FUJITSU SEMICONDUCTOR
DATA SHEET

DS07-16310-1E

32-Bit Microcontroller

CMOS

FR30 Series

MB91F127/F128

■ DESCRIPTION

This model, designed on the basis of 32-bit RISC CPU (FR30 series), is a standard single-chip micro controller with built-in I/O resources and bus control functions. The functions are suitable for built-in control that requires high-speed CPU processing.
MB91F127 includes 256 Kbytes built-in flash memory and 14 Kbytes built-in RAM. MB91F128 includes 510 Kbytes built-in flash memory and 14 Kbytes built-in RAM.
The specifications of the devices are best suited for applications requiring high-level CPU processing capabilities, such as navigation system, high-performance FAX, and printer controller.

■ FEATURES

FR-CPU

- 32-bit RISC (FR30), load/store architecture, 5-step pipeline
- Operating frequency : Internal 25 MHz
- General register : 32bit x 16 registers
- 16-bit fixed-length instructions (primitives), 1 instruction/1 cycle
- Instructions of memory-to-memory transfer, bit processing, and barrel shift : Instructions suitable for built-in control

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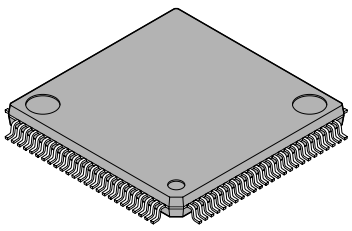
■ PACKAGE

100 pin, Plastic LQFP



(FPT-100P-M05)

- Function entry/exit instructions, multi load/store instruction for register data : High-level language compatible instructions
- Register interlock functions : Simple description of assembler language
- Branch instructions with delay slot : Reduced overhead on branching process
- Built-in multiplier/ Supporting at instruction level
  Signed 32-bit multiplying : 5 cycles
  Signed 16-bit multiplying : 3 cycles
- Interrupt (saving PC and PS) : 6 cycles, 16 priority levels

Bus interface

- Maximum of 25 MHz internal operation rate
- 25-bit address bus (32 MB space)
- 16-bit address output, 8/16-bit data input/output
- Basic bus cycle : 2-clock cycle
- Chip selection outputs specifiable in a minimum of 64 Kbytes steps : 6 outputs
- Automatic wait cycle : Specifiable flexibly from 0 cycle to 7 cycles for each area
- Supporting time-division input/output interface for address/data (for area 1 only)
- Unassigned data/address terminals are available as input/output ports
- Supporting little endian mode (selecting one area from area 1 to area 5)

DMAC (DMA controller)

- 8 channels
- Transfer factor : Interrupt request of built-in resources
- Transfer sequence : Step transfer/Block transfer/Burst transfer/Consecutive transfer
- Transfer data length : Selectable among 8 bits, 16 bits, and 32 bits
- Pausing is allowed by interrupt request

UART

- 3 channels
- Full-duplex double buffer
- Data length : 7 to 9 bits (no parity), 6 to 8 bits (with parity)
- Asynchronous (start-stop synchronization) or CLK synchronous communication is selectable
- Multi processor mode
- Built-in 16-bit timer (U-Timer) used as a baud-rate generator : Generates an arbitrary baud rate
- External clock is available as a transfer clock
- Error detection : parity, frame, and overrun

A/D converter (sequential transducer)

- 8/10-bit resolution, 8 channels
- Sequential comparison and transducer : At 25 MHz, 5.2 µs
- Built-in sample and hold circuit
- Conversion mode : Selectable among single conversion, scan conversion, and repeat conversion
- Activation : Selectable among software, external trigger, and built-in timer

Reload timer

- 16-bit timer : 3 channels
- Internal clock : 2-clock cycle resolution, selectable among 2/8/32 dividing and external clock

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Other interval timers
- 16-bit timer : 3 channels (U-Timer)
- PPG timer : 4 channels
- 16-bit OCU : 4 channels, ICU : 4 channels, Free-run timer : 1 channel
- Watchdog timer: 1 channel

Flash memory 510 KB
- 510 KB FLASH ROM: Read/Write/Erase is allowed with a same power

Built- in RAM 14 KB
- D-bus RAM 12 KB, C-bus RAM 2 KB

Bit search module
- Position of a first bit that changes between “1” and “0” is searched in one cycle, within an MSB of one word.

Interrupt controller
- External interrupt input : Normal interrupt×6 (INT0 to INT5)
- Internal interrupt factors : UART, DMAC, A/D, Reload timer, UTIMER, delay interrupt, PPG, ICU, and OCU
- Priority levels are programmable (16 levels)

Reset factors
- Power-on reset/watchdog timer/software reset/external reset

Low power consumption mode
- Sleep/stop mode

Clock control
- Built-in PLL circuit, selectable among 1-multiplication, and 2-multiplication
- Gearing function : Operation clock frequencies are freely and independently specifiable for CPU and peripherals.
  Gear clocks are selectable among 1/1, 1/2, 1/4, and 1/8 (or among 1/2, 1/4, 1/8, and 1/16).
  Upper limit of peripheral operations is 25 MHz.

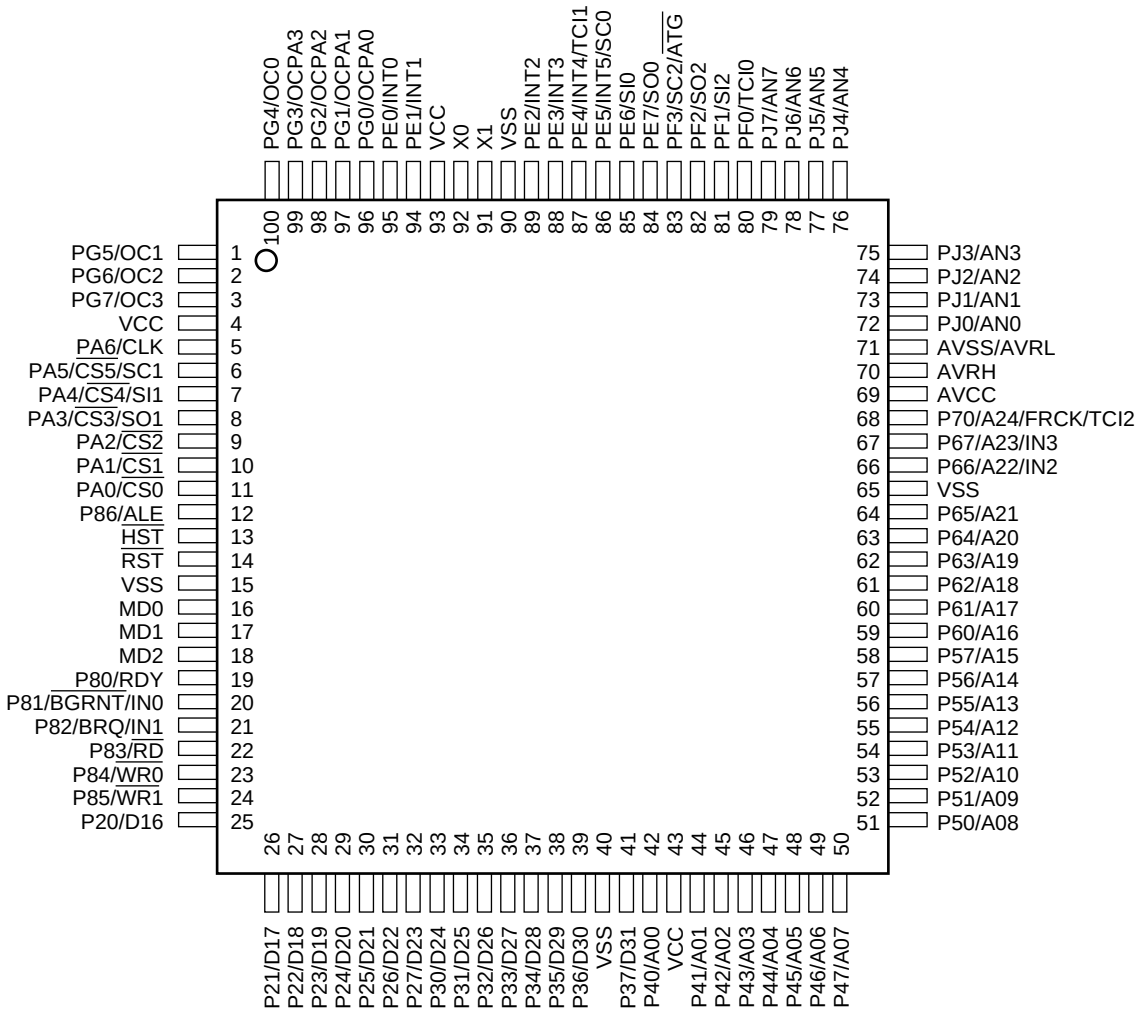
Others
- Package : LQFP-100
- CMOS technology : 0.35 µm
- Power supply voltage : 3.3 V±0.3 V

■ SERIES CONFIGURATION

Model name	MB91F127	MB91F128	MB91FV129
Outline	Quantity production	Quantity production	Evaluation product
FLASH memory	256 KB	510 KB	510 KB
D-bus RAM	12 KB	12 KB	16 KB
C-bus RAM	2 KB	2 KB	2 KB

■ PIN ASSIGNMENT

(TOP VIEW)



(FPT-100P-M05)

■ PIN DESCRIPTION

Note that the numbers in the table are not pin numbers on a package.

No.	Pin name	Input/output circuit type	Description
1 2 3 4 5 6 7 8	D16/P20 D17/P21 D18/P22 D19/P23 D20/P24 D21/P25 D22/P26 D23/P27	D	Bit 16 through bit 23 of external data bus. The terminals are available as general I/O ports (P20 through P27) when external bus width is specified at 8 bits or in single-chip mode.
9 10 11 12 13 14 15 16	D24/P30 D25/P31 D26/P32 D27/P33 D28/P34 D29/P35 D30/P36 D31/P37	D	Bit 24 through bit 31 of external data bus. The terminals are available as general I/O ports (P30 through P37) when the terminals are not used.
17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32	A00/P40 A01/P41 A02/P42 A03/P43 A04/P44 A05/P45 A06/P46 A07/P47 A08/P50 A09/P51 A10/P52 A11/P53 A12/P54 A13/P55 A14/P56 A15/P57	D	Bit 00 through bit 15 of external address bus. The terminals are available as general I/O ports (P40 through P47 and P50 through P57) when the terminals are not used as address buses.
33 34 35 36 37 38 39 40	A16/P60 A17/P61 A18/P62 A19/P63 A20/P64 A21/P65 A22/P66/IN2 A23/P67/IN3	D	Bit 16 through bit 23 of external address bus. The terminals are available as general I/O ports (P60 through P67) when the terminals are not used as address busses. [IN2,IN3]: Input terminals of input capture. This function is active when input capture is operating.

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<table>
<tr><th>No.</th><th>Pin name</th><th>Input/output circuit type</th><th>Description</th></tr>
<tr><td>41</td><td>A24/P70/FRCK/ TCI2</td><td>D</td><td>Bit 24 of external address bus.
[P70] A24, FRCK and TCI2 are available as general input ports when they are not used.
[FRCK] External clock input of free-run timer. This function is active when external clock input of free-run timer is used.
[TCI2] External clock input of timer 2. This function is active when external clock input of timer 2 is used.</td></tr>
<tr><td>42</td><td>RDY/P80</td><td>D</td><td>External ready input. Enter “0” when bus cycle under execution does not complete. This terminal is available as general input/ output port when it is not used.</td></tr>
<tr><td>43</td><td>$\overline{\text{BGRNT}}$/P81/IN0</td><td>D</td><td>External bus open receive output. This terminal outputs “L” when an external bus is released. This terminal is available as general input/output port when it is not used.
[IN0] Input capture input.
This function is active when input capture is under input operation.</td></tr>
<tr><td>44</td><td>BRQ/P82/IN1</td><td>D</td><td>External bus open request input. Enter “1” when releasing external bus. This terminal is available as general input/output port when it is not used.
[IN1] Input capture input.
This function is active when input capture is under input operation.</td></tr>
<tr><td>45</td><td>$\overline{\text{RD}}$/P83</td><td>D</td><td>External bus read strobe.
This terminal is available as general input/output port when it is not used.</td></tr>
<tr><td>46</td><td>$\overline{\text{WR0}}$/P84</td><td>D</td><td rowspan="2">External bus write strobe.Control signals and data bus byte positions are related as the following :
<table><tr><th></th><th>16-bit bus width</th><th>8-bit bus width</th><th>Single chip mode</th></tr><tr><td>D31 to D24</td><td>$\overline{\text{WR0}}$</td><td>$\overline{\text{WR0}}$</td><td>(port allowed)</td></tr><tr><td>D23 to D16</td><td>$\overline{\text{WR1}}$</td><td>(port allowed)</td><td>(port allowed)</td></tr></table>Note : $\overline{\text{WR1}}$ is set to Hi-z during resetting.
For using with 16-bit bus width, use an external pull-up resistor.
[P84 or P85] Available as general input/output ports when $\overline{\text{WR0}}$ and $\overline{\text{WR1}}$ are not used.</td></tr>
<tr><td>47</td><td>$\overline{\text{WR1}}$/P85</td><td>D</td></tr>
<tr><td>48
49
50</td><td>$\overline{\text{CS0}}$/PA0
$\overline{\text{CS1}}$/PA1
$\overline{\text{CS2}}$/PA2</td><td>D</td><td>Chip select 0 output (Low active)
Chip select 1 output (Low active)
Chip select 2 output (Low active)
[PA0,1,or 2] Available as general input/output ports when $\overline{\text{CS0}}$, $\overline{\text{CS1}}$ and $\overline{\text{CS2}}$ are not used.</td></tr>
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No.	Pin name	Input/output circuit type	Description
51 52 53	$\overline{CS3}$/PA3/SO1 $\overline{CS4}$/PA4/SI1 $\overline{CS5}$/PA5/SC1	D	Chip select 3, 4, 5 output (Low active). [PA3,4,5] Available as general input/output ports when channel 1 of chip select UART is not used. [SO1,SI1,SC1] Data output, data input, and clock terminals of UART1. Active when UART1 operation is allowed.
54	CLK/PA6	D	System clock output. Outputs a same clock as the same frequency of external bus operation. [PA6] Available as general input/output ports it is not used.
55 56 57 58 59 60 61 62	OCPA0/PG0 OCPA1/PG1 OCPA2/PG2 OCPA3/PG3 OC0/PG4 OC1/PG5 OC2/PG6 OC3/PG7	D	[OCPA0 to 3] PPG timer outputs. The function is active when PPG timer output is allowed. [OC0 to 3] Output comparison output. The function is active when output comparison output is allowed. [PB0-7] Available as general input/output ports it is not used.
63 64 65	MD0 MD1 MD2	B	Mode terminals 0 through 2. The terminals specify basic operation mode of MCU. Use the terminals by connecting them directly to VCC or VSS.
66 67	X0 X1	A	Clock (oscillation) input. Clock (oscillation) output.
68	$\overline{RST}$	C	External reset input.
69	$\overline{HST}$	C	Hardware standby input.
70	P86/ALE	D	[ALE] Address latch signal output. The function is active when ALE output of EPCR is allowed.
71 72	INT0/PE0 INT1/PE1 INT2/PE2 INT3/PE3	D	[INT0,1,2,3] External interrupt request inputs. The input is used whenever necessary if external interrupt is allowed. Output of other functions must be suspended if not on purpose.
			[PE0,1,2,3] General input/output port
75 76	INT4/PE4/TCI1 INT5/PE5/SC0	D	[INT4,5] External interrupt request inputs.The input is used whenever necessary if concerned external interrupt is allowed. Output of other functions must be suspended if not on purpose. [TCI1] External clock input of timer 1. [SC0] Clock input of UART0.
			[PE4,5] General input/output port
77	SI0/PE6	D	[SI0] Data input of UART0.This function is active when data input of UART0 is allowed.
			[PE6]General input/output port
78	SO0/PE7	D	[SO0] Data output of UART0.This function is active when data output of UART0 is allowed.
			[PE7] General input/output port

