FUJITSU SEMICONDUCTOR
DATA SHEET

DS07-12509-6E

8-bit Proprietary Microcontroller

CMOS

F²MC-8L MB89120/120A Series

MB89121/P131/123A/P133A/125A/P135A/ MB89PV130A

■ DESCRIPTION

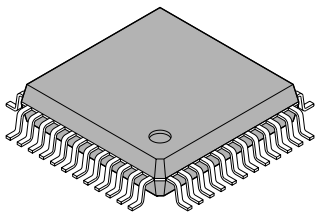
The MB89120 series is a line of single-chip microcontrollers containing a compact instruction set and a great variety of peripheral functions such as a timer, serial interface, and external interrupt. The MB89120A series is an extended variant of the MB89120, with a remote control transmission function and wake-up interrupt channels.

■ FEATURES

- F²MC-8L family CPU core
- Low-voltage operation
- Low current consumption (allowing for dual clock)
- Minimum execution time : 0.95 µs at 4.2 MHz
- 21-bit timebase counter
- I/O ports : Max. 36 ports
- External interrupts : 3 channels
- External interrupts (wake-up function) : 8 channels (only in the MB89120A series)
- 8-bit serial I/O : 1 channel
- 8-/16-bit timer/counter : 1 channel
- Built-in remote-control transmitting frequency generator (only in the MB89120A series)
- Low-power consumption modes (stop mode, sleep mode, watch mode)
- Package : QFP-48
- CMOS technology

■ PACKAGE

48-pin plastic QFP



(FPT-48P-M13)

■ PRODUCT LINEUP

Item \ Part number	MB89121	MB89123A	MB89125A	MB89P133A	MB89P131
Classification	Mass-produced products (Mask ROM products)			One-time products	
ROM size	4 K × 8 bits (internal mask ROM)	8 K × 8 bits (internal mask ROM)	16 K × 8 bits (internal mask ROM)	8 K × 8 bits (Internal PROM to be programmed with a general-purpose EPROM programmer)	4 K × 8 bits (Internal PROM to be programmed with a general-purpose EPROM programmer)
RAM size	128 × 8 bits	256 × 8 bits			128 × 8 bits
CPU functions	The number of instructions : 136 Instruction bit length : 8 bits Instruction length : 1 to 3 bytes Data bit length : 1, 8, 16 bits Minimum execution time : 0.95 µs at 4.2 MHz Minimum interrupt processing time : 8.57 µs at 4.2 MHz				
Ports	Output ports (N-ch open-drain) : 4 (All also serves as peripherals.) Output ports (CMOS) : 8 I/O ports (CMOS) : 24 (8 ports also serve as peripherals.) Total : 36				
Timer/counter	8-bit timer/counter × 2 channels or 16-bit event counter × 1 channel				
Serial I/O	8 bits LSB/MSB first selectable				
External interrupt 1	3 Independent channels (edge selection, interrupt vector, source flag) Rising edge/falling edge/both edges selectable Also for wake-up from stop/sleep mode (edge detection is also permitted in stop mode)				
External interrupt 2 (wake-up function)	—	8 channels (only for level detection)			—
Remote control transmitting frequency generator	—	1 channel (pulse width and frequency selectable by program)			—
Standby mode	Sleep mode, stop mode, watch mode				
Process	CMOS				
Operating voltage*	2.2 V to 4.0 V (with the dual clock option) 2.2 V to 6.0 V (with the single clock option)			2.7 V to 6.0 V	
EPROM for use	—				

* : Varies with conditions such as operating frequencies. (See "■ ELECTRICAL CHARACTERISTICS".)

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Part number / Item	MB89P135A	MB89PV130A
Classification	One-time PROM products	Piggyback/evaluation product
ROM size	16 K × 8 bits (internal PROM, to be programmed with general-purpose EPROM programmer)	32 K × 8 bits (external ROM)
RAM size	512 × 8 bits	1 K × 8 bits
CPU functions	The number of instructions : 136 Instruction bit length : 8 bits Instruction length : 1 to 3 bytes Data bit length : 1, 8, 16 bits Minimum execution time : 0.95 µs/4.2 MHz Minimum interrupt processing time : 8.57 µs/4.2 MHz	
Ports	Output ports (N-ch open-drain ports) : 4 (All also serve as peripherals.) Output ports (CMOS) : 8 I/O ports (CMOS) : 24 (8 ports also serve as peripherals.) Total : 36	
Timer/counter	8-bit timer/counter × 2 channels or 16-bit event counter × 1 channel	
Serial I/O	8 bits LSB/MSB first selectable	
External interrupt 1	3 independent channels (edge selection, interrupt vector, source flag) Rising/falling/both edges selectable Used also for wake-up from stop/sleep mode. (Edge detection is also permitted in stop mode.)	
External interrupt 2 (wake-up function)	8 channels (only for level detection)	
Remote control transmitting frequency generator	1 channel (Pulse width and cycle selectable by program)	
Standby mode	Sleep mode, stop mode, and clock mode	
Process	CMOS	
Operating voltage	2.7 V to 6.0 V	2.7 V to 6.0 V
EPROM for use	—	MBM27C256A-20TVM

■ PACKAGE AND CORRESPONDING PRODUCTS

Package	MB89121	MB89123A	MB89125A	MB89P133A	MB89P131
FPT-48P-M13	○	○	○	○	○
MQP-48C-P01	×	×	×	×	×

Package	MB89P135A	MB89PV130A
FPT-48P-M13	○	×
MQP-48C-P01	×	○

○ : Available, × : Not available

Note : Package details of OTPROM products and piggyback/evaluation products are common to those of MB89130/130A series. Refer to the MB89130/130A series data sheet for details.

■ DIFFERENCES AMONG PRODUCTS

1. Memory Size

Before evaluating using the one-time ROM product, verify its difference from the product that will actually be used. Take particular care on the following points :

- The number of register banks available is different between the MB89121 and the MB89123A/125A/P135A/PV130A.
- The stack area, etc., is set at the upper limit of the RAM.

2. Current Consumption

- When operated at low speed, a product with an OTPROM (EPROM) will consume more current than a product with a mask ROM. However, the same is current consumption in the sleep/stop mode is the same. (For more information, see "■ ELECTRICAL CHARACTERISTICS".)
- In the case of the MB89PV130A, added is the current consumed by the EPROM which is connected to the top socket.

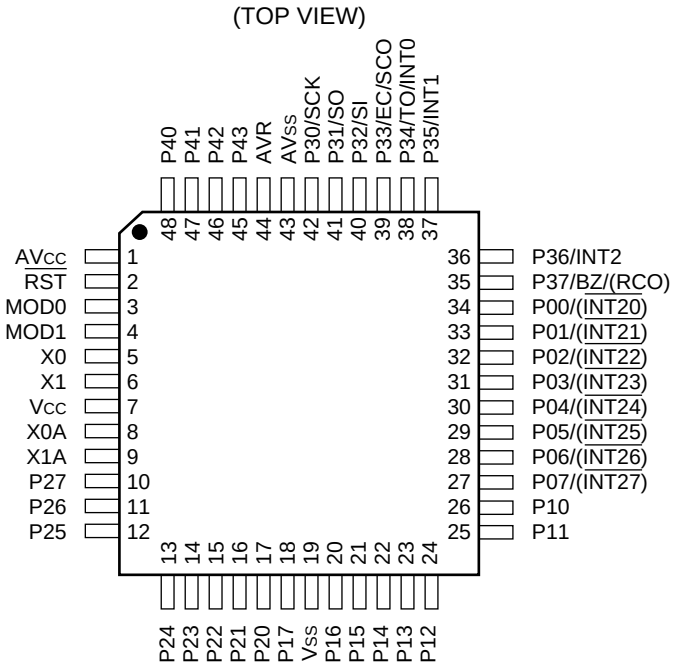
3. Mask Options

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 point :

- Pull-up resistor can't be set for P40 to P43 on the MB89P135A.
- Options are fixed on the MB89PV130A.

■ PIN ASSIGNMENT



(FPT-48P-M13)

Note : Parenthesized function is available only for the MB89120A series.

■ PIN DESCRIPTION

Pin no.	Pin name	Circuit type	Function
5	X0	A	Main clock crystal oscillator pins (max. 4.2 MHz)
6	X1		
8	X0A	B	Subclock crystal oscillator pins (for 32.768 kHz)
9	X1A		
3	MOD0	C	Operation mode select pins Connect these pins directly to V_{SS}.
4	MOD1		
2	$\overline{RST}$	D	Reset I/O pin This port is of N-ch open-drain output type with pull-up resistor and a hysteresis input type. The internal circuit is initialized by the input of “L”. “L” is output from this pin by an internal reset source as optional setting.
27 to 34	P07/ ($\overline{INT27}$) to P00/ ($\overline{INT20}$)	I	General-purpose I/O ports On the MB89120A series, these pins also serve as external interrupt input. External interrupt input is hysteresis input.
18, 20 to 26	P17 to P10	E	General-purpose I/O ports
10 to 17	P27 to P20	G	General-purpose output-only ports
42	P30/SCK	F	General-purpose I/O port Also serves as clock I/O for the 8-bit serial I/O interface. This port is of hysteresis input type.
41	P31/SO	F	General-purpose I/O port Also serves as a serial I/O data output. This port is of hysteresis input type.
40	P32/SI	F	General-purpose I/O port Also serves as a serial I/O data input. This port is of hysteresis input type.
39	P33/EC/SCO	F	General-purpose I/O port Also serves as the external clock input for the 8-bit timer/counter. This port is of hysteresis input type. System clock output is optional.
38	P34/TO/INT0	F	General-purpose I/O port Also serves as the overflow output and external interrupt input for the 8-bit timer/counter. This port is of hysteresis input type.
36, 37	P36/INT2, P35/INT1	F	General-purpose I/O ports Also serve as an external interrupt input. These ports are of hysteresis input type.
35	P37/BZ/ (RCO)	F	General-purpose I/O port Also serves as a buzzer output. This port is of hysteresis input type. On the MB89120A series, the pin also serves as a remote control output.

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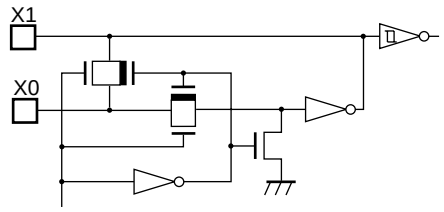
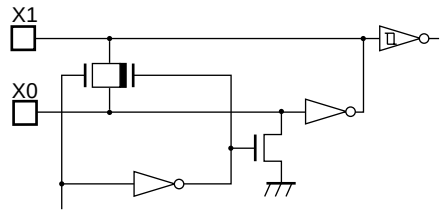
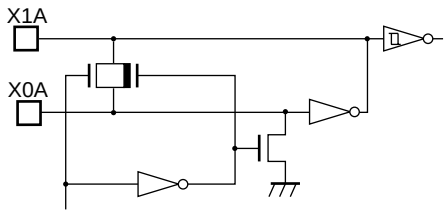
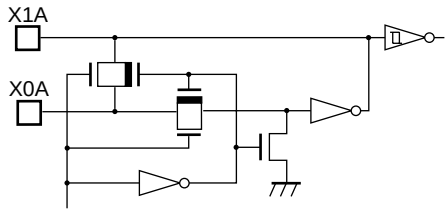
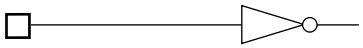
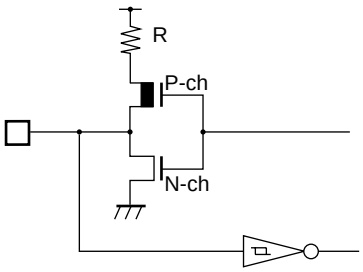
Pin no.	Pin name	Circuit type	Function
45 to 48	P43 to P40	H	N-ch open-drain output ports
7	V_{CC}	—	Power supply pin
19	V_{SS}	—	Power supply (GND) pin
1	AV_{CC}	—	Power supply (GND) pin Use this pin at the same voltage as V_{CC}.
44	AVR	—	Reference voltage input pin
43	AV_{SS}	—	Power supply (GND) pin Use this pin at the same voltage as V_{SS}.

