FUJITSU SEMICONDUCTOR
DATA SHEET

DS07-12613-3E

8-bit Microcontroller

CMOS

F²MC-8FX MB95150M Series

MB95156M/F156M/F156N/F156J/FV100D-103

■ DESCRIPTION

The MB95150M series is general-purpose, single-chip microcontrollers. In addition to a compact instruction set, the microcontrollers contain a variety of peripheral functions.

Note : F²MC is the abbreviation of FUJITSU Flexible Microcontroller.

■ 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
  - Sub PLL clock

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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
    Can be used to interval timer, PWC timer, PWM timer and input capture.
  - 8/16-bit PPG × 2 channels
  - 16-bit PPG × 1 channel
  - Time-base timer × 1 channel
  - Watch prescaler × 1 channel
- LIN-UART × 1 channel
  - LIN function, clock asynchronous (UART) or clock synchronous (SIO) serial data transfer capable
  - Full duplex double buffer
- UART/SIO × 1 channel
  - Clock asynchronous (UART) or clock synchronous (SIO) serial data transfer capable
  - Full duplex double buffer
- External interrupt × 8 channels
  - 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 channels
  8-bit or 10-bit resolution can be selected.
- LCD controller (LCDC)
  - 16 SEG × 4 COM (Max 64 pixels)
  - With blinking function
- Low-power consumption (standby) mode
  - Stop mode
  - Sleep mode
  - Watch mode
  - Time-base timer mode
- I/O port: Max 39
  - General-purpose I/O ports (CMOS) : 39 ports
- Programmable input voltage levels of port
  Automotive input level / CMOS input level / hysteresis input level
- Flash memory security function
  Protects the content of Flash memory (Flash memory device only)

■ PRODUCT LINEUP

Parameter \ Part number		MB95156M	MB95F156M	MB95F156N	MB95F156J
Type		MASK ROM product	Flash memory product		
ROM capacity		32 Kbytes			
RAM capacity		1 Kbyte			
Reset output		Yes/No	Yes		No
Option*1	Clock system	Dual clock			
	Low voltage detection reset	Yes/No	No	Yes	
	Clock supervisor	Yes/No	No		Yes
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 : 61.5 ns (at machine clock frequency 16.25 MHz) Interrupt processing time : 0.6 μs (at machine clock frequency 16.25 MHz)			
Peripheral functions	Ports (Max 39 ports)	General-purpose I/O port (CMOS) : 39 ports Programmable input voltage levels of port : Automotive input level / CMOS input level / hysteresis input level			
	Time-base timer (1 channel)	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 : Min 250 ms			
	Wild register	Capable of replacing 3 bytes of ROM data			
	UART/SIO (1 channel)	Data transfer capable in UART/SIO Full duplex double buffer, variable data length (5/6/7/8-bit), built-in baud rate generator NRZ type transfer format, error detected function LSB-first or MSB-first can be selected. Clock asynchronous (UART) or clock synchronous (SIO) serial data transfer capable			
	LIN-UART (1 channel)	Dedicated reload timer allowing a wide range of communication speeds to be set. Full duplex double buffer Clock asynchronous (UART) or clock synchronous (SIO) serial data transfer capable LIN functions available as the LIN master or LIN slave.			
	8/10-bit A/D converter (8 channels)	8-bit or 10-bit resolution can be selected.			
	LCD controller (LCDC)	COM output : 4 (Max) SEG output : 16 (Max) LCD drive power supply (bias) pin : 4 16 SEG × 4 COM : 64 pixels can be displayed. Duty LCD mode Operable in LCD standby mode With blinking function Built-in division resistance for LCD drive			

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Parameter \ Part number		MB95156M	MB95F156M	MB95F156N	MB95F156J
Peripheral functions	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 waveform output Count clock : 7 internal clocks and external clock can be selected.			
	16-bit PPG (1 channel)	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	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 (1 channel)	4 selectable interval times (125 ms, 250 ms, 500 ms, or 1 s)			
	External interrupt (8 channels)	Interrupt by edge detection (rising, falling, or both edges can be selected.) Can be used to recover from standby modes.			
Flash memory		Supports automatic programming, Embedded Algorithm™ *2 Write/Erase/Erase-Suspend/Resume commands A flag indicating completion of the algorithm Number of write/erase cycles (Minimum) : 10000 times Data retention time : 20 years Boot block configuration Erase can be performed on each block Block protection with external programming voltage Flash Security Feature for protecting the content of the Flash			
Standby mode		Sleep, stop, watch, and time-base timer			

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

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

Note : Part number of evaluation products in MB95150M series is MB95FV100D-103. When using it, the MCU board (MB2146-303A) is required.

■ OSCILLATION STABILIZATION WAIT TIME

The initial value of the main clock oscillation stabilization wait time is fixed to the maximum value. The maximum value is shown as follows.

Oscillation stabilization wait time	Remarks
$(2^{14}–2) /F_{CH}$	Approx. 4.10 ms (at main oscillation clock 4 MHz)

■ PACKAGES AND CORRESPONDING PRODUCTS

Part number / Package	MB95156M	MB95F156M/F156N/F156J	MB95FV100D-103
FPT-48P-M26	○	○	×
FPT-52P-M01	○	○	×
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 MB95150M 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 MB95150M 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).

Also, as the read values of prohibited addresses on the evaluation product are different to the values on the Flash memory and MASK ROM products, do not use these values in the program.

The functions corresponding to certain bits in single-byte registers may not be supported on some mask ROM and Flash memory products. However, reading or writing to these bits will not cause malfunction of the hardware. Also, as the evaluation, Flash memory, and mask ROM products are designed to have identical software operation, no particular precautions are required.

• Difference of Memory Spaces

If the amount of memory on the Evaluation product is different from that of the Flash memory product 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 typically greater than for MASK ROM product.
- For details of current consumption, refer to “■ ELECTRICAL CHARACTERISTICS”.

• Package

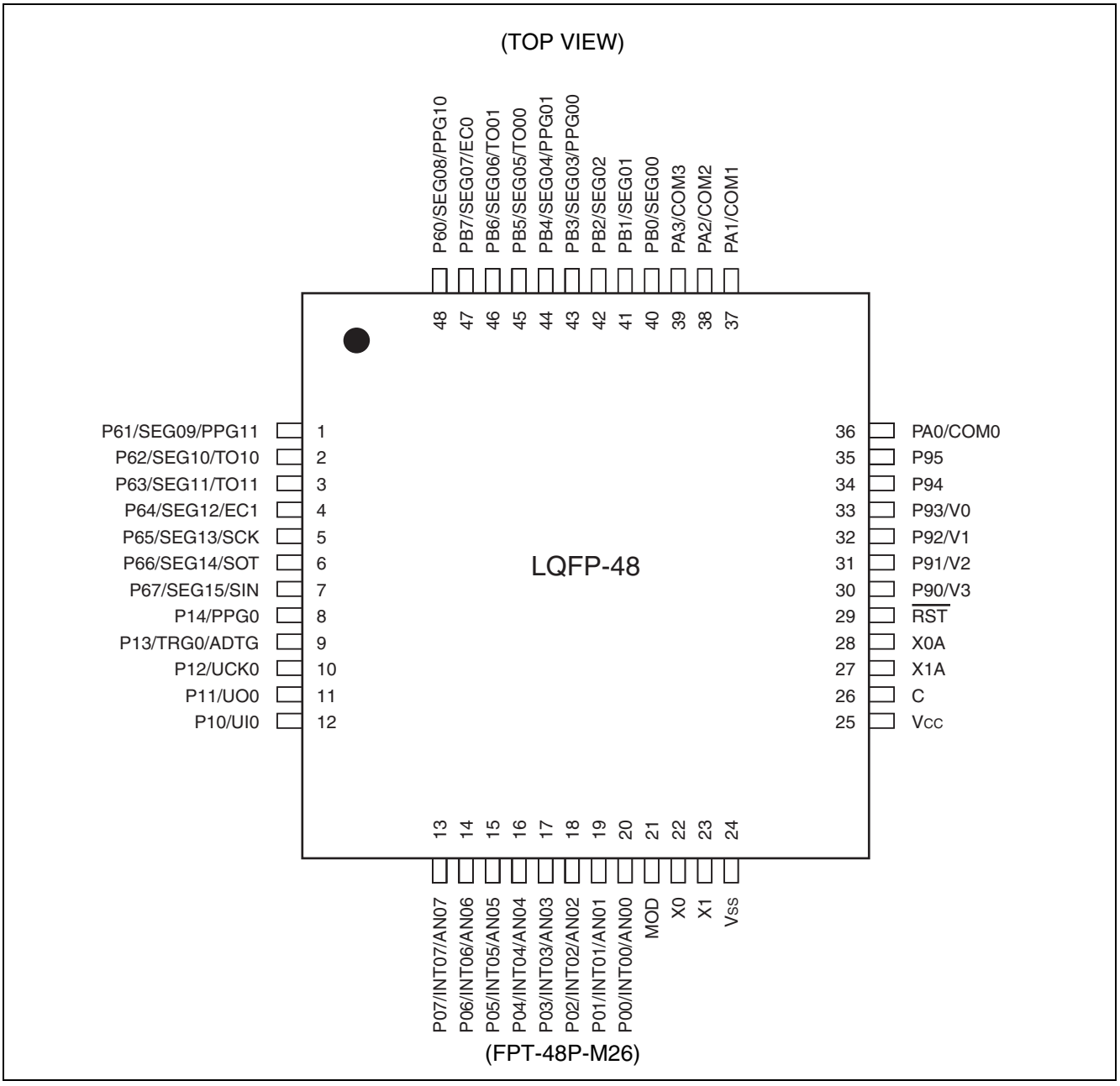
For details of information on each package, refer to “■ PACKAGES AND CORRESPONDING PRODUCTS” and “■ PACKAGE DIMENSIONS”.

• Operating voltage

The operating voltage are different between the Evaluation, Flash memory products, and MASK ROM product.

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

■ PIN ASSIGNMENT



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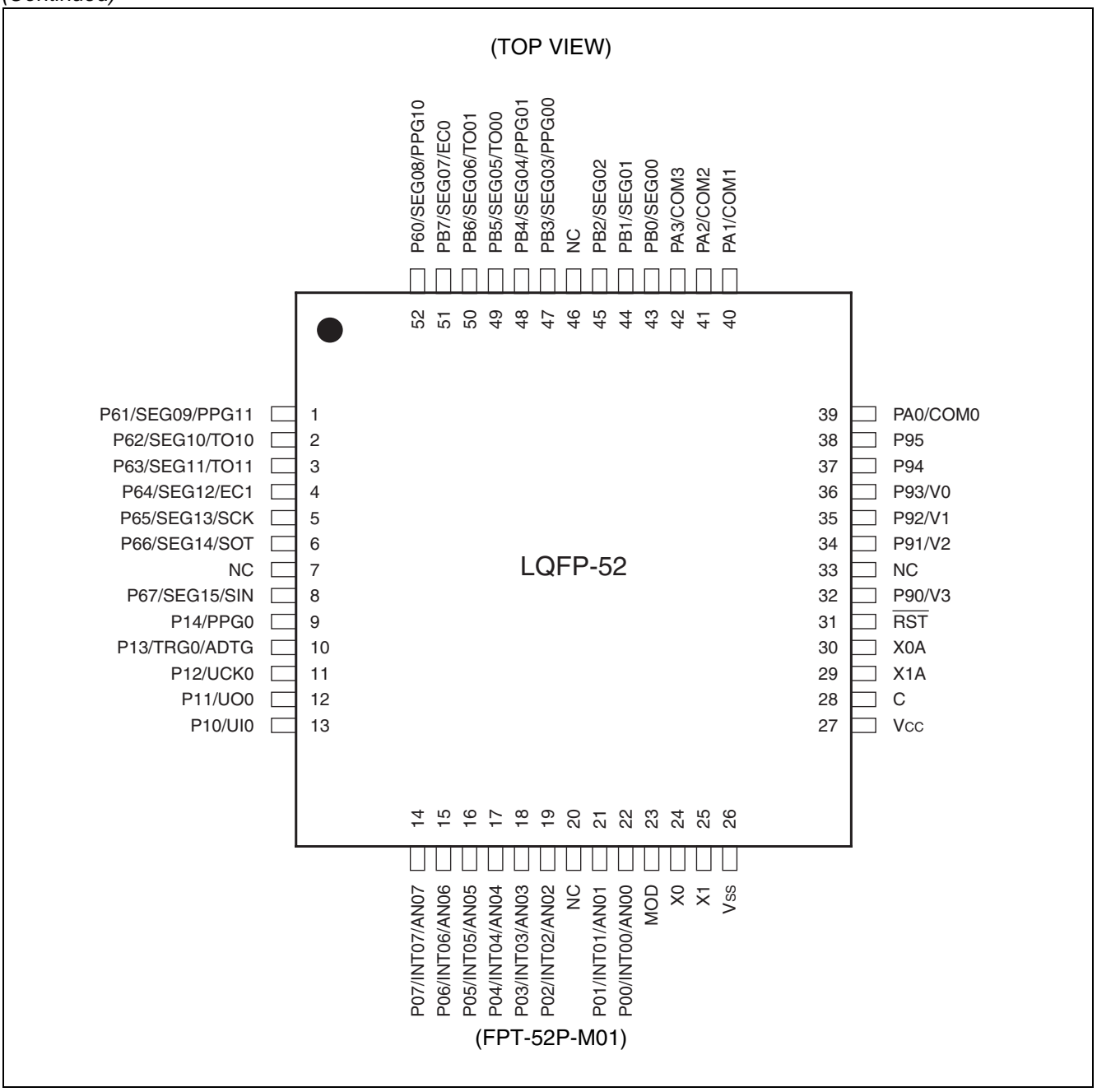
(TOP VIEW)
P60/SEG08/PPG10 52
PB7/SEG07/EC0 51
PB6/SEG06/TO01 50
PB5/SEG05/TO00 49
PB4/SEG04/PPG01 48
PB3/SEG03/PPG00 47
NC 46
PB2/SEG02 45
PB1/SEG01 44
PB0/SEG00 43
PA3/COM3 42
PA2/COM2 41
PA1/COM1 40
P61/SEG09/PPG11 1
P62/SEG10/TO10 2
P63/SEG11/TO11 3
P64/SEG12/EC1 4
P65/SEG13/SCK 5
P66/SEG14/SOT 6
NC 7
P67/SEG15/SIN 8
P14/PPG0 9
P13/TRG0/ADTG 10
P12/UCK0 11
P11/UO0 12
P10/UI0 13
LQFP-52
39 PA0/COM0
38 P95
37 P94
36 P93/V0
35 P92/V1
34 P91/V2
33 NC
32 P90/V3
31 RST
30 X0A
29 X1A
28 C
27 VCC
14 P07/INT07/AN07
15 P06/INT06/AN06
16 P05/INT05/AN05
17 P04/INT04/AN04
18 P03/INT03/AN03
19 P02/INT02/AN02
20 NC
21 P01/INT01/AN01
22 P00/INT00/AN00
23 MOD
24 X0
25 X1
26 VSS
(FPT-52P-M01)

■ PIN DESCRIPTION

Pin no.		Pin name	I/O circuit type*3	Function
LQFP*1	LQFP*2			
1	1	P61/SEG09/ PPG11	M	General-purpose I/O port. The pin is shared with LCDC SEG output (SEG09) and 8/16-bit PPG ch.1 output (PPG11).
2	2	P62/SEG10/TO10		General-purpose I/O port. The pins are shared with LCDC SEG output (SEG10, SEG11) and 8/16-bit compound timer ch.1 output (TO10, TO11) .
3	3	P63/SEG11/TO11		
4	4	P64/SEG12/EC1		General-purpose I/O port. The pin is shared with LCDC SEG output (SEG12) and 8/16-bit compound timer ch.1 clock input (EC1).
5	5	P65/SEG13/SCK		General-purpose I/O port. The pin is shared with LCDC SEG output (SEG13) and LIN-UART clock I/O (SCK) .
6	6	P66/SEG14/SOT		General-purpose I/O port. The pin is shared with LCDC SEG output (SEG14) and LIN-UART data output (SOT) .
7	8	P67/SEG15/SIN	N	General-purpose I/O port. The pin is shared with LCDC SEG output (SEG15) and LIN-UART data input (SIN) .
8	9	P14/PPG0	H	General-purpose I/O port. The pin is shared with 16-bit PPG ch.0 output (PPG0) .
9	10	P13/TRG0/ADTG		General-purpose I/O port. The pin is shared with 16-bit PPG ch.0 trigger input (TRG0) and A/D converter trigger input (ADTG) .
10	11	P12/UCK0		General-purpose I/O port. The pin is shared with UART/SIO ch.0 clock I/O (UCK0) .
11	12	P11/UO0		General-purpose I/O port. The pin is shared with UART/SIO ch.0 data output (UO0) .
12	13	P10/UI0	G	General-purpose I/O port. The pin is shared with UART/SIO ch.0 data input (UI0) .
13	14	P07/INT07/AN07	D	General-purpose I/O port. The pins are shared with external interrupt input (INT00 to INT07) and A/D converter analog input (AN00 to AN07).
14	15	P06/INT06/AN06		
15	16	P05/INT05/AN05		
16	17	P04/INT04/AN04		
17	18	P03/INT03/AN03		
18	19	P02/INT02/AN02		
19	21	P01/INT01/AN01		
20	22	P00/INT00/AN00		
21	23	MOD	B	The operating mode designation pin

