

# 8-bit Proprietary Microcontroller

CMOS

## F<sup>2</sup>MC-8L MB89810A Series

### MB89816A/P817A

#### ■ DESCRIPTION

The MB89810A series is a line of single-chip microcontrollers based on the F<sup>2</sup>MC\*-8L CPU core which can operate at low voltage but at high speed. The microcontrollers contain peripheral function such as timer, serial interface, a UART, and an external interrupt. The MB89810A series is applicable to a wide range of applications from welfare products to industrial equipment, including portable devices.

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

#### ■ FEATURES

High speed processing at low voltage

Minimum execution time: 0.8  $\mu$ s/3.0 V, 1.33  $\mu$ s/2.2 V

- F<sup>2</sup>MC-8L family CPU core

Instruction set optimized for controllers

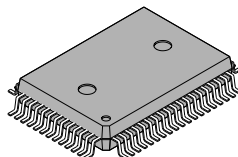
Multiplication and division instructions  
16-bit arithmetic operations  
Test and branch instructions  
Bit manipulation instructions, etc.

- Four types of timers
  - 8-bit PWM timer: 2 channels (also serve as reload timers)
  - 16-bit timer/counter
  - 21-bit time-base timer
- Two serial interface
  - 8-bit synchronous serial (Switchable transfer direction allows communication with various equipment.)
  - UART (5-, 7-, or 8-bit transfer capable)

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#### ■ PACKAGE

64-pin Plastic QFP



(FPT-64P-M06)

# MB89810A Series

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- External interrupt: 8 channels  
Eight channels are independent and 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	MB89816A	MB89P817A
Classification	Mass-production product (mask ROM products)	One-time PROM product (for evaluation and development)
ROM size	24 K × 8 bits (internal mask ROM)	32 K × 8 bits (internal PROM, programming with general-purpose EPROM programmer)
RAM size	2048 × 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 Interrupt processing time: 7.2 μs/5 MHz	
Ports	Input ports: 8 (All also serve as peripherals.) Output ports: 8 I/O ports (N-ch open-drain): 5 (for LED driving) I/O ports (CMOS): 32 (14 ports also serve as peripherals.) Total: 53	
8-bit PWM timer	Two internal channels 8-bit reload timer operation (toggled output capable, operating clock cycle: 3 different cycles) 8-bit resolution PWM operation (conversion cycle: 3 different cycles)	
8-bit timer/counter	16-bit timer operation 16-bit event counter operation	
UART	5-, 7-, or 8-bit transfer capable Built-in baud rate generator Clock synchronous/asynchronous data transfer capable	
8-bit Serial I/O	8-bits LSB-first/MSB first selectability One clock selectable from four transfer clocks (one external shift clock, three internal shift clocks)	
External interrupt	8 independent channels (edge selection, interrupt vector, source flag) 4 channels: Level detection (level selectable) 4 channels: Edge detection (edge selectable) Used also for wake-up from the stop/sleep mode. (Edge detection is also permitted in stop mode.)	

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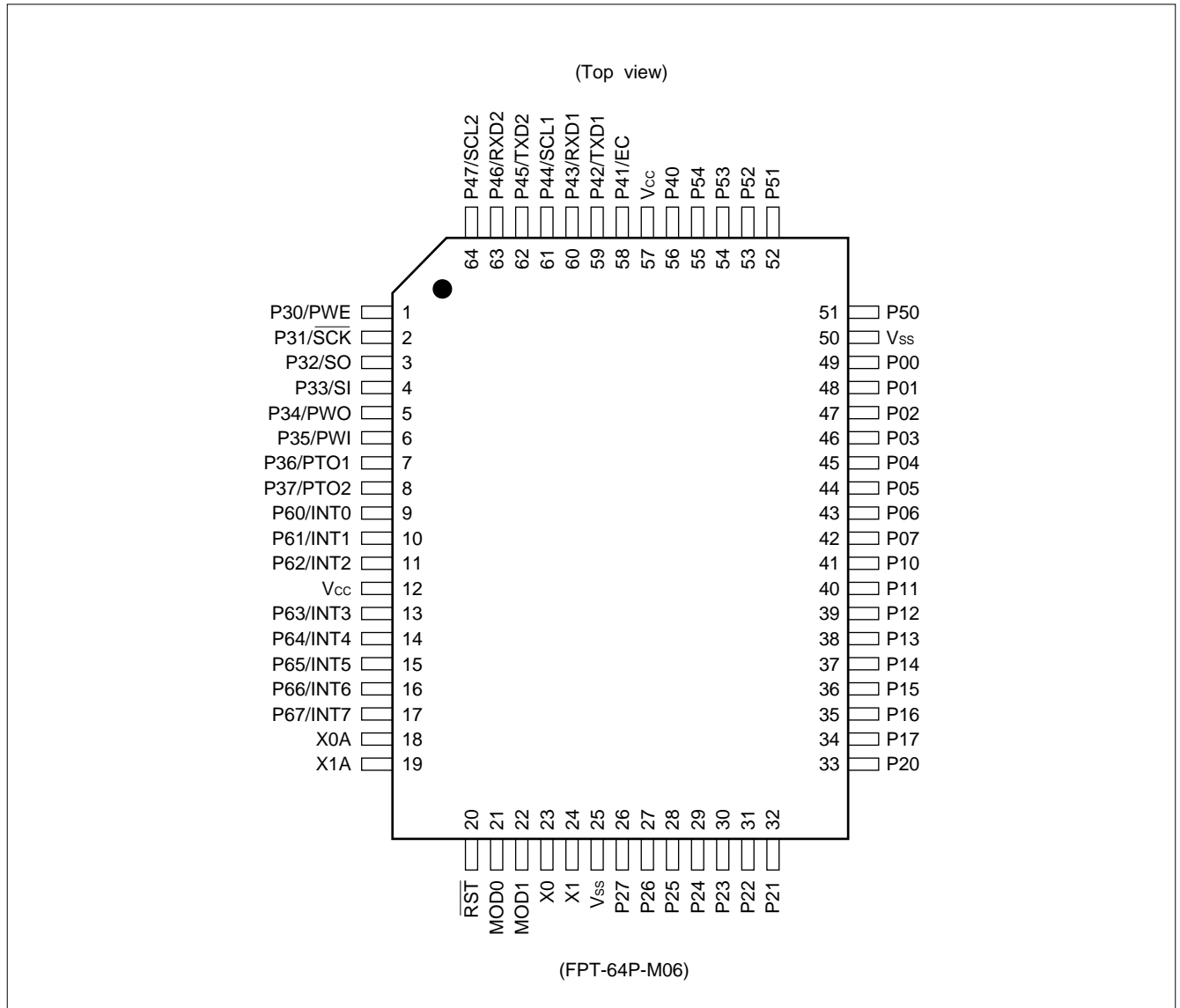
# MB89810A Series

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Part number	MB89816A	MB89P817A
Watch interrupt	Interrupt cycles: 4 different cycles (subclock)	
Watchdog timer reset	Reset occurrence cycle: 839 ms/5 MHz	
Standby mode	Sleep mode, stop mode	
Process	CMOS	
Package	FPT-64P-M06	
Operating voltage	2.2 V to 6.0 V*	2.7 V to 6.0 V*

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

## ■ PIN ASSIGNMENT



# MB89810A Series

## ■ PIN DESCRIPTION

Pin no.	Pin name	Circuit type	Function
23	X0	A	Main clock oscillator pins
24	X1		
18	X0A	I	Subclock crystal oscillator pins
19	X1A		
21	MOD0	B	Operating mode selection pins Connect directly these pins directly to V <sub>SS</sub> .
22	MOD1		
20	RST	C	Reset I/O pin This pin is an N-ch open-drain output type with a pull-up resistor and a hysteresis input type. “L” is output from this pin by an internal reset source. The internal circuit is initialized by the input of “L”.
49 to 42	P00 to P07	D	General-purpose I/O ports A pull-up resistor option is provided. These ports have the port output inverting function.
41 to 34	P10 to P17	D	General-purpose I/O ports A pull-up resistor option is provided. These ports have the port output inverting function.
33 to 30	P20 to P23	F	General-purpose output ports These ports have the port output inverting function.
29 to 26	P24 to P27	F	General-purpose output ports
1	P30 /PWE	E	General-purpose I/O port A pull-up resistor option is provided. Also serves as a pulse width detection enable input (PWE). PWE input is hysteresis input.
2	P31/SCK	E	General-purpose I/O port A pull-up resistor option is provided. Also serves as the clock I/O for the 8-bit serial I/O (SCK). SCK input is hysteresis input.
3	P32/SO	D	General-purpose I/O port A pull-up resistor option is provided. Also serves as the data output for the 8-bit serial I/O (SO).
4	P33/SI	E	General-purpose I/O port A pull-up resistor option is provided. Also serves as the data input for the 8-bit serial I/O (SI). SI input is hysteresis input.
5	P34/PWO	D	General-purpose I/O port A pull-up resistor option is provided. Also serves as a pulse width detection output (PWO).
6	P35/PWI	E	General-purpose I/O port A pull-up resistor option is provided. Also serves as a pulse width detection input (PWI). PWI input is hysteresis input.
7	P36/PTO1	D	General-purpose I/O port A pull-up resistor option is provided. Also serves as the toggle output for the 8-bit PWM timer 1 (PTO1).

