FUJITSU MICROELECTRONICS
DATA SHEET

DS07-16507-2Ea

32-bit Proprietary Microcontroller

CMOS

FR60Lite MB91260B Series

MB91263B/MB91264B/MB91F264B

■ DESCRIPTION

The MB91260B series is a 32-bit RISC microcontroller designed by Fujitsu Microelectronics for embedded control applications which require high-speed processing.
The CPU is used the FR family and the compatibility of FR60Lite.

■ FEATURES

- FR60Lite CPU
  - 32-bit RISC, load/store architecture with a five-stage pipeline
  - Maximum operating frequency : 33 MHz (oscillation frequency 4.192 MHz, oscillation frequency 8-multiplier (PLL clock multiplication method)
  - 16-bit fixed length instructions (basic instructions)
  - Execution speed of instructions : 1 instruction per cycle
  - Memory-to-memory transfer, bit handling, barrel shift instructions, etc. : Instructions suitable for embedded applications
  - Function entry/exit instructions, multiple-register load/store instructions : Instructions adapted for C-language

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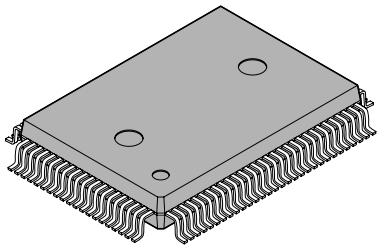
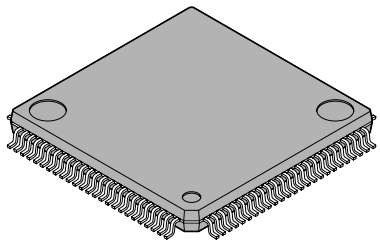
■ PACKAGES

100-pin plastic QFP



(FPT-100P-M06)

100-pin plastic LQFP



(FPT-100P-M05)

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- Register interlock function : Facilitates coding in assembler.
- Built-in multiplier with instruction-level support
  - 32 bit multiplication with sign : 5 cycles
  - 16 bit multiplication with sign : 3 cycles
- Interrupt (PC, PS save) : 6 cycles, 16 priority levels
- Harvard architecture allowing program access and data access to be executed simultaneously
- FR family instruction compatible

• Internal peripheral functions

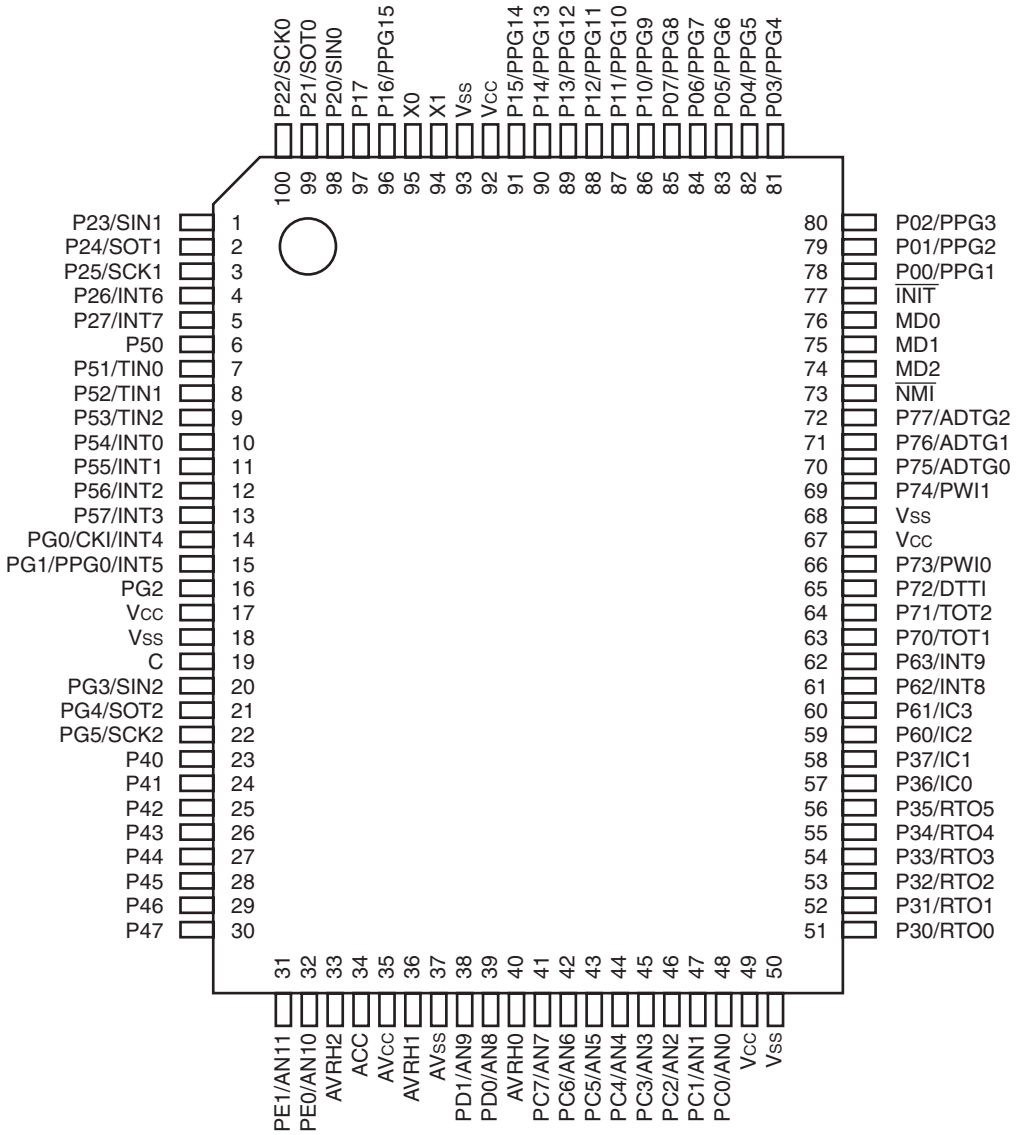
- Capacity of internal ROM and ROM type
  MASK ROM : 128 Kbytes (MB91263B)/256 Kbytes (MB91264B)
  FLASH ROM : 256 Kbytes (MB91F264B)
- Capacity of internal RAM : 8 Kbytes
- A/D converter (sequential comparison type)
- Resolution : 10 bits : 2 channels × 2 units, 8 channels × 1 unit
- Conversion time : 1.2 μs (Minimum conversion time system clock at 33 MHz)
  1.35 μs (Minimum conversion time system clock at 20 MHz)
- External interrupt input : 10 channels
- Bit search module (for REALOS)
  Function for searching the MSB in each word for the first 1-to-0 inverted bit position
- UART (Full-duplex double buffer) : 3 channels
  Selectable parity On/Off
  Asynchronous (start-stop synchronized) or clock-synchronous communications selectable
  Internal timer for dedicated baud rate (U-Timer) on each channel
  External clock can be used as transfer clock
  Error detection function for parity, frame and overrun errors
- 8/16-bit PPG timer : 16 channels (at 8-bit) / 8 channels (at 16-bit)
- 16-bit reload timer : 3 channels (with cascade mode, without output of reload timer 0)
- 16-bit free-run timer : 1 channel
- 16-bit PWC timer : 2 channels
- Input capture : 4 channels (interface with free-run timer)
- Output compare : 6 channels (interface with free-run timer)
- Waveform generator
  Various waveforms which are generated by using output compare, 16-bit PPG timer 0 and 16-bit dead timer
- MAC
  RAM : instruction RAM 256 × 16-bit
  XRAM 64 × 16-bit
  YRAM 64 × 16-bit
  Execution of 1 cycle product addition (16-bit × 16-bit + 40 bits)
  Operation results are extracted rounded from 40 to 16 bits
- DMAC (DMA Controller) : 5 channels
  Operation of transfer and activation by internal peripheral interrupts and software
- Watchdog timer
- Low Power Consumption Mode
  Sleep/stop function

• Other

- Package : QFP-100, LQFP-100
- Technology : CMOS 0.35 μm
- Power supply : 1-power supply [Vcc = 4.0 V to 5.5 V]

■ PIN ASSIGNMENT

(TOP VIEW)



(FPT-100-M06)

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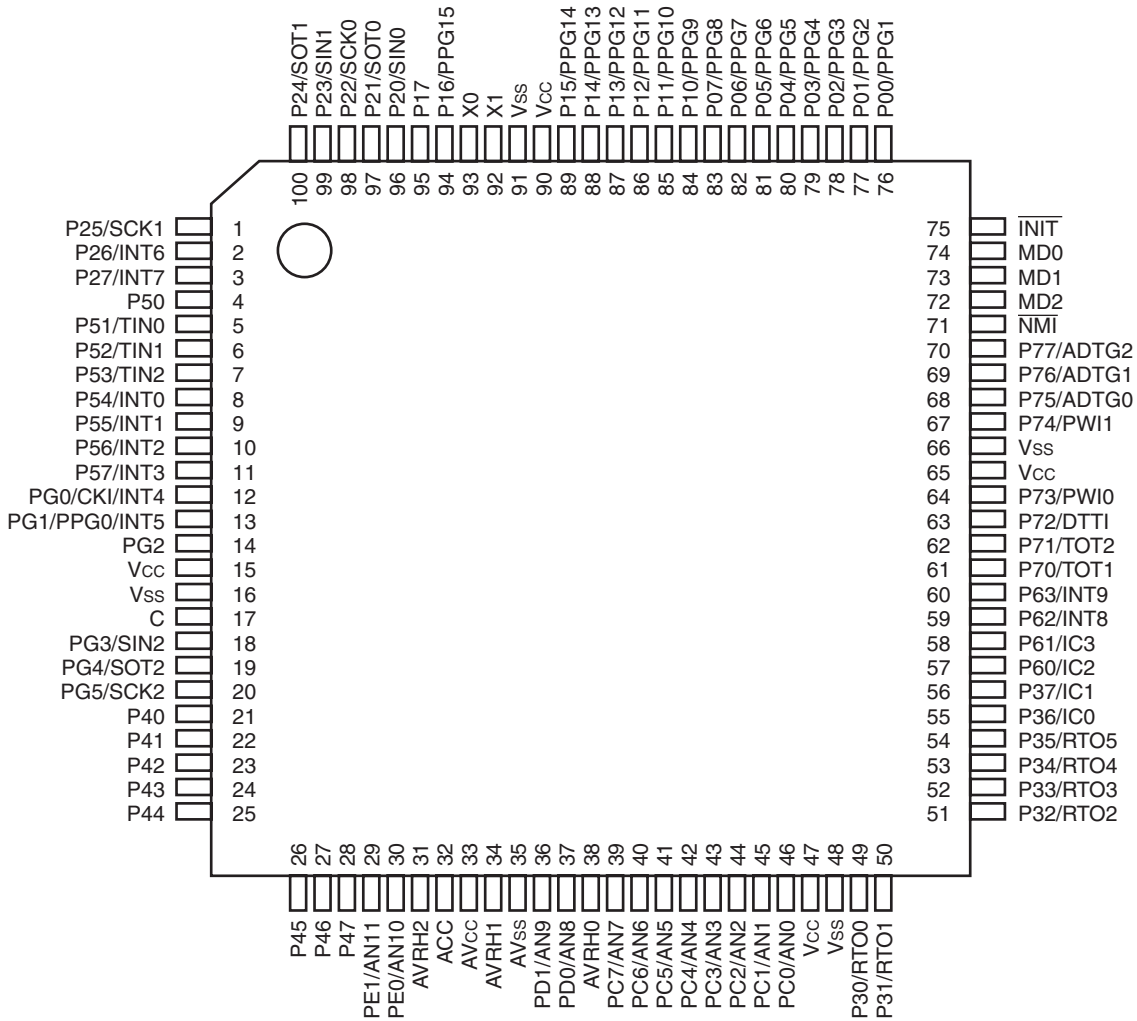
(TOP VIEW)



(FPT-100-M05)

■ PIN DESCRIPTION

Pin no.		Pin name	Circuit type	Description
QFP	LQFP			
1	99	SIN1	D	UART1 data input pin. Since this input is used as required when UART1 is performing input operation, the port output must remain off unless used intentionally.
		P23		General-purpose I/O port. This port is enabled when UART1 data input is disabled.
2	100	SOT1	D	UART1 data output pin. This function is enabled when UART1 data output is enabled.
		P24		General-purpose I/O port. This function is enabled when UART1 data output is disabled.
3	1	SCK1	D	UART1 clock input/output pin. This function is enabled when UART1 clock output is enabled.
		P25		General-purpose I/O port. This function is enabled when UART1 clock output is disabled.
4	2	INT6	E	External interrupt input pin. Since this input is used as required when the corresponding external interrupt is enabled, the port output must remain off unless used intentionally.
		P26		General-purpose I/O port. This function is enabled when external interrupt input is disabled.
5	3	INT7	E	External interrupt input pin. Since this input is used as required when the corresponding external interrupt is enabled, the port output must remain off unless used intentionally.
		P27		General-purpose I/O port. This function is enabled when external interrupt input is disabled.
6	4	P50	C	General-purpose I/O port. This port is enabled in single-chip mode.
7	5	TIN0	C	Reload timer 0 external trigger input pin. Since this input is used as required when trigger input is enabled, the port output must remain off unless used intentionally.
		P51		General-purpose I/O port. This function is enabled when reload timer 0 external clock input is disabled.
8	6	TIN1	C	Reload timer 1 external trigger input pin. Since this input is used as required when trigger input is enabled, the port output must remain off unless used intentionally.
		P52		General-purpose I/O port. This function is enabled when reload timer 1 external clock input is disabled.
9	7	TIN2	C	Reload timer 2 external trigger input pin. Since this input is used as required when trigger input is enabled, the port output must remain off unless used intentionally.
		P53		General-purpose I/O port. This function is enabled when reload timer 2 external clock input is disabled.

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Pin no.		Pin name	Circuit type	Description
QFP	LQFP			
10	8	INT0	E	External interrupt input pin. Since this input is used as required when the corresponding external interrupt is enabled, the port output must remain off unless used intentionally.
		P54		General-purpose I/O port. This function is enabled when external interrupt input is disabled.
11	9	INT1	E	External interrupt input pin. Since this input is used as required when the corresponding external interrupt is enabled, the port output must remain off unless used intentionally.
		P55		General-purpose I/O port. This function is enabled when external interrupt input is disabled.
12	10	INT2	E	External interrupt input pin. Since this input is used as required when the corresponding external interrupt is enabled, the port output must remain off unless used intentionally.
		P56		General-purpose I/O port. This function is enabled when external interrupt input is disabled.
13	11	INT3	E	External interrupt input pin. Since this input is used as required when the corresponding external interrupt is enabled, the port output must remain off unless used intentionally.
		P57		General-purpose I/O port. This function is enabled when external interrupt input is disabled.
14	12	CKI	E	Free-running timer external clock input pin. Since this input is used as required when selected as the external clock input for the free-running timer, the port output must remain off unless used intentionally.
		INT4		External interrupt input pin. Since this input is used as required when the corresponding external interrupt is enabled, the port output must remain off unless used intentionally.
		PG0		General-purpose I/O port. This port is enabled when free-running timer external clock input and external interrupt input are disabled.
15	13	PPG0	E	PPG timer 0 output pin. This function is enabled when PPG timer 0 output is enabled.
		INT5		External interrupt input pin. Since this input is used as required when the corresponding external interrupt is enabled, the port output must remain off unless used intentionally.
		PG1		General-purpose I/O port. This port is enabled when PPG timer 0 output and external interrupt input are disabled.
16	14	PG2	C	General-purpose I/O port.
20	18	SIN2	D	UART2 data input pin. Since this input is used as required when UART2 is performing input operation, the port output must remain off unless used intentionally.
		PG3		General-purpose I/O port. This port is enabled when UART2 data input is disabled.

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Pin no.		Pin name	Circuit type	Description
QFP	LQFP			
21	19	SOT2	D	UART2 data output pin. This function is enabled when UART2 data output is enabled.
		PG4		General-purpose I/O port. This port is enabled when UART2 data output is disabled.
22	20	SCK2	D	UART2 clock input/output pin. This function is enabled when UART2 clock output is enabled.
		PG5		General-purpose I/O port. This function is enabled when UART2 clock output is disabled.
23	21	P40	C	General-purpose I/O port.
24	22	P41	C	General-purpose I/O port.
25	23	P42	C	General-purpose I/O port.
26	24	P43	C	General-purpose I/O port.
27	25	P44	C	General-purpose I/O port.
28	26	P45	C	General-purpose I/O port.
29	27	P46	C	General-purpose I/O port.
30	28	P47	C	General-purpose I/O port.
31	29	AN11	G	A/D converter analog input pin. This function is enabled when the AICR2 register specifies analog input.
		PE1		General-purpose I/O port. This function is enabled when analog input is disabled.
32	30	AN10	G	A/D converter analog input pin. This function is enabled when the AICR2 register specifies analog input.
		PE0		General-purpose I/O port. This function is enabled when analog input is disabled.
38	36	AN9	G	A/D converter analog input pin. This function is enabled when the AICR1 register specifies analog input.
		PD1		General-purpose I/O port. This function is enabled when analog input is disabled.
39	37	AN8	G	A/D converter analog input pin. This function is enabled when the AICR1 register specifies analog input.
		PD0		General-purpose I/O port. This function is enabled when analog input is disabled.
41	39	AN7	G	A/D converter analog input pin. This function is enabled when the AICR0 register specifies analog input.
		PC7		General-purpose I/O port. This function is enabled when analog input is disabled.

