

8-bit Proprietary Microcontroller

CMOS

F²MC-8L MB89140 Series

MB89145/146 and MB89P147/PV140

DESCRIPTION

The MB89140 series is a line of single-chip microcontrollers that use the F²MC*-8L CPU core which can operate at low voltage but at high speed. The MB89140 series contains a variety of peripheral functions, such as timers, a serial interface, an A/D converter, and an external interrupt. The MB89140 series is applicable to a wide range of applications from welfare products to industrial equipment, including portable devices.

*: F²MC stands for FUJITSU Flexible Microcontroller.

FEATURES

- Minimum execution time: 0.5 μ s/8-MHz oscillation
- F²MC-8L family CPU core

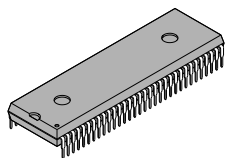
Instruction set optimized for controllers

Multiplication and division instructions
16-bit arithmetic operations
Test and branch instructions
Bit manipulation instructions, etc.

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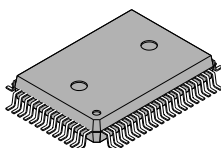
PACKAGE

64-pin Plastic SH-DIP



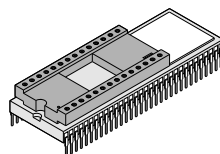
(DIP-64P-M01)

64-pin Plastic QFP



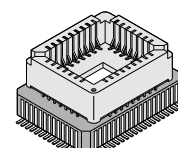
(FPT-64P-M06)

64-pin Ceramic MDIP



(MDP-64C-P02)

64-pin Ceramic MQFP



(MQP-64C-P01)

MB89140 Series

(Continued)

- Low-voltage operation (when an A/D converter is not used)
- Low current consumption (compatible with dual-clock system)
- High-voltage ports on chip
- Five types of timers
 - 8-bit PWM timer (also usable as a reload timer)
 - 12-bit MPG timer (also usable as a PPG output, PWM output, and reload timer)
 - 8/16-bit timer (also usable as two 8-bit timers)
 - 21-bit time-base timer
- One serial interface
 - Swichable transfer direction allows communication with various equipment.
- 10-bit A/D converter: 12 channels
 - Successive approximation type
- External interrupt: 2 channels
 - Two channels are independent and capable of wake-up from low-power consumption modes. (Rising edge, falling edge/both edges selectability)
 - 0.3 V to +7.0 V can be applied to INT1 (N-ch open-drain)
- Low-power consumption modes
 - Stop mode (Oscillation stops to minimize the current consumption.)
 - Sleep mode (The CPU stops to reduce the current consumption to approx. 1/3 of normal.)
 - Subclock mode
 - Watch mode
- Reset output and power-on reset selectability

MB89140 Series

■ PRODUCT LINEUP

| Part number | MB89145 | MB89146 | MB89P147 | MB89PV140 |
|---|--|---|----------------------------------|---|
| Classification | Mass production products (mask ROM products) | | One-time PROM/ EPROM product | Piggyback/ evaluation product (for evaluation and development) |
| ROM size | 16 K × 8 bits (internal mask ROM) | 24 K × 8 bits (internal mask ROM) | 32 K × 8 bits (internal PROM) | 32 K × 8 bits (external ROM) |
| RAM size | 512 × 8 bits | 768 × 8 bits | 1 K × 8 bits | |
| CPU functions | Number of instructions: 136 Instruction bit length: 8 bits Instruction length: 1 to 3 bytes Data bit length: 1, 8, 16 bits Minimum execution time: 0.5 μs/8 MHz to 8.0 μs/8 MHz, 61 μs/32.768 kHz Interrupt processing time: 4.5 μs/8 MHz to 72.0 μs/8 MHz, 562.5 μs/32.768 kHz Note: The above times change according to the gear function. | | | |
| Ports | High-voltage output port (P-ch open-drain): 8 (P60 to P67, for heavy current) 16 (P40 to P47, P50 to P57 for low current) Buzzer output (P-ch open-drain, high-voltage): 1 (heavy current) Output ports (CMOS): 4 (P20 to P23) Input ports (CMOS): 2 (P70 and P71, function as X0A and X1A pins when dual-clock system is used.) I/O ports (CMOS): 23 (P00 to P07, P10 to P17, P30, and P32 to P37) I/O ports (N-ch open-drain): 1 (P31) Total: 55 | | | |
| Clock timer | 21 bits × 1 (in main clock mode), 15 bits × 1 (at 32.768 kHz) | | | |
| 8-bit PWM timer (timer 1) | 8-bit timer operation (toggled output capable, operating clock: 1, 2, 8, 16 system clock cycles) 8-bit resolution PWM operation (conversion cycle: 128 μs to 2.0 ms at 8.0-MHz oscillation, and highest gear speed) | | | |
| 12-bit MPG (timer 4) | 12-bit resolution PWM operation (maximum conversion cycle of 2048.4 μs to 16.4 ms at 8.0 MHz-oscillation, and highest gear speed) 12-bit resolution reload timer operation (toggled output capable) 12-bit resolution PPG operation (minimum resolution of 0.5 μs at 8.0-MHz oscillation, and highest gear speed) | | | |
| 8/16-bit timer counter (timer 2, 3) | 8/16-bit timer operation (operating clock, internal clock, external trigger) 8/16-bit event counter operation (Rising edge/falling edge/both edges selectability) | | | |

(Continued)

MB89140 Series

(Continued)

| Part number | MB89145 | MB89146 | MB89P147 | MB89PV140 |
|----------------------|--|---------|----------|------------------------------------|
| Parameter | | | | |
| 8-bit serial I/O | 8 bits LSB first/MSB first selectability One clock selectable from four transfer clocks (one external shift clock, three internal shift clocks: 4, 8, 16 system clock cycles) | | | |
| 10-bit A/D converter | 10-bit resolution × 12 channels A/D conversion mode (conversion time of 16.5 μs/8 MHz, and highest gear speed) Sense mode (conversion time of 9.0 μs/8 MHz, and highest gear speed) External activation capable | | | |
| External interrupt | 2 independent channels (edge selection, interrupt vector, source flag) Rising edge/falling edge/both edges selectability Built-in analog noise canceller Used also for wake-up from stop/sleep mode. (Edge detection is also permitted in stop mode.) | | | |
| Standby mode | Sleep mode, stop mode, watch mode, and subclock mode | | | |
| Process | CMOS | | | |
| Operating voltage* | 2.7 V to 6.0 V | | | |
| EPROM for use | | | | MBM27C256A-20TV MBM27C256A-20CZ |

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

■ PACKAGE AND CORRESPONDING PRODUCTS

| Package | MB89145 MB89146 MB89P147 | MB89PV140 |
|-------------|--------------------------------|-----------|
| DIP-64P-M01 | ○ | × |
| DIP-64C-A06 | × | × |
| FPT-64P-M06 | ○ | × |
| MDP-64C-P02 | × | ○ |
| MQP-64C-P01 | × | ○ |

○ : Available × : Not available

Note: For more information about each package, see section “**■ 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 MB89P147, the program area starts from address 8007_H but on the MB89PV140 starts from 8000_H.
(On the MB89P147, addresses 8000_H to 8006_H comprise the option setting area, option settings can be read by reading these addresses. On the MB89PV140, addresses 8000_H to 8006_H could also be used as a program ROM. However, do not use these addresses in order to maintain compatibility of the MB89P147.)
- The stack area, etc., is set at the upper limit of the RAM.

2. Current Consumption

- In the case of the MB89PV140, 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 sleep/stop modes is the same. (For more information, see section “■ 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 section “■ Mask Options.”

Take particular care on the following points:

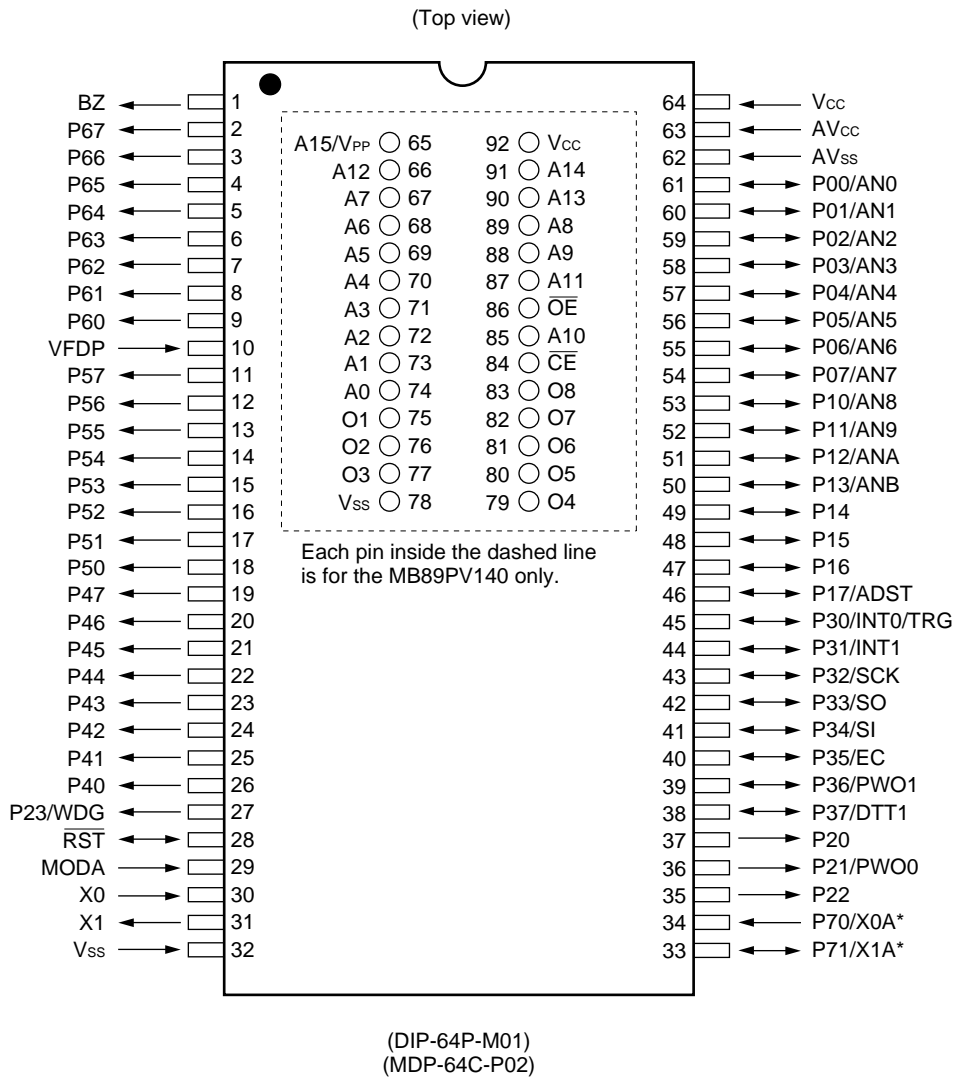
- Options are fixed on the MB89PV140.
- On the MB89P147, MB89145, and MB89146, the pull-down resistor option can either be selected for all affected pins, or for no pin; it is not possible to specify the pull-down resistor option for individual pins.

4. Subclock Oscillation Feedback Resistor

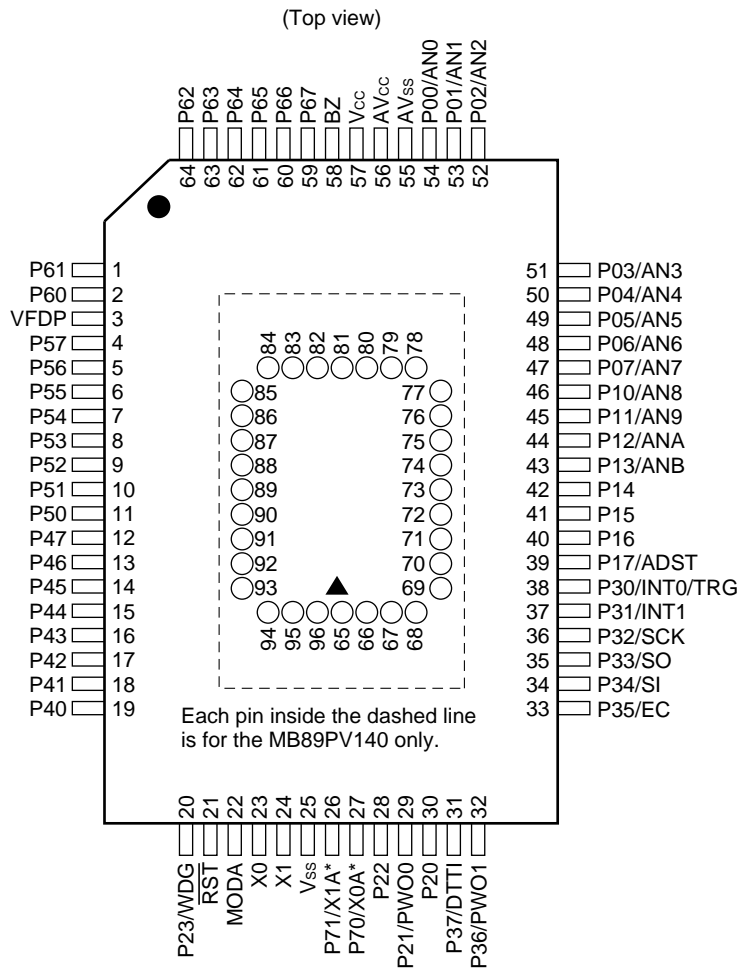
A built-in oscillation feedback resistor is provided for the subclock oscillator pin on the MB89PV140, but it is not provided for the MB89145, MB89146, MB89P147. Therefore these products should be connected to an external oscillation feedback resistor.

MB89140 Series

■ PIN ASSIGNMENT



*: When dual-clock system is selected.



(FPT-64P-M06)
(MQP-64C-P01)

*: When dual-clock system is selected.

• Pin assignment on package top (MB89PV140 only)

| Pin no. | Pin name | Pin no. | Pin name | Pin no. | Pin name | Pin no. | Pin name |
|---------|---------------|---------|----------|---------|-----------------|---------|-----------------|
| 65 | N.C. | 73 | A2 | 81 | N.C. | 89 | \overline{OE} |
| 66 | A15/ V_{PP} | 74 | A1 | 82 | O4 | 90 | N.C. |
| 67 | A12 | 75 | A0 | 83 | O5 | 91 | A11 |
| 68 | A7 | 76 | N.C. | 84 | O6 | 92 | A9 |
| 69 | A6 | 77 | O1 | 85 | O7 | 93 | A8 |
| 70 | A5 | 78 | O2 | 86 | O8 | 94 | A13 |
| 71 | A4 | 79 | O3 | 87 | \overline{CE} | 95 | A14 |
| 72 | A3 | 80 | V_{SS} | 88 | A10 | 96 | V_{CC} |

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

MB89140 Series

■ PIN DESCRIPTION

| Pin no. | | Pin name | Circuit type | Function |
|--|---|---------------------|--------------|--|
| SDIP ^{*1} MDIP ^{*2} | QFP ^{*3} MQFP ^{*4} | | | |
| 30 | 23 | X0 | A | Main clock crystal oscillator pins |
| 31 | 24 | X1 | | |
| 29 | 22 | MODA | C | Operating mode selection pin Connect directly to V _{SS} in normal operation. This pin functions as the V _{PP} pin in EPROM products. |
| 28 | 21 | RST | D | Reset I/O pin 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 when the option is set. The internal circuit is initialized by the input of “L”. This pin is with a noise canceller. |
| 54 to 61 | 47 to 54 | P07/AN7 to P00/AN0 | G | General-purpose I/O ports The input is a hysteresis input type and with a built-in noise canceller. Although these ports also serve as an analog input, analog input does not pass through the hysteresis input noise canceller. |
| 46 | 39 | P17/ADST | J | General-purpose I/O port The input is a hysteresis input type and with a built-in noise canceller. Also serves as an A/D converter external activation. |
| 47 to 49 | 40 to 42 | P16 to P14 | J | General-purpose I/O ports The input is a hysteresis input type and with a built-in noise canceller. |
| 50 to 53 | 43 to 46 | P13/ANB to P10/AN8 | G | General-purpose I/O ports The input is a hysteresis input type and with a built-in noise canceller. Although these ports also serves as an analog input, analog input does not pass through the hysteresis input noise canceller. |
| 34, 33 | 27, 26 | P70/X0A, P71/X1A | B/K | General-purpose I/O ports with a built-in noise canceller (single-clock operation) Function as subclock crystal oscillator pins. (dual-clock operation) |
| 35 | 28 | P22 | E | General-purpose output port |
| 27 | 20 | P23/WDG | E | General-purpose output port Also serves as a watchdog output. |
| 36 | 29 | P21/PW00 | E | General-purpose output port Also serves as the PWM output for the 8-bit PWM timer. |
| 37 | 30 | P20 | E | General-purpose output port |

*1: DIP-64P-M01

*2: MDP-64C-P02

*3: FPT-64P-M06

*4: MQP-64C-P01

(Continued)

MB89140 Series

| Pin no. | | Pin name | Circuit type | Function |
|-----------------------|----------------------|---------------------------|--------------|---|
| SDIP*1 MDIP*2 | QFP*3 MQFP*4 | | | |
| 38 | 31 | P37/DTTI | J | General-purpose I/O port The input is a hysteresis input type and with a built-in noise canceller. When overcurrent is detected, the 12-bit MPG output can be inactivated by the external edge input. |
| 39 | 32 | P36/PWO1 | J | General-purpose I/O port The input is a hysteresis input type and with a built-in noise canceller. Also serves as a 12-bit MPG output. |
| 40 | 33 | P35/EC | J | General-purpose I/O port The input is a hysteresis input type and with a built-in noise canceller. Also serves as the external clock input for the 8/16-bit timer/counter. |
| 41 | 34 | P34/SI | J | General-purpose I/O port The input is a hysteresis input type and with a built-in noise canceller. Also serves as the serial data input for the 8-bit serial interface. |
| 42 | 35 | P33/SO | J | General-purpose I/O port The input is a hysteresis input type and with a built-in noise canceller. Also serves as the serial data output for the 8-bit serial interface. |
| 43 | 36 | P32/SCK | J | General-purpose I/O port The input is a hysteresis input type and with a built-in noise canceller. Also serves as the serial transfer clock for the 8-bit serial interface. |
| 44 | 37 | P31/INT1 | F | General-purpose I/O port The output is an N-ch open-drain type. The input is a hysteresis input type and with a built-in noise canceller. Also serves as an external interrupt. The interrupt input is also a hysteresis input type and with a built-in noise canceller. |
| 45 | 38 | P30/INT0/TRG | J | General-purpose I/O port The input is a hysteresis input type and with a built-in noise canceller. Also serve as an external interrupt or as an MPG trigger input. The interrupt input is also a hysteresis input type and with a built-in noise canceller. |
| 1 | 58 | BZ | I | Buzzer output-only pin P-ch high-voltage open-drain output port |
| 19 to 26, 11 to 18 | 12 to 19, 4 to 11 | P47 to P40, P57 to P50 | H | Low-current P-ch high-voltage open-drain output ports Products with and without a built-in pull-down resistor between these pins and the VFDP pin are provided. |

*1: DIP-64P-M01

*2: MDP-64C-P02

*3: FPT-64P-M06

*4: MQP-64C-P01

(Continued)

