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F²MC-16LX MB90590G Series CMOS 16-bit Proprietary Microcontroller

The MB90590G series with two FULL-CAN interfaces and FLASH ROM is especially designed for automotive and industrial applications. Its main features are two on board CAN Interfaces, which conform to V2.0 Part A and Part B, while supporting a very flexible message buffer scheme and so offering more functions than a normal full CAN approach.
The instruction set of 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 microcontroller has a 32-bit accumulator for processing long word data.
The MB90590/590G series has peripheral resources of 8/10-bit A/D converters, UART (SCI), extended I/O serial interface, 8/16-bit PPG timer, I/O timer (input capture (ICU), output compare (OCU)), stepping motor controller, and sound generator.

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 (at oscillation of 4 MHz, 4 MHz to 16 MHz).
  Minimum instruction execution time : 62.5 ns (operation at oscillation of 4 MHz, four times the oscillation clock, V_{CC} of 5.0 V)
- 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) : Up to 10 channels
- Embedded ROM size and types
  Mask ROM : 256 Kbytes/384 Kbytes
  Flash ROM : 256 Kbytes/384 Kbytes
  Embedded RAM size : 6 Kbytes/8 Kbytes
- Flash ROM
  Supports automatic programming, Embedded Algorithm 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
  Watch mode
  Hardware stand-by mode
- Process
  0.5μm CMOS technology
- I/O port
  General-purpose I/O ports : 78 ports
- Timer
  Watchdog timer : 1 channel
  8/16-bit PPG timer : 8/16-bit × 6 channels
  16-bit re-load timer : 2 channels
- 16-bit I/O timer
  16-bit free-run timer : 1 channel
  Input capture : 6 channels
  Output compare : 6 channels
- Extended I/O serial interface : 1 channel
- UART (3 channels)
  With full-duplex double buffer (8-bit length)
  Clock asynchronized or clock synchronized (with start/stop bit) transmission can be selectively used.
- Stepping motor controller (4 channels)
- 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.
- FULL-CAN interfaces : 2
  Conforming to Version 2.0 Part A and Part B
  Flexible message buffering (mailbox and FIFO buffering can be mixed)
- Sound generator
- 18-bit Time-base counter
- Watch timer : 1 channel
- External bus interface : Maximum address space 16 Mbytes

Contents

1. Product Lineup

Features		MB90591G/594G	MB90F591G/F594G	MB90V590G
Classification		Mask ROM product	Flash ROM product	Evaluation product
ROM size		384/256 Kbytes	384/256 Kbytes Boot block Hard-wired reset vector	None
RAM size		8/6 Kbytes	8/6 Kbytes	8 Kbytes
Emulator-specific power supply *1		—		None
CPU functions		The number of instructions : 340 Instruction bit length : 8 bits, 16 bits Instruction length : 1 byte to 7 bytes Data bit length : 1 bit, 8 bits, 16 bits Minimum execution time : 62.5 ns (at machine clock frequency of 16 MHz) Interrupt processing time : 1.5 μs (at machine clock frequency of 16 MHz, minimum value)		
UART (3 channels)		Clock synchronized transmission (500 Kbps / 1 Mbps / 2 Mbps) Clock asynchronized transmission (4808/5208/9615/10417/19230/38460/62500 /500000 bps at machine clock frequency of 16 MHz) Transmission can be performed by bi-directional serial transmission or by master/slave connection.		
8/10-bit A/D converter		Conversion precision : 8/10-bit can be selectively used. Number of inputs : 8 One-shot conversion mode (converts selected channel once only) Scan conversion mode (converts two or more successive channels and can program up to 8 channels) Continuous conversion mode (converts selected channel continuously) Stop conversion mode (converts selected channel and stop operation repeatedly)		
8/16-bit PPG timers (6 channels)		Number of channels : 6 (8/16-bit × 6 channels) PPG operation of 8-bit or 16-bit A pulse wave of given intervals and given duty ratios can be output. Pulse interval : fsys, fsys/2^1, fsys/2^2, fsys/2^3, fsys/2^4, 128μs (at oscillation of 4 MHz, fsys = system clock frequency of 16 MHz, fosc = oscillation clock frequency)		
16-bit Reload timer		Number of channels : 2 Operation clock frequency : fsys/2^1, fsys/2^3, fsys/2^5 (fsys = System clock frequency) Supports External Event Count function		
16-bit I/O timer	16-bit Output compares	Number of channels : 6 (8/16-bit × 6 channels) Pin input factor : A match signal of compare register		
	Input captures	Number of channels : 6 Rewriting a register value upon a pin input (rising, falling, or both edges)		

(Continued)

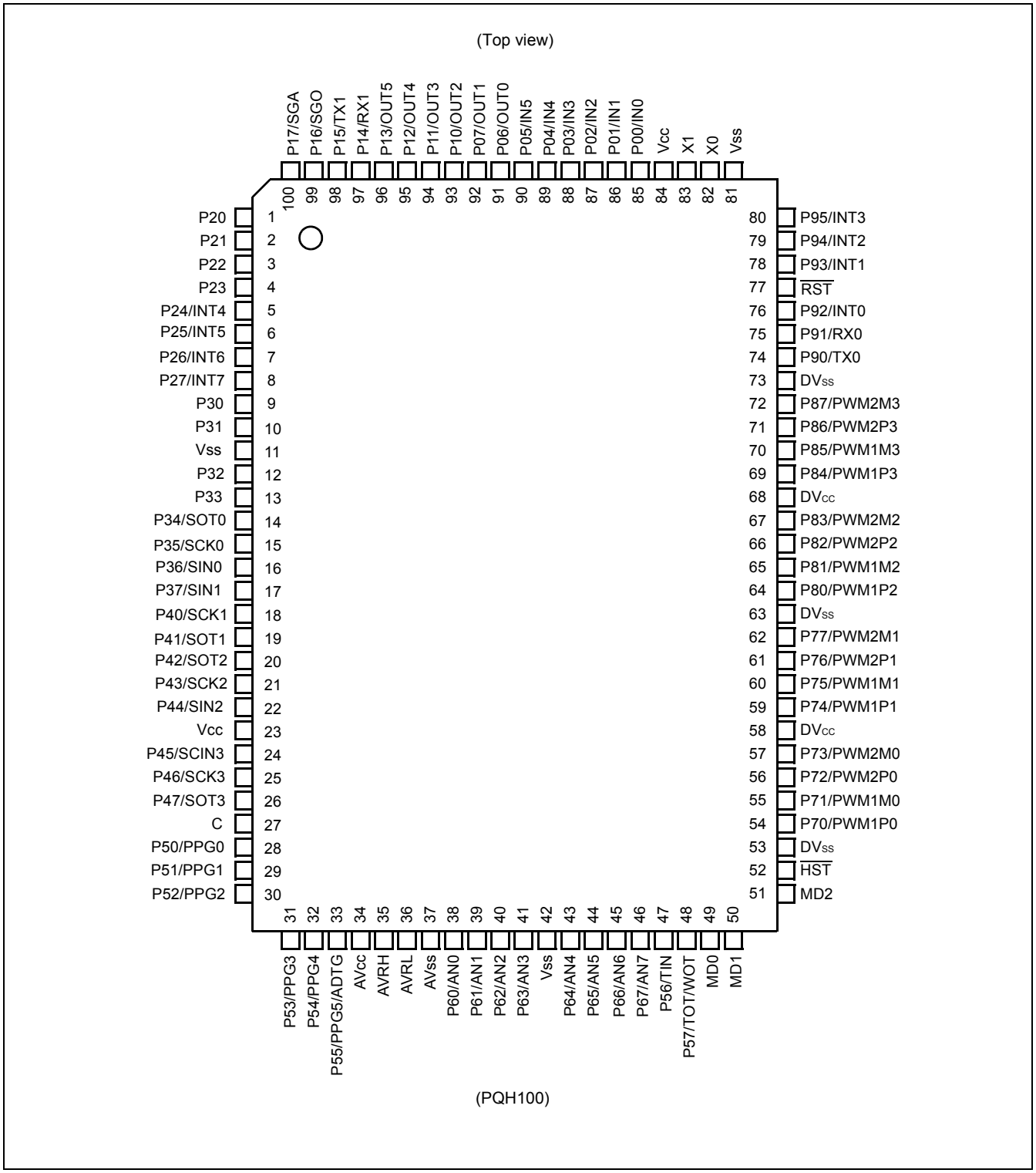
(Continued)

Features	MB90591G/594G	MB90F591G/F594G	MB90V590G
CAN Interface	Number of channels : 2 Conforms to CAN Specification Version 2.0 Part A and B Automatic re-transmission in case of error Automatic transmission responding to Remote Frame Prioritized 16 message buffers for data and ID's Supports multiple messages Flexible configuration of acceptance filtering : Full bit compare / Full bit mask / Two partial bit masks Supports up to 1Mbps CAN bit timing setting : MB90(F)59xG : TSEG2 ≥ RSJW		
Stepping motor controller (4 channels)	Four high current outputs for each channel Synchronized two 8-bit PWM's for each channel		
External interrupt circuit	Number of inputs : 8 Started by a rising edge, a falling edge, an "H" level input, or an "L" level input.		
Sound generator	8-bit PWM signal is mixed with tone frequency from 8-bit reload counter PWM frequency : 62.5K, 31.2K, 15.6K, 7.8KHz (at System clock = 16MHz) Tone frequency : PWM frequency / 2 / (reload value + 1)		
Extended I/O serial interface	Clock synchronized transmission (31.25K/62.5K/125K/500K/1Mbps at machine clock frequency of 16 MHz) LSB first/MSB first		
Watch timer	Directly operates with the system clock Read/Write accessible Second/Minute/Hour registers		
Watchdog timer	Reset generation interval : 3.58 ms, 14.33 ms, 57.23 ms, 458.75 ms (at oscillation of 4 MHz, minimum value)		
Flash Memory	Supports automatic programming, Embedded Algorithm and 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 Boot block configuration Erase can be performed on each block Block protection with external programming voltage Flash Writer from Minato Electronics Inc.		
Low-power consumption (stand-by) mode	Sleep/stop/CPU intermittent operation/watch timer/hardware stand-by		
Process	CMOS		
Power supply voltage for operation*2	5 V±10 % (MB90V590G, MB90F594G, MB90594G) 5 V±5 % (MB90F591G, MB90591G)		
Package	QFP-100		PGA-256

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

*2 : Varies with conditions such as the operating frequency. (See section "Electrical Characteristics.")

2. Pin Assignment



3. Pin Description

No.	Pin name	Circuit type	Function
82	X0	A	Oscillator pin
83	X1		
77	$\overline{RST}$	B	Reset input
52	$\overline{HST}$	C	Hardware standby input
85 to 90	P00 to P05	D	General purpose I/O
	IN0 to IN5		Inputs for the Input Captures
91 to 96	P06, P07, P10 to P13	D	General purpose I/O
	OUT0 to OUT5		Outputs for the Output Compares. To enable the signal outputs, the corresponding bits of the Port Direction registers should be set to “1”.
97	P14	D	General purpose I/O
	RX1		RX input for CAN Interface 1
98	P15	D	General purpose I/O
	TX1		TX output for CAN Interface 1. To enable the signal output, the corresponding bit of the Port Direction register should be set to “1”.
99	P16	D	General purpose I/O
	SGO		SGO output for the Sound Generator. To enable the signal output, the corresponding bit of the Port Direction register should be set to “1”.
100	P17	D	General purpose I/O
	SGA		SGA output for the Sound Generator. To enable the signal output, the corresponding bit of the Port Direction register should be set to “1”.
1 to 4	P20 to P23	D	General purpose I/O
5 to 8	P24 to P27	D	General purpose I/O
	INT4 to INT7		External interrupt input for INT4 to INT7
9, 10	P30, P31	D	General purpose I/O
12, 13	P32, P33	D	General purpose I/O
14	P34	D	General purpose I/O
	SOT0		SOT output for UART 0. To enable the signal output, the corresponding bit of the Port Direction register should be set to “1”.
15	P35	D	General purpose I/O
	SCK0		SCK input/output for UART 0. To enable the signal output, the corresponding bit of the Port Direction register should be set to “1”.

(Continued)

No.	Pin name	Circuit type	Function
16	P36	D	General purpose I/O
	SIN0		SIN input for UART 0
17	P37	D	General purpose I/O
	SIN1		SIN input for UART 1
18	P40	D	General purpose I/O
	SCK1		SCK input/output for UART 1
19	P41	D	General purpose I/O
	SOT1		SOT output for UART 1
20	P42	D	General purpose I/O
	SOT2		SOT output for UART 2
21	P43	D	General purpose I/O
	SCK2		SCK input/output for UART 2
22	P44	D	General purpose I/O
	SIN2		SIN input for UART 2
24	P45	D	General purpose I/O
	SIN3		SIN input for the Serial I/O
25	P46	D	General purpose I/O
	SCK3		SCK input/output for the Serial I/O
26	P47	D	General purpose I/O
	SOT3		SOT output for the Serial I/O
28 to 33	P50 to P55	D	General purpose I/O
	PPG0 to PPG5, ADTG		Outputs for the Programmable Pulse Generators. Pin number 33 is also shared with ADTG input for the external trigger of the A/D Converter.
38 to 41	P60 to P63	E	General purpose I/O
	AN0 to AN3		Inputs for the A/D Converter
43 to 46	P64 to P67	E	General purpose I/O
	AN4 to AN7		Inputs for the A/D Converter
47	P56	D	General purpose I/O
	TIN		TIN input for the 16-bit Reload Timers
48	P57	D	General purpose I/O
	TOT/WOT		TOT output for the 16-bit Reload Timers and WOT output for the Watch Timer. Only one of three output enable flags in these peripheral blocks can be set at a time. Otherwise the output signal has no meaning.

