

# 8-bit Proprietary Microcontroller

CMOS

## F<sup>2</sup>MC-8L MB89190/190A Series

**MB89191/193/195/P195/PV190****MB89191A/193A/195A/P195A/PV190A**

### ■ OUTLINE

The MB89190/190A series microcontrollers contain various resources such as timers, serial interfaces, A/D converters, external interrupts, and remote-control functions, as well as an F<sup>2</sup>MC\*-8L CPU core for low-voltage and high-speed operations. These single-chip microcontrollers are suitable for small devices such as remote controllers with compact packages.

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

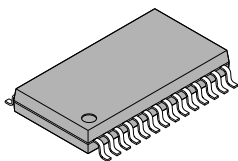
### ■ FEATURES

- Minimum execution time: 0.95  $\mu$ s at 4.2 MHz ( $V_{CC} = 2.7$  V)
- F<sup>2</sup>MC-8L family CPU core
- Two timers
  - 8/16-bit timer/counter
  - 20-bit timebase counter
- Serial interface
  - 8-bit synchronous serial (Selectable transfer direction allows communication with various equipment.)

(Continued)

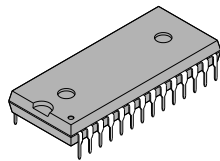
### ■ PACKAGE

28-pin Plastic SOP



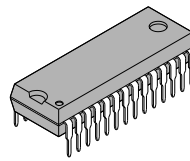
(FPT-28P-M17)

28-pin Plastic DIP



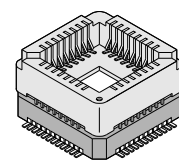
(DIP-28P-M05)

28-pin Plastic SH-DIP



(DIP-28P-M03)

48-pin Ceramic MQFP



(MQP-48C-P01)

# MB89190/190A Series

(Continued)

- External interrupts
  - Edge detection (Selectable edge): 3 channels
  - Low-level interrupt (Wake-up function): 8 channels
- A/D converter (MB89190A series only)
  - 8-bit successive approximation type: 8 channels
- Built-in remote-control transmitting frequency generator
- Low-power consumption modes
  - Stop mode (Almost no current consumption occurs because oscillation stops.)
  - Sleep mode (The current consumption is reduced about 1/3 of that during normal operation because the CPU stops.)
- Packages
  - SOP-28, SH-DIP-28, and DIP-28

## ■ PRODUCT LINEUP

Part number Item	MB89191 MB89191A	MB89193 MB89193A	MB89195 MB89195A	MB89P195 MB89P195A	MB89PV190 MB89PV190A
Classification	Mask ROM products			One-time product	For development and evaluation
ROM size	4 K × 8 bits (internal mask ROM)	8 K × 8 bits (internal mask ROM)	16 K × 8 bits (internal mask ROM)	16 K × 8 bits (internal PROM, to be programmed with general-purpose EPROM programmer)	32 K × 8 bits (external ROM)
RAM size	128 × 8 bits	256 × 8 bits			
CPU functions	The number of basic instructions: 136 Instruction bit length: 8 bits Instruction length: 1 to 3 bytes Data bit length: 1, 8, and 16 bits Minimum execution time: 0.95 μs at 4.2 MHz Interrupt processing time: 8.57 μs at 4.2 MHz				
Ports	Output port (N channel open drain): 4 (also serves as peripherals for MB89190A series) or 6 (for MB89190 series) I/O port (CMOS): 16 (also serves as peripherals) Total: 20 or 22				
Timer counter	2 channels of 8-bit timer counter or one 16-bit event counter (operation clock: 1.9 μs, 30.4 μs, and 487.6 μs at 4.2 MHz, and external clock)				
Serial I/O	8 bits LSB/MSB first selectable Transfer clock (external, 1.9 μs, 7.6 μs, 30.4 μs at 4.2 MHz)				
A/D converter (MB89190A series only)	8 bits x 8 channels A/D conversion mode (conversion time: 41.9 μs at 4.2 MHz) Sense mode (conversion time: 11.9 μs at 4.2 MHz) Capable of continuous activation by an internal timer. Reference voltage input				

(Continued)

# MB89190/190A Series

(Continued)

Part number Item	MB89191 MB89191A	MB89193 MB89193A	MB89195 MB89195A	MB89P195 MB89P195A	MB89PV190 MB89PV190A
External interrupt 1	3 independent channels (selectable edge, interrupt vector, and interrupt source flag) Rising/falling/both edge selectable Used for wake-up from stop/sleep mode. (Edge detection is also permitted in the stop mode.)				
External interrupt 2 (Wake-up function)	8 channels (low-level interrupt only)				
Remote-control transmitting frequency generator	The pulse width and cycle are software-programmable.				
Standby mode	Sleep mode and stop mode				
Process	CMOS				
Operating voltage*	2.2 V to 6.0 V			2.7 V to 6.0 V	
EPROM for use					MBM27C256A- 20TVM

\* : Varies with conditions such as operating frequencies (see “■ Electrical Characteristics.”) It differs from the operating voltage of an A/D converter.

## ■ PACKAGE AND CORRESPONDING PRODUCTS

Package	MB89191 MB89191A MB89193 MB89193A MB89195 MB89195A	MB89P195 MB89P195A	MB89PV190 MB89PV190A
DIP-28P-M05	○	○	×
DIP-28P-M03	○	×	×
FPT-28P-M17	○	○	×
MQP-48C-P01	×	×	○*

○ : Available    × : Not available

\* : A socket (manufacturer: Sun Hayato Co., Ltd.) for pin pitch conversion is available.

48QF-28SOP-8L: (MQP-48C-P01) → for conversion to FPT-28P-M17

Inquiry: Sun Hayato Co., Ltd.: TEL (81)-3-3986-0403

FAX (81)-3-5396-9106

Note: For more information on each package, see “■ Package Dimensions.”

# MB89190/190A Series

## ■ DIFFERENCES AMONG PRODUCTS

### 1. Memory Size

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

- On the MB89191/191A, addresses 0140<sub>H</sub> to 0180<sub>H</sub> cannot be used for register banks.
- The stack area, etc., is set in the upper limit of the RAM.

### 2. Current Consumption

- In the case of MB89PV190/PV190A, added is the current consumed by the EPROM which is connected to the top socket.
- When operated at low speed, the products with an OTPROM (EPROM) will consume more current than the products with a mask ROM.  
However, the same is current consumption in the sleep/stop mode. (For more information, see “■ Electrical Characteristics.”)

### 3. Mask Options

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

Before using options, check “■ Mask Options.”

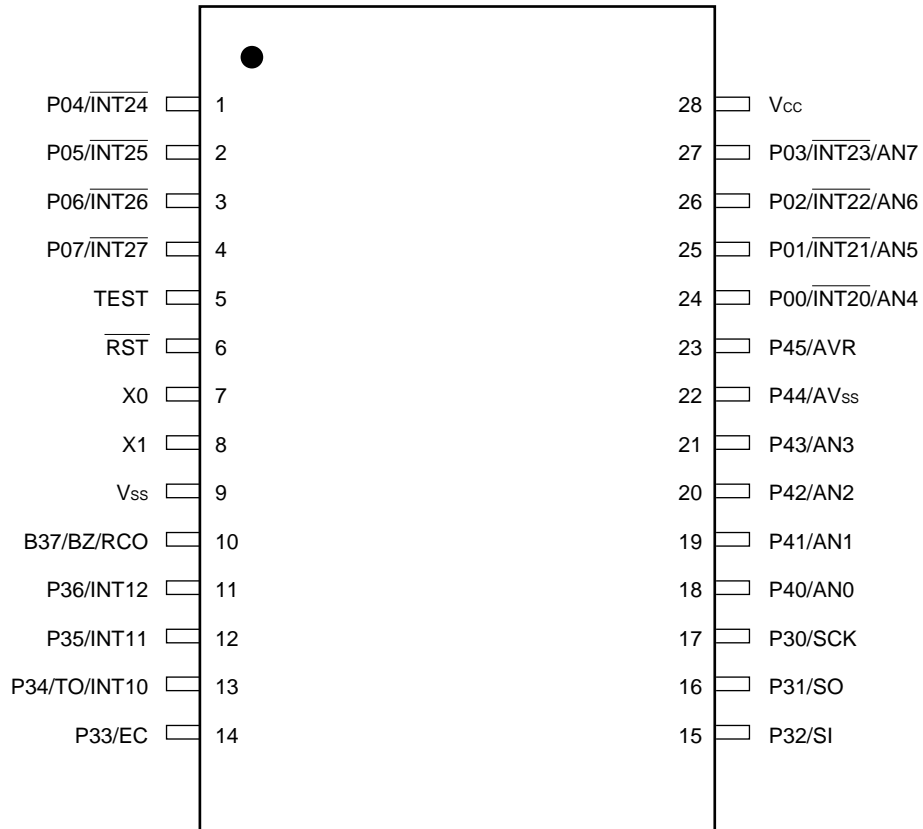
Take particular care on the following points:

- Pull-up resistor optional cannot be set for P00 to P03, and P40 to P45 on the MB89191A/193A/195A/P195A.
- The power-on reset option is fixed as “enabled” for MB89P195/P195A.
- Options are fixed on the MB89PV190/PV190A.

# MB89190/190A Series

## ■ PIN ASSIGNMENT

(Top view)



(FPT-28P-M17)  
(DIP-28P-M03)  
(DIP-28P-M05)



# MB89190/190A Series

## ■ PIN DESCRIPTION

Pin no.		Pin name	Circuit type	Function
SOP* <sup>1</sup> , DIP* <sup>2</sup> SH-DIP* <sup>3</sup>	MQFP* <sup>4</sup>			
7	31	X0	A	Clock oscillation pins
8	32	X1		
5	29	TEST	B	Test input pin Connect directly to V <sub>ss</sub> .
6	30	RST	C	Reset I/O pin This pin consists of an N-ch open-drain output with a pull-up resistor and of hysteresis input. A low level is output from this pin by internal source. The internal circuit is initialized by the input of a low level.
24 to 27	12, 13, 23, 24	P00/INT20/AN4 to P03/INT23/AN7	G	General-purpose I/O ports Also serve as external interrupt input pins. In the MB89190A series, also serve as analog input pins. External interrupt input is of hysteresis input type.
1 to 4	25 to 28	P04/INT24 to P07/INT27	D	General-purpose I/O ports Also serve as external interrupt input. External interrupt input is of hysteresis input type.
17	5	P30/SCK	D	General-purpose I/O port Also serves as clock I/O for the 8-bit serial I/O interface. The serial I/O clock input is of hysteresis input type with a built-in noise filter.
16	4	P31/SO	E	General-purpose I/O port Also serves as a serial I/O data output pin.
15	3	P32/SI	D	General-purpose I/O port Also serves as a serial I/O data input pin. The serial I/O data input is of hysteresis input type with a built-in noise filter.
14	2	P33/EC	D	General-purpose I/O port Also serves as an external clock input pin for the 8-bit timer/counter. External clock input of the 8-bit timer/counter is hysteresis input type with a built-in noise filter.
13	1	P34/TO/ INT10	D	General-purpose I/O port Also serves as the overflow output and external interrupt input for the 8-bit timer/counter. External interrupt input is of hysteresis input type with a built-in noise filter.

\*1: FPT-28P-M17

\*2: DIP-28C-M05

\*3: DIP-28P-M03

\*4: MQP-48C-P01

(Continued)

# MB89190/190A Series

(Continued)

Pin no.		Pin name	Circuit type	Function
SOP* <sup>1</sup> , DIP* <sup>2</sup> SH-DIP* <sup>3</sup>	MQFP* <sup>4</sup>			
12	48	P35/INT11	D	General-purpose I/O port Also serve as external interrupt input pins. External interrupt input is of hysteresis input type with a built-in noise filter.
11	34	P35/INT12		
10	33	P37/BZ/RCO	E	General-purpose I/O port Also serves as a buzzer output pin and remote-control output pin.
18 to 21	6 to 9	P40/AN0 to P43/AN3	F	N-ch open-drain output ports Also serve as analog input pins for the A/D converter.
23	11	P45/AVR	F	In the MB89190A series, also serves as a reference voltage input pin for the A/D converter. In the MB89190 series, serves as an N-ch open-drain output port.
22	10	P44/AV <sub>SS</sub>	F	In the MB89190A series, also serves as a power pin for the A/D converter, and should be applied the same voltage as V <sub>SS</sub> to. In the MB89190 series, also serves as an N-ch open-drain output port.
28	18	V <sub>CC</sub>	—	Power supply pin
9	42	V <sub>SS</sub>	—	Power supply (GND) pin

\*1: FPT-28P-M17

\*2: DIP-28P-M05

\*3: DIP-28P-M03

\*4: MQP-48C-P01



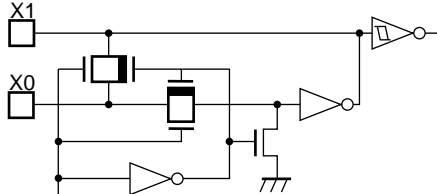
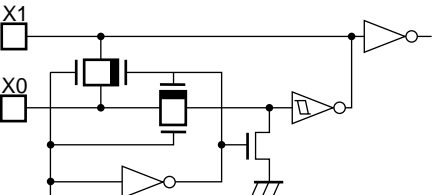
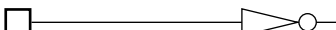
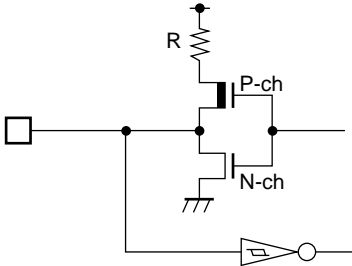
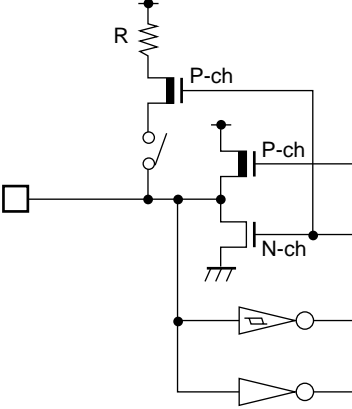
# MB89190/190A Series

