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### What is "[Embedded - Microcontrollers](#)"?

"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

### Applications of "[Embedded - Microcontrollers](#)"

#### Details

|                            |                                                                                                                                                                                 |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Status             | Obsolete                                                                                                                                                                        |
| Core Processor             | F <sup>2</sup> MC-16LX                                                                                                                                                          |
| Core Size                  | 16-Bit                                                                                                                                                                          |
| Speed                      | 16MHz                                                                                                                                                                           |
| Connectivity               | CANbus, EBI/EMI, SCI, Serial I/O, UART/USART                                                                                                                                    |
| Peripherals                | POR, PWM, WDT                                                                                                                                                                   |
| Number of I/O              | 78                                                                                                                                                                              |
| Program Memory Size        | 128KB (128K x 8)                                                                                                                                                                |
| Program Memory Type        | Mask ROM                                                                                                                                                                        |
| EEPROM Size                | -                                                                                                                                                                               |
| RAM Size                   | 4K x 8                                                                                                                                                                          |
| Voltage - Supply (Vcc/Vdd) | 3V ~ 5.5V                                                                                                                                                                       |
| Data Converters            | A/D 8x8/10b                                                                                                                                                                     |
| Oscillator Type            | External                                                                                                                                                                        |
| Operating Temperature      | -40°C ~ 85°C (TA)                                                                                                                                                               |
| Mounting Type              | Surface Mount                                                                                                                                                                   |
| Package / Case             | 100-BQFP                                                                                                                                                                        |
| Supplier Device Package    | 100-QFP (14x20)                                                                                                                                                                 |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/infineon-technologies/mb90598gpf-g-172-jne1">https://www.e-xfl.com/product-detail/infineon-technologies/mb90598gpf-g-172-jne1</a> |

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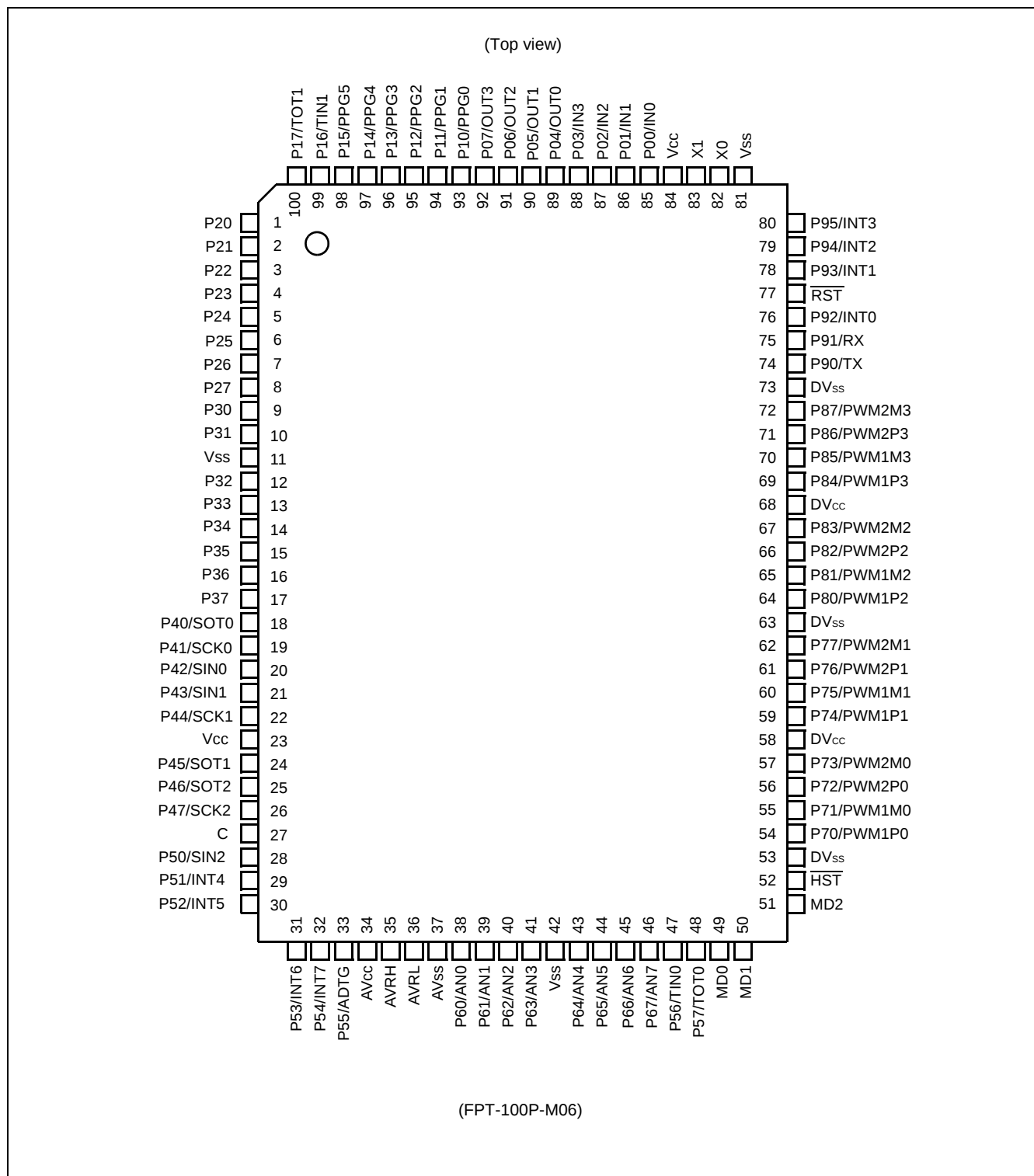
| Features                               | MB90598G                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | MB90F598G | MB90V595G |
|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|
| CAN Interface                          | Number of channels: 1<br>Conforms to CAN Specification Version 2.0 Part A and B<br>Automatic re-transmission in case of error<br>Automatic transmission responding to Remote Frame<br>Prioritized 16 message buffers for data and ID's<br>Supports multiple messages<br>Flexible configuration of acceptance filtering:<br>Full bit compare / Full bit mask / Two partial bit masks<br>Supports up to 1Mbps<br>CAN bit timing setting:<br>MB90598G/F598G:TSEG2 $\geq$ RSJW |           |           |
| Stepping motor controller (4 channels) | Four high current outputs for each channel<br>Synchronized two 8-bit PWM's for each channel                                                                                                                                                                                                                                                                                                                                                                                |           |           |
| External interrupt circuit             | Number of inputs: 8<br>Started by a rising edge, a falling edge, an "H" level input, or an "L" level input.                                                                                                                                                                                                                                                                                                                                                                |           |           |
| Serial IO                              | Clock synchronized transmission (31.25 K/62.5 K/125 K/500 K/1 Mbps at system clock frequency of 16 MHz)<br>LSB first/MSB first                                                                                                                                                                                                                                                                                                                                             |           |           |
| Watchdog timer                         | Reset generation interval: 3.58 ms, 14.33 ms, 57.23 ms, 458.75 ms<br>(at oscillation of 4 MHz, minimum value)                                                                                                                                                                                                                                                                                                                                                              |           |           |
| Flash Memory                           | Supports automatic programming, Embedded Algorithm and Write/Erase/Erase-Suspend/Resume commands<br>A flag indicating completion of the algorithm<br>Hard-wired reset vector available in order to point to a fixed boot sector in Flash Memory<br>Boot block configuration<br>Erase can be performed on each block<br>Block protection with external programming voltage<br>Flash Writer from Minato Electronics, Inc.                                                    |           |           |
| Low-power consumption (stand-by) mode  | Sleep/stop/CPU intermittent operation/watch timer/hardware stand-by                                                                                                                                                                                                                                                                                                                                                                                                        |           |           |
| Process                                | CMOS                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |           |           |
| Power supply voltage for operation*2   | +5 V $\pm$ 10 %                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |           |
| 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 "Electrical Characteristics.")

