8-bit Proprietary Microcontroller

CMOS

F²MC-8L MB89190/190A Series

MB89191/193/195/P195/PV190
MB89191A/191AH/193A/193AH/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 F²MC*-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.
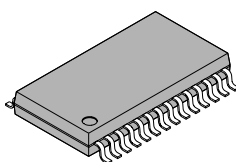
*: F²MC stands for FUJITSU Flexible Microcontroller.

■ FEATURES

- Minimum execution time: 0.95 μs at 4.2 MHz (V_{CC} = 2.7 V)
- F²MC-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.)
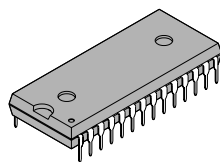
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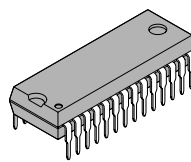## ■ PACKAGE

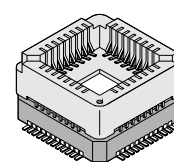| 28-pin Plastic SOP	28-pin Plastic DIP	28-pin Plastic SH-DIP	48-pin Ceramic MQFP
(FPT-28P-M17)	(DIP-28P-M05)	(DIP-28P-M03)	(MQP-48C-P01)

(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 MB89191AH	MB89193 MB89193A MB89193AH	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				

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Part number \ Item	MB89191 MB89191A MB89191AH	MB89193 MB89193A MB89193AH	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 MB89191AH MB89193 MB89193A MB89193AH 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."

■ 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$_H$ to 0180$_H$ 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.

4. MB89191AH/MB89193AH

MB89191AH/193AH are "L" level heavy output current drive type of P30 to P32 and P40 to P43 of MB89191A/193A.Characteristics other than "L" level output of P30 to P32 and P40 to P43 are the same as MB89191A/193A.

■ **PIN ASSIGNMENT**

（TOP VIEW）

Pin	Signal		Pin	Signal
1	P04/$\overline{INT24}$		28	V_{CC}
2	P05/$\overline{INT25}$		27	P03/$\overline{INT23}$/AN7
3	P06/$\overline{INT26}$		26	P02/$\overline{INT22}$/AN6
4	P07/$\overline{INT27}$		25	P01/$\overline{INT21}$/AN5
5	TEST		24	P00/$\overline{INT20}$/AN4
6	$\overline{RST}$		23	P45/AVR
7	X0		22	P44/AV$_{SS}$
8	X1		21	P43/AN3
9	V$_{SS}$		20	P42/AN2
10	P37/BZ/RCO		19	P41/AN1
11	P36/INT12		18	P40/AN0
12	P35/INT11		17	P30/SCK
13	P34/TO/INT10		16	P31/SO
14	P33/EC		15	P32/SI

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

(Top view)

Each pin inside the dashed line is for MB89PV190/PV190A units only.

(MQP-48C-P01)

Pin numbers around the package:

Top side (pins 48–37): P35/INT11 (48), N.C. (47), N.C. (46), N.C. (45), N.C. (44), N.C. (43), Vss (42), N.C. (41), N.C. (40), N.C. (39), N.C. (38), N.C. (37)

Left side (pins 1–12):
- 1 — P34/TO/INT10
- 2 — P33/EC
- 3 — P32/SI
- 4 — P31/SO
- 5 — P30/SCK
- 6 — P40/AN0
- 7 — P41/AN1
- 8 — P42/AN2
- 9 — P43/AN3
- 10 — P44/AVss
- 11 — P45/AVR
- 12 — P00/INT20/AN4

Right side (pins 36–25):
- 36 — N. C.
- 35 — N. C.
- 34 — P36/INT12
- 33 — P37/BZ/RCO
- 32 — X1
- 31 — X0
- 30 — RST
- 29 — TEST
- 28 — P07/INT27
- 27 — P06/INT26
- 26 — P05/INT25
- 25 — P04/INT24

Bottom side (pins 13–24): P01/INT21/AN5 (13), N.C. (14), N.C. (15), N.C. (16), N.C. (17), Vcc (18), N.C. (19), N.C. (20), N.C. (21), N.C. (22), P02/INT22/AN6 (23), P03/INT23/AN7 (24)

• **Pin assignment on the package top (MB89PV190/PV190A only)**

Pin no.	Pin name	Pin no.	Pin name	Pin no.	Pin name	Pin no.	Pin name
49	V$_{PP}$	57	N.C.	65	O4	73	$\overline{OE}$
50	A12	58	A2	66	O5	74	N.C.
51	A7	59	A1	67	O6	75	A11
52	A6	60	A0	68	O7	76	A9
53	A5	61	O1	69	O8	77	A8
54	A4	62	O2	70	$\overline{CE}$	78	A13
55	A3	63	O3	71	A10	79	A14
56	N.C.	64	Vss	72	N.C.	80	Vcc

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

■ PIN DESCRIPTION

Pin no.		Pin name	Circuit type	Function
SOP*1, DIP*2 SH-DIP*3	MQFP*4			
7	31	X0	A	Clock oscillation pins
8	32	X1		
5	29	TEST	B	Test input pin Connect directly to V_{SS}.
6	30	$\overline{RST}$	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/$\overline{INT20}$/ AN4 to P03/ $\overline{INT23}$/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/$\overline{INT24}$ to P07/$\overline{INT27}$	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

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Pin no.		Pin name	Circuit type	Function
SOP*1, DIP*2 SH-DIP*3	MQFP*4			
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$_{SS}$	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$_{SS}$ to. In the MB89190 series, also serves as an N-ch open-drain output port.
28	18	V$_{CC}$	—	Power supply pin
9	42	V$_{SS}$	—	Power supply (GND) pin

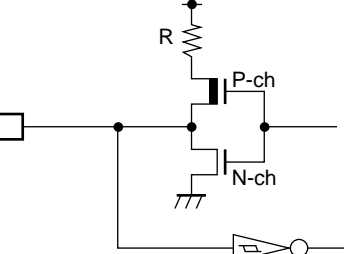*1: FPT-28P-M17
*2: DIP-28P-M05
*3: DIP-28P-M03
*4: MQP-48C-P01
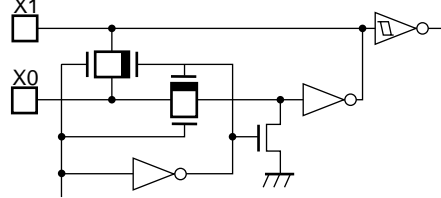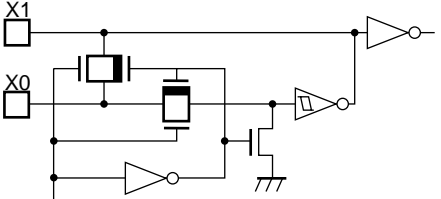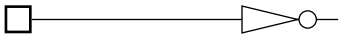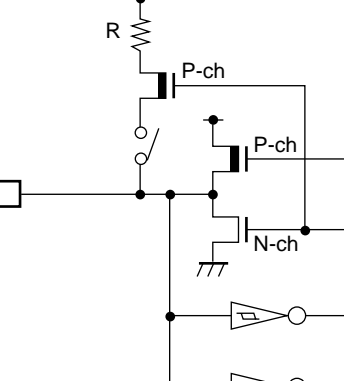
• **External EPROM pins (MB89PV190/PV190A)**

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

■ I/O CIRCUIT TYPE

Type	Circuit	Remarks
A	X1 X0 Standby control signal	• Oscillation feedback registor of approximately 1 MΩ at 5 V • When crystal and ceramic oscillators are selected optionally
	X1 X0 Standby control signal	• When CR oscillation is selected optionally
B		
C	R P-ch N-ch	• Output pull-up resistor (P-ch): Approx. 50 kΩ at 5 V • Hysteresis input
D	R P-ch P-ch N-ch	• CMOS output • CMOS input • Hysteresis input (resource input) • Pull-up resistor optional

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Type	Circuit	Remarks
E		• CMOS output • CMOS input • Pull-up resistor optional
F		• N-ch open-drain output • Analog input • Pull-up resistor optional (MB89190 series only)
G		• CMOS output • CMOS input • Hysteresis input (resource input) • Analog input • Pull-up resistor optional (MB89190 series only)

■ 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.

■ 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
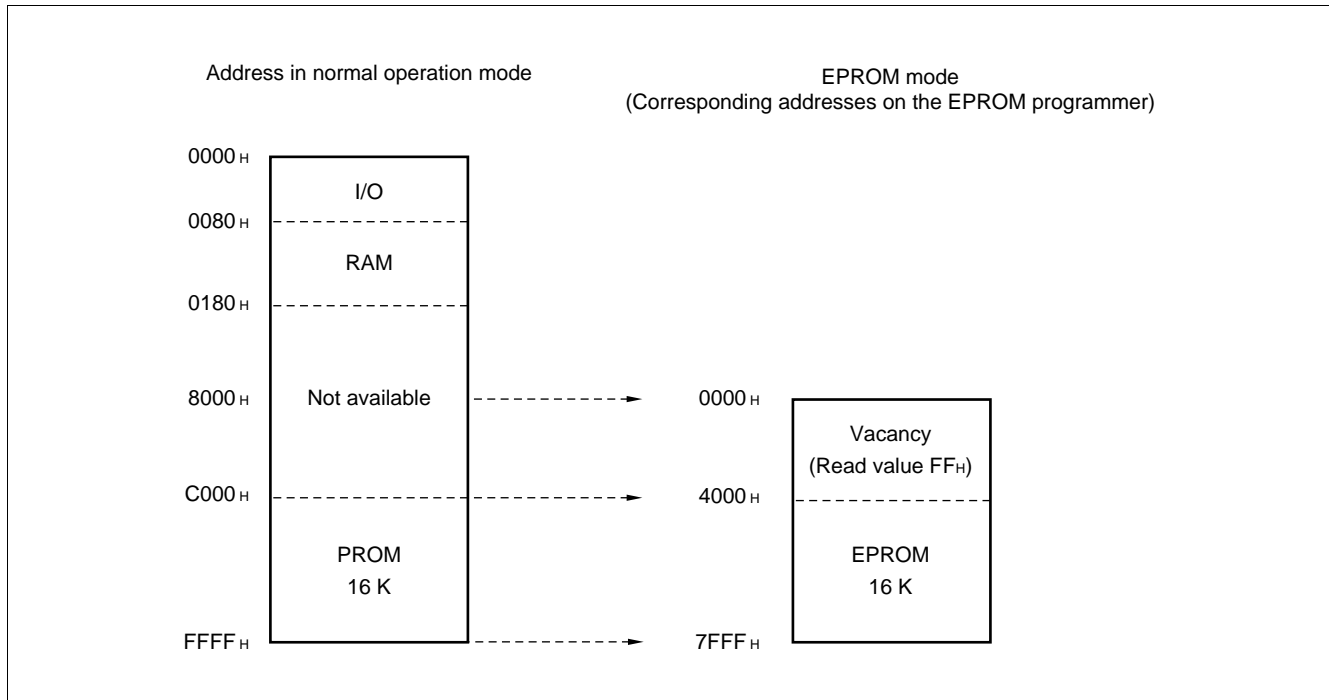
* **Programming procedure**
(1) Load program data into the ROM programmer at addresses 4000_H to $7FFF_H$. (Addresses $0C000_H$ to $0FFFF_H$ in the operation mode correspond to 4000_H to $7FFF_H$ in ROM programmer. See the illustration above.)

(2) Set the data at addresses 0000_H to $3FFF_H$ of the programmer ROM in the ROM programmer, to FF_H.

(3) Program in the successive-address write mode of the ROM programmer.

Note: Program must be started at the address 00000_H.
For details, contact our Sales Division.