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Pin no.		Pin name	Circuit type	Description
QFP	LQFP			
42	40	AN6	G	A/D converter analog input pin. This function is enabled when the AICR0 register specifies analog input.
		PC6		General-purpose I/O port. This function is enabled when analog input is disabled.
43	41	AN5	G	A/D converter analog input pin. This function is enabled when the AICR0 register specifies analog input.
		PC5		General-purpose I/O port. This function is enabled when analog input is disabled.
44	42	AN4	G	A/D converter analog input pin. This function is enabled when the AICR0 register specifies analog input.
		PC4		General-purpose I/O port. This function is enabled when analog input is disabled.
45	43	AN3	G	A/D converter analog input pin. This function is enabled when the AICR0 register specifies analog input.
		PC3		General-purpose I/O port. This function is enabled when analog input is disabled.
46	44	AN2	G	A/D converter analog input pin. This function is enabled when the AICR0 register specifies analog input.
		PC2		General-purpose I/O port. This function is enabled when analog input is disabled.
47	45	AN1	G	A/D converter analog input pin. This function is enabled when the AICR0 register specifies analog input.
		PC1		General-purpose I/O port. This function is enabled when analog input is disabled.
48	46	AN0	G	A/D converter analog input pin. This function is enabled when the AICR0 register specifies analog input.
		PC0		General-purpose I/O port. This function is enabled when analog input is disabled.
51	49	RTO0	J	Multifunction timer waveform generator output pin. This pin outputs a specified waveform to the waveform generator. The waveform output is enabled when waveform generator output is enabled.
		P30		General-purpose I/O port. This function is enabled when waveform generator output is disabled.
52	50	RTO1	J	Multifunction timer waveform generator output pin. This pin outputs a specified waveform to the waveform generator. The waveform output is enabled when waveform generator output is enabled.
		P31		General-purpose I/O port. This function is enabled when waveform generator output is disabled.

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Pin no.		Pin name	Circuit type	Description
QFP	LQFP			
53	51	RTO2	J	Multifunction timer waveform generator output pin. This pin outputs a specified waveform to the waveform generator. The waveform output is enabled when waveform generator output is enabled.
		P32		General-purpose I/O port. This function is enabled when waveform generator output is disabled.
54	52	RTO3	J	Multifunction timer waveform generator output pin. This pin outputs a specified waveform to the waveform generator. The waveform output is enabled when waveform generator output is enabled.
		P33		General-purpose I/O port. This function is enabled when waveform generator output is disabled.
55	53	RTO4	J	Multifunction timer waveform generator output pin. This pin outputs a specified waveform to the waveform generator. The waveform output is enabled when waveform generator output is enabled.
		P34		General-purpose I/O port. This function is enabled when waveform generator output is disabled.
56	54	RTO5	J	Multifunction timer waveform generator output pin. This pin outputs a specified waveform to the waveform generator. The waveform output is enabled when waveform generator output is enabled.
		P35		General-purpose I/O port. This function is enabled when waveform generator output is disabled.
57	55	IC0	D	Input capture 0 trigger input pin. The trigger can be input when the input capture trigger input and input port are set. Since this input is used as required when selected as the input capture input, the port output must remain off unless used intentionally.
		P36		General-purpose I/O port. This function is enabled when input capture trigger input is disabled.
58	56	IC1	D	Input capture 1 trigger input pin. The trigger can be input when the input capture trigger input and input port are set. Since this input is used as required when selected as the input capture input, the port output must remain off unless used intentionally.
		P37		General-purpose I/O port. This function is enabled when input capture trigger input is disabled.
59	57	IC2	D	Input capture 2 trigger input pin. The trigger can be input when the input capture trigger input and input port are set. Since this input is used as required when selected as the input capture input, the port output must remain off unless used intentionally.
		P60		General-purpose I/O port. This function is enabled when input capture trigger input is disabled.

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Pin no.		Pin name	Circuit type	Description
QFP	LQFP			
60	58	IC3	D	Input capture 3 trigger input pin. The trigger can be input when the input capture trigger input and input port are set. Since this input is used as required when selected as the input capture input, the port output must remain off unless used intentionally.
		P61		General-purpose I/O port. This function is enabled when input capture trigger input is disabled.
61	59	INT8	E	External interrupt input pin. Since this input is used as required when the corresponding external interrupt is enabled, the port output must remain off unless used intentionally.
		P62		General-purpose I/O port. This function is enabled when external interrupt input is disabled.
62	60	INT9	E	External interrupt input pin. Since this input is used as required when the corresponding external interrupt is enabled, the port output must remain off unless used intentionally.
		P63		General-purpose I/O port. This function is enabled when external interrupt input is disabled.
63	61	TOT1	C	Reload timer 1 output pin. This function is enabled when reload timer output is enabled.
		P70		General-purpose I/O port. This function is enabled when reload timer output is disabled.
64	62	TOT2	C	Reload timer 2 output pin. This function is enabled when reload timer output is enabled.
		P71		General-purpose I/O port. This function is enabled when reload timer output is disabled.
65	63	DTTI	D	Input signal for controlling multifunction timer waveform generator output pins RTO0 to RTO5. This function is enabled when DTTI input is enabled.
		P72		General-purpose I/O port. This function is enabled when DTTI input is disabled.
66	64	PWI0	D	PWC timer 0 pulse width counter input pin. This function is enabled when PWC timer 0 pulse width counter input is enabled.
		P73		General-purpose I/O port. This function is enabled when PWC timer 0 pulse width counter input is disabled.
69	67	PWI1	D	PWC timer 1 pulse width counter input pin. This function is enabled when PWC timer 1 pulse width counter input is enabled.
		P74		General-purpose I/O port. This function is enabled when PWC timer 1 pulse width counter input is disabled.
70	68	ADTG0	C	A/D converter 0 external trigger input pin. Since this input is used as required when selected as the A/D converter trigger source, the port output must remain off unless used intentionally.
		P75		General-purpose I/O port. This function is enabled when A/D converter 0 external trigger input is disabled.

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Pin no.		Pin name	Circuit type	Description
QFP	LQFP			
71	69	ADTG1	C	A/D converter 1 external trigger input pin. Since this input is used as required when selected as the A/D converter trigger source, the port output must remain off unless used intentionally.
		P76		General-purpose I/O port. This function is enabled when A/D converter 1 external trigger input is disabled.
72	70	ADTG2	C	A/D converter 2 external trigger input pin. Since this input is used as required when selected as the A/D converter trigger source, the port output must remain off unless used intentionally.
		P77		General-purpose I/O port. This function is enabled when A/D converter 2 external trigger input is disabled.
73	71	$\overline{\text{NMI}}$	H	NMI (Non Maskable Interrupt) input pin.
74	72	MD2	K	Mode pin 2. The setting of this pin determines the basic operation mode. Connect the pin to Vcc or Vss.
75	73	MD1	K	Mode pin 1. The setting of this pin determines the basic operation mode. Connect the pin to Vcc or Vss.
76	74	MD0	K	Mode pin 0. The setting of this pin determines the basic operation mode. Connect the pin to Vcc or Vss.
77	75	$\overline{\text{INIT}}$	I	External reset input pin.
78	76	PPG1	C	PPG timer 1 output pin. This function is enabled when PPG timer 1 output is enabled.
		P00		General-purpose I/O port. This function is enabled when PPG timer 1 output is disabled.
79	77	PPG2	C	PPG timer 2 output pin. This function is enabled when PPG timer 2 output is enabled.
		P01		General-purpose I/O port. This function is enabled when PPG timer 2 output is disabled.
80	78	PPG3	C	PPG timer 3 output pin. This function is enabled when PPG timer 3 output is enabled.
		P02		General-purpose I/O port. This function is enabled when PPG timer 3 output is disabled.
81	79	PPG4	C	PPG timer 4 output pin. This function is enabled when PPG timer 4 output is enabled.
		P03		General-purpose I/O port. This function is enabled when PPG timer 4 output is disabled.
82	80	PPG5	C	PPG timer 5 output pin. This function is enabled when PPG timer 5 output is enabled.
		P04		General-purpose I/O port. This function is enabled when PPG timer 5 output is disabled.

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Pin no.		Pin name	Circuit type	Description
QFP	LQFP			
83	81	PPG6	C	PPG timer 6 output pin. This function is enabled when PPG timer 6 output is enabled.
		P05		General-purpose I/O port. This function is enabled when PPG timer 6 output is disabled.
84	82	PPG7	C	PPG timer 7 output pin. This function is enabled when PPG timer 7 output is enabled.
		P06		General-purpose I/O port. This function is enabled when PPG timer 7 output is disabled.
85	83	PPG8	C	PPG timer 8 output pin. This function is enabled when PPG timer 8 output is enabled.
		P07		General-purpose I/O port. This function is enabled when PPG timer 8 output is disabled.
86	84	PPG9	C	PPG timer 9 output pin. This function is enabled when PPG timer 9 output is enabled.
		P10		General-purpose I/O port. This function is enabled when PPG timer 9 output is disabled.
87	85	PPG10	C	PPG timer 10 output pin. This function is enabled when PPG timer 10 output is enabled.
		P11		General-purpose I/O port. This function is enabled when PPG timer 10 output is disabled.
88	86	PPG11	C	PPG timer 11 output pin. This function is enabled when PPG timer 11 output is enabled.
		P12		General-purpose I/O port. This function is enabled when PPG timer 11 output is disabled.
89	87	PPG12	C	PPG timer 12 output pin. This function is enabled when PPG timer 12 output is enabled.
		P13		General-purpose I/O port. This function is enabled when PPG timer 12 output is disabled.
90	88	PPG13	C	PPG timer 13 output pin. This function is enabled when PPG timer 13 output is enabled.
		P14		General-purpose I/O port. This function is enabled when PPG timer 13 output is disabled.
91	89	PPG14	C	PPG timer 14 output pin. This function is enabled when PPG timer 14 output is enabled.
		P15		General-purpose I/O port. This function is enabled when PPG timer 14 output is disabled.
94	92	X1	A	Clock (oscillation) output pin.
95	93	X0	A	Clock (oscillation) input pin.

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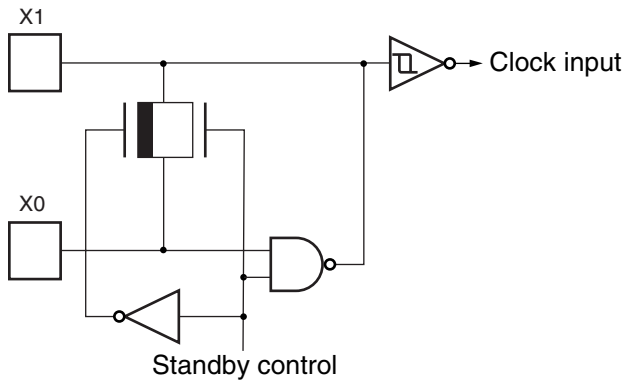
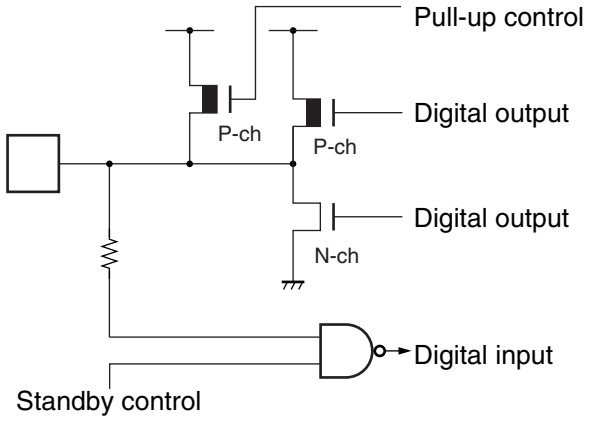
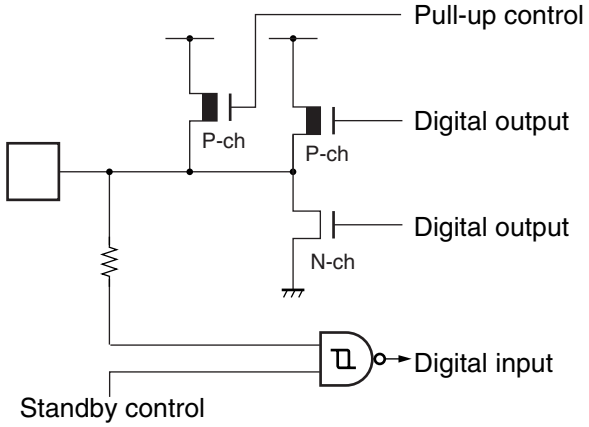
Pin no.		Pin name	Circuit type	Description
QFP	LQFP			
96	94	PPG15	C	PPG timer 15 output pin. This function is enabled when PPG timer 15 output is enabled.
		P16		General-purpose I/O port. This function is enabled when PPG timer 15 output is disabled.
97	95	P17	C	General-purpose I/O port.
98	96	SIN0	D	UART0 data input pin. Since this input is used as required when UART0 is performing input operation, the port output must remain off unless used intentionally.
		P20		General-purpose I/O port. This port is enabled when UART0 data input is disabled.
99	97	SOT0	D	UART0 data output pin. This function is enabled when UART0 data output is enabled.
		P21		General-purpose I/O port. This port is enabled when UART0 data output is disabled.
100	98	SCK0	D	UART0 clock input/output pin. This function is enabled when UART0 clock output is enabled.
		P22		General-purpose I/O port. This function is enabled when UART0 clock output is disabled.

• Power supply and GND pins

Pin no.		Pin name	Description
QFP	LQFP		
18, 50, 68, 93	16, 48, 66, 91	Vss	GND pins. Use all of these pins at equal potential.
17, 49, 67, 92	15, 47, 65, 90	Vcc	Power-supply pins. Use all of these pins at equal potential.
35	33	AVcc	Analog power-supply pin for A/D converter
33	31	AVRH2	Analog reference power-supply pin for A/D converter 2
36	34	AVRH1	Analog reference power-supply pin for A/D converter 1
40	38	AVRH0	Analog reference power-supply pin for A/D converter 0
37	35	AVss	Analog GND pin for A/D converter
19	17	C	Capacitor coupling pin for internal regulator
34	32	ACC	Analog capacitor coupling pin

■ I/O CIRCUIT TYPE

Type	Circuit type	Remarks
A		• Oscillation circuit • Oscillation feedback resistance : approx. 1 MΩ
C		• CMOS level output • CMOS level input. • With standby control • With Pull-up control • I_{OL} = 4 mA
D		• CMOS level output • CMOS level hysteresis input. • With standby control • With Pull-up control • I_{OL} = 4 mA

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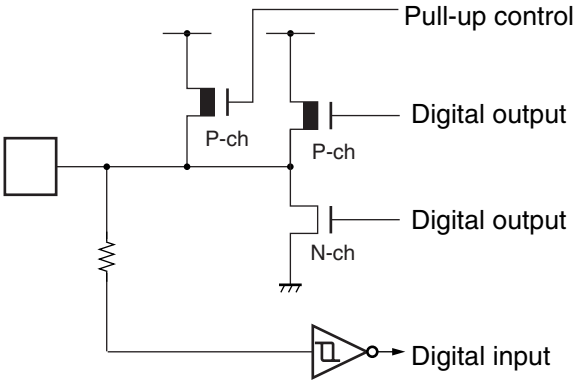
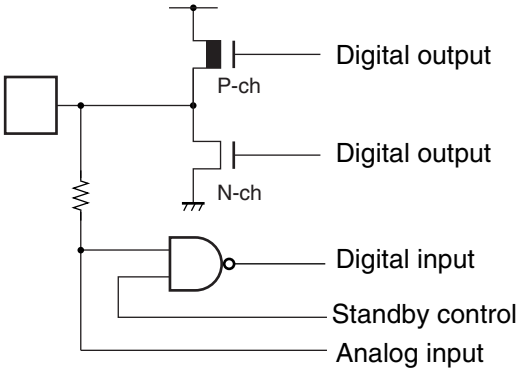
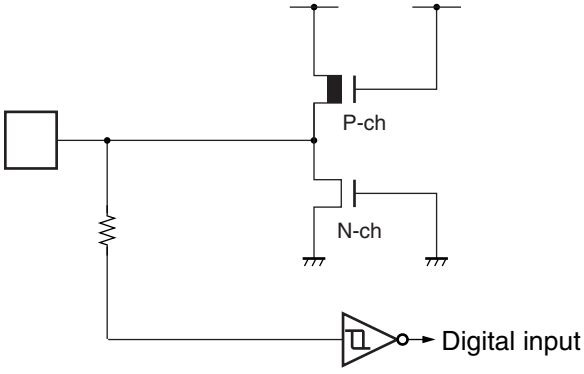
Type	Circuit type	Remarks
E		• CMOS level output • CMOS level hysteresis input. • Without standby control • With Pull-up control • I_{OL} = 4 mA
G		• Analog/CMOS level input/output pin • CMOS level output • CMOS level input. (attached with standby control) • Analog input (Analog input is enabled when AICR register's corresponding bit is set to "1".) • I_{OL} = 4 mA
H		• CMOS level hysteresis input. • Without standby control

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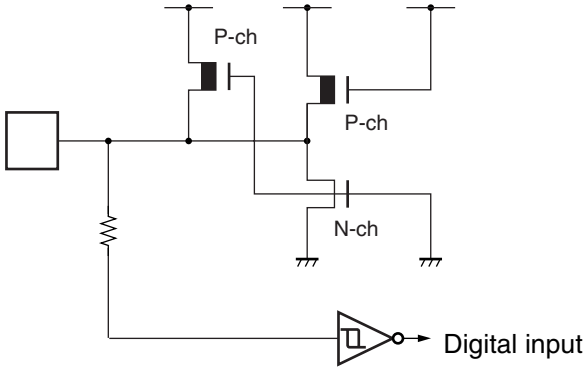
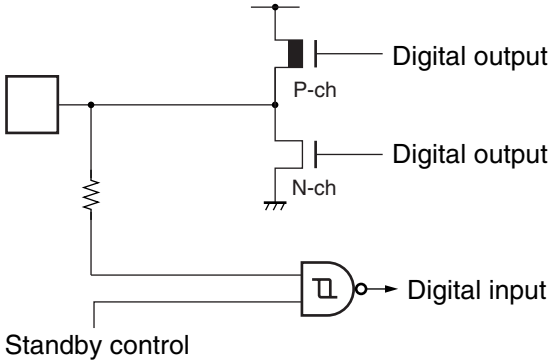
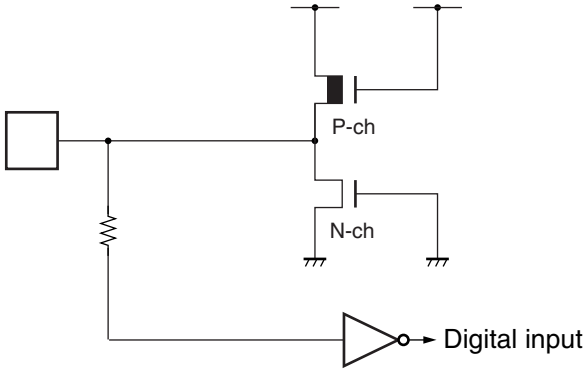
(Continued)

Type	Circuit type	Remarks
I		• CMOS level hysteresis input. • With pull-up resistor • Without standby control
J		• CMOS level output • CMOS level hysteresis input. • With standby control • I_{OL} = 12 mA
K		• CMOS level input. • Without standby control

■ HANDLING DEVICES

Preventing Latch-up

Latch-up may occur in a CMOS IC if a voltage greater than V_{CC} or less than V_{SS} is applied to an input or output pin or if an above-rating voltage is applied between V_{CC} and V_{SS}.