MB89140 Series

(Continued)

| Pin no. | | Pin name | Circuit type | Function |
|--|---|------------------|--------------|--|
| SDIP ^{*1} MDIP ^{*2} | QFP ^{*3} MQFP ^{*4} | | | |
| 2 to 9 | 59 to 64 1, 2 | P67 to P60 | H | Heavy-current P-ch high-voltage open-drain output port Products with and without a built-in pull-down resistor between these pins and the VFDP pin are provided. |
| 10 | 3 | VFDP | — | Voltage supply pin for connection to a pull-down resistor for ports 4, 5, and 6. In products without a built-in pull-down resistor and in the MB89PV140, this pin should be left open. |
| 64 | 57 | V _{cc} | — | Power supply pin |
| 32 | 25 | V _{ss} | — | Power supply (GND) pin |
| 63 | 56 | AV _{cc} | — | A/D converter power supply pin Use this pin at the same voltage as V _{cc} . |
| 62 | 55 | AV _{ss} | — | A/D converter power supply (GND) pin Use this pin at the same voltage as V _{ss} . |

*1: DIP-64P-M01

*2: MDP-64C-P02

*3: FPT-64P-M06

*4: MQP-64C-P01

MB89140 Series

- External EPROM pins (MB89PV140 only)

| Pin no. | | Pin name | I/O | Function |
|--|---|---------------------|-----|--|
| SDIP ^{*3} MDIP ^{*4} | QFP ^{*1} MQFP ^{*2} | | | |
| 65 | 66 | A15/V _{PP} | O | "H" level output pin |
| 66 | 67 | A12 | O | Address output pins |
| 67 | 68 | A7 | | |
| 68 | 69 | A6 | | |
| 69 | 70 | A5 | | |
| 70 | 71 | A4 | | |
| 71 | 72 | A3 | | |
| 72 | 73 | A2 | | |
| 73 | 74 | A1 | | |
| 74 | 75 | A0 | | |
| 75 | 77 | O1 | I | Data input pins |
| 76 | 78 | O2 | | |
| 77 | 79 | O3 | | |
| 78 | 80 | V _{SS} | O | Power supply (GND) pin |
| 79 | 82 | O4 | I | Data input pins |
| 80 | 83 | O5 | | |
| 81 | 84 | O6 | | |
| 82 | 85 | O7 | | |
| 83 | 86 | O8 | | |
| 84 | 87 | \overline{CE} | O | ROM chip enable pin Outputs "H" during standby. |
| 85 | 88 | A10 | O | Address output pin |
| 86 | 89 | \overline{OE} | O | ROM output enable pin Outputs "L" at all times. |
| 87 | 91 | A11 | O | Address output pins |
| 88 | 92 | A9 | | |
| 89 | 93 | A8 | | |
| 90 | 94 | A13 | | |
| 91 | 95 | A14 | | |
| 92 | 96 | V _{CC} | O | EPROM power supply pin |
| — | 65 | N.C. | — | Internally connected pins Be sure to leave them open. |
| | 76 | | | |
| | 81 | | | |
| | 90 | | | |

*1: DIP-64P-M01

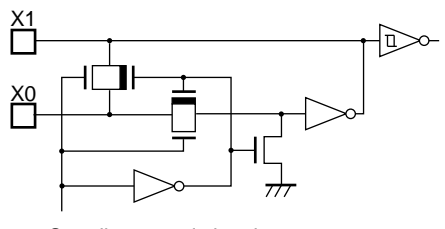
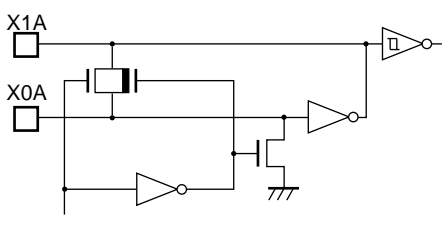

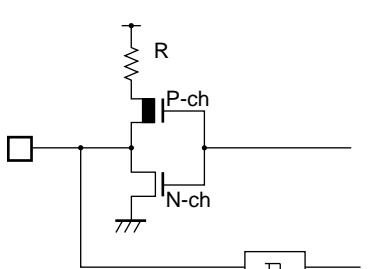
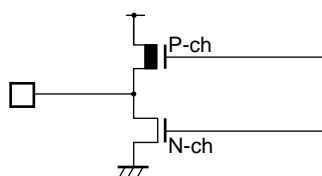
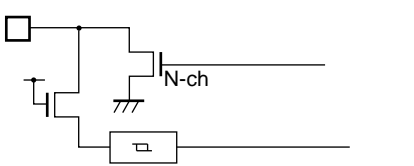
*2: MDP-64C-P02

*3: FPT-64P-M06

*4: MQP-64C-P01

MB89140 Series

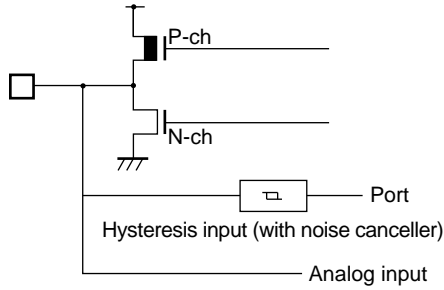
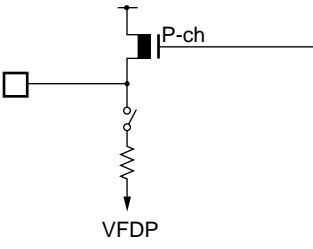
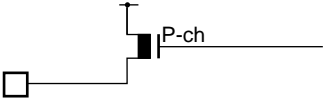
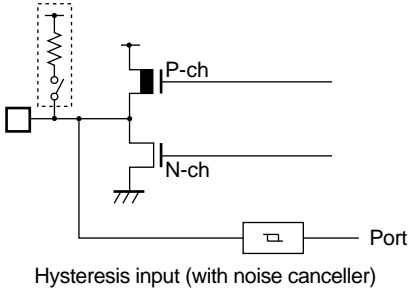
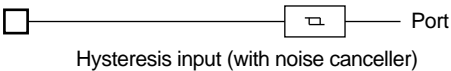
I/O CIRCUIT TYPE

| Type | Circuit | Remarks |
|------|--|---|
| A |  <p>Standby control signal</p> | <ul style="list-style-type: none"> Crystal or ceramic oscillation type (main clock) At an oscillation feedback resistor of approximately 1 MΩ/5.0 V |
| B |  <p>Standby control signal</p> | <ul style="list-style-type: none"> Crystal or ceramic oscillation type (subclock) At an oscillation feedback resistor of approximately 4.5 MΩ/5.0 V (The built-in feedback resistor is not provided except on the MB89PV140-102.) |
| C |  | |
| D |  <p>Hysteresis input (with noise canceller)</p> | <ul style="list-style-type: none"> At an output pull-up resistor (P-ch) of approximately 50 kΩ/5.0 V CMOS hysteresis input (with noise canceller) |
| E |  | <ul style="list-style-type: none"> CMOS output |
| F |  <p>Hysteresis input (with noise canceller)</p> | <ul style="list-style-type: none"> N-ch open-drain output CMOS hysteresis input (with noise canceller) |

(Continued)

MB89140 Series

(Continued)

| Type | Circuit | Remarks |
|------|--|---|
| G |  <p>P-ch</p> <p>N-ch</p> <p>Port</p> <p>Hysteresis input (with noise canceller)</p> <p>Analog input</p> | <ul style="list-style-type: none"> • CMOS output • CMOS hysteresis input (with noise canceller, except analog input) |
| H |  <p>P-ch</p> <p>VFD</p> | <ul style="list-style-type: none"> • P-ch high-voltage open-drain output • Products with and without a built-in pull-down resistor are provided (except the MB89PV140). |
| I |  <p>P-ch</p> | <ul style="list-style-type: none"> • P-ch high-voltage open-drain output |
| J |  <p>P-ch</p> <p>N-ch</p> <p>Port</p> <p>Hysteresis input (with noise canceller)</p> | <ul style="list-style-type: none"> • CMOS output • CMOS hysteresis input (with noise canceller) • Pull-up resistor optional |
| K |  <p>Port</p> <p>Hysteresis input (with noise canceller)</p> | <ul style="list-style-type: none"> • CMOS hysteresis input (with noise canceller) |

MB89140 Series

■ 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 section “■ Electrical Characteristics” is applied between V_{CC} and V_{SS} . (However, up to 7.0 V can be applied to P31/INT pin, regardless of V_{CC})

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.

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 N.C. Pins

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

4. 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 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.

5. 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.

■ PROGRAMMING TO THE EPROM ON THE MB89P147

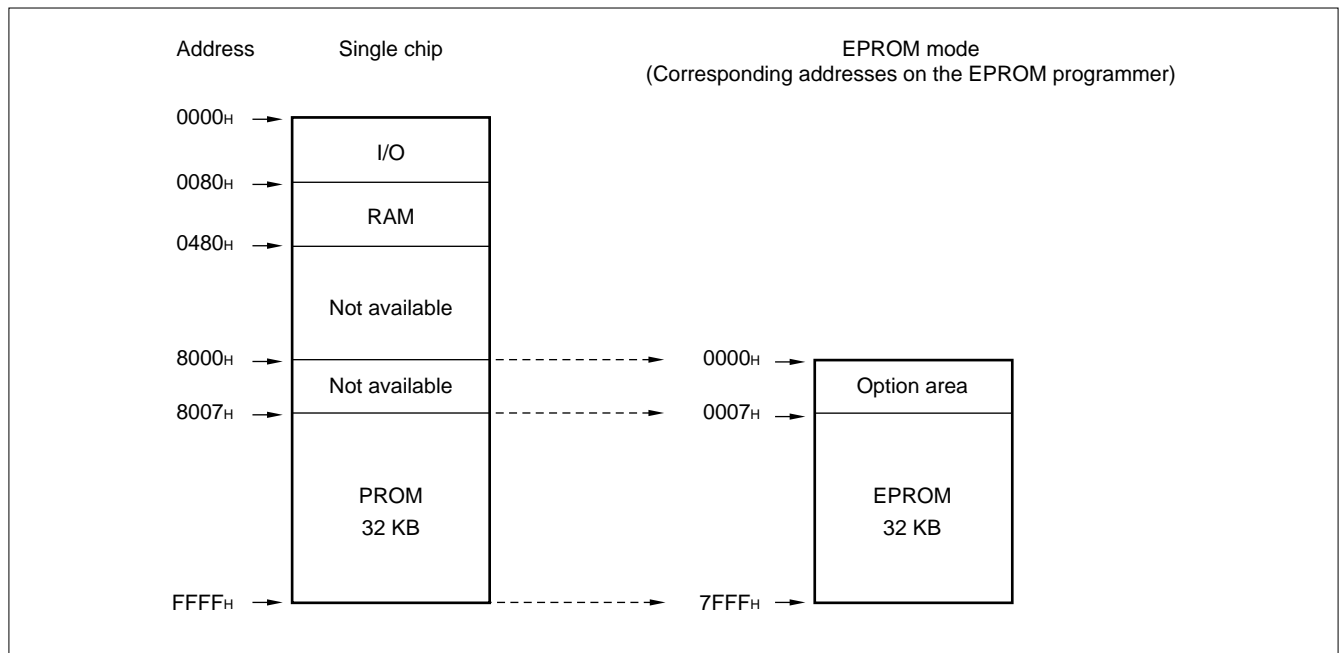
The MB89P147 is an OTPROM version of the MB89140 series.

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 MB89P147 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 ROM area for a single chip is 32 Kbytes (8007_H to FFFF_H) the PROM can be programmed as follows:

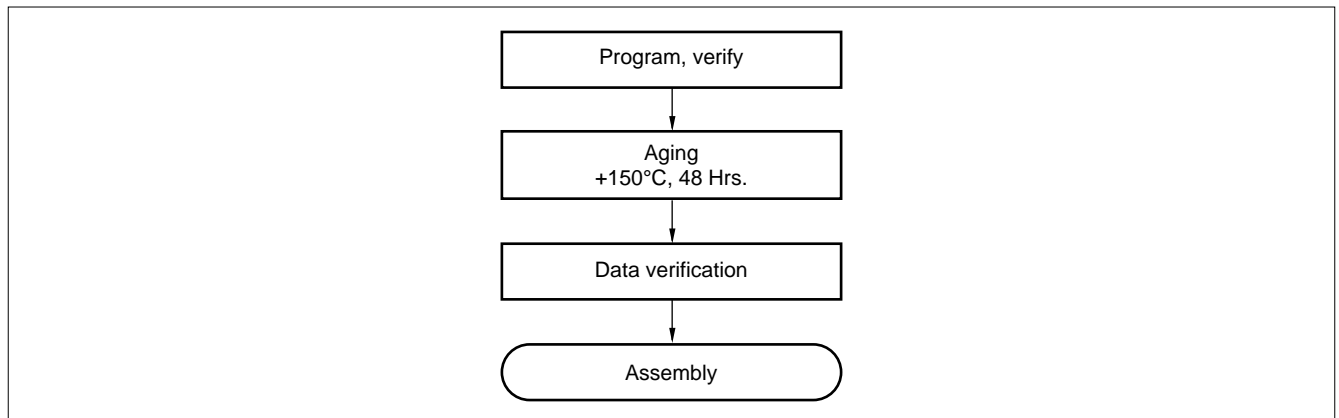
• Programming procedure

- (1) Set the EPROM programmer to the MBM27C256A.
- (2) Load program data into the EPROM programmer at 0007_H to 7FFF_H (note that addresses 8007_H to FFFF_H while operating as a single chip assign to 0007_H to 7FFF_H in EPROM mode).
Load option data into addresses 0000_H to 0006_H of the EPROM programmer. (For information about each corresponding option, see “5. Setting OTPROM Options.” in section “■ Programming to the EPROM with Piggyback/evaluation Device”)
- (3) Program to 0000_H to 7FFF_H with the EPROM programmer.

MB89140 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 Socket Adapter

| Package | Compatible socket adapter |
|-------------|---------------------------|
| DIP-64P-M01 | ROM-64SD-28DP-8L4 |
| FPT-64P-M06 | ROM-64QF-28DP-8L4 |

Inquiry: Sun Hayato Co., Ltd.: TEL 81-3-3802-5760

MB89140 Series

■ PROGRAMMING TO THE EPROM WITH PIGGYBACK/EVALUATION DEVICE

1. EPROM for Use

MBM27C256A-20TV, MBM27C256A-20CZ

2. Programming Socket Adapter

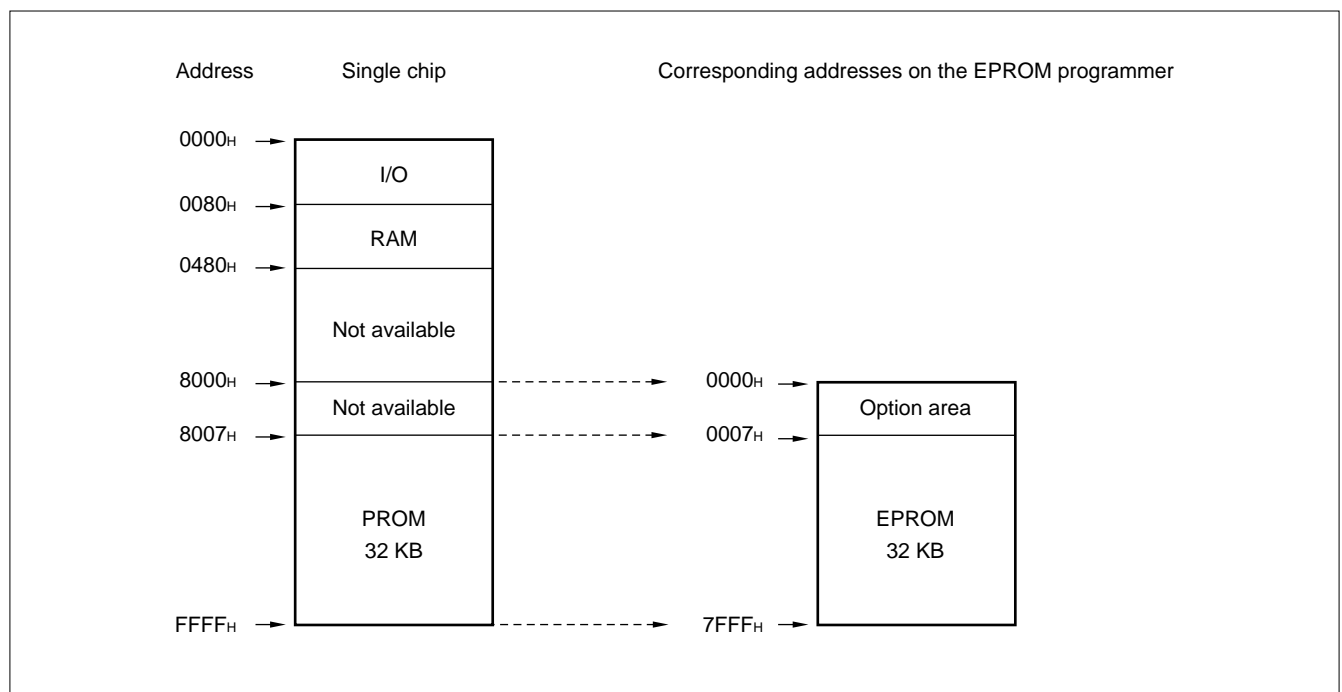
To program to the PROM using an EPROM programmer, use the socket adapter (manufacturer: Sun Hayato Co., Ltd.) listed below.

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

Inquiry: Sun Hayato Co., Ltd.: TEL 81-3-3802-5760

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 0007H to 7FFFH.
- (3) Program to 0000H to 7FFFH with the EPROM programmer.

