

16-bit Proprietary Microcontroller

CMOS

F²MC-16LX MB90590/590G Series

**MB90591/591G/F591A/F591G/594/594G/F594A/F594G
MB90V590A/V590G**

■ DESCRIPTION

The MB90590/590G series with two FULL-CAN*¹ interfaces and FLASH ROM is especially designed for automotive and industrial applications. Its main features are two on board CAN Interfaces, which conform to V2.0 Part A and Part B, while supporting a very flexible message buffer scheme and so offering more functions than a normal full CAN approach.

The instruction set of F²MC-16LX CPU core inherits an AT architecture of the F²MC*² family with additional instruction sets for high-level languages, extended addressing mode, enhanced multiplication/division instructions, and enhanced bit manipulation instructions. The microcontroller has a 32-bit accumulator for processing long word data.

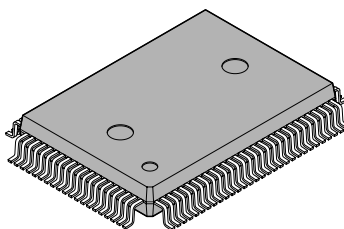
The MB90590/590G series has peripheral resources of 8/10-bit A/D converters, UART (SCI), extended I/O serial interface, 8/16-bit PPG timer, I/O timer (input capture (ICU), output compare (OCU)), stepping motor controller, and sound generator.

*1 : Controller Area Network (CAN) - License of Robert Bosch GmbH

*2 : F²MC stands for FUJITSU Flexible Microcontroller.

■ PACKAGE

100-pin Plastic QFP



(FPT-100P-M06)

MB90590/590G Series

■ FEATURES

- Clock
 - Embedded PLL clock multiplication circuit
 - Operating clock (PLL clock) can be selected from divided-by-2 of oscillation or one to four times the oscillation (at oscillation of 4 MHz, 4 MHz to 16 MHz).
 - Minimum instruction execution time : 62.5 ns (operation at oscillation of 4 MHz, four times the oscillation clock, V_{CC} of 5.0 V)
- Instruction set to optimize controller applications
 - Rich data types (bit, byte, word, long word)
 - Rich addressing mode (23 types)
 - Enhanced signed multiplication/division instruction and RETI instruction functions
 - Enhanced precision calculation realized by the 32-bit accumulator
- Instruction set designed for high level language (C language) and multi-task operations
 - Adoption of system stack pointer
 - Enhanced pointer indirect instructions
 - Barrel shift instructions
- Program patch function (for two address pointers)
- Enhanced execution speed : 4-byte instruction queue
- Enhanced interrupt function : 8 levels, 34 factors
- Automatic data transmission function independent of CPU operation
 - Extended intelligent I/O service function (EI²OS) : Up to 10 channels
- Embedded ROM size and types
 - Mask ROM : 256 Kbytes/384 Kbytes
 - Flash ROM : 256 Kbytes/384 Kbytes
 - Embedded RAM size : 6 Kbytes/8 Kbytes
- Flash ROM
 - Supports automatic programming, Embedded Algorithm TM*
 - Write/Erase/Erase-Suspend/Resume commands
 - A flag indicating completion of the algorithm
 - Hard-wired reset vector available in order to point to a fixed boot sector in Flash Memory
 - Erase can be performed on each block
 - Block protection with external programming voltage
- Low-power consumption (stand-by) mode
 - Sleep mode (mode in which CPU operating clock is stopped)
 - Stop mode (mode in which oscillation is stopped)
 - CPU intermittent operation mode
 - Clock mode
 - Hardware stand-by mode
- Process
 - 0.5 μ m CMOS technology
- I/O port
 - General-purpose I/O ports : 78 ports
- Timer
 - Watchdog timer : 1 channel
 - 8/16-bit PPG timer : 8/16-bit \times 6 channels
 - 16-bit re-load timer : 2 channels

- 16-bit I/O timer
16-bit free-run timer : 1 channel
Input capture : 6 channels
Output compare : 6 channels
- Extended I/O serial interface : 1 channel
- UART (3 channels)
With full-duplex double buffer (8-bit length)
Clock asynchronized or clock synchronized (with start/stop bit) transmission can be selectively used.
- Stepping motor controller (4 channels)
- External interrupt circuit (8 channels)
A module for starting an extended intelligent I/O service (EI²OS) and generating an external interrupt which is triggered by an external input.
- Delayed interrupt generation module
Generates an interrupt request for switching tasks.
- 8/10-bit A/D converter (8 channels)
8/10-bit resolution can be selectively used.
Starting by an external trigger input.
- FULL-CAN interfaces : 2
Conforming to Version 2.0 Part A and Part B
Flexible message buffering (mailbox and FIFO buffering can be mixed)
- Sound generator
- 18-bit Time-base counter
- Clock timer : 1 channel
- External bus interface : Maximum address space 16 Mbytes

* : Embedded Algorithm is a trade mark of Advanced Micro Devices Inc.

MB90590/590G Series

■ PRODUCT LINEUP

| Features | | MB90591/591G/594/594G | MB90F591A/F591G/ F594A/F594G | MB90V590A/V590G |
|-----------------------------------|------------------------|---|---|--------------------|
| Classification | | Mask ROM product | Flash ROM product | Evaluation product |
| ROM size | | 384/256 Kbytes | 384/256 Kbytes Boot block Hard-wired reset vector | None |
| RAM size | | 8/6 Kbytes | 8/6 Kbytes | 8 Kbytes |
| Emulator-specific power supply *1 | | — | | None |
| CPU functions | | The number of instructions : 340 Instruction bit length : 8 bits, 16 bits Instruction length : 1 byte to 7 bytes Data bit length : 1 bit, 8 bits, 16 bits Minimum execution time : 62.5 ns (at machine clock frequency of 16 MHz) Interrupt processing time : 1.5 μs (at machine clock frequency of 16 MHz, minimum value) | | |
| UART (3 channels) | | Clock synchronized transmission (500 Kbps / 1 Mbps / 2 Mbps) Clock asynchronized transmission (4808/5208/9615/10417/19230/38460/62500 /500000 bps at machine clock frequency of 16 MHz) Transmission can be performed by bi-directional serial transmission or by master/slave connection. | | |
| 8/10-bit A/D converter | | Conversion precision : 8/10-bit can be selectively used. Number of inputs : 8 One-shot conversion mode (converts selected channel once only) Scan conversion mode (converts two or more successive channels and can program up to 8 channels) Continuous conversion mode (converts selected channel continuously) Stop conversion mode (converts selected channel and stop operation repeatedly) | | |
| 8/16-bit PPG timers (6 channels) | | Number of channels : 6 (8/16-bit × 6 channels) PPG operation of 8-bit or 16-bit A pulse wave of given intervals and given duty ratios can be output. Pulse interval : fsys, fsys/2 ¹ , fsys/2 ² , fsys/2 ³ , fsys/2 ⁴ , 128μs (at oscillation of 4 MHz, fsys = system clock frequency of 16 MHz, fosc = oscillation clock frequency) | | |
| 16-bit Reload timer | | Number of channels : 2 Operation clock frequency : fsys/2 ¹ , fsys/2 ³ , fsys/2 ⁵ (fsys = System clock frequency) Supports External Event Count function | | |
| 16-bit I/O timer | 16-bit Output compares | Number of channels : 6 (8/16-bit × 6 channels) Pin input factor : A match signal of compare register | | |
| | Input captures | Number of channels : 6 Rewriting a register value upon a pin input (rising, falling, or both edges) | | |

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MB90590/590G Series

(Continued)

| Features | MB90591/591G/594/594G | MB90F591A/F591G/ F594A/F594G | MB90V590A/V590G |
|---|--|---|------------------------|
| CAN Interface | Number of channels : 2 Conforms to CAN Specification Version 2.0 Part A and B Automatic re-transmission in case of error Automatic transmission responding to Remote Frame Prioritized 16 message buffers for data and ID's Supports multiple messages Flexible configuration of acceptance filtering : Full bit compare / Full bit mask / Two partial bit masks Supports up to 1Mbps CAN bit timing setting : MB90xxx : TSEG2 ≥ RSJW+2TQ MB90xxxG : TSEG2 ≥ RSJW | | |
| Stepping motor controller (4 channels) | Four high current outputs for each channel Synchronized two 8-bit PWM's for each channel | | |
| External interrupt circuit | Number of inputs : 8 Started by a rising edge, a falling edge, an "H" level input, or an "L" level input. | | |
| Sound generator | 8-bit PWM signal is mixed with tone frequency from 8-bit reload counter PWM frequency : 62.5K, 31.2K, 15.6K, 7.8KHz (at System clock = 16MHz) Tone frequency : PWM frequency / 2 / (reload value + 1) | | |
| Extended I/O serial interface | Clock synchronized transmission (31.25K/62.5K/125K/500K/1Mbps at machine clock frequency of 16 MHz) LSB first/MSB first | | |
| Clock timer | Directly operates with the system clock Read/Write accessible Second/Minute/Hour registers | | |
| Watchdog timer | Reset generation interval : 3.58 ms, 14.33 ms, 57.23 ms, 458.75 ms (at oscillation of 4 MHz, minimum value) | | |
| Flash Memory | Supports automatic programming, Embedded Algorithm™ and Write/Erase/Erase-Suspend/Resume commands A flag indicating completion of the algorithm Hard-wired reset vector available in order to point to a fixed boot sector in Flash Memory Boot block configuration Erase can be performed on each block Block protection with external programming voltage Flash Writer from Minato Electronics Inc. | | |
| Low-power consumption (stand-by) mode | Sleep/stop/CPU intermittent operation/clock timer/hardware stand-by | | |
| Process | CMOS | | |
| Power supply voltage for operation*2 | 5 V±10 % (MB90V590A, MB90F594A, MB90594, MB90V590G, MB90F594G, MB90594G) 5 V±5 % (MB90F591G, MB90591G, MB90F591A, MB90591) | | |
| Package | QFP-100 | | PGA-256 |

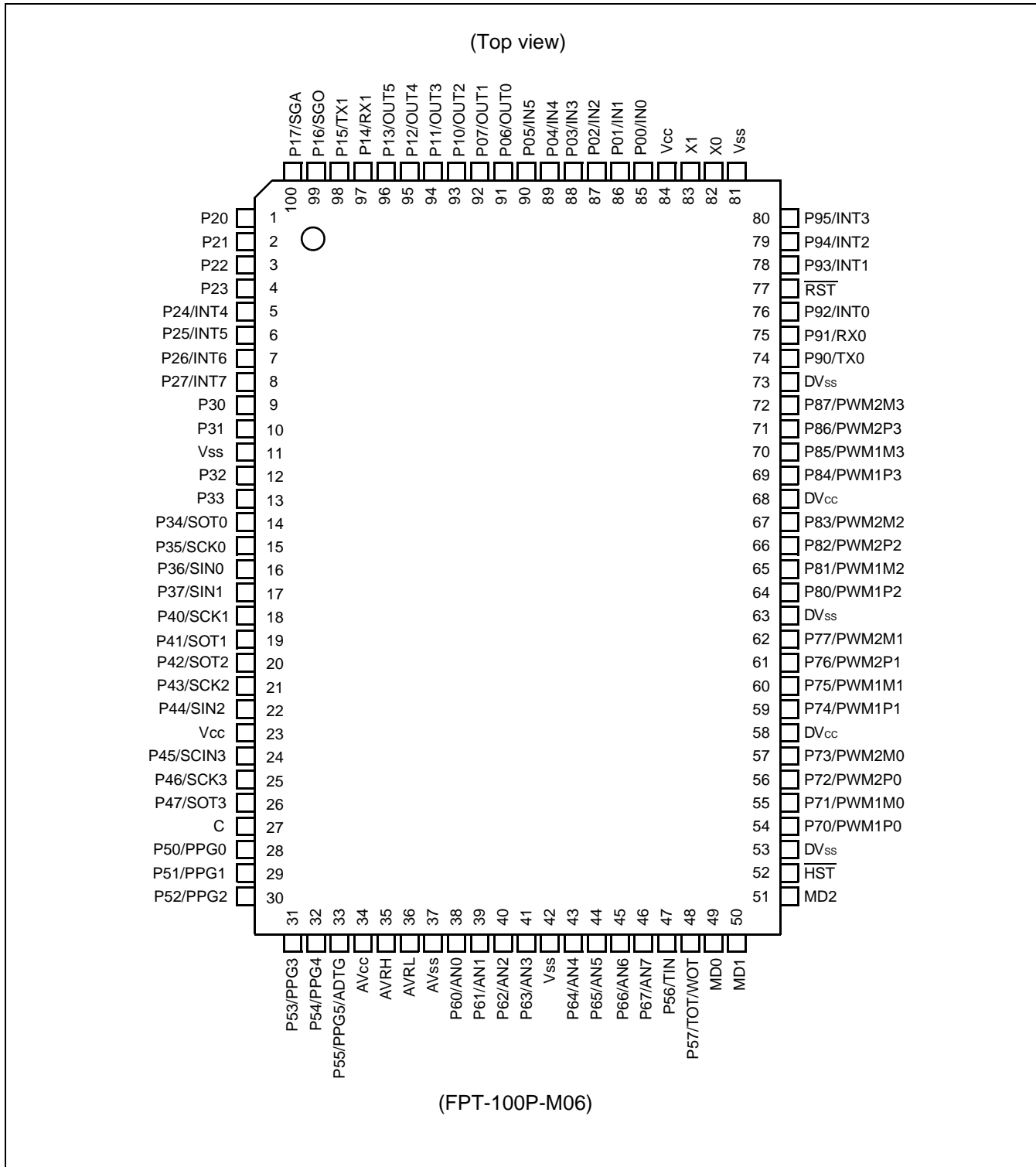
*1 : It is setting of DIP switch S2 when Emulation pod (MB2145-507) is used.

Please refer to the MB2145-507 hardware manual (2.7 Emulator-specific Power Pin) about details.

*2 : Varies with conditions such as the operating frequency. (See section “■ Electrical Characteristics.”)

MB90590/590G Series

PIN ASSIGNMENT



■ PIN DESCRIPTION

| No. | Pin name | Circuit type | Function |
|----------|---------------------------|--------------|--|
| 82 | X0 | A | Oscillator pin |
| 83 | X1 | | |
| 77 | $\overline{\text{RST}}$ | B | Reset input |
| 52 | $\overline{\text{HST}}$ | C | Hardware standby input |
| 85 to 90 | P00 to P05 | D | General purpose I/O |
| | IN0 to IN5 | | Inputs for the Input Captures |
| 91 to 96 | P06 to P07, P10 to P13 | D | General purpose I/O |
| | OUT0 to OUT5 | | Outputs for the Output Compares. To enable the signal outputs, the corresponding bits of the Port Direction registers should be set to "1". |
| 97 | P14 | D | General purpose I/O |
| | RX1 | | RX input for CAN Interface 1 |
| 98 | P15 | D | General purpose I/O |
| | TX1 | | TX output for CAN Interface 1. To enable the signal output, the corresponding bit of the Port Direction register should be set to "1". |
| 99 | P16 | D | General purpose I/O |
| | SGO | | SGO output for the Sound Generator. To enable the signal output, the corresponding bit of the Port Direction register should be set to "1". |
| 100 | P17 | D | General purpose I/O |
| | SGA | | SGA output for the Sound Generator. To enable the signal output, the corresponding bit of the Port Direction register should be set to "1". |
| 1 to 4 | P20 to P23 | D | General purpose I/O |
| 5 to 8 | P24 to P27 | D | General purpose I/O |
| | INT4 to INT7 | | External interrupt input for INT4 to INT7 |
| 9 to 10 | P30 to P31 | D | General purpose I/O |
| 12 to 13 | P32 to P33 | D | General purpose I/O |
| 14 | P34 | D | General purpose I/O |
| | SOT0 | | SOT output for UART 0. To enable the signal output, the corresponding bit of the Port Direction register should be set to "1". |
| 15 | P35 | D | General purpose I/O |
| | SCK0 | | SCK input/output for UART 0. To enable the signal output, the corresponding bit of the Port Direction register should be set to "1". |

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| No. | Pin name | Circuit type | Function |
|----------|--------------------|--------------|--|
| 16 | P36 | D | General purpose I/O |
| | SIN0 | | SIN input for UART 0 |
| 17 | P37 | D | General purpose I/O |
| | SIN1 | | SIN input for UART 1 |
| 18 | P40 | D | General purpose I/O |
| | SCK1 | | SCK input/output for UART 1 |
| 19 | P41 | D | General purpose I/O |
| | SOT1 | | SOT output for UART 1 |
| 20 | P42 | D | General purpose I/O |
| | SOT2 | | SOT output for UART 2 |
| 21 | P43 | D | General purpose I/O |
| | SCK2 | | SCK input/output for UART 2 |
| 22 | P44 | D | General purpose I/O |
| | SIN2 | | SIN input for UART 2 |
| 24 | P45 | D | General purpose I/O |
| | SIN3 | | SIN input for the Serial I/O |
| 25 | P46 | D | General purpose I/O |
| | SCK3 | | SCK input/output for the Serial I/O |
| 26 | P47 | D | General purpose I/O |
| | SOT3 | | SOT output for the Serial I/O |
| 28 to 33 | P50 to P55 | D | General purpose I/O |
| | PPG0 to PPG5, ADTG | | Outputs for the Programmable Pulse Generators. Pin number 33 is also shared with ADTG input for the external trigger of the A/D Converter. |
| 38 to 41 | P60 to P63 | E | General purpose I/O |
| | AN0 to AN3 | | Inputs for the A/D Converter |
| 43 to 46 | P64 to P67 | E | General purpose I/O |
| | AN4 to AN7 | | Inputs for the A/D Converter |
| 47 | P56 | D | General purpose I/O |
| | TIN | | TIN input for the 16-bit Reload Timers |
| 48 | P57 | D | General purpose I/O |
| | TOT/WOT | | TOT output for the 16-bit Reload Timers and WOT output for the Watch Timer. Only one of three output enable flags in these peripheral blocks can be set at a time. Otherwise the output signal has no meaning. |