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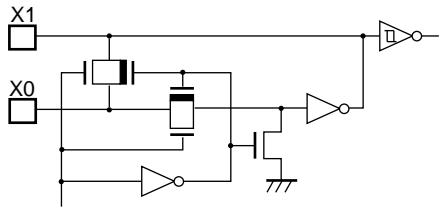
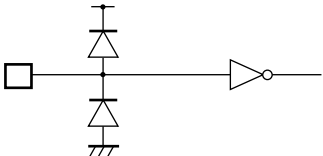
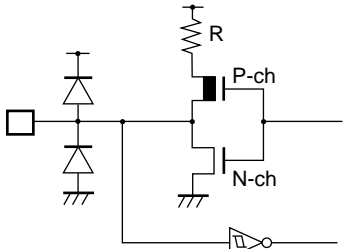
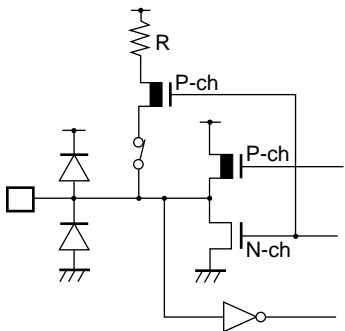
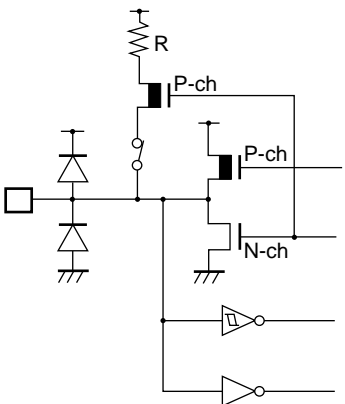
# MB89810A Series

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Pin no.	Pin name	Circuit type	Function
8	P37/PTO2	D	General-purpose I/O port A pull-up resistor option is provided. Also serves as the toggle output for the 8-bit PWM timer 2 (PTO2).
56	P40	D	General-purpose I/O port A pull-up resistor option is provided.
58	P41/EC	E	General-purpose I/O port A pull-up resistor option is provided. Also serves as a 16-bit timer/counter input (EC). EC input is hysteresis input.
59	P42/TXD1	D	General-purpose I/O port A pull-up resistor option is provided. Also serves as the data output 1 for the UART (TXD1).
60	P43/RXD1	E	General-purpose I/O port A pull-up resistor option is provided. Also serves as the data input 1 for the UART (RXD1). RXD1 input is hysteresis input.
61	P44/SCL1	E	General-purpose I/O port A pull-up resistor option is provided. Also serves as the clock I/O 1 for the UART (SCL1). SCL1 input is hysteresis input.
62	P45/TXD2	D	General-purpose I/O port A pull-up resistor option is provided. Also serves as the data output 2 for the UART (TXD2).
63	P46/RXD2	E	General-purpose I/O port A pull-up resistor option is provided. Also serves as the data input 2 for the UART (RXD2). RXD2 input is hysteresis input.
64	P47/SCL2	E	General-purpose I/O port A pull-up resistor option is provided. Also serves as the clock I/O 2 for the UART (SCL2). SCL2 input is hysteresis input.
51 to 55	P50 to P54	G	N-channel open-drain I/O ports A pull-up resistor option is provided only for the MB89816A.
9 to 11	P60/INT0 to P62/INT2	H	General-purpose I/O ports A pull-up resistor option is provided. Also serve as an external interrupt input (INT0 to INT2). These ports are a hysteresis input type.
13 to 17	P63/INT3 to P67/INT7	H	General-purpose I/O ports A pull-up resistor option is provided. Also serve as an external interrupt input (INT3 to INT7). These ports are a hysteresis input type.
12, 57	V <sub>CC</sub>	–	Power supply pin
25, 50	V <sub>SS</sub>	–	Power supply (GND) pin

# MB89810A Series

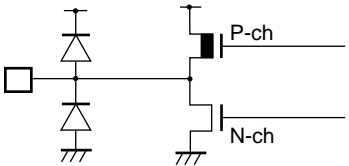
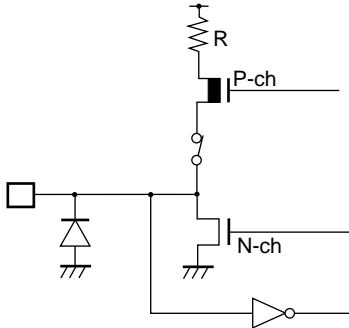
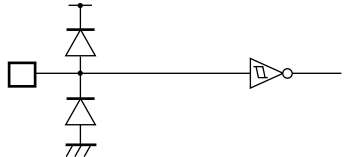
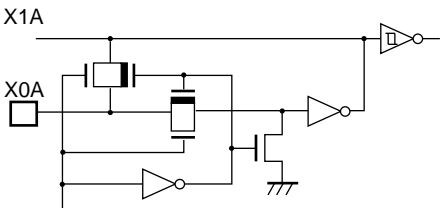
## I/O CIRCUIT TYPE

Type	Circuit	Remarks
A	 <p>Standby control signal</p>	<ul style="list-style-type: none"> <li>• Main clock</li> <li>• At an oscillation feedback resistor of approximately 2 MΩ (1 to 5 MHz)</li> <li>• CR oscillator circuit selectability</li> </ul>
B		
C		<ul style="list-style-type: none"> <li>• At an output pull-up resistor (P-ch) of approximately 50 kΩ/5.0 V</li> <li>• Hysteresis input</li> </ul>
D		<ul style="list-style-type: none"> <li>• CMOS output</li> <li>• CMOS input</li> </ul> <p>• Pull-up resistor optional</p>
E		<ul style="list-style-type: none"> <li>• CMOS output</li> <li>• CMOS input</li> <li>• Hysteresis input (resource input)</li> </ul> <p>• Pull-up resistor optional</p>

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## MB89810A Series

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Type	Circuit	Remarks
F		<ul style="list-style-type: none"> <li>• CMOS output</li> </ul>
G		<ul style="list-style-type: none"> <li>• N-ch open-drain output</li> <li>• CMOS input</li> <li>• Pull-up resistor optional (only for the MB89816A)</li> </ul>
H		<ul style="list-style-type: none"> <li>• Hysteresis input</li> <li>• Pull-up resistor optional</li> </ul>
I		<ul style="list-style-type: none"> <li>• Subclock (30 to 40 kHz)</li> <li>• At an oscillation feedback resistor of approximately 4.5 MΩ</li> </ul>

# MB89810A 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.

### 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. 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.

### 4. 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 MB89P817A**

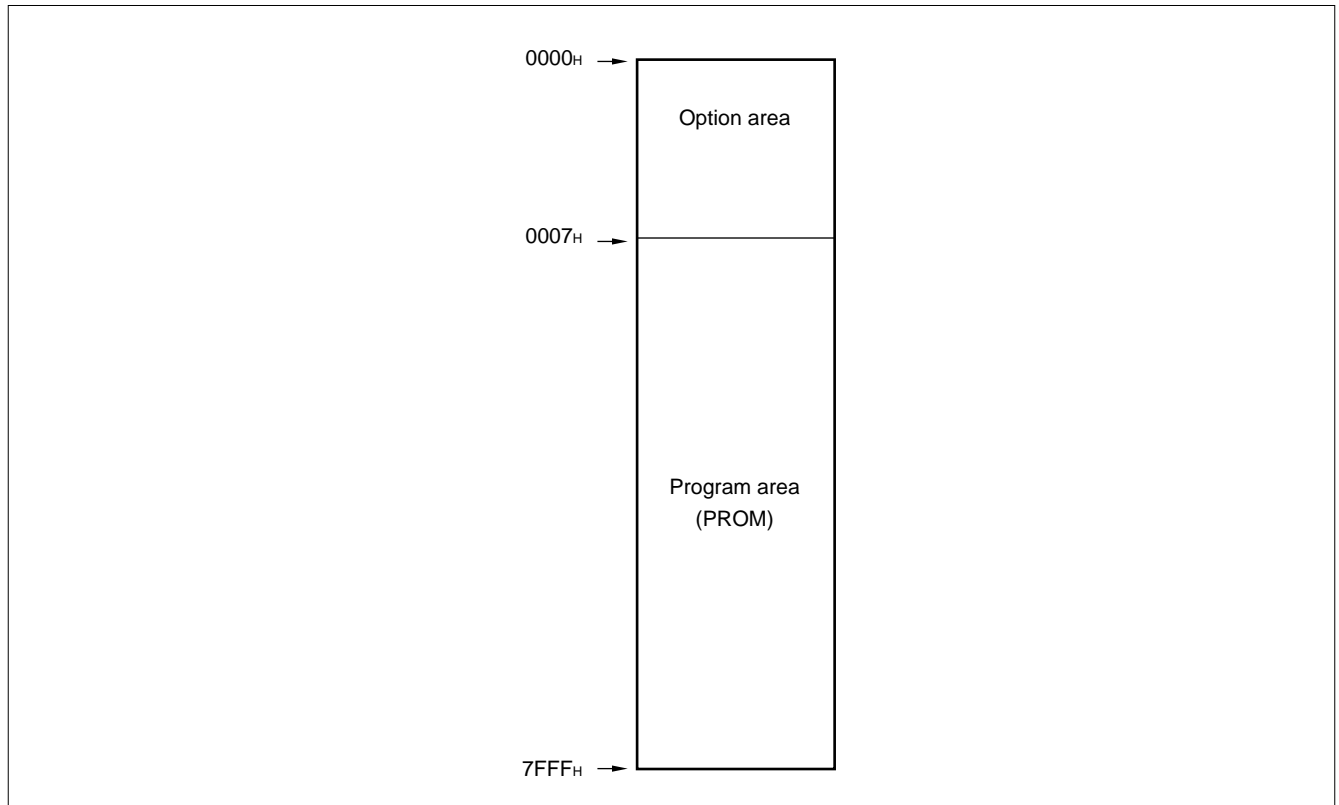
In EPROM mode, the MB89P817A functions equivalent to the MBM27C256A. This allows the PROM to be programmed with a general-purpose EPROM programmer (the electronic signature mode cannot be used) by using the dedicated socket adapter.

