

# 8-bit Proprietary Microcontroller

CMOS

## F<sup>2</sup>MC-8L MB89820 Series

### MB89821/823/P825/PV820

#### ■ DESCRIPTION

MB89820 series is a line of single-chip microcontrollers using the F<sup>2</sup>MC-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.

\*: F<sup>2</sup>MC stands for FUJITSU Flexible Microcontroller.

#### ■ FEATURES

- Minimum execution time: 0.8  $\mu$ s/5 MHz ( $V_{CC} = +5.0$  V)
- F<sup>2</sup>MC-8L family CPU core

Instruction set optimized for controllers

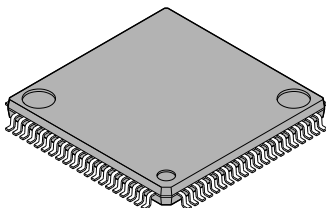
Multiplication and division instructions  
16-bit arithmetic operations  
Test and branch instructions  
Bit manipulation instructions, etc.

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

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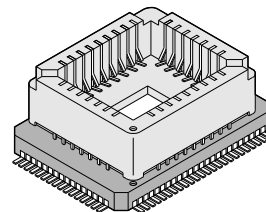
#### ■ PACKAGES

80-pin Plastic QFP



(FPT-80P-M11)

80-pin Ceramic 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 Parameter	MB89821	MB89823	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 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: Instruction bit length: Instruction length: Data bit length: Minimum execution time: Interrupt processing time:		136 8 bits 1 to 3 bytes 1, 8, 16 bits 0.8 μs/5 MHz (V <sub>CC</sub> = 5.0 V) 7.2 μs/5 MHz (V <sub>CC</sub> = 5.0 V)	
Ports	I/O ports (N-ch open-drain): I/O ports (N-ch open-drain): I/O ports (CMOS): Input ports:  Total:		16 (All also serve as segment pins.) <sup>*1</sup> 6 6 (5 ports also serve as peripheral I/O.) 4 (1 port also serves as an external interrupt input.) 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)			
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 μs, 6.4 μs, 25.6 μs/5 MHz) LSB first/MSB first selectability			

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**MB89820 Series**

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Part number	MB89821	MB89823	MB89P825	MB89PV820
Parameter				
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 × 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 <sup>2</sup>	2.2 V <sup>3</sup> 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 MB89823 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<sub>H</sub> cannot be used. On the MB89823 and MB89P825, each register bank addresses upper than 0180<sub>H</sub> can be used.
- On the MB89P825, addresses BFF0<sub>H</sub> to BFF6<sub>H</sub> 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.

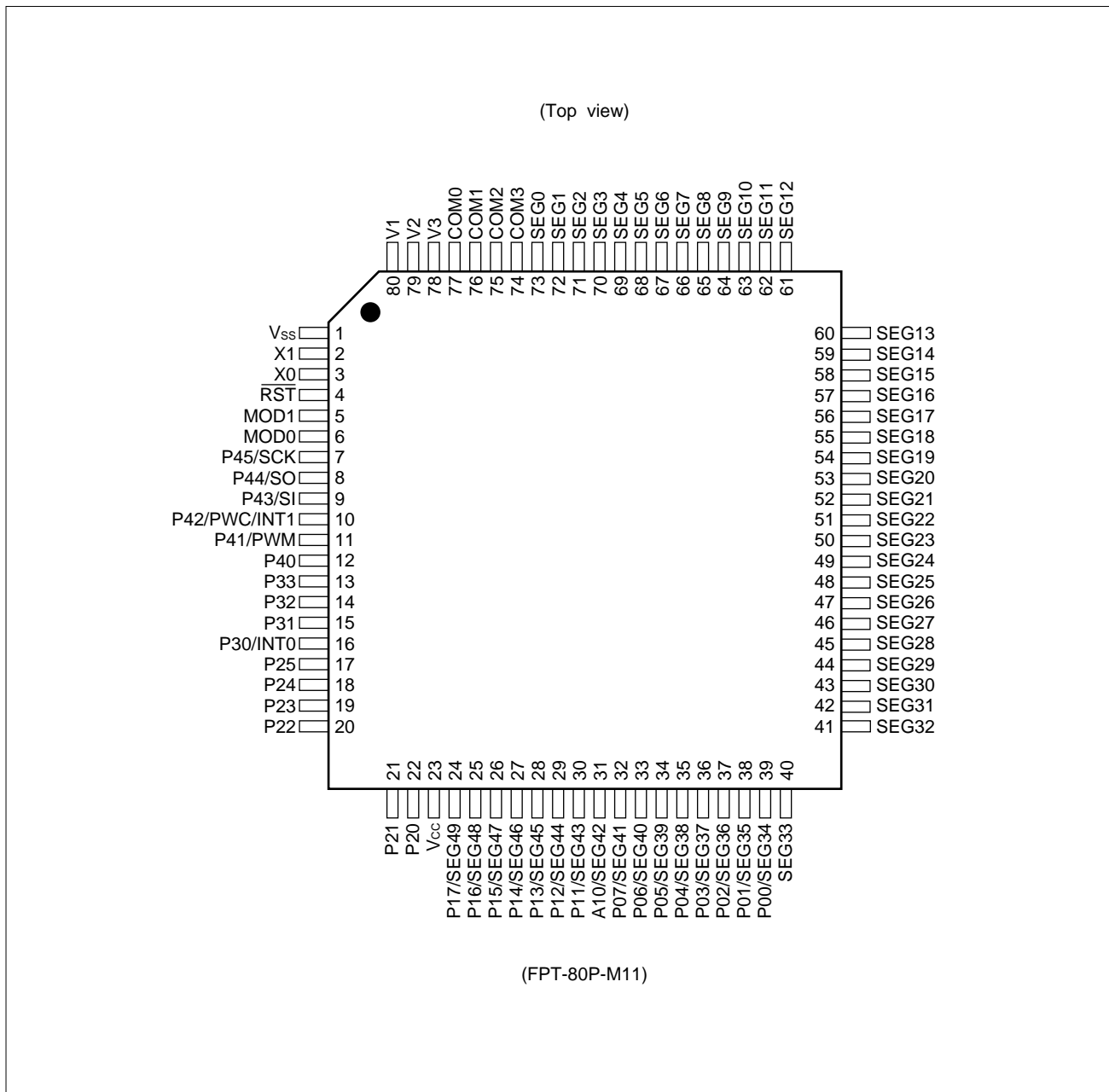
Before using options check section “■ Mask Options.”

Take particular care on the following point:

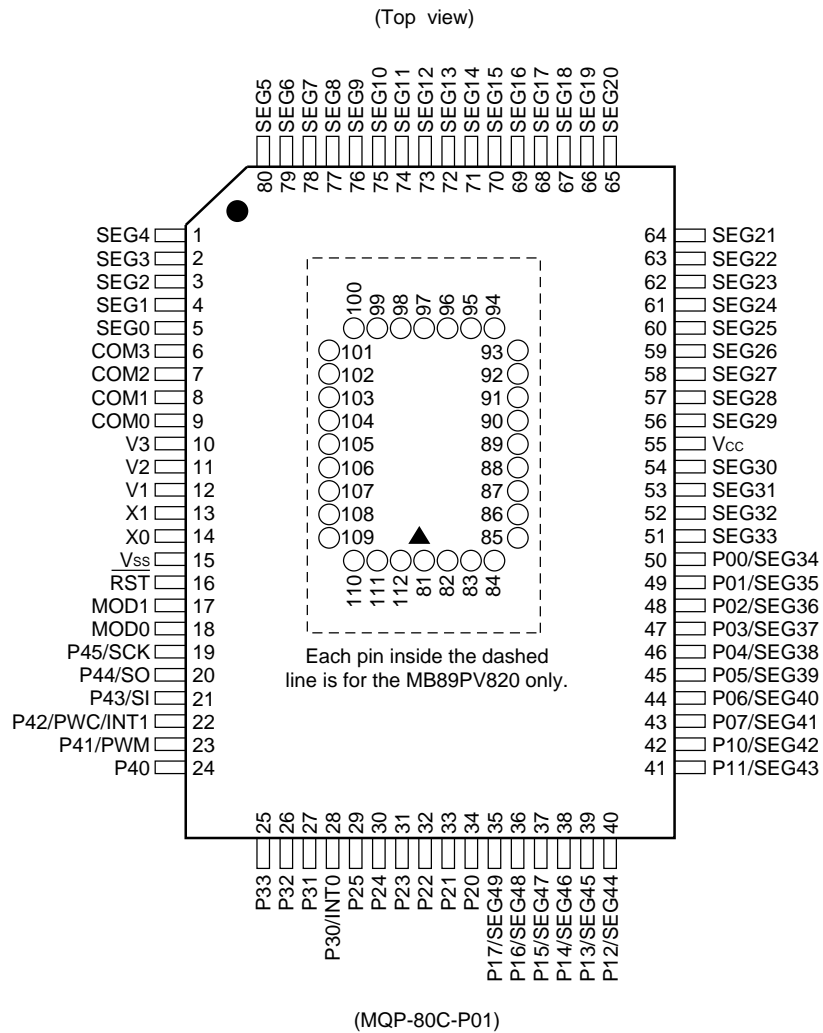
- Options are fixed on the MB89PV820.