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MB90590/590G Series

| No. | Pin name | Circuit type | Function |
|------------|---|--------------|--|
| 54 to 57 | P70 to P73 | F | General purpose I/O |
| | PWM1P0, PWM1M0, PWM2P0, PWM2M0 | | Output for Stepping Motor Controller channel 0. |
| 59 to 62 | P74 to P77 | F | General purpose I/O |
| | PWM1P1, PWM1M1, PWM2P1, PWM2M1 | | Output for Stepping Motor Controller channel 1. |
| 64 to 67 | P80 to P83 | F | General purpose I/O |
| | PWM1P2, PWM1M2, PWM2P2, PWM2M2 | | Output for Stepping Motor Controller channel 2. |
| 69 to 72 | P84 to P87 | F | General purpose I/O |
| | PWM1P3, PWM1M3, PWM2P3, PWM2M3 | | Output for Stepping Motor Controller channel 3. |
| 74 | P90 | D | General purpose I/O |
| | TX0 | | TX output for CAN Interface 0 |
| 75 | P91 | D | General purpose I/O |
| | RX0 | | RX input for CAN Interface 0 |
| 76 | P92 | D | General purpose I/O |
| | INT0 | | External interrupt input for INT0 |
| 78 | P93 | D | General purpose I/O |
| | INT1 | | External interrupt input for INT1 |
| 79 | P94 | D | General purpose I/O |
| | INT2 | | External interrupt input for INT2 |
| 80 | P95 | D | General purpose I/O |
| | INT3 | | External interrupt input for INT3 |
| 58, 68 | DV _{CC} | — | Dedicated power supply pins for the high current output buffers (Pin No. 54 to 72) |
| 53, 63, 73 | DV _{SS} | — | Dedicated ground pins for the high current output buffers (Pin No. 54 to 72) |
| 34 | AV _{CC} | Power supply | Power supply for analog circuit pin When turning this power supply on or off, always be sure to first apply electric potential equal to or greater than AV _{CC} to V _{CC} . |
| 37 | AV _{SS} | Power supply | Ground level for analog circuit |

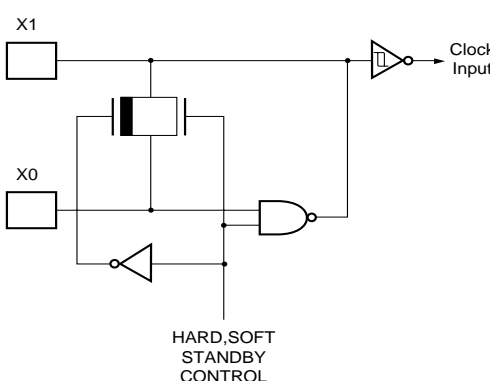
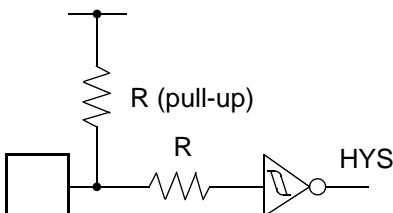
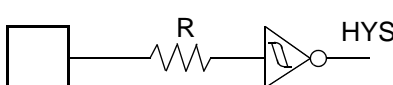
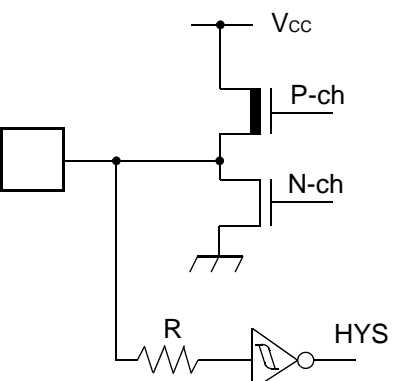
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MB90590/590G Series

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| No. | Pin name | Circuit type | Function |
|----------|-----------------|--------------|--|
| 35 | AVRH | Power supply | Reference voltage input pin for analog circuit When turning this power supply on or off, always be sure to first apply electric potential equal to or greater than AVRH to AV _{CC} . |
| 36 | AVRL | Power supply | Reference voltage input pin for analog circuit |
| 49, 50 | MD0, MD1 | C | Operating mode selection input pins Connect directly to V _{CC} or V _{SS} . |
| 51 | MD2 | G | Operating mode selection input pin Connect directly to V _{CC} or V _{SS} . |
| 27 | C | — | This is the power supply stabilization capacitor pin. It should be connected externally to an 0.1 μ F ceramic capacitor. |
| 23, 84 | V _{CC} | Power supply | Power supply (5.0 V) input pin for digital circuit |
| 11,42,81 | V _{SS} | Power supply | Power supply (GND) input pin for digital circuit |

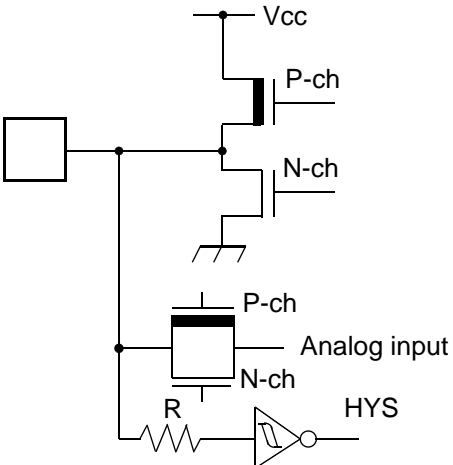
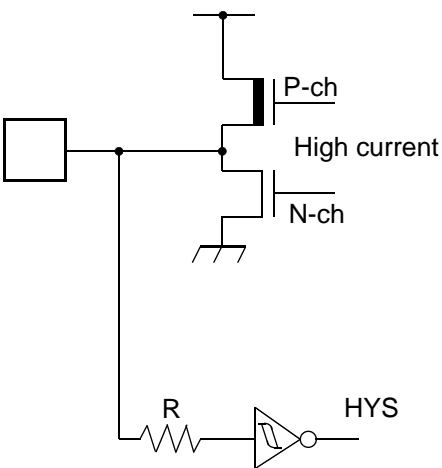
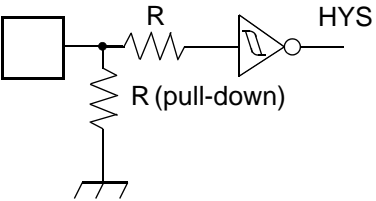
■ I/O CIRCUIT TYPE

| Circuit Type | Circuit | Remarks |
|--------------|---|--|
| A |  | <ul style="list-style-type: none"> Oscillation feedback resistor : 1 MΩ approx. |
| B |  | <ul style="list-style-type: none"> Hysteresis input with pull-up resistor : 50 kΩ approx. |
| C |  | <ul style="list-style-type: none"> Hysteresis input |
| D |  | <ul style="list-style-type: none"> CMOS output Hysteresis input |

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MB90590/590G Series

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| Circuit Type | Circuit | Remarks |
|--------------|---|---|
| E |  | <ul style="list-style-type: none"> • CMOS output • Hysteresis input • Analog input |
| F |  | <ul style="list-style-type: none"> • CMOS high current output • Hysteresis input |
| G |  | <ul style="list-style-type: none"> • Hysteresis input with pull-down resistor : 50 kΩ approx. • Flash version does not have pull-down resistor. |

■ HANDLING DEVICES

(1) Preventing latch-up

CMOS IC chips may suffer latch-up under the following conditions :

- A voltage higher than V_{cc} or lower than V_{ss} is applied to an input or output pin.
- A voltage higher than the rated voltage is applied between V_{cc} and V_{ss} .
- The AV_{cc} power supply is applied before the V_{cc} voltage.

Latch-up may increase the power supply current drastically, causing thermal damage to the device.

For the same reason, also be careful not to let the analog power-supply voltage (AV_{cc} , AV_{RH}) exceed the digital power-supply voltage.

(2) Treatment of unused pins

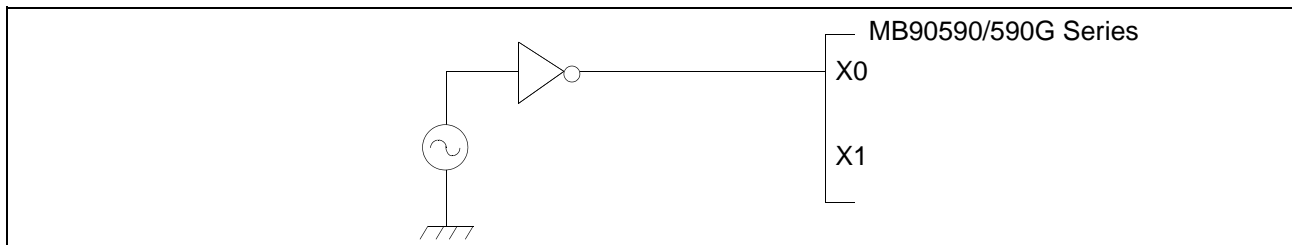
Leaving unused input pins open may result in misbehavior or latch up and possible permanent damage of the device. Therefore they must be pulled up or pulled down through resistors. In this case those resistors should be more than 2 k Ω .

Unused bidirectional pins should be set to the output state and can be left open, or the input state with the above described connection.

(3) Using external clock

To use external clock, drive X0 pin only and leave X1 pin unconnected.

Below is a diagram of how to use external clock.



Using external clock

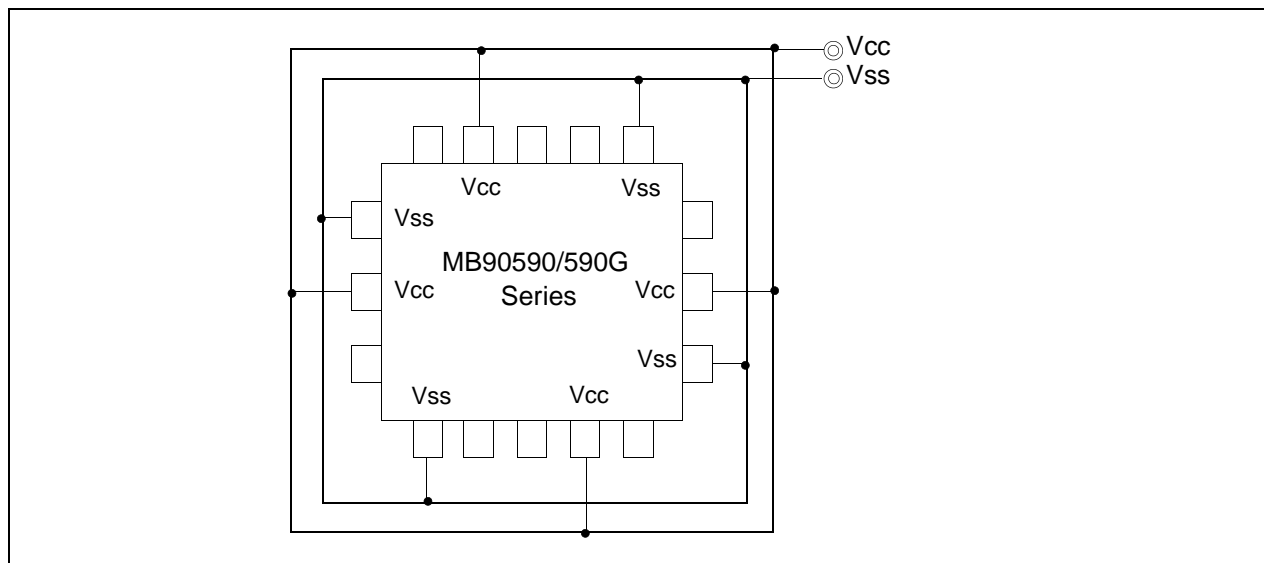
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(4) Power supply pins (Vcc/Vss)

In products with multiple Vcc or Vss pins, pins with the same potential are internally connected in the device to avoid abnormal operations including latch-up. However, you must connect the pins to an external power and a ground line 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 Vcc and Vss pins via lowest impedance to power lines.

It is recommended to provide a bypass capacitor of around 0.1 μF between Vcc and Vss pin near the device.



(5) Pull-up/down resistors

The MB90590/590G Series does not support internal pull-up/down resistors. Use external components where needed.

(6) Crystal Oscillator Circuit

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

A printed circuit board artwork surrounding the X0 and X1 pins with a ground area for stabilizing the operation is highly recommended.

(7) Turning-on Sequence of Power Supply to A/D Converter and Analog Inputs

Make sure to turn on the A/D converter power supply (AVcc, AVRH, AVRL) and analog inputs (AN0 to AN7) after turning-on the digital power supply (Vcc).

Turn-off the digital power after turning off the A/D converter supply and analog inputs. In this case, make sure that the voltage does not exceed AVRH or AVcc (turning on/off the analog and digital power supplies simultaneously is acceptable).

(8) Connection of Unused Pins of A/D Converter

Connect unused pins of A/D converter to AVcc = Vcc, AVss = AVRH = Vss.

(9) N.C. Pin

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

(10) Notes on Energization

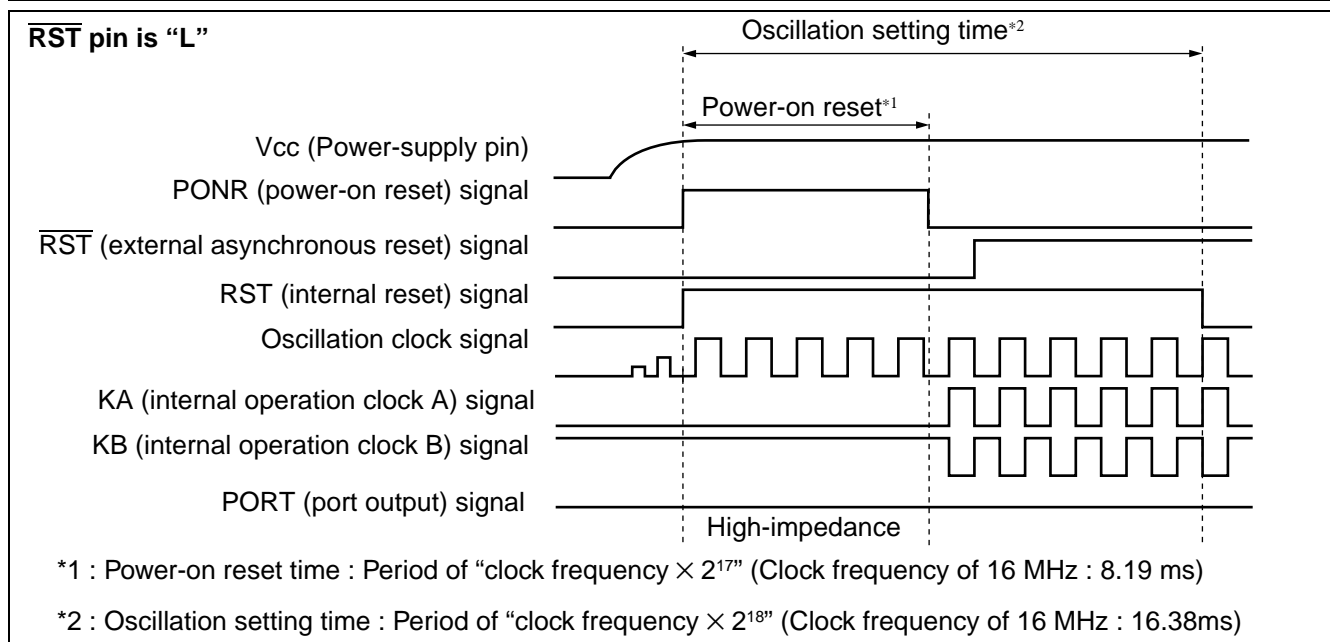
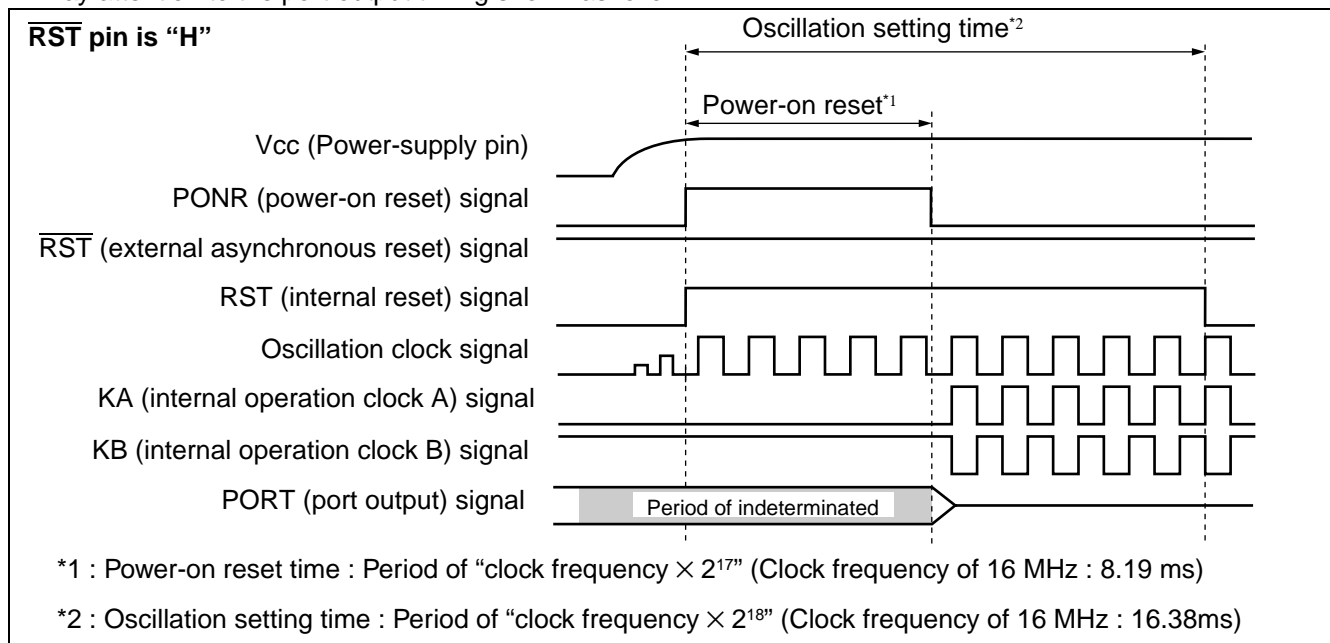
To prevent the internal regulator circuit from malfunctioning, set the voltage rise time during energization at 50 μ s or more (0.2 V to 2.7 V).

