

# *8-bit Proprietary Microcontroller*

CMOS

## **F<sup>2</sup>MC-8L MB89160L Series**

### **MB89163L/165L/P165/W165/PV160**

#### ■ DESCRIPTION

The MB89160L series is a line of the general-purpose, single-chip microcontrollers. In addition to a compact instruction set, the microcontrollers contain a variety of peripheral functions such as an LCD controller/driver, an A/D converter, timers, a serial interface, PWM timers, and external interrupts.

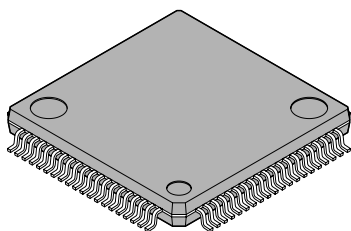
#### ■ FEATURES

- F<sup>2</sup>MC-8L family CPU core
- Dual-clock control system
- Maximum memory size: 16-Kbyte ROM, 512-byte RAM (Max)
- Minimum execution time: 0.95  $\mu$ s/4.2 MHz
- I/O ports: Max 54 channels
- 21-bit time-base timer
- 8/16-bit timer/counter: 2 or 1 channels
- 8-bit serial I/O: 1 channel
- External interrupts (wake-up function): Four channels with edge detection plus eight level-interrupt channels
- 8-bit A/D converter: 8 channels
- 8-bit PWM timers: 2 channels
- Watch prescaler (15 bits)
- LCD controller/driver: 24 segments  $\times$  4 commons (Max 96 pixels)
- Remote control transmission output
- Buzzer output
- Power-on reset function (option)
- Low-power consumption modes (stop, sleep, and watch mode)
- CMOS technology

# MB89160L Series

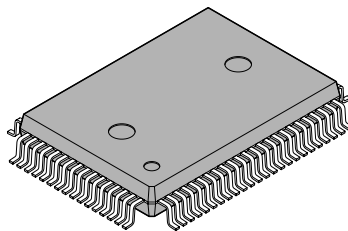
## ■ PACKAGES

80-pin Plastic LQFP



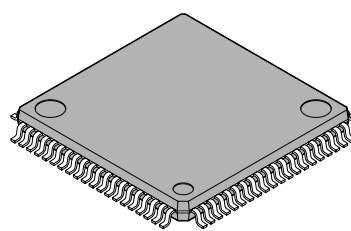
(FPT-80P-M05)

80-pin Plastic QFP



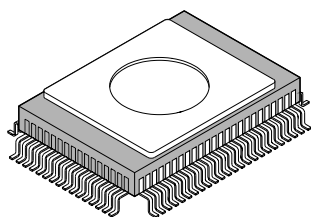
(FPT-80P-M06)

80-pin Plastic LQFP



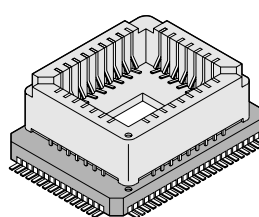
(FPT-80P-M11)

80-pin Ceramic QFP



(FPT-80C-A02)

80-pin Ceramic MQFP



(MQP-80C-P01)

# MB89160L Series

## ■ PRODUCT LINEUP

| <div>Part number</div> <div>Parameter</div> | MB89163L                                                                                                                                                                                                                                                                                                                                                                                                                                                     | MB89165L                                | MB89P165                                                                                  | MB89W165         | MB89PV160                                             |
|---------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|-------------------------------------------------------------------------------------------|------------------|-------------------------------------------------------|
| Classification                              | Mass production products<br>(mask ROM products)                                                                                                                                                                                                                                                                                                                                                                                                              |                                         | One-time<br>PROM<br>product                                                               | EPROM<br>product | Piggyback/<br>evaluation product<br>(for development) |
| ROM size                                    | 8 K × 8 bits<br>(internal mask<br>ROM)                                                                                                                                                                                                                                                                                                                                                                                                                       | 16 K × 8 bits<br>(internal mask<br>ROM) | 16 K × 8 bits<br>(internal PROM, programming<br>with general-purpose EPROM<br>programmer) |                  | 32 K × 8 bits<br>(external ROM)                       |
| RAM size                                    | 256 × 8 bits                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 512 × 8 bits                            |                                                                                           |                  |                                                       |
| CPU functions                               | Number of instructions : 136<br>Instruction bit length : 8 bits<br>Instruction length : 1 to 3 bytes<br>Data bit length : 1, 8,16 bits<br>Minimum execution time : 0.95 μs/4.2 MHz<br>Interrupt processing time : 8.6 μs to 137.1 μs/4.2 MHz                                                                                                                                                                                                                 |                                         |                                                                                           |                  |                                                       |
| Ports                                       | I/O port (N-ch open-drain) : 8 (6 ports also serve as peripherals, 3 ports<br>are a heavy-current drive type.)<br>Output ports (N-ch open-drain) : 28 (16 ports also serve as segment pins, 2 ports<br>serve as common pins,<br>2 ports serve as common pins.) *2<br>(8 ports also serve as an A/D input)<br>I/O ports (CMOS) : 16 (12 ports also serve as an external interrupt)<br>Output ports (CMOS) : 2 (Also serve as peripherals)<br>Total : 54 (Max) |                                         |                                                                                           |                  |                                                       |
| Timer/counter                               | 8-bit timer operation (toggled output capable, operating clock cycle 1.9 μs to 487.6 μs)<br>16-bit timer operation (toggled output capable, operating clock cycle 1.9 μs to 487.6 μs)                                                                                                                                                                                                                                                                        |                                         |                                                                                           |                  |                                                       |
| Serial I/O                                  | 8 bits<br>LSB first/MSB first selectability<br>One clock selectable from four operation clocks<br>(one external shift clock, three internal shift clocks: 1.9 μs, 7.6 μs, 30.5 μs)                                                                                                                                                                                                                                                                           |                                         |                                                                                           |                  |                                                       |
| LCD controller/<br>driver                   | Common output : 4 (Max)*2<br>Segment output : 24 (Max) *2<br>Bias power supply pins : 4<br>LCD display RAM size : 24 × 4 bits<br>Dividing resistor for LCD driving : Built-in (an external resistor selectability)                                                                                                                                                                                                                                           |                                         |                                                                                           |                  |                                                       |
| A/D converter                               | 8-bit resolution × 8 channels<br>Sense mode (conversion time 11.9 μs/4.2 MHz)<br>Continuous activation by an internal timer capable<br>Reference voltage input                                                                                                                                                                                                                                                                                               |                                         |                                                                                           |                  |                                                       |
|                                             | A/D conversion mode<br>(conversion time 49.5 μs/4.2 MHz<br>(52 instruction cycles))                                                                                                                                                                                                                                                                                                                                                                          |                                         | A/D conversion mode (conversion time<br>43 μs/ 4.2 MHz (44 instruction cycles))           |                  |                                                       |

(Continued)

# MB89160L Series

(Continued)

| Part number<br>Parameter                   | MB89163L                                                                                                                                                                                           | MB89165L | MB89P165       | MB89W165 | MB89PV160       |
|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------------|----------|-----------------|
| PWM timer 1,<br>PWM timer 2                | 8 bits × 2 channels<br>8-bit reload timer operation<br>(toggled output capable, operating clock cycle: 0.95 μs to 124 ms)<br>8-bit resolution PWM operation (conversion cycle: 243.8 μs to 63.9 s) |          |                |          |                 |
| External interrupt 1<br>(wake-up function) | 4 independent channels (edge selectability)<br>Rising edge/falling edge selectability<br>Used also for wake-up from stop/sleep mode.<br>(Edge detection is also permitted in stop mode.)           |          |                |          |                 |
| External interrupt 2<br>(wake-up function) | “L” level interrupts × 8 channels                                                                                                                                                                  |          |                |          |                 |
| Buzzer output                              | 1 (7 frequencies are selectable by the software.)                                                                                                                                                  |          |                |          |                 |
| Remote control<br>transmission<br>output   | 1 (Pulse width and cycle are software selectable.)                                                                                                                                                 |          |                |          |                 |
| Standby modes                              | Subclock mode, sleep mode, stop mode, and watch mode                                                                                                                                               |          |                |          |                 |
| Process                                    | CMOS                                                                                                                                                                                               |          |                |          |                 |
| Operating voltage                          | 2.2 V to 3.6 V *1                                                                                                                                                                                  |          | 2.7 V to 6.0 V |          |                 |
| EPROM for use                              |                                                                                                                                                                                                    |          |                |          | MBM27C256A-20TV |

\*1 : Varies with conditions such as the operating frequency. (The operating voltage of the A/D converter is assured separately. See ■ ELECTRICAL CHARACTERISTICS.)

\*2 : See ■ MASK OPTIONS.

## ■ PACKAGE AND CORRESPONDING PRODUCTS

| Package     | MB89163L | MB89165L | MB89P165 | MB89W165 | MB89PV160 |
|-------------|----------|----------|----------|----------|-----------|
| FPT-80P-M05 | ○        | ○        | ○        | ×        | ×         |
| FPT-80P-M06 | ○        | ○        | ○        | ×        | ×         |
| FPT-80P-M11 | ○        | ○        | ○        | ×        | ×         |
| FPT-80C-A02 | ×        | ×        | ×        | ○        | ×         |
| MQP-80C-P01 | ×        | ×        | ×        | ×        | ○         |

○ : Available    × : Not available

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

## ■ DIFFERENCES AMONG PRODUCTS

### 1. Memory Size

Before evaluating using the piggyback product, verify its differences from the product that will actually be used. Take particular care on the following points:

- On the MB89163L, addresses 0180<sub>H</sub> and later of the register bank cannot be used.
- The stack area, etc., is set at the upper limit of the RAM.

### 2. Current Consumption

- In the case of the MB89PV160, add the current consumed by the EPROM which is connected to the top socket.
- When operated at low speed, the product with an OTPROM (one-time PROM) or an EPROM will consume more current than the product with a mask ROM.

However, the current consumption in the sleep/stop modes is the same. (For more information, see ■ ELECTRICAL CHARACTERISTICS.)

### 3. Mask Options

Functions that can be selected as options and how to designate these options vary by the product.

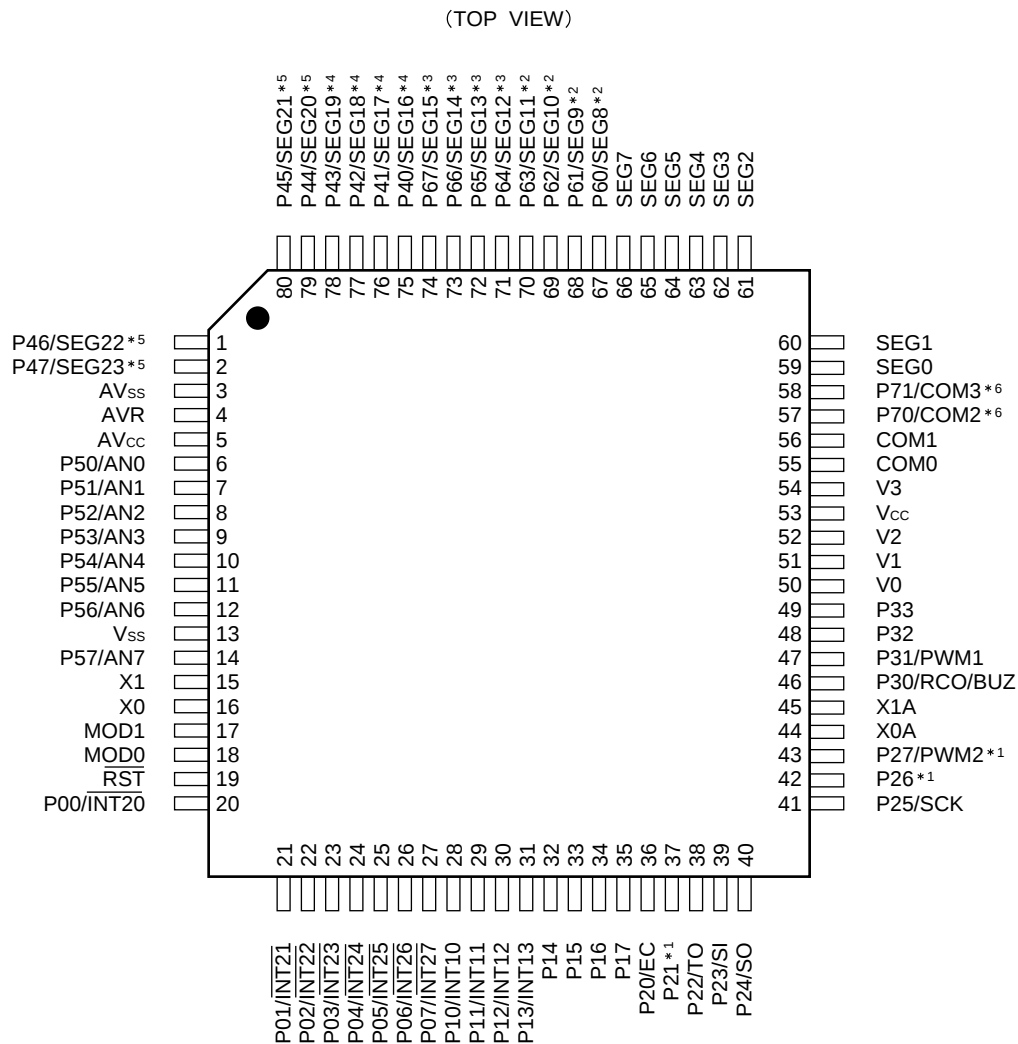
Before using options check ■ MASK OPTIONS.

Take particular care on the following points:

- A pull-up resistor cannot be set for P20 to P27, P40 to P47 and P60 to P67 on the MB89P165/W165.
- A pull-up resistor is not selectable for P40 to P47 and P60 to P67 if they are used as LCD pins.
- Options are fixed on the MB89PV160.

# MB89160L Series

## ■ PIN ASSIGNMENTS



(FPT-80P-M11)

\*1 : N-ch open-drain heavy-current drive type

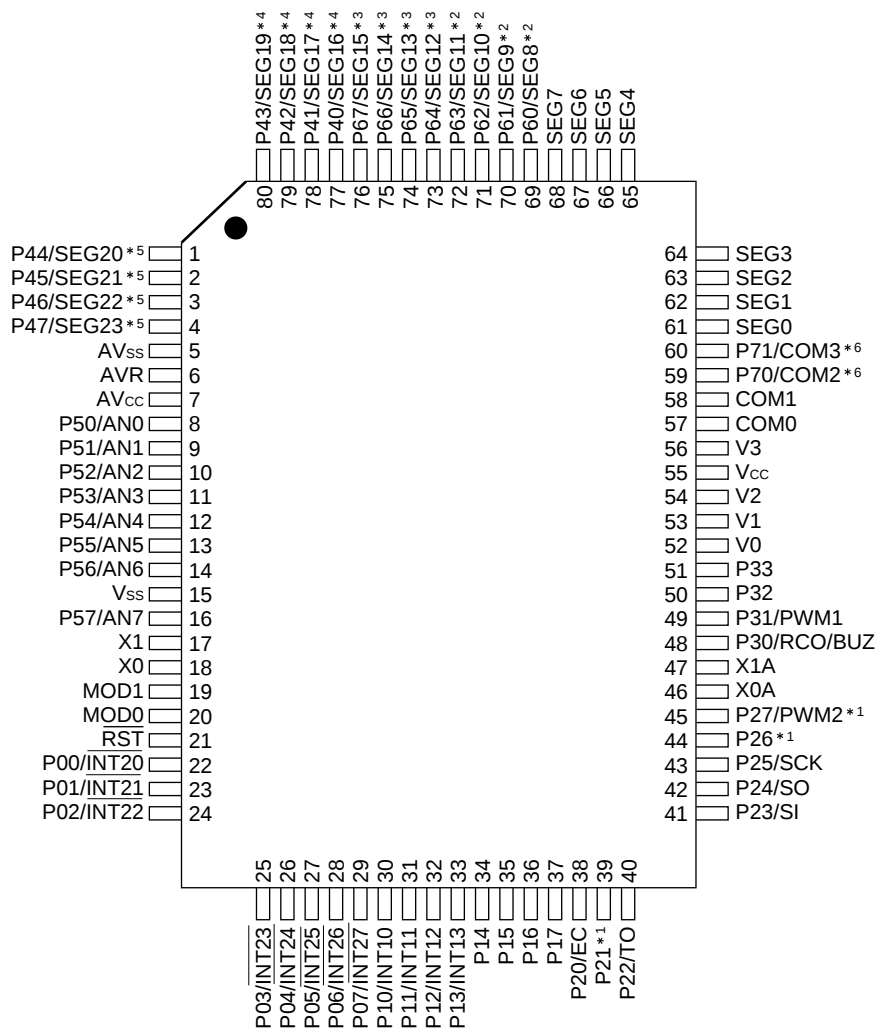
\*2 to \*5 : Output selected using the mask option (in units of 4 pins)

\*6 : Output selected using the mask option (in units of 2 pins)

Note : For more information on output selected combinations of \*2 to \*6, see ■ MASK OPTIONS.

(Continued)

(TOP VIEW)



(FPT-80P-M06)  
(FPT-80C-A02)

\*1 : N-ch open-drain heavy-current drive type

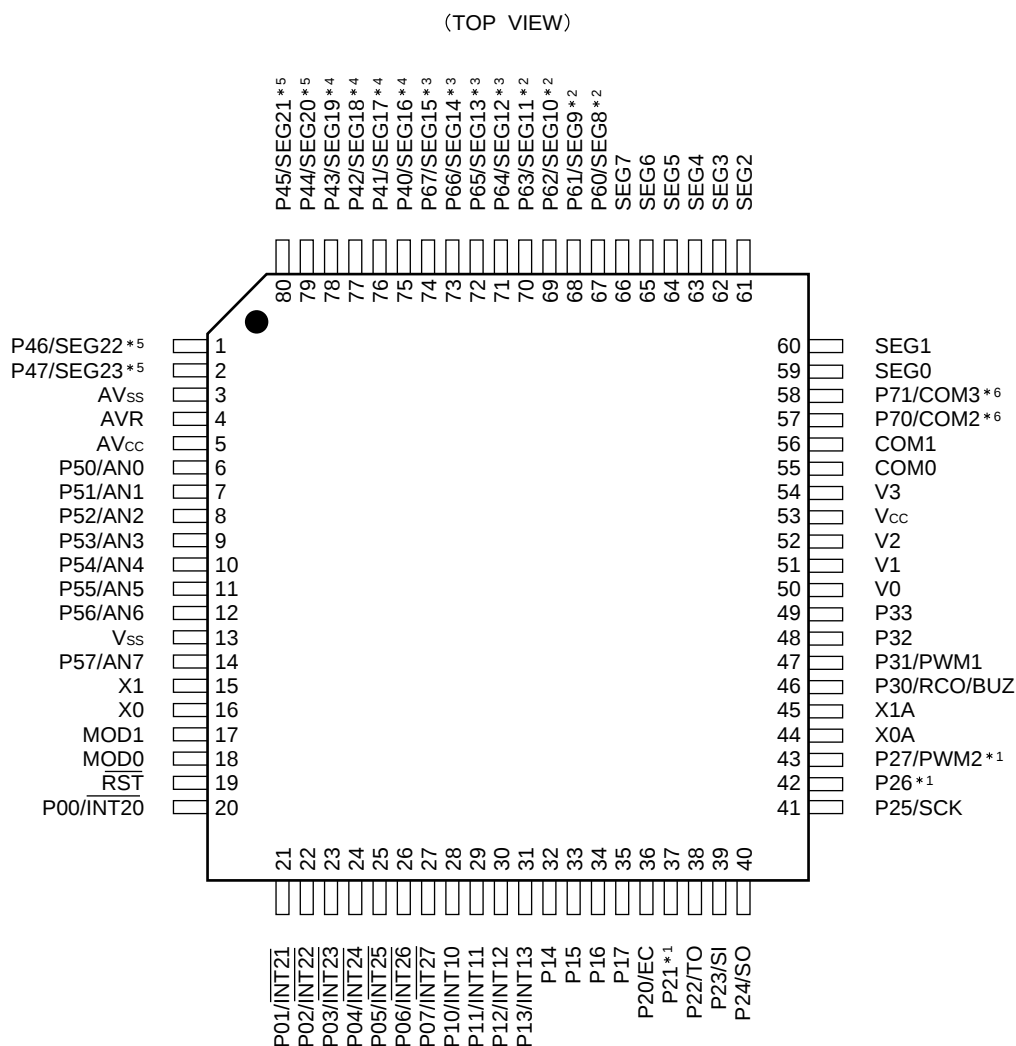
\*2 to \*5 : Selected using the mask option (in units of 4 pins)

\*6 : Selected using the mask option (in units of 2 pins)

Note : For more information on mask option combinations of \*2 to \*6, see ■ MASK OPTIONS.

