

To all our customers

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**Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.**

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The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.  
Customer Support Dept.  
April 1, 2003

# Mitsubishi Microcomputers

## 32170 Group, 32174 Group

### SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

#### Description

The M32170 and M32174 Group are 32-bit single chip RISC microcomputers designed for use in general industrial and household equipment.

These microcomputers contains a variety of peripheral functions ranging from 16-channel A-D converters to 64-channel multifunction timers, 10-channel DMAs, 6-channel serial I/Os, 1-channel real time debugger, 1-channel Full-CAN, and JTAG (boundary scan facility).

With lower power consumption and low noise characteristics also considered, these microcomputers are ideal for embedded equipment applications.

#### Features

M32R RISC CPU core

- Uses the M32R family RISC CPU core (Instruction set common to all microcomputers in the M32R family)
- Five-stage pipelined processing
- Sixteen 32-bit general-purpose registers
- 16-bit/32-bit instructions implemented
- DSP function instructions (sum-of-products calculation using 56-bit accumulator)
- Built-in flash memory
- Built-in flash programming boot program
- Built-in RAM
- PLL clock generating circuit ..... Built-in × 4 PLL circuit
- Maximum operating frequency of the CPU clock  
40MHz(when operating at -40 to +85°C)  
32MHz(when operating at -40 to +125°C)

**Table 1 32170 Group Name List by type**

| Type Name   | RAM Size  | ROM Size   | Package |
|-------------|-----------|------------|---------|
| M32170F6VFP | 40K bytes | 768K bytes | 240QFP  |
| M32170F4VFP | 32K bytes | 512K bytes | 240QFP  |
| M32170F3VFP | 32K bytes | 384K bytes | 240QFP  |
| M32170F6VWG | 40K bytes | 768K bytes | 255FBGA |
| M32170F4VWG | 32K bytes | 512K bytes | 255FBGA |
| M32170F3VWG | 32K bytes | 384K bytes | 255FBGA |

Note: 255FBGA is currently under development.

**Table 2 32170 Group Name List by type**

| Type Name   | RAM Size  | ROM Size   | Package |
|-------------|-----------|------------|---------|
| M32174F4VFP | 40K bytes | 512K bytes | 240QFP  |
| M32174F3VFP | 40K bytes | 384K bytes | 240QFP  |
| M32174F4VWG | 40K bytes | 512K bytes | 255FBGA |
| M32174F3VWG | 40K bytes | 384K bytes | 255FBGA |

Note: 255FBGA is currently under development.

#### 64-channel multifunction timers (MJT)

Multifunction timers are incorporated that support various purposes of use.

|                                          |      |
|------------------------------------------|------|
| 16-bit output related timers .....       | 35ch |
| 16-bit input/output related timers ..... | 10ch |
| 16-bit input related timers .....        | 11ch |
| 32-bit input related timers .....        | 8ch  |

- Flexible configuration is possible through interconnection of timers.
- The internal DMAC and A-D converter can be started by a timer.

#### Real-time Debugger

- Includes dedicated clock-synchronized serial I/O that can read and write the contents of the internal RAM independently of the CPU.
- Can look up and update the data table in real time while the program is running.
- Can generate a dedicated interrupt based on RTD communication.

#### Abundant internal peripheral functions

In addition to the timers and real-time debugger, the microcomputer contains the following peripheral functions.

- DMAC ..... 10 channels
- Two independent  
A-D converter ..... (10-bit converter × 16 channels) × 2
- Serial I/O ..... 6 channels
- Interrupt controller ..... 31 interrupt sources, 8 priority levels
- Wait controller
- Full CAN ..... 1 channel
- JTAG (boundary scan function)

#### Designed to operate at high temperatures

To meet the need for use at high temperatures, the microcomputer is designed to be able to operate in the temperature range of -40 to +125°C when CPU clock operating frequency = 32 MHz. When CPU clock operating frequency = 40 MHz, the microcomputer can be used in the temperature range of -40 to +85°C.

Note: This does not guarantee continuous operation at 125°C. If you are considering use of the microcomputer at 125°C, please consult Mitsubishi.

#### Applications

Automobile equipment control (e.g., Engine, ABS, AT), industrial equipment system control, and high-function OA equipment (e.g., PPC)

# 32170 Group, 32174 Group

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

Pin Assignment(top view)

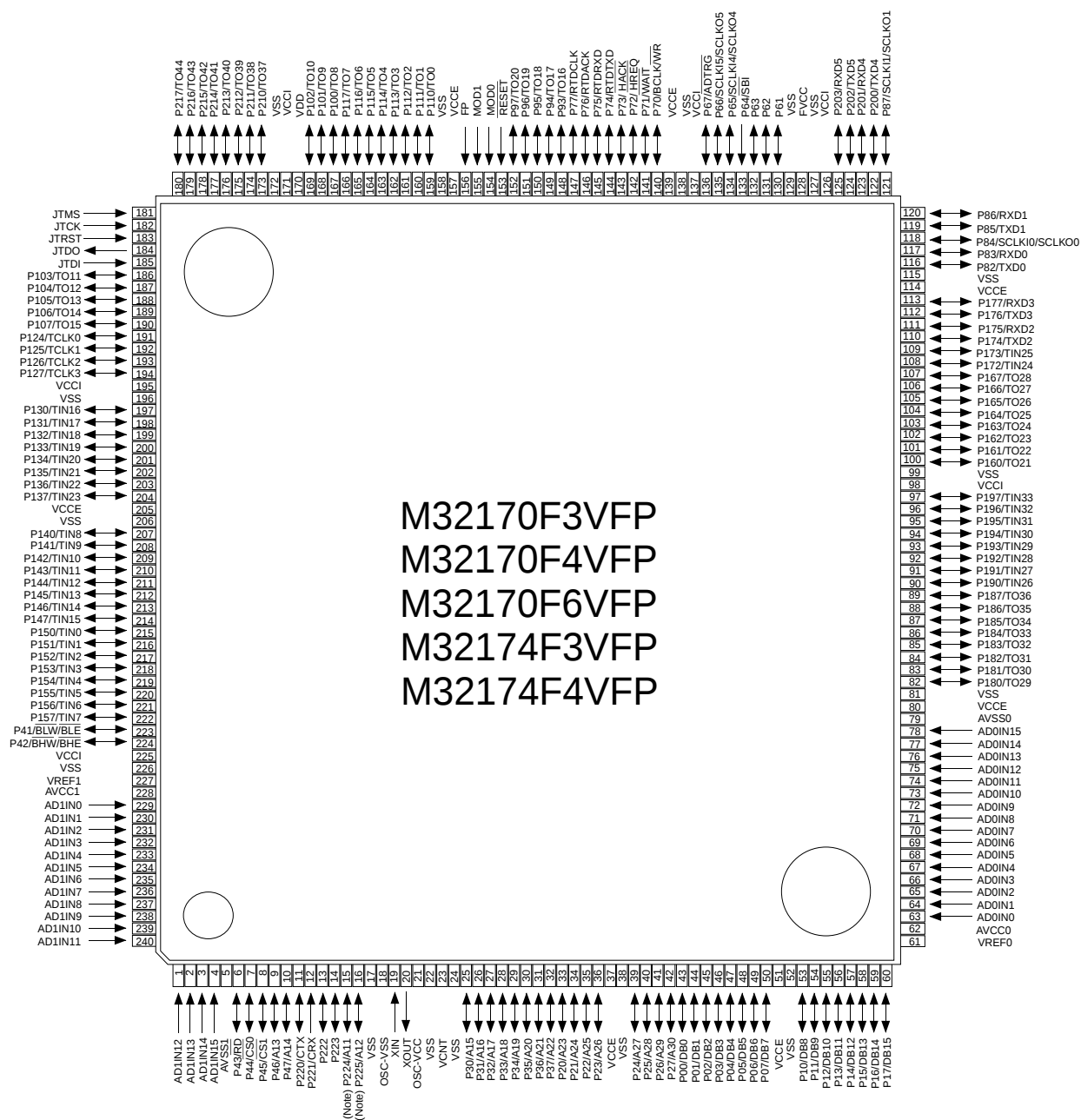


Figure 1 Pin Layout Diagram of the 240QFP

**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

Pin Assignment(top view)

|    |             |             |             |             |                                                                         |           |           |           |           |           |           |             |           |            |            |          |             |             |             |             |
|----|-------------|-------------|-------------|-------------|-------------------------------------------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-------------|-----------|------------|------------|----------|-------------|-------------|-------------|-------------|
| 20 | JTMS        | P216 /TO43  | P214 /TO41  | P210 /TO37  | P102 /TO10                                                              | P116 /TO6 | TRDATA 6  | P112 /TO2 | VCCE      | RESET     | P96 /TO19 | P77/ RTDCLK | P73 /HACK | VCCE       | P66 /SCLK5 | P62      | VSS         | P202 /TXD5  | P201 /RXD4  | TRDATA 3    |
| 19 | JTCK        | P217 /TO44  | P215 /TO42  | P211 /TO38  | VDD                                                                     | P117 /TO7 | TRDATA 7  | P113 /TO3 | VSS       | MOD0      | P95 /TO18 | P76/ RTDACK | P72 /HREQ | VSS        | P65 /SCLK4 | P61      | VCCI        | P200 /TXD4  | N.C         | TRDATA 1    |
| 18 | JEVENT 0    | JDBI        | P213 /TO40  | P212 /TO39  | VCCI                                                                    | P100 /TO8 | P114 /TO4 | TRDATA 4  | P110 /TO0 | MOD1      | P94 /TO17 | P75/ RTDRXD | P71 /WAIT | VCCI       | P64 /SBI   | VSS      | P203 /RXD5  | P87 /SCLK1  | TRDATA 2    | TRDATA 0    |
| 17 | JEVENT 1    | JTRST       | JTDO        | VSS         | P101 /TO9                                                               | P115 /TO5 | TRDATA 5  | P111 /TO1 | FP        | P97 /TO20 | P93 /TO16 | P74/ RTDTXD | P70 /BCLK | P67 /ADTRG | P63        | FVCC     | P83 /RXD0   | P84 /SCLK0  | P86 /RXD1   | P85 /TXD1   |
| 16 | P104 /TO12  | P103 /TO11  | P105 /TO13  | JTDI        | M32170F3VWG<br>M32170F4VWG<br>M32170F6VWG<br>M32174F3VWG<br>M32174F4VWG |           |           |           |           |           |           |             |           |            |            |          | P177 /RXD3  | VCCE        | P82 /TXD0   | VSS         |
| 15 | P124 /TCLK0 | P107 /TO15  | P125 /TCLK1 | P106 /TO14  |                                                                         |           |           |           |           |           |           |             |           |            |            |          | P173 /TIN25 | P174 /TXD2  | P176 /TXD3  | P175 /RXD2  |
| 14 | VCCI        | P127 /TCLK3 | VSS         | P126 /TCLK2 |                                                                         |           |           |           |           |           |           |             |           |            |            |          | P165 /TO26  | P166 /TO27  | P172 /TIN24 | P167 /TO28  |
| 13 | P132 /TIN18 | P131 /TIN17 | P133 /TIN19 | P130 /TIN16 |                                                                         |           |           |           |           |           |           |             |           |            |            |          | P161 /TO22  | P162 /TO23  | P164 /TO25  | P163 /TO24  |
| 12 | P136 /TIN22 | P135 /TIN21 | P137 /TIN23 | P134 /TIN20 |                                                                         |           |           |           |           |           |           |             |           |            |            |          | P197 /TIN33 | VCCI        | P160 /TO21  | VSS         |
| 11 | P140 /TIN8  | VSS         | P141 /TIN9  | VCCE        |                                                                         |           |           |           |           |           |           |             |           |            |            |          | P193 /TIN29 | P194 /TIN30 | P196 /TIN32 | P195 /TIN31 |
| 10 | P144 /TIN12 | P145 /TIN13 | P143 /TIN11 | P142 /TIN10 |                                                                         |           |           |           |           |           |           |             |           |            |            |          | P187 /TO36  | P192 /TIN28 | P190 /TIN26 | P191 /TIN27 |
| 9  | P150 /TIN0  | P151 /TIN1  | P147 /TIN15 | P146 /TIN14 |                                                                         |           |           |           |           |           |           |             |           |            |            |          | P183 /TO32  | P186 /TO35  | P184 /TO33  | P185 /TO34  |
| 8  | P154 /TIN4  | P155 /TIN5  | P153 /TIN3  | P152 /TIN2  |                                                                         |           |           |           |           |           |           |             |           |            |            |          | VSS         | P182 /TO31  | P180 /TO29  | P181 /TO30  |
| 7  | P41 /BLW    | P42 /BHW    | P157 /TIN7  | P156 /TIN6  | AD0IN14                                                                 | VCCE      | AD0IN15   | AVSS0     |           |           |           |             |           |            |            |          |             |             |             |             |
| 6  | VREF1       | AVCC1       | VSS         | VCCI        | AD0IN10                                                                 | AD0IN13   | AD0IN11   | AD0IN12   |           |           |           |             |           |            |            |          |             |             |             |             |
| 5  | AD1IN2      | AD1IN3      | AD1IN1      | AD1IN0      | AD0IN6                                                                  | AD0IN9    | AD0IN7    | AD0IN8    |           |           |           |             |           |            |            |          |             |             |             |             |
| 4  | AD1IN6      | AD1IN7      | AD1IN5      | AD1IN15     | P45 /CS1                                                                | P221 /CRX | P225 /A12 | XOUT      | VSS       | P33 /A18  | TRSYNC    | P21 /A24    | VSS       | P27 /A30   | P03 /DB3   | P07 /DB7 | P11 /DB9    | AD0IN5      | AD0IN3      | AD0IN4      |
| 3  | AD1IN8      | AD1IN10     | AD1IN4      | AVSS1       | P46 /A13                                                                | P222      | VSS       | OSC-VCC   | P30 /A15  | P34 /A19  | P20 /A23  | VCCE        | P26 /A29  | P02 /DB2   | P06 /DB6   | P10 /DB8 | P14 /DB12   | AD0IN1      | AD0IN0      | AD0IN2      |
| 2  | AD1IN9      | AD1IN11     | AD1IN13     | P43 /RD     | P47 /A14                                                                | P223      | OSC-VSS   | VSS       | P31 /A16  | P35 /A20  | P37 /A22  | P23 /A26    | P25 /A28  | P01 /DB1   | P05 /DB5   | VSS      | P13 /DB11   | P17 /DB15   | VREF0       | AVCC0       |
| 1  |             | AD1IN12     | AD1IN14     | P44 /CS0    | P220 /CTX                                                               | P224 /A11 | XIN       | VCNT      | P32 /A17  | TRCLK     | P36 /A21  | P22 /A25    | P24 /A27  | P00 /DB0   | P04 /DB4   | VCCE     | P12 /DB10   | P15 /DB13   | P16 /DB14   | N.C         |
|    | A           | B           | C           | D           | E                                                                       | F         | G         | H         | J         | K         | L         | M           | N         | P          | R          | T        | U           | V           | W           | Y           |

Package 255FBGA

Note 1: NC pin (W19, Y1) shows non-connect. Be open state.

Note 2: Use caution when using P224/A11 and P225/A12 because they have a debug event function.

Note 3: 255FBGA is currently under development.

Figure 2 Pin Layout Diagram of the 255FBGA

**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

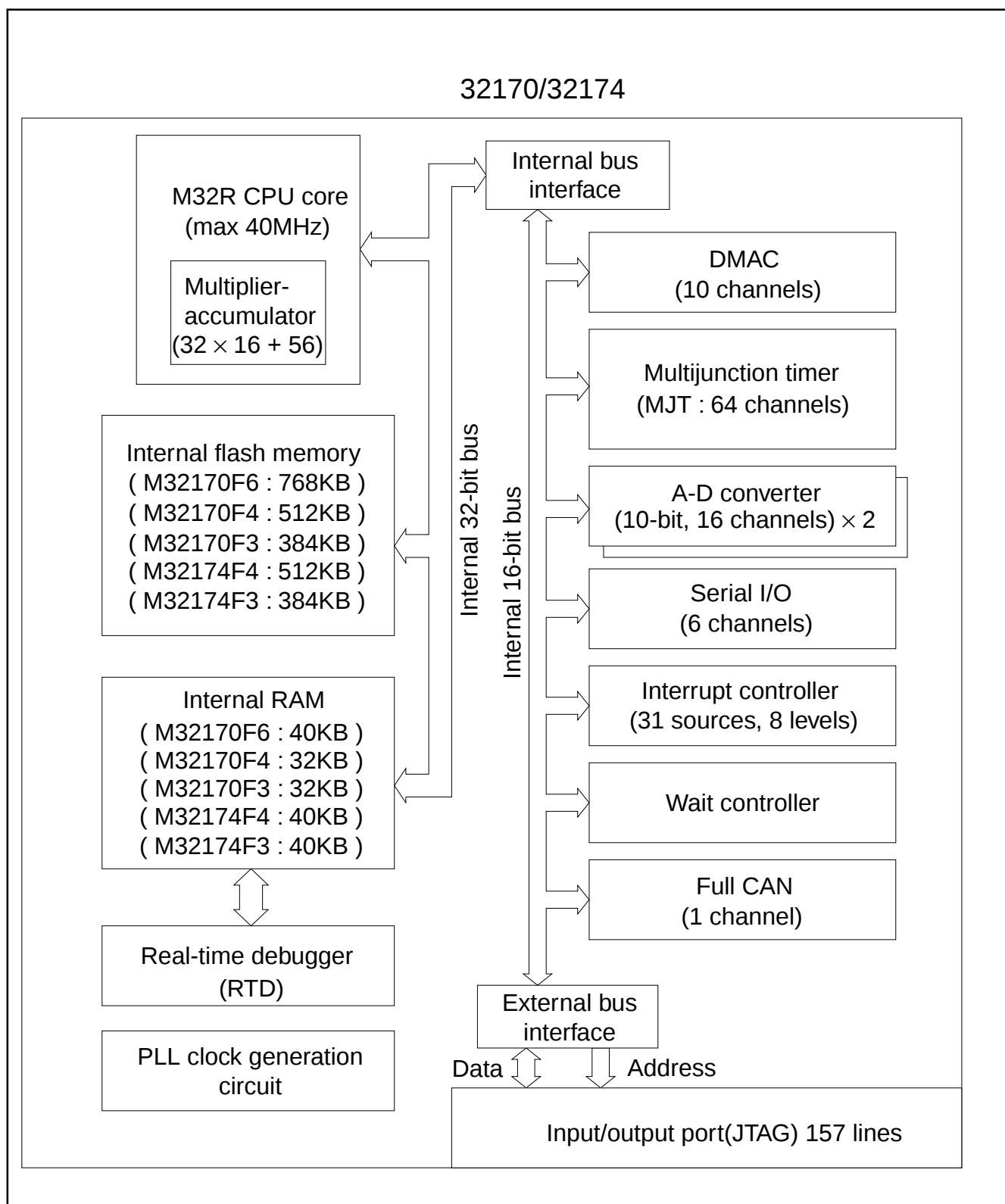


Figure 3 Block diagram

**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

**Table 3 Outline Performance (1/2)**

| Functional Block         | Features                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| M32R CPU core            | <p>M32R family CPU core, internally configured in 32 bits</p> <p>Built-in multiplier-accumulator (<math>32 \times 16 + 56</math>)</p> <p>Basic bus cycle : 25 ns (Internal CPU clock frequency at 40 MHz, Internal peripheral clock frequency at 20 MHz)</p> <p>Logical address space : 4G bytes, linear</p> <p>General-purpose register : 32-bit register <math>\times 16</math>, Control register: 32-bit register <math>\times 5</math></p> <p>accumulator : 56 bits</p>                                                                                                                                                                                                               |
| External data bus        | 16 bits data bus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Instruction set          | <p>16-bit/32-bit instruction formats</p> <p>83 instructions/ 9 addressing modes</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Internal flash memory    | <p>M32170F6 : 768K bytes</p> <p>M32170F4, M32174F4 : 512K bytes</p> <p>M32170F3, M32174F3 : 384K bytes</p> <p>Rewrite durability : 100 times</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Internal RAM             | <p>M32170F6, M32174F4, M32174F3 : 40K bytes</p> <p>M32170F4, M32170F3 : 32K bytes</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| DMAC                     | <p>10 channels (DMA transfers between internal peripheral I/Os, between internal peripheral I/O and internal RAM, and between internal RAMs)</p> <p>Channels can be cascaded and can operate in combination with internal peripheral I/O</p>                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Multijunction timer      | <p>64 channels of multijunction timers.</p> <ul style="list-style-type: none"> <li>• 16-bit output-related timers <math>\times 35</math> channels (single-shot, delayed single-shot, PWM, single-shot PWM)</li> <li>• 16-bit input/output-related timers <math>\times 10</math> channels (event count mode, single-shot, PWM, measurement)</li> <li>• 16-bit input-related timers <math>\times 11</math> channels (measurement, event count mode, multiply-by-4 count 3 channels)</li> <li>• 32-bit input-related timers <math>\times 8</math> channels (measurement)</li> </ul> <p>Flexible timer configuration is possible through interconnection of channels using the event bus.</p> |
| A-D converter            | <p>2 independent 10-bit multifunction A-D converters</p> <ul style="list-style-type: none"> <li>• Input 16 channels <math>\times 2</math></li> <li>• Scan-based conversion can be switched with 4, 8, and 16</li> <li>• Capable of interrupt conversion during scan</li> <li>• 8-bit/10-bit readout function available</li> </ul>                                                                                                                                                                                                                                                                                                                                                         |
| Serial I/O               | <p>6 channels (The serial I/Os can be set for synchronous serial I/O or UART.</p> <p>SIO2,3 are UART mode only)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Real-time debugger (RTD) | <p>1-channels dedicated clock-synchronized serial</p> <p>The entire internal RAM can be read or rewritten from the outside without CPU intervention.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Interrupt controller     | <p>Controls interrupts from internal peripheral I/Os</p> <p>(Priority can be set to one of 8 levels including interrupt disabled)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Wait controller          | <p>Controls wait when accessing external extended area</p> <p>(1 to 4 wait cycles inserted + prolonged by external WAIT signal input)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| CAN                      | 16-channels message slots                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| JTAG                     | Boundary-Scan function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

**Table 4 Outline Performance (2/2)**

| Function Block             | Features                                                                                                                                                                                                                                                    |
|----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Clock                      | Maximum internal CPU memory clock : 40MHz (access to CPU, internal ROM, and internal RAM)<br>Maximum internal peripheral clock : 20MHz (access to internal peripheral module)<br>Maximum external input clock : 10.0MHz, Built-in multiply-by-4 PLL circuit |
| Power Supply Voltage       | External I/O : 5V ( $\pm 0.5V$ ) or 3.3V ( $\pm 0.3V$ )<br>Internal logic : 3.3V ( $\pm 0.3V$ )                                                                                                                                                             |
| Operating temperature rang | -40 to +125°C (Internal CPU memory clock 32MHz, internal peripheral clock 16MHz)<br>-40 to +85°C (Internal CPU memory clock 40MHz, internal peripheral clock 20MHz)                                                                                         |
| Package                    | 0.5mm pitches / 240-pin plastic QFP, 0.8mm pitches / 255-pin FBGA (Note)                                                                                                                                                                                    |

Note: 255-pin FBGA is currently under development.

