

8-bit Proprietary Microcontroller

CMOS

F²MC-8L MB89820 Series

MB89821/823R/825/P825/PV820

DESCRIPTION

MB89820 series is a line of single-chip microcontrollers using the F²MC-8L* CPU core which can operate at low voltage but at high speed. In addition to an LCD controller/driver allowing 200-pixel display the microcontrollers contain a variety of peripheral functions such as timers, a UART, a serial interface, and an external interrupt. The configuration of the MB89820 series is therefore best suited to control of LCD display panels.

* : F²MC stands for FUJITSU Flexible Microcontroller.

FEATURES

- Minimum execution time : 0.8 μ s/5 MHz ($V_{CC} = +5.0$ V)
- F²MC-8L family CPU core

Instruction set optimized for controllers

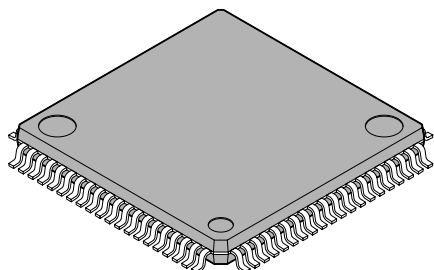
Multiplication and division instructions
16-bit arithmetic operations
Test and branch instructions
Bit manipulation instructions, etc.

- LCD controller/driver
Max 50 segments \times 4 commons
Divided resistor for LCD power supply

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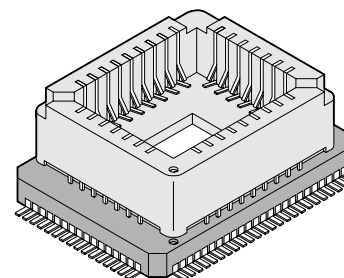
PACKAGES

80 Pin Plastic QFP



(FTP-80P-M11)

80 Pin Plastic MQFP



(MQP-80C-P01)

MB89820 Series

(Continued)

- Three types of timers
 - 8-bit PWM timer (also usable as a reload timer)
 - 8-bit pulse width count timer (also usable as a reload timer)
 - 20-bit time-base timer
- Two serial interfaces
 - 8-bit synchronous serial interface (Switchable transfer direction allows communication with various equipment.)
 - UART (5-, 7-, 8-bit transfer capable)
- External interrupt : 2 channels
 - Capable of wake-up from low-power consumption modes (with an edge detection function)
- 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.)

■ PRODUCT LINEUP

| Part number | MB89821 | MB89823R | MB89825 | MB89P825 | MB89PV820 |
|----------------------------------|--|--|---|--|--|
| Classification | Mass production product (mask ROM products) | | | One-time PROM product | Piggyback/ evaluation product for evaluation and development |
| ROM size | 4 K × 8 bits (internal mask ROM) | 8 K × 8 bits (internal mask ROM) | 16 K × 8 bits (internal mask ROM) | 16 K × 8 bits (internal PROM, programming with general- purpose EPROM programmer) | 32 K × 8 bits (external ROM) |
| RAM size | 128 × 8 bits | 256 × 8 bits | | | 1024 × 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: | | 0.8 μs/5 MHz (V _{CC} = 5.0 V) | | |
| | Interrupt processing time: | | 7.2 μs/5 MHz (V _{CC} = 5.0 V) | | |
| Ports | I/O ports (N-ch open-drain): | | 16 (All also serve as segment pins.)*1 | | |
| | I/O ports (N-ch open-drain): | | 6 | | |
| | I/O ports (CMOS): | | 6 (5 ports also serve as peripheral I/O.) | | |
| | Input ports: | | 4 (1 port also serves as an external interrupt input.) | | |
| | Total: | | 32 (Max) | | |
| 8-bit PWM timer | 8-bit reload timer operation (toggled output capable) 8-bit resolution PWM operation Operating clock (pulse width count timer output: 0.8 μs, 12.8 μs, 51.2 μs/5 MHz) | | | | |
| 8-bit pulse width count timer | 8-bit reload timer operation 8-bit pulse width count operation (continuous measurement capable "H" width, "L" width, or single-cycle measurement capable) Operating clock (0.8 μs, 3.2 μs, 25.6 μs/5 MHz) | | | | |

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MB89820 Series

(Continued)

| Part number | MB89821 | MB89823R | MB89825 | MB89P825 | MB89PV820 |
|-----------------------|---|----------|---------|----------------|-------------------------------|
| Parameter | | | | | |
| 8-bit serial I/O | 8 bits One clock selectable from four transfer clocks (one external shift clock, three internal shift clock, three internal shift clocks: 1.6 μ s, 6.4 μ s, 25.6 μ s/5 MHz) LSB first/MSB first selectability | | | | |
| UART | 5-, 7-, 8-bit transfer capable Internal baud-rate generator (Max 78125 bps/5 MHz) | | | | |
| LCD controller/driver | Common output: 4 Segment output: 50 (Max) Operating mode: 1/2 bias, 1/2 duty; 1/3 bias, 1/3 duty; 1/3 bias, 1/4 duty LCD display RAM size: 50 \times 4 bits Dividing resistor for LCD driving: Built-in (An external resistor selectable) | | | | |
| External interrupt | 2 channels (edge selectable) (1 channel also serves as a pulse width count timer input) | | | | |
| Standby mode | Sleep mode, stop mode | | | | |
| Process | CMOS | | | | |
| Operating voltage*2 | 2.2 V*3 to 6.0 V | | | 2.7 V to 6.0 V | |
| EPROM for use | | | | | MBM27C256A-20TV (LCC package) |

*1: The function is selected by the mask option.

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

*3: The operation at less than 2.2 V is assured separately. Please contact FUJITSU LIMITED.

■ PACKAGE AND CORRESPONDING PRODUCTS

| Package | MB89821 MB89823R MB89825 MB89P825 | MB89PV820 |
|-------------|--|-----------|
| FPT-80P-M11 | ○ | × |
| MQP-80C-P01 | × | ○ |

○ : Available × : Not available

Note: For more information about each package, see section "■ Package Dimensions."

MB89820 Series

■ 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 MB89821, the register bank address upper than 0140_H cannot be used. On the MB89823R, MB89825 and MB89P825, each register bank addresses upper than 0180_H can be used.
- On the MB89P825, addresses BFF0_H to BFF6_H comprise the option setting area, option settings can be read by reading these addresses.
- The stack area, etc., is set at the upper limit of the RAM.

2. Current Consumption

- In the case of the MB89PV820, add the current consumed by the EPROM which is connected to the top socket.
- However, the current consumption in sleep/stop modes is the same. (For more information, see section “■ Electrical Characteristics.”)

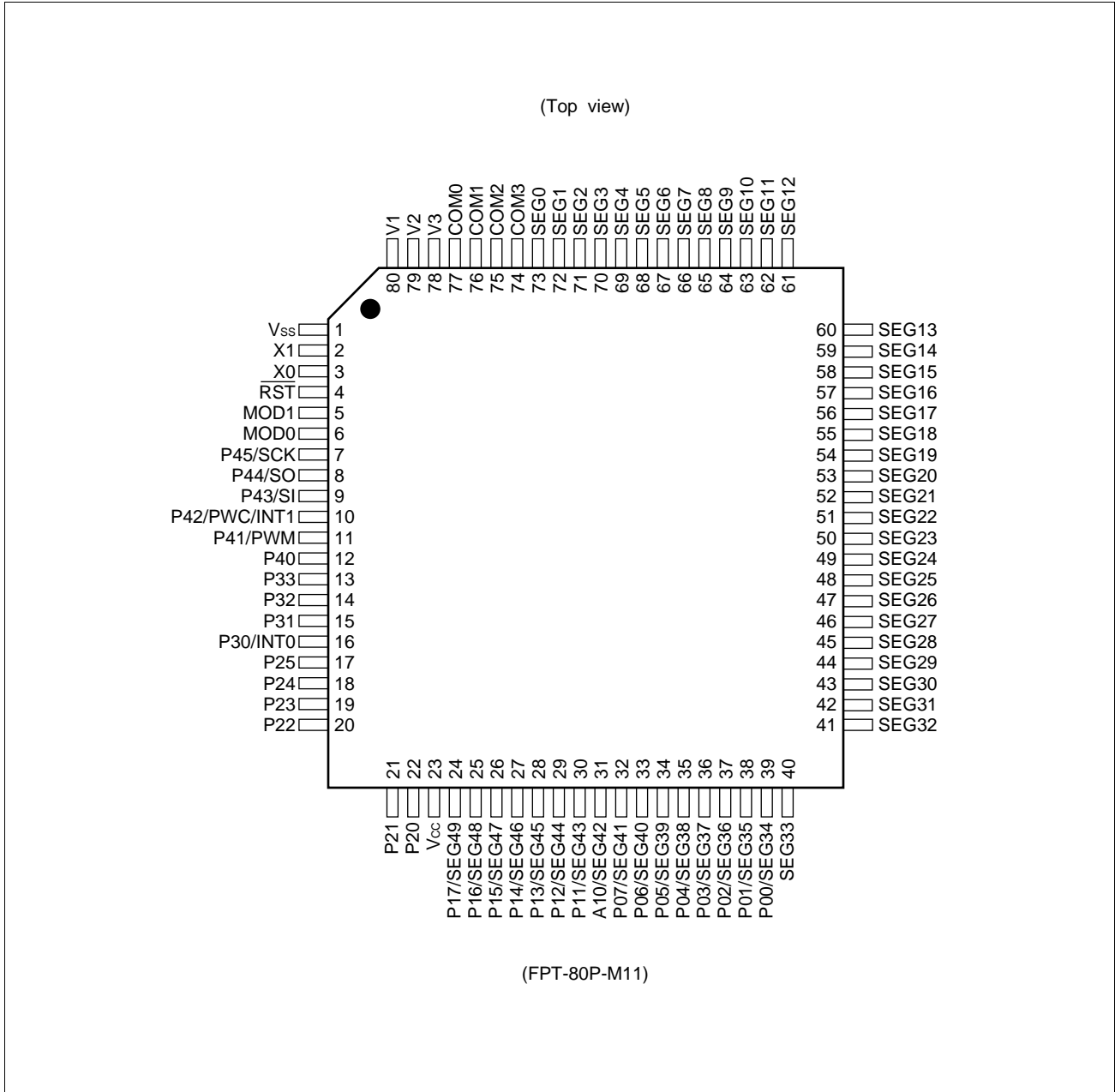
3. Mask Options

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

Before using options check section “■ Mask Options.”

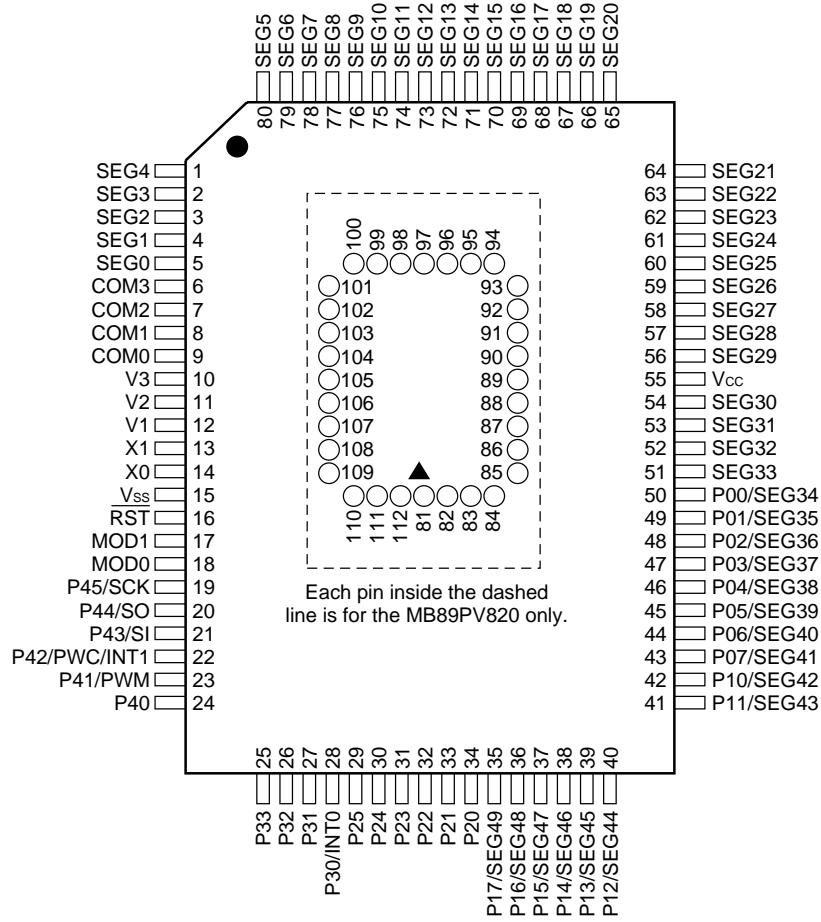
Take particular care on the following point : Options are fixed on the MB89PV820.

