0000 X011b |
| 0130h | Group 1 Data Compare Register 0 | G1CMP0 | XXh |
| 0131h | Group 1 Data Compare Register 1 | G1CMP1 | XXh |
| 0132h | Group 1 Data Compare Register 2 | G1CMP2 | XXh |
| 0133h | Group 1 Data Compare Register 3 | G1CMP3 | XXh |
| 0134h | Group 1 Data Mask Register 0 | G1MSK0 | XXh |
| 0135h | Group 1 Data Mask Register 1 | G1MSK1 | XXh |
| 0136h | | | |
| 0137h | | | |
| 0138h | Group 1 Receive CRC Code Register | G1RCRC | XXXXh |
| 0139h | | | |
| 013Ah | Group 1 Transmit CRC Code Register | G1TCRC | 0000h |
| 013Bh | | | |
| 013Ch | Group 1 SI/O Expansion Mode Register | G1EMR | 00h |
| 013Dh | Group 1 SI/O Extended Receive Control Register | G1ERC | 00h |
| 013Eh | Group 1 SI/O Special Communication Interrupt Detection Register | G1IRF | 0000 XXXXb |
| 013Fh | Group 1 SI/O Extended Transmit Control Register | G1ETC | 0000 0XXXb |
| 0140h | Group 2 Waveform Generation Register 0 | G2PO0 | XXXXh |
| 0141h | | | |
| 0142h | Group 2 Waveform Generation Register 1 | G2PO1 | XXXXh |
| 0143h | | | |
| 0144h | Group 2 Waveform Generation Register 2 | G2PO2 | XXXXh |
| 0145h | | | |
| 0146h | Group 2 Waveform Generation Register 3 | G2PO3 | XXXXh |
| 0147h | | | |
| 0148h | Group 2 Waveform Generation Register 4 | G2PO4 | XXXXh |
| 0149h | | | |
| 014Ah | Group 2 Waveform Generation Register 5 | G2PO5 | XXXXh |
| 014Bh | | | |
| 014Ch | Group 2 Waveform Generation Register 6 | G2PO6 | XXXXh |
| 014Dh | | | |
| 014Eh | Group 2 Waveform Generation Register 7 | G2PO7 | XXXXh |
| 014Fh | | | |

X: Undefined

Blank spaces are all reserved. No access is allowed.

Table 4.7 SFR Address Map (7/20)

| Address | Register | Symbol | After Reset |
|---------|--|---------|-------------|
| 0150h | Group 2 Waveform Generation Control Register 0 | G2POCR0 | 00h |
| 0151h | Group 2 Waveform Generation Control Register 1 | G2POCR1 | 00h |
| 0152h | Group 2 Waveform Generation Control Register 2 | G2POCR2 | 00h |
| 0153h | Group 2 Waveform Generation Control Register 3 | G2POCR3 | 00h |
| 0154h | Group 2 Waveform Generation Control Register 4 | G2POCR4 | 00h |
| 0155h | Group 2 Waveform Generation Control Register 5 | G2POCR5 | 00h |
| 0156h | Group 2 Waveform Generation Control Register 6 | G2POCR6 | 00h |
| 0157h | Group 2 Waveform Generation Control Register 7 | G2POCR7 | 00h |
| 0158h | | | |
| 0159h | | | |
| 015Ah | | | |
| 015Bh | | | |
| 015Ch | | | |
| 015Dh | | | |
| 015Eh | | | |
| 015Fh | | | |
| 0160h | Group 2 Base Timer Register | G2BT | XXXXh |
| 0161h | | | |
| 0162h | Group 2 Base Timer Control Register 0 | G2BCR0 | 00h |
| 0163h | Group 2 Base Timer Control Register 1 | G2BCR1 | 00h |
| 0164h | Base Timer Start Register | BTSR | XXXX 0000b |
| 0165h | | | |
| 0166h | Group 2 Function Enable Register | G2FE | 00h |
| 0167h | Group 2 RTP Output Buffer Register | G2RTP | 00h |
| 0168h | | | |
| 0169h | | | |
| 016Ah | Group 2 SI/O Communication Mode Register | G2MR | 00XX X000b |
| 016Bh | Group 2 SI/O Communication Control Register | G2CR | 0000 X000b |
| 016Ch | Group 2 SI/O Transmit Buffer Register | G2TB | XXXXh |
| 016Dh | | | |
| 016Eh | Group 2 SI/O Receive Buffer Register | G2RB | XXXXh |
| 016Fh | | | |
| 0170h | Group 2 IEBus Address Register | IEAR | XXXXh |
| 0171h | | | |
| 0172h | Group 2 IEBus Control Register | IECR | 00XX X000b |
| 0173h | Group 2 IEBus Transmit Interrupt Source Detection Register | IETIF | XXX0 0000b |
| 0174h | Group 2 IEBus Receive Interrupt Source Detection Register | IERIF | XXX0 0000b |
| 0175h | | | |
| 0176h | | | |
| 0177h | Input Function Select Register B | IPSB | 00h |
| 0178h | Input Function Select Register | IPS | 00h |
| 0179h | Input Function Select Register A | IPSA | 00h |
| 017Ah | | | |
| 017Bh | | | |
| 017Ch | | | |
| 017Dh | | | |
| to | | | |
| 01BFh | | | |

X: Undefined

Blank spaces are all reserved. No access is allowed.

Table 4.8 SFR Address Map (8/20)

| Address | Register | Symbol | After Reset |
|---------|--|------------|-------------|
| 01C0h | UART5 Transmit/Receive Mode Register | U5MR | 00h |
| 01C1h | UART5 Baud Rate Register | U5BRG | XXh |
| 01C2h | UART5 Transmit Buffer Register | U5TB | XXXXh |
| 01C3h | | | |
| 01C4h | UART5 Transmit/Receive Control Register 0 | U5C0 | 0000 1000b |
| 01C5h | UART5 Transmit/Receive Control Register 1 | U5C1 | XXXX 0010b |
| 01C6h | UART5 Receive Buffer Register | U5RB | XXXXh |
| 01C7h | | | |
| 01C8h | UART6 Transmit/Receive Mode Register | U6MR | 00h |
| 01C9h | UART6 Baud Rate Register | U6BRG | XXh |
| 01CAh | UART6 Transmit Buffer Register | U6TB | XXXXh |
| 01CBh | | | |
| 01CCh | UART6 Transmit/Receive Control Register 0 | U6C0 | 0000 1000b |
| 01CDh | UART6 Transmit/Receive Control Register 1 | U6C1 | XXXX 0010b |
| 01CEh | UART6 Receive Buffer Register | U6RB | XXXXh |
| 01CFh | | | |
| 01D0h | UART5, UART6 Transmit/Receive Control Register | U56CON | X000 0000b |
| 01D1h | UART5, UART6 Input Pin Function Select Register | U56IS | X000 X000b |
| 01D2h | | | |
| 01D3h | | | |
| 01D4h | | | |
| 01D5h | | | |
| 01D6h | | | |
| 01D7h | | | |
| 01D8h | RTP Output Buffer Register 0 | RTP0R | XXh |
| 01D9h | RTP Output Buffer Register 1 | RTP1R | XXh |
| 01DAh | RTP Output Buffer Register 2 | RTP2R | XXh |
| 01DBh | RTP Output Buffer Register 3 | RTP3R | XXh |
| 01DCh | | | |
| 01DDh | | | |
| 01DEh | | | |
| 01DFh | | | |
| 01E0h | CAN0 Message Slot Buffer 0 Standard ID0 ⁽¹⁾⁽²⁾ | C0SLOT0_0 | XXh |
| 01E1h | CAN0 Message Slot Buffer 0 Standard ID1 ⁽¹⁾⁽²⁾ | C0SLOT0_1 | XXh |
| 01E2h | CAN0 Message Slot Buffer 0 Extended ID0 ⁽¹⁾⁽²⁾ | C0SLOT0_2 | XXh |
| 01E3h | CAN0 Message Slot Buffer 0 Extended ID1 ⁽¹⁾⁽²⁾ | C0SLOT0_3 | XXh |
| 01E4h | CAN0 Message Slot Buffer 0 Extended ID2 ⁽¹⁾⁽²⁾ | C0SLOT0_4 | XXh |
| 01E5h | CAN0 Message Slot Buffer 0 Data Length Code ⁽¹⁾⁽²⁾ | C0SLOT0_5 | XXh |
| 01E6h | CAN0 Message Slot Buffer 0 Data 0 ⁽¹⁾⁽²⁾ | C0SLOT0_6 | XXh |
| 01E7h | CAN0 Message Slot Buffer 0 Data 1 ⁽¹⁾⁽²⁾ | C0SLOT0_7 | XXh |
| 01E8h | CAN0 Message Slot Buffer 0 Data 2 ⁽¹⁾⁽²⁾ | C0SLOT0_8 | XXh |
| 01E9h | CAN0 Message Slot Buffer 0 Data 3 ⁽¹⁾⁽²⁾ | C0SLOT0_9 | XXh |
| 01EAh | CAN0 Message Slot Buffer 0 Data 4 ⁽¹⁾⁽²⁾ | C0SLOT0_10 | XXh |
| 01EBh | CAN0 Message Slot Buffer 0 Data 5 ⁽¹⁾⁽²⁾ | C0SLOT0_11 | XXh |
| 01ECh | CAN0 Message Slot Buffer 0 Data 6 ⁽¹⁾⁽²⁾ | C0SLOT0_12 | XXh |
| 01EDh | CAN0 Message Slot Buffer 0 Data 7 ⁽¹⁾⁽²⁾ | C0SLOT0_13 | XXh |
| 01EEh | CAN0 Message Slot Buffer 0 Time Stamp High-Order ⁽¹⁾⁽²⁾ | C0SLOT0_14 | XXh |
| 01EFh | CAN0 Message Slot Buffer 0 Time Stamp Low-Order ⁽¹⁾⁽²⁾ | C0SLOT0_15 | XXh |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTES:

1. The CAN-associated registers (allocated in addresses 01E0h to 02BFh) cannot be used in M32C/87B. In M32C/87A, only CAN0-associated registers can be used.
2. Set the PM13 bit in the PM1 register to 1 (2 wait states for SFR area) before accessing the CAN-associated registers.

Table 4.9 SFR Address Map (9/20)

| Address | Register ⁽²⁾⁽³⁾ | Symbol | After Reset |
|---------|--|------------|---------------------------|
| 01F0h | CAN0 Message Slot Buffer 1 Standard ID0 | C0SLOT1_0 | XXh |
| 01F1h | CAN0 Message Slot Buffer 1 Standard ID1 | C0SLOT1_1 | XXh |
| 01F2h | CAN0 Message Slot Buffer 1 Extended ID0 | C0SLOT1_2 | XXh |
| 01F3h | CAN0 Message Slot Buffer 1 Extended ID1 | C0SLOT1_3 | XXh |
| 01F4h | CAN0 Message Slot Buffer 1 Extended ID2 | C0SLOT1_4 | XXh |
| 01F5h | CAN0 Message Slot Buffer 1 Data Length Code | C0SLOT1_5 | XXh |
| 01F6h | CAN0 Message Slot Buffer 1 Data 0 | C0SLOT1_6 | XXh |
| 01F7h | CAN0 Message Slot Buffer 1 Data 1 | C0SLOT1_7 | XXh |
| 01F8h | CAN0 Message Slot Buffer 1 Data 2 | C0SLOT1_8 | XXh |
| 01F9h | CAN0 Message Slot Buffer 1 Data 3 | C0SLOT1_9 | XXh |
| 01FAh | CAN0 Message Slot Buffer 1 Data 4 | C0SLOT1_10 | XXh |
| 01FBh | CAN0 Message Slot Buffer 1 Data 5 | C0SLOT1_11 | XXh |
| 01FCh | CAN0 Message Slot Buffer 1 Data 6 | C0SLOT1_12 | XXh |
| 01FDh | CAN0 Message Slot Buffer 1 Data 7 | C0SLOT1_13 | XXh |
| 01FEh | CAN0 Message Slot Buffer 1 Time Stamp High-Order | C0SLOT1_14 | XXh |
| 01FFh | CAN0 Message Slot Buffer 1 Time Stamp Low-Order | C0SLOT1_15 | XXh |
| 0200h | CAN0 Control Register 0 | C0CTRL0 | XX01 0X01b ⁽¹⁾ |
| 0201h | | | XXXX 0000b ⁽¹⁾ |
| 0202h | CAN0 Status Register | C0STR | 0000 0000b ⁽¹⁾ |
| 0203h | | | X000 0X01b ⁽¹⁾ |
| 0204h | CAN0 Extended ID Register | C0IDR | 0000h ⁽¹⁾ |
| 0205h | | | |
| 0206h | CAN0 Configuration Register | C0CONR | 0000 XXXXb ⁽¹⁾ |
| 0207h | | | 0000 0000b ⁽¹⁾ |
| 0208h | CAN0 Time Stamp Register | C0TSR | 0000h ⁽¹⁾ |
| 0209h | | | |
| 020Ah | CAN0 Transmit Error Count Register | C0TEC | 00h ⁽¹⁾ |
| 020Bh | CAN0 Receive Error Count Register | C0REC | 00h ⁽¹⁾ |
| 020Ch | CAN0 Slot Interrupt Status Register | C0SISTR | 0000h ⁽¹⁾ |
| 020Dh | | | |
| 020Eh | | | |
| 020Fh | | | |
| 0210h | CAN0 Slot Interrupt Mask Register | C0SIMKR | 0000h ⁽¹⁾ |
| 0211h | | | |
| 0212h | | | |
| 0213h | | | |
| 0214h | CAN0 Error Interrupt Mask Register | C0EIMKR | XXXX X000b ⁽¹⁾ |
| 0215h | CAN0 Error Interrupt Status Register | C0EISTR | XXXX X000b ⁽¹⁾ |
| 0216h | CAN0 Error Source Register | C0EFR | 00h ⁽¹⁾ |
| 0217h | CAN0 Baud Rate Prescaler | C0BRP | 0000 0001b ⁽¹⁾ |
| 0218h | | | |
| 0219h | CAN0 Mode Register | C0MDR | XXXX XX00b ⁽¹⁾ |
| 021Ah | | | |
| 021Bh | | | |
| 021Ch | | | |
| 021Dh | | | |
| 021Eh | | | |
| 021Fh | | | |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTES:

- Values are obtained by setting the SLEEP bit in the C0SLPR register to "1" (sleep mode exited) after reset and supplying a clock to the CAN module.
- The CAN-associated registers (allocated in addresses 01E0h to 02BFh) cannot be used in M32C/87B. In M32C/87A, only CAN0-associated registers can be used.
- Set the PM13 bit in the PM1 register to 1 (2 wait states for SFR area) before accessing the CAN-associated registers.

