FUJITSU SEMICONDUCTOR
DATA SHEET

8-bit Proprietary Microcontroller

CMOS

F²MC-8L MB89630R Series

MB89635R/T635R/636R/637R/T637R
MB89P637/W637/PV630

■ OUTLINE

The MB89630R series has been developed as a general-purpose version of the F²MC*-8L family consisting of proprietary 8-bit, single-chip microcontrollers.

In addition to a compact instruction set, the microcontrollers contain a variety of peripheral functions such as dual-clock control system, five operating speed control stages, a UART, timers, a PWM timer, a serial interface, an A/D converter, an external interrupt, and a watch prescaler.

*: F²MC stands for FUJITSU Flexible Microcontroller.

■ FEATURES

- High-speed operating capability at low voltage
- Minimum execution time: 0.4 µs@3.5 V, 0.8 µs@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.

- Five types of timers
  8-bit PWM timer: 2 channels (Also usable as a reload timer)
  8-bit pulse-width count timer (Continuous measurement capable, applicable to remote control, etc.)
  16-bit timer/counter
  21-bit timebase timer
- UART
  CLK-synchronous/CLK-asynchronous data transfer capable (6, 7, and 8 bits)
- Serial interface
  Switchable transfer direction to allows communication with various equipment.
- 10-bit A/D converter
 Start by an external input capable

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MB89630R Series

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- 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 minimize the current consumption.)
  Sleep mode (The CPU stops to reduce the current consumption to approx. 1/3 of normal.)
  Subclock mode
  Watch mode
- Bus interface function
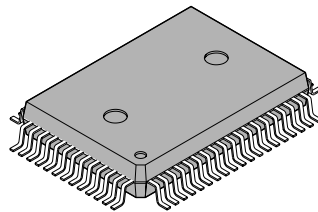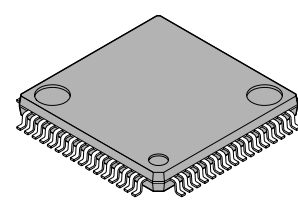 With hold and ready function

■ PACKAGE

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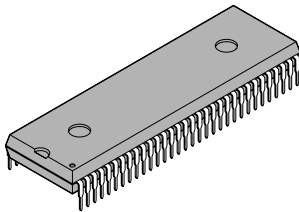
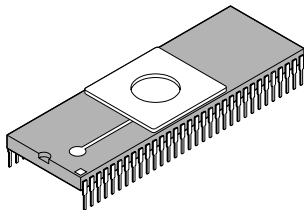(DIP-64P-M01)

64-pin Plastic QFP

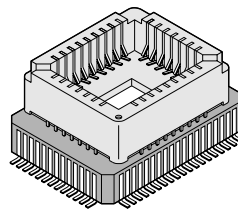(FPT-64P-M06)
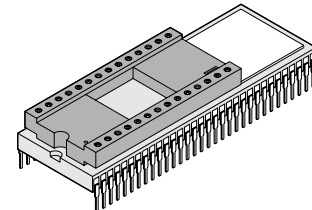
64-pin Plastic QFP

(FPT-64P-M09)

64-pin Ceramic SH-DIP

(DIP-64C-A06)

64-pin Ceramic MQFP

(MQP-64C-P01)

64-pin Ceramic MDIP

(MDP-64C-P02)

MB89630R Series

■ PRODUCT LINEUP

Part number Item	MB89635R	MB89636R	MB89637R	MB89T635R	MB89T637R	MB89P637	MB89W637	MB89PV630
Classification	Mass-produced products (mask ROM products)			External ROM products		One-time PROM product	EPROM product	Piggyback/ evaluation product (for evaluation and development)
ROM size	16 K × 8 bits (internal mask ROM)	24 K × 8 bits (internal mask ROM)	32 K × 8 bits (internal mask ROM)	Fixed to external ROM		32 K × 8 bits (Internal PROM, to be programmed with general-purpose EPROM programmer)		32 K × 8 bits (external ROM)
RAM size	512 × 8 bits	768 × 8 bits	1024 × 8 bits	512 × 8 bits	1024 × 8 bits			1 K × 8 bits
CPU functions	The number of instructionns: 136 Instruction bit length: 8 bits Instruction length: 1 to 3 bytes Data bit length: 1, 8, 16 bits Minimum execution time: 0.4 to 6.4 μs/10 MHz, 61 μs@32.768 kHz Interrupt processing time: 3.6 to 57.6 μs/10 MHz, 562.5 μs@32.768 kHz							
Ports	Input ports: 5 (All also serve as peripherals.) Output ports (N-ch open-drain): 8 (All also serve as peripherals.) I/O ports (N-ch open-drain): 4 (All also serve as peripherals.) Output ports (CMOS): 8 (All also serve as bus control.) I/O ports (CMOS): 28 (27 ports also serve as bus pins and peripherals.) Total: 53							
Clock timer	21 bits × 1 (in main clock)/15 bits × 1 (at 32.768 kHz)							
8-bit PWM timer	8-bit reload timer operation (toggled output capable, operating clock cycle: 0.4 μs to 3.3 ms) × 2 channels 7/8-bit resolution PWM operation (conversion cycle: 51.2 μs to 839 ms) × 2 channels							
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 (capable of continuous measurement, and measurement of "H" pulse width/ "L" pulse width/ from ↑ to ↑/from ↓ to ↓)							
16-bit timer/counter	16-bit timer operation (operating clock cycle: 0.4 μs) 16-bit event counter operation (rising edge/falling edge/both edge selectable)							
8-bit serial I/O	8 bits LSB first/MSB first selectable One clock selectable from four transfer clocks (one external shift clock, three internal shift clocks: 0.8 μs, 3.2 μs, 12.8 μs)							
UART	Capable of switching two I/O systems by software Transfer data length (6, 7, and 8 bits) Transfer rate (300 to 62500 bps. at 10 MHz osciliation)							
10-bit A/D converter	10-bit resolution × 8 channels A/D conversion mode (conversion time: 13.2 μs) Sense mode (conversion time: 7.2 μs) Capable of continuous activation by an external activation or an internal timer							

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3

MB89630R Series

(Continued)

Part number / Item	MB89635R	MB89636R	MB89637R	MB89T635R	MB89T637R	MB89P637	MB89W637	MB89PV630
External interrupt input	4 independent channels (edge selection, interrupt vector, source flag). Rising edge/falling edge selectable. Used also for wake-up from stop/sleep mode. (Edge detection is also permitted in stop mode.)							
Standby mode	Sleep mode, stop mode, watch mode, and subclock mode							
Process	CMOS							
Operating voltage*	2.2 V to 6.0 V			2.7 V to 6.0 V				
EPROM for use								MBM27C256A-20CZ MBM27C256A-20TV

* : Varies with conditions such as the operating frequency. (See section "■ Electrical Characteristics.")
  In the case of the MB89PV630, the voltage varies with the restrictions of the EPROM for use.

■ PACKAGE AND CORRESPONDING PRODUCTS

Package	MB89635R MB89T635R	MB89636R MB89637R MB89T637R	MB89P637	MB89W637	MB89PV630
DIP-64P-M01	○	○	○	×	×
FPT-64P-M06	○	○	○	×	×
FPT-64P-M09	○	○	×*	×*	×*
DIP-64C-A06	×	×	×	○	×
MQP-64C-P01	×	×	×	×	○
MDP-64C-P02	×	×	×	×	○

○ : Available   ×: Not available

* : To convert pin pitches, an adapter socket (manufacturer: Sun Hayato Co., Ltd.) is available.
  64SD-64QF2-8L: For conversion from (DIP-64P-M01, DIP-64C-A06, or MDP-64C-P02) to FPT-64P-M09
  Inquiry: Sun Hayato Co., Ltd.: TEL (81)-3-3986-0403
                    FAX (81)-3-5396-9106

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

4

■ 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 MB89P637/W637, the program area starts from address 8007$_H$ but on the MB89PV630 and MB89637R starts from 8000$_H$.

- On the MB89P637/W637, addresses 8000$_H$ to 8006$_H$ comprise the option setting area, option settings can be read by reading these addresses. On the MB89PV630/MB89637R, 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 MB89P637/W637.
- The stack area, etc., is set at the upper limit of the RAM.
- The external area is used.

2. Current Consumption

- In the case of the MB89PV630, add the current consumed by the EPROM which 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 sections "■ Electrical Characteristics" and "■ Example 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 P50 to P53 on the MB89P637 and MB89W637.
- Options are fixed on the MB89PV630, MB89T635R, and MB89T637R.

4. Differences between the MB89630 and MB89630R Series

- Memory access area
  There are no difference between the access area of MB89635/MB89635R, and that of MB89637/MB89637R. The access area of MB89636 is different from that of the MB89636R when using in external bus mode.

Address	Memory area	
	MB89636	MB89636R
0000$_H$ to 007F$_H$	I/O area	I/O area
0080$_H$ to 037F$_H$	RAM area	RAM area
0380$_H$ to 047F$_H$	External area	Access prohibited
0480$_H$ to 7FFF$_H$		External area
8000$_H$ to 9FFF$_H$		Access prohibited
A000$_H$ to FFFF$_H$	ROM area	ROM area

5

MB89630R Series

• Other specifications
 Both MB89630 series and MB89630R is the same.

• Electrical specifications/electrical characteristics
 Electrical specifications of the MB89630R series are the same as that of the MB89630 series.
 Electrical characteristics of both the series are much the same.

■ CORRESPONDENCE BETWEEN THE MB89630 AND MB89630R SERIES
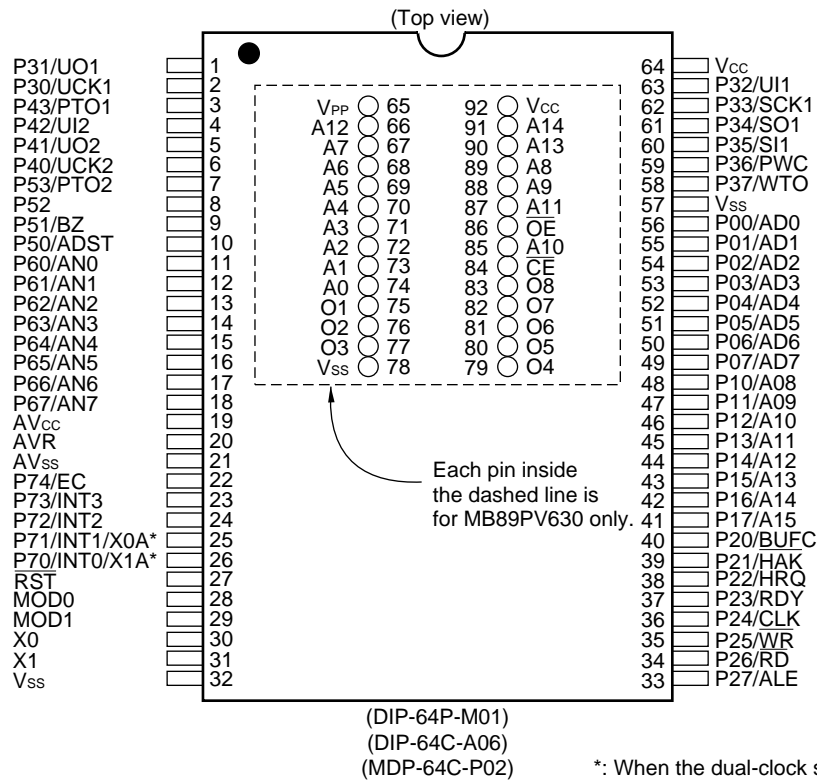
• The MB89630R series is the reduction version of the MB89630 series.

• The the MB89630 and MB89630R series consist of the following products:
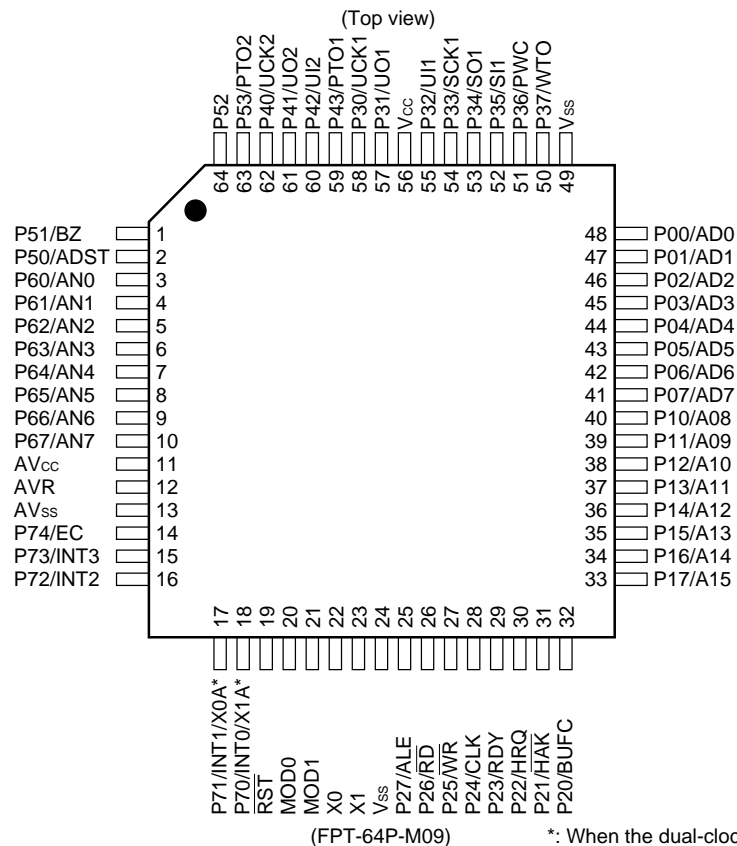
MB89630 series	MB89635	MB89T635	MB89636	MB89637	MB89T637	MB89P637	MB89W637	MB89PV630
MB89630R series	MB89635R	MB89T635R	MB89636R	MB89637R	MB89T637R			

MB89630R Series

■ PIN ASSIGNMENT

(Top view)

```
P31/UO1          1              64   VCC
P30/UCK1         2              63   P32/UI1
P43/PTO1         3   VPP 65  92 VCC  62   P33/SCK1
P42/UI2          4   A12 66  91 A14  61   P34/SO1
P41/UO2          5   A7  67  90 A13  60   P35/SI1
P40/UCK2         6   A6  68  89 A8   59   P36/PWC
P53/PTO2         7   A5  69  88 A9   58   P37/WTO
P52              8   A4  70  87 A11  57   VSS
P51/BZ           9   A3  71  86 OE   56   P00/AD0
P50/ADST        10   A2  72  85 A10  55   P01/AD1
P60/AN0         11   A1  73  84 CE   54   P02/AD2
P61/AN1         12   A0  74  83 O8   53   P03/AD3
P62/AN2         13   O1  75  82 O7   52   P04/AD4
P63/AN3         14   O2  76  81 O6   51   P05/AD5
P64/AN4         15   O3  77  80 O5   50   P06/AD6
P65/AN5         16   VSS 78  79 O4   49   P07/AD7
P66/AN6         17              48   P10/A08
P67/AN7         18              47   P11/A09
AVCC            19              46   P12/A10
AVR             20              45   P13/A11
AVSS            21              44   P14/A12
P74/EC          22              43   P15/A13
P73/INT3        23              42   P16/A14
P72/INT2        24   Each pin inside  41   P17/A15
P71/INT1/X0A*   25   the dashed line is  40   P20/BUFC
P70/INT0/X1A*   26   for MB89PV630 only.  39   P21/HAK
RST             27              38   P22/HRQ
MOD0            28              37   P23/RDY
MOD1            29              36   P24/CLK
X0              30              35   P25/WR
X1              31              34   P26/RD
VSS             32              33   P27/ALE
```

(DIP-64P-M01)
(DIP-64C-A06)
(MDP-64C-P02)   *: When the dual-clock system is selected.

(Top view)

```
            P52
            P53/PTO2
            P40/UCK2
            P41/UO2
            P42/UI2
            P43/PTO1
            P30/UCK1
            P31/UO1
            VCC
            P32/UI1
            P33/SCK1
            P34/SO1
            P35/SI1
            P36/PWC
            P37/WTO
            VSS
            64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49

P51/BZ       1                              48   P00/AD0
P50/ADST     2                              47   P01/AD1
P60/AN0      3                              46   P02/AD2
P61/AN1      4                              45   P03/AD3
P62/AN2      5                              44   P04/AD4
P63/AN3      6                              43   P05/AD5
P64/AN4      7                              42   P06/AD6
P65/AN5      8                              41   P07/AD7
P66/AN6      9                              40   P10/A08
P67/AN7     10                              39   P11/A09
AVCC        11                              38   P12/A10
AVR         12                              37   P13/A11
AVSS        13                              36   P14/A12
P74/EC      14                              35   P15/A13
P73/INT3    15                              34   P16/A14
P72/INT2    16                              33   P17/A15

            17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32
            P71/INT1/X0A*
            P70/INT0/X1A*
            RST
            MOD0
            MOD1
            X0
            X1
            VSS
            P27/ALE
            P26/RD
            P25/WR
            P24/CLK
            P23/RDY
            P22/HRQ
            P21/HAK
            P20/BUFC
```

(FPT-64P-M09)   *: When the dual-clock system is selected.