**• Writing Procedure**

- (1) Set the EPROM programmer to the MBM27C256A.
- (2) Load program data into the EPROM programmer at 0007<sub>H</sub> to 7FFF<sub>H</sub> (note that addresses 8007<sub>H</sub> to FFFF<sub>H</sub> while operating as operating mode assign to 0007<sub>H</sub> to 7FFF<sub>H</sub> in EPROM mode).  
Load option data into addresses 0000<sub>H</sub> to 0006<sub>H</sub> of the EPROM programmer. (For information about each corresponding option, see “• Setting OTPROM Option Bit Map.”)
- (3) Program with the EPROM programmer.

**• Memory Space**

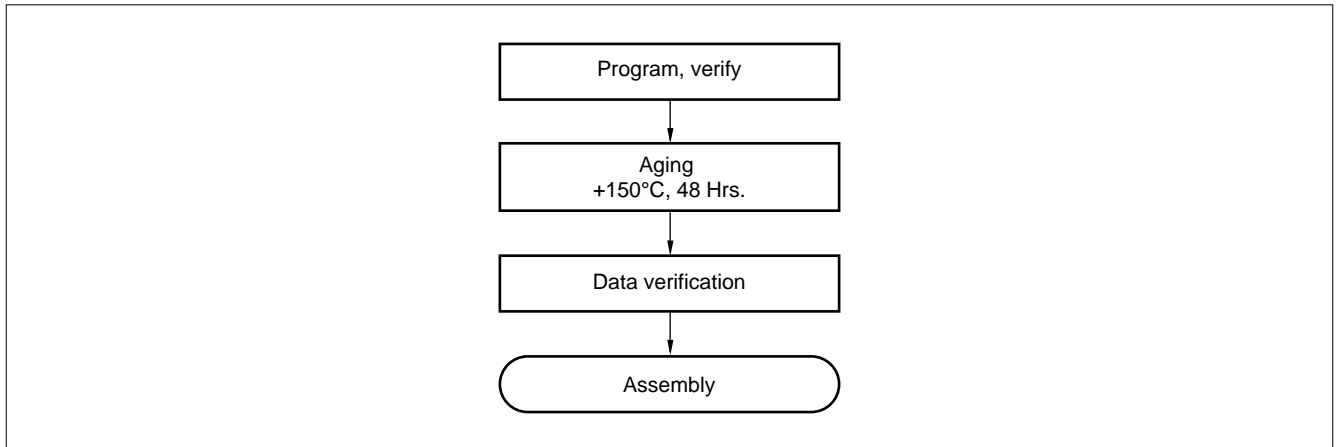
Memory space is diagrammed below.



# MB89810A Series

## • Recommended Screening Conditions

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



## • 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.

## • EPROM Programmer Socket Adapter

Package	Compatible socket adapter
FPT-64P-M06	ROM-64QF-28DP-8L

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

Note: Connect the jumper pin to  $V_{SS}$  when using.

Depending on the EPROM programmer, inserting a capacitor of approx. 0.1  $\mu\text{F}$  between  $V_{PP}$  and  $V_{SS}$  or  $V_{CC}$  and  $V_{SS}$  can stabilize programming operations.

# MB89810A Series

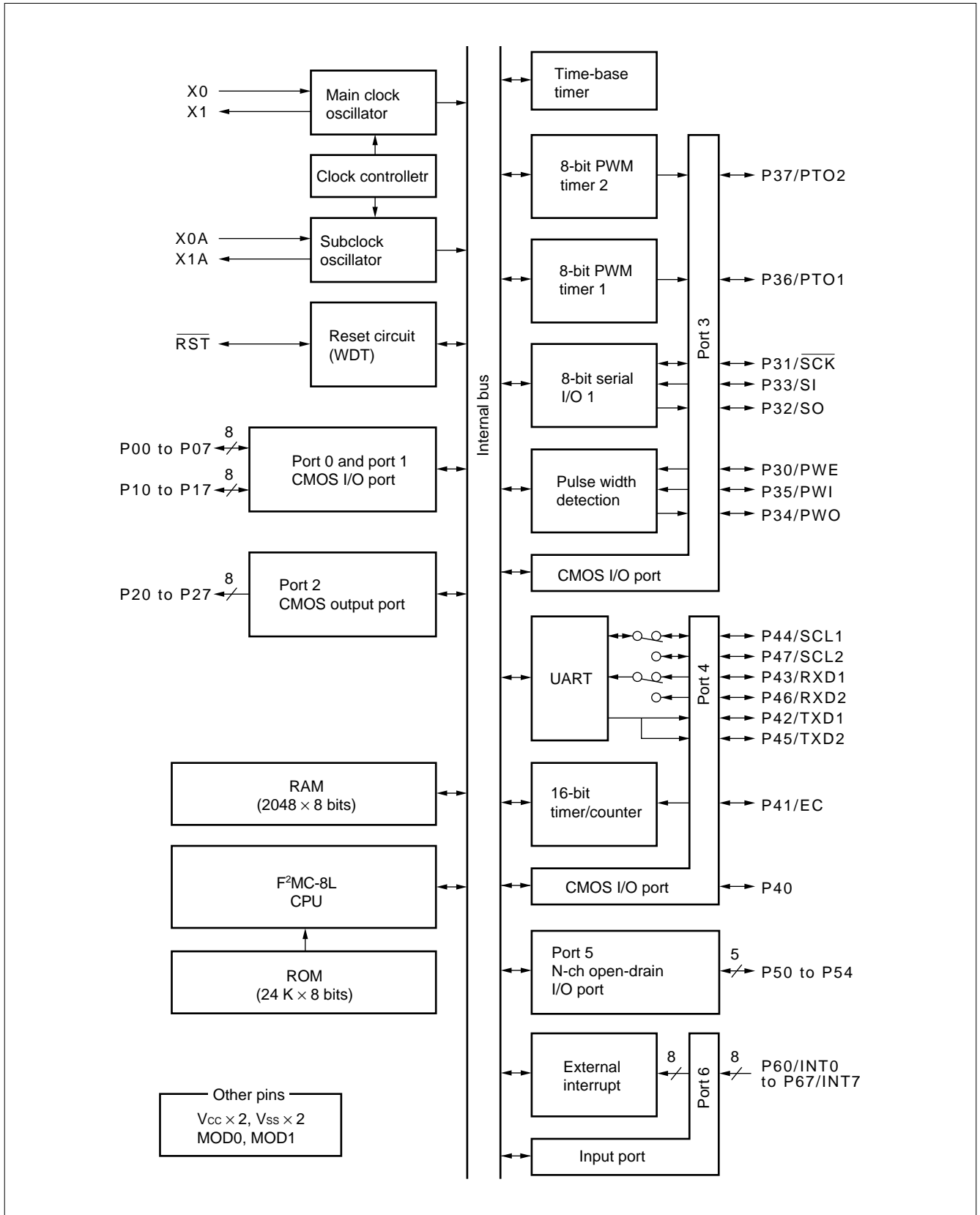
## • OTPROM Option Bit Map

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0000 <sub>H</sub>	Vacancy	Vacancy	Vacancy	Single-clock setting	Reset pin output	Power-on reset	Oscillation stabilization time	
	Readable and writable	Readable and writable	Readable and writable	1: Dual-clock 0: Single-clock	1: Enabled 0: Disabled	1: Enabled 0: Disabled	00 $2^4/F_{CH}$ 10 $2^{17}/F_{CH}$	01 $2^{14}/F_{CH}$ 11 $2^{18}/F_{CH}$
0001 <sub>H</sub>	P07 Pull-up 1: No 0: Yes	P06 Pull-up 1: No 0: Yes	P05 Pull-up 1: No 0: Yes	P04 Pull-up 1: No 0: Yes	P03 Pull-up 1: No 0: Yes	P02 Pull-up 1: No 0: Yes	P01 Pull-up 1: No 0: Yes	P00 Pull-up 1: No 0: Yes
0002 <sub>H</sub>	P17 Pull-up 1: No 0: Yes	P16 Pull-up 1: No 0: Yes	P15 Pull-up 1: No 0: Yes	P14 Pull-up 1: No 0: Yes	P13 Pull-up 1: No 0: Yes	P12 Pull-up 1: No 0: Yes	P11 Pull-up 1: No 0: Yes	P10 Pull-up 1: No 0: Yes
0003 <sub>H</sub>	P37 Pull-up 1: No 0: Yes	P36 Pull-up 1: No 0: Yes	P35 Pull-up 1: No 0: Yes	P34 Pull-up 1: No 0: Yes	P33 Pull-up 1: No 0: Yes	P32 Pull-up 1: No 0: Yes	P31 Pull-up 1: No 0: Yes	P30 Pull-up 1: No 0: Yes
0004 <sub>H</sub>	P47 Pull-up 1: No 0: Yes	P46 Pull-up 1: No 0: Yes	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
0005 <sub>H</sub>	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	P64 Pull-up 1: No 0: Yes	P63 Pull-up 1: No 0: Yes	P62 Pull-up 1: No 0: Yes	P61 Pull-up 1: No 0: Yes	P60 Pull-up 1: No 0: Yes
0006 <sub>H</sub>	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writables	Oscillator type 1: Crystal 0: CR	P67 Pull-up 1: No 0: Yes	P66 Pull-up 1: No 0: Yes	P65 Pull-up 1: No 0: Yes

Note: Each bit defaults to 1.