Table 4.10 SFR Address Map (10/20)

| Address | Register ⁽³⁾⁽⁴⁾ | Symbol | After Reset |
|----------------------|--|-----------------------|--|
| 0220h | CAN0 Single Shot Control Register | C0SSCTLR | 0000h ⁽¹⁾⁽²⁾ |
| 0221h | | | |
| 0222h | | | |
| 0223h | | | |
| 0224h | CAN0 Single Shot Status Register | C0SSSTR | 0000h ⁽¹⁾⁽²⁾ |
| 0225h | | | |
| 0226h | | | |
| 0227h | | | |
| 0228h | CAN0 Global Mask Register Standard ID0 | C0GMR0 | XXX0 0000b ⁽¹⁾⁽²⁾ |
| 0229h | CAN0 Global Mask Register Standard ID1 | C0GMR1 | XX00 0000b ⁽¹⁾⁽²⁾ |
| 022Ah | CAN0 Global Mask Register Extended ID0 | C0GMR2 | XXXX 0000b ⁽¹⁾⁽²⁾ |
| 022Bh | CAN0 Global Mask Register Extended ID1 | C0GMR3 | 00h ⁽¹⁾⁽²⁾ |
| 022Ch | CAN0 Global Mask Register Extended ID2 | C0GMR4 | XX00 0000b ⁽¹⁾⁽²⁾ |
| 022Dh | | | |
| 022Eh | | | |
| 022Fh | | | |
| 0230h | CAN0 Message Slot 0 Control Register / CAN0 Local Mask Register A Standard ID0 | C0MCTL0 / C0LMAR0 | 0000 0000b ⁽¹⁾⁽²⁾ / XXX0 0000b ⁽¹⁾⁽²⁾ |
| 0231h | CAN0 Message Slot 1 Control Register / CAN0 Local Mask Register A Standard ID1 | C0MCTL1 / C0LMAR1 | 0000 0000b ⁽¹⁾⁽²⁾ / XX00 0000b ⁽¹⁾⁽²⁾ |
| 0232h | CAN0 Message Slot 2 Control Register / CAN0 Local Mask Register A Extended ID0 | C0MCTL2 / C0LMAR2 | 0000 0000b ⁽¹⁾⁽²⁾ / XXXX 0000b ⁽¹⁾⁽²⁾ |
| 0233h | CAN0 Message Slot 3 Control Register / CAN0 Local Mask Register A Extended ID1 | C0MCTL3 / C0LMAR3 | 00h ⁽¹⁾⁽²⁾ / 00h ⁽¹⁾⁽²⁾ |
| 0234h | CAN0 Message Slot 4 Control Register / CAN0 Local Mask Register A Extended ID2 | C0MCTL4 / C0LMAR4 | 0000 0000b ⁽¹⁾⁽²⁾ / XX00 0000b ⁽¹⁾⁽²⁾ |
| 0235h | CAN0 Message Slot 5 Control Register | C0MCTL5 | 00h ⁽¹⁾⁽²⁾ |
| 0236h | CAN0 Message Slot 6 Control Register | C0MCTL6 | 00h ⁽¹⁾⁽²⁾ |
| 0237h | CAN0 Message Slot 7 Control Register | C0MCTL7 | 00h ⁽¹⁾⁽²⁾ |
| 0238h | CAN0 Message Slot 8 Control Register / CAN0 Local Mask Register B Standard ID0 | C0MCTL8 / C0LMBR0 | 0000 0000b ⁽¹⁾⁽²⁾ / XXX0 0000b ⁽¹⁾⁽²⁾ |
| 0239h | CAN0 Message Slot 9 Control Register / CAN0 Local Mask Register B Standard ID1 | C0MCTL9 / C0LMBR1 | 0000 0000b ⁽¹⁾⁽²⁾ / XX00 0000b ⁽¹⁾⁽²⁾ |
| 023Ah | CAN0 Message Slot 10 Control Register / CAN0 Local Mask Register B Extended ID0 | C0MCTL10 / C0LMBR2 | 0000 0000b ⁽¹⁾⁽²⁾ / XXXX 0000b ⁽¹⁾⁽²⁾ |
| 023Bh | CAN0 Message Slot 11 Control Register / CAN0 Local Mask Register B Extended ID1 | C0MCTL11 / C0LMBR3 | 00h ⁽¹⁾⁽²⁾ / 00h ⁽¹⁾⁽²⁾ |
| 023Ch | CAN0 Message Slot 12 Control Register / CAN0 Local Mask Register B Extended ID2 | C0MCTL12 / C0LMBR4 | 0000 0000b ⁽¹⁾⁽²⁾ / XX00 0000b ⁽¹⁾⁽²⁾ |
| 023Dh | CAN0 Message Slot 13 Control Register | C0MCTL13 | 00h ⁽¹⁾⁽²⁾ |
| 023Eh | CAN0 Message Slot 14 Control Register | C0MCTL14 | 00h ⁽¹⁾⁽²⁾ |
| 023Fh | CAN0 Message Slot 15 Control Register | C0MCTL15 | 00h ⁽¹⁾⁽²⁾ |
| 0240h | CAN0 Slot Buffer Select Register | C0SBS | 00h ⁽²⁾ |
| 0241h | CAN0 Control Register 1 | C0CTLR1 | X000 00XXb ⁽²⁾ |
| 0242h | CAN0 Sleep Control Register | C0SLPR | XXXX XXX0b |
| 0243h | | | |
| 0244h | CAN0 Acceptance Filter Support Register | C0AFS | 0000 0000b ⁽²⁾ |
| 0245h | | | 0000 0001b ⁽²⁾ |
| 0246h | | | |
| 0247h | | | |
| 0248h | | | |
| 0249h | | | |
| 024Ah to 024Fh | | | |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTES:

1. The BANKSEL bit in the C0CTLR1 register can switch functions for addresses 0220h to 023Fh.
2. Values are obtained by setting the SLEEP bit in the C0SLPR register to "1" (sleep mode exited) after reset and supplying a clock to the CAN module.
3. The CAN-associated registers (allocated in addresses 01E0h to 02BFh) cannot be used in M32C/87B. In M32C/87A, only CAN0-associated registers can be used.
4. Set the PM13 bit in the PM1 register to 1 (2 wait states for SFR area) before accessing the CAN-associated registers.

Table 4.11 SFR Address Map (11/20)

| Address | Register ⁽²⁾⁽³⁾ | Symbol | After Reset |
|---------|--|------------|---------------------------|
| 0250h | CAN1 Slot Buffer Select Register | C1SBS | 00h ⁽¹⁾ |
| 0251h | CAN1 Control Register 1 | C1CTLR1 | X000 00XXb ⁽¹⁾ |
| 0252h | CAN1 Sleep Control Register | C1SLPR | XXXX XXX0b ⁽¹⁾ |
| 0253h | | | |
| 0254h | CAN1 Acceptance Filter Support Register | C1AFS | 0000 0000b ⁽¹⁾ |
| 0255h | | | 0000 0001b ⁽¹⁾ |
| 0256h | | | |
| 0257h | | | |
| 0258h | | | |
| 0259h | | | |
| 025Ah | | | |
| 025Bh | | | |
| 025Ch | | | |
| 025Dh | | | |
| 025Eh | | | |
| 025Fh | | | |
| 0260h | CAN1 Message Slot Buffer 0 Standard ID0 | C1SLOT0_0 | XXh |
| 0261h | CAN1 Message Slot Buffer 0 Standard ID1 | C1SLOT0_1 | XXh |
| 0262h | CAN1 Message Slot Buffer 0 Extended ID0 | C1SLOT0_2 | XXh |
| 0263h | CAN1 Message Slot Buffer 0 Extended ID1 | C1SLOT0_3 | XXh |
| 0264h | CAN1 Message Slot Buffer 0 Extended ID2 | C1SLOT0_4 | XXh |
| 0265h | CAN1 Message Slot Buffer 0 Data Length Code | C1SLOT0_5 | XXh |
| 0266h | CAN1 Message Slot Buffer 0 Data 0 | C1SLOT0_6 | XXh |
| 0267h | CAN1 Message Slot Buffer 0 Data 1 | C1SLOT0_7 | XXh |
| 0268h | CAN1 Message Slot Buffer 0 Data 2 | C1SLOT0_8 | XXh |
| 0269h | CAN1 Message Slot Buffer 0 Data 3 | C1SLOT0_9 | XXh |
| 026Ah | CAN1 Message Slot Buffer 0 Data 4 | C1SLOT0_10 | XXh |
| 026Bh | CAN1 Message Slot Buffer 0 Data 5 | C1SLOT0_11 | XXh |
| 026Ch | CAN1 Message Slot Buffer 0 Data 6 | C1SLOT0_12 | XXh |
| 026Dh | CAN1 Message Slot Buffer 0 Data 7 | C1SLOT0_13 | XXh |
| 026Eh | CAN1 Message Slot Buffer 0 Time Stamp High-Order | C1SLOT0_14 | XXh |
| 026Fh | CAN1 Message Slot Buffer 0 Time Stamp Low-Order | C1SLOT0_15 | XXh |
| 0270h | CAN1 Message Slot Buffer 1 Standard ID0 | C1SLOT1_0 | XXh |
| 0271h | CAN1 Message Slot Buffer 1 Standard ID1 | C1SLOT1_1 | XXh |
| 0272h | CAN1 Message Slot Buffer 1 Extended ID0 | C1SLOT1_2 | XXh |
| 0273h | CAN1 Message Slot Buffer 1 Extended ID1 | C1SLOT1_3 | XXh |
| 0274h | CAN1 Message Slot Buffer 1 Extended ID2 | C1SLOT1_4 | XXh |
| 0275h | CAN1 Message Slot Buffer 1 Data Length Code | C1SLOT1_5 | XXh |
| 0276h | CAN1 Message Slot Buffer 1 Data 0 | C1SLOT1_6 | XXh |
| 0277h | CAN1 Message Slot Buffer 1 Data 1 | C1SLOT1_7 | XXh |
| 0278h | CAN1 Message Slot Buffer 1 Data 2 | C1SLOT1_8 | XXh |
| 0279h | CAN1 Message Slot Buffer 1 Data 3 | C1SLOT1_9 | XXh |
| 027Ah | CAN1 Message Slot Buffer 1 Data 4 | C1SLOT1_10 | XXh |
| 027Bh | CAN1 Message Slot Buffer 1 Data 5 | C1SLOT1_11 | XXh |
| 027Ch | CAN1 Message Slot Buffer 1 Data 6 | C1SLOT1_12 | XXh |
| 027Dh | CAN1 Message Slot Buffer 1 Data 7 | C1SLOT1_13 | XXh |
| 027Eh | CAN1 Message Slot Buffer 1 Time Stamp High-Order | C1SLOT1_14 | XXh |
| 027Fh | CAN1 Message Slot Buffer 1 Time Stamp Low-Order | C1SLOT1_15 | XXh |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTES:

1. Values are obtained by setting the SLEEP bit in the C1SLPR register to "1" (sleep mode exited) after reset and supplying a clock to the CAN module.
2. The CAN-associated registers (allocated in addresses 01E0h to 02BFh) cannot be used in M32C/87B. In M32C/87A, only CAN0-associated registers can be used.
3. Set the PM13 bit in the PM1 register to 1 (2 wait states for SFR area) before accessing the CAN-associated registers.

Table 4.12 SFR Address Map (12/20)

| Address | Register ⁽³⁾ (4) | Symbol | After Reset |
|---------|--|----------|------------------------------|
| 0280h | CAN1 Control Register 0 | C1CTLR0 | XX01 0X01b ⁽²⁾ |
| 0281h | | | XXXX 0000b ⁽²⁾ |
| 0282h | CAN1 Status Register | C1STR | 0000 0000b ⁽²⁾ |
| 0283h | | | X000 0X01b ⁽²⁾ |
| 0284h | CAN1 Extended ID Register | C1IDR | 0000h ⁽²⁾ |
| 0285h | | | |
| 0286h | CAN1 Configuration Register | C1CONR | 0000 XXXXb ⁽²⁾ |
| 0287h | | | 0000 0000b ⁽²⁾ |
| 0288h | CAN1 Time Stamp Register | C1TSR | 0000h ⁽²⁾ |
| 0289h | | | |
| 028Ah | CAN1 Transmit Error Count Register | C1TEC | 00h ⁽²⁾ |
| 028Bh | CAN1 Receive Error Count Register | C1REC | 00h ⁽²⁾ |
| 028Ch | CAN1 Slot Interrupt Status Register | C1SISTR | 0000h ⁽²⁾ |
| 028Dh | | | |
| 028Eh | | | |
| 028Fh | | | |
| 0290h | CAN1 Slot Interrupt Mask Register | C1SIMKR | 0000h ⁽²⁾ |
| 0291h | | | |
| 0292h | | | |
| 0293h | | | |
| 0294h | CAN1 Error Interrupt Mask Register | C1EIMKR | XXXX X000b ⁽²⁾ |
| 0295h | CAN1 Error Interrupt Status Register | C1EISTR | XXXX X000b ⁽²⁾ |
| 0296h | CAN1 Error Source Register | C1EFR | 00h ⁽²⁾ |
| 0297h | CAN1 Baud Rate Prescaler | C1BRP | 0000 0001b ⁽²⁾ |
| 0298h | | | |
| 0299h | CAN1 Mode Register | C1MDR | XXXX XX00b ⁽²⁾ |
| 029Ah | | | |
| 029Bh | | | |
| 029Ch | | | |
| 029Dh | | | |
| 029Eh | | | |
| 029Fh | | | |
| 02A0h | CAN1 Single Shot Control Register | C1SSCTLR | 0000h ⁽¹⁾⁽²⁾ |
| 02A1h | | | |
| 02A2h | | | |
| 02A3h | | | |
| 02A4h | CAN1 Single Shot Status Register | C1SSSTR | 0000h ⁽¹⁾⁽²⁾ |
| 02A5h | | | |
| 02A6h | | | |
| 02A7h | | | |
| 02A8h | CAN1 Global Mask Register Standard ID0 | C1GMR0 | XXX0 0000b ⁽¹⁾⁽²⁾ |
| 02A9h | CAN1 Global Mask Register Standard ID1 | C1GMR1 | XX00 0000b ⁽¹⁾⁽²⁾ |
| 02AAh | CAN1 Global Mask Register Extended ID0 | C1GMR2 | XXXX 0000b ⁽¹⁾⁽²⁾ |
| 02ABh | CAN1 Global Mask Register Extended ID1 | C1GMR3 | 00h ⁽¹⁾⁽²⁾ |
| 02ACh | CAN1 Global Mask Register Extended ID2 | C1GMR4 | XX00 0000b ⁽¹⁾⁽²⁾ |
| 02ADh | | | |
| 02AEh | | | |
| 02AFh | | | |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTES:

1. The BANKSEL bit in the C0CTLR1 register can switch functions for addresses 02A0h to 02BFh.
2. Values are obtained by setting the SLEEP bit in the C1SLPR register to "1" (sleep mode exited) after reset and supplying a clock to the CAN module.
3. The CAN-associated registers (allocated in addresses 01E0h to 02BFh) cannot be used in M32C/87B. In M32C/87A, only CAN0-associated registers can be used.
4. Set the PM13 bit in the PM1 register to 1 (2 wait states for SFR area) before accessing the CAN-associated registers.

Table 4.13 SFR Address Map (13/20)

| Address | Register ⁽³⁾⁽⁴⁾ | Symbol | After Reset |
|---------|--|-----------------------|--|
| 02B0h | CAN1 Message Slot 0 Control Register / CAN1 Local Mask Register A Standard ID0 | C1MCTL0 / C1LMAR0 | 0000 0000b ⁽¹⁾⁽²⁾ / XXX0 0000b ⁽¹⁾⁽²⁾ |
| 02B1h | CAN1 Message Slot 1 Control Register / CAN1 Local Mask Register A Standard ID1 | C1MCTL1 / C1LMAR1 | 0000 0000b ⁽¹⁾⁽²⁾ / XX00 0000b ⁽¹⁾⁽²⁾ |
| 02B2h | CAN1 Message Slot 2 Control Register / CAN1 Local Mask Register A Extended ID0 | C1MCTL2 / C1LMAR2 | 0000 0000b ⁽¹⁾⁽²⁾ / XXXX 0000b ⁽¹⁾⁽²⁾ |
| 02B3h | CAN1 Message Slot 3 Control Register / CAN1 Local Mask Register A Extended ID1 | C1MCTL3 / C1LMAR3 | 00h ⁽¹⁾⁽²⁾ / 00h ⁽¹⁾⁽²⁾ |
| 02B4h | CAN1 Message Slot 4 Control Register / CAN1 Local Mask Register A Extended ID2 | C1MCTL4 / C1LMAR4 | 0000 0000b ⁽¹⁾⁽²⁾ / XX00 0000b ⁽¹⁾⁽²⁾ |
| 02B5h | CAN1 Message Slot 5 Control Register | C1MCTL5 | 00h ⁽¹⁾⁽²⁾ |
| 02B6h | CAN1 Message Slot 6 Control Register | C1MCTL6 | 00h ⁽¹⁾⁽²⁾ |
| 02B7h | CAN1 Message Slot 7 Control Register | C1MCTL7 | 00h ⁽¹⁾⁽²⁾ |
| 02B8h | CAN1 Message Slot 8 Control Register / CAN1 Local Mask Register B Standard ID0 | C1MCTL8 / C1LMBR0 | 0000 0000b ⁽¹⁾⁽²⁾ / XXX0 0000b ⁽¹⁾⁽²⁾ |
| 02B9h | CAN1 Message Slot 9 Control Register / CAN1 Local Mask Register B Standard ID1 | C1MCTL9 / C1LMBR1 | 0000 0000b ⁽¹⁾⁽²⁾ / XX00 0000b ⁽¹⁾⁽²⁾ |
| 02BAh | CAN1 Message Slot 10 Control Register / CAN1 Local Mask Register B Extended ID0 | C1MCTL10 / C1LMBR2 | 0000 0000b ⁽¹⁾⁽²⁾ / XXXX 0000b ⁽¹⁾⁽²⁾ |
| 02BBh | CAN1 Message Slot 11 Control Register / CAN1 Local Mask Register B Extended ID1 | C1MCTL11 / C1LMBR3 | 00h ⁽¹⁾⁽²⁾ / 00h ⁽¹⁾⁽²⁾ |
| 02BCh | CAN1 Message Slot 12 Control Register / CAN1 Local Mask Register B Extended ID2 | C1MCTL12 / C1LMBR4 | 0000 0000b ⁽¹⁾⁽²⁾ / XX00 0000b ⁽¹⁾⁽²⁾ |
| 02BDh | CAN1 Message Slot 13 Control Register | C1MCTL13 | 00h ⁽¹⁾⁽²⁾ |
| 02BEh | CAN1 Message Slot 14 Control Register | C1MCTL14 | 00h ⁽¹⁾⁽²⁾ |
| 02BFh | CAN1 Message Slot 15 Control Register | C1MCTL15 | 00h ⁽¹⁾⁽²⁾ |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTES:

1. The BANKSEL bit in the C1CTRL1 register can switch functions for addresses 02A0h to 02BFh.
2. Values are obtained by setting the SLEEP bit in the C1SLPR register to "1" (sleep mode exited) after reset and supplying a clock to the CAN module.
3. The CAN-associated registers (allocated in addresses 01E0h to 02BFh) cannot be used in M32C/87B. In M32C/87A, only CAN0-associated registers can be used.
4. Set the PM13 bit in the PM1 register to 1 (2 wait states for SFR area) before accessing the CAN-associated registers.