# 32170 Group, 32174 Group

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

## Outline of the CPU core

The M32170 and M32174 Group uses the M32R RISC CPU core, and has an instruction set which is common to all microcomputers in the M32R family.

Instructions are processed in five pipelined stages consisting of instruction fetch, decode, execution, memory access, and write back. Thanks to its "out-of-order-completion" mechanism, the M32R CPU allows for clock cycle efficient, instruction execution control.

The M32R CPU internally has sixteen 32-bit general-purpose registers. The instruction set consists of 83 discrete instructions, which come in either a 16-bit instruction or a 32-bit instruction format. Use of the 16-bit instruction format helps to reduce the code size of a program. Also, the availability of 32-bit instructions facilitates programming and increases the performance at the same clock speed, as compared to architectures with segmented address spaces.

## Sum-of-products instructions comparable to DSP

The M32R CPU contains a multiplier/accumulator that can execute  $32 \text{ bits} \times 16 \text{ bits}$  in one cycle. Therefore, it executes a  $32 \text{ bit} \times 32 \text{ bit}$  integer multiplication instruction in three cycles. Also, the M32R CPU supports the following four sum-of-products instructions (or multiplication instructions) for DSP function use.

- (1) 16 high-order register bits  $\times$  16 high-order register bits
- (2) 16 low-order register bits  $\times$  16 low-order register bits
- (3) All 32 register bits  $\times$  16 high-order register bits
- (4) All 32 register bits  $\times$  16 low-order register bits

Furthermore, the M32R CPU has instructions for rounding the value stored in the accumulator to 16 or 32 bits, and instructions for shifting the accumulator value to adjust digits before storing in a register. Because these instructions also can be executed in one cycle, DSP comparable data processing capability can be obtained by using them in combination with high-speed data transfer instructions such as Load & Address Update or Store & Address Update.

## Built-in clock multiplier circuit

The clock multiplier circuit multiplies the frequency of the input clock signal by 4 to produce the internal operating clock. When the maximum CPU memory clock frequency = 40 MHz, the input clock frequency is 10.0 MHz.

## Three operation modes

The M32170 and M32174 Group has three operation modes: single-chip mode, external extended mode, and processor mode. These operation modes are changed from one to another by setting the MOD0 and MOD1 pins.

## Address space

The M32170 and M32174 Group's logical addresses are always handled in 32 bits, providing 4 Gbytes of linear address space. The M32170 and M32174 Group's address space consists of the following.

## User space

A 2-Gbyte area from H'0000 0000 to H'7FFF FFFF is the user space. Located in this space are the user ROM area, external extended area, internal RAM area, and SFR (Special Function Register) area (internal peripheral I/O registers). Of these, the user ROM area and external extended area are located differently depending on mode settings.

## Boot program space

A 1-Gbyte area from H'8000 0000 to H'BFFF FFFF is the boot program area. This space contains the on-board programming program (boot program) used in blank state by the internal flash memory.

## System space

A 1-Gbyte area from H'C000 0000 to H'FFFF FFFF is the system area. This space is reserved for use by development tools such as an in-circuit emulator and debug monitor, and cannot be used by the user.

# 32170 Group, 32174 Group

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

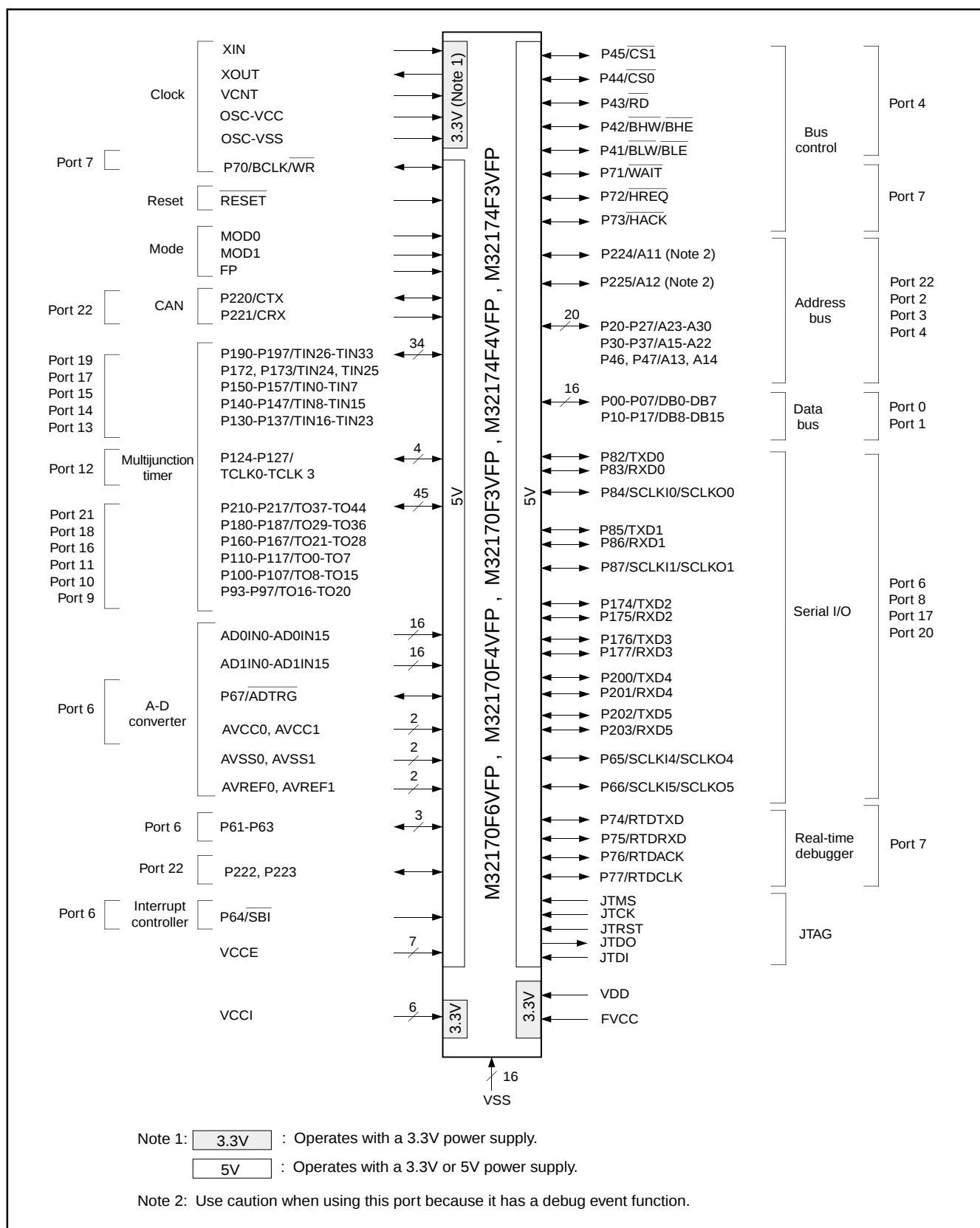


Figure 4 Pin Function Diagram of 240QFP

# 32170 Group, 32174 Group

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

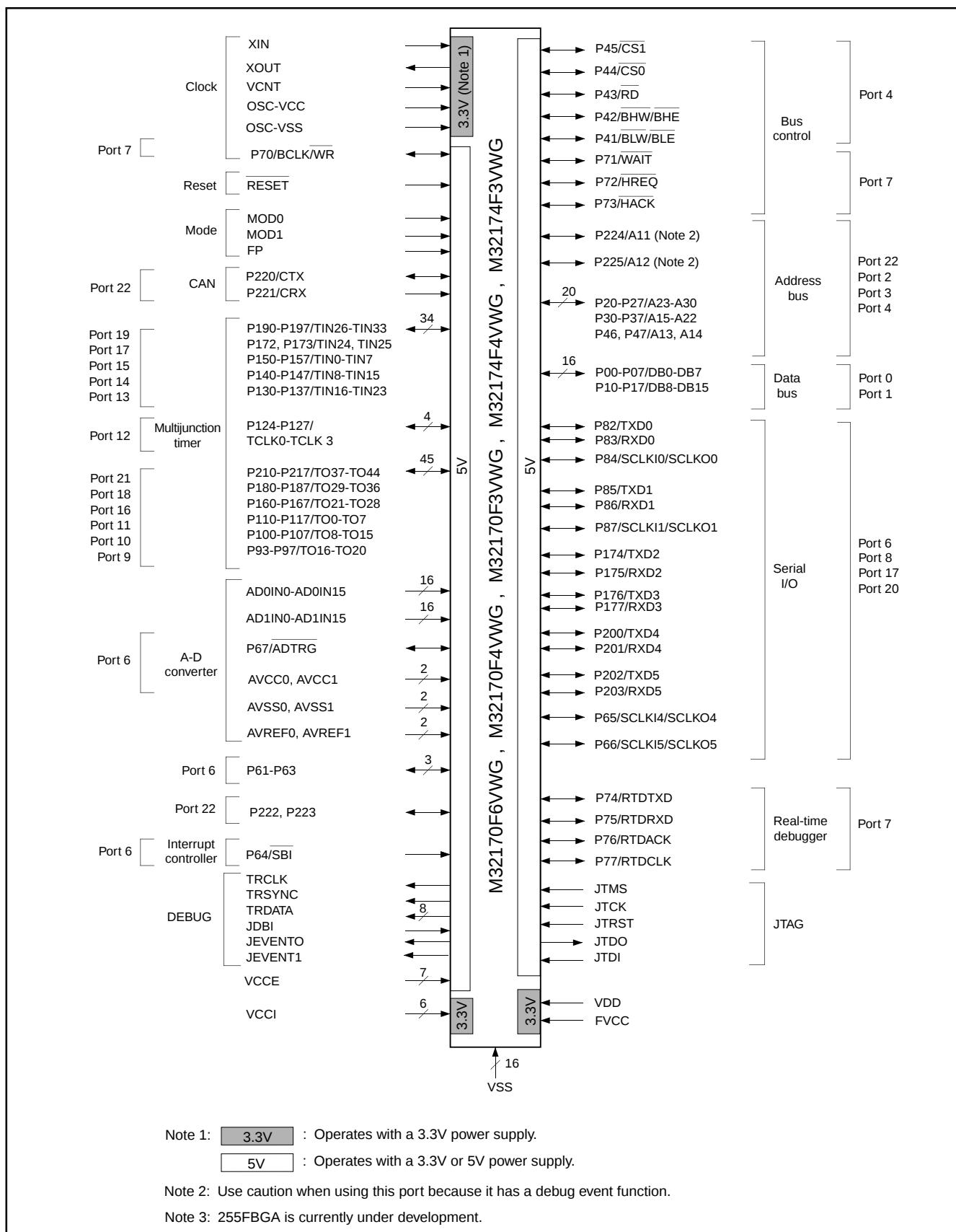


Figure 5 Pin Function Diagram of 255FBGA

**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

**Table 5 Description of Pin Function (1/5)**

| Type         | Pin Name               | Description        | Input/Output                         | Function                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|--------------|------------------------|--------------------|--------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|------|---|---|------------------|---|---|------------------------|---|---|--------------------------------------|---|---|------------|
| Power supply | VCCE                   | Power supply       | —                                    | Supplies power (5 V or 3.3V) to external I/O ports.                                                                                                                                                                                                                                                                                                                                                                                                                                             |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | VCCI                   | Power supply       | —                                    | Supplies power (3.3 V) to the internal logic.                                                                                                                                                                                                                                                                                                                                                                                                                                                   |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | VDD                    | RAM power supply   | —                                    | Internal RAM backup power supply (3.3 V).                                                                                                                                                                                                                                                                                                                                                                                                                                                       |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | FVCC                   | Flash power supply | —                                    | Internal flash memory backup power supply (3.3 V).                                                                                                                                                                                                                                                                                                                                                                                                                                              |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | VSS                    | Ground             | —                                    | Connect all VSS pins to ground (GND).                                                                                                                                                                                                                                                                                                                                                                                                                                                           |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
| Clock        | XIN, XOUT              | Clock              | Input<br>Output                      | Clock input/output pins. These pins contain a PLL-based frequency multiply-by-4, so input the clock whose frequency is quarter the operating frequency. (XIN input = 10 MHz when CPU clock operates at 40 MHz)                                                                                                                                                                                                                                                                                  |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | BCLK / $\overline{WR}$ | System clock       | Output                               | When this signal is System Clock(BCLK), it outputs a clock whose is twice that of external input clock. (BCLK output = 20 MHz when CPU clock operates at 40 MHz). Use this clock when circuits are synchronized externally. When this signal is Write( $\overline{WR}$ ),during external write access it indicates the valid data on the data bus to transfer.                                                                                                                                  |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | OSC-VCC                | Power supply       | —                                    | Power supply to the PLL circuit. Connect OSC-VCC to the power supply(3.3V)                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | OSC-VSS                | Ground             | —                                    | Connect OSC-VSS to ground.                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | VCNT                   | PLL control        | Input                                | This pin controls the PLL circuit. Connect a resistor and capacitor to this pin.                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              |                        |                    |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
| Reset        | $\overline{RESET}$     | Reset              | Input                                | This pin resets the internal circuits.                                                                                                                                                                                                                                                                                                                                                                                                                                                          |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
| Mode         | MOD0<br>MOD1           | Mode               | Input                                | These pins set an operation mode. <table><tr><th>MOD0</th><th>MOD1</th><th>Mode</th></tr><tr><td>0</td><td>0</td><td>Single-chip mode</td></tr><tr><td>0</td><td>1</td><td>Expanded external mode</td></tr><tr><td>1</td><td>0</td><td>Processor mode<br/>(Boot mode) (Note)</td></tr><tr><td>1</td><td>1</td><td>(Reserved)</td></tr></table>                                                                                                                                                  | MOD0 | MOD1 | Mode | 0 | 0 | Single-chip mode | 0 | 1 | Expanded external mode | 1 | 0 | Processor mode<br>(Boot mode) (Note) | 1 | 1 | (Reserved) |
|              | MOD0                   | MOD1               | Mode                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | 0                      | 0                  | Single-chip mode                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | 0                      | 1                  | Expanded external mode               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | 1                      | 0                  | Processor mode<br>(Boot mode) (Note) |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              | 1                      | 1                  | (Reserved)                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              |                        |                    |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              |                        |                    |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              |                        |                    |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              |                        |                    |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              |                        |                    |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
| Address bus  | A11-A30                | Address bus        | Output                               | 20 lines of address bus (A11-A30) are provided to accommodate two channels of 2 MB memory space (max.) connected external to the chip. A31 is not output.<br><br>In the write cycle, of the 16-bit data bus the valid byte positions to write are output as $\overline{BHW}/\overline{BHE}$ and $\overline{BLW}/\overline{BLE}$ . In read cycle, data on the entire 16-bit data bus is read. However, only the data at the valid byte positions are transferred to the M32R's internal circuit. |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
|              |                        |                    |                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |
| Data bus     | DB0-DB15               | Data bus           | Input/output                         | This 16-bit data bus connects to external device.                                                                                                                                                                                                                                                                                                                                                                                                                                               |      |      |      |   |   |                  |   |   |                        |   |   |                                      |   |   |            |

Note: FP pin should be "H" level in Boot Mode.

**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

**Table 6 Description of Pin Function (2/5)**

| Type                 | Pin type                            | Description             | Input/Output | Function                                                                                                                                                                                                                                                                                  |
|----------------------|-------------------------------------|-------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bus control          | $\overline{CS0}$ ,<br>CS1           | Chip select             | Output       | Chip select signals for external devices.                                                                                                                                                                                                                                                 |
|                      | $\overline{RD}$                     | Read                    | Output       | This signal is output when reading external devices.                                                                                                                                                                                                                                      |
|                      | $\overline{BHW}$ / $\overline{BHE}$ | Byte high write         | Output       | Indicates the byte positions to which valid are transferred when writing to external devices. $\overline{BHW}$ / $\overline{BHE}$ and $\overline{BLW}$ / $\overline{BLE}$ correspond to the upper address side(D0-D7 effective) and the lower address side(D8-D15 effective),respectivel. |
|                      | $\overline{BLW}$ / $\overline{BLE}$ | Byte low write          | Output       |                                                                                                                                                                                                                                                                                           |
|                      | $\overline{WAIT}$                   | Wait                    | Input        | If $\overline{WAIT}$ input is low when the M32R accesses external devices, the wait cycle extended.                                                                                                                                                                                       |
|                      | $\overline{HREQ}$                   | Hold request            | Input        | This pin is used by an external device to request control of the external bus. The M32R goes to a hold state when $\overline{HREQ}$ input is pulled low.                                                                                                                                  |
|                      | $\overline{HACK}$                   | Hold acknowledge        | Output       | This signal indicates to the external device that the M32R has entered a hold state and relinquished control of the external bus.                                                                                                                                                         |
| Multijunction timer  | TIN0<br>-TIN33                      | Timer input             | Input        | Input pins for multijunction timer.                                                                                                                                                                                                                                                       |
|                      | TO0<br>-TO44                        | Timer output            | Output       | Output pins for multijunction timer.                                                                                                                                                                                                                                                      |
|                      | TCLK0<br>-TCLK3                     | Timer clock             | Input        | Clock input pins for multijunction timer.                                                                                                                                                                                                                                                 |
| A-D converter        | AVCC0,<br>AVCC1                     | Analog power supply     | –            | AVCC0 is the power supply for the A-D0 converters. AVCC1 is the power supply for the A-D1 converters.<br>Connect AVCC0 and AVCC1 to the power supply (5V or 3.3V).                                                                                                                        |
|                      | AVSS0,<br>AVSS1                     | Analog ground           | –            | AVSS0 is the analog ground for the A-D0 converters. AVSS1 is the analog ground for the A-D1 converters.<br>Connect AVCC0 and AVCC1 to ground.                                                                                                                                             |
|                      | AD0IN0<br>-AD0IN15                  | Analog input            | Input        | One block of 16-channel analog input pin for A-D0 converter.                                                                                                                                                                                                                              |
|                      | AD1IN0<br>-AD1IN15                  |                         |              | Two blocks of 16-channel analog input pin for A-D1 converter.                                                                                                                                                                                                                             |
|                      | VREF0,<br>VREF1                     | Reference voltage input | Input        | VREF0 is the reference voltage input pin (5V or 3.3V) for the A-D0 converters. VREF1 is the reference voltage input pin (5V or 3.3V) for the A-D1 converters.                                                                                                                             |
|                      | $\overline{ADTRG}$                  | Conversion trigger      | Input        | Hardware trigger input pin to start A-D conversion.                                                                                                                                                                                                                                       |
| Interrupt controller | $\overline{SBI}$                    | System break interrupt  | Input        | System break interrupt(SBI) input pin of the interrupt controller.                                                                                                                                                                                                                        |