(Continued)

# MB89160L Series



(FPT-80P-M05)

\*1 : N-ch open-drain heavy-current drive type

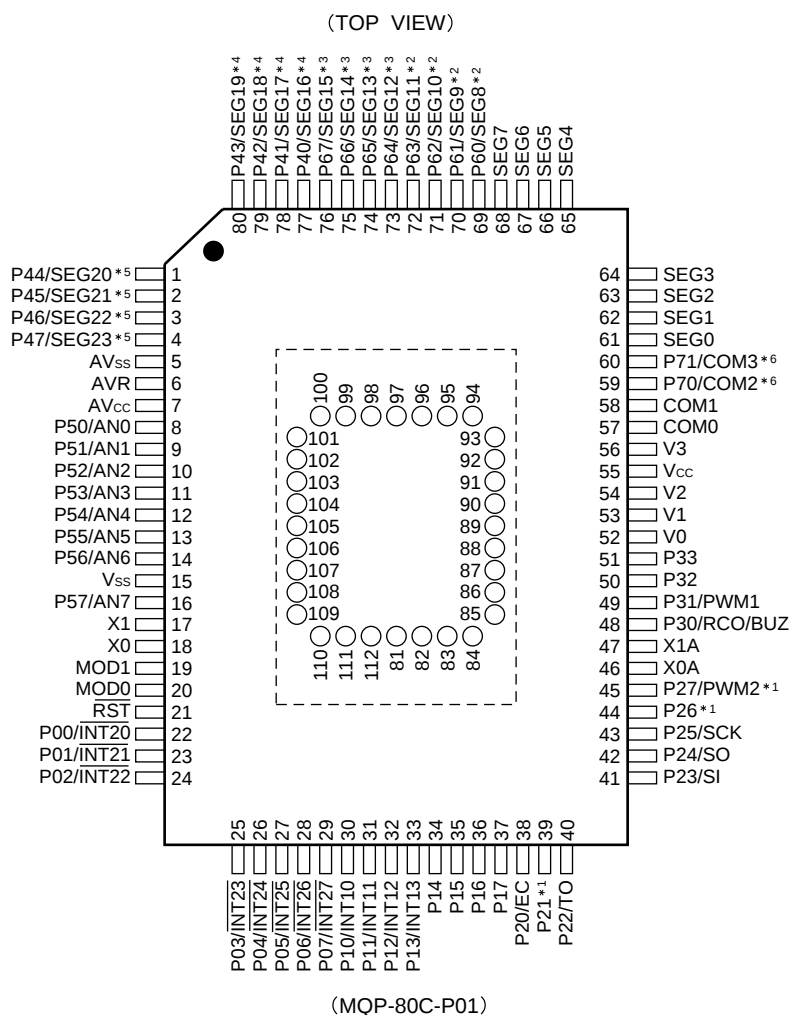
\*2 to \*5 : Selected using the mask option (in units of 4 pins)

\*6 : Selected using the mask option (in units of 2 pins)

Note : For more information on mask option combinations of \*2 to \*6, see ■ MASK OPTIONS.

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\*1 : N-ch open-drain heavy-current drive type

\*2 to \*5 : Selected using the mask option (in units of 4 pins)

\*6 : Selected using the mask option (in units of 2 pins)

Note : For more information on mask option combinations of \*2 to \*6, see ■ MASK OPTIONS.

## • Pin assignment on package top (MB89PV160 only)

| Pin no. | Pin name        | Pin no. | Pin name        | Pin no. | Pin name | Pin no. | Pin name        |
|---------|-----------------|---------|-----------------|---------|----------|---------|-----------------|
| 81      | N.C.            | 89      | A2              | 97      | N.C.     | 105     | OE              |
| 82      | V <sub>PP</sub> | 90      | A1              | 98      | O4       | 106     | N.C.            |
| 83      | A12             | 91      | A0              | 99      | O5       | 107     | A11             |
| 84      | A7              | 92      | N.C.            | 100     | O6       | 108     | A9              |
| 85      | A6              | 93      | O1              | 101     | O7       | 109     | A8              |
| 86      | A5              | 94      | O2              | 102     | O8       | 110     | A13             |
| 87      | A4              | 95      | O3              | 103     | CE       | 111     | A14             |
| 88      | A3              | 96      | V <sub>SS</sub> | 104     | A10      | 112     | V <sub>CC</sub> |

N.C.: Internally connected. Do not use.

# MB89160L Series

## ■ PIN DESCRIPTION

| Pin no.                                 |                                         | Pin name                                                            | Circuit type | Function                                                                                                                                                                                                                            |
|-----------------------------------------|-----------------------------------------|---------------------------------------------------------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SQFP <sup>*1</sup><br>QFP <sup>*2</sup> | MQFP <sup>*3</sup><br>QFP <sup>*4</sup> |                                                                     |              |                                                                                                                                                                                                                                     |
| 16                                      | 18                                      | X0                                                                  | A            | Main clock crystal oscillator pins                                                                                                                                                                                                  |
| 15                                      | 17                                      | X1                                                                  |              |                                                                                                                                                                                                                                     |
| 18                                      | 20                                      | MOD0                                                                | C            | Operating mode selection pins<br>Connect directly to V <sub>SS</sub> .                                                                                                                                                              |
| 17                                      | 19                                      | MOD1                                                                |              |                                                                                                                                                                                                                                     |
| 19                                      | 21                                      | $\overline{\text{RST}}$                                             | D            | Reset I/O pin<br>This pin is an N-ch open-drain output type with a pull-up resistor, and a hysteresis input type. "L" is output from this pin by an internal reset source. The internal circuit is initialized by the input of "L". |
| 20 to 27                                | 22 to 29                                | P00/ $\overline{\text{INT20}}$ to<br>P07/ $\overline{\text{INT27}}$ | E            | General-purpose I/O ports<br>Also serve as an external interrupt 2 input (wake-up function).<br>External interrupt 2 input is hysteresis input.                                                                                     |
| 28 to 31                                | 30 to 33                                | P10/ $\overline{\text{INT10}}$ to<br>P13/ $\overline{\text{INT13}}$ | E            | General-purpose I/O ports<br>Also serve as an external interrupt 1 input. External interrupt 1 input is hysteresis input.                                                                                                           |
| 32 to 35                                | 34 to 37                                | P14 to P17                                                          | F            | General-purpose I/O ports                                                                                                                                                                                                           |
| 36                                      | 38                                      | P20/EC                                                              | H            | N-ch open-drain general-purpose I/O port<br>Also serves as the external clock input for the timer.<br>The peripheral is a hysteresis input type.                                                                                    |
| 37                                      | 39                                      | P21                                                                 | I            | N-ch open-drain general-purpose I/O port                                                                                                                                                                                            |
| 38                                      | 40                                      | P22/TO                                                              | I            | N-ch open-drain general-purpose I/O port<br>Also serves as a timer output.                                                                                                                                                          |
| 39                                      | 41                                      | P23/SI                                                              | H            | N-ch open-drain general-purpose I/O port<br>Also serves as the data input for the serial I/O.<br>The peripheral is a hysteresis input type.                                                                                         |
| 40                                      | 42                                      | P24/SO                                                              | I            | N-ch open-drain general-purpose I/O port<br>Also serves as the data output for the serial I/O.                                                                                                                                      |
| 41                                      | 43                                      | P25/SCK                                                             | H            | N-ch open-drain general-purpose I/O port<br>Also serves as the clock I/O for the serial I/O.<br>The peripheral is a hysteresis input type.                                                                                          |
| 42                                      | 44                                      | P26                                                                 | I            | N-ch open-drain general-purpose I/O port                                                                                                                                                                                            |
| 43                                      | 45                                      | P27/PWM2                                                            | I            | N-ch open-drain general-purpose I/O port<br>Also serves as the square wave or PWM wave output for the 8-bit PWM timer 2.                                                                                                            |
| 49                                      | 51                                      | P33                                                                 | J            | Functions as an N-ch open-drain general-purpose output port only.                                                                                                                                                                   |

(Continued)

# MB89160L Series

(Continued)

| Pin no.           |                    | Pin name                  | Circuit type | Function                                                                                                                                                                     |
|-------------------|--------------------|---------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| SQFP*1<br>QFP*2   | MQFP*3<br>QFP*4    |                           |              |                                                                                                                                                                              |
| 48                | 50                 | P32                       | J            | Functions as an N-ch open-drain general-purpose output port only.                                                                                                            |
| 47                | 49                 | P31/PWM1                  | G            | General-purpose output-only port<br>Also serves as the square wave or PWM wave output for the 8-bit PWM timer 1.                                                             |
| 46                | 48                 | P30/RCO/BUZ               | G            | General-purpose output-only port<br>Also serves as a buzzer output and a remote control transmission frequency output.                                                       |
| 14,<br>12 to 6    | 16,<br>14 to 8     | P57/AN7 to<br>P50/AN0     | L            | N-ch open-drain general-purpose output ports<br>Also serve as an analog input.                                                                                               |
| 2, 1,<br>80 to 75 | 4 to 1<br>80 to 77 | P47/SEG23 to<br>P40/SEG16 | J/K          | N-ch open-drain general-purpose output ports<br>Also serve as an LCD controller/driver segment output. Switching between port and segment output is done by the mask option. |
| 74 to 67          | 76 to 69           | P67/SEG15 to<br>P60/SEG8  | J/K          |                                                                                                                                                                              |
| 66 to 59          | 68 to 61           | SEG7 to SEG0              | K            | LCD controller/driver segment output pins                                                                                                                                    |
| 58,<br>57         | 60,<br>59          | P71/COM3,<br>P70/COM2     | J/K          | N-ch open-drain general-purpose output ports<br>Also serve as an LCD controller/driver common output. Switching between port and common output is done by the mask option.   |
| 56,<br>55         | 58,<br>57          | COM1,<br>COM0             | K            | LCD controller/driver common output-only pins                                                                                                                                |
| 54,<br>52 to 50   | 56,<br>54 to 52    | V3,<br>V2 to V0           | —            | LCD driving power supply pins                                                                                                                                                |
| 44                | 46                 | X0A                       | B            | Subclock crystal oscillator pins (32.768 KHz)                                                                                                                                |
| 45                | 47                 | X1A                       |              |                                                                                                                                                                              |
| 53                | 55                 | V <sub>CC</sub>           | —            | Power supply pin                                                                                                                                                             |
| 13                | 15                 | V <sub>SS</sub>           | —            | Power supply (GND) pin                                                                                                                                                       |
| 5                 | 7                  | AV <sub>CC</sub>          | —            | A/D converter power supply pin<br>Use this pin at the same voltage as V <sub>CC</sub> .                                                                                      |
| 4                 | 6                  | AV <sub>R</sub>           | —            | A/D converter reference voltage input pin                                                                                                                                    |
| 3                 | 5                  | AV <sub>SS</sub>          | —            | A/D converter power supply pin<br>Use this pin at the same voltage as V <sub>SS</sub> .                                                                                      |

\*1 : FPT-80P-M05

\*2 : FPT-80P-M11

\*3 : MQP-80C-P01

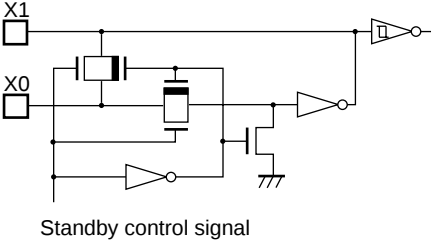
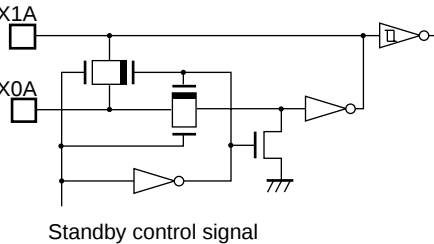
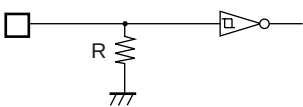
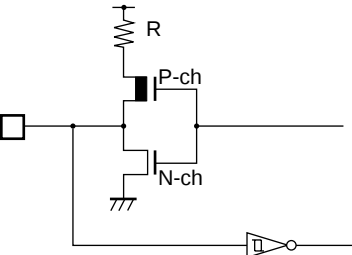
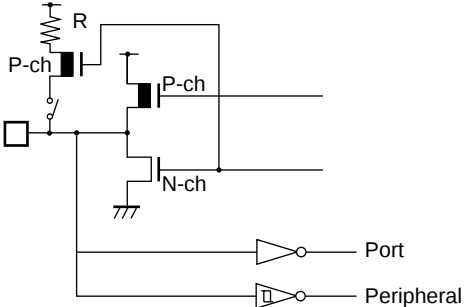
\*4 : FPT-80P-M06, FPT-80C-A02

# MB89160L Series

• External EPROM pins (MB89PV160 only)

| Pin no. | Pin name               | I/O | Function                                                 |
|---------|------------------------|-----|----------------------------------------------------------|
| 82      | V <sub>PP</sub>        | O   | "H" level output pin                                     |
| 83      | A12                    | O   | Address output pins                                      |
| 84      | A7                     |     |                                                          |
| 85      | A6                     |     |                                                          |
| 86      | A5                     |     |                                                          |
| 87      | A4                     |     |                                                          |
| 88      | A3                     |     |                                                          |
| 89      | A2                     |     |                                                          |
| 90      | A1                     |     |                                                          |
| 91      | A0                     |     |                                                          |
| 93      | O1                     | I   | Data input pins                                          |
| 94      | O2                     |     |                                                          |
| 95      | O3                     |     |                                                          |
| 96      | V <sub>SS</sub>        | O   | Power supply (GND) pin                                   |
| 98      | O4                     | I   | Data input pins                                          |
| 99      | O5                     |     |                                                          |
| 100     | O6                     |     |                                                          |
| 101     | O7                     |     |                                                          |
| 102     | O8                     |     |                                                          |
| 103     | $\overline{\text{CE}}$ | O   | ROM chip enable pin<br>Outputs "H" during standby.       |
| 104     | A10                    | O   | Address output pin                                       |
| 105     | $\overline{\text{OE}}$ | O   | ROM output enable pin<br>Outputs "L" at all times.       |
| 107     | A11                    | O   | Address output pins                                      |
| 108     | A9                     |     |                                                          |
| 109     | A8                     |     |                                                          |
| 110     | A13                    |     |                                                          |
| 111     | A14                    |     |                                                          |
| 112     | V <sub>CC</sub>        | O   | EPROM power supply pin                                   |
| 81      | N.C.                   | —   | Internally connected pins<br>Be sure to leave them open. |
| 92      |                        |     |                                                          |
| 97      |                        |     |                                                          |
| 106     |                        |     |                                                          |

## ■ I/O CIRCUIT TYPE

| Type | Circuit                                                                                                         | Remarks                                                                                                                                                                             |
|------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A    |  <p>Standby control signal</p> | <p>Main clock</p> <ul style="list-style-type: none"> <li>At an oscillation feedback resistor of approximately 1 MΩ</li> </ul>                                                       |
| B    |  <p>Standby control signal</p> | <p>Subclock</p> <ul style="list-style-type: none"> <li>At an oscillation feedback resistor of approximately 4.5 MΩ</li> </ul>                                                       |
| C    |                              | <ul style="list-style-type: none"> <li>Hysteresis input</li> <li>The pull-down resistor (R) is approximately 50 kΩ for MB89163L/165L only.</li> </ul>                               |
| D    |                              | <ul style="list-style-type: none"> <li>At an output pull-up resistor of approximately 50 kΩ</li> <li>Hysteresis input</li> </ul>                                                    |
| E    |                              | <ul style="list-style-type: none"> <li>CMOS I/O</li> <li>The peripheral is a hysteresis input type.</li> <li>Pull-up resistor optional (Not available on the MB89PV160.)</li> </ul> |

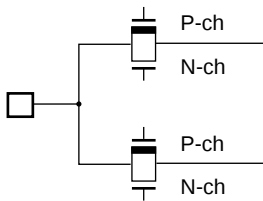
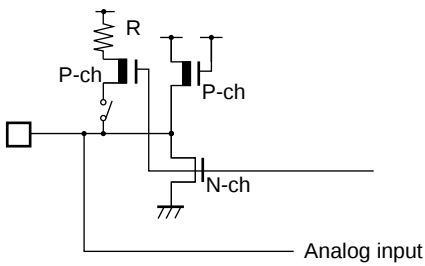
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# MB89160L Series

| Type | Circuit | Remarks                                                                                                                                                                                                                                                                                                          |
|------|---------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| F    |         | <ul style="list-style-type: none"> <li>• CMOS I/O</li> <li>• Pull-up resistor optional<br/>(Not available on the MB89PV160)</li> </ul>                                                                                                                                                                           |
| G    |         | <ul style="list-style-type: none"> <li>• CMOS output</li> <li>• P-ch output is a heavy-current drive type.</li> </ul>                                                                                                                                                                                            |
| H    |         | <ul style="list-style-type: none"> <li>• N-ch open-drain I/O</li> <li>• CMOS input</li> <li>• The peripheral is a hysteresis input type.</li> <li>• P21, P26 and P27 are a heavy-current drive type.</li> <li>• Pull-up resistor optional<br/>(Not available on the MB89P165, MB89W165 and MB89PV160)</li> </ul> |
| I    |         | <ul style="list-style-type: none"> <li>• N-ch open-drain output</li> <li>• CMOS input</li> <li>• Pull-up resistor optional<br/>(Not available on the MB89P165, MB89W165 and MB89PV160)</li> </ul>                                                                                                                |
| J    |         | <ul style="list-style-type: none"> <li>• N-ch open-drain output</li> <li>• Pull-up resistor optional<br/>(Not available on the MB89P165, MB89W165 and MB89PV160)</li> <li>• P32 and P33 are not provided with a pull-up resistor.</li> </ul>                                                                     |

(Continued)

(Continued)

| Type | Circuit                                                                           | Remarks                                                                                                                                                                      |
|------|-----------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| K    |  | <ul style="list-style-type: none"> <li>• LCD controller/driver segment output</li> </ul>                                                                                     |
| L    |  | <ul style="list-style-type: none"> <li>• N-ch open-drain output</li> <li>• Analog input</li> <li>• Pull-up resistor optional<br/>(Not available on the MB89PV160)</li> </ul> |

## ■ HANDLING DEVICES

### 1. Preventing Latchup

Latchup may occur on CMOS ICs if voltage higher than  $V_{CC}$  or lower than  $V_{SS}$  is applied to input and output pins other than medium- to high-voltage pins or if higher than the voltage which shows on “1. Absolute Maximum Ratings” in ■ ELECTRICAL CHARACTERISTICS is applied between  $V_{CC}$  and  $V_{SS}$ .

When latchup occurs, power supply current increases rapidly and might thermally damage elements. When using, take great care not to exceed the absolute maximum ratings.

Also, take care to prevent the analog power supply ( $AV_{CC}$  and  $AVR$ ) and analog input from exceeding the digital power supply ( $V_{CC}$ ) when the analog system power supply is turned on and off.

### 2. Treatment of Unused Input Pins

Leaving unused input pins open could cause malfunctions. They should be connected to a pull-up or pull-down resistor.

### 3. Treatment of Power Supply Pins on Microcontrollers with A/D and D/A Converters

Connect to be  $AV_{CC} = DAVC = V_{CC}$  and  $AV_{SS} = AVR = V_{SS}$  even if the A/D and D/A converters are not in use.

### 4. Treatment of N.C. Pin

Be sure to leave (internally connected) N.C. pins open.

### 5. Power Supply Voltage Fluctuations

Although  $V_{CC}$  power supply voltage is assured to operate within the rated range, a rapid fluctuation of the voltage could cause malfunctions, even if it occurs within the rated range. Stabilizing voltage supplied to the IC is therefore important. As stabilization guidelines, it is recommended to control power so that  $V_{CC}$  ripple fluctuations (P-P value) will be less than 10% of the standard  $V_{CC}$  value at the commercial frequency (50 Hz to 60 Hz) and the transient fluctuation rate will be less than 0.1 V/ms at the time of a momentary fluctuation such as when power is switched.

### 6. Precautions when Using an External Clock

Even when an external clock is used, oscillation stabilization time is required for power-on reset (optional) and wake-up from stop mode.

### 7. Note on Noise in the External Reset Pin ( $\overline{RST}$ )

If the reset pulse applied to the external reset pin ( $\overline{RST}$ ) does not meet the specifications, it may cause malfunctions. Use caution so that the reset pulse less than the specifications will not be fed to the external reset pin ( $\overline{RST}$ ).

## ■ PROGRAMMING TO THE EPROM ON THE MB89P165

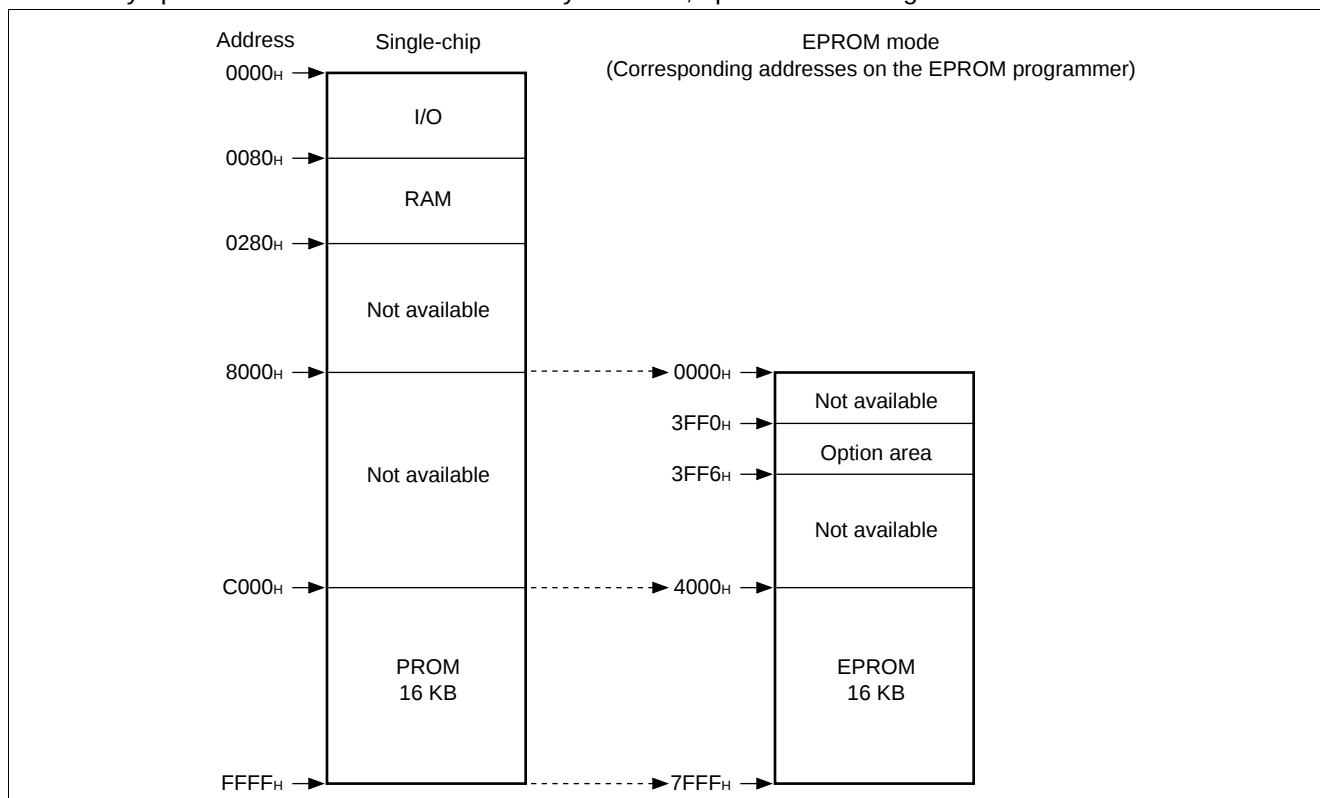
The MB89P165 is an OTPROM version of the MB89160 series.