PIN ASSIGNMENT



MB89820 Series

(Top view)



(MQP-80C-P01)

• Pin assignment on package top (MB89PV820 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 | \overline{OE} |
| 82 | V_{PP} | 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 | \overline{CE} | 111 | A14 |
| 88 | A3 | 96 | V_{SS} | 104 | A10 | 112 | V_{CC} |

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

■ PIN DESCRIPTION

| Pin no. | | Pin name | Circuit type | Function |
|----------|----------|------------------------|--------------|--|
| QFP*1 | MQFP*2 | | | |
| 3 | 14 | X0 | A | Clock crystal oscillator pins |
| 2 | 13 | X1 | | |
| 6 | 18 | MOD0 | B | Operating mode selection pins Connect directly to V _{SS} . |
| 5 | 17 | MOD1 | | |
| 4 | 16 | RST | C | Reset I/O pin This pin is an N-ch open-drain type with a pull-up resistor, and a hysteresis input type. "L" is output from this pin by an internal reset source (optional function). The internal circuit is initialized by the input of "L". |
| 39 to 32 | 50 to 43 | P00/SEG34 to P07/SEG41 | D | General-purpose N-ch open-drain I/O ports Also serve as an LCD controller/driver segment output. The port and segment output are switched by mask option in 8-bit unit. |
| 31 to 24 | 42 to 35 | P10/SEG42 to P17/SEG49 | D | General-purpose N-ch open-drain I/O ports Also serve as an LCD controller/driver segment output. The port and segment output are switched by mask option in 4 to 1-bit unit. |
| 22 to 17 | 34 to 29 | P20 to P25 | F | General-purpose N-ch open-drain I/O ports A pull-up resistor option is provided. |
| 16 | 28 | P30/INT0 | H | General-purpose input port The input is hysteresis input. Also serves as an external interrupt input (INT0). A pull-up resistor option is provided. |
| 15 to 13 | 27 to 25 | P31 to P33 | H | General-purpose input ports These pins are a hysteresis input type. A pull-up resistor option is provided. |
| 12 | 24 | P40 | E | General-purpose I/O port A pull-up resistor option is provided. |
| 11 | 23 | P41/PWM | E | General-purpose I/O port A pull-up resistor option is provided. Also serves as an 8-bit PWM timer toggle output (PWM). |
| 10 | 22 | P42/PWC/INT1 | E | General-purpose I/O port A pull-up resistor option is provided. Also serves as an 8-bit pulse width count timer input (PWC) and an external interrupt input (INT1). The PWC and INT1 input is hysteresis input. |
| 9 | 21 | P43/SI | E | General-purpose I/O port A pull-up resistor option is provided. Also serves as an 8-bit serial I/O and a UART data input (SI). The SI input is hysteresis input. |

*1: FPT-80P-M11

*2: MQP-80C-P01

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MB89820 Series

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| Pin no. | | Pin name | Circuit type | Function |
|----------|----------------------------------|------------------|--------------|---|
| QFP*1 | MQFP*2 | | | |
| 8 | 20 | P44/SO | E | General-purpose I/O port A pull-up resistor option is provided. Also serves as a serial I/O and a UART data output (SO). |
| 7 | 19 | P45/SCK | E | General-purpose I/O port A pull-up resistor option is provided. Also serves as a serial I/O and a UART clock I/O (SCK). The SCK input is hysteresis input. |
| 73 to 40 | 5 to 1, 80 to 56, 54 to 51 | SEG0 to SEG33 | G | LCD controller/driver segment output pins |
| 77 to 74 | 9 to 6 | COM0 to COM3 | G | LCD controller/driver common output pins |
| 80 to 78 | 12 to 10 | V1 to V3 | — | LCD driving power supply pins |
| 23 | 55 | V _{cc} | — | Power supply pin |
| 1 | 15 | V _{ss} | — | Power supply (GND) pin |

*1: FPT-80P-M11

*2: MQP-80C-P01

MB89820 Series

- External EPROM pins (MB89PV820 only)

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

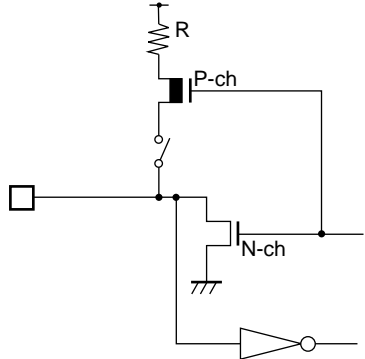
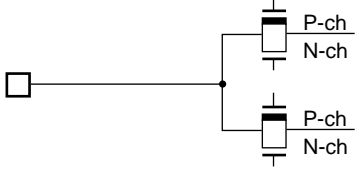
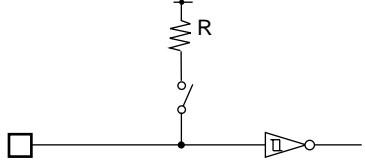
MB89820 Series

I/O CIRCUIT TYPE

| Type | Circuit | Remarks |
|------|--|---|
| A | <p>Standby control signal</p> | <ul style="list-style-type: none"> • Crystal oscillator circuit • At an oscillation feedback resistor of approximately 1 MΩ/5.0 V |
| B | | |
| C | <p>R</p> <p>P-ch</p> <p>N-ch</p> | <ul style="list-style-type: none"> • At an output pull-up resistor (P-ch) of approximately 50 kΩ/5.0 V • Hysteresis input |
| D | <p>P-ch</p> <p>N-ch</p> <p>P-ch</p> <p>N-ch</p> <p>N-ch</p> <p>Port</p> | <ul style="list-style-type: none"> • N-ch open-drain output • CMOS input <p>• Segment output optional</p> |
| E | <p>R</p> <p>P-ch</p> <p>P-ch</p> <p>N-ch</p> <p>N-ch</p> <p>Peripheral</p> <p>Port</p> | <ul style="list-style-type: none"> • CMOS output • CMOS input • Hysteresis input (peripheral input) <p>• Pull-up resistor optional</p> |

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| Type | Circuit | Remarks |
|------|---|---|
| F |  | <ul style="list-style-type: none"> • N-ch open-drain output • CMOS input • Pull-up resistor optional |
| G |  | <ul style="list-style-type: none"> • LCD controller/driver |
| H |  | <ul style="list-style-type: none"> • Hysteresis input • Pull-up resistor optional |

■ 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} .

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 $AV_{CC} = DA_{VC} = V_{CC}$ and $AV_{SS} = AVR = V_{SS}$ even if the A/D and D/A converters are not in use.

4. Treatment of N.C. Pins

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 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 to 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 MB89P825

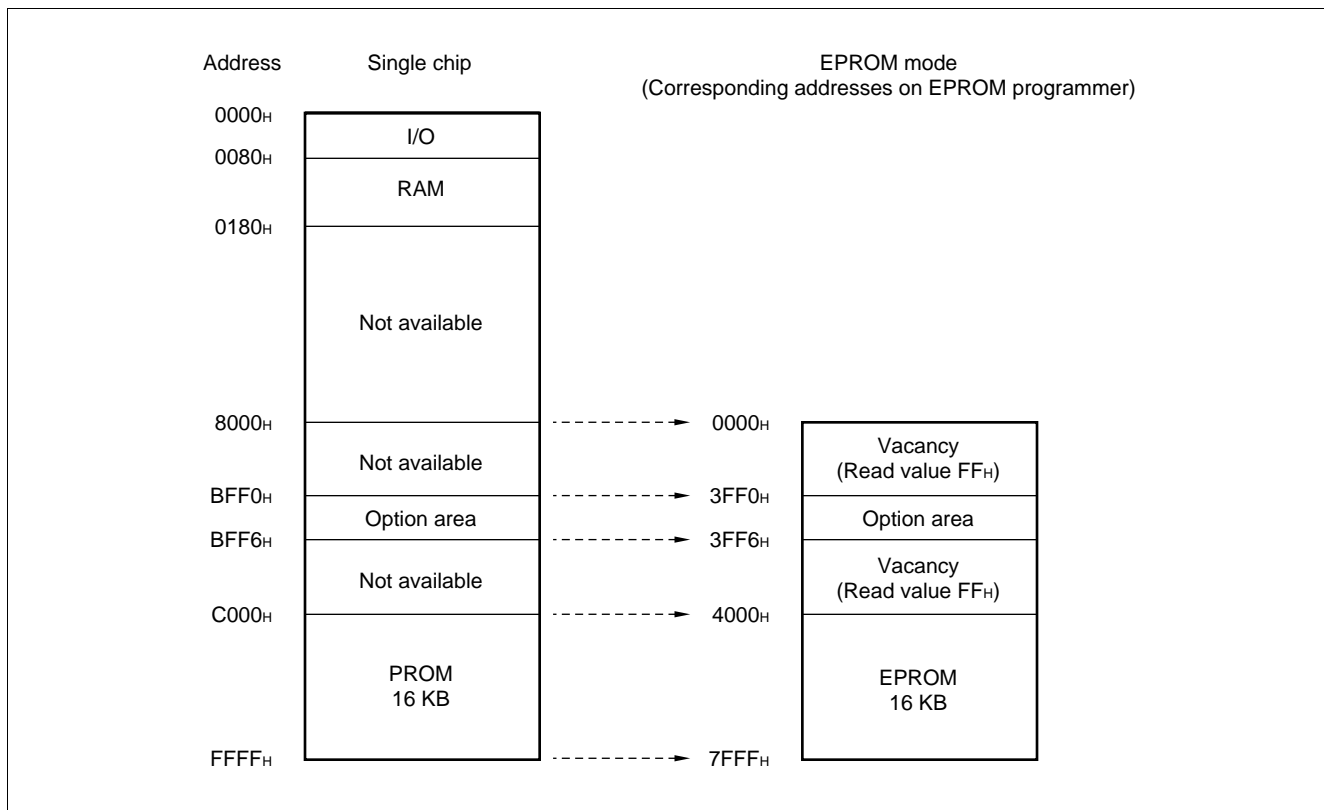
The MB89P825 is an OTPROM (one-time PROM) version for the MB89820 series.

1. Features

- 16-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 EPROM mode is diagrammed below.



3. Programming to the EPROM

In EPROM mode, the MB89P825 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.

