

8-bit Proprietary Microcontroller

CMOS

F²MC-8L MB89628R/629R/P629

MB89628R/629R/P629

■ DESCRIPTION

The MB89628R/629R/P629 have been developed as a general-purpose version of the F²MC*-8L family consisting of proprietary 8-bit, single-chip microcontrollers.

In addition to the F²MC-8L CPU core which can operate at low voltage but at high speed, the microcontrollers contain a variety of peripheral functions such as timers, serial interfaces, an A/D converter, and an external interrupt.

The MB89628R/629R/P629 are applicable to a wide range of applications from welfare to industrial equipment, including portable devices.

*: F²MC stands for FUJITSU Flexible Microcontroller.

■ FEATURES

- Large-size RAM
 - MB89P629: 4 Kbytes
 - MB89628R: 3 Kbytes
 - MB89629R: 3 Kbytes
- High-speed processing at low voltage
 - Minimum execution time: 0.4 μ s/3.5 V, 0.8 μ s/2.7 V
- F²MC-8L family CPU core

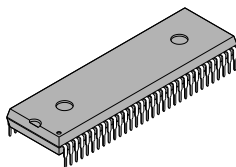
Instruction set optimized for controllers

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

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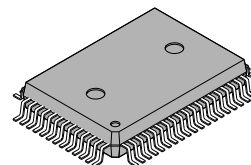
■ PACKAGE

64-pin Plastic SH-DIP



(DIP-64P-M01)

64-pin Plastic QFP



(FPT-64P-M06)

MB89628R/629R/P629

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- Four types of timers
 - 8-bit PWM timer (also usable as a reload timer)
 - 8-bit pulse width count timer (Continuous measurement capable, applicable to remote control, etc.)
 - 16-bit timer/counter
 - 20-bit time-base timer
- Two serial interfaces
 - Swichable the transfer direction allows communication with various equipment.
- 8-bit A/D converter
 - Sense mode function enabling comparison at 5 μ s
 - Activation by an external input capable
- External interrupt: 4 channels
 - Four channels are independent and capable of wake-up from low-power consumption modes (with an edge detection function).
- Low-power consumption modes
 - Stop mode (Oscillation stops to reduce the current consumption.)
 - Sleep mode (The CPU stops to reduce the current consumption to approx. 1/3 of normal.)

MB89628R/629R/P629

■ PRODUCT LINEUP

Part number	MB89628R	MB89629R	MB89P629	MB89PV620 ^{*1}
Parameter				
Classification	Mass production products (mask ROM products)		One-time PROM product for evaluation and development	Piggyback/evaluation product for evaluation and development
ROM size	24 K × 8 bits (internal mask ROM)	32 K × 8 bits (internal mask ROM)	32 K × 8 bits (internal PROM, programming with general-purpose EPROM programmer)	32 K × 8 bits (external ROM)
RAM size	3072 × 8 bits		4096 × 8 bits	1 K × 8 bits
CPU functions	Number of instructions: Instruction bit length: Instruction length: Data bit length: Minimum execution time: Interrupt processing time:		136 8 bits 1 to 3 bytes 1, 8, 16 bits 0.4 μs/10 MHz 3.6 μs/10 MHz	
Ports	Input ports: Output ports (N-ch open-drain): I/O ports (N-ch open-drain): Output ports (CMOS): I/O ports (CMOS): Total:		5 (4 ports also serve as peripherals.) 8 (All also serve as peripherals.) 8 (4 ports also serve as peripherals.) 8 24 53	
8-bit PWM timer	8-bit reload timer operation (toggled output capable, operating clock cycle: 0.4 μs to 3.3 ms) 8-bit resolution PWM operation (conversion cycle: 102 μs to 839 ms)			
8-bit pulse width count timer	8-bit timer operation (overflow output capable, operating clock cycle: 0.4 to 12.8 μs) 8-bit reload timer operation (toggled output capable, operating clock cycle: 0.4 to 12.8 μs) 8-bit pulse width measurement operation (Continuous measurement "H" pulse width/"L" pulse width/from ↑ to ↑/from ↓ to ↓ capable)			
16-bit timer/counter	16-bit timer operation (operating clock cycle: 0.4 μs) 16-bit event counter operation (Rising/falling/both edges selectability)			
8-bit serial I/O 1, 8-bit serial I/O 2	8-bits LSB first/MSB first transfer selectability One clock selectable from four transfer clocks (one external shift clock, three internal shift clocks: 0.8 μs, 3.2 μs, 12.8 μs)			
8-bit A/D converter	8-bit resolution × 8 channels A/D conversion mode (conversion time: 18 μs) Sense mode (conversion time: 5 μs) Continuous activation by an external activation or an internal timer capable Reference voltage input			
External interrupt	4 independent channels (edge selection, interrupt vector, source flag) Rising edge/falling edge selectability Used also for wake-up from stop/sleep mode. (Edge detection is also permitted in stop mode.)			
Standby modes	Sleep mode, stop mode			
Process	CMOS			
Operating voltage ^{*2}	2.2 V to 6.0 V		2.7 V to 6.0 V	
EPROM for use				MBM27C256A-20

*1: The piggyback/evaluation product is applicable to the MB89620 series.

*2: Varies with conditions such as the operating frequency. (See section "■ Electrical Characteristics.") In the case of the MB89PV620, the voltage varies with the restrictions of the EPROM for use.

MB89628R/629R/P629

■ PACKAGE AND CORRESPONDING PRODUCTS

Package	MB89628R MB89629R MB89P629	MB89PV620
DIP-64P-M01	○	×
FPT-64P-M06	○	×
MDP-64C-P02	×	○
MQP-64C-P01	×	○

○ : Available × : Not available

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

■ DIFFERENCES AMONG PRODUCTS

1. Memory Size

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

- On the MB89P629, the program area starts from address 8007_H but on the MB89PV620, MB89628R, and MB89629R starts from 8000_H. (On the MB89P629, addresses 8000_H to 8006_H comprise the option setting area, option settings can be read by reading these addresses. On the MB89PV620, MB89628R, and MB89629R, addresses 8000_H to 8006_H could also be used as a program ROM. However, do not use these addresses in order to maintain compatibility of the MB89P629.)

2. Current Consumption

- In the case of the MB89PV620, add the current consumed by the EPROM which is connected to the top socket.
- When operated at low speed, the product with an OTPROM (one-time PROM) or an EPROM will consume more current than the product with a mask ROM.

However, the current consumption in sleep/stop modes is the same. (For more information, see section “■ Electrical Characteristics”.)

3. Mask Options

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

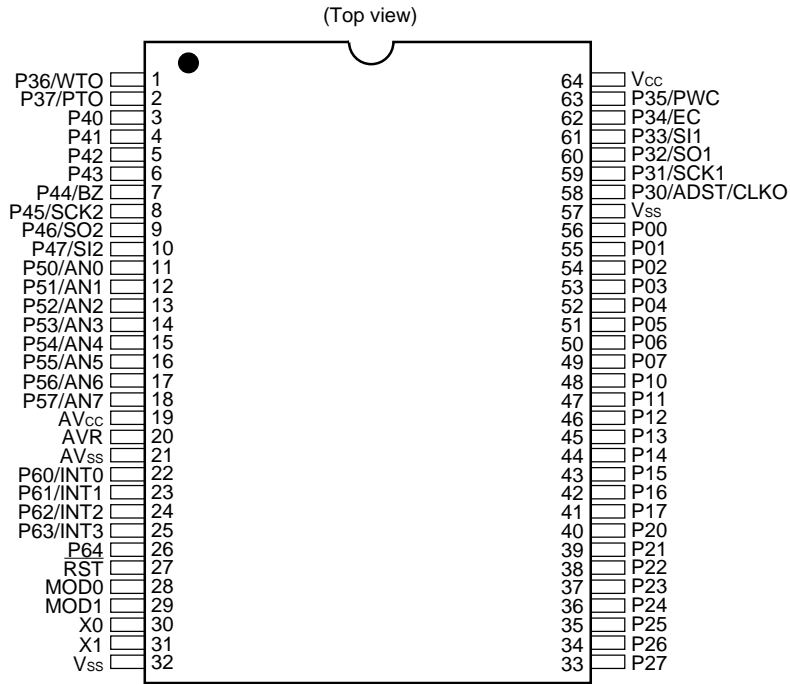
Before using options check section “■ Mask Options.”

Take particular care on the following points:

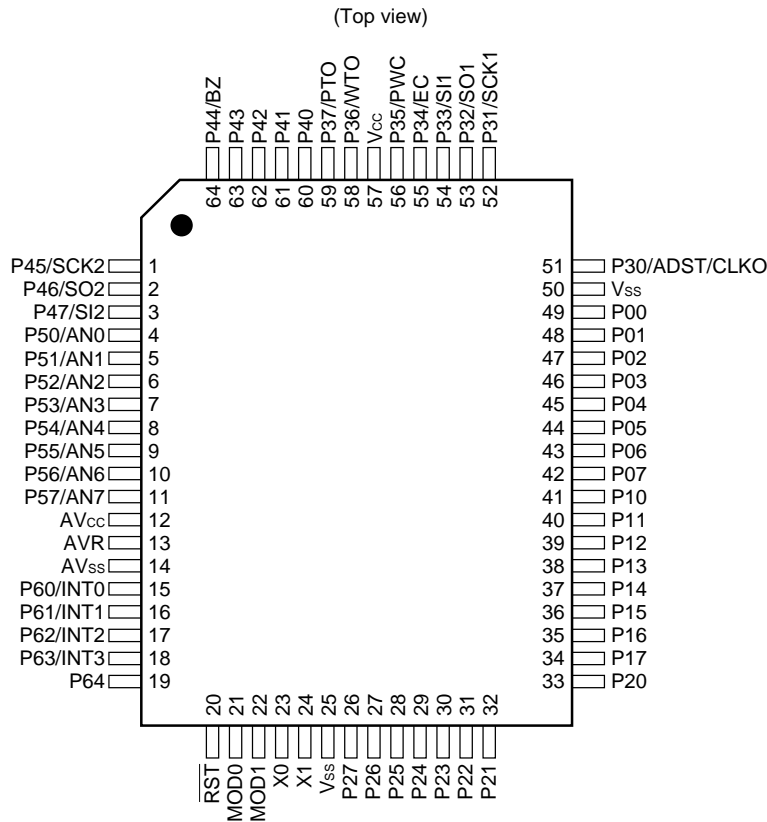
- A pull-up resistor cannot be set for P40 to P47 on the MB89P629.
- A pull-up resistor is not selected for P50 to P57 when the A/D converter is used.
- Options are fixed on the MB89PV620.

MB89628R/629R/P629

■ PIN ASSIGNMENT



(DIP-64P-M01)



(FPT-64P-M06)

MB89628R/629R/P629

■ PIN DESCRIPTION

Pin no.		Pin name	Circuit type	Function
SH-DIP ^{*1}	QFP ^{*2}			
30	23	X0	A	Crystal oscillator pins
31	24	X1		
28	21	MOD0	B	Operating mode selection pins Connect directly to V _{CC} or V _{SS} .
29	22	MOD1		
27	20	$\overline{\text{RST}}$	C	Reset I/O pin This pin is an N-ch open-drain output type with a pull-up resistor, and a hysteresis input type. "L" is output from this pin by an internal reset source. The internal circuit is initialized by the input of "L".
56 to 49	49 to 42	P00 to P07	D	General-purpose I/O ports
48 to 41	41 to 34	P10 to P17	D	
40, 39	33, 32	P20, P21	F	General-purpose output-only ports
38, 37	31, 30	P22, P23	D	
36 to 33	29 to 26	P24 to P27	F	
58	51	P30/ADST/ CLKO	E	General-purpose I/O port Also serves as an A/D converter external activation and an oscillation monitor clock output. This port is a hysteresis input type.
59	52	P31/SCK1	E	General-purpose I/O port Also serves as the clock I/O for the 8-bit serial I/O 1. This port is a hysteresis input type.
60	53	P32/SO1	E	General-purpose I/O port Also serves as the data output for the 8-bit serial I/O 1. This port is a hysteresis input type.
61	54	P33/SI1	E	General-purpose I/O port Also serves as the data input for the 8-bit serial I/O 1. This port is a hysteresis input type.
62	55	P34/EC	E	General-purpose I/O port Also serves as the external clock input for the 16-bit timer/counter. This port is a hysteresis input type.
63	56	P35/PWC	E	General-purpose I/O port Also serves as the measured pulse input for the 8-bit pulse width count timer. This port is a hysteresis input type.
1	58	P36/WTO	E	General-purpose I/O port Also serves as the toggle output for the 8-bit pulse width count timer. This port is a hysteresis input type.