(Continued)

No.	Pin name	Circuit type	Function
54 to 57	P70 to P73	F	General purpose I/O
	PWM1P0, PWM1M0, PWM2P0, PWM2M0		Output for Stepping Motor Controller channel 0.
59 to 62	P74 to P77	F	General purpose I/O
	PWM1P1, PWM1M1, PWM2P1, PWM2M1		Output for Stepping Motor Controller channel 1.
64 to 67	P80 to P83	F	General purpose I/O
	PWM1P2, PWM1M2, PWM2P2, PWM2M2		Output for Stepping Motor Controller channel 2.
69 to 72	P84 to P87	F	General purpose I/O
	PWM1P3, PWM1M3, PWM2P3, PWM2M3		Output for Stepping Motor Controller channel 3.
74	P90	D	General purpose I/O
	TX0		TX output for CAN Interface 0
75	P91	D	General purpose I/O
	RX0		RX input for CAN Interface 0
76	P92	D	General purpose I/O
	INT0		External interrupt input for INT0
78	P93	D	General purpose I/O
	INT1		External interrupt input for INT1
79	P94	D	General purpose I/O
	INT2		External interrupt input for INT2
80	P95	D	General purpose I/O
	INT3		External interrupt input for INT3
58, 68	DV_{CC}	—	Dedicated power supply pins for the high current output buffers (Pin No. 54 to 72)
53, 63, 73	DV_{SS}	—	Dedicated ground pins for the high current output buffers (Pin No. 54 to 72)
34	AV_{CC}	Power supply	Power supply for analog circuit pin When turning this power supply on or off, always be sure to first apply electric potential equal to or greater than AV_{CC} to V_{CC}.
37	AV_{SS}	Power supply	Ground level for analog circuit

(Continued)

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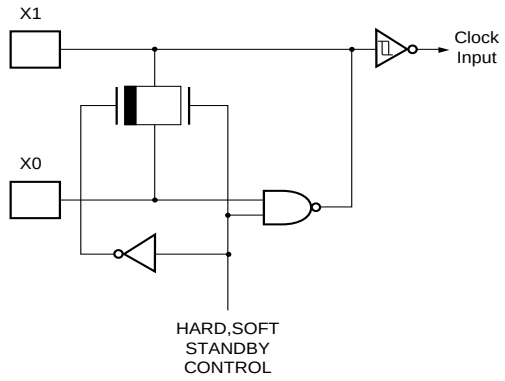
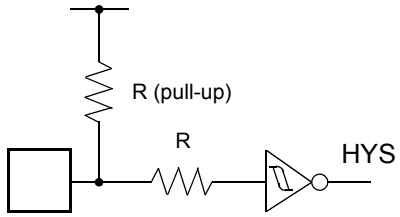
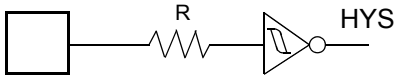
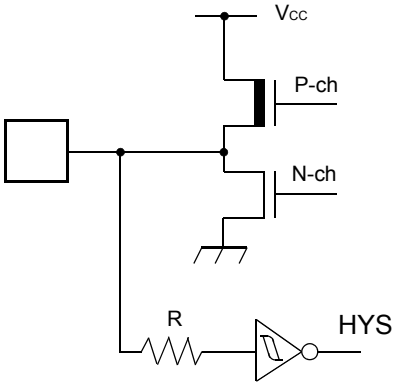
No.	Pin name	Circuit type	Function
35	AVRH	Power supply	Reference voltage input pin for analog circuit When turning this power supply on or off, always be sure to first apply electric potential equal to or greater than AVRH to AV_{CC}.
36	AVRL	Power supply	Reference voltage input pin for analog circuit
49, 50	MD0, MD1	C	Operating mode selection input pins Connect directly to V_{CC} or V_{SS}.
51	MD2	G	Operating mode selection input pin Connect directly to V_{CC} or V_{SS}.
27	C	—	This is the power supply stabilization capacitor pin. It should be connected externally to an 0.1 µF ceramic capacitor.
23, 84	V_{CC}	Power supply	Power supply (5.0 V) input pin for digital circuit
11,42,81	V_{SS}	Power supply	Power supply (GND) input pin for digital circuit

4. I/O Circuit Type

Circuit Type	Circuit	Remarks
A		■ Oscillation feedback resistor : 1 MΩ approx.
B		■ Hysteresis input with pull-up resistor : 50 kΩ approx.
C		■ Hysteresis input
D		■ CMOS output ■ Hysteresis input

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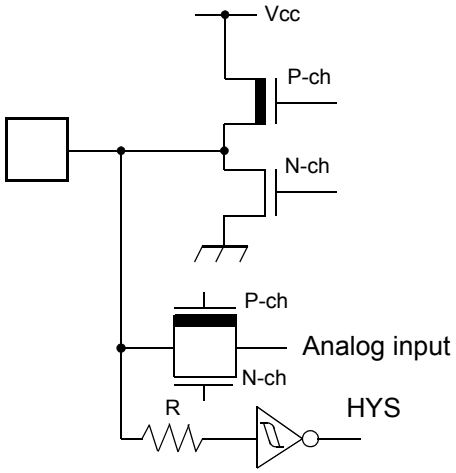
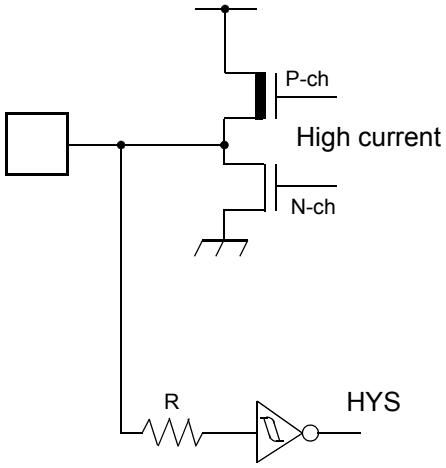
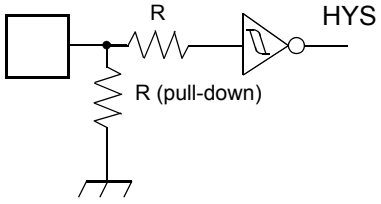
Circuit Type	Circuit	Remarks
E		■ CMOS output ■ Hysteresis input ■ Analog input
F		■ CMOS high current output ■ Hysteresis input
G		■ Hysteresis input with pull-down resistor : 50 kΩ approx. ■ Flash version does not have pull-down resistor.

5. Handling Devices

(1) Preventing latch-up
CMOS IC chips may suffer latch-up under the following conditions :

■ A voltage higher than Vcc or lower than Vss is applied to an input or output pin.

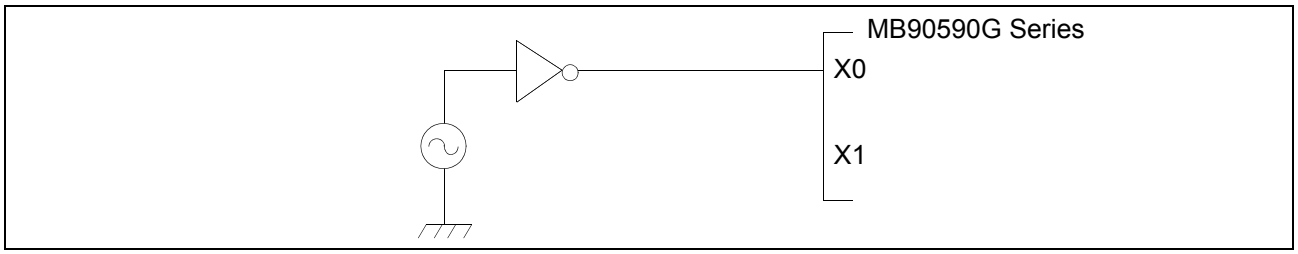
■ A voltage higher than the rated voltage is applied between Vcc and Vss.

■ The AVcc power supply is applied before the Vcc voltage.
Latch-up may increase the power supply current drastically, causing thermal damage to the device.
For the same reason, also be careful not to let the analog power-supply voltage (AV_{CC}, AVRH) exceed the digital power-supply voltage.

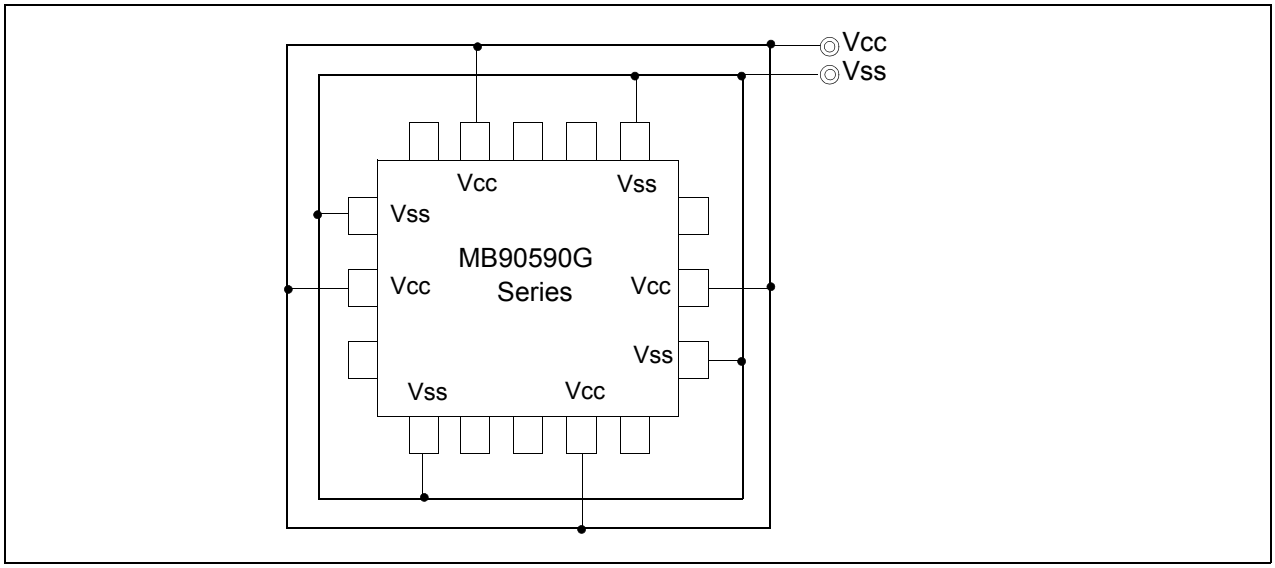
(2) Treatment of unused pins
Leaving unused input pins open may result in misbehavior or latch up and possible permanent damage of the device. Therefor they must be pulled up or pulled down through resistors. In this case those resistors should be more than 2 kΩ.
Unused bidirectional pins should be set 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.

Using external clock



(4)Power supply pins (Vcc/Vss)
In products with multiple V_{CC} or V_{SS} pins, pins with the 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 lowest impedance to power lines.
It is recommended to provide a bypass capacitor of around 0.1 µF between V_{CC} and V_{SS} pin near the device.



(5) Pull-up/down resistors
The MB90590G Series does not support internal pull-up/down resistors. Use external components where needed.

(6) Crystal Oscillator Circuit
Noises around X0 or X1 pins may cause 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 that lines of oscillation circuits do not cross the lines of other circuits.
A printed circuit board artwork surrounding the X0 and X1 pins with a ground area for stabilizing the operation is highly recommended.

(7) 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).

(8) 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}.

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

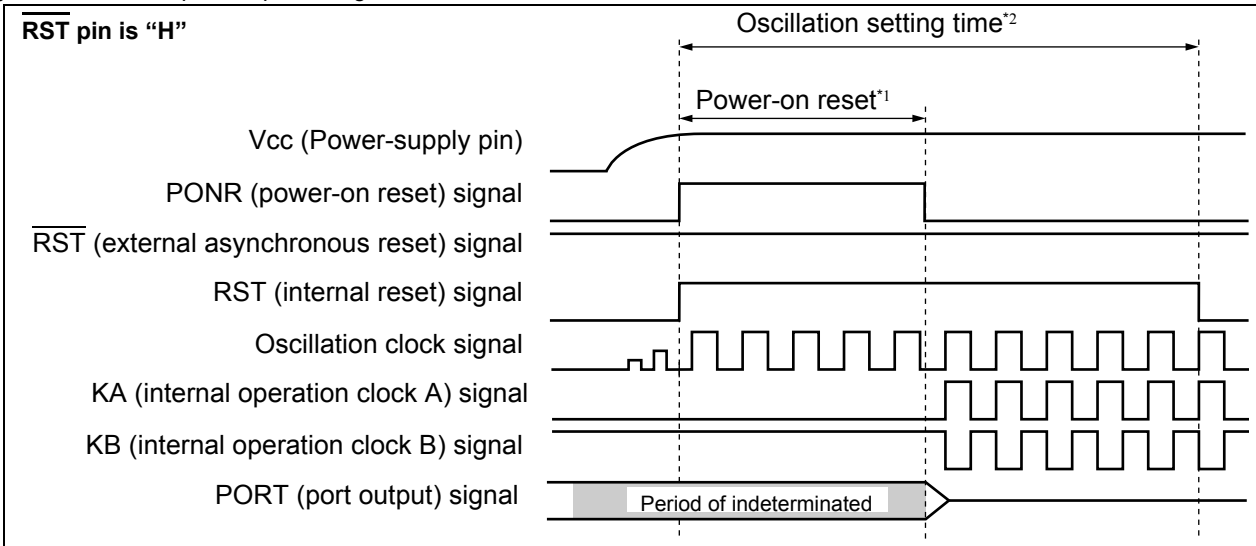
(10) Notes on Energization
To prevent the internal regulator circuit from malfunctioning, set the voltage rise time during energization at 50 µs or more (0.2 V to 2.7 V).

(11) Indeterminate outputs from ports 0 and 1 (without MB90F591G/591G, MB90F594G)
During oscillation setting time of step-down circuit (during a power-on reset) after the power is turned on, the outputs from ports 0 and 1 become following state.

■ If $\overline{RST}$ pin is “H”, the outputs become indeterminate.

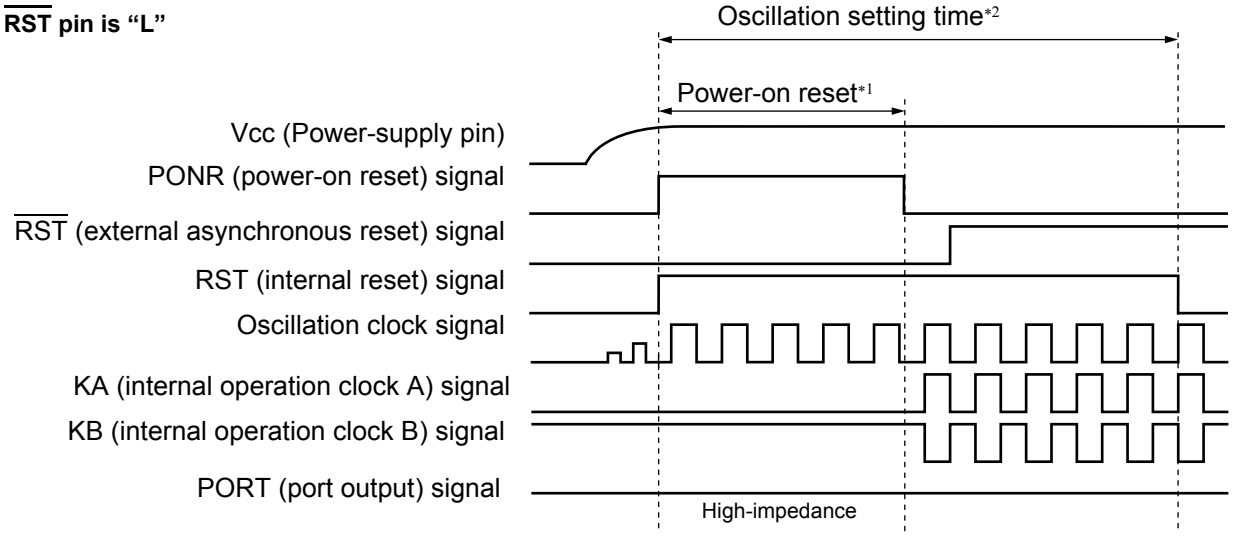
■ If $\overline{RST}$ pin is “L”, the outputs become high-impedance.
Pay attention to the port output timing shown as follow.