Table 4.14 SFR Address Map (14/20)

| Address | Register | Symbol | After Reset |
|---------|---|------------|-------------|
| 02C0h | X0 Register, Y0 Register | X0R, Y0R | XXXXh |
| 02C1h | | | |
| 02C2h | X1 Register, Y1 Register | X1R, Y1R | XXXXh |
| 02C3h | | | |
| 02C4h | X2 Register, Y2 Register | X2R, Y2R | XXXXh |
| 02C5h | | | |
| 02C6h | X3 Register, Y3 Register | X3R, Y3R | XXXXh |
| 02C7h | | | |
| 02C8h | X4 Register, Y4 Register | X4R, Y4R | XXXXh |
| 02C9h | | | |
| 02CAh | X5 Register, Y5 Register | X5R, Y5R | XXXXh |
| 02CBh | | | |
| 02CCh | X6 Register, Y6 Register | X6R, Y6R | XXXXh |
| 02CDh | | | |
| 02CEh | X7 Register, Y7 Register | X7R, Y7R | XXXXh |
| 02CFh | | | |
| 02D0h | X8 Register, Y8 Register | X8R, Y8R | XXXXh |
| 02D1h | | | |
| 02D2h | X9 Register, Y9 Register | X9R, Y9R | XXXXh |
| 02D3h | | | |
| 02D4h | X10 Register, Y10 Register | X10R, Y10R | XXXXh |
| 02D5h | | | |
| 02D6h | X11 Register, Y11 Register | X11R, Y11R | XXXXh |
| 02D7h | | | |
| 02D8h | X12 Register, Y12 Register | X12R, Y12R | XXXXh |
| 02D9h | | | |
| 02DAh | X13 Register, Y13 Register | X13R, Y13R | XXXXh |
| 02DBh | | | |
| 02DCh | X14 Register, Y14 Register | X14R, Y14R | XXXXh |
| 02DDh | | | |
| 02DEh | X15 Register, Y15 Register | X15R, Y15R | XXXXh |
| 02DFh | | | |
| 02E0h | X/Y Control Register | XYC | XXXX XX00b |
| 02E1h | | | |
| 02E2h | | | |
| 02E3h | | | |
| 02E4h | UART1 Special Mode Register 4 | U1SMR4 | 00h |
| 02E5h | UART1 Special Mode Register 3 | U1SMR3 | 00h |
| 02E6h | UART1 Special Mode Register 2 | U1SMR2 | 00h |
| 02E7h | UART1 Special Mode Register | U1SMR | 00h |
| 02E8h | UART1 Transmit/Receive Mode Register | U1MR | 00h |
| 02E9h | UART1 Baud Rate Register | U1BRG | XXh |
| 02EAh | UART1 Transmit Buffer Register | U1TB | XXXXh |
| 02EBh | | | |
| 02ECh | UART1 Transmit/Receive Control Register 0 | U1C0 | 0000 1000b |
| 02EDh | UART1 Transmit/Receive Control Register 1 | U1C1 | 0000 0010b |
| 02EEh | UART1 Receive Buffer Register | U1RB | XXXXh |
| 02EFh | | | |

X: Undefined

Blank spaces are all reserved. No access is allowed.

Table 4.15 SFR Address Map (15/20)

| Address | Register | Symbol | After Reset |
|---------|--|--------|-------------|
| 02F0h | | | |
| 02F1h | | | |
| 02F2h | | | |
| 02F3h | | | |
| 02F4h | UART4 Special Mode Register 4 | U4SMR4 | 00h |
| 02F5h | UART4 Special Mode Register 3 | U4SMR3 | 00h |
| 02F6h | UART4 Special Mode Register 2 | U4SMR2 | 00h |
| 02F7h | UART4 Special Mode Register | U4SMR | 00h |
| 02F8h | UART4 Transmit/Receive Mode Register | U4MR | 00h |
| 02F9h | UART4 Baud Rate Register | U4BRG | XXh |
| 02FAh | UART4 Transmit Buffer Register | U4TB | XXXXh |
| 02FBh | | | |
| 02FCh | UART4 Transmit/Receive Control Register 0 | U4C0 | 0000 1000b |
| 02FDh | UART4 Transmit/Receive Control Register 1 | U4C1 | 0000 0010b |
| 02FEh | UART4 Receive Buffer Register | U4RB | XXXXh |
| 02FFh | | | |
| 0300h | Timer B3, B4, B5 Count Start Register | TBSR | 000X XXXXb |
| 0301h | | | |
| 0302h | Timer A11 Register | TA11 | XXXXh |
| 0303h | | | |
| 0304h | Timer A21 Register | TA21 | XXXXh |
| 0305h | | | |
| 0306h | Timer A41 Register | TA41 | XXXXh |
| 0307h | | | |
| 0308h | Three-Phase PWM Control Register 0 | INVC0 | 00h |
| 0309h | Three-Phase PWM Control Register 1 | INVC1 | 00h |
| 030Ah | Three-Phase Output Buffer Register 0 | IDB0 | XX11 1111b |
| 030Bh | Three-Phase Output Buffer Register 1 | IDB1 | XX11 1111b |
| 030Ch | Dead Time Timer | DTT | XXh |
| 030Dh | Timer B2 Interrupt Generation Frequency Set Counter | ICTB2 | XXh |
| 030Eh | | | |
| 030Fh | | | |
| 0310h | Timer B3 Register | TB3 | XXXXh |
| 0311h | | | |
| 0312h | Timer B4 Register | TB4 | XXXXh |
| 0313h | | | |
| 0314h | Timer B5 Register | TB5 | XXXXh |
| 0315h | | | |
| 0316h | | | |
| 0317h | | | |
| 0318h | | | |
| 0319h | | | |
| 031Ah | | | |
| 031Bh | Timer B3 Mode Register | TB3MR | 00XX 0000b |
| 031Ch | Timer B4 Mode Register | TB4MR | 00XX 0000b |
| 031Dh | Timer B5 Mode Register | TB5MR | 00XX 0000b |
| 031Eh | External Interrupt Source Select Register 1 ⁽¹⁾ | IFSRA | 00h |
| 031Fh | External Interrupt Source Select Register | IFSR | 00h |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTE:

1. The IFSRA register is included in the 144-pin package only.

Table 4.16 SFR Address Map (16/20)

| Address | Register | Symbol | After Reset |
|---------|---|--------|-------------|
| 0320h | | | |
| 0321h | | | |
| 0322h | | | |
| 0323h | | | |
| 0324h | UART3 Special Mode Register 4 | U3SMR4 | 00h |
| 0325h | UART3 Special Mode Register 3 | U3SMR3 | 00h |
| 0326h | UART3 Special Mode Register 2 | U3SMR2 | 00h |
| 0327h | UART3 Special Mode Register | U3SMR | 00h |
| 0328h | UART3 Transmit/Receive Mode Register | U3MR | 00h |
| 0329h | UART3 Baud Rate Register | U3BRG | XXh |
| 032Ah | UART3 Transmit Buffer Register | U3TB | XXXXh |
| 032Bh | | | |
| 032Ch | UART3 Transmit/Receive Control Register 0 | U3C0 | 0000 1000b |
| 032Dh | UART3 Transmit/Receive Control Register 1 | U3C1 | 0000 0010b |
| 032Eh | UART3 Receive Buffer Register | U3RB | XXXXh |
| 032Fh | | | |
| 0330h | | | |
| 0331h | | | |
| 0332h | | | |
| 0333h | | | |
| 0334h | UART2 Special Mode Register 4 | U2SMR4 | 00h |
| 0335h | UART2 Special Mode Register 3 | U2SMR3 | 00h |
| 0336h | UART2 Special Mode Register 2 | U2SMR2 | 00h |
| 0337h | UART2 Special Mode Register | U2SMR | 00h |
| 0338h | UART2 Transmit/Receive Mode Register | U2MR | 00h |
| 0339h | UART2 Baud Rate Register | U2BRG | XXh |
| 033Ah | UART2 Transmit Buffer Register | U2TB | XXXXh |
| 033Bh | | | |
| 033Ch | UART2 Transmit/Receive Control Register 0 | U2C0 | 0000 1000b |
| 033Dh | UART2 Transmit/Receive Control Register 1 | U2C1 | 0000 0010b |
| 033Eh | UART2 Receive Buffer Register | U2RB | XXXXh |
| 033Fh | | | |
| 0340h | Count Start Register | TABSR | 00h |
| 0341h | Clock Prescaler Reset Register | CPSRF | 0XXX XXXXb |
| 0342h | One-Shot Start Register | ONSF | 00h |
| 0343h | Trigger Select Register | TRGSR | 00h |
| 0344h | Up/Down Select Register | UDF | 00h |
| 0345h | | | |
| 0346h | Timer A0 Register | TA0 | XXXXh |
| 0347h | | | |
| 0348h | Timer A1 Register | TA1 | XXXXh |
| 0349h | | | |
| 034Ah | Timer A2 Register | TA2 | XXXXh |
| 034Bh | | | |
| 034Ch | Timer A3 Register | TA3 | XXXXh |
| 034Dh | | | |
| 034Eh | Timer A4 Register | TA4 | XXXXh |
| 034Fh | | | |

X: Undefined

Blank spaces are all reserved. No access is allowed.

Table 4.17 SFR Address Map (17/20)

| Address | Register | Symbol | After Reset |
|---------|--|--------|-------------|
| 0350h | Timer B0 Register | TB0 | XXXXh |
| 0351h | | | |
| 0352h | Timer B1 Register | TB1 | XXXXh |
| 0353h | | | |
| 0354h | Timer B2 Register | TB2 | XXXXh |
| 0355h | | | |
| 0356h | Timer A0 Mode Register | TA0MR | 00h |
| 0357h | Timer A1 Mode Register | TA1MR | 00h |
| 0358h | Timer A2 Mode Register | TA2MR | 00h |
| 0359h | Timer A3 Mode Register | TA3MR | 00h |
| 035Ah | Timer A4 Mode Register | TA4MR | 00h |
| 035Bh | Timer B0 Mode Register | TB0MR | 00XX 0000b |
| 035Ch | Timer B1 Mode Register | TB1MR | 00XX 0000b |
| 035Dh | Timer B2 Mode Register | TB2MR | 00XX 0000b |
| 035Eh | Timer B2 Special Mode Register | TB2SC | XXXX XXX0b |
| 035Fh | Count Source Prescaler Register ⁽¹⁾ | TCSPR | 0XXX 0000b |
| 0360h | | | |
| 0361h | | | |
| 0362h | | | |
| 0363h | | | |
| 0364h | UART0 Special Mode Register 4 | U0SMR4 | 00h |
| 0365h | UART0 Special Mode Register 3 | U0SMR3 | 00h |
| 0366h | UART0 Special Mode Register 2 | U0SMR2 | 00h |
| 0367h | UART0 Special Mode Register | U0SMR | 00h |
| 0368h | UART0 Transmit/Receive Mode Register | U0MR | 00h |
| 0369h | UART0 Baud Rate Register | U0BRG | XXh |
| 036Ah | UART0 Transmit Buffer Register | U0TB | XXXXh |
| 036Bh | | | |
| 036Ch | UART0 Transmit/Receive Control Register 0 | U0C0 | 0000 1000b |
| 036Dh | UART0 Transmit/Receive Control Register 1 | U0C1 | 0000 0010b |
| 036Eh | UART0 Receive Buffer Register | U0RB | XXXXh |
| 036Fh | | | |
| 0370h | | | |
| 0371h | | | |
| 0372h | IrDA Control Register | IRCON | X000 0000b |
| 0373h | | | |
| 0374h | | | |
| 0375h | | | |
| 0376h | | | |
| 0377h | | | |
| 0378h | DMA0 Request Source Select Register | DM0SL | 0X00 0000b |
| 0379h | DMA1 Request Source Select Register | DM1SL | 0X00 0000b |
| 037Ah | DMA2 Request Source Select Register | DM2SL | 0X00 0000b |
| 037Bh | DMA3 Request Source Select Register | DM3SL | 0X00 0000b |
| 037Ch | CRC Data Register | CRCD | XXXXh |
| 037Dh | | | |
| 037Eh | CRC Input Register | CRCIN | XXh |
| 037Fh | | | |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTE:

1. The TCSPR register maintains values set before reset, even after software reset or watchdog timer reset has been performed.

Table 4.18 SFR Address Map (18/20)

| Address | Register | Symbol | After Reset |
|---------|-------------------------|---------|-------------|
| 0380h | A/D0 Register 0 | AD00 | 00XXh |
| 0381h | | | |
| 0382h | A/D0 Register 1 | AD01 | 00XXh |
| 0383h | | | |
| 0384h | A/D0 Register 2 | AD02 | 00XXh |
| 0385h | | | |
| 0386h | A/D0 Register 3 | AD03 | 00XXh |
| 0387h | | | |
| 0388h | A/D0 Register 4 | AD04 | 00XXh |
| 0389h | | | |
| 038Ah | A/D0 Register 5 | AD05 | 00XXh |
| 038Bh | | | |
| 038Ch | A/D0 Register 6 | AD06 | 00XXh |
| 038Dh | | | |
| 038Eh | A/D0 Register 7 | AD07 | 00XXh |
| 038Fh | | | |
| 0390h | | | |
| 0391h | | | |
| 0392h | A/D0 Control Register 4 | AD0CON4 | XXXX 00XXb |
| 0393h | | | |
| 0394h | A/D0 Control Register 2 | AD0CON2 | XX0X X000b |
| 0395h | A/D0 Control Register 3 | AD0CON3 | XXXX X000b |
| 0396h | A/D0 Control Register 0 | AD0CON0 | 00h |
| 0397h | A/D0 Control Register 1 | AD0CON1 | 00h |
| 0398h | D/A Register 0 | DA0 | XXh |
| 0399h | | | |
| 039Ah | D/A Register 1 | DA1 | XXh |
| 039Bh | | | |
| 039Ch | D/A Control Register | DACON | XXXX XX00b |
| 039Dh | D/A Control Register 1 | DACON1 | XXXX 0000b |
| 039Eh | | | |
| 039Fh | | | |

X: Undefined

Blank spaces are all reserved. No access is allowed.

Table 4.19 SFR Address Map (19/20)

| Address | Register | Symbol | After Reset |
|---------|---|--------|-------------|
| 03A0h | Function Select Register A8 ⁽¹⁾ | PS8 | X000 0000b |
| 03A1h | Function Select Register A9 ⁽¹⁾ | PS9 | 00h |
| 03A2h | | | |
| 03A3h | Function Select Register B9 ⁽¹⁾ | PSL9 | XXX0 XX00b |
| 03A4h | Function Select Register E2 | PSE2 | XXXX XX0Xb |
| 03A5h | | | |
| 03A6h | | | |
| 03A7h | Function Select Register D1 | PSD1 | 00X0 XX00b |
| 03A8h | Function Select Register D2 | PSD2 | XXXX XX0Xb |
| 03A9h | | | |
| 03AAh | Function Select Register C6 ⁽¹⁾ | PSC6 | XXXX 0X00b |
| 03ABh | Function Select Register E1 | PSE1 | 00XX XX00b |
| 03ACh | Function Select Register C2 | PSC2 | XXXX X00Xb |
| 03ADh | Function Select Register C3 | PSC3 | X0XX XXXXb |
| 03AEh | | | |
| 03AFh | Function Select Register C | PSC | 00h |
| 03B0h | Function Select Register A0 | PS0 | 00h |
| 03B1h | Function Select Register A1 | PS1 | 00h |
| 03B2h | Function Select Register B0 | PSL0 | 00h |
| 03B3h | Function Select Register B1 | PSL1 | 00h |
| 03B4h | Function Select Register A2 | PS2 | 00X0 0000b |
| 03B5h | Function Select Register A3 | PS3 | 00h |
| 03B6h | Function Select Register B2 | PSL2 | 00X0 0000b |
| 03B7h | Function Select Register B3 | PSL3 | 00h |
| 03B8h | Function Select Register A4 | PS4 | 00h |
| 03B9h | Function Select Register A5 ⁽¹⁾ | PS5 | XXX0 0000b |
| 03BAh | | | |
| 03BBh | Function Select Register B5 ⁽¹⁾ | PSL5 | XXX0 0000b |
| 03BCh | Function Select Register A6 ⁽¹⁾ | PS6 | 00h |
| 03BDh | Function Select Register A7 ⁽¹⁾ | PS7 | 00h |
| 03BEh | Function Select Register B6 ⁽¹⁾ | PSL6 | 00h |
| 03BFh | Function Select Register B7 ⁽¹⁾ | PSL7 | 00h |
| 03C0h | Port P6 Register | P6 | XXh |
| 03C1h | Port P7 Register | P7 | XXh |
| 03C2h | Port P6 Direction Register | PD6 | 00h |
| 03C3h | Port P7 Direction Register | PD7 | 00h |
| 03C4h | Port P8 Register | P8 | XXh |
| 03C5h | Port P9 Register | P9 | XXh |
| 03C6h | Port P8 Direction Register | PD8 | 00X0 0000b |
| 03C7h | Port P9 Direction Register | PD9 | 00h |
| 03C8h | Port P10 Register | P10 | XXh |
| 03C9h | Port P11 Register ⁽¹⁾ | P11 | XXh |
| 03CAh | Port P10 Direction Register | PD10 | 00h |
| 03CBh | Port P11 Direction Register ⁽¹⁾⁽²⁾ | PD11 | XXX0 0000b |
| 03CCh | Port P12 Register ⁽¹⁾ | P12 | XXh |
| 03CDh | Port P13 Register ⁽¹⁾ | P13 | XXh |
| 03CEh | Port P12 Direction Register ⁽¹⁾⁽²⁾ | PD12 | 00h |
| 03CFh | Port P13 Direction Register ⁽¹⁾⁽²⁾ | PD13 | 00h |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTES:

