FUJITSU SEMICONDUCTOR
DATA SHEET

DS07-12558-1E

8-bit Proprietary Microcontrollers

CMOS

F²MC-8L MB89210 Series

MB89215/P215/PV210

■ DESCRIPTION

The MB89210 series is a one-chip microcontroller that features a compact instruction set and contains a range of peripheral functions including timers, a serial interface, A/D converters and external interrupts.

■ FEATURES

- F²MC-8L CPU core
- Maximum memory spaces : 64 Kbytes
- Minimum instruction execution time : 0.32 µs to 5.12 µs (at 12.5 MHz)
- Interrupt processing time : 2.88 µs to 46.08 µs (at 12.5 MHz)
- I/O port : Max 22
- 21-bit time base timer
- 8-bit PWM timer
- 8-/16-bit capture timer/counter : 2 ch
- Watchdog timer
- 12-bit PPG timer

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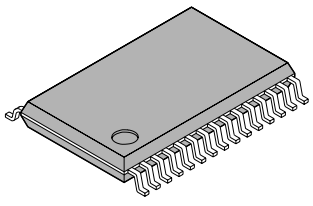
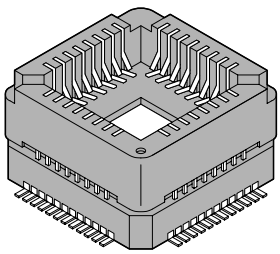
■ PACKAGE

30-pin Plastic SSOP



(FPT-30P-M02)

48-pin Ceramic MQFP



(MQP-48C-P02)

FUJITSU

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- 10-bit A/D converter : 8 ch
- LIN-UART
- 8-bit serial I/O
- External Interrupt : 3 ch
- External or CR (built-in) oscillation clock, switchable
- Low power consumption modes (stop modes, sleep modes)
- Package : SSOP-30,MQFP-48
- CMOS technology

■ PRODUCT LINEUP

Parameter \ Part number		MB89215	MB89P215	MB89PV210
Type		For mass products (Mask ROM product)	One-time product (for small-scale production)	Piggy back/ Evaluation product (for development)
ROM capacity		16 Kbyte (Built-in ROM)	16 Kbyte (Built-in PROM)	32 Kbyte (External EPROM)
RAM capacity		512byte	512byte	1.92Kbyte
CPU functions		Number of basic instructions : 136 Instruction bit length : 8 bits Instruction length : 1 to 3 bytes Data bit length : 1, 8, and 16 bits Minimum instruction execution time : 0.32 µs to 5.12 µs (at 12.5 MHz) Interruption processing time : 2.88 µs to 46.08 µs (at 12.5 MHz)		
Peripheral functions	Ports	General purpose I/O port × 21 (also usable as resources) General purpose input port × 1		
	21-bit time base timer	21 bits Interrupt cycle : at 10 MHz (0.82 ms,3.3 ms,26.2 ms,419.4 ms)		
	Watchdog timer	Reset generation cycle : at 10 MHz (Min 419.4 ms)		
	8-bit PWM timer	8-bit interval timer operation (supports square wave output, operating clock period : 0.4 µs to 25.6 µs) 8-bit resolution PWM operation (conversion period : 102.4 µs to 26.84 µs)		
	8/16-bit capture timer counter	8-bit capture timer/counter × 1 channel + 8-bit timer or 16-bit capture timer/counter × 1 channel Capable of event count operation and square wave output using external clock input with 8-bit timer 0 or 16-bit counter		
	LIN-UART	Full duplex, Synchronous/asynchronous transfer (with start/stop bit), Capable of setting over 30,000 different baud rates using a 15-bit reload counter Support for the LIN protocol, slave nodes, and LIN synch break/sync field detection		
	8-bit serial I/O	8-bit length, Selectable LSB first or MSB first Transfer clock (0.8 µs external, 0.8 µs, 3.2 µs, 12.8 µs internal)		
	12-bit PPG timer	Output requency : Selectable pulth width and cycle (Cycle : 1.6 µs to 419.3 ms)		
	External interrupt circuit	3-channel (interrupt vector, request flag, requesr output acceptance) Edge selectable (selectable rising, falling or both edge) Can be use for recovery from stop or sleep mode (edge detection also available in stop mode).		
	A/D converter	10-bit accurasy × 8-channel A/D conversion function (conversion time : 15.2 µs/10 MHz) Continuous activation by an 8-/16-bit timer/counter output or time base timer output capable.		
Standby mode		Sleep mode and Stop mode		
Operating voltage *		3.5 V to 5.5 V	3.5 V to 5.5 V	3.5 V to 5.5 V
CR(built-in) oscillator		Yes	Yes	No

* : The minimum operating voltage varies with the operating frequency, the function and the connected ICE.

Note : Unless otherwise stated, clock periods and conversion times are for 10 MHz operation with the internal clock operating at maximum speed.

■ PACKAGES AND CORRESPONDING PRODUCTS

Package	MB89215	MB89P215	MB89PV210
FPT-30P-M02	O	O	× *
MQP-48C-P02	×	×	O
Power supply pins	Vcc,Vss × 2		Vcc,Vss × 2,AVcc,AVss

O : Yes × : No

* : Adapter for 48-pin to 30-pin conversion (manufactured by Sunhayato Corp.)
Part number : 48QF-30SOP-8L
Inquiry : Sunhayato Corp. TEL : (81)-3-3984-7791
FAX : (81)-3-3971-0535
E-mail : adapter@sunhayato.co.jp

■ DIFFERENCES AMONG PRODUCTS

1. Memory space

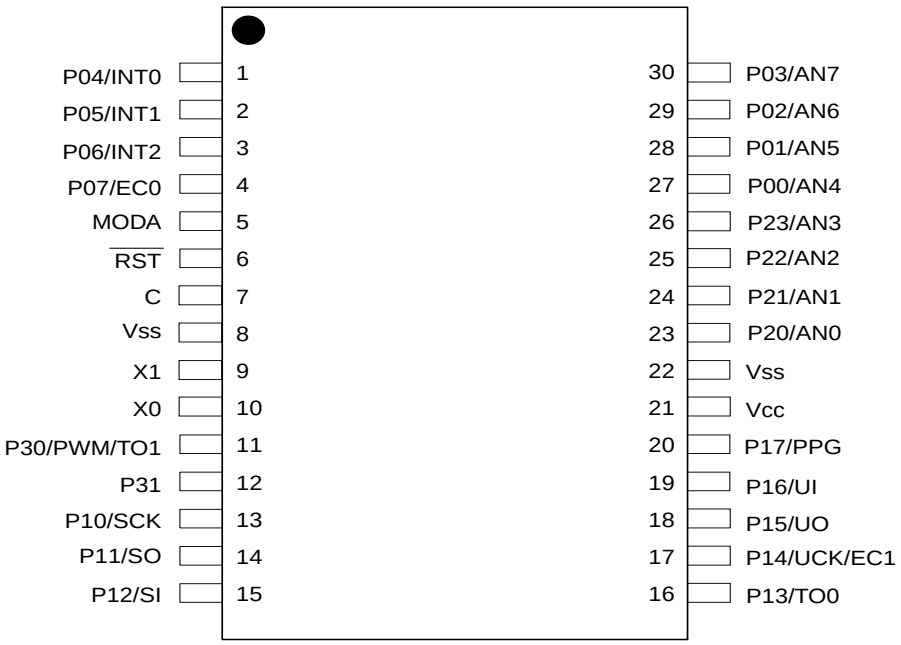
When this product is used in a piggy-back or other evaluation configuration, it is necessary to carefully confirm the differences between the model being used and the product it is evaluating.

2. Current Consumption

- On the MB89P210, the additional current consumed by the EPROM is added at the connecting socket on the back side.
- When operating at low speed, the current consumption in the one-time PROM or EPROM models is greater than on the mask ROM models. However, current consumption in sleep or stop modes is identical. However, in sleep/stop mode the current consumption is the same.

■ PIN ASSIGNMENT

(TOP VIEW)



(FPT-30P-M02)

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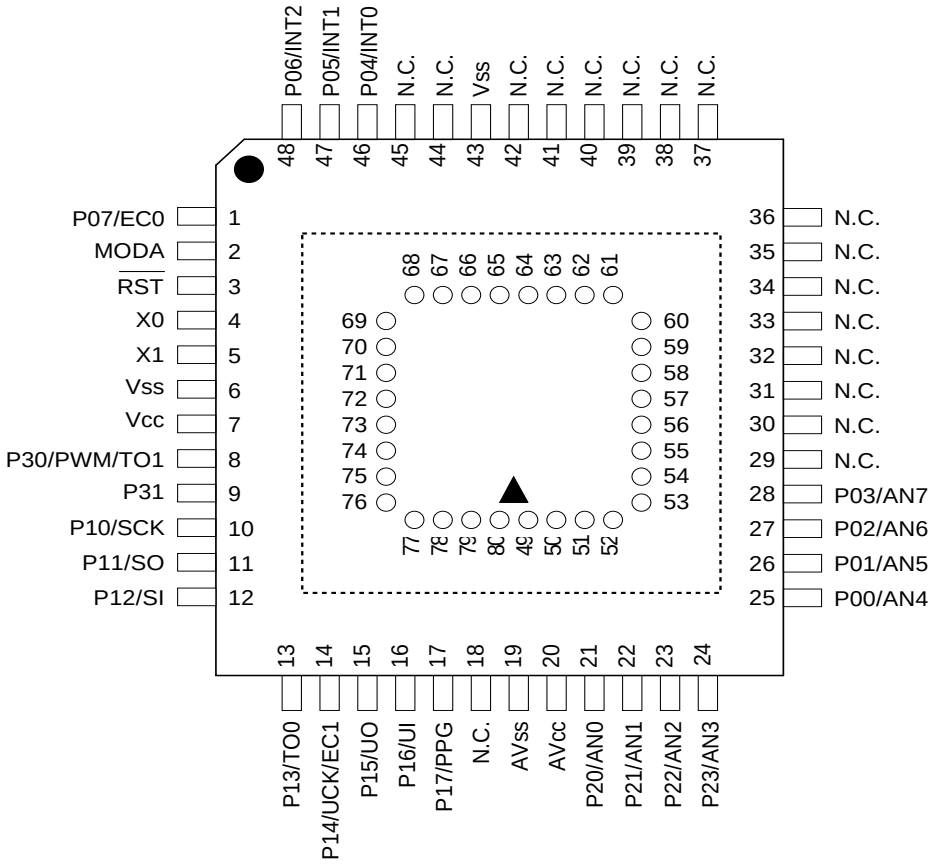
(TOP VIEW)



(MQP-48C-P02)

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

N.C. : Internal connection only. Not for use.

■ PIN DESCRIPTIONS

Pin no.		Pin name	Circuit type	Function
SSOP*1	MQFP*2			
10	4	X0	A	Connecting pins to crystal oscillator or other oscillator. When using ecternal clock, input to X0 and X1 is left open.
9	5	X1		
5	2	MODA	C/D*3	Input pins for memory access mode setting. Connect directly to V_{SS}.
6	3	$\overline{RST}$	E	Reset I/O pin. This pin has pull-up resistance with N-ch open drain or hysteresis input. At an internal reset request, an “L” signal is output. An “L” level input initializes the internal circuits.
27 to 30	25 to 28	P00/AN4 to P03/AN7	G	General purpose I/O port. Hysteresis input. These pins also functions as the analog input of A/D converter.
1 to 3	46 to 48	P04/INT0 to P06/INT2	F	General purpose I/O port. These pins also functions as the external interrupt input. Hysteresis input.
4	1	P07/EC0		General purpose I/O port. This pin also functions as external clock of 8-/16-bit capture timer/counter 0 or capture input pin. Hysteresis input.
13	10	P10/SCK		General purpose I/O port. This pin also functions as clock input/output pin of serial I/O. Hysteresis input.
14	11	P11/SO		General purpose I/O port. This pin also functions as the data output pin of serial I/O. Hysteresis input.
15	12	P12/SI		General purpose I/O port. This pin also functions as the data input pin of serial I/O. Hysteresis input.
16	13	P13/TO0		General purpose I/O port. This pin also functions as the output pin of 8-/16-bit capture timer/counter 0. Hysteresis input.
17	14	P14/UCK/EC1		General purpose I/O port. This pin also functions as the clock input/output pin of LIN-UART and the external clock of 8-/16-bit capture timer/counter 1 or capture input pin. Hysteresis input.
18	15	P15/UO		General purpose I/O port. This pin also functions as the data output pin of LIN-UART. Hysteresis input

*1 : FPT-30P-M02

*2 : MQP-48C-P02

*3 : Only MB89P215 is C.