2. Recommended Screening Conditions

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

```
┌─────────────────────┐
│   Program, verify   │
└─────────────────────┘
          │
          ▼
┌─────────────────────┐
│       Aging         │
│  +150°C for 48 Hrs. │
└─────────────────────┘
          │
          ▼
┌─────────────────────┐
│  Data verification  │
└─────────────────────┘
          │
          ▼
    (    Assembly    )
```
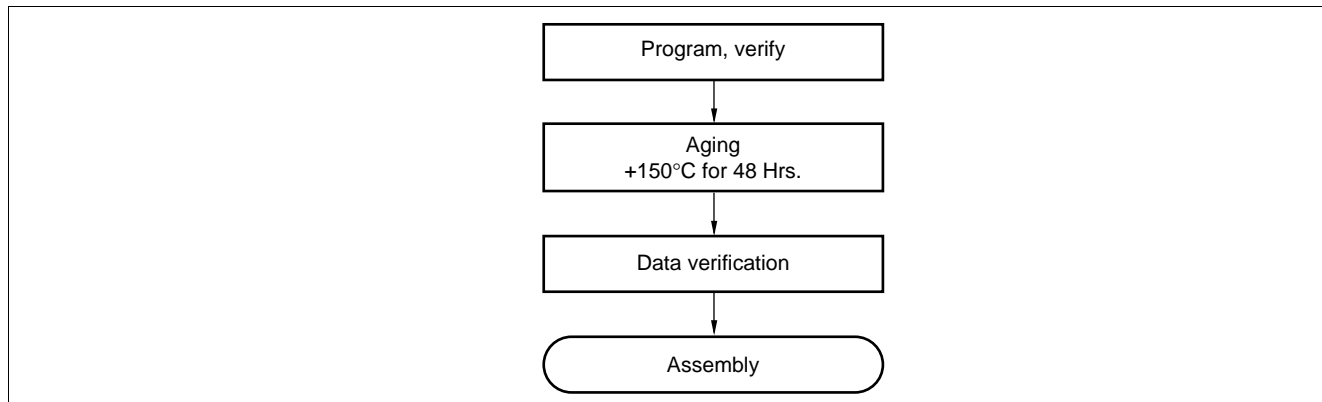
3. Programming Yield

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	Recommended	Recommended		
MB89P195A						
MB89P195PF	SOP-28	ROM-28SOP-28DP-8L	Recommended	Recommended		
MB89P195APF						

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

■ 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

Address in normal operation mode

Address when writing to EPROM
(Corresponding addresses on the EPROM programmer)

0000_H
I/O
0080_H
RAM
0180_H
Not available
8000_H → 0000_H

PROM
32 K

EPROM
32 K

$FFFF_H$ → $7FFF_H$
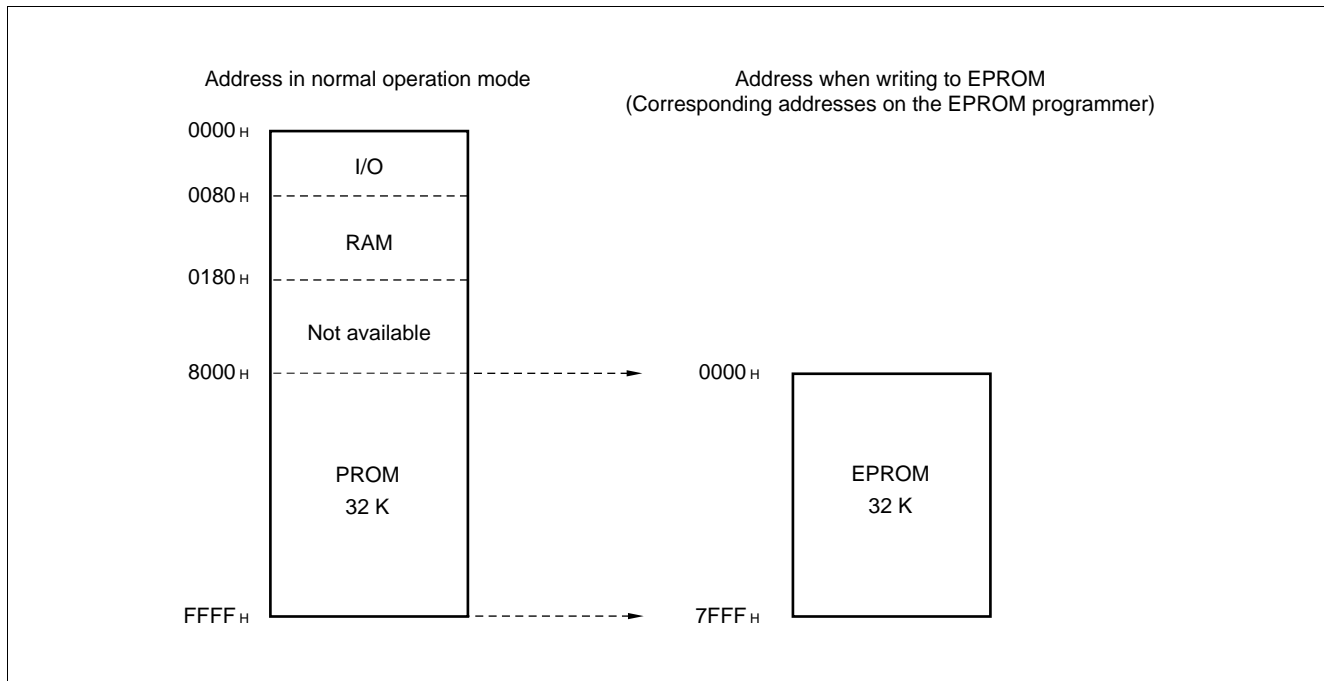
4. Programming to the EPROM

(1) Set the EPROM programmer for MBM27C256A.

(2) Load program data into the EPROM programmer at 0000_H to $7FFF_H$.

(3) Program to 0000_H to $7FFF_H$ with the EPROM programmer.

■ BLOCK DIAGRAM

X0
X1

Oscillator
(Max. 4.2 MHz)

Clock control

Timebase timer

Reset circuit
(WDT)

$\overline{RST}$

Internal bus

CMOS I/O port

Port 0

External interrupt
(Wake-up)

P04/$\overline{INT24}$ to
P07/$\overline{INT27}$

4

P00/$\overline{INT20}$/AN4 to
P03/$\overline{INT23}$/AN7

4

8-bit A/D converter
(MB89190A only)