*1: DIP-64P-M01

*2: FPT-64P-M06

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MB89628R/629R/P629

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Pin no.		Pin name	Circuit type	Function
SH-DIP ^{*1}	QFP ^{*2}			
2	59	P37/PTO	E	General-purpose I/O port Also serves as the toggle output for the 8-bit PWM timer. This port is a hysteresis input type.
3 to 6	60 to 63	P40 to P43	G	N-ch open-drain I/O ports These ports are a hysteresis input type.
7	64	P44/BZ	G	N-ch open-drain I/O port Also serves as a buzzer output. This port is a hysteresis input type.
8	1	P45/SCK2	G	N-ch open-drain I/O port Also serves as the clock I/O for the 8-bit serial I/O 2. This port is a hysteresis input type.
9	2	P46/SO2	G	N-ch open-drain I/O port Also serves as the data output for the 8-bit serial I/O 2. This port is a hysteresis input type.
10	3	P47/SI2	G	N-ch open-drain I/O port Also serves as the data input for the 8-bit serial I/O 2. This port is a hysteresis input type.
11 to 18	4 to 11	P50/AN0 to P57/AN7	H	N-ch open-drain output-only port Also serves as the analog input for the A/D converter.
22 to 25	15 to 18	P60/INT0 to P63/INT2	I	General-purpose input-only ports Also serve as an external interrupt input. These ports are a hysteresis input type.
26	19	P64	I	General-purpose input-only port This port is a hysteresis input type.
64	57	V _{cc}	—	Power supply pin
32, 57	25, 50	V _{ss}	—	Power supply (GND) pins
19	12	AV _{cc}	—	A/D converter power supply pin
20	13	AVR	—	A/D converter reference voltage input pin
21	14	AV _{ss}	—	A/D converter power supply (GND) pin. Use this pin at the same voltage as V _{ss} .

*1: DIP-64P-M01

*2: FPT-64P-M06

MB89628R/629R/P629

■ I/O CIRCUIT TYPE

Type	Circuit	Remarks
A	<p>Standby control signal</p>	<ul style="list-style-type: none"> At an oscillation feedback resistor of approximately 1 MΩ/5.0 V
B		
C		<ul style="list-style-type: none"> At an output pull-up resistor (P-ch) of approximately 50 MΩ/5.0 V CMOS hysteresis input
D		<ul style="list-style-type: none"> CMOS output CMOS input <p>• Pull-up resistor optional (except P22 and P23)</p>
E		<ul style="list-style-type: none"> CMOS output Hysteresis input <p>• Pull-up resistor optional</p>
F		<ul style="list-style-type: none"> CMOS output

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MB89628R/629R/P629

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Type	Circuit	Remarks
G		<ul style="list-style-type: none"> • N-ch open-drain output • Hysteresis input <ul style="list-style-type: none"> • Pull-up resistor optional (MB89628R and MB89629R only)
H		<ul style="list-style-type: none"> • N-ch open-drain output • Analog input
I		<ul style="list-style-type: none"> • Hysteresis input <ul style="list-style-type: none"> • Pull-up resistor optional

MB89628R/629R/P629

■ HANDLING DEVICES

1. Preventing Latchup

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

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

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

2. Treatment of Unused Input Pins

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

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

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

4. Treatment of N.C. Pins

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

5. Power Supply Voltage Fluctuations

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

6. Precautions when Using an External Clock

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

■ PROGRAMMING TO THE EPROM ON THE MB89P629

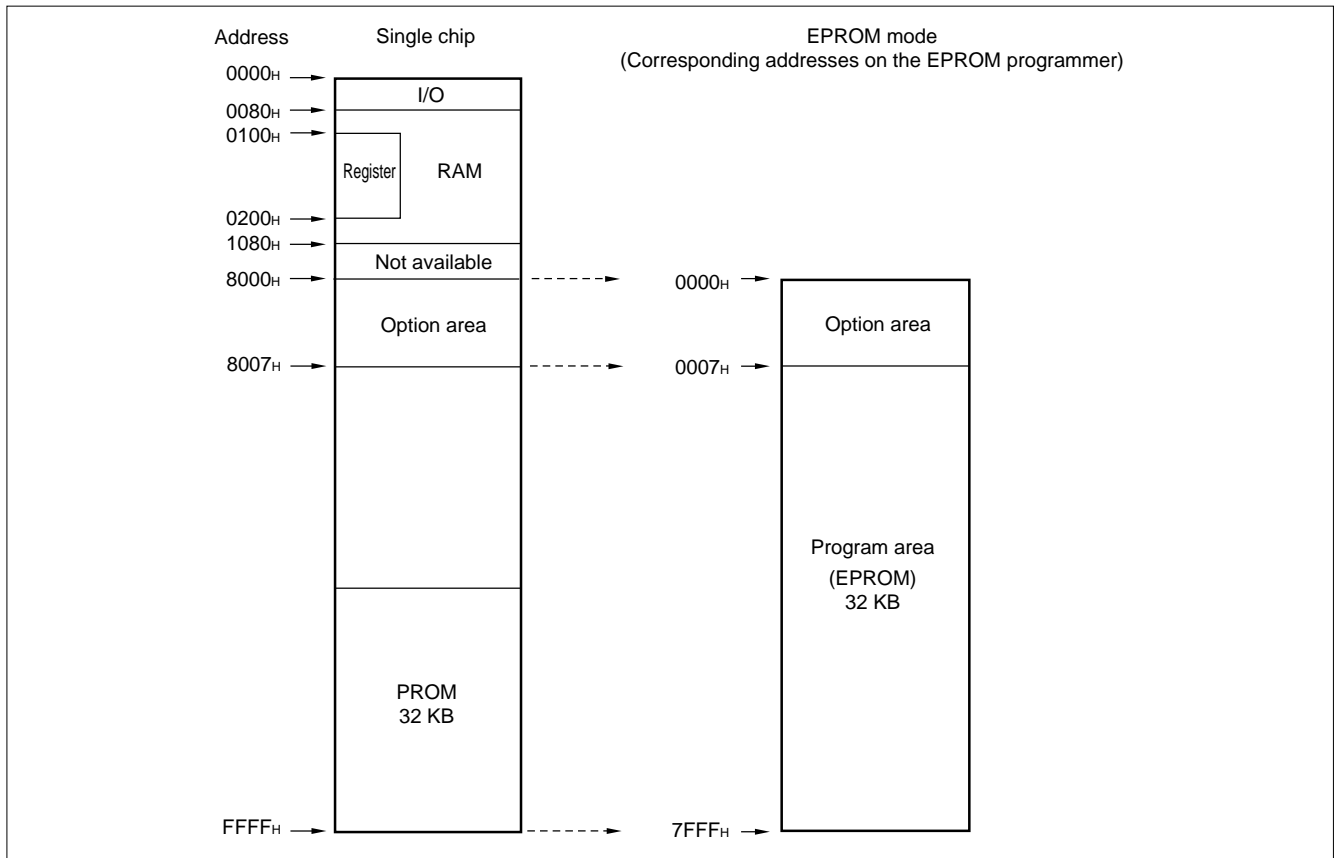
The MB89P629 is an OTPROM version of the MB89628R and MB89629R.

1. Features

- 16-Kbyte PROM on chip
- Options can be set using the EPROM programmer.
- Equivalency to the MBM27C256A in EPROM mode (when programmed with the EPROM programmer)

2. Memory Space

Memory space in EPROM mode, option area is diagrammed below.



3. Programming to the EPROM

In EPROM mode, the MB89P629 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.

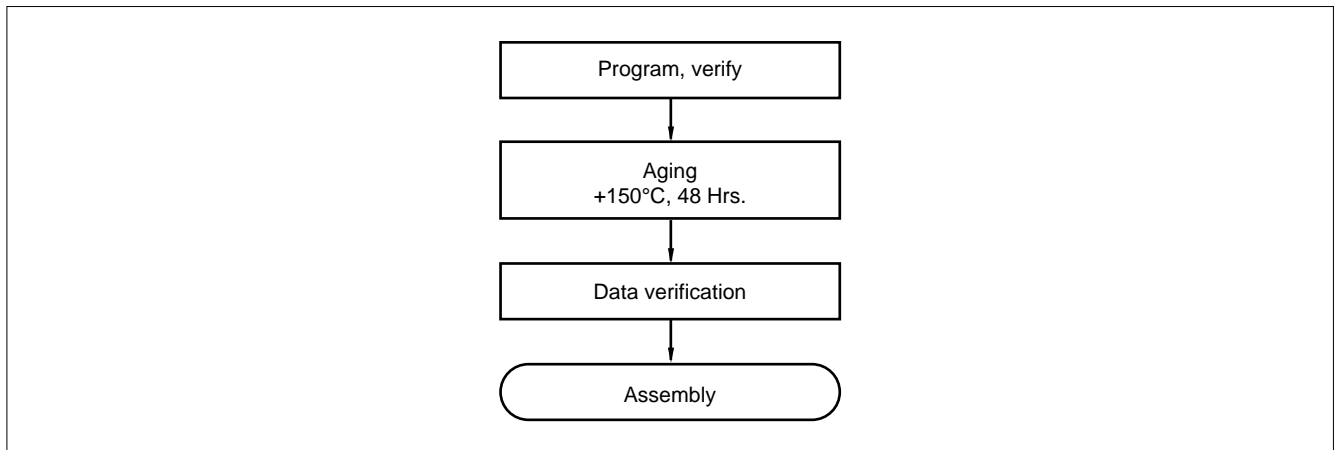
• Programming procedure

- (1) Set the EPROM programmer to the MBM27C256A.
- (2) Load program data into the EPROM programmer at 0000H to 7FFFH (note that addresses 8000H to FFFFH while operating as a single chip assign to 0000H to 7FFFH in EPROM mode. For information about each corresponding option, see "7. Setting OTPROM Options.")
- (3) Program to 0000H to 7FFFH with the EPROM programmer.

MB89628R/629R/P629

4. Recommended Screening Conditions

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



5. Programming Yield

All bits cannot be programmed at Fujitsu shipping test to a blanked OTPROM microcomputer, due to its nature. For this reason, a programming yield of 100% cannot be assured at all times.

6. EPROM Programmer Socket Adapter

Package	Compatible socket adapter
DIP-64P-M01	ROM-64SD-28DP-8L
FPT-64P-M06	ROM-64QF-28DP-8L

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

7. Setting OTPROM Options

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

	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
8000 _H (0000 _H)	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Oscillation stabilization time 1: Crystal 0: Ceramic	Reset pin output 1: Yes 2: No	Power-on reset 1: Yes 0: No	Vacancy Readable and writable	Vacancy Readable and writable
8001 _H (0001 _H)	P07 Pull-up 1: No 0: Yes	P06 Pull-up 1: No 0: Yes	P05 Pull-up 1: No 0: Yes	P04 Pull-up 1: No 0: Yes	P03 Pull-up 1: No 0: Yes	P02 Pull-up 1: No 0: Yes	P01 Pull-up 1: No 0: Yes	P00 Pull-up 1: No 0: Yes
8002 _H (0002 _H)	P17 Pull-up 1: No 0: Yes	P16 Pull-up 1: No 0: Yes	P15 Pull-up 1: No 0: Yes	P14 Pull-up 1: No 0: Yes	P13 Pull-up 1: No 0: Yes	P12 Pull-up 1: No 0: Yes	P11 Pull-up 1: No 0: Yes	P10 Pull-up 1: No 0: Yes
8003 _H (0003 _H)	P37 Pull-up 1: No 0: Yes	P36 Pull-up 1: No 0: Yes	P35 Pull-up 1: No 0: Yes	P34 Pull-up 1: No 0: Yes	P33 Pull-up 1: No 0: Yes	P32 Pull-up 1: No 0: Yes	P31 Pull-up 1: No 0: Yes	P30 Pull-up 1: No 0: Yes
8004 _H (0004 _H)	P57 Pull-up 1: No 0: Yes	P56 Pull-up 1: No 0: Yes	P55 Pull-up 1: No 0: Yes	P54 Pull-up 1: No 0: Yes	P53 Pull-up 1: No 0: Yes	P52 Pull-up 1: No 0: Yes	P51 Pull-up 1: No 0: Yes	P50 Pull-up 1: No 0: Yes
8005 _H (0005 _H)	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	P64 Pull-up 1: No 0: Yes	P63 Pull-up 1: No 0: Yes	P62 Pull-up 1: No 0: Yes	P61 Pull-up 1: No 0: Yes	P60 Pull-up 1: No 0: Yes
8006 _H (0006 _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	Reserved bit Readable and writable

- Notes:
- Set each bit to 1 to erase.
 - Do not write 0 to the vacant bit.
The read value of the vacant bit is 1, unless 0 is written to it.
 - Always write 0 to the reserved bit.

