

16-bit Proprietary Microcontroller

CMOS

F²MC-16LX MB90435 Series

**MB90437L (S) /438L (S) /F438L (S)
MB90439 (S) /F439 (S) /V540G**

■ DESCRIPTION

The MB90435 series with FLASH ROM is specially designed for industrial applications.

The instruction set by F²MC-16LX CPU core inherits an AT architecture of the F²MC* family with additional instruction sets for high-level languages, extended addressing mode, enhanced multiplication/division instructions, and enhanced bit manipulation instructions. The micro controller has a 32-bit accumulator for processing long word data.

The MB90435 series has peripheral resources of 8/10-bit A/D converters, UART (SCI) , extended I/O serial interfaces, 8/16-bit timer, I/O timer (input capture (ICU) , output compare (OCU)) .

* : F²MC stands for FUJITSU Flexible Microcontroller.

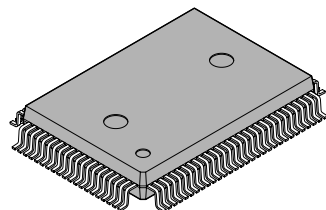
■ FEATURES

- Clock
Embedded PLL clock multiplication circuit
Operating clock (PLL clock) can be selected from : divided-by-2 of oscillation or one to four times the oscillation
Minimum instruction execution time : 62.5 ns (operation at oscillation of 4 MHz, four times the oscillation clock, V_{CC} of 5.0 V)
Subsystem Clock : 32 kHz

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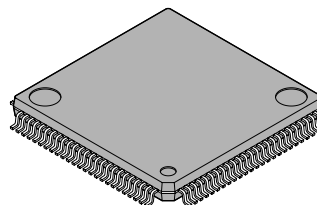
■ PACKAGES

100-pin Plastic QFP



(FPT-100P-M06)

100-pin Plastic LQFP



(FPT-100P-M05)

MB90435 Series

- Instruction set to optimize controller applications
 - Rich data types (bit, byte, word, long word)
 - Rich addressing mode (23 types)
 - Enhanced signed multiplication/division instruction and RETI instruction functions
 - Enhanced precision calculation realized by the 32-bit accumulator
- Instruction set designed for high level language (C language) and multi-task operations
 - Adoption of system stack pointer
 - Enhanced pointer indirect instructions
 - Barrel shift instructions
- Program patch function (for two address pointers)
- Enhanced execution speed : 4-byte Instruction queue
- Enhanced interrupt function : 8 levels, 34 factors
- Automatic data transmission function independent of CPU operation
 - Extended intelligent I/O service function (EI²OS)
- Embedded ROM size and types
 - Mask ROM : 64 Kbytes / 128 Kbytes / 256 Kbytes
 - Flash ROM : 128 Kbytes/256 Kbytes
 - Embedded RAM size : 2 Kbytes/4 Kbytes/6 Kbytes/8 Kbytes (evaluation chip)
- Flash ROM
 - Supports automatic programming, Embedded Algorithm TM*
 - Write/Erase/Erase-Suspend/Resume commands
 - A flag indicating completion of the algorithm
 - Hard-wired reset vector available in order to point to a fixed boot sector in Flash Memory
 - Erase can be performed on each block
 - Block protection with external programming voltage
- Low-power consumption (stand-by) mode
 - Sleep mode (mode in which CPU operating clock is stopped)
 - Stop mode (mode in which oscillation is stopped)
 - CPU intermittent operation mode
 - Clock mode
 - Hardware stand-by mode
- Process
 - 0.5 μm CMOS technology
- I/O port
 - General-purpose I/O ports : 81 ports
- Timer
 - Watchdog timer : 1 channel
 - 8/16-bit PPG timer : 8/16-bit × 4 channels
 - 16-bit re-load timer : 2 channels
- 16-bit I/O timer
 - 16-bit free-run timer : 1 channel
 - Input capture : 8 channels
 - Output compare : 4 channels
- Extended I/O serial interface : 1 channel
- UART 0
 - With full-duplex double buffer (8-bit length)
 - Clock asynchronous or clock synchronized (with start/stop bit) transmission can be selectively used.

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- UART 1

With full-duplex double buffer (8-bit length)

Clock asynchronous or clock synchronized serial (extended I/O serial) can be used.

- External interrupt circuit (8 channels)

A module for starting an extended intelligent I/O service (EI²OS) and generating an external interrupt which is triggered by an external input.

- Delayed interrupt generation module

Generates an interrupt request for switching tasks.

- 8/10-bit A/D converter (8 channels)

8/10-bit resolution can be selectively used.

Starting by an external trigger input.

Conversion time : 26.3 μ s

- External bus interface : Maximum address space 16 Mbytes

- Package: QFP-100, LQFP-100

* : Embedded Algorithm is a trade mark of Advanced Micro Devices Inc.

MB90435 Series

■ PRODUCT LINEUP

Features	MB90F438L (S) /F439 (S)	MB90437L (S) *1 /438L (S) /439 (S)	MB90V540G
CPU	F ² MC-16LX CPU		
System clock	On-chip PLL clock multiplier (×1, ×2, ×3, ×4, 1/2 when PLL stop) Minimum instruction execution time : 62.5 ns (4 MHz osc. PLL × 4)		
ROM	Flash memory MB90F438L(S) : 128 Kbytes MB90F439(S) : 256 Kbytes	Mask ROM : MB90437L(S): 64 Kbytes MB90438L(S): 128 Kbytes MB90439(S): 256 Kbytes	External
RAM	MB90F438L(S) : 4 Kbytes MB90F439(S) : 6 Kbytes	MB90437L(S): 2 Kbytes MB90438L(S): 4 Kbytes MB90439(S): 6 Kbytes	8 Kbytes
Clocks	MB90F438L/F439 : Two clocks system MB90F438LS/F439S : One clock system	MB90437L/438L/439 : Two clocks system MB90437LS/438LS/439S : One clock system	Two clocks system*2
Operating voltage range	*5		
Temperature range	-40 °C to 105 °C		
Package	QFP100, LQFP100		PGA-256
Emulator-specify power supply ³	—		None
UART0	Full duplex double buffer Support asynchronous/synchronous (with start/stop bit) transfer Baud rate : 4808/5208/9615/10417/19230/38460/62500/500000 bps (asynchronous) 500 K/1 M/2 Mbps (synchronous) at System clock = 16 MHz		
UART1 (SCI)	Full duplex double buffer Asynchronous (start-stop synchronized) and CLK-synchronous communication Baud rate : 1202/2404/4808/9615/19230/31250/38460/62500 bps (asynchronous) 62.5 K/125 K/250 K/500 K/1 M/2 Mbps (synchronous) at 6, 8, 10, 12, 16 MHz		
Serial I/O	Transfer can be started from MSB or LSB Supports internal clock synchronized transfer and external clock synchronized transfer Supports positive-edge and negative-edge clock synchronization Baud rate : 31.25 K/62.5 K/125 K/500 K/1 Mbps at System clock = 16 MHz		
A/D Converter	10-bit or 8-bit resolution 8 input channels Conversion time : 26.3 μs (per one channel)		

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MB90435 Series

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Features	MB90F438L (S) /F439 (S)	MB90437L (S) *1 /438L (S) /439 (S)	MB90V540G
16-bit Reload Timer (2 channels)	Operation clock frequency : $f_{sys}/2^1$, $f_{sys}/2^3$, $f_{sys}/2^5$ (f_{sys} = System clock frequency) Supports External Event Count function Signals an interrupt when overflow		
16-bit I/O Timer	Supports Timer Clear when a match with Output Compare (Channel 0) Operation clock freq. : $f_{sys}/2^2$, $f_{sys}/2^4$, $f_{sys}/2^6$, $f_{sys}/2^8$ (f_{sys} = System clock freq.)		
16-bit Output Compare (4 channels)	Signals an interrupt when a match with 16-bit I/O Timer Four 16-bit compare registers A pair of compare registers can be used to generate an output signal		
16-bit Input Capture (8 channels)	Rising edge, falling edge or rising & falling edge sensitive Four 16-bit Capture registers Signals an interrupt upon external event		
8/16-bit Programmable Pulse Generator (4 channels)	Supports 8-bit and 16-bit operation modes Eight 8-bit reload counters Eight 8-bit reload registers for L pulse width Eight 8-bit reload registers for H pulse width A pair of 8-bit reload counters can be configured as one 16-bit reload counter or as 8-bit prescaler plus 8-bit reload counter 4 output pins Operation clock freq. : f_{sys} , $f_{sys}/2^1$, $f_{sys}/2^2$, $f_{sys}/2^3$, $f_{sys}/2^4$ or 128 μs @ $f_{osc} = 4$ MHz (f_{sys} = System clock frequency, f_{osc} = Oscillation clock frequency)		
32 kHz Sub-clock	Sub-clock for low power operation		
External Interrupt (8 channels)	Can be programmed edge sensitive or level sensitive		
External bus interface	External access using the selectable 8-bit or 16-bit bus is enabled (external bus mode.)		
I/O Ports	Virtually all external pins can be used as general purpose I/O All push-pull outputs and schmitt trigger inputs Bit-wise programmable as input/output or peripheral signal		
Flash Memory	Supports automatic programming, Embedded Algorithm TM ⁴ Write/Erase/Erase-Suspend/Erase-Resume commands A flag indicating completion of the algorithm Number of erase cycles : 10,000 times Data retention time : 10 years Boot block configuration Erase can be performed on each block Block protection by externally programmed voltage		

*1 : Under development

*2 : If the one clock system is used, equip X0A and X1A with clocks from the tool side.

*3 : It is setting of DIP switch S2 when Emulator pod (MB2145-507) is used. Please refer to the MB2145-507 hardware manual (2.7 Emulator-specific Power Pin) about details.

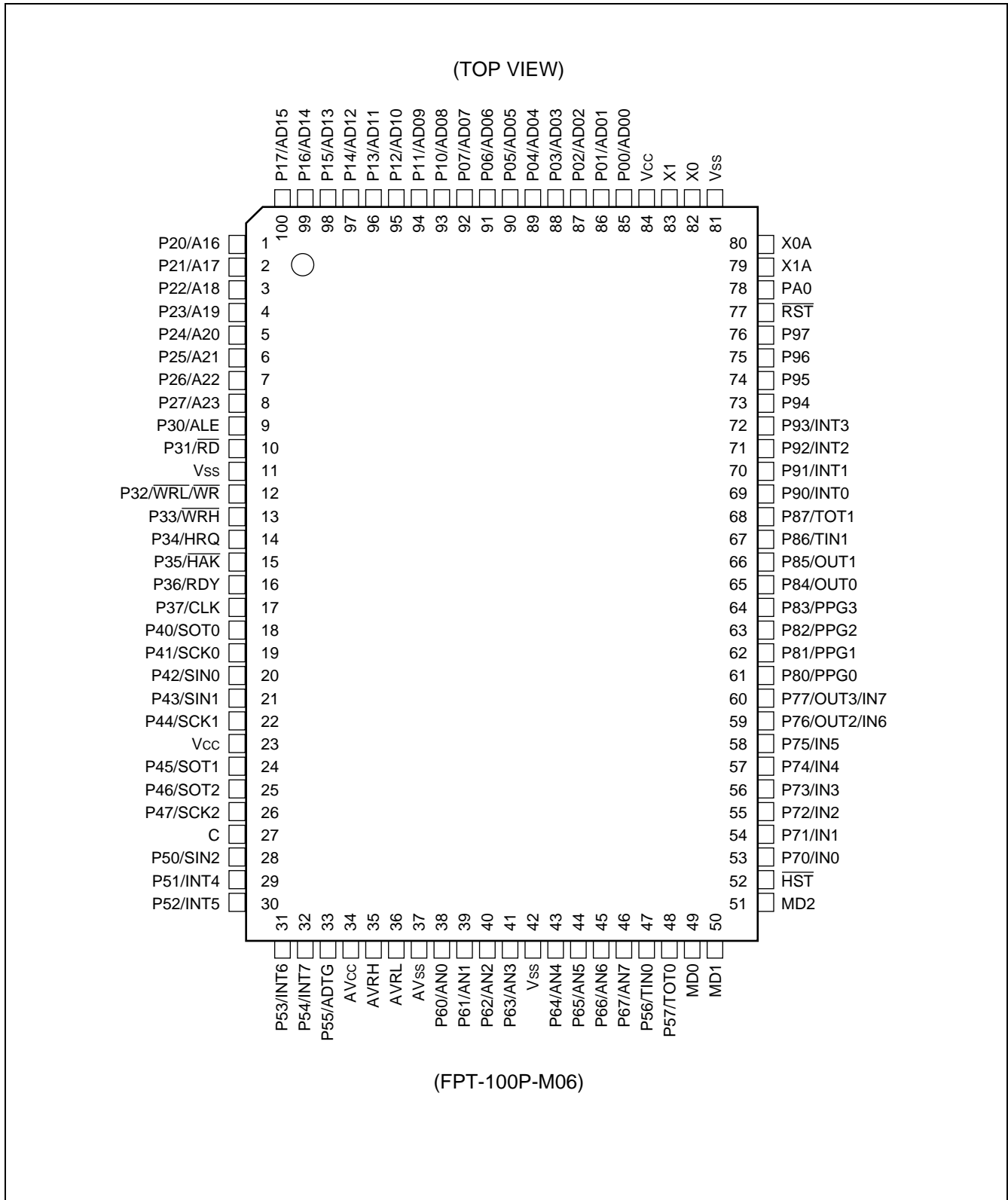
*4 : Embedded Algorithm is a trade mark of Advanced Micro Devices Inc.

*5 : OPERATING VOLTAGE RANGE

Products	Operation guarantee range
MB90F439 (S) /439 (S) /V540G	4.5 V to 5.5 V
MB90F438L (S) /437L (S) /438L (S)	3.5 V to 5.5 V

MB90435 Series

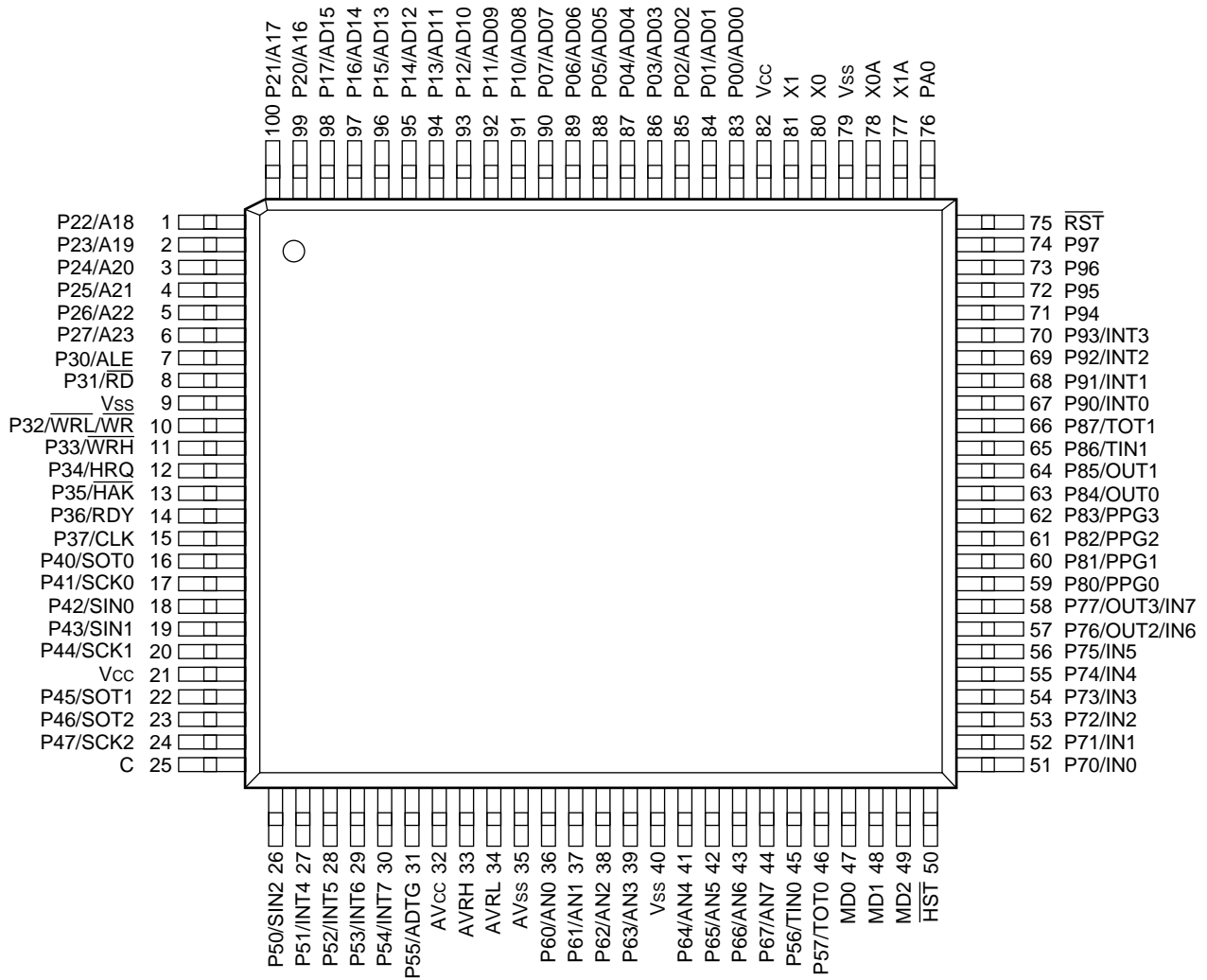
PIN ASSIGNMENT



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(TOP VIEW)



(FPT-100P-M05)