- External EPROM pins (MB89PV190/PV190A)

Pin no.	Pin name	I/O	Function
49	V <sub>PP</sub>	O	"H" level output pin
79	A14	O	Address output pins
78	A13		
50	A12		
75	A11		
71	A10		
76	A9		
77	A8		
51	A7		
52	A6		
53	A5		
54	A4		
55	A3		
58	A2	I	Data input pins
59	A1		
60	A0		
61	O1		
62	O2		
63	O3		
65	O4		
66	O5		
67	O6	O	ROM chip enable pin Outputs "H" during standby.
68	O7		
69	O8	O	ROM output enable pin Outputs "L" at all times.
70	$\overline{CE}$		
73	$\overline{OE}$	O	EPROM power pin
80	V <sub>CC</sub>	O	Power supply (GND) pin
64	V <sub>SS</sub>	O	

# MB89190/190A Series

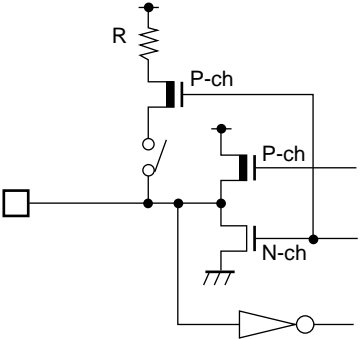
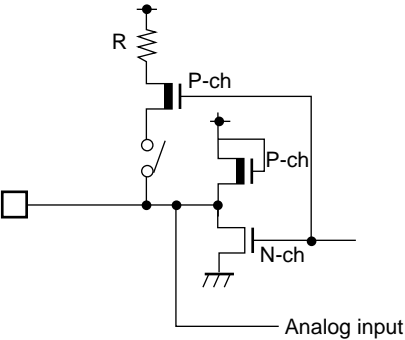
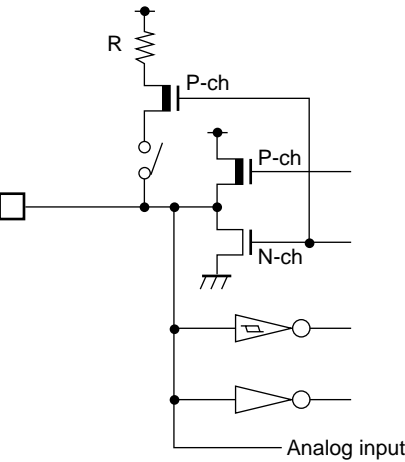
## ■ I/O CIRCUIT TYPE

Type	Circuit	Remarks
A	 <p>Standby control signal</p>	<ul style="list-style-type: none"> <li>• Oscillation feedback resistor of approximately 1 MΩ at 5 V</li> <li>• When crystal and ceramic oscillators are selected optionally</li> </ul>
	 <p>Standby control signal</p>	<ul style="list-style-type: none"> <li>• When CR oscillation is selected optionally</li> </ul>
B		
C		<ul style="list-style-type: none"> <li>• Output pull-up resistor (P-ch): Approx. 50 kΩ at 5 V</li> <li>• Hysteresis input</li> </ul>
D		<ul style="list-style-type: none"> <li>• CMOS output</li> <li>• CMOS input</li> <li>• Hysteresis input (resource input)</li> <li>• Pull-up resistor optional</li> </ul>

(Continued)

# MB89190/190A Series

(Continued)

Type	Circuit	Remarks
E		<ul style="list-style-type: none"> <li>• CMOS output</li> <li>• CMOS input</li> <li>• Pull-up resistor optional</li> </ul>
F		<ul style="list-style-type: none"> <li>• N-ch open-drain output</li> <li>• Analog input</li> <li>• Pull-up resistor optional (MB89190 series only)</li> </ul>
G		<ul style="list-style-type: none"> <li>• CMOS output</li> <li>• CMOS input</li> <li>• Hysteresis input (resource input)</li> <li>• Analog input</li> <li>• Pull-up resistor optional (MB89190 series only)</li> </ul>

# MB89190/190A Series

## ■ HANDLING DEVICES

### 1. Preventing Latch-up

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

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 pull-up or pull-down resistor.

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

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

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

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

### 5. Power Supply Voltage Fluctuations

Although operation is assured within the rated range of  $V_{CC}$  power supply voltage, a rapid fluctuation of the voltage could cause malfunctions 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

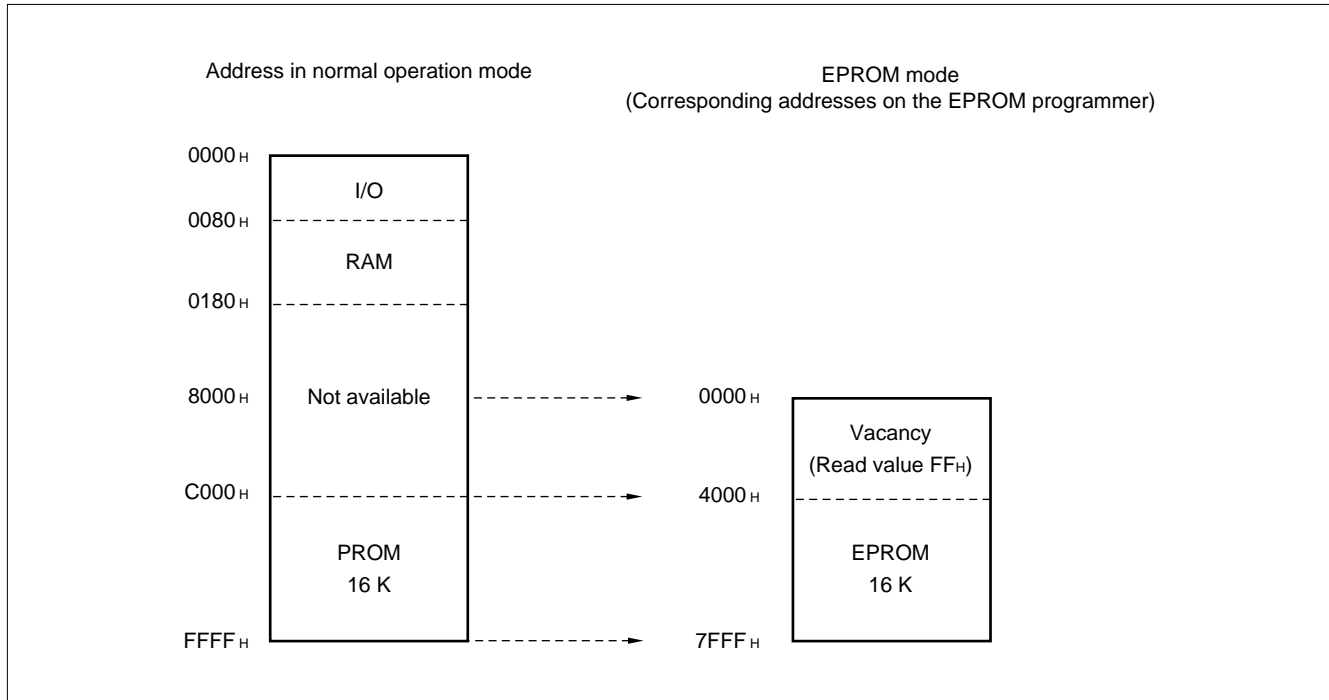
Even when an external clock is used, oscillation stabilization time is required for power-on reset (optional) and release from stop mode.

# MB89190/190A Series

## ■ PROGRAMMING TO PROM ON THE MB89P195/P195A

The MB89P195/P195A can program data in the internal PROM using a dedicated conversion adaptor and specified general-purpose EPROM programmer.

### 1. Memory Space



#### • Programming procedure

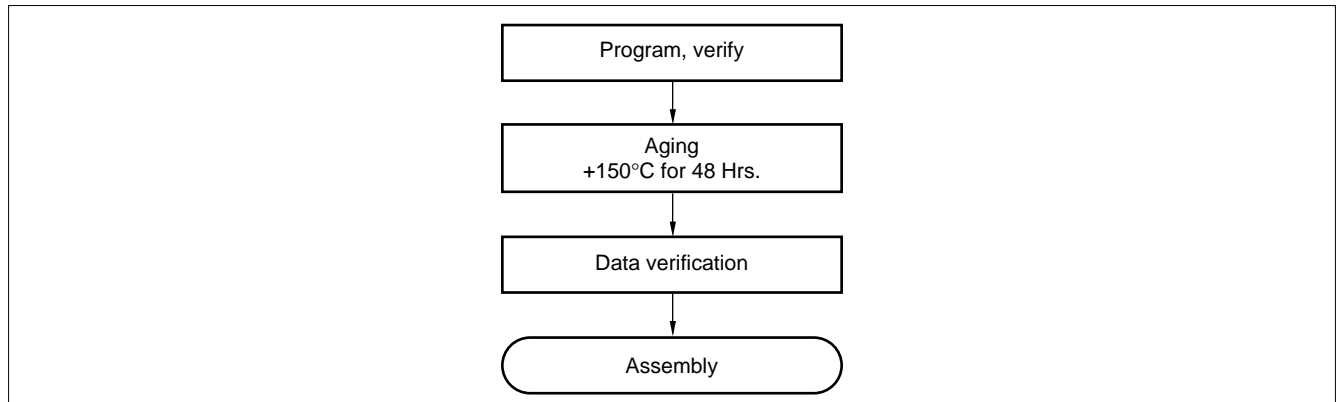
- (1) Load program data into the ROM programmer at addresses 4000<sub>H</sub> to 7FFF<sub>H</sub>. (Addresses 0C000<sub>H</sub> to 0FFFF<sub>H</sub> in the operation mode correspond to 4000<sub>H</sub> to 7FFF<sub>H</sub> in ROM programmer. See the illustration above.)
- (2) Set the data at addresses 0000<sub>H</sub> to 3FFF<sub>H</sub> of the programmer ROM in the ROM programmer, to FF<sub>H</sub>.
- (3) Program in the successive-address write mode of the ROM programmer.

Note: Program must be started at the address 00000<sub>H</sub>.  
For details, contact our Sales Division.

# MB89190/190A Series

## 2. Recommended Screening Conditions

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



## 3. Programming Yield

Due to its nature, bit programming test can't be conducted as Fujitsu delivery test. For this reason, a programming yield of 100% cannot be assured at all times.

## 4. EPROM Programmer Socket Adapter

Part no.	Package	Compatible socket adapter Sun Hayato Co., Ltd.	Recommended programmer manufacturer and programmer name			
			Minato Electronics Inc.	Data I/O Co., Ltd.		
			MODEL1890A (ver.2.2) + OU-910 (ver.4.1)	UNISITE (ver.5.0 or later)	3900 (ver.2.8 or later)	2900 (ver.3.8 or later)
MB89P195	DIP-28	ROM-28DP-28DP-8L	—	—		
MB89P195PF MB89P195APF	SQP-28	ROM-28SOP-28DP-8L	Recommended	Recommended		

