

# 16-bit Proprietary Microcontroller

CMOS

## F<sup>2</sup>MC-16LX MB90460 Series

### MB90462/467/F462/V460

#### ■ DESCRIPTION

The MB90460 series is a line of general-purpose, Fujitsu 16-bit microcontrollers designed for process control applications which require high-speed real-time processing, such as consumer products.

While inheriting the AT architecture of the F<sup>2</sup>MC\* family, the instruction set for the F<sup>2</sup>MC-16LX CPU core of the MB90460 series incorporates additional instructions for high-level languages, supports extended addressing modes, and contains enhanced multiplication and division instructions as well as a substantial collection of improved bit manipulation instructions. In addition, the MB90460 has an on-chip 32-bit accumulator which enables processing of long-word data.

The peripheral resources integrated in the MB90460 series include : an 8/10-bit A/D converter, UARTs (SCI) 0 to 1, 16-bit PPG timer, a multi-functional timer (16-bit free-run timer, input capture units (ICUs) 0 to 3, output compare units (OCUs) 0 and 5, 16-bit PPG timer, a waveform generator) , a multi-pulse generator (16-bit PPG timer, 16-bit reload timer, waveform sequencer) , PWC 0 to 1, 16-bit reload timer and DTP/external interrupt.

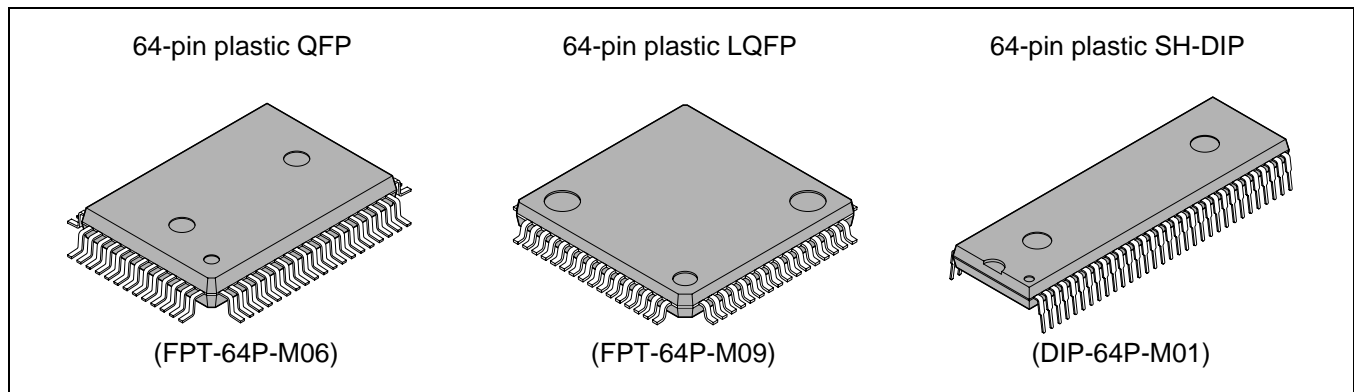
\* : F<sup>2</sup>MC stands for FUJITSU Flexible Microcontroller, a registered trademark of FUJITSU LIMITED.

#### ■ FEATURES

- Minimum execution time : 62.5 ns/4 MHz oscillation (Uses PLL clock multiplication) maximum multiplier = 4
- Maximum memory space  
16 Mbyte  
Linear/bank access

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#### ■ PACKAGES



# MB90460 Series

(Continued)

- Instruction set optimized for controller applications
  - Supported data types : bit, byte, word, and long-word types
  - Standard addressing modes : 23 types
  - 32-bit accumulator enhancing high-precision operations
  - Signed multiplication/division and extended RETI instructions
- Enhanced high level language (C) and multi-tasking support instructions
  - Use of a system stack pointer
  - Symmetrical instruction set and barrel shift instructions
- Program patch function (for two address pointers)
- Enhanced execution speed : 4 byte instruction queue
- Enhanced interrupt function
  - Up to eight programmable priority levels
  - External interrupt inputs : 8 lines
- Automatic data transmission function independent of CPU operation
  - Up to 16 channels for the extended intelligent I/O service
  - DTP request inputs : 8 lines
- Internal ROM
  - FLASH : 64 Kbyte (with flash security)
  - MASKROM : 64 Kbyte
- Internal RAM
  - EVA : 8 Kbyte
  - FLASH : 2 Kbyte
  - MASKROM : 2 Kbyte
- General-purpose ports
  - Up to 51 channels (Input pull-up resistor settable for : 16 channels)
- A/D Converter (RC) : 8 ch
  - 8/10-bit resolution selectable
  - Conversion time : 6.13  $\mu$ s (Min) , 16 MHz operation
- UART : 2 channels
- 16 bit PPG : 3 channels
  - Mode switching function provided (PWM mode or one-shot mode)
  - Can be worked with a multi-functional timer, a multi-pulse generator or individually
- 16 bit reload timer : 2 channels
  - Can be worked with multi-pulse generator or individually
- 16-bit PWC timer : 2 channels
- A multi-functional timer
  - Input capture : 4 channels
  - Output compare with selectable buffer : 6 channels
  - Free-run timer with up or up/down mode selection and selectable buffer : 1 channel
  - 16-bit PPG : 1 channel
  - A waveform generator : (16-bit timer : 3 channels, 3-phase waveform or dead time)
- A multi-pulse generator
  - 16-bit PPG : 1 channel
  - 16-bit reload timer : 1 channel
  - Waveform sequencer : (16-bit timer with buffer and compare clear function)
- Time-base counter/watchdog timer : 18-bit

- Low-power consumption mode :
  - Sleep mode
  - Stop mode
  - CPU intermittent operation mode
- Package :
  - QFP-64 (FPT-64P-M09 : 0.65 mm pitch)
  - QFP-64 (FPT-64P-M06 : 1.00 mm pitch)
  - SDIP-64 (DIP-64P-M01 : 1.78 mm pitch)
- CMOS technology

# MB90460 Series

## ■ PRODUCT LINEUP

| Part number<br>Item                              | MB90V460   | MB90F462                           | MB90462                           | MB90467                         |
|--|--|------------------------------------|-----------------------------------|---------------------------------|
| Classification                                   | Development/evaluation product   | Mass-produced products (Flash ROM) | Mass-produced products (Mask ROM) |                                 |
| ROM size   | —  | 64 KBytes                          |                                   |                                 |
| RAM size   | 8 KBytes   | 2 KBytes                           |                                   |                                 |
| CPU function                                     | Number of Instruction : 351<br>Minimum execution time : 62.5 ns / 4 MHz (PLL × 4)<br>Addressing mode : 23<br>Data bit length : 1, 8, 16 bits<br>Maximum memory space : 16 MBytes   |                                    |                                   |                                 |
| I/O port   | I/O port (CMOS) : 51   |                                    |                                   |                                 |
| PWC  | Pulse width counter timer : 2 channels   |                                    |                                   | Pulse width counter timer : 1ch |
|  | Timer function (select the counter timer from three internal clocks)<br>Various Pulse width measuring function (H pulse width, L pulse width, rising edge to falling edge period, falling edge to rising edge period, rising edge to rising edge period and falling edge to falling edge period) |                                    |                                   |                                 |
| UART   | UART : 2 channels<br>With full-duplex double buffer (8-bit length)<br>Clock asynchronized or clock synchronized transmission (with start and stop bits) can be selectively used<br>Transmission can be one-to-one (bi-directional communication) or one-to-n (Master-Slave communication)        |                                    |                                   |                                 |
| 16-bit reload timer                              | Reload timer : 2 channels<br>Reload mode, single-shot mode or event count mode selectable<br>Can be worked with a multi-pulse generator or individually  |                                    |                                   |                                 |
| 16-bit PPG timer                                 | PPG timer : 3 channels   |                                    |                                   | PPG timer : 2ch                 |
|  | PWM mode or single-shot mode selectable<br>Can be worked with multi-functional timer / multi-pulse generator or individually   |                                    |                                   |                                 |
| Multi-functional timer (for AC/DC motor control) | 16-bit free-running timer with up or up/down mode selection and buffer : 1 channel<br>16-bit output compare : 6 channels<br>16-bit input capture : 4 channels<br>16-bit PPG timer : 1 channel<br>Waveform generator (16-bit timer : 3 channels, 3-phase waveform or dead time)                   |                                    |                                   |                                 |
| Multi-pulse generator (for DC motor control)     | 16-bit PPG timer : 1 channel<br>16-bit reload timer operation (toggle output, one shot output selectable)<br>Event counter function : 1 channel built-in<br>A waveform sequencer (includes 16-bit timer with buffer and compare clear function)  |                                    |                                   | —                               |
| 8/10-bit A/D converter                           | 8/10-bit resolution (8 channels)<br>Conversion time : Less than 6.13 μS (16 MHz internal clock)  |                                    |                                   |                                 |
| DTP/External interrupt                           | 8 independent channels<br>Selectable causes : Rising edge, falling edge, "L" level or "H" level  |                                    |                                   |                                 |
| Lower power consumption                          | Stop mode / Sleep mode / CPU intermittent operation mode   |                                    |                                   |                                 |

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# MB90460 Series

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| Part number<br>Item                 | MB90V460         | MB90F462   | MB90462 | MB90467 |
|-------------------------------------|------------------|--|---------|---------|
| Package                             | PGA256           | LQFP-64 (FPT-64P-M09 : 0.65 mm pitch)<br>QFP-64 (FPT-64P-M06 : 1.00 mm pitch)<br>SDIP-64 (DIP-64P-M01 : 1.78 mm pitch) |         |         |
| Power supply voltage for operation* | 4.5 V to 5.5 V * |  |         |         |
| Process                             | CMOS             |  |         |         |

\* : Varies with conditions such as the operating frequency (See section “■ ELECTRICAL CHARACTERISTICS”). Assurance for the MB90V460 is given only for operation with a tool at a power supply voltage of 4.5 V to 5.5 V, an operating temperature of 0 to +25 °C, and an operating frequency of 1 MHz to 16 MHz.

## ■ PACKAGE AND CORRESPONDING PRODUCTS

| Package     | MB90V460 | MB90F462 | MB90462 | MB90467 |
|-------------|----------|----------|---------|---------|
| PGA256      | ○        | ×        | ×       | ×       |
| FPT-64P-M09 | ×        | ○        | ○       | ○       |
| FPT-64P-M06 | ×        | ○        | ○       | ○       |
| DIP-64P-M01 | ×        | ○        | ○       | ○       |

○ : Available, × : Not available

Note : For more information about each package, see section “■ PACKAGE DIMENSIONS”.

## ■ DIFFERENCES AMONG PRODUCTS

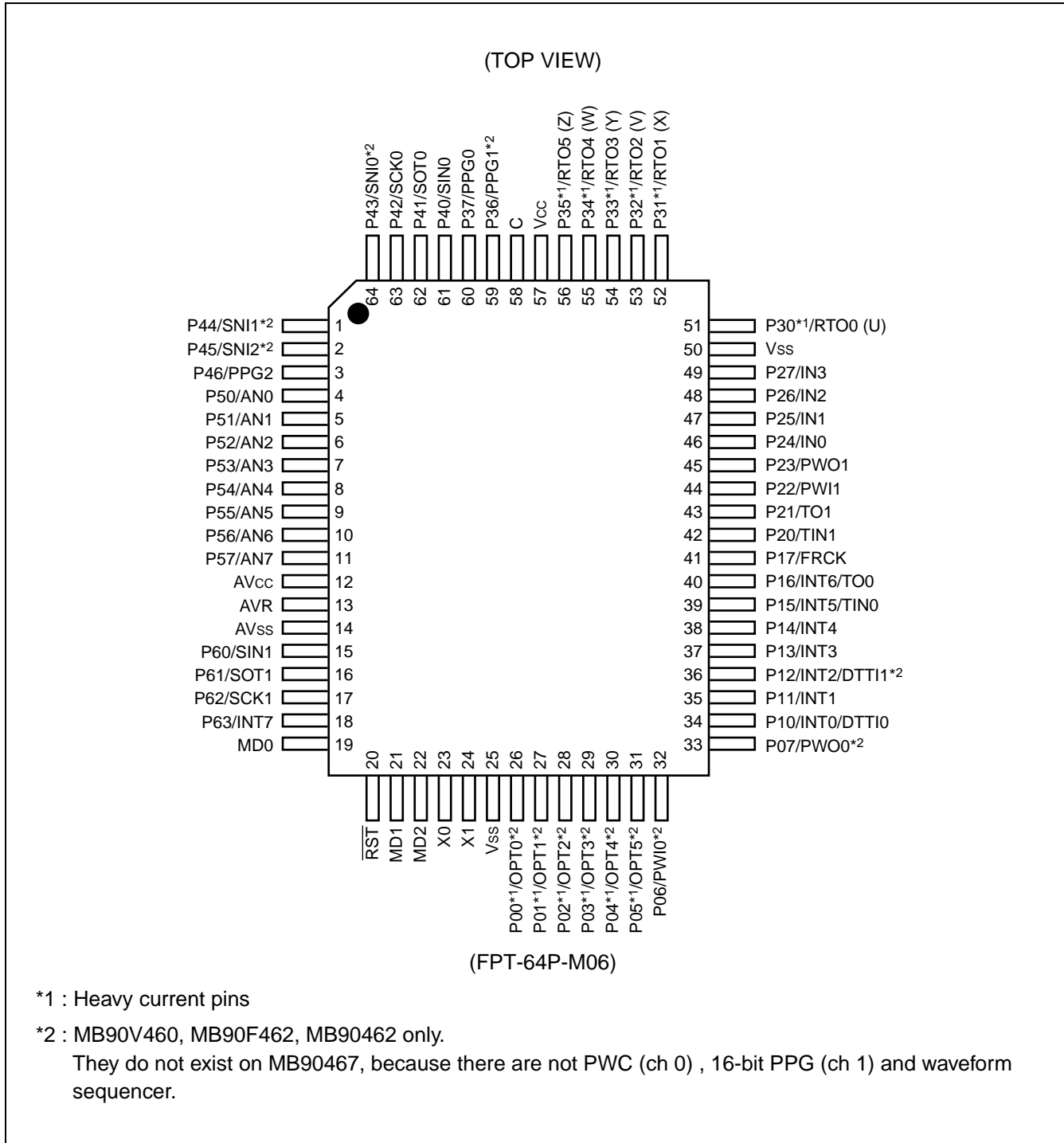
### Memory Size

In evaluation with an evaluation product, note the difference between the evaluation product and the product actually used. The following items must be taken into consideration.

- The MB90V460 does not have an internal ROM, however, operations equivalent to chips with an internal ROM can be evaluated by using a dedicated development tool, enabling selection of ROM size by settings of the development tool.
- In the MB90V460, images from FF4000<sub>H</sub> to FFFFFFF<sub>H</sub> are mapped to bank 00, and FE0000<sub>H</sub> to FF3FFF<sub>H</sub> are mapped to bank FF only. (This setting can be changed by configuring the development tool.)
- In the MB90462/F462/467, images from FF4000<sub>H</sub> to FFFFFFF<sub>H</sub> are mapped to bank 00, and FF0000<sub>H</sub> to FF3FFF<sub>H</sub> are mapped to bank FF only.

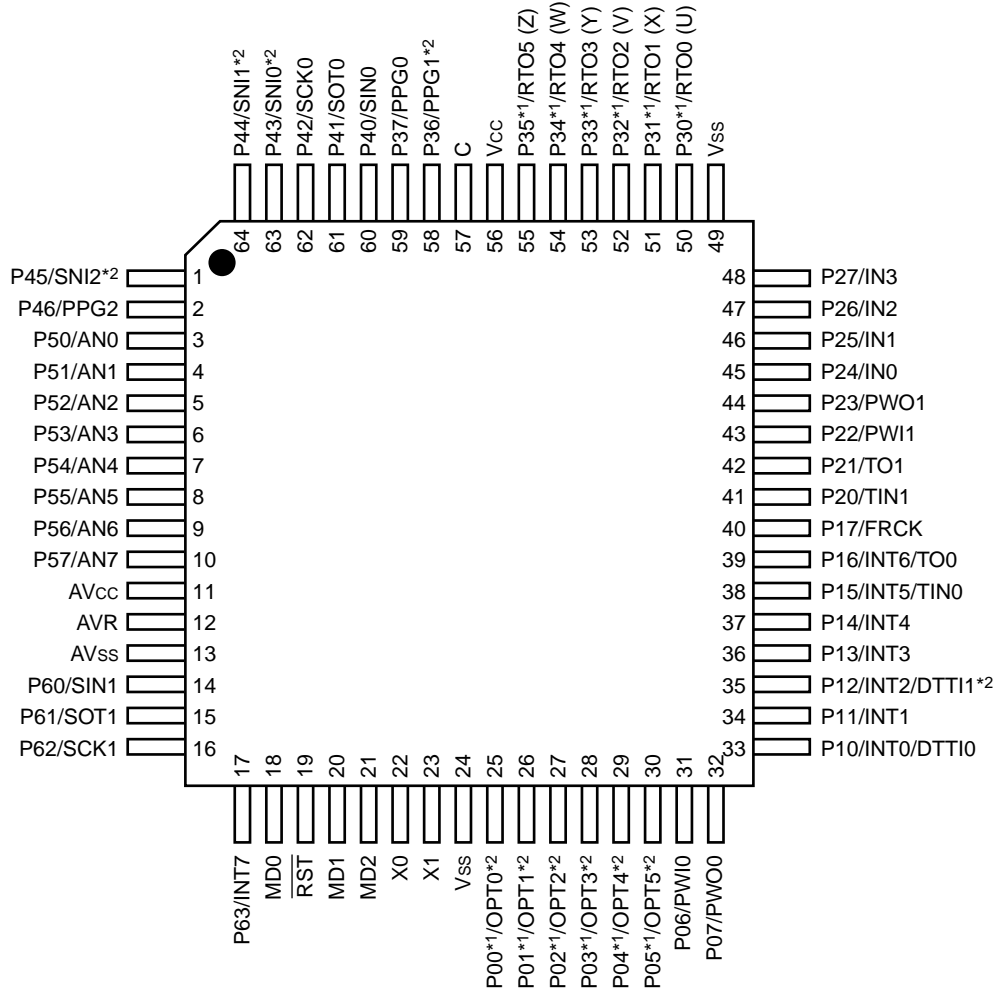
# MB90460 Series

## PIN ASSIGNMENT



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(TOP VIEW)



(FPT-64P-M09)

\*1 : Heavy current pins

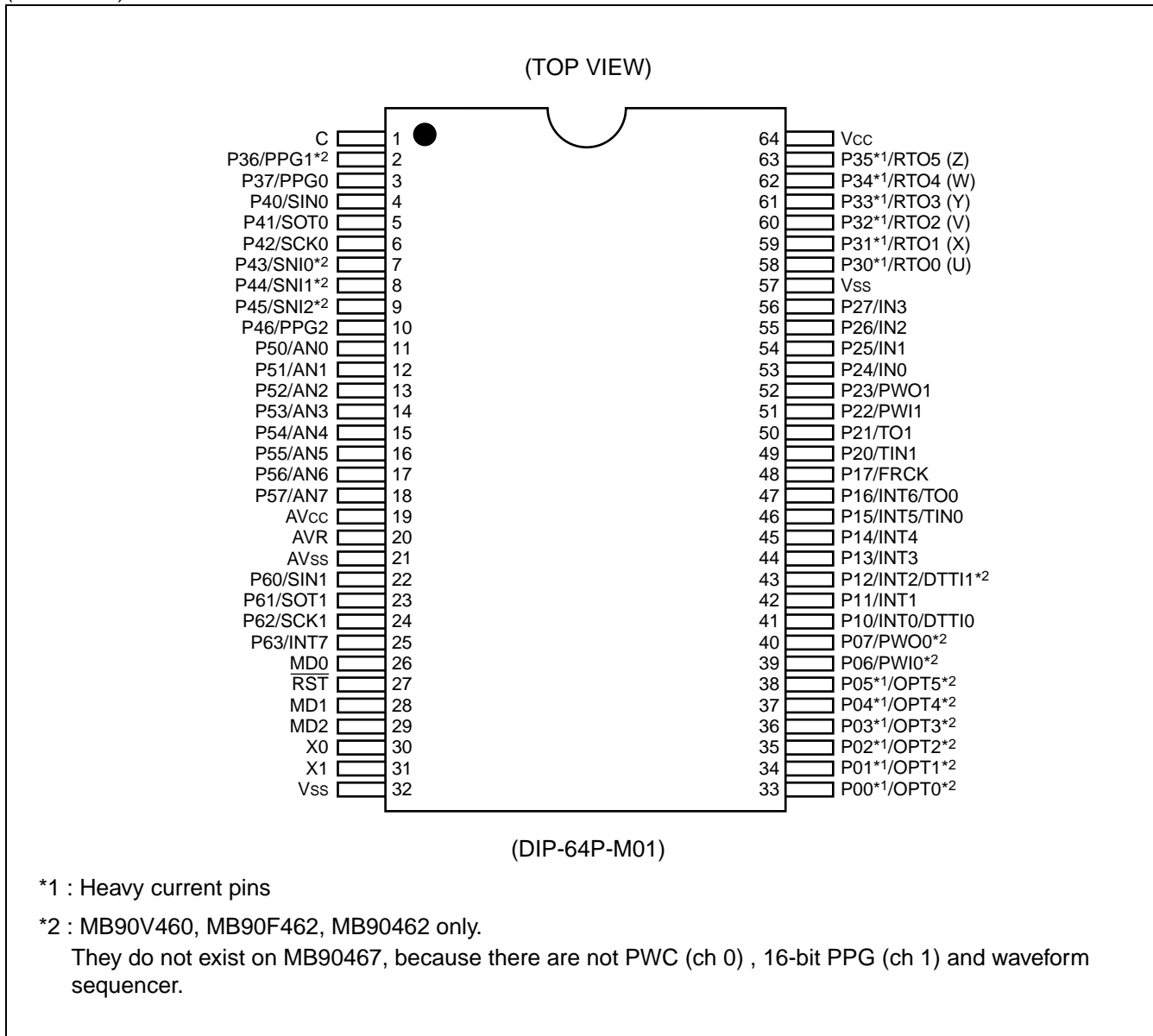
\*2 : MB90V460, MB90F462, MB90462 only.

They do not exist on MB90467, because there are not PWC (ch 0) , 16-bit PPG (ch 1) and waveform sequencer.

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# MB90460 Series

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## ■ PIN DESCRIPTION

| Pin No.   |            |          | Pin name         | I/O circuit | Function   |
|-----------|------------|----------|------------------|-------------|--|
| QFP-M06*2 | LQFP-M09*1 | SDIP*3   |                  |             |  |
| 23, 24    | 22, 23     | 30, 31   | X0, X1           | A           | Oscillation input pins.  |
| 20        | 19         | 27       | $\overline{RST}$ | B           | External reset input pin.  |
| 26 to 31  | 25 to 30   | 33 to 38 | P00 to P05       | D           | General-purpose I/O ports.   |
|           |            |          | OPT0 to OPT5*4   |             | Output terminals OPT0 to 5 of the waveform sequencer. These pins output the waveforms specified at the output data registers of the waveform sequencer circuit. Output is generated when OPE0 to 5 of OPCR is enabled.*4 |
| 32        | 31         | 39       | P06              | E           | General-purpose I/O ports.   |
|           |            |          | PWIO*4           |             | PWC 0 signal input pin.*4  |
| 33        | 32         | 40       | P07              | E           | General-purpose I/O ports.   |
|           |            |          | PWO0*4           |             | PWC 0 signal output pin.*4   |
| 34        | 33         | 41       | P10              | C           | General-purpose I/O ports.   |
|           |            |          | INT0             |             | Can be used as interrupt request input channels 0. Input is enabled when 1 is set in EN0 in standby mode.  |
|           |            |          | DTTI0            |             | RTO0 to 5 pins for fixed-level input. This function is enabled when the waveform generator enables its input bits.   |
| 35        | 34         | 42       | P11              | C           | General-purpose I/O ports.   |
|           |            |          | INT1             |             | Can be used as interrupt request input channels 1. Input is enabled when 1 is set in EN1 in standby mode.  |
| 36        | 35         | 43       | P12              | C           | General-purpose I/O ports.   |
|           |            |          | INT2             |             | Can be used as interrupt request input channels 2. Input is enabled when 1 is set in EN2 in standby mode.  |
|           |            |          | DTTI1*4          |             | OPT0 to 5 pins for fixed-level input. This function is enabled when the waveform sequencer enables its input bit.*4  |
| 37 to 38  | 36 to 37   | 44 to 45 | P13 to P14       | C           | General-purpose I/O ports.   |
|           |            |          | INT3 to INT4     |             | Can be used as interrupt request input channels 3 to 4. Input is enabled when 1 is set in EN3 to EN4 in standby mode.  |
| 39        | 38         | 46       | P15              | C           | General-purpose I/O ports.   |
|           |            |          | INT5             |             | Can be used as interrupt request input channel 5. Input is enabled when 1 is set in EN5 in standby mode.   |
|           |            |          | TIN0             |             | External clock input pin for reload timer 0.   |

(Continued)

# MB90460 Series

| Pin No.   |            |          | Pin name           | I/O circuit | Function  |
|-----------|------------|----------|--------------------|-------------|---|
| QFP-M06*2 | LQFP-M09*1 | SDIP*3   |                    |             |   |
| 40        | 39         | 47       | P16                | C           | General-purpose I/O ports.  |
|           |            |          | INT6               |             | Can be used as interrupt request input channels 6. Input is enabled when 1 is set in EN6 in standby mode.   |
|           |            |          | TO0                |             | Event output pin for reload timer 0.  |
| 41        | 40         | 48       | P17                | C           | General-purpose I/O ports.  |
|           |            |          | FRCK               |             | External clock input pin for free-running timer.  |
| 42        | 41         | 49       | P20                | F           | General-purpose I/O ports.  |
|           |            |          | TIN1               |             | External clock input pin for reload timer 1.  |
| 43        | 42         | 50       | P21                | F           | General-purpose I/O ports.  |
|           |            |          | TO1                |             | Event output pin for reload timer 1.  |
| 44        | 43         | 51       | P22                | F           | General-purpose I/O ports.  |
|           |            |          | PWI1               |             | PWC 1 signal input pin.   |
| 45        | 44         | 52       | P23                | F           | General-purpose I/O ports.  |
|           |            |          | PWO1               |             | PWC 1 signal output pin.  |
| 46 to 49  | 45 to 48   | 53 to 56 | P24 to P27         | F           | General-purpose I/O ports.  |
|           |            |          | IN0 to IN3         |             | Trigger input pins for input capture channels 0 to 3. When input capture channels 0 to 3 are used for input operation, these pins are enabled as required and must not be used for any other I/P.                         |
| 51 to 56  | 50 to 55   | 58 to 63 | P30 to P35         | G           | General-purpose I/O ports.  |
|           |            |          | RTO0(U) to RTO5(Z) |             | Waveform generator output pins. These pins output the waveforms specified at the waveform generator. Output is generated when waveform generator output is enabled. (U) to (Z) show the coils that control 3-phase motor. |
| 59        | 58         | 2        | P36                | H           | General-purpose I/O ports.  |
|           |            |          | PPG1*4             |             | Output pins for PPG channels 1. This function is enabled when PPG channels 1 enable output.*4   |
| 60        | 59         | 3        | P37                | H           | General-purpose I/O ports.  |
|           |            |          | PPG0               |             | Output pins for PPG channels 0. This function is enabled when PPG channels 0 enable output.   |
| 61        | 60         | 4        | P40                | F           | General-purpose I/O ports.  |
|           |            |          | SIN0               |             | Serial data input pin for UART channel 0. While UART channel 0 is operating for input, the input of this pin is used as required and must not be used for any other input.  |
| 62        | 61         | 5        | P41                | F           | General-purpose I/O ports.  |
|           |            |          | SOT0               |             | Serial data output pin for UART channel 0. This function is enabled when UART channel 0 enables data output.  |

# MB90460 Series

(Continued)

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| Pin No.   |            |          | Pin name         | I/O circuit | Function   |
|-----------|------------|----------|------------------|-------------|--|
| QFP-M06*2 | LQFP-M09*1 | SDIP*3   |                  |             |  |
| 63        | 62         | 6        | P42              | F           | General-purpose I/O ports.   |
|           |            |          | SCK0             |             | Serial clock I/O pin for UART channel 0. This function is enabled when UART channel 0 enables clock output.  |
| 64        | 63         | 7        | P43              | F           | General-purpose I/O ports.   |
|           |            |          | SNI0*4           |             | Trigger input pins for position detection of the waveform sequencer. When this pin is used for input operation, it is enabled as required and must not be used for any other I/P.*4    |
| 1         | 64         | 8        | P44              | F           | General-purpose I/O ports.   |
|           |            |          | SNI1*4           |             | Trigger input pins for position detection of the Multi-pulse generator. When this pin is used for input operation, it is enabled as required and must not be used for any other I/P.*4 |
| 2         | 1          | 9        | P45              | F           | General-purpose I/O ports.   |
|           |            |          | SNI2*4           |             | Trigger input pins for position detection of the Multi-pulse generator. When this pin is used for input operation, it is enabled as required and must not be used for any other I/P.*4 |
| 3         | 2          | 10       | P46              | F           | General-purpose I/O ports.   |
|           |            |          | PPG2             |             | Output pins for PPG channel 2. This function is enabled when PPG channel 2 enables output.   |
| 4 to 11   | 3 to 10    | 11 to 18 | P50 to P57       | I           | General-purpose I/O ports.   |
|           |            |          | AN0 to AN7       |             | A/D converter analog input pins. This function is enabled when the analog input specification is enabled. (ADER) .   |
| 12        | 11         | 19       | AV <sub>cc</sub> | —           | V <sub>cc</sub> power input pin for analog circuits.   |
| 13        | 12         | 20       | AVR              | —           | Reference voltage (+) input pin for the A/D converter. This voltage must not exceed V <sub>cc</sub> and AV <sub>cc</sub> . Reference voltage (–) is fixed to AV <sub>ss</sub> .        |
| 14        | 13         | 21       | AV <sub>ss</sub> | —           | V <sub>ss</sub> power input pin for analog circuits.   |
| 15        | 14         | 22       | P60              | F           | General-purpose I/O ports.   |
|           |            |          | SIN1             |             | Serial data input pin for UART channel 1. While UART channel 1 is operating for input, the input of this pin is used as required and must not be used for any other in-put.            |
| 16        | 15         | 23       | P61              | F           | General-purpose I/O ports.   |
|           |            |          | SOT1             |             | Serial data output pin for UART channel 1. This function is enabled when UART channel 1 enables data output.   |

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# MB90460 Series

(Continued)

| Pin No.   |            |        | Pin name        | I/O circuit | Function  |
|-----------|------------|--------|-----------------|-------------|---|
| QFP-M06*2 | LQFP-M09*1 | SDIP*3 |                 |             |   |
| 17        | 16         | 24     | P62             | F           | General-purpose I/O port.   |
|           |            |        | SCK1            |             | Serial clock I/O pin for UART channel 1. This function is enabled when UART channel 1 enables clock output.   |
| 18        | 17         | 25     | P63             | F           | General-purpose I/O port.   |
|           |            |        | INT7            |             | Usable as interrupt request input channel 7. Input is enabled when 1 is set in EN7 in standby mode.           |
| 19        | 18         | 26     | MD0             | J           | Input pin for operation mode specification. Connect this pin directly to V <sub>CC</sub> or V <sub>SS</sub> . |
| 21, 22    | 20, 21     | 28, 29 | MD1, MD2        | J           | Input pin for operation mode specification. Connect this pin directly to V <sub>CC</sub> or V <sub>SS</sub> . |
| 25, 50    | 24, 49     | 32, 57 | V <sub>SS</sub> | —           | Power (0 V) input pin.  |
| 57        | 56         | 64     | V <sub>CC</sub> | —           | Power (5 V) input pin.  |
| 58        | 57         | 1      | C               | —           | Capacity pin for power stabilization. Please connect to an approximately 0.1 μF ceramic capacitor.            |

\*1 : FPT-64P-M09

\*2 : FPT-64P-M06

\*3 : DIP-64P-M01

\*4 : MB90V460, MB90F462, MB90462 only.

