16-bit Proprietary Microcontroller

CMOS

F²MC-16LX MB90330 Series

MB90333A/F334A/V330A

■ DESCRIPTION

The MB90330 series are 16-bit microcontrollers designed for applications, such as personal computer peripheral devices, that require USB communications. The USB feature supports not only 12-Mbps Function operation but also Mini-HOST operation. It is equipped with functions that are suitable for personal computer peripheral devices such as displays and audio devices, and control of mobile devices that support USB communications. While inheriting the AT architecture of the F²MC* family, the instruction set supports the C language and extended addressing modes and contains enhanced signed multiplication and division instructions as well as a substantial collection of improved bit manipulation instructions. In addition, long word processing is now available by introducing a 32-bit accumulator.

* : F²MC stands for FUJITSU Flexible Microcontroller, a registered trademark of FUJITSU LIMITED.

## ■ FEATURES

● **Clock**
  • Built-in oscillation circuit and PLL clock frequency multiplication circuit
  • Oscillation clock
  • The main clock is the oscillation clock divided into 2 (for oscillation 6 MHz : 3 MHz)
  • Clock for USB is 48 MHz
  • Machine clock frequency of 6 MHz, 12 MHz, or 24 MHz selectable
  • Minimum execution time of instruction : 41.6 ns (6 MHz oscillation clock, 4-time multiplied : machine clock
    24 MHz and at operating V_{CC} = 3.3 V.

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■ PACKAGES

120-pin Plastic LQFP   120-pin Plastic LQFP

(FPT-120P-M05)   (FPT-120P-M21)

FUJITSU
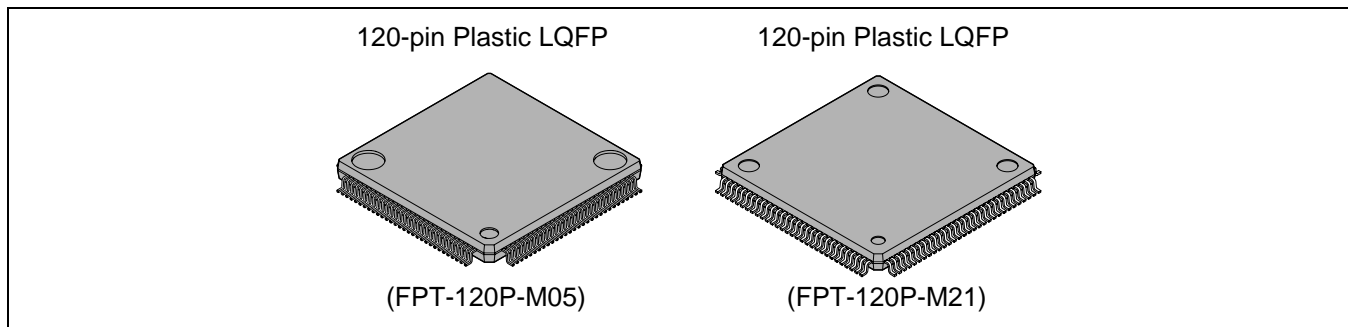
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● **The maximum memory space : 16 MB**

● **24-bit addressing**

● **Bank addressing**

● **Instruction system**
  • Data types : Bit, Byte, Word and Long word
  • Addressing mode (23 types)
  • Enhanced high-precision computing with 32-bit accumulator
  • Enhanced Multiply/Divide instructions with sign and the RETI instruction

● **Instruction system compatible with high-level language (C language) and multi-task**
  • Employing system stack pointer
  • Instruction set symmetry and barrel shift instructions

● **Program Patch Function (2 address pointer)**

● **4-byte instruction queue**

● **Interrupt function**
  • Priority levels are programmable
  • 32 interrupts function

● **Data transfer function**
  • Extended intelligent I/O service function (EI^{2}OS) : Maximum of 16 channels
  • μDMAC : Maximum 16 channels

● **Low Power Consumption Mode**
  • Sleep mode (with the CPU operating clock stopped)
  • Time-base timer mode (with the oscillator clock and time-base timer operating)
  • Stop mode (with the oscillator clock stopped)
  • CPU intermittent operation mode (with the CPU operating at fixed intervals of set cycles)
  • Watch mode (with 32 kHz oscillator clock and watch timer operating)

● **Package**
  • LQFP-120P (FPT-120P-M05 : 0.40 mm pin pitch)
  • LQFP-120P (FPT-120P-M21 : 0.50 mm pin pitch)

● **Process : CMOS technology**

● **Operation guaranteed temperature : – 40 °C to + 85 °C (0 °C to + 70 °C when USB is in use)**

■ INTERNAL PERIPHERAL FUNCTION (RESOURCE)

● **I/O port : Max 94 ports**

● **Time-base timer : 1 channel**

● **Watchdog timer : 1 channel**

● **Watch timer : 1channel**

● **16-bit reload timer : 3 channels**

● **Multi-functional timer**
- 16-bit free run timer : 1 channel
- Output compare : 4 channels
  An interrupt request can be output when the 16-bit free-run timer value matches the compare register value.
- Input capture : 4channels
  Upon detection of the effective edge of the signal input to the external input pin, the input capture unit sets the input capture data register to the 16-bit free-run timer value to output an interrupt request.
- 8/16-bit PPG timer (8-bit × 6 channels or 16-bit × 3 channels) the period and duty of the output pulse can be set by the program.
- 16-bit PWC timer : 1 channel
  Timer function and pulse width measurement function

● **UART : 4 channels**
- Full-duplex double buffer (8-bit length)
- Asynchronous transfer or clock-synchronous serial (I/O extended serial) transfer can be set.

● **I/O extended serial interface : 1 channel**

● **DTP/External interrupt circuit (8 channels)**
- Activate the extended intelligent I/O service by external interrupt input
- Interrupt output by external interrupt input

● **Delay interrupt output module**
- Output an interrupt request for task switching

● **8/10-bit A/D converter : 16 channels**
- 8-bit resolution or 10-bit resolution can be set.

● **USB : 1 channel**
- USB function (conform to USB2.0 Full Speed)
- Full Speed is supported/Endpoint are specifiable up to six.
- Dual port RAM (The FIFO mode is supported).
- Transfer type : Control, Interrupt, Bulk, or Isochronous transfer possible
- USB Mini-HOST function

● **I²C* Interface : 3 channels**
- Supports Intel SM bus standard and Phillips I²C bus standards
- Two-wire data transfer protocol specification
- Master and slave transmission/reception

* : I²C license :
  Purchase of Fujitsu I²C components conveys a license under the Philips I²C Patent Rights to use, these components in an I²C system provided that the system conforms to the I²C Standard Specification as defined by Philips.

MB90330 Series

■ PRODUCT LINEUP

Part number	MB90V330A	MB90F334A	MB90333A
Type	For evaluation	Built-in Flash memory	Built-in Mask ROM
ROM capacity	No	384 KB	256 KB
RAM capacity	28 KB	24 KB	16 KB
Emulator-specific power supply *	Used bit	—	
CPU functions	Number of basic instructions : 351 instructions Minimum instruction : 41.6 ns/at oscillation of 6 MHz execution time (When 4 times are used : Machine clock of 24 MHz) Addressing type : 23 types Program Patch Function : For 2 address pointers Maximum memory space : 16 MB		
Ports	I/O Ports (CMOS) 94 ports		
UART	Equipped with full-duplex double buffer Clock synchronous or asynchronous operation selectable It can also be used for I/O serial Built-in special baud-rate generator Built-in 4 channels		
16-bit reload timer	16-bit reload timer operation Built-in 3 channels		
Multi-functional timer	16-bit free run timer × 1 channel Output compare × 4 channels Input capture × 4 channels 8/16-bit PPG timer (8-bit mode × 6 channels, 16-bit mode × 3 channels) 16-bit PWC timer × 1 channel		
8/10-bit A/D converter	16 channels (input multiplex) 8-bit resolution or 10-bit resolution can be set. Conversion time : 7.16 μs at minimum (24 MHz machine clock at maximum)		
DTP/External interrupt	8 channels Interrupt factor : "L"→"H" edge/"H"→"L" edge/"L" level/"H" level selectable		
I²C	3 channels		
I/O extended serial interface	1 channel		
USB	1 channel USB function (conform to USB2.0 Full Speed) USB Mini-HOST function		
External bus interface	For multi-bus/non-multi-bus		
Withstand voltage of 5 V	16 ports (excluding VBUS and I/O for I²C)		
Low Power Consumption Mode	Sleep mode/Time-base timer mode/Stop mode/CPU intermittent mode/ Watch mode		
Process	CMOS		
Operating voltage	3.3 V ± 0.3 V (at maximum machine clock 24 MHz)		

* : It is setting of Jumper switch (TOOL VCC) when Emulator (MB2147-01) is used. Please refer to the
MB2147-01 or MB2147-20 hardware manual (3.3 Emulator-dedicated Power Supply Switching) about details.

■ PACKAGES AND PRODUCT MODELS

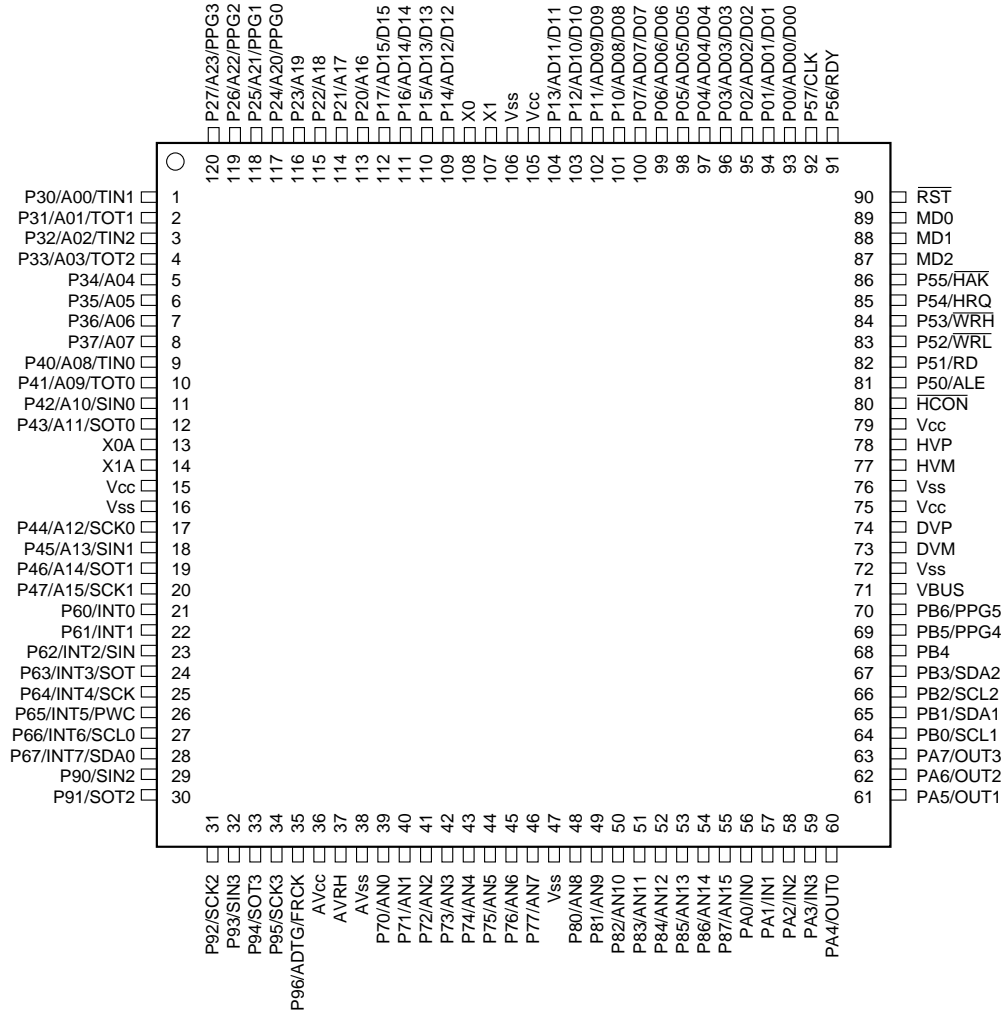| Package	MB90333A	MB90F334A	MB90V330A
FPT-120P-M05 (LQFP-0.40 mm)	○	○	×
FPT-120P-M21 (LQFP-0.50 mm)	○	○	×
PGA-299C-A01 (PGA)	×	×	○

○ : Yes × : No

Note : For detailed information on each package, see "■ PACKAGE DIMENSIONS".

■ PIN ASSIGNMENT

(TOP VIEW)

Top edge pins (120 down to 91):
P27/A23/PPG3 (120), P26/A22/PPG2 (119), P25/A21/PPG1 (118), P24/A20/PPG0 (117), P23/A19 (116), P22/A18 (115), P21/A17 (114), P20/A16 (113), P17/AD15/D15 (112), P16/AD14/D14 (111), P15/AD13/D13 (110), P14/AD12/D12 (109), X0 (108), X1 (107), Vss (106), Vcc (105), P13/AD11/D11 (104), P12/AD10/D10 (103), P11/AD09/D09 (102), P10/AD08/D08 (101), P07/AD07/D07 (100), P06/AD06/D06 (99), P05/AD05/D05 (98), P04/AD04/D04 (97), P03/AD03/D03 (96), P02/AD02/D02 (95), P01/AD01/D01 (94), P00/AD00/D00 (93), P57/CLK (92), P56/RDY (91)

Left edge pins (1 to 30):
Pin	Name
1	P30/A00/TIN1
2	P31/A01/TOT1
3	P32/A02/TIN2
4	P33/A03/TOT2
5	P34/A04
6	P35/A05
7	P36/A06
8	P37/A07
9	P40/A08/TIN0
10	P41/A09/TOT0
11	P42/A10/SIN0
12	P43/A11/SOT0
13	X0A
14	X1A
15	Vcc
16	Vss
17	P44/A12/SCK0
18	P45/A13/SIN1
19	P46/A14/SOT1
20	P47/A15/SCK1
21	P60/INT0
22	P61/INT1
23	P62/INT2/SIN
24	P63/INT3/SOT
25	P64/INT4/SCK
26	P65/INT5/PWC
27	P66/INT6/SCL0
28	P67/INT7/SDA0
29	P90/SIN2
30	P91/SOT2

Right edge pins (90 to 61):
Pin	Name
90	RST
89	MD0
88	MD1
87	MD2
86	P55/HAK
85	P54/HRQ
84	P53/WRH
83	P52/WRL
82	P51/RD
81	P50/ALE
80	HCON
79	Vcc
78	HVP
77	HVM
76	Vss
75	Vcc
74	DVP
73	DVM
72	Vss
71	VBUS
70	PB6/PPG5
69	PB5/PPG4
68	PB4
67	PB3/SDA2
66	PB2/SCL2
65	PB1/SDA1
64	PB0/SCL1
63	PA7/OUT3
62	PA6/OUT2
61	PA5/OUT1

Bottom edge pins (31 to 60):
P92/SCK2 (31), P93/SIN3 (32), P94/SOT3 (33), P95/SCK3 (34), P96/ADTG/FRCK (35), AVcc (36), AVRH (37), AVss (38), P70/AN0 (39), P71/AN1 (40), P72/AN2 (41), P73/AN3 (42), P74/AN4 (43), P75/AN5 (44), P76/AN6 (45), P77/AN7 (46), Vss (47), P80/AN8 (48), P81/AN9 (49), P82/AN10 (50), P83/AN11 (51), P84/AN12 (52), P85/AN13 (53), P86/AN14 (54), P87/AN15 (55), PA0/IN0 (56), PA1/IN1 (57), PA2/IN2 (58), PA3/IN3 (59), PA4/OUT0 (60)

(FPT-120P-M05 / FPT-120P-M21)

■ PIN DESCRIPTION

Pin no. LQFP	Pin name	Circuit type*	Function
108, 107	X0, X1	A	Terminals to connect the oscillator. When connecting an external clock, leave the X1 pin side unconnected.
13, 14	X0A, X1A	A	32 kHz oscillation terminals.
90	$\overline{RST}$	F	External reset input pin.
93 to 100	P00 to P07	H	General purpose input/output port. The ports can be set to be added with a pull-up resistor (RD00 to RD07 = 1) by the pull-up resistor setting register (RDR0). (When the power output is set, it is invalid.)
	AD00 to AD07		Function as an I/O pin for the low-order external address and data bus in multiplex mode.
	D00 to D07		Function as an output pin for the low-order external data bus in non-multiplex mode.
101 to 104	P10 to P13	H	General purpose input/output port. The ports can be set to be added with a pull-up resistor (RD10 to RD13 = 1) by the pull-up resistor setting register (RDR1). (When the power output is set, it is invalid.)
	AD08 to AD11		Function as an I/O pin for the high-order external address and data bus in multiplex mode.
	D08 to D11		Function as an output pin for the high-order external data bus in non-multiplex mode.
109 to 112	P14 to P17	H	General purpose input/output port. The ports can be set to be added with a pull-up resistor (RD14 to RD17 = 1) by the pull-up resistor setting register (RDR1). (When the power output is set, it is invalid.)
	AD12 to D15		Function as an I/O pin for the high-order external address and data bus in multiplex mode.
	D12 to D15		Function as an output pin for the high-order external data bus in non-multiplex mode.
113 to 116	P20 to P23	D	This is a general purpose I/O port. When the bits of external address output control register (HACR) are set to "1" in external bus mode, these pins function as general purpose I/O ports.
	A16 to A19		When the bits of external address output control register (HACR) are set to "0" in multiplex mode, these pins function as address high output pins (A16 to A19).
	A16 to A19		When the bits of external address output control register (HACR) are set to "0" in non-multiplex mode, these pins function as address high output pins (A16 to A19).

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Pin no.	Pin name	Circuit type*	Function
LQFP			
117 to 120	P24 to P27	D	This is a general purpose I/O port. When the bits of external address output control register (HACR) are set to "1" in external bus mode, these pins function as general purpose I/O ports.
	A20 to A23		When the bits of external address output control register (HACR) are set to "0" in multiplex mode, these pins function as address high output pins (A20 to A23).
	A20 to A23		When the bits of external address output control register (HACR) are set to "0" in non-multiplex mode, these pins function as address high output pins (A20 to A23).
	PPG0 to PPG3		Function as ch0 to ch3 output pins for the 8-bit PPG timer.
1	P30	D	General purpose input/output port.
	A00		Function as the external address pin in non-multi-bus mode.
	TIN1		Function as an event input pin for 16-bit reload timer ch1.
2	P31	D	General purpose input/output port.
	A01		Function as the external address pin in non-multi-bus mode.
	TOT1		Function as the output pin for 16-bit reload timer ch1.
3	P32	D	General purpose input/output port.
	A02		Function as the external address pin in non-multi-bus mode.
	TIN2		Function as an event input pin for 16-bit reload timer ch2.
4	P33	D	General purpose input/output port.
	A03		Function as the external address pin in non-multi-bus mode.
	TOT2		Function as the output pin for 16-bit reload timer ch2.
5 to 8	P34 to P37	D	General purpose input/output port.
	A04 to A07		Function as the external address pin in non-multi-bus mode.
9	P40	G	General purpose input/output port.
	A08		Function as the external address pin in non-multi-bus mode.
	TIN0		Function as an event input pin for 16-bit reload timer ch0.
10	P41	G	General purpose input/output port.
	A09		Function as the external address pin in non-multi-bus mode.
	TOT0		Function as the output pin for 16-bit reload timer ch0.
11	P42	G	General purpose input/output port.
	A10		Function as the external address pin in non-multi-bus mode.
	SIN0		Function as a data input pin for UART ch0.
12	P43	G	General purpose input/output port.
	A11		Function as the external address pin in non-multi-bus mode.
	SOT0		Function as a data output pin for UART ch0.
17	P44	G	General purpose input/output port.
	A12		Function as the external address pin in non-multi-bus mode.
	SCK0		Function as a clock I/O pin for UART ch0.

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Pin no. LQFP	Pin name	Circuit type*	Function
18	P45	G	General purpose input/output port.
	A13		Function as the external address pin in non-multi-bus mode.
	SIN1		Function as a data input pin for UART ch1.
19	P46	G	General purpose input/output port.
	A14		Function as the external address pin in non-multi-bus mode.
	SOT1		Function as a data output pin for UART ch1.
20	P47	G	General purpose input/output port.
	A15		Function as the external address pin in non-multi-bus mode.
	SCK1		Function as a clock I/O pin for UART ch1.
81	P50	L	General purpose input/output port.
	ALE		Function as the address latch enable signal (ALE) pin in external bus mode.
82	P51	L	General purpose input/output port.
	$\overline{\text{RD}}$		Function as the read strobe output ($\overline{\text{RD}}$) pin in external bus mode.
83	P52	L	General purpose input/output port.
	$\overline{\text{WRL}}$		Function as the data write strobe output ($\overline{\text{WRL}}$) pin on the lower side in external bus mode. This pin functions as a general-purpose I/O port when the WRE bit in the EPCR register is "0".
84	P53	L	General purpose input/output port.
	$\overline{\text{WRH}}$		Function as the data write strobe output ($\overline{\text{WRH}}$) pin on the higher side in bus width 16-bit external bus mode. This pin functions as a general-purpose I/O port when the WRE bit in the EPCR register is "0".
85	P54	L	General purpose input/output port.
	HRQ		Function as the hold request input (HRQ) pin in external bus mode. This pin functions as a general-purpose I/O port when the HDE bit in the EPCR register is "0".
86	P55	L	General purpose input/output port.
	$\overline{\text{HAK}}$		Function as the hold acknowledge output ($\overline{\text{HAK}}$) pin in external bus mode. This pin functions as a general-purpose I/O port when the HDE bit in the EPCR register is "0".
91	P56	L	General purpose input/output port.
	RDY		Function as the external ready input (RDY) pin in external bus mode. This pin functions as a general-purpose I/O port when the RYE bit in the EPCR register is "0".
92	P57	L	General purpose input/output port.
	CLK		Function as the machine cycle clock output (CLK) pin in external bus mode. This pin functions as a general-purpose I/O port when the CKE bit in the EPCR register is "0".
21, 22	P60, P61	C	General purpose input/output port. (With stand voltage of 5 V)
	INT0, INT1		Function as external interrupt ch0 and ch1 input pins.

