MB90911AS/F912BS/V950AMAS

F²MC-16LX MB90910 Series 16-bit Microcontroller

The MB90910 series, loaded 1 channel FULL-CAN controller and Flash ROM, is general-purpose Cypress 16-bit microcontroller designing for automotive and industrial applications. Its main feature is the on-board CAN controllers, which conform to Ver 2.0 Part A and Part B, while supporting a very flexible message buffer scheme and so offering more functions than a normal FULL-CAN approach. With the new 0.18 µm CMOS technology, Cypress now offers on-chip Flash ROM program memory up to 128 Kbytes.
The power supply (1.8 V) is supplied to the MCU core from an internal regulator circuit. This creates a major advantage in terms of EMI and power consumption.
The internal PLL clock frequency multiplier provides an internal 31.25 ns instruction execution time from an external 4 MHz clock.
The unit features a 4-channel input capture unit 1 channel 16-bit free-run timer, 2-channel LIN-UART, 1-channel UART, and 16-channel 8/10-bit A/D converter as the peripheral resource.

Features

Clock

- Built-in PLL clock frequency multiplication circuit
- Selection of machine clocks (PLL clocks) is allowed among frequency division by 2 on oscillation clock and multiplication of 1 to 8 times of oscillation clock (for 4 MHz oscillation clock, 4 MHz to 32 MHz)
- Minimum execution time of instruction : 31.25 ns (when operating with 4-MHz oscillation clock and 8-time multiplied PLL clock)

Instruction system best suited to controller

- 16 Mbytes CPU memory space
- 24-bit internal addressing
- Wide choice of data types (bit, byte, word, and long word)
- Wide choice of addressing modes (23 types)
- Enhanced multiply-divide instructions with sign and RETI instructions
- Enhanced high-precision computing with 32-bit accumulator

Instruction system compatible with high-level language (C language) and multitask

- Employing system stack pointer
- Enhanced various pointer indirect instructions
- Barrel shift instructions

Increased processing speed

4-byte instruction queue

Powerful interrupt function

- Powerful 8-level, 34-condition interrupt feature
- Up to 8 channels external interrupts are supported

CPU-independent automatic data transfer function

Expanded intelligent I/O service function (EI²OS) : up to 16 channels

Low power consumption (standby) mode

- Sleep mode (a mode that halts CPU operating clock)
- Main timer mode (timebase timer mode that is transferred from main clock mode)
- PLL timer mode (timebase timer mode that is transferred from PLL clock mode)
- Stop mode (a mode that stops oscillation clock)
- CPU blocking operation mode

Process

CMOS technology

I/O port

General purpose input/output port (CMOS output) :
- 36 ports

Timer

- Timebase timer, watchdog timer : 1 channel
- 8/16-bit PPG timer : 8-bit × 6 channels or 16-bit × 3 channels
- 16-bit reload timer : 2 channels
- 16- bit input/output timer
  - ❒ -16-bit free-run timer : 1 channel (FRT0 : ICU 0/1/2/3)
  - ❒ -16- bit input capture : (ICU) : 4 channels

FULL-CAN controller : 1 channel

- Compliant with CAN specifications Version 2.0 Part A and B
- 16 message buffers are built in
- CAN wake-up function

UART (LIN/SCI) : LIN-UART×2 channels, UART × 1 channel

- Equipped with full-duplex double buffer
- Clock-asynchronous or clock-synchronous serial transmission is available

DTP/External interrupt : up to 8 channels, CAN wakeup : up to 1 channel

Module for activation of expanded intelligent I/O service (EI^{2}OS) and generation of external interrupt by external input

Delay interrupt generator module

Generates interrupt request for task switching

8/10-bit A/D converter : 16 channels

- Resolution is selectable between 8-bit and 10-bit
- Activation by external trigger input is allowed
- Conversion time : 3 µs (at 24 MHz machine clock, including sampling time)

Program patch function

Address matching detection for 6 address pointers

Capable of changing input voltage for port

Automotive/CMOS-Schmitt input level (initial level is Automotive in single-chip mode)

ROM security function

The content of ROM can be protected (Only MASK ROM product).

Flash memory security function

Protects the content of Flash memory

Contents

1. Product Lineup

Part number / Parameter	MB90V950AMAS	MB90F912BS	MB90911AS
Type	Evaluation product	Flash memory product	MASK ROM product
CPU	F^2MC-16LX CPU		
System clock	On-chip PLL clock multiplier (×1, ×2, ×3, ×4, ×6, ×8, 1/2 when PLL stops) Minimum instruction execution time : 31.25 ns (4 MHz osc. PLL ×8)		
ROM	External	128 Kbytes	64 Kbytes
RAM	30 Kbytes	8 Kbytes	4 Kbytes
Emulator-specific power supply*1	Yes	—	
FPGA data*2	Rev 050617	—	
Adaptor board*2	MB2147-20 Rev.04C or later	—	
Technology	0.35 μm CMOS with built-in power supply regulator	0.18 μm CMOS with built-in power supply regulator	
Operation voltage range	5 V ± 10 %	3.0 V to 5.5 V : When normal operating	
Operating ambient temperature	—	−40 °C to +105 °C	
Package	PGA-299	LQFP-48	
UART	LIN-UART × 7 channels	LIN-UART × 2 channels, UART × 1 channel	
	Wide range of baud rate settings using a dedicated reload timer Special synchronous options for adapting to different synchronous serial protocols LIN functionality working either as master or slave LIN device (Supported by LIN-UART only)		
I^2C (400 kbps)	2 channels	—	
A/D converter	24 input channels	16 input channels	
	10-bit or 8-bit resolution Conversion time : Min 3 μs include sample time (per one channel)		
16-bit Reload timer	4 channels	2 channels	
	Operation clock frequency : fsys/2^1, fsys/2^3, fsys/2^5 (fsys = Machine clock frequency) Supports External Event Count function		
16-bit I/O timer	2 channels	1 channel	
	Generates an interrupt signal on overflow Operation clock freq. : fsys, fsys/2^1, fsys/2^2, fsys/2^3, fsys/2^4, fsys/2^5, fsys/2^6, fsys/2^7 (fsys = Machine clock freq.) I/O Timer 0 (clock input FRCK0) corresponds to ICU0/1/2/3, OCU 0/1/2/3 I/O Timer 1 (clock input FRCK1) corresponds to ICU4/5/6/7, OCU 4/5/6/7		
16-bit Output compare	8 channels	—	
	Generates an interrupt signal when one of the 16-bit I/O timer matches the output compare register A pair of compare registers can be used to generate an output signal.		

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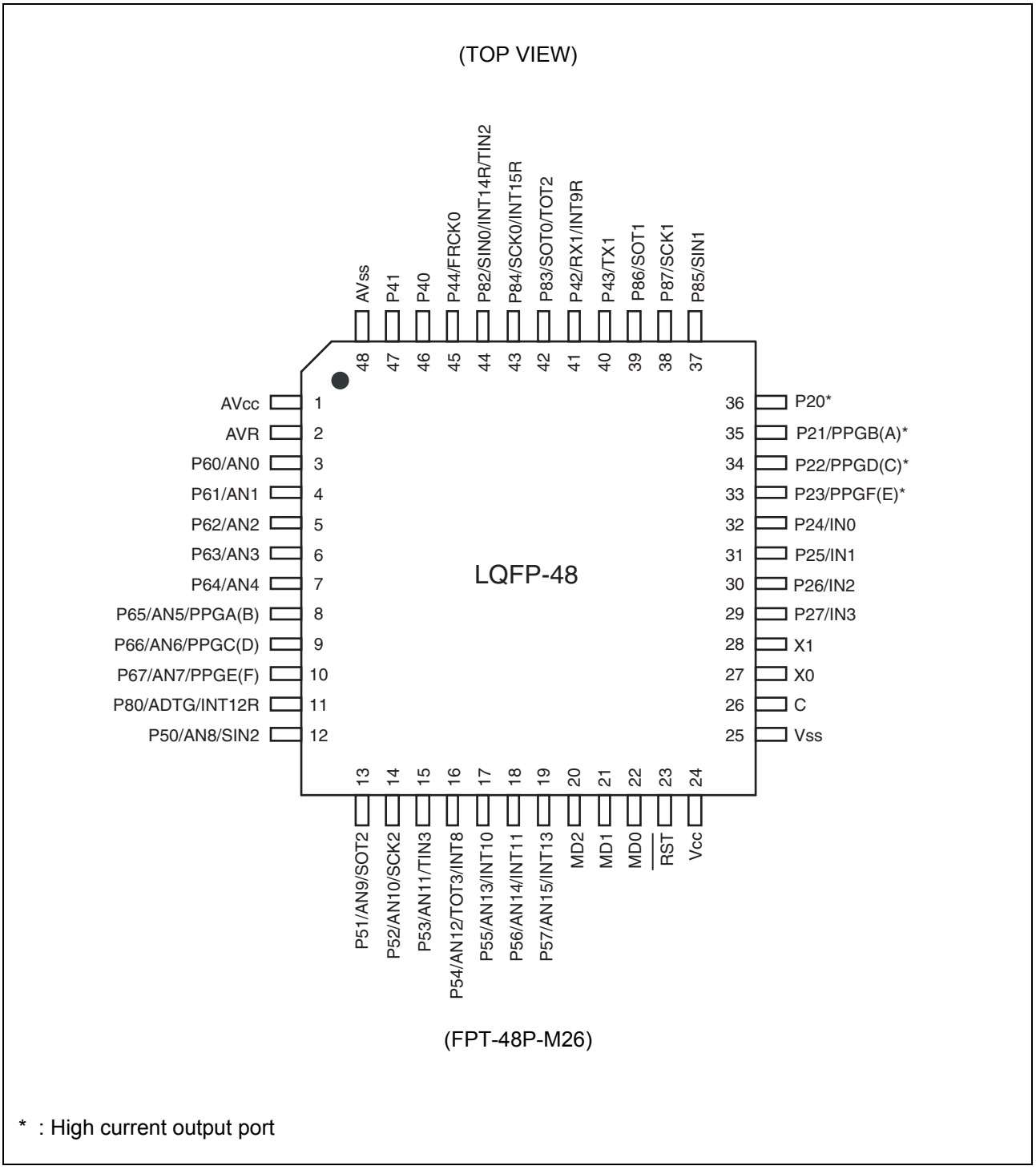
Part number / Parameter	MB90V950AMAS	MB90F912BS	MB90911AS
16-bit Input capture	8 channels	4 channels	
	Rising edge, falling edge or rising & falling edge sensitive Signals an interrupt upon external event		
8/16-bit PPG	8 channels (16-bit) /16 channels (8-bit) Sixteen 8-bit reload counters Sixteen 8-bit reload registers for L pulse width Sixteen 8-bit reload registers for H pulse width	3 channels (16-bit) /6 channels (8-bit) Six 8-bit reload counters Six 8-bit reload registers for L pulse width Six 8-bit reload registers for H pulse width	
	Supports 8-bit and 16-bit operation modes 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 Operating clock freq. : fsys, fsys/2^1, fsys/2^2, fsys/2^3, fsys/2^4 or 128 μs@fosc = 4 MHz (fsys = Machine clock frequency, fosc = Oscillation clock frequency)		
CAN controller	3 channels	1 channel	
	Conforms to CAN Specification Version 2.0 Part A and B Automatic re-transmission in case of error Automatic transmission in response to Remote Frames 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 1 Mbps		
DTP/External interrupt (8 channels)	Can be used rising edge, falling edge, starting up by H/L level input, external interrupt, expanded intelligent I/O services (EI^{2}OS)		
D/A Converter	8-bit × 2 channels	—	
I/O Ports	Virtually all external pins can be used as general purpose I/O port All ports are push-pull outputs Bit-wise settable as input/output or peripheral signal Can be configured 8 as CMOS schmitt trigger/ automotive inputs (in blocks of 8 pins) TTL input level settable for external bus (32-pin only for external bus)		
Flash memory (Flash memory product only)	Supports automatic programming, Embedded Algorithm Write/Erase/Erase-Suspend/Resume commands A flag indicating completion of the algorithm Boot block configuration Erase can be performed on each block Flash Security		

*1: It is setting of Jumper switch (TOOL VCC) when emulator (MB2147-01) is used. Please refer to the Emulator hardware manual for the details.

*2: Contact the sales or support representative if using other than those above of FPGA data and adaptor boards.

2. Pin Assignment

■ **MB90F912BS, MB90911A**S



* : High current output port

3. Pin Description

Pin No.	Pin name	I/O circuit type*	Function
1	AV_{CC}	I	V_{CC} power input pin for analog circuit.
2	AVR	—	Power (Vref+) input pin for A/D converter. It should be below V_{CC}.
3 to 7	P60 to P64	H	General-purpose I/O port.
	AN0 to AN4		Analog input pins for A/D converter.
8 to 10	P65 to P67	H	General-purpose I/O port.
	AN5 to AN7		Analog input pins for A/D converter.
	PPGA (B) , PPGC (D) , PPGE (F)		Output pins for PPG.
11	P80	F	General-purpose I/O port.
	ADTG		Trigger input pin for A/D converter.
	INT12R		External interrupt request input pin for INT12R.
12	P50	L	General-purpose I/O port.
	AN8		Analog input pin for A/D converter.
	SIN2		Serial data input pin for UART2.
13	P51	H	General-purpose I/O port.
	AN9		Analog input pin for A/D converter.
	SOT2		Serial data output pin for UART2.
14	P52	H	General-purpose I/O port.
	AN10		Analog input pin for A/D converter.
	SCK2		Clock I/O pin for UART2.
15	P53	H	General-purpose I/O port.
	AN11		Analog input pin for A/D converter.
	TIN3		Event input pin for reload timer 3.
16	P54	H	General-purpose I/O port.
	AN12		Analog input pin for A/D converter.
	TOT3		Output pin for reload timer 3
	INT8		External interrupt request input pin for INT8.
17	P55	H	General-purpose I/O port.
	AN13		Analog input pin for A/D converter.
	INT10		External interrupt request input pin for INT10.

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Pin No.	Pin name	I/O circuit type*	Function
18	P56	H	General-purpose I/O port (Different I/O circuit type from MB90V950AMAS).
	AN14		Analog input pin for A/D converter.
	INT11		External interrupt request input pin for INT11.
19	P57	H	General-purpose I/O port (Different I/O circuit type from MB90V950AMAS).
	AN15		Analog input pin for A/D converter.
	INT13		External interrupt request input pin for INT13.
20	MD2	D	Input pin for operation mode specification.
21, 22	MD1, MD0	C	Input pins for operation mode specification.
23	$\overline{RST}$	E	Reset input pin.
24	V_{CC}	—	Power input pin (3.5 V to 5.5 V) .
25	V_{SS}	—	Power input pin (0 V) .
26	C	I	Power supply stabilization capacitor pin. It should be connected to a higher than or equal to 0.1 μF ceramic condenser.
27	X0	A	Oscillation input pin.
28	X1		Oscillation output pin.
29 to 32	P27 to P24	G	General-purpose I/O port. The register can be set to select whether to use a pull-up resistor. This function is enabled in single-chip mode.
	IN3 to IN0		Event input pins for input capture 0 to 3.
33 to 35	P23 to P21	J	General-purpose I/O port. The register can be set to select whether to use a pull-up resistor. This function is enabled in single-chip mode. High current output port (Different I/O circuit type from MB90V950AMAS).
	PPGF (E) , PPGD (C) , PPGB(A)		Output pins for PPG.
36	P20	J	General-purpose I/O port. The register can be set to select whether to use a pull-up resistor. This function is enabled in single-chip mode. High current output port (Different I/O circuit type from MB90V950AMAS).
37	P85	K	General-purpose I/O port.
	SIN1		Serial data input pin for UART1.
38	P87	F	General-purpose I/O port.
	SCK1		Clock I/O pin for UART1.
39	P86	F	General-purpose I/O port.
	SOT1		Serial data output pin for UART1.

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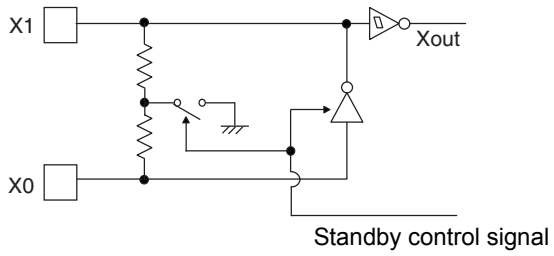
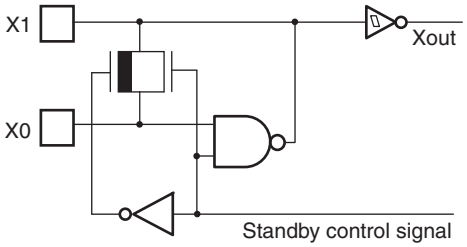
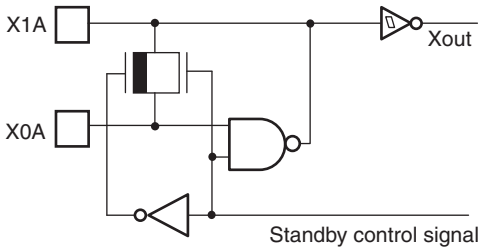
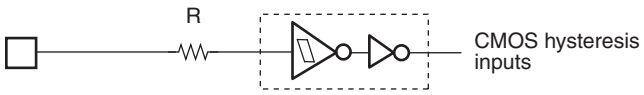
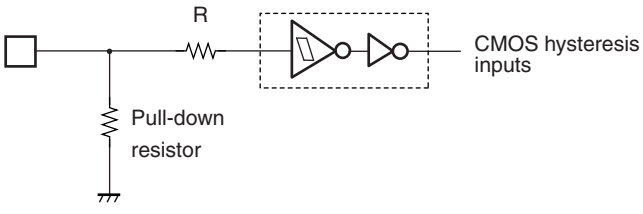
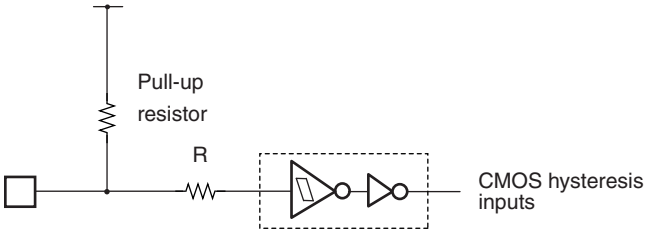
Pin No.	Pin name	I/O circuit type*	Function
40	P43	F	General-purpose I/O port.
	TX1		TX output pin for CAN1 controller.
41	P42	F	General-purpose I/O port.
	RX1		RX input pin for CAN1 controller.
	INT9R		External interrupt request input pin for INT9R.
42	P83	F	General-purpose I/O port.
	SOT0		Serial data output pin for UART0.
	TOT2		Output pin for reload timer 2.
43	P84	F	General-purpose I/O port.
	SCK0		Clock I/O pin for UART0.
	INT15R		External interrupt request input pin for INT15R.
44	P82	K	General-purpose I/O port.
	SIN0		Serial data input pin for UART0.
	INT14R		External interrupt request input pin for INT14R.
	TIN2		Event input pin for reload timer 2.
45	P44	F	General-purpose I/O port (Different I/O circuit type from MB90V950AMAS).
	FRCK0		Free-run timer 0 clock input pin.
46, 47	P40, P41	F	General-purpose I/O port
48	AV_{SS}	I	V_{SS} power input pin for analog circuit.