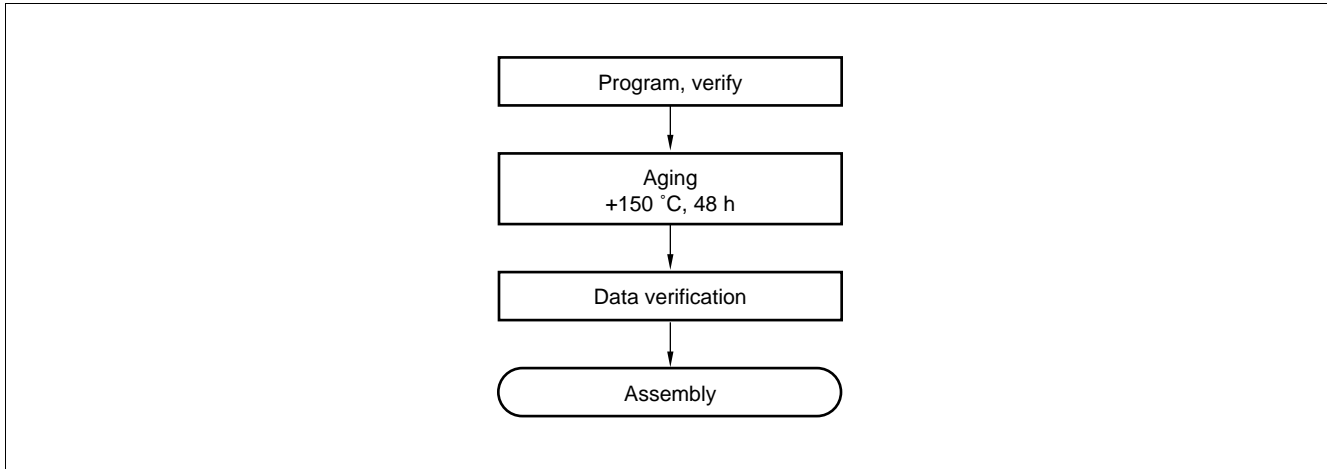
• Programming procedure

- (1) Set the EPROM programmer to the MBM27C256A.
- (2) Load program data into the EPROM programmer at 4000_H to 7FFF_H (note that addresses C000_H to FFFF_H while operating as a single chip assign to 4000_H to 7FFF_H in EPROM mode).
Load option data into addresses 3FF0_H to 3FF5_H of the EPROM programmer. (For information about each corresponding option, see "7. OTPROM Option Bit Map.")
- (3) Program with the EPROM programmer.

MB89820 Series

4. Recommended Screening Conditions

High-temperature aging is recommended as the pre-assembly screening procedure for a product 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 |
|-------------|---------------------------|
| FPT-80P-M11 | ROM-80QF2-28DP-8L3 |

Inquiry: Sunhayato Corp. : TEL : +81-3-3984-7791
FAX : +81-3-3971-0535
E-mail : adapter@sunhayato.co.jp

7. OTPROM Option Bit Map

| | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|-------------------|---------------------|---------------------|--------------------------------|--------------------------------|--------------------------------|-------------------------------------|--|-----------------------------------|
| 3FF0 _H | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | Reset pin output 1: Yes 0: No | Oscillation stabilization time 1: 2 ¹⁸ /F _C 0: 2 ¹⁴ /F _C | Power-on reset 1: Yes 0: No |
| 3FF1 _H | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable |
| 3FF2 _H | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable |
| 3FF3 _H | Vacancy Readable | Vacancy Readable | P25 Pull-up 1: No 0: Yes | P24 Pull-up 1: No 0: Yes | P23 Pull-up 1: No 0: Yes | P22 Pull-up 1: No 0: Yes | P21 Pull-up 1: No 0: Yes | P20 Pull-up 1: No 0: Yes |
| 3FF4 _H | Vacancy Readable | Vacancy Readable | P45 Pull-up 1: No 0: Yes | P44 Pull-up 1: No 0: Yes | P43 Pull-up 1: No 0: Yes | P42 Pull-up 1: No 0: Yes | P41 Pull-up 1: No 0: Yes | P40 Pull-up 1: No 0: Yes |
| 3FF5 _H | Vacancy Readable | Vacancy Readable | Vacancy Readable | Vacancy Readable | P33 Pull-up 1: No 0: Yes | P32 Pull-up 1: No 0: Yes | P31 Pull-up 1: No 0: Yes | P30 Pull-up 1: No 0: Yes |

- 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.

MB89820 Series

■ PROGRAMMING TO THE EPROM WITH PIGGYBACK/EVALUATION DEVICE

1. EPROM for Use

MBM27C256A-20TV

2. Programming Socket Adapter

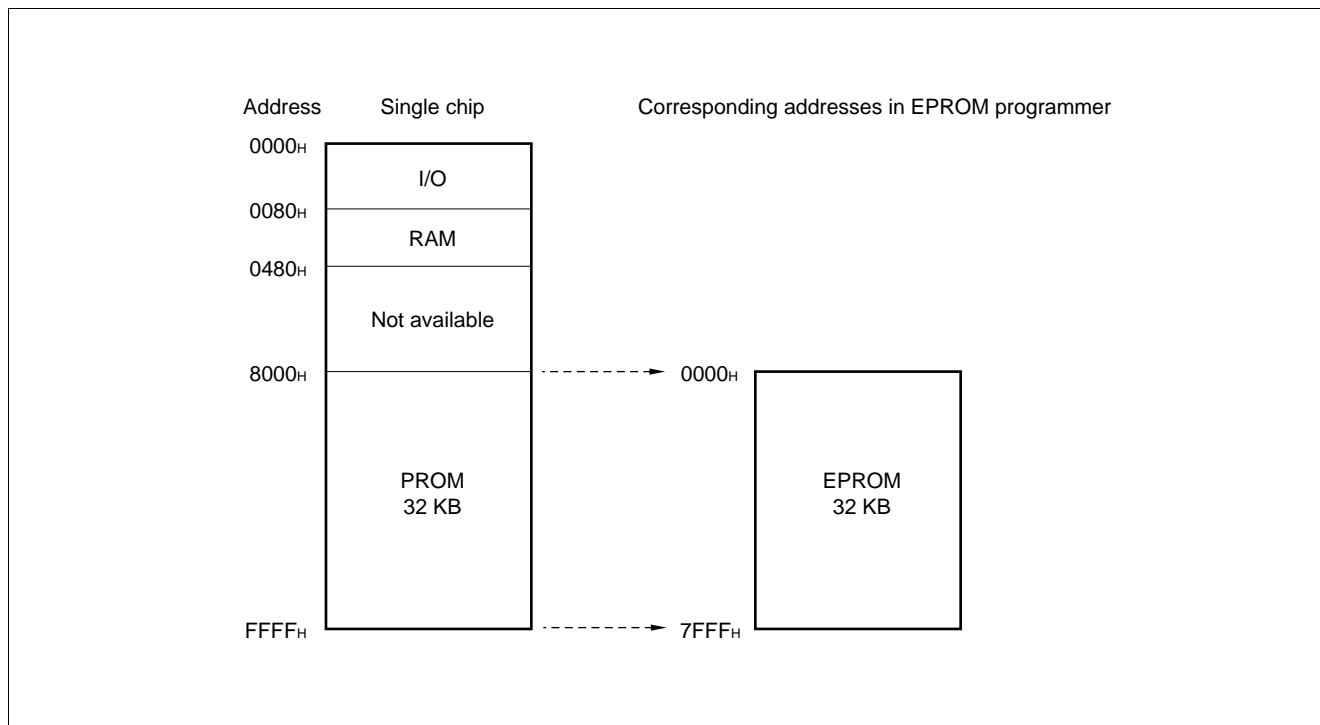
To program to the PROM using an EPROM programmer, use the socket adapter (manufacturer: Sunhayato Corp.) listed below.

| 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

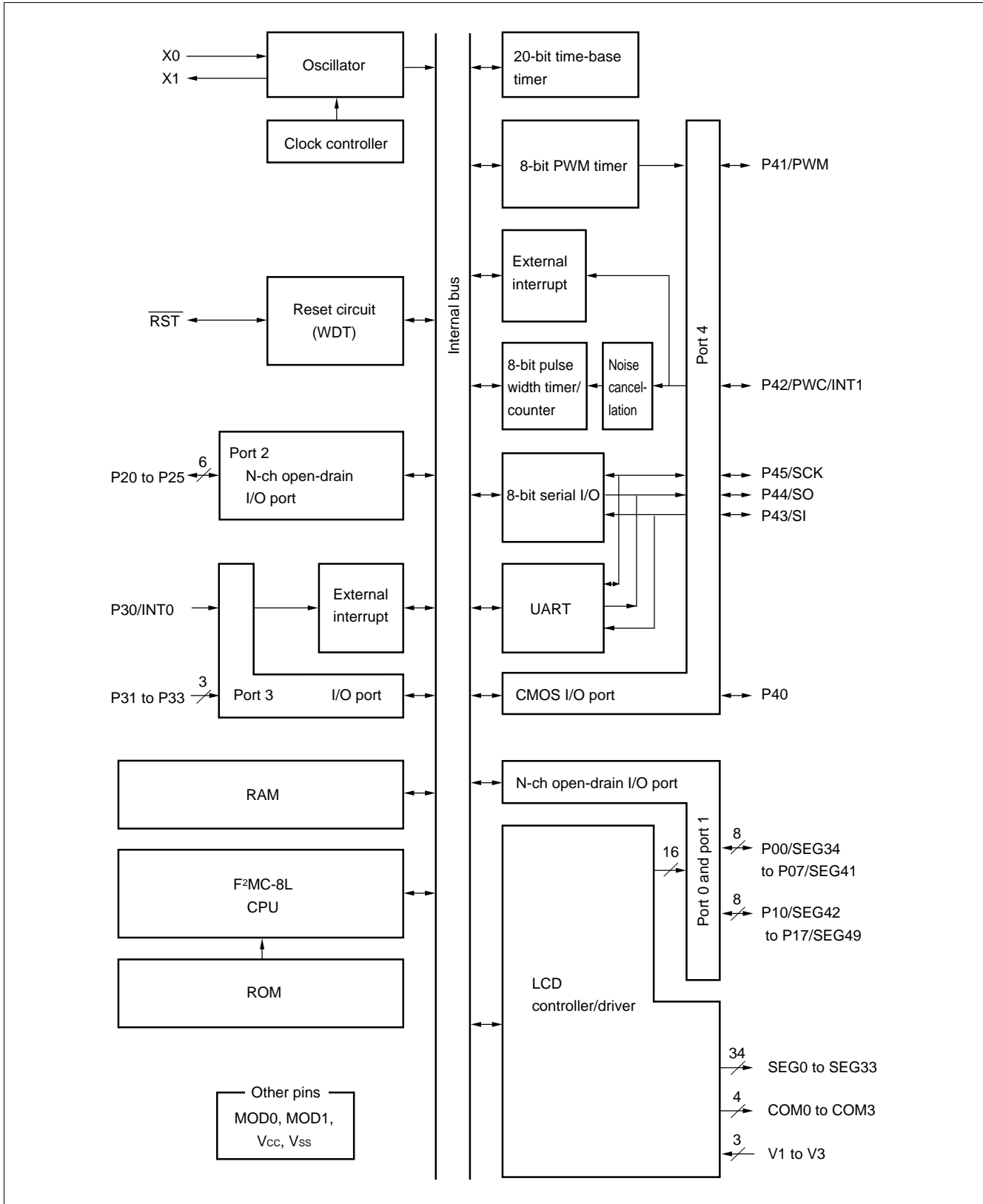
Memory space in each mode, such as 32 Kbyte PROM, option area is diagrammed below.



4. Programming to the EPROM

- (1) Set the EPROM programmer to the MBM27C256A.
- (2) Load program data into the EPROM programmer at 0000H to 7FFFH.
- (3) Program to 0000H to 7FFFH with the EPROM programmer.