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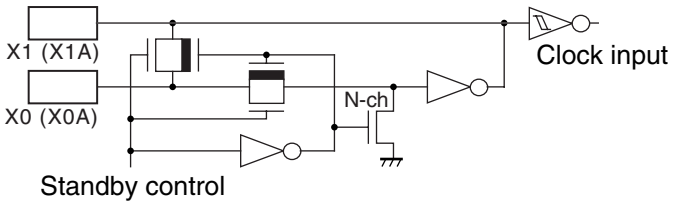
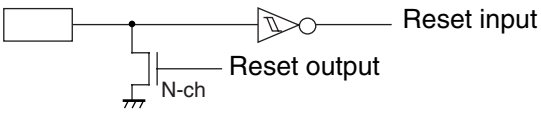
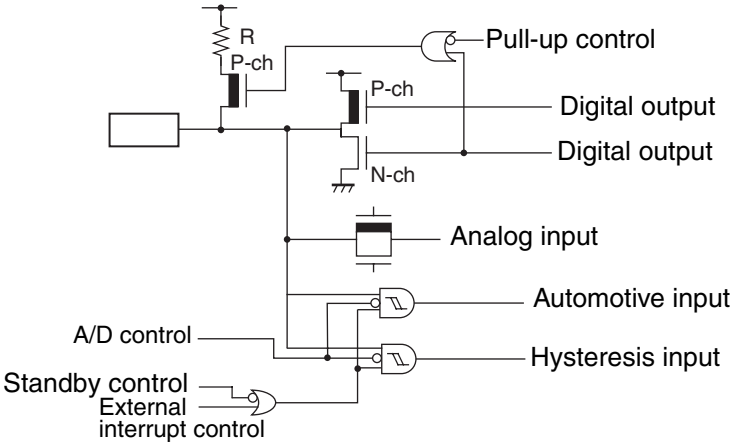
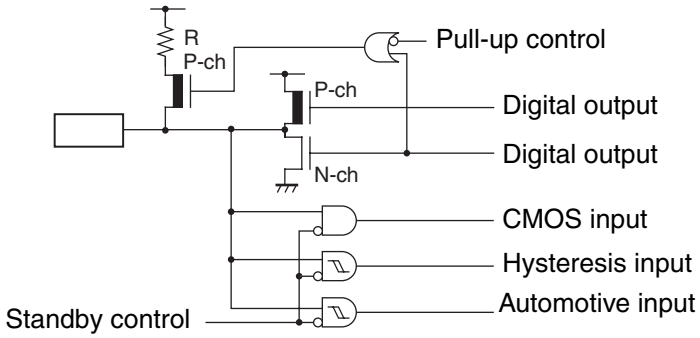
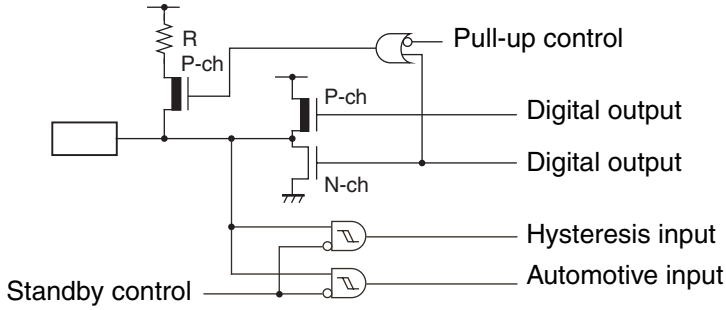
Pin no.		Pin name	I/O circuit type*3	Function
LQFP*1	LQFP*2			
22	24	X0	A	Main clock oscillation pins
23	25	X1		
24	26	V_{SS}	—	Power supply pin (GND)
25	27	V_{CC}	—	Power supply pin
26	28	C	—	Capacitor connection pin
27	29	X1A	A	Sub clock oscillation pins (32 kHz)
28	30	X0A		
29	31	$\overline{RST}$	B'	Reset pin
30	32	P90/V3	R	General-purpose I/O port. The pins are shared with power supply pin for LCDC drive (V0 to V3) .
31	34	P91/V2		
32	35	P92/V1		
33	36	P93/V0		
34	37	P94	S	General-purpose I/O port
35	38	P95		
36	39	PA0/COM0	M	General-purpose I/O port. The pins are shared with LCDC COM output (COM0 to COM3) .
37	40	PA1/COM1		
38	41	PA2/COM2		
39	42	PA3/COM3		
40	43	PB0/SEG00	M	General-purpose I/O port. The pins are shared with LCDC SEG output (SEG00 to SEG02) .
41	44	PB1/SEG01		
42	45	PB2/SEG02		
43	47	PB3/SEG03/ PPG00		General-purpose I/O port. The pins are shared with LCDC SEG output (SEG03, SEG04) and 8/16-bit PPG ch.0 output (PPG00, PPG01).
44	48	PB4/SEG04/ PPG01		
45	49	PB5/SEG05/TO00		General-purpose I/O port. The pins are shared with LCDC SEG output (SEG05, SEG06) and 8/16-bit compound timer ch.0 output (TO00, TO01).
46	50	PB6/SEG06/TO01		
47	51	PB7/SEG07/EC0		General-purpose I/O port. The pin is shared with LCDC SEG output (SEG07) and 8/16-bit compound timer ch.0 clock input (EC0).
48	52	P60/SEG08/ PPG10	M	General-purpose I/O port. The pin is shared with LCDC SEG output (SEG08) and 8/16-bit PPG ch.1 output (PPG10) .
—	7, 20, 33, 46	NC	—	Internal connect pins. Be sure this pin is left open.

*1 : FPT-48P-M26

*2 : FPT-52P-M01

*3 : 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 : approx. 1 MΩ • Low-speed side Feedback resistance : approx. 10 MΩ
B		• Only for input • Hysteresis input
B’		• Hysteresis input • Reset output
D		• CMOS output • Hysteresis input • Analog input • With pull-up control • Automotive input
G		• CMOS output • CMOS input • Hysteresis input • With pull-up control • Automotive input
H		• CMOS output • Hysteresis input • With pull-up control • Automotive input

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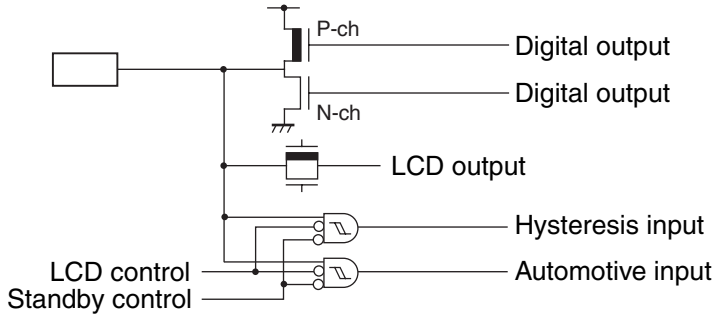
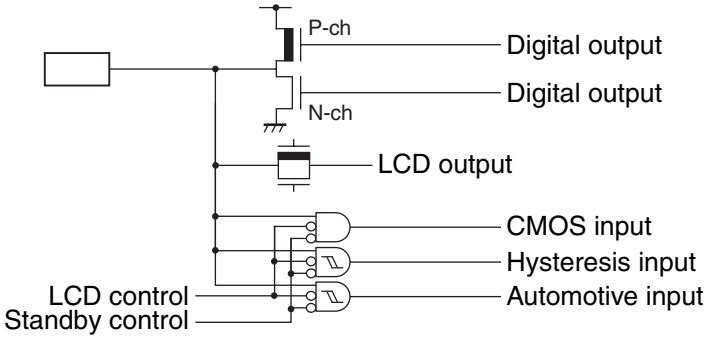
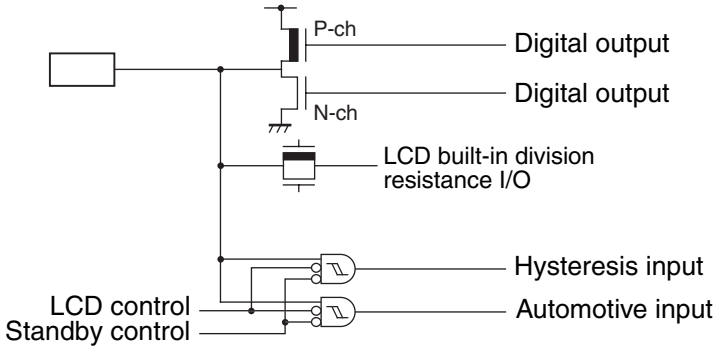
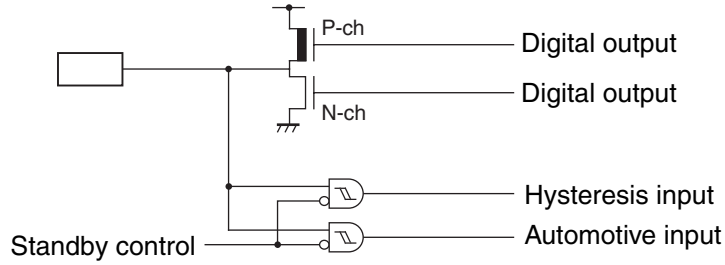
Type	Circuit	Remarks
M		• CMOS output • LCD output • Hysteresis input • Automotive input
N		• CMOS output • LCD output • CMOS input • Hysteresis input • Automotive input
R		• CMOS output • LCD power supply • Hysteresis input • Automotive input
S		• CMOS output • Hysteresis input • Automotive input

■ HANDLING 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.

• 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 Vcc power-supply voltage.

For stabilization, in principle, keep the variation in Vcc ripple (p-p value) in a commercial frequency range (50/60 Hz) not to exceed 10% of the standard Vcc 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 unused output pin, make it to open.

• 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.

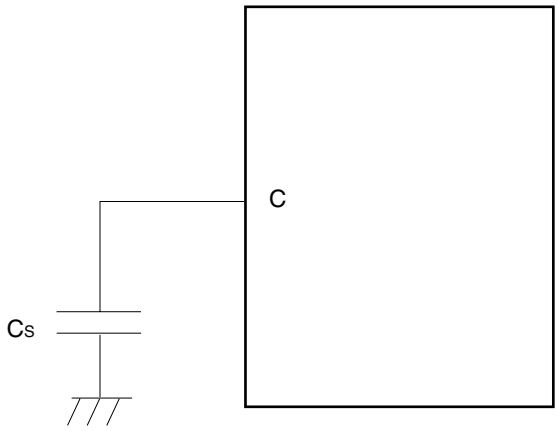
• Mode Pin (MOD)

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

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

Use a ceramic capacitor or a capacitor with equivalent frequency characteristics. A bypass capacitor of V_{CC} pin must have a capacitance value higher than C_S. For connection of smoothing capacitor C_S, refer to the diagram below.

• C pin connection diagram



• NC Pins

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

■ 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-48P-M26	TEF110-95F156HPFV	AF9708 (Ver 02.35G or more) AF9709/B (Ver 02.35G or more) AF9723+AF9834 (Ver 02.08E or more)
FPT-52P-M01	TEF110-95F156HPMC	

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:

• MB95F156M/F156N/F156J

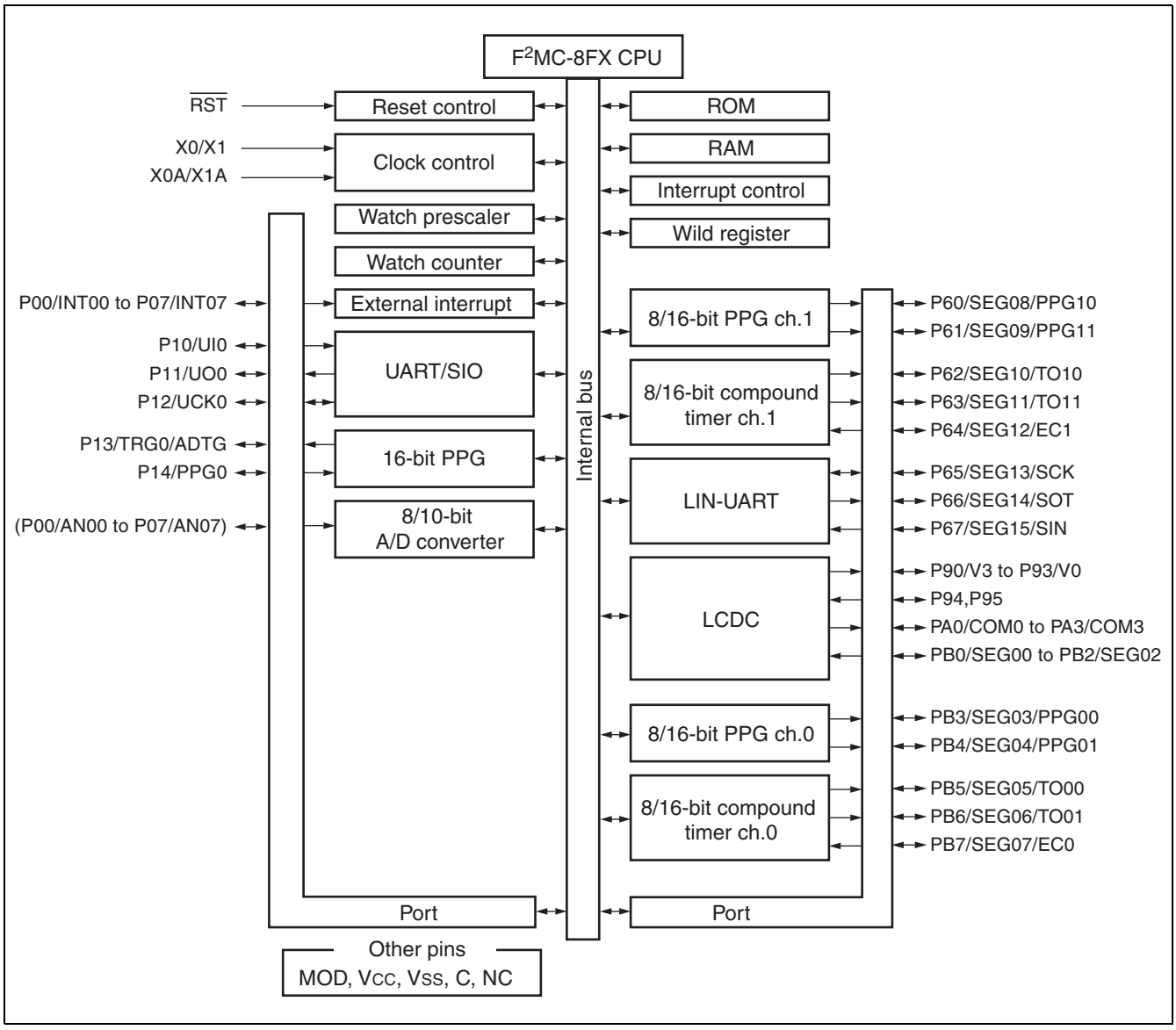
Flash memory	CPU address	Programmer address*
32 Kbytes	8000_H	18000_H
	$FFFF_H$	$1FFFF_H$

*: 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 17222.
2) Load program data to programmer addresses 18000_H to $1FFFF_H$.
3) Programmed by parallel programmer.

■ BLOCK DIAGRAM

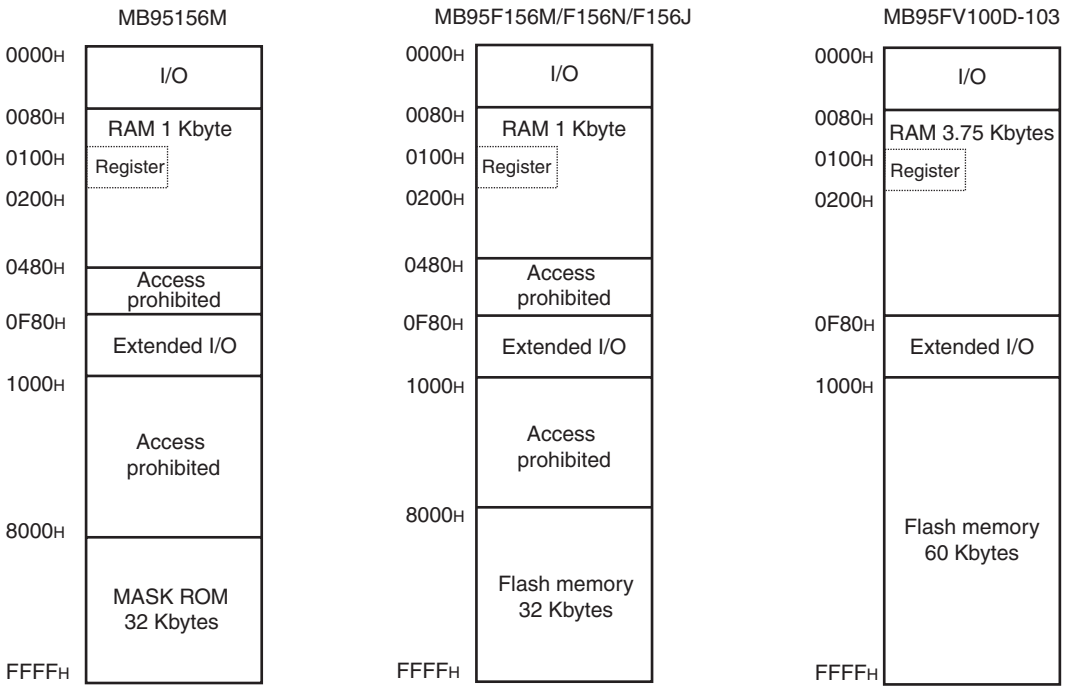


■ CPU CORE

1. Memory space

Memory space of the MB95150M series is 64 Kbytes 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 MB95150M series is shown below.

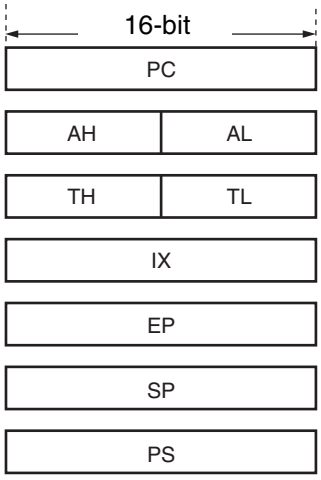
• Memory Map



2. Register

The MB95150M series has two types of registers; dedicated registers in the CPU and general-purpose registers in the memory. The dedicated registers are as follows:

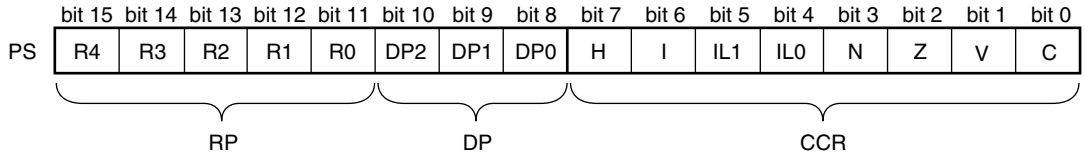
Program counter (PC)	:	A 16-bit register to indicate locations where instructions are stored.
Accumulator (A)	:	A 16-bit register for temporary storage of arithmetic operations. In the case of an 8-bit data processing instruction, the lower 1 byte is used.
Temporary accumulator (T)	:	A 16-bit register 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.