* : For the I/O circuit type, refer to “I/O Circuit Type”.

4. I/O Circuit Type

Type	Circuit	Remarks
A		Oscillation circuit : High-speed oscillation feedback resistor = approx. 1 MΩ (MASK ROM product, Flash memory product)
		Oscillation circuit : High-speed oscillation feedback resistor = approx. 1 MΩ (Evaluation product)
B		Unused
C		• MASK ROM product / Evaluation product : CMOS hysteresis input pin • Flash memory product : CMOS input pin
D		• MASK ROM product / Evaluation product : CMOS hysteresis input pin • Flash memory product : - CMOS input pin - No Pull-down

Type	Circuit	Remarks
E		CMOS hysteresis input pin

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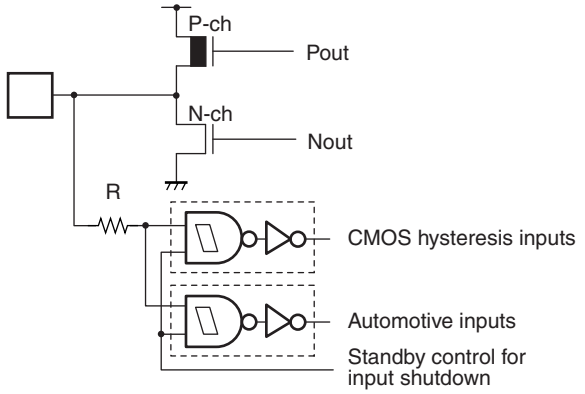
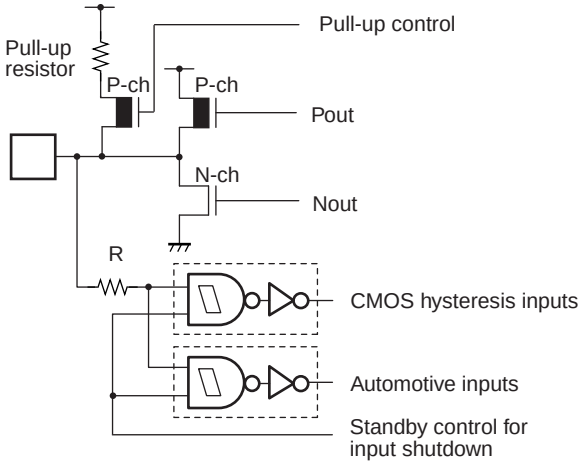
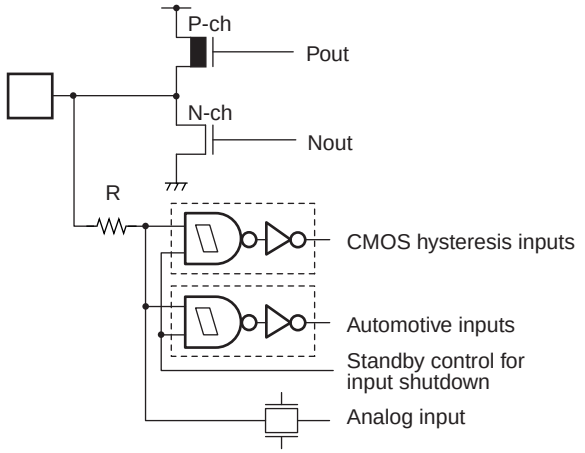
Type	Circuit	Remarks
F		• CMOS level output (I_{OL} = 4 mA, I_{OH} = − 4 mA) • CMOS hysteresis inputs (V_{IH}0.8Vcc V_{IL}0.2Vcc) (With the standby-time input shutdown function) • Automotive input (With the standby-time input shutdown function)
G		• CMOS level output (I_{OL} = 4 mA, I_{OH} = − 4 mA) • CMOS hysteresis inputs (V_{IH}0.8Vcc V_{IL}0.2Vcc) (With the standby-time input shutdown function) • Automotive input (With the standby-time input shutdown function)
H		• CMOS level output (I_{OL} = 4 mA, I_{OH} = − 4 mA) • CMOS hysteresis inputs (V_{IH}0.8Vcc V_{IL}0.2Vcc) (With the standby-time input shutdown function) • Automotive input (With the standby-time input shutdown function) • A/D analog input

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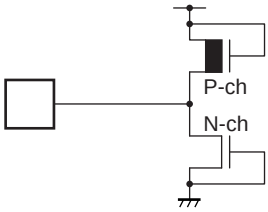
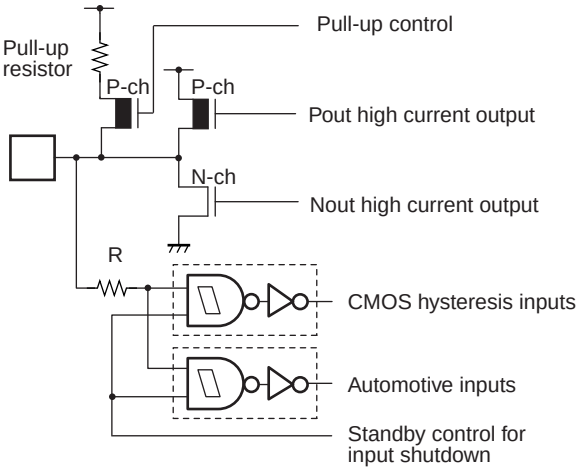
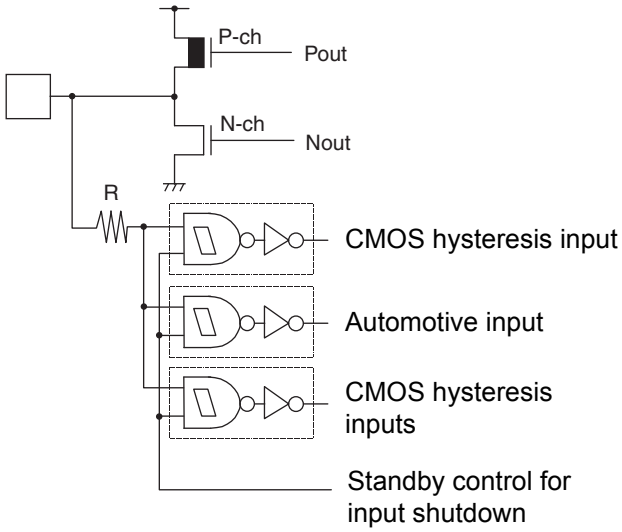
Type	Circuit	Remarks
I		Protection circuit for power supply input
J		• CMOS level output (I_{OL} = 20 mA, I_{OH} = − 14 mA) (I_{OL} = 4 mA, I_{OH} = − 4 mA) • CMOS hysteresis inputs (V_{IH}0.8Vcc V_{IL}0.2Vcc) (With the standby-time input shutdown function) • Automotive input (With the standby-time input shutdown function)
K		• CMOS level output (I_{OL} = 4 mA, I_{OH} = − 4 mA) • CMOS hysteresis input (V_{IH}0.7Vcc V_{IL}0.3Vcc) (With standby-time input shutdown function) • Automotive input (With standby-time input shutdown function) • CMOS hysteresis inputs (V_{IH}0.8Vcc V_{IL}0.2Vcc) (With the standby-time input shutdown function)

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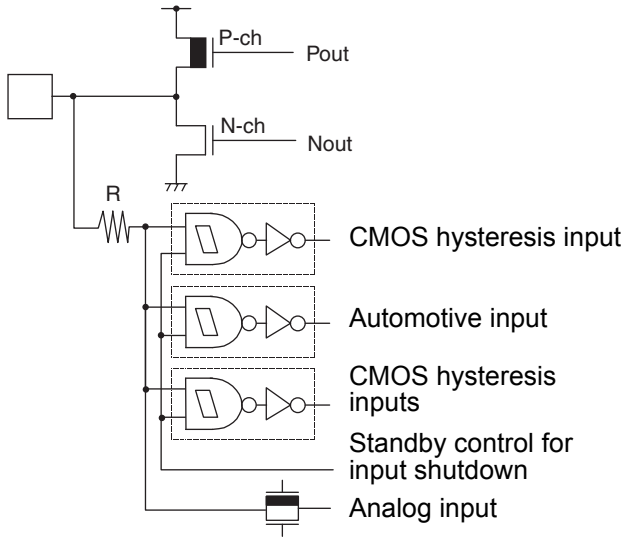
Type	Circuit	Remarks
L		• CMOS level output (I_{OL} = 4 mA, I_{OH} = – 4 mA) • CMOS hysteresis inputs (V_{IH}0.8Vcc V_{IL}0.2Vcc) (With the standby-time input shutdown function) • Automotive input (With the standby-time input shutdown function) • CMOS hysteresis input (V_{IH}0.7Vcc V_{IL}0.3Vcc) (With the standby-time input shutdown function) • A/D analog input

5. Handling Devices

1. Preventing latch-up

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

■ A voltage higher than V_{CC} pin or lower than V_{SS} pin is applied to an input or output pin.

■ A voltage higher than the rated voltage is applied between V_{CC} pin and V_{SS} pin.

■ 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.

Use meticulous care not to exceed the rating.

For the same reason, also be careful not to let the analog power-supply voltage (AV_{CC}, AVR) exceed the digital power-supply voltage.

2. Treatment of unused pins

Leaving unused input pins open may result in permanent damage of the device due to misbehavior or latch-up. Therefore, 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

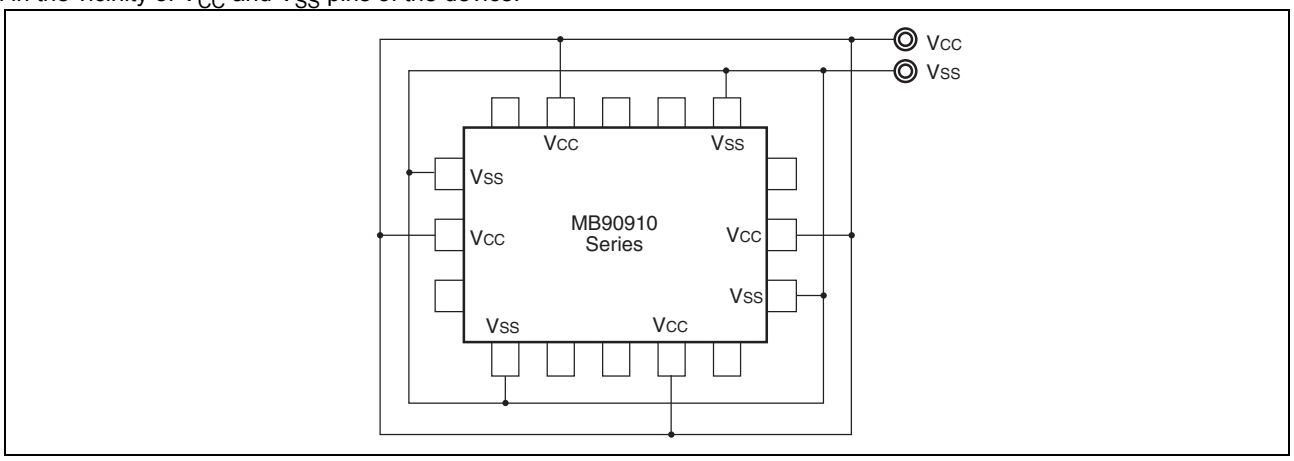
The high-speed oscillator pins (X0, X1) can not be used for external clock inputs.

4. Notes on during operation of PLL clock mode

On this microcontroller, if in case the crystal oscillator breaks off or an external reference clock input stops while the PLL clock mode is selected, a self-oscillator circuit contained in the PLL may continue its operation at its self-running frequency. However, Cypress will not guarantee results of operations if such failure occurs.

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

- If there are multiple V_{CC} and V_{SS} pins, from the point of view of device design, pins to be of the same potential are connected the inside of the device to prevent malfunction such as latch-up.
  To reduce unnecessary radiation, prevent malfunctioning of the strobe signal due to the rise of ground level, and observe the standard for total output current, be sure to connect the V_{CC} and V_{SS} pins to the power supply and ground externally.
- Connect V_{CC} and V_{SS} pins to the device from the current supply source at a low impedance.
- As a measure against power supply noise, connect a capacitor of about 0.1 µF as a bypass capacitor between V_{CC} pin and V_{SS} pin in the vicinity of V_{CC} and V_{SS} pins of the device.



6. Pull-up/down resistors

- The MB90910 series does not support internal pull-up/down resistors (Port 2 : built-in pull-up resistors) . Use external components where needed.

7. Crystal oscillator circuit

Noises around X0 or X1 pin may be possible causes of malfunctions. Make sure to provide bypass capacitors via shortest distance from X0, X1 pins, crystal oscillator (or ceramic resonator) and ground lines, and make sure, that lines of oscillation circuit 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. Please ask the crystal maker to evaluate the oscillational characteristics of the crystal and this device.

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} and AVR) and analog inputs (AN0 to AN15) after turning-on the digital power supply (V_{CC}) .

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

9. Connection of unused pins of A/D converter if A/D converter is not used

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

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. Stabilization of power supply voltage

A sudden change in the power supply voltage may cause the device to malfunction even within the specified V_{CC} power supply voltage operating guarantee range. Therefore, the V_{CC} power supply voltage should be stabilized.

For reference, the power supply voltage should be controlled so that V_{CC} ripple variations (peak-to-peak value) at commercial frequencies (50 Hz/60 Hz) fall below 10% of the standard V_{CC} power supply voltage and the coefficient of transient fluctuation does not exceed 0.1 V/ms at instantaneous power switching.

12. Initialization

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

13. Notes on using CAN function

To use CAN function, please set ’1’ to DIRECT bit of CAN direct mode register (CDMR) .
If DIRECT bit is set to ’0’ (initial value) , wait states will be performed when accessing CAN registers.

Note : Please refer to Hardware Manual of “MB90910 series for detail of CAN Direct Mode Register”.

14. Flash security function

The security bit is located in the area of the Flash memory.
If protection code 01_H is written in the security bit, the Flash memory is in the protected state by security.
Therefore, please do not write 01_H in this address if you do not use the security function.
Please refer to following table for the address of the security bit.