MB89140 Series

5. Setting OTPROM Options

The programming procedure is the same as that for the PROM. Options can be set by programming values at the addresses shown on the memory map. The relationship between bits and options is shown on the following bit map:

- **OTPROM option bit map**

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|----------------------------------|----------------------------------|----------------------------------|--|-------------------------------------|-----------------------------------|-------------------------------------|-------------------------------------|
| 8000 _H (0000 _H) | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Single/dual-clock system 1: Dual clock 0: Single clock | Reset pin output 1: Yes 0: No | Power-on reset 1: Yes 0: No | Reserved (Write 1 bit to this bit.) | Reserved (Write 1 bit to this bit.) |
| 8001 _H (0001 _H) | P17 Pull-up 1: No 0: Yes | P16 Pull-up 1: No 0: Yes | P15 Pull-up 1: No 0: Yes | P14 Pull-up 1: No 0: Yes | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable |
| 8002 _H (0002 _H) | P37 Pull-up 1: No 0: Yes | P36 Pull-up 1: No 0: Yes | P35 Pull-up 1: No 0: Yes | P34 Pull-up 1: No 0: Yes | P33 Pull-up 1: No 0: Yes | P32 Pull-up 1: No 0: Yes | Vacancy Readable and writable | Vacancy Readable and writable |
| 8003 _H (0003 _H) | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable |
| 8004 _H (0004 _H) | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable |
| 8005 _H (0005 _H) | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable |
| 8006 _H (0006 _H) | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable | Vacancy Readable and writable |

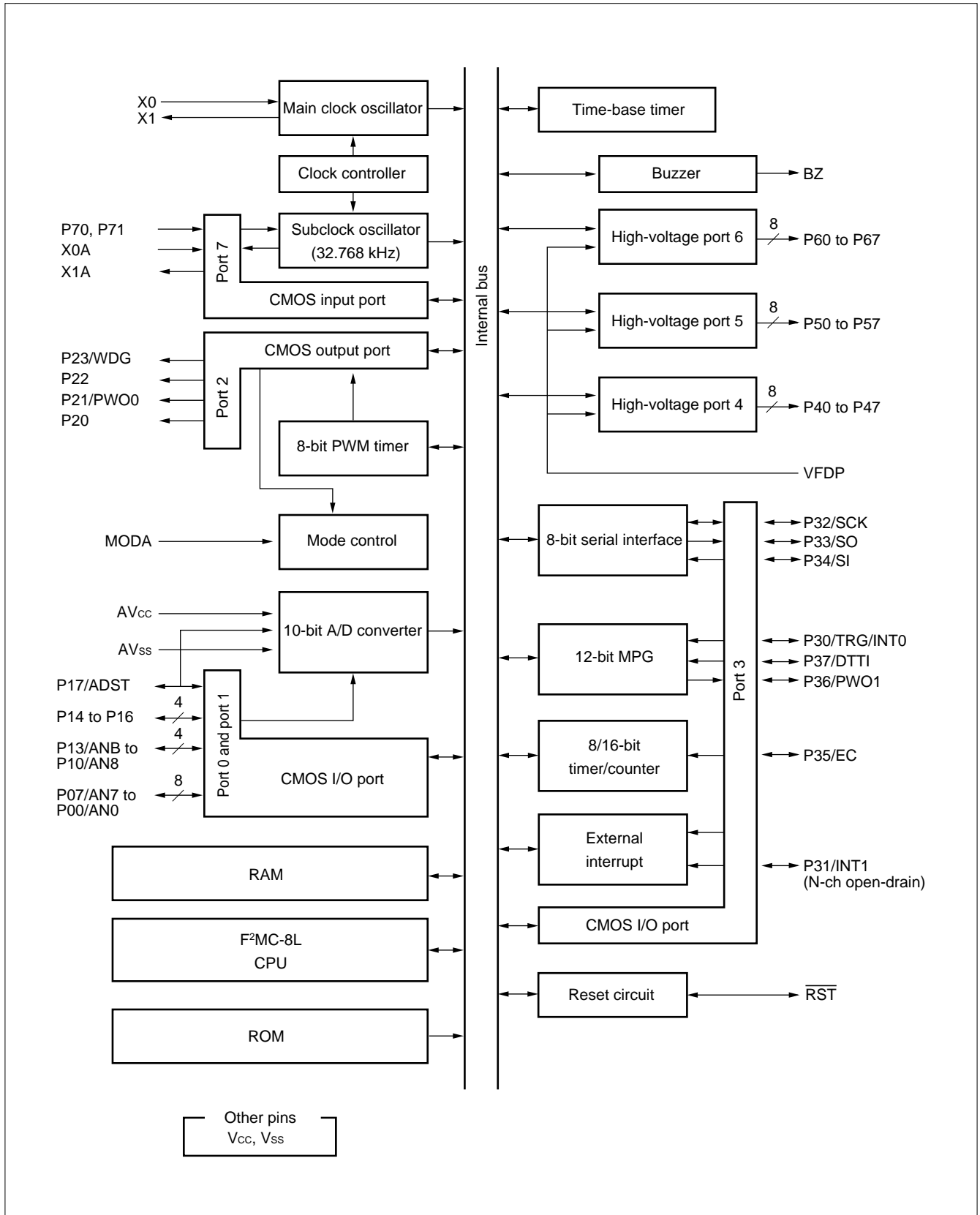
Notes: • Set each bit to 1 to erase.

- Do not write 0 to the vacant bit.

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

- The parenthesized addresses are the corresponding addresses on the EPROM programmer.

■ **BLOCK DIAGRAM**

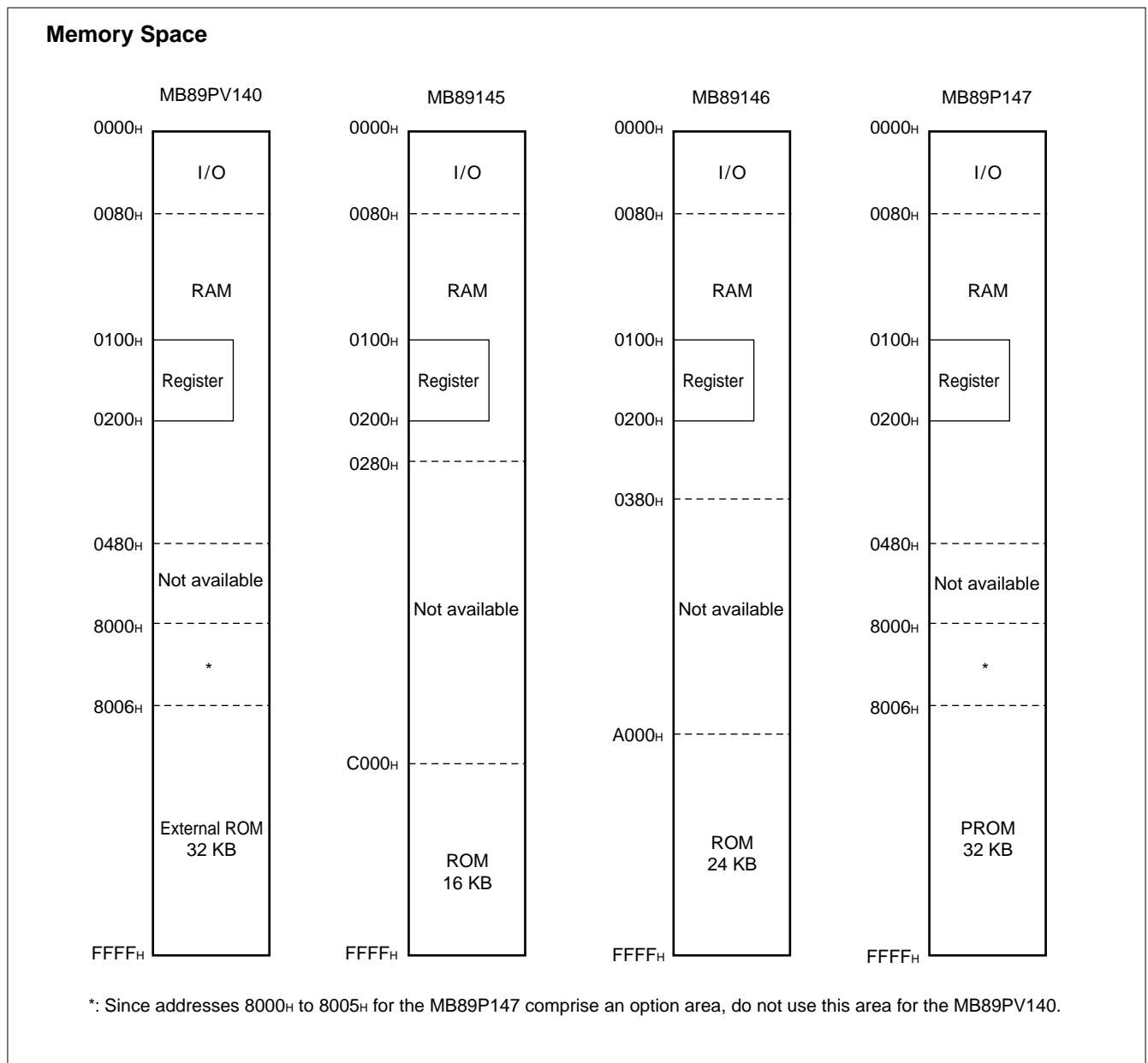


MB89140 Series

■ CPU CORE

1. Memory Space

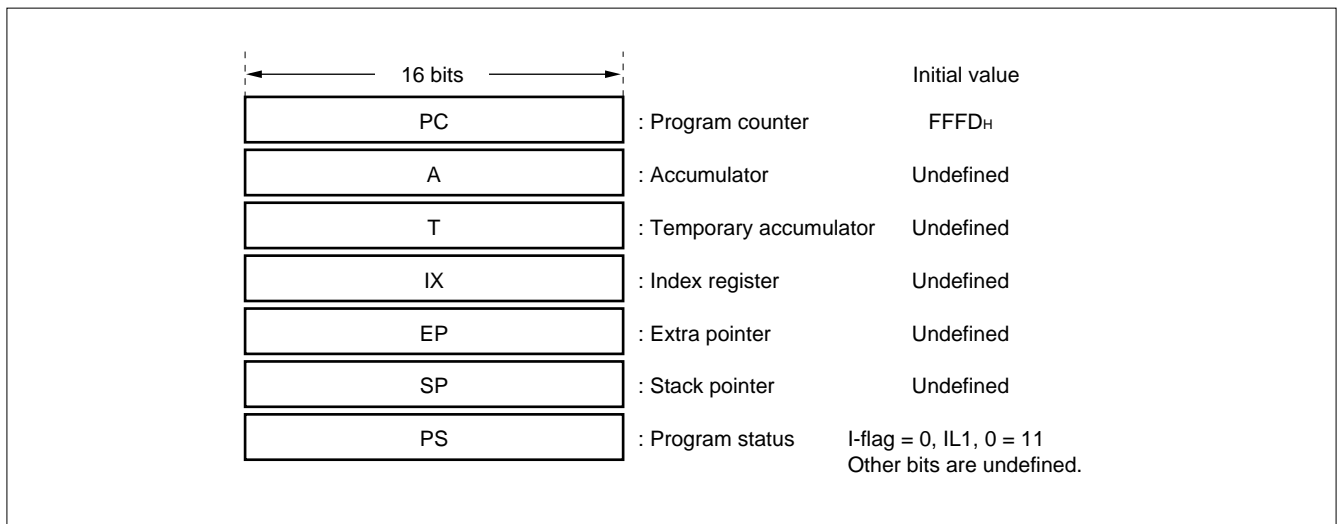
The microcontrollers of the MB89140 series offer a memory space of 64 Kbytes for storing all of I/O, data, and program areas. The I/O area is located at the lowest address. The data area is provided immediately above the I/O area. The data area can be divided into register, stack, and direct areas according 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 MB89140 series is structured as illustrated below.



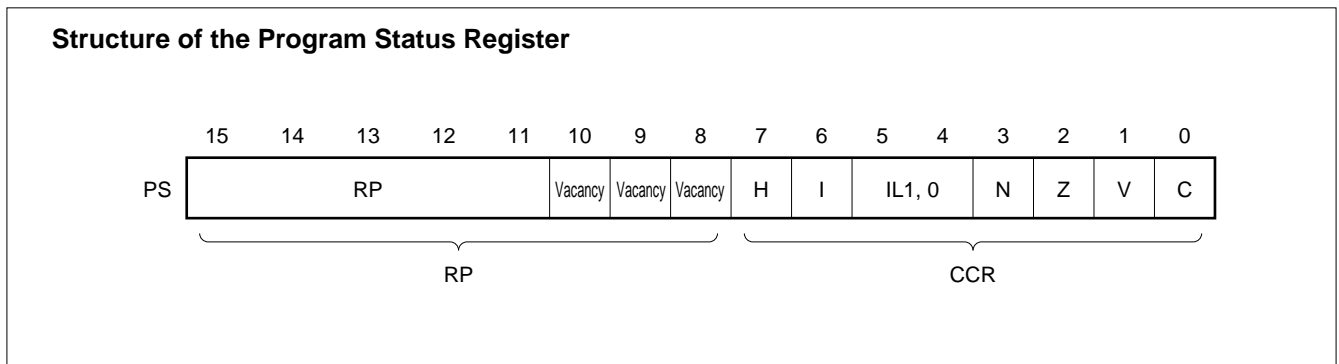
2. Registers

The F²MC-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 8-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 |



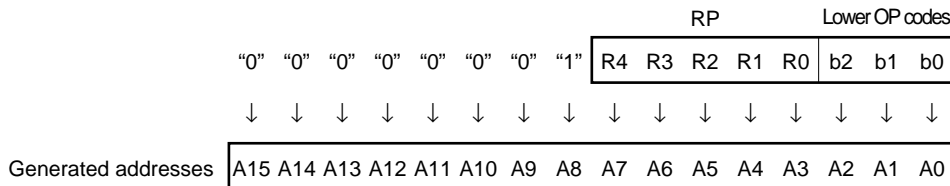
The PS can further be divided into higher 8 bits for use as a register bank pointer (RP) and the lower 8 bits for use as a condition code register (CCR). (See the diagram below.)



MB89140 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 | ILO | Interrupt level | High-low |
|-----|-----|-----------------|--------------------------------------|
| 0 | 0 | 1 | High ↑ ↓ Low = no interrupt |
| 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 to the shift-out value in the case of a shift instruction.

MB89140 Series

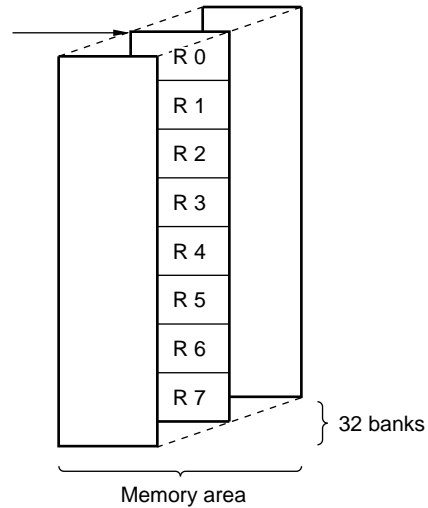
The following general-purpose registers are provided:

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 and up to a total of 32 banks can be used in the MB89140 series. The bank currently in use is indicated by the register bank pointer (RP).

Register Bank Configuration

This address = $0100_{\text{H}} + 8 \times (\text{RP})$



MB89140 Series

■ I/O MAP

| Address | Read/write | Register name | Register description |
|-----------------|------------|---------------|-------------------------------------|
| 00 _H | (R/W) | PDR0 | Port 0 data register |
| 01 _H | (W) | DDR0 | Port 0 data direction register |
| 02 _H | (R/W) | PDR1 | Port 1 data register |
| 03 _H | (W) | DDR1 | Port 1 data direction register |
| 04 _H | (R/W) | PDR2 | Port 2 data register |
| 05 _H | | | Vacancy |
| 06 _H | | | Vacancy |
| 07 _H | (R/W) | SYCC | System clock control register |
| 08 _H | (R/W) | STBC | Standby control register |
| 09 _H | (R/W) | WDTC | Watchdog timer control register |
| 0A _H | (R/W) | TBCR | Time-base timer control register |
| 0B _H | (R/W) | WPCR | Watch prescaler control register |
| 0C _H | (R/W) | PDR3 | Port 3 data register |
| 0D _H | (W) | DDR3 | Port 3 data direction register |
| 0E _H | (R/W) | BUZR | Buzzer register |
| 0F _H | (R/W) | EIC | External interrupt control register |
| 10 _H | (R/W) | PDR4 | Port 4 data register |
| 11 _H | (R/W) | PDR5 | Port 5 data register |
| 12 _H | (R/W) | PDR6 | Port 6 data register |
| 13 _H | (R) | PDR7 | Port 7 data register |
| 14 _H | | | Vacancy |
| 15 _H | | | Vacancy |
| 16 _H | (W) | COMR | 8-bit PWM timer compare register |
| 17 _H | (R/W) | CNTR | 8-bit PWM timer control register |
| 18 _H | (R/W) | T3CR | Timer 3 control register |
| 19 _H | (R/W) | T2CR | Timer 2 control register |
| 1A _H | (R/W) | T3DR | Timer 3 data register |
| 1B _H | (R/W) | T2DR | Timer 2 data register |
| 1C _H | (R/W) | SMR | Serial mode register |
| 1D _H | (R/W) | SDR | Serial data register |
| 1E _H | (R/W) | ADC1 | A/D converter control register 1 |
| 1F _H | (R/W) | ADC2 | A/D converter control register 2 |

(Continued)

MB89140 Series

(Continued)

| Address | Read/write | Register name | Register description |
|------------------------------------|------------|---------------|-------------------------------------|
| 20 _H | (R/W) | ADDH | A/D converter data register (H) |
| 21 _H | (R/W) | ADDL | A/D converter data register (L) |
| 22 _H | (W) | PCR0 | Port input control register 0 |
| 23 _H | (W) | PCR1 | Port input control register 1 |
| 24 _H | (R/W) | MCNT | MPG control register |
| 25 _H | (R/W) | INTSTR | MPG interrupt status register |
| 26 _H | (W) | CMCLBR (H) | MPG compare clear buffer register H |
| 27 _H | (W) | CMCLBR (L) | MPG compare clear buffer register L |
| 28 _H | (W) | OUTCBR (H) | MPG output buffer register H |
| 29 _H | (W) | OUTCBR (L) | MPG output buffer register L |
| 2A _H | | | Vacancy |
| 2B _H | | | Vacancy |
| 2C _H | | | Vacancy |
| 2D _H | | | Vacancy |
| 2E _H | | | Vacancy |
| 2F _H | | | Vacancy |
| 30 _H to 77 _H | | | Vacancy |
| 78 _H | | | Vacancy |
| 79 _H | | | Vacancy |
| 7A _H | | | Vacancy |
| 7B _H | | | Vacancy |
| 7C _H | (W) | ILR1 | Interrupt level setting register 1 |
| 7D _H | (W) | ILR2 | Interrupt level setting register 2 |
| 7E _H | (W) | ILR3 | Interrupt level setting register 3 |
| 7F _H | | | Vacancy |

Note: Do not use vacancies.

MB89140 Series

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

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

| Parameter | Symbol | Value | | Unit | Remarks |
|--|-------------------|----------------|----------------|------|---|
| | | Min. | Max. | | |
| Power supply voltage | V_{CC} | $V_{SS} - 0.3$ | $V_{SS} + 7.0$ | V | |
| | AV_{CC} | $V_{SS} - 0.3$ | $V_{SS} + 7.0$ | V | *2 |
| I/O voltage | V_{IO1} | $V_{SS} - 0.3$ | $V_{CC} + 0.3$ | V | Except P31 |
| | V_{IO2} | $V_{SS} - 0.3$ | 7 | V | P31 |
| "H" level total average output current | ΣI_{OH} | — | -120 | mA | Average value (operating current × operating rate) |
| "H" level maximum output current | I_{OH} | — | -12 | mA | P00 to P07, P10 to P17, P20 to P23, P30, P32 to P37 |
| | | — | -20 | mA | P40 to P47, P50 to P57 |
| | | — | -36 | mA | P60 to P67, BZ |
| "H" level average output current | I_{OHAV} | — | -6 | mA | P00 to P07, P10 to P17, P20 to P23, P30, P32 to P37 Average value (operating current × operating rate) ^{*1} |
| | | — | -10 | mA | P40 to P47, P50 to P57 Average value (operating current × operating rate) ^{*1} |
| | | — | -18 | mA | P60 to P67, BZ Average value (operating current × operating rate) ^{*1} |
| "L" level total average output current | ΣI_{OLAV} | — | 150 | mA | Average value (operating current × operating rate) ^{*1} |
| "L" level maximum output current | I_{OL} | — | 12 | mA | P00 to P07, P10 to P17, P20 to P23, P30 to P37 |
| "L" level average output current | I_{OLAV} | — | 6 | mA | P00 to P07, P10 to P17, P20 to P23, P30 to P37 Average value (operating current × operating rate) ^{*1} |
| Power consumption | P_D | — | 500 | mW | |
| Operating temperature | T_A | -40 | +85 | °C | |
| Storage temperature | T_{stg} | -55 | +150 | °C | |

*1: The total average output current is defined as the average current that flows through all of the relevant pins in a 100 ms period. The output peak current is defined as the peak value of any one of the relevant pins. The average output current is defined as the average current that flows through any one of the relevant pins in a 100 ms period.