# MB89810A Series

## ■ BLOCK DIAGRAM

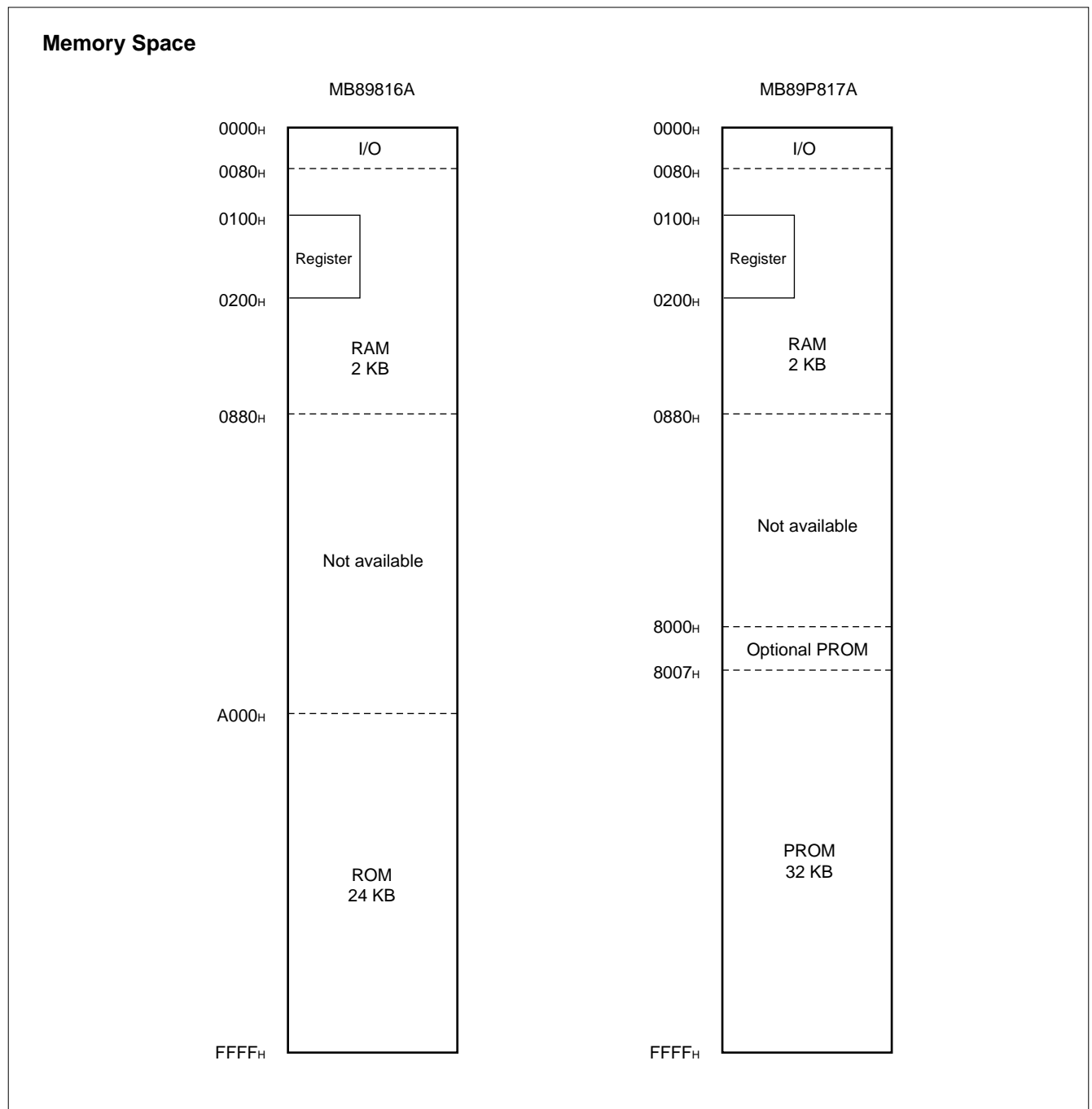


# MB89810A Series

## ■ CPU CORE

### 1. Memory Space

The microcontrollers of the MB89810A 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 MB89810A series is structured as illustrated below.

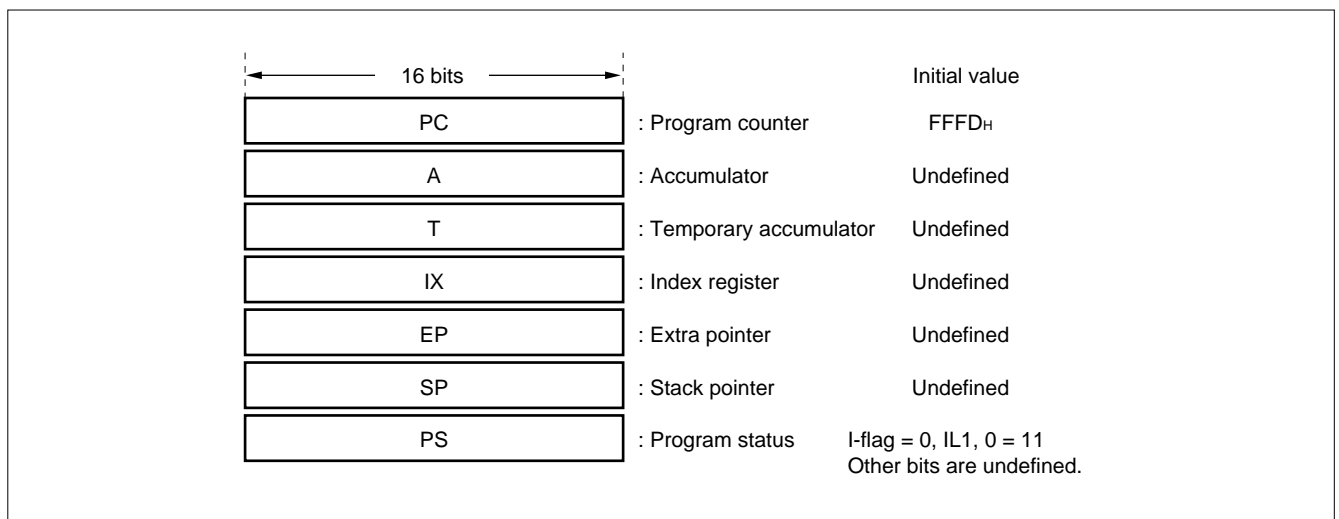


# MB89810A Series

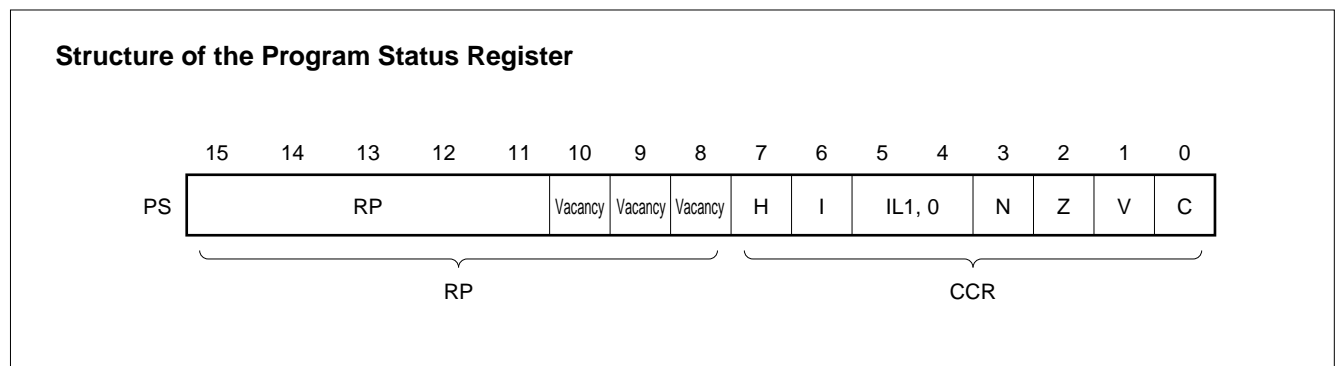
## 2. Registers

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.)



# MB89810A 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.

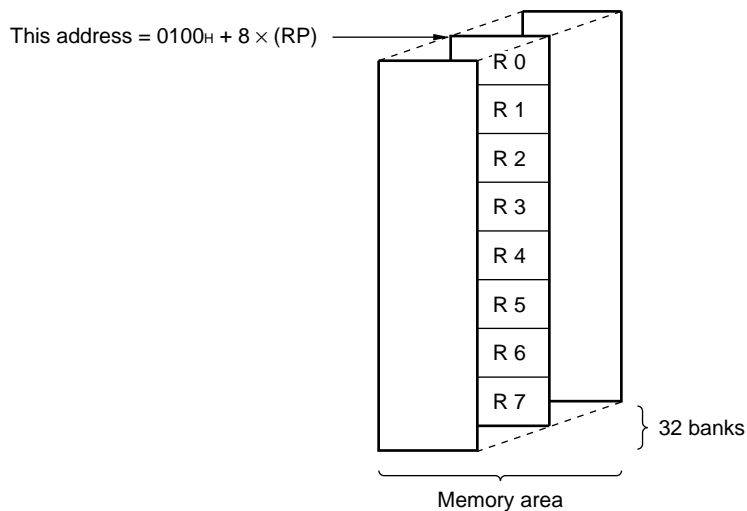
# MB89810A Series

The following general-purpose registers are provided:

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

The general-purpose registers are 8 bits and located in the register banks of the memory. One bank contains eight registers and up to a total of 32 banks can be used on the MB89816A. The bank currently in use is indicated by the register bank pointer (RP).