	Initial Value
: Program counter	$FFFD_H$
: Accumulator	0000_H
: Temporary accumulator	0000_H
: Index register	0000_H
: Extra pointer	0000_H
: Stack pointer	0000_H
: Program status	0030_H

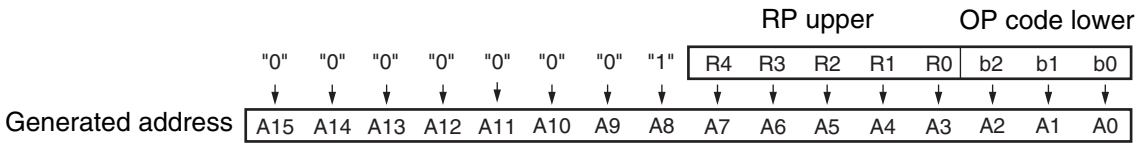
The PS can further be divided into higher 8 bits for use as a register bank pointer (RP) and a direct bank pointer (DP) and the lower 8 bits for use as a condition code register (CCR) . (Refer to the diagram below.)

• 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 set 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.

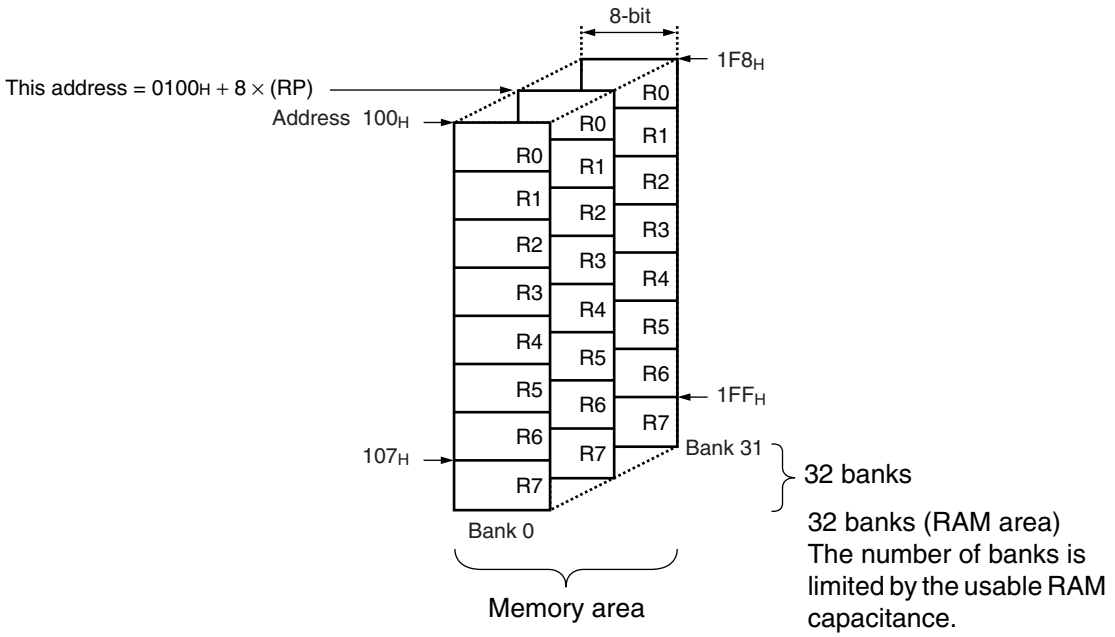
C flag : Set to “1” when a carry or a borrow from bit 7 occurs as a result of an arithmetic operation. Cleared to “0” otherwise. Set to the shift-out value in the case of a shift instruction.

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 MB95150M 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



■ I/O MAP

Address	Register abbreviation	Register name	R/W	Initial value
0000H	PDR0	Port 0 data register	R/W	00000000B
0001H	DDR0	Port 0 direction register	R/W	00000000B
0002H	PDR1	Port 1 data register	R/W	00000000B
0003H	DDR1	Port 1 direction register	R/W	00000000B
0004H	—	(Disabled)	—	—
0005H	WATR	Oscillation stabilization wait time setting register	R/W	11111111B
0006H	PLLC	PLL control register	R/W	00000000B
0007H	SYCC	System clock control register	R/W	1010X011B
0008H	STBC	Standby control register	R/W	00000000B
0009H	RSRR	Reset source register	R/W	XXXXXXXXB
000AH	TBTC	Time-base timer control register	R/W	00000000B
000BH	WPCR	Watch prescaler control register	R/W	00000000B
000CH	WDTC	Watchdog timer control register	R/W	00000000B
000DH to 0015H	—	(Disabled)	—	—
0016H	PDR6	Port 6 data register	R/W	00000000B
0017H	DDR6	Port 6 direction register	R/W	00000000B
0018H to 001BH	—	(Disabled)	—	—
001CH	PDR9	Port 9 data register	R/W	00000000B
001DH	DDR9	Port 9 direction register	R/W	00000000B
001EH	PDRA	Port A data register	R/W	00000000B
001FH	DDRA	Port A direction register	R/W	00000000B
0020H	PDRB	Port B data register	R/W	00000000B
0021H	DDRB	Port B direction register	R/W	00000000B
0022H to 002BH	—	(Disabled)	—	—
002CH	PUL0	Port 0 pull-up register	R/W	00000000B
002DH	PUL1	Port 1 pull-up register	R/W	00000000B
002EH to 0035H	—	(Disabled)	—	—

(Continued)

Address	Register abbreviation	Register name	R/W	Initial value
0036H	T01CR1	8/16-bit compound timer 01 control status register 1 ch.0	R/W	00000000B
0037H	T00CR1	8/16-bit compound timer 00 control status register 1 ch.0	R/W	00000000B
0038H	T11CR1	8/16-bit compound timer 11 control status register 1 ch.1	R/W	00000000B
0039H	T10CR1	8/16-bit compound timer 10 control status register 1 ch.1	R/W	00000000B
003AH	PC01	8/16-bit PPG1 control register ch.0	R/W	00000000B
003BH	PC00	8/16-bit PPG0 control register ch.0	R/W	00000000B
003CH	PC11	8/16-bit PPG1 control register ch.1	R/W	00000000B
003DH	PC10	8/16-bit PPG0 control register ch.1	R/W	00000000B
003EH to 0041H	—	(Disabled)	—	—
0042H	PCNTH0	16-bit PPG status control register (upper byte) ch.0	R/W	00000000B
0043H	PCNTL0	16-bit PPG status control register (lower byte) ch.0	R/W	00000000B
0044H to 0047H	—	(Disabled)	—	—
0048H	EIC00	External interrupt circuit control register ch.0/ch.1	R/W	00000000B
0049H	EIC10	External interrupt circuit control register ch.2/ch.3	R/W	00000000B
004AH	EIC20	External interrupt circuit control register ch.4/ch.5	R/W	00000000B
004BH	EIC30	External interrupt circuit control register ch.6/ch.7	R/W	00000000B
004CH to 004FH	—	(Disabled)	—	—
0050H	SCR	LIN-UART serial control register	R/W	00000000B
0051H	SMR	LIN-UART serial mode register	R/W	00000000B
0052H	SSR	LIN-UART serial status register	R/W	00001000B
0053H	RDR/TDR	LIN-UART reception/transmission data register	R/W	00000000B
0054H	ESCR	LIN-UART extended status control register	R/W	00000100B
0055H	ECCR	LIN-UART extended communication control register	R/W	000000XXB
0056H	SMC10	UART/SIO serial mode control register 1 ch.0	R/W	00000000B
0057H	SMC20	UART/SIO serial mode control register 2 ch.0	R/W	00100000B
0058H	SSR0	UART/SIO serial status register ch.0	R/W	00000001B
0059H	TDR0	UART/SIO serial output data register ch.0	R/W	00000000B
005AH	RDR0	UART/SIO serial input data register ch.0	R	00000000B
005BH to 006BH	—	(Disabled)	—	—

(Continued)

Address	Register abbreviation	Register name	R/W	Initial value
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$_B$
0078$_H$	—	Register bank pointer (RP) , Mirror of direct bank pointer (P)	—	—
0079$_H$	ILR0	Interrupt level setting register 0	R/W	11111111$_B$
007A$_H$	ILR1	Interrupt level setting register 1	R/W	11111111$_B$
007B$_H$	ILR2	Interrupt level setting register 2	R/W	11111111$_B$
007C$_H$	ILR3	Interrupt level setting register 3	R/W	11111111$_B$
007D$_H$	ILR4	Interrupt level setting register 4	R/W	11111111$_B$
007E$_H$	ILR5	Interrupt level setting register 5	R/W	11111111$_B$
007F$_H$	—	(Disabled)	—	—
0F80$_H$	WRARH0	Wild register address setting register (upper byte) ch.0	R/W	00000000$_B$
0F81$_H$	WRARL0	Wild register address setting register (lower byte) ch.0	R/W	00000000$_B$
0F82$_H$	WRDR0	Wild register data setting register ch.0	R/W	00000000$_B$
0F83$_H$	WRARH1	Wild register address setting register (upper byte) ch.1	R/W	00000000$_B$
0F84$_H$	WRARL1	Wild register address setting register (lower byte) ch.1	R/W	00000000$_B$
0F85$_H$	WRDR1	Wild register data setting register ch.1	R/W	00000000$_B$
0F86$_H$	WRARH2	Wild register address setting register (upper byte) ch.2	R/W	00000000$_B$
0F87$_H$	WRARL2	Wild register address setting register (lower byte) ch.2	R/W	00000000$_B$
0F88$_H$	WRDR2	Wild register data setting register ch.2	R/W	00000000$_B$
0F89$_H$ to 0F91$_H$	—	(Disabled)	—	—
0F92$_H$	T01CR0	8/16-bit compound timer 01 control status register 0 ch.0	R/W	00000000$_B$
0F93$_H$	T00CR0	8/16-bit compound timer 00 control status register 0 ch.0	R/W	00000000$_B$
0F94$_H$	T01DR	8/16-bit compound timer 01 data register ch.0	R/W	00000000$_B$

(Continued)

Address	Register abbreviation	Register name	R/W	Initial value
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
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 to 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 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 selection register ch.0	R/W	00000000B
0FBFH	BRSR0	UART/SIO dedicated baud rate generator baud rate setting register ch.0	R/W	00000000B
0FC0H to 0FC2H	—	(Disabled)	—	—

(Continued)

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Address	Register abbreviation	Register name	R/W	Initial value
0FC3H	AIDRL	A/D input disable register (lower byte)	R/W	00000000B
0FC4H	LCDCC	LCDC control register	R/W	00010000B
0FC5H	LCDCE1	LCDC enable register 1	R/W	00110000B
0FC6H	LCDCE2	LCDC enable register 2	R/W	00000000B
0FC7H	LCDCE3	LCDC enable register 3	R/W	00000000B
0FC8H to 0FCAH	—	(Disabled)	—	—
0FCBH	LCDCB1	LCDC blinking setting register 1	R/W	00000000B
0FCCH	LCDCB2	LCDC blinking setting register 2	R/W	00000000B
0FCDH to 0FD4H	LCDRAM	LCDC display RAM	R/W	00000000B
0FD5H to 0FE2H	—	(Disabled)	—	—
0FE3H	WCDR	Watch counter data register	R/W	00111111B
0FE4H to 0FE6H	—	(Disabled)	—	—
0FE7H	ILSR2	Input level select register 2	R/W	00000000B
0FE8H, 0FE9H	—	(Disabled)	—	—
0FEAH	CSVCR	Clock supervisor control register	R/W	00011100B
0FEBH 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.

■ 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]	
(Unused)	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]	
(Unused)	IRQ16	FFDA$_H$	FFDB$_H$	L16 [1 : 0]	
(Unused)	IRQ17	FFD8$_H$	FFD9$_H$	L17 [1 : 0]	
8/10-bit A/D converter	IRQ18	FFD6$_H$	FFD7$_H$	L18 [1 : 0]	
Time-base timer	IRQ19	FFD4$_H$	FFD5$_H$	L19 [1 : 0]	
Watch prescaler/Watch counter	IRQ20	FFD2$_H$	FFD3$_H$	L20 [1 : 0]	
(Unused)	IRQ21	FFD0$_H$	FFD1$_H$	L21 [1 : 0]	
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	Vcc	Vss − 0.3	Vss + 6.0	V	
Power supply voltage for LCD	V0 to V3	Vss − 0.3	Vss + 6.0	V	*2
Input voltage*1	V_I	Vss − 0.3	Vss + 6.0	V	*3
Output voltage*1	V_O	Vss − 0.3	Vss + 6.0	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_{OL}	—	15	mA	Applicable to pins*4
"L" level average current	I_{OLAV}	—	4	mA	Applicable to pins*4 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_{OH}	—	− 15	mA	Applicable to pins*4
"H" level average current	I_{OHAV}	—	− 4	mA	Applicable to pins*4 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)
Power consumption	Pd	—	320	mW	
Operating temperature	T_A	− 40	+ 85	°C	
Storage temperature	Tstg	− 55	+ 150	°C	

(Continued)

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

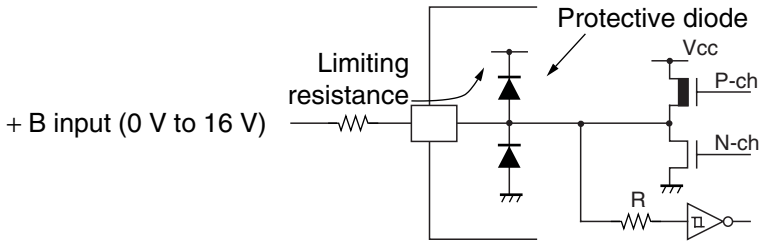
*2 : V0 to V3 should not exceed V_{CC} + 0.3 V.

*3 : V_I and Vo should not exceed V_{CC} + 0.3 V. V_I 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_I rating.

*4 : Applicable to pins : P00 to P07, P10 to P14, P60 to P67, P90 to P95, PA0 to PA3, PB0 to PB7

- Use within recommended operating conditions.
- Use at DC voltage (current).
- +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.
- Note that analog system input/output pins other than the A/D input pins (LCD drive pins, etc.) cannot accept + B signal input.
- 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

(Vss = 0.0 V)

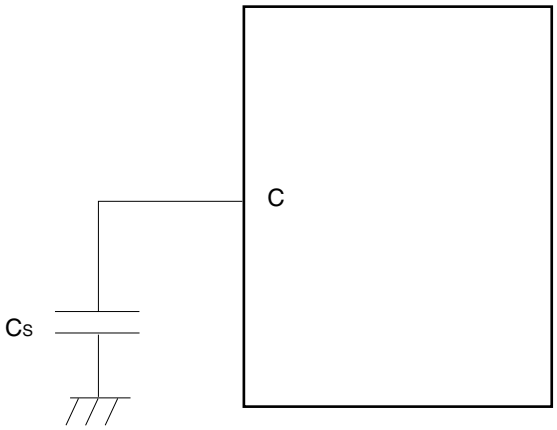
Parameter	Symbol	Conditions	Value		Unit	Remarks	
			Min	Max			
Power supply voltage	V_{CC}	—	2.4*1,*2	5.5*1	V	In normal operating	Other than MB95FV100D-103
			2.3	5.5		Hold condition in STOP mode	
			2.7	5.5		In normal operating	MB95FV100D-103
			2.3	5.5		Hold condition in STOP mode	
Power supply voltage for LCD	V0 to V3		V_{SS}	V_{CC}	V	The range of liquid crystal power supply (The optimal value depends on liquid crystal display elements used.)	
Smoothing capacitor	C_S		0.1	1.0	µF	*3	
Operating temperature	T_A		−40	+85	°C	Other than MB95FV100D-103	
			+5	+35	°C	MB95FV100D-103	

*1 : The values vary with the operating frequency, machine clock or analog guarantee range.

*2 : The value is 2.88 V when the low voltage detection reset is used.

*3 : Use a ceramic capacitor or a capacitor with equivalent frequency characteristics. A bypass capacitor of V_{CC} pin must have a capacitance value higher than C_S. For connection of smoothing capacitor C_S, refer to the diagram below.