■ BLOCK DIAGRAM

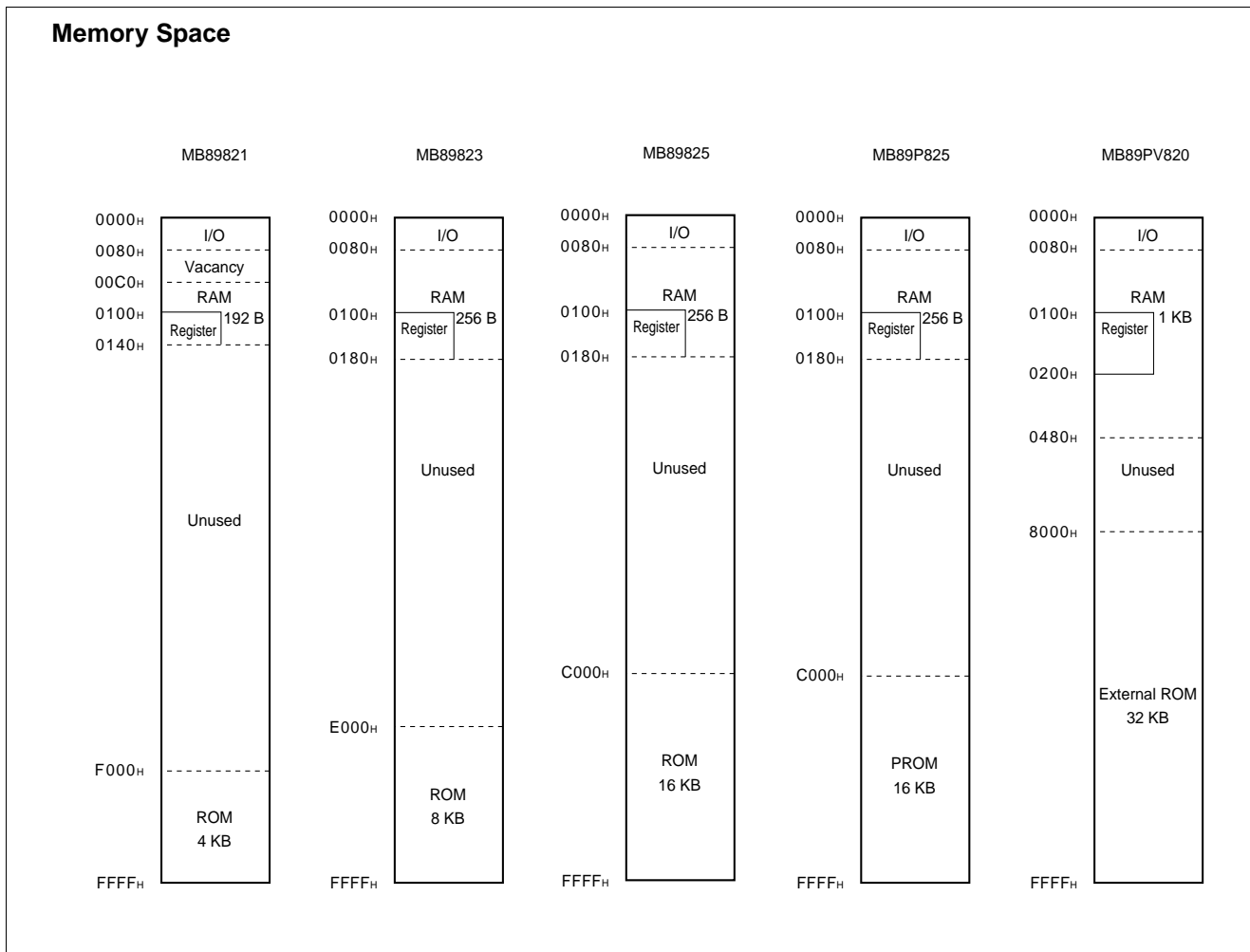


MB89820 Series

■ CPU CORE

1. Memory Space

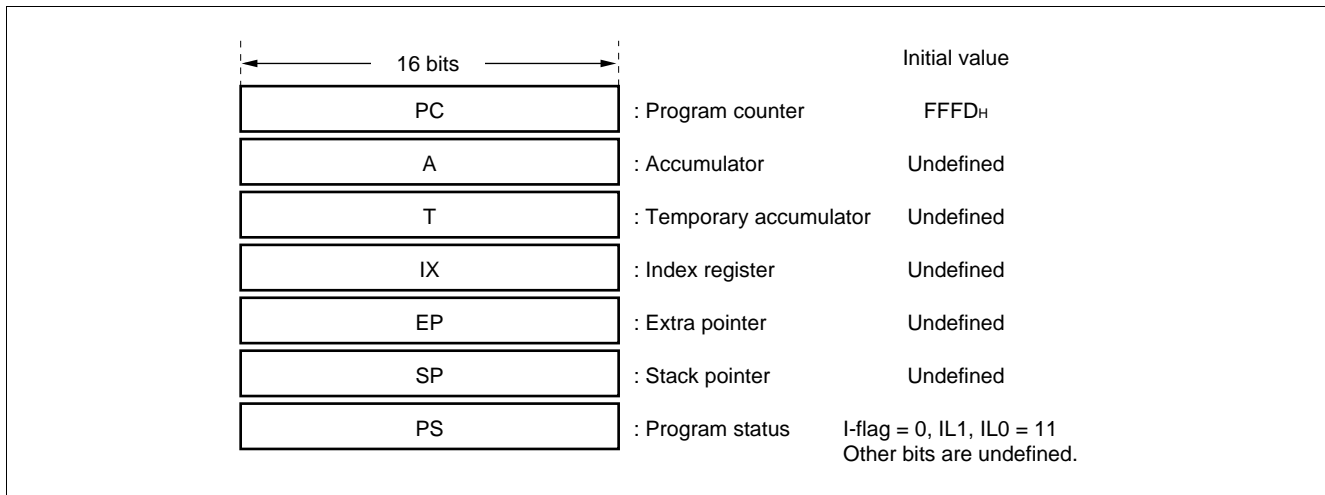
The microcontrollers of the MB89820 series offer a memory space of 64 Kbytes for storing all of I/O, data, and program areas. The I/O area is located at the lowest address. The data area is provided immediately above the I/O area. The data area can be divided into register, stack, and direct areas according 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 MB89820 series is structured as illustrated below.



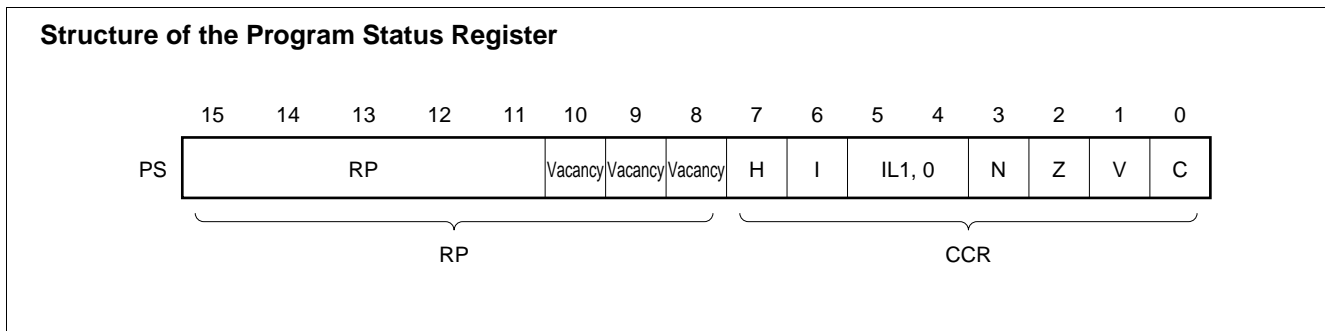
2. Registers

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

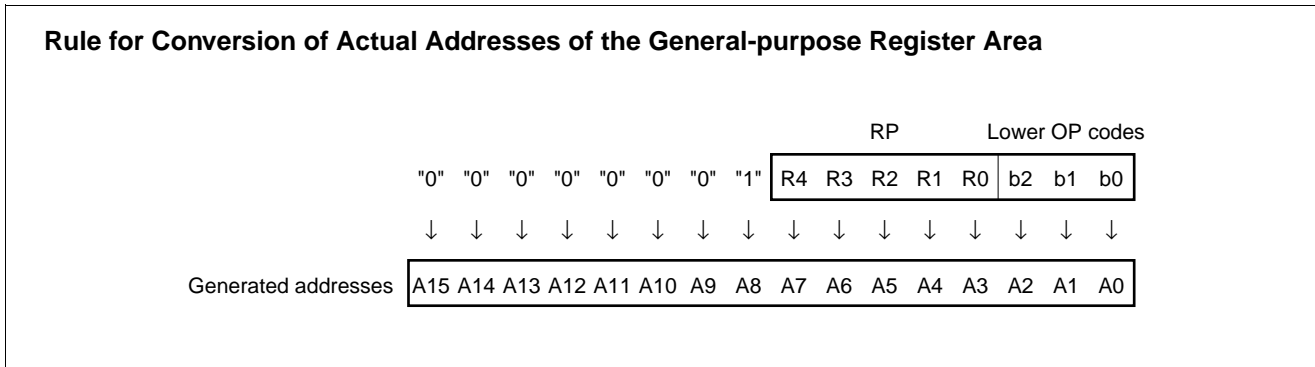


The PS can further be divided into higher 8 bits for use as a register bank pointer (RP) and the lower 8 bits for use as a condition code register (CCR). (See the diagram below.)



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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.



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 | High |
| 0 | 1 | | ↑ |
| 1 | 0 | 2 | ↓ |
| 1 | 1 | 3 | Low = no interrupt |

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.

MB89820 Series

The following general-purpose registers are provided:

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

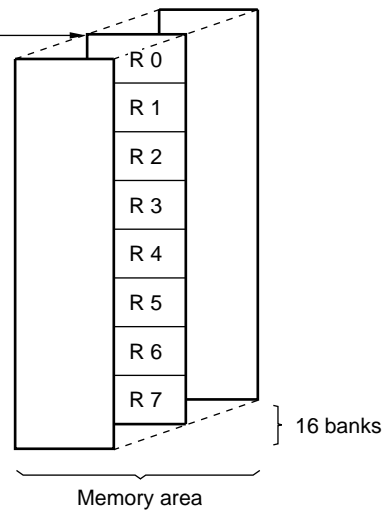
The general-purpose registers are 8 bits and located in the register banks of the memory. One bank contains eight registers and up to a total of 16 banks can be used on the MB89823R/825 (RAM 256×8 bits). The bank currently in use is indicated by the register bank pointer (RP).