**32170 Group, 32174 Group**

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**Table 7 Description of Pin Functions (3/5)**

| Type       | Pin name          | Description      | Input/output | Function                                                      |
|------------|-------------------|------------------|--------------|---------------------------------------------------------------|
| Serial I/O | SCLKI0/<br>SCLKO0 | UART transmit/   | Input/output | When channel 0 is in UART mode:                               |
|            |                   | receive clock    |              | Clock output derived from BRG output by dividing it by 2      |
|            |                   | output or CSIO   |              |                                                               |
|            |                   | transmit/receive |              | When channel 0 is in CSIO mode:                               |
|            |                   | clock            |              | Transmit/receive clock input when external clock is selected  |
|            |                   | input/output     |              | Transmit/receive clock output when internal clock is selected |
|            | SCLKI1/<br>SCLKO1 | UART transmit/   | Input/output | When channel 1 is in UART mode:                               |
|            |                   | receive clock    |              | Clock output derived from BRG output by dividing it by 2      |
|            |                   | output or CSIO   |              |                                                               |
|            |                   | transmit/receive |              | When channel 1 is in CSIO mode:                               |
|            |                   | clock            |              | Transmit/receive clock input when external clock is selected  |
|            |                   | input/output     |              | Transmit/receive clock output when internal clock is selected |
|            | SCLKI4/<br>SCLKO4 | UART transmit/   | Input/output | When channel 4 is in UART mode:                               |
|            |                   | receive clock    |              | Clock output derived from BRG output by dividing it by 2      |
|            |                   | output or CSIO   |              |                                                               |
|            |                   | transmit/receive |              | When channel 4 is in CSIO mode:                               |
|            |                   | clock            |              | Transmit/receive clock input when external clock is selected  |
|            |                   | input/output     |              | Transmit/receive clock output when internal clock is selected |
|            | SCLKI5<br>SCLKO5  | UART transmit/   | Input/output | When channel 5 is in UART mode:                               |
|            |                   | receive clock    |              | Clock output derived from BRG output by dividing it by 2      |
|            |                   | output or CSIO   |              |                                                               |
|            |                   | transmit/receive |              | When channel 5 is in CSIO mode:                               |
|            |                   | clock            |              | Transmit/receive clock input when external clock is selected  |
|            |                   | input/output     |              | Transmit/receive clock output when internal clock is selected |
|            | TXD0              | Transmit data    | Output       | Transmit data output pin for serial I/O channel 0             |
|            | RXD0              | Receive data     | Input        | Receive data input pin for serial I/O channel 0               |
|            | TXD1              | Transmit data    | Output       | Transmit data output pin for serial I/O channel 1             |
|            | RXD1              | Receive data     | Input        | Receive data input pin for serial I/O channel 1               |
|            | TXD2              | Transmit data    | Output       | Transmit data output pin for serial I/O channel 2             |
|            | RXD2              | Receive data     | Input        | Receive data input pin for serial I/O channel 2               |
|            | TXD3              | Transmit data    | Output       | Transmit data output pin for serial I/O channel 3             |
|            | RXD3              | Receive data     | Input        | Receive data input pin for serial I/O channel 3               |
|            | TXD4              | Transmit data    | Output       | Transmit data output pin for serial I/O channel 4             |
|            | RXD4              | Receive data     | Input        | Receive data input pin for serial I/O channel 4               |
|            | TXD5              | Transmit data    | Output       | Transmit data output pin for serial I/O channel 5             |
|            | RXD5              | Receive data     | Input        | Receive data input pin for serial I/O channel 5               |

**32170 Group, 32174 Group**

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**Table 8 Description of Pin Functions (4/5)**

| Type                        | Pin name  | Description          | Input/output | Function                                                                                                                                                                                                        |
|-----------------------------|-----------|----------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Real-Time Debugger          | RTDTXD    | Transmit data        | Output       | Serial data output pin of the real-time debugger                                                                                                                                                                |
|                             | RTDRXD    | Receive data         | Input        | Serial data input pin of the real-time debugger                                                                                                                                                                 |
|                             | RTDCLK    | Clock input          | Input        | Serial data transmit/receive clock input pin of the real-time debugger                                                                                                                                          |
|                             | RTDACK    | Acknowledge          | Output       | This pin outputs a low pulse synchronously with the real-time debugger's first clock of serial data output word. The low pulse width indicates the type of the command/data the realtime debugger has received. |
| Flash-only                  | FP        | Flash protect        | Input        | This pin protects the flash memory against E/W in hardware.                                                                                                                                                     |
| CAN                         | CTX       | Transmit data        | Output       | Data output pin from CAN module.                                                                                                                                                                                |
|                             | CRX       | Receive data         | Input        | Data input pin to CAN module.                                                                                                                                                                                   |
| JTAG                        | JTMS      | Test mode            | Input        | Test select input for controlling the test circuit's state transition                                                                                                                                           |
|                             | JTCK      | Clock                | Input        | Clock input to the debugger module and test circuit.                                                                                                                                                            |
|                             | JTRST     | Test reset           | Input        | Test reset input for initializing the test circuit asynchronously.                                                                                                                                              |
|                             | JTDO      | Serial output        | Output       | Serial output of test instruction code or test data.                                                                                                                                                            |
|                             | JTDI      | Serial input         | Input        | Serial input of test instruction code or test data.                                                                                                                                                             |
| Input/output port<br>(Note) | P00-P07   | Input/output port 0  | Input/output | Programmable input/output port.                                                                                                                                                                                 |
|                             | P10-P17   | Input/output port 1  | Input/output | Programmable input/output port.                                                                                                                                                                                 |
|                             | P20-P27   | Input/output port 2  | Input/output | Programmable input/output port.                                                                                                                                                                                 |
|                             | P30-P37   | Input/output port 3  | Input/output | Programmable input/output port.                                                                                                                                                                                 |
|                             | P41-P47   | Input/output port 4  | Input/output | Programmable input/output port.                                                                                                                                                                                 |
|                             | P61-P67   | Input/output port 6  | Input/output | Programmable input/output port.<br>(However, P64 is an input-only port)                                                                                                                                         |
|                             | P70-P77   | Input/output port 7  | Input/output | Programmable input/output port.                                                                                                                                                                                 |
|                             | P82-P87   | Input/output port 8  | Input/output | Programmable input/output port.                                                                                                                                                                                 |
|                             | P93-P97   | Input/output port 9  | Input/output | Programmable input/output port.                                                                                                                                                                                 |
|                             | P100-P107 | Input/output port 10 | Input/output | Programmable input/output port.                                                                                                                                                                                 |
|                             | -P107     |                      |              |                                                                                                                                                                                                                 |

Note: Input/output port 5 is reserved for future use.

**32170 Group, 32174 Group**

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**Table 9 Description of Pin Functions (5/5)**

| Type                     | Pin name      | Description          | Input/output | Function                                                                        |
|--------------------------|---------------|----------------------|--------------|---------------------------------------------------------------------------------|
| Input/<br>output<br>port | P110<br>-P117 | Input/output port 11 | Input/output | Programmable input/output port.                                                 |
|                          | P124<br>-P127 | Input/output port 12 | Input/output | Programmable input/output port.                                                 |
|                          | P130<br>-P137 | Input/output port 13 | Input/output | Programmable input/output port.                                                 |
|                          | P140<br>-P147 | Input/output port 14 | Input/output | Programmable input/output port.                                                 |
|                          | P150<br>-P157 | Input/output port 15 | Input/output | Programmable input/output port.                                                 |
|                          | P160<br>-P167 | Input/output port 16 | Input/output | Programmable input/output port.                                                 |
|                          | P172<br>-P177 | Input/output port 17 | Input/output | Programmable input/output port.                                                 |
|                          | P180<br>-P187 | Input/output port 18 | Input/output | Programmable input/output port.                                                 |
|                          | P190<br>-P197 | Input/output port 19 | Input/output | Programmable input/output port.                                                 |
|                          | P200<br>-P203 | Input/output port 20 | Input/output | Programmable input/output port.                                                 |
|                          | P210<br>-P217 | Input/output port 21 | Input/output | Programmable input/output port.                                                 |
|                          | P220<br>-P225 | Input/output port 22 | Input/output | Programmable input/output port. (Note)<br>(However, P221 is an input-only port) |

Note: Use caution when using P224 and P225 because they have a debug event function.

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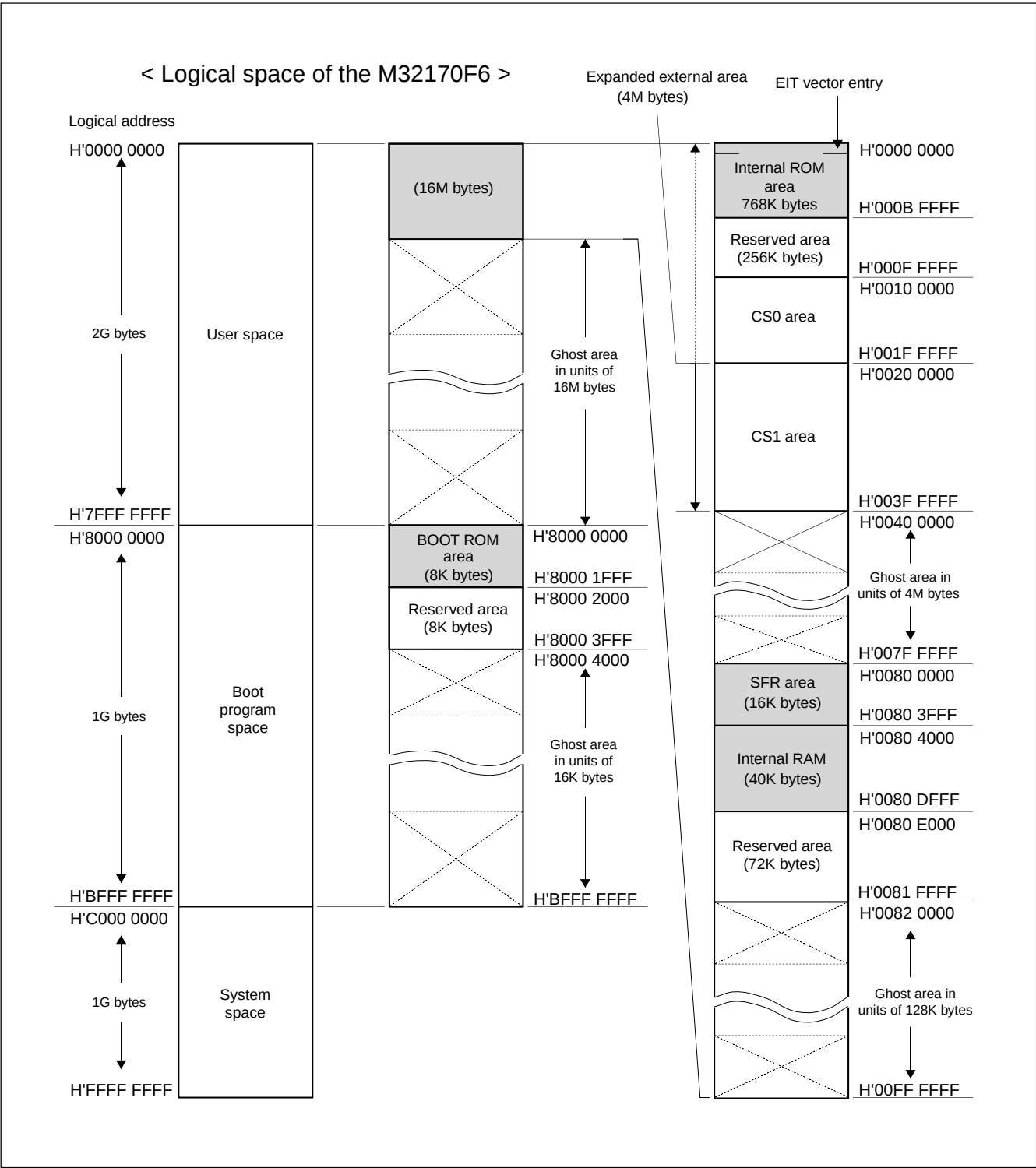
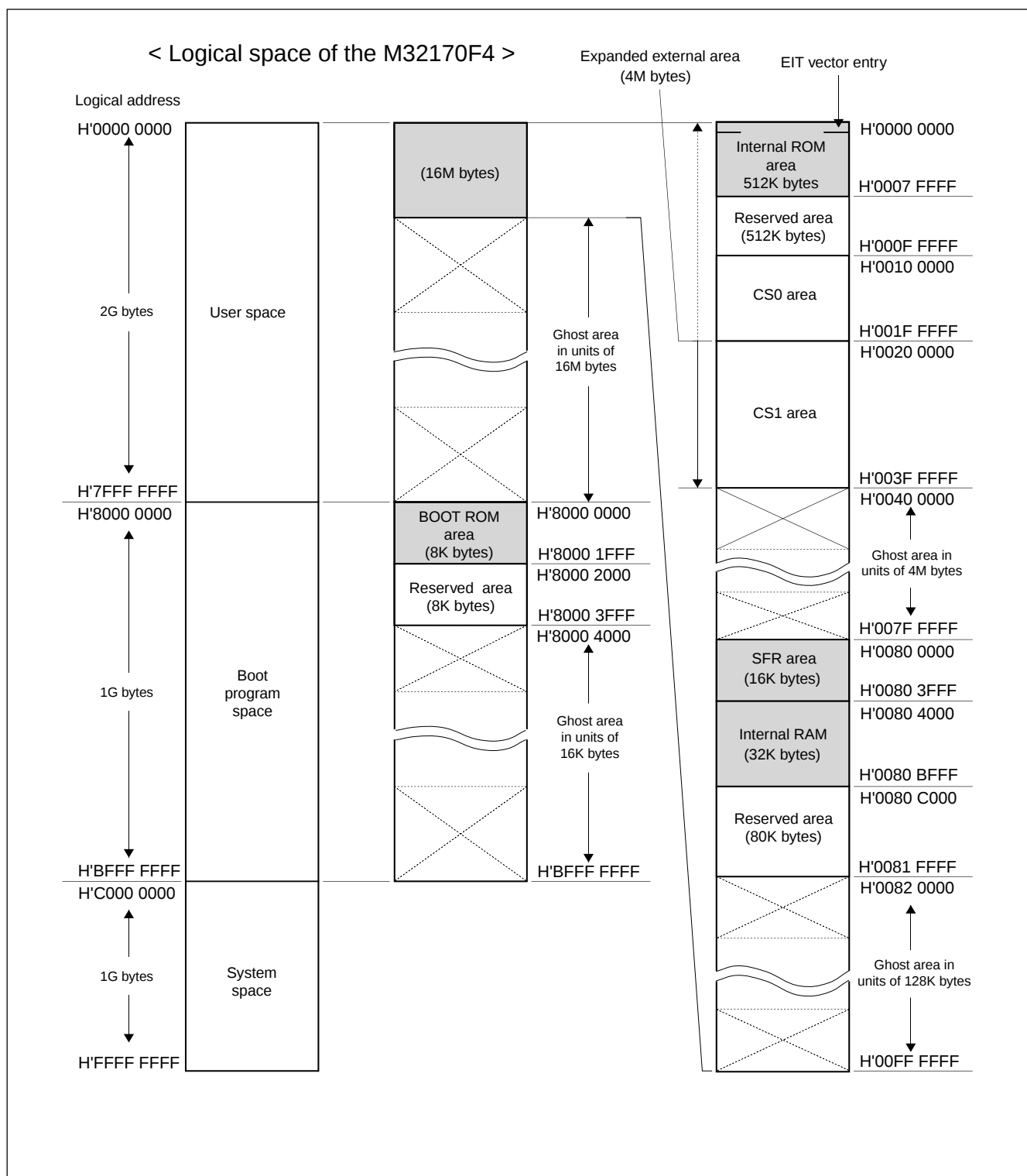


Figure 6 Address Space of the M32170F6

**32170 Group, 32174 Group**

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**Figure 7 Address Space of the M32170F4**

# 32170 Group, 32174 Group

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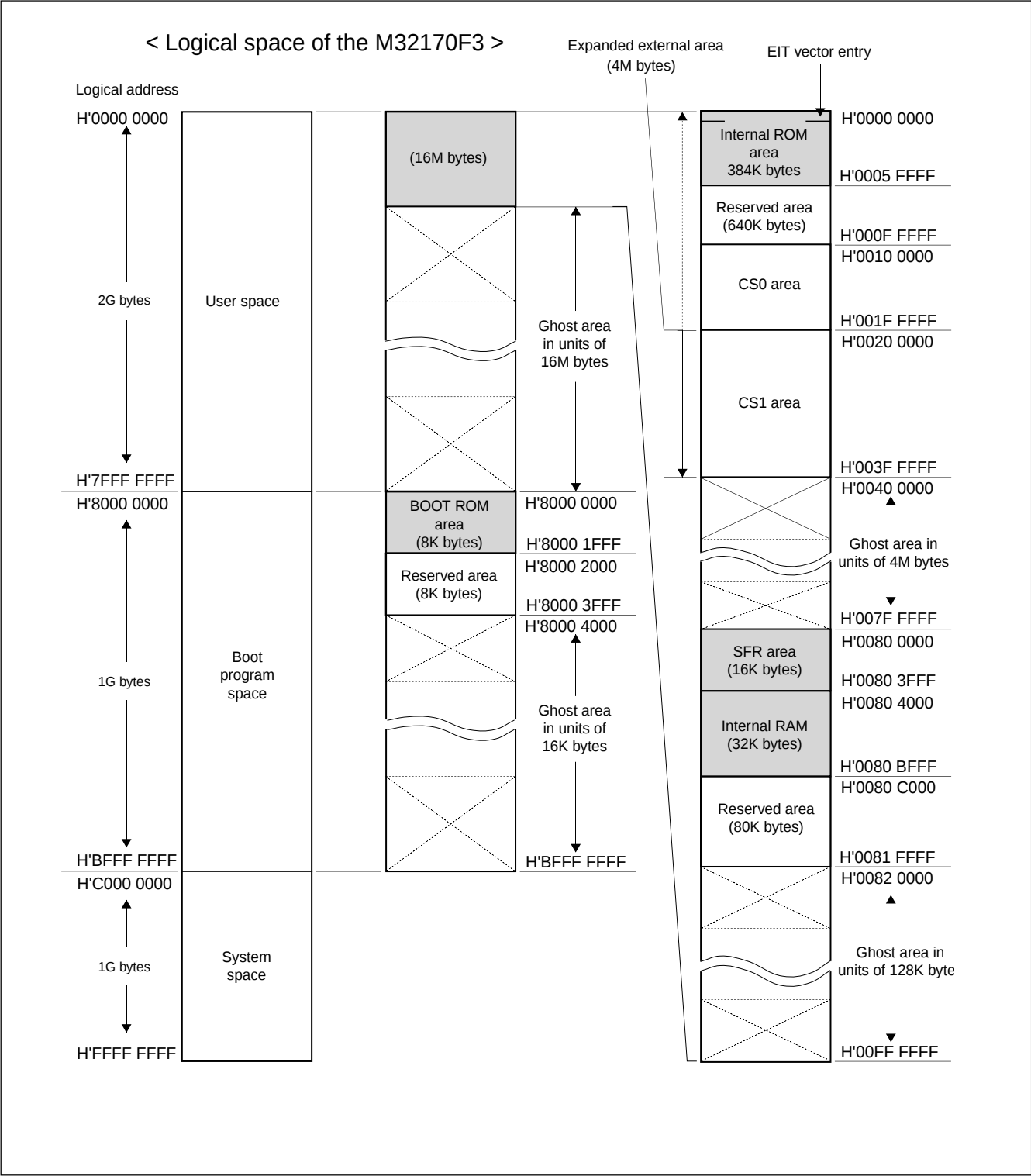
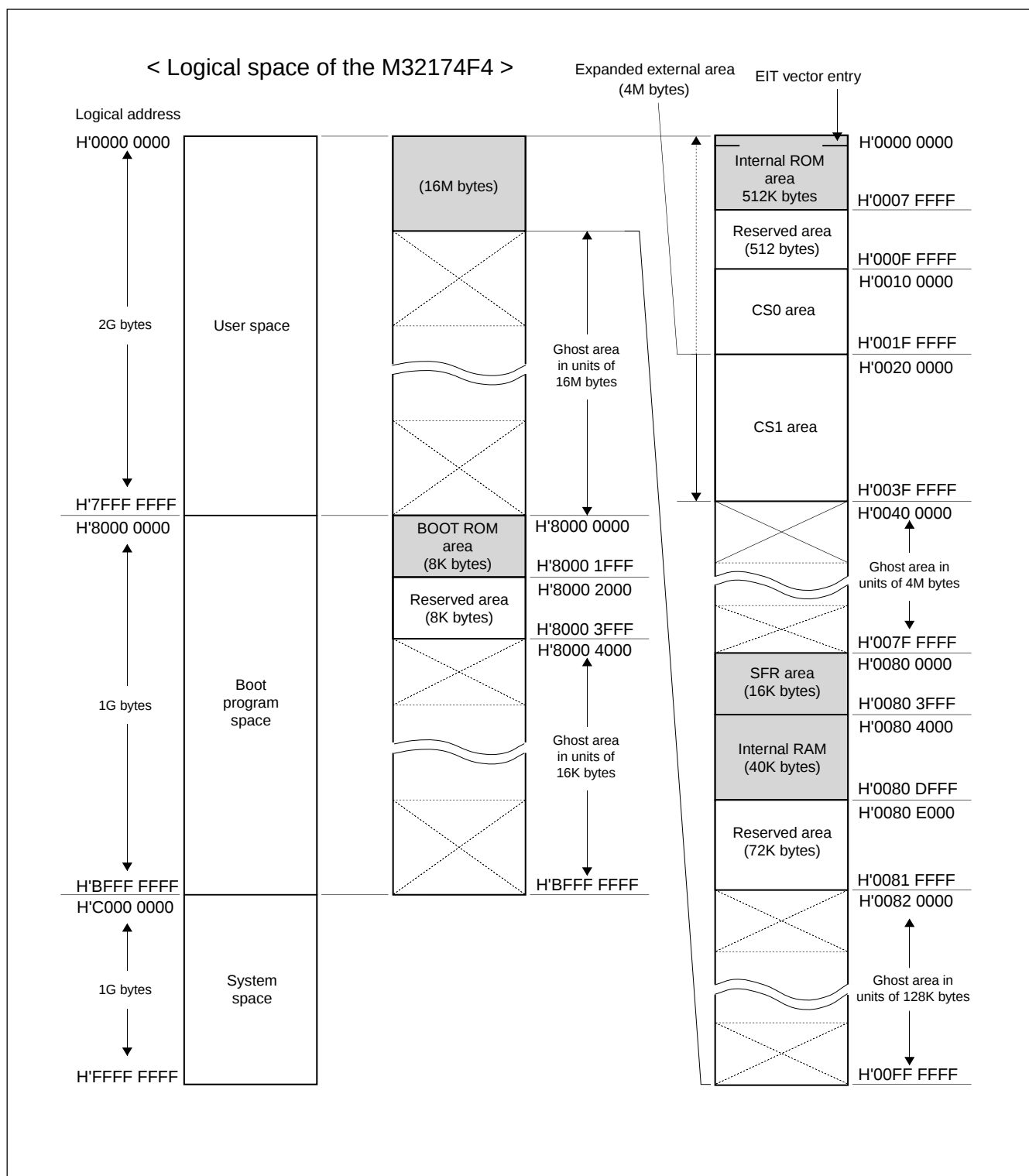