(11) Indeterminate outputs from ports 0 and 1 (without MB90F591G/591G, MB90F594G)

During oscillation setting time of step-down circuit (during a power-on reset) after the power is turned on, the outputs from ports 0 and 1 become following state.

- If $\overline{\text{RST}}$ pin is "H", the outputs become indeterminate.
- If $\overline{\text{RST}}$ pin is "L", the outputs become high-impedance.

Pay attention to the port output timing shown as follow.



(12) Initialization

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

(13) Directions of “DIV A, Ri” and “DIVW A, RWi” instructions

In the Signed multiplication and division instructions (“DIV A, Ri” and “DIVW A, RWi”), the value of the corresponding bank register (DTB, ADB, USB, SSB) is set in “00 H”.

If the values of the corresponding bank registers (DTB, ADB, USB, SSB) are set to other than “00 H”, the remainder by the execution result of the instruction is not stored in the register of the instruction operand.

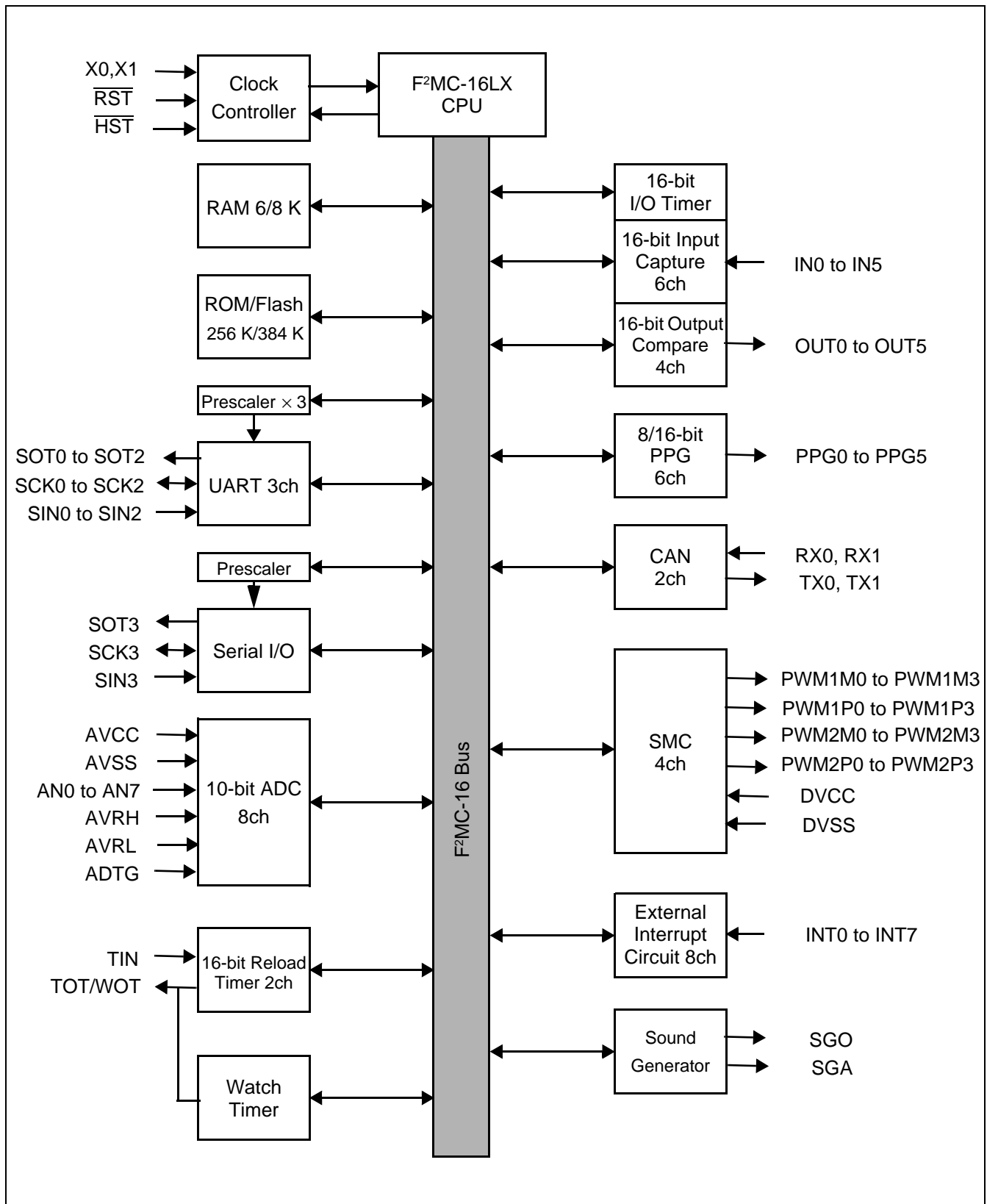
(14) Using REALOS

The use of EI²OS is not possible with the REALOS real time operating system.

(15) Caution on Operations during PLL Clock Mode

If the PLL clock mode is selected in the microcontroller, it may attempt to continue the operation using the free-running frequency of the automatic oscillating circuit in the PLL circuitry even if the oscillator is out of place or the clock input is stopped. Performance of this operation, however, cannot be guaranteed.

■ BLOCK DIAGRAM



MB90590/590G Series

■ MEMORY SPACE

The memory space of the MB90590/590G Series is shown below

| MB90V590A/V590G | | MB90594/F594A/ 594G/F594G | | MB90591/F591A/ 591G/F591G | |
|---|---------------------------|---|---------------------------|---|---------------------------|
| FFFFFF _H FF0000 _H | ROM (FF bank) | FFFFFF _H FF0000 _H | ROM (FF bank) | FFFFFF _H FF0000 _H | ROM (FF bank) |
| FEFFFF _H FE0000 _H | ROM (FE bank) | FEFFFF _H FE0000 _H | ROM (FE bank) | FEFFFF _H FE0000 _H | ROM (FE bank) |
| FDFFFF _H FD0000 _H | ROM (FD bank) | FDFFFF _H FD0000 _H | ROM (FD bank) | FDFFFF _H FD0000 _H | ROM (FD bank) |
| FCFFFF _H FC0000 _H | ROM (FC bank) | FCFFFF _H FC0000 _H | ROM (FC bank) | FCFFFF _H FC0000 _H | |
| FBFFFF _H FB0000 _H | ROM (FB bank) | | | FBFFFF _H FB0000 _H | ROM (FB bank) |
| FAFFFF _H FA0000 _H | ROM (FA bank) | | | FAFFFF _H FA0000 _H | ROM (FA bank) |
| F9FFFF _H F90000 _H | ROM (F9 bank) | | | F9FFFF _H F90000 _H | ROM (F9 bank) |
| | | | | | |
| 00FFFF _H 004000 _H | ROM (Image of FF bank) | 00FFFF _H 004000 _H | ROM (Image of FF bank) | 00FFFF _H 004000 _H | ROM (Image of FF bank) |
| | | | | | |
| 0028FF _H 002100 _H 0020FF _H | RAM 2K | | | 0028FF _H 002100 _H 0020FF _H | RAM 2K |
| | | | | | |
| 001FFF _H 001900 _H 0018FF _H | Peripheral | 001FFF _H 001900 _H 0018FF _H | Peripheral | 001FFF _H 001900 _H 0018FF _H | Peripheral |
| | RAM 6K | | RAM 6K | | RAM 6K |
| 000100 _H | | 000100 _H | | 000100 _H | |
| | | | | | |
| 0000BF _H 000000 _H | Peripheral | 0000BF _H 000000 _H | Peripheral | 0000BF _H 000000 _H | Peripheral |

Memory space map

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 of bank FF and the lower 16-bit of bank 00 are 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_H, the contents of the ROM at FFC000_H are accessed. 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_H to FFFFFFF_H looks, therefore, as if it were the image for 004000_H to 00FFFF_H. Thus, it is recommended that the ROM data table be stored in the area of FF4000_H to FFFFFFF_H.

MB90590/590G Series

■ I/O MAP

| Address | Register | Abbreviation | Access | Peripheral | Initial value |
|------------------------------------|-------------------------------------|-----------------|--------|-------------|------------------------------|
| 00 _H | Port 0 Data Register | PDR0 | R/W | Port 0 | XXXXXXXX _B |
| 01 _H | Port 1 Data Register | PDR1 | R/W | Port 1 | XXXXXXXX _B |
| 02 _H | Port 2 Data Register | PDR2 | R/W | Port 2 | XXXXXXXX _B |
| 03 _H | Port 3 Data Register | PDR3 | R/W | Port 3 | XXXXXXXX _B |
| 04 _H | Port 4 Data Register | PDR4 | R/W | Port 4 | XXXXXXXX _B |
| 05 _H | Port 5 Data Register | PDR5 | R/W | Port 5 | XXXXXXXX _B |
| 06 _H | Port 6 Data Register | PDR6 | R/W | Port 6 | XXXXXXXX _B |
| 07 _H | Port 7 Data Register | PDR7 | R/W | Port 7 | XXXXXXXX _B |
| 08 _H | Port 8 Data Register | PDR8 | R/W | Port 8 | XXXXXXXX _B |
| 09 _H | Port 9 Data Register | PDR9 | R/W | Port 9 | __ XXXXXX _B |
| 0A _H to 0F _H | Reserved | | | | |
| 10 _H | Port 0 Direction Register | DDR0 | R/W | Port 0 | 0 0 0 0 0 0 0 0 _B |
| 11 _H | Port 1 Direction Register | DDR1 | R/W | Port 1 | 0 0 0 0 0 0 0 0 _B |
| 12 _H | Port 2 Direction Register | DDR2 | R/W | Port 2 | 0 0 0 0 0 0 0 0 _B |
| 13 _H | Port 3 Direction Register | DDR3 | R/W | Port 3 | 0 0 0 0 0 0 0 0 _B |
| 14 _H | Port 4 Direction Register | DDR4 | R/W | Port 4 | 0 0 0 0 0 0 0 0 _B |
| 15 _H | Port 5 Direction Register | DDR5 | R/W | Port 5 | 0 0 0 0 0 0 0 0 _B |
| 16 _H | Port 6 Direction Register | DDR6 | R/W | Port 6 | 0 0 0 0 0 0 0 0 _B |
| 17 _H | Port 7 Direction Register | DDR7 | R/W | Port 7 | 0 0 0 0 0 0 0 0 _B |
| 18 _H | Port 8 Direction Register | DDR8 | R/W | Port 8 | 0 0 0 0 0 0 0 0 _B |
| 19 _H | Port 9 Direction Register | DDR9 | R/W | Port 9 | __ 0 0 0 0 0 0 _B |
| 1A _H | Reserved | | | | |
| 1B _H | Analog Input Enable Register | ADER | R/W | Port 6, A/D | 1 1 1 1 1 1 1 1 _B |
| 1C _H to 1F _H | Reserved | | | | |
| 20 _H | Serial Mode Control Register 0 | UMC0 | R/W | UART0 | 0 0 0 0 1 0 0 _B |
| 21 _H | Serial Status Register 0 | USR0 | R/W | | 0 0 0 1 0 0 0 _B |
| 22 _H | Serial Input/Output Data Register 0 | UIDR0/ UODR0 | R/W | | XXXXXXXX _B |
| 23 _H | Rate and Data Register 0 | URD0 | R/W | | 0 0 0 0 0 0 0 X _B |
| 24 _H | Serial Mode Control Register 1 | UMC1 | R/W | UART1 | 0 0 0 0 1 0 0 _B |
| 25 _H | Serial Status Register 1 | USR1 | R/W | | 0 0 0 1 0 0 0 _B |
| 26 _H | Serial Input/Output Data Register 1 | UIDR1/ UODR1 | R/W | | XXXXXXXX _B |
| 27 _H | Rate and Data Register 1 | URD1 | R/W | | 0 0 0 0 0 0 0 X _B |

(Continued)

MB90590/590G Series

| Address | Register | Abbreviation | Access | Peripheral | Initial value |
|-----------------|---|-----------------|--------|---|------------------------------|
| 28 _H | Serial Mode Control Register 2 | UMC2 | R/W | UART2 | 0 0 0 0 0 1 0 0 _B |
| 29 _H | Serial Status Register 2 | USR2 | R/W | | 0 0 0 1 0 0 0 0 _B |
| 2A _H | Serial Input/Output Data Register 2 | UIDR2/ UODR2 | R/W | | XXXXXXXX _B |
| 2B _H | Rate and Data Register 2 | URD2 | R/W | | 0 0 0 0 0 0 0 X _B |
| 2C _H | Serial Mode Control Register (low-order) | SMCS | R/W | Serial I/O | ____0 0 0 0 _B |
| 2D _H | Serial Mode Control Register (high-order) | SMCS | R/W | | 0 0 0 0 0 0 1 0 _B |
| 2E _H | Serial Data Register | SDR | R/W | | XXXXXXXX _B |
| 2F _H | Edge Selector Register | SES | R/W | | _______0 _B |
| 30 _H | External Interrupt Enable Register | ENIR | R/W | External Interrupt | 0 0 0 0 0 0 0 0 _B |
| 31 _H | External Interrupt Request Register | EIRR | R/W | | XXXXXXXX _B |
| 32 _H | External Interrupt Level Register | ELVR | R/W | | 0 0 0 0 0 0 0 0 _B |
| 33 _H | External Interrupt Level Register | ELVR | R/W | | 0 0 0 0 0 0 0 0 _B |
| 34 _H | A/D Control Status Register 0 | ADCS0 | R/W | A/D Converter | 0 0 0 0 0 0 0 0 _B |
| 35 _H | A/D Control Status Register 1 | ADCS1 | R/W | | 0 0 0 0 0 0 0 0 _B |
| 36 _H | A/D Data Register 0 | ADCR0 | R | | XXXXXXXX _B |
| 37 _H | A/D Data Register 1 | ADCR1 | R/W | | 0 0 0 0 1 0 X X _B |
| 38 _H | PPG0 Operation Mode Control Register | PPGC0 | R/W | 16-bit Programmable Pulse Generator 0/1 | 0 _ 0 0 0 _ _ 1 _B |
| 39 _H | PPG1 Operation Mode Control Register | PPGC1 | R/W | | 0 _ 0 0 0 0 0 1 _B |
| 3A _H | PPG0,1 Output Pin Control Register | PPG01 | R/W | | 0 0 0 0 0 0 0 0 _B |
| 3B _H | Reserved | | | | |
| 3C _H | PPG2 Operation Mode Control Register | PPGC2 | R/W | 16-bit Programmable Pulse Generator 2/3 | 0 _ 0 0 0 _ _ 1 _B |
| 3D _H | PPG3 Operation Mode Control Register | PPGC3 | R/W | | 0 _ 0 0 0 0 0 1 _B |
| 3E _H | PPG2,3 Output Pin Control Register | PPG23 | R/W | | 0 0 0 0 0 0 0 0 _B |
| 3F _H | Reserved | | | | |
| 40 _H | PPG4 Operation Mode Control Register | PPGC4 | R/W | 16-bit Programmable Pulse Generator 4/5 | 0 _ 0 0 0 _ _ 1 _B |
| 41 _H | PPG5 Operation Mode Control Register | PPGC5 | R/W | | 0 _ 0 0 0 0 0 1 _B |
| 42 _H | PPG4,5 Output Pin Control Register | PPG45 | R/W | | 0 0 0 0 0 0 0 0 _B |
| 43 _H | Reserved | | | | |
| 44 _H | PPG6 Operation Mode Control Register | PPGC6 | R/W | 16-bit Programmable Pulse Generator 6/7 | 0 _ 0 0 0 _ _ 1 _B |
| 45 _H | PPG7 Operation Mode Control Register | PPGC7 | R/W | | 0 _ 0 0 0 0 0 1 _B |
| 46 _H | PPG6,7 Output Pin Control Register | PPG67 | R/W | | 0 0 0 0 0 0 0 0 _B |
| 47 _H | Reserved | | | | |

(Continued)

MB90590/590G Series

| Address | Register | Abbreviation | Access | Peripheral | Initial value |
|-----------------|--|--------------|--------|---|------------------------------|
| 48 _H | PPG8 Operation Mode Control Register | PPGC8 | R/W | 16-bit Programmable Pulse Generator 8/9 | 0 _ 0 0 0 _ _ 1 _B |
| 49 _H | PPG9 Operation Mode Control Register | PPGC9 | R/W | | 0 _ 0 0 0 0 0 1 _B |
| 4A _H | PPG8,9 Output Pin Control Register | PPG89 | R/W | | 0 0 0 0 0 0 0 0 _B |
| 4B _H | Reserved | | | | |
| 4C _H | PPGA Operation Mode Control Register | PPGCA | R/W | 16-bit Programmable Pulse Generator A/B | 0 _ 0 0 0 _ _ 1 _B |
| 4D _H | PPGB Operation Mode Control Register | PPGCB | R/W | | 0 _ 0 0 0 0 0 1 _B |
| 4E _H | PPGA,B Output Pin Control Register | PPGAB | R/W | | 0 0 0 0 0 0 0 0 _B |
| 4F _H | Reserved | | | | |
| 50 _H | Timer Control Status Register 0 (low-order) | TMCSR0 | R/W | 16-bit Reload Timer 0 | 0 0 0 0 0 0 0 0 _B |
| 51 _H | Timer Control Status Register 0 (high-order) | TMCSR0 | R/W | | _ _ _ _ 0 0 0 0 _B |
| 52 _H | Timer Control Status Register 1 (low-order) | TMCSR1 | R/W | 16-bit Reload Timer 1 | 0 0 0 0 0 0 0 0 _B |
| 53 _H | Timer Control Status Register 1 (high-order) | TMCSR1 | R/W | | _ _ _ _ 0 0 0 0 _B |
| 54 _H | Input Capture Control Status Register 0/1 | ICS01 | R/W | Input Capture 0/1 | 0 0 0 0 0 0 0 0 _B |
| 55 _H | Input Capture Control Status Register 2/3 | ICS23 | R/W | Input Capture 2/3 | 0 0 0 0 0 0 0 0 _B |
| 56 _H | Input Capture Control Status Register 4/5 | ICS45 | R/W | Input Capture 4/5 | 0 0 0 0 0 0 0 0 _B |
| 57 _H | Reserved | | | | |
| 58 _H | Output Compare Control Status Register 0 | OCS0 | R/W | Output Compare 0/1 | 0 0 0 0 _ _ 0 0 _B |
| 59 _H | Output Compare Control Status Register 1 | OCS1 | R/W | | _ _ _ 0 0 0 0 0 _B |
| 5A _H | Output Compare Control Status Register 2 | OCS2 | R/W | Output Compare 2/3 | 0 0 0 0 _ _ 0 0 _B |
| 5B _H | Output Compare Control Status Register 3 | OCS3 | R/W | | _ _ _ 0 0 0 0 0 _B |
| 5C _H | Output Compare Control Status Register 4 | OCS4 | R/W | Output Compare 4/5 | 0 0 0 0 _ _ 0 0 _B |
| 5D _H | Output Compare Control Status Register 5 | OCS5 | R/W | | _ _ _ 0 0 0 0 0 _B |
| 5E _H | Sound Control Register (low-order) | SGCR | R/W | Sound Generator | 0 0 0 0 0 0 0 0 _B |
| 5F _H | Sound Control Register (high-order) | SGCR | R/W | | 0 _ _ _ _ _ 0 _B |