### 1. Features

- 32-Kbyte PROM on chip
- Options can be set using the EPROM programmer.
- Equivalency to the MBM27C256A in EPROM mode (when programmed with the EPROM programmer)

### 2. Memory Space

Memory space in each mode such as 32-Kbyte PROM, option area is diagrammed below.



### 3. Programming to the EPROM

In EPROM mode, the MB89P165 functions equivalent to the MBM27C256A. This allows the PROM to be programmed with a general-purpose EPROM programmer (the electronic signature mode cannot be used) by using the dedicated socket adapter.

When the operating area for a single chip is 16 Kbyte (C000H to FFFFH) the PROM can be programmed as follows:

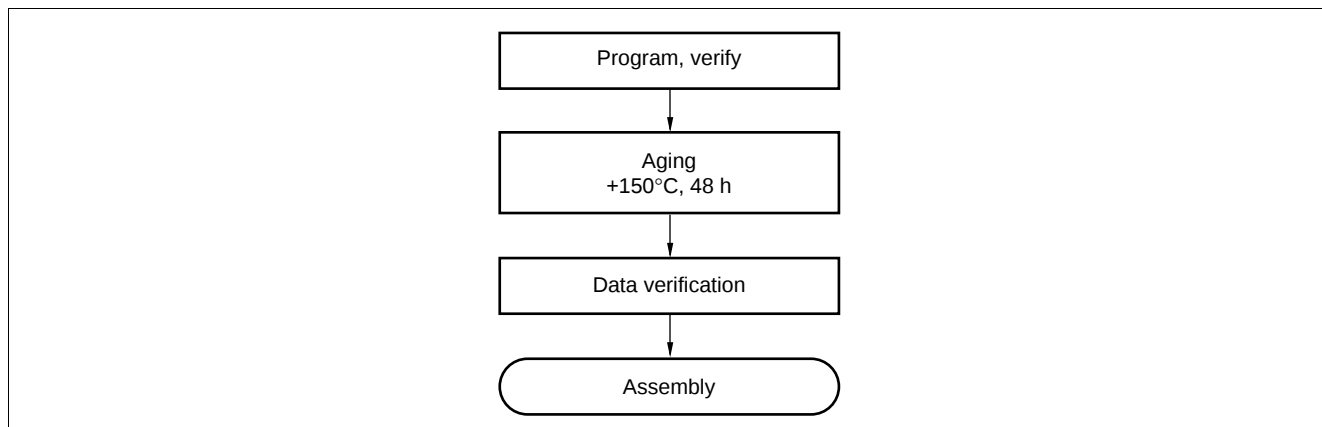
#### • Programming procedure

- (1) Set the EPROM programmer to the MBM27C256A.
- (2) Load program into the EPROM programmer at 4000H to 7FFFH.  
(Note that addresses C000H to FFFFH while operating as a single chip assign to 4000H to 7FFFH in EPROM mode.)  
Load option data into address 3FF0H to 3FF5H of the EPROM programmer.  
(For information about each corresponding option, see "8. Setting OTPROM Options.")
- (3) Program with the EPROM programmer.

# MB89160L Series

## 4. Recommended Screening Conditions

High-temperature aging is recommended as the pre-assembly screening procedure for a product with a blanked OTPROM microcomputer program.



## 5. Programming Yield

All bits cannot be programmed at Fujitsu shipping test to a blanked OTPROM microcomputer, due to its nature. For this reason, a programming yield of 100% cannot be assured at all times.

## 6. EPROM Programmer Adapter Socket

| Package     | Compatible adapter socket |
|-------------|---------------------------|
| FPT-80P-M05 | ROM-80SQF-28DP-8L         |
| FPT-80P-M06 | ROM-80QF-28DP-8L3         |
| FPT-80P-M11 | ROM-80QF2-28DP-8L2        |

## 7. Erasure

In order to clear all locations of their programmed contents, it is necessary to expose the internal EPROM to an ultraviolet light source. A dosage of 10 W-seconds/cm<sup>2</sup> is required to completely erase an internal EPROM. This dosage can be obtained by exposure to an ultraviolet lamp (wavelength of 2537 Angstroms (Å)) with intensity of 12000 μW/cm<sup>2</sup> for 15 to 21 minutes. The internal EPROM should be about one inch from the source and all filters should be removed from the UV light source prior to erasure.

It is important to note that the internal EPROM and similar devices, will erase with light sources having wavelengths shorter than 4000Å. Although erasure time will be much longer than with UV source at 2537Å, nevertheless the exposure to fluorescent light and sunlight will eventually erase the internal EPROM, and exposure to them should be prevented to realize maximum system reliability. If used in such an environment, the package windows should be covered by an opaque label or substance.

## 8. Setting OTPROM Options

### • OTPROM option bit map

|                   | Bit 7                             | Bit 6                             | Bit 5                             | Bit 4                             | Bit 3                             | Bit 2                               | Bit 1                                                    | Bit 0                             |
|-------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-------------------------------------|----------------------------------------------------------|-----------------------------------|
| 3FF0 <sub>H</sub> | Vacancy                           | Vacancy                           | Oscillation stabilization time    |                                   | Vacancy                           | Reset pin output<br>1: Yes<br>0: No | Clock mode selection<br>1: Dual clock<br>0: Single clock | Power-on reset<br>1: Yes<br>0: No |
|                   | Readable                          | Readable                          | WTM1<br>See ■ MASK OPTIONS.       | WTM0                              | Readable                          |                                     |                                                          |                                   |
| 3FF1 <sub>H</sub> | P07<br>Pull-up<br>1: No<br>0: Yes | P06<br>Pull-up<br>1: No<br>0: Yes | P05<br>Pull-up<br>1: No<br>0: Yes | P04<br>Pull-up<br>1: No<br>0: Yes | P03<br>Pull-up<br>1: No<br>0: Yes | P02<br>Pull-up<br>1: No<br>0: Yes   | P01<br>Pull-up<br>1: No<br>0: Yes                        | P00<br>Pull-up<br>1: No<br>0: Yes |
| 3FF2 <sub>H</sub> | P17<br>Pull-up<br>1: No<br>0: Yes | P16<br>Pull-up<br>1: No<br>0: Yes | P15<br>Pull-up<br>1: No<br>0: Yes | P14<br>Pull-up<br>1: No<br>0: Yes | P13<br>Pull-up<br>1: No<br>0: Yes | P12<br>Pull-up<br>1: No<br>0: Yes   | P11<br>Pull-up<br>1: No<br>0: Yes                        | P10<br>Pull-up<br>1: No<br>0: Yes |
| 3FF3 <sub>H</sub> | P57<br>Pull-up<br>1: No<br>0: Yes | P56<br>Pull-up<br>1: No<br>0: Yes | P55<br>Pull-up<br>1: No<br>0: Yes | P54<br>Pull-up<br>1: No<br>0: Yes | P53<br>Pull-up<br>1: No<br>0: Yes | P52<br>Pull-up<br>1: No<br>0: Yes   | P51<br>Pull-up<br>1: No<br>0: Yes                        | P50<br>Pull-up<br>1: No<br>0: Yes |
| 3FF4 <sub>H</sub> | Vacancy                           | Vacancy                           | Vacancy                           | Vacancy                           | Vacancy                           | Vacancy                             | Vacancy                                                  | Vacancy                           |
|                   | Readable                          | Readable                          | Readable                          | Readable                          | Readable                          | Readable                            | Readable                                                 | Readable                          |
| 3FF5 <sub>H</sub> | Vacancy                           | Vacancy                           | Vacancy                           | Vacancy                           | Vacancy                           | Vacancy                             | Vacancy                                                  | Vacancy                           |
|                   | Readable                          | Readable                          | Readable                          | Readable                          | Readable                          | Readable                            | Readable                                                 | Readable                          |

Notes : • Set each bit to 1 to erase.

• Do not write 0 to the vacant bit.

The read value of the vacant bit is 1, unless 0 is written to it.

# MB89160L Series

## ■ PROGRAMMING TO THE EPROM WITH PIGGYBACK/EVALUATION DEVICE

### 1. EPROM for Use

MBM27C256A-20TV

### 2. Programming Socket Adapter

To program to the PROM using an EPROM programmer, use the socket adapter (manufacturer: Sun Hayato Co., Ltd.) listed below.

| Package            | Adapter socket part number |
|--------------------|----------------------------|
| LCC-32 (Rectangle) | ROM-32LC-28DP-YG           |

Inquiry: Sunhayato Corp.

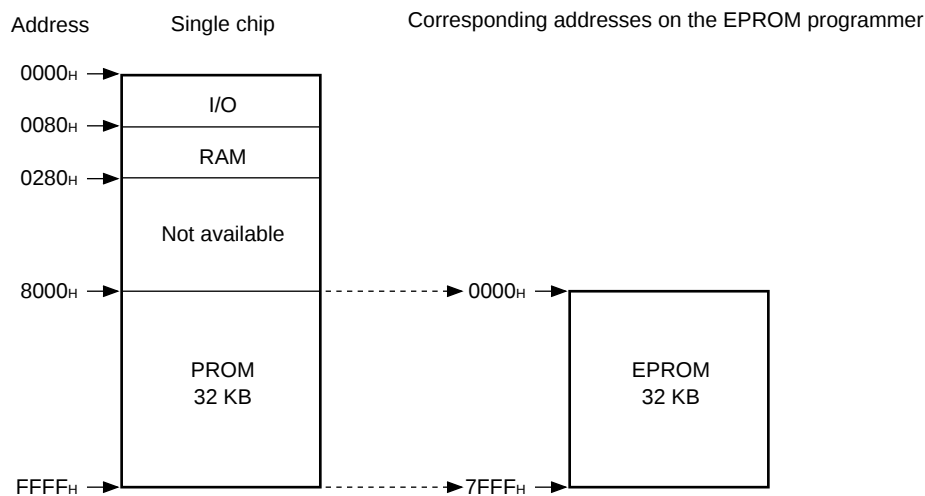
TEL : 81-3-3984-7791

FAX : 81-3-3971-0535

E-mail : adapter@sunhayato.co.jp

### 3. Memory Space

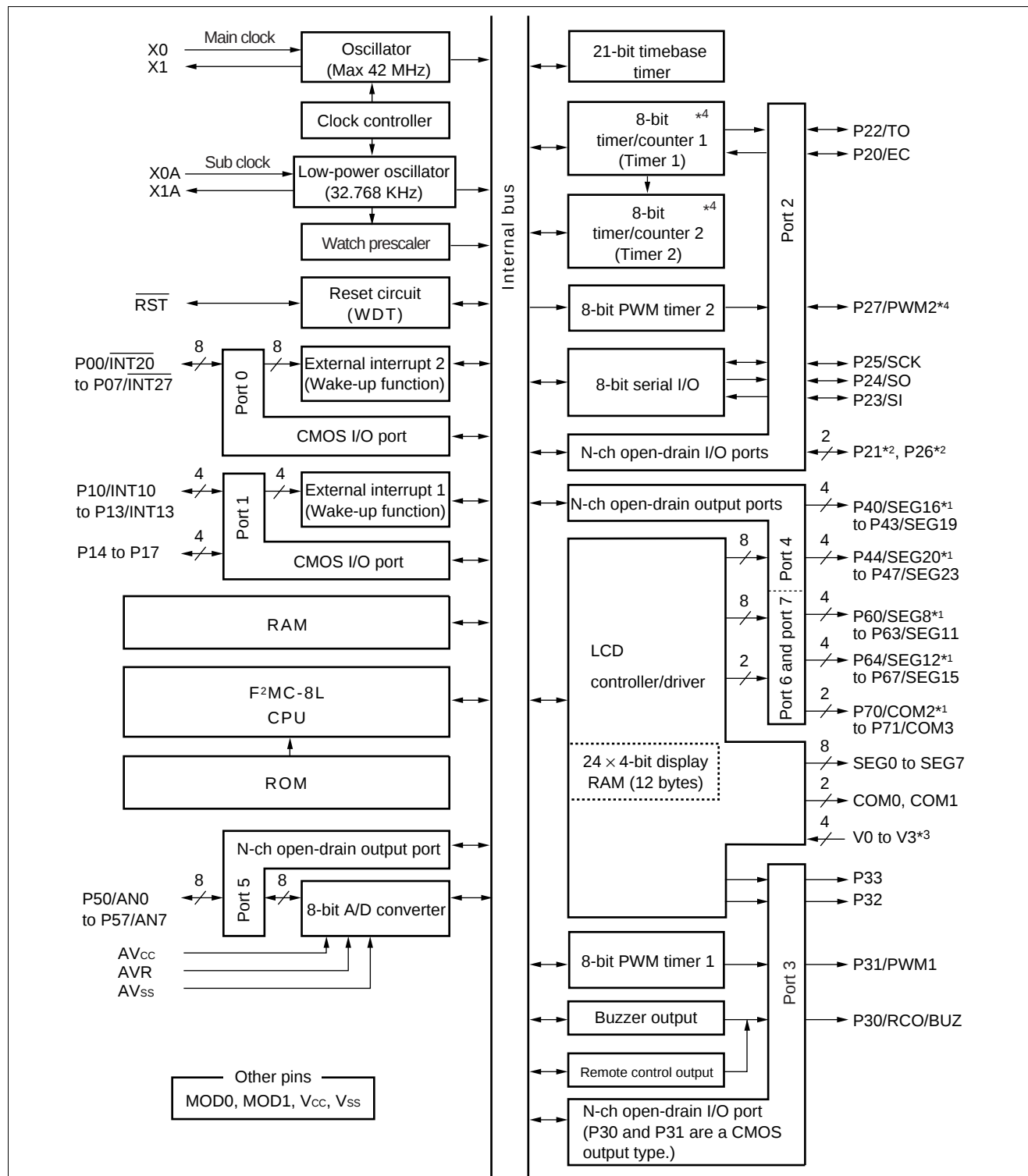
Memory space in each mode, such as 32-Kbyte PROM, option area is diagrammed below.



### 4. Programming to the EPROM

- (1) Set the EPROM programmer to the MBM27C256A.
- (2) Load program data into the EPROM programmer at 0000<sub>H</sub> to 7FFF<sub>H</sub>.
- (3) Program to 0000<sub>H</sub> to 7FFF<sub>H</sub> with the EPROM programmer.

## ■ BLOCK DIAGRAM



\*1 : Functions selected by mask option.

\*2 : Heavy-current drive type

\*3 : Internal dividing resistor in MB89160/160L series. (External dividing resistors connection capable) .

\*4 : Can be used as a 16-bit timer/counter by connecting Timer 1 output to Timer 2 input.

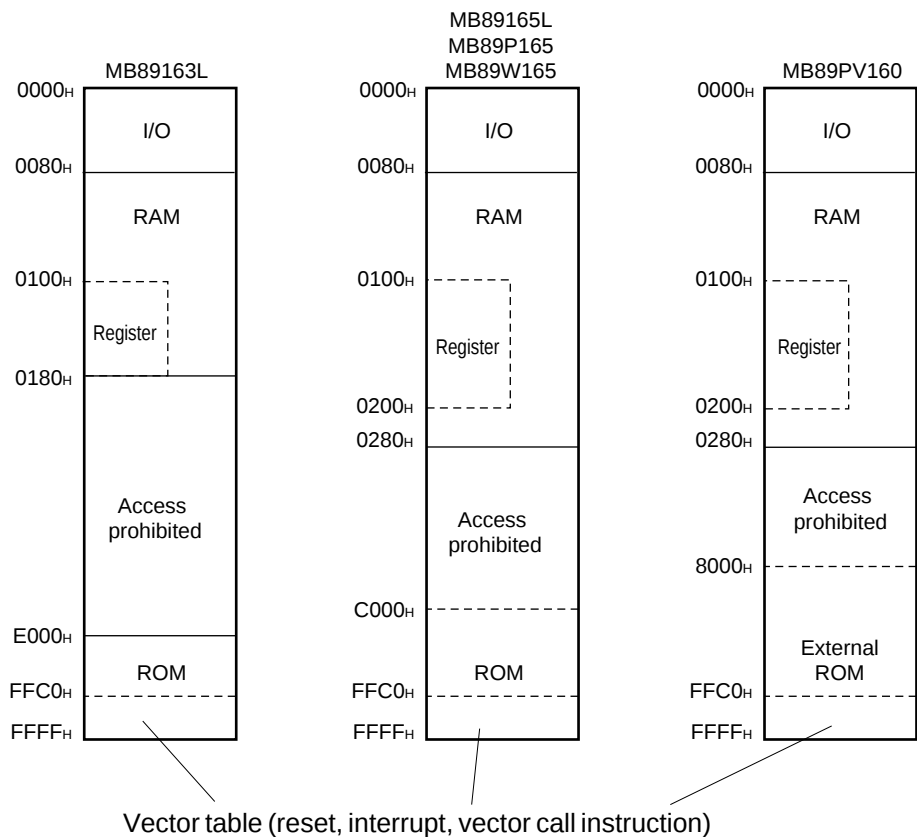
# MB89160L Series

## ■ CPU CORE

### 1. Memory Space

The microcontrollers of the MB89160L series offer a memory space of 64 Kbytes for storing all of I/O, data, and program areas. The I/O area is located at the lowest address. The data area is provided immediately above the I/O area. The data area can be divided into register, stack, and direct areas according to the application. The program area is located at exactly the opposite end, that is, near the highest address. Provide the tables of interrupt reset vectors and vector call instructions toward the highest address within the program area. The memory space of the MB89160L series is structured as illustrated below.

#### Memory Space



## 2. Registers

The F<sup>2</sup>MC-8L family has two types of registers; dedicated registers in the CPU and general-purpose registers in the memory. The following dedicated registers are provided:

Program counter (PC): A 16-bit register for indicating instruction storage positions

**Accumulator (A):** A 16-bit temporary register for storing arithmetic operations, etc. When the instruction is an 8-bit data processing instruction, the lower byte is used.

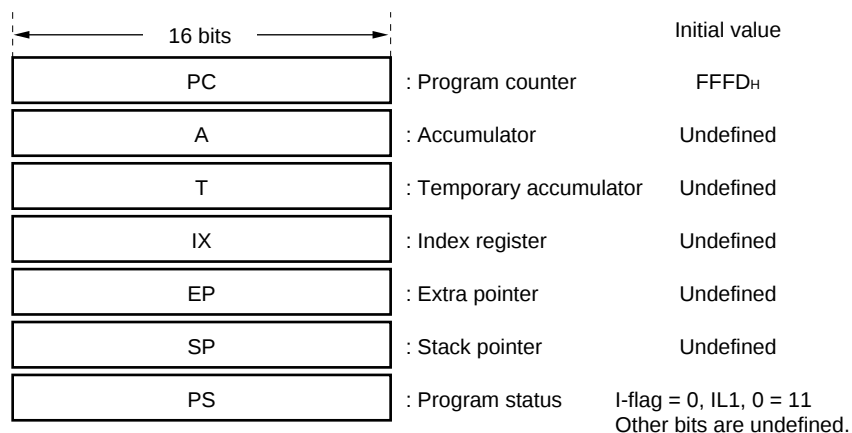
Temporary accumulator (T): A 16-bit register which performs arithmetic operations with the accumulator  
When the instruction is an 18-bit data processing instruction, the lower byte is used.

Index register (IX):           A 16-bit register for index modification

Extra pointer (EP):            A 16-bit pointer for indicating a memory address

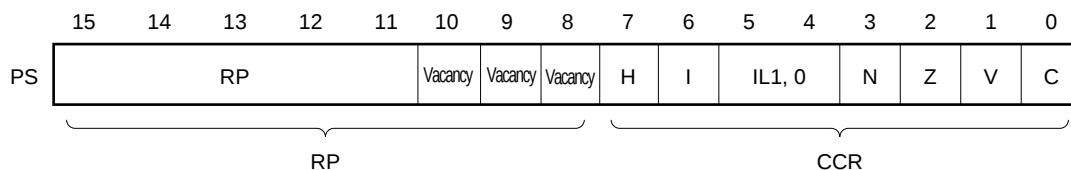
Stack pointer (SP):            A 16-bit register for indicating a stack area

Program status (PS): A 16-bit register for storing a register pointer, a condition code



The PS can further be divided into higher 8 bits for use as a register bank pointer (RP) and the lower 8 bits for use as a condition code register (CCR). (See the diagram below.)

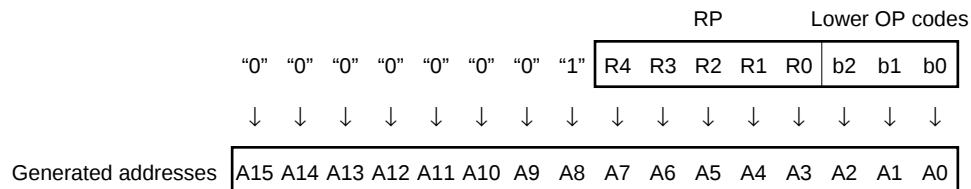
## Structure of the Program Status Register



# MB89160L Series

The RP indicates the address of the register bank currently in use. The relationship between the pointer contents and the actual address is based on the conversion rule illustrated below.

## Rule for Conversion of Actual Addresses of the General-purpose Register Area



The CCR consists of bits indicating the results of arithmetic operations and the contents of transfer data and bits for control of CPU operations at the time of an interrupt.