$\overline{RST}$ pin is “H”



*1 : Power-on reset time : "Period of clock frequency" × 2^{17} (Clock frequency of 16 MHz : 8.19 ms)
*2 : Oscillation setting time : "Period of clock frequency" × 2^{18} (Clock frequency of 16 MHz : 16.38ms)

$\overline{RST}$ pin is “L”



*1 : Power-on reset time : "Period of clock frequency" × 2^{17} (Clock frequency of 16 MHz : 8.19 ms)
*2 : Oscillation setting time : "Period of clock frequency" × 2^{18} (Clock frequency of 16 MHz : 16.38ms)

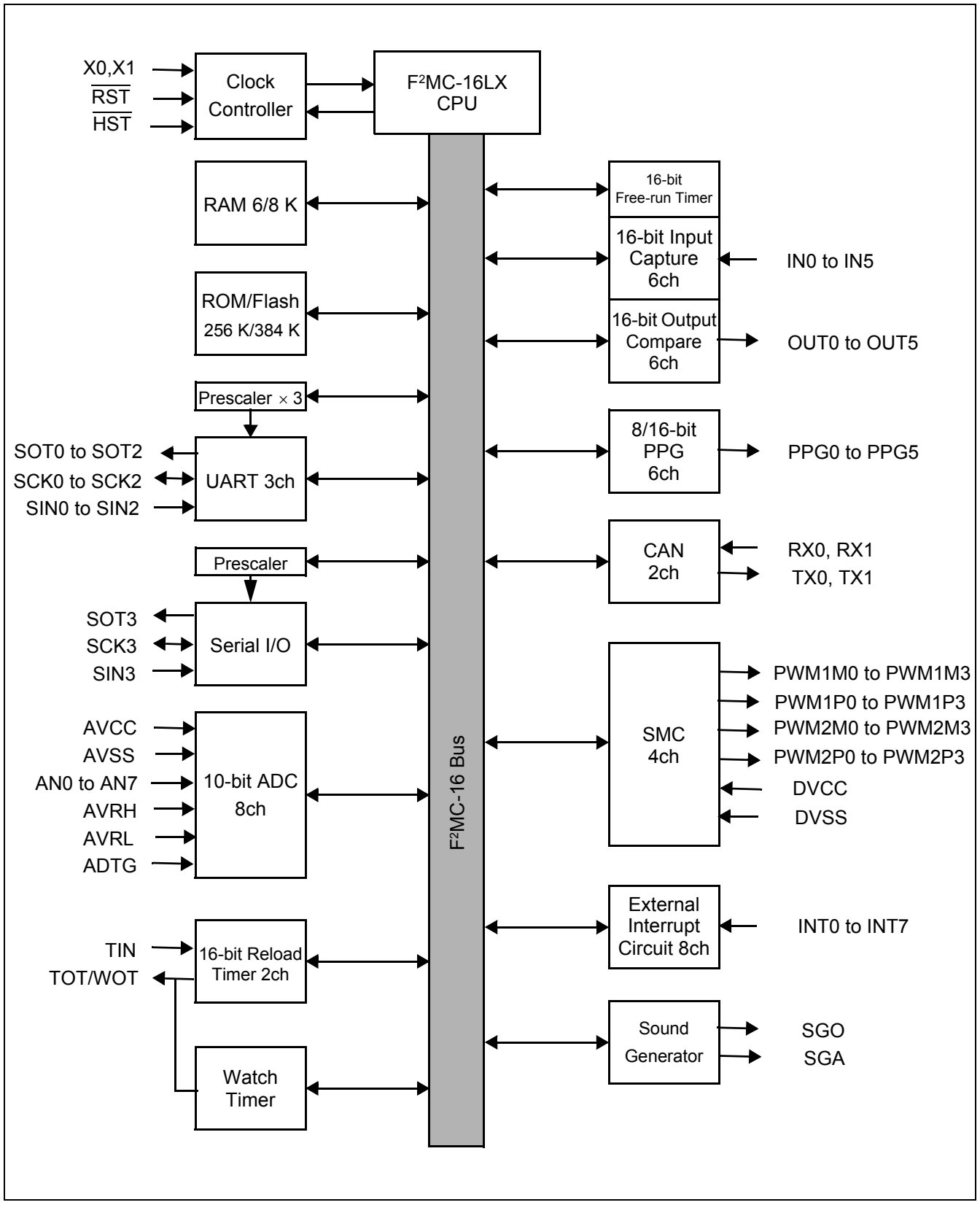
(12) Initialization
The device contains internal registers which are initialized only by a power-on reset. To initialize these registers, please turn on the power again.

(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 "00 H".
If the values of the corresponding bank registers (DTB,ADB,USB,SSB) are set to other than "00 H", 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 in the microcontroller, it may attempt to continue the operation using the free-running frequency of the automatic oscillating circuit in the PLL circuitry even if the oscillator is out of place or the clock input is stopped. Performance of this operation, however, cannot be guaranteed.

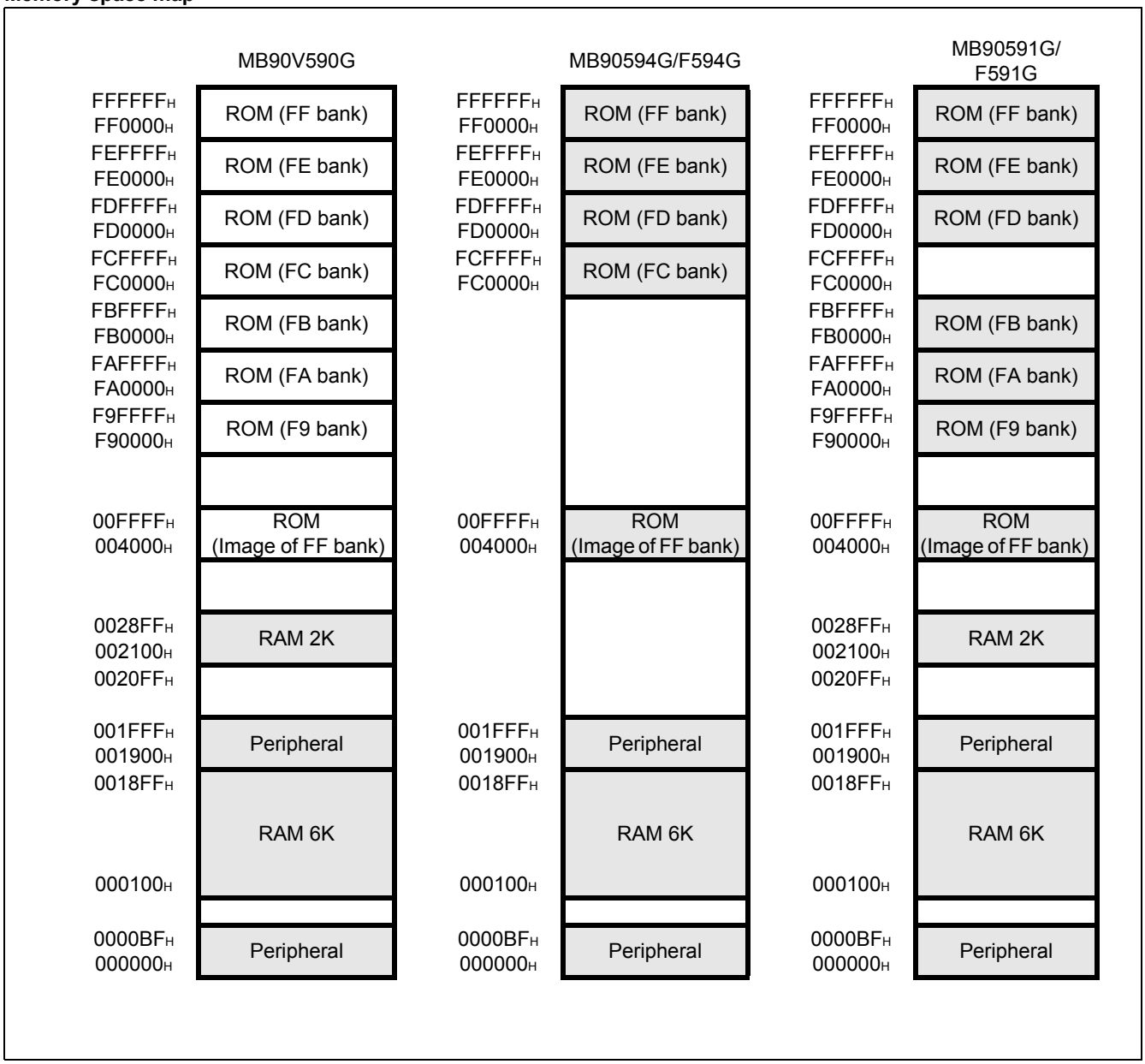
6. Block Diagram



7. Memory Space

The memory space of the MB90590/590G Series is shown below

Memory space map



Note: : The ROM data of bank FF is reflected in the upper address of bank 00, realizing effective use of the C compiler small model. The lower 16-bit of bank FF and the lower 16-bit of bank 00 are assigned to the same address, enabling reference of the table on the ROM without stating “far”.
For example, if an attempt has been made to access 00C000H , the contents of the ROM at FFC000H are accessed. Since the ROM area of the FF bank exceeds 48 Kbytes, the whole area cannot be reflected in the image for the 00 bank. The ROM data at FF4000H to FFFFFFH looks, therefore, as if it were the image for 004000H to 00FFFFH. Thus, it is recommended that the ROM data table be stored in the area of FF4000H to FFFFFFH.

8. I/O Map

Address	Register	Abbreviation	Access	Peripheral	Initial value
00_H	Port 0 Data Register	PDR0	R/W	Port 0	XXXXXXXX$_B$
01_H	Port 1 Data Register	PDR1	R/W	Port 1	XXXXXXXX$_B$
02_H	Port 2 Data Register	PDR2	R/W	Port 2	XXXXXXXX$_B$
03_H	Port 3 Data Register	PDR3	R/W	Port 3	XXXXXXXX$_B$
04_H	Port 4 Data Register	PDR4	R/W	Port 4	XXXXXXXX$_B$
05_H	Port 5 Data Register	PDR5	R/W	Port 5	XXXXXXXX$_B$
06_H	Port 6 Data Register	PDR6	R/W	Port 6	XXXXXXXX$_B$
07_H	Port 7 Data Register	PDR7	R/W	Port 7	XXXXXXXX$_B$
08_H	Port 8 Data Register	PDR8	R/W	Port 8	XXXXXXXX$_B$
09_H	Port 9 Data Register	PDR9	R/W	Port 9	_ _ XXXXXX$_B$
$0A_H$ to $0F_H$	Reserved				
10_H	Port 0 Direction Register	DDR0	R/W	Port 0	0 0 0 0 0 0 0 0$_B$
11_H	Port 1 Direction Register	DDR1	R/W	Port 1	0 0 0 0 0 0 0 0$_B$
12_H	Port 2 Direction Register	DDR2	R/W	Port 2	0 0 0 0 0 0 0 0$_B$
13_H	Port 3 Direction Register	DDR3	R/W	Port 3	0 0 0 0 0 0 0 0$_B$
14_H	Port 4 Direction Register	DDR4	R/W	Port 4	0 0 0 0 0 0 0 0$_B$
15_H	Port 5 Direction Register	DDR5	R/W	Port 5	0 0 0 0 0 0 0 0$_B$
16_H	Port 6 Direction Register	DDR6	R/W	Port 6	0 0 0 0 0 0 0 0$_B$
17_H	Port 7 Direction Register	DDR7	R/W	Port 7	0 0 0 0 0 0 0 0$_B$
18_H	Port 8 Direction Register	DDR8	R/W	Port 8	0 0 0 0 0 0 0 0$_B$
19_H	Port 9 Direction Register	DDR9	R/W	Port 9	_ _ 0 0 0 0 0 0$_B$
$1A_H$	Reserved				
$1B_H$	Analog Input Enable Register	ADER	R/W	Port 6, A/D	1 1 1 1 1 1 1 1$_B$
$1C_H$ to $1F_H$	Reserved				
20_H	Serial Mode Control Register 0	UMC0	R/W	UART0	0 0 0 0 0 1 0 0$_B$
21_H	Serial Status Register 0	USR0	R/W		0 0 0 1 0 0 0 0$_B$
22_H	Serial Input/Output Data Register 0	UIDR0/UODR0	R/W		XXXXXXXX$_B$
23_H	Rate and Data Register 0	URD0	R/W		0 0 0 0 0 0 0X$_B$
24_H	Serial Mode Control Register 1	UMC1	R/W	UART1	0 0 0 0 0 1 0 0$_B$
25_H	Serial Status Register 1	USR1	R/W		0 0 0 1 0 0 0 0$_B$
26_H	Serial Input/Output Data Register 1	UIDR1/UODR1	R/W		XXXXXXXX$_B$
27_H	Rate and Data Register 1	URD1	R/W		0 0 0 0 0 0 0X$_B$

(Continued)

Address	Register	Abbreviation	Access	Peripheral	Initial value
28H	Serial Mode Control Register 2	UMC2	R/W	UART2	0 0 0 0 0 1 0 0B
29H	Serial Status Register 2	USR2	R/W		0 0 0 1 0 0 0 0B
2AH	Serial Input/Output Data Register 2	UIDR2/UODR2	R/W		XXXXXXXXB
2BH	Rate and Data Register 2	URD2	R/W		0 0 0 0 0 0 0XB
2CH	Serial Mode Control Register (low-order)	SMCS	R/W	Serial I/O	_ _ _ _0 0 0 0B
2DH	Serial Mode Control Register (high-order)	SMCS	R/W		0 0 0 0 0 0 1 0B
2EH	Serial Data Register	SDR	R/W		XXXXXXXXB
2FH	Edge Selector Register	SES	R/W		_ _ _ _ _ _ _0B
30H	External Interrupt Enable Register	ENIR	R/W	External Interrupt	0 0 0 0 0 0 0 0B
31H	External Interrupt Request Register	EIRR	R/W		XXXXXXXXB
32H	External Interrupt Level Register	ELVR	R/W		0 0 0 0 0 0 0 0B
33H	External Interrupt Level Register	ELVR	R/W		0 0 0 0 0 0 0 0B
34H	A/D Control Status Register 0	ADCS0	R/W	A/D Converter	0 0 0 0 0 0 0 0B
35H	A/D Control Status Register 1	ADCS1	R/W		0 0 0 0 0 0 0 0B
36H	A/D Data Register 0	ADCR0	R		XXXXXXXXB
37H	A/D Data Register 1	ADCR1	R/W		0 0 0 0 1 0 XXB
38H	PPG0 Operation Mode Control Register	PPGC0	R/W	16-bit Programmable Pulse Generator 0/1	0 _ 0 0 0 _ _ 1B
39H	PPG1 Operation Mode Control Register	PPGC1	R/W		0 _ 0 0 0 0 0 1B
3AH	PPG0,1 Output Pin Control Register	PPG01	R/W		0 0 0 0 0 0 0 0B
3BH	Reserved				
3CH	PPG2 Operation Mode Control Register	PPGC2	R/W	16-bit Programmable Pulse Generator 2/3	0 _ 0 0 0 _ _ 1B
3DH	PPG3 Operation Mode Control Register	PPGC3	R/W		0 _ 0 0 0 0 0 1B
3EH	PPG2,3 Output Pin Control Register	PPG23	R/W		0 0 0 0 0 0 0 0B
3FH	Reserved				
40H	PPG4 Operation Mode Control Register	PPGC4	R/W	16-bit Programmable Pulse Generator 4/5	0 _ 0 0 0 _ _ 1B
41H	PPG5 Operation Mode Control Register	PPGC5	R/W		0 _ 0 0 0 0 0 1B
42H	PPG4,5 Output Pin Control Register	PPG45	R/W		0 0 0 0 0 0 0 0B
43H	Reserved				
44H	PPG6 Operation Mode Control Register	PPGC6	R/W	16-bit Programmable Pulse Generator 6/7	0 _ 0 0 0 _ _ 1B
45H	PPG7 Operation Mode Control Register	PPGC7	R/W		0 _ 0 0 0 0 0 1B
46H	PPG6,7 Output Pin Control Register	PPG67	R/W		0 0 0 0 0 0 0 0B
47H	Reserved				

(Continued)

Address	Register	Abbreviation	Access	Peripheral	Initial value
48H	PPG8 Operation Mode Control Register	PPGC8	R/W	16-bit Programmable Pulse Generator 8/9	0 _ 0 0 0 _ _ 1B
49H	PPG9 Operation Mode Control Register	PPGC9	R/W		0 _ 0 0 0 0 0 1B
4AH	PPG8,9 Output Pin Control Register	PPG89	R/W		0 0 0 0 0 0 0 0B
4BH	Reserved				
4CH	PPGA Operation Mode Control Register	PPGCA	R/W	16-bit Programmable Pulse Generator A/B	0 _ 0 0 0 _ _ 1B
4DH	PPGB Operation Mode Control Register	PPGCB	R/W		0 _ 0 0 0 0 0 1B
4EH	PPGA,B Output Pin Control Register	PPGAB	R/W		0 0 0 0 0 0 0 0B
4FH	Reserved				
50H	Timer Control Status Register 0 (low-order)	TMCSR0	R/W	16-bit Reload Timer 0	0 0 0 0 0 0 0 0B
51H	Timer Control Status Register 0 (high-order)	TMCSR0	R/W		_ _ _ _ 0 0 0 0B
52H	Timer Control Status Register 1 (low-order)	TMCSR1	R/W	16-bit Reload Timer 1	0 0 0 0 0 0 0 0B
53H	Timer Control Status Register 1 (high-order)	TMCSR1	R/W		_ _ _ _ 0 0 0 0B
54H	Input Capture Control Status Register 0/1	ICS01	R/W	Input Capture 0/1	0 0 0 0 0 0 0 0B
55H	Input Capture Control Status Register 2/3	ICS23	R/W	Input Capture 2/3	0 0 0 0 0 0 0 0B
56H	Input Capture Control Status Register 4/5	ICS45	R/W	Input Capture 4/5	0 0 0 0 0 0 0 0B
57H	Reserved				
58H	Output Compare Control Status Register 0	OCS0	R/W	Output Compare 0/1	0 0 0 0 _ _ 0 0B
59H	Output Compare Control Status Register 1	OCS1	R/W		_ _ _ 0 0 0 0 0B
5AH	Output Compare Control Status Register 2	OCS2	R/W	Output Compare 2/3	0 0 0 0 _ _ 0 0B
5BH	Output Compare Control Status Register 3	OCS3	R/W		_ _ _ 0 0 0 0 0B
5CH	Output Compare Control Status Register 4	OCS4	R/W	Output Compare 4/5	0 0 0 0 _ _ 0 0B
5DH	Output Compare Control Status Register 5	OCS5	R/W		_ _ _ 0 0 0 0 0B
5EH	Sound Control Register (low-order)	SGCR	R/W	Sound Generator	0 0 0 0 0 0 0 0B
5FH	Sound Control Register (high-order)	SGCR	R/W		0 _ _ _ _ _ _ 0B