A latch-up, if it occurs, significantly increases the power supply current and may cause thermal destruction of an element. When you use a CMOS IC, be very careful not to exceed the absolute maximum rating.

Treatment of Unused Pins

Do not leave an unused input pin open, since it may cause a malfunction. Handle by, for example, using a pull-up or pull-down resistor.

About 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} near this device.

About Crystal Oscillator Circuit

Noise near the X0, X1, X0A and X1A pins may cause the device to malfunction. Design the printed circuit board so that X0, X1, X0A and X1A the crystal oscillator (or ceramic oscillator) , and the bypass capacitor to ground are located as close to the device as possible.

It is strongly recommended to design the PC board artwork with the X0, X1, X0A and X1A pins surrounded by ground plane because stable operation can be expected with such a layout.

Please ask the crystal maker to evaluate the oscillational characteristics of the crystal and this device.

About Mode Pins (MD0 to MD2)

These pins should be connected directly to V_{CC} or V_{SS}.

To prevent the device erroneously switching to test mode due to noise, design the printed circuit board such that the distance between the mode pins and V_{CC} or V_{SS} is as short as possible and the connection impedance is low.

Operation at Start-up

Be sure to execute setting initialized reset (INIT) with $\overline{\text{INIT}}$ pin immediately after start-up.

Also, in order to provide the oscillation stabilization wait time for the oscillation circuit immediately after start-up, hold the “L” level input to the $\overline{\text{INIT}}$ pin for the required stabilization wait time. (For INIT via the $\overline{\text{INIT}}$ pin, the oscillation stabilization wait time setting is initialized to the minimum value) .

About Oscillation Input at Power On

When turning the power on, maintain clock input until the device is released from the oscillation stabilization wait state.

Caution operation during PLL clock mode

Even if the oscillator comes off or the clock input stops with the PLL clock selected for this device, the device may continue to operate at the free-run frequency of the PLL's internal self-oscillating oscillator circuit.

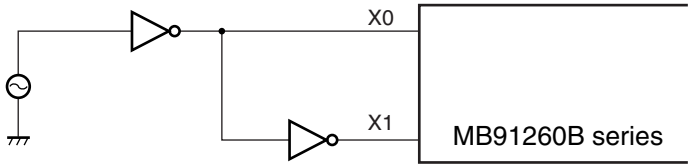
Performance of this operation, however, cannot be guaranteed.

External clock

When external clock is selected, the opposite phase clock to X0 pin must be supplied to X1 pin simultaneously.

If the STOP mode (oscillation stop mode) is used simultaneously, the X1 pin is stopped with the "H" output. So, when STOP mode is specified, approximately 1 kΩ of resistance should be added externally to avoid the conflict of output.

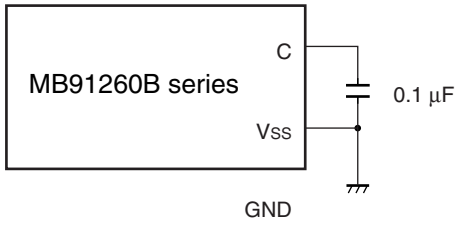
The following figure shows using an external clock.



Using an external clock

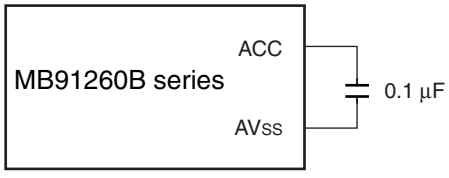
C pin

A bypass capacitor of approximately 0.1 μF should be connected the C pin for built-in regulator.



ACC pin

A capacitor should be inserted between the ACC pin and the AVcc pin as this product has built-in regulator for A/D converter.



Clock Control Block

Input the “L” signal to the $\overline{\text{INIT}}$ pin to assure the clock oscillation stabilization wait time.

Switch Shared Port Function

To switch between the use as a port and the use as a dedicated pin, use the port function register (PFR) .

Low Power Consumption Mode

To enter the standby mode, use the synchronous standby mode (set with the SYNCS bit as bit 8 in the TBCR : timebase counter control register) and be sure to use the following sequence

```
(LDI     #value_of_standby, R0)    : Value_of standby is write data to STCR.
(LDI     #_STCR, R12)              : _STCR is address (481H) of STCR.
STB      R0, @R12                  : Writing to standby control register (STCR)
LDUB     @R12, R0                  : STCR read for synchronous standby
LDUB     @R12, R0                  : Dummy re-read of STCR
NOP                                : NOP × 5 for arrangement of timing
NOP
NOP
NOP
NOP
```

In addition, please set I flag, ILM, and ICR to diverge to the interruption handler that is the return factor after the standby returns.

•Please do not do the following when the monitor debugger is used.
- Break point setting for above instruction lines
- Step execution for above instruction lines

Notes on the PS register

As the PS register is processed by some instructions in advance, exception handling below may cause the interrupt handling routine to break when the debugger is used or the display contents of flags in the PS register to be updated.

As the microcontroller is designed to carry out reprocessing correctly upon returning from such an EIT event, it performs operations before and after the EIT as specified in either case.

- The following operations may be performed when the instruction immediately followed by a DIVOU/DIVOS instruction is (a) acceptance of a user interrupt, (b) single-stepped, or (c) breaks in response to a data event or emulator menu :

  1) The D0 and D1 flags are updated in advance.

  2) An EIT handling routine (user interrupt or emulator) is executed.

  3) Upon returning from the EIT, the DIVOU/DIVOS instruction is executed, and the D0 and D1 flags are updated to the same values as in 1).

- The following operations are performed when the ORCCR/STILM/MOVRi and PS instructions are executed to allow the interrupt.

1) The PS register is updated in advance.
2) An EIT handling routine (user interrupt) is executed.
3) Upon returning from the EIT, the above instructions are executed, and the PS register is updated to the same value as in 1).

Watchdog Timer

The watchdog timer built in this model monitors a program that it defers a reset within a certain period of time. The watchdog timer resets the CPU if the program runs out of controls, preventing the reset defer function from being executed. Once the function of the watchdog timer is enabled, therefore, the watchdog timer keeps on operating programs until it resets the CPU.

As an exception, the watchdog timer defers a reset automatically under the condition in which the CPU stops program execution.

For those conditions to which this exception applies, see the function description of watchdog timer.

■ NOTE ON DEBUGGER

• Step execution of RETI command

If an interrupt occurs frequently during step execution, the corresponding interrupt handling routine is executed repeatedly after step execution.

This will prevent the main routine and low-interrupt-level programs from being executed.

Do not execute step of RETI instruction for escape.

Disable the corresponding interrupt and execute debugger when the corresponding interrupt handling routine no longer needs debugging.

• Operand break

Do not apply a data event break to access to the area containing the address of a system stack pointer.

• Execution in an unused area of FLASH memory

Accidentally executing an instruction in an unused area of FLASH memory (with data placed at $0XFFFF_H$) prevents breaks from being accepted.

To prevent this, the code event address mask function of the debugger should be used to cause a break when accessing an instruction in an unused area.

• Power-on debugging

All of the following three conditions must be satisfied when the power supply is turned off by power-on debugging.

(1) The time for the user power to fall from 0.9 V_{CC} to 0.5 V_{CC} is 25 μs or longer.
Note : In a dual-power system, VCC indicates the external I/O power supply voltage.

(2) CPU operating frequency must be higher than 1 MHz.

(3) During execution of user program

• Interrupt handler for NMI request (tool)

Add the following program to the interrupt handler to prevent the device from malfunctioning in case the factor flag to be set only in response to a break request from the ICE is set, for example, by an adverse effect of noise to the DSU pin while the ICE is not connected. Enable to use the ICE while adding this program.

Additional location

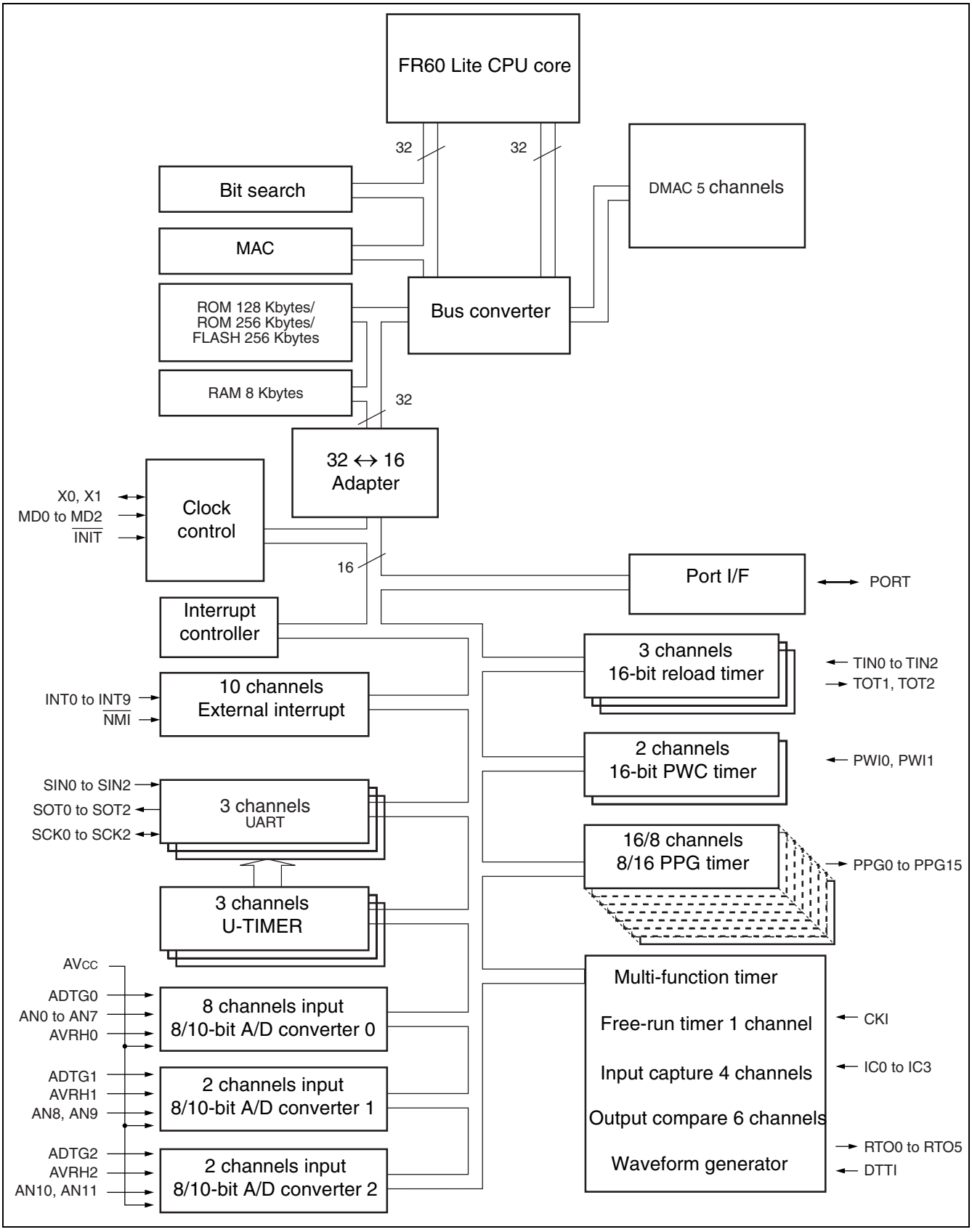
Next interrupt handler

Interrupt source	: NMI request (tool)
Interrupt number	: #13 (decimal) , $0D_H$ (hexa decimal)
Offset	: $3C8_H$
Address TBR is default	: $000FFFC8_H$

Additional program

```
STM     (R0, R1)
LDI     #B00H, R0;   : B00H is the address of DSU break factor register.
LDI     #0, R1
STB     R1, @R0      : Clear the break factor register.
LDM     (R0, R1)
RETI
```

■ BLOCK DIAGRAM



■ MEMORY SPACE

1. Memory space

The FR family has 4 Gbytes of logical address space (2^{32} addresses) available to the CPU by linear access.

- Direct Addressing Areas

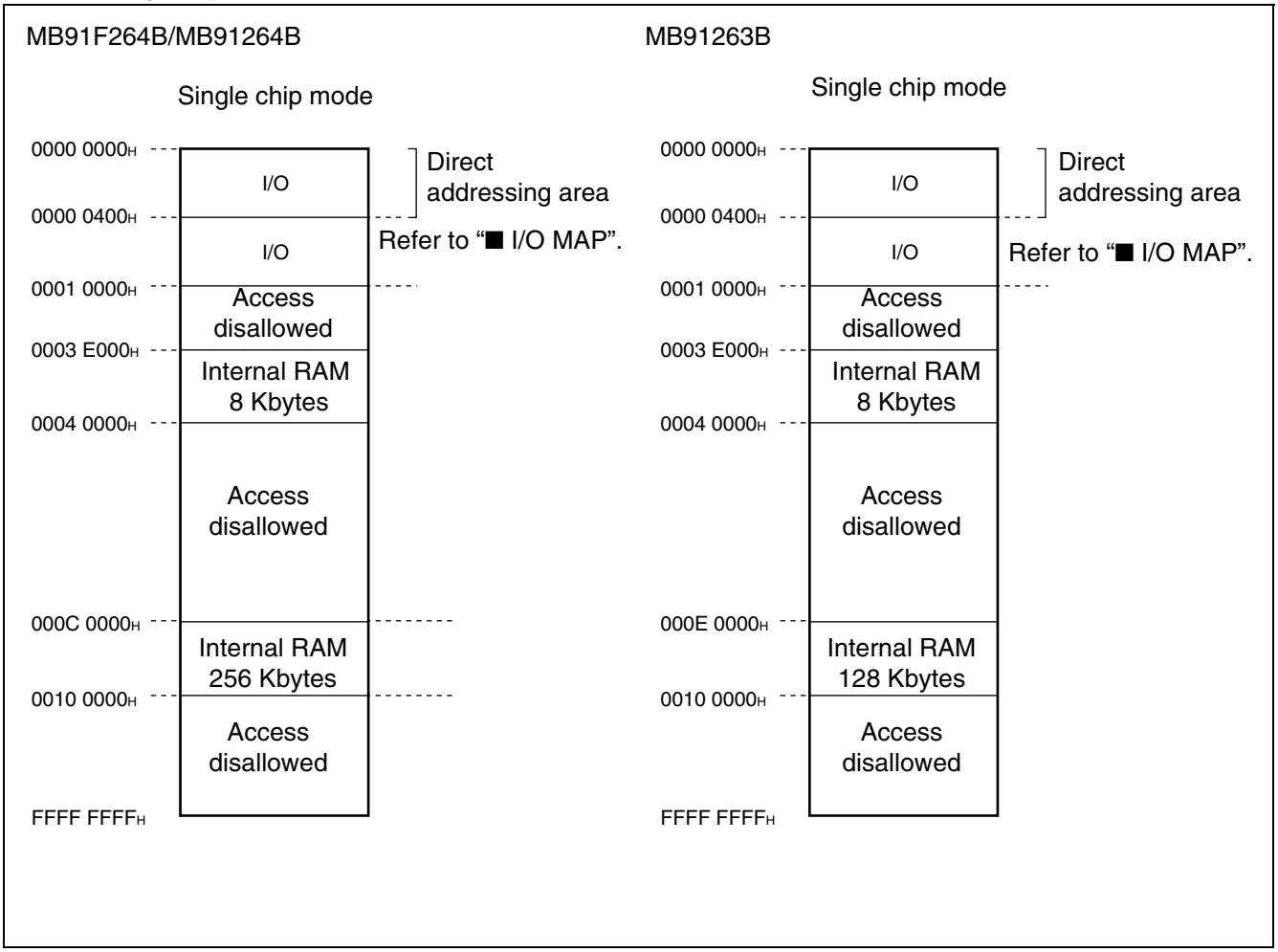
The following address space areas are used as I/O areas.

These areas are called direct addressing areas, in which the address of an operand can be specified directly during an instruction.

The size of directly addressable areas depends on the data size to be being accessed as follows.

→ Byte data access : 000H to 0FFH
→ Half word data access : 000H to 1FFH
→ Word data access : 000H to 3FFH

2. Memory Map



■ MODE SETTINGS

The FR family uses mode pins (MD2 to MD0) and a mode data to set the operation mode.

- Mode Pins

The MD2 to MD0 pins specify how the mode vector fetch and reset vector fetch is performed.

Setting is prohibited other than that shown in the following table.

Mode Pins			Mode name	Reset vector access area	Remarks
MD2	MD1	MD0			
0	0	0	Internal ROM mode vector	Internal	
0	0	1	External ROM mode vector	External	Not supported by this model.