# MB89820 Series

## ■ PIN ASSIGNMENT



# MB89820 Series



• 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 <sub>PP</sub>	90	A1	98	O4	106	N.C.
83	A12	91	A0	99	O5	107	A11
84	A7	92	N.C.	100	O6	108	A9
85	A6	93	O1	101	O7	109	A8
86	A5	94	O2	102	O8	110	A13
87	A4	95	O3	103	$\overline{CE}$	111	A14
88	A3	96	V <sub>SS</sub>	104	A10	112	V <sub>CC</sub>

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

**■ PIN DESCRIPTION**

Pin no.		Pin name	Circuit type	Function
QFP <sup>*1</sup>	MQFP <sup>*2</sup>			
3	14	X0	A	Clock crystal oscillator pins
2	13	X1		
6	18	MOD0	B	Operating mode selection pins Connect directly to V <sub>SS</sub> .
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 <sub>CC</sub>	—	Power supply pin
1	15	V <sub>SS</sub>	—	Power supply (GND) pin

\*1: FPT-80P-M11

\*2: MQP-80C-P01



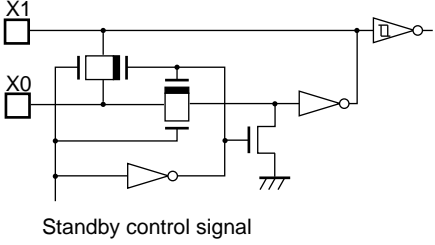

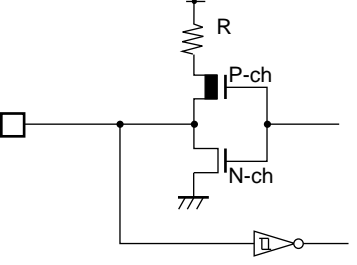
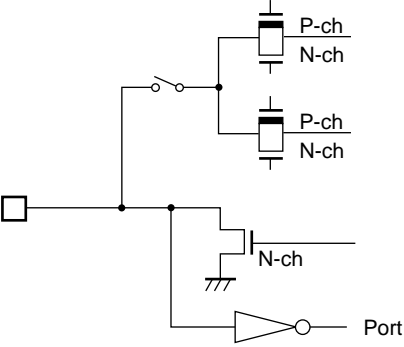
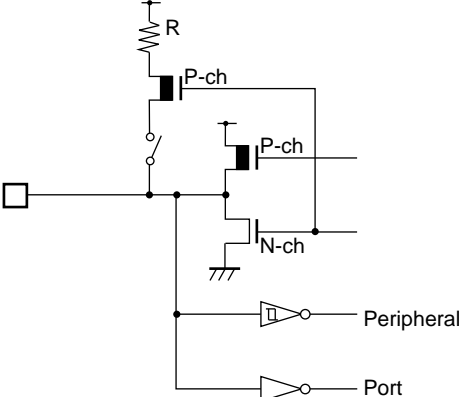
# MB89820 Series

- External EPROM pins (MB89PV820 only)

Pin no.	Pin name	I/O	Function
82	V <sub>PP</sub>	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 <sub>SS</sub>	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 <sub>CC</sub>	O	EPROM power supply pin
81 92 97 106	N.C.	—	Internally connected pins Be sure to leave them open.

# MB89820 Series

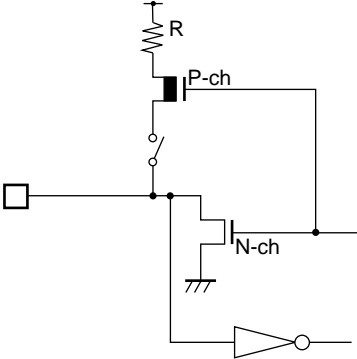
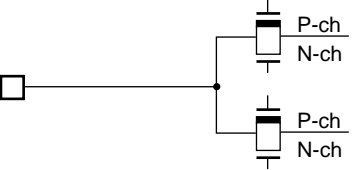
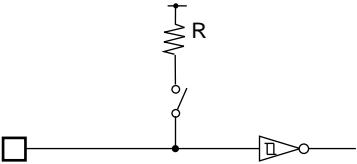
## ■ I/O CIRCUIT TYPE

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

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# MB89820 Series

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

# MB89820 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  $V_{SS}$ .

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.

**PROGRAMMING TO THE EPROM ON THE MB89P825**

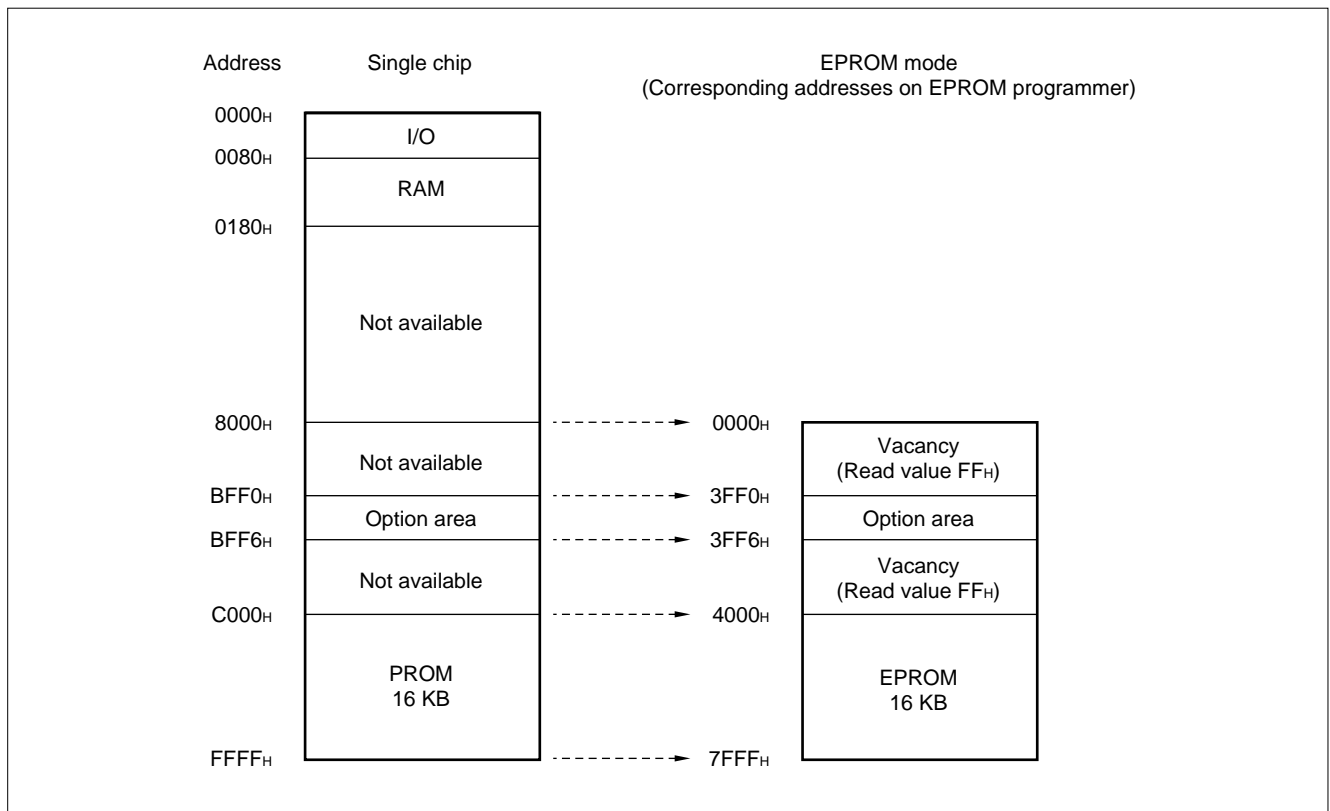
The MB89P825 is an OTPROM (one-time PROM) version for the MB89820 series.

**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.

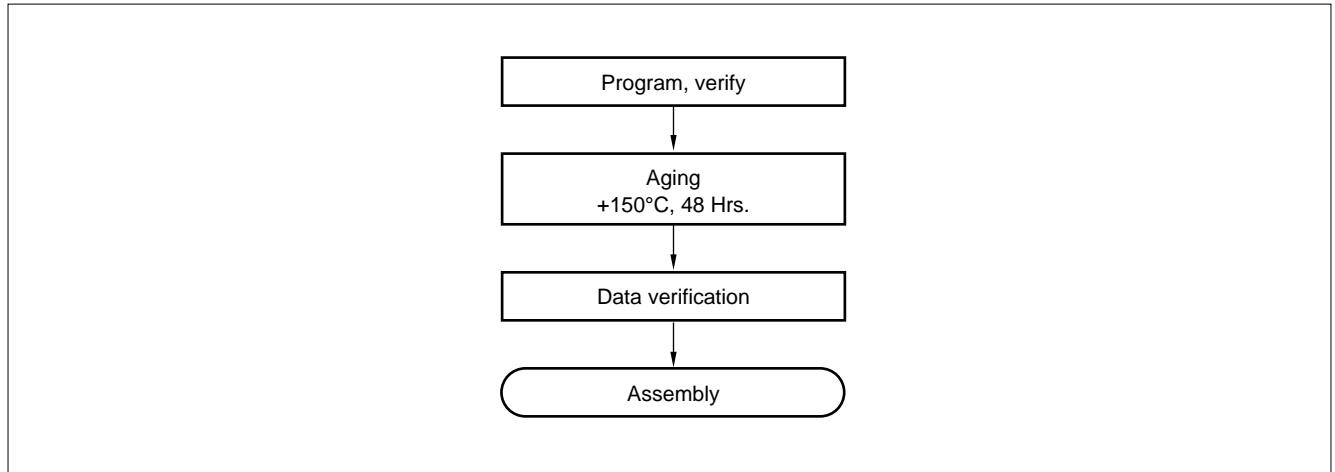
- **Programming procedure**

- (1) Set the EPROM programmer to the MBM27C256A.
- (2) Load program data into the EPROM programmer at 4000<sub>H</sub> to 7FFF<sub>H</sub> (note that addresses C000<sub>H</sub> to FFFF<sub>H</sub> while operating as a single chip assign to 4000<sub>H</sub> to 7FFF<sub>H</sub> in EPROM mode).  
Load option data into addresses 3FF0<sub>H</sub> to 3FF5<sub>H</sub> 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: Sun Hayato Co., Ltd.: TEL 81-3-3802-5760

**7. OTPROM Option Bit Map**

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
3FF0 <sub>H</sub>	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable	Reset pin output 1: Yes 0: No	Oscillation stabilization time 1: 2 <sup>17</sup> /F <sub>C</sub> 0: 2 <sup>13</sup> /F <sub>C</sub>	Power-on reset 1: Yes 0: No
3FF1 <sub>H</sub>	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable
3FF2 <sub>H</sub>	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable	Vacancy Readable
3FF3 <sub>H</sub>	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 <sub>H</sub>	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 <sub>H</sub>	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