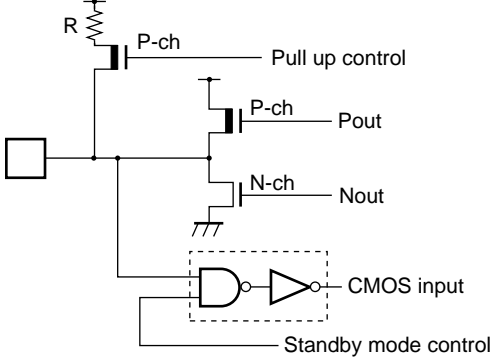
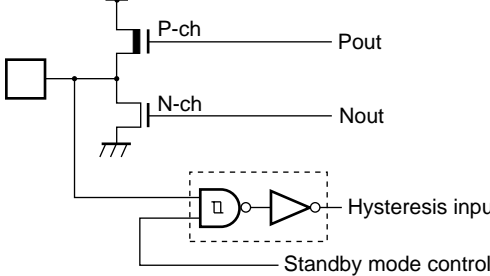
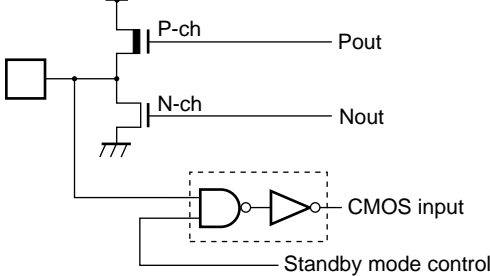
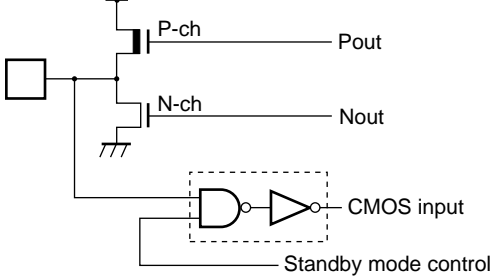
They do not exist on MB90467, because there are not PWC (ch 0) , 16-bit PPG (ch 1) and waveform sequencer.

## I/O CIRCUIT TYPE

| Classification | Type | Remarks   |
|----------------|------|---|
| A              |      | <p>Main clock (main clock crystal oscillator)</p> <ul style="list-style-type: none"> <li>At an oscillation feedback resistor of approximately 1 M<math>\Omega</math></li> </ul>   |
| B              |      | <ul style="list-style-type: none"> <li>Hysteresis input</li> <li>Pull-up resistor approximately 50 k<math>\Omega</math></li> </ul>  |
| C              |      | <ul style="list-style-type: none"> <li>CMOS output</li> <li>Hysteresis input</li> <li>Selectable pull-up resistor approximately 50 k<math>\Omega</math></li> <li><math>I_{OL} = 4</math> mA</li> <li>Standby control available</li> </ul> |
| D              |      | <ul style="list-style-type: none"> <li>CMOS output</li> <li>CMOS input</li> <li>Selectable pull-up resistor approximately 50 k<math>\Omega</math></li> <li>Standby control available</li> <li><math>I_{OL} = 12</math> mA</li> </ul>      |

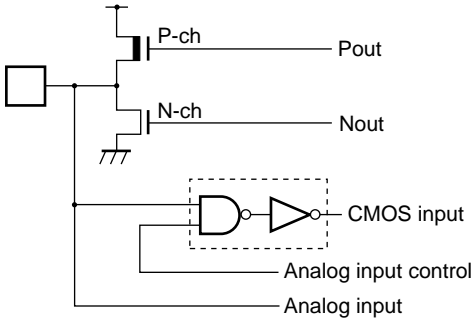
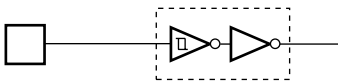
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# MB90460 Series

| Classification | Type  | Remarks  |
|----------------|---|--|
| E              |    | <ul style="list-style-type: none"> <li>• CMOS output</li> <li>• CMOS input</li> <li>• Selectable pull-up resistor approximately 50 kΩ</li> <li>• Standby control available</li> <li>• I<sub>OL</sub> = 4 mA</li> </ul> |
| F              |   | <ul style="list-style-type: none"> <li>• CMOS output</li> <li>• Hysteresis input</li> <li>• Standby control available</li> <li>• I<sub>OL</sub> = 4 mA</li> </ul>  |
| G              |  | <ul style="list-style-type: none"> <li>• CMOS output</li> <li>• CMOS input</li> <li>• Standby control available</li> <li>• I<sub>OL</sub> = 12 mA</li> </ul>   |
| H              |  | <ul style="list-style-type: none"> <li>• CMOS output</li> <li>• CMOS input</li> <li>• Standby control available</li> <li>• I<sub>OL</sub> = 4 mA</li> </ul>  |

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| Classification | Type   | Remarks  |
|----------------|--|--|
| I              |  <p>The diagram shows a CMOS output stage with a P-channel MOSFET (P-ch) and an N-channel MOSFET (N-ch). The P-ch MOSFET is connected to a supply rail (V<sub>DD</sub>) and its source is connected to the N-ch MOSFET's source, which is connected to ground. The gates of both MOSFETs are connected to a common input node. The output of the P-ch MOSFET is labeled Pout, and the output of the N-ch MOSFET is labeled Nout. Below this, there is a CMOS input stage consisting of a CMOS input terminal connected to an AND gate, which is followed by an inverter. The output of this stage is labeled CMOS input. The AND gate has two inputs: one is the Analog input control signal, and the other is the Analog input signal.</p> | <ul style="list-style-type: none"> <li>• CMOS output</li> <li>• CMOS input</li> <li>• Analog input</li> <li>• I<sub>OL</sub> = 4 mA</li> </ul> |
| J              |  <p>The diagram shows a hysteresis input stage. It consists of two inverters connected in a feedback loop. The input of the first inverter is connected to the output of the second inverter, forming a Schmitt trigger configuration. The input of the first inverter is labeled as the hysteresis input.</p>  | <ul style="list-style-type: none"> <li>• Hysteresis input</li> </ul>   |

# MB90460 Series

## ■ HANDLING DEVICES

### 1. Preventing Latchup

CMOS ICs may cause latchup in the following situations :

- When a voltage higher than  $V_{CC}$  or lower than  $V_{SS}$  is applied to input or output pins.
- When a voltage exceeding the rating is applied between  $V_{CC}$  and  $V_{SS}$ .
- When  $AV_{CC}$  power is supplied prior to the  $V_{CC}$  voltage.

If latchup occurs, the power supply current increases rapidly, sometimes resulting in thermal breakdown of the device. Use meticulous care not to let it occur.

For the same reason, also be careful not to let the analog power-supply voltage exceed the digital power-supply voltage.

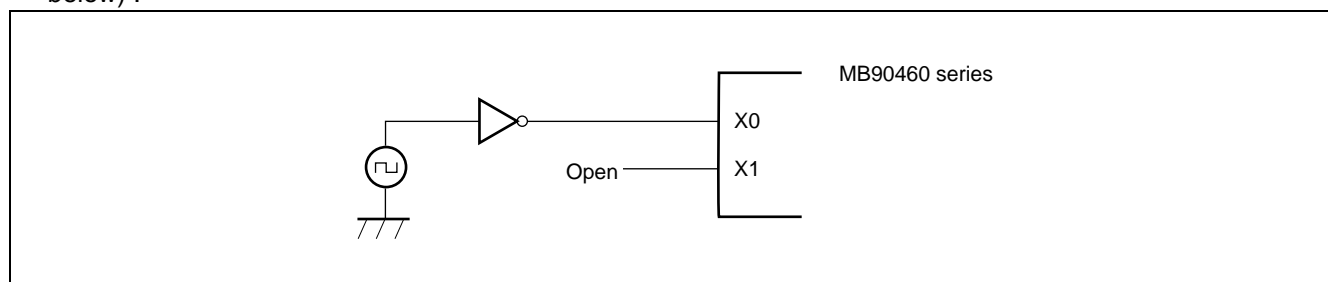
### 2. Handling unused input pins

Unused input pins left open may cause abnormal operation, or latch-up leading to permanent damage. Unused input pins should be pulled up or pulled down through at least 2 k $\Omega$  resistance.

Unused input/output pins may be left open in the output state, but if such pins are in the input state they should be handled in the same way as input pins.

### 3. Use of the external clock

When the device uses an external clock, drive only the X0 pin while leaving the X1 pin open (See the illustration below) .



### 4. Power Supply Pins ( $V_{CC}/V_{SS}$ )

In products with multiple  $V_{CC}$  or  $V_{SS}$  pins, the pins of a same potential are internally connected in the device to avoid abnormal operations including latch-up. However, connect the pins external power and ground lines to lower the electro-magnetic emission level to prevent abnormal operation of strobe signals caused by the rise in the ground level, and to conform to the total current rating.

Make sure to connect  $V_{CC}$  and  $V_{SS}$  pins via the lowest impedance to power lines.

It is recommended to provide a bypass capacitor of around 0.1  $\mu$ F between  $V_{CC}$  and  $V_{SS}$  pins near the device.

### 5. Crystal Oscillator Circuit

Noise around X0 or X1 pins may cause abnormal operations. Make sure to provide bypass capacitors via the shortest distance from X0, X1 pins, crystal oscillator (or ceramic resonator) and ground lines, and make sure, to the utmost effort, that lines of oscillation circuit not cross the lines of other circuits.

It is highly recommended to provide a printed circuit board art work surrounding X0 and X1 pins with the ground area for stabilizing the operation.

### 6. Turning-on Sequence of Power Supply to A/D Converter and Analog Inputs

Make sure to turn on the A/D converter power supply ( $AV_{CC}$ ,  $AV_{SS}$ , AVR) and analog inputs (AN0 to AN7) after turning-on the digital power supply ( $V_{CC}$ ) .

Turn-off the digital power after turning off the A/D converter supply and analog inputs. In this case, make sure that the voltage of AVR dose not exceed  $AV_{CC}$  (turning on/off the analog and digital power supplies simultaneously is acceptable) .



## 7. Connection of Unused Pins of A/D Converter

Connect unused pin of A/D converter to  $AV_{CC} = V_{CC}$ ,  $AV_{SS} = AVR = V_{SS}$ .

## 8. N.C. Pin

The N.C. (internally connected) pin must be opened for use.

## 9. Notes on Energization

To prevent the internal regulator circuit from malfunctioning, set the voltage rise time during energization at 50  $\mu$ s or more.

## 10. Initialization

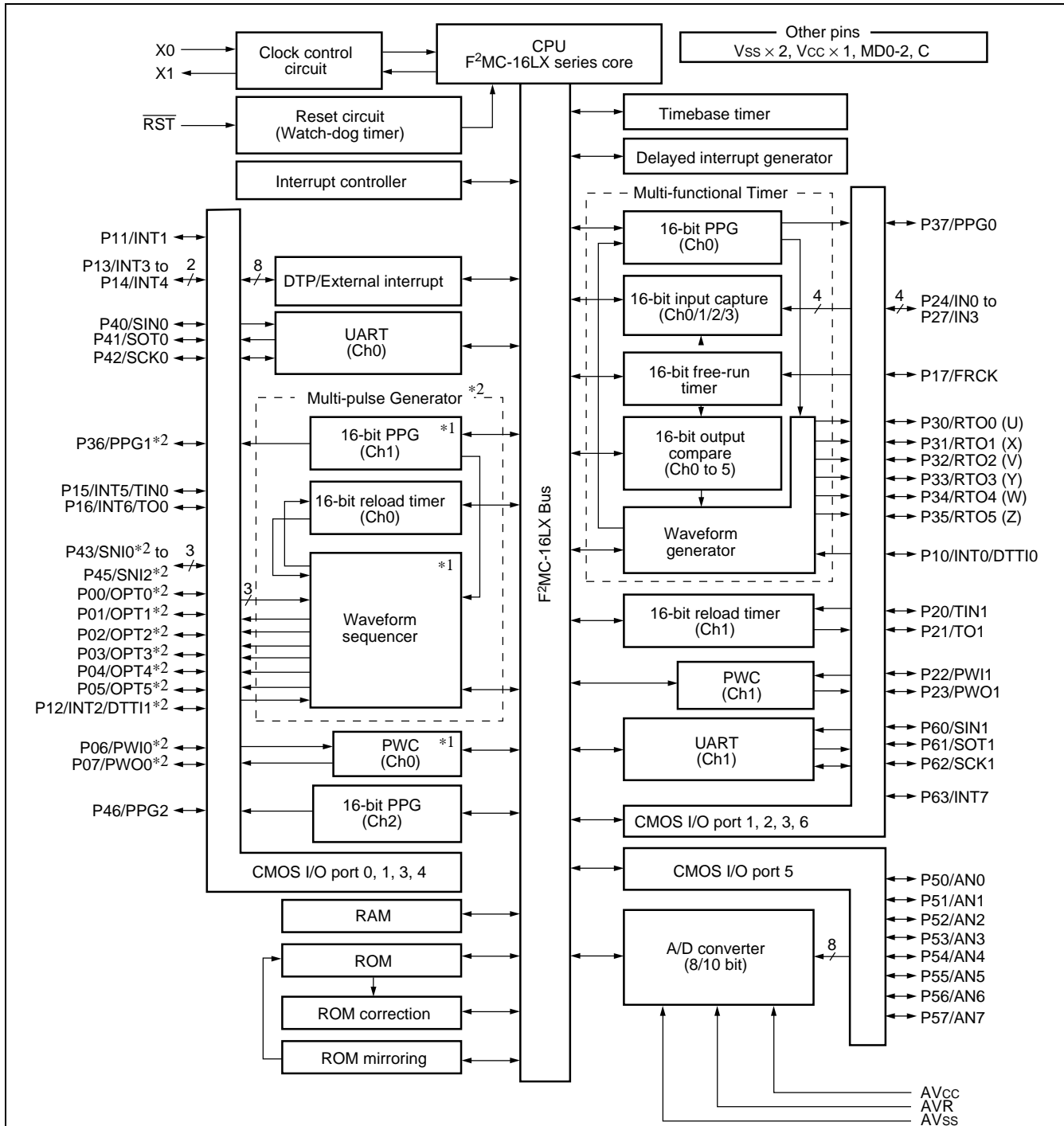
In the device, there are internal registers which are initialized only by a power-on reset. To initialize these registers, please turn on the power again.

## 11. Return from standby state

If the power-supply voltage goes below the standby RAM holding voltage in the standby state, the device may fail to return from the standby state. In this case, reset the device via the external reset pin to return to the normal state.

# MB90460 Series

## ■ BLOCK DIAGRAM



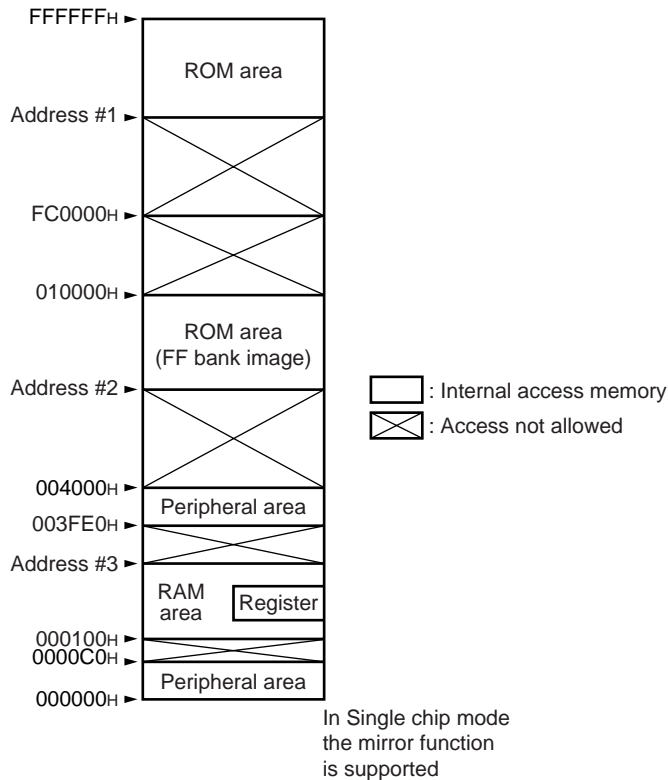
Note : P00 to P07 (8 channels) : With registers that can be used as input pull-up resistors

P10 to P17 (8 channels) : With registers that can be used as input pull-up resistors

\*1: Only MB90V460, MB90F462 and MB90462 have PWC (ch 0) , 16-bit PPG (ch 1) and waveform sequencer. They do not exist on MB90467.

\*2: The multi-pulse generator function can be used only by MB90V460, MB90F462 and MB90462. This function can not be used by MB90467.

## MEMORY MAP



| Parts No.   | Address#1              | Address#2           | Address#3           |
|-------------|------------------------|---------------------|---------------------|
| MB90462/467 | FF0000 <sub>H</sub>    | 004000 <sub>H</sub> | 000900 <sub>H</sub> |
| MB90F462    | FF0000 <sub>H</sub>    | 004000 <sub>H</sub> | 000900 <sub>H</sub> |
| MB90V460    | (FF0000 <sub>H</sub> ) | 004000 <sub>H</sub> | 002100 <sub>H</sub> |

Note : The ROM data of bank FF is reflected in the upper address of bank 00, realizing effective use of the C compiler small model. The lower 16-bit is assigned to the same address, enabling reference of the table on the ROM without stating "far". For example, if an attempt has been made to access 00C000<sub>H</sub>, the contents of the ROM at FFC000<sub>H</sub> are accessed actually. Since the ROM area of the FF bank exceeds 48 Kbytes, the whole area cannot be reflected in the image for the 00 bank. The ROM data at FF4000<sub>H</sub> to FFFFFFF<sub>H</sub> looks, therefore, as if it were the image for 004000<sub>H</sub> to 00FFFF<sub>H</sub>. Thus, it is recommended that the ROM data table be stored in the area of FF4000<sub>H</sub> to FFFFFFF<sub>H</sub>.

# MB90460 Series

## ■ I/O MAP

| Address       | Abbreviation    | Register                                 | Byte access           | Word access | Resource name             | Initial value          |
|---------------|-----------------|--|-----------------------|-------------|---------------------------|------------------------|
| 00000H        | PDR0            | Port 0 data register                     | R/W                   | R/W         | Port 0                    | XXXXXXXX <sub>B</sub>  |
| 00001H        | PDR1            | Port 1 data register                     | R/W                   | R/W         | Port 1                    | XXXXXXXX <sub>B</sub>  |
| 00002H        | PDR2            | Port 2 data register                     | R/W                   | R/W         | Port 2                    | XXXXXXXX <sub>B</sub>  |
| 00003H        | PDR3            | Port 3 data register                     | R/W                   | R/W         | Port 3                    | XXXXXXXX <sub>B</sub>  |
| 00004H        | PDR4            | Port 4 data register                     | R/W                   | R/W         | Port 4                    | -XXXXXXXX <sub>B</sub> |
| 00005H        | PDR5            | Port 5 data register                     | R/W                   | R/W         | Port 5                    | XXXXXXXX <sub>B</sub>  |
| 00006H        | PDR6            | Port 6 data register                     | R/W                   | R/W         | Port 6                    | ----XXXX <sub>B</sub>  |
| 00007H        | Prohibited area |  |                       |             |                           |                        |
| 00008H        | PWCSL0          | PWC control status register CH0          | R/W                   | R/W         | PWC timer (CH0)           | 0000000 <sub>B</sub>   |
| 00009H        | PWCSH0          |  | R/W                   | R/W         |                           | 0000000 <sub>B</sub>   |
| 0000AH        | PWC0            | PWC data buffer register CH0             | —                     | R/W         |                           | XXXXXXXX <sub>B</sub>  |
| 0000BH        |                 |  | XXXXXXXX <sub>B</sub> |             |                           |                        |
| 0000CH        | DIV0            | Divide ratio control register CH0        | R/W                   | R/W         |                           | -----00 <sub>B</sub>   |
| 0000DH to 0FH | Prohibited area |  |                       |             |                           |                        |
| 00010H        | DDR0            | Port 0 direction register                | R/W                   | R/W         | Port 0                    | 0000000 <sub>B</sub>   |
| 00011H        | DDR1            | Port 1 direction register                | R/W                   | R/W         | Port 1                    | 0000000 <sub>B</sub>   |
| 00012H        | DDR2            | Port 2 direction register                | R/W                   | R/W         | Port 2                    | 0000000 <sub>B</sub>   |
| 00013H        | DDR3            | Port 3 direction register                | R/W                   | R/W         | Port 3                    | 0000000 <sub>B</sub>   |
| 00014H        | DDR4            | Port 4 direction register                | R/W                   | R/W         | Port 4                    | -000000 <sub>B</sub>   |
| 00015H        | DDR5            | Port 5 direction register                | R/W                   | R/W         | Port 5                    | 0000000 <sub>B</sub>   |
| 00016H        | DDR6            | Port 6 direction register                | R/W                   | R/W         | Port 6                    | ----0000 <sub>B</sub>  |
| 00017H        | ADER            | Analog input enable register             | R/W                   | R/W         | Port 5, A/D               | 1111111 <sub>B</sub>   |
| 00018H        | Prohibited area |  |                       |             |                           |                        |
| 00019H        | CDCR0           | Clock division control register 0        | R/W                   | R/W         | Communication prescaler 0 | 0---0000 <sub>B</sub>  |
| 0001AH        | Prohibited area |  |                       |             |                           |                        |
| 0001BH        | CDCR1           | Clock division control register 1        | R/W                   | R/W         | Communication prescaler 1 | 0---0000 <sub>B</sub>  |
| 0001CH        | RDR0            | Port 0 pull-up resistor setting register | R/W                   | R/W         | Port 0                    | 0000000 <sub>B</sub>   |
| 0001DH        | RDR1            | Port 1 pull-up resistor setting register | R/W                   | R/W         | Port 1                    | 0000000 <sub>B</sub>   |
| 0001EH to 1FH | Prohibited area |  |                       |             |                           |                        |

(Continued)

# MB90460 Series

| Address                                | Abbreviation    | Register                                       | Byte access           | Word access | Resource name          | Initial value         |
|--|-----------------|--|-----------------------|-------------|------------------------|-----------------------|
| 000020 <sub>H</sub>                    | SMR0            | Serial mode register 0                         | R/W                   | R/W         | UART0                  | 00000000 <sub>B</sub> |
| 000021 <sub>H</sub>                    | SCR0            | Serial control register 0                      | R/W                   | R/W         |                        | 00000100 <sub>B</sub> |
| 000022 <sub>H</sub>                    | SIDR0 / SODR0   | Input data register 0 / output data register 0 | R/W                   | R/W         |                        | XXXXXXXX <sub>B</sub> |
| 000023 <sub>H</sub>                    | SSR0            | Serial status register 0                       | R/W                   | R/W         |                        | 00001000 <sub>B</sub> |
| 000024 <sub>H</sub>                    | SMR1            | Serial mode register 1                         | R/W                   | R/W         | UART1                  | 00000000 <sub>B</sub> |
| 000025 <sub>H</sub>                    | SCR1            | Serial control register 1                      | R/W                   | R/W         |                        | 00000100 <sub>B</sub> |
| 000026 <sub>H</sub>                    | SIDR1 / SODR1   | Input data register 1 / output data register 1 | R/W                   | R/W         |                        | XXXXXXXX <sub>B</sub> |
| 000027 <sub>H</sub>                    | SSR1            | Status register 1                              | R/W                   | R/W         |                        | 00001000 <sub>B</sub> |
| 000028 <sub>H</sub>                    | PWCSL1          | PWC control status register CH1                | R/W                   | R/W         | PWC timer (CH1)        | 00000000 <sub>B</sub> |
| 000029 <sub>H</sub>                    | PWCSH1          |  | R/W                   | R/W         |                        | 00000000 <sub>B</sub> |
| 00002A <sub>H</sub>                    | PWC1            | PWC data buffer register CH1                   | —                     | R/W         |                        | XXXXXXXX <sub>B</sub> |
| 00002B <sub>H</sub>                    |                 |  | XXXXXXXX <sub>B</sub> |             |                        |                       |
| 00002C <sub>H</sub>                    | DIV1            | Divide ratio control register CH1              | R/W                   | R/W         |                        | -----00 <sub>B</sub>  |
| 00002D <sub>H</sub> to 2F <sub>H</sub> | Prohibited area |  |                       |             |                        |                       |
| 000030 <sub>H</sub>                    | ENIR            | Interrupt / DTP enable register                | R/W                   | R/W         | DTP/external interrupt | 00000000 <sub>B</sub> |
| 000031 <sub>H</sub>                    | EIRR            | Interrupt / DTP cause register                 | R/W                   | R/W         |                        | XXXXXXXX <sub>B</sub> |
| 000032 <sub>H</sub>                    | ELVRL           | Request level setting register (Lower Byte)    | R/W                   | R/W         |                        | 00000000 <sub>B</sub> |
| 000033 <sub>H</sub>                    | ELVRH           | Request level setting register (Higher Byte)   | R/W                   | R/W         |                        | 00000000 <sub>B</sub> |
| 000034 <sub>H</sub>                    | ADCS0           | A/D control status register 0                  | R/W                   | R/W         | 8/10-bit A/D converter | 00000000 <sub>B</sub> |
| 000035 <sub>H</sub>                    | ADCS1           | A/D control status register 1                  | R/W                   | R/W         |                        | 00000000 <sub>B</sub> |
| 000036 <sub>H</sub>                    | ADCR0           | A/D data register 0                            | R                     | R           |                        | XXXXXXXX <sub>B</sub> |
| 000037 <sub>H</sub>                    | ADCR1           | A/D data register 1                            | R/W                   | R/W         |                        | 0000-XX <sub>B</sub>  |
| 000038 <sub>H</sub>                    | PDCR0           | PPG0 down counter register                     | —                     | R           | 16-bit PPG timer (CH0) | 11111111 <sub>B</sub> |
| 000039 <sub>H</sub>                    |                 |  |                       |             |                        | 11111111 <sub>B</sub> |
| 00003A <sub>H</sub>                    | PCSR0           | PPG0 period setting register                   | —                     | W           |                        | XXXXXXXX <sub>B</sub> |
| 00003B <sub>H</sub>                    |                 |  |                       |             |                        | XXXXXXXX <sub>B</sub> |
| 00003C <sub>H</sub>                    | PDUT0           | PPG0 duty setting register                     | —                     | W           |                        | XXXXXXXX <sub>B</sub> |
| 00003D <sub>H</sub>                    |                 |  |                       |             |                        | XXXXXXXX <sub>B</sub> |
| 00003E <sub>H</sub>                    | PCNTL0          | PPG0 control status register                   | R/W                   | R/W         |                        | --00000 <sub>B</sub>  |
| 00003F <sub>H</sub>                    | PCNTH0          |  | R/W                   | R/W         |                        | 00000000 <sub>B</sub> |

(Continued)

# MB90460 Series

| Address             | Abbreviation   | Register   | Byte access | Word access | Resource name             | Initial value          |                       |
|---------------------|----------------|--|-------------|-------------|---------------------------|------------------------|-----------------------|
| 000040 <sub>H</sub> | PDCR1          | PPG1 down counter register                                     | —           | R           | 16-bit PPG timer (CH1)    | 11111111 <sub>B</sub>  |                       |
| 000041 <sub>H</sub> |                |  |             |             |                           | 11111111 <sub>B</sub>  |                       |
| 000042 <sub>H</sub> | PCSR1          | PPG1 period setting register                                   | —           | W           |                           | XXXXXXXX <sub>B</sub>  |                       |
| 000043 <sub>H</sub> |                |  |             |             |                           | XXXXXXXX <sub>B</sub>  |                       |
| 000044 <sub>H</sub> | PDUT1          | PPG1 duty setting register                                     | —           | W           |                           | XXXXXXXX <sub>B</sub>  |                       |
| 000045 <sub>H</sub> |                |  |             |             |                           | XXXXXXXX <sub>B</sub>  |                       |
| 000046 <sub>H</sub> | PCNTL1         | PPG1 control status register                                   | R/W         | R/W         |                           | --000000 <sub>B</sub>  |                       |
| 000047 <sub>H</sub> | PCNTH1         |  | R/W         | R/W         |                           | 00000000 <sub>B</sub>  |                       |
| 000048 <sub>H</sub> | PDCR2          | PPG2 down counter register                                     | —           | R           |                           | 16-bit PPG timer (CH2) | 11111111 <sub>B</sub> |
| 000049 <sub>H</sub> |                |  |             |             |                           |                        | 11111111 <sub>B</sub> |
| 00004A <sub>H</sub> | PCSR2          | PPG2 period setting register                                   | —           | W           | XXXXXXXX <sub>B</sub>     |                        |                       |
| 00004B <sub>H</sub> |                |  |             |             | XXXXXXXX <sub>B</sub>     |                        |                       |
| 00004C <sub>H</sub> | PDUT2          | PPG2 duty setting register                                     | —           | W           | XXXXXXXX <sub>B</sub>     |                        |                       |
| 00004D <sub>H</sub> |                |  |             |             | XXXXXXXX <sub>B</sub>     |                        |                       |
| 00004E <sub>H</sub> | PCNTL2         | PPG2 control status register                                   | R/W         | R/W         | --000000 <sub>B</sub>     |                        |                       |
| 00004F <sub>H</sub> | PCNTH2         |  | R/W         | R/W         | 00000000 <sub>B</sub>     |                        |                       |
| 000050 <sub>H</sub> | TMRR0          | 16-bit timer register 0  | —           | R/W         | Waveform generator        |                        | XXXXXXXX <sub>B</sub> |
| 000051 <sub>H</sub> |                |  |             |             |                           |                        | XXXXXXXX <sub>B</sub> |
| 000052 <sub>H</sub> | TMRR1          | 16-bit timer register 1  | —           | R/W         |                           | XXXXXXXX <sub>B</sub>  |                       |
| 000053 <sub>H</sub> |                |  |             |             |                           | XXXXXXXX <sub>B</sub>  |                       |
| 000054 <sub>H</sub> | TMRR2          | 16-bit timer register 2  | —           | R/W         |                           | XXXXXXXX <sub>B</sub>  |                       |
| 000055 <sub>H</sub> |                |  |             |             |                           | XXXXXXXX <sub>B</sub>  |                       |
| 000056 <sub>H</sub> | DTCR0          | 16-bit timer control register 0                                | R/W         | R/W         |                           | 00000000 <sub>B</sub>  |                       |
| 000057 <sub>H</sub> | DTCR1          | 16-bit timer control register 1                                | R/W         | R/W         |                           | 00000000 <sub>B</sub>  |                       |
| 000058 <sub>H</sub> | DTCR2          | 16-bit timer control register 2                                | R/W         | R/W         |                           | 00000000 <sub>B</sub>  |                       |
| 000059 <sub>H</sub> | SIGCR          | Waveform control register                                      | R/W         | R/W         |                           | 00000000 <sub>B</sub>  |                       |
| 00005A <sub>H</sub> | CPCLRB / CPCLR | Compare clear buffer register / Compare clear register (lower) | —           | R/W         | 16-bit free-running timer | 11111111 <sub>B</sub>  |                       |
| 00005B <sub>H</sub> |                |  |             |             |                           | 11111111 <sub>B</sub>  |                       |
| 00005C <sub>H</sub> | TCDT           | Timer data register (lower)                                    | —           | R/W         |                           | 00000000 <sub>B</sub>  |                       |
| 00005D <sub>H</sub> |                |  |             |             |                           | 00000000 <sub>B</sub>  |                       |
| 00005E <sub>H</sub> | TCCSL          | Timer control status register (lower)                          | R/W         | R/W         |                           | 00000000 <sub>B</sub>  |                       |
| 00005F <sub>H</sub> | TCCSH          | Timer control status register (upper)                          | R/W         | R/W         |                           | -0000000 <sub>B</sub>  |                       |

(Continued)