Inquiry: Sun Hayato Co., Ltd.: TEL: (81)-3-3986-0403

FAX: (81)-3-5396-9106

Minato Electronics Inc.: TEL: USA (1)-916-348-6066

JAPAN (81)-45-591-5611

Data I/O Co., Ltd.: TEL: USA/ASIA (1)-206-881-6444

EUROPE (49)-8-985-8580

# MB89190/190A Series

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

### 1. EPROM for Use

MBM27C256A-20TVM

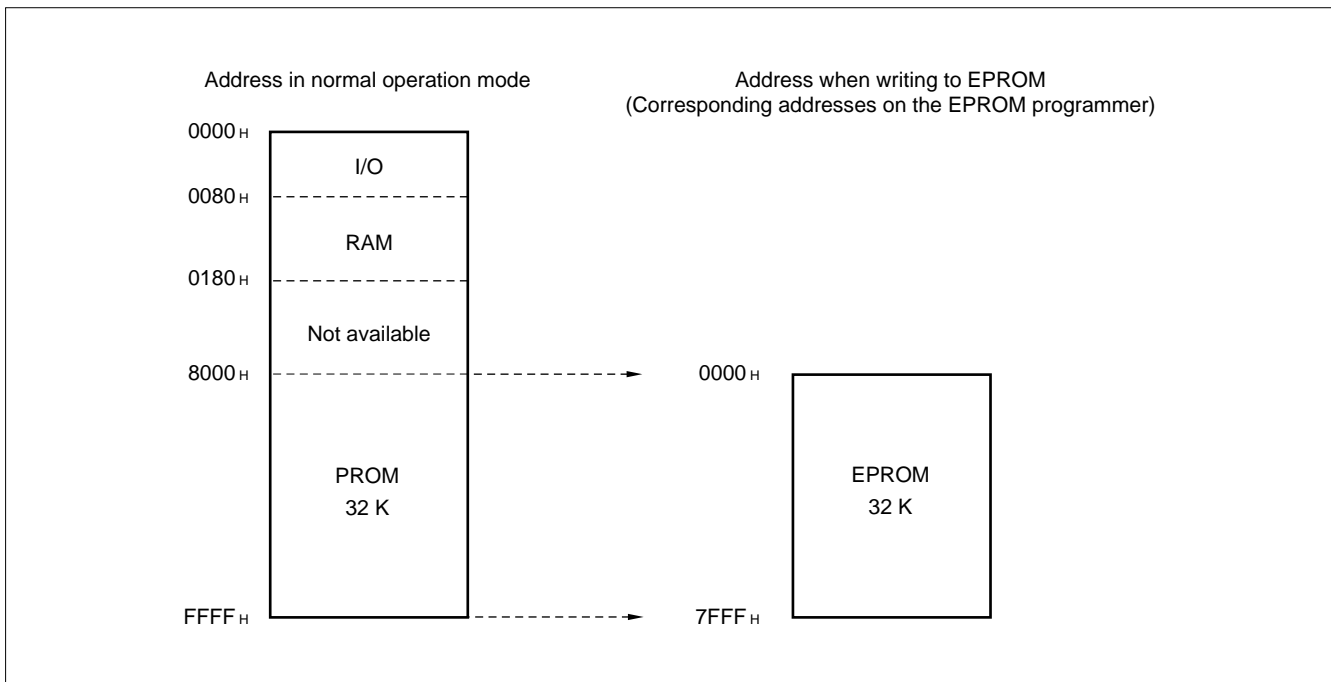
### 2. Programming Socket Adapter

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

Package	Adapter socket part number
LCC-32	ROM-32LC-28DP-YS

Inquiry: Sun Hayato Co., Ltd.: TEL (81)-3-3986-0403  
FAX (81)-3-5396-9106

### 3. Memory Space

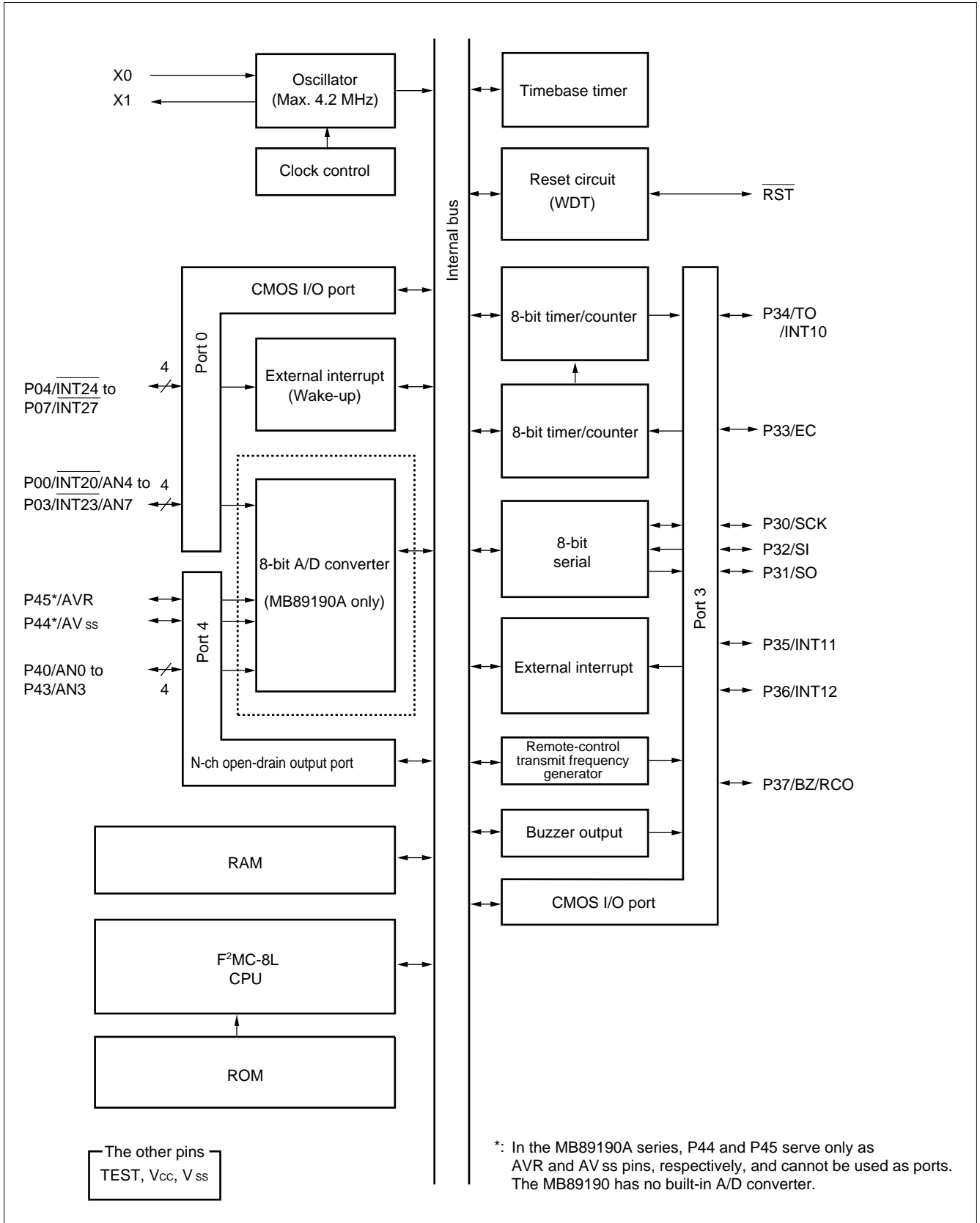


### 4. Programming to the EPROM

- (1) Set the EPROM programmer for MBM27C256A.
- (2) Load program data into the EPROM programmer at 0006<sub>H</sub> to 7FFF<sub>H</sub>.
- (3) Program to 0000<sub>H</sub> to 7FFF<sub>H</sub> with the EPROM programmer.

# MB89190/190A Series

## ■ BLOCK DIAGRAM



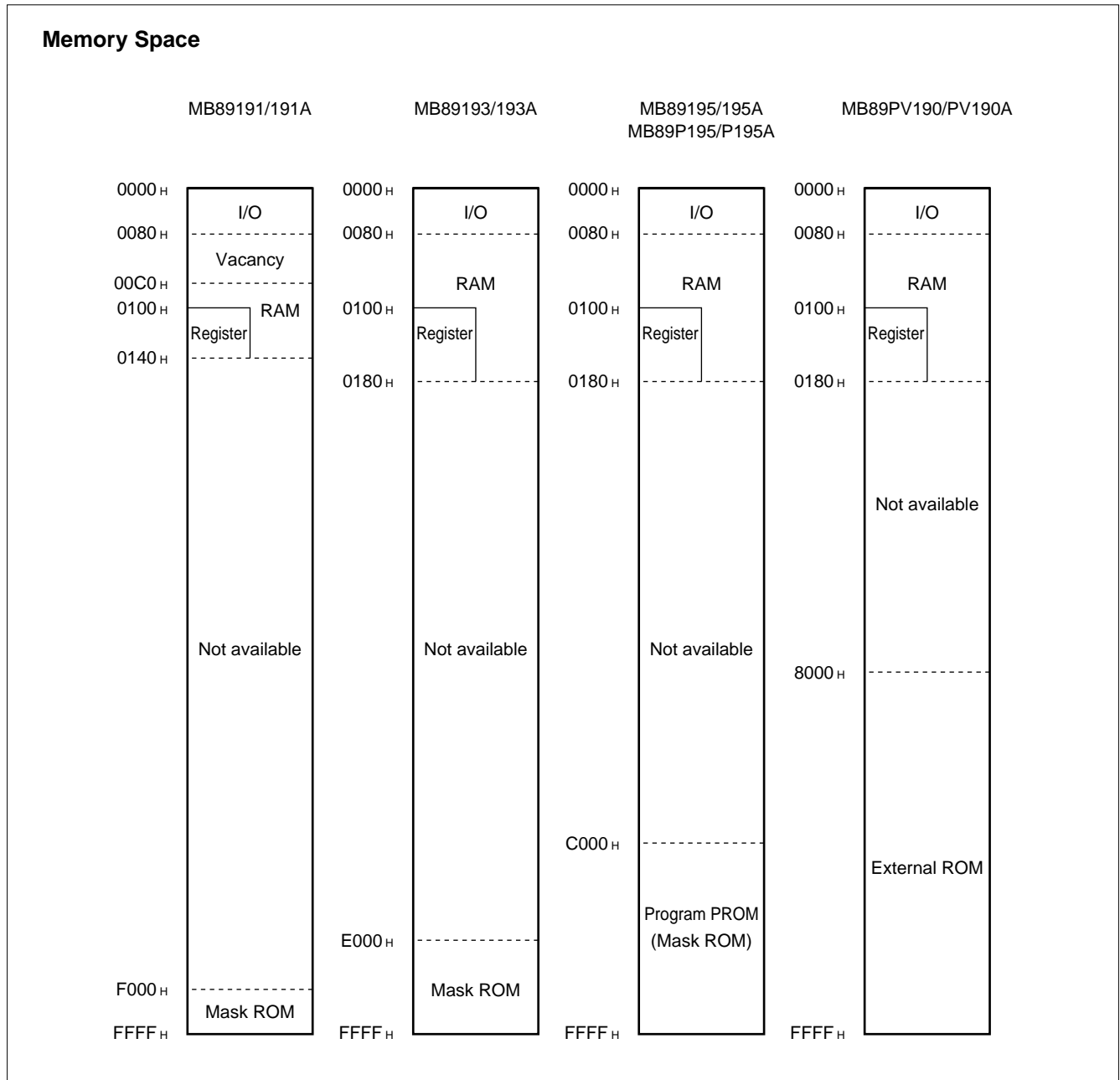


# MB89190/190A Series

## ■ CPU CORE

### 1. Memory Space

The microcontrollers of MB89190/190A series offer a 64 Kbytes of memory for storing all of I/O, data, and program areas. The I/O area is allocated from the lowest address. The data area is allocated 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 allocated from exactly the opposite end of I/O area, that is, the highest address. The tables of interrupt reset vectors, and vector call instructions are allocated from the highest address within the program area. The memory space of the MB89190/190A series is structured below:



# MB89190/190A Series

## 2. Registers

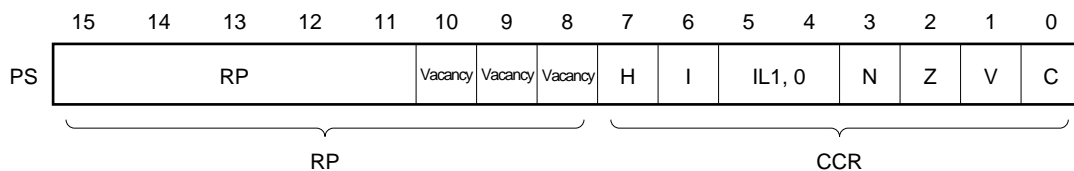
The F<sup>2</sup>MC-8L family has two types of registers; dedicated hardware registers and general-purpose memory registers. The following dedicated registers are provided:

Program counter (PC):	A 16-bit-long register for indicating the instruction storage positions
Accumulator (A):	A 16-bit-long temporary register for arithmetic operations, etc. When the instruction is an 8-bit data processing instruction, the lower byte is used.
Temporary accumulator (T):	A 16-bit-long register which is used for 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-long register for index modification
Extra pointer (EP) :	A 16-bit-long pointer for indicating a memory address
Stack pointer (SP) :	A 16-bit-long pointer for indicating a stack area
Program status (PS) :	A 16-bit-long register for storing a register pointer, a condition code

← 16 bits →		Initial value
PC	: Program counter	FFFD <sub>H</sub>
A	: Accumulator	Indeterminate
T	: Temporary accumulator	Indeterminate
IX	: Index register	Indeterminate
EP	: Extra pointer	Indeterminate
SP	: Stack pointer	Indeterminate
PS	: Program status	I-flag = 0, IL1, 0 = 11 The other bit values are indeterminate

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





# MB89190/190A Series

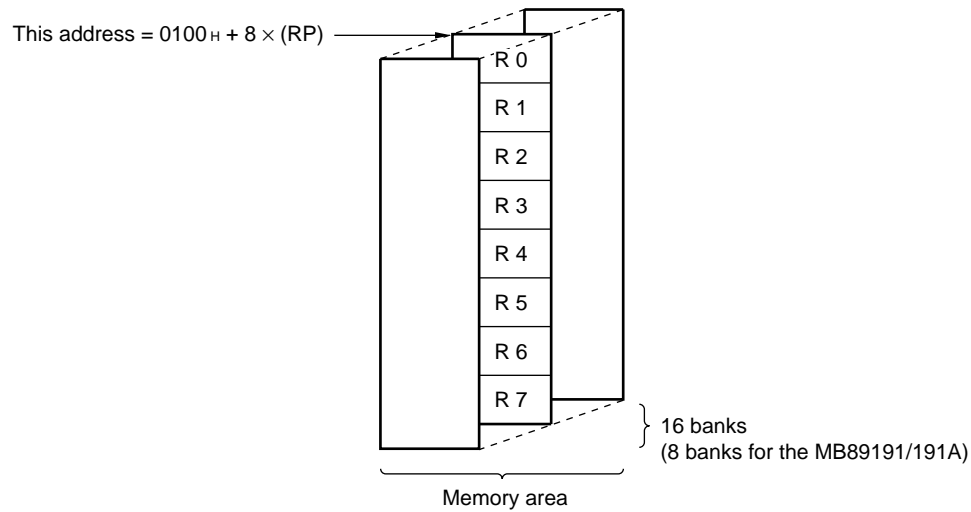
The following general-purpose registers are provided:

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

The general-purpose registers are of 8 bits and located in register banks of the memory. One bank contains eight registers and up to a total of 16 banks can be used on the MB89190/190A (8 banks on MB89191/191A). The bank currently in use is indicated by the register bank pointer. (RP)

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

## Register Bank Configuraiton



**MB89190/190A 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)	ENI0	Port 0 input enable register
03 <sub>H</sub> to 07 <sub>H</sub>			Vacancy
08 <sub>H</sub>	(R/W)	STBC	Standby control register
09 <sub>H</sub>	(R/W)	WDTC	Watchdog control register
0A <sub>H</sub>	(R/W)	TBTC	Time-base timer control register
0B <sub>H</sub>			Vacancy
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>	(R/W)	BUZR	Buzzer register
10 <sub>H</sub> to 13 <sub>H</sub>			Vacancy
14 <sub>H</sub>	(R/W)	RCR1	Remote-control transmit control register 1
15 <sub>H</sub>	(R/W)	RCR2	Remote-control transmit control register 2
16 <sub>H</sub>			Vacancy
17 <sub>H</sub>			Vacancy
18 <sub>H</sub>	(R/W)	T2CR	Timer 2 control register
19 <sub>H</sub>	(R/W)	T1CR	Timer 1 control register
1A <sub>H</sub>	(R/W)	T2DR	Timer 2 data register
1B <sub>H</sub>	(R/W)	T1DR	Timer 1 data register
1C <sub>H</sub>	(R/W)	SMR	Serial mode register
1D <sub>H</sub>	(R/W)	SDR	Serial data register
1E <sub>H</sub>			Vacancy
1F <sub>H</sub>			Vacancy
20 <sub>H</sub>	(R/W)	ADC1	A/D converter control register 1
21 <sub>H</sub>	(R/W)	ADC2	A/D converter control register 2
22 <sub>H</sub>	(R/W)	ADCD	A/D converter data register
23 <sub>H</sub>	(R/W)	EIC1	External interrupt control register 1
24 <sub>H</sub>	(R/W)	EIC2	External interrupt control register 2
25 <sub>H</sub> to 31 <sub>H</sub>			Vacancy
32 <sub>H</sub>	(R/W)	EIE2	External interrupt 2 enable register

*(Continued)*

# MB89190/190A Series

(Continued)

Address	Read/write	Register name	Register description
33 <sub>H</sub>	(R/W)	EIF2	External interrupt 2 flag register
34 <sub>H</sub> to 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>			Vacancy

Note: Do not use vacancies.

