

8-bit Microcontroller

CMOS

F²MC-8L MB89530A Series

**MB89535A/537A/537AC/538A/538AC/F538
MB89F538L/P538/PV530**

■ DESCRIPTION

The MB89530A series is a one-chip microcontroller featuring the F²MC-8L core supporting low-voltage and high-speed operation. Built-in peripheral functions include timers, serial interface, A/D converter, and external interrupt. This product is an ideal general-purpose one-chip microcontroller for a wide variety of applications from household to industrial equipment, as well as use in portable devices.

Note : F²MC is the abbreviation of FUJITSU Flexible Microcontroller.

■ FEATURES

- Wide range of package options
 - QFP package (1.00 mm pitch)
 - Two types of LQFP packages (0.65 mm pitch, 0.50 mm pitch)
 - SH-DIP package (1.778 mm pitch)
 - BCC package (0.50 mm pitch)
- Low voltage, high-speed operating capability
Minimum instruction execution time 0.32 μ s (at base oscillator 12.5 MHz)
- F²MC-8L CPU Core
 - Instruction set optimized for controller operation
 - Multiplication/division instructions
 - 16-bit calculation
 - Branching instructions with bit testing
 - Bit operation instructions, etc.

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For the information for microcontroller supports, see the following web site.

<http://edevic.fujitsu.com/micom/en-support/>

MB89530A Series

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- Five timer systems
 - 8-bit PWM timer with 2 channels (usable as either interval timer or PWM timer)
 - Pulse width count timer (supports continuous measurement or remote control receiving applications)
 - 16-bit timer counter
 - 21-bit time base timer
 - Watch prescaler (17-bit)
- UART
 - Synchronous or asynchronous operation, switchable
- 2 serial interfaces (Serial I/O)
 - Selection of transfer direction (specify MSB first or LSB first) for communication with a variety of devices
- 10-bit A/D converter (8 channels)
 - External clock input for startup support
 - Time base timer output for startup support (except MB89F538/F538L)
- Pulse generators (PPG) with 2-program capability
 - 6-bit PPG with selection of pulse width and pulse period
 - 12-bit PPG (2 channels) with selection of pulse width and pulse period
- I²C interface circuits
- External interrupt 1 (single-clock system : 4 channels, dual-clock system : 3 channels)
 - 4 or 3 independent inputs, release enabled from standby mode (includes edge detection function)
- External interrupt 2 (except for MB89F538/F538L : 8 channels, MB89F538/F538L : 7 channels)
 - 8 or 7 independent input, release enabled from standby mode (includes level edge detection function)
- Standby modes (low power consumption modes)
 - Stop mode (oscillator stops, virtually no power consumed)
 - Sleep mode (CPU stops, power consumption reduced to one-third)
 - Sub clock mode
 - Watch mode
- Watchdog timer reset
- I/O ports
 - Maximum ports

Single-clock system	: Except MB89F538/F538L	53 ports
	MB89F538/F538L	52 ports
Dual-clock system	: Except MB89F538/F538L	51 ports
	: MB89F538/F538L	50 ports
 - 38 general-purpose I/O ports (CMOS) (MB89F538/F538L : 37 general-purpose I/O ports)
 - 2 general-purpose I/O ports (N-ch open drain)
 - 8 general-purpose output ports (N-ch open drain)
 - General-purpose input ports (CMOS) : single-clock system : 5 ports, dual-clock system : 3 ports

MB89530A Series

■ PRODUCT LINEUP

Part number	MB89535A	MB89537A/ 537AC	MB89538A/ 538AC	MB89F538/ MB89F538L	MB89P538	MB89PV530
Type	Mass produced (MASK ROM)			Flash product	One-time programmable product	Evaluation product
ROM capacity	16 Kbytes × 8-bit (built-in ROM)	32 Kbytes × 8-bit (built-in ROM)	48 Kbytes × 8-bit (built-in ROM)	48 Kbytes × 8-bit (built-in Flash) (write from general purpose EPROM writer)	48 Kbytes × 8-bit (built-in ROM) (write from general purpose EPROM writer)	48 Kbytes × 8-bit (external ROM) *2
RAM capacity	512 bytes × 8-bit	1 Kbyte × 8-bit	2 Kbytes × 8-bit			
Operating voltage	2.2 V to 5.5 V *1 (MB89535A/537A/538A/537AC/538AC)			MB89F538 : 3.5 V to 5.5 V MB89F538L : 2.4 V to 3.6 V *1	2.7 V to 5.5 V	2.7 V to 5.5 V
CPU functions	Basic instructions : 136 Instruction bit length : 8 bits Instruction length : 1 bit to 3 bits Data bit length : 1, 8, 16 bits Minimum instruction execution time : 0.32 μs / 12.5 MHz Minimum interrupt processing time : 2.88 μs / 12.5 MHz					
Peripheral functions	Ports	Input ports : single-clock system : 5 (4 also usable as external interrupts) dual-clock system : 3 (3 also usable as external interrupts) Output-only ports (N-ch open drain) : 8 (8 also usable as A/D converter input) I/O ports (N-ch open drain) : 2 (2 also usable as SO2/SDA or SI2/SCL) I/O ports (CMOS) (Except MB89F538/F538L) : 38 I/O ports (CMOS) (MB89F538/F538L) : 37 (21 have no other function) Total (except MB89F538/F538L) : single-clock system : 53 dual-clock system : 51 Total (MB89F538/F538L) : single-clock system : 52 dual-clock system : 50				
	Time base timer	21 bits Interrupt periods at main clock oscillation frequency of 12.5 MHz (approx. 0.655 ms, 2.621 ms, 20.97 ms, 335.5 ms)				
	Watchdog timer	Reset period of approx. 167.8 ms to 335.6 ms at main clock frequency of 12.5 MHz Reset period of approx. 500 ms to 1000 ms at sub clock frequency of 32.768 kHz.				
	PWM timer	8-bit interval timer operation (supports square wave output, operating clock period : 1, 8, 16, 64 tinst*3) Pulse width measurement with 8-bit resolution (conversion period : 2^8 tinst*3 to 2^8 × 64 tinst*3) 2 channels (can also be used as interval timer, can also be used as ch.1 output and ch.2 count clock)				
Watch prescaler	Interval times at 17-bit sub clock base frequency of 32.768 kHz (approx. 31.25 ms, 0.25 s, 0.50 s, 1.00 s, 2.00 s, 4.00 s)					

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MB89530A Series

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Part number		MB89535A	MB89537A/ 537AC	MB89538A/ 538AC	MB89F538/ MB89F538L	MB89P538	MB89PV530
Parameter							
Peripheral functions	Pulse width count timer	8-bit one-shot timer operation (supports underflow output, operating clock period : 1, 4, 32 t_{inst}^{*3} , external) 8-bit reload timer operation (supports square wave output, operating clock period : 1, 4, 32 t_{inst}^{*3} , external) 8-bit pulse width measurement operation (continuous measurement, “H” width measurement, “L” width measurement, $\uparrow$ to $\uparrow$, $\downarrow$ to $\downarrow$, “H” width measurement and $\uparrow$ to $\uparrow$)					
	16-bit timer/counter	16-bit timer operation (operating clock period : 1 t_{inst}^{*3} , external) 16-bit event counter operation (select rising, falling, or both edges) 16-bit $\times$ 1 channel					
	Serial I/O	8 bits length Selection of LSB first or MSB first Transfer clock (2, 8, 32 t_{inst}^{*3} , external)					
	UART/SIO	CLK synchronous/CLK asynchronous data transfer capability (8, 9-bit with parity bit, or 7,8-bit without parity bit) . Built-in baud rate generator provides selection of 14 baud rate settings.					
	UART	CLK synchronous/CLK asynchronous data transfer capability (4, 6, 7, 8-bit with parity bit, or 5, 7, 8, 9-bit without parity bit) . Built-in baud rate generator provides selection of 14 baud rate settings. External clock output, 2-channel 8-bit PWM timer output also available for baud rate settings.					
	External interrupt 1	Single-clock system : 4 channels independent, dual-clock system : 3 channels independent. Selection of rising, falling, or both edge detection. Can be used for recovery from standby mode (edge detection also available in stop mode)					
	External interrupt 2	Except MB89F538/F538L : 8 channels, MB89F538/F538L : 7 channels Can be used for recovery from standby mode.					
	6-bit PPG, 12-bit PPG	Can generate square wave signals with programmable period. 6-bit $\times$ 1 channel or 12-bit $\times$ 2 channels.					
	I ² C bus interface	—	1-channel , compatible with Intel System Administrator bus version 1.0 and Philips I ² C specifications. 2-line communications (on MB89PV530/P538/F538/F538L/537AC/538AC)				
	A/D converter	10-bit resolution $\times$ 8 channels. A/D conversion functions (conversion time : 60 t_{inst}^{*3}) Supports repeated calls from external clock (except MB89F538/F538L) . Supports repeated calls from internal clock. Standard voltage input provided (AVR)					
Standby modes (power saving modes)		Sleep mode, stop mode, sub clock mode, watch mode.					
Process		CMOS					

*1 : Depends on operating frequency.

*2 : Using external ROM and MBM27C512.

*3 : t_{inst} represents instruction execution time. This can be selected as 1/4, 1/8, 1/16, 1/64 of the main clock cycle or 1/2 of the sub clock cycle.

Note : MB89535A/537A/538A have no built-in I²C functions.

To use I²C functions, choose the MB89PV530/MB89P538/F538/F538L/537AC/538AC.

MB89530A Series

■ MODEL DIFFERENCES AND SELECTION CONSIDERATIONS

Part number Package	MB89535A	MB89537A/ 537AC	MB89538A/ 538AC	MB89F538	MB89F538L	MB89P538	MB89PV530
DIP-64P-M01	○	○	○	○	○	○	×
FPT-64P-M24	○	○	○	×	×	×	×
FPT-64P-M06	○	○	○	○	○	○	×
FPT-64P-M23	○	○	○	○	○	○	×
LCC-64P-M19	○	○	○	×	○	×	×
MDP-64C-P02	×	×	×	×	×	×	○
MQP-64C-P01	×	×	×	×	×	×	○

○ : Model-package combination available

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Conversion sockets for pin pitch conversion can be used.

MB89530A Series

■ DIFFERENCES AMONG PRODUCTS

1. Memory Capacity

When this product is used in an evaluation product or other evaluation configuration, it is necessary to carefully confirm the differences between the model being used and the product it is evaluating. Particular attention should be given to the following (Refer to “■CPU CORE 1.Memory Space”) .

- The program ROM area starts from address 4000_H on the MB89F538, MB89F538L, MB89P538 and MB89PV530 models.
- Note upper limits on RAM, such as stack areas, etc.

2. Current Consumption

- On the MB89PV530, 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.

For details, refer to “■ELECTRICAL CHARACTERISTICS”.

3. Mask Options

The options available for use, and the method of specifying options, differ according to the model. Before use, check the “■ MASK OPTIONS” specification section.

4. Wild Register Functions

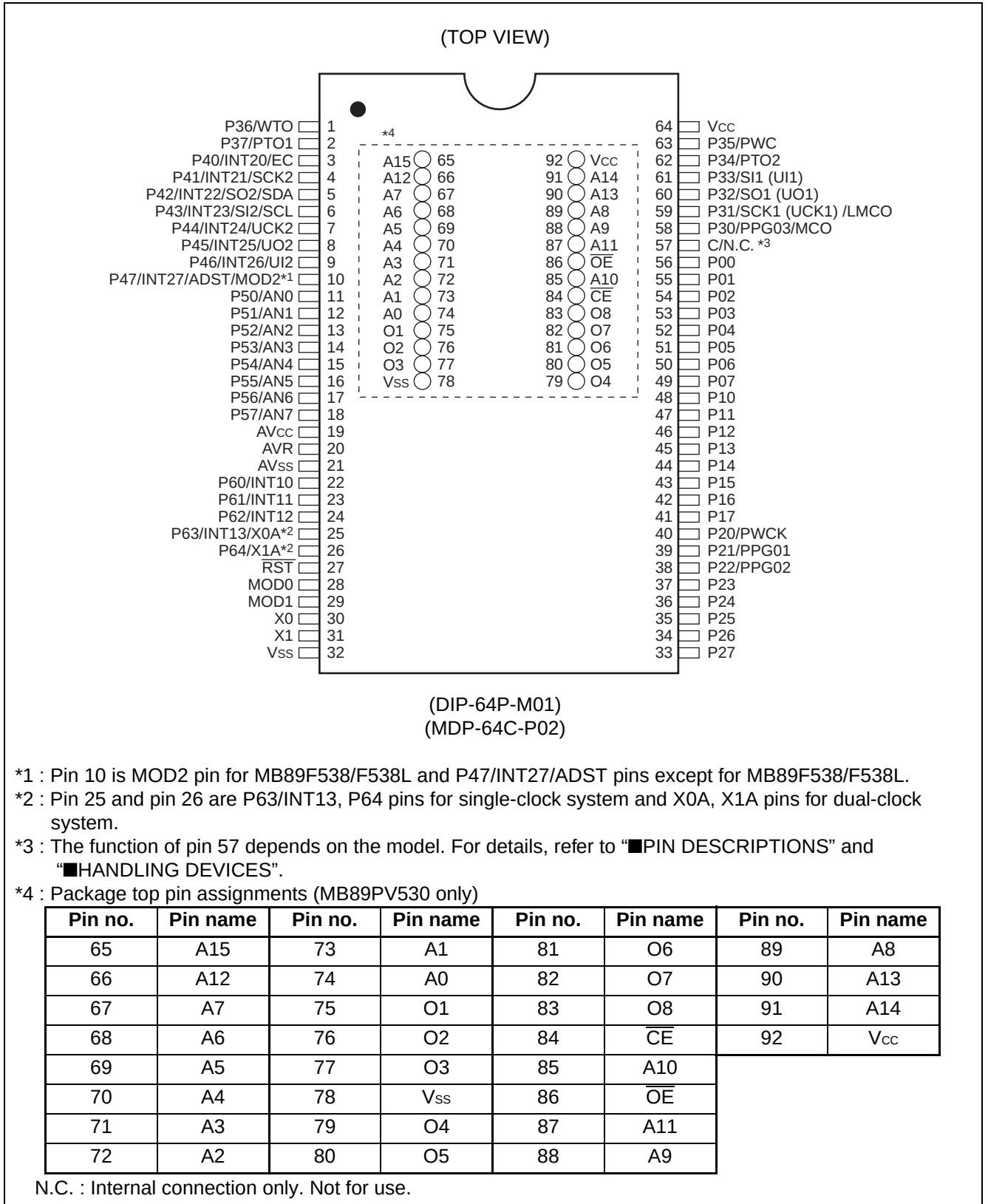
The following table shows areas in which wild register functions can be used.

Wild Register Usage Areas

Part number	Address space
MB89PV530	4000 _H to FFFF _H
MB89P538	4000 _H to FFFF _H
MB89F538/F538L	4000 _H to FFFF _H
MB89537A/537AC	8000 _H to FFFF _H
MB89538A/538AC	4000 _H to FFFF _H
MB89535A	C000 _H to FFFF _H

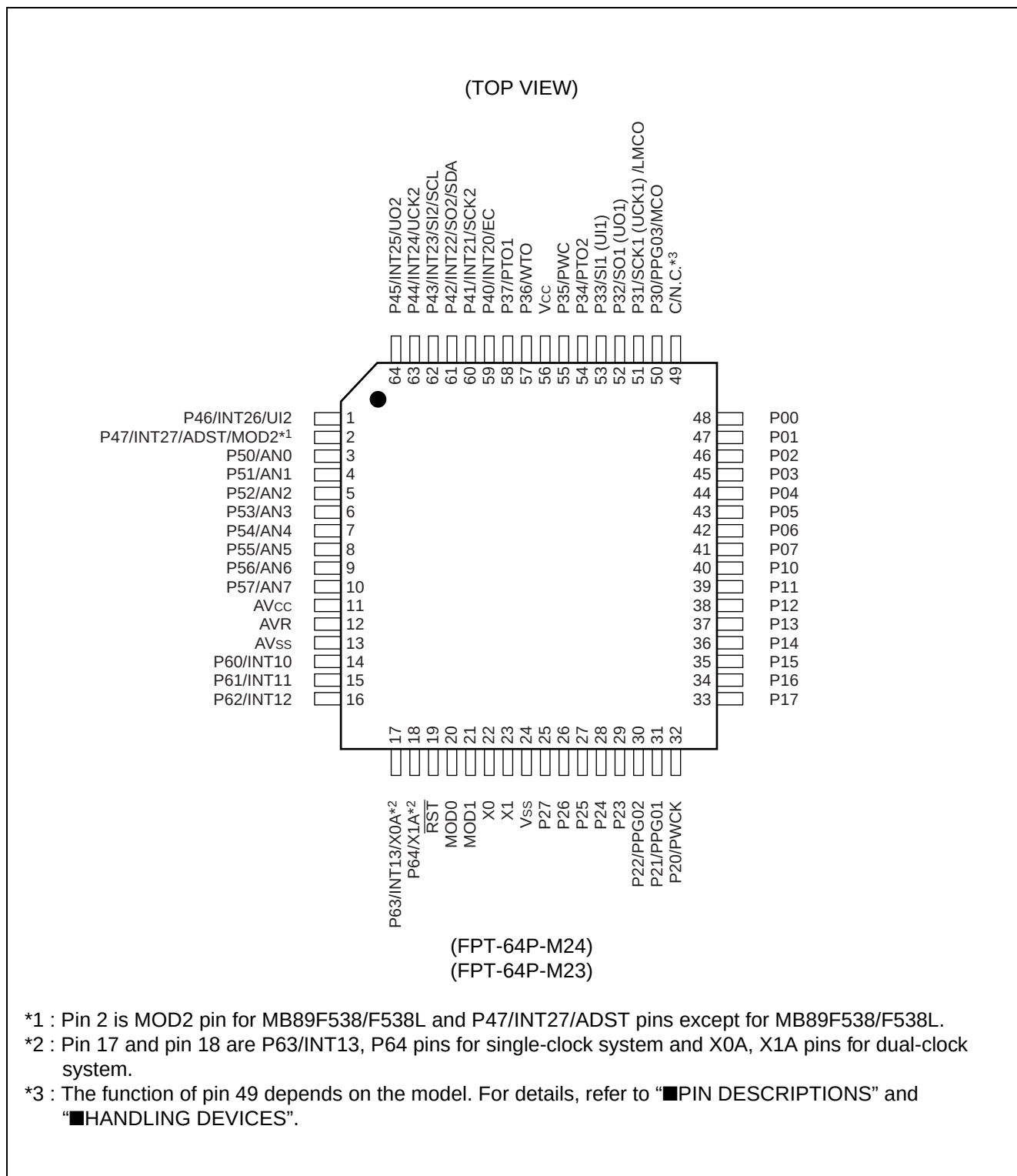
MB89530A Series

PIN ASSIGNMENTS



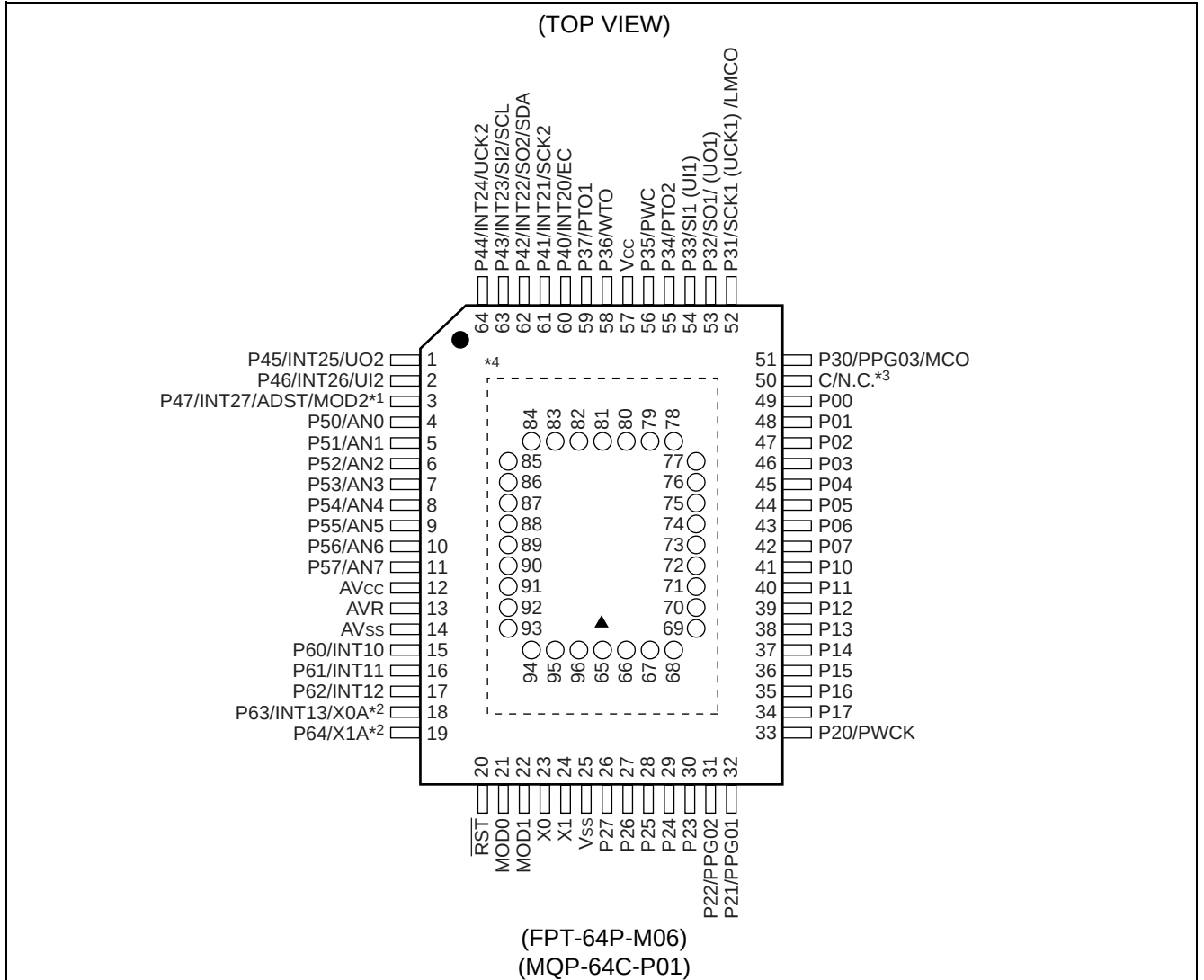
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MB89530A Series



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*1 : Pin 3 is MOD2 pin for MB89F538/F538L and P47/INT27/ADST pins except for MB89F538/F538L.

*2 : Pin 18 and pin 19 are P63/INT13, P64 pins for single-clock system and X0A, X1A pins for dual-clock system.

*3 : The function of pin 50 depends on the model. For details, refer to "PIN DESCRIPTIONS" and "HANDLING DEVICES".