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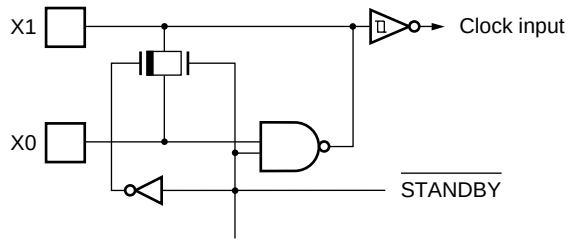
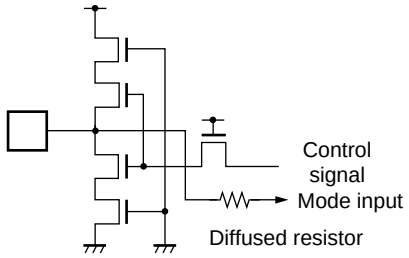
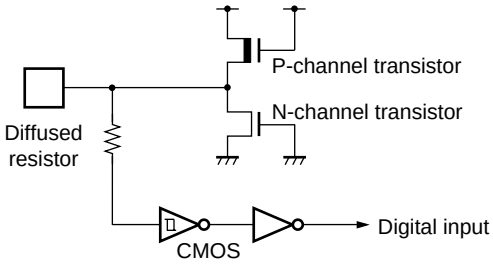
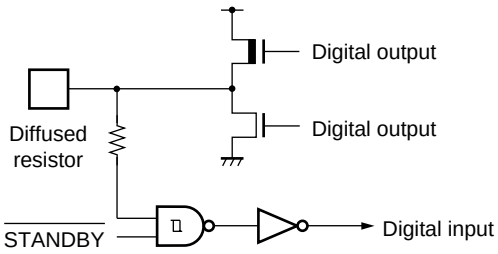
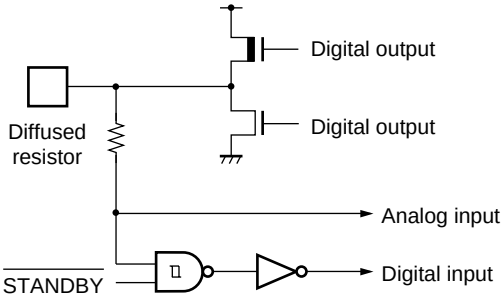
No.	Pin name	Input/output circuit type	Description
79	PF0/TCI0	D	[TCI0] External clock input of timer 0.
			[PF0] General input/output port
80	SI2/PF1	D	[SI2] Data input of UART2.This function is active when data input of UART2 is allowed.
			[PF1] General input/output port
81	SO2/PF2	D	[SO2] Data output of UART2.This function is active when data output of UART2 is allowed.
			[PF2] General input/output port. This function is active when data output of UART2 is disallowed.
82	SC2/PF3/$\overline{ATG}$	D	[SC2] Clock input of UART2 [$\overline{ATG}$]External trigger input of A/D converter The input is used whenever necessary if a function concerned is selected. Output of other functions must be suspended if not on purpose.
			[PF3] General input/output port
83 to 90	AN0/PJ0 AN1/PJ1 AN2/PJ2 AN3/PJ3 AN4/PJ4 AN5/PJ5 AN6/PJ6 AN7/PJ7	E	[AN0 to AN7] Analog input of A/D converter. This function is active when analog input is specified in AIC register.
			[PJ0 through PJ7] General input/output ports
91	AVCC	—	VCC power supply for A/D converter
92	AVRH	—	Reference voltage of A/D converter (high potential side). Be sure to turn on or off this terminal with a potential higher than AVRH applied to VCC.
93	AVSS/AVRL	—	A/D converter VSS power source and reference voltage (low potential side).
94 to 96	VCC	—	Power sources of digital circuits. Be sure to connect power source to all terminals when the device is used.
97 to 100	VSS	—	Ground level of digital circuits.

Note : Most of the above terminals multiplex inputs and outputs of I/O ports and resources, as indicated as “XXXX/PXX”. If the outputs of ports and resources conflict with each other on the terminals, resources take preferences.

■ INPUT/OUTPUT CIRCUIT TYPE

Type	Circuit	Remarks
A		• For 25 MHz system • Oscillation feedback register : Approx. 1MΩ • Standby control is available.
B		• CMOS level input • High-voltage control is available for FLASH test.
C		• CMOS level hysteresis input • Standby control is not available.
D		• CMOS level output • CMOS level hysteresis input • Standby control is available
E		• Standby control is available • CMOS level output • CMOS level hysteresis input • Analog input

■ HANDLING DEVICES

1. Preventing latch up

On a CMOS IC, latch up may occur when a voltage higher than VCC or a voltage lower than VSS is applied to input terminal or output terminal, or when a voltage exceeding rated level is applied across VCC and VSS. Latch up causes drastic increase of power source current, which may result in destruction of the element by heat. Take extra care not to exceed maximum rating in use. Also, take extra care so that analog terminal does not exceed digital power source.

2. Treatment of unused input terminals

Leaving unused terminals open may cause malfunction. Apply pull-up or pull-down treatment on unused terminals.

3. External reset input

Complete resetting of internal system requires inputting “L” level signal to $\overline{\text{RST}}$ terminal for a minimum of 5 machine cycles.

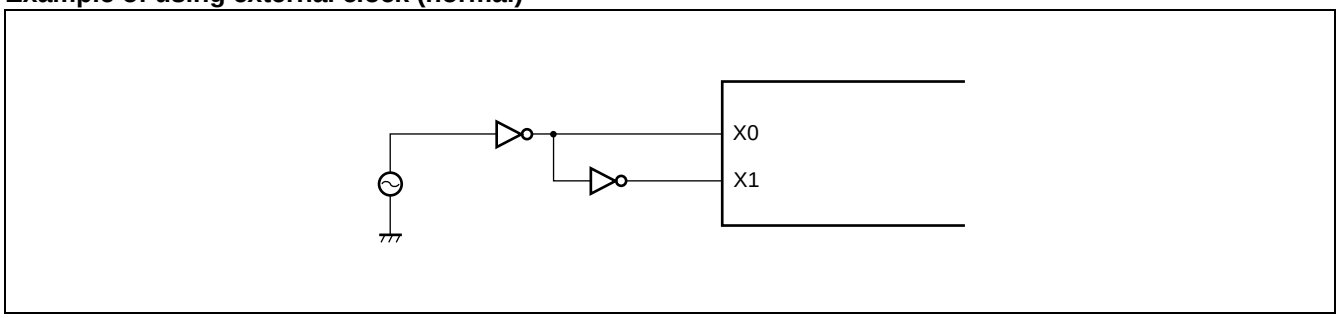
4. Notes on using external clock

When using an external clock, supply a clock signal to X0 terminal and supply its antiphase clock to X1 terminal simultaneously. In this case, do not use STOP mode (oscillation stop mode). (Because X1 terminal halts with "H" output under STOP status.)

Under a 12.5 MHz frequency, the device operates with a clock supplied to X0 terminal only.

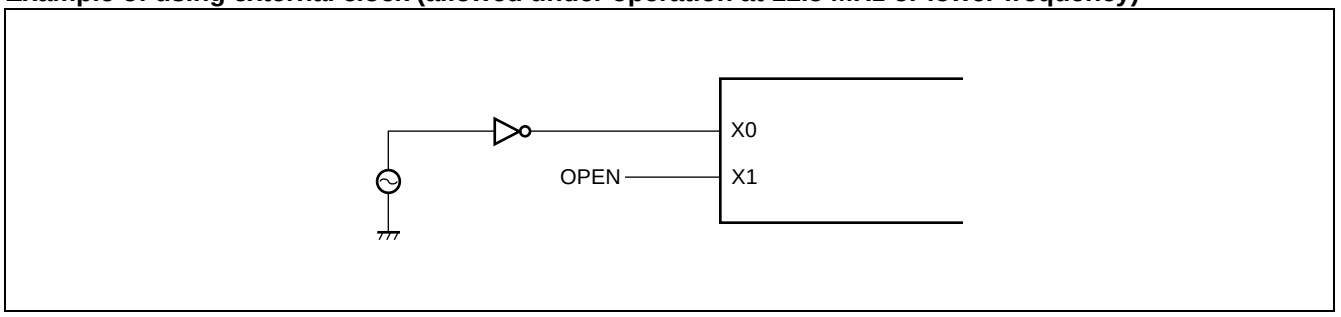
Figures show examples of using an external clock.

Example of using external clock (normal)



Note : STOP mode (oscillation stop mode) is not available.

Example of using external clock (allowed under operation at 12.5 MHz or lower frequency)



5. Connecting power supply terminals (VCC, VSS)

If two or more VCC, VSS terminals are used, the terminals to be placed under the same potentials are connected with each other internally for preventing malfunctions such as latch up. However, for reducing unwanted radiation, preventing malfunctions of strobe signals and observing total power and current ratings, be sure to connect all of these terminals to power supply and ground externally.

Connecting power supply to VCC - VSS in impedance as low as possible is desirable.

6. Crystal oscillator circuit

Noises around X0 and X1 terminals causes malfunction of the device. Design printed wiring so that X0, X1, and crystal oscillator (or ceramic oscillator), and bypass capacitor to the ground are aligned as close as possible one another. Also the wiring of those elements should not cross with other wiring if possible. Printed wiring with ground wires around X0 and X1 terminals ensures more stable operations. Such designing is strongly recommended.

7. Treating NC terminals

Be sure to leave NC terminals open.

8. Mode terminals (MD0 through MD2)

Do not connect the mode terminals directly to VCC or VSS.

For preventing malfunctions caused by noises, make printed traces between the mode terminals and VCC or VSS as short as possible, and connect the elements in lower impedance.

9. Turning power on

Be sure to turn on the power of the device with $\overline{\text{RST}}$ terminal placed under "L" level. Ensure a period at a minimum of 5 cycles of internal operation clock before placing the terminal under "H" level.

10. Terminal status upon turning on power

Status upon turning on the power is indefinite. Upon turning on the power, oscillation starts and the circuit is initialized.

11. Oscillation input upon turning on power

Upon turning on the power, be sure to input a clock signal until oscillation stabilizing wait status is released.

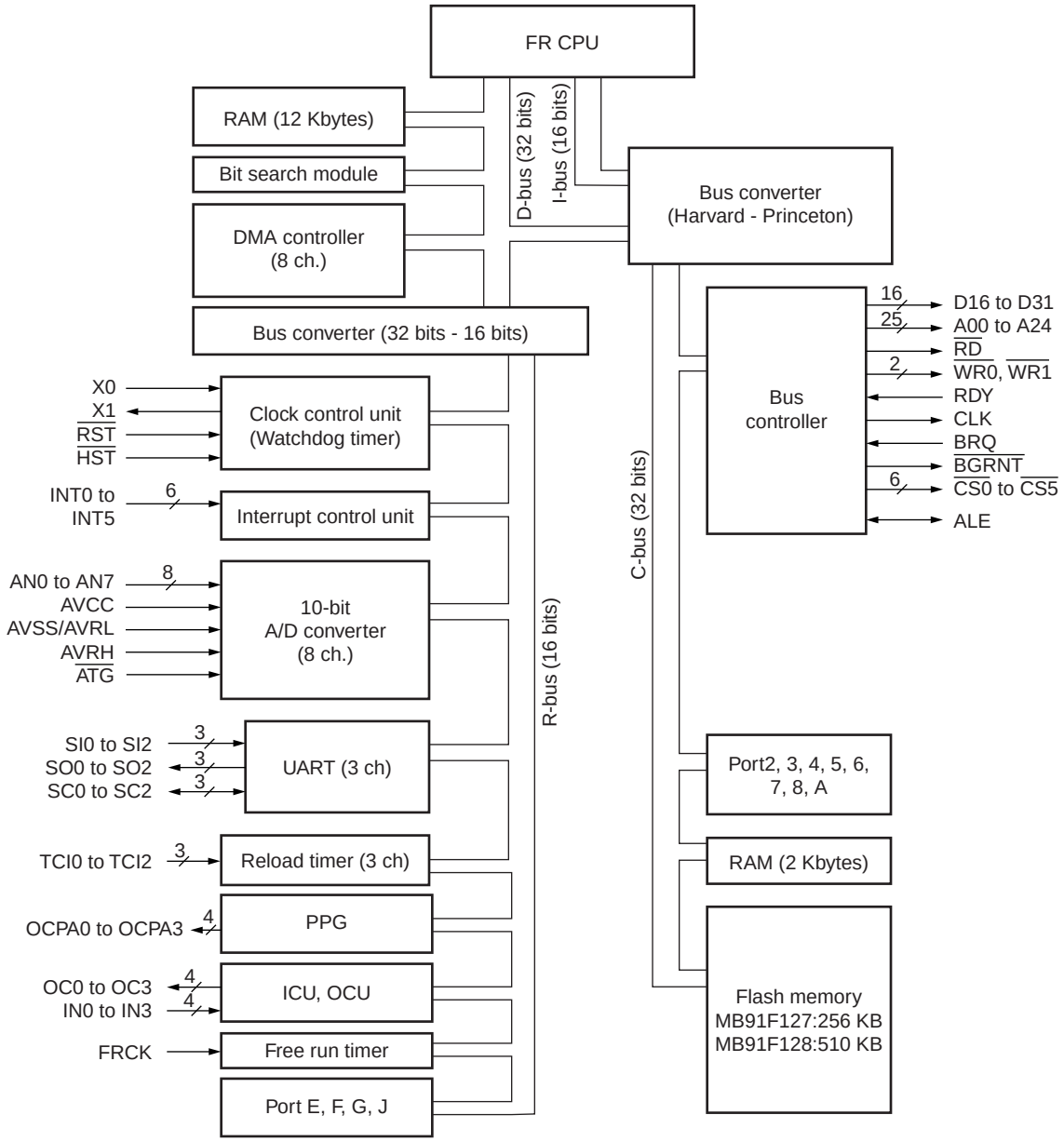
12. Initializing power-on reset

The device includes some built-in registers that are initialized only with power-on reset operation. For initializing the registers, perform power-on reset by turning on the power again.

13. Recovery from Sleep/Stop status

For recovering from Sleep/Stop status initiated by a program in C-Bus RAM, reset the device instead of recovering by an interrupt process.