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Pin no.		Pin name	Circuit type	Function
SSOP*1	MQFP*2			
19	16	P16/UI	H	General purpose I/O port. This pin also functions as the data input pin of LIN-UART. General port input is hysteresis and resource input is CMOS.
20	17	P17/PPG	F	General purpose I/O port. This pin also functions as 12-bit PPG timer output. Hysteresis input.
23 to 26	21 to 24	P20/AN0 to P23/AN3	G	General purpose I/O port. Shared for A/D converter analog input pin. Hysteresis input.
11	8	P30/PWM/ TO1	F	General purpose I/O port. This pin also functions as the output pin of 8-bit PWM and 8-/16-bit capture timer/counter 1. Hysteresis input.
12	9	P31	B	General purpose I/O port of CMOS type.
21	7	V_{CC}	—	Power supply pin.
8,22	6,43	V_{SS}	—	Power supply pin (GND). Use the both pins at the same voltage level.
—	20	AV_{CC}	—	A/D converter power supply pin. Apply potential under V_{CC} to this pin.
—	19	AV_{SS}	—	A/D converter power supply pin (GND). Use at the same voltage level as the V_{SS} supply.
7	—	C	—	This is the power supply stabilization capacitor pin for MB89P215. Connect an external capacitor of 0.1 μ F. MB89215 is not internally connected. It is unnecessary to connect a capacitor.
—	18, 29 to 42, 44,45	N.C.	—	Internal connect pin. Be sure this pin is left open.

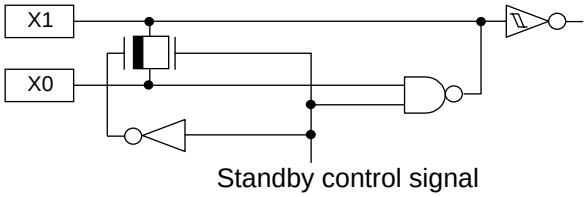
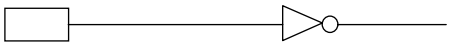
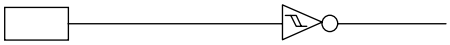
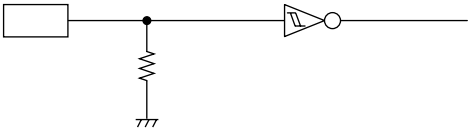
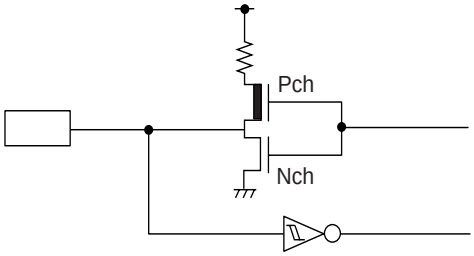
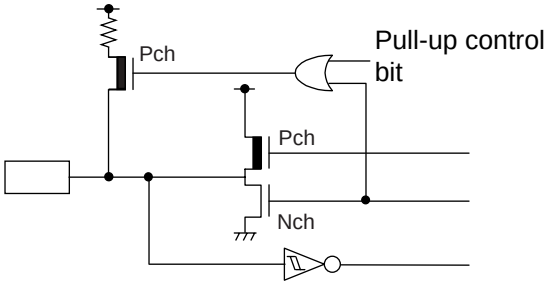
*1 : FPT-30P-M02

*2 : MQP-48C-P02

■ EXTERNAL EPROM PIN DESCRIPTION (MB89PV210 only)

Pin no.	Pin name	I/O	Function
49	Vpp	O	“H” level output pin.
50 51 52 53 54 55 58 59 60	A12 A7 A6 A5 A4 A3 A2 A1 A0	O	Address output pin.
61 62 63	O1 O2 O3	I	Data input pin.
64	V_{SS}	O	Power supply pin (GND).
65 66 67 68 69	O4 O5 O6 O7 O8	I	Data input pin.
70	CE	O	Chip acceptance pin for ROM. Output “H” at standby.
71	A10	O	Address output pin.
73	OE	O	Output acceptance pin for ROM. Output “L” usually.
75 76 77 78 79	A11 A9 A8 A13 A14	O	Address output pin.
80	V_{CC}	O	Power supply pin for EPROM.
56 57 72 74	N.C.	—	Internal connect pin. Must be left open.

■ I/O CIRCUIT TYPE

Type	Circuit	Remarks
A		• Oscillator feedback resistance : approx. 1 MΩ
B		• CMOS input
C		• Hysteresis input
D		• With pull-down resistance : approx. 50 kΩ(5V) • Hysteresis input
E		• Output pull-up resistance (Pch) approx. 50 kΩ (5V) • Hysteresis input
F		• CMOS output • Hysteresis input • Selectable by pull-up resistor register

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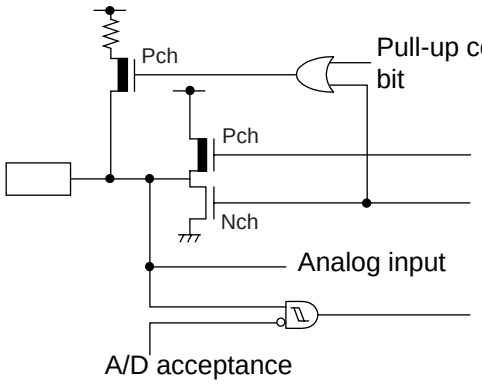
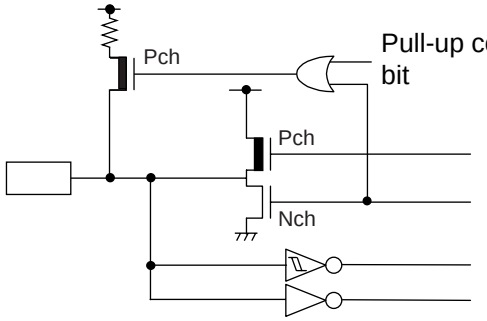
Type	Circuit	Remarks
G		• CMOS output • Hysteresis input • Analog input • Selectable by pull-up resistor register
H		• CMOS output • Hysteresis input • CMOS input • Selectable by pull-up resistor register

■ 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 or output pins other than the medium-and high-voltage pins or if voltage higher than the rating 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 input from exceeding the digital power supply (V_{CC}) when the analog system power supply is turned on and off.

To supply power, turn on the digital power supply (V_{CC}) and then the analog power supply (AV_{CC}).

2. Treatment of Unused Input Pins

Leaving unused input teminals open may lead to permanent damage due to malfunction and latchup; pull up or pull down the terminals through the resistors of 2 kΩ or more.

Make the unused I/O terminal in a state of output and leave it open and if it is in an input state, handle it with the same procedure as the input terminals.

3. Treatment of N.C. Pins

Any pins marked “NC” (not connected) must be left open.

4. Power Supply Voltage Fluctuations

Although Vcc 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.

5. Treatment of power supply pin

All V_{SS} power suppluy pin must be use at the same voltage level.

Connect to be $AV_{CC} = V_{CC}$, $AV_{SS} = V_{SS}$ even if the A/D converters are not in use in MB89PV210.

6. Notes on Using External Clock

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

7. Notes on using the CR (internal) oscillator

To use the CR (internal) oscillator as the operating clock for the MB89215 or MB89P215, adjust the timer value and baud rate setting.

8. Program Execution in RAM

When the MB89PV210 is used with an emulation pod other than the MB2144-508, no program can be executed in RAM.

9. Operation check for evaluating the LIN-UART

When the MB89215 or MB89P215 uses the CR (internal) oscillator as the clock for the LIN-UART, the evaluation program (MB89PV210 [customized for external oscillation]) requires an operation check within a range of oscillation frequencies from 8.5 MHz to 11.5 MHz.

10. Handling reset pin

Reset pin must be inputted external reset.

11. Up/down conversion circuit stabilization waiting time

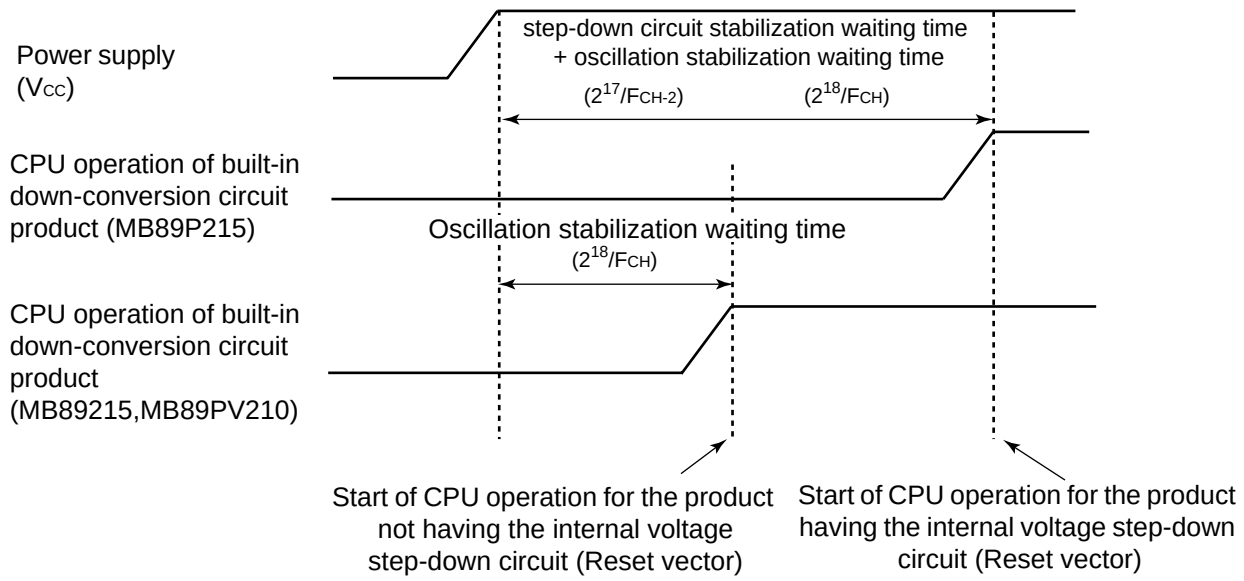
MB89210 series contains the following products and the operating characteristics vary with whether they contain the internal stepdown circuit.

Product name	Operating voltage *	Down conversion
MB89215	3.5 V to 5.5 V	not built-in
MB89P215	3.5 V to 5.5 V	built-in
MB89PV210	3.5 V to 5.5 V	not built-in

* : The minimum operating voltage varies with the operating frequency, the function and the connected ICE.

The same built-in resources are used for the above product types; operating sequences after the power-on reset are different depending on whether they have the internal voltages step-down circuit.

The operating sequences after the power-on reset with the different models will be described below.



* : F_{CH-2} : CR (built-in) oscillation
F_{CH} : Base oscillator

As described above, CPU starts at delayed time with the product having the internal voltage step-down circuit compared with the product not having the internal voltage step-down circuit. This is because the time should be allowed for the stabilization time for voltage step-down circuit for normal operation.