H-flag: Set when a carry or a borrow from bit 3 to bit 4 occurs as a result of an arithmetic operation. Cleared otherwise. This flag is for decimal adjustment instructions.

I-flag: Interrupt is allowed when this flag is set to 1. Interrupt is prohibited when the flag is set to 0. Set to 0 when reset.

IL1, 0: Indicates the level of the interrupt currently allowed. Processes an interrupt only if its request level is higher than the value indicated by this bit.

| IL1 | IL0 | Interrupt level | High-low                                                                                                                                                                                |
|-----|-----|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 0   | 0   | 1               | <div style="text-align: center;">High</div> <div style="text-align: center;">↑</div> <div style="text-align: center;">↓</div> <div style="text-align: center;">Low = no interrupt</div> |
| 0   | 1   |                 |                                                                                                                                                                                         |
| 1   | 0   | 2               |                                                                                                                                                                                         |
| 1   | 1   | 3               |                                                                                                                                                                                         |

N-flag: Set if the MSB is set to 1 as the result of an arithmetic operation. Cleared when the bit is set to 0.

Z-flag: Set when an arithmetic operation results in 0. Cleared otherwise.

V-flag: Set if the complement on 2 overflows as a result of an arithmetic operation. Reset if the overflow does not occur.

C-flag: Set when a carry or a borrow from bit 7 occurs as a result of an arithmetic operation. Cleared otherwise. Set the shift-out value in the case of a shift instruction.

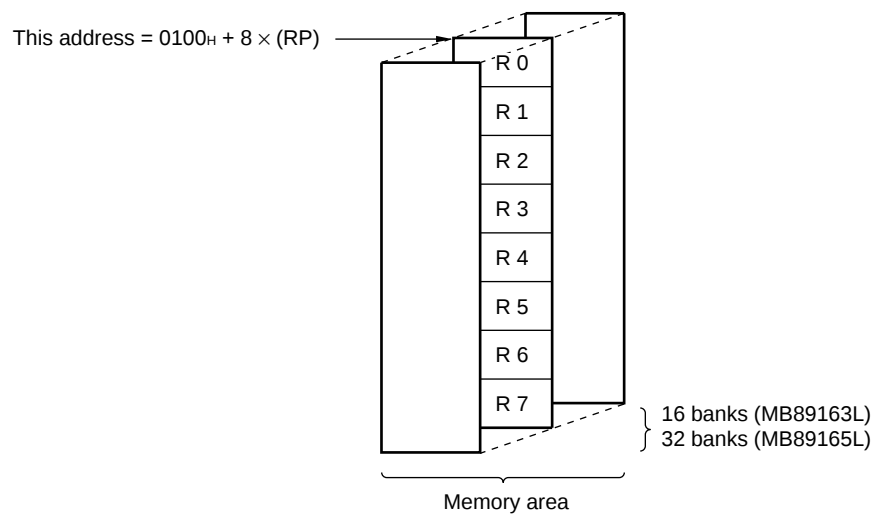
The following general-purpose registers are provided:

General-purpose registers: An 8-bit register for storing data

The general-purpose registers are 8 bits and located in the register banks of the memory. One bank contains eight registers. Up to a total of 16 banks can be used on the MB89163L (RAM  $256 \times 8$  bits), and a total of 32 banks can be used on the MB89165L, MB89P165/W165, MB89PV160 (RAM  $512 \times 8$  bits). The bank currently in use is indicated by the register bank pointer (RP).

Note : The number of register banks that can be used varies with the RAM size.

## Register Bank Configuration



# MB89160L Series

## ■ I/O MAP

| Address         | Read/write | Register name | Register description                   |
|-----------------|------------|---------------|----------------------------------------|
| 00 <sub>H</sub> | (R/W)      | PDR0          | Port 0 data register                   |
| 01 <sub>H</sub> | (W)        | DDR0          | Port 0 data direction register         |
| 02 <sub>H</sub> | (R/W)      | PDR1          | Port 1 data register                   |
| 03 <sub>H</sub> | (W)        | DDR1          | Port 1 data direction register         |
| 04 <sub>H</sub> | (R/W)      | PDR2          | Port 2 data register                   |
| 05 <sub>H</sub> | (W)        | DDR2          | Port 2 data direction register         |
| 06 <sub>H</sub> |            |               | Vacancy                                |
| 07 <sub>H</sub> | (R/W)      | SYCC          | System clock control register          |
| 08 <sub>H</sub> | (R/W)      | STBC          | Standby control register               |
| 09 <sub>H</sub> | (R/W)      | WDTC          | Watchdog timer control register        |
| 0A <sub>H</sub> | (R/W)      | TBTC          | Time-base timer control register       |
| 0B <sub>H</sub> | (R/W)      | WPCR          | Watch prescaler control register       |
| 0C <sub>H</sub> | (R/W)      | PDR3          | Port 3 data register                   |
| 0D <sub>H</sub> |            |               | Vacancy                                |
| 0E <sub>H</sub> | (R/W)      | PDR4          | Port 4 data register                   |
| 0F <sub>H</sub> | (R/W)      | PDR5          | Port 5 data register                   |
| 10 <sub>H</sub> | (R/W)      | BUZR          | Buzzer register                        |
| 11 <sub>H</sub> |            |               | Vacancy                                |
| 12 <sub>H</sub> | (R/W)      | PDR6          | Port 6 data register                   |
| 13 <sub>H</sub> | (R/W)      | PDR7          | Port 7 data register                   |
| 14 <sub>H</sub> | (R/W)      | RCR1          | Remote control transmission register 1 |
| 15 <sub>H</sub> | (R/W)      | RCR2          | Remote control transmission register 2 |
| 16 <sub>H</sub> |            |               | Vacancy                                |
| 17 <sub>H</sub> |            |               | Vacancy                                |
| 18 <sub>H</sub> | (R/W)      | T2CR          | Timer 2 control register               |
| 19 <sub>H</sub> | (R/W)      | T1CR          | Timer 1 control register               |
| 1A <sub>H</sub> | (R/W)      | T2DR          | Timer 2 data register                  |
| 1B <sub>H</sub> | (R/W)      | T1DR          | Timer 1 data register                  |
| 1C <sub>H</sub> | (R/W)      | SMR           | Serial mode register                   |
| 1D <sub>H</sub> | (R/W)      | SDR           | Serial data register                   |
| 1E <sub>H</sub> | (R/W)      | CNTR1         | PWM 1 control register                 |
| 1F <sub>H</sub> | (W)        | COMR1         | PWM 1 compare register                 |

(Continued)

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| Address                            | Read/write        | Register name | Register description                     |
|------------------------------------|-------------------|---------------|------------------------------------------|
| 20 <sub>H</sub>                    | (R/W)             | CNTR2         | PWM 2 control register                   |
| 21 <sub>H</sub>                    | (W)               | COMR2         | PWM 2 compare register                   |
| 22 <sub>H</sub> to 2C <sub>H</sub> |                   |               | Vacancy                                  |
| 2D <sub>H</sub>                    | (R/W)             | ADC1          | A/D converter control register 1         |
| 2E <sub>H</sub>                    | (R/W)             | ADC2          | A/D converter control register 2         |
| 2F <sub>H</sub>                    | (R/W)             | ADCD          | A/D converter data register              |
| 30 <sub>H</sub>                    | (R/W)             | EIE1          | External interrupt 1 enable register 1   |
| 31 <sub>H</sub>                    | (R/W)             | EIF1          | External interrupt 1 flag register 1     |
| 32 <sub>H</sub>                    | (R/W)             | EIE2          | External interrupt 2 enable register 2   |
| 33 <sub>H</sub>                    | (R/W)             | EIF2          | External interrupt 2 flag register 2     |
| 34 <sub>H</sub> to 5F <sub>H</sub> |                   |               | Vacancy                                  |
| 60 <sub>H</sub> to 6B <sub>H</sub> | (R/W)             | VRAM          | Display data RAM                         |
| 6C <sub>H</sub> to 71 <sub>H</sub> |                   |               | Vacancy                                  |
| 72 <sub>H</sub>                    | (R/W)             | LCDR          | LCD controller/driver control register 1 |
| 73 <sub>H</sub> to 7B <sub>H</sub> |                   |               | Vacancy                                  |
| 7C <sub>H</sub>                    | (W)               | ILR1          | Interrupt level setting register 1       |
| 7D <sub>H</sub>                    | (W)               | ILR2          | Interrupt level setting register 2       |
| 7E <sub>H</sub>                    | (W)               | ILR3          | Interrupt level setting register 3       |
| 7F <sub>H</sub>                    | Access prohibited | ITR           | Interrupt test register                  |

Note : Do not use vacancies.

# MB89160L Series

## ■ ELECTRICAL CHARACTERISTICS

### 1. Absolute Maximum Ratings

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

| Parameter                        | Symbol                             | Rating         |                | Unit | Remarks                                                                                                                                                                                                              |
|----------------------------------|------------------------------------|----------------|----------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                  |                                    | Min            | Max            |      |                                                                                                                                                                                                                      |
| Power supply voltage             | $V_{CC}$ ,<br>$AV_{CC}$ ,<br>$AVR$ | $V_{SS} - 0.3$ | $V_{SS} + 4.0$ | V    | For MB89163L/165L<br>$AV_{CC}$ must not exceed $V_{CC} + 0.3\text{ V}$ .<br>$AVR$ must not exceed $AV_{CC} + 0.3\text{ V}$ .                                                                                         |
|                                  |                                    | $V_{SS} - 0.3$ | $V_{SS} + 7.0$ | V    | For MB89PV160/P165/W165<br>$AV_{CC}$ must not exceed $V_{CC} + 0.3\text{ V}$ .<br>$AVR$ must not exceed $AV_{CC} + 0.3\text{ V}$ .                                                                                   |
| LCD power supply voltage         | V0 to V3                           | $V_{SS} - 0.3$ | $V_{SS} + 4.0$ | V    | For MB89163L/165L<br>V0 to V3 must not exceed $V_{CC}$ .                                                                                                                                                             |
|                                  |                                    | $V_{SS} - 0.3$ | $V_{SS} + 7.0$ | V    | For MB89PV160/P165/W165<br>V0 to V3 must not exceed $V_{CC}$ .                                                                                                                                                       |
| Input voltage                    | $V_{I1}$                           | $V_{SS} - 0.3$ | $V_{CC} + 0.3$ | V    | $V_{I1}$ must not exceed $V_{SS} + 4.0\text{ V}$ for MB89163L/165L and $V_{SS} + 7.0\text{ V}$ for MB89PV160/P165/W165. All pins except P20 to P27 without a pull-up resistor.                                       |
|                                  | $V_{I2}$                           | $V_{SS} - 0.3$ | $V_{CC} + 4.0$ | V    | P20 to P27 without a pull-up resistor for MB89163L/165L                                                                                                                                                              |
|                                  |                                    | $V_{SS} - 0.3$ | $V_{SS} + 7.0$ |      | P20 to P27 without a pull-up resistor for MB89PV160/P165/W165                                                                                                                                                        |
| Output voltage                   | $V_{O1}$                           | $V_{SS} - 0.3$ | $V_{CC} + 0.3$ | V    | $V_{O1}$ must not exceed $V_{SS} + 4.0\text{ V}$ for MB89163L/165L and $V_{SS} + 7.0\text{ V}$ for MB89PV160/P165/W165. All pins except P20 to P27, P32, P33, P40 to P47, and P60 to P67 without a pull-up resistor. |
|                                  | $V_{O2}$                           | $V_{SS} - 0.3$ | $V_{SS} + 4.0$ | V    | P20 to P27, P32, P33, P40 to P47, and P60 to P67 without a pull-up resistor for MB89163L/165L                                                                                                                        |
|                                  |                                    | $V_{SS} - 0.3$ | $V_{SS} + 7.0$ | V    | P20 to P27, P32, P33, P40 to P47, and P60 to P67 without a pull-up resistor for MB89PV160/P165/W165                                                                                                                  |
| “L” level maximum output current | $I_{OL1}$                          | —              | 10             | mA   | All pins except P21, P26, and P27                                                                                                                                                                                    |
|                                  | $I_{OL2}$                          | —              | 20             | mA   | P21, P26, and P27                                                                                                                                                                                                    |
| “L” level average output current | $I_{OLAV1}$                        | —              | 4              | mA   | All pins except P21, P26, P27, and power supply pins<br>Average value (operating current × operating rate)                                                                                                           |
|                                  | $I_{OLAV2}$                        | —              | 8              | mA   | P21, P26, and P27<br>Average value (operating current × operating rate)                                                                                                                                              |

(Continued)

# MB89160L Series

(Continued)

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

| Parameter                              | Symbol            | Rating |      | Unit | Remarks                                                                                                      |
|----------------------------------------|-------------------|--------|------|------|--------------------------------------------------------------------------------------------------------------|
|                                        |                   | Min    | Max  |      |                                                                                                              |
| "L" level total maximum output current | $\Sigma I_{OL}$   | —      | 100  | mA   | Peak value                                                                                                   |
| "L" level total average output current | $\Sigma I_{OLAV}$ | —      | 40   | mA   | Average value (operating current $\times$ operating rate)                                                    |
| "H" level maximum output current       | $I_{OH1}$         | —      | −5   | mA   | All pins except P30, P31, and power supply pins                                                              |
|                                        | $I_{OH2}$         | —      | −10  | mA   | P30 and P31                                                                                                  |
| "H" level average output current       | $I_{OHAV1}$       | —      | −2   | mA   | All pins except P30, P31, and power supply pins<br>Average value (operating current $\times$ operating rate) |
|                                        | $I_{OHAV2}$       | —      | −4   | mA   | P30 and P31<br>Average value (operating current $\times$ operating rate)                                     |
| "H" level total maximum output current | $\Sigma I_{OH}$   | —      | −50  | mA   | Peak value                                                                                                   |
| "H" level total average output current | $\Sigma I_{OHAV}$ | —      | −10  | mA   | Average value (operating current $\times$ operating rate)                                                    |
| Power consumption                      | $P_D$             | —      | 300  | mW   |                                                                                                              |
| Operating temperature                  | $T_a$             | −40    | +85  | °C   |                                                                                                              |
| Storage temperature                    | $T_{stg}$         | −55    | +150 | °C   |                                                                                                              |

**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.

# MB89160L Series

## 2. Recommended Operating Conditions

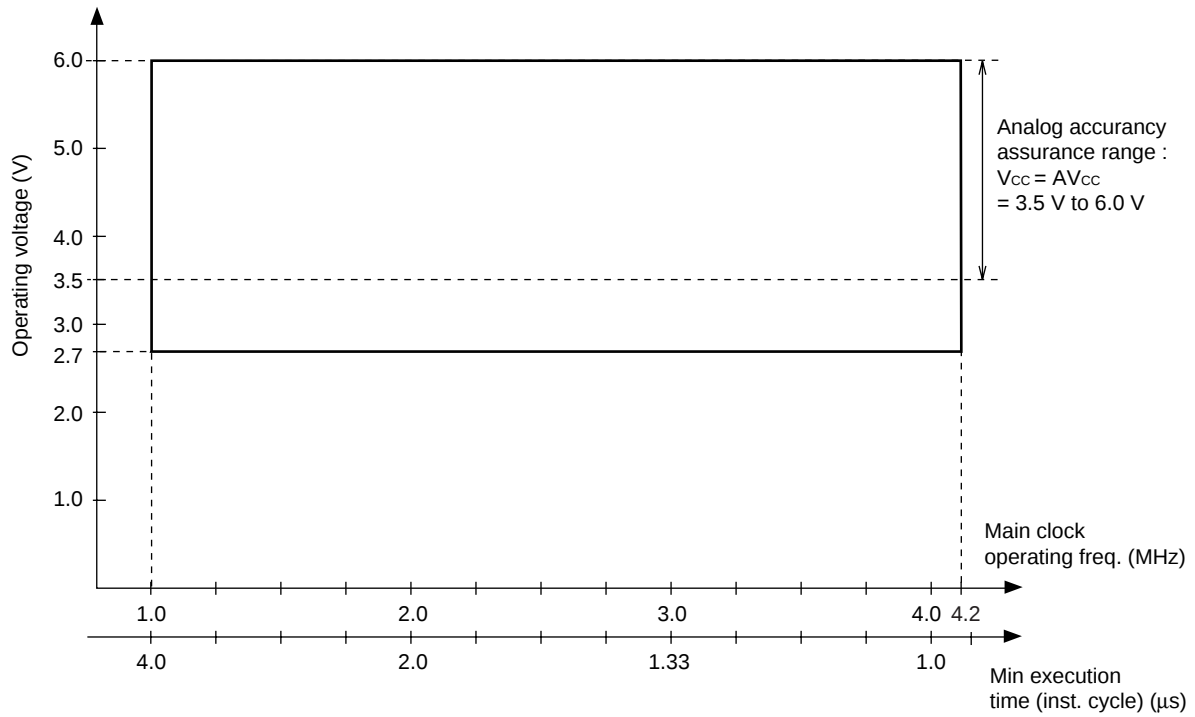
( $AV_{SS} = V_{SS} = 0.0\text{ V}$ )

| Parameter                          | Symbol            | Value    |                 | Unit | Remarks                                                                                        |
|------------------------------------|-------------------|----------|-----------------|------|------------------------------------------------------------------------------------------------|
|                                    |                   | Min      | Max             |      |                                                                                                |
| Power supply voltage               | $V_{CC}, AV_{CC}$ | 2.2*     | 3.6*            | V    | Normal operation assurance range* for MB89163L/165L                                            |
|                                    |                   | 2.7      | 6.0             | V    | Normal operation assurance range for MB89PV160 and MB89P165/W165                               |
|                                    |                   | 1.5      | 3.6             | V    | Retains the RAM state in stop mode for MB89163L/165L                                           |
|                                    |                   | 1.5      | 6.0             | V    | Retains the RAM state in stop mode for MB89PV160 and MB89P165/W165                             |
|                                    | AVR               | 2.0      | $AV_{CC}$       | V    | Normal operation assurance range                                                               |
| LCD power supply voltage           | V0 to V3          | $V_{SS}$ | $V_{CC}$        | V    | V0 to V3<br>LCD power supply range<br>(The optimum value dependent on the LCD element in use.) |
| EPROM program power supply voltage | $V_{PP}$          | —        | $V_{SS} + 13.0$ | V    | MOD1 pin of the MB89P165/W165                                                                  |
| Operating temperature              | $T_a$             | −40      | +85             | °C   |                                                                                                |

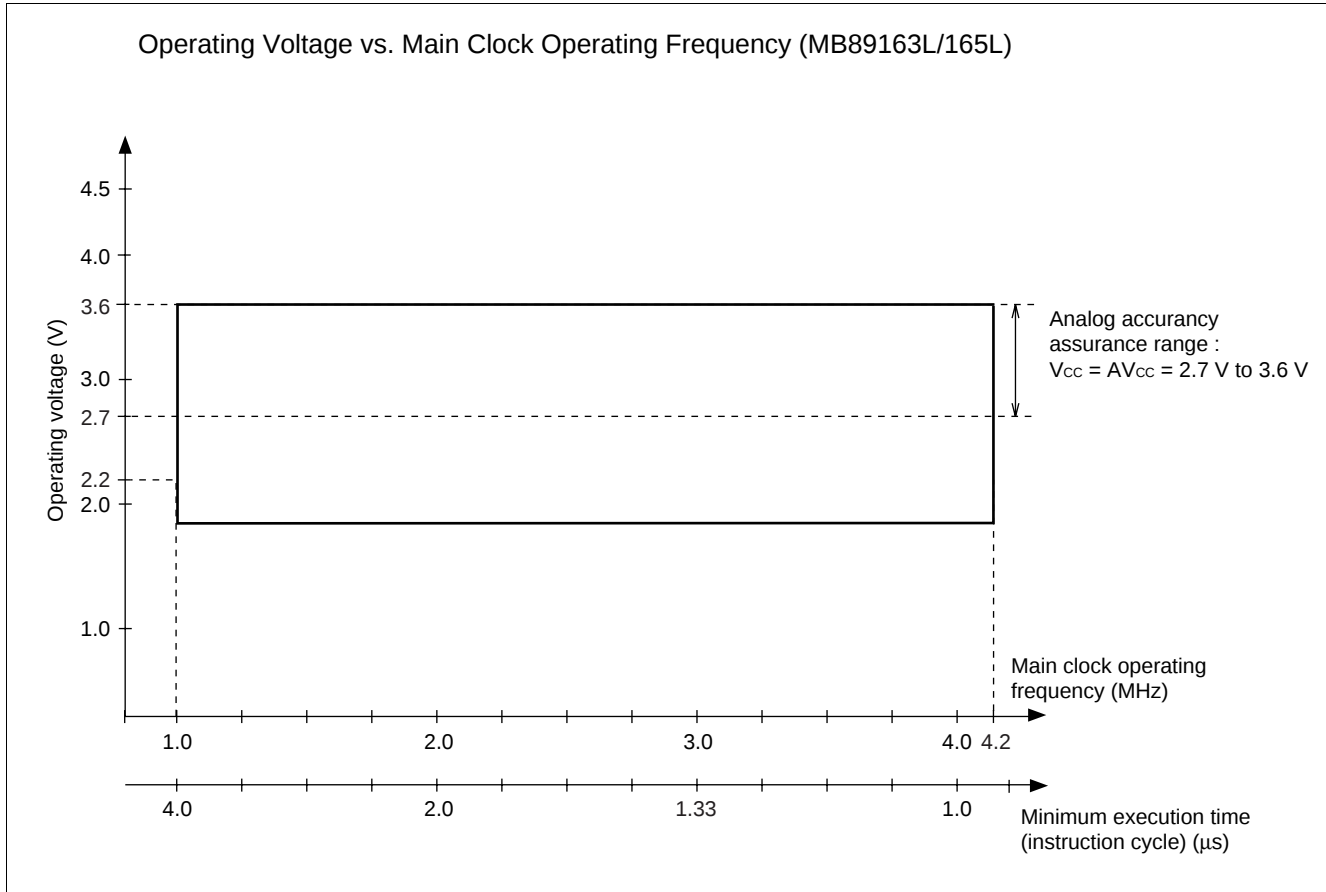
\* : The minimum operating power supply voltage varies with the execution time (instruction cycle time) setting for the operating frequency.