■ I/O CIRCUIT TYPE

Type	Circuit	Remarks
A		• Crystal and ceramic oscillation type (main clock) • Cricuit for the MB89P133A/P131/P135A/PV130A • External clock input select versions of MB89121/123A/125A At an oscillation feedback resistor of approximately 1 MΩ / 5 V
		• Crystal and ceramic oscillation type (main clock) • Crystal or ceramic oscillator select versions of MB89121/123A/125A At an oscillation feedback resistor of approximately 1 MΩ / 5 V
B		• Crystal and ceramic oscillation type (sub clock) Circuit for the MB89121/123A/125A At an oscillation feedback resistor of approximately 4.5 MΩ / 5 V
		• Crystal and ceramic oscillation type (sub clock) Circuit for the MB89P131/P133A/P135A/PV130A At an oscillation feedback resistor of approximately 4.5 MΩ / 5 V
C		
D		• Output pull-up resistor (P-ch) of approximately 50 kΩ / 5 V • Hysteresis input

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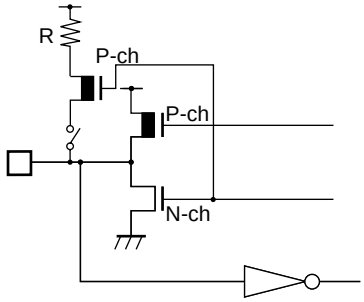
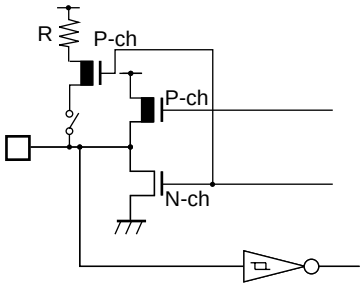
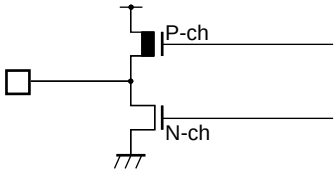
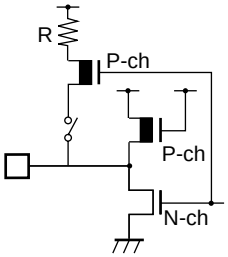
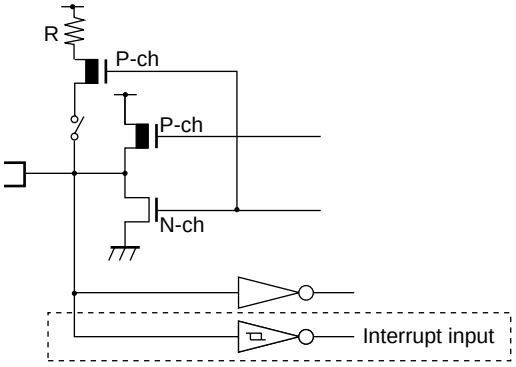
Type	Circuit	Remarks
E		• CMOS output • CMOS input • Pull-up resistor optional
F		• CMOS output • Hysteresis input • Pull-up resistor optional
G		• CMOS output
H		• N-ch open-drain output • Pull-up resistor optional
I	 Only for the MB89120A series	• CMOS output • CMOS input • The interrupt input is a hysteresis input (available only on the MB89120A series) . • Pull-up resistor optional

■ HANDLING DEVICES

1. Preventing Latchup

Latchup may occur on CMOS ICs if voltage higher than V_{CC} or lower than V_{SS} is applied to input and output pins other than medium- 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} and V_{SS}.

When latchup occurs, power supply current increases rapidly, and might thermally damage elements. When using, take great care not to exceed the absolute maximum ratings.

Also, take care to prevent the analog power supply (AV_{CC} and AVR) and analog input from exceeding the digital power supply (V_{CC}) when the analog system power supply is turned on and off.

2. Treatment of Unused Input Pins

Leaving unused input pins open could cause malfunctions. They should be connected to pull-up or pull-down resistor.

3. Treatment of N.C. Pins

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

4. 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, even if it occurs within the rated range. Stabilizing voltage supplied to the IC is therefore important. As stabilization guidelines, it is recommended to control power so that V_{CC} ripple fluctuations (P-P value) will be less than 10% of the standard V_{CC} value at the commercial frequency (50 to 60 Hz) and the transient fluctuation rate will be less than 0.1 V/ms at the time of a momentary fluctuation such as when power is switched.

5. Precautions when Using an External Clock

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

6. Turning on the supply voltage (only for the MB89P135A)

When the power supply is turned on if MB89P135A is used, power on sharply up to 2.0 V within 13 clock cycles after starting of oscillation.
Further, various option may be set, if power supply up to keep this condition.

■ PROGRAMMING TO THE EPROM ON THE MB89P131

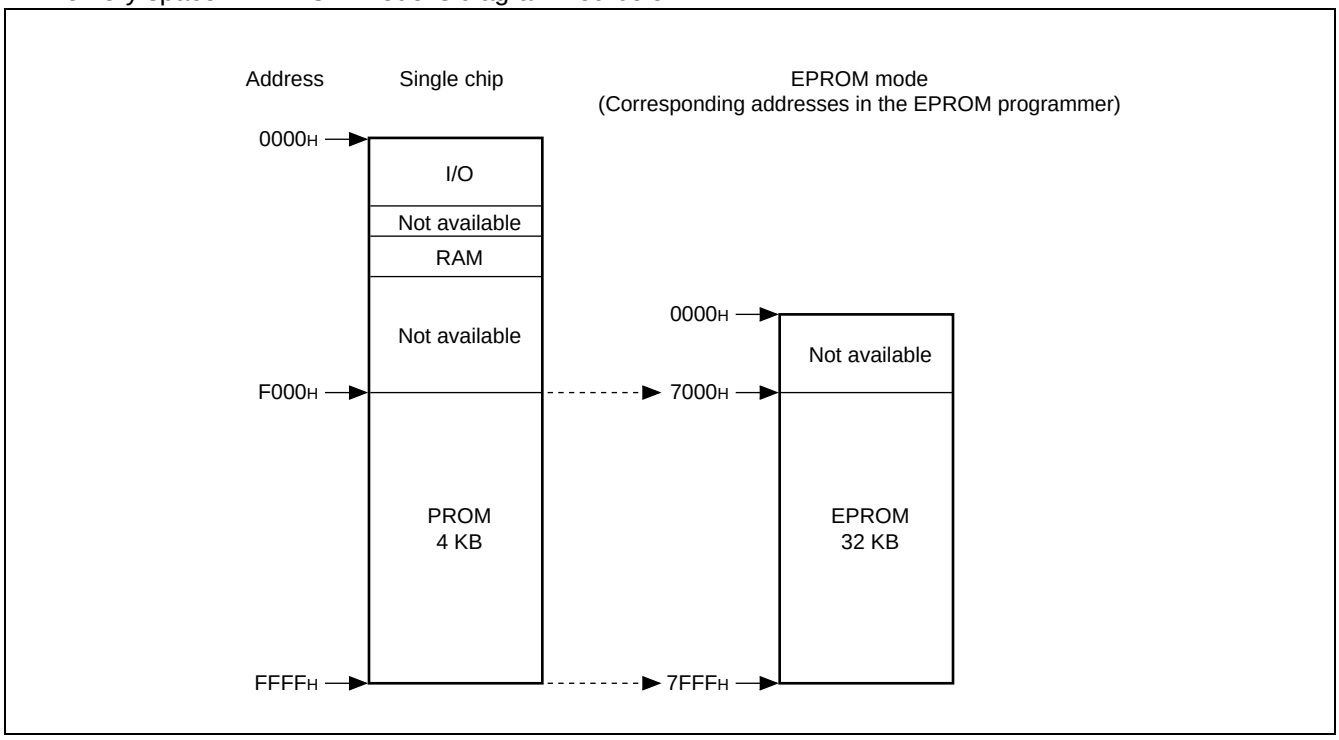
The MB89P131 is a one-time PROM version of the MB89121.

1. Features

- 4-Kbyte PROM on chip
- Equivalency to the MBM27C256A in EPROM mode (when programmed with the EPROM programmer)

2. Memory Space

Memory space in EPROM mode is diagrammed below :



3. Programming to the EPROM

In EPROM mode the MB89P131 functions equivalent to the MBM27C256A. This allows the EPROM to be programmed with a general-purpose EPROM programmer by using the dedicated socket adapter. Note, however, that the electronic signature mode cannot be used.

- **Programming procedure**

(1) Set the EPROM programmer to MBM27C256A.

(2) Load program data into the EPROM programmer at 7000_H to $7FFF_H$ (note that addresses $F000_H$ to $FFFF_H$ while operating as a single chip correspond to 7000_H to $7FFF_H$ in EPROM mode) .

(3) Program with the EPROM programmer.

■ PROGRAMMING TO THE EPROM ON THE MB89P133A

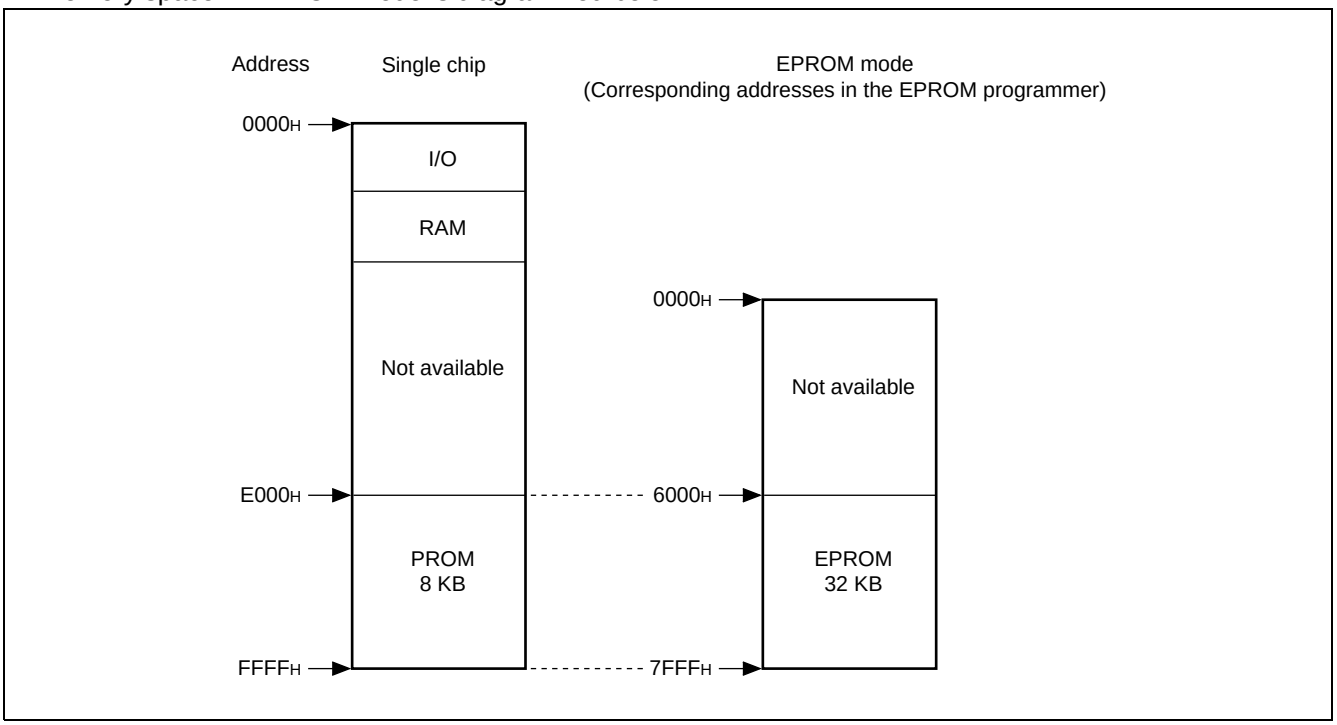
The MB89P133A is a one-time PROM version of the MP89123A.

1. Features

- 8-Kbyte PROM on chip
- Equivalency to the MBM27C256A in EPROM mode (when programmed with the EPROM programmer)

2. Memory Space

Memory space in EPROM mode is diagrammed below :



3. Programming to the EPROM

In EPROM mode the MB89P133A functions equivalent to the MBM27C256A, This allows the EPROM to be programmed with a general-purpose EPROM programmer by using the dedicated socket adapter. Note, however, that the MB89P133A cannot use the electronic signature mode.

