FUJITSU SEMICONDUCTOR
DATA SHEET

DS07-12601-3E

8-bit Proprietary Microcontrollers

CMOS

F²MC-8FX MB95100A Series

MB95107A/F108AS/F108AW/R107A/D108AS/ MB95D108AW/FV100B-101

■ DESCRIPTION

The MB95100A series is general-purpose, single-chip microcontrollers. In addition to a compact instruction set, the microcontrollers contain a variety of peripheral functions.

■ FEATURE

- F²MC-8FX CPU core
  Instruction set optimized for controllers
  - Multiplication and division instructions
  - 16-bit arithmetic operations
  - Bit test branch instruction
  - Bit manipulation instructions etc.
- Clock
  - Main clock
  - Main PLL clock
  - Sub clock (for dual clock product)
  - Sub PLL clock (for dual clock product)

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Be sure to refer to the “Check Sheet” for the latest cautions on development.

“Check Sheet” is seen at the following support page
URL : http://www.fujitsu.com/global/services/microelectronics/product/micom/support/index.html

“Check Sheet” lists the minimal requirement items to be checked to prevent problems beforehand in system development.

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- Timer
  - 8/16-bit compound timer × 2 channels
  - 16-bit reload timer
  - 8/16-bit PPG × 2 channels
  - 16-bit PPG × 2 channels
  - Timebase timer
  - Watch prescaler (for dual clock product)
- FRAM
  2K bytes FRAM is loaded (MB95R107A/MB95D108AS/MB95D108AW only)
- LIN-UART
  - Full duplex double buffer
  - Clock asynchronous or clock synchronous serial data transfer capable
- UART/SIO
  - Full duplex double buffer
  - Clock asynchronous or clock synchronous serial data transfer capable
- I^2C*
  Built-in wake-up function
- External interrupt
  - Interrupt by edge detection (rising, falling, or both edges can be selected)
  - Can be used to recover from low-power consumption (standby) modes.
- 8/10-bit A/D converter
  8-bit or 10-bit resolution can be selected.
- Low-power consumption (standby) mode
  - Stop mode
  - Sleep mode
  - Watch mode (for dual clock product)
  - Timebase timer mode
- I/O port
  - The number of maximum ports
    - Single clock product : 55 ports
    - Dual clock product : 53 ports
  - Port configuration
    - General-purpose I/O ports (N-ch open drain) : 6 ports
    - General-purpose I/O ports (CMOS) : Single-clock product : 49 ports
      Dual-clock product : 47 ports

* : Purchase of Fujitsu I^2C components conveys a license under the Philips I^2C Patent Rights to use, these components in an I^2C system provided that the system conforms to the I^2C Standard Specification as defined by Philips.

■ PRODUCT LINEUP

Parameter \ Part number		MB95107A	MB95F108AS/ MB95F108AW	MB95R107A*3	MB95D108AS/ MB95D108AW
Type		MASK ROM product	Flash memory product	MASK ROM product	Flash memory product
ROM capacity		48K bytes	60K bytes	48K bytes	60K bytes
RAM capacity		2K bytes			
FRAM capacity		No		2K bytes	
Reset output		No			
Option*4	Clock system	Selectable Single/Dual clock*1	Single/Dual clock*2	Selectable Single/Dual clock*1	Single/Dual clock*2
	Low voltage detection reset	No			
CPU functions		Number of basic instructions : 136 Instruction bit length : 8 bits Instruction length : 1 to 3 bytes Data bit length : 1, 8, and 16 bits Minimum instruction execution time : 0.1 µs (at machine clock frequency 10 MHz) Interrupt processing time : 0.9 µs (at machine clock frequency 10 MHz)			
Peripheral functions	General purpose I/O ports	• Single clock product : 55 ports (N-ch open drain : 6 ports, CMOS : 49 ports) • Dual clock product : 53 ports (N-ch open drain : 6 ports, CMOS : 47 ports)			
	Timebase timer	Interrupt cycle : 0.5 ms, 2.1 ms, 8.2 ms, 32.8 ms (at main oscillation clock 4 MHz)			
	Watchdog timer	Reset generated cycle At main oscillation clock 10 MHz : Min 105 ms At sub oscillation clock 32.768 kHz (for dual clock product) : Min 250 ms			
	Wild register	Capable of replacing 3 bytes of ROM data			
	I^2C	Master/slave sending and receiving Bus error function and arbitration function Detecting transmitting direction function Start condition repeated generation and detection functions Built-in wake-up function			
	UART/SIO	Data transfer capable in UART/SIO Full duplex double buffer, Variable data length (5/6/7/8-bit), built-in baud rate generator Transfer rate : 2400 bps to 1250000 bps (at machine clock 10 MHz) NRZ type transfer format, error detected function LSB-first or MSB-first can be selected. Clock synchronous (SIO) or clock asynchronous (UART) serial data transfer capable			
	LIN-UART	Dedicated reload timer allowing a wide range of communication speeds to be set. Full duplex double buffer. Capable of serial data transfer synchronous or asynchronous to clock signal. LIN functions available as the LIN master or LIN slave.			

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Parameter \ Part number		MB95107A	MB95F108AS/ MB95F108AW	MB95R107A*3	MB95D108AS/ MB95D108AW
Peripheral functions	8/10-bit A/D converter (12 channels)	8-bit or 10-bit resolution can be selected.			
	16-bit reload timer	Two clock modes and two counter operating modes can be selected. Square waveform output Count clock : 7 internal clocks and external clock can be selected. Counter operating mode : reload mode or one-shot mode can be selected.			
	8/16-bit compound timer (2 channels)	Each channel of the timer can be used as “8-bit timer × 2 channels” or “16-bit timer × 1 channel”. Built-in timer function, PWC function, PWM function, capture function and square wave-form output Count clock : 7 internal clocks and external clock can be selected.			
	16-bit PPG (2 channels)	PWM mode or one-shot mode can be selected. Counter operating clock : Eight selectable clock sources Support for external trigger start			
	8/16-bit PPG (2 channels)	Each channel of the PPG can be used as “8-bit PPG × 2 channels” or “16-bit PPG × 1 channel”. Counter operating clock : Eight selectable clock sources			
	Watch counter (for dual clock product)	Count clock : Four selectable clock sources (125 ms, 250 ms, 500 ms, or 1 s) Counter value can be set from 0 to 63. (Capable of counting for 1 minute when selecting clock source 1 second and setting counter value to 60)			
	Watch prescaler (for dual clock product)	4 selectable interval times (125 ms, 250 ms, 500 ms, or 1 s)			
	External interrupt (12 channels)	Interrupt by edge detection (rising, falling, or both edges can be selected.) Can be used to recover from standby modes.			
Standby mode		Sleep, stop, watch (for dual clock product), and timebase timer			

*1 : Specify clock mode when ordering MASK ROM.

*2 : MB95F108AS/MB95D108AS is single clock and MB95F108AW/MB95D108AW is dual clock.

*3 : This device is under development.

*4 : For details of option, refer to “■ MASK OPTION”.

Note : Part number of the evaluation device in MB95100A series is MB95FV100B-101. When using it, the MCU board (MB2146-301) is required.

■ SELECT OF OSCILLATION STABILIZATION WAIT TIME (MASK ROM PRODUCT ONLY)

For the MASK ROM product, you can set the mask option when ordering MASK ROM to select the initial value of main clock oscillation stabilization wait time from among the following four values.

Note that the evaluation and Flash memory products are fixed their initial value of main clock oscillation stabilization wait time at the maximum value.

Select of oscillation stabilization wait time	Remarks
$(2^2 - 2) /F_{CH}$	0.5 µs (at main oscillation clock 4 MHz)
$(2^{12} - 2) /F_{CH}$	Approx. 1.02 ms (at main oscillation clock 4 MHz)
$(2^{13} - 2) /F_{CH}$	Approx. 2.05 ms (at main oscillation clock 4 MHz)
$(2^{14} - 2) /F_{CH}$	Approx. 4.10 ms (at main oscillation clock 4 MHz)

■ PACKAGES AND CORRESPONDING PRODUCTS

Part number / Package	MB95107A MB95R107A	MB95F108AS MB95D108AS	MB95F108AW MB95D108AW	MB95FV100B-101
FPT-64P-M03	○	○	○	×
FPT-64P-M09	○	○	○	×
BGA-224P-M08	×	×	×	○

○ : Available
× : Unavailable

■ DIFFERENCES AMONG PRODUCTS AND NOTES ON SELECTING PRODUCTS

- Notes on Using Evaluation Products

  The evaluation product has not only the functions of the MB95100A series but also those of other products to support software development for multiple series and models of the F²MC-8FX family. The I/O addresses for peripheral resources not used by the MB95100A series are therefore access-barred. Read/write access to these access-barred addresses may cause peripheral resources supposed to be unused to operate, resulting in unexpected malfunctions of hardware or software.

  Particularly, do not use word access to odd numbered byte address in the prohibited areas (If these access are used, the address may be read or written unexpectedly).

  Note that the values read from barred addresses are different between the evaluation product and the Flash memory or MASK ROM product. Therefore, the data must not be used for software processing.

  The evaluation product do not support the functions of some bits in single-byte registers. Read/write access to these bits does not cause hardware malfunctions. The evaluation, Flash memory, and MASK ROM products are designed to behave completely the same way in terms of hardware and software.

- Difference of Memory Spaces

  If the amount of memory on the evaluation product is different from that of the Flash memory or MASK ROM product, carefully check the difference in the amount of memory from the model to be actually used when developing software.

  For details of memory space, refer to “■ CPU CORE”.

- Current Consumption

  The current consumption of Flash memory product is greater than for MASK ROM product.
  For details of current consumption, refer to “■ ELECTRICAL CHARACTERISTICS”.

- Package

  For details of information on each package, refer to “■ PACKAGES AND CORRESPONDING PRODUCTS” and “■ PACKAGE DIMENSIONS”.

- Operating voltage

  The operating voltage are different among the evaluation, Flash memory, and MASK ROM products.

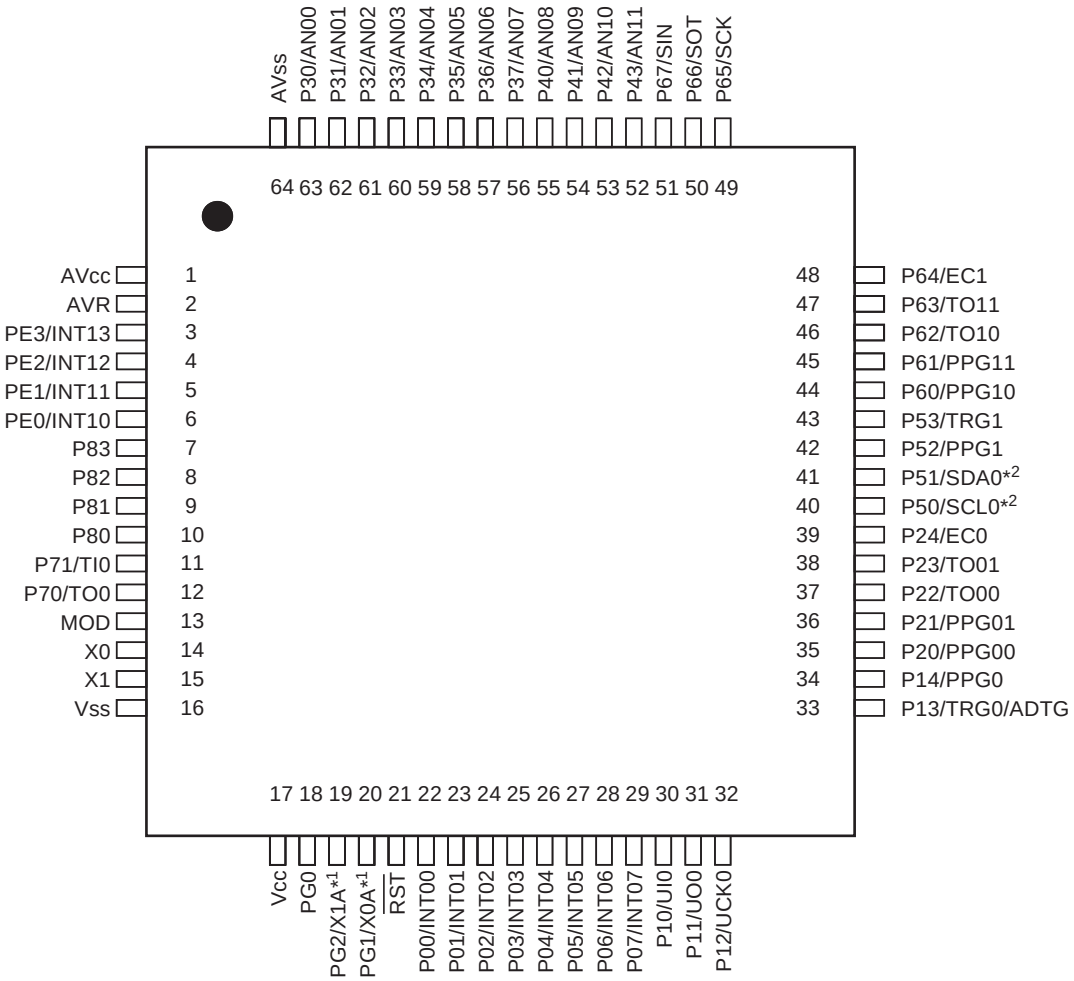
  For details of operating voltage, refer to “■ ELECTRICAL CHARACTERISTICS”.

- Difference between $\overline{\text{RST}}$ and MOD pins

  The input type of $\overline{\text{RST}}$ and MOD pins is CMOS input on the Flash memory product. The $\overline{\text{RST}}$ and MOD pins are hysteresis inputs on the MASK ROM product. A pull - down resistor is provided for the MOD pin of the MASK ROM product.

■ PIN ASSIGNMENT

(TOP VIEW)



(FPT-64P-M03, FPT-64P-M09)

*1 : Single clock product is general-purpose port, and dual clock product is sub clock oscillation pin.

*2 : P50 and P51 cannot be used in MB95R107A, MB95D108AS, and MB95D108AW.

■ PIN DESCRIPTION

Pin no.	Pin name	I/O circuit type*	Function
1	AV_{CC}	—	A/D converter power supply pin
2	AVR	—	A/D converter reference input pin
3	PE3/INT13	P	General-purpose I/O port The pins are shared with the external interrupt input.
4	PE2/INT12		
5	PE1/INT11		
6	PE0/INT10		
7	P83	O	General-purpose I/O port
8	P82		
9	P81		
10	P80		
11	P71/TI0	H	General-purpose I/O port. The pin is shared with 16 - bit reload timer ch.0 input.
12	P70/TO0		General-purpose I/O port. The pin is shared with 16 - bit reload timer ch.0 output.
13	MOD	B	An operating mode designation pin
14	X0	A	Main clock input oscillation pin
15	X1		Main clock input/output oscillation pin
16	V_{SS}	—	Power supply pin (GND)
17	V_{CC}	—	Power supply pin
18	PG0	H	General-purpose I/O port.
19	PG2/X1A	H/A	Single-system product is general-purpose port (PG2). Dual-system product is sub clock input/output oscillation pin (32 kHz).
20	PG1/X0A		Single-system product is general-purpose port (PG1). Dual-system product is sub clock input oscillation pin (32 kHz).
21	$\overline{RST}$	B’	Reset pin
22	P00/INT00	C	General-purpose I/O port. The pins are shared with external interrupt input. Large current port.
23	P01/INT01		
24	P02/INT02		
25	P03/INT03		
26	P04/INT04		
27	P05/INT05		
28	P06/INT06		
29	P07/INT07		
30	P10/UI0	G	General-purpose I/O port. The pin is shared with UART/SIO ch.0 data input.

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Pin no.	Pin name	I/O circuit type*	Function
31	P11/UO0	H	General-purpose I/O port. The pin is shared with UART/SIO ch.0 data output.
32	P12/UCK0		General-purpose I/O port. The pin is shared with UART/SIO ch.0 clock I/O.
33	P13/TRG0/ ADTG		General-purpose I/O port. The pin is shared with 16-bit PPG ch.0 trigger input (TRG0) and A/D trigger input (ADTG).
34	P14/PPG0		General-purpose I/O port. The pin is shared with 16-bit PPG ch.0 output.
35	P20/PPG00	H	General-purpose I/O port. The pins are shared with 8/16-bit PPG ch.0 output.
36	P21/PPG01		
37	P22/TO00		General-purpose I/O port. The pins are shared with 8/16-bit compound timer ch.0 output.
38	P23/TO01		
39	P24/EC0		General-purpose I/O port. The pin is shared with 8/16-bit compound timer ch.0 clock input.
40	P50/SCL0	I	General-purpose I/O port (Except MB95R107A, MB95D108AS, and MB95D108AW) . The pin is shared with I^2C ch.0 clock I/O.
41	P51/SDA0		General-purpose I/O port (Except MB95R107A, MB95D108AS, and MB95D108AW) . The pin is shared with I^2C ch.0 data I/O.
42	P52/PPG1	H	General-purpose I/O port. The pin is shared with 16-bit PPG ch.1 output.
43	P53/TRG1		General-purpose I/O port. The pin is shared with 16-bit PPG ch.1 trigger input.
44	P60/PPG10	K	General-purpose I/O port. The pins are shared with 8/16-bit PPG ch.1 output.
45	P61/PPG11		
46	P62/TO10		General-purpose I/O port. The pins are shared with 8/16-bit compound timer ch.1 output.
47	P63/TO11		
48	P64/EC1		General-purpose I/O port. The pin is shared with 8/16-bit compound timer ch.1 clock input.
49	P65/SCK		General-purpose I/O port. The pin is shared with LIN-UART clock I/O.
50	P66/SOT		General-purpose I/O port. The pin is shared with LIN-UART data output.
51	P67/SIN	L	General-purpose I/O port. The pin is shared with LIN-UART data input.