MB90435 Series

■ PIN DESCRIPTION

Pin No.		Pin name	Circuit type	Function
LQFP ²	QFP ¹			
80 81	82 83	X0 X1	A (Oscillation)	High speed crystal oscillator input pins
78	80	X0A	A (Oscillation)	Low speed crystal oscillator input pins. For the one clock system parts, perform external pull-down processing.
77	79	X1A		Low speed crystal oscillator input pins. For the one clock system parts, leave it open.
75	77	$\overline{\text{RST}}$	B	External reset request input pin
50	52	$\overline{\text{HST}}$	C	Hardware standby input pin
83 to 90	85 to 92	P00 to P07	I	General I/O port with programmable pull-up. This function is enabled in the single-chip mode.
		AD00 to AD07		I/O pins for 8 lower bits of the external address/data bus. This function is enabled when the external bus is enabled.
91 to 98	93 to 100	P10 to P17	I	General I/O port with programmable pull-up. This function is enabled in the single-chip mode.
		AD08 to AD15		I/O pins for 8 higher bits of the external address/data bus. This function is enabled when the external bus is enabled.
99 to 6	1 to 8	P20 to P27	I	General I/O port with programmable pull-up. In external bus mode, this function is valid when the corresponding bits in the external address output control register (HACR) are set to "1".
		A16 to A23		8-bit output pins for A16 to A23 at the external address bus. In external bus mode, this function is valid when the corresponding bits in the external address output control register (HACR) are set to "0".
7	9	P30	I	General I/O port with programmable pull-up. This function is enabled in the single-chip mode.
		ALE		Address latch enable output pin. This function is enabled when the external bus is enabled.
8	10	P31	I	General I/O port with programmable pull-up. This function is enabled in the single-chip mode.
		$\overline{\text{RD}}$		Read strobe output pin for the data bus. This function is enabled when the external bus is enabled.
10	12	P32	I	General I/O port with programmable pull-up. This function is enabled in the single-chip mode or when the $\overline{\text{WR}}/\overline{\text{WRL}}$ pin output is disabled.
		$\overline{\text{WRL}}$		Write strobe output pin for the data bus. This function is enabled when both the external bus and the $\overline{\text{WR}}/\overline{\text{WRL}}$ pin output are enabled. $\overline{\text{WRL}}$ is write-strobe output pin for the lower 8 bits of the data bus in 16-bit access. $\overline{\text{WR}}$ is write-strobe output pin for the 8 bits of the data bus in 8-bit access.
		$\overline{\text{WR}}$		

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MB90435 Series

Pin No.		Pin name	Circuit type	Function
LQFP ^{*2}	QFP ^{*1}			
11	13	P33	I	General I/O port with programmable pull-up. This function is enabled in the single-chip mode, external bus 8-bit mode or when $\overline{\text{WRH}}$ pin output is disabled.
		$\overline{\text{WRH}}$		Write strobe output pin for the 8 higher bits of the data bus. This function is enabled when the external bus is enabled, when the external bus 16-bit mode is selected, and when the $\overline{\text{WRH}}$ output pin is enabled.
12	14	P34	I	General I/O port with programmable pull-up. This function is enabled in the single-chip mode or when the hold function is disabled.
		HRQ		Hold request input pin. This function is enabled when both the external bus and the hold functions are enabled.
13	15	P35	I	General I/O port with programmable pull-up. This function is enabled in the single-chip mode or when the hold function is disabled.
		$\overline{\text{HAK}}$		Hold acknowledge output pin. This function is enabled when both the external bus and the hold functions are enabled.
14	16	P36	I	General I/O port with programmable pull-up. This function is enabled in the single-chip mode or when the external ready function is disabled.
		RDY		Ready input pin. This function is enabled when both the external bus and the external ready functions are enabled.
15	17	P37	H	General I/O port with programmable pull-up. This function is enabled in the single-chip mode or when the CLK output is disabled.
		CLK		CLK output pin. This function is enabled when both the external bus and CLK outputs are enabled.
16	18	P40	G	General I/O port. This function is enabled when UART0 disables the serial data output.
		SOT0		Serial data output pin for UART0. This function is enabled when UART0 enables the serial data output.
17	19	P41	G	General I/O port. This function is enabled when UART0 disables serial clock output.
		SCK0		Serial clock I/O pin for UART0. This function is enabled when UART0 enables the serial clock output.
18	20	P42	G	General I/O port. This function is always enabled.
		SIN0		Serial data input pin for UART0. Set the corresponding Port Direction Register to input if this function is used.
19	21	P43	G	General I/O port. This function is always enabled.
		SIN1		Serial data input pin for UART1. Set the corresponding Port Direction Register to input if this function is used.

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MB90435 Series

Pin No.		Pin name	Circuit type	Function
LQFP ^{*2}	QFP ^{*1}			
20	22	P44	G	General I/O port. This function is enabled when UART1 disables the clock output.
		SCK1		Serial clock pulse I/O pin for UART1. This function is enabled when UART1 enables the serial clock output.
22	24	P45	G	General I/O port. This function is enabled when UART1 disables the serial data output.
		SOT1		Serial data output pin for UART1. This function is enabled when UART1 enables the serial data output.
23	25	P46	G	General I/O port. This function is enabled when the Extended I/O serial interface disables the serial data output.
		SOT2		Serial data output pin for the Extended I/O serial interface. This function is enabled when the Extended I/O serial interface enables the serial data output.
24	26	P47	G	General I/O port. This function is enabled when the Extended I/O serial interface disables the clock output.
		SCK2		Serial clock pulse I/O pin for the Extended I/O serial interface . This function is enabled when the Extended I/O serial interface enables the Serial clock output.
26	28	P50	D	General I/O port. This function is always enabled.
		SIN2		Serial data input pin for the Extended I/O serial interface . Set the corresponding Port Direction Register to input if this function is used.
27 to 30	29 to 32	P51 to P54	D	General I/O port. This function is always enabled.
		INT4 to INT7		External interrupt request input pins for INT4 to INT7. Set the corresponding Port Direction Register to input if this function is used.
31	33	P55	D	General I/O port. This function is always enabled.
		ADTG		Trigger input pin for the A/D converter. Set the corresponding Port Direction Register to input if this function is used.
36 to 39	38 to 41	P60 to P63	E	General I/O port. This function is enabled when the analog input enable register specifies a port.
		AN0 to AN3		Analog input pins for the 8/10-bit A/D converter. This function is enabled when the analog input enable register specifies A/D.
41 to 44	43 to 46	P64 to P67	E	General I/O port. The function is enabled when the analog input enable register specifies a port.
		AN4 to AN7		Analog input pins for the 8/10-bit A/D converter. This function is enabled when the analog input enable register specifies A/D.
45	47	P56	D	General I/O port. This function is always enabled.
		TIN0		Event input pin for the 16-bit reload timers 0. Set the corresponding Port Direction Register to input if this function is used.

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MB90435 Series

Pin No.		Pin name	Circuit type	Function
LQFP ²	QFP ¹			
46	48	P57	D	General I/O port. This function is enabled when the 16-bit reload timers 0 disables the output.
		TOT0		Output pin for the 16-bit reload timers 0. This function is enabled when the 16-bit reload timers 0 enables the output.
51 to 56	53 to 58	P70 to P75	D	General I/O ports. This function is always enabled.
		IN0 to IN5		Trigger input pins for input captures ICU0 to ICU5. Set the corresponding Port Direction Register to input if this function is used.
57 , 58	59 , 60	P76 , P77	D	General I/O ports. This function is enabled when the OCU disables the waveform output.
		OUT2 , OUT3		Event output pins for output compares OCU2 and OCU3. This function is enabled when the OCU enables the waveform output.
		IN6 , IN7		Trigger input pins for input captures ICU6 and ICU7. Set the corresponding Port Direction Register to input and disable the OCU waveform output if this function is used.
59 , 62	61 to 64	P80 to P83	D	General I/O ports. This function is enabled when 8/16-bit PPG disables the waveform output.
		PPG0 to PPG3		Output pins for 8/16-bit PPGs. This function is enabled when 8/16-bit PPG enables the waveform output.
63 , 64	65 , 66	P84 , P85	D	General I/O ports. This function is enabled when the OCU disables the waveform output.
		OUT0 , OUT1		Waveform output pins for output compares OCU0 and OCU1. This function is enabled when the OCU enables the waveform output.
65	67	P86	D	General I/O port. This function is always enabled.
		TIN1		Input pin for the 16-bit reload timers 1. Set the corresponding Port Direction Register to input if this function is used.
66	68	P87	D	General I/O port. This function is enabled when the 16-bit reload timers 0 disables the output.
		TOT1		Output pin for the 16-bit reload timers 1. This function is enabled when the 16-bit reload timers 1 enables the output.
67 to 70	69 to 72	P90 to P93	D	General I/O port. This function is always enabled.
		INT0 to INT3		External interrupt request input pins for INT0 to INT3. Set the corresponding Port Direction Register to input if this function is used.
71	73	P94	D	General I/O port.

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MB90435 Series

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Pin No.		Pin name	Circuit type	Function
LQFP*2	QFP*1			
72	74	P95	D	General I/O port.
73	75	P96	D	General I/O port.
74	76	P97	D	General I/O port.
76	78	PA0	D	General I/O port.
32	34	AV _{CC}	Power supply	Power supply pin for the A/D Converter. This power supply must be turned on or off while a voltage higher than or equal to AV _{CC} is applied to V _{CC} .
35	37	AV _{SS}	Power supply	Power supply pin for the A/D Converter.
33	35	AVRH	Power supply	External reference voltage input pin for the A/D Converter. This power supply must be turned on or off while a voltage higher than or equal to AVRH is applied to AV _{CC} .
34	36	AVRL	Power supply	External reference voltage input pin for the A/D Converter.
47 48	49 50	MD0 MD1	C	Input pins for specifying the operating mode. The pins must be directly connected to V _{CC} or V _{SS} .
49	51	MD2	F	Input pin for specifying the operating mode. The pin must be directly connected to V _{CC} or V _{SS} .
25	27	C	—	Power supply stabilization capacitor pin. It should be connected externally to an 0.1 μF ceramic capacitor.
21, 82	23, 84	V _{CC}	Power supply	Input pin for power supply (5.0 V) .
9, 40, 79	11, 42, 81	V _{SS}	Power supply	Input pin for power supply (0.0 V) .

*1 : FPT-100P-M06

*2 : FPT-100P-M05

■ I/O CIRCUIT TYPE

Circuit type	Diagram	Remarks
A		<ul style="list-style-type: none"> • High-speed oscillation feedback resistor : 1 MΩ approx. • Low-speed oscillation feedback resistor : 10 MΩ approx.
B		<ul style="list-style-type: none"> • Hysteresis input • Pull-up resistor : 50 kΩ approx.
C		<ul style="list-style-type: none"> • Hysteresis input
D		<ul style="list-style-type: none"> • CMOS level output • CMOS Hysteresis input

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MB90435 Series

Circuit type	Diagram	Remarks
E		<ul style="list-style-type: none"> • CMOS level output • CMOS Hysteresis input • Analog input
F		<ul style="list-style-type: none"> • Hysteresis input • Pull-down Resistor : 50 kΩ approx. (except FLASH devices)
G		<ul style="list-style-type: none"> • CMOS level output • CMOS Hysteresis input • TTL level input (FLASH devices in FLASH writer mode only)

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Circuit type	Diagram	Remarks
H	<p>The diagram for circuit type H shows a pull-up transistor (P-ch) connected to Vcc and a pull-down transistor (N-ch) connected to ground. A 'Pull-up ON/OFF select signal' is connected to the gate of the P-ch transistor. The output node is connected to a resistor R and a hysteresis input (HYS input) through an inverter.</p>	<ul style="list-style-type: none"> • CMOS level output • CMOS Hysteresis input • Programmable pull-up resistor : 50 kΩ approx.
I	<p>The diagram for circuit type I shows a pull-up transistor (P-ch) connected to Vcc and a pull-down transistor (N-ch) connected to ground. A 'Pull-up ON/OFF select signal' is connected to the gate of the P-ch transistor. The output node is connected to two resistors R, each leading to a different input: a hysteresis input (HYS input) through an inverter and a TTL level input through a buffer.</p>	<ul style="list-style-type: none"> • CMOS level output • CMOS Hysteresis input • TTL level input (FLASH devices in FLASH writer mode only) • Programmable pull-up resistor : 50 kΩ approx.

MB90435 Series

■ HANDLING DEVICES

(1) Preventing latch-up

CMOS IC chips may suffer latch-up under the following conditions :

- A voltage higher than V_{CC} or lower than V_{SS} is applied to an input or output pin.
- A voltage higher than the rated voltage is applied between V_{CC} and V_{SS} .
- The AV_{CC} power supply is applied before the V_{CC} voltage.

Latch-up may increase the power supply current drastically, causing thermal damage to the device.

For the same reason, care must also be taken in not allowing the analog power-supply voltage (AV_{CC} , $AVRH$) to exceed the digital power-supply voltage.

(2) Handling unused pins

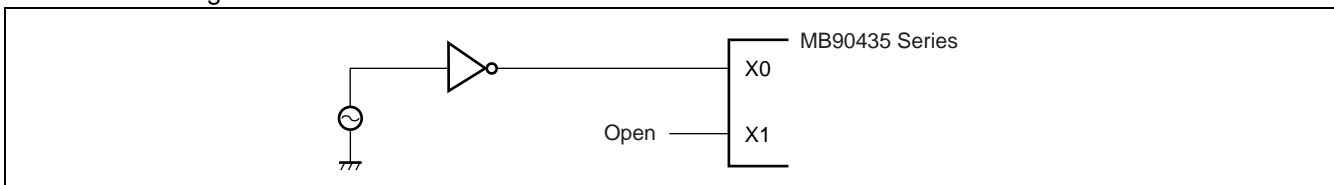
Leaving unused input pins open may result in misbehavior or latch up and possible permanent damage of the device. Therefore they must be pulled up or pulled down through resistors. In this case those resistors should be more than 2 k Ω .

Unused bi-directional pins should be set to the output state and can be left open, or the input state with the above described connection.

(3) Using external clock

To use external clock, drive X0 pin only and leave X1 pin unconnected.

Below is a diagram of how to use external clock.



(4) Use of the sub-clock

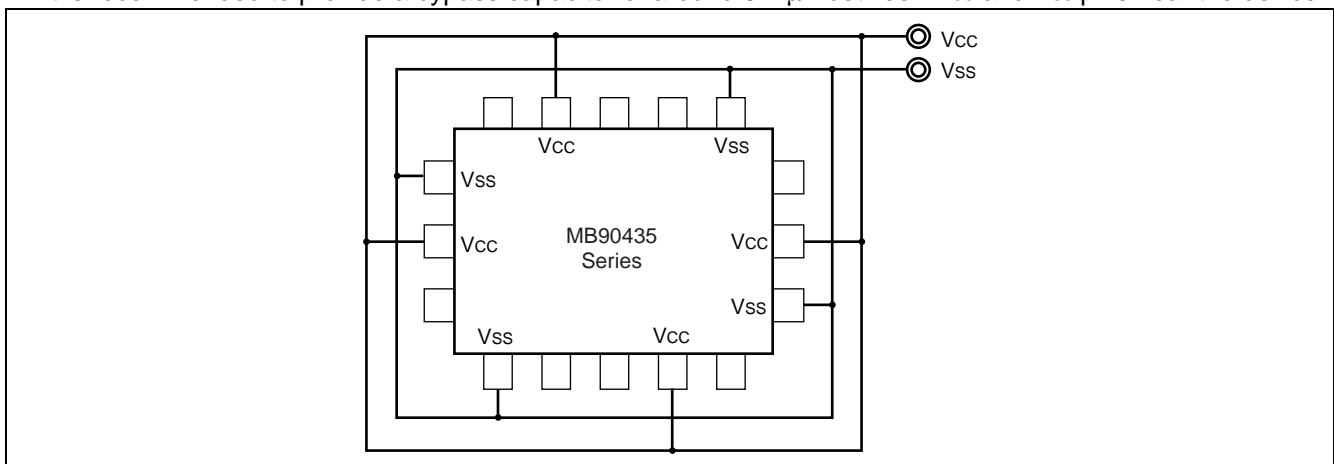
Use one clock system parts when the sub-clock is not used. In that case, pull-down the pin X0A and leave the pin X1A open. When using two clock system parts, a 32 kHz oscillator has to be connected to the X0A and X1A pins.

(5) Power supply pins (V_{CC}/V_{SS})

In products with multiple V_{CC} or V_{SS} pins, the pins of a same potential are internally connected in the device to avoid abnormal operations including latch-up. However you must connect the pins to an external power and a ground line to lower the electro-magnetic emission level to prevent abnormal operation of strobe signals caused by the rise in the ground level, and to conform to the total current rating.

Make sure to connect V_{CC} and V_{SS} pins via the lowest impedance to power lines.

It is recommended to provide a bypass capacitor of around 0.1 μF between V_{CC} and V_{SS} pins near the device.



(6) Pull-up/down resistors

The MB90435 Series does not support internal pull-up/down resistors (except Port0 – Port3 : pull-up resistors) . Use external components where needed.

(7) Crystal Oscillator Circuit

Noises around X0 or X1 pins may be possible causes of abnormal operations. Make sure to provide bypass capacitors via the shortest distances from X0, X1 pins, crystal oscillator (or ceramic resonator) and ground lines, and make sure, to the utmost effort, that lines of oscillation circuits do not cross the lines of other circuits.

It is highly recommended to provide a printed circuit board artwork surrounding X0 and X1 pins with a ground area for stabilizing the operation.

(8) Turning-on Sequence of Power Supply to A/D Converter and Analog Inputs

Make sure to turn on the A/D converter power supply (AV_{CC} , $AVRH$, $AVRL$) and analog inputs ($AN0$ to $AN7$) after turning-on the digital power supply (V_{CC}) .

Turn-off the digital power after turning off the A/D converter supply and analog inputs. In this case, make sure that the voltage does not exceed $AVRH$ or AV_{CC} (turning on/off the analog and digital power supplies simultaneously is acceptable) .

(9) Connection of Unused Pins of A/D Converter

Connect unused pins of A/D converter to $AV_{CC} = V_{CC}$, $AV_{SS} = AVRH = V_{SS}$.

(10) N.C. Pin

The N.C. (internally connected) pin must be opened for use.

(11) Notes on Energization

To prevent the internal regulator circuit from malfunctioning, set the voltage rise time during energization at 50 μ s or more (0.2 V to 2.7 V) .

(12) Initialization

In the device, there are internal registers which are initialized only by a power-on reset. To initialize these registers, please turn on the power again.

(13) Directions of “DIV A, Ri” and “DIVW A, RWi” instructions

In the Signed multiplication and division instructions (“DIV A, Ri” and “DIVW A, RWi”) , the value of the corresponding bank register (DTB, ADB, USB, SSB) is set in “00H”.

If the values of the corresponding bank registers (DTB, ADB, USB, SSB) are set to other than “00H”, the remainder by the execution result of the instruction is not stored in the register of the instruction operand.