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

| | | |
|-----------|--|----------|
| MB89821 | 0100 _H to 013F _H | 8 banks |
| MB89823R | 0100 _H to 017F _H | 16 banks |
| MB89825 | 0100 _H to 017F _H | 16 banks |
| MB89P825 | 0100 _H to 017F _H | 16 banks |
| MB89PV820 | 0100 _H to 01FF _H | 32 banks |

Register Bank Configuration

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



MB89820 Series

■ I/O MAP

| Address | Read/write | Register name | Register description |
|---------|------------|---------------|---|
| 00H | (R/W) | PDR0 | Port 0 data register |
| 01H | | | Vacancy |
| 02H | (R/W) | PDR1 | Port 1 data register |
| 03H | | | Vacancy |
| 04H | (R/W) | PDR2 | Port 2 data register |
| 05H | | | Vacancy |
| 06H | | | Vacancy |
| 07H | | | Vacancy |
| 08H | (R/W) | STBC | Standby control register |
| 09H | (R/W) | WDTA | Watchdog timer control register |
| 0AH | (R/W) | TBCR | Time-base timer control register |
| 0BH | | | Vacancy |
| 0CH | (R) | PDR3 | Port 3 data register |
| 0DH | | | Vacancy |
| 0EH | (R/W) | PDR4 | Port 4 data register |
| 0FH | (W) | DDR4 | Port 4 data direction register |
| 10H | | | Vacancy |
| 11H | | | Vacancy |
| 12H | (R/W) | CNTR | PWM timer control register |
| 13H | (W) | COMR | PWM timer compare register |
| 14H | (R/W) | PCR1 | PWC pulse width control register 1 |
| 15H | (R/W) | PCR2 | PWC pulse width control register 2 |
| 16H | (R/W) | RLBR | PWC reload buffer register |
| 17H | (R/W) | NCCR | PWC noise cancellation control register |
| 18H | | | Vacancy |
| 19H | | | Vacancy |
| 1AH | | | Vacancy |
| 1BH | | | Vacancy |
| 1CH | (R/W) | SMR | Serial mode register |
| 1DH | (R/W) | SDR | Serial data register |
| 1EH | | | Vacancy |
| 1FH | | | Vacancy |

(Continued)

MB89820 Series

(Continued)

| Address | Read/write | Register name | Register description |
|------------------------------------|------------|---------------|--|
| 20 _H | (R/W) | SMC1 | UART serial mode control register 1 |
| 21 _H | (R/W) | SRC | UART serial rate control register |
| 22 _H | (R/W) | SSD | UART serial status/data register |
| 23 _H | (R/W) | SIDR/SODR | UART serial data register |
| 24 _H | (R/W) | SMC2 | UART serial mode control register 2 |
| 25 _H | | | Vacancy |
| 26 _H | | | Vacancy |
| 27 _H | | | Vacancy |
| 28 _H | | | Vacancy |
| 29 _H | | | Vacancy |
| 2A _H | | | Vacancy |
| 2B _H | | | Vacancy |
| 2C _H | | | Vacancy |
| 2D _H | | | Vacancy |
| 2E _H | | | Vacancy |
| 2F _H | | | Vacancy |
| 30 _H | (R/W) | EIC1 | External interrupt 1 control register |
| 31 _H to 5F _H | | | Vacancy |
| 60 _H to 78 _H | (R/W) | VRAM | Display data RAM |
| 79 _H | (R/W) | LCR1 | LCD controller/driver control register |
| 7A _H | (R/W) | SEGR | Segment output selection register |
| 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.

MB89820 Series

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

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

| Parameter | Symbol | Value | | Unit | Remarks |
|----------------------------------|-----------------|----------------|----------------|------|---|
| | | Min | Max | | |
| Power supply voltage | V_{CC} | $V_{SS} - 0.3$ | $V_{SS} + 7.0$ | V | |
| LCD power supply voltage | V_3 | $V_{SS} - 0.3$ | $V_{SS} + 7.0$ | V | V3 pin |
| Input voltage | V_{I1} | $V_{SS} - 0.3$ | $V_{CC} + 0.3$ | V | V_{I1} must not exceed $V_{SS} + 7.0\text{ V}$. Except P00 to P07 and P10 to P17 for the MB89P825/PV820, and P20 to P25 without a pull-up resistor |
| | V_{I2} | $V_{SS} - 0.3$ | $V_{SS} + 7.0$ | V | P00 to P07 and P10 to P17 (when selected as ports) for the MB89821/823R/825, and P20 to P25 without a pull-up resistor |
| | V_{I3} | $V_{SS} - 0.3$ | $V_3 + 0.3$ | V | P00 to P07 and P10 to P17 for the MB89P825/PV820 |
| Output voltage | V_{O1} | $V_{SS} - 0.3$ | $V_{CC} + 0.3$ | V | V_{O1} must not exceed $V_{SS} + 7.0\text{ V}$. Except P00 to P07 and P10 to P17 for the MB89P825/PV820, and P20 to P25 without a pull-up resistor |
| | V_{O2} | $V_{SS} - 0.3$ | $V_{SS} + 7.0$ | V | P00 to P07 and P10 to P17 (when selected as ports) for the MB89821/823R/825, and P20 to P25 without a pull-up resistor |
| | V_{O3} | $V_{SS} - 0.3$ | $V_3 + 0.3$ | V | P00 to P07 and P10 to P17 for the MB89P825/PV820 |
| “L” level output current | I_{OL} | — | 10 | mA | Except power supply pins |
| “L” level average output current | I_{OLAV} | — | 4 | mA | Average value (operating current × operating rate) Except power supply pins |
| Total “L” level output current | ΣI_{OL} | — | 40 | mA | |
| “H” level output current | I_{OH} | — | -5 | mA | Except power supply pins |
| “H” level average output current | I_{OHAV} | — | -2 | mA | Average value (operating current × operating rate) Except power supply pins |
| Total “H” level output current | ΣI_{OH} | — | -10 | mA | |
| 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.

2. Recommended Operating Conditions

(V_{SS} = 0.0 V)

| Parameter | Symbol | Value | | Unit | Remarks |
|--------------------------|-----------------|-----------------|------|------|---|
| | | Min | Max | | |
| Power supply voltage | V _{CC} | 2.2* | 6.0* | V | Normal operation assurance range* |
| | | 1.5 | 6.0 | V | Retains the RAM state in stop mode |
| LCD power supply voltage | V3 | V _{SS} | 6.0 | V | V3 pin LCD power supply range. The optimum value is dependent on the element in use. |
| Operating temperature | T _A | -40 | +85 | °C | |

*: The minimum operating power supply voltage varies with the operating frequency.

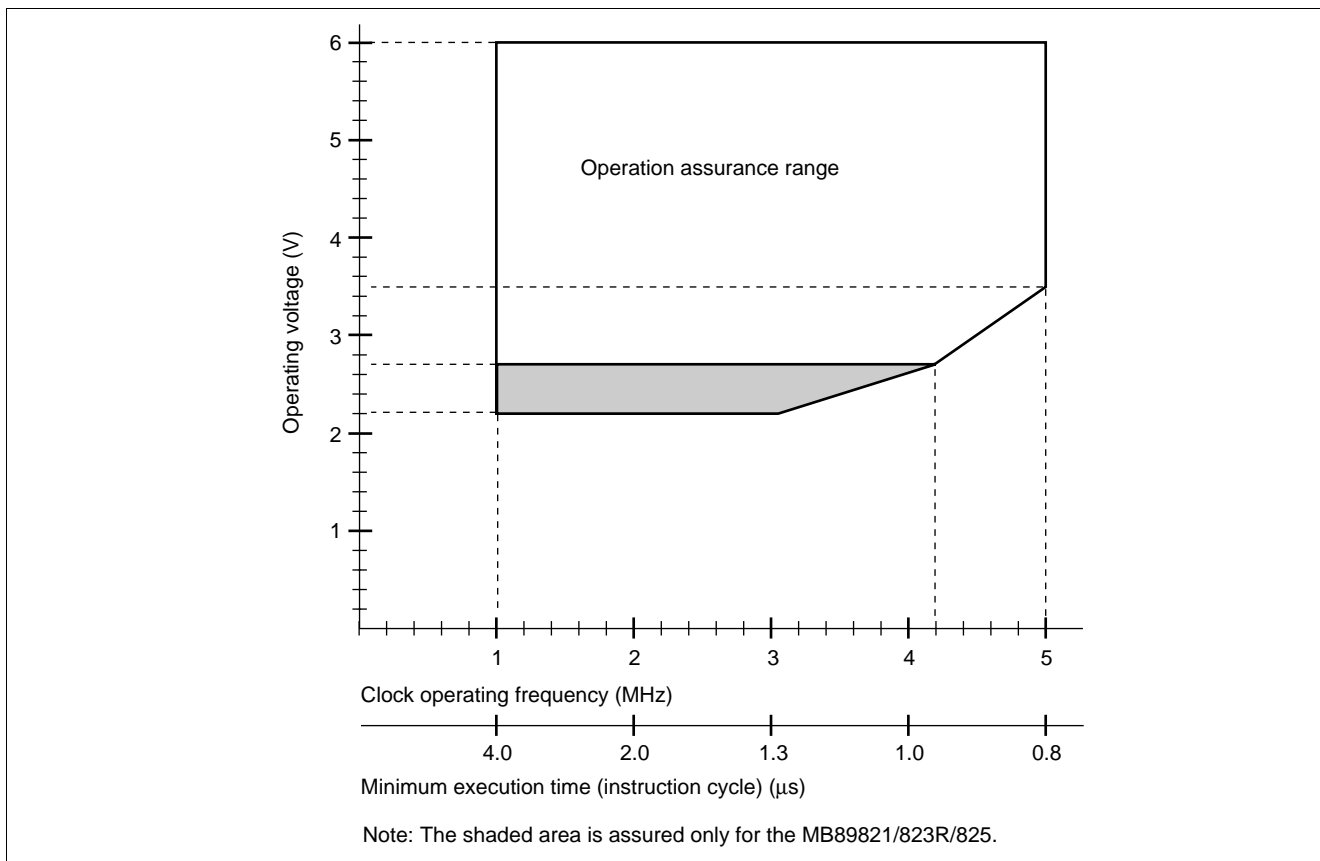


Figure 1 Operating Voltage vs. Clock Operating Frequency

Figure 1 indicates the operating frequency of the external oscillator at an instruction cycle of $4/F_c$.

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.

MB89820 Series

3. DC Characteristics

($V_{CC} = V_3 = +5.0\text{ V}$, $V_{SS} = 0.0\text{ V}$, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

| Parameter | Symbol | Pin | Condition | Value | | | Unit | Remarks |
|---|-----------|--|-------------------------------------|-------------------|-----|---------------------|---------------|--|
| | | | | Min | Typ | Max | | |
| “H” level input voltage | V_{IH} | P00 to P07, P10 to P17, P20 to P25, P30 to P33, P40 to P45 | — | $0.7 V_{CC}^{*1}$ | — | $V_{CC} + 0.3^{*1}$ | V | |
| | V_{IHS} | \overline{RST} , MOD0, MOD1, INT0, SCK, SI, PWC/INT1 | — | $0.8 V_{CC}$ | — | $V_{CC} + 0.3$ | V | |
| “L” level input voltage | V_{IL} | P00 to P07, P10 to P17, P22 to P25, P30 to P33, P40 to P45 | — | $V_{CC} - 0.3$ | — | $0.3 V_{CC}^{*1}$ | V | |
| | V_{ILS} | \overline{RST} , MOD0, MOD1, INT0, SCK, SI, PWC/INT1 | — | $V_{SS} - 0.3$ | — | $0.2 V_{CC}$ | V | |
| Open-drain output pin application voltage | V_D | P20 to P25, P00 to P07, P10 to P17 | — | $V_{SS} - 0.3$ | — | $V_{CC} + 6.0$ | V | P00 to P07 and P10 to P17 (when selected as ports) for the MB89821/823R/825, and P20 to P25 without pull-up resistor |
| “H” level output voltage | V_{OH} | P40 to P45 | $I_{OH} = -2\text{ mA}$ | 2.4 | — | — | V | |
| “L” level output voltage | V_{OL1} | P00 to P07, P10 to P17, P20 to P25, P40 to P45 | $I_{OL} = 1.8\text{ mA}$ | — | — | 0.4 | V | |
| | V_{OL2} | \overline{RST} | $I_{OL} = 4\text{ mA}$ | — | — | 0.4 | V | |
| Input leakage current (Hi-Z output leakage current) | I_{LI1} | MOD0, MOD1, P30 to P33, P40 to P45 | $0.0\text{ V} < V_I < V_{CC}$ | — | — | ± 5 | μA | Without pull-up resistor for the MB89821/823R/825 |
| | | MOD0, MOD1, P00 to P07, P10 to P17, P30 to P33, P40 to P45 | | — | — | ± 5 | μA | Without pull-up resistor for the MB89P825/PV820 |
| | I_{LI2} | P00 to P07, P10 to P17, P20 to P25 | $0.0\text{ V} < V_I < 6.0\text{ V}$ | — | — | ± 1 | μA | Without pull-up resistor for the MB89821/823R/825 |
| | | P20 to P25 | | — | — | ± 1 | μA | Without pull-up resistor for the MB89P825/PV820 |