*4 : Package top pin assignments (MB89PV530 only)

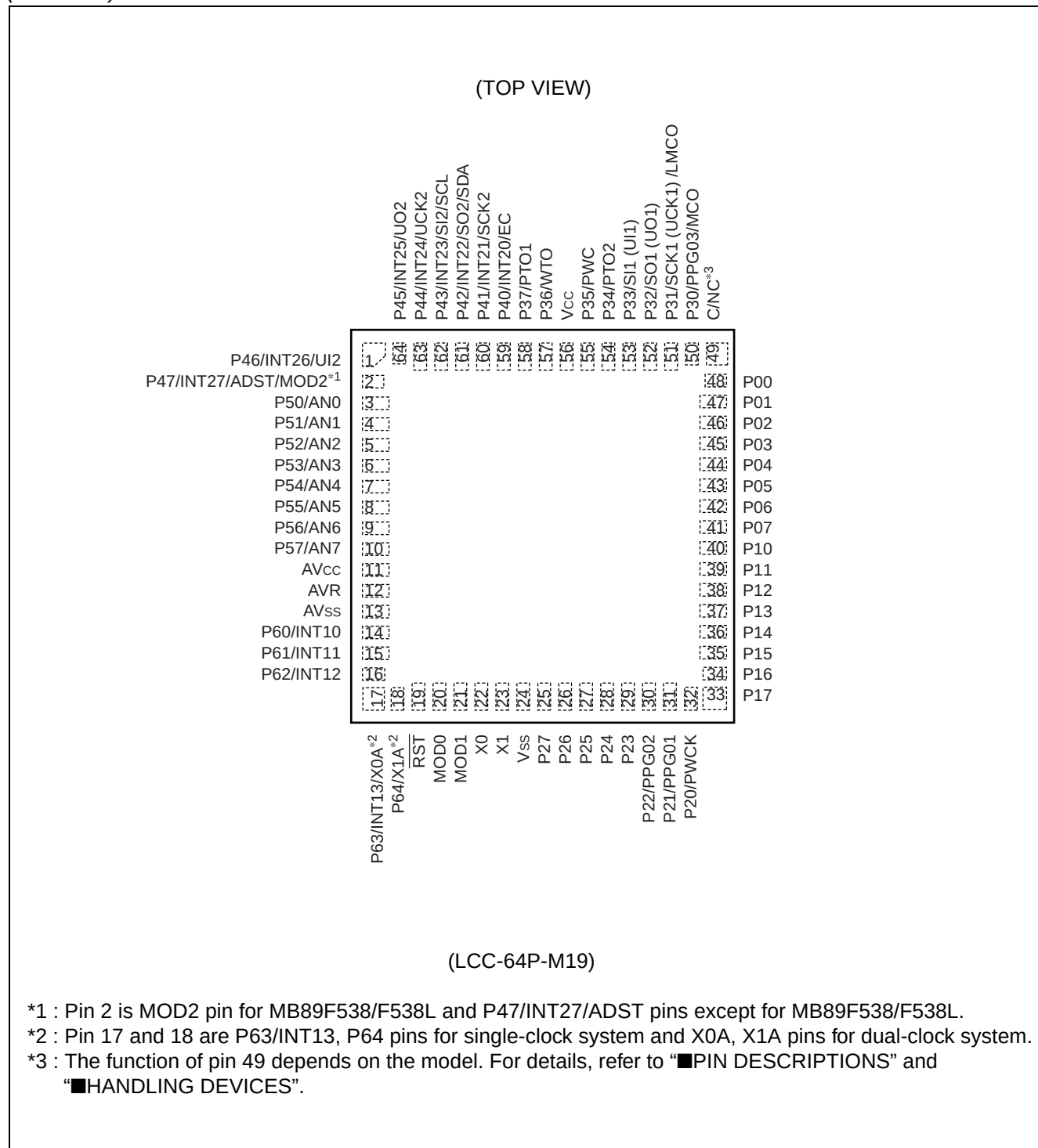
Pin no.	Pin name	Pin no.	Pin name	Pin no.	Pin name	Pin no.	Pin name
65	N.C.	73	A2	81	N.C.	89	OE
66	A15	74	A1	82	O4	90	N.C.
67	A12	75	A0	83	O5	91	A11
68	A7	76	N.C.	84	O6	92	A9
69	A6	77	O1	85	O7	93	A8
70	A5	78	O2	86	O8	94	A13
71	A4	79	O3	87	CE	95	A14
72	A3	80	Vss	88	A10	96	Vcc

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

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MB89530A Series

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MB89530A Series

■ PIN DESCRIPTIONS

Pin no.			Pin name	I/O circuit type*7	Function
SH-DIP*1 MDIP*2	QFP*3 MQFP*4	LQFP*5 BCC*6			
30	23	22	X0	A	Connecting pins to crystal oscillator circuit or other oscillator circuit. The X0 pin can connect to an external clock. In that case, X1 is left open.
31	24	23	X1		
28	21	20	MOD0	B	Input pins for memory access mode setting. Connect directly to Vss.
29	22	21	MOD1		
27	20	19	$\overline{\text{RST}}$	C	Reset I/O pin. This pin has pull-up resistance with CMOS I/O or hysteresis input. At an internal reset request, an 'L' signal is output. An 'L' level input initializes the internal circuits.
56 to 49	49 to 42	48 to 41	P00 to P07	D	General purpose I/O ports.
48 to 41	41 to 34	40 to 33	P10 to P17	D	General purpose I/O ports.
40	33	32	P20/PWCK	E	General purpose I/O port.Resource I/O pin (hysteresis input).Hysteresis input. This pin also functions as a PWC input.
39	32	31	P21/ PPG01	D	General purpose I/O port.This pin also functions as the PPG01 output.
38	31	30	P22/ PPG02	D	General purpose I/O port.This pin also functions as the PPG02 output.
37	30	29	P23	D	General purpose I/O port.
36	29	28	P24	D	General purpose I/O port.
35	28	27	P25	D	General purpose I/O port.
34	27	26	P26	D	General purpose I/O port.
33	26	25	P27	D	General purpose I/O port.
58	51	50	P30/ PPG03/ MCO	D	General purpose I/O port.This pin also functions as the PPG03 output.
59	52	51	P31/SCK1 (UCK1) / LMCO	E	General purpose I/O port.Resource I/O pin (hysteresis input).This pin also functions as the UART/SIO clock input/output pin.
60	53	52	P32/SO1 (UO1)	D	General purpose I/O port.This pin also functions as the UART/SIO data output pin.
61	54	53	P33/SI1 (UI1)	E	General purpose I/O port.Resource input/output pin (hysteresis input).This pin also functions as the UART/SIO serial data input pin.
62	55	54	P34/PTO2	D	General purpose I/O port.This pin also functions as the PWM timer 2 output pin.
63	56	55	P35/PWC	E	General purpose I/O port.Resource I/O pin (hysteresis input).This pin also functions as a PWC input.

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Pin no.			Pin name	I/O circuit type*7	Function
SH-DIP*1 MDIP*2	QFP*3 MQFP*4	LQFP*5 BCC*6			
1	58	57	P36/ WTO	D	General purpose I/O port.Resource output. This pin also functions as the PWC output pin.
2	59	58	P37/ PTO1	D	General purpose I/O port.Resource output. This pin also functions as the PWM timer 1 output pin.
3	60	59	P40/ INT20/ EC	E	General purpose I/O port.Resource I/O pin (hysteresis input).This pin also functions as an external interrupt input or 16-bit timer/counter input.
4	61	60	P41/ INT21/ SCK2	E	General purpose I/O port.Resource I/O pin (hysteresis input).This pin also functions as an external interrupt input or SIO clock I/O pin.
5	62	61	P42/ INT22/ SO2/ SDA	G	N-ch open drain output. Resource I/O pin (hysteresis only for INT22 input) . This pin also functions as an external interrupt input, SIO serial data output, or I ² C data line.
6	63	62	P43/ INT23/ SI2/SCL	G	N-ch open drain output. Resource I/O pin (hysteresis only for INT23 input) . This pin also functions as an external interrupt, SIO serial data input, or I ² C clock I/O pin.
7	64	63	P44/ INT24/ UCK2	E	General purpose I/O port. Resource I/O pin (hysteresis input) . This pin also functions as an external interrupt input or UART clock I/O pin.
8	1	64	P45/ INT25/ UO2	E	General purpose I/O port. Resource I/O pin (hysteresis input) . This pin also functions as an external interrupt input or UART data output pin.
9	2	1	P46/ INT26/ UI2	E	General purpose I/O port. Resource I/O pin (hysteresis input) . This pin also functions as an external interrupt input or UART data input pin.
10	3	2	P47/ INT27/ ADST	E	Except MB89F538/F538L General purpose I/O port. Resource I/O pin (hysteresis input) . This pin also functions as an external interrupt input or A/D converter clock input pin.
			MOD2	B	MB89F538/F538L Input pins for memory access mode setting. Connect directly to Vss.
11 to 18	4 to 11	3 to 10	P50/AN0 to P57/ AN7	H	N-ch open drain output port. This pin also functions as an A/D converter analog input pin.

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MB89530A Series

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Pin no.			Pin name	I/O circuit type*7	Function	
SH-DIP*1 MDIP*2	QFP*3 MQFP*4	LQFP*5 BCC*6				
22 to 24	15 to 17	14 to 16	P60/INT10 to P62/INT12	I	General purpose input port. Resource input pin (hysteresis input) . This pin also functions as an external interrupt input pin.	
25	18	17	P63/INT13	I	Single-clock system	General purpose input port. Resource input (hysteresis input) . This pin also functions as an external interrupt.
			X0A	A	Dual-clock system	Connected pin for sub clock.
26	19	18	P64	J	Single-clock system	General purpose input port.
			X1A	A	Dual-clock system	Connected pin for sub clock.
64	57	56	V _{CC}	—	Power supply pin.	
32	25	24	V _{SS}	—	Ground pin (GND) .	
19	12	11	AV _{CC}	—	A/D converter power supply pin.	
20	13	12	AVR	—	A/D converter reference voltage input pin.	
21	14	13	AV _{SS}	—	A/D converter power supply pin. Used at the same voltage level as the V _{SS} supply.	
57	50	49	C	—	MB89F538	Capacitor connection pin for stabilization power supply. Connect an external ceramic capacitor of approximately 0.1 μ F.
					MB89P538	If “Available” is selected for the step-down circuit stabilization time, V _{CC} is fixed. If “Unavailable” is selected for the step-down circuit stabilization time, V _{SS} is fixed.
					MB89PV530 MB89537A/537AC MB89538A/538AC MB89535A MB89F538L	N.C. pin

*1 : DIP-64P-M01

*2 : MDP-64C-P02

*3 : FPT-64P-M06

*4 : MQP-64C-P01

*5 : FPT-64P-M24/M23

*6 : LCC-64P-M19

*7 : For I/O circuit type, refer to “ I/O CIRCUIT TYPE” .

MB89530A Series

External EPROM Socket Pin Function Descriptions (MB89PV530 only)

Pin no.		Pin name	I/O Circuit type*3	Function
MDIP*1	MQFP*2			
65	66	A15	O	Address output pins.
66	67	A12		
67	68	A7		
68	69	A6		
69	70	A5		
70	71	A4		
71	72	A3		
72	73	A2		
73	74	A1		
74	75	A0		
75	77	O1	I	Data input pins
76	78	O2		
77	79	O3		
78	80	V _{SS}	O	Power supply pin (GND) .
79	82	O4	I	Data input pins.
80	83	O5		
81	84	O6		
82	85	O7		
83	86	O8		
84	87	$\overline{CE}$	O	ROM chip enable pin. Outputs an "H" level signal in standby mode.
85	88	A10	O	Address output pin.
86	89	$\overline{OE}$	O	ROM output enable pin. Outputs "L" at all times.
87	91	A11	O	Address output pins.
88	92	A9		
89	93	A8		
90	94	A13	O	
91	95	A14	O	
92	96	V _{CC}	O	EPROM power supply pin.
—	65 76 81 90	N.C.	O	Internally connected. These pins always left open.

*1 : MDP-64C-P02

*2 : MQP-64C-P01

*3 : For I/O circuit type, refer to "■ I/O CIRCUIT TYPE" .

MB89530A Series

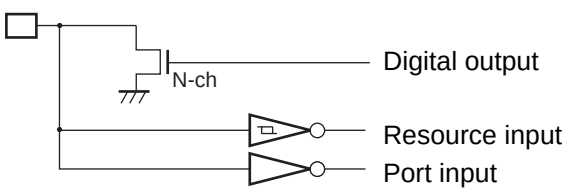
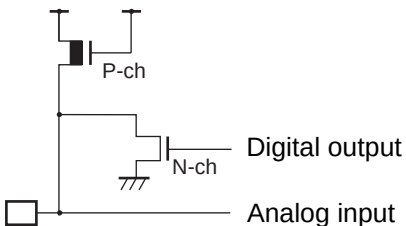
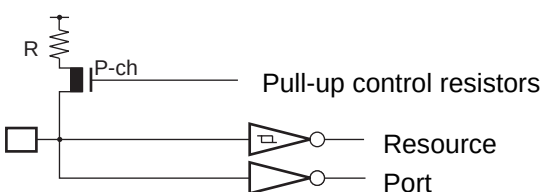
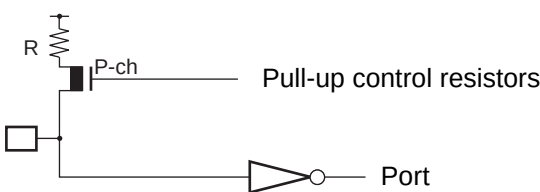
I/O CIRCUIT TYPES

Type	Circuit	Remarks
A	Standby control	Oscillator feedback resistance • High speed side = approx. 1 MΩ • Low speed side = approx. 10 MΩ
B		• Hysteresis input • Pull-down resistance built-in to MB89535A MB89537A/537AC MB89538A/538AC
C		• Pull-up resistance approx. 50 kΩ • Hysteresis input
D		• CMOS I/O • Software pull-up resistance can be used. Approx. 50 kΩ
E		• CMOS I/O • Software pull-up resistance can be used. Approx. 50 kΩ

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MB89530A Series

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Type	Circuit	Remarks
G		• N-ch open drain output • Hysteresis input • CMOS input
H		• N-ch open drain output • Analog input (A/D converter)
I		• Hysteresis input • CMOS input • Software pull-up resistance can be used. Approx. 50 kΩ
J		• CMOS input • Software pull-up resistance can be used. Approx. 50 kΩ

■ HANDLING DEVICES

1. Preventing Latch-up

Care must be taken to ensure that maximum voltage ratings are not exceeded (to prevent latch-up) . When CMOS integrated circuit devices are subjected to applied voltages higher than V_{CC} at input and output pins (other than medium- and high-withstand voltage pins), or to voltages lower than V_{SS} , as well as when voltages in excess of rated levels are applied between V_{CC} and V_{SS} , the phenomenon known as latch-up can occur.

When a latch-up condition occurs, supply current can increase dramatically and may destroy semiconductor elements. In using semiconductor devices, always take sufficient care to avoid exceeding maximum ratings.

Also when switching power on or off to analog systems, care must be taken that analog power supplies (AV_{CC} , AVR) and analog input signals do not exceed the level of the digital power supply.

2. Power Supply Voltage Fluctuations

Even within the warranted operating range of the V_{CC} supply voltage, sudden changes in supply voltage can cause abnormal operation. As a measure for stability, it is recommended that the V_{CC} ripple fluctuation (peak to peak value) should be kept within 10% of the reference V_{CC} value on commercial power supply (50 Hz/60 Hz), and instantaneous voltage fluctuations such as at power-on and shutdown should be kept within a transient variability limit of 0.1V/ms.

3. Treatment of Unused Input Pins

If unused input pins are left open, abnormal operation may result. Any unused input pins should be connected to pull-up or pull-down resistance.

4. Treatment of N.C. Pins

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

5. Treatment of Power Supply Pins on Models with Built-in A/D Converter

Even when A/D converters are not in use, pins should be connected so that $AV_{CC} = V_{CC}$, and $AV_{SS} = AVR = V_{SS}$.

6. Precautions for Use of External Clock

Even when an external clock signal is used, an oscillator stabilization wait period is used after a power-on reset, or escape from sub clock mode or stop mode.

7. Execution of Programs on RAM

Debugging of programs executed on RAM cannot be performed even when using the MB89PV530.

8. Wild Register Functions

Wild registers cannot be debugged with the MB89PV530 and tools. To verify operations, actual in-device testing on the MB89P538 or MB89F538/F538L is advised.

MB89530A Series

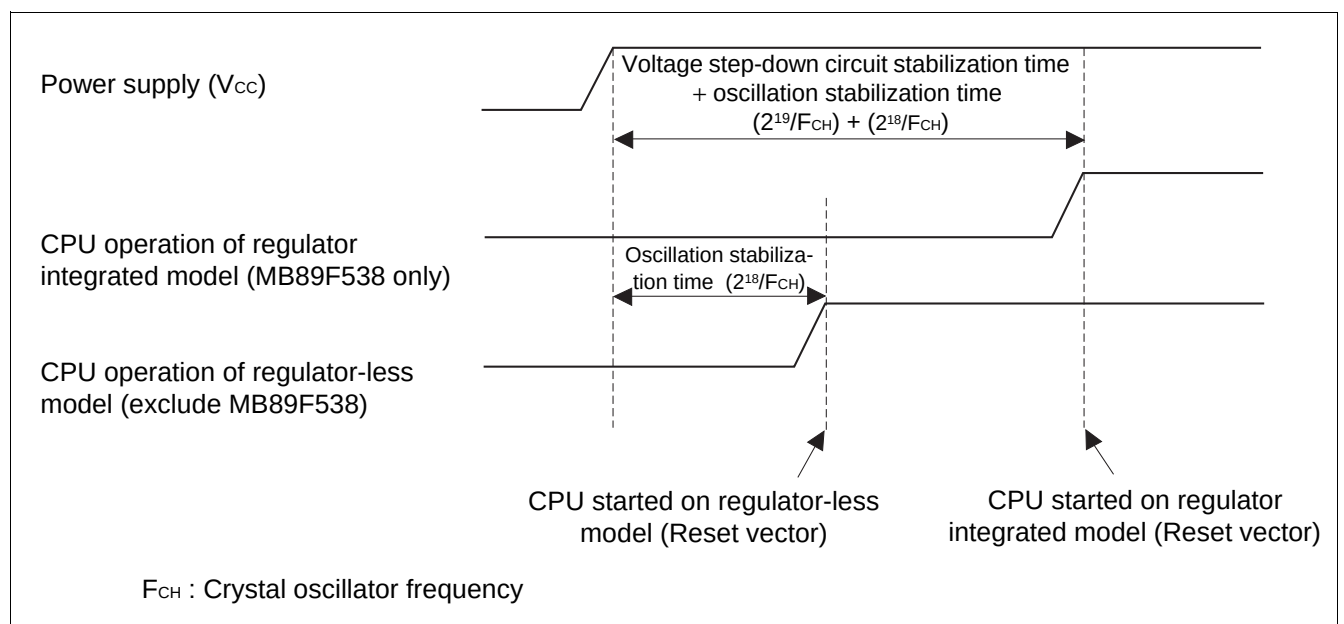
9. Details on handling the C terminal of the MB89530 series

The MB89530 series contains the following products. The regulator integrated model and the regulator-less model have different performance characteristics.

Part No.	Operation Voltage	integrated model	Terminal type	Terminal treatments
MB89PV530	2.7 V to 5.5 V	Not included	N.C. terminal	Not required
MB89P538		Included	C terminal	Fixed to V _{CC}
		Not included		Fixed to V _{SS}
MB89F538	3.5 V to 5.5 V	Included		
MB89F538L	2.3 V to 3.6 V	Not included	N.C. terminal	Not required
MB89537A/537AC	2.2 V to 5.5 V			
MB89538A/538AC				
MB89535A				

Although these product models have the same internal resources, the operation sequence after a power-on reset is different between the regulator integrated model and regulator-less model.

The operation sequence after a power-on reset of each model is shown below.



As above, the regulator integrated model starts the CPU behind the regulator-less model. This is because the regulator requires a settling time for normal operation.

The MB89P538 offers a choice of regulator-integrated and regulator-less models selectable depending on the C-terminal treatment. Use the right one for your mask board.

10. Note to Noise in the External Reset Pin ($\overline{RST}$)

If the reset pulse applied to the external reset pin ($\overline{RST}$) does not meet the specifications, it may cause malfunctions. Use caution so that the reset pulse less than the specifications will not be fed to the external reset pin ($\overline{RST}$).

MB89530A Series

■ PROGRAMMING AND ERASING FLASH MEMORY ON THE MB89F538/F538L

1. Flash Memory

The flash memory is located between 4000_H and FFFF_H in the CPU memory map and incorporates a flash memory interface circuit that allows read access and program access from the CPU to be performed in the same way as MASK ROM. Programming and erasing flash memory is also performed via the flash memory interface circuit by executing instructions in the CPU. This enables the flash memory to be updated in place under the control of the CPU, providing an efficient method of updating program and data.

2. Flash Memory Features

- 48 Kbytes × 8-bit configuration (16 Kbytes + 8 Kbytes + 8 Kbytes + 16 Kbytes sectors)
- Automatic programming algorithm (Embedded algorithm : Equivalent to MBM29LV200)
- Includes an erase pause and restart function
- Data polling and toggle bit for detection of program/erase completion
- Detection of program/erase completion via CPU interrupt
- Compatible with JEDEC-standard commands
- Sector Protection (sectors can be combined in any combination)
- No. of program/erase cycles : 10,000 (Min)

3. Procedure for Programming and Erasing Flash Memory

Programming and reading flash memory cannot be performed at the same time. Accordingly, to program or erase flash memory, the program must first be copied from flash memory to RAM so that programming can be performed without program access from flash memory.

4. Flash Memory Register

- Flash memory control status register (FMCS)

Address	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	Initial value
007A _H	INTE	RDYINT	WE	RDY	Reserved	Reserved	—	Reserved	00X00-0B
	R/W	R/W	R/W	R	R/W	R/W	—	R/W	

5. Sector Configuration

The table below shows the sector configuration of flash memory and lists the addresses of each sector for both during CPU access a flash memory programming.

- Sector configuration of flash memory

Flash Memory	CPU Address	Programmer Address*
16 Kbytes	FFFF _H to C000 _H	1FFFF _H to 1C000 _H
8 Kbytes	BFFF _H to A000 _H	1BFFF _H to 1A000 _H
8 Kbytes	9FFF _H to 8000 _H	19FFF _H to 18000 _H
16 Kbytes	7FFF _H to 4000 _H	17FFF _H to 14000 _H

* : Programmer address

The programmer address is the address to be used instead of the CPU address when programming data from a parallel flash memory programmer. Use the programmer address on programming or erasing using a general-purpose parallel programmer.

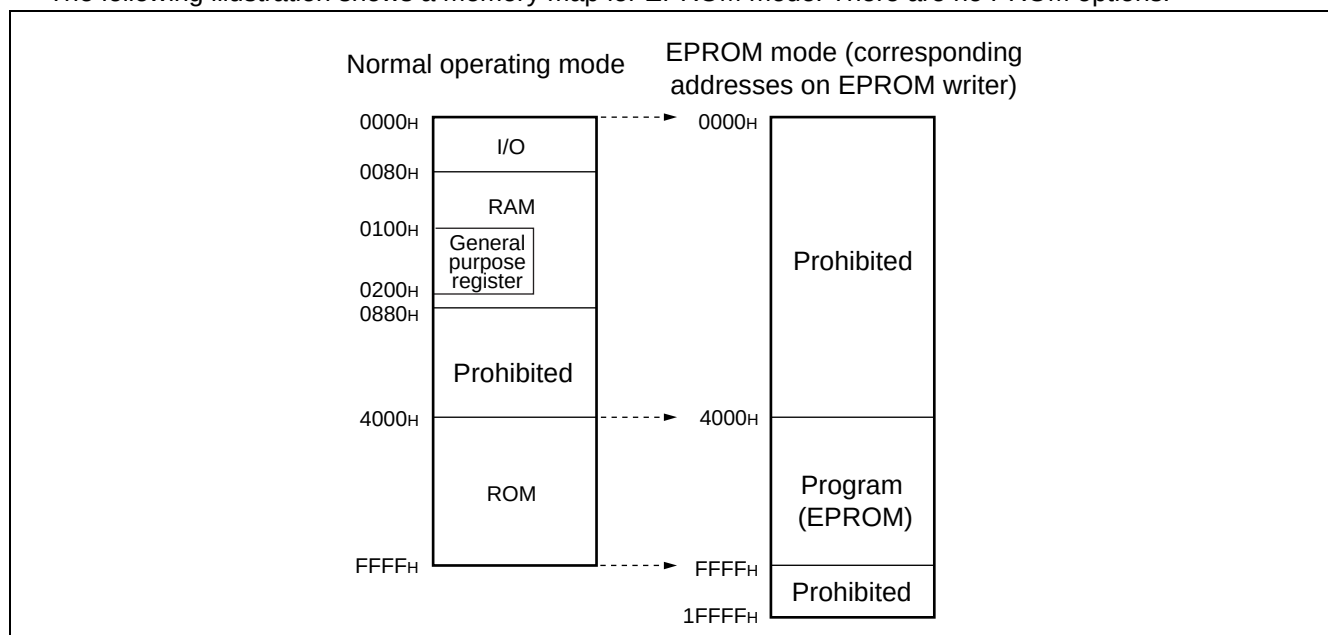
MB89530A Series

■ ONE-TIME WRITING SPECIFICATIONS WITH PROM AND EPROM MICROCONTROLLERS

The MB89P538 has a PROM mode with functions equivalent to the MBM27C1001, allowing writing with a general purpose ROM writer using a proprietary adapter. Note, however, that the use of electronic signature mode is not supported.