## 2. Pin Assignment

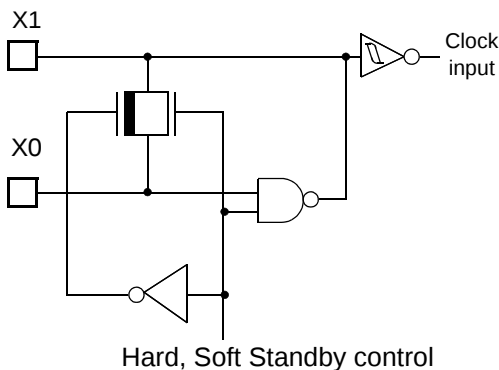
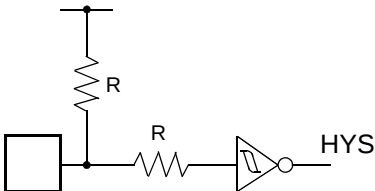
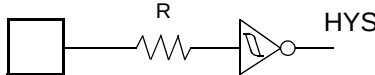


### 3. Pin Description

| Pin 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 88 | P00 to P03              | G            | General purpose IO                            |
|          | IN0 to IN3              |              | Inputs for the Input Captures                 |
| 89 to 92 | P04 to P07              | G            | General purpose IO                            |
|          | OUT0 to OUT3            |              | Outputs for the Output Compares.              |
| 93 to 98 | P10 to P15              | D            | General purpose IO                            |
|          | PPG0 to PPG5            |              | Outputs for the Programmable Pulse Generators |
| 99       | P16                     | D            | General purpose IO                            |
|          | TIN1                    |              | TIN input for the 16-bit Reload Timer 1       |
| 100      | P17                     | D            | General purpose IO                            |
|          | TOT1                    |              | TOT output for the 16-bit Reload Timer 1      |
| 1 to 8   | P20 to P27              | G            | General purpose IO                            |
| 9 to 10  | P30 to P31              | G            | General purpose IO                            |
| 12 to 16 | P32 to P36              | G            | General purpose IO                            |
| 17       | P37                     | D            | General purpose IO                            |
| 18       | P40                     | G            | General purpose IO                            |
|          | SOT0                    |              | SOT output for UART 0                         |
| 19       | P41                     | G            | General purpose IO                            |
|          | SCK0                    |              | SCK input/output for UART 0                   |
| 20       | P42                     | G            | General purpose IO                            |
|          | SIN0                    |              | SIN input for UART 0                          |
| 21       | P43                     | G            | General purpose IO                            |
|          | SIN1                    |              | SIN input for UART 1                          |
| 22       | P44                     | G            | General purpose IO                            |
|          | SCK1                    |              | SCK input/output for UART 1                   |
| 24       | P45                     | G            | General purpose IO                            |
|          | SOT1                    |              | SOT output for UART 1                         |
| 25       | P46                     | G            | General purpose IO                            |
|          | SOT2                    |              | SOT output for the Serial IO                  |
| 26       | P47                     | G            | General purpose IO                            |
|          | SCK2                    |              | SCK input/output for the Serial IO            |

| Pin no.    | Pin name         | Circuit type | Function                                                                                                    |
|------------|------------------|--------------|-------------------------------------------------------------------------------------------------------------|
| 76         | P92              | D            | General purpose IO                                                                                          |
|            | INT0             |              | External interrupt input for INT0                                                                           |
| 78 to 80   | P93 to P95       | D            | General purpose IO                                                                                          |
|            | INT1 to INT3     |              | External interrupt input for INT1 to INT3                                                                   |
| 58, 68     | DV <sub>CC</sub> | —            | Dedicated power supply pins for the high current output buffers (Pin No. 54 to 72)                          |
| 53, 63, 73 | DV <sub>SS</sub> | —            | Dedicated ground pins for the high current output buffers (Pin No. 54 to 72)                                |
| 34         | AV <sub>CC</sub> | Power supply | Dedicated power supply pin for the A/D Converter                                                            |
| 37         | AV <sub>SS</sub> | Power supply | Dedicated ground pin for the A/D Converter                                                                  |
| 35         | AVRH             | Power supply | Upper reference voltage input for the A/D Converter                                                         |
| 36         | AVRL             | Power supply | Lower reference voltage input for the A/D Converter                                                         |
| 49, 50     | MD0<br>MD1       | C            | Operating mode selection input pins. These pins should be connected to V <sub>CC</sub> or V <sub>SS</sub> . |
| 51         | MD2              | H            | Operating mode selection input pin. This pin should be connected to V <sub>CC</sub> or V <sub>SS</sub> .    |
| 27         | C                | —            | External capacitor pin. A capacitor of 0.1μF should be connected to this pin and V <sub>SS</sub> .          |
| 23, 84     | V <sub>CC</sub>  | Power supply | Power supply pins (5.0 V).                                                                                  |
| 11, 42, 81 | V <sub>SS</sub>  | Power supply | Ground pins (0.0 V).                                                                                        |

#### 4. I/O Circuit Type

| Circuit Type | Circuit                                                                                                               | Remarks                                                                                                       |
|--------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| A            |  <p>Hard, Soft Standby control</p> | <ul style="list-style-type: none"> <li>■ Oscillation feedback resistor:<br/>1 MΩ approx.</li> </ul>           |
| B            |                                    | <ul style="list-style-type: none"> <li>■ Hysteresis input with pull-up<br/>Resistor: 50 kΩ approx.</li> </ul> |
| C            |                                    | <ul style="list-style-type: none"> <li>■ Hysteresis input</li> </ul>                                          |

## 5. Handling Devices

### (1) Make Sure that the Voltage not Exceed the Maximum Rating (to Avoid a Latch-up).

In CMOS ICs, a latch-up phenomenon is caused when an voltage exceeding  $V_{CC}$  or an voltage below  $V_{SS}$  is applied to input or output pins or a voltage exceeding the rating is applied across  $V_{CC}$  and  $V_{SS}$ .

When a latch-up is caused, the power supply current may be dramatically increased causing resultant thermal break-down of devices. To avoid the latch-up, make sure that the voltage not exceed the maximum rating.

In turning on/turning off the analog power supply, make sure the analog power voltage ( $AV_{CC}$ ,  $AV_{RH}$ ,  $DV_{CC}$ ) and analog input voltages not exceed the digital voltage ( $V_{CC}$ ).