7

MB89630R Series

(Top view)

Top pins (64–52):
P53/PTO2 (64), P40/UCK2 (63), P41/UO2 (62), P42/UI2 (61), P43/PTO1 (60), P30/UCK1 (59), P31/UO1 (58), Vcc (57), P32/UI1 (56), P33/SCK1 (55), P34/SO1 (54), P35/SI1 (53), P36/PWC (52)

Left pins:
- 1 P52
- 2 P51/BZ
- 3 P50/ADST
- 4 P60/AN0
- 5 P61/AN1
- 6 P62/AN2
- 7 P63/AN3
- 8 P64/AN4
- 9 P65/AN5
- 10 P66/AN6
- 11 P67/AN7
- 12 AVcc
- 13 AVR
- 14 AVss
- 15 P74/EC
- 16 P73/INT3
- 17 P72/INT2
- 18 P71/INT1/X0A*
- 19 P70/INT0/X1A*

Right pins:
- 51 P37/WTO
- 50 Vss
- 49 P00/AD0
- 48 P01/AD1
- 47 P02/AD2
- 46 P03/AD3
- 45 P04/AD4
- 44 P05/AD5
- 43 P06/AD6
- 42 P07/AD7
- 41 P10/A08
- 40 P11/A09
- 39 P12/A10
- 38 P13/A11
- 37 P14/A12
- 36 P15/A13
- 35 P16/A14
- 34 P17/A15
- 33 P20/BUFC

Inner pins (MB89PV630 only): 84 83 82 81 80 79 78 / 85 ... 77 / 86 ... 76 / 87 ... 75 / 88 ... 74 / 89 ... 73 / 90 ... 72 / 91 ... 71 / 92 ... 70 / 93 ... 69 / 94 95 96 65 66 67 68

Each pin inside the dashed line is for MB89PV630 only.

Bottom pins (20–32):
RST (20), MOD0 (21), MOD1 (22), X0 (23), X1 (24), Vss (25), P27/ALE (26), P26/RD (27), P25/WR (28), P24/CLK (29), P23/RDY (30), P22/HRQ (31), P21/HAK (32)

(FPT-64P-M06)
(MQP-64C-P01)

*: When the dual-clock system is selected.

• **Pin assignment on package top (MB89PV630 only)**

Pin no.	Pin name	Pin no.	Pin name	Pin no.	Pin name	Pin no.	Pin name
65	N.C.	73	A2	81	N.C.	89	$\overline{OE}$
66	V_{PP}	74	A1	82	O4	90	N.C.
67	A12	75	A0	83	O5	91	A11
68	A7	76	N.C.	84	O6	92	A9
69	A6	77	O1	85	O7	93	A8
70	A5	78	O2	86	O8	94	A13
71	A4	79	O3	87	$\overline{CE}$	95	A14
72	A3	80	V_{SS}	88	A10	96	V_{CC}

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

8

MB89630R Series

■ PIN DESCRIPTION

Pin no.			Pin name	Circuit type	Function
SH-DIP[*1] MDIP[*2]	QFP2[*3]	QFP1[*4] MQFP[*5]			
30	22	23	X0	A	Main clock crystal oscillator pins
31	23	24	X1		
28	20	21	MOD0	D	Operating mode selection pins Connect directly to V_{CC} or V_{SS}.
29	21	22	MOD1		
27	19	20	$\overline{RST}$	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	48 to 41	49 to 42	P00/AD0 to P07/AD7	F	General-purpose I/O ports When an external bus is used, these ports function as the multiplex pins of the lower address output and the data I/O.
48 to 41	40 to 33	41 to 34	P10/A08 to P17/A157	F	General-purpose I/O ports When an external bus is used, these ports function as an upper address output.
40	32	33	P20/BUFC	H	General-purpose output port When an external bus is used, this port can also be used as a buffer control output by setting the BCTR.
39	31	32	P21/$\overline{HAK}$	H	General-purpose output port When an external bus is used, this port can also be used as a hold acknowledge by setting the BCTR.
38	30	31	P22/HRQ	F	General-purpose output port When an external bus is used, this port can also be used as a hold request input by setting the BCTR.
37	29	30	P23/RDY	F	General-purpose output port When an external bus is used, this port functions as a ready input.
36	28	29	P24/CLK	H	General-purpose output port When an external bus is used, this port functions as a clock output.
35	27	28	P25/$\overline{WR}$	H	General-purpose output port When an external bus is used, this port functions as a write signal output.
34	26	27	P26/$\overline{RD}$	H	General-purpose output port When an external bus is used, this port functions as a read signal output.

*1: DIP-64P-M01, DIP-64C-A06
*2: MDP-64C-P02
*3: FPT-64P-M09
*4: FPT-64P-M06
*5: MQP-M64C-P01

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9

MB89630R Series

(Continued)

Pin no.			Pin name	Circuit type	Function
SH-DIP[*1] MDIP[*2]	QFP2[*3]	QFP1[*4] MQFP[*5]			
33	25	26	P27/ALE	H	General-purpose output port When an external bus is used, this port functions as an address latch signal output.
2	58	59	P30/UCK1	G	General-purpose I/O port Also serves as the clock I/O 1 for the UART. This port is a hysteresis input type.
1	57	58	P31/UO1	F	General-purpose I/O port Also serves as the data output 1 for the UART.
63	55	56	P32/UI1	G	General-purpose I/O port Also serves as the data input 1 for the UART. This port is a hysteresis input type.
62	54	55	P33/SCK1	G	General-purpose I/O port Also serves as the data input for the 8-bit serial I/O. This port is a hysteresis input type.
61	53	54	P34/SO1	F	General-purpose I/O port Also serves as the data output for the 8-bit serial I/O.
60	52	53	P35/SI1	G	General-purpose I/O port Also serves as the data input for the 8-bit serial I/O. This port is a hysteresis input type.
59	51	52	P36/PWC	G	General-purpose I/O port Also serves as the measured pulse input for the 8-bit pulse width counter. This port is a hysteresis input type.
58	50	51	P37/WTO	F	General-purpose I/O port Also serves as the toggle output for the 8-bit pulse width counter.
6	62	63	P40/UCK2	G	General-purpose I/O port Also serves as the clock I/O 2 for the UART. This port is a hysteresis input type.
5	61	62	P41/UO2	F	General-purpose I/O port Also serves as the data output 2 for the UART.
4	60	61	P42/UI2	G	General-purpose I/O port Also serves as the data input 2 for the UART. This port is a hysteresis input type.
3	59	60	P43/PTO1	F	General-purpose I/O port Also serves as the toggle output for the 8-bit PWM timer.
10	2	3	P50/ADST	K	General-purpose I/O port Also serves as an A/D converter external activation. This port is a hysteresis input type.

*1: DIP-64P-M01, DIP-64C-A06   *4: FPT-64P-M06
*2: MDP-64C-P02   *5: MQP-M64C-P01
*3: FPT-64P-M09

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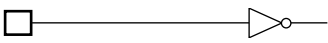10

MB89630R Series

(Continued)

Pin no.			Pin name	Circuit type	Function
SH-DIP[*1] MDIP[*2]	QFP2[*3]	QFP1[*4] MQFP[*5]			
9	1	2	P51/BZ	J	General-purpose I/O port. Also serves as a buzzer output.
8	64	1	P52	J	General-purpose I/O port
7	63	64	P53/PTO2	J	General-purpose I/O port. Also serves as the toggle output for the 8-bit PWM timer.
11 to 18	3 to 10	4 to 11	P60/AN0 to P67/AN7	I	N-ch open-drain output ports. Also serve as an A/D converter analog input.
26, 25	18, 17	19, 18	P70/INT0/X1A, P71/INT1/X0A	B/E	Input-only ports. These ports are a hysteresis input type. Also serve as an external interrupt input (at single-clock operation). Subclock crystal oscillator pins (at dual-clock operation)
24, 23	16, 15	17, 16	P72/INT2, P73/INT3	E	Input-only ports. Also serve as an external interrupt input. These ports are a hysteresis input type.
22	14	15	P74/EC	E	General-purpose input port. Also serves as the external clock input for the 16-bit timer/counter. This port is a hysteresis input type.
64	56	57	V_{CC}	—	Power supply pin
32, 57	24,49	25, 50	V_{SS}	—	Power supply (GND) pin
19	11	12	AV_{CC}	—	A/D converter power supply pin
20	12	13	AVR	—	A/D converter reference voltage input pin
21	13	14	AV_{SS}	—	A/D converter power supply pin. Use this pin at the same voltage as V_{SS}.

*1: DIP-64P-M01, DIP-64C-A06   *4: FPT-64P-M06
*2: MDP-64C-P02   *5: MQP-M64C-P01
*3: FPT-64P-M09

11
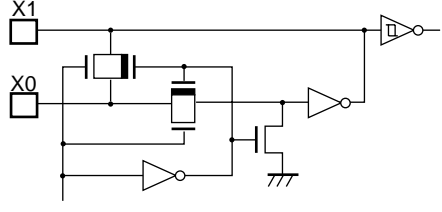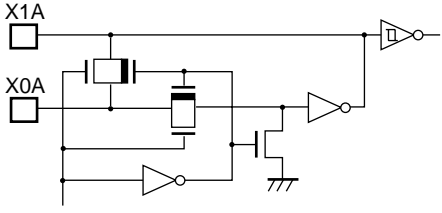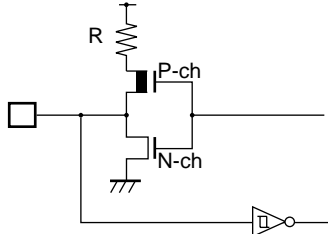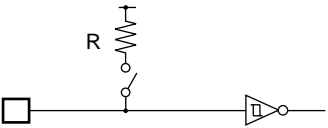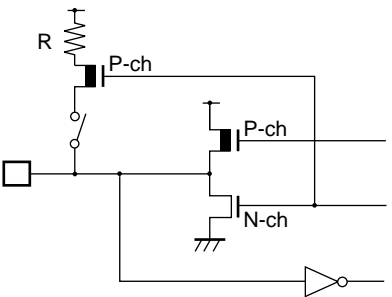
MB89630R Series

- **External EPROM pins (MB89PV630 only)**

Pin no.		Pin name	I/O	Function
MDIP	MQFP			
65	66	V_{PP}	O	"H" level output pin
66 67 68 69 70 71 72 73 74	67 68 69 70 71 72 73 74 75	A12 A7 A6 A5 A4 A3 A2 A1 A0	O	Address output pins
75 76 77	77 78 79	O1 O2 O3	I	Data input pins
78	80	V_{SS}	O	Power supply (GND) pin
79 80 81 82 83	82 83 84 85 86	O4 O5 O6 O7 O8	I	Data input pins
84	87	$\overline{CE}$	O	ROM chip enable pin Outputs "H" during standby.
85	88	A10	O	Address output pin
86	89	$\overline{OE}$	O	ROM output enable pin Outputs "L" at all times.
87 88 89	91 92 93	A11 A9 A8	O	Address output pins
90	94	A13	O	
91	95	A14	O	
92	96	V_{CC}	O	EPROM power supply pin
—	65 76 81 90	N.C.	—	Internally connected pins Be sure to leave them open.

MB89630R Series
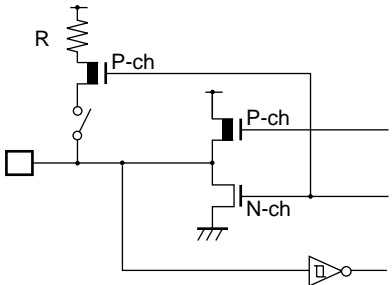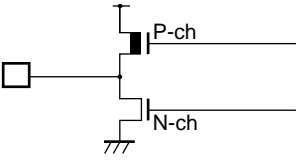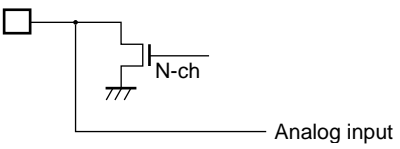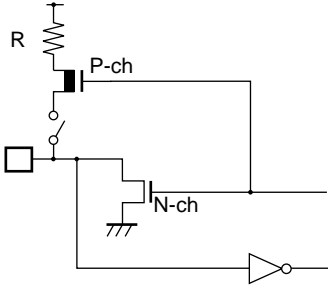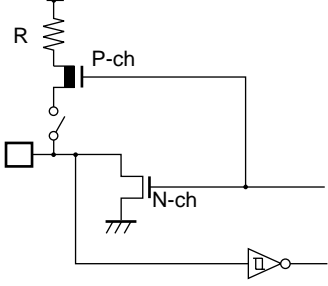
■ I/O CIRCUIT TYPE

Type	Circuit	Remarks
A	X1 X0 Standby control signal	• Crystal or ceramic oscillation type (main clock) External clock input selection versions of MB89PV630, MB89P637, MB89W637, MB89635R, MB89T635R, MB89636R, MB89637R, and MB89T637R At an oscillation feedback resistor of approximately 1 MΩ@5.0 V
B	X1A X0A Standby control signal	• Crystal or ceramic oscillation type (subclock) MB89PV630, MB89P637, MB89W637, MB89635R, MB89636R, and MB89637R with dual-clock system At an oscillation feedback resistor of approximately 4.5 MΩ@5.0 V
C	R, P-ch, N-ch	• At an output pull-up resistor (P-ch) of approximately 50 kΩ@5.0 V • Hysteresis input
D		
E	R	• Hysteresis input • Pull-up resistor optional (except P70 and P71)
F	R, P-ch, P-ch, N-ch	• CMOS output • CMOS input • Pull-up resistor optional (except P22 and P23)

(Continued)

13

MB89630R Series

(Continued)

Type	Circuit	Remarks
G	R — P-ch, P-ch, N-ch	• CMOS output • Hysteresis input • Pull-up resistor optional
H	P-ch, N-ch	• CMOS output
I	N-ch, Analog input	• Analog input
J	R — P-ch, N-ch	• CMOS input • Pull-up resistor optional
K	R — P-ch, N-ch	• Hysteresis input • Pull-up resistor optional

14

■ 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 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 Hz 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

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

MB89630R Series

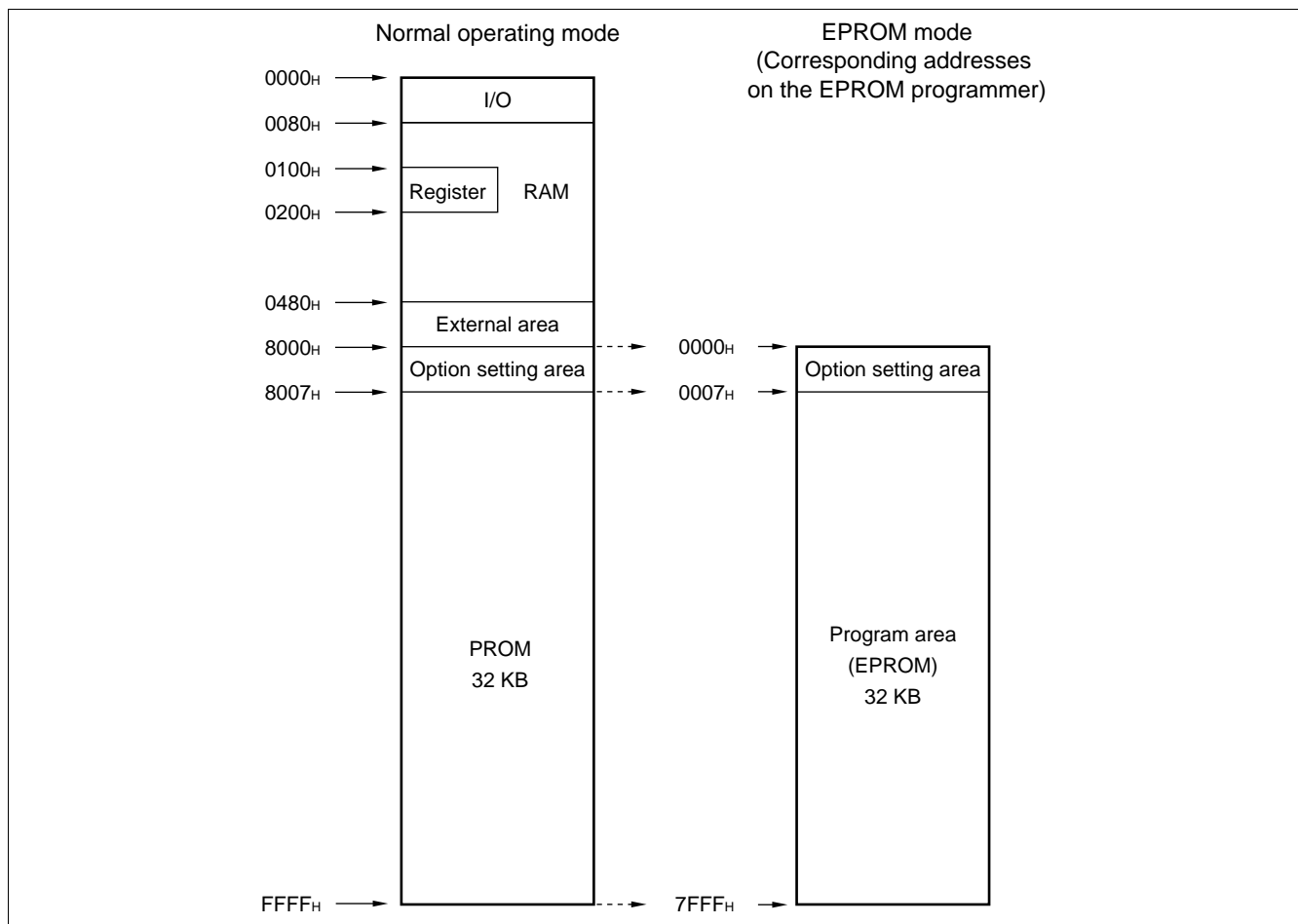## ■ PROGRAMMING TO THE EPROM ON THE MB89P637

The MB89P637 is an OTPROM version of the MB89630 series.

1. Features

- 32-Kbytes 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 each mode is illustrated below.

3. Programming to the EPPROM

In EPROM mode, the MB89P637 functions equivalent to the MBM27C256A. This allows the PROM to be programmed with a general-purpose EPROM programmer by using the dedicated socket adapter.

However, the electronic signature mode cannot be used.

When the operating ROM area for a single chip is 32 Kbytes (8007_H to $FFFF_H$) the EPROM can be programmed as follows:

- **Programming procedure**

(1) Set the EPROM programmer to the MBM27C256A-20CZ and MBM27C256A-20TV.

(2) Load program data into the EPROM programmer at 0007_H to $7FFF_H$. (Note that addresses 8000_H to $FFFF_H$ in the operating mode assign to 0000_H to $7FFF_H$ in EPROM mode).

(3) Load option data into addresses 0000_H to 0006_H of the EPROM programmer.
(For information about each corresponding option, see "8. OTPROM Option Bit Map.")