(Continued)

MB90590/590G Series

| Address | Register | Abbreviation | Access | Peripheral | Initial value |
|------------------------------------|---|--------------|--------|----------------------------------|------------------------------|
| 60 _H | Watch Timer Control Register (low-order) | WTCR | R/W | Watch Timer | 0 0 0 _ _ 0 0 0 _B |
| 61 _H | Watch Timer Control Register (high-order) | WTCR | R/W | | 0 0 0 0 0 0 0 0 _B |
| 62 _H | PWM Control Register 0 | PWC0 | R/W | Stepping Motor Controller 0 | 0 0 0 0 0 _ _ 0 _B |
| 63 _H | Reserved | | | | |
| 64 _H | PWM Control Register 1 | PWC1 | R/W | Stepping Motor Controller 1 | 0 0 0 0 0 _ _ 0 _B |
| 65 _H | Reserved | | | | |
| 66 _H | PWM Control Register 2 | PWC2 | R/W | Stepping Motor Controller 2 | 0 0 0 0 0 _ _ 0 _B |
| 67 _H | Reserved | | | | |
| 68 _H | PWM Control Register 3 | PWC3 | R/W | Stepping Motor Controller 3 | 0 0 0 0 0 _ _ 0 _B |
| 69 _H to 6C _H | Reserved | | | | |
| 6D _H | Serial I/O Prescaler Register | CDCR | R/W | Prescaler (Serial I/O) | 0 XXX 1 1 1 1 _B |
| 6E _H | Timer Control Status Register | TCCS | R/W | I/O Timer | 0 0 0 0 0 0 0 0 _B |
| 6F _H | ROM Mirror Function Select Register | ROMM | W | ROM Mirror | XXXXXXXX1 _B |
| 70 _H to 8F _H | Reserved for CAN Interface 0/1. Refer to section about CAN Controller | | | | |
| 90 _H to 9D _H | Reserved | | | | |
| 9E _H | Program Address Detection Control Status Register | PACSR | R/W | Address Match Detection Function | 0 0 0 0 0 0 0 0 _B |
| 9F _H | Delayed Interrupt/Release Register | DIRR | R/W | Delayed Interrupt | _ _ _ _ _ _ _ 0 _B |
| A0 _H | Low Power Mode Control Register | LPMCR | R/W | Low Power Controller | 0 0 0 1 1 0 0 0 _B |
| A1 _H | Clock Selection Register | CKSCR | R/W | Low Power Controller | 1 1 1 1 1 1 0 0 _B |
| A2 _H to A7 _H | Reserved | | | | |
| A8 _H | Watchdog Timer Control Register | WDTC | R/W | Watchdog Timer | XXXXX 1 1 1 _B |
| A9 _H | Time Base Timer Control Register | TBTC | R/W | Time Base Timer | 1 - - 0 0 1 0 0 _B |
| AA _H to AD _H | Reserved | | | | |
| AE _H | Flash Memory Control Status Register (Flash product only. Otherwise reserved) | FMCS | R/W | Flash Memory | 0 0 0 X 0 0 0 0 _B |
| AF _H | Reserved | | | | |

(Continued)

MB90590/590G Series

| Address | Register | Abbreviation | Access | Peripheral | Initial value |
|---------------------------------------|-------------------------------|--------------|--------|---|------------------------------|
| B0 _H | Interrupt Control Register 00 | ICR00 | R/W | Interrupt controller | 0 0 0 0 0 1 1 1 _B |
| B1 _H | Interrupt Control Register 01 | ICR01 | R/W | | 0 0 0 0 0 1 1 1 _B |
| B2 _H | Interrupt Control Register 02 | ICR02 | R/W | | 0 0 0 0 0 1 1 1 _B |
| B3 _H | Interrupt Control Register 03 | ICR03 | R/W | | 0 0 0 0 0 1 1 1 _B |
| B4 _H | Interrupt Control Register 04 | ICR04 | R/W | | 0 0 0 0 0 1 1 1 _B |
| B5 _H | Interrupt Control Register 05 | ICR05 | R/W | | 0 0 0 0 0 1 1 1 _B |
| B6 _H | Interrupt Control Register 06 | ICR06 | R/W | | 0 0 0 0 0 1 1 1 _B |
| B7 _H | Interrupt Control Register 07 | ICR07 | R/W | | 0 0 0 0 0 1 1 1 _B |
| B8 _H | Interrupt Control Register 08 | ICR08 | R/W | | 0 0 0 0 0 1 1 1 _B |
| B9 _H | Interrupt Control Register 09 | ICR09 | R/W | | 0 0 0 0 0 1 1 1 _B |
| BA _H | Interrupt Control Register 10 | ICR10 | R/W | | 0 0 0 0 0 1 1 1 _B |
| BB _H | Interrupt Control Register 11 | ICR11 | R/W | | 0 0 0 0 0 1 1 1 _B |
| BC _H | Interrupt Control Register 12 | ICR12 | R/W | | 0 0 0 0 0 1 1 1 _B |
| BD _H | Interrupt Control Register 13 | ICR13 | R/W | | 0 0 0 0 0 1 1 1 _B |
| BE _H | Interrupt Control Register 14 | ICR14 | R/W | | 0 0 0 0 0 1 1 1 _B |
| BF _H | Interrupt Control Register 15 | ICR15 | R/W | | 0 0 0 0 0 1 1 1 _B |
| C0 _H to FF _H | Reserved | | | | |
| 1900 _H | Reload L Register | PRLL0 | R/W | 16-bit Programmable Pulse Generator 0/1 | XXXXXXXX _B |
| 1901 _H | Reload H Register | PRLH0 | R/W | | XXXXXXXX _B |
| 1902 _H | Reload L Register | PRLL1 | R/W | | XXXXXXXX _B |
| 1903 _H | Reload H Register | PRLH1 | R/W | | XXXXXXXX _B |
| 1904 _H | Reload L Register | PRLL2 | R/W | 16-bit Programmable Pulse Generator 2/3 | XXXXXXXX _B |
| 1905 _H | Reload H Register | PRLH2 | R/W | | XXXXXXXX _B |
| 1906 _H | Reload L Register | PRLL3 | R/W | | XXXXXXXX _B |
| 1907 _H | Reload H Register | PRLH3 | R/W | | XXXXXXXX _B |
| 1908 _H | Reload L Register | PRLL4 | R/W | 16-bit Programmable Pulse Generator 4/5 | XXXXXXXX _B |
| 1909 _H | Reload H Register | PRLH4 | R/W | | XXXXXXXX _B |
| 190A _H | Reload L Register | PRLL5 | R/W | | XXXXXXXX _B |
| 190B _H | Reload H Register | PRLH5 | R/W | | XXXXXXXX _B |
| 190C _H | Reload L Register | PRLL6 | R/W | 16-bit Programmable Pulse Generator 6/7 | XXXXXXXX _B |
| 190D _H | Reload H Register | PRLH6 | R/W | | XXXXXXXX _B |
| 190E _H | Reload L Register | PRLL7 | R/W | | XXXXXXXX _B |
| 190F _H | Reload H Register | PRLH7 | R/W | | XXXXXXXX _B |

(Continued)

MB90590/590G Series

| Address | Register | Abbreviation | Access | Peripheral | Initial value |
|--|---------------------------------------|--------------|--------|---|-----------------------|
| 1910 _H | Reload L Register | PRLL8 | R/W | 16-bit Programmable Pulse Generator 8/9 | XXXXXXXX _B |
| 1911 _H | Reload H Register | PRLH8 | R/W | | XXXXXXXX _B |
| 1912 _H | Reload L Register | PRLL9 | R/W | | XXXXXXXX _B |
| 1913 _H | Reload H Register | PRLH9 | R/W | | XXXXXXXX _B |
| 1914 _H | Reload L Register | PRLLA | R/W | 16-bit Programmable Pulse Generator A/B | XXXXXXXX _B |
| 1915 _H | Reload H Register | PRLHA | R/W | | XXXXXXXX _B |
| 1916 _H | Reload L Register | PRLLB | R/W | | XXXXXXXX _B |
| 1917 _H | Reload H Register | PRLHB | R/W | | XXXXXXXX _B |
| 1918 _H to 191F _H | Reserved | | | | |
| 1920 _H | Input Capture Register 0 (low-order) | IPCP0 | R | Input Capture 0/1 | XXXXXXXX _B |
| 1921 _H | Input Capture Register 0 (high-order) | IPCP0 | R | | XXXXXXXX _B |
| 1922 _H | Input Capture Register 1 (low-order) | IPCP1 | R | | XXXXXXXX _B |
| 1923 _H | Input Capture Register 1 (high-order) | IPCP1 | R | | XXXXXXXX _B |
| 1924 _H | Input Capture Register 2 (low-order) | IPCP2 | R | Input Capture 2/3 | XXXXXXXX _B |
| 1925 _H | Input Capture Register 2 (high-order) | IPCP2 | R | | XXXXXXXX _B |
| 1926 _H | Input Capture Register 3 (low-order) | IPCP3 | R | | XXXXXXXX _B |
| 1927 _H | Input Capture Register 3 (high-order) | IPCP3 | R | | XXXXXXXX _B |
| 1928 _H | Input Capture Register 4 (low-order) | IPCP4 | R | Input Capture 4/5 | XXXXXXXX _B |
| 1929 _H | Input Capture Register 4 (high-order) | IPCP4 | R | | XXXXXXXX _B |
| 192A _H | Input Capture Register 5 (low-order) | IPCP5 | R | | XXXXXXXX _B |
| 192B _H | Input Capture Register 5 (high-order) | IPCP5 | R | | XXXXXXXX _B |
| 192C _H to 192F _H | Reserved | | | | |

(Continued)

MB90590/590G Series

| Address | Register | Abbreviation | Access | Peripheral | Initial value |
|--|--|--------------|--------|-----------------------|----------------------------|
| 1930 _H | Output Compare Register 0 (low-order) | OCCP0 | R/W | Output Compare 0/1 | XXXXXXXX _B |
| 1931 _H | Output Compare Register 0 (high-order) | OCCP0 | R/W | | XXXXXXXX _B |
| 1932 _H | Output Compare Register 1 (low-order) | OCCP1 | R/W | | XXXXXXXX _B |
| 1933 _H | Output Compare Register 1 (high-order) | OCCP1 | R/W | | XXXXXXXX _B |
| 1934 _H | Output Compare Register 2 (low-order) | OCCP2 | R/W | Output Compare 2/3 | XXXXXXXX _B |
| 1935 _H | Output Compare Register 2 (high-order) | OCCP2 | R/W | | XXXXXXXX _B |
| 1936 _H | Output Compare Register 3 (low-order) | OCCP3 | R/W | | XXXXXXXX _B |
| 1937 _H | Output Compare Register 3 (high-order) | OCCP3 | R/W | | XXXXXXXX _B |
| 1938 _H | Output Compare Register 4 (low-order) | OCCP4 | R/W | Output Compare 4/5 | XXXXXXXX _B |
| 1939 _H | Output Compare Register 4 (high-order) | OCCP4 | R/W | | XXXXXXXX _B |
| 193A _H | Output Compare Register 5 (low-order) | OCCP5 | R/W | | XXXXXXXX _B |
| 193B _H | Output Compare Register 5 (high-order) | OCCP5 | R/W | | XXXXXXXX _B |
| 193C _H to 193F _H | Reserved | | | | |
| 1940 _H | Timer 0/Reload Register 0 (low-order) | TMR0/ TMRLR0 | R/W | 16-bit Reload Timer 0 | XXXXXXXX _B |
| 1941 _H | Timer 0/Reload Register 0 (high-order) | TMR0/ TMRLR0 | R/W | | XXXXXXXX _B |
| 1942 _H | Timer 1/Reload Register 1 (low-order) | TMR1/ TMRLR1 | R/W | 16-bit Reload Timer 1 | XXXXXXXX _B |
| 1943 _H | Timer 1/Reload Register 1 (high-order) | TMR1/ TMRLR1 | R/W | | XXXXXXXX _B |
| 1944 _H | Timer Data Register (low-order) | TCDT | R/W | I/O Timer | 0 0 0 0 0 0 0 _B |
| 1945 _H | Timer Data Register (high-order) | TCDT | R/W | | 0 0 0 0 0 0 0 _B |
| 1946 _H | Frequency Data Register | SGFR | R/W | Sound Generator | XXXXXXXX _B |
| 1947 _H | Amplitude Data Register | SGAR | R/W | | XXXXXXXX _B |
| 1948 _H | Decrement Grade Register | SGDR | R/W | | XXXXXXXX _B |
| 1949 _H | Tone Count Register | SGTR | R/W | | XXXXXXXX _B |

(Continued)

MB90590/590G Series

| Address | Register | Abbreviation | Access | Peripheral | Initial value |
|--|---|--------------|--------|-----------------------------|------------------------|
| 194A _H | Sub-second Data Register (low-order) | WTBR | R/W | Watch Timer | XXXXXXXX _B |
| 194B _H | Sub-second Data Register (middle-order) | WTBR | R/W | | XXXXXXXX _B |
| 194C _H | Sub-second Data Register (high-order) | WTBR | R/W | | ___ XXXXX _B |
| 194D _H | Second Data Register | WTSR | R/W | | __ 000000 _B |
| 194E _H | Minute Data Register | WTMR | R/W | Watch Timer | __ 000000 _B |
| 194F _H | Hour Data Register | WTHR | R/W | | ___ 00000 _B |
| 1950 _H | PWM1 Compare Register 0 | PWC10 | R/W | Stepping Motor Controller 0 | XXXXXXXX _B |
| 1951 _H | PWM2 Compare Register 0 | PWC20 | R/W | | XXXXXXXX _B |
| 1952 _H | PWM1 Select Register 0 | PWS10 | R/W | | __ 000000 _B |
| 1953 _H | PWM2 Select Register 0 | PWS20 | R/W | | _ 0000000 _B |
| 1954 _H | PWM1 Compare Register 1 | PWC11 | R/W | Stepping Motor Controller 1 | XXXXXXXX _B |
| 1955 _H | PWM2 Compare Register 1 | PWC21 | R/W | | XXXXXXXX _B |
| 1956 _H | PWM1 Select Register 1 | PWS11 | R/W | | __ 000000 _B |
| 1957 _H | PWM2 Select Register 1 | PWS21 | R/W | | _ 0000000 _B |
| 1958 _H | PWM1 Compare Register 2 | PWC12 | R/W | Stepping Motor Controller 2 | XXXXXXXX _B |
| 1959 _H | PWM2 Compare Register 2 | PWC22 | R/W | | XXXXXXXX _B |
| 195A _H | PWM1 Select Register 2 | PWS12 | R/W | | __ 000000 _B |
| 195B _H | PWM2 Select Register 2 | PWS22 | R/W | | _ 0000000 _B |
| 195C _H | PWM1 Compare Register 3 | PWC13 | R/W | Stepping Motor Controller 3 | XXXXXXXX _B |
| 195D _H | PWM2 Compare Register 3 | PWC23 | R/W | | XXXXXXXX _B |
| 195E _H | PWM1 Select Register 3 | PWS13 | R/W | | __ 000000 _B |
| 195F _H | PWM2 Select Register 3 | PWS23 | R/W | | _ 0000000 _B |
| 1960 _H to 19FF _H | Reserved | | | | |
| 1A00 _H to 1AFF _H | Reserved for CAN Interface 0. Refer to section about CAN Controller | | | | |
| 1B00 _H to 1BFF _H | Reserved for CAN Interface 1. Refer to section about CAN Controller | | | | |
| 1C00 _H to 1CFF _H | Reserved for CAN Interface 0. Refer to section about CAN Controller | | | | |
| 1D00 _H to 1DFF _H | Reserved for CAN Interface 1. Refer to section about CAN Controller | | | | |
| 1E00 _H to 1EFF _H | Reserved | | | | |

(Continued)

(Continued)

| Address | Register | Abbreviation | Access | Peripheral | Initial value |
|--|---|--------------|--------|----------------------------------|-----------------------|
| 1FF0 _H | Program Address Detection Register 0 (low-order) | PADR0 | R/W | Address Match Detection Function | XXXXXXXX _B |
| 1FF1 _H | Program Address Detection Register 0 (middle-order) | PADR0 | R/W | | XXXXXXXX _B |
| 1FF2 _H | Program Address Detection Register 0 (high-order) | PADR0 | R/W | | XXXXXXXX _B |
| 1FF3 _H | Program Address Detection Register 1 (low-order) | PADR1 | R/W | | XXXXXXXX _B |
| 1FF4 _H | Program Address Detection Register 1 (middle-order) | PADR1 | R/W | | XXXXXXXX _B |
| 1FF5 _H | Program Address Detection Register 1 (high-order) | PADR1 | R/W | | XXXXXXXX _B |
| 1FF6 _H to 1FFF _H | Reserved | | | | |

Note : Initial value of “_” represents unused bit; “X” represents unknown value.