- **Programming procedure**

(1) Set the EPROM programmer to MBM27C256A.

(2) Load program data into the EPROM programmer at 6000_H to $7FFF_H$ (note that addresses $E000_H$ to $FFFF_H$ while operating as a single chip correspond to 6000_H to $7FFF_H$ in EPROM mode) .

(3) Program with the EPROM programmer.

■ PROGRAMMING TO THE EPROM ON THE MB89P135A

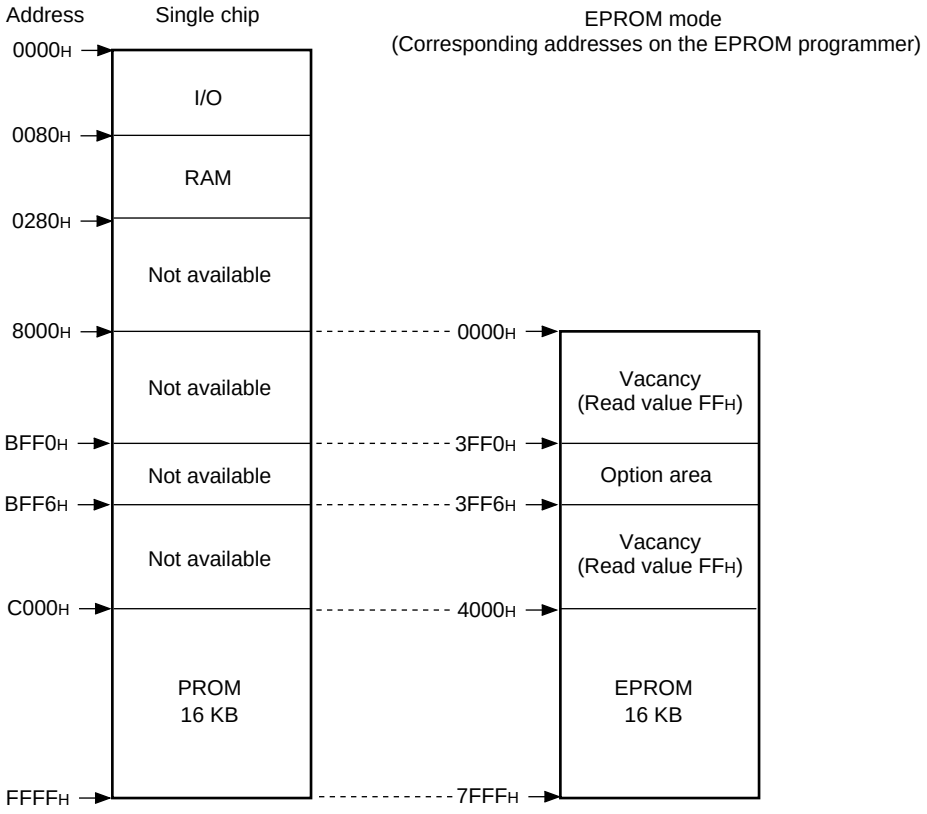
The MB89P135A is an OTPROM version of the MB89123A/125A.

1. Features

- 16-Kbyte PROM on chip
- Equivalency to the MBM27C256A in EPROM mode (when programmed with the EPROM programmer)

2. Memory Space

Memory space in EPROM mode is diagrammed below.



3. Programming to the EPROM

In EPROM mode, the MB89P135A functions equivalent to the MBM27C256A. This allows the PROM to be programmed with a general-purpose EPROM programmer (the electronic signature mode cannot be used) by using the dedicated socket adapter.

- **Programming procedure**

(1) Set the EPROM programmer to the MBM27C256A.

(2) Load program data into the EPROM programmer at 4000H to 7FFFH (note that addresses C000H to FFFFH while operating as a single chip correspond to 4000H to 7FFFH in EPROM mode) .

(3) Load option data into the EPROM programmer at 3FF0H to 3FF6H.

(4) Program with the EPROM programmer.

4. Setting OTPROM Options (MB89P135A Only)

The programming procedure is the same as that for the PROM. Options can be set by programming values at the addresses shown on the memory map. The relationship between bits and options is shown on the following bit map :

- **OTPROM option bit map**

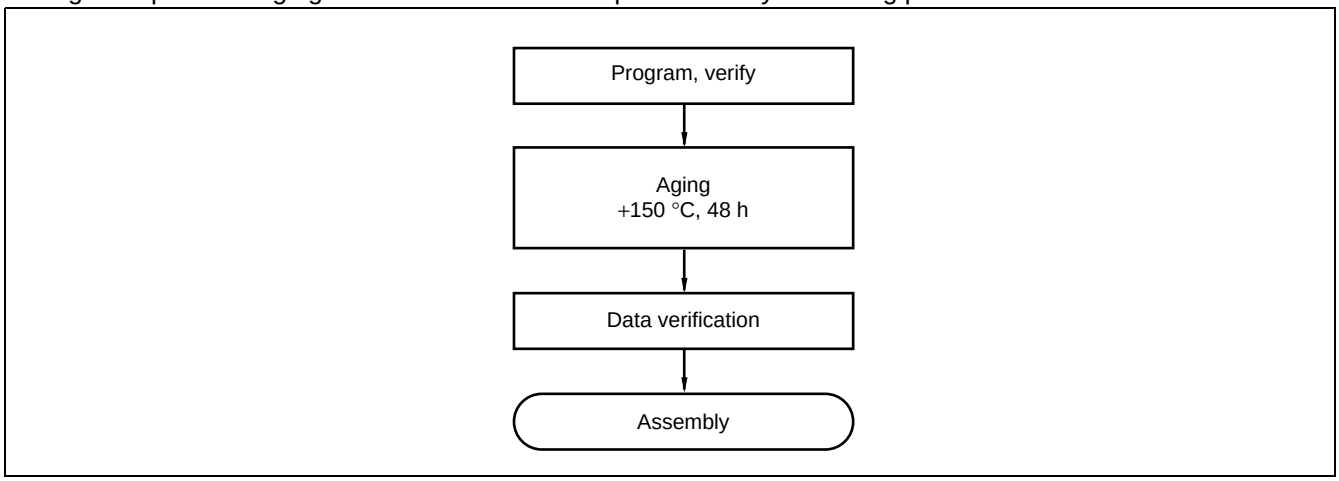
Address	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
$3FF0_H$	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Clock mode selection 1 : Single clock 0 : Dual clock	Reset pin output 1 : Yes 0 : No	Power-on reset 1 : Yes 0 : No	Oscillation stabilization time 00 : $2^2/F_{CH}$ 01 : $2^{12}/F_{CH}$	 10 : $2^{16}/F_{CH}$ 11 : $2^{18}/F_{CH}$
$3FF1_H$	P07 Pull-up 1 : Yes 0 : No	P06 Pull-up 1 : Yes 0 : No	P05 Pull-up 1 : Yes 0 : No	P04 Pull-up 1 : Yes 0 : No	P03 Pull-up 1 : Yes 0 : No	P02 Pull-up 1 : Yes 0 : No	P01 Pull-up 1 : Yes 0 : No	P00 Pull-up 1 : Yes 0 : No
$3FF2_H$	P17 Pull-up 1 : Yes 0 : No	P16 Pull-up 1 : Yes 0 : No	P15 Pull-up 1 : Yes 0 : No	P14 Pull-up 1 : Yes 0 : No	P13 Pull-up 1 : Yes 0 : No	P12 Pull-up 1 : Yes 0 : No	P11 Pull-up 1 : Yes 0 : No	P10 Pull-up 1 : Yes 0 : No
$3FF3_H$	P37 Pull-up 1 : Yes 0 : No	P36 Pull-up 1 : Yes 0 : No	P35 Pull-up 1 : Yes 0 : No	P34 Pull-up 1 : Yes 0 : No	P33 Pull-up 1 : Yes 0 : No	P32 Pull-up 1 : Yes 0 : No	P31 Pull-up 1 : Yes 0 : No	P30 Pull-up 1 : Yes 0 : No
$3FF4_H$	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable
$3FF5_H$	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable
$3FF6_H$	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable

Note : Each bit is set to “1” as the initialized value, therefore the pull-up option is not selected.

■ HANDLING MB89P131/P133A/P135A

1. Recommended Screening Conditions

High-temperature aging is recommended as the pre-assembly screening procedure.



2. Programming Yield

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

3. EPROM Programmer Socket Adapter and Recommended Programmer Manufacturer

Part no.	Package	Compatible socket adapter Sun Hayato Co., Ltd.	Recommended programmer manufacturer and programmer name
			Minato Electronics Inc.
			1890A
MB89P131PF	QFP-48	ROM-48QF2-28DP-8L	Recommended
MB89P133APFM			—

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

■ PROGRAMMING TO THE EPROM WITH PIGGYBACK/EVALUATION DEVICE

1. EPROM for Use

MBM27C256A-20TVM

2. Programming Socket Adapter

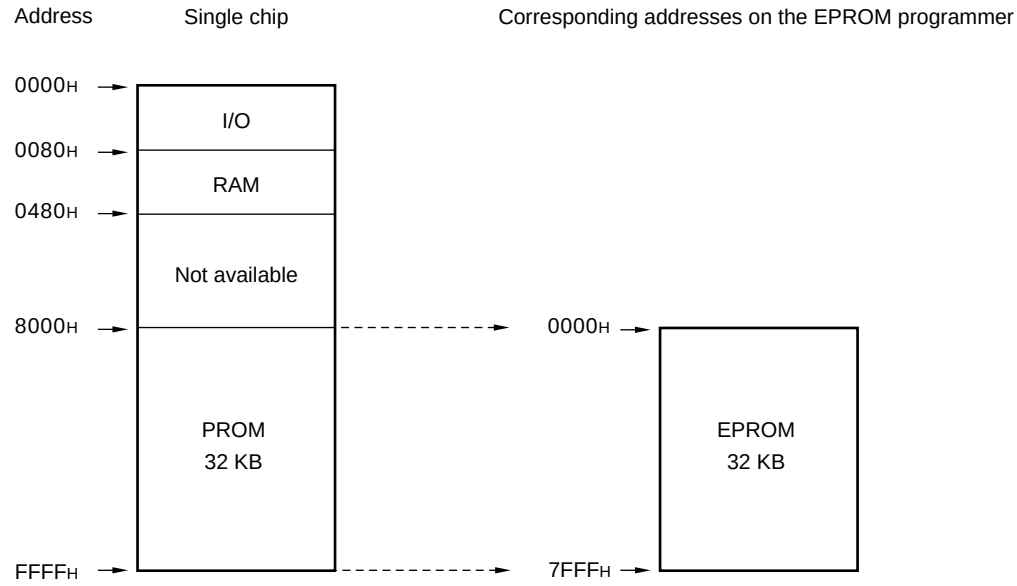
To program to the PROM using an EPROM programmer, use the socket adapter (manufacturer : Sun Hayato Co., Ltd.) listed below :