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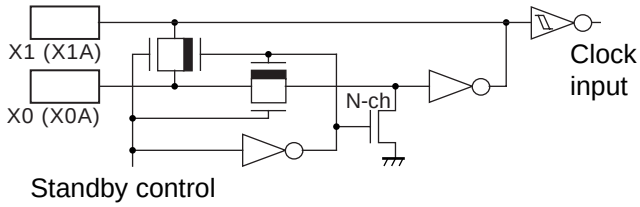
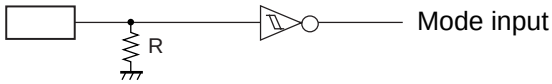
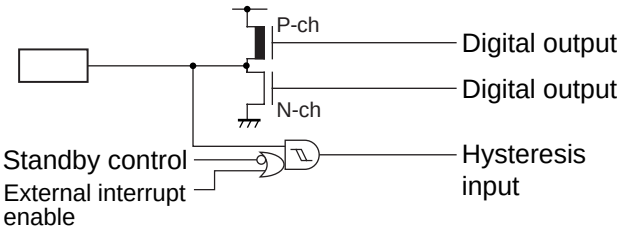
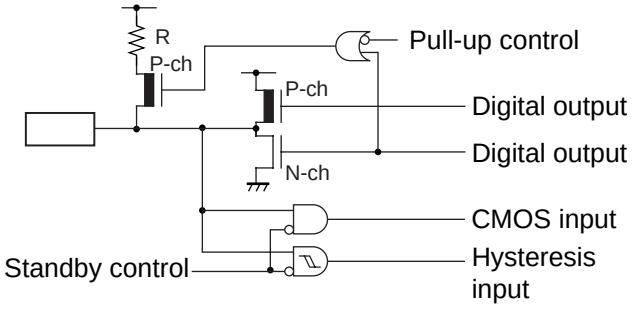
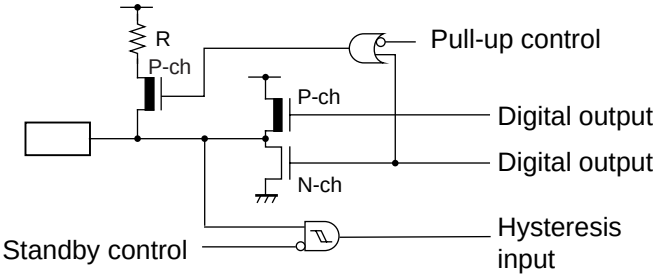
Pin no.	Pin name	I/O circuit type*	Function
52	P43/AN11	J	General-purpose I/O port. The pins are shared with A/D converter analog input.
53	P42/AN10		
54	P41/AN09		
55	P40/AN08		
56	P37/AN07	J	General-purpose I/O port. The pins are shared with A/D converter analog input.
57	P36/AN06		
58	P35/AN05		
59	P34/AN04		
60	P33/AN03		
61	P32/AN02		
62	P31/AN01		
63	P30/AN00		
64	AV_{SS}	—	A/D converter power supply pin (GND)

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

■ I/O CIRCUIT TYPE

Type	Circuit	Remarks
A		• Oscillation circuit • High-speed side Feedback resistance value : approx. 1 MΩ • Low-speed side Feedback resistance : approx. 24 MΩ (Evaluation product : approx. 10 MΩ) Dumping resistance : approx. 144 kΩ (Evaluation product : without dumping resistance)
B		• Only for input Hysteresis input only for MASK ROM product With pull-down resistor only for MASK ROM product
B’		• Hysteresis input only for MASK ROM product
C		• CMOS output • Hysteresis input
G		• CMOS output • CMOS input • Hysteresis input • With pull - up control
H		• CMOS output • Hysteresis input • With pull - up control

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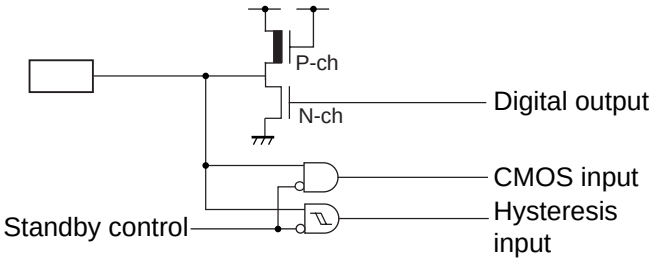
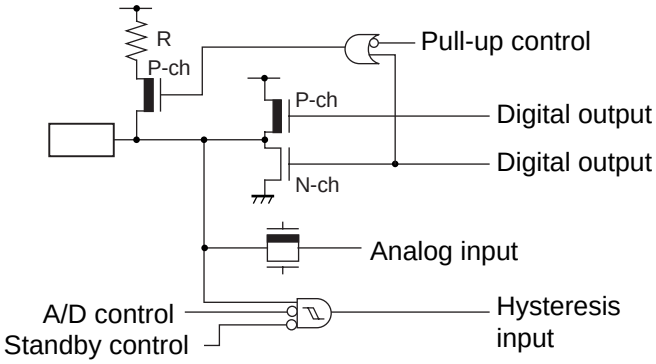
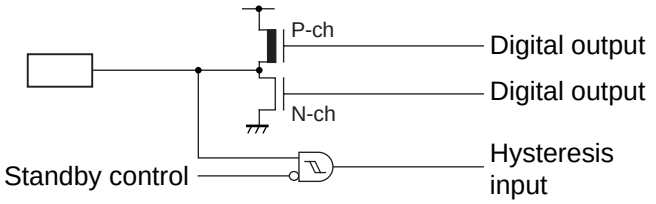
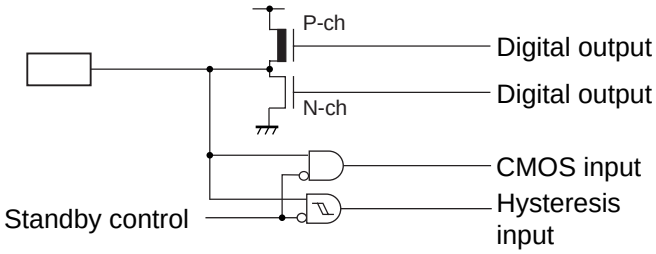
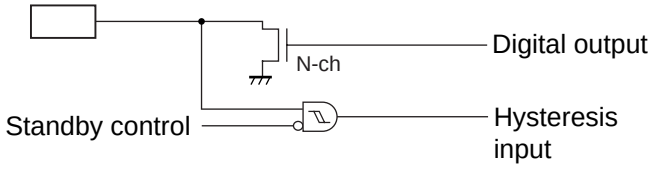
Type	Circuit	Remarks
I		• N-ch open drain output • CMOS input • Hysteresis input • P-ch transistor is existed in MB95D108AS, MB95D108AW, and MB95R107A.
J		• CMOS output • Hysteresis input • Analog input • With pull - up control
K		• CMOS output • Hysteresis input
L		• CMOS output • CMOS input • Hysteresis input
O		• N-ch open drain output • Hysteresis input

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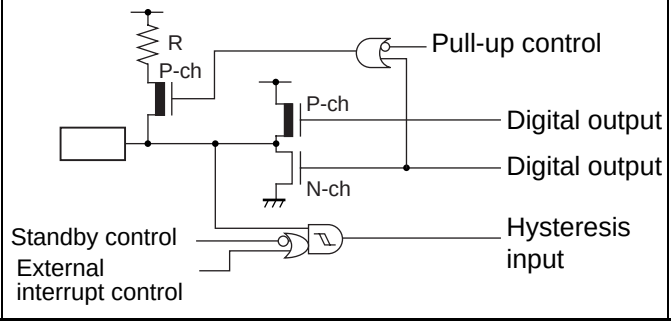
Type	Circuit	Remarks
P		• CMOS output • Hysteresis input • With pull - up control

■ CAUTION OF USING DEVICES

• Preventing Latch-up

Care must be taken to ensure that maximum voltage ratings are not exceeded when they are used.

Latch-up may occur on CMOS ICs if voltage higher than V_{CC} or lower than V_{SS} is applied to input and output pins other than medium- and high-withstand voltage pins or if higher than the rating voltage is applied between V_{CC} pin and V_{SS} pin.

When latch-up occurs, power supply current increases rapidly and might thermally damage elements.

Also, take care to prevent the analog power supply voltage (AV_{CC} , AVR) and analog input voltage from exceeding the digital power supply voltage (V_{CC}) when the analog system power supply is turned on or off.

• Stable Supply Voltage

Supply voltage should be stabilized.

A sudden change in power-supply voltage may cause a malfunction even within the guaranteed operating range of the V_{CC} power-supply voltage.

For stabilization, in principle, keep the variation in V_{CC} ripple (p-p value) in a commercial frequency range (50/60 Hz) not to exceed 10% of the standard V_{CC} value and suppress the voltage variation so that the transient variation rate does not exceed 0.1 V/ms during a momentary change such as when the power supply is switched.

• Precautions for Use of External Clock

Even when an external clock is used, oscillation stabilization wait time is required for power-on reset, wake-up from sub clock mode or stop mode.

■ PIN CONNECTION

• Treatment of Unused Pin

Leaving unused input pins unconnected can cause abnormal operation or latch-up, leaving to permanent damage.

Unused input pins should always be pulled up or down through resistance of at least 2 kΩ. Any unused input/output pins may be set to output mode and left open, or set to input mode and treated the same as unused input pins. If there is an unused output pin, make it open.

• Treatment of Power Supply Pins on A/D Converter

Connect to be $AV_{CC} = V_{CC}$ and $AV_{SS} = AVR = V_{SS}$ even if the A/D converter is not in use.
Noise riding on the AV_{CC} pin may cause accuracy degradation. So, connect approx. 0.1 µF ceramic capacitor as a bypass capacitor between AV_{CC} and AV_{SS} pins in the vicinity of this device.

• Power Supply Pins

In products with multiple V_{CC} or V_{SS} pins, the pins of the same potential are internally connected in the device to avoid abnormal operations including latch-up. However, you must connect the pins to external power supply 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 output current rating.

Moreover, connect the current supply source with the V_{CC} and V_{SS} pins of this device at the low impedance.

It is also advisable to connect a ceramic bypass capacitor of approximately 0.1 µF between V_{CC} and V_{SS} pins near this device.

- Mode Pin (MOD)

  Connect the mode pin directly to V_{CC} or V_{SS}.

  To prevent the device unintentionally entering the test mode due to noise, lay out the printed circuit board so as to minimize the distance from the mode pins to V_{CC} or V_{SS} and to provide a low-impedance connection.

- Analog Power Supply

  Always set the same potential to AV_{CC} and V_{CC} pins. When $V_{CC} > AV_{CC}$, the current may flow through the AN00 to AN11 pins.

- Precautions for Use of FRAM

  When the device is connected to I^2C external pins (SCL0 and SDA0) , the device with the same slave addresses (1010000_B to 1010111_B) as built-in FRAM cannot be used.

  When built-in FRAM is used without connecting the device to I^2C external pins, external pull-up resistor (1.1kΩ or more) should be connected to SCL0 and SDA0.

  P50 and P51 cannot be used in MB95R107A, MB95D108AS, and MB95D108AW.

■ PROGRAMMING FLASH MEMORY MICROCONTROLLERS USING PARALLEL PROGRAMMER

- **Supported Parallel Programmers and Adapters**

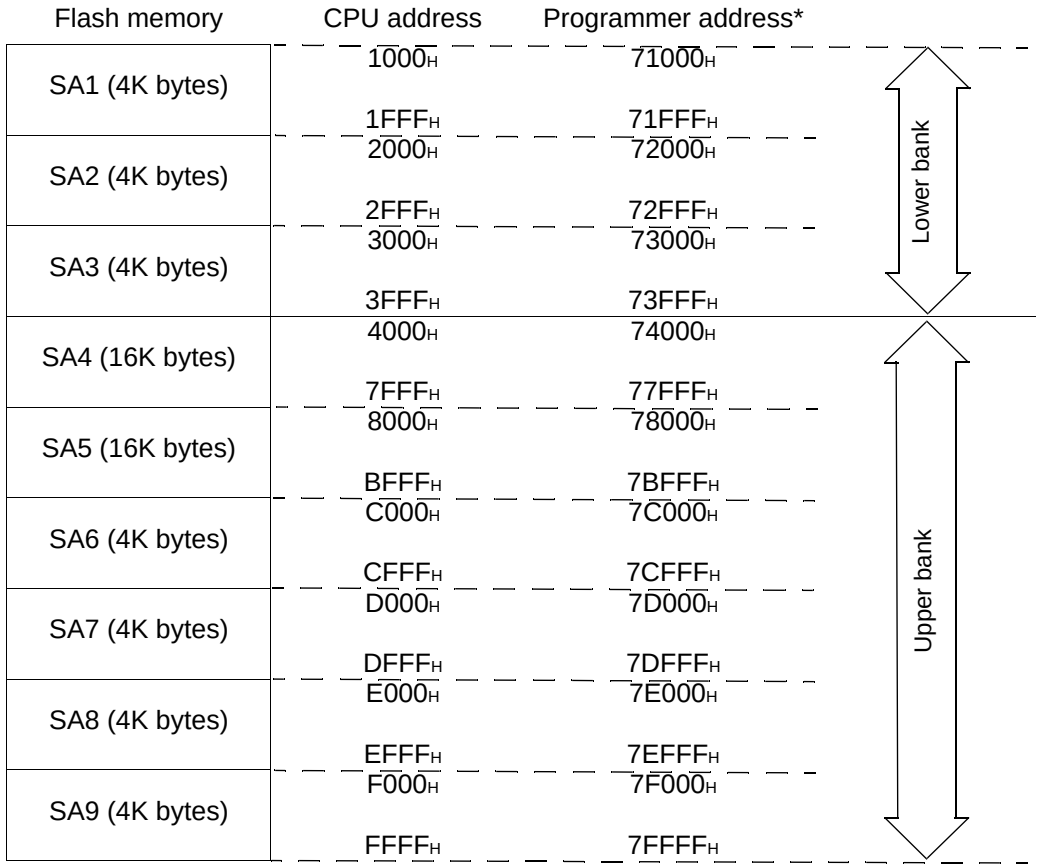
The following table lists supported parallel programmers and adapters.

Package	Applicable adapter model	Parallel programmers
FPT-64P-M03	TEF110-108F35AP	AF9708 (Ver 02.35G or more) AF9709/B (Ver 02.35G or more) AF9723+AF9834 (Ver 02.08E or more)
FPT-64P-M09	TEF110-108F36AP	

Note : For information on applicable adapter models and parallel programmers, contact the following:
Flash Support Group, Inc. TEL: +81-53-428-8380

- **Sector Configuration**

The individual sectors of flash memory correspond to addresses used for CPU access and programming by the parallel programmer as follows:



*: Programmer addresses are corresponding to CPU addresses, used when the parallel programmer programs data into flash memory.
These programmer addresses are used for the parallel programmer to program or erase data in flash memory.

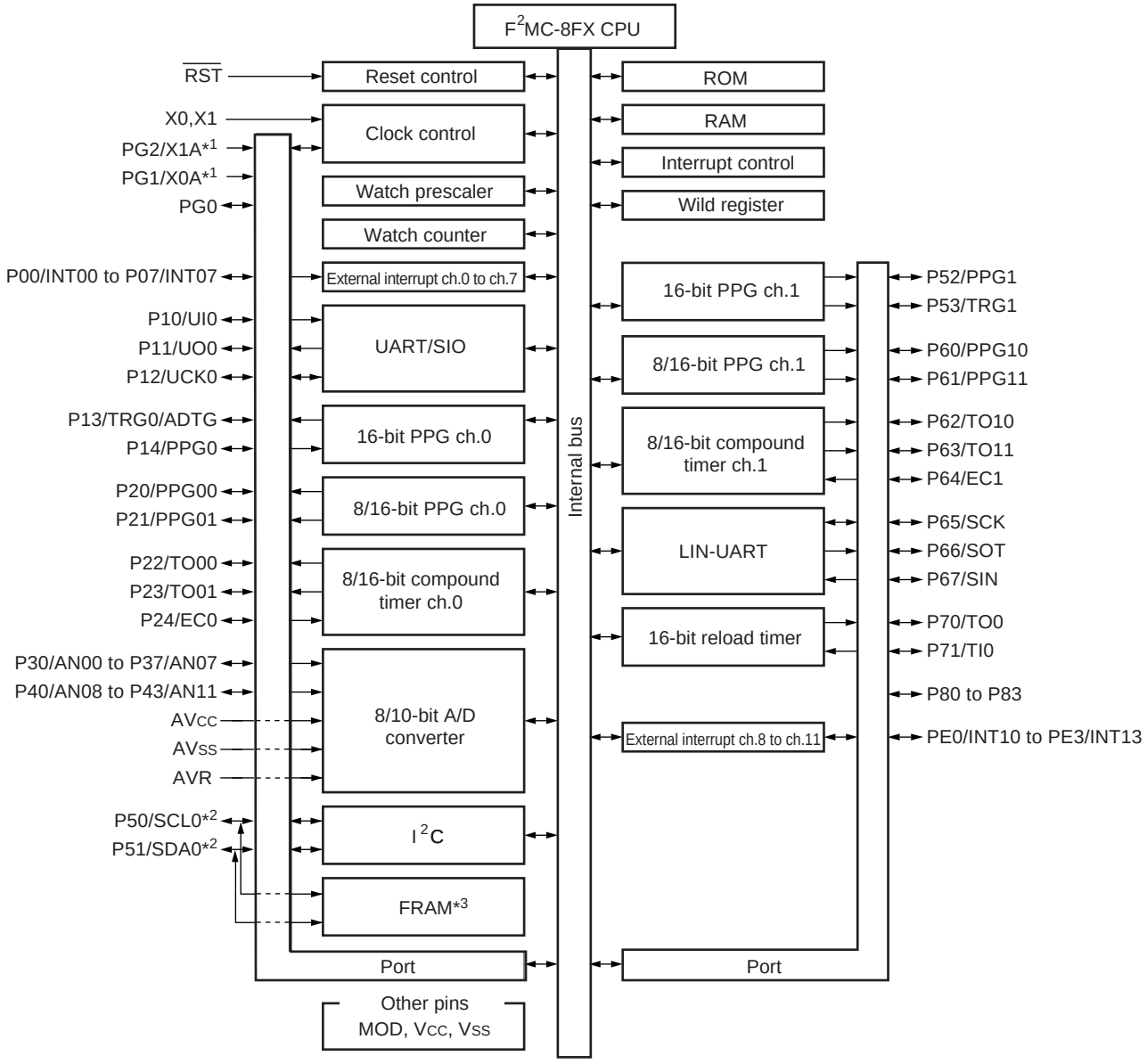
- **Programming Method**

1) Set the type code of the parallel programmer to 17226.

2) Load program data to parallel programmer addresses 71000H to 7FFFFH.

3) Programmed by parallel programmer

■ BLOCK DIAGRAM



*1 : Single clock product is general-purpose port, and dual clock product is sub clock oscillation pin.

*2 : P50 and P51 cannot be used in MB95R107A, MB95D108AS, and MB95D108AW.

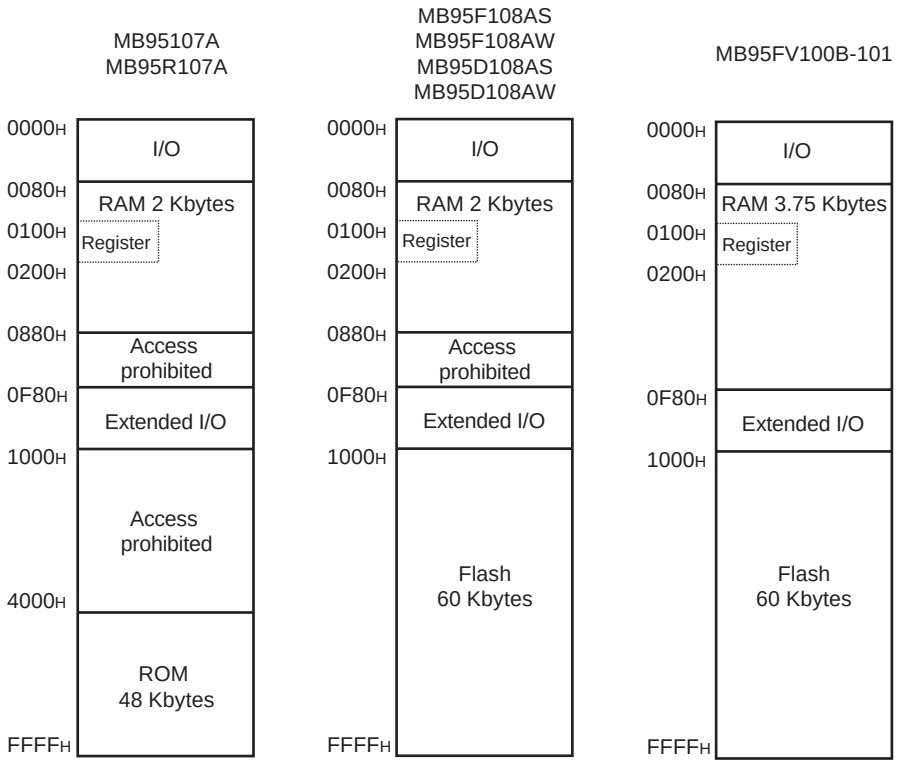
*3 : MB95R107A, MB95D108AS, and MB95D108AW only

■ CPU CORE

1. Memory space

Memory space of the MB95100A series is 64K bytes and consists of I/O area, data area, and program area. The memory space includes special - purpose areas such as the general - purpose registers and vector table. Memory map of the MB95100A series is shown below.