A/D converter assurance accuracy varies with the operating power supply voltage.

Operating Voltage vs. Main Clock Operating Frequency (MB89PV160/P165/W165)



# MB89160L Series



“Operating Voltage vs. Main Clock Operating Frequency (MB89PV160/P165/W165) and (MB89163L/165L) ” indicate the operating frequency of the external oscillator at an instruction cycle of  $4/F_{CH}$ .

Since the operating voltage range is dependent on the instruction cycle, see minimum execution time if the operating speed is switched using a gear.

**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.

# MB89160L Series

## 3. DC Characteristics

(1) Pin DC characteristics ( $V_{CC} = +3.0$  V for MB89163L/165L ;  $+5.0$  V for MB89PV160/P165/W165)

( $V_{SS} = 0.0$  V,  $T_a = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )

| Parameter                                          | Sym-<br>bol      | Pin                                                                                                                    | Condition                 | Value                 |     |                       | Unit | Remarks                                                                                                      |
|----------------------------------------------------|------------------|------------------------------------------------------------------------------------------------------------------------|---------------------------|-----------------------|-----|-----------------------|------|--------------------------------------------------------------------------------------------------------------|
|                                                    |                  |                                                                                                                        |                           | Min                   | Typ | Max                   |      |                                                                                                              |
| “H” level input<br>voltage                         | V <sub>IH</sub>  | P00 to P07,<br>P10 to P17,<br>P20 to P27                                                                               | —                         | 0.7 V <sub>CC</sub>   | —   | V <sub>CC</sub> + 0.3 | V    |                                                                                                              |
|                                                    | V <sub>IHS</sub> | $\overline{RST}$ , MOD0,<br>MOD1, EC, SI,<br>SCK,<br>INT10 to INT13,<br>$\overline{INT20}$ to $\overline{INT27}$       |                           | 0.8 V <sub>CC</sub>   | —   | V <sub>CC</sub> + 0.3 | V    |                                                                                                              |
| “L” level input<br>voltage                         | V <sub>IL</sub>  | P00 to P07,<br>P10 to P17,<br>P20 to P27                                                                               |                           | V <sub>SS</sub> – 0.3 | —   | 0.3 V <sub>CC</sub>   | V    |                                                                                                              |
|                                                    | V <sub>ILS</sub> | $\overline{RST}$ ,<br>MOD0, MOD1,<br>EC, SI, SCK,<br>INT10 to INT13,<br>$\overline{INT20}$ to $\overline{INT27}$       |                           | V <sub>SS</sub> – 0.3 | —   | 0.2 V <sub>CC</sub>   | V    |                                                                                                              |
| Open-drain<br>output pin<br>application<br>voltage | V <sub>D1</sub>  | P20 to P27,<br>P33, P32,<br>P40 to P47,<br>P60 to P67                                                                  |                           | V <sub>SS</sub> – 0.3 | —   | V <sub>SS</sub> + 4.0 | V    | For MB89163L/<br>165L, P20 to P27,<br>P40 to P47 and<br>P60 to P67 without<br>pull-up resistor only          |
|                                                    |                  |                                                                                                                        |                           | V <sub>SS</sub> – 0.3 | —   | V <sub>SS</sub> + 6.0 | V    | For MB89PV160/<br>P165/W165, P20 to<br>P27, P40 to P47<br>and P60 to P67<br>without pull-up<br>resistor only |
|                                                    | V <sub>D2</sub>  | P50 to P57                                                                                                             |                           | V <sub>SS</sub> – 0.3 | —   | V <sub>CC</sub> + 0.3 | V    |                                                                                                              |
| “H” level output<br>voltage                        | V <sub>OH1</sub> | P00 to P07,<br>P10 to P17                                                                                              | I <sub>OH</sub> = –2.0 mA | 2.2                   | —   | —                     | V    | MB89163L/165L                                                                                                |
|                                                    |                  |                                                                                                                        | I <sub>OH</sub> = –2.0 mA | 2.4                   | —   | —                     | V    | MB89PV160/P165/<br>W165                                                                                      |
|                                                    | V <sub>OH2</sub> | P30, P31                                                                                                               | I <sub>OH</sub> = –8.0 mA | 2.2                   | —   | —                     | V    | MB89163L/165L                                                                                                |
|                                                    |                  |                                                                                                                        | I <sub>OH</sub> = –6.0 mA | 4.0                   | —   | —                     | V    | MB89PV160/P165/<br>W165                                                                                      |
| “L” level output<br>voltage                        | V <sub>OL</sub>  | P00 to P07,<br>P10 to P17,<br>P20, P20 to P25,<br>P30 to P33,<br>P40 to P47,<br>P50 to P57,<br>P60 to P67,<br>P70, P71 | I <sub>OL</sub> = 1.8 mA  | —                     | —   | 0.4                   | V    |                                                                                                              |

(Continued)

# MB89160L Series

(Continued)

( $V_{SS} = 0.0 \text{ V}$ ,  $T_a = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ )

| Parameter                                             | Symbol     | Pin                                                                                             | Condition                              | Value |     |         | Unit             | Remarks                                          |
|-------------------------------------------------------|------------|-------------------------------------------------------------------------------------------------|----------------------------------------|-------|-----|---------|------------------|--------------------------------------------------|
|                                                       |            |                                                                                                 |                                        | Min   | Typ | Max     |                  |                                                  |
| “L” level output voltage                              | $V_{OL2}$  | P21, P26, P27                                                                                   | $I_{OL} = 8.0 \text{ mA}$              | —     | —   | 0.4     | V                |                                                  |
|                                                       | $V_{OL3}$  | $\overline{\text{RST}}$                                                                         | $I_{OL} = 4.0 \text{ mA}$              | —     | —   | 0.4     | V                | MB89163L/165L                                    |
|                                                       |            |                                                                                                 | $I_{OL} = 4.0 \text{ mA}$              | —     | —   | 0.6     | V                | MB89PV160/P165/W165                              |
| Input leakage current (High-Z output leakage current) | $I_{LI1}$  | P00 to P07, P10 to P17, MOD0, MOD1, P30, P31                                                    | $0.45 \text{ V} < V_i < V_{CC}$        | —     | —   | $\pm 5$ | $\mu\text{A}$    | Without pull-up resistor                         |
| Open-drain output leakage current                     | $I_{LO1}$  | P20 to P27, P32, P33, P40 to P47, P60 to P67, P70, P71                                          | $0.45 \text{ V} < V_i < 4.0 \text{ V}$ | —     | —   | $\pm 5$ | $\mu\text{A}$    | Without pull-up resistor for MB89163L/165L       |
|                                                       |            |                                                                                                 | $0.45 \text{ V} < V_i < 6.0 \text{ V}$ | —     | —   | $\pm 5$ | $\mu\text{A}$    | Without pull-up resistor for MB89PV160/P165/W165 |
|                                                       | $I_{LO2}$  | P50 to P57                                                                                      | $0.45 \text{ V} < V_i < V_{CC}$        | —     | —   | $\pm 5$ | $\mu\text{A}$    | Without pull-up resistor                         |
| Pull-up resistance                                    | $R_{PULL}$ | P00 to P07, P10 to P17, P20 to P27, P40 to P47, P50 to P57, P60 to P67, $\overline{\text{RST}}$ | $V_i = 0.0 \text{ V}$                  | 25    | 50  | 100     | $\text{k}\Omega$ | With pull-up resistor                            |
| Common output impedance                               | $R_{VCOM}$ | COM0 to COM3                                                                                    | $V1 \text{ to } V3 = +3.0 \text{ V}$   | —     | —   | 2.5     | $\text{k}\Omega$ | MB89163L/165L                                    |
|                                                       |            |                                                                                                 | $V1 \text{ to } V3 = +5.0 \text{ V}$   | —     | —   | 2.5     | $\text{k}\Omega$ | MB89PV160/P165/W165                              |
| Segment output impedance                              | $R_{VSEG}$ | SEG0 to SEG23                                                                                   | $V1 \text{ to } V3 = +3.0 \text{ V}$   | —     | —   | 15      | $\text{k}\Omega$ | MB89163L/165L                                    |
|                                                       |            |                                                                                                 | $V1 \text{ to } V3 = +5.0 \text{ V}$   | —     | —   | 15      | $\text{k}\Omega$ | MB89PV160/P165/W165                              |
| LCD divided resistance                                | $R_{LCD}$  | —                                                                                               | Between $V_{CC}$ and $V_0$             | 300   | 500 | 750     | $\text{k}\Omega$ |                                                  |
| LCD controller/driver leakage current                 | $I_{LCDL}$ | $V_0$ to $V_3$ , COM0 to COM3, SEG0 to SEG23                                                    | —                                      | —     | —   | $\pm 1$ | $\mu\text{A}$    |                                                  |
| Input capacitance                                     | $C_{IN}$   | Other than $V_{CC}$ , $V_{SS}$                                                                  | $f = 1 \text{ MHz}$                    | —     | 10  | —       | pF               |                                                  |

Note : For pins which serve as the segment (SEG8 to SEG23) and ports (P40 to P47 and P60 to P67), see the port parameter when these pins are used as ports and the segment parameter when they are used as segments.

# MB89160L Series

## (2) Pin DC Characteristics ( $V_{CC} = +3.0$ V for MB89163L/165L, MB89PV160, MB89P165/W165)

( $V_{SS} = 0.0$  V,  $T_a = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )

| Parameter                | Sym-<br>bol | Pin                                                                                               | Condition          | Value |     |     | Unit       | Remarks                                          |
|--------------------------|-------------|---------------------------------------------------------------------------------------------------|--------------------|-------|-----|-----|------------|--------------------------------------------------|
|                          |             |                                                                                                   |                    | Min   | Typ | Max |            |                                                  |
| “H” level output voltage | $V_{OH1}$   | P00 to P07, P10 to P17                                                                            | $I_{OH} = -2.0$ mA | 2.2   | —   | —   | V          | MB89163L/165L                                    |
|                          |             |                                                                                                   | $I_{OH} = -1.0$ mA | 2.4   | —   | —   | V          | MB89PV160/P165/W165                              |
|                          | $V_{OH2}$   | P30, P31                                                                                          | $I_{OH} = -8.0$ mA | 2.2   | —   | —   | V          | MB89163L/165L                                    |
|                          |             |                                                                                                   | $I_{OH} = -3.0$ mA | 2.4   | —   | —   | V          | MB89PV160/P165/W165                              |
| “L” level output voltage | $V_{OL}$    | P00 to P07, P10 to P17, P20, P22 to P27, P30 to P33, P40 to P47, P50 to P57, P60 to P67, P70, P71 | $I_{OL} = 4.0$ mA  | —     | —   | 0.4 | V          | MB89163L/165L                                    |
|                          |             |                                                                                                   | $I_{OL} = 1.8$ mA  | —     | —   | 0.4 | V          | MB89PV160/P165/W165                              |
|                          | $V_{OL2}$   | $\overline{\text{RST}}$                                                                           | $I_{OL} = 4.0$ mA  | —     | —   | 0.4 | V          | MB89163L/165L                                    |
|                          |             |                                                                                                   | $I_{OL} = 1.8$ mA  | —     | —   | 0.4 | V          | MB89PV160/P165/W165                              |
|                          | $V_{OL3}$   | P21, P26, P27                                                                                     | $I_{OL} = 8.0$ mA  | —     | —   | 0.4 | V          | MB89163L/165L                                    |
|                          |             |                                                                                                   | $I_{OL} = 3.6$ mA  | —     | —   | 0.4 | V          | MB89PV160/P165/W165                              |
| Pull-up resistance       | $R_{PULL}$  | P00 to P07, P10 to P17, P20 to P27, P40 to P47, P50 to P57, P60 to P67, $\overline{\text{RST}}$   | $V_i = 0.0$ V      | 50    | 100 | 150 | k $\Omega$ | With pull-up resistor for MB89163L/165L          |
|                          |             |                                                                                                   |                    | 25    | 50  | 100 | k $\Omega$ | Without pull-up resistor for MB89PV160/P165/W165 |

# MB89160L Series

## (3) Power Supply Current Characteristics (MB8916X)

(V<sub>SS</sub> = 0.0 V, T<sub>a</sub> = -40°C to +85°C)

| Parameter                                        | Sym-<br>bol       | Pin                                                                                         | Condition                                                                                                                                  | Value |      |                             | Unit                        | Remarks                     |
|--------------------------------------------------|-------------------|---------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|-------|------|-----------------------------|-----------------------------|-----------------------------|
|                                                  |                   |                                                                                             |                                                                                                                                            | Min   | Typ  | Max                         |                             |                             |
| Power supply<br>current*1                        | I <sub>CC1</sub>  | V <sub>CC</sub>                                                                             | F <sub>CH</sub> = 4.2 MHz, V <sub>CC</sub> = 3.0 V<br>t <sub>inst</sub> *2 = 4/F <sub>CH</sub><br>Main clock operation mode                | —     | 1.0  | 2.5                         | mA                          | MB89163L/165L               |
|                                                  |                   |                                                                                             | F <sub>CH</sub> = 4.2 MHz, V <sub>CC</sub> = 5.0 V<br>t <sub>inst</sub> *2 = 4/F <sub>CH</sub><br>Main clock operation mode                | —     | 5.0  | 10.0                        | mA                          | MB89PV160                   |
|                                                  |                   |                                                                                             |                                                                                                                                            | —     | 8.0  | 15.0                        | mA                          | MB89P165/W165               |
|                                                  | I <sub>CC2</sub>  |                                                                                             | F <sub>CH</sub> = 4.2 MHz, V <sub>CC</sub> = 3.0 V<br>t <sub>inst</sub> *2 = 64/F <sub>CH</sub><br>Main clock operation mode               | —     | 0.6  | 2.0                         | mA                          | MB89163L/165L               |
|                                                  |                   |                                                                                             |                                                                                                                                            | —     | 1.5  | 2.0                         | mA                          | MB89PV160                   |
|                                                  |                   |                                                                                             |                                                                                                                                            | —     | 2.4  | 2.8                         | mA                          | MB89P165/W165               |
|                                                  | I <sub>CCL</sub>  |                                                                                             | F <sub>CL</sub> = 32.768 kHz, V <sub>CC</sub> = 3.0 V<br>t <sub>inst</sub> *2 = 2/F <sub>CL</sub> , Ta = +25 °C<br>Subclock operation mode | —     | 0.02 | 0.1                         | mA                          | MB89163L/165L               |
|                                                  |                   |                                                                                             |                                                                                                                                            | —     | 0.05 | 0.1                         | mA                          | MB89PV160                   |
|                                                  |                   |                                                                                             |                                                                                                                                            | —     | 1.0  | 3.0                         | mA                          | MB89P165/W165               |
|                                                  | I <sub>CCS1</sub> |                                                                                             | F <sub>CH</sub> = 4.2 MHz, V <sub>CC</sub> = 3.0 V<br>t <sub>inst</sub> *2 = 4/F <sub>CH</sub><br>Main clock sleep mode                    | —     | 0.3  | 2.0                         | mA                          | MB89163L/165L               |
|                                                  |                   |                                                                                             | F <sub>CH</sub> = 4.2 MHz, V <sub>CC</sub> = 5.0 V<br>t <sub>inst</sub> *2 = 4/F <sub>CH</sub><br>Main clock sleep mode                    | —     | 2.5  | 5.0                         | mA                          | MB89PV160,<br>MB89P165/W165 |
|                                                  | I <sub>CCS2</sub> |                                                                                             | F <sub>CH</sub> = 4.2 MHz, V <sub>CC</sub> = 3.0 V<br>t <sub>inst</sub> *2 = 64/F <sub>CH</sub><br>Main clock sleep mode                   | —     | 0.2  | 1.5                         | mA                          | MB89163L/165L               |
|                                                  |                   |                                                                                             |                                                                                                                                            | —     | 1.0  | 1.5                         | mA                          | MB89PV160,<br>MB89P165/W165 |
|                                                  | I <sub>CCSL</sub> |                                                                                             | F <sub>CL</sub> = 32.768 kHz, V <sub>CC</sub> = 3.0 V<br>t <sub>inst</sub> *2 = 2/F <sub>CL</sub><br>Subclock sleep mode<br>Ta = +25 °C    | —     | 4.0  | 50                          | μA                          | MB89163L/165L               |
|                                                  |                   |                                                                                             |                                                                                                                                            | —     | 25   | 50                          | μA                          | MB89PV160,<br>MB89P165/W165 |
|                                                  | I <sub>CCT</sub>  |                                                                                             | F <sub>CL</sub> = 32.768 kHz, V <sub>CC</sub> = 3.0 V<br>Watch mode<br>Ta = +25 °C                                                         | —     | 1    | 15                          | μA                          | MB89163L/165L               |
|                                                  |                   |                                                                                             |                                                                                                                                            | —     | 10   | 15                          | μA                          | MB89PV160,<br>MB89P165/W165 |
|                                                  | I <sub>CCH</sub>  |                                                                                             | Ta = +25°C, V <sub>CC</sub> = 3.0 V<br>Stop mode                                                                                           | —     | 0.8  | 10.0                        | μA                          | MB89163L/165L               |
| Ta = +25°C, V <sub>CC</sub> = 5.0 V<br>Stop mode |                   | —                                                                                           | 0.1                                                                                                                                        | 10.0  | μA   | MB89PV160,<br>MB89P165/W165 |                             |                             |
| I <sub>A</sub>                                   | A <sub>VCC</sub>  | F <sub>CH</sub> = 4.2 MHz, V <sub>CC</sub> = 3.0 V<br>When A/D conversion is acti-<br>vated | —                                                                                                                                          | 0.6   | 2.0  | mA                          | MB89163L/165L               |                             |
|                                                  |                   | F <sub>CH</sub> = 4.2 MHz, V <sub>CC</sub> = 5.0 V<br>When A/D conversion is acti-<br>vated | —                                                                                                                                          | 1.0   | 3.0  | mA                          | MB89PV160,<br>MB89P165/W165 |                             |

\*1 : The power supply current is measured at the external clock, open output pins, and the external LCD dividing resistor (or external input for the reference voltage). In the case of the MB89PV160, the current consumed by the connected EPROM and ICE is not included.

\*2 : For information on t<sub>inst</sub>, see “(4) Instruction Cycle” in “4. AC Characteristics.”

## 4. AC Characteristics

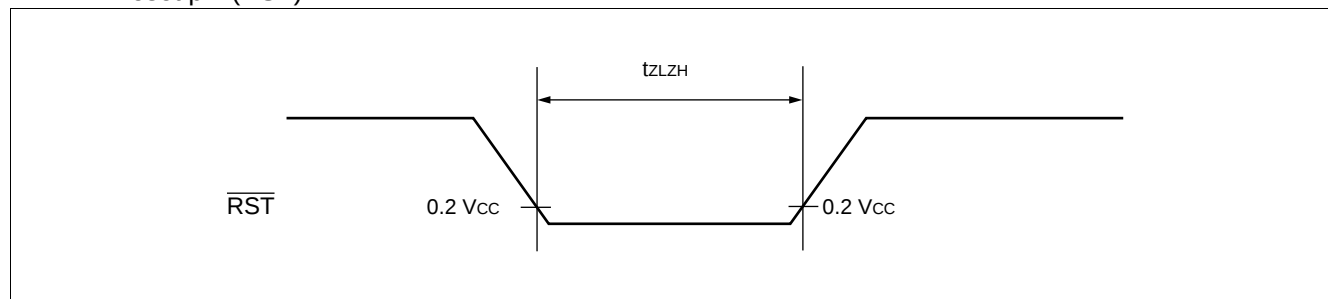
### (1) Reset Timing

( $V_{CC} = +3.0\text{ V} \pm 10\%$  for MB89163L/165L;  $+5.0\text{ V} \pm 10\%$  for MB89PV160/P165/W165,  $V_{SS} = 0.0\text{ V}$ ,  $T_a = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ )

| Parameter                               | Symbol           | Condition | Value                |     | Unit | Remarks |
|-----------------------------------------|------------------|-----------|----------------------|-----|------|---------|
|                                         |                  |           | Min                  | Max |      |         |
| $\overline{\text{RST}}$ "L" pulse width | $t_{\text{LZH}}$ | —         | 48 $t_{\text{HCYL}}$ | —   | ns   |         |

Notes : •  $t_{\text{HCYL}}$  is the main clock oscillator period.

- If the reset pulse applied to the external reset pin ( $\overline{\text{RST}}$ ) does not meet the specifications, it may cause malfunctions. Use caution so that the reset pulse less than the specifications will not be fed to the external reset pin ( $\overline{\text{RST}}$ ) .