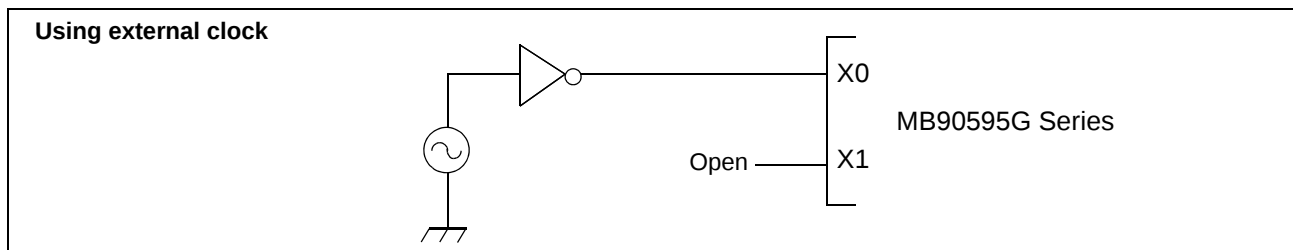
### (2) Treatment of Unused Pins

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

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

### (3) Using external clock

In using the external clock, drive X0 pin only and leave X1 pin unconnected.

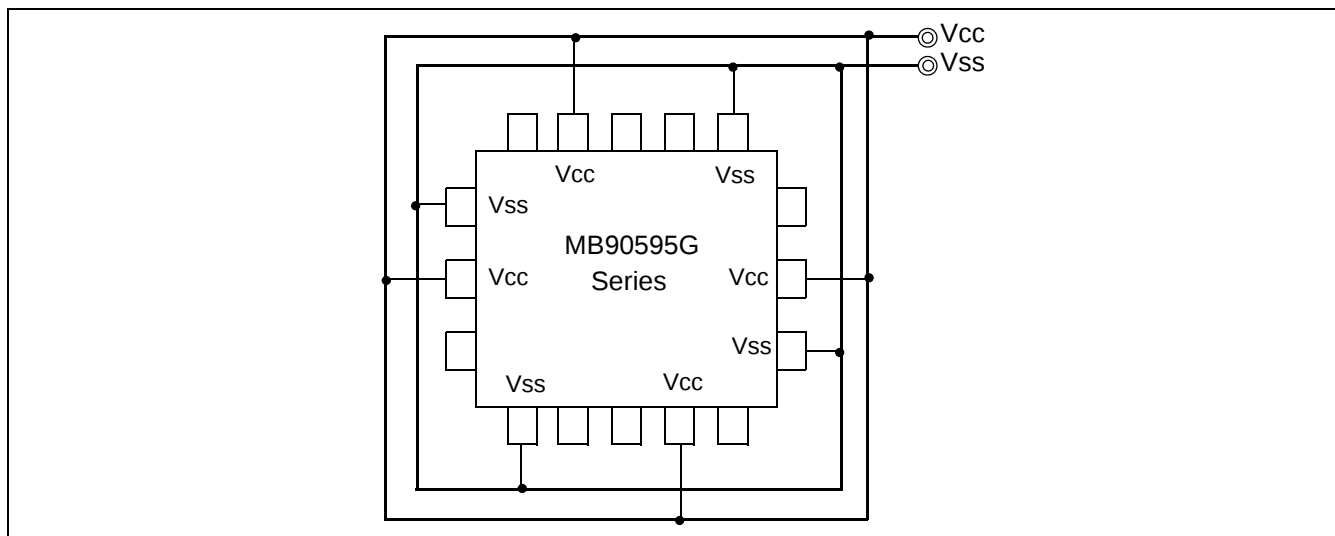


### (4) Power supply pins ( $V_{CC}/V_{SS}$ )

In products with multiple  $V_{CC}$  or  $V_{SS}$  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 (See the figure below.)

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

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



##### (5) Pull-up/down resistors

The MB90595G 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 shortest distance from X0, X1 pins, crystal oscillator (or ceramic resonator) and ground lines, and make sure that lines of oscillation circuit not cross the lines of other circuits.

A printed circuit board artwork surrounding the X0 and X1 pins with 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 ( $AV_{CC}$ ,  $AV_{RH}$ ,  $AV_{RL}$ ) and analog inputs ( $AN_0$  to  $AN_7$ ) after turning-on the digital power supply ( $V_{CC}$ ).

Turn-off the digital power after turning off the A/D converter supply and analog inputs. In this case, make sure that the voltage does not exceed  $AV_{RH}$  or  $AV_{CC}$  (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  $AV_{CC} = V_{CC}$ ,  $AV_{SS} = AV_{RH} = DV_{CC} = V_{SS}$ .