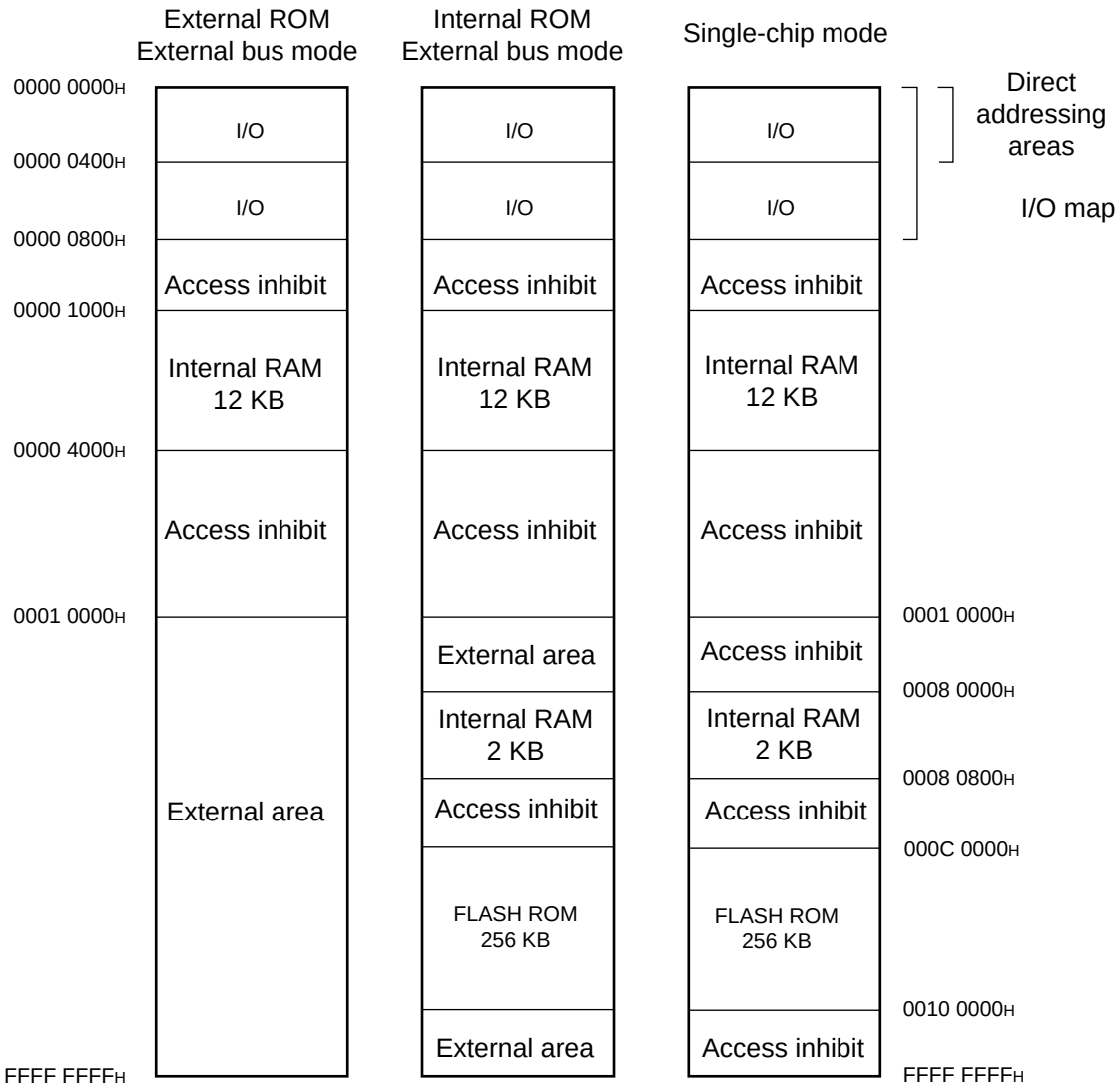
■ BLOCK DIAGRAM



Notes : • Terminals are described in functional groups (actual terminals are partially multiplexed).
• For using REALOS, perform time management by external interrupt or built-in timer.

■ CPU CORE MEMORY SPACE

- **MB91F127**



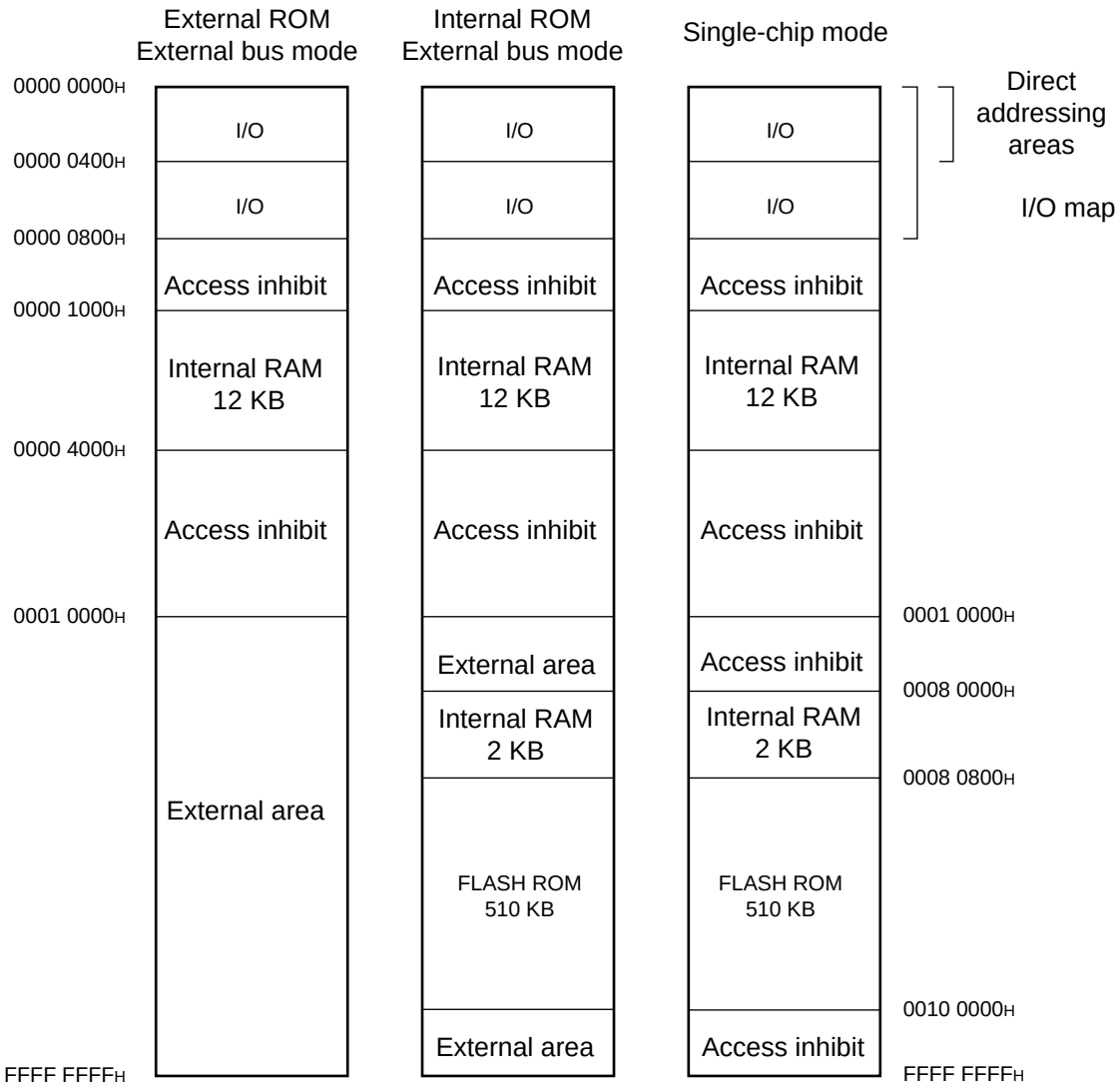
Note : External area is not accessible in single-chip mode. When accessing to external areas, select the internal ROM external bus mode in mode register.

Direct addressing areas

The areas described below are used for I/O processes. The areas, referred to as “direct addressing areas,” allow specifying an operand address directly by an instruction. The direct addressing areas varies as the following, depending on size of the data to be accessed.

- Byte-data access : 0 to 0FF$_H$
- Half-word data access : 0 to 1FF$_H$
- Word-data access : 0 to 3FF$_H$

- **MB91F128**



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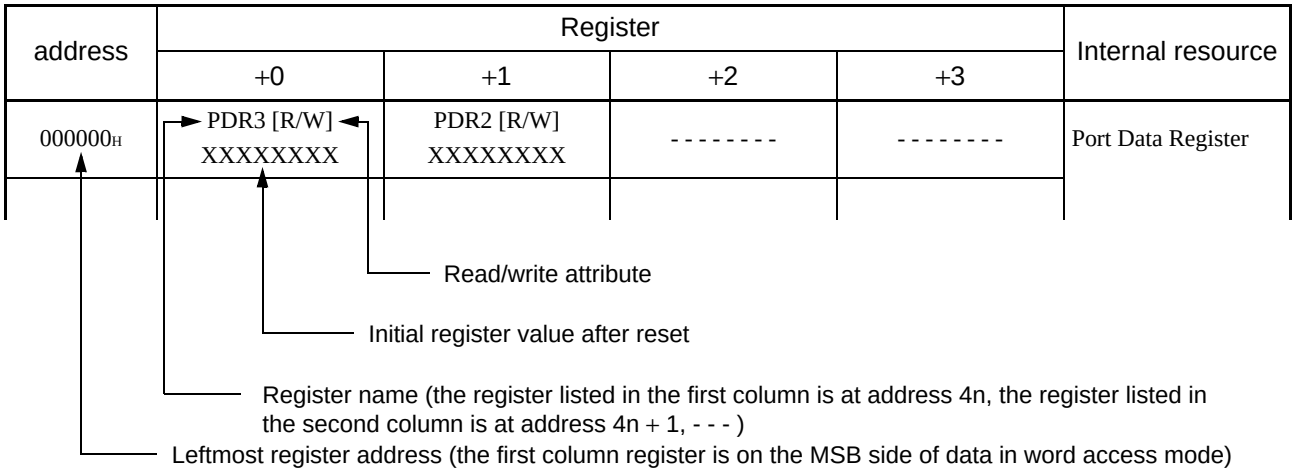
■ LEGEND OF I/O MAP



Note : Register bit values indicate initial values as shown below :

"1" : Initial value"1"

"0" : Initial value"0"

"X" : Initial value "X"

"-" : Register does not exist physically in this position.

■ I/O MAP

Address	Register				Internal resource
	+0	+1	+2	+3	
000000H	PDR3 [R/W] XXXXXXXX	PDR2 [R/W] XXXXXXXX	—	—	Port data Register
000004H	PDR7 [R/W] - - - - - - - X	PDR6 [R/W] XXXXXXXX	PDR5 [R/W] XXXXXXXX	PDR4 [R/W] XXXXXXXX	
000008H	—	PDRA [R/W] XXXXXXXX	—	PDR8[R/W] - - XXXXXX	
00000CH	—				
000010H	—	—	PDRE [R/W] XXXXXXXX	PDRF [R/W] XXXXXXXX	
000014H	PDRG [R/W] XXXXXXXX	—	—	PDRJ [R/W] XXXXXXXX	
000018H	—	—	—	—	Reserved
00001CH	SSR [R/W] 00001- 00	SIDR [R/W] XXXXXXXX	SCR [R/W] 00000100	SMR [R/W] 00 - - 0 - 00	UART0
000020H	SSR [R/W] 00001- 00	SIDR [R/W] XXXXXXXX	SCR [R/W] 00000100	SMR [R/W] 00 - - 0 - 00	UART1
000024H	SSR [R/W] 00001- 00	SIDR [R/W] XXXXXXXX	SCR [R/W] 00000100	SMR [R/W] 00 - - 0 - 00	UART2
000028H	TMRLR [W] XXXXXXXX XXXXXXXX		TMR [W] XXXXXXXX XXXXXXXX		Reload Timer 0
00002CH	—		TMCSR [R/W] - - - - 0000 00000000		
000030H	TMRLR [W] XXXXXXXX XXXXXXXX		TMR [W] XXXXXXXX XXXXXXXX		Reload Timer 1
000034H	—		TMCSR [R/W] - - - - 0000 00000000		
000038H	—		—		Reserved
00003CH	TMRLR [W] XXXXXXXX XXXXXXXX		TMR [W] XXXXXXXX XXXXXXXX		Reload Timer 2
000040H	—		TMCSR [R/W] - - - - 0000 00000000		
000044H	IPCP1[R] XXXXXXXX XXXXXXXX		IPCP0[R] XXXXXXXX XXXXXXXX		16 bit ICU
000048H	IPCP3[R] XXXXXXXX XXXXXXXX		IPCP2[R] XXXXXXXX XXXXXXXX		
00004CH	—	ICS23[R/W] 00000000	—	ICS01[R/W] 00000000	
000050H	ADCR [W] 00101-XX XXXXXXXX		ADCS [R/W] 000000000 00000000		A/D converter (Serially compared)

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Address	Register				Internal resource
	+0	+1	+2	+3	
000054H	OCCP1[R/W] XXXXXXXX XXXXXXXX		OCCP0[R/W] XXXXXXXX XXXXXXXX		16 bit OCU
000058H	OCCP3[R/W] XXXXXXXX XXXXXXXX		OCCP2[R/W] XXXXXXXX XXXXXXXX		
00005CH	—		—		Reserved
000060H	—		—		
000064H	OCS2, 3[R/W] XXX00000 0000XX00		OCS0, 1[R/W] XXX00000 0000XX00		16 bit OCU
000068H	—		—		Reserved
00006CH	TCDT [R/W] 00000000 00000000		TCCS [R/W] 0 - - - - - - - 00000000		Free run timer
000070H	—		—		Reserved
000074H	—		—		Reserved
000078H	UTM/UTIMR [R/W] 00000000 00000000		—	UTIMC[R/W] 0 - - 00001	U-Timer0
00007CH	UTM/UTIMR [R/W] 00000000 00000000		—	UTIMC[R/W] 0 - - 00001	U-Timer1
000080H	UTM/UTIMR [R/W] 00000000 00000000		—	UTIMC[R/W] 0 - - 00001	U-Timer2
000084H	—		—		Reserved
000088H	—		—		
00008CH	—		—		Reserved
000090H	—		—		
000094H	EIRR [R/W] 00000000	ENIR [R/W] 00000000	—		External interrupt/ NMI
000098H	EHVR [R/W] - - - - 0000	ELVR [R/W] 00000000	—		

(Continued)

Address	Register				Internal resource
	+0	+1	+2	+3	
00009CH	—				Reserved
0000A0H	—				
0000A4H	—				
0000A8H	—				
0000ACH	—				
0000B0H	—				
0000B4H	—				
0000B8H	—				
0000BCH	—				
0000C0H	—				
0000C4H	—				
0000C8H	—				
0000CCH	—				
0000D0H	—	—	DDRE [W] 00000000	DDRF [W] 00000000	Port direction register
0000D4H	—	AIC3[W] 11111111	—	—	A/D converter
0000D8H	DDRG [W] 00000000	—	—	DDRJ [W] 00000000	Port direction register
0000DCH	GCN1 [R/W] 00110010 00010000		- - - - - - - -	GCN2[R/W] 00000000	PPG ctl
0000E0H	PTMR0 [R] 11111111 11111111		PCSR0 [W] XXXXXXXX XXXXXXXX		PPG0
0000E4H	PDUT0 [W] XXXXXXXX XXXXXXXX		PCNH0[R/W] 0000000 -	PCNL0[R/W] 00000000	
0000E8H	PTMR1 [R] 11111111 11111111		PCSR1 [W] XXXXXXXX XXXXXXXX		PPG1
0000ECH	PDUT1 [W] XXXXXXXX XXXXXXXX		PCNH1[R/W] 0000000 -	PCNL1[R/W] 00000000	
0000F0H	PTMR2 [R] 11111111 11111111		PCSR2 [W] XXXXXXXX XXXXXXXX		PPG2
0000F4H	PDUT2 [W] XXXXXXXX XXXXXXXX		PCNH2[R/W] 0000000 -	PCNL2[R/W] 00000000	
0000F8H	PTMR3 [R] 11111111 11111111		PCSR3 [W] XXXXXXXX XXXXXXXX		PPG3
0000FCH	PDUT3 [W] XXXXXXXX XXXXXXXX		PCNH3[R/W] 0000000 -	PCNL3[R/W] 00000000	