# MB89190/190A Series

## ■ ELECTRICAL CHARACTERISTICS

### 1. Absolute Maximum Rating

(AV<sub>SS</sub> = 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	
	AVR	V <sub>SS</sub> - 0.3	V <sub>SS</sub> + 7.0	V	Must not exceed V <sub>CC</sub> + 0.3 V. MB89190A series only
EPROM program voltage	V <sub>PP</sub>	V <sub>SS</sub> - 0.3	V <sub>SS</sub> + 13.0	V	
Input voltage	V <sub>I</sub>	V <sub>SS</sub> - 0.3	V <sub>CC</sub> + 0.3	V	
Output voltage	V <sub>O</sub>	V <sub>SS</sub> - 0.3	V <sub>CC</sub> + 0.3	V	
“L” level maximum output current	I <sub>OL1</sub>	—	10	mA	Except P33 and P34
	I <sub>OL2</sub>	—	20	mA	P33, P34
“L” level average output current	I <sub>OLAV1</sub>	—	4	mA	Except P33 and P34 Average value (operating current × operation rate)
	I <sub>OLAV2</sub>	—	8	mA	P33 and P34 Average value (operating current × operation rate)
“L” level total average output current	ΣI <sub>OLAV</sub>	—	20	mA	Average value (operating current × operation rate)
“L” level total maximum output current	ΣI <sub>OL</sub>	—	100	mA	
“H” level maximum output current	I <sub>OH1</sub>	—	-10	mA	Except P33, P34, and P37
	I <sub>OH2</sub>	—	-20	mA	P33, P34, P37
“H” level average output current	I <sub>OHAV1</sub>	—	-2	mA	Except P33, P34, and P37 Average value (operating current × operation rate)
	I <sub>OHAV2</sub>	—	-4	mA	Except P33, P34, and P37 Average value (operating current × operation rate)
“H” level total average output current	ΣI <sub>OHAV</sub>	—	-10	mA	Average value (operating current × operation rate)
“H” level total maximum output current	ΣI <sub>OH</sub>	—	-30	mA	
Power consumption	P <sub>D</sub>	—	200	mW	
Operating temperature	T <sub>a</sub>	-40	+85	°C	
Storage temperature	T <sub>stg</sub>	-55	+150	°C	

WARNING: Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

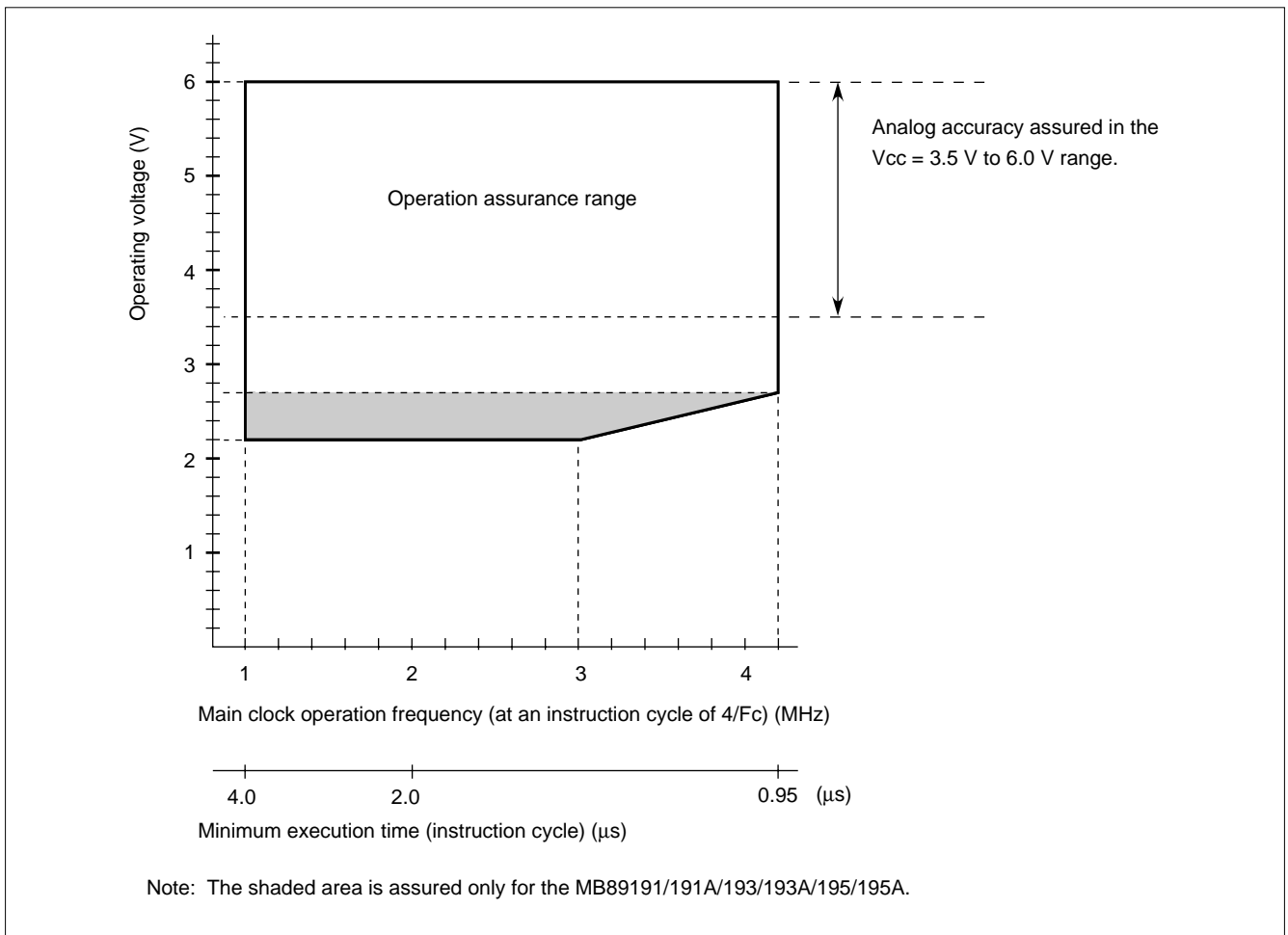
# MB89190/190A Series

## 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* MB89191/191A/193/193A/195/195A
		2.7*	6.0*	V	Normal operation assurance range* MB89P195/P195A/PV190/PV190A
		1.5	6.0	V	Retains the RAM state in the stop mode
A/D converter reference input voltage	AVR	0.0	V <sub>CC</sub>	V	
Operating temperature	T <sub>A</sub>	-40	+85	°C	

\* : These values vary with the operation frequency and the assured analog operation range. See Figure 1 and “5. A/D Converter Electrical Characteristics.”



**Figure 1 Operating Voltage vs. Main Clock Operating Frequency**

Figure 1 indicates the operating frequency of the external oscillator at an instruction cycle of 4/F<sub>C</sub>.



# MB89190/190A Series

**WARNING:** Recommended operating conditions are normal operating ranges for the semiconductor device. All the device's electrical characteristics are warranted when operated within these ranges.

Always use semiconductor devices within the recommended operating conditions. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representative beforehand.

## 3. DC Characteristics

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

Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
“H” level input voltage	$V_{IH}$	P00 to P07, P30 to P37, TEST	—	$0.7 V_{CC}$	—	$V_{CC} + 0.3$	V	
	$V_{IHS}$	$\overline{RST}$ , INT10 to INT12, EC, SCK, SI, INT20 to INT27	—	$0.8 V_{CC}$	—	$V_{CC} + 0.3$	V	
“L” level input voltage	$V_{IL}$	P00 to P03, P33 to P36, TEST	—	$V_{SS} - 0.3$	—	$0.3 V_{CC}$	V	
	$V_{ILS}$	$\overline{RST}$ , INT10 to INT12, EC, SCK, SI, INT 20 to INT27	—	$V_{SS} - 0.3$	—	$0.2 V_{CC}$	V	
Open-drain output pin applied voltage	$V_D$	P40 to P44	—	$V_{SS} - 0.3$	—	$V_{SS} + 0.3$	V	
“H” level output voltage	$V_{OH1}$	P00 to P07, P30 to P32, P35, P36	$I_{OH} = -2.0\text{ mA}$	2.4	—	—	V	
	$V_{OH2}$	P33, P34	$I_{OH} = -15\text{ mA}$	2.4	—	—	V	
	$V_{OH3}$	P37	$I_{OH} = -7.0\text{ mA}$	2.4	—	—	V	
“L” level output voltage	$V_{OL1}$	P00 to P07, P40 to P45, P30 to P32, P35 to P37	$I_{OL} = 1.8\text{ mA}$	—	—	0.4	V	
	$V_{OL2}$	$\overline{RST}$	$I_{OL} = 4.0\text{ mA}$	—	—	0.4	V	
	$V_{OL3}$	P33, P34	$I_{OL} = 12\text{ mA}$	—	—	0.4	V	
Input leakage current (Hi-z output leakage current)	$I_{LI1}$	P00 to P07, P30 to P37, TEST	$0.0\text{ V} < V_I < V_{CC}$	—	—	$\pm 5$	$\mu\text{A}$	Without pull-up resistor
Open-drain output leakage current (Off state)	$I_{LD1}$	P40 to P45	$0.0\text{ V} < V_I < V_{CC}$	—	—	$\pm 1$	$\mu\text{A}$	Without pull-up resistor

(Continued)

# MB89190/190A Series

(Continued)

(V<sub>CC</sub> = 5.0 V, 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.	Typ.	Max.		
Pull-up resistance	R <sub>PULL</sub>	P00 to P07, P30 to P37, P40 to P45, RST	V <sub>I</sub> = 0.0 V	25	50	100	kΩ	
Power supply voltage*	I <sub>CC</sub>	V <sub>CC</sub>	F <sub>C</sub> = 4.2 MHz	—	5	10	mA	MB89191/ 191A/193/ 193A/195/ 195A/PV190/ PV190A
				—	7	12	mA	MB89P195/ P195A
	I <sub>CCS</sub>		F <sub>C</sub> = 4.2 MHz	—	3	7	mA	Sleep mode
	I <sub>CH</sub>		T <sub>A</sub> = +25 °C	—	—	1	μA	Stop mode
	I <sub>CCA</sub>		F <sub>C</sub> = 4.2 MHz During A/D converter operation	—	6	13	mA	MB89191A/ 193A/195A/ PV190A
—		8		15	mA	MB89P195A		
Input capacitance	C <sub>IN</sub>	Except AVR, AV <sub>SS</sub> , V <sub>CC</sub> , and V <sub>SS</sub>	f = 1 MHz	—	10	—	pF	

\* : For the MB89PV190/PV190A, the current consumption of a connected EPROM and ICE is not included.  
The measurement condition of the power supply current are set as V<sub>CC</sub> = 5.0 V with an external clock.

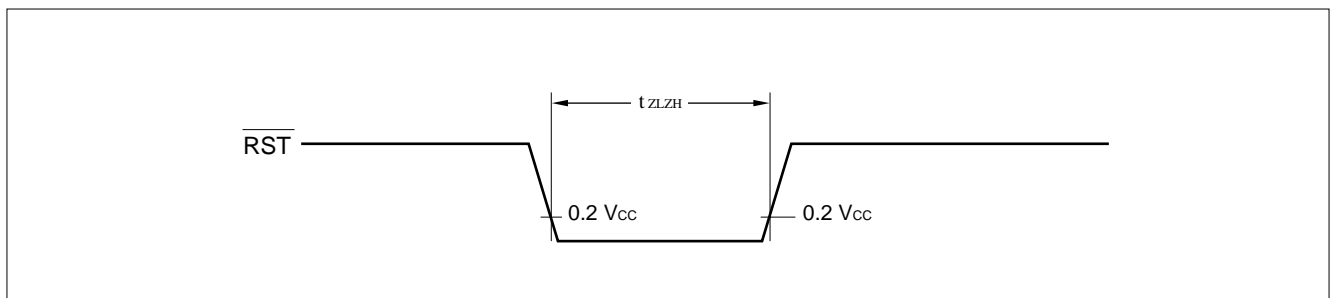
## 4. AC Characteristics

### (1) Reset Timing

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

Parameter	Symbol	Condition	Value		Unit	Remarks
			Min.	Max.		
RST "L" pulse width	t <sub>ZLZH</sub>	—	16 t <sub>CYCL</sub>	—	ns	

Note: t<sub>CYCL</sub> is the oscillation period (1/F<sub>C</sub>) input to the X0 pin.