# MB90460 Series

| Address                                   | Abbreviation     | Register  | Byte access | Word access | Resource name                     | Initial value         |                       |
|---|------------------|---|-------------|-------------|-----------------------------------|-----------------------|-----------------------|
| 000060 <sub>H</sub>                       | IPCP0            | Input capture data register CH0                                       | —           | R           | 16-bit input capture (CH0 to CH3) | XXXXXXXX <sub>B</sub> |                       |
| 000061 <sub>H</sub>                       |                  |   |             |             |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000062 <sub>H</sub>                       | IPCP1            | Input capture data register CH1                                       | —           | R           |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000063 <sub>H</sub>                       |                  |   |             |             |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000064 <sub>H</sub>                       | IPCP2            | Input capture data register CH2                                       | —           | R           |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000065 <sub>H</sub>                       |                  |   |             |             |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000066 <sub>H</sub>                       | IPCP3            | Input capture data register CH3                                       | —           | R           |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000067 <sub>H</sub>                       |                  |   |             |             |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000068 <sub>H</sub>                       | PICSL01          | PPG output control / Input capture control status register 01 (lower) | R/W         | R/W         |                                   |                       | 00000000 <sub>B</sub> |
| 000069 <sub>H</sub>                       | PICSH01          | PPG output control / Input capture control status register 01 (upper) | R/W         | R/W         |                                   |                       | 00000000 <sub>B</sub> |
| 00006A <sub>H</sub>                       | ICSL23           | Input capture control status register 23 (lower)                      | R/W         | R/W         |                                   | 00000000 <sub>B</sub> |                       |
| 00006B <sub>H</sub>                       | ICSH23           | Input capture control status register 23 (upper)                      | R           | R           |                                   | -----00 <sub>B</sub>  |                       |
| 00006C <sub>H</sub><br>to 6E <sub>H</sub> | Prohibited area  |   |             |             |                                   |                       |                       |
| 00006F <sub>H</sub>                       | ROMM             | ROM mirroring function selection register                             | W           | W           | ROM mirroring function            | -----1 <sub>B</sub>   |                       |
| 000070 <sub>H</sub>                       | OCCPB0/<br>OCCP0 | Output compare buffer register /<br>output compare register 0         | —           | R/W         | Output compare (CH0 to CH5)       | XXXXXXXX <sub>B</sub> |                       |
| 000071 <sub>H</sub>                       |                  |   |             |             |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000072 <sub>H</sub>                       | OCCPB1/<br>OCCP1 | Output compare buffer register /<br>output compare register 1         | —           | R/W         |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000073 <sub>H</sub>                       |                  |   |             |             |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000074 <sub>H</sub>                       | OCCPB2/<br>OCCP2 | Output compare buffer register /<br>output compare register 2         | —           | R/W         |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000075 <sub>H</sub>                       |                  |   |             |             |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000076 <sub>H</sub>                       | OCCPB3/<br>OCCP3 | Output compare buffer register /<br>output compare register 3         | —           | R/W         |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000077 <sub>H</sub>                       |                  |   |             |             |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000078 <sub>H</sub>                       | OCCPB4/<br>OCCP4 | Output compare buffer register /<br>output compare register 4         | —           | R/W         |                                   | XXXXXXXX <sub>B</sub> |                       |
| 000079 <sub>H</sub>                       |                  |   |             |             |                                   | XXXXXXXX <sub>B</sub> |                       |
| 00007A <sub>H</sub>                       | OCCPB5/<br>OCCP5 | Output compare buffer register /<br>output compare register 5         | —           | R/W         | XXXXXXXX <sub>B</sub>             |                       |                       |
| 00007B <sub>H</sub>                       |                  |   |             |             | XXXXXXXX <sub>B</sub>             |                       |                       |

(Continued)

# MB90460 Series

| Address                                | Abbreviation    | Register                                       | Byte access | Word access | Resource name                          | Initial value          |
|--|-----------------|--|-------------|-------------|--|------------------------|
| 00007C <sub>H</sub>                    | OCS0            | Compare control register 0                     | R/W         | R/W         | Output compare (CH0 to CH5)            | 00000000 <sub>B</sub>  |
| 00007D <sub>H</sub>                    | OCS1            | Compare control register 1                     | R/W         | R/W         |  | -00000000 <sub>B</sub> |
| 00007E <sub>H</sub>                    | OCS2            | Compare control register 2                     | R/W         | R/W         |  | 00000000 <sub>B</sub>  |
| 00007F <sub>H</sub>                    | OCS3            | Compare control register 3                     | R/W         | R/W         |  | -00000000 <sub>B</sub> |
| 000080 <sub>H</sub>                    | OCS4            | Compare control register 4                     | R/W         | R/W         |  | 00000000 <sub>B</sub>  |
| 000081 <sub>H</sub>                    | OCS5            | Compare control register 5                     | R/W         | R/W         |  | -00000000 <sub>B</sub> |
| 000082 <sub>H</sub>                    | TMCSRL0         | Timer control status register CH0 (lower)      | R/W         | R/W         | 16-bit reload timer (CH0)              | 00000000 <sub>B</sub>  |
| 000083 <sub>H</sub>                    | TMCSRH0         | Timer control status register CH0 (upper)      | R/W         | R/W         |  | ----0000 <sub>B</sub>  |
| 000084 <sub>H</sub>                    | TMR0 / TMRD0    | 16 bit timer register CH0 /                    | —           | R/W         |  | XXXXXXXX <sub>B</sub>  |
| 000085 <sub>H</sub>                    |                 | 16-bit reload register CH0                     |             |             |  | XXXXXXXX <sub>B</sub>  |
| 000086 <sub>H</sub>                    | TMCSRL1         | Timer control status register CH1 (lower)      | R/W         | R/W         | 16-bit reload timer (CH1)              | 00000000 <sub>B</sub>  |
| 000087 <sub>H</sub>                    | TMCSRH1         | Timer control status register CH1 (upper)      | R/W         | R/W         |  | ----0000 <sub>B</sub>  |
| 000088 <sub>H</sub>                    | TMR1 / TMRD1    | 16 bit timer register CH1 /                    | —           | R/W         |  | XXXXXXXX <sub>B</sub>  |
| 000089 <sub>H</sub>                    |                 | 16-bit reload register CH1                     |             |             |  | XXXXXXXX <sub>B</sub>  |
| 00008A <sub>H</sub>                    | OPCLR           | Output control lower register                  | R/W         | R/W         | Waveform sequencer                     | 00000000 <sub>B</sub>  |
| 00008B <sub>H</sub>                    | OPCUR           | Output control upper register                  | R/W         | R/W         |  | 00000000 <sub>B</sub>  |
| 00008C <sub>H</sub>                    | IPCLR           | Input control lower register                   | R/W         | R/W         |  | 00000000 <sub>B</sub>  |
| 00008D <sub>H</sub>                    | IPCUR           | Input control upper register                   | R/W         | R/W         |  | 00000000 <sub>B</sub>  |
| 00008E <sub>H</sub>                    | TCSR            | Timer control status register                  | R/W         | R/W         |  | 00000000 <sub>B</sub>  |
| 00008F <sub>H</sub>                    | NCCR            | Noise cancellation control register            | R/W         | R/W         |  | 00000000 <sub>B</sub>  |
| 000090 <sub>H</sub> to 9D <sub>H</sub> | Prohibited area |  |             |             |  |                        |
| 00009E <sub>H</sub>                    | PACSR           | Program address detect control status register | R/W         | R/W         | Rom correction                         | 00000000 <sub>B</sub>  |
| 00009F <sub>H</sub>                    | DIRR            | Delayed interrupt cause / clear register       | R/W         | R/W         | Delayed interrupt                      | -----0 <sub>B</sub>    |
| 0000A0 <sub>H</sub>                    | LPMCR           | Low-power consumption mode register            | R/W         | R/W         | Low-power consumption control register | 00011000 <sub>B</sub>  |
| 0000A1 <sub>H</sub>                    | CKSCR           | Clock selection register                       | R/W         | R/W         |  | 11111100 <sub>B</sub>  |
| 0000A2 <sub>H</sub> to A7 <sub>H</sub> | Prohibited area |  |             |             |  |                        |
| 0000A8 <sub>H</sub>                    | WDTC            | Watchdog control register                      | R/W         | R/W         | Watchdog timer                         | X-XXX111 <sub>B</sub>  |
| 0000A9 <sub>H</sub>                    | TBTC            | Timebase timer control register                | R/W         | R/W         | Timebase timer                         | 1--00100 <sub>B</sub>  |

(Continued)



# MB90460 Series

| Address                                   | Abbreviation    | Register   | Byte access | Word access | Resource name                  | Initial value         |
|---|-----------------|--|-------------|-------------|--------------------------------|-----------------------|
| 0000AA <sub>H</sub><br>to AD <sub>H</sub> | Prohibited area |  |             |             |                                |                       |
| 0000AE <sub>H</sub>                       | FMCS            | Flash memory control status register               | R/W         | R/W         | Flash memory interface circuit | 00010000 <sub>B</sub> |
| 0000AF <sub>H</sub>                       | Prohibited area |  |             |             |                                |                       |
| 0000B0 <sub>H</sub>                       | ICR00           | Interrupt control register 00                      | R/W         | R/W         | Interrupt controller           | 00000111 <sub>B</sub> |
| 0000B1 <sub>H</sub>                       | ICR01           | Interrupt control register 01                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000B2 <sub>H</sub>                       | ICR02           | Interrupt control register 02                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000B3 <sub>H</sub>                       | ICR03           | Interrupt control register 03                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000B4 <sub>H</sub>                       | ICR04           | Interrupt control register 04                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000B5 <sub>H</sub>                       | ICR05           | Interrupt control register 05                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000B6 <sub>H</sub>                       | ICR06           | Interrupt control register 06                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000B7 <sub>H</sub>                       | ICR07           | Interrupt control register 07                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000B8 <sub>H</sub>                       | ICR08           | Interrupt control register 08                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000B9 <sub>H</sub>                       | ICR09           | Interrupt control register 09                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000BA <sub>H</sub>                       | ICR10           | Interrupt control register 10                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000BB <sub>H</sub>                       | ICR11           | Interrupt control register 11                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000BC <sub>H</sub>                       | ICR12           | Interrupt control register 12                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000BD <sub>H</sub>                       | ICR13           | Interrupt control register 13                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000BE <sub>H</sub>                       | ICR14           | Interrupt control register 14                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000BF <sub>H</sub>                       | ICR15           | Interrupt control register 15                      | R/W         | R/W         |                                | 00000111 <sub>B</sub> |
| 0000C0 <sub>H</sub><br>to FF <sub>H</sub> | External area   |  |             |             |                                |                       |
| 001FF0 <sub>H</sub>                       | PADR0L          | Program address detection register 0 (Lower Byte)  | R/W         | R/W         | Rom correction                 | XXXXXXXX <sub>B</sub> |
| 001FF1 <sub>H</sub>                       | PADR0M          | Program address detection register 0 (Middle Byte) | R/W         | R/W         |                                | XXXXXXXX <sub>B</sub> |
| 001FF2 <sub>H</sub>                       | PADR0H          | Program address detection register 0 (Higher Byte) | R/W         | R/W         |                                | XXXXXXXX <sub>B</sub> |
| 001FF3 <sub>H</sub>                       | PADR1L          | Program address detection register 1 (Lower Byte)  | R/W         | R/W         |                                | XXXXXXXX <sub>B</sub> |
| 001FF4 <sub>H</sub>                       | PADR1M          | Program address detection register 1 (Middle Byte) | R/W         | R/W         |                                | XXXXXXXX <sub>B</sub> |
| 001FF5 <sub>H</sub>                       | PADR1H          | Program address detection register 1 (Higher Byte) | R/W         | R/W         |                                | XXXXXXXX <sub>B</sub> |

(Continued)

# MB90460 Series

(Continued)

| Address  | Abbreviation    | Register                      | Byte access | Word access | Resource name      | Initial value         |  |
|--|-----------------|-------------------------------|-------------|-------------|--------------------|-----------------------|--|
| 003FE0 <sub>H</sub>                              | OPDBR0          | Output data buffer register 0 | —           | R/W         | Waveform sequencer | 00000000 <sub>B</sub> |  |
| 003FE1 <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FE2 <sub>H</sub>                              | OPDBR1          | Output data buffer register 1 | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FE3 <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FE4 <sub>H</sub>                              | OPDBR2          | Output data buffer register 2 | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FE5 <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FE6 <sub>H</sub>                              | OPDBR3          | Output data buffer register 3 | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FE7 <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003F78 <sub>H</sub>                              | OPDBR4          | Output data buffer register 4 | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FE9 <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FEA <sub>H</sub>                              | OPDBR5          | Output data buffer register 5 | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FEB <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FEC <sub>H</sub>                              | OPEBR6          | Output data buffer register 6 | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FED <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FEE <sub>H</sub>                              | OPEBR7          | Output data buffer register 7 | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FEF <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FF0 <sub>H</sub>                              | OPEBR8          | Output data buffer register 8 | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FF1 <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FF2 <sub>H</sub>                              | OPEBR9          | Output data buffer register 9 | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FF3 <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FF4 <sub>H</sub>                              | OPEBRA          | Output data buffer register A | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FF5 <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FF6 <sub>H</sub>                              | OPEBRB          | Output data buffer register B | —           | R/W         |                    | 00000000 <sub>B</sub> |  |
| 003FF7 <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FF8 <sub>H</sub>                              | OPDR            | Output data register          | —           | R           |                    | XXXXXXXX <sub>B</sub> |  |
| 003FF9 <sub>H</sub>                              |                 |                               |             |             |                    | 0000XXXX <sub>B</sub> |  |
| 003FFA <sub>H</sub>                              | CPCR            | Compare clear register        | —           | R/W         |                    | XXXXXXXX <sub>B</sub> |  |
| 003FFB <sub>H</sub>                              |                 |                               |             |             |                    | XXXXXXXX <sub>B</sub> |  |
| 003FFC <sub>H</sub>                              | TMBR            | Timer buffer register         | —           | R           |                    | 00000000 <sub>B</sub> |  |
| 003FFD <sub>H</sub>                              |                 |                               |             |             |                    | 00000000 <sub>B</sub> |  |
| 003FFE <sub>H</sub><br>to<br>003FFF <sub>H</sub> | Prohibited area |                               |             |             |                    |                       |  |

- Meaning of abbreviations used for reading and writing

R/W : Read and write enabled

R : Read only

W : Write only

- Explanation of initial values

0 : The bit is initialized to 0.

1 : The bit is initialized to 1.

X : The initial value of the bit is undefined.

- : The bit is not used. Its initial value is undefined.

The Instruction using IO addressing e.g. MOV A, io, is not supported for registers area 003FE0<sub>H</sub> to 003FFF<sub>H</sub>.

Note : For bits that is initialized by an reset operation, the initial value set by the reset operation is listed as an initial value. Note that the values are different from reading results.

For LPMCR/CKSCR/WDTC, there are cases where initialization is performed or not performed, depending on the types of the reset. However, initial value for resets that initializes the value is listed.

# MB90460 Series

## ■ INTERRUPT FACTORS, INTERRUPT VECTORS, INTERRUPT CONTROL REGISTER

| Interrupt cause  | EI <sup>2</sup> OS support | Interrupt vector |                 | Interrupt control register |         | Priority <sup>*2</sup>            |           |
|--|----------------------------|------------------|-----------------|----------------------------|---------|-----------------------------------|-----------|
|  |                            | Number           | Address         | ICR                        | Address |                                   |           |
| Reset  | ×                          | #08              | 08 <sub>H</sub> | FFFFDC <sub>H</sub>        | —       | —                                 | High<br>↑ |
| INT9 instruction                                       | ×                          | #09              | 09 <sub>H</sub> | FFFFD8 <sub>H</sub>        | —       | —                                 |           |
| Exception processing                                   | ×                          | #10              | 0A <sub>H</sub> | FFFFD4 <sub>H</sub>        | —       | —                                 |           |
| A/D converter conversion termination                   | ○                          | #11              | 0B <sub>H</sub> | FFFFD0 <sub>H</sub>        | ICR00   | 0000B0 <sub>H</sub> <sup>*1</sup> |           |
| Output compare channel 0 match                         | ○                          | #12              | 0C <sub>H</sub> | FFFFCC <sub>H</sub>        |         |                                   |           |
| End of measurement by PWC0 timer / PWC0 timer overflow | ○                          | #13              | 0D <sub>H</sub> | FFFFC8 <sub>H</sub>        | ICR01   | 0000B1 <sub>H</sub> <sup>*1</sup> |           |
| 16-bit PPG timer 0                                     | ○                          | #14              | 0E <sub>H</sub> | FFFFC4 <sub>H</sub>        |         |                                   |           |
| Output compare channel 1 match                         | ○                          | #15              | 0F <sub>H</sub> | FFFFC0 <sub>H</sub>        | ICR02   | 0000B2 <sub>H</sub> <sup>*1</sup> |           |
| 16-bit PPG timer 1                                     | ○                          | #16              | 10 <sub>H</sub> | FFFFBC <sub>H</sub>        |         |                                   |           |
| Output compare channel 2 match                         | ○                          | #17              | 11 <sub>H</sub> | FFFFB8 <sub>H</sub>        | ICR03   | 0000B3 <sub>H</sub> <sup>*1</sup> |           |
| 16-bit reload timer 1 underflow                        | ○                          | #18              | 12 <sub>H</sub> | FFFFB4 <sub>H</sub>        |         |                                   |           |
| Output compare channel 3 match                         | ○                          | #19              | 13 <sub>H</sub> | FFFFB0 <sub>H</sub>        | ICR04   | 0000B4 <sub>H</sub> <sup>*1</sup> |           |
| DTP/ext. interrupt channels 0/1 detection              | ○                          | #20              | 14 <sub>H</sub> | FFFFAC <sub>H</sub>        |         |                                   |           |
| DTTI0  | Δ                          |                  |                 |                            |         |                                   |           |
| Output compare channel 4 match                         | ○                          | #21              | 15 <sub>H</sub> | FFFFA8 <sub>H</sub>        | ICR05   | 0000B5 <sub>H</sub> <sup>*2</sup> |           |
| DTP/ext. interrupt channels 2/3 detection              | ○                          | #22              | 16 <sub>H</sub> | FFFFA4 <sub>H</sub>        |         |                                   |           |
| DTTI1  | Δ                          |                  |                 |                            |         |                                   |           |
| Output compare channel 5 match                         | ○                          | #23              | 17 <sub>H</sub> | FFFFA0 <sub>H</sub>        | ICR06   | 0000B6 <sub>H</sub> <sup>*1</sup> |           |
| End of measurement by PWC1 timer / PWC1 timer overflow | ○                          | #24              | 18 <sub>H</sub> | FFFF9C <sub>H</sub>        |         |                                   |           |
| DTP/ext. interrupt channels 4/5 detection              | ○                          | #25              | 19 <sub>H</sub> | FFFF98 <sub>H</sub>        | ICR07   | 0000B7 <sub>H</sub> <sup>*1</sup> |           |
| Waveform sequencer timer compare match / write timing  | ○                          | #26              | 1A <sub>H</sub> | FFFF94 <sub>H</sub>        |         |                                   |           |
| DTP/ext. interrupt channels 6/7 detection              | ○                          | #27              | 1B <sub>H</sub> | FFFF90 <sub>H</sub>        | ICR08   | 0000B8 <sub>H</sub> <sup>*1</sup> |           |
| Waveform sequencer position detect / compare interrupt | ○                          | #28              | 1C <sub>H</sub> | FFFF8C <sub>H</sub>        |         |                                   |           |
| Waveform generator 16-bit timer 0/1/2 underflow        | Δ                          | #29              | 1D <sub>H</sub> | FFFF88 <sub>H</sub>        | ICR09   | 0000B9 <sub>H</sub> <sup>*1</sup> |           |
| 16-bit reload timer 0 underflow                        | ○                          | #30              | 1E <sub>H</sub> | FFFF84 <sub>H</sub>        |         |                                   |           |
| 16-bit free-running timer zero detect                  | Δ                          | #31              | 1F <sub>H</sub> | FFFF80 <sub>H</sub>        | ICR10   | 0000BA <sub>H</sub> <sup>*1</sup> |           |
| 16-bit PPG timer 2                                     | ○                          | #32              | 20 <sub>H</sub> | FFFF7C <sub>H</sub>        |         |                                   |           |
| Input capture channels 0/1                             | ○                          | #33              | 21 <sub>H</sub> | FFFF78 <sub>H</sub>        | ICR11   | 0000BB <sub>H</sub> <sup>*1</sup> |           |
| 16-bit free-running timer compare clear                | Δ                          | #34              | 22 <sub>H</sub> | FFFF74 <sub>H</sub>        |         |                                   |           |

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| Interrupt cause                    | EI <sup>2</sup> OS support | Interrupt vector |                 | Interrupt control register |         | Priority <sup>*2</sup>            |
|------------------------------------|----------------------------|------------------|-----------------|----------------------------|---------|-----------------------------------|
|                                    |                            | Number           | Address         | ICR                        | Address |                                   |
| Input capture channels 2/3         | ○                          | #35              | 23 <sub>H</sub> | FFFF70 <sub>H</sub>        | ICR12   | 0000BC <sub>H</sub> <sup>*1</sup> |
| Timebase timer                     | Δ                          | #36              | 24 <sub>H</sub> | FFFF6C <sub>H</sub>        |         |                                   |
| UART1 receive                      | ◎                          | #37              | 25 <sub>H</sub> | FFFF68 <sub>H</sub>        | ICR13   | 0000BD <sub>H</sub> <sup>*1</sup> |
| UART1 send                         | Δ                          | #38              | 26 <sub>H</sub> | FFFF64 <sub>H</sub>        |         |                                   |
| UART0 receive                      | ◎                          | #39              | 27 <sub>H</sub> | FFFF60 <sub>H</sub>        | ICR14   | 0000BE <sub>H</sub> <sup>*1</sup> |
| UART0 send                         | Δ                          | #40              | 28 <sub>H</sub> | FFFF5C <sub>H</sub>        |         |                                   |
| Flash memory status                | Δ                          | #41              | 29 <sub>H</sub> | FFFF58 <sub>H</sub>        | ICR15   | 0000BF <sub>H</sub> <sup>*1</sup> |
| Delayed interrupt generator module | Δ                          | #42              | 2A <sub>H</sub> | FFFF54 <sub>H</sub>        |         |                                   |

- ◎ : Can be used and support the EI<sup>2</sup>OS stop request.
- : Can be used and interrupt request flag is cleared by EI<sup>2</sup>OS interrupt clear signal.
- × : Cannot be used.
- Δ : Usable when an interrupt cause that shares the ICR is not used.

## ■ PERIPHERAL RESOURCES

### 1. Low-Power Consumption Control Circuit

The MB90460 series has the following CPU operating mode configured by selection of an operating clock and clock operation control.

- Clock mode

PLL clock mode : A PLL clock that is a multiple of the oscillation clock (HCLK) frequency is used to operate the CPU and peripheral functions.

Main clock mode : The main clock, with a frequency one-half that of the oscillation clock (HCLK) , is used to operate the CPU and peripheral functions. In main clock mode, the PLL multiplier circuit is inactive.

- CPU intermittent operation mode

CPU intermittent operation mode causes the CPU to operate intermittently, while high-speed clock pulses are supplied to peripheral functions, reducing power consumption. In CPU intermittent operation mode, intermittent clock pulses are only applied to the CPU when it is accessing a register, internal memory, a peripheral function, or an external unit.

- Standby mode

In standby mode, the low power consumption control circuit stops supplying the clock to the CPU (sleep mode) or the CPU and peripheral functions (timebase timer mode) , or stops the oscillation clock itself (stop mode) , reducing power consumption.

- PLL sleep mode

PLL sleep mode is activated to stop the CPU operating clock when the microcontroller enters PLL clock mode; other components continue to operate on the PLL clock.

- Main sleep mode

Main sleep mode is activated to stop the CPU operating clock when the microcontroller enters main clock mode; other components continue to operate on the main clock.

- PLL timebase timer mode

PLL timebase timer mode causes microcontroller operation, with the exception of the oscillation clock, PLL clock and timebase timer, to stop. All functions other than the timebase timer are deactivated.

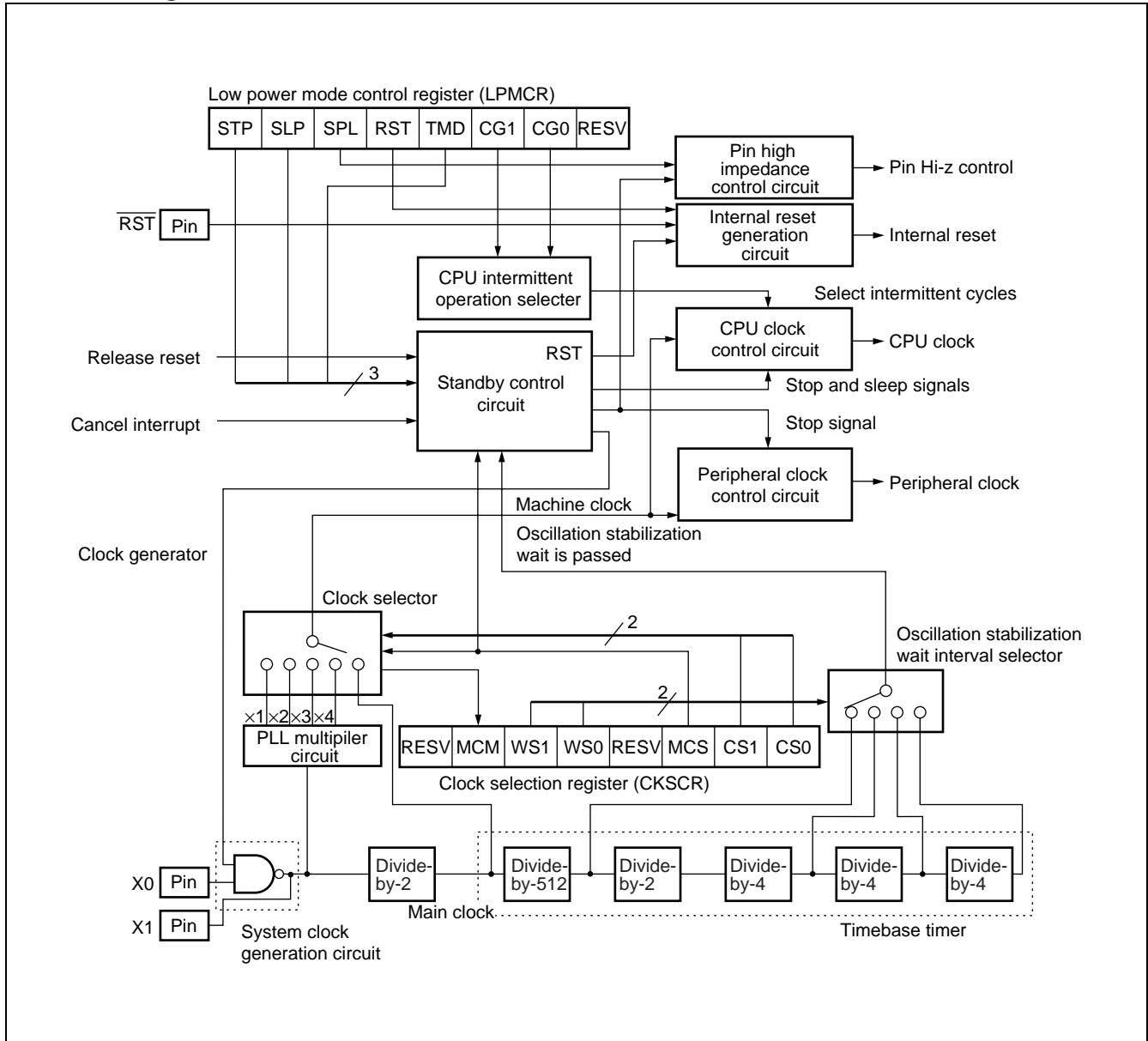
- Main timebase timer mode

Main timebase timer mode causes microcontroller operation, with the exception of the oscillation clock, main clock and the timebase timer, to stop. All functions other than the timebase timer are deactivated.

- Stop mode

Stop mode causes the source oscillation to stop. All functions are deactivated.

## Block Diagram



# MB90460 Series

## 2. I/O Ports

### (1) Outline of I/O ports

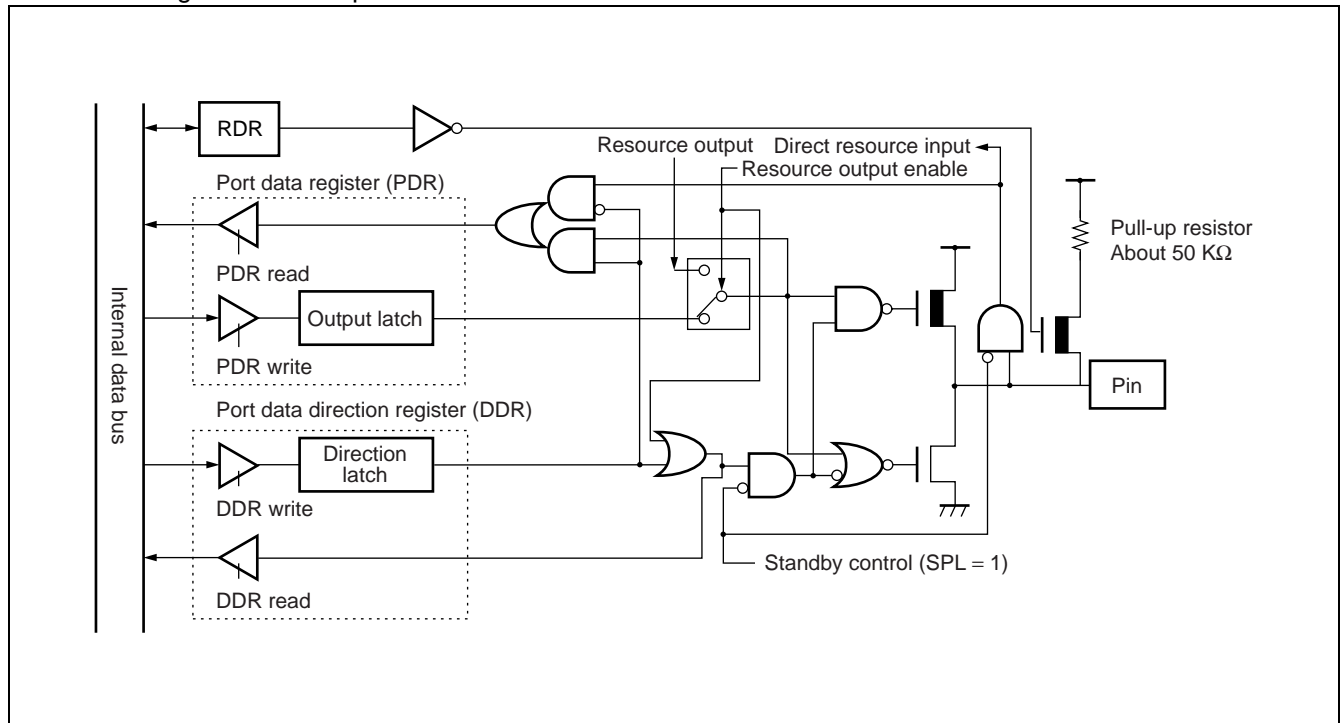
When a data register serving for control output is read, the data output from it as a control output is read regardless of the value in the direction register. Note that, if a read-modify-write instruction (such as a bit set instruction) is used to preset output data in the data register when changing its setting from input to output, the data read is not the data register latched value but the input data from the pin.

Ports 0 to 4 and 6 are input/output ports which serve as inputs when the direction register value is "0" or as outputs when the value is "1".

Port 5 are input/output ports as other port when ADER is 00H.