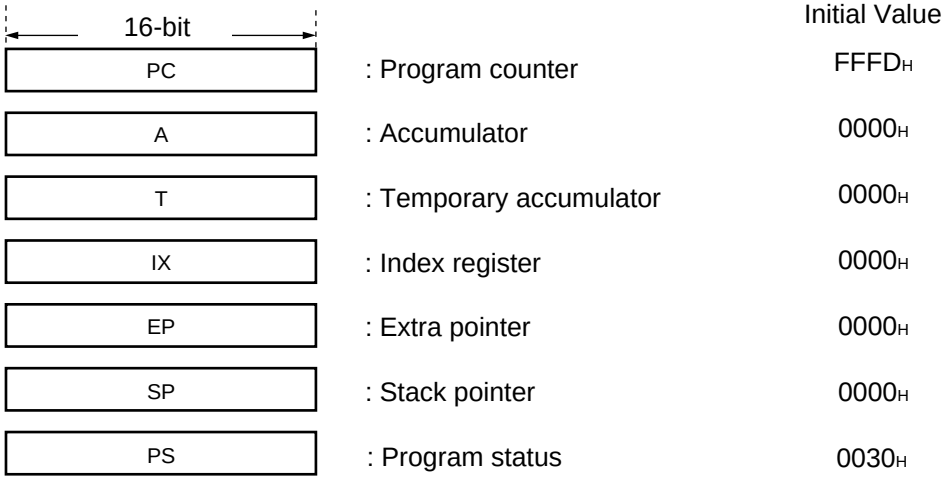
• Memory Map



2. Register

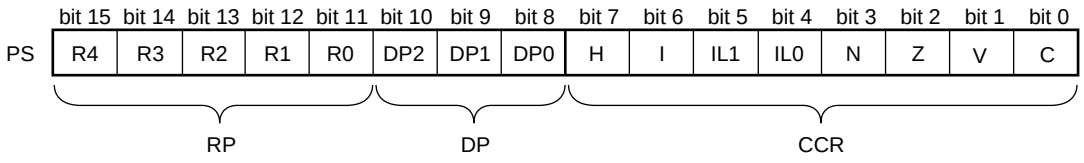
The MB95100A series has two types of registers; dedicated registers in the CPU and general-purpose registers in the memory. The dedicated registers are as follows:

Program counter (PC)	:	A 16-bit register to indicate locations where instructions are stored
Accumulator (A)	:	A 16-bit register for temporary storage of arithmetic operations. In the case of an 8-bit data processing instruction, the lower 1 byte is used.
Temporary accumulator (T)	:	A 16-bit register which performs arithmetic operations with the accumulator. In the case of an 8-bit data processing instruction, the lower 1 byte is used.
Index register (IX)	:	A 16-bit register for index modification
Extra pointer (EP)	:	A 16-bit pointer to point to a memory address
Stack pointer (SP)	:	A 16-bit register to indicate a stack area
Program status (PS)	:	A 16-bit register for storing a register bank pointer, a direct bank pointer, and a condition code register



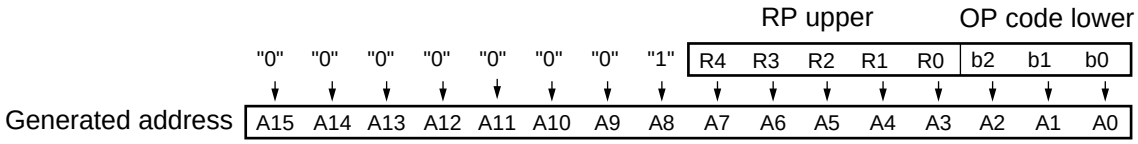
The PS can further be divided into higher 8 bits for use as a register bank pointer (RP) and a direct bank pointer (DP) and the lower 8 bits for use as a condition code register (CCR) . (See the diagram below.)

• Structure of the program status



The RP indicates the address of the register bank currently being used. The relationship between the content of RP and the real address conforms to the conversion rule illustrated below:

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



The DP specifies the area for mapping instructions (16 different instructions such as MOV A, dir) using direct addresses to 0080_H to $00FF_H$.

Direct bank pointer (DP2 to DP0)	Specified address area	Mapping area
XXX_B (no effect to mapping)	0000_H to $007F_H$	0000_H to $007F_H$ (without mapping)
000_B (initial value)	0080_H to $00FF_H$	0080_H to $00FF_H$ (without mapping)
001_B		0100_H to $017F_H$
010_B		0180_H to $01FF_H$
011_B		0200_H to $027F_H$
100_B		0280_H to $02FF_H$
101_B		0300_H to $037F_H$
110_B		0380_H to $03FF_H$
111_B		0400_H to $047F_H$

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

H flag : Set to “1” when a carry or a borrow from bit 3 to bit 4 occurs as a result of an arithmetic operation. Cleared to “0” otherwise. This flag is for decimal adjustment instructions.

I flag : Interrupt is enabled when this flag is set to “1”. Interrupt is disabled when this flag is set to “0”. The flag is cleared to “0” when reset.

IL1, IL0 : Indicates the level of the interrupt currently enabled. Processes an interrupt only if its request level is higher than the value indicated by these bits.

IL1	IL0	Interrupt level	Priority
0	0	0	High
0	1	1	↕
1	0	2	
1	1	3	Low = no interruption

N flag : Set to “1” if the MSB is set to “1” as the result of an arithmetic operation. Cleared to “0” when the bit is set to “0”.

Z flag : Set to “1” when an arithmetic operation results in “0”. Cleared to “0” otherwise.

V flag : Set to “1” if the complement on 2 overflows as a result of an arithmetic operation. Cleared to “0” otherwise.

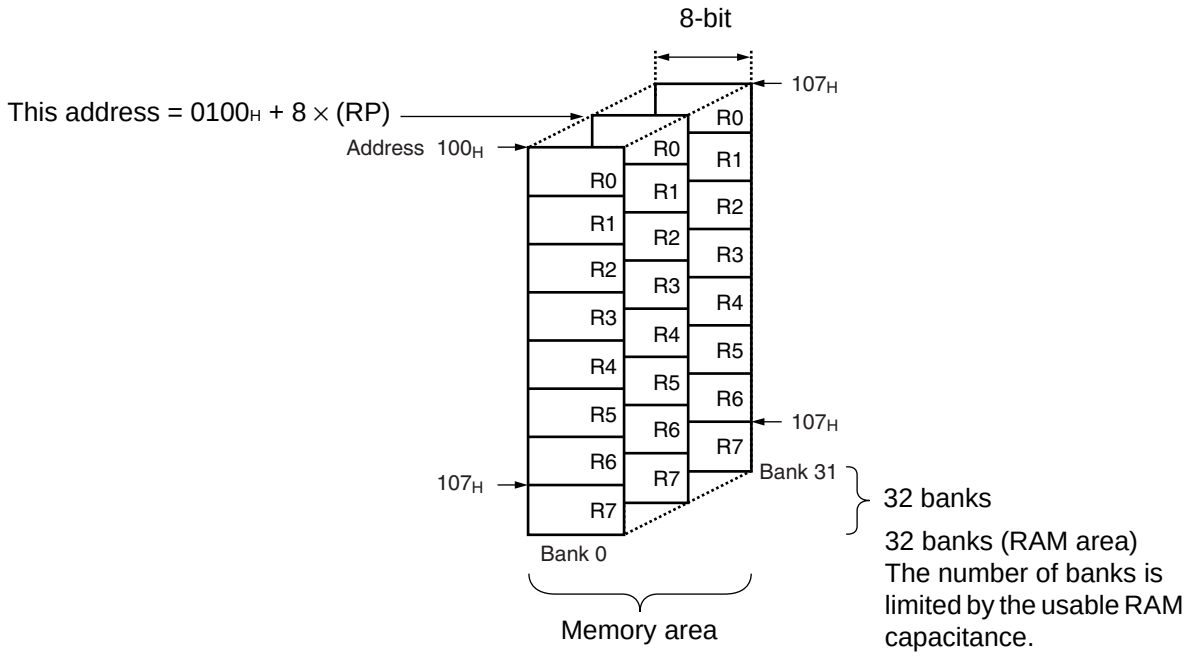
C flag : Set to “1” when a carry or a borrow from bit 7 occurs as a result of an arithmetic operation. Cleared to “0” otherwise. Set to the shift-out value in the case of a shift instruction.

The following general-purpose registers are provided:

General-purpose registers: 8-bit data storage registers

The general-purpose registers are 8 bits and located in the register banks on the memory. 1-bank contains 8-register. Up to a total of 32 banks can be used on the MB95100A series. The bank currently in use is specified by the register bank pointer (RP), and the lower 3 bits of OP code indicates the general-purpose register 0 (R0) to general-purpose register 7 (R7).

- Register Bank Configuration



■ FRAM

• **Slave address of FRAM**

FRAM operates as one of the slave devices connected to the I²C, and the I²C is used to read from or write to FRAM.
When data is transferred by the I²C, the slave address of FRAM is shown below.

Slave address (7 bits)					R/W bit (1 bit)
Slave ID (4 bits)				Page select bit* (3 bits)	
1	0	1	0	000_B : page 0 001_B : page 1 010_B : page 2 011_B : page 3 100_B : page 4 101_B : page 5 110_B : page 6 111_B : page 7	0 : at write 1 : at read

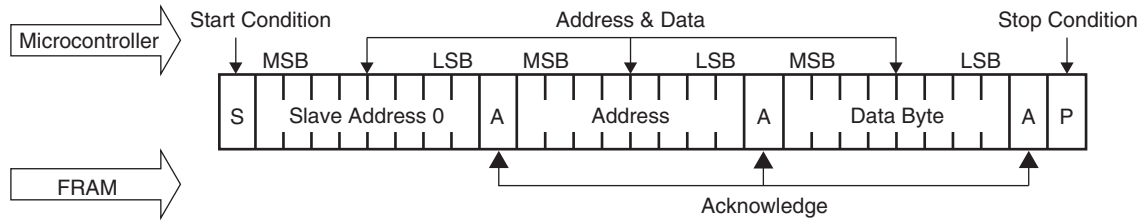
* : Page select bit : Set the value corresponding to the accessed page

• **Memory configuration of FRAM**

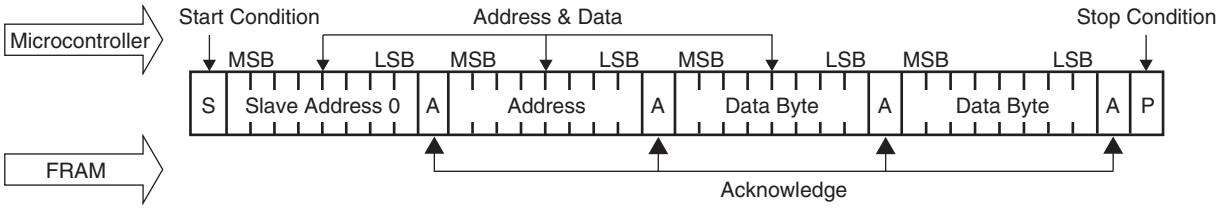
The capacitance of the built-in FRAM is 2 Kbytes. The memory configuration of FRAM consists of 8 pages as follows. The capacitance of each page is 256 bytes.

Page	Address	Capacitance
0	00_H to FF_H	256 bytes
1	00_H to FF_H	256 bytes
2	00_H to FF_H	256 bytes
3	00_H to FF_H	256 bytes
4	00_H to FF_H	256 bytes
5	00_H to FF_H	256 bytes
6	00_H to FF_H	256 bytes
7	00_H to FF_H	256 bytes

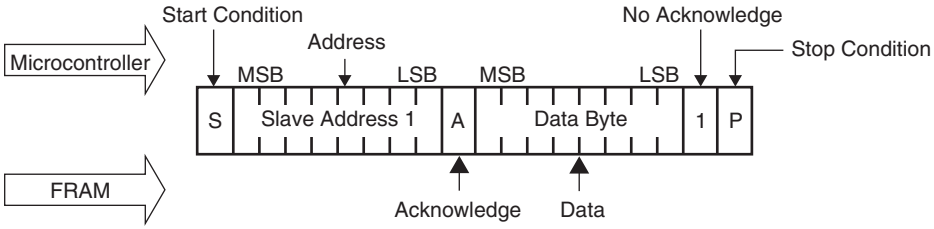
• Single byte write



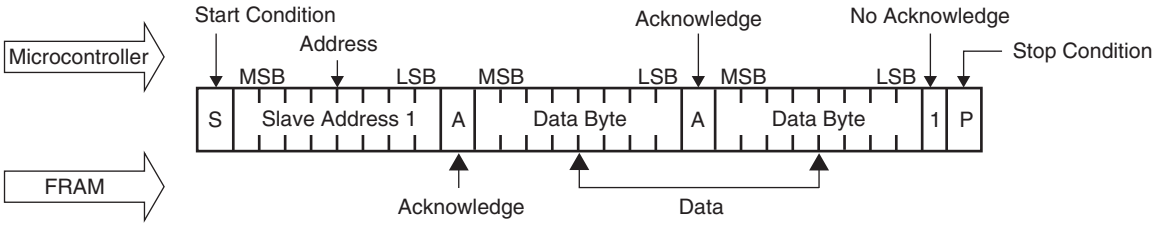
• Compound byte write



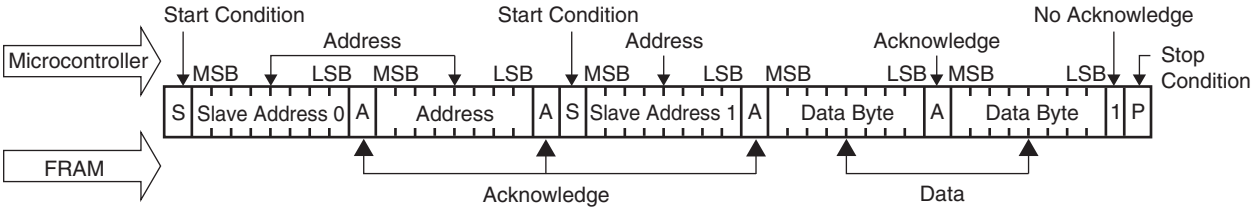
• Current address read



• Continuous address read



• Select (random) read



Notes :
- When the device is connected to I²C external pins (SCL0 and SDA0) , the device with the same addresses (1010000B to 1010111B) as built-in FRAM cannot be used.
- When FRAM is used without connecting the device built into the pull-up resistor to I²C external pins, external pull-up resistor (1.1 kΩ or more) should be connected to SCL0 and SDA0.
- P50 and P51 cannot be used in MB95R107A, MB95D108AS, and MB95D108AW.

■ I/O MAP

Address	Register abbreviation	Register name	R/W	Initial value
0000_H	PDR0	Port 0 data register	R/W	00000000_B
0001_H	DDR0	Port 0 direction register	R/W	00000000_B
0002_H	PDR1	Port 1 data register	R/W	00000000_B
0003_H	DDR1	Port 1 direction register	R/W	00000000_B
0004_H	—	(Disabled)	—	—
0005_H	WATR	Oscillation stabilization wait time setting register	R/W	11111111_B
0006_H	PLLC	PLL control register	R/W	00000000_B
0007_H	SYCC	System clock control register	R/W	$1010X011_B$
0008_H	STBC	Standby control register	R/W	00000000_B
0009_H	RSRR	Reset source register	R	$XXXXXXXX_B$
$000A_H$	TBTC	Timebase timer control register	R/W	0000000_B
$000B_H$	WPCR	Watch prescaler control register	R/W	00000000_B
$000C_H$	WDTC	Watchdog timer control register	R/W	00000000_B
$000D_H$	—	(Disabled)	—	—
$000E_H$	PDR2	Port 2 data register	R/W	00000000_B
$000F_H$	DDR2	Port 2 direction register	R/W	00000000_B
0010_H	PDR3	Port 3 data register	R/W	00000000_B
0011_H	DDR3	Port 3 direction register	R/W	00000000_B
0012_H	PDR4	Port 4 data register	R/W	00000000_B
0013_H	DDR4	Port 4 direction register	R/W	00000000_B
0014_H	PDR5	Port 5 data register	R/W	00000000_B
0015_H	DDR5	Port 5 direction register	R/W	00000000_B
0016_H	PDR6	Port 6 data register	R/W	00000000_B
0017_H	DDR6	Port 6 direction register	R/W	00000000_B
0018_H	PDR7	Port 7 data register	R/W	00000000_B
0019_H	DDR7	Port 7 direction register	R/W	00000000_B
$001A_H$	PDR8	Port 8 data register	R/W	00000000_B
$001B_H$	DDR8	Port 8 direction register	R/W	00000000_B
$001C_H$ to 0025_H	—	(Disabled)	—	—
0026_H	PDRE	Port E data register	R/W	00000000_B
0027_H	DDRE	Port E direction register	R/W	00000000_B
0028_H, 0029_H	—	(Disabled)	—	—
$002A_H$	PDRG	Port G data register	R/W	00000000_B

(Continued)

Address	Register abbreviation	Register name	R/W	Initial value
002B$_H$	DDRG	Port G direction register	R/W	00000000$_B$
002C$_H$	—	(Disabled)	—	—
002D$_H$	PUL1	Port 1 pull - up register	R/W	00000000$_B$
002E$_H$	PUL2	Port 2 pull - up register	R/W	00000000$_B$
002F$_H$	PUL3	Port 3 pull - up register	R/W	00000000$_B$
0030$_H$	PUL4	Port 4 pull - up register	R/W	00000000$_B$
0031$_H$	PUL5	Port 5 pull - up register	R/W	00000000$_B$
0032$_H$	PUL7	Port 7 pull - up register	R/W	00000000$_B$
0033$_H$	—	(Disabled)	—	—
0034$_H$	PULE	Port E pull - up register	R/W	00000000$_B$
0035$_H$	PULG	Port G pull - up register	R/W	00000000$_B$
0036$_H$	T01CR1	8/16-bit compound timer 01 control status register 1 ch.0	R/W	00000000$_B$
0037$_H$	T00CR1	8/16-bit compound timer 00 control status register 1 ch.0	R/W	00000000$_B$
0038$_H$	T11CR1	8/16-bit compound timer 11 control status register 1 ch.1	R/W	00000000$_B$
0039$_H$	T10CR1	8/16-bit compound timer 10 control status register 1 ch.1	R/W	00000000$_B$
003A$_H$	PC01	8/16-bit PPG1 control register ch.0	R/W	00000000$_B$
003B$_H$	PC00	8/16-bit PPG0 control register ch.0	R/W	00000000$_B$
003C$_H$	PC11	8/16-bit PPG1 control register ch.1	R/W	00000000$_B$
003D$_H$	PC10	8/16-bit PPG0 control register ch.1	R/W	00000000$_B$
003E$_H$	TMCSRH0	16-bit reload timer control status register (Upper byte) ch.0	R/W	00000000$_B$
003F$_H$	TMCSRL0	16-bit reload timer control status register (Lower byte) ch.0	R/W	00000000$_B$
0040$_H$, 0041$_H$	—	(Disabled)	—	—
0042$_H$	PCNTH0	16-bit PPG control status register (Upper byte) ch.0	R/W	00000000$_B$
0043$_H$	PCNTL0	16-bit PPG control status register (Lower byte) ch.0	R/W	00000000$_B$
0044$_H$	PCNTH1	16-bit PPG control status register (Upper byte) ch.1	R/W	00000000$_B$
0045$_H$	PCNTL1	16-bit PPG control status register (Lower byte) ch.1	R/W	00000000$_B$
0046$_H$, 0047$_H$	—	(Disabled)	—	—
0048$_H$	EIC00	External interrupt circuit control register ch.0/ch.1	R/W	00000000$_B$
0049$_H$	EIC10	External interrupt circuit control register ch.2/ch.3	R/W	00000000$_B$
004A$_H$	EIC20	External interrupt circuit control register ch.4/ch.5	R/W	00000000$_B$
004B$_H$	EIC30	External interrupt circuit control register ch.6/ch.7	R/W	00000000$_B$
004C$_H$	EIC01	External interrupt circuit control register ch.8/ch.9	R/W	00000000$_B$
004D$_H$	EIC11	External interrupt circuit control register ch10/ch.11	R/W	00000000$_B$

(Continued)