Figure 8 Address Space of the M32170F3

**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

**Figure 9 Address Space of the M32174F4**

# 32170 Group, 32174 Group

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

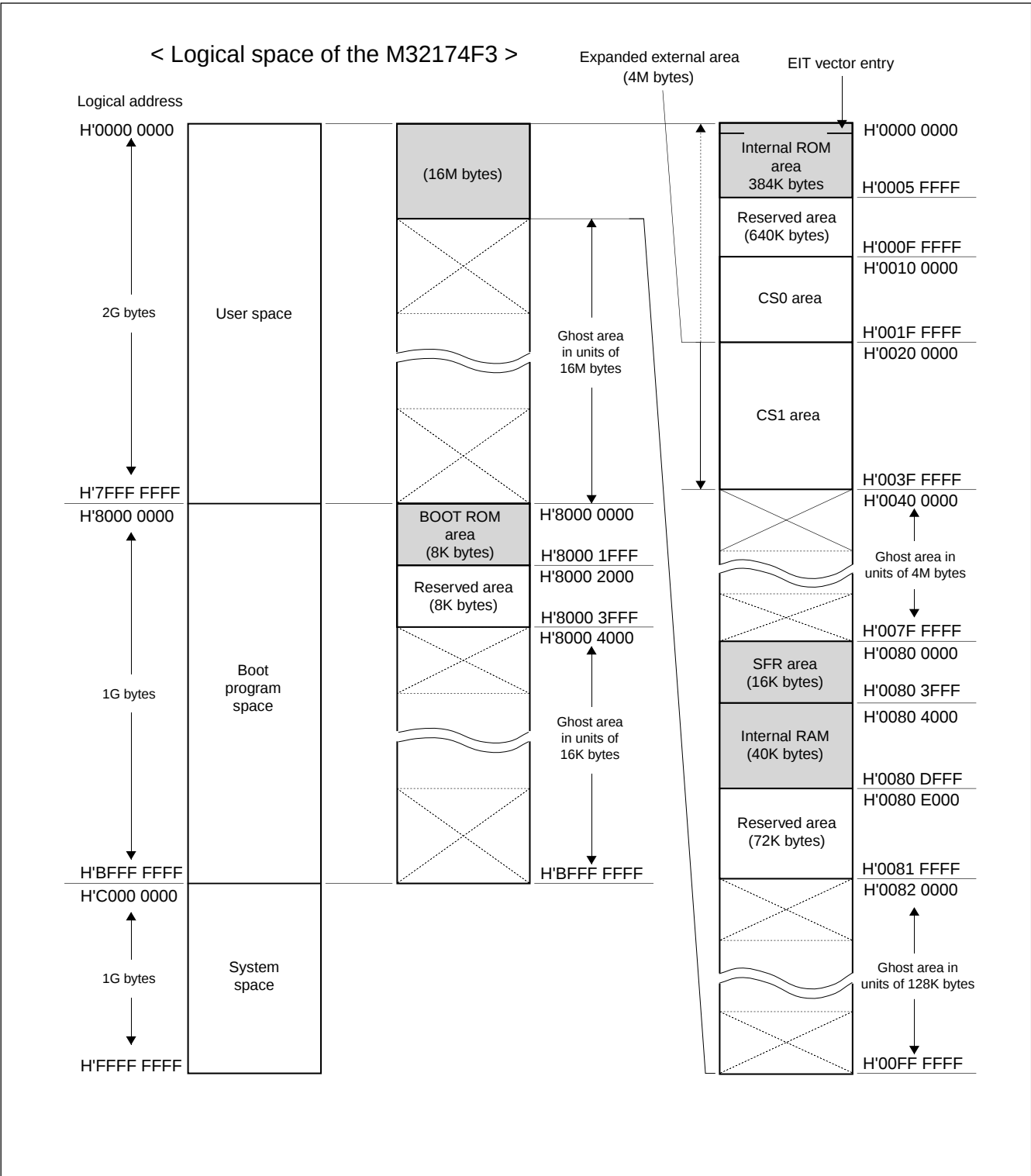
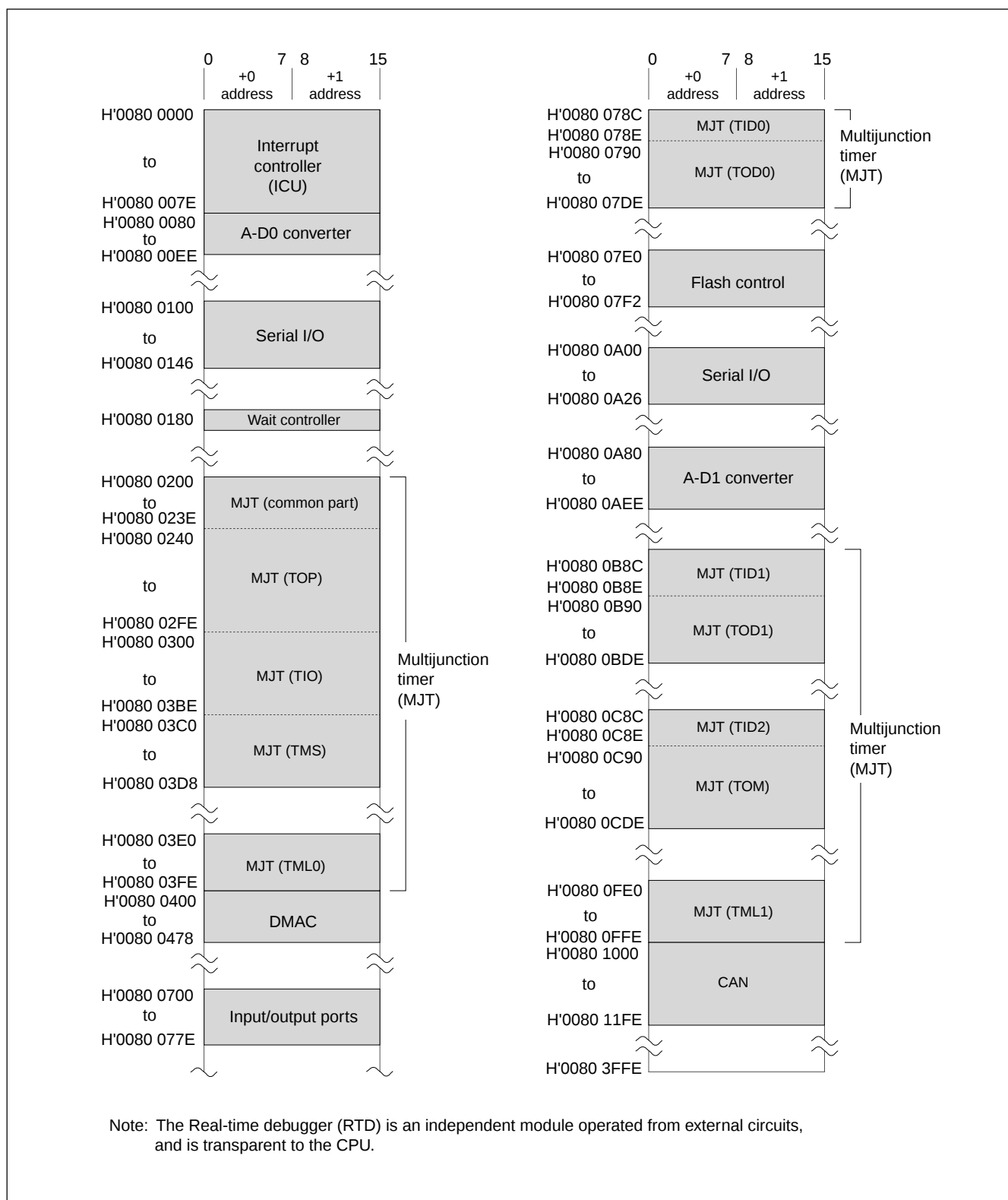


Figure 10 Address Space of the M32174F3

**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

**Figure 11 SFR Area**

**32170 Group, 32174 Group**

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**Built-in Flash Memory and RAM**

32170 and 32174 Group contain Flash Memory and RAM stated as follows.

The internal flash memory can be programmed on-board (i.e., while being mounted on the printed circuit board). This means that the same chip as will be used in mass-production can be used directly from the development stage on, allowing for system development without having to change the printed circuit board when proceeding from trial production to mass-production.

**Table 10 Flash memory and RAM Size (32170 Group)**

| Type Name   | ROM Size   | RAM Size  |
|-------------|------------|-----------|
| M32170F6VFP | 768K bytes | 40K bytes |
| M32170F4VFP | 512K bytes | 32K bytes |
| M32170F3VFP | 384K bytes | 32K bytes |
| M32170F6VWG | 768K bytes | 40K bytes |
| M32170F4VWG | 512K bytes | 32K bytes |
| M32170F3VWG | 384K bytes | 32K bytes |

**Table 11 Flash memory and RAM Size (32174 Group)**

| Type Name   | ROM Size   | RAM Size  |
|-------------|------------|-----------|
| M32174F4VFP | 512K bytes | 40K bytes |
| M32174F3VFP | 384K bytes | 40K bytes |
| M32174F4VWG | 512K bytes | 40K bytes |
| M32174F3VWG | 384K bytes | 40K bytes |

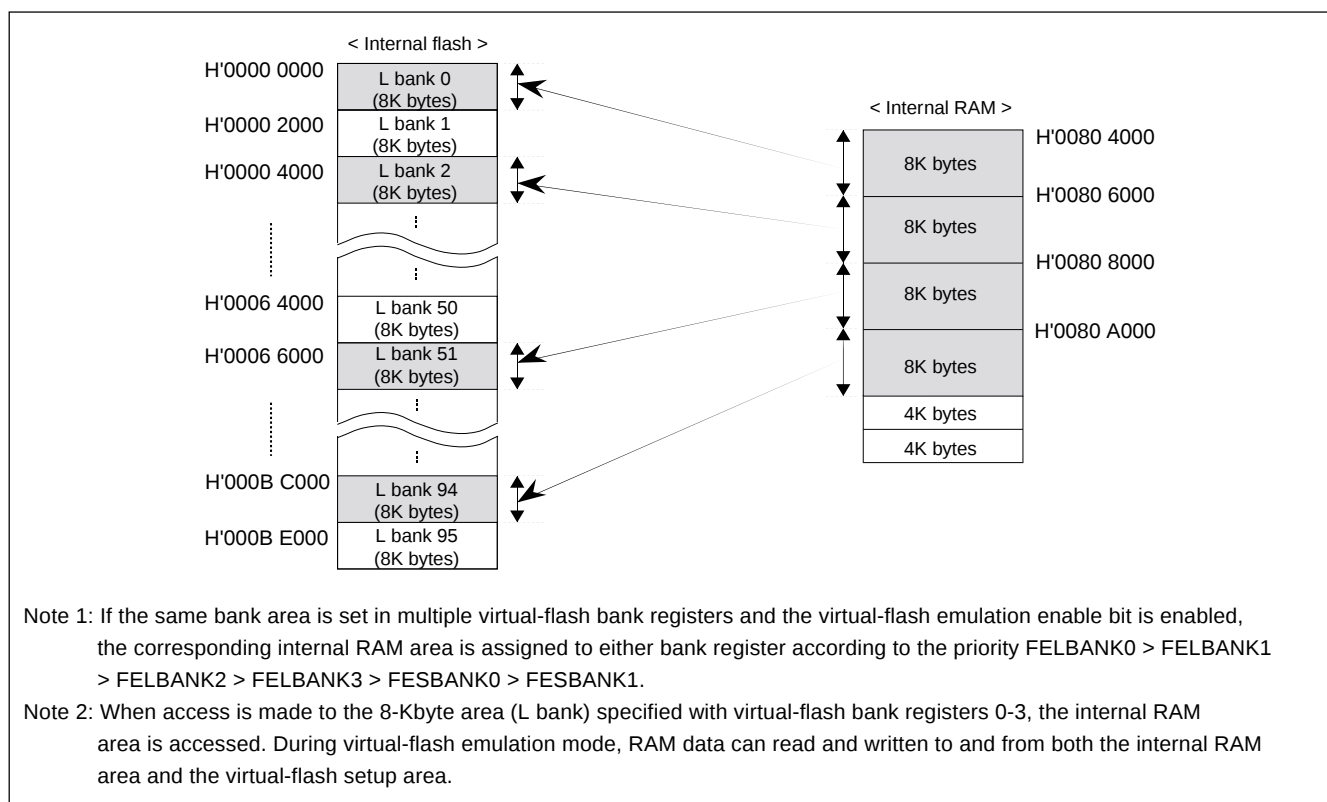
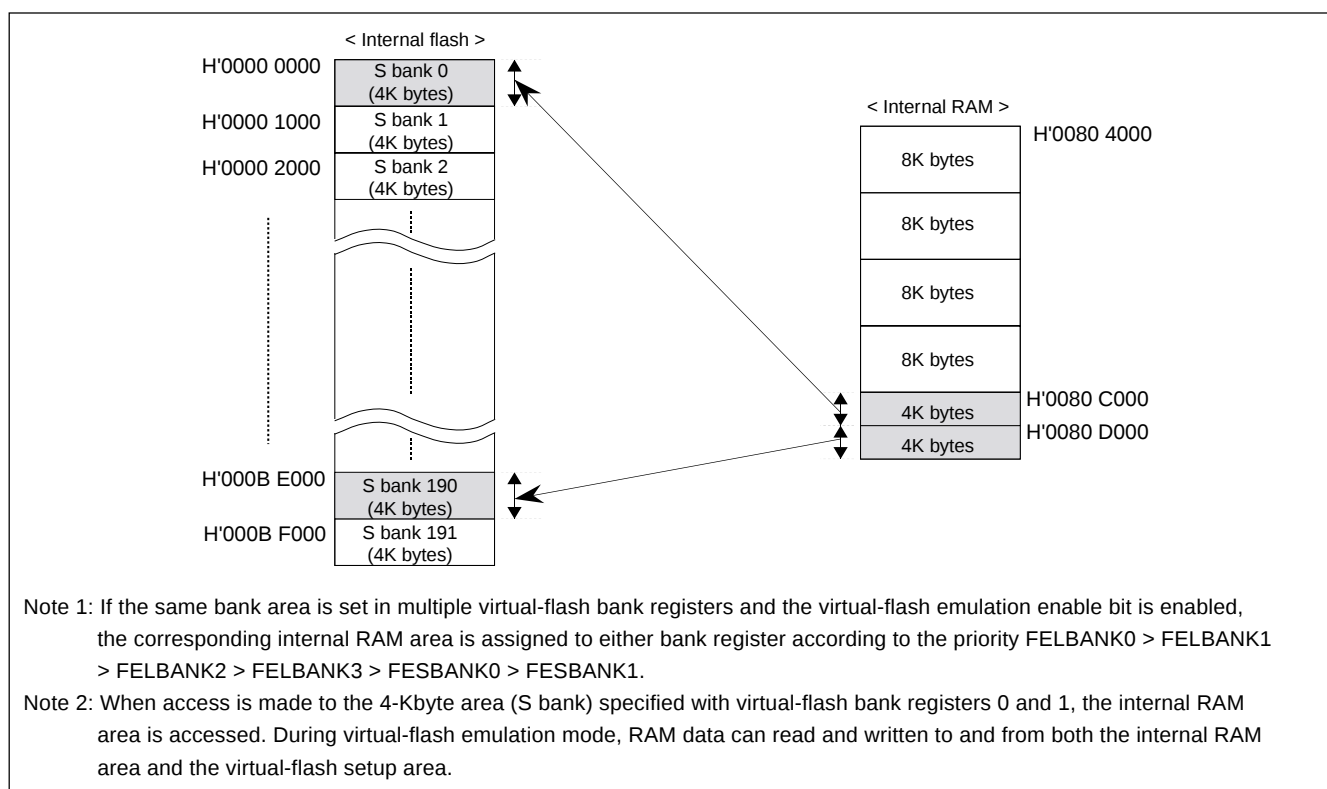
**Built-in Virtual-flash Emulation Function**

Internal flash memory, which is divided from the first address in units of 8 Kbyte (L banks), can be replaced in 8 -Kbyte blocks (H70080 4000-H'0080 5FFF) of the internal RAM. And also the internal flash memory, which is divided from the first address in units of 4-Kbyte areas (S banks), can be replaced in 4 Kbytes areas.

This function allows parts of the program which are frequently changed during development to be altered or evaluated without having to reset the microcomputer each time. What's more, when combined with the realtime debugger, this function helps to reduce the program evaluation period, because data in the RAM can be rewritten without requiring any CPU load.

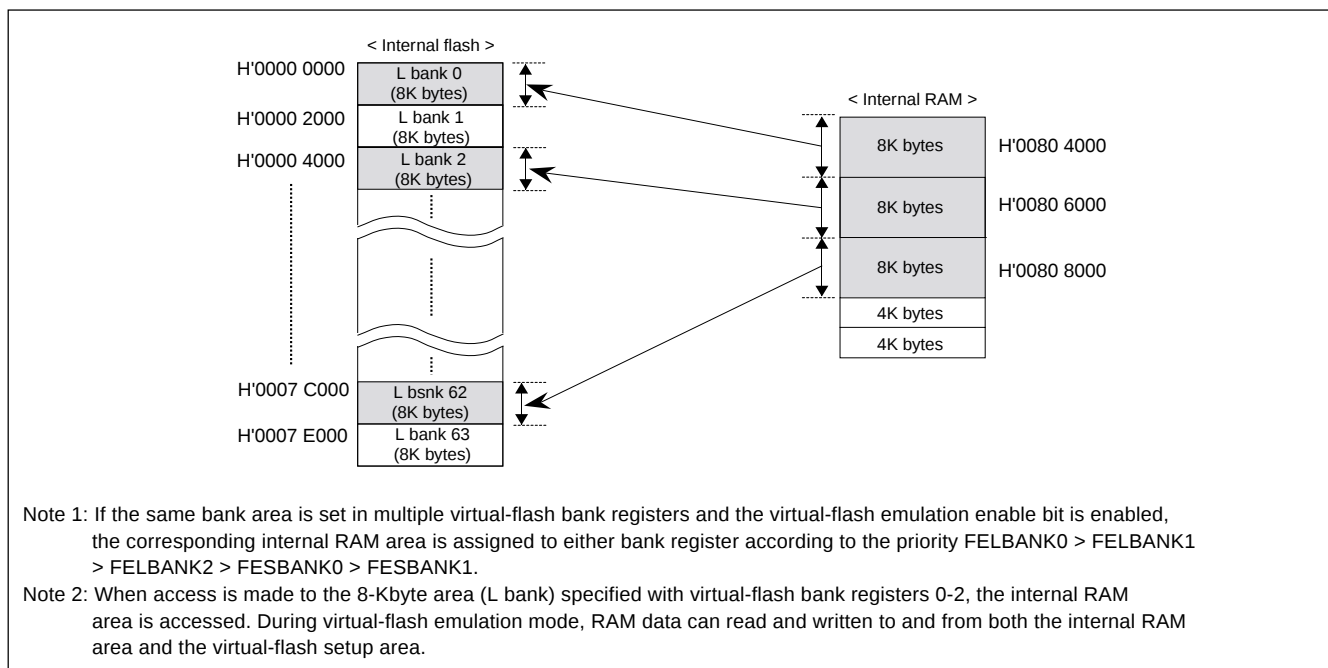
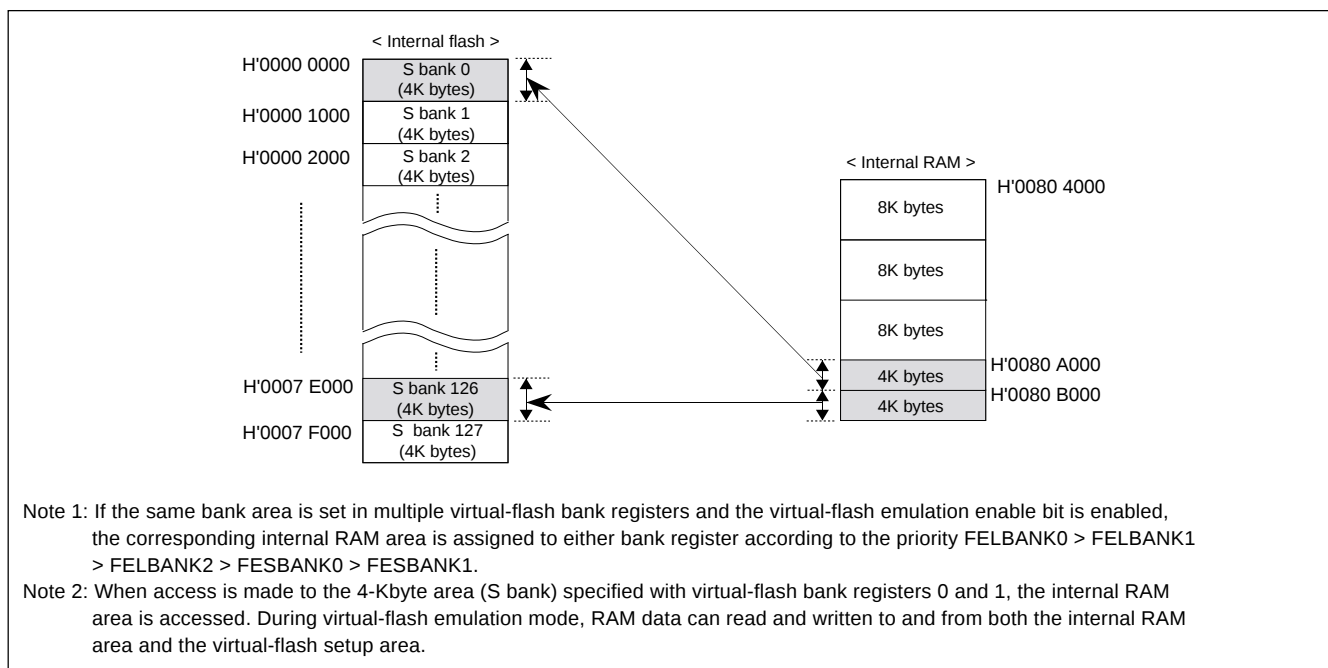
**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