1. These registers cannot be used in the 100-pin package.
2. Set to FFh in the 100-pin package.

Table 4.20 SFR Address Map (20/20)

| Address | Register | Symbol | After Reset |
|---------|---|--------|-------------|
| 03D0h | Port P14 Register ⁽¹⁾ | P14 | XXh |
| 03D1h | Port P15 Register ⁽¹⁾ | P15 | XXh |
| 03D2h | Port P14 Direction Register ⁽¹⁾⁽²⁾ | PD14 | X000 0000b |
| 03D3h | Port P15 Direction Register ⁽¹⁾⁽²⁾ | PD15 | 00h |
| 03D4h | | | |
| 03D5h | | | |
| 03D6h | | | |
| 03D7h | | | |
| 03D8h | | | |
| 03D9h | | | |
| 03DAh | Pull-Up Control Register 2 | PUR2 | 00h |
| 03DBh | Pull-Up Control Register 3 | PUR3 | 00h |
| 03DCh | Pull-Up Control Register 4 ⁽¹⁾⁽³⁾ | PUR4 | XXXX 0000b |
| 03DDh | | | |
| 03DEh | | | |
| 03DFh | | | |
| 03E0h | Port P0 Register | P0 | XXh |
| 03E1h | Port P1 Register | P1 | XXh |
| 03E2h | Port P0 Direction Register | PD0 | 00h |
| 03E3h | Port P1 Direction Register | PD1 | 00h |
| 03E4h | Port P2 Register | P2 | XXh |
| 03E5h | Port P3 Register | P3 | XXh |
| 03E6h | Port P2 Direction Register | PD2 | 00h |
| 03E7h | Port P3 Direction Register | PD3 | 00h |
| 03E8h | Port P4 Register | P4 | XXh |
| 03E9h | Port P5 Register | P5 | XXh |
| 03EAh | Port P4 Direction Register | PD4 | 00h |
| 03EBh | Port P5 Direction Register | PD5 | 00h |
| 03ECh | | | |
| 03EDh | | | |
| 03EEh | | | |
| 03EFh | | | |
| 03F0h | Pull-Up Control Register 0 | PUR0 | 00h |
| 03F1h | Pull-Up Control Register 1 | PUR1 | XXXX 0000b |
| 03F2h | | | |
| 03F3h | | | |
| 03F4h | | | |
| 03F5h | | | |
| 03F6h | | | |
| 03F7h | | | |
| 03F8h | | | |
| 03F9h | | | |
| 03FAh | | | |
| 03FBh | | | |
| 03FCh | | | |
| 03FDh | | | |
| 03FEh | | | |
| 03FFh | Port Control Register | PCR | XXXX X000b |

X: Undefined

Blank spaces are all reserved. No access is allowed.

NOTES:

1. These registers cannot be used in the 100-pin package.
2. Set to FFh in the 100-pin package.
3. Set to 00h in the 100-pin package.

5. Electrical Characteristics

Table 5.1 Absolute Maximum Ratings

| Symbol | Parameter | | Condition | Value | Unit |
|---------------|-------------------------------|---|---------------------|--|------|
| VCC1, VCC2 | Supply voltage | | VCC1 = AVCC | -0.3 to 6.0 | V |
| VCC2 | Supply voltage | | – | -0.3 to VCC1 + 0.1 | V |
| AVCC | Analog supply voltage | | VCC1 = AVCC | -0.3 to 6.0 | V |
| VI | Input voltage | RESET, CNVSS, BYTE, P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_7, P9_0 to P9_7, P10_0 to P10_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ , VREF, XIN | | -0.3 to VCC1 + 0.3 | V |
| | | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7 ⁽¹⁾ | | -0.3 to VCC2 + 0.3 | |
| | | P7_0, P7_1 | | -0.3 to 6.0 | |
| VO | Output voltage | P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P14_0 to 14_6, P15_0 to P15_7 ⁽¹⁾ , XOUT | | -0.3 to VCC1 + 0.3 | V |
| | | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7 ⁽¹⁾ | | -0.3 to VCC2 + 0.3 | |
| | | P7_0, P7_1 | | -0.3 to 6.0 | |
| Pd | Power consumption | | -40°C ≤ Topr ≤ 85°C | 500 | mW |
| Topr | Operating ambient temperature | during CPU operation | | -20 to 85/ -40 to 85 ⁽²⁾ | °C |
| | | during programming or erasing Flash memory | | 0 to 60 | °C |
| Tstg | Storage temperature | | | -65 to 150 | °C |

NOTES:

1. P11 to P15 are provided in the 144-pin package only.
2. Contact a Renesas sales office if temperature range of -40 to 85°C is required.

Table 5.2 Recommended Operating Conditions (1/3)
(VCC1 = VCC2 = 3.0 to 5.5 V, Topr = -20 to 85°C unless otherwise specified)

| Symbol | Parameter | | Standard | | | Unit |
|------------|------------------------------|--|----------|------|----------|------|
| | | | Min. | Typ. | Max. | |
| VCC1, VCC2 | Supply voltage (VCC1 ≥ VCC2) | | 3.0 | 5.0 | 5.5 | V |
| AVCC | Analog supply voltage | | | VCC1 | | V |
| VSS | Supply voltage | | | 0 | | V |
| AVSS | Analog supply voltage | | | 0 | | V |
| VIH | Input high "H" voltage | P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7 ⁽²⁾ | 0.8VCC2 | | VCC2 | V |
| | | P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_7 ⁽¹⁾ , P9_0 to P9_7, P10_0 to P10_7, P14_0 to P14_6, P15_0 to P15_7 ⁽²⁾ , XIN, $\overline{\text{RESET}}$, CNVSS, BYTE | 0.8VCC1 | | VCC1 | |
| | | P7_0, P7_1 | 0.8VCC1 | | 6.0 | |
| | | P0_0 to P0_7, P1_0 to P1_7 (in single-chip mode) | 0.8VCC2 | | VCC2 | |
| | | P0_0 to P0_7, P1_0 to P1_7 (in memory expansion mode and microprocessor mode) | 0.5VCC2 | | VCC2 | |
| VIL | Input low "L" voltage | P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7 ⁽²⁾ | 0 | | 0.2VCC2 | V |
| | | P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_7 ⁽¹⁾ , P9_0 to P9_7, P10_0 to P10_7, P14_0 to P14_6, P15_0 to P15_7 ⁽²⁾ , XIN, $\overline{\text{RESET}}$, CNVSS, BYTE | 0 | | 0.2VCC1 | |
| | | P0_0 to P0_7, P1_0 to P1_7 (in single-chip mode) | 0 | | 0.2VCC2 | |
| | | P0_0 to P0_7, P1_0 to P1_7 (in memory expansion mode and microprocessor mode) | 0 | | 0.16VCC2 | |

NOTES:

1. VIH and VIL reference for P8_7 apply when P8_7 is used as a programmable input port. It does not apply when P8_7 is used as XCIN.
2. P11 to P15 are provided in the 144-pin package only.

Table 5.3 Recommended Operating Conditions (2/3)
(VCC1 = VCC2 = 3.0 to 5.5 V, Topr = -20 to 85°C unless otherwise specified)

| Symbol | Parameter | Standard | | | Unit | |
|-----------|--|---|------|------|-------|----|
| | | Min. | Typ. | Max. | | |
| IOH(peak) | Peak output high "H" current ⁽²⁾ | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽³⁾ | | | -10.0 | mA |
| IOH(avg) | Average output high "H" current ⁽¹⁾ | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽³⁾ | | | -5.0 | mA |
| IOL(peak) | Peak output low "L" current ⁽²⁾ | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽³⁾ | | | 10.0 | mA |
| IOL(avg) | Average output low "L" current ⁽¹⁾ | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽³⁾ | | | 5.0 | mA |

NOTES:

- Average output current is the average value within 100 ms.
- A total IOL(peak) of P0, P1, P2, P8_6, P8_7, P9, P10, P11, P14, and P15 must be 80 mA or less.
A total IOL(peak) of P3, P4, P5, P6, P7, P8_0 to P8_4, P12, and P13 must be 80 mA or less.
A total IOH(peak) of P0, P1, P2, and P11 must be -40 mA or less.
A total IOH(peak) of P8_6 to P8_7, P9, P10, P14, and P15 must be -40 mA or less.
A total IOH(peak) of P3, P4, P5, P12, and P13 must be -40 mA or less.
A total IOH(peak) of P6, P7, and P8_0 to P8_4 must be -40 mA or less.
- P11 to P15 are provided in the 144-pin package only.

Table 5.4 Recommended Operating Conditions (3/3)
(VCC1 = VCC2 = 3.0 to 5.5 V, Topr = -20 to 85°C unless otherwise specified)

| Symbol | Parameter | | Standard | | | Unit |
|----------|--|--------------------|----------|--------|------|------|
| | | | Min. | Typ. | Max. | |
| f(CPU) | CPU clock frequency (same frequency as f(BCLK)) | VCC1 = 4.2 to 5.5V | 0 | | 32 | MHz |
| | | VCC1 = 3.0 to 5.5V | 0 | | 24 | MHz |
| f(XIN) | Main clock input oscillation frequency | VCC1 = 4.2 to 5.5V | 0 | | 32 | MHz |
| | | VCC1 = 3.0 to 5.5V | 0 | | 24 | MHz |
| f(XCIN) | Sub clock frequency | | | 32.768 | 50 | kHz |
| f(Ring) | On-chip oscillator frequency | | | 1 | | MHz |
| f(VCO) | VCO clock frequency (PLL frequency synthesizer) | | 20 | | 80 | MHz |
| f(PLL) | PLL clock frequency | VCC1 = 4.2 to 5.5V | 10 | | 32 | MHz |
| | | VCC1 = 3.0 to 5.5V | 10 | | 24 | MHz |
| tsu(PLL) | Wait time to stabilize PLL frequency synthesizer | VCC1 = 5.0V | | | 5 | ms |
| | | VCC1 = 3.3V | | | 10 | ms |

$$VCC1 = VCC2 = 5V$$

Table 5.5 Electrical Characteristics (1/3)
(VCC1 = VCC2 = 4.2 to 5.5 V, VSS = 0 V, Topr = -20 to 85°C, f(CPU) = 32 MHz unless otherwise specified)

| Symbol | Parameter | | Measurement Condition | Standard | | | Unit | |
|-----------|-------------------------|---|-------------------------|-----------------|------|------|------|---|
| | | | | Min. | Typ. | Max. | | |
| VOH | Output high "H" voltage | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7 ⁽¹⁾ | IOH = -5 mA | VCC2 - 2.0 | | VCC2 | V | |
| | | P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ | IOH = -5 mA | VCC1 - 2.0 | | VCC1 | | |
| | | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7 ⁽¹⁾ | IOH = -200 μ A | VCC2 - 0.3 | | VCC2 | V | |
| | | P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ | IOH = -200 μ A | VCC1 - 0.3 | | VCC1 | | |
| | | XOUT | IOH = -1 mA | 3.0 | | VCC1 | V | |
| | | XCOU | Drive capability = high | No load applied | | 2.5 | | V |
| | Drive capability = low | No load applied | | 1.6 | | V | | |
| VOL | Output low "L" voltage | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ | IOL = 5 mA | | | 2.0 | V | |
| | | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ | IOL = 200 μ A | | | 0.45 | V | |
| | | XOUT | IOL = 1 mA | | | 2.0 | V | |
| | | XCOU | Drive capability = high | No load applied | | 0 | | V |
| | | | Drive capability = low | No load applied | | 0 | | V |
| VT+ - VT- | Hysteresis | HOLD, RDY, TA0IN to TA4IN, TB0IN to TB5IN, INT0 to INT8, ADTRG, CTS0 to CTS6, CLK0 to CLK6, TA0OUT to TA4OUT, NMI, KI0 to KI3, RXD0 to RXD6, SCL0 to SCL4, SDA0 to SDA4, INPC1_0 to INPC1_7, ISCLK0 to ISCLK2, ISRXD0 to ISRXD2, IEIN, CAN0IN, CAN1IN, CAN1WU | | 0.2 | | 1.0 | V | |
| | | RESET | | 0.2 | | 1.8 | V | |

NOTE:

1. P11 to P15 are provided in the 144-pin package only.

$$VCC1 = VCC2 = 5V$$

Table 5.6 Electrical Characteristics (2/3)
(VCC1 = VCC2 = 4.2 to 5.5 V, VSS = 0 V, Topr = -20 to 85°C, f(CPU) = 32 MHz unless otherwise specified)

| Symbol | Parameter | | Measurement Condition | Standard | | | Unit |
|---------|----------------------------|--|-----------------------|----------|------|------|------|
| | | | | Min. | Typ. | Max. | |
| IIH | Input high "H" current | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ , XIN, $\overline{\text{RESET}}$, CNVSS, BYTE | VI = 5 V | | | 5.0 | μA |
| IIL | Input low "L" current | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ , XIN, $\overline{\text{RESET}}$, CNVSS, BYTE | VI = 0V | | | -5.0 | μA |
| RPULLUP | Pull-up resistance | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ | VI = 0V | 30 | 50 | 167 | kΩ |
| RfXIN | Feedback resistance | XIN | | | 1.5 | | MΩ |
| RfXCIN | Feedback resistance | XCIN | | | 10 | | MΩ |
| VRAM | RAM data retention voltage | In stop mode | | 2.0 | | | V |

NOTE:

1. P11 to P15 are provided in the 144-pin package only.

$$VCC1 = VCC2 = 5V$$

Table 5.7 Electrical Characteristics (3/3)
(VCC1 = VCC2 = 5.5 V, VSS = 0 V, Topr = 25°C)

| Symbol | Parameter | Measurement Condition ⁽¹⁾ | Standard | | | Unit | |
|--------|----------------------|--------------------------------------|---|------|------|------|----|
| | | | Min. | Typ. | Max. | | |
| ICC | Power supply current | Flash memory version | f(CPU) = 32 MHz | | 32 | 45 | mA |
| | | | f(CPU) = 16 MHz | | 19 | | mA |
| | | | f(CPU) = 8 MHz | | 12 | | mA |
| | | | f(CPU) = f(Ring) In on-chip oscillator low-power consumption mode | | 2.6 | | mA |
| | | | f(CPU) = 32 kHz In low-power consumption mode While flash memory is operating | | 430 | | μA |
| | | | f(CPU) = 32 kHz In low-power consumption mode While flash memory is stopped ⁽²⁾ | | 30 | | μA |
| | | | Wait mode: f(CPU) = f(Ring) After entering wait mode from on-chip oscillator low-power consumption mode | | 50 | | μA |
| | | | Stop mode (while clock is stopped) | | 0.8 | 5 | μA |
| | | | Stop mode (while clock is stopped) Topr = 85°C | | | 50 | μA |
| | | Mask ROM version | f(CPU) = 32 MHz | | 32 | 45 | mA |
| | | | f(CPU) = 16 MHz | | 19 | | mA |
| | | | f(CPU) = 8 MHz | | 12 | | mA |
| | | | f(CPU) = f(Ring) In on-chip oscillator low-power consumption mode | | 1 | | mA |
| | | | f(CPU) = 32 kHz In low-power consumption mode | | 30 | | μA |
| | | | Wait mode: f(CPU) = f(Ring) After entering wait mode from on-chip oscillator low-power consumption mode | | 50 | | μA |
| | | | Stop mode (while clock is stopped) | | 0.8 | 5 | μA |
| | | | Stop mode (while clock is stopped) Topr = 85°C | | | 50 | μA |

NOTES:

1. In single-chip mode, leave the output pins open and connect the input pins to VSS.
2. Value is obtained when setting the FMSTP bit in the FMR0 register to 1 (flash memory stopped) and running the program on RAM.