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Pin no. LQFP	Pin name	Circuit type*	Function
23	P62	C	General purpose input/output ports. (Withstand voltage of 5 V)
	INT2		Function as an external interrupt ch2 input pin.
	SIN		Simple serial I/O data input pin.
24	P63	C	General purpose input/output port. (Withstand voltage of 5 V)
	INT3		Function as an external interrupt ch3 input pin.
	SOT		Simple serial I/O data output pin.
25	P64	C	General purpose input/output port. (Withstand voltage of 5 V)
	INT4		Function as an external interrupt ch4 input pin.
	SCK		Simple serial I/O clock input/output pin.
26	P65	C	General purpose input/output port. (Withstand voltage of 5 V)
	INT5		Function as an external interrupt ch5 input pin.
	PWC		Function as the PWC input pin.
27	P66	C	General purpose input/output port. (Withstand voltage of 5 V)
	INT6		Function as an external interrupt ch6 input pin.
	SCL0		Function as the ch0 clock I/O pin for the I^{2}C interface. Set port output to High-Z during I^{2}C interface operations.
28	P67	C	General purpose input/output port. (Withstand voltage of 5 V)
	INT7		Function as an external interrupt ch7 input pin.
	SDA0		Function as the ch0 data I/O pin for the I^{2}C interface. Set port output to High-Z during I^{2}C interface operations.
39 to 46	P70 to P77	I	General purpose input/output port.
	AN0 to AN7		Function as input pins for analog ch0 to ch7.
48 to 55	P80 to P87	I	General purpose input/output port.
	AN8 to AN15		Function as input pins for analog ch8 to ch15.
29	P90	D	General purpose input/output port.
	SIN2		Function as a data input pin for UART ch2.
30	P91	D	General purpose input/output port.
	SOT2		Function as a data output pin for UART ch2.
31	P92	D	General purpose input/output port.
	SCK2		Function as a clock I/O pin for UART ch2.
32	P93	D	General purpose input/output port.
	SIN3		Function as a data input pin for UART ch3.
33	P94	D	General purpose input/output port.
	SOT3		Function as a data output pin for UART ch3.
34	P95	D	General purpose input/output port.
	SCK3		Function as a clock I/O pin for UART ch3.
35	P96	C	General purpose input/output port. (Withstand voltage of 5 V)
	ADTG		Function as the external trigger input pin when the A/D converter is being used.
	FRCK		Function as the external clock input pin when the free-run timer is being used.

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Pin no. LQFP	Pin name	Circuit type*	Function
56 to 59	PA0 to PA3	C	General purpose input/output port. (Withstand voltage of 5 V)
	IN0 to IN3		Function as the input capture ch0 to ch3 trigger inputs.
60 to 63	PA4 to PA7	C	General purpose input/output port. (Withstand voltage of 5 V)
	OUT0 to OUT3		Function as the output compare ch0 to ch3 event output pins.
64	PB0	C	General purpose input/output port. (Withstand voltage of 5 V)
	SCL1		Function as the ch1 clock I/O pin for the I^2C interface. Set port output to High-Z during I^2C interface operations.
65	PB1	C	General purpose input/output port. (Withstand voltage of 5 V)
	SDA1		Function as the ch1 data I/O pin for the I^2C interface. Set port output to High-Z during I^2C interface operations.
66	PB2	C	General purpose input/output port. (Withstand voltage of 5 V)
	SCL2		Function as the ch2 clock I/O pin for the I^2C interface. Set port output to High-Z during I^2C interface operations.
67	PB3	C	General purpose input/output port. (Withstand voltage of 5 V)
	SDA2		Function as the ch2 data I/O pin for the I^2C interface. Set port output to High-Z during I^2C interface operations.
68	PB4	C	General purpose input/output port. (Withstand voltage of 5 V)
69, 70	PB5, PB6	D	General purpose input/output port.
	PPG4, PPG5		Function as ch4 and ch5 output pins for the 8-bit PPG timer.
71	VBUS	C	Terminal for state detection of USB cable. (Withstand voltage of 5 V)
73	DVM	K	USB function D− pin.
74	DVP	K	USB function D+ pin.
77	HVM	K	USB Mini-HOST D− pin.
78	HVP	K	USB Mini-HOST D+ pin.
80	HCON	E	External pull-up resistor connect pin.
36	AVcc	—	A/D converter power supply pin.
37	AVRH	J	A/D converter external reference power supply pin.
38	AVss	—	A/D converter power supply pin.
87 to 89	MD2 to MD0	B	Operation mode select input pin.
15	Vcc	—	Power supply pin.
75	Vcc	—	Power supply pin.
79	Vcc	—	Power supply pin.
105	Vcc	—	Power supply pin.
16	Vss	—	Power supply pin (GND).
47	Vss	—	Power supply pin (GND).
72	Vss	—	Power supply pin (GND).
76	Vss	—	Power supply pin (GND).
106	Vss	—	Power supply pin (GND).

* : For circuit information, see "■ I/O CIRCUIT TYPE".

■ I/O CIRCUIT TYPE

Type	Circuit	Remarks
A	X1 X1A X0 X0A → Clock input / Standby control signal	• High-rate oscillation feedback resistor, approx.1 MΩ • Low-rate oscillation feedback resistor, approx.10 MΩ • With standby control
B	Hysteresis input	• CMOS hysteresis input
C	Nch — Nout / Hysteresis input / Standby control signal	• CMOS hysteresis input • Nch open drain output

D	Pch — Pout / Nch — Nout / Hysteresis input / Standby control signal	• CMOS output
		• CMOS hysteresis input
		  (With input interception function at standby)
		Notes : • Share one output buffer because both output of I/O port and internal resource are used.
		  • Share one input buffer because both input of I/O port and internal resource are used.

E	Pch — Pout / Nch — Nout	• CMOS output
F	R — Hysteresis input	• CMOS hysteresis input with pull-up resistor
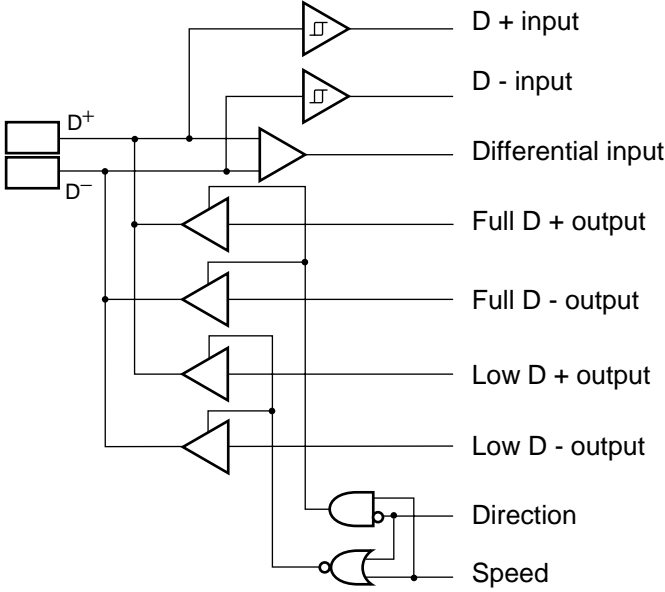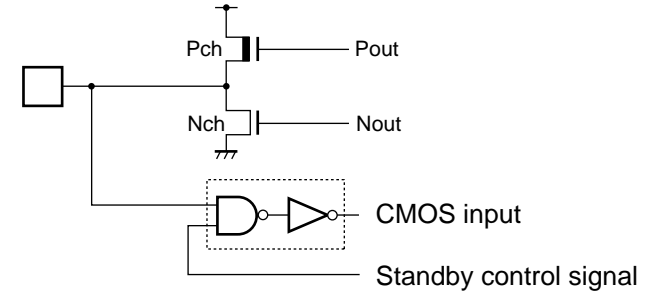
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Type	Circuit	Remarks
G	Pch — Pout, Nch — Nout — Open drain control signal; Hysteresis input; Standby control signal	• CMOS output • CMOS hysteresis input (With input interception function at standby) With open drain control signal
H	R, CTL, Pch — Pout, Nch — Nout — CMOS input; Standby control signal	• CMOS output • CMOS input (With input interception function at standby) • With input pull-up register control
I	Pch — Pout, Nch — Nout — Hysteresis input; Standby control signal; A/D converter analog input	• CMOS output • CMOS hysteresis input (With input interception function at standby) • Analog input (The A/D converter analog input is enabled when the corresponding bit in the analog input enable register (ADER) is 1.) Notes: • Because the output of the I/O port and the output of internal resources are used combinedly, one output buffer is shared. • Because the input of the I/O port and the input of internal resources are used combinedly, one input buffer is shared.
J	Pch, Nch, Pch, Nch — AVRH input; A/D converter analog input enable signal	• A/D converter (AVRH) voltage input pin

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Type	Circuit	Remarks
K	D⁺ / D⁻ circuit with outputs: D + input, D - input, Differential input, Full D + output, Full D - output, Low D + output, Low D - output, Direction, Speed	• USB I/O pin
L	Pch/Pout, Nch/Nout circuit with CMOS input and Standby control signal	• CMOS output • CMOS input • With standby control

■ HANDLING DEVICES

1. Preventing latchup and turning on power supply

Latchup may occur on CMOS IC under the following conditions:

- If a voltage higher than V_{CC} or lower than V_{SS} is applied to input and output pins.
- A voltage higher than the rated voltage is applied between V_{CC} and V_{SS}.
- If the AV_{CC} power supply is turned on before the V_{CC} voltage.

Ensure that you apply a voltage to the analog power supply at the same time as V_{CC} or after you turn on the digital power supply (when you perform power-off, turn off the analog power supply first or at the same time as V_{CC} and the digital power supply).

If latch-up occurs, the supply current increases rapidly, sometimes resulting in thermal breakdown of the device. Use meticulous care not to let any voltage exceed the maximum rating.

2. Treatment of unused pins

Leaving unused input pins unconnected can cause abnormal operation or latchup, leading to permanent damage. Unused input pins should always be pulled up or down through resistance of at least 2 kΩ. Any unused input/output pins may be set to output mode and left open, or set to input mode and treated the same as unused input pins. If there is unused output pin, make it to open.

3. Treatment of power supply pins on models with A/D converters

Even when the A/D converters are not in use, be sure to make the necessary connections AV_{CC} = AVRH = V_{CC}, and AV_{SS} = V_{SS}.

4. About the attention when the external clock is used
• Using external clock
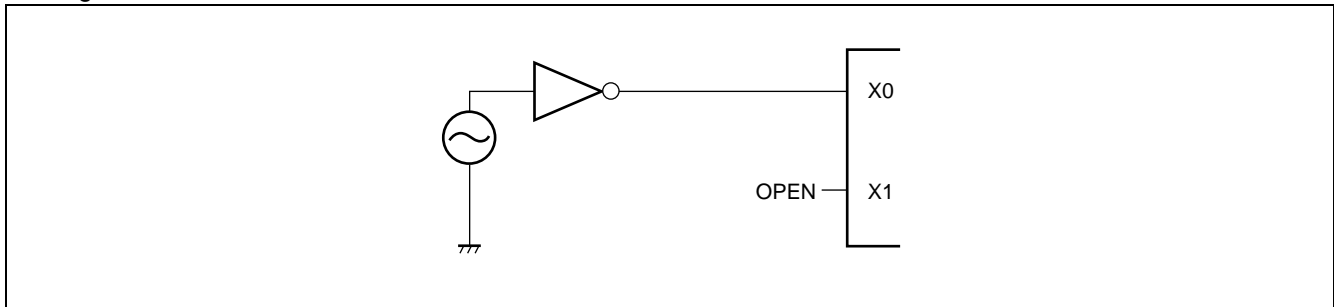
5. Treatment of power supply pins (V_{CC}/V_{SS})

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.

6. About Crystal oscillator circuit

Noise near the X0/X1 pins and X0A/X1A pins may cause the device to malfunction. Design the printed circuit board so that X0/X1 pins and X0A/X1A pins, the crystal oscillator (or the 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 pins and X0A/X1A pins surrounded by ground plane because stable operation can be expected with such a layout.

7. **Caution on Operations during PLL Clock Mode**

Even if the oscillator comes off or the clock input stops with the PLL clock selected for this microcontroller, the microcontroller may continue to operate at the free-running frequency of the PLL internal automatic oscillator circuit. Performance of this operation, however, cannot be guaranteed.

8. **Stabilization of supply voltage**

A sudden change in the supply voltage may cause the device to malfunction even within the V_{CC} supply voltage operating range. For stabilization reference, the supply voltage should be stabilized so that V_{CC} ripple variations (peak-to-peak value) at commercial frequencies (50 MHz to 60 MHz) fall below 10% of the standard V_{CC} supply voltage and the transient regulation does not exceed 0.1 V/ms at temporary changes such as power supply switching.

9. **When the dual-supply is used as a single-supply device**

If you are using only a single-system of the MB90330 series that come in the dual-system product, use it with X0A = VSS : X1A = OPEN.
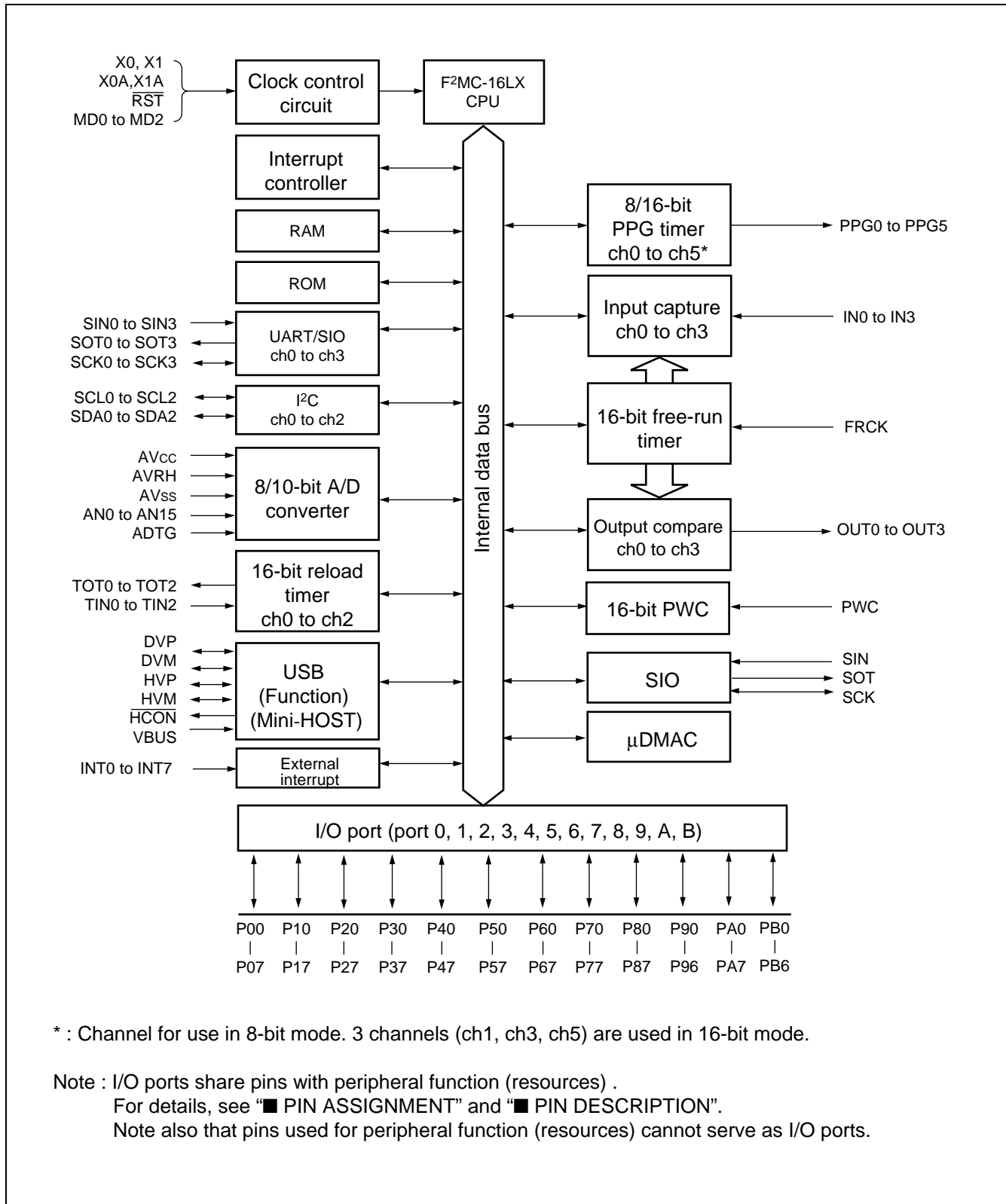
10. **Writing to flash memory**

For serial writing to flash memory, always make sure that the operating voltage V_{CC} is between 3.13 V and 3.6 V.

For normal writing to flash memory, always make sure that the operating voltage V_{CC} is between 3.0 V and 3.6 V.
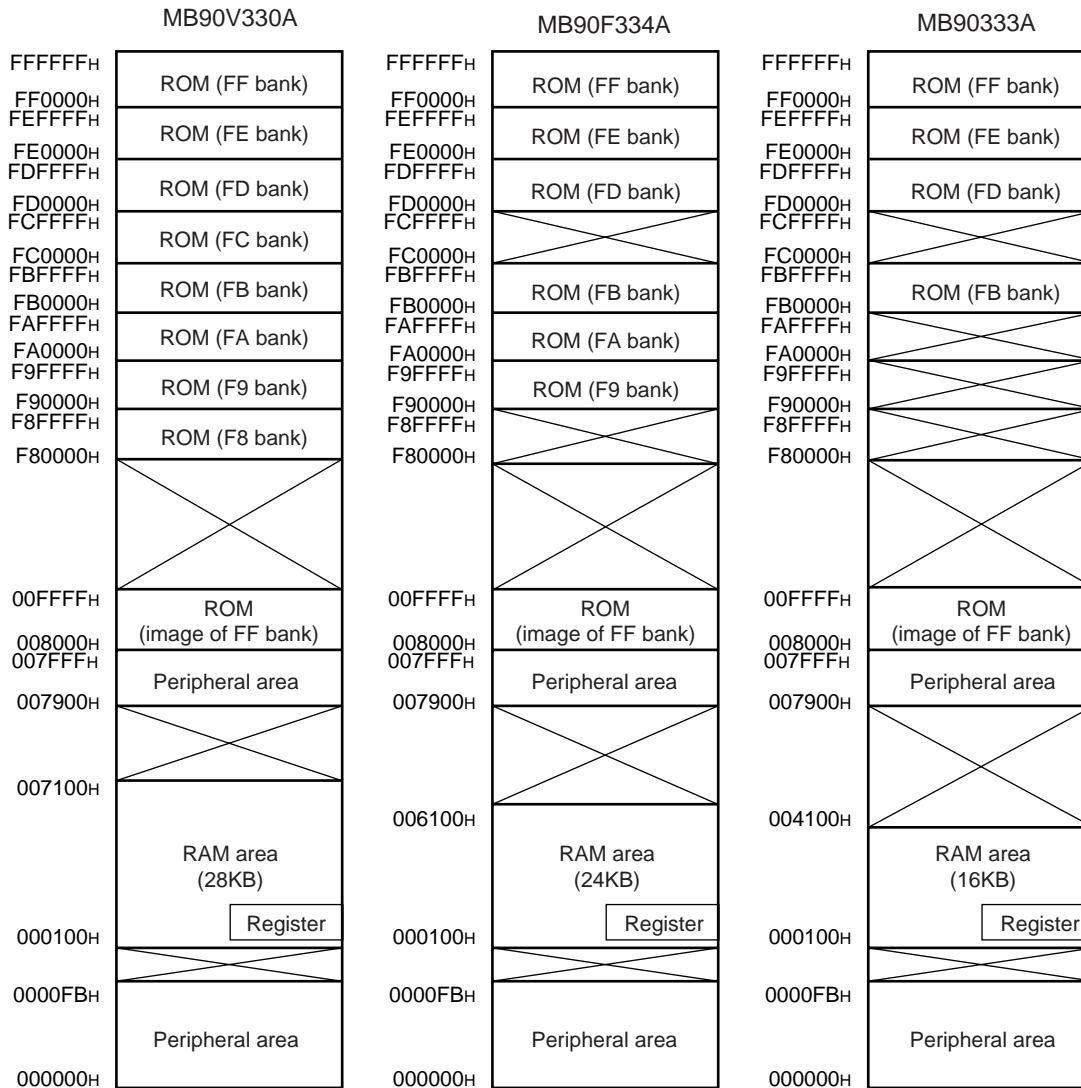
■ BLOCK DIAGRAM

* : Channel for use in 8-bit mode. 3 channels (ch1, ch3, ch5) are used in 16-bit mode.

Note : I/O ports share pins with peripheral function (resources) .
For details, see "■ PIN ASSIGNMENT" and "■ PIN DESCRIPTION".
Note also that pins used for peripheral function (resources) cannot serve as I/O ports.

■ **MEMORY MAP**

Single chip mode (with ROM mirror function)

MB90V330A

Address	Region
FFFFFFH	ROM (FF bank)
FF0000H	
FEFFFFH	ROM (FE bank)
FE0000H	
FDFFFFH	ROM (FD bank)
FD0000H	
FCFFFFH	ROM (FC bank)
FC0000H	
FBFFFFH	ROM (FB bank)
FB0000H	
FAFFFFH	ROM (FA bank)
FA0000H	
F9FFFFH	ROM (F9 bank)
F90000H	
F8FFFFH	ROM (F8 bank)
F80000H	
00FFFFH	ROM (image of FF bank)
008000H	
007FFFH	Peripheral area
007900H	
007100H	
	RAM area (28KB)
	Register
000100H	
0000FBH	
	Peripheral area
000000H	

MB90F334A

Address	Region
FFFFFFH	ROM (FF bank)
FF0000H	
FEFFFFH	ROM (FE bank)
FE0000H	
FDFFFFH	ROM (FD bank)
FD0000H	
FCFFFFH	
FC0000H	
FBFFFFH	ROM (FB bank)
FB0000H	
FAFFFFH	ROM (FA bank)
FA0000H	
F9FFFFH	ROM (F9 bank)
F90000H	
F8FFFFH	
F80000H	
00FFFFH	ROM (image of FF bank)
008000H	
007FFFH	Peripheral area
007900H	
006100H	
	RAM area (24KB)
	Register
000100H	
0000FBH	
	Peripheral area
000000H	

MB90333A

Address	Region
FFFFFFH	ROM (FF bank)
FF0000H	
FEFFFFH	ROM (FE bank)
FE0000H	
FDFFFFH	ROM (FD bank)
FD0000H	
FCFFFFH	
FC0000H	
FBFFFFH	ROM (FB bank)
FB0000H	
FAFFFFH	
FA0000H	
F9FFFFH	
F90000H	
F8FFFFH	
F80000H	
00FFFFH	ROM (image of FF bank)
008000H	
007FFFH	Peripheral area
007900H	
004100H	
	RAM area (16KB)
	Register
000100H	
0000FBH	
	Peripheral area
000000H	

Memory map of MB90330 series (1/3)

Internal ROM external bus mode (with ROM mirror function)

MB90V330A

FFFFFFH	ROM (FF bank)
FF0000H	
FEFFFFH	ROM (FE bank)
FE0000H	
FDFFFFH	ROM (FD bank)
FD0000H	
FCFFFFH	ROM (FC bank)
FC0000H	
FBFFFFH	ROM (FB bank)
FB0000H	
FAFFFFH	ROM (FA bank)
FA0000H	
F9FFFFH	ROM (F9 bank)
F90000H	
F8FFFFH	ROM (F8 bank)
F80000H	
	External area
00FFFFH	ROM (image of FF bank)
008000H	
007FFFH	Peripheral area
007900H	
	External area
007100H	
	RAM area (28KB)
	Register
000100H	
0000FBH	
	Peripheral area
000000H	

MB90F334A

FFFFFFH	ROM (FF bank)
FF0000H	
FEFFFFH	ROM (FE bank)
FE0000H	
FDFFFFH	ROM (FD bank)
FD0000H	
FCFFFFH	*1
FC0000H	
FBFFFFH	ROM (FB bank)
FB0000H	
FAFFFFH	ROM (FA bank)
FA0000H	
F9FFFFH	ROM (F9 bank)
F90000H	
F8FFFFH	*1
F80000H	
	External area
00FFFFH	ROM (image of FF bank)
008000H	
007FFFH	Peripheral area
007900H	
	External area
006100H	
	RAM area (24KB)
	Register
000100H	
0000FBH	
	Peripheral area
000000H	

MB90333A

FFFFFFH	ROM (FF bank)
FF0000H	
FEFFFFH	ROM (FE bank)
FE0000H	
FDFFFFH	ROM (FD bank)
FD0000H	
FCFFFFH	*2
FC0000H	
FBFFFFH	ROM (FB bank)
FB0000H	
FAFFFFH	*2
FA0000H	
F9FFFFH	External area
F90000H	
F8FFFFH	External area
F80000H	
	External area
00FFFFH	ROM (image of FF bank)
008000H	
007FFFH	Peripheral area
007900H	
	External area
004100H	
	RAM area (16KB)
	Register
000100H	
0000FBH	
	Peripheral area
000000H	

*1 : In the area of F80000H to F8FFFFH and FC0000H to FCFFFFH at MB90F334, a value of "1" is read at read operating.