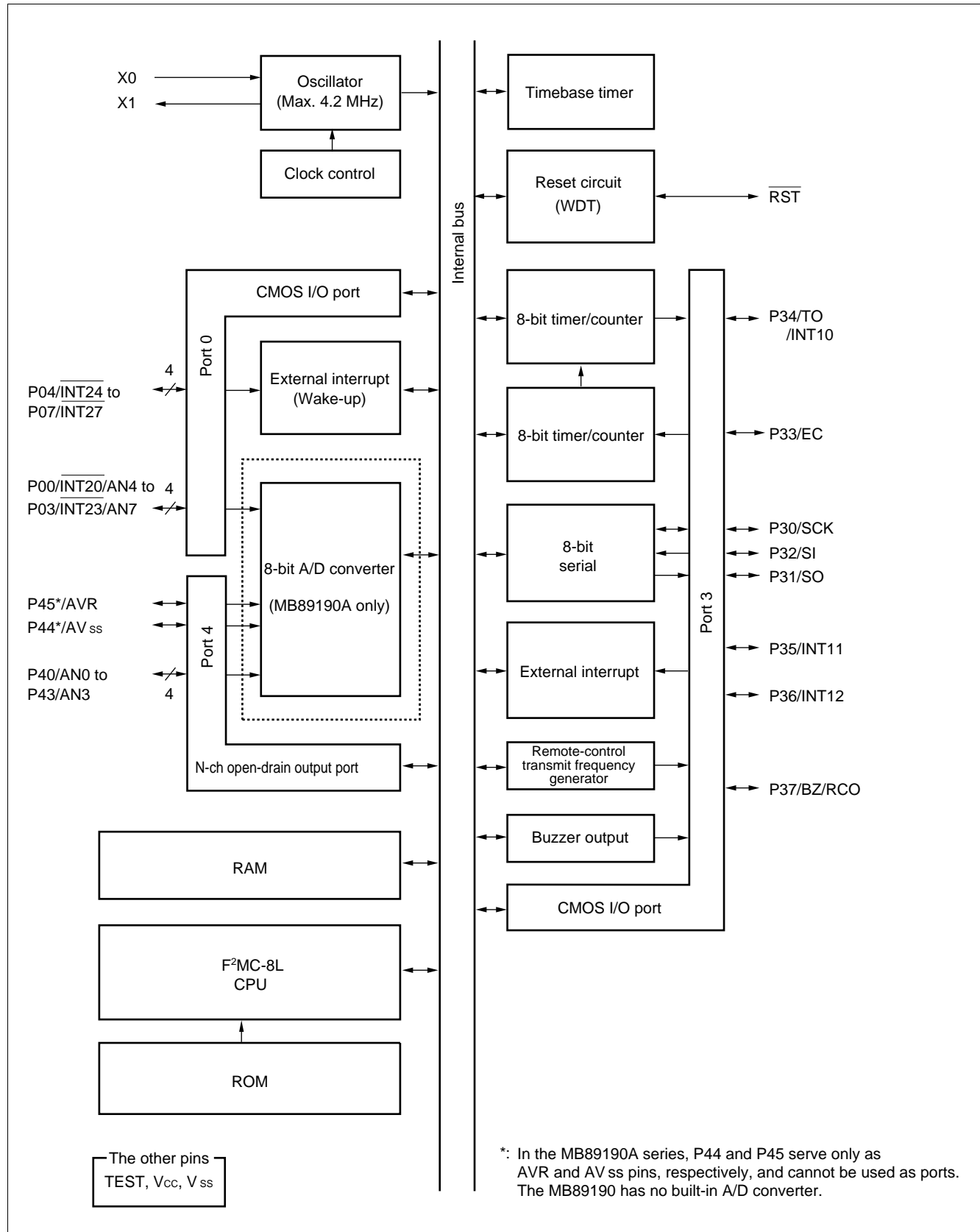P45*/AVR
P44*/AV ss

Port 4

P40/AN0 to
P43/AN3

4

N-ch open-drain output port

RAM

F^{2}MC-8L
CPU

ROM

8-bit timer/counter

P34/TO
/INT10

8-bit timer/counter

P33/EC

8-bit
serial

P30/SCK
P32/SI
P31/SO

Port 3

External interrupt

P35/INT11

P36/INT12

Remote-control
transmit frequency
generator

P37/BZ/RCO

Buzzer output

CMOS I/O port

The other pins
TEST, V$_{CC}$, V ss

*: In the MB89190A series, P44 and P45 serve only as
AVR and AV ss pins, respectively, and cannot be used as ports.
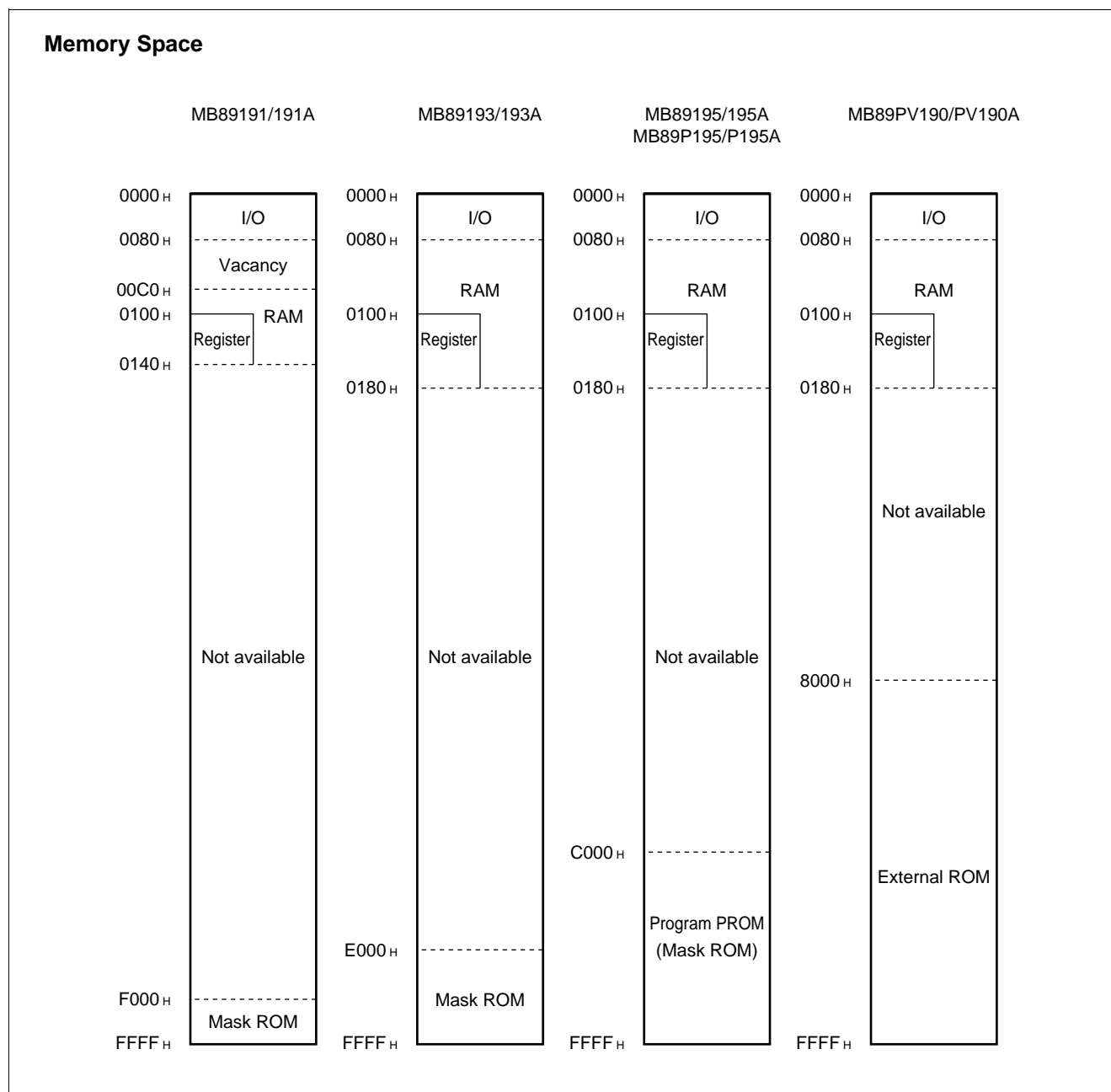The MB89190 has no built-in A/D converter.

■ 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:

Memory Space

|	MB89191/191A	MB89193/193A	MB89195/195A MB89P195/P195A	MB89PV190/PV190A
0000 H	I/O	I/O	I/O	I/O
0080 H	Vacancy	RAM	RAM	RAM
00C0 H				
0100 H	RAM / Register	Register	Register	Register
0140 H				
0180 H				
	Not available	Not available	Not available	Not available
8000 H				
C000 H			Program PROM (Mask ROM)	External ROM
E000 H		Mask ROM		
F000 H	Mask ROM			
FFFF H				

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2. Registers

The F^{2}MC-8L family has two types of registers; dedicated hardware registers and general-purpose memory registers. The following dedicated registers are provided:

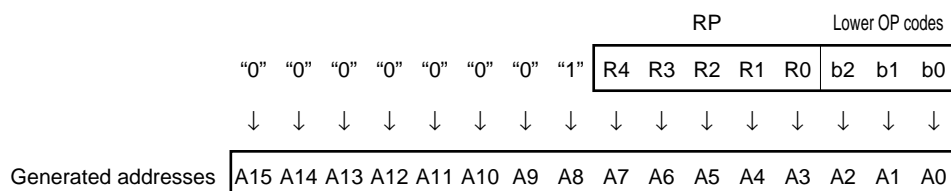|	
Program counter (PC):	A 16-bit-long register for indicating the instruction storage positions
Accumulator (A):	A 16-bit-long temporary register for arithmetic operations, etc. When the instruction is an 8-bit data processing instruction, the lower byte is used.
Temporary accumulator (T):	A 16-bit-long 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
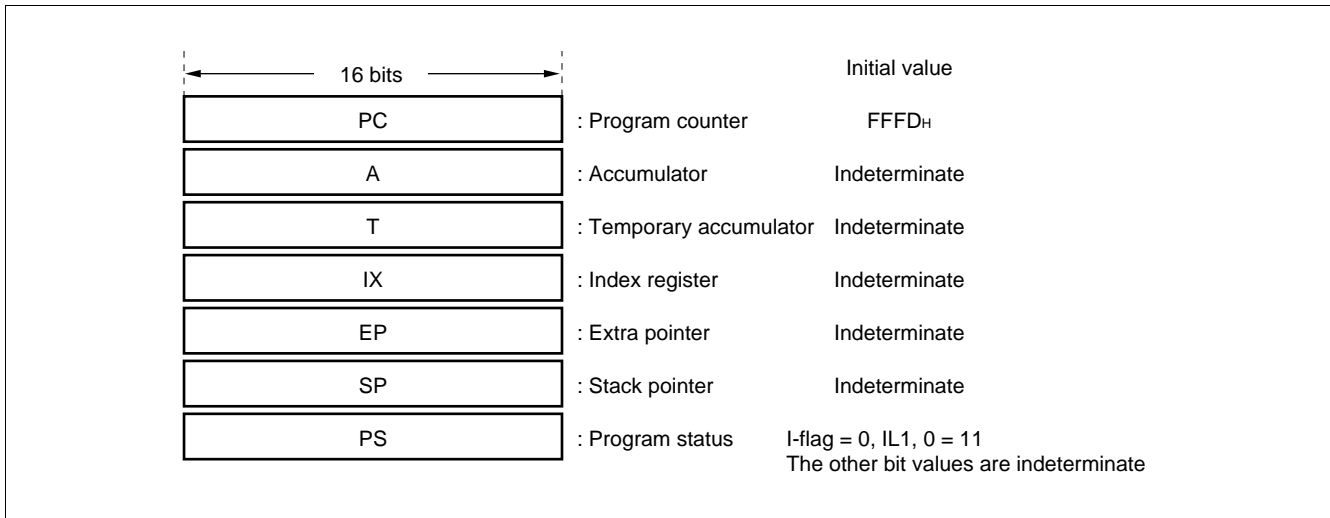
The PS can further be divided into higher 8 bits for use as a register bank pointer (RP) and the lower 8 bits for use as a condition code register (CCR) (see the diagram below).

Structure of the Program Status Register
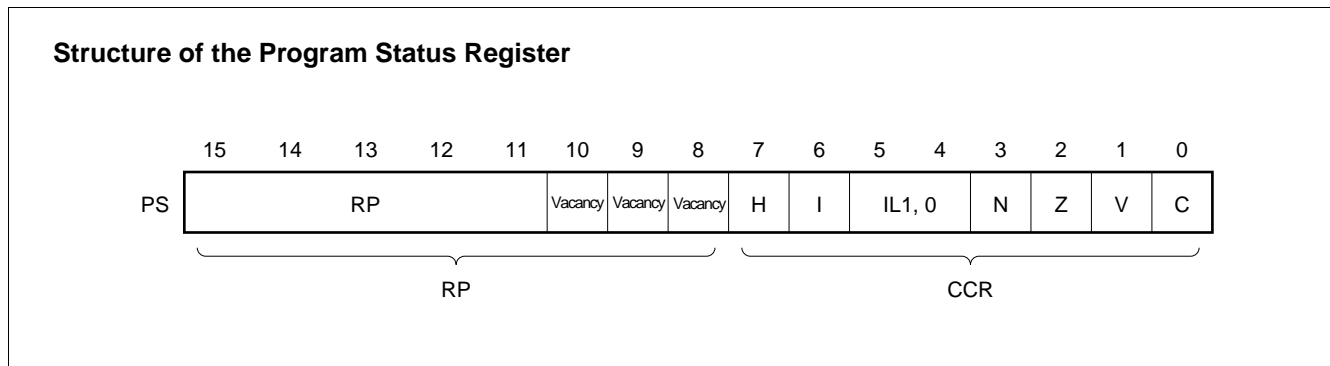
The RP indicates the address of the register bank currently in use. The relationship between the pointer contents and the actual address is based on the conversion rule illustrated below.

Rule for Conversion of Actual Addresses of the General-purpose Register Area

								RP					Lower OP codes		
"0"	"0"	"0"	"0"	"0"	"0"	"0"	"1"	R4	R3	R2	R1	R0	b2	b1	b0
↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓

Generated addresses

A15	A14	A13	A12	A11	A10	A9	A8	A7	A6	A5	A4	A3	A2	A1	A0

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 to '1' when a carry or a borrow from bit 3 to bit 4 occurs as a result of an arithmetic operation. Cleared to '0' otherwise. This flag is for decimal adjustment instructions.

I-flag: Interrupt is enabled when this flag is set to '1'. Interrupt is disabled when the flag is cleared to '0'. Cleared to '0' at the reset.

IL1, 0: Indicates the level of the interrupt currently allowed. Processes an interrupt only if its request level is higher than the value indicated by this bit.

IL1	IL0	Interrupt level	High-low
0	0	1	High
0	1		
1	0	2	
1	1	3	Low

N-flag: Set to '1' if the MSB becomes '1' as the result of an arithmetic operation. Cleared to '0' otherwise.

Z-flag: Set to '1' when an arithmetic operation results in 0. Cleared to '0' otherwise.

V-flag: Set to '1' if the complement on '2' overflows as a result of an arithmetic operation. Cleared to '0' if the overflow does not occur.

C-flag: Set to '1' when a carry or a borrow from bit 7 occurs as a result of an arithmetic operation. Cleared to '0' otherwise. Set to '1' the shift-out value in the case of a shift instruction.
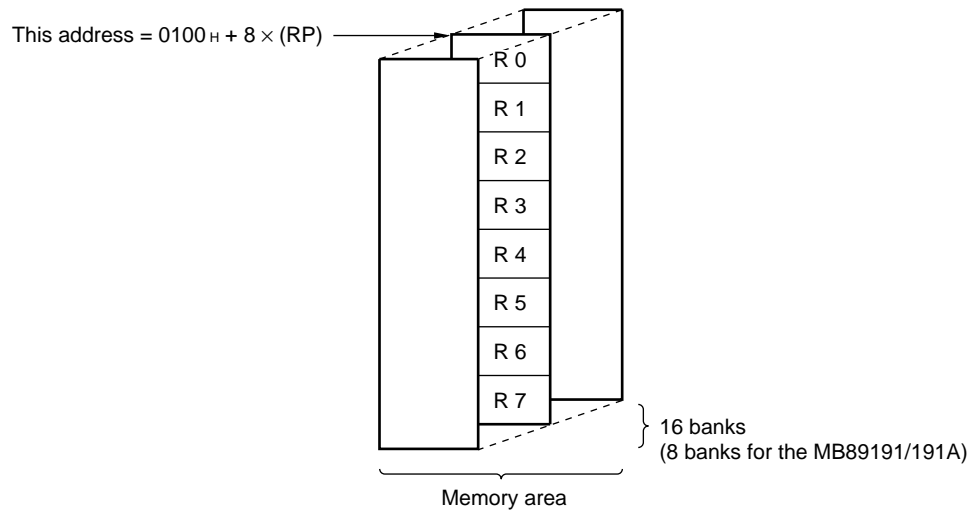
The following general-purpose registers are provided:

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

This address = $0100_H + 8 \times (RP)$

| R 0 |
| R 1 |
| R 2 |
| R 3 |
| R 4 |
| R 5 |
| R 6 |
| R 7 |

16 banks
(8 banks for the MB89191/191A)

Memory area

■ I/O MAP

Address	Read/write	Register name	Register description
00H	(R/W)	PDR0	Port 0 data register
01H	(W)	DDR0	Port 0 data direction register
02H	(R/W)	ENI0	Port 0 input enable register
03H to 07H			Vacancy
08H	(R/W)	STBC	Standby control register
09H	(R/W)	WDTC	Watchdog control register
0AH	(R/W)	TBTC	Time-base timer control register
0BH			Vacancy
0CH	(R/W)	PDR3	Port 3 data register
0DH	(W)	DDR3	Port 3 data direction register
0EH	(R/W)	PDR4	Port 4 data register
0FH	(R/W)	BUZR	Buzzer register
10H to 13H			Vacancy
14H	(R/W)	RCR1	Remote-control transmit control register 1
15H	(R/W)	RCR2	Remote-control transmit control register 2
16H			Vacancy
17H			Vacancy
18H	(R/W)	T2CR	Timer 2 control register
19H	(R/W)	T1CR	Timer 1 control register
1AH	(R/W)	T2DR	Timer 2 data register
1BH	(R/W)	T1DR	Timer 1 data register
1CH	(R/W)	SMR	Serial mode register
1DH	(R/W)	SDR	Serial data register
1EH			Vacancy
1FH			Vacancy
20H	(R/W)	ADC1	A/D converter control register 1
21H	(R/W)	ADC2	A/D converter control register 2
22H	(R/W)	ADCD	A/D converter data register
23H	(R/W)	EIC1	External interrupt control register 1
24H	(R/W)	EIC2	External interrupt control register 2
25H to 31H			Vacancy
32H	(R/W)	EIE2	External interrupt 2 enable register
33H	(R/W)	EIF2	External interrupt 2 flag register
34H to 7BH			Vacancy
7CH	(W)	ILR1	Interrupt level register 1
7DH	(W)	ILR2	Interrupt level register 2
7EH	(W)	ILR3	Interrupt level register 3
7FH			Vacancy

Note: Do not use vacancies.

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Rating

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

| Parameter	Symbol	Value Min.	Value Max.	Unit	Remarks
Power supply voltage	V_{CC}	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	
	AVR	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	Must not exceed $V_{CC} + 0.3$ V. MB89190A series only
EPROM program voltage	V_{PP}	$V_{SS} - 0.3$	$V_{SS} + 13.0$	V	MB89P195/P195A only
Input voltage	V_I	$V_{SS} - 0.3$	$V_{CC} + 0.3$	V	
Output voltage	V_O	$V_{SS} - 0.3$	$V_{CC} + 0.3$	V	
"L" level maximum output current	I_{OL1}	—	10	mA	Except P33 and P34 (Except P30 toP34 and P40 to P43 for MB89191AH/193AH)
	I_{OL2}	—	20	mA	P33, P34(P30 toP34 and P40 to P43 for MB89191AH/193AH)
"L" level average output current	I_{OLAV1}	—	4	mA	Except P33 and P34 (Except P30 toP34 and P40 to P43 for MB89191AH/193AH) Average value (operating current $\times$ operation rate)
	I_{OLAV2}	—	8	mA	P33 and P34(P30 toP34 and P40 to P43 for MB89191AH/193AH) Average value (operating current $\times$ operation rate)
"L" level total average output current	ΣI_{OLAV}	—	20	mA	Average value (operating current $\times$ operation rate)
"L" level total maximum output current	ΣI_{OL}	—	100	mA	
"H" level maximum output current	I_{OH1}	—	-10	mA	Except P33, P34, and P37
	I_{OH2}	—	-20	mA	P33, P34, P37
"H" level average output current	I_{OHAV1}	—	-2	mA	Except P33, P34, and P37 Average value (operating current $\times$ operation rate)
	I_{OHAV2}	—	-4	mA	Except P33, P34, and P37 Average value (operating current $\times$ operation rate)
"H" level total average output current	ΣI_{OHAV}	—	-10	mA	Average value (operating current $\times$ operation rate)
"H" level total maximum output current	ΣI_{OH}	—	-30	mA	
Power consumption	P_D	—	200	mW	
Operating temperature	Ta	-40	$+85$	°C	
Storage temperature	Tstg	-55	$+150$	°C	

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

2. Recommended Operating Conditions

(V_{SS} = 0.0 V)

Parameter	Symbol	Value		Unit	Remarks
		Min.	Max.		
Power supply voltage	V_{CC}	2.2*	6.0*	V	Normal operation assurance range* 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_{CC}	V	
Operating temperature	T_A	−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."
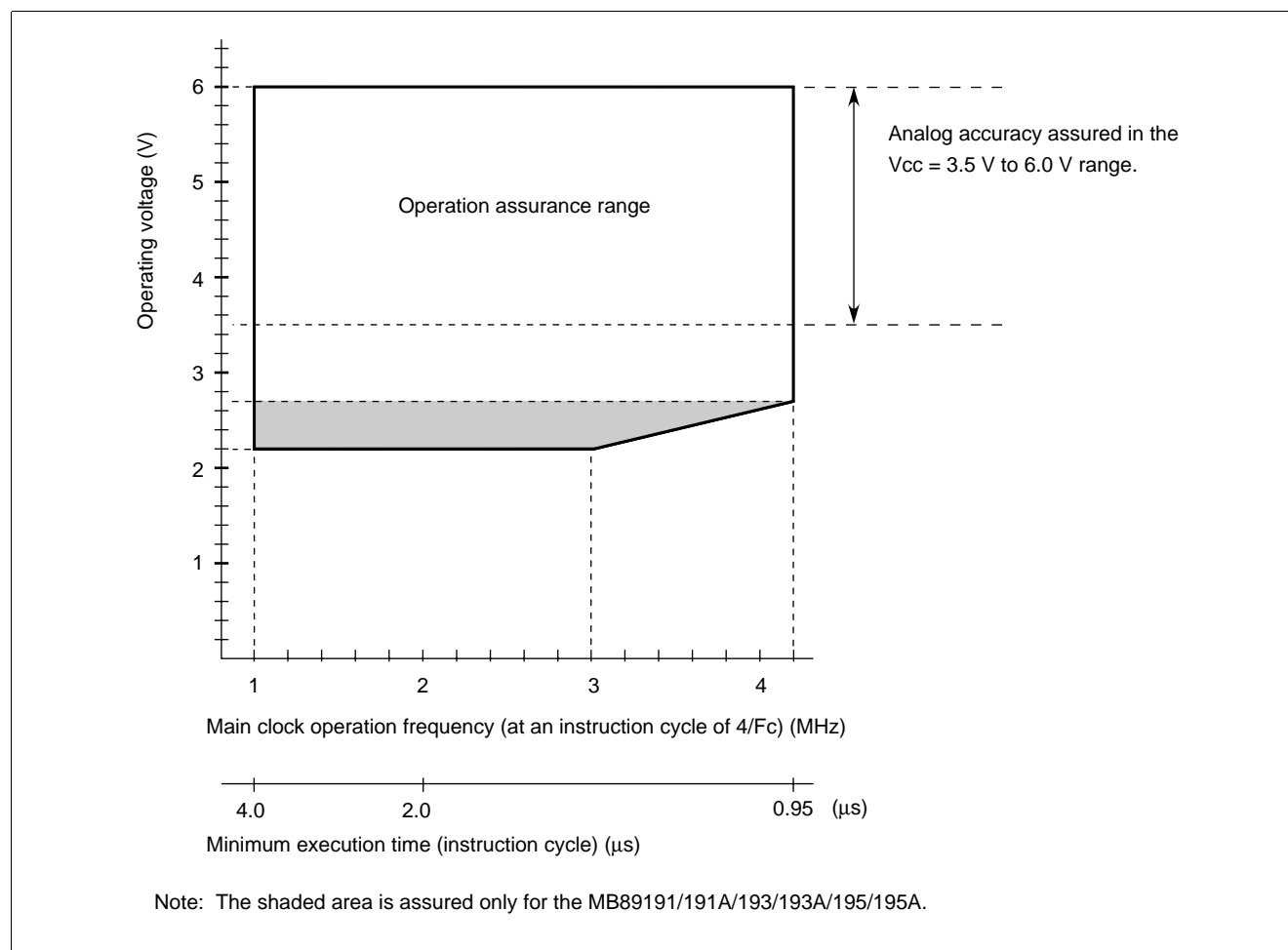
Figure 1   Operating Voltage vs. Main Clock Operating Frequency

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

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

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

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	$I_{OH} = -2.0$ mA	2.4	—	—	V	
	V_{OH2}	P33, P34	$I_{OH} = -15$ mA	2.4	—	—	V	
	V_{OH3}	P37	$I_{OH} = -7.0$ mA	2.4	—	—	V	
"L" level output voltage	V_{OL1}	P00 to P07, P40 to P45, P30 to P32, P35 to P37	$I_{OL} = 1.8$ mA	—	—	0.4	V	Except MB89191AH/ 193AH
		P00 to P07, P35 to P37						MB89191AH/ 193AH
	V_{OL2}	$\overline{RST}$	$I_{OL} = 4.0$ mA	—	—	0.4	V	
	V_{OL3}	P33, P34	$I_{OL} = 12$ mA	—	—	0.4	V	Except MB89191AH/ 193AH
		P30 to P34, P40 to P43						MB89191AH/ 193AH
Input leakage current(Hi-z output leakage current)	I_{LI1}	P00 to P07, P30 to P37, TEST	$0.0 \text{ V} < V_I < V_{CC}$	—	—	±5	µA	Without pull-up resistor
Open-drain output leakage current (Off state)	I_{LD1}	P40 to P45	$0.0 \text{ V} < V_I < V_{CC}$	—	—	±1	µA	Without pull-up resistor

(Continued)

(Continued)

(Vcc = 5.0 V, AVss = Vss = 0.0 V, TA = –40°C to +85°C)

Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Pull-up resistance	R$_{PULL}$	P00 to P07, P30 to P37, P40 to P45, $\overline{RST}$	V$_I$ = 0.0 V	25	50	100	kΩ	
Power supply voltage*	I$_{CC}$	V$_{CC}$	F$_C$ = 4.2 MHz	—	5	10	mA	MB89191/ 191A/193/ 193A/195/ 195A/PV190/ PV190A
				—	7	12	mA	MB89P195/ P195A
	I$_{CCS}$		F$_C$ = 4.2 MHz	—	3	7	mA	Sleep mode
	I$_{CCH}$		T$_A$ = +25 °C	—	—	1	μA	Stop mode
	I$_{CCA}$		F$_C$ = 4.2 MHz During A/D converter operation	—	6	13	mA	MB89191A/ 193A/195A/ PV190A
				—	8	15	mA	MB89P195A
Input capacitance	C$_{IN}$	Except AVR, AV$_{SS}$, V$_{CC}$, and V$_{SS}$	f = 1 MHz	—	10	—	pF	

* : For the MB89PV190/PV190A, the current consumption of a connected EPROM and ICE is not included.
The mesurement condition of the power supply current are set as V$_{CC}$ = 5.0 V with an external clock.
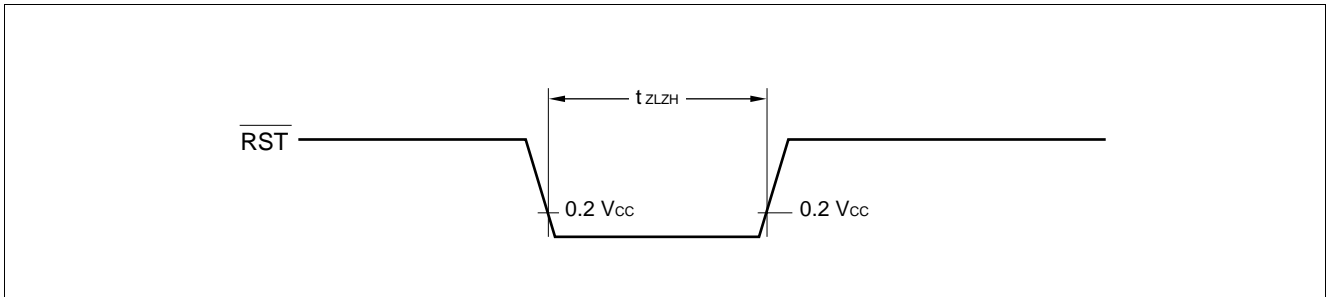
MB89190/190A Series

4. AC Characteristics

(1) Reset Timing

$(V_{CC} = +5.0\ V\pm10\%, AV_{SS} = V_{SS} = 0.0\ V, T_A = -40°C\ to\ +85°C)$

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

Note: t_{XCYL} is the oscillation period $(1/F_C)$ input to the X0 pin.