(4) Program with the EPROM programmer.

4. Recommended Screening Conditions

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

Program, verify

↓

Aging
+150°C, 48 Hrs.

↓

Data verification

↓

Assembly
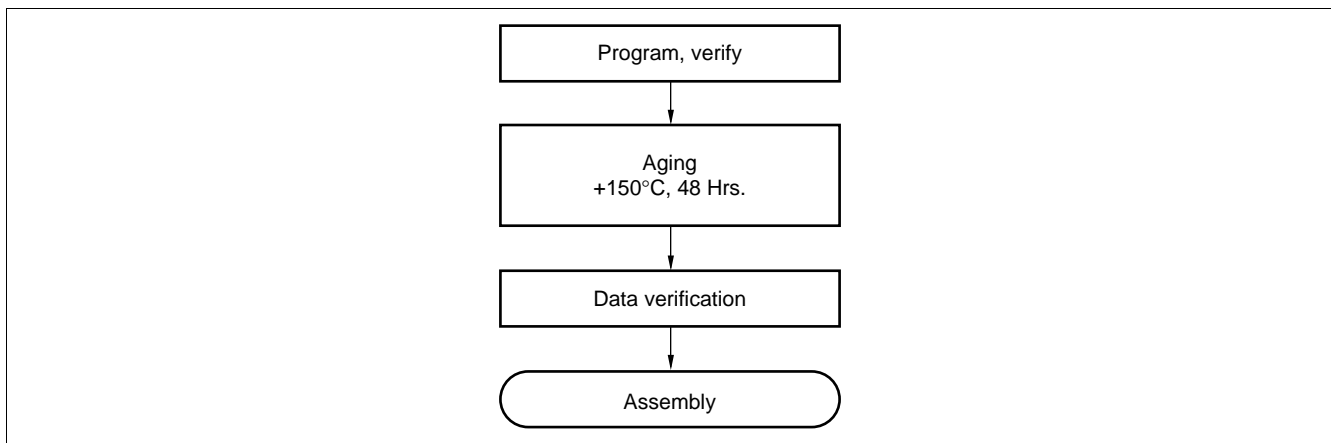
5. Programming Yield

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. Erasure

In order to clear all locations of their programmed contents, it is necessary to expose the internal EPROM to an ultraviolet light source. A dosage of 10 W-seconds/cm^2 is required to completely erase an internal EPROM. This dosage can be obtained by exposure to an ultraviolet lamp (wavelength of 2537 Angstroms (Å)) with intensity of 12000 μW/cm^2 for 15 to 21 minutes. The internal EPROM should be about one inch from the source and all filters should be removed from the UV light source prior to erasure.

It is important to note that the internal EPROM and similar devices, will erase with light sources having wavelengths shorter than 4000 Å. Although erasure time will be much longer than with UV source at 2537 Å, nevertheless the exposure to fluorescent light and sunlight will eventually erase the internal EPROM, and exposure to them should be prevented to realize maximum system reliability. If used in such an environment, the package windows should be covered by an opaque label or substance.

MB89630R Series

7. EPROM Programmer Socket Adapter

Part No.	MB89P637-SH	MB89P637PF
Package	SH-DIP-64	QFP-64
Compatible socket adapter Sun Hayato Co., Ltd.	ROM-64SD-28DP-8L	ROM-64QF-28DP-8L

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

8. OTPROM Option Bit Map

Address	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0000$_H$	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Single/dual-clock system 1: Dual clock 0: Single clock	Reset pin output 1: Yes 0: No	Power-on reset 1: Yes 0: No	Oscillation stabilization (/F$_{CH}$) 11:2^{18}/F$_{CH}$ 01:2^{17}/F$_{CH}$ 10:2^{14}/F$_{CH}$ 00:2^{4}/F$_{CH}$	
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
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
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
0004$_H$	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	P43 Pull-up 1: No 0: Yes	P42 Pull-up 1: No 0: Yes	P41 Pull-up 1: No 0: Yes	P40 Pull-up 1: No 0: Yes
0005$_H$	Vacancy Readable and writable	Vacancy Readable and writable	Vacancy Readable and writable	P74 Pull-up 1: No 0: Yes	P73 Pull-up 1: No 0: Yes	P72 Pull-up 1: No 0: Yes	Vacancy Readable and writable	Vacancy Readable and writable
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

Note: Each bit is set to '1' as the initialized value.

18

MB89630R Series

■ PROGRAMMING TO THE EPROM WITH PIGGYBACK/EVALUATION DEVICE

1. EPROM for Use

MBM27C256A-20CZ, MBM27C256A-20TV

2. Programming Socket Adapter

To program to the PROM using an EPROM programmer, use the socket adapter (manufacturer: Sun Hayato Co., Ltd.) listed below.
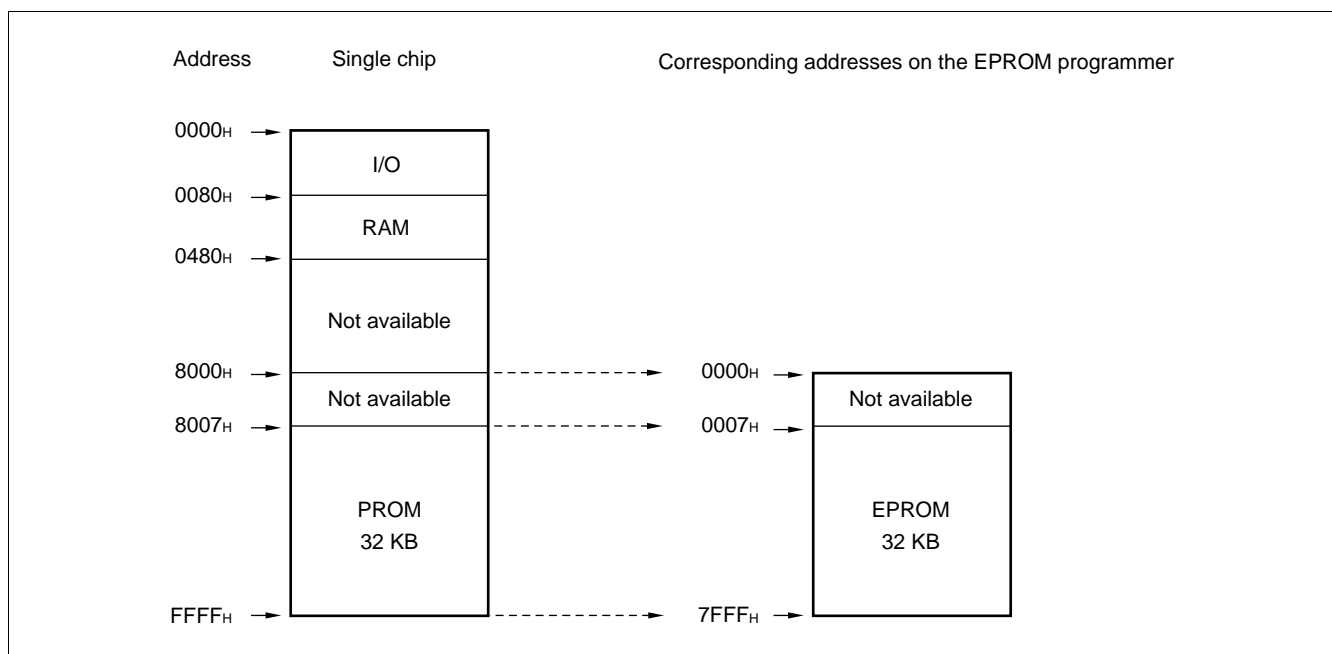
Package	Adapter socket part number
LCC-32 (Rectangle)	ROM-32LC-28DP-YG

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

3. Memory Space

Memory space in each mode, such as 32-Kbyte PROM, option area 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 0007_H to $7FFF_H$.

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

MB89630R Series

■ BLOCK DIAGRAM
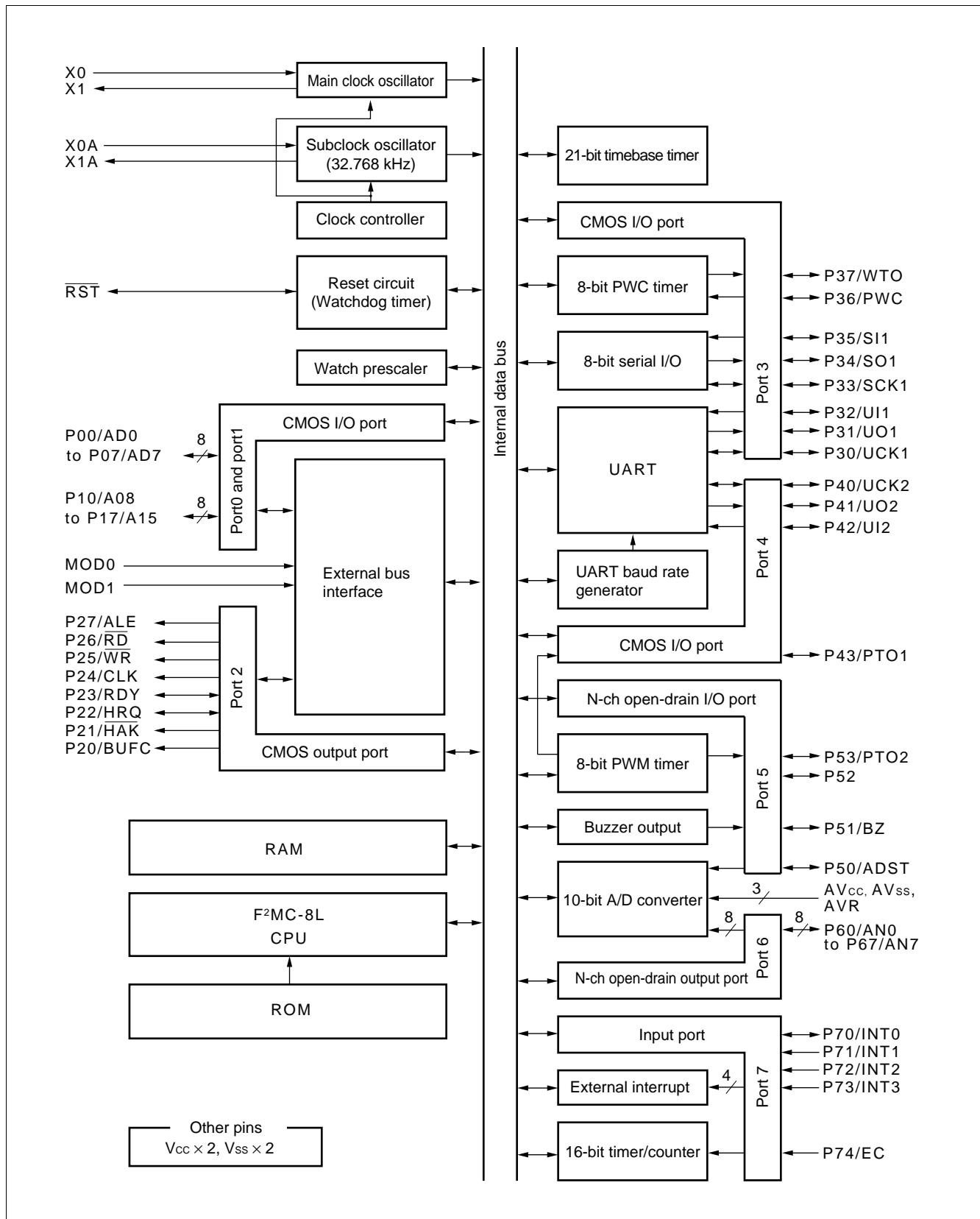
MB89630R Series

■ CPU CORE

1. Memory Space

The microcontrollers of the MB89630R series offer 64 Kbytes of memory 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 of I/O area, 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 MB89630R series is structured as illustrated below.

• Memory space
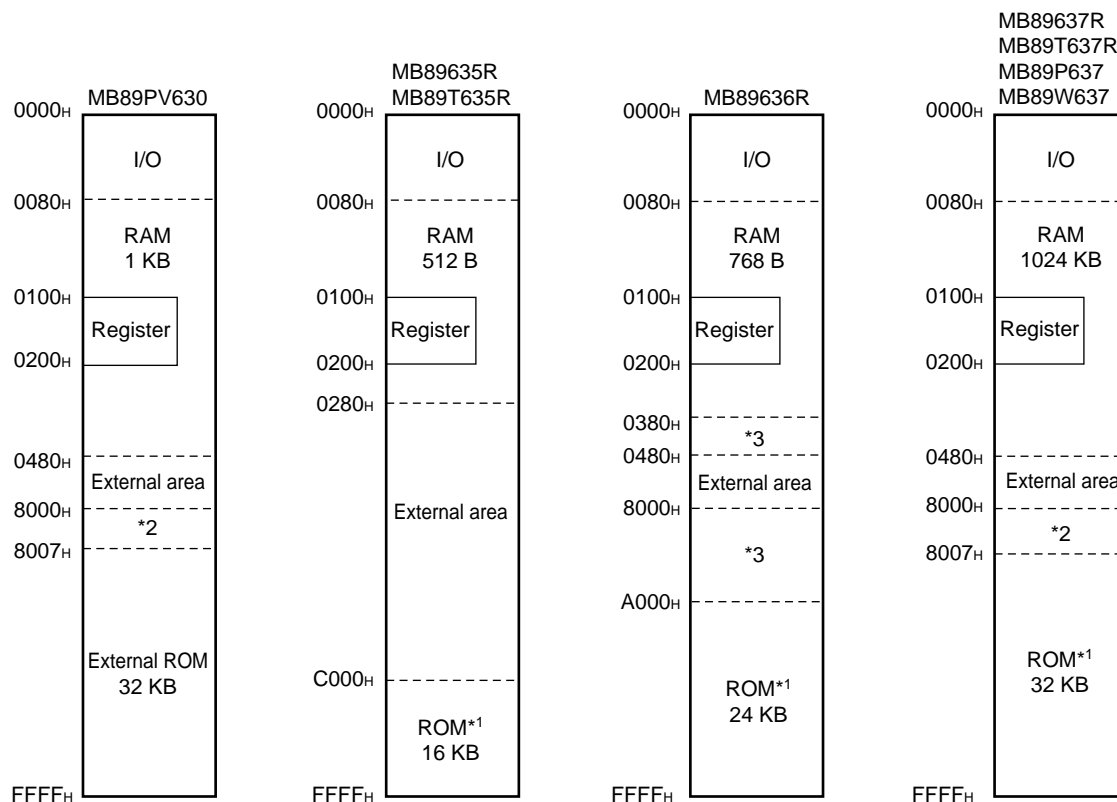
*1: The ROM area is an external area depending on the mode.
    The internal ROM cannot be used on the MB89T635R and MB89T637R.

*2: Addresses 8000$_H$ to 8006$_H$ for the MB89P637 and MB89W637 comprise an option area, do not use this area for the MB89PV630 and MB89637R.

*3: The access is forbidden in the external bus mode.
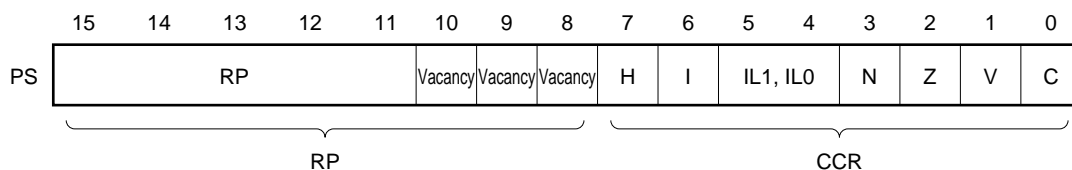
21

MB89630R Series

2. Registers

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

Program counter (PC):   A 16-bit register for indicating the 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):   A16-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):   A16-bit register for index modification

Extra pointer (EP):   A16-bit pointer for indicating a memory address

Stack pointer (SP):   A16-bit register for indicating a stack area

Program status (PS):   A16-bit register for storing a register pointer, a condition code

		Initial value
16 bits		
PC	: Program counter	FFFD$_H$
A	: Accumulator	Indeterminate
T	: Temporary accumulator	Indeterminate
IX	: Index register	Indeterminate
EP	: Extra pointer	**Indeterminate**
SP	: Stack pointer	Indeterminate
PS	: Program status	I-flag = 0, IL1, IL0 = 11 The other bit values are indeterminate.

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

• **Structure of the program status register**

	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
PS			RP			Vacancy	Vacancy	Vacancy	H	I	IL1, IL0		N	Z	V	C

RP   CCR

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

• Rule for conversion of actual addresses of the general-purpose register area

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

↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓

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

The CCR consists of bits indicating the results of arithmetic operations and the contents of transfer data and bits for control of CPU operations at the time of an interrupt.

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

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

IL1, IL0: 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 to '1' as the result of an arithmetic operation. Cleared to '0' when the bit is cleared to '0'.

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 doesnot 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.

MB89630R Series

The following general-purpose registers are provided:

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

The general-purpose registers are 8 bits and located in the register banks of the memory. One bank contains eight registers and up to a total of 32 banks can be used on the MB89653A (RAM 512 × 8 bits). The bank currently in use is indicated by the register bank pointer (RP).