Package	Adapter socket part number
LCC-32 (Square)	ROM-32LC-28DP-S

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

3. Memory Space

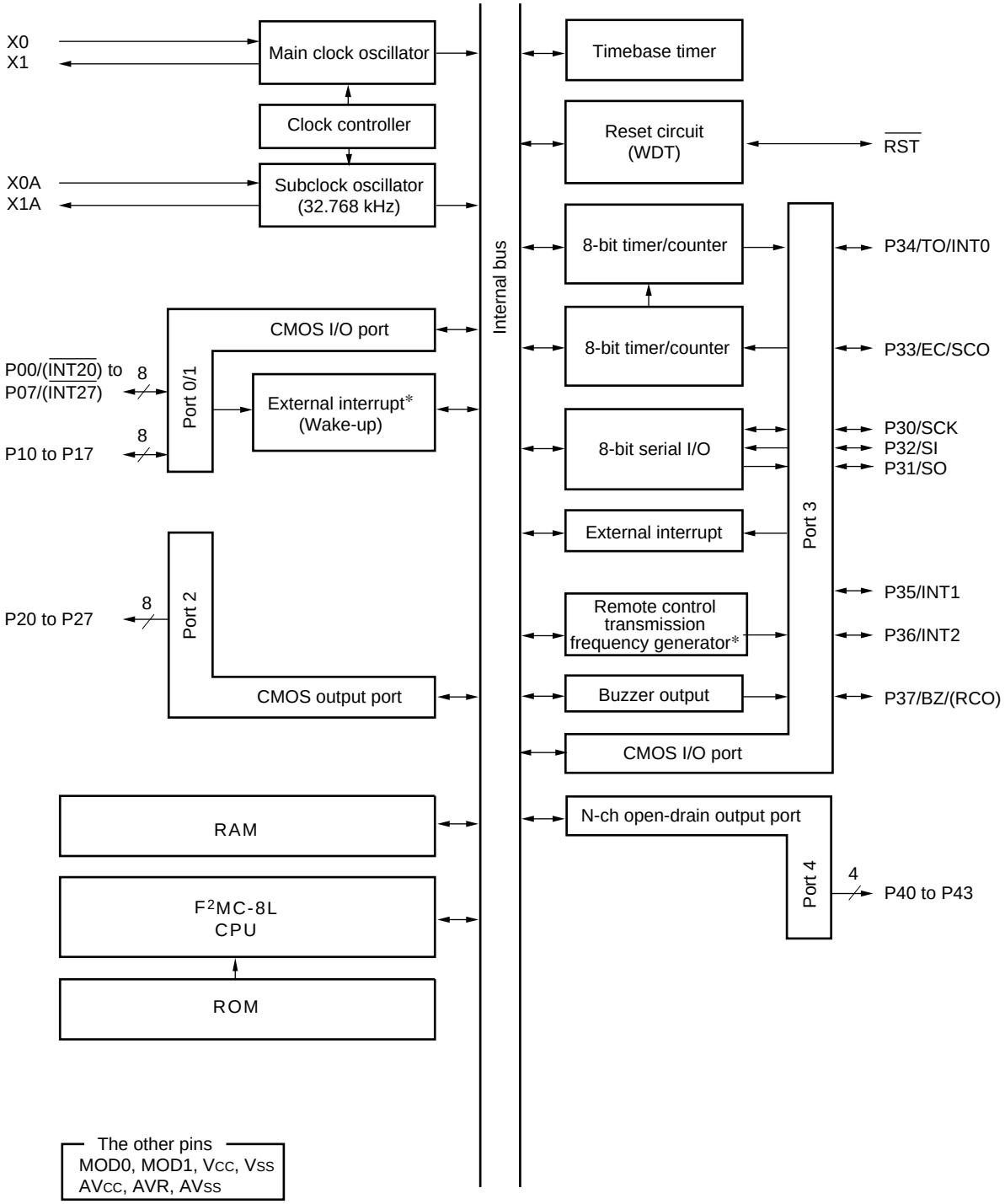
Memory space in each mode, such as 32-Kbyte PROM is diagrammed below.



4. Programming to the EPROM

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

■ BLOCK DIAGRAM



* : Only the MB89120A series has wake-up interrupt inputs and remote control transmission.

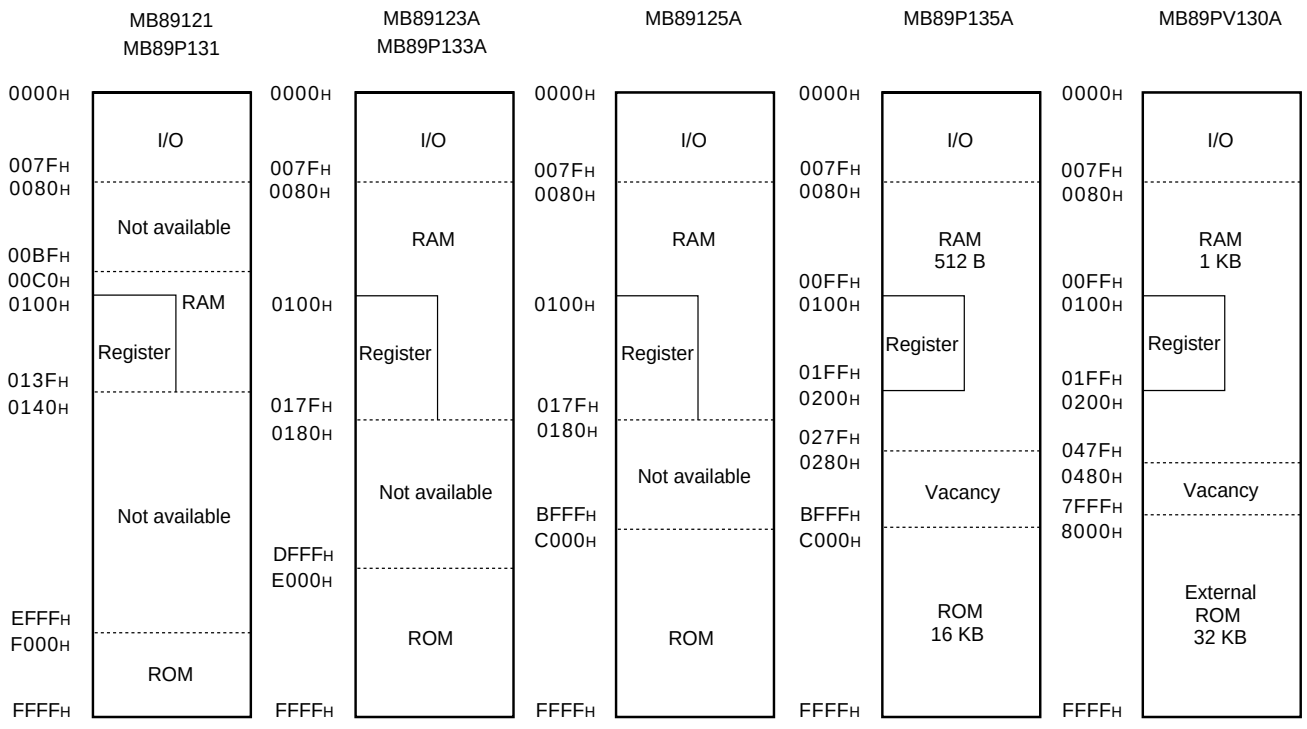
Note : Parenthesized pins are available only with the MB89120A series.

■ CPU CORE

1. Memory Space

The microcontrollers of the MB89120/A series offer 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, near the highest address. The tables of interrupt reset vectors and vector call instructions are allocated from the highest address with the program area. The memory space of the MB89120/A series is structured as illustrated below :

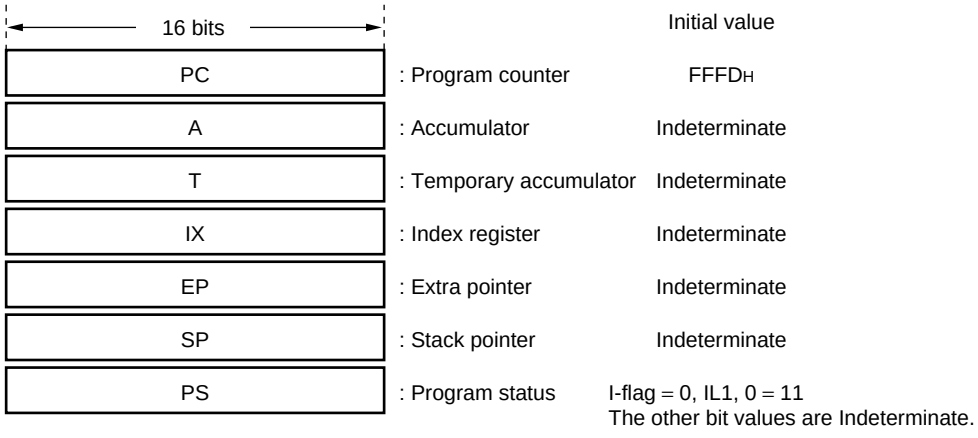
Memory Space



2. Registers

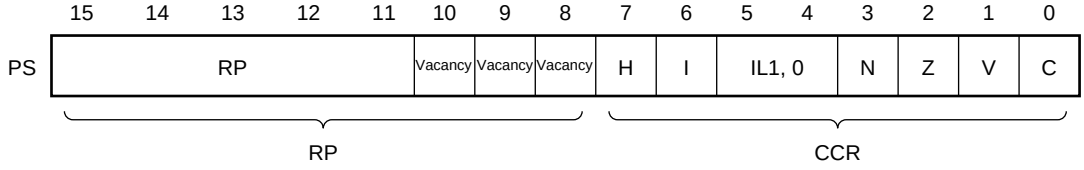
The F²MC-8L family has two types of registers; dedicated hardware registers and general-purpose memory registers. The following dedicated registers are provided :

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



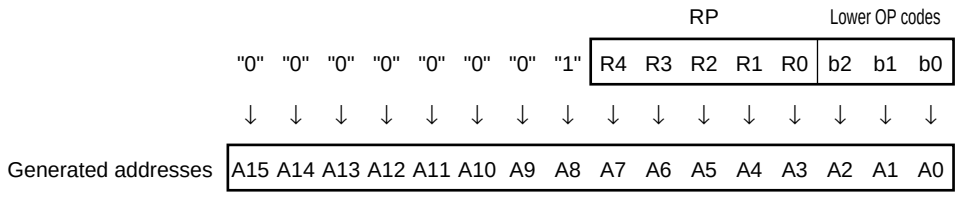
The PS can further be divided into higher 8 bits for use as a register bank pointer (RP) and the lower 8 bits for use as a condition code register (CCR) (see the diagram below) .

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



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 “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 the shift-out value in the case of a shift instruction.

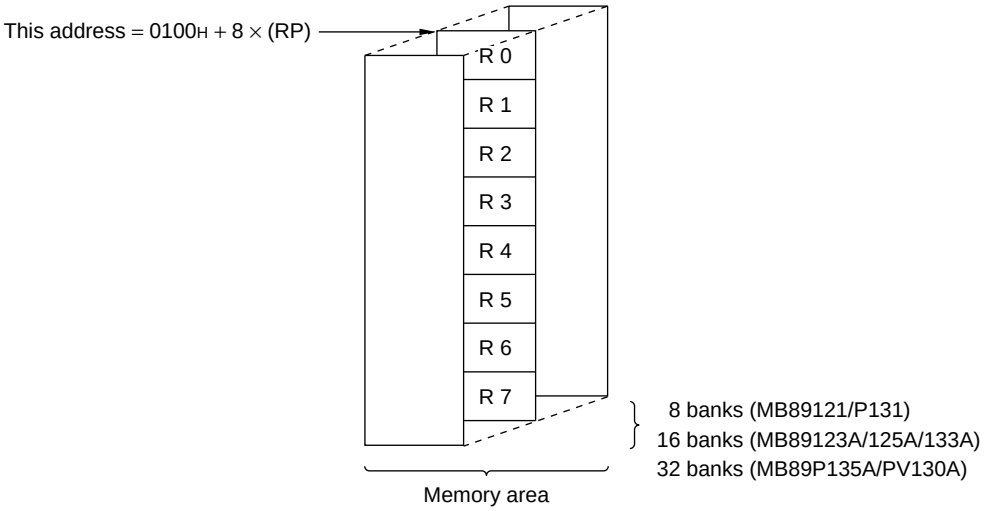
The following general-purpose registers are provided :

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

The general-purpose registers are of 8 bits and located in the register banks of the memory. One bank contains eight registers and up to a total of 8 banks can be used on the MB89121/P131, and a total of 16 banks can be used on the MB89123A/125A/P133A and a total of 32 banks can be used on the MB89P135A/PV130A.

The bank currently in use is indicated by the register bank pointer (RP) .