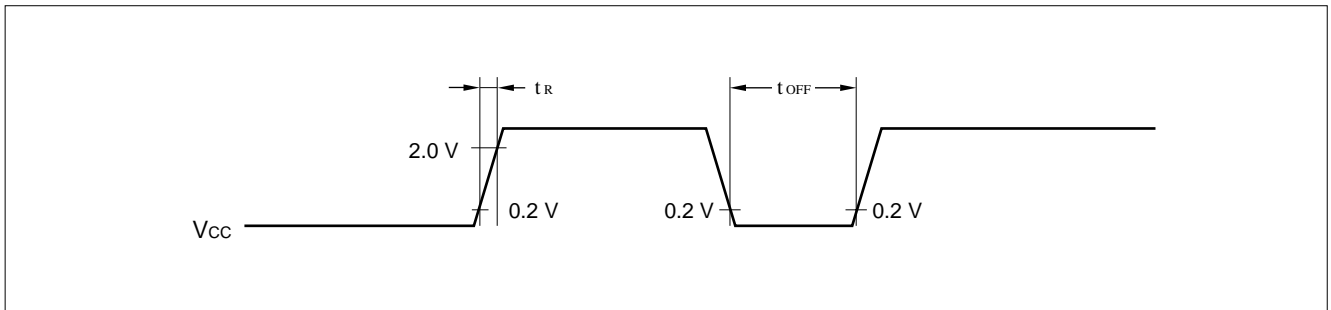
# MB89190/190A Series

## (2) Power-on Reset

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

Parameter	Symbol	Condition	Value		Unit	Remarks
			Min.	Max.		
Power supply rising time	$t_R$	—	—	50	ms	
Power supply cut-off time	$t_{OFF}$	—	1	—	ms	Due to repeated operations

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



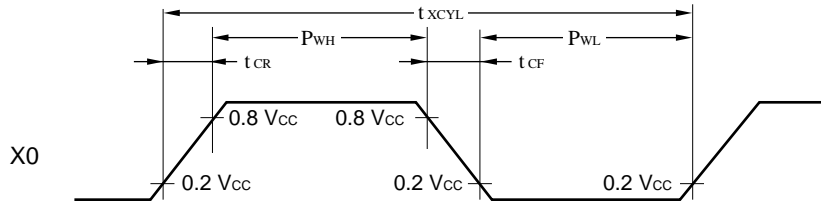
# MB89190/190A Series

## (3) Clock Timings

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

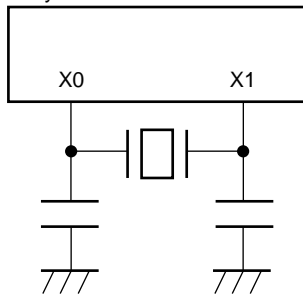
Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Clock frequency	$F_C$	X0, X1	—	1	4.2	MHz	
Clock cycle time	$t_{XCYL}$	X0, X1	—	238	1000	ns	
Input clock pulse width	$P_{WH}$ $P_{WL}$	X0	—	20	—	ns	External clock
Input clock pulse rising/ falling time	$t_{CR}$ $t_{CF}$	X0	—	—	10	ns	External clock

### X0, X1 Timings and Conditions of Applied Voltage

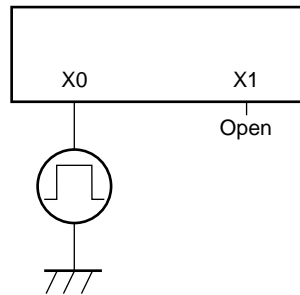


### Clock Conditions

When a crystal or ceramic resonator is used



When an external clock is used



## (4) Instruction Cycles

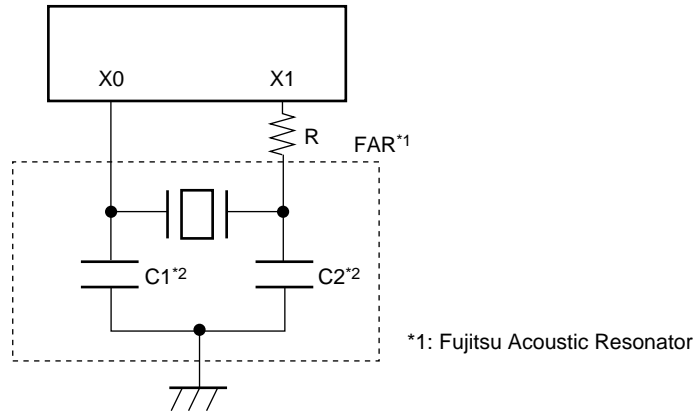
( $A_{V_{SS}} = V_{SS} = 0.0\text{ V}$ ,  $T_A = -40^\circ\text{C}$  to  $+85^\circ\text{C}$ )

Parameter	Symbol	Value (typical)	Unit	Remarks
Instruction cycle (minimum execution time)	$t_{inst}$	$4/F_C$	$\mu\text{s}$	$t_{inst} = 0.95\ \mu\text{s}$ when operating at $F_C = 4.2\ \text{MHz}$

# MB89190/190A Series

## (5) Recommended Resonator Manufacturers

### • Sample Application of Piezoelectric Resonator (FAR Series)

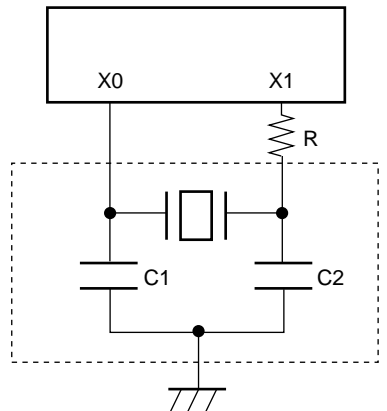


FAR part number (built-in capacitor type)	Frequency (MHz)	Damping resistor	Initial deviation of FAR frequency ( $T_A = +25^\circ\text{C}$ )	Temperature characteristics of FAR frequency ( $T_A = -20^\circ\text{C}$ to $+60^\circ\text{C}$ )	Loading capacitors*2
FAR-C4SA-04000-□01M	4.00	200 $\Omega$	$\pm 0.5\%$	$\pm 0.5\%$	Built-in

Inquiry: FUJITSU LIMITED

# MB89190/190A Series

## • Sample Application of Ceramic Resonator



### • Mask ROM products

Resonator manufacturer*	Resonator	Frequency (MHz)	C1 (pF)	C2 (pF)	R
Murata Mfg. Co., Ltd.	CSA2.00MG040	2.00	100	100	Not required
	CST2.00MG040		Built-in	Built-in	Not required
	CSA4.00MG	4.00	30	30	Not required
	CST4.00MGW		Built-in	Built-in	Not required
	CSTCS4.00MG0C5		Built-in	Built-in	Not required
TDK. Co., Ltd.	CCR4.0MC3	4.00	Built-in	Built-in	Not required
	FCR4.0MC5		Built-in	Built-in	Not required

### • One-time products

Resonator manufacturer*	Resonator	Frequency (MHz)	C1 (pF)	C2 (pF)	R
Murata Mfg. Co., Ltd.	CSA3.20MGCA	3.20	30	30	1 k $\Omega$
	CST3.20MGA		Built-in	Built-in	1 k $\Omega$
	CSA3.20MGA040	3.20	100	100	Not required
	CST3.20MGWA040		Built-in	Built-in	Not required
	CSA3.58MGCA	3.58	30	30	Not required
	CST3.58MGWHA		Built-in	Built-in	Not required

Inquiry: Murata Mfg. Co., Ltd

- Murata Electronics North America. Inc.: TEL 1-404-436-1300
- Murata Europe Mngement GmbH: TEL 49-911-66870
- Murata Electronics Singapore (Pte.) Ltd.: TEL 65-758-4233

TDK Corporation

- TDK Corporation of America  
Chicago Regional Office: TEL 1-708-803-6100
- TDK Electronics Europe GmbH  
Components Division: TEL 49-2102-9450
- TDK Singapore (PTE) Ltd.: TEL 65-273-5022
- TDK Hongkong Co., Ltd.: TEL 852-736-2238
- Korea Branch, TDK Corporation: TEL 82-2-554-6633

# MB89190/190A Series

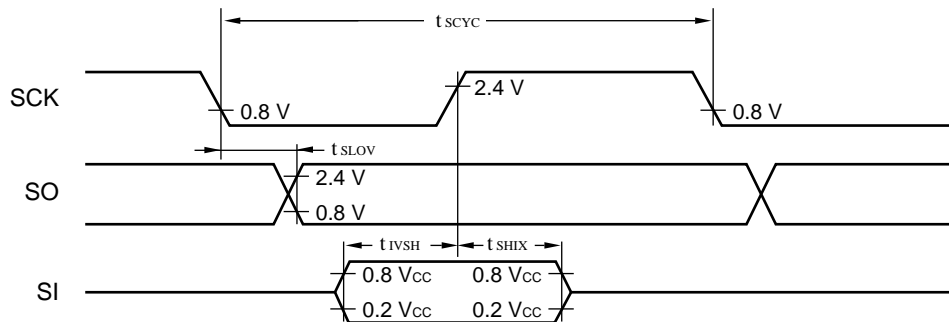
## (6) Serial I/O Timings

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

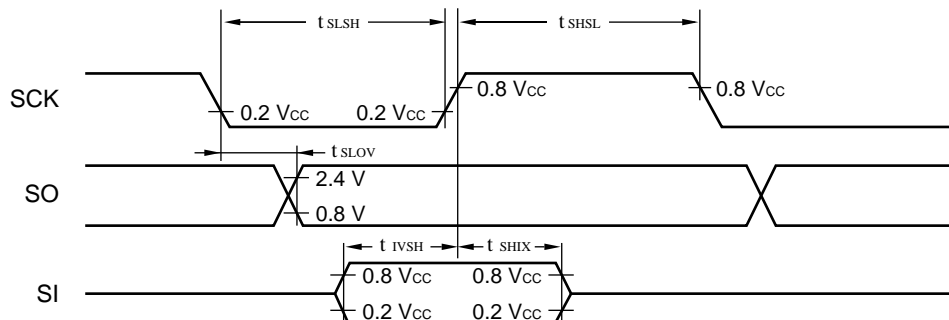
Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Serial clock cycle time	$t_{SCYC}$	SCK	Internal clock operation	$2 t_{inst}^*$	—	$\mu s$	
SCK $\downarrow \rightarrow$ SO time	$t_{SLOV}$	SCK, SO		-200	200	ns	
Valid SI $\rightarrow$ SCK $\uparrow$	$t_{IVSH}$	SI, SCK		$1/2 t_{inst}^*$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

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

### Internal Shift Clock Mode



### External Shift Clock Mode



# MB89190/190A Series

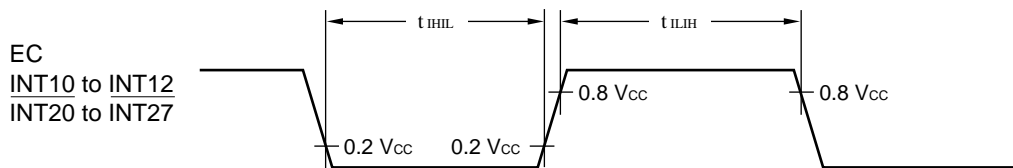
## (7) Peripheral Input Timings

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

Parameter	Symbol	Pin	Value		Unit	Remarks
			Min.	Max.		
Peripheral input "H" pulse width 1	$t_{ILIH1}$	EC, INT10 to INT12, INT20 to INT27	$2 t_{inst}^*$	—	$\mu s$	
Peripheral input "L" pulse width 1	$t_{IHIL1}$		$2 t_{inst}^*$	—	$\mu s$	

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

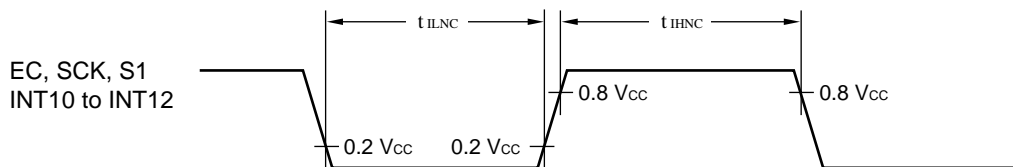
### Peripheral Input Timing Diagram



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

Parameter	Symbol	Pin	Value			Unit	Remarks
			Min.	Typ.	Max.		
Peripheral input "H" noise limit width	$t_{IHNC}$	EC, SI, SCK INT10 to INT12	7	15	23	ns	
Peripheral input "L" noise limit width	$t_{ILNC}$	EC, SI, SCK INT10 to INT12	7	15	23	ns	

### Peripheral Input Timing Diagram





# MB89190/190A Series

## 5. A/D Converter Electrical Characteristics (MB89190A Series Only)

( $AV_{CC} = V_{CC} = 3.5\text{ V to }6.0\text{ V}$ ,  $AV_{SS} = V_{SS} = 0.0\text{ V}$ ,  $T_A = -40^\circ\text{C to }+85^\circ\text{C}$ )

Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Resolution	—	—	—	—	—	8	bit	
Total error				—	—	$\pm 1.5$	LSB	
Linearity error				—	—	$\pm 1.0$	LSB	
Differential linearity error				—	—	$\pm 0.9$	LSB	
Zero transition voltage	$V_{OT}$	—	$AVR = AV_{CC}$	$AV_{SS}$ -1.0 LSB	$AV_{SS}$ +0.5 LSB	$AV_{SS}$ +2.0 LSB	mV	
Full-scale transition voltage	$V_{FST}$			$AVR$ -3.0 LSB	$AVR$ -1.5 LSB	$AVR$	mV	
Inter channel disparity	—			—	—	0.5	LSB	
A/D mode conversion time	—	—	—	—	$44 t_{inst}^*$	—	$\mu\text{s}$	
Sense mode conversion time				—	$12 t_{inst}^*$	—	$\mu\text{s}$	
Analog port input current	$I_{AIN}$	AN0 to AN7	—	—	—	10	$\mu\text{A}$	
Analog input voltage	—			0	—	$AVR$	V	
Reference voltage	—	AVR	$AVR = V_{CC} = 5.0\text{ V}$ when A/D conversion is operating	0	—	$V_{CC}$	V	
Reference voltage supply current	$I_R$			—	100	300	$\mu\text{A}$	
	$I_{RH}$			—	—	1	$\mu\text{A}$	

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

## 6. A/D Converter Glossary

- Resolution

Analog changes that are identifiable by the A/D converter.

When the number of bits is 8, analog voltage can be divided into  $2^8=256$ .

Linearity error (unit: LSB)

The deviation of the straight line connecting the zero transition point ("0000 0000"  $\leftrightarrow$  "0000 0001") with the full-scale transition point ("1111 1110"  $\leftrightarrow$  "1111 1111") from actual conversion characteristics.