• Register bank configuraiton

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

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

32 banks

Memory area
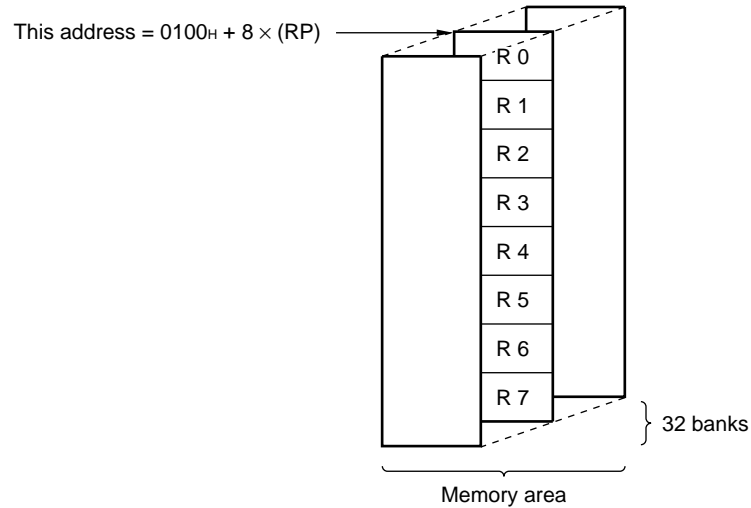
MB89630R Series

■ 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$_H$	(W)	BCTR	External bus pin control register
06$_H$	Vacancy		
07$_H$	(R/W)	SYCC	System clock control register
08$_H$	(R/W)	STBC	System clock control register
09$_H$	(R/W)	WDTE	Watchdog timer control register
0A$_H$	(R/W)	TBCR	Timebase timer control register
0B$_H$	(R/W)	WPCR	Watch prescaler control register
0C$_H$	(R/W)	CHG3	Port 3 switching register
0D$_H$	(R/W)	PDR3	Port 3 data register
0E$_H$	(W)	DDR3	Port 3 data direction register
0F$_H$	(R/W)	PDR4	Port 4 data register
10$_H$	(W)	DDR4	Port 4 data direction register
11$_H$	(R/W)	BUZR	Buzzer register
12$_H$	(R/W)	PDR5	Port 5 data register
13$_H$	(R/W)	PDR6	Port 6 data register
14$_H$	(R)	PDR7	Port 7 data register
15$_H$	(R/W)	PCR1	PWC pulse width control register 1
16$_H$	(R/W)	PCR2	PWC pulse width control register 2
17$_H$	(R/W)	RLBR	PWC reload buffer register
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 mode register
1D$_H$	(R/W)	SDR1	Serial data register
1E$_H$	Vacancy		
1F$_H$	Vacancy		

(Continued)

25

MB89630R Series

(Continued)

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)	ADDH	A/D converter data register (H)
23$_H$	(R/W)	ADDL	A/D converter data register (L)
24$_H$	(R/W)	EIC1	External interrupt control register 1
25$_H$	(R/W)	EIC2	External interrupt control register 2
26$_H$	Vacancy		
27$_H$	Vacancy		
28$_H$	(R/W)	CNTR1	PWM timer control register 1
29$_H$	(R/W)	CNTR2	PWM timer control register 2
2A$_H$	(R/W)	CNTR3	PWM timer control register 3
2B$_H$	(W)	COMR1	PWM timer compare register 1
2C$_H$	(W)	COMR2	PWM timer compare register 2
2D$_H$	(R/W)	SMC	UART serial mode control register
2E$_H$	(R/W)	SRC	UART serial rate control register
2F$_H$	(R/W)	SSD	UART serial status/data register
30$_H$	(R) (W)	SIDR SODR	UART serial input data control register UART serial output data control register
31$_H$ to 7B$_H$	Vacancy		
7C$_H$	(W)	ILR1	Interrupt level setting register 1
7D$_H$	(W)	ILR2	Interrupt level settingregister 2
7E$_H$	(W)	ILR3	Interrupt level setting register 3
7F$_H$	Vacancy		

Note: Do not use vacancies.

26

MB89630R Series

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

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

Parameter	Symbol	Value Min.	Value Max.	Unit	Remarks
Power supply voltage	V_{CC}	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	*
	AV_{CC}	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	*
A/D converter reference input voltage	AVR	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	AVR must not exceed "$AV_{CC} + 0.3$ V".
Input voltage	V_I	$V_{SS} - 0.3$	$V_{CC} + 0.3$	V	Except P50 to P53
	V_{I2}	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	P50 to P53
Output voltage	V_O	$V_{SS} - 0.3$	$V_{CC} + 0.3$	V	Except P50 to P53
	V_{O2}	$V_{SS} - 0.3$	$V_{SS} + 7.0$	V	P50 to P53
"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	$\sum I_{OL}$	—	100	mA	
"L" level total average output current	$\sum I_{OLAV}$	—	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	$\sum I_{OH}$	—	−50	mA	
"H" level total average output current	$\sum I_{OHAV}$	—	−20	mA	Average value (operating current × operating rate)
Power consumption	P_D	—	500	mW	
Operating temperature	T_A	−40	+85	°C	
Storage temperature	Tstg	−55	+150	°C	

* : 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.

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.

27

MB89630R Series

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* MB89635R/637R
		2.7*	6.0*	V	Normal operation assurance range* MB89PV630/P637/ W637/T635R/T637R
	AV_{CC}	1.5	6.0	V	Retains the RAM state in stop mode
A/D converter reference input voltage	AVR	3.0	AV_{CC}	V	
Operating temperature	T_A	–40	+85	°C	

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

Figure 1 Operating Voltage vs. Main Clock Operating Frequency
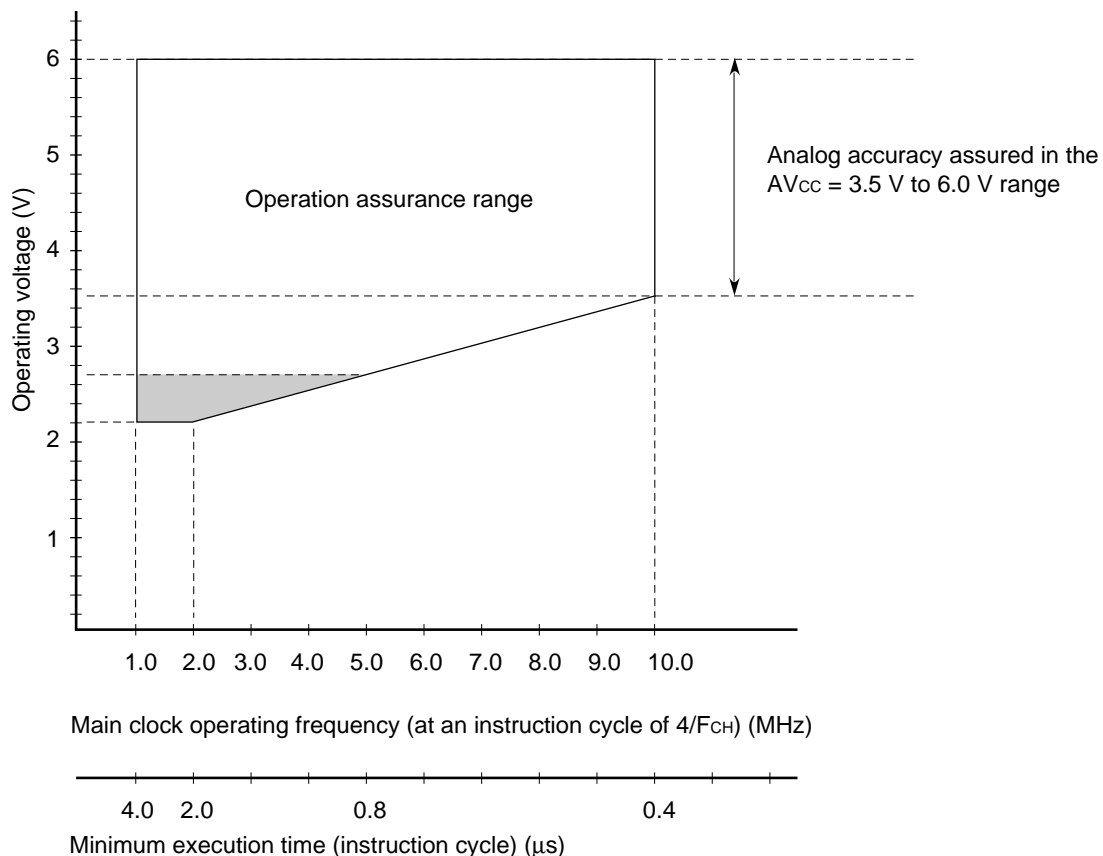
Note: The shaded area is assured only for the MB89635R/636R/637R.

Figure 1 indicates the operating frequency of the external oscillator at an instruction cycle of 4/F_{CH}.

Since the operating voltage range is dependent on the instruction cycle, see minimum execution time if the operating speed is switched using a gear.

28

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.

MB89630R Series

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 name	Condition	Value Min.	Value Typ.	Value Max.	Unit	Remarks
"H" level input voltage	V_{IH1}	P00 to P07, P10 to P17, P22, P23, P31, P34, P37, P41, P43, P51 to P53	—	$0.7\ V_{CC}$	—	$V_{CC} + 0.3$	V	P51 to P53 with pull-up resistor
	V_{IH2}	P51 to P53		$0.7\ V_{CC}$	—	$V_{SS} + 6.0$	V	Without pull-up resistor
	V_{IHS}	$\overline{RST}$, MOD0, MOD1, P30, P32, P33, P35, P36, P40, P42,P50, P72 to P74		$0.8\ V_{CC}$	—	$V_{CC} + 0.3$	V	P50 with pull-up resistor
	V_{IHS2}	P50, P70, P71		$0.8\ V_{CC}$	—	$V_{SS} + 6.0$	V	Without pull-up resistor
"L" level input voltage	V_{IL}	P00 to P07, P10 to P17, P22, P23, P31, P34, P37, P41, P43		$V_{SS} - 0.3$	—	$0.3\ V_{CC}$	V	
	V_{ILS}	P30, P32, P33, P35, P36, P40, P42, P50 to P53, P70 to P74, $\overline{RST}$, MOD0, MOD1		$V_{SS} - 0.3$	—	$0.2\ V_{CC}$	V	
Open-drain output pin application voltage	V_D	P50 to P53		$V_{SS} - 0.3$	—	$V_{SS} + 6.0$	V	
"H" level output voltage	V_{OH}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P43	$I_{OH} = -2.0\ mA$	4.0	—	—	V	
"L" level output voltage	V_{OL}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P43, P50 to P53, P60 to P67, $\overline{RST}$	$I_{OL} = 4.0\ mA$	—	—	0.4	V	
Input leakage current (Hi-z output leakage current)	I_{LI}	P00 to P07, P10 to P17, P20 to P23, P30 to P37, P40 to P43, P50 to P53, P70 to P74, MOD0, MOD1	$0.0\ V < V_I < V_{CC}$	—	—	±5	µA	Without pull-up resistor

(Continued)

30

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

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Pull-up resistance	R_{PULL}	P00 to P07, P10 to P17, P30 to P37, P40 to P43, P50 to P53, P72 to P74	$V_I = 0.0 \text{ V}$	25	50	100	kΩ	With pull-up resistor
Power supply current[*1]	I_{CC1}	V_{CC}	$F_{CH} = 10 \text{ MHz}$ $V_{CC} = 5.0 \text{ V}$ $t_{inst}{}^{*2} = 0.4 \text{ μs}$	—	12	20	mA	
	I_{CC2}		$F_{CH} = 10 \text{ MHz}$ $V_{CC} = 3.0 \text{ V}$ $t_{inst}{}^{*2} = 6.4 \text{ μs}$	—	1.0	2	mA	MB89635R/T635R/636R/637R/T637R/PV630
				—	1.5	2.5	mA	MB89P637/W637
	I_{CCS1}		Sleep mode $F_{CH} = 10 \text{ MHz}$ $V_{CC} = 5.0 \text{ V}$ $t_{inst}{}^{*2} = 0.4 \text{ μs}$	—	3	7	mA	
	I_{CCS2}		Sleep mode $F_{CH} = 10 \text{ MHz}$ $V_{CC} = 3.0 \text{ V}$ $t_{inst}{}^{*2} = 6.4 \text{ μs}$	—	0.5	1.5	mA	
	I_{CCL}		$F_{CL} = 32.768 \text{ kHz}$, $V_{CC} = 3.0 \text{ V}$ Subclock mode	—	50	100	μA	MB89635R/T635R/636R/637R/T637R/PV630
				—	500	700	μA	MB89P637/W637
	I_{CCLS}		$F_{CL} = 32.768 \text{ kHz}$, $V_{CC} = 3.0 \text{ V}$ Subclock sleep mode	—	25	50	μA	
	I_{CCT}		$F_{CL} = 32.768 \text{ kHz}$, $V_{CC} = 3.0 \text{ V}$ • Watch mode • Main clock stop mode at dual-clock system	—	3	15	μA	
	I_{CCH}		$T_A = +25°C$ • Subclock stop mode • Main clock stop mode at single-clock system	—	—	1	μA	

(Continued)

31

MB89630R Series

(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 name	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Power supply current[*1]	I_A	AV_{CC}	$F_{CH} = 10\ MHz$, when A/D conversion operates.	—	6	—	mA	
	I_{AH}		$F_{CH} = 10\ MHz$, $T_A = +25°C$, when A/D conversion in a stop.	—	—	1	μA	
Input capacitance	C_{IN}	Other than AV_{CC}, AV_{SS}, V_{CC}, and V_{SS}	$f = 1\ MHz$	—	10	—	pF	

*1: The power supply current is measured at the external clock.

In the case of the MB89PV630, the current consumed by the connected EPROM and ICE is not counted.

*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	

32
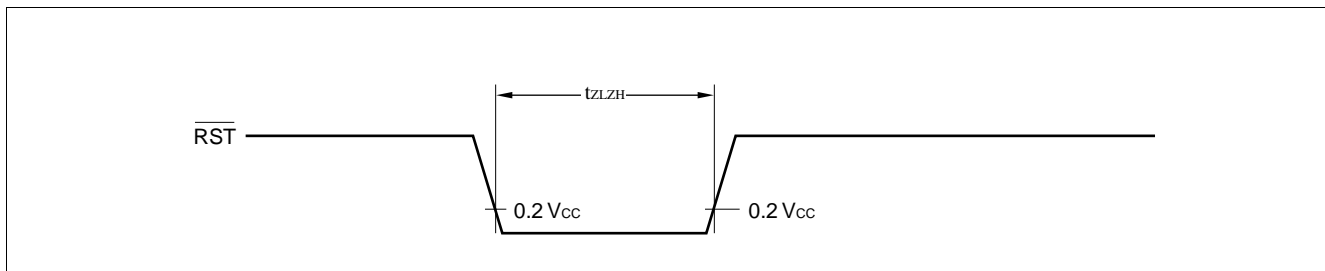
(2) Specification for Power-on Reset

(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	Min. interval time for the next power-on reset

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.
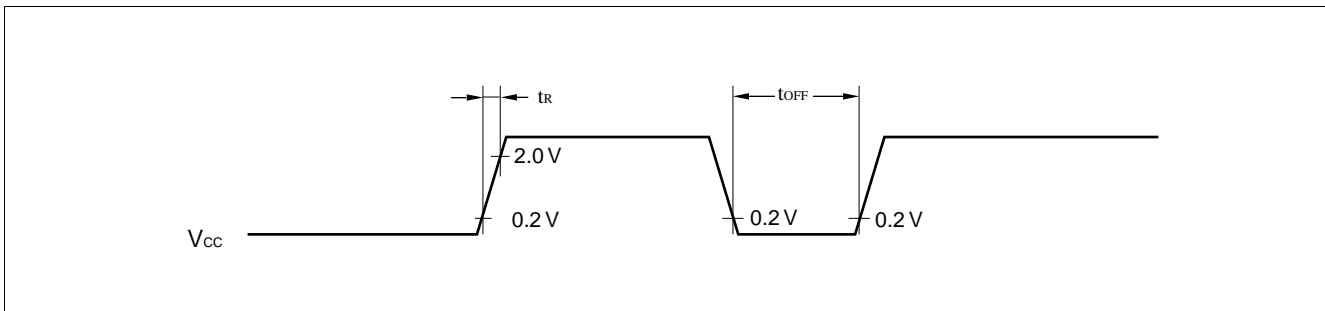
(3) Clock Timing

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

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Clock frequency	F$_{CH}$	X0, X1	—	1	—	10	MHz	
	F$_{CL}$	X0A, X1A		—	32.768	—	kHz	
Clock cycle time	t$_{HCYL}$	X0, X1		100	—	1000	ns	
	t$_{LCYL}$	X0A, X1A		—	30.5	—	µs	
Input clock pulse width	P$_{WH}$ P$_{WL}$	X0		20	—	—	ns	External clock
	P$_{WLH}$ P$_{WLL}$	X0A		—	15.2	—	µs	External clock
Input clock rising/falling time	t$_{CR}$ t$_{CF}$	X0		—	—	10	ns	External clock

33

MB89630R Series

• **Main clock timing condition**
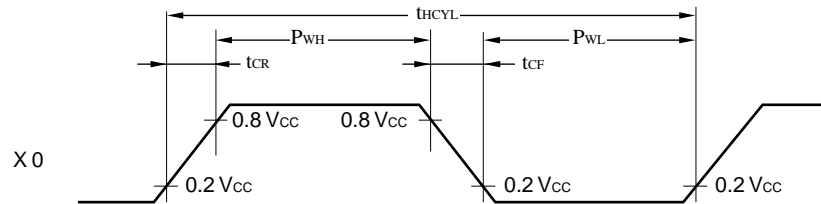
t_{HCYL}

P_{WH} P_{WL}

t_{CR} t_{CF}

0.8 V$_{CC}$ 0.8 V$_{CC}$

X 0

0.2 V$_{CC}$ 0.2 V$_{CC}$ 0.2 V$_{CC}$

• **Main clock configurations**

When a crystal
or
ceramic reasonator is used

When an external clock is used

X0   X1

X0   X1

Open

• **Subclock timing condition**

t_{LCYL}

P_{WLH} P_{WLL}

t_{CR} t_{CF}

0.8 V$_{CC}$ 0.8 V$_{CC}$

X0A

0.2 V$_{CC}$ 0.2 V$_{CC}$ 0.2 V$_{CC}$

• **Subclock configurations**

When a crystal
or
ceramic reasonator is used

When an external clock is used

X0A   X1A

X0A   X1A

Open
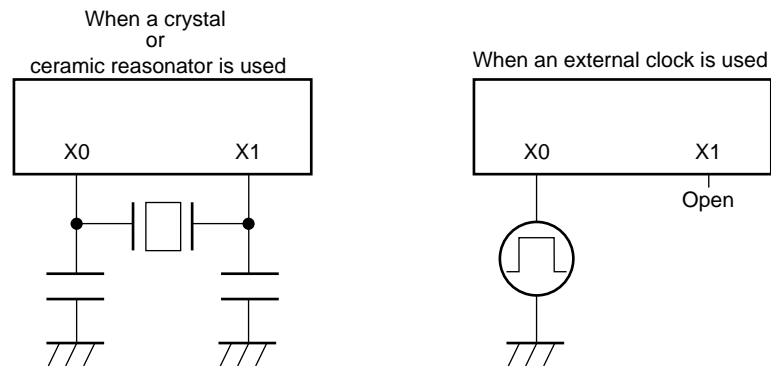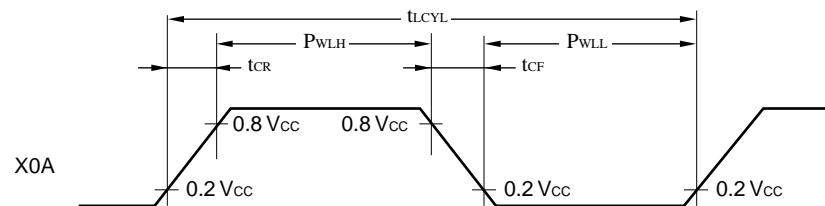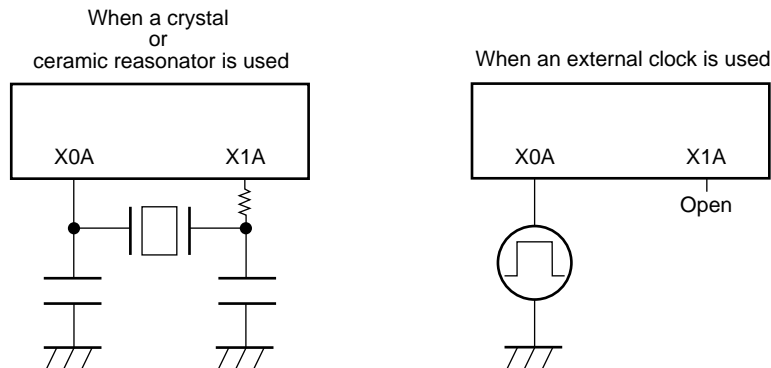
MB89630R Series

(4) Instruction Cycle

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} = 0.4 μs, operating at F_{CH} = 10 MHz
		$2/F_{CL}$	μs	t_{inst} = 61.036 μs, operating at F_{CL} = 32.768 kHz

Note: Operating at 10 MHz, the cycle varies with the set execution time.