##### (9) N.C. Pin

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

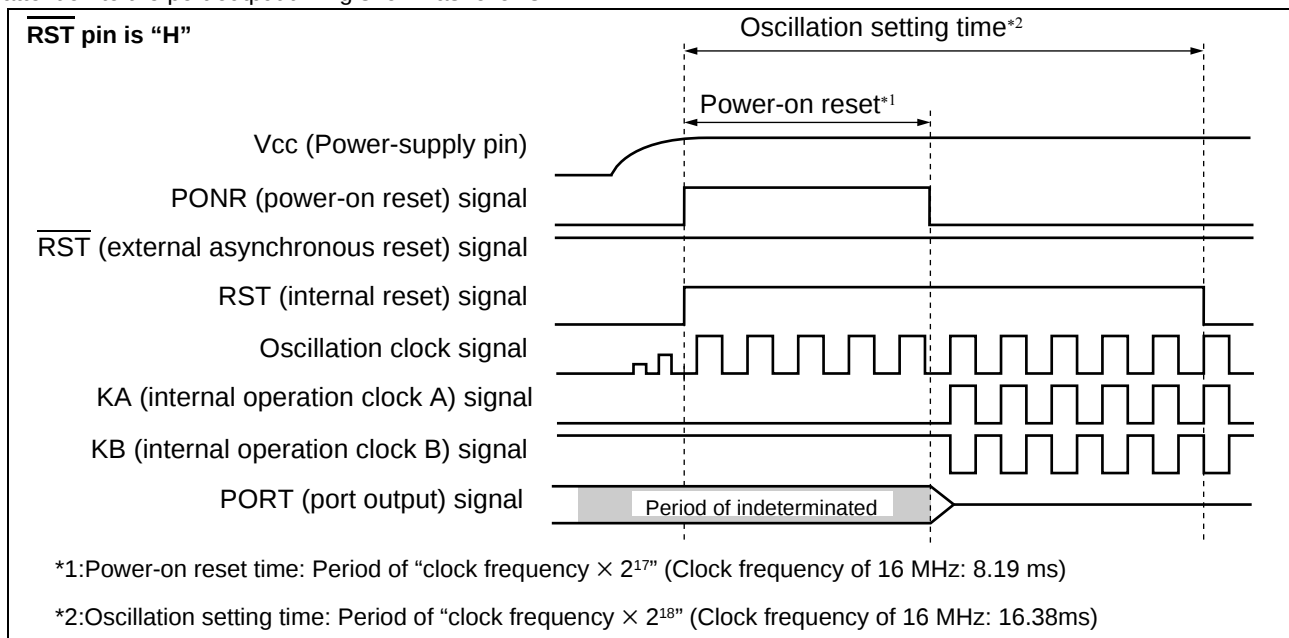
##### (10) Notes on Energization

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

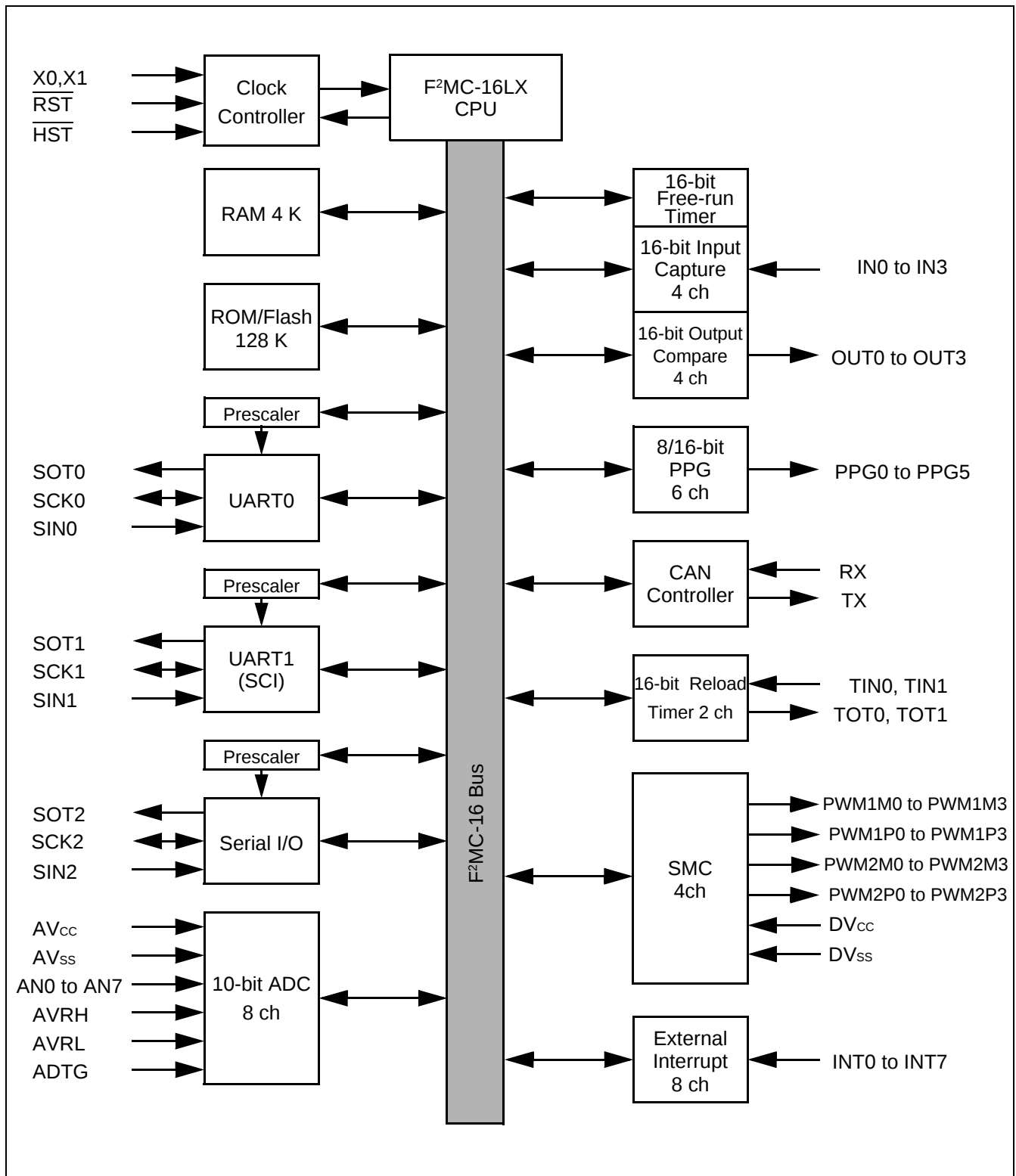
##### (11) Indeterminate outputs from ports 0 and 1 (MB90V595G only)

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  $\overline{RST}$  pin is "H", the outputs become indeterminate.
  - If  $\overline{RST}$  pin is "L", the outputs become high-impedance.
- Pay attention to the port output timing shown as follows.



## 6. Block Diagram



| Address                            | Register                      | Abbreviation | Access | Peripheral                              | Initial value                |
|------------------------------------|-------------------------------|--------------|--------|-----------------------------------------|------------------------------|
| B0 <sub>H</sub>                    | Interrupt Control Register 00 | ICR00        | R/W    | Interrupt controller                    | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| B1 <sub>H</sub>                    | Interrupt Control Register 01 | ICR01        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| B2 <sub>H</sub>                    | Interrupt Control Register 02 | ICR02        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| B3 <sub>H</sub>                    | Interrupt Control Register 03 | ICR03        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| B4 <sub>H</sub>                    | Interrupt Control Register 04 | ICR04        | R/W    | Interrupt controller                    | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| B5 <sub>H</sub>                    | Interrupt Control Register 05 | ICR05        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| B6 <sub>H</sub>                    | Interrupt Control Register 06 | ICR06        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| B7 <sub>H</sub>                    | Interrupt Control Register 07 | ICR07        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| B8 <sub>H</sub>                    | Interrupt Control Register 08 | ICR08        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| B9 <sub>H</sub>                    | Interrupt Control Register 09 | ICR09        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| BA <sub>H</sub>                    | Interrupt Control Register 10 | ICR10        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| BB <sub>H</sub>                    | Interrupt Control Register 11 | ICR11        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| BC <sub>H</sub>                    | Interrupt Control Register 12 | ICR12        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| BD <sub>H</sub>                    | Interrupt Control Register 13 | ICR13        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| BE <sub>H</sub>                    | Interrupt Control Register 14 | ICR14        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| BF <sub>H</sub>                    | Interrupt Control Register 15 | ICR15        | R/W    |                                         | 0 0 0 0 0 1 1 1 <sub>B</sub> |
| C0 <sub>H</sub> to FF <sub>H</sub> | Reserved                      |              |        |                                         |                              |
| 1900 <sub>H</sub>                  | Reload Register L             | PRL0         | R/W    | 16-bit Programmable Pulse Generator 0/1 | XXXXXXXX <sub>B</sub>        |
| 1901 <sub>H</sub>                  | Reload Register H             | PRLH0        | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 1902 <sub>H</sub>                  | Reload Register L             | PRL1         | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 1903 <sub>H</sub>                  | Reload Register H             | PRLH1        | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 1904 <sub>H</sub>                  | Reload Register L             | PRL2         | R/W    | 16-bit Programmable Pulse Generator 2/3 | XXXXXXXX <sub>B</sub>        |
| 1905 <sub>H</sub>                  | Reload Register H             | PRLH2        | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 1906 <sub>H</sub>                  | Reload Register L             | PRL3         | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 1907 <sub>H</sub>                  | Reload Register H             | PRLH3        | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 1908 <sub>H</sub>                  | Reload Register L             | PRL4         | R/W    | 16-bit Programmable Pulse Generator 4/5 | XXXXXXXX <sub>B</sub>        |
| 1909 <sub>H</sub>                  | Reload Register H             | PRLH4        | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 190A <sub>H</sub>                  | Reload Register L             | PRL5         | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 190B <sub>H</sub>                  | Reload Register H             | PRLH5        | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 190C <sub>H</sub>                  | Reload Register L             | PRL6         | R/W    | 16-bit Programmable Pulse Generator 6/7 | XXXXXXXX <sub>B</sub>        |
| 190D <sub>H</sub>                  | Reload Register H             | PRLH6        | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 190E <sub>H</sub>                  | Reload Register L             | PRL7         | R/W    |                                         | XXXXXXXX <sub>B</sub>        |
| 190F <sub>H</sub>                  | Reload Register H             | PRLH7        | R/W    |                                         | XXXXXXXX <sub>B</sub>        |