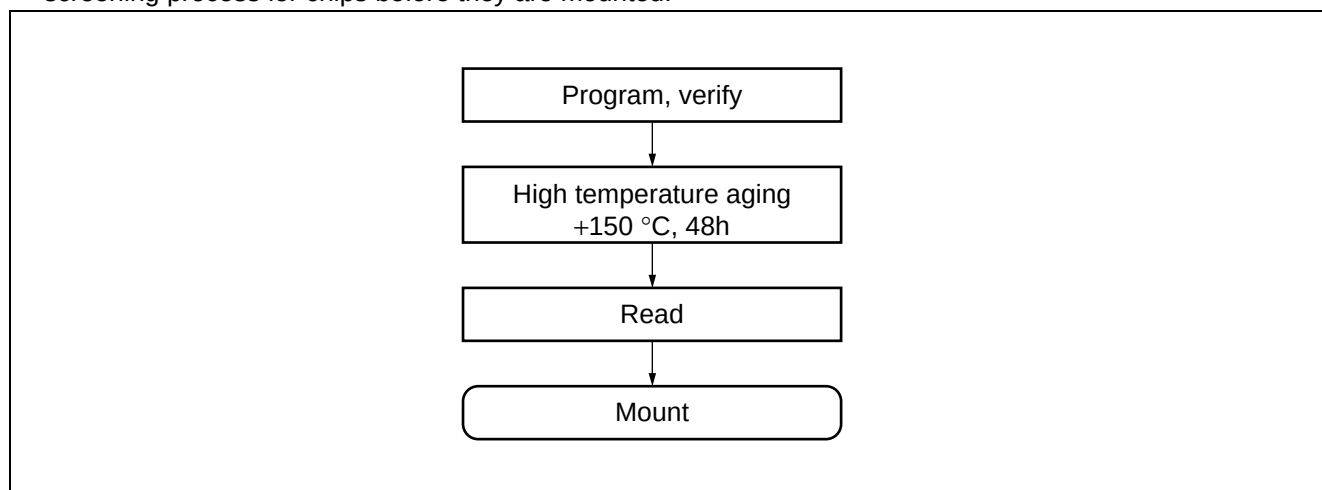
- Memory map for EPROM mode

The following illustration shows a memory map for EPROM mode. There are no PROM options.



- Recommended screening conditions

Before one-time writing of microcontroller programs to PROM, high temperature aging is recommended as a screening process for chips before they are mounted.



- About writing yields

The nature of chips before one-time writing of microcontroller programs to PROM prevents the use of all-bit writing tests. Therefore it is not possible to guarantee writing yields of 100% in some cases.

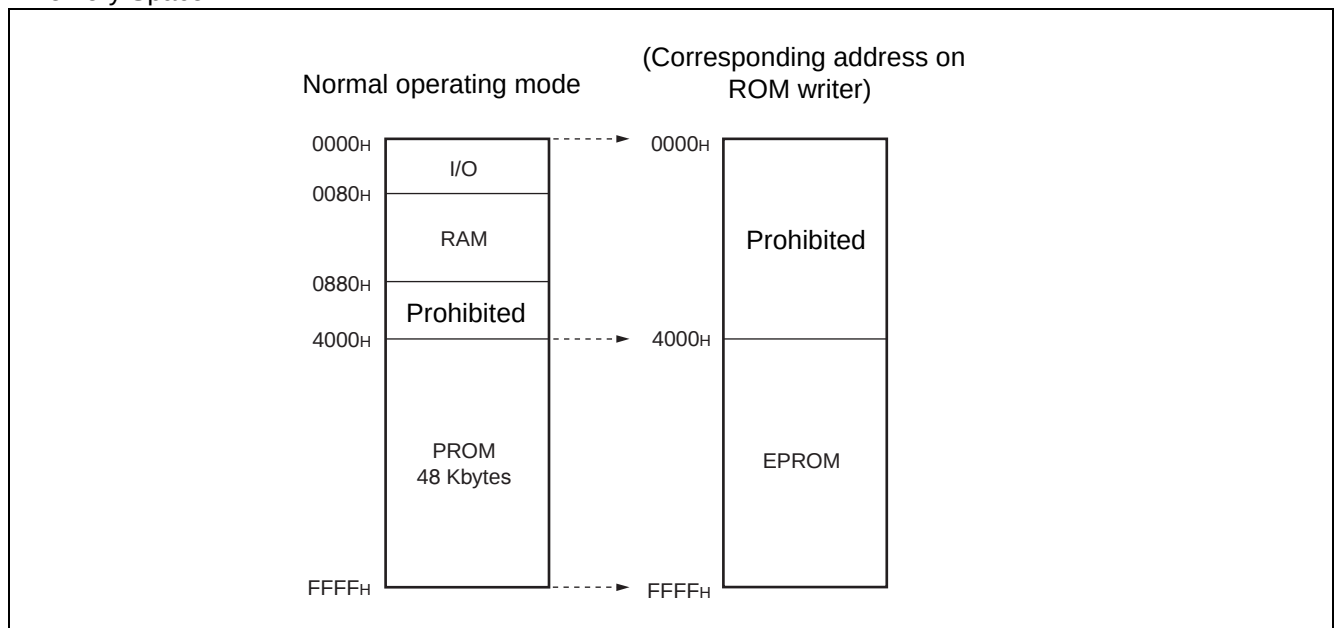
MB89530A Series

■ EPROM WRITING TO PIGGY-BACK/EVALUATION CHIPS

This section describes methods of writing to EPROM on piggy-back/evaluation chips.

- EPROM model
MBM27C512-20TV

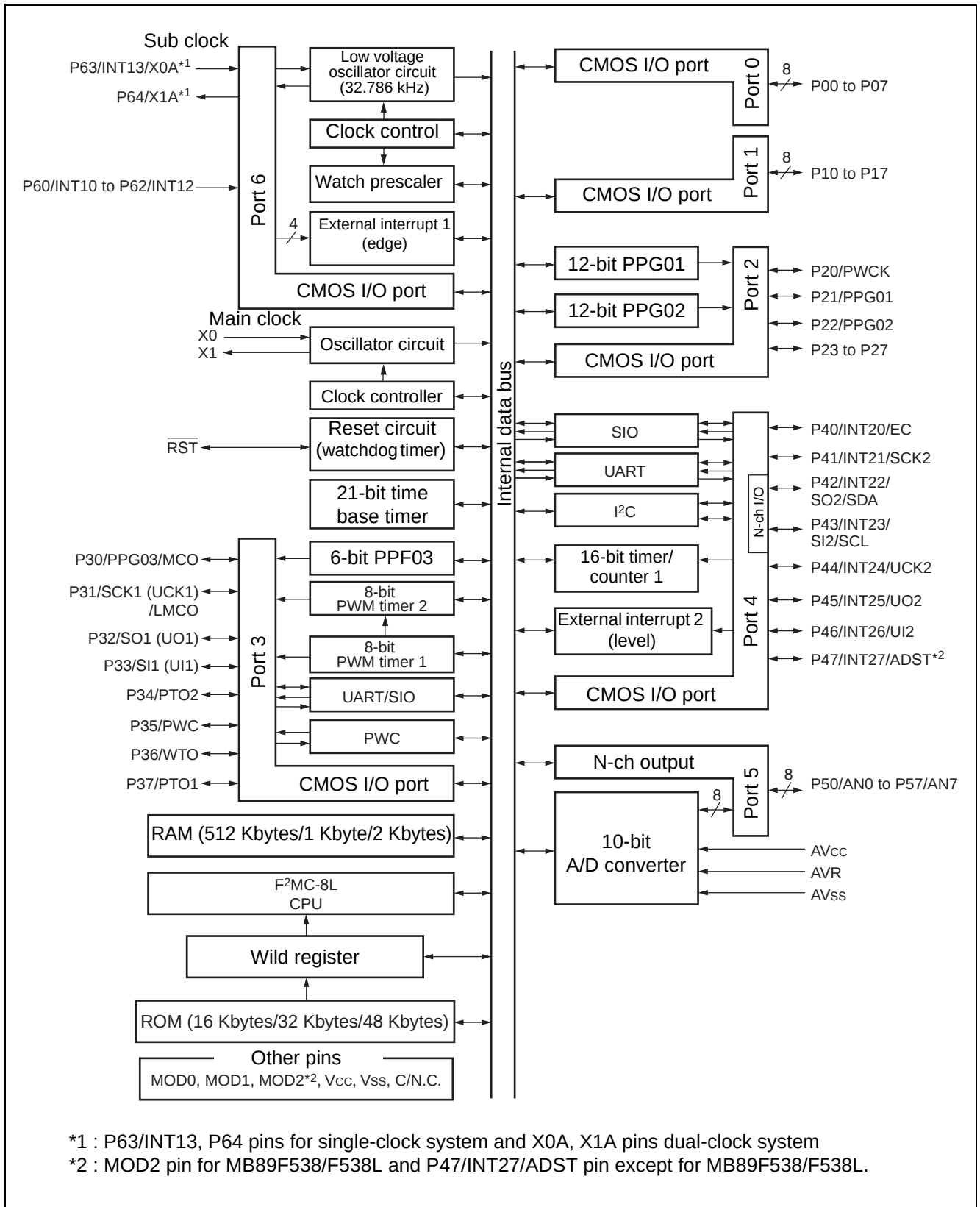
- Memory Space



- Writing to EPROM
 - 1) Set up the EPROM writer for the MBM27C512.
 - 2) Load program data to the EPROM writer, in the area 4000H to FFFFH.
 - 3) Use the EPROM writer to write to the area 4000H to FFFFH.

MB89530A Series

■ BLOCK DIAGRAM



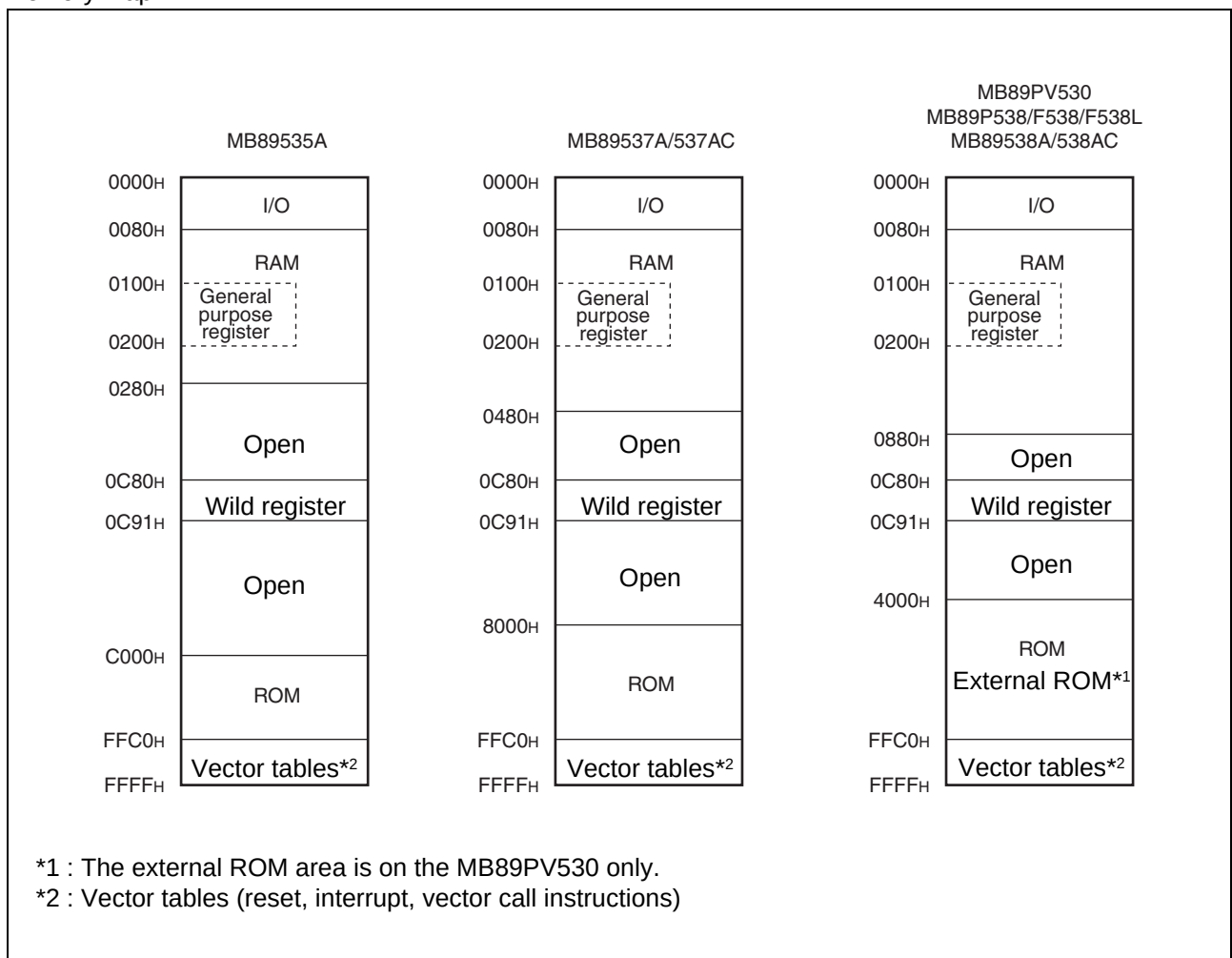
MB89530A Series

■ CPU CORE

1. Memory Space

The MB89530A series has 64 Kbytes 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 MB89530A series.

• Memory Map



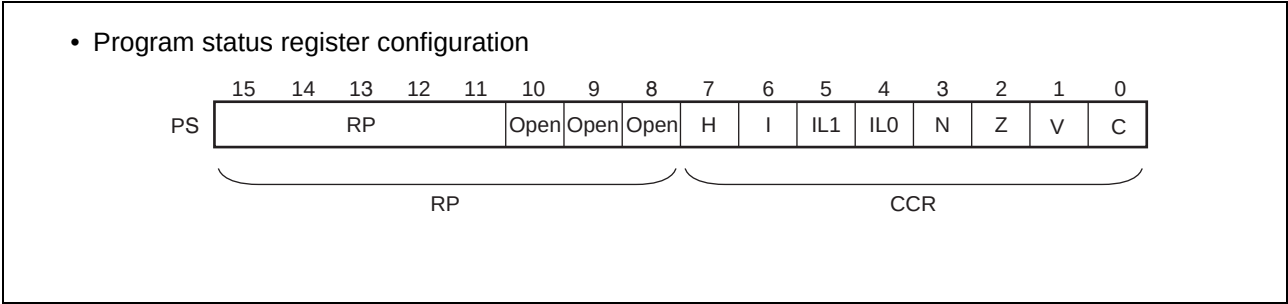
2. Registers

The F²MC-8L series has two types of registers, dedicated-use registers within the CPU, and general-purpose registers in memory.

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

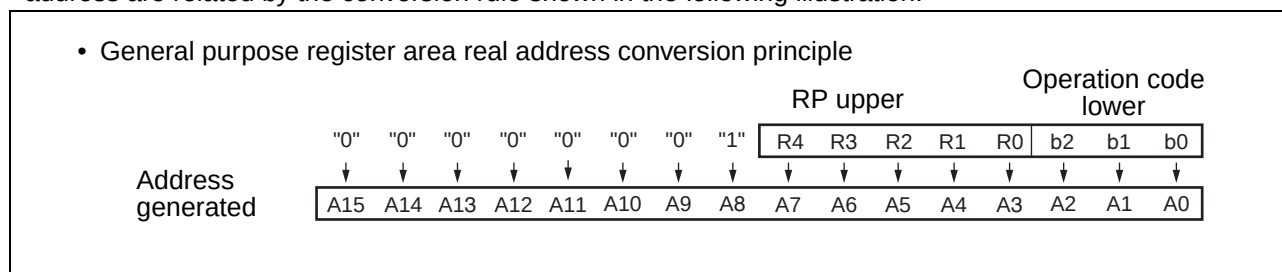
16 bits		
PC	: Program counter	Initial value FFFD _H
A	: Accumulator	Not fixed
T	: Temporary accumulator	Not fixed
IX	: Index register	Not fixed
EP	: Extra pointer	Not fixed
SP	: Stack pointer	Not fixed
PS	: Program status	I-flag = 0, IL1, 0 = 11 Other bits not fixed

In addition, the PS register can be divided so that the upper 8 bits are used as a register bank pointer (RP), and the lower 8 bits as a condition code register (CCR). (Refer to the following illustration.)



MB89530A Series

The RP register shows the address of the register bank currently being used, so that the RP value and the actual address are related by the conversion rule shown in the following illustration.



The CCR register has bits that show the content of results of calculations and transferred data, and bits that control CPU operation during interrupts.

- H-flag : Set to "1" if calculations result in carry or borrow operations from bit 3 to bit 4, otherwise set to "0".
This flag is used for decimal correction instructions.
- 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 currently permitted interrupts.
Only interrupt requests having a more powerful level than the value of these bits will be processed.

IL1	IL0	Interrupt level	Strength
0	0	1	Strong ↑ ↓ Weak
0	1		
1	0	2	
1	1	3	

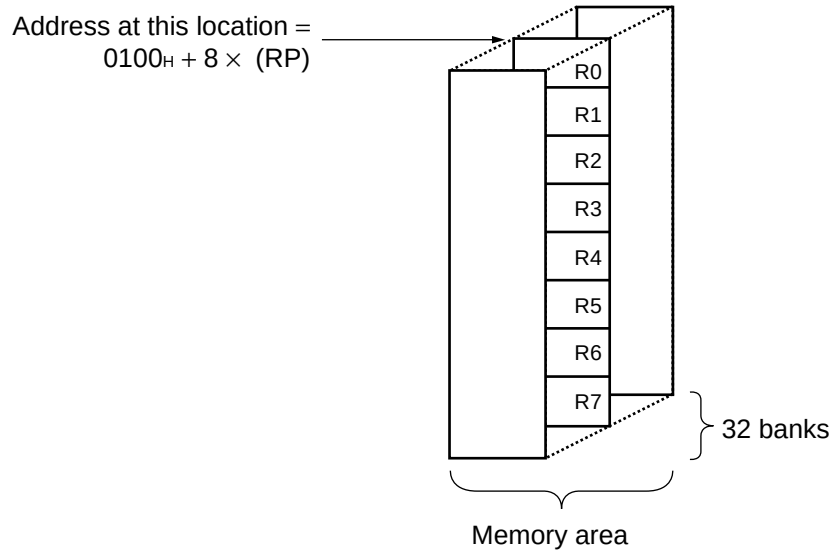
- N-flag : Set to "1" if the highest bit is "1" after a calculation, otherwise cleared to "0".
- Z-flag : Set to "1" if a calculation result is "0", otherwise cleared to "0".
- V-flag : Set to "1" if a two's complement overflow results during a calculation, otherwise cleared to "0".
- C-flag : Set to "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.

In addition, the following general purpose registers are available.

General purpose registers: 8 bits length, used to contain data.

The general purpose registers are 8-bit registers located in memory. There are eight such registers per bank, and the MB89530A series have up to 32 banks for use. The bank currently in use is indicated by the register bank pointer (RP).

- Register bank configuration



MB89530A Series

■ I/O MAP

Address	Register name	Register description	Write/Read	Initial value
00 _H	PDR0	Port 0 data register	R/W	XXXXXXXX _B
01 _H	DDR0	Port 0 direction register	W	00000000 _B
02 _H	PDR1	Port 1 data register	R/W	XXXXXXXX _B
03 _H	DDR1	Port 1 direction register	W	00000000 _B
04 _H to 06 _H	(Reserved area)			
07 _H	SYCC	System clock control register	R/W	X-1MM100 _B
08 _H	STBC	Standby control register	R/W	00010--- _B
09 _H	WDTC	Watchdog control register	R/W	0---XXXX _B
0A _H	TBTC	Time base timer control register	R/W	00---000 _B
0B _H	WPCR	Watch prescaler control register	R/W	00-0000 _B
0C _H	PDR2	Port 2 data register	R/W	XXXXXXXX _B
0D _H	DDR2	Port 2 direction register	R/W	00000000 _B
0E _H	PDR3	Port 3 data register	R/W	XXXXXXXX _B
0F _H	DDR3	Port 3 direction register	R/W	00000000 _B
10 _H	PDR4	Port 4 data register	R/W	XXXX11XX _B
11 _H	DDR4	Port 4 direction register	R/W	0000--00 _B
12 _H	PDR5	Port 5 data register	R/W	11111111 _B
13 _H	PDR6	Port 6 data register	R	XXXXXXXX _B
14 _H to 21 _H	(Reserved area)			
22 _H	SMC11	Serial mode control register 1 (UART)	R/W	00000000 _B
23 _H	SRC1	Serial rate control register (UART)	R/W	--011000 _B
24 _H	SSD1	Serial status and data register (UART)	R/W	00100-1X _B
25 _H	SIDR1/ SODR1	Serial input/output data register (UART)	R/W	XXXXXXXX _B
26 _H	SMC12	Serial mode control register 2 (UART)	R/W	--100001 _B
27 _H	CNTR1	PWM control register 1	R/W	00000000 _B
28 _H	CNTR2	PWM control register 2	R/W	000-0000 _B
29 _H	CNTR3	PWM control register 3	R/W	-000--- _B
2A _H	COMR1	PWM compare register 1	W	XXXXXXXX _B
2B _H	COMR2	PWM compare register 2	W	XXXXXXXX _B
2C _H	PCR1	PWC pulse width control register 1	R/W	000--000 _B
2D _H	PCR2	PWC pulse width control register 2	R/W	00000000 _B
2E _H	RLBR	PWC reload buffer register	R/W	XXXXXXXX _B
2F _H	SMC21	Serial mode control register 1 (UART/SIO)	R/W	00000000 _B
30 _H	SMC22	Serial mode control register 2 (UART/SIO)	R/W	00000000 _B
31 _H	SSD2	Serial status and data register (UART/SIO)	R/W	00001--- _B
32 _H	SIDR2/ SODR2	Serial data register (UART/SIO)	R/W	XXXXXXXX _B
33 _H	SRC2	Baud rate generator reload register	R/W	XXXXXXXX _B

(Continued)

MB89530A Series

Address	Register name	Register description	Write/Read	Initial value
34 _H	ADC1	A/D control register 1	R/W	000000-0 _B
35 _H	ADC2	A/D control register 2	R/W	-0000001 _B
36 _H	ADDL	A/D data register low	R/W	XXXXXXXX _B
37 _H	ADDH	A/D data register high	R/W	-----00 _B
38 _H	PPGC2	PPG2 control register (12-bit PPG)	R/W	00000000 _B
39 _H	PRL22	PPG2 reload register 2 (12-bit PPG)	R/W	0X000000 _B
3A _H	PRL21	PPG2 reload register 1 (12-bit PPG)	R/W	XX000000 _B
3B _H	PRL23	PPG2 reload register 3 (12-bit PPG)	R/W	XX000000 _B
3C _H	TMCR	16-bit timer control register	R/W	--000000 _B
3D _H	TCHR	16-bit timer counter register high	R/W	00000000 _B
3E _H	TCLR	16-bit timer counter register low	R/W	00000000 _B
3F _H	EIC1	External interrupt 1 control register 1	R/W	00000000 _B
40 _H	EIC2	External interrupt 1 control register 2	R/W	00000000 _B
41 _H to 48 _H	(Reserved area)			
49 _H	DDCR	DDC select register	R/W	-----0 _B
4A _H , 4B _H	(Reserved area)			
4C _H	PPGC1	PPG1 control register (12-bit PPG)	R/W	00000000 _B
4D _H	PRL12	PPG1 reload register 2 (12-bit PPG)	R/W	0X000000 _B
4E _H	PRL11	PPG1 reload register 1 (12-bit PPG)	R/W	XX000000 _B
4F _H	PRL13	PPG1 reload register 3 (12-bit PPG)	R/W	XX000000 _B
50 _H	IACR	I ² C address control register	R/W	-----000 _B
51 _H	IBSR	I ² C bus status register	R	00000000 _B
52 _H	IBCR	I ² C bus control register	R/W	00000000 _B
53 _H	ICCR	I ² C clock control register	R/W	000XXXXX _B
54 _H	IADR	I ² C address register	R/W	-XXXXXXXX _B
55 _H	IDAR	I ² C data register	R/W	XXXXXXXXXX _B
56 _H	EIE2	External interrupt 2 control register	R/W	00000000 _B
57 _H	EIF2	External interrupt 2 flag register	R/W	-----0 _B
58 _H	RCR1	6-bit PPG control register 1	R/W	00000000 _B
59 _H	RCR2	6-bit PPG control register 2	R/W	0X000000 _B
5A _H	CKR	Clock output control register	R/W	-----00 _B
5B _H to 6F _H	(Reserved area)			
70 _H	SMR	Serial mode register (SIO)	R/W	00000000 _B
71 _H	SDR	Serial data register (SIO)	R/W	XXXXXXXXXX _B
72 _H	PURR0	Port 0 pull-up resistance register	R/W	11111111 _B
73 _H	PURR1	Port 1 pull-up resistance register	R/W	11111111 _B
74 _H	PURR2	Port 2 pull-up resistance register	R/W	11111111 _B
75 _H	PURR3	Port 3 pull-up resistance register	R/W	11111111 _B
76 _H	PURR4	Port 4 pull-up resistance register	R/W	1111--11 _B
77 _H	WREN	Wild register enable register	R/W	--000000 _B