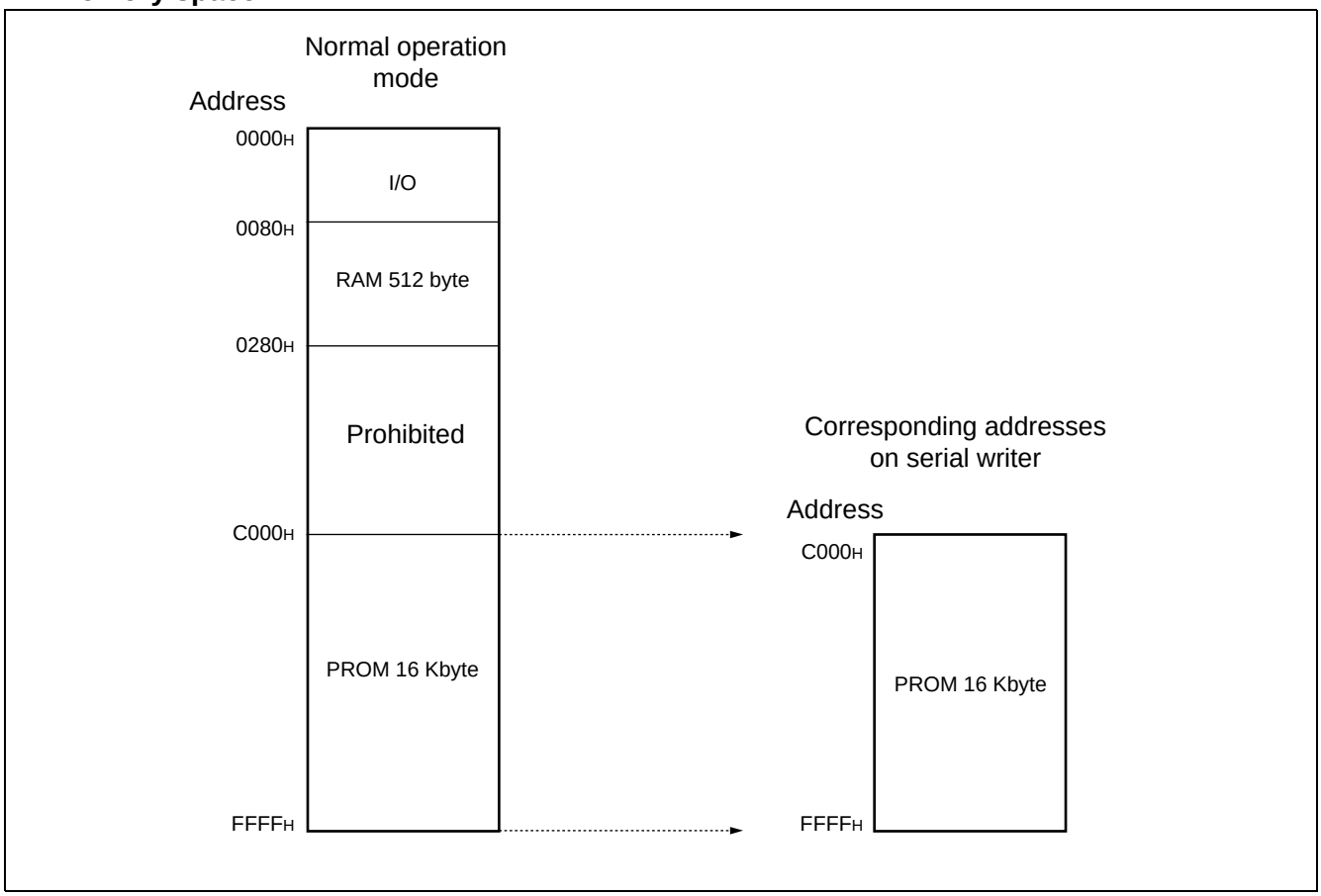
Note : As the period of the oscillation is unstable immediately after oscillation starts, the listed oscillation stabilization delay times are guides only.

12. Treatment of analog input

The analog input also serves as a general-purpose input/output port. The A/D enable register is initialized at a reset. When the intermediate-level signal is input in port input mode (ADEN:ADEx = 0), an input leakage current flows to the gate. Set the corresponding pin to an analog input.

■ PROGRAMMING TO OTPROM ON THE MB89P215

1. Memory space



2. Programming to the OTPROM

To program to the OTPROM using an EPROM programmer AF220/AF210/AF120/AF110 (manufacturer : Yokogawa Digital Computer Corp.).

Inquiry : Yokogawa Digital Computer Corp. : TEL(81)-42-333-6224

Note : Programming to the OTPROM with MB89P215 is serial programming mode only.

3. Programming Adaptor for OTPROM

To program to the OTPROM using an EPROM programmer AF220/AF210/AF120/AF110, use the programming adapter (manufacturer : Sunhayato Corp.) listed below.

Adaptor socket : ROM3-FPT30M02-8L3

Inquiry : Sunhayato Corp. : TEL : (81)-3-3984-7791
FAX : (81)-3-3971-0535
E-mail : adapter@sunhayato.co.jp

4. Programming yields

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.

■ EPROM WRITING TO PIGGY-BACK/EVALUATION CHIPS

1. EPROM model

MBM27C256A-20TVM

2. Writer adapter

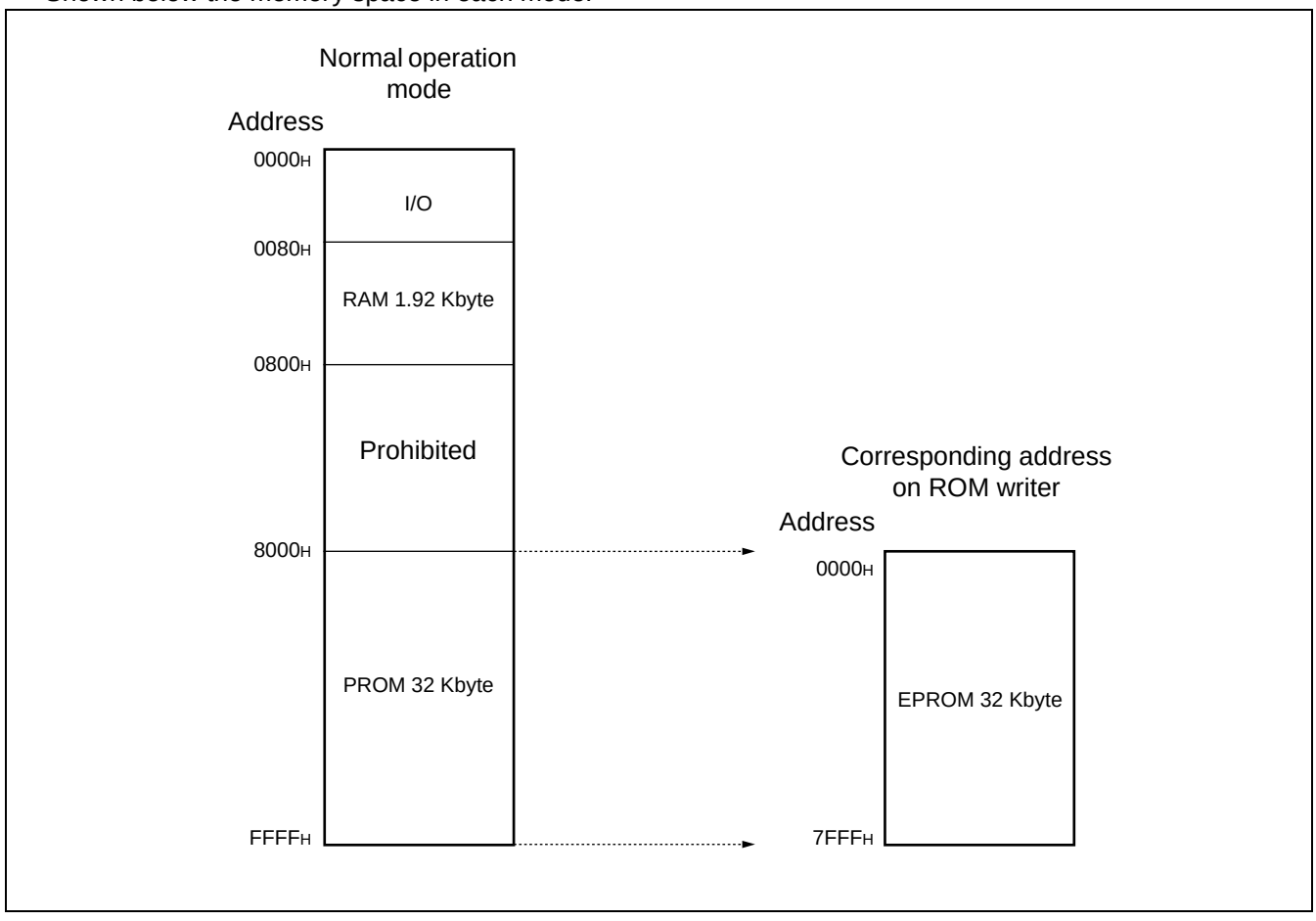
For writing to EPROM using a ROM writer, use one of the writer adapters shown below (manufactured by Sunhayato) .

Package	Adapter socket model
LCC-32	ROM-32LC-28DP-S

Inquiries should be addressed to Sunhayato Corp. : TEL : (81)-3-3984-7791
FAX : (81)-3-3971-0535
E-mail : adapter@sunhayato.co.jp

3. Memory space

Shown below the memory space in each mode.



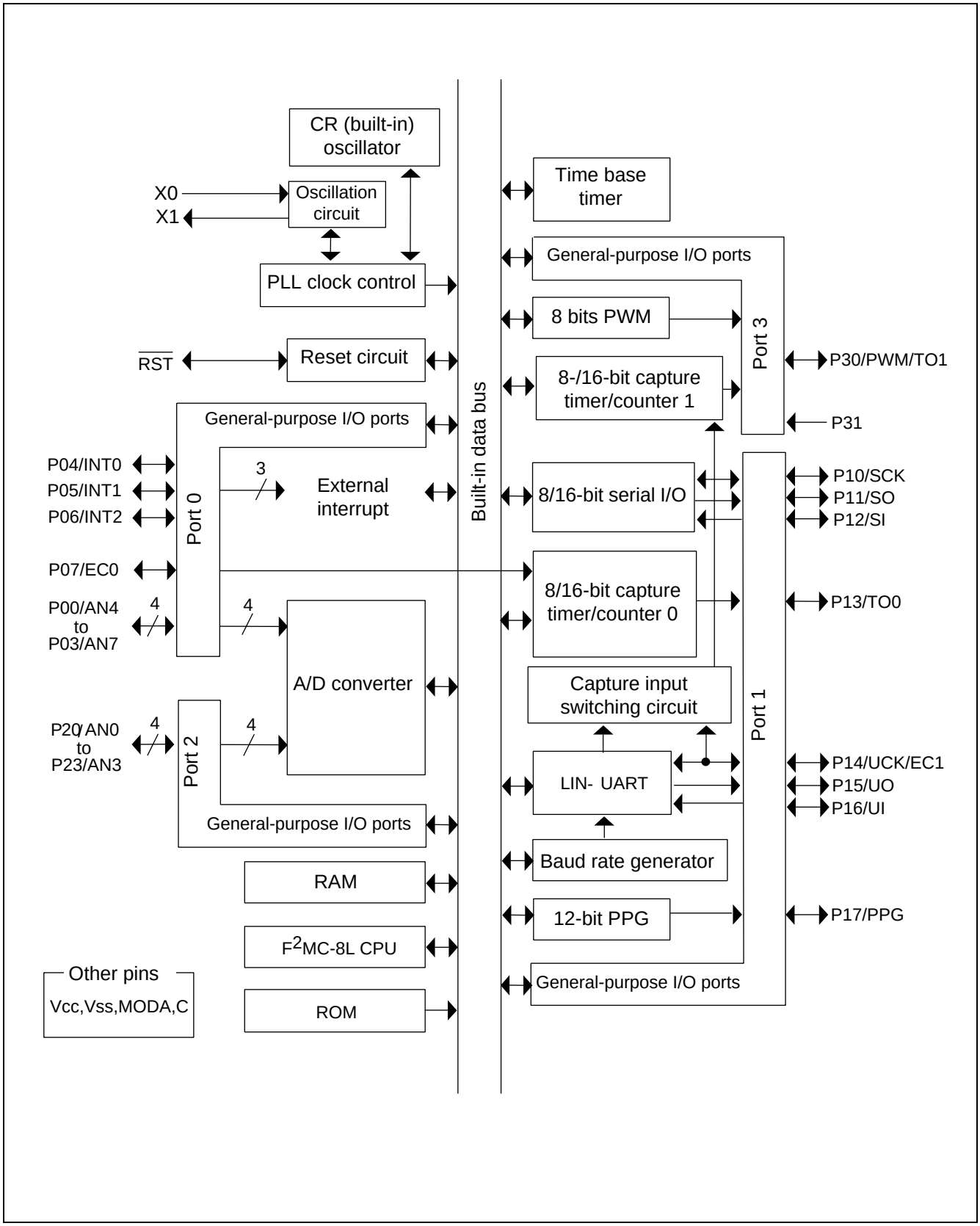
4. Writing to EPROM

(1) Set up the EPROM writer for the MBM27C256A.

(2) Load program data on to the EPROM programmer at 0000H to 7FFFH.

(3) Program 0000H to 7FFFH with the EPROM programmer.