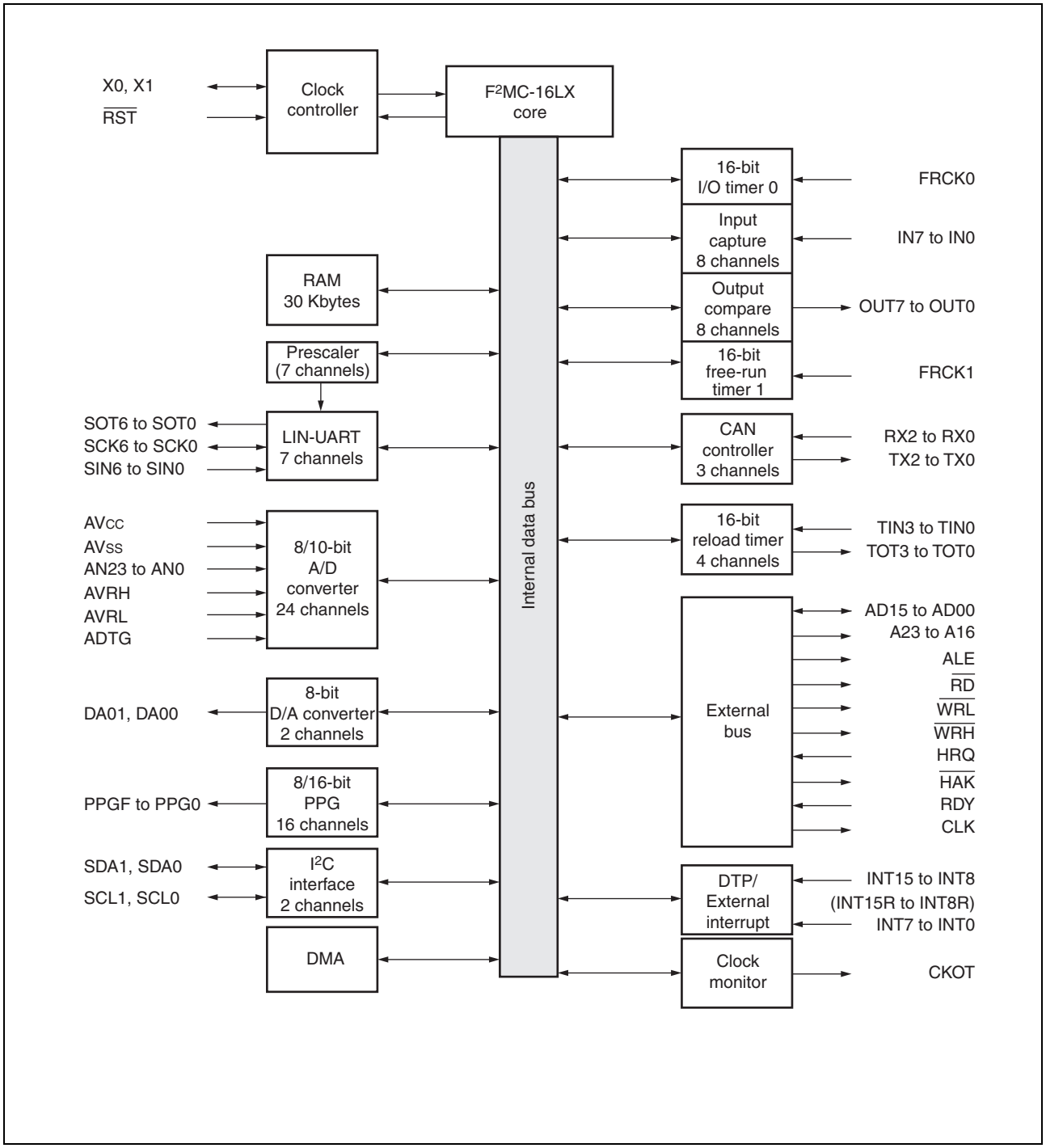
	Flash memory size	Address for security bit
MB90F912BS	Embedded 1 Mbit Flash Memory	$FE0001_H$

15. Correspondence with T_A = +105 °C or more

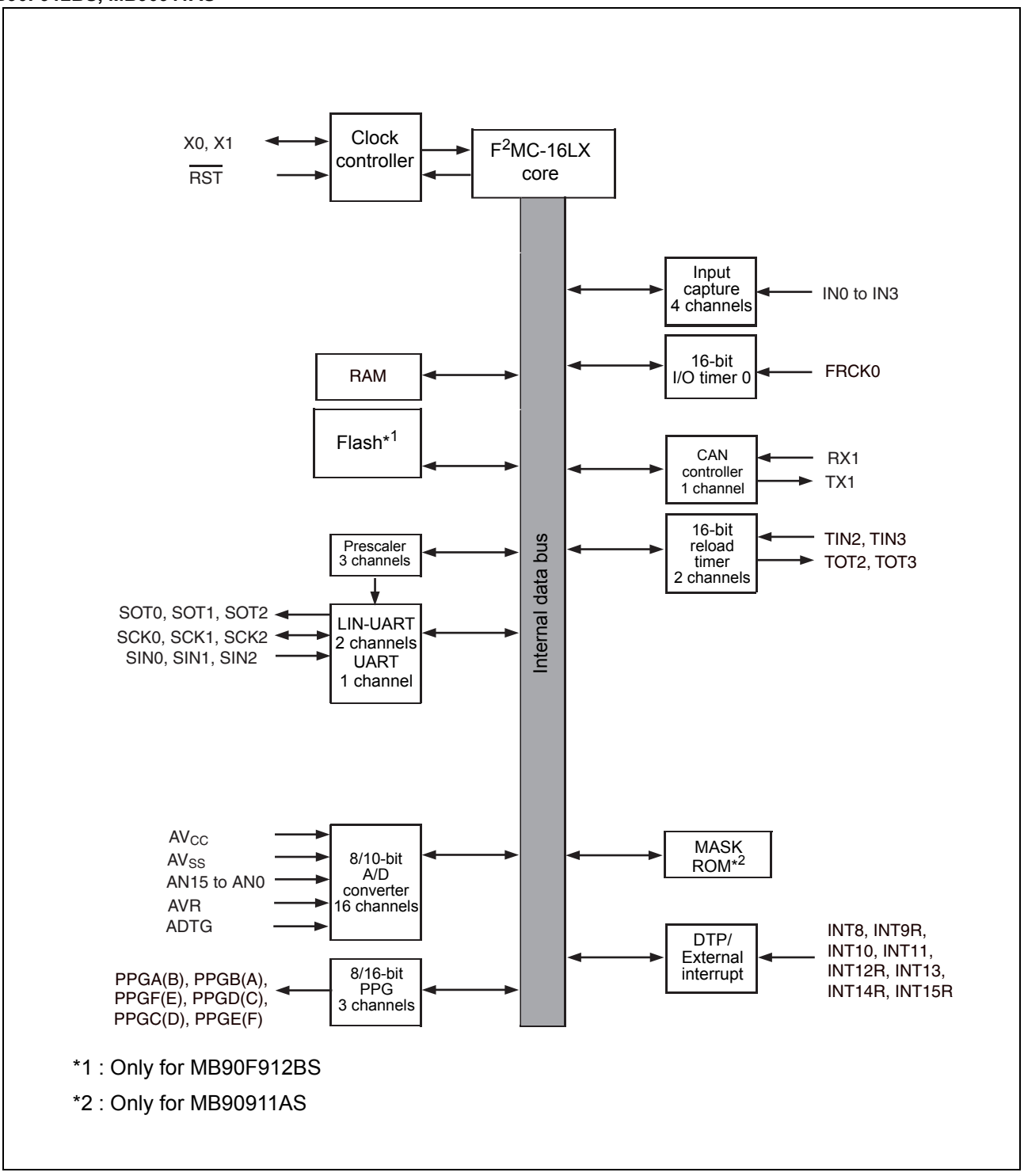
If used exceeding $T_A = +105$ °C, please consult with us due to the restricted reliability.
It is ensured to write/erase data to the Flash memory between $T_A = -40$ °C and +105 °C.

6. Block Diagrams

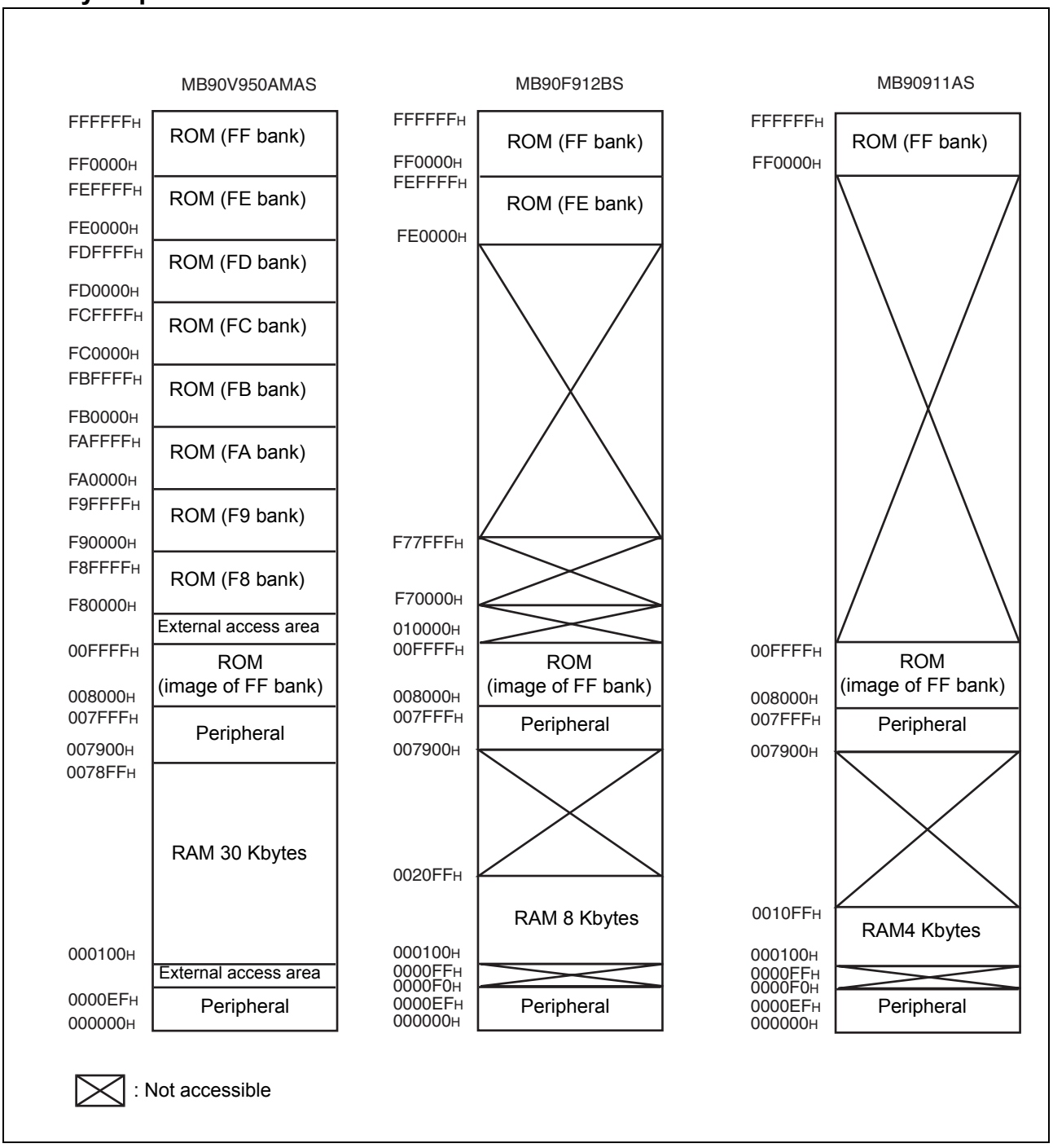
■ **MB90V950AMAS**



■ **MB90F912BS, MB90911AS**



7. Memory Map



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 are the same, the table in ROM can be referred without using the far specification in the pointer declaration.
For example, an attempt to access $00C000_H$ practically accesses the value at $FFC000_H$ in ROM.
The ROM area in bank FF exceeds 32 Kbytes, and its entire image cannot be shown in bank 00.
The image between $FF8000_H$ and $FFFFFF_H$ is visible in bank 00, while the image between $FF0000_H$ and $FF7FFF_H$ is visible only in bank FF.

8. I/O Map

Address	Register	Abbreviation	Access	Resource name	Initial value
000000_H,000001_H	Reserved				
000002_H	Port 2 Data Register	PDR2	R/W	Port 2	$XXXXXXXX_B$
000003_H	Reserved				
000004_H	Port 4 Data Register	PDR4	R/W	Port 4	$XXXXXXXX_B$
000005_H	Port 5 Data Register	PDR5	R/W	Port 5	$XXXXXXXX_B$
000006_H	Port 6 Data Register	PDR6	R/W	Port 6	$XXXXXXXX_B$
000007_H	Reserved				
000008_H	Port 8 Data Register	PDR8	R/W	Port 8	$XXXXXXXX_B$
000009_H,$000A_H$	Reserved				
$00000B_H$	Port 5 Analog Input Enable Register	ADER5	R/W	Port 5, A/D	11111111_B
$00000C_H$	Port 6 Analog Input Enable Register	ADER6	R/W	Port 6, A/D	11111111_B
$00000D_H$	Reserved				
$00000E_H$	Input Level Select Register 0	ILSR0	R/W	Ports	$XXXXXXXX_B$
$00000F_H$	Input Level Select Register 1	ILSR1	R/W	Ports	$XXXX0XXX_B$
000010_H,0011_H	Reserved				
000012_H	Port 2 Direction Register	DDR2	R/W	Port 2	00000000_B
000013_H	Reserved				
000014_H	Port 4 Direction Register	DDR4	R/W	Port 4	00000000_B
000015_H	Port 5 Direction Register	DDR5	R/W	Port 5	00000000_B
000016_H	Port 6 Direction Register	DDR6	R/W	Port 6	00000000_B
000017_H	Reserved				
000018_H	Port 8 Direction Register	DDR8	R/W	Port 8	00000000_B
000019_H	Reserved				
$00001A_H$	Port A Direction Register	DDRA	W	Port A	00000111_B
$00001B_H$ to $00001D_H$	Reserved				
$00001E_H$	Port 2 Pull-up Control Register	PUCR2	R/W	Port 2	00000000_B
$00001F_H$	Reserved				

(Continued)

Address	Register	Abbreviation	Access	Resource name	Initial value
000020_H	Serial Mode Register 0	SMR0	W, R/W	UART0	00000000_B
000021_H	Serial Control Register 0	SCR0	W, R/W		00000000_B
000022_H	Reception/Transmission Data Register 0	RDR0/TDR0	R/W		00000000_B/ 11111111_B
000023_H	Serial Status Register 0	SSR0	R, R/W		00001000_B
000024_H	Extended Communication Control Register 0	ECCR0	R, W, R/W		$000000XX_B$
000025_H	Extended Status/Control Register 0	ESCR0	R/W		$00000X00_B$
000026_H	Baud Rate Generator Register 00	BGR00	R/W, R		00000000_B
000027_H	Baud Rate Generator Register 01	BGR01	R/W, R		00000000_B
000028_H	Serial Mode Register 1	SMR1	W, R/W	UART1	00000000_B
000029_H	Serial Control Register 1	SCR1	W, R/W		00000000_B
$00002A_H$	Reception/Transmission Data Register 1	RDR1/TDR1	R/W		00000000_B/ 11111111_B
$00002B_H$	Serial Status Register 1	SSR1	R, R/W		00001000_B
$00002C_H$	Extended Communication Control Register 1	ECCR1	R, W, R/W		$000000XX_B$
$00002D_H$	Extended Status/Control Register 1	ESCR1	R/W		$00000X00_B$
$00002E_H$	Baud Rate Generator Register 10	BGR10	R/W, R		00000000_B
$00002F_H$	Baud Rate Generator Register 11	BGR11	R/W, R		00000000_B
000030_H to $00003A_H$	Reserved				
$00003B_H$	Address Detect Control Register 1	PACSR1	R/W	Address Match Detection 1	11000000_B
$00003C_H$ to 000043_H	Reserved				
000044_H	PPGA Operation Mode Control Register	PPGCA	W, R/W	16-bit PPG A/B	01000111_B
000045_H	PPGB Operation Mode Control Register	PPGCB	W, R/W		01000001_B
000046_H	PPGA/B Count Clock Select Register	PPGAB	R/W		00000010_B
000047_H	Reserved				
000048_H	PPG C Operation Mode Control Register	PPGCC	W, R/W	16-bit PPG C/D	01000111_B
000049_H	PPG D Operation Mode Control Register	PPGCD	W, R/W		01000001_B
$00004A_H$	PPG C/PPG D Count Clock Select Register	PPGCD	R/W		00000010_B
$00004B_H$	Reserved				

(Continued)

Address	Register	Abbreviation	Access	Resource name	Initial value
$00004C_H$	PPG E Operation Mode Control Register	PPGCE	W, R/W	16-bit PPG E/F	01000111_B
$00004D_H$	PPG F Operation Mode Control Register	PPGCF	W, R/W		01000001_B
$00004E_H$	PPG E/PPG F Count Clock Select Register	PPGEF	R/W		00000010_B
$00004F_H$	Reserved				
000050_H	Input Capture Control Status 0/1	ICS01	R/W	Input Capture 0/1	00000000_B
000051_H	Input Capture Edge 0/1	ICE01	R/W, R		$111010XX_B$
000052_H	Input Capture Control Status 2/3	ICS23	R/W	Input Capture 2/3	00000000_B
000053_H	Input Capture Edge 2/3	ICE23	R		$111111XX_B$
000054_H to 000063_H	Reserved				
000064_H	Timer Control Status 2	TMCSR2	R/W	16-bit Reload Timer 2	00000000_B
000065_H	Timer Control Status 2	TMCSR2	R/W		11110000_B
000066_H	Timer Control Status 3	TMCSR3	R/W	16-bit Reload Timer 3	00000000_B
000067_H	Timer Control Status 3	TMCSR3	R/W		11110000_B
000068_H	A/D Control Status 0	ADCS0	R/W	A/D Converter	00011110_B
000069_H	A/D Control Status 1	ADCS1	R/W, W		00000001_B
$00006A_H$	A/D Data 0	ADCR0	R		00000000_B
$00006B_H$	A/D Data 1	ADCR1	R		11111100_B
$00006C_H$	A/D Converter Setting 0	ADSR0	R/W		00000000_B
$00006D_H$	A/D Converter Setting 1	ADSR1	R/W		00000000_B
$00006E_H$	Reserved				
$00006F_H$	ROM Mirror Function Select Register	ROMM	W	ROM Mirror	11111101_B
000070_H to $00007F_H$	Reserved				
000080_H to $00008F_H$	Reserved for CAN Controller 1. Refer to "CAN Controllers"				
000090_H to $00009D_H$	Reserved				
$00009E_H$	Address Detect Control Register 0	PACSR0	R/W	Address Match Detection 0	11000000_B

(Continued)

Address	Register	Abbreviation	Access	Resource name	Initial value
$00009F_H$	Delayed Interrupt/Release Register	DIRR	R/W	Delayed Interrupt Generation module	11111110_B
$0000A0_H$	Low-power Consumption Mode Control Register	LPMCR	W, R/W	Low-Power Consumption Control Circuit	00011000_B
$0000A1_H$	Clock Selection Register	CKSCR	R, R/W	Low-Power consumption Control Circuit	11111100_B
$0000A2_H$ to $0000A7_H$	Reserved				
$0000A8_H$	Watchdog Timer Control Register	WDTC	R, W	Watchdog Timer	$XXXXX111_B$
$0000A9_H$	Timebase Timer Control Register	TBTC	W, R/W	Timebase Timer	11100100_B
$0000AA_H$	Reserved				
$0000AB_H$ to $0000AD_H$	Reserved				
$0000AE_H$	Flash memory Control Status Register (Flash Devices only. Otherwise reserved)	FMCS	R, R/W	Flash Memory	$000X0000_B$
$0000AF_H$	Reserved				
$0000B0_H$	Interrupt Control Register 00	ICR00	W, R/W	Interrupt Control	00000111_B
$0000B1_H$	Interrupt Control Register 01	ICR01	W, R/W		00000111_B
$0000B2_H$	Interrupt Control Register 02	ICR02	W, R/W		00000111_B
$0000B3_H$	Interrupt Control Register 03	ICR03	W, R/W		00000111_B
$0000B4_H$	Interrupt Control Register 04	ICR04	W, R/W		00000111_B
$0000B5_H$	Interrupt Control Register 05	ICR05	W, R/W		00000111_B
$0000B6_H$	Interrupt Control Register 06	ICR06	W, R/W		00000111_B
$0000B7_H$	Interrupt Control Register 07	ICR07	W, R/W		00000111_B
$0000B8_H$	Interrupt Control Register 08	ICR08	W, R/W		00000111_B
$0000B9_H$	Interrupt Control Register 09	ICR09	W, R/W		00000111_B
$0000BA_H$	Interrupt Control Register 10	ICR10	W, R/W		00000111_B
$0000BB_H$	Interrupt Control Register 11	ICR11	W, R/W		00000111_B
$0000BC_H$	Interrupt Control Register 12	ICR12	W, R/W		00000111_B
$0000BD_H$	Interrupt Control Register 13	ICR13	W, R/W		00000111_B
$0000BE_H$	Interrupt Control Register 14	ICR14	W, R/W		00000111_B
$0000BF_H$	Interrupt Control Register 15	ICR15	W, R/W		00000111_B
$0000C0_H$	Reserved				