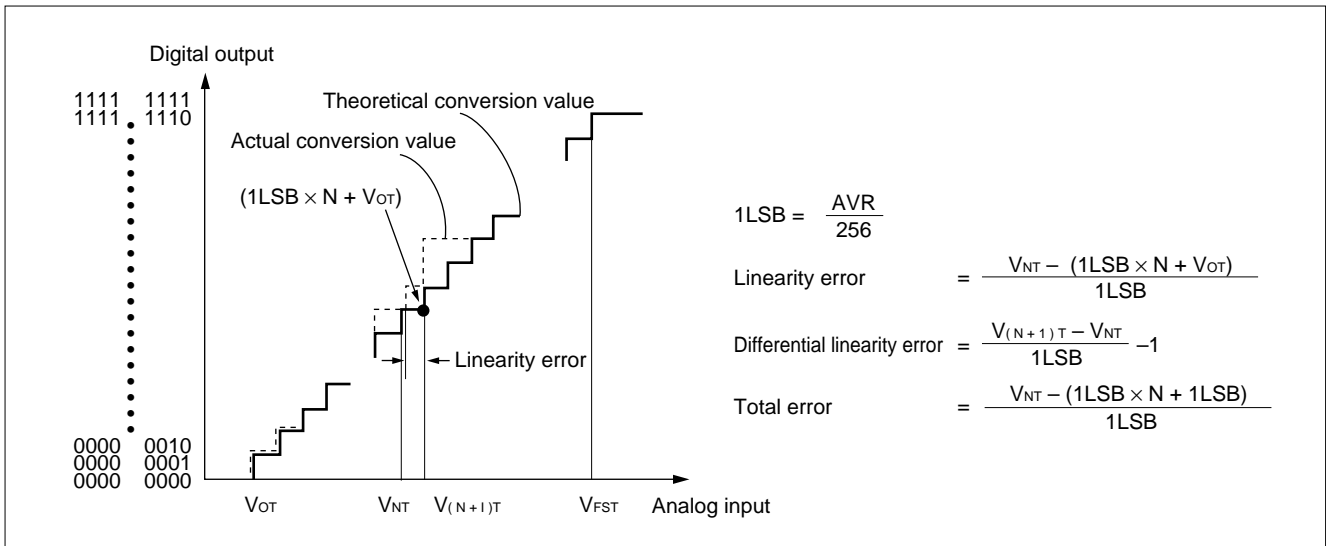
Differential linearity error (unit: LSB)

The deviation of input voltage needed change the output code by 1 LSB from the theoretical value.

- Total error (unit: LSB)

The difference between theoretical and actual conversion values.

# MB89190/190A Series



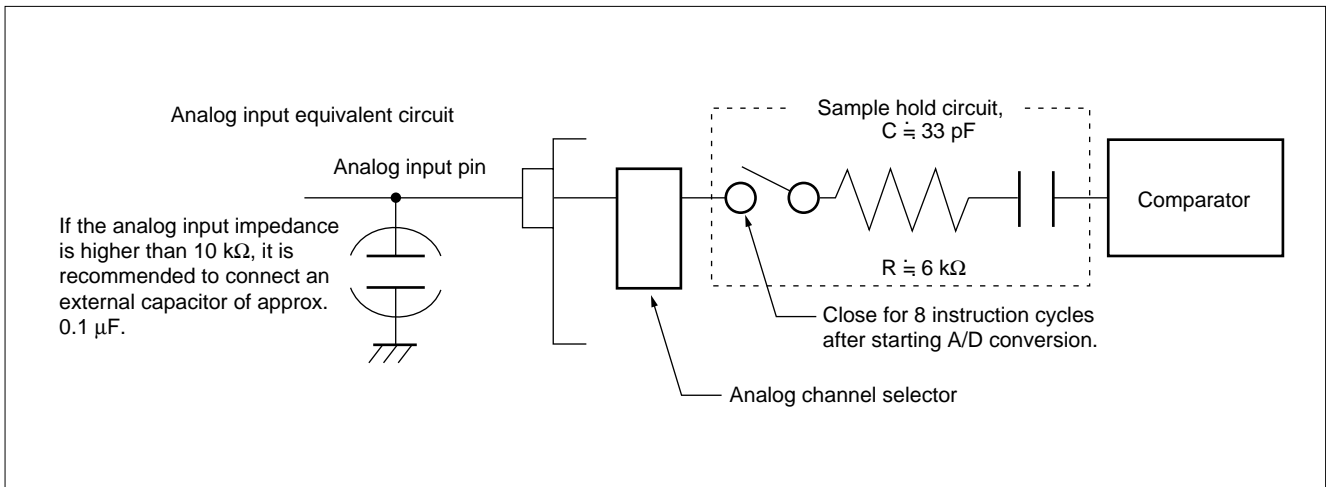
## 7. Notes on Using A/D Converter

- **Input impedance of analog input pins**

The A/D converter used for the MB89190A series contains a sample hold circuit as illustrated below to fetch analog input voltage into the sample hold capacitor for eight instruction cycles after starting A/D conversion.

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

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

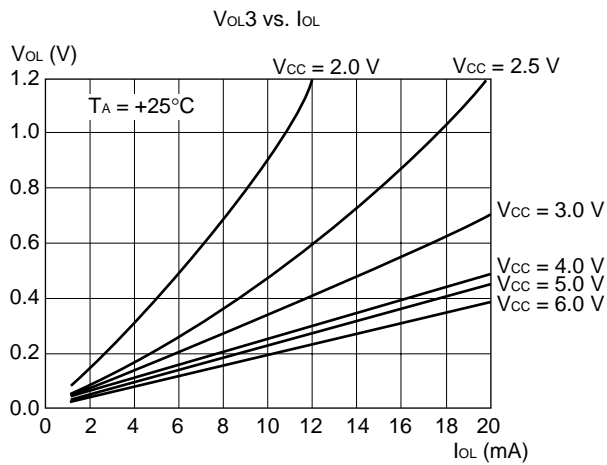
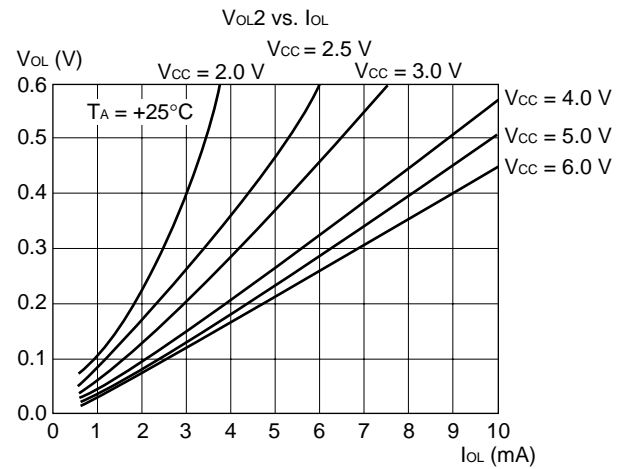
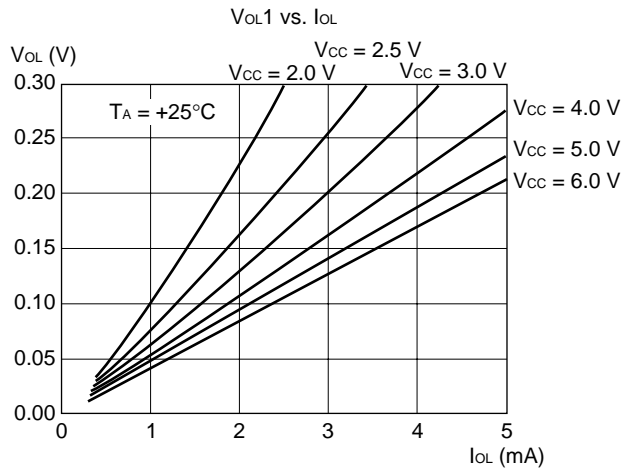