*2: Use AV_{CC} and V_{CC} set at the same voltage.

Take care so that AV_{CC} does not exceed V_{CC} , such as when power is turned on.

Precautions: Permanent device damage may occur if the above "Absolute Maximum Ratings" are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

2. Recommended Operating Conditions

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

| Parameter | Symbol | Value | | Unit | Remarks |
|-----------------------|-----------------------|---------------|----------------|------|--|
| | | Min. | Max. | | |
| Power supply voltage | V_{CC} AV_{CC} | 2.7* | 6.0* | V | Normal operation assurance range* |
| | | 2.2 | 6.0 | V | In watch mode or subclock operation (Only for the MB89P147, the minimum value is 2.7 V.) |
| | | 1.5 | 6.0 | V | Retains the RAM state in stop mode |
| | VFDP | $V_{CC} - 40$ | $V_{CC} + 0.3$ | V | |
| Operating temperature | T_A | -40 | +85 | °C | |

* : These values vary with the operating frequency and analog assurance range. See Figure 1 and "5. A/D Converter Electrical Characteristics."

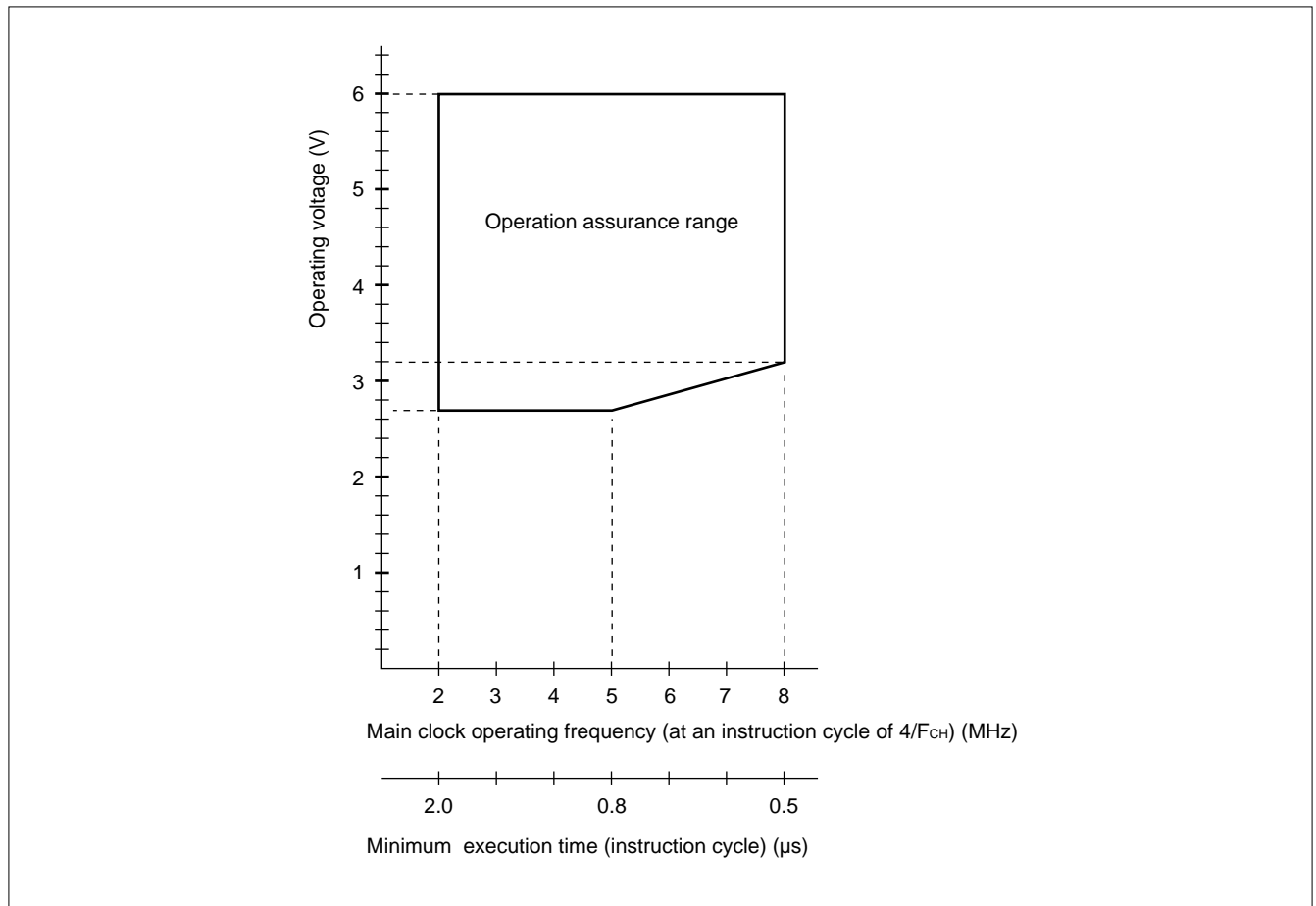


Figure 1 Operating Voltage vs. Main Clock Operating Frequency

Figure 1 indicates 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.

MB89140 Series

3. DC Characteristics

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

| Parameter | Symbol | Pin | Condition | Value | | | Unit | Remarks |
|--------------------------|------------|---|-------------------------------------|----------------|------|----------------|---------------|--|
| | | | | Min. | Typ. | Max. | | |
| "H" level input voltage | V_{IHS} | P00 to P07, P10 to P17, P30 to P37, P70, P71, X0, X1, \overline{RST} , MODA | — | $0.7 V_{CC}$ | — | $V_{CC} + 0.3$ | V | Hysteresis input |
| "L" level input voltage | V_{ILS} | P00 to P07, P10 to P17, P30 to P37, P70, P71, X0, X1, \overline{RST} , MODA | — | $V_{SS} - 0.3$ | — | $0.2 V_{CC}$ | V | Hysteresis input |
| "H" level output voltage | V_{OH1} | P00 to P07, P10 to P17, P20 to P23, P30, P32 to P37 | $I_{OH} = -2.0\text{ mA}$ | 2.4 | — | — | V | |
| | V_{OH2} | P40 to P47, P50 to P57 | $I_{OH} = -10\text{ mA}$ | 3.0 | — | — | V | |
| | V_{OH3} | P60 to P67, BZ | $I_{OH} = -18\text{ mA}$ | 3.0 | — | — | V | |
| "L" level output voltage | V_{OL1} | P00 to P07, P10 to P17, P20 to P23, P30, P32 to P37 | $I_{OL} = 1.8\text{ mA}$ | — | — | 0.4 | V | |
| | V_{OL2} | \overline{RST} | $I_{OL} = 4.0\text{ mA}$ | — | — | 0.6 | V | |
| Input leakage current | I_{LI1} | P00 to P07, P10 to P17, P30 to P37, P70, P71, MODA | $0.45\text{ V} < V_I < V_{CC}$ | — | — | ± 5 | μA | Without pull-up resistor for P14 to P17 and P32 to P37 |
| | I_{LI2} | P14 to P17, P32 to P37 | $V_I = 0.0\text{ V}$ | -200 | -100 | -50 | μA | With pull-up resistor |
| Output leakage current | I_{LO1} | P40 to P47, P50 to P57 | $V_I = VFDP = V_{CC} - 40\text{ V}$ | — | — | -10 | μA | |
| | I_{LO2} | P60 to P67, BZ | $V_I = VFDP = V_{CC} - 40\text{ V}$ | — | — | -20 | μA | |
| Pull-up resistance | R_{PULU} | \overline{RST} P14 to P17, P32 to P37 | $V_I = 0.0\text{ V}$ | 25 | 50 | 100 | k Ω | With pull-up resistor |
| Pull-down resistance | R_{PULD} | P40 to P47, P50 to P57, P60 to P67 | $V_{OH} = 5.0\text{ V}$ | 50 | 100 | 150 | k Ω | With pull-down resistor optional |

(Continued)

MB89140 Series

(Continued)

(AV_{CC} = V_{CC} = 5.0 V, AV_{SS} = V_{SS} = 0.0 V, T_A = -40°C to +85°C)

| Parameter | Symbol | Pin | Condition | Value | | | Unit | Remarks | |
|------------------------|-------------------|--|--|---|------|------|------|----------|----------|
| | | | | Min. | Typ. | Max. | | | |
| Power supply current*1 | I _{CC1} | V _{CC} | F _{CH} = 8 MHz V _{CC} = 5.0 V t _{inst} *2 = 0.5 μs Output open | — | 9 | 15 | mA | | |
| | I _{CC2} | | F _{CH} = 8 MHz V _{CC} = 3.2 V | — | 1.5 | 2 | mA | | |
| | | | t _{inst} *2 = 8.0 μs Output open | — | 2.5 | 5.0 | mA | MB89P147 | |
| | I _{CCS1} | | Sleep mode | F _{CH} = 8 MHz V _{CC} = 5.0 V t _{inst} *2 = 0.5 μs | — | 3 | 7 | mA | |
| | | | | F _{CH} = 8 MHz V _{CC} = 3.2 V t _{inst} *2 = 8.0 μs | — | 1 | 1.5 | mA | |
| | I _{CCS2} | | Subclock mode | F _{CL} = 32.768 kHz V _{CC} = 3.0 V | — | 50 | 150 | μA | |
| | | | | | — | 1 | 3 | mA | MB89P147 |
| | I _{CCCL} | | Subclock sleep mode F _{CL} = 32.768 kHz V _{CC} = 3.0 V | — | 25 | 50 | μA | | |
| | I _{CCCT} | | Watch mode F _{CL} = 32.768 kHz V _{CC} = 3.0 V | — | 3 | 15 | μA | | |
| | I _{CCCH} | | Stop mode T _A = +25°C | — | — | 10 | μA | | |
| I _A | AV _{CC} | F _{CH} = 8 MHz, when A/D conversion is activated | — | 1.5 | 4 | mA | | | |
| | | T _A = +25°C, when A/D conversion is stopped | — | 1 | 5 | μA | | | |
| Input capacitance | C _{IN} | Other than AV _{CC} , AV _{SS} , V _{CC} , and V _{SS} | f = 1 MHz | — | 10 | — | pF | | |

*1: The power supply current is measured at the external clock.

*2: For information on t_{inst}, see “(4) Instruction Cycle” in “4. AC Characteristics.”Note: F_{CH} indicates the main clock oscillation frequency. When F_{CH} = 8 MHz, the 4/F_{CH} execution time is 0.5 μs, and the 64/F_{CH} execution time is 8 μs.

MB89140 Series

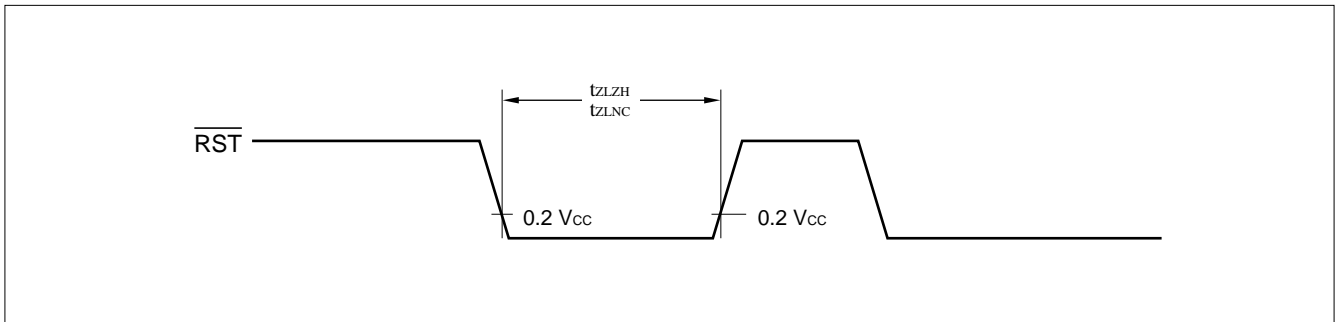
4. AC Characteristics

(1) Reset Timing

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

| Parameter | Symbol | Condition | Value | | | Unit | Remarks |
|-----------------------|------------|-----------|---------------|------|------|------|---------|
| | | | Min. | Typ. | Max. | | |
| RST "L" pulse width | t_{ZLZH} | — | $16 t_{XCYL}$ | — | — | ns | |
| RST noise limit width | t_{ZLNC} | | 30 | 50 | 80 | ns | |

Note: T_{XCYL} is the oscillation cycle ($1/F_{CH}$) to input to the X0 pin.



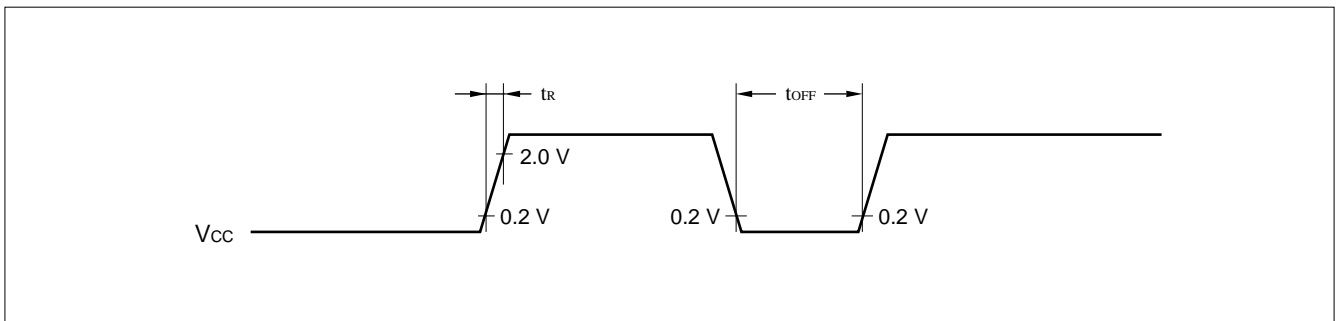
(2) Power-on Reset

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

| Parameter | Symbol | Condition | Value | | Unit | Remarks |
|---------------------------|-----------|-----------|-------|------|------|------------------------------|
| | | | Min. | Max. | | |
| Power supply rising time | t_R | — | — | 50 | ms | Power-on reset function only |
| Power supply cut-off time | t_{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.

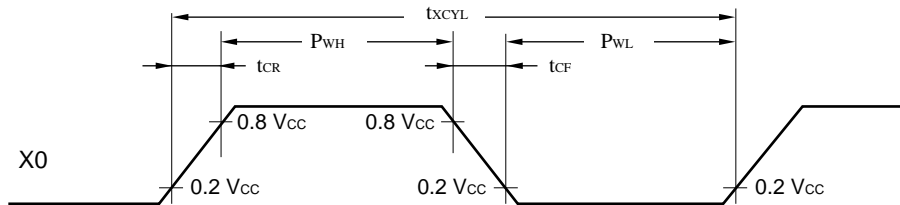


(3) Clock Timing

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

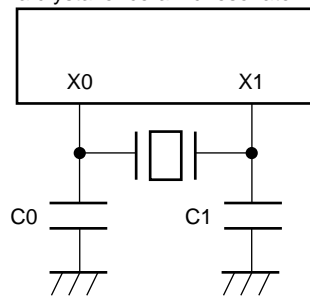
| Parameter | Symbol | Pin | Condition | Value | | | Unit | Remarks |
|---------------------------------|------------------------|----------|-----------|-------|--------|------|----------------|----------------|
| | | | | Min. | Typ. | Max. | | |
| Clock frequency | F_{CH} | X0, X1 | — | 2 | — | 8 | MHz | |
| | F_{CL} | X0A, X1A | | — | 32.768 | — | kHz | |
| Clock cycle time | t_{XCYL} | X0, X1 | — | 125 | — | 500 | ns | |
| | t_{LXCYL} | X0A, X1A | | — | 30.5 | — | μs | |
| Input clock pulse width | P_{WH} P_{WL} | X0 | — | 30 | — | — | ns | External clock |
| | P_{WHL} P_{WLL} | X0A | | — | 15.2 | — | μs | |
| Input clock rising/falling time | t_{CR} t_{CF} | X0, X0A | — | — | 10 | ns | External clock | |

X0 and X1 Timing and Conditions

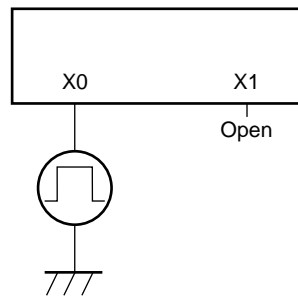


Main Clock Conditions

When a crystal or ceramic resonator is used

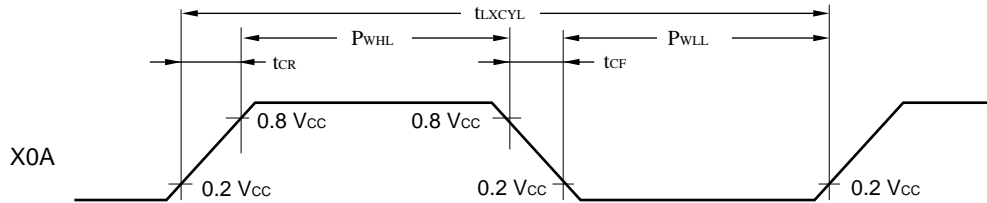


When an external clock is used



MB89140 Series

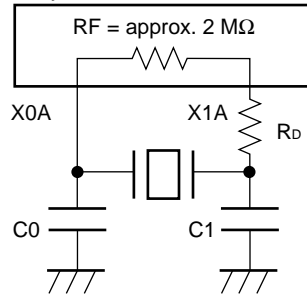
X0A and X1A Timing and Conditions



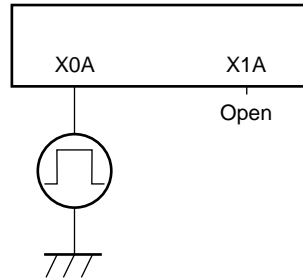
Subclock Conditions

MB89PV140

When a crystal or ceramic resonator is used

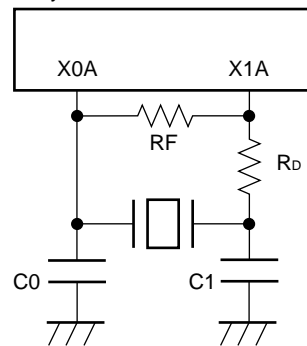


When an external clock is used

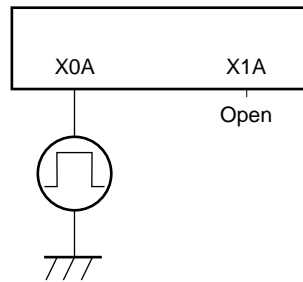


Mask ROM products and MB89P147

When a crystal or ceramic resonator is used



When an external clock is used



Note: The subclock oscillator feedback resistor is connected externally in dual-clock mask ROM products and in the MB89P147. (The subclock oscillator feedback resistor is connected internally in the MB89PV140-102.)