(Continued)

## 10. Interrupt Source, Interrupt Vector, and Interrupt Control Register

| Interrupt source               | EI <sup>2</sup> OS clear | Interrupt vector |                     | Interrupt control register |                     |
|--------------------------------|--------------------------|------------------|---------------------|----------------------------|---------------------|
|                                |                          | Number           | Address             | Number                     | Address             |
| Reset                          | N/A                      | # 08             | FFFFDC <sub>H</sub> | —                          | —                   |
| INT9 instruction               | N/A                      | # 09             | FFFFD8 <sub>H</sub> | —                          | —                   |
| Exception                      | N/A                      | # 10             | FFFFD4 <sub>H</sub> | —                          | —                   |
| CAN RX                         | N/A                      | # 11             | FFFFD0 <sub>H</sub> | ICR00                      | 0000B0 <sub>H</sub> |
| CAN TX/NS                      | N/A                      | # 12             | FFFFCC <sub>H</sub> |                            |                     |
| External Interrupt (INT0/INT1) | *1                       | # 13             | FFFFC8 <sub>H</sub> | ICR01                      | 0000B1 <sub>H</sub> |
| Time Base Timer                | N/A                      | # 14             | FFFFC4 <sub>H</sub> |                            |                     |
| 16-bit Reload Timer 0          | *1                       | # 15             | FFFFC0 <sub>H</sub> | ICR02                      | 0000B2 <sub>H</sub> |
| 8/10-bit A/D Converter         | *1                       | # 16             | FFFFBC <sub>H</sub> |                            |                     |
| 16-bit Free-run Timer          | N/A                      | # 17             | FFFFB8 <sub>H</sub> | ICR03                      | 0000B3 <sub>H</sub> |
| External Interrupt (INT2/INT3) | *1                       | # 18             | FFFFB4 <sub>H</sub> |                            |                     |
| Serial I/O                     | *1                       | # 19             | FFFFB0 <sub>H</sub> | ICR04                      | 0000B4 <sub>H</sub> |
| External Interrupt (INT4/INT5) | *1                       | # 20             | FFFFAC <sub>H</sub> |                            |                     |
| Input Capture 0                | *1                       | # 21             | FFFFA8 <sub>H</sub> | ICR05                      | 0000B5 <sub>H</sub> |
| 8/16-bit PPG 0/1               | N/A                      | # 22             | FFFFA4 <sub>H</sub> |                            |                     |
| Output Compare 0               | *1                       | # 23             | FFFFA0 <sub>H</sub> | ICR06                      | 0000B6 <sub>H</sub> |
| 8/16-bit PPG 2/3               | N/A                      | # 24             | FFFF9C <sub>H</sub> |                            |                     |
| External Interrupt (INT6/INT7) | *1                       | # 25             | FFFF98 <sub>H</sub> | ICR07                      | 0000B7 <sub>H</sub> |
| Input Capture 1                | *1                       | # 26             | FFFF94 <sub>H</sub> |                            |                     |
| 8/16-bit PPG 4/5               | N/A                      | # 27             | FFFF90 <sub>H</sub> | ICR08                      | 0000B8 <sub>H</sub> |
| Output Compare 1               | *1                       | # 28             | FFFF8C <sub>H</sub> |                            |                     |
| 8/16-bit PPG 6/7               | N/A                      | # 29             | FFFF88 <sub>H</sub> | ICR09                      | 0000B9 <sub>H</sub> |
| Input Capture 2                | *1                       | # 30             | FFFF84 <sub>H</sub> |                            |                     |
| 8/16-bit PPG 8/9               | N/A                      | # 31             | FFFF80 <sub>H</sub> | ICR10                      | 0000BA <sub>H</sub> |
| Output Compare 2               | *1                       | # 32             | FFFF7C <sub>H</sub> |                            |                     |
| Input Capture 3                | *1                       | # 33             | FFFF78 <sub>H</sub> | ICR11                      | 0000BB <sub>H</sub> |
| 8/16-bit PPG A/B               | N/A                      | # 34             | FFFF74 <sub>H</sub> |                            |                     |
| Output Compare 3               | *1                       | # 35             | FFFF70 <sub>H</sub> | ICR12                      | 0000BC <sub>H</sub> |
| 16-bit Reload Timer 1          | *1                       | # 36             | FFFF6C <sub>H</sub> |                            |                     |
| UART 0 RX                      | *2                       | # 37             | FFFF68 <sub>H</sub> | ICR13                      | 0000BD <sub>H</sub> |
| UART 0 TX                      | *1                       | # 38             | FFFF64 <sub>H</sub> |                            |                     |
| UART 1 RX                      | *2                       | # 39             | FFFF60 <sub>H</sub> | ICR14                      | 0000BE <sub>H</sub> |
| UART 1 TX                      | *1                       | # 40             | FFFF5C <sub>H</sub> |                            |                     |
| Flash Memory                   | N/A                      | # 41             | FFFF58 <sub>H</sub> | ICR15                      | 0000BF <sub>H</sub> |
| Delayed interrupt              | N/A                      | # 42             | FFFF54 <sub>H</sub> |                            |                     |

\*1: The interrupt request flag is cleared by the EI<sup>2</sup>OS interrupt clear signal.

\*2: The interrupt request flag is cleared by the EI<sup>2</sup>OS interrupt clear signal. A stop request is available.

N/A: The interrupt request flag is not cleared by the EI<sup>2</sup>OS interrupt clear signal.

## 11. Electrical Characteristics

### 11.1 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                                   |
|                                       | $AV_{RH}$ ,<br>$AV_{RL}$ | $V_{SS} - 0.3$ | $V_{SS} + 6.0$ | V    | $AV_{CC} \geq AV_{RH}/L$ ,<br>$AV_{RH} \geq AV_{RL}$ *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                                                      |
| Maximum Clamp Current                 | $I_{CLAMP}$              | -2.0           | 2.0            | mA   | *6                                                      |
| Maximum Total Clamp Current           | $\sum I_{CLAMP}$         | —              | 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 | $\sum I_{OL1}$           | —              | 100            | mA   | Total normal output                                     |
| "L" level Max. overall output current | $\sum I_{OL2}$           | —              | 330            | mA   | Total high current output                               |
| "L" level Avg. overall output current | $\sum I_{OLAV1}$         | —              | 50             | mA   | Total normal output, average value *5                   |
| "L" level Avg. overall output current | $\sum I_{OLAV2}$         | —              | 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 | $\sum I_{OH1}$           | —              | -100           | mA   | Total normal output                                     |
| "H" level Max. overall output current | $\sum I_{OH2}$           | —              | -330           | mA   | Total high current output                               |
| "H" level Avg. overall output current | $\sum I_{OHAV1}$         | —              | -50            | mA   | Total normal output, average value *5                   |
| "H" level Avg. overall output current | $\sum I_{OHAV2}$         | —              | -250           | mA   | Total high current output, average value *5             |
| Power consumption                     | $P_D$                    | —              | 500            | mW   | MB90F598G                                               |
|                                       |                          | —              | 400            | mW   | MB90598G                                                |
| 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 never exceed  $AV_{RH}$ .