(Continued)

Address	Register	Abbreviation	Access	Peripheral	Initial value
60_H	Watch Timer Control Register (low-order)	WTCR	R/W	Watch Timer	0 0 0 _ _ 0 0 0_B
61_H	Watch Timer Control Register (high-order)	WTCR	R/W		0 0 0 0 0 0 0 0_B
62_H	PWM Control Register 0	PWC0	R/W	Stepping Motor Controller 0	0 0 0 0 0 _ _ 0_B
63_H	Reserved				
64_H	PWM Control Register 1	PWC1	R/W	Stepping Motor Controller 1	0 0 0 0 0 _ _ 0_B
65_H	Reserved				
66_H	PWM Control Register 2	PWC2	R/W	Stepping Motor Controller 2	0 0 0 0 0 _ _ 0_B
67_H	Reserved				
68_H	PWM Control Register 3	PWC3	R/W	Stepping Motor Controller 3	0 0 0 0 0 _ _ 0_B
69_H to $6C_H$	Reserved				
$6D_H$	Serial I/O Prescaler Register	CDCR	R/W	Prescaler (Serial I/O)	0 XXX 1 1 1 1_B
$6E_H$	Timer Control Status Register	TCCS	R/W	16-bit Free-run Timer	0 0 0 0 0 0 0 0_B
$6F_H$	ROM Mirror Function Select Register	ROMM	W	ROM Mirror	XXXXXXX 1_B
70_H to $8F_H$	Reserved for CAN Interface 0/1. Refer to section about CAN Controller				
90_H to $9D_H$	Reserved				
$9E_H$	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
$A2_H$ to $A7_H$	Reserved				
$A8_H$	Watchdog Timer Control Register	WDTC	R/W	Watchdog Timer	XXXXX 1 1 1_B
$A9_H$	Time Base Timer Control Register	TBTC	R/W	Time Base Timer	1 - - 0 0 1 0 0_B
AA_H to AD_H	Reserved				
AE_H	Flash Memory Control Status Register (Flash product only. Otherwise reserved)	FMCS	R/W	Flash Memory	0 0 0 X 0 0 0 0_B
AF_H	Reserved				

(Continued)

Address	Register	Abbreviation	Access	Peripheral	Initial value
$B0_H$	Interrupt Control Register 00	ICR00	R/W	Interrupt controller	0 0 0 0 0 1 1 1_B
$B1_H$	Interrupt Control Register 01	ICR01	R/W		0 0 0 0 0 1 1 1_B
$B2_H$	Interrupt Control Register 02	ICR02	R/W		0 0 0 0 0 1 1 1_B
$B3_H$	Interrupt Control Register 03	ICR03	R/W		0 0 0 0 0 1 1 1_B
$B4_H$	Interrupt Control Register 04	ICR04	R/W		0 0 0 0 0 1 1 1_B
$B5_H$	Interrupt Control Register 05	ICR05	R/W		0 0 0 0 0 1 1 1_B
$B6_H$	Interrupt Control Register 06	ICR06	R/W		0 0 0 0 0 1 1 1_B
$B7_H$	Interrupt Control Register 07	ICR07	R/W		0 0 0 0 0 1 1 1_B
$B8_H$	Interrupt Control Register 08	ICR08	R/W		0 0 0 0 0 1 1 1_B
$B9_H$	Interrupt Control Register 09	ICR09	R/W		0 0 0 0 0 1 1 1_B
BA_H	Interrupt Control Register 10	ICR10	R/W		0 0 0 0 0 1 1 1_B
BB_H	Interrupt Control Register 11	ICR11	R/W		0 0 0 0 0 1 1 1_B
BC_H	Interrupt Control Register 12	ICR12	R/W		0 0 0 0 0 1 1 1_B
BD_H	Interrupt Control Register 13	ICR13	R/W		0 0 0 0 0 1 1 1_B
BE_H	Interrupt Control Register 14	ICR14	R/W		0 0 0 0 0 1 1 1_B
BF_H	Interrupt Control Register 15	ICR15	R/W		0 0 0 0 0 1 1 1_B
$C0_H$ to FF_H	Reserved				
1900_H	Reload L Register	PRLL0	R/W	16-bit Programmable Pulse Generator 0/1	$XXXXXXXX_B$
1901_H	Reload H Register	PRLH0	R/W		$XXXXXXXX_B$
1902_H	Reload L Register	PRLL1	R/W		$XXXXXXXX_B$
1903_H	Reload H Register	PRLH1	R/W		$XXXXXXXX_B$
1904_H	Reload L Register	PRLL2	R/W	16-bit Programmable Pulse Generator 2/3	$XXXXXXXX_B$
1905_H	Reload H Register	PRLH2	R/W		$XXXXXXXX_B$
1906_H	Reload L Register	PRLL3	R/W		$XXXXXXXX_B$
1907_H	Reload H Register	PRLH3	R/W		$XXXXXXXX_B$
1908_H	Reload L Register	PRLL4	R/W	16-bit Programmable Pulse Generator 4/5	$XXXXXXXX_B$
1909_H	Reload H Register	PRLH4	R/W		$XXXXXXXX_B$
$190A_H$	Reload L Register	PRLL5	R/W		$XXXXXXXX_B$
$190B_H$	Reload H Register	PRLH5	R/W		$XXXXXXXX_B$
$190C_H$	Reload L Register	PRLL6	R/W	16-bit Programmable Pulse Generator 6/7	$XXXXXXXX_B$
$190D_H$	Reload H Register	PRLH6	R/W		$XXXXXXXX_B$
$190E_H$	Reload L Register	PRLL7	R/W		$XXXXXXXX_B$
$190F_H$	Reload H Register	PRLH7	R/W		$XXXXXXXX_B$

(Continued)

Address	Register	Abbreviation	Access	Peripheral	Initial value
1910H	Reload L Register	PRLL8	R/W	16-bit Programmable Pulse Generator 8/9	XXXXXXXXB
1911H	Reload H Register	PRLH8	R/W		XXXXXXXXB
1912H	Reload L Register	PRLL9	R/W		XXXXXXXXB
1913H	Reload H Register	PRLH9	R/W		XXXXXXXXB
1914H	Reload L Register	PRLLA	R/W	16-bit Programmable Pulse Generator A/B	XXXXXXXXB
1915H	Reload H Register	PRLHA	R/W		XXXXXXXXB
1916H	Reload L Register	PRLLB	R/W		XXXXXXXXB
1917H	Reload H Register	PRLHB	R/W		XXXXXXXXB
1918H to 191FH	Reserved				
1920H	Input Capture Register 0 (low-order)	IPCP0	R	Input Capture 0/1	XXXXXXXXB
1921H	Input Capture Register 0 (high-order)	IPCP0	R		XXXXXXXXB
1922H	Input Capture Register 1 (low-order)	IPCP1	R		XXXXXXXXB
1923H	Input Capture Register 1 (high-order)	IPCP1	R		XXXXXXXXB
1924H	Input Capture Register 2 (low-order)	IPCP2	R	Input Capture 2/3	XXXXXXXXB
1925H	Input Capture Register 2 (high-order)	IPCP2	R		XXXXXXXXB
1926H	Input Capture Register 3 (low-order)	IPCP3	R		XXXXXXXXB
1927H	Input Capture Register 3 (high-order)	IPCP3	R		XXXXXXXXB
1928H	Input Capture Register 4 (low-order)	IPCP4	R	Input Capture 4/5	XXXXXXXXB
1929H	Input Capture Register 4 (high-order)	IPCP4	R		XXXXXXXXB
192AH	Input Capture Register 5 (low-order)	IPCP5	R		XXXXXXXXB
192BH	Input Capture Register 5 (high-order)	IPCP5	R		XXXXXXXXB
192CH to 192FH	Reserved				

(Continued)

Address	Register	Abbreviation	Access	Peripheral	Initial value
1930H	Output Compare Register 0 (low-order)	OCCP0	R/W	Output Compare 0/1	XXXXXXXXB
1931H	Output Compare Register 0 (high-order)	OCCP0	R/W		XXXXXXXXB
1932H	Output Compare Register 1 (low-order)	OCCP1	R/W		XXXXXXXXB
1933H	Output Compare Register 1 (high-order)	OCCP1	R/W		XXXXXXXXB
1934H	Output Compare Register 2 (low-order)	OCCP2	R/W	Output Compare 2/3	XXXXXXXXB
1935H	Output Compare Register 2 (high-order)	OCCP2	R/W		XXXXXXXXB
1936H	Output Compare Register 3 (low-order)	OCCP3	R/W		XXXXXXXXB
1937H	Output Compare Register 3 (high-order)	OCCP3	R/W		XXXXXXXXB
1938H	Output Compare Register 4 (low-order)	OCCP4	R/W	Output Compare 4/5	XXXXXXXXB
1939H	Output Compare Register 4 (high-order)	OCCP4	R/W		XXXXXXXXB
193AH	Output Compare Register 5 (low-order)	OCCP5	R/W		XXXXXXXXB
193BH	Output Compare Register 5 (high-order)	OCCP5	R/W		XXXXXXXXB
193CH to 193FH	Reserved				
1940H	Timer 0/Reload Register 0 (low-order)	TMR0/TMRLR0	R/W	16-bit Reload Timer 0	XXXXXXXXB
1941H	Timer 0/Reload Register 0 (high-order)	TMR0/TMRLR0	R/W		XXXXXXXXB
1942H	Timer 1/Reload Register 1 (low-order)	TMR1/TMRLR1	R/W	16-bit Reload Timer 1	XXXXXXXXB
1943H	Timer 1/Reload Register 1 (high-order)	TMR1/TMRLR1	R/W		XXXXXXXXB
1944H	Timer Data Register (low-order)	TCDT	R/W	16-bit Free-run Timer	00000000B
1945H	Timer Data Register (high-order)	TCDT	R/W		00000000B
1946H	Frequency Data Register	SGFR	R/W	Sound Generator	XXXXXXXXB
1947H	Amplitude Data Register	SGAR	R/W		XXXXXXXXB
1948H	Decrement Grade Register	SGDR	R/W		XXXXXXXXB
1949H	Tone Count Register	SGTR	R/W		XXXXXXXXB

(Continued)

Address	Register	Abbreviation	Access	Peripheral	Initial value
194A$_H$	Sub-second Data Register (low-order)	WTBR	R/W	Watch Timer	XXXXXXXX$_B$
194B$_H$	Sub-second Data Register (middle-order)	WTBR	R/W		XXXXXXXX$_B$
194C$_H$	Sub-second Data Register (high-order)	WTBR	R/W		_ _ _ XXXXX$_B$
194D$_H$	Second Data Register	WTSR	R/W		_ _ 0 0 0 0 0 0 $_B$
194E$_H$	Minute Data Register	WTMR	R/W	Watch Timer	_ _ 0 0 0 0 0 0 $_B$
194F$_H$	Hour Data Register	WTHR	R/W		_ _ _ 0 0 0 0 0 $_B$
1950$_H$	PWM1 Compare Register 0	PWC10	R/W	Stepping Motor Controller 0	XXXXXXXX$_B$
1951$_H$	PWM2 Compare Register 0	PWC20	R/W		XXXXXXXX$_B$
1952$_H$	PWM1 Select Register 0	PWS10	R/W		_ _ 0 0 0 0 0 0 $_B$
1953$_H$	PWM2 Select Register 0	PWS20	R/W		_ 0 0 0 0 0 0 0 $_B$
1954$_H$	PWM1 Compare Register 1	PWC11	R/W	Stepping Motor Controller 1	XXXXXXXX$_B$
1955$_H$	PWM2 Compare Register 1	PWC21	R/W		XXXXXXXX$_B$
1956$_H$	PWM1 Select Register 1	PWS11	R/W		_ _ 0 0 0 0 0 0 $_B$
1957$_H$	PWM2 Select Register 1	PWS21	R/W		_ 0 0 0 0 0 0 0 $_B$
1958$_H$	PWM1 Compare Register 2	PWC12	R/W	Stepping Motor Controller 2	XXXXXXXX$_B$
1959$_H$	PWM2 Compare Register 2	PWC22	R/W		XXXXXXXX$_B$
195A$_H$	PWM1 Select Register 2	PWS12	R/W		_ _ 0 0 0 0 0 0 $_B$
195B$_H$	PWM2 Select Register 2	PWS22	R/W		_ 0 0 0 0 0 0 0 $_B$
195C$_H$	PWM1 Compare Register 3	PWC13	R/W	Stepping Motor Controller 3	XXXXXXXX$_B$
195D$_H$	PWM2 Compare Register 3	PWC23	R/W		XXXXXXXX$_B$
195E$_H$	PWM1 Select Register 3	PWS13	R/W		_ _ 0 0 0 0 0 0 $_B$
195F$_H$	PWM2 Select Register 3	PWS23	R/W		_0 0 0 0 0 0 0 $_B$
1960$_H$ to 19FF$_H$	Reserved				
1A00$_H$ to 1AFF$_H$	CAN Interface 0. Refer to section about CAN Controller				
1B00$_H$ to 1BFF$_H$	CAN Interface 1. Refer to section about CAN Controller				
1C00$_H$ to 1CFF$_H$	CAN Interface 0. Refer to section about CAN Controller				
1D00$_H$ to 1DFF$_H$	CAN Interface 1. Refer to section about CAN Controller				
1E00$_H$ to 1EFF$_H$	Reserved				

(Continued)

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Address	Register	Abbreviation	Access	Peripheral	Initial value
1FF0H	Program Address Detection Register 0 (low-order)	PADR0	R/W	Address Match Detection Function	XXXXXXXX B
1FF1H	Program Address Detection Register 0 (middle-order)	PADR0	R/W		XXXXXXXX B
1FF2H	Program Address Detection Register 0 (high-order)	PADR0	R/W		XXXXXXXX B
1FF3H	Program Address Detection Register 1 (low-order)	PADR1	R/W		XXXXXXXX B
1FF4H	Program Address Detection Register 1 (middle-order)	PADR1	R/W		XXXXXXXX B
1FF5H	Program Address Detection Register 1 (high-order)	PADR1	R/W		XXXXXXXX B
1FF6H to 1FFFH	Reserved				

Note: : Initial value of "_" represents unused bit; "X" represents unknown value.
Addresses in the rage 0000H to 00FFH, which are not listed in the table, are reserved for the primary functions of the MCU. A read access to these reserved addresses results in reading "X", and any write access should not be performed.