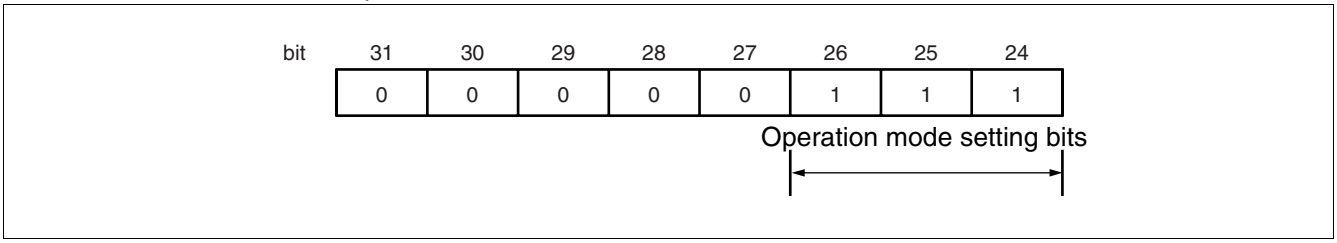
- Mode data

Data written to the internal mode register (MODR) by a mode vector fetch is called mode data.

After an operation mode has been set in the mode register, the device operates in the operation mode.

The mode data is set by all reset source. User programs cannot set data to the mode register.

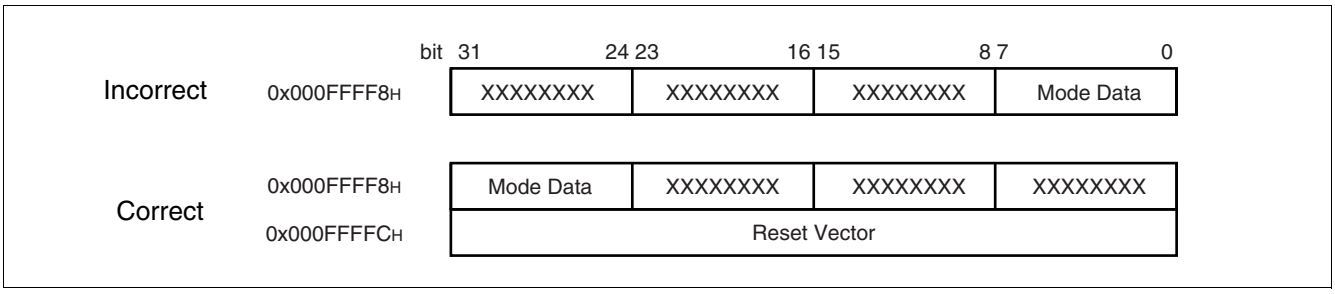
Details of mode data description



Bit31 to bit24 are all reserved bits.

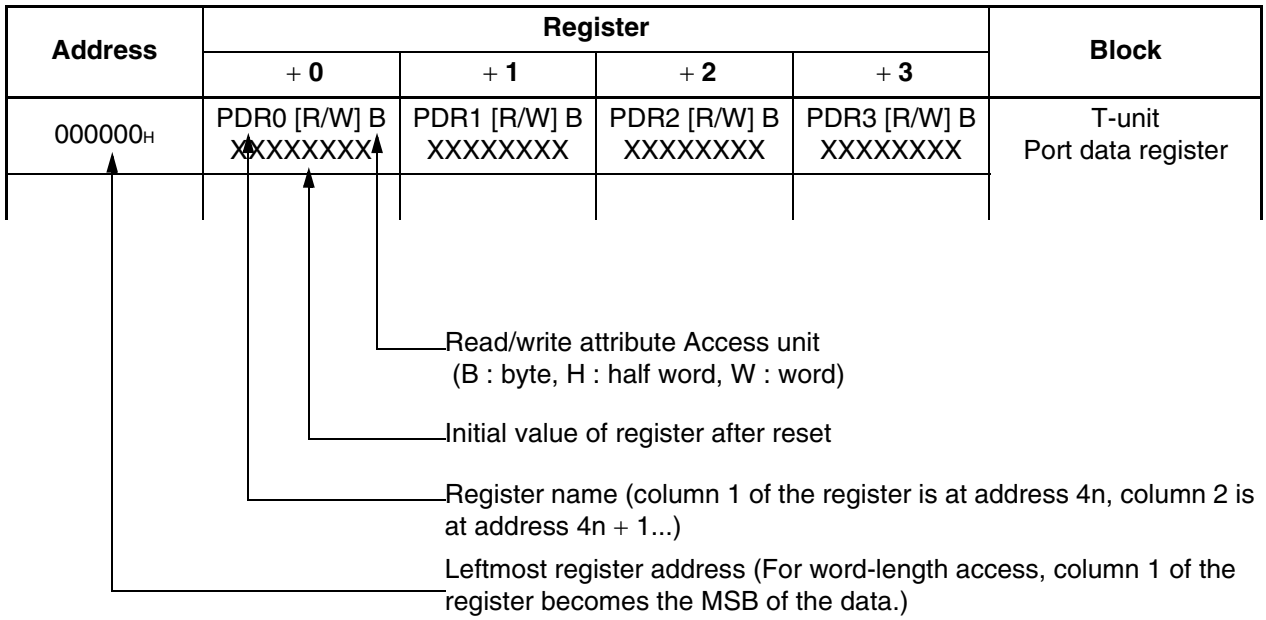
Be sure to set this bit to “00000111”.
Operation is not guaranteed when any value other than “00000111” is set.

Note : Mode data set in the mode vector must be placed as byte data at 0x000FFFF8H.
Use the highest byte from bit31 to bit24 for placement as the FR family uses the big endian for byte endian.



■ I/O MAP

[How to read the table]



Note : Initial values of register bits are represented as follows :

" 1 " : Initial Value " 1 "
" 0 " : Initial Value " 0 "
" X " : Initial Value " undefined"
" - " : No physical register at this location

Access is barred with an undefined data access attribute.

Address	Register				Block
	+ 0	+ 1	+ 2	+ 3	
000000H	PDR0 [R/W] B XXXXXXXX	PDR1 [R/W] B XXXXXXXX	PDR2 [R/W] B XXXXXXXX	PDR3 [R/W] B XXXXXXXX	Port data register
000004H	PDR4 [R/W] B XXXXXXXX	PDR5 [R/W] B XXXXXXXX	PDR6 [R/W] B ----XXXX	PDR7 [R/W] B XXXXXXXX	
000008H	—				
00000CH	PDRC [R/W] B XXXXXXXX	PDRD [R/W] B ------XX	PDRE [R/W] B ------XX	—	
000010H	PDRG [R/W] B --XXXXXX	—	—	—	
000014H to 00003CH	—				Reserved
000040H	EIRR0 [R/W] B, H, W 00000000	ENIR0 [R/W] B, H, W 00000000	ELVR0 [R/W] B, H, W 00000000 00000000		External interrupt (INT0 to INT7)
000044H	DICR [R/W] B, H, W -------0	HRCL [R/W, R] B, H, W 0--11111	—	—	Delay interrupt/ Hold request
000048H	TMRLR0 [W] H, W XXXXXXXX XXXXXXXX		TMR0 [R] H, W XXXXXXXX XXXXXXXX		Reload timer 0
00004CH	—		TMCSR0 [R/W, R] B, H, W ---00000 00000000		
000050H	TMRLR1 [W] H, W XXXXXXXX XXXXXXXX		TMR1 [R] H, W XXXXXXXX XXXXXXXX		Reload timer 1
000054H	—		TMCSR1 [R/W, R] B, H, W ---00000 00000000		
000058H	TMRLR2 [W] H, W XXXXXXXX XXXXXXXX		TMR2 [R] H, W XXXXXXXX XXXXXXXX		Reload timer 2
00005CH	—		TMCSR2 [R/W, R] B, H, W ---00000 00000000		
000060H	SSR0 [R/W, R] B, H, W 00001000	SIDR0 [R]/SODR0[W] B, H, W XXXXXXXX	SCR0 [R/W] B, H, W 00000100	SMR0 [R/W, W] B, H, W 00--0-0-	UART0
000064H	UTIM0 [R] H / UTIMR0 [W] H 00000000 00000000		DRCL0 [W] B --------	UTIMC0 [R/W] B 0--00001	U-TIMER 0
000068H	SSR1 [R/W, R] B, H, W 00001000	SIDR1, SODR1 [R/W] B, H, W XXXXXXXX	SCR1 [R/W] B, H, W 00000100	SMR1 [R/W] B, H, W 00--0-0-	UART1
00006CH	UTIM1 [R] H / UTIMR1 [W] H 00000000 00000000		DRCL1 [W] B --------	UTIMC1 [R/W] B 0--00001	U-TIMER 1
000070H	SSR2 [R/W, R] B, H, W 00001000	SIDR2, SODR2 [R/W] B, H, W XXXXXXXX	SCR2 [R/W] B, H, W 00000100	SMR2 [R/W] B, H, W 00--0-0-	UART2
000074H	UTIM2 [R] H / UTIMR2 [W] H 00000000 00000000		DRCL2 [W] B --------	UTIMC2 [R/W] B 0--00001	U-TIMER 2

(Continued)

Address	Register				Block
	+ 0	+ 1	+ 2	+ 3	
000078H	ADCH0 [R/W] B, H, W XX000000	ADMD0 [R/W] B, H, W 00001111	ADCD01 [R] B, H, W XXXXXXXX	ADCD00 [R] B, H, W XXXXXXXX	A/D converter 0/ AICR0
00007CH	ADCS0 [R/W, W] B, H, W 00000X00	—	AICR0 [R/W] B, H, W 00000000	—	
000080H	ADCH1 [R/W] B, H, W XXXX0XX0	ADMD1 [R/W] B, H, W 00001111	ADCD11 [R] B, H, W XXXXXXXX	ADCD10 [R] B, H, W XXXXXXXX	A/D converter 1/ AICR1
000084H	ADCS1 [R/W, W] B, H, W 00000X00	—	AICR1 [R/W] B, H, W ------00	—	
000088H	ADCH2 [R/W] B, H, W XXXX0XX0	ADMD2 [R/W] B, H, W 00001111	ADCD21 [R] B, H, W XXXXXXXX	ADCD20 [R] B, H, W XXXXXXXX	A/D converter 2/ AICR2
00008CH	ADCS2 [R/W, W] B, H, W 00000X00	—	AICR2 [R/W] B, H, W ------00	—	
000090H	OCCPBH0, OCCPBL0[W]/ OCCPH0, OCCPL0[R] H, W 00000000 00000000		OCCPBH1, OCCPBL1[W]/ OCCPH1, OCCPL1 [R] H, W 00000000 00000000		16-bit output compare
000094H	OCCPBH2, OCCPBL2[W]/ OCCPH2, OCCPL2 [R] H, W 00000000 00000000		OCCPBH3, OCCPBL3[W]/ OCCPH3, OCCPL3 [R] H, W 00000000 00000000		
000098H	OCCPBH4, OCCPBL4[W]/ OCCPH4, OCCPL4 [R] H, W 00000000 00000000		OCCPBH5, OCCPBL5[W]/ OCCPH5, OCCPL5 [R] H, W 00000000 00000000		
00009CH	OCSH1 [R/W] B, H, W X1100000	OCSL0 [R/W] B, H, W 00001100	OCSH3 [R/W] B, H, W X1100000	OCSL2 [R/W] B, H, W 00001100	
0000A0H	OCSH5 [R/W] B, H, W X1100000	OCSL4 [R/W] B, H, W 00001100	OCMOD [R/W] B, H, W XX000000	—	
0000A4H	CPCLRBH, CPCLRBL[W]/ CPCLRH, CPCLRL[R] H, W 11111111 11111111		TCDTH, TCDTL [R/W] H, W 00000000 00000000		16-bit free-run timer
0000A8H	TCCSH [R/W] B, H, W 00000000	TCCSL [R/W] B, H, W 01000000	—	ADTRGC [R/W] B, H, W XXXX0000	
0000ACH	IPCPH0, IPCPL0 [R] H, W XXXXXXXX XXXXXXXX		IPCPH1, IPCPL1 [R] H, W XXXXXXXX XXXXXXXX		16-bit input capture
0000B0H	IPCPH2, IPCPL2 [R] H, W XXXXXXXX XXXXXXXX		IPCPH3, IPCPL3 [R] H, W XXXXXXXX XXXXXXXX		
0000B4H	PICSH01 [W] B, H, W 000000--	PICSL01 [R/W] B, H, W 00000000	ICSH23 [R] B, H, W XXXXXX00	ICSL23 [R/W] B, H, W 00000000	
0000B8H	EIRR1 [R/W] B, H, W ------00	ENIR1 [R/W] B, H, W ------00	ELVR1 [R/W] B, H, W -------- ----0000		External interrupt (INT8, INT9)

(Continued)

Address	Register				Block
	+ 0	+ 1	+ 2	+ 3	
0000BC$_H$	TMRRH0, TMRRL0 [R/W] H, W XXXXXXXX XXXXXXXX		TMRRH1, TMRRL1 [R/W] H, W XXXXXXXX XXXXXXXX		Waveform generator
0000C0$_H$	TMRRH2, TMRRL2 [R/W] H, W XXXXXXXX XXXXXXXX		—	—	
0000C4$_H$	DTCR0 [R/W] B, H, W 00000000	DTCR1 [R/W] B, H, W 00000000	DTCR2 [R/W] B, H, W 00000000	—	
0000C8$_H$	—	SIGCR1 [R/W] B, H, W 10000000	—	SIGCR2 [R/W] B, H, W XXXXXXX1	
0000CC$_H$	ADCOMP0 [R/W] H, W 00000000 00000000		ADCOMP1 [R/W] H, W 00000000 00000000		A/D COMP
0000D0$_H$	ADCOMP2 [R/W] H, W 00000000 00000000		—	ADCOMPC [R/W] B, H, W XXXXX000	
0000D4$_H$ to 0000DC$_H$	—				Reserved
0000E0$_H$	PWCSR0 [R/W, R] B, H, W 00000000 00000000		PWCR0 [R] H, W 00000000 00000000		PWC timer
0000E4$_H$	PWCSR1 [R/W, R] B, H, W 00000000 00000000		PWCR1 [R] H, W 00000000 00000000		
0000E8$_H$	—	PDIVR0 [R/W] B, H, W XXXXX000	—	PDIVR1 [R/W] B, H, W XXXXX000	
0000EC$_H$ to 000FC$_H$	—				Reserved
000100$_H$	PRLH0 [R/W] B, H, W XXXXXXXX	PRLL0 [R/W] B, H, W XXXXXXXX	PRLH1 [R/W] B, H, W XXXXXXXX	PRLL1 [R/W] B, H, W XXXXXXXX	PPG0 to PPG15
000104$_H$	PRLH2 [R/W] B, H, W XXXXXXXX	PRLL2 [R/W] B, H, W XXXXXXXX	PRLH3 [R/W] B, H, W XXXXXXXX	PRLL3 [R/W] B, H, W XXXXXXXX	
000108$_H$	PPGC0 [R/W] B, H, W 0000000X	PPGC1 [R/W] B, H, W 0000000X	PPGC2 [R/W] B, H, W 0000000X	PPGC3 [R/W] B, H, W 0000000X	
00010C$_H$	PRLH4 [R/W] B, H, W XXXXXXXX	PRLL4 [R/W] B, H, W XXXXXXXX	PRLH5 [R/W] B, H, W XXXXXXXX	PRLL5 [R/W] B, H, W XXXXXXXX	
000110$_H$	PRLH6 [R/W] B, H, W XXXXXXXX	PRLL6 [R/W] B, H, W XXXXXXXX	PRLH7 [R/W] B, H, W XXXXXXXX	PRLL7 [R/W] B, H, W XXXXXXXX	
000114$_H$	PPGC4 [R/W] B, H, W 0000000X	PPGC5 [R/W] B, H, W 0000000X	PPGC6 [R/W] B, H, W0000000X	PPGC7 [R/W] B, H, W 0000000X	
000118$_H$	PRLH8 [R/W] B, H, W XXXXXXXX	PRLL8 [R/W] B, H, W XXXXXXXX	PRLH9 [R/W] B, H, W XXXXXXXX	PRLL9 [R/W] B, H, W XXXXXXXX	
00011C$_H$	PRLH10 [R/W] B, H, W XXXXXXXX	PRLL10 [R/W] B, H, W XXXXXXXX	PRLH11 [R/W] B, H, W XXXXXXXX	PRLL11 [R/W] B, H, W XXXXXXXX	
000120$_H$	PPGC8 [R/W] B, H, W 0000000X	PPGC9 [R/W] B, H, W 0000000X	PPGC10 [R/W] B, H, W 0000000X	PPGC11 [R/W] B, H, W 0000000X	

(Continued)

Address	Register				Block
	+ 0	+ 1	+ 2	+ 3	
000124H	PRLH12 [R/W] B, H, W XXXXXXXX	PRLL12 [R/W] B, H, W XXXXXXXX	PRLH13 [R/W] B, H, W XXXXXXXX	PRLL13 [R/W] B, H, W XXXXXXXX	PPG0 to PPG15
000128H	PRLH14 [R/W] B, H, W XXXXXXXX	PRLL14 [R/W] B, H, W XXXXXXXX	PRLH15 [R/W] B, H, W XXXXXXXX	PRLL15 [R/W] B, H, W XXXXXXXX	
00012CH	PPGC12 [R/W] B, H, W 0000000X	PPGC13 [R/W] B, H, W 0000000X	PPGC14 [R/W] B, H, W 0000000X	PPGC15 [R/W] B, H, W 0000000X	
000130H	TRG [R/W] B, H, W 00000000 00000000		—	GATEC [R/W] B, H, W XXXXXX00	
000134H	REVC [R/W] B, H, W 00000000 00000000		—	—	
000138H to 0001FCH	—				Reserved
000200H	DMACA0 [R/W] B, H, W *1 00000000 00000000 00000000 00000000				DMAC
000204H	DMACB0 [R/W] B, H, W 00000000 00000000 00000000 00000000				
000208H	DMACA1 [R/W] B, H, W*1 00000000 00000000 00000000 00000000				
00020CH	DMACB1 [R/W] B, H, W 00000000 00000000 00000000 00000000				
000210H	DMACA2 [R/W] B, H, W *1 00000000 00000000 00000000 00000000				
000214H	DMACB2 [R/W] B, H, W 00000000 00000000 00000000 00000000				
000218H	DMACA3 [R/W] B, H, W *1 00000000 00000000 00000000 00000000				
00021CH	DMACB3 [R/W] B, H, W 00000000 00000000 00000000 00000000				
000220H	DMACA4 [R/W] B, H, W *1 00000000 00000000 00000000 00000000				
000224H	DMACB4 [R/W] B, H, W 00000000 00000000 00000000 00000000				
000228H to 00023CH	—				Reserved
000240H	DMACR [R/W] B 0XX00000 XXXXXXXX XXXXXXXX XXXXXXXX				DMAC
000244H to 000398H	—				Reserved