Address	Register abbreviation	Register name	R/W	Initial value
004E$_H$, 004F$_H$	—	(Disabled)	—	—
0050$_H$	SCR	LIN-UART serial control register	R/W	00000000$_B$
0051$_H$	SMR	LIN-UART serial mode register	R/W	00000000$_B$
0052$_H$	SSR	LIN-UART serial status register	R/W	00001000$_B$
0053$_H$	RDR/TDR	LIN-UART reception/transmission data register	R/W	00000000$_B$
0054$_H$	ESCR	LIN-UART extended status control register	R/W	00000100$_B$
0055$_H$	ECCR	LIN-UART extended communication control register	R/W	000000XX$_B$
0056$_H$	SMC10	UART/SIO serial mode control register 1 ch.0	R/W	00000000$_B$
0057$_H$	SMC20	UART/SIO serial mode control register 2 ch.0	R/W	00100000$_B$
0058$_H$	SSR0	UART/SIO serial status register ch.0	R/W	00000001$_B$
0059$_H$	TDR0	UART/SIO serial output data register ch.0	R/W	00000000$_B$
005A$_H$	RDR0	UART/SIO serial input data register ch.0	R	00000000$_B$
005B$_H$ to 005F$_H$	—	(Disabled)	—	—
0060$_H$	IBCR00	I^{2}C bus control register 0 ch.0	R/W	00000000$_B$
0061$_H$	IBCR10	I^{2}C bus control register 1 ch.0	R/W	00000000$_B$
0062$_H$	IBSR0	I^{2}C bus status register ch.0	R	00000000$_B$
0063$_H$	IDDR0	I^{2}C data register ch.0	R/W	00000000$_B$
0064$_H$	IAAR0	I^{2}C address register ch.0	R/W	00000000$_B$
0065$_H$	ICCR0	I^{2}C clock control register ch.0	R/W	00000000$_B$
0066$_H$ to 006B$_H$	—	(Disabled)	—	—
006C$_H$	ADC1	8/10-bit A/D converter control register 1	R/W	00000000$_B$
006D$_H$	ADC2	8/10-bit A/D converter control register 2	R/W	00000000$_B$
006E$_H$	ADDH	8/10-bit A/D converter data register (Upper byte)	R/W	00000000$_B$
006F$_H$	ADDL	8/10-bit A/D converter data register (Lower byte)	R/W	00000000$_B$
0070$_H$	WCSR	Watch counter status register	R/W	00000000$_B$
0071$_H$	—	(Disabled)	—	—
0072$_H$	FSR	FLASH memory status register	R/W	000X0000$_B$
0073$_H$	SWRE0	FLASH memory sector writing control register 0	R/W	00000000$_B$
0074$_H$	SWRE1	FLASH memory sector writing control register 1	R/W	00000000$_B$
0075$_H$	—	(Disabled)	—	—
0076$_H$	WREN	Wild register address compare enable register	R/W	00000000$_B$
0077$_H$	WROR	Wild register data test setting register	R/W	00000000$_B$

(Continued)

Address	Register abbreviation	Register name	R/W	Initial value
0078H	—	Mirror of register bank pointer (RP) and direct bank pointer (DP)	—	—
0079H	ILR0	Interrupt level setting register 0	R/W	11111111B
007AH	ILR1	Interrupt level setting register 1	R/W	11111111B
007BH	ILR2	Interrupt level setting register 2	R/W	11111111B
007CH	ILR3	Interrupt level setting register 3	R/W	11111111B
007DH	ILR4	Interrupt level setting register 4	R/W	11111111B
007EH	ILR5	Interrupt level setting register 5	R/W	11111111B
007FH	—	(Disabled)	—	—
0F80H	WRARH0	Wild register address setting register (Upper byte) ch.0	R/W	00000000B
0F81H	WRARL0	Wild register address setting register (Lower byte) ch.0	R/W	00000000B
0F82H	WRDR0	Wild register data setting register ch.0	R/W	00000000B
0F83H	WRARH1	Wild register address setting register (Upper byte) ch.1	R/W	00000000B
0F84H	WRARL1	Wild register address setting register (Lower byte) ch.1	R/W	00000000B
0F85H	WRDR1	Wild register data setting register ch.1	R/W	00000000B
0F86H	WRARH2	Wild register address setting register (Upper byte) ch.2	R/W	00000000B
0F87H	WRARL2	Wild register address setting register (Lower byte) ch.2	R/W	00000000B
0F88H	WRDR2	Wild register data setting register ch.2	R/W	00000000B
0F89H to 0F91H	—	(Disabled)	—	—
0F92H	T01CR0	8/16-bit compound timer 01 control status register 0 ch.0	R/W	00000000B
0F93H	T00CR0	8/16-bit compound timer 00 control status register 0 ch.0	R/W	00000000B
0F94H	T01DR	8/16-bit compound timer 01 data register ch.0	R/W	00000000B
0F95H	T00DR	8/16-bit compound timer 00 data register ch.0	R/W	00000000B
0F96H	TMCR0	8/16-bit compound timer 00/01 timer mode control register ch.0	R/W	00000000B
0F97H	T11CR0	8/16-bit compound timer 11 control status register 0 ch.1	R/W	00000000B
0F98H	T10CR0	8/16-bit compound timer 10 control status register 0 ch.1	R/W	00000000B
0F99H	T11DR	8/16-bit compound timer 11 data register ch.1	R/W	00000000B
0F9AH	T10DR	8/16-bit compound timer 10 data register ch.1	R/W	00000000B
0F9BH	TMCR1	8/16-bit compound timer 10/11 timer mode control register ch.1	R/W	00000000B
0F9CH	PPS01	8/16-bit PPG1 cycle setting buffer register ch.0	R/W	11111111B
0F9DH	PPS00	8/16-bit PPG0 cycle setting buffer register ch.0	R/W	11111111B
0F9EH	PDS01	8/16-bit PPG1 duty setting buffer register ch.0	R/W	11111111B
0F9FH	PDS00	8/16-bit PPG0 duty setting buffer register ch.0	R/W	11111111B

(Continued)

Address	Register abbreviation	Register name	R/W	Initial value
0FA0H	PPS11	8/16-bit PPG1 cycle setting buffer register ch.1	R/W	11111111B
0FA1H	PPS10	8/16-bit PPG0 cycle setting buffer register ch.1	R/W	11111111B
0FA2H	PDS11	8/16-bit PPG1 duty setting buffer register ch.1	R/W	11111111B
0FA3H	PDS10	8/16-bit PPG0 duty setting buffer register ch.1	R/W	11111111B
0FA4H	PPGS	8/16-bit PPG start register	R/W	00000000B
0FA5H	REVC	8/16-bit PPG output inversion register	R/W	00000000B
0FA6H	TMRH0/ TMRLRH0	16-bit timer register (Upper byte) ch.0/ 16-bit reload register (Upper byte) ch.0	R/W	00000000B
0FA7H	TMRL0/ TMRLRL0	16-bit timer register (Lower byte) ch.0/ 16-bit reload register (Lower byte) ch.0	R/W	00000000B
0FA8H, 0FA9H	—	(Disabled)	—	—
0FAAH	PDCRH0	16-bit PPG down counter register (Upper byte) ch.0	R	00000000B
0FABH	PDCRL0	16-bit PPG down counter register (Lower byte) ch.0	R	00000000B
0FACH	PCSRH0	16-bit PPG cycle setting buffer register (Upper byte) ch.0	R/W	11111111B
0FADH	PCSRL0	16-bit PPG cycle setting buffer register (Lower byte) ch.0	R/W	11111111B
0FAEH	PDUTH0	16-bit PPG duty setting buffer register (Upper byte) ch.0	R/W	11111111B
0FAFH	PDUTL0	16-bit PPG duty setting buffer register (Lower byte) ch.0	R/W	11111111B
0FB0H	PDCRH1	16-bit PPG down counter register (Upper byte) ch.1	R	00000000B
0FB1H	PDCRL1	16-bit PPG down counter register (Lower byte) ch.1	R	00000000B
0FB2H	PCSRH1	16-bit PPG cycle setting buffer register (Upper byte) ch.1	R/W	11111111B
0FB3H	PCSRL1	16-bit PPG cycle setting buffer register (Lower byte) ch.1	R/W	11111111B
0FB4H	PDUTH1	16-bit PPG duty setting buffer register (Upper byte) ch.1	R/W	11111111B
0FB5H	PDUTL1	16-bit PPG duty setting buffer register (Lower byte) ch.1	R/W	11111111B
0FB6H to 0FBBH	—	(Disabled)	—	—
0FBCH	BGR1	LIN-UART baud rate generator register 1	R/W	00000000B
0FBDH	BGR0	LIN-UART baud rate generator register 0	R/W	00000000B
0FBEH	PSSR0	UART/SIO dedicated baud rate generator prescaler select register ch.0	R/W	00000000B
0FBFH	BRSR0	UART/SIO dedicated baud rate generator baud rate setting register ch.0	R/W	00000000B
0FC0H, 0FC1H	—	(Disabled)	—	—
0FC2H	AIDRH	A/D input disable register (Upper byte)	R/W	00000000B
0FC3H	AIDRL	A/D input disable register (Lower byte)	R/W	00000000B

(Continued)

(Continued)

Address	Register abbreviation	Register name	R/W	Initial value
0FC4H to 0FE2H	—	(Disabled)	—	—
0FE3H	WCDR	Watch counter data register	R/W	00111111B
0FE4H to 0FEDH	—	(Disabled)	—	—
0FEEH	ILSR	Input level select register	R/W	00000000B
0FEFH	WICR	Interrupt pin control register	R/W	01000000B
0FF0H to 0FFFH	—	(Disabled)	—	—

• R/W access symbols
  R/W : Readable/Writable
  R : Read only
  W : Write only

• Initial value symbols
  0 : The initial value of this bit is “0”.
  1 : The initial value of this bit is “1”.
  X : The initial value of this bit is undefined.

Note : Do not write to the “ (Disabled) ”. Reading the “ (Disabled) ” returns an undefined value.

■ INTERRUPT SOURCE TABLE

Interrupt source	Interrupt request number	Vector table address		Bit name of interrupt level setting register	Same level priority order (at simultaneous occurrence)
		Upper	Lower		
External interrupt ch.0	IRQ0	FFFA$_H$	FFFB$_H$	L00 [1 : 0]	High
External interrupt ch.4					
External interrupt ch.1	IRQ1	FFF8$_H$	FFF9$_H$	L01 [1 : 0]	
External interrupt ch.5					
External interrupt ch.2	IRQ2	FFF6$_H$	FFF7$_H$	L02 [1 : 0]	
External interrupt ch.6					
External interrupt ch.3	IRQ3	FFF4$_H$	FFF5$_H$	L03 [1 : 0]	
External interrupt ch.7					
UART/SIO ch.0	IRQ4	FFF2$_H$	FFF3$_H$	L04 [1 : 0]	
8/16-bit compound timer ch.0 (Lower)	IRQ5	FFF0$_H$	FFF1$_H$	L05 [1 : 0]	
8/16-bit compound timer ch.0 (Upper)	IRQ6	FFEE$_H$	FFEF$_H$	L06 [1 : 0]	
LIN-UART (reception)	IRQ7	FFEC$_H$	FFED$_H$	L07 [1 : 0]	
LIN-UART (transmission)	IRQ8	FFEA$_H$	FFEB$_H$	L08 [1 : 0]	
8/16-bit PPG ch.1 (Lower)	IRQ9	FFE8$_H$	FFE9$_H$	L09 [1 : 0]	
8/16-bit PPG ch.1 (Upper)	IRQ10	FFE6$_H$	FFE7$_H$	L10 [1 : 0]	
16-bit reload timer ch.0	IRQ11	FFE4$_H$	FFE5$_H$	L11 [1 : 0]	
8/16-bit PPG ch.0 (Upper)	IRQ12	FFE2$_H$	FFE3$_H$	L12 [1 : 0]	
8/16-bit PPG ch.0 (Lower)	IRQ13	FFE0$_H$	FFE1$_H$	L13 [1 : 0]	
8/16-bit compound timer ch.1 (Upper)	IRQ14	FFDE$_H$	FFDF$_H$	L14 [1 : 0]	
16-bit PPG ch.0	IRQ15	FFDC$_H$	FFDD$_H$	L15 [1 : 0]	
I^2C ch.0	IRQ16	FFDA$_H$	FFDB$_H$	L16 [1 : 0]	
16-bit PPG ch.1	IRQ17	FFD8$_H$	FFD9$_H$	L17 [1 : 0]	
8/10-bit A/D converter	IRQ18	FFD6$_H$	FFD7$_H$	L18 [1 : 0]	
Timebase timer	IRQ19	FFD4$_H$	FFD5$_H$	L19 [1 : 0]	
Watch timer/counter	IRQ20	FFD2$_H$	FFD3$_H$	L20 [1 : 0]	
External interrupt ch.8	IRQ21	FFD0$_H$	FFD1$_H$	L21 [1 : 0]	
External interrupt ch.9					
External interrupt ch.10					
External interrupt ch.11					
8/16-bit compound timer ch.1 (Lower)	IRQ22	FFCE$_H$	FFCF$_H$	L22 [1 : 0]	
Flash memory	IRQ23	FFCC$_H$	FFCD$_H$	L23 [1 : 0]	Low

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power supply voltage*1	V_{CC} AV_{CC}	V_{SS} – 0.3	V_{SS} + 4.0	V	*2
	AVR	V_{SS} – 0.3	V_{SS} + 4.0		*2
Input voltage*1	V_{I1}	V_{SS} – 0.3	V_{SS} + 4.0	V	Other than P80 to P83*3
	V_{I2}	V_{SS} – 0.3	V_{SS} + 6.0		P80 to P83
Output voltage*1	V_O	V_{SS} – 0.3	V_{SS} + 4.0	V	*3
Maximum clamp current	I_{CLAMP}	– 2.0	+ 2.0	mA	Applicable to pins*4
Total maximum clamp current	$\Sigma\lvert I_{CLAMP}\rvert$	—	20	mA	Applicable to pins*4
“L” level maximum output current	I_{OL1}	—	15	mA	Other than P00 to P07
	I_{OL2}		15		P00 to P07
“L” level average current	I_{OLAV1}	—	4	mA	Other than P00 to P07 Average output current = operating current × operating ratio (1 pin)
	I_{OLAV2}		12		P00 to P07 Average output current = operating current × operating ratio (1 pin)
“L” level total maximum output current	ΣI_{OL}	—	100	mA	
“L” level total average output current	ΣI_{OLAV}	—	50	mA	Total average output current = operating current × operating ratio (Total of pins)
“H” level maximum output current	I_{OH1}	—	– 15	mA	Other than P00 to P07
	I_{OH2}		– 15		P00 to P07
“H” level average current	I_{OHAV1}	—	– 4	mA	Other than P00 to P07 Average output current = operating current × operating ratio (1 pin)
	I_{OHAV2}		– 8		P00 to P07 Average output current = operating current × operating ratio (1 pin)
“H” level total maximum output current	ΣI_{OH}	—	– 100	mA	
“H” level total average output current	ΣI_{OHAV}	—	– 50	mA	Total average output current = operating current × operating ratio (Total of pins)

(Continued)

(Continued)

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power consumption	Pd	—	320	mW	
Operating temperature	T_A	− 40	+ 85	°C	
Storage temperature	T_{STG}	− 55	+ 150	°C	MB95107A, MB95F108AS, MB95F108AW
		− 40	+ 125		MB95R107A, MB95D108AS, MB95D108AW

*1 : The parameter is based on $AV_{SS} = V_{SS} = 0.0$ V.

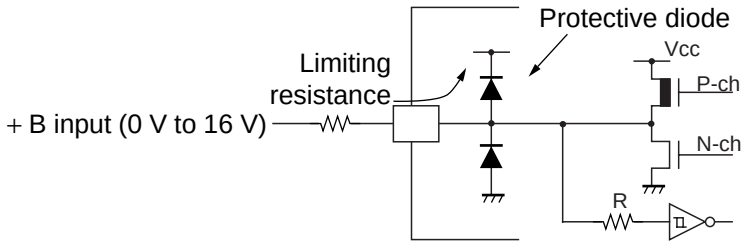
*2 : Apply equal potential to AV_{CC} and V_{CC}. AVR should not exceed $AV_{CC} + 0.3$ V.

*3 : V_{I1} and Vo should not exceed $V_{CC} + 0.3$ V. V_{I1} must not exceed the rating voltage. However, if the maximum current to/from an input is limited by some means with external components, the I_{CLAMP} rating supersedes the V_{I1} rating.

*4 : Applicable to pins : P00 to P07, P10 to P14, P20 to P24, P30 to P37, P40 to P43, P52, P53, P70, P71, PE0 to PE3, PG0

- Use within recommended operating conditions.
- Use at DC voltage (current).
- The + B signal is an input signal that exceeds V_{CC} voltage. The + B signal should always be applied a limiting resistance placed between the + B signal and the microcontroller.
- The value of the limiting resistance should be set so that when the + B signal is applied the input current to the microcontroller pin does not exceed rated values, either instantaneously or for prolonged periods.
- Note that when the microcontroller drive current is low, such as in the power saving modes, the +B input potential may pass through the protective diode and increase the potential at the V_{CC} pin, and this affects other devices.
- Note that if the + 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.
- Sample recommended circuits :

- Input/Output Equivalent circuits



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

2. Recommended Operating Conditions

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

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Power supply voltage	V_{CC}, AV_{CC}	—	—	1.8*1	3.3	V	At normal operating, Flash memory product, $T_A = -10$ °C to +85 °C
		—	—	1.8*1	3.6		At normal operating, MASK ROM product, $T_A = -10$ °C to +85 °C
		—	—	2.0*1	3.3		At normal operating, Flash memory product, $T_A = -40$ °C to +85 °C
		—	—	2.0*1	3.6		At normal operating, MASK ROM product, $T_A = -40$ °C to +85 °C
		—	—	2.7	3.3		At normal operating, Flash memory product, at FRAM access, $T_A = -40$ °C to +85 °C
		—	—	2.7	3.6		At normal operating, MASK ROM product, at FRAM access, $T_A = -40$ °C to +85 °C
		—	—	2.6	3.6		MB95FV100B-101 $T_A = +5$ °C to +35 °C
		—	—	1.5	3.3		Retain status in stop mode, Flash memory product
		—	—	1.5	3.6		Retain status in stop mode, MASK ROM product
“H” level input voltage	V_{IH1}	P10, P67	*2	0.7 V_{CC}	$V_{CC} + 0.3$	V	At selecting CMOS input level
	V_{IH2}	P50, P51	—	0.7 V_{CC}	$V_{SS} + 5.5$	V	At selecting CMOS input level MB95F108AS, MB95F108AW, MB95107A, MB95FV100B-101
					$V_{CC} + 0.3$		At selecting CMOS input level MB95D108AS, MB95D108AW, MB95R107A

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Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
"H" level input voltage	V_{IHS1}	P00 to P07, P10 to P14, P20 to P24, P30 to P37, P40 to P43, P52, P53, P60 to P67, P70, P71, PE0 to PE3, PG0, PG1*3, PG2*3	*2	0.8 V_{CC}	V_{CC} + 0.3	V	Hysteresis input
	V_{IHS2}	P80 to P83	*2	0.8 V_{CC}	V_{SS} + 5.5	V	Hysteresis input
	V_{IHS3}	P50, P51	—	0.8 V_{CC}	V_{SS} + 5.5	V	Hysteresis input MB95F108AS, MB95F108AW, MB95107A, MB95FV100B-101
					V_{SS} + 5.0		Hysteresis input MB95D108AS, MB95D108AW, MB95R107A
	V_{IHM}	$\overline{RST}$, MOD	—	0.7 V_{CC}	V_{CC} + 0.3	V	CMOS input (Flash memory product)
			—	0.8 V_{CC}	V_{CC} + 0.3	V	Hysteresis input (Mask ROM product)
"L" level input voltage	V_{IL}	P10, P50, P51, P67	*2	V_{SS} – 0.3	0.3 V_{CC}	V	At selecting CMOS input level (Hysteresis input)
	V_{ILS}	P00 to P07, P10 to P14, P20 to P24, P30 to P37, P40 to P43, P50 to P53, P60 to P67, P70, P71, P80 to P83, PE0 to PE3, PG0, PG1*3, PG2*3	*2	V_{SS} – 0.3	0.2 V_{CC}	V	Hysteresis input
	V_{ILM}	$\overline{RST}$, MOD	—	V_{SS} – 0.3	0.3 V_{CC}	V	CMOS input (Flash memory product)
			—	V_{SS} – 0.3	0.2 V_{CC}	V	Hysteresis input (Mask ROM product)
A/D converter reference input voltage	AVR	—	—	1.8	AV_{CC}	V	
Operating temperature	T_A	—	—	– 40	+ 85	°C	

*1 : The values vary with the operating frequency.