### Block Diagram

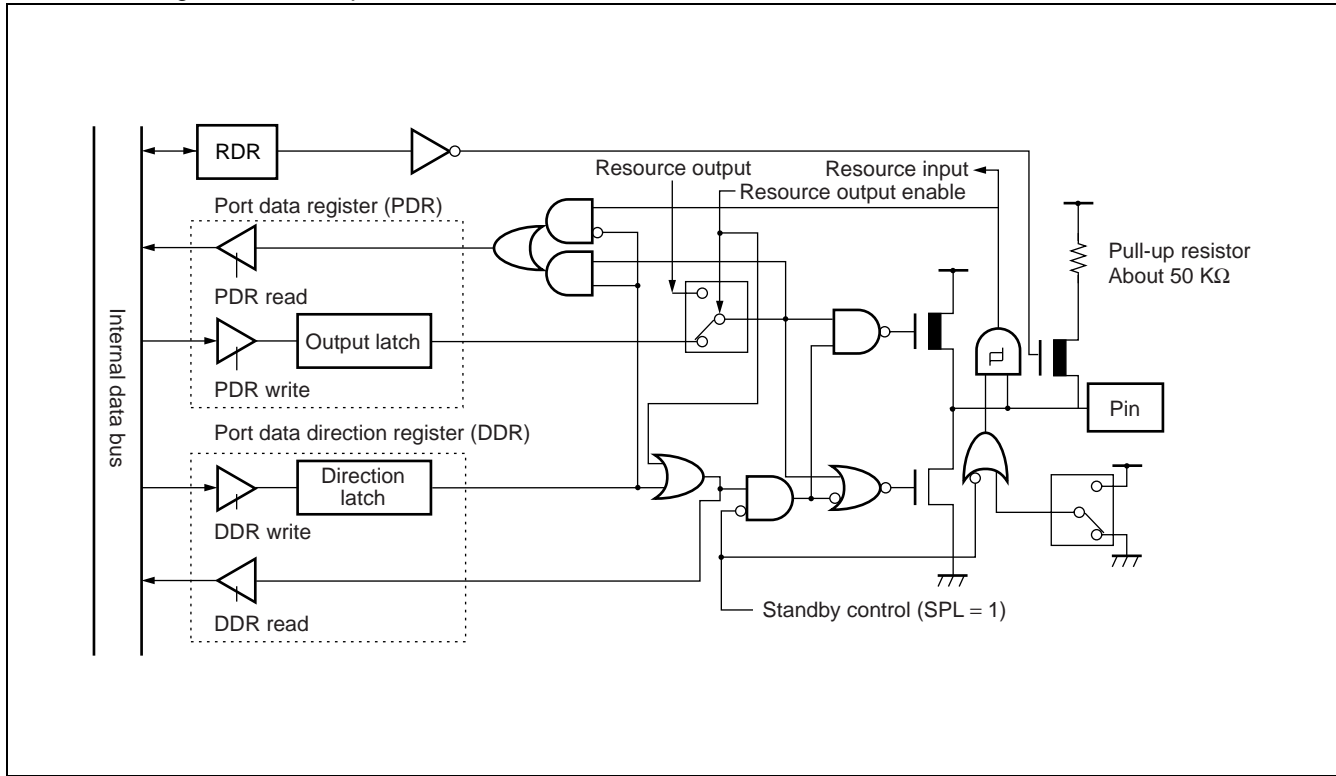
- Block diagram of Port 0 pins



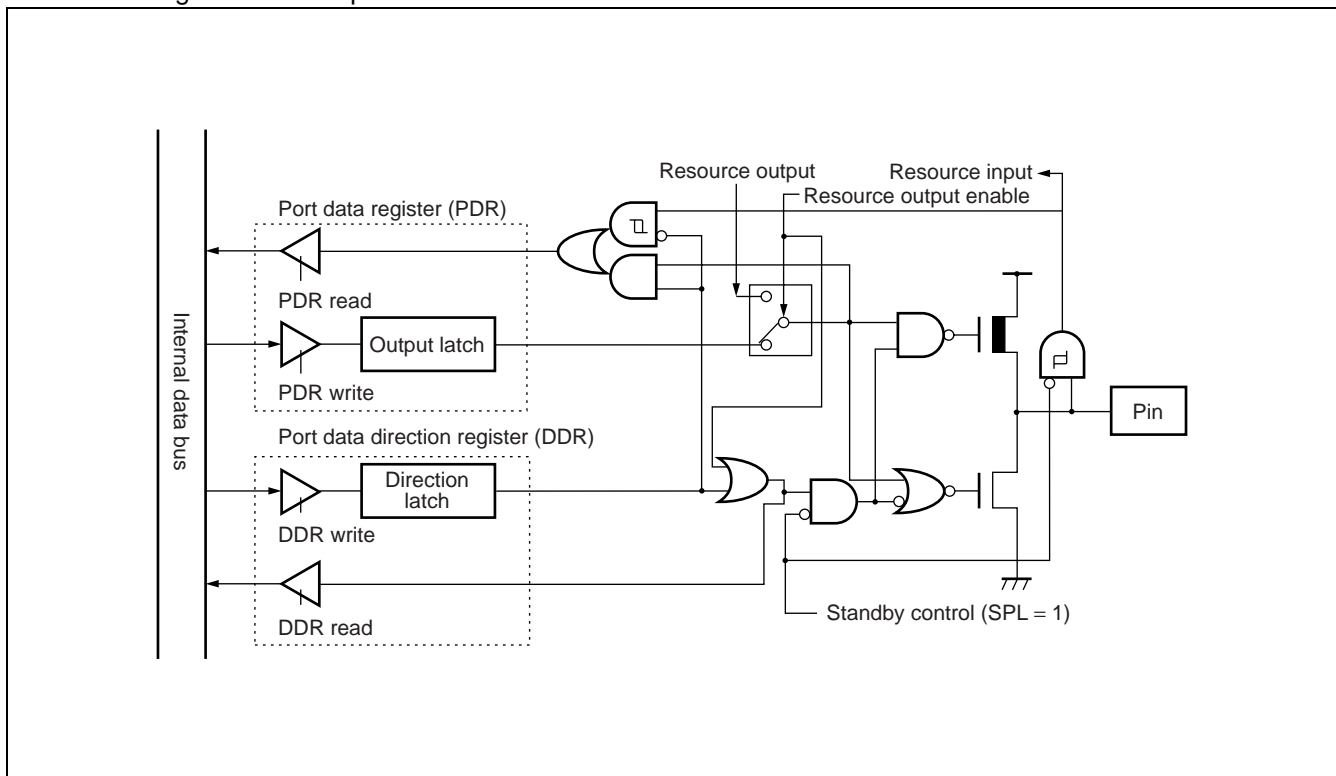
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• Block diagram of Port 1 pins



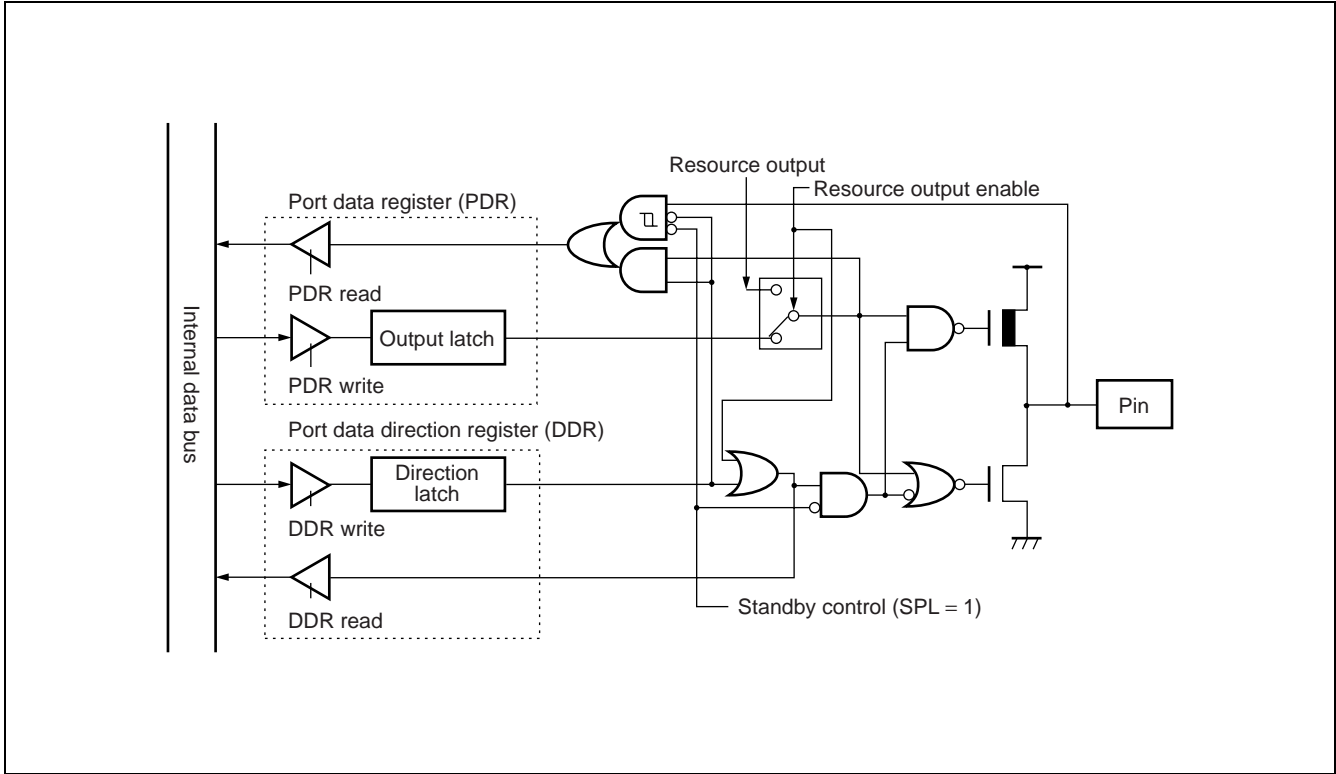
• Block diagram of Port 2 pins



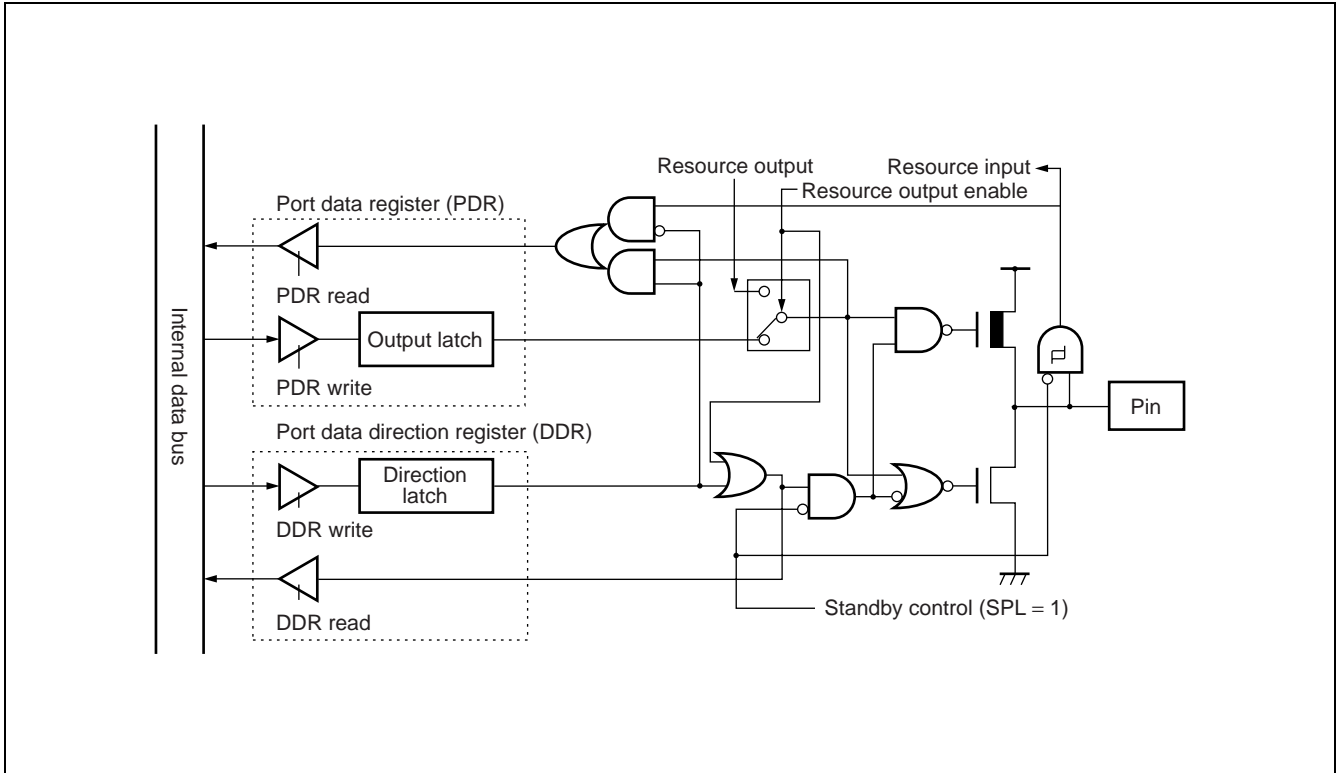
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# MB90460 Series

- Block diagram of Port 3 pins



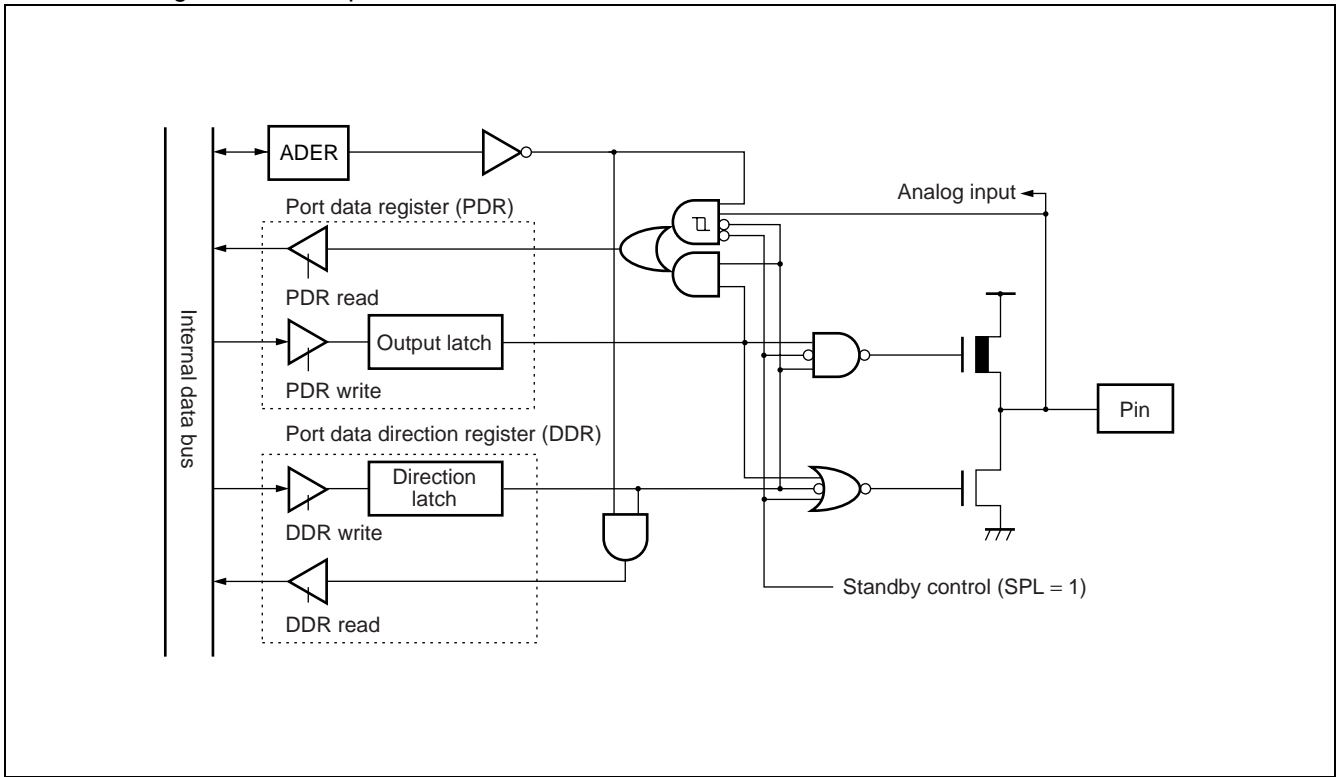
- Block diagram of Port 4 pins



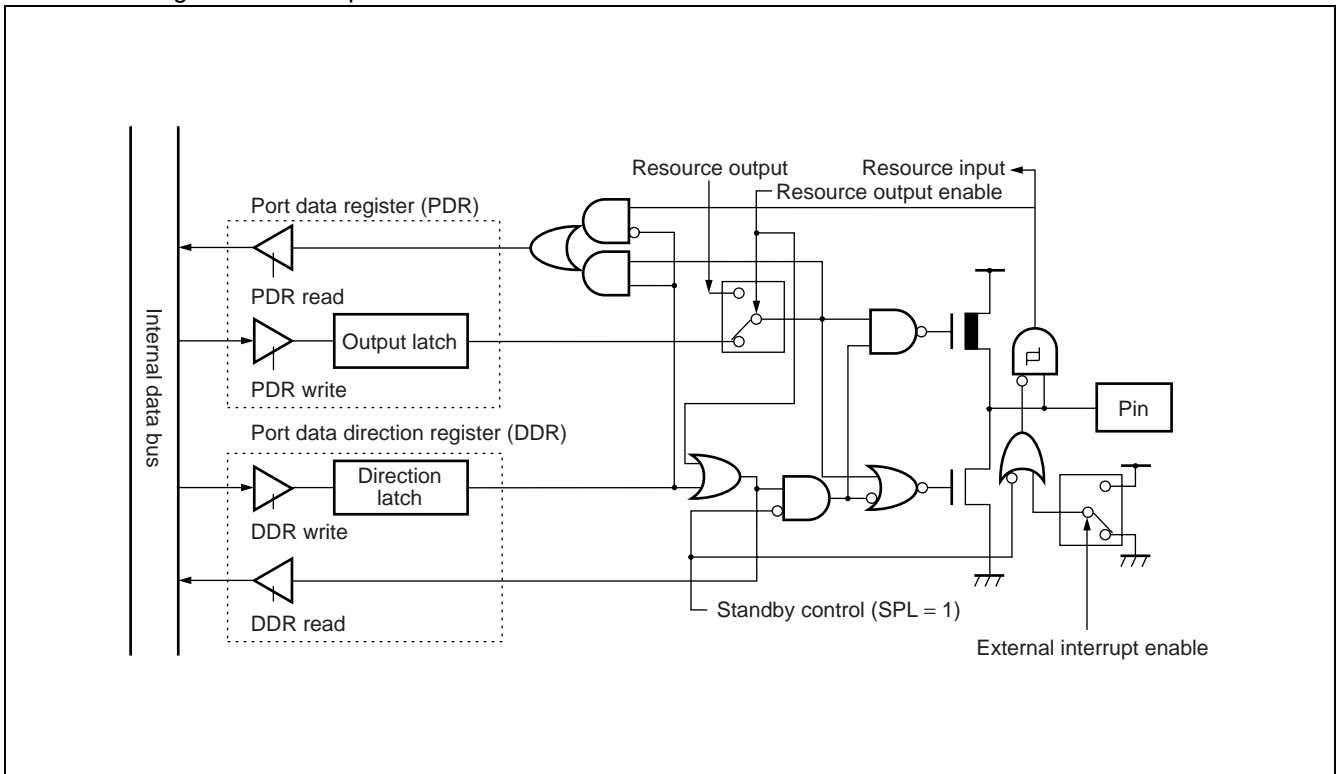
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- Block diagram of Port 5 pins



- Block diagram of Port 6 pins



# MB90460 Series

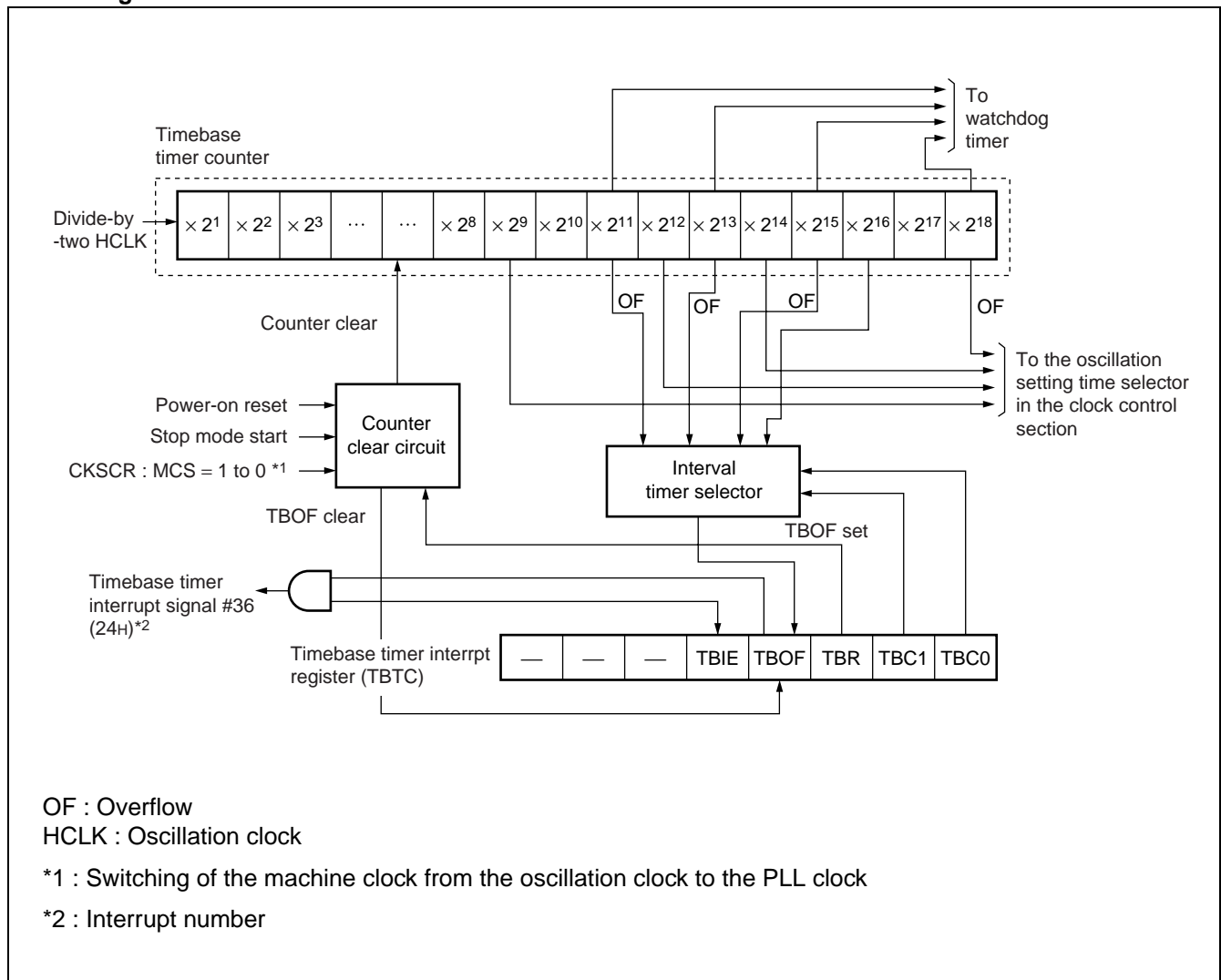
## 3. Timebase Timer

The timebase timer is an 18-bit free-running counter (timebase counter) that counts up in synchronization to the internal count clock (main oscillator clock divided by 2) .

Features of timebase timer :

- Interrupt generated when counter overflow
- EI<sup>2</sup>OS supported
- Interval timer function :  
An interrupt generated at four different time intervals
- Clock supply function :  
Four different clocks can be selected as a watchdog timer's count clock  
Supply clock for oscillation stabilization

### Block Diagram

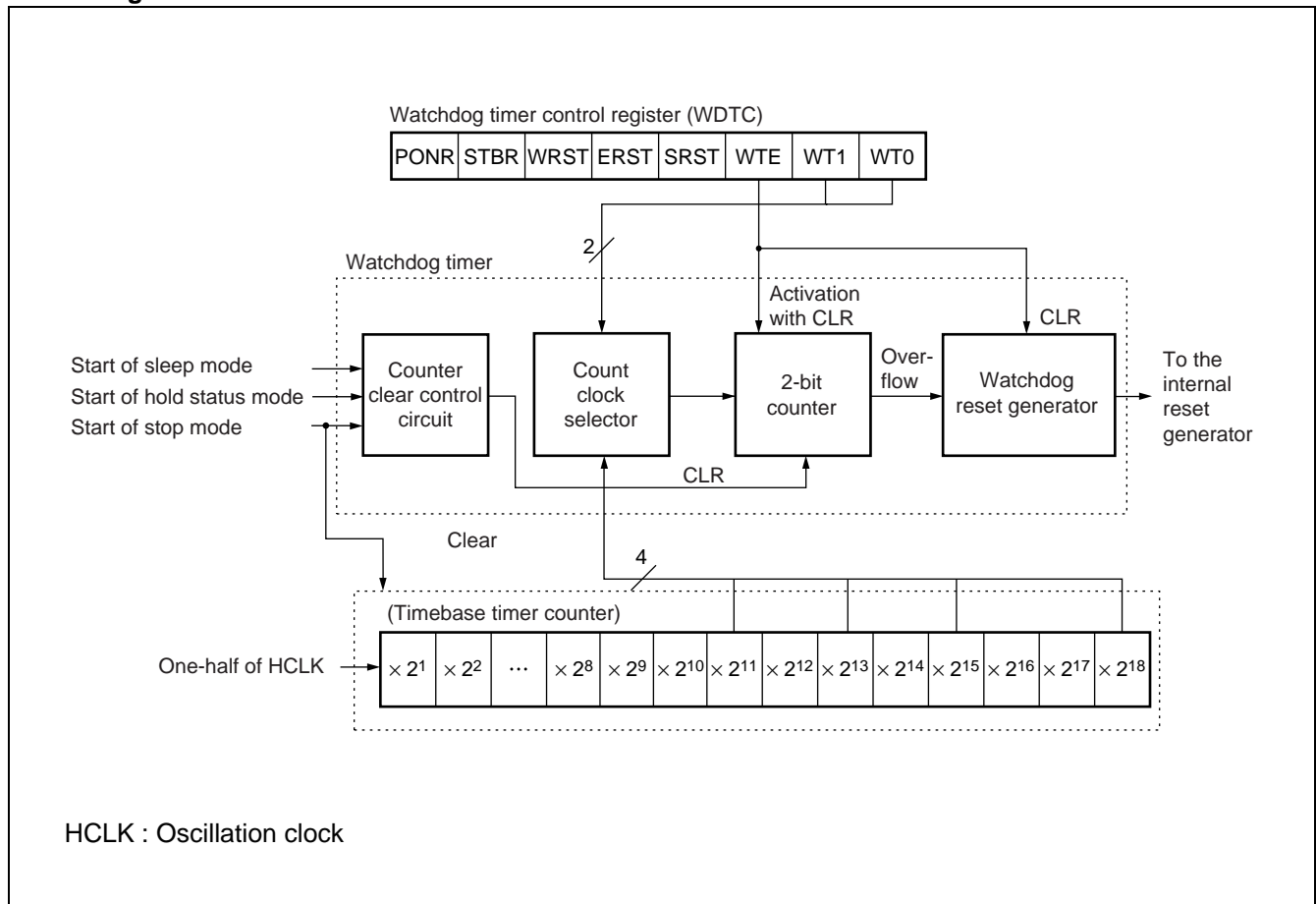


## 4. Watchdog Timer

The watchdog timer is a 2-bit counter that uses the timebase timer's supply clock as the count clock. After activation, if the watchdog timer is not cleared within a given period, the CPU will be reset.

- Features of Watchdog Timer :
  - Reset CPU at four different time intervals
  - Status bits to indicate the reset causes

### Block Diagram



## 5. 16 bit reload timer ( × 2)

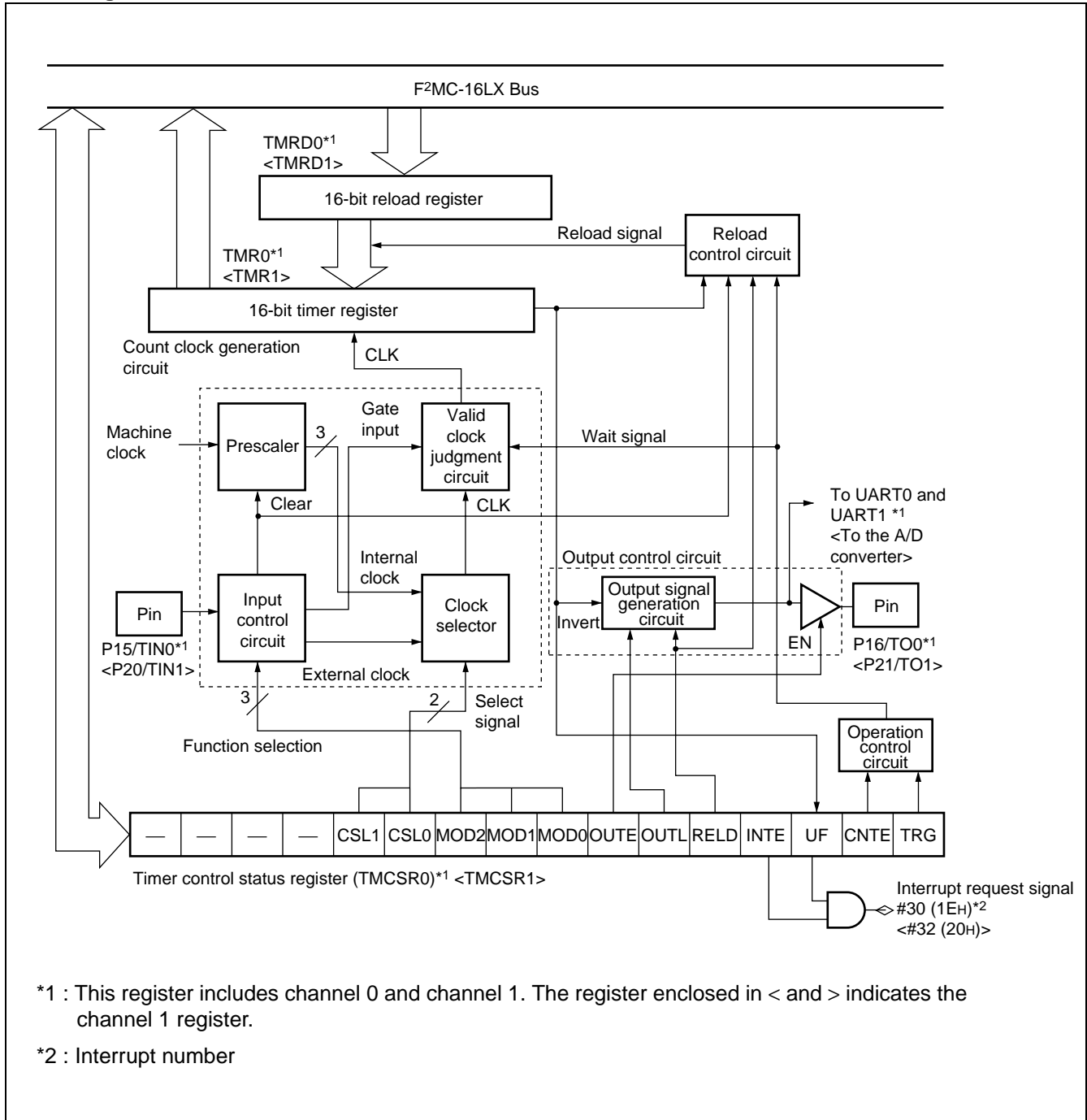
The 16-bit reload timer provides two operating mode, internal clock mode and event count mode. In each operating mode, the 16-bit down counter can be reloaded (reload mode) or stopped when underflow (one-shot mode) .

Output pins TO1 - TO0 are able to output different waveform according to the counter operating mode. TO1 - TO0 toggles when counter underflow if counter is operated as reload mode. TO1 - TO0 output specified level (H or L) when counter is counting if the counter is in one-shot mode.

Features of the 16 bit reload timer :

- Interrupt generated when timer underflow
- EI<sup>2</sup>OS supported
- Internal clock operating mode :
  - Three internal count clocks can be selected
  - Counter can be activated by software or external trigger (signal at TIN1 - TIN0 pin)
  - Counter can be reloaded or stopped when underflow after activated
- Event count operating mode :
  - Counter counts down by one when specified edge at TIN1 - TIN0 pin
  - Counter can be reloaded or stopped when underflow

## Block Diagram



\*1 : This register includes channel 0 and channel 1. The register enclosed in < and > indicates the channel 1 register.