9. CAN Controllers

The CAN controller has the following features : Conforms to CAN Specification Version 2.0 Part A and B

- Supports transmission/reception in standard frame and extended frame formats
- Supports transmission of data frames by receiving remote frames
- 16 transmitting/receiving message buffers
  - 29-bit ID and 8-byte data
  - Multi-level message buffer configuration
- Provides full-bit comparison, full-bit mask, acceptance register 0/acceptance register 1 for each message buffer as 1D acceptance mask
  - Two acceptance mask registers in either standard frame format or extended frame formats
- Bit rate programmable from 10 Kbit/s to 2 Mbit/s (when input clock is at 16 MHz)

List of Control Registers

Address		Register	Abbreviation	Access	Initial Value
CAN0	CAN1				
000070H	000080H	Message buffer valid register	BVALR	R/W	00000000 00000000B
000071H	000081H				
000072H	000082H	Transmit request register	TREQR	R/W	00000000 00000000B
000073H	000083H				
000074H	000084H	Transmit cancel register	TCANR	W	00000000 00000000B
000075H	000085H				
000076H	000086H	Transmit complete register	TCR	R/W	00000000 00000000B
000077H	000087H				
000078H	000088H	Receive complete register	RCR	R/W	00000000 00000000B
000079H	000089H				
00007AH	00008AH	Remote request receiving register	RRTRR	R/W	00000000 00000000B
00007BH	00008BH				
00007CH	00008CH	Receive overrun register	ROVRR	R/W	00000000 00000000B
00007DH	00008DH				
00007EH	00008EH	Receive interrupt enable register	RIER	R/W	00000000 00000000B
00007FH	00008FH				

(Continued)

(Continued)

List of Control Registers

Address		Register	Abbreviation	Access	Initial Value
CAN0	CAN1				
001C00H	001D00H	Control status register	CSR	R/W, R	00---000 0----0-1B
001C01H	001D01H				
001C02H	001D02H	Last event indicator register	LEIR	R/W	-------- 000-0000B
001C03H	001D03H				
001C04H	001D04H	Receive/transmit error counter	RTEC	R	00000000 00000000B
001C05H	001D05H				
001C06H	001D06H	Bit timing register	BTR	R/W	-1111111 11111111B
001C07H	001D07H				
001C08H	001D08H	IDE register	IDER	R/W	XXXXXXXX XXXXXXXXB
001C09H	001D09H				
001C0AH	001D0AH	Transmit RTR register	TRTRR	R/W	00000000 00000000B
001C0BH	001D0BH				
001C0CH	001D0CH	Remote frame receive waiting register	RFWTR	R/W	XXXXXXXX XXXXXXXXB
001C0DH	001D0DH				
001C0EH	001D0EH	Transmit interrupt enable register	TIER	R/W	00000000 00000000B
001C0FH	001D0FH				
001C10H	001D10H	Acceptance mask select register	AMSR	R/W	XXXXXXXX XXXXXXXXB
001C11H	001D11H				
001C12H	001D12H				XXXXXXXX XXXXXXXXB
001C13H	001D13H				
001C14H	001D14H	Acceptance mask register 0	AMR0	R/W	XXXXXXXX XXXXXXXXB
001C15H	001D15H				
001C16H	001D16H				XXXXX--- XXXXXXXXB
001C17H	001D17H				
001C18H	001D18H	Acceptance mask register 1	AMR1	R/W	XXXXXXXX XXXXXXXXB
001C19H	001D19H				
001C1AH	001D1AH				XXXXX--- XXXXXXXXB
001C1BH	001D1BH				

List of Message Buffers (ID Registers)

Address		Register	Abbreviation	Access	Initial Value
CAN0	CAN1				
001A20H	001B20H	ID register 0	IDR0	R/W	XXXXXXXX XXXXXXXXB
001A21H	001B21H				
001A22H	001B22H				XXXXX--- XXXXXXXXB
001A23H	001B23H				
001A24H	001B24H	ID register 1	IDR1	R/W	XXXXXXXX XXXXXXXXB
001A25H	001B25H				
001A26H	001B26H				XXXXX--- XXXXXXXXB
001A27H	001B27H				
001A28H	001B28H	ID register 2	IDR2	R/W	XXXXXXXX XXXXXXXXB
001A29H	001B29H				
001A2AH	001B2AH				XXXXX--- XXXXXXXXB
001A2BH	001B2BH				
001A2CH	001B2CH	ID register 3	IDR3	R/W	XXXXXXXX XXXXXXXXB
001A2DH	001B2DH				
001A2EH	001B2EH				XXXXX--- XXXXXXXXB
001A2FH	001B2FH				
001A30H	001B30H	ID register 4	IDR4	R/W	XXXXXXXX XXXXXXXXB
001A31H	001B31H				
001A32H	001B32H				XXXXX--- XXXXXXXXB
001A33H	001B33H				
001A34H	001B34H	ID register 5	IDR5	R/W	XXXXXXXX XXXXXXXXB
001A35H	001B35H				
001A36H	001B36H				XXXXX--- XXXXXXXXB
001A37H	001B37H				
001A38H	001B38H	ID register 6	IDR6	R/W	XXXXXXXX XXXXXXXXB
001A39H	001B39H				
001A3AH	001B3AH				XXXXX--- XXXXXXXXB
001A3BH	001B3BH				
001A3CH	001B3CH	ID register 7	IDR7	R/W	XXXXXXXX XXXXXXXXB
001A3DH	001B3DH				
001A3EH	001B3EH				XXXXX--- XXXXXXXXB
001A3FH	001B3FH				

(Continued)

(Continued)

Address		Register	Abbreviation	Access	Initial Value
CAN0	CAN1				
001A40H	001B40H	ID register 8	IDR8	R/W	XXXXXXXX XXXXXXXXB
001A41H	001B41H				
001A42H	001B42H				XXXXX--- XXXXXXXXB
001A43FH	001B43H				
001A44H	001B44H	ID register 9	IDR9	R/W	XXXXXXXX XXXXXXXXB
001A45H	001B45H				
001A46H	001B46H				XXXXX--- XXXXXXXXB
001A47H	001B47H				
001A48H	001B48H	ID register 10	IDR10	R/W	XXXXXXXX XXXXXXXXB
001A49H	001B49H				
001A4AH	001B4AH				XXXXX--- XXXXXXXXB
001A4BH	001B4BH				
001A4CH	001B4CH	ID register 11	IDR11	R/W	XXXXXXXX XXXXXXXXB
001A4DH	001B4DH				
001A4EH	001B4EH				XXXXX--- XXXXXXXXB
001A4FH	001B4FH				
001A50H	001B50H	ID register 12	IDR12	R/W	XXXXXXXX XXXXXXXXB
001A51H	001B51H				
001A52H	001B52H				XXXXX--- XXXXXXXXB
001A53H	001B53H				
001A54H	001B54H	ID register 13	IDR13	R/W	XXXXXXXX XXXXXXXXB
001A55H	001B55H				
001A56H	001B56H				XXXXX--- XXXXXXXXB
001A57H	001B57H				
001A58H	001B58H	ID register 14	IDR14	R/W	XXXXXXXX XXXXXXXXB
001A59H	001B59H				
001A5AH	001B5AH				XXXXX--- XXXXXXXXB
001A5BH	001B5BH				
001A5CH	001B5CH	ID register 15	IDR15	R/W	XXXXXXXX XXXXXXXXB
001A5DH	001B5DH				
001A5EH	001B5EH				XXXXX--- XXXXXXXXB
001A5FH	001B5FH				

List of Message Buffers (DLC Registers and Data Registers)

Address		Register	Abbreviation	Access	Initial Value
CAN0	CAN1				
001A60H	001B60H	DLC register 0	DLCR0	R/W	----XXXXB
001A61H	001B61H				
001A62H	001B62H	DLC register 1	DLCR1	R/W	----XXXXB
001A63H	001B63H				
001A64H	001B64H	DLC register 2	DLCR2	R/W	----XXXXB
001A65H	001B65H				
001A66H	001B66H	DLC register 3	DLCR3	R/W	----XXXXB
001A67H	001B67H				
001A68H	001B68H	DLC register 4	DLCR4	R/W	----XXXXB
001A69H	001B69H				
001A6AH	001B6AH	DLC register 5	DLCR5	R/W	----XXXXB
001A6BH	001B6BH				
001A6CH	001B6CH	DLC register 6	DLCR6	R/W	----XXXXB
001A6DH	001B6DH				
001A6EH	001B6EH	DLC register 7	DLCR7	R/W	----XXXXB
001A6FH	001B6FH				
001A70H	001B70H	DLC register 8	DLCR8	R/W	----XXXX
001A71H	001B71H				
001A72H	001B72H	DLC register 9	DLCR9	R/W	----XXXXB
001A73H	001B73H				
001A74H	001B74H	DLC register 10	DLCR10	R/W	----XXXXB
001A75H	001B75H				
001A76H	001B76H	DLC register 11	DLCR11	R/W	----XXXXB
001A77H	001B77H				
001A78H	001B78H	DLC register 12	DLCR12	R/W	----XXXXB
001A79H	001B79H				
001A7AH	001B7AH	DLC register 13	DLCR13	R/W	----XXXXB
001A7BH	001B7BH				
001A7CH	001B7CH	DLC register 14	DLCR14	R/W	----XXXXB
001A7DH	001B7DH				
001A7EH	001B7EH	DLC register 15	DLCR15	R/W	----XXXXB
001A7FH	001B7FH				
001A80H to 001A87H	001B80H to 001B87H	Data register 0 (8 bytes)	DTR0	R/W	XXXXXXXXB to XXXXXXXXB

(Continued)

(Continued)

Address		Register	Abbreviation	Access	Initial Value
CAN0	CAN1				
001A88H to 001A8FH	001B88H to 001B8FH	Data register 1 (8 bytes)	DTR1	R/W	XXXXXXXXB to XXXXXXXXB
001A90H to 001A97H	001B90H to 001B97H	Data register 2 (8 bytes)	DTR2	R/W	XXXXXXXXB to XXXXXXXXB
001A98H to 001A9FH	001B98H to 001B9FH	Data register 3 (8 bytes)	DTR3	R/W	XXXXXXXXB to XXXXXXXXB
001AA0H to 001AA7H	001BA0H to 001BA7H	Data register 4 (8 bytes)	DTR4	R/W	XXXXXXXXB to XXXXXXXXB
001AA8H to 001AAFH	001BA8H to 001BAFH	Data register 5 (8 bytes)	DTR5	R/W	XXXXXXXXB to XXXXXXXXB
001AB0H to 001AB7H	001BB0H to 001BB7H	Data register 6 (8 bytes)	DTR6	R/W	XXXXXXXXB to XXXXXXXXB
001AB8H to 001ABFH	001BB8H to 001BBFH	Data register 7 (8 bytes)	DTR7	R/W	XXXXXXXXB to XXXXXXXXB
001AC0H to 001AC7H	001BC0H to 001BC7H	Data register 8 (8 bytes)	DTR8	R/W	XXXXXXXXB to XXXXXXXXB
001AC8H to 001ACFH	001BC8H to 001BCFH	Data register 9 (8 bytes)	DTR9	R/W	XXXXXXXXB to XXXXXXXXB
001AD0H to 001AD7H	001BD0H to 001BD7H	Data register 10 (8 bytes)	DTR10	R/W	XXXXXXXXB to XXXXXXXXB
001AD8H to 001ADFH	001BD8H to 001BDFH	Data register 11 (8 bytes)	DTR11	R/W	XXXXXXXXB to XXXXXXXXB
001AE0H to 001AE7H	001BE0H to 001BE7H	Data register 12 (8 bytes)	DTR12	R/W	XXXXXXXXB to XXXXXXXXB
001AE8H to 001AEFH	001BE8H to 001BEFH	Data register 13 (8 bytes)	DTR13	R/W	XXXXXXXXB to XXXXXXXXB
001AF0H to 001AF7H	001BF0H to 001BF7H	Data register 14 (8 bytes)	DTR14	R/W	XXXXXXXXB to XXXXXXXXB
001AF8H to 001AFFH	001BF8H to 001BFFH	Data register 15 (8 bytes)	DTR15	R/W	XXXXXXXXB to XXXXXXXXB

10. Interrupt Map

Interrupt cause	EI²OS 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$_H$	—	—
Time Base Timer	N/A	# 11	FFFFD0$_H$	ICR00	0000B0$_H$
External Interrupt (INT0 to INT7)	*1	# 12	FFFFCC$_H$		
CAN 0 RX	N/A	# 13	FFFFC8$_H$	ICR01	0000B1$_H$
CAN 0 TX/NS	N/A	# 14	FFFFC4$_H$		
CAN 1 RX	N/A	# 15	FFFFC0$_H$	ICR02	0000B2$_H$
CAN 1 TX/NS	N/A	# 16	FFFFBC$_H$		
8/16 bit PPG 0/1	N/A	# 17	FFFFB8$_H$	ICR03	0000B3$_H$
8/16 bit PPG 2/3	N/A	# 18	FFFFB4$_H$		
8/16 bit PPG 4/5	N/A	# 19	FFFFB0$_H$	ICR04	0000B4$_H$
8/16 bit PPG 6/7	N/A	# 20	FFFFAC$_H$		
8/16 bit PPG 8/9	N/A	# 21	FFFFA8$_H$	ICR05	0000B5$_H$
8/16 bit PPG A/B	N/A	# 22	FFFFA4$_H$		
16-bit Reload Timer 0	*1	# 23	FFFFA0$_H$	ICR06	0000B6$_H$
16-bit Reload Timer 1	*1	# 24	FFFF9C$_H$		
Input Capture 0/1	*1	# 25	FFFF98$_H$	ICR07	0000B7$_H$
Output compare 0/1	*1	# 26	FFFF94$_H$		
Input Capture 2/3	*1	# 27	FFFF90$_H$	ICR08	0000B8$_H$
Output Compare 2/3	*1	# 28	FFFF8C$_H$		
Input Capture 4/5	*1	# 29	FFFF88$_H$	ICR09	0000B9$_H$
Output Compare 4/5	*1	# 30	FFFF84$_H$		
8/10 bit A/D Converter	*1	# 31	FFFF80$_H$	ICR10	0000BA$_H$
16-bit Free-run Timer/Watch Timer	N/A	# 32	FFFF7C$_H$		
Serial I/O	*1	# 33	FFFF78$_H$	ICR11	0000BB$_H$
Sound Generator	N/A	# 34	FFFF74$_H$		
UART 0 RX	*2	# 35	FFFF70$_H$	ICR12	0000BC$_H$
UART 0 TX	*1	# 36	FFFF6C$_H$		
UART 1 RX	*2	# 37	FFFF68$_H$	ICR13	0000BD$_H$
UART 1 TX	*1	# 38	FFFF64$_H$		
UART 2 RX	*2	# 39	FFFF60$_H$	ICR14	0000BE$_H$
UART 2 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.

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

Notes:

- For a peripheral module with two interrupt 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.

11. Electrical Characteristics

11.1 Absolute Maximum Ratings

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

Parameter	Symbol	Rating		Unit	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} ≥ AVRH/L, AVRH ≥ AVRL *1
	DV_{CC}	V_{SS} − 0.3	V_{SS} + 6.0	V	V_{CC} ≥ DV_{CC}
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
Max clamp current	I_{CLAMP}	−2.0	+ 2.0	mA	*6
Total Max clamp current	$\sum \lvert I_{CLAMP} \rvert$	—	20	mA	*6
“L” level Max output current	I_{OL1}	—	15	mA	Normal output *3
“L” level avg. output current	I_{OLAV1}	—	4	mA	Normal output, average value *4
“L” level Max output current	I_{OL2}	—	40	mA	High current output *3
“L” level avg. output current	I_{OLAV2}	—	30	mA	High current output, average value *4
“L” level Max overall output current	$\sum I_{OL1}$	—	100	mA	Total normal output
“L” level Max overall output current	$\sum I_{OL2}$		330	mA	Total high current output
“L” level avg. overall output current	$\sum I_{OLAV1}$	—	50	mA	Total normal output, average value *5
“L” level avg. overall output current	$\sum I_{OLAV2}$		250	mA	Total high current output, average value *5
“H” level Max output current	I_{OH1}	—	–15	mA	Normal output *3
“H” level avg. output current	I_{OHAV1}	—	–4	mA	Normal output, average value *4
“H” level Max output current	I_{OH2}	—	–40	mA	High current output *3
“H” level avg. output current	I_{OHAV2}	—	–30	mA	High current output, average value *4
“H” level Max overall output current	$\sum I_{OH1}$	—	–100	mA	Total normal output
“H” level Max overall output current	$\sum I_{OH2}$	—	–330	mA	Total high current output
“H” level avg. overall output current	$\sum I_{OHAV1}$	—	–50	mA	Total normal output, average value *5
“H” level avg. overall output current	$\sum I_{OHAV2}$	—	–250	mA	Total high current output, average value *5
Power consumption	P_D	—	500	mW	MB90F594G, MB90F591G
		—	400	mW	MB90594G, MB90591G
Operating temperature	T_A	–40	+85	°C	
Storage temperature	T_{STG}	–55	+150	°C	

*1 : AV_{CC}, AVRH, AVRL and DV_{CC} shall not exceed V_{CC}. AVRH and AVRL shall not exceed AV_{CC}. Also, AVRL shall not exceed AVRH.