MB89628R/629R/P629

■ PROGRAMMING TO THE EPROM WITH PIGGYBACK/EVALUATION DEVICE

1. EPROM for Use

MBM27C256A-20TV, MBM27C256A-20CZ

2. Programming Socket Adapter

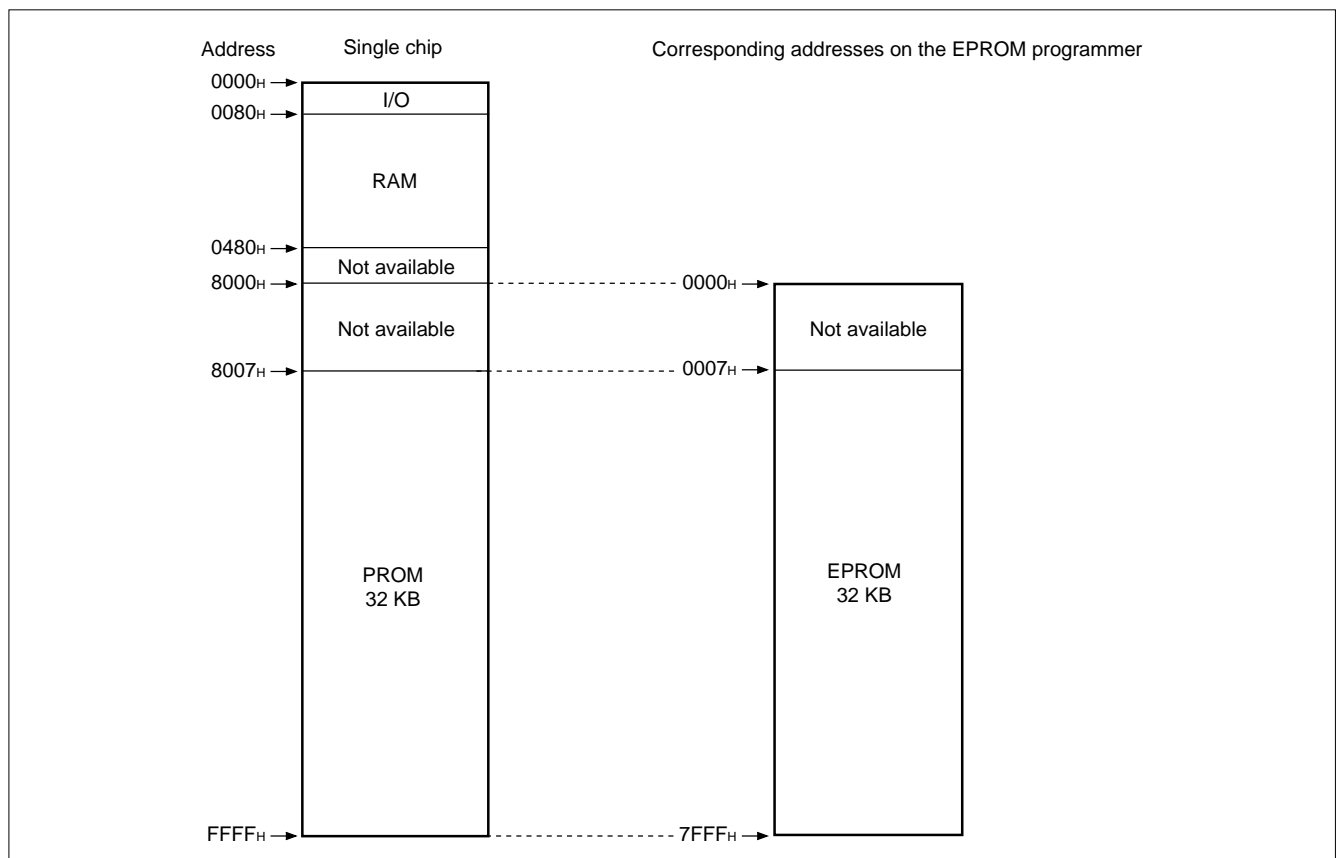
To program to the PROM using an EPROM programmer, use the socket adapter (manufacturer: Sun Hayato Co., Ltd.) listed below.

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

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

3. Memory Space

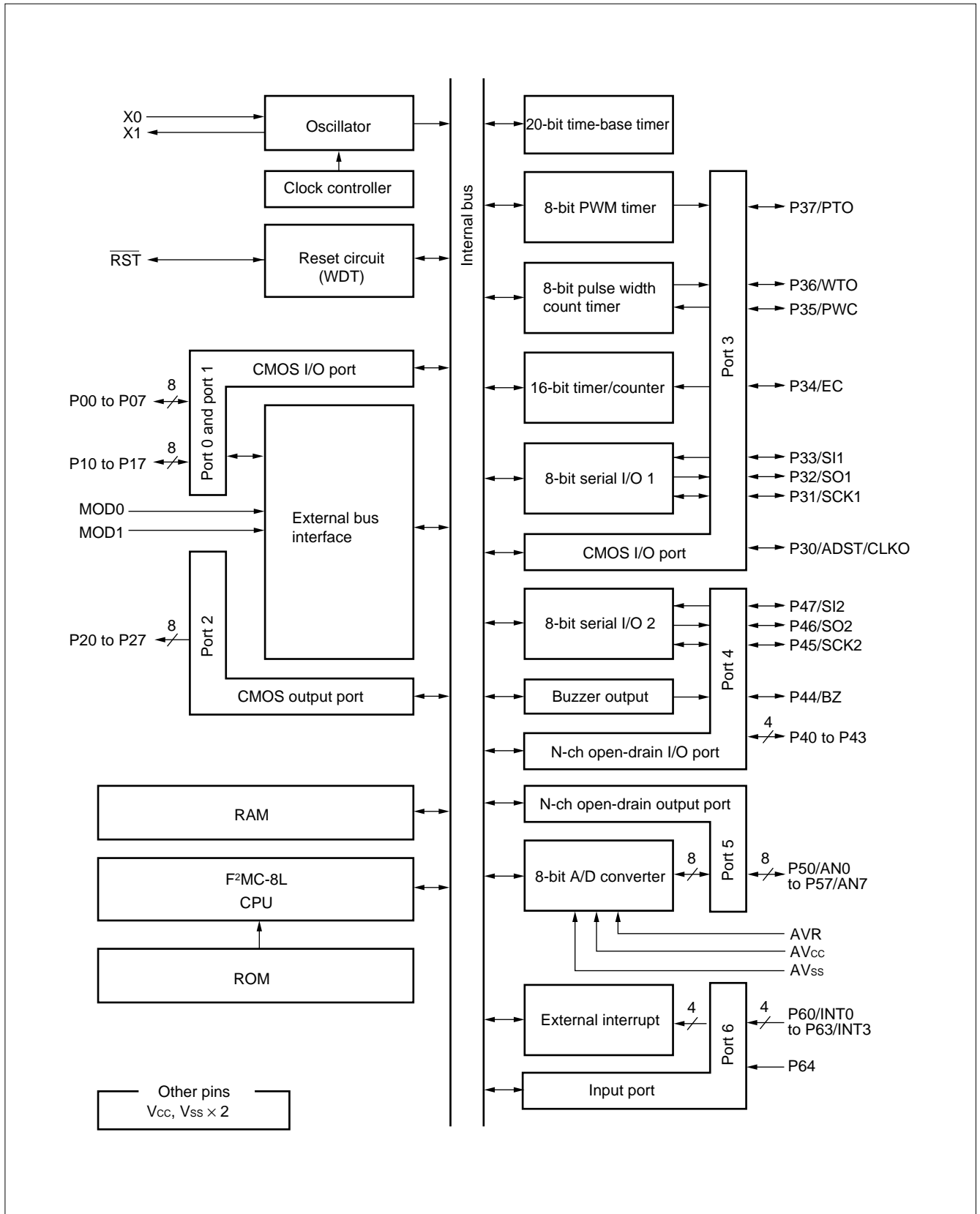
Memory space in 32-Kbyte PROM on the EPROM programmer is diagrammed below.



4. Programming to the EPROM

- (1) Set the EPROM programmer to the MBM27C256A.
- (2) Load program data into the EPROM programmer at 0007H to 7FFFH.
- (3) Program to 0000H to 7FFFH with the EPROM programmer.