(Continued)

MB89530A Series

(Continued)

Address	Register name	Register description	Write/Read	Initial value
78 _H	WROR	Wild register data test register	R/W	--000000 _B
79 _H	PURR6	Port 6 pull-up resistance register	R/W	---11111 _B
7A _H	FMCS	Flash memory control status register	R/W	000X00-0 _B
7B _H	ILR1	Interrupt level setting register 1	W	11111111 _B
7C _H	ILR2	Interrupt level setting register 2	W	11111111 _B
7D _H	ILR3	Interrupt level setting register 3	W	11111111 _B
7E _H	ILR4	Interrupt level setting register 4	W	11111111 _B
7F _H	ITR	Interrupt test register	Access prohibited	XXXXXX00 _B
C80 _H	WRARH1	Upper address setting register 1	R/W	XXXXXXXX _B
C81 _H	WRARL1	Lower address setting register 1	R/W	XXXXXXXX _B
C82 _H	WRDR1	Data setting register 1	R/W	XXXXXXXX _B
C83 _H	WRARH2	Upper address setting register 2	R/W	XXXXXXXX _B
C84 _H	WRARL2	Lower address setting register 2	R/W	XXXXXXXX _B
C85 _H	WRDR2	Data setting register 2	R/W	XXXXXXXX _B
C86 _H	WRARH3	Upper address setting register 3	R/W	XXXXXXXX _B
C87 _H	WRARL3	Lower address setting register 3	R/W	XXXXXXXX _B
C88 _H	WRDR3	Data setting register 3	R/W	XXXXXXXX _B
C89 _H	WRARH4	Upper address setting register 4	R/W	XXXXXXXX _B
C8A _H	WRARL4	Lower address setting register 4	R/W	XXXXXXXX _B
C8B _H	WRDR4	Data setting register 4	R/W	XXXXXXXX _B
C8C _H	WRARH5	Upper address setting register 5	R/W	XXXXXXXX _B
C8D _H	WRARL5	Lower address setting register 5	R/W	XXXXXXXX _B
C8E _H	WRDR5	Data setting register 5	R/W	XXXXXXXX _B
C8F _H	WRARH6	Upper address setting register 6	R/W	XXXXXXXX _B
C90 _H	WRARL6	Lower address setting register 6	R/W	XXXXXXXX _B
C91 _H	WRDR6	Data setting register 6	R/W	XXXXXXXX _B

• 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 not determined.

M : The initial value of this bit is a mask option.

- : This bit is not used.

Note : Do not use reserved spaces.

MB89530A Series

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Supply voltage*1	V _{CC} , AV _{CC}	V _{SS} – 0.3	V _{SS} + 6.0	V	MB89535A/537A/538A*2 MB89537AC/538AC MB89F538/F538L//P538 MB89PV530
	AVR	V _{SS} – 0.3	V _{SS} + 6.0	V	
Input voltage*1	V _I	V _{SS} – 0.3	V _{CC} + 0.3	V	Other than P42, P43
		V _{SS} – 0.3	V _{SS} + 6.0	V	P42, P43
Output voltage*1	V _O	V _{SS} – 0.3	V _{CC} + 0.3	V	Other than P42, P43
		V _{SS} – 0.3	V _{SS} + 6.0	V	P42, P43
Maximum clamp current	I _{CLAMP}	– 2.0	+ 2.0	mA	*3
Total maximum clamp current	Σ I _{CLAMP}	—	20	mA	*3
“L” level maximum output current	I _{OL}	—	15	mA	
“L” level average output current	I _{OLAV}	—	4	mA	Average value (operating current × operating duty)
“L” level maximum total output current	ΣI _{OL}	—	100	mA	
“L” level average total output current	ΣI _{OLAV}	—	40	mA	Average value (operating current × operating duty)
“H” level maximum output current	I _{OH}	—	–15	mA	
“H” level average output current	I _{OHAV}	—	–4	mA	Average value (operating current × operating duty)
“H” level maximum total output current	ΣI _{OH}	—	–50	mA	
“H” level average total output current	ΣI _{OHAV}	—	–20	mA	Average value (operating current × operating duty)
Current consumption	P _D	—	300	mW	
Operating temperature	T _A	–40	+85	°C	
Storage temperature	T _{stg}	–55	+150	°C	

*1 : The parameter is based on AV_{SS} = V_{SS} = 0 V.

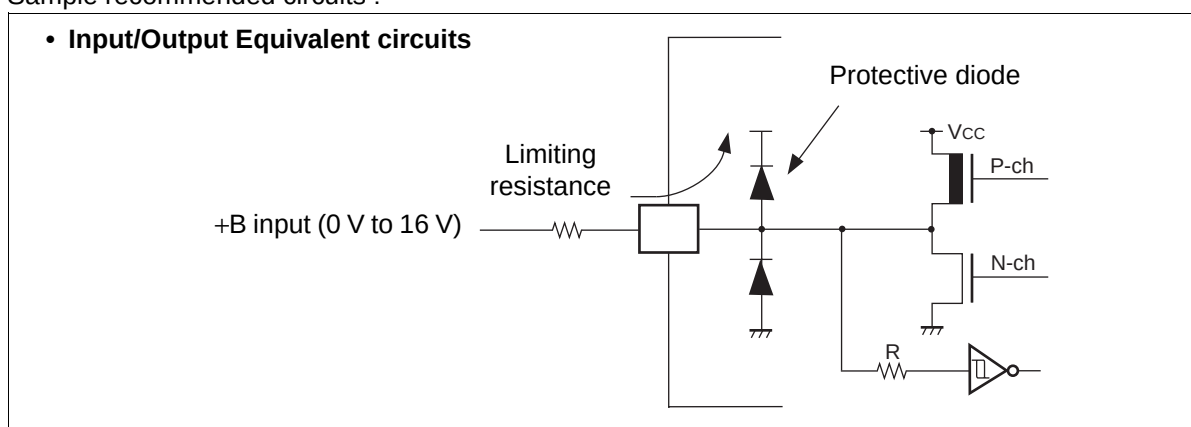
*2 : AV_{CC} and V_{CC} are to be used at the same potential. AVR should not exceed AV_{CC} + 0.3 V.

(Continued)

MB89530A Series

(Continued)

- *3 :
- Applicable to pins : P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40, P41, P44 to P47, P60 to P64
 - 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 result.
 - 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.
 - Sample recommended 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.

MB89530A Series

2. Recommended Operating Conditions

(AVss = Vss = 0 V)

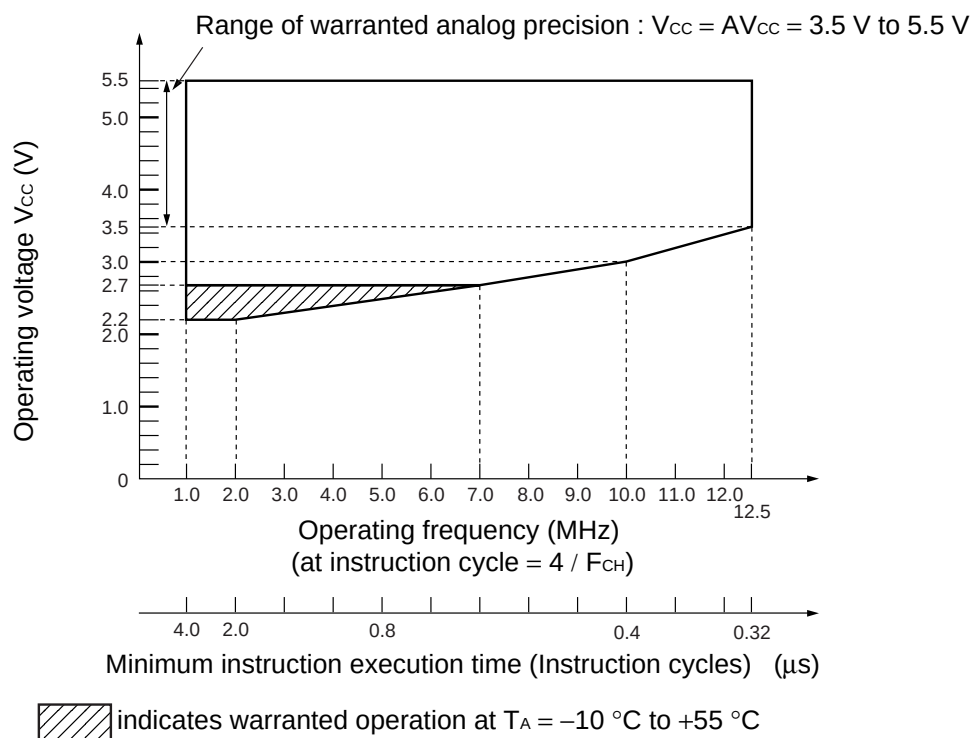
Parameter	Symbol	Value		Unit	Remarks	
		Min	Max			
Supply voltage	V _{CC} , AV _{CC}	2.2*	5.5	V	Range warranted for normal operation	MB89535A MB89537A/538A
		1.5	5.5	V	RAM status in stop mode	MB89537AC/ 538AC
		2.7*	5.5	V	Range warranted for normal operation	MB89P538 MB89PV530
		1.5	5.5	V	RAM status in stop mode	
		3.5	5.5	V	Range warranted for normal operation	MB89F538
		3.0	5.5	V	RAM status in stop mode	
		2.4	3.6	V	Range warranted for normal operation	MB89F538L
		1.5	3.6	V	RAM status in stop mode	
	AVR	3.5	AV _{CC}	V		
Operating temperature	T _A	-40	+85	°C		

* : Varies according to frequency used, and instruction cycle.

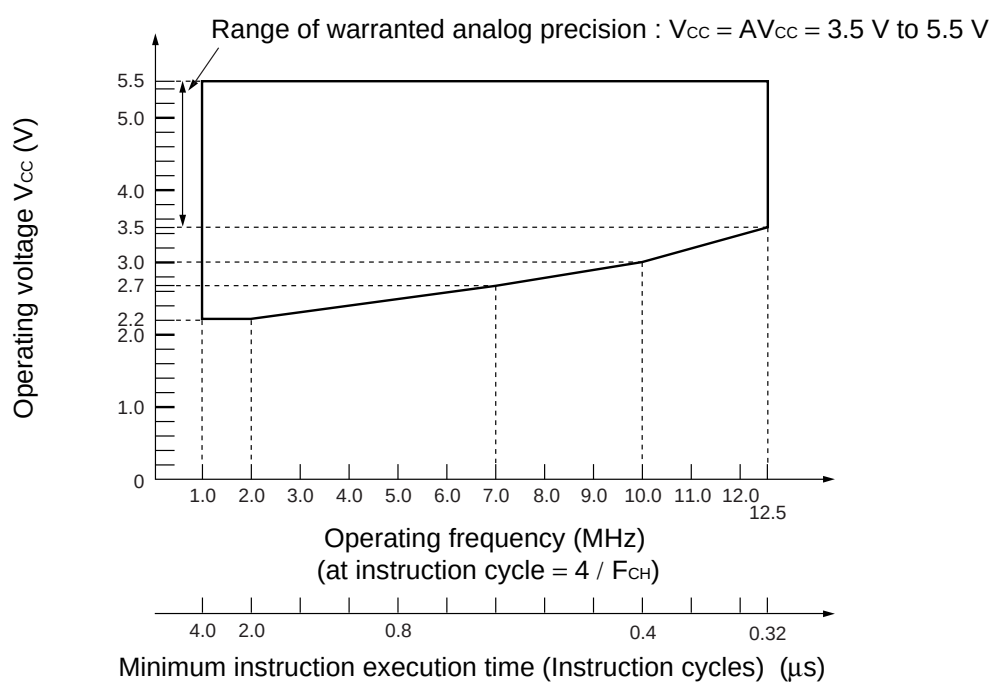
Refer to "Operating voltage vs. operating frequency (MB89P538/MB89PV530)", "Operating voltage vs. operating frequency (MB89535A/537A/538A/537AC/538AC)", "Operating voltage vs. operating frequency (MB89F538)" and "5. A/D Converter Electrical Characteristics".

MB89530A Series

• Operating voltage vs. operating frequency (MB89P538/MB89PV530)

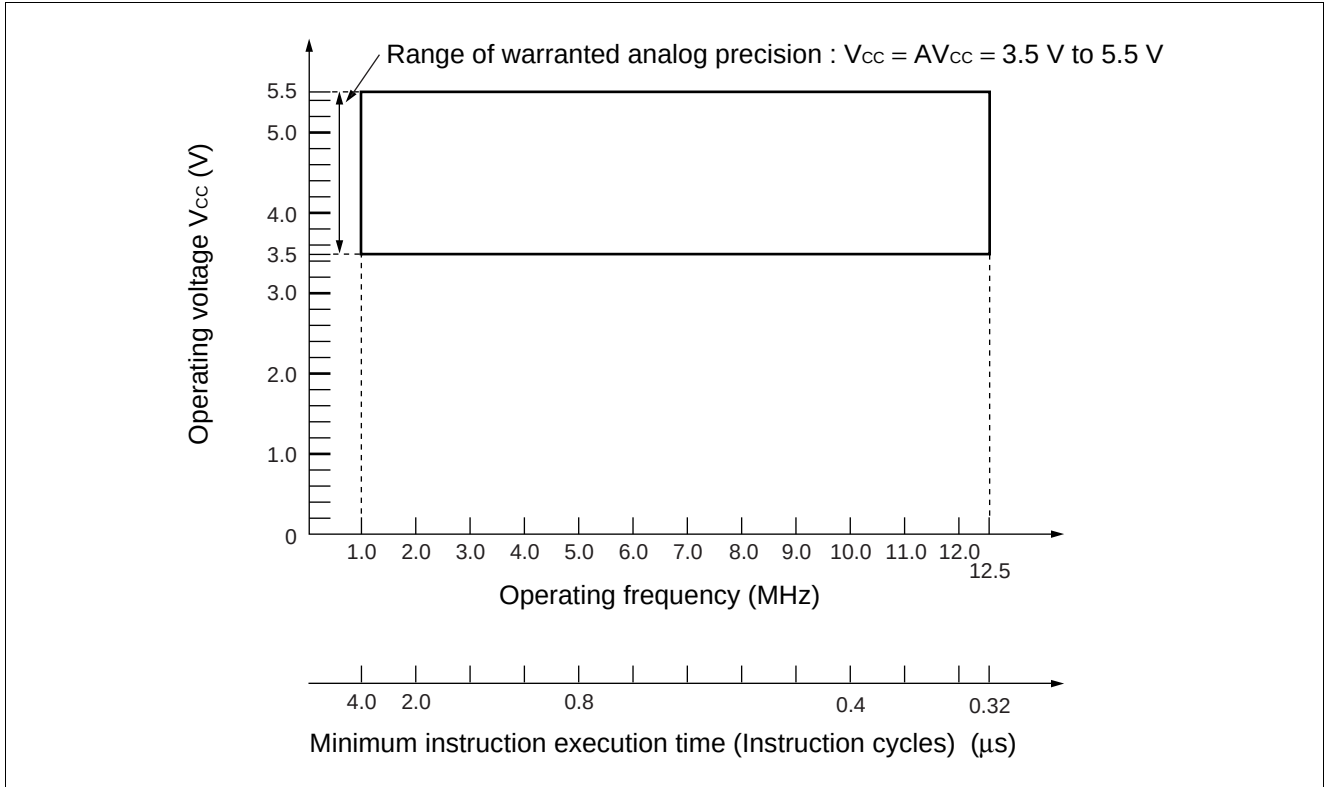


• Operating voltage vs. operating frequency (MB89535A/537A/538A/537AC/538AC)

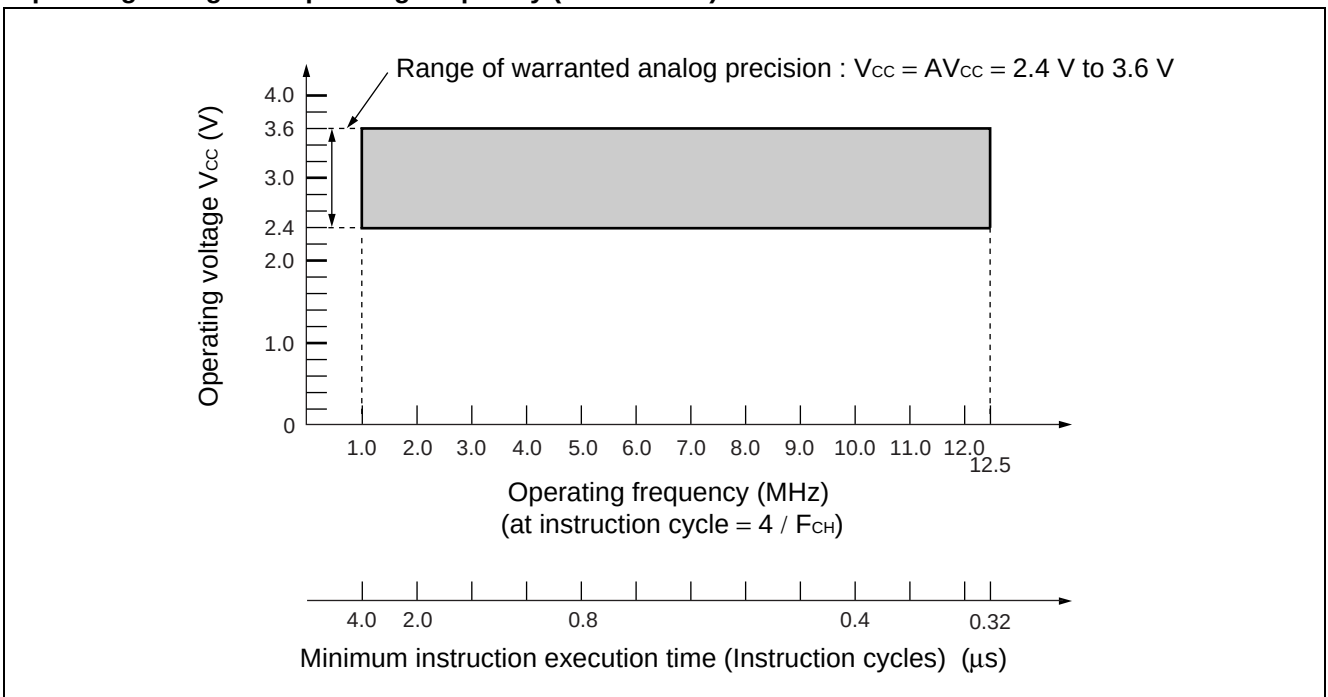


MB89530A Series

- Operating voltage vs. operating frequency (MB89F538)



- Operating voltage vs. operating frequency (MB89F538L)



MB89530A Series

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 representatives beforehand.

MB89530A Series

3. DC Characteristics

(1) Supply Voltage at 5.0 (V) (except MB89F538L)

($AV_{CC} = V_{CC} = 5.0\text{ V}$, $AV_{SS} = V_{SS} = 0\text{ V}$, $T_A = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$)

Parameter	Symbol	Pin name	Condi- tion	Value			Unit	Remarks
				Min	Typ	Max		
“H” level input voltage	V_{IH}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P60 to P64, SI1, SI2	—	$0.7 V_{CC}$	—	$V_{CC} + 0.3$	V	
	V_{IHS}	$\overline{RST}$, MOD0, MOD1, INT20 to INT27, UCK1, UI1, INT10 to INT13, SCK1, EC, PWCK, PWC, SCK2, UCK2, UI2, ADST	—	$0.8 V_{CC}$	—	$V_{CC} + 0.3$	V	
	V_{IHSMB}	SCL, SDA	—	$V_{SS} + 1.4$	—	$V_{SS} + 5.5$	V	With SMB input buffer selected*1
	V_{IHI2C}		—	$0.7 V_{CC}$	—	$V_{SS} + 5.5$	V	With I ² C input buffer selected*1
“L” level input voltage	V_{IL}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P60 to P64, SI1, SI2	—	$V_{SS} - 0.3$	—	$0.3 V_{CC}$	V	
	V_{ILS}	$\overline{RST}$, MOD0, MOD1, INT20 to INT27, UCK1, UI1, INT10 to INT13, SCK1, EC, PWCK, PWC, SCK2, UCK2, UI2, ADST	—	$V_{SS} - 0.3$	—	$0.2 V_{CC}$	V	
	V_{ILSMB}	SCL, SDA	—	$V_{SS} - 0.3$	—	$V_{SS} + 0.6$	V	With SMB input buffer selected*1
	V_{ILI2C}		—	$V_{SS} - 0.3$	—	$0.3 V_{CC}$	V	With I ² C input buffer selected*1
Open drain output applied voltage	V_{D1}	P50 to P57	—	$V_{SS} - 0.3$	—	$V_{CC} + 0.3$	V	
	V_{D2}	P42, P43				$V_{SS} + 5.5$	V	
“H” level output voltage	V_{OH}	P00 to P07, P10 to P17, P20 to P24, P30 to P37, P40, P41, P44 to P47	$I_{OH} = -2.0\text{ mA}$	4.0	—	—	V	
		P25 to P27	$I_{OH} = -3.0\text{ mA}$					
“L” level output voltage	V_{OL}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, $\overline{RST}$	$I_{OL} = 4.0\text{ mA}$	—	—	0.4	V	

(Continued)

MB89530A Series

($AV_{CC} = V_{CC} = 5.0\text{ V}$, $AV_{SS} = V_{SS} = 0\text{ V}$, $T_A = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Input leak current (Hi-Z output leak current)	I _{LI}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, P60 to P64	0.0 V < V _I < V _{CC}	−5	—	+5	μA	With no pull-up resistance specified
Open drain output leak current	I _{LIOD}	P42, P43	0.0 V < V _I < V _{SS} + 5.5 V	—	—	5	μA	
Pull-up resistance	R _{UP}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40, P41, P44 to P46, P47*2, P60 to P64, $\overline{\text{RST}}$	—	25	40	100	kΩ	With pull-up resistance specified. The $\overline{\text{RST}}$ signal is excluded.
Pull-down resistance	R _{DOWN}	MOD0, MOD1	—	25	40	100	kΩ	Only for mask ROM product.
Supply current	I _{CC1}	V _{CC}	F _{CH} = 10.0 MHz V _{CC} = 5.0 V t _{inst} = 0.4 μs	—	15	20	mA	MB89P538/ PV530
				—	6	10	mA	MB89F538
				—	8	13	mA	MB89535A/7A/8A MB89537AC/ 538AC
	I _{CC2}		F _{CH} = 10.0 MHz V _{CC} = 5.0 V t _{inst} = 6.4 μs	—	5	8.5	mA	MB89P538/ PV530
				—	1.5	3	mA	MB89F538
				—	1.5	3	mA	MB89535A/7A/8A MB89537AC/ 538AC
	I _{CCS1}		F _{CH} = 10.0 MHz V _{CC} = 5.0 V t _{inst} = 0.4 μs	—	5	7	mA	Sleep mode MB89P538/ PV530
				—	3	5	mA	Sleep mode MB89F538
				—	2.5	5	mA	Sleep mode MB89535A/7A/8A MB89537AC/ 538AC
	I _{CCS2}		F _{CH} = 10.0 MHz V _{CC} = 5.0 V t _{inst} = 6.4 μs	—	1.5	3	mA	Sleep mode MB89P538/ PV530
				—	1	2	mA	Sleep mode MB89F538
				—	1	2	mA	Sleep mode MB89535A/7A/8A MB89537AC/ 538AC

(Continued)

MB89530A Series

(Continued)

($AV_{CC} = V_{CC} = 5.0\text{ V}$, $AV_{SS} = V_{SS} = 0\text{ V}$, $T_A = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Supply current	I _{CCL}	V _{CC}	F _{CL} = 32.768 kHz V _{CC} = 5.0 V T _A = +25 °C	—	3	7	mA	Sub mode MB89P538/ PV530
				—	400	800	μA	Sub mode MB89F538
				—	50	85	μA	Sub mode MB89535A/7A/8A MB89537AC/ 538AC
	I _{CCLS}		F _{CL} = 32.768 kHz V _{CC} = 5.0 V T _A = +25 °C	—	30	50	μA	Sub, sleep mode MB89P538/ PV530
				—	15	30	μA	Sub, sleep mode MB89F538
				—	15	30	μA	Sub, sleep mode MB89535A/7A/8A MB89537AC/ 538AC
	I _{CCT}		F _{CL} = 32.768 kHz V _{CC} = 5.0 V T _A = +25 °C	—	5	15	μA	Watch mode, main stop
	I _{CCH}		T _A = +25 °C	—	3	10	μA	Sub, stop modes
	I _A		A _V _{CC}	F _{CH} = 10.0 MHz	—	4	6	mA
	I _{AH}	T _A = +25 °C		—	1	5	μA	A/D stopped
Input capacitance	C _{IN}	Except V _{CC} , V _{SS} , A _V _{CC} , A _V _{SS}	f = 1 MHz	—	5	15	pF	

*1 : The MB89PV530/P538/F538/537AC/538AC have a built-in I²C function, and a choice of input buffers by software setting.