Register Bank Configuration



■ I/O MAP

Address	Read/write	Register name	Register description
00_H	(R/W)	PDR0	Port 0 data register
01_H	(W)	DDR0	Port 0 data direction register
02_H	(R/W)	PDR1	Port 1 data register
03_H	(W)	DDR1	Port 1 data direction register
04_H	(R/W)	PDR2	Port 2 data register
05_H			Vacancy
06_H			Vacancy
07_H	(R/W)	SYCC	System clock control register
08_H	(R/W)	STBC	Standby control register
09_H	(R/W)	WDTC	Watchdog control register
$0A_H$	(R/W)	TBTC	Time-base timer control register
$0B_H$	(R/W)	WPCR	Watch prescaler control register
$0C_H$	(R/W)	PDR3	Port 3 data register
$0D_H$	(W)	DDR3	Port 3 data direction register
$0E_H$	(R/W)	PDR4	Port 4 data register
$0F_H$	(R/W)	BZCR	Buzzer register
10_H			Vacancy
11_H			Vacancy
12_H	(R/W)	SCGC	Peripheral control clock register
13_H			Vacancy
14_H	(R/W)	RCR1	Remote control transmission control register 1*
15_H	(R/W)	RCR2	Remote control transmission control register 2*
16_H			Vacancy
17_H			Vacancy
18_H	(R/W)	T2CR	Timer 2 control register
19_H	(R/W)	T1CR	Timer 1 control register
$1A_H$	(R/W)	T2DR	Timer 2 data register
$1B_H$	(R/W)	T1DR	Timer 1 data register
$1C_H$	(R/W)	SMR1	Serial mode register
$1D_H$	(R/W)	SDR1	Serial data register
$1E_H$			Vacancy
$1F_H$			Vacancy

(Continued)

(Continued)

Address	Read/write	Register name	Register description
20_H			Vacancy
21_H			Vacancy
22_H			Vacancy
23_H	(R/W)	EIC1	External interrupt control register 1
24_H	(R/W)	EIC2	External interrupt control register 2
25_H			Vacancy
26_H to 31_H			Vacancy
32_H	(R/W)	EIE2	External interrupt 2 enable register*
33_H	(R/W)	EIF2	External interrupt 2 flag register*
34_H to $7B_H$			Vacancy
$7C_H$	(W)	ILR1	Interrupt level register 1
$7D_H$	(W)	ILR2	Interrupt level register 2
$7E_H$	(W)	ILR3	Interrupt level register 3
$7F_H$			Vacancy

* : Only in the MB89120A series

Note : Do not use vacancies.

■ ELECTRICAL CARACTERISTICS

1. Absolute Maximum Ratings

(AV_{SS} = V_{SS} = 0.0 V)

Parameter	Symbol	Value		Unit	Remarks
		Min.	Max.		
Power supply voltage	V_{CC} AV_{CC} AVR	V_{SS} – 0.3	V_{SS} + 7.2	V	Use V_{CC}, AV_{CC} , and AVR set to the same voltage.
Program voltage	V_{PP}	V_{SS} – 0.6	V_{SS} + 13.0	V	MOD1 pin on the MB89P131/P133A/P135A
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_{OL}	—	10	mA	
“L” level average output current	I_{OLAV}	—	4	mA	Avarage value (operating current × operating rate)
“L” level total maximum output current	ΣI_{OL}	—	100	mA	
“L” level total average output current	ΣI_{OLAV}	—	20	mA	Avarage value (operating current × operating rate)
“H” level maximum output current	I_{OH}	—	–10	mA	
“H” level average output current	I_{OHAV}	—	–2	mA	Avarage value (operating current × operating rate)
“H” level total maximum output current	ΣI_{OH}	—	–30	mA	
“H” level total average output current	ΣI_{OHAV}	—	–10	mA	Avarage value (operating current × operating rate)
Power consumption	P_D	—	200	mW	
Operating temperature	T_A	–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

(AV_{SS} = 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 Applied to “MB89P131/P133A/P135A/PV130A, and single-clock MB89121/123A/125A*”
		2.7*	6.0*	V	Normal operation assurance range Applied to “ Dual-clock MB89121/123A/125A*”
		1.5	6.0	V	Retains the RAM state in stop mode
Operating temperature	T_A	–40	+85	°C	

* : These values vary with the operating conditions. See **“ Operating Voltage vs. Main Clock Operating Frequency.”**

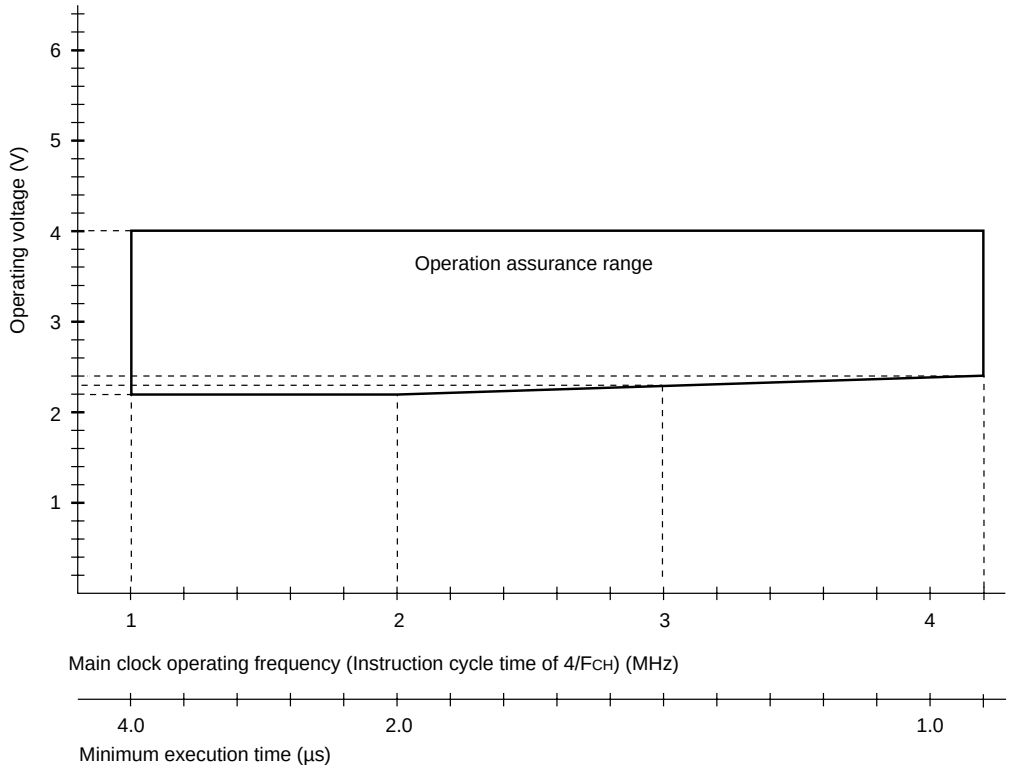
WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device’s electrical characteristics are warranted when the device is operated within these ranges.

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

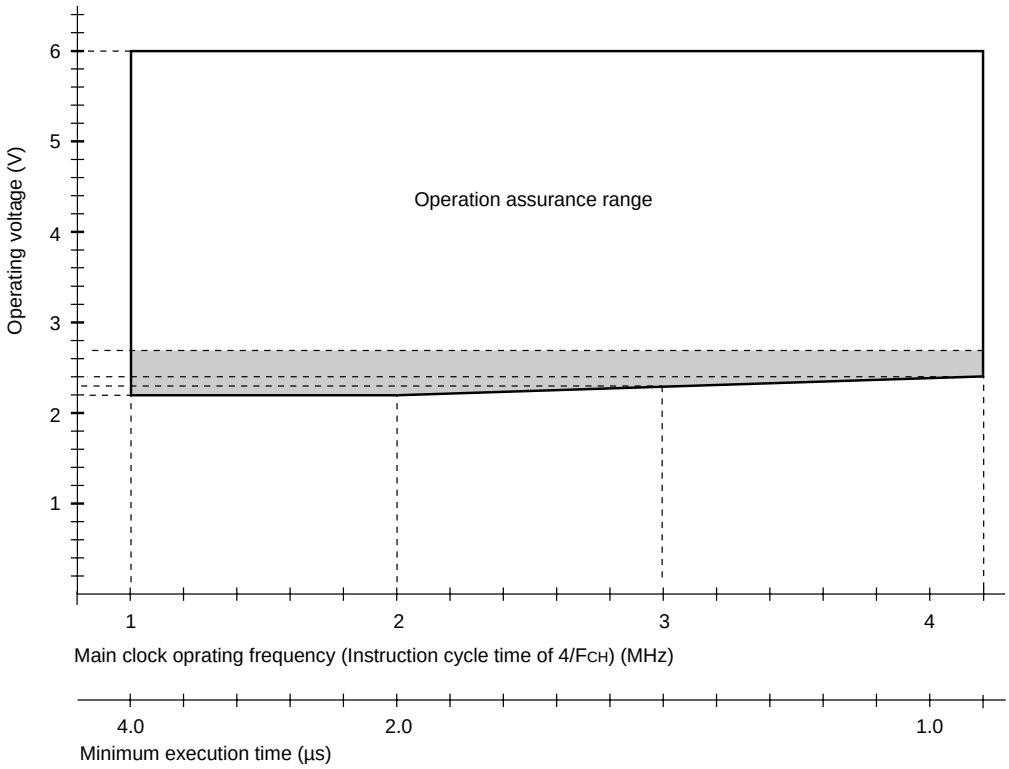
No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

- **Operating Voltage vs. Main Clock Operating Frequency**

Dual-clock MB89121/123A/125A



MB89P131/P133A/P135A/PV130A, and single-clock MB89121/123A/125A



Note : The shaded area is assured only for the MB89121/123A/125A (instruction cycle time of 4/F_{CH}) .

3. DC Characteristics

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

Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
"H" level input voltage	V_{IH}	P00 to P07, P10 to P17	—	0.7 V_{CC}	—	V_{CC} + 0.3	V	
	V_{IHS}	$\overline{RST}$, P30 to P37, $\overline{INT20}$ to $\overline{INT27}$	—	0.8 V_{CC}	—	V_{CC} + 0.3	V	$\overline{INT20}$ to $\overline{INT27}$ are available only in the MB89120A series.
"L" level input voltage	V_{IL}	P00 to P07, P10 to P17	—	V_{SS} – 0.3	—	0.3 V_{CC}	V	
	V_{ILS}	$\overline{RST}$, P30 to P37, $\overline{INT20}$ to $\overline{INT27}$	—	V_{SS} – 0.3	—	0.2 V_{CC}	V	$\overline{INT20}$ to $\overline{INT27}$ are available only in the MB89120A series.
Open-drain output pin applied voltage	V_D	P40 to P43	—	V_{SS} – 0.3	—	V_{CC} + 0.3	V	
"H" level output voltage	V_{OH}	P00 to P07, P10 to P17, P20 to P27, P30 to P37	$I_{OH} = -2.0$ mA	2.4	—	—	V	
"L" level output voltage	V_{OL}	P00 to P07, P10 to P17 P20 to P27, P30 to P37, P40 to P43	$I_{OL} = 1.8$ mA	—	—	0.4	V	
	V_{OL2}	$\overline{RST}$	$I_{OL} = 4.0$ mA	—	—	0.6	V	
Input leakage current (Hi-z output leakage current)	I_{LI}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P43, MOD0, MOD1	0.45 V < V_I < V_{CC}	—	—	±5	µA	Without pull-up resistor
Pull-up resistance	R_{PULL}	P00 to P07, P10 to P17, P30 to P37, P40 to P43, $\overline{RST}$	$V_I = 0.0$ V	25	50	100	kΩ	

(Continued)

(Continued)

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

Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Power supply current*1	I_{CC1}	V_{CC} (External clock operation)	V_{CC} = 5.0 V F_{CH} = 4.00 MHz t_{inst}*2 = 1.0 µs	—	4	7	mA	MB89121/ 123A/125A
				—	6	10	mA	MB89P131/ P133A/ P135A
	I_{CCS1}		V_{CC} = 5.0 V F_{CH} = 4.00 MHz Main sleep mode t_{inst}*2 = 1.0 µs	—	2	5	mA	
	I_{CCL}		V_{CC} = 3.0 V F_{CL} = 32.768 kHz Subclock mode	—	50	100	µA	MB89121/ 123A/125A
				—	1	3	mA	MB89P131/ P133A/ P135A
	I_{CCLS}		V_{CC} = 3.0 V F_{CL} = 32.768 kHz Subclock sleep mode	—	25	50	µA	
	I_{CCT}		V_{CC} = 3.0 V F_{CL} = 32.768 kHz • Watch mode • Main clock stop mode at dual clock system	—	—	15	µA	
	I_{CCH}		T_A = +25 °C • Subclock stop mode • Main clock stop mode at single clock system	—	—	1	µA	
Input capacitance	C_{IN}	Other than AV_{CC}, AV_{SS}, V_{CC}, and V_{SS}	f = 1 MHz	—	10	—	pF	