## Register Bank Configuration





**MB89810A Series****■ I/O MAP**

Address	Read/write	Register name	Register description
00 <sub>H</sub>	(R/W)	PDR0	Port 0 data register
01 <sub>H</sub>	(W)	DDR0	Port 0 data direction register
02 <sub>H</sub>	(R/W)	PDR1	Port 1 data register
03 <sub>H</sub>	(W)	DDR1	Port 1 data direction register
04 <sub>H</sub>	(R/W)	PDR2	Port 2 data register
05 <sub>H</sub>			Vacancy
06 <sub>H</sub>			Vacancy
07 <sub>H</sub>	(R/W)	SYCC	System clock control register
08 <sub>H</sub>	(R/W)	STBC	Standby control register
09 <sub>H</sub>	(R/W)	WDTC	Watchdog timer control register
0A <sub>H</sub>	(R/W)	TBCR	Time-base timer control register
0B <sub>H</sub>	(R/W)	WPCR	Watch prescaler control register
0C <sub>H</sub>	(R/W)	PDR3	Port 3 data register
0D <sub>H</sub>	(W)	DDR3	Port 3 data direction register
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>	(R/W)	PDR5	Port 5 data register
11 <sub>H</sub>	(R)	PDR6	Port 6 data register
12 <sub>H</sub>			Vacancy
13 <sub>H</sub>			Vacancy
14 <sub>H</sub>			Vacancy
15 <sub>H</sub>			Vacancy
16 <sub>H</sub>			Vacancy
17 <sub>H</sub>	(R/W)	PIVE	Port inverting operation enable register
18 <sub>H</sub>	(R/W)	TMCR	16-bit timer count register
19 <sub>H</sub>	(R/W)	TCHR	16-bit timer count register (H)
1A <sub>H</sub>	(R/W)	TCLR	16-bit timer count register (L)
1B <sub>H</sub>			Vacancy
1C <sub>H</sub>	(R/W)	SMR	Serial I/O mode register
1D <sub>H</sub>	(R/W)	SDR	Serial I/O data register
1E <sub>H</sub>			Vacancy
1F <sub>H</sub>			Vacancy

*(Continued)*

# MB89810A Series

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Address	Read/write	Register name	Register description
20 <sub>H</sub>	(R/W)	SMC1	UART serial I/O mode control register 1
21 <sub>H</sub>	(R/W)	SRC	UART serial I/O rate control register
22 <sub>H</sub>	(R/W)	SSD	UART serial I/O status/data control register
23 <sub>H</sub>	(R/W)	SIDR/SODR	UART serial I/O data control register
24 <sub>H</sub>	(R/W)	SMC2	UART serial I/O mode control register 2
25 <sub>H</sub>			Vacancy
26 <sub>H</sub>			Vacancy
27 <sub>H</sub>			Vacancy
28 <sub>H</sub>	(R/W)	CNTR1	PWM timer control register 1
29 <sub>H</sub>	(R/W)	CNTR2	PWM timer control register 2
2A <sub>H</sub>	(R/W)	CNTR3	PWM timer control register 3
2B <sub>H</sub>	(W)	COMR2	PWM timer compare register 2
2C <sub>H</sub>	(W)	COMR1	PWM timer compare register 1
2D <sub>H</sub>			Vacancy
2E <sub>H</sub>			Vacancy
2F <sub>H</sub>	(R/W)	PWCR	Pulse width detection control register
30 <sub>H</sub>	(R/W)	EIC1	External interrupt 1 control register 1
31 <sub>H</sub>	(R/W)	EIC2	External interrupt 1 control register 2
32 <sub>H</sub>	(R/W)	EI2E	External interrupt 2 enable register
33 <sub>H</sub>	(R/W)	EI2F	External interrupt 2 flag register
34 <sub>H</sub>			Vacancy
35 <sub>H</sub> to 7A <sub>H</sub>			Vacancy
7B <sub>H</sub>			Vacancy
7C <sub>H</sub>	(W)	ILR1	Interrupt level register 1
7D <sub>H</sub>	(W)	ILR2	Interrupt level register 2
7E <sub>H</sub>	(W)	ILR3	Interrupt level register 3
7F <sub>H</sub>	Not available	ITR	Interrupt test register

Note: Do not use vacancies.

# MB89810A Series

## ■ ELECTRICAL CHARACTERISTICS

### 1. Absolute Maximum Ratings

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

Parameter	Symbol	Value		Unit	Remarks
		Min.	Max.		
Power supply voltage	V <sub>CC</sub>	V <sub>SS</sub> - 0.3	V <sub>SS</sub> + 7.0	V	
Input voltage	V <sub>I1</sub>	V <sub>SS</sub> - 0.3	V <sub>CC</sub> + 0.3	V	Except P50 to P54
	V <sub>I2</sub>	V <sub>SS</sub> - 0.3	V <sub>SS</sub> + 7.0	V	P50 to P54
Output voltage	V <sub>O1</sub>	V <sub>SS</sub> - 0.3	V <sub>CC</sub> + 0.3	V	Except P50 to P54
	V <sub>O2</sub>	V <sub>SS</sub> - 0.3	V <sub>SS</sub> + 7.0	V	P50 to P54
"L" level maximum output current	I <sub>OL</sub>	—	20	mA	Peak value
"L" level average output current	I <sub>OLAV1</sub>	—	4	mA	Average value except pins other than P50 to P54
	I <sub>OLAV2</sub>	—	10	mA	Average value for P50 to P54
"L" level total maximum output current	∑I <sub>OL</sub>	—	100	mA	Peak value
"L" level total average output current	∑I <sub>OLAV</sub>	—	40	mA	Average value
"H" level maximum output current	I <sub>OH</sub>	—	-20	mA	Peak value
"H" level average output current	I <sub>OHAV</sub>	—	-4	mA	Average value
"H" level total maximum output current	∑I <sub>OH</sub>	—	-50	mA	Peak value
"H" level total average output current	∑I <sub>OHAV</sub>	—	-20	mA	Average value
Power consumption	P <sub>D</sub>	—	300	mW	
Operating temperature	T <sub>A</sub>	-40	+85	°C	
Storage temperature	T <sub>stg</sub>	-55	+150	°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.

# MB89810A Series

## 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 MB89816A
		2.7*	6.0	V	Normal operation assurance range MB89P817A
		1.5	6.0	V	Retains the RAM state in stop mode
“H” level voltage	V <sub>IH</sub>	0.7 V <sub>CC</sub>	V <sub>CC</sub> + 0.3	V	P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P54 (with pull-up resistor)
	V <sub>IHS</sub>	0.8 V <sub>CC</sub>	V <sub>CC</sub> + 0.3	V	$\overline{\text{RST}}$ , MOD0, MOD1, P60 to P67, Pheripheral input for port 3 and port 4
	V <sub>IHS2</sub>	0.8 V <sub>CC</sub>	V <sub>SS</sub> + 6.0	V	P50 to P54 (without pull-up resistor)
“L” level voltage	V <sub>IL</sub>	V <sub>SS</sub> - 0.3	0.3 V <sub>CC</sub>	V	P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P54
	V <sub>ILS</sub>	V <sub>SS</sub> - 0.3	0.2 V <sub>CC</sub>	V	$\overline{\text{RST}}$ , MOD0, MOD1, P60 to P67, Pheripheral input for port 3 and port 4
Open-drain output pin application voltage	V <sub>D</sub>	V <sub>SS</sub> - 0.3	V <sub>SS</sub> + 6.0	V	P50 to P54 (without pull-up resistor)
Operating temperature	T <sub>A</sub>	-40	+85	°C	

\* : These values vary with the operating frequency. See Figure 1.

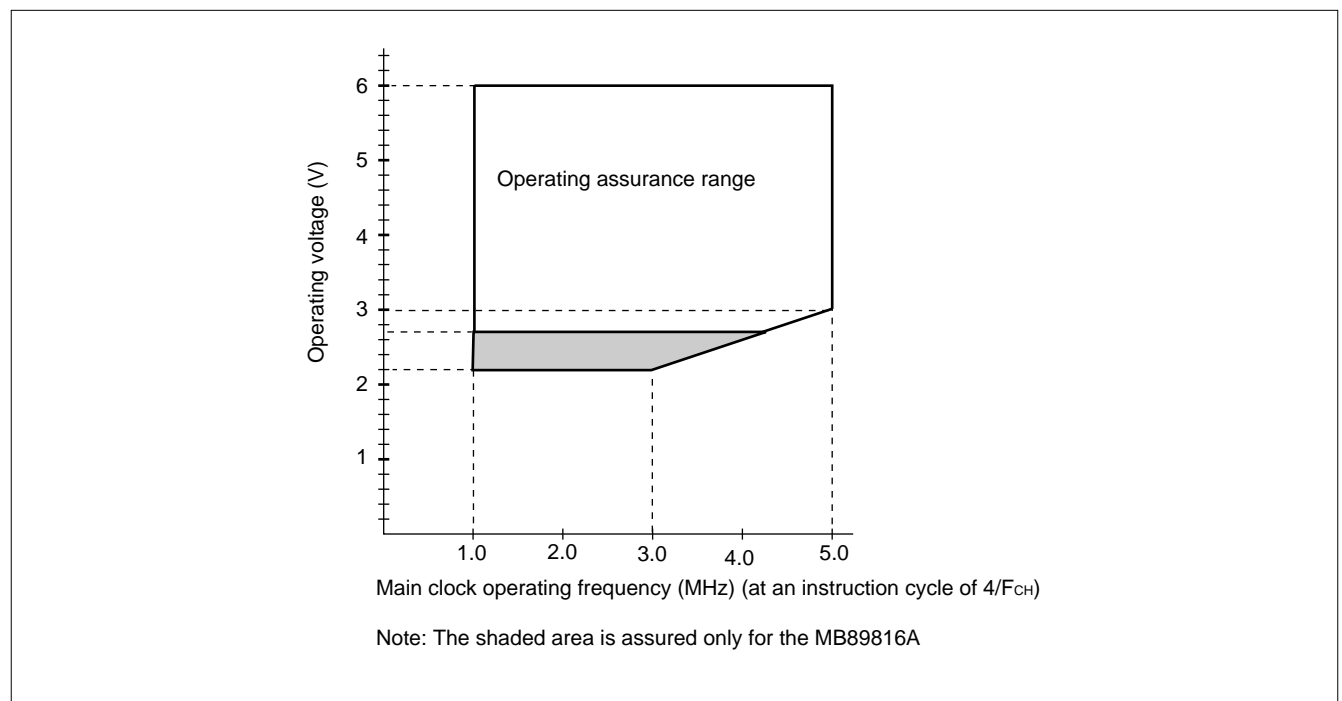


Figure 1 Operating Voltage vs. Main Clock Operating Frequency (for MB89816A)