$$VCC1 = VCC2 = 5V$$

Table 5.8 A/D Conversion Characteristics
($VCC1 = VCC2 = AVCC = VREF = 4.2$ to 5.5 V, $VSS = AVSS = 0$ V, $Topr = -20$ to $85^{\circ}C$, $f(CPU) = 32MHz$ unless otherwise specified)

| Symbol | Parameter | Measurement Condition | Standard | | | Unit | |
|---------|--|----------------------------|--|------|---------|------------|-----|
| | | | Min. | Typ. | Max. | | |
| – | Resolution | $VREF = VCC1$ | | | 10 | Bits | |
| INL | Integral nonlinearity error | $VREF = VCC1 = VCC2 = 5$ V | AN_0 to AN_7, AN0_0 to AN0_7, AN2_0 to AN2_7, AN15_0 to AN15_7, ANEX0, ANEX1 | | | ± 3 | LSB |
| | | | | | | ± 7 | LSB |
| DNL | Differential nonlinearity error | | | | ± 1 | LSB | |
| – | Offset error | | | | ± 3 | LSB | |
| – | Gain error | | | | ± 3 | LSB | |
| RLADDER | Resistor ladder | $VREF = VCC1$ | 8 | | 40 | k Ω | |
| tCONV | 10-bit conversion time ⁽¹⁾⁽²⁾ | | 2.06 | | | μs | |
| tCONV | 8-bit conversion time ⁽¹⁾⁽²⁾ | | 1.75 | | | μs | |
| tSAMP | Sampling time ⁽¹⁾ | | 0.188 | | | μs | |
| VREF | Reference voltage | | 2 | | VCC1 | V | |
| VIA | Analog input voltage | | 0 | | VREF | V | |

NOTES:

1. The value is obtained when ϕ_{AD} frequency is at 16 MHz. Keep ϕ_{AD} frequency at 16 MHz or lower.
2. With using the sample and hold function

Table 5.9 D/A Conversion Characteristics
($VCC1 = VCC2 = VREF = 4.2$ to 5.5 V, $VSS = AVSS = 0$ V, $Topr = -20$ to $85^{\circ}C$, $f(CPU) = 32MHz$ unless otherwise specified)

| Symbol | Parameter | Measurement Condition | Standard | | | Unit |
|--------|--------------------------------------|-----------------------|----------|------|------|------------|
| | | | Min. | Typ. | Max. | |
| – | Resolution | | | | 8 | Bits |
| – | Absolute accuracy | | | | 1.0 | % |
| tsu | Setup time | | | | 3 | μs |
| RO | Output resistance | | 4 | 10 | 20 | k Ω |
| IVREF | Reference power supply input current | (note 1) | | | 1.5 | mA |

NOTE:

1. Measured when one D/A converter is used, and the DAi register ($i = 0, 1$) of the unused D/A converter is set to 00h. The current flown into the resistor ladder in the A/D converter is excluded. IVREF flows even if the VCUT bit in the AD0CON1 register is set to 0 (VREF not connected)

$$VCC1 = VCC2 = 5V$$

**Table 5.10 Flash Memory Electrical Characteristics (VCC1 = 4.5 V to 5.5 V, 3.0 to 3.6 V,
Topr = 0 to 60°C unless otherwise specified)**

| Symbol | Parameter | Measurement Condition | Standard | | | Unit |
|--------|---|-----------------------|----------|------|------|-------|
| | | | Min. | Typ. | Max. | |
| – | Erase and program endurance ⁽¹⁾ | | 100 | | | times |
| – | Word program time (16 bits) (VCC1 = 5.0 V, Topr = 25°C) | | | 25 | 300 | μs |
| – | Lock bit program time | | | 25 | 300 | μs |
| – | Block erase time (VCC1 = 5.0 V, Topr = 25°C) | 4-Kbyte block | | 0.3 | 4 | s |
| | | 8-Kbyte block | | 0.3 | 4 | s |
| | | 32-Kbyte block | | 0.5 | 4 | s |
| | | 64-Kbyte block | | 0.8 | 4 | s |
| tps | Wait time to stabilize flash memory circuit | | | 15 | | μs |
| – | Data hold time (Topr = -40 to 85°C) | | 10 | | | years |

NOTE:

1. If erase and program endurance is n times (n = 100), each block can be erased n times. For example, if a 4-Kbyte block A is erased after programming a word data 2,048 times, each to a different address, this counts as one erase and program time. Data can not be programmed to the same address more than once without erasing the block. (rewrite prohibited)

$$VCC1 = VCC2 = 5V$$

Table 5.11 Voltage Detection Circuit Electrical Characteristics
($VCC1 = VCC2 = 3.0$ to 5.5 V, $VSS = 0$ V, $T_{opr} = 25^{\circ}\text{C}$ unless otherwise specified)

| Symbol | Parameter | Measurement Condition | Standard | | | Unit |
|--------|----------------------------------|-----------------------|----------|------|------|------|
| | | | Min. | Typ. | Max. | |
| Vdet4 | Vdet4 detection voltage | VCC1 = 3.0 V to 5.5 V | 3.3 | 3.8 | 4.4 | V |
| Vdet3 | Vdet3 detection voltage | | | 3.0 | | V |
| Vdet3s | Hardware reset 2 hold voltage | | | | 2.0 | V |
| Vdet3r | Hardware reset 2 release voltage | | | 3.1 | | V |

NOTES:

1. $V_{det4} > V_{det3}$
2. $V_{det3r} > V_{det3}$ is not guaranteed.

Table 5.12 Power Supply Circuit Timing Characteristics

| Symbol | Parameter | Measurement Condition | Standard | | | Unit |
|---------|--|------------------------|----------|------------------|------|---------------|
| | | | Min. | Typ. | Max. | |
| td(P-R) | Wait time to stabilize internal supply voltage when power-on | VCC1 = 3.0 to 5.5 V | | | 2 | ms |
| td(S-R) | Wait time to release hardware reset 2 | VCC1 = Vdet3r to 5.5 V | | 6 ⁽¹⁾ | 20 | ms |
| td(E-A) | Start-up time for Vdet3 and Vdet4 detection circuit | VCC1 = 3.0 to 5.5 V | | | 20 | μs |

NOTE:

1. When $VCC1 = 5$ V

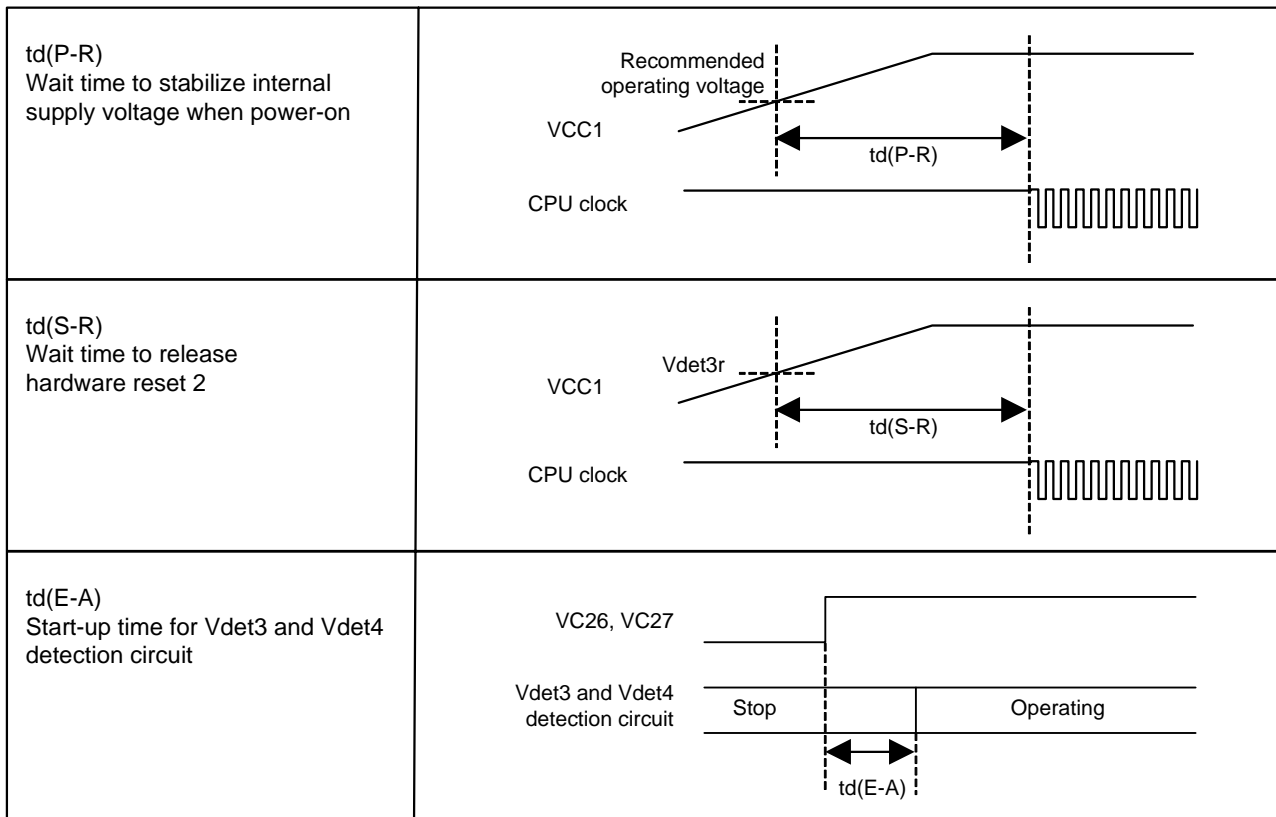


Figure 5.1 Power Supply Timing Diagram

$$VCC1 = VCC2 = 5V$$

Timing Requirements

(VCC1 = VCC2 = 4.2 to 5.5 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.13 External Clock Input

| Symbol | Parameter | Standard | | Unit |
|--------|---|----------|------|------|
| | | Min. | Max. | |
| tc | External clock input cycle time | 31.25 | | ns |
| tw(H) | External clock input high ("H") pulse width | 13.75 | | ns |
| tw(L) | External clock input low ("L") pulse width | 13.75 | | ns |
| tr | External clock rise time | | 5 | ns |
| tf | External clock fall time | | 5 | ns |

Table 5.14 Timer A Input (Count Source Input in Event Counter Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TA) | TAiIN input cycle time | 100 | | ns |
| tw(TAH) | TAiIN input high ("H") pulse width | 40 | | ns |
| tw(TAL) | TAiIN input low ("L") pulse width | 40 | | ns |

i = 0 to 4

Table 5.15 Timer A Input (Gate Signal Input in Timer Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TA) | TAiIN input cycle time | 400 | | ns |
| tw(TAH) | TAiIN input high ("H") pulse width | 200 | | ns |
| tw(TAL) | TAiIN input low ("L") pulse width | 200 | | ns |

i = 0 to 4

Table 5.16 Timer A Input (External Trigger Input in One-Shot Timer Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TA) | TAiIN input cycle time | 200 | | ns |
| tw(TAH) | TAiIN input high ("H") pulse width | 100 | | ns |
| tw(TAL) | TAiIN input low ("L") pulse width | 100 | | ns |

i = 0 to 4

Table 5.17 Timer A Input (External Trigger Input in Pulse Width Modulation Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tw(TAH) | TAiIN input high ("H") pulse width | 100 | | ns |
| tw(TAL) | TAiIN input low ("L") pulse width | 100 | | ns |

i = 0 to 4

$$VCC1 = VCC2 = 5V$$

Timing Requirements

(VCC1 = VCC2 = 4.2 to 5.5 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.18 Timer A Input (Counter Increment/Decrement Input in Event Counter Mode)

| Symbol | Parameter | Standard | | Unit |
|-------------|-------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(UP) | TAiOUT input cycle time | 2000 | | ns |
| tw(UPH) | TAiOUT input high ("H") pulse width | 1000 | | ns |
| tw(UPL) | TAiOUT input low ("L") pulse width | 1000 | | ns |
| tsu(UP-TIN) | TAiOUT input setup time | 400 | | ns |
| th(TIN-UP) | TAiOUT input hold time | 400 | | ns |

i = 0 to 4

Table 5.19 Timer A Input (Two-Phase Pulse Input in Event Counter Mode)

| Symbol | Parameter | Standard | | Unit |
|-----------------|-------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TA) | TAiIN input cycle time | 800 | | ns |
| tsu(TAIN-TAOUT) | TAiOUT input setup time | 200 | | ns |
| tsu(TAOUT-TAIN) | TAiIN input setup time | 200 | | ns |

i = 0 to 4

Table 5.20 Timer B Input (Count Source Input in Event Counter Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|--|----------|------|------|
| | | Min. | Max. | |
| tc(TB) | TBiIN input cycle time (counted on one edge) | 100 | | ns |
| tw(TBH) | TBiIN input high ("H") pulse width (counted on one edge) | 40 | | ns |
| tw(TBL) | TBiIN input low ("L") pulse width (counted on one edge) | 40 | | ns |
| tc(TB) | TBiIN input cycle time (counted on both edges) | 200 | | ns |
| tw(TBH) | TBiIN input high ("H") pulse width (counted on both edges) | 80 | | ns |
| tw(TBL) | TBiIN input low ("L") pulse width (counted on both edges) | 80 | | ns |

i = 0 to 5

Table 5.21 Timer B Input (Pulse Period Measurement Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TB) | TBiIN input cycle time | 400 | | ns |
| tw(TBH) | TBiIN input high ("H") pulse width | 200 | | ns |
| tw(TBL) | TBiIN input low ("L") pulse width | 200 | | ns |

i = 0 to 5

Table 5.22 Timer B Input (Pulse Width Measurement Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TB) | TBiIN input cycle time | 400 | | ns |
| tw(TBH) | TBiIN input high ("H") pulse width | 200 | | ns |
| tw(TBL) | TBiIN input low ("L") pulse width | 200 | | ns |

i = 0 to 5

$$VCC1 = VCC2 = 5V$$

Timing Requirements

(VCC1 = VCC2 = 4.2 to 5.5 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.23 A/D Trigger Input

| Symbol | Parameter | Standard | | Unit |
|---------|---|----------|------|------|
| | | Min. | Max. | |
| tc(AD) | ADTRG input cycle time (required for trigger) | 1000 | | ns |
| tw(ADL) | ADTRG input low ("L") pulse width | 125 | | ns |

Table 5.24 Serial Interface

| Symbol | Parameter | Standard | | Unit |
|----------|-----------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(CK) | CLKi input cycle time | 200 | | ns |
| tw(CKH) | CLKi input high ("H") pulse width | 100 | | ns |
| tw(CKL) | CLKi input low ("L") pulse width | 100 | | ns |
| td(C-Q) | TXDi output delay time | | 80 | ns |
| th(C-Q) | TXDi output hold time | 0 | | ns |
| tsu(D-C) | RXDi input setup time | 70 | | ns |
| th(C-D) | RXDi input hold time | 90 | | ns |

i = 0 to 6

Table 5.25 Intelligent I/O Communication Function (Groups 0 and 1)

| Symbol | Parameter | Standard | | Unit |
|----------|-------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(CK) | ISCLKi input cycle time | 600 | | ns |
| tw(CKH) | ISCLKi input high ("H") pulse width | 300 | | ns |
| tw(CKL) | ISCLKi input low ("L") pulse width | 300 | | ns |
| td(C-Q) | ISTXDi output delay time | | 100 | ns |
| th(C-Q) | ISTXDi output hold time | 0 | | ns |
| tsu(D-C) | ISRXDi input setup time | 100 | | ns |
| th(C-D) | ISRXDi input hold time | 100 | | ns |

i = 0, 1

Table 5.26 Intelligent I/O Communication Function (Group 2)

| Symbol | Parameter | Standard | | Unit |
|----------|-------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(CK) | ISCLK2 input cycle time | 600 | | ns |
| tw(CKH) | ISCLK2 input high ("H") pulse width | 300 | | ns |
| tw(CKL) | ISCLK2 input low ("L") pulse width | 300 | | ns |
| td(C-Q) | ISTXD2 output delay time | | 180 | ns |
| th(C-Q) | ISTXD2 output hold time | 0 | | ns |
| tsu(D-C) | ISRXD2 input setup time | 150 | | ns |
| th(C-D) | ISRXD2 input hold time | 100 | | ns |

$$VCC1 = VCC2 = 5V$$

Timing Requirements

(VCC1 = VCC2 = 4.2 to 5.5 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.27 External Interrupt \overline{INTi} Input (Edge Sensitive)

| Symbol | Parameter | Standard | | Unit |
|---------|--|----------|------|------|
| | | Min. | Max. | |
| tw(INH) | \overline{INTi} input high ("H") pulse width | 250 | | ns |
| tw(INL) | \overline{INTi} input low ("L") pulse width | 250 | | ns |

i = 0 to 8⁽¹⁾

NOTE:

- $\overline{INT6}$ to $\overline{INT8}$ are provided in the 144-pin package only.