*1 : The measurement conditions of power supply current is external clock. (V_{CC} = 5.0 V, V_{CC} = 3.0 V)

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

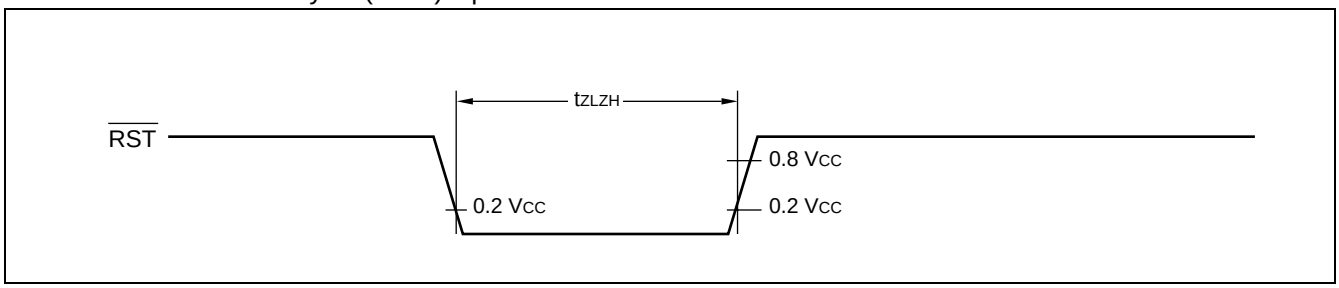
4. AC Characteristics

(1) Reset Timing

(V_{CC} = +5.0 V ±10%, AV_{SS} = V_{SS} = 0.0 V, T_A = –40 °C to +85 °C)

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

* : t_{HCYL} is the oscillation cycle (1/F_{CH}) input to the X0.

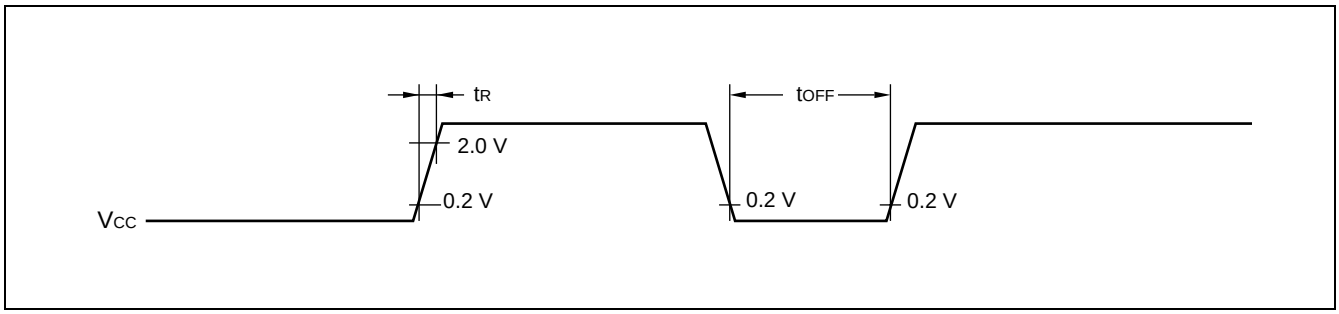


(2) Power-on Reset

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

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

Note : Make sure that power supply rises within the oscillation stabilization time selected.
When the main clock is operating at F_{CH} = 3 MHz and the oscillation stabilization time select option has been set to $2^{12}/F_{CH}$, for example, the oscillation settling time is 1.4 ms and accordingly the maximum value of power supply rising time is about 1.4 ms.
Keep in mind that rapid changes in power supply voltage may cause a power-on reset. If power supply voltage needs to be varied in the course of operation, a smooth voltage rise is recommended.

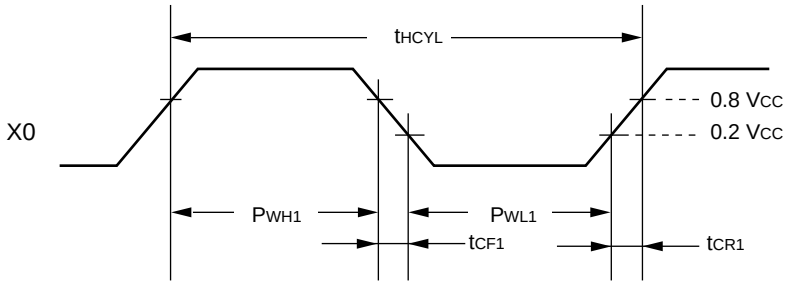


(3) Clock Timings

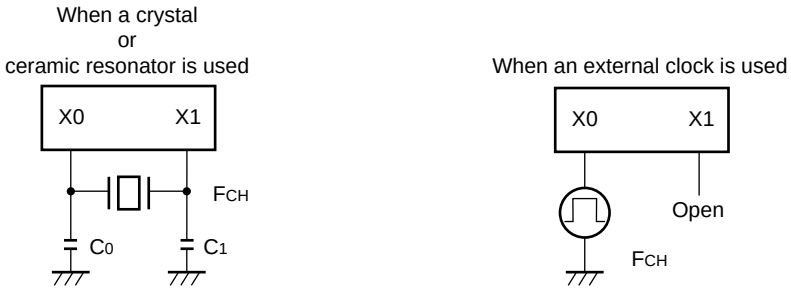
(V_{SS} = 0.0 V, T_A = –40 °C to +85 °C)

Parameter	Symbol	Pin	Value			Unit	Remarks
			Min.	Typ.	Max.		
Clock frequency	F_{CH}	X0, X1	1	—	4.2	MHz	Main clock
	F_{CL}	X0A, X1A	—	32.768	—	kHz	Subclock
Clock cycle time	t_{HCYL}	X0, X1	238	—	1000	ns	Main clock
	t_{LCYL}	X0A, X1A	—	30.5	—	µs	Subclock
Input clock pulse width	P_{WH1} P_{WL1}	X0	72	—	—	ns	External clock
Input clock rising/falling time	t_{CR1} t_{CF1}	X0	—	—	24	ns	External clock

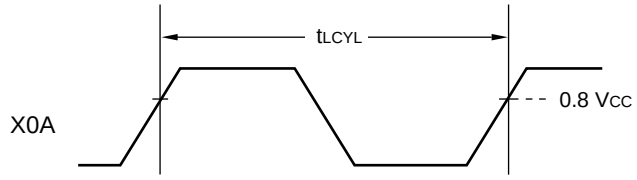
X0, X1 Timings and Conditions of Applied Voltage



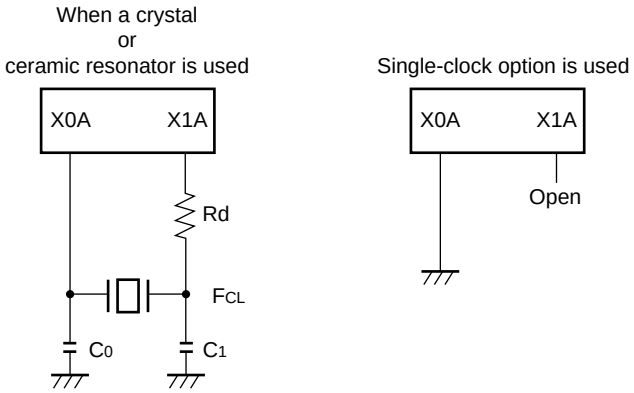
Main Clock Conditions of Applied Voltage



X0A, X1A Timings and Conditions of Applied Voltage



Subclock Conditions of Applied Voltage



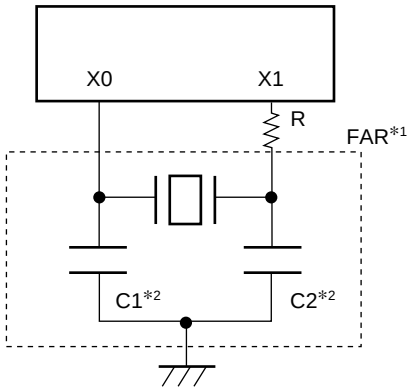
(4) Instruction Cycles

(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}	$4/F_{CH}$, $8/F_{CH}$, $16/F_{CH}$, $64/F_{CH}$	µs	($4/F_{CH}$) t_{inst} = 1.0 µs when operating at F_{CH} = 4 MHz
		$2/F_{CL}$	µs	t_{inst} = 61.036 µs when operating at F_{CL} = 32.768 kHz

(5) Recommended Resonator Manufacturers

Sample Application of Piezoelectric Resonator (FAR Series) for Main Clock Oscillation Circuit
(Only in the MB89120A Series)

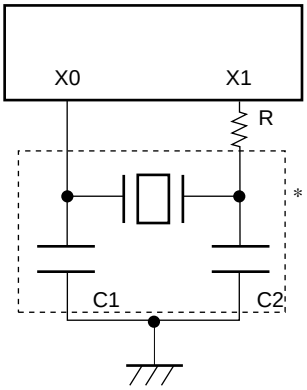


*1 : FUJITSU MEDIA DEVICE LIMITED

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-C4CC-02000-L00	2.00	1000	±0.5%	±0.5%	Built-in
		510			
FAR-C4□A-03580-□01	3.58	—			
FAR-C4CB-04000-M00	4.00				

Inquiry : FUJITSU MEDIA DEVICES LIMITED

Sample Application of Ceramic Resonator for Main Clock Oscillation Circuit



- **Mask ROM products**

Resonator manufacturer*	Resonator	Frequency (MHz)	C1 (pF)	C2 (pF)	R (kΩ)
Kyocera Corporation	KBR-4.0MKS	4.00	33	33	Not required
Matsushita Electronic Components	EFOV4004B	4.00	Built-in	Built-in	1.5
Murata Mfg. Co. Ltd.	CSBF1000J	1.00	100	100	6.8
	CSTCS4.00MG800	4.00	Built-in	Built-in	Not required
	CSA4.00MG040		100	100	Not required
	CST4.00MGW040		Built-in	Built-in	Not required

Inquiry : Kyocera Corporation

- AVX Corporation
  North American Sales Headquarters : TEL (803) 448-9411
- AVX Limited
  European Sales Headquarters : TEL (01252) 770000
- AVX/Kyocera H.K. Ltd.
  Asian Sales Headquarters : TEL 363-3303

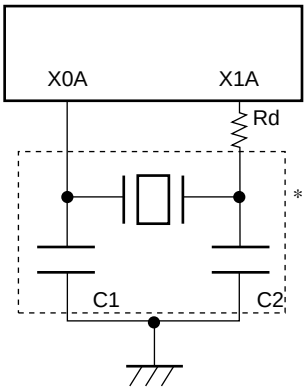
Matsushita Electronic Components Co., Ltd.

- Ceramic Division : TEL 81-6-908-1101

Murata Mfg Co., Ltd.