\*2 : Interrupt number

# MB90460 Series

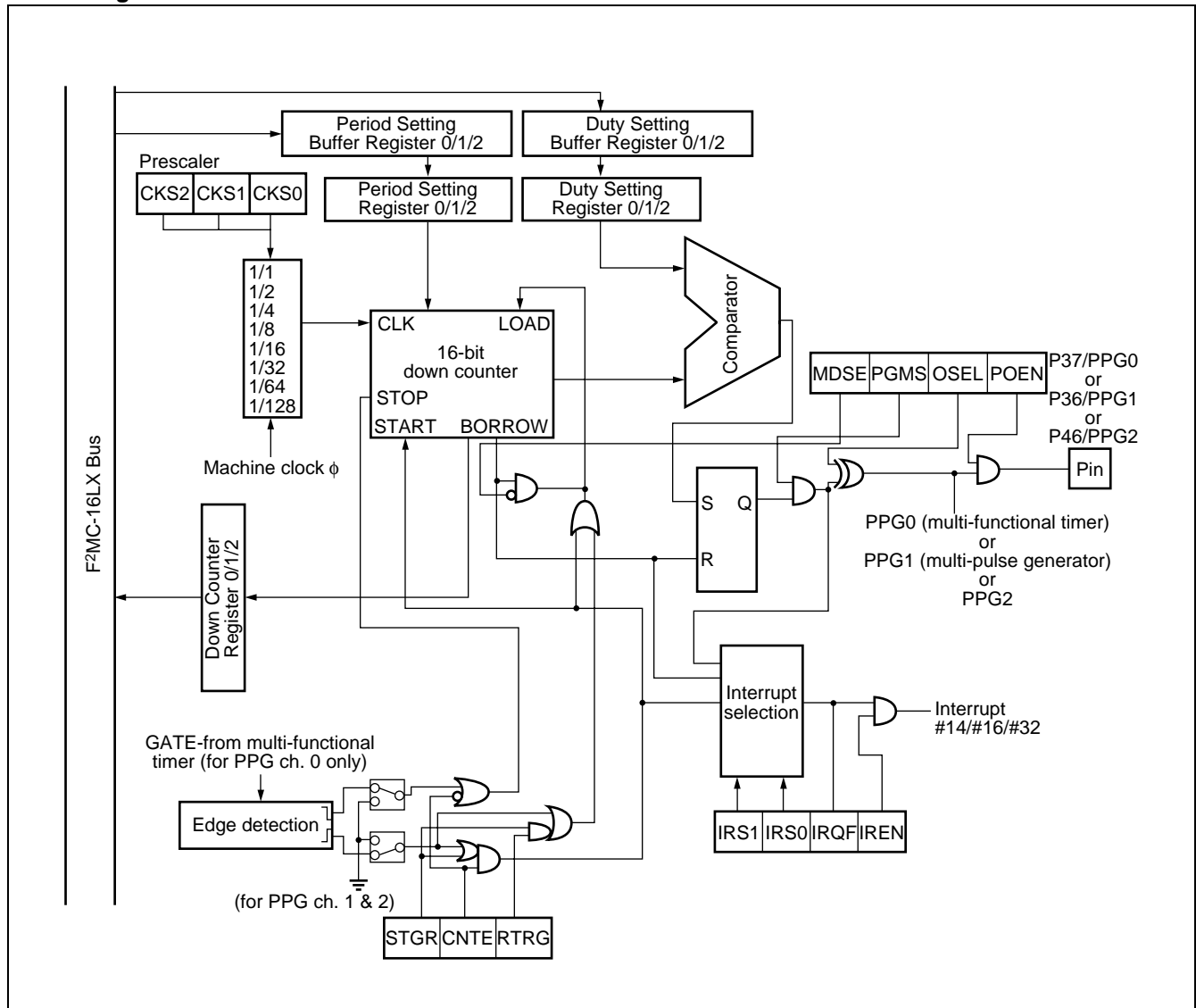
## 6. 16-bit PPG Timer ( × 3 )

The 16-bit PPG timer consists of a 16-bit down counter, prescaler, 16-bit period setting buffer register, 16-bit duty setting buffer register, 16-bit control register and a PPG output pin. This module can be used to output pulses synchronized by software trigger or GATE signal from Multi-functional timer, refer to "Multi-functional Timer"

Features of 16-bit PPG Timer :

- Two operating mode : PWM and One-shot
- 8 types of counter operation clock ( $\phi$ ,  $\phi/2$ ,  $\phi/4$ ,  $\phi/8$ ,  $\phi/16$ ,  $\phi/32$ ,  $\phi/64$ ,  $\phi/128$ ) can be selected
- Interrupt generated when trigger signal arrived, or counter borrow, or change of PPG output
- EI<sup>2</sup>OS supported

### Block Diagram





## 7. Multi-functional Timer

The 16-bit multi-functional timer module consists of one 16-bit free-running timer, four input capture circuits, six output comparators and one channel of 16-bit PPG timer. This module allows six independent waveforms generated by PPG timer or waveform generator to be outputted. With the 16-bit free-run timer and the input capture circuit, a input pulse width measurement and external clock cycle measurement can be done.

### (1) 16-bit free-running timer (1 channel)

- The 16-bit free-running timer consists of a 16-bit up/up-down counter, control register, 16-bit compare clear register (with buffer register) and a prescaler.
- 8 types of counter operation clock ( $\phi$ ,  $\phi/2$ ,  $\phi/4$ ,  $\phi/8$ ,  $\phi/16$ ,  $\phi/32$ ,  $\phi/64$ ,  $\phi/128$ ) can be selected. ( $\phi$  is the machine clock)
- Two types of interrupt causes :
  - Compare clear interrupt is generated when there is a comparing match with compare clear register and 16-bit free-run timer.
  - Zero detection interrupt is generated while 16-bit free-running timer is detected as zero in count value.
- EI<sup>2</sup>OS supported
- The compare clear register has a selectable buffer register, into which data is written for transfer to the compare clear register. When the timer is stopped, transfer occurs immediately when the data is written to the buffer. When the timer is operation, data transfer from the buffer occurs when the timer value is detected to be zero.
- Reset, software clear, compare match with compare clear register in up-count mode will reset the counter value to "0000H".
- Supply clock to output compare module :  
The prescaler output is acted as the count clock of the output compare.

### (2) Output compare module (6 channels)

- The output compare module consists of six 16-bit compare registers (with selectable buffer register) , compare output latch and compare control registers. An interrupt is generated and output level is inverted when the value of 16-bit free-running timer and compare register are matched.
- 6 compare registers can be operated independently.
- Output pins and interrupt flag are corresponding to each compare register.
- Inverts output pins by using 2 compare registers together. 2 compare registers can be paired to control the output pins.
- Setting the initial value for each output pin is possible.
- Interrupt generated when there is a comparing match with output compare register and 16 bit free-run timer
- EI<sup>2</sup>OS supported

### (3) Input capture module (4 channels)

Input capture consists of 4 independent external input pins, the corresponding capture register and capture control register. By detecting any edge of the input signal from the external pin, the value of the 16-bit free-running timer can be stored in the capture register and an interrupt is generated simultaneously.

- Operation synchronized with the 16-bit free-run timer's count clock.
- 3 types of trigger edge (rising edge, falling edge and both edge) of the external input signal can be selected and there is indication bit to show the trigger edge is rising or falling.
- 4 input captures can be operated independently.
- Two independent interrupts are generated when detecting a valid edge from external input.
- EI<sup>2</sup>OS supported

### (4) 16-bit PPG timer ( × 1)

The 16-bit PPG timer 0 is used to provide a PPG signal for waveform generator.

# MB90460 Series

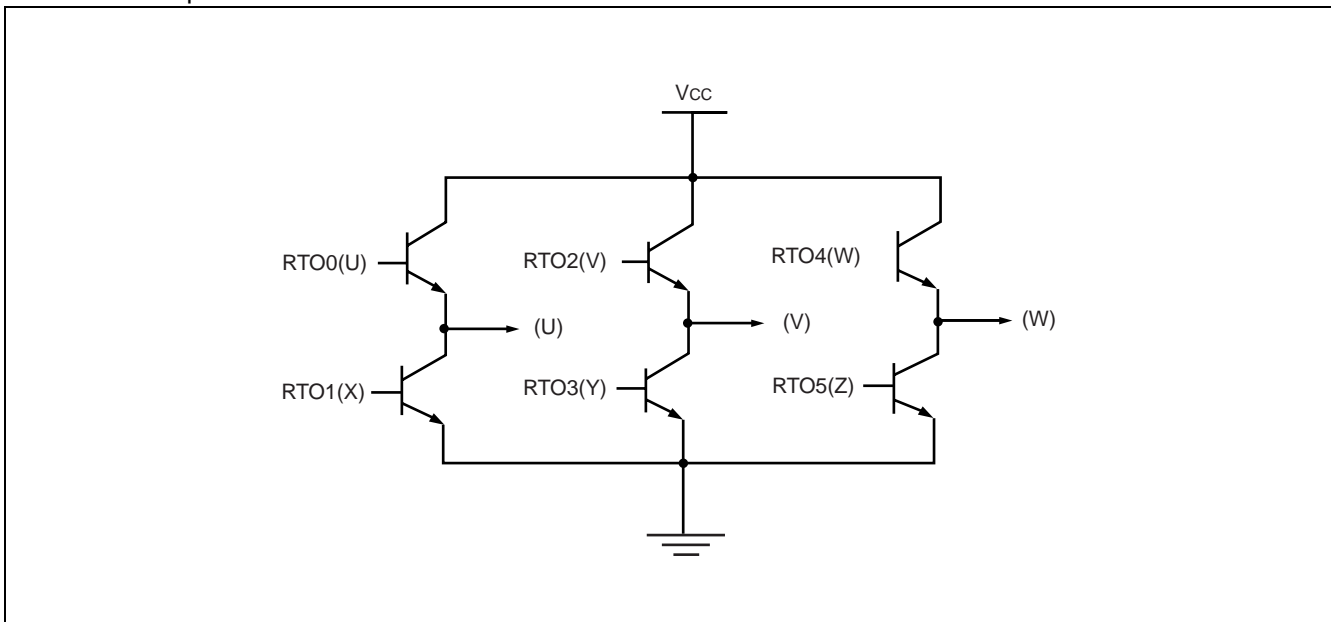
## (5) Waveform Generator module

The waveform generator consists of three 16-bit timer registers, three timer control registers and 16-bit waveform control register.

With waveform generator, it is possible to generate real time output, 16-bit PPG waveform output, non-overlap 3-phase waveform output for inverter control and DC chopper waveform output.

- It is possible to generate a non-overlap waveform output based on dead-time of 16-bit timer. (Dead-time timer function)
- It is possible to generate a non-overlap waveform output when realtime output is operated in 2-channel mode. (Dead-time timer function)
- By detecting realtime output compare match, GATE signal of the PPG timer operation will be generated to start or stop PPG timer operation. (GATE function)
- When a match is detected by realtime output compare, the 16-bit timer is activated. The PPG timer can be started or stopped easily by generating a GATE signal for PPG operation until the 16-bit timer stops. (GATE function)
- Forced to stop output waveform using DTTI0 pin input
- Interrupt generated when DTTI0 active or 16-bit timer underflow
- EI<sup>2</sup>OS supported

- MCU to 3-phase Motor Interface Circuit



RTO0 (U) , RTO2 (V) , RTO4 (W) are called “UPPER ARM”.

RTO1 (X) , RTO3 (Y) , RTO5 (Z) are called “LOWER ARM”.

RTO0 (U) and RTO1 (X) are called “non-overlapping output pair”.

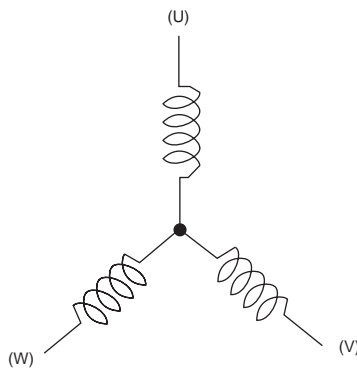
RTO2 (V) and RTO3 (Y) are called “non-overlapping output pair”.

RTO4 (W) and RTO5 (Z) are called “non-overlapping output pair”.

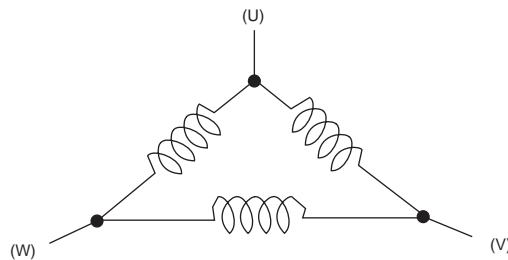
(U) , (V) , (W) are the 3-phase coil connection.

- 3-phase Motor Coil Connection Circuit

Star Connection Circuit



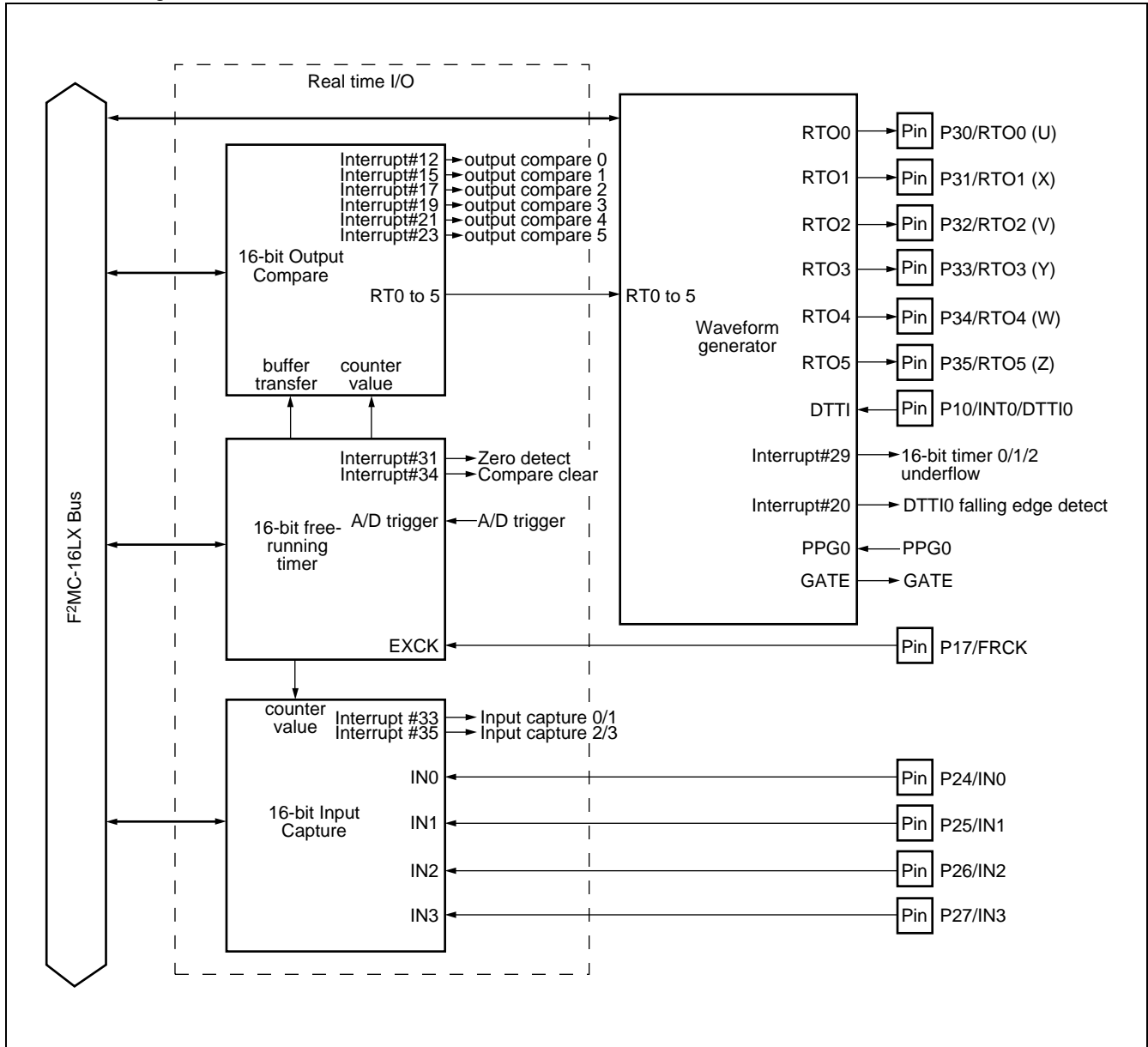
Delta Connection Circuit



# MB90460 Series

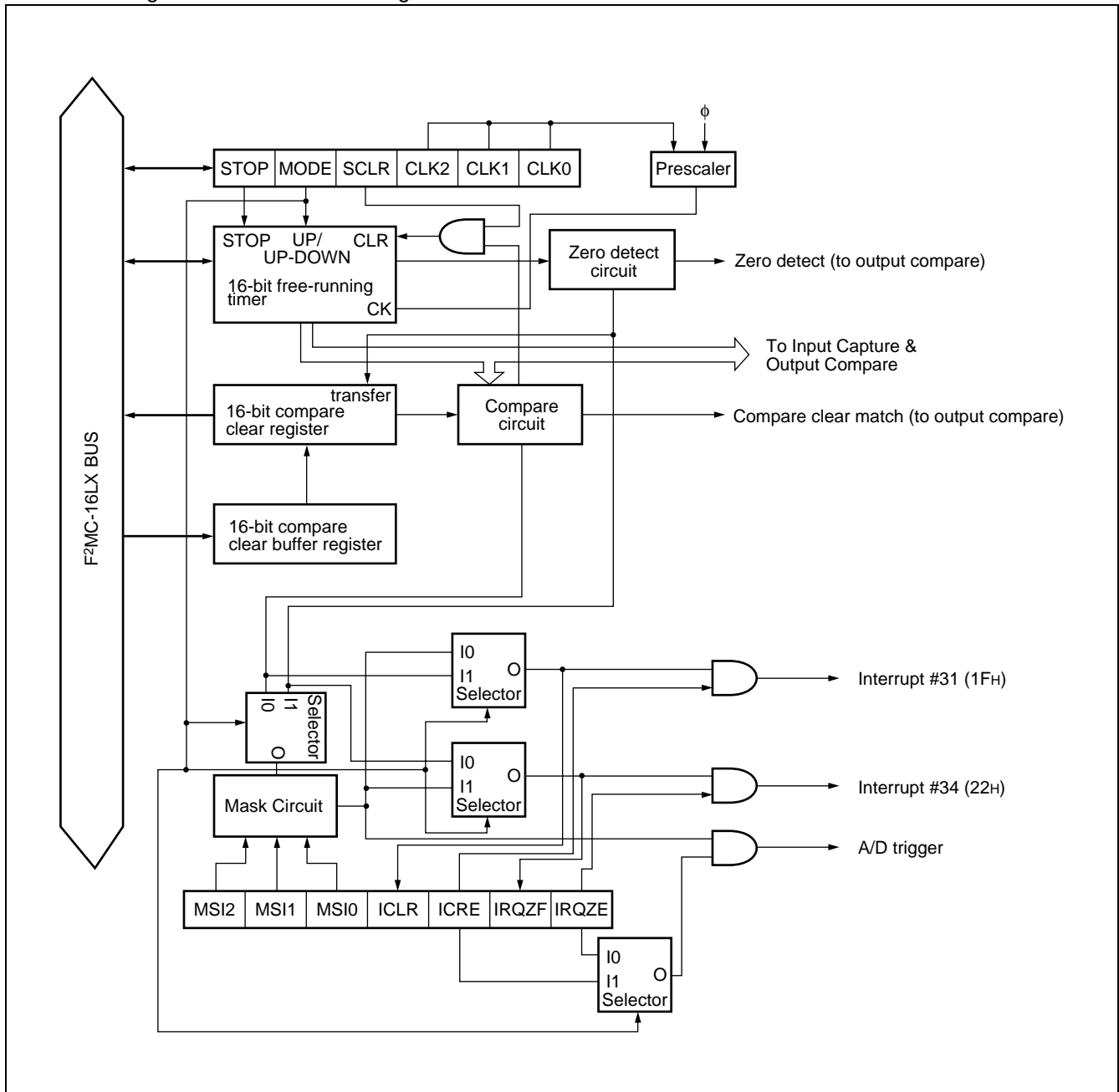
## Block Diagram

- Block Diagram of Multi-functional Timer



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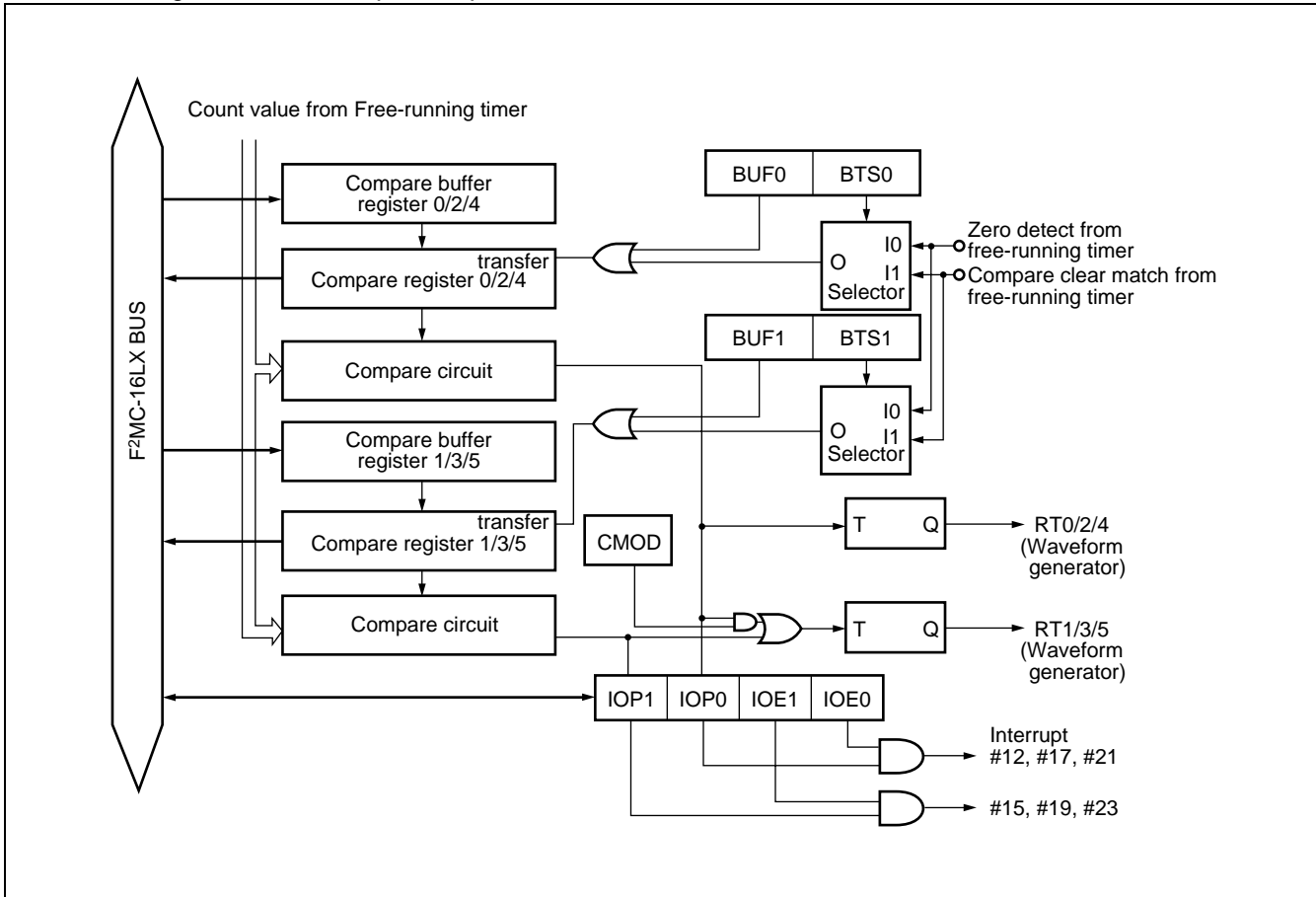
• Block diagram of 16-bit free-running timer



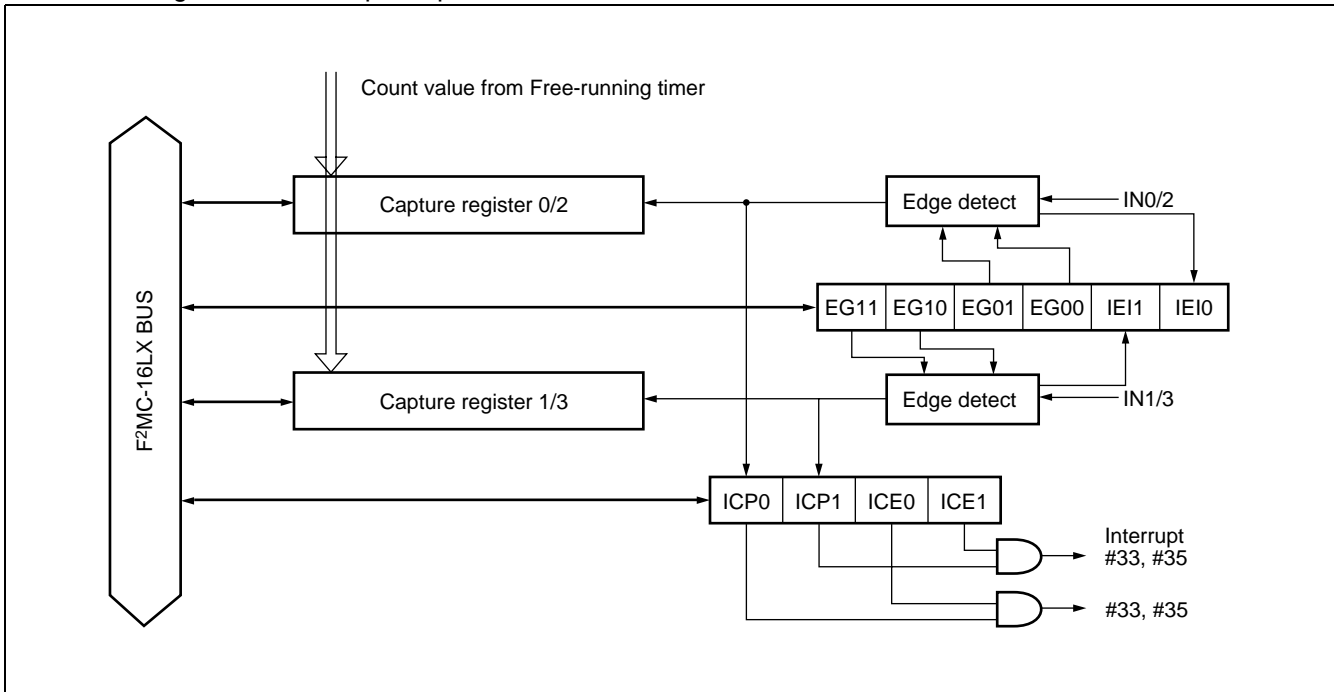
(Continued)

# MB90460 Series

• Block diagram of 16-bit output compare



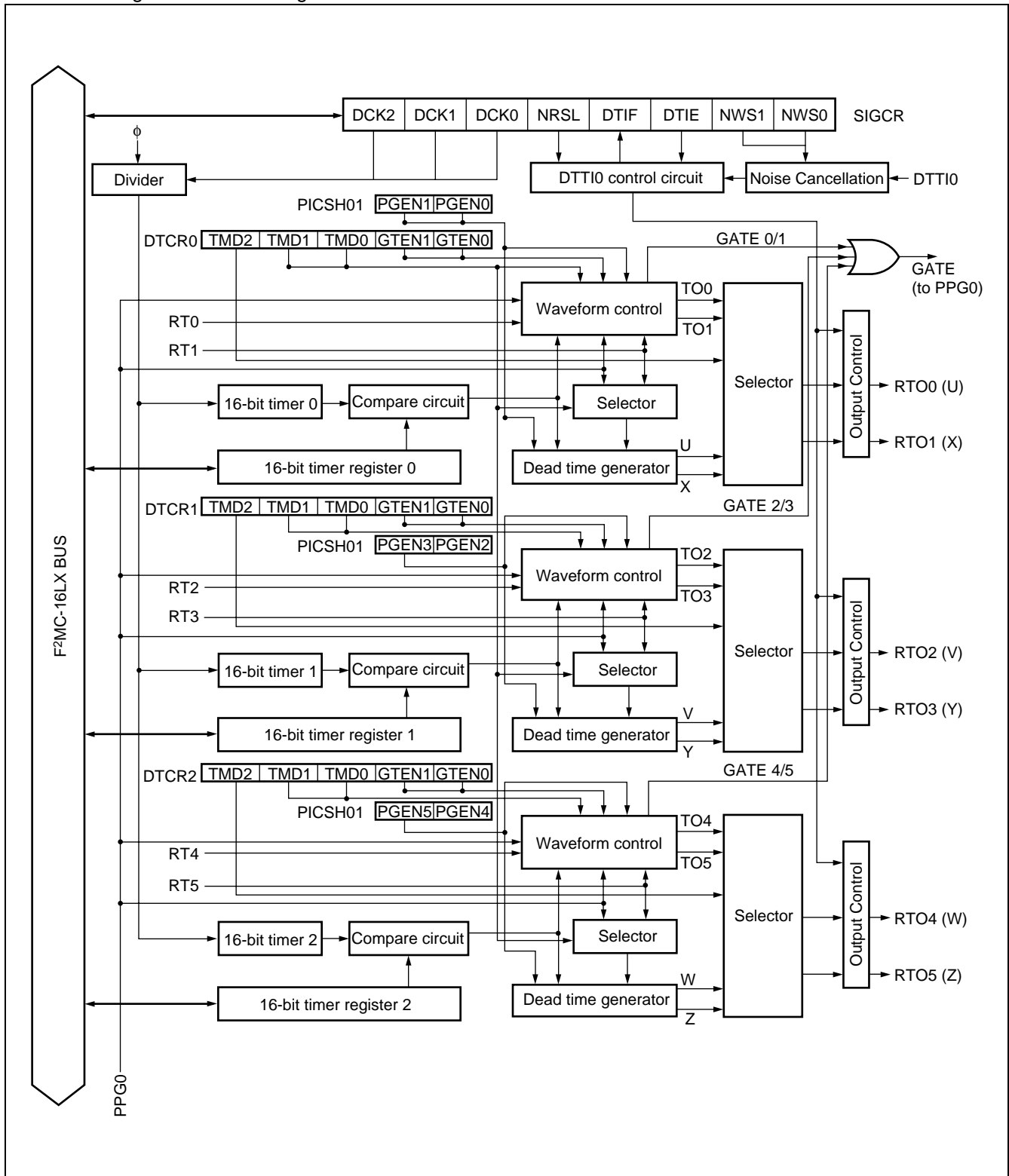
• Block diagram of 16-bit input capture



(Continued)

(Continued)

- Block diagram of waveform generator



## 8. Multi-Pulse Generator

The Multi-pulse Generator consists of a 16-bit PPG timer, a 16-bit reload timer and a waveform sequencer. By using the waveform sequencer, 16-bit PPG timer output signal can be directed to Multi-pulse Generator output (OPT5 to 0) according to the input signal of Multi-pulse Generator (SNI2 to 0). Meanwhile, the OPT5 to 0 output signal can be hardware terminated by DTTI input (DTTI1) in case of emergency. The OPT5 to 0 output signals are synchronized with the PPG signal in order to eliminate the unwanted glitch.