(14) Using REALOS

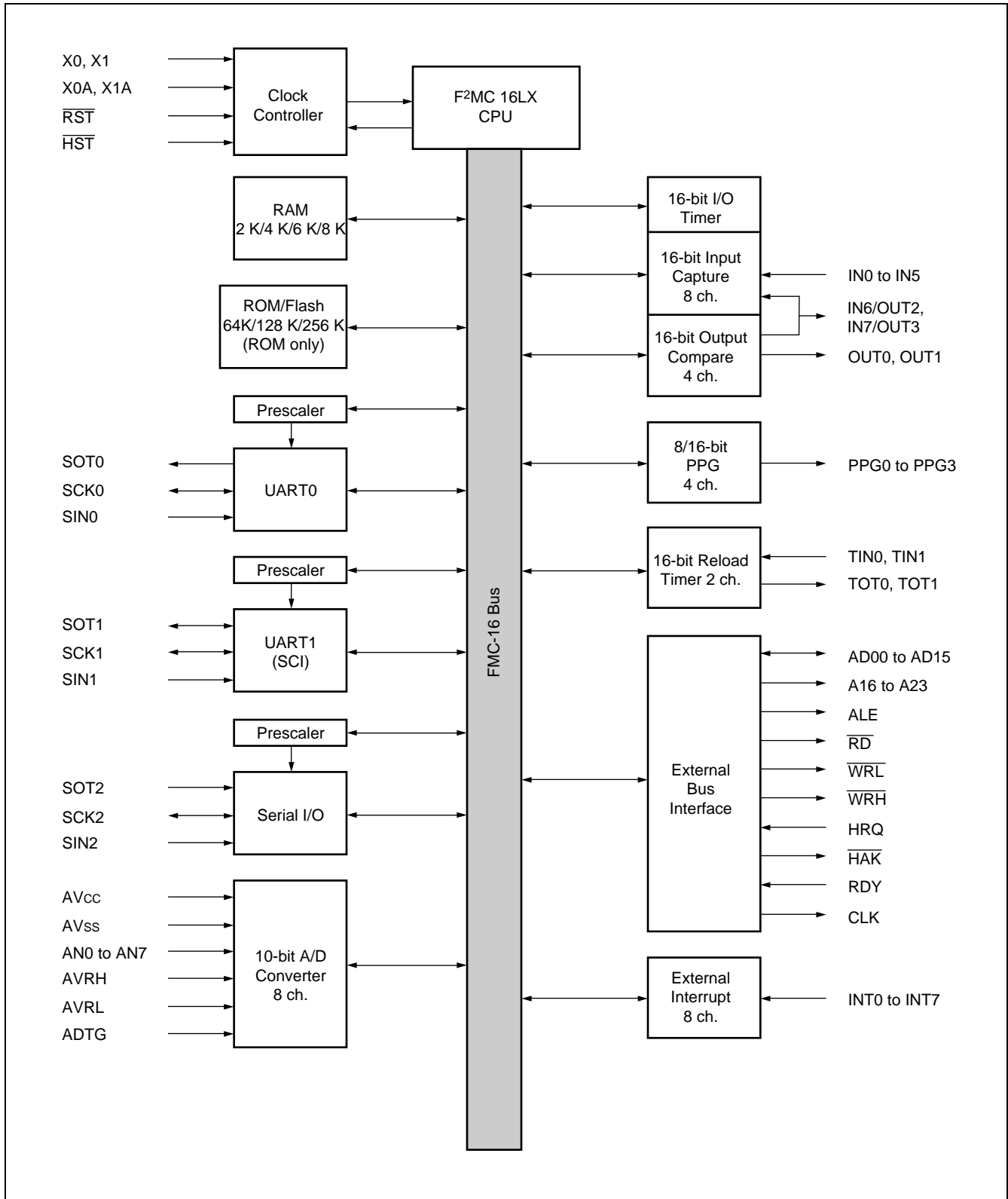
The use of EI²OS is not possible with the REALOS real time operating system.

(15) Caution on Operations during PLL Clock Mode

If the PLL clock mode is selected, the microcontroller attempt to be working with the self-oscillating circuit even when there is no external oscillator or external clock input is stopped. Performance of this operation, however, cannot be guaranteed.

MB90435 Series

■ BLOCK DIAGRAM



MEMORY MAP

The memory space of the MB90435 Series is shown below.

MB90V540G		MB90F437L (S)*		MB90F438L (S)/438L (S)		MB90F439 (S) /439 (S)	
FFFFFFH	ROM (FF bank)	FFFFFFH	ROM (FF bank)	FFFFFFH	ROM (FF bank)	FFFFFFH	ROM (FF bank)
FF0000H		FF0000H		FF0000H		FF0000H	
FEFFFFH	ROM (FE bank)			FEFFFFH	ROM (FE bank)	FEFFFFH	ROM (FE bank)
FE0000H				FE0000H		FE0000H	
FDFFFFH	ROM (FD bank)					FDFFFFH	ROM (FD bank)
FD0000H			External			FD0000H	
FCFFFFH	ROM (FC bank)					FCFFFFH	ROM (FC bank)
FC0000H						FC0000H	
	External						External
00FFFFH	ROM (Image of FF bank)	00FFFFH	ROM (Image of FF bank)	00FFFFH	ROM (Image of FF bank)	00FFFFH	ROM (Image of FF bank)
004000H		004000H		004000H		004000H	
003FFFH	Peripheral	003FFFH	Peripheral	003FFFH	Peripheral	003FFFH	Peripheral
003900H		003900H		003900H		003900H	
	External						External
0020FFH		002000H		002000H		002100H	
001FF5H	ROM correction					0018FFH	
001FF0H							RAM 6 K
	RAM 8 K	0008FFH		0010FFH	RAM 4 K		
000100H		000100H	RAM 2 K	000100H		000100H	
	External	000100H					External
0000BFH		0000BFH		0000BFH		0000BFH	
000000H	Peripheral	000000H	Peripheral	000000H	Peripheral	000000H	Peripheral

* : Under development

Note : The high-order portion of bank 00 gives the image of the FF bank ROM to make the small model of the C compiler effective. Since the low-order 16 bits address are the same, the table in ROM can be referenced without using the "far" specification in the pointer declaration.
 For example, an attempt to access 00C000H accesses the value at FFC000H in ROM. The ROM area in bank FF exceeds 48 Kbytes, and its entire image cannot be shown in bank 00. The image between FF4000H and FFFFFFFH is visible in bank 00, while the image between FF0000H and FF3FFFH is visible only in bank FF.

MB90435 Series

■ I/O MAP

Address	Register	Abbreviation	Access	Resource name	Initial value
00H	Port 0 data register	PDR0	R/W	Port 0	XXXXXXXX _B
01H	Port 1 data register	PDR1	R/W	Port 1	XXXXXXXX _B
02H	Port 2 data register	PDR2	R/W	Port 2	XXXXXXXX _B
03H	Port 3 data register	PDR3	R/W	Port 3	XXXXXXXX _B
04H	Port 4 data register	PDR4	R/W	Port 4	XXXXXXXX _B
05H	Port 5 data register	PDR5	R/W	Port 5	XXXXXXXX _B
06H	Port 6 data register	PDR6	R/W	Port 6	XXXXXXXX _B
07H	Port 7 data register	PDR7	R/W	Port 7	XXXXXXXX _B
08H	Port 8 data register	PDR8	R/W	Port 8	XXXXXXXX _B
09H	Port 9 data register	PDR9	R/W	Port 9	XXXXXXXX _B
0AH	Port A data register	PDRA	R/W	Port A	_____X _B
0BH to 0FH	Reserved				
10H	Port 0 direction register	DDR0	R/W	Port 0	0 0 0 0 0 0 0 0 _B
11H	Port 1 direction register	DDR1	R/W	Port 1	0 0 0 0 0 0 0 0 _B
12H	Port 2 direction register	DDR2	R/W	Port 2	0 0 0 0 0 0 0 0 _B
13H	Port 3 direction register	DDR3	R/W	Port 3	0 0 0 0 0 0 0 0 _B
14H	Port 4 direction register	DDR4	R/W	Port 4	0 0 0 0 0 0 0 0 _B
15H	Port 5 direction register	DDR5	R/W	Port 5	0 0 0 0 0 0 0 0 _B
16H	Port 6 direction register	DDR6	R/W	Port 6	0 0 0 0 0 0 0 0 _B
17H	Port 7 direction register	DDR7	R/W	Port 7	0 0 0 0 0 0 0 0 _B
18H	Port 8 direction register	DDR8	R/W	Port 8	0 0 0 0 0 0 0 0 _B
19H	Port 9 direction register	DDR9	R/W	Port 9	0 0 0 0 0 0 0 0 _B
1AH	Port A direction register	DDRA	R/W	Port A	_____0 _B
1BH	Analog Input Enable register	ADER	R/W	Port 6, A/D	1 1 1 1 1 1 1 1 _B
1CH	Port 0 pull-up control register	PUCR0	R/W	Port 0	0 0 0 0 0 0 0 0 _B
1DH	Port 1 pull-up control register	PUCR1	R/W	Port 1	0 0 0 0 0 0 0 0 _B
1EH	Port 2 pull-up control register	PUCR2	R/W	Port 2	0 0 0 0 0 0 0 0 _B
1FH	Port 3 pull-up control register	PUCR3	R/W	Port 3	0 0 0 0 0 0 0 0 _B
20H	Serial Mode Control Register 0	UMC0	R/W	UART0	0 0 0 0 0 1 0 0 _B
21H	Serial Status Register 0	USR0	R/W		0 0 0 1 0 0 0 0 _B
22H	Serial input data register 0/ Serial output data register 0	UIDR0/ UODR0	R/W		XXXXXXXX _B
23H	Rate and data register 0	URD0	R/W		0 0 0 0 0 0 0 X _B

(Continued)

MB90435 Series

Address	Register	Abbreviation	Access	Resource name	Initial value
24H	Serial mode register 1	SMR1	R/W	UART1	0 0 0 0 0 0 0 0 _B
25H	Serial control register 1	SCR1	R/W		0 0 0 0 0 1 0 0 _B
26H	Serial input data register 1/ Serial output data register 1	SIDR1/ SODR1	R/W		XXXXXXXX _B
27H	Serial status register 1	SSR1	R/W		0 0 0 0 1_0 0 _B
28H	UART1 prescaler control register	U1CDCR	R/W		0_ _ _ 1 1 1 1 _B
29H	Serial Edge select register	SES1	R/W		_ _ _ _ _ _ 0 _B
2AH	Prohibited				
2BH	Serial I/O prescaler	SCDCR	R/W	Extended I/O Serial Interface	0_ _ _ 1 1 1 1 _B
2CH	Serial mode control register	SMCS	R/W		_ _ _ _ 0 0 0 0 _B
2DH	Serial mode control register	SMCS	R/W		0 0 0 0 0 1 0 _B
2EH	Serial data register	SDR	R/W		XXXXXXXX _B
2FH	Serial Edge select register	SES2	R/W		_ _ _ _ _ _ 0 _B
30H	External interrupt enable register	ENIR	R/W		External Interrupt
31H	External interrupt request register	EIRR	R/W	XXXXXXXX _B	
32H	External interrupt level register	ELVR	R/W	0 0 0 0 0 0 0 0 _B	
33H	External interrupt level register	ELVR	R/W	0 0 0 0 0 0 0 0 _B	
34H	A/D control status register 0	ADCS0	R/W	A/D Converter	0 0 0 0 0 0 0 0 _B
35H	A/D control status register 1	ADCS1	R/W		0 0 0 0 0 0 0 0 _B
36H	A/D data register 0	ADCR0	R		XXXXXXXX _B
37H	A/D data register 1	ADCR1	R/W		0 0 0 0 1_ _ XX _B
38H	PPG0 operation mode control register	PPGC0	R/W	16-bit Programmable Pulse Generator 0/1	0_ 0 0 0_ _ 1 _B
39H	PPG1 operation mode control register	PPGC1	R/W		0_ 0 0 0 0 0 1 _B
3AH	PPG0/1 clock selection register	PPG01	R/W		0 0 0 0 0 0_ _ _B
3BH	Prohibited				
3CH	PPG2 operation mode control register	PPGC2	R/W	16-bit Programmable Pulse Generator 2/3	0_ 0 0 0_ _ 1 _B
3DH	PPG3 operation mode control register	PPGC3	R/W		0_ 0 0 0 0 0 1 _B
3EH	PPG2/3 Clock Selection Register	PPG23	R/W		0 0 0 0 0 0_ _ _B
3FH	Prohibited				
40H	PPG4 operation mode control register	PPGC4	R/W	16-bit Programmable Pulse Generator 4/5	0_ 0 0 0_ _ 1 _B
41H	PPG5 operation mode control register	PPGC5	R/W		0_ 0 0 0 0 0 1 _B
42H	PPG4/5 clock selection register	PPG45	R/W		0 0 0 0 0 0_ _ _B
43H	Prohibited				
44H	PPG6 operation mode control register	PPGC6	R/W	16-bit Programmable Pulse Generator 6/7	0_ 0 0 0_ _ 1 _B
45H	PPG7 operation mode control register	PPGC7	R/W		0_ 0 0 0 0 0 1 _B
46H	PPG6/7 clock selection register	PPG67	R/W		0 0 0 0 0 0_ _ _B

(Continued)

MB90435 Series

Address	Register	Abbreviation	Access	Resource name	Initial value
47 _H to 4B _H	Prohibited				
4C _H	Input capture control status register 0/1	ICS01	R/W	Input Capture 0/1	0 0 0 0 0 0 0 0 _B
4D _H	Input capture control status register 2/3	ICS23	R/W	Input Capture 2/3	0 0 0 0 0 0 0 0 _B
4E _H	Input capture control status register 4/5	ICS45	R/W	Input Capture 4/5	0 0 0 0 0 0 0 0 _B
4F _H	Input capture control status register 6/7	ICS67	R/W	Input Capture 6/7	0 0 0 0 0 0 0 0 _B
50 _H	Timer control status register 0	TMCSR0	R/W	16-bit Reload Timer 0	0 0 0 0 0 0 0 0 _B
51 _H	Timer control status register 0	TMCSR0	R/W		__ __ __ 0 0 0 0 _B
52 _H	Timer register 0/reload register 0	TMR0/ TMRLR0	R/W		XXXXXXXX _B
53 _H	Timer register 0/reload register 0	TMR0/ TMRLR0	R/W		XXXXXXXX _B
54 _H	Timer control status register 1	TMCSR1	R/W	16-bit Reload Timer 1	0 0 0 0 0 0 0 0 _B
55 _H	Timer control status register 1	TMCSR1	R/W		__ __ __ 0 0 0 0 _B
56 _H	Timer register 1/reload register 1	TMR1/ TMRLR1	R/W		XXXXXXXX _B
57 _H	Timer register 1/reload register 1	TMR1/ TMRLR1	R/W		XXXXXXXX _B
58 _H	Output compare control status register 0	OCS0	R/W	Output Compare 0/1	0 0 0 0 __ 0 0 _B
59 _H	Output compare control status register 1	OCS1	R/W		__ __ 0 0 0 0 0 _B
5A _H	Output compare control status register 2	OCS2	R/W	Output Compare 2/3	0 0 0 0 __ 0 0 _B
5B _H	Output compare control status register 3	OCS3	R/W		__ __ 0 0 0 0 0 _B
5C _H to 6B _H	Prohibited				
6C _H	Timer Counter Data register	TCDT	R/W	I/O Timer	0 0 0 0 0 0 0 0 _B
6D _H	Timer Counter Data register	TCDT	R/W		0 0 0 0 0 0 0 0 _B
6E _H	Timer Counter Control status register	TCCS	R/W		0 0 0 0 0 0 0 0 _B
6F _H	ROM mirror function selection register	ROMM	R/W	ROM Mirror	__ __ __ __ __ 1 _B
70 _H to 7F _H	Reserved				
80 _H to 8F _H	Reserved				
90 _H to 9D _H	Prohibited				
9E _H	Program address detection control status register	PACSR	R/W	Address Match Detection Function	0 0 0 0 0 0 0 0 _B
9F _H	Delayed interrupt/release register	DIRR	R/W	Delayed Interrupt	__ __ __ __ __ 0 _B
A0 _H	Low-power mode control register	LPMCR	R/W	Low Power Controller	0 0 0 1 1 0 0 0 _B
A1 _H	Clock selection register	CKSCR	R/W	Low Power Controller	1 1 1 1 1 1 0 0 _B

(Continued)

MB90435 Series

(Continued)

Address	Register	Abbreviation	Access	Resource name	Initial value
A2 _H to A4 _H	Prohibited				
A5 _H	Automatic ready function select register	ARSR	W	External Memory Access	0011__00 _B
A6 _H	External address output control register	HACR	W		00000000 _B
A7 _H	Bus control signal selection register	ECSR	W		0000000_ _B
A8 _H	Watchdog Timer control register	WDTC	R/W	Watchdog Timer	XXXXX111 _B
A9 _H	Time Base Timer Control register	TBTC	R/W	Time Base Timer	1--00100 _B
AA _H	Watch timer control register	WTC	R/W	Watch Timer	1X000000 _B
AB _H to AD _H	Prohibited				
AE _H	Flash memory control status register (Flash only, otherwise reserved)	FMCS	R/W	Flash Memory	000X0000 _B
AF _H	Prohibited				
B0 _H	Interrupt control register 00	ICR00	R/W	Interrupt controller	00000111 _B
B1 _H	Interrupt control register 01	ICR01	R/W		00000111 _B
B2 _H	Interrupt control register 02	ICR02	R/W		00000111 _B
B3 _H	Interrupt control register 03	ICR03	R/W		00000111 _B
B4 _H	Interrupt control register 04	ICR04	R/W		00000111 _B
B5 _H	Interrupt control register 05	ICR05	R/W		00000111 _B
B6 _H	Interrupt control register 06	ICR06	R/W		00000111 _B
B7 _H	Interrupt control register 07	ICR07	R/W		00000111 _B
B8 _H	Interrupt control register 08	ICR08	R/W		00000111 _B
B9 _H	Interrupt control register 09	ICR09	R/W		00000111 _B
BA _H	Interrupt control register 10	ICR10	R/W		00000111 _B
BB _H	Interrupt control register 11	ICR11	R/W		00000111 _B
BC _H	Interrupt control register 12	ICR12	R/W		00000111 _B
BD _H	Interrupt control register 13	ICR13	R/W		00000111 _B
BE _H	Interrupt control register 14	ICR14	R/W		00000111 _B
BF _H	Interrupt control register 15	ICR15	R/W		00000111 _B
C0 _H to FF _H	External				

Address	Register	Abbreviation	Access	Resource name	Initial value
1FF0 _H	Program address detection register 0	PADR0	R/W	Address Match Detection Function	XXXXXXXX _B
1FF1 _H	Program address detection register 0	PADR0	R/W		XXXXXXXX _B
1FF2 _H	Program address detection register 0	PADR0	R/W		XXXXXXXX _B
1FF3 _H	Program address detection register 1	PADR1	R/W		XXXXXXXX _B
1FF4 _H	Program address detection register 1	PADR1	R/W		XXXXXXXX _B
1FF5 _H	Program address detection register 1	PADR1	R/W		XXXXXXXX _B

(Continued)