(Continued)

Address	Register				Internal resource
	+0	+1	+2	+3	
000100H to 0001FCH	—				Reserved
000200H	DPDP [R/W] - - - - - - - -	- - - - - - - -	- - - - - - - -	-0000000	DMAC
000204H	DACSR [R/W] 00000000	00000000	00000000	00000000	
000208H	DATCR [R/W] - - - - - - - -	- - XX0000	- - XX0000	- - XX0000	
00020CH	—				
000210H to 0002FCH	—				Reserved
000300H to 0003ECH	—				Reserved
0003F0H	BSD0 [W] XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	Bit search module
0003F4 H	BSD1 [R/W] XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	
0003F8H	BSDC [W] XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	
0003FCH	BSRR [R/W] XXXXXXXX	XXXXXXXX	XXXXXXXX	XXXXXXXX	

(Continued)

Address	Register				Internal resource
	+0	+1	+2	+3	
000400H	ICR00 [R/W] - - -11111	ICR01[R/W] - - -11111	ICR02[R/W] - - -11111	ICR03[R/W] - - -11111	Interrupt controller
000404H	ICR04[R/W] - - -11111	ICR05[R/W] - - -11111	ICR06[R/W] - - -11111	ICR07[R/W] - - -11111	
000408H	ICR08 [R/W] - - -11111	ICR09[R/W] - - -11111	ICR10[R/W] - - -11111	ICR11[R/W] - - -11111	
00040CH	ICR12[R/W] - - -11111	ICR13[R/W] - - -11111	ICR14[R/W] - - -11111	ICR15[R/W] - - -11111	
000410H	ICR16[R/W] - - -11111	ICR17[R/W] - - -11111	ICR18[R/W] - - -11111	ICR19[R/W] - - -11111	
000414H	ICR20[R/W] - - -11111	ICR21[R/W] - - -11111	ICR22[R/W] - - -11111	ICR23[R/W] - - -11111	
000418H	ICR24 [R/W] - - -11111	ICR25[R/W] - - -11111	ICR26[R/W] - - -11111	ICR27[R/W] - - -11111	
00041CH	ICR28[R/W] - - -11111	ICR29[R/W] - - -11111	ICR30[R/W] - - -11111	ICR31[R/W] - - -11111	
000420H	ICR32[R/W] - - -11111	ICR33[R/W] - - -11111	ICR34[R/W] - - -11111	ICR35[R/W] - - -11111	
000424H	ICR36[R/W] - - -11111	ICR37[R/W] - - -11111	ICR38[R/W] - - -11111	ICR39[R/W] - - -11111	
000428H	ICR40[R/W] - - -11111	ICR41[R/W] - - -11111	ICR42[R/W] - - -11111	ICR43[R/W] - - -11111	
00042CH	ICR44[R/W] - - -11111	ICR45[R/W] - - -11111	ICR46[R/W] - - -11111	ICR47[R/W] - - -11111	
000430H	DICR [R/W] - - - - - - - 0	HRCL [R/W] - - -11111	—	—	Delay interrupt
000434H to 00047CH	—				Reserved
000480H	RSRR/WTCR [R/W] 1XXXX - 00	STCR [R/W] 000111- -	PDDR [R/W] - - - - 0000	CTBR [W] XXXXXXXX	Clock controller block
000484H	GCR [R/W] 110011 - 1	WPR [W] XXXXXXXX	—	—	
000488H	PTCR [R/W] 00 - - 0 - - -	—			PLL controller block
00048CH to 0005FCH	—				Reserved

(Continued)

(Continued)

Address	Register				Internal resource
	+0	+1	+2	+3	
000600H	DDR3 [W] 00000000	DDR2 [W] 00000000	—	—	Data direction register
000604H	DDR7 [W] - - - - - - - 0	DDR6 [W] 00000000	DDR5 [W] 00000000	DDR4 [W] 00000000	
000608H	—	DDRA [W] -0000000	—	DDR8 [W] - - 000000	
00060CH	ASR1 [W] 00000000 00000001		AMR1 [W] 00000000 00000000		External bus interface
000610H	ASR2 [W] 00000000 00000010		AMR2 [W] 00000000 00000000		
000614H	ASR3 [W] 00000000 00000011		AMR3 [W] 00000000 00000000		
000618H	ASR4 [W] 00000000 00000100		AMR4 [W] 00000000 00000000		
00061CH	ASR5 [W] 00000000 00000101		AMR5 [W] 00000000 00000000		
000620H	AMD0 [R/W] - - - XX111	AMD1 [R/W] 0 - - 00000	AMD32[R/W] 00000000	AMD4 [R/W] 0 - - 00000	
000624H	AMD5[R/W] 0 - - 00000	DSCR [W] 00000000	RFCR [R/W] --XXXXXX 00 - - - 000		
000628H	EPCR0 [W] - - 1 - 1100 -1111111		EPCR1 [W] - - - - - - - 1 11111111		
00062CH	DMCR4 [R/W] 00000000 0000000-		DMCR5 [R/W] 00000000 0000000-		
000630H to 0007BCH	—				Reserved
0007C0H	FSTR [R/W] 000XXXX0	—	—	—	Flash memory
0007C4H to 0007F8H	—				Reserved
0007FCH	—		LER [W] - - - - - 000	MODR [W] XXXXXXXX	Little endian register mode register

Note : Do not issue RMW instructions to a register with write-only bit.

RMW instructions (RMW : Read modify write)

AND Rj, @Ri	OR Rj, @Ri	EOR Rj, @Ri
ANDH Rj, @Ri	ORH Rj, @Ri	EORH Rj, @Ri
ANDB Rj, @Ri	ORB Rj, @Ri	EORB Rj, @Ri
BANDL #u4, @Ri	BORL #u4, @Ri	BEORL #u4, @Ri
BANDH #u4, @Ri	BORH #u4, @Ri	BEORH #u4, @Ri

Data in “Reserved” or “-” area is indefinite.

■ INTERRUPT CAUSES, INTERRUPT VECTORS AND INTERRUPT CONTROL REGISTER ALLOCATIONS

Interrupt causes	Interrupt number		Interrupt level		TBR default Address*2
	Decimal	Hexadecimal	Register*1	Offset	
Reset	0	00	—	$3FC_H$	$000FFFFC_H$
Reserved by system	1	01	—	$3F8_H$	$000FFFF8_H$
Reserved by system	2	02	—	$3F4_H$	$000FFFF4_H$
Reserved by system	3	03	—	$3F0_H$	$000FFFF0_H$
Reserved by system	4	04	—	$3EC_H$	$000FFFEC_H$
Reserved by system	5	05	—	$3E8_H$	$000FFFE8_H$
Reserved by system	6	06	—	$3E4_H$	$000FFFE4_H$
Reserved by system	7	07	—	$3E0_H$	$000FFFE0_H$
Reserved by system	8	08	—	$3DC_H$	$000FFFDC_H$
Reserved by system	9	09	—	$3D8_H$	$000FFFD8_H$
Reserved by system	10	0A	—	$3D4_H$	$000FFFD4_H$
Reserved by system	11	0B	—	$3D0_H$	$000FFFD0_H$
Reserved by system	12	0C	—	$3CC_H$	$000FFFCC_H$
Reserved by system	13	0D	—	$3C8_H$	$000FFFC8_H$
Undefined instruction exception	14	0E	—	$3C4_H$	$000FFFC4_H$
NMI request	15	0F	15 (F_H) fixed	$3C0_H$	$000FFFC0_H$
External interrupt 0	16	10	ICR00	$3BC_H$	$000FFFBC_H$
External interrupt 1	17	11	ICR01	$3B8_H$	$000FFFB8_H$
External interrupt 2	18	12	ICR02	$3B4_H$	$000FFFB4_H$
External interrupt 3	19	13	ICR03	$3B0_H$	$000FFFB0_H$
UART 0 reception complete	20	14	ICR04	$3AC_H$	$000FFFAC_H$
UART 1 reception complete	21	15	ICR05	$3A8_H$	$000FFFA8_H$
UART 2 reception complete	22	16	ICR06	$3A4_H$	$000FFFA4_H$
UART 0 transmission complete	23	17	ICR07	$3A0_H$	$000FFFA0_H$
UART 1 transmission complete	24	18	ICR08	$39C_H$	$000FFF9C_H$
UART 2 transmission complete	25	19	ICR09	398_H	$000FFF98_H$

(Continued)

Interrupt causes	Interrupt number		Interrupt level		TBR default Address*2
	Decimal	Hexadecimal	Register*1	Offset	
DMAC 0 (end, error)	26	1A	ICR10	394H	000FFF94H
DMAC 1 (end, erro)	27	1B	ICR11	390H	000FFF90H
DMAC 2 (end, erro)	28	1C	ICR12	38CH	000FFF8CH
DMAC 3 (end, erro)	29	1D	ICR13	388H	000FFF88H
DMAC 4 (end, erro)	30	1E	ICR14	384H	000FFF84H
DMAC 5 (end, erro)	31	1F	ICR15	380H	000FFF80H
DMAC 6 (end, erro)	32	20	ICR16	37CH	000FFF7CH
DMAC 7 (end, erro)	33	21	ICR17	378H	000FFF78H
A/D (sequential type)	34	22	ICR18	374H	000FFF74H
Reload timer 0	35	23	ICR19	370H	000FFF70H
Reload timer 1	36	24	ICR20	36CH	000FFF6CH
Reload timer 2	37	25	ICR21	368H	000FFF68H
External interrupt 4	38	26	ICR22	364H	000FFF64H
External interrupt 5	39	27	ICR23	360H	000FFF60H
Reserved by system	40	28	ICR24	35CH	000FFF5CH
Reserved by system	41	29	ICR25	358H	000FFF58H
U-TIMER 0	42	2A	ICR26	354H	000FFF54H
U-TIMER 1	43	2B	ICR27	350H	000FFF50H
U-TIMER 2	44	2C	ICR28	34CH	000FFF4CH
FLASH memory	45	2D	ICR29	348H	000FFF48H
Reserved by system	46	2E	ICR30	344H	000FFF44H
Reserved by system	47	2F	ICR31	340H	000FFF40H
PPG0	48	30	ICR32	33CH	000FFF3CH
PPG1	49	31	ICR33	338H	000FFF38H
PPG2	50	32	ICR34	334H	000FFF34H
PPG3	51	33	ICR35	330H	000FFF30H
ICU0 (capture)	52	34	ICR36	32CH	000FFF2CH
ICU1 (capture)	53	35	ICR37	328H	000FFF28H
ICU2 (capture)	54	36	ICR38	324H	000FFF24H
ICU3 (capture)	55	37	ICR39	320H	000FFF20H

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Interrupt causes	Interrupt number		Interrupt level		TBR default Address*2
	Decimal	Hexadecimal	Register*1	Offset	
OCU0 (match)	56	38	ICR40	$31C_H$	$000FFF1C_H$
OCU1 (match)	57	39	ICR41	318_H	$000FFF18_H$
OCU2 (match)	58	3A	ICR42	314_H	$000FFF14_H$
OCU3 (match)	59	3B	ICR43	310_H	$000FFF10_H$
Reserved by system	60	3C	ICR44	$30C_H$	$000FFF0C_H$
16 bit free-run timer	61	3D	ICR45	308_H	$000FFF08_H$
Reserved by system	62	3E	ICR46	304_H	$000FFF04_H$
Delay interrupt cause bit	63	3F	ICR47	300_H	$000FFF00_H$
Reserved by system (used by REALOS) *3	64	40	—	$2FC_H$	$000FFEFC_H$
Reserved by system (used by REALOS) *3	65	41	—	$2F8_H$	$000FFEF8_H$
Used by INT	66 to 255	42 to FF	—	$2F4_H$ to 000_H	$000FFEF4_H$ to $000FFC00_H$

*1 : ICR specifies interrupt levels for interrupt requests, using the registers in interrupt controller. ICR is provided for each interrupt request.

*2 : TBR is a register that indicates a head address of the vector table for EIT. An address that is found by adding offset values defined by TBR and EIT cause, is a vector address.

*3 : If REALOS/FR is used, 0x40 and 0x41 interrupts are used for system code.

Information : An 1 Kbyte area starting with an address indicated by TBR is the vector area for EIT. Size of the area for one vector is 4 byte. Relation between a vector number and a vector address is as follows:

vctadr = TBR + vctofs

= TBR + ($3FC_H$ – 4 × vct)

Vctadr Vector address, vctofs: Vector offset, vct: Vector number

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

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

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power supply voltage	V_{CC}	V_{SS} – 0.3	V_{SS} + 4.0	V	
Analog supply voltage	AV_{CC}	V_{SS} – 0.3	V_{SS} + 4.0	V	*1
Analog reference voltage	AVRH	V_{SS} – 0.3	V_{SS} + 4.0	V	*1
Input voltage	V_I	V_{SS} – 0.3	V_{CC} + 0.3	V	
Analog input voltage	V_{IA}	V_{SS} – 0.3	A_{VCC} + 0.3	V	
Output voltage	V_O	V_{SS} – 0.3	V_{CC} + 0.3	V	
Maximum clamp current	I_{CLAMP}	– 2.0	+ 2.0	mA	*5
Total maximum clamp current	$\Sigma \mid I_{CLAMP} \mid$	—	20	mA	*5
“L” level maximum output current	I_{OL}	—	10	mA	*2
“L” level average output current	I_{OLAV}	—	4	mA	*3
“L” level maximum total output current	ΣI_{OL}	—	100	mA	
“L” level average total output current	ΣI_{OLAV}	—	50	mA	*4
“H” level maximum output current	I_{OH}	—	–10	mA	*2
“H” level average output current	I_{OHAV}	—	–4	mA	*3
“H” level maximum total output current	ΣI_{OH}	—	–50	mA	
“H” level average total output current	ΣI_{OHAV}	—	–20	mA	*4
Power consumption	Pd	—	500	mW	
Operating temperature	T_A	–30	+70	°C	
Storage temperature	Tstg	–55	+150	°C	

*1 : Care must be taken that AV_{CC}, AVRH do not exceed V_{CC} + 0.3 V. Also, care must be taken that AVRH do not exceed AV_{CC}.

*2 : Maximum output current defines a peak value of a specific terminal.

*3 : Average output current defines a mean value of current flow within a period of 100 ms in a specific terminal.

*4 : Average total output current defines a mean value of current flow within a period of 100 ms in all terminals.