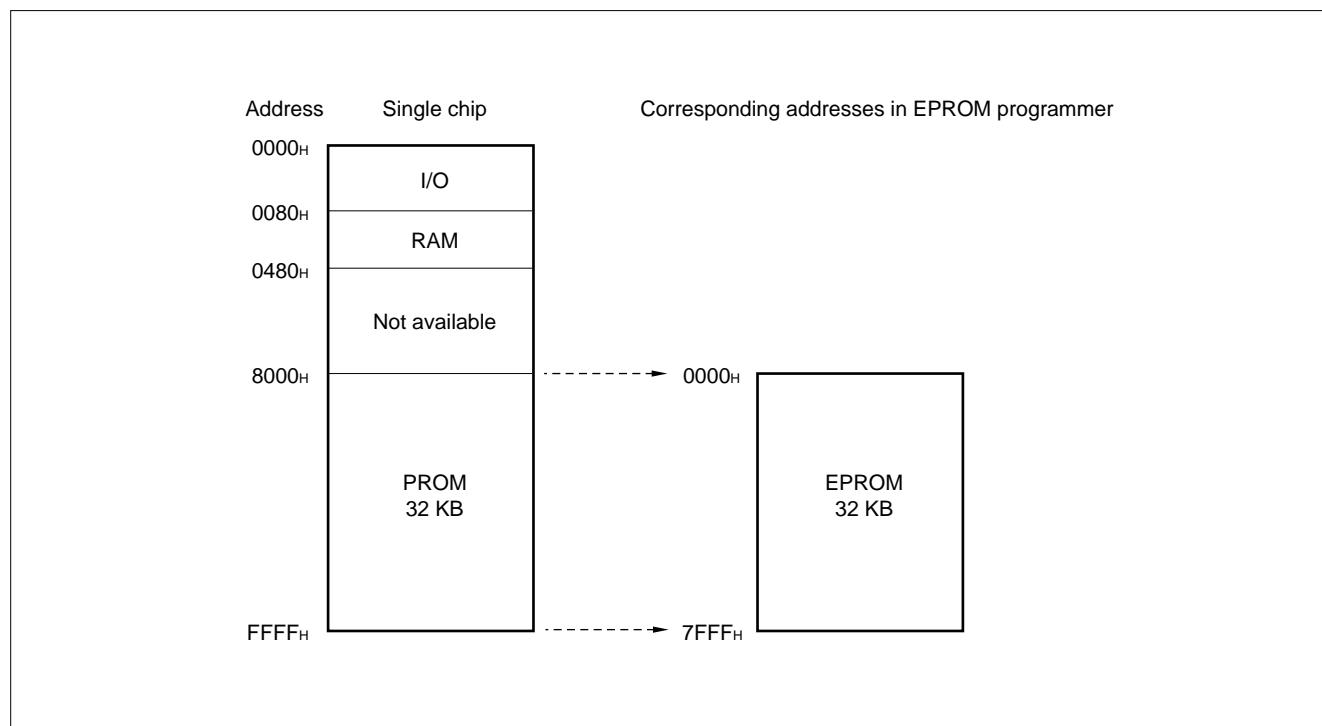
To program to the PROM using an EPROM programmer, use the socket adapter (manufacturer: Sun Hayato Co., Ltd.) listed below.

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

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.