■ BLOCK DIAGRAM

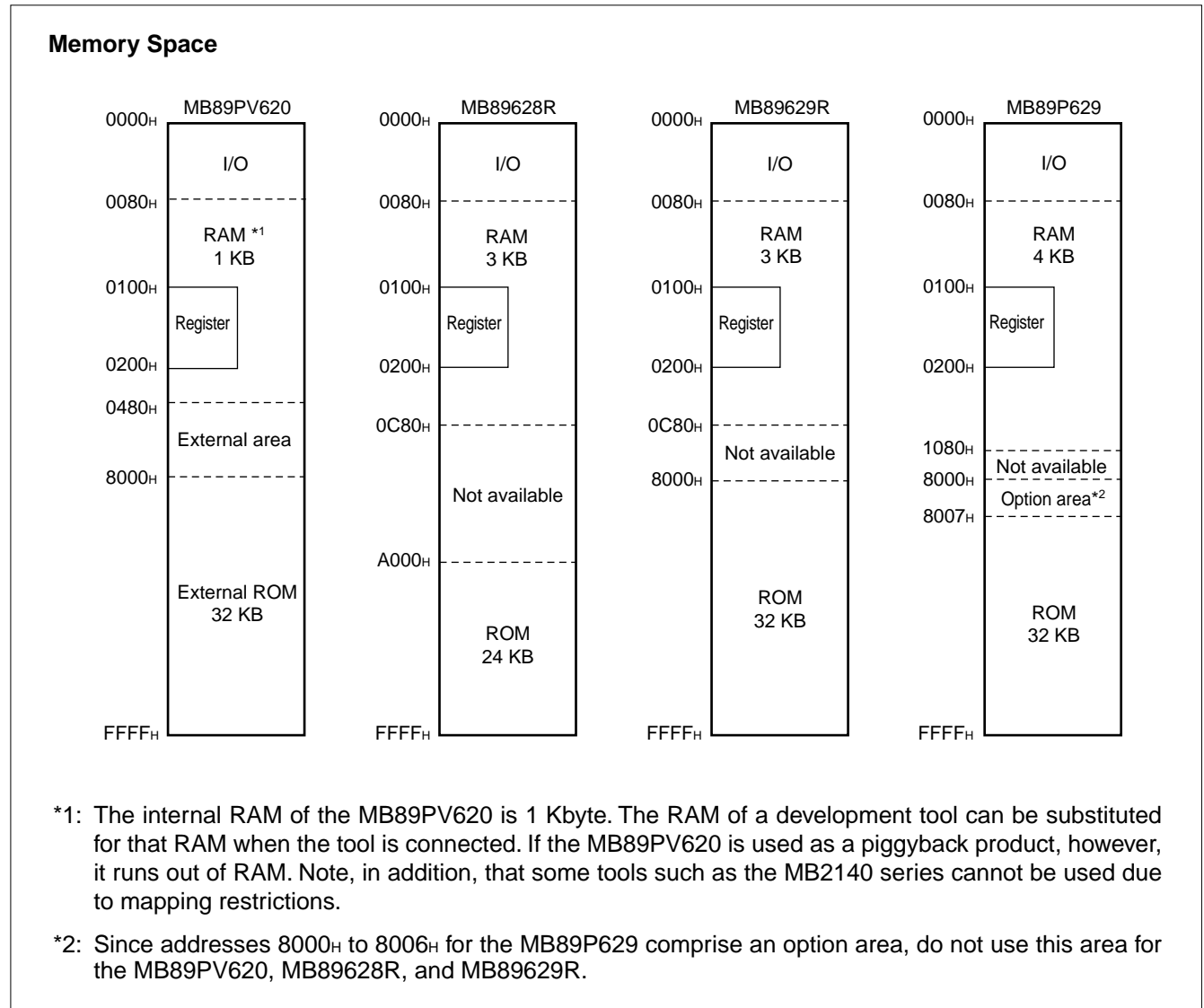


MB89628R/629R/P629

■ CPU CORE

1. Memory Space

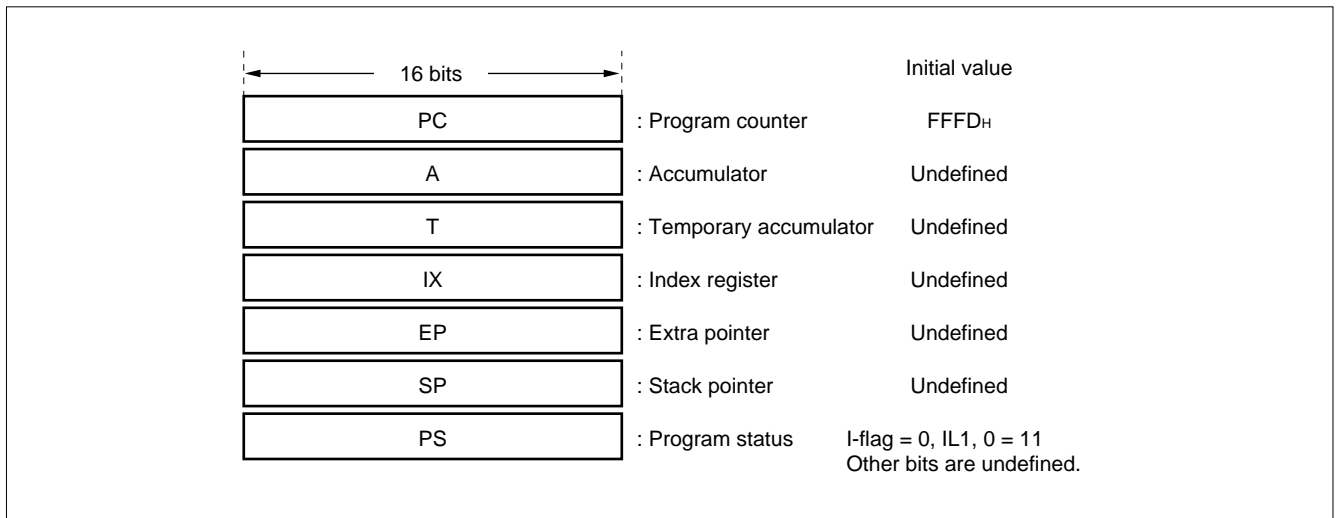
The microcontrollers of the MB89628R/629R/P629 offer a memory space of 64 Kbytes for storing all of I/O, data, and program areas. The I/O area is located at the lowest address. The data area is provided immediately above the I/O area. The data area can be divided into register, stack, and direct areas according to the application. The program area is located at exactly the opposite end, that is, near the highest address. Provide the tables of interrupt reset vectors and vector call instructions toward the highest address within the program area. The memory space of the MB89628R/629R/P629 is structured as illustrated below.



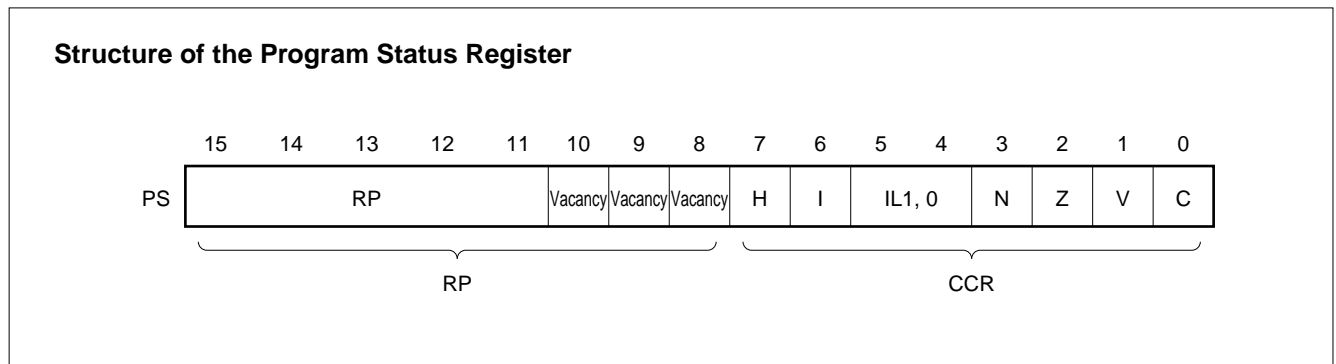
3. Registers

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

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



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

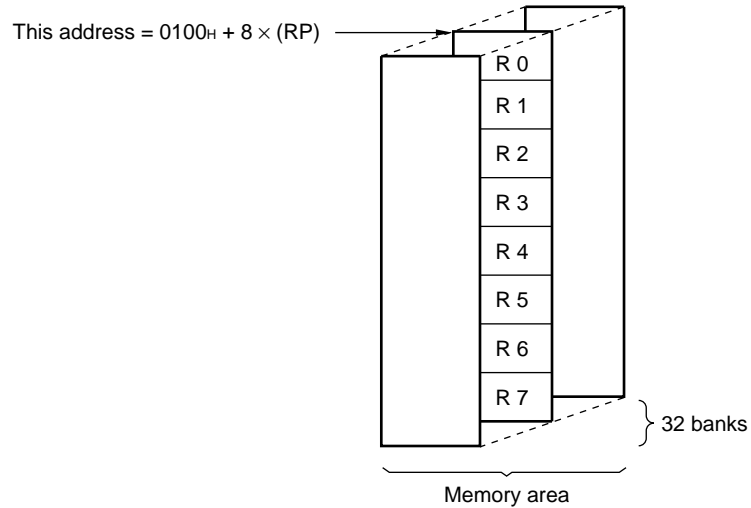


The following general-purpose registers are provided:

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

The general-purpose registers are 8 bits and located in the register banks of the memory. One bank contains eight registers and up to a total of 32 banks can be used on the MB89628R and MB89629R. The bank currently in use is indicated by the register bank pointer (RP).

Register Bank Configuration



MB89628R/629R/P629

■ 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	(R/W)	BCTR	External bus pin control register
06 _H			Vacancy
07 _H			Vacancy
08 _H	(R/W)	STBC	Standby control register
09 _H	(R/W)	WDTC	Watchdog timer control register
0A _H	(R/W)	TBTC	Time-base timer control register
0B _H			Vacancy
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	(R/W)	PDR5	Port 5 data register
11 _H	(R)	PDR6	Port 6 data register
12 _H	(R/W)	CNTR	PWM control register
13 _H	(W)	COMR	PWM compare register
14 _H	(R/W)	PCR1	PWC pulse width control register 1
15 _H	(R/W)	PCR2	PWC pulse width control register 2
16 _H	(R/W)	RLBR	PWC reload buffer register
17 _H			Vacancy
18 _H	(R/W)	TMCR	16-bit timer control register
19 _H	(R/W)	TCHR	16-bit timer count register (H)
1A _H	(R/W)	TCLR	16-bit timer count register (L)
1B _H			Vacancy
1C _H	(R/W)	SMR1	Serial I/O 1 mode register
1D _H	(R/W)	SDR1	Serial I/O 1 data register
1E _H	(R/W)	SMR2	Serial I/O 2 mode register
1F _H	(R/W)	SDR2	Serial I/O 2 data register

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Address	Read/write	Register name	Register description
20 _H	(R/W)	ADC1	A/D converter control register 1
21 _H	(R/W)	ADC2	A/D converter control register 2
22 _H	(R/W)	ADCD	A/D converter data register
23 _H			Vacancy
24 _H	(R/W)	EIC1	External interrupt control register 1
25 _H	(R/W)	EIC2	External interrupt control register 2
26 _H	(R/W)	CLKE	Clock output control register
27 _H to 7B _H			Vacancy
7C _H	(W)	ILR1	Interrupt level setting register 1
7D _H	(W)	ILR2	Interrupt level setting register 2
7E _H	(W)	ILR3	Interrupt level setting register 3
7F _H			Vacancy

Note: Do not use vacancies.

MB89628R/629R/P629

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

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

Parameter	Symbol	Value		Unit	Remarks
		Min.	Max.		
Power supply voltage	V_{CC} AV_{CC}	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	*1
A/D converter reference input voltage	AVR	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	AVR must not exceed $AV_{CC} + 0.3\text{ V}$.
Input voltage	V_I	$V_{SS} - 0.3$	$V_{CC} + 0.3$	V	Except P40 to P47*2
	V_{I2}	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	P40 to P47
Output voltage	V_O	$V_{SS} - 0.3$	$V_{CC} + 0.3$	V	Except P40 to P47*2
	V_{O2}	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	P40 to P47
“L” level maximum output current	I_{OL}	—	20	mA	
“L” level average output current	I_{OLAV}	—	4	mA	Average value (operating current × operating rate)
“L” level total maximum output current	ΣI_{OL}	—	100	mA	
“L” level total average output current	ΣI_{OLAV}	—	40	mA	Average value (operating current × operating rate)
“H” level maximum output current	I_{OH}	—	-20	mA	
“H” level average output current	I_{OHAV}	—	-4	mA	Average value (operating current × operating rate)
“H” level total maximum output current	ΣI_{OH}	—	-50	mA	
“H” level total average output current	ΣI_{OHAV}	—	-20	mA	Average value (operating current × operating rate)
Power consumption	P_D	—	300	mW	
Operating temperature	T_A	-40	+85	°C	
Storage temperature	T_{stg}	-55	+150	°C	

*1: Use AV_{CC} and V_{CC} set at the same voltage.

Take care so that AV_{CC} does not exceed V_{CC} , such as when power is turned on.

*2: V_I and V_O must not exceed $V_{CC} + 0.3\text{ V}$.

Precautions: Permanent device damage may occur if the above “Absolute Maximum Ratings” are exceeded. Functional operation should be restricted to the conditions as detailed in the operational sections of this data sheet. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

2. Recommended Operating Conditions

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

Parameter	Symbol	Value		Unit	Remarks
		Min.	Max.		
Power supply voltage	V _{CC} AV _{CC}	2.2*	6.0*	V	Normal operation assurance range* (MB89628R/629R)
		2.7*	6.0*	V	Normal operation assurance range* (MB89P629/PV620)
		1.5	6.0	V	Retains the RAM state in stop mode
A/D converter reference input voltage	AVR	0.0	AV _{CC}	V	
Operating temperature	T _A	-40	+85	°C	

* : These values vary with the operating frequency and analog assurance range. See Figure 1 and "5. A/D Converter Electrical Characteristics."