*5 : • Aplicable to pins : D16 to D31, A00 to A24, RDY, $\overline{BGRNT}$, BRQ, $\overline{RD}$, $\overline{WR0}$, $\overline{WR1}$, $\overline{CS0}$ to $\overline{CS5}$, CLK, OCPA0 to OCPA3, OC0 to OC3, ALE, INT0 to INT5, SI0, SI2, SO0, SO2, TCI0, SC2

- Use within recommended operating conditions.
- Use at DC voltage (current) .
- The +B signal should always be applied with a limiting resistance placed between the +B signal and the microcontroller.

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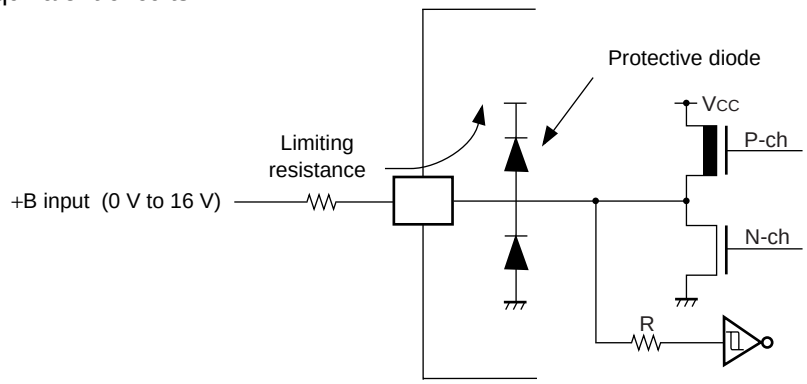
- The value of the limiting resistance should be set so that when the signal is applied the input current to the microcontroller pins does not exceed rated values, either instantaneously or for prolonged periods.
- Note that when the microcontroller drive current is low, such as in the power saving modes, the +B input potential may pass through the protective diode and increase the potential at the VCC pin, and this may affect other devices.
- Note that if a +B signal is input when the microcontroller power supply is off (not fixed at 0 V) , the power supply is provided from the pins, so that incomplete operation may result.
- Note that if the +B input is applied during power-on, the power suplly is provided from the pins and the resulting supply voltage may not be sufficient to operate the power-on reset.
- Care must be taken not to leave the 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

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

Parameter	Symbol	Value		Unit	Remarks
		Min	Max		
Power supply	V_{CC}	3.0	3.6	V	Normal operation
		2.0	3.6		Retain RAM data under “stop” condition
Analog supply voltage	AV_{CC}	V_{SS} – 0.3	V_{SS} + 3.6	V	
Analog reference voltage	AVRH	AV_{SS}	AV_{CC}	V	
Operating temperature	T_A	–30	+70	°C	

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

(AV_{CC} = V_{CC} = 3.3 V ± 0.3 V, AV_{SS} = V_{SS} = 0 V, T_A = –30 °C to +70 °C)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min	Typ	Max		
"H" level input voltage	V_{IHS}	Hysteresis input terminal	—	0.8 × V_{CC}	—	V_{CC} + 0.3	V	*
"L" level input voltage	V_{ILS}	Hysteresis input terminal	—	V_{SS}–0.3	—	0.2 × V_{CC}	V	*
"H" level output voltage	V_{OH}	Port2 to PortJ	V_{CC} = 3.3 V I_{OH} = –4.0 mA	V_{CC}–0.5	—	—	V	
"L" level output voltage	V_{OL}	Port2 to PortJ	V_{CC} = 3.3 V I_{OL} = 4.0 mA	—	—	0.4	V	
Input leak current	I_{LI}	Port2 to PortJ	V_{CC} = 3.6 V V_{SS} < VI < V_{CC}	—	—	±5	µA	
Power supply current	I_{CC}	VCC	25 MHz V_{CC} = 3.3 V	—	75	100	mA	
	I_{CC}		25 MHz V_{CC} = 3.3 V	—	85	120	mA	FLASH writing
	I_{CCS}		25 MHz V_{CC} = 3.3 V	—	60	85	mA	Sleeping
	I_{CCH}		T_A = 25 °C V_{CC} = 3.3 V	—	10	150	µA	Stopping
Input capacity	C_{IN}	Other than AVCC, AVSS, AVRH, VCC, VSS	—	—	10	—	pF	

* : Refer to "■ INPUT/OUTPUT CIRCUIT TYPE".

4. AC Characteristics

(1) Clock Timing Ratings

(V_{CC} = 3.3 V ± 0.3 V, AV_{SS} = V_{SS} = 0 V, T_A = –30 °C to +70 °C)

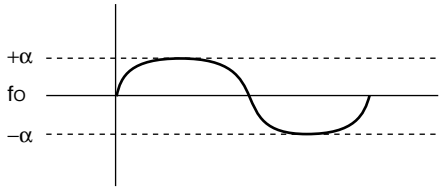
Parameter		Symbol	Condition	Value		Unit	Remarks
				Min	Max		
Clock frequency (High speed, automatic oscillation)		f_C	—	10	25	MHz	Self oscillation allowable range
Clock frequency (High speed, PLL used)				10	25	MHz	PLL-use allowable area for self oscillation and external clock input *1
Clock frequency (High speed, 1/2 division input)				10	25	MHz	External clock input allowable range
Clock cycle time		t_C		40	100	ns	
Frequency regulation (when locked)		Δf		—	10	%	*2
Input clock pulse width		P_{WH}, P_{WL}	—	9.5	—	ns	
Input clock rise and fall time		t_{CR} t_{CF}	—	—	8	ns	(t_{CR} + t_{CF})
Internal operation clock frequency	CPU system	f_{CP}	—	0.625 *3	25	MHz	
	Peripheral system	f_{CPP}		0.625 *3	25	MHz	
Internal operation clock cycle time	CPU system	t_{CP}		40	1600 *3	ns	
	Peripheral system	t_{LCPP}		40	1600 *3	ns	

*1 : Although PLL allows selection among x1 and x2 multiplication modes, the selection is limited by oscillation frequency as follows:

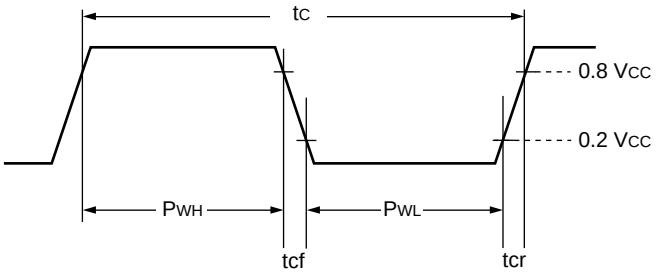
Specifying "x2 multiplication" is not allowed if oscillation frequency exceeds 12.5 MHz.

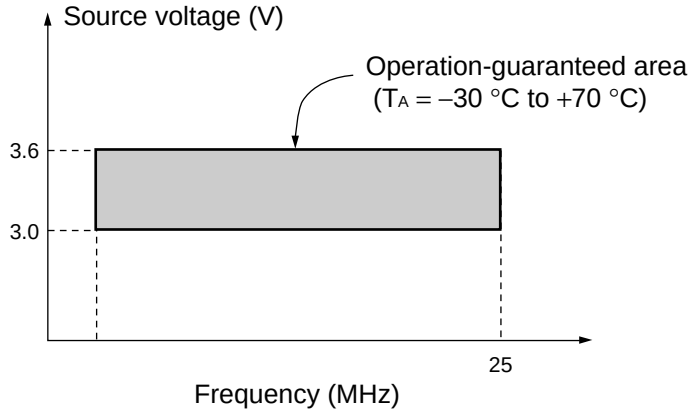
*2 : Frequency regulation indicates a maximum fluctuation from a specified center frequency under locked frequency multiplication.

$$\Delta f = \frac{|\alpha|}{f_O} \times 100\ (\%)$$



*3 : This is a value in the case where 10 MHz signal, a minimum value of clock frequency, is input to X0 and where 1/2-division in oscillation circuit and 1/8-gear are used.





(2) Clock Output Timing

(V_{CC} = 3.3 V ± 0.3 V, AV_{SS} = V_{SS} = 0 V, T_A = –30 °C to +70 °C)

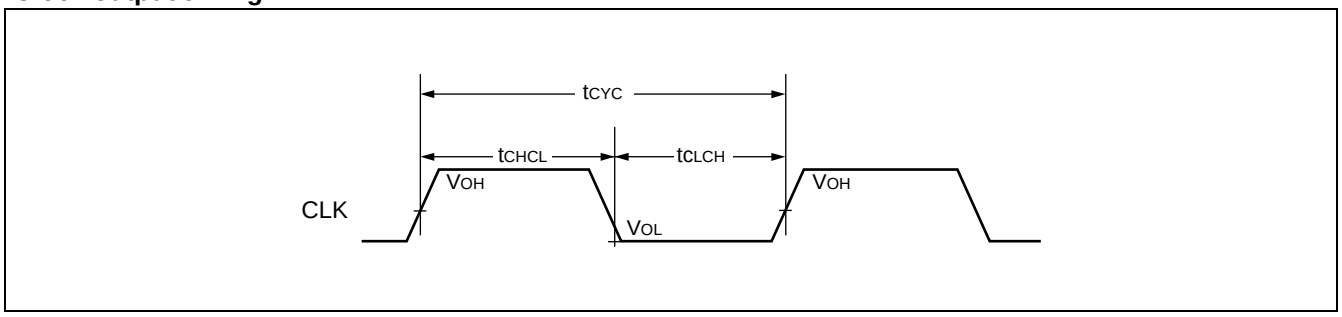
Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Cycle time	t_{CYC}	CLK	—	t_{CP}	—	ns	*1
CLK↑ →CLK↓	t_{CHCL}	CLK		1 / 2 × t_{CYC} – 10	1 / 2 × t_{CYC} + 10	ns	*2
CLK↓ →CLK↑	t_{CLCH}	CLK		1 / 2 × t_{CYC} – 10	1 / 2 × t_{CYC} + 10	ns	*3

*1 : t_{CYC} is a frequency of 1 clock cycle indicating gear cycle.

*2 : The values indicate specifications where x1 gear cycle is used.
If gear cycle of 1/2, 1/4, or 1/8 is specified, calculate in the formula below by substituting 1/2, 1/4, or 1/8 into n.
Min : (1 – n / 2) × t_{CYC} – 10
Max : (1 – n / 2) × t_{CYC} + 10

*3 : The values indicate specifications where x1 gear cycle is used.
If gear cycle of 1/2, 1/4, or 1/8 is specified, calculate in the formula below by substituting 1/2, 1/4, or 1/8 into n.
Min : n / 2 × t_{CYC} – 10
Max : n / 2 × t_{CYC} + 10

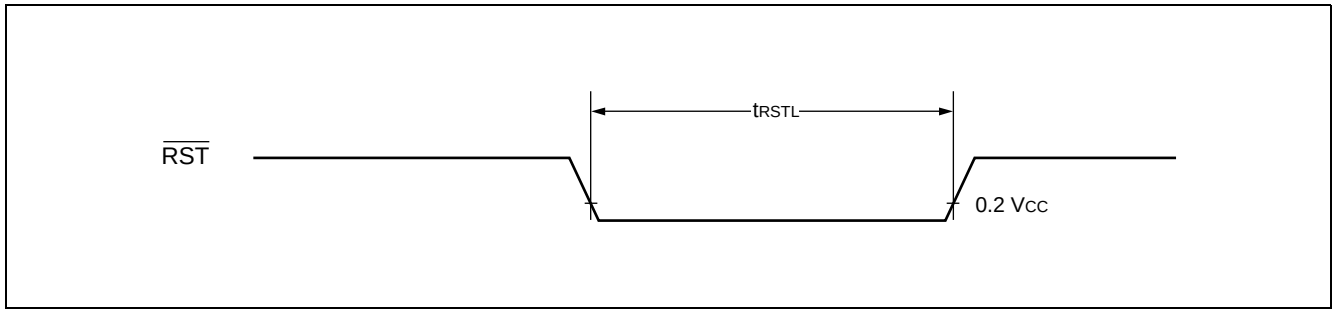
Clock output timing



(3) Reset Input Ratings

(V_{CC} = 3.3 V ± 0.3 V, AV_{SS} = V_{SS} = 0 V, T_A = –30 °C to +70 °C)

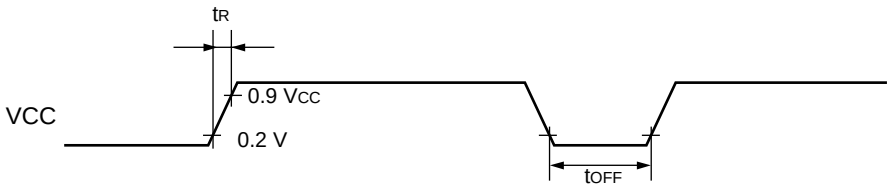
Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Reset input time	t_{RSTL}	$\overline{RST}$	—	t_{CP} × 5	—	ns	



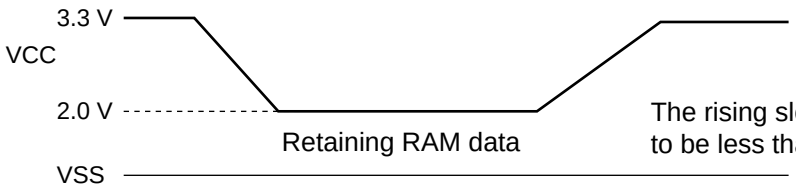
(4) Power-on Reset

(V_{CC} = 3.3 V ± 0.3 V, V_{SS} = 0 V, T_A = –30 °C to +70 °C)

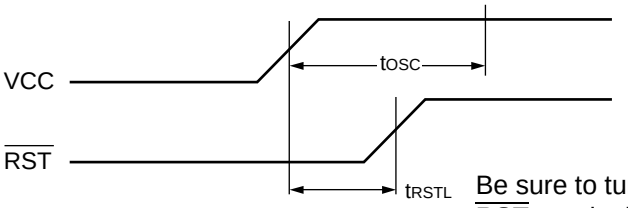
Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Power supply rise time	t_R	VCC	V_{CC} = 3.3 V	—	20	ms	V_{CC} < 0.2 V before turning on power
Power supply shut off time	t_{OFF}	VCC	—	2	—	ms	
Oscillation stabilizing wait time	t_{OSC}	—	—	$2 \times t_C \times 2^{21}$ + 100 µs	—	ns	



A sudden change of supply voltage may activate the power-on reset function. It is recommended that power voltage should be changed smoothly with less fluctuation of voltages.



The rising slope is recommended to be less than 50 mV / ms.



Be sure to turn on the power while keeping $\overline{RST}$ terminal at L level first. When the power becomes V_{CC} level, rise the voltage to H level after a period of t_{RSTL}.