MB90435 Series

Address	Register	Abbreviation	Access	Resource name	Initial value
3900 _H	Reload L	PRL0	R/W	16-bit Programmable Pulse Generator 0/1	XXXXXXXX _B
3901 _H	Reload H	PRLH0	R/W		XXXXXXXX _B
3902 _H	Reload L	PRL1	R/W		XXXXXXXX _B
3903 _H	Reload H	PRLH1	R/W		XXXXXXXX _B
3904 _H	Reload L	PRL2	R/W	16-bit Programmable Pulse Generator 2/3	XXXXXXXX _B
3905 _H	Reload H	PRLH2	R/W		XXXXXXXX _B
3906 _H	Reload L	PRL3	R/W		XXXXXXXX _B
3907 _H	Reload H	PRLH3	R/W		XXXXXXXX _B
3908 _H	Reload L	PRL4	R/W	16-bit Programmable Pulse Generator 4/5	XXXXXXXX _B
3909 _H	Reload H	PRLH4	R/W		XXXXXXXX _B
390A _H	Reload L	PRL5	R/W		XXXXXXXX _B
390B _H	Reload H	PRLH5	R/W		XXXXXXXX _B
390C _H	Reload L	PRL6	R/W	16-bit Programmable Pulse Generator 6/7	XXXXXXXX _B
390D _H	Reload H	PRLH6	R/W		XXXXXXXX _B
390E _H	Reload L	PRL7	R/W		XXXXXXXX _B
390F _H	Reload H	PRLH7	R/W		XXXXXXXX _B
3910 _H to 3917 _H	Reserved				
3918 _H	Input Capture Register 0	IPCP0	R	Input Capture 0/1	XXXXXXXX _B
3919 _H	Input Capture Register 0	IPCP0	R		XXXXXXXX _B
391A _H	Input Capture Register 1	IPCP1	R		XXXXXXXX _B
391B _H	Input Capture Register 1	IPCP1	R		XXXXXXXX _B
391C _H	Input Capture Register 2	IPCP2	R	Input Capture 2/3	XXXXXXXX _B
391D _H	Input Capture Register 2	IPCP2	R		XXXXXXXX _B
391E _H	Input Capture Register 3	IPCP3	R		XXXXXXXX _B
391F _H	Input Capture Register 3	IPCP3	R		XXXXXXXX _B
3920 _H	Input Capture Register 4	IPCP4	R	Input Capture 4/5	XXXXXXXX _B
3921 _H	Input Capture Register 4	IPCP4	R		XXXXXXXX _B
3922 _H	Input Capture Register 5	IPCP5	R		XXXXXXXX _B
3923 _H	Input Capture Register 5	IPCP5	R		XXXXXXXX _B
3924 _H	Input Capture Register 6	IPCP6	R	Input Capture 6/7	XXXXXXXX _B
3925 _H	Input Capture Register 6	IPCP6	R		XXXXXXXX _B
3926 _H	Input Capture Register 7	IPCP7	R		XXXXXXXX _B
3927 _H	Input Capture Register 7	IPCP7	R		XXXXXXXX _B

(Continued)

(Continued)

Address	Register	Abbreviation	Access	Resource name	Initial value
3928 _H	Output Compare Register 0	OCCP0	R/W	Output Compare 0/1	XXXXXXXX _B
3929 _H	Output Compare Register 0	OCCP0	R/W		XXXXXXXX _B
392A _H	Output Compare Register 1	OCCP1	R/W		XXXXXXXX _B
392B _H	Output Compare Register 1	OCCP1	R/W		XXXXXXXX _B
392C _H	Output Compare Register 2	OCCP2	R/W	Output Compare 2/3	XXXXXXXX _B
392D _H	Output Compare Register 2	OCCP2	R/W		XXXXXXXX _B
392E _H	Output Compare Register 3	OCCP3	R/W		XXXXXXXX _B
392F _H	Output Compare Register 3	OCCP3	R/W		XXXXXXXX _B
3930 _H to 39FF _H	Reserved				
3A00 _H to 3AFF _H	Reserved				
3B00 _H to 3BFF _H	Reserved				
3C00 _H to 3CFF _H	Reserved				
3D00 _H to 3DFF _H	Reserved				
3E00 _H to 3FFF _H	Reserved				

- Read/write notation

R/W : Reading and writing permitted

R : Read-only

W : Write-only

- Initial value notation

0 : Initial value is "0".

1 : Initial value is "1".

X : Initial value is undefined.

Note : Any write access to reserved addresses in I/O map should not be performed. A read access to reserved addresses results in reading "X".

MB90435 Series

■ INTERRUPT MAP

Interrupt cause	EI ² OS clear	Interrupt vector		Interrupt control register	
		Number	Address	Number	Address
Reset	N/A	#08	FFFFDC _H	—	—
INT9 instruction	N/A	#09	FFFFD8 _H	—	—
Exception	N/A	#10	FFFFD4 _H	—	—
Reserved	N/A	#11	FFFFD0 _H	ICR00	0000B0 _H
Reserved	N/A	#12	FFFFCC _H		
Reserved	N/A	#13	FFFFC8 _H	ICR01	0000B1 _H
Reserved	N/A	#14	FFFFC4 _H		
External Interrupt INT0/INT1	*1	#15	FFFFC0 _H	ICR02	0000B2 _H
Time Base Timer	N/A	#16	FFFFBC _H		
16-bit Reload Timer 0	*1	#17	FFFFB8 _H	ICR03	0000B3 _H
8/10-bit A/D Converter	*1	#18	FFFFB4 _H		
I/O Timer	N/A	#19	FFFFB0 _H	ICR04	0000B4 _H
External Interrupt INT2/INT3	*1	#20	FFFFAC _H		
Serial I/O	*1	#21	FFFFA8 _H	ICR05	0000B5 _H
8/16-bit PPG 0/1	N/A	#22	FFFFA4 _H		
Input Capture 0	*1	#23	FFFFA0 _H	ICR06	0000B6 _H
External Interrupt INT4/INT5	*1	#24	FFFF9C _H		
Input Capture 1	*1	#25	FFFF98 _H	ICR07	0000B7 _H
8/16-bit PPG 2/3	N/A	#26	FFFF94 _H		
External Interrupt INT6/INT7	*1	#27	FFFF90 _H	ICR08	0000B8 _H
Watch Timer	N/A	#28	FFFF8C _H		
8/16-bit PPG 4/5	N/A	#29	FFFF88 _H	ICR09	0000B9 _H
Input Capture 2/3	*1	#30	FFFF84 _H		
8/16-bit PPG 6/7	N/A	#31	FFFF80 _H	ICR10	0000BA _H
Output Compare 0	*1	#32	FFFF7C _H		
Output Compare 1	*1	#33	FFFF78 _H	ICR11	0000BB _H
Input Capture 4/5	*1	#34	FFFF74 _H		
Output Compare 2/3 - Input Capture 6/7	*1	#35	FFFF70 _H	ICR12	0000BC _H
16-bit Reload Timer 1	*1	#36	FFFF6C _H		
UART 0 RX	*2	#37	FFFF68 _H	ICR13	0000BD _H
UART 0 TX	*1	#38	FFFF64 _H		
UART 1 RX	*2	#39	FFFF60 _H	ICR14	0000BE _H
UART 1 TX	*1	#40	FFFF5C _H		
Flash Memory	N/A	#41	FFFF58 _H	ICR15	0000BF _H
Delayed interrupt	N/A	#42	FFFF54 _H		

*1 : The interrupt request flag is cleared by the EI²OS interrupt clear signal.

*2 : The interrupt request flag is cleared by the EI²OS interrupt clear signal. A stop request is available.

Notes : • N/A : The interrupt request flag is not cleared by the EI²OS interrupt clear signal.

- For a peripheral module with two interrupt causes for a single interrupt number, both interrupt request flags are cleared by the EI²OS interrupt clear signal.
- At the end of EI²OS, the EI²OS clear signal will be asserted for all the interrupt flags assigned to the same interrupt number. If one interrupt flag starts the EI²OS and in the meantime another interrupt flag is set by a hardware event, the later event is lost because the flag is cleared by the EI²OS clear signal caused by the first event. So it is recommended not to use the EI²OS for this interrupt number.
- If EI²OS is enabled, EI²OS is initiated when one of the two interrupt signals in the same interrupt control register (ICR) is asserted. This means that different interrupt sources share the same EI²OS Descriptor which should be unique for each interrupt source. For this reason, when one interrupt source uses the EI²OS, the other interrupt should be disabled.

MB90435 Series

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

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

Parameter	Symbol	Value		Units	Remarks
		Min	Max		
Power supply voltage	V_{CC}	$V_{SS} - 0.3$	$V_{SS} + 6.0$	V	
	AV_{CC}	$V_{SS} - 0.3$	$V_{SS} + 6.0$	V	$V_{CC} = AV_{CC}$ *1
	$AVRH, AVRL$	$V_{SS} - 0.3$	$V_{SS} + 6.0$	V	$AV_{CC} \geq AVRH/AVRL, AVRH \geq AVRL$ *1
Input voltage	V_I	$V_{SS} - 0.3$	$V_{SS} + 6.0$	V	*2
Output voltage	V_O	$V_{SS} - 0.3$	$V_{SS} + 6.0$	V	*2
Maximum clamp current	I_{CLAMP}	-2.0	+2.0	mA	*6
Total maximum clamp current	$\sum I_{CLAMP} $	—	20	mA	*6
"L" level max output current	I_{OL}	—	15	mA	*3
"L" level avg. output current	I_{OLAV}	—	4	mA	*4
"L" level max overall output current	$\sum I_{OL}$	—	100	mA	
"L" level avg. overall output current	$\sum I_{OLAV}$	—	50	mA	*5
"H" level max output current	I_{OH}	—	-15	mA	*3
"H" level avg. output current	I_{OHAV}	—	-4	mA	*4
"H" level max overall output current	$\sum I_{OH}$	—	-100	mA	
"H" level avg. overall output current	$\sum I_{OHAV}$	—	-50	mA	*5
Power consumption	P_D	—	500	mW	Flash device
		—	400	mW	Mask ROM
Operating temperature	T_A	-40	+105	°C	
Storage temperature	T_{STG}	-55	+150	°C	

*1 : AV_{CC} , $AVRH$, $AVRL$ should not exceed V_{CC} . Also, $AVRH$, $AVRL$ should not exceed AV_{CC} , and $AVRL$ does not exceed $AVRH$.

*2 : V_I and V_O should not exceed $V_{CC} + 0.3\text{ V}$. V_I should not exceed the specified ratings. However if the maximum current to/from an input is limited by some means with external components, the I_{CLAMP} rating supercedes the V_I rating.

*3 : The maximum output current is a peak value for a corresponding pin.

*4 : Average output current is an average current value observed for a 100 ms period for a corresponding pin.

*5 : Total average current is an average current value observed for a 100 ms period for all corresponding pins.

*6 : • Applicable to pins : P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, P60 to P67, P70 to P77, P80 to P87, P90 to P97, PA0

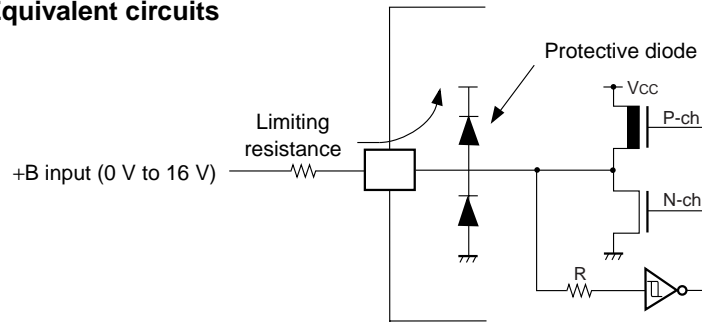
- Use within recommended operating conditions.
- Use at DC voltage (current) .
- The +B signal should always be applied with a limiting resistance placed between the +B signal and the microcontroller.
- The value of the limiting resistance should be set so that when the +B signal is applied the input 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.

(Continued)

(Continued)

- 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 :

- **Input/Output Equivalent circuits**



Note : Average output current = operating current × operating efficiency

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.

MB90435 Series

2. Recommended Conditions

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

Parameter	Symbol	Value			Units	Remarks
		Min	Typ	Max		
Power supply voltage	V_{CC} , AV_{CC}	4.5	5.0	5.5	V	Under normal operation : MB90F439 (S) /439 (S) /V540G
		3.5	5.0	5.5	V	Under normal operation : MB90F438L (S) /437L (S) /438L (S)
		3.0	—	5.5	V	Maintain RAM data in stop mode
Smooth capacitor	C_S	0.022	0.1	1.0	μF	*
Operating temperature	T_A	-40	—	+105	$^{\circ}\text{C}$	

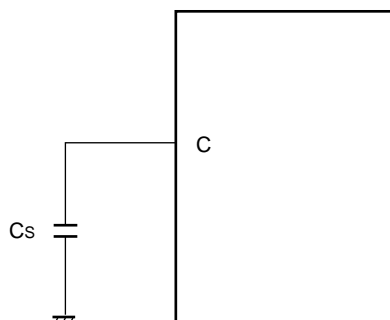
*: Use a ceramic capacitor or a capacitor of better 4. AC characteristics. The V_{CC} Capacitor should be greater than this capacitor.

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.

• C Pin Connection Diagram



3. DC Characteristics

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value			Units	Remarks
				Min	Typ	Max		
Input H voltage	V_{IHS}	CMOS hysteresis input pin	—	$0.8 V_{CC}$	—	$V_{CC} + 0.3$	V	
	V_{IH}	TTL input pin	—	2.0	—	—	V	
	V_{IHM}	MD input pin	—	$V_{CC} - 0.3$	—	$V_{CC} + 0.3$	V	
Input L voltage	V_{ILS}	CMOS hysteresis input pin	—	$V_{CC} - 0.3$	—	$0.2 V_{CC}$	V	
	V_{IL}	TTL input pin	—	—	—	0.8	V	
	V_{ILM}	MD input pin	—	$V_{SS} - 0.3$	—	$V_{CC} + 0.3$	V	
Output H voltage	V_{OH}	All output pins	$V_{CC} = 4.5 \text{ V}$, $I_{OH} = -4.0 \text{ mA}$	$V_{CC} - 0.5$	—	—	V	
Output L voltage	V_{OL}	All output pins	$V_{CC} = 4.5 \text{ V}$, $I_{OL} = 4.0 \text{ mA}$	—	—	0.4	V	
Input leak current	I_{IL}	—	$V_{CC} = 5.5 \text{ V}$, $V_{SS} < V_i < V_{CC}$	-5	—	5	μA	
Pull-up resistance	R_{UP}	P00 to P07, P10 to P17, P20 to P27, P30 to P37, RST	—	25	50	100	$\text{k}\Omega$	
Pull-down resistance	R_{DO} R_{WN}	MD2	—	25	50	100	$\text{k}\Omega$	

(Continued)

MB90435 Series

(Continued)

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value			Units	Remarks
				Min	Typ	Max		
Power supply current*	I _{CC}	V _{CC}	Internal frequency : 16 MHz, At normal operating	—	40	55	mA	
			Internal frequency : 16 MHz, At Flash programming/erasing	—	50	70	mA	Flash device
	I _{CCS}		Internal frequency : 16 MHz, At sleep mode	—	12	20	mA	
	I _{CTS}		$V_{CC} = 5.0 \text{ V} \pm 1\%$, Internal frequency : 2 MHz, At pseudo timer mode	—	300	600	μA	
				—	600	1100	μA	MB90F348L (S)
				—	200	400	μA	MB90437L (S) / 438L (S)
	I _{CCL}		Internal frequency : 8 kHz, At sub operation, $T_A = 25 \text{ }^\circ\text{C}$	—	400	750	μA	MB90F438L (S)
				—	50	100	μA	Mask ROM
				—	150	300	μA	Flash device
	I _{CCLS}		Internal frequency : 8 kHz, At sub sleep, $T_A = 25 \text{ }^\circ\text{C}$	—	15	40	μA	
I _{CCt}	Internal frequency : 8 kHz, At timer mode, $T_A = 25 \text{ }^\circ\text{C}$	—	7	25	μA			
I _{CCH1}	At stop, $T_A = 25 \text{ }^\circ\text{C}$	—	5	20	μA			
I _{CCH2}	At hardware standby mode, $T_A = 25 \text{ }^\circ\text{C}$	—	50	100	μA			
Input capacity	C _{IN}	Other than AV _{CC} , AV _{SS} , AVRH, AVRL, C, V _{CC} , V _{SS}	—	5	15	pF		

* : The power supply current testing conditions are when using the external clock.