\*2:  $V_I$  and  $V_O$  should not exceed  $V_{CC} + 0.3\text{V}$ .  $V_I$  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.

\*6:

- Applicable to pins : P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, 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.

## 11.2 Recommended Conditions

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

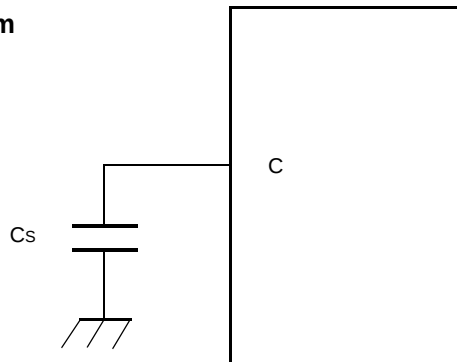
| Parameter             | Symbol    | Value |     |     | Unit               | Remarks                         |
|-----------------------|-----------|-------|-----|-----|--------------------|---------------------------------|
|                       |           | Min   | Typ | Max |                    |                                 |
| Power supply voltage  | $V_{CC}$  | 4.5   | 5.0 | 5.5 | V                  | Under normal operation          |
|                       | $AV_{CC}$ | 3.0   | —   | 5.5 | V                  | Maintains RAM data in stop mode |
| Smooth capacitor      | $C_S$     | 0.022 | 0.1 | 1.0 | $\mu\text{F}$      | *                               |
| 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.

### • C Pin Connection Diagram



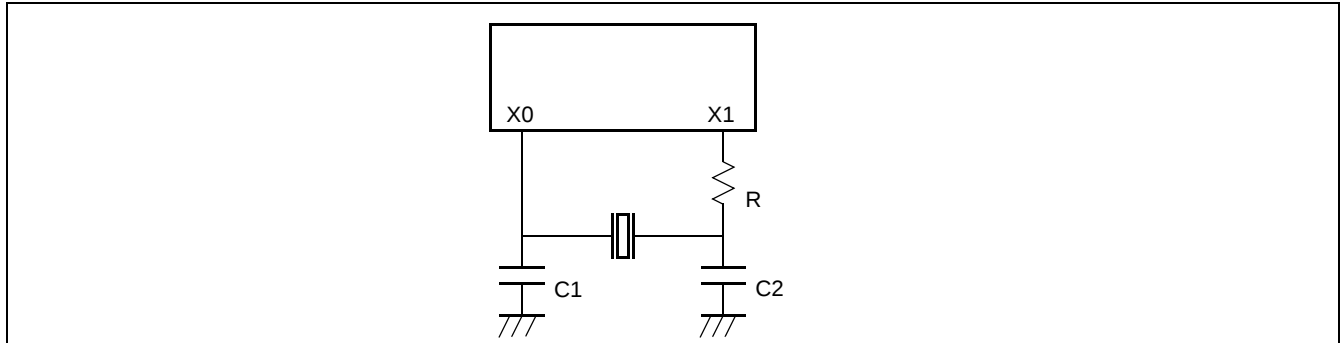
## 11.3 DC Characteristics

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

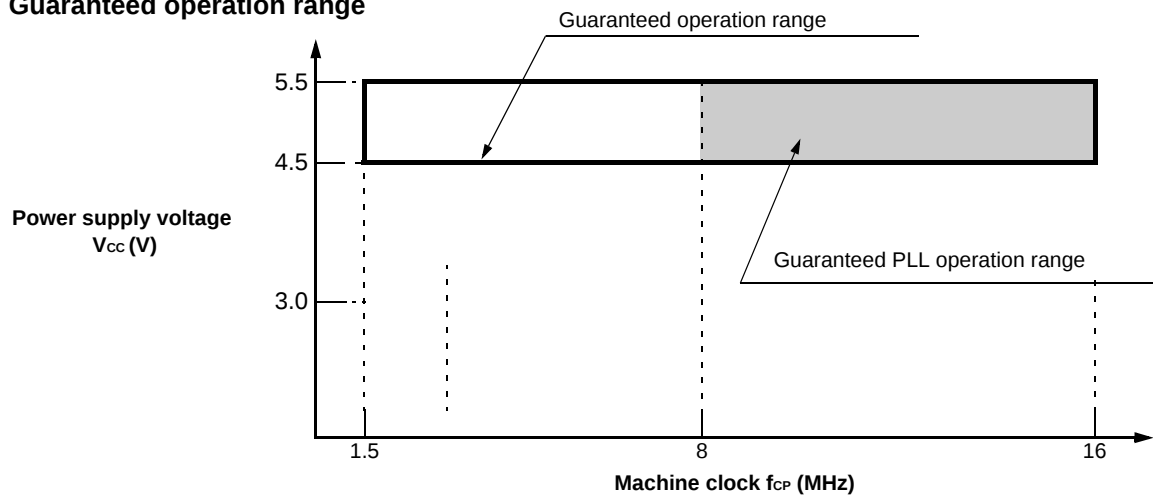
| Parameter        | Symbol    | Pin name                      | Condition                                                | Value          |     |                | Unit | Remarks |
|------------------|-----------|-------------------------------|----------------------------------------------------------|----------------|-----|----------------|------|---------|
|                  |           |                               |                                                          | Min            | Typ | Max            |      |         |
| Input H voltage  | $V_{IHS}$ | CMOS hysteresis input pin     | —                                                        | $0.8 V_{CC}$   | —   | $V_{CC} + 0.3$ | V    |         |
|                  | $V_{IHM}$ | MD input pin                  | —                                                        | $V_{CC} - 0.3$ | —   | $V_{CC} + 0.3$ | V    |         |
| Input L voltage  | $V_{ILS}$ | CMOS hysteresis input pin     | —                                                        | $V_{SS} - 0.3$ | —   | $0.2 V_{CC}$   | V    |         |
|                  | $V_{ILM}$ | MD input pin                  | —                                                        | $V_{SS} - 0.3$ | —   | $V_{SS} + 0.3$ | V    |         |
| Output H voltage | $V_{OH1}$ | Output pins except P70 to P87 | $V_{CC} = 4.5\text{ V}$ ,<br>$I_{OH1} = -4.0\text{ mA}$  | $V_{CC} - 0.5$ | —   | —              | V    |         |
|                  | $V_{OH2}$ | P70 to P87                    | $V_{CC} = 4.5\text{ V}$ ,<br>$I_{OH2} = -30.0\text{ mA}$ | $V_{CC} - 0.5$ | —   | —              | V    |         |
| Output L voltage | $V_{OL1}$ | Output pins except P70 to P87 | $V_{CC} = 4.5\text{ V}$ ,<br>$I_{OL1} = 4.0\text{ mA}$   | —              | —   | 0.4            | V    |         |
|                  | $V_{OL2}$ | P70 to P87                    | $V_{CC} = 4.5\text{ V}$ ,<br>$I_{OL2} = 30.0\text{ mA}$  | —              | —   | 0.5            | V    |         |