*2 : P10, P50, P51, and P67 can switch the input level to either the “CMOS input level” or “hysteresis input level”. The switching of the input level can be set by the input level selection register (ILSR).

*3 : Single clock product only

WARNING: The recommended operating conditions are required in order to ensure the normal operation of the semiconductor device. All of the device’s electrical characteristics are warranted when the device is operated within these ranges.

Always use semiconductor devices within their recommended operating condition ranges. Operation outside these ranges may adversely affect reliability and could result in device failure.

No warranty is made with respect to uses, operating conditions, or combinations not represented on the data sheet. Users considering application outside the listed conditions are advised to contact their FUJITSU representatives beforehand.

3. DC Characteristics

(V_{CC} = AV_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
"H" level output voltage	V_{OH1}	Output pin other than P00 to P07	I_{OH} = − 4.0 mA	2.4	—	—	V	
	V_{OH2}	P00 to P07	I_{OH} = − 8.0 mA	2.4	—	—	V	
"L" level output voltage	V_{OL1}	Output pin other than P00 to P07	I_{OL} = 4.0 mA	—	—	0.4	V	
	V_{OL2}	P00 to P07	I_{OL} = 12 mA	—	—	0.4	V	
Open-drain output application voltage	V_{D1}	P80 to P83	—	V_{SS} − 0.3	—	V_{SS} + 5.5	V	
	V_{D2}	P50, P51	—	V_{SS} − 0.3	—	V_{SS} + 5.5		MB95F108AS, MB95F108AW, MB95107A
						V_{CC} + 0.3		MB95D108AS, MB95D108AW, MB95R107A
Input leakage current (Hi-Z output leakage current)	I_{LI}	Port other than P50, P51, P80 to P83	0.0 V < V_I < V_{CC}	− 5	—	+ 5	µA	When the pull-up is prohibition setting
Open-drain output leakage current	I_{LIOD}	P50, P51, P80 to P83	0.0 V < V_I < V_{SS} + 5.5 V	—	—	+ 5	µA	
Pull-up resistor	R_{PULL}	P10 to P14, P20 to P24, P30 to P37, P40 to P43, P52, P53, P70, P71, PE0 to PE3, PG0, PG1*1, PG2*1	V_I = 0.0 V	25	50	100	kΩ	When the pull-up is permission setting
Pull-down resistor	R_{MOD}	MOD	V_I = V_{CC}	25	50	100	kΩ	MASK ROM product
Input capacitance	C_{IN}	Other than AV_{CC}, AV_{SS}, AVR, V_{CC}, V_{SS}	f = 1 MHz	—	5	15	pF	

(Continued)

(V_{CC} = AV_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Sym-bol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Power supply current*2	I_{CC}	V_{CC} (External clock operation)	F_{CH} = 20 MHz F_{MP} = 10 MHz Main clock mode (divided by 2)	—	11.0	14.0	mA	MB95F108AS, MB95F108AW
				—	7.3	10.0	mA	MB95107A
				—	30.0	35.0	mA	MB95F108AS, MB95F108AW (at Flash memory writing and erasing)
			F_{CH} = 20 MHz F_{MP} = 10 MHz Main clock mode (divided by 2) When FRAM read and write (f_{SCL} = 400 kHz)	—	11.1	15.0	mA	MB95D108AS, MB95D108AW
				—	7.4	11.0	mA	MB95R107A
				—	30	35	mA	MB95D108AS, MB95D108AW (at Flash memory write and erase)
	I_{CCS}		F_{CH} = 20 MHz F_{MP} = 10 MHz Main Sleep mode (divided by 2)	—	4.5	6.0	mA	
	I_{CCL}		F_{CL} = 32 kHz F_{MPL} = 16 kHz Sub clock mode (divided by 2) , T_A = + 25 °C	—	25	35	µA	
	I_{CCLS}		F_{CL} = 32 kHz F_{MPL} = 16 kHz Sub sleep mode (divided by 2) , T_A = + 25 °C	—	7	15	µA	
	I_{CCT}		F_{CL} = 32 kHz Watch mode Main stop mode T_A = + 25 °C	—	2	10	µA	Flash memory product
				—	1	5	µA	MASK ROM product
	I_{CCMPLL}		F_{CH} = 4 MHz F_{MP} = 10 MHz Main PLL mode (multiplied by 2.5)	—	10	14	mA	Flash memory product
				—	6.7	10.0	mA	MASK ROM product

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(V_{CC} = AV_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Sym-bol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Power supply current*2	I_{CCSPLL}	V_{CC} (External clock operation)	F_{CL} = 32 kHz F_{MPL} = 128 kHz Sub PLL mode (multiplied by 4), T_A = + 25 °C	—	190	250	µA	
	I_{CTS}		F_{CH} = 10 MHz Timebase timer mode T_A = + 25 °C	—	0.4	0.5	mA	
	I_{CCH}		Sub stop mode T_A = + 25 °C	—	1	5	µA	
	I_A	AV_{CC}	F_{CH} = 10 MHz At operating of A/D conversion	—	1.3	2.2	mA	
	I_{AH}		F_{CH} = 10 MHz At stopping of A/D conversion T_A = + 25 °C	—	1	5	µA	

*1 : Single clock product only

*2 : Power supply current is regulated by external clock.

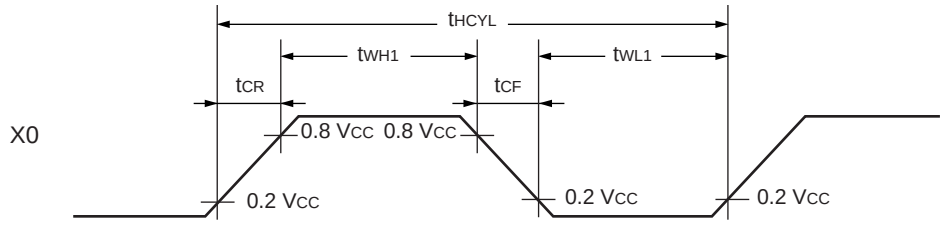
- Refer to “4. AC characteristics (1) Clock Timing” for F_{CH} and F_{CL}.
- Refer to “4. AC characteristics (2) Source Clock/Machine Clock” for F_{MP} and F_{MPL}.

4. AC Characteristics

(1) Clock Timing

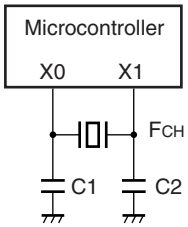
(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Clock frequency	F_{CH}	X0, X1	—	1	—	10	MHz	When using main oscillation circuit
				1	—	20	MHz	When using external clock
				3	—	10	MHz	Main PLL multiplied by 1
				3	—	5	MHz	Main PLL multiplied by 2
				3	—	4	MHz	Main PLL multiplied by 2.5
	F_{CL}	X0A, X1A		—	32.768	—	kHz	When using sub oscillation circuit
				—	32.768	—	kHz	When using sub PLL Flash memory product : V_{CC} = 2.3 V to 3.3 V MASK ROM product : V_{CC} = 2.3 V to 3.6 V
Clock cycle time	t_{HCYL}	X0, X1		100	—	1000	ns	When using main oscillation circuit
				50	—	1000	ns	When using external clock
	t_{LCYL}	X0A, X1A		—	30.5	—	µs	When using sub oscillation circuit
Input clock pulse width	t_{WH1} t_{WL1}	X0		10	—	—	ns	When using external clock Duty ratio is about 30% to 70%.
	t_{WH2} t_{WL2}	X0A		—	15.2	—	µs	
Input clock rise time and fall time	t_{CR} t_{CF}	X0, X0A		—	—	10	ns	When using external clock

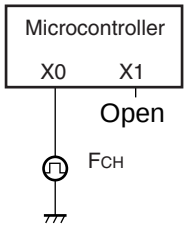


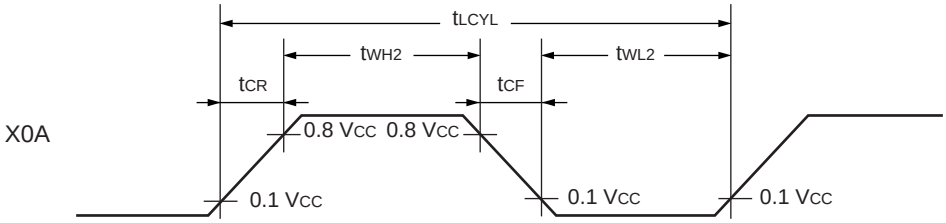
- Figure of main clock Input port external connection

When using a crystal or ceramic oscillator



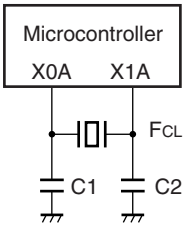
When using external clock



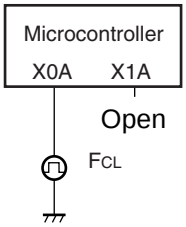


- Figure of sub clock input port external connection

When using a crystal or ceramic oscillator



When using external clock



(2) Source Clock/Machine Clock

(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Sym-bol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Source clock cycle time*1 (Clock before setting division)	t_{SCLK}	—	100	—	2000	ns	When using main clock Min : F_{CH} = 10 MHz, PLL multiplied by 1 Max : F_{CH} = 1 MHz, divided by 2
			7.6	—	61.0	µs	When using sub clock Min : F_{CL} = 32 kHz, PLL multiplied by 4 Max : F_{CL} = 32 kHz, divided by 2
Source clock frequency	F_{SP}	—	0.5	—	10.0	MHz	When using main clock
	F_{SPL}	—	16.384	—	131.072	kHz	When using sub clock
Machine clock cycle time*2 (Minimum instruction execution time)	t_{MCLK}	—	100	—	32000	ns	When using main clock Min : F_{SP} = 10 MHz, no division Max : F_{SP} = 0.5 MHz, divided by 16
			7.6	—	976.5	µs	When using sub clock Min : F_{SPL} = 131 kHz, no division Max : F_{SPL} = 16 kHz, divided by 16
Machine clock frequency	F_{MP}	—	0.031	—	10.000	MHz	When using main clock
	F_{MPL}		1.024	—	131.072	kHz	When using sub clock

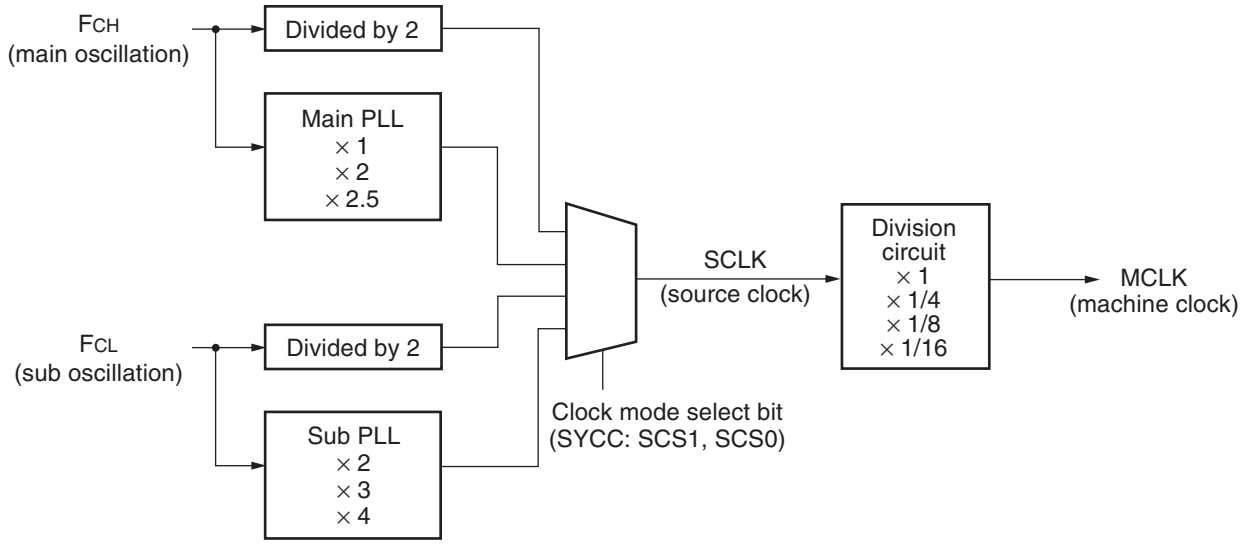
*1 : Clock before setting division due to machine clock division ratio selection bit (SYCC : DIV1 and DIV0) . This source clock is divided by the machine clock division ratio selection bit (SYCC : DIV1 and DIV0) , and it becomes the machine clock. Further, the source clock can be selected as follow.

- Main clock divided by 2
- PLL multiplication of main clock (select from 1, 2, 2.5 multiplication)
- Sub clock divided by 2
- PLL multiplication of sub clock (select from 2, 3, 4 multiplication)

*2 : Operation clock of the microcontroller. Machine clock can be selected as follow.

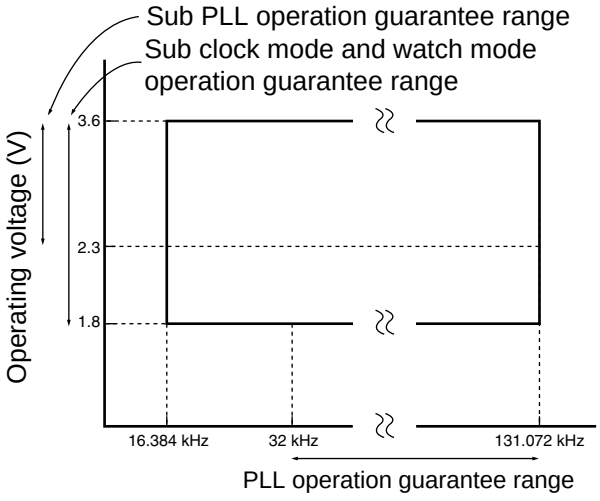
- Source clock (no division)
- Source clock divided by 4
- Source clock divided by 8
- Source clock divided by 16

• Outline of clock generation block

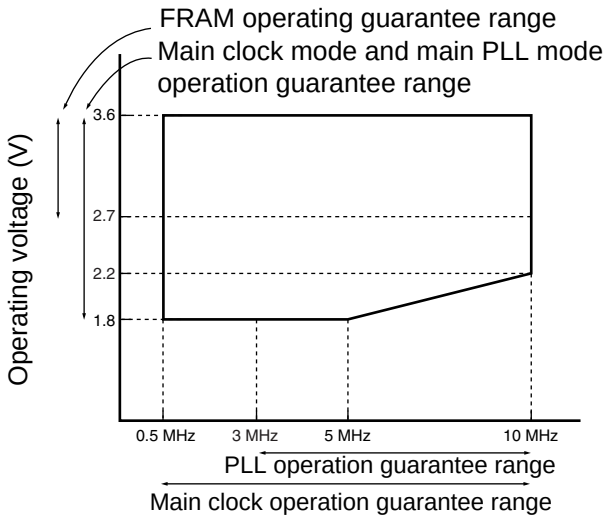


- Operating voltage - Operating frequency (When T_A = − 10 °C to + 85 °C)

  - MB95107A, MB95R107A

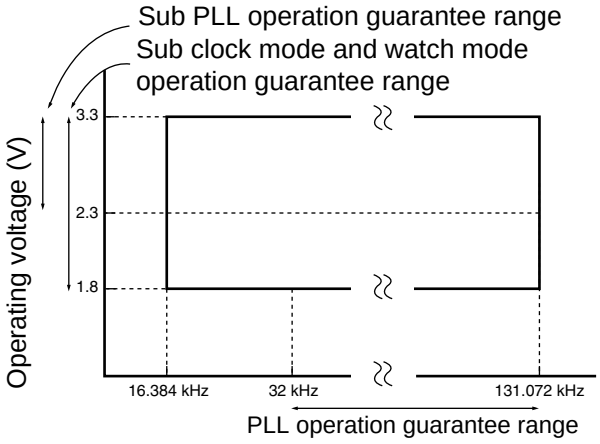


Source clock frequency (F_{SPL})

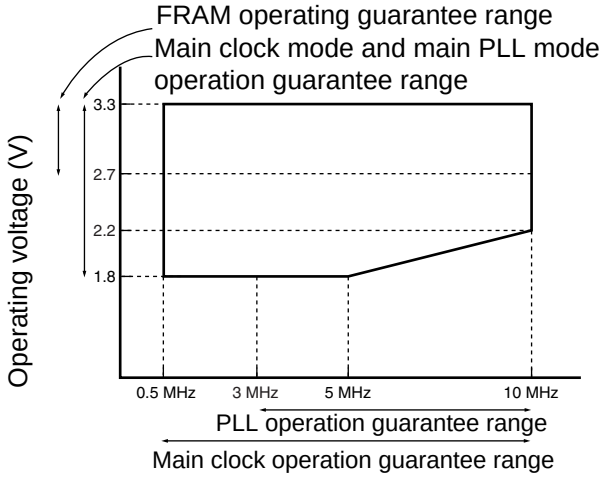


Source clock frequency (F_{SP})

  - MB95F108AS, MB95F108AW, MB95D108AS, MB95D108AW

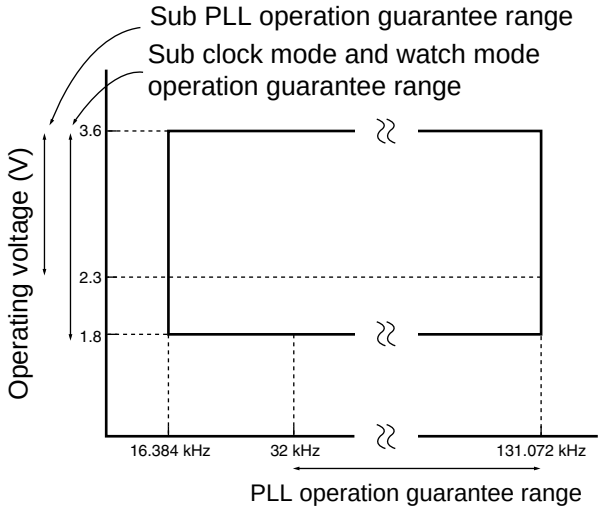


Source clock frequency (F_{SPL})

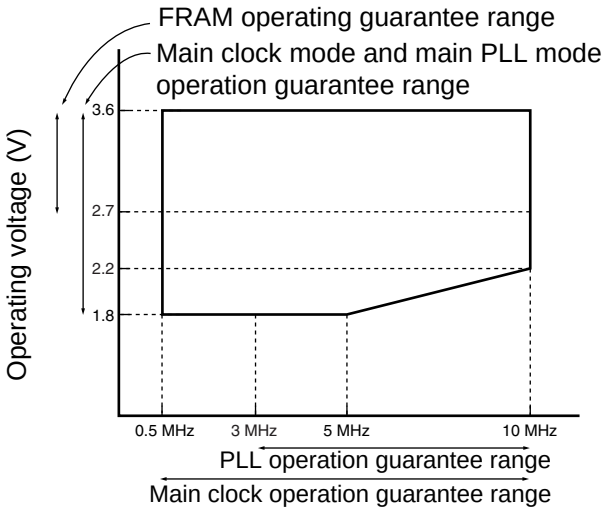


Source clock frequency (F_{SP})

- Operating voltage - Operating frequency (When T_A = − 40 °C to + 85 °C)
  - MB95107A, MB95R107A

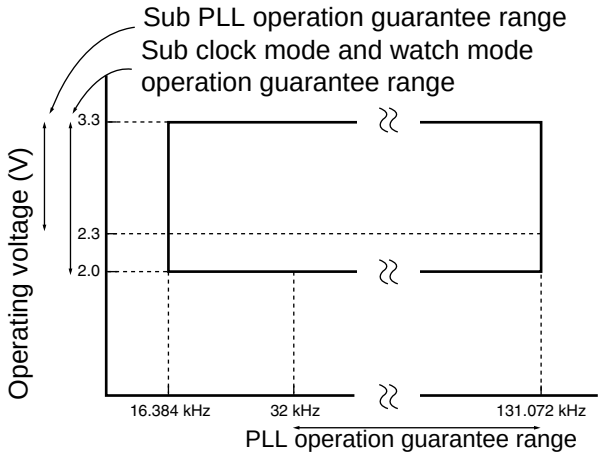


Source clock frequency (F_{SPL})