- **Error**

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

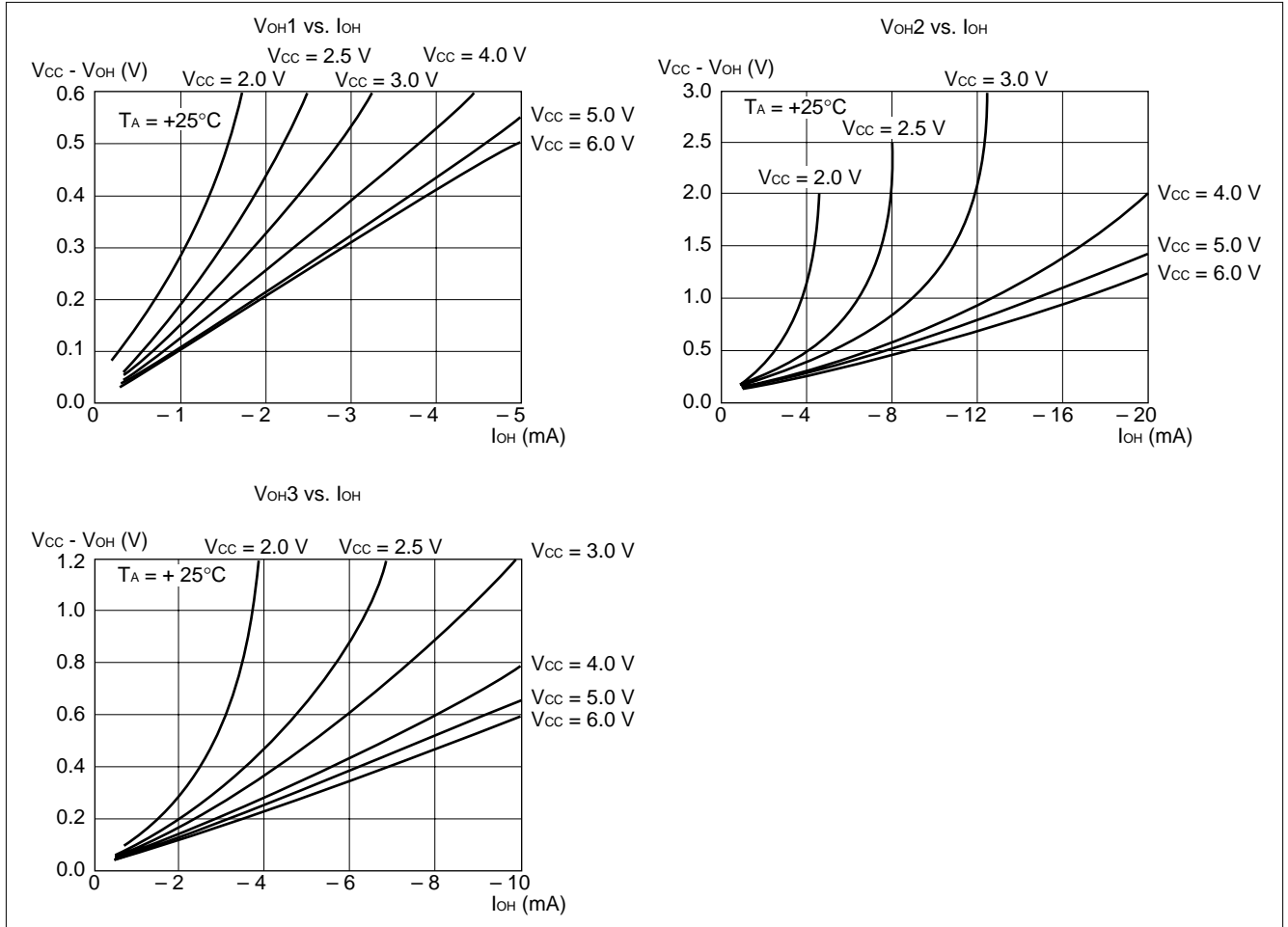
## EXAMPLE CHARACTERISTICS

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

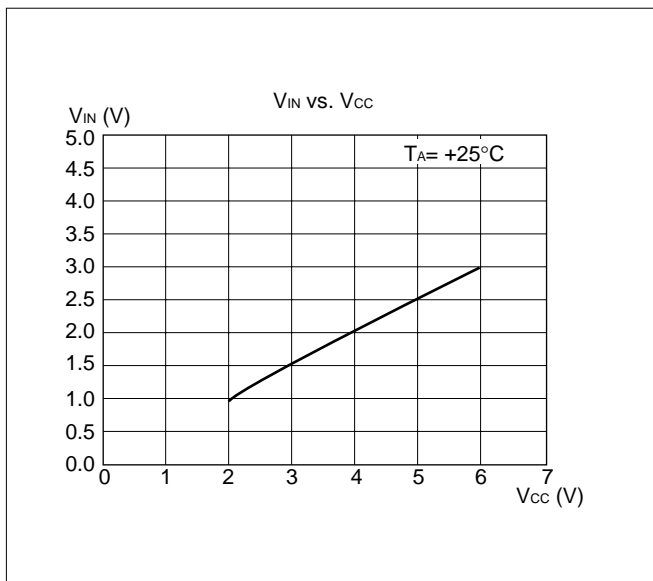


# MB89190/190A Series

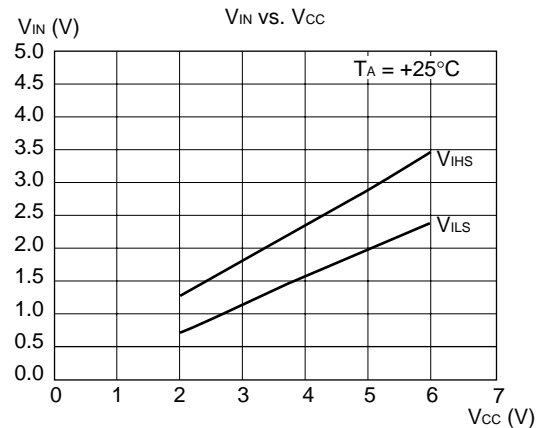
## (2) "H" Level Output Voltage



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



## (4) "H" Level Input Voltage/"L" Level Input Voltage (Hysteresis Input)

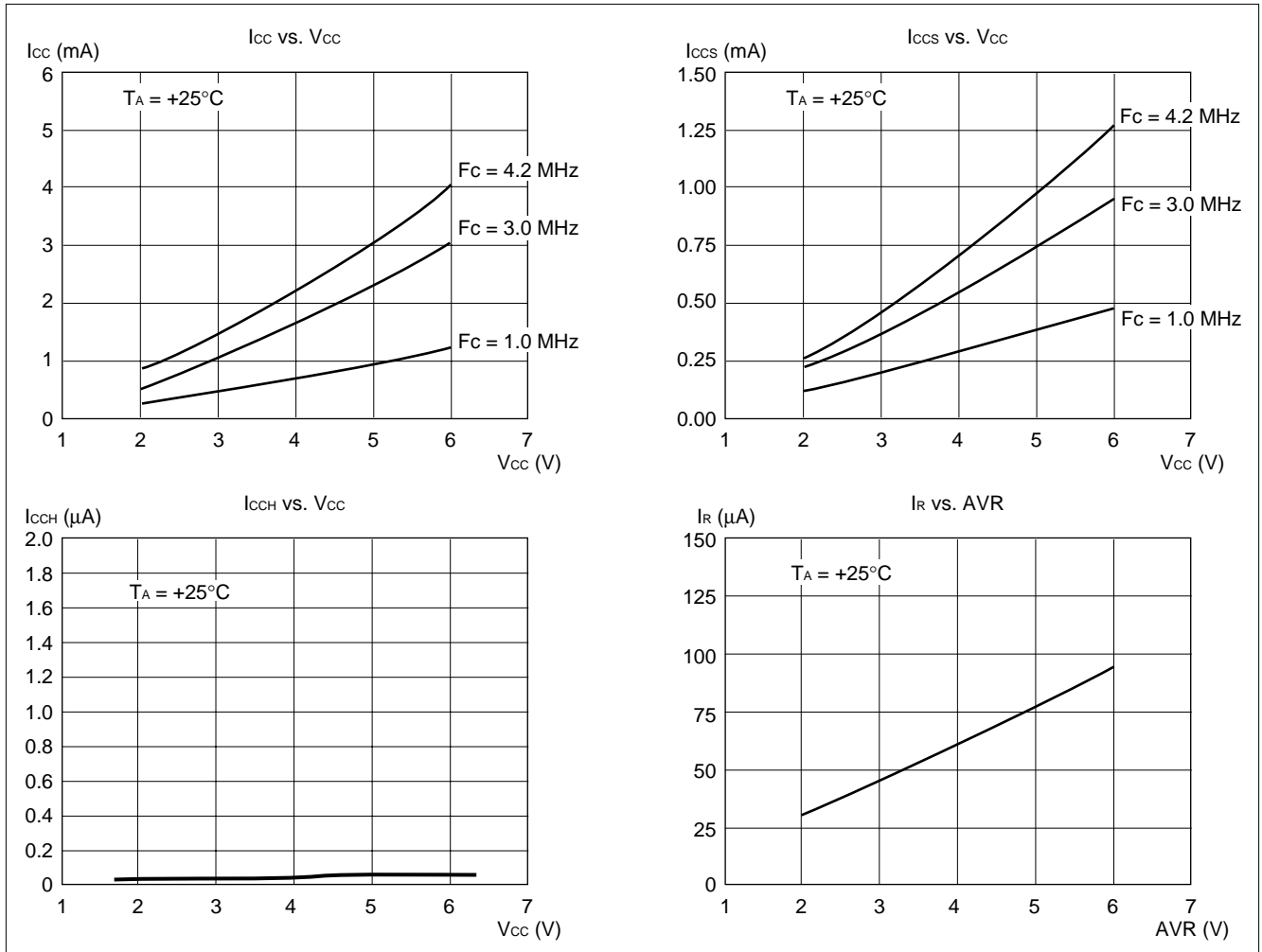


$V_{IHS}$ : Threshold when input voltage in hysteresis characteristics is set to "H" level

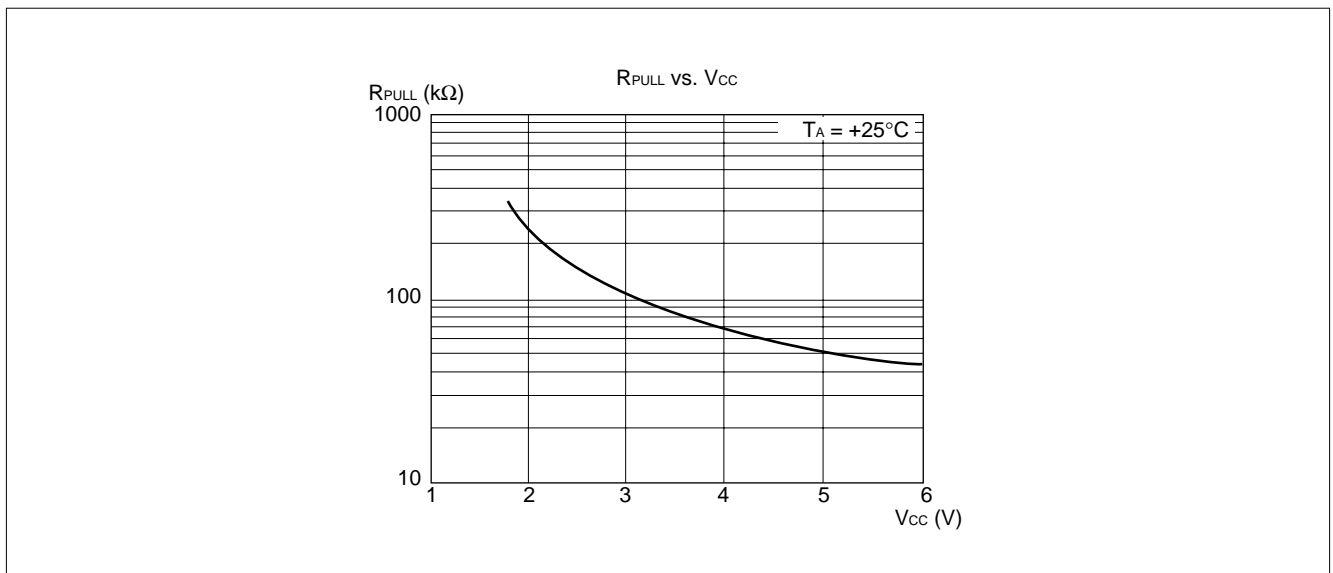
$V_{ILS}$ : Threshold when input voltage in hysteresis characteristics is set to "L" level

# MB89190/190A Series

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



## (6) Pull-up Resistance



# MB89190/190A Series

## ■ INSTRUCTIONS

Execution instructions can be divided into the following four groups:

- Transfer
- Arithmetic operation
- Branch
- Others

Table 1 lists symbols used for notation for 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)

# MB89190/190A 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 at address '×' 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 at address '×' 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

~: The number of instructions

#: The number of bytes

Operation: Operation of an instruction

TL, TH, AH: A changed content of the TL, TH and AH when instruction is executed. Symbols in the column indicate the following:

- “-” indicates no change.
- dH is the 8 upper bits of data described in the column “operation”.
- AL and AH must become the contents of AL and AH preceding the instruction executed.
- 00 becomes 00.

N, Z, V, C: Flags of the condition code register. 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.

# MB89190/190A 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)



## MB89190/190A 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	$\boxed{\rightarrow C \rightarrow A}$	-	-	-	++ - +	03
ROLC A	2	1	$\boxed{\leftarrow C \leftarrow A}$	-	-	-	++ - +	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)

# MB89190/190A 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 The 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

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	CLRI	SETI	CLRB dir: 0	BBC dir: 0,rel	INCW A	DECW A	JMP @A	MOVW A,PC
1	MULU A	DIVU A	JMP addr16	CALL addr16	PUSHW IX	POPW IX	MOV ext,A	MOVW PS,A	CLRC	SETC	CLRB dir: 1	BBC dir: 1,rel	INCW SP	DECW SP	MOVW SPA	MOVW A,SP
2	ROLA A	COMPA A	ADDCA A	SUBCA A	XCH A,T	XOR A	AND A	OR A	MOVA @A,T	MOVA A,@A	CLRB dir: 2	BBC dir: 2,rel	INCW IX	DECW IX	MOVW IX,A	MOVW A,IX
3	RORCA A	COMPA A	ADDCW A	SUBCW A	XCHW A,T	XORW A	ANDW A	ORW A	MOVW @A,T	MOVW A,@A	CLRB dir: 3	BBC dir: 3,rel	INCW EP	DECW EP	MOVW EPA	MOVW A,EP
4	MOVA A,#d8	COMPA A,#d8	ADDCA A,#d8	SUBCA A,#d8		XOR A,#d8	AND A,#d8	OR A,#d8	DAA	DAS	CLRB dir: 4	BBC dir: 4,rel	MOVW A,ext	MOVW ext,A	MOVW A,#d16	XCHW A,PC
5	MOVA A,dir	COMPA A,dir	ADDCA A,dir	SUBCA A,dir	MOVA dir,A	XOR A,dir	AND A,dir	OR A,dir	MOVA dir,#d8	COMPA dir,#d8	CLRB dir: 5	BBC dir: 5,rel	MOVW A,dir	MOVW dir,A	MOVW SP,#d16	XCHW A,SP
6	MOVA A,@IX+d	COMPA A,@IX+d	ADDCA A,@IX+d	SUBCA A,@IX+d	MOVA @IX+d,A	XOR A,IX+d	AND A,@IX+d	OR A,@IX+d	MOVA @IX+d,#d8	COMPA @IX+d,#d8	CLRB dir: 6	BBC dir: 6,rel	MOVW A,@IX+d	MOVW @IX+d,A	MOVW IX,#d16	XCHW A,IX
7	MOVA A,@EP	COMPA A,@EP	ADDCA A,@EP	SUBCA A,@EP	MOVA @EPA	XOR A,@EP	AND A,@EP	OR A,@EP	MOVA @EP,#d8	COMPA @EP,#d8	CLRB dir: 7	BBC dir: 7,rel	MOVW A,@EP	MOVW @EPA	MOVW EP,#d16	XCHW A,EP
8	MOVA A,R0	COMPA A,R0	ADDCA A,R0	SUBCA A,R0	MOVA R0,A	XOR A,R0	AND A,R0	OR A,R0	MOVA R0,#d8	COMPA R0,#d8	SETB dir: 0	BBS dir: 0,rel	INCR R0	DEC R0	CALLV #0	BNC rel
9	MOVA A,R1	COMPA A,R1	ADDCA A,R1	SUBCA A,R1	MOVA R1,A	XOR A,R1	AND A,R1	OR A,R1	MOVA R1,#d8	COMPA R1,#d8	SETB dir: 1	BBS dir: 1,rel	INCR R1	DEC R1	CALLV #1	BC rel
A	MOVA A,R2	COMPA A,R2	ADDCA A,R2	SUBCA A,R2	MOVA R2,A	XOR A,R2	AND A,R2	OR A,R2	MOVA R2,#d8	COMPA R2,#d8	SETB dir: 2	BBS dir: 2,rel	INCR R2	DEC R2	CALLV #2	BP rel
B	MOVA A,R3	COMPA A,R3	ADDCA A,R3	SUBCA A,R3	MOVA R3,A	XOR A,R3	AND A,R3	OR A,R3	MOVA R3,#d8	COMPA R3,#d8	SETB dir: 3	BBS dir: 3,rel	INCR R3	DEC R3	CALLV #3	BN rel
C	MOVA A,R4	COMPA A,R4	ADDCA A,R4	SUBCA A,R4	MOVA R4,A	XOR A,R4	AND A,R4	OR A,R4	MOVA R4,#d8	COMPA R4,#d8	SETB dir: 4	BBS dir: 4,rel	INCR R4	DEC R4	CALLV #4	BNZ rel
D	MOVA A,R5	COMPA A,R5	ADDCA A,R5	SUBCA A,R5	MOVA R5,A	XOR A,R5	AND A,R5	OR A,R5	MOVA R5,#d8	COMPA R5,#d8	SETB dir: 5	BBS dir: 5,rel	INCR R5	DEC R5	CALLV #5	BZ rel
E	MOVA A,R6	COMPA A,R6	ADDCA A,R6	SUBCA A,R6	MOVA R6,A	XOR A,R6	AND A,R6	OR A,R6	MOVA R6,#d8	COMPA R6,#d8	SETB dir: 6	BBS dir: 6,rel	INCR R6	DEC R6	CALLV #6	BGE rel
F	MOVA A,R7	COMPA A,R7	ADDCA A,R7	SUBCA A,R7	MOVA R7,A	XOR A,R7	AND A,R7	OR A,R7	MOVA R7,#d8	COMPA R7,#d8	SETB dir: 7	BBS dir: 7,rel	INCR R7	DEC R7	CALLV #7	BLT rel

INSTRUCTION MAP

# MB89190/190A Series

## ■ MASK OPTION LIST

No.	Part number		MB89191 /193 /195	MB89191A /193A /195A	MB89P195		MB89P195A		MB89PV190 MB89PV190A
	Specifying procedure		Specify when ordering masking		-101 <sup>2</sup>	Specify when ordering masking		-201 <sup>2</sup>	Fixed
1	Port pull-up resistors	P00 to P07 P30 to P37	Selectable by pin		None	Selectable by pin		None	Not available
		P00 to P03 P40 to P45	Selectable by pin	Not available	None	Selectable by pin	Not available	None	Not available
2	Power-on reset <ul style="list-style-type: none"> <li>• Power-on reset provided</li> <li>• No power-on reset</li> </ul>		Selectable		Provided	Provided		Provided	Provided
3	Selection of oscillation stabilization wait time (at 4.2 MHz) <sup>1</sup> <ul style="list-style-type: none"> <li>• 2<sup>18</sup>/F<sub>C</sub> (approx. 62.4 ms)</li> <li>• 2<sup>16</sup>/F<sub>C</sub> (approx. 15.6 ms)</li> <li>• 2<sup>12</sup>/F<sub>C</sub> (approx. 0.98 ms)</li> <li>• 2<sup>2</sup>/F<sub>C</sub> (approx. 0 ms)</li> </ul>		Selectable		Fixed to 2 <sup>16</sup> /F <sub>C</sub>	Selectable		Fixed to 2 <sup>16</sup> /F <sub>C</sub>	Fixed to 2 <sup>16</sup> /F <sub>C</sub>
4	Reset pin output <ul style="list-style-type: none"> <li>• Reset output provided</li> <li>• No reset output</li> </ul>		Selectable		Provided	Selectable		Provided	Provided
5	Oscillation type of clock <ul style="list-style-type: none"> <li>1 Crystal and ceramic oscillators</li> <li>2 CR</li> </ul>		Selectable		"1" only	Selectable		"1" only	"1" only

\*1: The oscillation stabilization time is generated by dividing the original clock oscillation. The time described in this item should be used as a rough guideline since the oscillation cycle is unstable immediately after oscillation starts. "F<sub>C</sub>" indicates the original oscillation frequency.