**Figure 12 Virtual-Flash Emulation Areas of the M32170F6VFP (Replaced in Units of 8 Kbytes)****Figure 13 Virtual-Flash Emulation Areas of the M32170F6VFP (Replaced in Units of 4 Kbytes)**

**32170 Group, 32174 Group**

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**Figure 14 Virtual-Flash Emulation Areas of the M32170F4VFP (Replaced in Units of 8 Kbytes)****Figure 15 Virtual-Flash Emulation Areas of the M32170F4VFP (Replaced in Units of 4 Kbytes)**

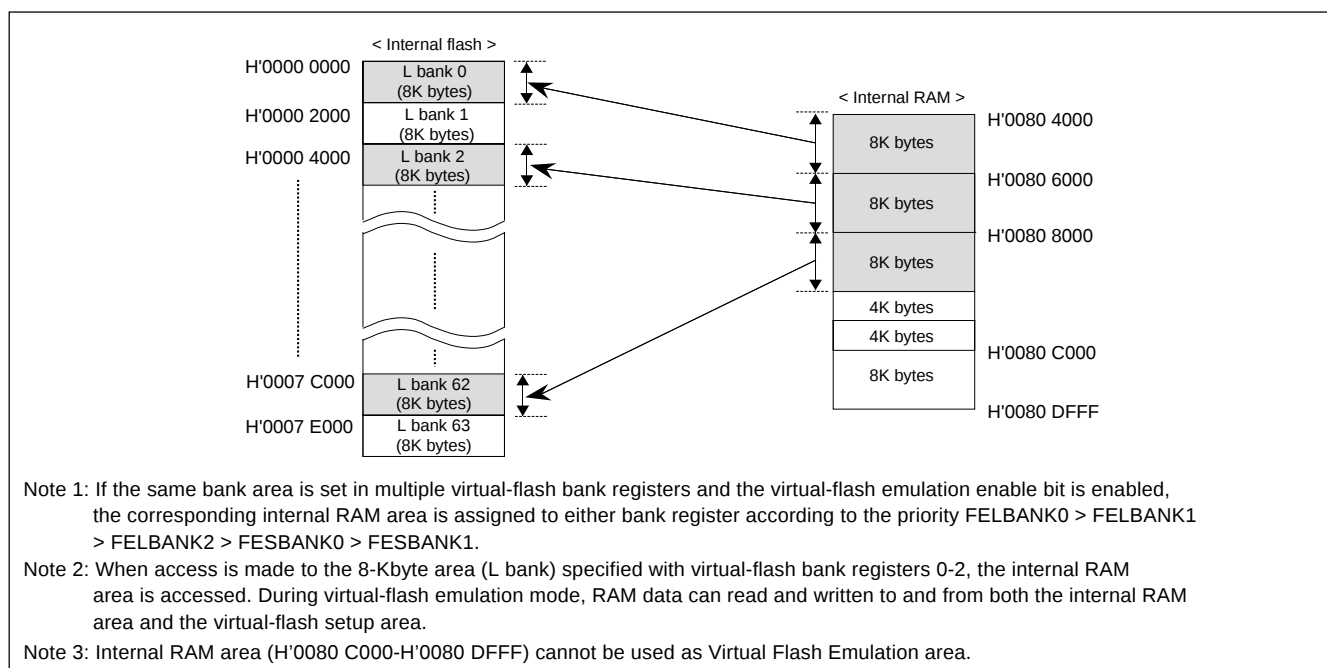
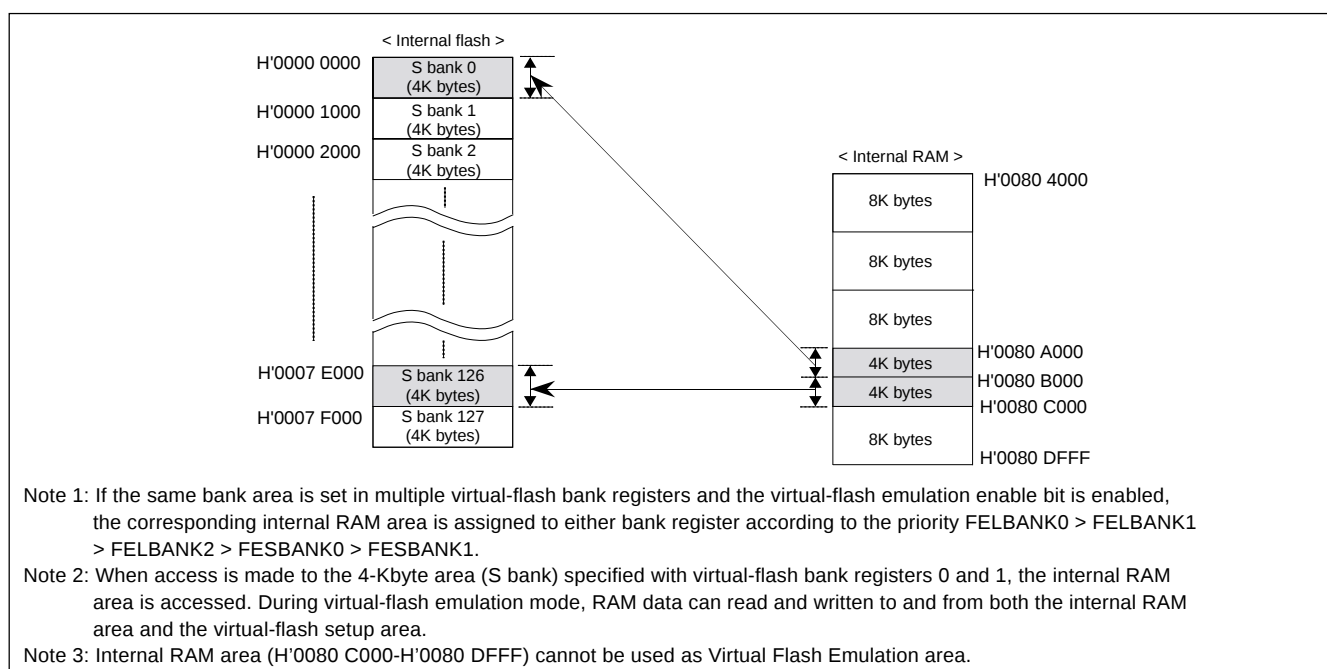
The table below shows Virtual-Flash Emulation Areas of the M32170F4 and M32170F3.

**Table 12 Virtual-Flash Emulation Areas of the M32170F4 and M32170F3**

| Type                    | Virtual-Flash Emulation Areas |
|-------------------------|-------------------------------|
| M32170F4VFP,M32170F4VWG | H' 0000 0000 - H' 0007 FFFF   |
| M32170F3VFP,M32170F3VWG | H' 0000 0000 - H' 0005 FFFF   |

**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

**Figure 16 Virtual-Flash Emulation Areas of the M32174F4VFP (Replaced in Units of 8 Kbytes)****Figure 17 Virtual-Flash Emulation Areas of the M32174F4VFP (Replaced in Units of 4 Kbytes)**

The table below shows Virtual-Flash Emulation Areas of the M32174F4 and M32174F3.

**Table 13. Virtual-Flash Emulation Areas of the M32174F4 and M32174F3**

| Type Name                | Virtual-Flash Emulation Areas |
|--------------------------|-------------------------------|
| M32174F4VFP, M32174F4VWG | H' 0000 0000 - H' 0007 FFFF   |
| M32174F3VFP, M32174F3VWG | H' 0000 0000 - H' 0005 FFFF   |

**32170 Group, 32174 Group**

SINGLE-CHIP 32-BIT CMOS MICROCOMPUTER

**Input/output Ports**

The microcomputer has a total of 157 input/output ports P0-P22. (However, P5 is reserved for future use.) The input/output ports can be used as input ports or output ports by setting up their direction registers.

Each input/output port is a dual-function pin shared with

other internal peripheral I/O or external extended bus signal lines. These pin functions are selected by using the chip operation mode select or the input/output port operation mode registers. These input/output ports are interfaced using a dedicated power supply to allow for connections to the peripheral circuits operating with 5V or 3.3V.

**Table 14 Outline of Input/output Ports**

| Item                       | Specification                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |             |           |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|-----------|-----------|-----------|----|---|-----------|-----------|----|---|-----------|-----------|----|---|-----------|-----------|----|---|-----------|-----------|----|---|-----------|-----------|----|---|-----------|-----------|----|---|-----------|-----------|----|---|-----------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|-----|---|-------------|-----------|
| Number of Port             | <div>Total 157 ports</div> <table><tr><td>P0</td><td>:</td><td>P00 - P07</td><td>(8 lines)</td></tr><tr><td>P1</td><td>:</td><td>P10 - P17</td><td>(8 lines)</td></tr><tr><td>P2</td><td>:</td><td>P20 - P27</td><td>(8 lines)</td></tr><tr><td>P3</td><td>:</td><td>P30 - P37</td><td>(8 lines)</td></tr><tr><td>P4</td><td>:</td><td>P41 - P47</td><td>(7 lines)</td></tr><tr><td>P6</td><td>:</td><td>P61 - P67</td><td>(7 lines)</td></tr><tr><td>P7</td><td>:</td><td>P70 - P77</td><td>(8 lines)</td></tr><tr><td>P8</td><td>:</td><td>P82 - P87</td><td>(6 lines)</td></tr><tr><td>P9</td><td>:</td><td>P93 - P97</td><td>(5 lines)</td></tr><tr><td>P10</td><td>:</td><td>P100 - P107</td><td>(8 lines)</td></tr><tr><td>P11</td><td>:</td><td>P110 - P117</td><td>(8 lines)</td></tr><tr><td>P12</td><td>:</td><td>P124 - P127</td><td>(4 lines)</td></tr><tr><td>P13</td><td>:</td><td>P130 - P137</td><td>(8 lines)</td></tr><tr><td>P14</td><td>:</td><td>P140 - P147</td><td>(8 lines)</td></tr><tr><td>P15</td><td>:</td><td>P150 - P157</td><td>(8 lines)</td></tr><tr><td>P16</td><td>:</td><td>P160 - P167</td><td>(8 lines)</td></tr><tr><td>P17</td><td>:</td><td>P172 - P177</td><td>(6 lines)</td></tr><tr><td>P18</td><td>:</td><td>P180 - P187</td><td>(8 lines)</td></tr><tr><td>P19</td><td>:</td><td>P190 - P197</td><td>(8 lines)</td></tr><tr><td>P20</td><td>:</td><td>P200 - P203</td><td>(4 lines)</td></tr><tr><td>P21</td><td>:</td><td>P210 - P217</td><td>(8 lines)</td></tr><tr><td>P22</td><td>:</td><td>P220 - P225</td><td>(6 lines)</td></tr></table> | P0          | :         | P00 - P07 | (8 lines) | P1 | : | P10 - P17 | (8 lines) | P2 | : | P20 - P27 | (8 lines) | P3 | : | P30 - P37 | (8 lines) | P4 | : | P41 - P47 | (7 lines) | P6 | : | P61 - P67 | (7 lines) | P7 | : | P70 - P77 | (8 lines) | P8 | : | P82 - P87 | (6 lines) | P9 | : | P93 - P97 | (5 lines) | P10 | : | P100 - P107 | (8 lines) | P11 | : | P110 - P117 | (8 lines) | P12 | : | P124 - P127 | (4 lines) | P13 | : | P130 - P137 | (8 lines) | P14 | : | P140 - P147 | (8 lines) | P15 | : | P150 - P157 | (8 lines) | P16 | : | P160 - P167 | (8 lines) | P17 | : | P172 - P177 | (6 lines) | P18 | : | P180 - P187 | (8 lines) | P19 | : | P190 - P197 | (8 lines) | P20 | : | P200 - P203 | (4 lines) | P21 | : | P210 - P217 | (8 lines) | P22 | : | P220 - P225 | (6 lines) |
| P0                         | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P00 - P07   | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P1                         | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P10 - P17   | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P2                         | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P20 - P27   | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P3                         | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P30 - P37   | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P4                         | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P41 - P47   | (7 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P6                         | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P61 - P67   | (7 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P7                         | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P70 - P77   | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P8                         | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P82 - P87   | (6 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P9                         | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P93 - P97   | (5 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P10                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P100 - P107 | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P11                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P110 - P117 | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P12                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P124 - P127 | (4 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P13                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P130 - P137 | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P14                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P140 - P147 | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P15                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P150 - P157 | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P16                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P160 - P167 | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P17                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P172 - P177 | (6 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P18                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P180 - P187 | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P19                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P190 - P197 | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P20                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P200 - P203 | (4 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P21                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P210 - P217 | (8 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| P22                        | :                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | P220 - P225 | (6 lines) |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| Port function              | The input/output ports can be set for input or output mode bitwise by using the input/output port direction control register. (However, P64 is an $\overline{\text{SBI}}$ input-only port, and P221 is CAN input-only port.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |             |           |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| Pin function               | Dual-functions shared with peripheral I/O or external extended signals (or multi-functions shared with peripheral I/Os which have multiple functions.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |             |           |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |
| Pin function<br>changeover | <div>P0-4, P225, P225 : Changed by setting CPU operation mode (MOD0 and MOD1 pins)</div> <div>P6-22 : Changed by setting the input/output port operation mode register.</div> <div>(However, peripheral I/O pin functions are selected using the peripheral I/O register.)</div>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |             |           |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |    |   |           |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |     |   |             |           |

**Table 15 CPU Operation Modes and P0-P4, P224, and P225 Pin Functions**

| MOD0 | MOD1 | Operation mode                | Pin functions of P0-P4, P224, P225 |
|------|------|-------------------------------|------------------------------------|
| VSS  | VSS  | Single-chip mode              | Input/output port pin              |
| VSS  | VCCE | External extended mode        | External extended signal pin       |
| VCCE | VSS  | Processor mode (FP pin = VSS) |                                    |
| VCCE | VCC  | Reserved (use inhibited)      | —                                  |

Note: VCC and VSS are connected to +5 V and GND, respectively.

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|                                                             |     | 0     | 1     | 2      | 3      | 4                 | 5                 | 6                 | 7                 |
|-------------------------------------------------------------|-----|-------|-------|--------|--------|-------------------|-------------------|-------------------|-------------------|
| CPU<br>operation mode<br>settings (Note1)                   | P0  | DB0   | DB1   | DB2    | DB3    | DB4               | DB5               | DB6               | DB7               |
|                                                             | P1  | DB8   | DB9   | DB10   | DB11   | DB12              | DB13              | DB14              | DB15              |
|                                                             | P2  | A23   | A24   | A25    | A26    | A27               | A28               | A29               | A30               |
|                                                             | P3  | A15   | A16   | A17    | A18    | A19               | A20               | A21               | A22               |
|                                                             | P4  |       | BLW   | BHW    | RD     | CS0               | CS1               | A13               | A14               |
| (Reserved)                                                  | P5  |       |       |        |        |                   |                   |                   |                   |
| Input/output<br>port operation<br>mode register<br>settings | P6  |       | (P61) | (P62)  | (P63)  | SBI               | SCLKI4/<br>SCLKO4 | SCLKI5/<br>SCLKO5 | ADTRG             |
|                                                             | P7  | BCLK  | WAIT  | HREQ   | HACK   | RTD TXD           | RTD RXD           | RTD ACK           | RTD CLK           |
|                                                             | P8  |       |       | TXD0   | RXD0   | SCLKI0/<br>SCLKO0 | TXD1              | RXD1              | SCLKI1/<br>SCLKO1 |
|                                                             | P9  |       |       |        | TO16   | TO17              | TO18              | TO19              | TO20              |
|                                                             | P10 | TO8   | TO9   | TO10   | TO11   | TO12              | TO13              | TO14              | TO15              |
|                                                             | P11 | TO0   | TO1   | TO2    | TO3    | TO4               | TO5               | TO6               | TO7               |
|                                                             | P12 |       |       |        |        | TCLK0             | TCLK1             | TCLK2             | TCLK3             |
|                                                             | P13 | TIN16 | TIN17 | TIN18  | TIN19  | TIN20             | TIN21             | TIN22             | TIN23             |
|                                                             | P14 | TIN8  | TIN9  | TIN10  | TIN11  | TIN12             | TIN13             | TIN14             | TIN15             |
|                                                             | P15 | TIN0  | TIN1  | TIN2   | TIN3   | TIN4              | TIN5              | TIN6              | TIN7              |
|                                                             | P16 | TO21  | TO22  | TO23   | TO24   | TO25              | TO26              | TO27              | TO28              |
|                                                             | P17 |       |       | TIN24  | TIN25  | TXD2              | RXD2              | TXD3              | RXD3              |
|                                                             | P18 | TO29  | TO30  | TO31   | TO32   | TO33              | TO34              | TO35              | TO36              |
|                                                             | P19 | TIN26 | TIN27 | TIN28  | TIN29  | TIN30             | TIN31             | TIN32             | TIN33             |
|                                                             | P20 | TXD4  | RXD4  | TXD5   | RXD5   |                   |                   |                   |                   |
|                                                             | P21 | TO37  | TO38  | TO39   | TO40   | TO41              | TO42              | TO43              | TO44              |
|                                                             | P22 | CTX   | CRX   | (P222) | (P223) | A11<br>(Note2)    | A12<br>(Note2)    |                   |                   |

Note 1: The pin function are selected by setting the MOD0 and MOD1 pins.

Note 2: The pin function are selected by setting the MOD0 and MOD1 pins. Also, use of this pin requires caution because it has a debug event function.

**Figure 18 Input/output Ports and Pin Function Assignments**

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**Built-in 10-Channel DMAC**

The microcomputer contains 10 channels of DMAC, allowing for data transfer between internal peripheral I/Os, between internal RAM and internal peripheral I/O, and between internal RAMs.

DMA transfer requests can be issued from the user-created software, as well as can be triggered by a signal generated by the internal peripheral I/O (A-D converter, MJT, or serial I/O).

The microcomputer also supports cascaded connection between DMA channels (starting DMA transfer on a channel at end of transfer on another channel). This makes advanced transfer processing possible without causing any additional CPU load.

**Table 16 Outline of the DMAC**

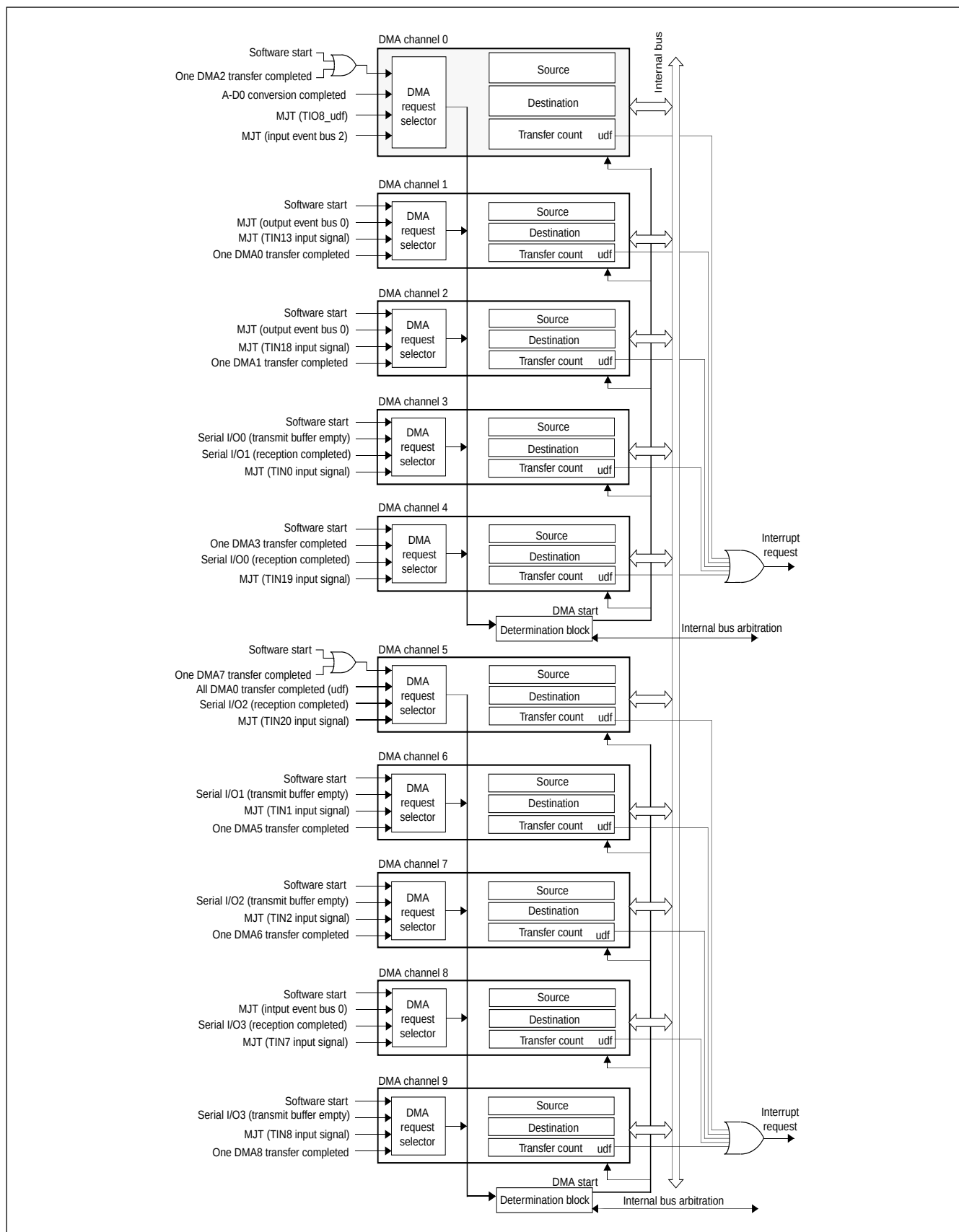
| Item                                | Content                                                                                                                                                                                                                                                                                  |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of channels                  | 10 channels                                                                                                                                                                                                                                                                              |
| Transfer request                    | <ul style="list-style-type: none"> <li>• Software trigger</li> <li>• Request from internal peripheral I/O: A-D converter, multijunction timer, or serial I/O (reception completed, transmit buffer empty)</li> <li>• Cascaded connection between DMA channels possible (Note)</li> </ul> |
| Maximum number of times transferred | 256 times                                                                                                                                                                                                                                                                                |
| Transferable address space          | <ul style="list-style-type: none"> <li>• 64 Kbytes (address space from H'0080 0000 to H'0080 FFFF)</li> <li>• Transfers between internal peripheral I/Os, between internal RAM and internal peripheral IO, and between internal RAMs are supported</li> </ul>                            |
| Transfer data size                  | 16 bits or 8 bits                                                                                                                                                                                                                                                                        |
| Transfer method                     | Single transfer DMA (control of the internal bus is relinquished for each transfer performed), dual-address transfer                                                                                                                                                                     |
| Transfer mode                       | Single transfer mode                                                                                                                                                                                                                                                                     |
| Direction of transfer               | One of three modes can be selected for the source and destination of transfer: <ul style="list-style-type: none"> <li>• Address fixed</li> <li>• Address increment</li> <li>• 32-channel ring buffer</li> </ul>                                                                          |
| Channel priority                    | Channel 0 > channel 1 > channel 2 > channel 3 > channel 4 > channel 5 > channel 6 > channel 7 > channel 8 > channel 9<br>(Fixed priority)                                                                                                                                                |
| Maximum transfer rate               | 13.3 Mbytes per second (when internal peripheral clock = 20 MHz)                                                                                                                                                                                                                         |
| Interrupt request                   | Group interrupt request can be generated when each transfer count register underflows                                                                                                                                                                                                    |
| Transfer area                       | 64 Kbytes from H'0080 0000 to H'0080 FFFF (Transfer is possible in the entire internal RAM/SFR area)                                                                                                                                                                                     |

Note: The following DMA channels can be cascaded.