*2 : In the area of FA0000H to FAFFFFH and FC0000H to FCFFFFH at MB90333, a value of "1" is read at read operating.

Memory map of MB90330 series (2/3)

External ROM external bus mode

| MB90V330A | MB90F334A | MB90333A |
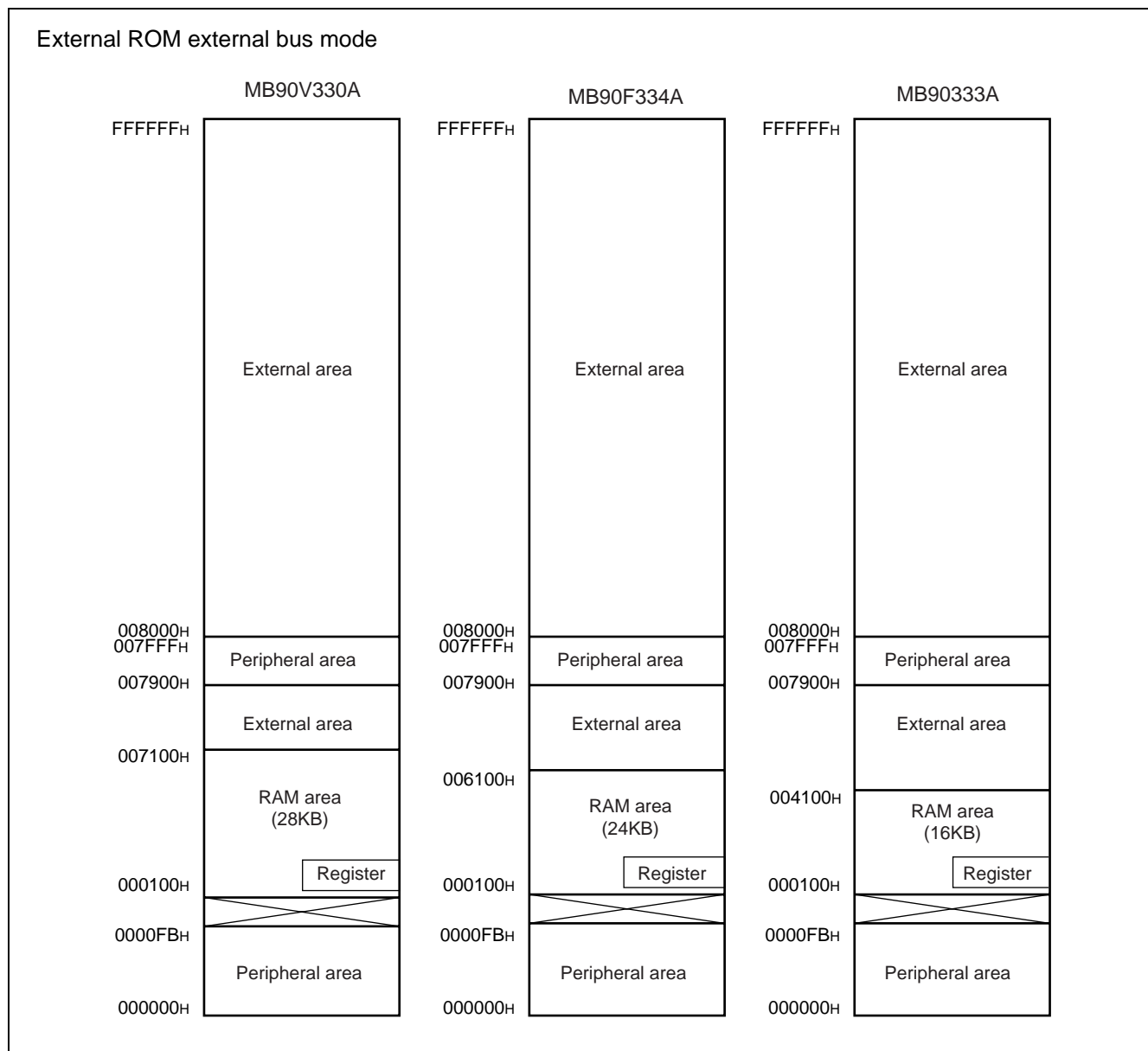
Memory map of MB90330 series (3/3)

Notes : • When the ROM mirror function register has been set, the mirror image data at higher addresses ("FF8000$_H$ to FFFFFF$_H$") of bank FF is visible from the higher addresses ("008000$_H$ to 00FFFF$_H$") of bank 00.

• The ROM mirror function is effective for using the C compiler small model.

• The lower 16-bit addresses of bank FF are equivalent to those of bank 00. Since the ROM area in bank FF exceeds 48 KB, however, the mirror image of all the data in the ROM area cannot be reproduced in bank 00.

• When the C compiler small model is used, the data table mirror image can be shown at "008000$_H$ to 00FFFF$_H$" by storing the data table at "FF8000$_H$ to FFFFFF$_H$". Therefore, data tables in the ROM area can be referred without declaring the far addressing with the pointer.

■ F2MC-16L CPU PROGRAMMING MODEL

• Dedicated register

AH	AL	Accumulator
	USP	User stack pointer
	SSP	System stack pointer
	PS	Processor status
	PC	Program counter
	DPR	Direct page register
	PCB	Program bank register
	DTB	Data bank register
	USB	User stack bank register
	SSB	System stack bank register
	ADB	Additional data bank register

8-bit

16-bit

32-bit
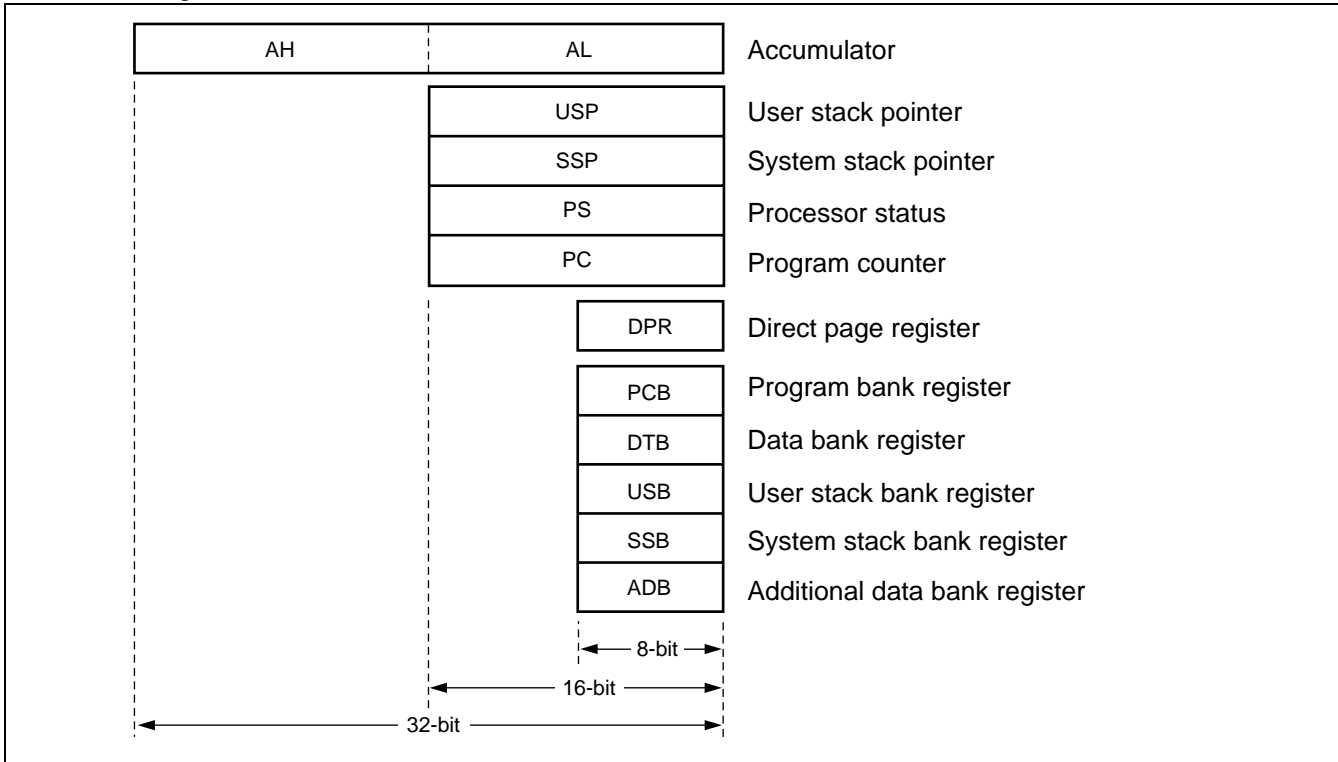
• General purpose register

MSB   16-bit   LSB

$000180_H + RP \times 10_H$

RW0		RL0
RW1		
RW2		RL1
RW3		
R1 / R0	RW4	RL2
R3 / R2	RW5	
R5 / R4	RW6	RL3
R7 / R6	RW7	

• Processor status

Bit 15 ←→ 13 12 ←————→ 8 7 ←————————→ 0

PS	ILM	RP	CCR
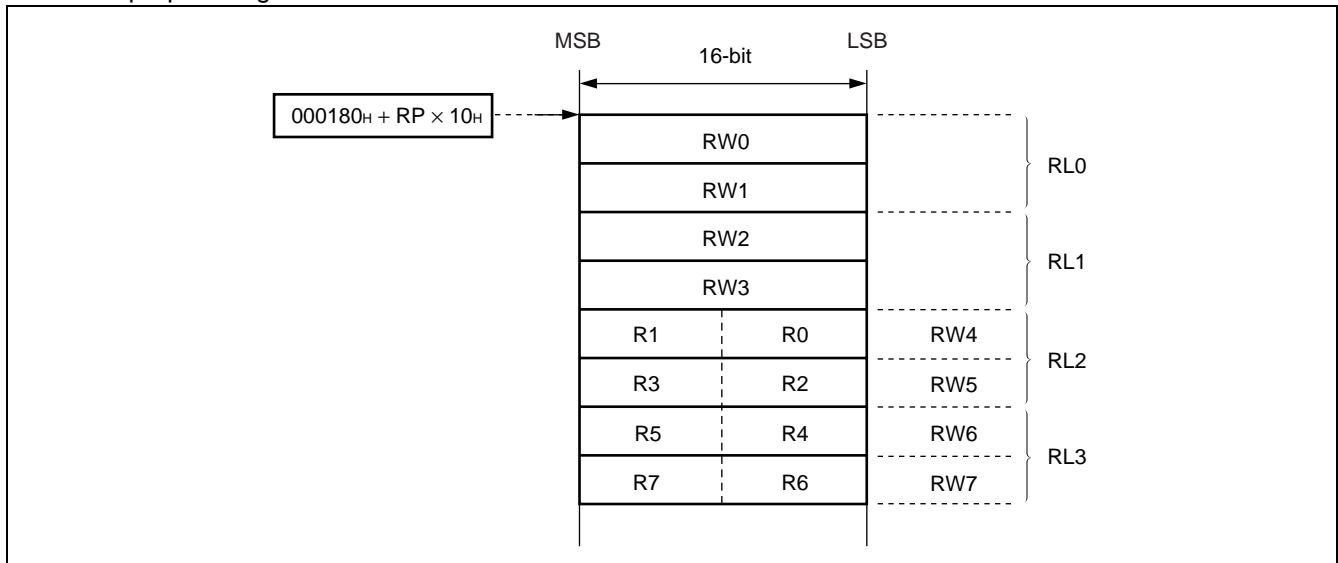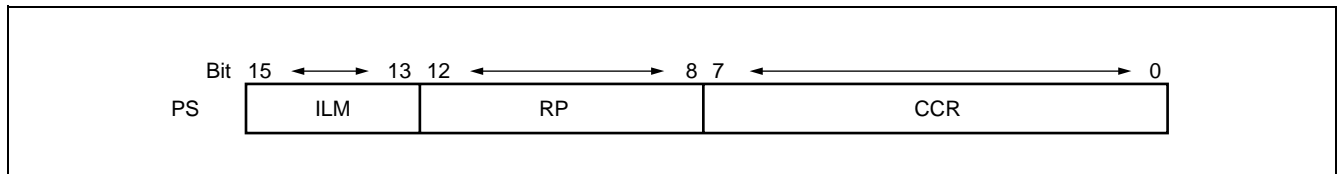
MB90330 Series

■ I/O MAP

Address	Register abbreviation	Register	Read/Write	Resource name	Initial Value
000000$_H$	PDR0	Port 0 Data Register	R/W	Port 0	XXXXXXXX$_B$
000001$_H$	PDR1	Port 1 Data Register	R/W	Port 1	XXXXXXXX$_B$
000002$_H$	PDR2	Port 2 Data Register	R/W	Port 2	XXXXXXXX$_B$
000003$_H$	PDR3	Port 3 Data Register	R/W	Port 3	XXXXXXXX$_B$
000004$_H$	PDR4	Port 4 Data Register	R/W	Port 4	XXXXXXXX$_B$
000005$_H$	PDR5	Port 5 Data Register	R/W	Port 5	XXXXXXXX$_B$
000006$_H$	PDR6	Port 6 Data Register	R/W	Port 6	XXXXXXXX$_B$
000007$_H$	PDR7	Port 7 Data Register	R/W	Port 7	XXXXXXXX$_B$
000008$_H$	PDR8	Port 8 Data Register	R/W	Port 8	XXXXXXXX$_B$
000009$_H$	PDR9	Port 9 Data Register	R/W	Port 9	- XXXXXXX$_B$
00000A$_H$	PDRA	Port A Data Register	R/W	Port A	XXXXXXXX$_B$
00000B$_H$		Prohibited			
00000C$_H$	PDRB	Port B Data Register	R/W	Port B	- XXXXXXX$_B$
00000D$_H$	DDRB	Port B Direction Register	R/W	Port B	- 0 0 0 0 0 0 0$_B$
00000E$_H$		Prohibited			
00000F$_H$					
000010$_H$	DDR0	Port 0 Direction Register	R/W	Port 0	0 0 0 0 0 0 0 0$_B$
000011$_H$	DDR1	Port 1 Direction Register	R/W	Port 1	0 0 0 0 0 0 0 0$_B$
000012$_H$	DDR2	Port 2 Direction Register	R/W	Port 2	0 0 0 0 0 0 0 0$_B$
000013$_H$	DDR3	Port 3 Direction Register	R/W	Port 3	0 0 0 0 0 0 0 0$_B$
000014$_H$	DDR4	Port 4 Direction Register	R/W	Port 4	0 0 0 0 0 0 0 0$_B$
000015$_H$	DDR5	Port 5 Direction Register	R/W	Port 5	0 0 0 0 0 0 0 0$_B$
000016$_H$	DDR6	Port 6 Direction Register	R/W	Port 6	0 0 0 0 0 0 0 0$_B$
000017$_H$	DDR7	Port 7 Direction Register	R/W	Port 7	0 0 0 0 0 0 0 0$_B$
000018$_H$	DDR8	Port 8 Direction Register	R/W	Port 8	0 0 0 0 0 0 0 0$_B$
000019$_H$	DDR9	Port 9 Direction Register	R/W	Port 9	- 0 0 0 0 0 0 0$_B$
00001A$_H$	DDRA	Port A Direction Register	R/W	Port A	0 0 0 0 0 0 0 0$_B$
00001B$_H$	ODR4	Port 4 Output Pin Register	R/W	Port 4 (open drain control)	0 0 0 0 0 0 0 0$_B$
00001C$_H$	RDR0	Port 0 Pull-up Resistance Register	R/W	Port 0 (PULL-UP)	0 0 0 0 0 0 0 0$_B$
00001D$_H$	RDR1	Port 1 Pull-up Resistance Register	R/W	Port 1 (PULL-UP)	0 0 0 0 0 0 0 0$_B$
00001E$_H$	ADER0	Analog Input Enable Register 0	R/W	Port 7, 8, A/D	1 1 1 1 1 1 1 1$_B$
00001F$_H$	ADER1	Analog Input Enable Register 1	R/W	Port 7, 8, A/D	1 1 1 1 1 1 1 1$_B$
000020$_H$	SMR0	Serial Mode Register ch0	R/W	UART0	0 0 1 0 0 0 0 0$_B$
000021$_H$	SCR0	Serial Control Register ch0	R/W		0 0 0 0 0 1 0 0$_B$
000022$_H$	SIDR0	Serial Input Data Register ch0	R		XXXXXXXX$_B$
	SODR0	Serial Output Data Register ch0	W		
000023$_H$	SSR0	Serial Status Register ch0	R/W		0 0 0 0 1 0 0 0$_B$
000024$_H$	UTRLR0	UART Prescaler Reload Register ch0	R/W	Communication Prescaler (UART0)	0 0 0 0 0 0 0 0$_B$
000025$_H$	UTCR0	UART Prescaler Control Register ch0	R/W		0 0 0 0 - 0 0 0$_B$

(Continued)

Address	Register abbreviation	Register	Read/Write	Resource name	Initial Value
000026_H	SMR1	Serial Mode Register ch1	R/W	UART1	$0\ 0\ 1\ 0\ 0\ 0\ 0\ 0_B$
000027_H	SCR1	Serial Control Register ch1	R/W		$0\ 0\ 0\ 0\ 0\ 1\ 0\ 0_B$
000028_H	SIDR1	Serial Input Data Register ch1	R		$XXXXXXXX_B$
	SODR1	Serial Output Data Register ch1	W		
000029_H	SSR1	Serial Status Register ch1	R/W		$0\ 0\ 0\ 0\ 1\ 0\ 0\ 0_B$
$00002A_H$	UTRLR1	UART Prescaler Reload Register ch1	R/W	Communication Prescaler (UART1)	$0\ 0\ 0\ 0\ 0\ 0\ 0\ 0_B$
$00002B_H$	UTCR1	UART Prescaler Control Register ch1	R/W		$0\ 0\ 0\ 0\ \text{-}\ 0\ 0\ 0_B$
$00002C_H$	SMR2	Serial Mode Register ch2	R/W	UART2	$0\ 0\ 1\ 0\ 0\ 0\ 0\ 0_B$
$00002D_H$	SCR2	Serial Control Register ch2	R/W		$0\ 0\ 0\ 0\ 0\ 1\ 0\ 0_B$
$00002E_H$	SIDR2	Serial Input Data Register ch2	R		$XXXXXXXX_B$
	SODR2	Serial Output Data Register ch2	W		
$00002F_H$	SSR2	Serial Status Register ch2	R/W		$0\ 0\ 0\ 0\ 1\ 0\ 0\ 0_B$
000030_H	UTRLR2	UART Prescaler Reload Register ch2	R/W	Communication Prescaler (UART2)	$0\ 0\ 0\ 0\ 0\ 0\ 0\ 0_B$
000031_H	UTCR2	UART Prescaler Control Register ch2	R/W		$0\ 0\ 0\ 0\ \text{-}\ 0\ 0\ 0_B$
000032_H	SMR3	Serial Mode Register ch3	R/W	UART3	$0\ 0\ 1\ 0\ 0\ 0\ 0\ 0_B$
000033_H	SCR3	Serial Control Register ch3	R/W		$0\ 0\ 0\ 0\ 0\ 1\ 0\ 0_B$
000034_H	SIDR3	Serial Input Data Register ch3	R		$XXXXXXXX_B$
	SODR3	Serial Output Data Register ch3	W		
000035_H	SSR3	Serial Status Register ch3	R/W		$0\ 0\ 0\ 0\ 1\ 0\ 0\ 0_B$
000036_H	UTRLR3	UART Prescaler Reload Register ch3	R/W	Communication Prescaler (UART3)	$0\ 0\ 0\ 0\ 0\ 0\ 0\ 0_B$
000037_H	UTCR3	UART Prescaler Control Register ch3	R/W		$0\ 0\ 0\ 0\ \text{-}\ 0\ 0\ 0_B$
000038_H to $00003B_H$		Prohibited			
$00003C_H$	ENIR	DTP/Interrupt Enable Register	R/W	DTP/External Interrupt	$0\ 0\ 0\ 0\ 0\ 0\ 0\ 0_B$
$00003D_H$	EIRR	DTP/Interrupt Source Register	R/W		$0\ 0\ 0\ 0\ 0\ 0\ 0\ 0_B$
$00003E_H$	ELVR	Request Level Setting Register Lower	R/W		$0\ 0\ 0\ 0\ 0\ 0\ 0\ 0_B$
$00003F_H$		Request Level Setting Register Upper	R/W		$0\ 0\ 0\ 0\ 0\ 0\ 0\ 0_B$
000040_H	ADCS0	A/D Control Status Register Lower	R/W	8/10-bit A/D Converter	$0\ 0\ \text{-}\ \text{-}\ \text{-}\ \text{-}\ \text{-}\ 0_B$
000041_H	ADCS1	A/D Control Status Register Upper	R/W		$0\ 0\ 0\ 0\ 0\ 0\ 0\ 0_B$
000042_H	ADCR0	A/D Data Register Lower	R/W		$XXXXXXXX_B$
000043_H	ADCR1	A/D Data Register Upper	R/W		$0\ 0\ 1\ 0\ 1\ XXX_B$
000044_H		Prohibited			
000045_H	ADMR	A/D Conversion Channel Selection Register	R/W	8/10-bit A/D Converter	$0\ 0\ 0\ 0\ 0\ 0\ 0\ 0_B$
000046_H	PPGC0	PPG0 Operation Mode Control Register	R/W	PPG ch0	$0X0\ 0\ 0XX1_B$
000047_H	PPGC1	PPG1 Operation Mode Control Register	R/W	PPG ch1	$0X0\ 0\ 0\ 0\ 0\ 1_B$
000048_H	PPGC2	PPG2 Operation Mode Control Register	R/W	PPG ch2	$0X0\ 0\ 0XX1_B$

(Continued)