(4) Instruction Cycle

| Parameter | Symbol | Value (typical) | Unit | Remarks |
|---|------------|---|---------|--|
| Instruction cycle (minimum execution time) | t_{inst} | $4/F_{CH}$, $8/F_{CH}$, $16/F_{CH}$, $64/F_{CH}$ | μs | $(4/F_{CH}) t_{inst} = 0.5 \mu s$ when operating at $F_{CH} = 8 \text{ MHz}$ |
| | | $2/F_{CL}$ | μs | $t_{inst} = 61.036 \mu s$ when operating at $F_{CL} = 32.768 \text{ kHz}$ |

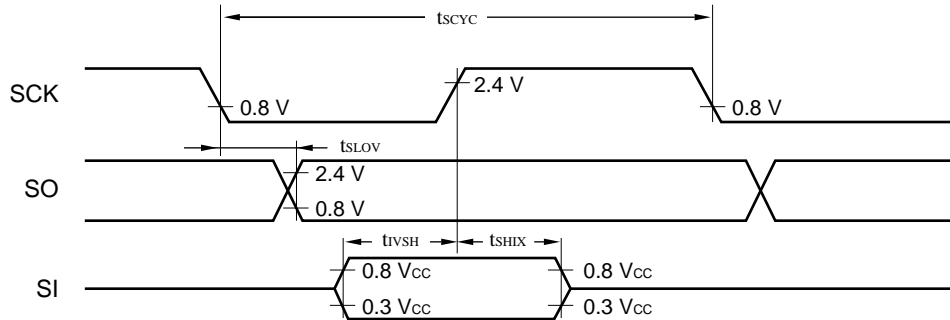
(5) Serial I/O Timing

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

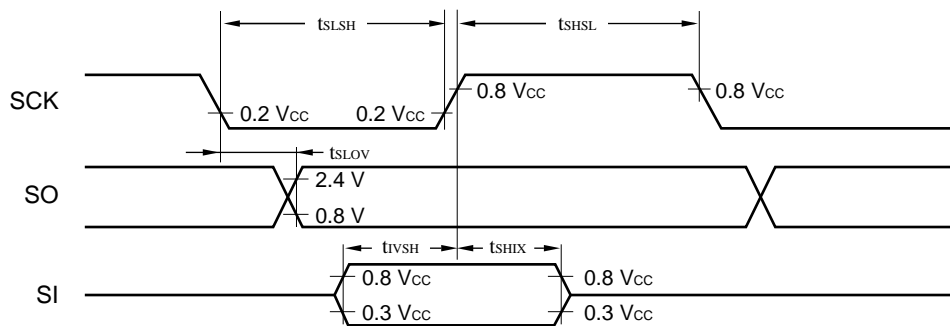
| Parameter | Symbol | Pin | Condition | Value | | Unit | Remarks |
|---|------------|---------|---------------------------|------------------|---------|---------|---------|
| | | | | Min. | Max. | | |
| Serial clock cycle time | t_{SCYC} | SCK | Internal shift clock mode | $2 t_{inst}^*$ | — | μs | |
| SCK $\downarrow \rightarrow$ SO time | t_{SLOV} | SCK, SO | | -200 | 200 | ns | |
| Valid SI \rightarrow SCK \uparrow | t_{VSH} | SI, SCK | | $1/2 t_{inst}^*$ | — | μs | |
| SCK $\uparrow \rightarrow$ valid SI hold time | t_{SHIX} | SCK, SI | | $1/2 t_{inst}^*$ | — | μs | |
| Serial clock "H" pulse width | t_{SHSL} | SCK | External shift clock mode | $1 t_{inst}^*$ | — | μs | |
| Serial clock "L" pulse width | t_{LSLH} | SCK | | $1 t_{inst}^*$ | — | μs | |
| SCK $\downarrow \rightarrow$ SO time | t_{SLOV} | SCK, SO | | 0 | 200 | ns | |
| Valid SI \rightarrow SCK \uparrow | t_{VSH} | SI, SCK | | $1/2 t_{inst}^*$ | — | μs | |
| SCK $\uparrow \rightarrow$ valid SI hold time | t_{SHIX} | SCK, SI | $1/2 t_{inst}^*$ | — | μs | | |

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

Internal Shift Clock Mode



External Shift Clock Mode



MB89140 Series

(6) Peripheral Input Timing

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

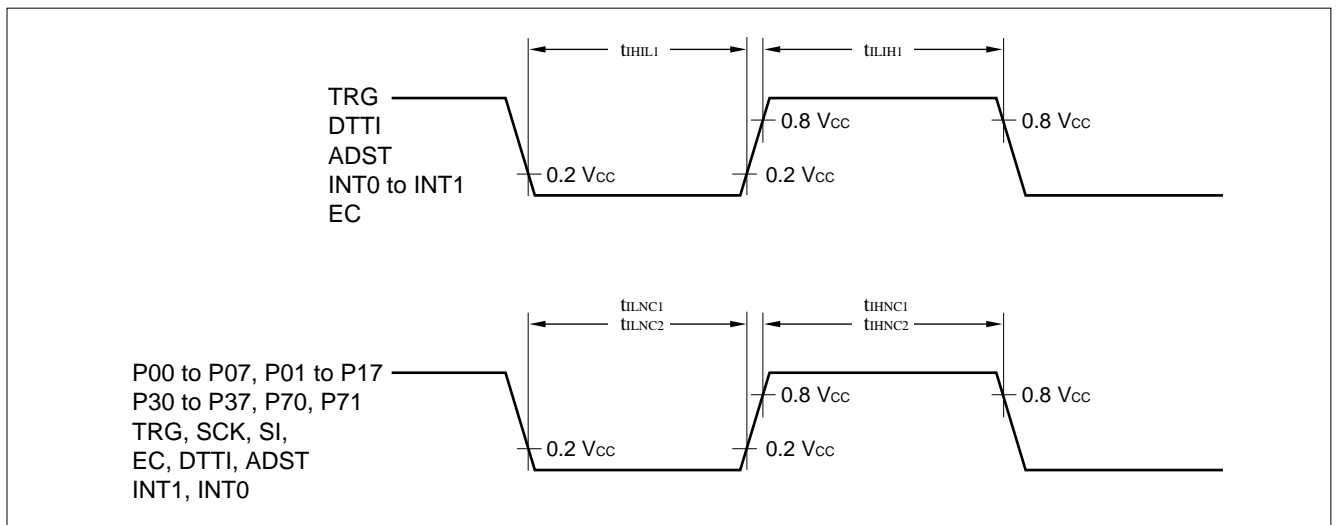
| Parameter | Symbol | Pin | Condition | Value | | Unit | Remarks |
|------------------------------------|-----------|---------------------------------------|-----------|----------------|------|---------------|---------|
| | | | | Min. | Max. | | |
| Peripheral input "H" pulse width 1 | t_{LH1} | TRG, DTTI ADST, EC INT0 to INT1 | — | $2 t_{inst}^*$ | — | μs | |
| Peripheral input "L" pulse width 1 | t_{HL1} | TRG, DTTI ADST, EC INT0 to INT1 | — | $2 t_{inst}^*$ | — | μs | |

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

(7) Peripheral Input Noise Limit Width

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

| Parameter | Symbol | Condition | Value | | | Unit | Remarks |
|--|------------|------------------------------------|-------|------|------|------|-----------------------|
| | | | Min. | Typ. | Max. | | |
| Peripheral input "H" level noise limit width 1 | t_{HNC1} | All inputs except INT1 and INT0 | 7 | 15 | 30 | ns | MB89P147/PV140 |
| | | | 15 | 30 | 60 | ns | Except MB89P147/PV140 |
| Peripheral input "L" level noise limit width 1 | t_{LNC1} | All inputs except INT1 and INT0 | 7 | 15 | 30 | ns | MB89P147/PV140 |
| | | | 15 | 30 | 60 | ns | Except MB89P147/PV140 |
| Interrupt "H" level noise limit width 2 | t_{HNC2} | INT1, INT0 | 30 | 50 | 100 | ns | MB89P147/PV140 |
| | | | 50 | 100 | 250 | ns | Except MB89P147/PV140 |
| Interrupt "L" level noise limit width 2 | t_{LNC2} | INT1, INT0 | 30 | 50 | 100 | ns | MB89P147/PV140 |
| | | | 50 | 100 | 250 | ns | Except MB89P147/PV140 |



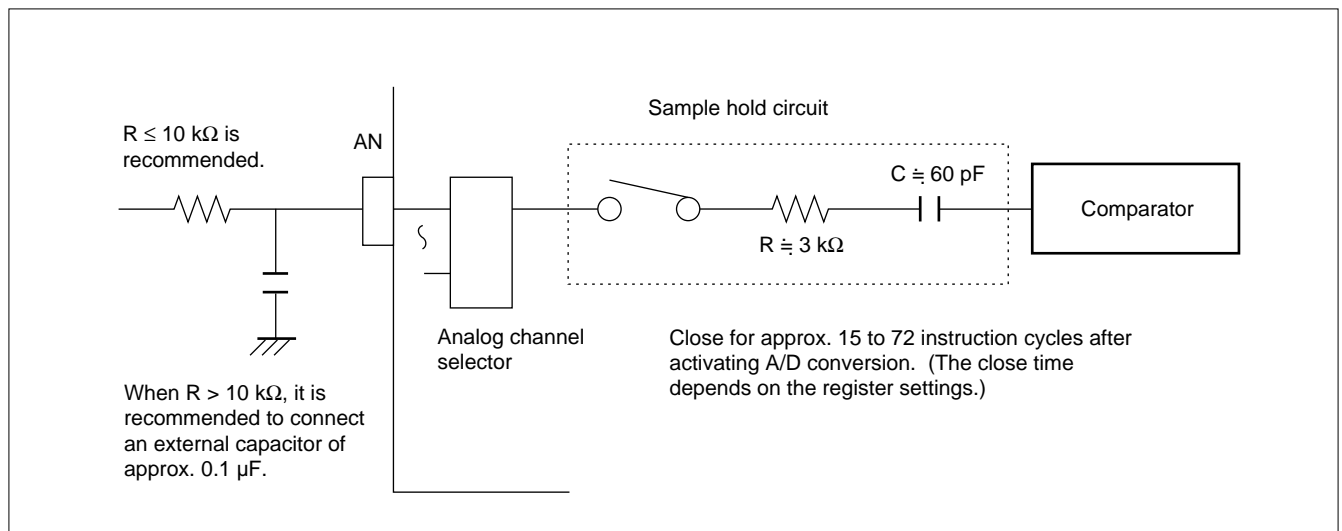
5. A/D Converter Electrical Characteristics

($AV_{CC} = V_{CC} = 5.0\text{ V} \pm 10\%$, $F_{CH} = 8\text{ MHz}$, $AV_{SS} = V_{SS} = 0.0\text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

| Parameter | Symbol | Pin | Condition | Value | | | Unit | Remarks |
|-------------------------------|-----------|------------|-----------------------------------|----------------------------|----------------------------|----------------------------|---------------|---------|
| | | | | Min. | Typ. | Max. | | |
| Resolution | — | — | — | — | — | 10 | bit | |
| Total error | | | $AV_{CC} = V_{CC} = 5.0\text{ V}$ | — | — | ± 3.0 | LSB | |
| Linearity error | | | — | — | ± 2.0 | LSB | | |
| Differential linearity error | | | — | ± 1.5 | LSB | | | |
| Zero transition voltage | V_{OT} | AN0 to ANB | — | $AV_{SS} - 1.5\text{ LSB}$ | $AV_{SS} + 0.5\text{ LSB}$ | $AV_{SS} + 2.5\text{ LSB}$ | mV | |
| Full-scale transition voltage | V_{FST} | AN0 to ANB | — | $AV_{CC} - 3.5\text{ LSB}$ | $AV_{CC} - 1.5\text{ LSB}$ | $AV_{CC} + 0.5\text{ LSB}$ | mV | |
| Interchannel disparity | — | — | — | — | — | 4 | LSB | |
| A/D mode conversion time | | | At 8-MHz oscillation | 33 | — | — | t_{inst}^* | |
| Analog port input current | I_{AIN} | AN0 to ANB | $AV_{CC} = V_{CC} = 5.0\text{ V}$ | — | — | 10 | μA | |
| Analog input voltage | — | AN0 to ANB | — | 0.0 | — | AV_{CC} | V | |

* : For information on t_{inst} , see "(4) Instruction Cycle" in "4. AC Characteristics."

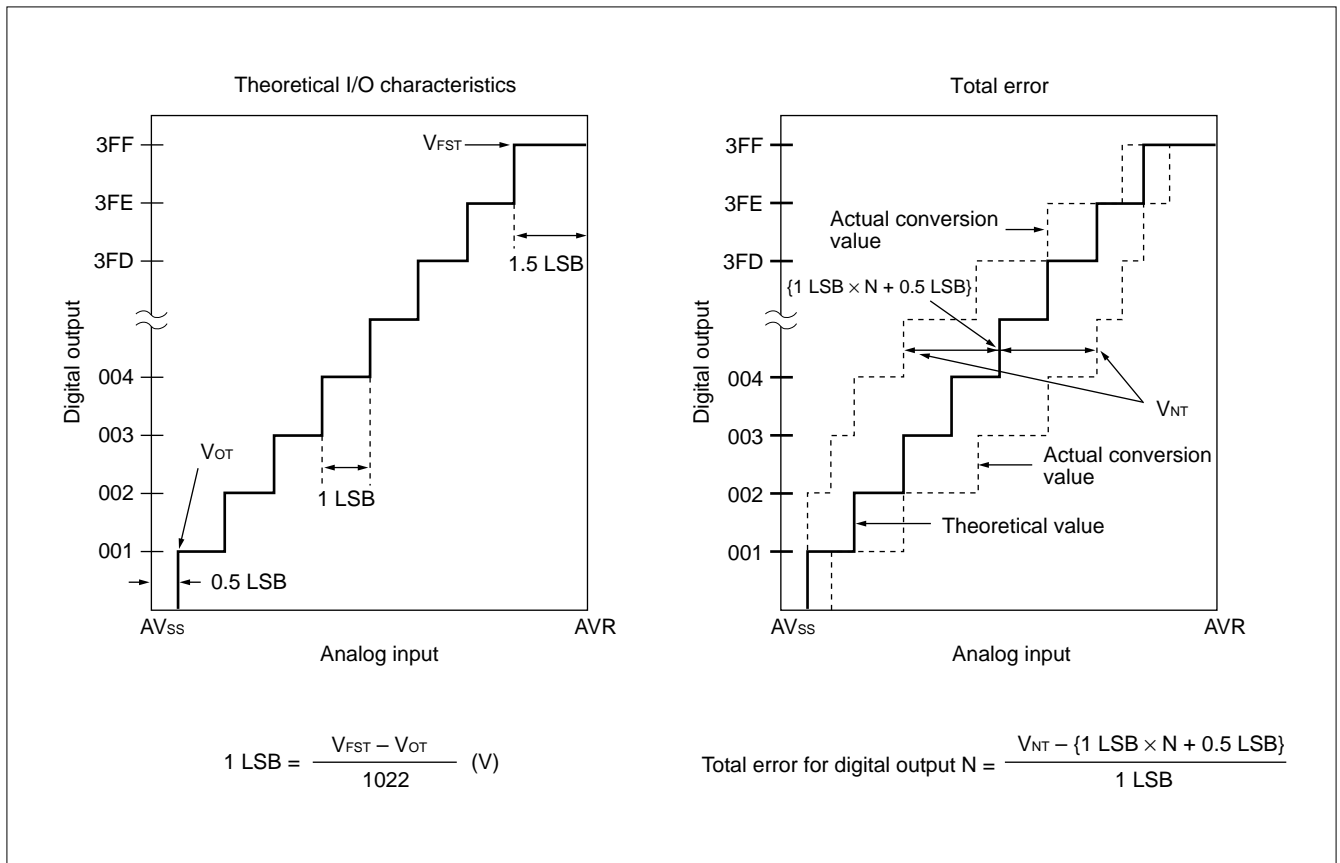
- Notes:
- The smaller AV_{CC} , the greater the error would become relatively.
 - The output impedance of the external circuit connected to an analog input block should be no more than several $k\Omega$. If the output impedance is too high, the analog voltage sampling time might be insufficient.



MB89140 Series

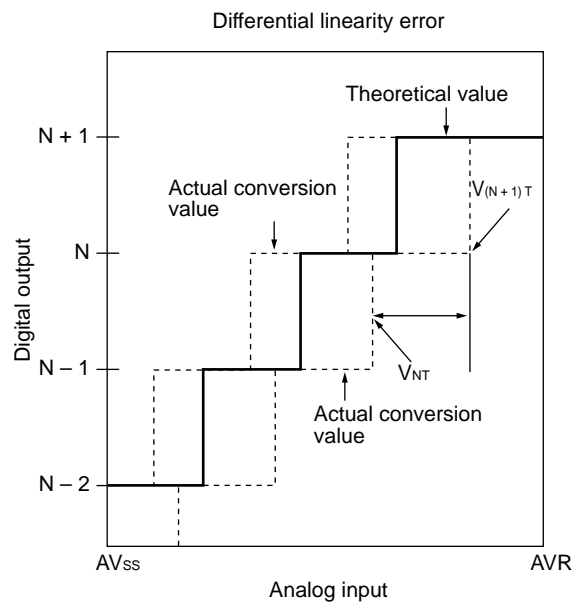
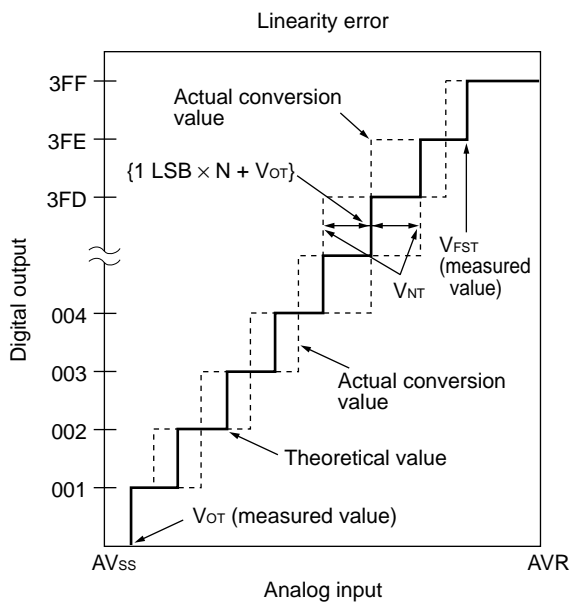
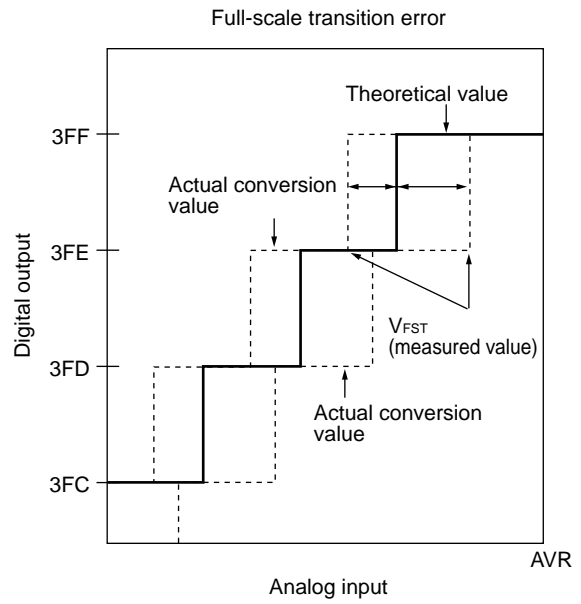
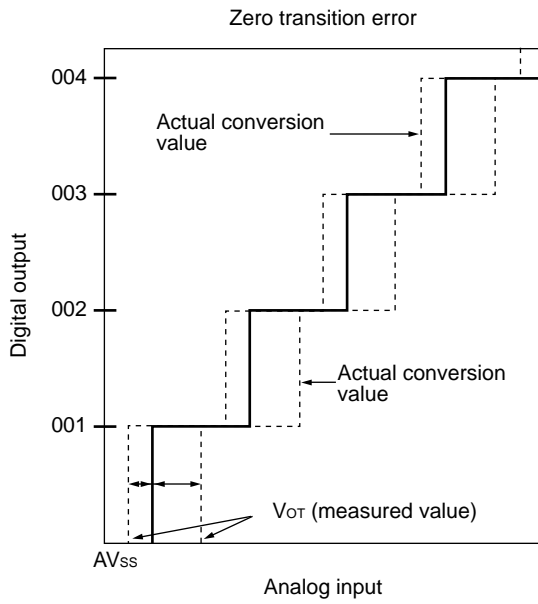
(1) A/D Glossary