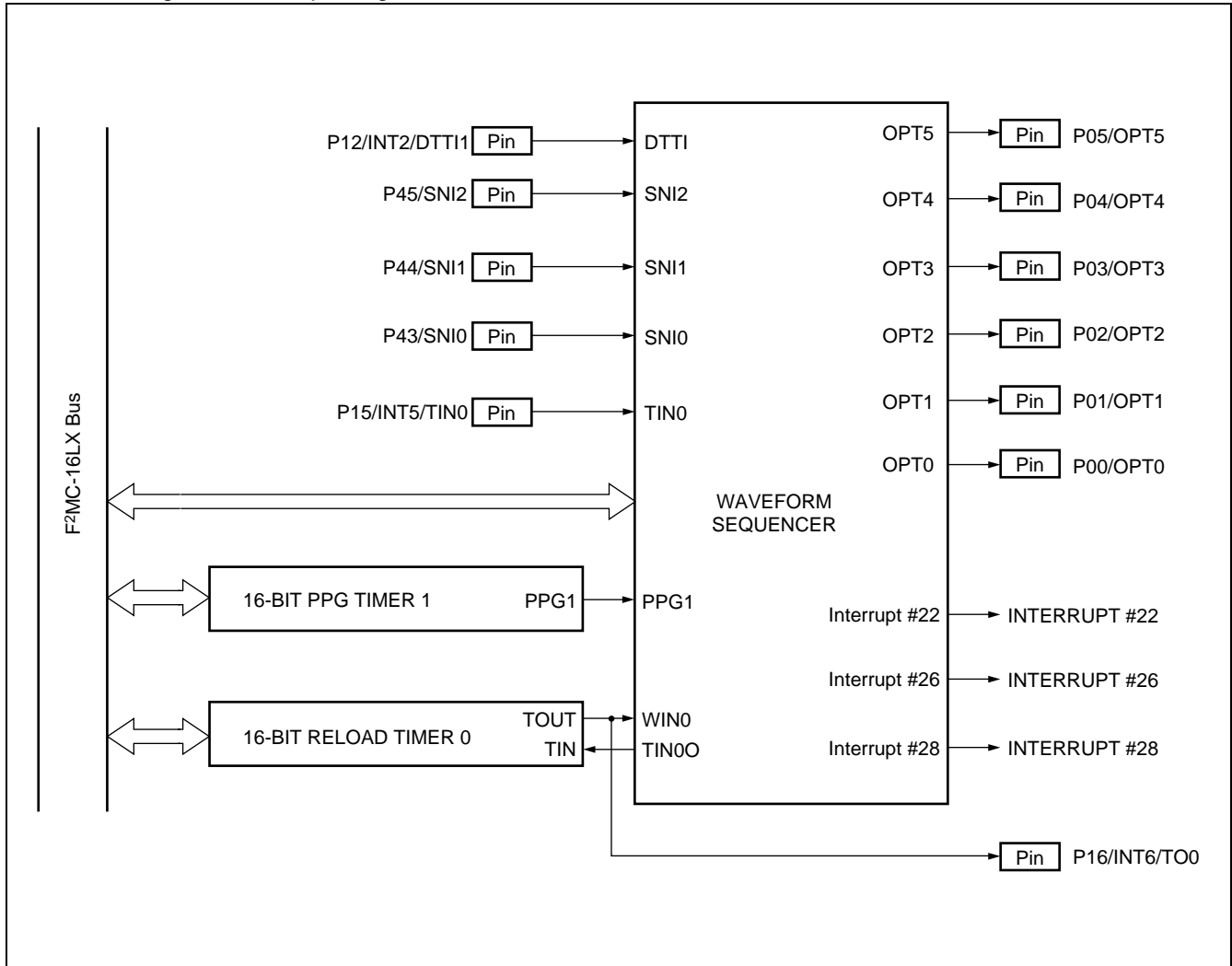
The Multi-pulse generator has the following features :

- Output Signal Control
  - 12 output data buffer registers are provided
  - Output data register can be updated by any one of output data buffer registers when :
    1. an effective edge detected at SNI2 - SNI0 pin
    2. 16-bit reload timer underflow
    3. output data buffer register OPDBR0 is written
- Output data register (OPDR) determines which OPT terminals (OPT5 - 0) output the 16-bit PPG waveform
  - Waveform sequencer is provided with a 16-bit timer to measure the speed of motor
  - The 16-bit timer can be used to disable the OPT output when the position detection is missing
- Input Position Detect Control
  - SNI2 - SNI0 input can be used to detect the rotor position
  - A controllable noise filter is provided to the SNI2 - SNI0 input
- PPG Synchronization for Output signal
  - OPT output is able to synchronize the edge of PPG waveform to avoid a short pulse (or glitch) appearance
- Various interrupt generation causes
- EI<sup>2</sup>OS supported



## Block Diagram

- Block diagram of Multi-pulse generator

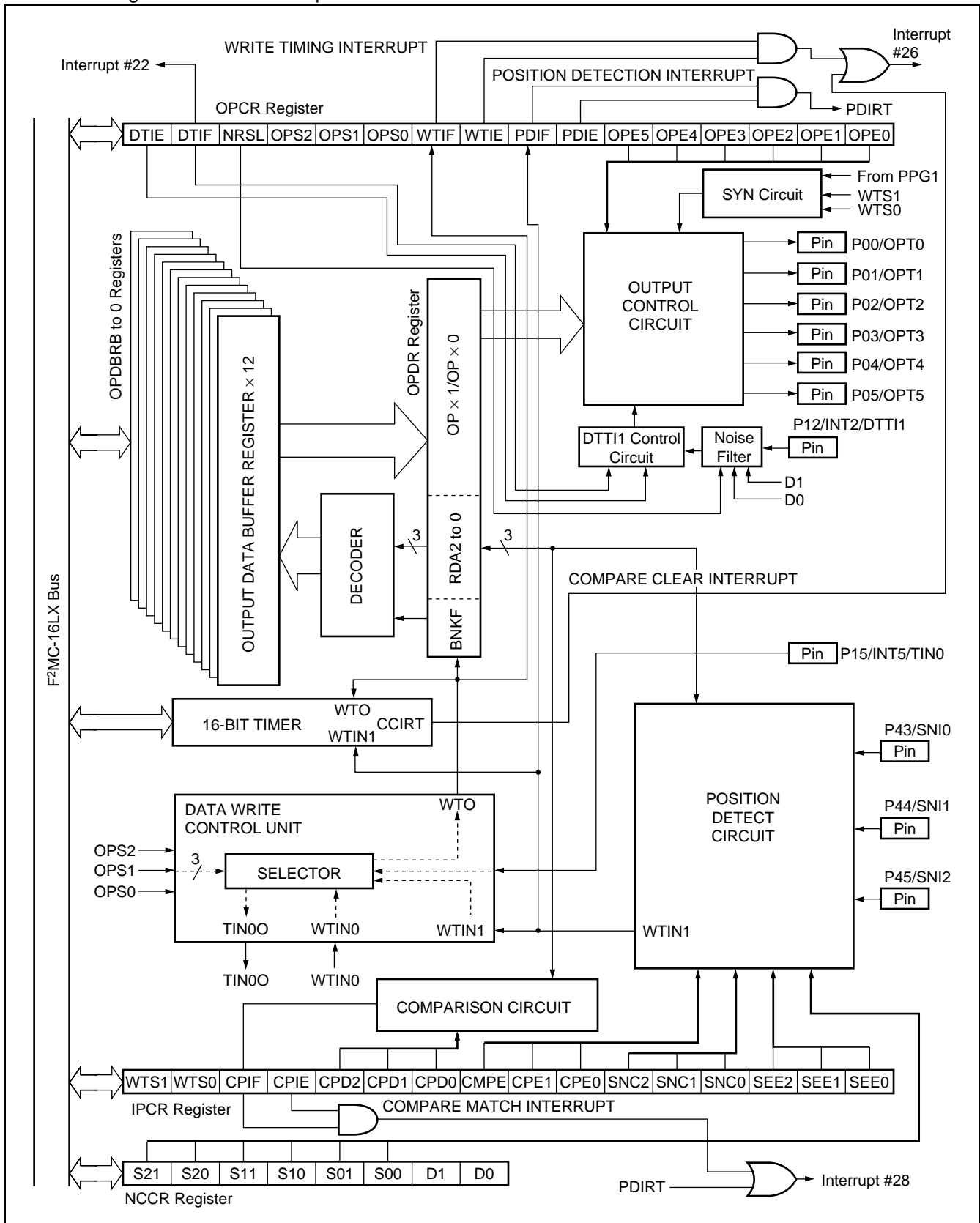


(Continued)

# MB90460 Series

(Continued)

- Block diagram of waveform sequencer



## 9. PWC Timer

The PWC (pulse width count) timer is a 16-bit multi-function up-counter with reload timer functions and input-signal pulse-width count functions as well.

The PWC timer consists of a 16-bit counter, an input pulse divider, a divide ratio control register, a count input pin, a pulse output pin, and a 16-bit control register.

The PWC timer has the following features :

- Interrupt generated when timer overflow or end of PWC measurement.
- EI<sup>2</sup>OS supported
- Timer functions :
  - Generates an interrupt request at set time intervals.
  - Outputs pulse signals synchronized with the timer cycle.
  - Selects the counter clock from among three internal clocks.
- Pulse-width count functions
  - Counts the time between external pulse input events.
  - Selects the counter clock from among three internal clocks.
  - Count mode
    - H pulse width (rising edge to falling edge) /L pulse width (falling edge to rising edge)
    - Rising-edge cycle (rising edge to falling edge) /Falling-edge cycle (falling edge to rising edge)
    - Count between edges (rising or falling edge to falling or rising edge)

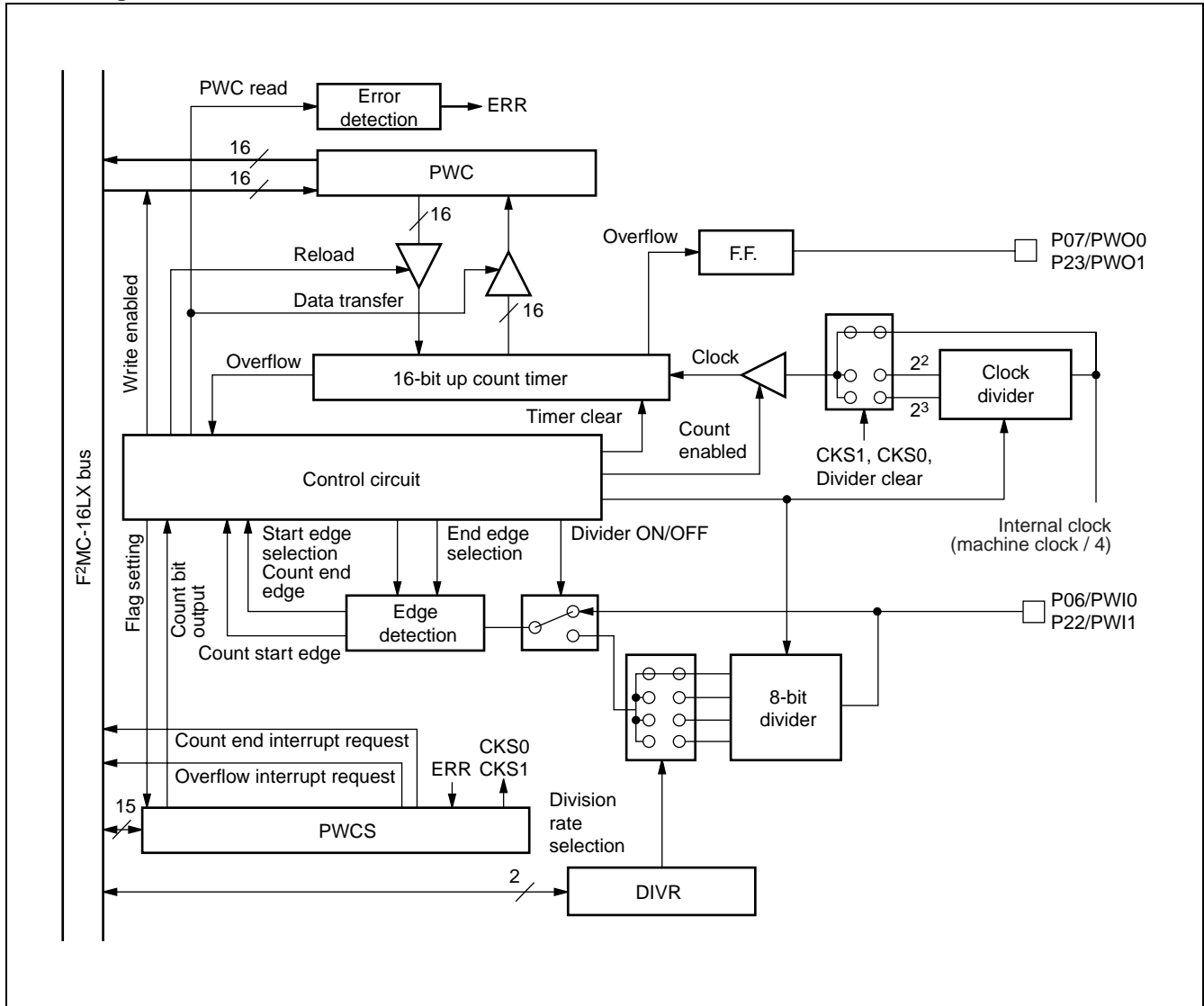
Capable of counting cycles by dividing input pulses by  $2^2$ ,  $2^4$ ,  $2^6$ ,  $2^8$  using an 8-bit input divider.

Generates an interrupt request upon the completion of count operation.

Selects single or consecutive count operation.

# MB90460 Series

## Block Diagram



## 10. UART

The UART is a serial I/O port for asynchronous (start-stop) communication or clock-synchronous communication.

The UART has the following features :

- Full-duplex double buffering
- Capable of asynchronous (start-stop bit) and CLK-synchronous communications
- Support for the multiprocessor mode
- Various method of baud rate generation :
  - External clock input possible
  - Internal clock (a clock supplied from 16-bit reload timer can be used.)
  - Embedded dedicated baud rate generator

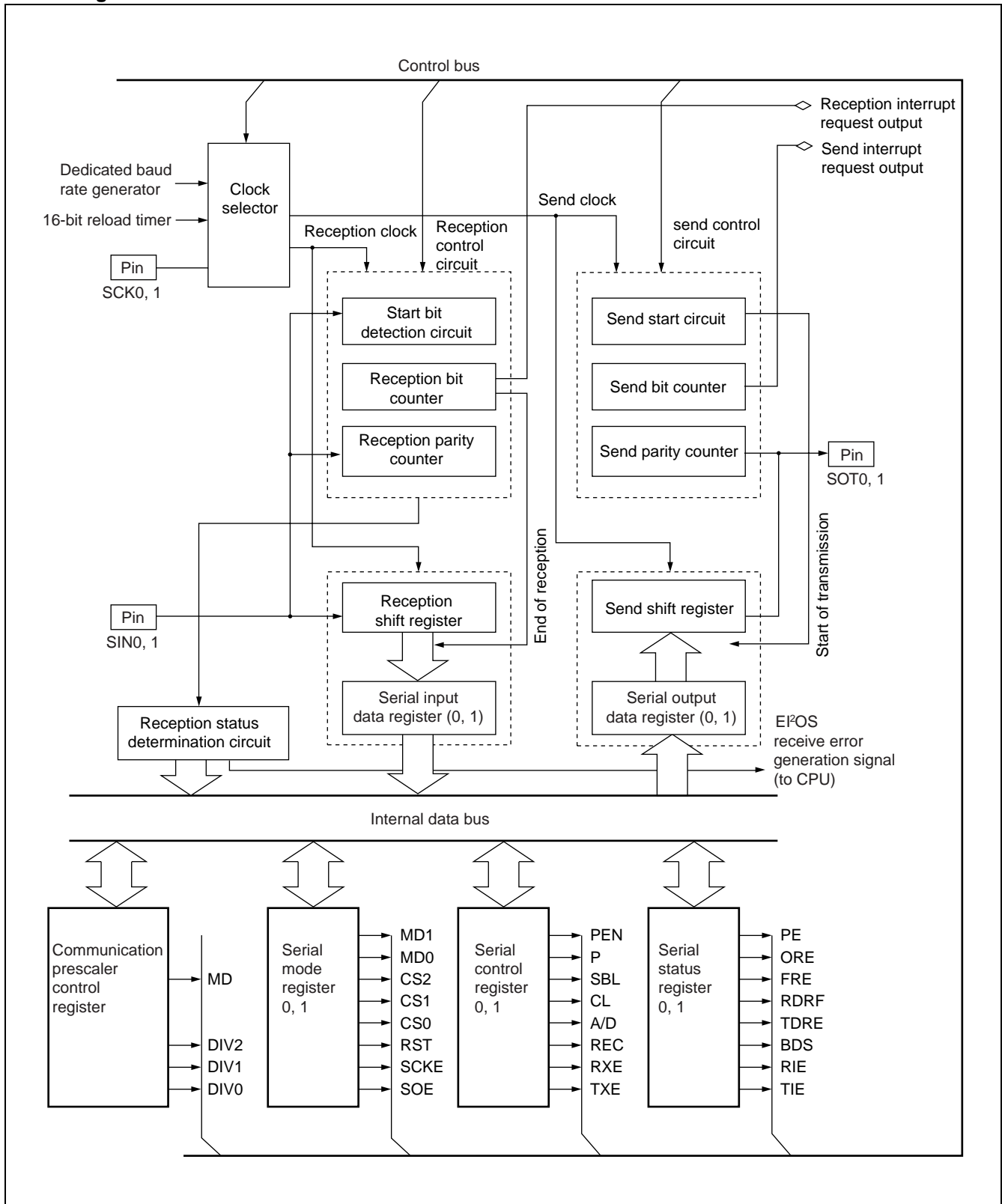
| Operation       | Baud rate                           |
|-----------------|-------------------------------------|
| Asynchronous    | 31250/9615/4808/2404/1202 bps       |
| CLK synchronous | 2 M/1 M/500 K/250 K/125 K/62.5 Kbps |

\* : Assuming internal machine clock frequencies of 6, 8, 10, 12, and 16 MHz

- Error detection functions (parity, framing, overrun)
- NRZ (Non Return to Zero) Signal format
- Interrupt request :
  - Receive interrupt (receive complete, receive error detection)
  - Transmit interrupt (transmission complete)
  - Transmit / receive conforms to extended intelligent I/O service (EI<sup>2</sup>OS)
- Flexible data length :
  - 7 bit to 9 bit selective (without a parity bit)
  - 6 bit to 8 bit selective (with a parity bit)

# MB90460 Series

## Block Diagram



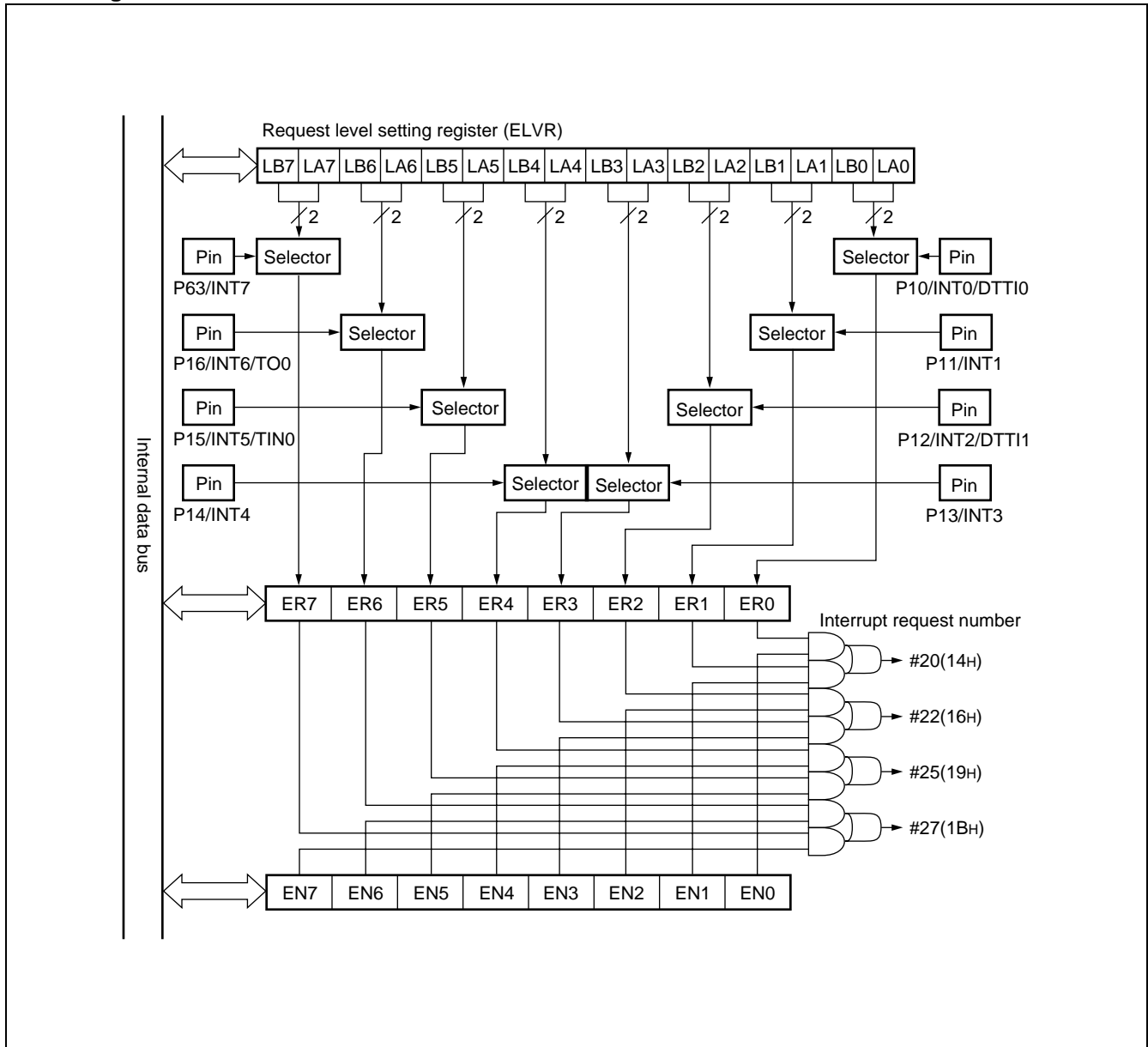
## 11. DTP/External Interrupts

The DTP/external interrupt circuit is activated by the signal supplied to a DTP/external interrupt pin. The CPU accepts the signal using the same procedure it uses for normal hardware interrupts and generates external interrupts or activates the extended intelligent I/O service (EI<sup>2</sup>OS) .

Features of DTP/External Interrupt :

- Total 8 external interrupt channels
- Two request levels (“H” and “L”) are provided for the intelligent I/O service.
- Four request levels (rising edge, falling edge, “H” level and “L” level) are provided for external interrupt requests.

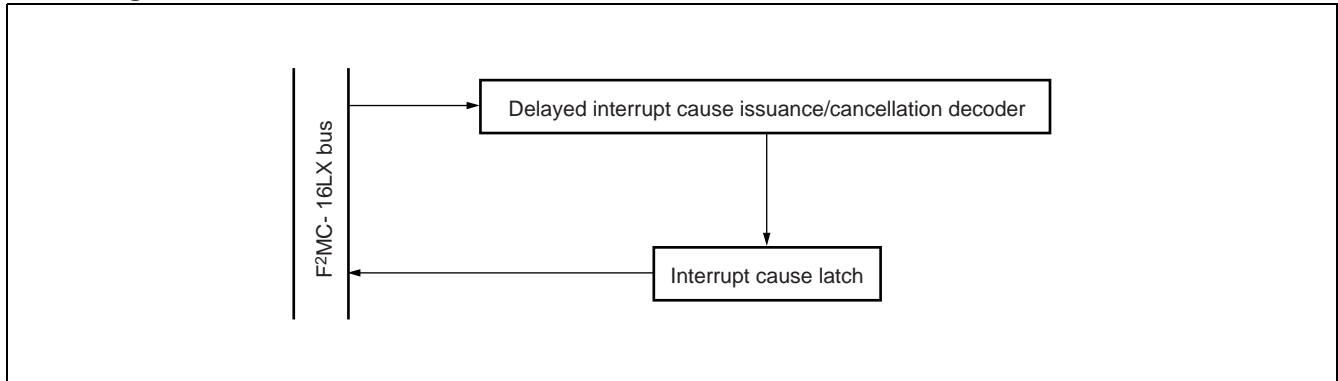
### Block Diagram



## 12. Delayed Interrupt Generation Module

The delayed interrupt generation module is used to generate a task switching interrupt. Interrupt requests to the F<sup>2</sup>MC-16LX CPU can be generated and cleared by software using this module.

### Block Diagram





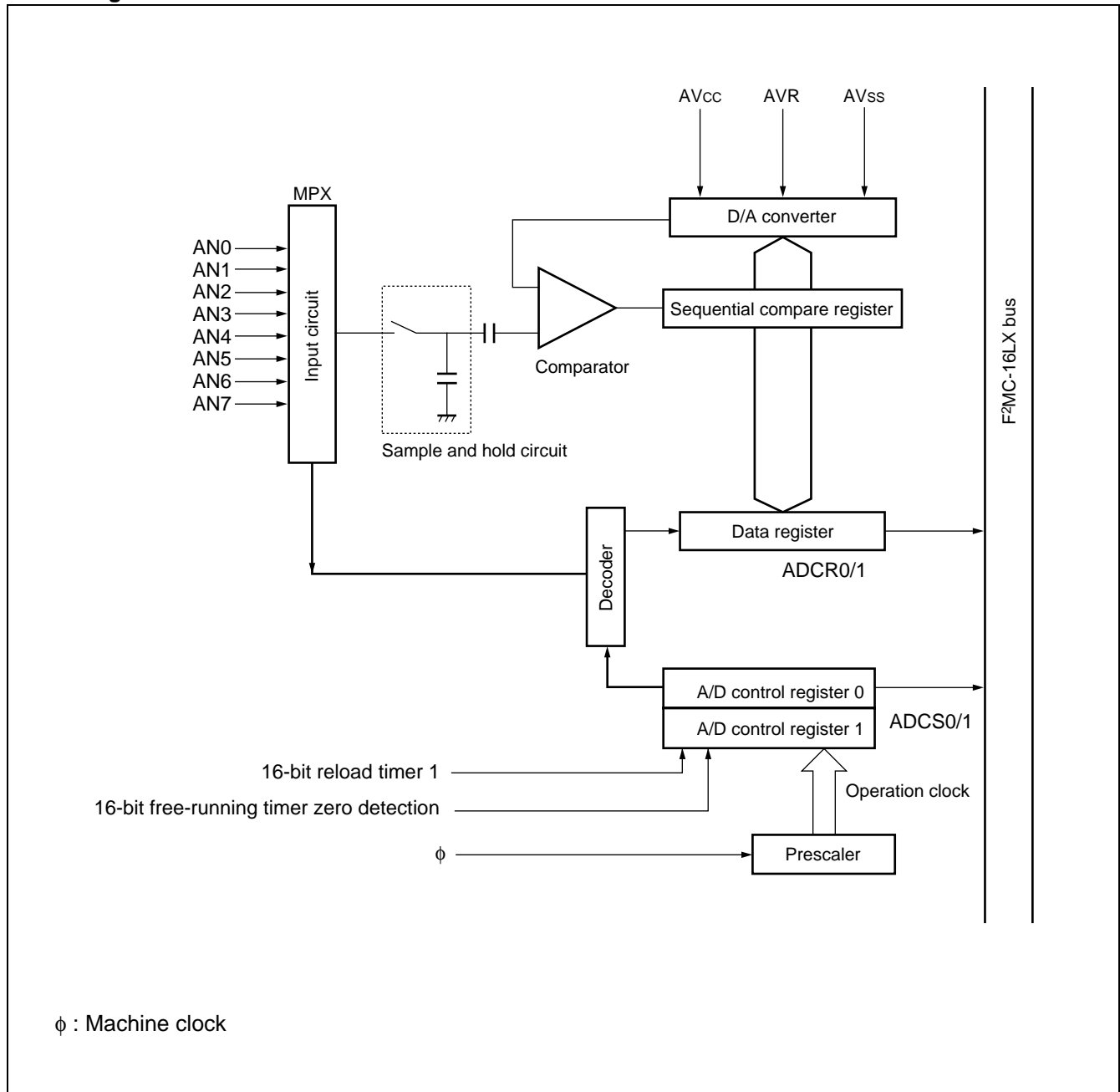
## 13. A/D Converter

The converter converts the analog voltage input to an analog input pin (input voltage) to a digital value. The converter has the following features :

- The minimum conversion time is 6.13  $\mu\text{s}$  (for a machine clock of 16 MHz; includes the sampling time) .
- The minimum sampling time is 2.0  $\mu\text{s}$  (for a machine clock of 16 MHz) .
- The converter uses the RC-type successive approximation conversion method with a sample hold circuit.
- A resolution of 10 bits or 8 bits can be selected.
- Up to eight channels for analog input pins can be selected by a program.
- Various conversion mode :
  - Single conversion mode : Selectively convert one channel.
  - Scan conversion mode : Continuously convert multiple channels. Maximum of 8 program selectable channels.
  - Continuous conversion mode : Repeatedly convert specified channels.
  - Stop conversion mode : Convert one channel then halt until the next activation. (Enables synchronization of the conversion start timing.)
- At the end of A/D conversion, an interrupt request can be generated and EI<sup>2</sup>OS can be activated.
- In the interrupt-enabled state, the conversion data protection function prevents any part of the data from being lost through continuous conversion.
- The conversion can be activated by software, 16-bit reload timer 1 (rising edge) and 16-bit free-running timer zero detection edge.

# MB90460 Series

## Block Diagram



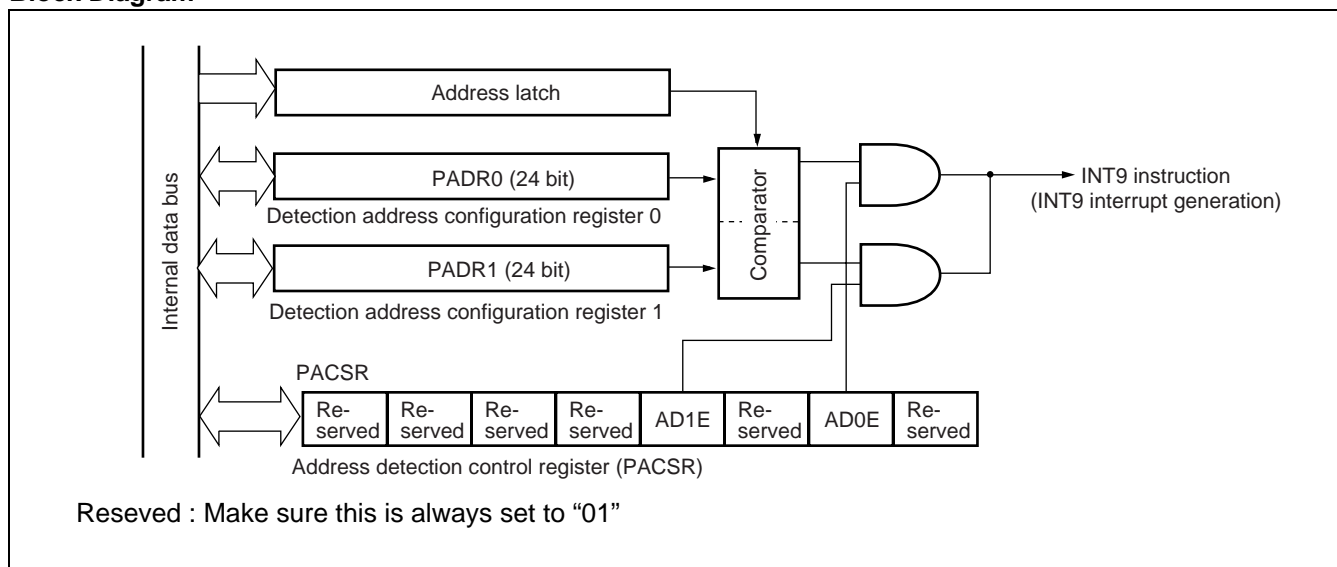
## 14. ROM Correction Function

In the case that the address of the instruction after the one that a program is currently processing matches the address configured in the detection address configuration register, the program forces the next instruction to be processed into an INT9 instruction, and branches to the interrupt process program. Since processing can be conducted using INT9 interrupts, programs can be repaired using batch processing.

### •Overview of the Rom correction Function

- The address of the instruction after the one that a program is currently processing is always stored in an address latch via the internal data bus. Address match detection constantly compares the address stored in the address latch with the one configured in the detection address configuration register. If the two compared addresses match, the CPU forcibly changes this instruction into an INT9 instruction, and executes an interrupt processing program.
- There are two detection address configuration registers : PADR0 and PADR1. Each register provides an interrupt enable bit. This allows you to individually configure each register to enable/prohibit the generation of interrupts when the address stored in the address latch matches the one configured in the detection address configuration register.