(Continued)

Address	Register				Block
	+ 0	+ 1	+ 2	+ 3	
00039CH	—	—	—	—	MAC
0003A0H	DSP-PC [R/W] XXXXXXXX	DSP-CSR [R/W, R, W] 00000000	DSP-LY [R/W] XXXXXXXX XXXXXXXX		
0003A4H	DSP-OT0 [R] XXXXXXXX XXXXXXXX		DSP-OT1 [R] XXXXXXXX XXXXXXXX		
0003A8H	DSP-OT2 [R] XXXXXXXX XXXXXXXX		DSP-OT3 [R] XXXXXXXX XXXXXXXX		
0003ACH	—	—	—	—	
0003B0H	DSP-OT4 [R] XXXXXXXX XXXXXXXX		DSP-OT5 [R] XXXXXXXX XXXXXXXX		
0003B4H	DSP-OT6 [R] XXXXXXXX XXXXXXXX		DSP-OT7 [R] XXXXXXXX XXXXXXXX		
0003B8H to 0003ECH	—				Reserved
0003F0H	BSD0 [W] W XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				Bit search
0003F4H	BSD1 [R/W] W XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
0003F8H	BSDC [W] W XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
0003FCH	BSRR [R] XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX				
000400H	DDR0 [R/W] B 00000000	DDR1 [R/W] B 00000000	DDR2 [R/W] B 00000000	DDR3 [R/W] B 00000000	Data direction register
000404H	DDR4 [R/W] B 00000000	DDR5 [R/W] B 00000000	DDR6 [R/W] B ----0000	DDR7 [R/W] B 00000000	
000408H	—	—	—	—	
00040CH	DDRC [R/W] B 00000000	DDRD [R/W] B ------00	DDRE [R/W] B ------00	—	
000410H	DDRG [R/W] B --000000	—	—	—	
000414H to 00041CH	—				Reserved
000420H	PFR0 [R/W] B 00000000	PFR1 [R/W] B -0000000	PFR2 [R/W] B --00-00-	—	Port function register
000424H	—	—	—	PFR7 [R/W] B ------00	
000428H	—	—	—	—	
00042CH	—	—	—	—	
000430H	PFRG [R/W] B --00--0-	—	—	—	

(Continued)

Address	Register				Block
	+ 0	+ 1	+ 2	+ 3	
000434H to 00043CH	—				Reserved
000440H	ICR00 [R/W, R] B, H, W ----1111	ICR01 [R/W, R] B, H, W ----1111	ICR02 [R/W, R] B, H, W ----1111	ICR03 [R/W, R] B, H, W ----1111	Interrupt controller
000444H	ICR04 [R/W, R] B, H, W ----1111	ICR05 [R/W, R] B, H, W ----1111	ICR06 [R/W, R] B, H, W ----1111	ICR07 [R/W, R] B, H, W ----1111	
000448H	ICR08 [R/W, R] B, H, W ----1111	ICR09 [R/W, R] B, H, W ----1111	ICR10 [R/W, R] B, H, W ----1111	ICR11 [R/W, R] B, H, W ----1111	
00044CH	ICR12 [R/W, R] B, H, W ----1111	ICR13 [R/W, R] B, H, W ----1111	ICR14 [R/W, R] B, H, W ----1111	ICR15 [R/W, R] B, H, W ----1111	
000450H	ICR16 [R/W, R] B, H, W ----1111	ICR17 [R/W, R] B, H, W ----1111	ICR18 [R/W, R] B, H, W ----1111	ICR19 [R/W, R] B, H, W ----1111	
000454H	ICR20 [R/W, R] B, H, W ----1111	ICR21 [R/W, R] B, H, W ----1111	ICR22 [R/W, R] B, H, W ----1111	ICR23 [R/W, R] B, H, W ----1111	
000458H	ICR24 [R/W, R] B, H, W ----1111	ICR25 [R/W, R] B, H, W ----1111	ICR26 [R/W, R] B, H, W ----1111	ICR27 [R/W, R] B, H, W ----1111	
00045CH	ICR28 [R/W, R] B, H, W ----1111	ICR29 [R/W, R] B, H, W ----1111	ICR30 [R/W, R] B, H, W ----1111	ICR31 [R/W, R] B, H, W ----1111	
000460H	ICR32 [R/W, R] B, H, W ----1111	ICR33 [R/W, R] B, H, W ----1111	ICR34 [R/W, R] B, H, W ----1111	ICR35 [R/W, R] B, H, W ----1111	
000464H	ICR36 [R/W, R] B, H, W ----1111	ICR37 [R/W, R] B, H, W ----1111	ICR38 [R/W, R] B, H, W ----1111	ICR39 [R/W, R] B, H, W ----1111	
000468H	ICR40 [R/W, R] B, H, W ----1111	ICR41 [R/W, R] B, H, W ----1111	ICR42 [R/W, R] B, H, W ----1111	ICR43 [R/W, R] B, H, W ----1111	
00046CH	ICR44 [R/W, R] B, H, W ----1111	ICR45 [R/W, R] B, H, W ----1111	ICR46 [R/W, R] B, H, W ----1111	ICR47 [R/W, R] B, H, W ----1111	
000470H to 00047CH	—				Reserved
000480H	RSRR [R/W] B, H, W 10000000	STCR [R/W] B, H, W 00110011	TBCR [R/W] B, H, W 00XXXX00	CTBR [W] B, H, W XXXXXXXX	Clock control
000484H	CLKR [R/W] B, H, W 00000000	WPR [W] B, H, W XXXXXXXX	DIVR0 [R/W] B, H, W 00000011	DIVR1 [R/W] B, H, W 00000000	
000488H to 0005FCH	—				Reserved
000600H	PCR0 [R/W] B 00000000	PCR1 [R/W] B 00000000	PCR2 [R/W] B 00000000	PCR3 [R/W] B 00------	Pull-up controller
000604H	PCR4 [R/W] B 00000000	PCR5 [R/W] B 00000000	PCR6 [R/W] B ----0000	PCR7 [R/W] B 00000000	
000608H	—	—	—	—	
00060CH	—	—	—	—	

(Continued)

Address	Register				Block
	+ 0	+ 1	+ 2	+ 3	
000610H	PCRG [R/W] B --000000	—	—	—	Pull-up controller
000614H to 000FFCH	—				Reserved
001000H	DMASA0 [R/W] W 00000000 00000000 00000000 00000000				DMAC
001004H	DMADA0 [R/W] W 00000000 00000000 00000000 00000000				
001008H	DMASA1 [R/W] W 00000000 00000000 00000000 00000000				
00100CH	DMADA1 [R/W] W 00000000 00000000 00000000 00000000				
001010H	DMASA2 [R/W] W 00000000 00000000 00000000 00000000				
001014H	DMADA2 [R/W] W 00000000 00000000 00000000 00000000				
001018H	DMASA3 [R/W] W 00000000 00000000 00000000 00000000				
00101CH	DMADA3 [R/W] W 00000000 00000000 00000000 00000000				
001020H	DMASA4 [R/W] W 00000000 00000000 00000000 00000000				
001024H	DMADA4 [R/W] W 00000000 00000000 00000000 00000000				
001028H to 006FFCH	—				Reserved
007000H	FLCR [R/W] 0110X000	—	—	—	FLASH
007004H	FLWC [R/W] 00000011*2	—	—	—	
007008H	—	—	—	—	
00700CH	—	—	—	—	
007010H	—	—	—	—	
007014H to 00BFFCH	—				Reserved

(Continued)

(Continued)

Address	Register				Block
	+ 0	+ 1	+ 2	+ 3	
00C000H to 00C07CH	X-RAM (coefficient RAM) [R/W] 64 × 16 bits				MAC
00C080H to 00C0FCH	Y-RAM (variable RAM) [R/W] 64 × 16 bits				
00C100H to 00C2FCH	I-RAM (instruction RAM) [R/W] 256 × 16 bits				
00C300H to 00FFFCH	—				Reserved

*1 : The lower 16 bits (DTC15 to DCT0) of DMACA0 to DMACA4 cannot be accessed in bytes.

*2 : The initial value of 1FLWC (7004H) is “00010011B” on EVA tool.
Writing “00000011B” on the evaluation model has no effect on its operation.

Notes : • Do not execute Read Modify Write instructions on registers having a write-only bit.
• Data is undefined in reserved or (-) area.

■ INTERRUPT VECTOR

Interrupt source	Interrupt number		Interrupt level	Offset	TBR default address	RN
	10	16				
Reset	0	00	—	3FC$_H$	000FFFFC$_H$	—
Mode vector	1	01	—	3F8$_H$	000FFFF8$_H$	—
System reserved	2	02	—	3F4$_H$	000FFFF4$_H$	—
System reserved	3	03	—	3F0$_H$	000FFFF0$_H$	—
System reserved	4	04	—	3EC$_H$	000FFFEC$_H$	—
System reserved	5	05	—	3E8$_H$	000FFFE8$_H$	—
System reserved	6	06	—	3E4$_H$	000FFFE4$_H$	—
Coprocessor absent trap	7	07	—	3E0$_H$	000FFFE0$_H$	—
Coprocessor error trap	8	08	—	3DC$_H$	000FFFDC$_H$	—
INTE instruction	9	09	—	3D8$_H$	000FFFD8$_H$	—
Instruction break exception	10	0A	—	3D4$_H$	000FFFD4$_H$	—
Operand break trap	11	0B	—	3D0$_H$	000FFFD0$_H$	—
Step trace trap	12	0C	—	3CC$_H$	000FFFCC$_H$	—
NMI request (tool)	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$_H$	6
External interrupt 1	17	11	ICR01	3B8$_H$	000FFFB8$_H$	7
External interrupt 2	18	12	ICR02	3B4$_H$	000FFFB4$_H$	—
External interrupt 3	19	13	ICR03	3B0$_H$	000FFFB0$_H$	—
External interrupt 4	20	14	ICR04	3AC$_H$	000FFFAC$_H$	—
External interrupt 5	21	15	ICR05	3A8$_H$	000FFFA8$_H$	—
External interrupt 6	22	16	ICR06	3A4$_H$	000FFFA4$_H$	—
External interrupt 7	23	17	ICR07	3A0$_H$	000FFFA0$_H$	—
Reload timer 0	24	18	ICR08	39C$_H$	000FFF9C$_H$	8
Reload timer 1	25	19	ICR09	398$_H$	000FFF98$_H$	9
Reload timer 2	26	1A	ICR10	394$_H$	000FFF94$_H$	10
UART0(Reception completed)	27	1B	ICR11	390$_H$	000FFF90$_H$	0
UART0 (RX completed)	28	1C	ICR12	38C$_H$	000FFF8C$_H$	3
DTTI	29	1D	ICR13	388$_H$	000FFF88$_H$	—
DMAC0 (end, error)	30	1E	ICR14	384$_H$	000FFF84$_H$	—
DMAC1 (end, error)	31	1F	ICR15	380$_H$	000FFF80$_H$	—
DMAC2/3/4 (end, error)	32	20	ICR16	37C$_H$	000FFF7C$_H$	—

(Continued)

Interrupt source	Interrupt number		Interrupt level	Offset	TBR default address	RN
	10	16				
UART1(Reception completed)	33	21	ICR17	378H	000FFF78H	1
UART1 (RX completed)	34	22	ICR18	374H	000FFF74H	4
UART2 (Reception completed)	35	23	ICR19	370H	000FFF70H	2
UART2 (RX completed)	36	24	ICR20	36CH	000FFF6CH	5
MAC	37	25	ICR21	368H	000FFF68H	—
PPG0	38	26	ICR22	364H	000FFF64H	—
PPG1	39	27	ICR23	360H	000FFF60H	—
PPG2/3	40	28	ICR24	35CH	000FFF5CH	—
PPG4/5/6/7	41	29	ICR25	358H	000FFF58H	—
PPG8/9/10/11/12/13/14/15	42	2A	ICR26	354H	000FFF54H	—
External interrupt 8/9	43	2B	ICR27	350H	000FFF50H	—
Waveform0 (under flow)	44	2C	ICR28	34CH	000FFF4CH	—
Waveform1 (under flow)	45	2D	ICR29	348H	000FFF48H	—
Waveform2 (under flow)	46	2E	ICR30	344H	000FFF44H	—
Timebase timer overflow	47	2F	ICR31	340H	000FFF40H	—
Free-run timer (Compare clear)	48	30	ICR32	33CH	000FFF3CH	—
Free-run timer (zero detection)	49	31	ICR33	338H	000FFF38H	—
A/D0	50	32	ICR34	334H	000FFF34H	—
A/D1	51	33	ICR35	330H	000FFF30H	—
A/D2	52	34	ICR36	32CH	000FFF2CH	—
PWC0 (measurement completed)	53	35	ICR37	328H	000FFF28H	—
PWC1 (measurement completed)	54	36	ICR38	324H	000FFF24H	—
PWC0 (overflow)	55	37	ICR39	320H	000FFF20H	—
PWC1 (overflow)	56	38	ICR40	31CH	000FFF1CH	—
ICU0 (capture)	57	39	ICR41	318H	000FFF18H	—
ICU1 (capture)	58	3A	ICR42	314H	000FFF14H	—
ICU2/3 (capture)	59	3B	ICR43	310H	000FFF10H	—
OCU0/1 (match)	60	3C	ICR44	30CH	000FFF0CH	—
OCU2/3 (match)	61	3D	ICR45	308H	000FFF08H	—
OCU4/5 (match)	62	3E	ICR46	304H	000FFF04H	—
Delay interrupt source bit	63	3F	ICR47	300H	000FFF00H	—
System reserved (Used by REALOS)	64	40	—	2FCH	000FFEFCH	—
System reserved (Used by REALOS)	65	41	—	2F8H	000FFEF8H	—

(Continued)

(Continued)

Interrupt source	Interrupt number		Interrupt level	Offset	TBR default address	RN
	10	16				
System reserved	66	42	—	2F4H	000FFEF4H	—
System reserved	67	43	—	2F0H	000FFEF0H	—
System reserved	68	44	—	2ECH	000FFEECH	—
System reserved	69	45	—	2E8H	000FFEE8H	—
System reserved	70	46	—	2E4H	000FFEE4H	—
System reserved	71	47	—	2E0H	000FFEE0H	—
System reserved	72	48	—	2DCH	000FFEDCH	—
System reserved	73	49	—	2D8H	000FFED8H	—
System reserved	74	4A	—	2D4H	000FFED4H	—
System reserved	75	4B	—	2D0H	000FFED0H	—
System reserved	76	4C	—	2CCH	000FFECCH	—
System reserved	77	4D	—	2C8H	000FFEC8H	—
System reserved	78	4E	—	2C4H	000FFEC4H	—
System reserved	79	4F	—	2C0H	000FFEC0H	—
Used by INT instruction	80 to 255	50 to FF	—	2BCH to 000H	000FFEBCH to 000FFC00H	—

■ PIN STATUS IN EACH CPU STATE

Terms used as the status of pins mean as follows.

- Input enabled
- Indicates that the input function can be used.
- Input 0 fixed
- Indicates that the input level has been internally fixed to be 0 to prevent leakage when the input is released.
- Output Hi-Z
- Means the placing of a pin in a high impedance state by preventing the transistor for driving the pin from driving.
- Output is maintained.
- Indicates the output in the output state existing immediately before this mode is established.
- If the device enters this mode with an internal output peripheral operating or while serving as an output port, the output is performed by the internal peripheral or the port output is maintained, respectively.
- State existing immediately before is maintained.
- When the device serves for output or input immediately before entering this mode, the device maintains the output or is ready for the input, respectively.