## MB89810A Series

## 3. DC Characteristics

(V<sub>CC</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.		
"H" level output voltage	V <sub>OH</sub>	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47	I <sub>OH</sub> = -2.0 mA	2.4	—	—	V	
"L" level output voltage	V <sub>OL1</sub>	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P54 P60 to P67	I <sub>OL</sub> = 1.8 mA	—	—	0.4	V	
	V <sub>OL2</sub>	P50 to P54	I <sub>OL</sub> = 6 mA V <sub>CC</sub> = 3 V	—	—	0.5	V	
	V <sub>OL3</sub>	$\overline{\text{RST}}$	I <sub>OL</sub> = 4.0 mA	—	—	0.4	V	
Input leakage current (Hi-z output leakage current)	I <sub>LI1</sub>	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P54, P60 to P67, MOD0, MOD1	0.45 V < V <sub>I</sub> < V <sub>CC</sub>	—	—	±5	μA	Without pull-up resistor
Pull-up resistance	R <sub>PULL</sub>	P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P54, P60 to P67, $\overline{\text{RST}}$	V <sub>I</sub> = 0.0 V	25	50	100	kΩ	With pull-up resistor
Power supply current*	I <sub>CC1</sub>	V <sub>CC</sub>	F <sub>CH</sub> = 5 MHz V <sub>CC</sub> = 5.0 V t <sub>inst</sub> = 0.8 μs	—	4	6	mA	MB89816A
			—	—	4.8	7.5	mA	MB89P817A
	I <sub>CC2</sub>		F <sub>CH</sub> = 5 MHz V <sub>CC</sub> = 3.0 V t <sub>inst</sub> = 6.4 μs	—	0.4	0.6	mA	MB89816A
			—	—	1.0	1.5	mA	MB89P817A
	I <sub>CCS1</sub>		F <sub>CH</sub> = 5 MHz V <sub>CC</sub> = 5.0 V t <sub>inst</sub> = 0.8 μs	—	1.2	1.8	mA	Sleep mode
	I <sub>CCS2</sub>		F <sub>CH</sub> = 5 MHz V <sub>CC</sub> = 3.0 V t <sub>inst</sub> = 12.8 μs	—	0.3	0.5	mA	
I <sub>CCL</sub>	F <sub>CL</sub> = 32.768 kHz V <sub>CC</sub> = 3.0 V	—	50	100	μA	Subclock mode		
		—	500	700	μA	MB89P817A		

(Continued)

# MB89810A Series

(Continued)

(V<sub>CC</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.		
Power supply current*	I <sub>CCLS</sub>	V <sub>CC</sub>	F <sub>CL</sub> = 32.768 kHz V <sub>CC</sub> = 3.0 V	—	15	50	μA	Subclock sleep mode
	I <sub>CCT</sub>		F <sub>CL</sub> = 32.768 kHz V <sub>CC</sub> = 3.0 V	—	—	15	μA	Watch mode Main clock stop mode at dual-clock system
	I <sub>CCH</sub>		F <sub>CL</sub> = 32.768 kHz V <sub>CC</sub> = 3.0 V	—	—	10	μA	Subclock stop mode Main clock stop mode at single-clock system
Input capacitance	C <sub>IN</sub>	Other than V <sub>CC</sub> and V <sub>SS</sub>	f = 1 MHz	—	10	—	pF	

\* : The measurement conditions of power supply current are as follows: the external clock and T<sub>A</sub> = +25°C.

# MB89810A Series

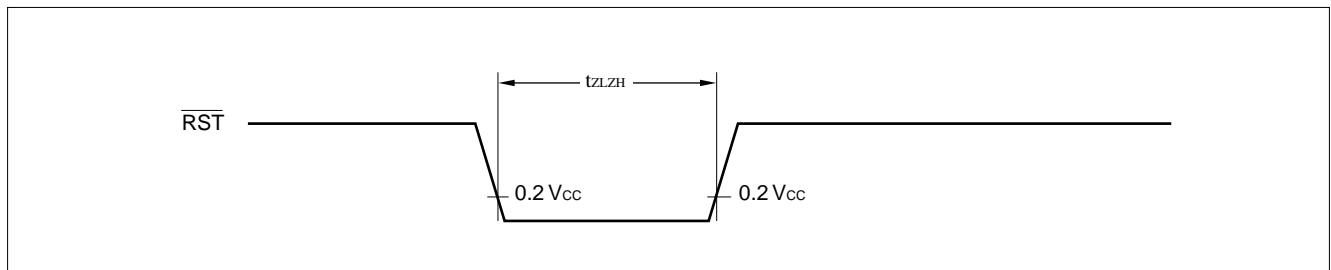
## 4. AC Characteristics

### (1) Reset Timing

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

Parameter	Symbol	Condition	Value		Unit	Remarks
			Min.	Max.		
$\overline{\text{RST}}$ "L" pulse width	$t_{\text{ZLZH}}$	—	16 $t_{\text{CH}}$	—	ns	

Note:  $t_{\text{CH}}$  is the cycle time of the main clock.



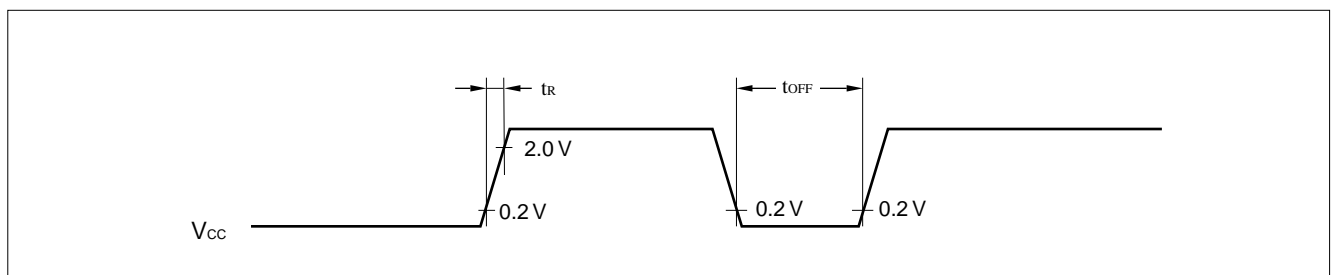
### (2) Power-on Reset

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

Parameter	Symbol	Condition	Value		Unit	Remarks
			Min.	Max.		
Power supply rising time	$t_{\text{R}}$	—	—	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.



Note that a sudden increase in supply voltage may result in a power-on reset.

When increasing the supply voltage during operation, voltage variation should be within twice the intended increment so that the voltage rises as smoothly as possible.

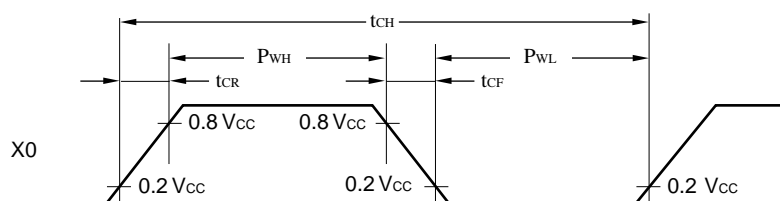
# MB89810A Series

## (3) Clock Timing

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

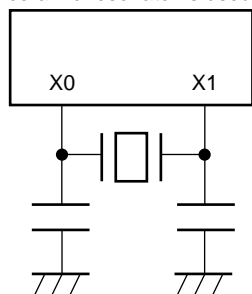
Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Clock frequency	$F_{CH}$	X0, X1	—	1	—	5	MHz	
	$F_{CL}$	X0A, X1A		—	32.768	—	kHz	
Clock cycle time	$t_{CH}$	X0, X1		200	—	1000	ns	
	$t_{CL}$	X0A, X1A		—	30.5	—	$\mu\text{s}$	
Input clock pulse width	$P_{WH}$ $P_{WL}$	X0		20	—	—	ns	External clock
	$P_{WHL}$ $P_{WLL}$	X0A		—	15.2	—	$\mu\text{s}$	
Input clock rising/falling time	$t_{CR}$ $t_{CF}$	X0	—	—	10	ns	External clock	

### X0 and X1 Timing and Conditions

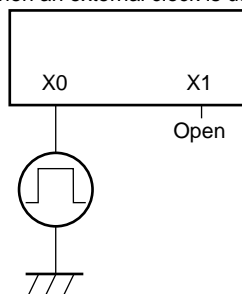


### Main Clock Conditions

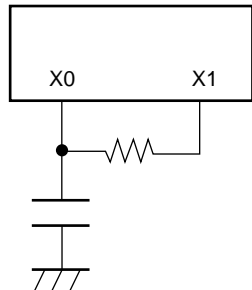
When a crystal  
or  
ceramic resonator is used