### Block Diagram

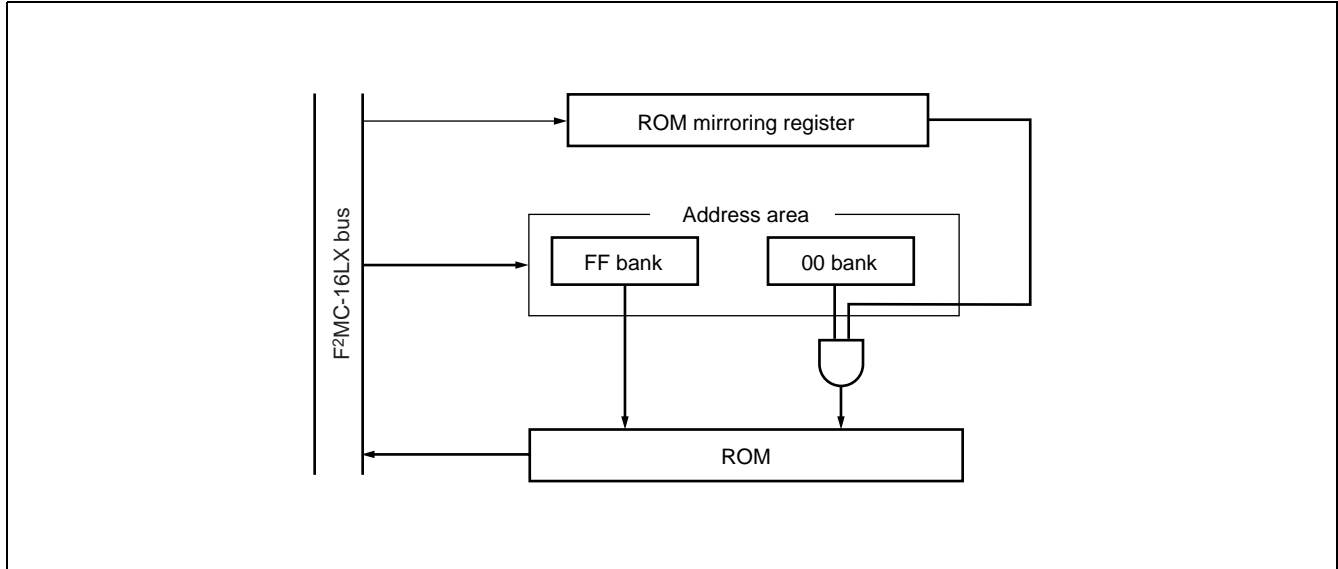


- Address latch  
Stores value of address output to internal data bus.
- Address detection control register (PACSR)  
Set this register to enable/prohibit interrupt output when an address match is detected.
- Detection address configuration register (PADR0, PADR1)  
Configure an address with which to compare the address latch value.

## 15. ROM Mirroring Function Selection Module

The ROM mirroring function selection module can select what the FF bank allocated the ROM and see through the 00 bank according to register settings.

### Block Diagram



## 16. 512 Kbit Flash Memory

The 512 Kbit flash memory is allocated in the FE<sub>H</sub> to FF<sub>H</sub> banks on the CPU memory map. Like masked ROM, flash memory is read-accessible and program-accessible to the CPU using the flash memory interface circuit.

The flash memory can be programmed/erased by the instruction from the CPU via the flash memory interface circuit. The flash memory can therefore be reprogrammed (updated) while still on the circuit board under integrated CPU control, allowing program code and data to be improved efficiently.

Note that sector operations such as “enable sector protect” cannot be used.

Features of 512 Kbit flash memory

- 64 kwords × 8 bits/32 kwords × 16 bits (16 k + 8 k + 8 k + 32 k) sector configuration
- Automatic program algorithm (same as the Embedded Algorithm\* : MBM29F400TA)
- Installation of the deletion temporary stop/delete restart function
- Write/delete completion detected by the data polling or toggle bit
- Write/delete completion detected by the CPU interrupt
- Compatibility with the JEDEC standard-type command
- Each sector deletion can be executed (Sectors can be freely combined) .
- Flash security feature
- Number of write/delete operations 10,000 times guaranteed.
- Flash reading cycle time (Min) 2 machine cycles

\* : Embedded Algorithm is a trademark of Advanced Micro Devices, Inc.

### (1) Register configuration

| Flash Memory Control status register |      |        |     |     |          |      |          | Bit number |      |
|--------------------------------------|------|--------|-----|-----|----------|------|----------|------------|------|
| Address : 0000AE <sub>H</sub>        | 7    | 6      | 5   | 4   | 3        | 2    | 1        | 0          | FMCS |
|                                      | INTE | RDYINT | WE  | RDY | Reserved | LPM1 | Reserved | LMP0       |      |
| Read/write ⇒                         | R/W  | R/W    | R/W | R   | W        | W    | W        | R/W        |      |
| Initial value ⇒                      | 0    | 0      | 0   | 1   | 0        | 0    | 0        | 0          |      |

# MB90460 Series

## (2) Sector configuration of 512Kbit flash memory

The 512 Kbit flash memory has the sector configuration illustrated below. The addresses in the illustration are the upper and lower addresses of each sector.

When accessed from the CPU, SA0 to SA3 are allocated in the FF bank registers, respectively.

| Flash memory    | CPU address | *Writer address |
|-----------------|-------------|-----------------|
| SA3 (16 Kbytes) | FFFFFFH     | 7FFFFH          |
|                 | FFC000H     | 7C000H          |
| SA2 (8 Kbytes)  | FFBFFFH     | 7BFFFH          |
|                 | FFA000H     | 7A000H          |
| SA1 (8 Kbytes)  | FF9FFFH     | 79FFFH          |
|                 | FF8000H     | 78000H          |
| SA0 (32 Kbytes) | FF7FFFH     | 77FFFH          |
|                 | FF0000H     | 70000H          |

\* : Programmer addresses correspond to CPU addresses when data is programmed in flash memory by a parallel programmer. Programmer addresses are used to program/erase data using a general-purpose programmer.

## ■ ELECTRICAL CHARACTERISTICS

### 1. Absolute Maximum Ratings

( $V_{SS} = AV_{SS} = 0.0\text{ V}$ )

| Parameter                              | Symbol               | Rating         |                | Unit | Remarks  |
|--|----------------------|----------------|----------------|------|--|
|  |                      | Min            | Max            |      |  |
| Power supply voltage                   | $V_{CC}$             | $V_{SS} - 0.3$ | $V_{SS} + 6.0$ | V    |  |
|  | $AV_{CC}$            | $V_{SS} - 0.3$ | $V_{SS} + 6.0$ | V    | $V_{CC} \geq AV_{CC}^{*1}$   |
|  | AVR                  | $V_{SS} - 0.3$ | $V_{SS} + 6.0$ | V    | $AV_{CC} \geq AVR, AVR \geq AV_{SS}$                                     |
| Input voltage                          | $V_I$                | $V_{SS} - 0.3$ | $V_{SS} + 6.0$ | V    | *2   |
| Output voltage                         | $V_O$                | $V_{SS} - 0.3$ | $V_{SS} + 6.0$ | V    | *2   |
| Maximum clamp current                  | $I_{CLAMP}$          | - 2.0          | + 2.0          | mA   | *4   |
| Total maximum clamp current            | $\Sigma  I_{CLAMP} $ | —              | 20             | mA   | *4   |
| “L” level maximum output current       | $I_{OL}$             | —              | 15             | mA   | *3   |
| “L” level average output current       | $I_{OLAV}$           | —              | 4              | mA   | Average output current = operating current $\times$ operating efficiency |
| “L” level total maximum output current | $\Sigma I_{OL}$      | —              | 100            | mA   |  |
| “L” level total average output current | $\Sigma I_{OLAV}$    | —              | 50             | mA   | Average output current = operating current $\times$ operating efficiency |
| “H” level maximum output current       | $I_{OH}$             | —              | - 15           | mA   | *3   |
| “H” level average output current       | $I_{OHAV}$           | —              | - 4            | mA   | Average output current = operating current $\times$ operating efficiency |
| “H” level total maximum output current | $\Sigma I_{OH}$      | —              | - 100          | mA   |  |
| “H” level total average output current | $\Sigma I_{OHAV}$    | —              | - 50           | mA   | Average output current = operating current $\times$ operating efficiency |
| Power consumption                      | $P_D$                | —              | 300            | mW   |  |
| Operating temperature                  | $T_A$                | -40            | +85            | °C   |  |
| Storage temperature                    | $T_{stg}$            | -55            | +150           | °C   |  |

\*1 :  $AV_{CC}$  shall never exceed  $V_{CC}$  when power on.

\*2 :  $V_I$  and  $V_O$  shall never exceed  $V_{CC} + 0.3\text{ V}$ .

\*3 : The maximum output current is a peak value for a corresponding pin.

\*4 : • Applicable to pins : P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P46, P60 to P63

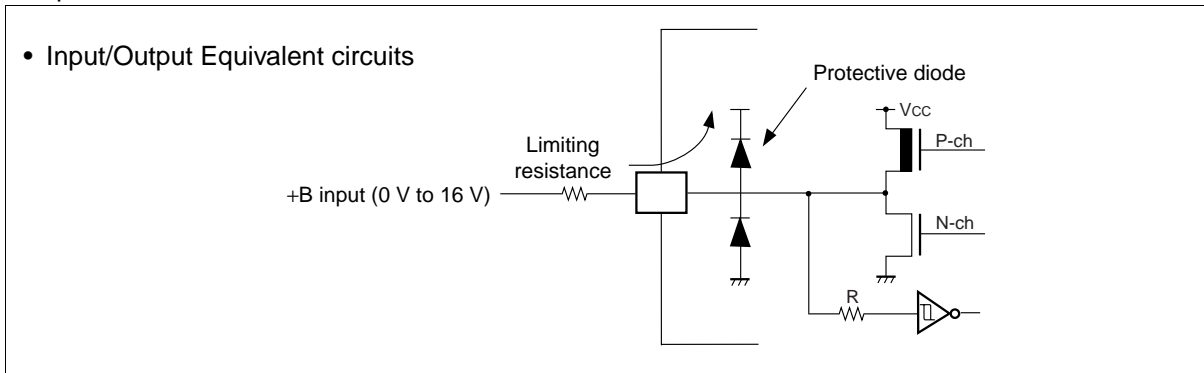
- Use within recommended operating conditions.
- Use at DC voltage (current) .
- The +B signal should always be applied with a limiting resistance placed between the +B signal and the microcontroller.
- The value of the limiting resistance should be set so that when the +B signal is applied the input current to the microcontroller pin does not exceed rated values, either instantaneously or for prolonged periods.

(Continued)

# MB90460 Series

(Continued)

- Note that when the microcontroller drive current is low, such as in the power saving modes, the +B input potential may pass through the protective diode and increase the potential at the V<sub>CC</sub> pin, and this may affect other devices.
- Note that if a +B signal is input when the microcontroller current is off (not fixed at 0 V), the power supply is provided from the pins, so that incomplete operation may result.
- Note that if the +B input is applied during power-on, the power supply is provided from the pins and the resulting supply voltage may not be sufficient to operate the power-on reset.
- Care must be taken not to leave the +B input pin open.
- Note that analog system input/output pins other than the A/D input pins (LCD drive pins, comparator input pins, etc.) cannot accept +B signal input.
- Sample recommended circuits:



**WARNING:** Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

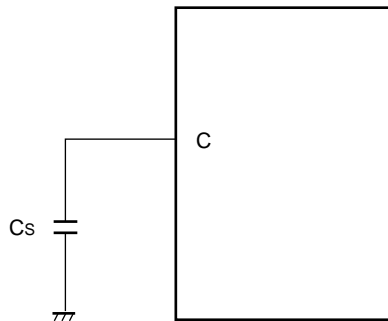


## 2. Recommended Operating Conditions

( $V_{SS} = AV_{SS} = 0.0\text{ V}$ )

| Parameter             | Symbol   | Value |     | Unit               | Remarks   |
|-----------------------|----------|-------|-----|--------------------|---|
|                       |          | Min   | Max |                    |   |
| Power supply voltage  | $V_{CC}$ | 3.0   | 5.5 | V                  | Normal operation (MB90462, MB90467, MB90V460)   |
|                       |          | 4.5   | 5.5 | V                  | Normal operation (MB90F462)   |
|                       | $V_{CC}$ | 3.0   | 5.5 | V                  | Retains status at the time of operation stop  |
| Smoothing capacitor   | $C_S$    | 0.1   | 1.0 | $\mu\text{F}$      | Use a ceramic capacitor or a capacitor with equivalent frequency characteristics. The smoothing capacitor to be connected to the $V_{CC}$ pin must have a capacitance value higher than $C_S$ . |
| Operating temperature | $T_A$    | -40   | +85 | $^{\circ}\text{C}$ |   |

- C pin connection circuit



**WARNING:** The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device's electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

# MB90460 Series

## 3. DC Characteristics

( $V_{CC} = 5.0\text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0.0\text{ V}$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ )

| Parameter                | Symbol    | Pin name  | Condition   | Value          |     |                | Unit          | Remarks                   |
|--------------------------|-----------|---|---|----------------|-----|----------------|---------------|---------------------------|
|                          |           |   |   | Min            | Typ | Max            |               |                           |
| "H" level output voltage | $V_{OH}$  | All output pins   | $V_{CC} = 4.5\text{ V}$ ,<br>$I_{OH} = -4.0\text{ mA}$  | $V_{CC} - 0.5$ | —   | —              | V             |                           |
| "L" level output voltage | $V_{OL}$  | All pins except P00 to P05 and P30 to P35                                 | $V_{CC} = 4.5\text{ V}$ ,<br>$I_{OL} = 4.0\text{ mA}$   | —              | —   | 0.4            | V             |                           |
|                          |           | P00 to P05, P30 to P35  | $V_{CC} = 4.5\text{ V}$ ,<br>$I_{OL} = 12.0\text{ mA}$  | —              | —   | 0.4            | V             |                           |
| "H" level input voltage  | $V_{IH}$  | P00 to P07<br>P30 to P37<br>P50 to P57                                    | $V_{CC} =$<br>3.0 V to 5.5 V<br>(MB90462)   | 0.7 $V_{CC}$   | —   | $V_{CC} + 0.3$ | V             | CMOS input pin            |
|                          | $V_{IHS}$ | P10 to P17<br>P20 to P27<br>P40 to P46<br>P60 to P63,<br>$\overline{RST}$ |   | 0.8 $V_{CC}$   | —   | $V_{CC} + 0.3$ | V             | CMOS hysteresis input pin |
|                          | $V_{IHM}$ | MD pins   |   | $V_{CC} - 0.3$ | —   | $V_{CC} + 0.3$ | V             | MD pin input              |
| "L" level input voltage  | $V_{IL}$  | P00 to P07<br>P30 to P37<br>P50 to P57                                    | $V_{CC} =$<br>4.5 V to 5.5 V<br>(MB90F462)  | $V_{SS} - 0.3$ | —   | 0.3 $V_{CC}$   | V             | CMOS input pin            |
|                          | $V_{ILS}$ | P10 to P17<br>P20 to P27<br>P40 to P46<br>P60 to P63,<br>$\overline{RST}$ |   | $V_{SS} - 0.3$ | —   | 0.2 $V_{CC}$   | V             | CMOS hysteresis input pin |
|                          | $V_{ILM}$ | MD pins   |   | $V_{SS} - 0.3$ | —   | $V_{SS} + 0.3$ | V             | MD pin input              |
| Input leakage current    | $I_{IL}$  | All input pins  | $V_{CC} = 5.5\text{ V}$ ,<br>$V_{SS} < V_I < V_{CC}$  | -5             | —   | 5              | $\mu\text{A}$ |                           |
| Power supply current*    | $I_{CC}$  | $V_{CC}$  | $V_{CC} = 5.0\text{ V}$ ,<br>Internal operation at 16 MHz,<br>Normal operation  | —              | 40  | 50             | mA            |                           |
|                          |           |   | $V_{CC} = 5.0\text{ V}$ ,<br>Internal operation at 16 MHz,<br>When data written in flash mode<br>programming of erasing | —              | 45  | 60             | mA            |                           |
|                          | $I_{CCS}$ |   | $V_{CC} = 5.0\text{ V}$ ,<br>Internal operation at 16 MHz,<br>In sleep mode   | —              | 15  | 20             | mA            |                           |

(Continued)

# MB90460 Series

(Continued)

( $V_{CC} = 5.0\text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0.0\text{ V}$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ )

| Parameter             | Symbol     | Pin name  | Condition  | Value |     |     | Unit             | Remarks |
|-----------------------|------------|---|--|-------|-----|-----|------------------|---------|
|                       |            |   |  | Min   | Typ | Max |                  |         |
| Power supply current* | $I_{CTS}$  | $V_{CC}$  | $V_{CC} = 5.0\text{ V}$ ,<br>Internal operation at 16 MHz,<br>In Timer mode,<br>$T_A = 25\text{ }^\circ\text{C}$ | —     | 2.5 | 5.0 | mA               |         |
|                       | $I_{CCH}$  |   | In stop mode,<br>$T_A = 25\text{ }^\circ\text{C}$  | —     | 5   | 20  | $\mu\text{A}$    |         |
| Input capacitance     | $C_{IN}$   | Except $AV_{CC}$ ,<br>$AV_{SS}$ , C, $V_{CC}$<br>and $V_{SS}$ | —  | —     | 10  | 80  | pF               |         |
| Pull-up resistance    | $R_{UP}$   | P00 to P07<br>P10 to P17<br>$\overline{RST}$                  | —  | 25    | 50  | 100 | $\text{k}\Omega$ |         |
| Pull-down resistance  | $R_{DOWN}$ | MD2   | —  | 25    | 50  | 100 | $\text{k}\Omega$ |         |

\* : The current value is preliminary value and may be subject to change for enhanced characteristics without previous notice. The power supply current is measured with an external clock.

# MB90460 Series

## 4. AC Characteristics

### (1) Clock Timings

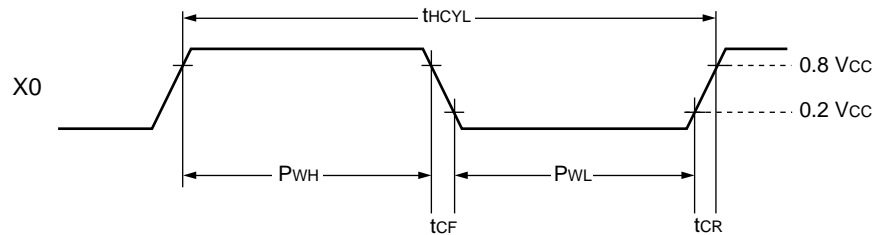
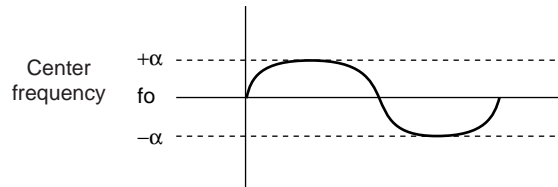
( $V_{CC} = 5.0 \text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0.0 \text{ V}$ ,  $T_A = -40 \text{ }^\circ\text{C}$  to  $+85 \text{ }^\circ\text{C}$ )

| Parameter                           | Symbol               | Pin name | Value |     |     | Unit | Remarks                              |
|-------------------------------------|----------------------|----------|-------|-----|-----|------|--------------------------------------|
|                                     |                      |          | Min   | Typ | Max |      |                                      |
| Clock frequency                     | $f_c$                | X0, X1   | 3     | —   | 16  | MHz  | Crystal oscillator                   |
|                                     |                      |          | 3     | —   | 32  |      | External clock *2                    |
| Clock cycle time                    | $t_{HCYL}$           | X0, X1   | 62.5  | —   | 333 | ns   |                                      |
| Frequency fluctuation rate locked*1 | $\Delta f$           | —        | —     | —   | 5   | %    |                                      |
| Input clock pulse width             | $P_{WH}$ $P_{WL}$    | X0       | 10    | —   | —   | ns   | Recommended duty ratio of 30% to 70% |
| Input clock rise/fall time          | $t_{CR}$<br>$t_{CF}$ | X0       | —     | —   | 5   | ns   | External clock operation             |
| Internal operating clock            | $f_{CP}$             | —        | 1.5   | —   | 16  | MHz  | Main clock operation                 |
| Internal operating clock cycle time | $t_{CP}$             | —        | 62.5  | —   | 666 | ns   | Main clock operation                 |

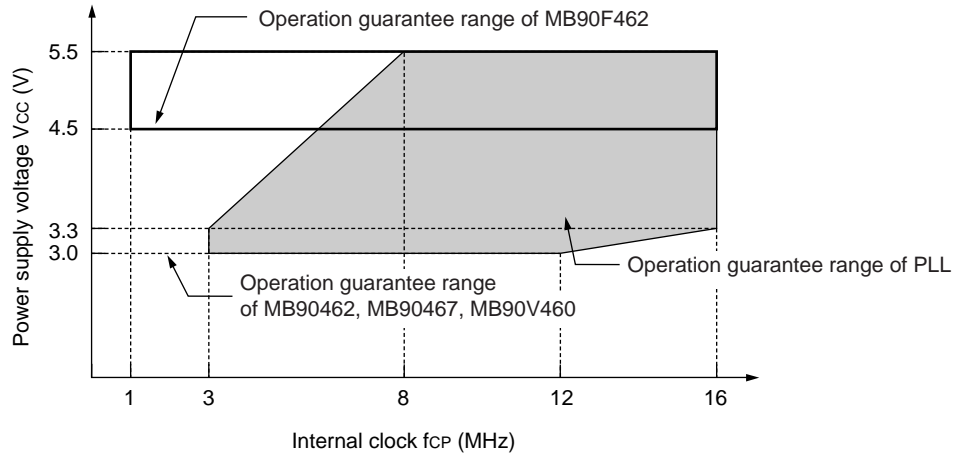
\*1 : The frequency fluctuation rate is the maximum deviation rate of the preset center frequency when the multiplied PLL signal is locked.

\*2 : Internal operating clock frequency must not be over 16 MHz.

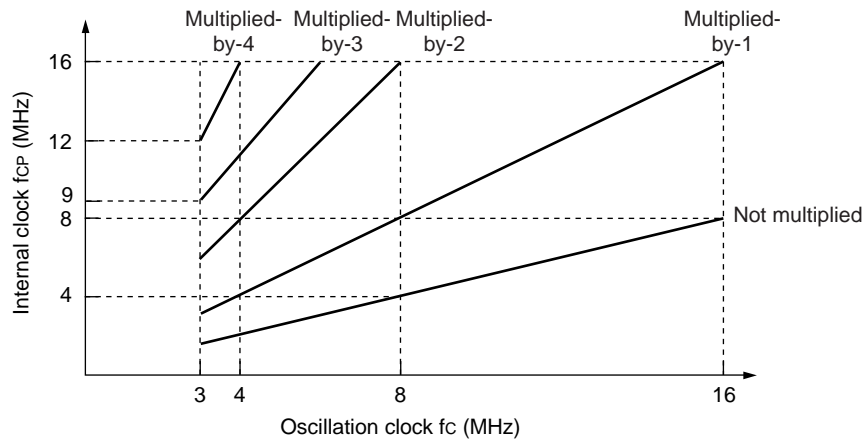
$$\Delta f = \frac{|\alpha|}{f_0} \times 100 (\%)$$



Relationship between internal operating clock frequency and power supply voltage



Relationship between oscillating frequency and internal operating clock frequency



The AC ratings are measured for the following measurement reference voltages

• **Input signal waveform**

Hysteresis Input Pin

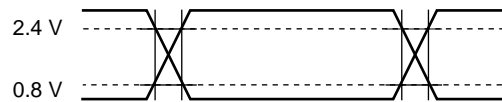


Pin other than hysteresis input/MD input



• **Output signal waveform**

Output Pin



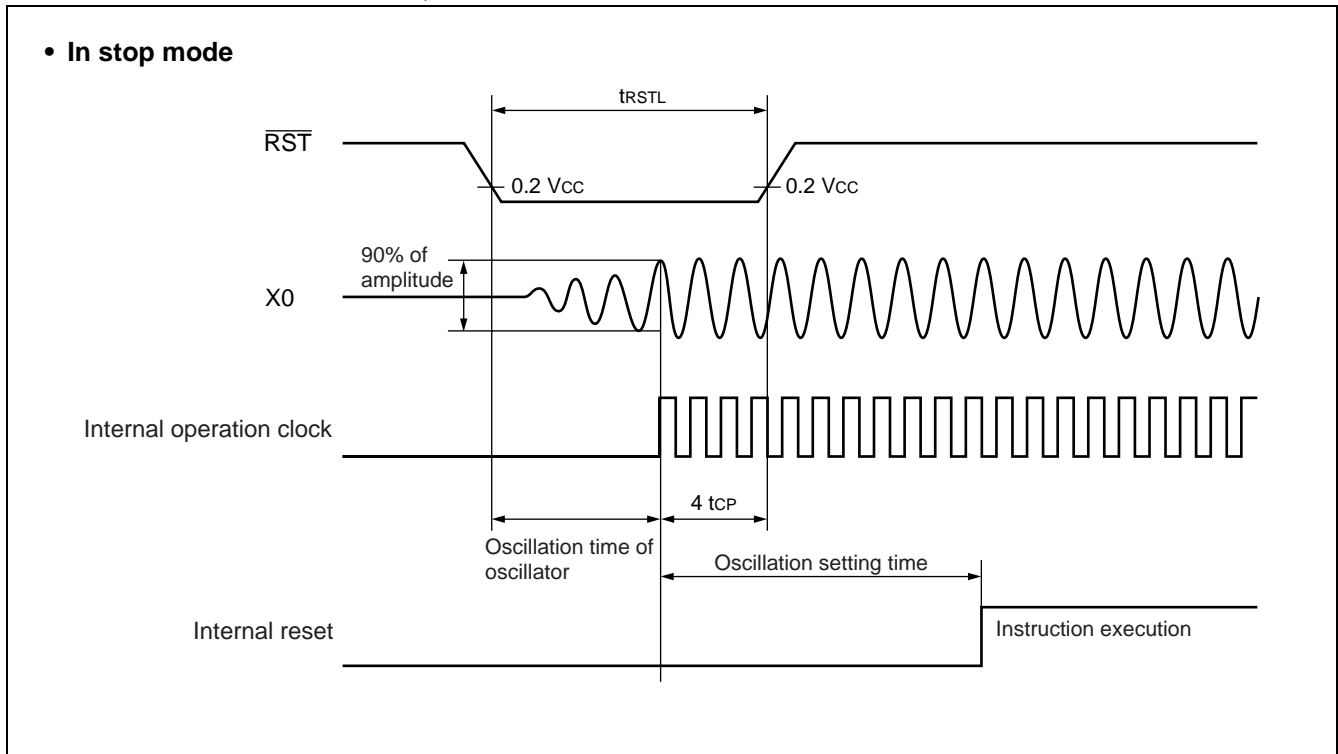
# MB90460 Series

## (2) Reset Input Timing

( $V_{CC} = 5.0 \text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0.0 \text{ V}$ ,  $T_A = -40 \text{ }^\circ\text{C}$  to  $+85 \text{ }^\circ\text{C}$ )

| Parameter        | Symbol     | Pin                     | Condition | Value   |     | Units | Remarks                |
|------------------|------------|-------------------------|-----------|---|-----|-------|------------------------|
|                  |            |                         |           | Min   | Max |       |                        |
| Reset input time | $t_{RSTL}$ | $\overline{\text{RST}}$ | —         | 4 $t_{CP}$                                    | —   | ns    | Under normal operation |
|                  |            |                         |           | Oscillation time of oscillator + 4 $t_{CP}$ * | —   | ms    | In stop mode           |

\* : Oscillation time of oscillator is time that amplitude reached the 90%. In the crystal oscillator, the oscillation time is between several ms to tens of ms. In FAR/ceramic oscillator, the oscillation time is between hundreds  $\mu\text{s}$  to several ms. In the external clock, the oscillation time is 0 ms.



## (3) Power-on Reset

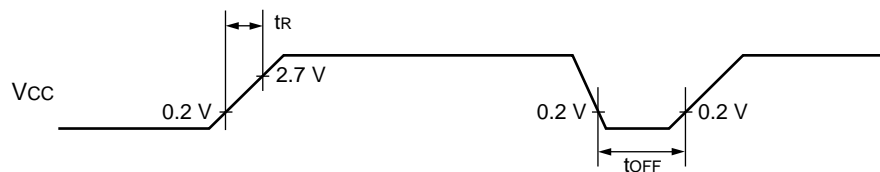
( $V_{CC} = 5.0\text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0.0\text{ V}$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ )

| Parameter                 | Symbol    | Pin name | Condition | Value |     | Unit | Remarks                    |
|---------------------------|-----------|----------|-----------|-------|-----|------|----------------------------|
|                           |           |          |           | Min   | Max |      |                            |
| Power supply rising time  | $t_R$     | $V_{CC}$ | —         | 0.05  | 30  | ms   |                            |
| Power supply cut-off time | $t_{OFF}$ | $V_{CC}$ | —         | 4     | —   | ms   | Due to repeated operations |

Note :  $V_{CC}$  must be kept lower than 0.2 V before power-on.

The above values are used for causing a power-on reset.

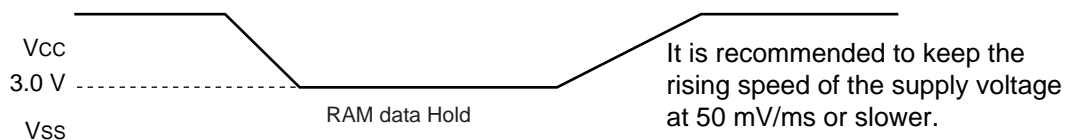
Some registers in the device are initialized only upon a power-on reset. To initialize these registers, turn the power supply using the above values.



Sudden changes in the power supply voltage may cause a power-on reset.

To change the power supply voltage while the device is in operation, it is recommended to raise the voltage smoothly to suppress fluctuations as shown below.

In this case, change the supply voltage with the PLL clock not used. If the voltage drop is 1 V or fewer per second, however, you can use the PLL clock.



# MB90460 Series

## (4) UART0 to UART1

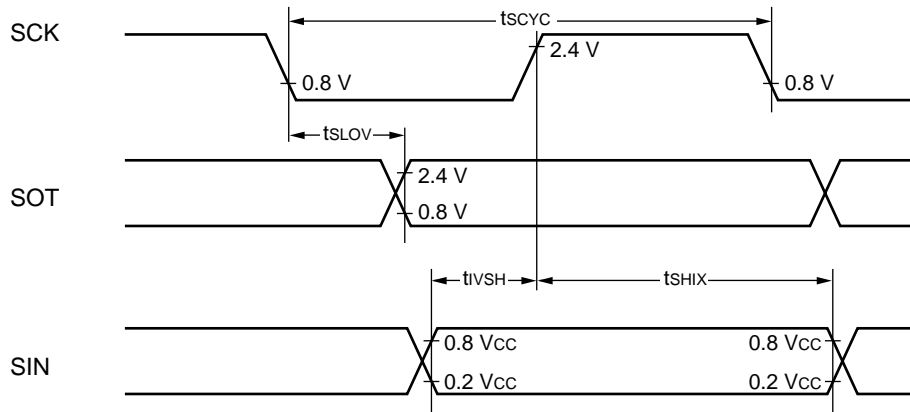
( $V_{CC} = 5.0 \text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0.0 \text{ V}$ ,  $T_A = -40 \text{ }^\circ\text{C}$  to  $+85 \text{ }^\circ\text{C}$ )

| Parameter                    | Symbol     | Pin name                      | Condition   | Value      |     | Unit | Remarks |
|------------------------------|------------|-------------------------------|---|------------|-----|------|---------|
|                              |            |                               |   | Min        | Max |      |         |
| Serial clock cycle time      | $t_{SCYC}$ | SCK0 to SCK1                  | $C_L = 80 \text{ pF} + 1 \text{ TTL}$<br>for an output pin of<br>internal shift clock<br>mode | 8 $t_{CP}$ | —   | ns   |         |
| SCK ↓ → SOT delay time       | $t_{SLOV}$ | SCK0 to SCK1<br>SOT0 to SOT1  |   | -80        | 80  | ns   |         |
| Valid SIN → SCK ↑            | $t_{IVSH}$ | SCK0 to SCK1<br>SIN0 to SIN1  |   | 100        | —   | ns   |         |
| SCK ↑ → valid SIN hold time  | $t_{SHIX}$ | SCK0 to SCK1,<br>SIN0 to SIN1 |   | 60         | —   | ns   |         |
| Serial clock "H" pulse width | $t_{SHSL}$ | SCK0 to SCK1                  | $C_L = 80 \text{ pF} + 1 \text{ TTL}$<br>for an output pin of<br>external shift clock<br>mode | 4 $t_{CP}$ | —   | ns   |         |
| Serial clock "L" pulse width | $t_{LSLH}$ | SCK0 to SCK1                  |   | 4 $t_{CP}$ | —   | ns   |         |
| SCK ↓ → SOT delay time       | $t_{SLOV}$ | SCK0 to SCK1,<br>SOT0 to SOT1 |   | —          | 150 | ns   |         |
| Valid SIN → SCK ↑            | $t_{IVSH}$ | SCK0 to SCK1,<br>SIN0 to SIN1 |   | 60         | —   | ns   |         |
| SCK ↑ → valid SIN hold time  | $t_{SHIX}$ | SCK0 to SCK1,<br>SIN0 to SIN1 |   | 60         | —   | ns   |         |

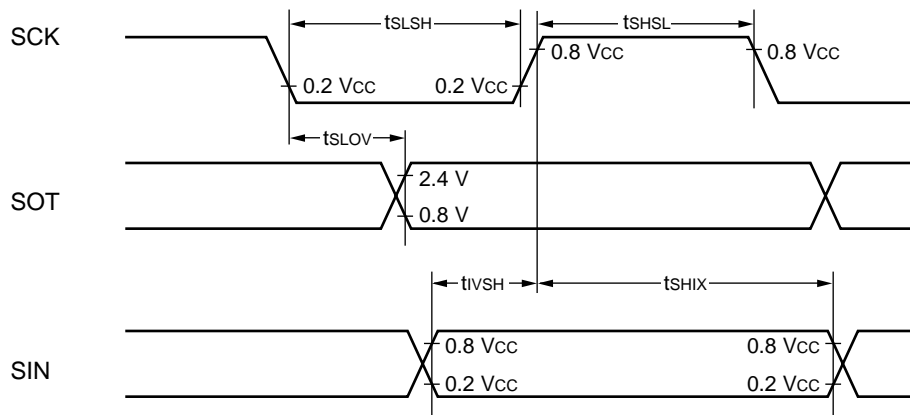
- Note :
- These are AC ratings in the CLK synchronous mode.
  - $C_L$  is the load capacitance value connected to pins while testing.
  - $t_{CP}$  is machine cycle time (unit : ns) .