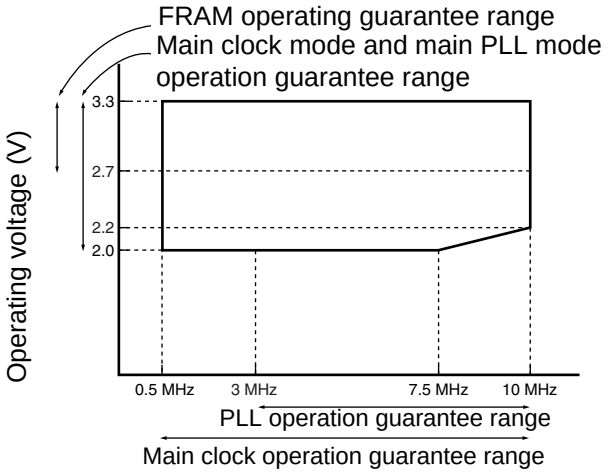


Source clock frequency (F_{SP})

  - MB95F108AS, MB95F108AW, MB95D108AS, MB95D108AW



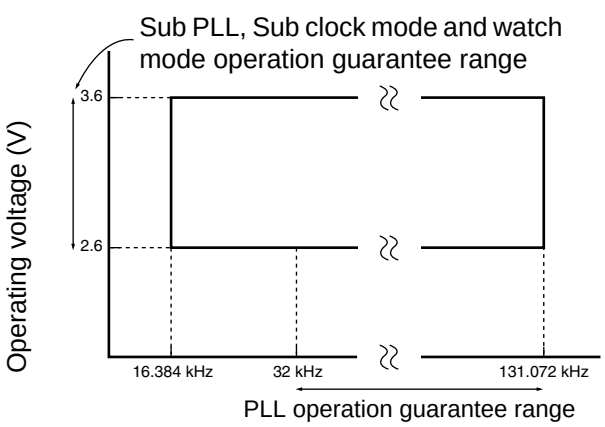
Source clock frequency (F_{SPL})

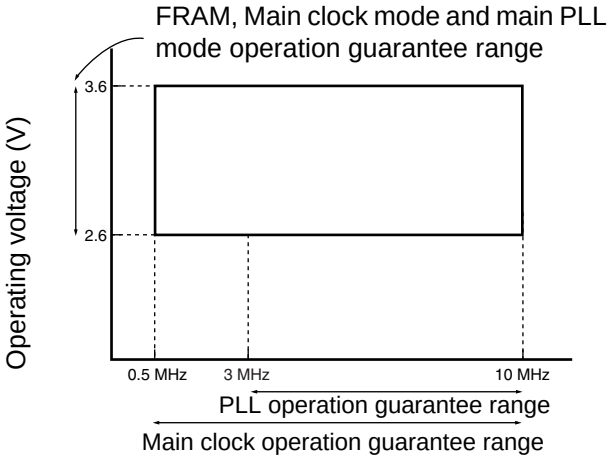


Source clock frequency (F_{SP})

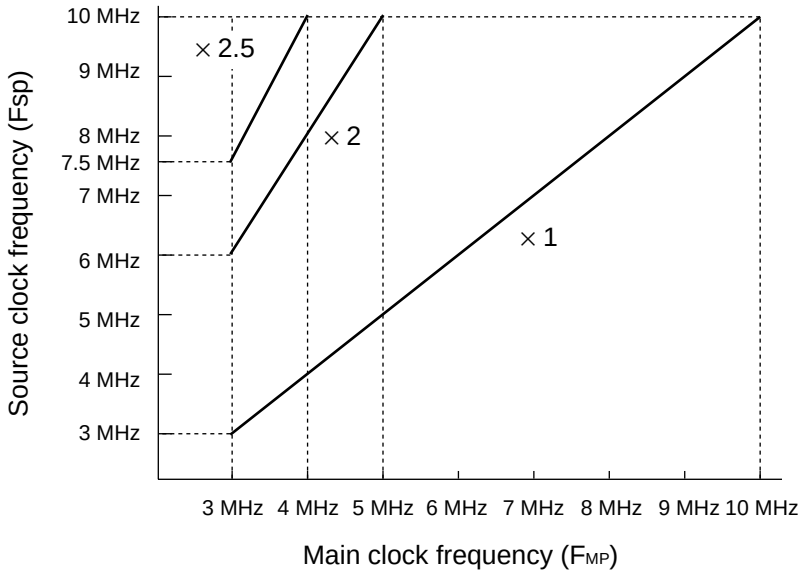
- Operating voltage - Operating frequency (T_A = +5 °C to +35 °C)

  - MB95FV100B-101





- Main PLL operation frequency



(3) External Reset

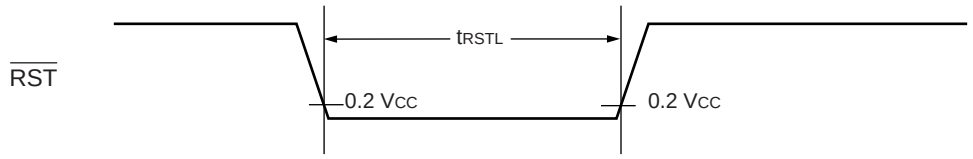
(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Value		Unit	Remarks
		Min	Max		
$\overline{RST}$ "L" level pulse width	t_{RSTL}	2 t_{MCLK}*1	—	ns	At normal operating
		Oscillation time of oscillator*2 + 2 t_{MCLK}*1	—	ns	At stop mode, sub clock mode, sub sleep mode, and watch mode

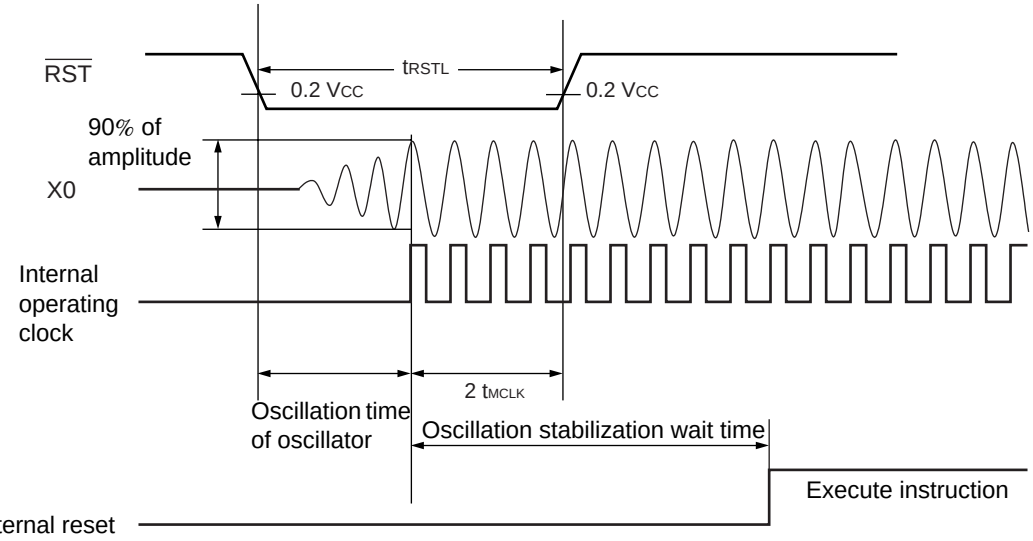
*1 : Refer to " (2) Source Clock/Machine Clock" for t_{MCLK}.

*2 : Oscillation start 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. In the external clock, the oscillation time is 0 ms.

- At normal operating



- At stop mode, sub clock mode, sub sleep mode, watch mode, and power-on

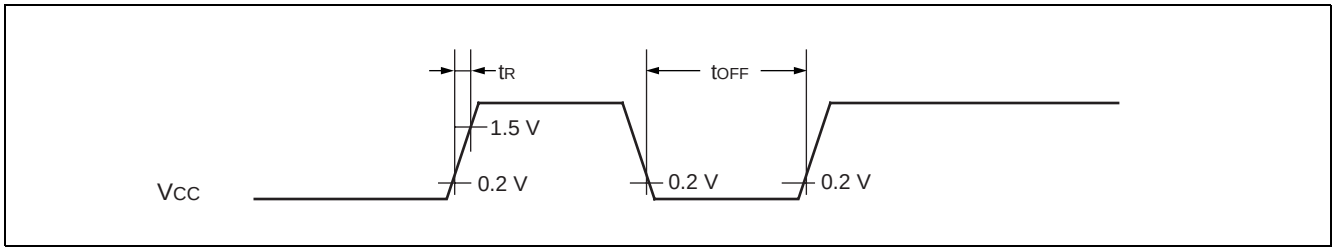


(4) Power-on Reset

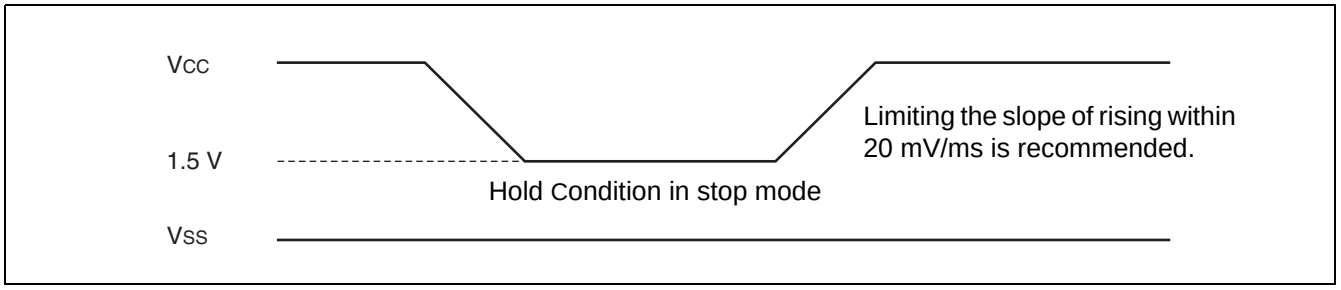
($AV_{SS} = V_{SS} = 0.0$ V, $T_A = -40$ °C to $+85$ °C)

Parameter	Symbol	Conditions	Value		Unit	Remarks
			Min	Max		
Power supply rising time	t_R	—	—	36	ms	
Power supply cutoff time	t_{OFF}	—	1	—	ms	Waiting time until power-on

Note : The power supply must be turned on within the selected oscillation stabilization time.



Note : Sudden change of power supply voltage may activate the power-on reset function. When changing power supply voltages during operation, set the slope of rising within 20 mV/ms as shown below.

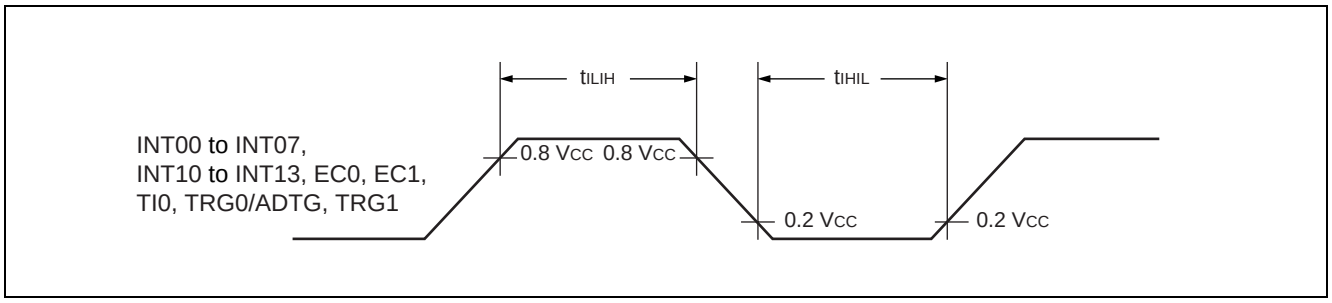


(5) Peripheral Input Timing

(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Value		Unit	Remarks
			Min	Max		
Peripheral input “H” pulse width	t_{ILIH}	INT00 to INT07, INT10 to INT13, EC0, EC1, TI0, TRG0/ADTG, TRG1	2 t_{MCLK}*	—	ns	
Peripheral input “L” pulse width	t_{IHIL}		2 t_{MCLK}*	—	ns	

* : Refer to “ (2) Source Clock/Machine Clock” for t_{MCLK}.



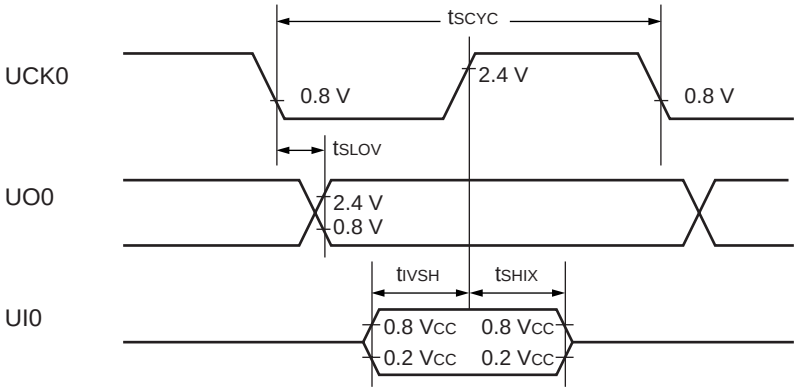
(6) UART/SIO, Serial I/O Timing

(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = − 40 °C to + 85 °C)

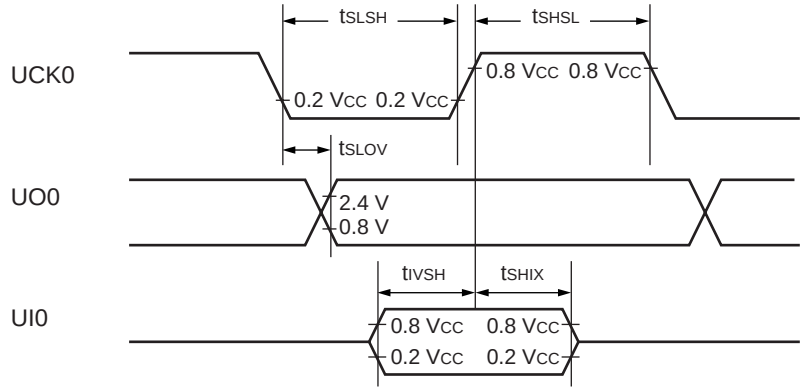
Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Serial clock cycle time	t_{SCYC}	UCK0	Internal clock operation output pin : C_L = 80 pF + 1TTL.	4 t_{MCLK}*	—	ns	
UCK ↓ → UO time	t_{SLOV}	UCK0, UO0		− 190	+ 190	ns	
Valid UI → UCK ↑	t_{IVSH}	UCK0, UI0		2 t_{MCLK}*	—	ns	
UCK ↑ → valid UI hold time	t_{SHIX}	UCK0, UI0		2 t_{MCLK}*	—	ns	
Serial clock “H” pulse width	t_{SHSL}	UCK0	External clock operation output pin : C_L = 80 pF + 1TTL.	4 t_{MCLK}*	—	ns	
Serial clock “L” pulse width	t_{SLSH}	UCK0		4 t_{MCLK}*	—	ns	
UCK ↓ → UO time	t_{SLOV}	UCK0, UO0		0	190	ns	
Valid UI → UCK ↑	t_{IVSH}	UCK0, UI0		2 t_{MCLK}*	—	ns	
UCK ↑ → valid UI hold time	t_{SHIX}	UCK0, UI0		2 t_{MCLK}*	—	ns	

* : Refer to “ (2) Source Clock/Machine Clock” for t_{MCLK}.

- Internal shift clock mode



- External shift clock mode



(7) LIN-UART Timing

Sampling at the rising edge of sampling clock*1 and prohibited serial clock delay*2
(ESCR register : SCES bit = 0, ECCR register : SCDE bit = 0)

(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40 °C to + 85 °C)

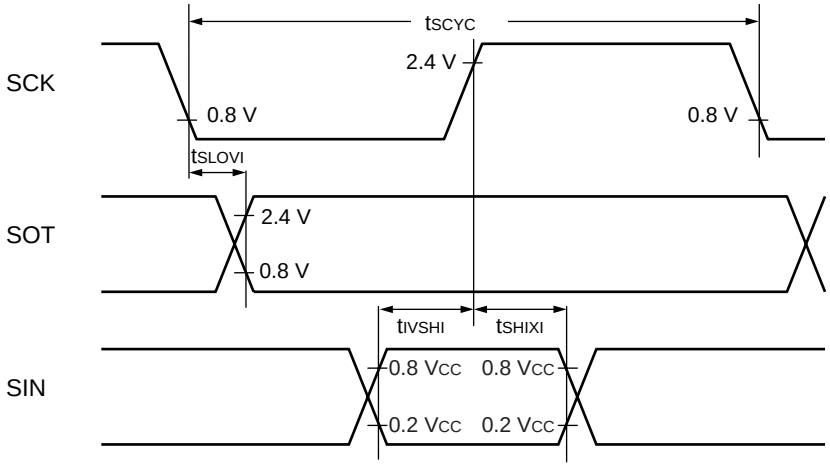
Parameter	Sym-bol	Pin name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operation output pin : C_L = 80 pF + 1 TTL.	5 t_{MCLK}*3	—	ns
SCK ↑→ SOT delay time	t_{SLOVI}	SCK, SOT		–95	+ 95	ns
Valid SIN→SCK↑	t_{IVSHI}	SCK, SIN		t_{MCLK}*3 + 190	—	ns
SCK↑→ valid SIN hold time	t_{SHIXI}	SCK, SIN		0	—	ns
Serial clock “L” pulse width	t_{SLSH}	SCK	External clock operation output pin : C_L = 80 pF + 1 TTL.	3 t_{MCLK}*3 – t_R	—	ns
Serial clock “H” pulse width	t_{SHSL}	SCK		t_{MCLK}*3 + 95	—	ns
SCK ↓→SOT delay time	t_{SLOVE}	SCK, SOT		—	2 t_{MCLK}*3 + 95	ns
Valid SIN→SCK↑	t_{IVSHE}	SCK, SIN		190	—	ns
SCK↑→ valid SIN hold time	t_{SHIXE}	SCK, SIN		t_{MCLK}*3 + 95	—	ns
SCK fall time	t_F	SCK		—	10	ns
SCK rise time	t_R	SCK		—	10	ns

*1 : Provide switch function whether sampling of reception data is performed at rising edge or falling edge of the serial clock.

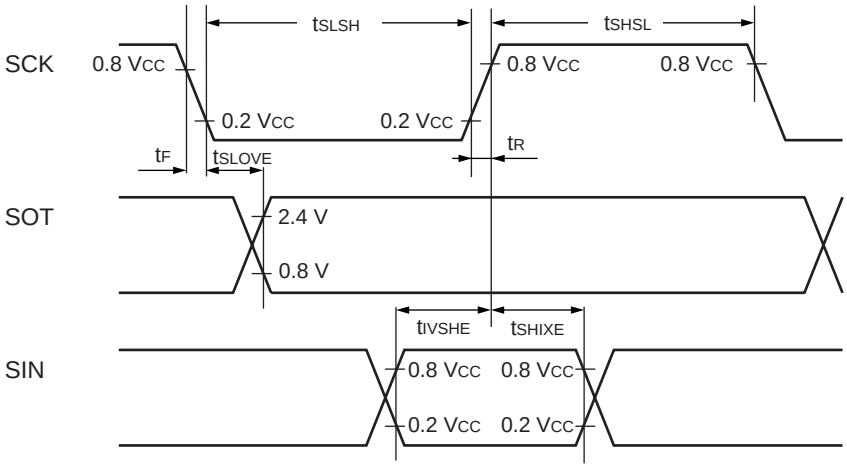
*2 : Serial clock delay function is used to delay half clock for the output signal of serial clock.

*3 : Refer to “ (2) Source Clock/Machine Clock” for t_{MCLK}.