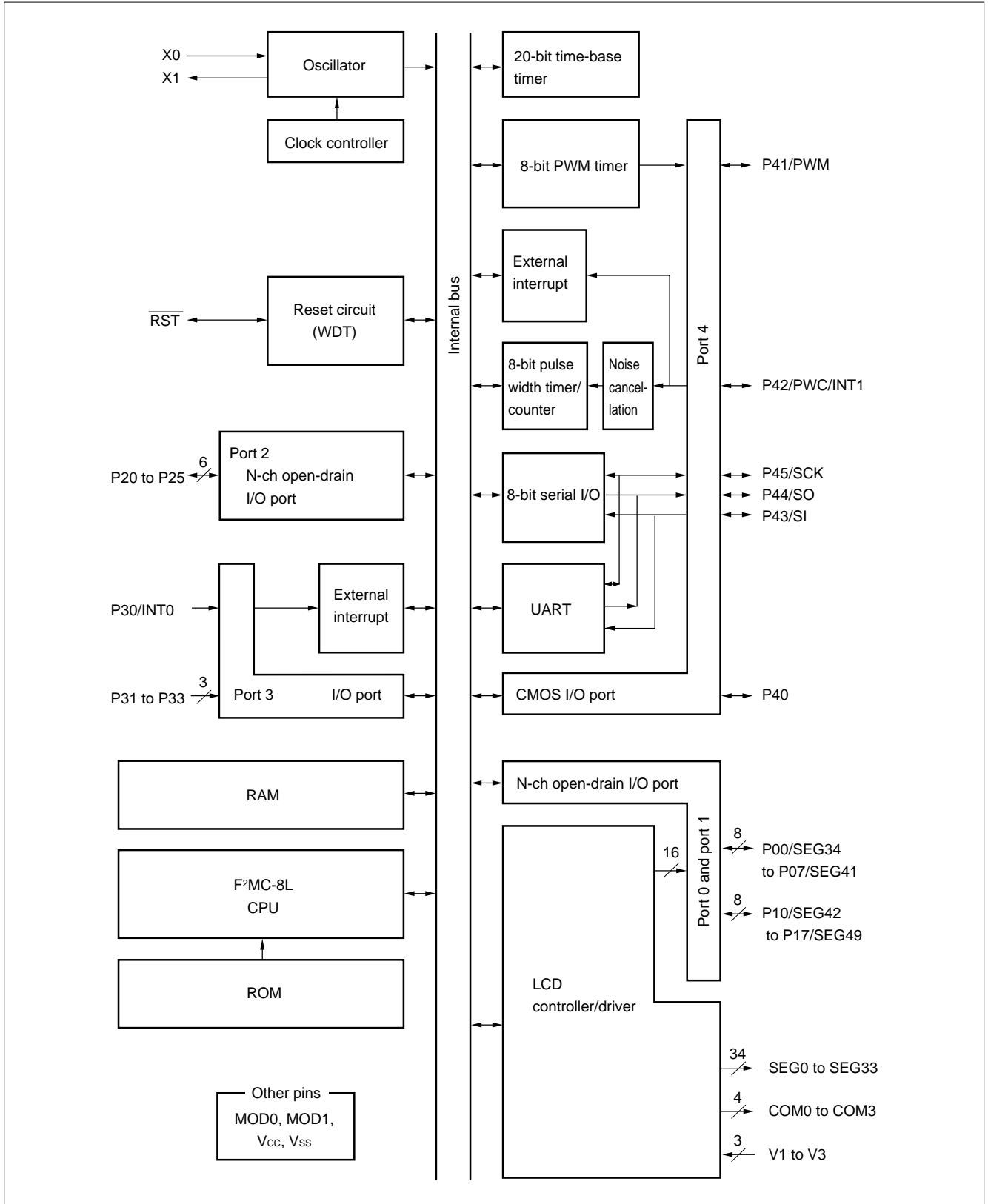
### 4. Programming to the EPROM

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



# MB89820 Series

## ■ BLOCK DIAGRAM

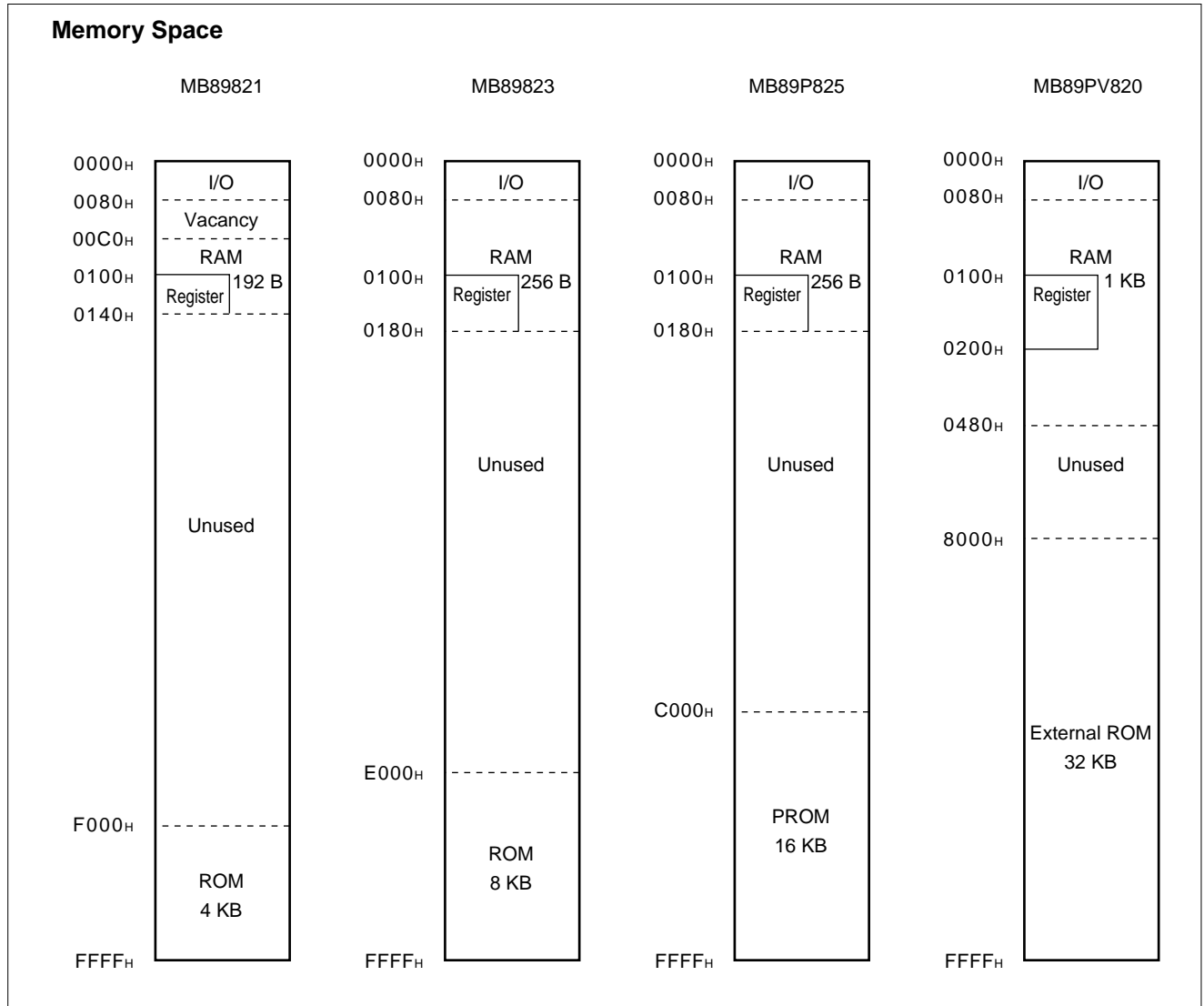


# MB89820 Series

## ■ CPU CORE

### 1. Memory Space

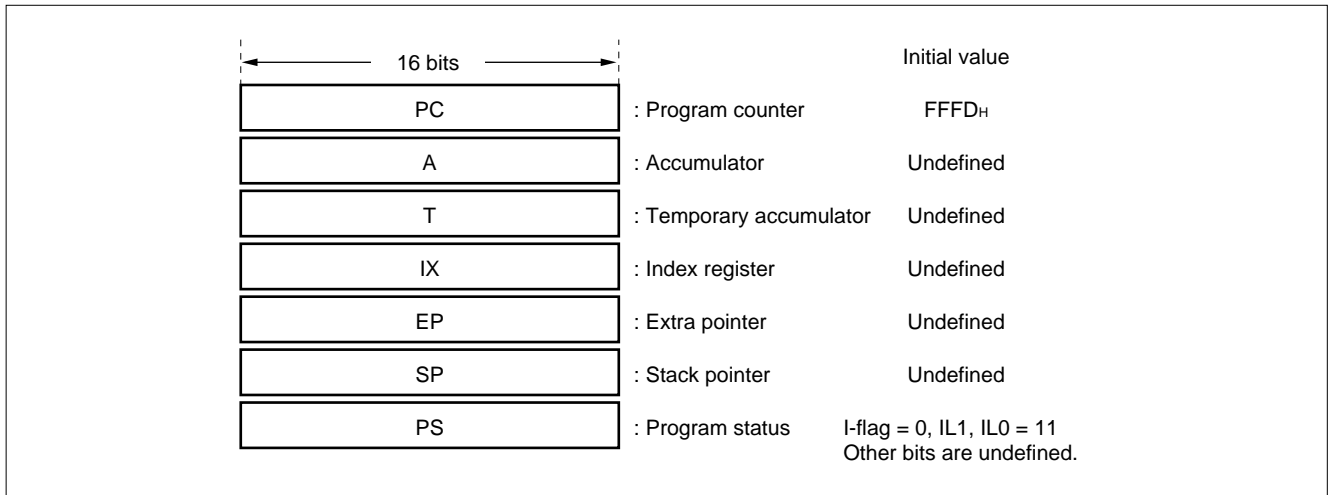
The microcontrollers of the MB89820 series offer a memory space of 64 Kbytes for storing all of I/O, data, and program areas. The I/O area is located at the lowest address. The data area is provided immediately above the I/O area. The data area can be divided into register, stack, and direct areas according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

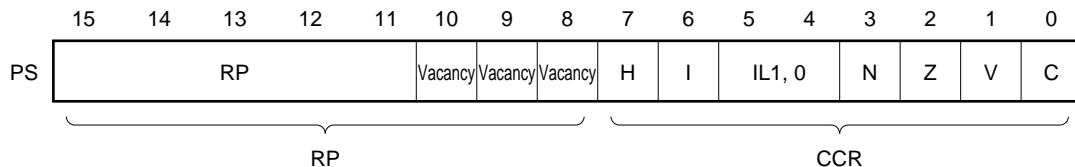
The F<sup>2</sup>MC-8L family has two types of registers; dedicated registers in the CPU and general-purpose registers in the memory. The following dedicated registers are provided:

Program counter (PC):	A 16-bit register for indicating instruction storage positions
Accumulator (A):	A 16-bit temporary register for storing arithmetic operations, etc. When the instruction is an 8-bit data processing instruction, the lower byte is used.
Temporary accumulator (T):	A 16-bit register which performs arithmetic operations with the accumulator. When the instruction is an 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.)

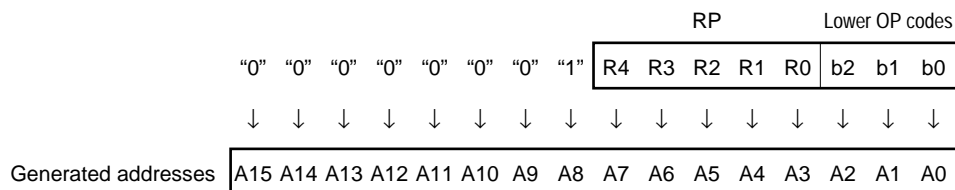
### Structure of the Program Status Register



# MB89820 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.

# MB89820 Series

The following general-purpose registers are provided:

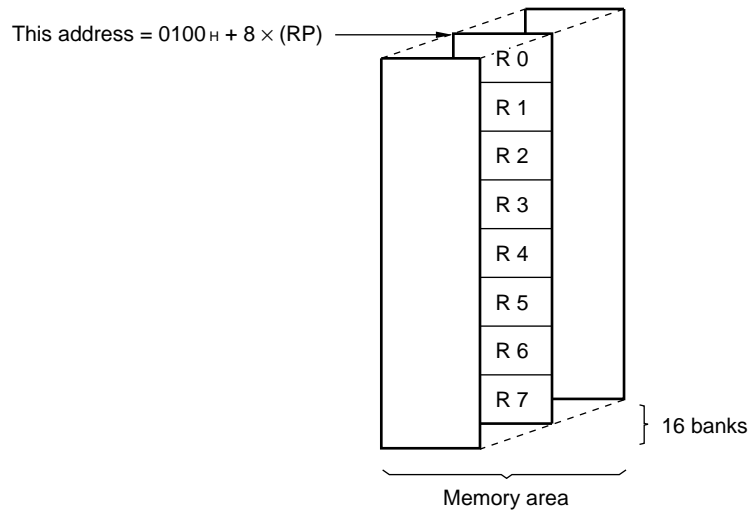
General-purpose registers: An 8-bit register for storing data

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 MB89823 (RAM  $256 \times 8$  bits). The bank currently in use is indicated by the register bank pointer (RP).

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

MB89821	0100 <sub>H</sub> to 013F <sub>H</sub>	8 banks
MB89823	0100 <sub>H</sub> to 017F <sub>H</sub>	16 banks
MB89P825	0100 <sub>H</sub> to 017F <sub>H</sub>	16 banks
MB89PV820	0100 <sub>H</sub> to 01FF <sub>H</sub>	32 banks

## Register Bank Configuration



# MB89820 Series

## ■ I/O MAP

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

(Continued)

**MB89820 Series**

(Continued)

Address	Read/write	Register name	Register description
20 <sub>H</sub>	(R/W)	SMC1	UART serial mode control register 1
21 <sub>H</sub>	(R/W)	SRC	UART serial rate control register
22 <sub>H</sub>	(R/W)	SSD	UART serial status/data register
23 <sub>H</sub>	(R/W)	SIDR/SODR	UART serial data register
24 <sub>H</sub>	(R/W)	SMC2	UART serial mode control register 2
25 <sub>H</sub>			Vacancy
26 <sub>H</sub>			Vacancy
27 <sub>H</sub>			Vacancy
28 <sub>H</sub>			Vacancy
29 <sub>H</sub>			Vacancy
2A <sub>H</sub>			Vacancy
2B <sub>H</sub>			Vacancy
2C <sub>H</sub>			Vacancy
2D <sub>H</sub>			Vacancy
2E <sub>H</sub>			Vacancy
2F <sub>H</sub>			Vacancy
30 <sub>H</sub>	(R/W)	EIC1	External interrupt 1 control register
31 <sub>H</sub> to 5F <sub>H</sub>			Vacancy
60 <sub>H</sub> to 78 <sub>H</sub>	(R/W)	VRAM	Display data RAM
79 <sub>H</sub>	(R/W)	LCR1	LCD controller/driver control register
7A <sub>H</sub>	(R/W)	SEGR	Segment output selection register
7B <sub>H</sub>			Vacancy
7C <sub>H</sub>	(W)	ILR1	Interrupt level setting register 1
7D <sub>H</sub>	(W)	ILR2	Interrupt level setting register 2
7E <sub>H</sub>	(W)	ILR3	Interrupt level setting register 3
7F <sub>H</sub>			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	V3	$V_{SS} - 0.3$	$V_{SS} + 7.0$	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 MB89821/823, and P20 to P25 without a pull-up resistor
	$V_{I3}$	$V_{SS} - 0.3$	$V3 + 0.3$	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 MB89821/823, and P20 to P25 without a pull-up resistor
	$V_{O3}$	$V_{SS} - 0.3$	$V3 + 0.3$	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 $\times$ operating rate) Except power supply pins
Total "L" level output current	$\Sigma I_{OL}$	—	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 $\times$ operating rate) Except power supply pins
Total "H" level output current	$\Sigma I_{OH}$	—	-10	mA	
Power consumption	$P_D$	—	300	mW	
Operating temperature	$T_A$	-40	+85	$^{\circ}\text{C}$	
Storage temperature	$T_{stg}$	-55	+150	$^{\circ}\text{C}$	

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.