- DMA transfer on channel 1 started at end of one DMA transfer on channel 0
- DMA transfer on channel 2 started at end of one DMA transfer on channel 1
- DMA transfer on channel 0 started at end of one DMA transfer on channel 2
- DMA transfer on channel 4 started at end of one DMA transfer on channel 3
- DMA transfer on channel 6 started at end of one DMA transfer on channel 5
- DMA transfer on channel 7 started at end of one DMA transfer on channel 6
- DMA transfer on channel 5 started at end of one DMA transfer on channel 7
- DMA transfer on channel 9 started at end of one DMA transfer on channel 8
- DMA transfer on channel 5 started at end of all DMA transfers on channel 0 (underflow of transfer count register)

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**Figure 19 Block Diagram of the DMAC**

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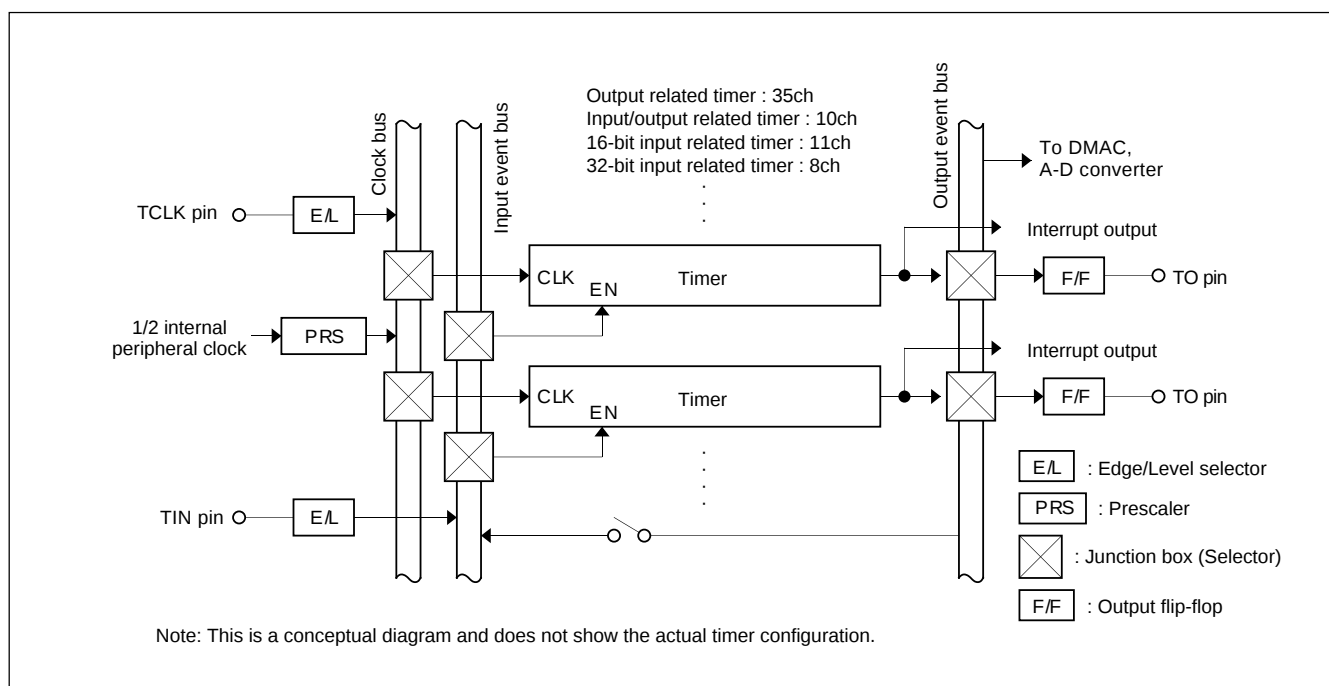
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**Built-in 64-Channel Multijunction Timers (MJT)**

The microcomputer contains a total of 64 channels of multijunction timers consisting of 35 channels of 16-bit output related timers, 10 channels of 16-bit input/output related timers, 11 channels of 16-bit input related timers, eight channels of 32-bit input related timers. Each timer has multiple operation modes to choose from, depending on the purposes of use.

Also, the multijunction timers internally have a clock bus, input event bus, and an output event bus, so that multiple timers can be used in combination allowing for a flexible timer configuration.

The output related timers have a correcting function that allows the timer's count value to be incremented or decremented as necessary while count is in progress, making real time output control possible.

**Figure 20 Conceptual Diagram of the Multijunction Timer (MJT)**

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**Table 17 Outline of Multijunction Timers (1/2)**

| Name                            | Type                                                   | Number of channels | Content                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------|--------------------------------------------------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TOP<br>(Timer Output)           | Output-related<br>16-bit timer<br>(down-counter)       | 11                 | One of three input modes can be selected in software.<br>< With correction function ><br><ul style="list-style-type: none"> <li>• Single-shot output mode</li> <li>• Delayed single-shot output mode</li> </ul> < Without correction function ><br><ul style="list-style-type: none"> <li>• Continuous output mode</li> </ul>                                                                                                                                                               |
| TIO<br>(Timer Input Output)     | Input/output-related<br>16-bit timer<br>(down-counter) | 10                 | One of three input modes or four output modes can be selected by software.<br>< Input modes ><br><ul style="list-style-type: none"> <li>• Measure clear input mode</li> <li>• Measure free-run input mode</li> <li>• Noise processing input mode</li> </ul> < Output mode without correction function<br><ul style="list-style-type: none"> <li>• PWM output mode</li> <li>• Single-shot output mod</li> <li>• Delayed single-shot output mode</li> <li>• Continuous output mode</li> </ul> |
| TMS<br>(Timer Measure Small)    | Input-related<br>16-bit timer<br>(up counter)          | 8                  | 16-bit input measure timer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TML<br>(Timer Measure Large)    | Input-related<br>32-bit timer<br>(up counter)          | 8                  | 32-bit input measure timer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| TID<br>(Timer Input Derivation) | Input-related<br>16-bit timer<br>(up counter)          | 3                  | One of three input modes can be selected in software.<br><ul style="list-style-type: none"> <li>• Fixed cycle mode</li> <li>• Event count mode</li> <li>• Multiply-by-4 event count mode</li> </ul>                                                                                                                                                                                                                                                                                         |

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**Table 18 Outline of Multijunction Timers (2/2)**

| Name                                  | Type                                             | Number of channels | Content                                                                                                                                                                                                                                                                    |
|---------------------------------------|--------------------------------------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| TOD<br>(Timer<br>output Modification) | output-related<br>16-bit timer<br>(down-counter) | 16                 | One of four output modes can be selected in software.<br>< No correction function ><br><ul style="list-style-type: none"> <li>• PWM output mode</li> <li>• Single-shot output mode</li> <li>• Delayed single-shot output mode</li> <li>• Continuous output mode</li> </ul> |
| TOM<br>(Timer<br>output Modification) | output-related<br>16-bit timer<br>(down-counter) | 8                  | One of four output modes can be selected in software.<br>< No correction function ><br><ul style="list-style-type: none"> <li>• PWM output mode</li> <li>• Single-shot PWM output mode</li> <li>• One-shot output mode</li> <li>• Continuous output mode</li> </ul>        |

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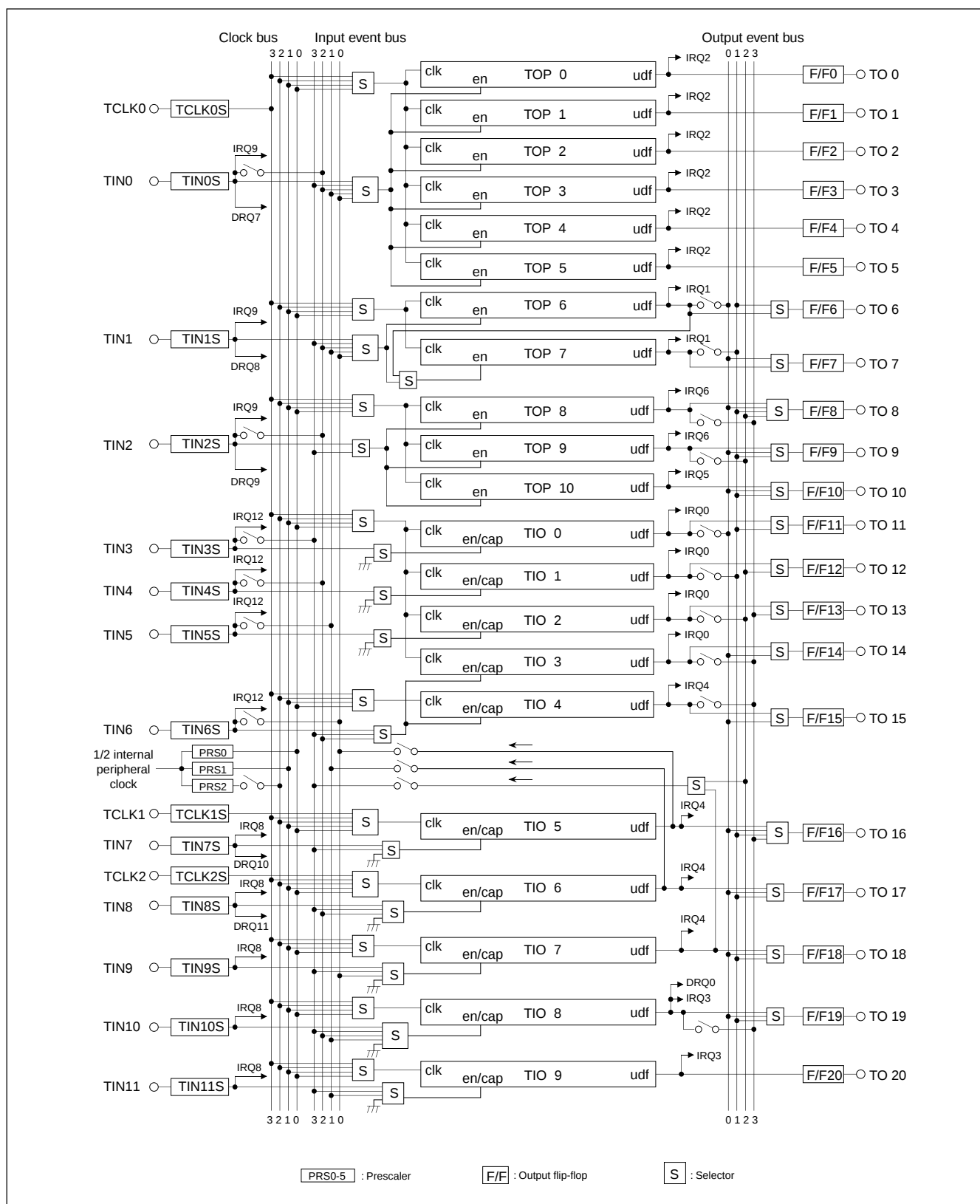
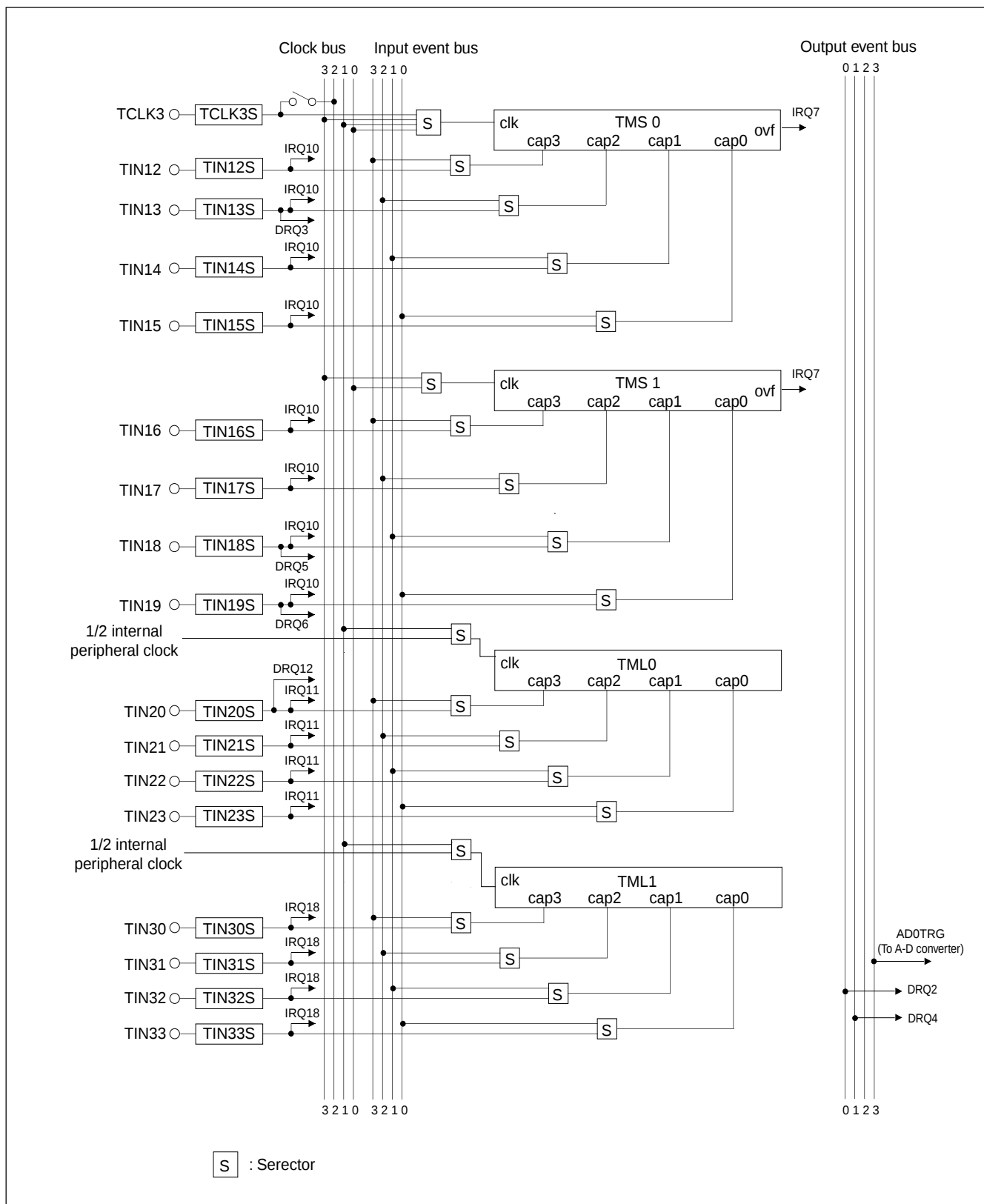


Figure 21 Block Diagram of Multijunction Timers (MJT) (1/4)

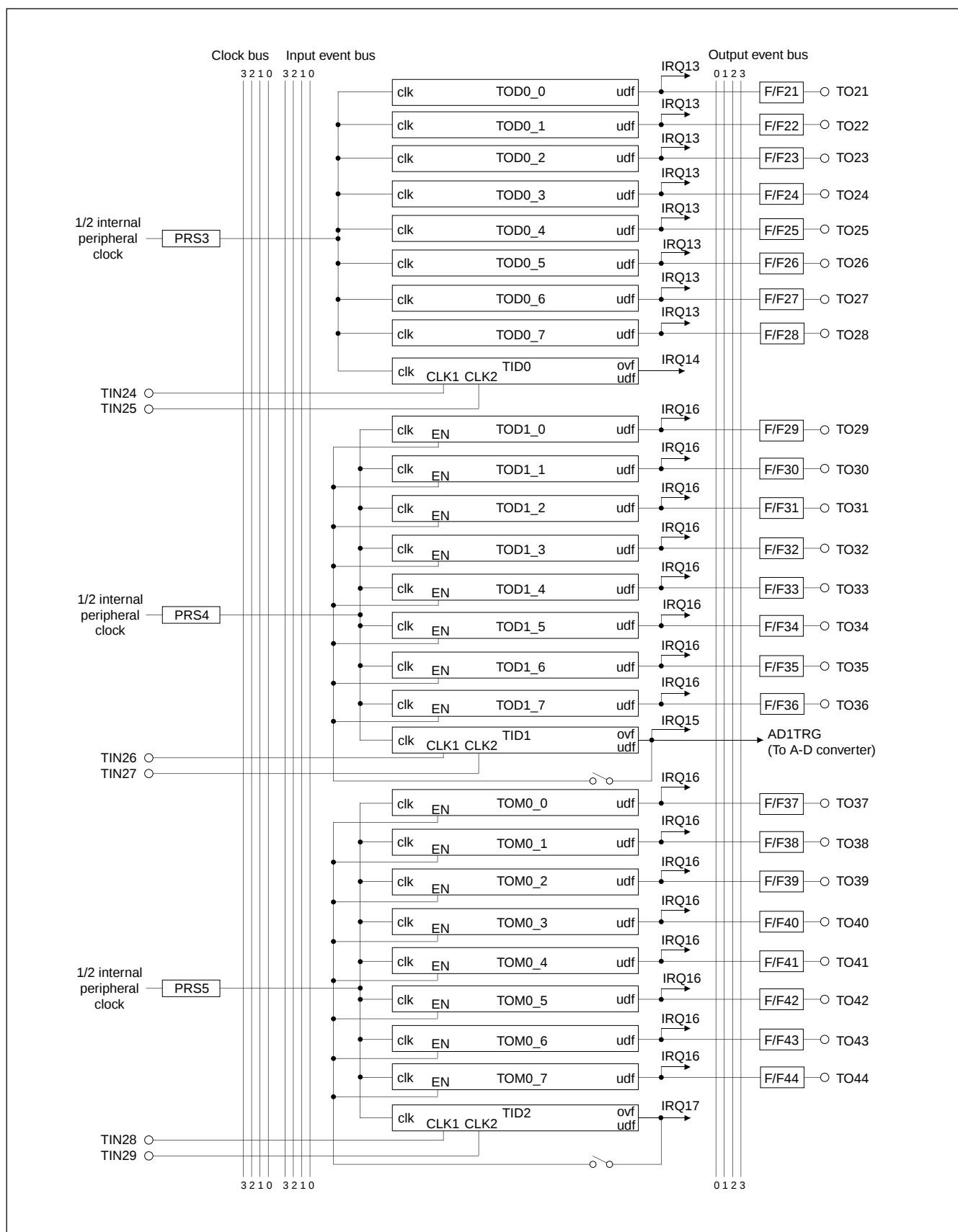
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**Figure 22 Block Diagram of Multijunction Timers (MJT) (2/4)**

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**Figure 23 Block Diagram of Multijunction Timers (MJT) (3/4)**