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



(Continued)

(Continued)



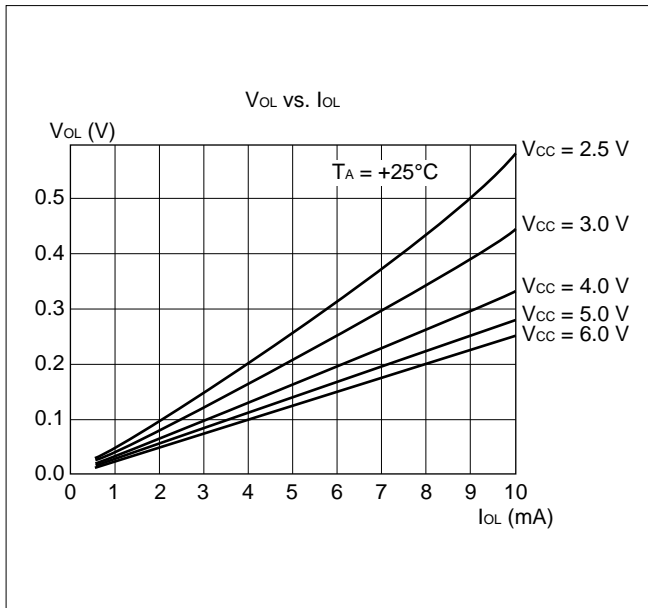
$$\text{Linearity error for digital output } N = \frac{V_{NT} - \{1 \text{ LSB} \times N + V_{0T}\}}{1 \text{ LSB}}$$

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

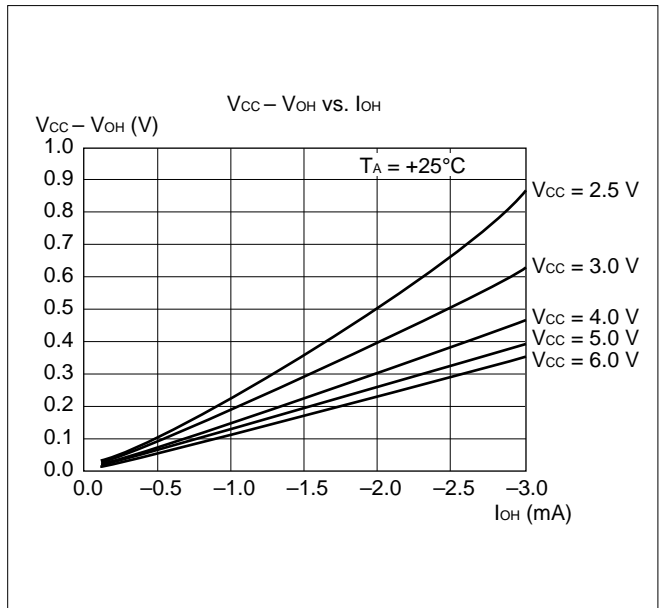
MB89140 Series

EXAMPLE CHARACTERISTICS

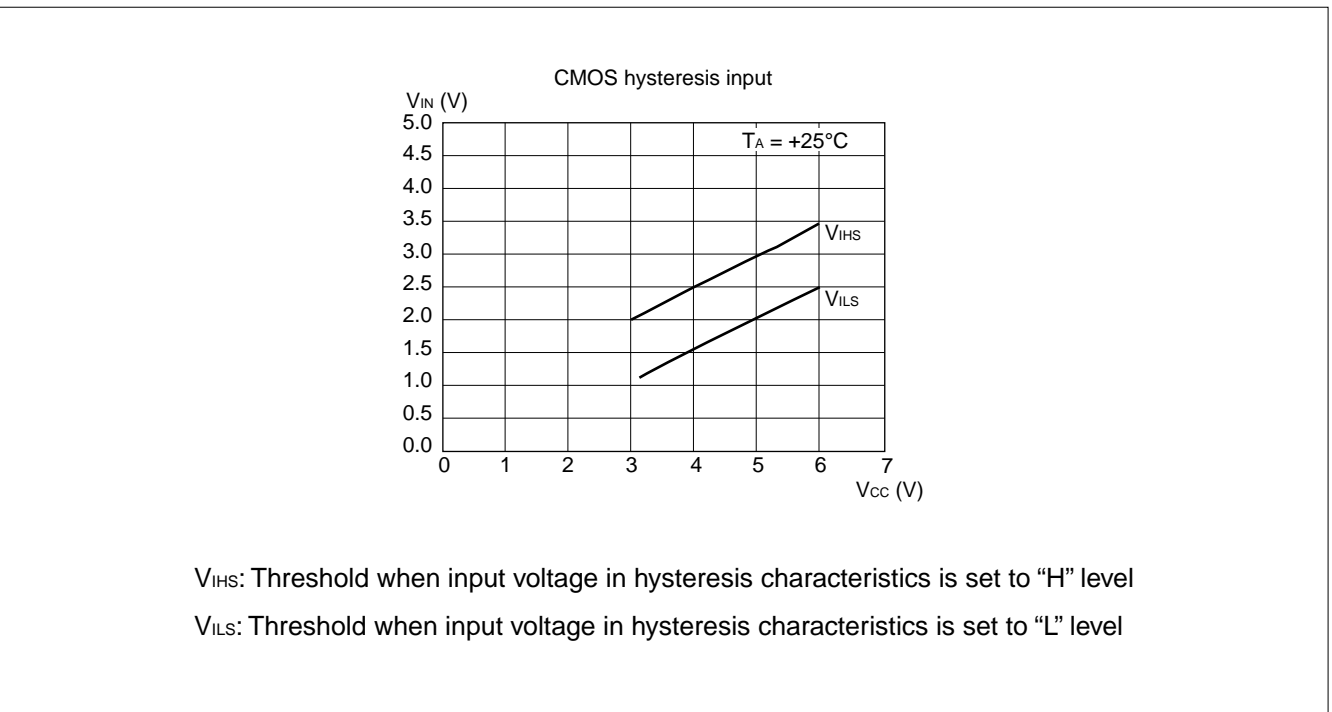
(1) "L" Level Output Voltage



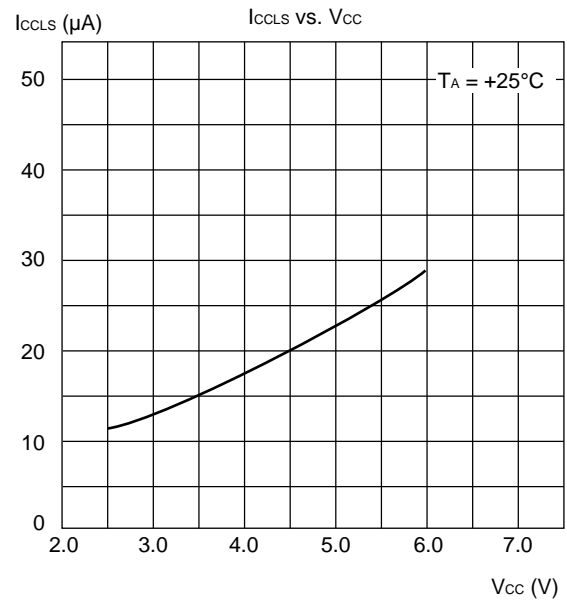
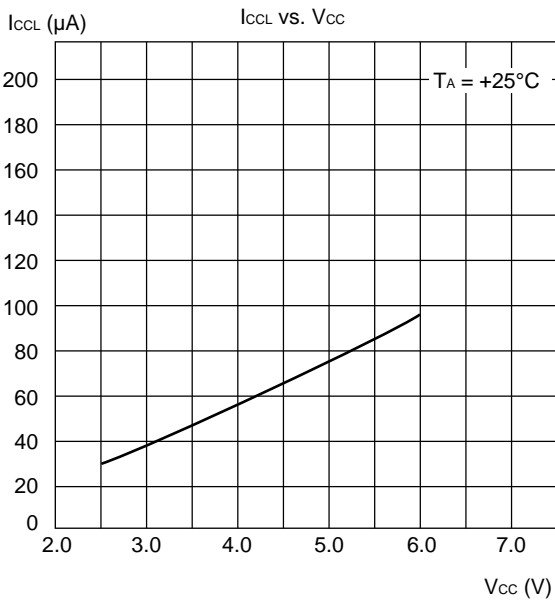
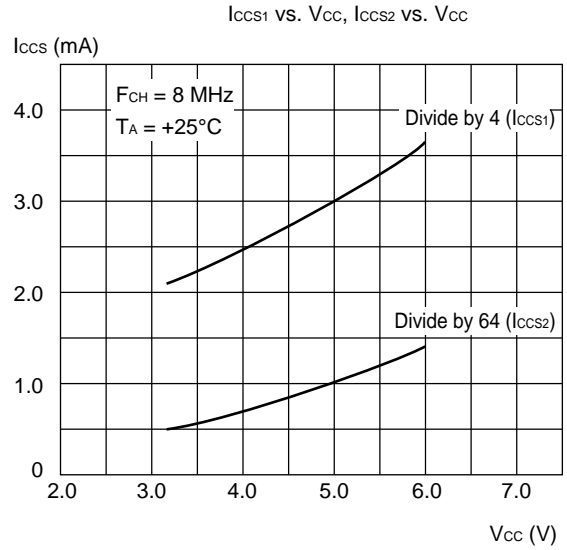
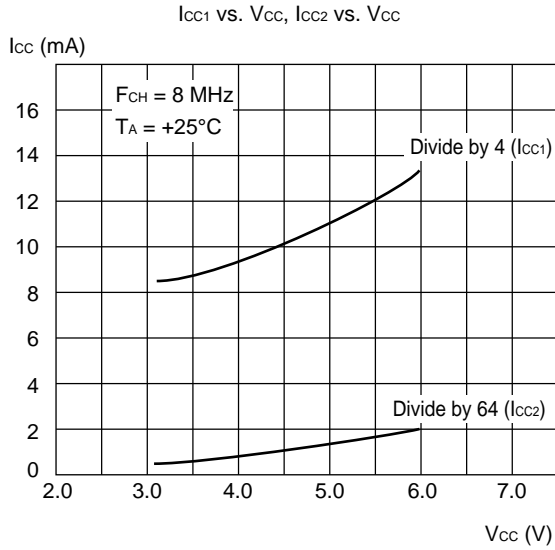
(2) "H" Level Output Voltage



(3) "H" Level Input Voltage/"L" Level Input Voltage (Hysteresis Input)



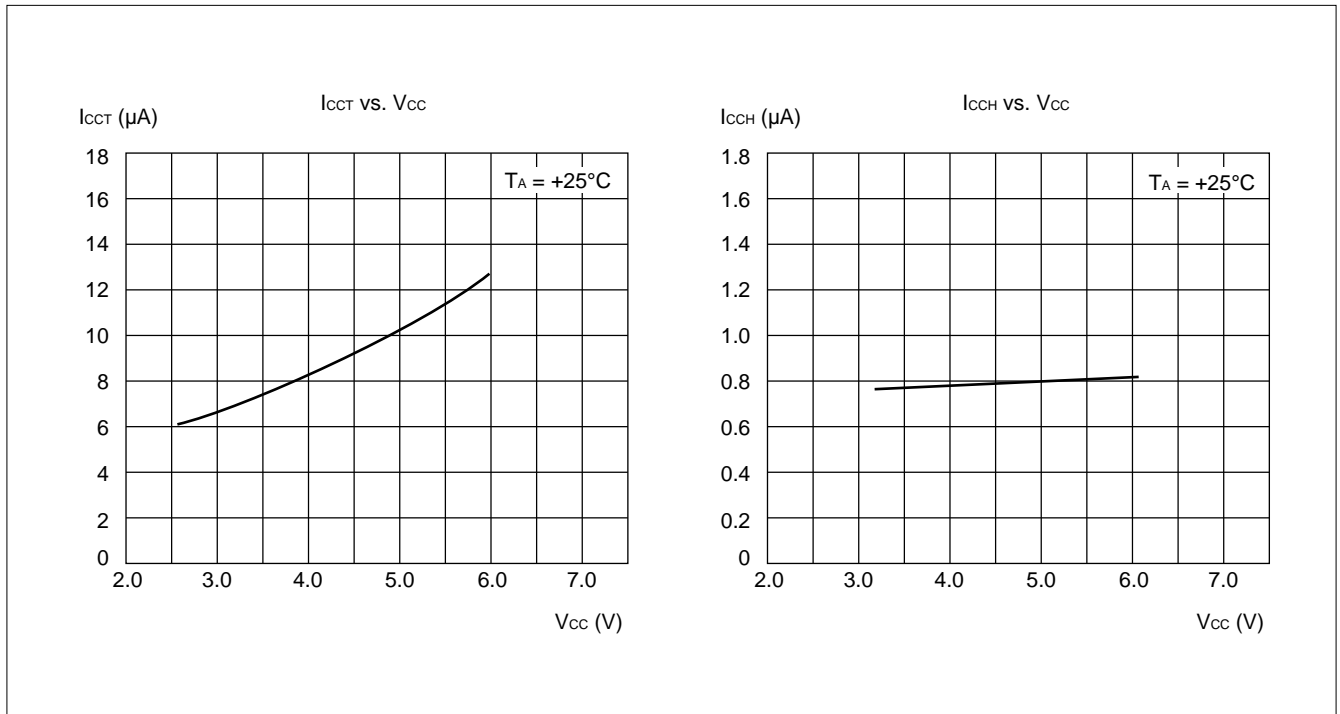
(4) Power Supply Current (External Clock)



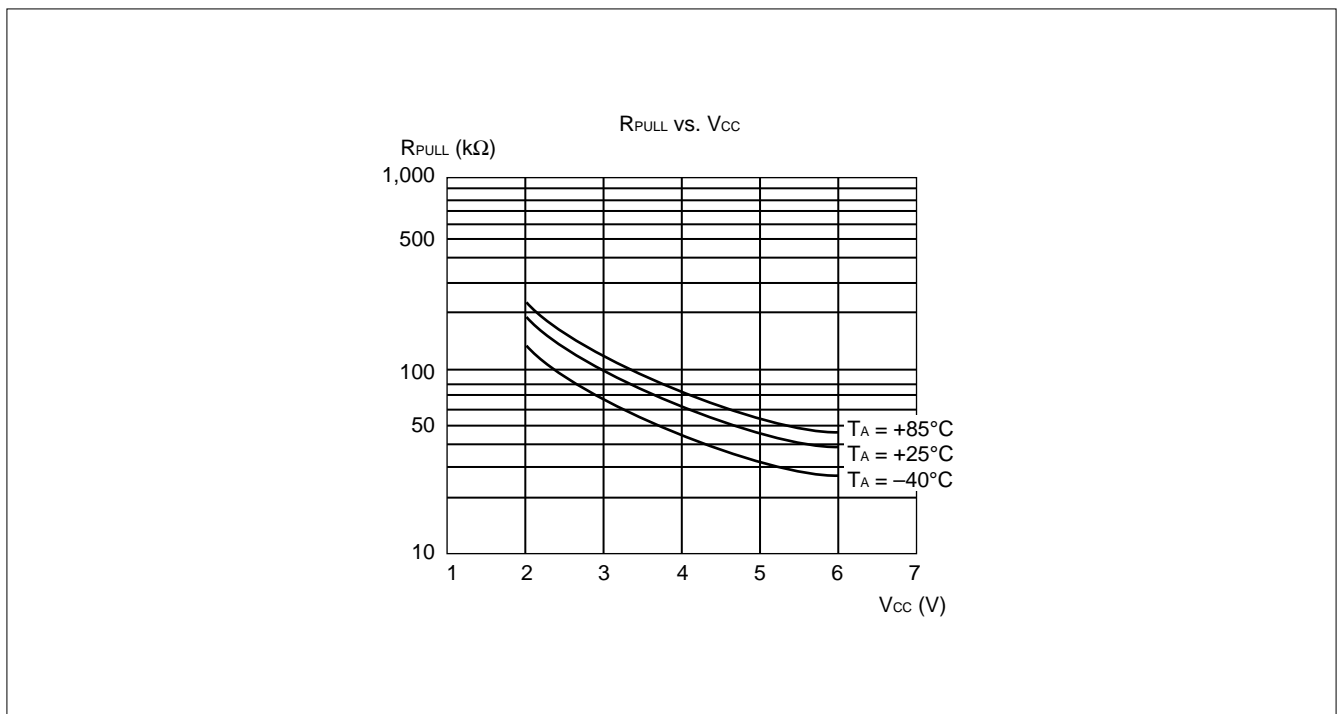
(Continued)

MB89140 Series

(Continued)



(5) Pull-up Resistance



■ INSTRUCTIONS

Execution instructions can be divided into the following four groups:

- Transfer
- Arithmetic operation
- Branch
- Others

Table 1 lists symbols used for notation of instructions.

Table 1 Instruction Symbols

| Symbol | Meaning |
|--------|---|
| dir | Direct address (8 bits) |
| off | Offset (8 bits) |
| ext | Extended address (16 bits) |
| #vct | Vector table number (3 bits) |
| #d8 | Immediate data (8 bits) |
| #d16 | Immediate data (16 bits) |
| dir: b | Bit direct address (8:3 bits) |
| rel | Branch relative address (8 bits) |
| @ | Register indirect (Example: @A, @IX, @EP) |
| A | Accumulator A (Whether its length is 8 or 16 bits is determined by the instruction in use.) |
| AH | Upper 8 bits of accumulator A (8 bits) |
| AL | Lower 8 bits of accumulator A (8 bits) |
| T | Temporary accumulator T (Whether its length is 8 or 16 bits is determined by the instruction in use.) |
| TH | Upper 8 bits of temporary accumulator T (8 bits) |
| TL | Lower 8 bits of temporary accumulator T (8 bits) |
| IX | Index register IX (16 bits) |

(Continued)

MB89140 Series

(Continued)

| Symbol | Meaning |
|--------|---|
| EP | Extra pointer EP (16 bits) |
| PC | Program counter PC (16 bits) |
| SP | Stack pointer SP (16 bits) |
| PS | Program status PS (16 bits) |
| dr | Accumulator A or index register IX (16 bits) |
| CCR | Condition code register CCR (8 bits) |
| RP | Register bank pointer RP (5 bits) |
| Ri | General-purpose register Ri (8 bits, i = 0 to 7) |
| × | Indicates that the very × is the immediate data. (Whether its length is 8 or 16 bits is determined by the instruction in use.) |
| (×) | Indicates that the contents of × is the target of accessing. (Whether its length is 8 or 16 bits is determined by the instruction in use.) |
| ((×)) | The address indicated by the contents of × is the target of accessing. (Whether its length is 8 or 16 bits is determined by the instruction in use.) |

Columns indicate the following:

Mnemonic: Assembler notation of an instruction

~: Number of instructions

#: Number of bytes

Operation: Operation of an instruction

TL, TH, AH: A content change when each of the TL, TH, and AH instructions is executed. Symbols in the column indicate the following:

- “–” indicates no change.
- dH is the 8 upper bits of operation description data.
- AL and AH must become the contents of AL and AH immediately before the instruction is executed.
- 00 becomes 00.