- C pin connection diagram



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

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

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

3. DC Characteristics

(Vcc = 5.0 V ± 10%, Vss = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
"H" level input voltage	V_{IH1}	P10, P67	*1	0.7 V_{CC}	—	V_{CC} + 0.3	V	When selecting CMOS input level
	V_{IHA}	P00 to P07, P10 to P14, P60 to P67, P90 to P95, PA0 to PA3, PB0 to PB7	—	0.8 Vcc	—	Vcc + 0.3	V	Pin input at selecting of automotive input level
	V_{IHS1}		*1	0.8 V_{CC}	—	V_{CC} + 0.3	V	Hysteresis input
	V_{IHM}	$\overline{RST}$, MOD	—	0.8 V_{CC}	—	V_{CC} + 0.3	V	Hysteresis input
"L" level input voltage	V_{IL}	P10, P67	*1	V_{SS} – 0.3	—	0.3 V_{CC}	V	When selecting CMOS input level (Hysteresis input)
	V_{ILA}	P00 to P07, P10 to P14, P60 to P67, P90 to P95, PA0 to PA3, PB0 to PB7	—	V_{SS} – 0.3	—	0.5 Vcc	V	Pin input at selecting of automotive input level
	V_{ILS}		*1	V_{SS} – 0.3	—	0.2 V_{CC}	V	Hysteresis input
	V_{ILM}	$\overline{RST}$, MOD	—	V_{SS} – 0.3	—	0.2 V_{CC}	V	Hysteresis input
"H" level output voltage	V_{OH}	All output pins	I_{OH} = –4.0 mA	V_{CC}–0.5	—	—	V	
"L"level output voltage	V_{OL}	All output pins, $\overline{RST}$*2	I_{OL} = 4.0 mA	—	—	0.4	V	
Input leak current (Hi-Z output leak current)	I_{LI}	Port other than P00 to P07, P10 to P14	0.0 V < V_I < Vcc	–5	—	+5	µA	When specifying without pull-up resistance
Pull-up resistance	R_{PULL}	P00 to P07, P10 to P14	V_I = 0.0 V	25	50	100	kΩ	When specifying with pull-up resistance
Pull-down resistance	R_{MOD}	MOD	V_I = V_{CC}	50	100	200	kΩ	MASK ROM product only

(Continued)

(Vcc = 5.0 V ± 10%, Vss = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Power supply current*3	I_{CC}	Vcc (External clock operation)	V_{CC} = 5.5 V, F_{CH} = 20 MHz, F_{MP} = 10 MHz Main clock mode (divided by 2)	—	9.5	12.5	mA	Flash memory product (at other than Flash memory writing and erasing)
				—	30	35	mA	Flash memory product (at Flash memory writing and erasing)
				—	11.9	17.2	mA	Flash memory product (When A/D conversion)
				—	7.2	9.5	mA	MASK ROM product
				—	9.6	14.2	mA	MASK ROM product (When A/D conversion)
			V_{CC} = 5.5 V, F_{CH} = 32 MHz, F_{MP} = 16 MHz, Main clock mode (divided by 2)	—	15.2	20.0	mA	Flash memory product (at other than Flash memory writing and erasing)
				—	35.7	42.5	mA	Flash memory product (at Flash memory writing and erasing)
				—	19.0	27.5	mA	Flash memory product (When A/D conversion)
				—	11.6	15.2	mA	MASK ROM product
				—	15.4	22.7	mA	MASK ROM product (When A/D conversion)
	I_{CCS}		V_{CC} = 5.5 V, F_{CH} = 20 MHz, F_{MP} = 10 MHz Main sleep mode (divided by 2)	—	4.5	7.5	mA	
			V_{CC} = 5.5 V, F_{CH} = 32 MHz, F_{MP} = 16 MHz Main sleep mode (divided by 2)	—	7.2	12.0	mA	
	I_{CCL}		V_{CC} = 5.5 V, F_{CL} = 32 kHz, F_{MPL} = 16 kHz Sub clock mode (divided by 2) , T_A = + 25 °C	—	45	100	µA	

(Continued)

(Vcc = 5.0 V ± 10%, Vss = 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*3	I_{CCLS}	Vcc (External clock operation)	V_{CC} = 5.5 V, F_{CL} = 32 kHz, F_{MPL} = 16 kHz Sub sleep mode (divided by 2) , T_A = + 25 °C	—	10	81	µA	
	I_{CCT}		V_{CC} = 5.5 V, F_{CL} = 32 kHz Watch mode, Main stop mode T_A = + 25 °C	—	4.6	27.0	µA	
	I_{CCMPLL}		V_{CC} = 5.5 V, F_{CH} = 4 MHz, F_{MP} = 10 MHz Main PLL mode (multiplied by 2.5)	—	9.3	12.5	mA	Flash memory product
				—	7.0	9.5	mA	MASK ROM product
			V_{CC} = 5.5 V, F_{CH} = 6.4 MHz, F_{MP} = 16 MHz Main PLL mode (multiplied by 2.5)	—	14.9	20.0	mA	Flash memory product
				—	11.2	15.2	mA	MASK ROM product
	I_{CCSPLL}		V_{CC} = 5.5 V, F_{CL} = 32 kHz, F_{MPL} = 128 kHz Sub PLL mode (multiplied by 4) T_A = + 25 °C	—	160	400	µA	
	I_{CTS}		V_{CC} = 5.5 V, F_{CH} = 10 MHz Time-base timer mode T_A = + 25 °C	—	0.40	1.10	mA	
	I_{CCH}		V_{CC} = 5.5 V, Sub stop mode T_A = + 25 °C	—	3.5	20	µA	
LCD division resistance	R_{LCD}	—	Between V3 and V_{SS}	—	300	—	kΩ	
COM0 to COM3 output impedance	R_{VCOM}	COM0 to COM3	V1 to V3 = 5.0V	—	—	5	kΩ	
SEG00 to SEG15 output impedance	R_{VSEG}	SEG00 to SEG15		—	—	7	kΩ	

(Continued)

(Continued)

(Vcc = 5.0 V ± 10%, Vss = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
LCD leak current	I_{LCDL}	V0 to V3 COM0 to COM3 SEG00 to SEG15	—	−1	—	+1	µA	
Input capacitance	C_{IN}	Other than Vcc, Vss	f = 1 MHz	—	5	15	pF	

*1 : P10 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) .

*2 : Product without clock supervisor only

*3 :
- The power-supply current is determined by the external clock. When both low voltage detection option and clock supervisor are selected, the power-supply current will be a value of adding current consumption of the low voltage detection circuit (I_{LVD}) and current consumption of built-in CR oscillator (I_{CSV}) to the specified value.
- 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}.

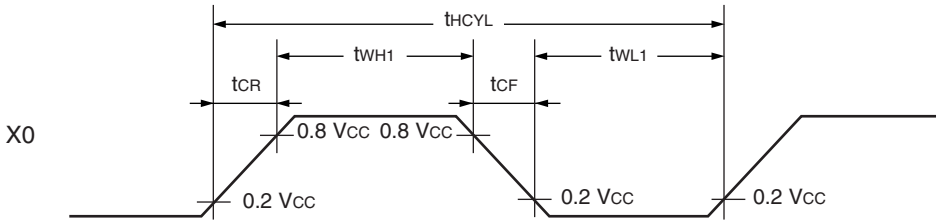
4. AC Characteristics

(1) Clock Timing

(Vcc = 2.4 V to 5.5 V, Vss = 0.0 V, T_A = − 40 °C to + 85 °C)

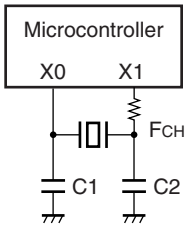
Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Clock frequency	F_{CH}	X0, X1	—	1.00	—	16.25	MHz	When using main oscillation circuit
				1.00	—	32.50	MHz	When using external clock
				3.00	—	10.00	MHz	Main PLL multiplied by 1
				3.00	—	8.13	MHz	Main PLL multiplied by 2
				3.00	—	6.50	MHz	Main PLL multiplied by 2.5
				3.00	—	4.06	MHz	Main PLL multiplied by 4
	F_{CL}	X0A, X1A		—	32.768	—	kHz	When using sub oscillation circuit
				—	32.768	—	kHz	When using sub PLL
Clock cycle time	t_{HCYL}	X0, X1		61.5	—	1000	ns	When using oscillation circuit
				30.8	—	1000	ns	When using external clock
	t_{LCYL}	X0A, X1A		—	30.5	—	µs	When using sub clock
Input clock pulse width	t_{WH1} t_{WL1}	X0		61.5	—	—	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		—	—	5	ns	When using external clock

• Input wave form for using external clock (main clock)

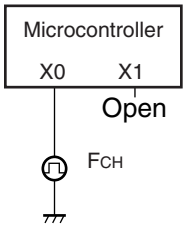


• Figure of main clock input port external connection

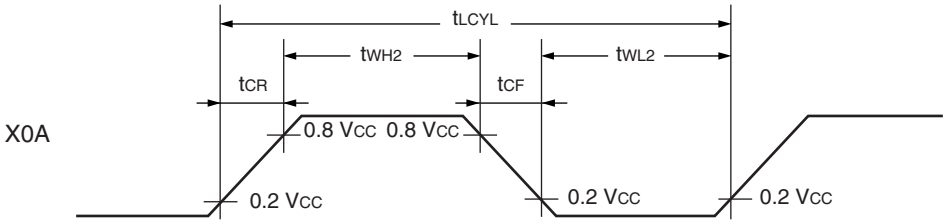
When using a crystal or ceramic oscillator



When using external clock

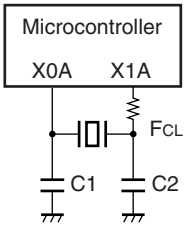


• Input wave form for using external clock (sub clock)

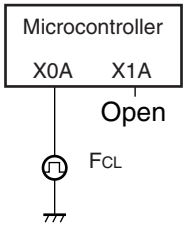


• Figure of sub clock input port external connection

When using a crystal or ceramic oscillator



When using external clock



(2) Source Clock/Machine Clock

(Vcc = 5.0 V ± 10%, Vss = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value Min	Value Typ	Value Max	Unit	Remarks
Source clock cycle time*1 (Clock before setting division)	t_{SCLK}	—	—	61.5	—	2000	ns	When using main clock Min : F_{CH} = 8.125 MHz, PLL multiplied by 2 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}	—		0.50	—	16.25	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}	—		61.5	—	32000	ns	When using main clock Min : F_{SP} = 16.25 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	—	16.250	MHz	When using main clock
	F_{MPL}			1.024	—	131.072	kHz	When using sub clock

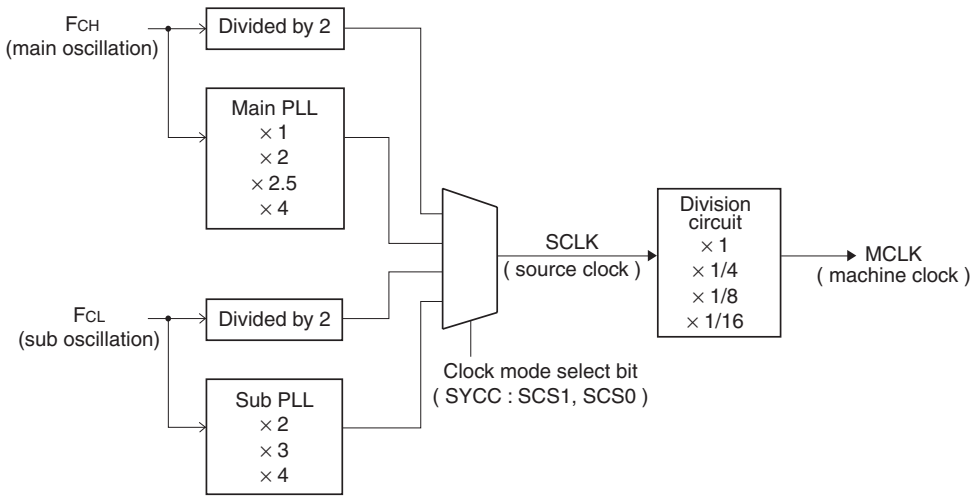
*1 : Clock before setting division due to machine clock division ratio selection bit (SYCC : DIV1 and DIV0) . This source clock is divided by the machine clock division ratio selection bit (SYCC : DIV1 and DIV0) , and it becomes the machine clock. Further, the source clock can be selected as follows.

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

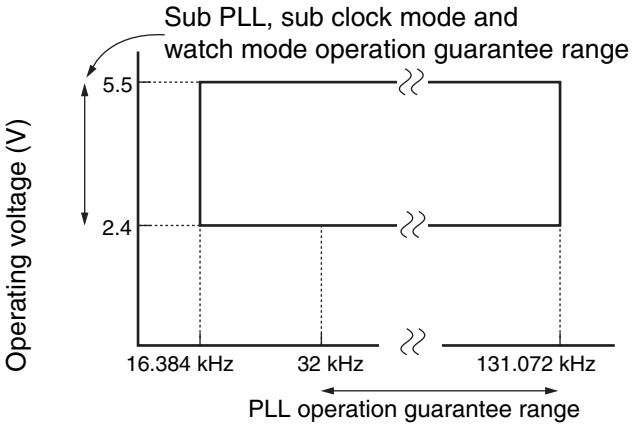
*2 : Operation clock of the microcontroller. Machine clock can be selected as follows.

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

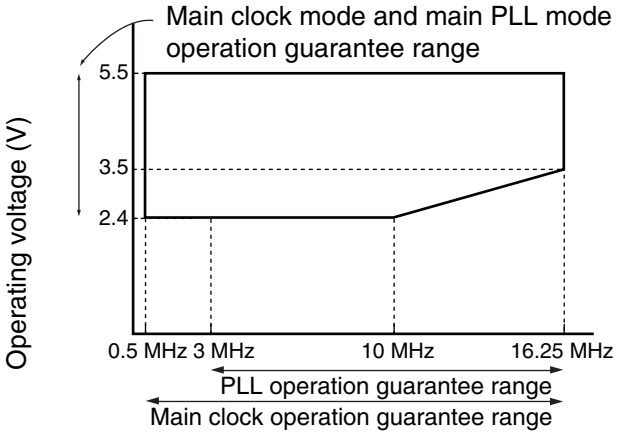
• Outline of clock generation block



- Operating voltage - Operating frequency (When $T_A = -40$ °C to $+85$ °C)
  - MB95156M/F156M/F156N/F156J

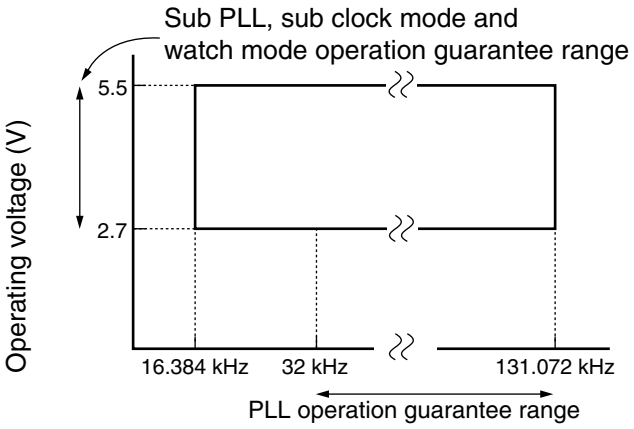


Source clock frequency (F_{SPL})

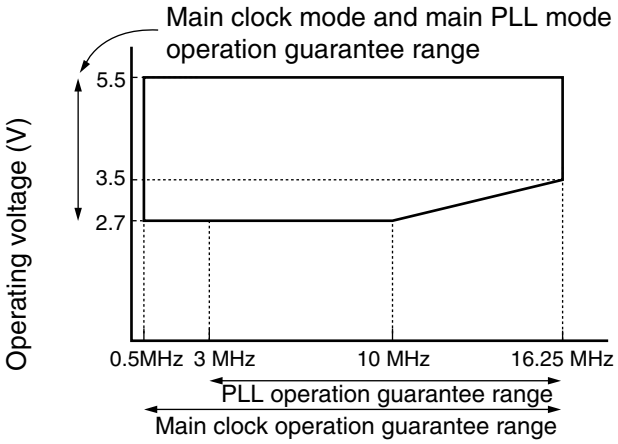


Source clock frequency (F_{SP})

- Operating voltage - Operating frequency (When $T_A = +5$ °C to $+35$ °C)
  - MB95FV100D-103

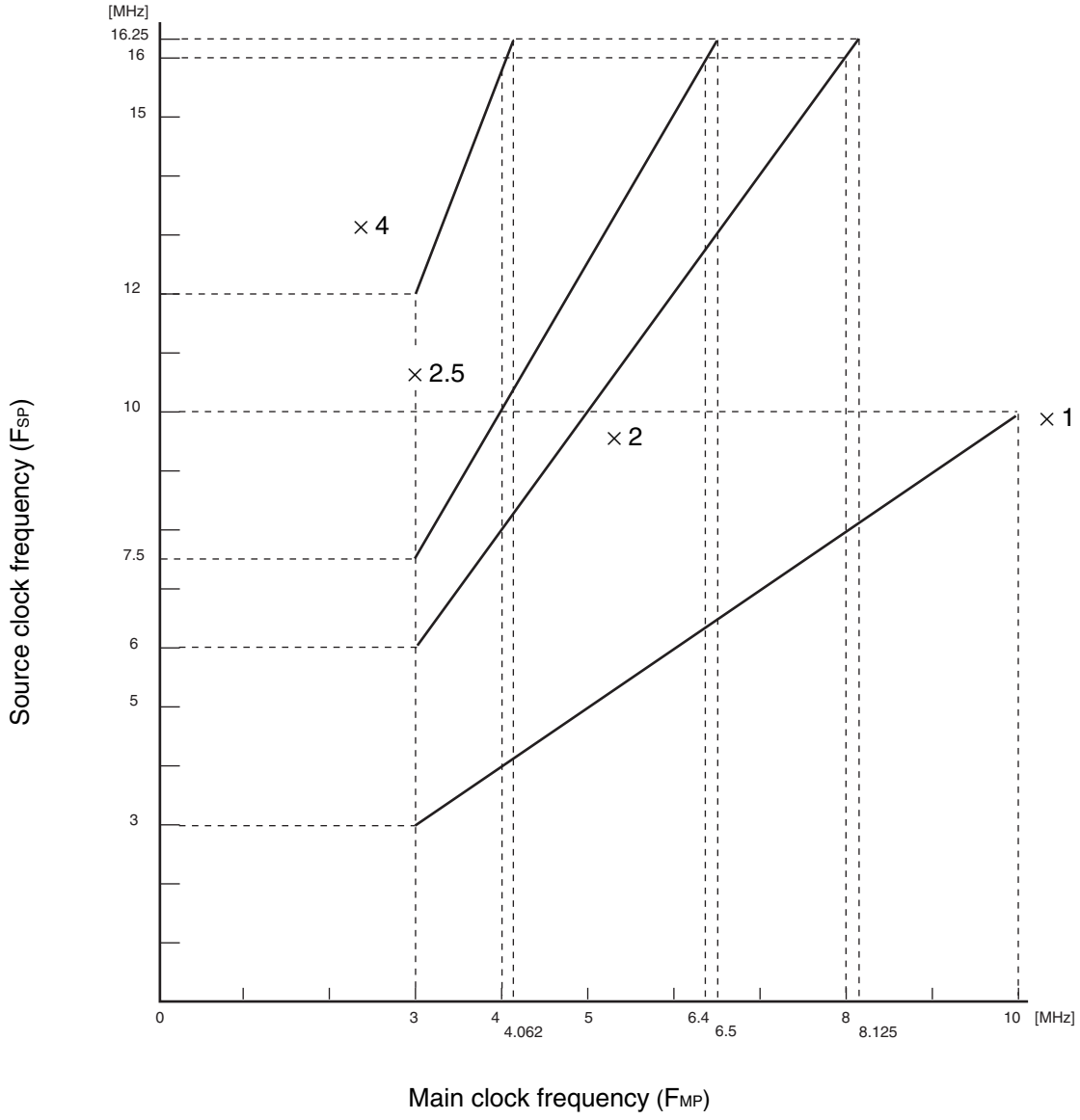


Source clock frequency (F_{SPL})



Source clock frequency (F_{SP})

• Main PLL operation frequency



(3) External Reset

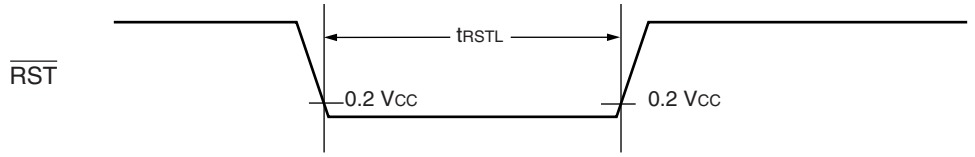
(Vcc = 5.0 V ± 10%, Vss = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
$\overline{RST}$ "L" level pulse width	t_{RSTL}	$\overline{RST}$	—	2 t_{MCLK}*1	—	ns	At normal operating
				Oscillation time of oscillator*2 + 100	—	µs	At stop mode, sub clock mode, sub sleep mode, and watch mode
				100	—	µs	At time-base timer mode

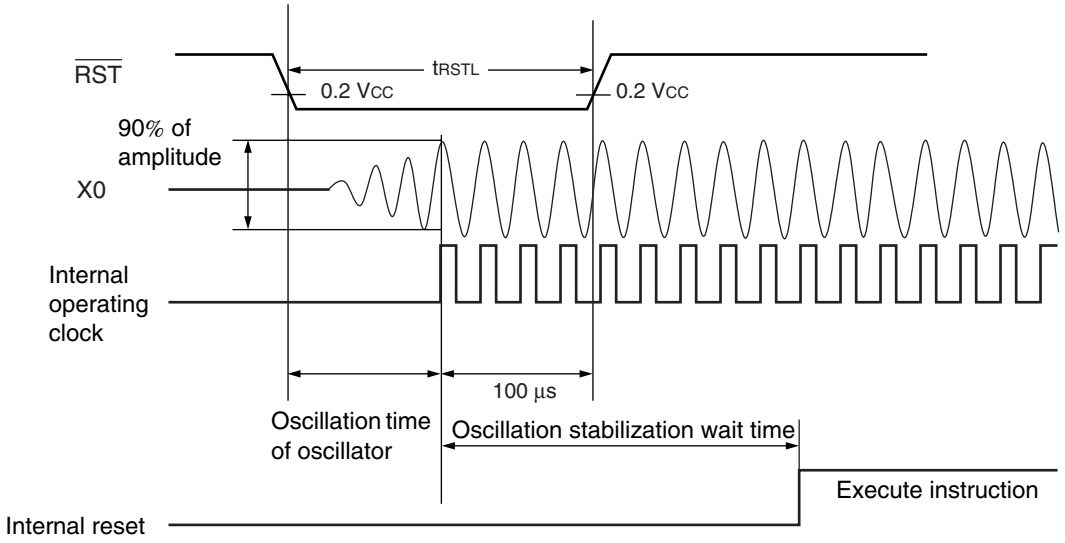
*1 : Refer to " (2) Source Clock/Machine Clock" for t_{MCLK}.