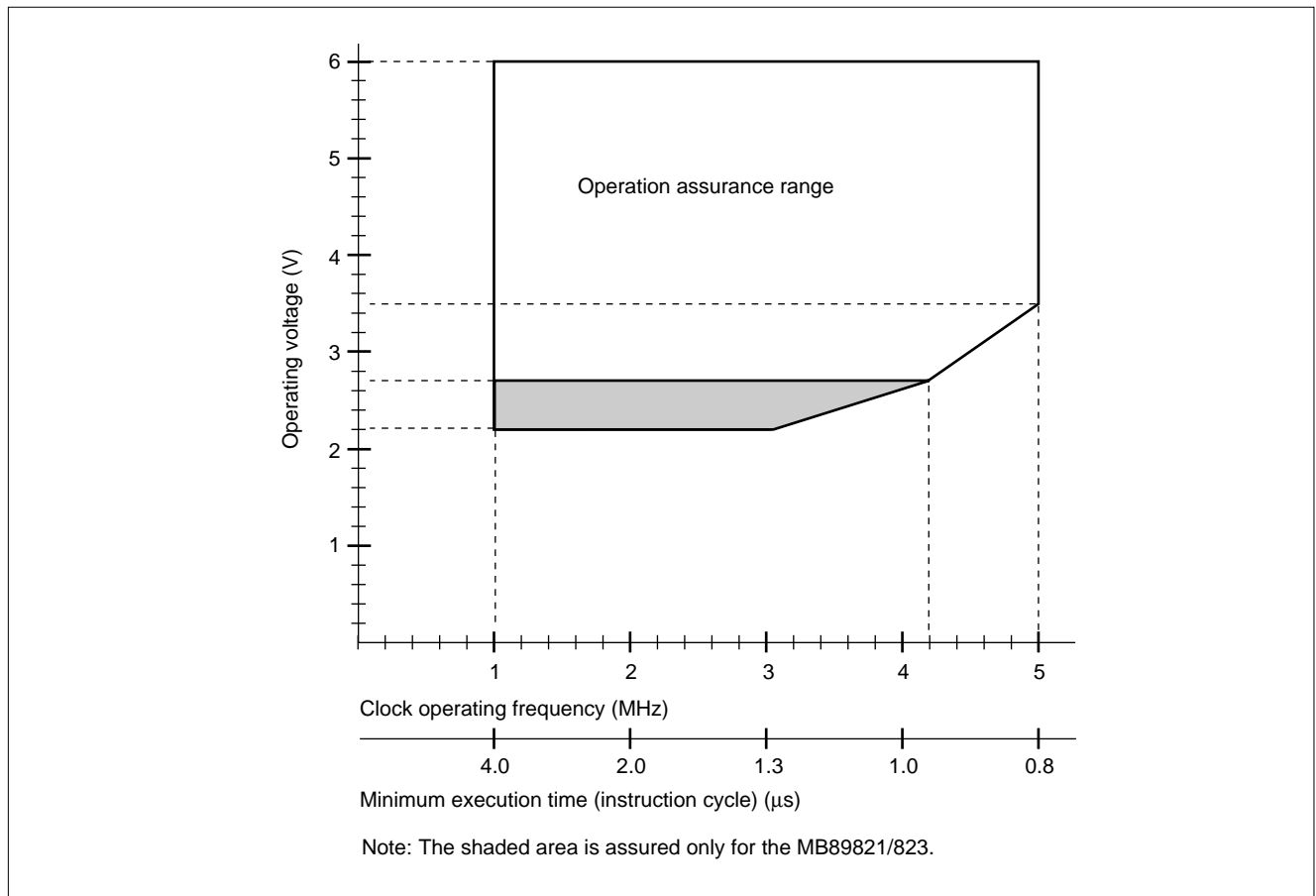


## 2. Recommended Operating Conditions

(V<sub>SS</sub> = 0.0 V)

Parameter	Symbol	Value		Unit	Remarks
		Min.	Max.		
Power supply voltage	V <sub>CC</sub>	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 <sub>SS</sub>	6.0	V	V3 pin LCD power supply range. The optimum value is dependent on the element in use.
Operating temperature	T <sub>A</sub>	-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  $4/F_c$ .

# 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 MB89821/823, 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)	$I_{L1}$	MOD0, MOD1, P30 to P33, P40 to P45	$0.0\text{ V} < V_I < V_{CC}$	—	—	$\pm 5$	$\mu\text{A}$	Without pull-up resistor for the MB89821/823
		MOD0, MOD1, P00 to P07, P10 to P17, P30 to P33, P40 to P45		—	—	$\pm 5$	$\mu\text{A}$	Without pull-up resistor for the MB89P825/PV820
	P00 to P07, P10 to P17, P20 to P25	$0.0\text{ V} < V_I < 6.0\text{ V}$		—	—	$\pm 1$	$\mu\text{A}$	Without pull-up resistor for the MB89821/823
				P20 to P25	—	—	$\pm 1$	$\mu\text{A}$

(Continued)

## MB89820 Series

(Continued)

(V<sub>CC</sub> = V<sub>3</sub> = +5.0 V, V<sub>SS</sub> = 0.0 V, T<sub>A</sub> = -40°C to +85°C)

Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Pull-up resistance	R <sub>PULL</sub>	P20 to P25, P30 to P33, P40 to P45, RST	V1 = 0.0 V	25	50	100	kΩ	With pull-up resistor
Common output impedance	R <sub>VCOM</sub>	COM0 to COM3	V1 to V3 = +5.0 V	—	—	2.5	kΩ	
Segment output impedance	R <sub>VSEG</sub>	SEG0 to SEG49	V1 to V3 = +5.0 V	—	—	15	kΩ	
LCD divided resistance	R <sub>LCD</sub>	—	Between V3 and V <sub>SS</sub>	30	60	120	kΩ	
LCD leakage current	I <sub>LCDL</sub>	V1 to V3, COM0 to COM3, SEG0 to SEG49	—	—	—	±1	μA	
Power supply current <sup>*2</sup>	I <sub>CC</sub>	V <sub>CC</sub>	F <sub>C</sub> = 5 MHz t <sub>inst</sub> <sup>*3</sup> = 0.8 μs	—	3.5	5.0	mA	MB89821, MB89823, MB89PV820
				—	4.0	6.5	mA	MB89P825
	I <sub>CCS</sub>		F <sub>C</sub> = 5 MHz t <sub>inst</sub> <sup>*3</sup> = 0.8 μs Sleep mode	—	1.1	1.7	mA	MB89821, MB89823, MB89PV820, MB89P825
				I <sub>CCH</sub>	T <sub>A</sub> = +25°C Stop mode	—	0.1	1
—	0.1	10	μA			MB89PV820, MB89P825		
Input capacitance	C <sub>IN</sub>	Other than V <sub>CC</sub> and V <sub>SS</sub>	f = 1 MHz	—	10	—	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<sub>3</sub> 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<sub>inst</sub>, see "(4) Instruction Cycle" in "4. AC Characteristics."

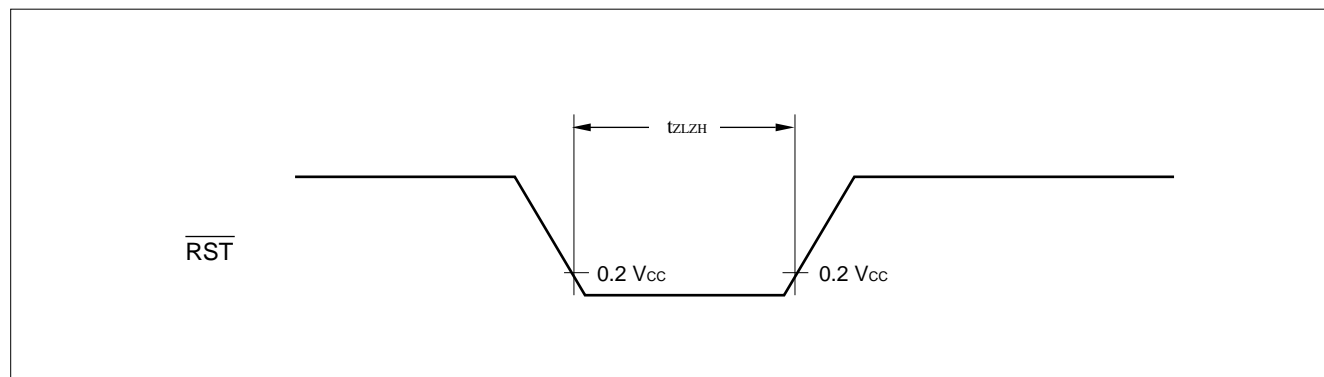
# MB89820 Series

## 4. AC Characteristics

### (1) Reset Timing

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

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



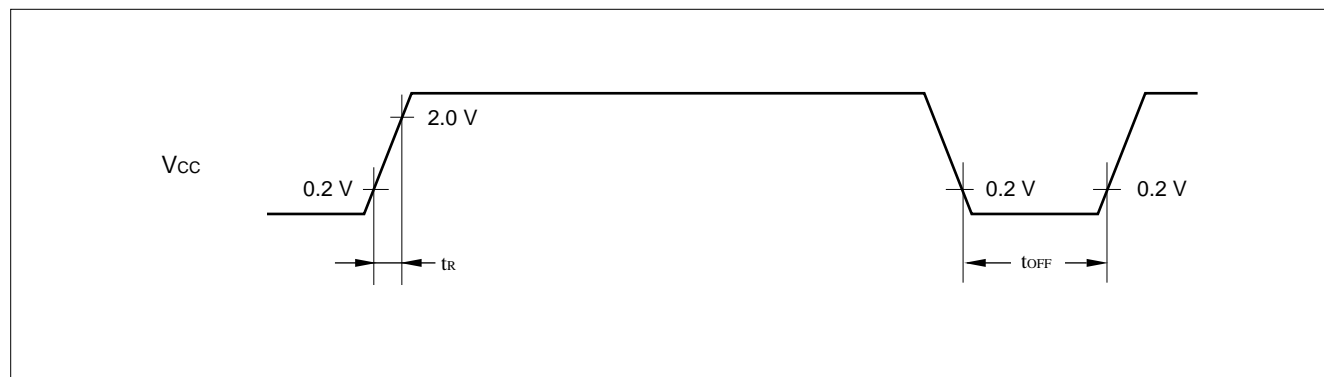
### (2) Power-on Reset

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

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

Note: Make sure that power supply rises within the selected oscillation stabilization time.

If power supply voltage needs to be varied in the course of operation, a smooth voltage rise is recommended.



# MB89820 Series

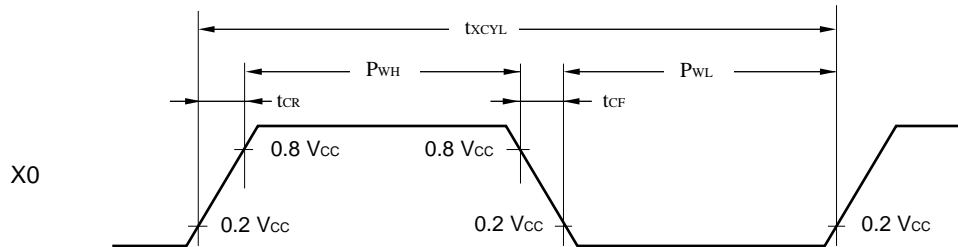
## (3) Clock Timing

( $V_{SS} = 0.0\text{ V}$ ,  $T_A = -40^\circ\text{C}$  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	$t_{XCYL}$			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

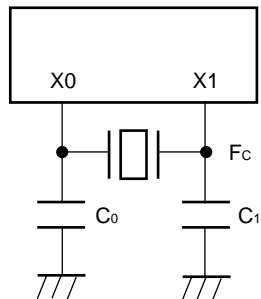
\* : duty =  $P_{WH}/t_{HCYL}$ ,  $P_{WL}/t_{HCYL}$