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

Sample Application of Crystal Resonator for Subclock Oscillation Circuit



- **Mask ROM product**

Resonator manufacturer*	Resonator	Frequency (kHz)	C1 (pF)	C2 (pF)	Rd (kΩ)
SII	DS-VT-200	32.768	24	24	680

Inquiry : SII
Seiko Instruments Inc. (Japan) : TEL 81-43-211-1219
Seiko Instruments U.S.A. Inc. : TEL 310-517-7770
Seiko Instruments GmbH : TEL 49-6102-297-122

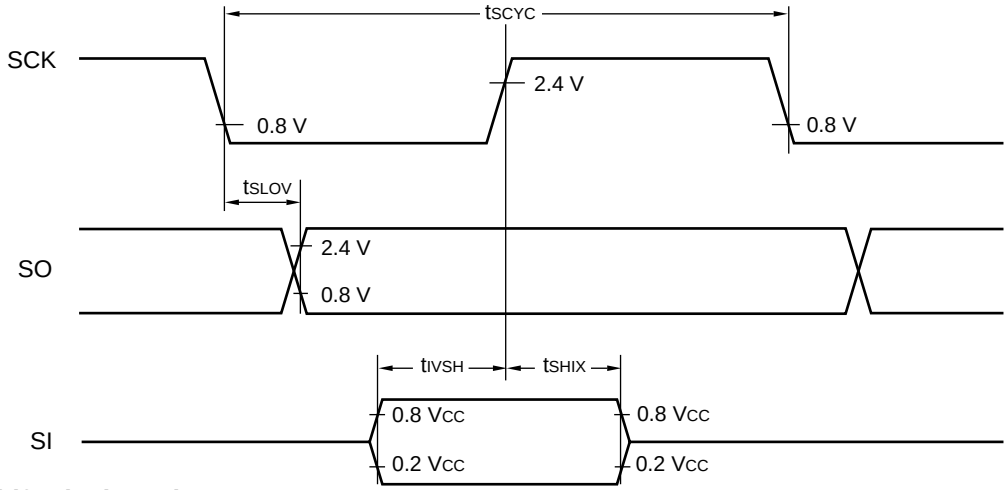
(6) Serial I/O Timings

(V_{CC} = +5.0 V ±10%, AV_{SS} = V_{SS} = 0.0 V, T_A = –40 °C to +85 °C)

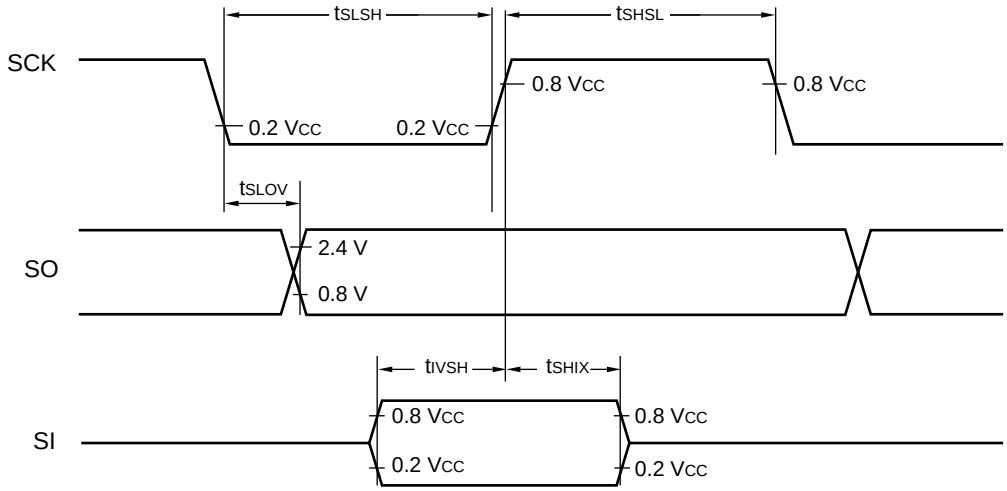
Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operation	2 t_{inst}*	—	µs	
SCK ↓ → SO time	t_{SLOV}	SCK, SO		–200	200	ns	
Valid SI → SCK ↑	t_{IVSH}	SI, SCK		200	—	ns	
SCK ↑ → Valid SI hold time	t_{SHIX}	SCK, SI		200	—	ns	
Serial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

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

Internal Shift Clock Mode



External Shift Clock Mode

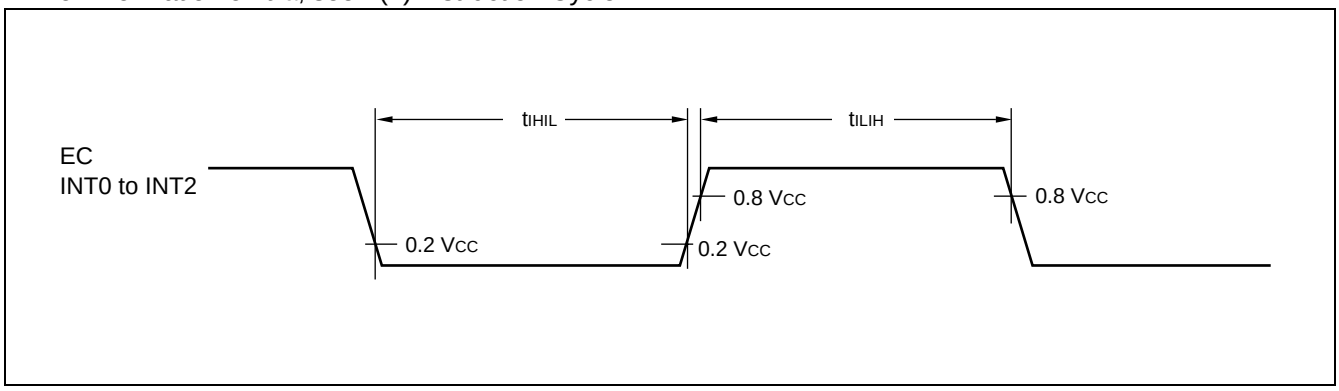


(7) Peripheral Input Timings

(V_{CC} = +5.0 V ±10%, AV_{SS} = V_{SS} = 0.0 V, T_A = –40 °C to +85 °C)

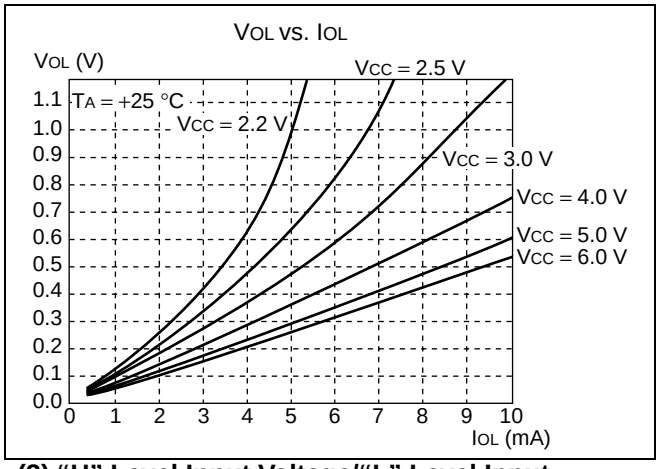
Parameter	Symbol	Pin	Value		Unit	Remarks
			Min.	Max.		
Peripheral input “H” pulse width	t_{ILIH}	EC, INT0 to INT2	2 t_{inst}*	—	µs	
Peripheral input “L” pulse width	t_{IHIL}		2 t_{inst}*	—	µs	

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

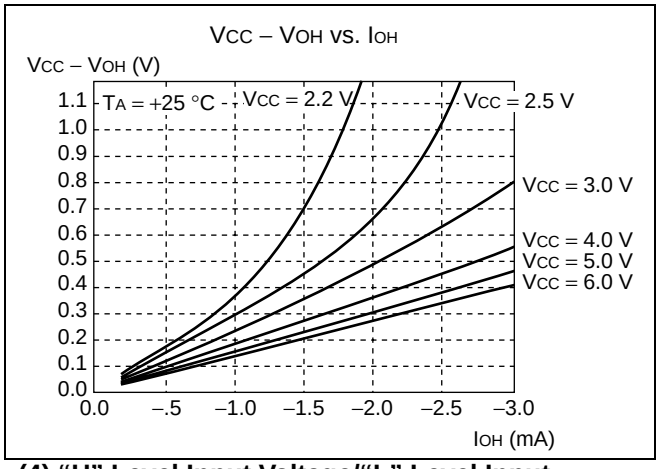


■ EXAMPLE CHARACTERISTICS

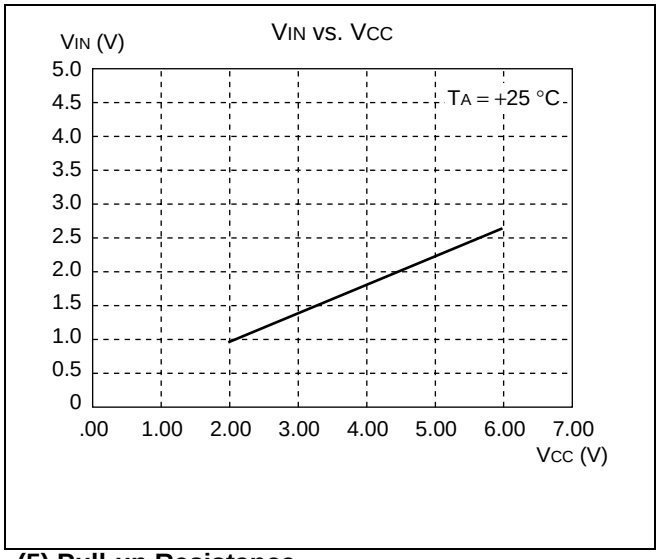
(1) “L” Level Output Voltage



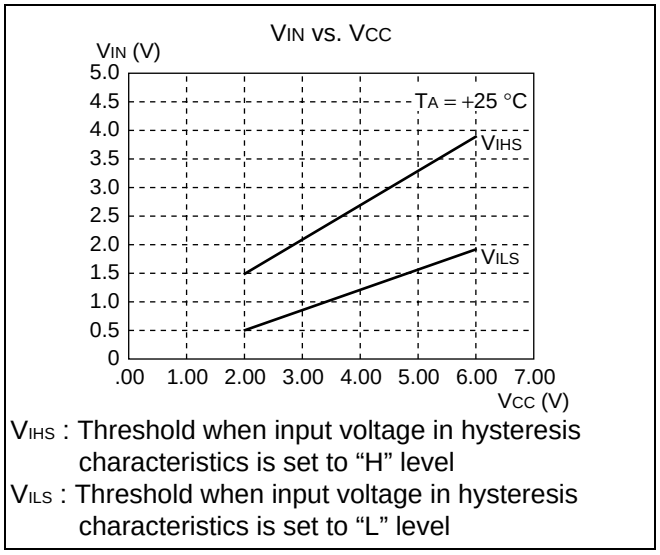
(2) “H” Level Output Voltage



(3) “H” Level Input Voltage/“L” Level Input Voltage (CMOS Input)



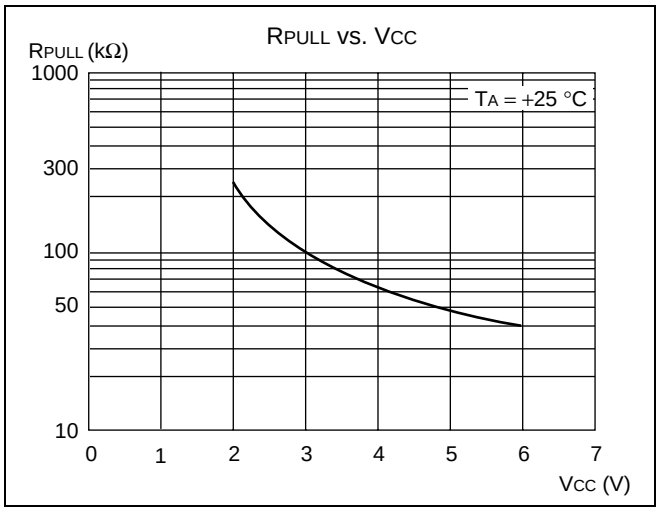
(4) “H” Level Input Voltage/“L” Level Input Voltage (Hysteresis Input)



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

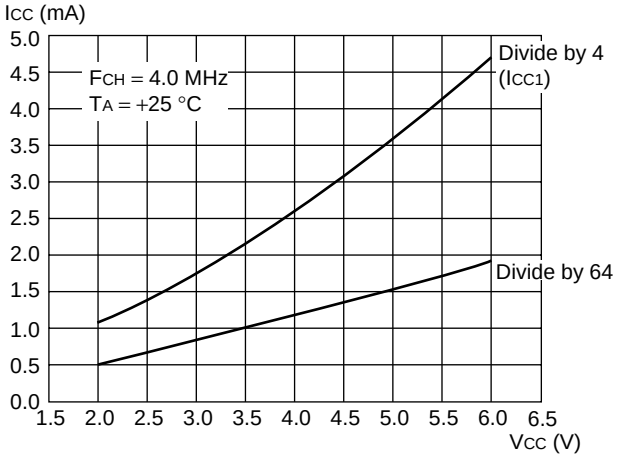
V_{ILS} : Threshold when input voltage in hysteresis characteristics is set to “L” level