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

• At normal operating



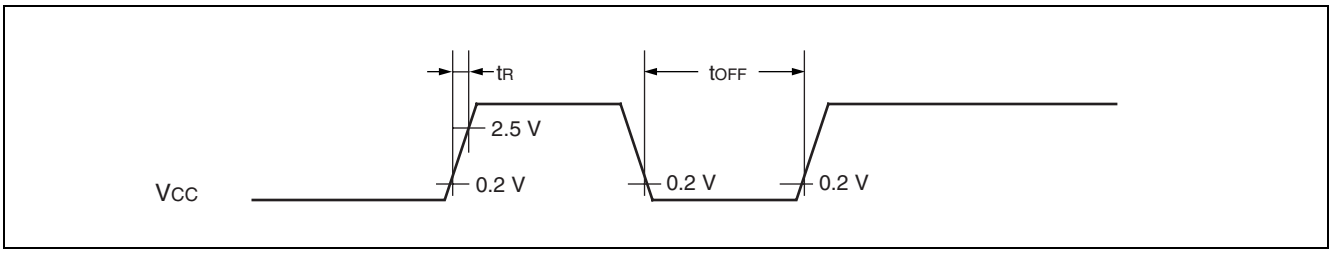
• At stop mode, sub clock mode, sub sleep mode, watch mode, and power-on



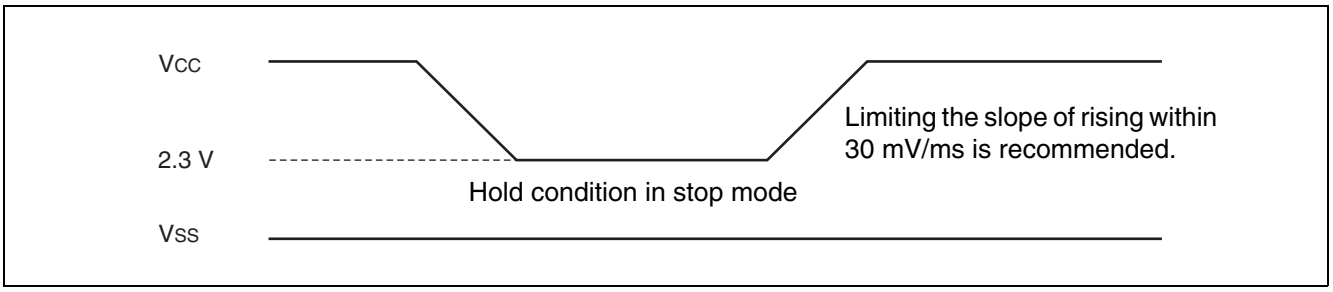
(4) Power-on Reset

(Vss = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Power supply rising time	t_R	V_{CC}	—	—	50	ms	
Power supply cutoff time	t_{OFF}			1	—	ms	Waiting time until power-on



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 30 mV/ms as shown below.

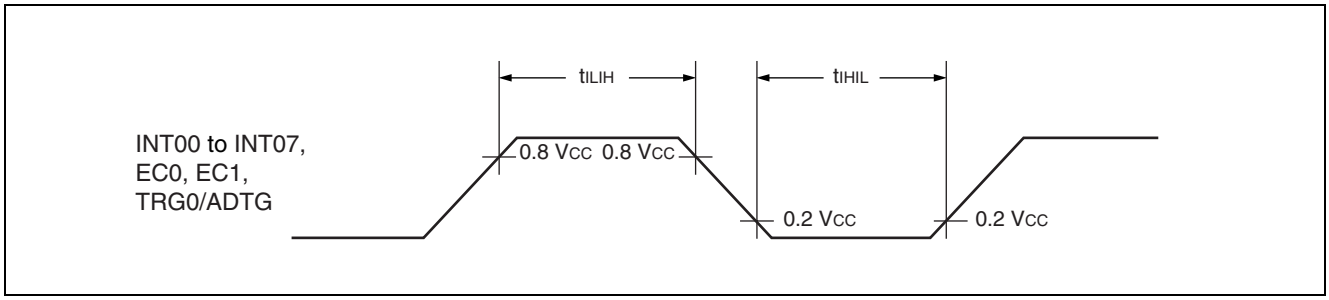


(5) Peripheral Input Timing

(Vcc = 5.0 V ± 10%, Vss = 0.0 V, T_A = − 40 °C to + 85 °C)

Parameter	Symbol	Pin name	Conditions	Value		Unit
				Min	Max	
Peripheral input “H” pulse width	t_{ILIH}	INT00 to INT07, EC0, EC1, TRG0/ADTG	—	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}.



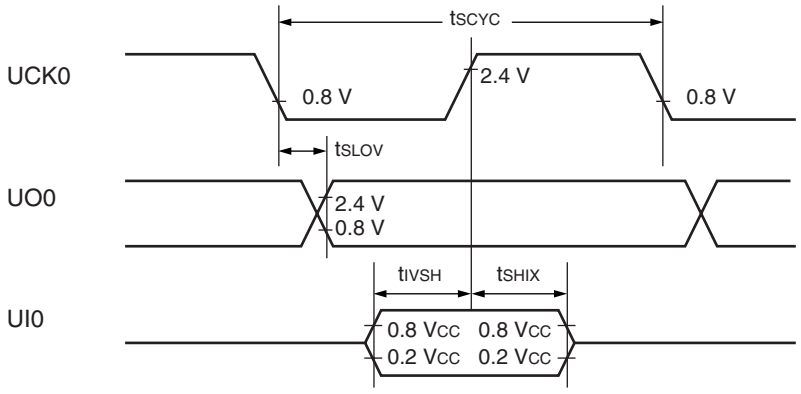
(6) UART/SIO, Serial I/O Timing

(Vcc = 5.0 V ± 10%, Vss = 0.0 V, T_A = − 40 °C to + 85 °C)

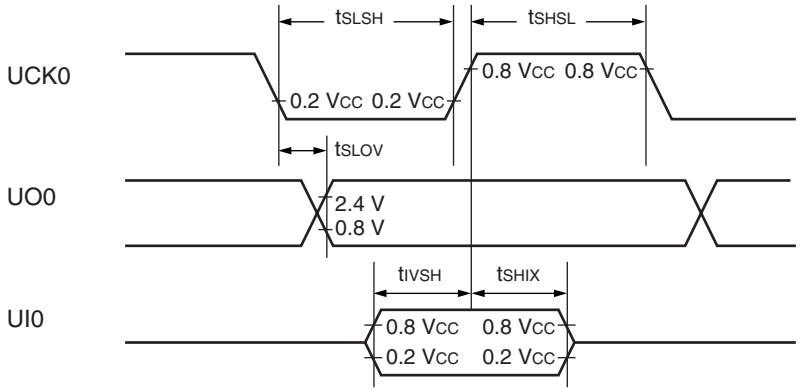
Parameter	Symbol	Pin name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	UCK0	Internal clock operation Output pin : C_L = 80 pF + 1TTL.	4 t_{MCLK}*	—	ns
UCK ↓ → UO time	t_{SLOV}	UCK0, UO0		− 190	+ 190	ns
Valid UI → UCK ↑	t_{IVSH}	UCK0, UI0		2 t_{MCLK}*	—	ns
UCK ↑ → valid UI hold 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		—	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)

(Vcc = 5.0 V ± 10%, Vss = 0.0 V, T_A = –40 °C to + 85 °C)

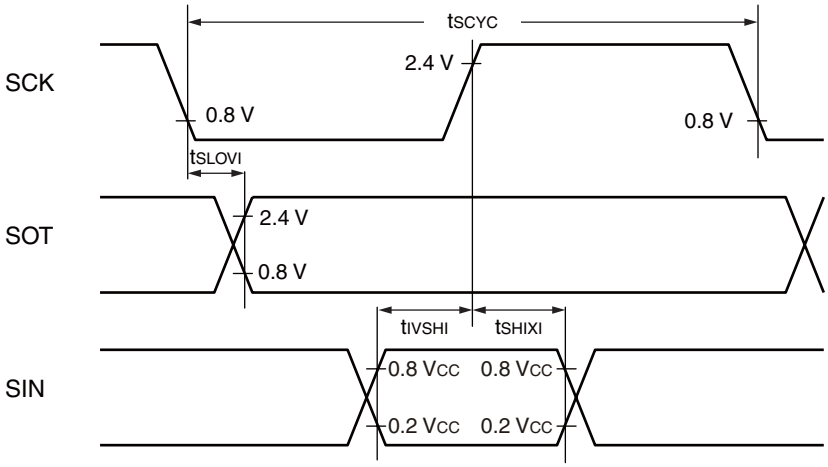
Parameter	Symbol	Pin name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operation output pin : C_L = 80 pF + 1 TTL.	5 t_{MCLK}*3	—	ns
SCK ↓ → SOT delay time	t_{SLOVI}	SCK, SOT		–95	+ 95	ns
Valid SIN → SCK ↑	t_{IVSHI}	SCK, SIN		t_{MCLK}*3 + 190	—	ns
SCK ↑ → valid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

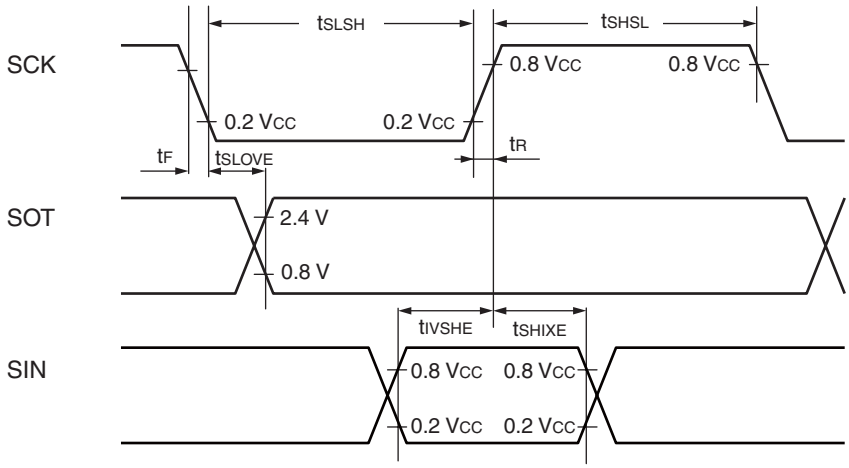
*2 : Serial clock delay function is used to delay half clock for the output signal of serial clock.

*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} = 5.0 V ± 10%, V_{SS} = 0.0 V, T_A = –40 °C to + 85 °C)

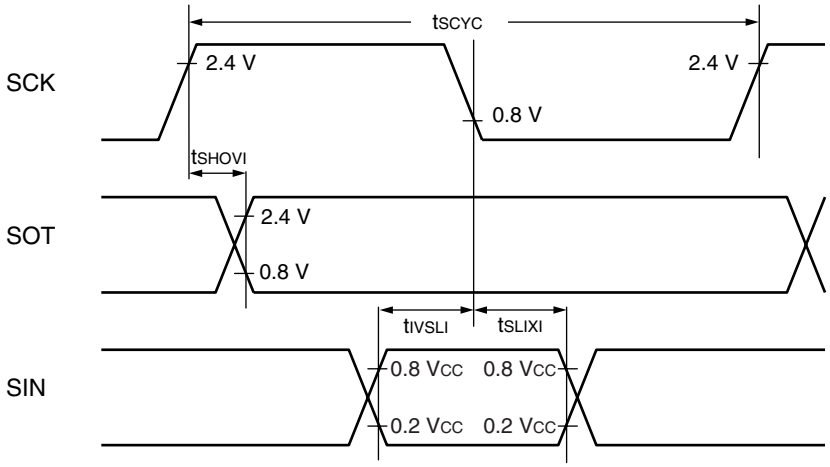
Parameter	Symbol	Pin name	Conditions	Value		Unit
				Min	Max	
Serial clock cycle time	t_{SCYC}	SCK	Internal clock operation output pin : C_L = 80 pF + 1 TTL.	5 t_{MCLK}*3	—	ns
SCK↑→ SOT delay time	t_{SHOVI}	SCK, SOT		–95	+ 95	ns
Valid SIN→SCK↓	t_{IVSLI}	SCK, SIN		t_{MCLK}*3 + 190	—	ns
SCK↓→ valid SIN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

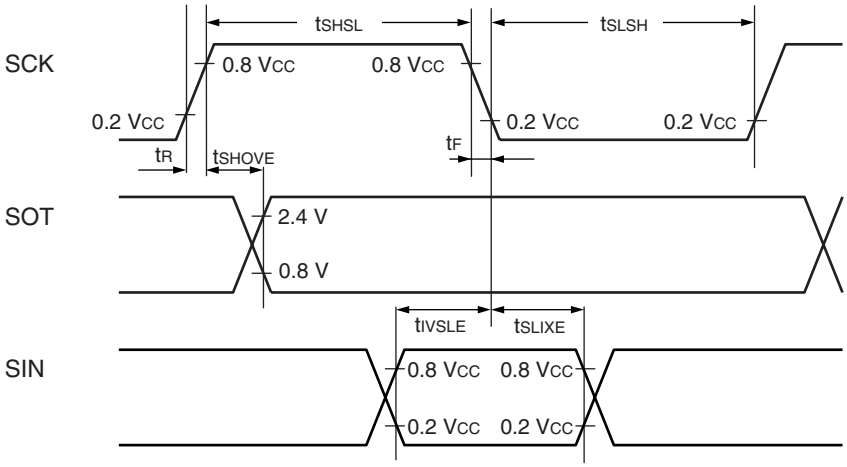
*2 : Serial clock delay function is used to delay half clock for the output signal of serial clock.