| Parameter              | Symbol            | Pin name        | Condition                                                                               | Value |     |     | Unit | Remarks   |
|------------------------|-------------------|-----------------|-----------------------------------------------------------------------------------------|-------|-----|-----|------|-----------|
|                        |                   |                 |                                                                                         | Min   | Typ | Max |      |           |
| Input leak current     | I <sub>IL</sub>   |                 | V <sub>CC</sub> = 5.5 V,<br>V <sub>SS</sub> < V <sub>I</sub> < V <sub>CC</sub>          | −5    | —   | 5   | μA   |           |
| Power supply current * | I <sub>CC</sub>   | V <sub>CC</sub> | V <sub>CC</sub> = 5.0 V±10%,<br>Internal frequency:<br>16 MHz,<br>At normal operating   | —     | 35  | 60  | mA   | MB90598G  |
|                        |                   |                 |                                                                                         | —     | 40  | 60  | mA   | MB90F598G |
|                        | I <sub>CCS</sub>  |                 | V <sub>CC</sub> = 5.0 V±10%,<br>Internal frequency:<br>16 MHz,<br>At sleep              | —     | 11  | 18  | mA   |           |
|                        | I <sub>CTS</sub>  |                 | V <sub>CC</sub> = 5.0 V±1%,<br>Internal frequency:<br>2 MHz,<br>At timer mode           | —     | 0.3 | 0.6 | mA   |           |
|                        | I <sub>CCH</sub>  |                 | V <sub>CC</sub> = 5.0 V±10%,<br>At stop, T <sub>A</sub> = 25°C                          | —     | —   | 20  | μA   |           |
|                        | I <sub>CCH2</sub> |                 | V <sub>CC</sub> = 5.0 V±10%,<br>At Hardware stand-<br>by mode,<br>T <sub>A</sub> = 25°C | —     | —   | 20  | μA   | MB90598G  |
|                        |                   |                 |                                                                                         | —     | 50  | 100 | μA   | MB90F598G |

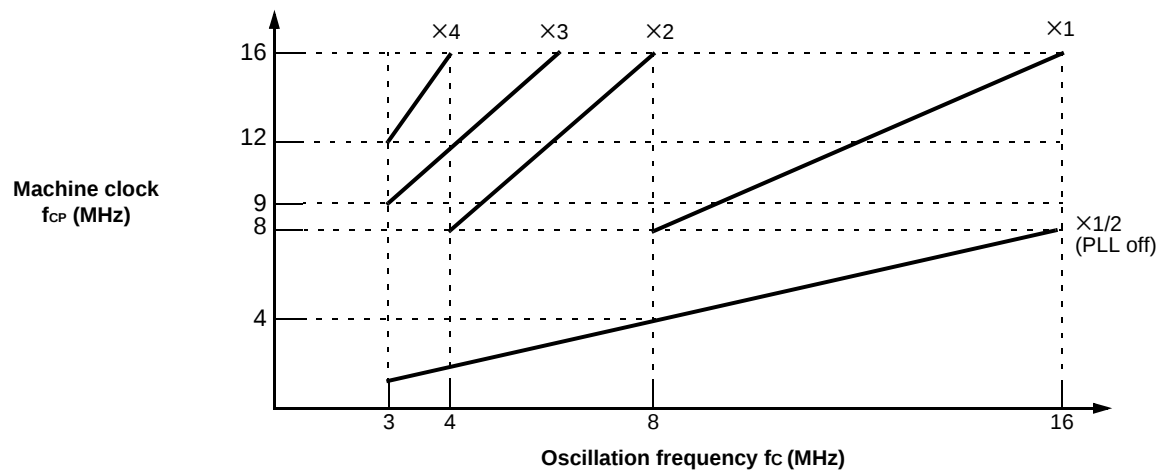
(Continued)

**■ Example of Oscillation circuit**

• **Guaranteed operation range**



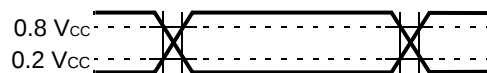
• **Oscillation frequency and machine clock frequency**



AC characteristics are set to the measured reference voltage values below.

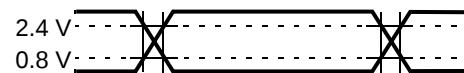
• **Input signal waveform**

Hysteresis Input Pin



• **Output signal waveform**

Output Pin



### 11.4.3 Power On Reset

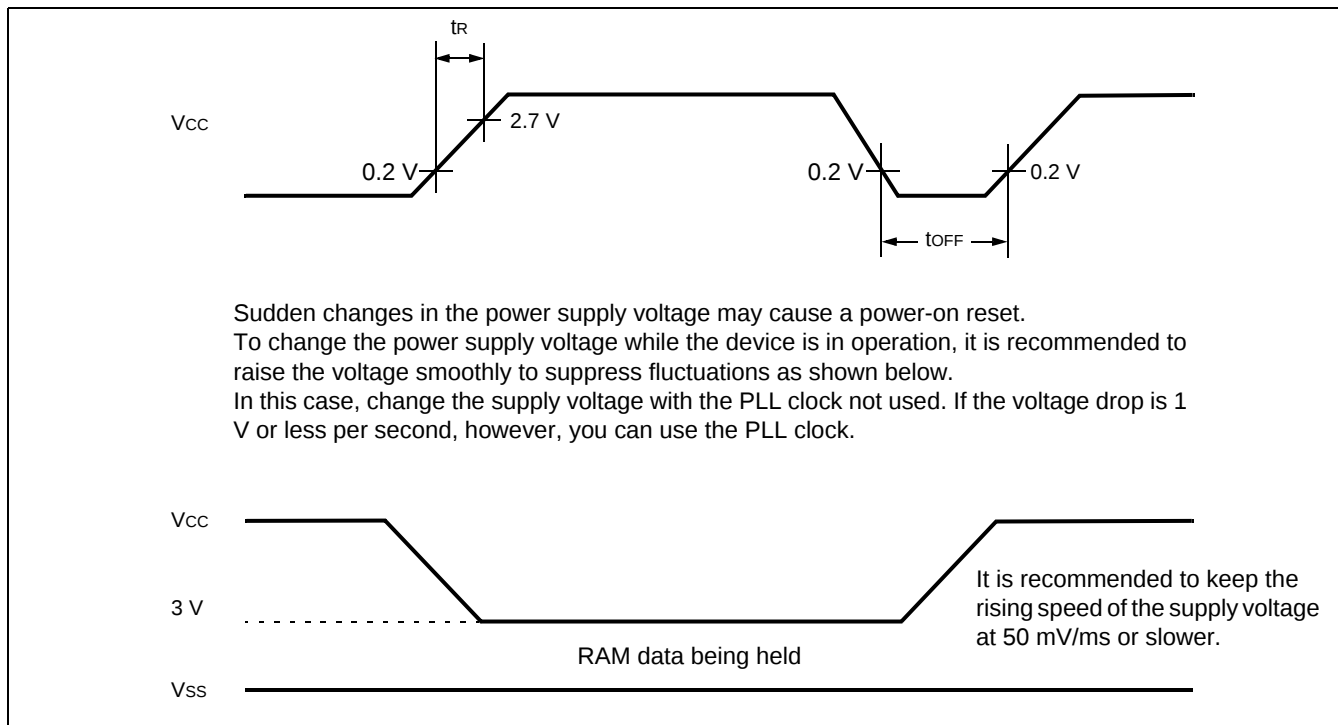
( $V_{CC} = 5.0\text{ V} \pm 10\%$ ,  $V_{SS} = AV_{SS} = 0.0\text{ V}$ ,  $T_A = -40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ )

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

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

Notes:

- 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 registers, turn on the power supply using the above values.