$$VCC1 = VCC2 = 5V$$

Timing Requirements

(VCC1 = VCC2 = 4.2 to 5.5 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.28 Memory Expansion mode and Microprocessor Mode

| Symbol | Parameter | Standard | | Unit |
|----------------|---|----------|----------|------|
| | | Min. | Max. | |
| tac1(RD-DB) | Data input access time (RD standard) | | (note 1) | ns |
| tac1(AD-DB) | Data input access time (AD standard, CS standard) | | (note 1) | ns |
| tac2(RD-DB) | Data input access time (RD standard, when accessing a space with the multiplexed bus) | | (note 1) | ns |
| tac2(AD-DB) | Data input access time (AD standard, when accessing a space with the multiplexed bus) | | (note 1) | ns |
| tsu(DB-BCLK) | Data input setup time | 26 | | ns |
| tsu(RDY-BCLK) | \overline{RDY} input setup time | 26 | | ns |
| tsu(HOLD-BCLK) | \overline{HOLD} input setup time | 30 | | ns |
| th(RD-DB) | Data input hold time | 0 | | ns |
| th(BCLK-RDY) | \overline{RDY} input hold time | 0 | | ns |
| th(BCLK-HOLD) | \overline{HOLD} input hold time | 0 | | ns |
| td(BCLK-HLDA) | \overline{HLDA} output delay time | | 25 | ns |

NOTE:

1. Values, which depend on BCLK frequency and external bus cycles, can be obtained from the following equations. Insert wait states or lower the operation frequency, f(BCLK), if the calculated value is negative.

$$tac1(RD-DB) = \frac{10^9 \times m}{f(BCLK) \times 2} - 35 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, m = (b \times 2) + 1)$$

$$tac1(AD-DB) = \frac{10^9 \times n}{f(BCLK)} - 35 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, n = a + b)$$

$$tac2(RD-DB) = \frac{10^9 \times m}{f(BCLK) \times 2} - 35 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, m = (b \times 2) - 1)$$

$$tac2(AD-DB) = \frac{10^9 \times p}{f(BCLK) \times 2} - 35 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, p = \{(a + b - 1) \times 2\} + 1)$$

$$VCC1 = VCC2 = 5V$$

Switching Characteristics

(VCC1 = VCC2 = 4.2 to 5.5 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.29 Memory Expansion Mode and Microprocessor Mode (when accessing external memory space)

| Symbol | Parameter | Measurement Condition | Standard | | Unit |
|-------------|--|-----------------------|----------|------|------|
| | | | Min. | Max. | |
| td(BCLK-AD) | Address output delay time | See Figure 5.2 | | 18 | ns |
| th(BCLK-AD) | Address output hold time (BCLK standard) | | -3 | | ns |
| th(RD-AD) | Address output hold time (RD standard) ⁽³⁾ | | 0 | | ns |
| th(WR-AD) | Address output hold time (WR standard) ⁽³⁾ | | (note 1) | | ns |
| td(BCLK-CS) | Chip-select signal output delay time | | | 18 | ns |
| th(BCLK-CS) | Chip-select signal output hold time (BCLK standard) | | -3 | | ns |
| th(RD-CS) | Chip-select signal output hold time (RD standard) ⁽³⁾ | | 0 | | ns |
| th(WR-CS) | Chip-select signal output hold time (WR standard) ⁽³⁾ | | (note 1) | | ns |
| td(BCLK-RD) | RD signal output delay time | | | 18 | ns |
| th(BCLK-RD) | RD signal output hold time | | -5 | | ns |
| td(BCLK-WR) | WR signal output delay time | | | 18 | ns |
| th(BCLK-WR) | WR signal output hold time | | -5 | | ns |
| td(DB-WR) | Data output delay time (WR standard) | | (note 2) | | ns |
| th(WR-DB) | Data output hold time (WR standard) ⁽³⁾ | | (note 1) | | ns |
| tw(WR) | WR output width | | (note 2) | | ns |

NOTES:

1. Values, which depend on BCLK frequency, can be obtained from the following equations.

$$th(WR-DB) = \frac{10^9}{f(BCLK) \times 2} - 15 \text{ [ns]}$$

$$th(WR-AD) = \frac{10^9}{f(BCLK) \times 2} - 10 \text{ [ns]}$$

$$th(WR-CS) = \frac{10^9}{f(BCLK) \times 2} - 10 \text{ [ns]}$$

2. Values, which depend on BCLK frequency and external bus cycles, can be obtained from the following equations.

$$td(DB-WR) = \frac{10^9 \times m}{f(BCLK)} - 20 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, m = b)$$

$$tw(WR) = \frac{10^9 \times n}{f(BCLK) \times 2} - 15 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, n = (b \times 2) - 1)$$

3. tc [ns] is added when recovery cycle is inserted.

$$VCC1 = VCC2 = 5V$$

Switching Characteristics

(VCC1 = VCC2 = 4.2 to 5.5 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.30 Memory Expansion Mode and Microprocessor Mode (when accessing external memory space with multiplexed bus)

| Symbol | Parameter | Measurement Condition | Standard | | Unit |
|--------------|--|-----------------------|----------|------|------|
| | | | Min. | Max. | |
| td(BCLK-AD) | Address output delay time | See Figure 5.2 | | 18 | ns |
| th(BCLK-AD) | Address output hold time (BCLK standard) | | -3 | | ns |
| th(RD-AD) | Address output hold time (RD standard) ⁽⁵⁾ | | (note 1) | | ns |
| th(WR-AD) | Address output hold time (WR standard) ⁽⁵⁾ | | (note 1) | | ns |
| td(BCLK-CS) | Chip-select signal output delay time | | | 18 | ns |
| th(BCLK-CS) | Chip-select signal output hold time (BCLK standard) | | -3 | | ns |
| th(RD-CS) | Chip-select signal output hold time (RD standard) ⁽⁵⁾ | | (note 1) | | ns |
| th(WR-CS) | Chip-select signal output hold time (WR standard) ⁽⁵⁾ | | (note 1) | | ns |
| td(BCLK-RD) | RD signal output delay time | | | 18 | ns |
| th(BCLK-RD) | RD signal output hold time | | -5 | | ns |
| td(BCLK-WR) | WR signal output delay time | | | 18 | ns |
| th(BCLK-WR) | WR signal output hold time | | -5 | | ns |
| td(DB-WR) | Data output delay time (WR standard) | | (note 2) | | ns |
| th(WR-DB) | Data output hold time (WR standard) ⁽⁵⁾ | | (note 1) | | ns |
| td(BCLK-ALE) | ALE signal output delay time (BCLK standard) | | | 18 | ns |
| th(BCLK-ALE) | ALE signal output hold time (BCLK standard) | | -2 | | ns |
| td(AD-ALE) | ALE signal output delay time (address standard) | | (note 3) | | ns |
| th(ALE-AD) | ALE signal output hold time (address standard) | | (note 4) | | ns |
| tdz(RD-AD) | Address output float start time | | | 8 | ns |

NOTES:

- Values, which depend on BCLK frequency, can be obtained from the following equations.

$$th(RD-AD) = \frac{10^9}{f(BCLK) \times 2} - 10 \text{ [ns]}$$

$$th(WR-AD) = \frac{10^9}{f(BCLK) \times 2} - 10 \text{ [ns]}$$

$$th(RD-CS) = \frac{10^9}{f(BCLK) \times 2} - 10 \text{ [ns]}$$

$$th(WR-CS) = \frac{10^9}{f(BCLK) \times 2} - 10 \text{ [ns]}$$

$$th(WR-DB) = \frac{10^9}{f(BCLK) \times 2} - 15 \text{ [ns]}$$

- Values, which depend on BCLK frequency and external bus cycles, can be obtained from the following equation.

$$td(DB-WR) = \frac{10^9 \times m}{f(BCLK) \times 2} - 25 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, m = (b \times 2) - 1)$$

- Values, which depend on BCLK frequency and external bus cycles, can be obtained from the following equation.

$$td(AD-ALE) = \frac{10^9 \times n}{f(BCLK) \times 2} - 20 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, n = a)$$

- Values, which depend on BCLK frequency and external bus cycles, can be obtained from the following equation.

$$th(ALE-AD) = \frac{10^9 \times n}{f(BCLK) \times 2} - 20 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, n = a)$$

- tc [ns] is added when recovery cycle is inserted.



Figure 5.2 P0 to P15 Measurement Circuit



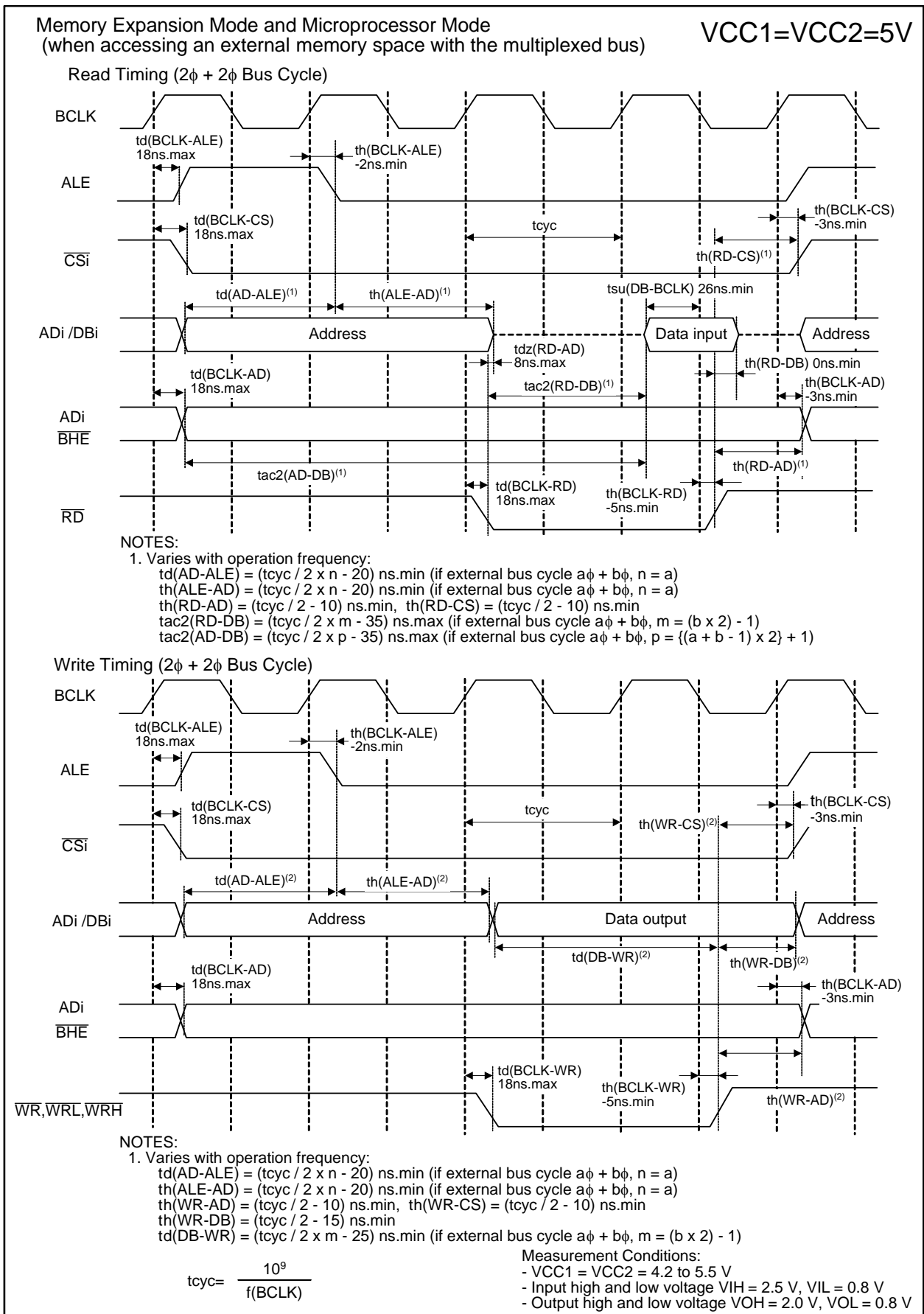
Figure 5.3 VCC1 = VCC2 = 5 V Timing Diagram (1/4)



Figure 5.4 VCC1 = VCC2 = 5 V Timing Diagram (2/4)



Figure 5.5 VCC1 = VCC2 = 5 V Timing Diagram (3/4)

Figure 5.6 $VCC1 = VCC2 = 5 \text{ V}$ Timing Diagram (4/4)

$$VCC1 = VCC2 = 3.3 \text{ V}$$

Table 5.31 Electrical Characteristics (1/3)

(VCC1 = VCC2 = 3.0 to 3.6 V, VSS = 0 V, Topr = -20 to 85°C, f(CPU) = 24 MHz unless otherwise specified)

| Symbol | Parameter | | Measurement Condition | Standard | | | Unit |
|-----------|-------------------------|---|-----------------------|--------------|------|------|------|
| | | | | Min. | Typ. | Max. | |
| VOH | Output high "H" voltage | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7 ⁽¹⁾ | IOH = -1 mA | VCC2 - 0.6 | | VCC2 | V |
| | | P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ | | VCC1 - 0.6 | | VCC1 | |
| | XOUT | IOH = -0.1 mA | 2.7 | | VCC1 | V | |
| | XCOU | Drive capability = high | No load applied | | 2.5 | | V |
| | | Drive capability = low | No load applied | | 1.6 | | V |
| VOL | Output low "L" voltage | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ | IOL = 1 mA | | | 0.5 | V |
| | | XOUT | | IOL = 0.1 mA | | | |
| | XCOU | Drive capability = high | No load applied | | 0 | | V |
| | | Drive capability = low | No load applied | | 0 | | V |
| VT+ - VT- | Hysteresis | HOLD, RDY, TA0IN to TA4IN, TBOIN to TB5IN, INT0 to INT8, ADTRG, CTS0 to CTS6, CLK0 to CLK6, TA0OUT to TA4OUT, NMI, KIO to KI3, RXD0 to RXD6, SCL0 to SCL4, SDA0 to SDA4, INPC1_0 to INPC1_7, ISCLK0 to ISCLK2, ISRXD0 to ISRXD2, IEIN, CAN0IN, CAN1IN, CAN1WU | | 0.2 | | 1.0 | V |
| | | RESET | | 0.2 | | 1.8 | V |

NOTE:

1. P11 to P15 are provided in the 144-pin package only.

$$VCC1 = VCC2 = 3.3 \text{ V}$$

Table 5.32 Electrical Characteristics (2/3)
(VCC1 = VCC2 = 3.0 to 3.6 V, VSS = 0 V, Topr = -20 to 85°C, f(CPU) = 24 MHz unless otherwise specified)

| Symbol | Parameter | | Measurement Condition | Standard | | | Unit |
|--------------------|----------------------------|--|-----------------------|----------|------|------|------|
| | | | | Min. | Typ. | Max. | |
| I _{IH} | Input high "H" current | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ , XIN, $\overline{\text{RESET}}$, CNVSS, BYTE | V _I = 3 V | | | 4.0 | μA |
| I _{IL} | Input low "L" current | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_0 to P7_7, P8_0 to P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ , XIN, $\overline{\text{RESET}}$, CNVSS, BYTE | V _I = 0V | | | -4.0 | μA |
| RPULLUP | Pull-up resistance | P0_0 to P0_7, P1_0 to P1_7, P2_0 to P2_7, P3_0 to P3_7, P4_0 to P4_7, P5_0 to P5_7, P6_0 to P6_7, P7_2 to P7_7, P8_0 to P8_4, P8_6, P8_7, P9_0 to P9_7, P10_0 to P10_7, P11_0 to P11_4, P12_0 to P12_7, P13_0 to P13_7, P14_0 to P14_6, P15_0 to P15_7 ⁽¹⁾ | V _I =0V | 40 | 90 | 500 | kΩ |
| R _{fXIN} | Feedback resistance | XIN | | | 3.0 | | MΩ |
| R _{fXCIN} | Feedback resistance | XCIN | | | 20.0 | | MΩ |
| VRAM | RAM data retention voltage | In stop mode | | 2.0 | | | V |

NOTE:

1. P11 to P15 are provided in the 144-pin package only.

$$VCC1 = VCC2 = 3.3 V$$

Table 5.33 Electrical Characteristics (3/3)
(VCC1 = VCC2 = 3.3 V, VSS = 0 V, Topr = 25°C)

| Symbol | Parameter | Measurement Condition ⁽¹⁾ | | | Standard | | | Unit |
|--------|----------------------|--------------------------------------|---|--|----------|------|------|------|
| | | | | | Min. | Typ. | Max. | |
| ICC | Power supply current | Flash memory version | f(CPU) = 24 MHz | | 23 | 33 | mA | |
| | | | f(CPU) = 16 MHz | | 17 | | mA | |
| | | | f(CPU) = 8 MHz | | 11 | | mA | |
| | | | f(CPU) = f(Ring) In on-chip oscillator low-power consumption mode | | 2.6 | | mA | |
| | | | f(CPU) = 32 kHz In low-power consumption mode While flash memory is operating | | 430 | | μA | |
| | | | f(CPU) = 32 kHz In low-power consumption mode While flash memory is stopped ⁽²⁾ | | 30 | | μA | |
| | | | Wait mode: f(CPU) = f(Ring) After entering wait mode from on-chip oscillator low-power consumption mode | | 45 | | μA | |
| | | | Stop mode (while clock is stopped) | | 0.8 | 5 | μA | |
| | | | Stop mode (while clock is stopped) Topr = 85°C | | | 50 | μA | |
| | | Mask ROM version | f(CPU) = 24 MHz | | 23 | 33 | mA | |
| | | | f(CPU) = 16 MHz | | 17 | | mA | |
| | | | f(CPU) = 8 MHz | | 11 | | mA | |
| | | | f(CPU) = f(Ring) In on-chip oscillator low-power consumption mode | | 1 | | mA | |
| | | | f(CPU) = 32 kHz In low-power consumption mode | | 30 | | μA | |
| | | | Wait mode: f(CPU) = f(Ring) After entering wait mode from on-chip oscillator low-power consumption mode | | 45 | | μA | |
| | | | Stop mode (while clock is stopped) | | 0.8 | 5 | μA | |
| | | | Stop mode (while clock is stopped) Topr = 85°C | | | 50 | μA | |