(Continued)

Address	Register	Abbreviation	Access	Resource name	Initial value
$0000C1_H$	Reserved				
$0000C2_H$	Reserved				
$0000C3_H$ to $0000C9_H$	Reserved				
$0000CA_H$	External Interrupt Enable 1	ENIR1	R/W	DTP/External Interrupt	00000000_B
$0000CB_H$	External Interrupt Source 1	EIRR1	R/W		$XXXXXXXX_B$
$0000CC_H$	Detection Level Setting 1	ELVR1	R/W		00000000_B
$0000CD_H$					00000000_B
$0000CE_H$	External Interrupt Source Select	EISSR	R/W		00000000_B
$0000CF_H$	PLL clock Control Register	PSCCR	W	PLL	11110000_B
$0000D0_H$ to $0000D7_H$	Reserved				
$0000D8_H$	Serial Mode Register 2	SMR2	W, R/W	UART2	00000000_B
$0000D9_H$	Serial Control Register 2	SCR2	W, R/W		00000000_B
$0000DA_H$	Reception/Transmission Data Register 2	RDR2/ TDR2	R/W		00000000_B/ 11111111_B
$0000DB_H$	Serial Status Register 2	SSR2	R, R/W		00001000_B
$0000DC_H$	Extended Communication Control Register 2	ECCR2	R, W, R/W		$000000XX_B$
$0000DD_H$	Extended Status/Control Register 2	ESCR2	R/W		$00000X00_B$
$0000DE_H$	Baud Rate Generator Register 20	BGR20	R/W, R		00000000_B
$0000DF_H$	Baud Rate Generator Register 21	BGR21	R/W, R		00000000_B
$0000E0_H$ to $0000FF_H$	Reserved				
007900_H to 007913_H	Reserved				
007914_H	Reload Register LA	PRLLA	R/W	16-bit PPG A/B	$XXXXXXXX_B$
007915_H	Reload Register HA	PRLHA	R/W		$XXXXXXXX_B$
007916_H	Reload Register LB	PRLLB	R/W		$XXXXXXXX_B$
007917_H	Reload Register HB	PRLHB	R/W		$XXXXXXXX_B$
007918_H	Reload Register LC	PRLLC	R/W	16-bit PPG C/D	$XXXXXXXX_B$
007919_H	Reload Register HC	PRLHC	R/W		$XXXXXXXX_B$
$00791A_H$	Reload Register LD	PRLLD	R/W		$XXXXXXXX_B$
$00791B_H$	Reload Register HD	PRLHD	R/W		$XXXXXXXX_B$

(Continued)

Address	Register	Abbreviation	Access	Resource name	Initial value
$00791C_H$	Reload Register LE	PRLLE	R/W	16-bit PPG E/F	$XXXXXXXX_B$
$00791D_H$	Reload Register HE	PRLHE	R/W		$XXXXXXXX_B$
$00791E_H$	Reload Register LF	PRLLF	R/W		$XXXXXXXX_B$
$00791F_H$	Reload Register HF	PRLHF	R/W		$XXXXXXXX_B$
007920_H	Input Capture Register 0	IPCP0	R	Input Capture 0/1*	00000000_B
007921_H	Input Capture Register 0	IPCP0	R		00000000_B
007922_H	Input Capture Register 1	IPCP1	R		00000000_B
007923_H	Input Capture Register 1	IPCP1	R		00000000_B
007924_H	Input Capture Register 2	IPCP2	R	Input Capture 2/3*	00000000_B
007925_H	Input Capture Register 2	IPCP2	R		00000000_B
007926_H	Input Capture Register 3	IPCP3	R		00000000_B
007927_H	Input CaptureRegister 3	IPCP3	R		00000000_B
007928_H to $00793F_H$	Reserved				
007940_H	Timer Data Register 0	TCDT0	R/W	I/O Timer 0	00000000_B
007941_H	Timer Data Register 0	TCDT0	R/W		00000000_B
007942_H	Timer Control Status Register 0	TCCSL0	R/W		00000000_B
007943_H	Timer Control Status Register 0	TCCSH0	R/W		01100000_B
007944_H to $00794B_H$	Reserved				
$00794C_H$	Timer Register 2/Reload Register 2	TMR2/TMRLR2	R/W	16-bit Reload Timer 2	$XXXXXXXX_B$
$00794D_H$			R/W		$XXXXXXXX_B$
$00794E_H$	Timer Register 3/Reload Register 3	TMR3/TMRLR3	R/W	16-bit Reload Timer 3	$XXXXXXXX_B$
$00794F_H$			R/W		$XXXXXXXX_B$
007950_H to $00795F_H$	Reserved				
007960_H	Reserved				
007961_H to $00796D_H$	Reserved				
$00796E_H$	CAN Direct Mode Register (MB90V950AMAS only)	CDMR	R/W	CAN clock sync	11111110_B
$00796F_H$ to $0079A1_H$	Reserved				

(Continued)

Address	Register	Abbrevia-tion	Access	Resource name	Initial value
$0079A2_H$	Flash Write Control Register 0	FWR0	R/W	Flash	00000000_B
$0079A3_H$	Flash Write Control Register 1	FWR1	R/W		00000000_B
$0079A4_H$ to $0079B1_H$	Reserved				
$0079B2_H$	Reserved				
$0079B3_H$ to $0079B7_H$	Reserved				
$0079B8_H$	Reserved				
$0079B9_H$	Reserved				
$0079BA_H$	Reserved				
$0079BB_H$	Reserved				
$0079BC_H$	Reserved				
$0079BD_H$	Reserved				
$0079BE_H$	Reserved				
$0079BF_H$	Reserved				
$0079C0_H$ to $0079DF_H$	Reserved				
$0079E0_H$	Detect Address Setting Register 0	PADR0	R/W	Address Match Detection 0	$XXXXXXXX_B$
$0079E1_H$	Detect Address Setting Register 0	PADR0	R/W		$XXXXXXXX_B$
$0079E2_H$	Detect Address Setting Register 0	PADR0	R/W		$XXXXXXXX_B$
$0079E3_H$	Detect Address Setting Register 1	PADR1	R/W		$XXXXXXXX_B$
$0079E4_H$	Detect Address Setting Register 1	PADR1	R/W		$XXXXXXXX_B$
$0079E5_H$	Detect Address Setting Register 1	PADR1	R/W		$XXXXXXXX_B$
$0079E6_H$	Detect Address Setting Register 2	PADR2	R/W		$XXXXXXXX_B$
$0079E7_H$	Detect Address Setting Register 2	PADR2	R/W		$XXXXXXXX_B$
$0079E8_H$	Detect Address Setting Register 2	PADR2	R/W		$XXXXXXXX_B$
$0079E9_H$ to $0079EF_H$	Reserved				

(Continued)

(Continued)

Address	Register	Abbreviation	Access	Resource name	Initial value
$0079F0_H$	Detect Address Setting Register 3	PADR3	R/W	Address Match Detection 1	$XXXXXXXX_B$
$0079F1_H$	Detect Address Setting Register 3	PADR3	R/W		$XXXXXXXX_B$
$0079F2_H$	Detect Address Setting Register 3	PADR3	R/W		$XXXXXXXX_B$
$0079F3_H$	Detect Address Setting Register 4	PADR4	R/W		$XXXXXXXX_B$
$0079F4_H$	Detect Address Setting Register 4	PADR4	R/W		$XXXXXXXX_B$
$0079F5_H$	Detect Address Setting Register 4	PADR4	R/W		$XXXXXXXX_B$
$0079F6_H$	Detect Address Setting Register 5	PADR5	R/W		$XXXXXXXX_B$
$0079F7_H$	Detect Address Setting Register 5	PADR5	R/W		$XXXXXXXX_B$
$0079F8_H$	Detect Address Setting Register 5	PADR5	R/W		$XXXXXXXX_B$
$0079F9_H$ to $007BFF_H$	Reserved				
$007C00_H$ to $007CFF_H$	Reserved for CAN Controller. Refer to “CAN Controllers”				
$007D00_H$ to $007DFF_H$	Reserved for CAN Controller. Refer to “CAN Controllers”				
$007E00_H$ to $007FFF_H$	Reserved				

* : The initial value of MB90V950AMAS is $XXXXXXXX_B$.

Notes :
- Initial value of “X” represents undefined value.
- Do not write to reserved address in I/O map. A read access to reserved addresses results in reading “X”.

9. CAN Controllers

- Conforms to CAN Specification Ver 2.0 Part A and Part B
  - Supports transmission/reception in standard frame and extended frame formats
- Supports transmitting 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 ID acceptance mask
  - 2 acceptance mask registers in either standard frame format or extended frame formats
- Bit rate programmable from 10 kbps/s to 1 Mbps/s (when input clock is at 16 MHz)

List of Control Registers (1)

Address	Register	Abbreviation	Access	Initial Value
CAN1				
000080_H	Message buffer valid register	BVALR	R/W	$00000000\ 00000000_B$
000081_H				
000082_H	Transmit request register	TREQR	R/W	$00000000\ 00000000_B$
000083_H				
000084_H	Transmit cancel register	TCANR	W	$00000000\ 00000000_B$
000085_H				
000086_H	Transmission complete register	TCR	R/W	$00000000\ 00000000_B$
000087_H				
000088_H	Receive complete register	RCR	R/W	$00000000\ 00000000_B$
000089_H				
$00008A_H$	Remote request receiving register	RRTRR	R/W	$00000000\ 00000000_B$
$00008B_H$				
$00008C_H$	Receive overrun register	ROVRR	R/W	$00000000\ 00000000_B$
$00008D_H$				
$00008E_H$	Reception interrupt enable register	RIER	R/W	$00000000\ 00000000_B$
$00008F_H$				

List of Control Registers (2)

Address CAN1	Register	Abbreviation	Access	Initial Value
$007D00_H$	Control status register	CSR	R/W, W R/W, R	$0XXXX0X1\ 00XXX000_B$
$007D01_H$				
$007D02_H$	Last event indicator register	LEIR	R/W	$000X0000\ XXXXXXXX_B$
$007D03_H$				
$007D04_H$	Receive and transmit error counter	RTEC	R	$00000000\ 00000000_B$
$007D05_H$				
$007D06_H$	Bit timing register	BTR	R/W	$11111111\ X1111111_B$
$007D07_H$				
$007D08_H$	IDE register	IDER	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007D09_H$				
$007D0A_H$	Transmit RTR register	TRTRR	R/W	$00000000\ 00000000_B$
$007D0B_H$				
$007D0C_H$	Remote frame receive waiting register	RFWTR	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007D0D_H$				
$007D0E_H$	Transmit interrupt enable register	TIER	R/W	$00000000\ 00000000_B$
$007D0F_H$				
$007D10_H$	Acceptance mask select register	AMSR	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007D11_H$				
$007D12_H$				$XXXXXXXX\ XXXXXXXX_B$
$007D13_H$				
$007D14_H$	Acceptance mask register 0	AMR0	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007D15_H$				
$007D16_H$				$XXXXXXXX\ XXXXXXXX_B$
$007D17_H$				
$007D18_H$	Acceptance mask register 1	AMR1	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007D19_H$				
$007D1A_H$				$XXXXXXXX\ XXXXXXXX_B$
$007D1B_H$				

List of Message Buffers (ID Registers)

Address CAN1	Register	Abbreviation	Access	Initial Value
$007C00_H$ to $007C1F_H$	General-purpose RAM	—	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007C20_H$	ID register 0	IDR0	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007C21_H$				
$007C22_H$				$XXXXXXXX\ XXXXXXXX_B$
$007C23_H$				
$007C24_H$	ID register 1	IDR1	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007C25_H$				
$007C26_H$				$XXXXXXXX\ XXXXXXXX_B$
$007C27_H$				
$007C28_H$	ID register 2	IDR2	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007C29_H$				
$007C2A_H$				$XXXXXXXX\ XXXXXXXX_B$
$007C2B_H$				
$007C2C_H$	ID register 3	IDR3	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007C2D_H$				
$007C2E_H$				$XXXXXXXX\ XXXXXXXX_B$
$007C2F_H$				
$007C30_H$	ID register 4	IDR4	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007C31_H$				
$007C32_H$				$XXXXXXXX\ XXXXXXXX_B$
$007C33_H$				
$007C34_H$	ID register 5	IDR5	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007C35_H$				
$007C36_H$				$XXXXXXXX\ XXXXXXXX_B$
$007C37_H$				
$007C38_H$	ID register 6	IDR6	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007C39_H$				
$007C3A_H$				$XXXXXXXX\ XXXXXXXX_B$
$007C3B_H$				
$007C3C_H$	ID register 7	IDR7	R/W	$XXXXXXXX\ XXXXXXXX_B$
$007C3D_H$				
$007C3E_H$				$XXXXXXXX\ XXXXXXXX_B$
$007C3F_H$				

(Continued)

(Continued)

Address CAN1	Register	Abbreviation	Access	Initial Value
$007C40_H$	ID register 8	IDR8	R/W	XXXXXXXX XXXXXXXX$_B$
$007C41_H$				
$007C42_H$				XXXXXXXX XXXXXXXX$_B$
$007C43_H$				
$007C44_H$	ID register 9	IDR9	R/W	XXXXXXXX XXXXXXXX$_B$
$007C45_H$				
$007C46_H$				XXXXXXXX XXXXXXXX$_B$
$007C47_H$				
$007C48_H$	ID register 10	IDR10	R/W	XXXXXXXX XXXXXXXX$_B$
$007C49_H$				
$007C4A_H$				XXXXXXXX XXXXXXXX$_B$
$007C4B_H$				
$007C4C_H$	ID register 11	IDR11	R/W	XXXXXXXX XXXXXXXX$_B$
$007C4D_H$				
$007C4E_H$				XXXXXXXX XXXXXXXX$_B$
$007C4F_H$				
$007C50_H$	ID register 12	IDR12	R/W	XXXXXXXX XXXXXXXX$_B$
$007C51_H$				
$007C52_H$				XXXXXXXX XXXXXXXX$_B$
$007C53_H$				
$007C54_H$	ID register 13	IDR13	R/W	XXXXXXXX XXXXXXXX$_B$
$007C55_H$				
$007C56_H$				XXXXXXXX XXXXXXXX$_B$
$007C57_H$				
$007C58_H$	ID register 14	IDR14	R/W	XXXXXXXX XXXXXXXX$_B$
$007C59_H$				
$007C5A_H$				XXXXXXXX XXXXXXXX$_B$
$007C5B_H$				
$007C5C_H$	ID register 15	IDR15	R/W	XXXXXXXX XXXXXXXX$_B$
$007C5D_H$				
$007C5E_H$				XXXXXXXX XXXXXXXX$_B$
$007C5F_H$				

List of Message Buffers (DLC Registers and Data Registers)

Address CAN1	Register	Abbreviation	Access	Initial Value
$007C60_H$	DLC register 0	DLCR0	R/W	$XXXXXXXX_B$
$007C61_H$				
$007C62_H$	DLC register 1	DLCR1	R/W	$XXXXXXXX_B$
$007C63_H$				
$007C64_H$	DLC register 2	DLCR2	R/W	$XXXXXXXX_B$
$007C65_H$				
$007C66_H$	DLC register 3	DLCR3	R/W	$XXXXXXXX_B$
$007C67_H$				
$007C68_H$	DLC register 4	DLCR4	R/W	$XXXXXXXX_B$
$007C69_H$				
$007C6A_H$	DLC register 5	DLCR5	R/W	$XXXXXXXX_B$
$007C6B_H$				
$007C6C_H$	DLC register 6	DLCR6	R/W	$XXXXXXXX_B$
$007C6D_H$				
$007C6E_H$	DLC register 7	DLCR7	R/W	$XXXXXXXX_B$
$007C6F_H$				
$007C70_H$	DLC register 8	DLCR8	R/W	$XXXXXXXX_B$
$007C71_H$				
$007C72_H$	DLC register 9	DLCR9	R/W	$XXXXXXXX_B$
$007C73_H$				
$007C74_H$	DLC register 10	DLCR10	R/W	$XXXXXXXX_B$
$007C75_H$				
$007C76_H$	DLC register 11	DLCR11	R/W	$XXXXXXXX_B$
$007C77_H$				
$007C78_H$	DLC register 12	DLCR12	R/W	$XXXXXXXX_B$
$007C79_H$				
$007C7A_H$	DLC register 13	DLCR13	R/W	$XXXXXXXX_B$
$007C7B_H$				
$007C7C_H$	DLC register 14	DLCR14	R/W	$XXXXXXXX_B$
$007C7D_H$				
$007C7E_H$	DLC register 15	DLCR15	R/W	$XXXXXXXX_B$
$007C7F_H$				

(Continued)