Addresses in the rage 0000_H to 00FF_H, which are not listed in the table, are reserved for the primary functions of the MCU. A read access to these reserved addresses results in reading “X”, and any write access should not be performed.

MB90590/590G Series

■ CAN CONTROLLERS

The CAN controller has the following features : Conforms to CAN Specification Version 2.0 Part A and B

- Supports transmission/reception in standard frame and extended frame formats
- Supports transmission of data frames by receiving remote frames
- 16 transmitting/receiving message buffers
 - 29-bit ID and 8-byte data
 - Multi-level message buffer configuration
- Provides full-bit comparison, full-bit mask, acceptance register 0/acceptance register 1 for each message buffer as 1D acceptance mask
 - Two acceptance mask registers in either standard frame format or extended frame formats
- Bit rate programmable from 10 Kbit/s to 2 Mbit/s (when input clock is at 16 MHz)

List of Control Registers

| Address | | Register | Abbreviation | Access | Initial Value |
|---------------------|---------------------|-----------------------------------|--------------|--------|--------------------------------|
| CAN0 | CAN1 | | | | |
| 000070 _H | 000080 _H | Message buffer valid register | BVALR | R/W | 00000000 00000000 _B |
| 000071 _H | 000081 _H | | | | |
| 000072 _H | 000082 _H | Transmit request register | TREQR | R/W | 00000000 00000000 _B |
| 000073 _H | 000083 _H | | | | |
| 000074 _H | 000084 _H | Transmit cancel register | TCANR | W | 00000000 00000000 _B |
| 000075 _H | 000085 _H | | | | |
| 000076 _H | 000086 _H | Transmit complete register | TCR | R/W | 00000000 00000000 _B |
| 000077 _H | 000087 _H | | | | |
| 000078 _H | 000088 _H | Receive complete register | RCR | R/W | 00000000 00000000 _B |
| 000079 _H | 000089 _H | | | | |
| 00007A _H | 00008A _H | Remote request receiving register | RRTRR | R/W | 00000000 00000000 _B |
| 00007B _H | 00008B _H | | | | |
| 00007C _H | 00008C _H | Receive overrun register | ROVRR | R/W | 00000000 00000000 _B |
| 00007D _H | 00008D _H | | | | |
| 00007E _H | 00008E _H | Receive interrupt enable register | RIER | R/W | 00000000 00000000 _B |
| 00007F _H | 00008F _H | | | | |

MB90590/590G Series

List of Control Registers

| Address | | Register | Abbreviation | Access | Initial Value |
|---------------------|---------------------|---------------------------------------|--------------|--------|-----------------------------------|
| CAN0 | CAN1 | | | | |
| 001C00 _H | 001D00 _H | Control status register | CSR | R/W, R | 00---000 0---0-1 _B |
| 001C01 _H | 001D01 _H | | | | |
| 001C02 _H | 001D02 _H | Last event indicator register | LEIR | R/W | ----- 000-0000 _B |
| 001C03 _H | 001D03 _H | | | | |
| 001C04 _H | 001D04 _H | Receive/transmit error counter | RTEC | R | 00000000 00000000 _B |
| 001C05 _H | 001D05 _H | | | | |
| 001C06 _H | 001D06 _H | Bit timing register | BTR | R/W | -1111111 11111111 _B |
| 001C07 _H | 001D07 _H | | | | |
| 001C08 _H | 001D08 _H | IDE register | IDER | R/W | XXXXXXXX XXXXXXXX _B |
| 001C09 _H | 001D09 _H | | | | |
| 001C0A _H | 001D0A _H | Transmit RTR register | TRTRR | R/W | 00000000 00000000 _B |
| 001C0B _H | 001D0B _H | | | | |
| 001C0C _H | 001D0C _H | Remote frame receive waiting register | RFWTR | R/W | XXXXXXXX XXXXXXXX _B |
| 001C0D _H | 001D0D _H | | | | |
| 001C0E _H | 001D0E _H | Transmit interrupt enable register | TIER | R/W | 00000000 00000000 _B |
| 001C0F _H | 001D0F _H | | | | |
| 001C10 _H | 001D10 _H | Acceptance mask select register | AMSR | R/W | XXXXXXXX XXXXXXXX _B |
| 001C11 _H | 001D11 _H | | | | XXXXXXXX XXXXXXXX _B |
| 001C12 _H | 001D12 _H | | | | |
| 001C13 _H | 001D13 _H | Acceptance mask register 0 | AMR0 | R/W | XXXXXXXX XXXXXXXX _B |
| 001C14 _H | 001D14 _H | | | | XXXXX--- XXXXXXXX _B |
| 001C15 _H | 001D15 _H | | | | |
| 001C16 _H | 001D16 _H | | | | |
| 001C17 _H | 001D17 _H | Acceptance mask register 1 | AMR1 | R/W | XXXXXXXX XXXXXXXX _B |
| 001C18 _H | 001D18 _H | | | | XXXXX--- XXXXXXXX _B |
| 001C19 _H | 001D19 _H | | | | |
| 001C1A _H | 001D1A _H | | | | |
| 001C1B _H | 001D1B _H | | | | XXXXX--- XXXXXXXX _B |

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List of Message Buffers (ID Registers)

| Address | | Register | Abbreviation | Access | Initial Value |
|---------------------|---------------------|---------------|--------------|--------|--------------------------------|
| CAN0 | CAN1 | | | | |
| 001A20 _H | 001B20 _H | ID register 0 | IDR0 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A21 _H | 001B21 _H | | | | |
| 001A22 _H | 001B22 _H | | | | XXXXX--- XXXXXXXX _B |
| 001A23 _H | 001B23 _H | | | | |
| 001A24 _H | 001B24 _H | ID register 1 | IDR1 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A25 _H | 001B25 _H | | | | |
| 001A26 _H | 001B26 _H | | | | XXXXX--- XXXXXXXX _B |
| 001A27 _H | 001B27 _H | | | | |
| 001A28 _H | 001B28 _H | ID register 2 | IDR2 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A29 _H | 001B29 _H | | | | |
| 001A2A _H | 001B2A _H | | | | XXXXX--- XXXXXXXX _B |
| 001A2B _H | 001B2B _H | | | | |
| 001A2C _H | 001B2C _H | ID register 3 | IDR3 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A2D _H | 001B2D _H | | | | |
| 001A2E _H | 001B2E _H | | | | XXXXX--- XXXXXXXX _B |
| 001A2F _H | 001B2F _H | | | | |
| 001A30 _H | 001B30 _H | ID register 4 | IDR4 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A31 _H | 001B31 _H | | | | |
| 001A32 _H | 001B32 _H | | | | XXXXX--- XXXXXXXX _B |
| 001A33 _H | 001B33 _H | | | | |
| 001A34 _H | 001B34 _H | ID register 5 | IDR5 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A35 _H | 001B35 _H | | | | |
| 001A36 _H | 001B36 _H | | | | XXXXX--- XXXXXXXX _B |
| 001A37 _H | 001B37 _H | | | | |
| 001A38 _H | 001B38 _H | ID register 6 | IDR6 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A39 _H | 001B39 _H | | | | |
| 001A3A _H | 001B3A _H | | | | XXXXX--- XXXXXXXX _B |
| 001A3B _H | 001B3B _H | | | | |
| 001A3C _H | 001B3C _H | ID register 7 | IDR7 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A3D _H | 001B3D _H | | | | |
| 001A3E _H | 001B3E _H | | | | XXXXX--- XXXXXXXX _B |
| 001A3F _H | 001B3F _H | | | | |

(Continued)

MB90590/590G Series

(Continued)

| Address | | Register | Abbreviation | Access | Initial Value |
|---------------------|---------------------|----------------|--------------|--------|--------------------------------|
| CAN0 | CAN1 | | | | |
| 001A40 _H | 001B40 _H | ID register 8 | IDR8 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A41 _H | 001B41 _H | | | | |
| 001A42 _H | 001B42 _H | | | | XXXXX--- XXXXXXXX _B |
| 001A43 _F | 001B43 _H | | | | |
| 001A44 _H | 001B44 _H | ID register 9 | IDR9 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A45 _H | 001B45 _H | | | | |
| 001A46 _H | 001B46 _H | | | | XXXXX--- XXXXXXXX _B |
| 001A47 _H | 001B47 _H | | | | |
| 001A48 _H | 001B48 _H | ID register 10 | IDR10 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A49 _H | 001B49 _H | | | | |
| 001A4A _H | 001B4A _H | | | | XXXXX--- XXXXXXXX _B |
| 001A4B _H | 001B4B _H | | | | |
| 001A4C _H | 001B4C _H | ID register 11 | IDR11 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A4D _H | 001B4D _H | | | | |
| 001A4E _H | 001B4E _H | | | | XXXXX--- XXXXXXXX _B |
| 001A4F _H | 001B4F _H | | | | |
| 001A50 _H | 001B50 _H | ID register 12 | IDR12 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A51 _H | 001B51 _H | | | | |
| 001A52 _H | 001B52 _H | | | | XXXXX--- XXXXXXXX _B |
| 001A53 _H | 001B53 _H | | | | |
| 001A54 _H | 001B54 _H | ID register 13 | IDR13 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A55 _H | 001B55 _H | | | | |
| 001A56 _H | 001B56 _H | | | | XXXXX--- XXXXXXXX _B |
| 001A57 _H | 001B57 _H | | | | |
| 001A58 _H | 001B58 _H | ID register 14 | IDR14 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A59 _H | 001B59 _H | | | | |
| 001A5A _H | 001B5A _H | | | | XXXXX--- XXXXXXXX _B |
| 001A5B _H | 001B5B _H | | | | |
| 001A5C _H | 001B5C _H | ID register 15 | IDR15 | R/W | XXXXXXXX XXXXXXXX _B |
| 001A5D _H | 001B5D _H | | | | |
| 001A5E _H | 001B5E _H | | | | XXXXX--- XXXXXXXX _B |
| 001A5F _H | 001B5F _H | | | | |

MB90590/590G Series

List of Message Buffers (DLC Registers and Data Registers)

| Address | | Register | Abbreviation | Access | Initial Value |
|--|--|---------------------------|--------------|--------|--|
| CAN0 | CAN1 | | | | |
| 001A60 _H | 001B60 _H | DLC register 0 | DLCR0 | R/W | ----XXXX _B |
| 001A61 _H | 001B61 _H | | | | |
| 001A62 _H | 001B62 _H | DLC register 1 | DLCR1 | R/W | ----XXXX _B |
| 001A63 _H | 001B63 _H | | | | |
| 001A64 _H | 001B64 _H | DLC register 2 | DLCR2 | R/W | ----XXXX _B |
| 001A65 _H | 001B65 _H | | | | |
| 001A66 _H | 001B66 _H | DLC register 3 | DLCR3 | R/W | ----XXXX _B |
| 001A67 _H | 001B67 _H | | | | |
| 001A68 _H | 001B68 _H | DLC register 4 | DLCR4 | R/W | ----XXXX _B |
| 001A69 _H | 001B69 _H | | | | |
| 001A6A _H | 001B6A _H | DLC register 5 | DLCR5 | R/W | ----XXXX _B |
| 001A6B _H | 001B6B _H | | | | |
| 001A6C _H | 001B6C _H | DLC register 6 | DLCR6 | R/W | ----XXXX _B |
| 001A6D _H | 001B6D _H | | | | |
| 001A6E _H | 001B6E _H | DLC register 7 | DLCR7 | R/W | ----XXXX _B |
| 001A6F _H | 001B6F _H | | | | |
| 001A70 _H | 001B70 _H | DLC register 8 | DLCR8 | R/W | ----XXXX |
| 001A71 _H | 001B71 _H | | | | |
| 001A72 _H | 001B72 _H | DLC register 9 | DLCR9 | R/W | ----XXXX _B |
| 001A73 _H | 001B73 _H | | | | |
| 001A74 _H | 001B74 _H | DLC register 10 | DLCR10 | R/W | ----XXXX _B |
| 001A75 _H | 001B75 _H | | | | |
| 001A76 _H | 001B76 _H | DLC register 11 | DLCR11 | R/W | ----XXXX _B |
| 001A77 _H | 001B77 _H | | | | |
| 001A78 _H | 001B78 _H | DLC register 12 | DLCR12 | R/W | ----XXXX _B |
| 001A79 _H | 001B79 _H | | | | |
| 001A7A _H | 001B7A _H | DLC register 13 | DLCR13 | R/W | ----XXXX _B |
| 001A7B _H | 001B7B _H | | | | |
| 001A7C _H | 001B7C _H | DLC register 14 | DLCR14 | R/W | ----XXXX _B |
| 001A7D _H | 001B7D _H | | | | |
| 001A7E _H | 001B7E _H | DLC register 15 | DLCR15 | R/W | ----XXXX _B |
| 001A7F _H | 001B7F _H | | | | |
| 001A80 _H to 001A87 _H | 001B80 _H to 001B87 _H | Data register 0 (8 bytes) | DTR0 | R/W | XXXXXXXX _B to XXXXXXXX _B |

(Continued)

MB90590/590G Series

(Continued)

| Address | | Register | Abbreviation | Access | Initial Value |
|--|--|----------------------------|--------------|--------|--|
| CAN0 | CAN1 | | | | |
| 001A88 _H to 001A8F _H | 001B88 _H to 001B8F _H | Data register 1 (8 bytes) | DTR1 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001A90 _H to 001A97 _H | 001B90 _H to 001B97 _H | Data register 2 (8 bytes) | DTR2 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001A98 _H to 001A9F _H | 001B98 _H to 001B9F _H | Data register 3 (8 bytes) | DTR3 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AA0 _H to 001AA7 _H | 001BA0 _H to 001BA7 _H | Data register 4 (8 bytes) | DTR4 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AA8 _H to 001AAF _H | 001BA8 _H to 001BAF _H | Data register 5 (8 bytes) | DTR5 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AB0 _H to 001AB7 _H | 001BB0 _H to 001BB7 _H | Data register 6 (8 bytes) | DTR6 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AB8 _H to 001ABF _H | 001BB8 _H to 001BBF _H | Data register 7 (8 bytes) | DTR7 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AC0 _H to 001AC7 _H | 001BC0 _H to 001BC7 _H | Data register 8 (8 bytes) | DTR8 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AC8 _H to 001ACF _H | 001BC8 _H to 001BCF _H | Data register 9 (8 bytes) | DTR9 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AD0 _H to 001AD7 _H | 001BD0 _H to 001BD7 _H | Data register 10 (8 bytes) | DTR10 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AD8 _H to 001ADF _H | 001BD8 _H to 001BDF _H | Data register 11 (8 bytes) | DTR11 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AE0 _H to 001AE7 _H | 001BE0 _H to 001BE7 _H | Data register 12 (8 bytes) | DTR12 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AE8 _H to 001AEF _H | 001BE8 _H to 001BEF _H | Data register 13 (8 bytes) | DTR13 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AF0 _H to 001AF7 _H | 001BF0 _H to 001BF7 _H | Data register 14 (8 bytes) | DTR14 | R/W | XXXXXXXX _B to XXXXXXXX _B |
| 001AF8 _H to 001AFF _H | 001BF8 _H to 001BFF _H | Data register 15 (8 bytes) | DTR15 | R/W | XXXXXXXX _B to XXXXXXXX _B |

MB90590/590G Series

■ INTERRUPT MAP

| Interrupt cause | I ² O/S clear | Interrupt vector | | Interrupt control register | |
|-----------------------------------|--------------------------|------------------|---------------------|----------------------------|---------------------|
| | | Number | Address | Number | Address |
| Reset | N/A | # 08 | FFFFDC _H | — | — |
| INT9 instruction | N/A | # 09 | FFFFD8 _H | — | — |
| Exception | N/A | # 10 | FFFFD4 _H | — | — |
| Time Base Timer | N/A | # 11 | FFFFD0 _H | ICR00 | 0000B0 _H |
| External Interrupt (INT0 to INT7) | *1 | # 12 | FFFFCC _H | | |
| CAN 0 RX | N/A | # 13 | FFFFC8 _H | ICR01 | 0000B1 _H |
| CAN 0 TX/NS | N/A | # 14 | FFFFC4 _H | | |
| CAN 1 RX | N/A | # 15 | FFFFC0 _H | ICR02 | 0000B2 _H |
| CAN 1 TX/NS | N/A | # 16 | FFFFBC _H | | |
| 8/16 bit PPG 0/1 | N/A | # 17 | FFFFB8 _H | ICR03 | 0000B3 _H |
| 8/16 bit PPG 2/3 | N/A | # 18 | FFFFB4 _H | | |
| 8/16 bit PPG 4/5 | N/A | # 19 | FFFFB0 _H | ICR04 | 0000B4 _H |
| 8/16 bit PPG 6/7 | N/A | # 20 | FFFFAC _H | | |
| 8/16 bit PPG 8/9 | N/A | # 21 | FFFFA8 _H | ICR05 | 0000B5 _H |
| 8/16 bit PPG A/B | N/A | # 22 | FFFFA4 _H | | |
| 16-bit Reload Timer 0 | *1 | # 23 | FFFFA0 _H | ICR06 | 0000B6 _H |
| 16-bit Reload Timer 1 | *1 | # 24 | FFFF9C _H | | |
| Input Capture 0/1 | *1 | # 25 | FFFF98 _H | ICR07 | 0000B7 _H |
| Output compare 0/1 | *1 | # 26 | FFFF94 _H | | |
| Input Capture 2/3 | *1 | # 27 | FFFF90 _H | ICR08 | 0000B8 _H |
| Output Compare 2/3 | *1 | # 28 | FFFF8C _H | | |
| Input Capture 4/5 | *1 | # 29 | FFFF88 _H | ICR09 | 0000B9 _H |
| Output Compare 4/5 | *1 | # 30 | FFFF84 _H | | |
| 8/10 bit A/D Converter | *1 | # 31 | FFFF80 _H | ICR10 | 0000BA _H |
| I/O Timer/Watch Timer | N/A | # 32 | FFFF7C _H | | |
| Serial I/O | *1 | # 33 | FFFF78 _H | ICR11 | 0000BB _H |
| Sound Generator | N/A | # 34 | FFFF74 _H | | |
| UART 0 RX | *2 | # 35 | FFFF70 _H | ICR12 | 0000BC _H |
| UART 0 TX | *1 | # 36 | FFFF6C _H | | |
| UART 1 RX | *2 | # 37 | FFFF68 _H | ICR13 | 0000BD _H |
| UART 1 TX | *1 | # 38 | FFFF64 _H | | |
| UART 2 RX | *2 | # 39 | FFFF60 _H | ICR14 | 0000BE _H |
| UART 2 TX | *1 | # 40 | FFFF5C _H | | |
| Flash Memory | N/A | # 41 | FFFF58 _H | ICR15 | 0000BF _H |
| Delayed interrupt | N/A | # 42 | FFFF54 _H | | |

*1 : The interrupt request flag is cleared by the I²OS interrupt clear signal.