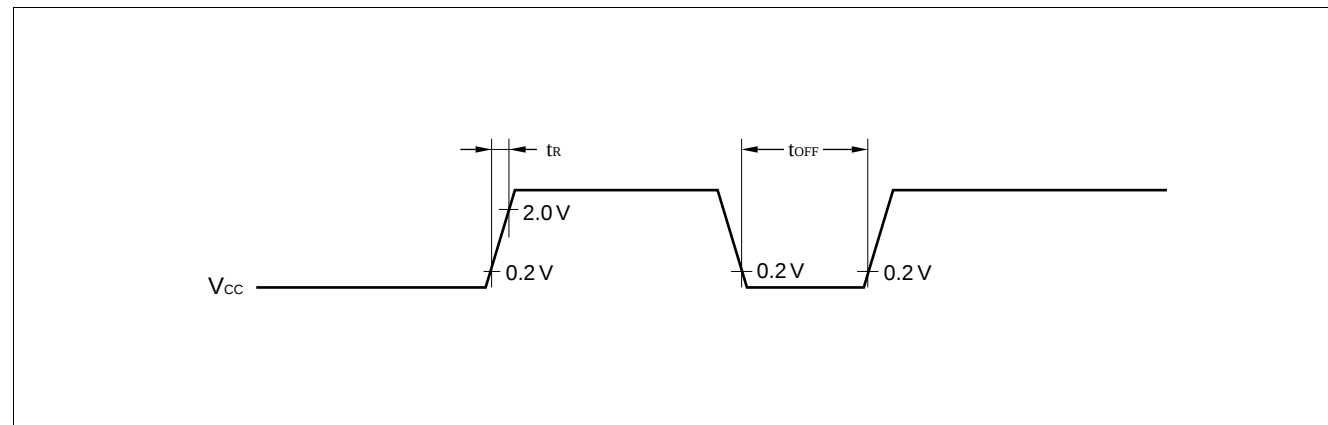


### (2) Power-on Reset

( $V_{SS} = 0.0\text{ V}$ ,  $T_a = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ )

| Parameter                 | Symbol           | Condition | Value |     | Unit | Remarks                      |
|---------------------------|------------------|-----------|-------|-----|------|------------------------------|
|                           |                  |           | Min   | Max |      |                              |
| Power supply rising time  | $t_{\text{R}}$   | —         | —     | 50  | ms   | Power-on reset function only |
| Power supply cut-off time | $t_{\text{OFF}}$ | —         | 1     | —   | ms   | Due to repeated operations   |

Note : Make sure that power supply rises within the selected oscillation stabilization time. If power supply voltage needs to be varied in the course of operation, a smooth voltage rise is recommended.



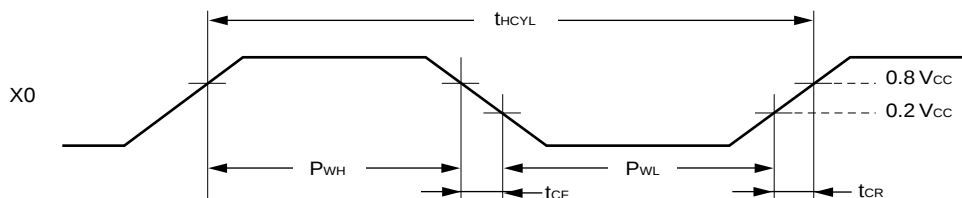
# MB89160L Series

## (3) Clock Timing

( $V_{SS} = 0.0\text{ V}$ ,  $T_a = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ )

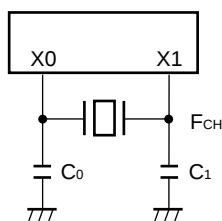
| Parameter                       | Symbol               | Pin      | Value |        |      | Unit          | Remarks        |
|---------------------------------|----------------------|----------|-------|--------|------|---------------|----------------|
|                                 |                      |          | Min   | Typ    | Max  |               |                |
| Clock frequency                 | $F_{CH}$             | X0, X1   | 1     | —      | 4.2  | MHz           | Main clock     |
|                                 | $F_{CL}$             | X0A, X1A | —     | 32.768 | —    | kHz           | Subclock       |
| Clock cycle time                | $t_{HCYL}$           | X0, X1   | 238   | —      | 1000 | ns            | Main clock     |
|                                 | $t_{LCYL}$           | X0A, X1A | —     | 30.5   | —    | $\mu\text{s}$ | Subclock       |
| Input clock pulse width         | $P_{WH}$<br>$P_{WL}$ | X0       | 20    | —      | —    | ns            | External clock |
| Input clock rising/falling time | $t_{CR}$<br>$t_{CF}$ | X0       | —     | —      | 24   | ns            |                |

### Main Clock Timing and Conditions

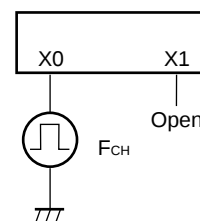


### Main Clock Conditions

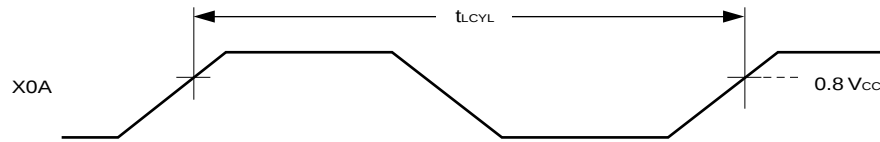
When a crystal  
or  
ceramic resonator is used



When an external clock is used

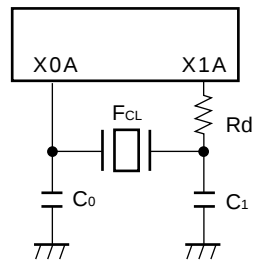


## Subclock Timing and Conditions

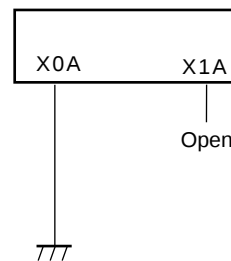


## Subclock Conditions

When a crystal  
or  
ceramic oscillator is used



When the single-clock option is used



## (4) Instruction Cycle

| Parameter                                     | Symbol     | Value (typical)                                        | Unit    | Remarks                                                       |
|-----------------------------------------------|------------|--------------------------------------------------------|---------|---------------------------------------------------------------|
| Instruction cycle<br>(minimum execution time) | $t_{inst}$ | $4/F_{CH}$ , $8/F_{CH}$ , $16/F_{CH}$ ,<br>$64/F_{CH}$ | $\mu s$ | $(4/F_{CH}) t_{inst} = 1.0 \mu s$ at $F_{CH} = 4 \text{ MHz}$ |
|                                               |            | $2/F_{CL}$                                             | $\mu s$ | $t_{inst} = 61.036 \mu s$ at $F_{CL} = 32.768 \text{ kHz}$    |

# MB89160L Series

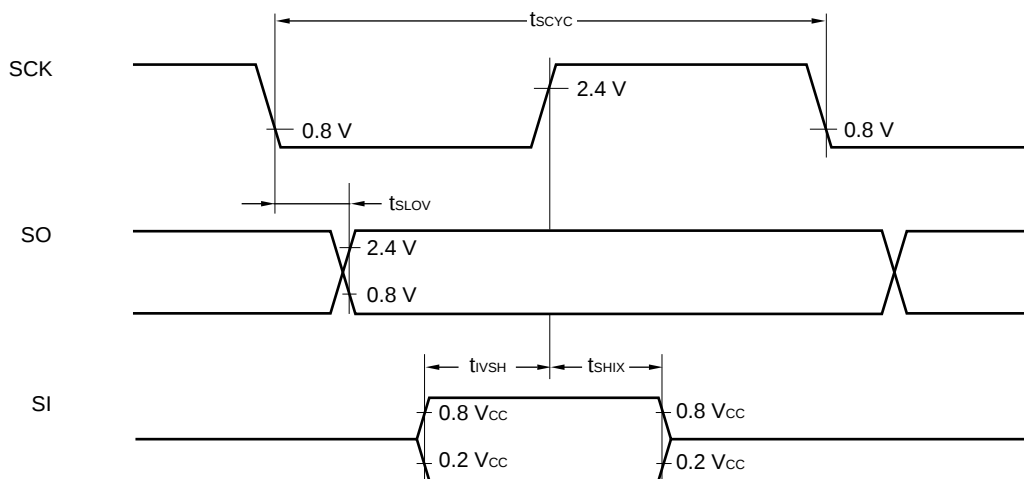
## (5) Serial I/O Timing

( $V_{CC} = +3.0\text{ V} \pm 10\%$  for MB89163L/165L;  $+5.0\text{ V} \pm 10\%$  for MB89PV160/P165/W165,  $AV_{SS} = V_{SS} = 0.0\text{ V}$ ,  $T_a = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ )

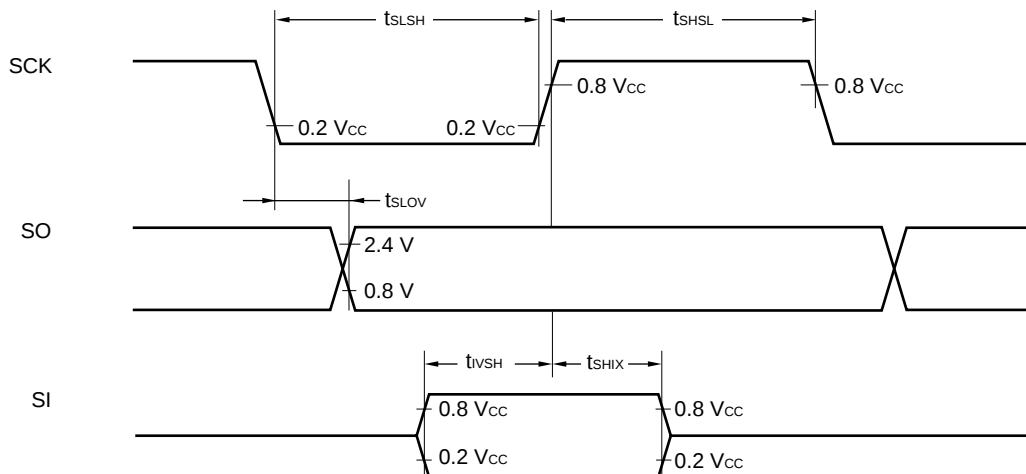
| Parameter                                     | Symbol     | Pin     | Condition                | Value             |      | Unit          | Remarks |
|-----------------------------------------------|------------|---------|--------------------------|-------------------|------|---------------|---------|
|                                               |            |         |                          | Min               | Max  |               |         |
| Serial clock cycle time                       | $t_{SCYC}$ | SCK     | Internal clock operation | $2\ t_{inst}^*$   | —    | $\mu\text{s}$ |         |
| SCK $\downarrow \rightarrow$ SO time          | $t_{SLOV}$ | SCK, SO |                          | -200              | +200 | ns            |         |
| Valid SI $\rightarrow$ SCK $\uparrow$         | $t_{IVSH}$ | SI, SCK |                          | $1/2\ t_{inst}^*$ | —    | $\mu\text{s}$ |         |
| SCK $\uparrow \rightarrow$ valid SI hold time | $t_{SHIX}$ | SCK, SI |                          | $1/2\ t_{inst}^*$ | —    | $\mu\text{s}$ |         |
| Serial clock "H" pulse width                  | $t_{SHSL}$ | SCK     | External clock operation | $1\ t_{inst}^*$   | —    | $\mu\text{s}$ |         |
| Serial clock "L" pulse width                  | $t_{SLSH}$ |         |                          | $1\ t_{inst}^*$   | —    | $\mu\text{s}$ |         |
| SCK $\downarrow \rightarrow$ SO time          | $t_{SLOV}$ | SCK, SO |                          | 0                 | 200  | ns            |         |
| Valid SI $\rightarrow$ SCK $\uparrow$         | $t_{IVSH}$ | SI, SCK |                          | $1/2\ t_{inst}^*$ | —    | $\mu\text{s}$ |         |
| SCK $\uparrow \rightarrow$ valid SI hold time | $t_{SHIX}$ | SCK, SI |                          | $1/2\ t_{inst}^*$ | —    | $\mu\text{s}$ |         |

\* : For information on  $t_{inst}$ , see "(4) Instruction Cycle."

### Internal Clock Operation



### External Clock Operation

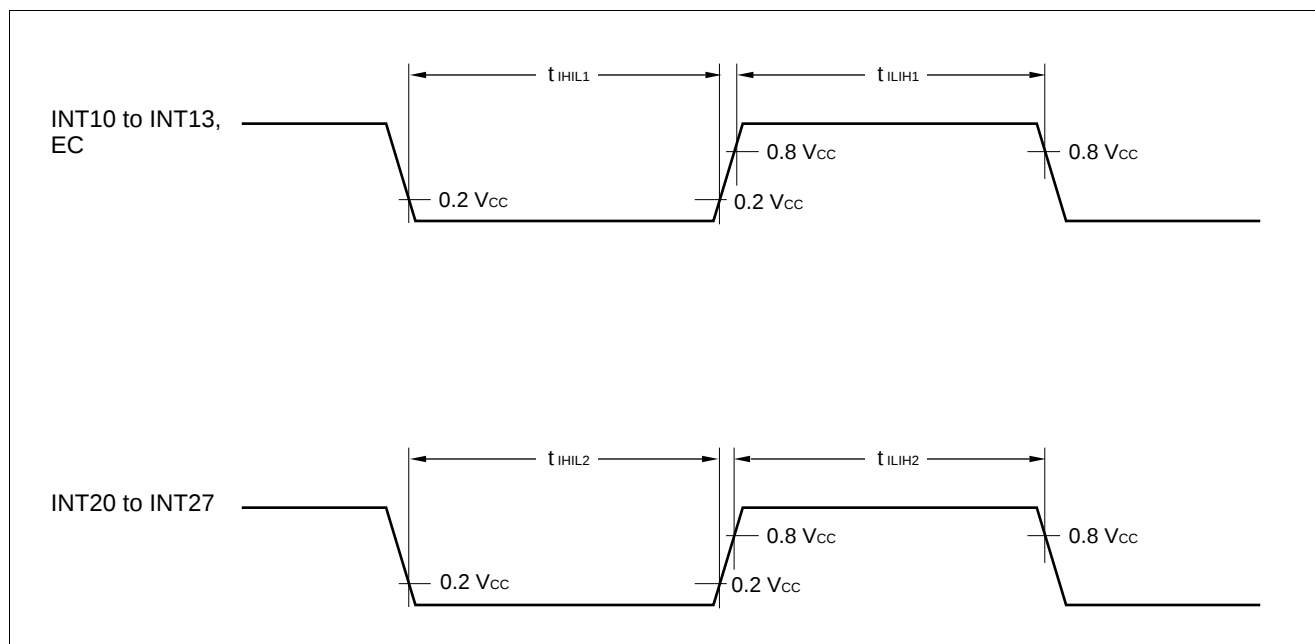


## (6) Peripheral Input Timing

( $V_{CC} = +3.0\text{ V} \pm 10\%$  for MB89163L/165L;  $+5.0\text{ V} \pm 10\%$  for MB89PV160/P165/W165,  $AV_{SS} = V_{SS} = 0.0\text{ V}$ ,  $T_a = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ )

| Parameter                          | Symbol      | Pin                                                    | Value          |     | Unit          | Remarks |
|------------------------------------|-------------|--------------------------------------------------------|----------------|-----|---------------|---------|
|                                    |             |                                                        | Min            | Max |               |         |
| Peripheral input "H" pulse width 1 | $t_{ILIH1}$ | INT10 to INT13, EC                                     | 1 $t_{inst}^*$ | —   | $\mu\text{s}$ |         |
| Peripheral input "L" pulse width 1 | $t_{IHIL1}$ |                                                        | 1 $t_{inst}^*$ | —   | $\mu\text{s}$ |         |
| Peripheral input "H" pulse width 2 | $t_{ILIH2}$ | $\overline{\text{INT20}}$ to $\overline{\text{INT27}}$ | 2 $t_{inst}^*$ | —   | $\mu\text{s}$ |         |
| Peripheral input "L" pulse width 2 | $t_{IHIL2}$ |                                                        | 2 $t_{inst}^*$ | —   | $\mu\text{s}$ |         |

\* : For information on  $t_{inst}$ , see "(4) Instruction Cycle."



# MB89160L Series

## 5. A/D Converter Electrical Characteristics

(3 MHz,  $AV_{CC} = V_{CC} = +2.7$  V to  $+3.6$  V for MB89163L/165L;  $+3.5$  V to  $+6.0$  V for MB89PV160/P165/W165,  $AV_{SS} = V_{SS} = 0.0$  V,  $T_a = -40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ )

| Parameter                     | Symbol           | Pin        | Condition              | Value                      |                            |                            | Unit | Remarks              |                      |
|-------------------------------|------------------|------------|------------------------|----------------------------|----------------------------|----------------------------|------|----------------------|----------------------|
|                               |                  |            |                        | Min                        | Typ                        | Max                        |      |                      |                      |
| Resolution                    | —                | —          | —                      | —                          | —                          | 8                          | bit  |                      |                      |
| Total error                   |                  |            | —                      | —                          | ±1.5                       | LSB                        |      |                      |                      |
| Linearity error               |                  |            | —                      | —                          | ±1.0                       | LSB                        |      |                      |                      |
| Differential linearity error  |                  |            | —                      | —                          | ±0.9                       | LSB                        |      |                      |                      |
| Zero transition voltage       | V <sub>OT</sub>  |            | AVR = AV <sub>CC</sub> | AV <sub>SS</sub> – 0.6 LSB | AV <sub>SS</sub> + 0.9 LSB | AV <sub>SS</sub> + 2.4 LSB | mV   | MB89163L/ 165L       |                      |
|                               |                  |            |                        | AV <sub>SS</sub> – 1.0 LSB | AV <sub>SS</sub> + 0.5 LSB | AV <sub>SS</sub> + 2.0 LSB |      | MB89PV160 /P165/W165 |                      |
| Full-scale transition voltage | V <sub>FST</sub> |            |                        | AV <sub>SS</sub> – 2.6 LSB | AVR + 1.1 LSB              | AVR + 0.4 LSB              | mV   | MB89163L/ 165L       |                      |
|                               |                  |            |                        | AVR – 3.0 LSB              | AVR – 1.5 LSB              | AVR                        |      | MB89PV160 /P165/W165 |                      |
| Interchannel disparity        | —                |            |                        | —                          | —                          | 0.5                        | LSB  |                      |                      |
| A/D mode conversion time      |                  |            |                        | —                          | —                          | 52 t <sub>inst</sub>       | —    | μs                   | MB89163L/ 165L       |
|                               |                  |            |                        |                            |                            | 44 t <sub>inst</sub>       |      |                      | MB89PV160 /P165/W165 |
| Sense mode conversion time    | —                |            |                        |                            | —                          | 12 t <sub>inst</sub>       | —    | μs                   |                      |
| Analog port input current     | I <sub>AI</sub>  | AN0 to AN7 | —                      | —                          | —                          | 10                         | μA   |                      |                      |
| Analog input voltage          | —                |            |                        | AV <sub>SS</sub>           | —                          | AVR                        | V    | MB89163L/ 165L       |                      |
|                               |                  |            |                        | 0.0                        |                            |                            |      | MB89PV160 /P165/W165 |                      |

(Continued)

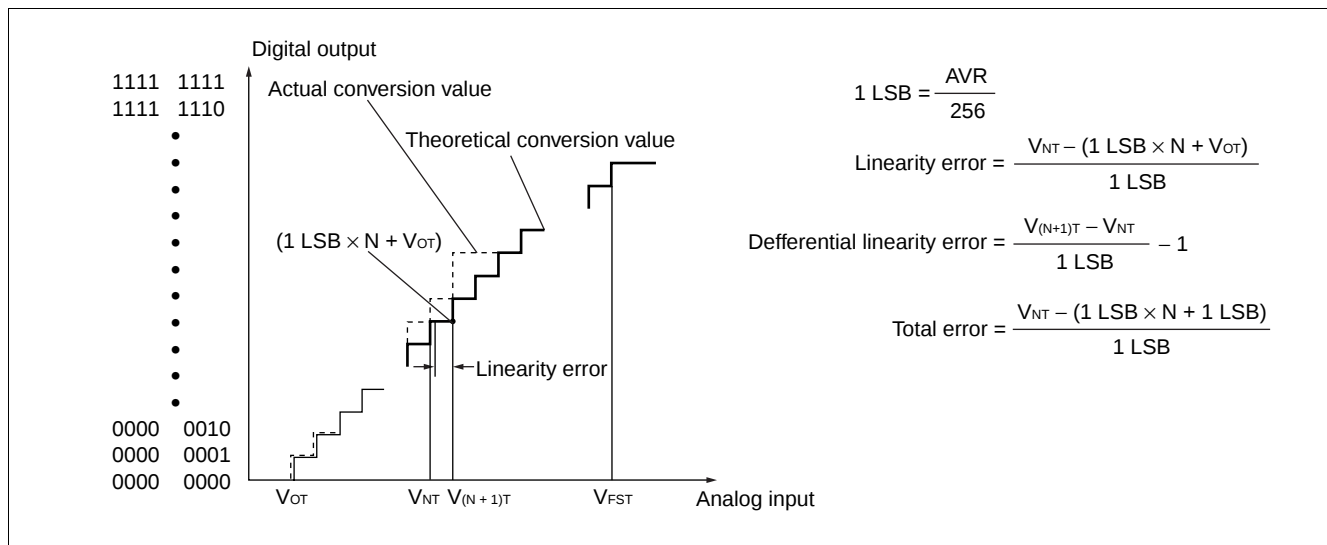
# MB89160L Series

(Continued)

| Parameter                           | Symbol          | Pin | Condition                                           | Value |     |                  | Unit | Remarks                 |
|-------------------------------------|-----------------|-----|-----------------------------------------------------|-------|-----|------------------|------|-------------------------|
|                                     |                 |     |                                                     | Min   | Typ | Max              |      |                         |
| Reference voltage                   | —               |     | —                                                   | 2.7   | —   | AV <sub>CC</sub> | V    | MB89163L/<br>165L       |
|                                     |                 |     |                                                     | 2.0   |     |                  |      | MB89PV160/<br>P165/W165 |
| Reference voltage<br>supply current | I <sub>R</sub>  | AVR | AVR = 3.0 V, when<br>A/D conversion is<br>activated | —     | 85  | 170              | μA   | MB89163L/<br>165L       |
|                                     |                 |     | AVR = 5.0 V, when<br>A/D conversion is<br>activated |       | 100 | —                |      | MB89PV160/<br>P165/W165 |
|                                     | I <sub>RH</sub> |     | AVR = 3.0 V, when<br>A/D conversion is<br>stopped   | —     | —   | 1                | μA   | MB89163L/<br>165L       |
|                                     |                 |     | AVR = 5.0 V, when<br>A/D conversion is<br>stopped   |       |     |                  |      | MB89PV160/<br>P165/W165 |

## (1) A/D Glossary

- Resolution  
Analog changes that are identifiable with the A/D converter.  
When the number of bits is 8, analog voltage can be divided into  $2^8=256$ .
- Linearity error (unit: LSB)  
The deviation of the straight line connecting the zero transition point ("0000 0000" ↔ "0000 0001") with the full-scale transition point ("1111 1111" ↔ "1111 1110") from actual conversion characteristics
- Differential linearity error (unit: LSB)  
The deviation of input voltage needed to change the output code by 1 LSB from the theoretical value
- Total error (unit: LSB)  
The difference between theoretical and actual conversion values



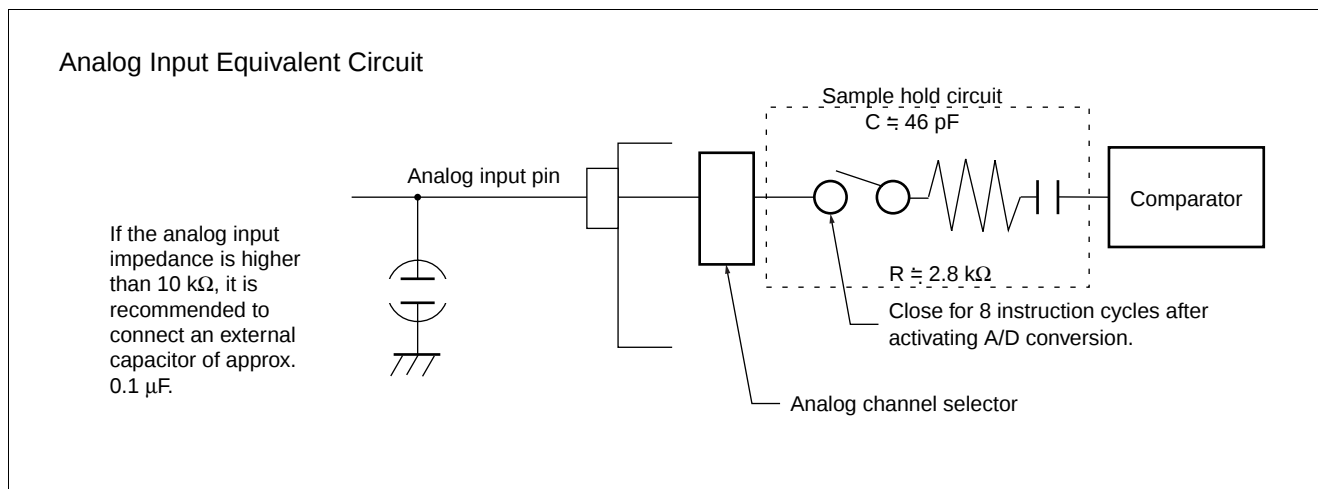
## (2) Precautions

### • Input impedance of analog input pins

The A/D converter contains a sample hold circuit as illustrated below to fetch analog input voltage into the sample hold capacitor for eight instruction cycles after activating A/D conversion.