(Continued)

MB89820 Series

(Continued)

($V_{CC} = V_3 = +5.0$ V, $V_{SS} = 0.0$ V, $T_A = -40^\circ\text{C}$ to $+85^\circ\text{C}$)

| Parameter | Symbol | Pin | Condition | Value | | | Unit | Remarks |
|------------------------------------|------------|---|--|-----------|--|------------------------|---------------|---|
| | | | | Min | Typ | Max | | |
| Pull-up resistance | R_{PULL} | P20 to P25, P30 to P33, P40 to P45, \overline{RST} | $V_1 = 0.0$ V | 25 | 50 | 100 | k Ω | With pull-up resistor |
| Common output impedance | R_{VCOM} | COM0 to COM3 | V_1 to $V_3 = +5.0$ V | — | — | 2.5 | k Ω | |
| Segment output impedance | R_{VSEG} | SEG0 to SEG49 | V_1 to $V_3 = +5.0$ V | — | — | 15 | k Ω | |
| LCD divided resistance | R_{LCD} | — | Between V_3 and V_{SS} | 30 | 60 | 120 | k Ω | |
| LCD leakage current | I_{LCDL} | V_1 to V_3 , COM0 to COM3, SEG0 to SEG49 | — | — | — | ± 1 | μA | |
| Power supply current* ₂ | I_{CC} | V_{CC} | $F_C = 5$ MHz $t_{inst}^{*3} = 0.8$ μs | — | 3.5 | 5.0 | mA | MB89821, MB89823R, MB89825, MB89PV820 |
| | | | | — | 4.0 | 6.5 | mA | MB89P825 |
| | I_{CCS} | | $F_C = 5$ MHz $t_{inst}^{*3} = 0.8$ μs Sleep mode | — | 1.1 | 1.7 | mA | MB89821, MB89823R, MB89825, MB89PV820, MB89P825 |
| | | | | I_{CCH} | $T_A = +25^\circ\text{C}$ Stop mode | — | 0.1 | 1 |
| — | 0.1 | 10 | μA | | | MB89PV820, MB89P825 | | |
| Input capacitance | C_{IN} | Other than V_{CC} and V_{SS} | $f = 1$ MHz | — | 5 | 15 | pF | |

*1: The input voltage to P00 to P07 and P10 to P17 for the MB89P825/PV820 must not exceed the LCD power supply voltage (V_3 pin voltage).

*2: The measurement condition of power supply current is as follows: the external clock, open output pins and the external LCD dividing resistor.
In the case of the MB89PV820, the current consumed by the connected EPROM and ICE is not included.

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

MB89820 Series

4. AC Characteristics

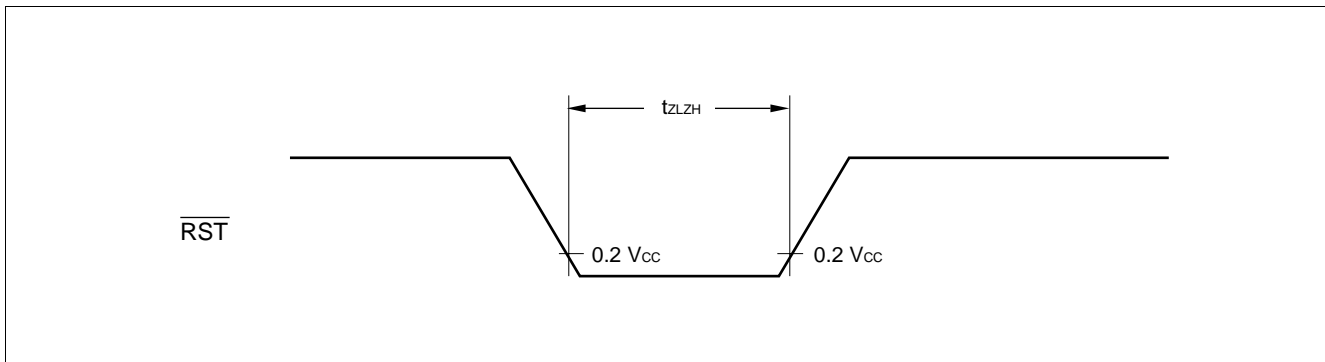
(1) Reset Timing

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

| Parameter | Symbol | Condition | Value | | Unit | Remarks |
|----------------------------------|------------|-----------|--------------|-----|------|---------|
| | | | Min | Max | | |
| \overline{RST} "L" pulse width | t_{ZLZH} | — | 48 t_{CYL} | — | ns | |

Notes : • t_{CYL} is the main clock oscillator period.

- 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}).



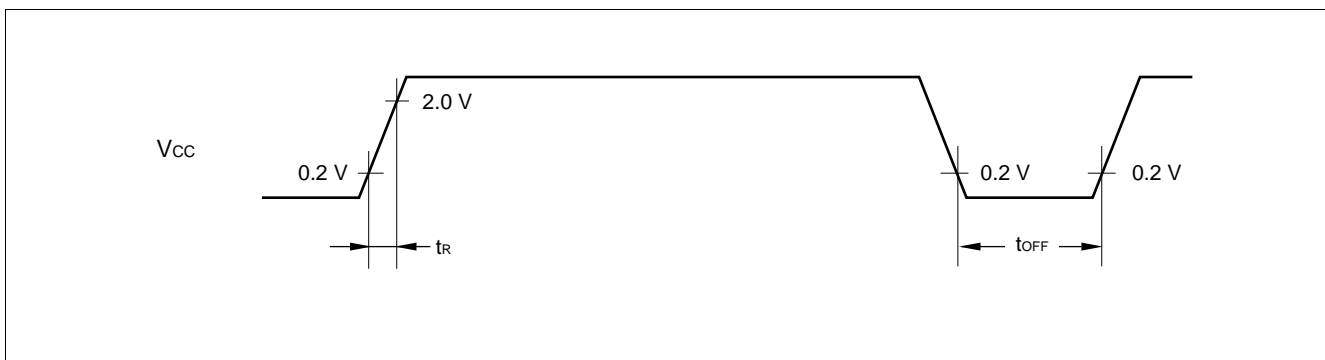
(2) Power-on Reset

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

| 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.



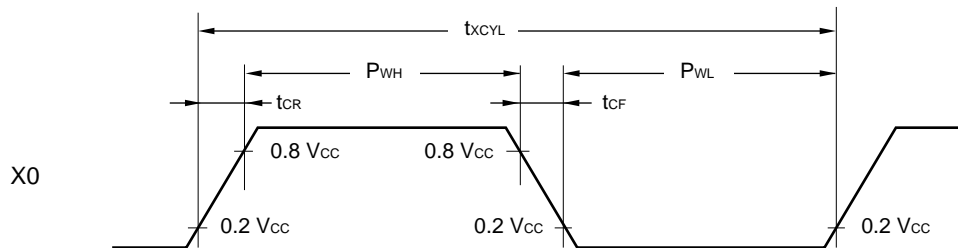
(3) Clock Timing

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

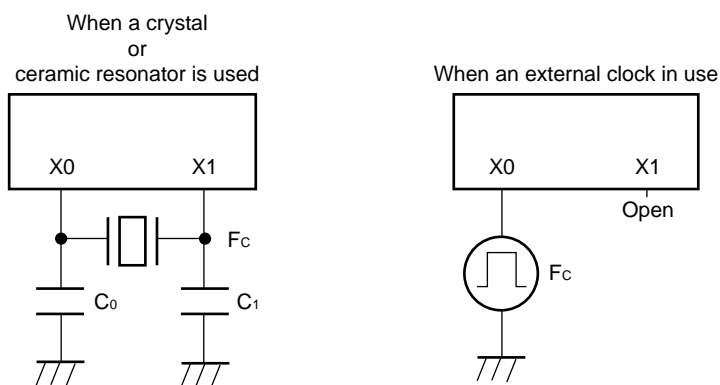
| Parameter | Symbol | Pin | Condition | Value | | | Unit | Remarks |
|-------------------------------------|----------------------|--------|-----------|-------|-----|------|------|------------------------------|
| | | | | Min | Typ | Max | | |
| Clock frequency | F_C | X0, X1 | — | 1 | — | 5 | MHz | |
| Clock cycle time | t_{CYL} | | | 200 | — | 1000 | ns | Crystal or ceramic resonator |
| Input clock duty ratio* | duty | X0 | — | 30 | — | 70 | % | External clock |
| Input clock rising/ falling time | t_{CR} t_{CF} | | | — | — | 10 | ns | External clock |

*: $\text{duty} = P_{WH}/t_{HCYL}$, P_{WL}/t_{HCYL}

X0 and X1 Timing and Conditions



Clock Conditions



(4) Instruction Cycle

| Parameter | Symbol | Value (typical) | Unit | Remarks |
|---|------------|-----------------|---------------|---|
| Instruction cycle (minimum execution time) | t_{inst} | $4/F_C$ | μS | $t_{inst} = 0.8\ \mu\text{S}$ when operating at $F_C = 5\ \text{MHz}$ |

MB89820 Series

(5) Serial I/O Timing

($V_{CC} = +5.0 V \pm 10\%$, $V_{SS} = 0.0 V$, $T_A = -40^\circ C$ 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 ↓ → SO time | t _{SLOV} | SCK, SO | | -200 | 200 | ns | |
| Valid SI → SCK ↑ | t _{IVSH} | SI, SCK | | 0.5 t _{inst} * | — | μs | |
| SCK ↑ → valid SI hold time | t _{SHIX} | SCK, SI | | 0.5 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 _{SLSH} | | | 1 t _{inst} * | — | μs | |
| SCK ↓ → SO time | t _{SLOV} | SCK, SO | | 0 | 200 | ns | |
| Valid SI → SCK ↑ | t _{IVSH} | SI, SCK | | 0.5 t _{inst} * | — | μs | |
| SCK ↑ → valid SI hold time | t _{SHIX} | SCK, SI | | 0.5 t _{inst} * | — | μs | |