*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)

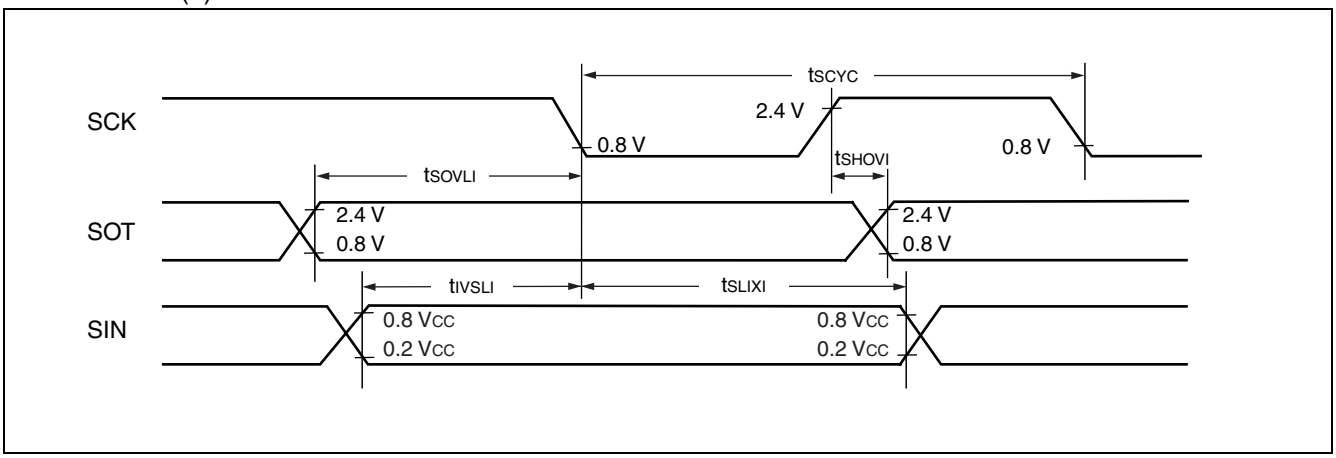
(V_{CC} = 5.0 V ± 10%, V_{SS} = 0.0 V, T_A = –40 °C to + 85 °C)

Parameter	Symbol	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)

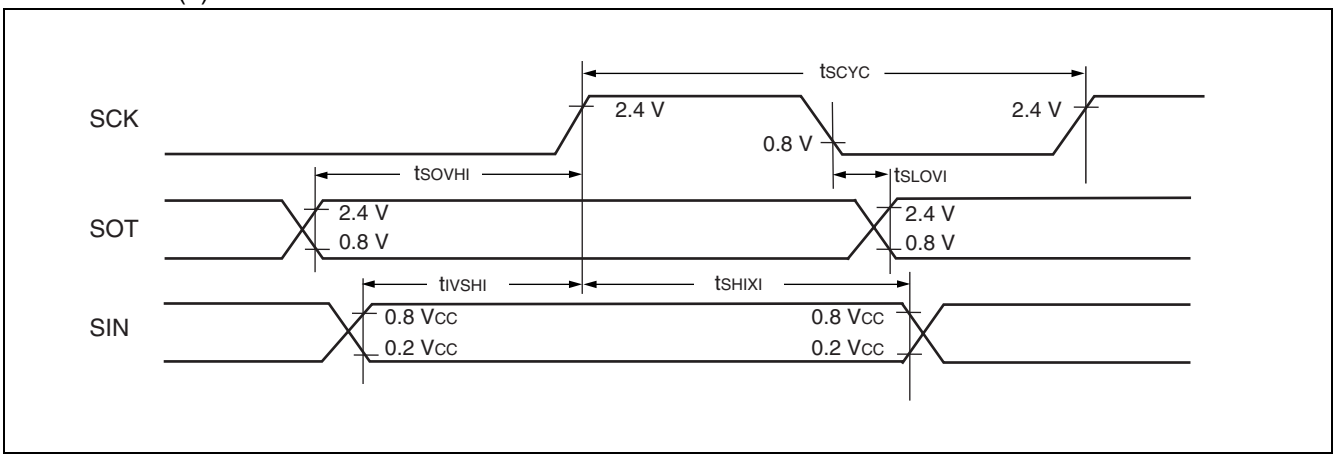
(V_{CC} = 5.0 V ± 10%, V_{SS} = 0.0 V, T_A = –40 °C to + 85 °C)

Parameter	Symbol	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
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.

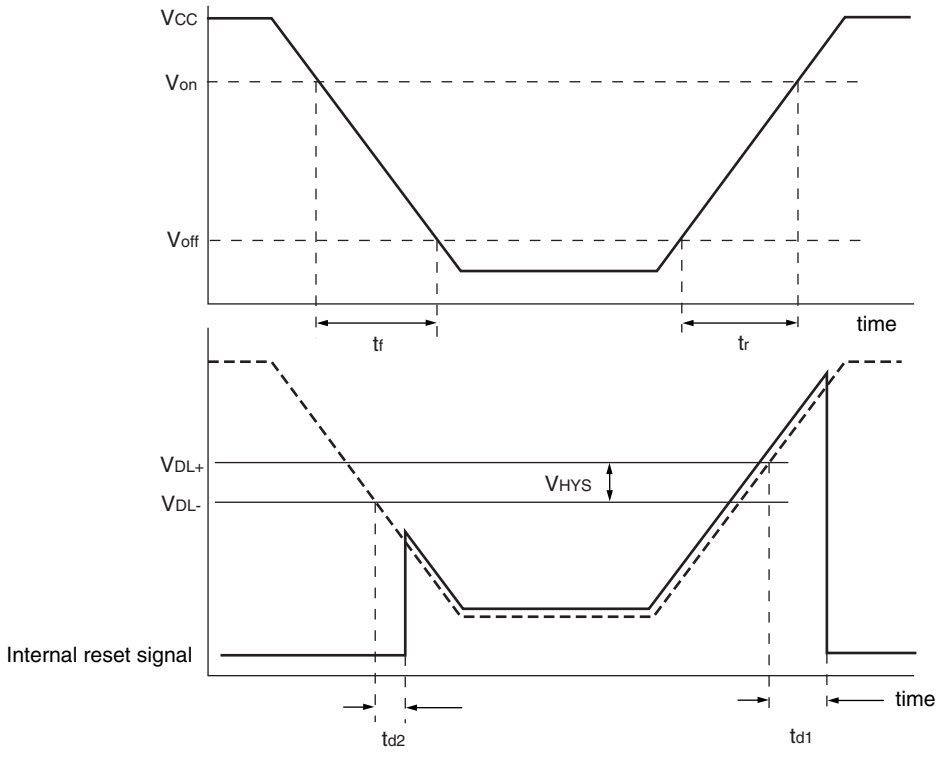
*3 : Refer to " (2) Source Clock/Machine Clock" for t_{MCLK}.



(8) Low Voltage Detection

(Vss = 0.0 V, T_A = –40 °C to + 85 °C)

Parameter	Symbol	Conditions	Value			Unit	Remarks
			Min	Typ	Max		
Release voltage	V_{DL+}	—	2.52	2.70	2.88	V	At power-supply rise
Detection voltage	V_{DL-}		2.42	2.60	2.78	V	At power-supply fall
Hysteresis width	V_{HYS}		70	100	—	mV	
Power-supply start voltage	V_{off}		—	—	2.3	V	
Power-supply end voltage	V_{on}		4.9	—	—	V	
Power-supply voltage change time (at power supply rise)	t_r		0.3	—	—	µs	Slope of power supply that reset release signal generates
			—	3000	—	µs	Slope of power supply that reset release signal generates within rating (V_{DL+})
Power-supply voltage change time (at power supply fall)	t_f		300	—	—	µs	Slope of power supply that reset detection signal generates
			—	300	—	µs	Slope of power supply that reset detection signal generates within rating (V_{DL-})
Reset release delay time	t_{d1}		—	—	400	µs	
Reset detection delay time	t_{d2}		—	—	30	µs	
Current consumption	I_{LVD}		—	38	50	µA	Current consumption of low voltage detection circuit only



(9) Clock Supervisor Clock

(Vcc = 5.0 V ± 10%, Vss = 0.0 V, T_A = –40 °C to + 85 °C)

Parameter	Symbol	Condi-tions	Value			Unit	Remarks
			Min	Typ	Max		
Oscillation frequency	f_{OUT}	—	50	100	200	kHz	
Oscillation start time	t_{wk}		—	—	10	µs	
Current consumption	I_{CSV}		—	20	36	µA	Current consumption of built-in CR oscillator, at 100 kHz oscillation

5. A/D Converter

(1) A/D Converter Electrical Characteristics

(Vcc = 4.0 V to 5.5 V, Vss = 0.0 V, T_A = − 40 °C to + 85 °C)

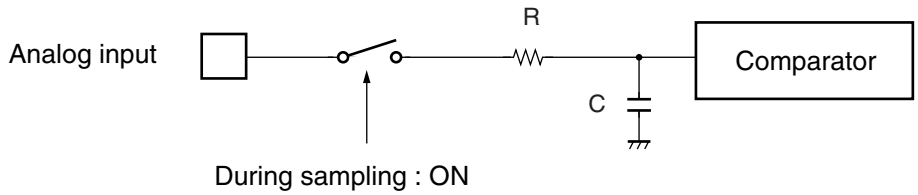
Parameter	Symbol	Value			Unit	Remarks
		Min	Typ	Max		
Resolution	—	—	—	10	bit	
Total error		− 3.0	—	+ 3.0	LSB	
Linearity error		− 2.5	—	+ 2.5	LSB	
Differential linear error		− 1.9	—	+ 1.9	LSB	
Zero transition voltage	V_{OT}	V_{SS} − 1.5 LSB	V_{SS} + 0.5 LSB	V_{SS} + 2.5 LSB	V	
Full-scale transition voltage	V_{FST}	V_{CC} − 3.5 LSB	V_{CC} − 1.5 LSB	V_{CC} + 0.5 LSB	V	
Compare time	—	0.9	—	16500	µs	4.5 V ≤ V_{CC} ≤ 5.5 V
		1.8	—	16500	µs	4.0 V ≤ V_{CC} < 4.5 V
Sampling time	—	0.6	—	∞	µs	4.5 V ≤ V_{CC} ≤ 5.5 V, At external impedance < 5.4 kΩ
		1.2	—	∞	µs	4.0 V ≤ V_{CC} < 4.5 V, At external impedance < 2.4 kΩ
Analog input current	I_{AIN}	−0.3	—	+ 0.3	µA	
Analog input voltage	V_{AIN}	V_{SS}	—	V_{CC}	V	

(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

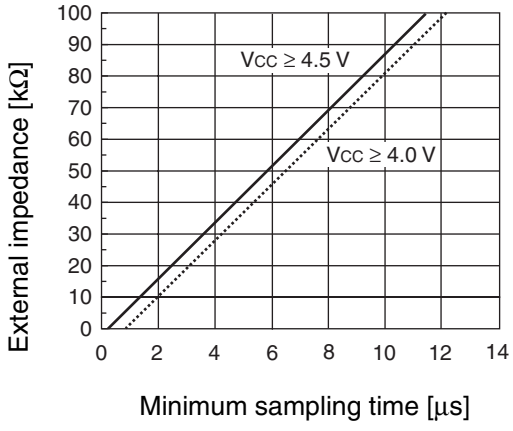


	R	C
4.5 V ≤ V_{CC} ≤ 5.5 V	2.0 kΩ (Max)	16 pF (Max)
4.0 V ≤ V_{CC} < 4.5 V	8.2 kΩ (Max)	16 pF (Max)

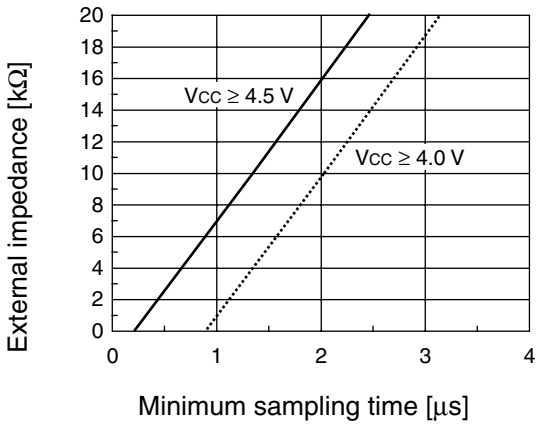
Note : The values are reference values.

- The relationship between external impedance and minimum sampling time

(External impedance = 0 kΩ to 100 kΩ)



(External impedance = 0 kΩ to 20 kΩ)



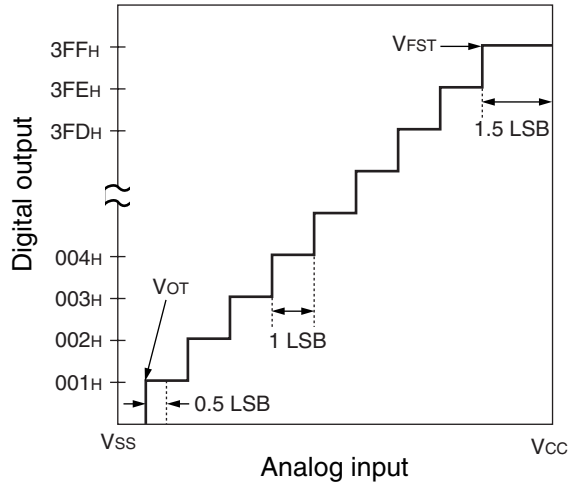
- **About errors**

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

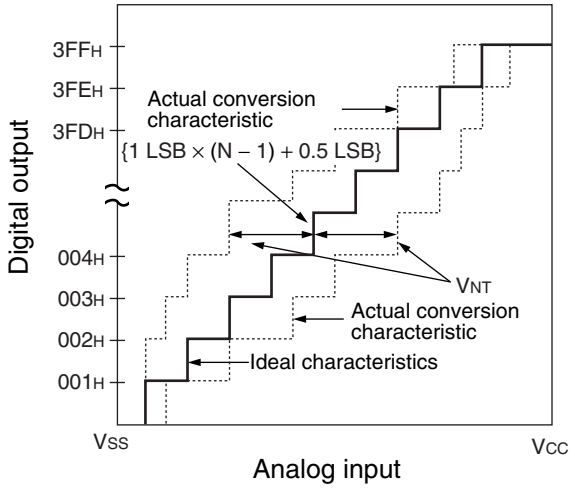
(3) Definition of A/D Converter Terms

- 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



$$1\ \text{LSB} = \frac{V_{CC} - Vss}{1024}\ (V)$$

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

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

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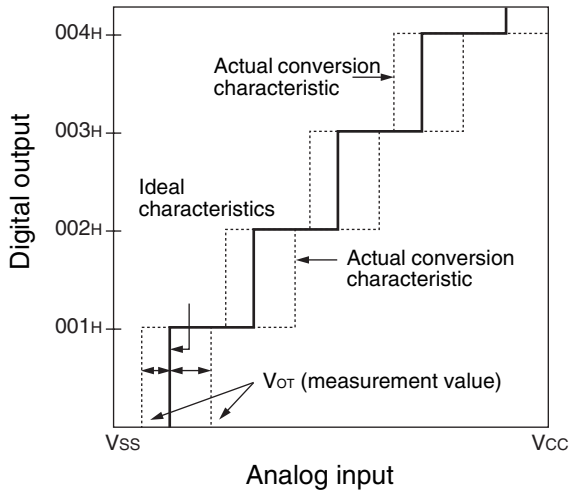
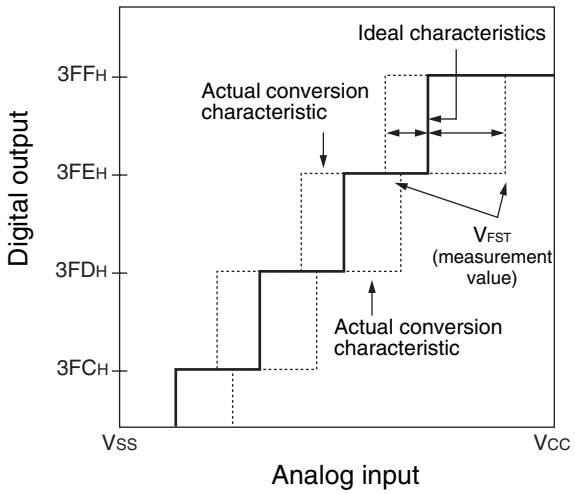
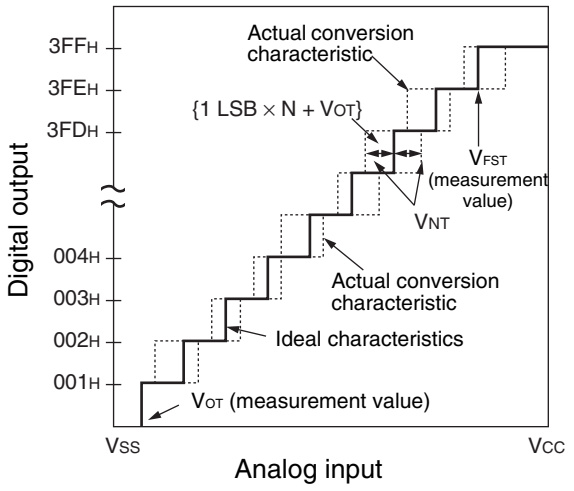
Zero transition error



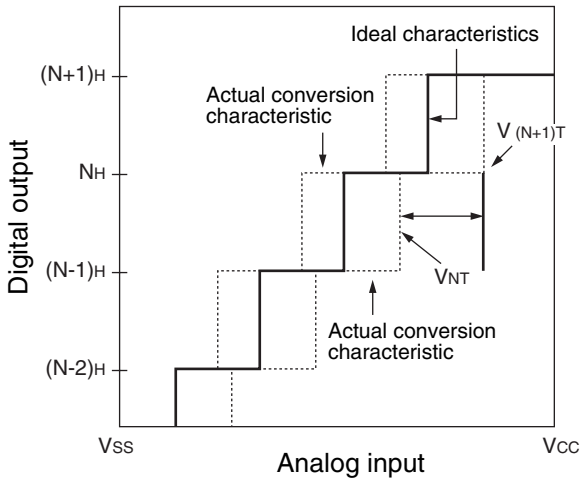
Full-scale transition error



Linearity error



Differential linear error



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

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

N : A/D converter digital output value
V_{NT} : A voltage at which digital output transits from (N – 1) H to N_H
V_{OT} (Ideal value) = V_{SS} + 0.5 LSB [V]
V_{FST} (Ideal value) = V_{CC} – 1.5 LSB [V]

6. Flash Memory Program/Erase Characteristics

Parameter	Value			Unit	Remarks
	Min	Typ	Max		
Chip erase time	—	1.0*1	15.0*2	s	Excludes 00_H programming prior erasure.
Byte programming time	—	32	3600	µs	Excludes system-level overhead.
Erase/program cycle	10000	—	—	cycle	
Power supply voltage at erase/ program	4.5	—	5.5	V	
Flash memory data retention time	20*3	—	—	year	Average T_A = +85 °C

*1 : T_A = + 25 °C, V_{CC} = 5.0 V, 10000 cycles

*2 : T_A = + 85 °C, V_{CC} = 4.5 V, 10000 cycles

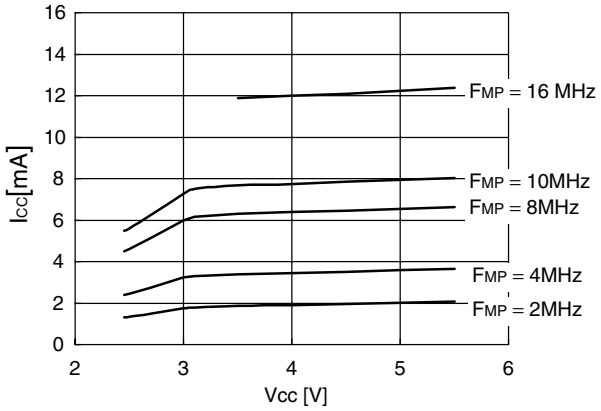
*3 : This value comes from the technology qualification (using Arrhenius equation to translate high temperature measurements into normalized value at +85 °C) .