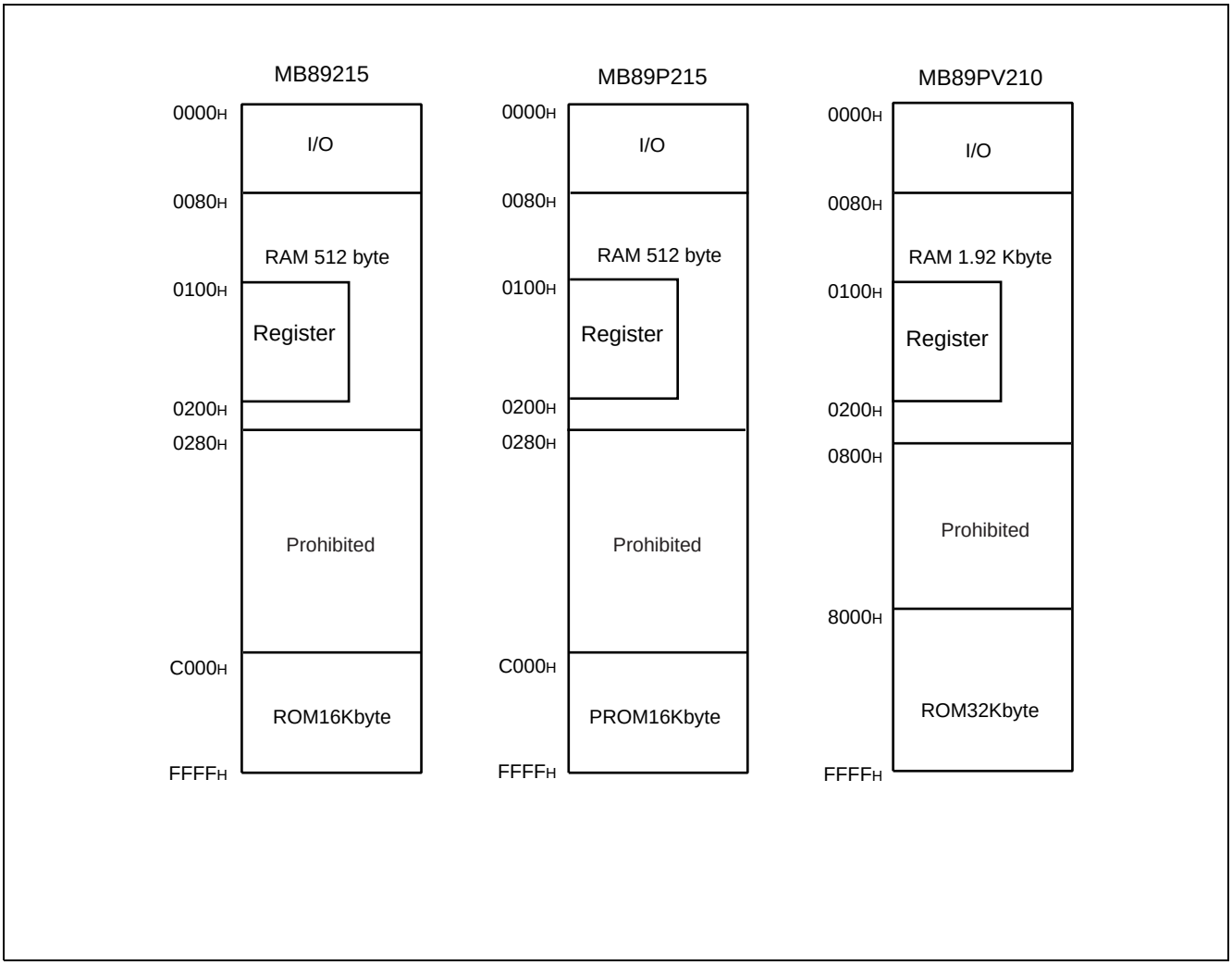
■ BLOCK DIAGRAM



■ CPU CORE

1. Memory space

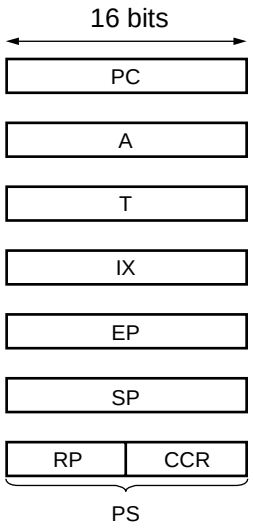
The MB89210 series has 64 KB of memory space, containing all I/O, data areas, and program areas. The I/O area is located at the lowest addresses, with the data area placed immediately above. The data area can be partitioned into register areas, stack areas, or direct access areas depending on the application. The program area is located at the opposite end of memory, closest to the highest addresses, and the highest part of this area is assigned to the tables of interrupt and reset vectors and vector call instructions. The following diagram shows the structure of memory space in the MB89210 series.



2. Register

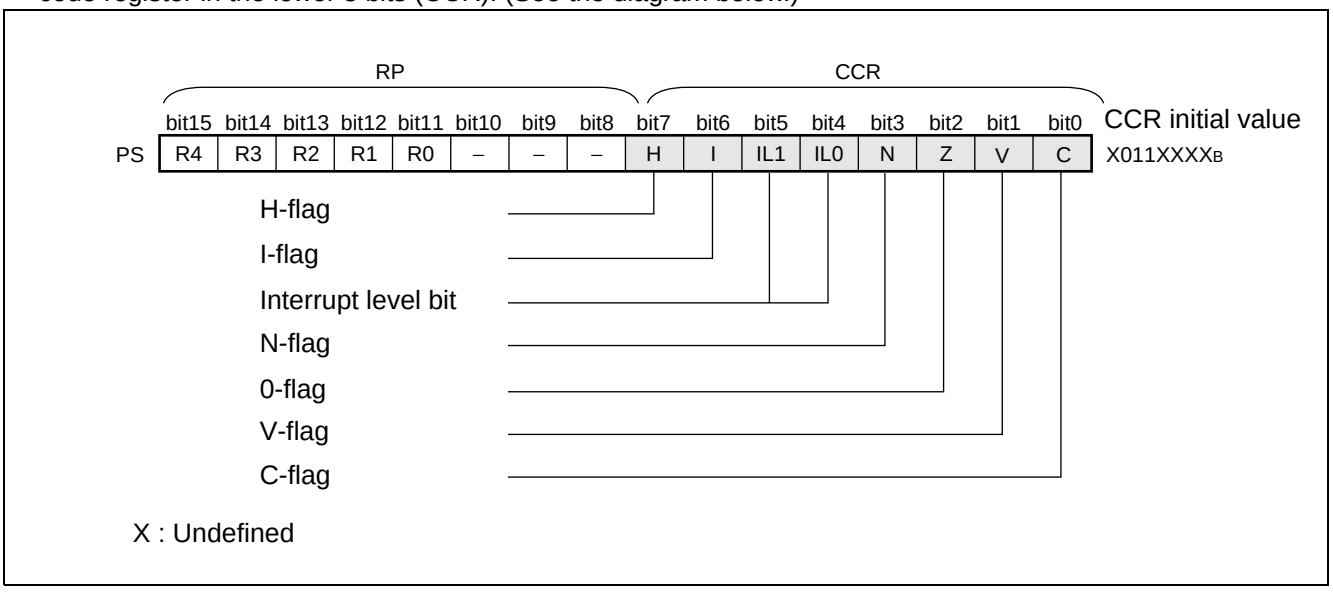
The MB89210 series has two types of registers; the registers dedicated to specific purposes in the CPU and the general-purpose registers. The dedicated registers are as follows:

Program counter (PC)	:	16-bit length, shows the locations where instructions are stored.
Accumulator (A)	:	16-bit length, a temporary memory register for calculation operations. In the case of an 8-bit data processing instruction, the lower one byte is used.
Temporary accumulator (T)	:	16-bit length, performs calculations with the accumulator. In the case of an 8-bit data processing instruction, the lower one byte is used.
Index register (IX)	:	16-bit length, a register for index modification.
Extra pointer (EP)	:	16-bit length, apointer indicating memory addresses.
Stack pointer (SP)	:	16-bit length, indicates stack areas.
Program status (PS)	:	16-bit length, contains register pointer and condition code.



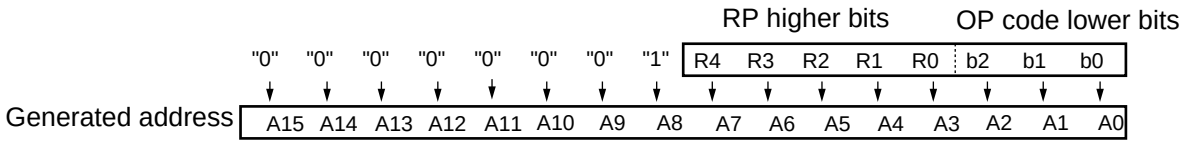
	Initial value
: Program counter	$FFFD_H$
: Accumulator	Indeterminate
: Temporary accumulator	Indeterminate
: Index register	Indeterminate
: Extra pointer	Indeterminate
: Stack pointer	Indeterminate
: Program status	I-flag = 0, IL1, 0 = 11 Initial values for other bits are indeterminate.

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



The RP points to 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 shown next.

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



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

H flag : Set to 1 if calculations result in carry operations from bit 3 to bit 4 or borrow operations from bit 4 to bit 3, otherwise set to 0.
The flag is for decimal adjustment instructions; do not use for other than additions and subtractions.

I flag : This flag is set to 1 if interrupts are enabled, and 0 if interrupts are prohibited. The default value at reset is 0.

IL1, 0 : Indicates the level of the interrupt currently enabled.
An interrupt is processed only if its level is higher than the value this bit indicates.

IL1	IL0	Interrupt level	High-low
0	0	1	Higher ↕ Lower = no interruption
0	1		
1	0	2	
1	1	3	

N flag : Set to 1 if the highest bit is 1 after a calculation, otherwise cleared to 0.

Z flag : Set to 1 if a calculation result is 0, otherwise cleared to 0.

V flag : Set to 1 if a 2's complement overflow results during a calculation, otherwise cleared to 0.

C flag : Set to 1 if a calculation results in a carry or borrow operation from bit 7, otherwise cleared to 0.
This is also the shift-out value in a shift instruction.

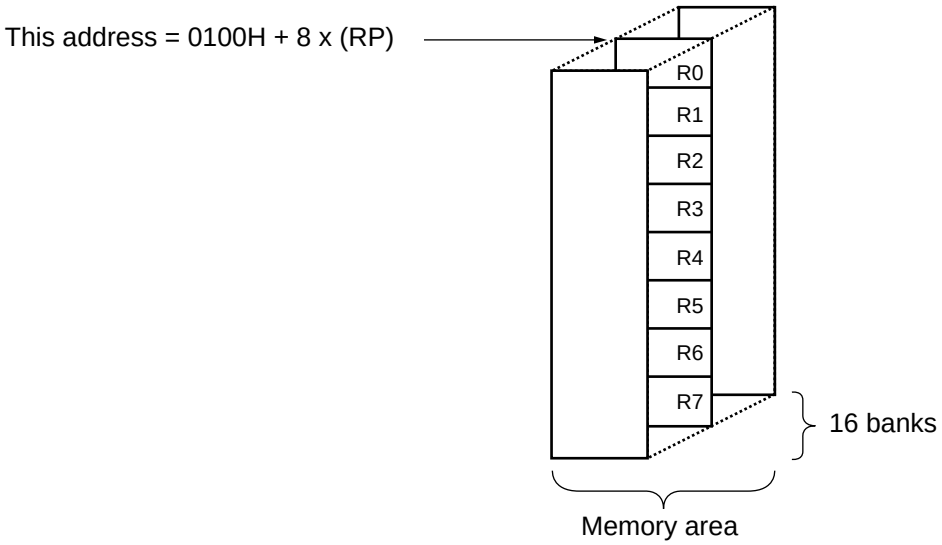
The following general-purpose registers are provided:

General-purpose registers: 8-bit length, data storage registers

The general-purpose registers are 8 bits in length and located in the register banks in the memory. One bank contains eight registers and the MB89210 series allow a total of 16 banks to be used at maximum.