- Internal shift clock mode



- External shift clock mode



Sampling at the falling edge of sampling clock*1 and prohibited serial clock delay*2
(ESCR register : SCES bit = 1, ECCR register : SCDE bit = 0)

(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40 °C to + 85 °C)

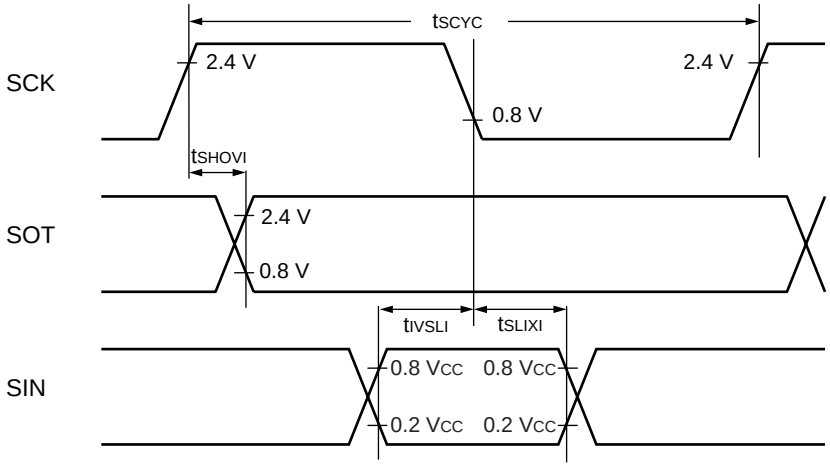
Parameter	Sym-bol	Pin name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operation output pin : C_L = 80 pF + 1 TTL.	5 t_{MCLK}*3	—	ns
SCK↑→ SOT delay time	t_{SHOVI}	SCK, SOT		–95	+ 95	ns
Valid SIN→SCK↓	t_{IVSLI}	SCK, SIN		t_{MCLK}*3 + 190	—	ns
SCK↓→ valid SIN hold time	t_{SLIXI}	SCK, SIN		0	—	ns
Serial clock “H” pulse width	t_{SHSL}	SCK	External clock operation output pin : C_L = 80 pF + 1 TTL.	3 t_{MCLK}*3 – t_R	—	ns
Serial clock “L” pulse width	t_{SLSH}	SCK		t_{MCLK}*3 + 95	—	ns
SCK↑ →SOT delay time	t_{SHOVE}	SCK, SOT		—	2 t_{MCLK}*3 + 95	ns
Valid SIN→SCK↓	t_{IVSLE}	SCK, SIN		190	—	ns
SCK↓→ valid SIN hold time	t_{SLIXE}	SCK, SIN		t_{MCLK}*3 + 95	—	ns
SCK fall time	t_F	SCK		—	10	ns
SCK rise time	t_R	SCK		—	10	ns

*1 : Provide switch function whether sampling of reception data is performed at rising edge or falling edge of the serial clock.

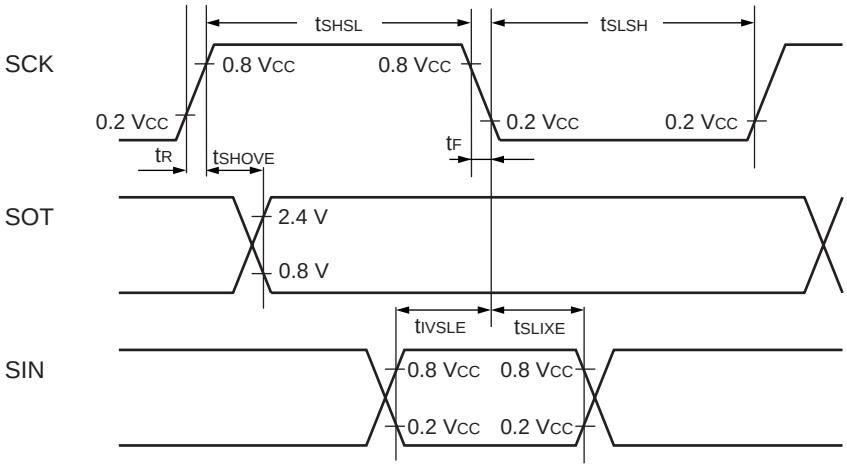
*2 : Serial clock delay function is used to delay half clock for the output signal of serial clock.

*3 : Refer to “ (2) Source Clock/Machine Clock” for t_{MCLK}.

- Internal shift clock mode



- External shift clock mode



Sampling at the rising edge of sampling clock*1 and enabled serial clock delay*2
(ESCR register : SCES bit = 0, ECCR register : SCDE bit = 1)

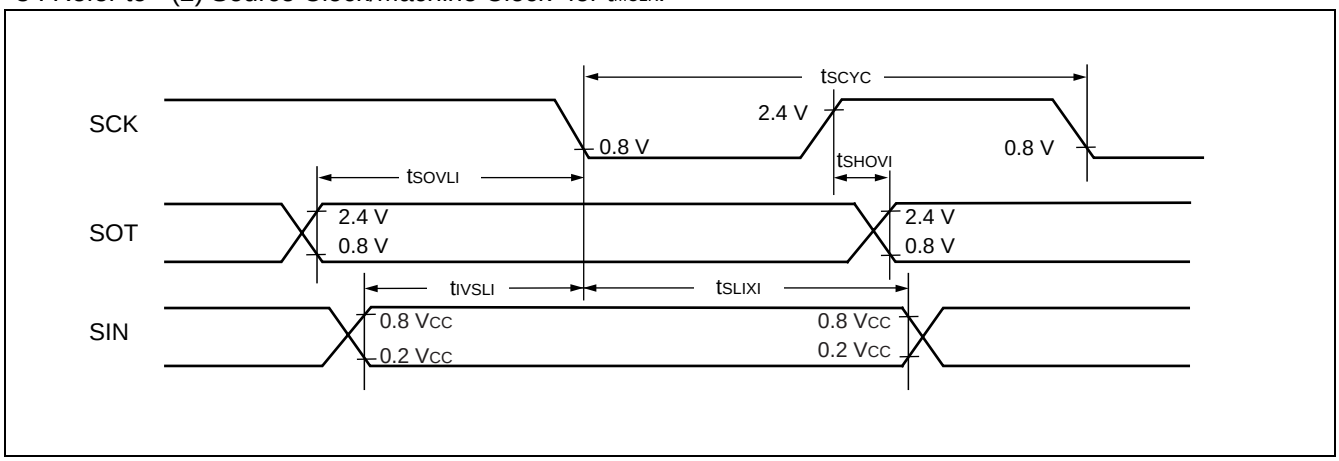
(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40 °C to + 85 °C)

Parameter	Sym-bol	Pin name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operation output pin : C_L = 80 pF + 1 TTL.	5 t_{MCLK}*3	—	ns
SCK↑→ SOT delay time	t_{SHOVI}	SCK, SOT		–95	+ 95	ns
Valid SIN→SCK↓	t_{IVSLI}	SCK, SIN		t_{MCLK}*3 + 190	—	ns
SCK↓→ valid SIN hold time	t_{SLIXI}	SCK, SIN		0	—	ns
SOT→SCK↓ delay time	t_{SOVLI}	SCK, SOT		—	4 t_{MCLK}*3	ns

*1 : Provide switch function whether sampling of reception data is performed at rising edge or falling edge of the serial clock.

*2 : Serial clock delay function is used to delay half clock for the output signal of serial clock.

*3 : Refer to " (2) Source Clock/Machine Clock" for t_{MCLK}.



Sampling at the falling edge of sampling clock*1 and enabled serial clock delay*2
(ESCR register : SCES bit = 1, ECCR register : SCDE bit = 1)

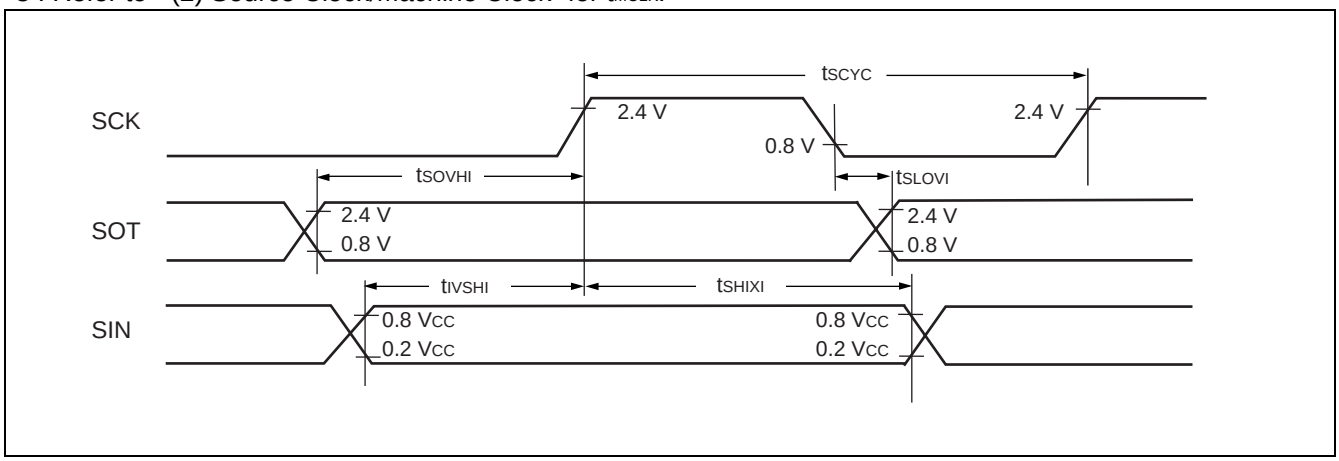
(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40 °C to + 85 °C)

Parameter	Sym-bol	Pin name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operating output pin : C_L = 80 pF + 1 TTL.	5 t_{MCLK}*3	—	ns
SCK↓→SOT delay time	t_{SLOVI}	SCK, SOT		–95	+ 95	ns
Valid SIN→SCK↑	t_{IVSHI}	SCK, SIN		t_{MCLK}*3 + 190	—	ns
SCK↑ → valid SIN hold time	t_{SHIXI}	SCK, SIN		0	—	ns
SOT→SCK↑ delay time	t_{SOVHI}	SCK, SOT		—	4 t_{MCLK}*3	ns

*1 : Provide switch function whether sampling of reception data is performed at rising edge or falling edge of the serial clock.

*2 : Serial clock delay function is used to delay half clock for the output signal of serial clock.

*3 : Refer to “ (2) Source Clock/Machine Clock” for t_{MCLK}.



(8) I²C Timing

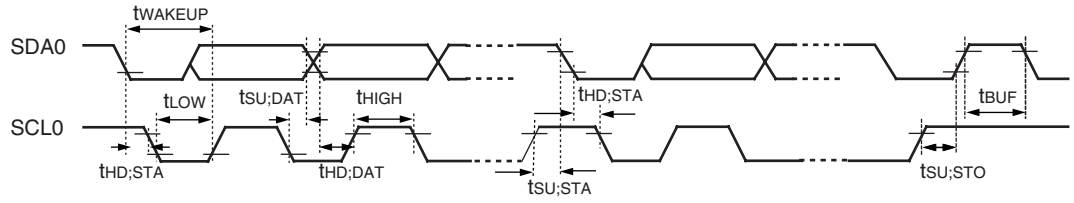
(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value				Unit	Remarks
				Standard-mode		Fast-mode			
				Min	Max	Min	Max		
SCL clock frequency	f_{SCL}	SCL0	R = 1.7 kΩ, C = 50 pF*1	0	100	0	400	kHz	
(Repeat) Start condition hold time SDA ↓ → SCL ↓	$t_{HD;STA}$	SCL0 SDA0		4.0	—	0.6	—	µs	
SCL clock “L” width	t_{LOW}	SCL0		4.7	—	1.3	—	µs	
SCL clock “H” width	t_{HIGH}	SCL0		4.0	—	0.6	—	µs	
(Repeat) Start condition setup time SCL ↑ → SDA ↓	$t_{SU;STA}$	SCL0 SDA0		4.7	—	0.6	—	µs	
Data hold time SCL ↓ → SDA ↓ ↑	$t_{HD;DAT}$	SCL0 SDA0		0	3.45*2	0	0.9*3	µs	
Data setup time SDA ↓ ↑ → SCL ↑	$t_{SU;DAT}$	SCL0 SDA0		0.25	—	0.1	—	µs	
Stop condition setup time SCL ↑ → SDA ↑	$t_{SU;STO}$	SCL0 SDA0		4	—	0.6	—	µs	
Bus free time between stop condition and start condition	t_{BUF}	SCL0 SDA0		4.7	—	1.3	—	µs	

*1 : R, C : Pull-up resistor and load capacitor of the SCL and SDA lines.

*2 : The maximum $t_{HD;DAT}$ have only to be met if the device dose not stretch the “L” width (t_{LOW}) of the SCL signal.

*3 : A fast-mode I²C-bus device can be used in a standard-mode I²C-bus system, but the requirement $t_{SU;DAT} \geq$ 250 ns must then be met.



(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40 °C to + 85 °C)

Parameter	Sym-bol	Pin name	Condi-tions	Value*2		Unit	Remarks
				Min	Max		
SCL clock “L” width	t_{LOW}	SCL0	R = 1.7 kΩ, C = 50 pF*1	(2 + nm / 2) t_{MCLK} – 20	—	ns	Master mode
SCL clock “H” width	t_{HIGH}	SCL0		(nm / 2) t_{MCLK} – 20	(nm / 2) t_{MCLK} + 20	ns	Master mode
Start condition hold time	$t_{HD;STA}$	SCL0 SDA0		(–1 + nm / 2) t_{MCLK} – 20	(–1 + nm) t_{MCLK} + 20	ns	Master mode Maximum value is applied when m, n = 1, 8. Otherwise, the minimum value is applied.
Stop condition setup time	$t_{SU;STO}$	SCL0 SDA0		(1 + nm / 2) t_{MCLK} – 20	(1 + nm / 2) t_{MCLK} + 20	ns	Master mode
Start condition setup time	$t_{SU;STA}$	SCL0 SDA0		(1 + nm / 2) t_{MCLK} – 20	(1 + nm / 2) t_{MCLK} + 20	ns	Master mode
Bus free time between stop condition and start condition	t_{BUF}	SCL0 SDA0		(2 nm + 4) t_{MCLK} – 20	—	ns	
Data hold time	$t_{HD;DAT}$	SCL0 SDA0		3 t_{MCLK} – 20	—	ns	Master mode
Data setup time	$t_{SU;DAT}$	SCL0 SDA0		(–2 + nm / 2) t_{MCLK} – 20	(–1 + nm / 2) t_{MCLK} + 20	ns	Master mode When assuming that “L” of SCL is not extended, the minimum value is applied to first bit of continuous data. Otherwise, the maximum value is applied.
Setup time between clearing interrupt and SCL rising	$t_{SU;INT}$	SCL0		(nm / 2) t_{MCLK} – 20	(1 + nm / 2) t_{MCLK} + 20	ns	Minimum value is applied to interrupt at 9th SCL↓. Maximum value is applied to interrupt at 8th SCL↓.
SCL clock “L” width	t_{LOW}	SCL0		4 t_{MCLK} – 20	—	ns	At reception
SCL clock “H” width	t_{HIGH}	SCL0		4 t_{MCLK} – 20	—	ns	At reception
Start condition detection	$t_{HD;STA}$	SCL0 SDA0		2 t_{MCLK} – 20	—	ns	Undetected when 1 t_{MCLK} is used at reception

(Continued)

(Continued)

(V_{CC} = 3.3 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value*2		Unit	Remarks
				Min	Max		
Stop condition detection	$t_{SU;STO}$	SCL0 SDA0	R = 1.7 kΩ, C = 50 pF*1	2 t_{MCLK} – 20	—	ns	Undetected when 1 t_{MCLK} is used at reception
Restart condition detection condition	$t_{SU;STA}$	SCL0 SDA0		2 t_{MCLK} – 20	—	ns	Undetected when 1 t_{MCLK} is used at reception
Bus free time	t_{BUF}	SCL0 SDA0		2 t_{MCLK} – 20	—	ns	At reception
Data hold time	$t_{HD;DAT}$	SCL0 SDA0		2 t_{MCLK} – 20	—	ns	At slave transmission mode
Data setup time	$t_{SU;DAT}$	SCL0 SDA0		t_{LOW} – 3 t_{MCLK} – 20	—	ns	At slave transmission mode
Data hold time	$t_{HD;DAT}$	SCL0 SDA0		0	—	ns	At reception
Data setup time	$t_{SU;DAT}$	SCL0 SDA0		t_{MCLK} – 20	—	ns	At reception
SDA↓→SCL↑ (at wakeup function)	$t_{WAKE-UP}$	SCL0 SDA0		Oscillation stabilization wait time + 2 t_{MCLK} – 20	—	ns	

*1 : R, C : Pull-up resistor and load capacitor of the SCL and SDA lines.

*2 :
- Refer to " (2) Source Clock/Machine Clock" for t_{MCLK}.
- m is CS4 bit and CS3 bit (bit 4 and bit 3) of clock control register (ICCR) .
- n is CS2 bit to CS0 bit (bit 2 to bit 0) of clock control register (ICCR) .
- Actual timing of I²C is determined by m and n values set by the machine clock (t_{MCLK}) and CS4 to CS0 of ICCR0 register.
- Standard-mode :
  m and n can be set at the range : 0.9 MHz < t_{MCLK} (machine clock) < 10 MHz.
  Setting of m and n determines the machine clock that can be used below.
  (m, n) = (1, 8) : 0.9 MHz < t_{MCLK} ≤ 1 MHz
  (m, n) = (1, 22) , (5, 4) , (6, 4) , (7, 4) , (8, 4) : 0.9 MHz < t_{MCLK} ≤ 2 MHz
  (m, n) = (1, 38) , (5, 8) , (6, 8) , (7, 8) , (8, 8) : 0.9 MHz < t_{MCLK} ≤ 4 MHz
  (m, n) = (1, 98) : 0.9 MHz < t_{MCLK} ≤ 10 MHz
- Fast-mode :
  m and n can be set at the range : 3.3 MHz < t_{MCLK} (machine clock) < 10 MHz.
  Setting of m and n determines the machine clock that can be used below.
  (m, n) = (1, 8) : 3.3 MHz < t_{MCLK} ≤ 4 MHz
  (m, n) = (1, 22) , (5, 4) : 3.3 MHz < t_{MCLK} ≤ 8 MHz
  (m, n) = (6, 4) : 3.3 MHz < t_{MCLK} ≤ 10 MHz

5. A/D Converter

(1) A/D Converter Electrical Characteristics

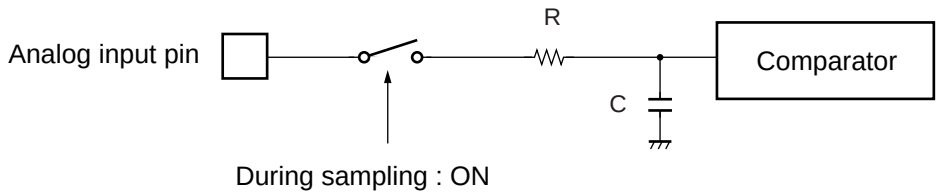
($AV_{CC} = V_{CC}$ = 1.8 V to 3.3 V [Flash memory product], $AV_{CC} = V_{CC}$ = 1.8 V to 3.6 V [MASK ROM product], $AV_{SS} = V_{SS}$ = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Sym-bol	Value			Unit	Remarks
		Min	Typ	Max		
Resolution	—	—	—	10	bit	
Total error	—	− 3.0	—	+ 3.0	LSB	
Linearity error	—	− 2.5	—	+ 2.5	LSB	
Differential linear error	—	− 1.9	—	+ 1.9	LSB	
Zero transition voltage	V_{OT}	AV_{SS} − 1.5 LSB	AV_{SS} + 0.5 LSB	AV_{SS} + 2.5 LSB	V	Flash memory product : 2.7 V ≤ AV_{CC} ≤ 3.3 V MASK ROM product : 2.7 V ≤ AV_{CC} ≤ 3.6 V
		AV_{SS} − 0.5 LSB	AV_{SS} + 1.5 LSB	AV_{SS} + 3.5 LSB	V	1.8 V ≤ AV_{CC} < 2.7 V
Full-scale transition voltage	V_{FST}	AVR − 3.5 LSB	AVR − 1.5 LSB	AVR + 0.5 LSB	V	Flash memory product : 2.7 V ≤ AV_{CC} ≤ 3.3 V MASK ROM product : 2.7 V ≤ AV_{CC} ≤ 3.6 V
		AVR − 2.5 LSB	AVR − 0.5 LSB	AVR + 1.5 LSB	V	1.8 V ≤ AV_{CC} < 2.7 V
Compare time	—	1.3	—	140	µs	Flash memory product : 2.7 V ≤ AV_{CC} ≤ 3.3 V MASK ROM product : 2.7 V ≤ AV_{CC} ≤ 3.6 V
		20	—	140	µs	1.8 V ≤ AV_{CC} < 2.7 V
Sampling time	—	0.4	—	∞	µs	Flash memory product : 2.7 V ≤ AV_{CC} ≤ 3.3 V MASK ROM product : 2.7 V ≤ AV_{CC} ≤ 3.6 V external impedance < at 1.8 kΩ
		30	—	∞	µs	1.8 V ≤ AV_{CC} < 2.7 V external impedance < at 14.8 kΩ
Analog input current	I_{AIN}	−0.3	—	+ 0.3	µA	
Analog input voltage	V_{AIN}	AV_{SS}	—	AVR	V	
Reference voltage	—	AV_{SS} + 1.8	—	AV_{CC}	V	AVR pin
Reference voltage supply current	I_R	—	400	600	µA	AVR pin, During A/D operation
	I_{RH}	—	—	5	µA	AVR pin, At stop mode

(2) Notes on Using A/D Converter

- **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 charged 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 register value and operating frequency or decrease the external impedance so that the sampling time is longer than the minimum value. Also, if the sampling time cannot be sufficient, connect a capacitor of about 0.1 µF to the analog input pin.