when an external clock is used



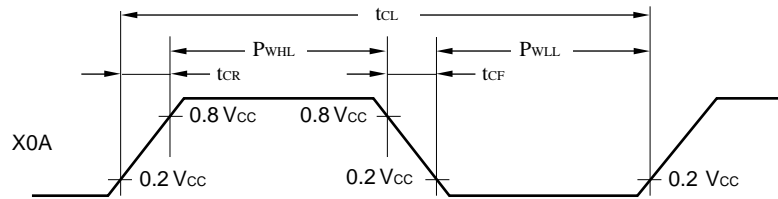
When a CR oscillator is used





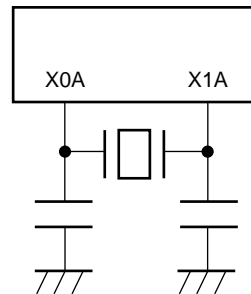
## MB89810A Series

## X0A and X1A Timings and Conditions

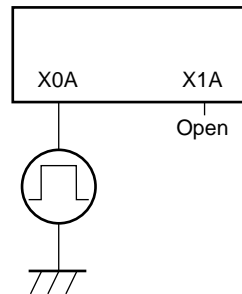


## Subclock Conditions

When a crystal  
or  
ceramic resonator is used



when an external clock is used



## (4) Serial I/O Timings

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

Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Serial clock cycle time	$t_{SCYC1}$	$\overline{SCK}$	Internal shift clock mode	$2 t_{inst}$	—	ns	
$\overline{SCK} \downarrow \rightarrow SO$ time	$t_{SLOV1}$	$\overline{SCK}, SO$		-200	200	ns	
Valid SI $\rightarrow \overline{SCK} \uparrow$	$t_{VSH1}$	SI, $\overline{SCK}$		$1/2 t_{inst}$	—	ns	
$\overline{SCK} \uparrow \rightarrow$ valid SI hold time	$t_{SHIX1}$	$\overline{SCK}, SI$		$1/2 t_{inst}$	—	ns	
Serial clock "H" pulse width	$t_{SHSL}$	$\overline{SCK}$	External shift clock mode	$1 t_{inst}$	—	ns	
Serial clock "L" pulse width	$t_{LSLH}$			$1 t_{inst}$	—	ns	
$\overline{SCK} \downarrow \rightarrow SO$ time	$t_{SLOV2}$	$\overline{SCK}, SO$		0	200	ns	
Valid SI $\rightarrow \overline{SCK} \uparrow$	$t_{VSH2}$	SI, $\overline{SCK}$		$1/2 t_{inst}$	—	ns	
$\overline{SCK} \uparrow \rightarrow$ valid SI hold time	$t_{SHIX2}$	$\overline{SCK}, SI$	$1/2 t_{inst}$	—	ns		

\* :  $t_{inst}$  represents the minimum instruction execution time. It varies with the selected system clock and operating mode.

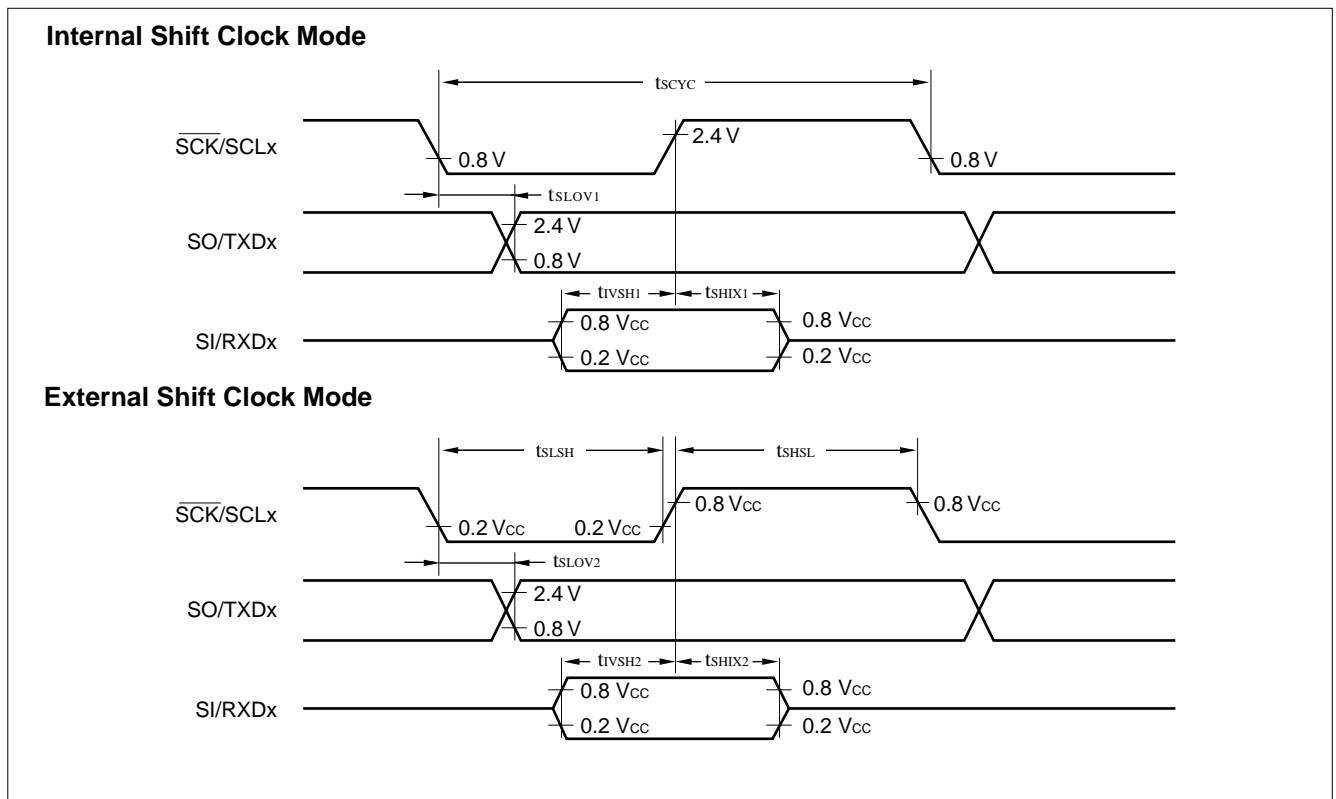
# MB89810A Series

## (5) UART Timings

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

Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Serial clock cycle time	$t_{SCYC}$	SCL1, SCL2	Internal shift clock mode	$2 t_{inst}$	—	ns	
SCL $\downarrow \rightarrow$ TXDx time	$t_{SLOV1}$	SCLx, TXDx		-200	200	ns	
Valid RXDx $\rightarrow$ SCLx $\uparrow$	$t_{VSH1}$	RXDx, SCLx		$1/2 t_{inst}$	—	ns	
SCLx $\uparrow \rightarrow$ valid RXDx hold time	$t_{SHX1}$	SCL1, RXD2		$1/2 t_{inst}$	—	ns	
Serial clock "H" pulse width	$t_{SHSL}$	SCL1, SCL2	External shift clock mode	$1 t_{inst}$	—	ns	
Serial clock "L" pulse width	$t_{LSH}$			$1 t_{inst}$	—	ns	
SCLx $\downarrow \rightarrow$ TXDx time	$t_{SLOV2}$	SCLx, TXDx		0	200	ns	
Valid RXDx $\rightarrow$ SCLx $\uparrow$	$t_{VSH2}$	RXDx, SCLx		$1/2 t_{inst}$	—	ns	
SCLx $\uparrow \rightarrow$ valid RXDx hold time	$t_{SHX2}$	SCL1, RXD2		$1/2 t_{inst}$	—	ns	

- Notes:
- $t_{inst}$  represents the minimum instruction execution time. It varies with the selected system clock and operating mode.
  - The edge polarity for the SCLx input is assumed when LSEL bit = 0 for SMC2. The polarity is inverted when LSEL = 1.



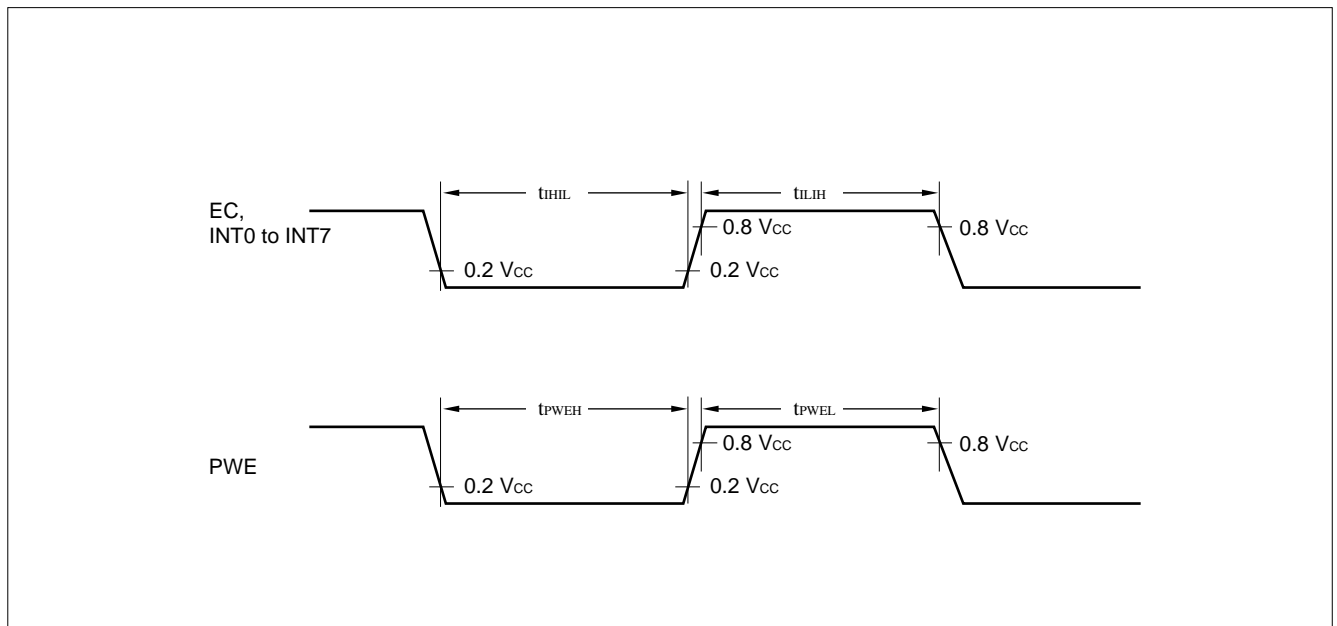
## MB89810A Series

## (6) Peripheral Input Timings

(V<sub>CC</sub> = +5.0 V $\pm$ 10%, AV<sub>SS</sub> = V<sub>SS</sub> = 0.0 V, T<sub>A</sub> = -40°C to +85°C)

Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Peripheral input "H" pulse width	t <sub>LIH</sub>	EC, INT0 to INT7	—	2 t <sub>inst</sub>	—	ns	
Peripheral input "L" pulse width	t <sub>HIL</sub>	EC, INT0 to INT7	—	2 t <sub>inst</sub>	—	ns	
"H" input pulse width of pulse width detection enable signal	t <sub>PWEH</sub>	PWE	—	512 t <sub>CL</sub> + 200 or 480 t <sub>CL</sub> + 200	—	ns	
"L" input pulse width of pulse width detection enable signal	t <sub>PWEL</sub>		—	512 t <sub>CL</sub> + 200 or 480 t <sub>CL</sub> + 200	—	ns	

- Notes:
- t<sub>inst</sub> represents the minimum instruction execution time. It varies with the selected system clock and operating mode.
  - t<sub>CL</sub> represents the subclock cycle time.
  - The PWE pulse width value varies with the first divider selection bit of the watch prescaler. The pulse width is "512 t<sub>CL</sub> + 200" when divide by 16 is selected; or "480 t<sub>CL</sub> + 200" when divide by 15 is selected.