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

Register Bank Configuration



■ I/O MAP

Address	Register name	Register description	Read/write	Initial value
0000H	PDR0	Port 0 data register	R/W	XXXXXXXX
0001H	DDR0	Port 0 direction register	R/W	0 0 0 0 0 0 0 0
0002H to 0006H	Access prohibited			
0007H	SYCC	System clock control register	R/W	1 – – 1 1 1 0 0
0008H	STBC	Standby control register	R/W	0 0 0 1 0 – – –
0009H	WDTC	Watchdog timer control register	W	0 – – –XXXX
000AH	TBTC	Time base timer control register	R/W	0 0 – – – 0 0 0
000BH	Access prohibited			
000CH	PDR1	Port 1 data register	R/W	XXXXXXXX
000DH	DDR1	Port 1 direction register	R/W	0 0 0 0 0 0 0 0
000EH	RSFR	Reset flag register	R	XXXX – – – –
000FH	PDR2	Port 2 data register	R/W	– – – – XXXX
0010H	DDR2	Port 2 direction register	R/W	– – – – 0 0 0 0
0011H	Access prohibited			
0012H	PDR3	Port 3 data register	R/W	– – – – – – XX
0013H	DDR3	Port 3 direction register	R/W	– – – – – – – 0
0014H	RCR21	12-bit PPG control register 1	R/W	0 0 0 0 0 0 0 0
0015H	RCR22	12-bit PPG control register 2	R/W	– – 0 0 0 0 0 0
0016H	RCR23	12-bit PPG control register 3	R/W	0 – 0 0 0 0 0 0
0017H	RCR24	12-bit PPG control register 4	R/W	– – 0 0 0 0 0 0
0018H	Access prohibited			
0019H	TCCR0	Capture control register 0	R/W	0 0 0 0 0 0 0 0
001AH	TCR10	Timer 1 control register 0	R/W	0 0 0 – 0 0 0 0
001BH	TCR00	Timer 0 control register 0	R/W	0 0 0 0 0 0 0 0
001CH	TDR10	Timer 1 Data 0	R/W	XXXXXXXX
001DH	TDR00	Timer 0 Data 0	R/W	XXXXXXXX
001EH	TCPH0	Capture data register H 0	R	XXXXXXXX
001FH	TCPL0	Capture data register L 0	R	XXXXXXXX
0020H	TCR20	Timer output control 0	R/W	– – – – – – 0 0
0021H	Access prohibited			
0022H	CNTR	PWM control register	R/W	0 – 0 0 0 0 0 0
0023H	COMR	PWM Compare register	W	XXXXXXXX
0024H	EIC1	External interrupt control register 1 (edge)	R/W	0 0 0 0 0 0 0 0
0025H	EIC2	External interrupt control register 2 (edge)	R/W	0 0 0 0 0 0 0 0

(Continued)

Address	Register name	Register description	Read/write	Initial value
0026H	Access prohibited			
0027H				
0028H	SCR	Serial control register	R/W	0 0 0 0 0 0 0 0
0029H	USMR	LIN-UART serial mode register	R/W	0 0 0 0 0 0 0 0
002AH	SSR	Serial status register	R/W	0 0 0 0 1 0 0 0
002BH	RDR	Recieving data register	R	0 0 0 0 0 0 0 0
	TDR	Sending data register	W	1 1 1 1 1 1 1 1
002CH	ESCR	Extended status control register	R/W	0 0 0 0 0 X 0 0
002DH	ECCR	Extended communication control register	R/W	0 0 0 0 0 0 1 1
002EH	BGRH	Baud rate generator register H	R/W	– 0 0 0 0 0 0 0
002FH	BGRL	Baud rate generator register L	R/W	0 0 0 0 0 0 0 0
0030H	ADC1	A/D control register 1	R/W	0 0 0 0 0 0 0 0
0031H	ADC2	A/D control register 2	R/W	0 0 0 0 0 0 0 1
0032H	ADDH	A/D data register H	R/W	0 0 0 0 0 0 XX
0033H	ADDL	A/D data register L	R/W	XXXXXXXX
0034H	ADEN	A/D enable register	R/W	0 0 0 0 0 0 0 0
0035H to 0038H	Access prohibited			
0039H	SMR	Serial mode register	R/W	0 0 0 0 0 0 0 0
003AH	SDR	Serial Data register	R/W	XXXXXXXX
003BH to 0040H	Access prohibited			
0041H	TCCR1	Capture control register 1	R/W	0 0 0 0 0 0 0 0
0042H	TCR11	Timer 1 control register 1	R/W	0 0 0 – 0 0 0 0
0043H	TCR01	Timer 0 control register 1	R/W	0 0 0 0 0 0 0 0
0044H	TDR11	Timer 1 Data register 1	R/W	XXXXXXXX
0045H	TDR01	Timer 0 Data register 1	R/W	XXXXXXXX
0046H	TCPH1	Capture status register H1	R	XXXXXXXX
0047H	TCPL1	Capture status register L1	R	XXXXXXXX
0048H	TCR21	Timer output control register 1	R/W	– – – – – – 0 0
0049H	TCSL	Capture input select register	R/W	– – – – – – – 0
004AH to 005FH	Access prohibited			
0060H	XCRS*	External/CR(built-in)oscillation clock control register	R/W	0 0 – 0 0 0 1 0
0061H to 006FH	Access prohibited			

(Continued)

(Continued)

Address	Register name	Register description	Read/write	Initial value
0070H	PUL0	Port 0 pull-up setting register	R/W	0 0 0 0 0 0 0 0
0071H	PUL1	Port 1 pull-up setting register	R/W	0 0 0 0 0 0 0 0
0072H	PUL2	Port 2 pull-up setting register	R/W	– – – – 0 0 0 0
0073H	PUL3	Port 3 pull-up setting register	R/W	– – – – – – – 0
0074H to 007AH	Access prohibited			
007BH	ILR1	Interrupt level setting register 1	W	1 1 1 1 1 1 1 1
007CH	ILR2	Interrupt level setting register 2	W	1 1 1 1 1 1 1 1
007DH	ILR3	Interrupt level setting register 3	W	1 1 1 1 1 1 1 1
007EH	ILR4	Interrupt level setting register 3	W	1 1 1 1 1 1 1 1
007FH	Access prohibited			

* : Only for MB89215, MB89P215

Description of write/read symbols :

R/W : Read/write enabled
R : Read only
W : Write only

Description of initial values

0 : This bit initialized to ”0”.
1 : This bit initialized to ”1”.
X : The initial value of this bit is undefined.
- : This bit is not defined.

Note : If a bit manipulation instruction accesses the serial mode register (SMR), a write-only register, or a register containing a write-only bit, the bit focused on by the instruction is set to a prescribed value but a malfunction occurs when the other bits contains a write-only bit. Do not use bit manipulation instructions to access such registers.

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power supply voltage	V_{CC}	V_{SS} – 0.3	V_{SS} + 6.0	V	
Input voltage	V_I	V_{SS} – 0.3	V_{CC} + 0.3	V	
Output voltage	V_O	V_{SS} – 0.3	V_{SS} + 6.0	V	
Maximum clamp current	I_{CLAMP}	– 0.4	+ 0.4	mA	*
Maximum clamp total current	$\Sigma\lvert I_{CLAMP}\rvert$	—	10	mA	*
“L” level output current	I_{OL}	—	10	mA	
“L” level average current	I_{OLAV}	—	4	mA	Average value (operating current × operating duty)
“L” level total output current	ΣI_{OL}	—	50	mA	
“H” level output current	I_{OH}	—	– 10	mA	
“H” level average current	I_{OHAV}	—	– 4	mA	Average value (operating current × operating duty)
“H” level total output current	ΣI_{OH}	—	– 50	mA	
Power consumption	Pd	—	200	mW	
Storage temperature	Tstg	– 55	+ 150	°C	

* :
- Applicable to pins : P00 to P07, P10 to P17, P20 to P23, P30 to P31
- Use within recommended operating conditions.
- Use at DC voltage (current) .
- The +B signal should always be applied with a limiting resistance placed between the +B signal and the microcontroller.
- The value of the limiting resistance should be set so that when the +B signal is applied the input current to the microcontroller pin does not exceed rated values, either instantaneously or for prolonged periods.
- Note that when the microcontroller drive current is low, such as in the power saving modes, the +B input potential may pass through the protective diode and increase the potential at the V_{CC} pin, and this may affect other devices.
- Note that if a +B signal is input when the microcontroller current is off (not fixed at 0 V), the power supply is provided from the pins, so that incomplete operation may result.
- Note that if the +B input is applied during power-on, the power supply is provided from the pins and the resulting supply voltage may not be sufficient to operate the power-on reset.
- Care must be taken not to leave the +B input pin open.
- Note that analog system input/output pins other than the A/D input pins (LCD drive pins, comparator input pins, etc.) cannot accept +B signal input.

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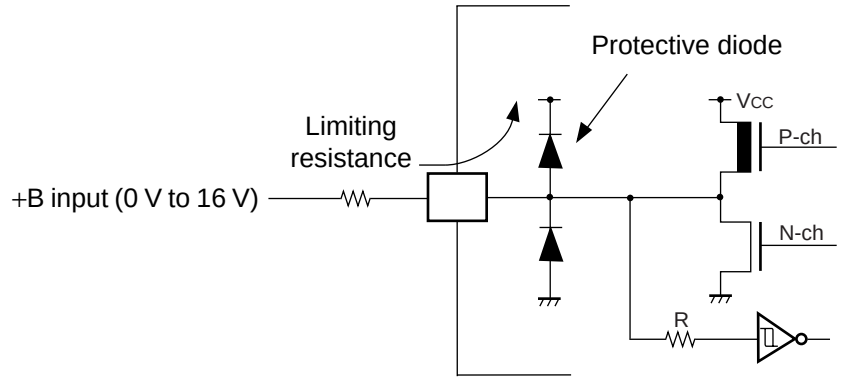
- Sample recommended circuits :

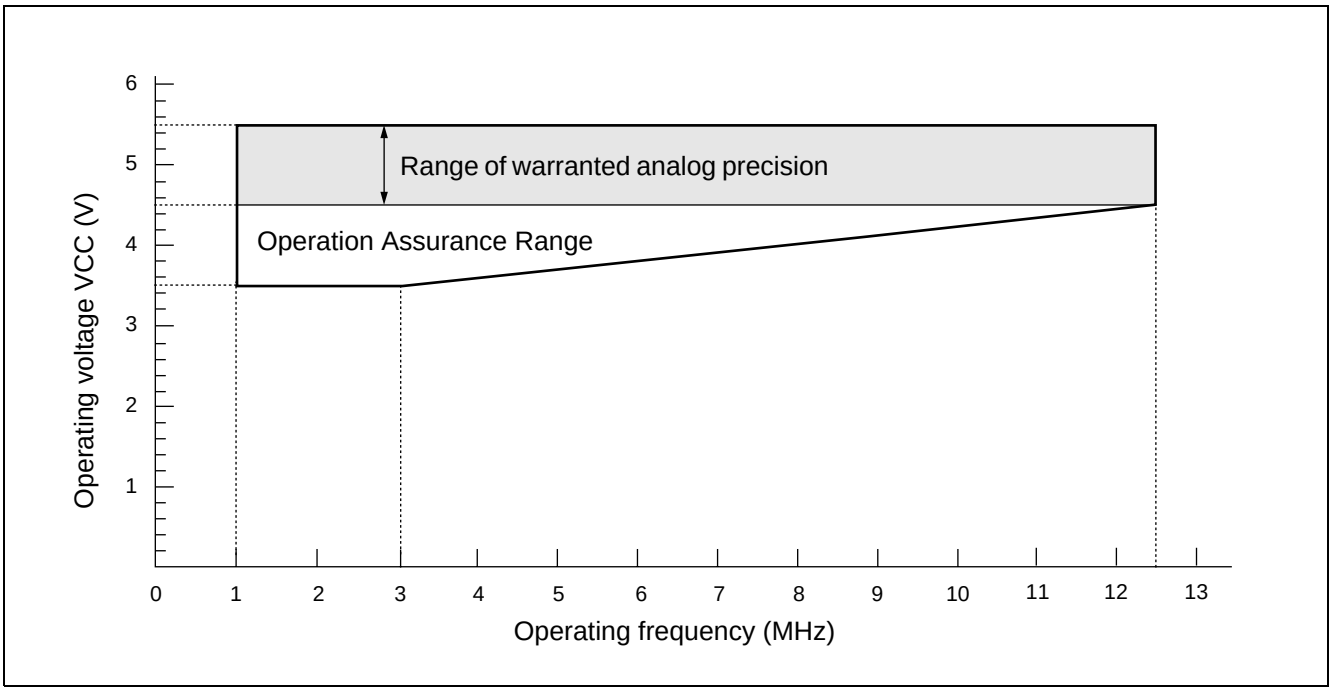
- Input/Output Equivalent circuits



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

2. Recommended Operating Conditions

Parameter	Symbol	Value		Unit	Remarks
		Min	Max		
Power supply voltage	V_{CC}	3.5	5.5	V	Normal Operation Assurance Range (MB89215)
		3.0	5.5	V	RAM status in stop mode
Input “H” voltage	V_{IH}	0.7 V_{CC}	V_{CC} + 0.3	V	P31,UI
	V_{IHS}	0.8 V_{CC}	V_{CC} + 0.3	V	MODA, $\overline{RST}$, P00 to P07, P10 to P17,P20 to P23,P30, INT0 to INT2, EC0, EC1,SCK, SI, UCK
Input “L” voltage	V_{IL}	V_{SS} – 0.3	0.3 V_{CC}	V	P31,UI
	V_{ILS}	V_{SS} – 0.3	0.2 V_{CC}	V	MODA, $\overline{RST}$, P00 to P07, P10 to P17,P20 to P23,P30, INT0 to INT2, EC0, EC1,SCK, SI,UCK
Operating temperature	Ta	– 40	+ 105	°C	



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.