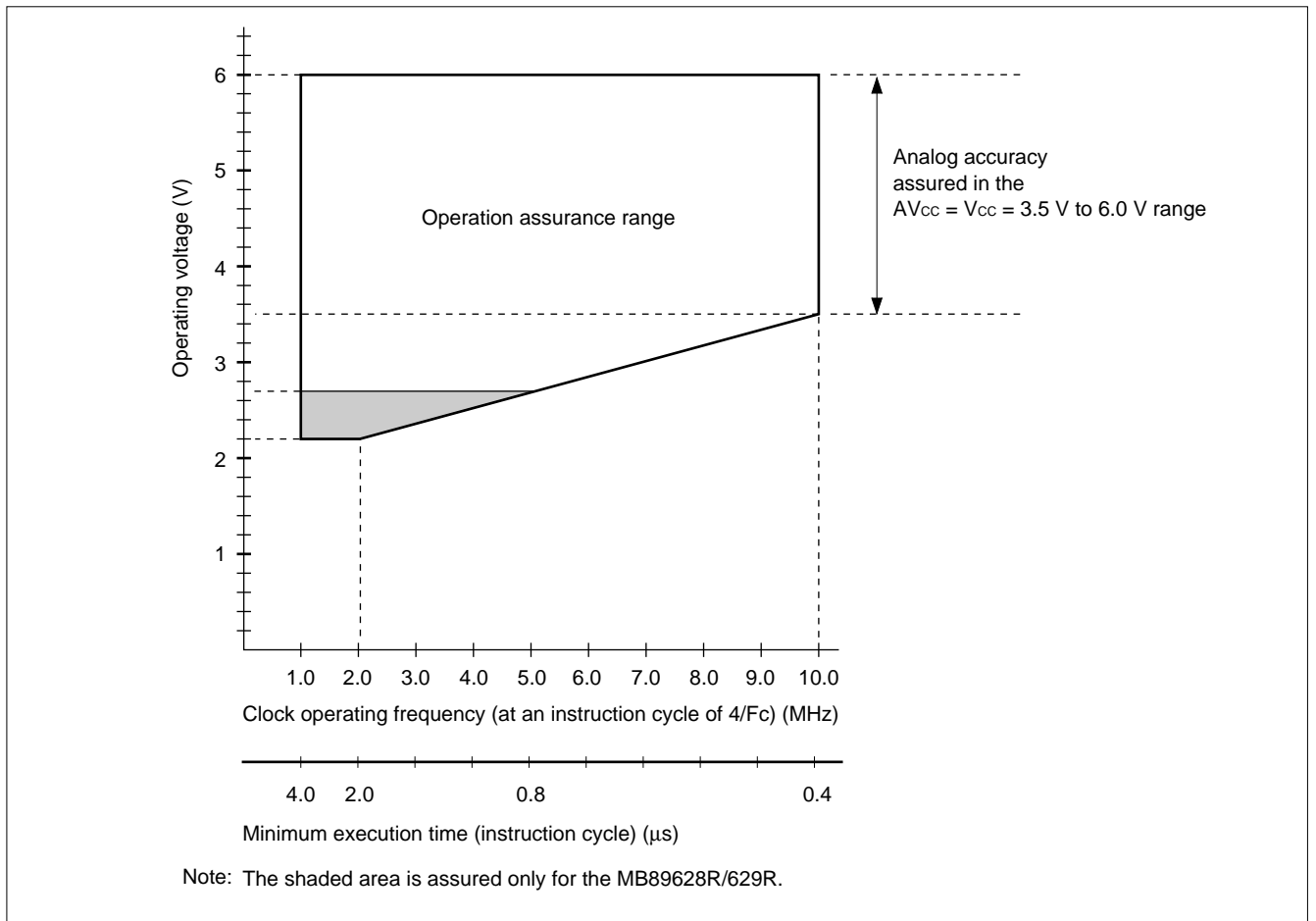


Figure 1 Operating Voltage vs. Clock Operating Frequency

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

MB89628R/629R/P629

3. DC Characteristics

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

Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
“H” level input voltage	V_{IH}	P00 to P07, P10 to P17, P22, P23	—	$0.7 V_{CC}$	—	$V_{CC} + 0.3$	V	
	V_{IHS}	\overline{RST} , MOD0, MOD1, P30 to P37, P60 to P64	—	$0.8 V_{CC}$	—	$V_{CC} + 0.3$	V	
	V_{IHS2}	P40 to P47	—	$0.8 V_{CC}$	—	$V_{SS} + 6.0$	V	
“L” level input voltage	V_{IL}	P00 to P07, P10 to P17, P22, P23	—	$V_{SS} - 0.3$	—	$0.3 V_{CC}$	V	
	V_{ILS}	\overline{RST} , MOD0, MOD1, P30 to P37, P40 to P47, P60 to P64	—	$V_{SS} - 0.3$	—	$0.2 V_{CC}$	V	
Open-drain output pin application voltage	V_D	P50 to P57	—	$V_{SS} - 0.3$	—	$V_{SS} + 0.3$	V	
	V_{D2}	P40 to P47	—	$V_{SS} - 0.3$	—	$V_{SS} + 6.0$	V	
“H” level output voltage	V_{OH}	P00 to P07, P10 to P17, P20 to P27, P30 to P37	$I_{OH} = -2.0\text{ mA}$	4.0	—	—	V	
“L” level output voltage	V_{OL}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57	$I_{OL} = +4.0\text{ mA}$	—	—	0.4	V	
	V_{OL2}	\overline{RST}		—	—	0.4	V	
Input leakage current (Hi-z output leakage current)	I_{LI1}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P60 to P64, MOD0, MOD1	$0.0\text{ V} < V_I < V_{CC}$	—	—	± 5	μA	Without pull-up resistor
Pull-up resistance	R_{PULL}	P00 to P07, P10 to P17, P30 to P37, P40 to P47, P50 to P57, P60 to P64, \overline{RST}	$V_I = 0.0\text{ V}$	25	50	100	$\text{k}\Omega$	

(Continued)

MB89628R/629R/P629

(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*	I _{CC}	V _{CC}	F _C = 10 MHz Normal operation mode (External clock)	—	9	15	mA	MB89628R, MB89629R	
				—	10	18	mA	MB89P629	
	I _{CCS}		F _C = 10 MHz Sleep mode (External clock)	—	3	4	mA		
	I _{CCH}		Stop mode T _A = +25°C	—	—	1	μA		
	I _A		AV _{CC}	F _C = 10 MHz, when A/D conversion is activated	—	1	3	mA	
	I _{AH}			F _C = 10 MHz, T _A = +25°C, when A/D conversion is stopped	—	—	1	μA	
Input capacitance	C _{IN}	Other than AV _{CC} , AV _{SS} , V _{CC} , and V _{SS}	f = 1 MHz	—	10	—	pF		

* : In the case of the MB89PV620, the current consumed by the connected EPROM and ICE is not included.
The power supply current is measured at the external clock.

MB89628R/629R/P629

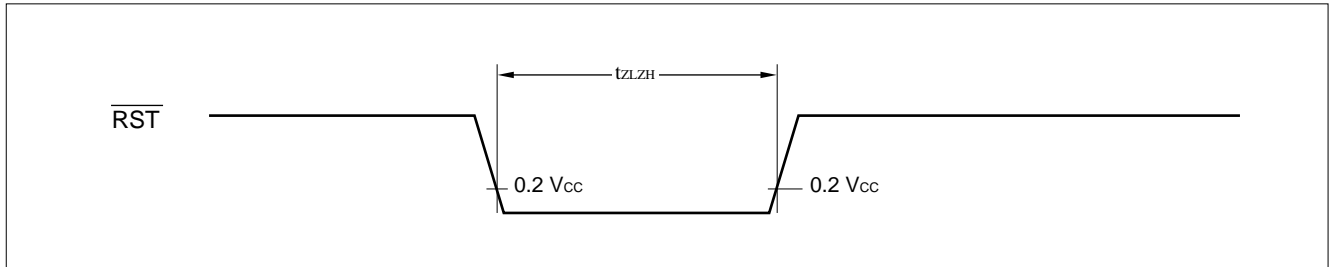
4. AC Characteristics

(1) Reset Timing

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

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

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



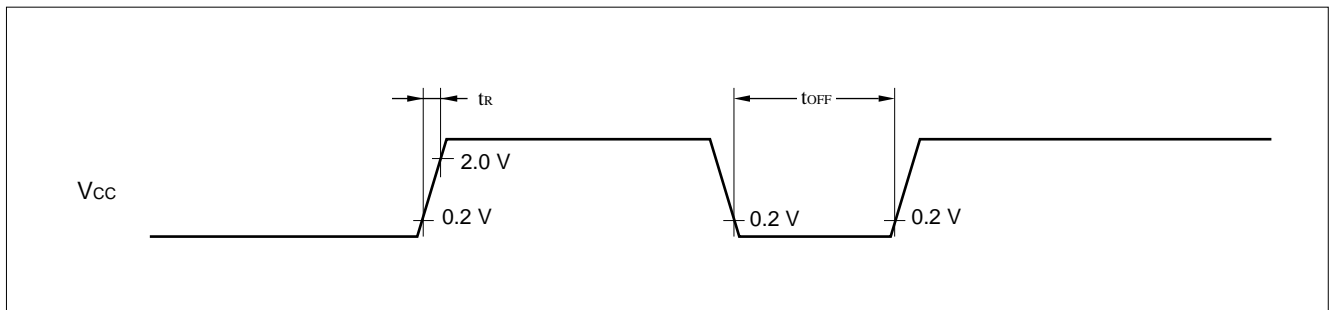
(2) Power-on Reset

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

Parameter	Symbol	Condition	Value		Unit	Remarks
			Min.	Max.		
Power supply rising time	t_{R}	—	—	50	ms	Power-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 selected oscillation stabilization time.

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

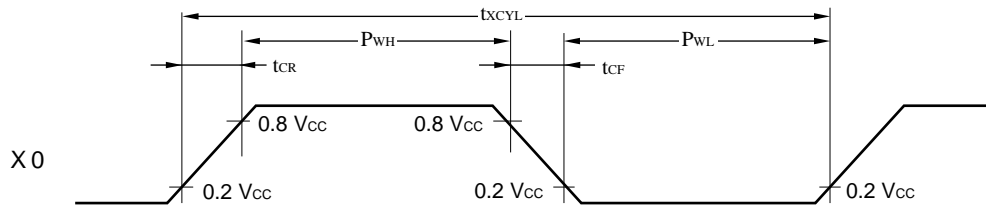


(3) Clock Timing

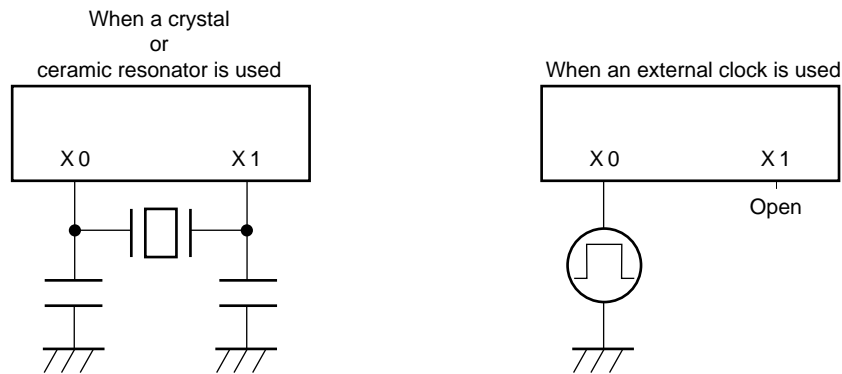
(AV_{SS} = V_{SS} = 0.0 V, T_A = -40°C to +85°C)

Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Clock frequency	F _C	X0, X1	—	1	10	MHz	
Clock cycle time	t _{xCYL}	X0, X1		100	1000	ns	
Input clock pulse width	P _{WH} P _{WL}	X0		20	—	ns	External clock
Input clock rising/falling time	t _{CR} t _{CF}	X0		—	10	ns	External clock

X0 and X1 Timing and Conditions



Clock Conditions



(4) Instruction Cycle

Parameter	Symbol	Value (typical)	Unit	Remarks
Instruction cycle (minimum execution time)	t _{inst}	4/F _C	μs	t _{inst} = 0.4 μs when operating at F _C = 10 MHz