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

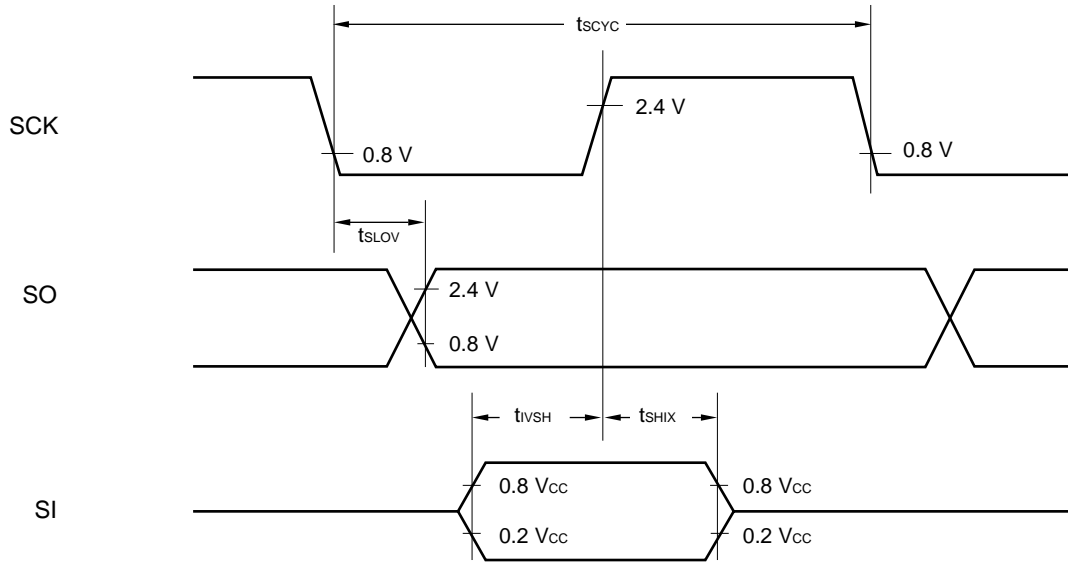
(6) UART Timing

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

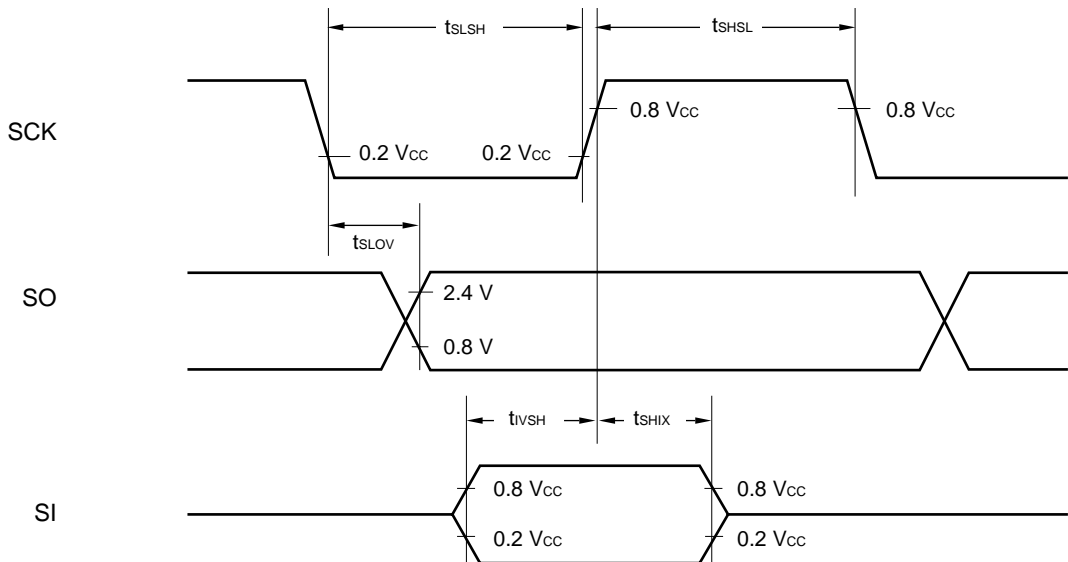
| Parameter | Symbol | Pin | Condition | Value | | Unit | Remarks |
|------------------------------|-------------------|---------|---------------------------|-------------------------|-----|------|---------|
| | | | | Min | Max | | |
| Serial clock cycle time | t _{SCYC} | SCK | Internal shift clock mode | 2 t _{inst} * | — | μs | |
| SCK ↓ → SO time | t _{SLOV} | SCK, SO | | -200 | 200 | ns | |
| Valid SI → SCK ↑ | t _{IVSH} | SI, SCK | | 0.5 t _{inst} * | — | μs | |
| SCK ↑ → valid SI hold time | t _{SHIX} | SCK, SI | | 0.5 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 _{SLSH} | | | 1 t _{inst} * | — | μs | |
| SCK ↓ → SO time | t _{SLOV} | SCK, SO | | 0 | 200 | ns | |
| Valid SI → SCK ↑ | t _{IVSH} | SI, SCK | | 0.5 t _{inst} * | — | μs | |
| SCK ↑ → valid SI hold time | t _{SHIX} | SCK, SI | | 0.5 t _{inst} * | — | μs | |

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

Internal Shift Clock Mode



External Shift Clock Mode



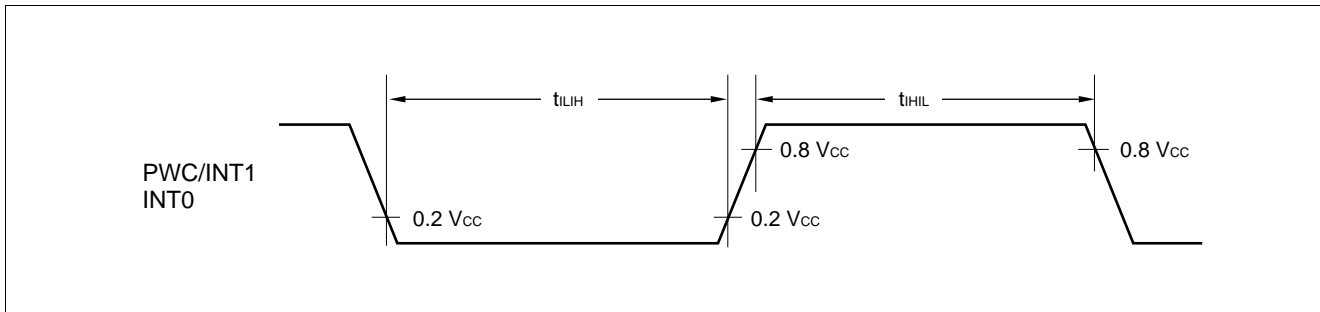
MB89820 Series

(7) Peripheral Input Timing

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

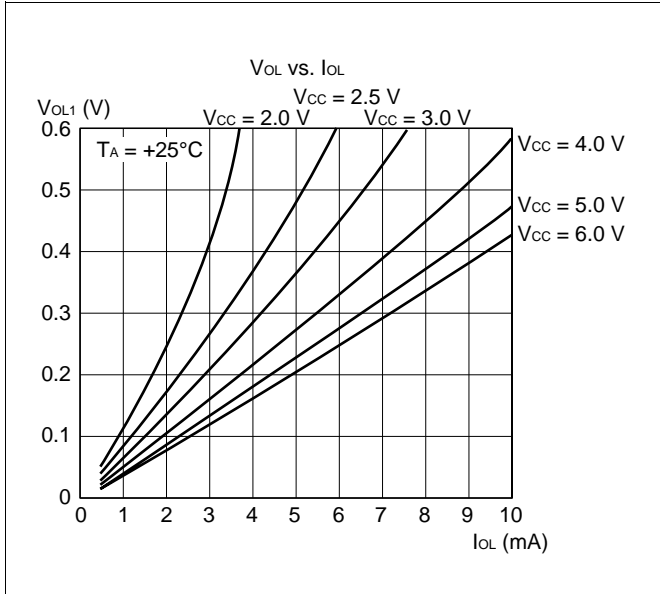
| Parameter | Symbol | Pin | Condition | Value | | Unit | Remarks |
|----------------------------------|----------|------------------|-----------|----------------|-----|---------|---------|
| | | | | Min | Max | | |
| Peripheral input "H" pulse width | t_{LH} | PWC/INT1 INT0 | — | $2 t_{inst}^*$ | — | μs | |
| Peripheral input "L" pulse width | t_{HL} | | | $2 t_{inst}^*$ | — | μs | |