### X0 and X1 Timing and Conditions

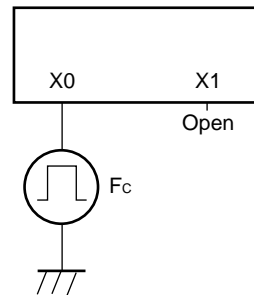


### Clock Conditions

When a crystal  
or  
ceramic resonator is used



When an external clock is in use



## (4) Instruction Cycle

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

# MB89820 Series

## (5) Serial I/O Timing

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

Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Serial clock cycle time	$t_{SCYC}$	SCK	Internal shift clock mode	$2 t_{inst}^*$	—	$\mu\text{s}$	
SCK $\downarrow \rightarrow$ SO time	$t_{SLOV}$	SCK, SO		-200	200	ns	
Valid SI $\rightarrow$ SCK $\uparrow$	$t_{IVSH}$	SI, SCK		$0.5 t_{inst}^*$	—	$\mu\text{s}$	
SCK $\uparrow \rightarrow$ valid SI hold time	$t_{SHIX}$	SCK, SI		$0.5 t_{inst}^*$	—	$\mu\text{s}$	
Serial clock "H" pulse width	$t_{SHSL}$	SCK	External shift clock mode	$1 t_{inst}^*$	—	$\mu\text{s}$	
Serial clock "L" pulse width	$t_{LSLH}$			$1 t_{inst}^*$	—	$\mu\text{s}$	
SCK $\downarrow \rightarrow$ SO time	$t_{SLOV}$	SCK, SO		0	200	ns	
Valid SI $\rightarrow$ SCK $\uparrow$	$t_{IVSH}$	SI, SCK		$0.5 t_{inst}^*$	—	$\mu\text{s}$	
SCK $\uparrow \rightarrow$ valid SI hold time	$t_{SHIX}$	SCK, SI		$0.5 t_{inst}^*$	—	$\mu\text{s}$	

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

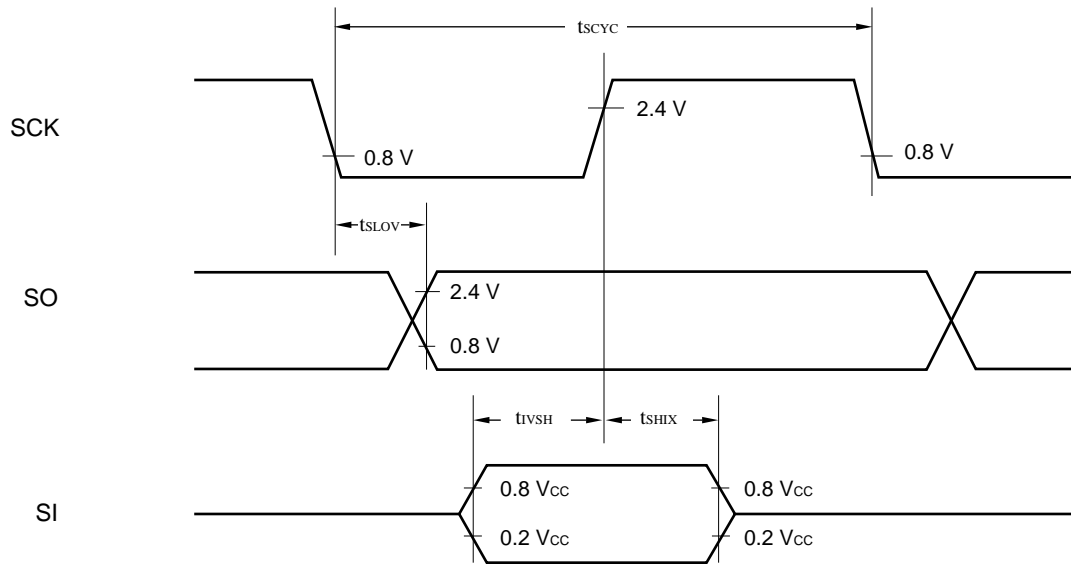
## (6) UART Timing

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

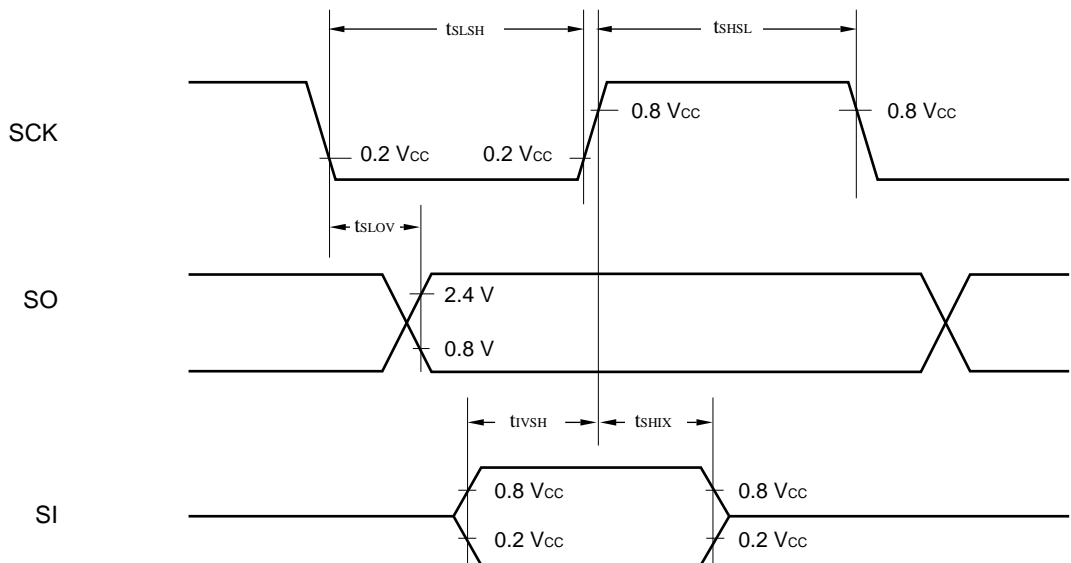
Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Serial clock cycle time	$t_{SCYC}$	SCK	Internal shift clock mode	$2 t_{inst}^*$	—	$\mu\text{s}$	
SCK $\downarrow \rightarrow$ SO time	$t_{SLOV}$	SCK, SO		-200	200	ns	
Valid SI $\rightarrow$ SCK $\uparrow$	$t_{IVSH}$	SI, SCK		$0.5 t_{inst}^*$	—	$\mu\text{s}$	
SCK $\uparrow \rightarrow$ valid SI hold time	$t_{SHIX}$	SCK, SI		$0.5 t_{inst}^*$	—	$\mu\text{s}$	
Serial clock "H" pulse width	$t_{SHSL}$	SCK	External shift clock mode	$1 t_{inst}^*$	—	$\mu\text{s}$	
Serial clock "L" pulse width	$t_{LSLH}$			$1 t_{inst}^*$	—	$\mu\text{s}$	
SCK $\downarrow \rightarrow$ SO time	$t_{SLOV}$	SCK, SO		0	200	ns	
Valid SI $\rightarrow$ SCK $\uparrow$	$t_{IVSH}$	SI, SCK		$0.5 t_{inst}^*$	—	$\mu\text{s}$	
SCK $\uparrow \rightarrow$ valid SI hold time	$t_{SHIX}$	SCK, SI		$0.5 t_{inst}^*$	—	$\mu\text{s}$	

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

## Internal Shift Clock Mode



## External Shift Clock Mode



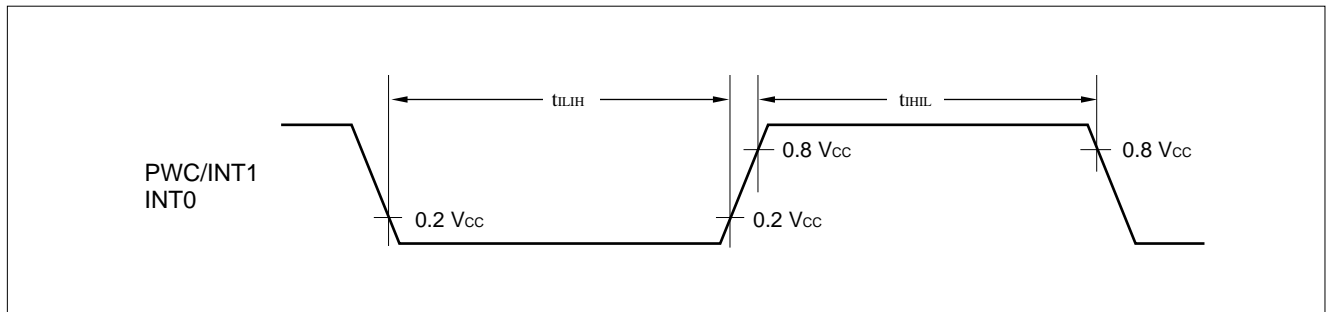
# MB89820 Series

## (7) Peripheral Input Timing

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

Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Peripheral input "H" pulse width	$t_{LH}$	PWC/INT1 INT0	—	$2 t_{inst}^*$	—	$\mu\text{s}$	
Peripheral input "L" pulse width	$t_{HL}$			$2 t_{inst}^*$	—	$\mu\text{s}$	