4. AC Characteristics

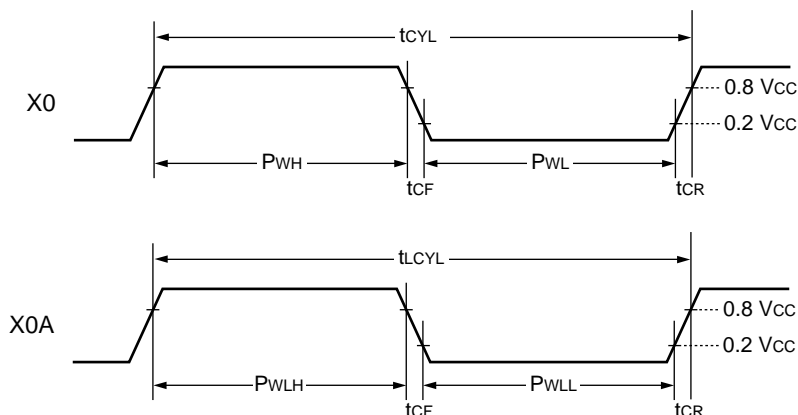
(1) Clock Timing

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

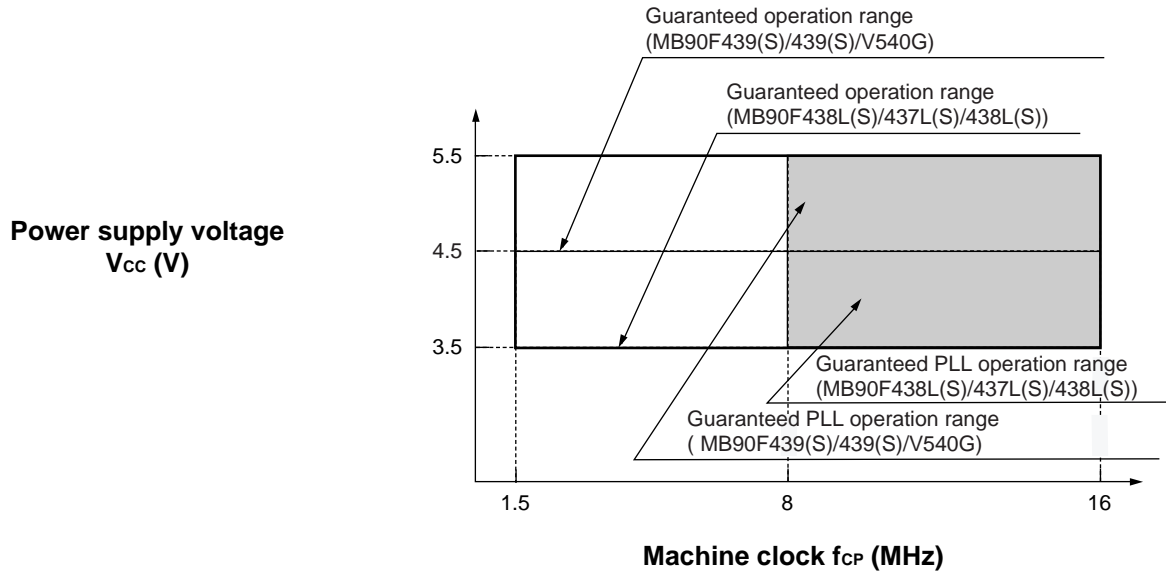
Parameter	Symbol	Pin name	Value			Units	Remarks
			Min	Typ	Max		
Oscillation frequency	f _c	X0, X1	3	—	16	MHz	$V_{CC} = 5.0 \text{ V} \pm 10\%$
			3	—	5	MHz	$V_{CC} < 4.5$ (MB90F438L (S) / 437L (S) /438L (S))
	f _{CL}	X0A, X1A	—	32.768	—	kHz	
Oscillation cycle time	t _{CYL}	X0, X1	62.5	—	333	ns	$V_{CC} = 5.0 \text{ V} \pm 10\%$
			200	—	333	ns	$V_{CC} < 4.5$ (MB90F438L (S) / 437L (S) /438L (S))
	t _{LCYL}	X0A, X1A	—	30.5	—	μs	
Input clock pulse width	P _{WH} , P _{WL}	X0	10	—	—	ns	Duty ratio is about 30% to 70%.
	P _{WLH} , P _{WLL}	X0A	—	15.2	—	μs	
Input clock rise and fall time	t _{CR} , t _{CF}	X0	—	—	5	ns	When using external clock
Machine clock frequency	f _{CP}	—	1.5	—	16	MHz	When using main clock
	f _{LCP}	—	—	8.192	—	kHz	When using sub-clock
Machine clock cycle time	t _{CP}	—	62.5	—	666	ns	When using main clock
	t _{LCP}	—	—	122.1	—	μs	When using sub-clock

• Clock Timing

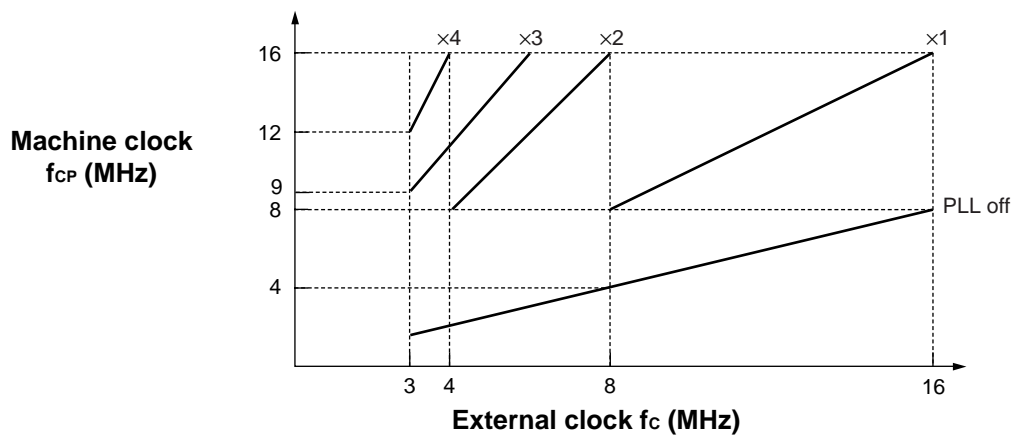


MB90435 Series

- **Guaranteed PLL operation range**



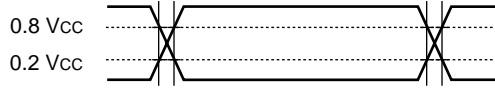
- **External clock frequency and Machine clock frequency**



AC characteristics are set to the measured reference voltage values below.

- **Input signal waveform**

Hysteresis Input Pin

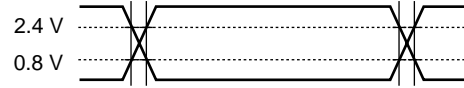


TTL Input Pin



- **Output signal waveform**

Output Pin



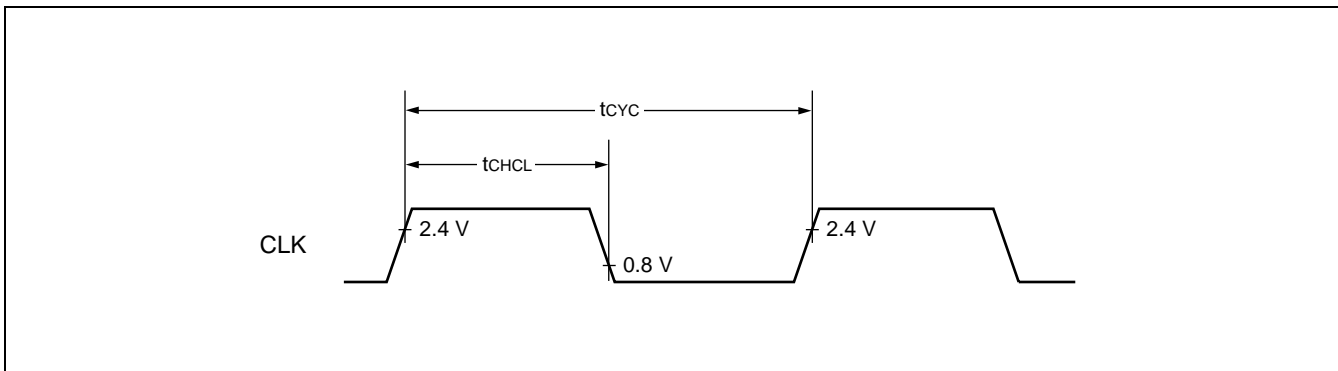
MB90435 Series

(2) Clock Output Timing

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Units	Remarks
				Min	Max		
Cycle time	t_{CYC}	CLK	$V_{CC} = 5 \text{ V} \pm 10\%$	62.5	—	ns	
CLK \uparrow \rightarrow CLK \downarrow	t_{CHCL}			20	—	ns	



(3) Reset and Hardware Standby Input Timing

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

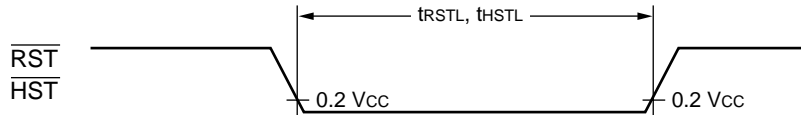
Parameter	Symbol	Pin name	Value		Units	Remarks
			Min	Max		
Reset input time	t_{RSTL}	\overline{RST}	$4 t_{CP}$	—	ns	Under normal operation
			Oscillation time of oscillator + $4 t_{CP}$	—	ms	In stop mode
			100	—	μs	Pseudo timer mode (MB90437L (S) /438L (S))
			$4 t_{CP}$	—	ns	Pseudo timer mode (Other than MB90437L (S) /438L (S))
			$2 t_{CP}$	—	μs	In sub clock mode, sub sleep mode and watch mode
Hardware standby input time	t_{HSTL}	\overline{HST}	$4 t_{CP}$	—	ns	Under normal operation

" t_{cp} " represents one cycle time of the machine clock.

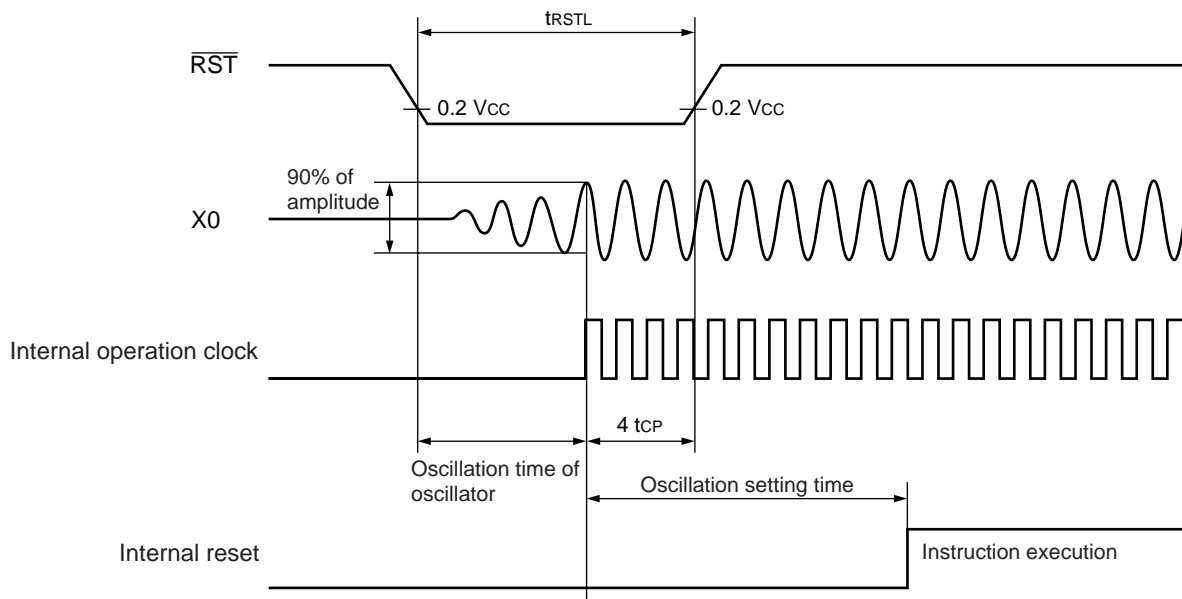
Oscillation time of oscillator is time that amplitude reached the 90%. In the crystal oscillator, the oscillation time is between several ms to tens of ms. In FAR/ceramic oscillator, the oscillation time is between hundreds of μs to several ms. In the external clock, the oscillation time is 0 ns.

Any reset can not fully initialize the Flash Memory if it is performing the automatic algorithm.

- Under normal operation, Pseudo timer mode, Sub clock mode, Sub sleep mode, Watch mode



- In stop mode



MB90435 Series

(4) Power On Reset

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

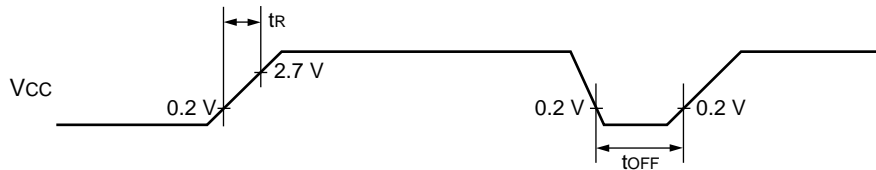
(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Units	Remarks
				Min	Max		
Power on rise time	t_R	V_{CC}	—	0.05	30	ms	*
Power off time	t_{OFF}	V_{CC}		50	—	ms	Due to repetitive operation

* : V_{CC} must be kept lower than 0.2 V before power-on.

Notes : • The above values are used for creating a power-on reset.

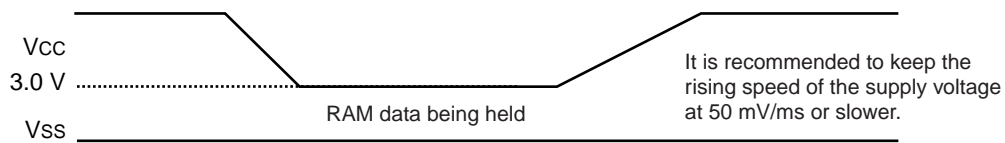
- Some registers in the device are initialized only upon a power-on reset. To initialize these register, turn on the power supply using the above values.



Sudden changes in the power supply voltage may cause a power-on reset.

To change the power supply voltage while the device is in operation, it is recommended to raise the voltage smoothly to suppress fluctuations as shown below.

In this case, change the supply voltage with the PLL clock not used. If the voltage drop is 1 V or fewer per second, however, you can use the PLL clock.



(5) Bus Timing (Read)

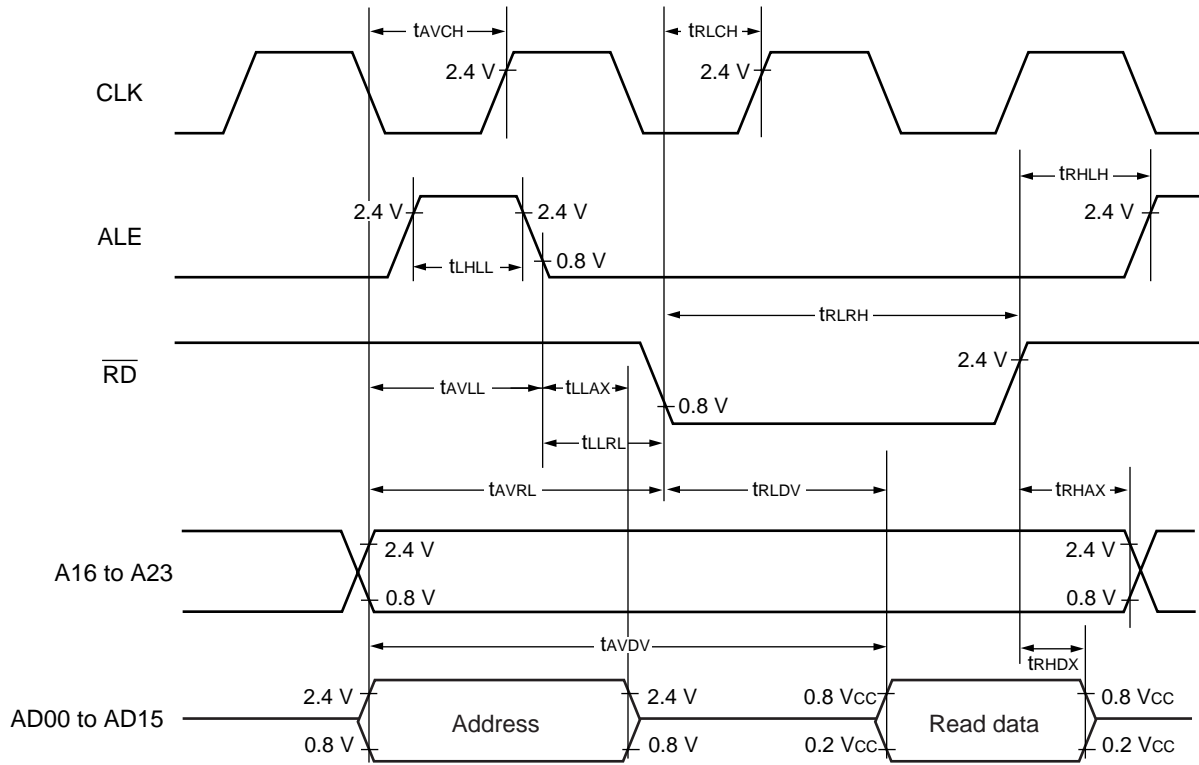
(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Units	Remarks
				Min	Max		
ALE pulse width	t_{LHLL}	ALE	—	$t_{CP}/2 - 20$	—	ns	
Valid address→ALE↓time	t_{AVLL}	ALE, A16 to A23, AD00 to AD15		$t_{CP}/2 - 20$	—	ns	
ALE↓→Address valid time	t_{LLAX}	ALE, AD00 to AD15		$t_{CP}/2 - 15$	—	ns	
Valid address→ \overline{RD} ↓time	t_{AVRL}	A16 to A23, AD00 to AD15, \overline{RD}		$t_{CP} - 15$	—	ns	
Valid address→Valid data input	t_{AVDV}	A16 to A23, AD00 to AD15		—	$5 t_{CP}/2 - 60$	ns	
\overline{RD} pulse width	t_{RLRH}	\overline{RD}		$3 t_{CP}/2 - 20$	—	ns	
\overline{RD} ↓→Valid data input	t_{RLDV}	\overline{RD} , AD00 to AD15		—	$3 t_{CP}/2 - 60$	ns	
\overline{RD} ↑→Data hold time	t_{RHDX}	\overline{RD} , AD00 to AD15		0	—	ns	
\overline{RD} ↓→ALE↑time	t_{RHLH}	\overline{RD} , ALE		$t_{CP}/2 - 15$	—	ns	
\overline{RD} ↑→Address valid time	t_{RHAX}	\overline{RD} , A16 to A23		$t_{CP}/2 - 10$	—	ns	
Valid address→CLK↑time	t_{AVCH}	A16 to A23, AD00 to AD15, CLK		$t_{CP}/2 - 20$	—	ns	
\overline{RD} ↓→CLK↑time	t_{RLCH}	\overline{RD} , CLK		$t_{CP}/2 - 20$	—	ns	
ALE↓→ \overline{RD} ↓time	t_{LLRL}	ALE, \overline{RD}		$t_{CP}/2 - 15$	—	ns	

MB90435 Series

• Bus Timing (Read)



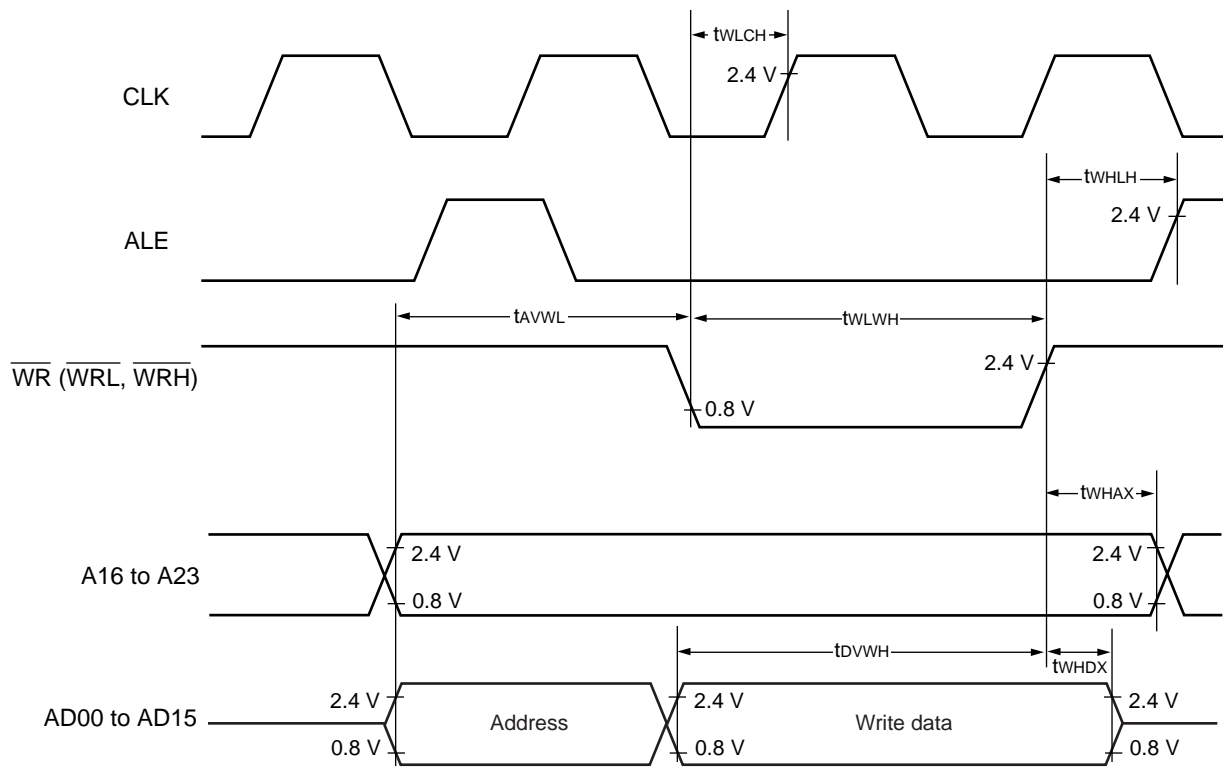
(6) Bus Timing (Write)