(5) Pull-up Resistance

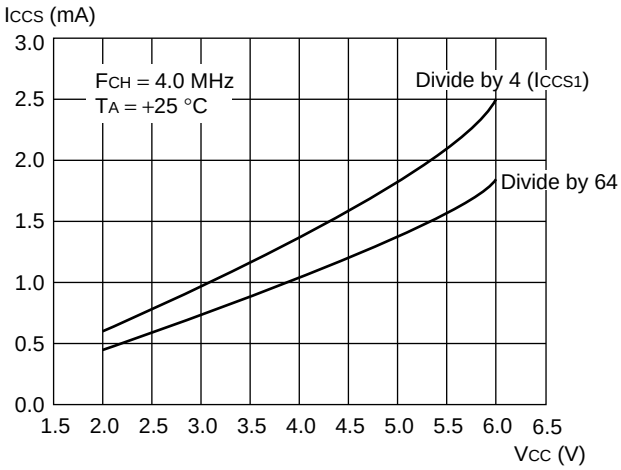


(6) Power Supply Current

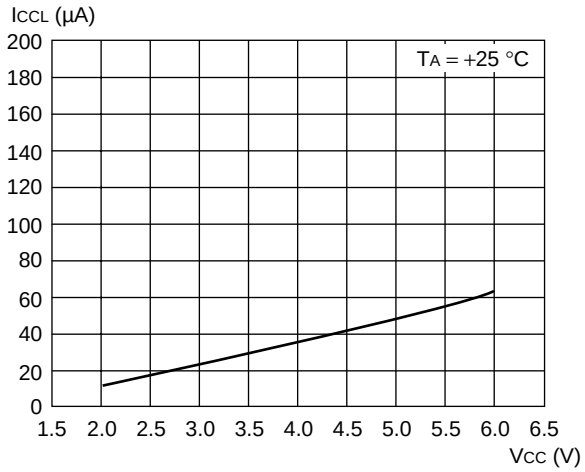
ICC1 vs. VCC



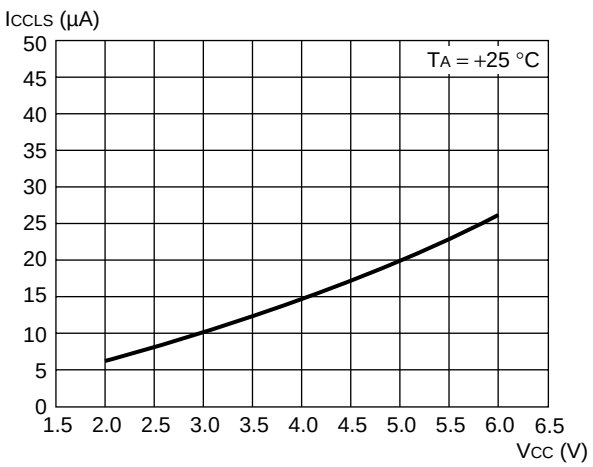
ICCS1 vs. VCC



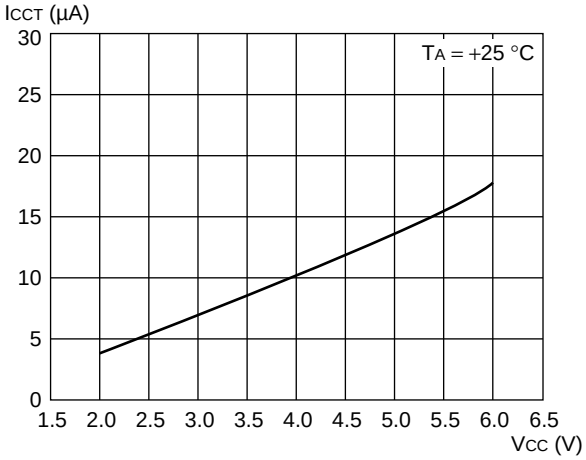
ICCL vs. VCC



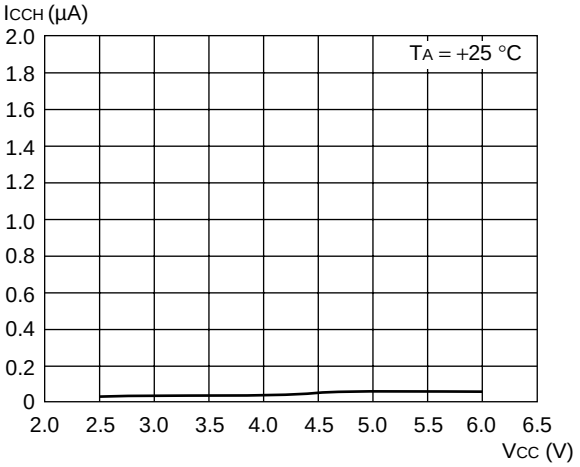
ICCLS vs. VCC



ICCT vs. VCC



ICCH vs. VCC



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

Columns indicate the following:

Mnemonic: Assembler notation of an instruction

~: 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.

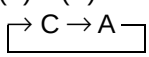
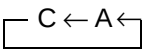
OP code: Code of an instruction. If an instruction is more than one code, it is written according to the following rule:
Example: 48 to 4F ← This indicates 48, 49, ... 4F.

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

Note: 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 F²MC-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		–	–	–	+ + – +	03
ROLC A	2	1		–	–	–	+ + – +	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)

(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 OPTIONS

No.	Part number	MB89121 MB89123A MB89125A	MB89P131 MB89P133A	MB89P135A	MB89PV130A
	Specifying procedure	Specify when ordering masking		Set with EPROM programmer	Specification impossible
1	Pull-up resistors • P00 to P07, P10 to P17, • P30 to P37, P40 to P43	Selectable by pin	Selectable by pin (P40 to P43 must be set to without a pull-up resistor.)		All pins fixed to no pull-up resistor optional
2	Power-on reset Power-on reset provided No power-on reset	Selectable	Selectable	Selectable	With power-on reset
3	Selection of oscillation stabilization wait time • The oscillation stabilization wait time initial value is selectable from 4 types given below. 0 : Oscillation stabilization $2^2/F_{CH}$ 1 : Oscillation stabilization $2^{12}/F_{CH}$ 2 : Oscillation stabilization $2^{16}/F_{CH}$ 3 : Oscillation stabilization $2^{18}/F_{CH}$	Selectable	Selectable	Selectable	Oscillation stabilization $2^{18}/F_{CH}$
4	Reset pin output • Reset output provided • No reset output	Selectable	Selectable	Selectable	With reset output
5	Clock mode selection • Single-clock mode • Dual-clock mode	Selectable	Selectable	Selectable	Dual-clock mode
6	Main clock oscillation circuit type • External clock input • Oscillation resonator	Selectable	Not required*1		
7	Peripheral control clock output function*2 • Not used • Used	Selectable	Not required*3		

*1 : Both external clock and oscillation resonator is usable on the one-time product.

*2 : “Used” must be selected when P33 (39 pin) is used as SCO for the peripheral control clock output.

*3 : The peripheral control clock function can be used only by software.

■ MB89P131/P133A STANDARD OPTIONS

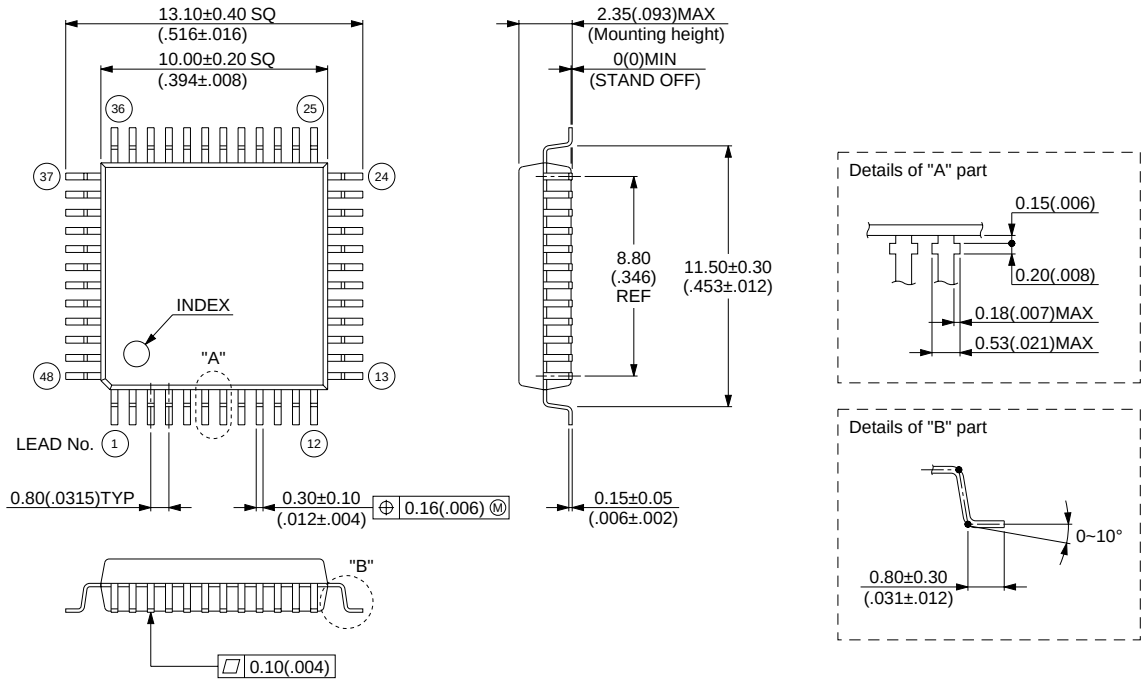
No.	Product option	MB89P131-101	MB89P133A-201
1	Pull-up resistor	Not provided for any port	Not provided for any port
2	Power-on reset	Provided	Provided
3	Selection of oscillation stabilization time	2 : Oscillation stabilization $2^{16}/F_{CH}$	2 : Oscillation stabilization $2^{16}/F_{CH}$
4	Reset pin output	Provided	Provided
5	Clock mode selection	Dual-clock mode	Dual-clock mode

■ ORDERING INFORMATION

Part number	Package	Remarks
MB89121PFM MB89123APFM MB89125APFM	48-pin Plastic QFP (FPT-48P-M13)	
MB89P131PFM-101 MB89P133APFM-201 MB89P135APFM		
MB89PV130ACF-ES	48-pin Ceramic MQFP (MQP-48C-P01)	

■ PACKAGE DIMENSION

48-pin Plastic QFP
(FPT-48P-M13)



Dimensions in mm (inches)

FUJITSU LIMITED

For further information please contact:

Japan

FUJITSU LIMITED
Corporate Global Business Support Division
Electronic Devices
Shinjuku Dai-Ichi Seimei Bldg. 7-1,
Nishishinjuku 2-chome, Shinjuku-ku,
Tokyo 163-0721, Japan
Tel: +81-3-5322-3347
Fax: +81-3-5322-3386

http://www.fujitsu.co.jp/

North and South America

FUJITSU MICROELECTRONICS, INC.
3545 North First Street,
San Jose, CA 95134-1804, U.S.A.
Tel: +1-408-922-9000
Fax: +1-408-922-9179

Customer Response Center
Mon. - Fri.: 7 am - 5 pm (PST)
Tel: +1-800-866-8608
Fax: +1-408-922-9179

http://www.fujitsumicro.com/

Europe

FUJITSU MICROELECTRONICS EUROPE GmbH
Am Siebenstein 6-10,
D-63303 Dreieich-Buchschlag,
Germany
Tel: +49-6103-690-0
Fax: +49-6103-690-122

http://www.fujitsu-fme.com/

Asia Pacific

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

http://www.fmap.com.sg/

Korea

FUJITSU MICROELECTRONICS KOREA LTD.
1702 KOSMO TOWER, 1002 Daechi-Dong,
Kangnam-Gu,Seoul 135-280
Korea
Tel: +82-2-3484-7100
Fax: +82-2-3484-7111

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