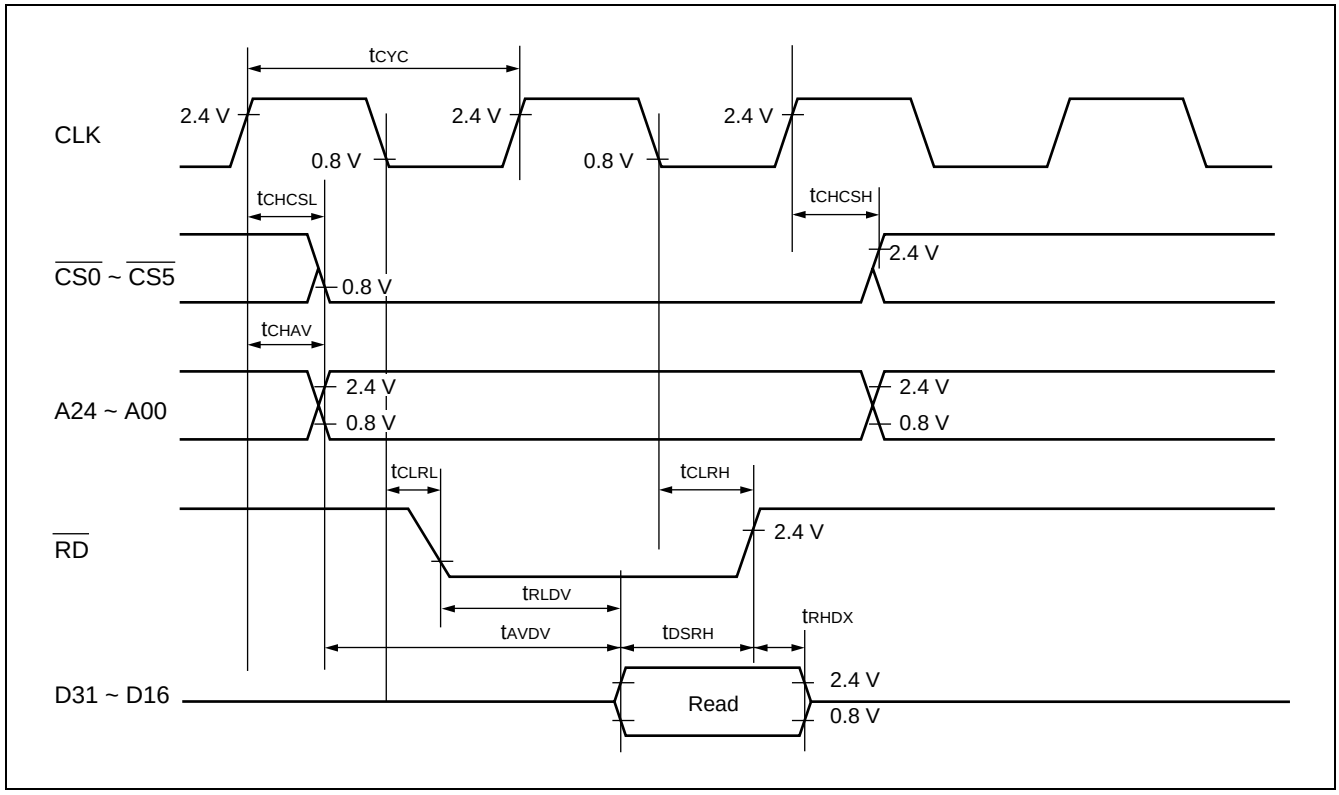
(5) Normal Bus Access Read/Write Operation

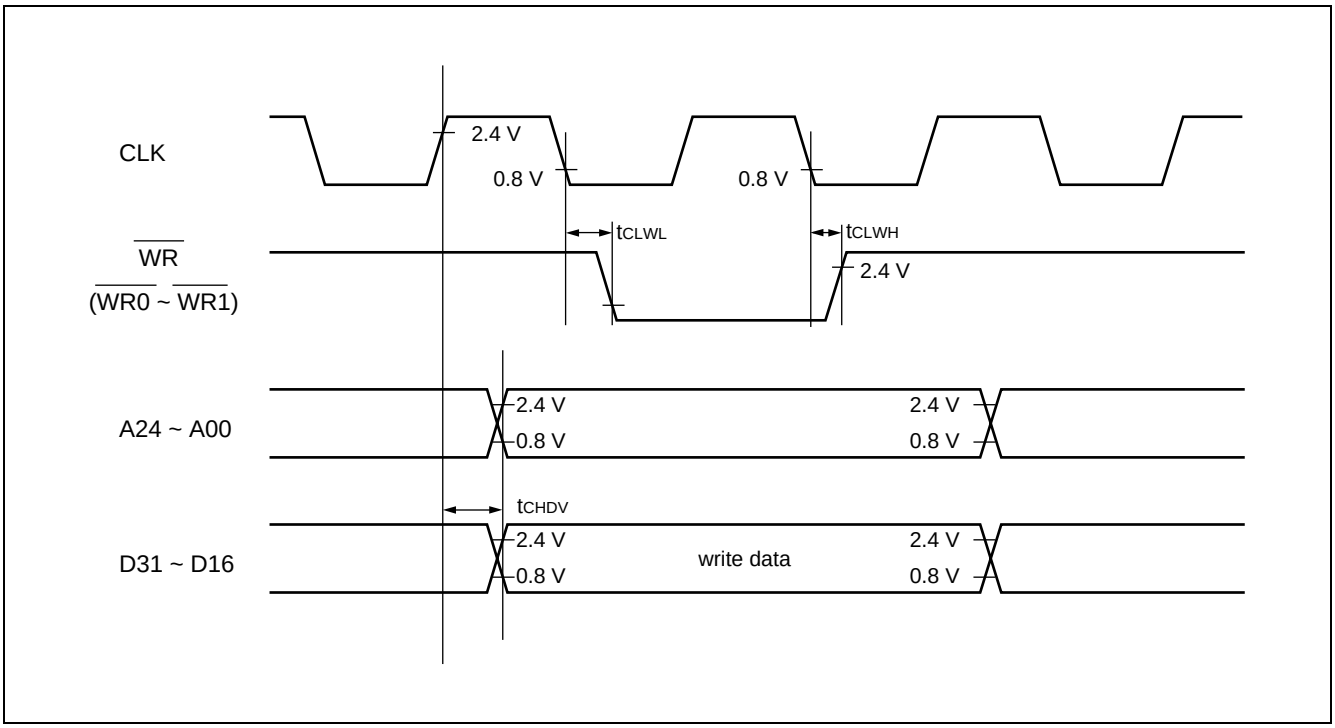
(V_{CC} = 3.3 V ± 0.3 V, V_{SS} = 0 V, T_A = –30 °C to +70 °C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
CS0 to CS5 delay time	t_{CHCSL}	CLK $\overline{CS0}$ to $\overline{CS5}$	—	—	15	ns	
CS0 to CS5 delay time	t_{CHCSH}			—	15	ns	
Address delay time	t_{CHAV}	CLK A24 to A00		—	15	ns	
Data delay time	t_{CHDV}	CLK D31 to D16		—	15	ns	
$\overline{RD}$ delay time	t_{CLRL}	CLK $\overline{RD}$		—	15	ns	
$\overline{RD}$ delay time	t_{CLRH}			—	15	ns	
$\overline{WR0}$, $\overline{1}$ delay time	t_{CLWL}	CLK $\overline{WR0}$, $\overline{1}$		—	15	ns	
$\overline{WR0}$, $\overline{1}$ delay time	t_{CLWH}			—	15	ns	
Valid address→ Valid data input time	t_{AVDV}	A24 to A00 D31 to D16		—	3 / 2 × tcyc – 25	ns	*1 *2
$\overline{RD}$↓→ Valid data input time	t_{RLDV}	$\overline{RD}$ D31 to D16		—	tcyc – 25	ns	*1
Data setup →$\overline{RD}$↑ Time	t_{DSRH}			25	—	ns	
$\overline{RD}$↑→ Data hold time	t_{RHDX}			0	—	ns	

*1 : If the bus is expanded by automatic wait insertion or RDY input, add time (tcyc × the number of expanded cycles) to the rated value.

*2 : The ratings are based on conditions with “gear cycle × 1”. If gear cycle of 1/2, 1/4, or 1/8 is specified, calculate in the formula below by substituting 1/2, 1/4, or 1/8 into n.
Formula : $(2 - n / 2) \times t_{CYC} - 25$



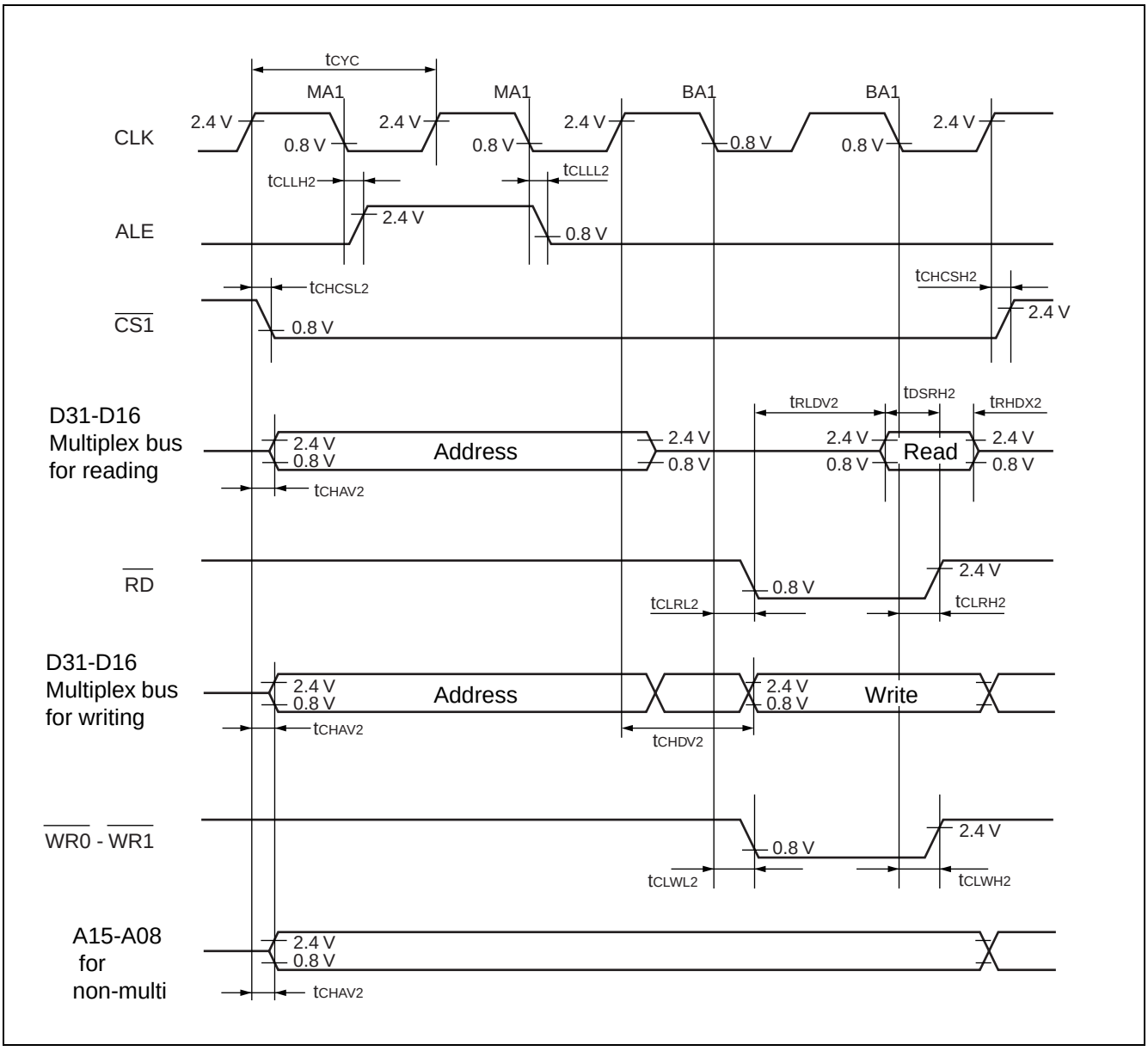


(6) Timeshared Bus Access Read/Write Operations

(V_{CC} = 3.3 V ± 0.3 V, V_{SS} = 0 V, T_A = –30 °C to +70 °C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
ALE delay time	t_{CLLH2}	CLK ALE	—	—	10	—	
ALE delay time	t_{CLLL2}			—	10	—	
$\overline{CS1}$ delay time	t_{CHCSL2}	CLK $\overline{CS1}$		—	15	—	
$\overline{CS1}$ delay time	t_{CHCSH2}			—	15	ns	
Address delay time	t_{CHAV2}	CLK D31 to D16		—	15	ns	
Data delay time	t_{CHDV2}			—	15	ns	
$\overline{RD}$ delay time	t_{CLRL2}	CLK $\overline{RD}$		—	10	ns	
$\overline{RD}$ delay time	t_{CLRH2}			—	10	ns	
$\overline{WR0}$, $\overline{1}$ delay time	t_{CLWL2}	CLK $\overline{WR0}$ $\overline{WR1}$		—	10	ns	
$\overline{WR0}$, $\overline{1}$ pulse width	t_{CLWH2}			—	10	ns	
$\overline{RD}\downarrow\rightarrow$ Valid data input time	t_{RLDV2}	$\overline{RD}$ D31 to D16		—	t_{CYC} – 25	—	*
Data setup $\rightarrow\overline{RD}\uparrow$time	t_{DSRH2}			25	—	ns	
$\overline{RD}\uparrow\rightarrow$ Data hold time	t_{RHDX2}			0	—	ns	

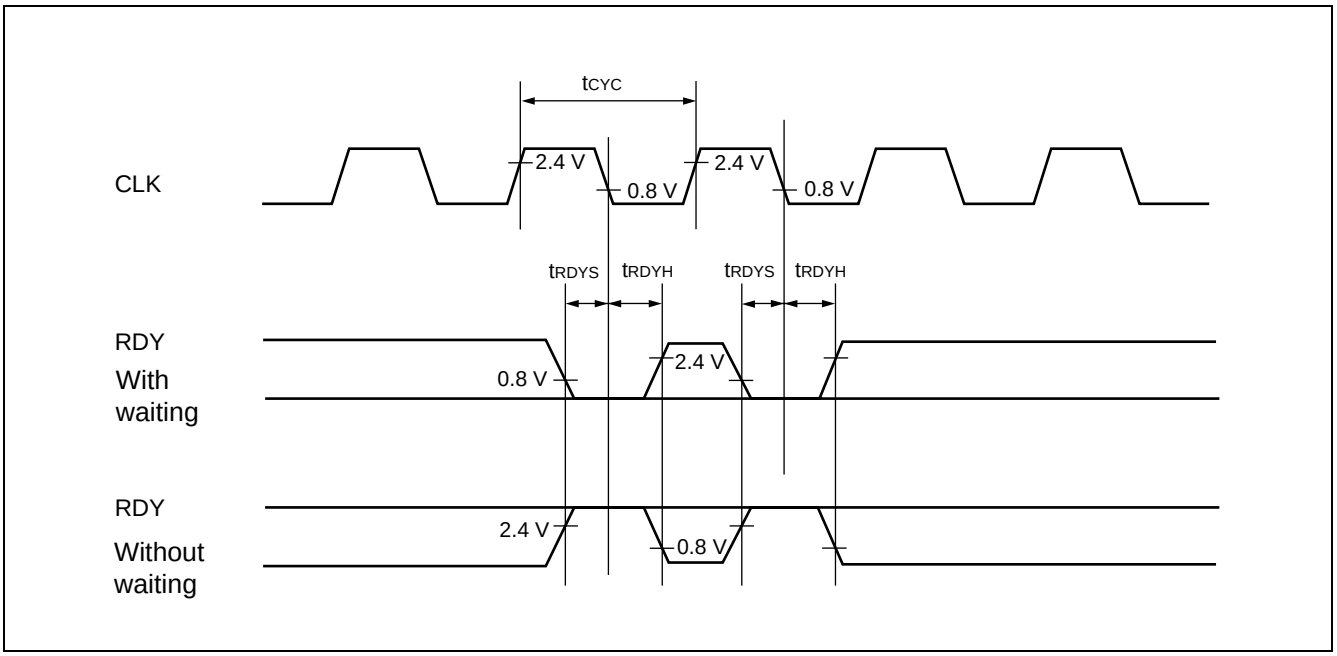
* : If the bus is expanded by automatic wait insertion or RDY input, add time (tcyc x the number of expanded cycles) to the rated value.