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Units	Remarks
				Min	Max		
Valid address $\rightarrow \overline{WR} \downarrow$ time	t_{AVWL}	A16 to A23 AD00 to AD15, \overline{WR}	—	$t_{CP} - 15$	—	ns	
\overline{WR} pulse width	t_{WLWH}	\overline{WR}		$3 t_{CP}/2 - 20$	—	ns	
Valid data output $\rightarrow \overline{WR} \uparrow$ time	t_{DVWH}	AD00 to AD15, \overline{WR}		$3 t_{CP}/2 - 20$	—	ns	
$\overline{WR} \uparrow \rightarrow$ Data hold time	t_{WHDX}	AD00 to AD15, \overline{WR}		20	—	ns	
$\overline{WR} \uparrow \rightarrow$ Address valid time	t_{WHAX}	A16 to A23, \overline{WR}		$t_{CP}/2 - 10$	—	ns	
$\overline{WR} \uparrow \rightarrow$ ALE \uparrow time	t_{WHLH}	\overline{WR} , ALE		$t_{CP}/2 - 15$	—	ns	
$\overline{WR} \uparrow \rightarrow$ CLK \uparrow time	t_{WLCH}	\overline{WR} , CLK		$t_{CP}/2 - 20$	—	ns	

• Bus Timing (Write)



MB90435 Series

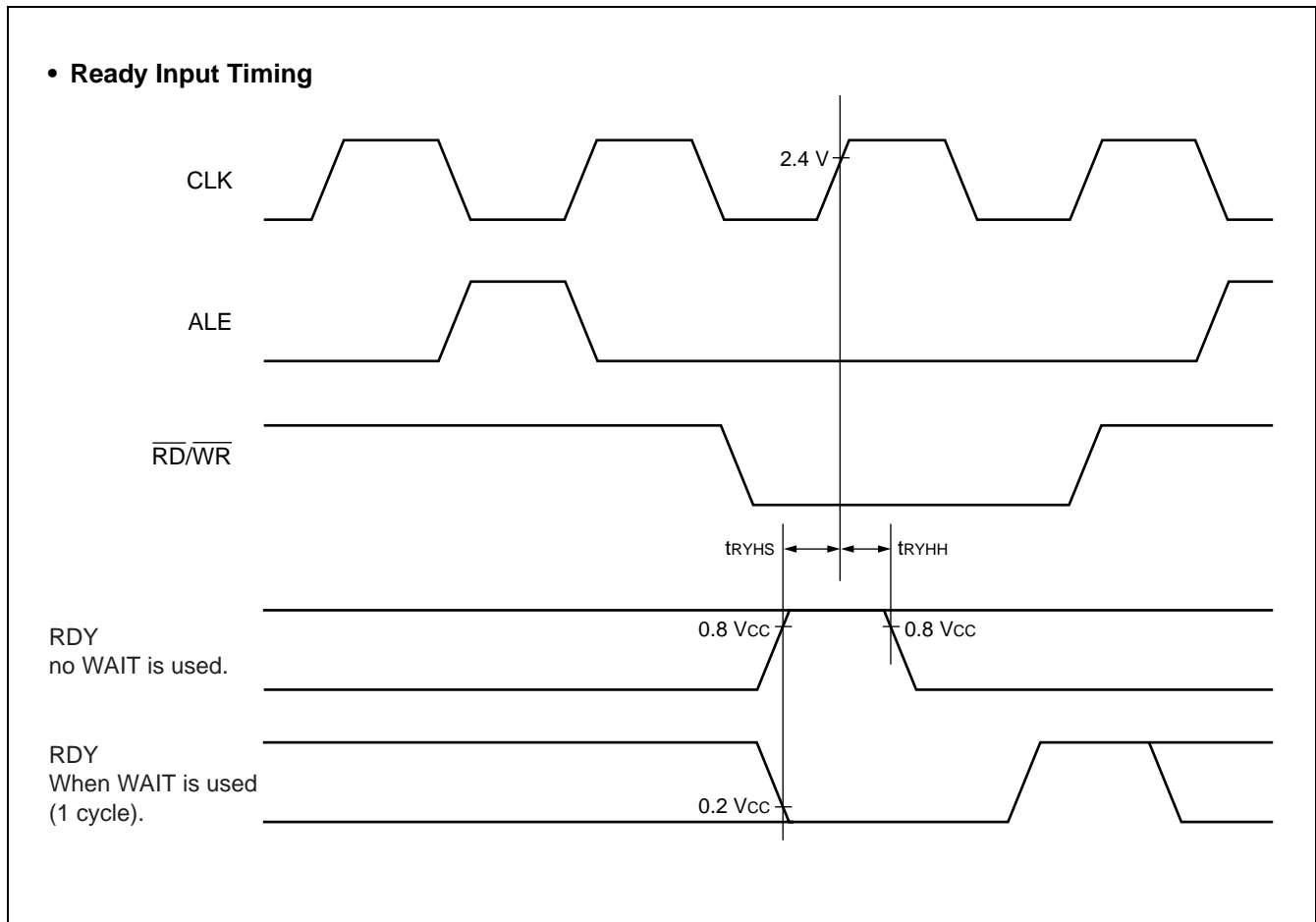
(7) Ready Input Timing

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Units	Remarks
				Min	Max		
RDY setup time	t_{RYHS}	RDY	—	45	—	ns	
RDY hold time	t_{RYHH}	RDY		0	—	ns	

Note : If the RDY setup time is insufficient, use the auto-ready function.



(8) Hold Timing

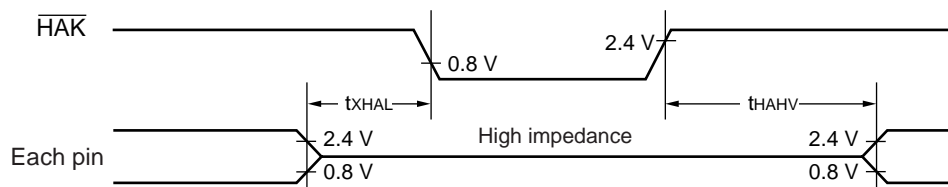
(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Units	Remarks
				Min	Max		
Pin floating \rightarrow $\overline{\text{HAK}} \downarrow$ time	t_{XHAL}	$\overline{\text{HAK}}$	—	30	t_{CP}	ns	
$\overline{\text{HAK}} \uparrow$ time \rightarrow Pin valid time	t_{HAHV}	$\overline{\text{HAK}}$		t_{CP}	$2 t_{CP}$	ns	

Note : There is more than 1 cycle from the time HRQ is read to the time the $\overline{\text{HAK}}$ is changed.

• Hold Timing



(9) UART0/1, Serial I/O Timing

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Units	Remarks
				Min	Max		
Serial clock cycle time	t_{SCYC}	SCK0 to SCK2	Internal clock operation output pins are $C_L = 80 \text{ pF} + 1 \text{ TTL}$.	$8 t_{CP}$	—	ns	
SCK \downarrow \rightarrow SOT delay time	t_{SLOV}	SCK0 to SCK2, SOT0 to SOT2		-80	80	ns	
Valid SIN \rightarrow SCK \uparrow	t_{VSH}	SCK0 to SCK2, SIN0 to SIN2		100	—	ns	
SCK \uparrow \rightarrow Valid SIN hold time	t_{SHIX}	SCK0 to SCK2, SIN0 to SIN2		60	—	ns	
Serial clock "H" pulse width	t_{SHSL}	SCK0 to SCK2	External clock operation output pins are $C_L = 80 \text{ pF} + 1 \text{ TTL}$.	$4 t_{CP}$	—	ns	
Serial clock "L" pulse width	t_{SLSH}	SCK0 to SCK2		$4 t_{CP}$	—	ns	
SCK \downarrow \rightarrow SOT delay time	t_{SLOV}	SCK0 to SCK2, SOT0 to SOT2		—	150	ns	
Valid SIN \rightarrow SCK \uparrow	t_{VSH}	SCK0 to SCK2, SIN0 to SIN2		60	—	ns	
SCK \uparrow \rightarrow Valid SIN hold time	t_{SHIX}	SCK0 to SCK2, SIN0 to SIN2		60	—	ns	

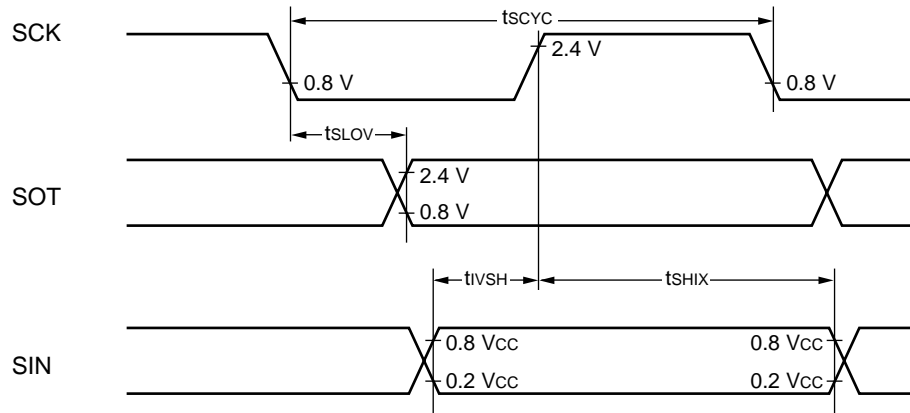
Notes : • AC characteristic in CLK synchronized mode.

• C_L is load capacity value of pins when testing.

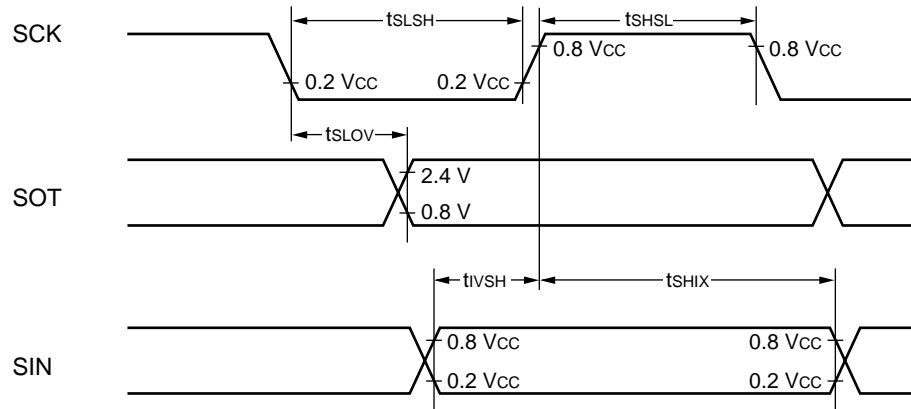
• For t_{CP} (Machine clock cycle time), refer to "(1) Clock Timing".

MB90435 Series

- Internal Shift Clock Mode



- External Shift Clock Mode



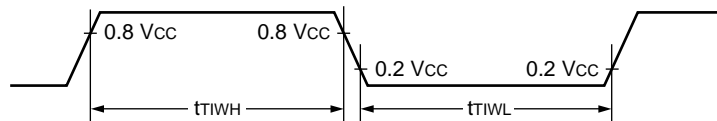
(10) Timer Input Timing

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Units	Remarks
				Min	Max		
Input pulse width	t_{TIWH}	TIN0, TIN1	—	4 t_{CP}	—	ns	
	t_{TIWL}	IN0 to IN7					

• Timer Input Timing



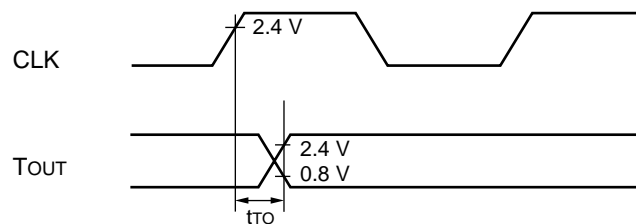
(11) Timer Output Timing

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5 \text{ V to } 5.5 \text{ V}$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0 \text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0 \text{ V}$, $T_A = -40 \text{ }^\circ\text{C to } +105 \text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Units	Remarks
				Min	Max		
$\text{CLK}\uparrow \rightarrow T_{OUT}$ change time	t_{TO}	TOT0 to TOT1, PPG0 to PPG3	—	30	—	ns	

• Timer Output Timing



MB90435 Series

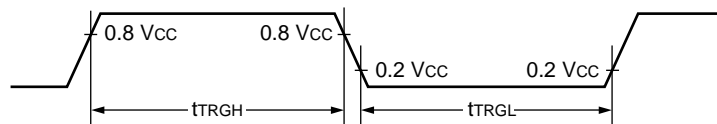
(12) Trigger Input Timing

(MB90F438L (S) /437L (S) /438L (S) : $V_{CC} = 3.5\text{ V to }5.5\text{ V}$, $V_{SS} = AV_{SS} = 0.0\text{ V}$, $T_A = -40\text{ }^\circ\text{C to }+105\text{ }^\circ\text{C}$)

(MB90F439 (S) /439 (S) /V540G : $V_{CC} = 5.0\text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0\text{ V}$, $T_A = -40\text{ }^\circ\text{C to }+105\text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Condition	Value		Units	Remarks
				Min	Max		
Input pulse width	t_{TRGH}	INT0 to INT7, ADTG	—	$5 t_{CP}$	—	ns	Under normal operation
	t_{TRGL}			1	—	μs	In stop mode

• Trigger Input Timing



5. A/D Converter

• Electrical Characteristics

($V_{CC} = AV_{CC} = 5.0\text{ V} \pm 10\%$, $V_{SS} = AV_{SS} = 0.0\text{ V}$, $3.0\text{ V} \leq AVR_{H} - AVR_{L}$, $T_A = -40\text{ }^\circ\text{C}$ to $+105\text{ }^\circ\text{C}$)

Parameter	Symbol	Pin name	Value			Units	Remarks
			Min	Typ	Max		
Resolution	—	—	—	—	10	bit	
Conversion error	—	—	—	—	± 5.0	LSB	
Nonlinearity error	—	—	—	—	± 2.5	LSB	
Differential nonlinearity error	—	—	—	—	± 1.9	LSB	
Zero transition voltage	V_{OT}	AN0 to AN7	$AVR_L - 3.5$ LSB	$AVR_L + 0.5$ LSB	$AVR_L + 4.5$ LSB	mV	
Full scale transition voltage	V_{FST}	AN0 to AN7	$AVR_H - 6.5$ LSB	$AVR_H - 1.5$ LSB	$AVR_H + 1.5$ LSB	mV	
Compare time	—	—	352 t_{CP}	—	—	ns	Internal frequency : 16 MHz
Sampling time	—	—	64 t_{CP}	—	—	ns	Internal frequency : 16 MHz
Analog port input current	I_{AIN}	AN0 to AN7	-1	—	1	μA	$V_{CC} = AV_{CC} = 5.0\text{ V} \pm 1\%$
Analog input voltage range	V_{AIN}	AN0 to AN7	AVR_L	—	AVR_H	V	
Reference voltage range	—	AVR_H	$AVR_L + 2.7$	—	AV_{CC}	V	
	—	AVR_L	0	—	$AVR_H - 2.7$	V	
Power supply current	I_A	AV_{CC}	—	5	—	mA	
	I_{AH}	AV_{CC}	—	—	5	μA	*
Reference voltage supply current	I_R	AVR_H	—	400	600	μA	Flash device
			—	140	260	μA	Mask ROM
	I_{RH}	AVR_H	—	—	5	μA	*
Offset between input channels	—	AN0 to AN7	—	—	4	LSB	

* : When not using an A/D converter, this is the current ($V_{CC} = AV_{CC} = AVR_H = 5.0\text{ V}$) when the CPU is stopped.

Note: The functionality of the A/D converter is only guaranteed for $V_{CC} = 5.0\text{ V} \pm 10\%$ (also for MB90F438L (S) / 437L (S) / 438L (S)).