Address	Register abbreviation	Register	Read/Write	Resource name	Initial Value
000049H	PPGC3	PPG3 Operation Mode Control Register	R/W	PPG ch3	0X0 0 0 0 0 1B
00004AH	PPGC4	PPG4 Operation Mode Control Register	R/W	PPG ch4	0X0 0 0XX1B
00004BH	PPGC5	PPG5 Operation Mode Control Register	R/W	PPG ch5	0X0 0 0 0 0 1B
00004CH	PPG01	PPG0 and PPG1 Output Control Register	R/W	PPG ch0/1	0 0 0 0 0 0XXB
00004DH	Prohibited				
00004EH	PPG23	PPG2 and PPG3 Output Control Register	R/W	PPG ch2/3	0 0 0 0 0 0 XXB
00004FH	Prohibited				
000050H	PPG45	PPG4 and PPG5 Output Control Register	R/W	PPG ch4/5	0 0 0 0 0 0 XXB
000051H	Prohibited				
000052H	ICS01	Input Capture Control Status Register 01	R/W	Input Capture ch0/1	0 0 0 0 0 0 0 0B
000053H	ICS23	Input Capture Control Status Register 23	R/W	Input Capture ch2/3	0 0 0 0 0 0 0 0B
000054H	OCS0	Output Compare Control Register ch0 Lower	R/W	Output Compare ch0/1	0 0 0 0 - - 0 0B
000055H	OCS1	Output Compare Control Register ch1 Upper	R/W		- - - 0 0 0 0 0B
000056H	OCS2	Output Compare Control Register ch2 Lower	R/W	Output Compare ch2/3	0 0 0 0 - - 0 0B
000057H	OCS3	Output Compare Control Register ch3 Upper	R/W		- - - 0 0 0 0 0B
000058H	SMCS	Serial Mode Control Status Register	R/W	Extended Serial I/O	XXXX0 0 0 0B
000059H					0 0 0 0 0 0 1 0B
00005AH	SDR	Serial Data Register	R/W		XXXXXXXXB
00005BH	SDCR	Communication Prescaler Control Register	R/W	Communication Prescaler	0XXX0 0 0 0B
00005CH	PWCSR	PWC Control Status Register	R/W	16-bit PWC Timer	0 0 0 0 0 0 0 0B
00005DH					0 0 0 0 0 0 0 XB
00005EH	PWCR	PWC Data Buffer Register	R/W		0 0 0 0 0 0 0 0B
00005FH					0 0 0 0 0 0 0 0B
000060H	DIVR	PWC Dividing Ratio Register	R/W		- - - - - - 0 0B
000061H	Prohibited				
000062H	TMCSR0	Timer Control Status Register ch0	R/W	16-bit Reload Timer ch0	0 0 0 0 0 0 0 0B
000063H					XXXX 0 0 0 0B
000064H	TMR0	16-bit Timer Register ch0 Lower	R		XXXXXXXXB
	TMRLR0	16-bit Reload Register ch0 Lower	W		XXXXXXXXB
000065H	TMR0	16-bit Timer Register ch0 Upper	R		XXXXXXXXB
	TMRLR0	16-bit Reload Register ch0 Upper	W		XXXXXXXXB

(Continued)

Address	Register abbreviation	Register	Read/Write	Resource name	Initial Value
000066_H	TMCSR1	Timer Control Status Register ch1	R/W	16-bit Reload Timer ch1	$0\,0\,0\,0\,0\,0\,0\,0_B$
000067_H					$XXXX\,0\,0\,0\,0_B$
000068_H	TMR1	16-bit Timer Register ch1 Lower	R		$XXXXXXXX_B$
	TMRLR1	16-bit Reload Register ch1 Lower	W		$XXXXXXXX_B$
000069_H	TMR1	16-bit Timer Register ch1 Upper	R		$XXXXXXXX_B$
	TMRLR1	16-bit Reload Register ch1 Upper	W		$XXXXXXXX_B$
$00006A_H$	TMCSR2	Timer Control Status Register ch2	R/W	16-bit Reload Timer ch2	$0\,0\,0\,0\,0\,0\,0\,0_B$
$00006B_H$					$XXXX\,0\,0\,0\,0_B$
$00006C_H$	TMR2	16-bit Timer Register ch2 Lower	R		$XXXXXXXX_B$
	TMRLR2	16-bit Reload Register ch2 Lower	W		$XXXXXXXX_B$
$00006D_H$	TMR2	16-bit Timer Register ch2 Upper	R		$XXXXXXXX_B$
	TMRLR2	16-bit Reload Register ch2 Upper	W		$XXXXXXXX_B$
$00006E_H$	Prohibited				
$00006F_H$	ROMM	ROM Mirror Function Selection Register	W	ROM Mirror Function Selection Module	$- - - - - - 1\,1_B$
000070_H	IBSR0	I^{2}C Bus Status Register ch0	R	I^{2}C Bus Interface ch0	$0\,0\,0\,0\,0\,0\,0\,0_B$
000071_H	IBCR0	I^{2}C Bus Control Register ch0	R/W		$0\,0\,0\,0\,0\,0\,0\,0_B$
000072_H	ICCR0	I^{2}C Bus Clock Selection Register ch0	R/W		$XX\,0\,XXXXX_B$
000073_H	IADR0	I^{2}C Bus Address Register ch0	R/W		$XXXXXXXX_B$
000074_H	IDAR0	I^{2}C Bus Data Register ch0	R/W		$XXXXXXXX_B$
000075_H	Prohibited				
000076_H	IBSR1	I^{2}C Bus Status Register ch1	R	I^{2}C Bus Interface ch1	$0\,0\,0\,0\,0\,0\,0\,0_B$
000077_H	IBCR1	I^{2}C Bus Control Register ch1	R/W		$0\,0\,0\,0\,0\,0\,0\,0_B$
000078_H	ICCR1	I^{2}C Bus Clock Selection Register ch1	R/W		$XX\,0\,XXXXX_B$
000079_H	IADR1	I^{2}C Bus Address Register ch1	R/W		$XXXXXXXX_B$
$00007A_H$	IDAR1	I^{2}C Bus Data Register ch1	R/W		$XXXXXXXX_B$
$00007B_H$	Prohibited				
$00007C_H$	IBSR2	I^{2}C Bus Status Register ch2	R	I^{2}C Bus Interface ch2	$0\,0\,0\,0\,0\,0\,0\,0_B$
$00007D_H$	IBCR2	I^{2}C Bus Control Register ch2	R/W		$0\,0\,0\,0\,0\,0\,0\,0_B$
$00007E_H$	ICCR2	I^{2}C Bus Clock Selection Register ch2	R/W		$XX\,0\,XXXXX_B$
$00007F_H$	IADR2	I^{2}C Bus Address Register ch2	R/W		$XXXXXXXX_B$
000080_H	IDAR2	I^{2}C Bus Data Register ch2	R/W		$XXXXXXXX_B$
000081_H to 000085_H	Prohibited				

(Continued)

Address	Register abbreviation	Register	Read/Write	Resource name	Initial Value
000086H	TCDT	Timer Data Register Lower	R/W	16-bit Free-Run Timer	0 0 0 0 0 0 0 0B
000087H		Timer Data Register Upper	R/W		0 0 0 0 0 0 0 0B
000088H	TCCS	Timer Control Status Register Lower	R/W		0 0 0 0 0 0 0 0B
000089H		Timer Control Status Register Upper	R/W		0 - - 0 0 0 0 0B
00008AH	CPCLR	Compare Clear Register Lower	R/W		XXXXXXXXB
00008BH		Compare Clear Register Upper	R/W		XXXXXXXXB
00008CH to 00009AH		Prohibited			
00009BH	DCSR	DMA Descriptor Channel Specification Register	R/W	μDMAC	0 0 0 0 0 0 0 0B
00009CH	DSRL	DMA Status Register Lower	R/W		0 0 0 0 0 0 0 0B
00009DH	DSRH	DMA Status Register Upper	R/W		0 0 0 0 0 0 0 0B
00009EH	PACSR	Program Address Detection Control Status Register	R/W	Address Match Detection	0 0 0 0 0 0 0 0B
00009FH	DIRR	Delay Interruption Factor Generation/Release Register	R/W	Delay Interrupt	- - - - - - - 0B
0000A0H	LPMCR	Low Power Consumption Mode Register	R/W	Low Power Consumption Control Circuit	0 0 0 1 1 0 0 0B
0000A1H	CKSCR	Clock Selection Register	R/W	Clock	1 1 1 1 1 1 0 0B
0000A2H		Prohibited			
0000A3H					
0000A4H	DSSR	DMA Stop Status Register	R/W	μDMAC	0 0 0 0 0 0 0 0B
0000A5H	ARSR	Automatic Ready Function Selection Register	W	External Pin	0 0 1 1- - 0 0B
0000A6H	HACR	External Address Output Control Register	W		* * * * * * * * B
0000A7H	EPCR	Bus Control Signal Control Register	W		1 0 0 0 * 1 0 -B
0000A8H	WDTC	Watchdog Control Register	R/W	Watchdog Timer	X - XXX 1 1 1B
0000A9H	TBTC	Time-base Timer Control Register	R/W	Time-base Timer	1 - - 0 0 1 0 0B
0000AAH	WTC	Watch Timer Control Register	R/W	Watch Timer	1 0 0 0 1 0 0 0B
0000ABH		Prohibited			
0000ACH	DERL	DMA Enable Register Lower	R/W	μDMAC	0 0 0 0 0 0 0 0B
0000ADH	DERH	DMA Enable Register Upper	R/W		0 0 0 0 0 0 0 0B
0000AEH	FMCR	Flash Memory Control Status Register	R/W	Flash Memory I/F	0 0 0 X 0 0 0 0B
0000AFH		Prohibited			

(Continued)

Address	Register abbreviation	Register	Read/ Write	Resource name	Initial Value
0000B0H	ICR00	Interrupt Control Register 00	R/W		0 0 0 0 0 1 1 1B
0000B1H	ICR01	Interrupt Control Register 01	R/W		0 0 0 0 0 1 1 1B
0000B2H	ICR02	Interrupt Control Register 02	R/W		0 0 0 0 0 1 1 1B
0000B3H	ICR03	Interrupt Control Register 03	R/W		0 0 0 0 0 1 1 1B
0000B4H	ICR04	Interrupt Control Register 04	R/W		0 0 0 0 0 1 1 1B
0000B5H	ICR05	Interrupt Control Register 05	R/W		0 0 0 0 0 1 1 1B
0000B6H	ICR06	Interrupt Control Register 06	R/W		0 0 0 0 0 1 1 1B
0000B7H	ICR07	Interrupt Control Register 07	R/W	Interrupt Controller	0 0 0 0 0 1 1 1B
0000B8H	ICR08	Interrupt Control Register 08	R/W		0 0 0 0 0 1 1 1B
0000B9H	ICR09	Interrupt Control Register 09	R/W		0 0 0 0 0 1 1 1B
0000BAH	ICR10	Interrupt Control Register 10	R/W		0 0 0 0 0 1 1 1B
0000BBH	ICR11	Interrupt Control Register 11	R/W		0 0 0 0 0 1 1 1B
0000BCH	ICR12	Interrupt Control Register 12	R/W		0 0 0 0 0 1 1 1B
0000BDH	ICR13	Interrupt Control Register 13	R/W		0 0 0 0 0 1 1 1B
0000BEH	ICR14	Interrupt Control Register 14	R/W		0 0 0 0 0 1 1 1B
0000BFH	ICR15	Interrupt Control Register 15	R/W		0 0 0 0 0 1 1 1B
0000C0H	HCNT0	USB Host Control Register 0	R/W		0 0 0 0 0 0 0 0B
0000C1H	HCNT1	USB Host Control Register 1	R/W		0 0 0 0 0 0 0 1B
0000C2H	HIRQ	USB Host Interruption Register	R/W		0 0 0 0 0 0 0 0B
0000C3H	HERR	USB Host Error Status Register	R/W		0 0 0 0 0 0 1 1B
0000C4H	HSTATE	USB Host State Status Register	R/W		XX 0 1 0 0 1 0B
0000C5H	HFCOMP	USB SOF Interrupt FRAME Compare Register	R/W		0 0 0 0 0 0 0 0B
0000C6H		USB Retry Timer Setting Register 0	R/W		0 0 0 0 0 0 0 0B
0000C7H	HRTIMER	USB Retry Timer Setting Register 1	R/W	USB Mini-HOST	0 0 0 0 0 0 0 0B
0000C8H		USB Retry Timer Setting Register 2	R/W		XXXXXX 0 0B
0000C9H	HADR	USB Host Address Register	R/W		X 0 0 0 0 0 0 0B
0000CAH	HEOF	USB EOF Setting Register 0	R/W		0 0 0 0 0 0 0 0B
0000CBH		USB EOF Setting Register 1	R/W		XX 0 0 0 0 0 0B
0000CCH	HFRAME	USB FRAME Setting Register 0	R/W		0 0 0 0 0 0 0 0B
0000CDH		USB FRAME Setting Register 1	R/W		XXXXX 0 0 0B
0000CEH	HTOKEN	USB Host Token End Point Register	R/W		0 0 0 0 0 0 0 0B
0000CFH	Prohibited				
0000D0H	UDCC	UDC Control Register	R/W	USB Function	1 0 1 0 0 0 0 0B
0000D1H	Prohibited				

(Continued)

Address	Register abbreviation	Register	Read/Write	Resource name	Initial Value
0000D2H	EP0C	EP0 Control Register	R/W		X 1 0 0 0 0 0 0B
0000D3H			R/W		XXXX 0 0 0 XB
0000D4H	EP1C	EP1 Control Register	R/W		0 0 0 0 0 0 0 0B
0000D5H			R/W		0 1 1 0 0 0 0 1B
0000D6H	EP2C	EP2 Control Register	R/W		0 1 0 0 0 0 0 0B
0000D7H			R/W		0 1 1 0 0 0 0 0B
0000D8H	EP3C	EP3 Control Register	R/W		0 1 0 0 0 0 0 0B
0000D9H			R/W		0 1 1 0 0 0 0 0B
0000DAH	EP4C	EP4 Control Register	R/W		0 1 0 0 0 0 0 0B
0000DBH			R/W		0 1 1 0 0 0 0 0B
0000DCH	EP5C	EP5 Control Register	R/W		0 1 0 0 0 0 0 0B
0000DDH			R/W		0 1 1 0 0 0 0 0B
0000DEH	TMSP	Time Stamp Register	R		0 0 0 0 0 0 0 0B
0000DFH			R/W		0 0 0 0 0 0 0 0B
0000E0H	UDCS	UDC Status Register	R/W		0 0 0 0 0 0 0 0B
0000E1H	UDCIE	UDC Interrupt Enable Register	R/W		0 0 0 0 0 0 0 0B
0000E2H	EP0IS	EP0I Status Register	R/W		XXXXXXXXB
0000E3H			R/W		1 0 XXX 1 XXB
0000E4H	EP0OS	EP0O Status Register	R/W	USB Function	XXXXXXXXB
0000E5H			R/W		1 0 0 XX 0 0 XB
0000E6H	EP1S	EP1 Status Register	R		XXXXXXXXB
0000E7H			R/W		1 0 0 0 0 0 0 XB
0000E8H	EP2S	EP2 Status Register	R		XXXXXXXXB
0000E9H			R/W		1 0 0 0 0 0 0 XB
0000EAH	EP3S	EP3 Status Register	R		XXXXXXXXB
0000EBH			R/W		1 0 0 0 0 0 0 XB
0000ECH	EP4S	EP4 Status Register	R		XXXXXXXXB
0000EDH			R/W		1 0 0 0 0 0 0 XB
0000EEH	EP5S	EP5 Status Register	R		XXXXXXXXB
0000EFH			R/W		1 0 0 0 0 0 0 XB
0000F0H	EP0DT	EP0 Data Register	R/W		XXXXXXXXB
0000F1H			R/W		XXXXXXXXB
0000F2H	EP1DT	EP1 Data Register	R/W		XXXXXXXXB
0000F3H			R/W		XXXXXXXXB
0000F4H	EP2DT	EP2 Data Register	R/W		XXXXXXXXB
0000F5H			R/W		XXXXXXXXB
0000F6H	EP3DT	EP3 Data Register	R/W		XXXXXXXXB
0000F7H			R/W		XXXXXXXXB

(Continued)

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Address	Register abbreviation	Register	Read/Write	Resource name	Initial Value
0000F8$_H$	EP4DT	EP4 Data Register	R/W	USB Function	XXXXXXXX$_B$
0000F9$_H$			R/W		XXXXXXXX$_B$
0000FA$_H$	EP5DT	EP5 Data Register	R/W		XXXXXXXX$_B$
0000FB$_H$			R/W		XXXXXXXX$_B$
0000FC$_H$ to 0000FF$_H$	Prohibited				
000100$_H$ to #$_H$	RAM Area				
001FF0$_H$	PADR0	Program Address Detection Register ch0 Lower	R/W	Address Match Detection	XXXXXXXX$_B$
001FF1$_H$		Program Address Detection Register ch0 Middle	R/W		XXXXXXXX$_B$
001FF2$_H$		Program Address Detection Register ch0 Upper	R/W		XXXXXXXX$_B$
001FF3$_H$	PADR1	Program Address Detection Register ch1 Lower	R/W		XXXXXXXX$_B$
001FF4$_H$		Program Address Detection Register ch1 Middle	R/W		XXXXXXXX$_B$
001FF5$_H$		Program Address Detection Register ch1 Upper	R/W		XXXXXXXX$_B$
#$_H$ to 0078FF$_H$	Unused Area				
007900$_H$	PRLL0	PPG Reload Register Lower ch0	R/W	PPG ch0	XXXXXXXX$_B$
007901$_H$	PRLH0	PPG Reload Register Upper ch0	R/W		XXXXXXXX$_B$
007902$_H$	PRLL1	PPG Reload Register Lower ch1	R/W	PPG ch1	XXXXXXXX$_B$
007903$_H$	PRLH1	PPG Reload Register Upper ch1	R/W		XXXXXXXX$_B$
007904$_H$	PRLL2	PPG Reload Register Lower ch2	R/W	PPG ch2	XXXXXXXX$_B$
007905$_H$	PRLH2	PPG Reload Register Upper ch2	R/W		XXXXXXXX$_B$
007906$_H$	PRLL3	PPG Reload Register Lower ch3	R/W	PPG ch3	XXXXXXXX$_B$
007907$_H$	PRLH3	PPG Reload Register Upper ch3	R/W		XXXXXXXX$_B$
007908$_H$	PRLL4	PPG Reload Register Lower ch4	R/W	PPG ch4	XXXXXXXX$_B$
007909$_H$	PRLH4	PPG Reload Register Upper ch4	R/W		XXXXXXXX$_B$
00790A$_H$	PRLL5	PPG Reload Register Lower ch5	R/W	PPG ch5	XXXXXXXX$_B$
00790B$_H$	PRLH5	PPG Reload Register Upper ch5	R/W		XXXXXXXX$_B$
00790C$_H$ to 00790F$_H$	Prohibited				

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MB90330 Series

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Address	Register abbreviation	Register	Read/ Write	Resource name	Initial Value
007910_H	IPCP0	Input Capture Data Register Lower ch0	R	Input Capture ch0/1	$XXXXXXXX_B$
007911_H		Input Capture Data Register Upper ch0	R		$XXXXXXXX_B$
007912_H	IPCP1	Input Capture Data Register Lower ch1	R		$XXXXXXXX_B$
007913_H		Input Capture Data Register Upper ch1	R		$XXXXXXXX_B$
007914_H	IPCP2	Input Capture Data Register Lower ch2	R	Input Capture ch2/3	$XXXXXXXX_B$
007915_H		Input Capture Data Register Upper ch2	R		$XXXXXXXX_B$
007916_H	IPCP3	Input Capture Data Register Lower ch3	R		$XXXXXXXX_B$
007917_H		Input Capture Data Register Upper ch3	R		$XXXXXXXX_B$
007918_H	OCCP0	Output Compare Register Lower ch0	R/W	Output Compare ch0/1	$XXXXXXXX_B$
007919_H		Output Compare Register Upper ch0	R/W		$XXXXXXXX_B$
$00791A_H$	OCCP1	Output Compare Register Lower ch1	R/W		$XXXXXXXX_B$
$00791B_H$		Output Compare Register Upper ch1	R/W		$XXXXXXXX_B$
$00791C_H$	OCCP2	Output Compare Register Lower ch2	R/W	Output Compare ch2/3	$XXXXXXXX_B$
$00791D_H$		Output Compare Register Upper ch2	R/W		$XXXXXXXX_B$
$00791E_H$	OCCP3	Output Compare Register Lower ch3	R/W		$XXXXXXXX_B$
$00791F_H$		Output Compare Register Upper ch3	R/W		$XXXXXXXX_B$
007920_H	DBAPL	DMA Buffer Address Pointer Lower 8-bit	R/W	µDMAC	$XXXXXXXX_B$
007921_H	DBAPM	DMA Buffer Address Pointer Middle 8-bit	R/W		$XXXXXXXX_B$
007922_H	DBAPH	DMA Buffer Address Pointer Upper 8-bit	R/W		$XXXXXXXX_B$
007923_H	DMACS	DMA Control Register	R/W		$XXXXXXXX_B$
007924_H	DIOAL	DMA I/O Register Address Pointer Lower 8-bit	R/W		$XXXXXXXX_B$
007925_H	DIOAH	DMA I/O Register Address Pointer Upper 8-bit	R/W		$XXXXXXXX_B$
007926_H	DDCTL	DMA Data Counter Lower 8-bit	R/W		$XXXXXXXX_B$
007927_H	DDCTH	DMA Data Counter Upper 8-bit	R/W		$XXXXXXXX_B$
007928_H to $007FFF_H$		Prohibited			

- Explanation on read/write
  - R/W : Readable and Writable
  - R : Read only
  - W : Write only

- Explanation on initial values
  - 0 : Initial value is "0".
  - 1 : Initial value is "1".
  - X : Initial value is undefined.
  - - : Initial value is undefined (None) .
  - ∗ : Initial value of this bit is "1" or "0".

Note : No I/O instruction can be used for registers located between 007900_H and $007FFF_H$.