(5) Clock Output Timing

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

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
Clock time	t_{CYC}	CLK	—	$1/2\ t_{inst}$*	—	μs	
CLK $\uparrow \rightarrow$ CLK $\downarrow$	t_{CHCL}	CLK		$1/4\ t_{inst}$* – 70 ns	$1/4\ t_{inst}$*	μs	

* : For information on t_{inst}, see "(4) Instruction Cycle."
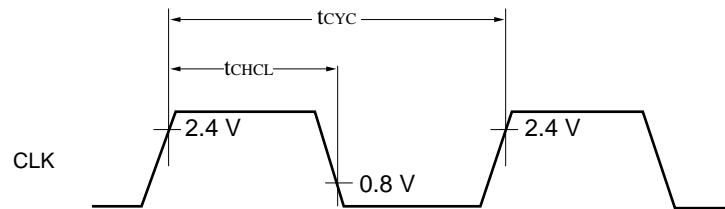
MB89630R Series

(6) Bus Read Timing

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

Parameter	Symbol	Pin name	Condition	Value Min.	Value Max.	Unit	Remarks
Valid address → $\overline{RD}$ ↓ time	t_{AVRL}	$\overline{RD}$, A15 to A08, AD7 to AD0		1/4 t_{inst}*− 64 ns	—	μs	
$\overline{RD}$ pulse width	t_{RLRH}	$\overline{RD}$		1/2 t_{inst}*− 20 ns	—	μs	
Valid address → data read time	t_{AVDV}	AD7 to AD0, A15 to A08		1/2 t_{inst}*	200	μs	No wait
$\overline{RD}$ ↓ → data read time	t_{RLDV}	$\overline{RD}$, AD7 to AD0		1/2 t_{inst}*− 80 ns	120	μs	No wait
$\overline{RD}$ ↑ → data hold time	t_{RHDX}	AD7 to AD0, $\overline{RD}$		0	—	μs	
$\overline{RD}$ ↑ → ALE ↑ time	t_{RHLH}	$\overline{RD}$, ALE	—	1/4 t_{inst}*− 40 ns	—	μs	
$\overline{RD}$ ↑ → address loss time	t_{RHAX}	$\overline{RD}$, A15 to A08		1/4 t_{inst}*− 40 ns	—	μs	
$\overline{RD}$ ↓ → CLK ↑ time	t_{RLCH}	$\overline{RD}$, CLK		1/4 t_{inst}*− 40 ns	—	μs	
CLK ↓ → $\overline{RD}$ ↑ time	t_{CLRH}			0	—	ns	
$\overline{RD}$ ↓ → BUFC ↓ time	t_{RLBL}	$\overline{RD}$, BUFC		−5	—	μs	
BUFC ↑ → valid address time	t_{BHAV}	A15 to A08, AD7 to AD0, BUFC		5	—	μs	

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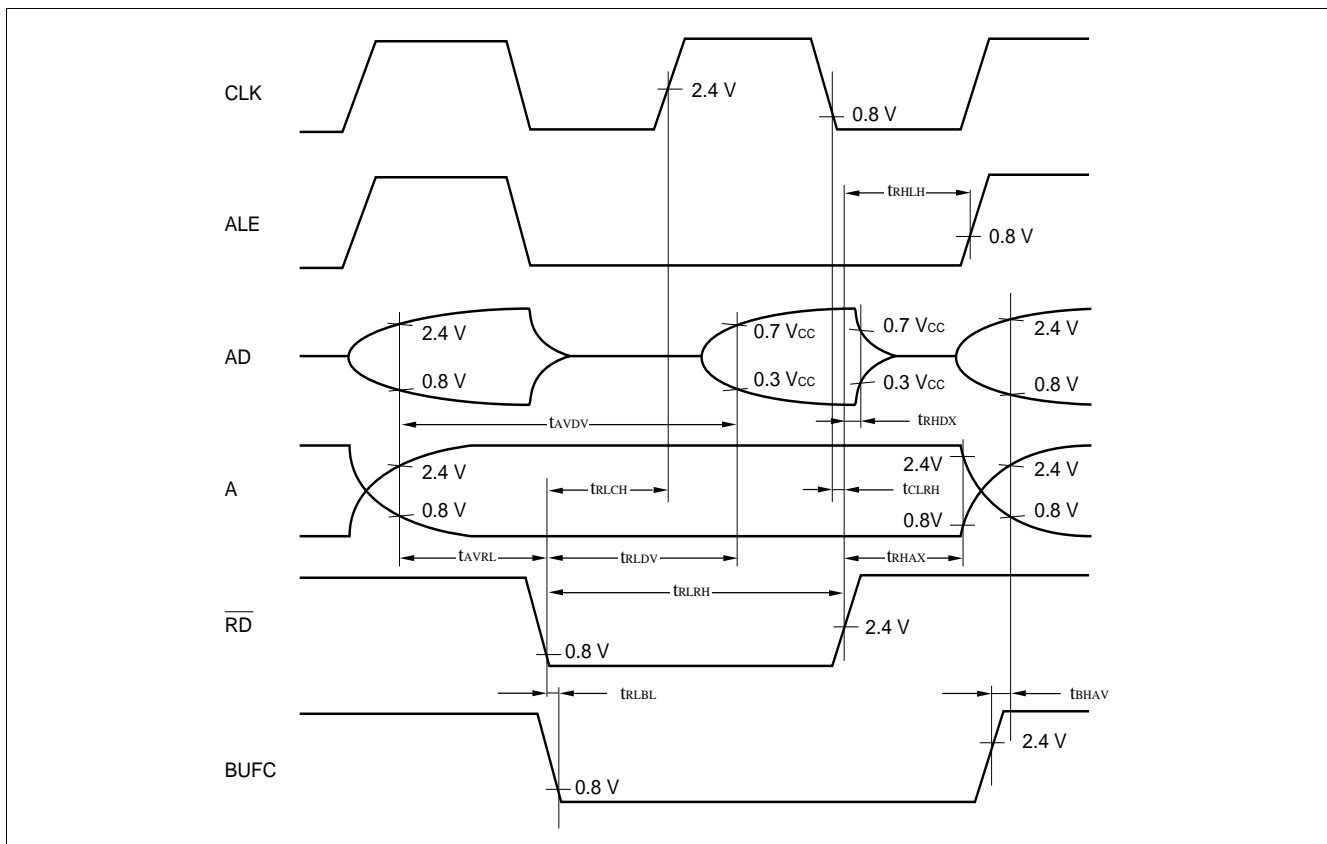
(7) Bus Write Timing

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

Parameter	Symbol	Pin name	Condition	Value Min.	Value Max.	Unit	Remarks
Valid address $\to$ ALE $\downarrow$ time	t_{AVLL}	AD7 to AD0, ALE A15 to A08		1/4 t_{inst}*1 – 64 ns*2	—	µs	
ALE $\downarrow$ time $\to$ address loss time	t_{LLAX}			5	—	ns	
Valid address $\to$ $\overline{WR}$ $\downarrow$ time	t_{AVWL}	$\overline{WR}$, ALE		1/4 t_{inst}*1 – 60 ns*2	—	µs	
$\overline{WR}$ pulse width	t_{WLWH}	$\overline{WR}$		1/2 t_{inst}*1 – 20 ns*2	—	µs	
Write data $\to$ $\overline{WR}$ $\uparrow$ time	t_{DVWH}	AD7 to AD0, $\overline{WR}$		1/2 t_{inst}*1 – 60 ns*2	—	µs	
$\overline{WR}$ $\uparrow$ $\to$ address loss time	t_{WHAX}	$\overline{WR}$, A15 to A08	—	1/4 t_{inst}*1 – 40 ns*2	—	µs	
$\overline{WR}$ $\uparrow$ $\to$ data hold time	t_{WHDX}	AD7 to AD0, $\overline{WR}$		1/4 t_{inst}*1 – 40 ns*2	—	µs	
$\overline{WR}$ $\uparrow$ $\to$ ALE $\uparrow$ time	t_{WHLH}	$\overline{WR}$, ALE		1/4 t_{inst}*1 – 40 ns*2	—	µs	
$\overline{WR}$ $\downarrow$ $\to$ CLK $\uparrow$ time	t_{WLCH}	$\overline{WR}$, CLK		1/4 t_{inst}*1 – 40 ns*2	—	µs	
CLK $\downarrow$ $\to$ $\overline{WR}$ $\uparrow$ time	t_{CLWH}			0	—	ns	
ALE pulse width	t_{LHLL}	ALE		1/4 t_{inst}*1 – 35 ns*2	—	µs	
ALE $\downarrow$ $\to$ CLK $\uparrow$ time	t_{LLCH}	ALE,CLK		1/4 t_{inst}*1 – 30 ns*2	—	µs	

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

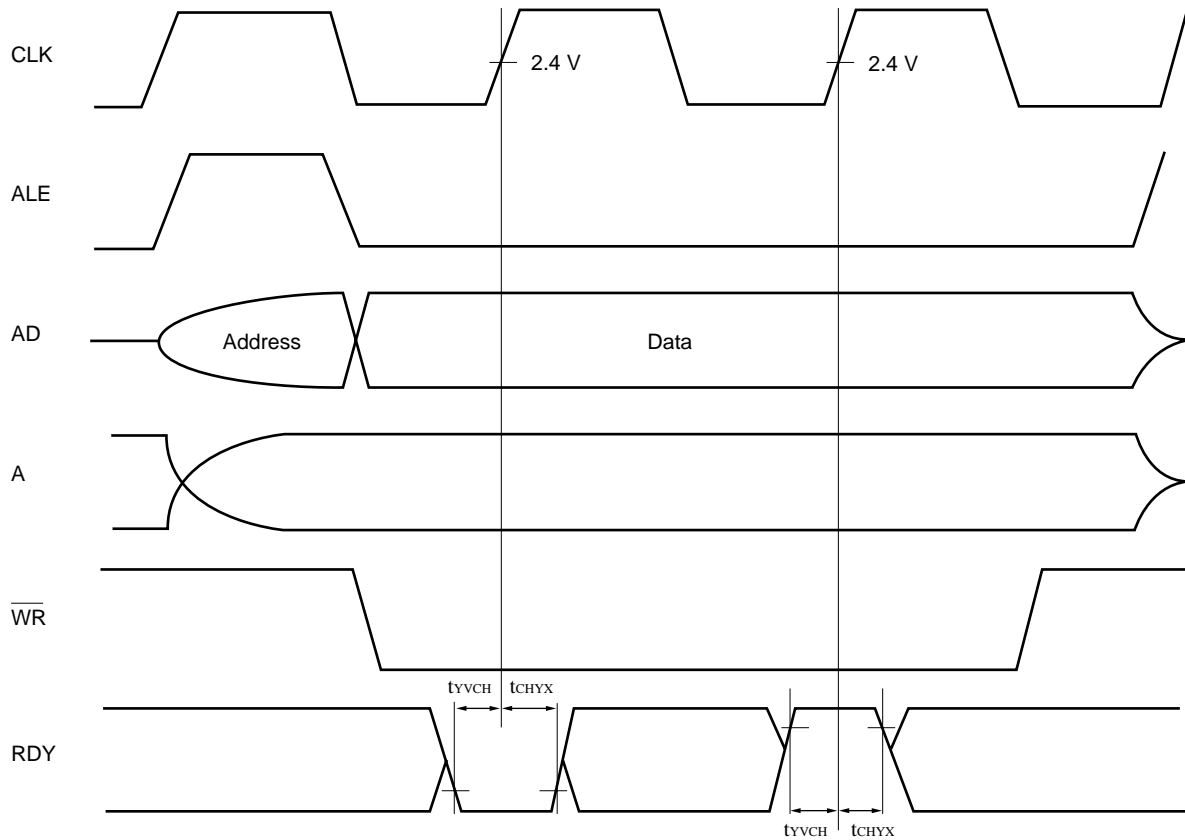*2: This characteristics are also applicable to the bus read timing.
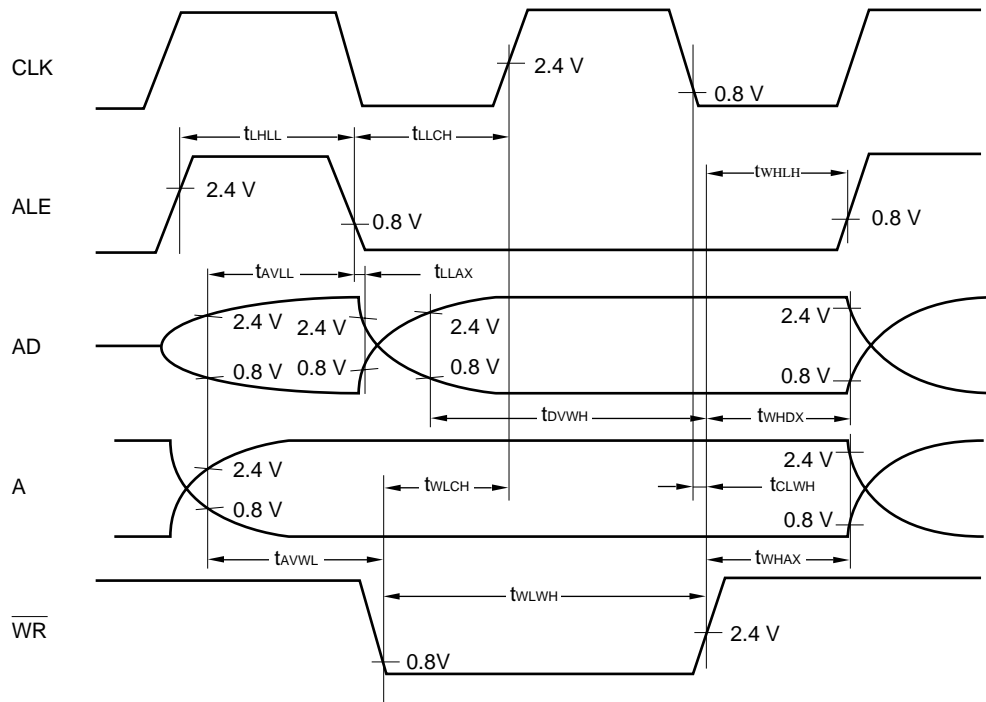
MB89630R Series

(8) Ready Input Timing

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

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
RDY valid $\rightarrow$ CLK $\uparrow$ time	t_{YVCH}	RDY, CLK	—	60	—	ns	*
CLK $\uparrow$ $\rightarrow$ RDY loss time	t_{CHYX}		—	0	—	ns	*

* : This characteristics are also applicable to the read cycle.

Note: The bus cycle is also extended in the read cycle in the same manner.