Address CAN1	Register	Abbreviation	Access	Initial Value
$007C80_H$ to $007C87_H$	Data register 0 (8 bytes)	DTR0	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007C88_H$ to $007C8F_H$	Data register 1 (8 bytes)	DTR1	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007C90_H$ to $007C97_H$	Data register 2 (8 bytes)	DTR2	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007C98_H$ to $007C9F_H$	Data register 3 (8 bytes)	DTR3	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CA0_H$ to $007CA7_H$	Data register 4 (8 bytes)	DTR4	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CA8_H$ to $007CAF_H$	Data register 5 (8 bytes)	DTR5	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CB0_H$ to $007CB7_H$	Data register 6 (8 bytes)	DTR6	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CB8_H$ to $007CBF_H$	Data register 7 (8 bytes)	DTR7	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CC0_H$ to $007CC7_H$	Data register 8 (8 bytes)	DTR8	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CC8_H$ to $007CCF_H$	Data register 9 (8 bytes)	DTR9	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CD0_H$ to $007CD7_H$	Data register 10 (8 bytes)	DTR10	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CD8_H$ to $007CDF_H$	Data register 11 (8 bytes)	DTR11	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CE0_H$ to $007CE7_H$	Data register 12 (8 bytes)	DTR12	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CE8_H$ to $007CEF_H$	Data register 13 (8 bytes)	DTR13	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$

(Continued)

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Address CAN1	Register	Abbreviation	Access	Initial Value
$007CF0_H$ to $007CF7_H$	Data register 14 (8 bytes)	DTR14	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$
$007CF8_H$ to $007CFF_H$	Data register 15 (8 bytes)	DTR15	R/W	$XXXXXXXX_B$ to $XXXXXXXX_B$

10. Interrupt Factors, Interrupt Vectors, Interrupt Control Register

Interrupt cause	EI^{2}OS corresponding	Interrupt vector		Interrupt control register	
		Number	Address	Number	Address
Reset	N	#08	$FFFFDC_H$	—	—
INT9 instruction	N	#09	$FFFFD8_H$	—	—
Exception	N	#10	$FFFFD4_H$	—	—
Reserved	N	#11	$FFFFD0_H$	ICR00	$0000B0_H$
Reserved	N	#12	$FFFFCC_H$		
CAN 1 reception	N	#13	$FFFFC8_H$	ICR01	$0000B1_H$
CAN 1 transmission/node status	N	#14	$FFFFC4_H$		
Reserved	N	#15	$FFFFC0_H$	ICR02	$0000B2_H$
Reserved	N	#16	$FFFFBC_H$		
Reserved	N	#17	$FFFFB8_H$	ICR03	$0000B3_H$
Reserved	N	#18	$FFFFB4_H$		
16-bit reload timer 2	Y1	#19	$FFFFB0_H$	ICR04	$0000B4_H$
16-bit reload timer 3	Y1	#20	$FFFFAC_H$		
Reserved	N	#21	$FFFFA8_H$	ICR05	$0000B5_H$
Reserved	N	#22	$FFFFA4_H$		
PPG C/D	N	#23	$FFFFA0_H$	ICR06	$0000B6_H$
PPG A/B/E/F	N	#24	$FFFF9C_H$		
Timebase timer	N	#25	$FFFF98_H$	ICR07	$0000B7_H$
External interrupt 8 to 11	Y1	#26	$FFFF94_H$		
Reserved	N	#27	$FFFF90_H$	ICR08	$0000B8_H$
External interrupt 12 to 15	Y1	#28	$FFFF8C_H$		
A/D converter	Y1	#29	$FFFF88_H$	ICR09	$0000B9_H$
I/O timer 0	N	#30	$FFFF84_H$		
Reserved	N	#31	$FFFF80_H$	ICR10	$0000BA_H$
Reserved	N	#32	$FFFF7C_H$		
Input capture 0 to 3	Y1	#33	$FFFF78_H$	ICR11	$0000BB_H$
Reserved	N	#34	$FFFF74_H$		
UART 0 reception	Y2	#35	$FFFF70_H$	ICR12	$0000BC_H$
UART 0 transmission	Y1	#36	$FFFF6C_H$		
UART 1 reception	Y2	#37	$FFFF68_H$	ICR13	$0000BD_H$
UART 1 transmission	Y1	#38	$FFFF64_H$		

(Continued)

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Interrupt cause	EI^{2}OS corresponding	Interrupt vector		Interrupt control register	
		Number	Address	Number	Address
UART 2 reception	Y2	#39	$FFFF60_H$	ICR14	$0000BE_H$
UART 2 transmission	Y1	#40	$FFFF5C_H$		
Flash memory	N	#41	$FFFF58_H$	ICR15	$0000BF_H$
Delayed interrupt generation module	N	#42	$FFFF54_H$		

Y1 : Usable

Y2 : Usable, with EI^{2}OS stop function

N : Unusable

Notes :
- The peripheral resources sharing the ICR register have the same interrupt level.
- When the peripheral resources sharing the ICR register use extended intelligent I/O service, only one can use extended intelligent I/O service at a time.
- When either of the 2 peripheral resources sharing the ICR register specifies extended intelligent I/O service, the other one cannot use interrupts.

11. Electrical Characteristics

11.1 Absolute Maximum Ratings

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power supply voltage*1	V_{CC}	V_{SS} − 0.3	V_{SS} + 6.0	V	
	AV_{CC}	V_{SS} − 0.3	V_{SS} + 6.0	V	$V_{CC} = AV_{CC}$*2
	AVR	V_{SS} − 0.3	V_{SS} + 6.0	V	AV_{CC} □ AVR*2
Input voltage*1	V_I	V_{SS} − 0.3	V_{SS} + 6.0	V	*3
Output voltage*1	V_O	V_{SS} − 0.3	V_{SS} + 6.0	V	*3
Maximum clamp current	I_{CLAMP}	−2.0	+2.0	mA	*6
Total Maximum clamp current	$\Sigma\lvert I_{CLAMP}\rvert$	—	40	mA	*6
“L” level maximum output current	I_{OL1}	—	15	mA	*4
	I_{OL2}	—	40	mA	*5
“L” level average output current	I_{OLAV1}	—	4	mA	*4
	I_{OLAV2}	—	30	mA	*5
“L” level maximum overall output current	ΣI_{OL1}	—	125	mA	*4
	ΣI_{OL2}	—	160	mA	*5
“L” level average overall output current	ΣI_{OLAV1}	—	40	mA	*4 +105 °C < T_A ≤ +125 °C
	ΣI_{OLAV2}				*5 +105 °C < T_A ≤ +125 °C
	ΣI_{OLAV1}	—	40	mA	*4 −40 °C ≤ T_A ≤ +105 °C
	ΣI_{OLAV2}				*5 −40 °C ≤ T_A ≤ +105 °C
“H” level maximum output current	I_{OH1}	—	−15	mA	*4
	I_{OH2}	—	−40	mA	*5
“H” level average output current	I_{OHAV1}	—	−4	mA	*4
	I_{OHAV2}	—	−30	mA	*5
“H” level maximum overall output current	ΣI_{OH1}	—	−125	mA	*4
	ΣI_{OH2}	—	−160	mA	*5
“H” level average overall output current	ΣI_{OHAV1}	—	−40	mA	*4 +105 °C < T_A ≤ +125 °C
	ΣI_{OHAV2}				*5 +105 °C < T_A ≤ +125 °C
	ΣI_{OHAV1}	—	−40	mA	*4 −40 °C ≤ T_A ≤ +105 °C
	ΣI_{OHAV2}				*5 −40 °C ≤ T_A ≤ +105 °C
Power consumption	P_D	—	420	mW	
Operating temperature	T_A	−40	+105	°C	
		−40	+125	°C	*7
Storage temperature	T_{STG}	−55	+150	°C	

(Continued)

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

*2 : Set AV_{CC} and V_{CC} to the same voltage. Make sure that AV_{CC} does not exceed V_{CC} and that the voltage at the analog inputs does not exceed AV_{CC} when the power is switched on.

*3 : V_I and V_O should not exceed V_{CC} + 0.3 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 supersedes the V_I rating.

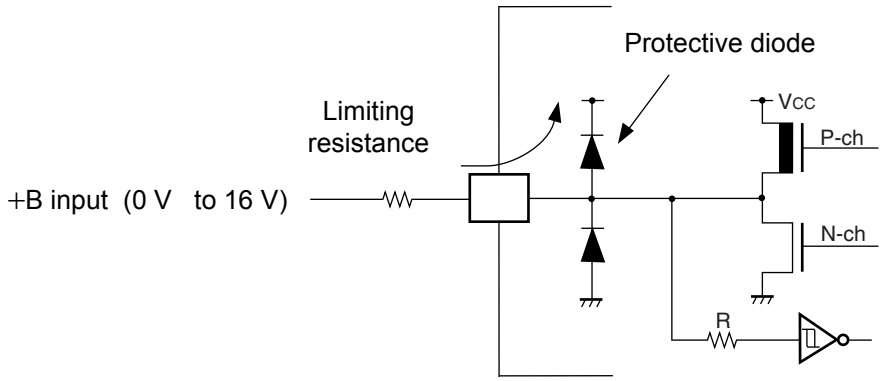
*4 : Applicable to pins : P24 to P27, P40 to P44, P50 to P57, P60 to P67, P80, P82 to P87

*5 : Applicable to pins : P20 to P23

*6 : Applicable to pins : P20 to P27, P40 to P44, P50 to P55, P57, P60 to P67, P80, P82 to P87

- Use within recommended operating conditions.
- Use at DC voltage (current) .
- The +B signal should always be applied a connecting limit resistance 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 inputted 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 power supply voltage may not be sufficient to operate the power-on reset.
- Care must be taken not to leave the +B input pin open.
- Recommended circuit sample :

- **Input/output equivalent circuits**



*7 : If used exceeding T_A = +105 °C, please consult with us due to the restricted reliability.
It is ensured to write/erase data to the Flash memory between T_A = − 40 °C and +105 °C.

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.

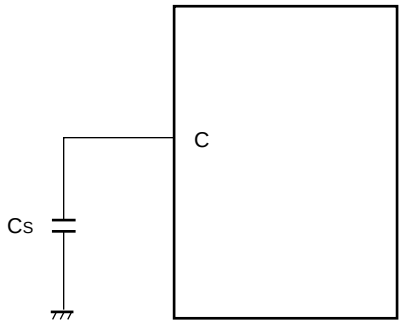
11.2 Recommended Conditions

(V_{SS} = AV_{SS} = 0 V)

Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
Power supply voltage	V_{CC}, AV_{CC}	3.0	5.0	5.5	V	Under normal operation
		2.6	—	5.5	V	Maintains RAM data in stop mode
Smoothing capacitor	C_S	0.1	—	1.0	µF	Use a ceramic capacitor or comparable capacitor of the AC characteristics. By-pass capacitor at the V_{CC} pin should be greater than this capacitor.
Operating temperature	T_A	−40	—	+105	°C	
		−40	—	+125	°C	*

* : For the restricted reliability, contact us if use the devices over Ta=+105 °C.
It is ensured to write/erase data to the Flash memory between T_A = −40 °C and +105 °C.

- **C Pin Connection Diagram**



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.

11.3 DC Characteristics

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Input "H" voltage	V_{IHS}	—	—	0.8 V_{CC}	—	V_{CC} + 0.3	V	Pin inputs if CMOS hysteresis input levels are selected
	V_{IHA}	—	—	0.8 V_{CC}	—	V_{CC} + 0.3	V	Pin inputs if Automotive input levels are selected
	V_{IHS}	P50, P82, P85	—	0.7 V_{CC}	—	V_{CC} + 0.3	V	Pin inputs if CMOS hysteresis input levels are selected
	V_{IHR}	$\overline{RST}$	—	0.8 V_{CC}	—	V_{CC} + 0.3	V	$\overline{RST}$ input pin (CMOS hysteresis)
	V_{IHM}	MD0 to MD2	—	V_{CC} – 0.3	—	V_{CC} + 0.3	V	MD input pin
Input "L" voltage	V_{ILS}	—	—	V_{SS} – 0.3	—	0.2 V_{CC}	V	Pin inputs if CMOS hysteresis input levels are selected
	V_{ILA}	—	—	V_{SS} – 0.3	—	0.5 V_{CC}	V	Pin inputs if Automotive input levels are selected
	V_{ILS}	P50, P82, P85	—	V_{SS} – 0.3	—	0.3 V_{CC}	V	Pin inputs if CMOS hysteresis input levels are selected
	V_{ILR}	$\overline{RST}$	—	V_{SS} – 0.3	—	0.2 V_{CC}	V	$\overline{RST}$ input pin (CMOS hysteresis)
	V_{ILM}	MD0 to MD2	—	V_{SS} – 0.3	—	V_{SS} + 0.3	V	MD input pin
Output "H" voltage	V_{OH}	Other than P20 to P23	V_{CC} = 4.5 V, I_{OH} = –4.0 mA	V_{CC} – 0.5	—	—	V	
	V_{OHI}	P20 to P23	V_{CC} = 4.5 V, I_{OH} = –14.0 mA	V_{CC} – 0.5	—	—	V	MASK ROM products and Evaluation products only
Output "L" voltage	V_{OL}	Other than P20 to P23	V_{CC} = 4.5 V, I_{OL} = 4.0 mA	—	—	0.4	V	
	V_{OLI}	P20 to P23	V_{CC} = 4.5 V, I_{OL} = 20.0 mA	—	—	0.4	V	MASK ROM products and Evaluation products only
Input leak current	I_{IL}	—	V_{CC} = 5.5 V, V_{SS} < V_I < V_{CC}	–3	—	+ 3	μA	
Pull-up resistance	R_{UP}	P20 to P27, $\overline{RST}$	—	25	50	100	kΩ	
Pull-down resistance	R_{DOWN}	MD2	—	25	50	100	kΩ	MASK ROM products and Evaluation products only

(Continued)

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Parameter	Sym-bol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
Power supply current*	I_{CC}	V_{CC}	V_{CC} = 5.0 V, Internal frequency : 32 MHz, At normal operation.	—	30	40	mA	
			V_{CC} = 5.0 V, Internal frequency : 24 MHz, At normal operation.	—	22.5	30	mA	
			V_{CC} = 5.0 V, Internal frequency : 2 MHz, At normal operation.	—	3	7	mA	
			V_{CC} = 5.0 V, Internal frequency : 32 MHz, At writing Flash memory.	—	50	65	mA	
			V_{CC} = 5.0 V, Internal frequency : 32 MHz, At erasing Flash memory.	—	50	65	mA	
	I_{CCS}		V_{CC} = 5.0 V, Internal frequency : 32 MHz, At sleep mode.	—	13	23	mA	
	I_{CTS}		V_{CC} = 5.0 V, Internal frequency : 2 MHz, At main timer mode	—	0.3	0.9	mA	
	$I_{CTSPLL8}$		V_{CC} = 5.0 V, Internal frequency : 32 MHz, At PLL timer mode, External frequency = 4 MHz	—	4	7	mA	
	I_{CCH}		V_{CC} = 5.0 V, At stop mode, T_A = +25°C	—	25	100	μA	
Input capacity	C_{IN}	Other than AV_{CC}, AV_{SS}, AVR, V_{CC}, V_{SS}, C	—	—	5	15	pF	

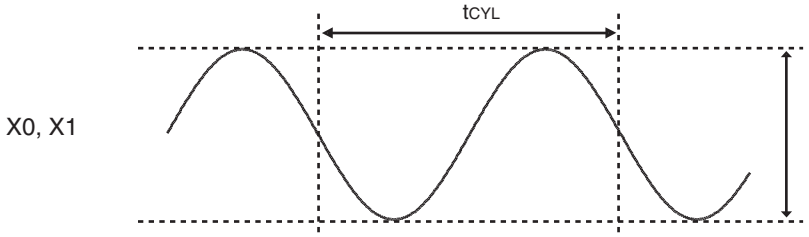
* : The power supply current is measured with an external clock.