3. DC Characteristics

(V_{CC} = 5.0 V ± 10%, V_{SS} = 0.0 V, F_{CH} = 10 MHz (external clock), Ta = –40 °C to +105 °C)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
"H" level input voltage	V_{IH}	P31,UI	—	0.7 V_{CC}	—	V_{CC}+0.3	V	
	V_{IHS}	MODA, $\overline{RST}$, P00 to P07, P10 to P17, P20 to P23,P30, INT0 to INT2, EC0, EC1,SCK,SI, UCK	—	0.8 V_{CC}	—	V_{CC}+0.3	V	
"L" level input voltage	V_{IL}	P31,UI	—	V_{SS}–0.3	—	0.3 V_{CC}	V	
	V_{ILS}	MODA, $\overline{RST}$, P00 to P07, P10 to P17, P20 to P23,P30, INT0 to INT2, EC0, EC1,SCK,SI, UCK	—	V_{SS}–0.3	—	0.2 V_{CC}	V	
"H" level output voltage	V_{OH}	P00 to P07, P10 to P17, P20 to P23, P30	Vcc = 4.5V I_{OH} = –4.0 mA	V_{CC}– 0.5	—	—	V	
"L" level output voltage	V_{OL}	P00 to P07, P10 to P17, P20 to P23, P30, $\overline{RST}$	Vcc = 4.5V I_{OL} = 4.0 mA	—	—	0.4	V	
Input leak current	I_{LI}	P00 to P07, P10 to P17, P20 to P23, P30, P31, MODA	0.45 V < V_I < V_{CC}	—	—	± 5	µA	With pull-up resistance specified
Pullup resistance	R_{PULL}	P00 to P07, P10 to P17, P20 to P23, P30, $\overline{RST}$	V_I = 0.0 V	25	50	100	kΩ	
Power supply current	I_{CC}	V_{CC}	At normal operating (External clock, Max gear speed)	When A/D convereter stops	—	8	12	mA	MB89215
					—	6	9	mA	MB89P215
				When A/D convereter starts	—	10	15	mA	MB89215
					—	8	12	mA	MB89P215
	I_{CCS}		at sleep mode (External clock, Max gear speed)	When A/D convereter stops	—	4	6	mA	MB89215
					—	3	5	mA	MB89P215
	I_{CCH}		At stop mode Ta = + 25 °C (External clock)	When A/D convereter stops	—	—	1	µA	MB89215
					—	—	10	µA	MB89P215
Input capacitance	C_{IN}	Other than V_{CC} and V_{SS}	—	—	—	5	15	pF	MB89P215

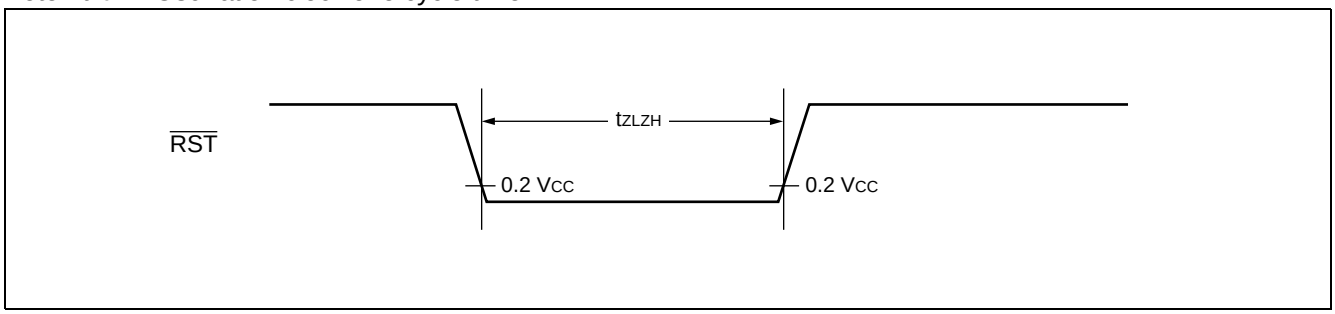
4. AC Characteristics

(1) Reset Timing

(V_{SS} = 0.0 V, Ta = –40 °C to +105 °C)

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

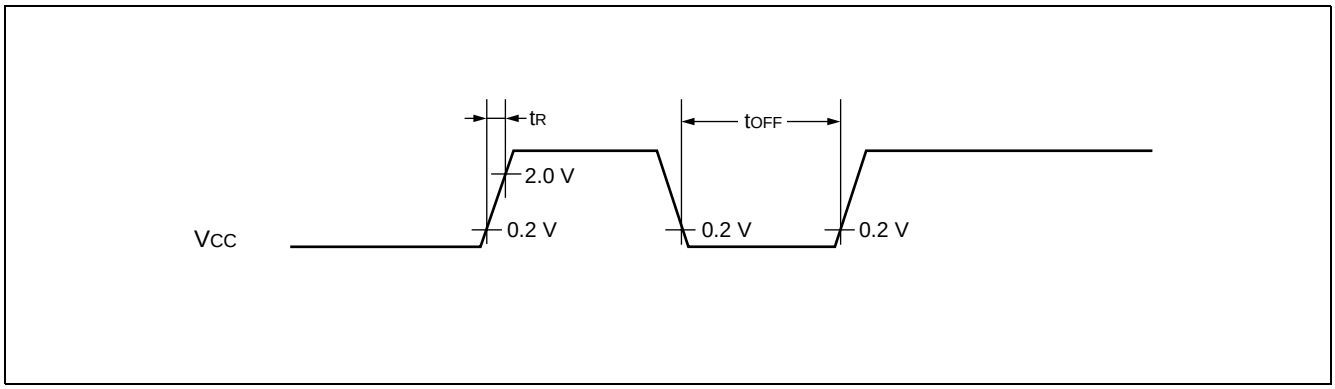
Note : t_{HCYL} : Oscillation clock one cycle time



(2) Power-on reset

(V_{SS} = 0.0 V, Ta = –40 °C to +105 °C)

Parameter	Symbol	Condition	Value		Unit	Remarks
			Min	Max		
Power on time	t_R	—	—	50	ms	
Power shutoff time	t_{OFF}	—	1	—	ms	For repeated operation



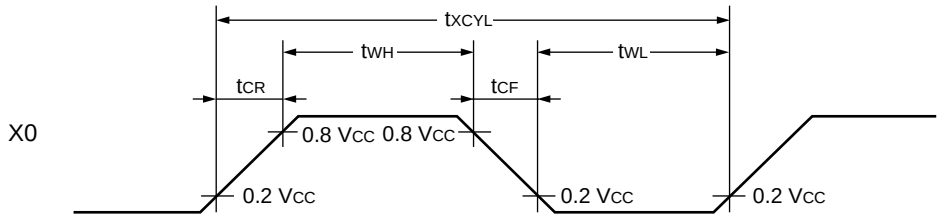
Note : The supply voltage must be set to minimum value required for operation within the prescribed default oscillation setting time.

(3) Clock Timing

(V_{SS} = 0.0 V, Ta = –40 °C to +105 °C)

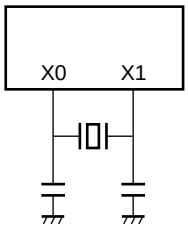
Parameter	Symbol	Condition	Value		Unit	Remarks
			Min	Max		
Clock frequency	F_{CH-1}	Crystal or ceramic oscillation	1	12.5	MHz	
Clock cycle time	t_{XCYL}		80	1000	ns	
Input clock pulse width	t_{WH} t_{WL}		20	—	ns	
Input clock rise, fall time	t_{CR} t_{CF}		—	10	ns	
Oscillation frequency	F_{CH-2}	CR(built-in) oscillator	8.5	11.5	MHz	

- X0 and X1 Timing and application Conditions

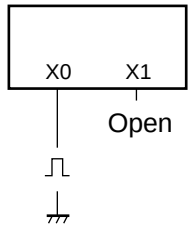


- Clock application Conditions

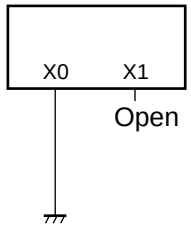
Using crystal oscillator or ceramic oscillator



Using external clock



Using CR (built-in) oscillator



(4) Instruction Cycle

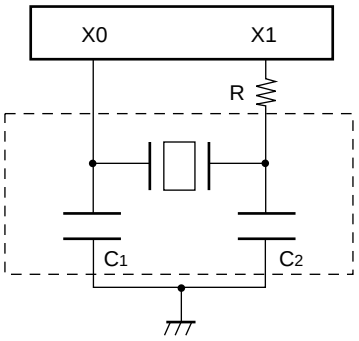
(V_{SS} = 0.0 V, Ta = –40 °C to +105 °C)

Parameter	Symbol	Value	Unit	Remarks
Instruction cycle (instruction execution time)	t_{INST}	$4/F_{CH}$, $8/F_{CH}$, $16/F_{CH}$, $64/F_{CH}$	µs	When operating at F_{CH} = 10 MHz t_{INST} = 0.4 µs ($4/F_{CH}$)

F_{CH} : Oscillation frequency (Operating clock frequency after switching between external and CR (internal) oscillator clocks)

(5) Recommended Resonator Manufactures

- Sample application of ceramic resonator



Resonator manufacture	Resonator	Frequency (MHz)	C_1	C_2	R
Murata Mfg. Co., Ltd.	CSTLS4M00G56-B0	4.00	built-in	built-in	680 Ω
	CSTCR4M00G55-R0	4.00	built-in	built-in	680 Ω
	CSTLS8M00G53-B0	8.00	built-in	built-in	—
	CSTCC8M00G53-R0	8.00	built-in	built-in	—
	CSTLS10M0G53-B0	10.00	built-in	built-in	—
	CSTCC10M00G53-R0	10.00	built-in	built-in	—

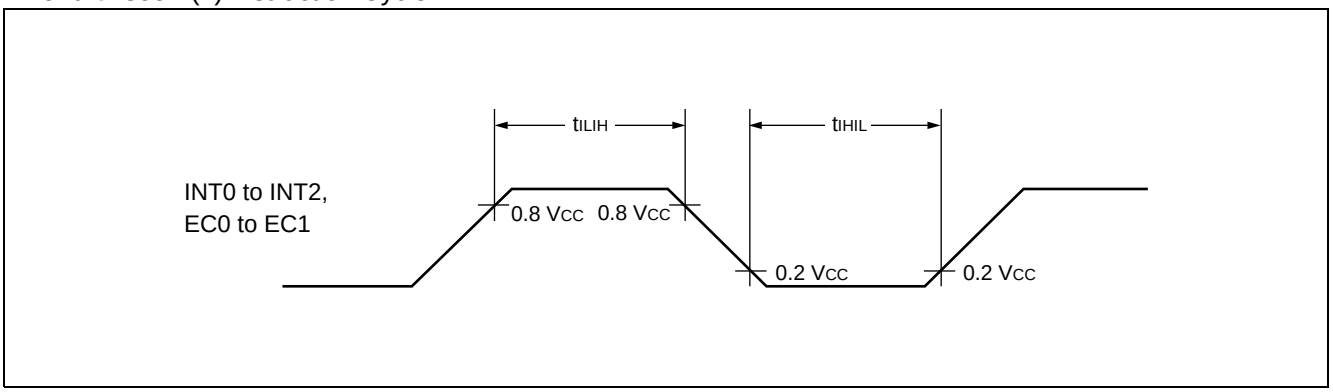
Inquiry :
- Murata Electronics North America Inc : TEL +1-404-436-1300
- Murata Europe Management GmbH : TEL +49-911-66870
- Murata Electronics Singapore (p/e) : TEL +65-758-4233

(6) Peripheral Input Timing

(V_{CC} = 5.0 V ± 10%, V_{SS} = 0.0 V, Ta = –40 °C to +105 °C)

Parameter	Symbol	Pin name	Value		Unit	Remarks
			Min	Max		
Peripheral input “H” pulse width	t_{ILIH}	INT0 to INT2, EC0, EC1	2 t_{INST}*	—	µs	
Peripheral input “L” pulse width	t_{IHIL}		2 t_{INST}*	—	µs	

*: For t_{INST} see “ (4) Instruction Cycle”.