MB89628R/629R/P629

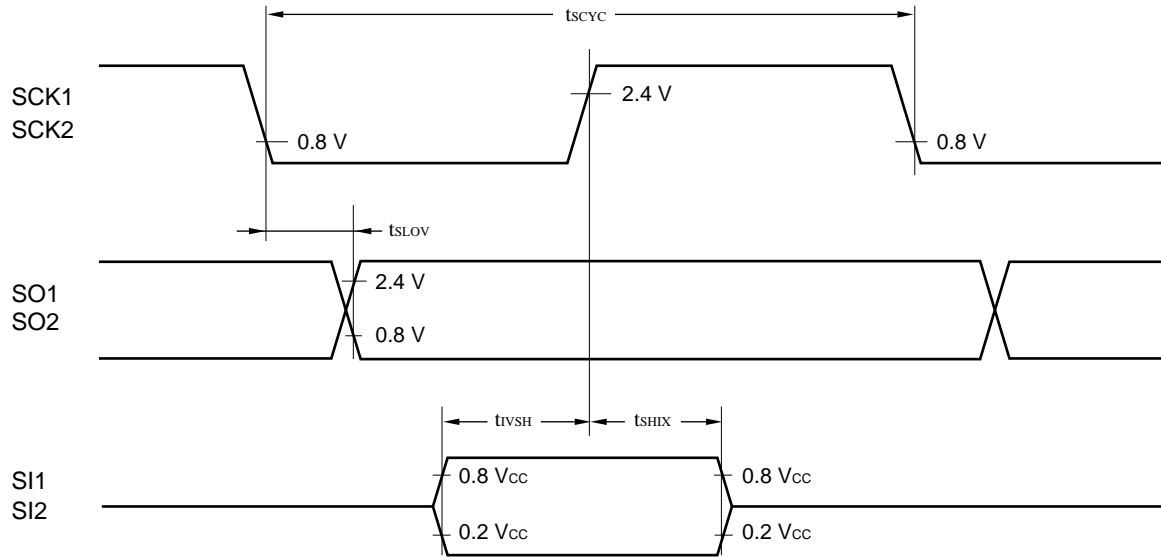
(5) Serial I/O Timing

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

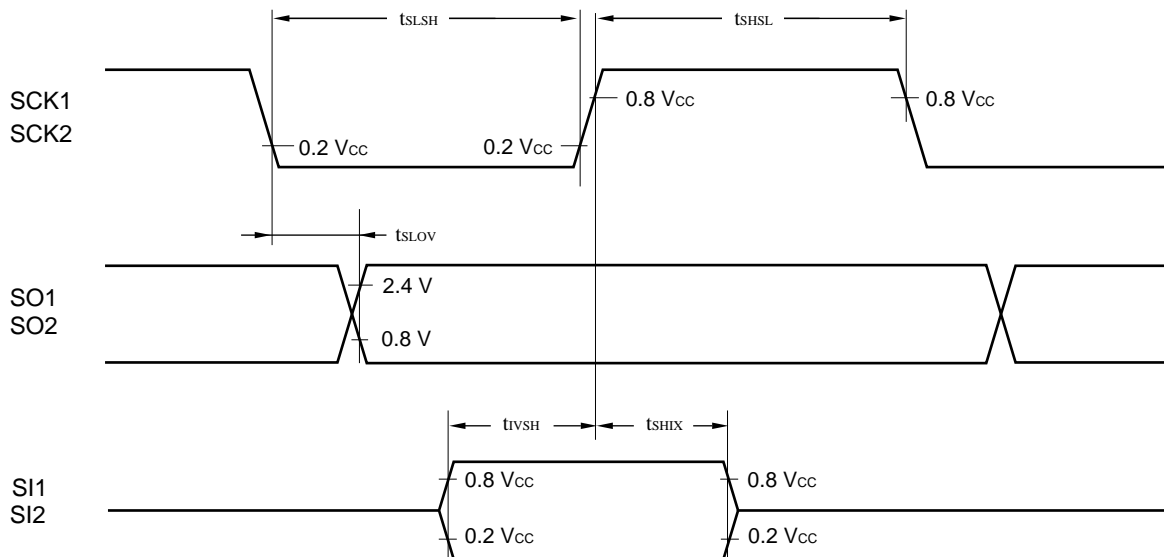
Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Serial clock cycle time	t_{SCYC}	SCK1, SCK2	Internal shift clock mode	$2 t_{inst}^*$	—	μs	
SCK1 $\downarrow \rightarrow$ SO1 time SCK2 $\downarrow \rightarrow$ SO2 time	t_{SLOV}	SCK1, SO1 SCK2, SO2		-200	200	ns	
Valid SI1 \rightarrow SCK1 \uparrow Valid SI2 \rightarrow SCK2 \uparrow	t_{IVSH}	SI1, SCK1 SI2, SCK2		$1/2 t_{inst}^*$	—	μs	
SCK1 $\uparrow \rightarrow$ valid SI1 hold time SCK2 $\uparrow \rightarrow$ valid SI2 hold time	t_{SHIX}	SCK1, SI1 SCK2, SI2		$1/2 t_{inst}^*$	—	μs	
Serial clock "H" pulse width	t_{SHSL}	SCK1, SCK2	External shift clock mode	$1 t_{inst}^*$	—	μs	
Serial clock "L" pulse width	t_{SLSH}	SCK1, SCK2		$1 t_{inst}^*$	—	μs	
SCK1 $\downarrow \rightarrow$ SO1 time SCK2 $\downarrow \rightarrow$ SO2 time	t_{SLOV}	SCK1, SO1 SCK2, SO2		0	200	ns	
Valid SI1 \rightarrow SCK1 \uparrow Valid SI2 \rightarrow SCK2 \uparrow	t_{IVSH}	SI1, SCK1 SI2, SCK2		$1/2 t_{inst}^*$	—	μs	
SCK1 $\uparrow \rightarrow$ valid SI1 hold time SCK2 $\uparrow \rightarrow$ valid SI2 hold time	t_{SHIX}	SCK1, SI1 SCK2, SI2		$1/2 t_{inst}^*$	—	μs	

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

Internal Shift Clock Mode



External Shift Clock Mode



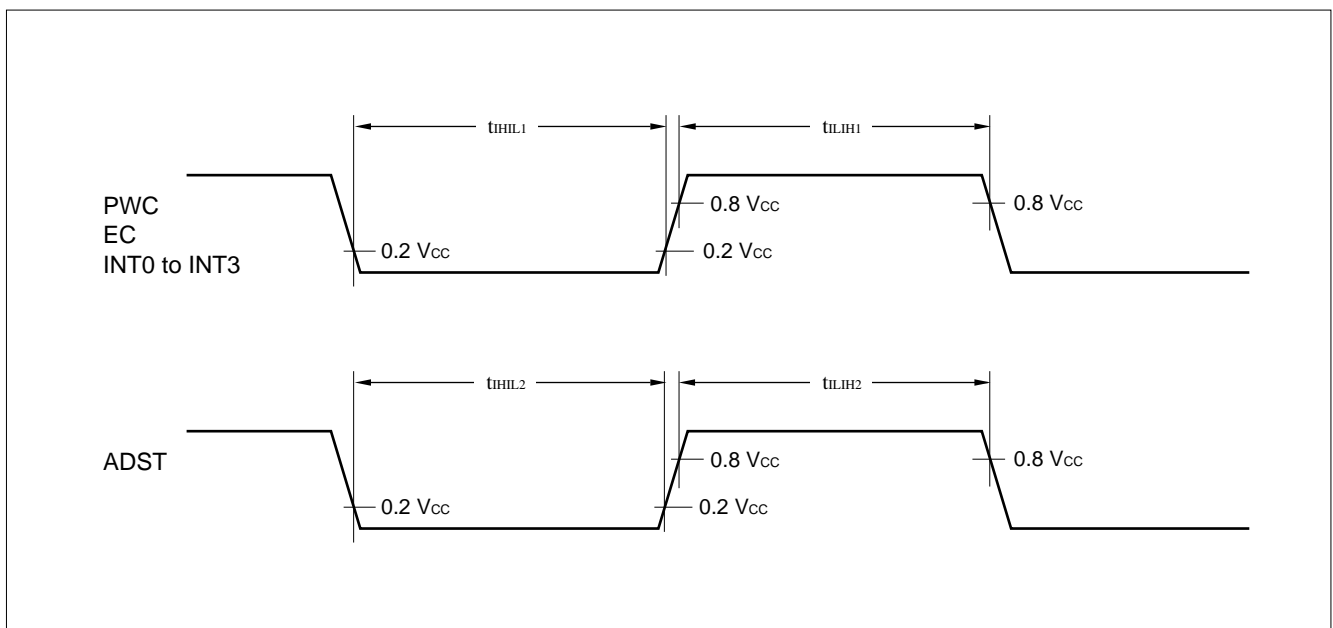
MB89628R/629R/P629

(6) Peripheral Input Timing

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

Parameter	Symbol	Pin	Condition	Value		Unit	Remarks
				Min.	Max.		
Peripheral input "H" pulse width 1	t_{LIH1}	PWC, EC, INT0 to INT3	—	$2 t_{inst}^*$	—	μs	
Peripheral input "L" pulse width 1	t_{LIL1}			$2 t_{inst}^*$	—	μs	
Peripheral input "H" pulse width 2	t_{LIH2}	ADST	A/D mode	$32 t_{inst}^*$	—	μs	
Peripheral input "L" pulse width 2	t_{LIL2}			$32 t_{inst}^*$	—	μs	
Peripheral input "H" pulse width 2	t_{LIH2}		Sense mode	$8 t_{inst}^*$	—	μs	
Peripheral input "L" pulse width 2	t_{LIL2}			$8 t_{inst}^*$	—	μs	

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



5. A/D Converter Electrical Characteristics

(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)

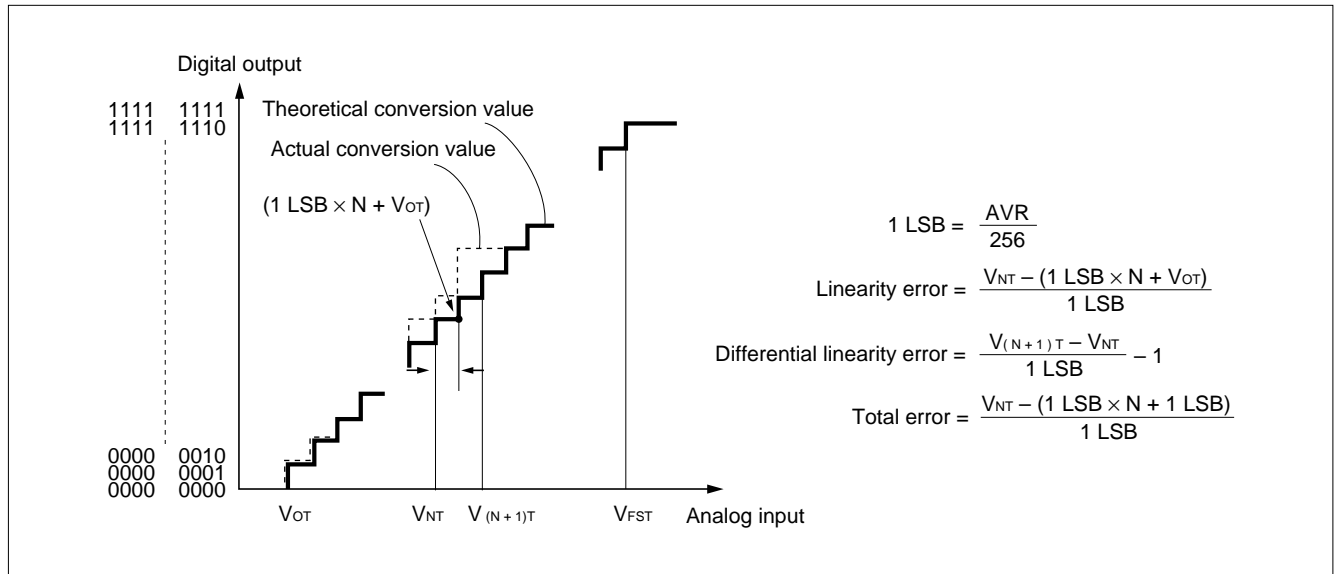
Parameter	Symbol	Pin	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Resolution			—	—	—	8	bit	
Total error	—	—	AVR = AV _{CC}	—	—	±1.5	LSB	
Linearity error				—	—	±1.0	LSB	
Differential linearity error				—	—	±0.9	LSB	
Zero transition voltage				V _{OT}	AV _{SS} - 1.0 LSB	AV _{SS} + 0.5 LSB	AV _{SS} + 2.0 LSB	mV
Full-scale transition voltage	V _{FST}	—	AVR - 3.0 LSB	AVR - 1.5 LSB	AVR	mV		
Interchannel 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	—	—	0.0	—	AVR	V		
Reference voltage	—	—	0.0	—	AV _{CC}	V		
Reference voltage supply current	I _R	AVR	AVR = 5.0 V, when A/D conversion activated	—	100	—	μA	
	I _{RH}	AVR	AVR = 5.0 V, when A/D conversion stopped	—	—	1	μA	