11.4 AC Characteristics

11.4.1 Clock Timing

Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Clock frequency	f_C	X0, X1	3	—	16	MHz	1/2 when PLL stops, When using an oscillation circuit
			4	—	16	MHz	PLL × 1, When using an oscillation circuit
			4	—	16	MHz	PLL × 2, When using an oscillation circuit
			4	—	10	MHz	PLL × 3, When using an oscillation circuit
			4	—	8	MHz	PLL × 4, When using an oscillation circuit
			4	—	5	MHz	PLL × 6, When using an oscillation circuit
			4	—	4	MHz	PLL × 8, When using an oscillation circuit
Clock cycle time	t_{CYL}	X0, X1	62.5	—	333	ns	When using an oscillation circuit
Internal operating clock frequency (machine clock)	f_{CP}	—	1.5	—	32	MHz	When using main clock
Internal operating clock cycle time (machine clock)	t_{CP}	—	31.25	—	666	ns	When using main clock

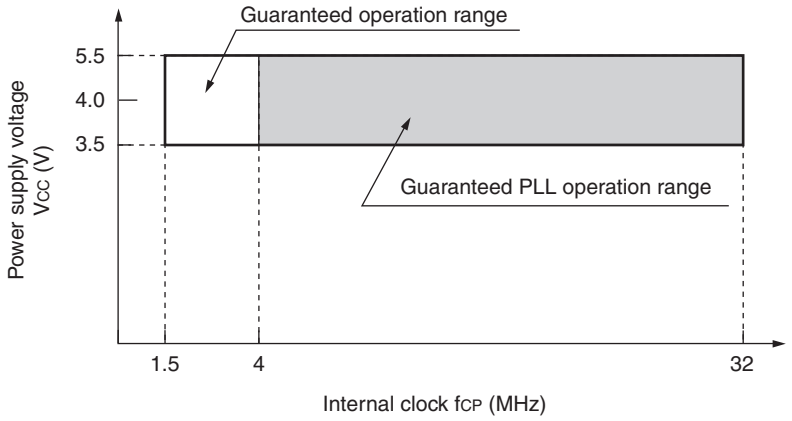
- **When using an oscillation circuit**



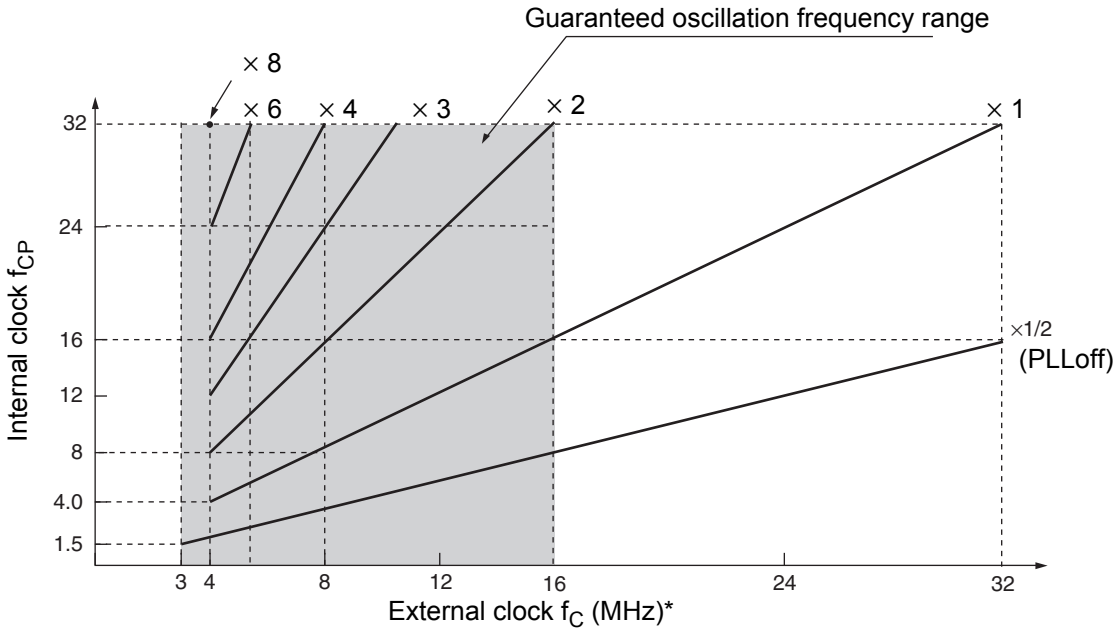
Amplitude:
It varies depending on the external resistance, power rating and the different kind of device.
Reference values: 1V to 2.5V

Note : The amplitude of MB90V950AMAS is the same as Vcc.

• Guaranteed PLL Operation Range



Guaranteed operation range of MB90910 series



* : When using the oscillation circuit, the maximum oscillation clock frequency is 16 MHz.

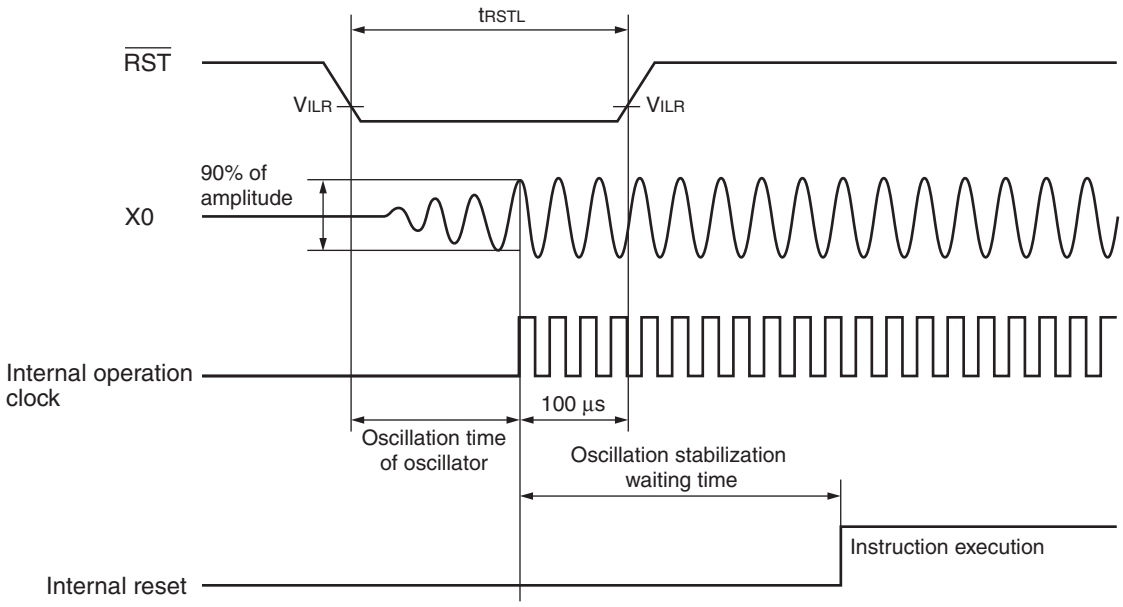
11.4.2 Reset Standby Input

Parameter	Symbol	Pin name	Value		Unit	Remarks
			Min	Max		
Reset input time	t_{RSTL}	$\overline{RST}$	500	—	ns	Under normal operation
			Oscillation time of oscillator* + 100 µs	—	µs	In stop mode
			100	—	µs	In timebase timer mode

* : Oscillation time of oscillator is the time that the amplitude reaches 90%. In the crystal oscillator, the oscillation time is between several ms and tens of ms. In ceramic oscillators, the oscillation time is between hundreds of µs and several ms. An External clock of oscillation time is 0 ms.

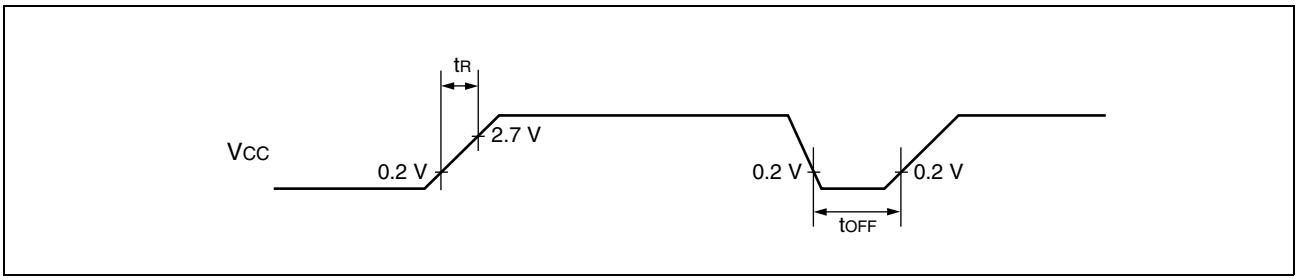
- **Under normal operation :**

- **In stop mode**

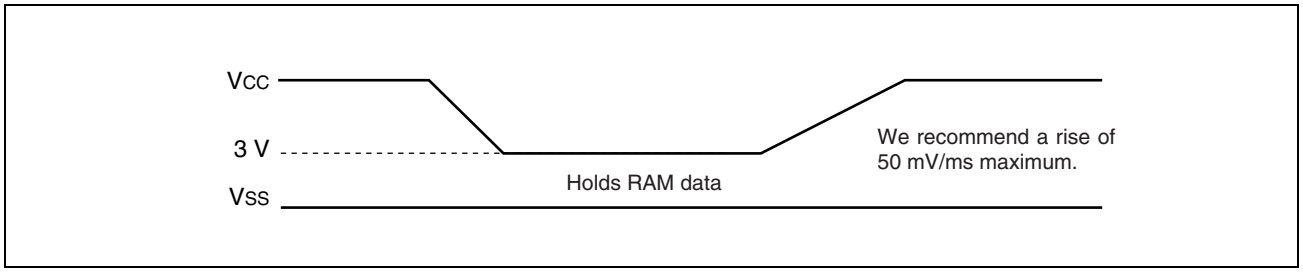


11.4.3 Power-on Reset

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}		1	–	ms	Due to repetitive operation



Note : If you change the power supply voltage too rapidly, a power-on reset may occur. We recommend that you start up smoothly by restraining voltages when changing the power supply voltage during operation, as shown in the figure below. Perform while not using the PLL clock. However, if voltage drops are within 1 V/s, you can operate while using the PLL clock.

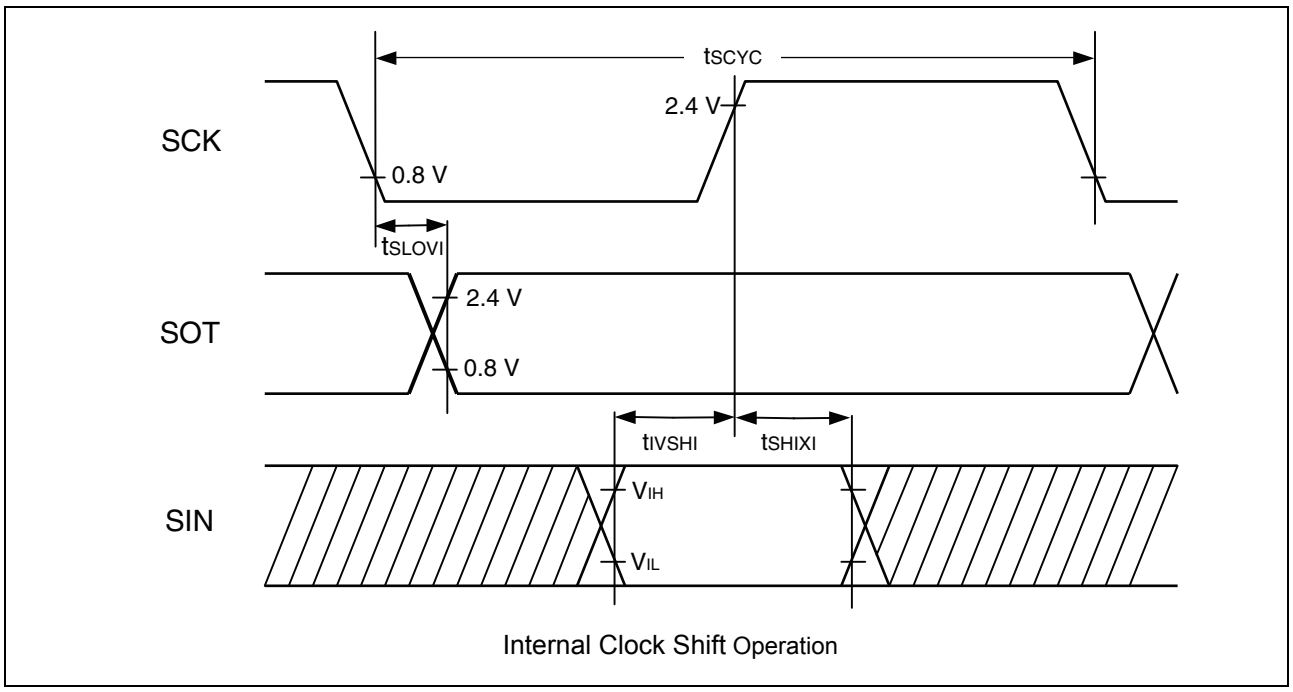


11.4.4 UART

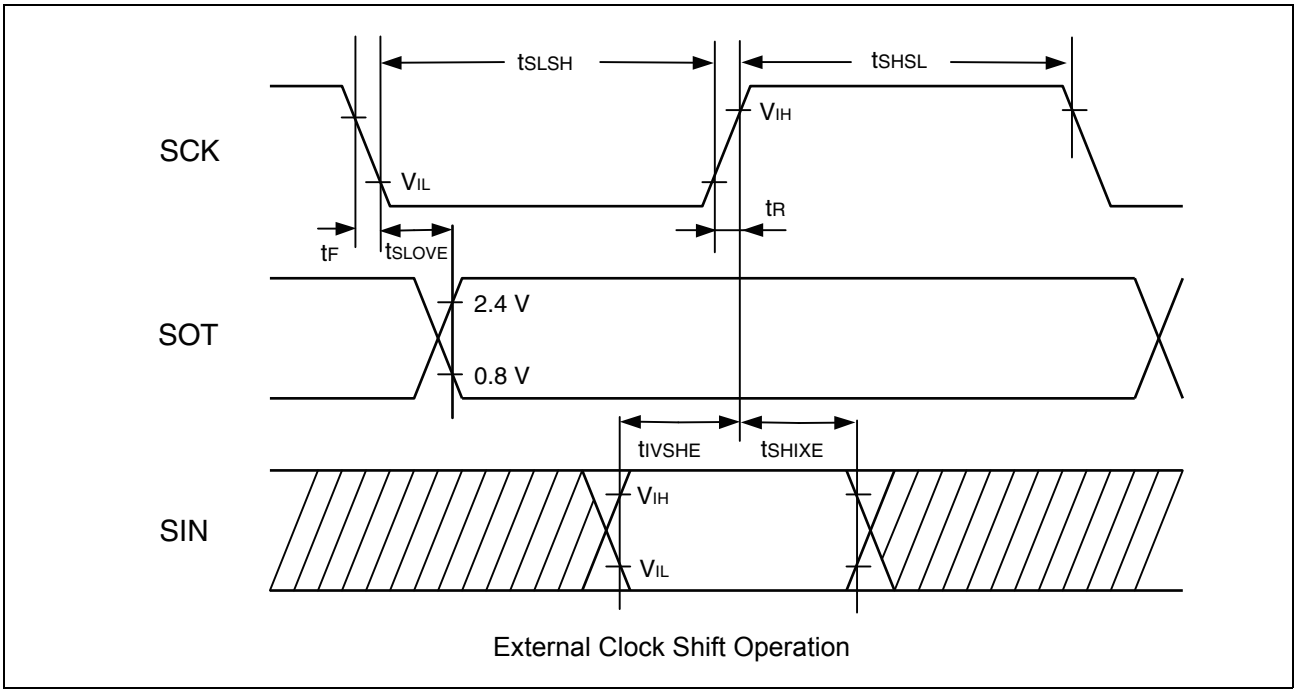
ESCR : SCES = 0, ECCR : SCDE = 0

Parameter	Symbol	Condition	Value		Unit
			Min	Max	
Serial clock cycle time	t_{SCYC}	Internal shift clock operation C_L = 80pF + 1TTL.	5 tcp*	–	ns
SCK ↓ → SOT delay time	t_{SLOVI}		– 50	+ 50	ns
SIN → SCK ↑ setup time	t_{IVSHI}		tcp + 80	–	ns
SCK↑ → SIN hold time	t_{SHIXI}		0	–	ns
Serial clock “L” pulse width	t_{SLSH}	External shift clock operation C_L = 80pF + 1TTL.	3 tcp – t_R	–	ns
Serial clock “H” pulse width	t_{SHSL}		tcp + 10	–	ns
SCK ↓ → SOT delay time	t_{SLOVE}		–	2 tcp + 60	ns
SIN → SCK ↑ setup time	t_{IVSHE}		30	–	ns
SCK↑ → SIN hold time	t_{SHIXE}		tcp + 30	–	ns
SCK fall time	t_F		–	10	ns
SCK rise time	t_R		–	10	ns