- Analog input equivalent circuit

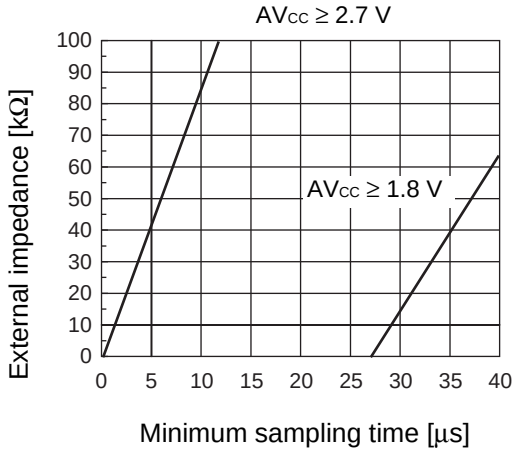


	R	C
2.7 V ≤ AV_{CC} ≤ 3.6 V	1.7 kΩ (Max)	14.5 pF (Max)
1.8 V ≤ AV_{CC} < 2.7 V	84 kΩ (Max)	25.2 pF (Max)

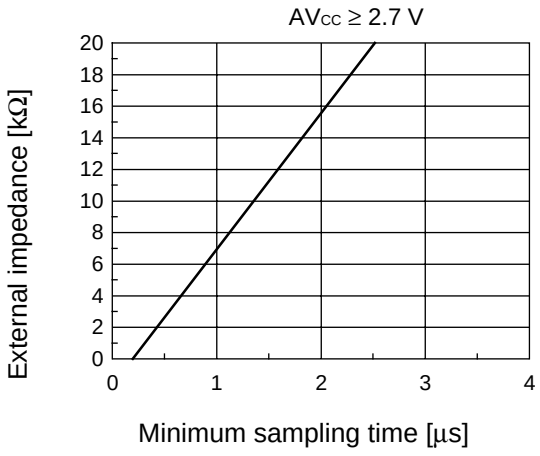
Note : The values are reference values.

- The relationship between external impedance and minimum sampling time

(External impedance = 0 kΩ to 100 kΩ)



(External impedance = 0 kΩ to 20 kΩ)



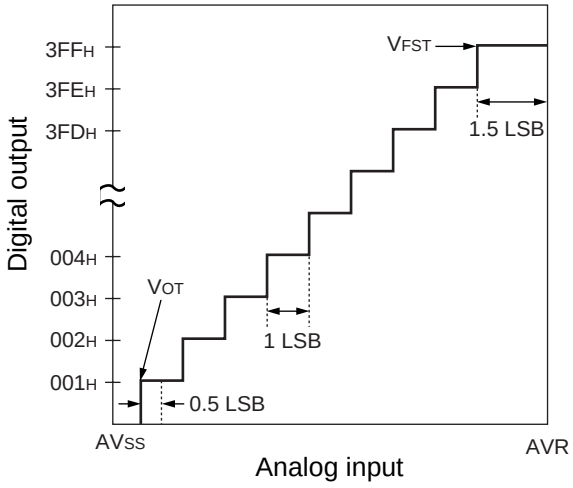
- **About errors**

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

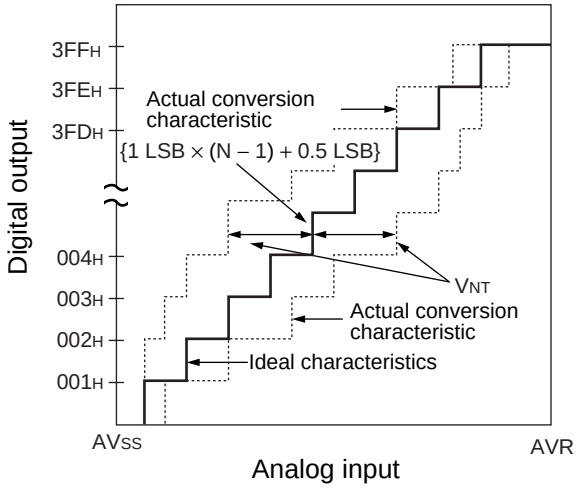
(3) Definition of A/D Converter Terms

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

Ideal I/O characteristics



Total error



$$1\ \text{LSB} = \frac{\text{AVR} - \text{AV}_{SS}}{1024}\ \text{(V)}$$

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

N : A/D converter digital output value
V_{NT} : A voltage at which digital output transits from (N - 1) to N.

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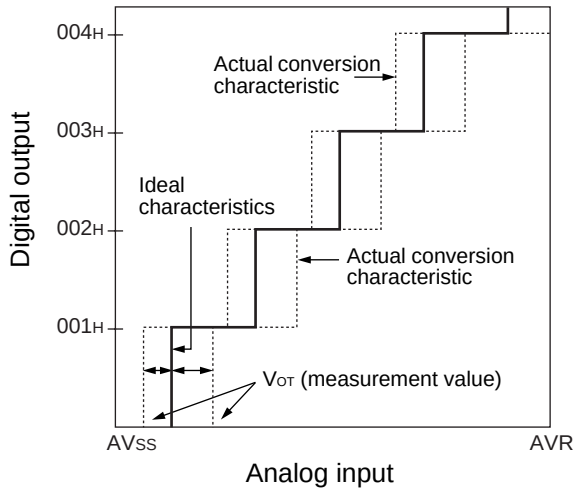
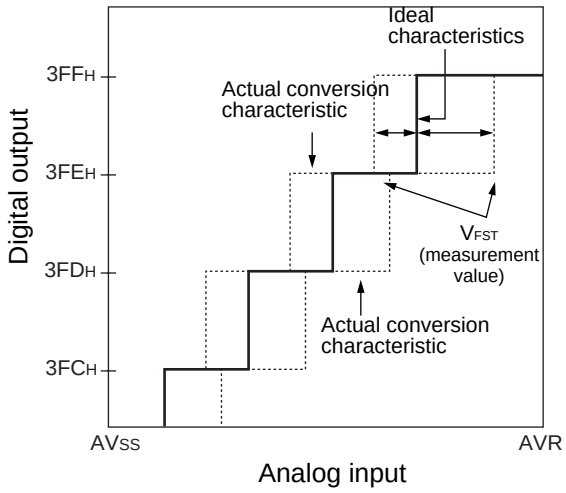
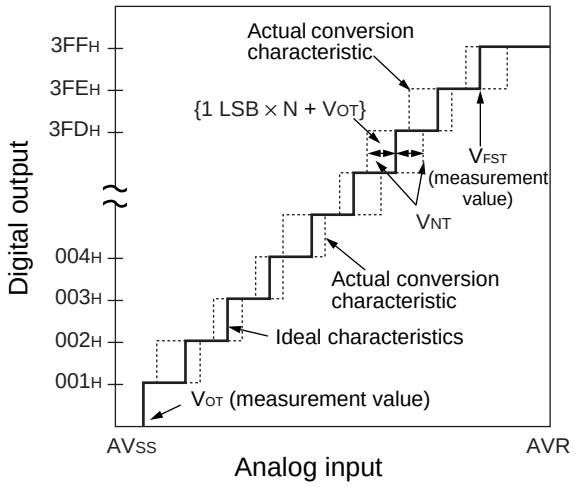
Zero transition error



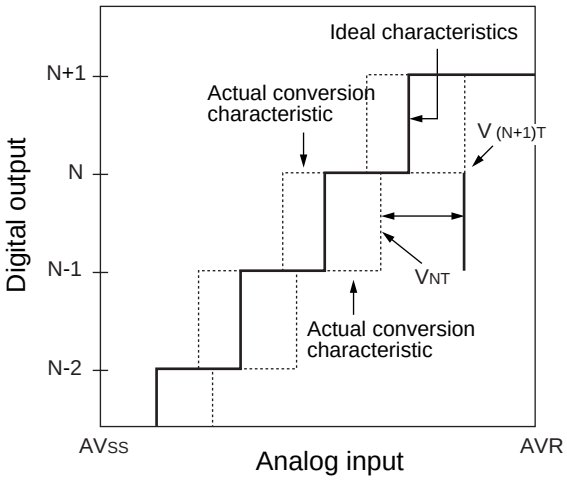
Full-scale transition error



Linearity error



Differential linear error



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

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

N : A/D converter digital output value
V_{NT} : A voltage at which digital output transits from (N - 1) to N.
V_{OT} (Ideal value) = AV_{SS} + 0.5 LSB [V]
V_{FST} (Ideal value) = AVR − 1.5 LSB [V]

6. Flash Memory Program/Erase Characteristics

Parameter	Value			Unit	Remarks
	Min	Typ	Max		
Sector erase time (4K bytes sector)	—	0.2*1	3.0*2	s	Excludes 00_H programming prior erasure.
Sector erase time (16K bytes sector)	—	0.5*1	12.0*2	s	Excludes 00_H programming prior erasure.
Byte programming time	—	32	3600	µs	Excludes system-level overhead.
Program/erase cycle	10000	—	—	cycle	
Power supply voltage at program/erase	2.7	—	3.3	V	
Flash memory data retention time	20*3	—	—	year	Average T_A = +85 °C

*1 : T_A = + 25 °C, V_{CC} = 3.0 V, 10000 cycles

*2 : T_A = + 85 °C, V_{CC} = 2.7 V, 10000 cycles

*3 : This value comes from the technology qualification (using Arrhenius equation to translate high temperature measurements into normalized value at +85 °C) .

7. FRAM Program Characteristics

Parameter	Value			Unit	Remarks
	Min	Typ	Max		
Read/write cycle*	10^{10}	—	—	cycle	
Power supply voltage at read/write	2.7	—	3.6	V	
Data retension time	10	—	—	year	T_A = 0 °C to +55 °C

* : Number of data read/write

■ MASK OPTION

No.	Part number	MB95107A MB95R107A	MB95F108AS MB95D108AS	MB95F108AW MB95D108AW	MB95FV100B-101
	Specifying procedure	**Specify when ordering MASK**	**Setting disabled**	**Setting disabled**	**Setting disabled**
1	Clock mode select*1 • Single-system clock mode • Dual-system clock mode	Selectable	Single-system clock mode	Dual-system clock mode	Changing by the switch on MCU board
2	FRAM*1 • With load of FRAM • Without load of FRAM	Specify by part number	Specify by part number	Specify by part number	No
3	Low voltage detection reset*2 • With low voltage detection reset • Without low voltage detection reset	No	No	No	No
4	Selection of oscillation stabilization wait time • Selectable the initial value of main clock oscillation stabilization wait time	Selectable 1 : $(2^2 - 2) / F_{CH}$ 2 : $(2^{12} - 2) / F_{CH}$ 3 : $(2^{13} - 2) / F_{CH}$ 4 : $(2^{14} - 2) / F_{CH}$	Fixed to oscillation stabilization wait time of $(2^{14} - 2) / F_{CH}$	Fixed to oscillation stabilization wait time of $(2^{14} - 2) / F_{CH}$	Fixed to oscillation stabilization wait time of $(2^{14} - 2) / F_{CH}$

*1 : Refer to table below about clock mode select and load of FRAM.

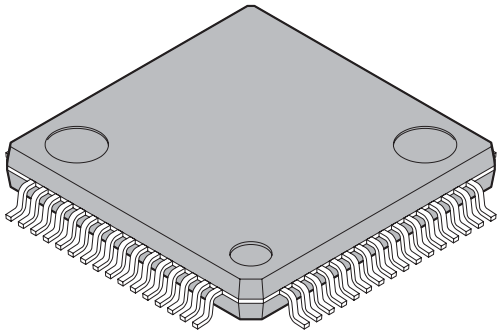
*2 : Low voltage detection reset is options of 5-V products.

Part number	Clock mode select	Load of FRAM
MB95107A	Single-system	No
	Dual-system	No
MB95F108AS	Single-system	No
MB95D108AS		Yes
MB95F108AW	Dual-system	No
MB95D108AW		Yes
MB95FV100B-101	Single-system	No
	Dual-system	No

■ ORDERING INFORMATION

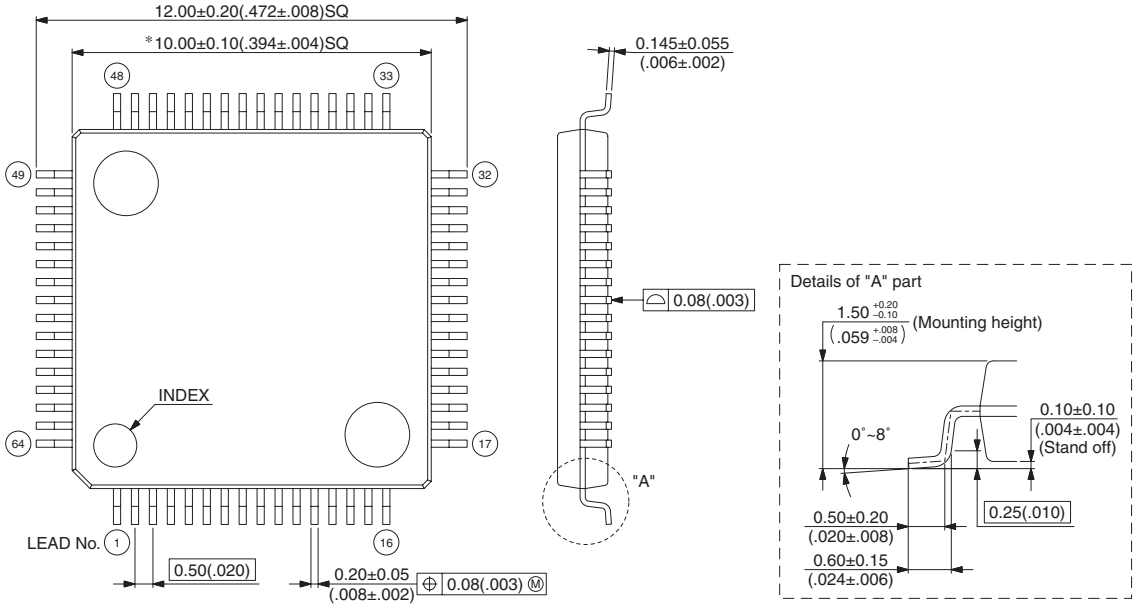
Part number	Package	Remarks
MB95107APFV MB95F108ASPFV MB95F108AWPFV MB95R107APFV MB95D108ASPFV MB95D108AWPFV	64-pin plastic LQFP (FPT-64P-M03)	
MB95107APFM MB95F108ASPFM MB95F108AWPFM MB95R107APFM MB95D108ASPFM MB95D108AWPFM	64-pin plastic LQFP (FPT-64P-M09)	
MB2146-301 (MB95FV100B-101PBT)	MCU board (224-pin plastic PFBGA (BGA-224P-M08))	

■ PACKAGE DIMENSIONS

64-pin plastic LQFP		
	Lead pitch	0.50 mm
	Package width × package length	10.0 × 10.0 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.70 mm MAX
	Weight	0.32g
(FPT-64P-M03)	Code (Reference)	P-LFQFP64-10×10-0.50

64-pin plastic LQFP
(FPT-64P-M03)

Note 1) * : These dimensions do not 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

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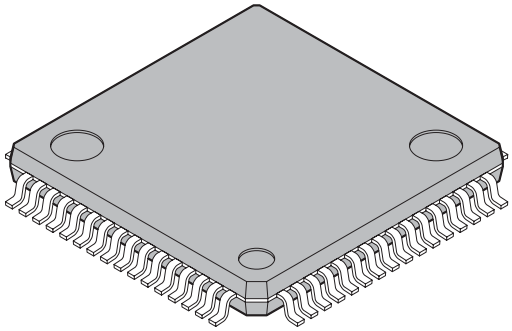
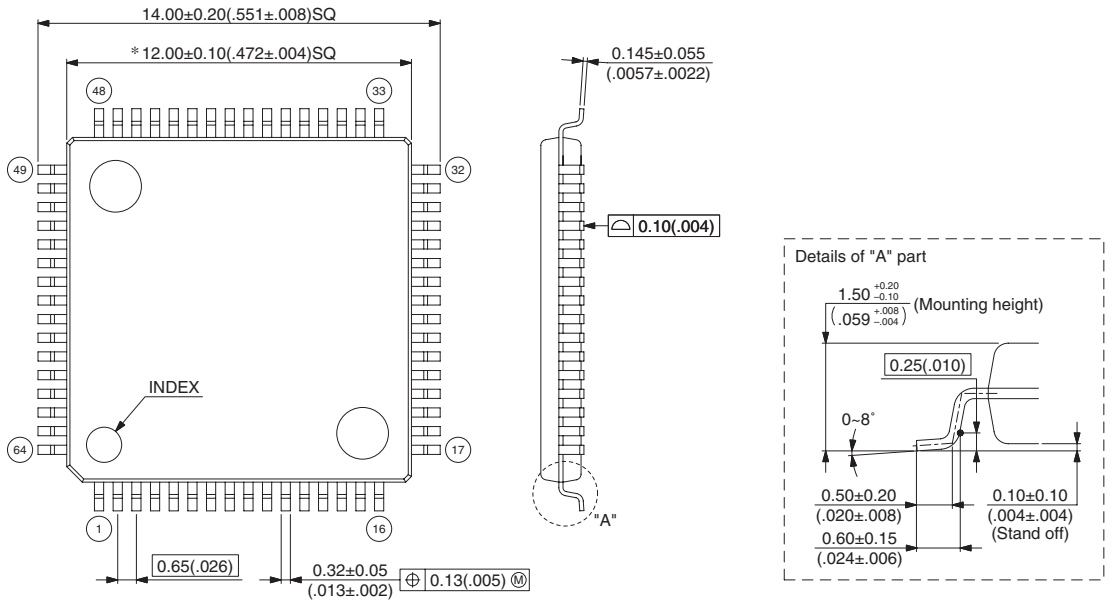
64-pin plastic LQFP		
 (FPT-64P-M09)	Lead pitch	0.65 mm
	Package width × package length	12 × 12 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.70 mm MAX
	Code (Reference)	P-LQFP64-12×12-0.65

64-pin plastic LQFP
(FPT-64P-M09)

Note 1) * : These dimensions do not 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.

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