For this reason, if the output impedance of the external circuit for the analog input is high, analog input voltage might not stabilize within the analog input sampling period. Therefore, it is recommended to keep the output impedance of the external circuit low (below 10 k $\Omega$ ).

Note that if the impedance cannot be kept low, it is recommended to connect an external capacitor of about 0.1  $\mu$ F for the analog input pin.



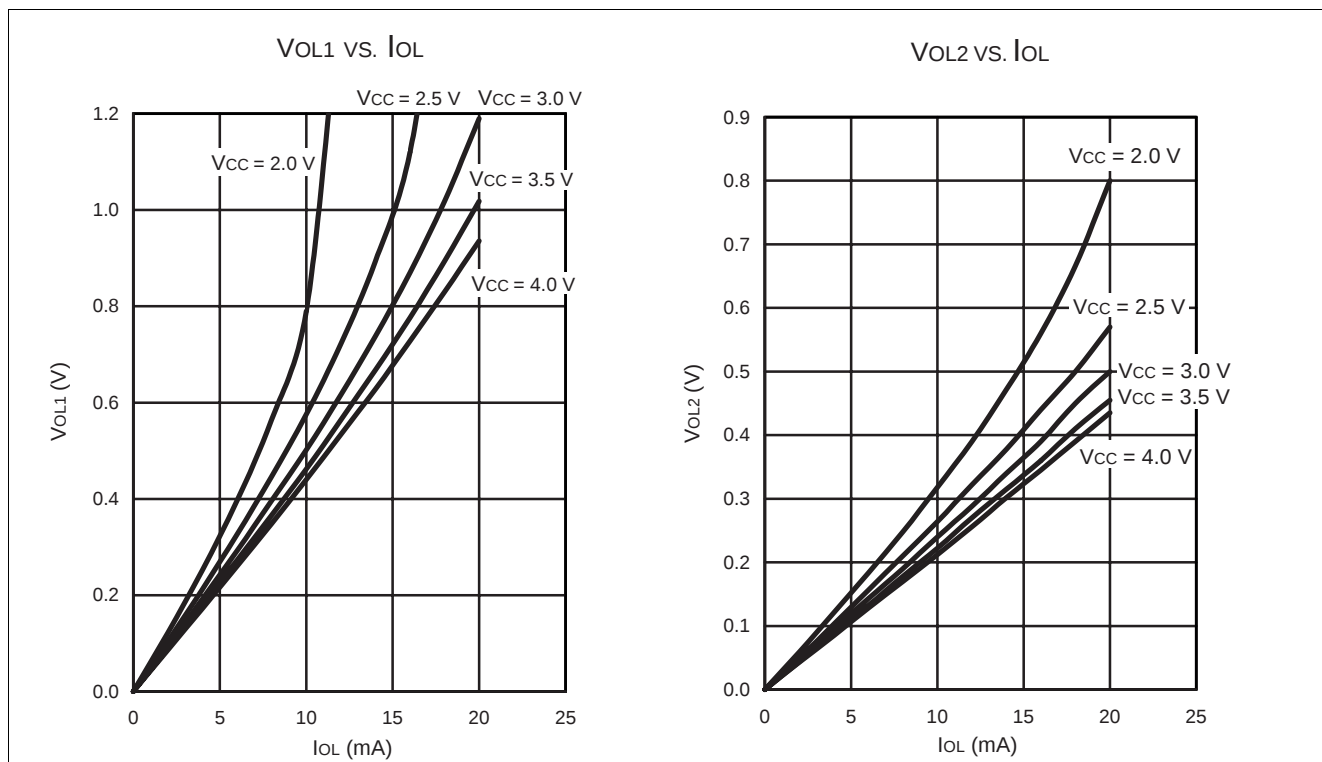
### • Error

The smaller the  $|AVR - AV_{ss}|$  is, the greater the error would become relatively.

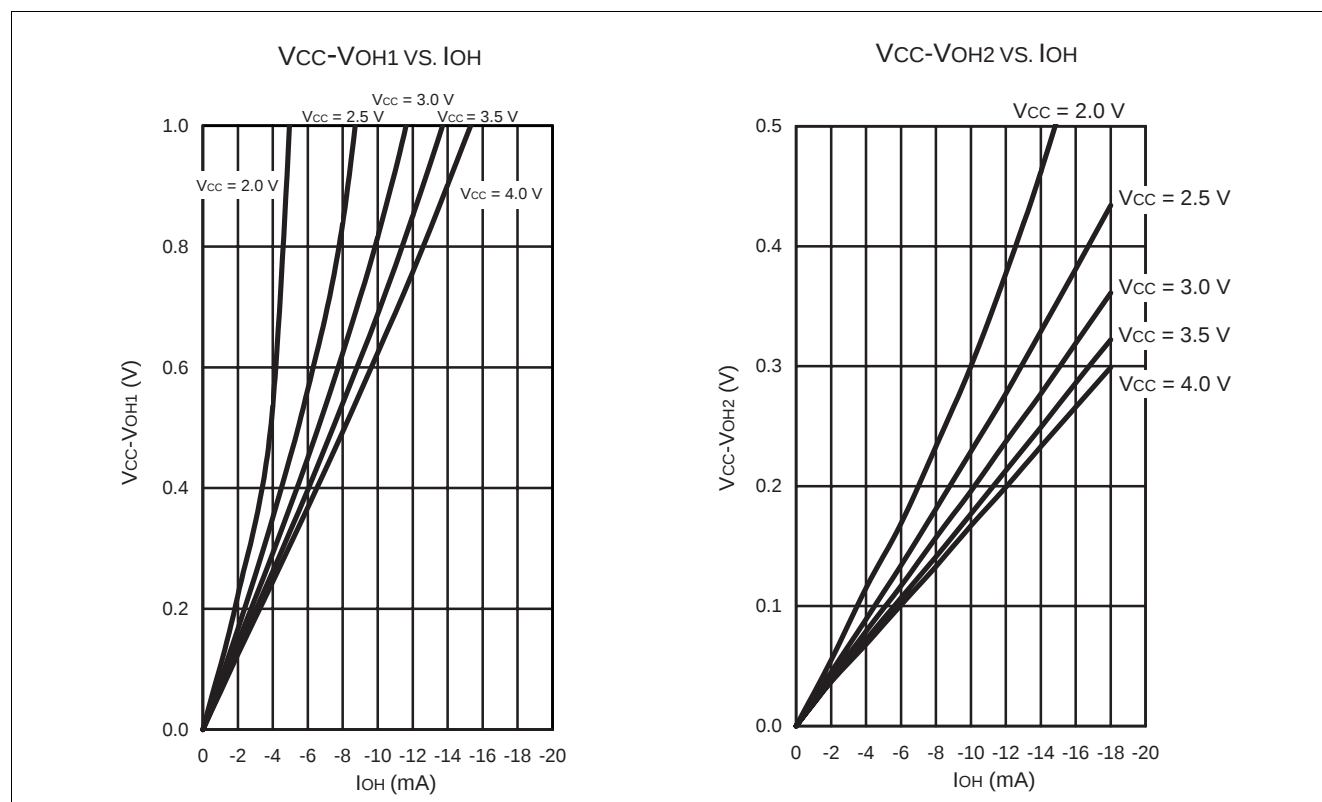
# MB89160L Series

## ■ EXAMPLE CHARACTERISTICS

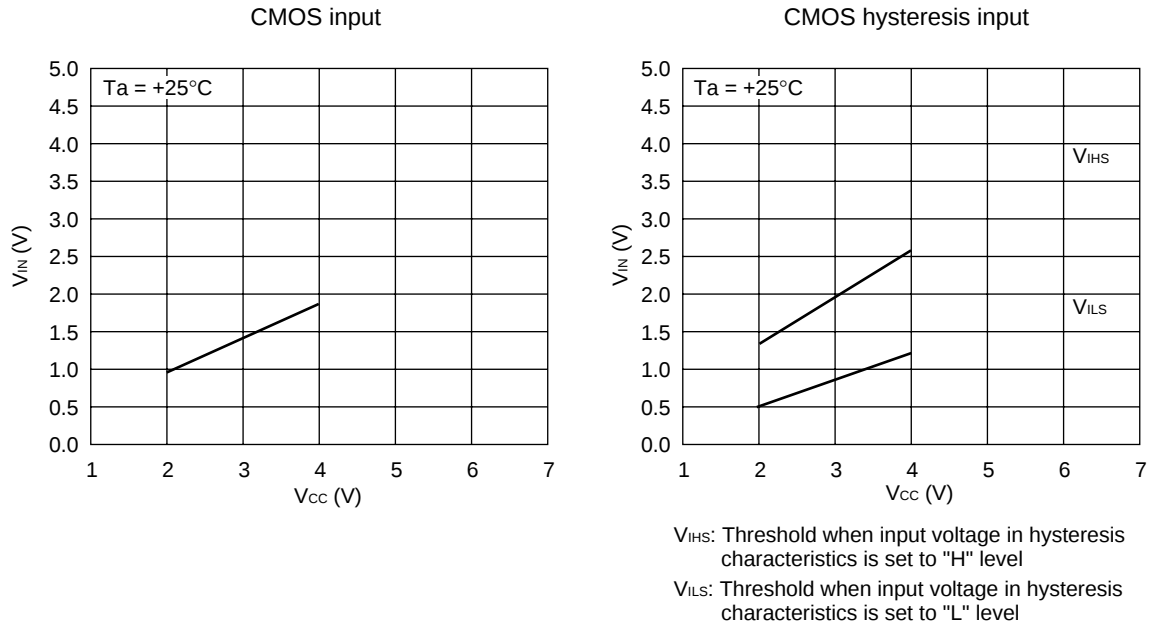
### (1) "L" Level Output Voltage



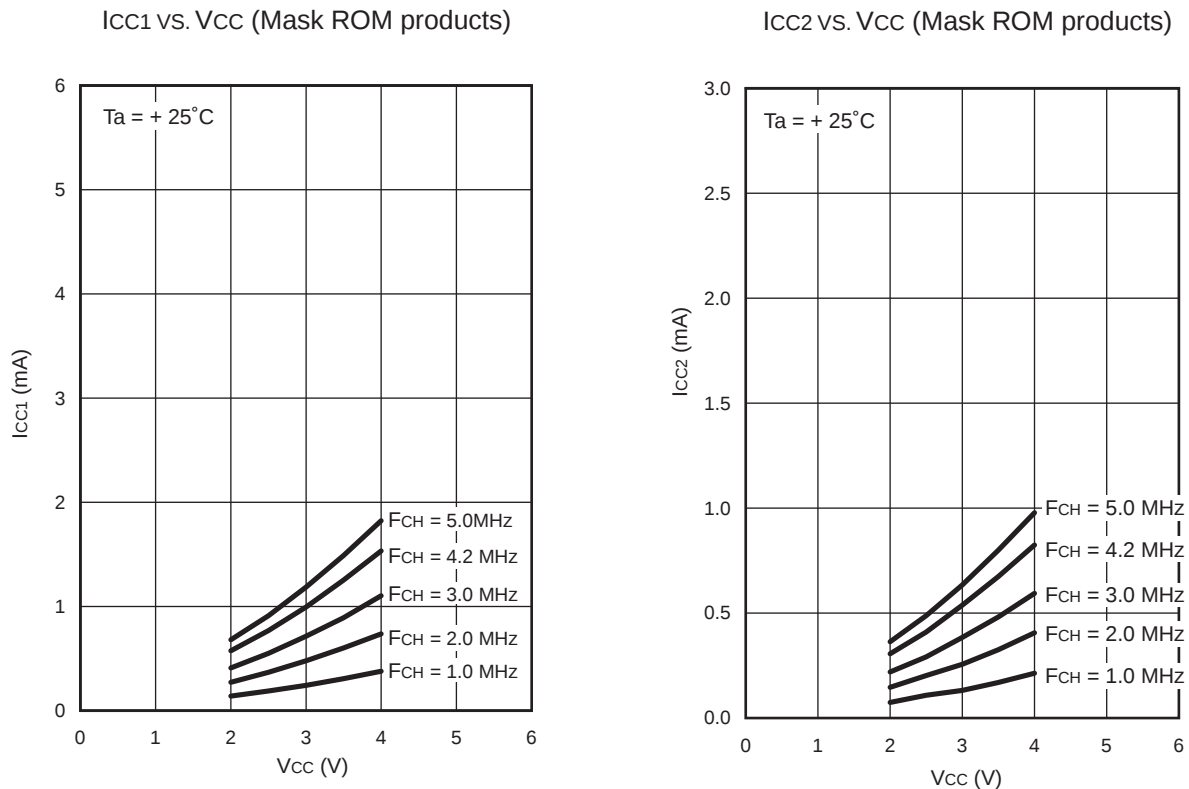
### (2) "H" Level Output Voltage



## (3) "H" Level Input Voltage/"L" level Input Voltage



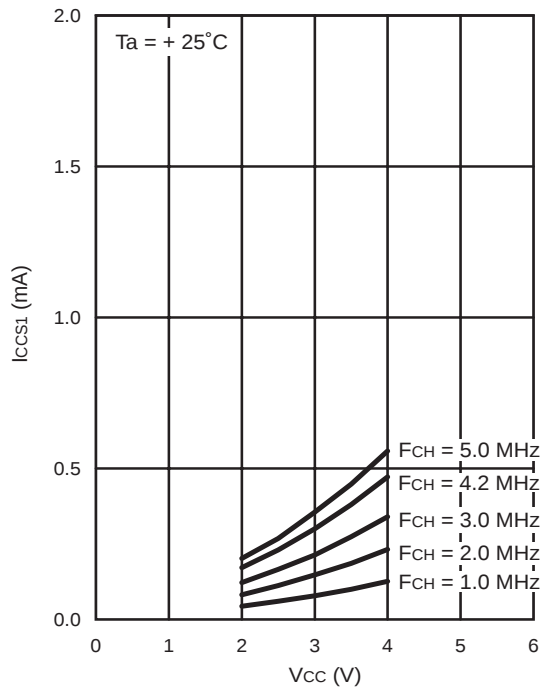
## (4) Power Supply Current (External Clock)



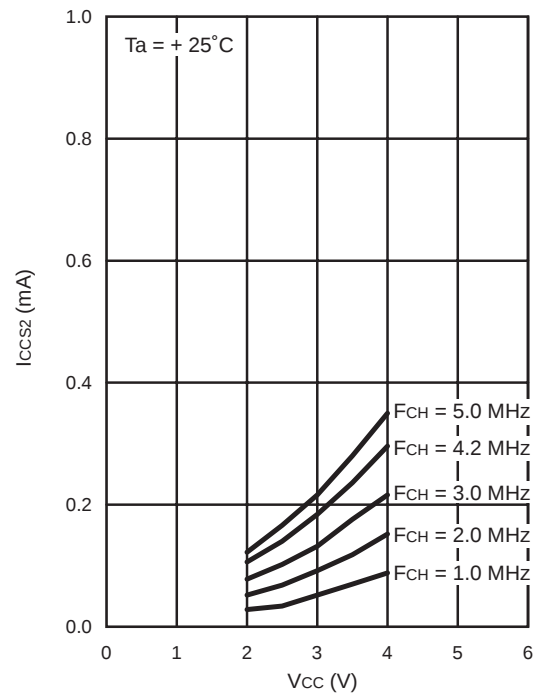
(Continued)

# MB89160L Series

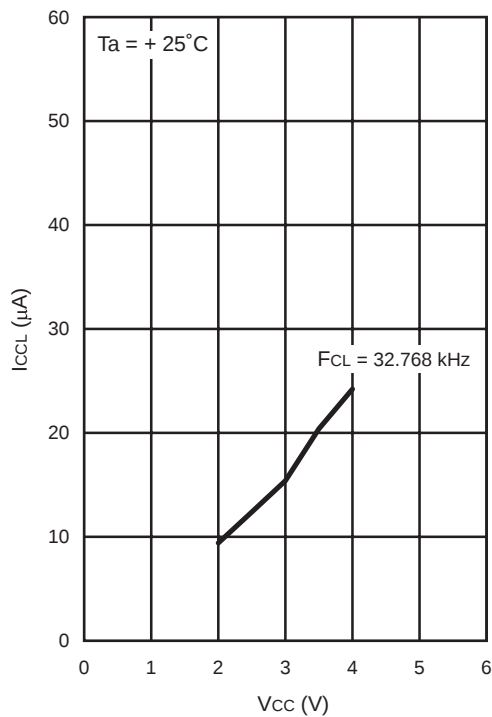
Icc1S vs. Vcc (Mask ROM products)



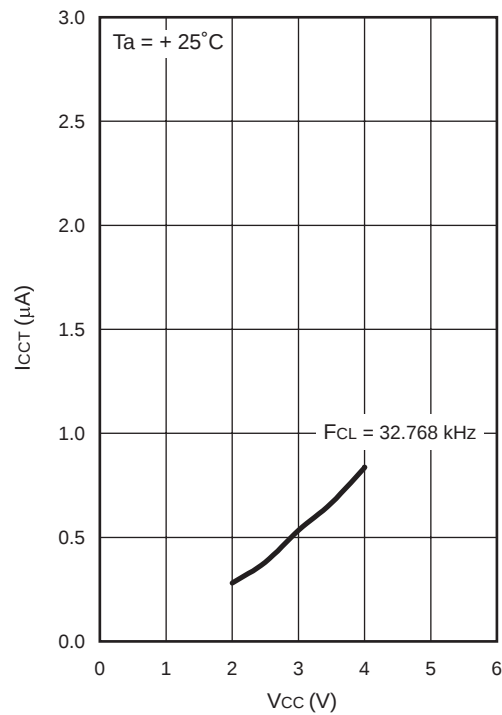
Icc2S vs. Vcc (Mask ROM products)



IcCL vs. Vcc (Mask ROM products)