*: The tcp indicates machine clock



Internal Clock Shift Operation

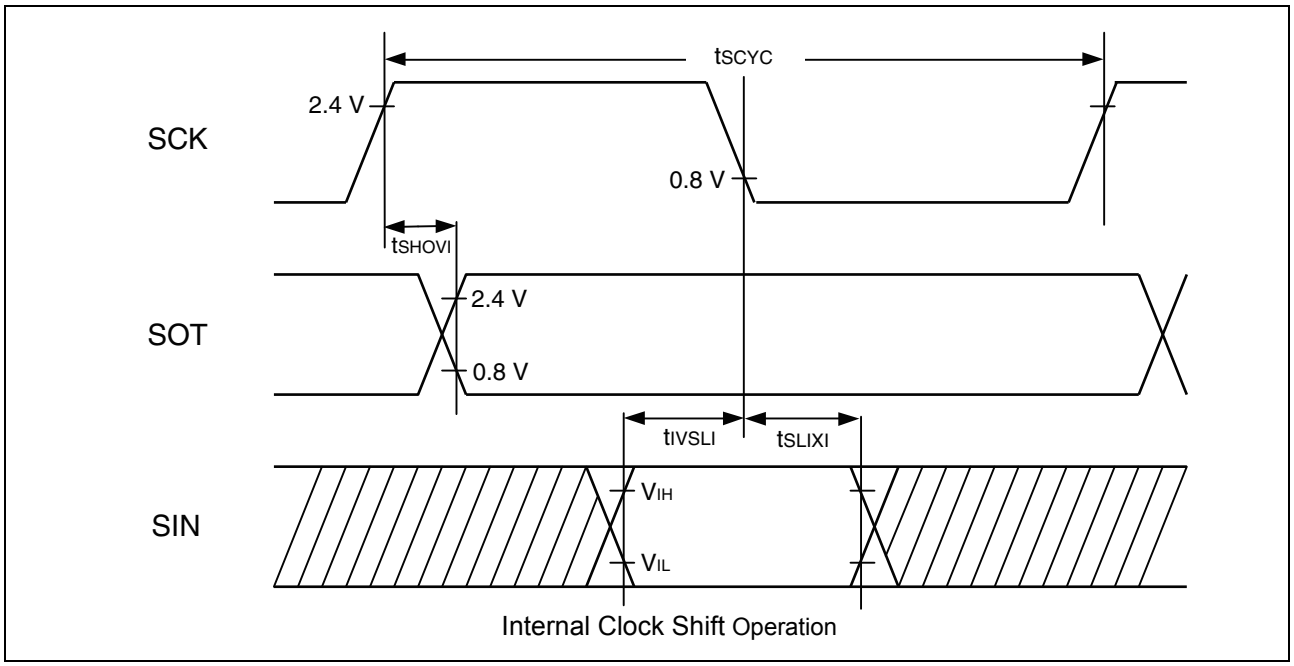


External Clock Shift Operation

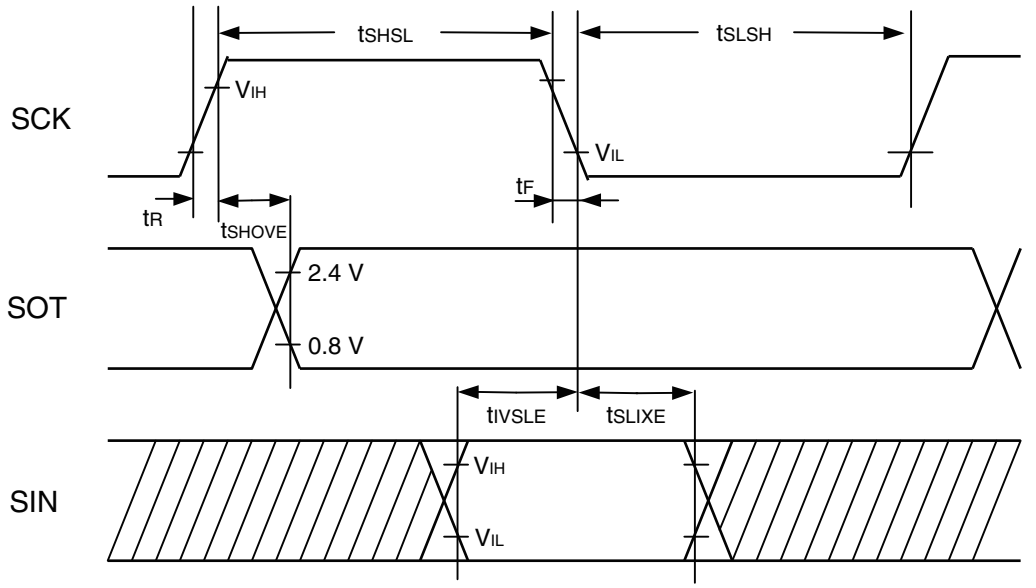
ESCR : SCES = 1, ECCR : SCDE = 0

Parameter	Symbol	Condition	Value		Unit
			Min	Max	
Serial clock cycle time	t_{SCYC}	Internal shift clock operation C_L = 80pF + 1TTL.	5 tcp*	–	ns
SCK ↑ → SOT delay time	t_{SHOVI}		– 50	+ 50	ns
SIN → SCK ↓ setup time	t_{IVSLI}		tcp + 80	–	ns
SCK ↓ → SIN hold time	t_{SLIXI}		0	–	ns
Serial clock “H” pulse width	t_{SHSL}	External shift clock operation C_L = 80pF + 1TTL.	3 tcp – t_R	–	ns
Serial clock “L” pulse width	t_{SLSH}		tcp + 10	–	ns
SCK ↑ → SOT delay time	t_{SHOVE}		–	2 tcp + 60	ns
SIN → SCK ↓ setup time	t_{IVSLE}		30	–	ns
SCK ↓ → SIN hold time	t_{SLIXE}		tcp + 30	–	ns
SCK fall time	t_F		–	10	ns
SCK rise time	t_R		–	10	ns

*: The tcp indicates machine clock



Internal Clock Shift Operation

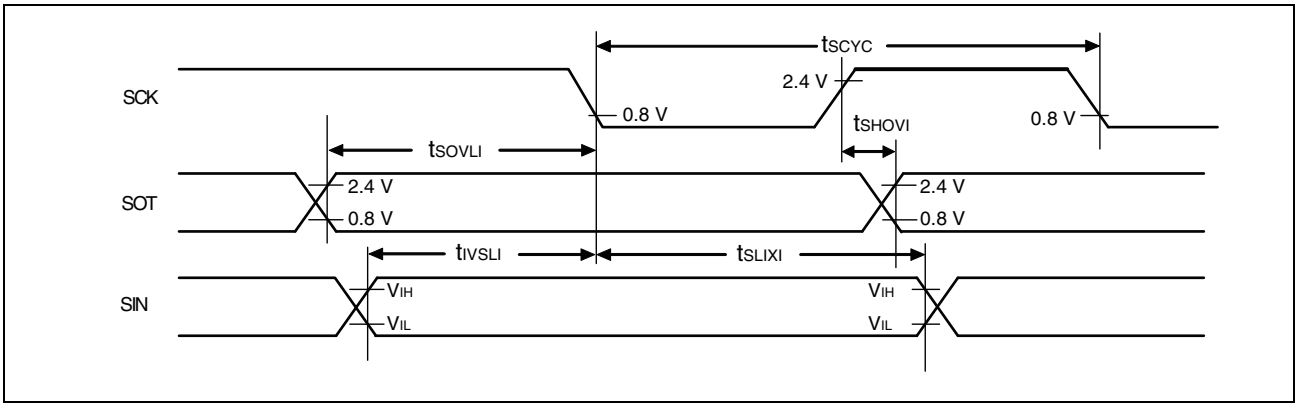


External Clock Shift Operation

ESCR : SCES = 0, ECCR : SCDE = 1

Parameter	Symbol	Condition	Value		Unit
			Min	Max	
Serial clock cycle time	t_{SCYC}	Internal shift clock operation C_L = 80pF + 1TTL.	5 tcp*	–	ns
SCK ↑ → SOT delay time	t_{SHOVI}		– 50	+ 50	ns
SIN → SCK ↓ setup time	t_{IVSLI}		tcp + 80	–	ns
SCK ↓ → SIN hold time	t_{SLIXI}		0	–	ns
SOT → SCK ↓ delay time	t_{SOVLI}		3 tcp – 70	–	ns

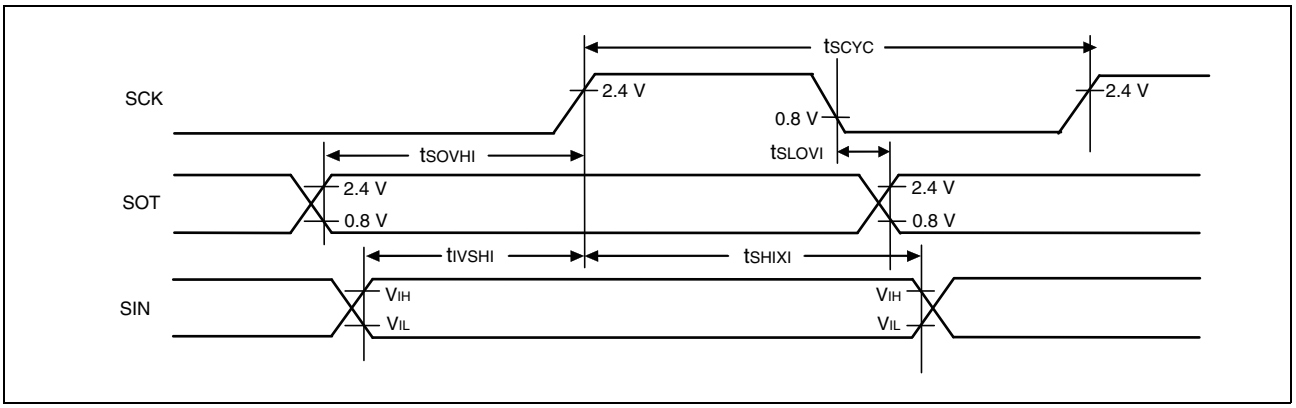
*: The tcp indicates machine clock



ESCR : SCES = 1, ECCR : SCDE = 1

Parameter	Symbol	Condition	Value		Unit
			Min	Max	
Serial clock cycle time	t_{SCYC}	Internal clock operation C_L = 80pF + 1TTL.	5 tcp*	–	ns
SCK ↓ → SOT delay time	t_{SLOVI}		– 50	+ 50	ns
SIN → SCK ↑ setup time	t_{IVSHI}		tcp + 80	–	ns
SCK ↑ → SIN hold time	t_{SHIXI}		0	–	ns
SOT → SCK ↑ delay time	t_{SOVHI}		3 tcp – 70	–	ns

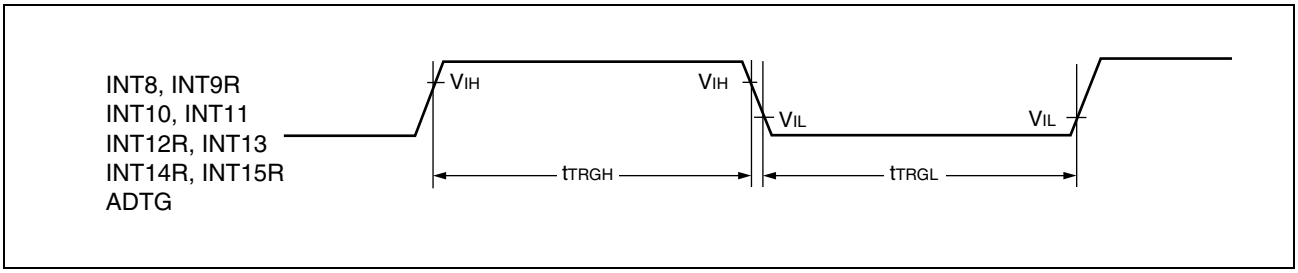
*: The tcp indicates machine clock



11.4.5 Trigger Input Timing

Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
Input pulse width	t_{TRGH} t_{TRGL}	INT8, INT9R INT10, INT11 INT12R, INT13 INT14R, INT15R ADTG	—	5 t_{CP}	—	ns

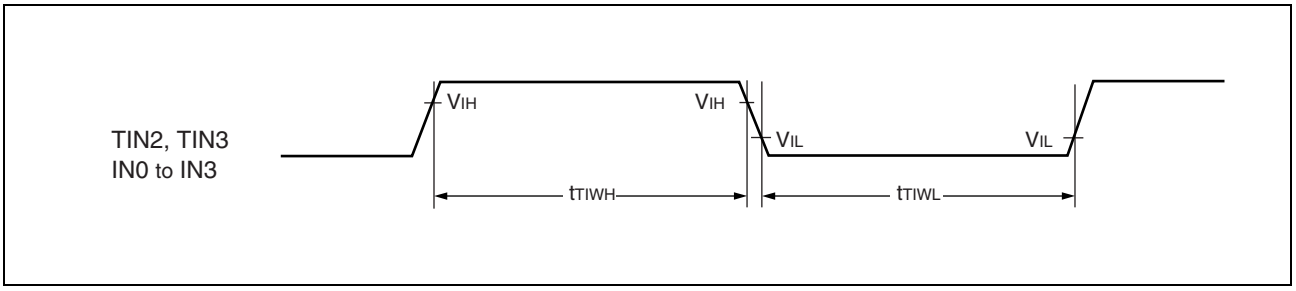
Note : t_{CP} is internal operating clock cycle time (machine clock) . Refer to “ (1) Clock Timing”.



11.4.6 Timer Related Resource Input Timing

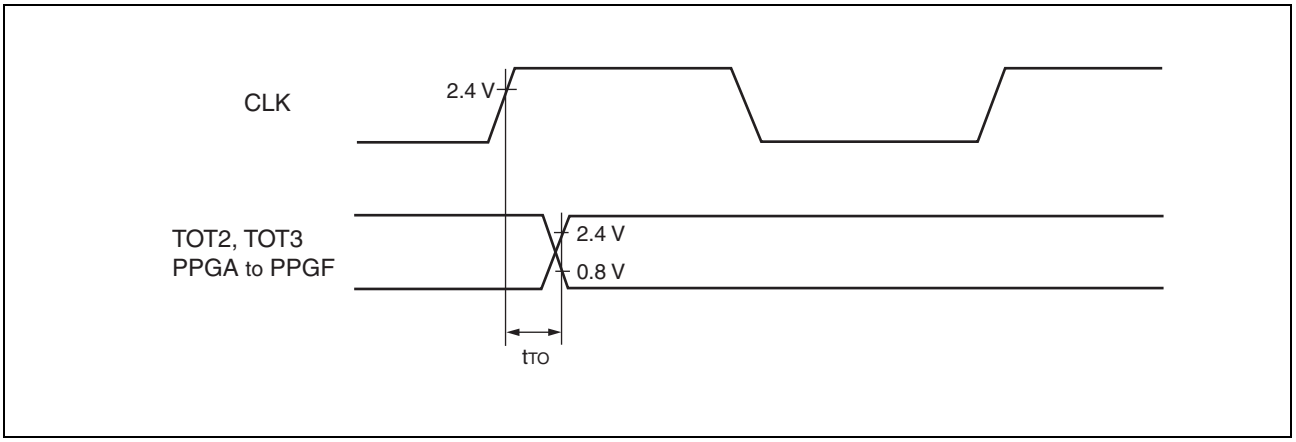
Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
Input pulse width	t_{TIWH} t_{TIWL}	TIN2, TIN3 IN0 to IN3	—	4 t_{CP}	—	ns

Note : t_{CP} is internal operating clock cycle time (machine clock) . Refer to “ (1) Clock Timing”.



11.4.7 Timer Related Resource Output Timing

Parameter	Symbol	Pin name	Condition	Value		Unit
				Min	Max	
CLK ↑ → T_{OUT} change time	t_{TO}	TOT2, TOT3 PPGA to PPGF	–	30	–	ns

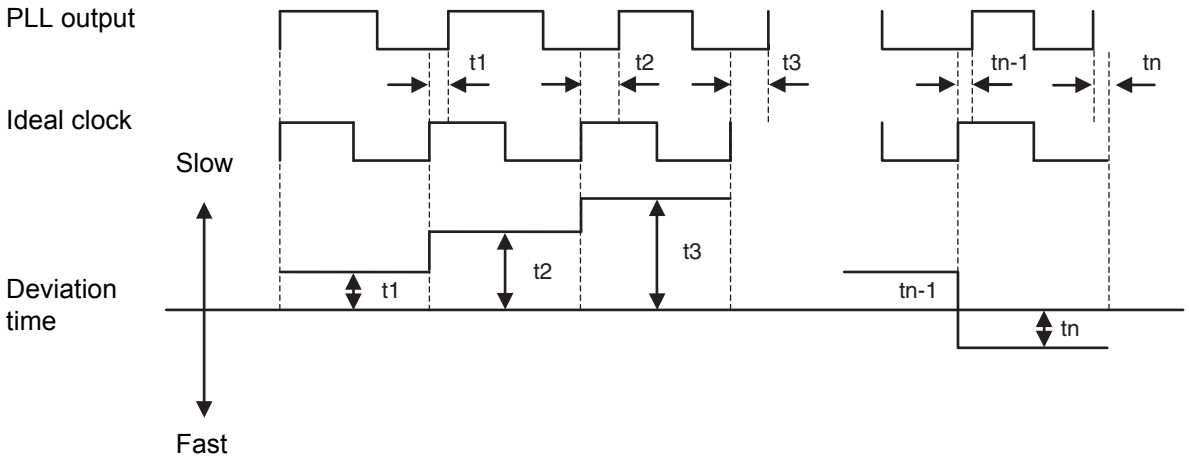


11.4.8 CAN PLL cycle jitter

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
CAN PLL cycle jitter (When locked)	t_{PJ}	—	—	− 10	—	+ 10	ns	F_{CP} = 16 MHz (4 MHz multiplied by 4) 24 MHz (4 MHz multiplied by 6) 32 MHz (4 MHz multiplied by 8)

- CAN PLL cycle jitter

Deviation time from the ideal clock is assured per cycle out of 20, 000 cycles.



11.5 A/D Converter

($3.0\ V \le AVR = AV_{SS}$)

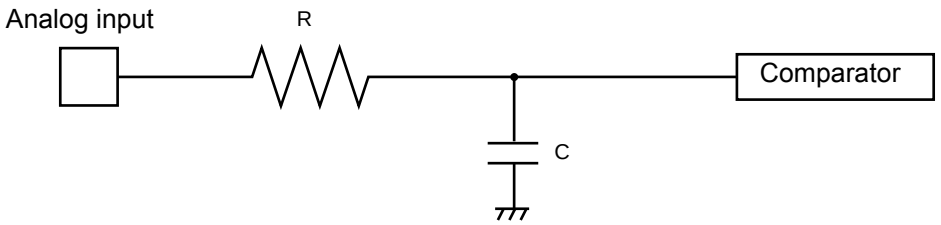
Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Resolution	—	—	—	—	10	bit	
Total error	—	—	—	—	±3.0	LSB	
Nonlinearity error	—	—	—	—	±2.5	LSB	
Differential nonlinearity error	—	—	—	—	±1.9	LSB	
Zero reading voltage	V_{OT}	AN0 to AN15	AV_{SS} – 1.5LSB	AV_{SS} + 0.5LSB	AV_{SS} + 2.5LSB	V	
Full scale reading voltage	V_{FST}	AN0 to AN15	AVR – 3.5LSB	AVR – 1.5LSB	AVR + 0.5LSB	V	
Compare time	—	—	0.66	—	16500	µs	$4.5\ V \le AV_{CC} \le 5.5\ V$
			2.2				$3.0\ V \le AV_{CC} < 4.5\ V$
Sampling time	—	—	0.4	—	∞	µs	$4.5\ V \le AV_{CC} \le 5.5\ V$
			1.0				$3.0\ V \le AV_{CC} <$ 4.5 V
Analog port input current	I_{AIN}	AN0 to AN15	– 3	—	+ 3	µA	
Analog input voltage range	V_{AIN}	AN0 to AN15	AV_{SS}	—	AVR	V	
Reference voltage range	—	AVR	AV_{SS} + 2.7	—	AV_{CC}	V	
Power supply current	I_A	AV_{CC}	—	3.5	7.5	mA	
	I_{AH}	AV_{CC}	—	—	5	µA	*
Reference voltage supply current	I_R	AVR	—	600	900	µA	
	I_{RH}	AVR	—	—	5	µA	*
Offset between input channels	—	AN0 to AN15	—	—	4	LSB	

* : If A/D converter is not operating, a current when CPU is stopped is applicable ($V_{CC} = AV_{CC} = AVR = 5.0\ V$) .