*2 : The interrupt request flag is cleared by the I²OS interrupt clear signal. A stop request is available.

N/A : The interrupt request flag is not cleared by the I²OS interrupt clear signal.

- Notes :
- For a peripheral module with two interrupt for a single interrupt number, both interrupt request flags are cleared by the I²OS interrupt clear signal.
 - At the end of I²OS, the I²OS clear signal will be asserted for all the interrupt flags assigned to the same interrupt number. If one interrupt flag starts the I²OS and in the meantime another interrupt flag is set by a hardware event, the later event is lost because the flag is cleared by the I²OS clear signal caused by the first event. So it is recommended not to use the I²OS for this interrupt number.
 - If I²OS is enabled, I²OS is initiated when one of the two interrupt signals in the same interrupt control register (ICR) is asserted. This means that different interrupt sources share the same I²OS Descriptor which should be unique for each interrupt source. For this reason, when one interrupt source uses the I²OS, the other interrupt should be disabled.

MB90590/590G Series

■ 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 | $V_{CC} = AV_{CC}$ *1 |
| | AV_{RH} , AV_{RL} | $V_{SS} - 0.3$ | $V_{SS} + 6.0$ | V | $AV_{CC} \geq AV_{RH}/L$, $AV_{RH} \geq AV_{RL}$ *1 |
| | DV_{CC} | $V_{SS} - 0.3$ | $V_{SS} + 6.0$ | V | $V_{CC} \geq DV_{CC}$ |
| 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 |
| Max clamp current | I_{CLAMP} | -2.0 | +2.0 | mA | *6 |
| Total Max clamp current | $\Sigma I_{CLAMP} $ | — | 20 | mA | *6 |
| "L" level Max output current | I_{OL1} | — | 15 | mA | Normal output *3 |
| "L" level avg. output current | I_{OLAV1} | — | 4 | mA | Normal output, average value *4 |
| "L" level Max output current | I_{OL2} | — | 40 | mA | High current output *3 |
| "L" level avg. output current | I_{OLAV2} | — | 30 | mA | High current output, average value *4 |
| "L" level Max overall output current | ΣI_{OL1} | — | 100 | mA | Total normal output |
| "L" level Max overall output current | ΣI_{OL2} | — | 330 | mA | Total high current output |
| "L" level avg. overall output current | ΣI_{OLAV1} | — | 50 | mA | Total normal output, average value *5 |
| "L" level avg. overall output current | ΣI_{OLAV2} | — | 250 | mA | Total high current output, average value *5 |
| "H" level Max output current | I_{OH1} | — | -15 | mA | Normal output *3 |
| "H" level avg. output current | I_{OHAV1} | — | -4 | mA | Normal output, average value *4 |
| "H" level Max output current | I_{OH2} | — | -40 | mA | High current output *3 |
| "H" level avg. output current | I_{OHAV2} | — | -30 | mA | High current output, average value *4 |
| "H" level Max overall output current | ΣI_{OH1} | — | -100 | mA | Total normal output |
| "H" level Max overall output current | ΣI_{OH2} | — | -330 | mA | Total high current output |
| "H" level avg. overall output current | ΣI_{OHAV1} | — | -50 | mA | Total normal output, average value *5 |
| "H" level avg. overall output current | ΣI_{OHAV2} | — | -250 | mA | Total high current output, average value *5 |
| Power consumption | P_D | — | 500 | mW | MB90F594A, MB90F591A, MB90F594G, MB90F591G |
| | | — | 400 | mW | MB90594, MB90591, MB90594G, MB90591G |
| Operating temperature | T_A | -40 | +85 | °C | |
| Storage temperature | T_{STG} | -55 | +150 | °C | |

*1 : AV_{CC} , AV_{RH} , AV_{RL} and DV_{CC} shall not exceed V_{CC} . AV_{RH} and AV_{RL} shall not exceed AV_{CC} . Also, AV_{RL} shall not exceed AV_{RH} .

*2 : V_I and V_O should not exceed $V_{CC} + 0.3V$. V_I should not exceed the specified ratings. However if the maximum current to/from an input is limited by some means with external components, the I_{CLAMP} rating supersedes the V_I rating.

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

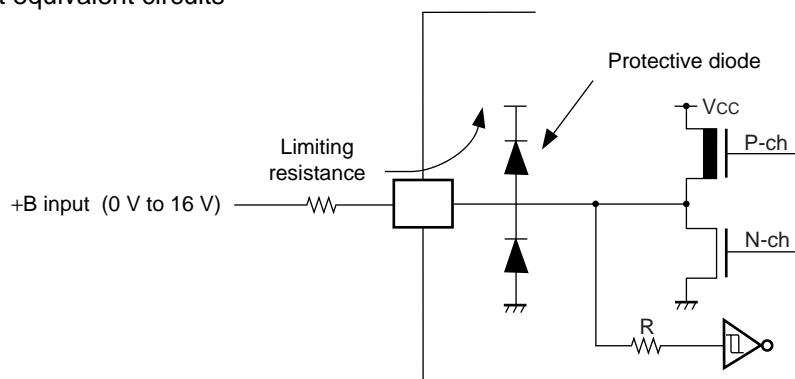
*4 : Average output current is an average current value observed for a 100 ms period for a corresponding pin.

*5 : Total average current is an average current value observed for a 100 ms period for all corresponding pins.

(Continued)

- *6 :
- Applicable to pins : P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, P60 to P67, P70 to P77, P80 to P87, P90 to P95
 - 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 pins does not exceed rated values, either instantaneously or for prolonged periods.
 - 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_{CC} pin, and this may affect other devices.
 - Note that if a +B signal is input when the microcontroller power supply 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

• Input/Output equivalent circuits



Note : Average output current = operating current × operating efficiency

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.

MB90590/590G Series

2. Recommended Conditions

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

| Parameter | Symbol | Value | | | Unit | Remarks | |
|-----------------------|-----------------------|-------|-----|------|--------------------|---------------------------------|--|
| | | Min | Typ | Max | | | |
| Power supply voltage | V_{CC} AV_{CC} | 4.5 | 5.0 | 5.5 | V | Under normal operation | MB90V590A MB90V590G MB90F594A MB90F594G |
| | | 3.0 | — | 5.5 | V | Maintains RAM data in stop mode | MB90594 MB90594G |
| | | 4.75 | 5.0 | 5.25 | V | Under normal operation | MB90F591G |
| | | 3.0 | — | 5.25 | V | Maintains RAM data in stop mode | MB90591G MB90F591A MB90591 |
| Smooth capacitor | C_S | 0.022 | 0.1 | 1.0 | μF | * | |
| Operating temperature | T_A | -40 | — | +85 | $^{\circ}\text{C}$ | | |

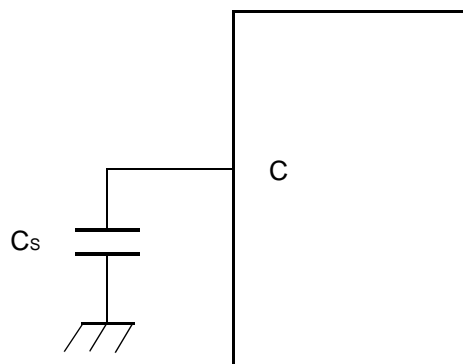
* : Use a ceramic capacitor or a capacitor with equivalent frequency characteristics. The smoothing capacitor to be connected to the V_{CC} pin must have a capacitance value higher than C_S .

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.

• C Pin Connection Diagram



MB90590/590G Series

3. DC Characteristics

(MB90V590A, MB90F594A, MB90594, MB90V590G, MB90F594G, MB90594G :
 $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

(MB90F591G, MB90591G, MB90F591A, MB90591 : $V_{CC} = 5.0 \text{ V} \pm 5\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

| Parameter | Symbol | Pin name | Condition | Value | | | Unit | Remarks |
|---------------------------|------------------|-----------------------------------|--|-----------------------|------|-----------------------|------|-----------------|
| | | | | Min | Typ | Max | | |
| Input H voltage | V _{IHS} | CMOS hys-teresis input | — | 0.8 V _{CC} | — | V _{CC} +0.3 | V | |
| | V _{IHM} | MD input | — | V _{CC} – 0.3 | — | V _{CC} +0.3 | V | |
| Input L voltage | V _{ILS} | CMOS hys-teresis input | — | V _{SS} – 0.3 | — | 0.5V _{CC} | V | |
| | V _{ILM} | MD input | — | V _{SS} – 0.3 | — | V _{SS} + 0.3 | V | |
| | V _{ILR} | R _{ST} , H _{ST} | — | V _{SS} – 0.3 | — | 0.2V _{CC} | V | |
| Output H voltage | V _{OH1} | Normal output | V _{CC} = 4.5 V, I _{OH1} = –4.0 mA | V _{CC} – 0.5 | — | — | V | |
| | V _{OH2} | High current output | V _{CC} = 4.5 V, I _{OH2} = –30.0 mA | V _{CC} – 0.5 | — | — | V | |
| Output L voltage | V _{OL1} | Normal output | V _{CC} = 4.5 V, I _{OL1} = 4.0 mA | — | — | 0.4 | V | |
| | V _{OL2} | High current output | V _{CC} = 4.5 V, I _{OL2} = 30.0 mA | — | — | 0.5 | V | |
| Input leak current | I _{IL} | — | V _{CC} = 5.5 V, V _{SS} < V _I < V _{CC} | –5 | — | 5 | μA | |
| Analog input leak current | I _{IAL} | AN0 to AN7 | V _{CC} = 5.5 V, AV _{SS} < V _I < AV _{CC} | –1 | — | 1 | μA | |
| Power supply current * | I _{CC} | V _{CC} | V _{CC} = 5.0 V±10%, Internal frequency : 16 MHz, At normal opera- tion. | — | 37 | 60 | mA | MB90594/594G |
| | | | | — | 50 | 80 | mA | MB90F594A/F594G |
| | | | | — | 50 | 80 | mA | MB90F591A/F591G |
| | | | | — | 45 | 60 | mA | MB90591/591G |
| | I _{CCS} | | V _{CC} = 5.0 V±10%, Internal frequency : 16 MHz, At Sleep mode. | — | 13 | 20 | mA | MB90594/594G |
| | | | | — | 15 | 23 | mA | MB90F594A/F594G |
| | | | | — | 15 | 23 | mA | MB90F591A/F591G |
| | | | | — | 15 | 23 | mA | MB90591/591G |
| | I _{CTS} | | V _{CC} = 5.0 V±10%, Internal frequency : 2 MHz, At Timer mode | — | 0.3 | 0.6 | mA | MB90594/594G |
| | | | | — | 0.35 | 0.6 | mA | MB90F594A/F594G |
| | | | | — | 0.35 | 0.6 | mA | MB90F591A/F591G |
| | | | | — | 0.35 | 0.6 | mA | MB90591/591G |
| | I _{CCH} | | V _{CC} = 5.0 V±10%, At Stop mode, T _A = 25°C | — | 5 | 20 | μA | MB90594/594G |
| | | | | — | 5 | 20 | μA | MB90F594A/F594G |
| | | | | — | 5 | 20 | μA | MB90F591A/F591G |
| | | | | — | 5 | 20 | μA | MB90591/591G |

* : The power supply current testing conditions are when using the external clock.

(Continued)

MB90590/590G Series

(Continued)

(MB90V590A, MB90F594A, MB90594, MB90V590G, MB90F594G, MB90594G :

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

(MB90F591G, MB90591G, MB90F591A, MB90591 : $V_{CC} = 5.0 \text{ V} \pm 5 \%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C}$ to $+85 \text{ }^\circ\text{C}$)

| Parameter | Symbol | Pin name | Condition | Value | | | Unit | Remarks |
|----------------------|------------|--|-----------|-------|-----|-----|------------|---------|
| | | | | Min | Typ | Max | | |
| Input capacity | C_{IN} | Other than C, AV_{CC} , AV_{SS} , $AVRH$, $AVRL$, V_{CC} , V_{SS} , DV_{CC} , DV_{SS} , P70 to P87 | — | — | 5 | 15 | pF | |
| | | P70 to P87 | — | — | 15 | 30 | pF | |
| Pull-up resistance | R_{UP} | \overline{RST} | — | 25 | 50 | 100 | k Ω | |
| Pull-down resistance | R_{DOWN} | MD2 | — | 25 | 50 | 100 | k Ω | |

4. AC Characteristics

(1) Clock Timing

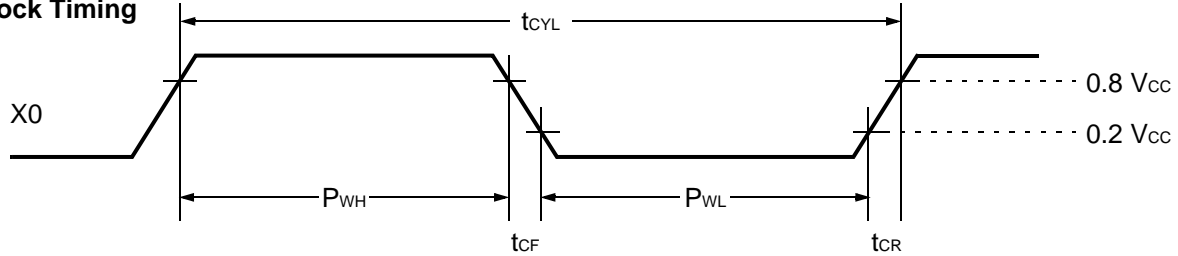
(MB90V590A, MB90F594A, MB90594, MB90V590G, MB90F594G, MB90594G :

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

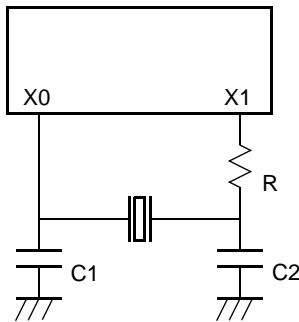
(MB90F591G, MB90591G, MB90F591A, MB90591 : $V_{CC} = 5.0 \text{ V} \pm 5 \%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C}$ to $+85 \text{ }^\circ\text{C}$)

| Parameter | Symbol | Pin name | Value | | | Unit | Remarks |
|--------------------------------|------------------|----------|-------|------------|-----|------|--------------------------------|
| | | | Min | Typ | Max | | |
| Oscillation frequency | f_C | X0, X1 | 3 | — | 16 | MHz | |
| Oscillation cycle time | t_{CYL} | X0, X1 | 62.5 | — | 333 | ns | |
| Input clock pulse width | P_{WH}, P_{WL} | X0 | 10 | — | — | ns | Duty ratio is about 30 to 70%. |
| Input clock rise and fall time | t_{CR}, t_{CF} | X0 | — | — | 5 | ns | When using external clock |
| Machine clock frequency | f_{CP} | — | 1.5 | — | 16 | MHz | |
| Machine clock cycle time | t_{CP} | — | 62.5 | — | 666 | ns | |
| Flash read cycle time | t_{CYCFL} | — | — | $2 t_{CP}$ | — | ns | When Flash is accessed by CPU |

• Clock Timing

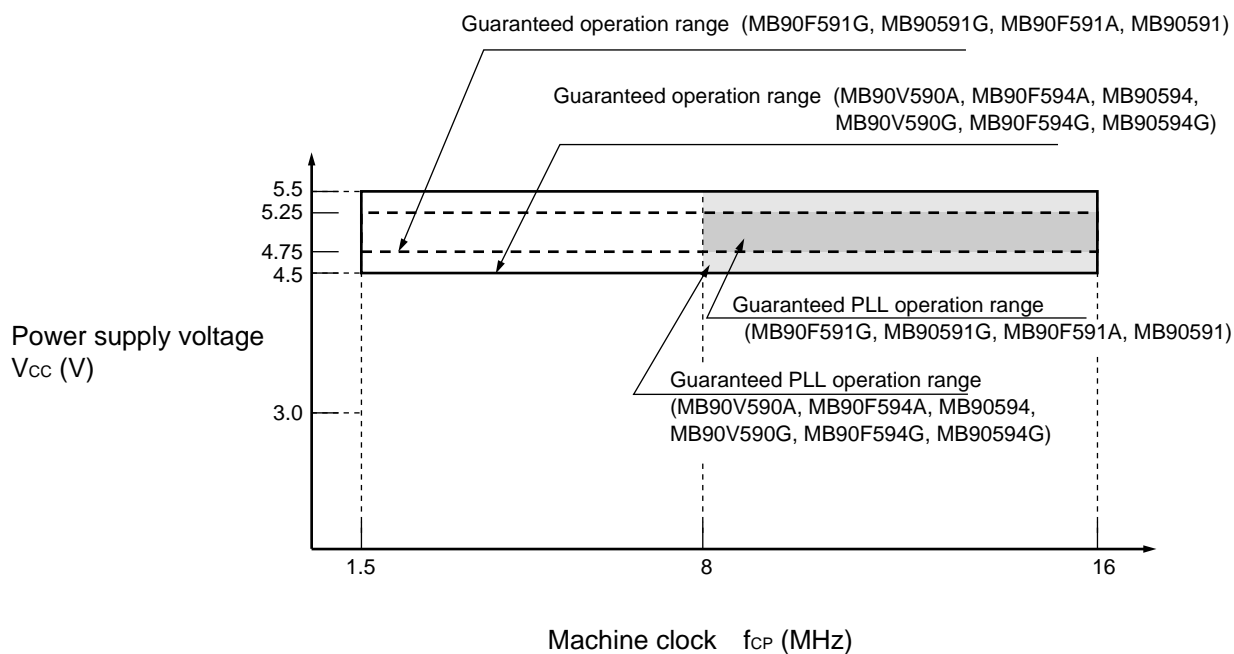


Example of Oscillation circuit

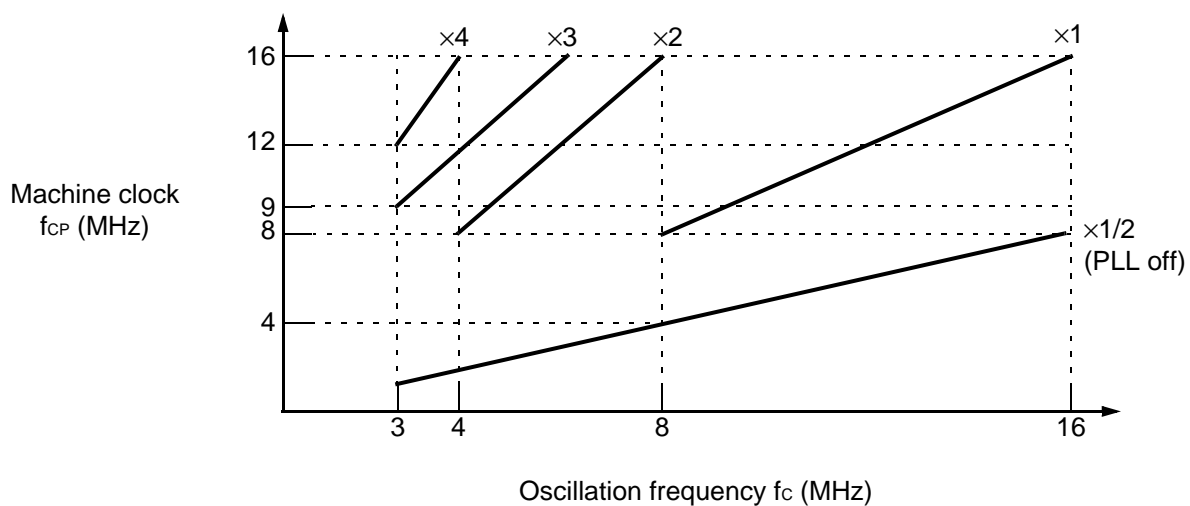


MB90590/590G Series

• Guaranteed operation range



• Oscillation clock frequency and machine clock frequency



(2) Reset and Hardware Standby Input

(MB90V590A, MB90F594A, MB90594, MB90V590G, MB90F594G, MB90594G :