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■ INTERRUPT SOURCES, INTERRUPT VECTORS, AND INTERRUPT CONTROL REGISTERS

Interrupt source	EI²OS support	μDMAC	Interrupt vector		Interrupt control register		Priority
			Number*	Address	ICR	Address	
Reset	×	×	#08	08$_H$	FFFFDC$_H$	—	—	High
INT 9 instruction	×	×	#09	09$_H$	FFFFD8$_H$	—	—	
Exceptional treatment	×	×	#10	0A$_H$	FFFFD4$_H$	—	—	
USB Function1	×	0, 1	#11	0B$_H$	FFFFD0$_H$	ICR00	0000B0$_H$	
USB Function2	×	2 to 6	#12	0C$_H$	FFFFCC$_H$			
USB Function3	×	×	#13	0D$_H$	FFFFC8$_H$	ICR01	0000B1$_H$	
USB Function4	×	×	#14	0E$_H$	FFFFC4$_H$			
USB Mini-HOST1	×	×	#15	0F$_H$	FFFFC0$_H$	ICR02	0000B2$_H$	
USB Mini-HOST2	×	×	#16	10$_H$	FFFFBC$_H$			
I²C ch0	×	×	#17	11$_H$	FFFFB8$_H$	ICR03	0000B3$_H$	
DTP/External interrupt ch0/1	○	×	#18	12$_H$	FFFFB4$_H$			
I²C ch1	×	×	#19	13$_H$	FFFFB0$_H$	ICR04	0000B4$_H$	
DTP/Extetrnal interrupt ch2/3	○	×	#20	14$_H$	FFFFAC$_H$			
I²C ch2	×	×	#21	15$_H$	FFFFA8$_H$	ICR05	0000B5$_H$	
DTP/External interrupt ch4/5	○	×	#22	16$_H$	FFFFA4$_H$			
PWC/Reload timer ch0	△	14	#23	17$_H$	FFFFA0$_H$	ICR06	0000B6$_H$	
DTP/External interrupt ch6/7	△	×	#24	18$_H$	FFFF9C$_H$			
Input capture ch0/1	△	7	#25	19$_H$	FFFF98$_H$	ICR07	0000B7$_H$	
Reload timer ch1	△	×	#26	1A$_H$	FFFF94$_H$			
Input capture ch2/3	△	8	#27	1B$_H$	FFFF90$_H$	ICR08	0000B8$_H$	
Reload timer ch2	△	×	#28	1C$_H$	FFFF8C$_H$			
Output compare ch0/1	○	×	#29	1D$_H$	FFFF88$_H$	ICR09	0000B9$_H$	
PPG ch0/1	×	×	#30	1E$_H$	FFFF84$_H$			
Output compare ch2/3	○	×	#31	1F$_H$	FFFF80$_H$	ICR10	0000BA$_H$	
PPG ch2/3	×	×	#32	20$_H$	FFFF7C$_H$			
UART (Send completed) ch2/3	○	11	#33	21$_H$	FFFF78$_H$	ICR11	0000BB$_H$	
PPG ch4/5	×	×	#34	22$_H$	FFFF74$_H$			
UART (Reception completed) ch2/3	◎	10	#35	23$_H$	FFFF70$_H$	ICR12	0000BC$_H$	
A/D converter/Free-run timer	△	15	#36	24$_H$	FFFF6C$_H$			
UART (Send completed) ch0/1	○	13	#37	25$_H$	FFFF68$_H$	ICR13	0000BD$_H$	
Extended serial I/O	×	9	#38	26$_H$	FFFF64$_H$			
UART (Reception completed) ch0/1	◎	12	#39	27$_H$	FFFF60$_H$	ICR14	0000BE$_H$	
Time-base timer/Watch timer	×	×	#40	28$_H$	FFFF5C$_H$			
Flash memory status	×	×	#41	29$_H$	FFFF58$_H$	ICR15	0000BF$_H$	
Delay interrupt output module	×	×	#42	2A$_H$	FFFF54$_H$			Low

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◎ : Available, EI^{2}OS stop function provided (The interrupt request flag is cleared by the interrupt clear signal. With a stop request).

○ : Available (The interrupt request flag is cleared by the interrupt clear signal.)

△ : Available when any interrupt source sharing ICR is not used.

× : Unavailable

* : If the same level interrupt is output simultaneously, the lower interrupt factor of interrupt vector number has priority.

Notes : • If the same interrupt control register (ICR) has two interrupt factors and the use of the EI^{2}OS is permitted, the EI^{2}OS is activated when either of the factors is detected. As any interrupt other than the activation factor is masked while the EI^{2}OS is running, it is recommended that you should mask either of the interrupt requests when using the EI^{2}OS.
• The interrupt flag is cleared by the EI^{2}OS interrupt clear signal for the resource that has two interrupt factors in the same interrupt control register (ICR).
• If a resource has two interrupt sources for the same interrupt number, both of the interrupt request flags are cleared by the μDMAC interrupt clear signal. Therefore, when you use either of two interrupt factors for the DMAC function, another interrupt function is disabled. Set the interrupt request permission bit to "0" in the appropriate resource, and take measures by software polling.

● **Content of USB interruption factor**

USB interrupt factor	Details
USB function 1	End Point0-IN End Point0-OUT
USB function 2	End Point1-5
USB function 3	VOFF VON SUSP SOF BRST WKUP CONF
USB function 4	SPK
USB Mini-HOST1	DIRQ CNNIRQ URIRQ RWKIRQ
USB Mini-HOST2	SOFIRQ CMPIRQ

■ PERIPHERAL RESOURCES

1. I/O port

The I/O ports are used as general-purpose input/output ports (parallel I/O ports). MB90330 series model is provided with 12 ports (94 inputs) . The ports function as input/output pins for peripheral functions also.

The port data register (PDR) can be used to send output data to the I/O pin and to receive the signal input to the I/O port. The port direction register (DDR) can be used to set the I/O direction of the I/O pin in bit units.

The following table lists the I/O ports and the peripheral functions with which they share pins.

	Port Pin Name	Pin Name (Peripheral)	Peripheral Function that Shares Pin
Port 0	P00 to P07	—	(External bus)
Port 1	P10 to P17	—	(External bus)
Port 2	P20 to P23	—	(External bus)
	P24 to P27	PPG0 to PPG3	8/16-bit PPG timer 0, 1 (External bus)
Port 3	P30 to P33	TIN1, TOT1, TIN2, TOT2	16-bit Reload timer 1, 2 (External bus)
	P34 to P37	—	(External bus)
Port 4	P40, P41	TIN0, TOT0	16-bit Reload timer 0 (External bus)
	P42 to P47	SIN0, SOT0, SCK0, SIN1, SOT1, SCK1	UART0, UART1 (External bus)
Port 5	P50 to P57	—	(External bus)
Port 6	P60, P61	INT0, INT1	External interrupt
	P62 to P64	INT2 to INT4, SIN, SOT, SCK	External interrupt, Serial I/O
	P65	INT5, PWC	External interrupt, PWC
	P66, P67	INT6, INT7, SCL0, SDA0	External interrupt, I^2C 0
Port 7	P70 to P77	AN0 to AN7	8/10-bit A/D converter
Port 8	P80 to P87	AN8 to AN15	8/10-bit A/D converter
Port 9	P90 to P95	SIN2, SOT2, SCK2, SIN3, SOT3, SCK3	UART2, 3
	P96	ADTG, FRCK	8/10-bit A/D converter, Free-run timer
Port A	PA0 to PA3	IN0 to IN3	Input capture 0, 1, 2, 3
	PA4 to PA7	OUT0 to OUT3	Output compare 0, 1, 2, 3
Port B	PB0 to PB3	SCL1, SDA1, SCL2, SDA2	I^2C 1, 2
	PB4	—	—
	PB5, PB6	PPG4, PPG5	PPG timer 2

Note : These pins also serve as the analog input pins for ports 7 and 8. To use them as general-purpose ports, be sure to set the corresponding bits in the analog input enable register (ADER) to 0_B. The ADER is initialized to FF_H at a reset.

• Register list (port data register)

	7	6	5	4	3	2	1	0	Initial Value	Access
PDR0 Address : 000000H	P07	P06	P05	P04	P03	P02	P01	P00	XXXXXXXXB	R/W*

	15	14	13	12	11	10	9	8		
PDR1 Address : 000001H	P17	P16	P15	P14	P13	P12	P11	P10	XXXXXXXXB	R/W*

	7	6	5	4	3	2	1	0		
PDR2 Address : 000002H	P27	P26	P25	P24	P23	P22	P21	P20	XXXXXXXXB	R/W*

	15	14	13	12	11	10	9	8		
PDR3 Address : 000003H	P37	P36	P35	P34	P33	P32	P31	P30	XXXXXXXXB	R/W*

	7	6	5	4	3	2	1	0		
PDR4 Address : 000004H	P47	P46	P45	P44	P43	P42	P41	P40	XXXXXXXXB	R/W*

	15	14	13	12	11	10	9	8		
PDR5 Address : 000005H	P57	P56	P55	P54	P53	P52	P51	P50	XXXXXXXXB	R/W*

	7	6	5	4	3	2	1	0		
PDR6 Address : 000006H	P67	P66	P65	P64	P63	P62	P61	P60	XXXXXXXXB	R/W*

	15	14	13	12	11	10	9	8		
PDR7 Address : 000007H	P77	P76	P75	P74	P73	P72	P71	P70	XXXXXXXXB	R/W*

	7	6	5	4	3	2	1	0		
PDR8 Address : 000008H	P87	P86	P85	P84	P83	P82	P81	P80	XXXXXXXXB	R/W*

	15	14	13	12	11	10	9	8		
PDR9 Address : 000009H	—	P96	P95	P94	P93	P92	P91	P90	- XXXXXXXB	R/W*

	7	6	5	4	3	2	1	0		
PDRA Address : 00000AH	PA7	PA6	PA5	PA4	PA3	PA2	PA1	PA0	XXXXXXXXB	R/W*

	7	6	5	4	3	2	1	0		
PDRB Address : 00000CH	—	PB6	PB5	PB4	PB3	PB2	PB1	PB0	- XXXXXXXB	R/W*

* : R/W access to I/O ports is a bit different in behavior from R/W access to memory as follows :

• Input mode

Read : The level at the relevant pin is read.
Write : Data is written to the output latch.

• Output mode

Read : The data register latch value is read.
Write : Data is output to the relevant pin.

• Register list (port direction register)

DDR0 Address : 000010H	7 D07	6 D06	5 D05	4 D04	3 D03	2 D02	1 D01	0 D00	Initial Value 00000000B	Access R/W
DDR1 Address : 000011H	15 D17	14 D16	13 D15	12 D14	11 D13	10 D12	9 D11	8 D10	00000000B	R/W
DDR2 Address : 000012H	7 D27	6 D26	5 D25	4 D24	3 D23	2 D22	1 D21	0 D20	00000000B	R/W
DDR3 Address : 000013H	15 D37	14 D36	13 D35	12 D34	11 D33	10 D32	9 D31	8 D30	00000000B	R/W
DDR4 Address : 000014H	7 D47	6 D46	5 D45	4 D44	3 D43	2 D42	1 D41	0 D40	00000000B	R/W
DDR5 Address : 000015H	15 D57	14 D56	13 D55	12 D54	11 D53	10 D52	9 D51	8 D50	00000000B	R/W
DDR6 Address : 000016H	7 D67	6 D66	5 D65	4 D64	3 D63	2 D62	1 D61	0 D60	00000000B	R/W
DDR7 Address : 000017H	15 D77	14 D76	13 D75	12 D74	11 D73	10 D72	9 D71	8 D70	00000000B	R/W
DDR8 Address : 000018H	7 D87	6 D86	5 D85	4 D84	3 D83	2 D82	1 D81	0 D80	00000000B	R/W
DDR9 Address : 000019H	15 —	14 D96	13 D95	12 D94	11 D93	10 D92	9 D91	8 D90	-0000000B	R/W
DDRA Address : 00001AH	7 DA7	6 DA6	5 DA5	4 DA4	3 DA3	2 DA2	1 DA1	0 DA0	00000000B	R/W
DDRB Address : 00000DH	15 —	14 DB6	13 DB5	12 DB4	11 DB3	10 DB2	9 DB1	8 DB0	-0000000B	R/W

• When each pin is serving as a port, the corresponding pin is controlled as follows :

0 : Input mode

1 : Output mode

This bit becomes 0 after a reset.

Note : If these registers are accessed by a read modify write instruction (such as a bit set instruction) , the bits manipulated by the instruction are set to prescribed values but those other bits in output registers which have been set for input are rewritten to current input values of the pins. When switching a pin from input port to output port, therefore, write a desired value in the PDR first, then set the DDR to switch the pin for output.

• Register list (Analog input enable register)

ADER0 Address : 00001E$_H$	7	6	5	4	3	2	1	0	Initial Value 11111111$_B$	Access R/W
	ADE7	ADE6	ADE5	ADE4	ADE3	ADE2	ADE1	ADE0		
ADER1 Address : 00001F$_H$	15	14	13	12	11	10	9	8	11111111$_B$	R/W
	ADE15	ADE14	ADE13	ADE12	ADE11	ADE10	ADE9	ADE8		

This register controls the port 7, 8 pins as follows.

0 : Port input/output mode.
1 : Analog input mode.
This bit becomes 1 after a reset.

• Register list (Port pull-up resistance register)

RDR0 Address : 00001C$_H$	7	6	5	4	3	2	1	0	Initial Value 00000000$_B$	Access R/W
	RD07	RD06	RD05	RD04	RD03	RD02	RD01	RD00		
RDR1 Address : 00001D$_H$	15	14	13	12	11	10	9	8	00000000$_B$	R/W
	RD17	RD16	RD15	RD14	RD13	RD12	RD11	RD10		

Controls the pull-up resistor in input mode.

0 : Without pull-up resistor in input mode.

1 : With pull-up resistor in input mode.

Meaningless in output mode. (Without pull-up resistor)/The input/output mode is decided by the setting of the port direction register (DDR).

Without pull-up resistor is used in stop mode (SPL = 1). (High-Z) This function is disabled when the external bus is used. Do not attempt to write to this register.

• Register list (Output pin register)

| ODR4 Address : 00001B$_H$	7	6	5	4	3	2	1	0	Initial Value 00000000$_B$	Access R/W
	OD47	OD46	OD45	OD44	OD43	OD42	OD41	OD40		

Controls open-drain in output mode.

0 : Serves as a standard output port in output mode.

1 : Serves as an open-drain output port in output mode.

Meaningless in input mode (output High-Z)./The input/output mode is decided by the setting of the port direction register (DDR). This function is disabled when the external bus is used. Do not attempt to write to this register.

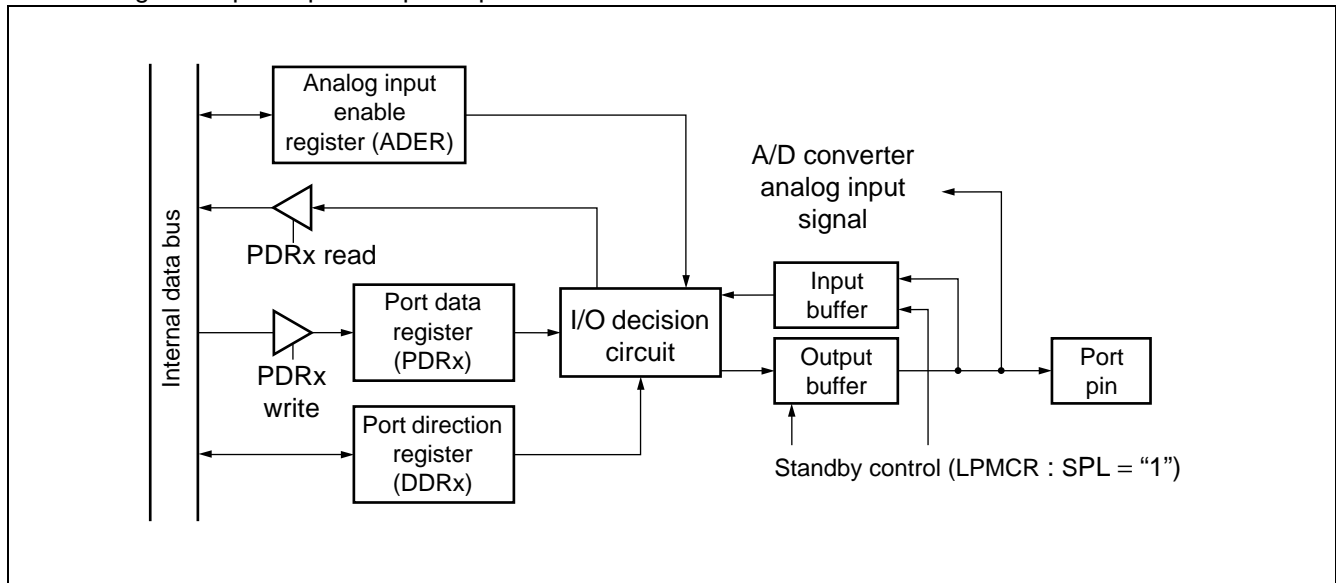• Block diagram of port 0 pin and port 1 pin
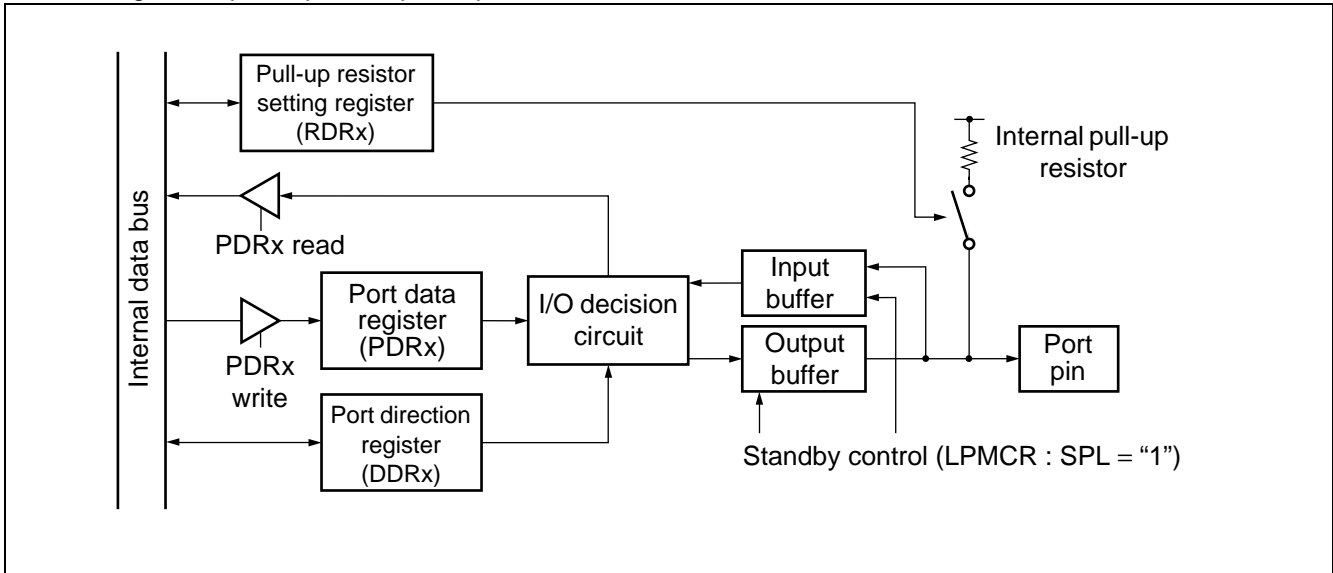
• Block diagram of port 2 pin, port 3 pin, port 4 pin, port 5 pin, port 6 pin, port 9 pin, port A pin and port B pin
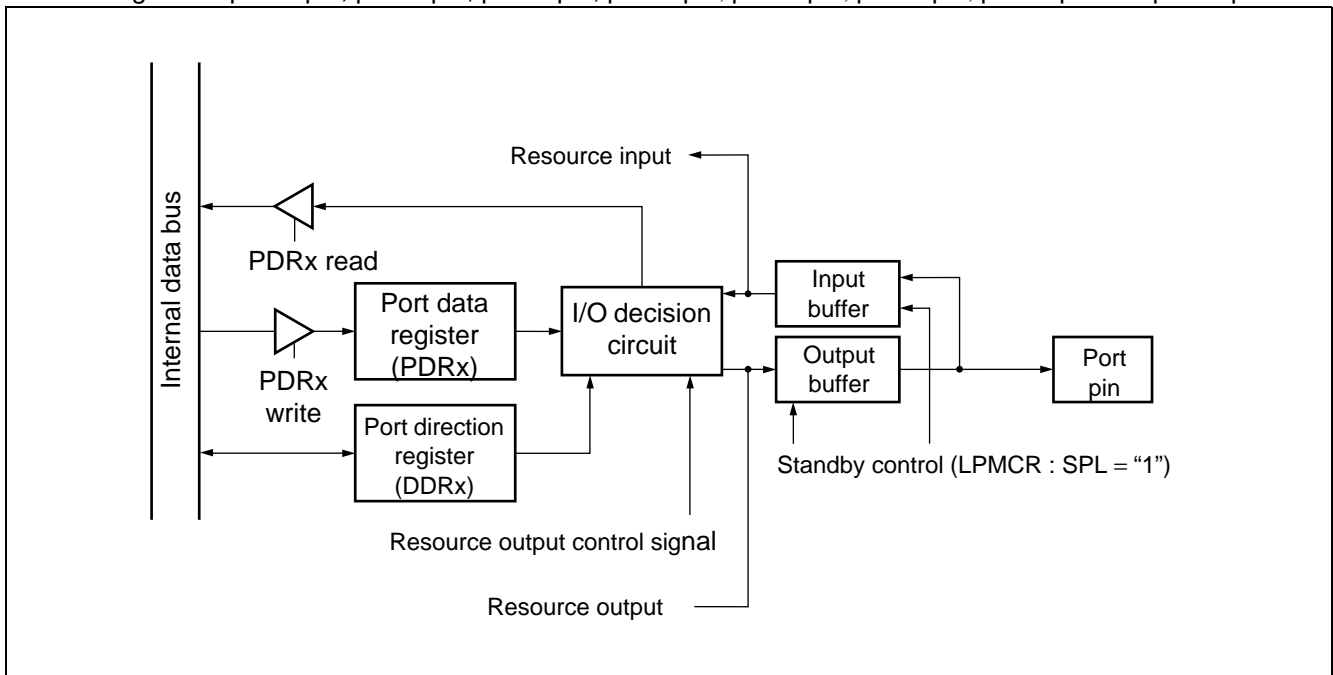
• Block diagram of port 7 pin and port 8 pin

Notes : • When using as an input port, set " 0 " in the corresponding bit of the port-7 and port-8 direction register
         (DDR7 and DDR8) and " 0 " in the related bit of the analog input enable register (ADER).
       • When using as an analog input pin, set " 0 " in the corresponding bit of the port-7 and port-8 direction
         register (DDR7 and DDR8) and " 1 " in the related bit of the analog input enable register (ADER).

2. Time-base timer

The time-base timer is an 18-bit free-run counter (time-base timer counter) that counts in synchronization with the main clock (2 cycles of the oscillation clock HCLK). Four different time intervals can be selected, for each of which an interrupt request can be generated. Operating clock signals are supplied to peripheral resources such as the oscillation stabilization wait timer and watchdog timer.

● Interval time of time-base timer

Internal count clock cycle	Interval time
2/HCLK (0.33 µs)	2^{12}/HCLK (Approx. 0.68 ms)
	2^{14}/HCLK (Approx. 2.7 ms)
	2^{16}/HCLK (Approx. 10.9 ms)
	2^{19}/HCLK (Approx. 87.4 ms)

Notes : ● HCLK : Oscillation clock frequency
● The parenthesized values assume an oscillator clock frequency of 6 MHz.