(7) Ready Input Timing

(V_{CC} = 3.3 V ± 0.3 V, AV_{SS} = V_{SS} = 0 V, T_A = –30 °C to +70 °C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
RDY setup time RCLK↓	t_{RDYS}	RDY CLK	—	15	—	ns	
CLK↓→ RDY hold time	t_{RDYH}	CLK RDY		0	—	ns	

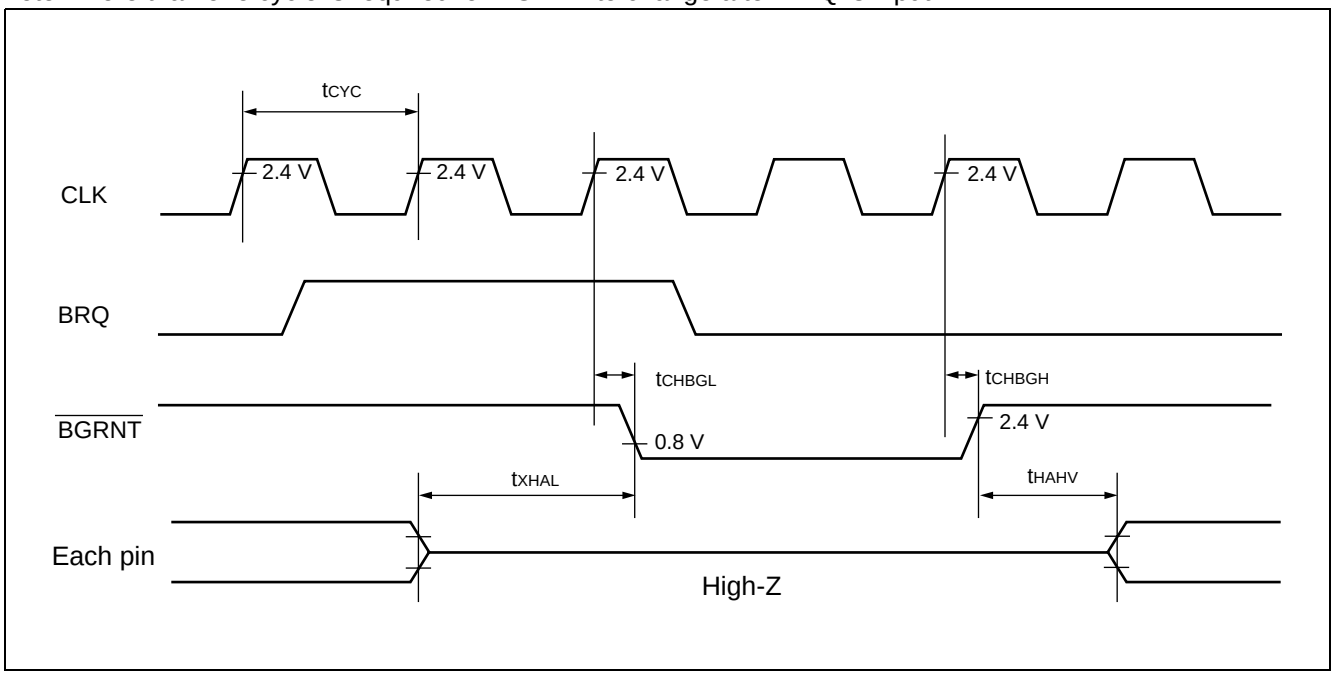


(8) Hold Timing

(V_{CC} = 3.0 V ± 0.3 V, AV_{SS} = V_{SS} = 0 V, T_A = –30 °C to +70 °C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
$\overline{BGRNT}$ delay time	t_{CHBGL}	CLK $\overline{BGRNT}$	—	—	10	ns	
$\overline{BGRNT}$ delay time	t_{CHBGH}			—	10	ns	
Terminal floating →$\overline{BGRNT}$↓ time	t_{XHAL}	$\overline{BGRNT}$		t_{CYC} – 10	t_{CYC} + 10	ns	
$\overline{BGRNT}$↑ →Terminal valid time	t_{HAHV}			t_{CYC} – 10	t_{CYC} + 10	ns	

Note : More than one cycle is required for $\overline{BGRNT}$ to change after BRQ is input.



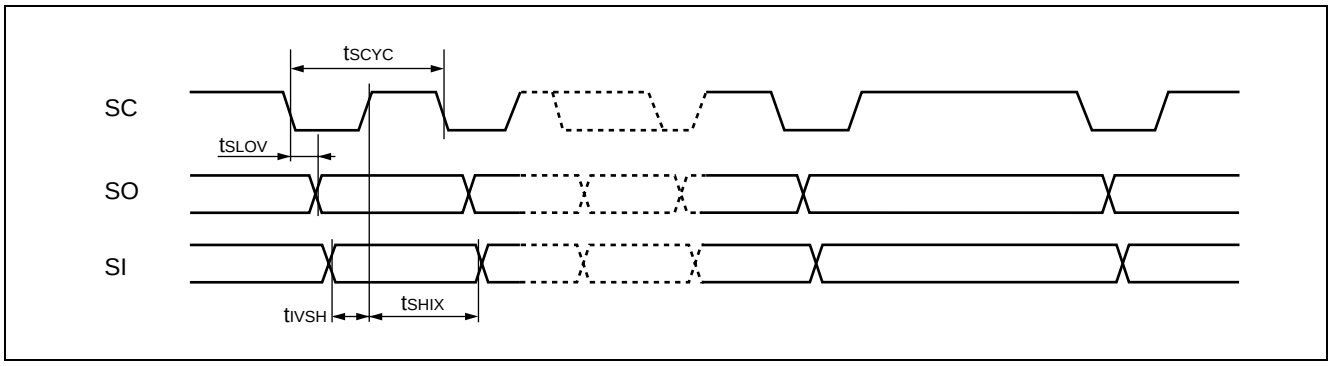
(9) UART Timing

(V_{CC} = 3.3 V ± 0.3 V, V_{SS} = 0 V, T_A = –30 °C to +70 °C)

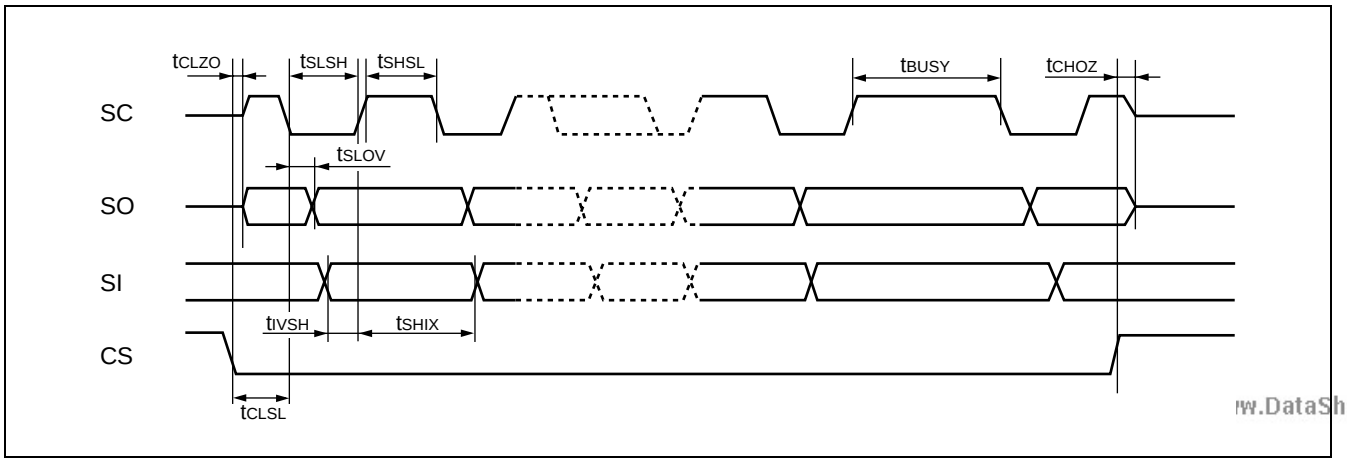
Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Serial clock cycle time	t_{SCYC}	—	Internal shift clock mode	8 t_{CYCP}*	—	ns	
SC↓ → SO delay time	t_{SLOV}	—		–10	+50	ns	
Valid SI → SC↑	t_{IVSH}	—		50	—	ns	
SC↑ → Valid SI hold time	t_{SHIX}	—		50	—	ns	
Serial clock “H” pulse width	t_{SHSL}	—	External shift clock mode	4 t_{CYCP}* – 10	—	ns	
Serial clock “L” pulse width	t_{SLSH}	—		4 t_{CYCP}* – 10	—	ns	
SC↓ → SO delay time	t_{SLOV}	—		0	50	ns	
Valid SI → SC↑	t_{IVSH}	—		50	—	ns	
SC↑ → Valid SI hold time	t_{SHIX}	—		50	—	ns	
Serial busy time	t_{BUSY}	—		—	6 t_{CYCP}*	ns	
CS↓ → SC, SO delay time	t_{CLZO}	—		—	50	ns	
CS↓ → SC input mask time	t_{CLSL}	—		—	3 t_{CYCP}*	ns	
SC↑ → SC, SO Hi-z time	t_{CHOZ}	—	—	50	—	ns	

* : t_{CYCP} is a cycle time of peripheral system clock.

Internal shift clock mode



External shift clock mode

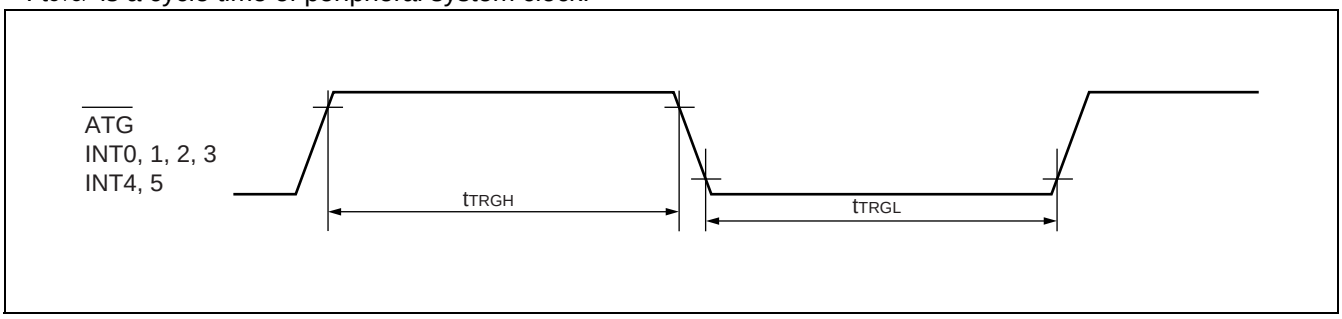


(10) Trigger Input Timing

(V_{CC} = 3.3 V ± 0.3 V, V_{SS} = 0 V, T_A = –30 °C to +70 °C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TRGH} t_{TRGL}	$\overline{ATG}$, INT0, 1, 2, 3 INT4, 5	—	5 t_{CYCP}*	—	ns	

* : t_{CYCP} is a cycle time of peripheral system clock.



(11) A/D Converter Block Electrical Characteristics

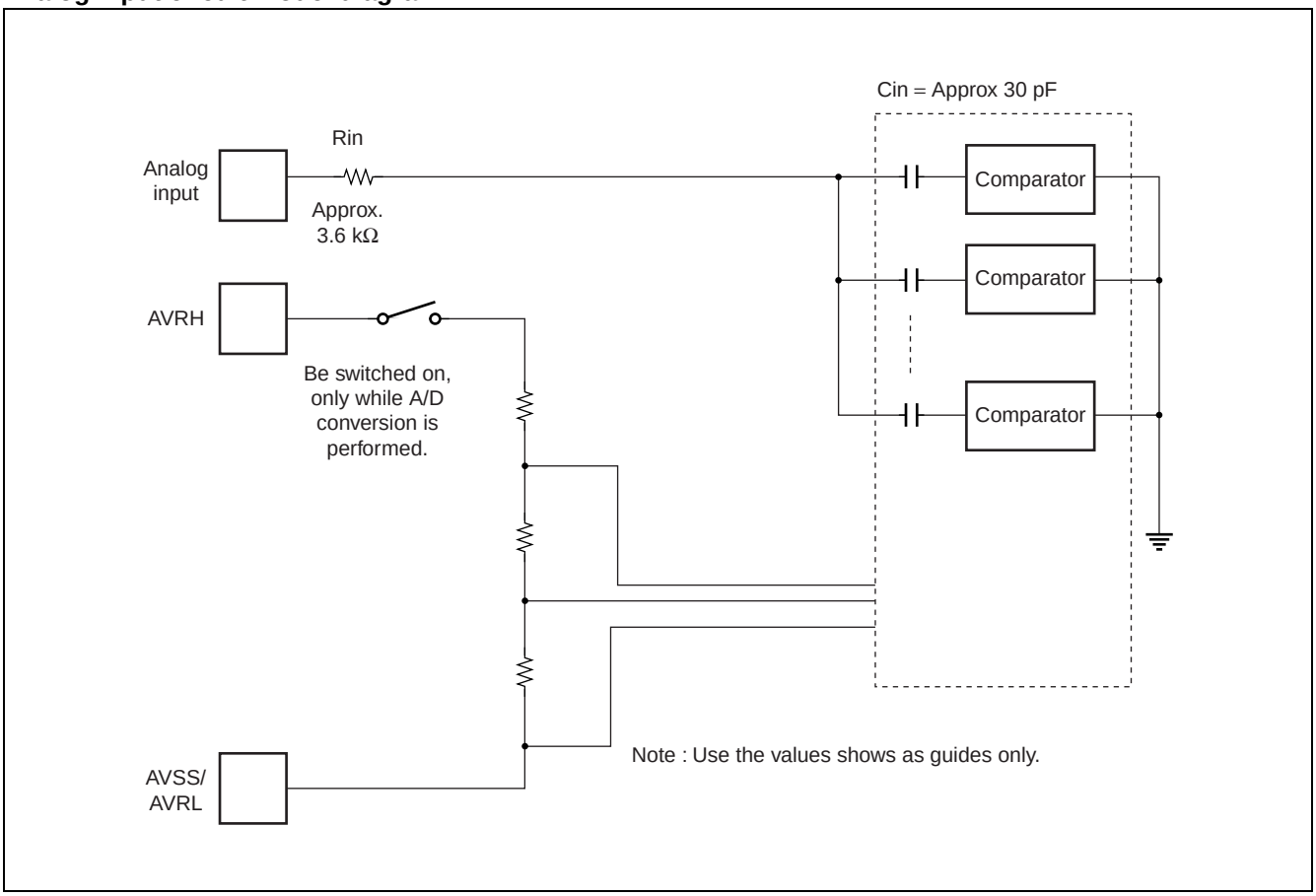
(V_{CC} = 3.3 V ± 0.3 V, AV_{SS} = V_{SS} = 0 V, T_A = –30 °C to +70 °C)

Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Resolution	—	—	—	10	10	BIT	
Total error	—	—	—	—	±4.0	LSB	
Linearity error	—	—	—	—	±3.5	LSB	
Differential linearity error	—	—	—	—	±2.0	LSB	
Zero transition voltage	V_{0t}	AN0 to AN7	AVSS – 1.5 LSB	AVSS + 0.5 LSB	AVSS + 2.5 LSB	mV	
Full-scale transition voltage	V_{FST}	AN0 to AN7	AVRH – 5.5 LSB	AVRH – 1.5 LSB	AVRH + 0.5 LSB	mV	
Conversion time	—	—	5.3	—	—	µs	
Analog input current	I_{AIN}	AN0 to AN7	—	0.1	10	µA	
Analog input voltage	V_{AIN}	AN0 to AN7	AV_{SS}	—	AVRH	V	
Reference voltage	—	AVRH	AV_{SS}	—	AV_{CC}	V	
Power supply current	I_A	AVCC	—	3.0	5.0	mA	
	I_{AH}		—	—	5.0	µA	
Reference voltage supply current	I_R	AVRH	—	100	150	µA	
	I_{RH}		—	—	10	µA	
Variation among channels	—	AN0 to AN7	—	—	4	LSB	

Notes : • Relatively, the errors increase as |AVRH| value becomes smaller.