NOTES:

1. In single-chip mode, leave the output pins open and connect the input pins to VSS.
2. Value is obtained when setting the FMSTP bit in the FMR0 register to 1 (flash memory stopped) and running the program on RAM.

$$VCC1 = VCC2 = 3.3 \text{ V}$$

Table 5.34 A/D Conversion Characteristics
(VCC1 = VCC2 = AVCC = VREF = 3.0 to 3.6 V, VSS = AVSS = 0 V, Topr = -20 to 85°C,
f(CPU) = 24MHz unless otherwise specified)

| Symbol | Parameter | Measurement Condition | Standard | | | Unit |
|---------|---|----------------------------|----------|------|------|------|
| | | | Min. | Typ. | Max. | |
| – | Resolution | VREF = VCC1 | | | 10 | Bits |
| INL | Integral nonlinearity error (8-bit) | VREF = VCC1 = VCC2 = 3.3 V | | | ±2 | LSB |
| DNL | Differential nonlinearity error (8-bit) | | | | ±1 | LSB |
| – | Offset error (8-bit) | | | | ±2 | LSB |
| – | Gain error (8-bit) | | | | ±2 | LSB |
| RLADDER | Resistor ladder | VREF = VCC1 | 8 | | 40 | kΩ |
| tCONV | 8-bit conversion time ⁽¹⁾⁽²⁾ | | 4.9 | | | μs |
| VREF | Reference voltage | | 3 | | VCC1 | V |
| VIA | Analog input voltage | | 0 | | VREF | V |

NOTES:

- The value when ϕ_{AD} frequency is at 10 MHz. Keep ϕ_{AD} frequency at 10 MHz or lower.
If f(CPU) (=fAD) is 24 MHz, divide f(CPU) by 3 to make it 8 MHz. The conversion time in this case is 6.1 μs.
- Sample and hold function is not available.

Table 5.35 D/A Conversion Characteristics
(VCC1 = VCC2 = VREF = 3.0 to 3.6 V, VSS = AVSS = 0 V, Topr = -20 to 85°C,
f(CPU) = 24MHz unless otherwise specified)

| Symbol | Parameter | Measurement Condition | Standard | | | Unit |
|--------|--------------------------------------|-----------------------|----------|------|------|------|
| | | | Min. | Typ. | Max. | |
| – | Resolution | | | | 8 | Bits |
| – | Absolute accuracy | | | | 1.0 | % |
| tsu | Setup time | | | | 3 | μs |
| RO | Output resistance | | 4 | 10 | 20 | kΩ |
| IVREF | Reference power supply input current | (note 1) | | | 1.0 | mA |

NOTE:

- Measurement when one D/A converter is used, and the DAI register (i = 0, 1) of the unused D/A converter is set to 00h. The current flown into the resistor ladder in the A/D converter is excluded. IVREF flows even if VCUT bit in the AD0CON1 register is set to 0 (VREF not connected)

$$VCC1 = VCC2 = 3.3 V$$

Timing Requirements

(VCC1 = VCC2 = 3.0 to 3.6 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.36 External Clock Input

| Symbol | Parameter | Standard | | Unit |
|--------|---|----------|------|------|
| | | Min. | Max. | |
| tc | External clock input cycle time | 41 | | ns |
| tw(H) | External clock input high ("H") pulse width | 18 | | ns |
| tw(L) | External clock input low ("L") pulse width | 18 | | ns |
| tr | External clock rise time | | 5 | ns |
| tf | External clock fall time | | 5 | ns |

Table 5.37 Timer A Input (Count Source Input in Event Counter Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TA) | TAiIN input cycle time | 100 | | ns |
| tw(TAH) | TAiIN input high ("H") pulse width | 40 | | ns |
| tw(TAL) | TAiIN input low ("L") pulse width | 40 | | ns |

i = 0 to 4

Table 5.38 Timer A Input (Gate Signal Input in Timer Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TA) | TAiIN input cycle time | 400 | | ns |
| tw(TAH) | TAiIN input high ("H") pulse width | 200 | | ns |
| tw(TAL) | TAiIN input low ("L") pulse width | 200 | | ns |

i = 0 to 4

Table 5.39 Timer A Input (External Trigger Input in One-Shot Timer Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TA) | TAiIN input cycle time | 200 | | ns |
| tw(TAH) | TAiIN input high ("H") pulse width | 100 | | ns |
| tw(TAL) | TAiIN input low ("L") pulse width | 100 | | ns |

i = 0 to 4

Table 5.40 Timer A Input (External Trigger Input in Pulse Width Modulation Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tw(TAH) | TAiIN input high ("H") pulse width | 100 | | ns |
| tw(TAL) | TAiIN input low ("L") pulse width | 100 | | ns |

i = 0 to 4

$$VCC1 = VCC2 = 3.3 V$$

Timing Requirements

(VCC1 = VCC2 = 3.0 to 3.6 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.41 Timer A Input (Counter Increment/Decrement Input in Event Counter Mode)

| Symbol | Parameter | Standard | | Unit |
|-------------|-------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(UP) | TAiOUT input cycle time | 2000 | | ns |
| tw(UPH) | TAiOUT input high ("H") pulse width | 1000 | | ns |
| tw(UPL) | TAiOUT input low ("L") pulse width | 1000 | | ns |
| tsu(UP-TIN) | TAiOUT input setup time | 400 | | ns |
| th(TIN-UP) | TAiOUT input hold time | 400 | | ns |

i = 0 to 4

Table 5.42 Timer A Input (Two-Phase Pulse Input in Event Counter Mode)

| Symbol | Parameter | Standard | | Unit |
|-----------------|-------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TA) | TAiIN input cycle time | 2 | | μs |
| tsu(TAIN-TAOUT) | TAiOUT input setup time | 500 | | ns |
| tsu(TAOUT-TAIN) | TAiIN input setup time | 500 | | ns |

i = 0 to 4

Table 5.43 Timer B Input (Count Source Input in Event Counter Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|--|----------|------|------|
| | | Min. | Max. | |
| tc(TB) | TBiIN input cycle time (counted on one edge) | 100 | | ns |
| tw(TBH) | TBiIN input high ("H") pulse width (counted on one edge) | 40 | | ns |
| tw(TBL) | TBiIN input low ("L") pulse width (counted on one edge) | 40 | | ns |
| tc(TB) | TBiIN input cycle time (counted on both edges) | 200 | | ns |
| tw(TBH) | TBiIN input high ("H") pulse width (counted on both edges) | 80 | | ns |
| tw(TBL) | TBiIN input low ("L") pulse width (counted on both edges) | 80 | | ns |

i = 0 to 5

Table 5.44 Timer B Input (Pulse Period Measurement Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TB) | TBiIN input cycle time | 400 | | ns |
| tw(TBH) | TBiIN input high ("H") pulse width | 200 | | ns |
| tw(TBL) | TBiIN input low ("L") pulse width | 200 | | ns |

i = 0 to 5

Table 5.45 Timer B Input (Pulse Width Measurement Mode)

| Symbol | Parameter | Standard | | Unit |
|---------|------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(TB) | TBiIN input cycle time | 400 | | ns |
| tw(TBH) | TBiIN input high ("H") pulse width | 200 | | ns |
| tw(TBL) | TBiIN input low ("L") pulse width | 200 | | ns |

i = 0 to 5

$$VCC1 = VCC2 = 3.3 V$$

Timing Requirements

(VCC1 = VCC2 = 3.0 to 3.6 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.46 A/D Trigger Input

| Symbol | Parameter | Standard | | Unit |
|---------|---|----------|------|------|
| | | Min. | Max. | |
| tc(AD) | ADTRG input cycle time (required for trigger) | 1000 | | ns |
| tw(ADL) | ADTRG input low ("L") pulse width | 125 | | ns |

Table 5.47 Serial Interface

| Symbol | Parameter | Standard | | Unit |
|----------|-----------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(CK) | CLKi input cycle time | 200 | | ns |
| tw(CKH) | CLKi input high ("H") pulse width | 100 | | ns |
| tw(CKL) | CLKi input low ("L") pulse width | 100 | | ns |
| td(C-Q) | TXDi output delay time | | 80 | ns |
| th(C-Q) | TXDi output hold time | 0 | | ns |
| tsu(D-C) | RXDi input setup time | 70 | | ns |
| th(C-D) | RXDi input hold time | 90 | | ns |

i = 0 to 6

Table 5.48 Intelligent I/O Communication Function (Groups 0 and 1)

| Symbol | Parameter | Standard | | Unit |
|----------|-------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(CK) | ISCLKi input cycle time | 600 | | ns |
| tw(CKH) | ISCLKi input high ("H") pulse width | 300 | | ns |
| tw(CKL) | ISCLKi input low ("L") pulse width | 300 | | ns |
| td(C-Q) | ISTXDi output delay time | | 100 | ns |
| th(C-Q) | ISTXDi output hold time | 0 | | ns |
| tsu(D-C) | ISRXDi input setup time | 100 | | ns |
| th(C-D) | ISRXDi input hold time | 100 | | ns |

i = 0, 1

Table 5.49 Intelligent I/O Communication Function (Group 2)

| Symbol | Parameter | Standard | | Unit |
|----------|-------------------------------------|----------|------|------|
| | | Min. | Max. | |
| tc(CK) | ISCLK2 input cycle time | 600 | | ns |
| tw(CKH) | ISCLK2 input high ("H") pulse width | 300 | | ns |
| tw(CKL) | ISCLK2 input low ("L") pulse width | 300 | | ns |
| td(C-Q) | ISTXD2 output delay time | | 180 | ns |
| th(C-Q) | ISTXD2 output hold time | 0 | | ns |
| tsu(D-C) | ISRXD2 input setup time | 150 | | ns |
| th(C-D) | ISRXD2 input hold time | 100 | | ns |

$$VCC1 = VCC2 = 3.3 \text{ V}$$

Timing Requirements

(VCC1 = VCC2 = 3.0 to 3.6 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.50 External Interrupt \overline{INTi} Input (Edge Sensitive)

| Symbol | Parameter | Standard | | Unit |
|---------|--|----------|------|------|
| | | Min. | Max. | |
| tw(INH) | \overline{INTi} input high ("H") pulse width | 250 | | ns |
| tw(INL) | \overline{INTi} input low ("L") pulse width | 250 | | ns |

i = 0 to 8⁽¹⁾

NOTE:

1. $\overline{INT6}$ to $\overline{INT8}$ are provided in the 144-pin package only.

$$VCC1 = VCC2 = 3.3 \text{ V}$$

Timing Requirements

(VCC1 = VCC2 = 3.0 to 3.6 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.51 Memory Expansion Mode and Microprocessor Mode

| Symbol | Parameter | Standard | | Unit |
|----------------|---|----------|----------|------|
| | | Min. | Max. | |
| tac1(RD-DB) | Data input access time (RD standard) | | (note 1) | ns |
| tac1(AD-DB) | Data input access time (AD standard, CS standard) | | (note 1) | ns |
| tac2(RD-DB) | Data input access time (RD standard, when accessing a space with the multiplexed bus) | | (note 1) | ns |
| tac2(AD-DB) | Data input access time (AD standard, when accessing a space with the multiplexed bus) | | (note 1) | ns |
| tsu(DB-BCLK) | Data input setup time | 30 | | ns |
| tsu(RDY-BCLK) | $\overline{\text{RDY}}$ input setup time | 40 | | ns |
| tsu(HOLD-BCLK) | $\overline{\text{HOLD}}$ input setup time | 60 | | ns |
| th(RD-DB) | Data input hold time | 0 | | ns |
| th(BCLK-RDY) | $\overline{\text{RDY}}$ input hold time | 0 | | ns |
| th(BCLK-HOLD) | $\overline{\text{HOLD}}$ input hold time | 0 | | ns |
| td(BCLK-HLDA) | $\overline{\text{HLDA}}$ output delay time | | 25 | ns |

NOTE:

1. Values, which depend on BCLK frequency and external bus cycles, can be obtained from the following equations. Insert wait states or lower the operation frequency, f(BCLK), if the calculated value is negative.

$$tac1(\text{RD-DB}) = \frac{10^9 \times m}{f(\text{BCLK}) \times 2} - 35 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, m = (b \times 2) + 1)$$

$$tac1(\text{AD-DB}) = \frac{10^9 \times n}{f(\text{BCLK})} - 35 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, n = a + b)$$

$$tac2(\text{RD-DB}) = \frac{10^9 \times m}{f(\text{BCLK}) \times 2} - 35 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, m = (b \times 2) - 1)$$

$$tac2(\text{AD-DB}) = \frac{10^9 \times p}{f(\text{BCLK}) \times 2} - 35 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, p = \{(a + b - 1) \times 2\} + 1)$$

$$VCC1 = VCC2 = 3.3 V$$

Switching Characteristics

(VCC1 = VCC2 = 3.0 to 3.6 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.52 Memory Expansion Mode and Microprocessor Mode (when accessing external memory space)

| Symbol | Parameter | Measurement Condition | Standard | | Unit |
|-------------|--|-----------------------|----------|------|------|
| | | | Min. | Max. | |
| td(BCLK-AD) | Address output delay time | See Figure 5.2 | | 18 | ns |
| th(BCLK-AD) | Address output hold time (BCLK standard) | | -3 | | ns |
| th(RD-AD) | Address output hold time (RD standard) ⁽³⁾ | | 0 | | ns |
| th(WR-AD) | Address output hold time (WR standard) ⁽³⁾ | | (note 1) | | ns |
| td(BCLK-CS) | Chip-select signal output delay time | | | 18 | ns |
| th(BCLK-CS) | Chip-select signal output hold time (BCLK standard) | | -3 | | ns |
| th(RD-CS) | Chip-select signal output hold time (RD standard) ⁽³⁾ | | 0 | | ns |
| th(WR-CS) | Chip-select signal output hold time (WR standard) ⁽³⁾ | | (note 1) | | ns |
| td(BCLK-RD) | RD signal output delay time | | | 18 | ns |
| th(BCLK-RD) | RD signal output hold time | | -5 | | ns |
| td(BCLK-WR) | WR signal output delay time | | | 18 | ns |
| th(BCLK-WR) | WR signal output hold time | | 0 | | ns |
| td(DB-WR) | Data output delay time (WR standard) | | (note 2) | | ns |
| th(WR-DB) | Data output hold time (WR standard) ⁽³⁾ | | (note 1) | | ns |
| tw(WR) | WR output width | | (note 2) | | ns |

NOTES:

1. Values, which depend on BCLK frequency, can be obtained from the following equations.

$$th(WR-DB) = \frac{10^9}{f(BCLK) \times 2} - 20 \text{ [ns]}$$

$$th(WR-AD) = \frac{10^9}{f(BCLK) \times 2} - 15 \text{ [ns]}$$

$$th(WR-CS) = \frac{10^9}{f(BCLK) \times 2} - 10 \text{ [ns]}$$

2. Values, which depend on BCLK frequency and external bus cycles, can be obtained from the following equations.

$$td(DB-WR) = \frac{10^9 \times m}{f(BCLK)} - 20 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, m = b)$$

$$tw(WR) = \frac{10^9 \times n}{f(BCLK) \times 2} - 15 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, n = (b \times 2) - 1)$$

3. tc [ns] is added when recovery cycle is inserted.

$$VCC1 = VCC2 = 3.3 V$$

Switching Characteristics

(VCC1 = VCC2 = 3.0 to 3.6 V, VSS = 0 V, Topr = -20 to 85°C unless otherwise specified)