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

(MB90F591G, MB90591G, MB90F591A, MB90591 : $V_{CC} = 5.0 \text{ V} \pm 5\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

| Parameter | Symbol | Pin name | Value | | Unit | Remarks |
|-----------------------------|------------|------------------|---|-----|------|------------------------|
| | | | Min | Max | | |
| Reset input time | t_{RSTL} | \overline{RST} | $16 t_{CP}^{*1}$ | — | ns | Under normal operation |
| | | | Oscillation time of oscillator ^{*2} + $16 t_{CP}^{*1}$ | — | ms | In stop mode |
| Hardware standby input time | t_{HSTL} | \overline{HST} | $16 t_{CP}^{*1}$ | — | ns | Under normal operation |

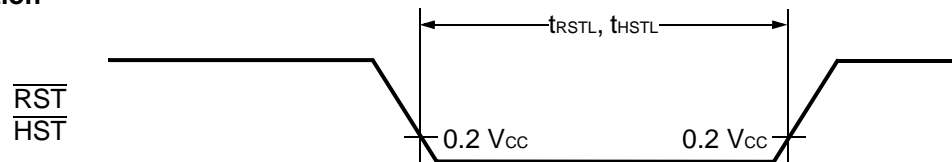
*1 : “ t_{CP} ” represents one cycle time of the machine clock.

No reset can fully initialize the Flash Memory if it is performing the automatic algorithm.

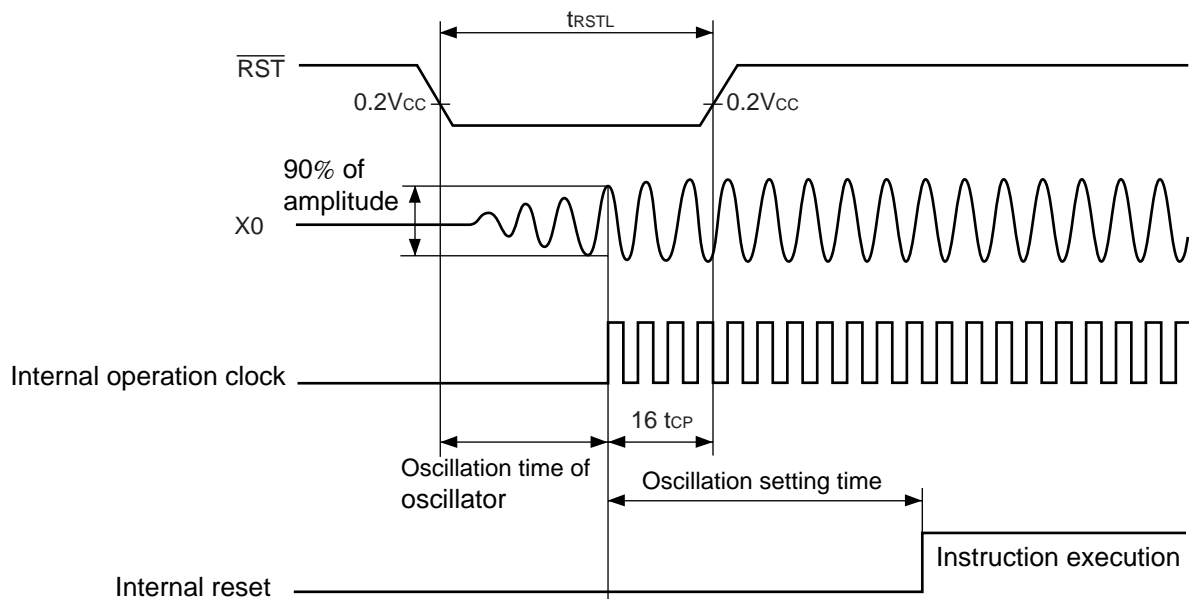
*2 : Oscillation time of oscillator is time that the amplitude reached the 90%.

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 of μs to several ms. In the external clock, the oscillation time is 0 ms.

Under Normal Operation



In Stop Mode



MB90590/590G Series

(3) Power On Reset

(MB90V590A, MB90F594A, MB90594, MB90V590G, MB90F594G, MB90594G :

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

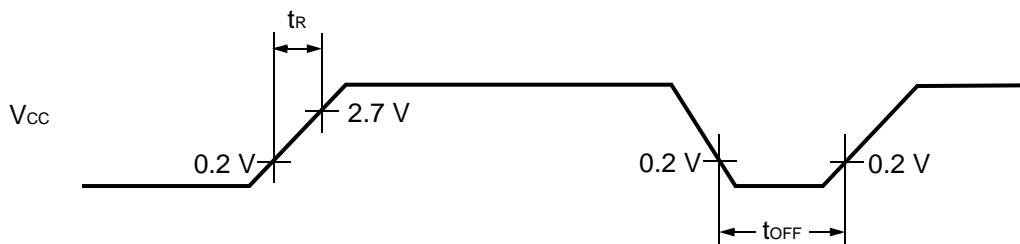
(MB90F591G, MB90591G, MB90F591A, MB90591 : $V_{CC} = 5.0 \text{ V} \pm 5 \%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C}$ to $+85 \text{ }^\circ\text{C}$)

| Parameter | Symbol | Pin name | Condition | Value | | Unit | Remarks |
|--------------------|-----------|----------|-----------|-------|-----|------|-----------------------------|
| | | | | Min | Max | | |
| Power on rise time | t_R | V_{CC} | — | 0.05 | 30 | ms | |
| Power off time | t_{OFF} | V_{CC} | | 50 | — | ms | Due to repetitive operation |

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

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

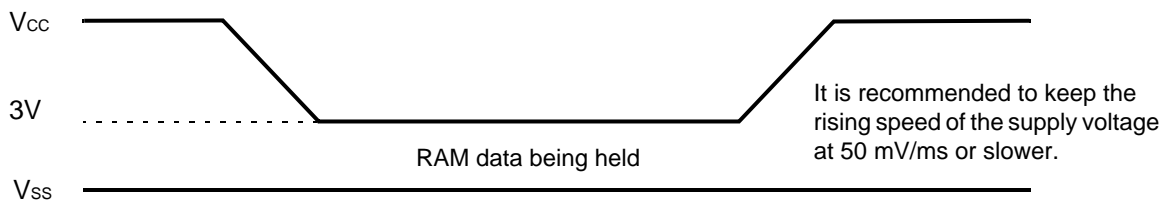
• Some registers in the device are initialized only upon a power-on reset. To initialize these register, turn on the power supply using the above values.



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.



MB90590/590G Series

(4) UART0/1/2, Serial I/O

(MB90V590A, MB90F594A, MB90594, MB90V590G, MB90F594G, MB90594G :

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

(MB90F591G, MB90591G, MB90F591A, MB90591 : $V_{CC} = 5.0 \text{ V} \pm 5 \%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

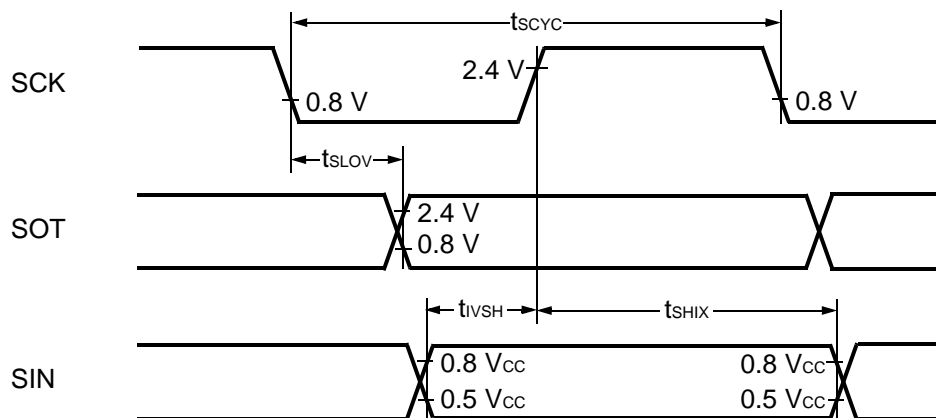
| Parameter | Symbol | Pin name | Condition | Value | | Unit | Remarks |
|--|------------|----------------------------|--|--------------|-----|------|---------|
| | | | | Min | Max | | |
| Serial clock cycle time | t_{SCYC} | SCK0 to SCK3 | Internal clock operation output pins are $C_L = 80 \text{ pF} + 1 \text{ TTL}$. | $8 t_{CP}^*$ | — | ns | |
| SCK $\downarrow \Rightarrow$ SOT delay time | t_{SLOV} | SCK0 to SCK3, SOT0 to SOT3 | | -80 | 80 | ns | |
| Valid SIN \Rightarrow SCK \uparrow | t_{IVSH} | SCK0 to SCK3, SIN0 to SIN3 | | 100 | — | ns | |
| SCK $\uparrow \Rightarrow$ Valid SIN hold time | t_{SHIX} | SCK0 to SCK3, SIN0 to SIN3 | | 60 | — | ns | |
| Serial clock "H" pulse width | t_{SHSL} | SCK0 to SCK3 | External clock operation output pins are $C_L = 80 \text{ pF} + 1 \text{ TTL}$. | $4 t_{CP}$ | — | ns | |
| Serial clock "L" pulse width | t_{SLSH} | SCK0 to SCK3 | | $4 t_{CP}$ | — | ns | |
| SCK $\downarrow \Rightarrow$ SOT delay time | t_{SLOV} | SCK0 to SCK3, SOT0 to SOT3 | | — | 150 | ns | |
| Valid SIN \Rightarrow SCK \uparrow | t_{IVSH} | SCK0 to SCK3, SIN0 to SIN3 | | 60 | — | ns | |
| SCK $\uparrow \Rightarrow$ Valid SIN hold time | t_{SHIX} | SCK0 to SCK3, SIN0 to SIN3 | | 60 | — | ns | |

* : t_{CP} is the machine cycle (Unit : ns)

Notes : • AC characteristic in CLK synchronized mode.

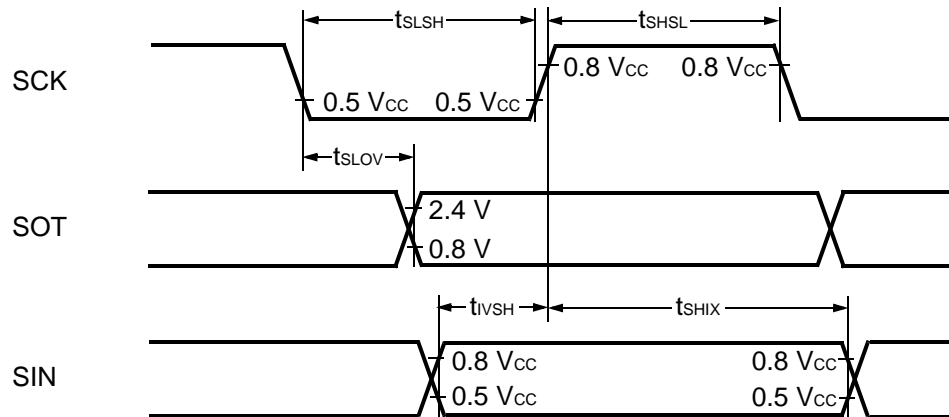
• C_L is load capacity value of pins when testing.

• Internal Shift Clock Mode



MB90590/590G Series

• External Shift Clock Mode



(5) Timer Input Timing

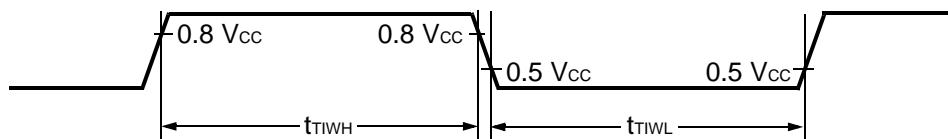
(MB90V590A, MB90F594A, MB90594, MB90V590G, MB90F594G, MB90594G :

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

(MB90F591G, MB90591G, MB90F591A, MB90591 : $V_{CC} = 5.0 V \pm 5\%$, $V_{SS} = AV_{SS} = 0.0 V$, $T_A = -40^\circ C$ to $+85^\circ C$)

| Parameter | Symbol | Pin name | Condition | Value | | Unit | Remarks |
|-------------------|------------|------------|-----------|------------|-----|---------|------------------------|
| | | | | Min | Max | | |
| Input pulse width | t_{TIWH} | TIN0 | — | $4 t_{CP}$ | — | ns | Under normal operation |
| | t_{TIWL} | IN0 to IN5 | | 1 | — | μs | In stop mode |

• Timer Input Timing



MB90590/590G Series

(6) Trigger Input Timing

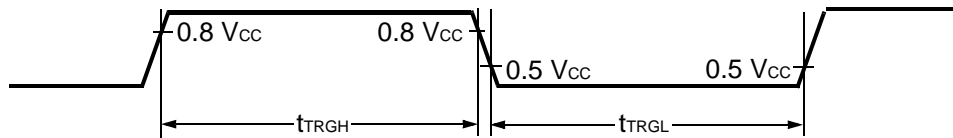
(MB90V590A, MB90F594A, MB90594, MB90V590G, MB90F594G, MB90594G :

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

(MB90F591G, MB90591G, MB90F591A, MB90591 : $V_{CC} = 5.0 \text{ V} \pm 5 \%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C}$ to $+85 \text{ }^\circ\text{C}$)

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

• Trigger Input Timing



(7) Slew Rate High Current Outputs

(MB90F591G, MB90591G, MB90F591A, MB90591, MB90594G and MB90F594G only)

(MB90F594G, MB90594G : $V_{CC} = 5.0 \text{ V} \pm 10 \%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C}$ to $+85 \text{ }^\circ\text{C}$)

(MB90F591G, MB90591G, MB90F591A, MB90591 : $V_{CC} = 5.0 \text{ V} \pm 5 \%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C}$ to $+85 \text{ }^\circ\text{C}$)

| Parameter | Symbol | Pin name | Condition | Value | | Unit | Remarks |
|-----------------------|----------------------|-------------------------------------|-----------|-------|-----|------|---------|
| | | | | Min | Max | | |
| Output Rise/Fall time | t_{R2} t_{F2} | Port P70 to P77, Port P80 to P87 | — | 15 | 40 | ns | |

• Slew Rate Output Timing



$$V_H = V_{OL2} + 0.1 \times (V_{OH2} - V_{OL2})$$

$$V_L = V_{OL2} + 0.9 \times (V_{OH2} - V_{OL2})$$

MB90590/590G Series

5. A/D Converter

(MB90V590A, MB90F594A, MB90594, MB90V590G, MB90F594G, MB90594G :

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

(MB90F591G, MB90591G, MB90F591A, MB90591 :

$V_{CC} = AV_{CC} = 5.0 \text{ V} \pm 5 \%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $3.0 \text{ V} \leq AVR+ - AVR-$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

| Parameter | Symbol | Pin name | Value | | | Unit | Remarks |
|-------------------------------|-----------|------------|-------------------|-------------------|-------------------|---------------|---|
| | | | Min | Typ | Max | | |
| Resolution | — | — | — | — | 10 | bit | |
| Conversion error | — | — | — | — | ± 5.0 | LSB | |
| Nonlinearity error | — | — | — | — | ± 2.5 | LSB | |
| Differential linearity error | — | — | — | — | ± 1.9 | LSB | |
| Zero transition voltage | V_{OT} | AN0 to AN7 | AVRL – 3.5 LSB | AVRL + 0.5 LSB | AVRL + 4.5 LSB | mV | |
| Full scale transition voltage | V_{FST} | AN0 to AN7 | AVRH – 6.5 LSB | AVRH – 1.5 LSB | AVRH + 1.5 LSB | mV | |
| Compare time | — | — | $352t_{CP}$ | — | — | ns | Internal frequency : 16 MHz |
| Sampling time | — | — | $64t_{CP}$ | — | — | ns | Internal frequency : 16 MHz |
| Analog port input current | I_{AIN} | AN0 to AN7 | -1 | — | +1 | μA | |
| Analog input voltage range | V_{AIN} | AN0 to AN7 | AVRL | — | AVRH | V | |
| Reference voltage range | — | AVRH | AVRL + 2.7 | — | AV_{CC} | V | |
| | — | AVRL | 0 | — | $AVRH - 2.7$ | V | |
| Power supply current | I_A | AV_{CC} | — | 5 | — | mA | |
| | I_{AH} | AV_{CC} | — | — | 5 | μA | * |
| Reference voltage current | I_R | AVRH | — | 400 | 600 | μA | MB90594 MB90V590A MB90V590G MB90F594A MB90F594G MB90F591A MB90F591G |
| | | | — | 140 | 600 | μA | MB90594G MB90591 MB90591G |
| | I_{RH} | AVRH | — | — | 5 | μA | * |
| Offset between input channels | — | AN0 to AN7 | — | — | 4 | LSB | |

* : When not operating A/D converter, this is the current ($V_{CC} = AV_{CC} = AVRH = 5.0 \text{ V}$) when the CPU is stopped.