38

MB89630R Series

(9) Serial I/O Timing

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

Parameter	Symbol	Pin name	Condition	Value Min.	Value Max.	Unit	Remarks
Serial clock cycle time	t_{SCYC}	SCK1, UCK1, UCK2	Internal shift clock mode	2 t_{inst}*	—	µs	
SCK1 ↓ → SO1 time UCK1 ↓ → UO1 time UCK2 ↓ → UO2 time	t_{SLOV}	SCK1, SO1 UCK1, UO1 UCK2, UO2		–200	200	ns	
Valid SI1 → SCK1 ↑ Valid UI1 → UCK1 ↑ Valid UI2 → UCK2 ↑	t_{IVSH}	SI1, SCK1 UI1, UCK1 UI2, UCK2		1/2 t_{inst}*	—	µs	
SCK1 ↑ → valid SI1 hold time UCK1 ↑ → valid UI1 hold time UCK2 ↑ → valid UI2 hold time	t_{SHIX}	SCK1, SI1 UCK1, UI1 UCK2, UI2		1/2 t_{inst}*	—	µs	
Serial clock "H" pulse width	t_{SHSL}	SCK1, UCK1, UCK2	External shift clock mode	1 t_{inst}*	—	µs	
Serial clock "L" pulse width	t_{SLSH}	SCK1, UCK1, UCK2		1 t_{inst}*	—	µs	
SCK1 ↓ → SO1 time UCK1 ↓ → UO1 time UCK2 ↓ → UO2 time	t_{SLOV}	SCK1, SO1 UCK1, UO1 UCK2, UO2		0	200	ns	
Valid SI1 → SCK1 ↑ Valid UI1 → UCK1 ↑ Valid UI2 → UCK2 ↑	t_{IVSH}	SI1, SCK1 UI1, UCK1 UI2, UCK2		1/2 t_{inst}*	—	µs	
SCK1 ↓ → valid SI1 hold time UCK1 ↓ → valid UI1 hold time UCK2 ↓ → valid UI2 hold time	t_{SHIX}	SCK1, SI1 UCK1, UI1 UCK2, UI2		1/2 t_{inst}*	—	µs	

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

MB89630R Series

• Internal shift clock mode

SCK1
UCK1
UCK2

t_{SCYC}

0.8 V
2.4 V
0.8 V

SO1
UO1
UO2

t_{SLOV}

2.4 V
0.8 V

SI1
UI1
UI

t_{IVSH}
t_{SHIX}

0.8 V_{CC}
0.2 V_{CC}
0.8 V_{CC}
0.2 V_{CC}

• External shift clock mode

SCK1
UCK1
UCK2

t_{SLSH}
t_{SHSL}

0.2 V_{CC}
0.2 V_{CC}
0.8 V_{CC}
0.8 V_{CC}

SO1
UO1
UO2

t_{SLOV}

2.4 V
0.8 V

SI1
UI1
UI

t_{IVSH}
t_{SHIX}

0.8 V_{CC}
0.2 V_{CC}
0.8 V_{CC}
0.2 V_{CC}
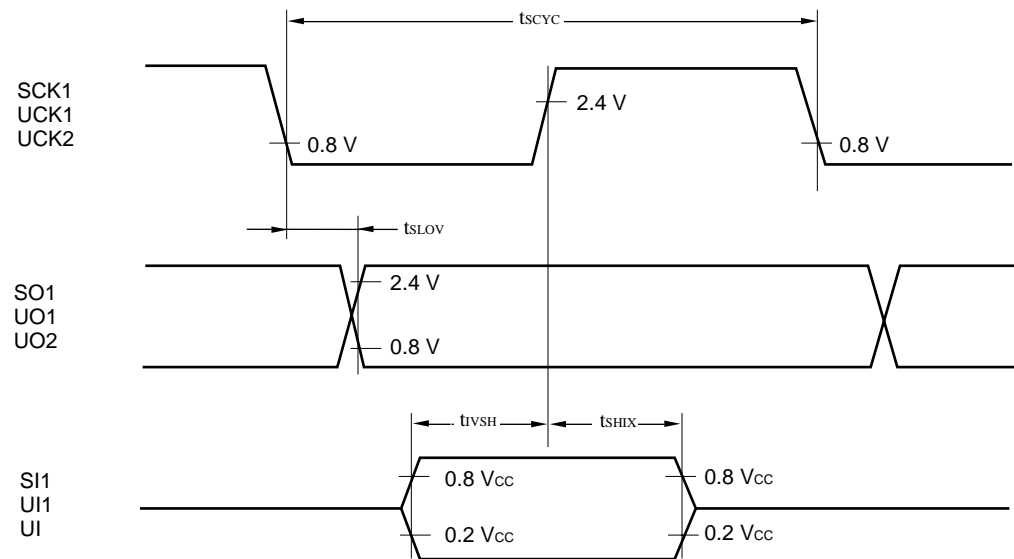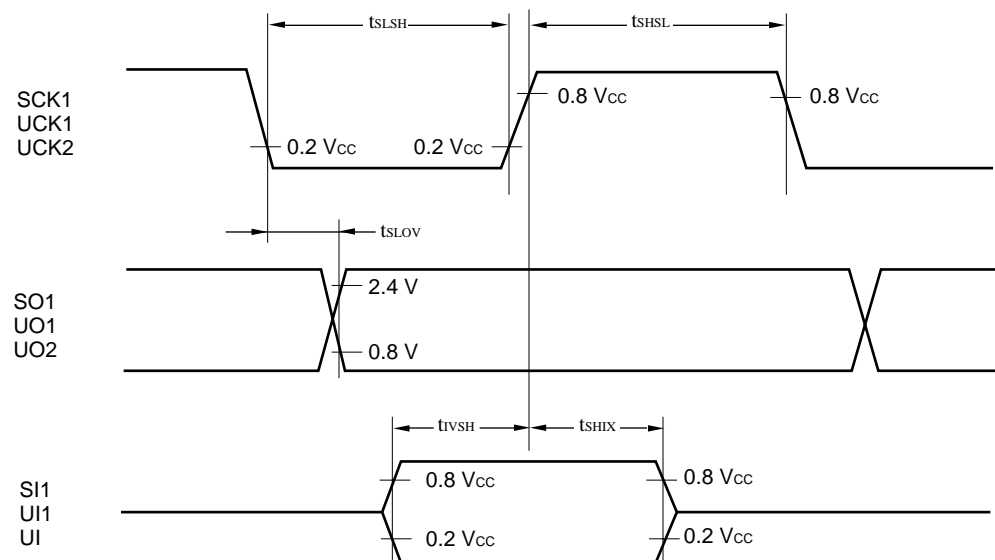
MB89630R Series

(10) Peripheral Input Timing

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

Parameter	Symbol	Pin name	Value		Unit	Remarks
			Min.	Max.		
Peripheral input "H" pulse width 1	t_{ILIH1}	PWC, INT0 to INT3,EC	$2\ t_{inst}*$	—	µs	
Peripheral input "L" pulse width 1	t_{IHIL1}		$2\ t_{inst}*$	—	µs	
Peripheral input "H" pulse width 2	t_{ILIH2}	ADST	$2^8\ t_{inst}*$	—	µs	A/D mode
Peripheral input "L" pulse width 2	t_{IHIL2}		$2^8\ t_{inst}*$	—	µs	A/D mode
Peripheral input "H" pulse width 3	t_{ILIH3}	ADST	$2^8\ t_{inst}*$	—	µs	Sense mode
Peripheral input "L" pulse width 3	t_{IHIL3}		$2^8\ t_{inst}*$	—	µs	Sense mode

* : For information on $t_{inst,}$ see "(4) Instruction Cycle."
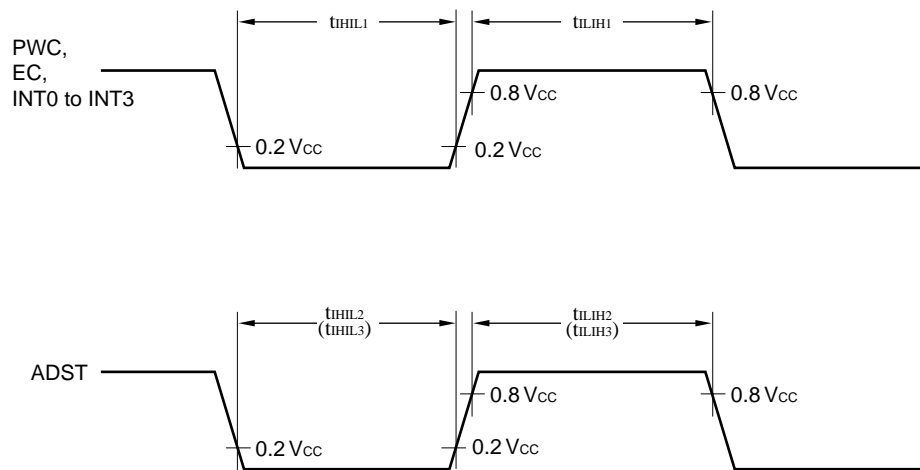
MB89630R Series

5. A/D Converter Electrical Characteristics

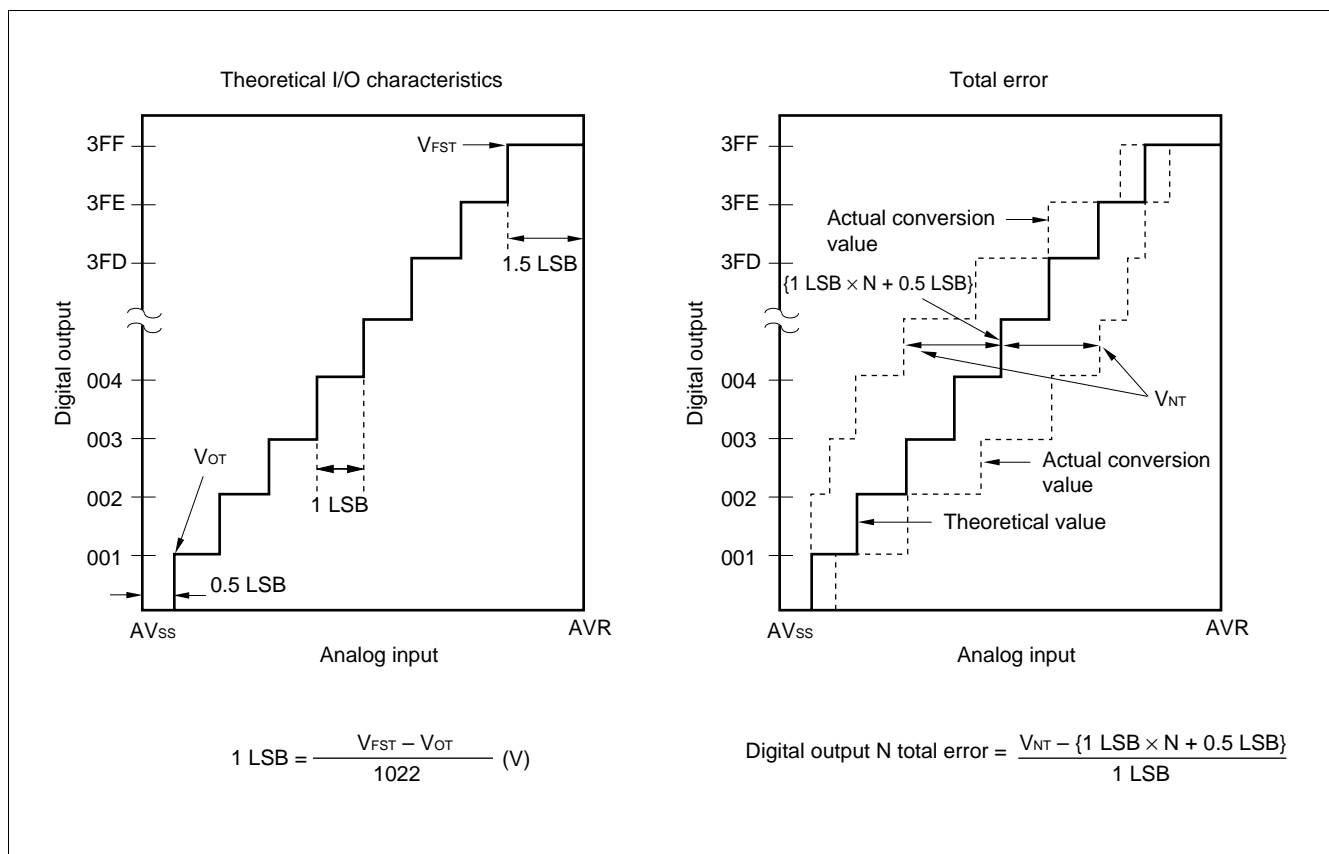(AV$_{CC}$ = V$_{CC}$ = 3.5 V to 6.0 V, F$_{CH}$ = 10 MHz, AV$_{SS}$ = V$_{SS}$ = 0.0 V, T$_A$ = –40°C to +85°C)

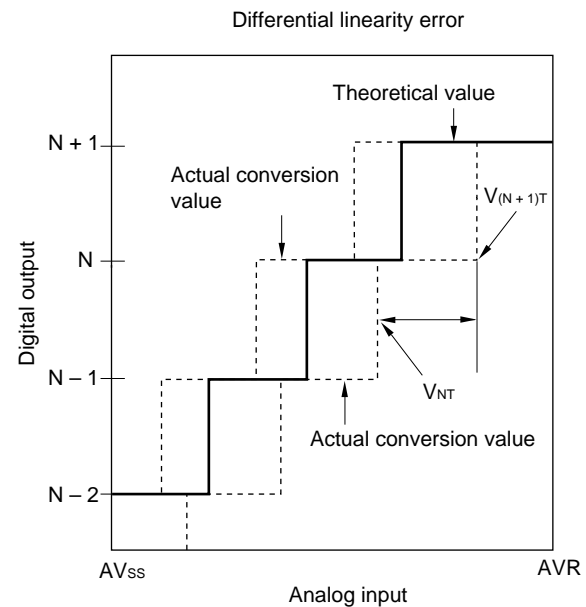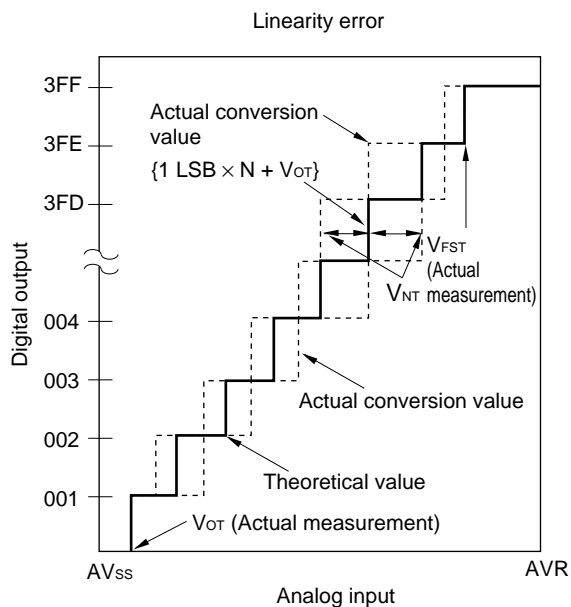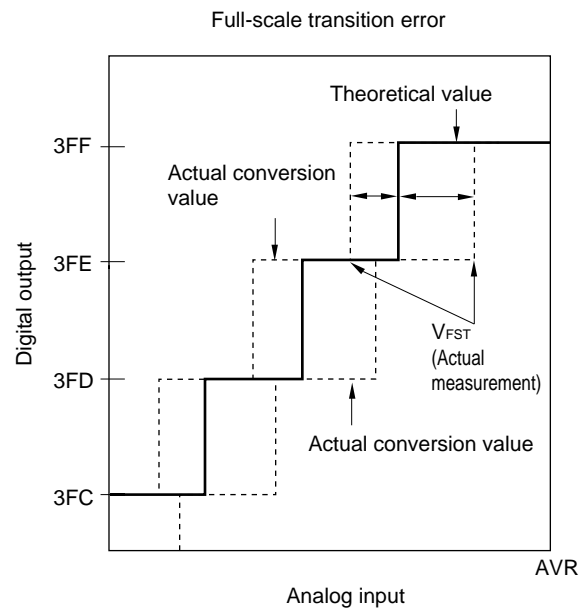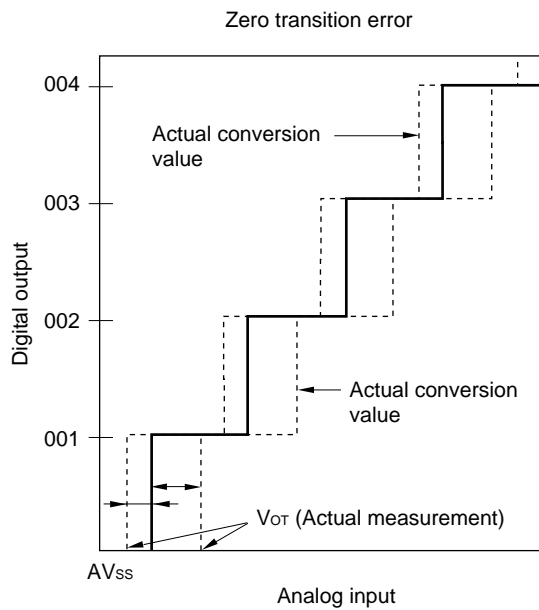| Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min.	Typ.	Max.		
Resolution	—	—	—	—	10	bit	At AV$_{CC}$ = V$_{CC}$
Linearity error			—	—	±2.0	LSB	
Differential linearity error			—	—	±1.5	LSB	
Total error			—	—	±3.0	LSB	
Zero transition voltage	V$_{OT}$	AN0 to AN7	AV$_{SS}$ – 1.5 LSB	AV$_{SS}$ + 0.5 LSB	AV$_{SS}$ + 2.5 LSB	mV	
Full-scale transition voltage	V$_{FST}$		AVR – 3.5 LSB	AVR – 1.5 LSB	AVR + 0.5 LSB	mV	
Interchannel disparity	—	—	—	—	4	LSB	
A/D mode conversion time			—	13.2	—	µs	At 10 MHz oscillation
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$_R$		—	200	—	µA	AVR = 5.0 V

6. A/D Converter Glossary

- Resolution
  Analog changes that are identifiable with the A/D converter
- Linearity error
  The deviation of the straight line connecting the zero transition point ("00 0000 0000" ↔ "00 0000 0001") with the full-scale transition point ("11 1111 1110" ↔ "11 1111 1111") from actual conversion characteristics
- Differential linearity error
  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 caused by the zero transition error, full-scale transition error, linearity error, quantization error, and noise

Theoretical I/O characteristics

$$1 \text{ LSB} = \frac{V_{FST} - V_{OT}}{1022} \text{ (V)}$$

Total error

$$\text{Digital output N total error} = \frac{V_{NT} - \{1 \text{ LSB} \times N + 0.5 \text{ LSB}\}}{1 \text{ LSB}}$$

MB89630R Series

(Continued)

Zero transition error

Digital output vs Analog input

004, 003, 002, 001

Actual conversion value

Actual conversion value

V_{OT} (Actual measurement)

AV$_{SS}$

Analog input

Full-scale transition error

Theoretical value

3FF, 3FE, 3FD, 3FC

Actual conversion value

V_{FST} (Actual measurement)

Actual conversion value

AVR

Analog input

Linearity error

3FF, 3FE, 3FD, 004, 003, 002, 001

Actual conversion value {1 LSB × N + V_{OT}}

V_{FST} (Actual measurement) V_{NT}

Actual conversion value

Theoretical value

V_{OT} (Actual measurement)

AV$_{SS}$ AVR

Analog input

Differential linearity error

Theoretical value

N + 1, N, N − 1, N − 2

Actual conversion value

$V_{(N + 1)T}$

V_{NT}

Actual conversion value

AV$_{SS}$ AVR

Analog input

$$\text{Digital output N linearity error} = \frac{V_{NT} - \{1\ LSB \times N + V_{OT}\}}{1\ LSB}$$

$$\text{Digital output N differential linearity error} = \frac{V_{(N + 1)T} - V_{NT}}{1\ LSB} - 1$$
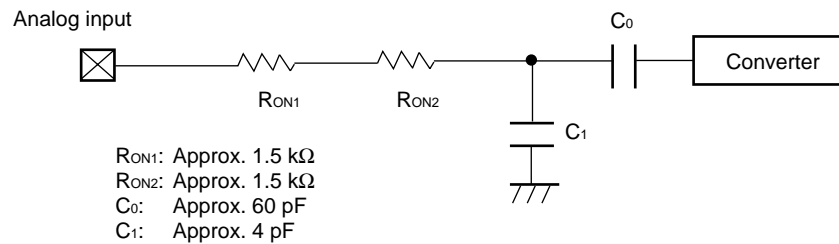
7. Notes on Using A/D Converter

• **Input impedance of the analog input pins**
The output impedance of the external circuit for the analog input must satisfy the followingconditions.
If the output impedance of the external circuit is too high, an analog voltage sampling time might beinsufficient (sampling time = 6 μs at 10MHz oscillation.) Therefore, it is recommended to keep the output impedance of the external circuit below 10 kΩ .