*2 : V_I and V_O should not exceed V_{CC} + 0.3V. 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 supersedes 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.

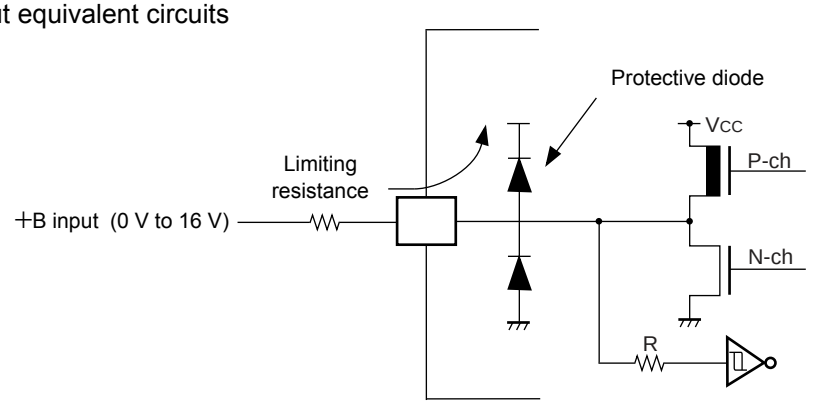
*5 : Total average current is an average current value observed for a 100 ms period for all corresponding pins.

*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 toP95
- 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 pins 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 power supply is off (not fixed at 0 V) , the power supply is provided from the pins, so that incomplete operation may result.
- Note that if the +B input is applied during power-on, the power supply is provided from the pins and the resulting supply voltage may not be sufficient to operate the power-on reset.
- Care must be taken not to leave the +B input pin open.
- Note that analog system input/output pins other than the A/D input pins (LCD drive pins, comparator input pins, etc.) cannot accept +B signal input.
- 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.

11.2 Recommended Conditions

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

Parameter	Symbol	Value			Unit	Remarks	
		Min	Typ	Max			
Power supply voltage	V_{CC} AV_{CC}	4.5	5.0	5.5	V	Under normal operation	MB90V590G MB90F594G MB90594G
		3.0	—	5.5	V	Maintains RAM data in stop mode	
		4.75	5.0	5.25	V	Under normal operation	MB90F591G MB90591G
		3.0	—	5.25	V	Maintains RAM data in stop mode	
Smooth capacitor	C_S	0.022	0.1	1.0	µF	*	
Operating temperature	T_A	–40	—	+85	°C		

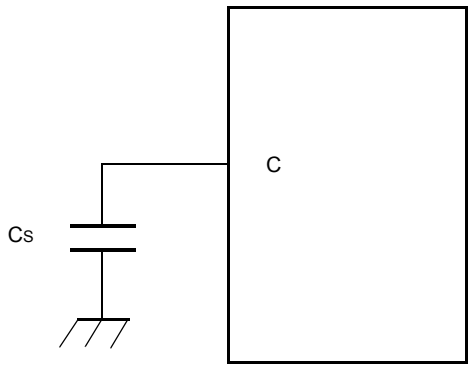
* : Use a ceramic capacitor or a capacitor with equivalent frequency characteristics. The smoothing capacitor to be connected to the V_{CC} pin must have a capacitance value higher than C_S.

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.

- **C Pin Connection Diagram**



11.3 DC Characteristics

(MB90V590G, MB90F594G, MB90594G : V_{CC} = 5.0 V±10 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)
(MB90F591G, MB90591G : V_{CC} = 5.0 V±5 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Input H voltage	V_{IHS}	CMOS hysteresis input	—	0.8 V_{CC}	—	V_{CC} +0.3	V	
	V_{IHM}	MD input	—	V_{CC} – 0.3	—	V_{CC} +0.3	V	
Input L voltage	V_{ILS}	CMOS hysteresis input	—	V_{SS} – 0.3	—	0.5V_{CC}	V	
	V_{ILM}	MD input	—	V_{SS} – 0.3	—	V_{SS} + 0.3	V	
	V_{ILR}	$\overline{RST}$, $\overline{HST}$	—	V_{SS} – 0.3	—	0.2V_{CC}	V	
Output H voltage	V_{OH1}	Normal output	V_{CC} = 4.5 V, I_{OH1} = –4.0 mA	V_{CC} – 0.5	—	—	V	
	V_{OH2}	High current output	V_{CC} = 4.5 V, I_{OH2} = –30.0 mA	V_{CC} – 0.5	—	—	V	
Output L voltage	V_{OL1}	Normal output	V_{CC} = 4.5 V, I_{OL1} = 4.0 mA	—	—	0.4	V	
	V_{OL2}	High current output	V_{CC} = 4.5 V, I_{OL2} = 30.0 mA	—	—	0.5	V	
Input leak current	I_{IL}	—	V_{CC} = 5.5 V, V_{SS} < V_I < V_{CC}	–5	—	5	µA	
Analog input leak current	I_{IAL}	AN0 to AN7	V_{CC} = 5.5 V, AV_{SS} < V_I < AV_{CC}	–1	—	1	µA	
Power supply current *	I_{CC}	V_{CC}	V_{CC} = 5.0 V±10%, Internal frequency : 16 MHz, At normal operation.	—	37	60	mA	MB90594G
				—	50	80	mA	MB90F594G
				—	50	80	mA	MB90F591G
				—	45	60	mA	MB90591G
	I_{CCS}		V_{CC} = 5.0 V±10%, Internal frequency : 16 MHz, At Sleep mode.	—	13	20	mA	MB90594G
				—	15	23	mA	MB90F594G
				—	15	23	mA	MB90F591G
				—	15	23	mA	MB90591G
	I_{CTS}		V_{CC} = 5.0 V±10%, Internal frequency : 2 MHz, At Timer mode	—	0.3	0.6	mA	MB90594G
				—	0.35	0.6	mA	MB90F594G
				—	0.35	0.6	mA	MB90F591G
				—	0.35	0.6	mA	MB90591G
	I_{CCH}		V_{CC} = 5.0 V±10%, At Stop mode, T_A = 25°C	—	5	20	µA	MB90594G
				—	5	20	µA	MB90F594G
				—	5	20	µA	MB90F591G
				—	5	20	µA	MB90591G

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

(Continued)

(MB90F591G, MB90591G : V_{CC} = 5.0 V±5 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Input capacity	C_{IN}	Other than C, AV_{CC}, AV_{SS}, AVRH, AVRL, V_{CC}, V_{SS}, DV_{CC}, DV_{SS}, P70 to P87	—	—	5	15	pF	
		P70 to P87	—	—	15	30	pF	
Pull-up resistance	R_{UP}	$\overline{RST}$	—	25	50	100	kΩ	
Pull-down resistance	R_{DOWN}	MD2	—	25	50	100	kΩ	

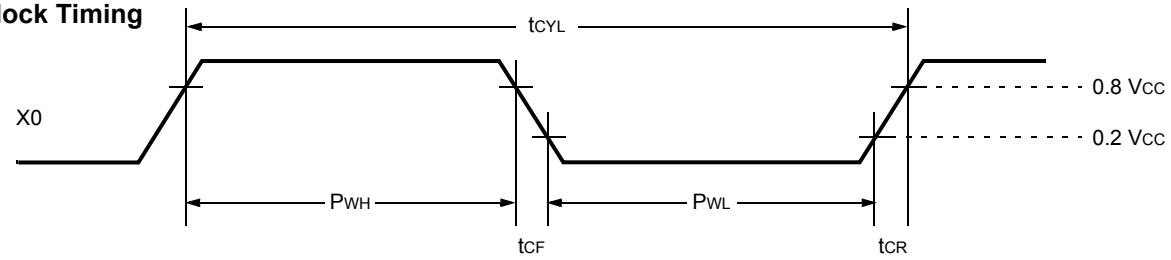
11.4 AC Characteristics

11.4.1 Clock Timing

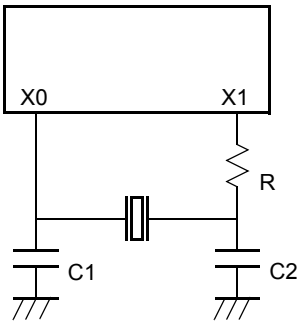
(MB90V590G, MB90F594G, MB90594G : V_{CC} = 5.0 V±10 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)
(MB90F591G, MB90591G : V_{CC} = 5.0 V±5 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)

Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Oscillation frequency	f_C	X0, X1	3	—	16	MHz	
Oscillation cycle time	t_{CYL}	X0, X1	62.5	—	333	ns	
Input clock pulse width	P_{WH}, P_{WL}	X0	10	—	—	ns	Duty ratio is about 30 to 70%.
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	
Machine clock cycle time	t_{CP}	—	62.5	—	666	ns	
Flash read cycle time	t_{CYCFL}	—	—	2 t_{CP}	—	ns	When Flash is accessed by CPU

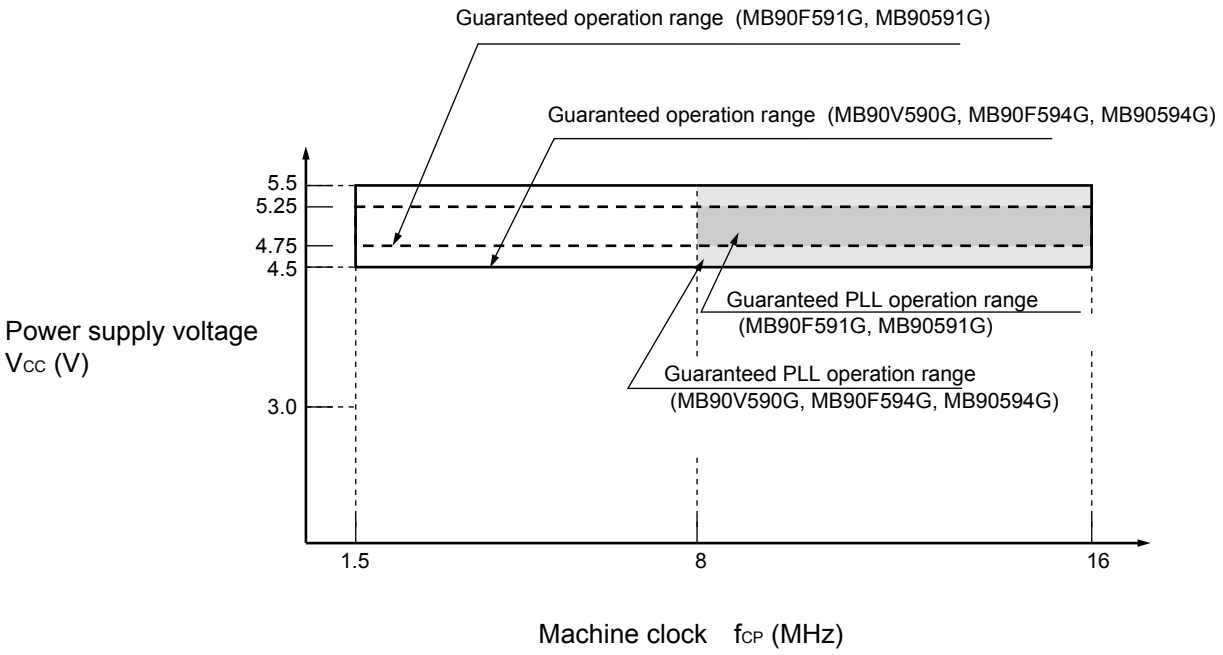
• **Clock Timing**



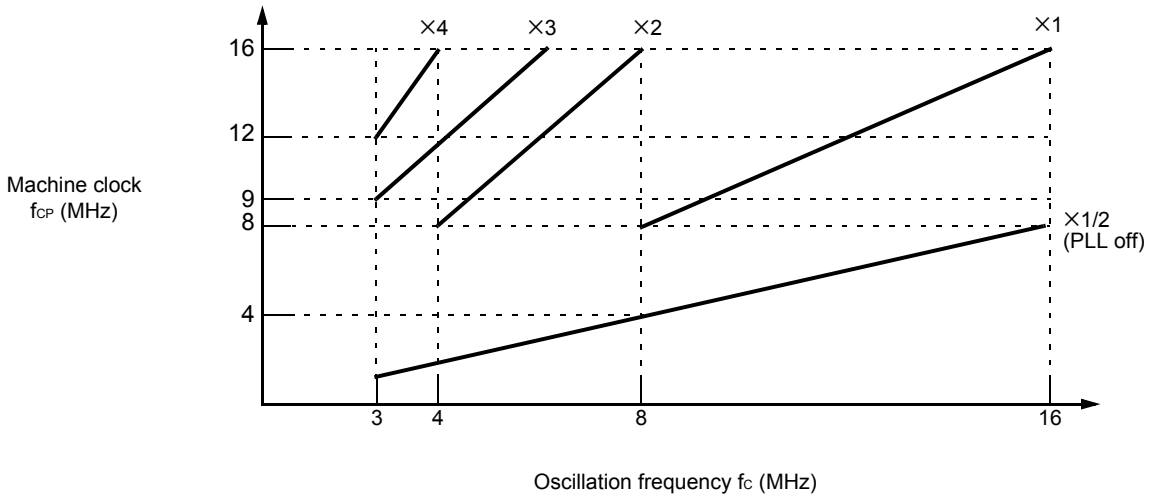
Example of Oscillation circuit



- **Guaranteed operation range**



- **Oscillation clock frequency and machine clock frequency**



11.4.2 Reset and Hardware Standby Input Timing

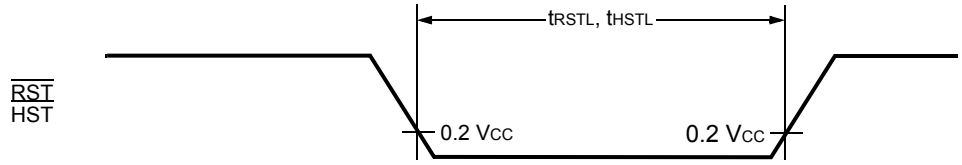
(MB90V590G, MB90F594G, MB90594G : V_{CC} = 5.0 V±10 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)
(MB90F591G, MB90591G : V_{CC} = 5.0 V±5 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)

Parameter	Symbol	Pin name	Value		Unit	Remarks
			Min	Max		
Reset input time	t_{RSTL}	$\overline{RST}$	16 t_{CP}*1	—	ns	Under normal operation
			Oscillation time of oscillator*2 + 16 t_{CP}*1	—	ms	In stop mode
Hardware standby input time	t_{HSTL}	$\overline{HST}$	16 t_{CP}*1	—	ns	Under normal operation

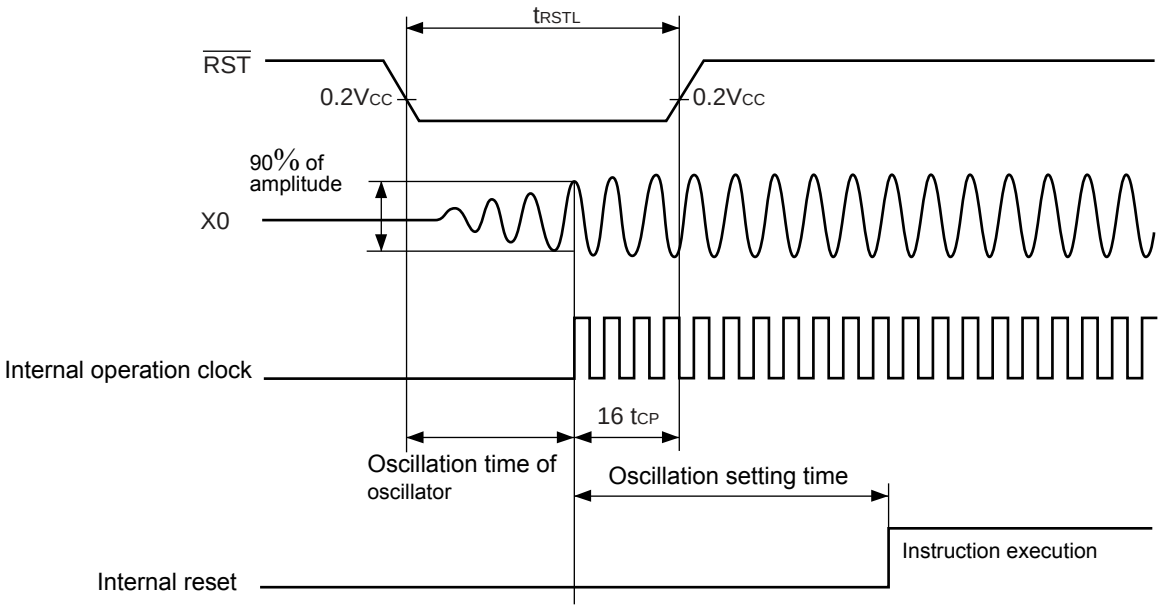
*1 : "t_{CP}" represents one cycle time of the machine clock.
No reset can fully initialize the Flash Memory if it is performing the automatic algorithm.