\*2: -101 and -201 are provided respectively for the MB89P195 and MB89P195A OTP versions as the standard products.

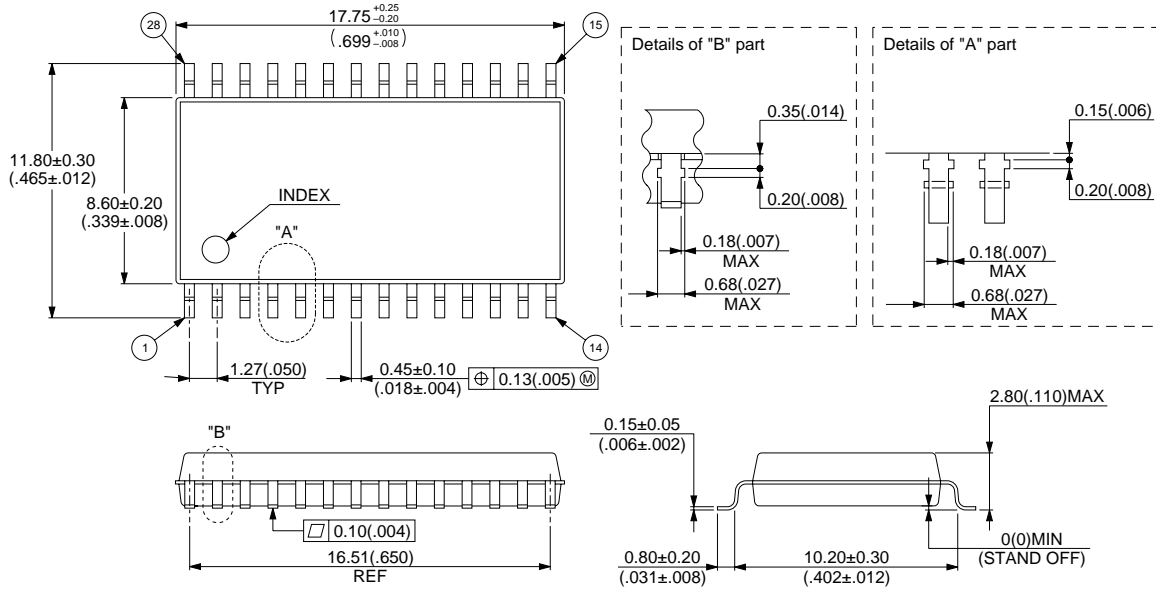
**MB89190/190A Series****■ ORDERING INFORMATION**

Part number	Package	Remarks
MB89191PF MB89193PF MB89195PF MB89P195PF-101 MB89191APF MB89193APF MB89195APF MB89P195APF-201	28-pin Plastic SOP (FPT-28P-M17)	
MB89191P-SH MB89193P-SH MB89195P-SH MB89191AP-SH MB89193AP-SH MB89195AP-SH	28-pin Plastic SH-DIP (DIP-28C-M03)	
MB89191P MB89193P MB89195P MB89P195P-101 MB89191AP MB89193AP MB89195AP MB89P195AP-201	28-pin Plastic DIP (DIP-28P-M05)	
MB89PV190CF MB89PV190ACF	48-pin Ceramic MQFP (MQP-48C-P01)	

# MB89190/190A Series

## PACKAGE DIMENSIONS

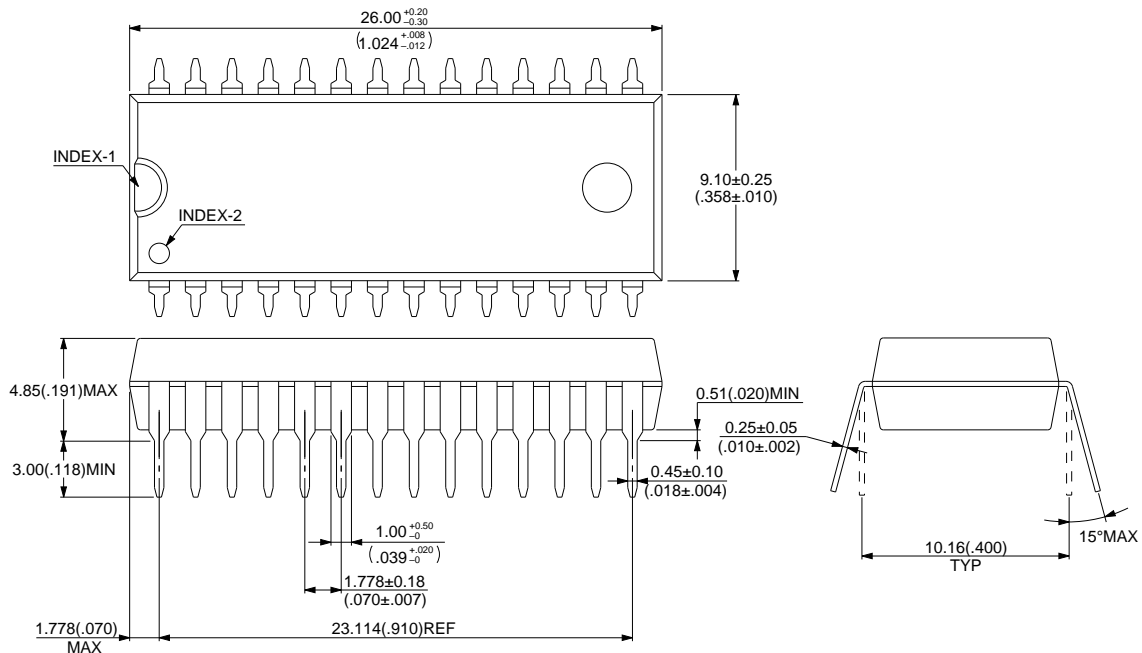
28-pin Plastic SOP  
(FPT-28P-M17)



© 1994 FUJITSU LIMITED F28048S-1C-1

Dimensions in mm (inches)

28-pin Plastic SH-DIP  
(DIP-28P-M03)

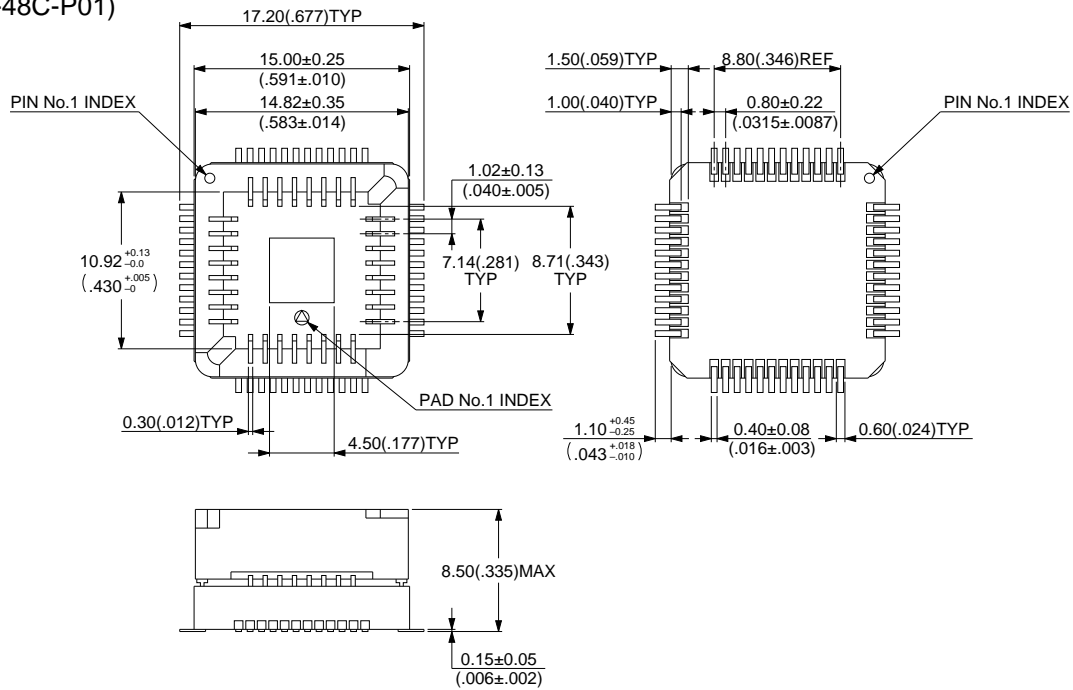


© 1994 FUJITSU LIMITED D28012S-3C-3

Dimensions in mm (inches)

# MB89190/190A Series

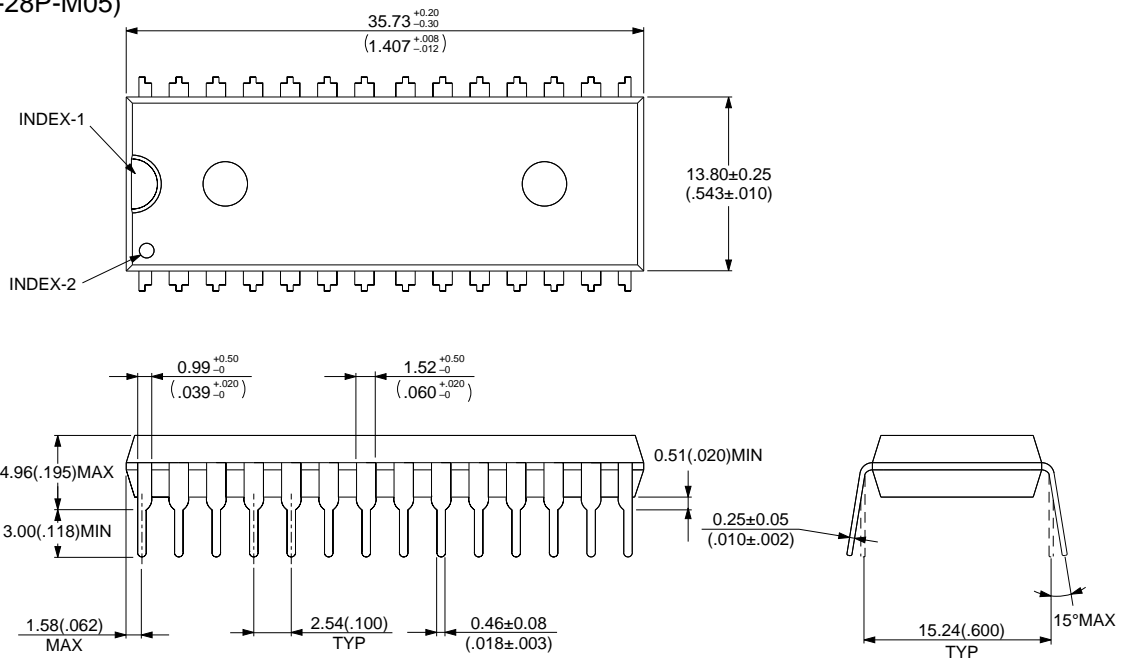
## 28-pin Ceramic MQFP (MQP-48C-P01)



© 1994 FUJITSU LIMITED M48001SC-4-2

Dimensions in mm (inches)

## 28-pin Ceramic DIP (DIP-28P-M05)



© 1994 FUJITSU LIMITED D28013S-3C-2

Dimensions in mm (inches)

# MB89190/190A Series

## FUJITSU LIMITED

*For further information please contact:*

### **Japan**

FUJITSU LIMITED  
Corporate Global Business Support Division  
Electronic Devices  
KAWASAKI PLANT, 4-1-1, Kamikodanaka  
Nakahara-ku, Kawasaki-shi  
Kanagawa 211-88, Japan  
Tel: (044) 754-3763  
Fax: (044) 754-3329

### **North and South America**

FUJITSU MICROELECTRONICS, INC.  
Semiconductor Division  
3545 North First Street  
San Jose, CA 95134-1804, U.S.A.  
Tel: (408) 922-9000  
Fax: (408) 432-9044/9045

### **Europe**

FUJITSU MIKROELEKTRONIK GmbH  
Am Siebenstein 6-10  
63303 Dreieich-Buchsschlag  
Germany  
Tel: (06103) 690-0  
Fax: (06103) 690-122

### **Asia Pacific**

FUJITSU MICROELECTRONICS ASIA PTE. LIMITED  
#05-08, 151 Lorong Chuan  
New Tech Park  
Singapore 556741  
Tel: (65) 281-0770  
Fax: (65) 281-0220

All Rights Reserved.

The contents of this document are subject to change without notice. Customers are advised to consult with FUJITSU sales representatives before ordering.

The information and circuit diagrams in this document presented as examples of semiconductor device applications, and are not intended to be incorporated in devices for actual use. Also, FUJITSU is unable to assume responsibility for infringement of any patent rights or other rights of third parties arising from the use of this information or circuit diagrams.

FUJITSU semiconductor devices are intended for use in standard applications (computers, office automation and other office equipment, industrial, communications, and measurement equipment, personal or household devices, etc.).

#### **CAUTION:**

Customers considering the use of our products in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage, or where extremely high levels of reliability are demanded (such as aerospace systems, atomic energy controls, sea floor repeaters, vehicle operating controls, medical devices for life support, etc.) are requested to consult with FUJITSU sales representatives before such use. The company will not be responsible for damages arising from such use without prior approval.

Any semiconductor devices have inherently a certain rate of failure. You must protect against injury, damage or loss from such failures by incorporating safety design measures into your facility and equipment such as redundancy, fire protection, and prevention of over-current levels and other abnormal operating conditions.

If any products described in this document represent goods or technologies subject to certain restrictions on export under the Foreign Exchange and Foreign Trade Control Law of Japan, the prior authorization by Japanese government should be required for export of those products from Japan.