• **Analog input circuit model**

Analog input

R_{ON1} R_{ON2} C_0 Converter

C_1

R_{ON1}: Approx. 1.5 kΩ
R_{ON2}: Approx. 1.5 kΩ
C_0:   Approx. 60 pF
C_1:   Approx. 4 pF

Note: The values mentioned here should be used as a guideline.

• **Error**
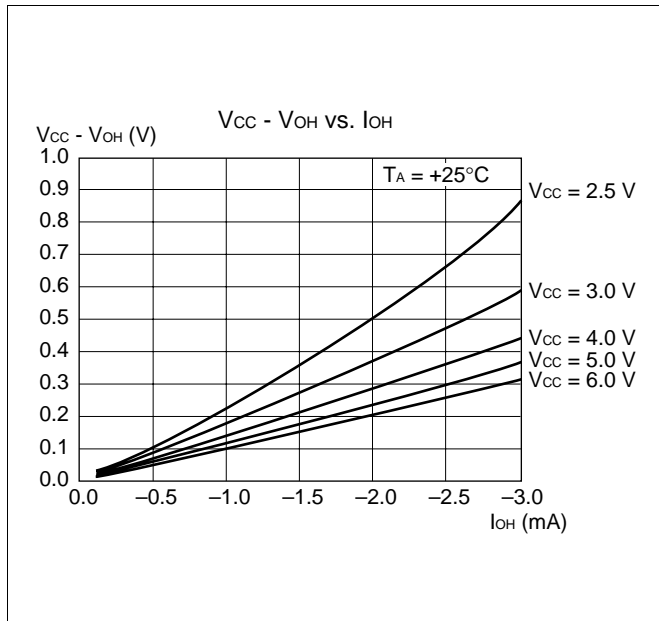The smaller the | AVR–AVss |, the greater the error would become relatively.

MB89630R Series

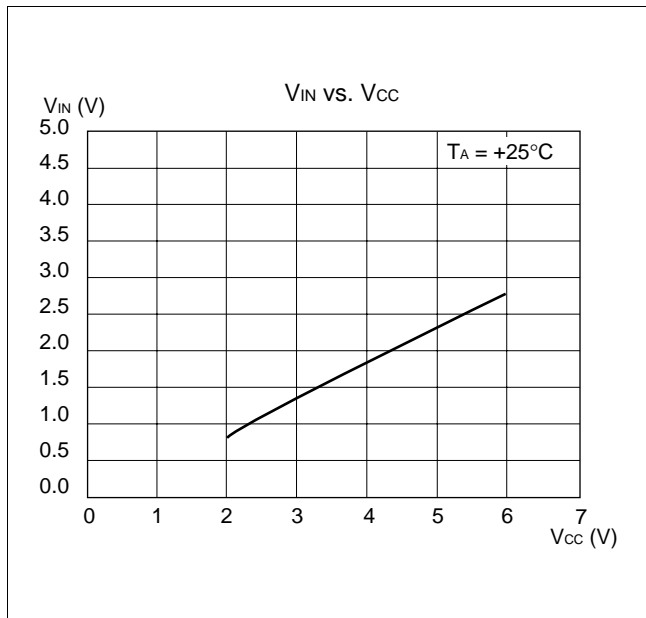## ■ CHARACTERISTICS EXAMPLE

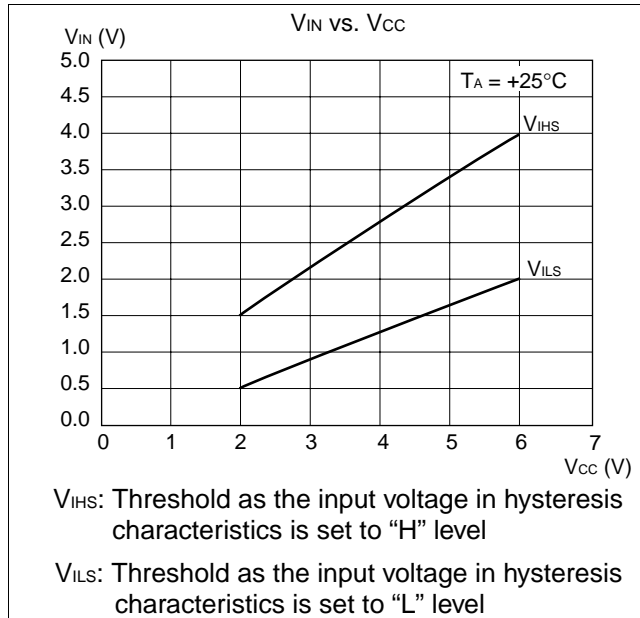### (1) "L" Level Output Voltage
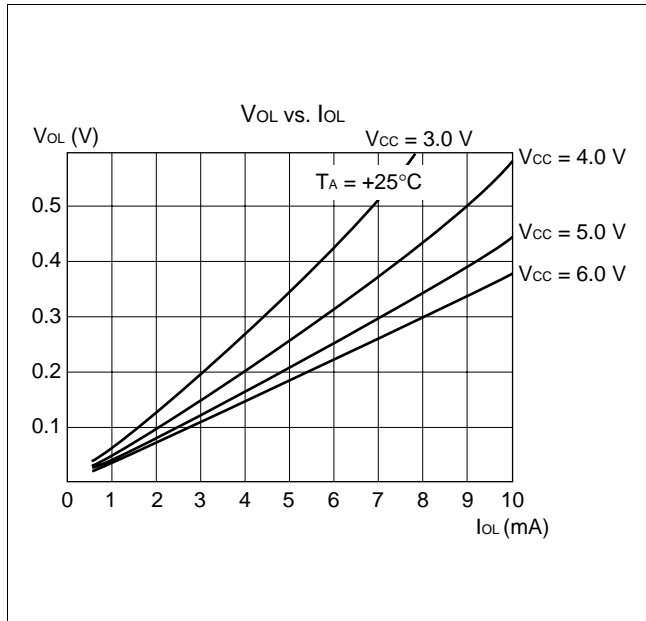
(2) "H" Level Output Voltage

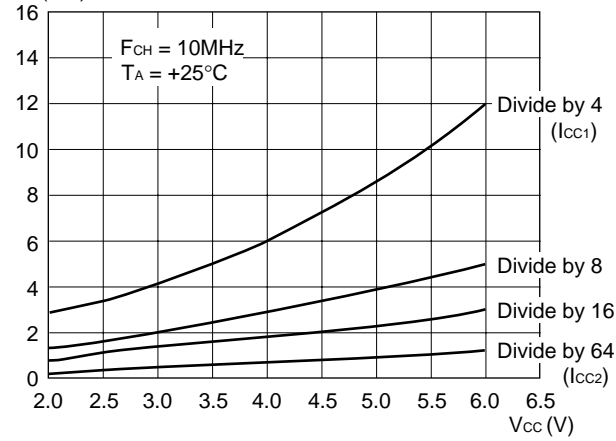
(3) "H" Level Input Voltage/"L" Level Input Voltage (CMOS Input)

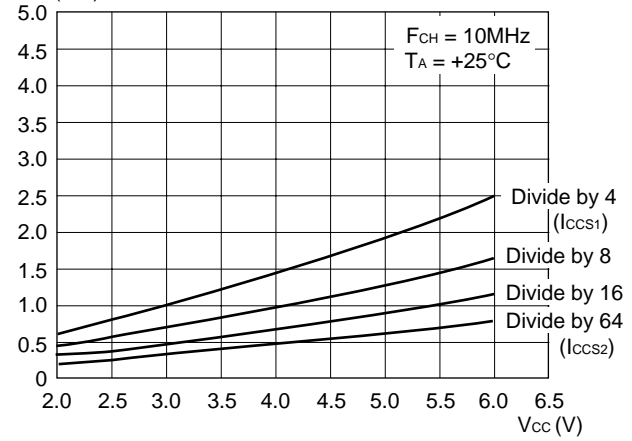### (4) "H" Level Input Voltage/"L" Level Input Voltage (Hysteresis Input)

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

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

MB89630R Series

(5) Power Supply Current (External Clock)

I_{CC1} vs. V_{CC}, I_{CC2} vs. V_{CC}

I_{CC} (mA)

$F_{CH} = 10MHz$
$T_A = +25°C$

Divide by 4 (I_{CC1})

Divide by 8

Divide by 16

Divide by 64 (I_{CC2})

V_{CC} (V)

I_{CCS1} vs. V_{CC}, I_{CCS2} vs. V_{CC}

I_{CCS} (mA)

$F_{CH} = 10MHz$
$T_A = +25°C$

Divide by 4 (I_{CCS1})

Divide by 8

Divide by 16

Divide by 64 (I_{CCS2})

V_{CC} (V)

I_{CCL} vs. V_{CC}

I_{CCL} (µA)

$T_A = +25°C$

V_{CC} (V)

I_{CCLS} vs. V_{CC}

I_{CCLS} (µA)

$T_A = +25°C$

V_{CC} (V)

(Continued)

MB89630R Series

(Continued)

I_{CCT} vs. V_{CC} / I_{CCH} vs. V_{CC}
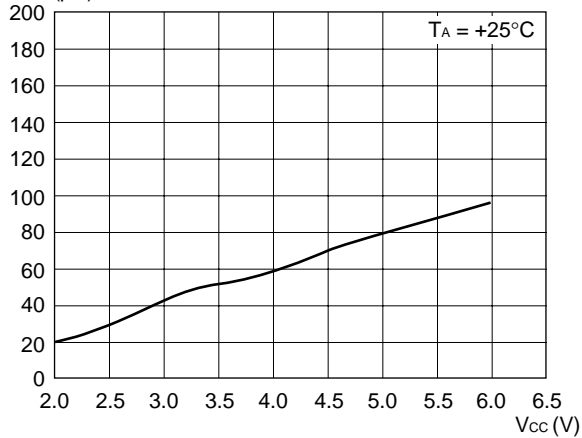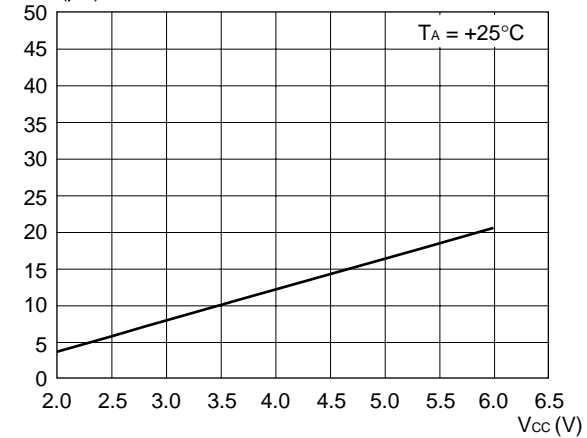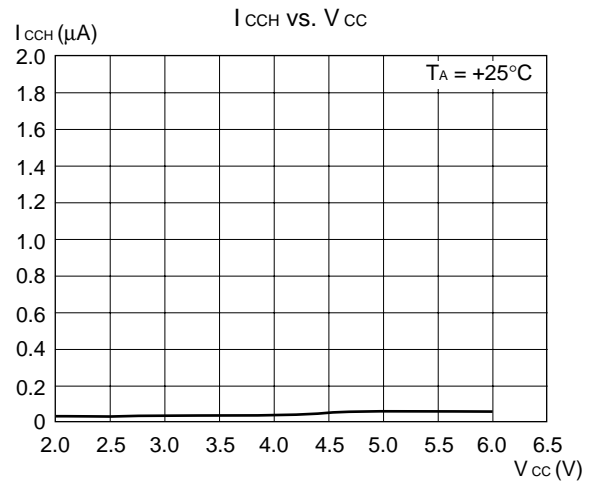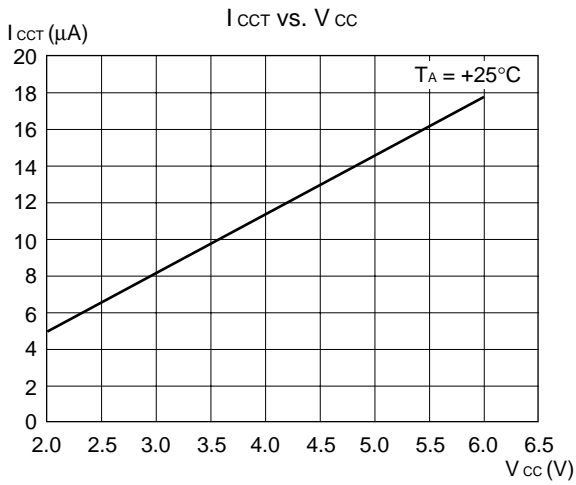
(6) Pull-up Resistance

R_{PULL} vs. V_{CC}
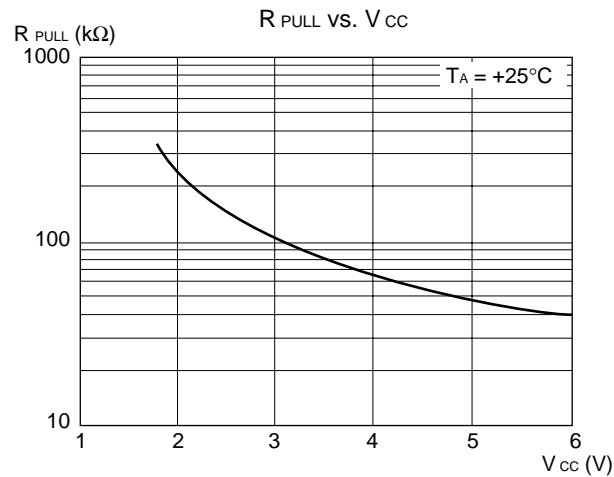
■ INSTRUCTIONS (136 INSTRUCTIONS)

Execution instructions can be divided into the following four groups:
• Transfer
• Arithmetic operation
• Branch
• Others
  Table 1 lists symbols used for notation of instructions.

Table 1   Instruction Symbols

Symbol	Meaning
dir	Direct address (8 bits)
off	Offset (8 bits)
ext	Extended address (16 bits)
#vct	Vector table number (3 bits)
#d8	Immediate data (8 bits)
#d16	Immediate data (16 bits)
dir: b	Bit direct address (8:3 bits)
rel	Branch relative address (8 bits)
@	Register indirect (Example: @A, @IX, @EP)
A	Accumulator A (Whether its length is 8 or 16 bits is determined by the instruction in use.)
AH	Upper 8 bits of accumulator A (8 bits)
AL	Lower 8 bits of accumulator A (8 bits)
T	Temporary accumulator T (Whether its length is 8 or 16 bits is determined by the instruction in use.)
TH	Upper 8 bits of temporary accumulator T (8 bits)
TL	Lower 8 bits of temporary accumulator T (8 bits)
IX	Index register IX (16 bits)
EP	Extra pointer EP (16 bits)
PC	Program counter PC (16 bits)
SP	Stack pointer SP (16 bits)
PS	Program status PS (16 bits)
dr	Accumulator A or index register IX (16 bits)
CCR	Condition code register CCR (8 bits)
RP	Register bank pointer RP (5 bits)
Ri	General-purpose register Ri (8 bits, i = 0 to 7)
$\times$	Indicates that the very $\times$ is the immediate data. (Whether its length is 8 or 16 bits is determined by the instruction in use.)
$(\times)$	Indicates that the contents of $\times$ is the target of accessing. (Whether its length is 8 or 16 bits is determined by the instruction in use.)
$((\times))$	The address indicated by the contents of $\times$ is the target of accessing. (Whether its length is 8 or 16 bits is determined by the instruction in use.)

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.