(2) Power-on Reset

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

Parameter	Symbol	Condition	Value Min.	Value Max.	Unit	Remarks
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.
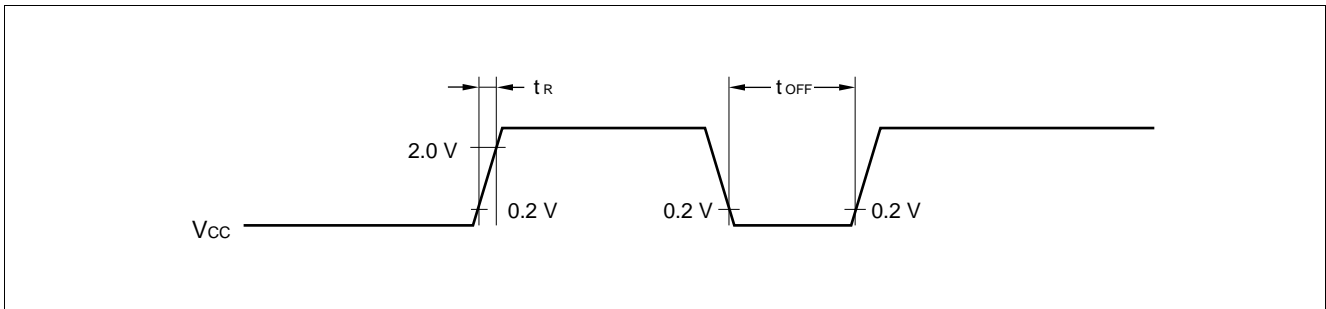
(3) Clock Timings

(AV$_{SS}$ = V$_{SS}$ = 0.0 V, T$_A$ = −40°C to +85°C)

Parameter	Symbol	Pin	Condition	Value Min.	Value Max.	Unit	Remarks
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 risilng/falling time	t$_{CR}$ t$_{CF}$	X0	—	—	10	ns	External clock

X0, X1 Timings and Conditions of Applied Voltage
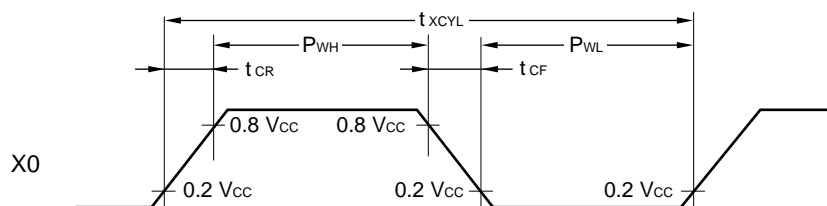
Clock Conditions
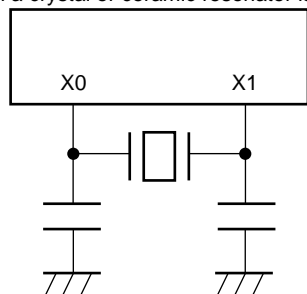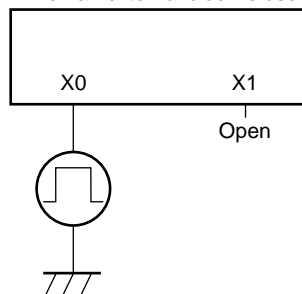
(4) Instruction Cycles

(AV$_{SS}$ = V$_{SS}$ = 0.0 V, T$_A$ = −40°C to +85°C)

Parameter	Symbol	Value (typical)	Unit	Remarks
Instruction cycle (minimum execution time)	t$_{inst}$	4/F$_C$	μs	t$_{inst}$ = 0.95 μs when operating at F$_C$ = 4.2 MHz

(5) Recommended Resonator Manufacturers

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

*1: Fujitsu Acoustic Resonator
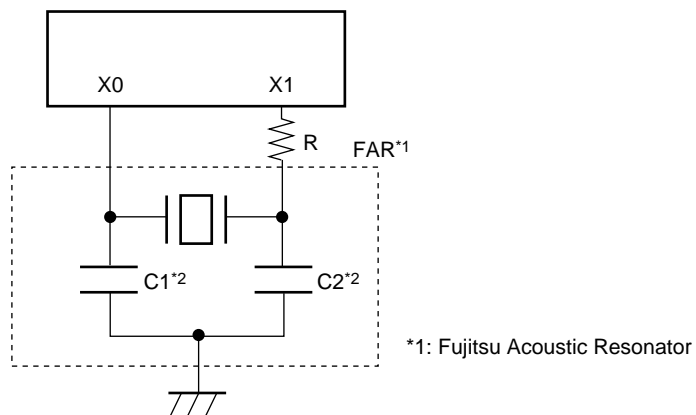
FAR part number (built-in capacitor type)	Frequency (MHz)	Dumping resistor	Initial deviation of FAR frequency (T_A = +25°C)	Temperature characteristics of FAR frequency (T_A = −20°C to +60°C)	Loading capacitors*2
FAR-C4SA-04000-□01M	4.00	200 Ω	±0.5%	±0.5%	Built-in

Inquiry: FUJITSU LIMITED

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• **Sample Application of Ceramic Resonator**
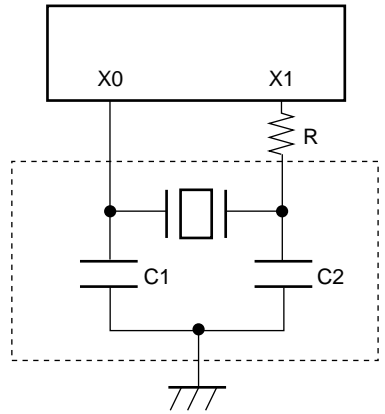
• Mask ROM products

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 kΩ
	CST3.20MGA		Built-in	Built-in	1 kΩ
	CSA3.20MGA040		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 Mnagement 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

(6) Serial I/O Timings

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

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

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

Internal Shift Clock Mode
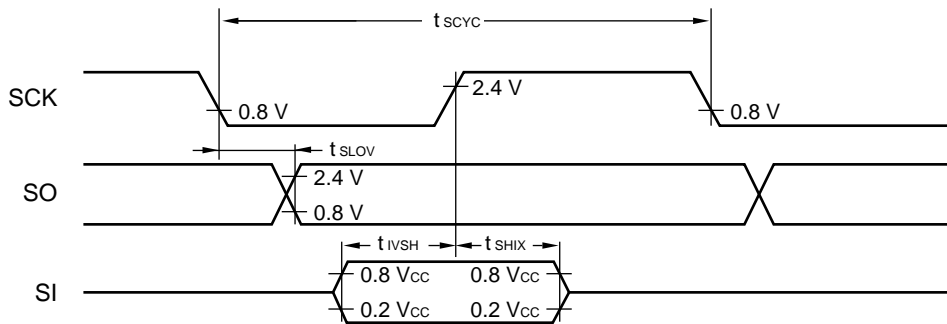
External Shift Clock Mode
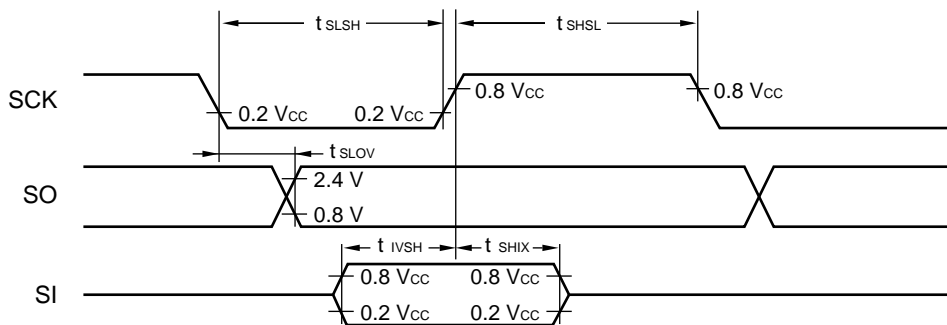
(7) Peripheral Input Timings

$(V_{CC} = 5.0\ V\pm10\%, AV_{SS} = V_{SS} = 0.0\ V, T_A = -40°C\ to\ +85°C)$

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}*	—	µs	
Peripheral input "L" pulse width 1	t_{IHIL1}		2 t_{inst}*	—	µs	

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

Peripheral Input Timing Diagram

EC
INT10 to INT12
INT20 to INT27
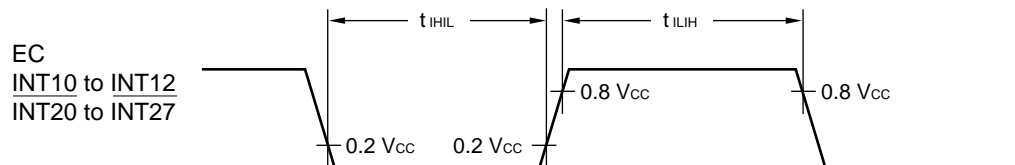
$(V_{CC} = 5.0\ V\pm10\%, AV_{SS} = V_{SS} = 0.0\ V, T_A = -40°C\ to\ +85°C)$

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

EC, SCK, S1
INT10 to INT12
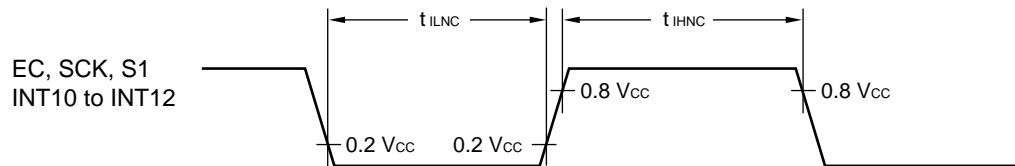
5. A/D Converter Electrical Characteristics (MB89190A Series Only)

(AV$_{CC}$ = V$_{CC}$ = 3.5 V to 6.0 V, AV$_{SS}$ = V$_{SS}$ = 0.0 V, T$_A$ = −40°C to +85°C)

Parameter	Sym-bol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Resolution	—	—	—	—	—	8	bit	
Total error			AVR = AV$_{CC}$	—	—	±1.5	LSB	
Linearity error				—	—	±1.0	LSB	
Differential linearity error				—	—	±0.9	LSB	
Zero transition voltage	V$_{OT}$			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$_{inst}$*	—	µs	
Sense mode conversion time				—	12 t$_{inst}$*	—	µs	
Analog port input current	I$_{AIN}$	AN0 to AN7		—	—	10	µA	
Analog input voltage	—			0	—	AVR	V	
Reference voltage		AVR		0	—	V$_{CC}$	V	
Reference voltage supply current	I$_R$		AVR = V$_{CC}$ = 5.0 V when A/D conversion is operating	—	100	300	µA	
	I$_{RH}$			—	—	1	µA	

* : 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" ↔ "0000 0001") with the full-scale transition point ("1111 1110" ↔ "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.