# MB89810A Series

## ■ INSTRUCTIONS

Execution instructions can be divided into the following four groups:

- Transfer
- Arithmetic operation
- Branch
- Others

Table 1 lists symbols used for notation of instructions.

**Table 1 Instruction Symbols**

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

*(Continued)*

# MB89810A 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.

# MB89810A 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)

## MB89810A 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	$\rightarrow C \rightarrow A$	-	-	-	++-+	03
ROLC A	2	1	$\leftarrow C \leftarrow A$	-	-	-	++-+	02
CMP A,#d8	2	2	$(A) - d8$	-	-	-	++++	14
CMP A,dir	3	2	$(A) - (dir)$	-	-	-	++++	15
CMP A,@EP	3	1	$(A) - ((EP))$	-	-	-	++++	17
CMP A,@IX +off	4	2	$(A) - ((IX) + off)$	-	-	-	++++	16
CMP A,Ri	3	1	$(A) - (Ri)$	-	-	-	++++	18 to 1F
DAA	2	1	Decimal adjust for addition	-	-	-	++++	84
DAS	2	1	Decimal adjust for subtraction	-	-	-	++++	94
XOR A	2	1	$(A) \leftarrow (AL) \nabla (TL)$	-	-	-	++R-	52
XOR A,#d8	2	2	$(A) \leftarrow (AL) \nabla d8$	-	-	-	++R-	54
XOR A,dir	3	2	$(A) \leftarrow (AL) \nabla (dir)$	-	-	-	++R-	55
XOR A,@EP	3	1	$(A) \leftarrow (AL) \nabla ((EP))$	-	-	-	++R-	57
XOR A,@IX +off	4	2	$(A) \leftarrow (AL) \nabla ((IX) + off)$	-	-	-	++R-	56
XOR A,Ri	3	1	$(A) \leftarrow (AL) \nabla (Ri)$	-	-	-	++R-	58 to 5F
AND A	2	1	$(A) \leftarrow (AL) \wedge (TL)$	-	-	-	++R-	62
AND A,#d8	2	2	$(A) \leftarrow (AL) \wedge d8$	-	-	-	++R-	64
AND A,dir	3	2	$(A) \leftarrow (AL) \wedge (dir)$	-	-	-	++R-	65

(Continued)

# MB89810A Series

(Continued)

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

Table 4 Branch Instructions (17 instructions)

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

Table 5 Other Instructions (9 instructions)

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



# MB89810A 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	CLRIB dir: 0	CLRI	SETI	CLRIB 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 ext,A	MOVW PSA	CLRIB dir: 1	CLRC	SETC	CLRIB dir: 1	BBC dir: 1,rel	INCW SP	DECW SP	MOVW SPA	MOVW A,SP
2	ROLC A	CMP A	ADDC A	SUBC A	XCH A,T	XOR A	AND A	OR A	CLRIB dir: 2	MOV @A,T	MOV A,@A	CLRIB 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	CLRIB dir: 3	MOVW @A,T	MOVW A,@A	CLRIB 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	DAA A,#d8	CLRIB dir: 4	MOV A,#d8	DAS	CLRIB dir: 4	BBC dir: 4,rel	MOVW A,ext	MOVW ext,A	MOVW A,#d16	XCHW A,PC
5	MOV A,dir	CMP A,dir	ADDC A,dir	SUBC A,dir	XOR A,dir	AND A,dir	OR A,dir	MOV dir,#d8	CLRIB dir: 5	MOV dir,#d8	CMP dir,#d8	CLRIB dir: 5	BBC dir: 5,rel	MOVW A,dir	MOVW dir,A	MOVW SP,#d16	XCHW A,SP
6	MOV A,@IX+d	CMP A,@IX+d	ADDC A,@IX+d	SUBC A,@IX+d	XOR A,@IX+d	AND A,@IX+d	OR A,@IX+d	MOV @IX+d,#d8	CLRIB dir: 6	MOV @IX+d,#d8	CMP @IX+d,#d8	CLRIB dir: 6	BBC dir: 6,rel	MOVW A,@IX+d	MOVW @IX+d,A	MOVW IX,#d16	XCHW A,IX
7	MOV A,@EP	CMP A,@EP	ADDC A,@EP	SUBC A,@EP	MOV @EPA	AND A,@EP	OR A,@EP	MOV @EP,#d8	CLRIB dir: 7	MOV @EP,#d8	CMP @EP,#d8	CLRIB dir: 7	BBC dir: 7,rel	MOVW A,@EP	MOVW @EPA	MOVW EP,#d16	XCHW A,EP
8	MOV A,R0	CMP A,R0	ADDC A,R0	SUBC A,R0	MOV R0,A	XOR A,R0	AND A,R0	OR A,R0	SETB dir: 0	MOV R0,#d8	CMP R0,#d8	SETB dir: 0	BBS dir: 0,rel	INC R0	DEC R0	CALLY #0	BNC rel
9	MOV A,R1	CMP A,R1	ADDC A,R1	SUBC A,R1	MOV R1,A	XOR A,R1	AND A,R1	OR A,R1	SETB dir: 1	MOV R1,#d8	CMP R1,#d8	SETB dir: 1	BBS dir: 1,rel	INC R1	DEC R1	CALLY #1	BC rel
A	MOV A,R2	CMP A,R2	ADDC A,R2	SUBC A,R2	MOV R2,A	XOR A,R2	AND A,R2	OR A,R2	SETB dir: 2	MOV R2,#d8	CMP R2,#d8	SETB dir: 2	BBS dir: 2,rel	INC R2	DEC R2	CALLY #2	BP rel
B	MOV A,R3	CMP A,R3	ADDC A,R3	SUBC A,R3	MOV R3,A	XOR A,R3	AND A,R3	OR A,R3	SETB dir: 3	MOV R3,#d8	CMP R3,#d8	SETB dir: 3	BBS dir: 3,rel	INC R3	DEC R3	CALLY #3	BN rel
C	MOV A,R4	CMP A,R4	ADDC A,R4	SUBC A,R4	MOV R4,A	XOR A,R4	AND A,R4	OR A,R4	SETB dir: 4	MOV R4,#d8	CMP R4,#d8	SETB dir: 4	BBS dir: 4,rel	INC R4	DEC R4	CALLY #4	BNZ rel
D	MOV A,R5	CMP A,R5	ADDC A,R5	SUBC A,R5	MOV R5,A	XOR A,R5	AND A,R5	OR A,R5	SETB dir: 5	MOV R5,#d8	CMP R5,#d8	SETB dir: 5	BBS dir: 5,rel	INC R5	DEC R5	CALLY #5	BZ rel
E	MOV A,R6	CMP A,R6	ADDC A,R6	SUBC A,R6	MOV R6,A	XOR A,R6	AND A,R6	OR A,R6	SETB dir: 6	MOV R6,#d8	CMP R6,#d8	SETB dir: 6	BBS dir: 6,rel	INC R6	DEC R6	CALLY #6	BGE rel
F	MOV A,R7	CMP A,R7	ADDC A,R7	SUBC A,R7	MOV R7,A	XOR A,R7	AND A,R7	OR A,R7	SETB dir: 7	MOV R7,#d8	CMP R7,#d8	SETB dir: 7	BBS dir: 7,rel	INC R7	DEC R7	CALLY #7	BLT rel

# MB89810A Series

## ■ MASK OPTIONS

No.	Part number	MB89816A	MB89P817A
	Specifying procedure	Specify when ordering masking	Set with EPROM programmer
1	Pull-up resistors P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P54, P60 to P67	Specify by pin	Can be set per pin. (P50 to P54 are available only for without a pull-up resistor.)
2	Power-on reset selection With power-on reset Without power-on reset	Selectable	Setting possible
3	Main clock oscillation (5 MHz) stabilization time selection approx. $218/F_{CH}$ (approx. 52.4 ms) approx. $217/F_{CH}$ (approx. 26.2 ms) approx. $214/F_{CH}$ (approx. 3.2 ms) approx. $24/F_{CH}$ (approx. 0 ms)	Selectable	Setting possible
4	Reset pin ouotput selection With reset output Without reset output	Selectable	Setting possible
5	Selection either single- or dual- clock system Single clock Dual clock	Selectable	Setting possible
6	Main clock oscillator type selection Crystal or ceramic oscillator CR	Selectable	Setting possible

$F_{CH}$ : Main clock frequency

\* : The main clock oscillation setting time is generated by dividing the main clock frequency. Note that the oscillation cycle is not stable immediately after oscillation is started. The settling time value in this data sheet should be used as a reference.

## ■ ORDERING INFORMATION

Part number	Package	Remarks
MB89816APF MB89P817APF	64-pin Plastic QFP (FPT-64P-M06)	



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