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

Under Normal Operation



In Stop Mode



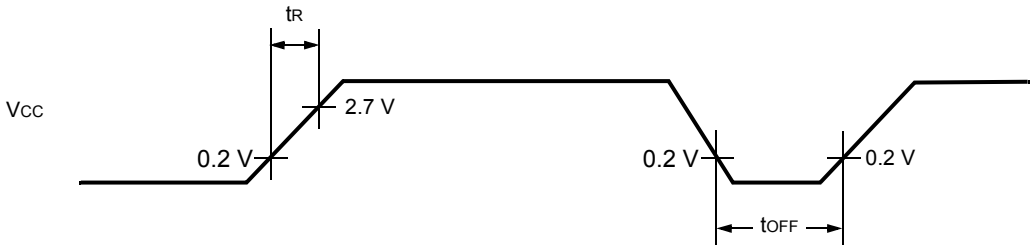
11.4.3 Power On Reset

(MB90V590G, MB90F594G, MB90594G : V_{CC} = 5.0 V±10 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)
(MB90F591G, MB90591G : V_{CC} = 5.0 V±5 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)

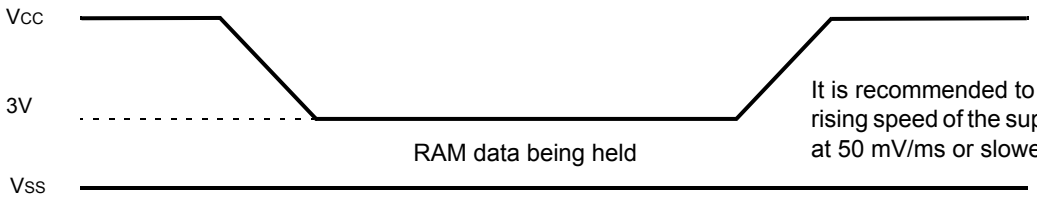
Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Power on rise time	t_R	V_{CC}	—	0.05	30	ms	
Power off time	t_{OFF}	V_{CC}		50	—	ms	Due to repetitive operation

Notes:

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



It is recommended to keep the rising speed of the supply voltage at 50 mV/ms or slower.

11.4.4 UART0/1/2, Serial I/O Timing

(MB90V590G, MB90F594G, MB90594G : V_{CC} = 5.0 V±10 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)
(MB90F591G, MB90591G : V_{CC} = 5.0 V±5 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)

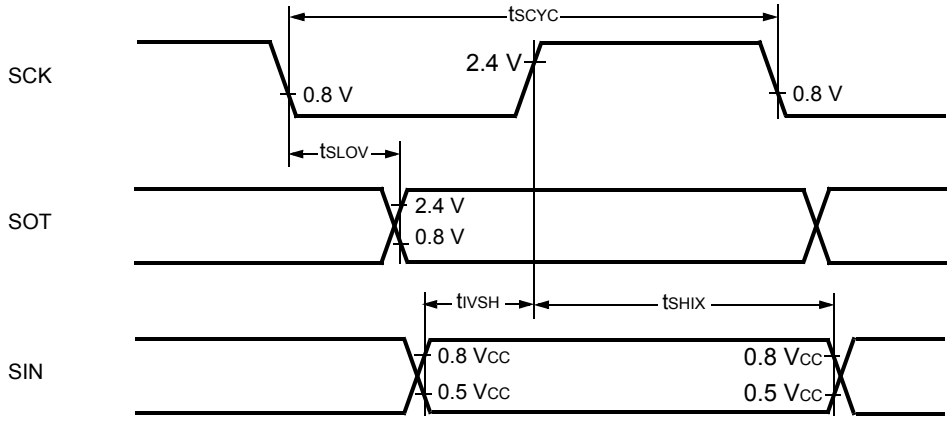
Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Serial clock cycle time	t_{SCYC}	SCK0 to SCK3	Internal clock operation output pins are C_L = 80 pF + 1 TTL.	8 t_{CP}*	—	ns	
SCK ↓ ⇒ SOT delay time	t_{SLOV}	SCK0 to SCK3, SOT0 to SOT3		–80	80	ns	
Valid SIN ⇒ SCK ↑	t_{IVSH}	SCK0 to SCK3, SIN0 to SIN3		100	—	ns	
SCK ↑ ⇒ Valid SIN hold time	t_{SHIX}	SCK0 to SCK3, SIN0 to SIN3		60	—	ns	
Serial clock "H" pulse width	t_{SHSL}	SCK0 to SCK3	External clock operation output pins are C_L = 80 pF + 1 TTL.	4 t_{CP}	—	ns	
Serial clock "L" pulse width	t_{SLSH}	SCK0 to SCK3		4 t_{CP}	—	ns	
SCK ↓ ⇒ SOT delay time	t_{SLOV}	SCK0 to SCK3, SOT0 to SOT3		—	150	ns	
Valid SIN ⇒ SCK ↑	t_{IVSH}	SCK0 to SCK3, SIN0 to SIN3		60	—	ns	
SCK ↑ ⇒ Valid SIN hold time	t_{SHIX}	SCK0 to SCK3, SIN0 to SIN3		60	—	ns	

* : t_{CP} is the machine cycle (Unit : ns)

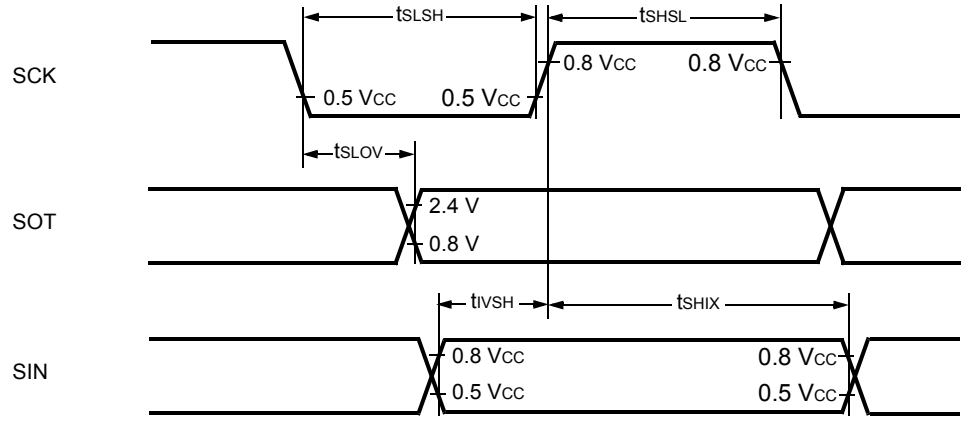
Notes:

- AC characteristic in CLK synchronized mode.
- C_L is load capacity value of pins when testing.

- **Internal Shift Clock Mode**



- **External Shift Clock Mode**

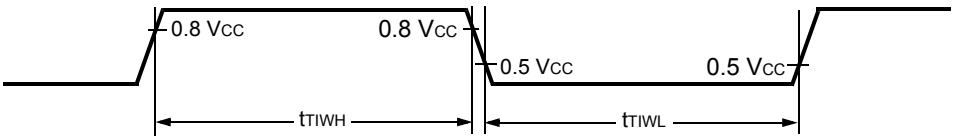


11.4.5 Timer Input Timing

(MB90V590G, MB90F594G, MB90594G : V_{CC} = 5.0 V±10 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)
(MB90F591G, MB90591G : V_{CC} = 5.0 V±5 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TIWH}	TIN0	—	4 t_{CP}	—	ns	Under normal operation
	t_{TIWL}	IN0 to IN5		1	—	µs	In stop mode

- **Timer Input Timing**

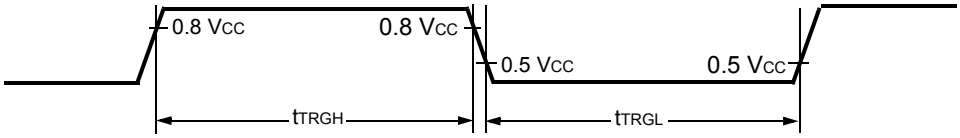


11.4.6 Trigger Input Timing

(MB90V590G, MB90F594G, MB90594G : V_{CC} = 5.0 V±10 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)
(MB90F591G, MB90591G : V_{CC} = 5.0 V±5 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TRGH} t_{TRGL}	INT0 to INT7, ADTG	—	5 t_{CP}	—	ns	

- **Trigger Input Timing**



11.4.7 Slew Rate High Current Outputs (MB90F591G, MB90591G, MB90594G and MB90F594G only)

(MB90F594G, MB90594G : V_{CC} = 5.0 V±10 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)
(MB90F591G, MB90591G : V_{CC} = 5.0 V±5 %, V_{SS} = AV_{SS} = 0.0 V, T_A = −40 °C to +85 °C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Output Rise/Fall time	t_{R2} t_{F2}	Port P70 to P77, Port P80 to P87	—	15	40	ns	

- Slew Rate Output Timing

$V_H = V_{OL2} + 0.1 \times (V_{OH2} - V_{OL2})$
$V_L = V_{OL2} + 0.9 \times (V_{OH2} - V_{OL2})$

11.5 A/D Converter

(MB90V590G, MB90F594G, MB90594G :
$V_{CC} = AV_{CC} = 5.0\ V \pm 10\ \%$, $V_{SS} = AV_{SS} = 0.0\ V$, $3.0\ V \leq AVR+ - AVR-$, $T_A = -40\ ^{\circ}C$ to $+85\ ^{\circ}C$)
(MB90F591G, MB90591G :
$V_{CC} = AV_{CC} = 5.0\ V \pm 5\ \%$, $V_{SS} = AV_{SS} = 0.0\ V$, $3.0\ V \leq AVR+ - AVR-$, $T_A = -40\ ^{\circ}C$ to $+85\ ^{\circ}C$)

Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Resolution	—	—	—	—	10	bit	
Conversion error	—	—	—	—	±5.0	LSB	
Nonlinearity error	—	—	—	—	±2.5	LSB	
Differential linearity error	—	—	—	—	±1.9	LSB	
Zero transition voltage	V_{OT}	AN0 to AN7	AVRL – 3.5 LSB	AVRL + 0.5 LSB	AVRL + 4.5 LSB	V	
Full scale transition voltage	V_{FST}	AN0 to AN7	AVRH – 6.5 LSB	AVRH – 1.5 LSB	AVRH + 1.5 LSB	V	
Compare time	—	—	$352t_{CP}$	—	—	ns	Internal frequency : 16 MHz
Sampling time	—	—	$64t_{CP}$	—	—	ns	Internal frequency : 16 MHz
Analog port input current	I_{AIN}	AN0 to AN7	-1	—	+1	µA	
Analog input voltage range	V_{AIN}	AN0 to AN7	AVRL	—	AVRH	V	
Reference voltage range	—	AVRH	AVRL + 2.7	—	AV_{CC}	V	
	—	AVRL	0	—	AVRH – 2.7	V	
Power supply current	I_A	AV_{CC}	—	5	—	mA	
	I_{AH}	AV_{CC}	—	—	5	µA	*
Reference voltage current	I_R	AVRH	—	400	600	µA	MB90V590G MB90F594G MB90F591G
			—	140	600	µA	MB90594G MB90591G
	I_{RH}	AVRH	—	—	5	µA	*
Offset between input channels	—	AN0 to AN7	—	—	4	LSB	

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

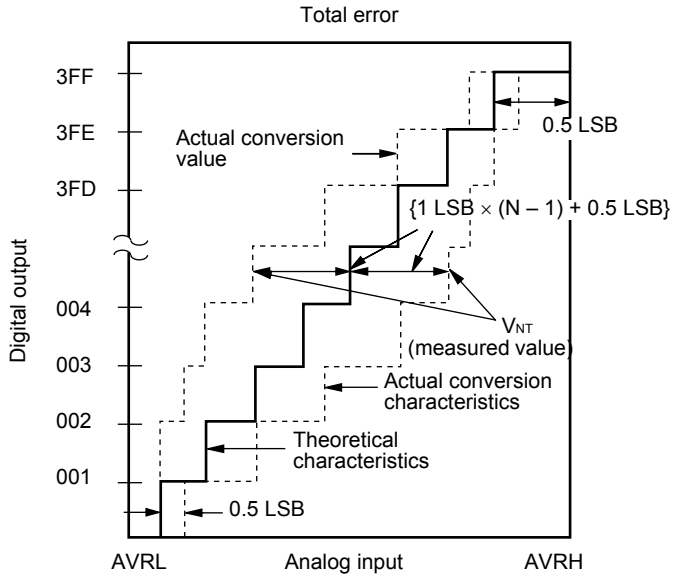
11.6 A/D Converter Glossary

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

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

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

Total error : 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.