• About the external impedance of analog input and its sampling time

A/D converter with sample and hold circuit. If the external impedance is too high to keep sufficient sampling time, the analog voltage changed to the internal sample and hold capacitor is insufficient, adversely affecting A/D conversion precision. Therefore, to satisfy the A/D conversion precision standard, consider the relationship between the external impedance and minimum sampling time and either adjust the resistor value and operating frequency or decrease the external impedance so that the sampling time is longer than the minimum value. And, if the sampling time cannot be sufficient, connect a capacitor of about 0.1 µF to the analog input pin.

• Analog input equivalent circuit model

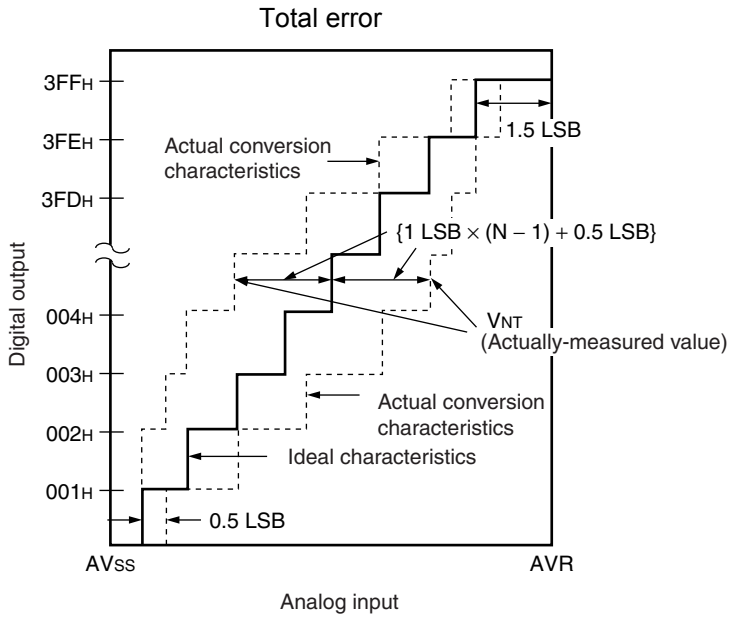


MB90V950AMAS	$4.5\ V \leq AV_{CC} \leq 5.5\ V$: R≒ 2.52 kΩ, C≒ 10.7 pF
	$4.0\ V \leq AV_{CC} < 4.5\ V$: R≒ 13.6 kΩ, C≒ 10.7 pF
MB90F912BS MB90911AS	$4.5\ V \leq AV_{CC} \leq 5.5\ V$: R≒ 4.1 kΩ, C≒ 8.5 pF
	$4.0\ V \leq AV_{CC} < 4.5\ V$: R≒ 10.33 kΩ, C≒ 8.5 pF

Note : The values are reference values.

11.6 Definition of A/D Converter Terms

Resolution	:	Analog variation that is recognized by an A/D converter.
Non linearity error	:	Deviation between a line across zero-transition line ("00 0000 0000_B" ← → "00 0000 0001_B") and full-scale transition line ("11 1111 1110_B" ← → "11 1111 1111_B") and actual conversion characteristics.
Differential linearity error	:	Deviation of input voltage, which is required for changing output code by 1 LSB, from an ideal value.
Total error	:	Difference between an actual value and an theoretical value. A total error includes zero transition error, full-scale transition error, and linear error.



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

$$1\ \text{LSB (Ideal value)} = \frac{AVR - AV_{SS}}{1024}\ [\text{V}]$$

N : A/D converter digital output value

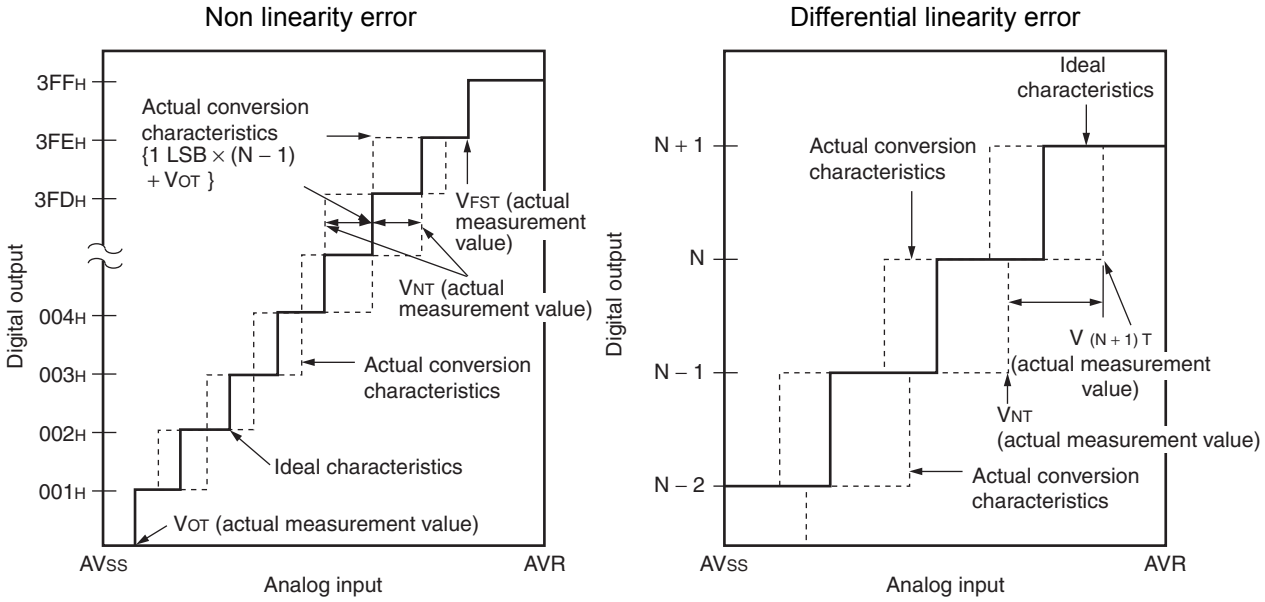
V_{OT} (Ideal value) $= AV_{SS} + 0.5$ LSB [V]

V_{FST} (Ideal value) $= AVR - 1.5$ LSB [V]

V_{NT} : A voltage at which digital output transits from $(N-1)_H$ to N_H.

(Continued)

(Continued)



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

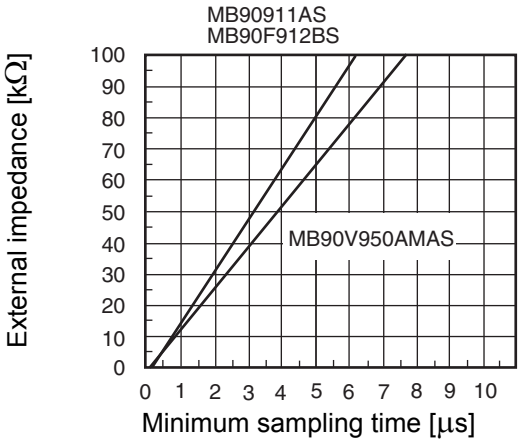
$$\text{Differential linearity error of digital output N} = \frac{V_{(N+1)T} - V_{NT}}{1\ \text{LSB}} - 1\ \text{LSB}\ [\text{LSB}]$$

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

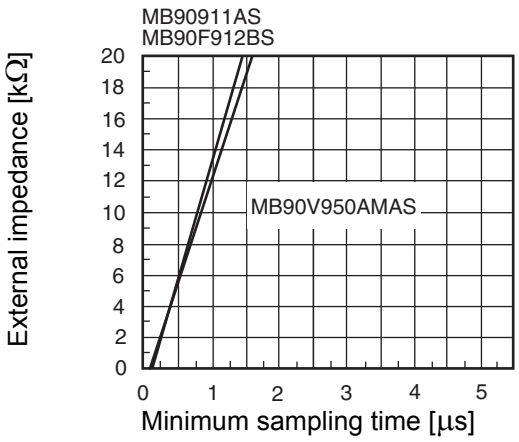
N : A/D converter digital output value
V_{OT} : Voltage at which digital output transits from "000_H" to "001_H."
V_{FST} : Voltage at which digital output transits from "$3FE_H$" to "$3FF_H$."

- The relationship between external impedance and minimum sampling time
  - At 4.5 V ≤ AV_{CC} ≤ 5.5 V

(External impedance = 0 kΩ to 100 kΩ)



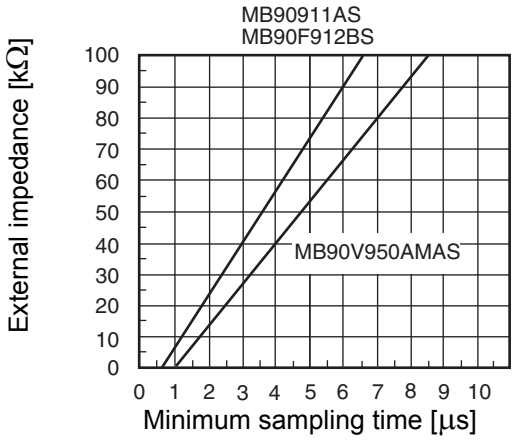
(External impedance = 0 kΩ to 20 kΩ)



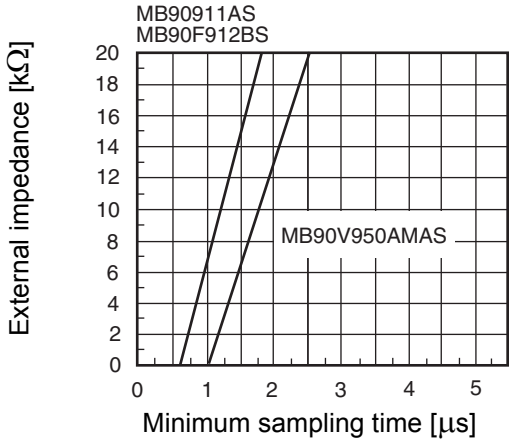
	Minimum sampling time [µs](4.5 V ≤ AVcc ≤ 5.5 V)		
External impedance [kΩ]	5	10	50
MB90911AS/MB90F912BS	0.54	0.84	3.22
MB90V950AMAS	0.56	0.94	3.93

  - At 3.0 V ≤ AV_{CC} < 4.5 V

(External impedance = 0 kΩ to 100 kΩ)



(External impedance = 0 kΩ to 20 kΩ)



	Minimum sampling time [µs] (3.0 V ≤ AVcc ≤ 4.5 V)		
External impedance [kΩ]	5	10	50
MB90911AS/MB90F912BS	0.91	1.21	3.59
MB90V950AMAS	1.39	1.77	4.76

- **About errors**

As | AVR − AV_{SS} | becomes smaller, values of relative errors grow larger.

11.7 Flash Memory Program/Erase Characteristics

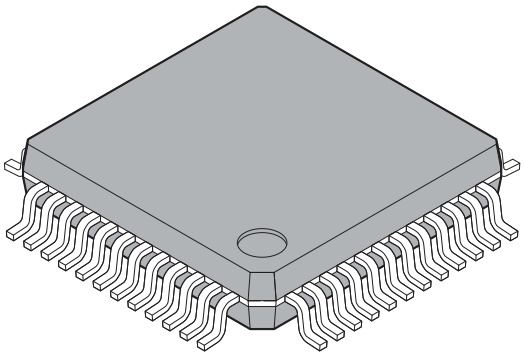
Parameter	Conditions	Value			Unit	Remarks
		Min	Typ	Max		
Sector erase time	T_A = + 25 °C V_{CC} = 5.0 V	—	0.9	3.6	s	Excludes programming prior to erasure
Chip erase time		—	5.4	21.6	s	
Byte (8-bit width) programming time		—	15	240	µs	Except for the overhead time of the system level
Word (16-bit width) programming time		—	23	370	µs	
Program/Erase cycle	T_A > +85 °C	10000	—	—	cycle	
	T_A ≤ +85 °C	100000	—	—	cycle	
Flash memory data retention time	Average T_A = +85 °C	20	—	—	year	*

* : Corresponding value comes from the technology reliability evaluation result (using Arrhenius equation to translate high temperature measurements into normalized value at +85 °C) .

12. Ordering Information

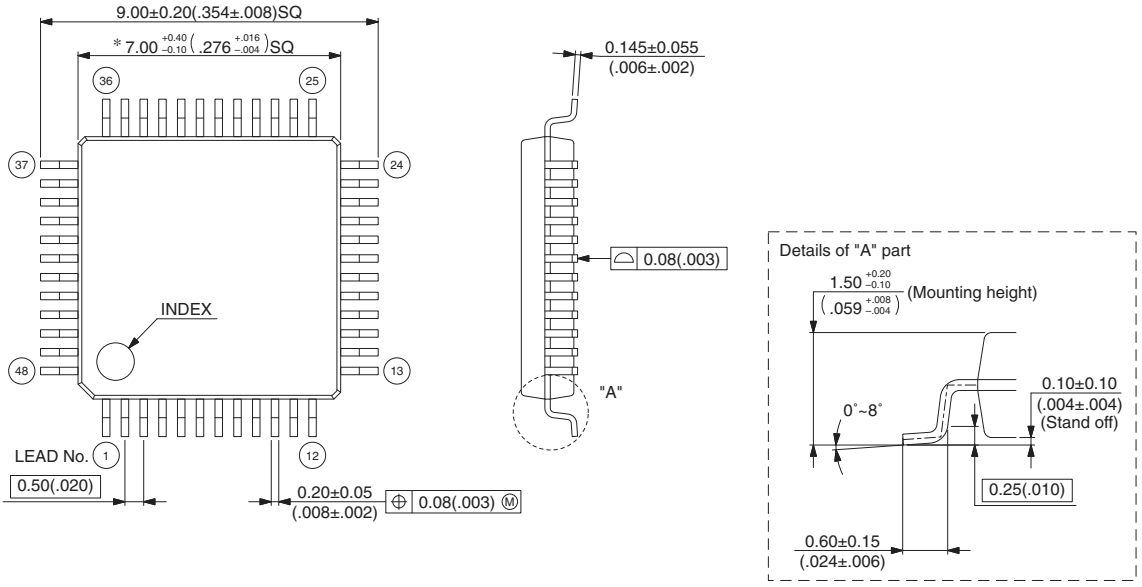
Part number	Package	Remarks
MB90F912BSPMC	48-pin plastic LQFP (FPT-48P-M26)	
MB90911ASPMC		
MB90V950AMASCR-ES	299-pin ceramic PGA (PGA-299C-A01)	For evaluation

13. Package Dimension

48-pin plastic LQFP		
	Lead pitch	0.50 mm
	Package width × package length	7 × 7 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.70 mm MAX
	Weight	0.17 g
(FPT-48P-M26)	Code (Reference)	P-LFQFP48-7×7-0.50

48-pin plastic LQFP
(FPT-48P-M26)

Note 1) * : These dimensions include resin protrusion.
Note 2) Pins width and pins thickness include plating thickness.
Note 3) Pins width do not include tie bar cutting remainder.



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

14. Major Changes

Section	Change Results
—	Changed the part number. MB90F912AS → MB90F912BS MB90V950MAS → MB90V950AMAS
Product Lineup MB90V950AMAS	Corrected the adapter boad. MB2147-20 Rev.04C → MB2147-20 Rev.04C or later
Pin Description Pin No.18,Pin No.19, Pin No.33 to Pin No.35,Pin No.36	Added the function as follows for pins P56, P57, P23 to P21, P20. (Different I/O circuit type from MB90V950AMAS).
I/O Circuit Types TypeC,TypeD	Added to the “Evaluation product” on remarks.
TypeK	Corrected the circuit. CMOS input → CMOS hysteresis input
TypeL	
Handling Devices	Added the item as follows. 3.Using external clock
Block Diagrams MB90V950AMAS	Corrected for the prescaler. 5 channels → 7 channels
Electrical Characteristics DC Characteristics Input “H” voltage	Corrected the pin V_{IHS}. “—” → P50, P82, P85 Corrected the pin V_{IHR}. “—” → $\overline{RST}$ Corrected the pin V_{IHM}. “—” → MD0 to MD2
Input “L” voltage	Corrected the pin V_{ILS}. “—” → P50,P82,P85 Corrected the pin V_{ILR}. “—”→ $\overline{RST}$ Corrected the pin V_{ILM}. “—” → MD0 to MD2
Output “H” voltage	Added to remarks of V_{OHI}. MASK ROM products and Evaluation products only
Output “L” voltage	Added to remarks of V_{OL}. MASK ROM products and Evaluation products only
Input leak current	Corrected the value. Min : − 1 → − 3 Max : + 1 → + 3
Pull-down resistance	Corrected the remark. MASK ROM products only → MASK ROM products and Evaluation products only
AC Characteristics Reset Standby Input	Changed the unit for “Oscillation time of oscillator*+ 100 µs” . ns → µs
CAN PLL cycle jitter	Added the item.

(Continued)

(Continued)

Section	Change Results
A/D Converter	Corrected the remark of “Compare time”. 4.5 V ≤ AV_{CC} → 4.5 V ≤ AV_{CC} ≤ 5.5 V 3.0 V ≤ AV_{CC} → 3.0 V ≤ AV_{CC} < 4.5 V
	Corrected the remark of “Sampling time”. 4.5 V ≤ AV_{CC} → 4.5 V ≤ AV_{CC} ≤ 5.5 V 3.0 V ≤ AV_{CC} → 3.0 V ≤ AV_{CC} < 4.5 V
	Changed the value of “Analog port input current ”. Min : − 0.3 → − 3 Max : + 0.3 → + 3
Ordering Information	Changed the part number. MB90F912ASPMC → MB90F912BSPMC MB90V950MASCR-ES → MB90V950AMASCR-ES

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

Document History

Document Title: MB90911AS/F912BS/V950AMAS F^2MC-16LX MB90910 Series 16-bit Microcontroller
Document Number: 002-04578

Revision	ECN	Orig. of Change	Submission Date	Description of Change
**	—	AKIH	06/04/2009	Migrated to Cypress and assigned document number 002-04578. No change to document contents or format.
*A	5218093	TAOA	04/12/2016	Updated to Cypress template

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