MB89535A/537A/538A have no built-in I²C functions, and therefore this standard does not apply.

*2 : For P47 of MB89F538, pull-up resistor is not mounted as this pin is used as MOD2 pin.

MB89530A Series

(2) Supply Voltage at 3.0 (V) (except MB89F538)

($AV_{CC} = V_{CC} = 3.0\text{ V}$, $AV_{SS} = V_{SS} = 0\text{ V}$, $T_A = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
“H” level input voltage	V_{IH}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P60 to P64, SI1, SI2	—	$0.7 V_{CC}$	—	$V_{CC} + 0.3$	V	
	V_{IHS}	$\overline{RST}$, MOD0, MOD1, INT20 to INT27, UCK1, UI1, INT10 to INT13, SCK1, EC, PWCK, PWC, SCK2, UCK2, UI2, ADST	—	$0.8 V_{CC}$	—	$V_{CC} + 0.3$	V	
	V_{IHSMB}	SCL, SDA	—	$V_{SS} + 1.4$	—	$V_{SS} + 5.5$	V	With SMB input buffer selected*
	V_{IHI2C}		—	$0.7 V_{CC}$	—	$V_{SS} + 5.5$	V	With I ² C input buffer selected*
“L” level input voltage	V_{IL}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P60 to P64, SI1, SI2	—	$V_{SS} - 0.3$	—	$0.3 V_{CC}$	V	
	V_{ILS}	$\overline{RST}$, MOD0, MOD1, INT20 to INT27, UCK1, UI1, INT10 to INT13, SCK1, EC, PWCK, PWC, SCK2, UCK2, UI2, ADST	—	$V_{SS} - 0.3$	—	$0.2 V_{CC}$	V	
	V_{ILSMB}	SCL, SDA	—	$V_{SS} - 0.3$	—	$V_{SS} + 0.6$	V	With SMB input buffer selected*
	V_{ILI2C}		—	$V_{SS} - 0.3$	—	$0.3 V_{CC}$	V	With I ² C input buffer selected*
Open drain output applied voltage	V_{D1}	P50 to P57	—	$V_{SS} - 0.3$	—	$V_{CC} + 0.3$	V	
	V_{D2}	P42, P43				$V_{SS} + 5.5$	V	
“H” level output voltage	V_{OH}	P00 to P07, P10 to P17, P20 to P24, P30 to P37, P40, P41, P44 to P47	$I_{OH} = -2.0\text{ mA}$	2.4	—	—	V	
		P25 to P27	$I_{OH} = -3.0\text{ mA}$					
“L” level output voltage	V_{OL}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, $\overline{RST}$	$I_{OL} = 4.0\text{ mA}$	—	—	0.4	V	

(Continued)

MB89530A Series

(Continued)

($AV_{CC} = V_{CC} = 3.0\text{ V}$, $AV_{SS} = V_{SS} = 0\text{ V}$, $T_A = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Input leak current (Hi-Z output leak current)	I _{LI}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, P60 to P64	0.0 V < V _I < V _{CC}	−5	—	+5	μA	With no pull-up resistance specified
Open drain output leak current	I _{LIOD}	P42, P43	0.0 V < V _I < V _{SS} + 5.5 V	—	—	5	μA	
Pull-up resistance	R _{UP}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40, P41, P44 to P47, P60 to P64, $\overline{\text{RST}}$	—	25	70	100	kΩ	With pull-up resistance specified. The $\overline{\text{RST}}$ signal is excluded.
Pull-down resistance	R _{DOWN}	MOD0, MOD1	—	25	70	100	kΩ	
Supply current	I _{CC1}	V _{CC}	F _{CH} = 10.0 MHz t _{inst} = 0.4 μs	—	6	10	mA	
				—	—	45	mA	Flash memory programming/erase MB89F538L
	I _{CC2}		F _{CH} = 10.0 MHz t _{inst} = 6.4 μs	—	1.5	3	mA	
	I _{CCS1}		F _{CH} = 10.0 MHz t _{inst} = 0.4 μs	—	2	4	mA	Sleep mode
	I _{CCS2}		F _{CH} = 10.0 MHz t _{inst} = 6.4 μs	—	1	2	mA	Sleep mode
	I _{CCL}		F _{CL} = 32.768 kHz V _{CC} = 3.0 V T _A = +25 °C	—	1	3	mA	Sub modes MB89P538/PV530
				—	35	90	μA	Sub modes MB89F538L
				—	20	50	μA	Sub modes MB89535A/7A/8A MB89537AC/538AC
	I _{CCLS}		F _{CL} = 32.768 kHz V _{CC} = 3.0 V T _A = +25 °C	—	15	30	μA	Sub, sleep modes
	I _{CCT}		F _{CL} = 32.768 kHz V _{CC} = 3.0 V T _A = +25 °C	—	5	15	μA	Watch mode, main stop
	I _{CCH}		T _A = +25 °C	—	1	5	μA	Sub, stop modes
	I _A		AV _{CC}	F _{CH} = 10.0 MHz	—	1	3	mA
	I _{AH}	T _A = +25 °C		—	1	5	μA	A/D stopped
Input capacitance	C _{IN}	Except V _{CC} , V _{SS} , AV _{CC} , AV _{SS}	f = 1 MHz	—	5	15	pF	

* : The MB89PV530/P538/F538L/537AC/538AC have a built-in I²C function, and a choice of input buffers by software setting.

MB89535A/537A/538A have no built-in I²C functions, and therefore this standard does not apply.

MB89530A Series

4. AC Characteristics

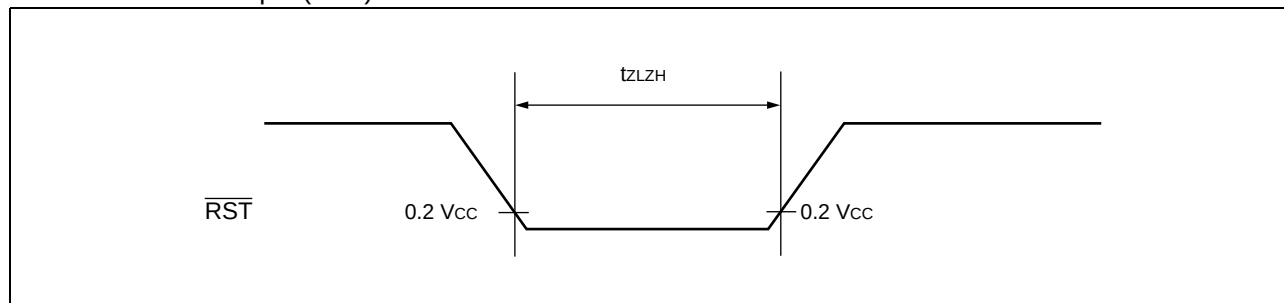
(1) Reset Timing

($V_{CC} = 5.0\text{ V}$, $AV_{SS} = V_{SS} = 0\text{ V}$, $T_A = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$)

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

Notes: • t_{HCYL} is the main clock oscillator period.

- If the reset pulse applied to the external reset pin ($\overline{\text{RST}}$) does not meet the specifications, it may cause malfunctions. Use caution so that the reset pulse less than the specifications will not be fed to the external reset pin ($\overline{\text{RST}}$).

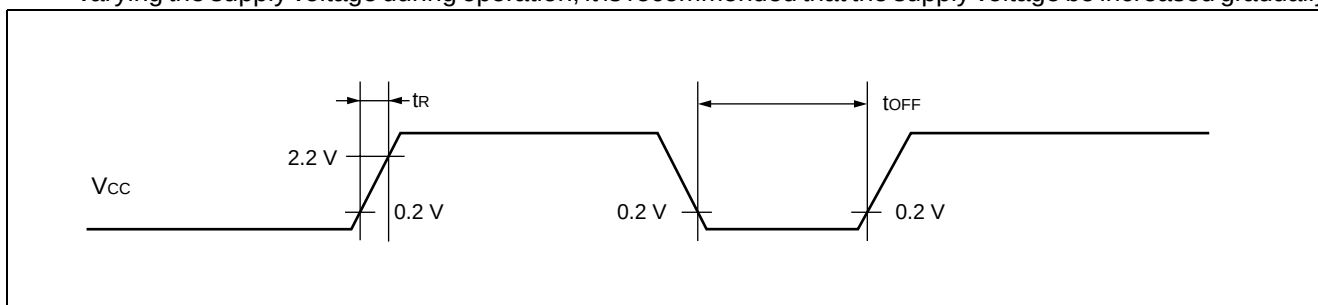


(2) Power-on Reset

($AV_{SS} = V_{SS} = 0\text{ V}$, $T_A = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$)

Parameter	Symbol	Condition	Value		Unit	Remarks
			Min	Max		
Power on time	t_R	—	0.5	50	ms	
Power shutoff time	t_{OFF}	—	1	—	ms	Waiting time until power-on

Note : Be sure that the power supply will come on within the selected oscillator stabilization period. Also, when varying the supply voltage during operation, it is recommended that the supply voltage be increased gradually.



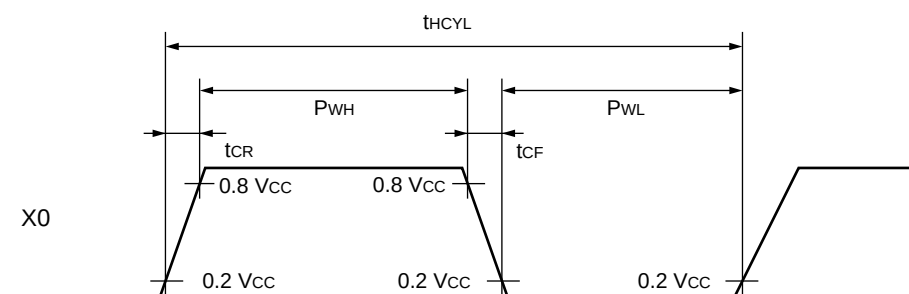
MB89530A Series

(3) Clock Timing Standards

(AVSS = VSS = 0 V, T_A = -40 °C to +85 °C)

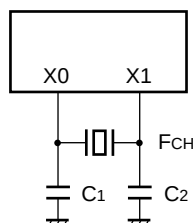
Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Clock frequency	F _{CH}	X0, X1	—	1	—	12.5	MHz	Main clock
	F _{CL}	X0A, X1A		—	32.768	—	kHz	Sub clock
Clock cycle time	t _{HCYL}	X0, X1		80	—	1000	ns	Main clock
	t _{LCYL}	X0A, X1A		—	30.5	—	μs	Sub clock
Input clock pulse width	P _{WH} P _{WL}	X0		20	—	—	ns	External clock
	P _{WHL} P _{WLL}	X0A		—	15.2	—	μs	External clock
Input clock rise, fall time	t _{CR} t _{CF}	X0		—	—	10	ns	External clock

- X0, X1 timing and application conditions

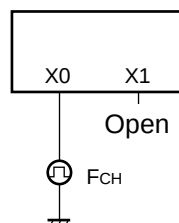


- Clock application conditions

Using a crystal oscillator
or
ceramic oscillator

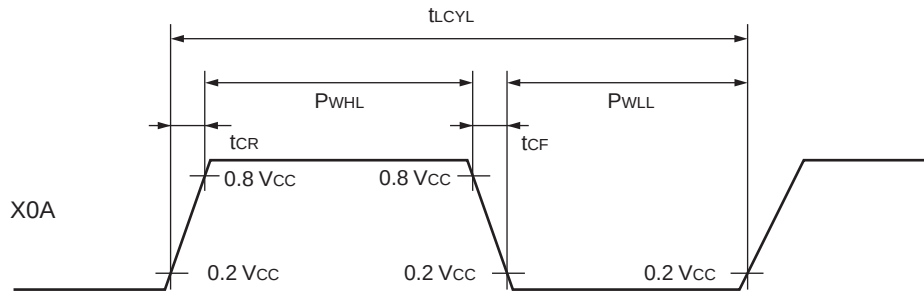


Using an external clock
signal



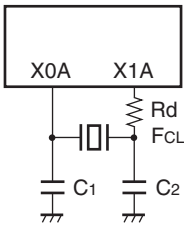
MB89530A Series

- X0A, X1A timing and application conditions

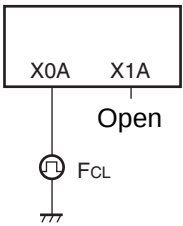


- Clock application conditions

Using a crystal oscillator
or
ceramic oscillator



Using an external clock
signal



(4) Instruction Cycle

(AV_{SS} = V_{SS} = 0 V, T_A = -40 °C to +85 °C)

Parameter	Symbol	Rated value	Unit	Remarks
Instruction cycle (minimum instruction execution time)	t _{inst}	4/F _{CH} , 8/F _{CH} , 16/F _{CH} , 64/F _{CH}	μs	Operating at F _{CH} = 12.5 MHz (4/F _{CH}) t _{inst} = 0.32 μs
		2/F _{CL}	μs	Operating at F _{CL} = 32.768 kHz t _{inst} = 61.036 μs

MB89530A Series

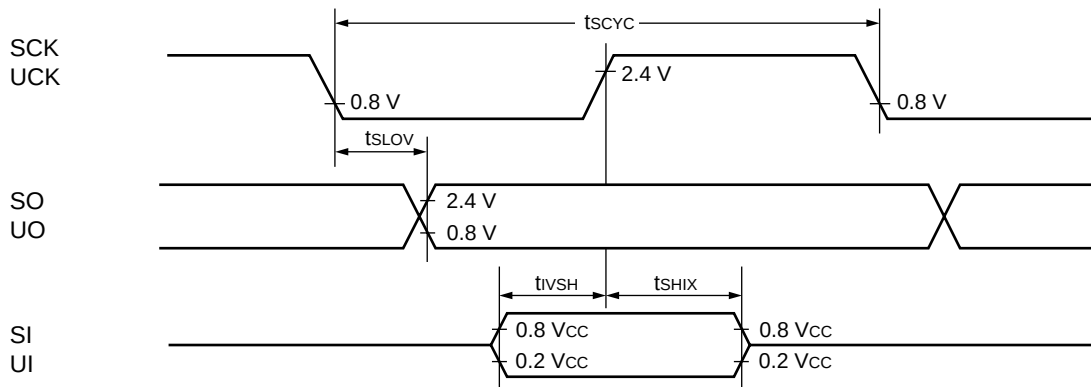
(5) Serial I/O Timing

($V_{CC} = 5.0\text{ V}$, $AV_{SS} = V_{SS} = 0\text{ V}$, $T_A = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$)

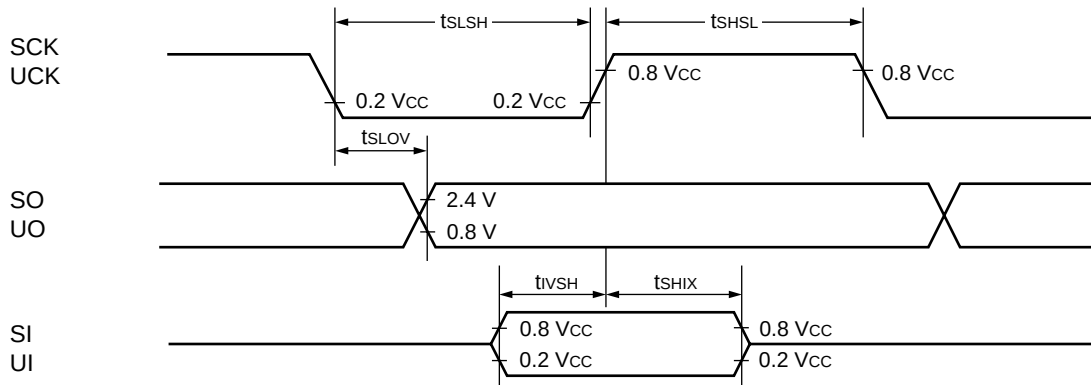
Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCK, UCK	Internal clock operation	$2\ t_{inst}$	—	μs
SCK↓→SO	t_{SLOV}	SCK, SO, UCK, UO		-200	+200	ns
Valid SI→SCK↑	t_{IVSH}	SI, SCK, UI, UCK		200	—	ns
SCK↑→valid SI hold time	t_{SHIX}	SCK, SI, UCK, UI		200	—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

Note : For t_{inst} refer to "(4) Instruction Cycle".

Internal shift clock mode



External shift clock mode



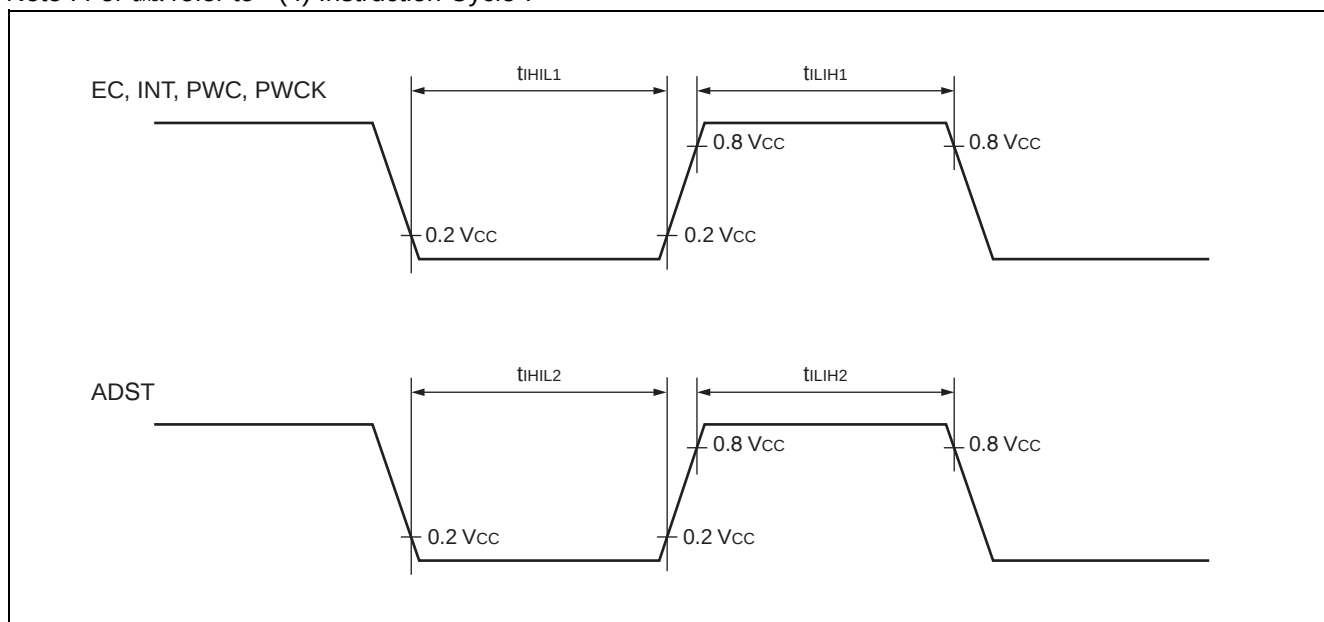
MB89530A Series

(6) Peripheral Input Timing

($V_{CC} = 5.0\text{ V}$, $AV_{SS} = V_{SS} = 0\text{ V}$, $T_A = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
Peripheral input "H" level pulse width 1	t_{LIH1}	INT10 to INT13, INT20 to INT27, EC, PWC, PWCK	—	$2\ t_{inst}$	—	μs
Peripheral input "L" level pulse width 1	t_{LIL1}		—	$2\ t_{inst}$	—	μs
Peripheral input "H" level pulse width 2	t_{LIH2}	ADST	—	$2^8\ t_{inst}$	—	μs
Peripheral input "L" level pulse width 2	t_{LIL2}		—	$2^8\ t_{inst}$	—	μs

Note : For t_{inst} refer to "(4) Instruction Cycle".



MB89530A Series

(7) I²C Timing

(V_{CC} = 5.0 V, AV_{SS} = V_{SS} = 0 V, T_A = -40 °C to +85 °C)

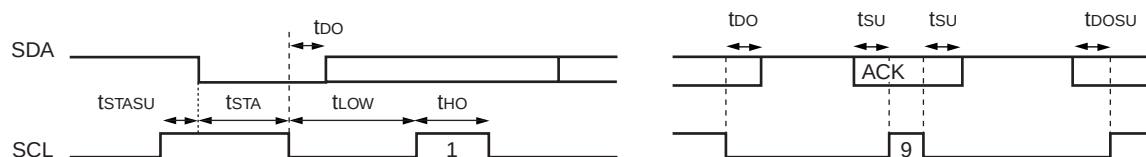
Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Start condition output	t _{STA}	SCL SDA	—	$\frac{1}{4} t_{inst} \times m \times n - 20$	$\frac{1}{4} t_{inst} \times m \times n + 20$	ns	Master only
Stop condition output	t _{STO}	SCL SDA	—	$\frac{1}{4} t_{inst} \times (m \times n + 8) - 20$	$\frac{1}{4} t_{inst} \times (m \times n + 8) + 20$	ns	Master only
Start condition detection	t _{STA}	SCL SDA	—	$\frac{1}{4} t_{inst} \times 6 + 40$	—	ns	
Stop condition detection	t _{STO}	SCL SDA	—	$\frac{1}{4} t_{inst} \times 6 + 40$	—	ns	
Restart condition output	t _{STASU}	SCL SDA	—	$\frac{1}{4} t_{inst} \times (m \times n + 8) - 20$	$\frac{1}{4} t_{inst} \times (m \times n + 8) + 20$	ns	Master only
Restart condition detection	t _{STASU}	SCL SDA	—	$\frac{1}{4} t_{inst} \times 4 + 40$	—	ns	
SCL output “L” width	t _{LOW}	SCL	—	$\frac{1}{4} t_{inst} \times m \times n - 20$	$\frac{1}{4} t_{inst} \times m \times n + 20$	ns	Master only
SCL output “H” width	t _{HIGH}	SCL	—	$\frac{1}{4} t_{inst} \times (m \times n + 8) - 20$	$\frac{1}{4} t_{inst} \times (m \times n + 8) + 20$	ns	Master only
SDA output delay time	t _{DO}	SDA	—	$\frac{1}{4} t_{inst} \times 4 - 20$	$\frac{1}{4} t_{inst} \times 4 + 20$	ns	
Setup after SDA output interrupt interval	t _{DOSU}	SDA	—	$\frac{1}{4} t_{inst} \times 4 - 20$	—	ns	
SCL input “L” width	t _{LOW}	SCL	—	$\frac{1}{4} t_{inst} \times 6 + 40$	—	ns	
SCL input “H” width	t _{HIGH}	SCL	—	$\frac{1}{4} t_{inst} \times 2 + 40$	—	ns	
SDA input setup	t _{SU}	SDA	—	40	—	ns	
SDA input hold	t _{HO}	SDA	—	0	—	ns	

Notes : • For t_{inst} refer to “(4) Instruction Cycle”.