- Internal shift clock mode



- External shift clock mode

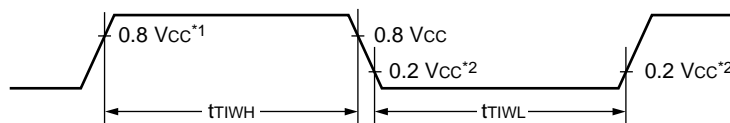


# MB90460 Series

## (5) Resources Input Timing

( $V_{CC} = 5.0\text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0.0\text{ V}$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ )

| Parameter         | Symbol                   | Pin name  | Condition | Value      |     | Unit | Remarks |
|-------------------|--------------------------|---|-----------|------------|-----|------|---------|
|                   |                          |   |           | Min        | Max |      |         |
| Input pulse width | $t_{TIWH}$<br>$t_{TIWL}$ | IN0 to IN3,<br>SNI0 to SNI2<br>TIN0 to TIN1<br>PWI0 to PWI1<br>DTTI0, DTTI1 | —         | 4 $t_{CP}$ | —   | ns   |         |



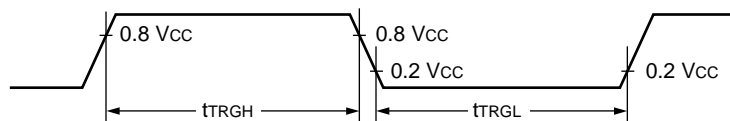
\*1 :  $0.7 V_{CC}$  for PWI0 input pin

\*2 :  $0.3 V_{CC}$  for PWI0 Input pin

## (6) Trigger Input Timing

( $V_{CC} = 5.0\text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0.0\text{ V}$ ,  $T_A = -40\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ )

| Parameter         | Symbol                   | Pin name     | Condition | Value      |     | Unit | Remarks |
|-------------------|--------------------------|--------------|-----------|------------|-----|------|---------|
|                   |                          |              |           | Min        | Max |      |         |
| Input pulse width | $t_{TRGH}$<br>$t_{TRGL}$ | INT0 to INT7 | —         | 5 $t_{CP}$ | —   | ns   |         |



## 5. A/D Converter Electrical Characteristics

( $3.0\text{ V} \leq \text{AVR} - \text{AV}_{\text{SS}}, V_{\text{CC}} = \text{AV}_{\text{CC}} = 5.0\text{ V} \pm 10\%$ ,  $V_{\text{SS}} = \text{AV}_{\text{SS}} = 0.0\text{ V}$ ,  $T_{\text{A}} = -40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ )

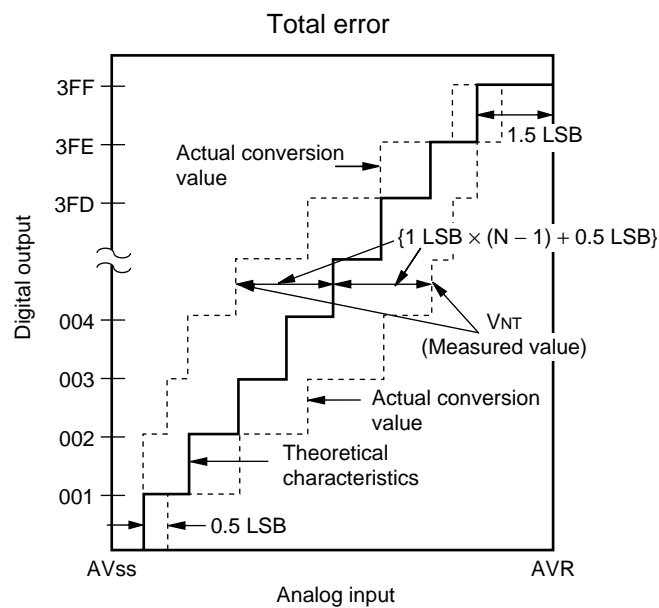
| Parameter                        | Symbol            | Pin name                | Value                                    |  |  | Unit          | Remarks   |
|----------------------------------|-------------------|-------------------------|--|--|--|---------------|---|
|                                  |                   |                         | Min                                      | Typ                                      | Max                                      |               |   |
| Resolution                       | —                 | —                       | —  | 10                                       | —  | bit           |   |
| Total error                      | —                 | —                       | —  | —  | $\pm 3.0$                                | LSB           | For MB90F462, MB90462, MB90467  |
|                                  | —                 | —                       | —  | —  | $\pm 5.0$                                | LSB           | For MB90V460  |
| Non-linear error                 | —                 | —                       | —  | —  | $\pm 2.5$                                | LSB           |   |
| Differential linearity error     | —                 | —                       | —  | —  | $\pm 1.9$                                | LSB           |   |
| Zero transition voltage          | $V_{\text{OT}}$   | AN0 to AN7              | $\text{AV}_{\text{SS}} - 1.5\text{ LSB}$ | $\text{AV}_{\text{SS}} + 0.5\text{ LSB}$ | $\text{AV}_{\text{SS}} + 2.5\text{ LSB}$ | mV            | For MB90F462, MB90462, MB90467  |
|                                  |                   |                         | $\text{AV}_{\text{SS}} - 3.5\text{ LSB}$ | $\text{AV}_{\text{SS}} + 0.5\text{ LSB}$ | $\text{AV}_{\text{SS}} + 4.5\text{ LSB}$ | mV            | For MB90V460  |
| Full-scale transition voltage    | $V_{\text{FST}}$  | AN0 to AN7              | $\text{AVR} - 3.5\text{ LSB}$            | $\text{AVR} - 1.5\text{ LSB}$            | $\text{AVR} + 0.5\text{ LSB}$            | mV            | For MB90F462, MB90462, MB90467  |
|                                  |                   |                         | $\text{AVR} - 6.5\text{ LSB}$            | $\text{AVR} - 1.5\text{ LSB}$            | $\text{AVR} + 1.5\text{ LSB}$            | mV            | For MB90V460  |
| Conversion time                  | —                 | —                       | 6.125                                    | —  | 1000                                     | $\mu\text{s}$ | Actual value is specified as a sum of values specified in ADCR0 : CT1, CT0 and ADCR0 : ST1, ST0. Be sure that the setting value is greater than the min value |
| Sampling period                  | —                 | —                       | 2  | —  | —  | $\mu\text{s}$ | Actual value is specified in ADCR0 : ST1, ST0 bits. Be sure that the setting value is greater than the min value  |
| Analog port input current        | $I_{\text{AIN}}$  | AN0 to AN7              | —  | —  | 10                                       | $\mu\text{A}$ |   |
| Analog input voltage             | $V_{\text{AIN}}$  | AN0 to AN7              | $\text{AV}_{\text{SS}}$                  | —  | AVR                                      | V             |   |
| Reference voltage                | —                 | AVR                     | $\text{AV}_{\text{SS}} + 2.7$            | —  | $\text{AV}_{\text{CC}}$                  | V             |   |
| Power supply current             | $I_{\text{A}}$    | $\text{AV}_{\text{CC}}$ | —  | 2.3                                      | 6  | mA            | For MB90F462, MB90462, MB90467  |
|                                  |                   |                         | —  | 2  | 5  | mA            | For MB90V460  |
|                                  | $I_{\text{AH}}^*$ | —                       | —  | 5  | $\mu\text{A}$                            | *             |   |
| Reference voltage supply current | IR                | AVR                     | —  | 140                                      | 260                                      | $\mu\text{A}$ | For MB90F462, MB90462, MB90467  |
|                                  |                   |                         | —  | 0.9                                      | 1.3                                      | mA            | For MB90V460  |
|                                  | $I_{\text{RH}}^*$ | —                       | —  | 5  | $\mu\text{A}$                            | *             |   |
| Offset between channels          | —                 | AN0 to AN7              | —  | —  | 4  | LSB           |   |

\* : The current when the A/D converter is not operating or the CPU is in stop mode (for  $V_{\text{CC}} = \text{AV}_{\text{CC}} = \text{AVR} = 5.0\text{ V}$ )

# MB90460 Series

## 6. A/D Converter Glossary

- Resolution : Analog changes that are identifiable with the A/D converter
- Linearity error : The deviation of the straight line connecting the zero transition point (“00 0000 0000” ↔ “000000 0001”) with the full-scale transition point (“11 1111 1110” ↔ “11 1111 1111”) from actual conversion characteristics
- Differential linearity error : The deviation of input voltage needed to change the output code by 1 LSB from the theoretical value
- Total error : The total error is defined as a difference between the actual value and the theoretical value, which includes zero-transition error/full-scale transition error and linearity error.



$$\text{Total error for digital output } N = \frac{V_{NT} - \{1 \text{ LSB} \times (N - 1) + 0.5 \text{ LSB}\}}{1 \text{ LSB}} \text{ [LSB]}$$

$$1 \text{ LSB} = (\text{Theoretical value}) \frac{AVR - AV_{SS}}{1024} \text{ [V]}$$

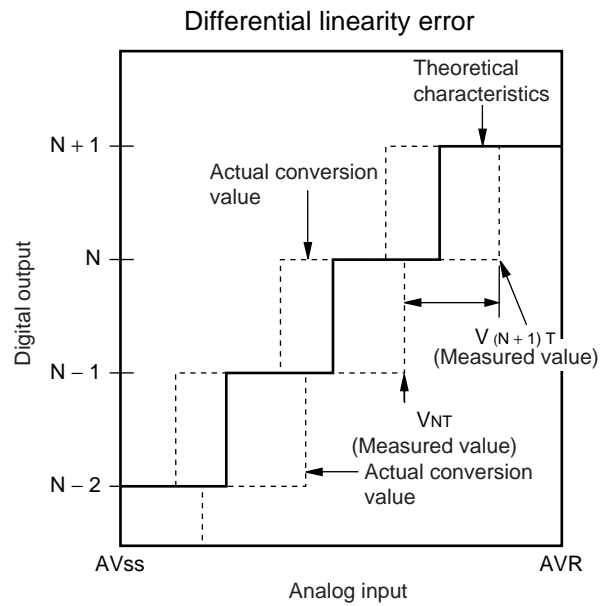
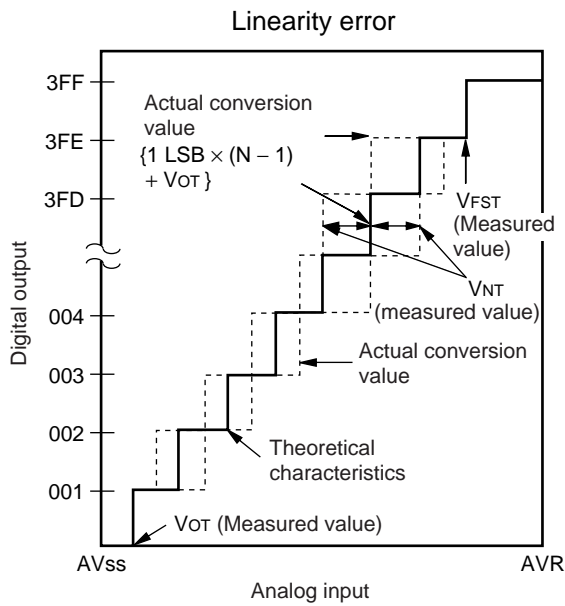
$$V_{OT} (\text{Theoretical value}) = AV_{SS} + 0.5 \text{ LSB [V]}$$

$$V_{FST} (\text{Theoretical value}) = AVR - 1.5 \text{ LSB [V]}$$

$V_{NT}$  : Voltage at a transition of digital output from (N - 1) to N

(Continued)

(Continued)



$$\text{Linearity error of digital output N} = \frac{V_{NT} - \{1 \text{ LSB} \times (N - 1) + V_{OT}\}}{1 \text{ LSB}} \text{ [LSB]}$$

$$\text{Differential linearity error of digital output N} = \frac{V_{(N+1)T} - V_{NT}}{1 \text{ LSB}} - 1 \text{ [LSB]}$$

$$1 \text{ LSB} = \frac{V_{FST} - V_{OT}}{1022} \text{ [V]}$$

$V_{OT}$  : Voltage at transition of digital output from "000<sub>H</sub>" to "001<sub>H</sub>"

$V_{FST}$  : Voltage at transition of digital output from "3FE<sub>H</sub>" to "3FF<sub>H</sub>"

# MB90460 Series

## 7. Notes on Using A/D Converter

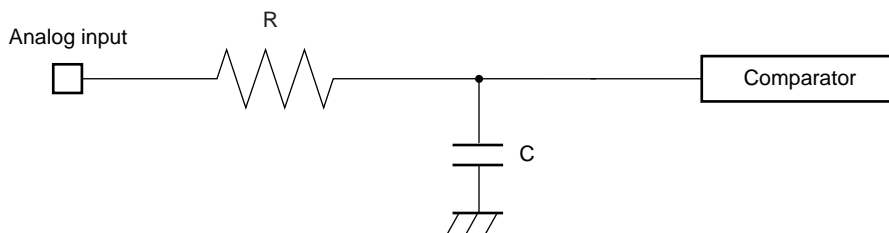
Select the output impedance value for the external circuit of analog input according to the following conditions.

Output impedance values of the external circuit recommends about 5 kΩ or lower (sampling period = 2.0 μs @ machine clock of 16 MHz) .

When capacitors are connected to external pins, the capacitance of several thousand times the internal capacitor value is recommended to minimized the effect of voltage distribution between the external capacitor and internal capacitor.

When the output impedance of the external circuit is too high, the sampling period for analog voltages may not be sufficient.

- Analog input circuit model



MB90462, MB90F462, MB90467 R ≅ 2.6 KΩ, C ≅ 28 pF  
 MB90V460 R ≅ 3.2 KΩ, C ≅ 30 pF

Note : Listed values must be considered as standards.

- Error

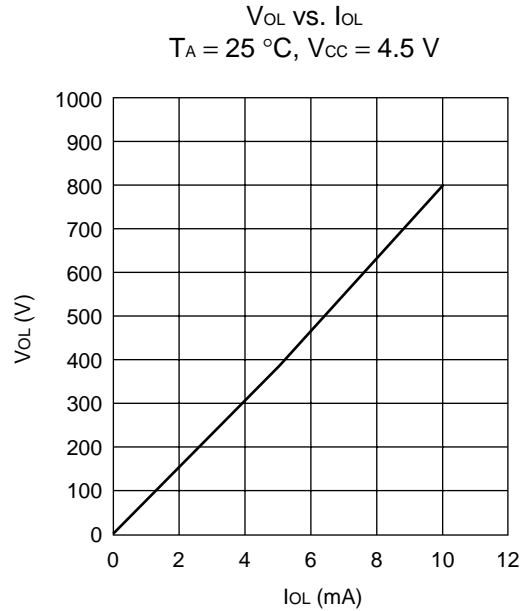
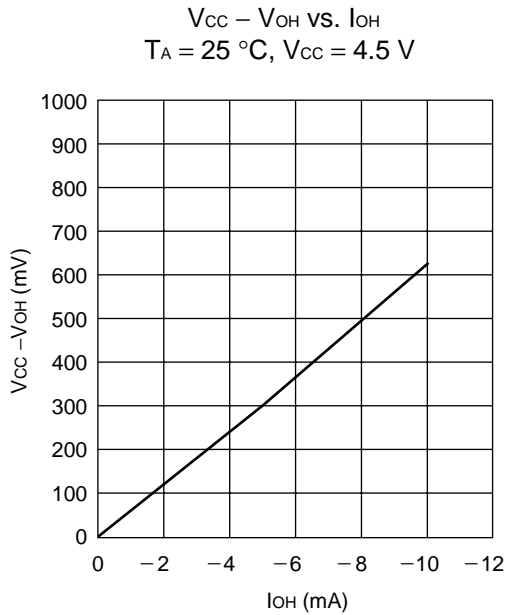
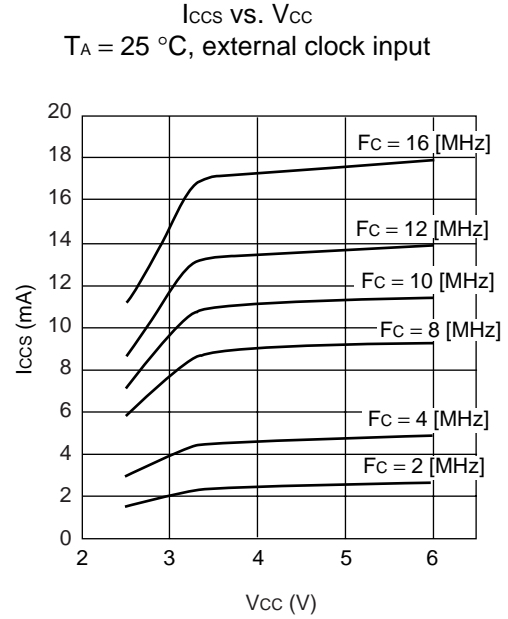
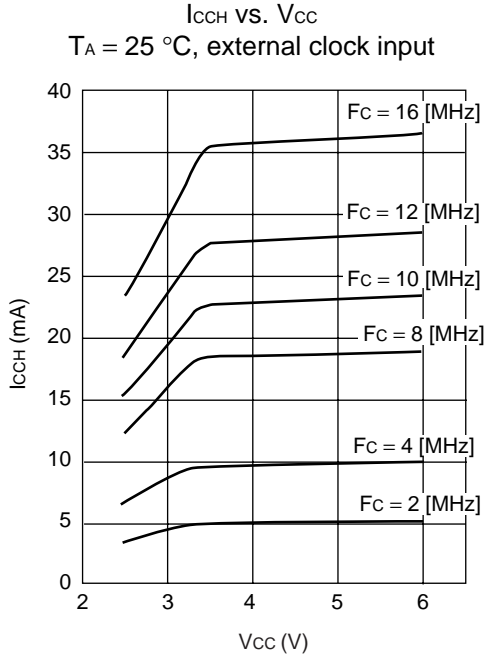
The smaller the absolute value of  $|AVR - AV_{SS}|$ , the greater the error would become relatively.

## 8. Flash Memory Program and Erase Performances

| Parameter                            | Condition   | Value  |     |       | Unit  | Remarks                                 |
|--------------------------------------|---|--------|-----|-------|-------|---|
|                                      |   | Min    | Typ | Max   |       |   |
| Sector erase time                    | T <sub>A</sub> = + 25 °C<br>V <sub>CC</sub> = 3.0 V | —      | 1   | 15    | s     | Excludes 00H programming prior erasure  |
| Chip erase time                      |   | —      | 5   | —     | s     | Excludes 00 H programming prior erasure |
| Word (16 bit width) programming time |   | —      | 16  | 3,600 | μs    | Excludes system-level overhead          |
| Erase/Program cycle                  | —   | 10,000 | —   | —     | cycle |   |

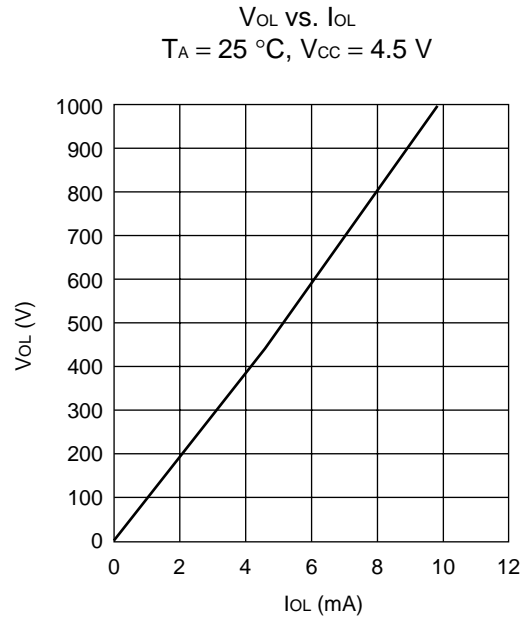
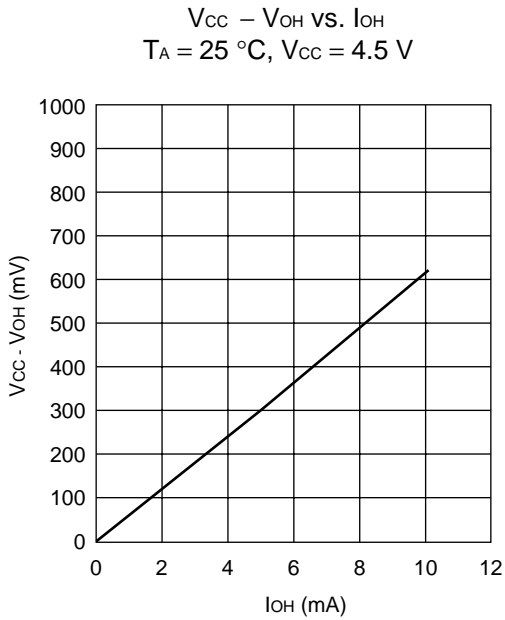
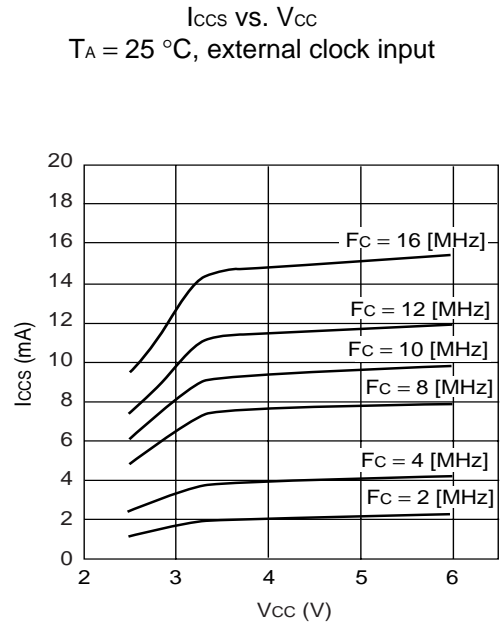
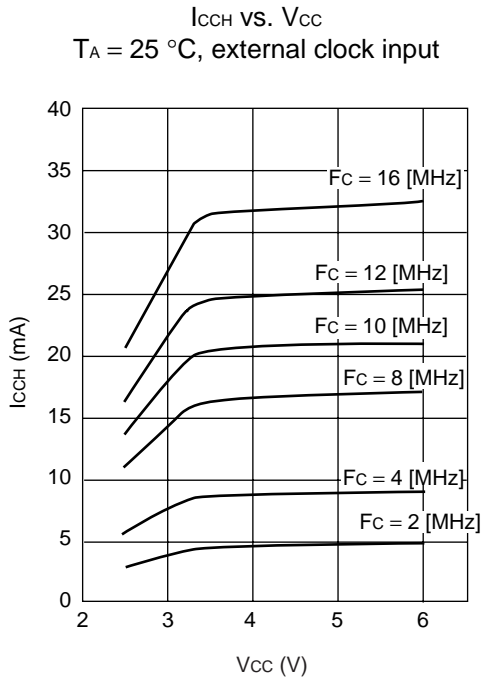
## EXAMPLE CHARACTERISTICS

- Power Supply Current of MB90462, MB90467



# MB90460 Series

- Power Supply Current of MB90F462





## ■ ORDERING INFORMATION

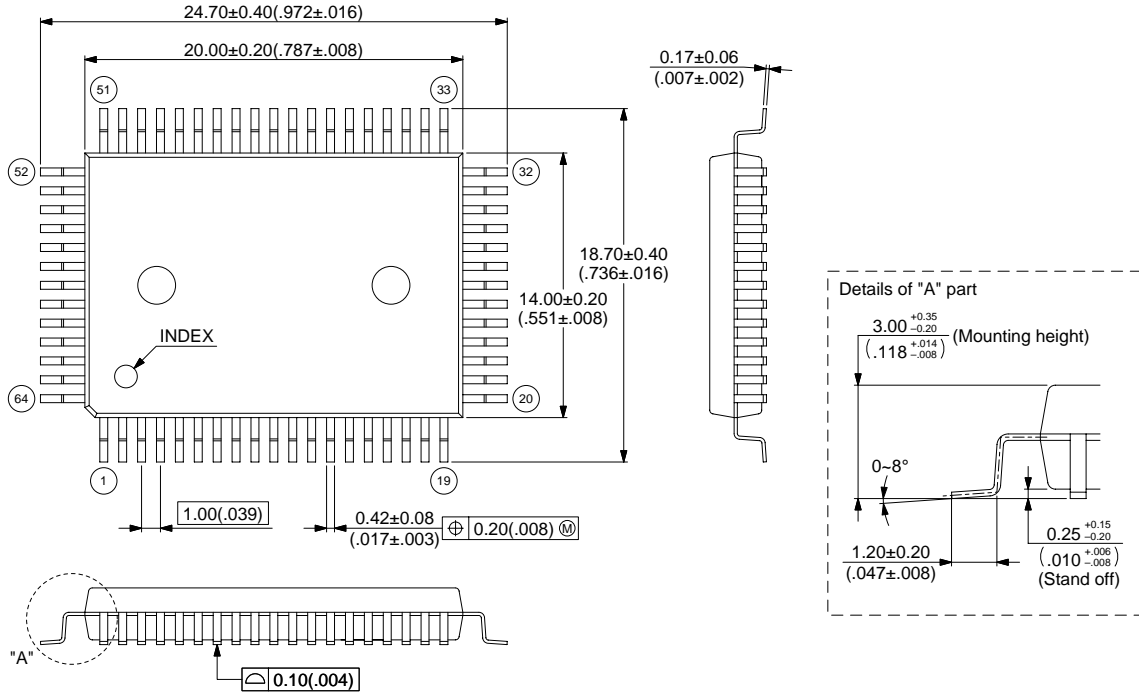
| Part number                                | Package                                | Remarks |
|--|--|---------|
| MB90F462PFM<br>MB90462PFM<br>MB90467PFM    | 64-pin Plastic LQFP<br>(FPT-64P-M09)   |         |
| MB90F462PF<br>MB90462PF<br>MB90467PF       | 64-pin Plastic QFP<br>(FPT-64P-M06)    |         |
| MB90F462P-SH<br>MB90462P-SH<br>MB90467P-SH | 64-pin Plastic SH-DIP<br>(DIP-64P-M01) |         |

# MB90460 Series

## PACKAGE DIMENSIONS

64-pin Plastic QFP  
(FPT-64P-M06)

Note : Pins width and pins thickness include plating thickness.



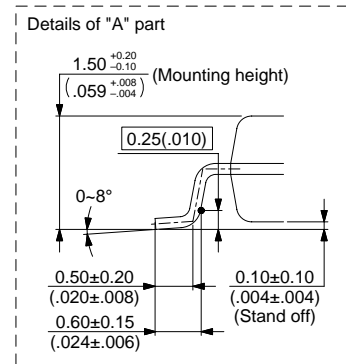
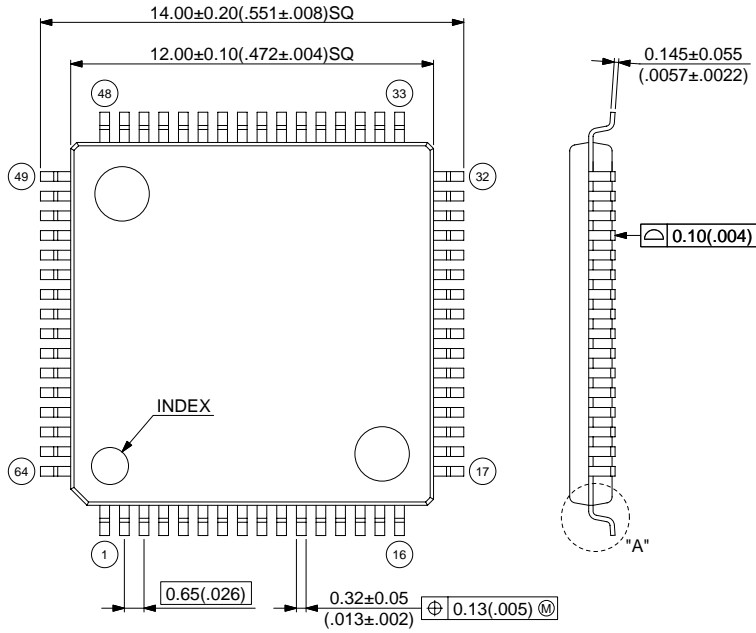
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Dimensions in mm (inches)

# MB90460 Series

64-pin Plastic LQFP  
(FPT-64P-M09)

Note : Pins width and pins thickness include plating thickness.



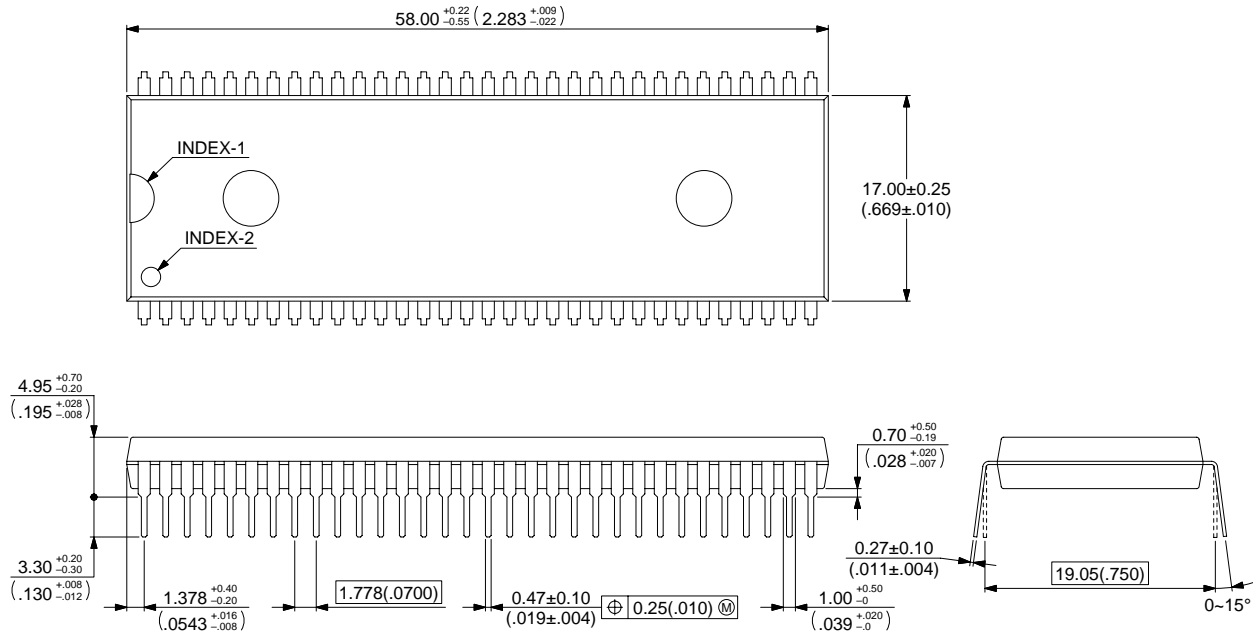
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Dimensions in mm (inches)

# MB90460 Series

64-pin Plastic SH-DIP  
(DIP-64P-M01)

Note : Pins width and pins thickness include plating thickness.



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Dimensions in mm (inches)

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