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

(1) A/D Glossary

- Resolution
Analog changes that are identifiable with the A/D converter.
When the number of bits is 8, analog voltage can be divided into 2⁸ = 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 1111" ↔ "1111 1110") from actual conversion characteristics
- Differential linearity error (unit: LSB)
The deviation of input voltage needed to change the output code by 1 LSB from the theoretical value
- Total error (unit: LSB)
The difference between theoretical and actual conversion values

MB89628R/629R/P629



(2) Precautions

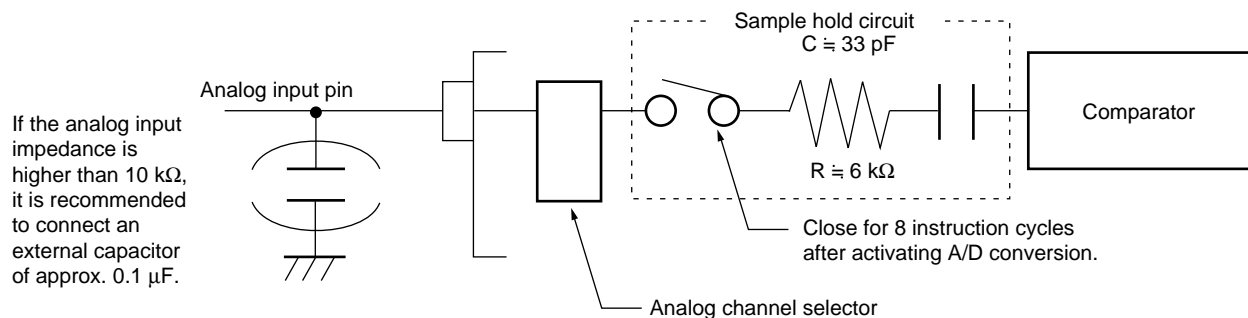
• Input impedance of the analog input pins

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

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

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

Analog Input Equivalent Circuit



• Error

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

■ INSTRUCTIONS

Execution instructions can be divided into the following four groups:

- Transfer
- Arithmetic operation
- Branch
- Others

Table 1 lists symbols used for notation of instructions.

Table 1 Instruction Symbols

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

(Continued)

MB89628R/629R/P629

(Continued)

Symbol	Meaning
EP	Extra pointer EP (16 bits)
PC	Program counter PC (16 bits)
SP	Stack pointer SP (16 bits)
PS	Program status PS (16 bits)
dr	Accumulator A or index register IX (16 bits)
CCR	Condition code register CCR (8 bits)
RP	Register bank pointer RP (5 bits)
Ri	General-purpose register Ri (8 bits, i = 0 to 7)
×	Indicates that the very × is the immediate data. (Whether its length is 8 or 16 bits is determined by the instruction in use.)
(×)	Indicates that the contents of × is the target of accessing. (Whether its length is 8 or 16 bits is determined by the instruction in use.)
((×))	The address indicated by the contents of × is the target of accessing. (Whether its length is 8 or 16 bits is determined by the instruction in use.)

Columns indicate the following:

Mnemonic: Assembler notation of an instruction

~: Number of instructions

#: Number of bytes

Operation: Operation of an instruction

TL, TH, AH: A content change when each of the TL, TH, and AH instructions is executed. Symbols in the column indicate the following:

- “–” indicates no change.
- dH is the 8 upper bits of operation description data.
- AL and AH must become the contents of AL and AH immediately before the instruction is executed.
- 00 becomes 00.

N, Z, V, C: An instruction of which the corresponding flag will change. If + is written in this column, the relevant instruction will change its corresponding flag.

OP code: Code of an instruction. If an instruction is more than one code, it is written according to the following rule:

Example: 48 to 4F ← This indicates 48, 49, ... 4F.

Table 2 Transfer Instructions (48 instructions)

Mnemonic	~	#	Operation	TL	TH	AH	NZVC	OP code
MOV dir,A	3	2	(dir) ← (A)	-	-	-	-----	45
MOV @IX +off,A	4	2	((IX) +off) ← (A)	-	-	-	-----	46
MOV ext,A	4	3	(ext) ← (A)	-	-	-	-----	61
MOV @EP,A	3	1	((EP)) ← (A)	-	-	-	-----	47
MOV Ri,A	3	1	(Ri) ← (A)	-	-	-	-----	48 to 4F
MOV A,#d8	2	2	(A) ← d8	AL	-	-	++--	04
MOV A,dir	3	2	(A) ← (dir)	AL	-	-	++--	05
MOV A,@IX +off	4	2	(A) ← ((IX) +off)	AL	-	-	++--	06
MOV A,ext	4	3	(A) ← (ext)	AL	-	-	++--	60
MOV A,@A	3	1	(A) ← ((A))	AL	-	-	++--	92
MOV A,@EP	3	1	(A) ← ((EP))	AL	-	-	++--	07
MOV A,Ri	3	1	(A) ← (Ri)	AL	-	-	++--	08 to 0F
MOV dir,#d8	4	3	(dir) ← d8	-	-	-	-----	85
MOV @IX +off,#d8	5	3	((IX) +off) ← d8	-	-	-	-----	86
MOV @EP,#d8	4	2	((EP)) ← d8	-	-	-	-----	87
MOV Ri,#d8	4	2	(Ri) ← d8	-	-	-	-----	88 to 8F
MOVW dir,A	4	2	(dir) ← (AH),(dir + 1) ← (AL)	-	-	-	-----	D5
MOVW @IX +off,A	5	2	((IX) +off) ← (AH), ((IX) +off + 1) ← (AL)	-	-	-	-----	D6
MOVW ext,A	5	3	(ext) ← (AH), (ext + 1) ← (AL)	-	-	-	-----	D4
MOVW @EP,A	4	1	((EP)) ← (AH),(EP) + 1) ← (AL)	-	-	-	-----	D7
MOVW EP,A	2	1	(EP) ← (A)	-	-	-	-----	E3
MOVW A,#d16	3	3	(A) ← d16	AL	AH	dH	++--	E4
MOVW A,dir	4	2	(AH) ← (dir), (AL) ← (dir + 1)	AL	AH	dH	++--	C5
MOVW A,@IX +off	5	2	(AH) ← ((IX) +off), (AL) ← ((IX) +off + 1)	AL	AH	dH	++--	C6
MOVW A,ext	5	3	(AH) ← (ext), (AL) ← (ext + 1)	AL	AH	dH	++--	C4
MOVW A,@A	4	1	(AH) ← ((A)), (AL) ← ((A) + 1)	AL	AH	dH	++--	93
MOVW A,@EP	4	1	(AH) ← ((EP)), (AL) ← ((EP) + 1)	AL	AH	dH	++--	C7
MOVW A,EP	2	1	(A) ← (EP)	-	-	dH	-----	F3
MOVW EP,#d16	3	3	(EP) ← d16	-	-	-	-----	E7
MOVW IX,A	2	1	(IX) ← (A)	-	-	-	-----	E2
MOVW A,IX	2	1	(A) ← (IX)	-	-	dH	-----	F2
MOVW SP,A	2	1	(SP) ← (A)	-	-	-	-----	E1
MOVW A,SP	2	1	(A) ← (SP)	-	-	dH	-----	F1
MOV @A,T	3	1	((A)) ← (T)	-	-	-	-----	82
MOVW @A,T	4	1	((A)) ← (TH),(A) + 1) ← (TL)	-	-	-	-----	83
MOVW IX,#d16	3	3	(IX) ← d16	-	-	-	-----	E6
MOVW A,PS	2	1	(A) ← (PS)	-	-	dH	-----	70
MOVW PS,A	2	1	(PS) ← (A)	-	-	-	++++	71
MOVW SP,#d16	3	3	(SP) ← d16	-	-	-	-----	E5
SWAP	2	1	(AH) ↔ (AL)	-	-	AL	-----	10
SETB dir: b	4	2	(dir): b ← 1	-	-	-	-----	A8 to AF
CLRB dir: b	4	2	(dir): b ← 0	-	-	-	-----	A0 to A7
XCH A,T	2	1	(AL) ↔ (TL)	AL	-	-	-----	42
XCHW A,T	3	1	(A) ↔ (T)	AL	AH	dH	-----	43
XCHW A,EP	3	1	(A) ↔ (EP)	-	-	dH	-----	F7
XCHW A,IX	3	1	(A) ↔ (IX)	-	-	dH	-----	F6
XCHW A,SP	3	1	(A) ↔ (SP)	-	-	dH	-----	F5
MOVW A,PC	2	1	(A) ← (PC)	-	-	dH	-----	F0

Notes: • During byte transfer to A, T ← A is restricted to low bytes.

- Operands in more than one operand instruction must be stored in the order in which their mnemonics are written. (Reverse arrangement of F²MC-8 family)

MB89628R/629R/P629

Table 3 Arithmetic Operation Instructions (62 instructions)

Mnemonic	~	#	Operation	TL	TH	AH	NZVC	OP code
ADDC A,Ri	3	1	$(A) \leftarrow (A) + (Ri) + C$	-	-	-	++++	28 to 2F
ADDC A,#d8	2	2	$(A) \leftarrow (A) + d8 + C$	-	-	-	++++	24
ADDC A,dir	3	2	$(A) \leftarrow (A) + (dir) + C$	-	-	-	++++	25
ADDC A,@IX +off	4	2	$(A) \leftarrow (A) + ((IX) + off) + C$	-	-	-	++++	26
ADDC A,@EP	3	1	$(A) \leftarrow (A) + ((EP)) + C$	-	-	-	++++	27
ADDCW A	3	1	$(A) \leftarrow (A) + (T) + C$	-	-	dH	++++	23
ADDC A	2	1	$(AL) \leftarrow (AL) + (TL) + C$	-	-	-	++++	22
SUBC A,Ri	3	1	$(A) \leftarrow (A) - (Ri) - C$	-	-	-	++++	38 to 3F
SUBC A,#d8	2	2	$(A) \leftarrow (A) - d8 - C$	-	-	-	++++	34
SUBC A,dir	3	2	$(A) \leftarrow (A) - (dir) - C$	-	-	-	++++	35
SUBC A,@IX +off	4	2	$(A) \leftarrow (A) - ((IX) + off) - C$	-	-	-	++++	36
SUBC A,@EP	3	1	$(A) \leftarrow (A) - ((EP)) - C$	-	-	-	++++	37
SUBCW A	3	1	$(A) \leftarrow (T) - (A) - C$	-	-	dH	++++	33
SUBC A	2	1	$(AL) \leftarrow (TL) - (AL) - C$	-	-	-	++++	32
INC Ri	4	1	$(Ri) \leftarrow (Ri) + 1$	-	-	-	+++ -	C8 to CF
INCW EP	3	1	$(EP) \leftarrow (EP) + 1$	-	-	-	----	C3
INCW IX	3	1	$(IX) \leftarrow (IX) + 1$	-	-	-	----	C2
INCW A	3	1	$(A) \leftarrow (A) + 1$	-	-	dH	++ - -	C0
DEC Ri	4	1	$(Ri) \leftarrow (Ri) - 1$	-	-	-	+++ -	D8 to DF
DECW EP	3	1	$(EP) \leftarrow (EP) - 1$	-	-	-	----	D3
DECW IX	3	1	$(IX) \leftarrow (IX) - 1$	-	-	-	----	D2
DECW A	3	1	$(A) \leftarrow (A) - 1$	-	-	dH	++ - -	D0
MULU A	19	1	$(A) \leftarrow (AL) \times (TL)$	-	-	dH	----	01
DIVU A	21	1	$(A) \leftarrow (T) / (AL), MOD \rightarrow (T)$	dL	00	00	----	11
ANDW A	3	1	$(A) \leftarrow (A) \wedge (T)$	-	-	dH	++ R -	63
ORW A	3	1	$(A) \leftarrow (A) \vee (T)$	-	-	dH	++ R -	73
XORW A	3	1	$(A) \leftarrow (A) \nabla (T)$	-	-	dH	++ R -	53
CMP A	2	1	$(TL) - (AL)$	-	-	-	++++	12
CMPW A	3	1	$(T) - (A)$	-	-	-	++++	13
RORC A	2	1	$\rightarrow C \rightarrow A$	-	-	-	++ - +	03
ROLC A	2	1	$\leftarrow C \leftarrow A$	-	-	-	++ - +	02
CMP A,#d8	2	2	$(A) - d8$	-	-	-	++++	14
CMP A,dir	3	2	$(A) - (dir)$	-	-	-	++++	15
CMP A,@EP	3	1	$(A) - ((EP))$	-	-	-	++++	17
CMP A,@IX +off	4	2	$(A) - ((IX) + off)$	-	-	-	++++	16
CMP A,Ri	3	1	$(A) - (Ri)$	-	-	-	++++	18 to 1F
DAA	2	1	Decimal adjust for addition	-	-	-	++++	84
DAS	2	1	Decimal adjust for subtraction	-	-	-	++++	94
XOR A	2	1	$(A) \leftarrow (AL) \nabla (TL)$	-	-	-	++ R -	52
XOR A,#d8	2	2	$(A) \leftarrow (AL) \nabla d8$	-	-	-	++ R -	54
XOR A,dir	3	2	$(A) \leftarrow (AL) \nabla (dir)$	-	-	-	++ R -	55
XOR A,@EP	3	1	$(A) \leftarrow (AL) \nabla ((EP))$	-	-	-	++ R -	57
XOR A,@IX +off	4	2	$(A) \leftarrow (AL) \nabla ((IX) + off)$	-	-	-	++ R -	56
XOR A,Ri	3	1	$(A) \leftarrow (AL) \nabla (Ri)$	-	-	-	++ R -	58 to 5F
AND A	2	1	$(A) \leftarrow (AL) \wedge (TL)$	-	-	-	++ R -	62
AND A,#d8	2	2	$(A) \leftarrow (AL) \wedge d8$	-	-	-	++ R -	64
AND A,dir	3	2	$(A) \leftarrow (AL) \wedge (dir)$	-	-	-	++ R -	65