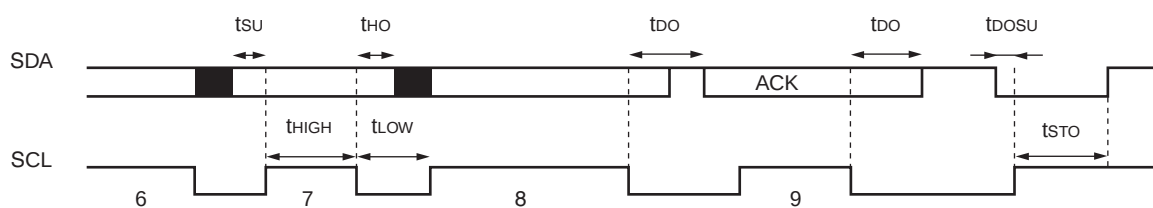
- The value “m” in the above table is the value from the shift clock frequency setting bits (CS4, CS3) in the I²C clock control register “ICCR”. For details, refer to the register description in the hardware manual.
- The value ‘n’ in the above table is the value from the shift clock frequency setting bits (CS2, CS0) in the I²C clock control register “ICCR”. For details, refer to the register description in the hardware manual.
- t_{DOSU} appears when the interrupt period is longer than the SCL “L” width.
- The rated values for SDA and SCL assume a start up time of 0 ns.

MB89530A Series

- I²C interface [Data sending (master/slave)]



- I²C interface [Data receiving (master/slave)]



MB89530A Series

5. A/D Converter Electrical Characteristics

(1) MB89535A/537A/537AC/538A/538AC/P538/PV530

($V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $AV_{SS} = V_{SS} = 0 \text{ V}$, $T_A = -40 \text{ }^{\circ}\text{C to } +85 \text{ }^{\circ}\text{C}$)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks	
				Min	Typ	Max			
Resolution capability	—	—	—	—	—	10	bit	AV _{CC} = V _{CC}	
Total error			AVR = AV _{CC}	—	—	±3.0	LSB		
Linear error				—	—	±2.5	LSB		
Differential linear error				—	—	±1.9	LSB		
Zero transition voltage	V _{OT}		—	AVR = AV _{CC}	AV _{SS} – 1.5 LSB	AV _{SS} + 0.5 LSB	AV _{SS} + 2.5 LSB		V
Full scale transition voltage	V _{FST}				AVR – 3.5 LSB	AVR – 1.5 LSB	AVR + 1.5 LSB		V
Inter-channel variation	—				—	—	4.0		LSB
Conversion time		—	—	60 t _{inst}	—	μs	*		
Sampling time				16 t _{inst}	—	μs			
Analog input current	I _{AIN}			AN0 to AN7	—	—	10	μA	
Analog input voltage	V _{AIN}	0	—		AVR	V			
Reference voltage	—	AV _{SS} + 3.5	—		AV _{CC}	V			
Reference voltage supply current	I _R	AVR	A/D running	—	400	—	μA		
	I _{RH}		A/D off	—	—	5	μA		

* : Includes sampling time.

Note : For t_{inst} refer to "4. AC Characteristics (4) Instruction Cycle".

(2) MB89F538

($V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $AV_{SS} = V_{SS} = 0 \text{ V}$, $T_A = -40 \text{ }^{\circ}\text{C to } +85 \text{ }^{\circ}\text{C}$)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks	
				Min	Typ	Max			
Resolution capability	—	—	—	—	—	10	bit	AV _{CC} = V _{CC}	
Total error			AVR = AV _{CC}	—	—	±5.0	LSB		
Linear error				—	—	±2.5	LSB		
Differential linear error				—	—	±1.9	LSB		
Zero transition voltage	V _{OT}		—	AVR = AV _{CC}	AV _{SS} – 1.5 LSB	AV _{SS} + 0.5 LSB	AV _{SS} + 4.5 LSB		V
Full scale transition voltage	V _{FST}				AVR – 6.5 LSB	AVR – 1.5 LSB	AVR + 1.5 LSB		V
Inter-channel variation	—				—	—	4.0		LSB
Conversion time		—	—	60 t _{inst}	—	μs	*		
Sampling time				—	16 t _{inst}	—	μs		
Analog input current	I _{AIN}	AN0 to AN7	—	—	—	10	μA		
Analog input voltage	V _{AIN}			0	—	AVR	V		
Reference voltage	—	AVR		AV _{SS} + 3.5	—	AV _{CC}	V		
Reference voltage supply current	I _R			A/D running	—	400	—	μA	
	I _{RH}		A/D off	—	—	5	μA		

* : Includes sampling time.

Note : For t_{inst} refer to "4. AC Characteristics (4) Instruction Cycle".

MB89530A Series

(3) MB89F538L

($V_{CC} = 2.4 \text{ V to } 3.6 \text{ V}$, $AV_{SS} = V_{SS} = 0 \text{ V}$, $T_A = -40 \text{ }^{\circ}\text{C to } +85 \text{ }^{\circ}\text{C}$)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks	
				Min	Typ	Max			
Resolution capability	—	—	—	—	—	10	bit	AV _{CC} = V _{CC}	
Total error			AVR = AV _{CC}	—	—	±3.0	LSB		
Linear error				—	—	±2.5	LSB		
Differential linear error				—	—	±1.9	LSB		
Zero transition voltage	V _{OT}		AVR = AV _{CC}	AV _{SS} – 1.5 LSB	AV _{SS} + 0.5 LSB	AV _{SS} + 2.5 LSB	V		
Full scale transition voltage	V _{FST}			AVR – 3.5 LSB	AVR – 1.5 LSB	AVR + 1.5 LSB	V		
Inter-channel variation	—			—	—	4.0	LSB		
Conversion time		—	—	60 t _{inst}	—	μs	*		
Sampling time	—		16 t _{inst}	—	μs				
Analog input current	I _{AIN}		AN0 to AN7	—	—	10	μA		
Analog input voltage	V _{AIN}			0	—	AVR	V		
Reference voltage	—	AVR	—	AV _{SS} + 2.4	—	AV _{CC}	V		
Reference voltage supply current	I _R			A/D running	—	200	—	μA	
	I _{RH}			A/D off	—	—	5	μA	

* : Includes sampling time

(4) A/D Converter Terms and Definitions

• Resolution

The level of analog variation that can be distinguished by the A/D converter.

• Linear error (unit : LSB)

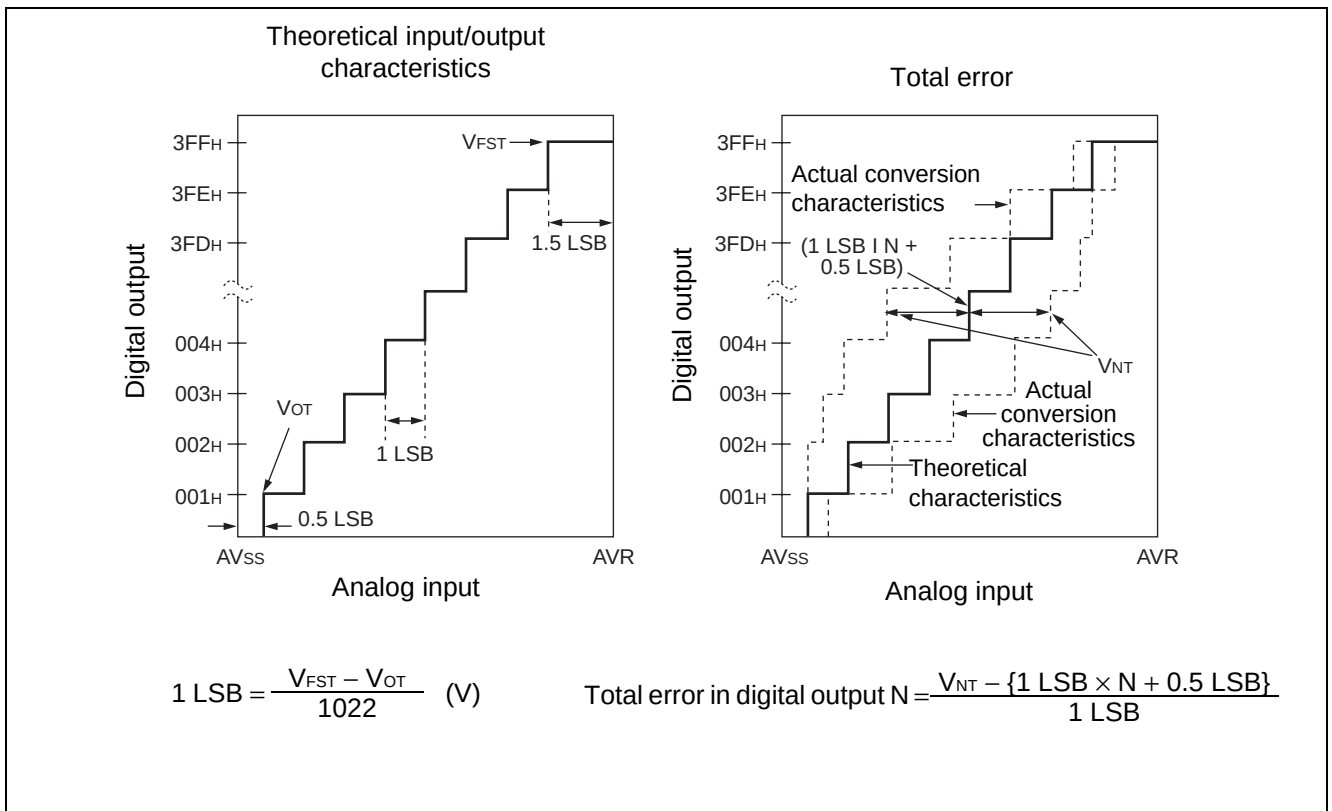
The deviation between the value along a straight line connecting the zero transition point ("00 0000 0000" ←→ "00 0000 0001") of a device and the full-scale transition point ("11 1111 1110" ←→ "11 1111 1111"), compared with the actual conversion values obtained.

• Differential linear error (Unit : LSB)

The deviation from the theoretical input voltage required to produce a change of 1 LSB in output code.

• Total error (Unit : LSB)

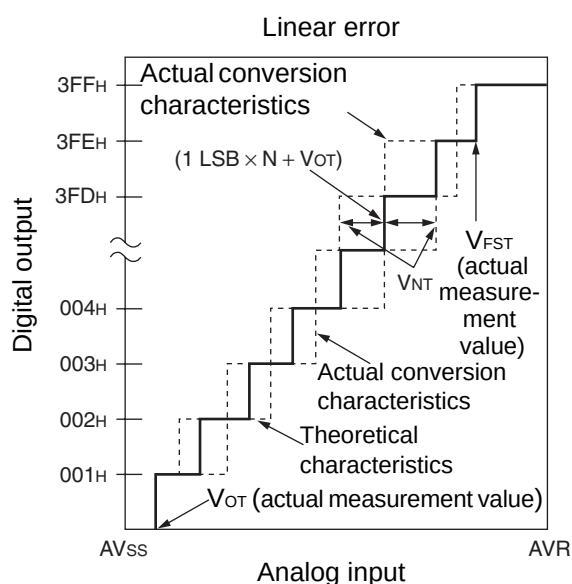
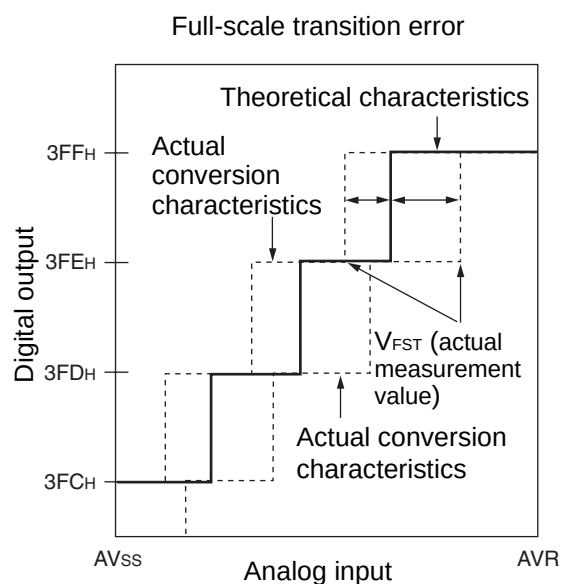
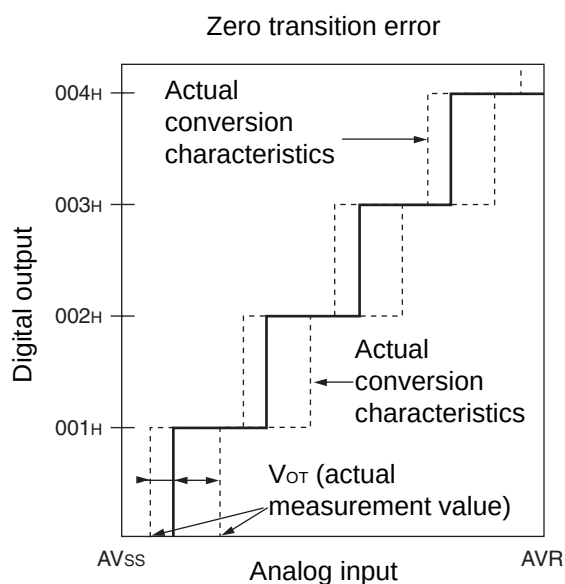
The difference between theoretical conversion value and actual conversion value.



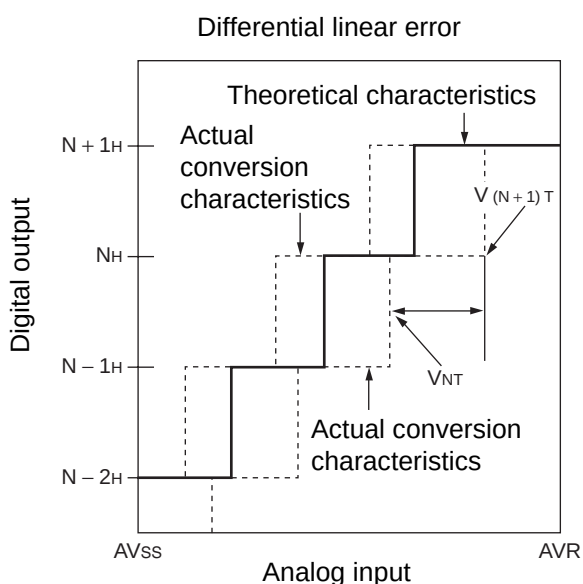
(Continued)

MB89530A Series

(Continued)



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



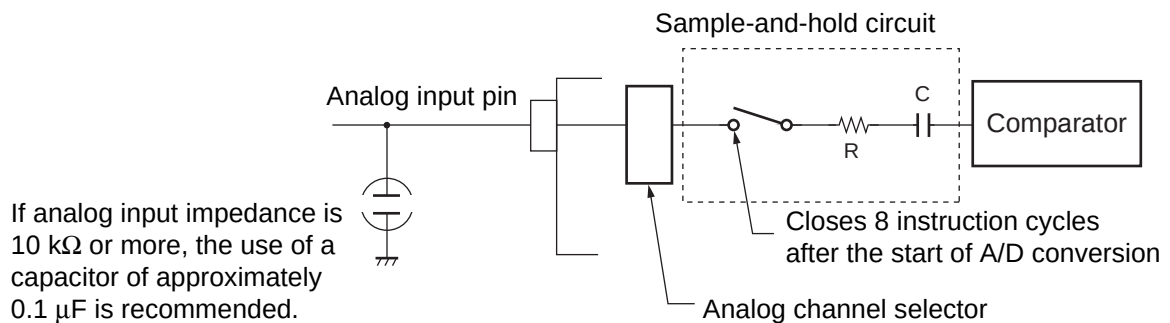
$$\text{Differential linear error in digital output } N = \frac{V_{(N+1)T} - V_{NT}}{1 \text{ LSB}} - 1$$

(5) Precautionary Information

• Input Impedance of Analog Input Pins

The A/D converter of MB89530A 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 8 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 10 kΩ or less.

• Analog Input Equivalent Circuit



MB89535A/537A/537AC/538A/538AC
C ≅ 45 pF R ≅ 2.2 kΩ

MB89F538
C ≅ 30 pF R ≅ 3.2 kΩ

MB89F538L
C ≅ 49 pF R ≅ 7.1 kΩ

MB89P538, MB89P530
C ≅ 64 pF R ≅ 3.0 kΩ

• About error

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

MB89530A Series

6. Flash Memory

- Flash memory programming/erase characteristics

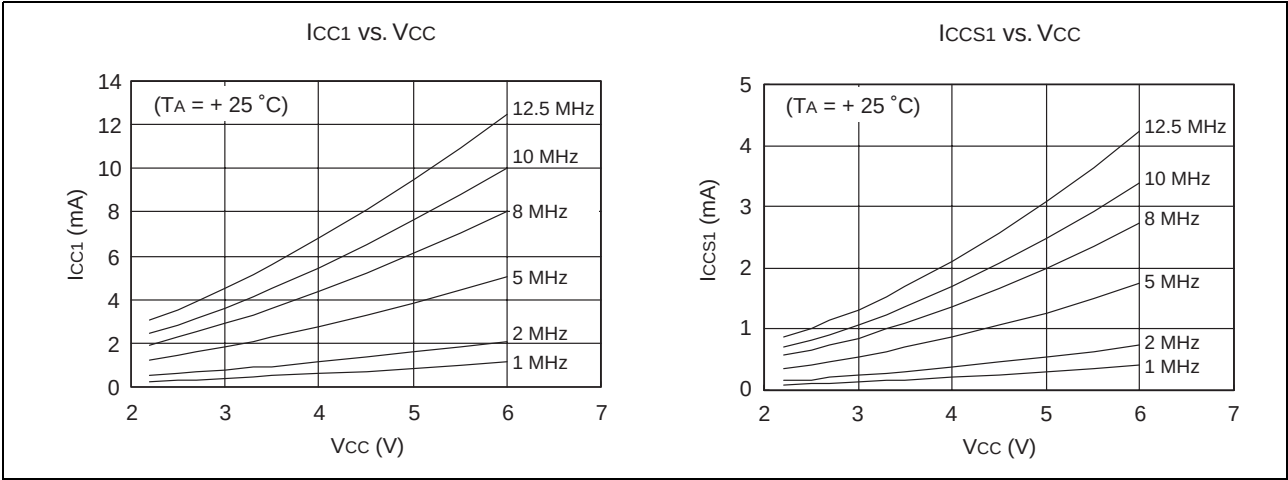
Parameter		Conditions	Value			Unit	Remarks
			Min	Typ	Max		
Sector erase time	Per 1 sector, Constant value independent with sector capacitance	$T_A = +25\text{ }^{\circ}\text{C}$, $V_{CC} = 5.0\text{ V}$	—	1	15	s	*
Programming time	Per 1 byte		—	8	3600	μs	
Chip erase time			—	5	—	s	*
Program/Erase cycle		—	10000	—	—	cycle	

* : Excludes internal programming time before erase.

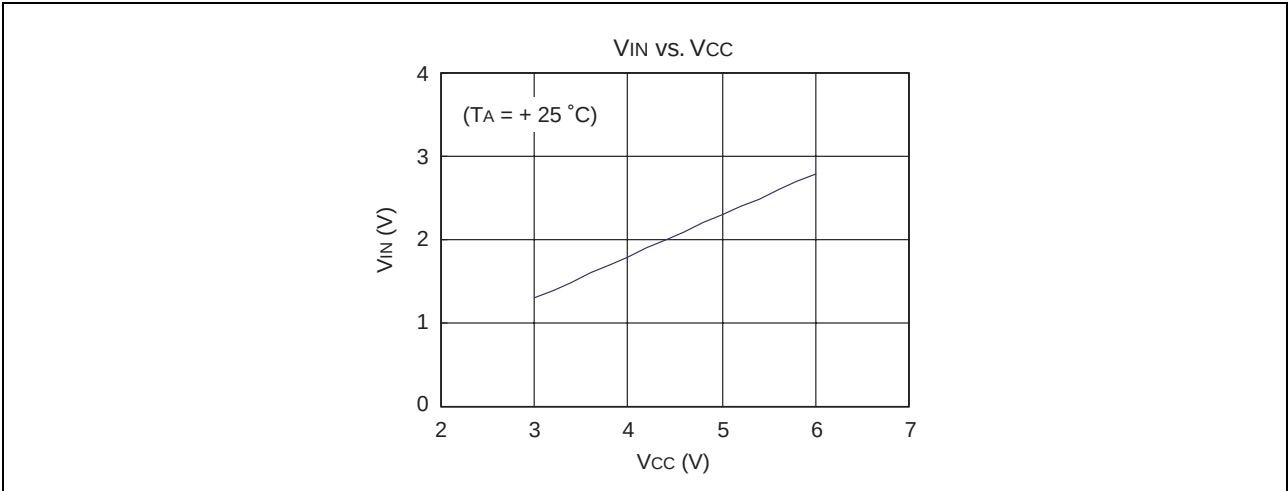
MB89530A Series

■ EXAMPLE CHARACTERISTICS (MB89538A)

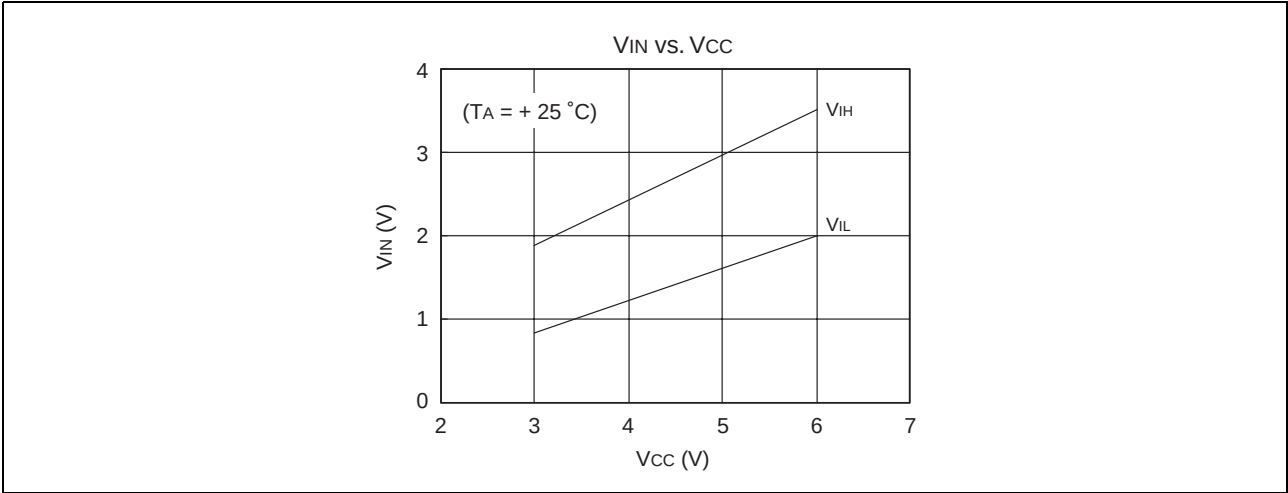
(1) Power Supply Current (External Clock)