Digital output

Theoretical conversion value
Actual conversion value
(1LSB × N + V$_{OT}$)
Linearity error

$$1LSB = \frac{AVR}{256}$$

$$\text{Linearity error} = \frac{V_{NT} - (1LSB \times N + V_{OT})}{1LSB}$$

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

$$\text{Total error} = \frac{V_{NT} - (1LSB \times N + 1LSB)}{1LSB}$$

V$_{OT}$ V$_{NT}$ V$_{(N+1)T}$ V$_{FST}$ Analog input
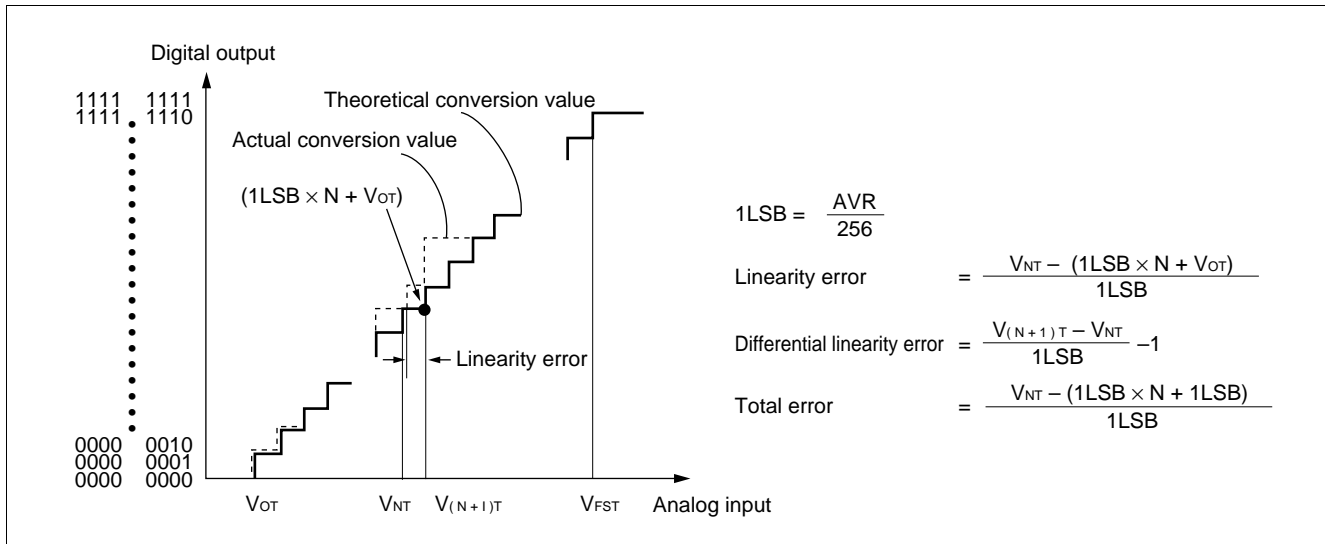
7. Notes on Using A/D Converter

- **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 kΩ).

  Note that if the impedance cannot be kept low, it is recommended to connect an external capacitor of approx. 0.1 μF for the analog input pin.

Analog input equivalent circuit

Sample hold circuit,
C ≒ 33 pF

Analog input pin

If the analog input impedance is higher than 10 kΩ, it is recommended to connect an external capacitor of approx. 0.1 μF.

Comparator

R ≒ 6 kΩ

Close for 8 instruction cycles after starting A/D conversion.

Analog channel selector
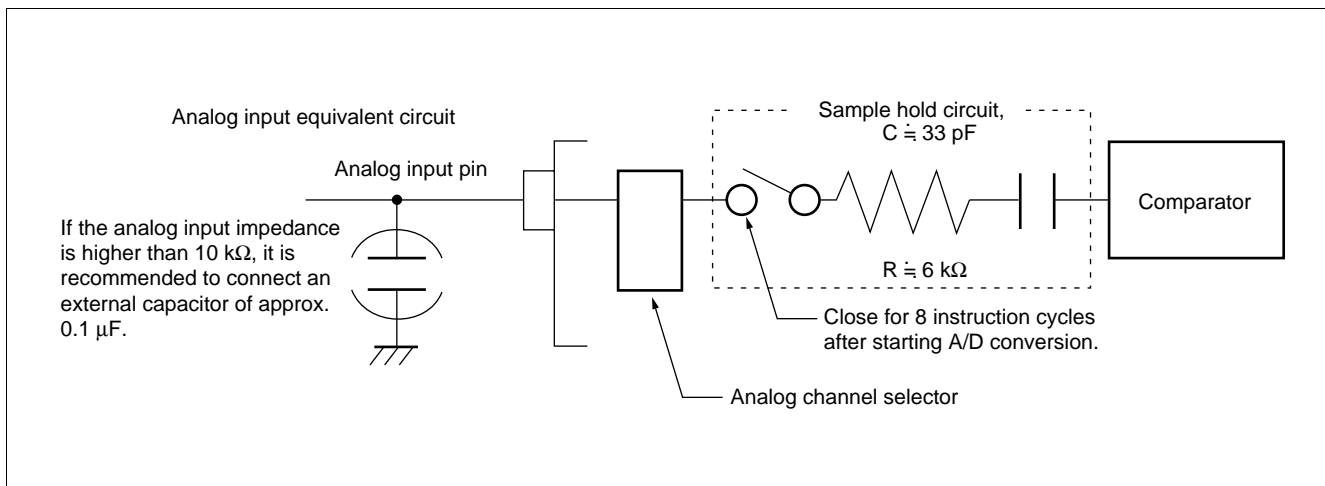
- **Error**

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

■ EXAMPLE CHARACTERISTICS

(1) "L" Level Output Voltage

$V_{OL}1$ vs. I_{OL}

V_{OL} (V)

$V_{CC} = 2.5$ V
$V_{CC} = 2.0$ V $V_{CC} = 3.0$ V
$V_{CC} = 4.0$ V
$V_{CC} = 5.0$ V
$V_{CC} = 6.0$ V
$T_A = +25°C$

I_{OL} (mA)

$V_{OL}2$ vs. I_{OL}

V_{OL} (V)

$V_{CC} = 2.5$ V
$V_{CC} = 2.0$ V $V_{CC} = 3.0$ V
$V_{CC} = 4.0$ V
$V_{CC} = 5.0$ V
$V_{CC} = 6.0$ V
$T_A = +25°C$

I_{OL} (mA)

$V_{OL}3$ vs. I_{OL}

V_{OL} (V)

$V_{CC} = 2.0$ V $V_{CC} = 2.5$ V
$T_A = +25°C$
$V_{CC} = 3.0$ V
$V_{CC} = 4.0$ V
$V_{CC} = 5.0$ V
$V_{CC} = 6.0$ V

I_{OL} (mA)

(2) "H" Level Output Voltage

$V_{OH}1$ vs. I_{OH}

V_{CC} - V_{OH} (V)

V_{CC} = 2.5 V V_{CC} = 4.0 V
V_{CC} = 2.0 V V_{CC} = 3.0 V

0.6
0.5
0.4
0.3
0.2
0.1
0.0

T_A = +25°C

V_{CC} = 5.0 V
V_{CC} = 6.0 V

0   − 1   − 2   − 3   − 4   − 5
I_{OH} (mA)

$V_{OH}2$ vs. I_{OH}

V_{CC} - V_{OH} (V)

3.0
2.5
2.0
1.5
1.0
0.5
0.0

T_A = +25°C
V_{CC} = 3.0 V
V_{CC} = 2.5 V
V_{CC} = 2.0 V

V_{CC} = 4.0 V
V_{CC} = 5.0 V
V_{CC} = 6.0 V

0   − 4   − 8   − 12   − 16   − 20
I_{OH} (mA)

$V_{OH}3$ vs. I_{OH}

V_{CC} - V_{OH} (V)

V_{CC} = 2.0 V V_{CC} = 2.5 V

1.2
1.0
0.8
0.6
0.4
0.2
0.0

T_A = + 25°C
V_{CC} = 3.0 V

V_{CC} = 4.0 V
V_{CC} = 5.0 V
V_{CC} = 6.0 V

0   − 2   − 4   − 6   − 8   − 10
I_{OH} (mA)

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

V_{IN} vs. V_{CC}

V_{IN} (V)

5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

T_A= +25°C

0   1   2   3   4   5   6   7
V_{CC} (V)
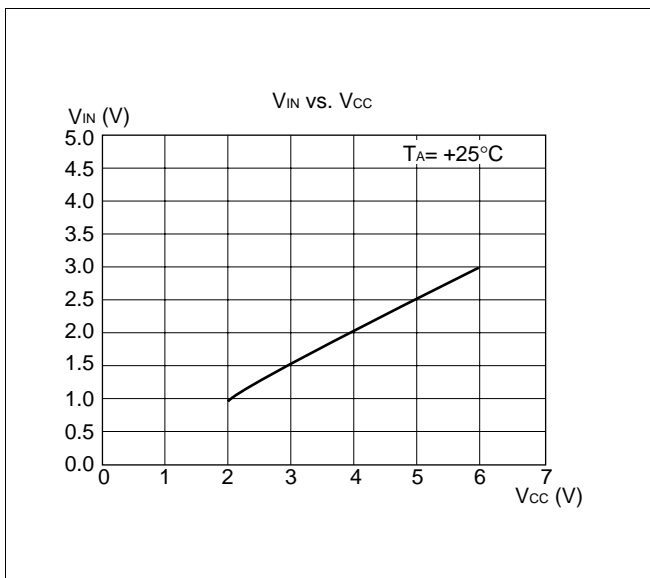
(4) "H" Level Input Voltage/"L" Level Input Voltage (Hysteresis Input)

V_{IN} vs. V_{CC}

V_{IN} (V)

5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0

T_A = +25°C

V_{IHS}
V_{ILS}

0   1   2   3   4   5   6   7
V_{CC} (V)
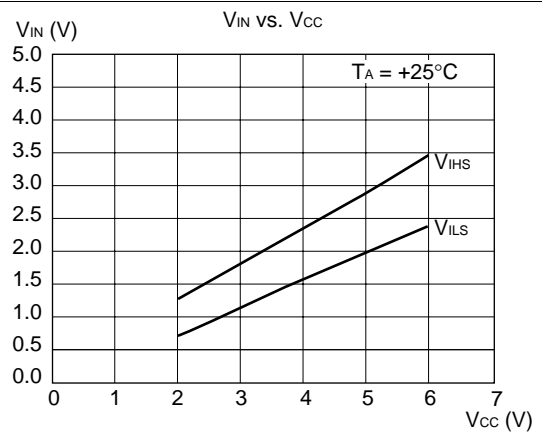
V_{IHS}: Threshold when input voltage in hysteresis characteristics is set to "H" level
V_{ILS}: Threshold when input voltage in hysteresis characteristics is set to "L" level

(5) Power Supply Current (External Clock)

I_CC (mA)   I_CC vs. V_CC

6
    T_A = +25°C
5
                                             Fc = 4.2 MHz
4
                                             Fc = 3.0 MHz
3

2
                                             Fc = 1.0 MHz
1

0
    1   2   3   4   5   6   7
                                             V_CC (V)

I_CCS (mA)   I_CCS vs. V_CC

1.50
    T_A = +25°C
1.25   Fc = 4.2 MHz

1.00   Fc = 3.0 MHz

0.75

0.50   Fc = 1.0 MHz

0.25

0.00
    1   2   3   4   5   6   7
                                             V_CC (V)