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

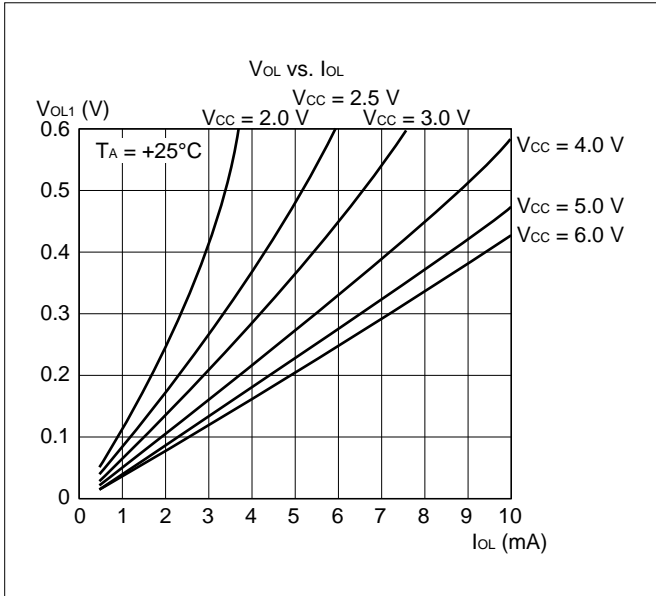




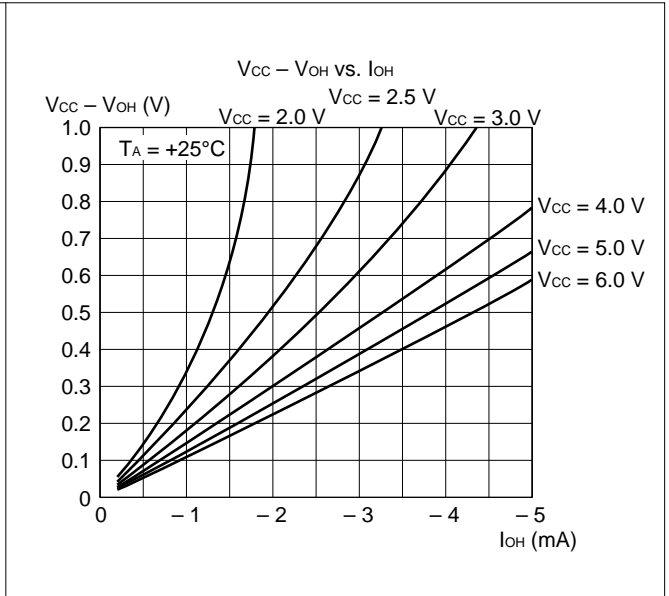
# MB89820 Series

## EXAMPLE CHARACTERISTICS

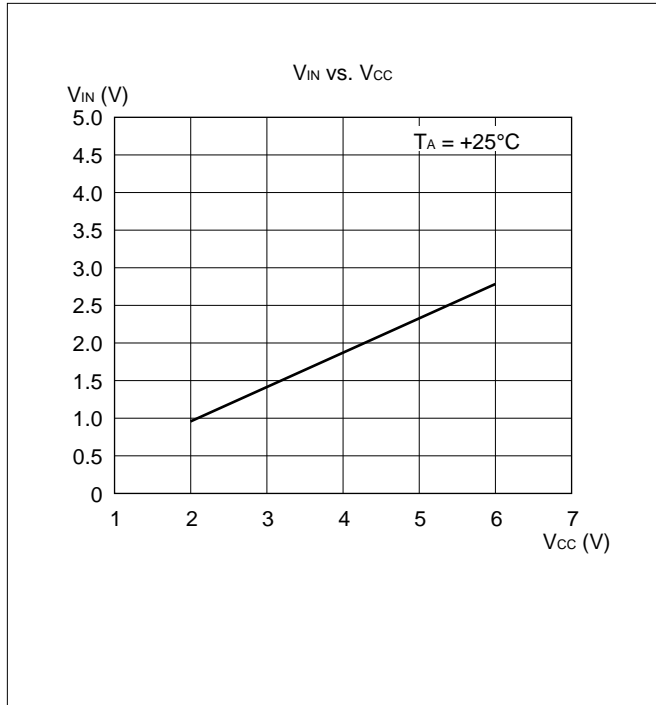
(1) "L" Level Output Voltage



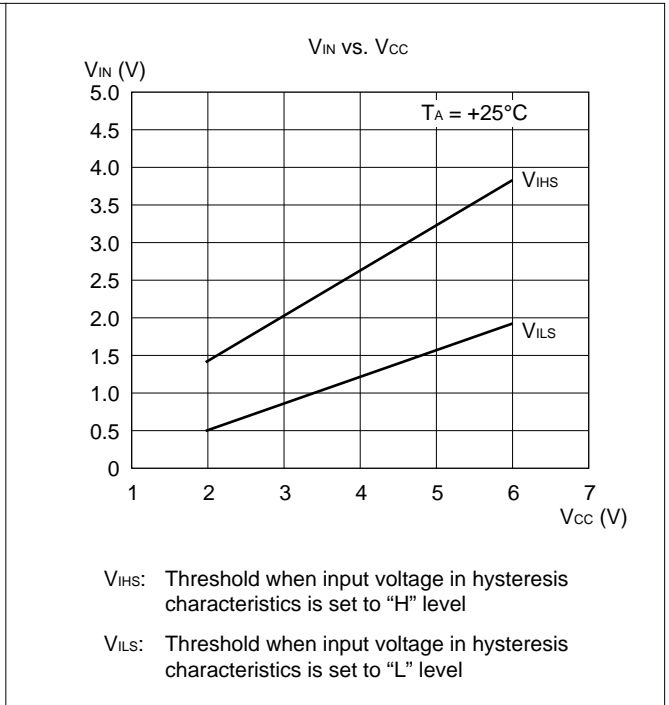
(2) "H" Level Output Voltage



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

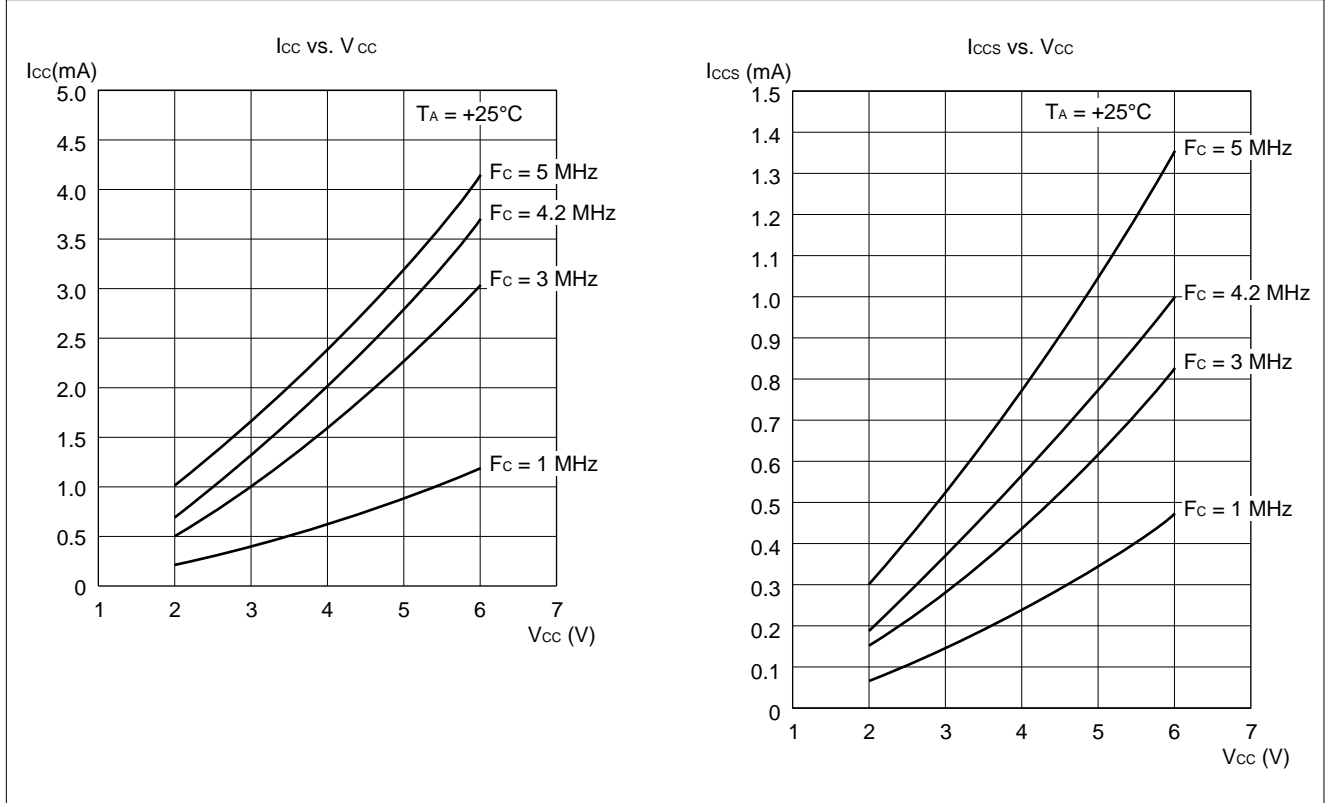


(4) "H" level Input Voltage/"L" Level Input Voltage (CMOS Hysteresis Input)

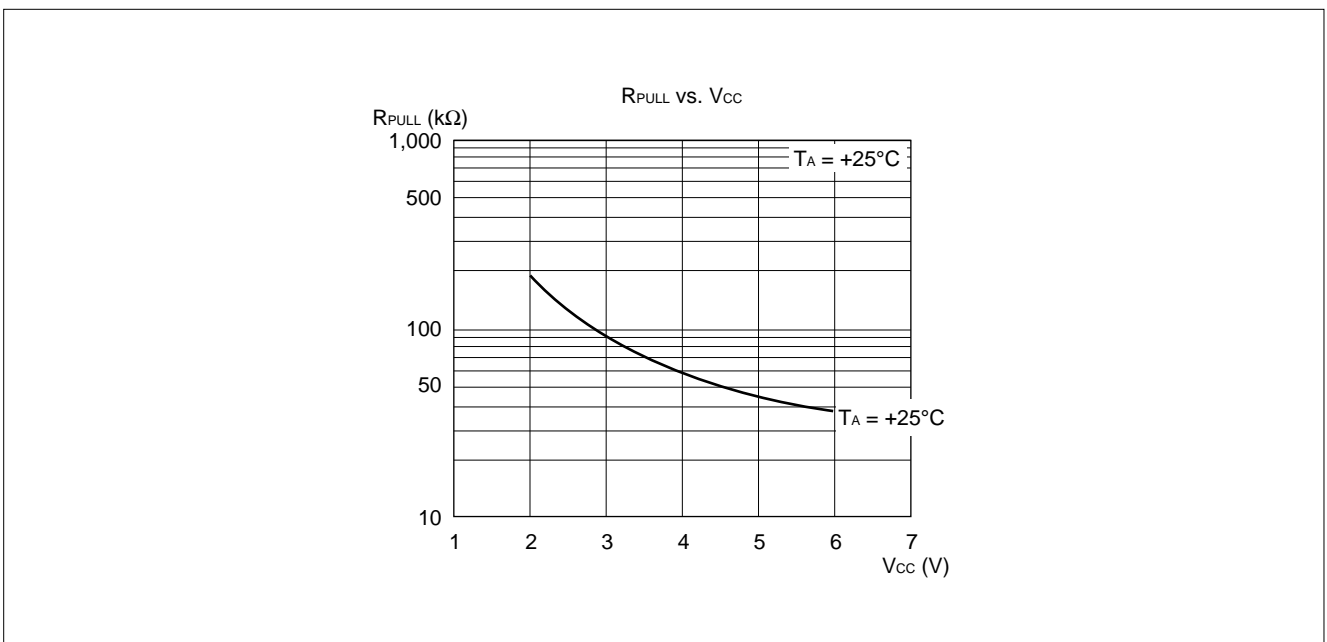


# MB89820 Series

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



## (6) Pull-up Resistance



**■ 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**

<b>Symbol</b>	<b>Meaning</b>
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)*

# MB89820 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.

## MB89820 Series

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 F<sup>2</sup>MC-8 family)

# MB89820 Series

**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	$\boxed{C} \rightarrow A$	-	-	-	++-+	03
ROLC A	2	1	$\boxed{C} \leftarrow A$	-	-	-	++-+	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

(Continued)