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

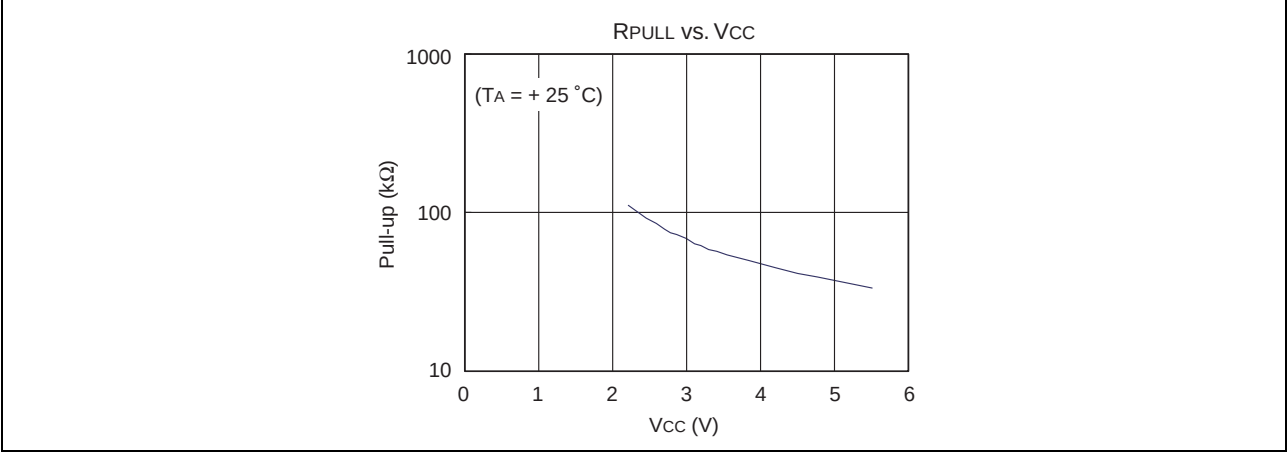


(3) “H” Level Input Voltage / “L” Level Input Voltage (Hysteresis Input)

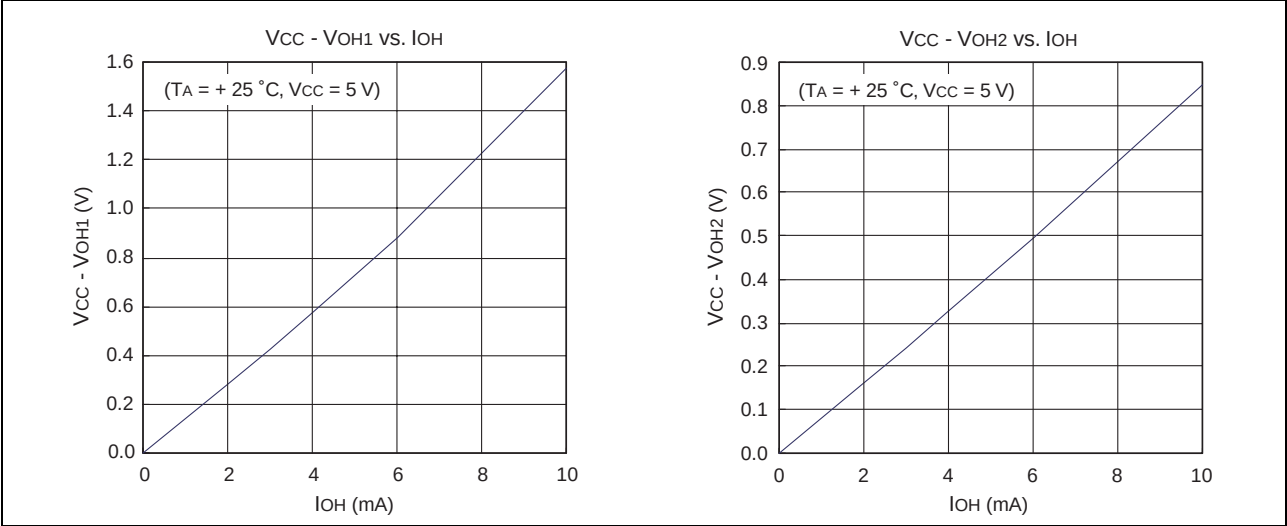


MB89530A Series

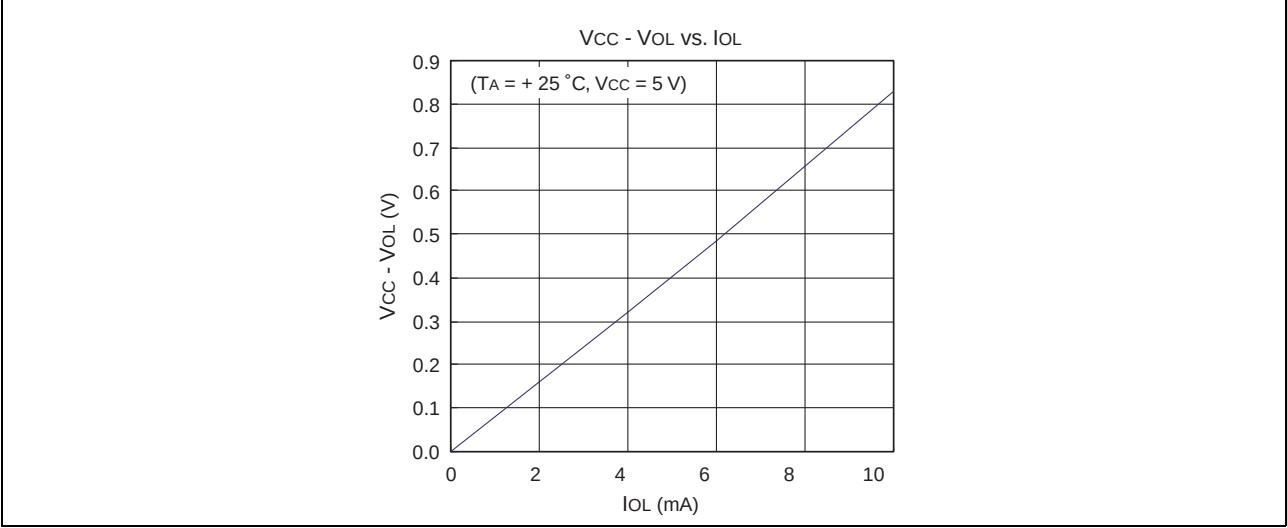
(4) Pull-up Resistor Value



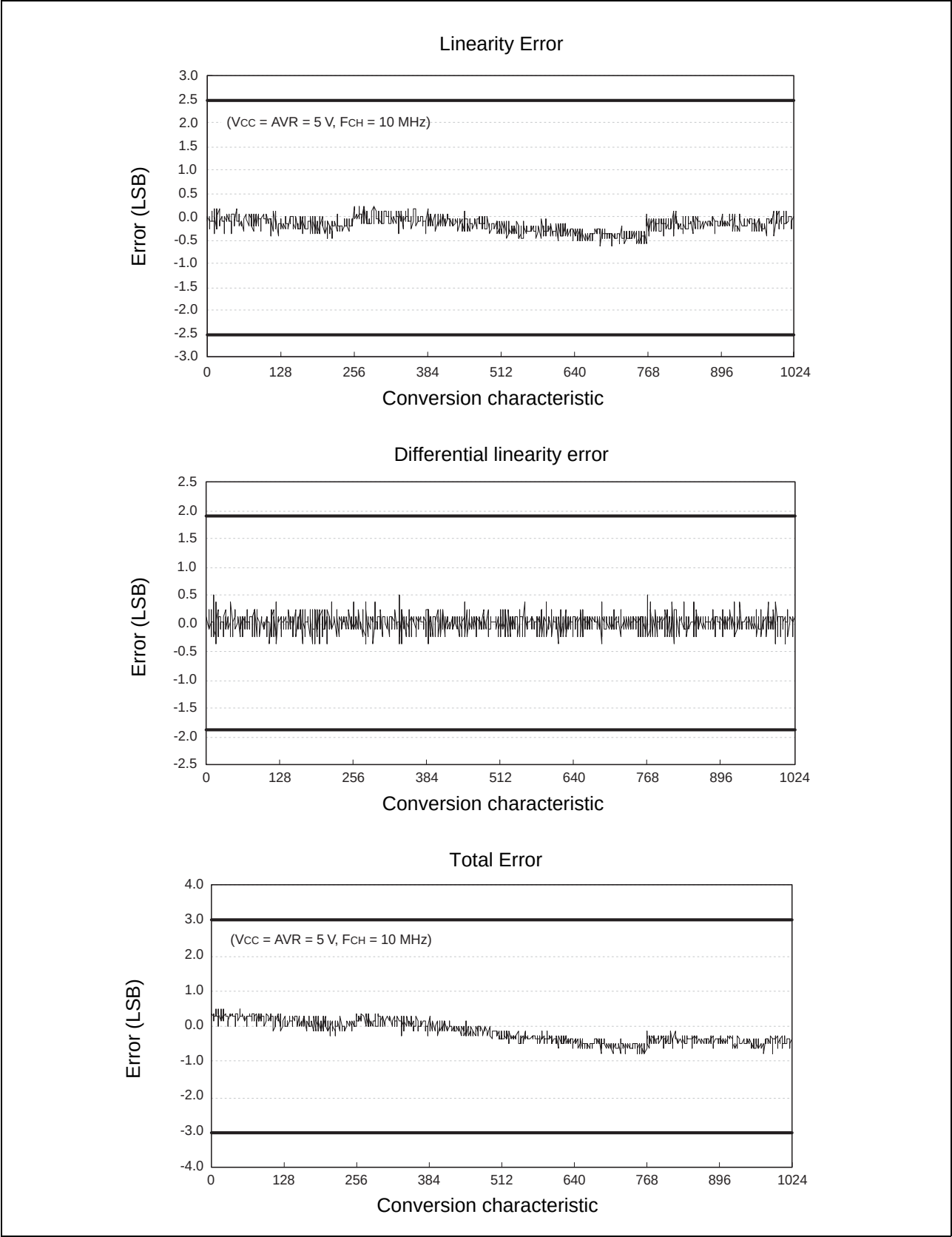
(5) "H" Level Output Voltage



(6) "L" Level Output Voltage



(7) AD Converter Characteristic Example



MB89530A Series

■ MASK OPTIONS

No	Part number	MB89535A MB89537A MB89537AC MB89538A MB89538AC	MB89F538-101 MB89F538-201 MB89F538L-101 MB89F538L-201	MB89P538-101 MB89P538-201	MB89PV530-101 MB89PV530-201
	Method of specification	Specify at time of mask order	Setting not possible	Setting not possible	Setting not possible
1	Main clock Select oscillator stabilization wait period ($F_{CH}^* = 10 \text{ MHz}$) approx. $2^{14}/F_{CH}^*$ (approx. 1.6 ms) approx. $2^{17}/F_{CH}^*$ (approx. 13.1 ms) approx. $2^{18}/F_{CH}^*$ (approx. 26.2 ms)	Selection available	$2^{18}/F_{CH}^*$ (approx. 26.2 ms)	$2^{18}/F_{CH}^*$ (approx. 26.2 ms)	$2^{18}/F_{CH}^*$ (approx. 26.2 ms)
2	Clock mode selection • 2-system clock mode • 1-system clock mode	Selection available	• 101 : 1-system clock mode • 201 : 2-system clock mode		

* : F_{CH} : Main clock frequency

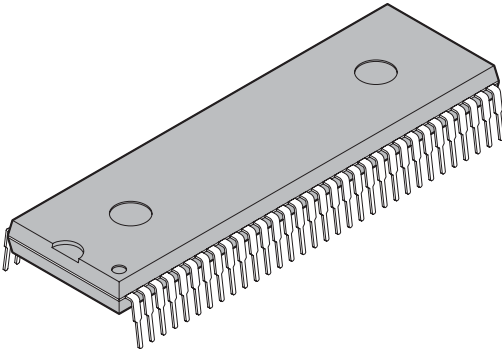
MB89530A Series

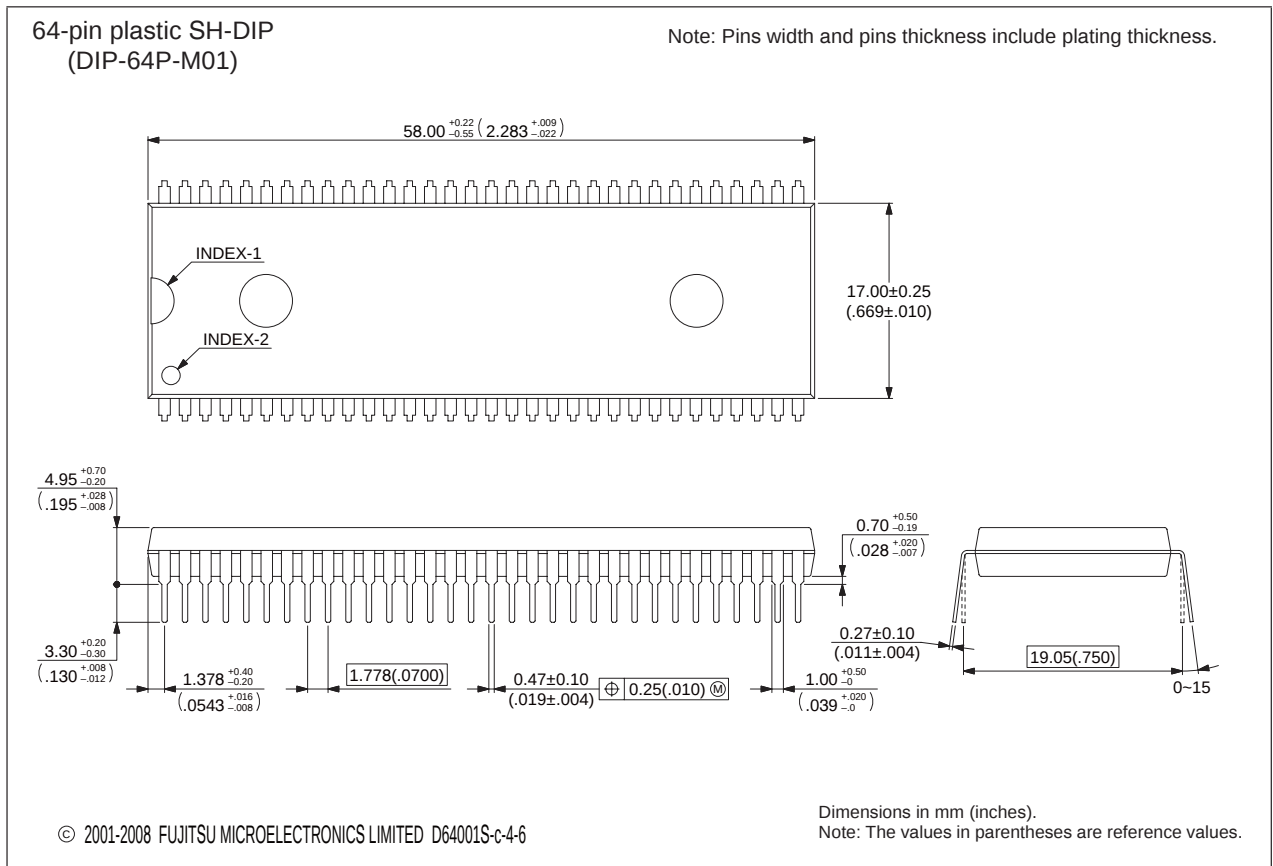
■ ORDERING INFORMATION

Part number	Package	Remarks
MB89535AP MB89537AP MB89537ACP MB89538AP MB89538ACP MB89P538-101P MB89P538-201P MB89F538-101P MB89F538-201P MB89F538L-101P MB89F538L-201P	DIP-64P-M01	MB89535AP, MB89537AP and MB89538AP do not have I ² C functions.
MB89535APF MB89537APF MB89537ACPF MB89538APF MB89538ACPF MB89P538-101PF MB89P538-201PF MB89F538-101PF MB89F538-201PF MB89F538L-101PF MB89F538L-201PF	FPT-64P-M06	MB89535APF, MB89537APF and MB89538APF do not have I ² C functions.
MB89535APMC MB89537APMC MB89537ACPMC MB89538APMC MB89538ACPMC MB89P538-101PMC MB89P538-201PMC MB89F538-101PMC MB89F538-201PMC MB89F538L-101PMC MB89F538L-201PMC	FPT-64P-M23	MB89535APMC, MB89537APMC and MB89538APMC do not have I ² C functions.
MB89535APMC1 MB89537APMC1 MB89537ACPMC1 MB89538APMC1 MB89538ACPMC1	FPT-64P-M24	MB89535APMC1, MB89537APMC1 and MB89538APMC1 do not have I ² C functions.
MB89535APV4 MB89537APV4 MB89537ACPV4 MB89538APV4 MB89538ACPV4 MB89F538L-101PV4 MB89F538L-201PV4	LCC-64P-M19	MB89535APV4, MB89537APV4, and MB89538APV4 do not have I ² C functions.
MB89PV530-101C MB89PV530-201C	MDP-64C-P02	
MB89PV530-101CF MB89PV530-201CF	MQP-64C-P01	

MB89530A Series

■ PACKAGE DIMENSIONS

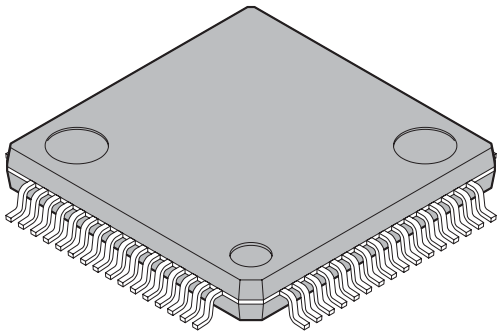
 64-pin plastic SH-DIP (DIP-64P-M01)	Lead pitch	1.778mm(70mil)
	Package width × package length	17 × 58 mm
	Sealing method	Plastic mold
	Mounting height	5.65 mm MAX

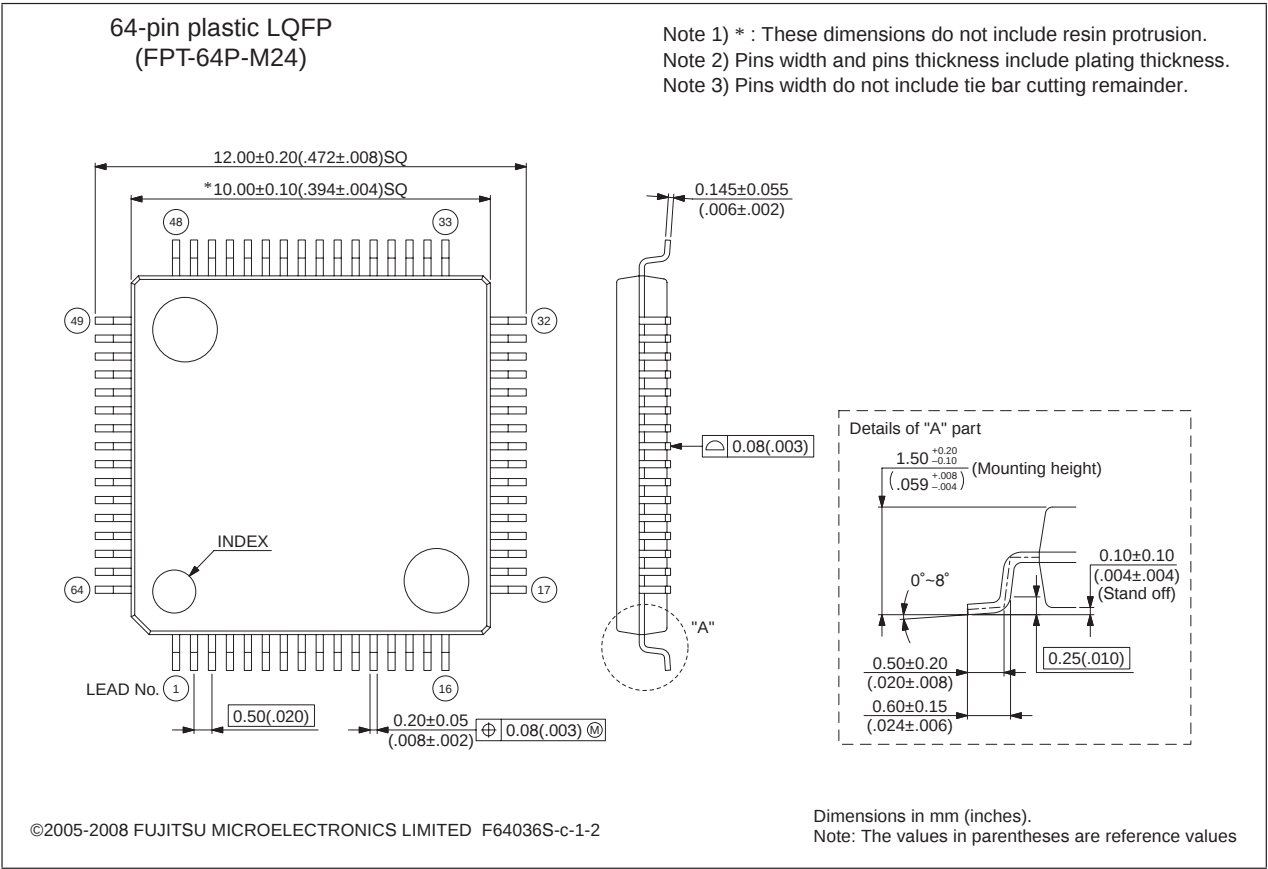


Please confirm the latest Package dimension by following URL.
<http://edevic.fujitsu.com/package/en-search/>

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MB89530A Series

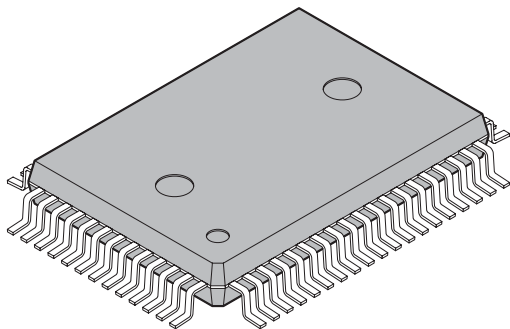
64-pin plastic LQFP  (FPT-64P-M24)	Lead pitch	0.50 mm
	Package width × package length	10.0 × 10.0 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.70 mm MAX
	Weight	0.32 g
	Code (Reference)	P-LFQFP64-10×10-0.50