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

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

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

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

V_{FST} (Theoretical value) = AVRH – 1.5 LSB[V]

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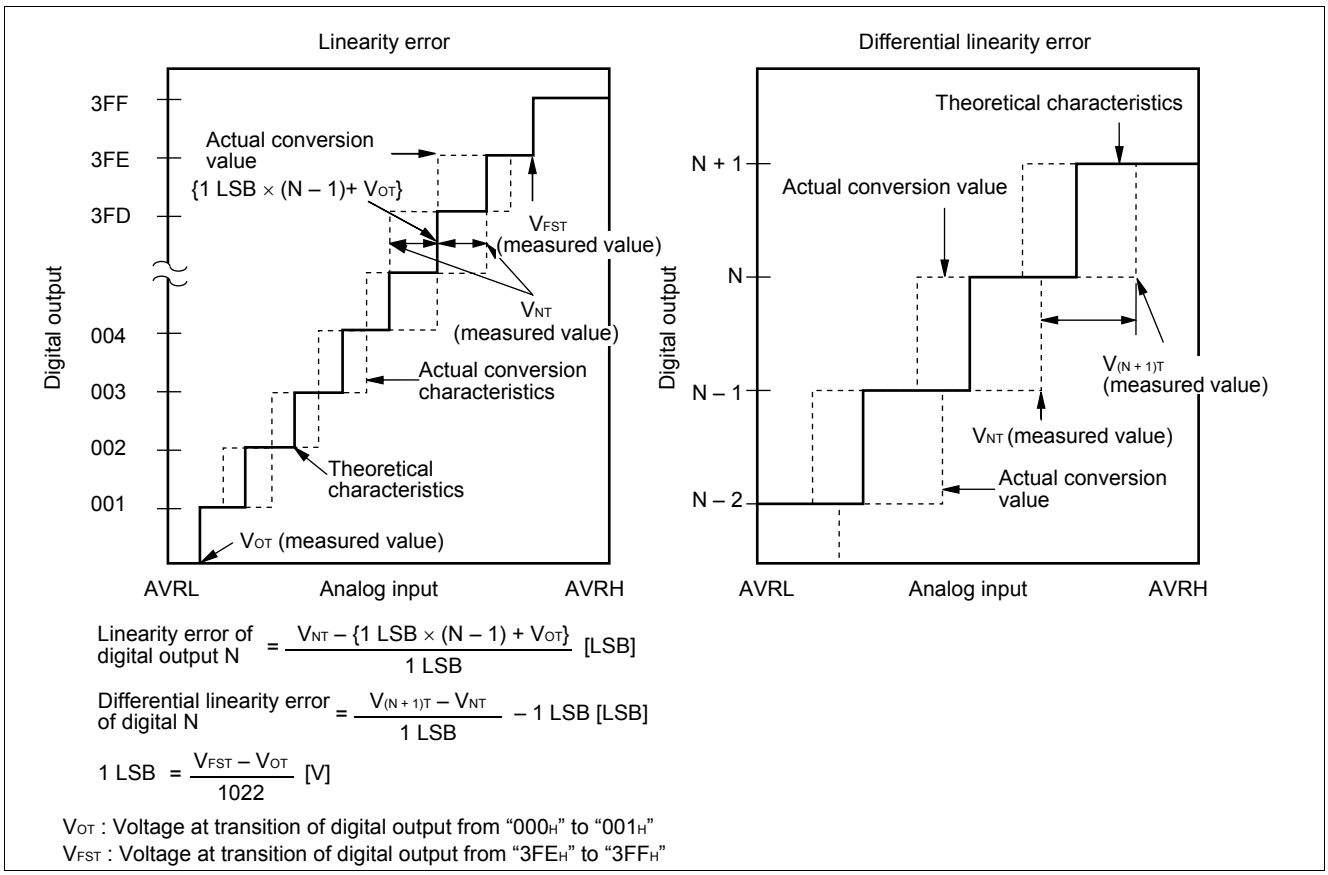
(Continued)



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

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

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

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 "$3FF_H$"

11.7 Notes on Using A/D Converter

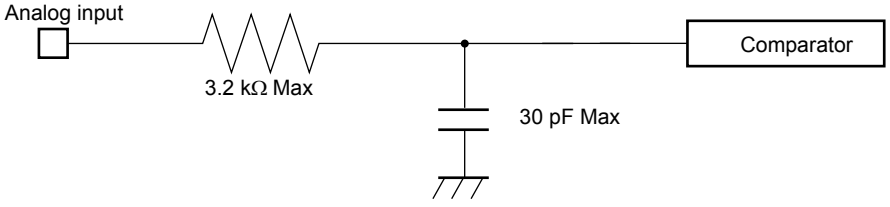
Select the output impedance value for the external circuit of analog input according to the following conditions, :

■ 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.

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**



Note : Listed values must be considered as standards.

■ **Error**

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

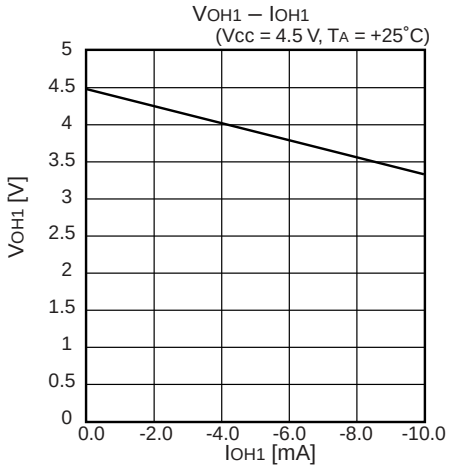
11.8 Flash Memory

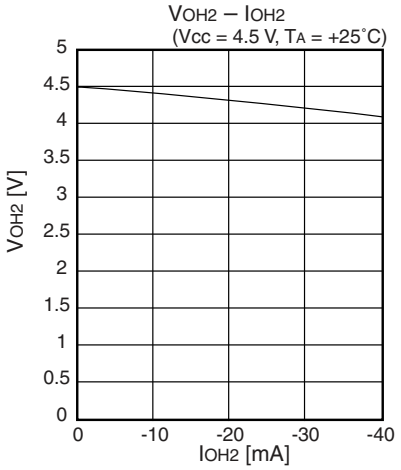
■ Erase and Programming Performance

Parameter	Condition	Value			Unit	Remarks	
		Min	Typ	Max			
Sector erase time	T_A = + 25 °C V_{CC} = 5.0 V	—	1	15	s	Excludes 00H programming prior erasure	
Chip erase time		—	7	—	s	MB90F594G	Excludes 00H programming prior erasure
		—	12	—	s	MB90F591G	
Word (16-bit) programming time		—	16	3,600	ns	Excludes system-level overhead	
Erase/Program cycle	—	10,000	—	—	cycle		

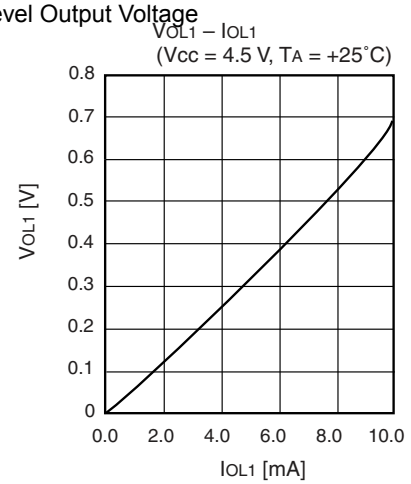
12. Example Characteristics

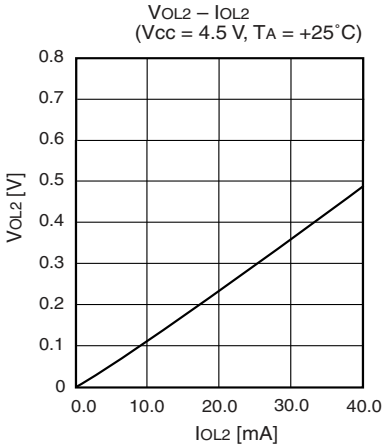
■ "H" Level Output Voltage



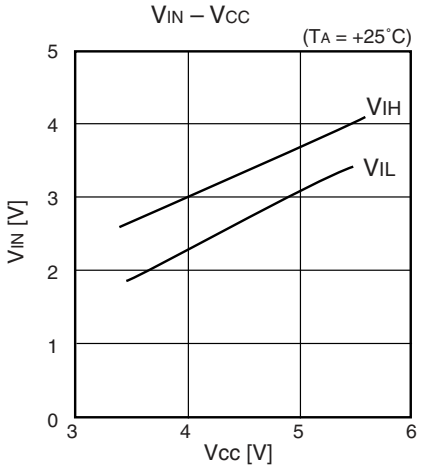


■ "L" Level Output Voltage





■ "H" Level Input Voltage/"L Level Input Voltage (Hysteresis Input)



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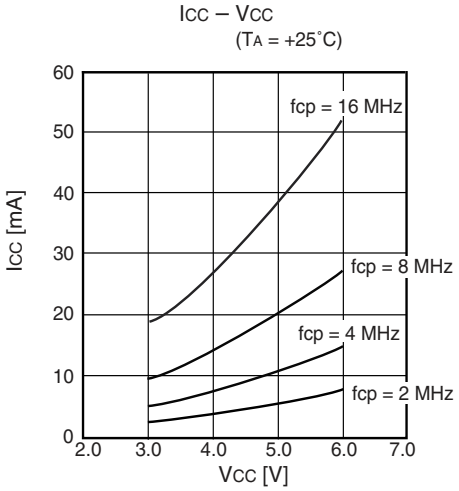
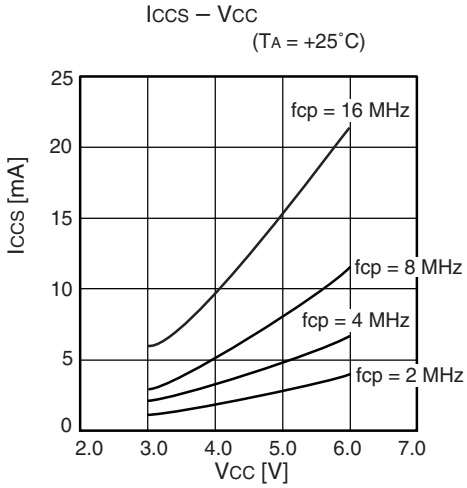
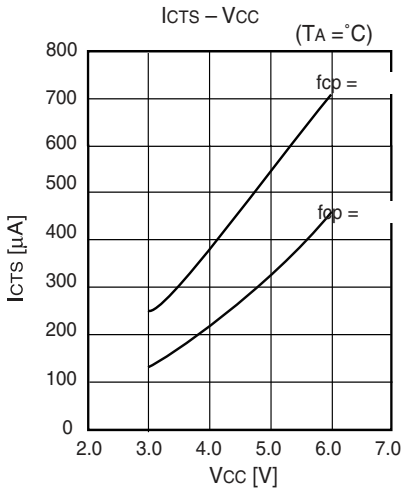
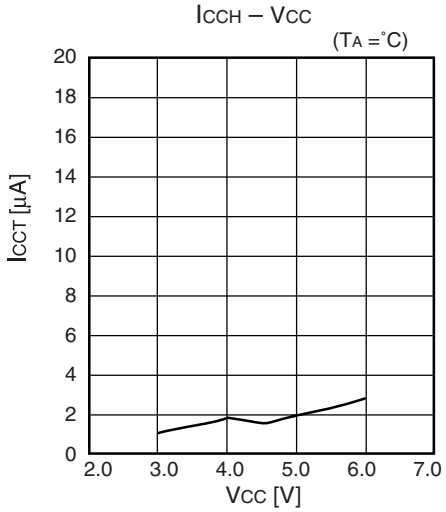
■ Power Supply Voltage







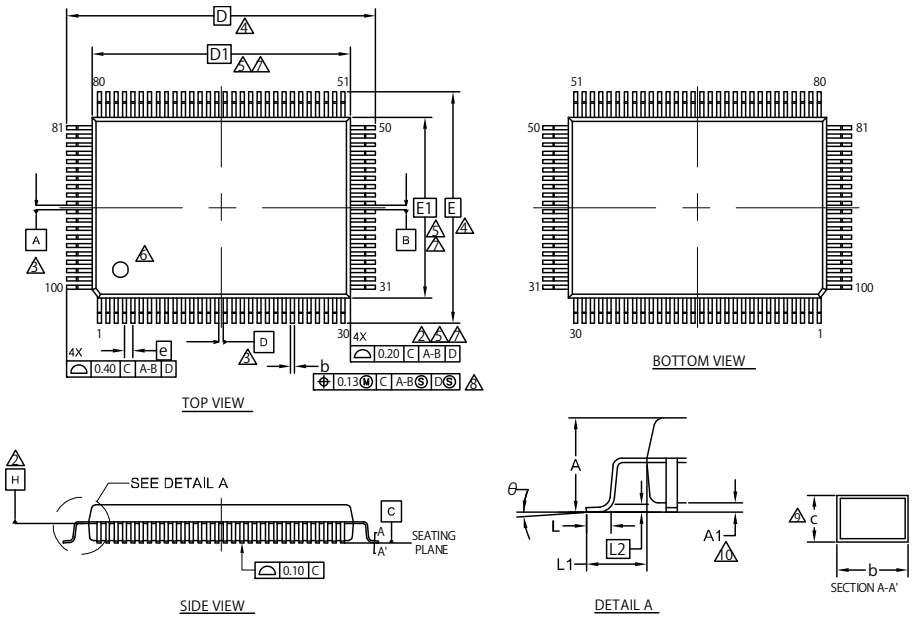


13. Ordering Information

Part number	Package	Remarks
MB90594GPF MB90F594GPF MB90F591GPF MB90591GPF	100-pin Plastic QFP (PQH100)	
MB90V590GCR	256-pin Ceramic PGA	For evaluation

14. Package Dimension

Package Type	Package Code
QFP 100	PQH100



SYMBOL	DIMENSIONS		
	MIN.	NOM.	MAX.
A	—	—	3.35
A1	0.05	—	0.45
b	0.27	0.32	0.37
c	0.11	—	0.23
D		23.90 BSC	
D1		20.00 BSC	
e		0.65 BSC	
E		17.90 BSC	
E1		14.00 BSC	
θ	0°	—	8°
L	0.73	0.88	1.03
L1		1.95 REF	
L2		0.25 BSC	

NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS.
2. DATUM PLANE H IS LOCATED AT THE BOTTOM OF THE MOLD PARTING LINE COINCIDENT WITH WHERE THE LEAD EXITS THE BODY.
3. DATUMS A-B AND D TO BE DETERMINED AT DATUM PLANE H.
4. TO BE DETERMINED AT SEATING PLANE C.
5. DIMENSIONS D1 AND E1 DO NOT INCLUDE MOLD PROTRUSION. ALLOWABLE PROTRUSION IS 0.25mm PRE SIDE. DIMENSIONS D1 AND E1 INCLUDE MOLD MISMATCH AND ARE DETERMINED AT DATUM PLANE H.
6. DETAILS OF PIN 1 IDENTIFIER ARE OPTIONAL BUT MUST BE LOCATED WITHIN THE ZONE INDICATED.
7. REGARDLESS OF THE RELATIVE SIZE OF THE UPPER AND LOWER BODY SECTIONS. DIMENSIONS D1 AND E1 ARE DETERMINED AT THE LARGEST FEATURE OF THE BODY EXCLUSIVE OF MOLD FLASH AND GATE BURRS. BUT INCLUDING ANY MISMATCH BETWEEN THE UPPER AND LOWER SECTIONS OF THE MOLDER BODY.
8. DIMENSION b DOES NOT INCLUDE DAMBER PROTRUSION. THE DAMBAR PROTRUSION (S) SHALL NOT CAUSE THE LEAD WIDTH TO EXCEED b MAXIMUM BY MORE THAN 0.08mm. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE LEAD FOOT.
9. THESE DIMENSIONS APPLY TO THE FLAT SECTION OF THE LEAD BETWEEN 0.10mm AND 0.25mm FROM THE LEAD TIP.
10. A1 IS DEFINED AS THE DISTANCE FROM THE SEATING PLANE TO THE LOWEST POINT OF THE PACKAGE BODY.

PACKAGE OUTLINE, 100 LEAD QFP
20.00X14.00X3.35 MM PQH100 REV**

002-15156 **

15. Major Changes

Spansion Publication Number: DS07-13704-6E

Section	Change Results
—	Deleted the part numbers. MB90591, MB90F591A, MB90594, MB90F594A, MB90V590A
—	Changed the series name. MB90590/590G series → MB90590G series
—	Changed the following name. I/O Timer → 16-bit Free-run Timer
—	Peripheral Resource name is changed. Clock Timer → Watch Timer
—	one of Standby mode name is changed. Clock mode → Watch mode
BLOCK DIAGRAM	Changed the number of channels of 16-bit output compare. 4 ch → 6 ch
INTERRUPT MAP	Changed the abbreviation of Extended Intelligent I/O Service. $I^2OS \rightarrow EI^2OS$
ELECTRICAL CHARACTERISTICS 5. A/D Converter	Changed the items of “Zero transition voltage” and “Full scale transition voltage”. mV → V

NOTE: Please see “Document History” about later revised information.

Document History

Document Title: F²MC-16LX MB90590G Series CMOS 16-bit Proprietary Microcontroller Document Number: 002-07698				
Revision	**ECN**	**Orig. of Change**	**Submission Date**	**Description of Change**
**	—	AKIH	10/01/2008	Migrated to Cypress and assigned document number 002-07698. No change to document contents or format.
*A	5537127	AKIH	11/30/2016	Updated to Cypress template
*B	6059031	TORS	02/06/2018	Adapted new Cypress logo Updated following package code FPT-100P-M06 → PQH100

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