I_CCH (μA)   I_CCH vs. V_CC

2.0
1.8
    T_A = +25°C
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
    1   2   3   4   5   6   7
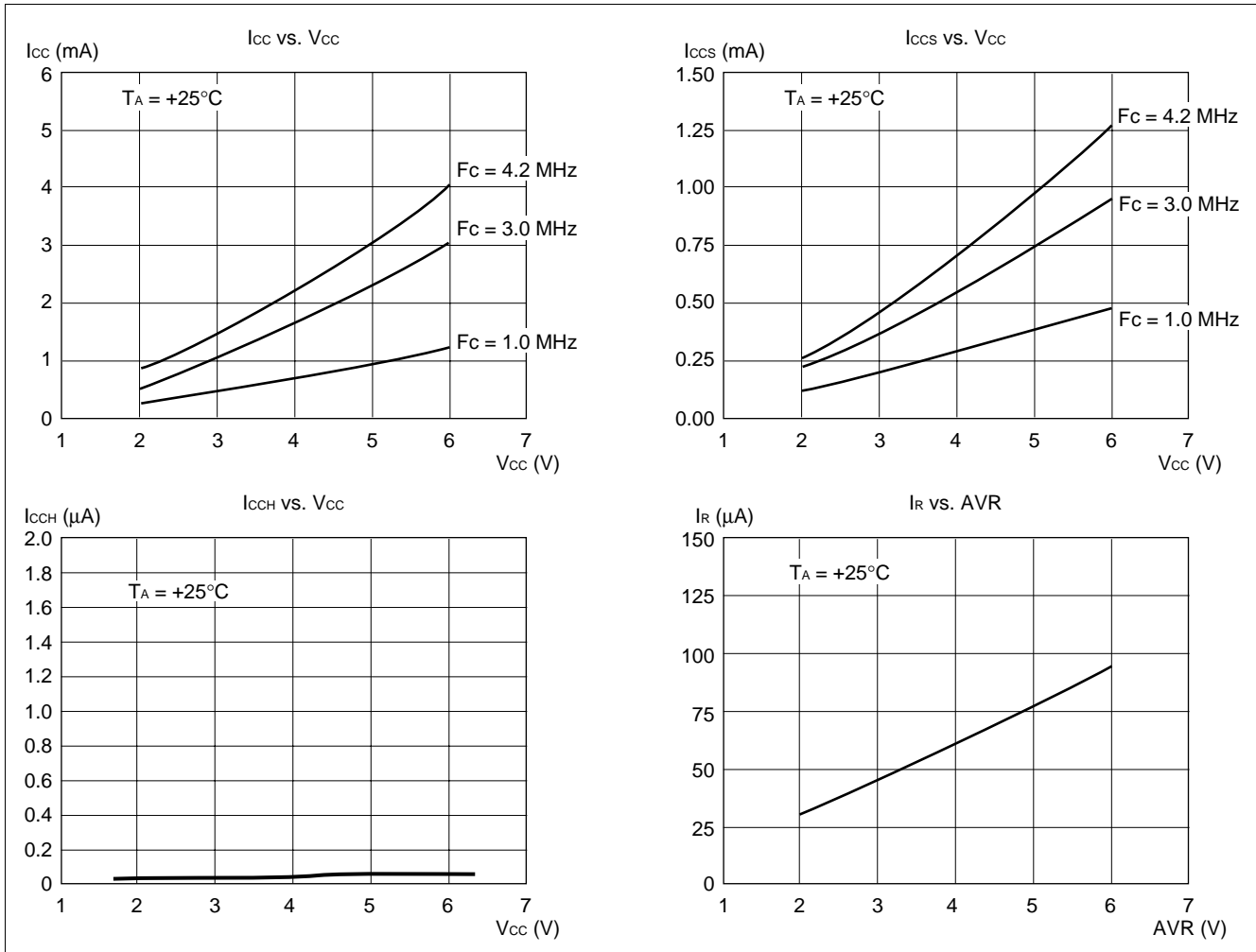   V_CC (V)

I_R (μA)   I_R vs. AVR

150
    T_A = +25°C
125

100

75

50

25

0
    1   2   3   4   5   6   7
                                             AVR (V)

(6) Pull-up Resistance

R_PULL (kΩ)   R_PULL vs. V_CC

1000
                                             T_A = +25°C

100

10
    1   2   3   4   5   6
                                             V_CC (V)
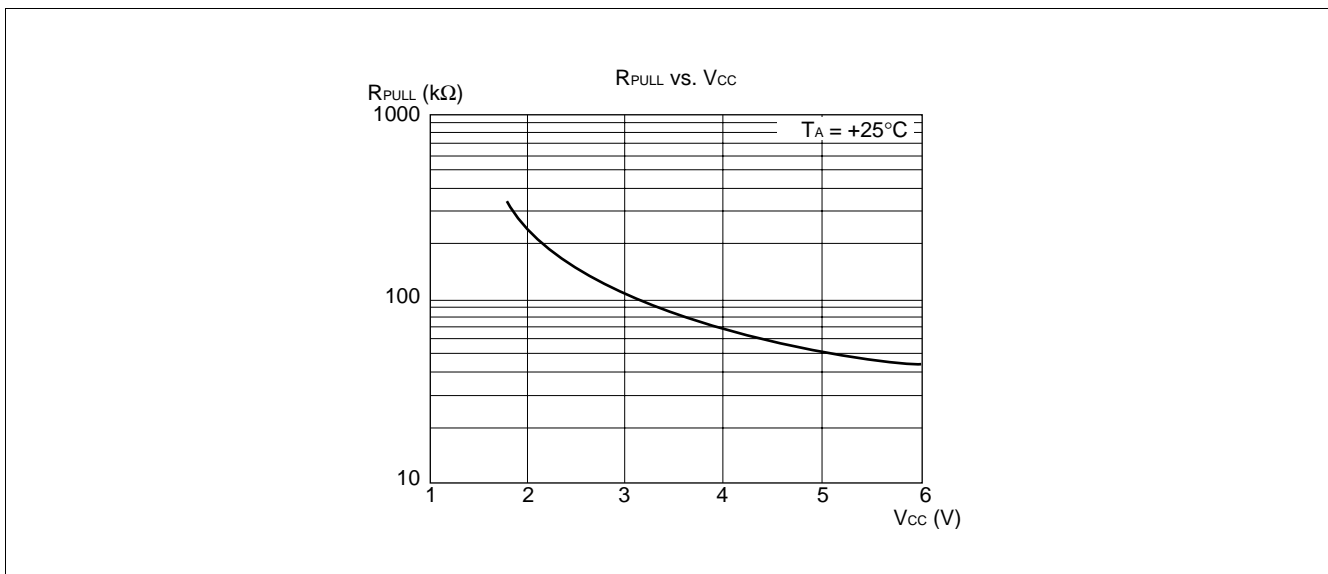
■ INSTRUCTIONS (136 INSTRUCTIONS)

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)
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)
$\times$	Indicates that the very $\times$ is the immediate data. (Whether its length is 8 or 16 bits is determined by the instruction in use.)
$(\times)$	Indicates that the contents of $\times$ is the target of accessing. (Whether its length is 8 or 16 bits is determined by the instruction in use.)
$((\times))$	The address indicated by the contents of $\times$ is the target of accessing. (Whether its length is 8 or 16 bits is determined by the instruction in use.)

37

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 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 prior to the instruction 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.

Table 2   Transfer Instructions (48 instructions)

Mnemonic	~	#	Operation	TL	TH	AH	N Z V C	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^{2}MC-8 family)

Table 3 Arithmetic Operation Instructions (62 instructions)

Mnemonic	~	#	Operation	TL	TH	AH	N Z V C	OP code
ADDC A,Ri	3	1	(A) ← (A) + (Ri) + C	–	–	–	+ + + +	28 to 2F
ADDC A,#d8	2	2	(A) ← (A) + d8 + C	–	–	–	+ + + +	24
ADDC A,dir	3	2	(A) ← (A) + (dir) + C	–	–	–	+ + + +	25
ADDC A,@IX +off	4	2	(A) ← (A) + ((IX) +off) + C	–	–	–	+ + + +	26
ADDC A,@EP	3	1	(A) ← (A) + ((EP)) + C	–	–	–	+ + + +	27
ADDCW A	3	1	(A) ← (A) + (T) + C	–	–	dH	+ + + +	23
ADDC A	2	1	(AL) ← (AL) + (TL) + C	–	–	–	+ + + +	22
SUBC A,Ri	3	1	(A) ← (A) − (Ri) − C	–	–	–	+ + + +	38 to 3F
SUBC A,#d8	2	2	(A) ← (A) − d8 − C	–	–	–	+ + + +	34
SUBC A,dir	3	2	(A) ← (A) − (dir) − C	–	–	–	+ + + +	35
SUBC A,@IX +off	4	2	(A) ← (A) − ((IX) +off) − C	–	–	–	+ + + +	36
SUBC A,@EP	3	1	(A) ← (A) − ((EP)) − C	–	–	–	+ + + +	37
SUBCW A	3	1	(A) ← (T) − (A) − C	–	–	dH	+ + + +	33
SUBC A	2	1	(AL) ← (TL) − (AL) − C	–	–	–	+ + + +	32
INC Ri	4	1	(Ri) ← (Ri) + 1	–	–	–	+ + + −	C8 to CF
INCW EP	3	1	(EP) ← (EP) + 1	–	–	–	− − − −	C3
INCW IX	3	1	(IX) ← (IX) + 1	–	–	–	− − − −	C2
INCW A	3	1	(A) ← (A) + 1	–	–	dH	+ + − −	C0
DEC Ri	4	1	(Ri) ← (Ri) − 1	–	–	–	+ + + −	D8 to DF
DECW EP	3	1	(EP) ← (EP) − 1	–	–	–	− − − −	D3
DECW IX	3	1	(IX) ← (IX) − 1	–	–	–	− − − −	D2
DECW A	3	1	(A) ← (A) − 1	–	–	dH	+ + − −	D0
MULU A	19	1	(A) ← (AL) × (TL)	–	–	dH	− − − −	01
DIVU A	21	1	(A) ← (T) / (AL),MOD → (T)	dL	00	00	− − − −	11
ANDW A	3	1	(A) ← (A) ∧ (T)	–	–	dH	+ + R −	63
ORW A	3	1	(A) ← (A) ∨ (T)	–	–	dH	+ + R −	73
XORW A	3	1	(A) ← (A) ∀ (T)	–	–	dH	+ + R −	53
CMP A	2	1	(TL) − (AL)	–	–	–	+ + + +	12
CMPW A	3	1	(T) − (A)	–	–	–	+ + + +	13
RORC A	2	1	→ C → A ⌐	–	–	–	+ + − +	03
ROLC A	2	1	⌐ C ← 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) ← (AL) ∀ (TL)	–	–	–	+ + R −	52
XOR A,#d8	2	2	(A) ← (AL) ∀ d8	–	–	–	+ + R −	54
XOR A,dir	3	2	(A) ← (AL) ∀ (dir)	–	–	–	+ + R −	55
XOR A,@EP	3	1	(A) ← (AL) ∀ ((EP))	–	–	–	+ + R −	57
XOR A,@IX +off	4	2	(A) ← (AL) ∀ ((IX) +off)	–	–	–	+ + R −	56
XOR A,Ri	3	1	(A) ← (AL) ∀ (Ri)	–	–	–	+ + R −	58 to 5F
AND A	2	1	(A) ← (AL) ∧ (TL)	–	–	–	+ + R −	62
AND A,#d8	2	2	(A) ← (AL) ∧ d8	–	–	–	+ + R −	64
AND A,dir	3	2	(A) ← (AL) ∧ (dir)	–	–	–	+ + R −	65

(Continued)

40

(Continued)