● Clock cycles supplied from time-base timer

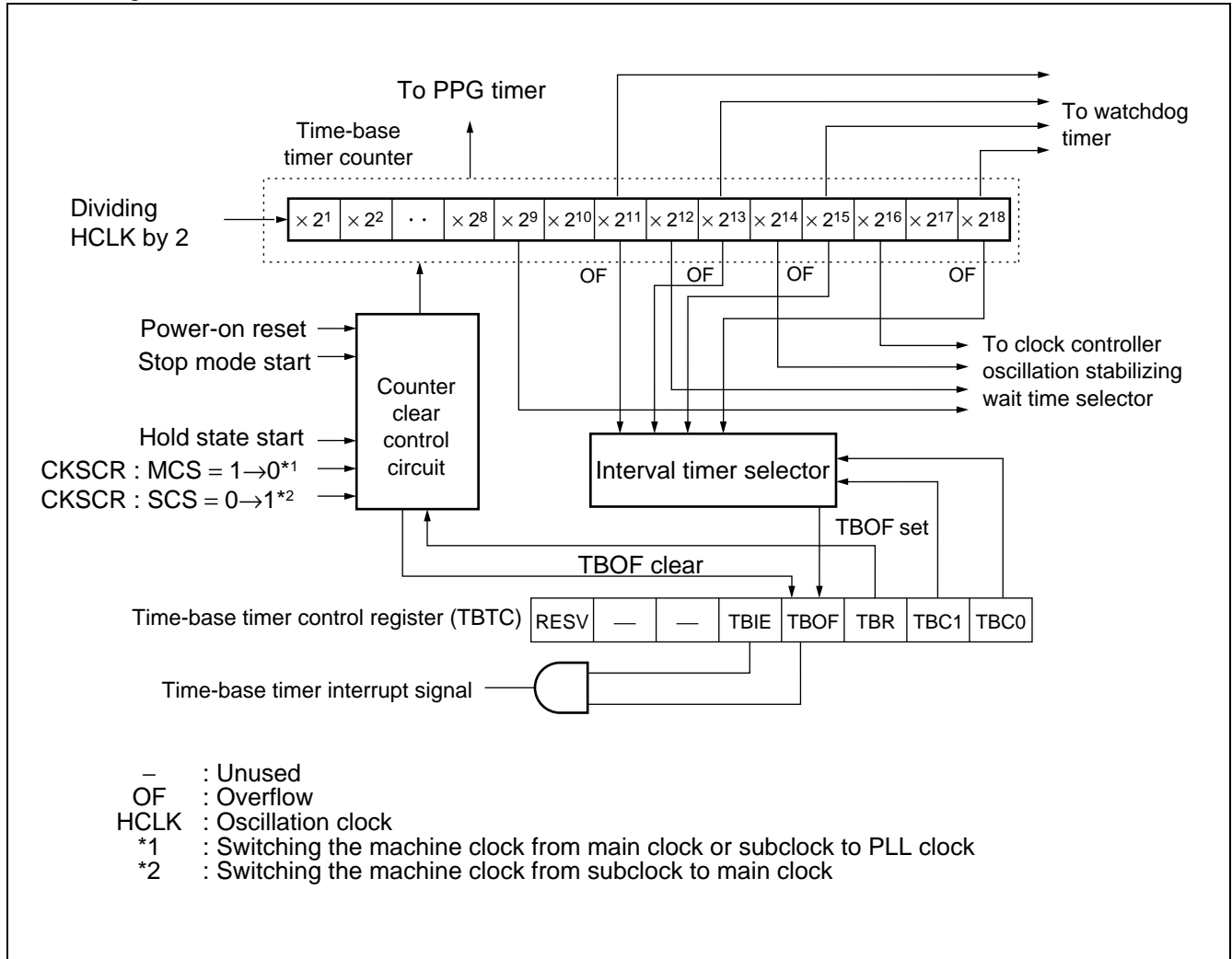| Where to supply clock	Clock cycle
Main clock oscillation stabilization wait	2^{13}/HCLK (Approx. 1.36 ms)
	2^{15}/HCLK (Approx. 5.46 ms)
	2^{17}/HCLK (Approx. 21.84 ms)
Watch dog timer	2^{12}/HCLK (Approx. 0.68 ms)
	2^{14}/HCLK (Approx. 2.7 ms)
	2^{16}/HCLK (Approx. 10.9 ms)
	2^{19}/HCLK (Approx. 87.4 ms)

Notes : ● HCLK : Oscillation clock frequency
● The parenthesized values assume an oscillator clock frequency of 6 MHz.

● Register list

Time-base timer control register (TBTC)

Address : 0000A9$_H$

	15	14	13	12	11	10	9	8
	RESV	—	—	TBIE	TBOF	TBR	TBC1	TBC0
	(R/W)	(—)	(—)	(R/W)	(R/W)	(W)	(R/W)	(R/W)

Initial Value
1 - - 00100$_B$

• Block Diagram

Counter clear control circuit inputs:
- Power-on reset
- Stop mode start
- Hold state start
- CKSCR : MCS = 1→0*1
- CKSCR : SCS = 0→1*2

Time-base timer counter: $\times 2^1$ | $\times 2^2$ | $\cdot\cdot$ | $\times 2^8$ | $\times 2^9$ | $\times 2^{10}$ | $\times 2^{11}$ | $\times 2^{12}$ | $\times 2^{13}$ | $\times 2^{14}$ | $\times 2^{15}$ | $\times 2^{16}$ | $\times 2^{17}$ | $\times 2^{18}$

Dividing HCLK by 2

To PPG timer
To watchdog timer
To clock controller oscillation stabilizing wait time selector

Interval timer selector
TBOF set
TBOF clear

Time-base timer control register (TBTC) : RESV | — | — | TBIE | TBOF | TBR | TBC1 | TBC0

Time-base timer interrupt signal

    −   : Unused
    OF   : Overflow
    HCLK : Oscillation clock
    *1   : Switching the machine clock from main clock or subclock to PLL clock
    *2   : Switching the machine clock from subclock to main clock

Actual interrupt request number of time-base timer is as follows :
    Interrupt request number : #40 (28H)

3. Watchdog timer

The watchdog timer is timer counter provided for measure of program runaway. It is a 2-bit counter operating with an output of the timebase timer or watch timer as the count clock and resets the CPU when the counter is not cleared for a preset period of time after start.

• Interval time of watchdog timer

HCLK : Oscillation clock(6 MHz) SCLK : Sub clock(8 KHz)		
Min	**Max**	**Clock cycle**
Approx. 2.39 ms	Approx. 3.07 ms	$2^{14} \pm 2^{11}$/HCLK
Approx. 9.56 ms	Approx. 12.29 ms	$2^{16} \pm 2^{13}$/HCLK
Approx. 38.23 ms	Approx. 49.15 ms	$2^{18} \pm 2^{15}$/HCLK
Approx. 305.83 ms	Approx. 393.22 ms	$2^{21} \pm 2^{18}$/HCLK
Approx. 0.448 s	Approx. 0.576 s	$2^{12} \pm 2^{9}$/SCLK
Approx. 3.584 s	Approx. 4.608 s	$2^{15} \pm 2^{12}$/SCLK
Approx. 7.168 s	Approx. 9.216 s	$2^{16} \pm 2^{13}$/SCLK
Approx. 14.336 s	Approx. 18.432 s	$2^{17} \pm 2^{14}$/SCLK

Notes : • The maximum and minimum time intervals for the watchdog timer depend on the counter clear timing.
   • The watchdog timer contains a 2-bit counter that counts the carry-up signal from the time-base timer or watch timer.
   • Interval time of watchdog timer is longer than the set time during the following conditions.
      - When clearing the timebase timer during operation on oscillation (HCLK)
      - When clearing the watch timer during operation on sub clock (SCLK)

• Events that stop the watchdog timer
   • Stop due to a power-on reset
   • Watchdog reset
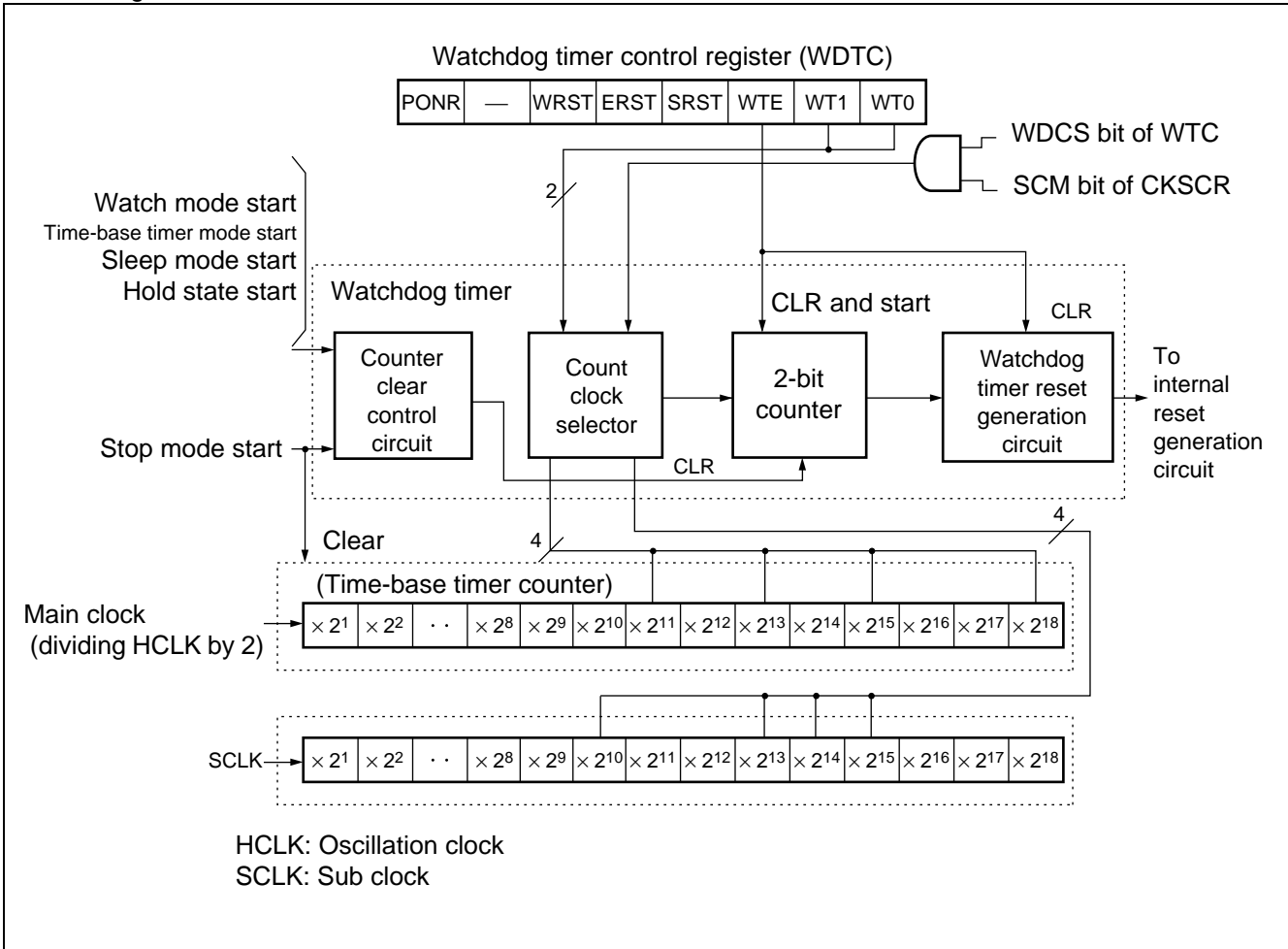
• Clear factor of watchdog timer
   • External reset input by $\overline{RST}$ pin
   • Writing "0" to the software reset bit
   • Writing "0" to the watchdog timer control bit (second and subsequent times)
   • Transition to sleep mode (clearing the watchdog timer to suspend counting)
   • Transition to time-base timer mode (clearing the watchdog timer to suspend counting)
   • Transition to stop mode (clearing the watchdog timer to suspend counting)

• Register list

Watchdog timer control register (WDTC)

Address : 0000A8$_H$

7	6	5	4	3	2	1	0
PONR	—	WRST	ERST	SRST	WTE	WT1	WT0
(R)	(—)	(R)	(R)	(R)	(W)	(W)	(W)

Initial Value
X-XXX111$_B$

• Block Diagram

Watchdog timer control register (WDTC)

| PONR | — | WRST | ERST | SRST | WTE | WT1 | WT0 |

WDCS bit of WTC

SCM bit of CKSCR

Watch mode start
Time-base timer mode start
Sleep mode start
Hold state start

Watchdog timer

CLR and start

CLR

Counter clear control circuit

Count clock selector

2-bit counter

Watchdog timer reset generation circuit

To internal reset generation circuit

Stop mode start

CLR

Clear

(Time-base timer counter)

Main clock (dividing HCLK by 2)

$\times 2^1$ $\times 2^2$ ·· $\times 2^8$ $\times 2^9$ $\times 2^{10}$ $\times 2^{11}$ $\times 2^{12}$ $\times 2^{13}$ $\times 2^{14}$ $\times 2^{15}$ $\times 2^{16}$ $\times 2^{17}$ $\times 2^{18}$

SCLK

$\times 2^1$ $\times 2^2$ ·· $\times 2^8$ $\times 2^9$ $\times 2^{10}$ $\times 2^{11}$ $\times 2^{12}$ $\times 2^{13}$ $\times 2^{14}$ $\times 2^{15}$ $\times 2^{16}$ $\times 2^{17}$ $\times 2^{18}$

HCLK: Oscillation clock
SCLK: Sub clock

4. Watch timer

The watch timer is a 15-bit timer using the subclock. It can generate interval interrupts. It can also be used as a clock source for the watchdog timer.

• Register list

Watch timer control register (WTC)

Address : 0000AA$_H$

	7	6	5	4	3	2	1	0
	WDCS	SCE	WTIE	WTOF	WTR	WTC2	WTC1	WTC0
	(R/W)	(R)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
10001000$_B$

• Block Diagram

Watch timer control register (WTC)

WDCS	SCE	WTIE	WTOF	WTR	WTC2	WTC1	WTC0

Clear

Watch counter

2^8
2^9
2^{10}
2^{11}
2^{12}
2^{13}
2^{14}

2^{10} 2^{13} 2^{14} 2^{15}

Sub clock

Interval selector

Interrupt generation circuit

Watch timer interrupt

To watchdog timer
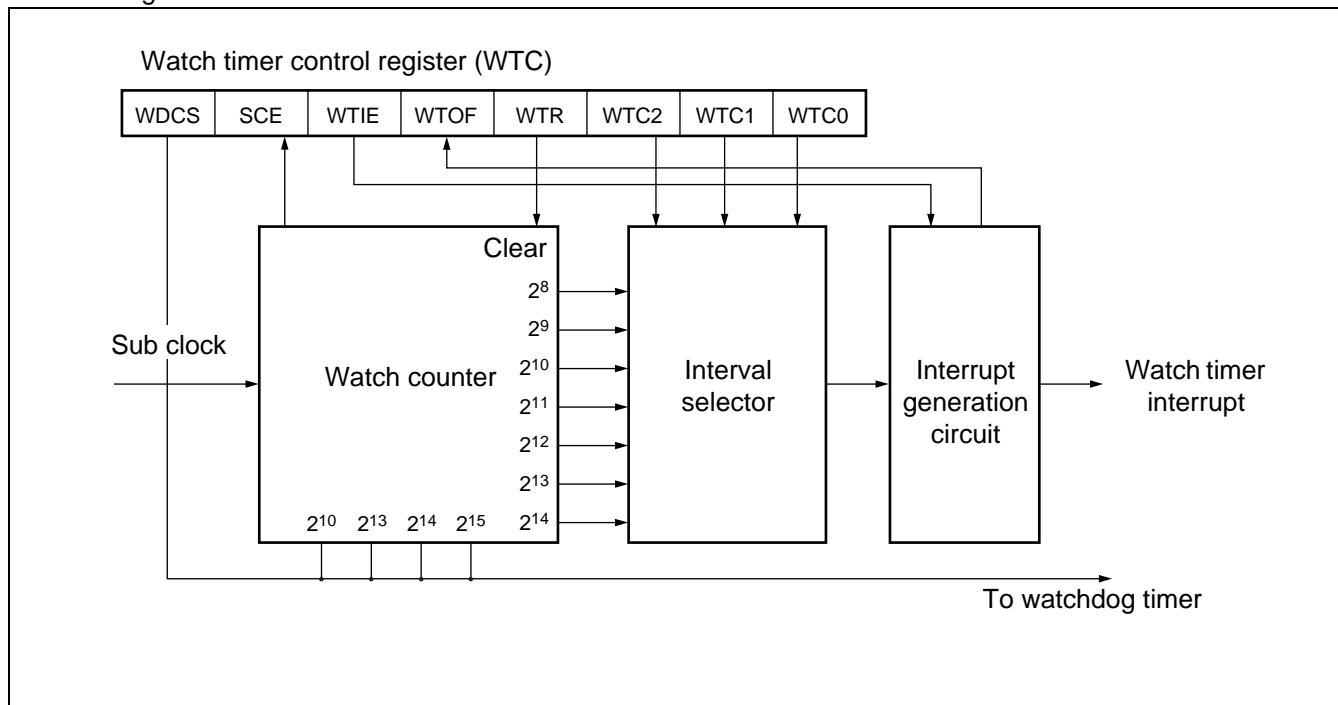
5. 16-bit reload timer

The 16-bit reload timer has the internal clock mode to decrement in synchronization with 3 different internal clocks and the event count mode to decrement upon detection of an arbitrary edge of the pulse input to the external pin. Either can be selected. This timer defines when the count value changes from 0000_H to $FFFF_H$ as an underflow. The timer therefore causes an underflow when the count reaches [reload register setting + 1]. Either mode can be selected for the count operation from the reload mode which repeats the count by reloading the count setting value at the underflow occurrence or the one-shot mode which stops the count at the underflow occurrence. The interrupt can be generated at the counter underflow occurrence so as to correspond to the DTC.

• Register list

• TMCSR (Timer control status register 0 to 2)
Timer control status register (upper) (TMCSR0 to TMCSR2)

Address : 000063_H
000067_H
$00006B_H$

	15	14	13	12	11	10	9	8
	—	—	—	—	CSL1	CSL0	MOD2	MOD1
	(—)	(—)	(—)	(—)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
$XXXX0000_B$

Timer control status register (lower) (TMCSR0 to TMCSR2)

Address : 000062_H
000066_H
$00006A_H$

	7	6	5	4	3	2	1	0
	MOD0	OUTE	OUTL	RELD	INTE	UF	CNTE	TRG
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000_B

• 16-bit timer register/16-bit reload register
TMR0 to TMR2/TMRLR0 to TMRLR2 (upper)

Address : 000065_H
000069_H
$00006D_H$

	15	14	13	12	11	10	9	8
	D15	D14	D13	D12	D11	D10	D09	D08
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
$XXXXXXXX_B$

TMR0 to TMR2/TMRLR0 to TMRLR2 (lower)

Address : 000064_H
000068_H
$00006C_H$

	7	6	5	4	3	2	1	0
	D07	D06	D05	D04	D03	D02	D01	D00
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
$XXXXXXXX_B$

• Block diagram

Internal data bus

TMRLR0*1
TMRLR1*2
TMRLR2*3

16-bit reload register

TMR0*1
TMR1*2
TMR2*3

Reload signal

Reload control circuit

16-bit timer register   UF *5

Count clock generation circuit   CLK

Gate input

Machine clock φ

Prescaler   3

Valid clock decision circuit

Wait signal

Clear
Trigger   Internal clock

CLK

Output control circuit

Pin

Input control circuit

Clock selector

Output signal generation circuit

Pin

TIN0*1
TIN1*2
TIN2*3

EN

TOT0*1
TOT1*2
TOT2*3

External clock   Select signal

3   2

Operating control circuit

Select function

| — | — | — | — | CSL1 | CSL0 | MOD2 | MOD1 | MOD0 | OUTE | OUTL | RELD | INTE | UF | CNTE | TRG |

Timer control status register (TMCSR0 to TMCSR2)

Interrupt request output
#23 (17H) *1, *4
#26 (1AH) *2, *4
#28 (1CH) *3, *4

*1 : channel 0
*2 : channel 1
*3 : channel 2
*4 : Interrupt number
*5 : Underflow

6. Multi function timer

The multi-function timer enables the following based on the 16-bit free-run timer.
- Output of independent waveform
- Measurement of input pulse width
- Measurement of external clock cycle

● Configuration of a multi-functional timer

16-bit free-run timer	16-bit Output Compare	16-bit Input Capture	8/16-bit PPG timer	16-bit PWC timer
1 channel	4 channels	4 channels	8-bit × 6 channels (16-bit × 3 channels)	1 channel

● 16-bit free-run timer : 1 channel

The 16-bit free-run timer consists of a 16-bit up counter (timer data register (TCDT)), compare clear register (CPCLR), timer control status register (TCCS), and prescaler.

The counter output value of the 16-bit free-run timer is used as the base timer for the output compare and input capture units.
- The count clock can be set, selected from among the following eight types.
  $1/\phi$, $2/\phi$, $4/\phi$, $8/\phi$, $16/\phi$, $32/\phi$, $64/\phi$, $128/\phi$
  ϕ : Machine clock frequency
- During the following conditions, the interrupt should be output.
  - The counter value of 16-bit free run timer will be overflowed.
  - The counter value of 16-bit free run timer will be cleared after the counter value of 16-bit free run timer = the compare clear register value (CPCLR) (TCCS : ICRE = "1", MODE = "1")
- The counter value of 16-bit free run timer should be cleared to "0000$_H$" during the following conditions.
  - Reset
  - When setting the clear bit (SCLR) of timer control status register (TCCS) to "1"
  - When the counter value of the 16-bit free run timer = the compare clear register value (CPCLR) (TCCS : MODE = "1")
  - When setting "0000$_H$" to the timer data register (TCDT)

● Output compare : 4 channels

The output compare unit consists of compare registers (OCCP0 to OCCP3), compare control registers (OCS0 to OCS3), and a compare output latch.

The output compare unit can invert the output level and output an interrupt when a compare register (OCCP0 to OCCP3) value matches the counter value of the 16-bit free-run timer.
- Output compare registers can operate as 4 independent channels. The compare registers (OCCP0 to OCCP3) of each channel have interrupt request flags of their respective output pins.
- Pin output can be inverted by using 2 channels of compare registers (OCCP0 to OCCP3).
- If the counter value of 16-bit free run timer = the compare register (OCCP0 to OCCP3) (OCS0, OCS2 : IOP0 = "1", IOP1 = "1"), the interrupt request should be generated.
- The initial value for pin output of each channel can be set.

● Input capture : 4 channels

The input capture unit consists of the input capture data registers (IPCP0 to IPCP3) corresponding to external input pins (IN0 to IN3) and input capture control registers (ICS01, ICS23).

The input capture unit can capture the counter value of the 16-bit free-run timer into the input capture data register (IPCP0 to IPCP3) to generated an interrupt request upon detection of the effective edge of the signal input through the external input.

- The input capture unit in each channel can operate independently.
- The effective edge of the external signal can be selected (rising edge, falling edge, both edges).
- An interrupt request can be generated upon detection of the selected effective edge of the external signal.(ICS01, ICS2 : ICE0 = "1", ICE1 = "1", ICE2 = "1", ICE3 = "1").