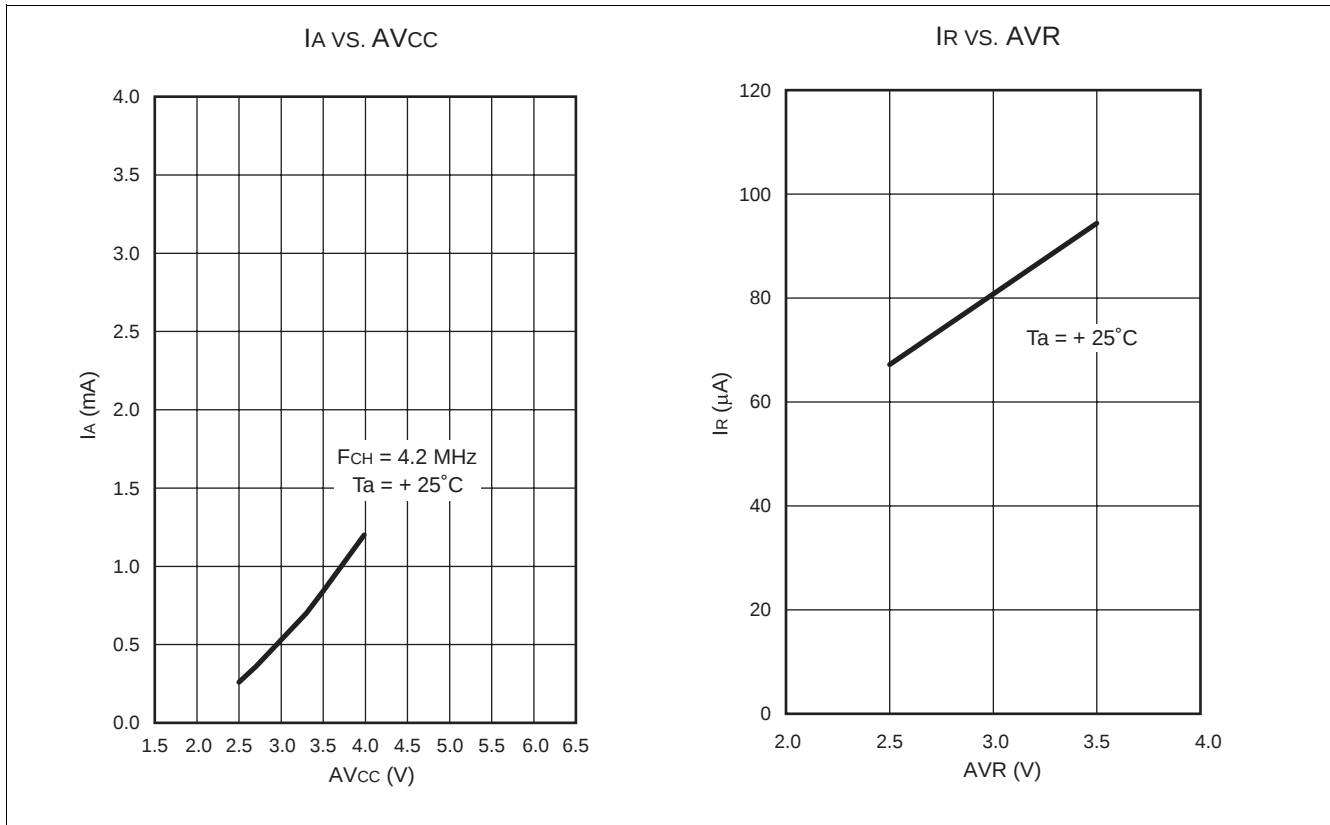


IcCT vs. Vcc

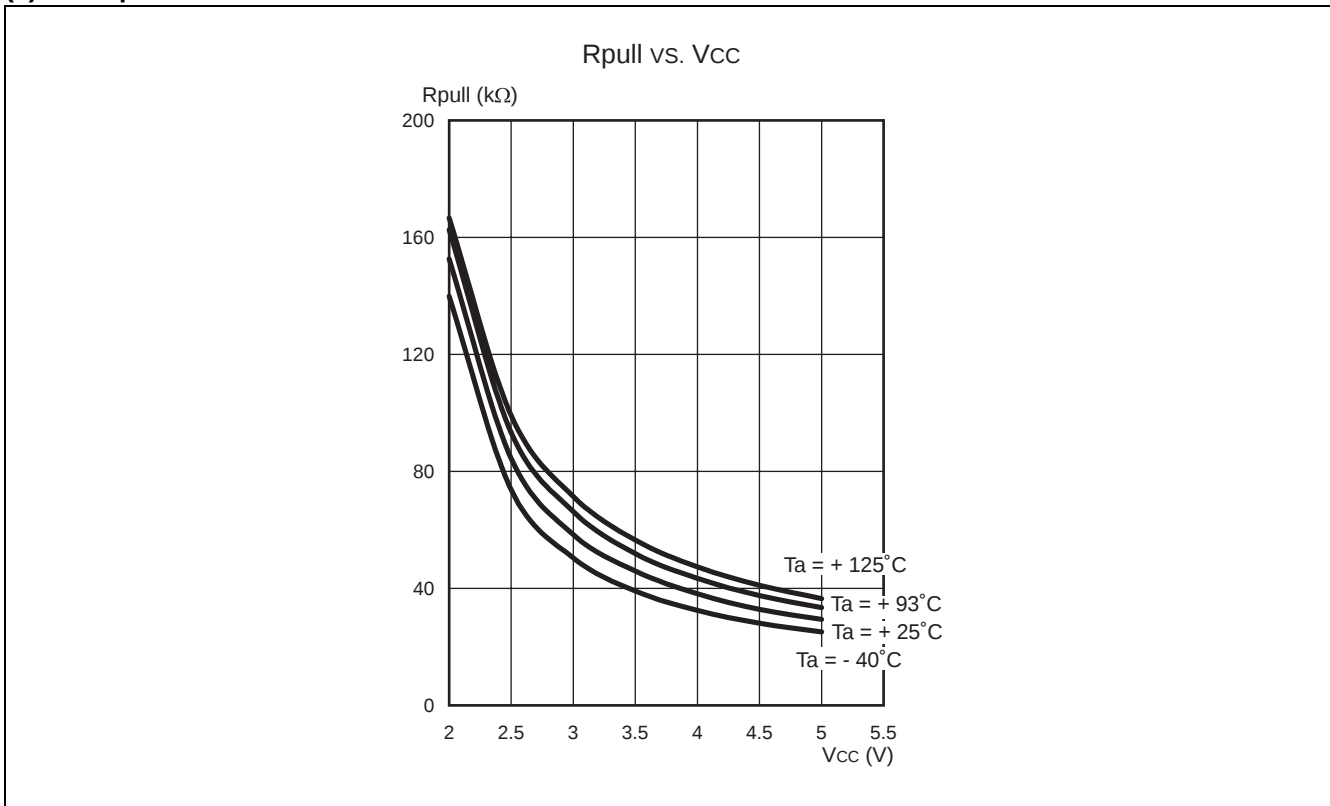


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## (5) Pull-up Resistance



# MB89160L Series

## ■ MASK OPTIONS

| No. | Part number                                                                                                                                                                                                  | MB89163L/165L                                                                                                                                                                                             | MB89P165/W165                                                                                                            | MB89PV160                                                  |
|-----|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|
|     | Specifying procedure                                                                                                                                                                                         | Specify when ordering masking                                                                                                                                                                             | Set with EPROM programmer                                                                                                | Setting not possible                                       |
| 1   | Pull-up resistors (PXX)<br>P00 to P07, P10 to P17,<br>P20 to P27, P40 to P47,<br>P50 to P57, P60 to P67                                                                                                      | Selectable per pin<br>(The pull-up resistors for P40 to P47 and P60 to P67 are only selectable when these pins are not set as segment outputs.<br>When the A/D is used, P50 to P57 must not be selected.) | Can be set per pin<br>(P20 to P27, P40 to P47, and P60 to P67 are available only for without a pull-up resistor.)        | Fixed to without pull-up resistor                          |
| 2   | Power-on reset (POR)<br>With power-on reset<br>Without power-on reset                                                                                                                                        | Selectable                                                                                                                                                                                                | Selectable                                                                                                               | Fixed to with power-on reset                               |
| 3   | Selection of oscillation stabilization time (OSC)<br>• The initial value of the oscillation stabilization time for the main clock can be set by selecting the values of the WTM1 and WTM0 bits on the right. | Selectable<br>OSC<br>0 : $2^2/F_{CH}$<br>1 : $2^{12}/F_{CH}$<br>2 : $2^{16}/F_{CH}$<br>3 : $2^{18}/F_{CH}$                                                                                                | Selectable<br>WTM1 WTM0<br>0 0 : $2^2/F_{CH}$<br>0 1 : $2^{12}/F_{CH}$<br>1 0 : $2^{16}/F_{CH}$<br>1 1 : $2^{18}/F_{CH}$ | Fixed to oscillation stabilization time of $2^{16}/F_{CH}$ |
| 4   | Main clock oscillation type (XSL)<br>Crystal or ceramic resonator                                                                                                                                            | Crystal or ceramic                                                                                                                                                                                        | Crystal or ceramic                                                                                                       | Crystal or ceramic only                                    |
| 5   | Reset pin output (RST)<br>With reset output<br>Without reset output                                                                                                                                          | Selectable                                                                                                                                                                                                | Selectable                                                                                                               | Fixed to with reset output                                 |
| 6   | Clock mode selection (CLK)<br>Dual-clock mode<br>Single-clock mode                                                                                                                                           | Selectable                                                                                                                                                                                                | Selectable                                                                                                               | Fixed to dual-clock mode                                   |

## • Segment Options

| No. | Part number                                                                                                            | MB89163L/165L                                   | MB89P165/W165                  | MB89PV160                      |
|-----|------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|--------------------------------|--------------------------------|
|     | Specifying procedure                                                                                                   | Specify when ordering masking                   | Select by version number       | Select by version number       |
| 7   | LCD output pin configuration choices                                                                                   | Specify by the option combinations listed below | —                              | —                              |
|     | SEG = 4:<br>P40 to P47 segment output<br>P60 to P67 segment output<br>P70, P71 common output                           | Specify as SEG = 4                              | −101:SEG 24 pins<br>COM 4 pins | −101:SEG 24 pins<br>COM 4 pins |
|     | SEG = 3:<br>P40 to P43 segment output<br>P44 to P47 port output<br>P60 to P67 segment output<br>P70, P71 common output | Specify as SEG = 3                              | −102:SEG 20 pins<br>COM 4 pins | −102:SEG 20 pins<br>COM 4 pins |
|     | SEG = 2:<br>P40 to P47 port output<br>P60 to P67 segment output<br>P70, P71 common output                              | Specify as SEG = 2                              | −103:SEG 16 pins<br>COM 4 pins | −103:SEG 16 pins<br>COM 4 pins |
|     | SEG = 1:<br>P40 to P47 port output<br>P60 to P63 segment output<br>P64 to P67 port output<br>P70, P71 port output      | Specify as SEG = 1                              | −104:SEG 12 pins<br>COM 2 pins | −104:SEG 12 pins<br>COM 2 pins |
|     | SEG = 0:<br>P40 to P47 port output<br>P60 to P67 port output<br>P70, P71 port output                                   | Specify as SEG = 0                              | −105:SEG 8 pins<br>COM 2 pins  | −105:SEG 8 pins<br>COM 2 pins  |

## ■ VERSIONS

| Version                 |                       |               |                              | Features               |
|-------------------------|-----------------------|---------------|------------------------------|------------------------|
| Mass production product | One-time PROM product | EPROM product | Piggyback/evaluation product | Number of segment pins |
| MB89160L series         | MB89P165-101          | MB89W165-101  | MB89PV160-101                | 24 (4 commons)         |
|                         | −102                  | −102          | −102                         | 20 (4 commons)         |
|                         | −103                  | −103          | −103                         | 16 (4 commons)         |
|                         | −104                  | −104          | −104                         | 12 (2 commons)         |
|                         | −105                  | −105          | −105                         | 8 (2 commons)          |

# MB89160L Series

## ■ ORDERING INFORMATION

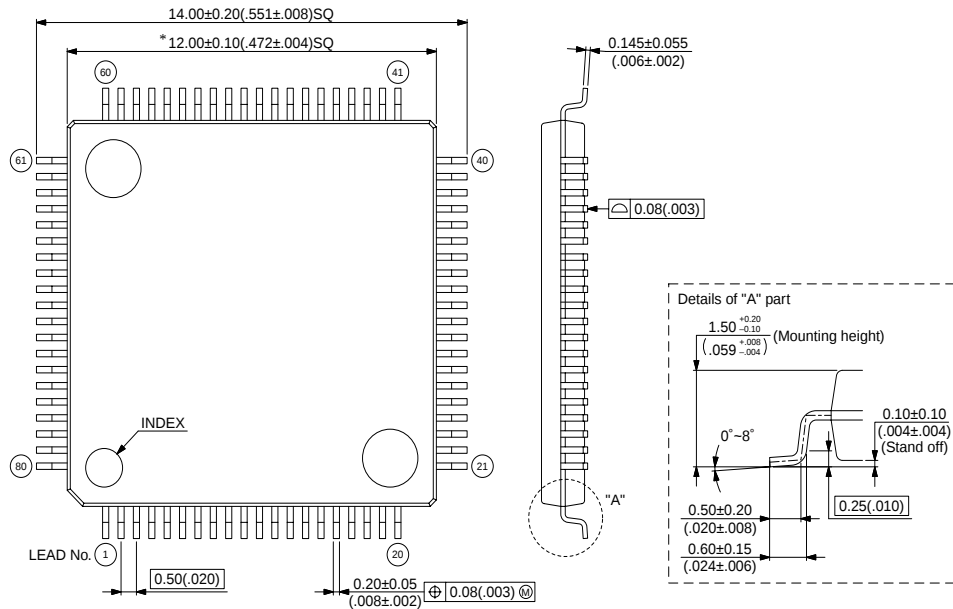
| Part number                                      | Package                              | Remarks |
|--------------------------------------------------|--------------------------------------|---------|
| MB89163L-PFV<br>MB89165L-PFV<br>MB89P165-xxx-PFV | 80-pin Plastic LQFP<br>(FPT-80P-M05) |         |
| MB89163L-PF<br>MB89165L-PF<br>MB89P165-xxx-PF    | 80-pin Plastic QFP<br>(FPT-80P-M06)  |         |
| MB89163L-PFM<br>MB89165L-PFM<br>MB89P165-xxx-PFM | 80-pin Plastic LQFP<br>(FPT-80P-M11) |         |
| MB89W165-xxx-PF                                  | 80-pin Ceramic QFP<br>(FPT-80C-A02)  |         |
| MB89PV160-xxx-PF                                 | 80-pin Ceramic MQFP<br>(MQP-80C-P01) |         |

Note : For information on xxx, see ■ VERSIONS.

## ■ PACKAGE DIMENSIONS

### 80-pin plastic LQFP (FPT-80P-M05)

Note 1) \* : These dimensions do not include resin protrusion.  
 Note 2) Pins width and pins thickness include plating thickness.  
 Note 3) Pins width do not include tie bar cutting remainder.

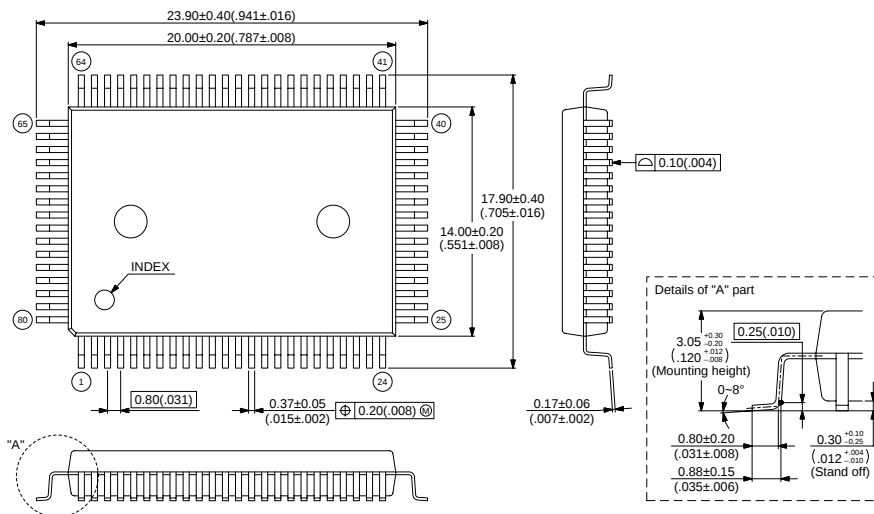


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Dimensions in mm (inches).

### 80-pin plastic QFP (FPT-80P-M06)

Note 1) \* : These dimensions do not include resin protrusion.  
 Note 2) Pins width and pins thickness include plating thickness.  
 Note 3) Pins width do not include tie bar cutting remainder.



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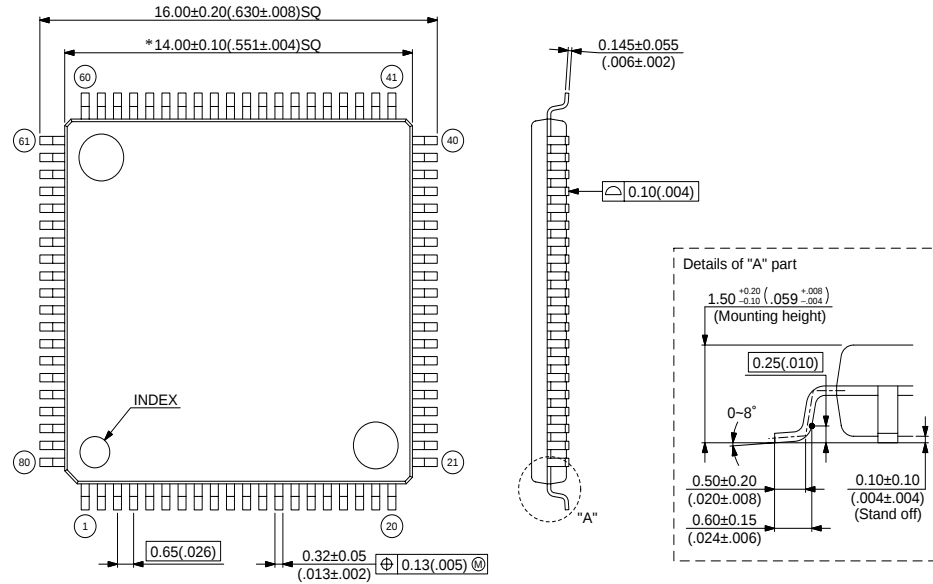
Dimensions in mm (inches).

(Continued)

# MB89160L Series

## 80-pin plastic LQFP (FPT-80P-M11)

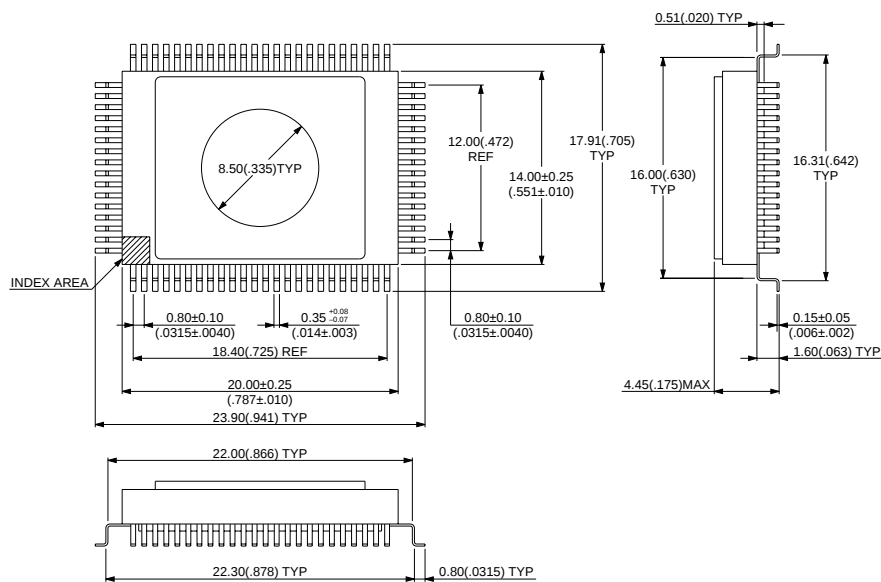
Note 1) \* : These dimensions do not include resin protrusion.  
 Note 2) Pins width and pins thickness include plating thickness.  
 Note 3) Pins width do not include tie bar cutting remainder.



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Dimensions in mm (inches).

## 80-pin ceramic QFP (FPT-80C-A02)



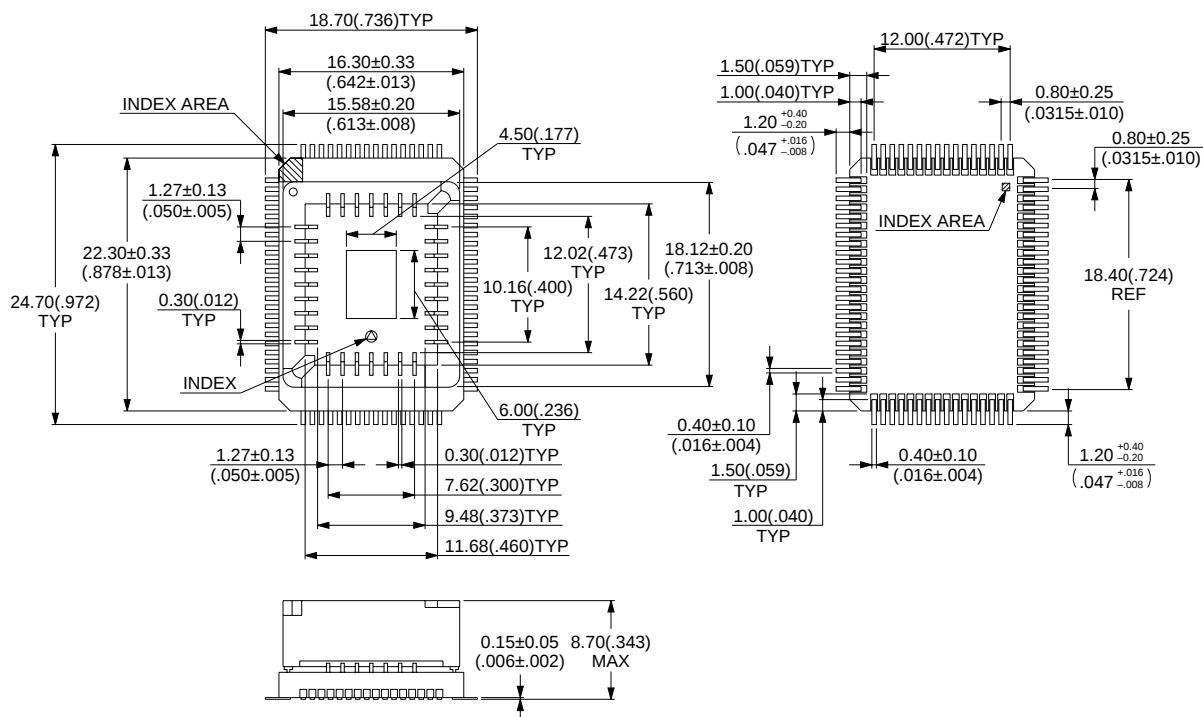
© 1994 FUJITSU LIMITED F80014SC-1-2

Dimensions in mm (inches).

(Continued)

# MB89160L Series

(Continued)

80-pin ceramic MQFP  
(MQP-80C-P01)

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Dimensions in mm (inches).

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