■ EXAMPLE CHARACTERISTICS

• Power supply current temperature (Flash memory product)

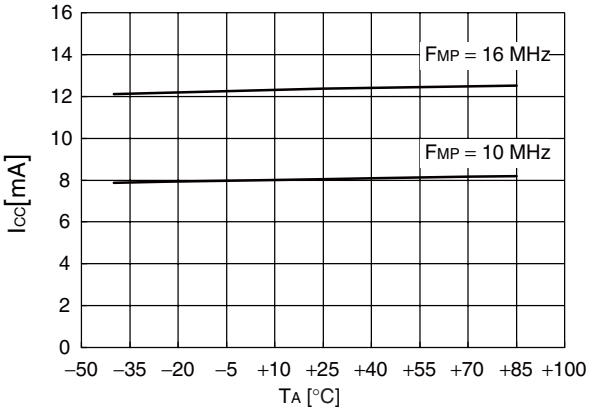
I_{CC} – V_{CC}

T_A = + 25 °C, F_{MP} = 2, 4, 8, 10, 16 MHz (divided by 2)
Main clock mode, at external clock operating



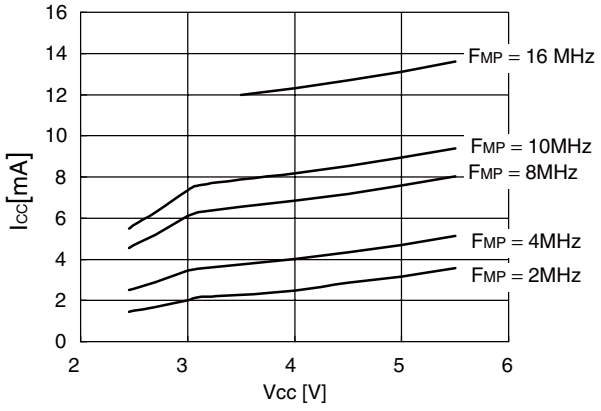
I_{CC} – T_A

V_{CC} = 5.5 V, F_{MP} = 10, 16 MHz (divided by 2)
Main clock mode, at external clock operating



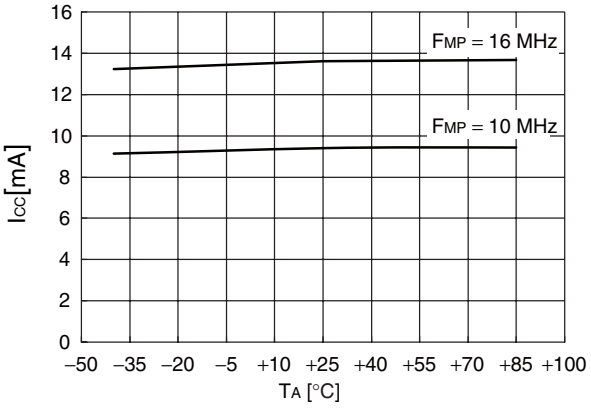
I_{CC} – V_{CC}

T_A = + 25 °C, F_{MP} = 2, 4, 8, 10, 16 MHz (divided by 2)
Main clock mode + AD operation,
at external clock operating



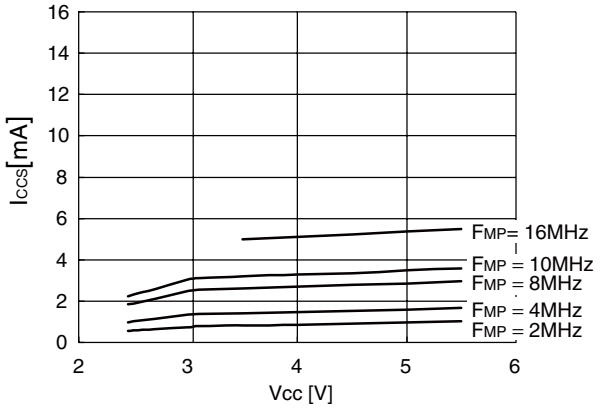
I_{CC} – T_A

V_{CC} = 5.5 V, F_{MP} = 10, 16 MHz (divided by 2)
Main clock mode + AD operation,
at external clock operating



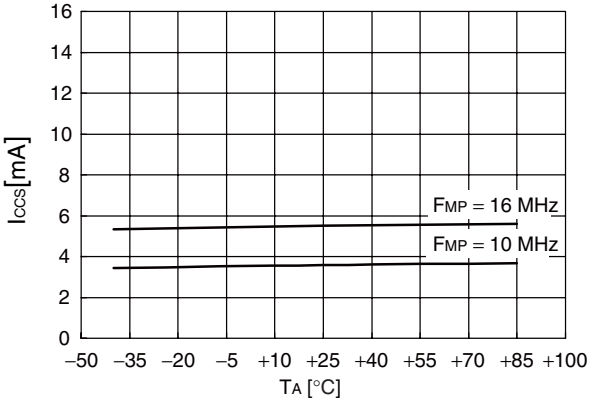
I_{CCS} – V_{CC}

T_A = + 25 °C, F_{MP} = 2, 4, 8, 10, 16 MHz (divided by 2)
Main sleep mode, at external clock operating



I_{CCS} – T_A

V_{CC} = 5.5 V, F_{MP} = 10, 16 MHz (divided by 2)
Main sleep mode, at external clock operating



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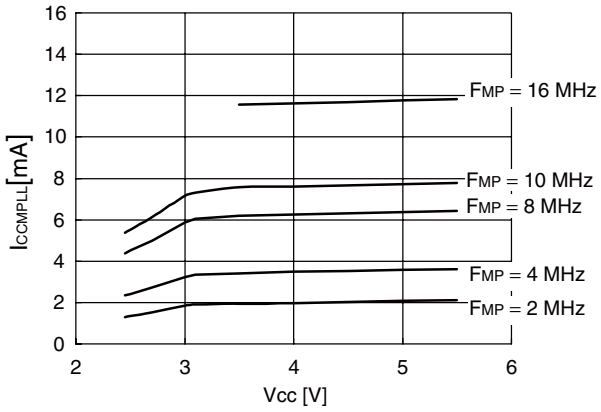
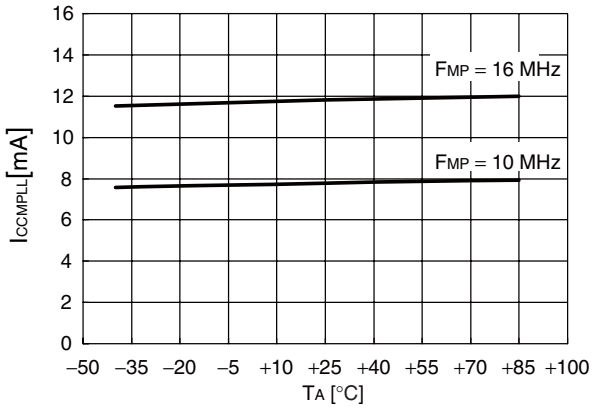
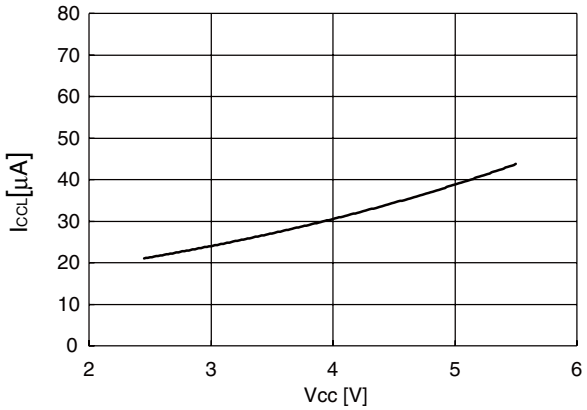
I_{CCMPLL} – V_{CC}
T_A = + 25 °C, F_{MP} = 2, 4, 8, 10, 16 MHz
(Main PLL multiplied by 2.5)
Main PLL mode, at external clock operating



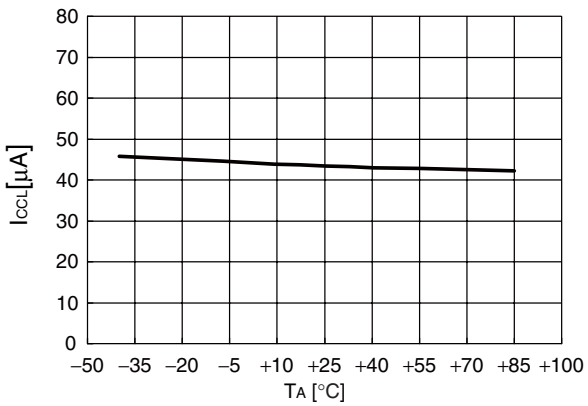
I_{CCMPLL} – T_A
V_{CC} = 5.5 V, F_{MP} = 10, 16 MHz (Main PLL multiplied by 2.5)
Main PLL mode, at external clock operating



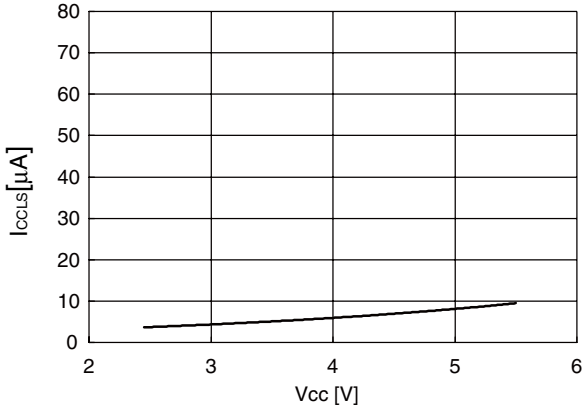
I_{CCL} – V_{CC}
T_A = + 25 °C, F_{MPL} = 16 kHz (divided by 2)
Sub clock mode, at external clock operating



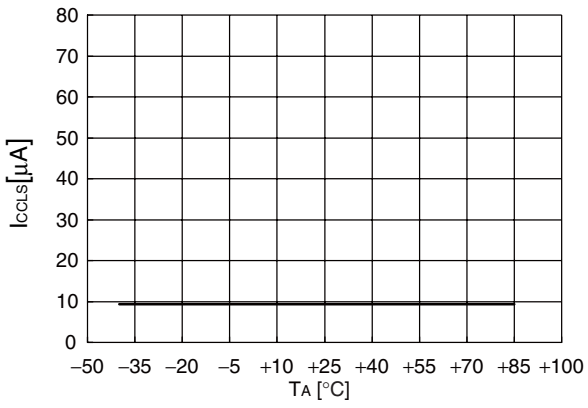
I_{CCL} – T_A
V_{CC} = 5.5 V, F_{MPL} = 16 kHz (divided by 2)
Sub clock mode, at external clock operating



I_{CCLS} – V_{CC}
T_A = + 25 °C, F_{MPL} = 16 kHz (divided by 2)
Sub sleep mode, at external clock operating



I_{CCLS} – T_A
V_{CC} = 5.5 V, F_{MPL} = 16 kHz (divided by 2)
Sub sleep mode, at external clock operating



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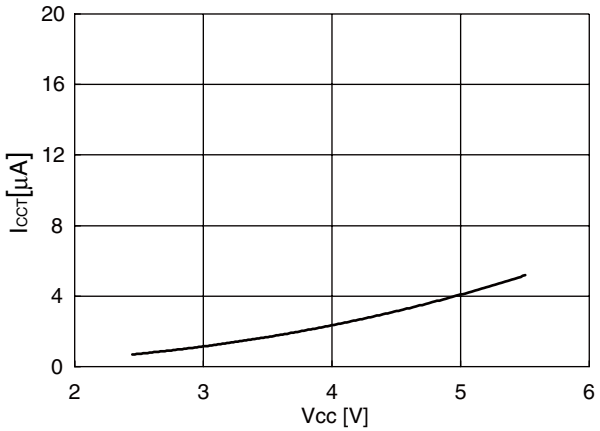
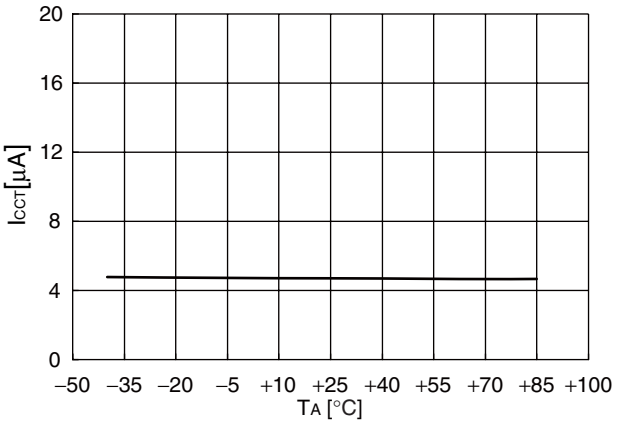
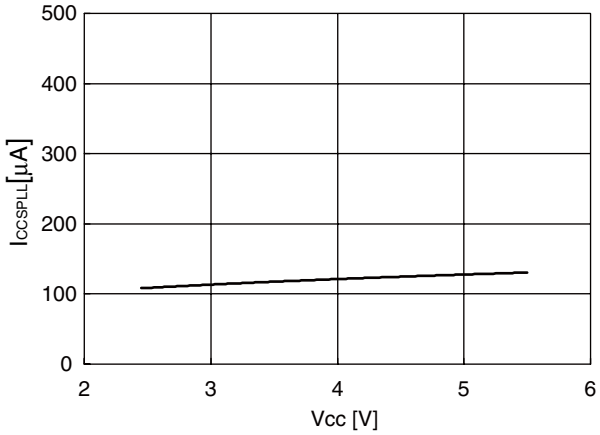
I_{CCT} – V_{CC}
T_A = + 25 °C, F_{MPL} = 16 kHz (divided by 2)
Clock mode, at external clock operating



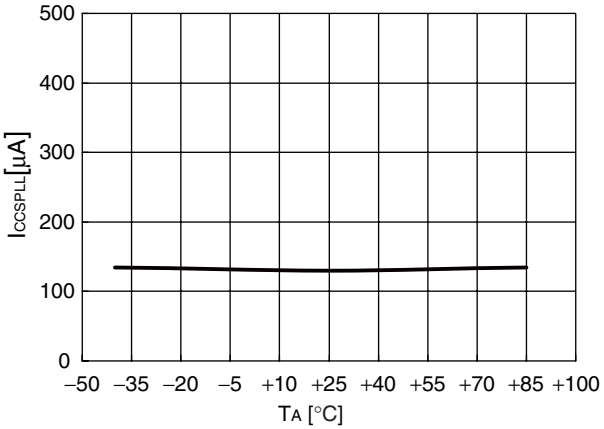
I_{CCT} – T_A
V_{CC} = 5.5 V, F_{MPL} = 16 kHz (divided by 2)
Clock mode, at external clock operating



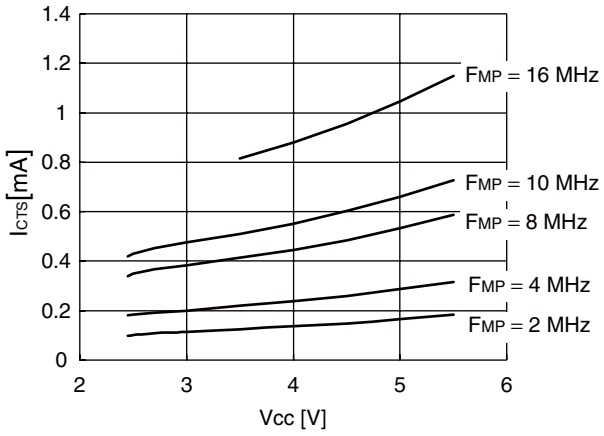
I_{CCSPLL} – V_{CC}
T_A = + 25 °C, F_{MPL} = 128 kHz (Main PLL multiplied by 4)
Sub PLL mode, at external clock operating



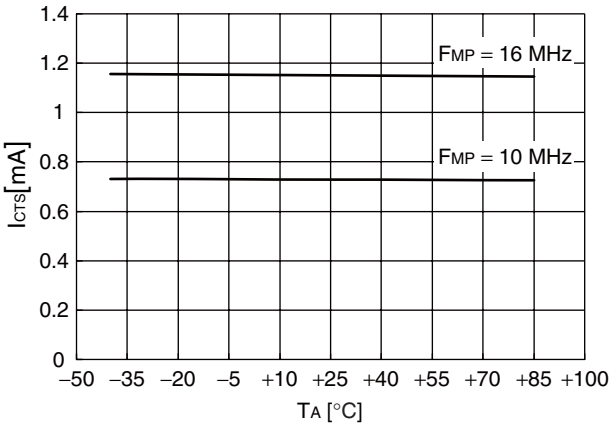
I_{CCSPLL} – T_A
V_{CC} = 5.5 V, F_{MPL} = 16 kHz (divided by 2)
Sub PLL mode, at external clock operating



I_{CTS} – V_{CC}
T_A = + 25 °C, F_{MP} = 2, 4, 8, 10, 16 MHz (divided by 2)
Time-base timer mode, at external clock operating



I_{CTS} – T_A
V_{CC} = 5.5 V, F_{MP} = 10, 16 MHz (divided by 2)
Time-base timer mode, at external clock operating



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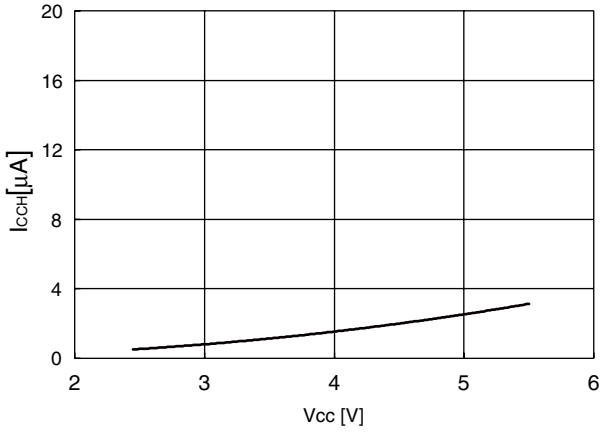
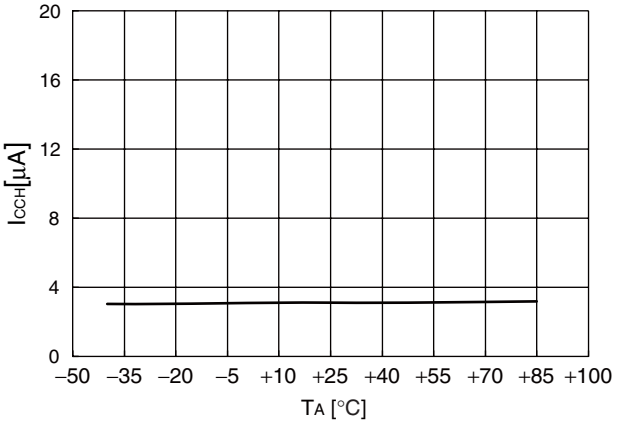
I_{CCH} – V_{CC}
T_A = + 25 °C, F_{MP} = stop
Sub stop mode, at external clock stopping