• Register list (16-bit free-run timer)

Compare clear register (CPCLR)

Address : 00008B$_H$

15	14	13	12	11	10	9	8
CL15	CL14	CL13	CL12	CL11	CL10	CL09	CL08
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXX$_B$

Address : 00008A$_H$

7	6	5	4	3	2	1	0
CL07	CL06	CL05	CL04	CL03	CL02	CL01	CL00
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXX$_B$

Timer data register (TCDT)

Address : 000087$_H$

15	14	13	12	11	10	9	8
T15	T14	T13	T12	T11	T10	T09	T08
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000$_B$

Address : 000086$_H$

7	6	5	4	3	2	1	0
T07	T06	T05	T04	T03	T02	T01	T00
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000$_B$

Timer control/status register (TCCS)

Address : 000089$_H$

15	14	13	12	11	10	9	8
ECKE	—	—	MSI2	MSI1	MSI0	ICLR	ICRE
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
0--00000$_B$

Address : 000088$_H$

7	6	5	4	3	2	1	0
IVF	IVFE	STOP	MODE	SCLR	CLK2	CLK1	CLK0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000$_B$

• Register list (output compare)

Compare register (OCCP0 to OCCP3)

Address : 007919H
00791BH
00791DH
00791FH

15	14	13	12	11	10	9	8
C15	C14	C13	C12	C11	C10	C09	C08
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXXB

Address : 007918H
00791AH
00791CH
00791EH

7	6	5	4	3	2	1	0
C07	C06	C05	C04	C03	C02	C01	C00
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXXB

Control register (OCS1/OCS3)

Address : 000055H
000057H

15	14	13	12	11	10	9	8
—	—	—	CMOD	OTE1	OTE0	OTD1	OTD0
(—)	(—)	(—)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
---00000B

Control register (OCS0/OCS2)

Address : 000054H
000056H

7	6	5	4	3	2	1	0
ICP1	ICP0	ICE1	ICE0	—	—	CST1	CST0
(R/W)	(R/W)	(R/W)	(R/W)	(—)	(—)	(R/W)	(R/W)

Initial Value
0000--00B

• Register list (input capture)

Input capture data register (IPCP0 to IPCP3)

Address : 007911H
007913H
007915H
007917H

15	14	13	12	11	10	9	8
CP15	CP14	CP13	CP12	CP11	CP10	CP09	CP08
(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)

Initial Value
XXXXXXXX$_B$

Address : 007910H
007912H
007914H
007916H

7	6	5	4	3	2	1	0
CP07	CP06	CP05	CP04	CP03	CP02	CP01	CP00
(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)

Initial Value
XXXXXXXX$_B$

Input capture control status register (ICS23)

Address : 000053H

15	14	13	12	11	10	9	8
ICP3	ICP2	ICE3	ICE2	EG31	EG30	EG21	EG20
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000$_B$

Input capture control status register (ICS01)

Address : 000052H

7	6	5	4	3	2	1	0
ICP1	ICP0	ICE1	ICE0	EG11	EG10	EG01	EG00
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000$_B$

• Block diagram of the 16-bit free-run timer, input capture units, and output compare units

* : Interrupt number
φ : Machine clock frequency
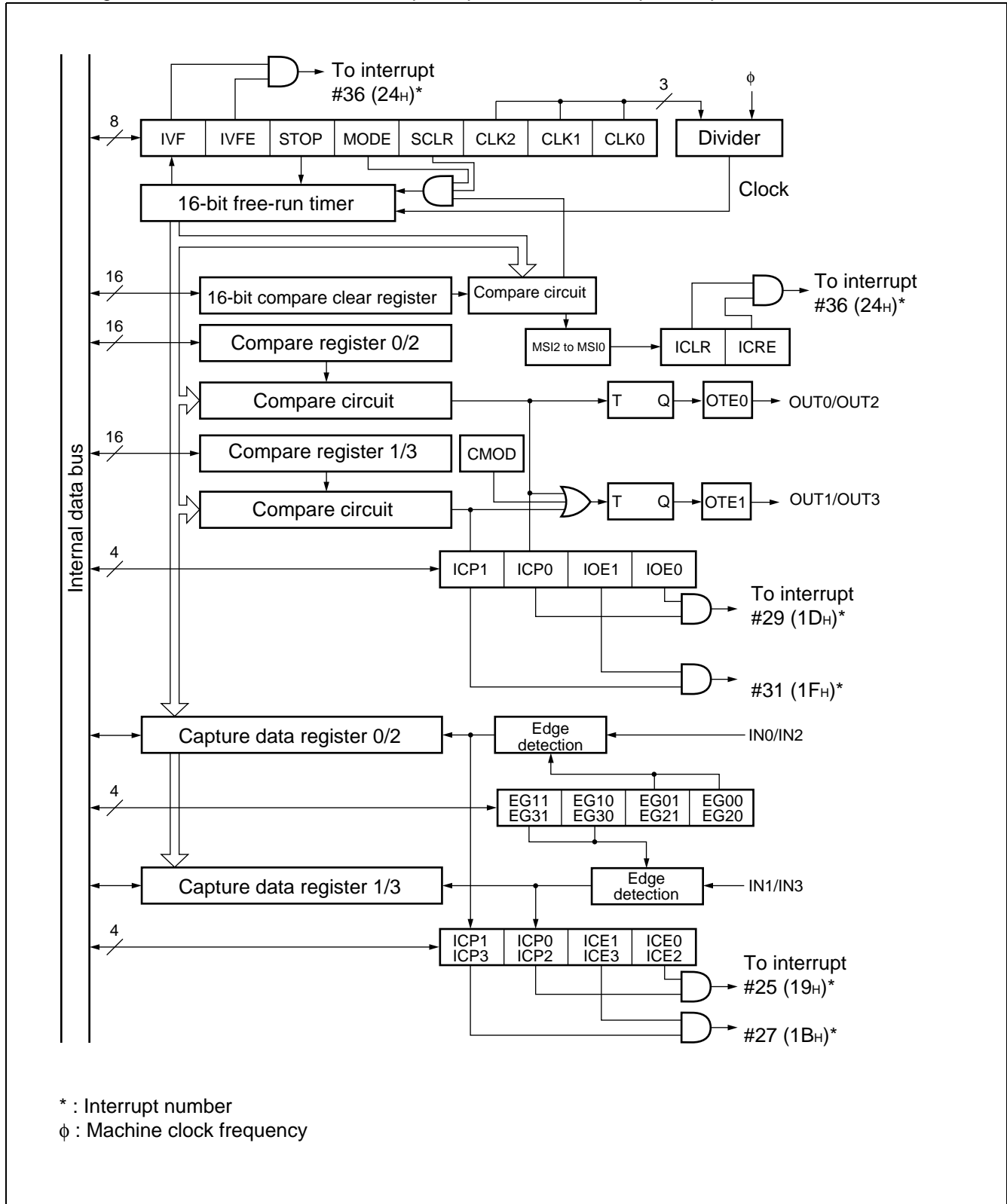
• 8/16-bit PPG timer (8-bit : 6 channels, 16-bit : 3 channels)

8/16-bit PPG timer consists of an 8-bit down counter (PCNT), PPG control register (PPGC0 to PPGC5), PPG output control register (PPG01, PPG23, PPG45) and PPG reload register (PRLL0 to PRLL5, PRLH0 to PRLH5). When used as an 8-/16-bit reload timer, the PPG timer serves as an event timer. It can also output pulses of an arbitrary duty ratio at an arbitrary frequency.
- 8-bit PPG mode
  Each channel operates as an independent 8-bit PPG.
- 8-bit prescaler + 8-bit PPG mode
  Operates as an arbitrary-cycle 8-bit PPG with PPG0 (PPG2, PPG4) operating as an 8-bit prescaler and PPG1 (PPG3, PPG5) counted by the borrow output of PPG0 (PPG2, PPG4).
- 16-bit PPG mode
  Operates as a 16-bit PPG with PPG0 (PPG2, PPG4) and PPG1 (PPG3, PPG5) connected.
- PPG operation
  The PPG timer outputs pulses of an arbitrary duty ratio (the ratio between the High and Low level periods of pulse waveform) at an arbitrary frequency. This can also be used as a D/A converter by an external circuit.

• Register list

PPG operation mode control register
(PPGC1/PPGC3/PPGC5)

Address : 000047H
000049H
00004BH

Initial Value
0X000001B

15	14	13	12	11	10	9	8
PEN1	—	PE10	PIE1	PUF1	MD1	MD0	Reserved
(R/W)	(—)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

(PPGC0/PPGC2/PPGC4)

Address : 000046H
000048H
00004AH

Initial Value
0X000XX1B

7	6	5	4	3	2	1	0
PEN0	—	PE00	PIE0	PUF0	—	—	Reserved
(R/W)	(—)	(R/W)	(R/W)	(R/W)	(—)	(—)	(R/W)

PPG output control register (PPG01/PPG23/PPG45)

Address : 00004CH
00004EH
000050H

Initial Value
000000XXB

7	6	5	4	3	2	1	0
PCS2	PCS1	PCS0	PCM2	PCM1	PCM0	Reserved	Reserved
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

PPG reload register
(PRLH0 to PRLH5)
Address : 007901H
007903H
007905H
007907H
007909H
00790BH

Initial Value
XXXXXXXXB

15	14	13	12	11	10	9	8
D15	D14	D13	D12	D11	D10	D09	D08
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

(PRLL0 to PRLL5)
Address : 007900H
007902H
007904H
007906H
007908H
00790AH

Initial Value
XXXXXXXXB

7	6	5	4	3	2	1	0
D07	D06	D05	D04	D03	D02	D01	D00
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

• 8/16-bit PPG ch0/2/4 block diagram

Peripheral clock dividing by 16
Peripheral clock dividing by 8
Peripheral clock dividing by 4
Peripheral clock dividing by 2
Peripheral clock

PPG0/PPG2/PPG4 output enable

PPG0/PPG2/PPG4

A/D converteer

PPG0/PPG2/PPG4 output latch

PEN0

Count clock select

PCNT (down counter)

S
R Q

IRQ

To interrupt
#30 (1E$_H$)*
#32 (20$_H$)*
#34 (22$_H$)*

ch1/3/5 borrow

Dividing by 512 of timebase counter output main clock

L/H selector

PUF0

PIE0

L/H select

PRLL   PRLBH

PRLL

PPGC0 (operating mode control)

L data bus

H data bus

* : Interrupt number

• 8-bit PPG ch1/3/5 block diagram

Peripheral clock dividing by 16
Peripheral clock dividing by 8
Peripheral clock dividing by 4
Peripheral clock dividing by 2
Peripheral clock

PPG1/PPG3/PPG5 output enable

PPG1/PPG3/PPG5

PPG1/PPG3/PPG5 output latch

PEN1

Count clock select

PCNT (down counter)

S R Q

To interrupt
#30 (1E$_H$)*
#32 (20$_H$)*
#34 (22$_H$)*

IRQ

Dividing by 512 timebase counter output main clock

L/H selector

PUF1

PIE1

L/H select

PRLL

PRLBH

PRLL

PPGC1 (operating mode control)

L data bus

H data bus

* : Interrupt number

• PWC timer

The PWC timer is a 16-bit multi-function up-count timer capable of measuring the input signal pulse width.

• Register list

PWC control status register (PWCSR)

	15	14	13	12	11	10	9	8	Initial Value
Address : 00005D$_H$	STRT	STOP	EDIR	EDIE	OVIR	OVIE	ERR	Reserved	0000000X$_B$
	(R/W)	(R/W)	(R)	(R/W)	(R/W)	(R/W)	(R)	(R/W)	

	7	6	5	4	3	2	1	0	Initial Value
Address : 00005C$_H$	CKS1	CKS0	PIS1	PIS0	S/C	MOD2	MOD1	MOD0	00000000$_B$
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	

PWC data buffer register (PWCR)

	15	14	13	12	11	10	9	8	Initial Value
Address : 00005F$_H$	D15	D14	D13	D12	D11	D10	D9	D8	00000000$_B$
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	

	7	6	5	4	3	2	1	0	Initial Value
Address : 00005E$_H$	D7	D6	D5	D4	D3	D2	D1	D0	00000000$_B$
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	

Ratio of dividing frequency control register (DIVR)

	7	6	5	4	3	2	1	0	Initial Value
Address : 000060$_H$	—	—	—	—	—	—	DIV1	DIV0	------00$_B$
	(—)	(—)	(—)	(—)	(—)	(—)	(R/W)	(R/W)	

• Block Diagram
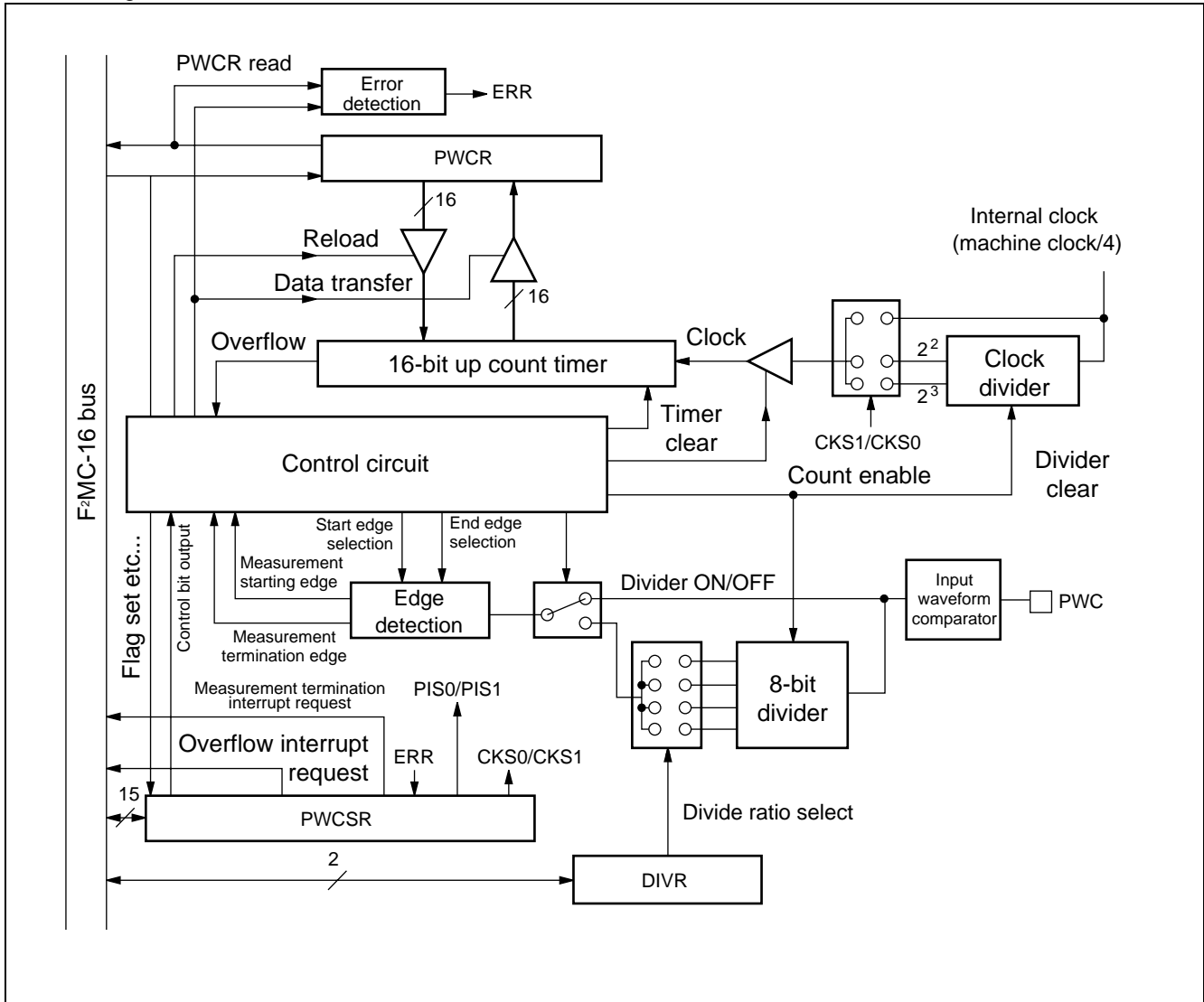
7. UART

UART is a general purpose serial communication interface for synchronous or asynchronous (start-stop synchronization) communications with external devices. It supports bi-directional communication (normal mode) and master/slave communication (multi-processor mode: supported on master side only). An interrupt can be generated upon completion of reception, detection of a reception error, or completion of transmission. EI^{2}OS is supported.

• UART functions

UART, or a generic serial data communication interface that sends and receives serial data to and from other CPU and peripherals, has the functions listed in following.

	Function
Data buffer	Full-duplex double-buffered
Transmission mode	• Clock synchronous (without start/stop bit) • Clock asynchronous (start-stop synchronous)
Baud rate	• Special-purpose baud-rate generator It is optional from 8 kinds. • Baud rate by external clock (SCK0/SCK1/SCK2/SCK3 terminal input)
Data length	• 8-bit or 7-bit (in the asynchronous normal mode only) • 1-bit to 8-bit (synchronous mode only)
Signal system	Non Return to Zero (NRZ) system
Reception error detection	• Framing error • Overrun error • Parity error (Not supported in operation mode 1)
Interrupt request	• Receive interrupt (reception completed, reception error detected) • Transmission interrupt (transmission completed) • Both the transmission and reception support EI^{2}OS.
Master/slave type communication function (multi processor mode)	Capable of 1 (master) to many (slaves) communication (available just as master)

Note : In clock synchronous transfer mode, the UART transfers only data with no start or stop bit added.

• UART operation modes

Operation mode	Data length		Synchronization	Stop bit length
	Without parity	With parity		
0 Normal mode	7-bit or 8-bit		Asynchronous	1-bit or 2-bit *2
1 Multi processor mode	8-bit + 1*1	—	Asynchronous	
2 Normal mode	1 to 8-bit	—	Synchronous	No

— : Setting disabled

*1 : + 1 is an address/data setting bit (A/D) which is used for communication control.

*2 : Only one bit can be detected as a stop bit at reception.

• Register list

Serial mode register (SMR0 to SMR3)

Address : 000020H
000026H
00002CH
000032H

Initial Value

00100000B

7	6	5	4	3	2	1	0
MD1	MD0	SCKL	M2L2	M2L1	M2L0	SCKE	SOE
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Serial control register (SCR0 to SCR3)

Address : 000021H
000027H
00002DH
000033H

Initial Value

00000100B

15	14	13	12	11	10	9	8
PEN	P	SBL	CL	A/D	REC	RXE	TXE
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(W)	(R/W)	(R/W)

Serial input/output data register (SIDR0 to SIDR3 / SODR0 to SODR3)

Address : 000022H
000028H
00002EH
000034H

Initial Value

XXXXXXXXB

7	6	5	4	3	2	1	0
D7	D6	D5	D4	D3	D2	D1	D0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Serial status register (SSR0 to SSR3)

Address : 000023H
000029H
00002FH
000035H

Initial Value

00001000B

15	14	13	12	11	10	9	8
PE	ORE	FRE	RDRF	TDRE	BDS	RIE	TIE
(R)	(R)	(R)	(R)	(R)	(R/W)	(R/W)	(R/W)

UART prescaler reload register (UTRLR0 to UTRLR3)

Address : 000024H
00002AH
000030H
000036H

Initial Value

00000000B

7	6	5	4	3	2	1	0
D7	D6	D5	D4	D3	D2	D1	D0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

UART prescaler control register (UTCR0 to UTCR3)

Address : 000025H
00002BH
000031H
000037H

Initial Value

0000-000B

15	14	13	12	11	10	9	8
MD	SRST	CKS	Reserved	—	D10	D9	D8
(R/W)	(R/W)	(R/W)	(R/W)	(—)	(R/W)	(R/W)	(R/W)

• Block Diagram

Control bus

Special-purpose
baud-rate generator
 (UART prescaler
control register
UTCR0 to UTCR3)
 (UART prescaler
reload UTRLR0 to
UTRLR3)

Clock
selector

Pin
SCK0 to SCK3

Reception interrupt signal
#39 (27H)*
#35 (23H)*

Send interrupt signal
#37 (25H)*
#33 (21H)*

Transmission clock

Reception clock

Reception clock

Reception control circuit

Transmission control circuit

Start bit detection circuit

Reception bit counter

Reception parity counter

Transmission start circuit

Transmission bit counter

Transmission parity counter

Pin
SOT0 to SOT3

Pin
SIN0 to SIN3

Shift register for reception

SIDR0 to SIDR3

Shift register for transmission

SODR0 to SODR3

Start transmission

Reception complete

Receive status decision circuit

Reception error occurrence signal for EI²OS • µDMAC (to CPU)

Internal data bus

SMR0 to SMR3
MD1
MD0
SCKL
M2L2
M2L1
M2L0
SCKE
SOE

SCR0 to SCR3
PEN
P
SBL
CL
A/D
REC
RXE
TXE

SSR0 to SSR3
PE
ORE
FRE
RDRF
TDRE
BDS
RIE
TIE

* : Interrupt number

8.   Extended I/O serial interface

The extended I/O serial interface is a serial I/O interface in an 8-bit, single-channel, capable of clock synchronous data transfer. LSB-first or MSB-first transfer mode can be selected for data transfer.

There are 2 serial I/O operation modes available:
• Internal shift clock mode: Transfer data in synchronization with the internal clock.
• External shift clock mode: Transfer data in synchronization with the clock supplied via the external pin (SCK). By manipulating the general-purpose port sharing the external pin (SCK) in this mode, data can also be transferred by a CPU instruction.