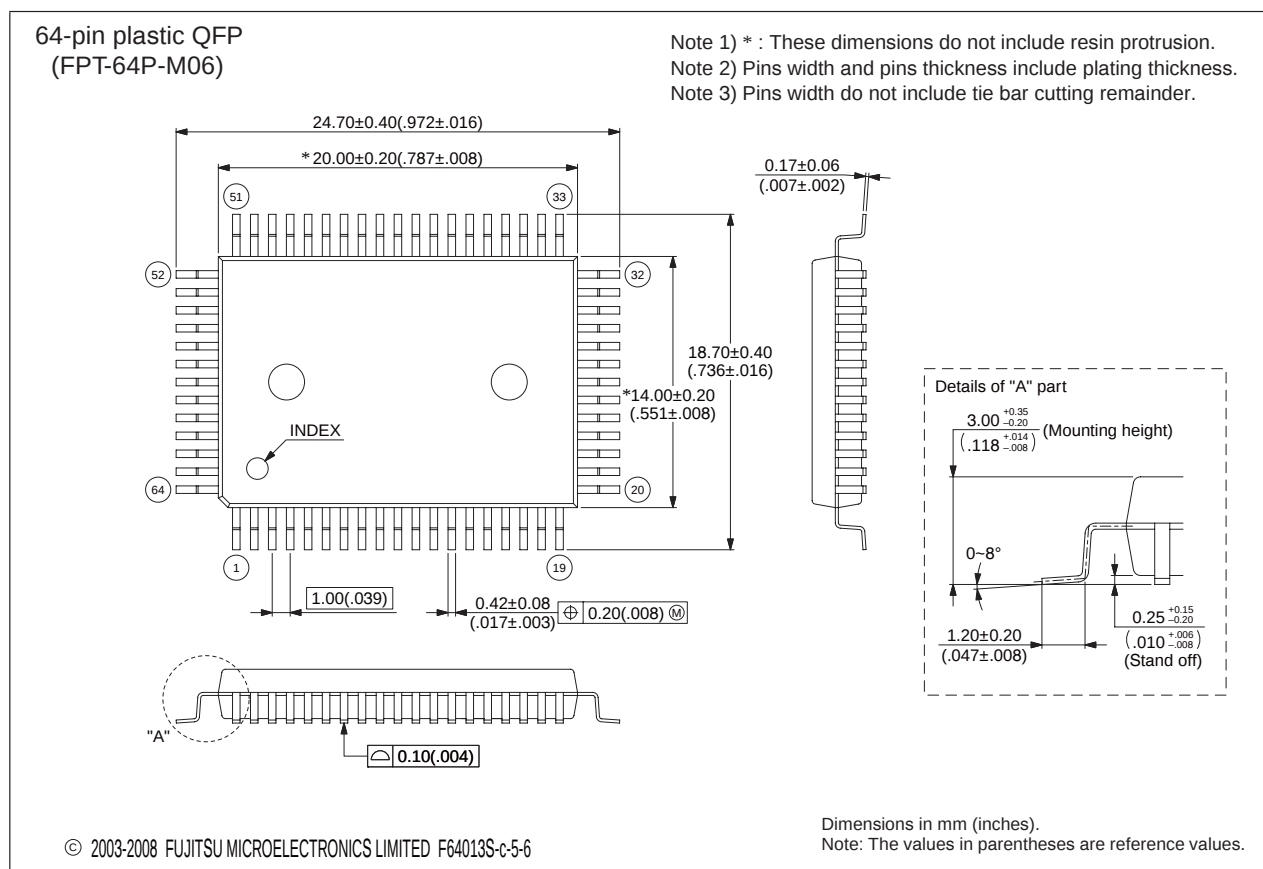


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MB89530A Series

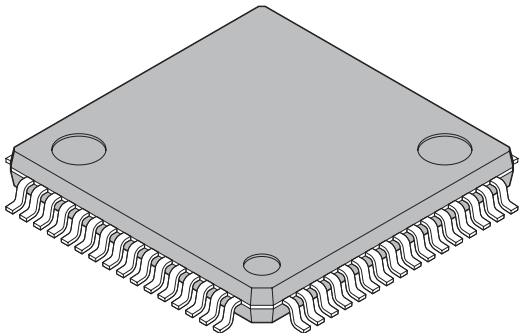
64-pin plastic QFP  (FPT-64P-M06)	Lead pitch	1.00 mm
	Package width × package length	14 × 20 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	3.35 mm MAX
	Code (Reference)	P-QFP64-14×20-1.00

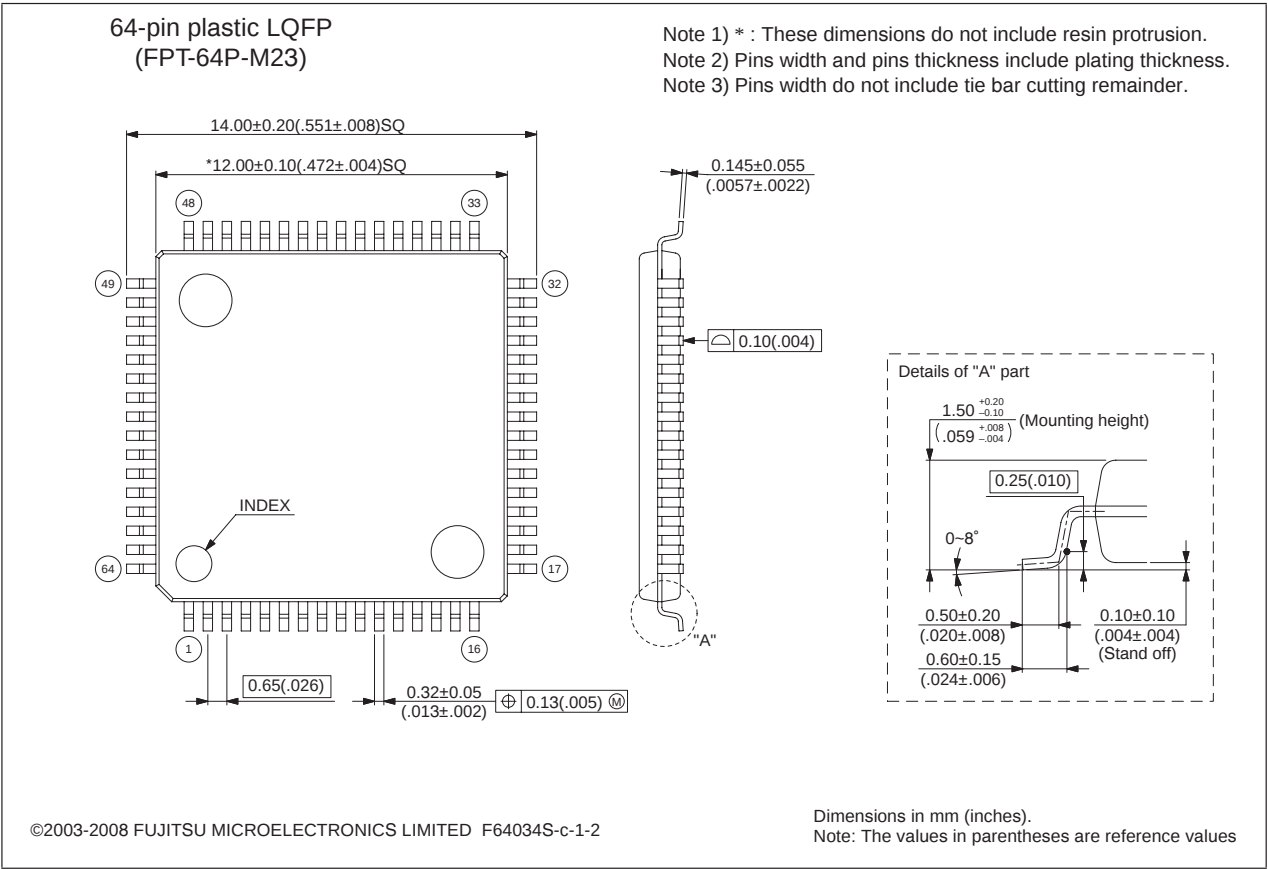


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MB89530A Series

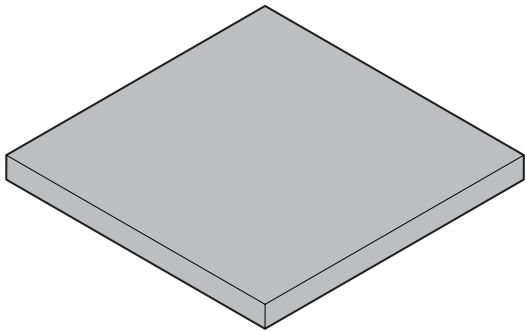
64-pin plastic LQFP  (FPT-64P-M23)	Lead pitch	0.65 mm
	Package width × package length	12.0 × 12.0 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.70 mm MAX
	Code (Reference)	P-LFQFP64-12×12-0.65

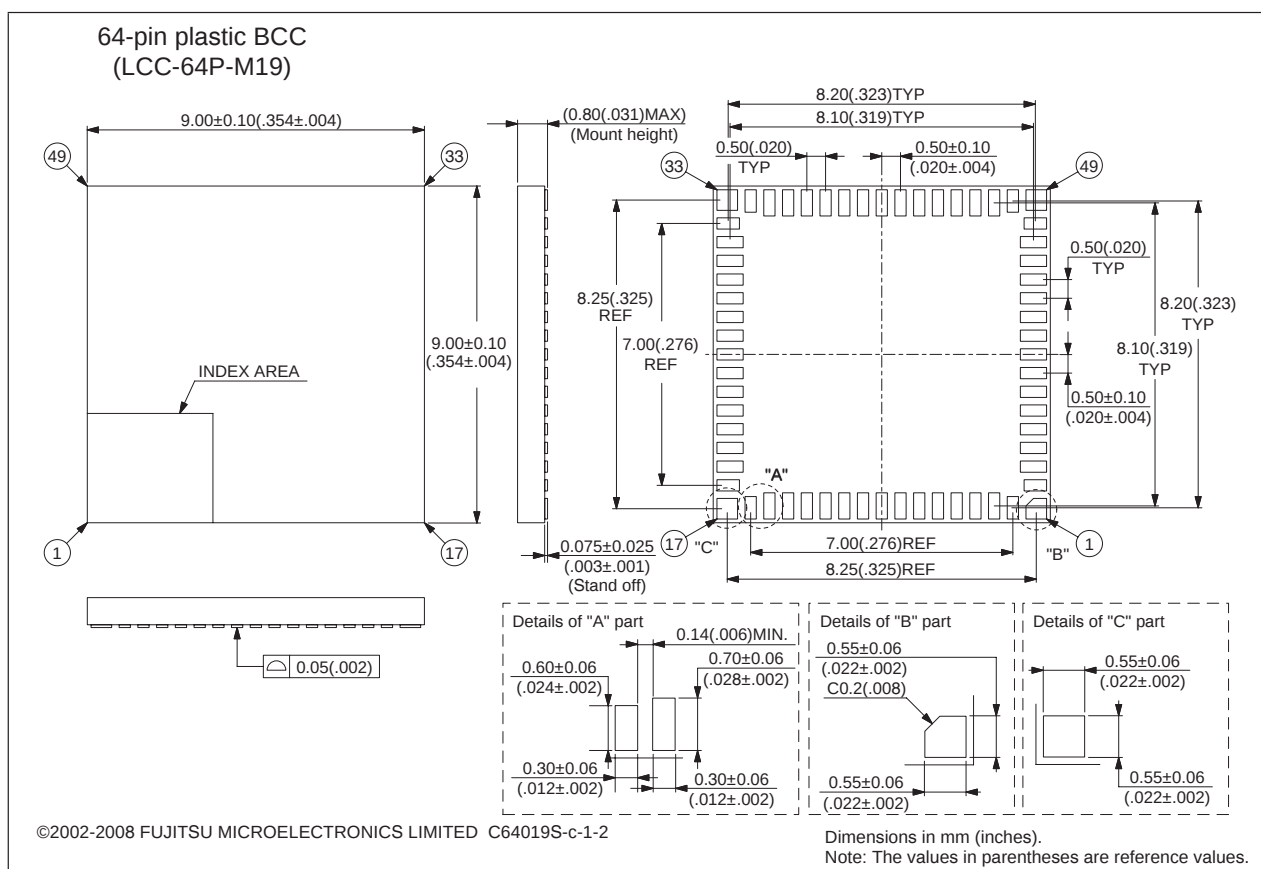


Please confirm the latest Package dimension by following URL.
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MB89530A Series

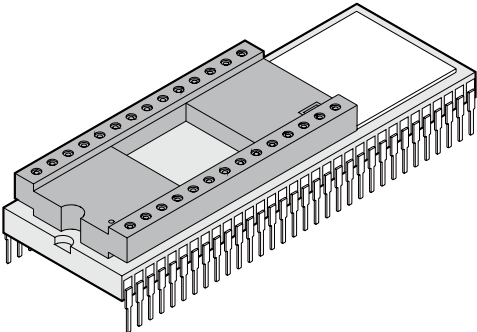
64-pin plastic BCC  (LCC-64P-M19)	Lead pitch	0.50 mm
	Package width × package length	9.00 mm × 9.00 mm
	Sealing method	Plastic mold
	Mounting height	0.80 mm MAX
	Weight	0.10g

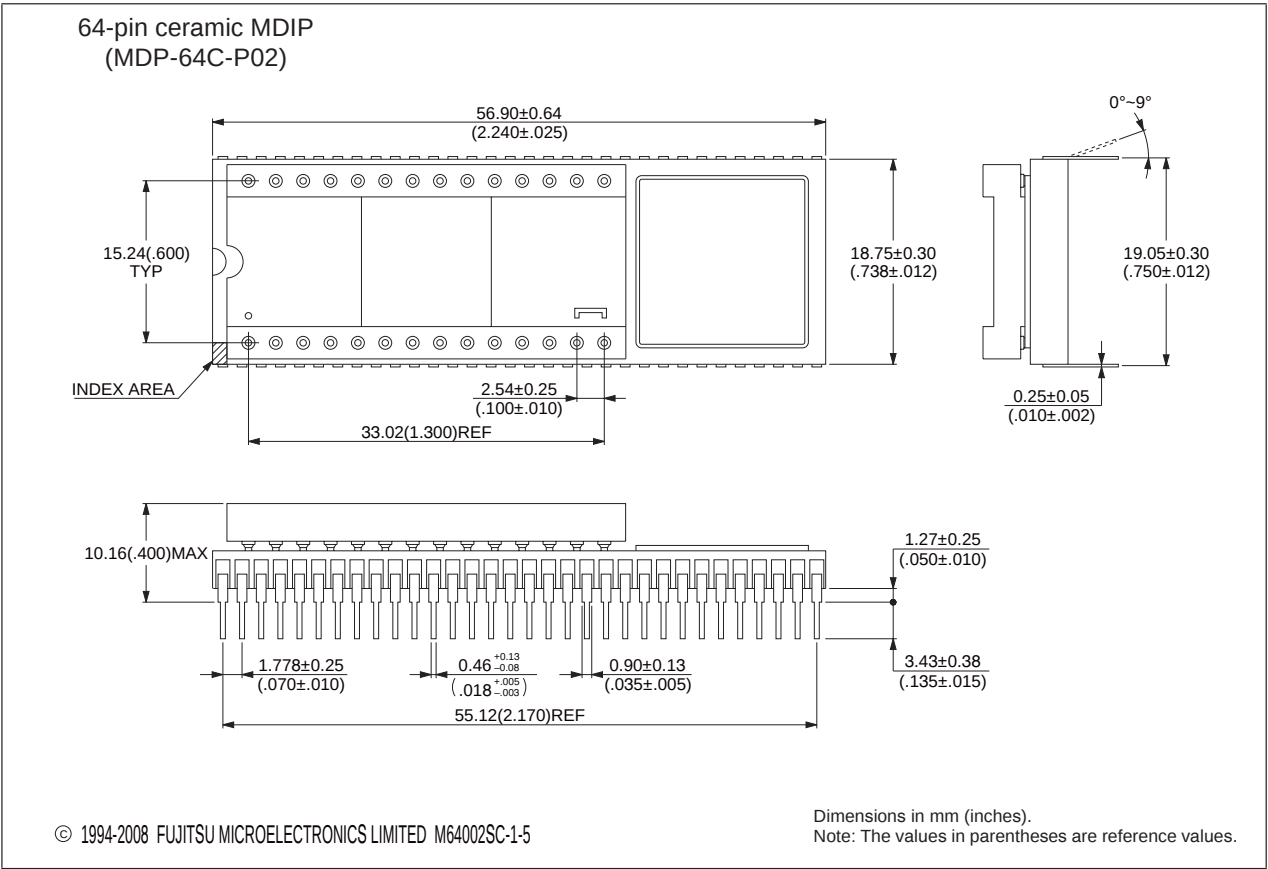


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MB89530A Series

64-pin ceramic MDIP  (MDP-64C-P02)	Lead pitch	1.778mm (70mil)
	Row spacing	19.05mm (750mil)
	Motherboard material	Ceramic
	Mounted packing material	Plastic

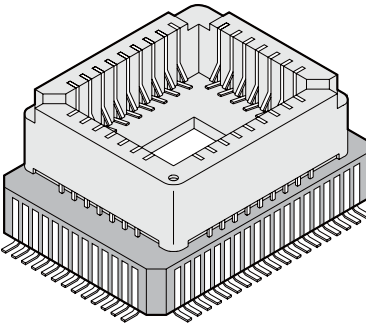


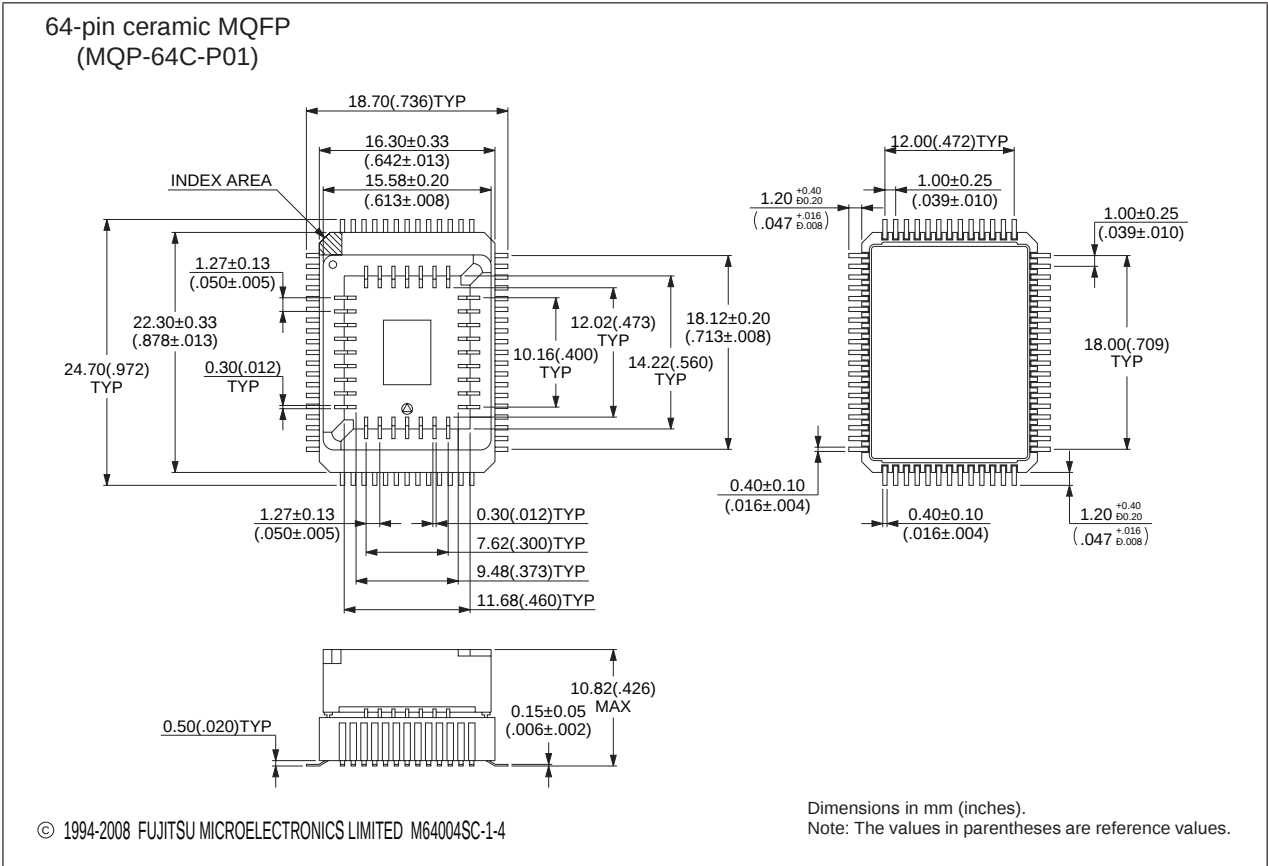
Please confirm the latest Package dimension by following URL.
<http://edevic.fujitsu.com/package/en-search/>

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MB89530A Series

(Continued)

64-pin ceramic MQFP  (MQP-64C-P01)	Lead pitch	1.00 mm
	Lead shape	Straight
	Motherboard material	Ceramic
	Mounted package material	Plastic



Please confirm the latest Package dimension by following URL.
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MB89530A Series

■ MAIN CHANGES IN THIS EDITION

Page	Section	Change Results
—	—	Added the part number. MB89F538L
—	—	Changed the package code. FPT-64P-M03 → FPT-64P-M24 FPT-64P-M09 → FPT-64P-M23 Deleted LCC-64P-M16 .
19	■ PROGRAMMING AND ERASING FLASH MEMORY ON THE MB89F538/F538L	Deleted the “6. ROM Programmer Adaptor and Recommended ROM Programmers”.
20	■ ONE-TIME WRITING SPECIFICATIONS WITH PROM AND EPROM MICROCONTROLLERS	Deleted the “• ROM writer adapters”.
22	■ EPROM WRITING TO PIGGY-BACK/ EVALUATION CHIPS	Deleted the “• Writer adapter”.
49	■ ELECTRICAL CHARACTERISTICS 5. A/D Converter Electrical Characteristics	Changed the unit of Zero transition voltage and Full scale transition voltage mV → V
53		Changed the figure of “• Input Impedance of Analog Input Pins”.

MB89530A Series

Page	Section	Change Results
59	■ ORDERING INFORMATION	Added the order informations. MB89F538L-101P, MB89F538L-201P MB89F538L-101PF, MB89F538L-201PF MB89F538L-101PMC, MB89F538L-201PMC MB89F538L-101PV4, MB89F538L-201PV4
		Changed the order informations. MB89P538P-101 → MB89P538-101P MB89P538P-201 → MB89P538-201P MB89F538P-101 → MB89F538-101P MB89F538P-201 → MB89F538-201P MB89P538PF-101 → MB89P538-101PF MB89P538PF-201 → MB89P538-201PF MB89F538PF-101 → MB89F538-101PF MB89F538PF-201 → MB89F538-201PF MB89535APFM → MB89535APMC MB89537APFM → MB89537APMC MB89537ACPFM → MB89537ACPMC MB89538APFM → MB89538APMC MB89538ACPFM → MB89538ACPMC MB89P588PFM-101 → MB89P538-101PMC MB89P588PFM-201 → MB89P538-201PMC MB89F538PFM-101 → MB89F538-101PMC MB89F538PFM-201 → MB89F538-201PMC MB89535APFV → MB89535APMC1 MB89537APFV → MB89537APMC1 MB89537ACPFV → MB89537ACPMC1 MB89538APFV → MB89538APMC1 MB89538ACPFV → MB89538ACPMC1 MB89PV530C-101 → MB89PV530-101C MB89PV530C-201 → MB89PV530-201C MB89PV530CF-101 → MB89PV530-101CF MB89PV530CF-201 → MB89PV530-201CF
61	■ PACKAGE DIMENSIONS	Changed the package figure. FPT-64P-M03 → FPT-64P-M24
63		Changed the package figure. FPT-64P-M09 → FPT-64P-M23

The vertical lines marked in the left side of the page show the changes.

MEMO

MB89530A Series

MEMO

MEMO

MB89530A Series

FUJITSU MICROELECTRONICS LIMITED

Shinjuku Dai-Ichi Seimei Bldg., 7-1, Nishishinjuku 2-chome,
Shinjuku-ku, Tokyo 163-0722, Japan
Tel: +81-3-5322-3347 Fax: +81-3-5322-3387
<http://jp.fujitsu.com/fml/en/>

For further information please contact:

North and South America

FUJITSU MICROELECTRONICS AMERICA, INC.
1250 E. Arques Avenue, M/S 333
Sunnyvale, CA 94085-5401, U.S.A.
Tel: +1-408-737-5600 Fax: +1-408-737-5999
<http://www.fma.fujitsu.com/>

Asia Pacific

FUJITSU MICROELECTRONICS ASIA PTE. LTD.
151 Lorong Chuan,
#05-08 New Tech Park 556741 Singapore
Tel : +65-6281-0770 Fax : +65-6281-0220
<http://www.fmal.fujitsu.com/>

Europe

FUJITSU MICROELECTRONICS EUROPE GmbH
Pittlerstrasse 47, 63225 Langen, Germany
Tel: +49-6103-690-0 Fax: +49-6103-690-122
<http://emea.fujitsu.com/microelectronics/>

FUJITSU MICROELECTRONICS SHANGHAI CO., LTD.
Rm. 3102, Bund Center, No.222 Yan An Road (E),
Shanghai 200002, China
Tel : +86-21-6146-3688 Fax : +86-21-6335-1605
<http://cn.fujitsu.com/fmc/>

Korea

FUJITSU MICROELECTRONICS KOREA LTD.
206 Kosmo Tower Building, 1002 Daechi-Dong,
Gangnam-Gu, Seoul 135-280, Republic of Korea
Tel: +82-2-3484-7100 Fax: +82-2-3484-7111
<http://kr.fujitsu.com/fmk/>

FUJITSU MICROELECTRONICS PACIFIC ASIA LTD.
10/F., World Commerce Centre, 11 Canton Road,
Tsimshatsui, Kowloon, Hong Kong
Tel : +852-2377-0226 Fax : +852-2376-3269
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