• List of pin status (single chip mode)

Pin no.		Pin name	Function	At initializing		At sleep mode	At Stop mode	
QFP	LQFP			$\overline{INIT}$ = L*1	$\overline{INIT}$ = H*2		HIZ = 0	HIZ = 1
1	99	P23	SIN1	Output Hi-Z/ Input disabled	Output Hi-Z/ Input enabled	Retention of the immediately prior state	Retention of the immediately prior state	Output Hi-Z/ Input 0 fixed
2	100	P24	SOT1					
3	1	P25	SCK1					
4, 5	2, 3	P26, P27	INT6, INT7			Input enabled	Input enabled	Input enabled
6	4	P51	Port			Retention of the immediately prior state	Retention of the immediately prior state	Output Hi-Z/ Input 0 fixed
7 to 9	5 to 7	P50, P52, P53	Ports/ TIN0 to TIN2					
10	8	P54	INT0			Input enabled	Input enabled	Input enabled
11	9	P55	INT1					
12	10	P56	INT2					
13	11	P57	INT3					
14	12	PG0	CKI/INT4					
15	13	PG1	PPG0/INT5					
16	14	PG2	Ports			Retention of the immediately prior state	Retention of the immediately prior state	Output Hi-Z/ Input 0 fixed
20	18	PG3	SIN2					
21	19	PG4	SOT2					
22	20	PG5	SCK2					
23 to 30	21 to 28	P40 to P47	Ports					
31, 32	29, 30	PE1, PE0	AN11, AN10					
38, 39	36, 37	PD1, PD0	AN9, AN8					
41 to 48	39 to 46	PC7 to PC0	AN7 to AN0					
51 to 56	49 to 54	P30 to P35	RTO0 to RTO5					
57, 58	55, 56	P36, P37	IC0, IC1					
59, 60	57, 58	P60, P61	IC2, IC3					
61, 62	59, 60	P62, P63	INT8, INT9			Input enabled	Input enabled	Input enabled

(Continued)

(Continued)

P : Selection of general purpose port, F : Selection of specified function

Pin no.		Pin name	Function	At initializing		At sleep mode	At Stop mode	
QFP	LQFP			$\overline{INIT}$ = L*1	$\overline{INIT}$ = H*2		HIZ = 0	HIZ = 1
63, 64	61, 62	P70, P71	TOT1, TOT2	Output Hi-Z/ input disabled	Output Hi-Z/ input enabled	Retention of the immediately prior state	Retention of the immediately prior state	Output Hi-Z/ Input 0 fixed
65	63	P72	DTTI					
66	64	P73	PWI0					
69	67	P74	PWI1					
70	68	P75	ADTG0					
71	69	P76	ADTG1					
72	70	P77	ADTG2					
73	71	NMI	NMI	Input enabled	Input enabled	Input enabled	Input enabled	Input enabled
78	76	P00	PPG1	Output Hi-Z/ input disabled	output Hi-Z/ input enabled	Retention of the immediately prior state	Retention of the immediately prior state	Output Hi-Z/ input 0 fixed
79	77	P01	PPG2					
80	78	P02	PPG3					
81	79	P03	PPG4					
82	80	P04	PPG5					
83	81	P05	PPG6					
84	82	P06	PPG7					
85	83	P07	PPG8					
86	84	P10	PPG9					
87	85	P11	PPG10					
88	86	P12	PPG11					
89	87	P13	PPG12					
90	88	P14	PPG13					
91	89	P15	PPG14					
96	94	P16	PPG15					
97	95	P17	Ports					
98	96	P20	SIN0					
99	97	P21	SOT0					
100	98	P22	SCK0					

*1 : $\overline{INIT}$ = L : Indicates the pin status with $\overline{INIT}$ remaining at the “L” level.

*2 : $\overline{INIT}$ = H : Indicates the pin status existing immediately after $\overline{INIT}$ transition from “L” to “H” level.

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

Parameter	Symbol	Rating		Unit	Remarks
		Min	Max		
Power supply voltage*1	V_{CC}	V_{SS} − 0.5	V_{SS} + 6.0	V	
Analog power supply voltage*1	AV_{CC}	V_{SS} − 0.5	V_{SS} + 6.0	V	*2
Analog reference voltage*1	AVRH	V_{SS} − 0.5	V_{SS} + 6.0	V	*2
Input voltage*1	V_I	V_{SS} − 0.3	V_{CC} + 0.3	V	
Analog pin input voltage*1	V_{IA}	V_{SS} − 0.3	AVcc + 0.3	V	
Output voltage*1	V_O	V_{SS} − 0.3	V_{CC} + 0.3	V	
"L" level maximum output current	I_{OL}	—	10	mA	*3
"L" level average output current	I_{OLAV}	—	8	mA	*4
"L" level total maximum output current	ΣI_{OL}	—	100	mA	
"L" level total average output current	ΣI_{OLAV}	—	50	mA	*5
"H" level maximum output current	I_{OH}	—	− 10	mA	*3
"H" level average output current	I_{OHAV}	—	− 4	mA	*4
"H" level total maximum output current	ΣI_{OH}	—	− 50	mA	
"H" level total average output current	ΣI_{OHAV}	—	− 20	mA	*5
Power consumption	P_D	—	600	mW	FLASH product
			600		MASK product Ta ≤ + 85 °C
			360		MASK product Ta ≤ + 105 °C *6
Operating temperature	Ta	− 40	+ 105	°C	MASK product (at single chip operating)
		− 40	+ 85	°C	FLASH product (at single chip operating)
Storage temperature	Tstg	− 55	125	°C	

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

*2 : Be careful not to exceed V_{CC} + 0.3 V, for example, when the power is turned on.
Be careful not to let AV_{CC} exceed V_{CC}, for example, when the power is turned on.

*3 : The maximum output current is the peak value for a single pin.

*4 : The average output current is the average current for a single pin over a period of 100 ms.

*5 : The total average output current is the average current for all pins over a period of 100 ms.

*6 : For use at Ta = +105 °C, lower the operating frequency to reduce power consumption.

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 = AVss = 0 V)

Parameter	Symbol	Value		Unit	Remarks
		Min	Max		
Power supply voltage	V_{CC}	4.0	5.5	V	At normal operating
Analog power supply voltage	AV_{CC}	V_{SS} + 4.0	V_{SS} + 5.5	V	
Analog reference voltage	AVRH0	AV_{SS}	AV_{CC}	V	For A/D converter 0
	AVRH1	AV_{SS}	AV_{CC}	V	For A/D converter 1
	AVRH2	AV_{SS}	AV_{CC}	V	For A/D converter 2
Operating temperature	Ta	− 40	+ 105	°C	MASK product (at single chip operation)
		− 40	+ 85	°C	FLASH product (at single chip operation)

Note : Upon power up, it takes approx. 100 μs for stabilization of internal power supply after the V_{CC} power supply is stabilized. Keep applying “L” to $\overline{INIT}$ signal during that period.

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

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

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

3. DC Characteristics

(V_{CC} = 4.0 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

Parameter	Symbol	Pin	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
"H" level input voltage	V_{IH}	Other than hysteresis input pin	—	0.8 × Vcc	—	Vcc	V	
	V_{IHS}	Hysteresis input pin	—	Vcc – 0.4	—	Vcc	V	
Input Low Voltage	V_{IL}	Other than hysteresis input pin	—	Vss	—	0.2 × Vcc	V	
	V_{ILS}	Hysteresis input pin	—	Vss	—	Vss + 0.4	V	
"H" level output voltage	V_{OH}	Other than P30 to P35	V_{CC} = 5.0 V, I_{OH} = 4.0 mA	Vcc – 0.5	—	—	V	
	V_{OH2}	P30 to P35	V_{CC} = 5.0 V, I_{OH} = 8.0 mA	Vcc – 0.7	—	—	V	
Output Low Voltage	V_{OL}	Other than P30 to P35	V_{CC} = 5.0 V, I_{OL} = 4.0 mA	—	—	0.4	V	
	V_{OL2}	P30 to P35	V_{CC} = 5.0 V, I_{OL} = 12 mA	—	—	0.6	V	
Input leak current	I_{LI}	—	V_{CC} = 5.0 V, $V_{SS} \le V_I \le V_{CC}$	– 5	—	5	μA	
Pull-up resistance	R_{PULL}	$\overline{INIT}$, Pull-up pin	—	—	50	—	kΩ	
Power supply current	I_{CC}	V_{CC}	V_{CC} = 5.0 V, 33 MHz	—	90	100	mA	
	I_{CCS}	V_{CC}	V_{CC} = 5.0 V, 33 MHz	—	60	80	mA	At SLEEP
	I_{CCH}	V_{CC}	V_{CC} = 5.0 V, Ta = + 25 °C	—	300	—	μA	At STOP
Input capacitance	C_{IN}	Other than V_{CC}, V_{SS}, AV_{CC}, AV_{SS}, AVRH0, 1, 2	—	—	10	—	pF	

4. FLASH MEMORY write/erase characteristics

Parameter	Conditions	Value			Unit	Remarks
		Min	Typ	Max		
Sector erase time	Ta = + 25 °C, Vcc = 5.0 V	—	1	15	s	Not including time for internal writing before deletion.
Chip erase time	Ta = + 25 °C, Vcc = 5.0 V	—	10	—	s	Not including time for internal writing before deletion.
Byte write time	Ta = + 25 °C, Vcc = 5.0 V	—	8	3,600	μs	Not including system-level overhead time.
Chip write time	Ta = + 25 °C, Vcc = 5.0 V	—	2.1	—	s	Not including system-level overhead time.
Erase/write cycle	—	10,000	—	—	cycle	
Flash memory data retention time	Average Ta = + 85 °C	20	—	—	year	*

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

5. AC Characteristics

(1) Clock Timing Ratings

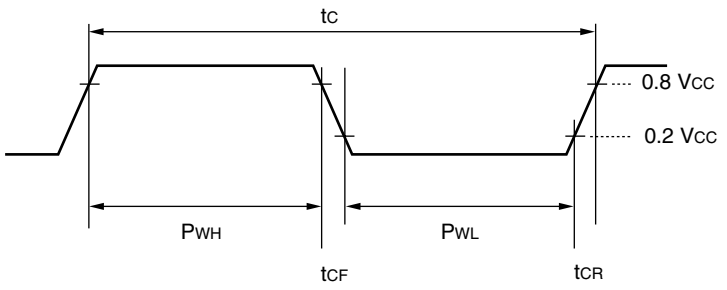
(V_{CC} = 4.0 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

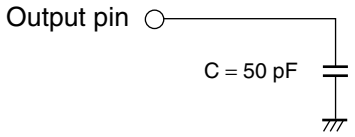
Parameter	Symbol	Pin	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Clock frequency	f_C	X0 X1	—	3.6*2	—	12	MHz	For using the PLL within the self-oscillation enabled range, set the multiplier for the internal clock not to let the operating frequency exceed 33 MHz.
Clock cycle time	t_C	X0 X1		83.3	—	278*2	ns	
Internal operating clock frequency	f_{CP}	—	When 4.125 MHz is input as the X0 clock frequency and ×8 multiplication is set for the PLL of the oscillator circuit.	2.06*1	—	33	MHz	CPU
	f_{CPP}			2.06*1	—	33	MHz	Peripheral
Internal operating clock cycle time	t_{CP}	—		30.3	—	485*1	ns	CPU
	t_{CPP}			30.3	—	485*1	ns	Peripheral

*1 : The values assume a gear cycle of 1/16.

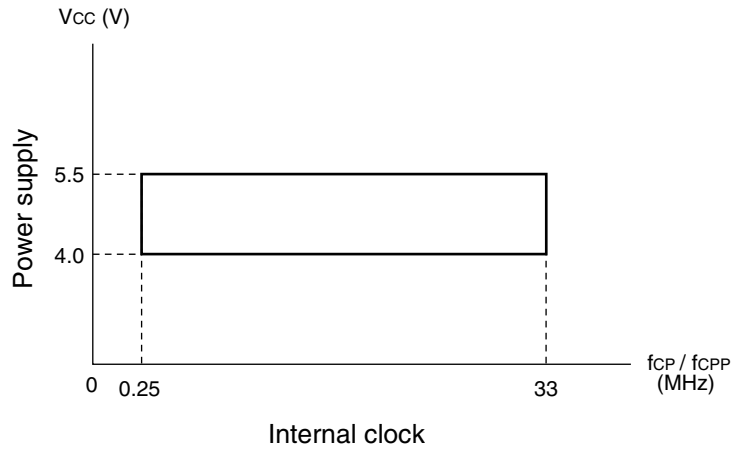
*2 : When the PLL is used, the lower-limit frequency of the input clock to the X0 and X1 pins determines depending on the PLL multiplication.
At × 1 multiplication : more than 8 MHz
At × 2 to × 8 multiplication : more than 4 MHz

• Conditions for measuring the clock timing ratings

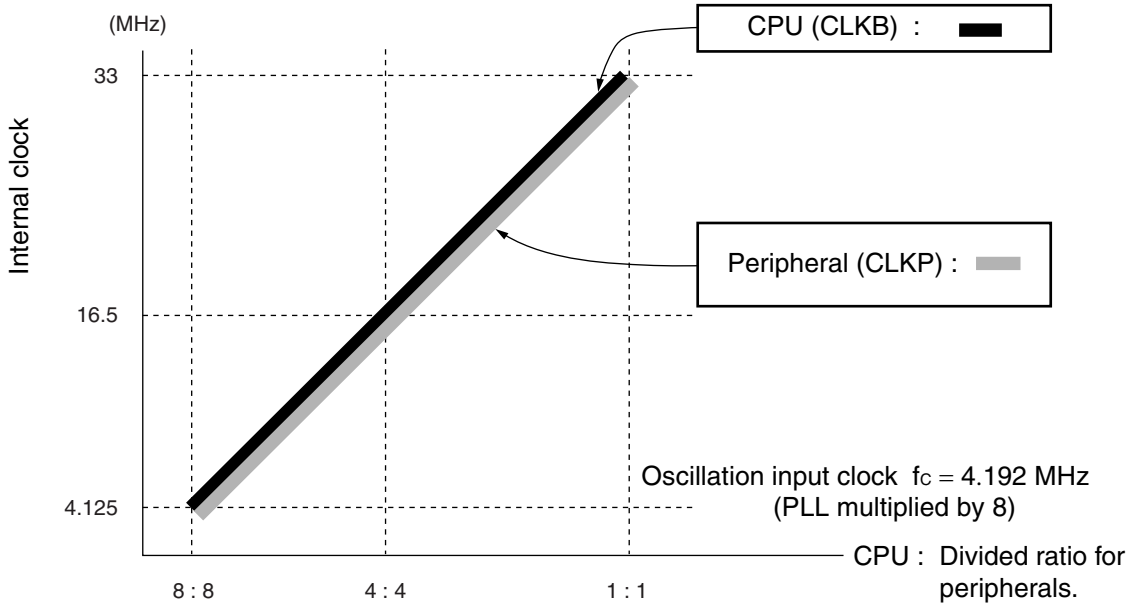




• Operation Assurance Range



• Internal clock setting range



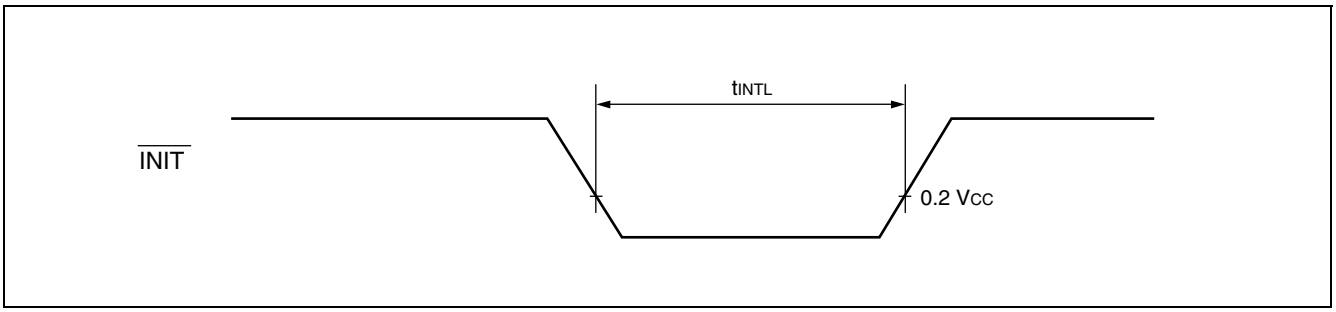
Notes : • Oscillation stabilization time of PLL > 600 μs
• The internal clock gear setting should be within the value shown in clock timing ratings table.

(2) Reset Input

(V_{CC} = 4.0 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

Parameter	Symbol	Pin	Conditions	Value		Unit	Remarks
				Min	Max		
$\overline{INIT}$ input time (at power-on and STOP mode)	t_{INTL}	$\overline{INIT}$	—	Oscillation time of oscillator + $t_C \times 10$	—	ns	*
$\overline{INIT}$ input time (other than the above)				$t_C \times 10$	—	ns	

* : After the power is stable, L level is kept inputting to $\overline{INIT}$ for the duration of approximately 100 μs until the internal power is stabilized.