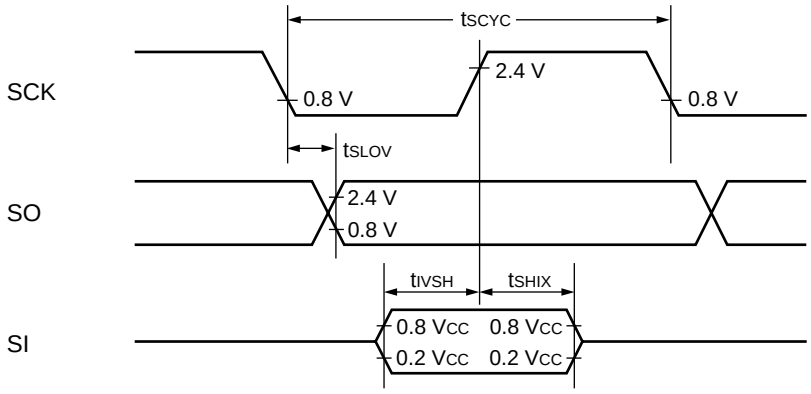
(7) Serial I/O Timing

(V_{CC} = 5.0 V ± 10%, V_{SS} = 0.0 V, Ta = –40 °C to +105 °C)

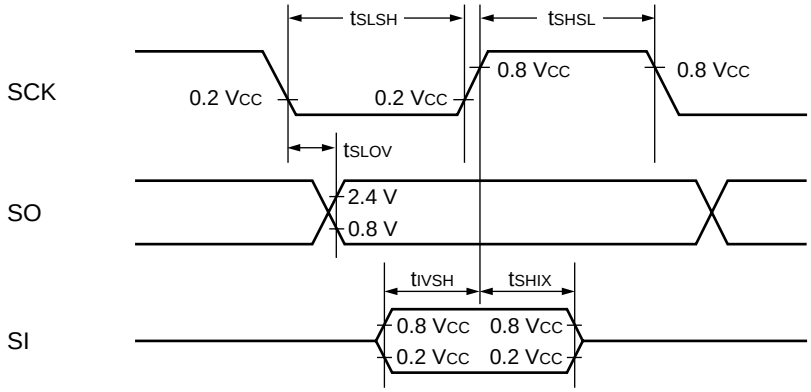
Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operation	2 t_{INST}*	—	µs	
SCK ↓ → SO time	t_{SLOV}	SCK, SO		– 200	200	ns	
Valid SI → SCK ↑	t_{IVSH}	SCK, SI		0.5 t_{INST}*	—	µs	
SCK ↑ → Valid SI hold time	t_{SHIX}	SCK, SI		0.5 t_{INST}*	—	µs	
Serial clock “H” pulse width	t_{SHSL}	SCK	External clock operation	t_{INST}*	—	µs	
Serial clock “L” pulse width	t_{SLSH}	SCK		t_{INST}*	—	µs	
SCK ↓ → SO time	t_{SLOV}	SCK, SO		0	200	ns	
Valid SI → SCK ↑	t_{IVSH}	SCK, SI		0.5 t_{INST}*	—	µs	
SCK ↑ → Valid SI hold time	t_{SHIX}	SCK, SI		0.5 t_{INST}*	—	µs	

*: For t_{INST} see “ (4) Instruction Cycle”.

- Internal shift clock mode



- External shift clock mode



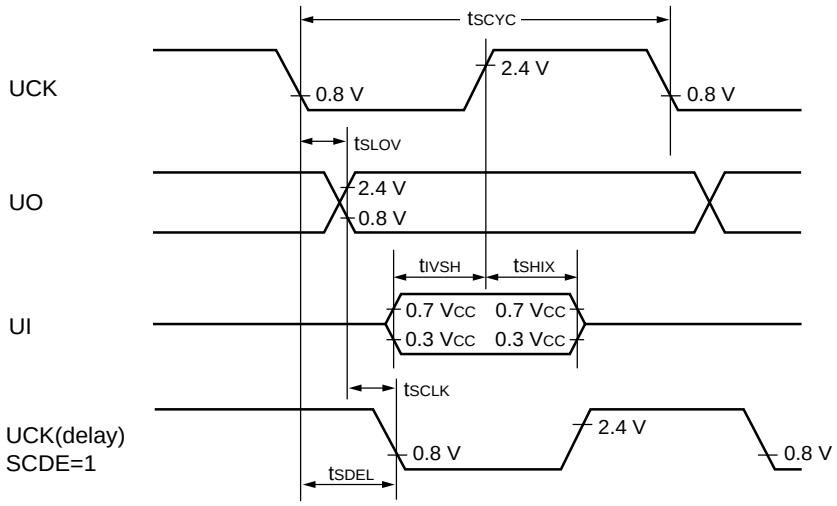
(8) LIN-UART timing

(V_{CC} = 5.0 V ± 10%, V_{SS} = 0.0 V, Ta = –40 °C to +105 °C)

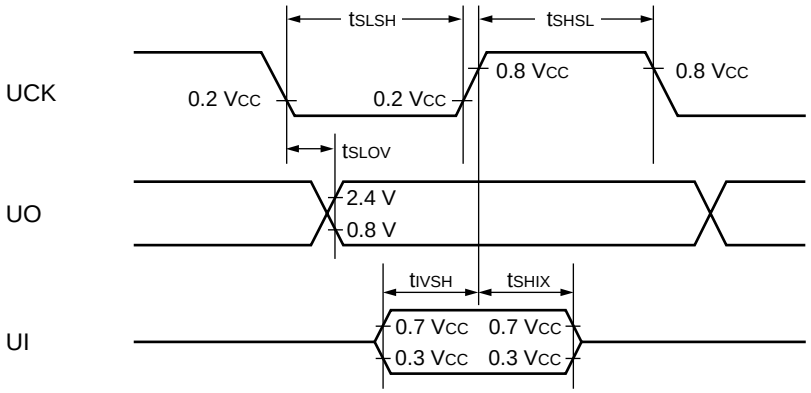
Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Serial clock cycle time	t_{SCYC}	UCK	Internal clock operation	2 t_{INST}*	—	µs	
UCK ↓ → UO time	t_{SLOV}	UCK, UO		– 200	200	ns	
Valid UI → UCK ↑	t_{IVSH}	UCK, UI		0	—	µs	
UCK ↑ → Valid UI hold time	t_{SHIX}	UCK, UI		0.5 t_{INST}*	—	µs	
UCK ↓ → UO time	t_{SLOV}	UCK, UO		– 200	200	ns	SCDE = 1
UCK (delay) ↓ → UO time	t_{SCLK}	UCK (delay), UO		– 0.5 t_{INST}*	—	µs	SCDE = 1
UCK ↓ → UCK (delay) ↓	t_{SDEL}	UCK, UCK (delay)		0.5 t_{INST}*	—	µs	SCDE = 1
Serial clock “H” pulse width	t_{SHSL}	UCK	External clock operation	1.5 t_{INST}*	—	µs	
Serial clock “L” pulse width	t_{SLSH}	UCK		1.5 t_{INST}*	—	µs	
UCK ↓ → UO time	t_{SLOV}	UCK, UO		t_{INST}*	—	µs	
Valid UI → UCK ↑	t_{IVSH}	UCK, UI		0	—	µs	
UCK ↑ → Valid UI hold time	t_{SHIX}	UCK, UI		0.5 t_{INST}*	—	µs	

*: For t_{INST} see “ (4) Instruction Cycle”.

- Internal shift clock mode



- External shift clock mode



5. A/D Converter

(1) A/D converter electrical characteristics

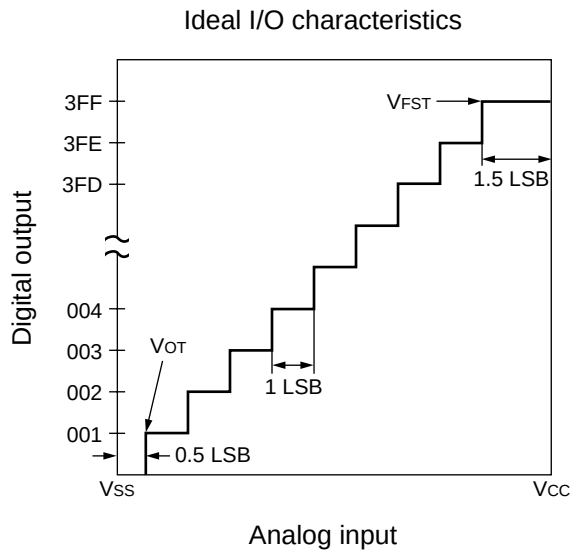
(V_{CC} = 5.0 V + 10%, V_{SS} = 0.0 V, Ta = –40 °C to +105 °C)

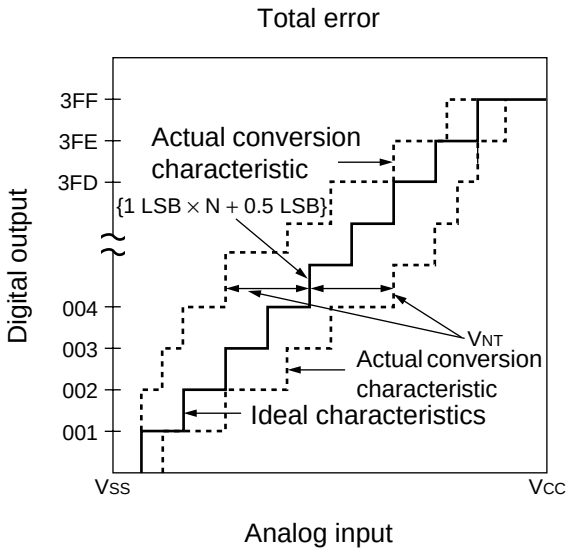
Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
Resolution	—	—	—	10	bit	
Total error	—	– 5.0	—	+ 5.0	LSB	
Linearity error	—	– 3.0	—	+ 3.0	LSB	
Differential linear error	—	– 2.5	—	+ 2.5	LSB	
Zero transition voltage	V_{OT}	V_{SS} – 3.5 LSB	V_{SS} + 0.5 LSB	V_{SS} + 4.5 LSB	V	
Full-scale transition voltage	V_{FST}	V_{CC} – 6.5 LSB	V_{CC} – 1.5 LSB	V_{CC} + 2.0 LSB	V	
A/D mode conversion time	—	—	—	38 t_{INST}*	µs	
Analog input current	I_{AIN}	—	—	10	µA	
Analog input voltage range	—	0	—	V_{CC}	V	

* : For t_{INST} see “ (4) Instruction Cycle” in “4. AC Characteristics”.

(2) Definition of A/D Converter Terms

- Resolution
  The level of analog variation that can be distinguished by the A/D converter.
  When the number of bits is 10, analog voltage can be divided into $2^{10} = 1024$.
- Linear error (Unit : LSB)
  The deviation between the value along a straight line connecting the zero transition point("00 0000 0000"←→"00 0000 0001") of a device and the full-scale transition point ("11 1111 1111"←→"11 1111 1110"), compared with the actual conversion values obtained.
- Differential linear error (Unit : LSB)
  Deviation of input voltage, which is required for changing output code by 1 LSB, from an ideal value.
- Total error (Unit : LSB)
  The difference between theoretical conversion value and actual conversion value.