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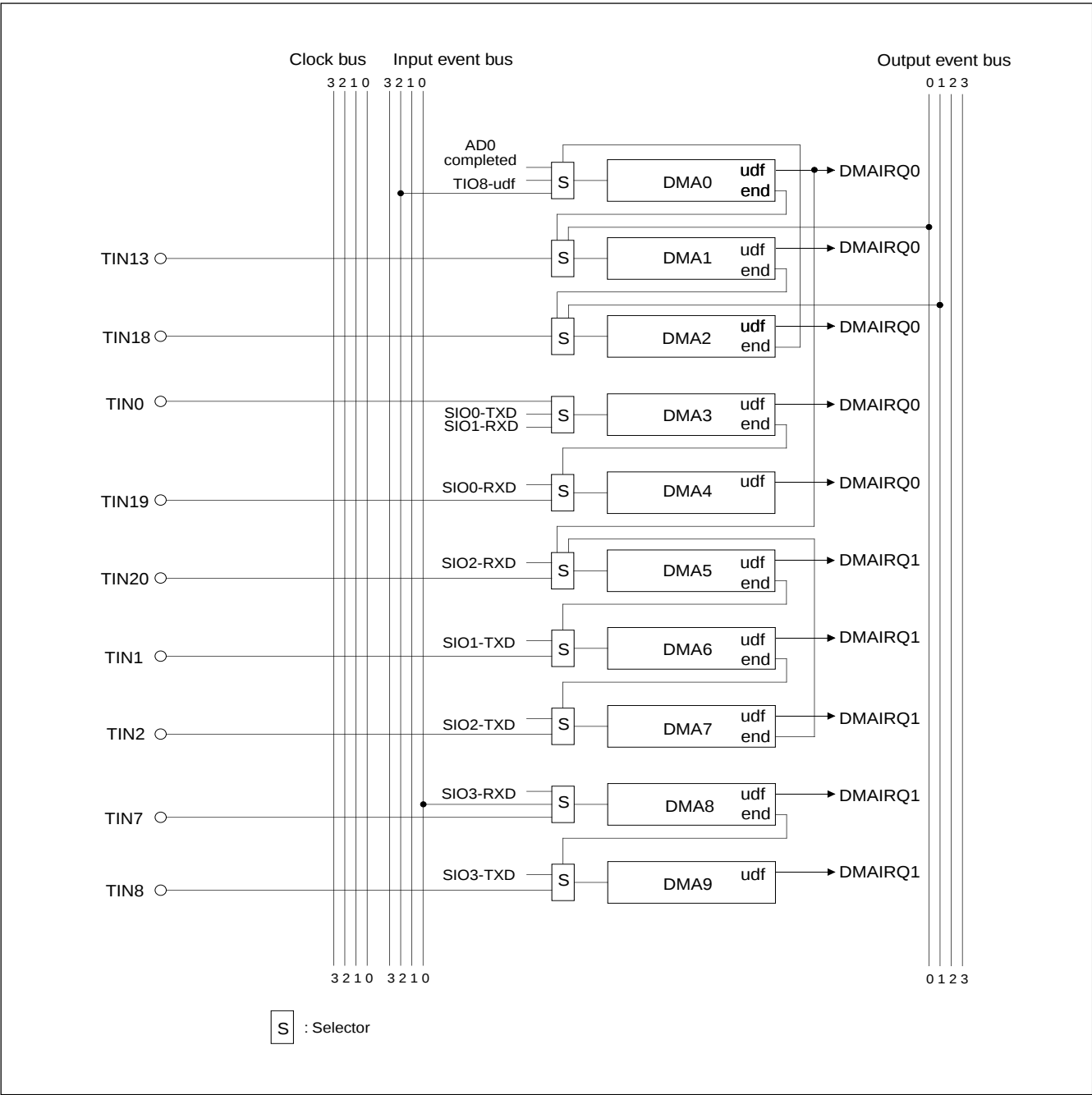


Figure 24 Block Diagram of Multijunction Timers (MJT) (4/4)

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**Built-in Two Independent A-D Converters**

The microcomputer contains two 16-channel converters with 10-bit resolution (A-D0 converter and A-D1 converter). In addition to single conversion on each channel, continuous A-D conversion on a combined group of 4, 8, and 16 channels is possible. The A-D converted value can be read out in either 10 bits or 8 bits.

In addition to ordinary A-D conversion, the converters support comparator mode in which the set value and A-D converted value are compared to determine which is larger or smaller than the other.

When A-D conversion is finished, the converters can generate a DMA transfer request (A-D0 converter only), as well as an interrupt.

The A-D converters are interfaced using a dedicated power supply to allow for connections to the peripheral circuits operating with 5 V or 3.3V.

**Table 19 Outline of the A-D Converters**

| Item                                                       | Content                                                                                                                                                     |                                                                                                            |                            |
|------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|----------------------------|
| Analog input                                               | 16 channels × 2                                                                                                                                             |                                                                                                            |                            |
| A-D conversion method                                      | Successive approximation method.                                                                                                                            |                                                                                                            |                            |
| Resolution                                                 | 10 bits (Conversion results can be read out in either 10 or 8 bits.)                                                                                        |                                                                                                            |                            |
| Absolute accuracy (Note 1)                                 | Normal rate mode                                                                                                                                            | ±2 LSB                                                                                                     |                            |
| (Conditions: Ta = -40 ~ +125°C, AVCC0,1 = VREF0,1 = 5.12V) | Double rate mode                                                                                                                                            | ±2 LSB                                                                                                     |                            |
| Conversion mode                                            | A-D conversion mode,comparator mode                                                                                                                         |                                                                                                            |                            |
| Operation mode                                             | Single mode, scan mode                                                                                                                                      |                                                                                                            |                            |
| Scan mode                                                  | Single -shot scan mode, continuous scan mode.                                                                                                               |                                                                                                            |                            |
| Conversion start trigger                                   | Software start                                                                                                                                              | Started by setting A-D conversion start bit to 1.                                                          |                            |
|                                                            | Hardware start                                                                                                                                              | A-D0 converter started by MJT output event bus 3,<br>A-D1 converter started by TID1 overflow or underflow. |                            |
|                                                            |                                                                                                                                                             | Started by external $\overline{\text{ADTRG}}$ pin input.                                                   |                            |
| Conversion rate                                            | During single mode<br>(Shortest time )                                                                                                                      | Normal                                                                                                     | 299 × 1/ f (BCLK) (Note 2) |
|                                                            |                                                                                                                                                             | Double speed                                                                                               | 173 × 1/ f (BCLK)          |
|                                                            | During comparator mode<br>(Shortest time )                                                                                                                  | Normal                                                                                                     | 47 × 1/ f (BCLK)           |
|                                                            |                                                                                                                                                             | Double speed                                                                                               | 29 × 1/ f (BCLK)           |
| Interrupt request generation                               | When A-D conversion is finished, when comparate operation is finished, when single-shot scan is finished, or when one cycle of continuous scan is finished. |                                                                                                            |                            |
| DMA transfer request generation<br>(Note 3)                | When A-D conversion is finished, when comparate operation is finished, when single-shot scan is finished, or when one cycle of continuous scan is finished. |                                                                                                            |                            |

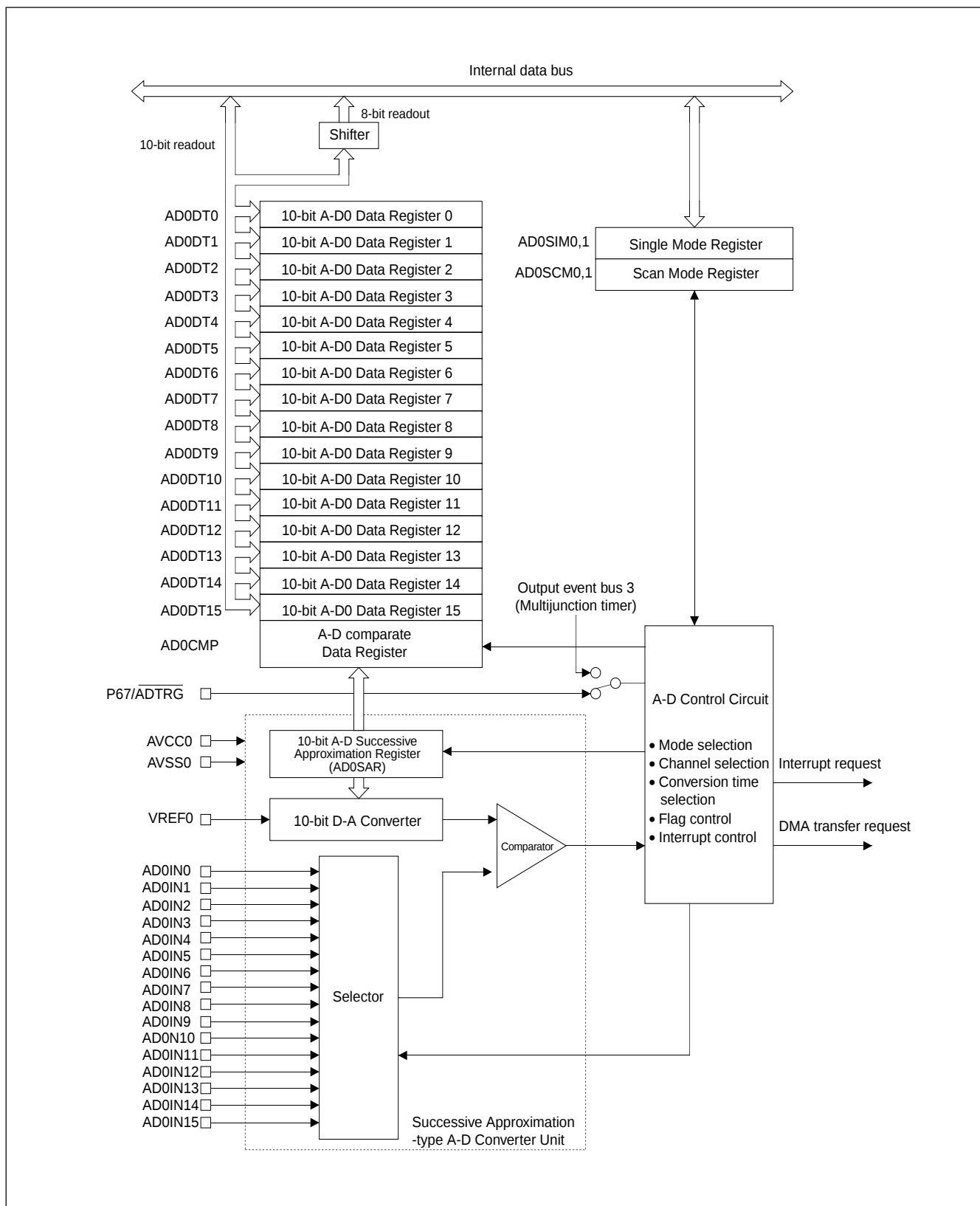
Note 1: The rated value of conversion accuracy here is that of the microcomputer's own as a single unit which can be exhibited when the microcomputer is used in an environment where it may not be affected by the power supply wiring or noise on the board.

Note 2: When BCLK = 20 MHz, this is  $1/f(\text{BCLK}) = 50\text{ns}$ .

Note 3: The DMA transfer request generation function is available for only the A-D0 converter. The A-D1 converter does not have this function.

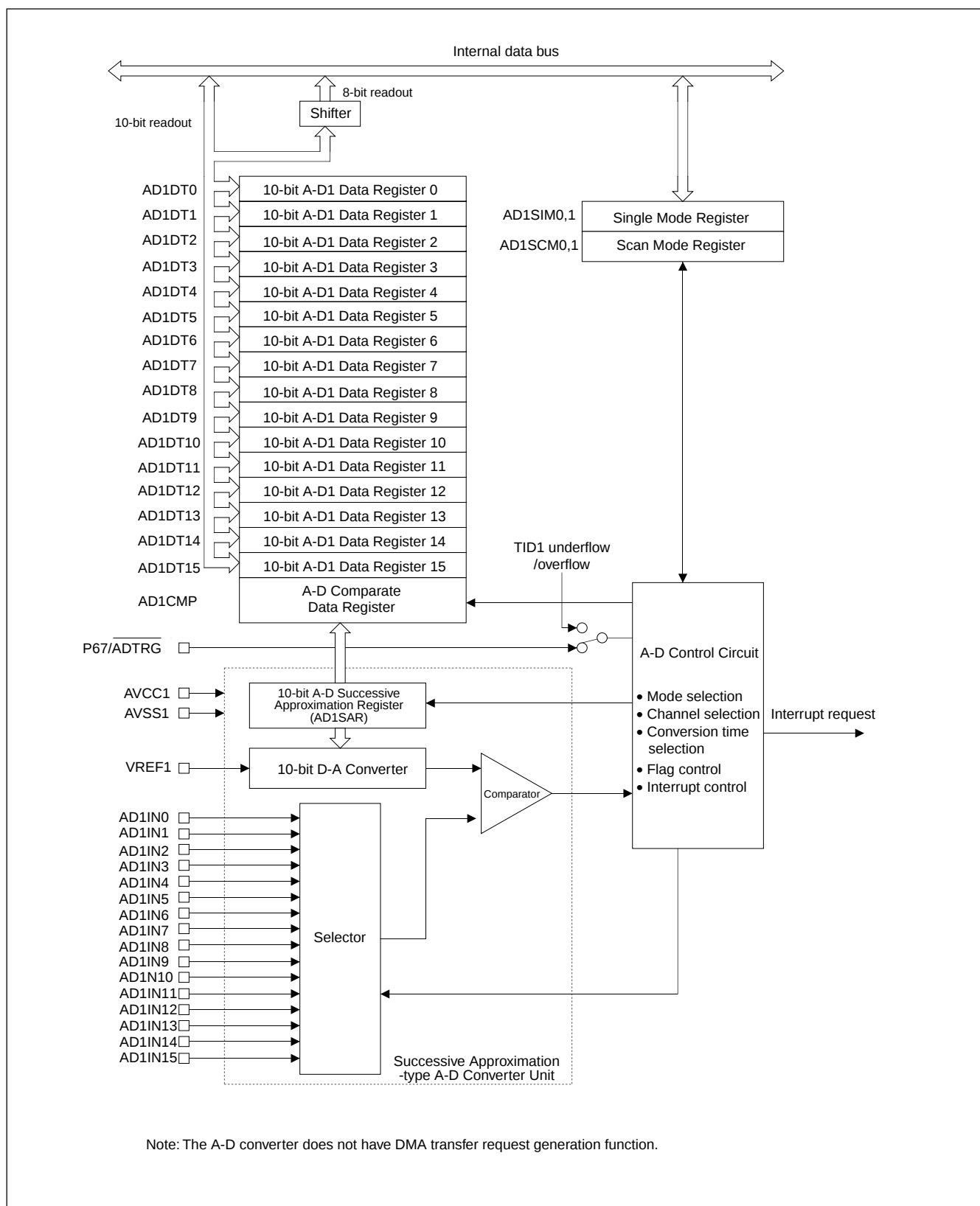
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**Figure 25 Block Diagram of the A-D0 Converter**

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**Figure 26 Block Diagram of the A-D1 Converter**

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**6-channel High-speed Serial I/Os**

The microcomputer contains six channels of serial I/Os consisting of four channels that can be set for CSIO mode (clock-synchronized serial I/O) or UART mode (asynchronous serial I/O) and two other channels that can only be set for UART mode.

The SIO has the function to generate a DMA transfer request when data reception is completed or the transmit register becomes empty, and is capable of high-speed serial communication without causing any additional CPU load.

**Table 20 Outline of Serial I/O**

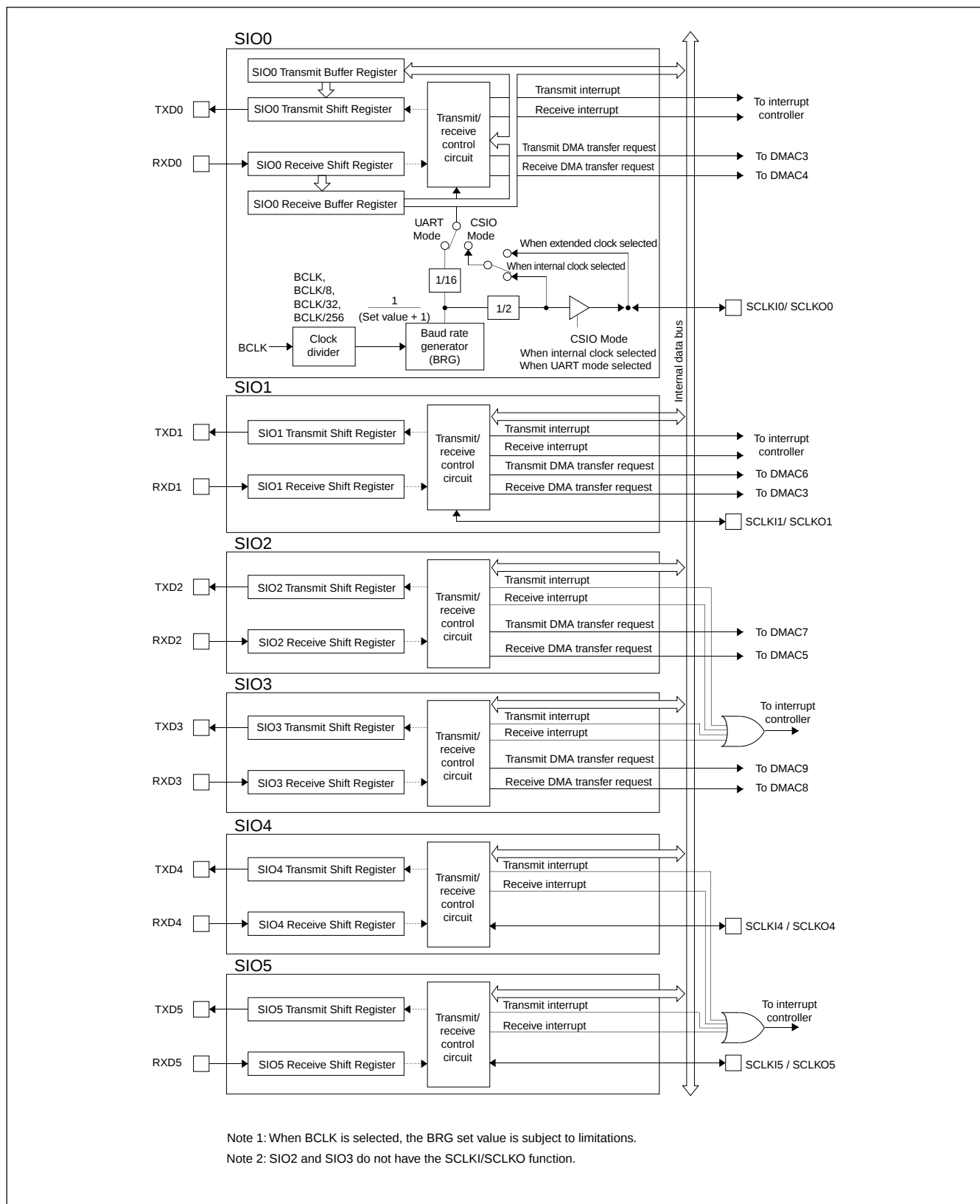
| Item                              | Content                                                                                                                                                                                                                                                                                                                   |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Number of channels                | CSIO/UART: 4 channels (SIO0,SIO1,SIO4,SIO5)<br>UART only : 2 channels (SIO2,SIO3)                                                                                                                                                                                                                                         |
| Clock                             | During CSIO mode : Internal clock / external clock, selectable (Note1)<br>During UART mode : Internal clock only                                                                                                                                                                                                          |
| Transfer mode                     | Transmit half-duplex, receive half-duplex, transmit/receive full-duplex                                                                                                                                                                                                                                                   |
| BRG count sourcef                 | (BCLK), f(BCLK)/8, f(BCLK)/32, f(BCLK)/256 (When internal clock is selected) (Note2)                                                                                                                                                                                                                                      |
| Data format                       | CSIO mode : Data length = Fixed to 8 bits<br>Order of transfer = Fixed to LSB first<br><br>UARTmode : Start bit = 1 bit<br>Character length = 7, 8, or 9 bits<br>Parity bit = Added or not added (When added, selectable between odd and even parity)<br>Stop bit = 1 or 2 bits<br>Order of transfer = Fixed to LSB first |
| Baud rate                         | CSIO mode : 152 bits per second to 2 Mbits per second (when operating with f(BCLK) = 20 MHz)<br>UARTmode : 19 bits per second to 156 Kbits per second (when operating with f(BCLK) = 20 MHz)                                                                                                                              |
| Error detection                   | CSIO mode : Overrun error only<br>UARTmode : Overrun, parity, and framing errors<br>(The error-sum bit indicates which error has occurred)                                                                                                                                                                                |
| Fixed cycle clock output function | When SIO0, SIO1, SIO4, or SIO5 is in UART mode, this function outputs a 1/2 BRG clock from the SCLK pin.                                                                                                                                                                                                                  |

Note 1: During CSIO mode, the maximum input frequency of an external clock is f(BCLK) divided by 16.

Note 2: When f(BCLK) is selected for the BRG count source, the BRG set value is subject to limitations.