(Continued)

(Continued)

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

Table 4 Branch Instructions (17 instructions)

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

Table 5 Other Instructions (9 instructions)

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

MB89628R/629R/P629

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	MULLU A	DIVU A	JMP addr16	CALL addr16	PUSHW IX	POPW IX	MOV ext,A	MOVW PS,A	CLRC	SETC	CLRB dir:1	BBC dir:1,rel	INCW SP	DECW SP	MOVW SPA	MOVW A,SP
2	ROLCL 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	RORCL 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 EPA	MOVW A,EP
4	MOV A,#d8	CMP A,#d8	ADDC A,#d8	SUBC A,#d8	/	XOR A,#d8	AND A,#d8	OR A,#d8	DAA	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 @EPA	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 @EPA	MOVW EP,#d16	XCHW A,EP
8	MOV A,R0	CMP A,R0	ADDC A,R0	SUBC A,R0	MOV R0,A	XOR A,R0	AND A,R0	OR A,R0	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

MB89628R/629R/P629

■ MASK OPTIONS

No.	Model	MB89628R/ MB89629R	MB89P629	MB89PV620
	Specifying procedure	Specify when ordering masking	Set with EPROM programmer	Setting not possible
1	Pull-up resistors <ul style="list-style-type: none"> ┌ P00 to P07, P10 to P17, ├ P30 to P37, P40 to P47, └ P50 to P57, P60 to P64 	Selectable per pin. (P50 to P57 must be set to without a pull-up resistor when an A/D converter is used.)	Can be set per pin. (P40 to P47 are available only for without a pull-up resistor.)	Fixed to without pull-up resistor
2	Power-on reset <ul style="list-style-type: none"> ┌ With power-on reset └ Without power-on reset 	Selectable	Setting possible	Fixed to with power-on reset
3	Oscillation stabilization time selection <ul style="list-style-type: none"> ┌ Crystal oscillator: ($2^{18}/F_c$) (26.2 ms/10 MHz) └ Ceramic oscillator: ($2^{14}/F_c$) (1.64 ms/10 MHz) 	Selectable	Setting possible	Fixed to crystal oscillator of $2^{18}/F_c$
4	Reset pin output <ul style="list-style-type: none"> ┌ With reset output └ Without reset output 	Selectable	Setting possible	Fixed to with reset output

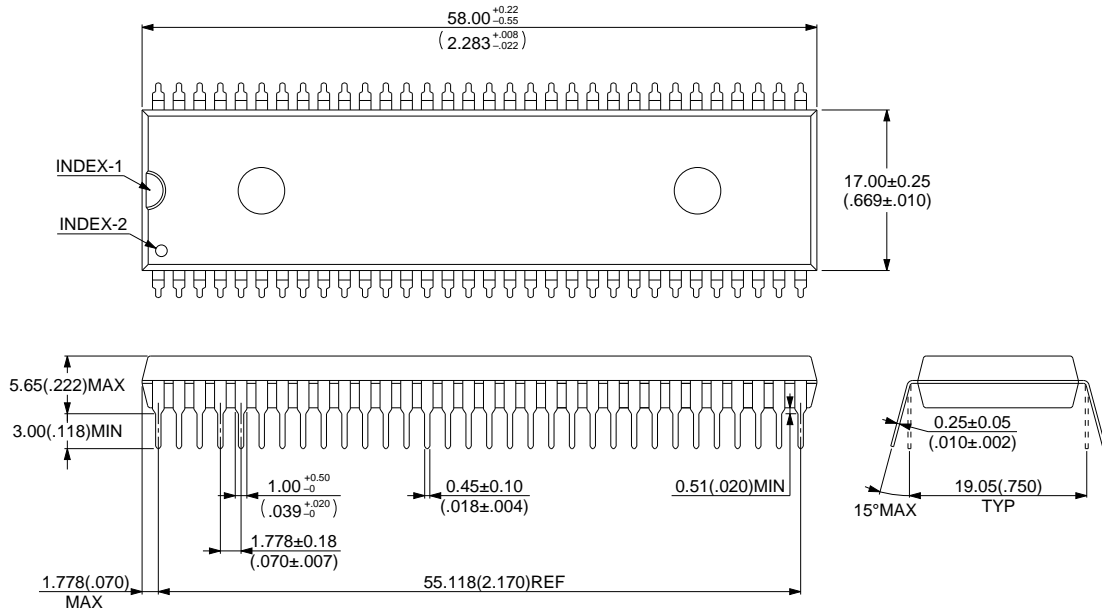
■ ORDERING INFORMATION

Part number	Package	Remarks
MB89628RP-SH MB89629RP-SH MB89P629P-SH	64-pin Plastic SH-DIP (DIP-64P-M01)	
MB89628RPF MB89629RPF MB89P629PF	64-pin Plastic QFP (FPT-64P-M06)	
MB89PV620C-SH	64-pin Ceramic MDIP (MDP-64C-P02)	
MB89PV620CF	64-pin Ceramic MQFP (MQP-64C-P01)	

MB89628R/629R/P629

■ PACKAGE DIMENSIONS

64-pin Plastic SH-DIP
(FPT-64P-M01)

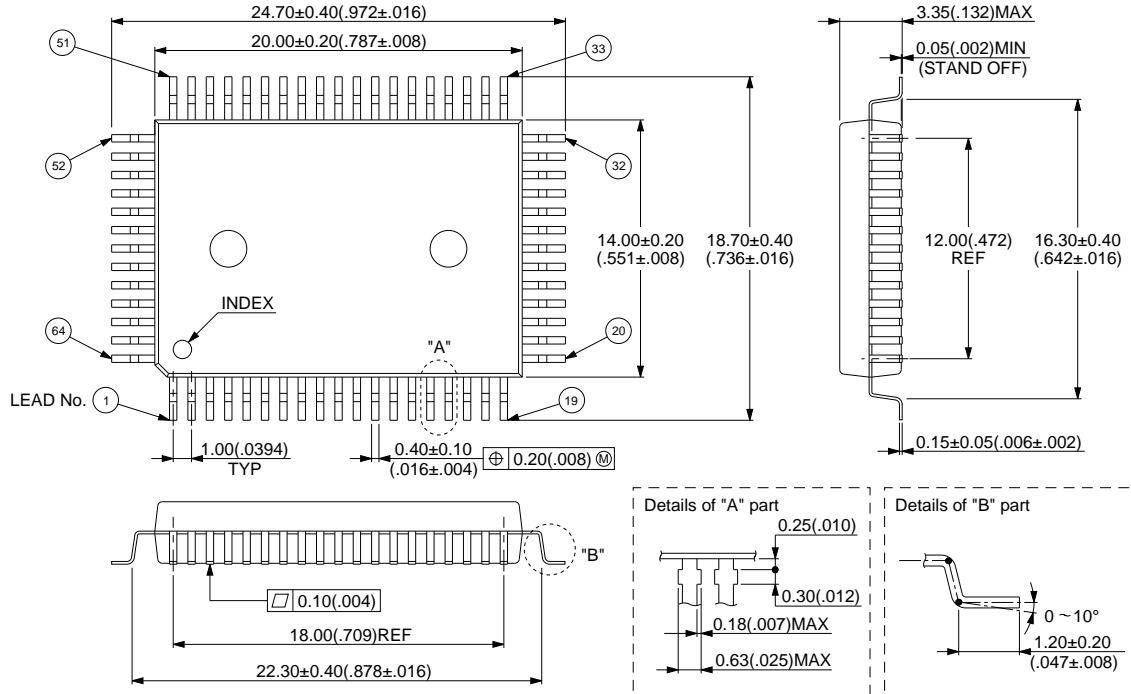


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Dimensions in mm (inches)

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64-pin Plastic QFP (FPT-64P-M06)

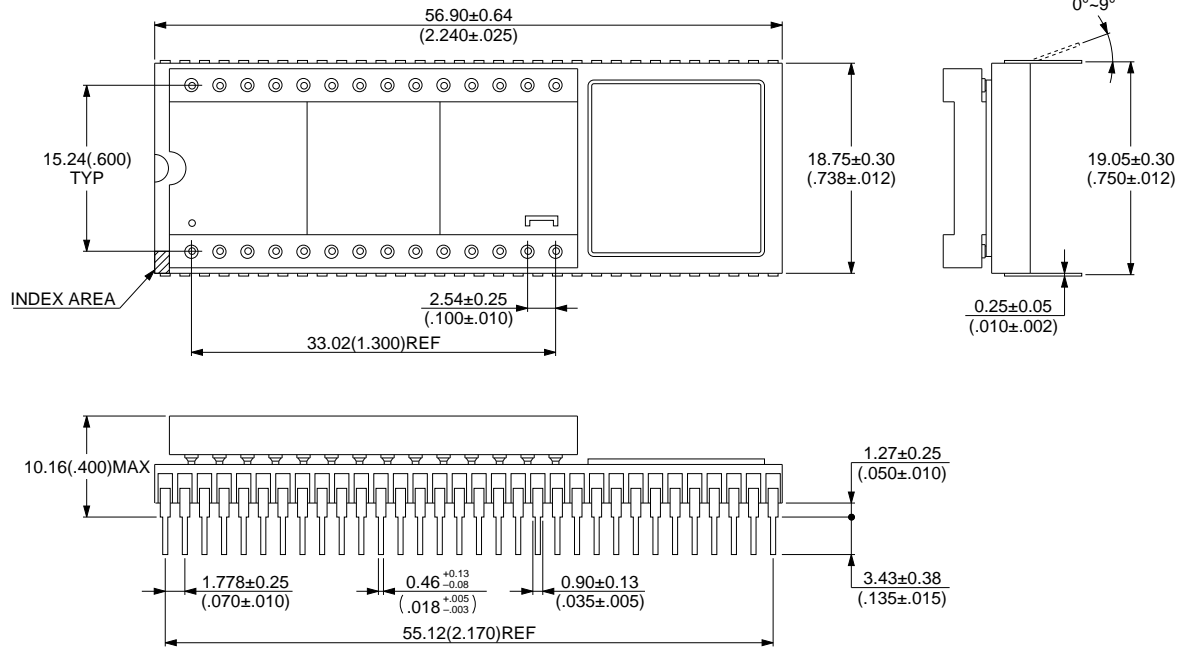


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Dimensions in mm (inches)

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64-pin Ceramic MDIP (MDP-64C-P02)



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Dimensions in mm (inches)

MB89628R/629R/P629

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