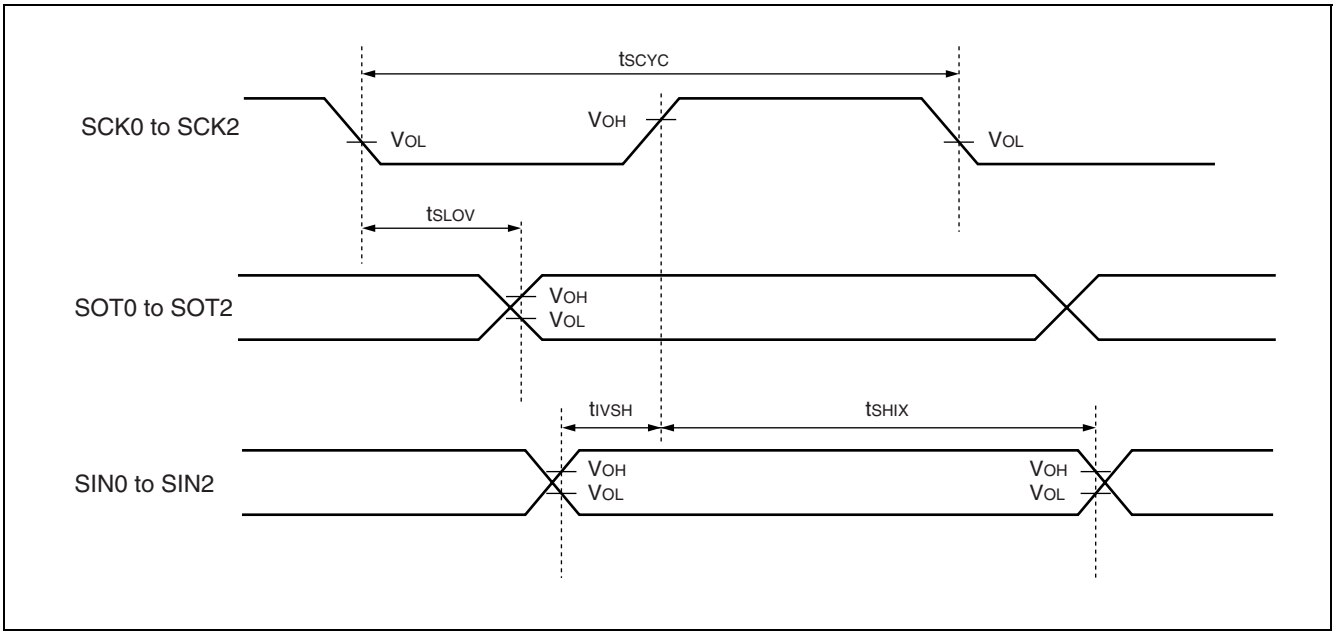
(3) UART Timing

(V_{CC} = 4.0 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

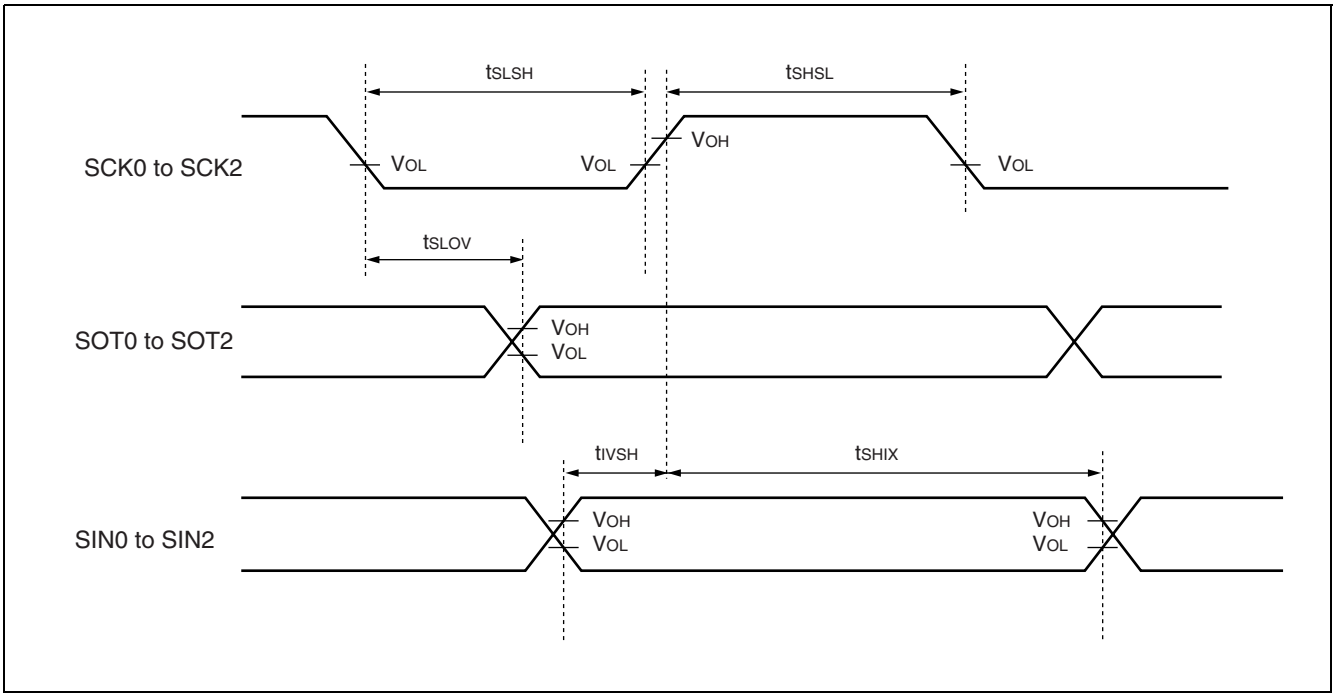
Parameter	Symbol	Pin	Conditions	Value		Unit	Remarks
				Min	Max		
Serial clock cycle time	t_{SCYC}	SCK0 to SCK2	Internal shift clock mode	8 t_{CYCP}	—	ns	
SCK ↓ → SOT delay time	t_{SLOV}	SCK0 to SCK2, SOT0 to SOT2		− 80	80	ns	
Valid SIN → SCK ↑	t_{IVSH}	SCK0 to SCK2, SIN0 to SIN2		100	—	ns	
SCK ↑ → valid SIN hold time	t_{SHIX}	SCK0 to SCK2, SIN0 to SIN2		60	—	ns	
Serial clock H pulse width	t_{SHSL}	SCK0 to SCK2	External shift clock mode	4 t_{CYCP}	—	ns	
Serial clock L pulse width	t_{SLSH}	SCK0 to SCK2		4 t_{CYCP}	—	ns	
SCK ↓ → SOT delay time	t_{SLOV}	SCK0 to SCK2, SOT0 to SOT2		—	150	ns	
Valid SIN → SCK ↑	t_{IVSH}	SCK0 to SCK2, SIN0 to SIN2		60	—	ns	
SCK ↑ → valid SIN hold time	t_{SHIX}	SCK0 to SCK2, SIN0 to SIN2		60	—	ns	

Notes : • There are the AC ratings for CLK synchronous mode.
• t_{CYCP} indicates the peripheral clock cycle time.

• Internal shift clock mode



• External shift clock mode

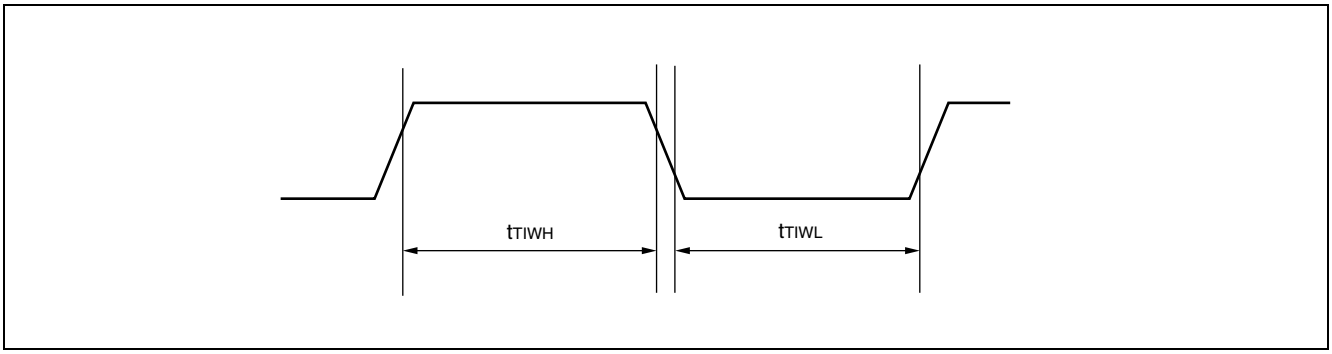


(4) Free-run Timer Clock, PWC Input and Reload Timer Trigger Timing

(V_{CC} = 4.0 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

Parameter	Symbol	Pin	Conditions	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TIWH} t_{TIWL}	CKI PWI0, PWI1 TIN0 to TIN2	—	4 t_{CYCP}	—	ns	

Note : t_{CYCP} indicates the peripheral clock cycle time.

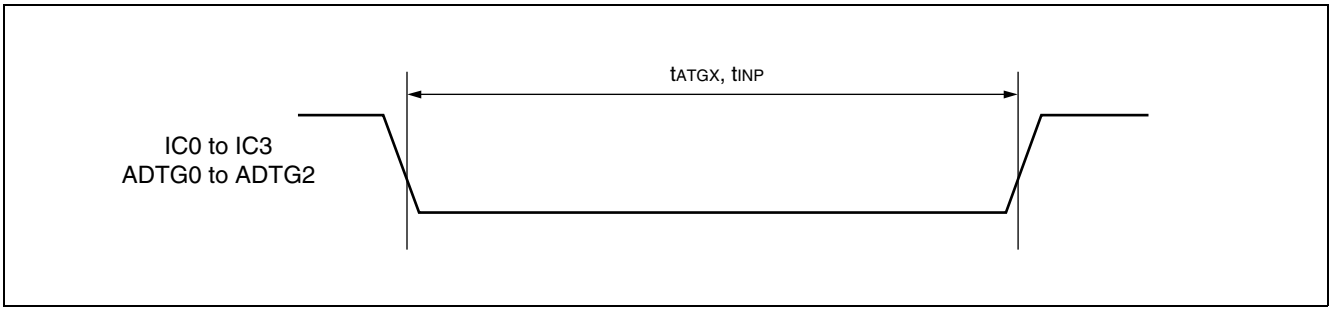


(5) Trigger Input Timing

(V_{CC} = 4.0 to 5.5 V, V_{SS} = AV_{SS} = 0 V)

Parameter	Symbol	Pin	Conditions	Value		Unit	Remarks
				Min	Max		
Input capture trigger input	t_{INP}	IC0 to IC3	—	5 t_{CYCP}	—	ns	
A/D activation trigger input	t_{ATGX}	ADTG0 to ADTG2	—	5 t_{CYCP}	—	ns	

Note : t_{CYCP} indicates the peripheral clock cycle time.



6. Electrical Characteristics for the A/D Converter

(V_{CC} = AVcc = 5.0 V, V_{SS} = AV_{SS} = 0 V)

Parameter	Symbol	Pin	Value			Unit	Remarks
			Min	Typ	Max		
Resolution	—	—	—	—	10	bit	
Total error*1	—	—	– 4	—	4	LSB	At AVRHn*4 = 5.0 V
Linearity error*	—	—	– 3.5	—	3.5	LSB	
Differential linearity error*1	—	—	– 3	—	3	LSB	
Zero transition voltage*1	V_{OT}	AN0 to AN11	AVss – 3.5	AVss + 0.5	AVss + 4.5	LSB	
Full transition voltage*1	V_{FST}	AN0 to AN11	AVRH – 5.5	AVRH – 1.5	AVRH + 2.5	LSB	
Conversion time	—	—	1.2*2	—	—	µs	
Analog port Input current	I_{AIN}	AN0 to AN11	—	—	10	µA	
Analog input voltage	V_{AIN}	AN0 to AN11	AVss	—	AVRH	V	
Reference voltage	—	AVRHn	AVss	—	AVcc	V	
Analog power supply current (analog + digital)	I_A	AVcc	—	2	—	mA	Per 1 unit
	I_{AH}*3		—	—	100	µA	Per 1 unit
reference power supply current (between AVRH and AVSS)	I_R	AVRHn	—	1	—	mA	Per 1 unit AVRHn*4 = 5.0 V, at AVss = 0 V
	I_{RH}*3		—	—	100	µA	per 1 unit at STOP
Analog input capacitance	—	—	—	10	—	pF	
Inter-channel disparity	—	AN0 to AN11	—	—	4	LSB	

*1 : Measured in the CPU sleep state

*2 : Vcc = AVcc = 5.0 V, machine clock at 33 MHz

*3 : The current when the CPU is in stop mode and the A/D converter is not operating (at Vcc = AVcc = AVRHn = 5.0 V)

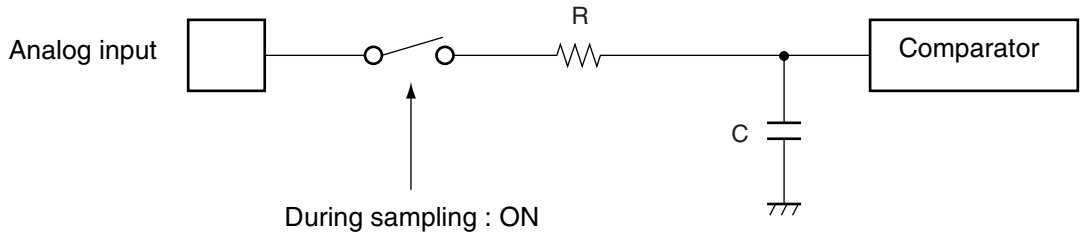
*4: AVRHn = AVRH0, AVRH1, AVRH2

Notes : • The above does not guarantee the inter-unit accuracy.
• Set the output impedance of the external circuit ≤ 2 kΩ.

• **About the external impedance of the 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 sampling and hold capacitor is insufficient, adversely affecting A/D conversion precision. So, to satisfy the A/D conversion precision standard, consider the relationship between the external impedance and minimum sampling time and either adjust the resistor value and operating frequency or decrease the external impedance so that the sampling time is longer than the minimum value. Also, if the sampling time cannot be sufficient, connect a capacitor of about 0.1 μF to the analog input pin.

• Analog input circuit model

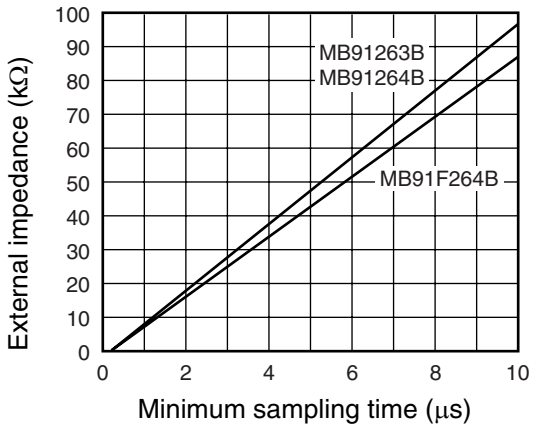


	R	C
MB91263B	2.0 kΩ (Max)	14.4 pF (Max)
MB91264B	2.0 kΩ (Max)	14.4 pF (Max)
MB91F264B	2.0 kΩ (Max)	16.0 pF (Max)

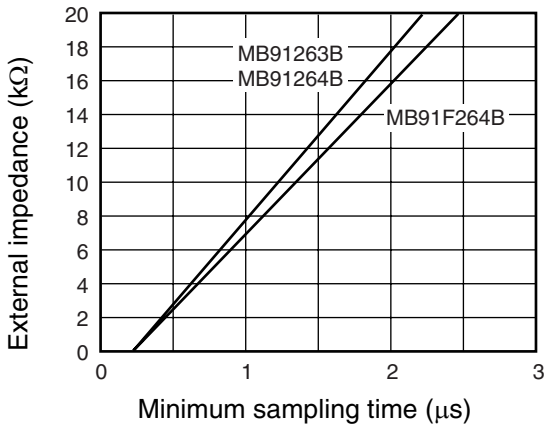
Note : The values are reference values.

• The relationship between the external impedance and minimum sampling time

(External impedance = 0 kΩ to 100 kΩ)



(External impedance = 0 kΩ to 20 kΩ)



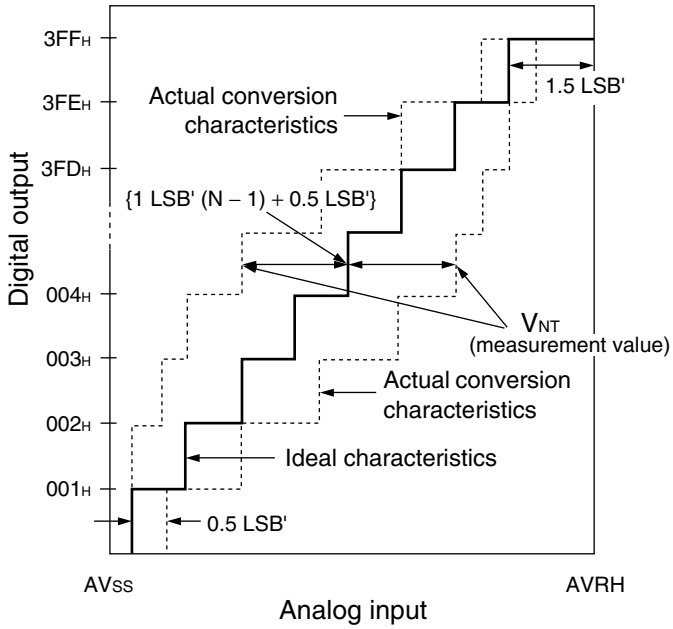
• **About errors**

As |AVRH − AVSS| becomes smaller, values of relative errors grow larger.

Definition of A/D Converter Terms

- Resolution : Analog variation that is recognized by an A/D converter.
- Linearity error : Zero transition point (00 0000 0000 ⟷ 00 0000 0001) and full-scale transition point. Difference between the line connected (11 1111 1110 ⟷ 11 1111 1111) and actual conversion characteristics.
- Differential linearity error : Deviation of input voltage, that is required for changing output code by 1 LSB, from an ideal value.
- Total error : This error indicates the difference between actual and ideal values, including the zero transition error/full-scale transition error/linearity error.

Total error



$$1LSB' \text{ (Ideal value)} = \frac{AVRH - AV_{SS}}{1024} \text{ [V]} \quad \text{Total error of digital output N} = \frac{V_{NT} - \{1\ LSB' \times (N - 1) + 0.5\ LSB'\}}{1\ LSB'}$$

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

$$V_{FST}' \text{ (Ideal value)} = AVRH - 1.5\ LSB' \text{ [V]}$$

V_{NT} : A voltage at which digital output transitions from (N + 1) to N.