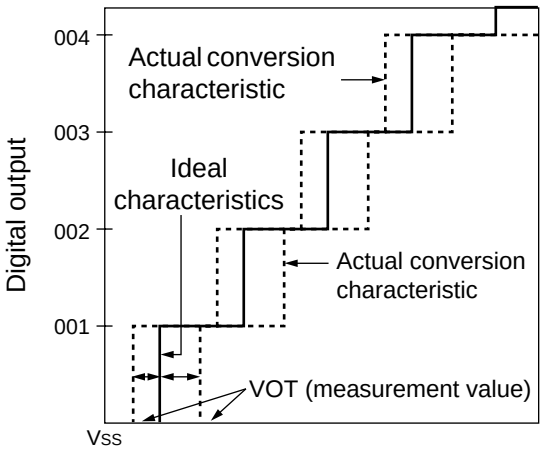
$$1\ \text{LSB} = \frac{V_{FST} - V_{OT}}{1022}\ \text{(V)}$$

$$\text{Total error in digital output N} = \frac{V_{NT} - \{1\ \text{LSB} \times N + 0.5\ \text{LSB}\}}{1\ \text{LSB}}$$

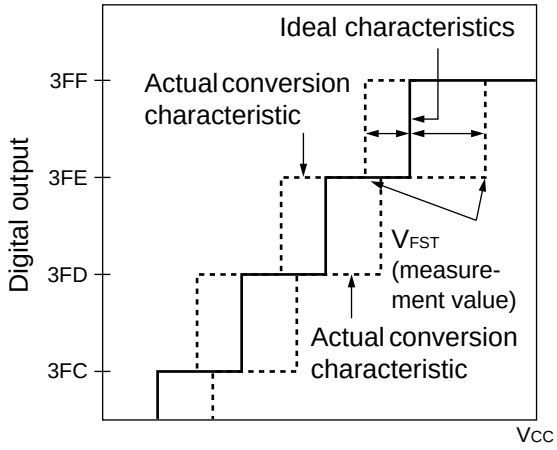
(Continued)

(Continued)

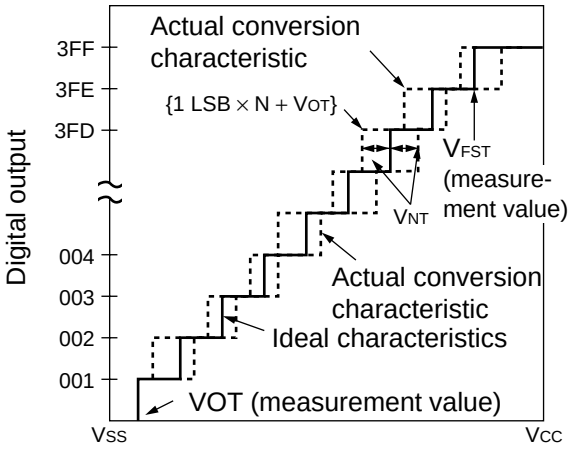
Zero transition error



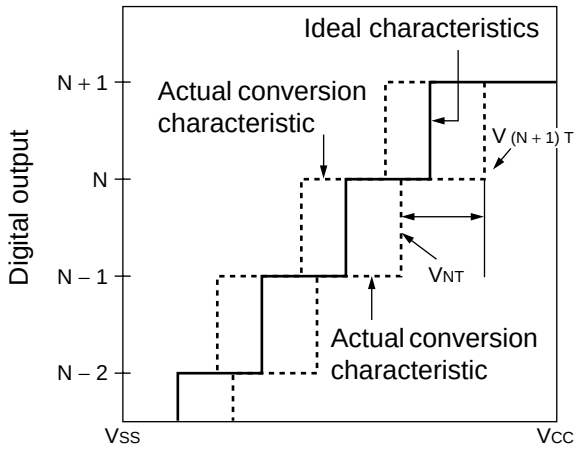
Full-scale transition error



Linearity error



Differential linear error



$$\text{Linear error in digital output N} = \frac{V_{NT} - \{1\ \text{LSB} \times N + V_{OT}\}}{1\ \text{LSB}}$$

$$\text{Differential linear error in digital output N} = \frac{V_{(N+1)\,T} - V_{NT}}{1\ \text{LSB}} - 1$$

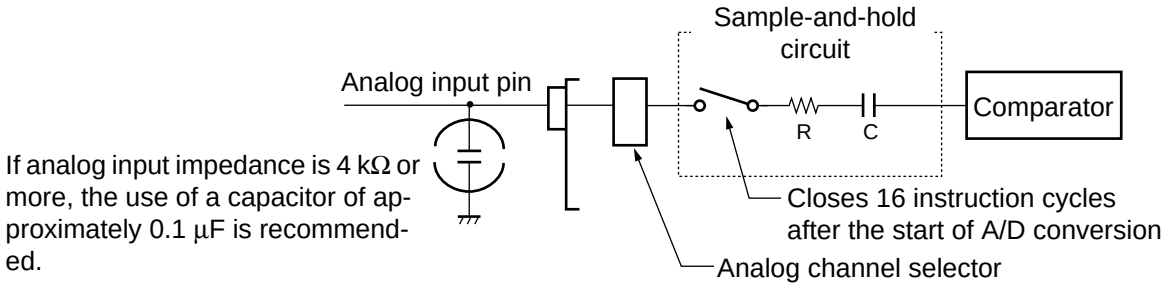
(3) Precautionary Information of A/D conversion

• Input Impedance of Analog Input Pins

The A/D converter has a sample & hold circuit as shown below, which uses a sample-and-hold capacitor to obtain the voltage at the analog input pin for 16 instruction cycles following the start of A/D conversion. For this reason if the external circuits providing the analog input signal have high output impedance, the analog input voltage may not stabilize within the analog input sampling time. It is therefore recommended that the output impedance of external circuits be reduced to 4 kΩ or less.

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



MB89215	R = approx. 2.2 kΩ,	C = approx. 45 pF
MB89P215	R = approx. 3.2 kΩ,	C = approx. 30 pF

• About errors

The smaller the absolute value $|V_{CC} - V_{SS}|$ is, the greater the relative error becomes.

■ MASK OPTIONS

No	Part number	MB89215	MB89P215	MB89PV210
	Specifying procedure	Setting disallowed		
1	Initial value* selection of internal clock oscillation stabilization wait time (at F_{CH} = 10 MHz) • 01 : $2^{14}/F_{CH}$ (Approx. 1.63ms) • 10 : $2^{17}/F_{CH}$ (Approx. 13.1ms) • 11 : $2^{18}/F_{CH}$ (Approx. 26.2ms)	2^{18}/Fch (Approx. 26.2 ms)		
2	Power-on reset • Power-on reset ON • Power-on reset OFF	Yes		
3	Reset pin output • Reset output ON • Reset output OFF	Yes		

F_{CH} : Base oscillator

* : Initial value to which the oscillation setting time bit (sync : WT1, WT0) in the system clock control register is set.

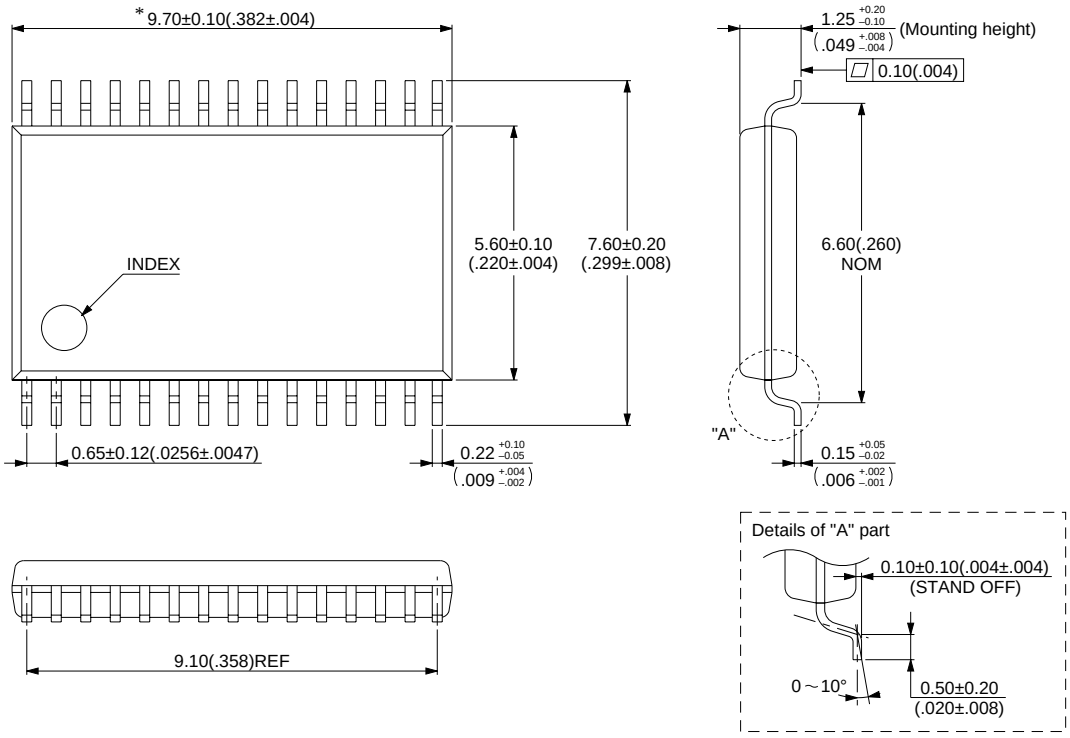
■ ORDERING INFORMATION

Part number	Package	Remarks
MB89215PFV MB89P215PFV	30-pin Plastic SSOP (FPT-30P-M02)	
MB89PV210CF	48-pin Ceramic MQFP (MQP-48C-P02)	

■ PACKAGE DIMENSIONS

30-pin Plastic SSOP
(FPT-30P-M02)

Note 1) *1 : Resin protrusion. (Each side +0.15 (.006) Max) .
Note 2) *2 : These dimensions do not include resin protrusion.
Note 3) Pins width and pins thickness include plating thickness.
Note 4) Pins width do not include tie bar cutting remainder.



Dimensions in mm (inches)
Note : The values in parentheses are reference values.

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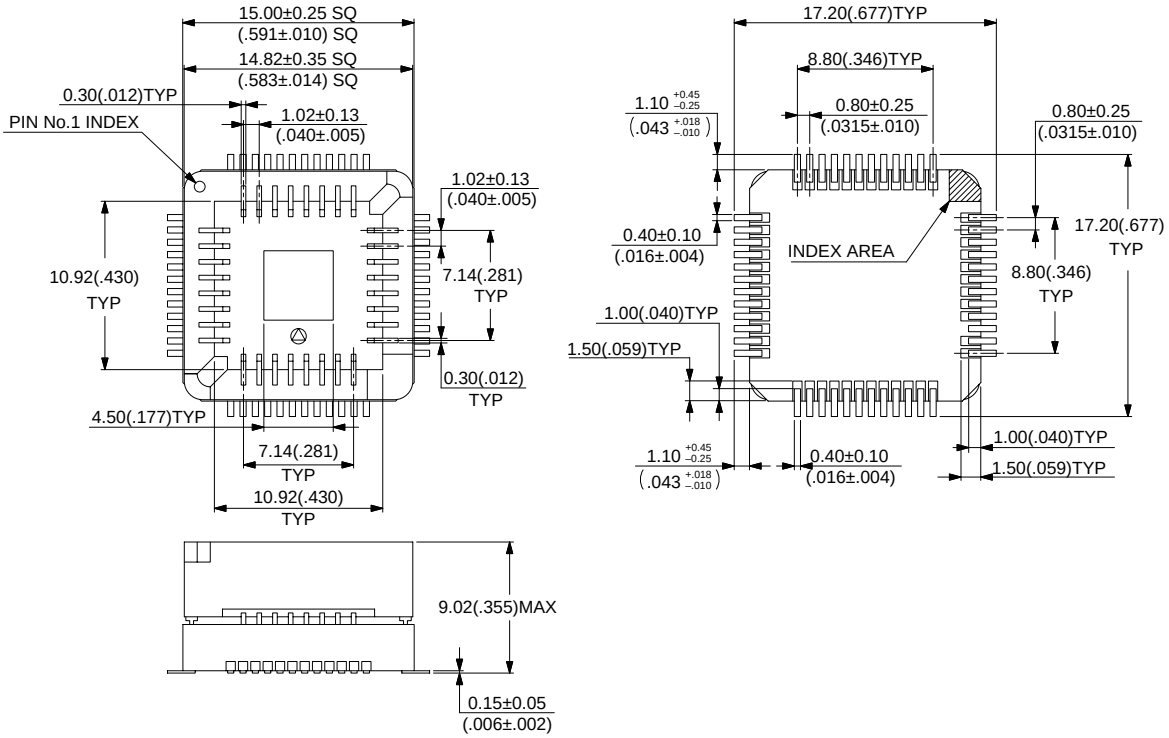
48-pin Ceramic MQFP
(MQP-48C-P02)



Dimensions in mm (inches)
Note : The values in parentheses are reference values.

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