Table 5.53 Memory Expansion Mode and Microprocessor Mode (when accessing external memory space with multiplexed bus)

| Symbol | Parameter | Measurement Condition | Standard | | Unit |
|--------------|--|-----------------------|----------|------|------|
| | | | Min. | Max. | |
| td(BCLK-AD) | Address output delay time | See Figure 5.2 | | 18 | ns |
| th(BCLK-AD) | Address output hold time (BCLK standard) | | -3 | | ns |
| th(RD-AD) | Address output hold time (RD standard) ⁽⁵⁾ | | (note 1) | | ns |
| th(WR-AD) | Address output hold time (WR standard) ⁽⁵⁾ | | (note 1) | | ns |
| td(BCLK-CS) | Chip-select signal output delay time | | | 18 | ns |
| th(BCLK-CS) | Chip-select signal output hold time (BCLK standard) | | -3 | | ns |
| th(RD-CS) | Chip-select signal output hold time (RD standard) ⁽⁵⁾ | | (note 1) | | ns |
| th(WR-CS) | Chip-select signal output hold time (WR standard) ⁽⁵⁾ | | (note 1) | | ns |
| td(BCLK-RD) | RD signal output delay time | | | 18 | ns |
| th(BCLK-RD) | RD signal output hold time | | -5 | | ns |
| td(BCLK-WR) | WR signal output delay time | | | 18 | ns |
| th(BCLK-WR) | WR signal output hold time | | 0 | | ns |
| td(DB-WR) | Data output delay time (WR standard) | | (note 2) | | ns |
| th(WR-DB) | Data output hold time (WR standard) ⁽⁵⁾ | | (note 1) | | ns |
| td(BCLK-ALE) | ALE signal output delay time (BCLK standard) | | | 18 | ns |
| th(BCLK-ALE) | ALE signal output hold time (BCLK standard) | | -2 | | ns |
| td(AD-ALE) | ALE signal output delay time (address standard) | | (note 3) | | ns |
| th(ALE-AD) | ALE signal output hold time (address standard) | | (note 4) | | ns |
| tdz(RD-AD) | Address output float start time | | | 8 | ns |

NOTES:

1. Values, which depend on BCLK frequency, can be obtained from the following equations.

$$th(RD-AD) = \frac{10^9}{f(BCLK) \times 2} - 10 \text{ [ns]}$$

$$th(WR-AD) = \frac{10^9}{f(BCLK) \times 2} - 15 \text{ [ns]}$$

$$th(RD-CS) = \frac{10^9}{f(BCLK) \times 2} - 10 \text{ [ns]}$$

$$th(WR-CS) = \frac{10^9}{f(BCLK) \times 2} - 10 \text{ [ns]}$$

$$th(WR-DB) = \frac{10^9}{f(BCLK) \times 2} - 20 \text{ [ns]}$$

2. Values, which depend on BCLK frequency and external bus cycles, can be obtained from the following equation.

$$td(DB-WR) = \frac{10^9 \times m}{f(BCLK) \times 2} - 25 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, m = (b \times 2) - 1)$$

3. Values, which depend on BCLK frequency and external bus cycles, can be obtained from the following equation.

$$td(AD-ALE) = \frac{10^9 \times n}{f(BCLK) \times 2} - 20 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, n = a)$$

4. Values, which depend on BCLK frequency and external bus cycles, can be obtained from the following equation.

$$th(ALE-AD) = \frac{10^9 \times n}{f(BCLK) \times 2} - 20 \text{ [ns]} \text{ (if external bus cycle is } a\phi + b\phi, n = a)$$

5. tc [ns] is added when recovery cycle is inserted.



Figure 5.7 VCC1 = VCC2 = 3.3 V Timing Diagram (1/4)



Figure 5.8 VCC1 = VCC2 = 3.3 V Timing Diagram (2/4)



Figure 5.9 VCC1 = VCC2 = 3.3 V Timing Diagram (3/4)



Figure 5.10 VCC1 = VCC2 = 3.3 V Timing Diagram (4/4)

Appendix 1. Package Dimensions





| | |
|------------------|-------------------------|
| REVISION HISTORY | M32C/87 Group Datasheet |
|------------------|-------------------------|

| Rev. | Date | Description | |
|----------|---|-------------|---|
| | | Page | Summary |
| 0.50 | Dec.16, 04 | – | New Document |
| 1.00 | Jul.14, 05 | – | M32C/87A and M32C/87B added |
| | | – | Package code changed: 144P6Q-A to PLQP0144KA-A, 100P6Q-A to PLQP0100KB-A, 100P6S-A to PRQP0100JB-A |
| | | – | “Low Voltage Detection Reset” changed to “Brown-out Detection Reset” |
| | | 2 | Overview • Table 1.2 M32C/87 Group Performance (144-Pin Package) M32C/87A and M32C/87B performance added to the CAN module performance; Power Consumption performance released |
| | | 3 | • Table 1.2 M32C/87 Group Performance (100-Pin Package) M32C/87A and M32C/87B performance added to the CAN module performance; Power Consumption performance released |
| | | 4 | • Figure 1.1 M32C/87 Group Block Diagram Note 4 deleted; note 5 added |
| | | 7 | • Figure 1.3 Pin Assignment for 144-Pin Package Note 15 added |
| | | 8 | • Table 1.4 Pin Characteristics for 144-Pin Package Note 1 added |
| | | 11 | • Figure 1.4 Pin Assignment for 100-Pin Package Note 19 added |
| | | 12 | • Figure 1.5 Pin Assignment for 100-Pin Package Note 15 added |
| 13 | • Table 1.5 Pin Characteristics for 100-Pin Package Note 1 added | | |
| 17 | • Table 1.6 Pin Description Note 2 added | | |
| 22 | Memory • Figure 3.1 Memory Map Note 3 changed | | |
| 26 | Special Function Register (SFR) • The RLVL register Value after reset modified | | |
| 26 | • The IIO0IR to IIO11IR registers Value after reset modified | | |
| 27 to 30 | • Name of the registers associated to Intelligent I/O changed | | |
| 27 | • The G0RB register Value after reset modified | | |
| 27 | • The G1BCR0 and G1BCR1 registers Value after reset modified | | |
| 29 | • The G0CR register Value after reset modified | | |
| 32 to 37 | • Note added to the CAN-associated registers | | |
| 40 | • The TCSPR register Value after reset modified; note 1 added | | |
| 41 | • The AD00 register Value after reset modified | | |
| 42 | • The PSC register Value after reset modified | | |
| 42 | • The PS2 register Value after reset modified | | |
| 43 | • The PCR register Value after reset modified | | |
| 44 | • The PSD1 register Value after reset modified | | |
| 45 | • The PCR register Value after reset modified | | |
| 48 | Electrical Characteristics • Table 5.2 Electrical Characteristics Parameter f(BCLK) and its values added; min. and max. values for f(RING) added | | |
| 49 | • Table 5.3 Electrical Characteristics V _{OH} values modified; R _{PULLUP} value modified | | |
| 50 | • Table 5.3 Electrical Characteristics (Continued) Measurement Condition and standard values for I _{CC} added and some released | | |
| 52 | • Table 5.6 Flash Memory Version Electrical Characteristics Word Program Time and Lock bit Program Time values modified; parameter All-Unlocked-Block-Erase Time deleted; note 1 deleted | | |
| 54 | • Table 5.10 Memory Expansion Mode and Microprocessor Mode <i>tac1(RD-DB)</i> expression on note 1 modified; <i>tac2(RD-DB)</i> expression on note 1 added | | |

| REVISION HISTORY | | M32C/87 Group Datasheet | |
|------------------|-------------|-------------------------|--|
| Rev. | Date | Description | |
| | | Page | Summary |
| | | 57 | Electrical Characteristics • Table 5.22 Memory Expansion Mode and Microprocessor Mode $t_h(WR-DB)$ expression on note 1 modified |
| | | 58 | • Table 5.23 Memory Expansion Mode and Microprocessor Mode $t_h(WR-DB)$ expression on note 1 modified; $t_h(ALE-AD)$ expression on note 4 modified |
| | | 60 | • Figure 5.3 Vcc1=Vcc2=5V Timing Diagram (1) $t_{ac1}(RD-DB)$ expression on note 2 modified; $t_h(WR-DB)$ and $t_w(ER)$ expressions on note 3 modified; t_{cyc} expression added |
| | | 61 | • Figure 5.4 Vcc1=Vcc2=5V Timing Diagram (2) $t_{ac2}(RD-DB)$ and $t_{ac2}(AD-DB)$ expressions on note 1 modified; $t_h(ALE-AD)$ expressions on notes 1 and 2 modified; $t_d(DB-WR)$ expression on note 2 modified; t_{cyc} expression added |
| | | 62 | • Figure 5.5 Vcc1=Vcc2=5V Timing Diagram (3) \overline{NMI} input diagram added |
| | | 64 | • Table 5.24 Electrical Characteristics V_{OH} values changed; R_{PULLUP} and I_{CC} values modified |
| | | 65 | • Table 5.25 A/D Conversion Characteristics t_{CONV} value modified |
| | | 66 | • Table 5.28 Memory Expansion Mode and Microprocessor Mode $t_{ac1}(RD-DB)$ expression on note 1 modified; $t_{ac2}(RD-DB)$ expression on note 1 added |
| | | 69 | • Table 5.40 Memory Expansion Mode and Microprocessor Mode $t_h(BCLK-AD)$, $t_h(BCLK-CS)$ and $t_h(BCLK-RD)$ values modified; $t_h(WR-AD)$ expression on note 1 modified |
| | | 70 | • Table 5.41 Memory Expansion Mode and Microprocessor Mode $t_h(BCLK-AD)$, $t_h(BCLK-CS)$ and $t_h(BCLK-RD)$ values modified; $t_h(WR-AD)$ expression on note 1 modified; $t_h(ALE-AD)$ expression on note 4 modified |
| | | 71 | • Figure 5.7 Vcc1=Vcc2=3.3V Timing Diagram (1) $t_h(BCLK-AD)$, $t_h(BCLK-CS)$ and $t_h(BCLK-RD)$ values modified; $t_{ac1}(AD-DB)$ expression on note 2 modified; $t_h(WR-DB)$, $t_h(WR-AD)$ and $t_w(WR)$ expression on note 3 modified; t_{cyc} expression added |
| | | 72 | • Figure 5.8 Vcc1=Vcc2=3.3V Timing Diagram (2) $t_{ac2}(RD-DB)$ and $t_{ac1}(AD-DB)$ expressions on note 1 modified; $t_h(ALE-AD)$ expressions on notes 1 and 2 modified; $t_d(WR-AD)$, $t_d(DB-WR)$ and $t_h(WR-DB)$ expressions on note 2 modified; t_{cyc} expression added |
| | | 73 | • Figure 5.9 Vcc1=Vcc2=3.3V Timing Diagram (3) \overline{NMI} input diagram added |
| 1.01 | Aug. 29, 05 | 17 | Overview • Tables 1.6 Pin Description Intelligent I/O functions modified |
| | | 29 | Special Function Register (SFR) • The G1BCR0 register Value after reset modified |
| | | 29 | • The G1BCR1 register Value after reset modified |
| | | 49 | Electrical Characteristics • Table 5.3 Electrical Characteristics I_{CC} standard value modified |

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| | | Page | Summary |
| 1.50 | Oct 20, 2007 | All | <p>All in this manual</p> <ul style="list-style-type: none"> • Descriptions and formats unified • Notation of numbers changed (e.g. 00₂ → 00_b, FF₁₆ → FF_h) • Notation of pin name changed (e.g. RTP00 → RTP_0, A15(/D15) → [A15/D15]) • [Term changed] Serial I/O → Serial interface Clock synchronous serial I/O mode → Clock synchronous mode Clock asynchronous serial I/O mode → Clock asynchronous mode Clock synchronous variable length → Variable data length clock synchronous Voltage detection circuit → Power supply voltage detection function Low voltage detection interrupt → Vdet4 detection interrupt Brown-out detection reset → Vdet3 detection function |
| | | 1 | <p>Overview</p> <ul style="list-style-type: none"> • Header SINGLE-CHIP 16/32-BIT CMOS MICROCOMPUTER → RENESAS MCU • 1.1 Features title added; 1.1 Applications changed to 1.1.1 Applications |
| | | 2 | <ul style="list-style-type: none"> • 1.2 Performance Overview changed to 1.1.2 Specifications |
| | | 2-5 | <ul style="list-style-type: none"> • Tables 1.1 to 1.4 Structure, descriptions in Specification field, NOTE, and value partially revised or deleted • Real-Time Port Item deleted; ROM Correction Function Item added |
| | | 8 | <ul style="list-style-type: none"> • 1.3 Block Diagram moved following the 1.2 Product List |
| | | 6-7 | <ul style="list-style-type: none"> • 1.2 Product List Tables revised; NOTE 1 added |
| | | 9, 14, 15 | <ul style="list-style-type: none"> • Figures 1.3 to 1.5 Arrows for VSS and VCC deleted; NOTES partially modified |
| | | 11,17 | <ul style="list-style-type: none"> • Tables 1.9 and 1.13 CLKOUT pin moved from Bus Control Pin column to Control Pin column |
| | | 19-22 | <ul style="list-style-type: none"> • Tables 1.15 to 1.19 Descriptions revised; NOTE 1 added |
| | | 26 | <p>Memory</p> <ul style="list-style-type: none"> • Text partially modified |
| | | 34-39 | <p>SFR</p> <ul style="list-style-type: none"> • Tables 4.8 to 4.13 NOTE “Set the PM13 bit in the PM1 register to 1 (2 wait states for SFR area) before accessing the CAN-associated registers.” added |
| | | 45 | <ul style="list-style-type: none"> • Table 4.19 The PSL5 register added to the Address field of 03BBh item; the PSL7 register added to the Address field of 03BFh item • [Register names changed] |
| | | 27 | <ul style="list-style-type: none"> 002Fh Low Voltage Detection Interrupt Register → Vdet4 Detection Interrupt Register |
| | | 34 | <ul style="list-style-type: none"> 01C1h UART5 Bit Rate Register → UART5 Baud Rate Register 01C9h UART6 Bit Rate Register → UART6 Baud Rate Register 01D0h UART5, UART6 Transmit/Receive Control Register 2 → UART5, UART6 Transmit/Receive Control Register 01DBh to 01D8h Pulse Output Data Register → RTP Output Buffer Register |
| | | 41 | <ul style="list-style-type: none"> 0303h to 0302h Timer A1-1 Register → Timer A11 Register 0305h to 0304h Timer A2-1 Register → Timer A21 Register 0307h to 0306h Timer A4-1 Register → Timer A41 Register |
| | | 42 | <ul style="list-style-type: none"> 0340h Count Start Flag → Count Start Register 0341h Clock Prescaler Reset Flag → Clock Prescaler Reset Register |

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| | | 42 | SFR <ul style="list-style-type: none"> [Register names changed] 0342h One-Shot Start Flag → One-Shot Start Register 0344h Up-Down Flag → Up/Down Select Register [Value After Reset changed] 27 000Fh WDC 000X XXX2 → 00XX XXXXb 27 002Fh D4INT 0016 → XX00 0000b 29 007Bh IIO6IC XX00 X0002 → XXXX X000b 31 00EFh G0CR XX00 X0112 → 0000 X011b 31 00FEh G0IRF 0016 → 0000 XXXXb 32 013Eh G1IRF 0016 → 0000 XXXXb 34 01C7h to 01C6h U5RB XXXX XXXX XXXX 0XXX2 → XXXXh 34 01CFh to 01CEh U6RB XXXX XXXX XXXX 0XXX2 → XXXXh 44 038Fh to 0382h AD07 to AD01 XXXX16 → 00XXh |
| | | 47 | Electrical Characteristics <ul style="list-style-type: none"> [Term changed] Low Voltage Reset → Hardware Reset 2 Low Voltage Detection → Vdet3 and Vdet4 detection circuit • Table 5.1 Description in Condition field of Pd (Power consumption) partially modified • Tables 5.2 to 5.9 f(BCLK) is changed to f(CPU) • Table 5.4 Description added in Parameter field of f(CPU); f(VCO) added • Tables 5.5 to 5.7 and Tables 5.31 to 5.33 Description in XCOUT and Hysteresis in Parameter fields partially modified • Table 5.7 and 5.33 Structure and standard values revised; items in Measurement Condition and NOTE added • Table 5.8 Description in Parameter field and NOTE partially modified • Table 5.9 and 5.10 Description in Parameter field and NOTE partially modified • Tables 5.11 and 5.36 Description in Parameter field and standard value partially modified • Tables 5.19 and 5.42 added • Table 5.24 Values revised; Table 5.25 and 5.26 added • Table 5.27 Titles modified; NOTE added • Table 5.28 moved to the last table in Timing Requirements • Table 5.29 NOTE 3 added; Table 26.30 NOTE 5 added • Figures 5.3 to 5.6 Order rearranged; measurement condition modified • Table 5.31 to 5.35 f(BCLK) revised to f(CPU) • Table 5.47 Values revised; Table 5.48 and 5.49 added • Table 5.50 Titles modified; NOTE added • Table 5.51 Table moved to the last table in Timing Requirements • Table 5.52 NOTE 3 added; Table 5.53 NOTE 5 added • Figures 5.7 to 5.10 Order rearranged |
| 1.51 | Jul 31, 2008 | – | All in this manual [description modified] <ul style="list-style-type: none"> • Title of group tables “(current table number / total tables)” added |
| | | 19 | Overview <ul style="list-style-type: none"> • 1.5 Pin Descriptions Chapter and table title changed to Pin Functions • Table 1.17 Supply voltage for AN0_0 to AN0_7, AN2_0 to AN2_7 modified |
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| | | 46 | Special Function Registers (SFRs) • Table 4.20 A value of After Reset column in 03FFh modified |

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