N, Z, V, C: An instruction of which the corresponding flag will change. If + is written in this column, the relevant instruction will change its corresponding flag.

OP code: Code of an instruction. If an instruction is more than one code, it is written according to the following rule:

Example: 48 to 4F ← This indicates 48, 49, ... 4F.

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Table 2 Transfer Instructions (48 instructions)

| Mnemonic | ~ | # | Operation | TL | TH | AH | NZVC | OP code |
|------------------|---|---|---|----|----|----|-------|----------|
| MOV dir,A | 3 | 2 | (dir) ← (A) | - | - | - | ----- | 45 |
| MOV @IX +off,A | 4 | 2 | ((IX) +off) ← (A) | - | - | - | ----- | 46 |
| MOV ext,A | 4 | 3 | (ext) ← (A) | - | - | - | ----- | 61 |
| MOV @EP,A | 3 | 1 | ((EP)) ← (A) | - | - | - | ----- | 47 |
| MOV Ri,A | 3 | 1 | (Ri) ← (A) | - | - | - | ----- | 48 to 4F |
| MOV A,#d8 | 2 | 2 | (A) ← d8 | AL | - | - | ++-- | 04 |
| MOV A,dir | 3 | 2 | (A) ← (dir) | AL | - | - | ++-- | 05 |
| MOV A,@IX +off | 4 | 2 | (A) ← ((IX) +off) | AL | - | - | ++-- | 06 |
| MOV A,ext | 4 | 3 | (A) ← (ext) | AL | - | - | ++-- | 60 |
| MOV A,@A | 3 | 1 | (A) ← ((A)) | AL | - | - | ++-- | 92 |
| MOV A,@EP | 3 | 1 | (A) ← ((EP)) | AL | - | - | ++-- | 07 |
| MOV A,Ri | 3 | 1 | (A) ← (Ri) | AL | - | - | ++-- | 08 to 0F |
| MOV dir,#d8 | 4 | 3 | (dir) ← d8 | - | - | - | ----- | 85 |
| MOV @IX +off,#d8 | 5 | 3 | ((IX) +off) ← d8 | - | - | - | ----- | 86 |
| MOV @EP,#d8 | 4 | 2 | ((EP)) ← d8 | - | - | - | ----- | 87 |
| MOV Ri,#d8 | 4 | 2 | (Ri) ← d8 | - | - | - | ----- | 88 to 8F |
| MOVW dir,A | 4 | 2 | (dir) ← (AH),(dir + 1) ← (AL) | - | - | - | ----- | D5 |
| MOVW @IX +off,A | 5 | 2 | ((IX) +off) ← (AH), ((IX) +off + 1) ← (AL) | - | - | - | ----- | D6 |
| MOVW ext,A | 5 | 3 | (ext) ← (AH), (ext + 1) ← (AL) | - | - | - | ----- | D4 |
| MOVW @EP,A | 4 | 1 | ((EP)) ← (AH),(EP + 1) ← (AL) | - | - | - | ----- | D7 |
| MOVW EP,A | 2 | 1 | (EP) ← (A) | - | - | - | ----- | E3 |
| MOVW A,#d16 | 3 | 3 | (A) ← d16 | AL | AH | dH | ++-- | E4 |
| MOVW A,dir | 4 | 2 | (AH) ← (dir), (AL) ← (dir + 1) | AL | AH | dH | ++-- | C5 |
| MOVW A,@IX +off | 5 | 2 | (AH) ← ((IX) +off), (AL) ← ((IX) +off + 1) | AL | AH | dH | ++-- | C6 |
| MOVW A,ext | 5 | 3 | (AH) ← (ext), (AL) ← (ext + 1) | AL | AH | dH | ++-- | C4 |
| MOVW A,@A | 4 | 1 | (AH) ← ((A)), (AL) ← ((A) + 1) | AL | AH | dH | ++-- | 93 |
| MOVW A,@EP | 4 | 1 | (AH) ← ((EP)), (AL) ← ((EP) + 1) | AL | AH | dH | ++-- | C7 |
| MOVW A,EP | 2 | 1 | (A) ← (EP) | - | - | dH | ----- | F3 |
| MOVW EP,#d16 | 3 | 3 | (EP) ← d16 | - | - | - | ----- | E7 |
| MOVW IX,A | 2 | 1 | (IX) ← (A) | - | - | - | ----- | E2 |
| MOVW A,IX | 2 | 1 | (A) ← (IX) | - | - | dH | ----- | F2 |
| MOVW SP,A | 2 | 1 | (SP) ← (A) | - | - | - | ----- | E1 |
| MOVW A,SP | 2 | 1 | (A) ← (SP) | - | - | dH | ----- | F1 |
| MOV @A,T | 3 | 1 | ((A)) ← (T) | - | - | - | ----- | 82 |
| MOVW @A,T | 4 | 1 | ((A)) ← (TH),(A + 1) ← (TL) | - | - | - | ----- | 83 |
| MOVW IX,#d16 | 3 | 3 | (IX) ← d16 | - | - | - | ----- | E6 |
| MOVW A,PS | 2 | 1 | (A) ← (PS) | - | - | dH | ----- | 70 |
| MOVW PS,A | 2 | 1 | (PS) ← (A) | - | - | - | ++++ | 71 |
| MOVW SP,#d16 | 3 | 3 | (SP) ← d16 | - | - | - | ----- | E5 |
| SWAP | 2 | 1 | (AH) ↔ (AL) | - | - | AL | ----- | 10 |
| SETB dir: b | 4 | 2 | (dir): b ← 1 | - | - | - | ----- | A8 to AF |
| CLRB dir: b | 4 | 2 | (dir): b ← 0 | - | - | - | ----- | A0 to A7 |
| XCH A,T | 2 | 1 | (AL) ↔ (TL) | AL | - | - | ----- | 42 |
| XCHW A,T | 3 | 1 | (A) ↔ (T) | AL | AH | dH | ----- | 43 |
| XCHW A,EP | 3 | 1 | (A) ↔ (EP) | - | - | dH | ----- | F7 |
| XCHW A,IX | 3 | 1 | (A) ↔ (IX) | - | - | dH | ----- | F6 |
| XCHW A,SP | 3 | 1 | (A) ↔ (SP) | - | - | dH | ----- | F5 |
| MOVW A,PC | 2 | 1 | (A) ← (PC) | - | - | dH | ----- | F0 |

Notes: • During byte transfer to A, T ← A is restricted to low bytes.

- Operands in more than one operand instruction must be stored in the order in which their mnemonics are written. (Reverse arrangement of F²MC-8 family)

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Table 3 Arithmetic Operation Instructions (62 instructions)

| Mnemonic | ~ | # | Operation | TL | TH | AH | NZVC | OP code |
|-----------------|----|---|--|----|----|----|------|----------|
| ADDC A,Ri | 3 | 1 | $(A) \leftarrow (A) + (Ri) + C$ | - | - | - | ++++ | 28 to 2F |
| ADDC A,#d8 | 2 | 2 | $(A) \leftarrow (A) + d8 + C$ | - | - | - | ++++ | 24 |
| ADDC A,dir | 3 | 2 | $(A) \leftarrow (A) + (dir) + C$ | - | - | - | ++++ | 25 |
| ADDC A,@IX +off | 4 | 2 | $(A) \leftarrow (A) + ((IX) + off) + C$ | - | - | - | ++++ | 26 |
| ADDC A,@EP | 3 | 1 | $(A) \leftarrow (A) + ((EP)) + C$ | - | - | - | ++++ | 27 |
| ADDCW A | 3 | 1 | $(A) \leftarrow (A) + (T) + C$ | - | - | dH | ++++ | 23 |
| ADDC A | 2 | 1 | $(AL) \leftarrow (AL) + (TL) + C$ | - | - | - | ++++ | 22 |
| SUBC A,Ri | 3 | 1 | $(A) \leftarrow (A) - (Ri) - C$ | - | - | - | ++++ | 38 to 3F |
| SUBC A,#d8 | 2 | 2 | $(A) \leftarrow (A) - d8 - C$ | - | - | - | ++++ | 34 |
| SUBC A,dir | 3 | 2 | $(A) \leftarrow (A) - (dir) - C$ | - | - | - | ++++ | 35 |
| SUBC A,@IX +off | 4 | 2 | $(A) \leftarrow (A) - ((IX) + off) - C$ | - | - | - | ++++ | 36 |
| SUBC A,@EP | 3 | 1 | $(A) \leftarrow (A) - ((EP)) - C$ | - | - | - | ++++ | 37 |
| SUBCW A | 3 | 1 | $(A) \leftarrow (T) - (A) - C$ | - | - | dH | ++++ | 33 |
| SUBC A | 2 | 1 | $(AL) \leftarrow (TL) - (AL) - C$ | - | - | - | ++++ | 32 |
| INC Ri | 4 | 1 | $(Ri) \leftarrow (Ri) + 1$ | - | - | - | +++- | C8 to CF |
| INCW EP | 3 | 1 | $(EP) \leftarrow (EP) + 1$ | - | - | - | ---- | C3 |
| INCW IX | 3 | 1 | $(IX) \leftarrow (IX) + 1$ | - | - | - | ---- | C2 |
| INCW A | 3 | 1 | $(A) \leftarrow (A) + 1$ | - | - | dH | ++-- | C0 |
| DEC Ri | 4 | 1 | $(Ri) \leftarrow (Ri) - 1$ | - | - | - | +++- | D8 to DF |
| DECW EP | 3 | 1 | $(EP) \leftarrow (EP) - 1$ | - | - | - | ---- | D3 |
| DECW IX | 3 | 1 | $(IX) \leftarrow (IX) - 1$ | - | - | - | ---- | D2 |
| DECW A | 3 | 1 | $(A) \leftarrow (A) - 1$ | - | - | dH | +--- | D0 |
| MULU A | 19 | 1 | $(A) \leftarrow (AL) \times (TL)$ | - | - | dH | ---- | 01 |
| DIVU A | 21 | 1 | $(A) \leftarrow (T) / (AL), MOD \rightarrow (T)$ | dL | 00 | 00 | ---- | 11 |
| ANDW A | 3 | 1 | $(A) \leftarrow (A) \wedge (T)$ | - | - | dH | ++R- | 63 |
| ORW A | 3 | 1 | $(A) \leftarrow (A) \vee (T)$ | - | - | dH | ++R- | 73 |
| XORW A | 3 | 1 | $(A) \leftarrow (A) \nabla (T)$ | - | - | dH | ++R- | 53 |
| CMP A | 2 | 1 | $(TL) - (AL)$ | - | - | - | ++++ | 12 |
| CMPW A | 3 | 1 | $(T) - (A)$ | - | - | - | ++++ | 13 |
| RORC A | 2 | 1 | $\rightarrow C \rightarrow A$ | - | - | - | ++-+ | 03 |
| ROLC A | 2 | 1 | $\leftarrow C \leftarrow A$ | - | - | - | ++-+ | 02 |
| CMP A,#d8 | 2 | 2 | $(A) - d8$ | - | - | - | ++++ | 14 |
| CMP A,dir | 3 | 2 | $(A) - (dir)$ | - | - | - | ++++ | 15 |
| CMP A,@EP | 3 | 1 | $(A) - ((EP))$ | - | - | - | ++++ | 17 |
| CMP A,@IX +off | 4 | 2 | $(A) - ((IX) + off)$ | - | - | - | ++++ | 16 |
| CMP A,Ri | 3 | 1 | $(A) - (Ri)$ | - | - | - | ++++ | 18 to 1F |
| DAA | 2 | 1 | Decimal adjust for addition | - | - | - | ++++ | 84 |
| DAS | 2 | 1 | Decimal adjust for subtraction | - | - | - | ++++ | 94 |
| XOR A | 2 | 1 | $(A) \leftarrow (AL) \nabla (TL)$ | - | - | - | ++R- | 52 |
| XOR A,#d8 | 2 | 2 | $(A) \leftarrow (AL) \nabla d8$ | - | - | - | ++R- | 54 |
| XOR A,dir | 3 | 2 | $(A) \leftarrow (AL) \nabla (dir)$ | - | - | - | ++R- | 55 |
| XOR A,@EP | 3 | 1 | $(A) \leftarrow (AL) \nabla ((EP))$ | - | - | - | ++R- | 57 |
| XOR A,@IX +off | 4 | 2 | $(A) \leftarrow (AL) \nabla ((IX) + off)$ | - | - | - | ++R- | 56 |
| XOR A,Ri | 3 | 1 | $(A) \leftarrow (AL) \nabla (Ri)$ | - | - | - | ++R- | 58 to 5F |
| AND A | 2 | 1 | $(A) \leftarrow (AL) \wedge (TL)$ | - | - | - | ++R- | 62 |
| AND A,#d8 | 2 | 2 | $(A) \leftarrow (AL) \wedge d8$ | - | - | - | ++R- | 64 |
| AND A,dir | 3 | 2 | $(A) \leftarrow (AL) \wedge (dir)$ | - | - | - | ++R- | 65 |

MB89140 Series

(Continued)

| Mnemonic | ~ | # | Operation | TL | TH | AH | NZVC | OP code |
|------------------|---|---|--|----|----|----|------|----------|
| AND A,@EP | 3 | 1 | $(A) \leftarrow (AL) \wedge ((EP))$ | - | - | - | ++R- | 67 |
| AND A,@IX +off | 4 | 2 | $(A) \leftarrow (AL) \wedge ((IX) + \text{off})$ | - | - | - | ++R- | 66 |
| AND A,Ri | 3 | 1 | $(A) \leftarrow (AL) \wedge (Ri)$ | - | - | - | ++R- | 68 to 6F |
| OR A | 2 | 1 | $(A) \leftarrow (AL) \vee (TL)$ | - | - | - | ++R- | 72 |
| OR A,#d8 | 2 | 2 | $(A) \leftarrow (AL) \vee d8$ | - | - | - | ++R- | 74 |
| OR A,dir | 3 | 2 | $(A) \leftarrow (AL) \vee (\text{dir})$ | - | - | - | ++R- | 75 |
| OR A,@EP | 3 | 1 | $(A) \leftarrow (AL) \vee ((EP))$ | - | - | - | ++R- | 77 |
| OR A,@IX +off | 4 | 2 | $(A) \leftarrow (AL) \vee ((IX) + \text{off})$ | - | - | - | ++R- | 76 |
| OR A,Ri | 3 | 1 | $(A) \leftarrow (AL) \vee (Ri)$ | - | - | - | ++R- | 78 to 7F |
| CMP dir,#d8 | 5 | 3 | $(\text{dir}) - d8$ | - | - | - | ++++ | 95 |
| CMP @EP,#d8 | 4 | 2 | $((EP)) - d8$ | - | - | - | ++++ | 97 |
| CMP @IX +off,#d8 | 5 | 3 | $((IX) + \text{off}) - d8$ | - | - | - | ++++ | 96 |
| CMP Ri,#d8 | 4 | 2 | $(Ri) - d8$ | - | - | - | ++++ | 98 to 9F |
| INCW SP | 3 | 1 | $(SP) \leftarrow (SP) + 1$ | - | - | - | ---- | C1 |
| DECW SP | 3 | 1 | $(SP) \leftarrow (SP) - 1$ | - | - | - | ---- | D1 |

Table 4 Branch Instructions (17 instructions)

| Mnemonic | ~ | # | Operation | TL | TH | AH | NZVC | OP code |
|----------------|---|---|---|----|----|----|---------|----------|
| BZ/BEQ rel | 3 | 2 | If $Z = 1$ then $PC \leftarrow PC + \text{rel}$ | - | - | - | ---- | FD |
| BNZ/BNE rel | 3 | 2 | If $Z = 0$ then $PC \leftarrow PC + \text{rel}$ | - | - | - | ---- | FC |
| BC/BLO rel | 3 | 2 | If $C = 1$ then $PC \leftarrow PC + \text{rel}$ | - | - | - | ---- | F9 |
| BNC/BHS rel | 3 | 2 | If $C = 0$ then $PC \leftarrow PC + \text{rel}$ | - | - | - | ---- | F8 |
| BN rel | 3 | 2 | If $N = 1$ then $PC \leftarrow PC + \text{rel}$ | - | - | - | ---- | FB |
| BP rel | 3 | 2 | If $N = 0$ then $PC \leftarrow PC + \text{rel}$ | - | - | - | ---- | FA |
| BLT rel | 3 | 2 | If $V \vee N = 1$ then $PC \leftarrow PC + \text{rel}$ | - | - | - | ---- | FF |
| BGE rel | 3 | 2 | If $V \vee N = 0$ then $PC \leftarrow PC + \text{rel}$ | - | - | - | ---- | FE |
| BBC dir: b,rel | 5 | 3 | If $(\text{dir}: b) = 0$ then $PC \leftarrow PC + \text{rel}$ | - | - | - | -+-- | B0 to B7 |
| BBS dir: b,rel | 5 | 3 | If $(\text{dir}: b) = 1$ then $PC \leftarrow PC + \text{rel}$ | - | - | - | -+-- | B8 to BF |
| JMP @A | 2 | 1 | $(PC) \leftarrow (A)$ | - | - | - | ---- | E0 |
| JMP ext | 3 | 3 | $(PC) \leftarrow \text{ext}$ | - | - | - | ---- | 21 |
| CALLV #vct | 6 | 1 | Vector call | - | - | - | ---- | E8 to EF |
| CALL ext | 6 | 3 | Subroutine call | - | - | - | ---- | 31 |
| XCHW A,PC | 3 | 1 | $(PC) \leftarrow (A), (A) \leftarrow (PC) + 1$ | - | - | dH | ---- | F4 |
| RET | 4 | 1 | Return from subroutine | - | - | - | ---- | 20 |
| RETI | 6 | 1 | Return from interrupt | - | - | - | Restore | 30 |

Table 5 Other Instructions (9 instructions)

| Mnemonic | ~ | # | Operation | TL | TH | AH | NZVC | OP code |
|----------|---|---|-----------|----|----|----|-------|---------|
| PUSHW A | 4 | 1 | | - | - | - | ---- | 40 |
| POPW A | 4 | 1 | | - | - | dH | ---- | 50 |
| PUSHW IX | 4 | 1 | | - | - | - | ---- | 41 |
| POPW IX | 4 | 1 | | - | - | - | ---- | 51 |
| NOP | 1 | 1 | | - | - | - | ---- | 00 |
| CLRC | 1 | 1 | | - | - | - | ----R | 81 |
| SETC | 1 | 1 | | - | - | - | ----S | 91 |
| CLRI | 1 | 1 | | - | - | - | ---- | 80 |
| SETI | 1 | 1 | | - | - | - | ---- | 90 |