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

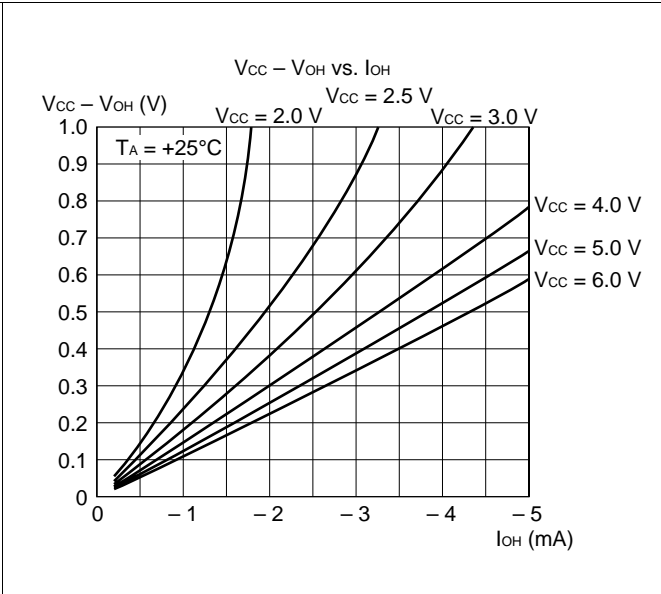


EXAMPLE CHARACTERISTICS

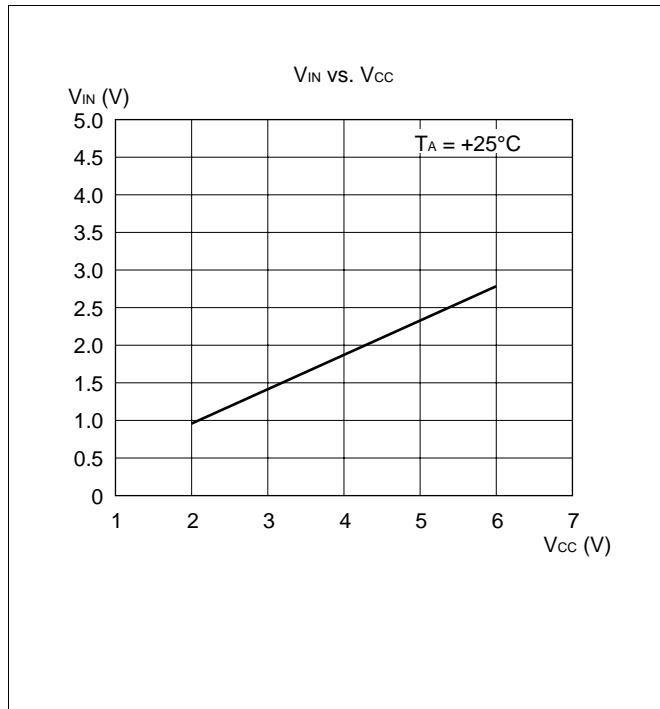
(1) "L" Level Output Voltage



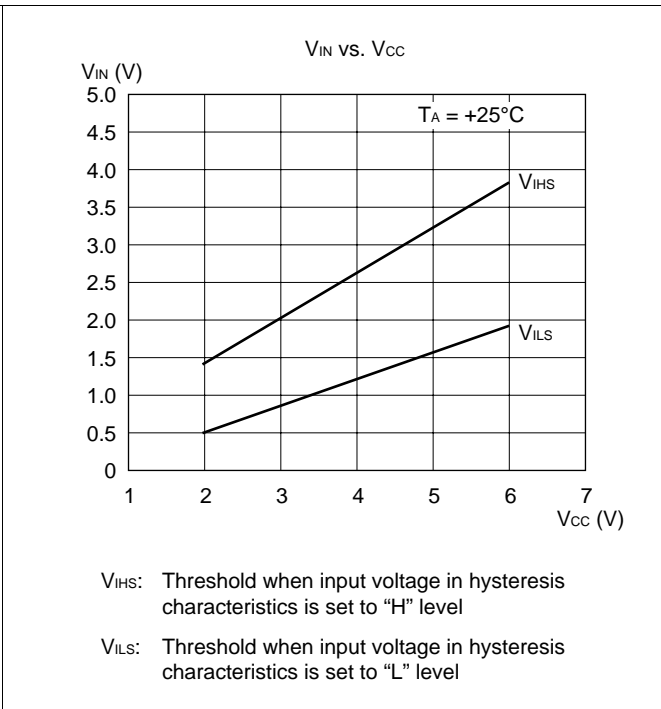
(2) "H" Level Output Voltage



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

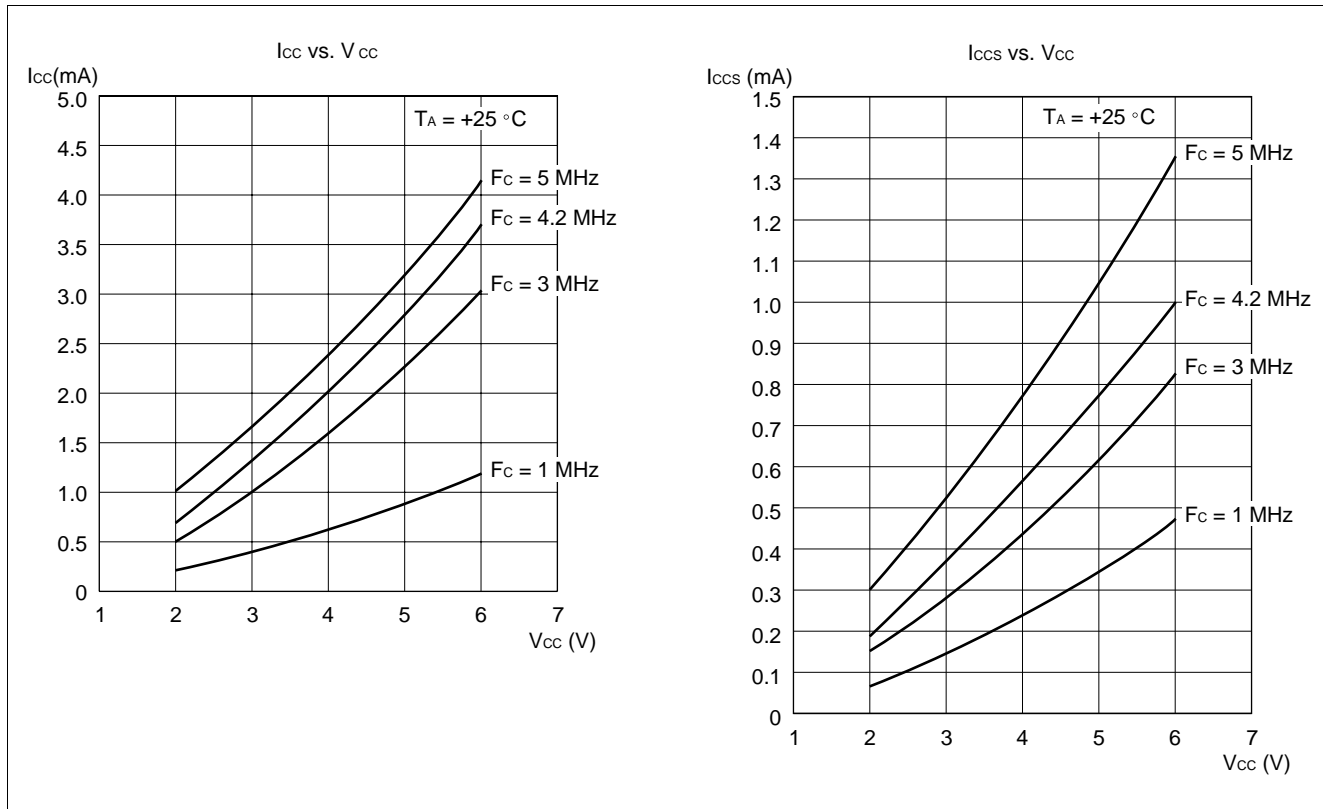


(4) "H" level Input Voltage/"L" Level Input Voltage (CMOS Hysteresis Input)

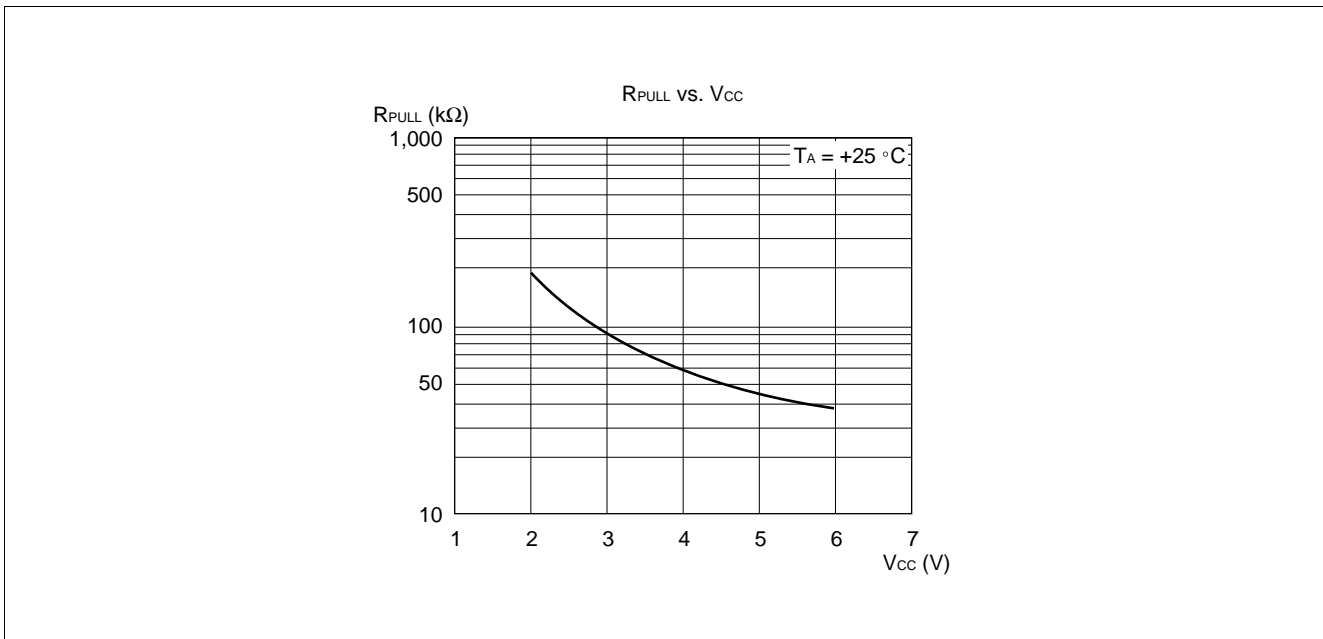


MB89820 Series

(5) Power Supply Current (External Clock)



(6) Pull-up Resistance



■ MASK OPTIONS

| No. | Part number | MB89821/823R/825 | MB89P825 | MB89PV820 |
|-----|--|-------------------------------|---------------------------|---|
| | Specifying procedure | Specify when ordering masking | Set with EPROM programmer | Setting not possible (Fixed) |
| 1 | Pull-up resistors P20 to P25, P30 to P33, P40 to P45 | Selectable by pin | Can be set per pin | Without pull-up resistor |
| 2 | Power-on reset <ul style="list-style-type: none"> └ With power-on reset └ Without power-on reset | Selectable | Can be set | With power-on reset |
| 3 | Oscillation stabilization time selection ($F_c = 5 \text{ MHz}$)* ¹ <ul style="list-style-type: none"> └ Approx. $2^{18}/F_c$ (Approx. 52.4 ms) └ Approx. $2^{14}/F_c$ (Approx. 3.28 ms) | Selectable | Can be set | Oscillation stabilization time Approx. $2^{18}/F_c$ (Approx. 52.4 ms) |
| 4 | Reset pin output <ul style="list-style-type: none"> └ With reset output └ Without reset output | Selectable | Can be set | With reset output |
| 5 | Segment output switching <ul style="list-style-type: none"> └ 50 segments: No port selection └ 49 segments: Selection of P17 └ 48 segments: Selection of P17 to P16 └ 46 segments: Selection of P17 to P14 └ 42 segments: Selection of P17 to P10 └ 34 segments: Selection of P17 to P10 and P07 to P00 | Selectable* ² | Can be set* ³ | Can be set* ³ |

*1: The oscillation settling time is generated by dividing the oscillation clock frequency. Since the oscillation period is not stable immediately after oscillation has been started, therefore, the oscillation settling time in the above list should be regarded as a reference.

*2: Port selection must be same setting of the segment output selection register of LCD controller.

*3: Note that, when ports are set, the input voltage value for the port pins are different from those for mask ROM products.

Ports are set by the register setting of the segment output selection register of LCD controller.

■ ORDERING INFORMATION

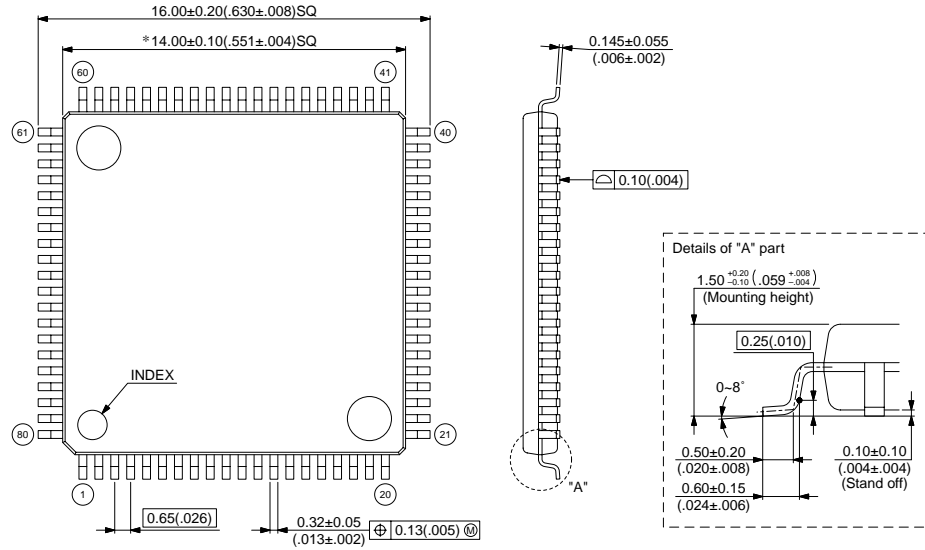
| Part number | Package | Remarks |
|--|--------------------------------------|---------|
| MB89821PFM MB89823RPFM MB89825PFM MB89P825PFM | 80-pin Plastic QFP (FPT-80P-M11) | |
| MB89PV820CF | 80-pin Ceramic MQFP (MQP-80C-P01) | |

MB89820 Series

PACKAGE DIMENSIONS

80-pin Plastic QFP
(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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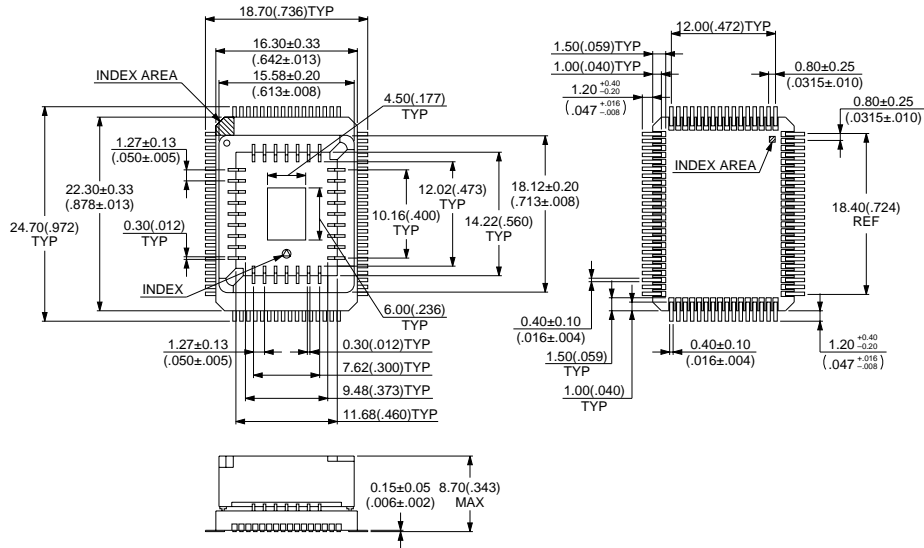
Dimensions in mm (inches) .

Note : The values in parentheses are reference values.

(Continued)

(Continued)

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



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Dimensions in mm (inches) .

Note : The values in parentheses are reference values.

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