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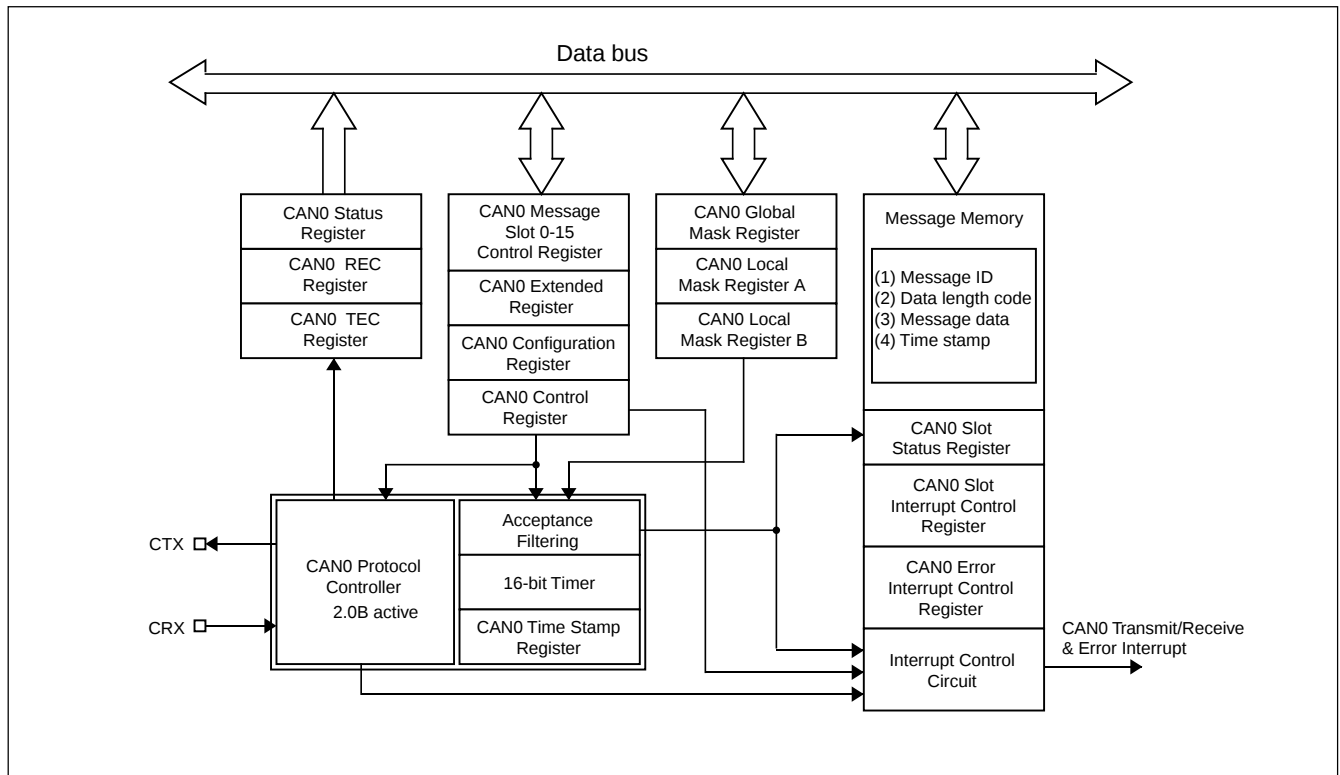
**Figure 27 Block Diagram of Serial I/O**

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**CAN Module**

The M32170 and M32174 Group contains two Full CAN modules compliant with CAN Specification V2.0B (CAN0 and CAN1), each of which has 16-channel message slots and three mask registers.



**Figure 28 Block Diagram of the CAN Module**

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## 8-level Interrupt Controller

The Interrupt Controller controls interrupt requests from each internal peripheral I/O (31 sources) by using eight priority levels assigned to each interrupt source, including interrupts disabled. In addition to these interrupts, it handles System Break Interrupt (SBI), Reserved Instruction Exception (RIE), and Address Exception (AE) as nonmaskable interrupts.

## Wait Controller

The Wait Controller supports access to external devices. For access to an external extended area of up to 1 Mbytes (during external extended or processor mode), the Wait Controller controls bus cycle extension by inserting one to four wait cycles or using external  $\overline{\text{WAIT}}$  signal input.

## Realtime Debugger (RTD)

The Realtime Debugger (RTD) provides a function for accessing directly from the outside to the internal RAM. It uses a dedicated clock-synchronized serial I/O to communicate with the outside.

Use of the RTD communicating via dedicated serial lines allows the internal RAM to be read out and rewritten without having to halt the CPU.

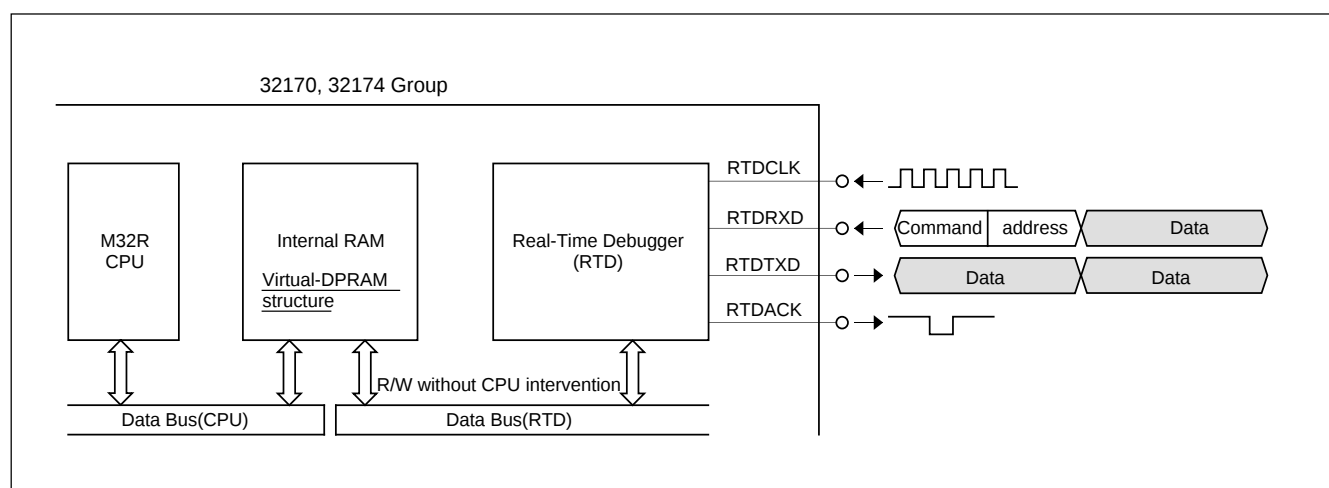


Figure 29 Conceptual Diagram of the Realtime Debugger (RTD)

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**CPU Instruction Set**

The M32R employs a RISC architecture, supporting a total of 83 discrete instructions.

**(1) Load/store instructions**

Perform data transfer between memory and registers.

|        |                        |
|--------|------------------------|
| LD     | Load                   |
| LDB    | Load byte              |
| LDUB   | Load unsigned byte     |
| LDH    | Load halfword          |
| LDUH   | Load unsigned halfword |
| LOCK   | Load locked            |
| ST     | Store                  |
| STB    | Store byte             |
| STH    | Store halfword         |
| UNLOCK | Store unlocked         |

**(2) Transfer instructions**

Perform register to register transfer or register to immediate transfer.

|      |                            |
|------|----------------------------|
| LD24 | Load 24-bit immediate      |
| LDI  | Load immediate             |
| MV   | Move register              |
| MVFC | Move from control register |
| MVTC | Move to control register   |
| SETH | Set high-order 16-bit      |

**(3) Branch instructions**

Used to change the program flow.

|      |                                      |
|------|--------------------------------------|
| BC   | Branch on C-bit                      |
| BEQ  | Branch on equal                      |
| BEQZ | Branch on equal zero                 |
| BGEZ | Branch on greater than or equal zero |
| BGTZ | Branch on greater than zero          |
| BL   | Branch and link                      |
| BLEZ | Branch on less than or equal zero    |
| BLTZ | Branch on less than zero             |
| BNC  | Branch on not C-bit                  |
| BNE  | Branch on not equal                  |
| BNEZ | Branch on not equal zero             |
| BRA  | Branch                               |
| JL   | Jump and link                        |
| JMP  | Jump                                 |
| NOP  | No operation                         |

**(4) Arithmetic/logic instructions**

Perform comparison, arithmetic/logic operation, multiplication/division, or shift between registers.

**• Comparison**

|       |                            |
|-------|----------------------------|
| CMP   | Compare                    |
| CMPI  | Compare immediate          |
| CMPU  | Compare unsigned           |
| CMPUI | Compare unsigned immediate |

**• Logical operation**

|      |                        |
|------|------------------------|
| AND  | AND                    |
| AND3 | AND 3-operand          |
| NOT  | Logical NOT            |
| OR   | OR                     |
| OR3  | OR 3-operand           |
| XOR  | Exclusive OR           |
| XOR3 | Exclusive OR 3-operand |

**• Arithmetic operation**

|       |                                   |
|-------|-----------------------------------|
| ADD   | Add                               |
| ADD3  | Add 3-operand                     |
| ADDI  | Add immediate                     |
| ADDV  | Add (with overflow checking)      |
| ADDV3 | Add 3-operand                     |
| ADDX  | Add with carry                    |
| NEG   | Negate                            |
| SUB   | Subtract                          |
| SUBV  | Subtract (with overflow checking) |
| SUBX  | Subtract with borrow              |

**• Multiplication/division**

|      |                    |
|------|--------------------|
| DIV  | Divide             |
| DIVU | Divide unsigned    |
| MUL  | Multiply           |
| REM  | Remainder          |
| REMU | Remainder unsigned |

**• Shift**

|      |                                  |
|------|----------------------------------|
| SLL  | Shift left logical               |
| SLL3 | Shift left logical 3-operand     |
| SLLI | Shift left logical immediate     |
| SRA  | Shift right arithmetic           |
| SRA3 | Shift right arithmetic 3-operand |
| SRAI | Shift right arithmetic immediate |
| SRL  | Shift right logical              |
| SRL3 | Shift right logical 3-operand    |
| SRLI | Shift right logical immediate    |

**(5) Instructions for the DSP function**

Perform 32 bit × 16 bit or 16 bit × 16 bit multiplication or sum-of-products calculation. These instructions also perform rounding of the accumulator data or transfer between accumulator and general-purpose register.

|         |                                                  |
|---------|--------------------------------------------------|
| MACHI   | Multiply-accumulate high-order halfwords         |
| MACLO   | Multiply-accumulate low-order halfwords          |
| MACWHI  | Multiply-accumulate word and high-order halfword |
| MACWLO  | Multiply-accumulate word and low-order halfword  |
| MULHI   | Multiply high-order halfwords                    |
| MULLO   | Multiply low-order halfwords                     |
| MULWHI  | Multiply word and high-order halfword            |
| MULWLO  | Multiply word and low-order halfword             |
| MVFACHI | Move from accumulator high-order word            |
| MVFACLO | Move from accumulator low-order word             |
| MVFACMI | Move from accumulator middle-order word          |
| MVTACHI | Move to accumulator high-order word              |
| MVTACLO | Move to accumulator low-order word               |
| RAC     | Round accumulator                                |
| RACH    | Round accumulator halfword                       |

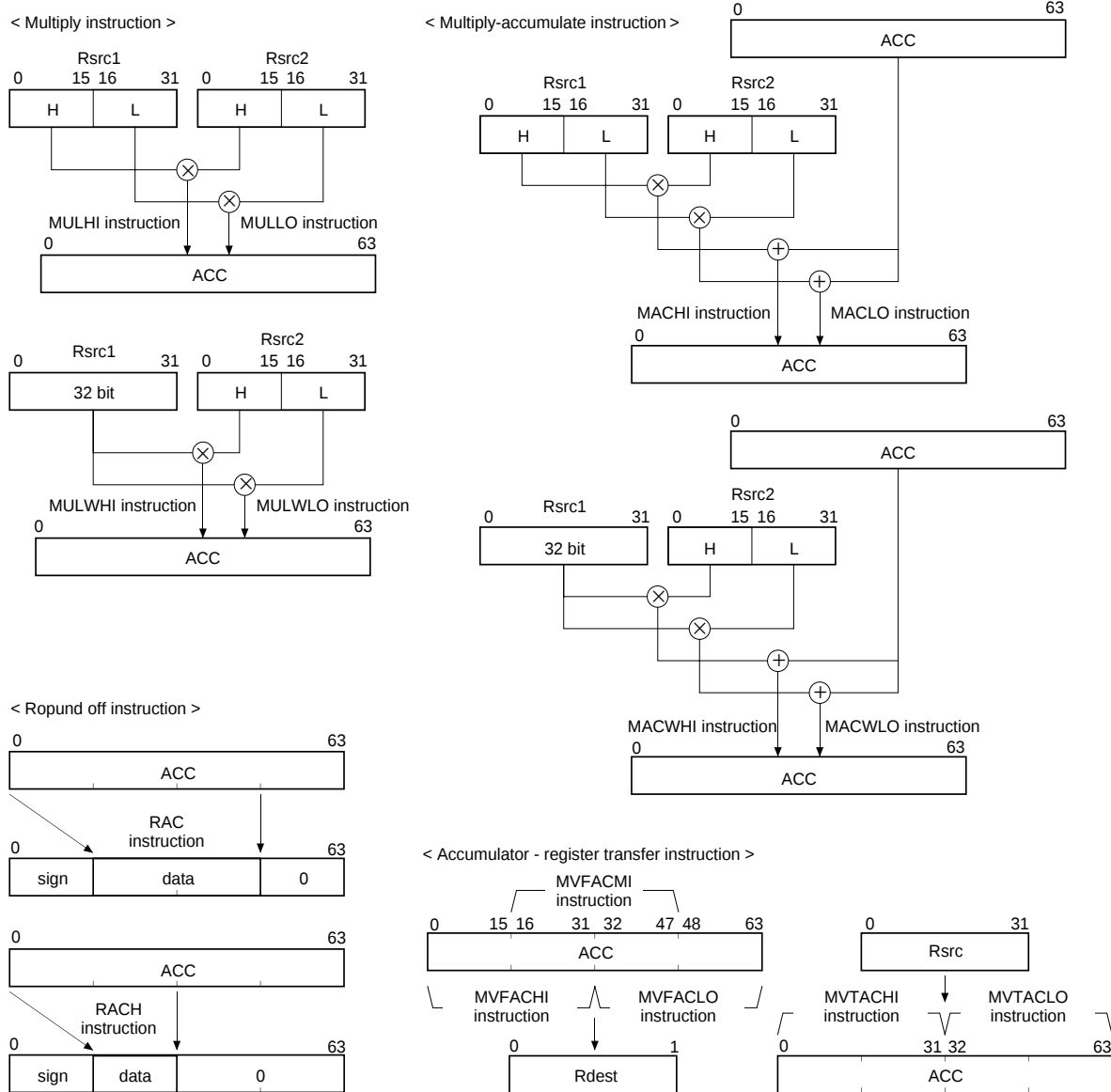
**(6) EIT related instructions**

Start trap or return from EIT processing.

|      |                 |
|------|-----------------|
| RTE  | Return from EIT |
| TRAP | Trap            |

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**Figure 30 Instructions for the DSP Function**

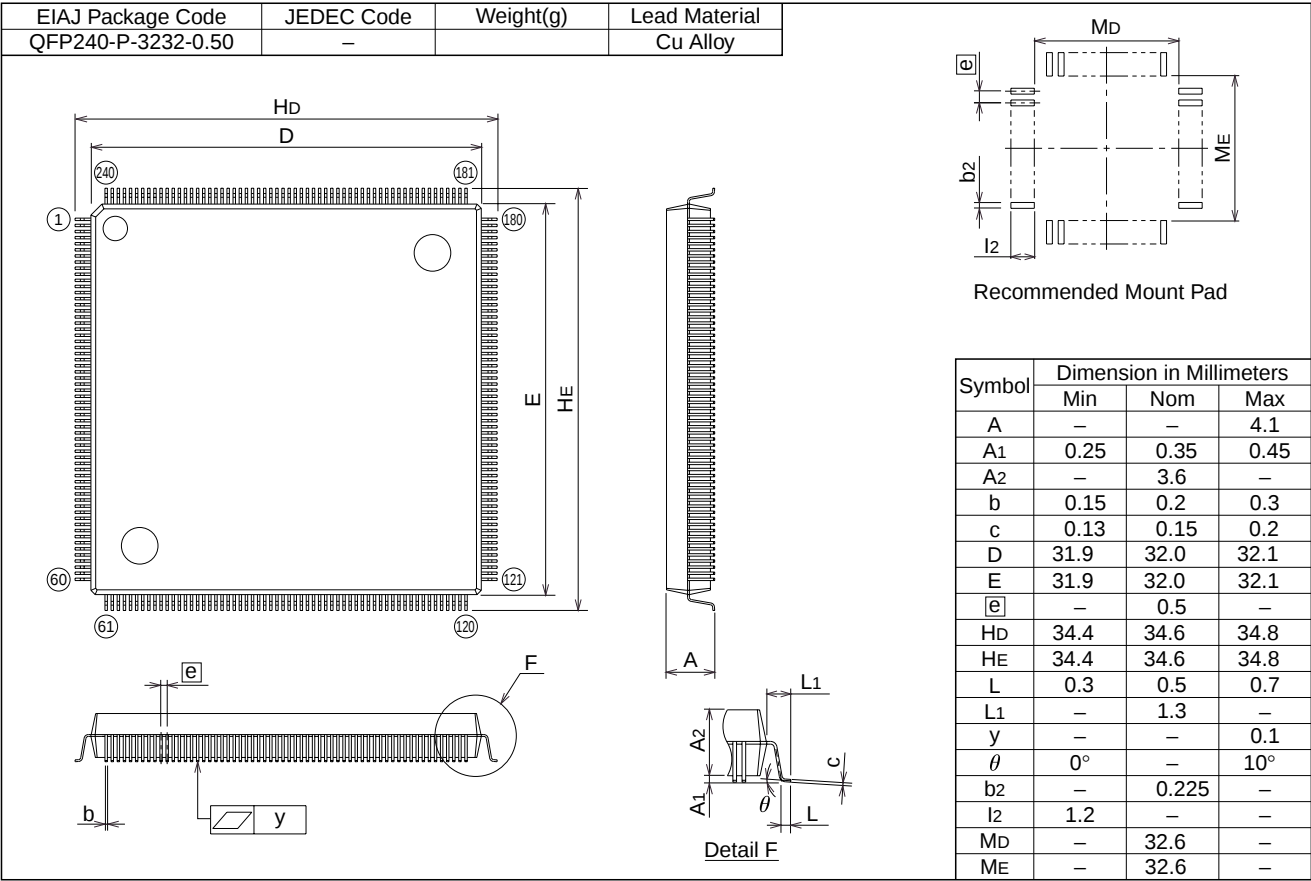
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## Package Dimensions Diagram

### 240P6Y-A

Plastic 240pin 32X32mm body QFP

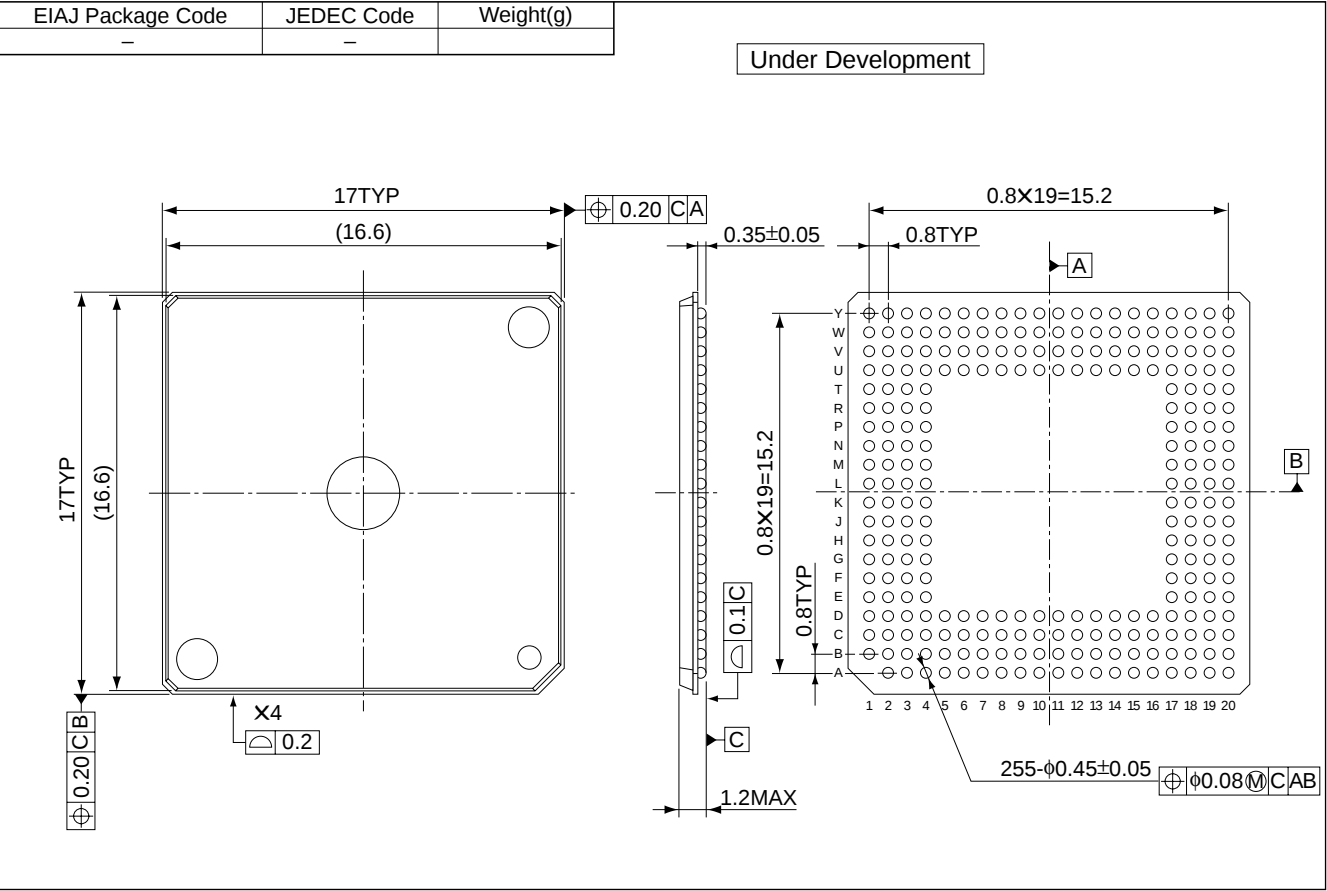


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255F7F

255pin 17X17mm body FBGA



Note: 255FBGA is currently under development.

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## MEMO

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## Renesas Technology Corp.

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