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INSTRUCTION MAP

| L | H | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | A | B | C | D | E | F |
|---|----------------|----------------|-----------------|-----------------|----------------|----------------|----------------|---------------|---------------|------------------|------------------|---------------|------------------|-----------------|-----------------|-----------------|--------------|
| 0 | NOP | SWAP | RET | RETI | PUSHW A | PUSHW A | POPW A | MOV A,ext | MOVW A,PS | CLRI | SETI | CLRB dir:0 | BBC dir:0,rel | INCW A | DECW A | JMP @A | MOVW A,PC |
| 1 | MULU A | DIVU A | JMP addr16 | CALL addr16 | PUSHW IX | PUSHW IX | POPW IX | MOV ext,A | MOVW PSA | CLRC | SETC | CLRB dir:1 | BBC dir:1,rel | INCW SP | DECW SP | MOVW SPA | MOVW A,SP |
| 2 | ROLC A | CMP A | ADDC A | SUBC A | XCH A,T | XCH A,T | XOR A | AND A | OR A | MOV @A,T | MOV A,@A | CLRB dir:2 | BBC dir:2,rel | INCW IX | DECW IX | MOVW IX,A | MOVW A,IX |
| 3 | RORC A | CMPW A | ADDCW A | SUBCW A | XCHW A,T | XCHW A,T | XORW A | ANDW A | ORW A | MOVW @A,T | MOVW A,@A | CLRB dir:3 | BBC dir:3,rel | INCW EP | DECW EP | MOVW EPA | MOVW A,EP |
| 4 | MOV A,#d8 | CMP A,#d8 | ADDC A,#d8 | SUBC A,#d8 | XOR A,#d8 | XOR A,#d8 | AND A,#d8 | OR A,#d8 | OR A,#d8 | DAA | DAS | CLRB dir:4 | BBC dir:4,rel | MOVW A,ext | MOVW ext,A | MOVW A,#d16 | XCHW A,PC |
| 5 | MOV A,dir | CMP A,dir | ADDC A,dir | SUBC A,dir | XOR A,dir | MOV dir,A | AND A,dir | OR A,dir | OR A,dir | MOV dir,#d8 | CMP dir,#d8 | CLRB dir:5 | BBC dir:5,rel | MOVW A,dir | MOVW dir,A | MOVW SP,#d16 | XCHW A,SP |
| 6 | MOV A,@IX+d | CMP A,@IX+d | ADDC A,@IX+d | SUBC A,@IX+d | XOR A,@IX+d | MOV @IX+d,A | AND A,@IX+d | OR A,@IX+d | OR A,@IX+d | MOV @IX+d,#d8 | CMP @IX+d,#d8 | CLRB dir:6 | BBC dir:6,rel | MOVW A,@IX+d | MOVW @IX+d,A | MOVW IX,#d16 | XCHW A,IX |
| 7 | MOV A,@EP | CMP A,@EP | ADDC A,@EP | SUBC A,@EP | XOR A,@EP | MOV @EPA | AND A,@EP | OR A,@EP | OR A,@EP | MOV @EP,#d8 | CMP @EP,#d8 | CLRB dir:7 | BBC dir:7,rel | MOVW A,@EP | MOVW @EPA | MOVW EP,#d16 | XCHW A,EP |
| 8 | MOV A,R0 | CMP A,R0 | ADDC A,R0 | SUBC A,R0 | XOR A,R0 | MOV R0,A | AND A,R0 | OR A,R0 | OR A,R0 | MOV R0,#d8 | CMP R0,#d8 | SETB dir:0 | BBS dir:0,rel | INC R0 | DEC R0 | CALLV #0 | BNC rel |
| 9 | MOV A,R1 | CMP A,R1 | ADDC A,R1 | SUBC A,R1 | XOR A,R1 | MOV R1,A | AND A,R1 | OR A,R1 | OR A,R1 | MOV R1,#d8 | CMP R1,#d8 | SETB dir:1 | BBS dir:1,rel | INC R1 | DEC R1 | CALLV #1 | BC rel |
| A | MOV A,R2 | CMP A,R2 | ADDC A,R2 | SUBC A,R2 | XOR A,R2 | MOV R2,A | AND A,R2 | OR A,R2 | OR A,R2 | MOV R2,#d8 | CMP R2,#d8 | SETB dir:2 | BBS dir:2,rel | INC R2 | DEC R2 | CALLV #2 | BP rel |
| B | MOV A,R3 | CMP A,R3 | ADDC A,R3 | SUBC A,R3 | XOR A,R3 | MOV R3,A | AND A,R3 | OR A,R3 | OR A,R3 | MOV R3,#d8 | CMP R3,#d8 | SETB dir:3 | BBS dir:3,rel | INC R3 | DEC R3 | CALLV #3 | BN rel |
| C | MOV A,R4 | CMP A,R4 | ADDC A,R4 | SUBC A,R4 | XOR A,R4 | MOV R4,A | AND A,R4 | OR A,R4 | OR A,R4 | MOV R4,#d8 | CMP R4,#d8 | SETB dir:4 | BBS dir:4,rel | INC R4 | DEC R4 | CALLV #4 | BNZ rel |
| D | MOV A,R5 | CMP A,R5 | ADDC A,R5 | SUBC A,R5 | XOR A,R5 | MOV R5,A | AND A,R5 | OR A,R5 | OR A,R5 | MOV R5,#d8 | CMP R5,#d8 | SETB dir:5 | BBS dir:5,rel | INC R5 | DEC R5 | CALLV #5 | BZ rel |
| E | MOV A,R6 | CMP A,R6 | ADDC A,R6 | SUBC A,R6 | XOR A,R6 | MOV R6,A | AND A,R6 | OR A,R6 | OR A,R6 | MOV R6,#d8 | CMP R6,#d8 | SETB dir:6 | BBS dir:6,rel | INC R6 | DEC R6 | CALLV #6 | BGE rel |
| F | MOV A,R7 | CMP A,R7 | ADDC A,R7 | SUBC A,R7 | XOR A,R7 | MOV R7,A | AND A,R7 | OR A,R7 | OR A,R7 | MOV R7,#d8 | CMP R7,#d8 | SETB dir:7 | BBS dir:7,rel | INC R7 | DEC R7 | CALLV #7 | BLT rel |

MB89140 Series

■ MASK OPTIONS

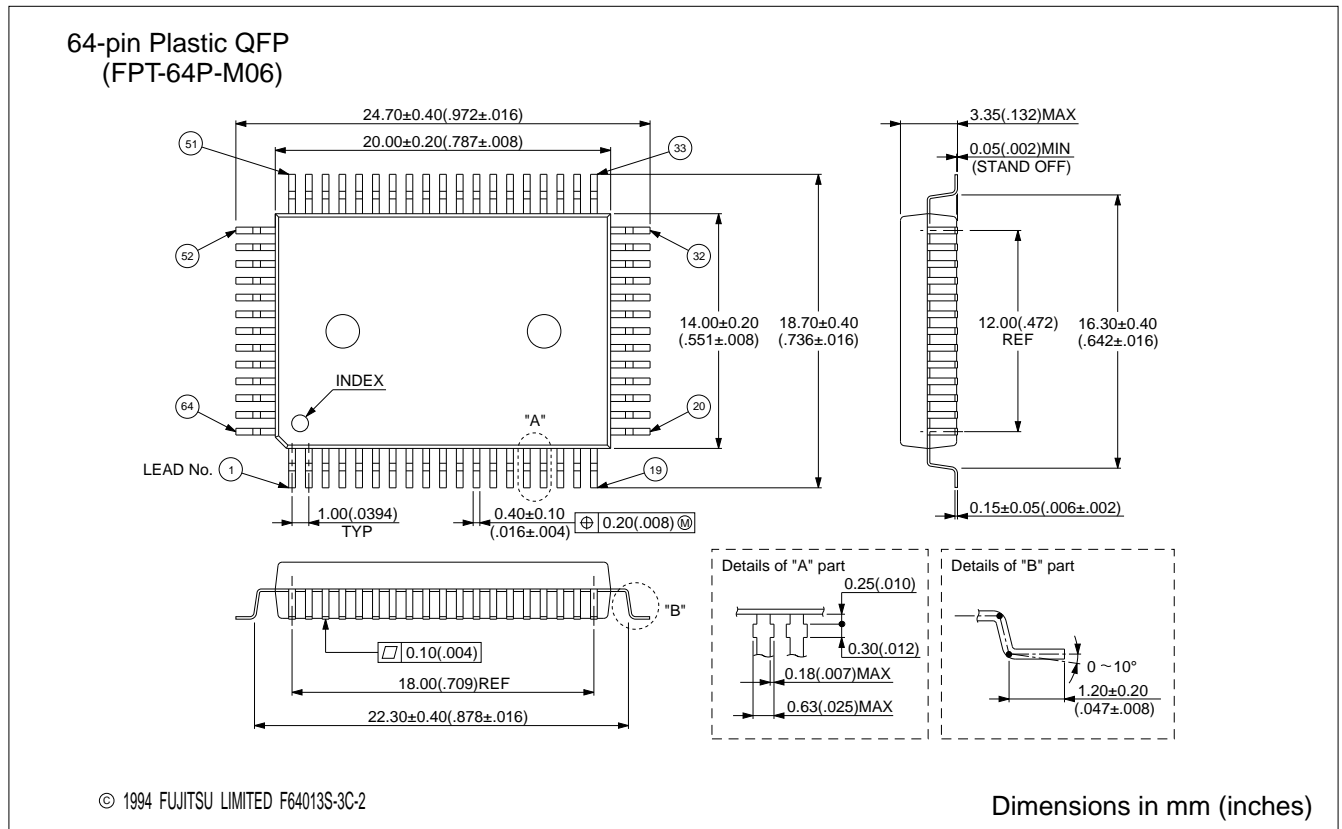
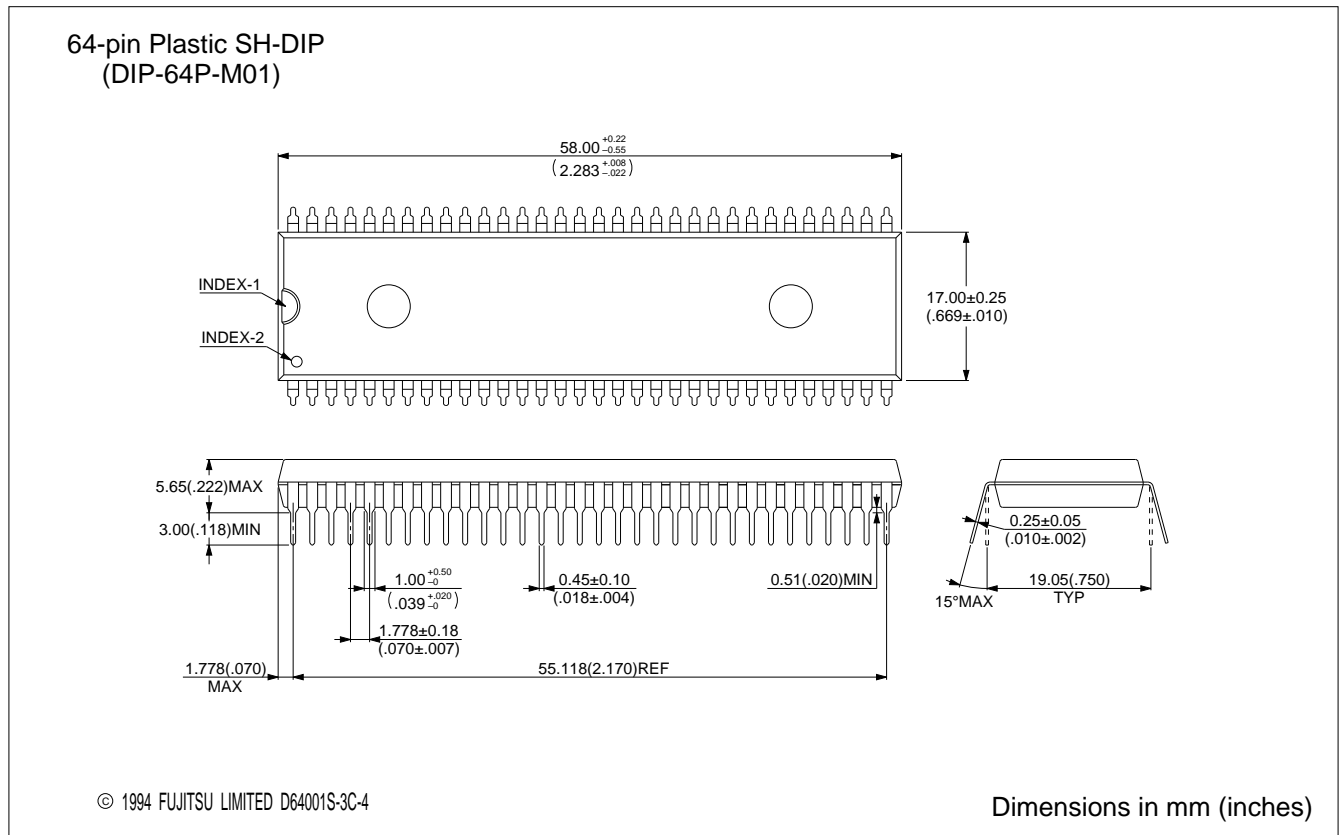
| No. | Part number Parameter | MB89PV140 | MB89PV140 | MB89145V1 | MB89145V2 | MB89P147V1 | MB89P147V2 |
|-----|---|-----------------------------------|------------|---|----------------------------------|---|----------------------------------|
| | | -101 | -102 | MB89146V1 | MB89146V2 | | |
| 1 | Power-on reset ┌ With power-on reset └ Without power-on reset | Fixed to with power-on reset | | Specify when ordering masking | | Set with EPROM programmer | |
| 2 | Reset pin output ┌ With reset output └ Without reset output | Fixed to with power-on reset | | Specify when ordering masking | | Set with EPROM programmer | |
| 3 | Clock mode selection ┌ Single-clock mode └ Dual-clock mode | Single clock | Dual clock | Specify when ordering masking | | Set with EPROM programmer | |
| 4 | Pull-up resistors ┌ P14 to P17 └ P32 to P37 | Fixed to without pull-up resistor | | Specify when ordering masking (specify by pin) | | Set with EPROM programmer (specify by pin) | |
| 5 | Pull-down resistors ┌ P47 to P40 └ P57 to P50 └ P67 to P60 | Fixed to without pull-up resistor | | Without pull-down resistor | All pins with pull-down resistor | Without pull-down resistor | All pins with pull-down resistor |

■ ORDERING INFORMATION

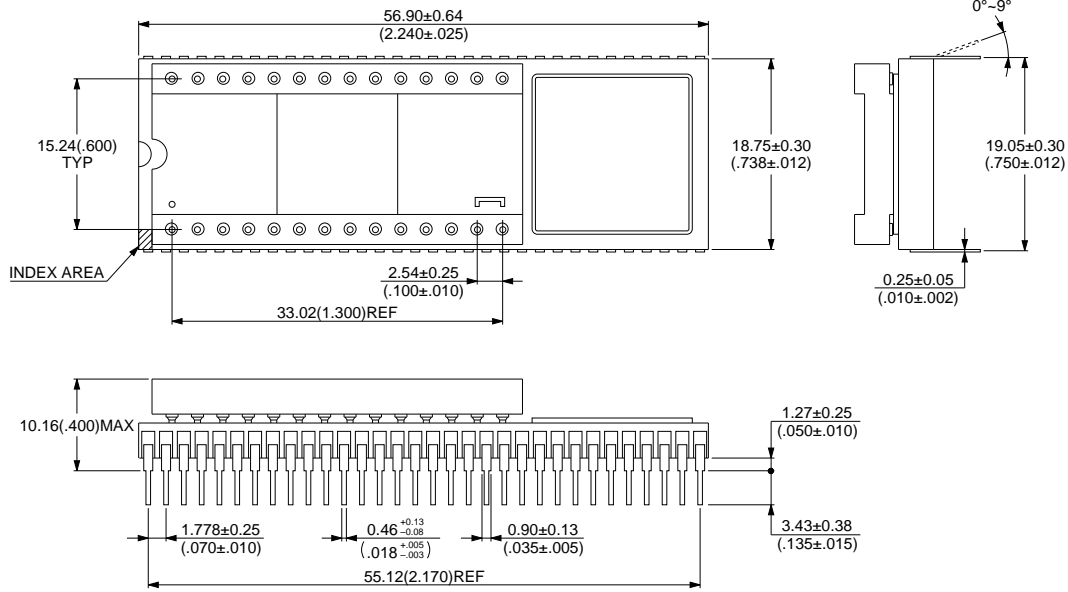
| Part number | Package | Remarks |
|--|--|---------|
| MB89145V1P-SH MB89145V2P-SH MB89146V1P-SH MB89146V2P-SH MB89P147V1P-SH MB89P147V2P-SH | 64-pin Plastic SH-DIP (DIP-64P-M01) | |
| MB89145V1PF MB89145V2PF MB89146V1PF MB89146V2PF MB89P147V1PF MB89P147V2PF | 64-pin Plastic QFP (FPT-64P-M06) | |
| MB89PV140C-101-ES-SH MB89PV140C-102-ES-SH | 64-pin Ceramic MDIP (MDP-64C-P02) | |
| MB89PV140CF-101-ES MB89PV140CF-102-ES | 64-pin Ceramic MQFP (MQP-64C-P01) | |

MB89140 Series

■ PACKAGE DIMENSIONS



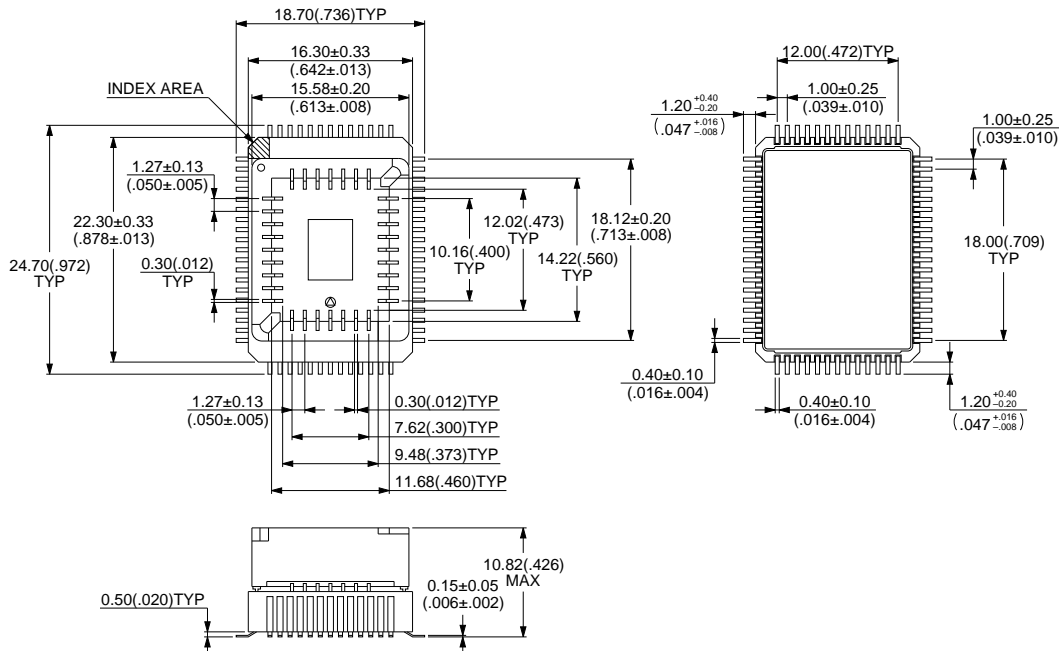
64-pin Ceramic MDIP
(MDP-64C-P02)



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Dimensions in mm (inches)

64-pin Ceramic MQFP
(MQP-64C-P01)



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Dimensions in mm (inches)

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