Mnemonic	~	#	Operation	TL	TH	AH	N Z V C	OP code
AND A,@EP	3	1	(A) ← (AL) ∧ ((EP))	–	–	–	+ + R –	67
AND A,@IX +off	4	2	(A) ← (AL) ∧ ((IX) +off)	–	–	–	+ + R –	66
AND A,Ri	3	1	(A) ← (AL) ∧ (Ri)	–	–	–	+ + R –	68 to 6F
OR A	2	1	(A) ← (AL) ∨ (TL)	–	–	–	+ + R –	72
OR A,#d8	2	2	(A) ← (AL) ∨ d8	–	–	–	+ + R –	74
OR A,dir	3	2	(A) ← (AL) ∨ (dir)	–	–	–	+ + R –	75
OR A,@EP	3	1	(A) ← (AL) ∨ ((EP))	–	–	–	+ + R –	77
OR A,@IX +off	4	2	(A) ← (AL) ∨ ((IX) +off)	–	–	–	+ + R –	76
OR A,Ri	3	1	(A) ← (AL) ∨ (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) ← (SP) + 1	–	–	–	– – – –	C1
DECW SP	3	1	(SP) ← (SP) – 1	–	–	–	– – – –	D1

Table 4   Branch Instructions (17 instructions)

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

Table 5   Other Instructions (9 instructions)

Mnemonic	~	#	Operation	TL	TH	AH	N Z V C	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

■ 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	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 SP,A	MOVW A,SP
2	ROLC A	CMP A	ADDC A	SUBC A	XCH A,T	XOR A	AND A	OR A	MOV @A,T	MOV A,@A	CLRB dir:2	BBC dir:2,rel	INCW IX	DECW IX	MOVW IX,A	MOVW A,IX
3	RORC A	CMPW A	ADDCW A	SUBCW A	XCHW A,T	XORW A	ANDW A	ORW A	MOVW @A,T	MOVW A,@A	CLRB dir:3	BBC dir:3,rel	INCW EP	DECW EP	MOVW EP,A	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	DAS	CLRB dir:4	BBC dir:4,rel	MOVW A,ext	MOVW ext,A	MOVW A,#d16	XCHW A,PC
5	MOV A,dir	CMP A,dir	ADDC A,dir	SUBC A,dir	MOV dir,A	XOR A,dir	AND A,dir	OR A,dir	MOV dir,#d8	CMP dir,#d8	CLRB dir:5	BBC dir:5,rel	MOVW A,dir	MOVW dir,A	MOVW SP,#d16	XCHW A,SP
6	MOV A,@IX+d	CMP A,@IX+d	ADDC A,@IX+d	SUBC A,@IX+d	MOV @IX+d,A	XOR A,@IX+d	AND A,@IX+d	OR A,@IX+d	MOV @IX+d,#d8	CMP @IX+d,#d8	CLRB dir:6	BBC dir:6,rel	MOVW A,@IX+d	MOVW @IX+d,A	MOVW IX,#d16	XCHW A,IX
7	MOV A,@EP	CMP A,@EP	ADDC A,@EP	SUBC A,@EP	MOV @EP,A	XOR A,@EP	AND A,@EP	OR A,@EP	MOV @EP,#d8	CMP @EP,#d8	CLRB dir:7	BBC dir:7,rel	MOVW A,@EP	MOVW @EP,A	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	MOV R0,#d8	CMP R0,#d8	SETB dir:0	BBS dir:0,rel	INC R0	DEC R0	CALLV #0	BNC rel
9	MOV A,R1	CMP A,R1	ADDC A,R1	SUBC A,R1	MOV R1,A	XOR A,R1	AND A,R1	OR A,R1	MOV R1,#d8	CMP R1,#d8	SETB dir:1	BBS dir:1,rel	INC R1	DEC R1	CALLV #1	BC rel
A	MOV A,R2	CMP A,R2	ADDC A,R2	SUBC A,R2	MOV R2,A	XOR A,R2	AND A,R2	OR A,R2	MOV R2,#d8	CMP R2,#d8	SETB dir:2	BBS dir:2,rel	INC R2	DEC R2	CALLV #2	BP rel
B	MOV A,R3	CMP A,R3	ADDC A,R3	SUBC A,R3	MOV R3,A	XOR A,R3	AND A,R3	OR A,R3	MOV R3,#d8	CMP R3,#d8	SETB dir:3	BBS dir:3,rel	INC R3	DEC R3	CALLV #3	BN rel
C	MOV A,R4	CMP A,R4	ADDC A,R4	SUBC A,R4	MOV R4,A	XOR A,R4	AND A,R4	OR A,R4	MOV R4,#d8	CMP R4,#d8	SETB dir:4	BBS dir:4,rel	INC R4	DEC R4	CALLV #4	BNZ rel
D	MOV A,R5	CMP A,R5	ADDC A,R5	SUBC A,R5	MOV R5,A	XOR A,R5	AND A,R5	OR A,R5	MOV R5,#d8	CMP R5,#d8	SETB dir:5	BBS dir:5,rel	INC R5	DEC R5	CALLV #5	BZ rel
E	MOV A,R6	CMP A,R6	ADDC A,R6	SUBC A,R6	MOV R6,A	XOR A,R6	AND A,R6	OR A,R6	MOV R6,#d8	CMP R6,#d8	SETB dir:6	BBS dir:6,rel	INC R6	DEC R6	CALLV #6	BGE rel
F	MOV A,R7	CMP A,R7	ADDC A,R7	SUBC A,R7	MOV R7,A	XOR A,R7	AND A,R7	OR A,R7	MOV R7,#d8	CMP R7,#d8	SETB dir:7	BBS dir:7,rel	INC R7	DEC R7	CALLV #7	BLT rel

■ MASK OPTION LIST

No.	Part number		MB89191 MB89193 MB89195 MB89191A MB89193A MB89195A	MB89P195	MB89P195A		MB89PV190 MB89PV190A
	Specifying procedure		Specify when ordering masking	−101[*2]	Specify when ordering masking	−201[*2]	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 • Power-on reset provided • No power-on reset		Selectable	Provided	Provided	Provided	Provided
3	Selection of oscillation stabilization wait time (at 4.2 MHz)[*1] • $2^{18}/F_C$ (approx. 62.4 ms) • $2^{16}/F_C$ (approx. 15.6 ms) • $2^{12}/F_C$ (approx. 0.98 ms) • $2^{2}/F_C$ (approx. 0 ms)		Selectable	Fixed to $2^{16}/F_C$	Selectable	Fixed to $2^{16}/F_C$	Fixed to $2^{16}/F_C$
4	Reset pin output • Reset output provided • No reset output		Selectable	Provided	Selectable	Provided	Provided
5	Oscillation type of clock 1 Crystal and ceramic oscillators 2 CR		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_C" indicates the original oscillation frequency.

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

■ **ORDERING INFORMATION**

Part number	Package	Remarks
MB89191PF MB89193PF MB89195PF MB89P195PF-101 MB89191APF MB89191AHPF MB89193APF MB89193AHPF MB89195APF MB89P195APF-201	28-pin Plastic SOP (FPT-28P-M17)	
MB89191P-SH MB89193P-SH MB89195P-SH MB89191AP-SH MB89191AHP-SH MB89193AP-SH MB89193AHP-SH MB89195AP-SH	28-pin Plastic SH-DIP (DIP-28C-M03)	
MB89191P MB89193P MB89195P MB89P195P-101 MB89191AP MB89191AHP MB89193AP MB89193AHP MB89195AP MB89P195AP-201	28-pin Plastic DIP (DIP-28P-M05)	
MB89PV190CF MB89PV190ACF	48-pin Ceramic MQFP (MQP-48C-P01)	

■ **PACKAGE DIMENSION**

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

Dimensions in mm (inches)
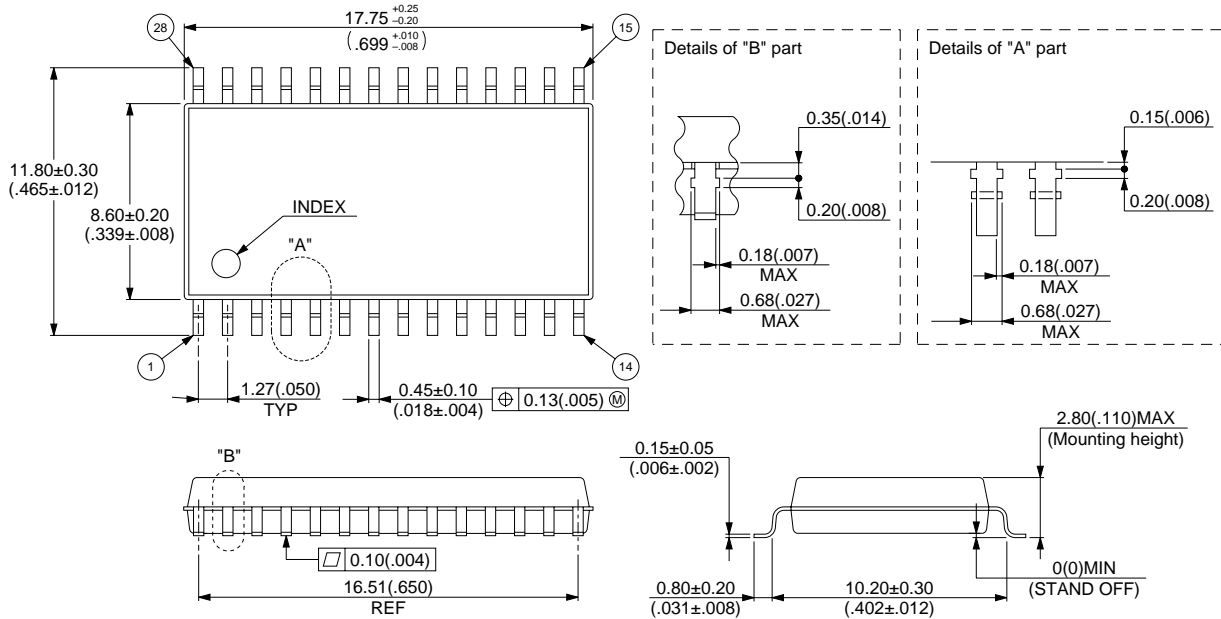
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28-pin Plastic DIP
(DIP-28P-M05)

Dimensions in mm (inches)

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MB89190/190A Series

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

INDEX-1

INDEX-2

$26.00^{+0.20}_{-0.30}$
$\left(1.024^{+.008}_{-.012}\right)$

9.10 ± 0.25
$(.358\pm.010)$

4.85(.191)MAX

3.00(.118)MIN

$1.00^{+0.50}_{-0}$
$\left(.039^{+.020}_{-0}\right)$

1.778 ± 0.18
$(.070\pm.007)$

1.778(.070)
MAX

23.114(.910)REF

0.51(.020)MIN

0.25 ± 0.05
$(.010\pm.002)$

0.45 ± 0.10
$(.018\pm.004)$

10.16(.400)
TYP

15°MAX

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Dimensions in mm (inches)

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

PIN No.1 INDEX

17.20(.677)TYP

15.00 ± 0.25
$(.591\pm.010)$

14.82 ± 0.35
$(.583\pm.014)$

1.02 ± 0.13
$(.040\pm.005)$

$10.92^{+0.13}_{-0.0}$
$\left(.430^{+.005}_{-0}\right)$

7.14(.281)
TYP

8.71(.343)
TYP

0.30(.012)TYP

PAD No.1 INDEX

4.50(.177)TYP

1.50(.059)TYP

1.00(.040)TYP

8.80(.346)REF

0.80 ± 0.22
$(.0315\pm.0087)$

PIN No.1 INDEX

$1.10^{+0.45}_{-0.25}$
$\left(.043^{+.018}_{-.010}\right)$

0.40 ± 0.08
$(.016\pm.003)$

0.60(.024)TYP

8.50(.335)MAX

0.15 ± 0.05
$(.006\pm.002)$

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Dimensions in mm (inches)

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