49

MB89630R Series

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 F^{2}MC-8 family)

Table 3   Arithmetic Operation Instructions (62 instructions)

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

(Continued)

51

MB89630R Series

(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

MB89630R Series

■ INSTRUCTION MAP

L \ H	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0	NOP	SWAP	RET	RETI	PUSHW A	POPW A	MOV A,ext	MOVW A,PS	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

MB89630R Series

■ MASK OPTIONS

No.	Part number	MB89635R MB89636R MB89637R	MB89P637 MB89W637	MB89PV630 MB89T635R MB89T637R
	Specifying procedure	Specify when ordering masking	Set with EPROM programmer	Setting not possible
1	Pull-up resistors 　P00 to P07, P10 to P17, 　P30 to P37, P40 to P43, 　P50 to P53, P72 to P74	Selectable by pin	Can be set per pin*	Fixed to "without pull-up resistor"
2	Power-on reset selection 　With power-on reset 　Without power-on reset	Selectable	Setting possible	Fixed to "with power-on reset"
3	Selection of the main clock oscillation stabilization time (at 10 MHz) 　Approx. $2^{18}/F_{CH}$ (Approx. 26.2 ms) 　Approx. $2^{17}/F_{CH}$ (Approx. 13.1 ms) 　Approx. $2^{14}/F_{CH}$ (Approx. 1.6 ms) 　Approx. $2^{4}/F_{CH}$ (Approx. 0 ms) F_{CH} : Main clock frequency	Selectable	Setting possible	Fixed to $2^{18}/F_{CH}$ (Approx. 26.2 ms)
4	Reset pin output 　Reset output provided 　No reset output	Selectable	Setting possible	Fixed to "with reset output"
5	Single/dual-clock system option 　Single clock 　Dual clock	Selectable	Setting possible	MB89PV630-101 Single-clock system MB89T635R-101 Single-clock system MB89T637R-101 Single-clock system MB89PV630-102 Dual-clock systems MB89T635R-102 Dual-clock systems MB89T637R-102 Dual-clock systems

* : Pull-up resistors cannot be set for P50 to P53.

MB89630R Series

■ ORDERING INFORMATION

Part number	Package	Remarks
MB89635RP-SH MB89T635RP-SH MB89636RP-SH MB89637RP-SH MB89P637P-SH MB89T637RP-SH	64-pin Plastic SH-DIP (DIP-64P-M01)	
MB89635RPF MB89T635RPF MB89636RPF MB89637RPF MB89P637PF MB89T637RPF	64-pin Plastic QFP (FPT-64P-M06)	
MB89635RPFM MB89636RPFM MB89637RPFM MB89T635PFM	64-pin Plastic QFP (FPT-64P-M09)	
MB89W637C-SH	64-pin Ceramic SH-DIP (DIP-64C-A06)	
MB89PV630CF	64-pin Ceramic MQFP (MQP-64C-P01)	
MB89PV630C-SH	64-pin Ceramic MDIP (MDP-64C-P02)	

MB89630R Series

■ PACKAGE DIMENSIONS

64-pin Plastic SH-DIP
(DIP-64P-M01)
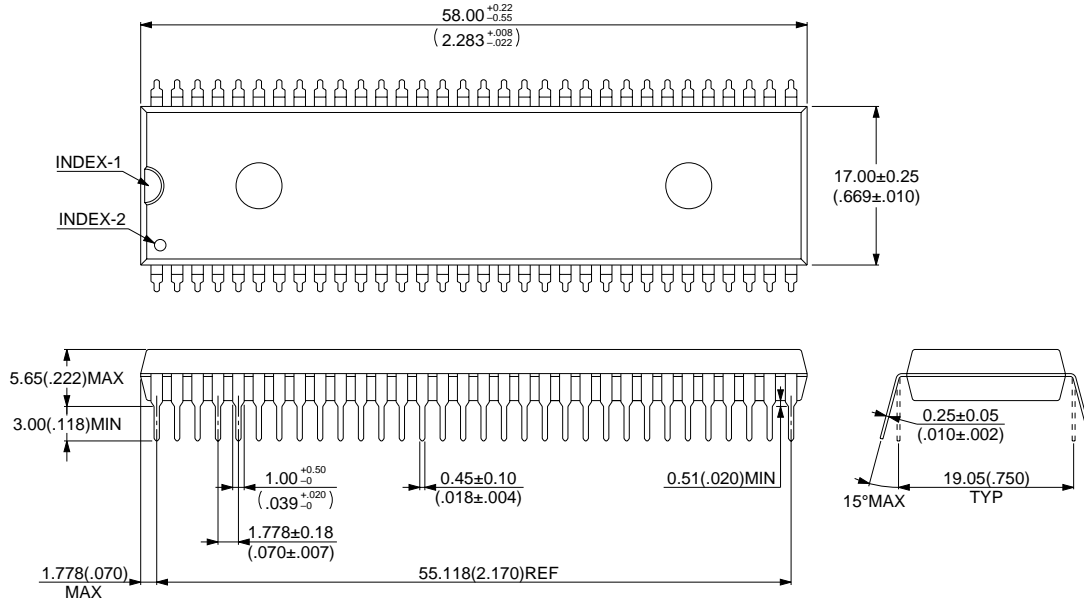
© 1994 FUJITSU LIMITED D64001S-3C-4

Dimensions in mm (inches)

64-pin Plastic QFP
(FPT-64P-M06)
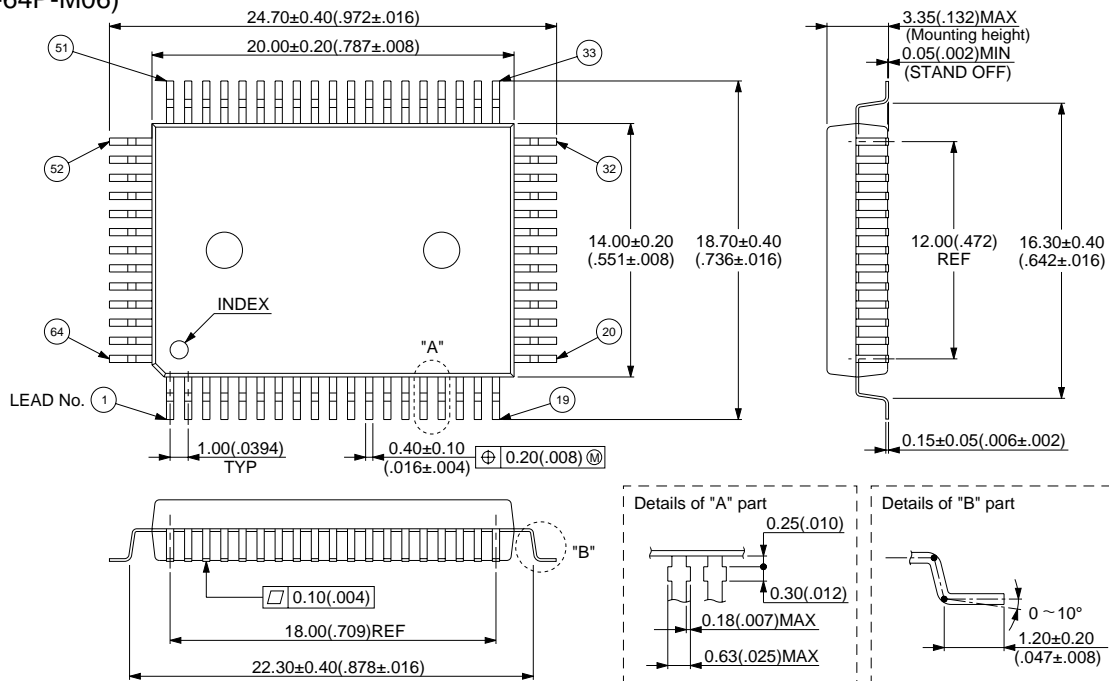
© 1994 FUJITSU LIMITED F64013S-3C-2

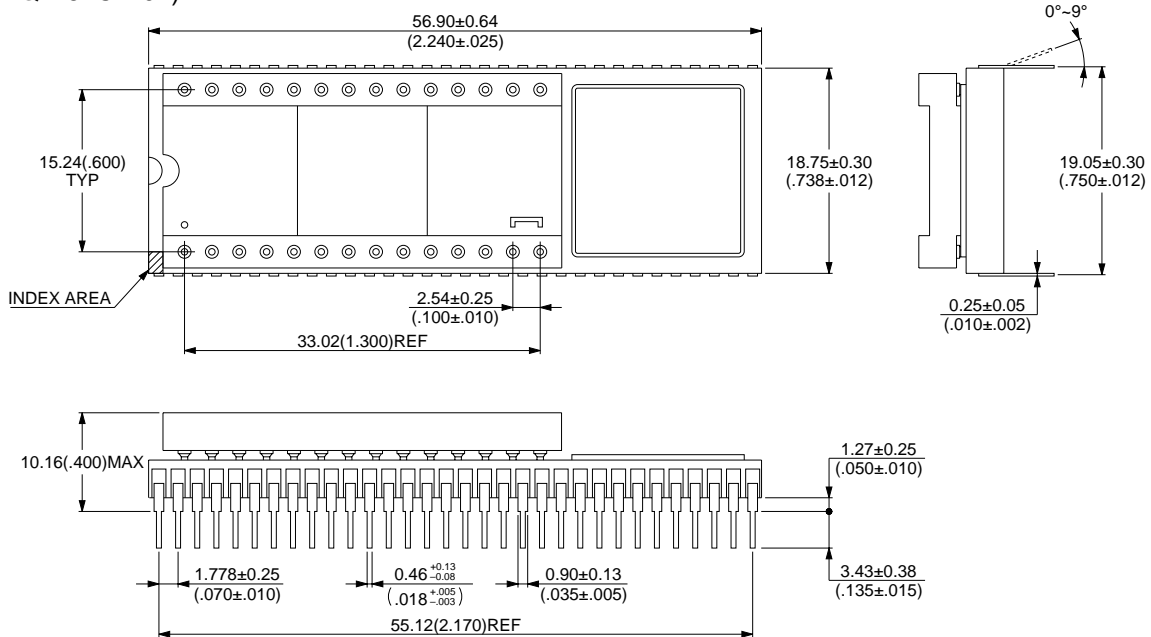Dimensions in mm (inches)

56

MB89630R Series

64-pin Plastic QFP
(FPT-64P-M09)

14.00±0.20(.551±.008)SQ
12.00±0.10(.472±.004)SQ

1.50$^{+0.20}_{-0.10}$ (Mounting height)
(.059$^{+.008}_{-.004}$)

9.75
(.384)
REF

13.00
(.512)
NOM

1 PIN INDEX

LEAD No. 1
0.65(.0256)TYP
0.30±0.10
(.012±.004)
0.13(.005) M

"A"
0.127$^{+0.05}_{-0.02}$
(.005$^{+.002}_{-.001}$)

Details of "A" part
0.10±0.10 (STAND OFF)
(.004±.004)
0 ～ 10°
0.50±0.20
(.020±.008)

0.10(.004)
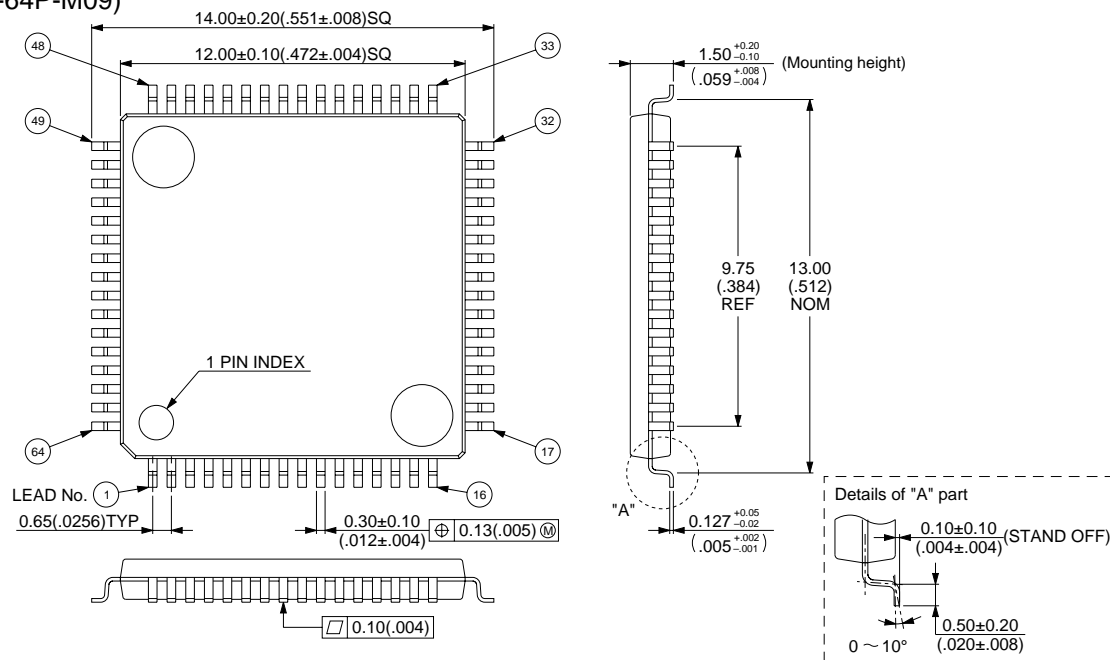
© 1994 FUJITSU LIMITED F64018S-1C-2

Dimensions in mm (inches)

64-pin Ceramic SH-DIP
(DIP-64C-A06)

56.90±0.56
(2.240±.022)

8.89(.350) DIA
TYP

R1.27(.050)
REF

18.75±0.25
(.738±.010)

INDEX AREA

5.84(.230)MAX

1.27±0.25
(.050±.010)

0.25±0.05
(.010±.004)

3.40±0.36
(.134±.014)

1.778±0.180
(.070±.007)

0.90±0.10
(.0355±.0040)

0.46$^{+0.13}_{-0.08}$
(.018$^{+.005}_{-.003}$)

19.05±0.25
(.750±.010)

0°~9°

1.45(.057)
MAX

55.118(2.170)REF
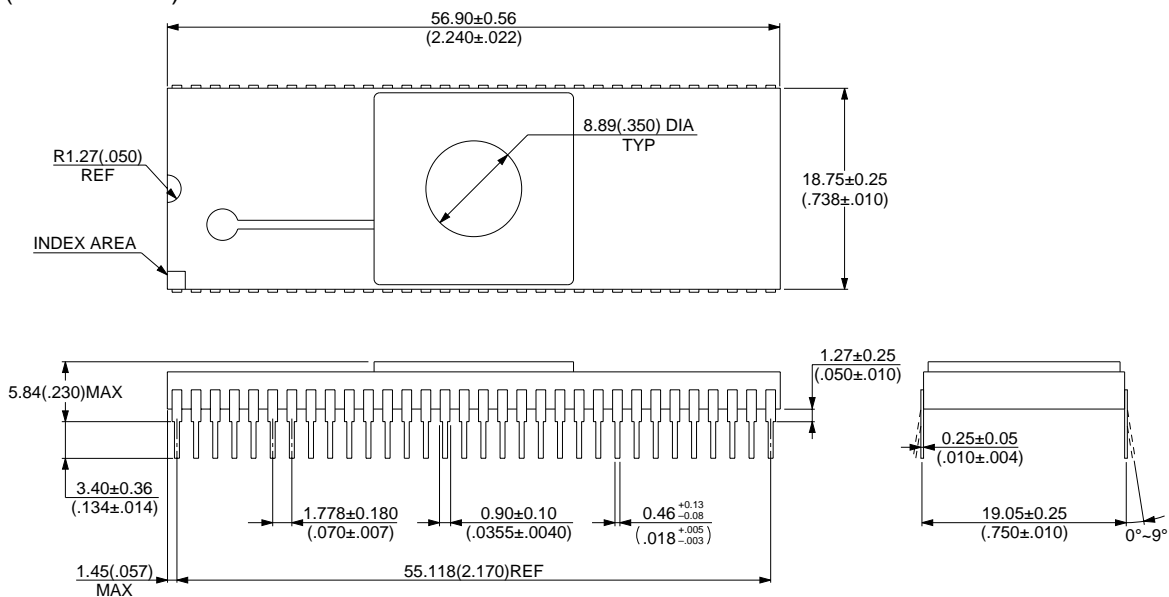
© 1994 FUJITSU LIMITED D64006SC-1-2

Dimensions in mm (inches)

57

MB89630R Series

64-pin Ceramic MQFP
(MDP-64C-P01)

18.70(.736)TYP

16.30±0.33
(.642±.013)
15.58±0.20
(.613±.008)

INDEX AREA

1.27±0.13
(.050±.005)

22.30±0.33
(.878±.013)

24.70(.972)
TYP

0.30(.012)
TYP

12.02(.473)
TYP

10.16(.400)
TYP

18.12±0.20
(.713±.008)

14.22(.560)
TYP

1.27±0.13
(.050±.005)

0.30(.012)TYP
7.62(.300)TYP
9.48(.373)TYP
11.68(.460)TYP

12.00(.472)TYP

1.00±0.25
(.039±.010)

$1.20^{+0.40}_{-0.20}$
$\left(.047^{+.016}_{-.008}\right)$

1.00±0.25
(.039±.010)

18.00(.709)
TYP

0.40±0.10
(.016±.004)

0.40±0.10
(.016±.004)

$1.20^{+0.40}_{-0.20}$
$\left(.047^{+.016}_{-.008}\right)$

10.82(.426)
MAX

0.15±0.05
(.006±.002)

0.50(.020)TYP

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Dimensions in mm (inches)

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

56.90±0.64
(2.240±.025)

15.24(.600)
TYP

INDEX AREA

2.54±0.25
(.100±.010)

33.02(1.300)REF

18.75±0.30
(.738±.012)

0°~9°

19.05±0.30
(.750±.012)

0.25±0.05
(.010±.002)

10.16(.400)MAX

1.778±0.25
(.070±.010)

$0.46^{+0.13}_{-0.08}$
$\left(.018^{+.005}_{-.003}\right)$

0.90±0.13
(.035±.005)

55.12(2.170)REF

1.27±0.25
(.050±.010)

3.43±0.38
(.135±.015)

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Dimensions in mm (inches)

FUJITSU LIMITED

For further information please contact:

Japan
FUJITSU LIMITED
Corporate Global Business Support Division
Electronic Devices
KAWASAKI PLANT, 4-1-1, Kamikodanaka,
Nakahara-ku, Kawasaki-shi,
Kanagawa 211-8588, Japan
Tel: +81-44-754-3763
Fax: +81-44-754-3329

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

North and South America
FUJITSU MICROELECTRONICS, INC.
3545 North First Street,
San Jose, CA 95134-1804, USA
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/

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