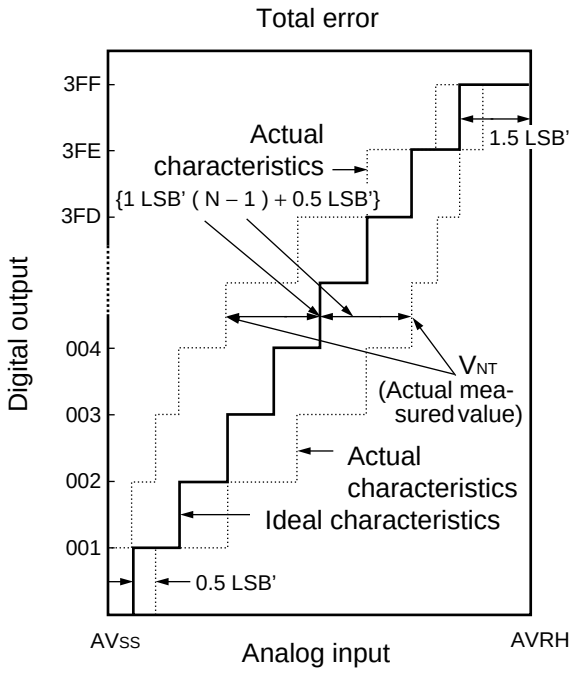
• Define an output impedance of external circuit analog input under the following conditions :
Output impedance of external circuit ≤ 2 (kΩ)
If an output impedance of external circuit is exceedingly high, sampling time for analog voltage may run short.

Analog input circuit model diagram



5. A/D Converter Block Electrical Characteristics

- Resolution
  Analog variations recognized by an A/D converter.
- Linearity error
  Deviation of actual conversion characteristics from an ideal line, which is across zero-transition point (“00 0000 0000”←→ “00 0000 0001”) and full-scale transition point (“11 1111 1110”←→ “11 1111 1111”)
- Differential linearity error
  Deviation from ideal value of input voltage, which is required for changing output code by 1 LSB.
- Total error
  Difference between actual value and ideal value. The error includes zero-transition error, full-scale transition error, and linearity error.



$$1\ \text{LSB'}\ (\text{Ideal value}) = \frac{\text{AVRH} - \text{AV}_{SS}}{1024}\ [\text{V}]$$

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

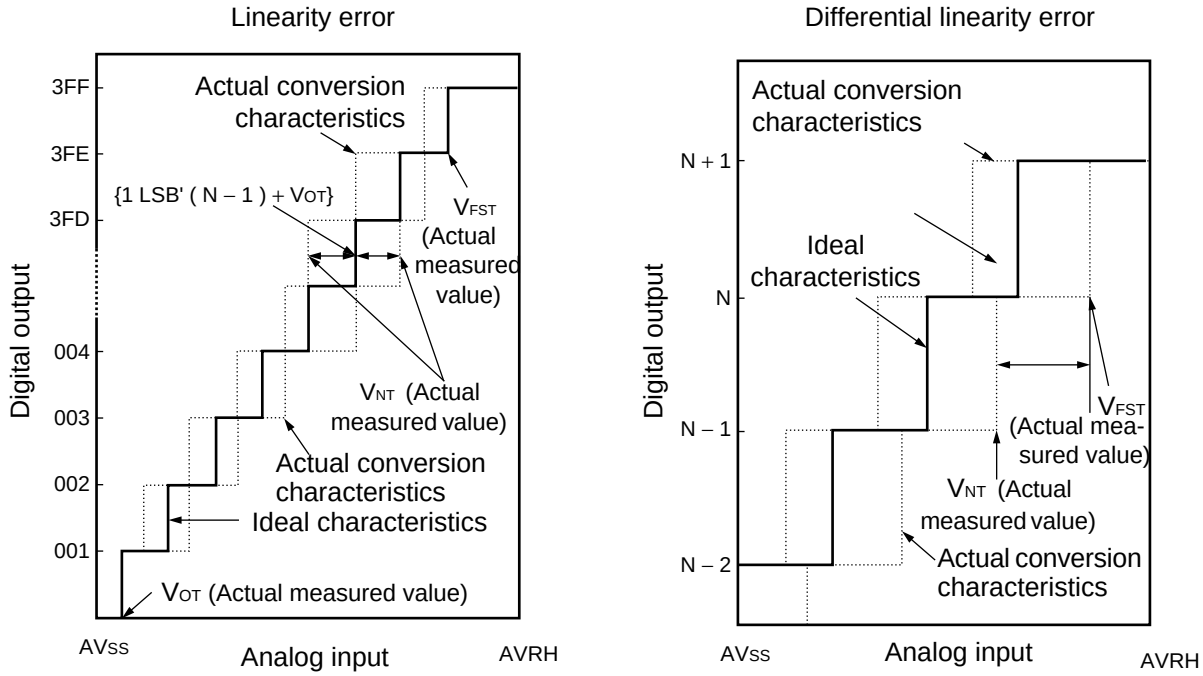
V_{NT} : Transition voltage for digital output to change from (N+1) to N.

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

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

(Continued)

(Continued)



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

$$\text{Differential linearity error of digital output N} = \frac{V_{(N+1)T} - V_{NT}\}}{1\ LSB'} - 1 \quad [LSB]$$

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

V_{OT} : Transition voltage for digital output to change from $(000)_H$ to $(001)_H$.

V_{FST} : Transition voltage for digital output to change from $(3FE)_H$ to $(3FF)_H$.

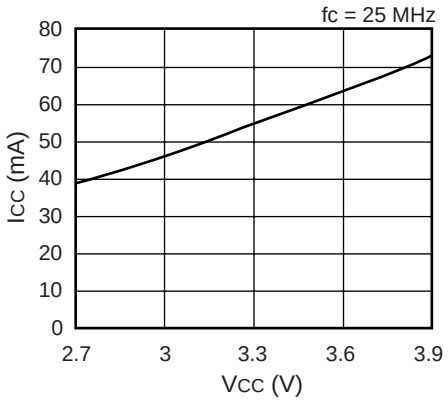
■ FLASH MEMORY WRITE/ERASE CHARACTERISTICS

Parameter	Condition	Value			Unit	Remarks
		Min	Typ	Max		
Sector erase time	T_A = +25 °C, V_{CC} = 3.3 V	—	1	15	s	Not including time for internal writing before deletion.
Chip erase time		—	4	—	s	Not including time for internal writing before deletion.
Half byte (16 bit width) writing time		—	16	3600	µs	Not including system-level overhead time.
Write/erase cycle	—	—	10,000	—	cycle	
Data holding time	—	—	100,000	—	h	

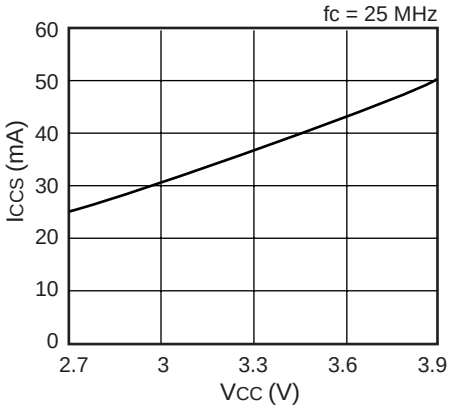
■ EXAMPLE CHARACTERISTICS

- Power Supply Current

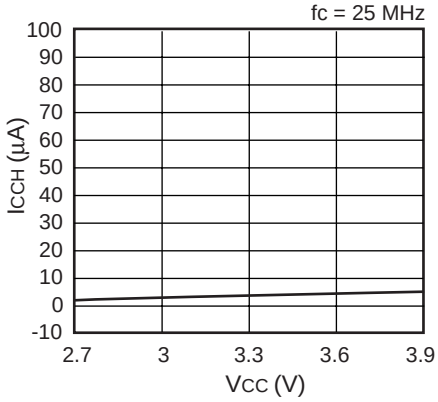
Power Supply Current vs. Power Supply Voltage



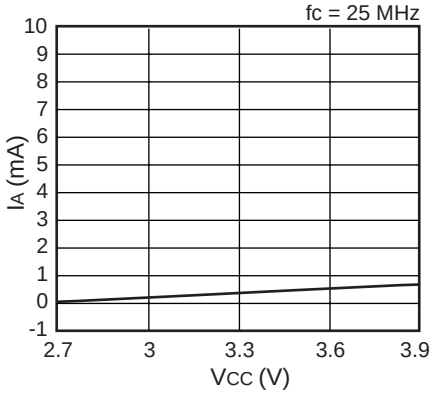
Power Supply Current (sleeping) vs. Power Supply Voltage



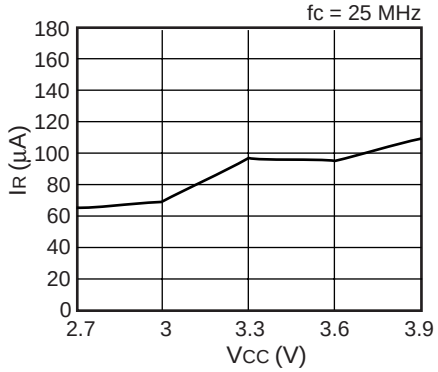
Power Supply Current (stopping) vs. Power Supply Voltage



A/D Power Supply Current vs. Power Supply Voltage

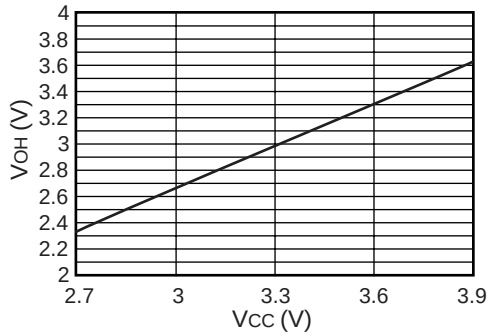


A/D Reference Power Supply Current vs. Power Supply Voltage

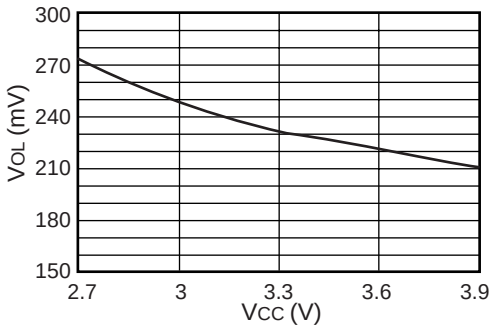


- Output Voltage

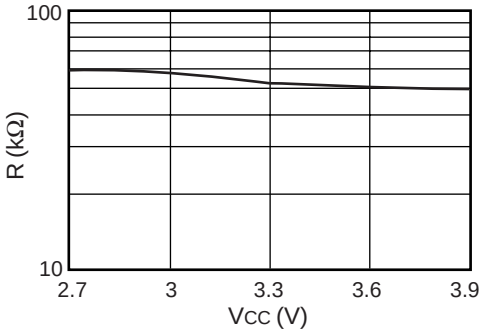
"H" Output Voltage vs.
Power Supply Voltage



"L" Output Voltage vs.
Power Supply Voltage



Pull-up resistance vs.
Power Supply Voltage



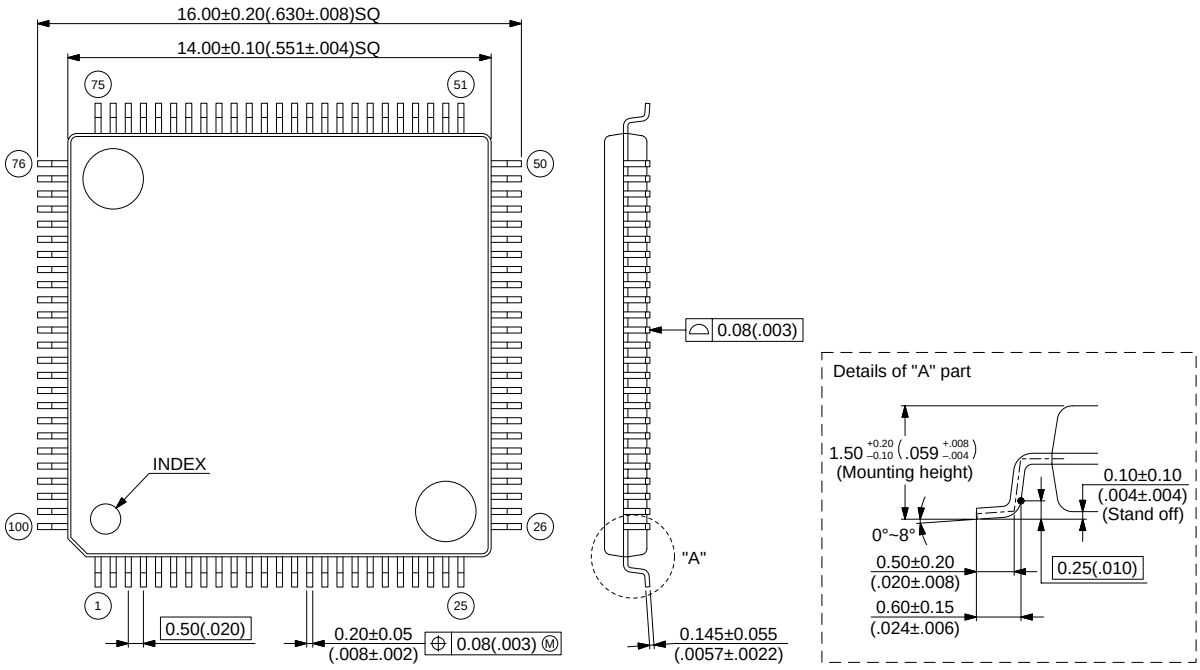
■ ORDERING INFORMATION

Part number	Package	Remarks
MB91F127PFV	100-pin plastic LQFP (FPT-100P-M05)	
MB91F128PFV	100-pin plastic LQFP (FPT-100P-M05)	

■ PACKAGE DIMENSIONS

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

*Pins width and pins thickness include plating thickness.



Dimensions in mm (inches)

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