MB90435 Series

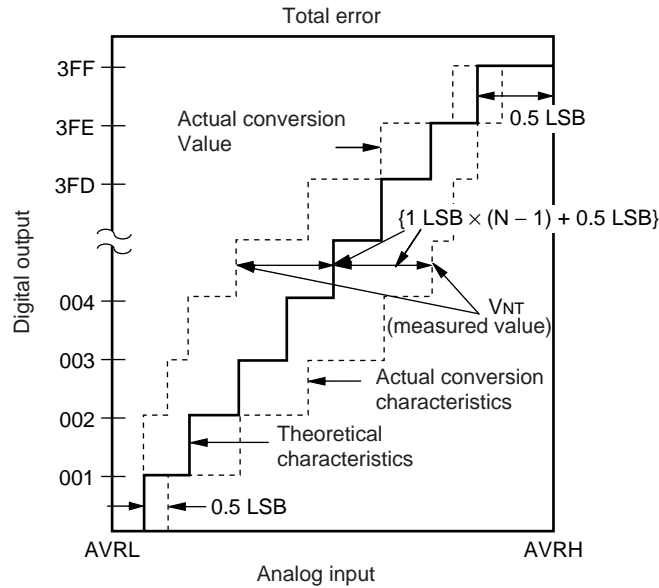
• A/D Converter Glossary

Resolution : Analog changes that are identifiable with the A/D converter

Linearity error : The deviation of the straight line connecting the zero transition point (“00 0000 0000” ↔ “00 0000 0001”) with the full-scale transition point (“11 1111 1110” ↔ “11 1111 1111”) from actual conversion characteristics

Differential linearity error : The deviation of input voltage needed to change the output code by 1 LSB from the theoretical value

Total error : The total error is defined as a difference between the actual value and the theoretical value, which includes zero-transition error/full-scale transition error and linearity error.



$$1 \text{ LSB} = (\text{Theoretical value}) \frac{AVRH - AVRL}{1024} \text{ [V]}$$

$$V_{OT} (\text{Theoretical value}) = AVRL + 0.5 \text{ LSB [V]}$$

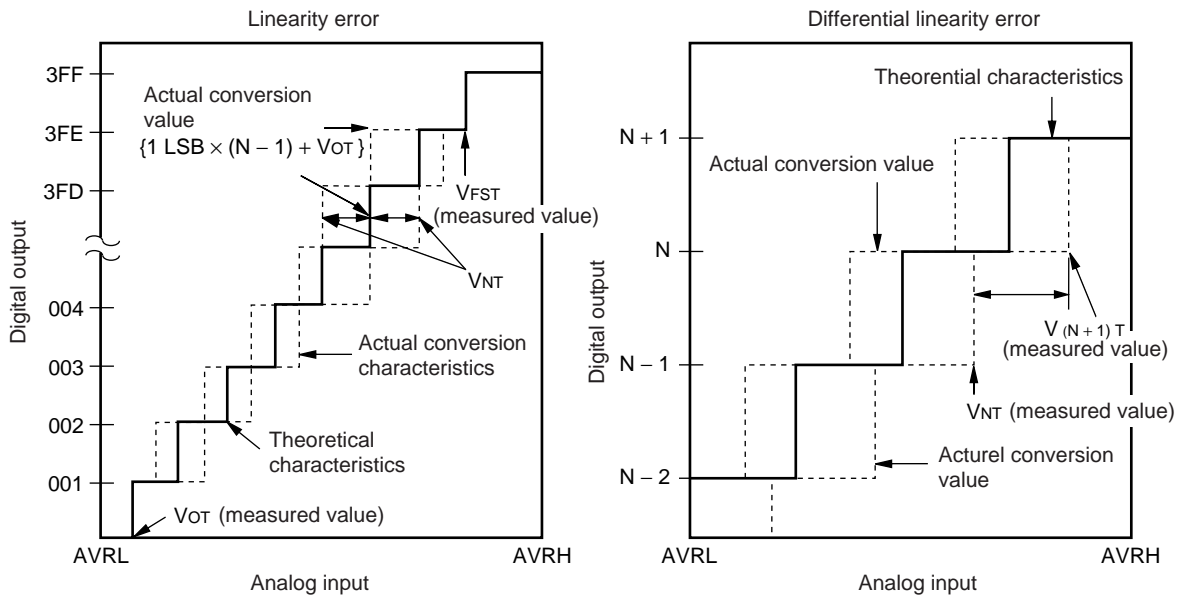
$$V_{FST} (\text{Theoretical value}) = AVRH - 1.5 \text{ LSB [V]}$$

$$\text{Total error for digital output } N = \frac{V_{NT} - \{1 \text{ LSB} \times (N - 1) + 0.5 \text{ LSB}\}}{1 \text{ LSB}} \text{ [LSB]}$$

V_{NT} : Voltage at a transition of digital output from (N - 1) to N

(Continued)

(Continued)



$$\text{Linearity error of digital output } N = \frac{V_{NT} - \{1 \text{ LSB} \times (N - 1) + V_{OT}\}}{1 \text{ LSB}} \text{ [LSB]}$$

$$\text{Differential linearity error of digital } N = \frac{V_{(N+1)T} - V_{NT}}{1 \text{ LSB}} - 1 \text{ LSB [LSB]}$$

$$1 \text{ LSB} = \frac{V_{FST} - V_{OT}}{1022} \text{ [V]}$$

V_{OT} : Voltage at transition of digital output from "000_H" to "001_H"

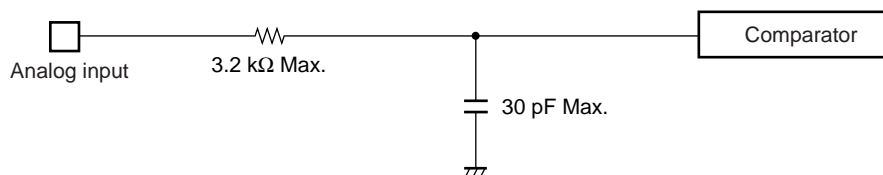
V_{FST} : Voltage at transition of digital output from "3FE_H" to "3FF_H"

• Notes on Using A/D Converter

- Select the output impedance value for the external circuit of analog input according to the following conditions, :
- Output impedance values of the external circuit of 15 kΩ or lower are recommended.
 - When capacitors are connected to external pins, the capacitance of several thousand times the internal capacitor value is recommended to minimized the effect of voltage distribution between the external capacitor and internal capacitor.

Note : When the output impedance of the external circuit is too high, the sampling period for analog voltages may not be sufficient (sampling period = 4.00 μs @machine clock of 16 MHz) .

• Equipment of analog input circuit model



• Error

The smaller the $|AVRH - AVRL|$, the greater the error would become relatively.

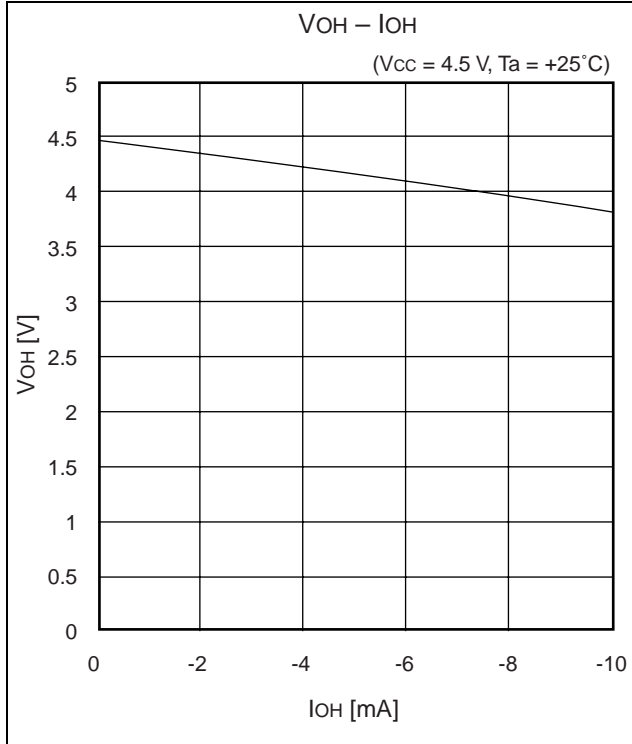
MB90435 Series

6. Flash Memory Program/Erase Characteristics

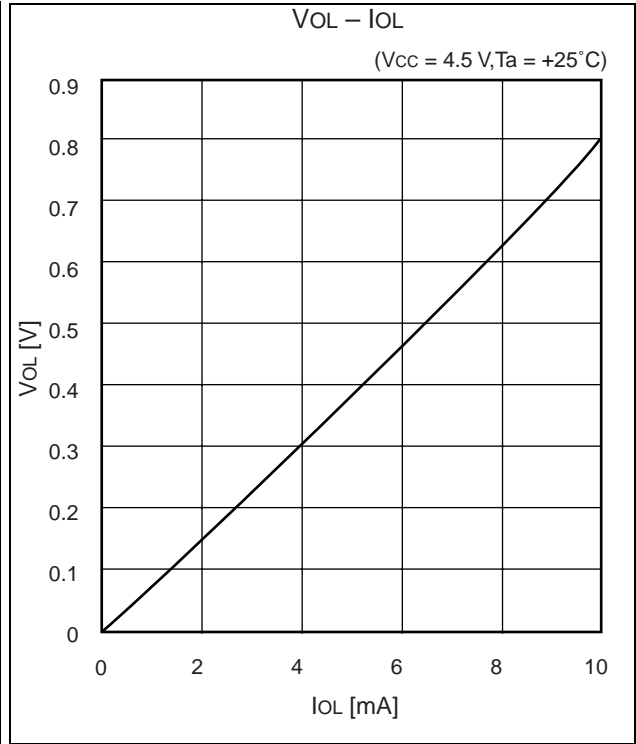
Parameter	Condition	Value			Units	Remarks	
		Min	Typ	Max			
Sector erase time	T _A = + 25 °C V _{CC} = 5.0 V	—	1	15	s	Excludes 00 _H programming prior erasure	
Chip erase time		—	5	—	s	MB90F438L (S)	Excludes 00 _H programming prior erasure
		—	7	—	s	MB90F439 (S)	
Word (16 bit width) programming time		—	—	16	3,600	μs	Excludes system-level overhead
Erase/Program cycle	—	10,000	—	—	cycle		

EXAMPLE CHARACTERISTICS

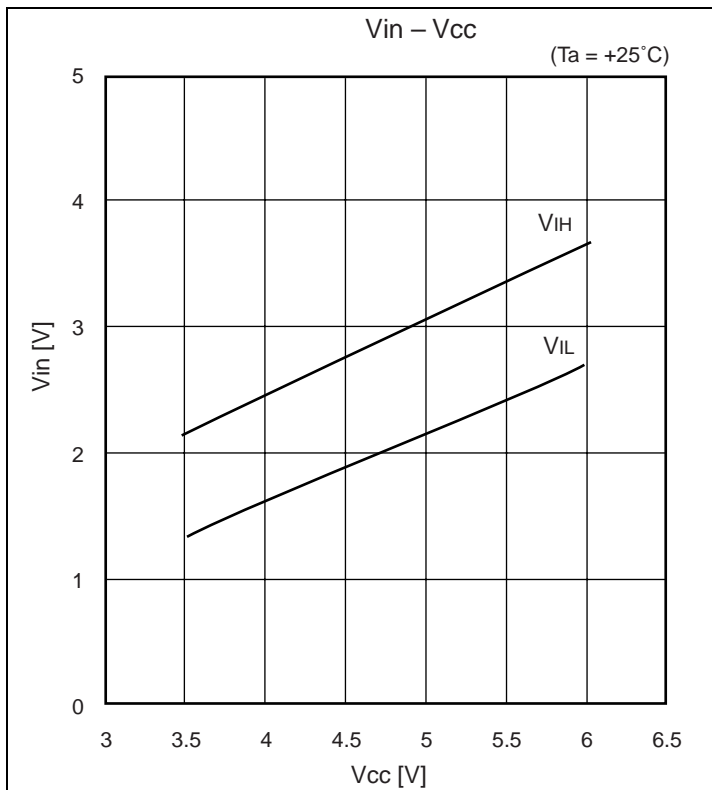
- "H" level output voltage



- "L" level output voltage

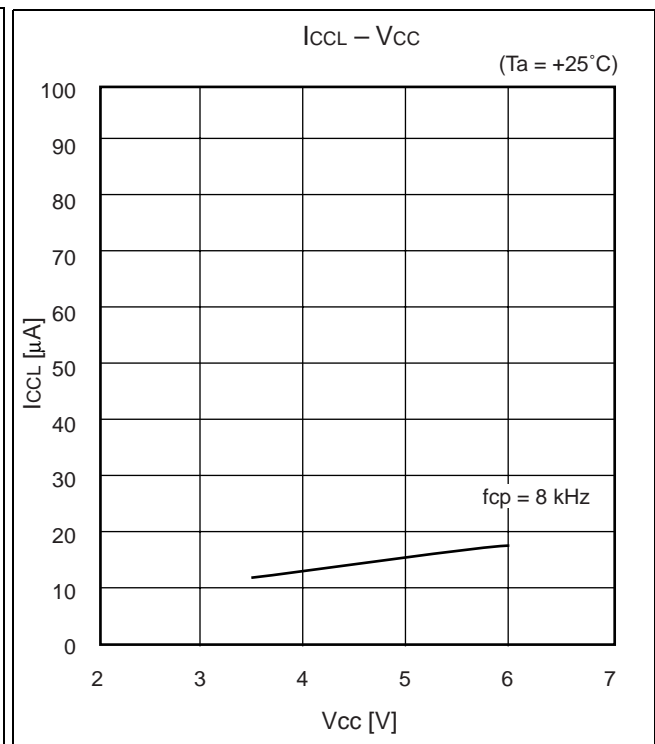
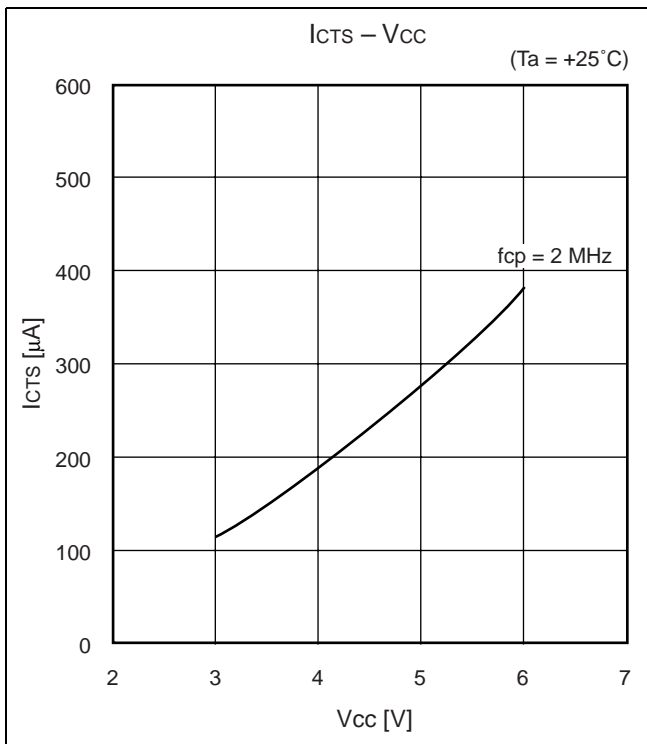
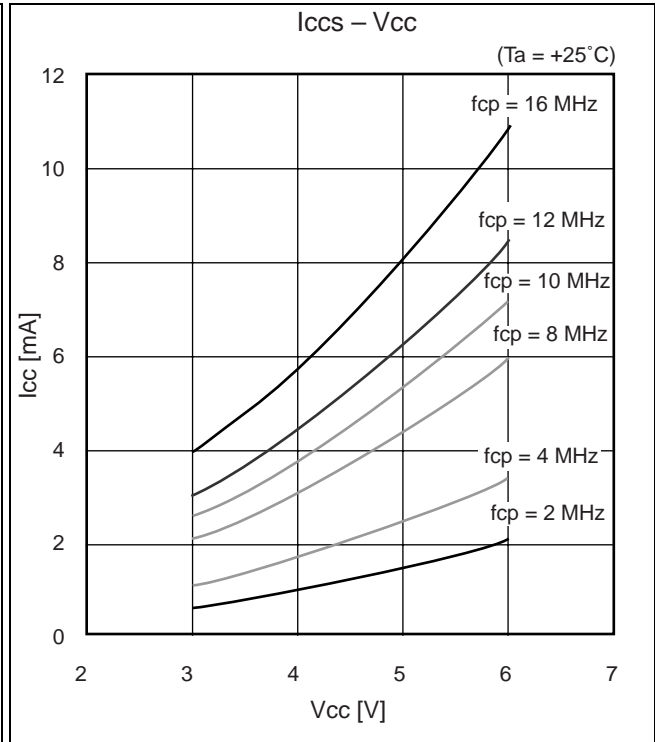
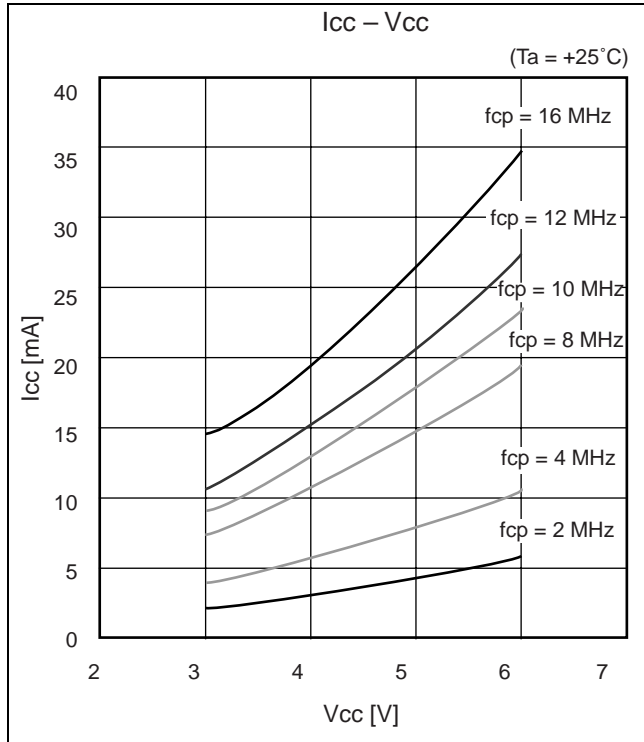


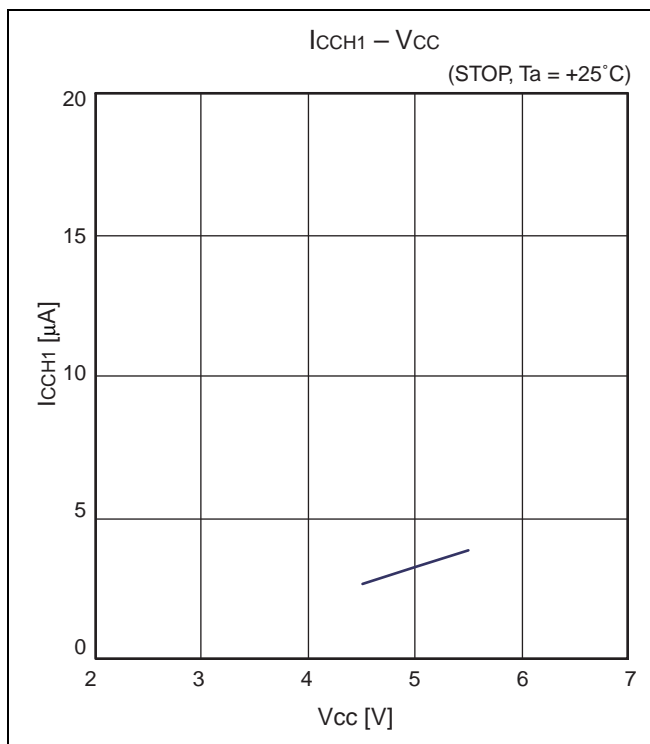
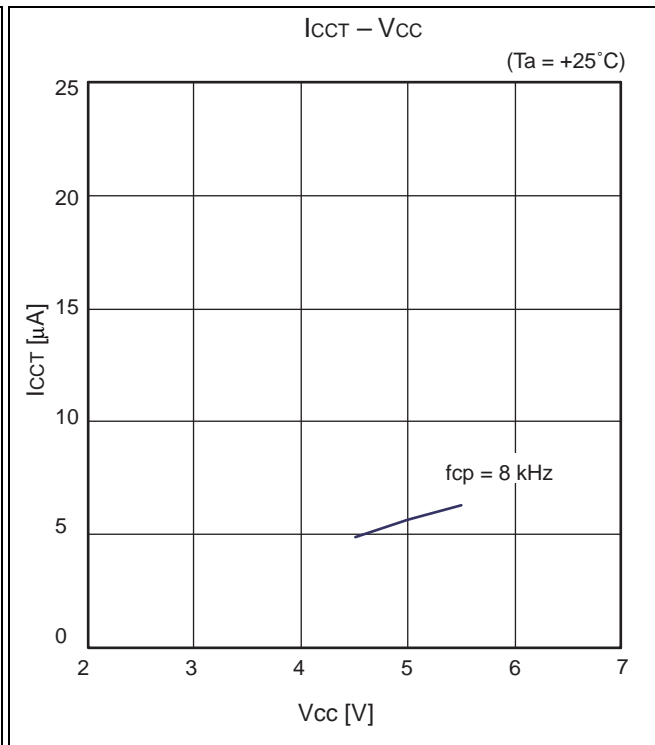
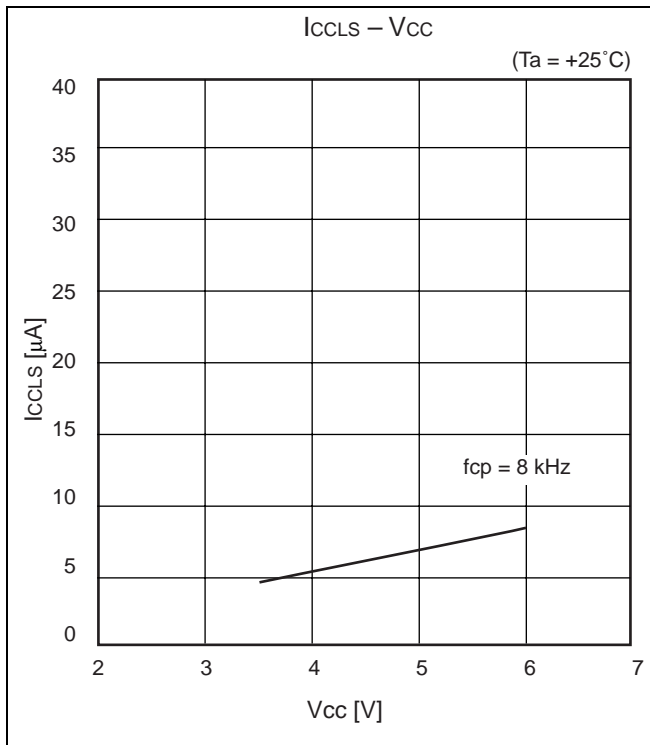
- "H" level input voltage/ "L" level input voltage
(Hysteresis input)