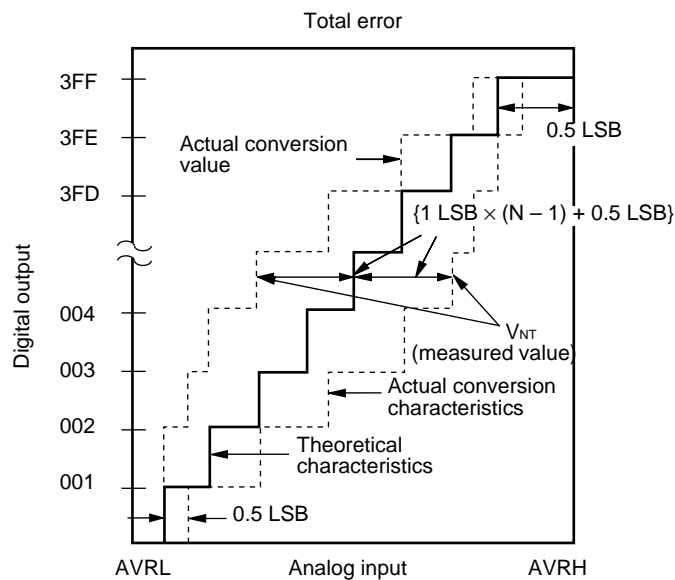
6. A/D Converter Glossary

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" ↔ "00 0000 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.



$$1 \text{ LSB} = (\text{Theoretical value}) \frac{\text{AVRH} - \text{AVRL}}{1024} [\text{V}]$$

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

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

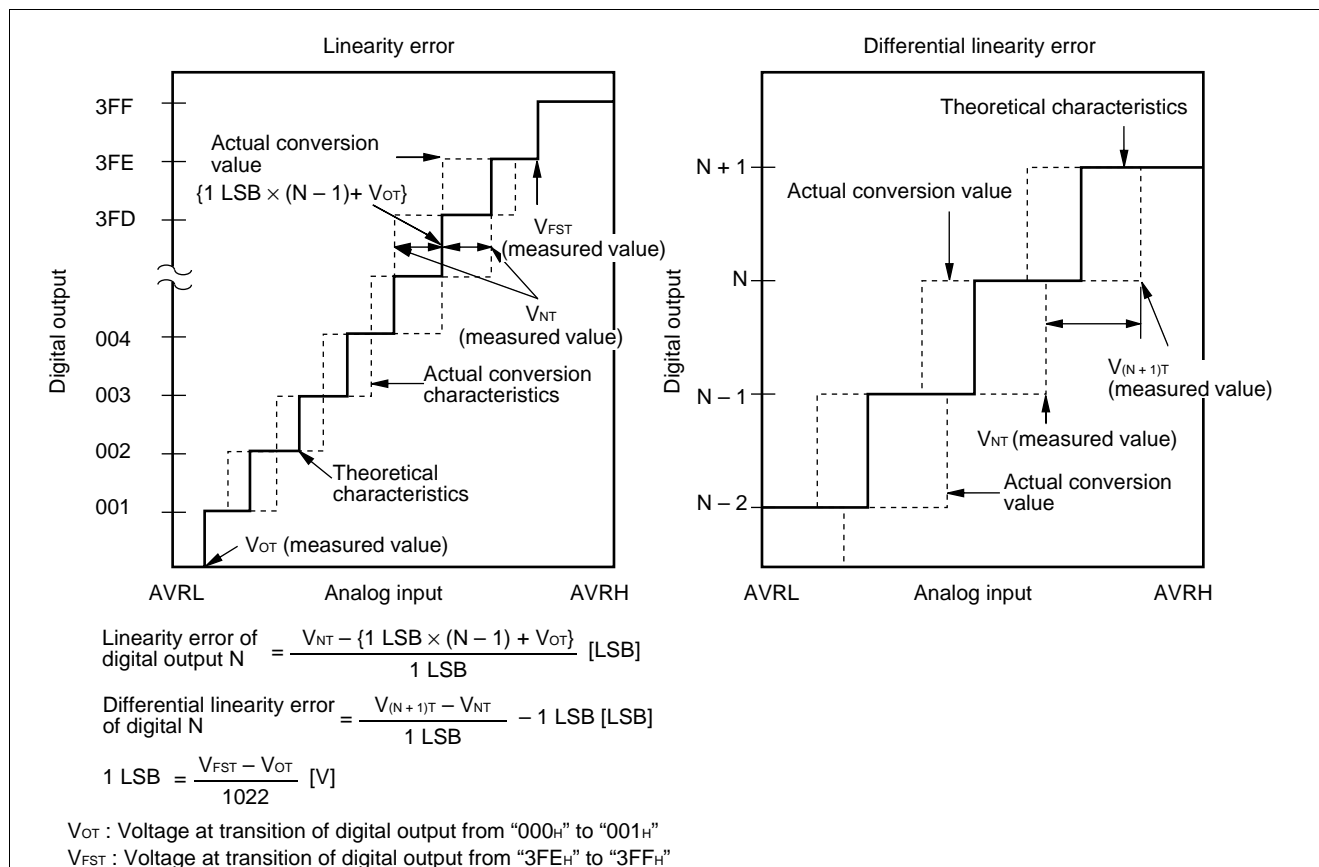
$$\text{Total error for digital output } N = \frac{V_{NT} - \{1 \text{ LSB} \times (N - 1) + 0.5 \text{ LSB}\}}{1 \text{ LSB}} [\text{LSB}]$$

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

(Continued)

MB90590/590G Series

(Continued)



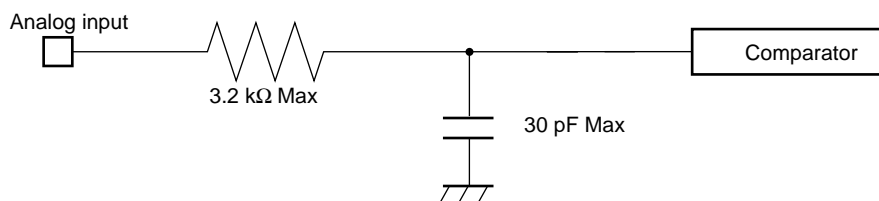
7. Notes on Using A/D Converter

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

- Output impedance values of the external circuit of 15 kΩ or lower are recommended.
- 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 (sampling period = 4.00 μs @ machine clock of 16 MHz).

• Equipment of analog input circuit model



Note : Listed values must be considered as standards.

• Error

The smaller the $|AVRH - AVRL|$, the greater the error would become relatively.

8. Flash Memory

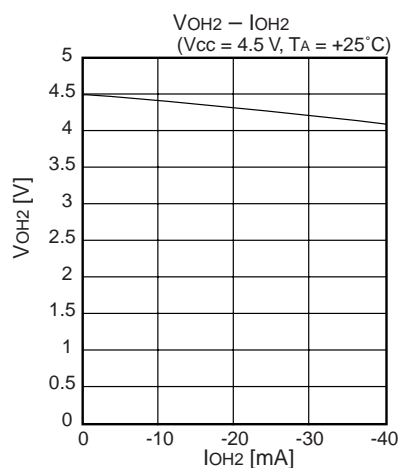
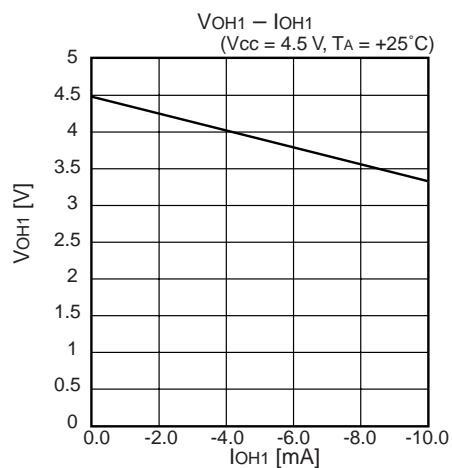
- Erase and Programming Performance

| Parameter | Condition | Value | | | Unit | Remarks | |
|--------------------------------|---|--------|-----|-----|-------|--|--|
| | | Min | Typ | Max | | | |
| Sector erase time | T _A = + 25 °C V _{CC} = 5.0 V | — | 1 | 15 | s | Excludes 00H programming prior erasure | |
| Chip erase time | | — | 7 | — | s | MB90F594A/F594G | Excludes 00H programming prior erasure |
| | | — | 12 | — | s | MB90F591A/F591G | |
| Word (16-bit) programming time | | | — | 16 | 3,600 | ns | Excludes system-level overhead |
| Erase/Program cycle | — | 10,000 | — | — | cycle | | |

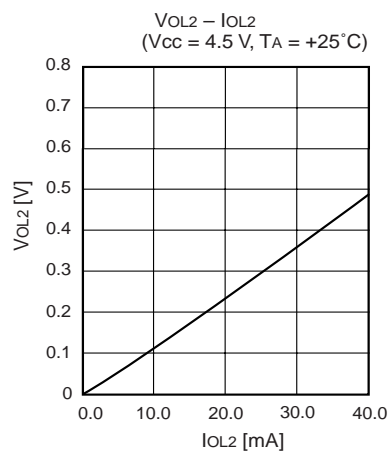
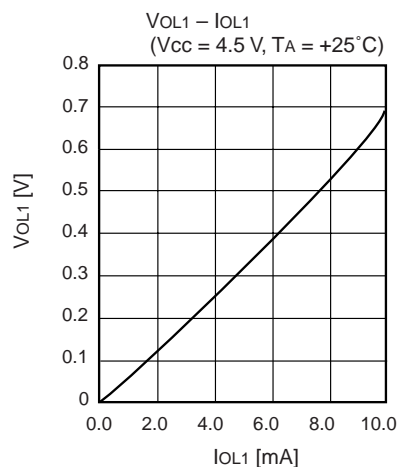
MB90590/590G Series

■ EXAMPLE CHARACTERISTICS

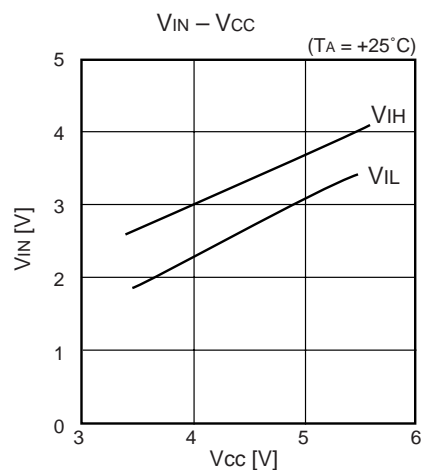
● “H” Level Output Voltage



● “L” Level Output Voltage



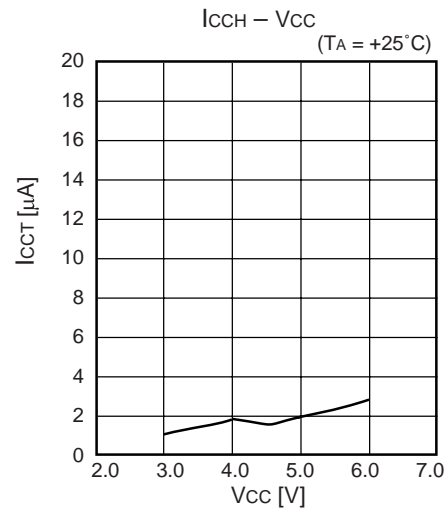
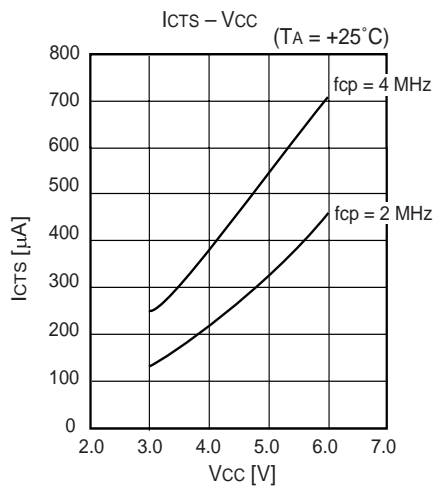
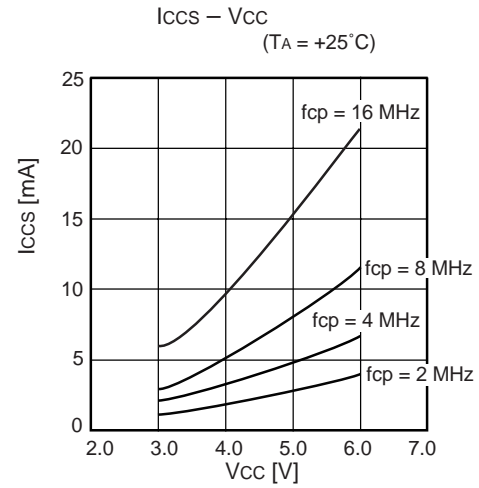
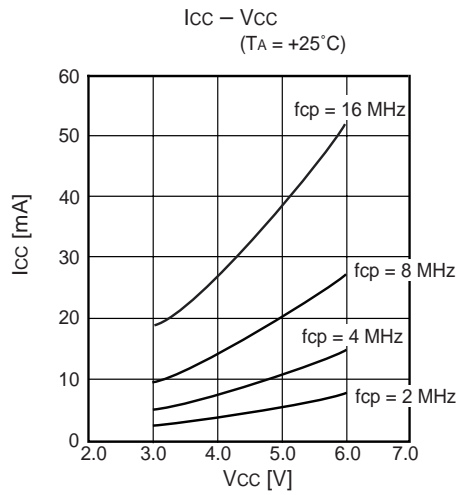
● “H” Level Input Voltage/“L” Level Input Voltage (Hysteresis Input)



(Continued)

(Continued)

• Power Supply Voltage



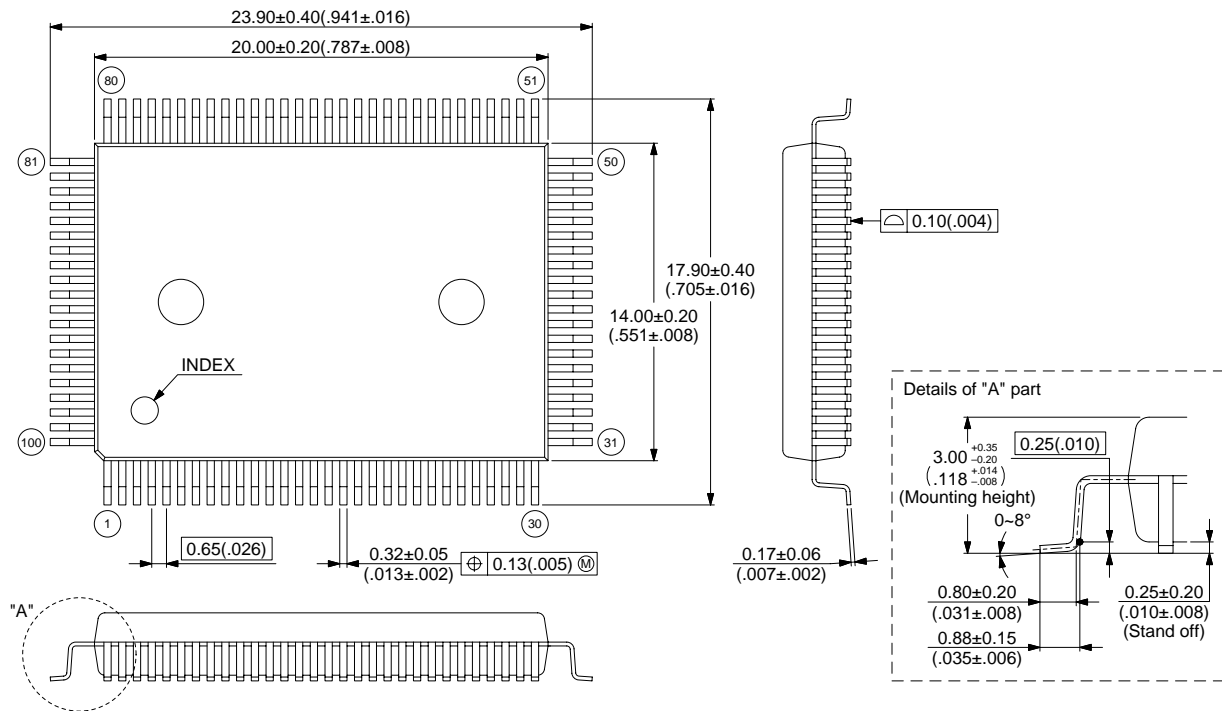
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■ ORDERING INFORMATION

| Part number | Package | Remarks |
|--|---------------------------------------|----------------|
| MB90594PF MB90591PF MB90594GPF MB90F594GPF MB90F594APF MB90F591APF MB90F591GPF MB90591GPF | 100-pin Plastic QFP (FPT-100P-M06) | |
| MB90V590ACR MB90V590GCR | 256-pin Ceramic PGA (PGA-256C-A01) | For evaluation |

■ PACKAGE DIMENSION

100-pin plastic QFP
(FPT-100P-M06)



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Dimensions in mm (inches)

MB90590/590G Series

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