## MB89820 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	$(A) \leftarrow (AL) \wedge ((IX) +off)$	-	-	-	++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	$(A) \leftarrow (AL) \vee (dir)$	-	-	-	++R-	75
OR A,@EP	3	1	$(A) \leftarrow (AL) \vee (EP)$	-	-	-	++R-	77
OR A,@IX +off	4	2	$(A) \leftarrow (AL) \vee ((IX) +off)$	-	-	-	++R-	76
OR A,Ri	3	1	$(A) \leftarrow (AL) \vee (Ri)$	-	-	-	++R-	78 to 7F
CMP dir,#d8	5	3	$(dir) - d8$	-	-	-	++++	95
CMP @EP,#d8	4	2	$(EP) - d8$	-	-	-	++++	97
CMP @IX +off,#d8	5	3	$((IX) +off) - d8$	-	-	-	++++	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 $PC \leftarrow PC + rel$	-	-	-	----	FD
BNZ/BNE rel	3	2	If $Z = 0$ then $PC \leftarrow PC + rel$	-	-	-	----	FC
BC/BLO rel	3	2	If $C = 1$ then $PC \leftarrow PC + rel$	-	-	-	----	F9
BNC/BHS rel	3	2	If $C = 0$ then $PC \leftarrow PC + rel$	-	-	-	----	F8
BN rel	3	2	If $N = 1$ then $PC \leftarrow PC + rel$	-	-	-	----	FB
BP rel	3	2	If $N = 0$ then $PC \leftarrow PC + rel$	-	-	-	----	FA
BLT rel	3	2	If $V \vee N = 1$ then $PC \leftarrow PC + rel$	-	-	-	----	FF
BGE rel	3	2	If $V \vee N = 0$ then $PC \leftarrow PC + rel$	-	-	-	----	FE
BBC dir: b,rel	5	3	If $(dir: b) = 0$ then $PC \leftarrow PC + rel$	-	-	-	-+--	B0 to B7
BBS dir: b,rel	5	3	If $(dir: b) = 1$ then $PC \leftarrow PC + rel$	-	-	-	-+--	B8 to BF
JMP @A	2	1	$(PC) \leftarrow (A)$	-	-	-	----	E0
JMP ext	3	3	$(PC) \leftarrow ext$	-	-	-	----	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

# MB89820 Series

## 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	POPW A	MOV A,ext	MOVW A,PS	CLR A	SETI	CLR 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	POPW IX	MOV extA	MOVW PS,A	CLR dir:1	SETC	CLR dir:1	BBC dir:1,rel	INCW SP	DECW SP	MOVW SPA	MOVW A,SP	
2	ROL A	CMP A	ADDC A	SUBC A	XCH A,T	XOR A	AND A	OR A	MOV @A,T	MOVW @A,T	CLR 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	XORW A	ANDW A	ORW A	MOVW @A,T	MOVW @A,T	CLR 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	AND A,#d8	OR A,#d8	MOV A,#d8	DAA	MOVW @A,T	CLR dir:4	BBC dir:4,rel	MOVW A,ext	MOVW extA	MOVW A,#d16	MOVW A,PC	
5	MOV A,dir	CMP A,dir	ADDC A,dir	SUBC A,dir	XOR A,dir	AND A,dir	OR A,dir	MOV A,dir	MOV dir,#d8	CMP dir,#d8	CLR dir:5	BBC dir:5,rel	MOVW A,dir	MOVW dir,A	MOVW SP,#d16	MOVW A,SP	
6	MOV A,@IX+d	CMP A,@IX+d	ADDC A,@IX+d	SUBC A,@IX+d	XOR A,@IX+d	AND A,@IX+d	OR A,@IX+d	MOV A,@IX+d	MOV @IX+d,#d8	CMP @IX+d,#d8	CLR dir:6	BBC dir:6,rel	MOVW A,@IX+d	MOVW @IX+d,A	MOVW IX,#d16	MOVW A,IX	
7	MOV A,@EP	CMP A,@EP	ADDC A,@EP	SUBC A,@EP	MOV @EPA	MOV @EPA	OR A,@EP	MOV A,@EP	MOV @EP,#d8	CMP @EP,#d8	CLR dir:7	BBC dir:7,rel	MOVW A,@EP	MOVW @EPA	MOVW EP,#d16	MOVW A,EP	
8	MOV A,R0	CMP A,R0	ADDC A,R0	SUBC A,R0	MOV R0,A	XOR R0,A	AND 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	MOV R1,A	XOR R1,A	AND 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	MOV R2,A	XOR R2,A	AND 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	MOV R3,A	XOR R3,A	AND 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	MOV R4,A	XOR R4,A	AND 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	MOV R5,A	XOR R5,A	AND 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	MOV R6,A	XOR R6,A	AND 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	MOV R7,A	XOR R7,A	AND 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	



# MB89820 Series

## ■ MASK OPTIONS

No.	Part number	MB89821/823	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"> <li>┌ With power-on reset</li> <li>└ Without power-on reset</li> </ul>	Selectable	Can be set	With power-on reset
3	Oscillation stabilization time selection ( $F_c = 5 \text{ MHz}$ ) <sup>*1</sup> <ul style="list-style-type: none"> <li>┌ Approx. <math>2^{17}/F_c</math> (Approx. 26.2 ms)</li> <li>└ Approx. <math>2^{13}/F_c</math> (Approx. 1.64 ms)</li> </ul>	Selectable	Can be set	Oscillation stabilization time Approx. $2^{17}/F_c$ (Approx. 26.2 ms)
4	Reset pin output <ul style="list-style-type: none"> <li>┌ With reset output</li> <li>└ Without reset output</li> </ul>	Selectable	Can be set	With reset output
5	Segment output switching <ul style="list-style-type: none"> <li>┌ 50 segments: No port selection</li> <li>┌ 49 segments: Selection of P17</li> <li>┌ 48 segments: Selection of P17 to P16</li> <li>┌ 46 segments: Selection of P17 to P14</li> <li>┌ 42 segments: Selection of P17 to P10</li> <li>└ 34 segments: Selection of P17 to P10 and P07 to P00</li> </ul>	Selectable <sup>*2</sup>	Can be set <sup>*3</sup>	Can be set <sup>*3</sup>

\*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.

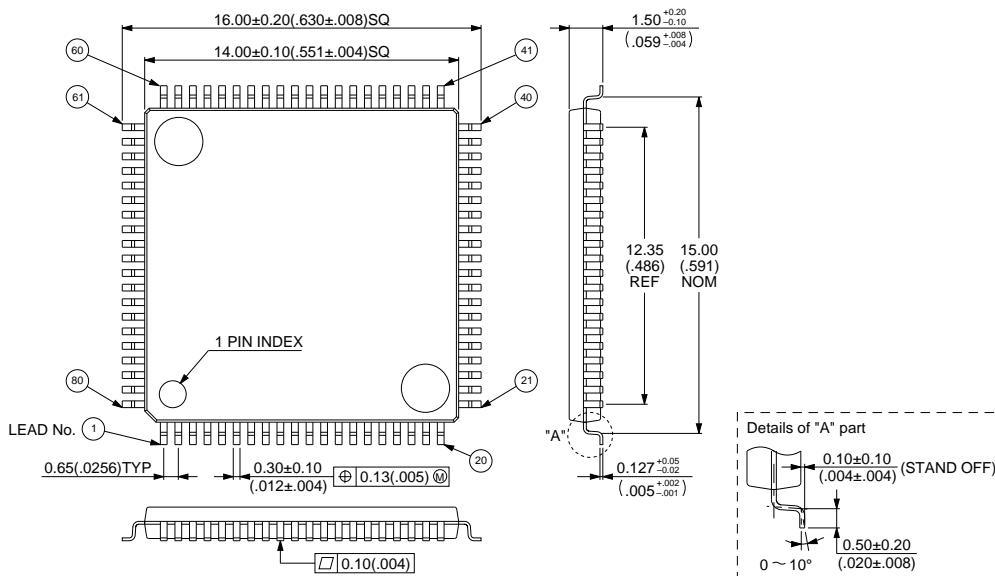
## ■ ORDERING INFORMATION

Part number	Package	Remarks
MB89821PFM MB89823PFM MB89P825PFM	80-pin Plastic QFP (FPT-80P-M11)	
MB89PV820CF	80-pin Ceramic MQFP (MQP-80C-P01)	

# MB89820 Series

## ■ PACKAGE DIMENSIONS

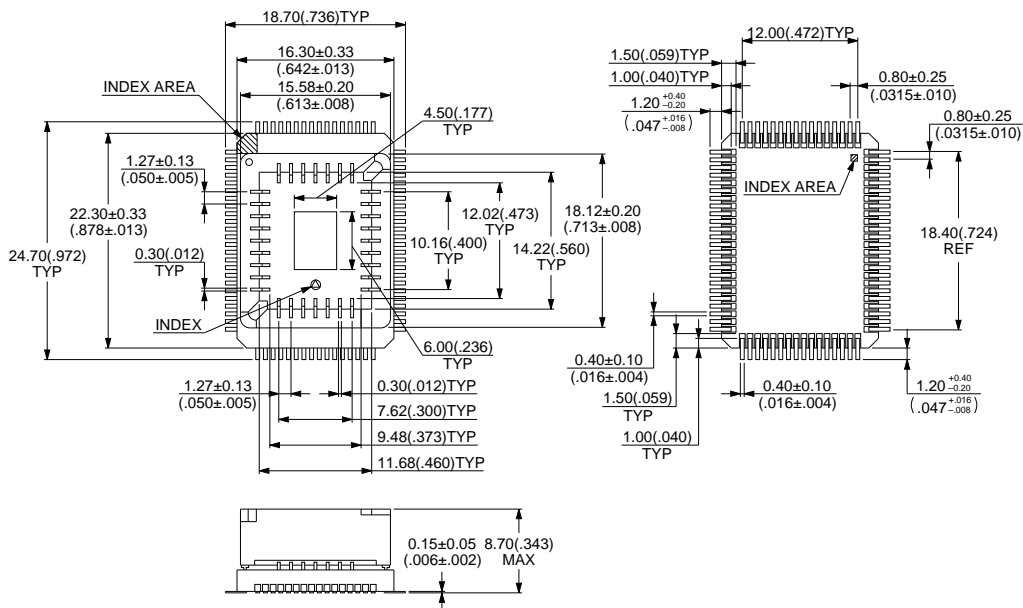
### 80-pin Plastic QFP (FPT-80P-M11)



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Dimensions in mm (inches)

### 80-pin Ceramic MQFP (MQP-80P-P01)



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Dimensions in mm (inches)

# MB89820 Series

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