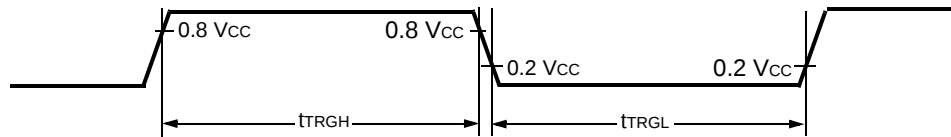


### 11.4.4 UART0/1, Serial I/O Timing

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

| Parameter                                      | Symbol     | Pin name                      | Condition                                                                         | Value       |     | Unit | Remarks |
|------------------------------------------------|------------|-------------------------------|-----------------------------------------------------------------------------------|-------------|-----|------|---------|
|                                                |            |                               |                                                                                   | Min         | Max |      |         |
| Serial clock cycle time                        | $t_{SCYC}$ | SCK0 to SCK2                  | Internal clock operation<br>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 SCK2,<br>SOT0 to SOT2 |                                                                                   | -80         | 80  | ns   |         |
| Valid SIN $\Rightarrow$ SCK $\uparrow$         | $t_{IVSH}$ | SCK0 to SCK2,<br>SIN0 to SIN2 |                                                                                   | 100         | —   | ns   |         |
| SCK $\uparrow \Rightarrow$ Valid SIN hold time | $t_{SHIX}$ | SCK0 to SCK2,<br>SIN0 to SIN2 |                                                                                   | 60          | —   | ns   |         |

### • Trigger Input Timing



#### 11.4.6 Slew Rate High Current Outputs (MB90598G, MB90F598G only)

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

| Parameter             | Symbol               | Pin name                            | Condition | Value |     |     | Unit | Remarks |
|-----------------------|----------------------|-------------------------------------|-----------|-------|-----|-----|------|---------|
|                       |                      |                                     |           | Min   | Typ | Max |      |         |
| Output Rise/Fall time | $t_{R2}$<br>$t_{F2}$ | Port P70 to P77,<br>Port P80 to P87 | —         | 15    | 40  | 150 | ns   |         |

### • Slew Rate Output Timing



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

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

## 11.5 A/D Converter

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

| Parameter                     | Symbol    | Pin name   | Value                      |                            |                            | Unit          | Remarks |
|-------------------------------|-----------|------------|----------------------------|----------------------------|----------------------------|---------------|---------|
|                               |           |            | Min                        | Typ                        | Max                        |               |         |
| Resolution                    | —         | —          | —                          |                            | 10                         | bit           |         |
| Conversion error              | —         | —          | —                          | —                          | $\pm 5.0$                  | LSB           |         |
| Nonlinearity error            | —         | —          | —                          | —                          | $\pm 2.5$                  | LSB           |         |
| Differential linearity error  | —         | —          | —                          | —                          | $\pm 1.9$                  | LSB           |         |
| Zero transition voltage       | $V_{OT}$  | AN0 to AN7 | $AV_{RL} - 3.5\text{ LSB}$ | $AV_{RL} + 0.5\text{ LSB}$ | $AV_{RL} + 4.5\text{ LSB}$ | V             |         |
| Full scale transition voltage | $V_{FST}$ | AN0 to AN7 | $AV_{RH} - 6.5\text{ LSB}$ | $AV_{RH} - 1.5\text{ LSB}$ | $AV_{RH} + 1.5\text{ LSB}$ | V             |         |
| Conversion time               | —         | —          | —                          | $352t_{CP}$                | —                          | ns            |         |
| Sampling time                 | —         | —          | —                          | $64t_{CP}$                 | —                          | ns            |         |
| Analog port input current     | $I_{AIN}$ | AN0 to AN7 | -10                        | —                          | 10                         | $\mu\text{A}$ |         |
| Analog input voltage range    | $V_{AIN}$ | AN0 to AN7 | $AV_{RL}$                  | —                          | $AV_{RH}$                  | V             |         |

| Parameter                     | Symbol          | Pin name         | Value      |     |                  | Unit | Remarks                 |
|-------------------------------|-----------------|------------------|------------|-----|------------------|------|-------------------------|
|                               |                 |                  | Min        | Typ | Max              |      |                         |
| Reference voltage range       | —               | AVRH             | AVRL + 3.0 | —   | AV <sub>CC</sub> | V    |                         |
|                               | —               | AVRL             | 0          | —   | AVRH – 3.0       | V    |                         |
| Power supply current          | I <sub>A</sub>  | AV <sub>CC</sub> | —          | 5   | —                | mA   |                         |
|                               | I <sub>AH</sub> | AV <sub>CC</sub> | —          | —   | 5                | μA   | *                       |
| Reference voltage current     | I <sub>R</sub>  | AVRH             | —          | 400 | 600              | μA   | MB90V595G,<br>MB90F598G |
|                               |                 |                  | —          | 140 | 600              | μA   | MB90598G                |
|                               | I <sub>RH</sub> | AVRH             | —          | —   | 5                | μA   | *                       |
| Offset between input channels | —               | AN0 to AN7       | —          | —   | 4                | LSB  |                         |

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

## 11.8 Flash memory

### ■ Erase and programming performance

| Parameter                      | Condition                                                        | Value |     |      | Unit  | Remarks   |                                        |
|--------------------------------|------------------------------------------------------------------|-------|-----|------|-------|-----------|----------------------------------------|
|                                |                                                                  | Min   | Typ | Max  |       |           |                                        |
| Sector erase time              | $T_A = +25\text{ }^{\circ}\text{C}$ ,<br>$V_{CC} = 5.0\text{ V}$ | —     | 1   | 15   | s     | MB90F598G | Excludes 00H programming prior erasure |
| Chip erase time                |                                                                  | —     | 5   | —    | s     | MB90F598G | Excludes 00H programming prior         |
| Word (16-bit) programming time |                                                                  | —     | 16  | 3600 | μs    | MB90F598G | Excludes system-level overhead         |
| Erase/Program cycle            | —                                                                | 10000 | —   | —    | cycle |           |                                        |

### 13. Ordering Information

| Part number               | Package                               | Remarks        |
|---------------------------|---------------------------------------|----------------|
| MB90598GPF<br>MB90F598GPF | 100-pin Plastic QFP<br>(FPT-100P-M06) |                |
| MB90V595GCR               | 256-pin Ceramic PGA<br>(PGA-256C-A01) | For evaluation |

### 14. Package Dimensions