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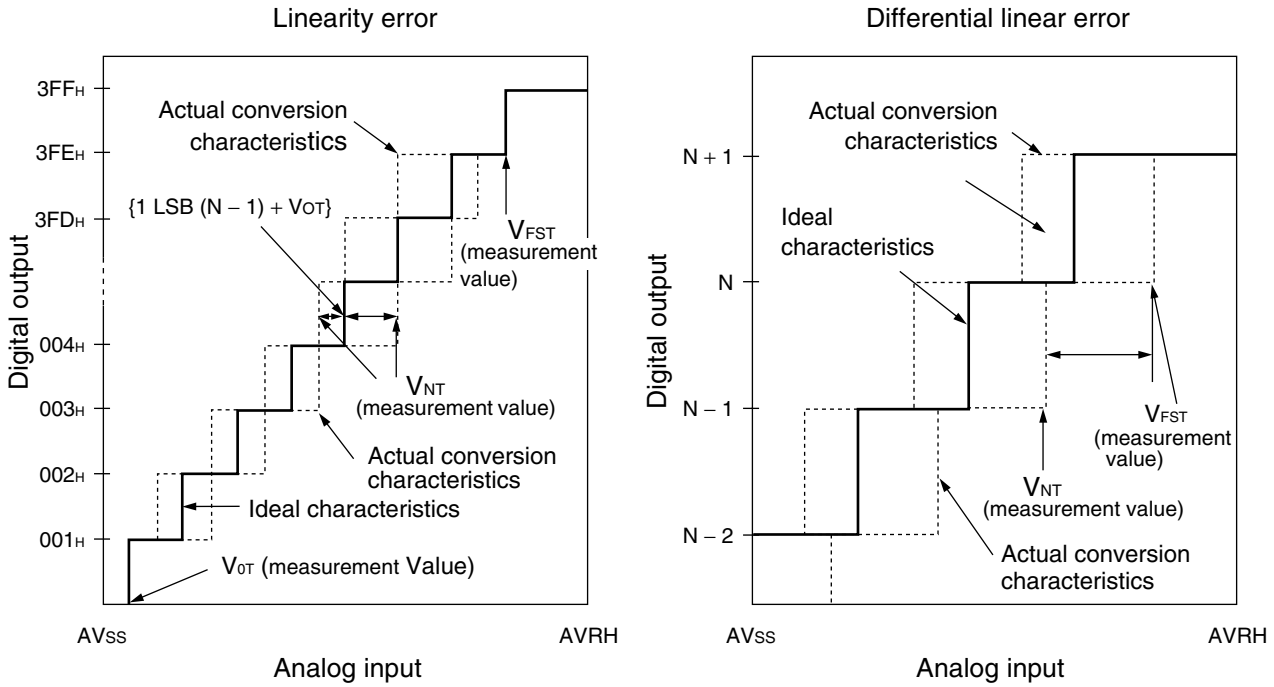


$$\text{Linearity error in digital output N} = \frac{VNT - \{ 1\ LSB \times (N - 1) + VOT \}}{1\ LSB}\ [LSB]$$

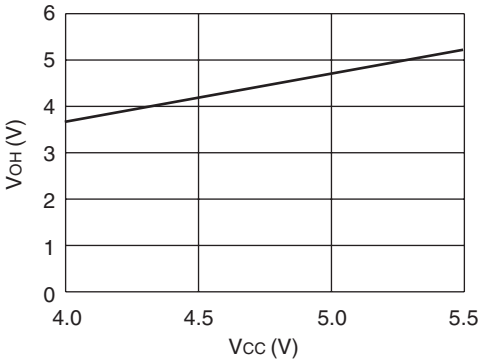
$$\text{Differential linearity error in digital output N} = \frac{V_{(N+1)T} - V_{NT}}{1\ LSB} - 1\ [LSB]$$

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

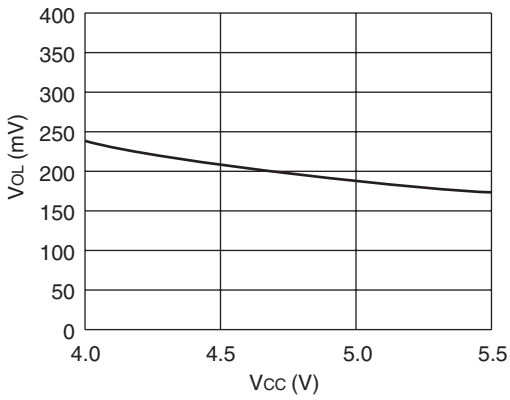
V_{OT} : A voltage at which digital output transitions from 000_H to 001_H.
V_{FST} : A voltage at which digital output transitions from $3FE_H$ to $3FF_H$.

■ EXAMPLE CHARACTERISTICS

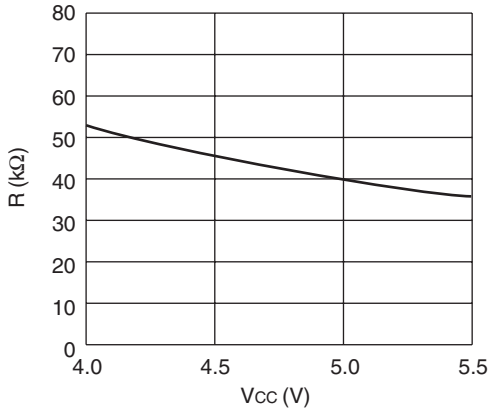
"H" Level Output Voltage vs. Power Supply Voltage



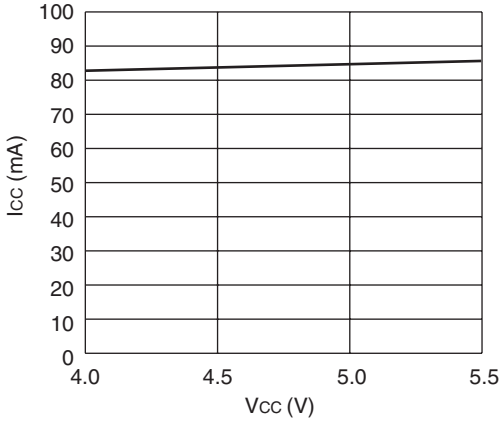
"L" Level Output Voltage vs. Power Supply Voltage



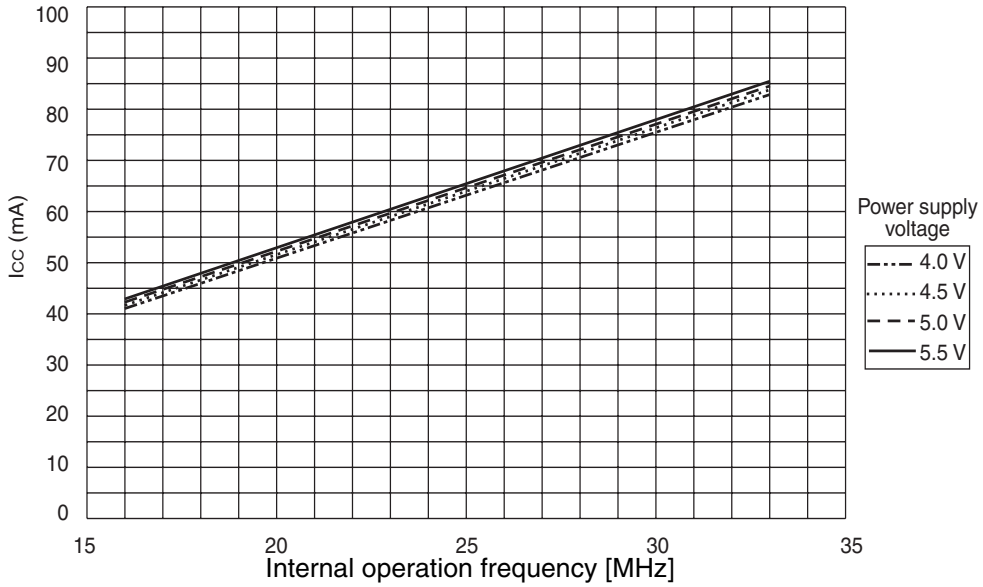
Pull-up Resistor vs. Power Supply Voltage



Power Supply Current vs. Power Supply Voltage



Power Supply Current vs. Internal Operation Frequency (MB91263B)



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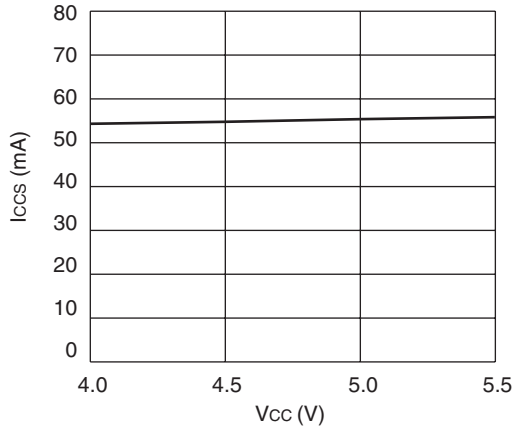
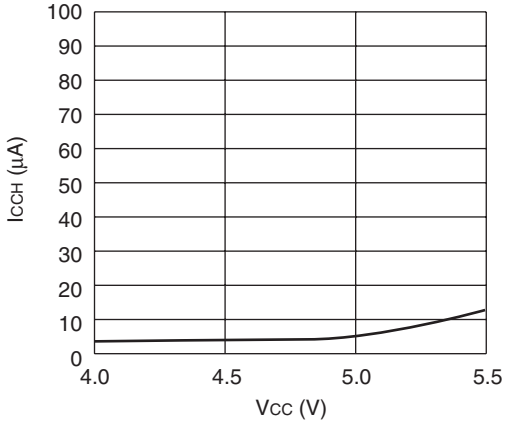
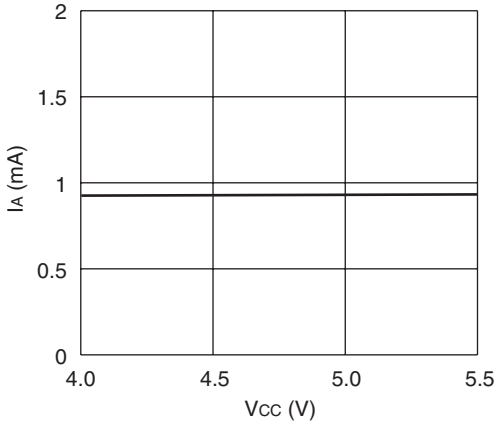
Power Supply Current (at sleep) vs. Power Supply Voltage



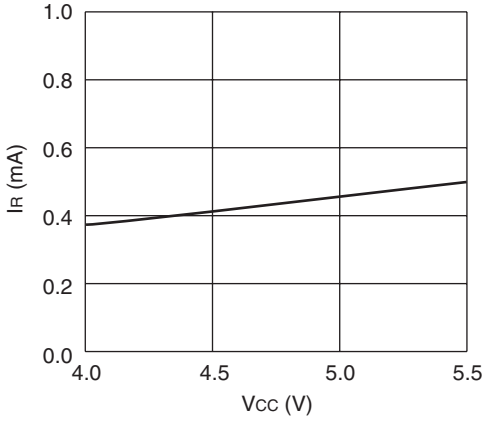
Power Supply Current (at stop) vs. Power Supply Voltage



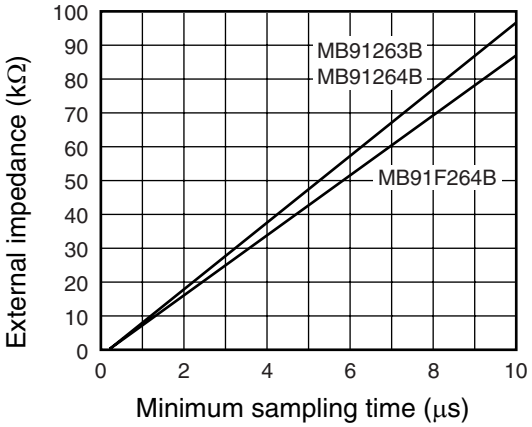
A/D Conversion Block Per 1 Unit (33 MHz) Analog Power Supply Current vs. Power Supply Voltage



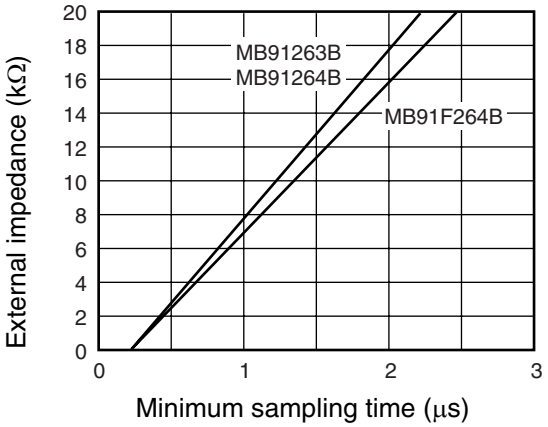
A/D Conversion Block Per 1 Unit (33 MHz) Reference Power Supply Current vs. Power Supply Voltage



(External impedance = 0 kΩ to 100 kΩ)



(External impedance = 0 kΩ to 20 kΩ)



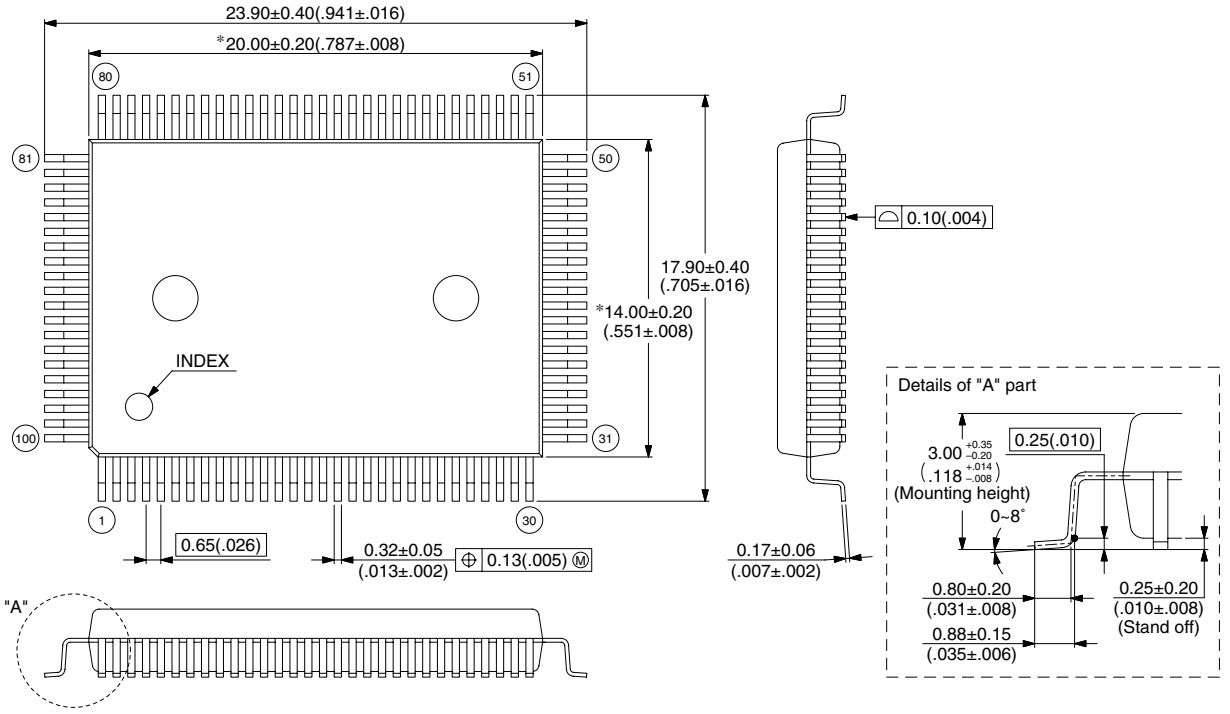
■ ORDERING INFORMATION

Part number	Package	Remarks
MB91F264BPF-G	100-pin plastic QFP (FPT-100P-M06)	
MB91F264BPF-GE1		Lead-free Package
MB91F264BPFV-G	100-pin plastic LQFP (FPT-100P-M05)	
MB91F264BPFV-GE1		Lead-free Package
MB91264BPF-G-xxx	100-pin plastic QFP (FPT-100P-M06)	
MB91264BPF-G-xxxE1		Lead-free Package
MB91264BPFV-G-xxx	100-pin plastic LQFP (FPT-100P-M05)	
MB91264BPFV-G-xxxE1		Lead-free Package
MB91263BPF-G-xxx	100-pin plastic QFP (FPT-100P-M06)	
MB91263BPF-G-xxxE1		Lead-free Package
MB91263BPFV-G-xxx	100-pin plastic LQFP (FPT-100P-M05)	
MB91263BPFV-G-xxxE1		Lead-free Package

■ PACKAGE DIMENSION

100 - pin plastic QFP
(FPT-100P-M06)

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.

(Continued)

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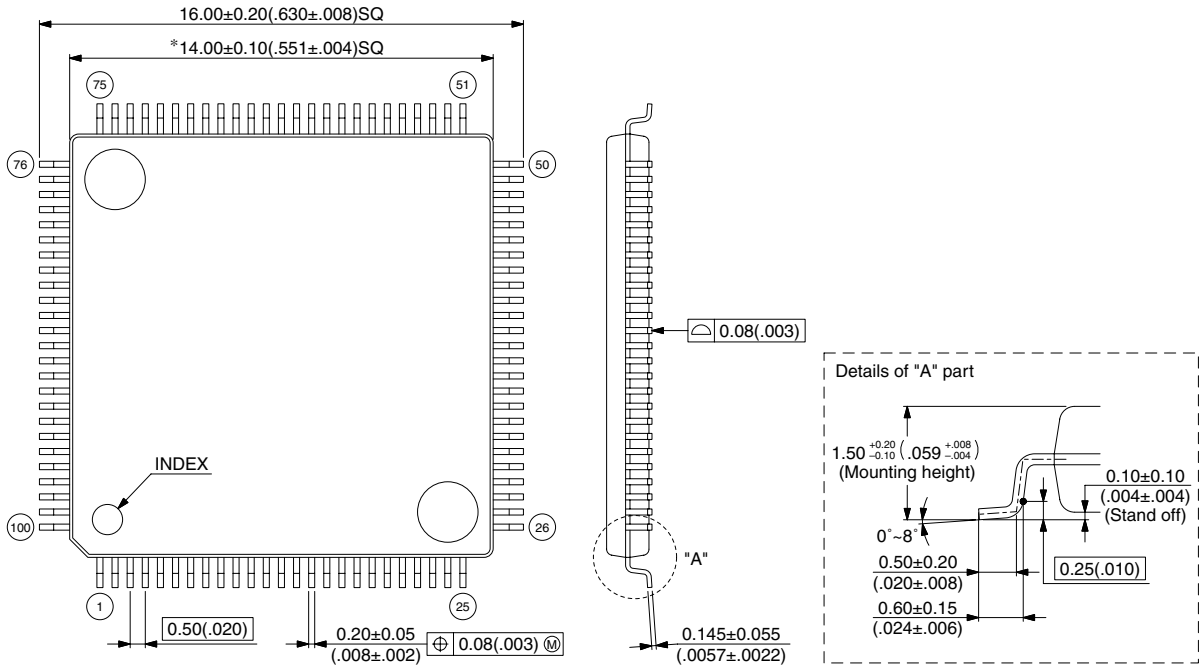
100-pin plastic LQFP
(FPT-100P-M05)

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



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

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