MB90435 Series

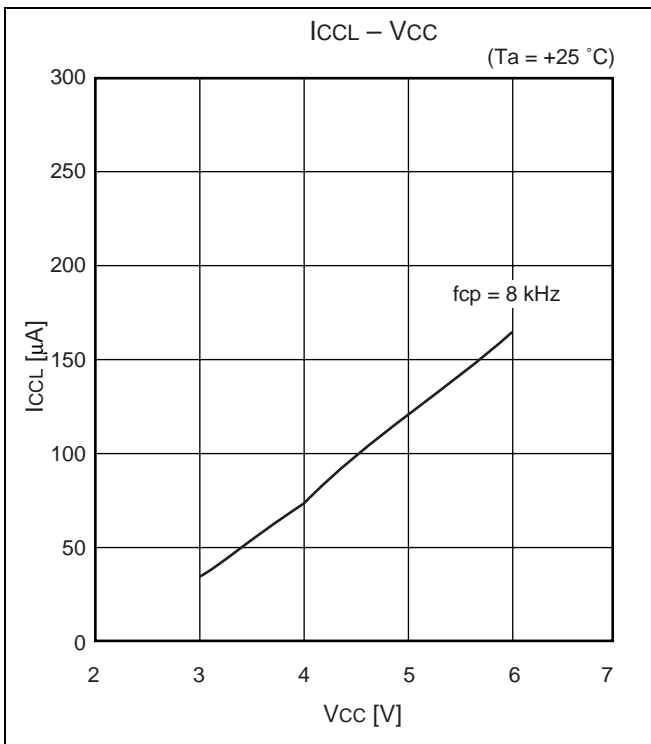
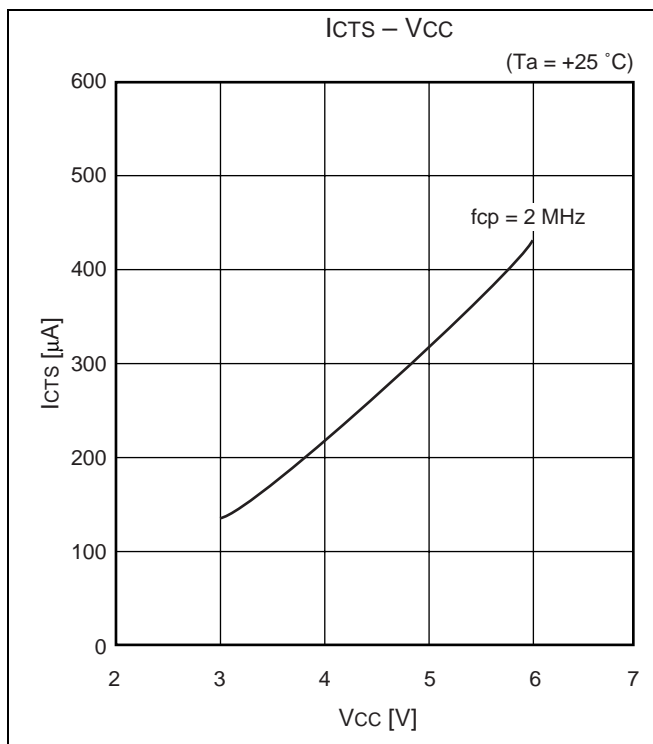
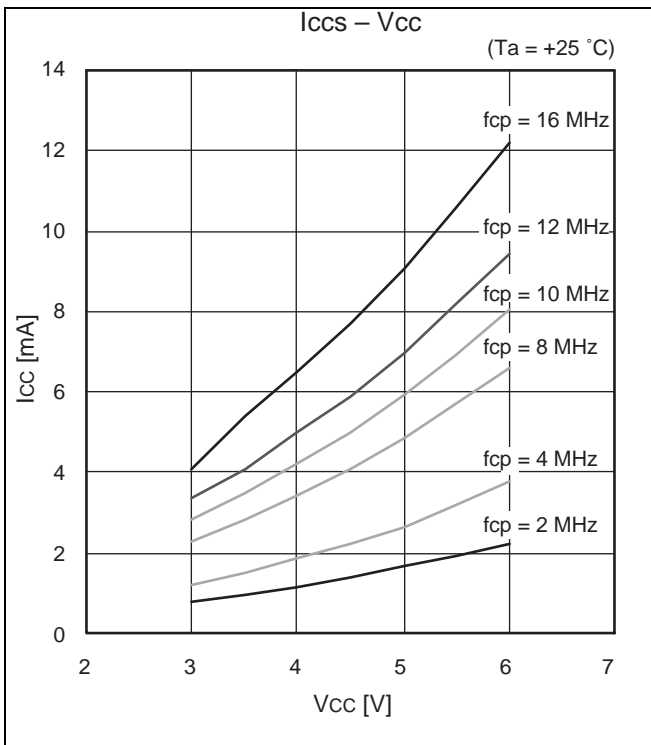
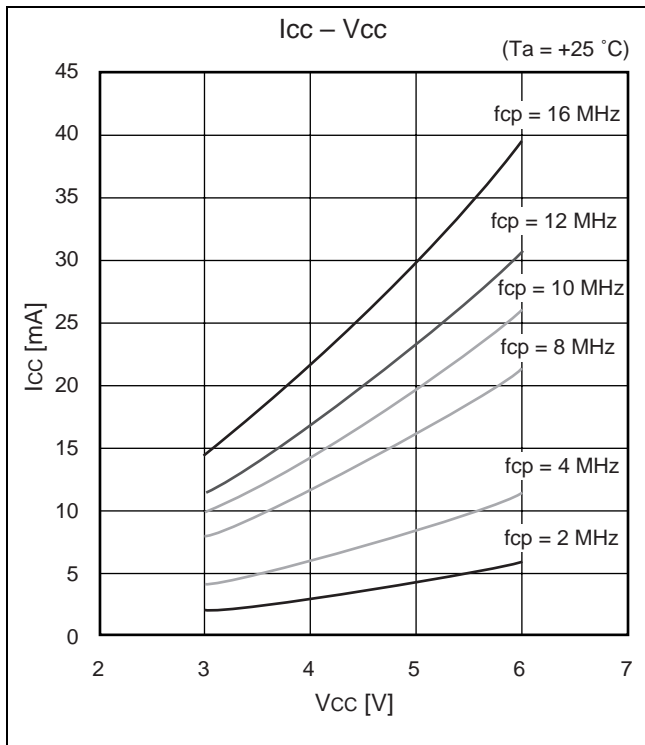
- Power supply current (MB90439)

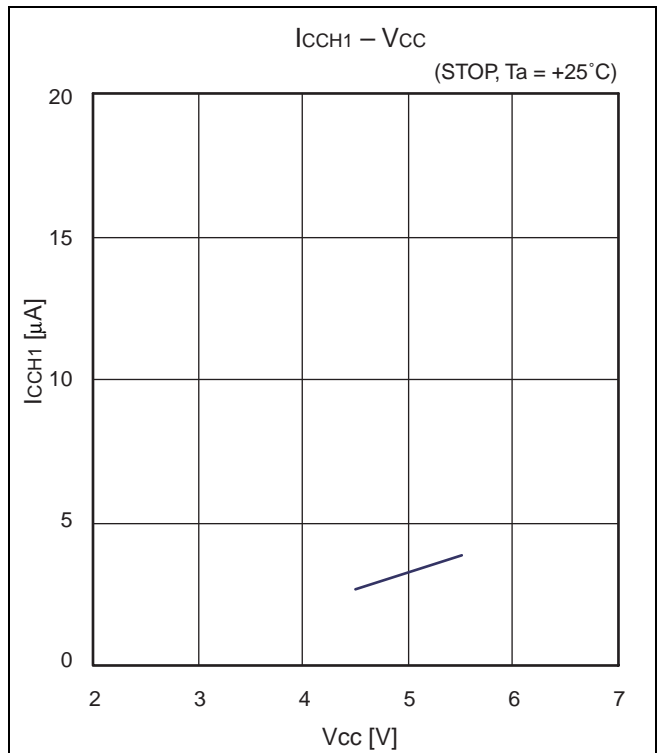
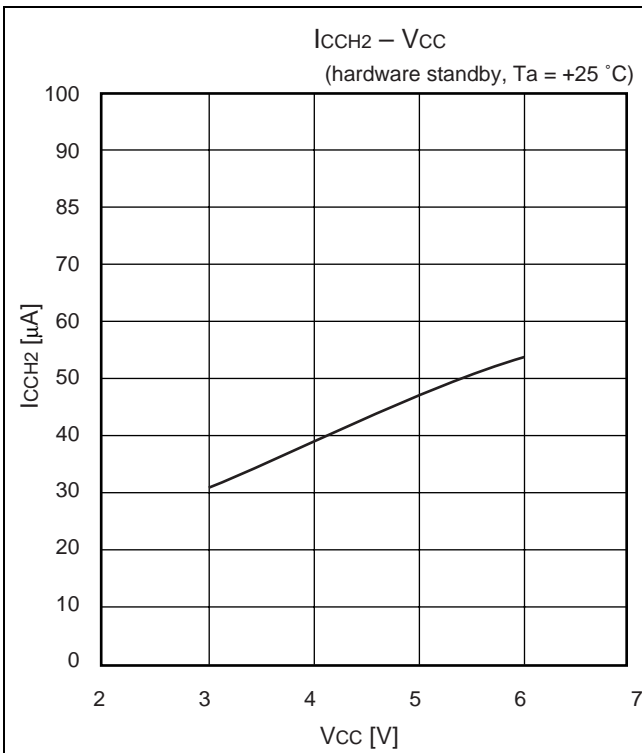
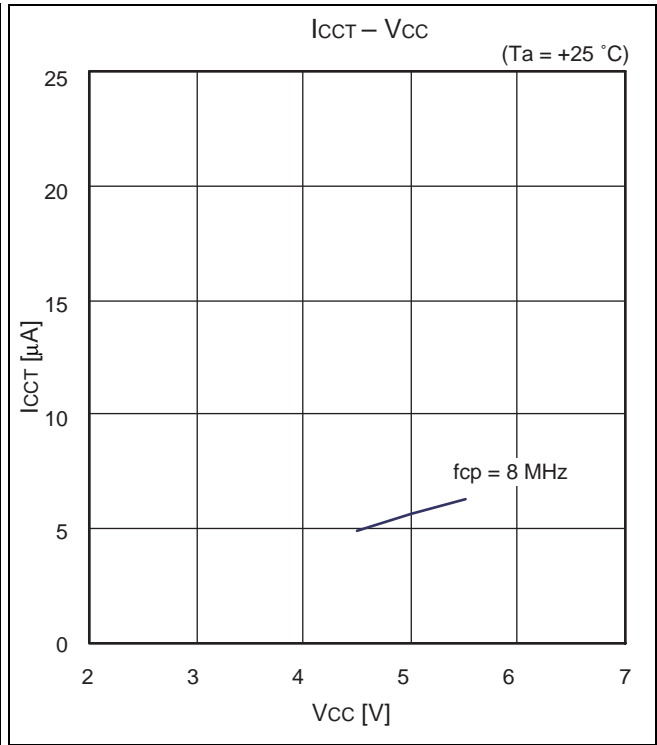
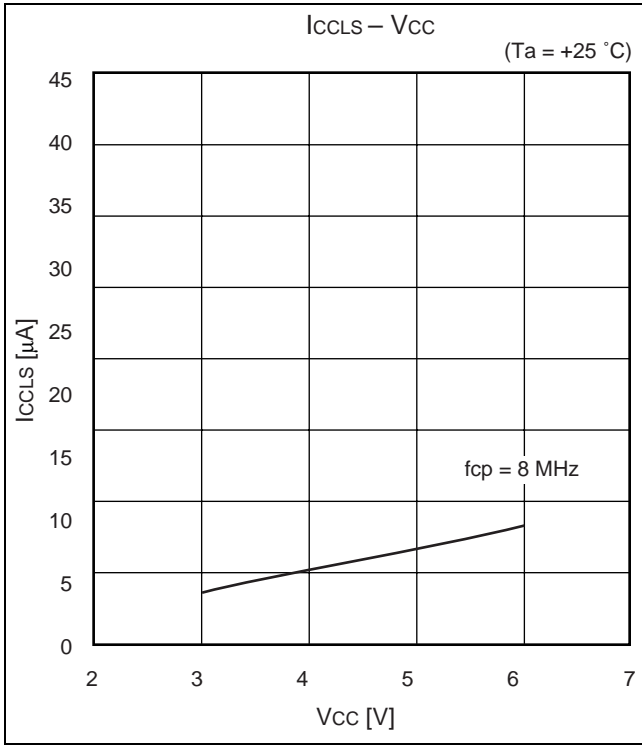




MB90435 Series

- Power supply current (MB90F439)





MB90435 Series

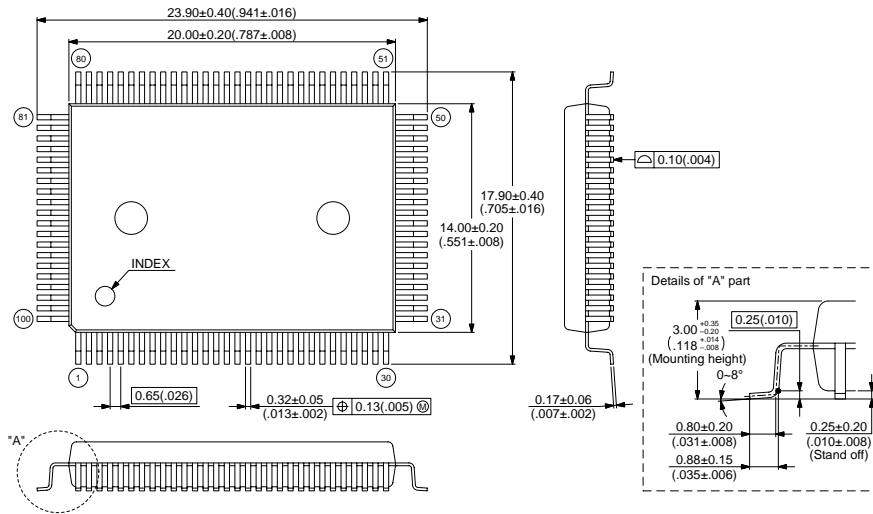
■ ORDERING INFORMATION

Part number	Package	Remarks
MB90F438LPF MB90F438LSPF MB90F439PF MB90F439SPF MB90437LPF MB90437LSPF MB90438LPF MB90438LSPF MB90439PF MB90439SPF	100-pin Plastic QFP (FPT-100P-M06)	
MB90F438LPFV MB90F438LSPFV MB90F439PFV MB90F439SPFV MB90437LPFV MB90437LSPFV MB90438LPFV MB90438LSPFV MB90439PFV MB90439SPFV	100-pin Plastic LQFP (FPT-100P-M05)	

PACKAGE DIMENSIONS

100-pin Plastic QFP
(FPT-100P-M06)

Note: Pins width and pins thickness include plating thickness.

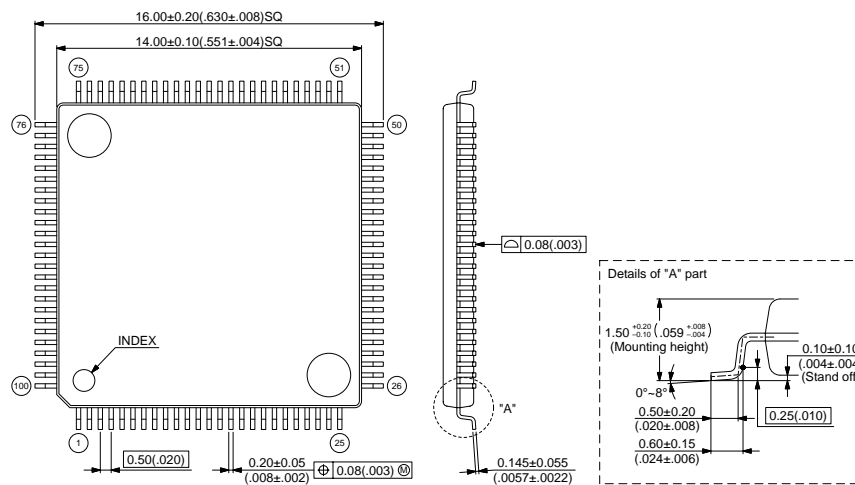


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Dimensions in mm (inches)

100-pin Plastic LQFP
(FPT-100P-M05)

Note : Pins width and pins thickness include plating thickness.



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Dimensions in mm (inches)

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