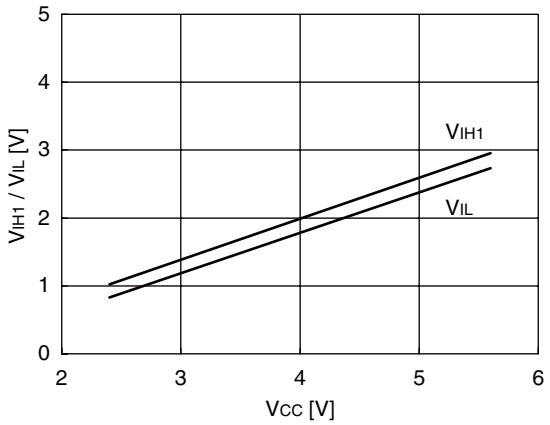


I_{CCH} – T_A
V_{CC} = 5.5 V, F_{MP} = stop
Sub stop mode, at external clock stopping

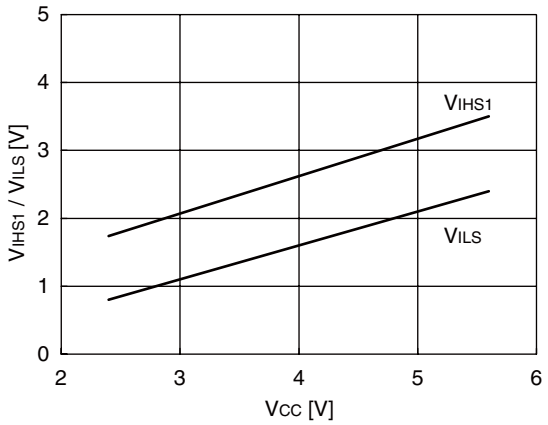


• Input voltage (Flash memory product)

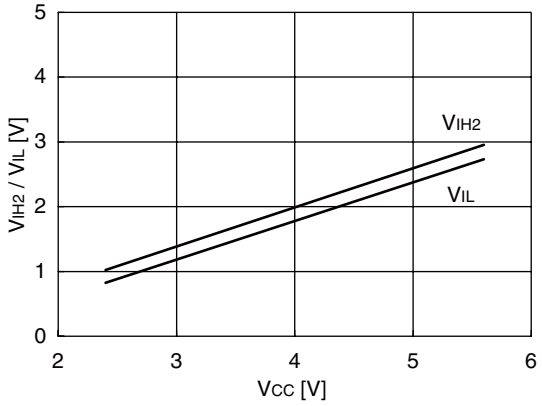
V_{IH1} – V_{CC} and V_{IL} – V_{CC}
T_A = + 25 °C



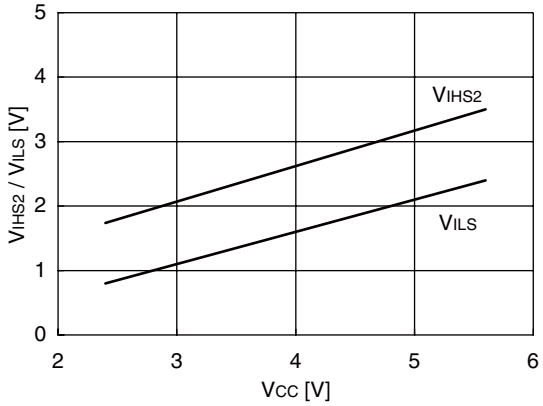
V_{IHS1} – V_{CC} and V_{ILS} – V_{CC}
T_A = + 25 °C



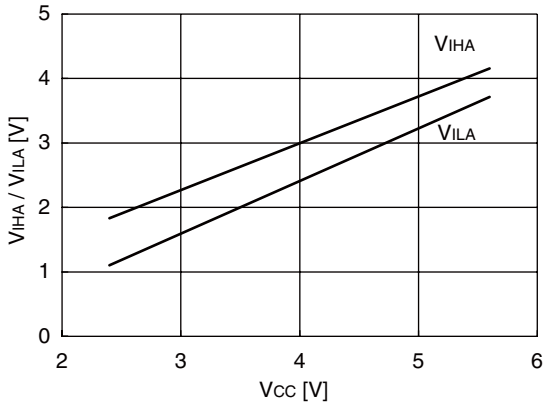
V_{IH2} – V_{CC} and V_{IL} – V_{CC}
T_A = + 25 °C



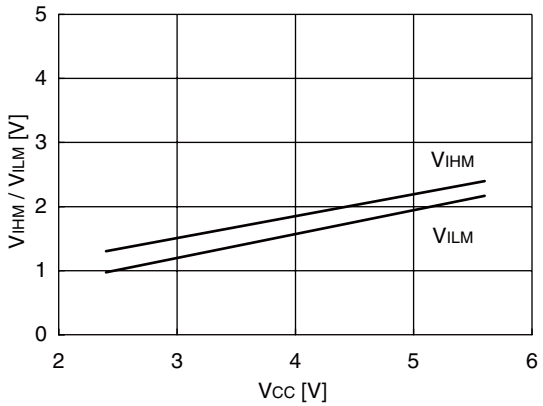
V_{IHS2} – V_{CC} and V_{ILS} – V_{CC}
T_A = + 25 °C



V_{IHA} – V_{CC} and V_{ILA} – V_{CC}
T_A = + 25 °C

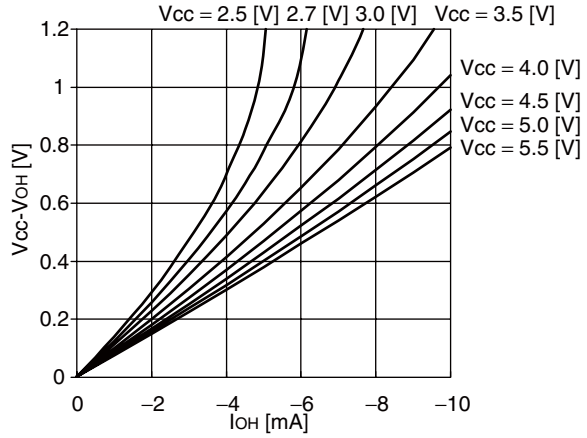


V_{IHM} – V_{CC} and V_{ILM} – V_{CC}
T_A = + 25 °C

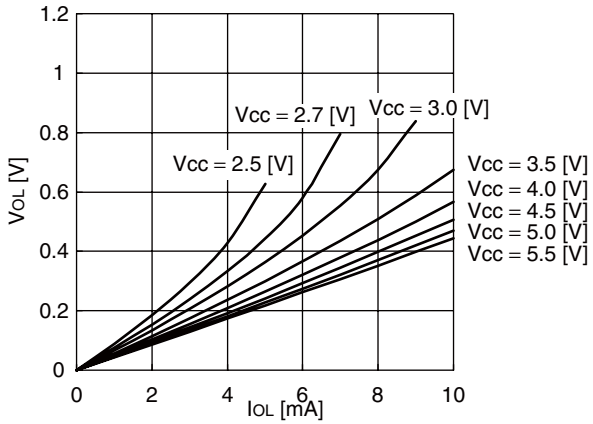


• Output voltage (Flash memory product)

$(V_{CC}-V_{OH}) - I_{OH}$
$T_A = +25\ °C$

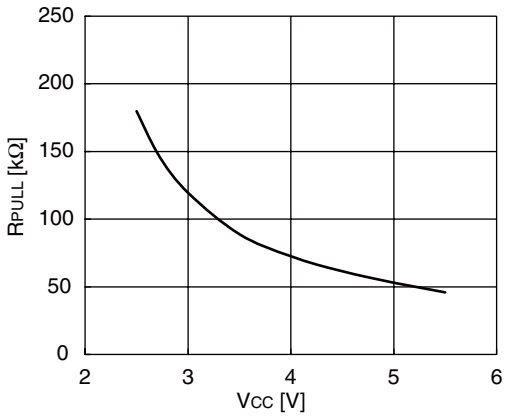


$V_{OL} - I_{OL}$
$T_A = +25\ °C$



• Pull-up (Flash memory product)

$R_{PULL} - V_{CC}$
$T_A = +25\ °C$



■ MASK OPTION

No.	Part number	MB95156M	MB95F156M MB95F156N MB95F156J	MB95FV100D-103
	Specifying procedure	Specify when ordering MASK	Setting disabled	Setting disabled
1	Clock mode select • Single-system clock mode • Dual-system clock mode	Dual-system clock mode	Dual-system clock mode	Changing by the switch on MCU board
2	Low voltage detection reset* • With low voltage detection reset • Without low voltage detection reset	Specify when ordering MASK	Specified by part number	Changing by the switch on MCU board
3	Clock supervisor* • With clock supervisor • Without clock supervisor	Specify when ordering MASK	Specified by part number	Changing by the switch on MCU board
4	Reset output* • With reset output • Without reset output	Specify when ordering MASK	Specified by part number	MCU board switch sets as follows ; • With clock supervisor : Without reset output • Without clock supervisor : With reset output
5	Oscillation stabilization wait time	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 $(2^{14}-2) / F_{CH}$

* : Refer to table below about clock mode select, low voltage detection reset, clock supervisor select and reset output.

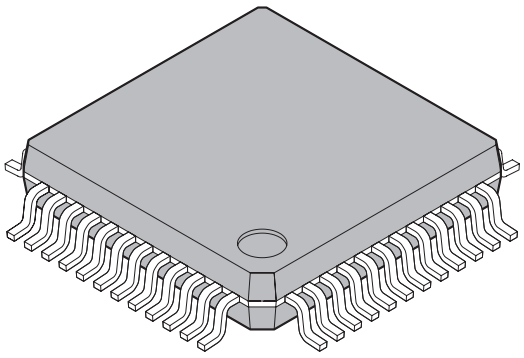
Part number	Clock mode select	Low voltage detection reset	Clock supervisor	Reset output
MB95156M	Dual-system	No	No	Yes
		Yes	No	Yes
		Yes	Yes	No
MB95F156M	Dual-system	No	No	Yes
MB95F156N		Yes	No	Yes
MB95F156J		Yes	Yes	No
MB95FV100D-103	Single-system	No	No	Yes
		Yes	No	Yes
		Yes	Yes	No
	Dual-system	No	No	Yes
		Yes	No	Yes
		Yes	Yes	No

■ ORDERING INFORMATION

Part number	Package
MB95156MPMT MB95F156MPMT MB95F156NPMT MB95F156JPMT	48-pin plastic LQFP (FPT-48P-M26)
MB95156MPMC MB95F156MPMC MB95F156NPMC MB95F156JPMC	52-pin plastic LQFP (FPT-52P-M01)
MB2146-303A (MB95FV100D-103PBT)	MCU board (224-pin plastic PFBGA (BGA-224P-M08))

■ PACKAGE DIMENSIONS

48-pin plastic LQFP

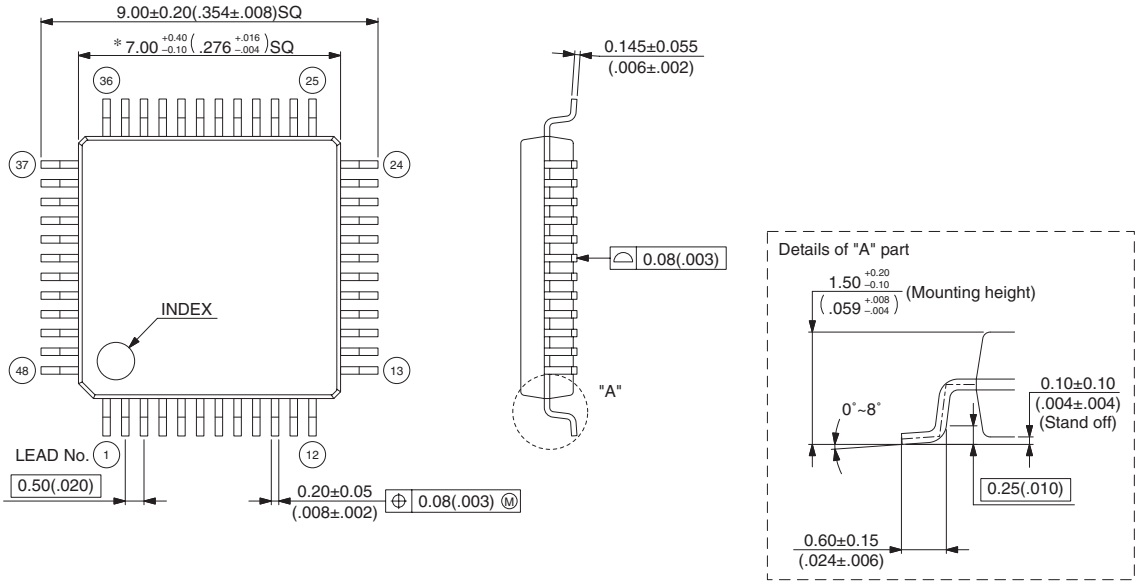


(FPT-48P-M26)

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

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

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



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

Please confirm the latest Package dimension by following URL.
http://edevice.fujitsu.com/fj/DATASHEET/ef-ovpklv.html

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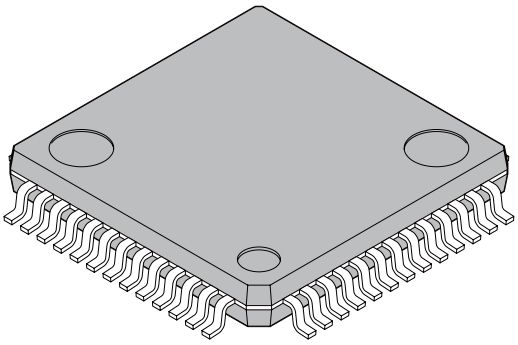
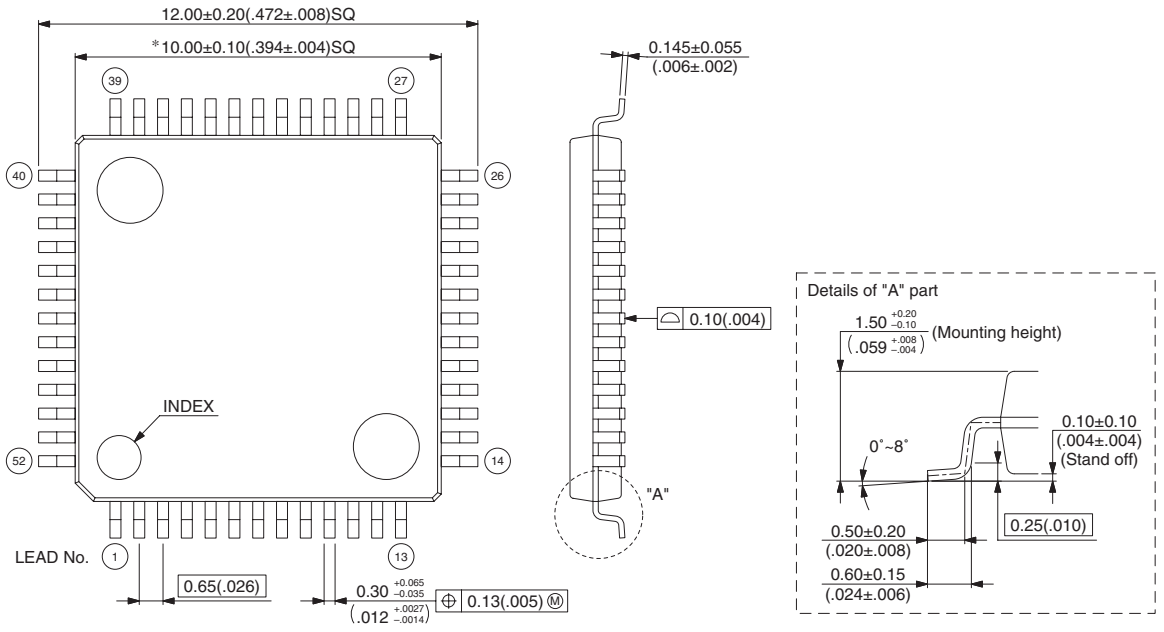
52-pin plastic LQFP		
	Lead pitch	0.65 mm
	Package width × package length	10.0 × 10.0 mm
	Lead shape	Gullwing
	Sealing method	Plastic mold
	Mounting height	1.70 mm Max
	Code (Reference)	P-LQFP52-10×10-0.65
(FPT-52P-M01)		

52-pin plastic LQFP
(FPT-52P-M01)

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

Please confirm the latest Package dimension by following URL.
http://edevice.fujitsu.com/fj/DATASHEET/ef-ovpklv.html

■ MAIN CHANGES IN THIS EDITION

Page	Section	Change Results
—	—	Added the part numbers. MB95156M (MASK ROM Product)
15	■ PROGRAMMING FLASH MEMORY MICROCONTROLLERS USING PARALLEL PROGRAMMER • Programming Method	Changed as follows “2) Load program data to programmer addresses 7800_H to $7FFFF_H$.” → “2) Load program data to programmer addresses 18000_H to $1FFFF_H$.”
21	■ I/O MAP Reset factor register	• Changed the register name to “Reset source register.” • Changed the item "R/W” as follows. “R” → “R/W”
35	4. AC Characteristics (1) Clock Timing	Added the Main PLL multiplied by 4.
37	(2) Source Clock/Machine Clock	Changed source clock cycle time (when using main clock) . Min : F_{CH} = 10 MHz, PLL multiplied by 1 → Min : F_{CH} = 8.125 MHz, PLL multiplied by 2
39		Changed the figure of “ • Main PLL operation frequency”.
57 to 62	■ EXAMPLE CHARACTERISTICS	Added the ■ EXAMPLE CHARACTERISTICS.

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

The information for microcontroller supports is shown in the following homepage.
http://www.fujitsu.com/global/services/microelectronics/product/micom/support/index.html

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