• Register list

Serial mode control status register (SMCS)

	15	14	13	12	11	10	9	8	Initial Value
Address : 000059H	SMD2	SMD1	SMD0	SIE	SIR	BUSY	STOP	STRT	00000010B
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	

	7	6	5	4	3	2	1	0	Initial Value
Address : 000058H	—	—	—	—	MODE	BDS	SOE	SCOE	XXXX0000B
	(—)	(—)	(—)	(—)	(R/W)	(R/W)	(R/W)	(R/W)	

Serial data register (SDR)

	7	6	5	4	3	2	1	0	Initial Value
Address : 00005AH	D7	D6	D5	D4	D3	D2	D1	D0	XXXXXXXXB
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	

Communication prescaler control register (SDCR)

	15	14	13	12	11	10	9	8	Initial Value
Address : 00005BH	MD	—	—	—	DIV3	DIV2	DIV1	DIV0	0XXX0000B
	(R/W)	(—)	(—)	(—)	(R/W)	(R/W)	(R/W)	(R/W)	

• Block Diagram

Internal data bus

(MSB fast) D0 to D7   D7 to D0 (LSB fast)   Initial value

Transfer direction selection

SIN

SDR (serial data register)   Read
                                   Write

SOT

SCK

Control circuit   Shift clock counter

Internal clock ◇

| 2 | 1 | 0 | | | | | | | | | |
| SMD2 | SMD1 | SMD0 | SIE | SIR | BUSY | STOP | STRT | MODE | BDS | SOE | SCOE |

Interrupt
request
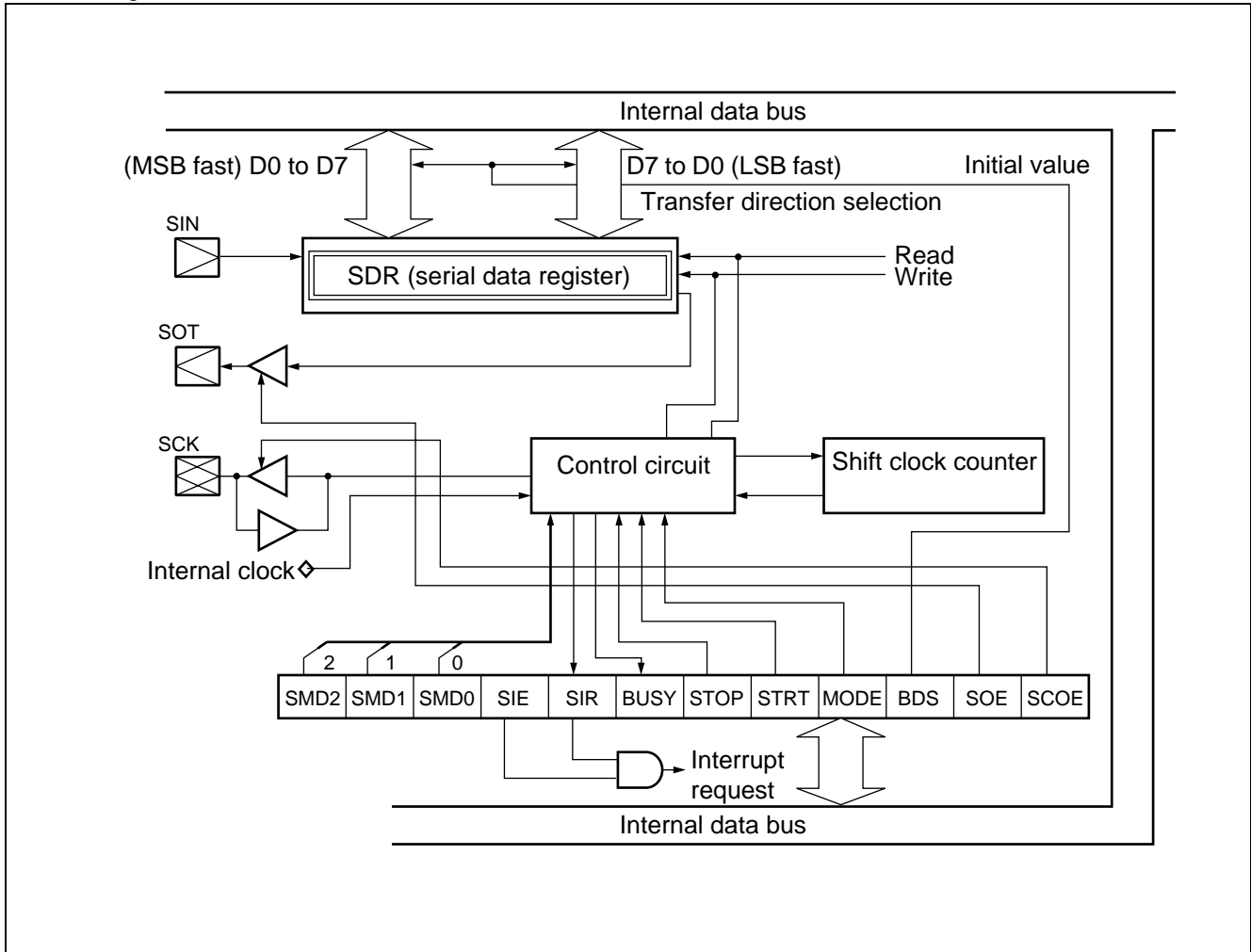
Internal data bus

9. I²C Interface

The I²C interface is a serial I/O port supporting the Inter IC BUS. It serves as a master/slave device on the I²C bus and has the following features.
- Master/slave sending and receiving
- Arbitration function
- Clock synchronization function
- Slave address and general call address detection function
- Detecting transmitting direction function
- Start condition repeated generation and detection function
- Bus error detection function

• Register list

I²C bus status register (IBSR0 to IBSR2)

Address : 000070H
000076H
00007CH

7	6	5	4	3	2	1	0
BB	RSC	AL	LRB	TRX	AAS	GCA	FBT
(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)

Initial Value
00000000B

I²C bus control register (IBCR0 to IBCR2)

Address : 000071H
000077H
00007DH

15	14	13	12	11	10	9	8
BER	BEIE	SCC	MSS	ACK	GCAA	INTE	INT
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000B

I²C bus clock selection register (ICCR0 to ICCR2)

Address : 000072H
000078H
00007EH

7	6	5	4	3	2	1	0
—	—	EN	CS4	CS3	CS2	CS1	CS0
(—)	(—)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XX0XXXXXB

I²C bus address register (IADR0 to IADR2)

Address : 000073H
000079H
00007FH

15	14	13	12	11	10	9	8
—	A6	A5	A4	A3	A2	A1	A0
(—)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXXB

I²C bus data register (IDAR0 to IDAR2)

Address : 000074H
00007AH
000080H

7	6	5	4	3	2	1	0
D7	D6	D5	D4	D3	D2	D1	D0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXXB

• Block Diagram

10. USB Function

The USB function is an interface supporting the USB (Universal Serial Bus) communications protocol.

- Feature of USB function
  - Conform to USB2.0 Full Speed
  - Full speed (12 Mbps) is supported.
  - The device status is auto-answer.
  - Bit stripping, bit stuffing, and automatic generation and check of CRC5 and CRC16
  - Toggle check by data synchronization bit
  - Automatic response to all standard commands except Get/SetDescriptor and SynchFrame commands (these 3 commands can be processed the same way as the class vendor commands).
  - The class vendor commands can be received as data and responded via firmware.
  - Supports up to 6 EndPoints (EndPoint0 is fixed to control transfer)
  - 2 transfer data buffers integrated for each end point (one IN buffer and one OUT buffer for EndPoint 0)
  - Supports automatic transfer mode for transfer data via DMA (except buffers for EndPoint 0)
  - Capable of detection of connection and disconnection by monitoring the USB bus power line

- Register list

UDC control register (UDCC)

Address : 0000D0H	7	6	5	4	3	2	1	0	Initial Value 10100000B
	RST	RESUM	HCON	USTP	Reserved	Reserved	RFBK	PWC	
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	

EP0 control register (EP0C)

Address : 0000D2H	7	6	5	4	3	2	1	0	Initial Value X1000000B
	Reserved	PKS0	PKS0	PKS0	PKS0	PKS0	PKS0	PKS0	
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	

Address : 0000D3H	15	14	13	12	11	10	9	8	Initial Value XXXX000XB
	—	—	—	—	Reserved	Reserved	STAL	Reserved	
	(—)	(—)	(—)	(—)	(R/W)	(R/W)	(R/W)	(R/W)	

EP1 control register (EP1C)

Address : 0000D4H	7	6	5	4	3	2	1	0	Initial Value 00000000B
	PKS1	PKS1	PKS1	PKS1	PKS1	PKS1	PKS1	PKS1	
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	

Address : 0000D5H	15	14	13	12	11	10	9	8	Initial Value 01100001B
	EPEN	TYPE	TYPE	DIR	DMAE	NULE	STAL	PKS1	
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	

(Continued)

EP2/3/4/5 control register (EP2C to EP5C)

Address : 0000D6H, 0000D8H, 0000DAH, 0000DCH — Initial Value 01000000B

7	6	5	4	3	2	1	0
Reserved	PKS2 to 5	PKS2 to 5	PKS2 to 5	PKS2 to 5	PKS2 to 5	PKS2 to 5	PKS2 to 5
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Address : 0000D7H, 0000D9H, 0000DBH, 0000DDH — Initial Value 01100000B

15	14	13	12	11	10	9	8
EPEN	TYPE	TYPE	DIR	DMAE	NULE	STAL	Reserved
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Time stamp register (TMSP)

Address : 0000DEH — Initial Value 00000000B

7	6	5	4	3	2	1	0
TMSP	TMSP	TMSP	TMSP	TMSP	TMSP	TMSP	TMSP
(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)

Address : 0000DFH — Initial Value 00000000B

15	14	13	12	11	10	9	8
—	—	—	—	—	TMSP	TMSP	TMSP
(—)	(—)	(—)	(—)	(—)	(R)	(R)	(R)

UDC status register (UDCS)

Address : 0000E0H — Initial Value 00000000B

7	6	5	4	3	2	1	0
VOFF	VON	SUSP	SOF	BRST	WKUP	SETP	CONF
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

UDC Interrupt enable register (UDCIE)

Address : 0000E1H — Initial Value 00000000B

15	14	13	12	11	10	9	8
VOFFIE	VONIE	SUSPIE	SOFIE	BRSTIE	WKUPIE	CONFN	CONFIE
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R)	(R/W)

EP0I status register (EP0IS)

Address : 0000E2H — Initial Value XXXXXXXXB

7	6	5	4	3	2	1	0
—	—	—	—	—	—	—	—
(—)	(—)	(—)	(—)	(—)	(—)	(—)	(—)

Address : 0000E3H — Initial Value 10XXX1XXB

15	14	13	12	11	10	9	8
BFINI	DRQIIE	—	—	—	DRQI	—	—
(R/W)	(R/W)	(—)	(—)	(—)	(R/W)	(—)	(—)

(Continued)

(Continued)

EP0O status register (EP0OS)

Address : 0000E4H

7	6	5	4	3	2	1	0
—	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE
(—)	(R)	(R)	(R)	(R)	(R)	(R)	(R)

Initial Value XXXXXXXXB

Address : 0000E5H

15	14	13	12	11	10	9	8
BFINI	DRQOIE	SPKIE	—	—	DRQO	SPK	—
(R/W)	(R/W)	(R/W)	(—)	(—)	(R/W)	(R/W)	(—)

Initial Value 100XX00XB

EP1 status register (EP1S)

Address : 0000E6H

7	6	5	4	3	2	1	0
SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value XXXXXXXXB

Address : 0000E7H

15	14	13	12	11	10	9	8
BFINI	DRQIE	SPKIE	—	BUSY	DRQ	SPK	SIZE
(R/W)	(R/W)	(R/W)	(—)	(R)	(R/W)	(R/W)	(R/W)

Initial Value 1000000XB

EP2/3/4/5 status register (EP2S to EP5S)

Address : 0000E8H
0000EAH
0000ECH
0000EEH

7	6	5	4	3	2	1	0
—	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE	SIZE
(—)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value XXXXXXXXB

Address : 0000E9H
0000EBH
0000EDH
0000EFH

15	14	13	12	11	10	9	8
BFINI	DRQIE	SPKIE	—	BUSY	DRQ	SPK	—
(R/W)	(R/W)	(R/W)	(—)	(R)	(R/W)	(R/W)	(—)

Initial Value 1000000XB

EP0/1/2/3/4/5 data register (EP0DT to EP5DT)

Address : 0000F0H
0000F2H
0000F4H
0000F6H
0000F8H
0000FAH

7	6	5	4	3	2	1	0
BFDT	BFDT	BFDT	BFDT	BFDT	BFDT	BFDT	BFDT
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value XXXXXXXXB

Address : 0000F1H
0000F3H
0000F5H
0000F7H
0000F9H
0000FBH

15	14	13	12	11	10	9	8
BFDT	BFDT	BFDT	BFDT	BFDT	BFDT	BFDT	BFDT
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value XXXXXXXXB

11. USB Mini-HOST

USB Mini-HOST provides minimal host operations required and is a function that enables data to be transferred to and from Device without PC intervention.

• Feature of USB Mini-HOST
  • Automatic detection of Low Speed/Full Speed transfer
  • Low Speed/Full Speed transfer support
  • Automatic detection of connection and cutting device
  • Reset sending function support to USB-bus
  • Support of IN/OUT/SETUP/SOF token
  • In-token handshake packet automatic transmission (excluding STALL)
  • Out-token handshake packet automatic detection
  • Supports a maximum packet length of 256 bytes.
  • Error (CRC error/toggle error/time-out) various supports
  • Wake-Up function support

• Differences between the USB HOST and USB Mini-HOST

		HOST	Mini-HOST
Hub support		○	×
Transfer	Bulk transfer	○	○
	Control transfer	○	○
	Interrupt transfer	○	○
	ISO transfer	○	×
Transfer speed	Low Speed	○	○
	Full Speed	○	○
PRE packet support		○	×
SOF packet support		○	○
Error	CRC error	○	○
	Toggle error	○	○
	Time-out	○	○
	Maximum packet < receive data	○	○
Detection of connection and cutting of device		○	○
Transfer speed detection		○	○

○ : Supported
× : Not supported

● Register list

USB host control register 0 (HCNT0)

Initial Value
00000000B

Address : 0000C0H

7	6	5	4	3	2	1	0
RWKIRE	URIRE	CMPIRE	CNNIRE	DIRE	SOFIRE	URST	HOST
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

USB host control register 1 (HCNT1)

Initial Value
00000001B

Address : 0000C1H

15	14	13	12	11	10	9	8
Reserved	Reserved	Reserved	Reserved	Reserved	SOFSTEP	CANCEL	RETRY
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

USB host interruption register (HIRQ)

Initial Value
00000000B

Address : 0000C2H

7	6	5	4	3	2	1	0
TCAN	Reserved	RWKIRQ	URIRQ	CMPIRQ	CNNIRQ	DIRQ	SOFIRQ
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

USB host error status register (HERR)

Initial Value
00000011B

Address : 0000C3H

15	14	13	12	11	10	9	8
LSTSOF	RERR	TOUT	CRC	TGERR	STUFF	HS	HS
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

USB host state status register (HSTATE)

Initial Value
XX010010B

Address : 0000C4H

7	6	5	4	3	2	1	0
—	—	ALIVE	CLKSEL	SOFBUSY	SUSP	TMODE	CSTAT
(—)	(—)	(R/W)	(R/W)	(R/W)	(R/W)	(R)	(R)

USB SOF interruption FRAME comparison register (HFCOMP)

Initial Value
00000000B

Address : 0000C5H

15	14	13	12	11	10	9	8
FRAME COMP	FRAME COMP	FRAME COMP	FRAME COMP	FRAME COMP	FRAME COMP	FRAME COMP	FRAME COMP
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

(Continued)

(Continued)

USB retry timer setting register 0/1/2 (HRTIMER)

Address : 0000C6H

7	6	5	4	3	2	1	0
RTIMER0	RTIMER0	RTIMER0	RTIMER0	RTIMER0	RTIMER0	RTIMER0	RTIMER0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000B

Address : 0000C7H

15	14	13	12	11	10	9	8
RTIMER1	RTIMER1	RTIMER1	RTIMER1	RTIMER1	RTIMER1	RTIMER1	RTIMER1
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000B

Address : 0000C8H

7	6	5	4	3	2	1	0
—	—	—	—	—	—	RTIMER2	RTIMER2
(—)	(—)	(—)	(—)	(—)	(—)	(R/W)	(R/W)

Initial Value
XXXXXX00B

USB host address register (HADR)

Address : 0000C9H

15	14	13	12	11	10	9	8
—	ADDRESS	ADDRESS	ADDRESS	ADDRESS	ADDRESS	ADDRESS	ADDRESS
(—)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
X0000000B

USB EOF setting register 0/1 (HEOF)

Address : 0000CAH

7	6	5	4	3	2	1	0
EOF0	EOF0	EOF0	EOF0	EOF0	EOF0	EOF0	EOF0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000B

Address : 0000CBH

15	14	13	12	11	10	9	8
—	—	EOF1	EOF1	EOF1	EOF1	EOF1	EOF1
(—)	(—)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XX000000B

USB FRAME setting register (HFRAME)

Address : 0000CCH

7	6	5	4	3	2	1	0
FRAME0	FRAME0	FRAME0	FRAME0	FRAME0	FRAME0	FRAME0	FRAME0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000B

Address : 0000CDH

15	14	13	12	11	10	9	8
—	—	—	—	—	FRAME1	FRAME1	FRAME1
(—)	(—)	(—)	(—)	(—)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXX000B

USB token end point register (HTOKEN)

Address : 0000CEH

7	6	5	4	3	2	1	0
TGGL	TKNEN	TKNEN	TKNEN	ENDPT	ENDPT	ENDPT	ENDPT
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000B

12. 8/10-bit A/D converter

The A/D converter converts analog input voltages into digital values and has the following features.
- RC sequential compare conversion method with sample and hold circuit
- Selectable 8-bit resolution or 10-bit resolution
- Analog input program-selectable from among 16 channels

Single conversion mode : Convert 1 selected channel

Scan conversion mode : Continuous plural channels (maximum 16 channels can be programmed) are converted.

Continuous conversion mode : Repeatedly convert the specified channels.

Stop conversion mode: Convert 1 channel then suspend conversion to remain on standby until the next activation. (Simultaneous conversion start available.)
- An interrupt request to the CPU can be generated upon completion of A/D conversion. Suitable for continuous processing as this interrupt activates µDMA to transfer the data resulting from A/D conversion to memory.
- The activation source can be selected from among software, external trigger (falling edge), and timer (rising edge).

• Register list

AD control status register lower/upper (ADCS0/ADCS1)

Address : 000040$_H$

Initial Value 00 - - - - - 0$_B$

7	6	5	4	3	2	1	0
MD1	MD0	—	—	—	—	—	Reserved
(R/W)	(R/W)	(—)	(—)	(—)	(—)	(—)	(R/W)

Address : 000041$_H$

Initial Value 00000000$_B$

15	14	13	12	11	10	9	8
BUSY	INT	INTE	PAUS	STS1	STS0	STRT	Reserved
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(W)	(R/W)

AD data register lower/upper (ADCR0/ADCR1)

Address : 000042$_H$

Initial Value XXXXXXXX$_B$

7	6	5	4	3	2	1	0
D7	D6	D5	D4	D3	D2	D1	D0
(R)	(R)	(R)	(R)	(R)	(R)	(R)	(R)

Address : 000043$_H$

Initial Value 00101XXX$_B$

15	14	13	12	11	10	9	8
S10	ST1	ST0	CT1	CT0	—	D9	D8
(R/W)	(W)	(W)	(W)	(W)	(—)	(R)	(R)

AD conversion channel selection register (ADMR)

Address : 000045$_H$

Initial Value 00000000$_B$

15	14	13	12	11	10	9	8
ANS3	ANS2	ANS1	ANS0	ANE3	ANE2	ANE1	ANE0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

• Block Diagram
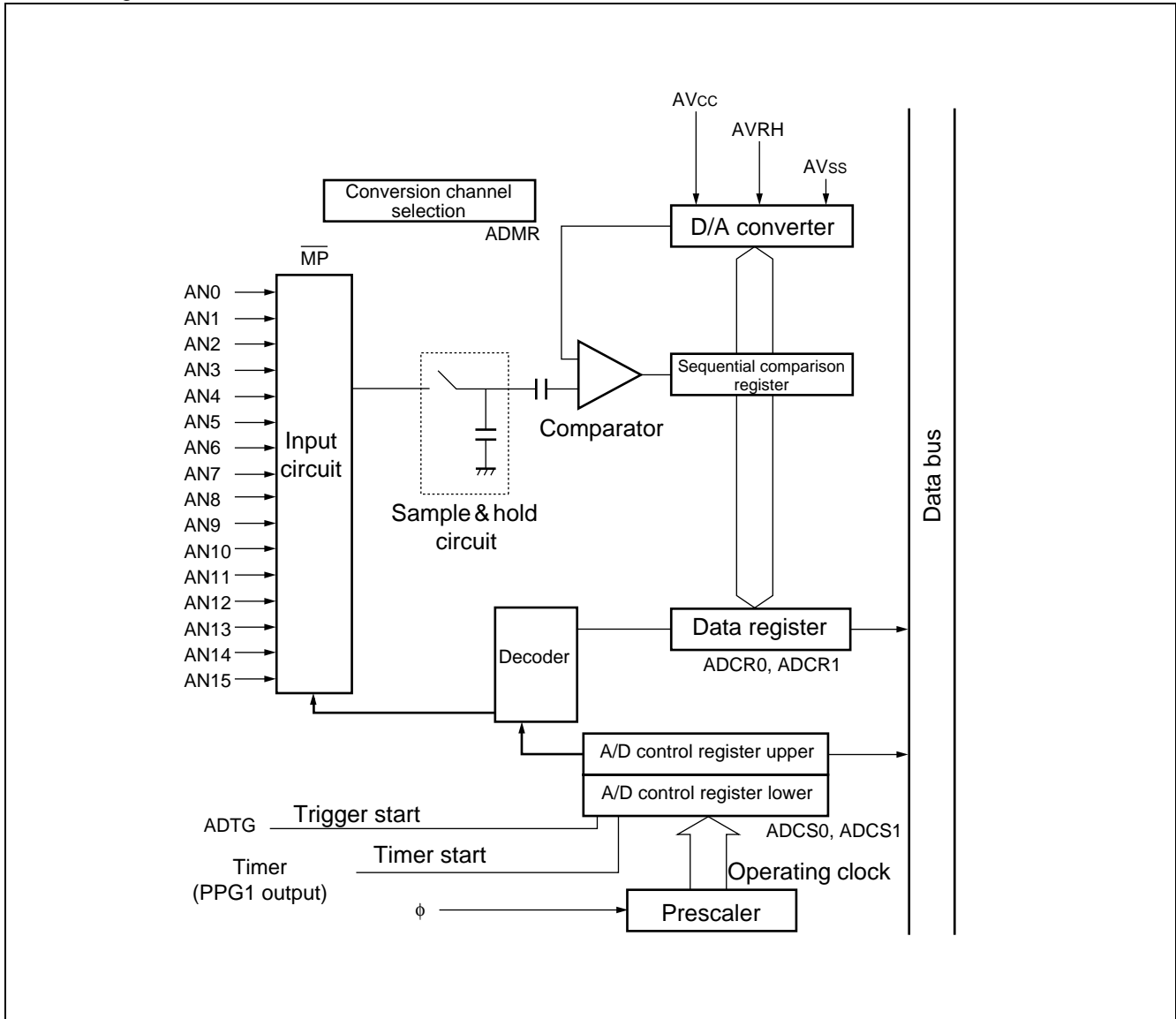
13. DTP/External interrupt circuit

DTP (Data Transfer Peripheral)/External interrupt circuit detects the interrupt request input from the external interrupt input terminal (INT7 to INT0) , and outputs the interrupt request.

● DTP/External interrupt circuit function

The DTP/External interrupt function outputs an interrupt request upon detection of the edge or level signal input to the external interrupt input pins (INT7 to INT0).

If CPU accepts the interrupt request, and if the extended intelligent I/O service (EI^{2}OS) is enabled, branches to the interrupt handling routine after completing the automatic data transfer (DTP function) performed by EI^{2}OS. And if EI^{2}OS is disabled, it branches to the interrupt handling routine without activating the automatic data transfer (DTP function) performed by EI^{2}OS.

● Overview of DTP/External interrupt circuit

	External interrupt	DTP function
Input pin	8 channels (P60/INT0, P61/INT1, P62/INT2/SIN, P63/INT3/SOT, P64/INT4/SCK, P65/INT5/PWC, P66/INT6/SCL0, P67/INT7/SDA0)	
Interrupt source	The detection level or the type of the edge for each terminal can be set in the request level setting register (ELVR).	
	Input of H level/L level/rising edge/falling edge.	
Interrupt number	#18 (12$_H$), #20 (14$_H$), #22 (16$_H$), #24 (18$_H$)	
Interrupt control	Enabling/disabling the interrupt request output using the DTP/interrupt enable register (ENIR)	
Interrupt flag	Holding the interrupt causes using the DTP/interrupt cause register (EIRR)	
Process setting	Disable EI^{2}OS (ICR: ISE="0")	Enable EI^{2}OS (ICR: ISE="1")
Process	Branched to the interrupt handling routine	After an automatic data transfer by EI^{2}OS, branched to the interrupt handling routine

• Register list

DTP/Interrupt enable register (ENIR)

| | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
Address : 00003C$_H$

| EN7 | EN6 | EN5 | EN4 | EN3 | EN2 | EN1 | EN0 |
| (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) |

Initial Value
00000000$_B$

DTP/Interrupt source register (EIRR)

15 14 13 12 11 10 9 8
Address : 00003D$_H$

| ER7 | ER6 | ER5 | ER4 | ER3 | ER2 | ER1 | ER0 |
| (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) |

Initial Value
00000000$_B$

Request level setting register (ELVR)

7 6 5 4 3 2 1 0
Address : 00003E$_H$

| LB3 | LA3 | LB2 | LA2 | LB1 | LA1 | LB0 | LA0 |
| (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) |

Initial Value
00000000$_B$

15 14 13 12 11 10 9 8
Address : 00003F$_H$

| LB7 | LA7 | LB6 | LA6 | LB5 | LA5 | LB4 | LA4 |
| (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) | (R/W) |

Initial Value
00000000$_B$

73

• Block Diagram

* : Interrupt number
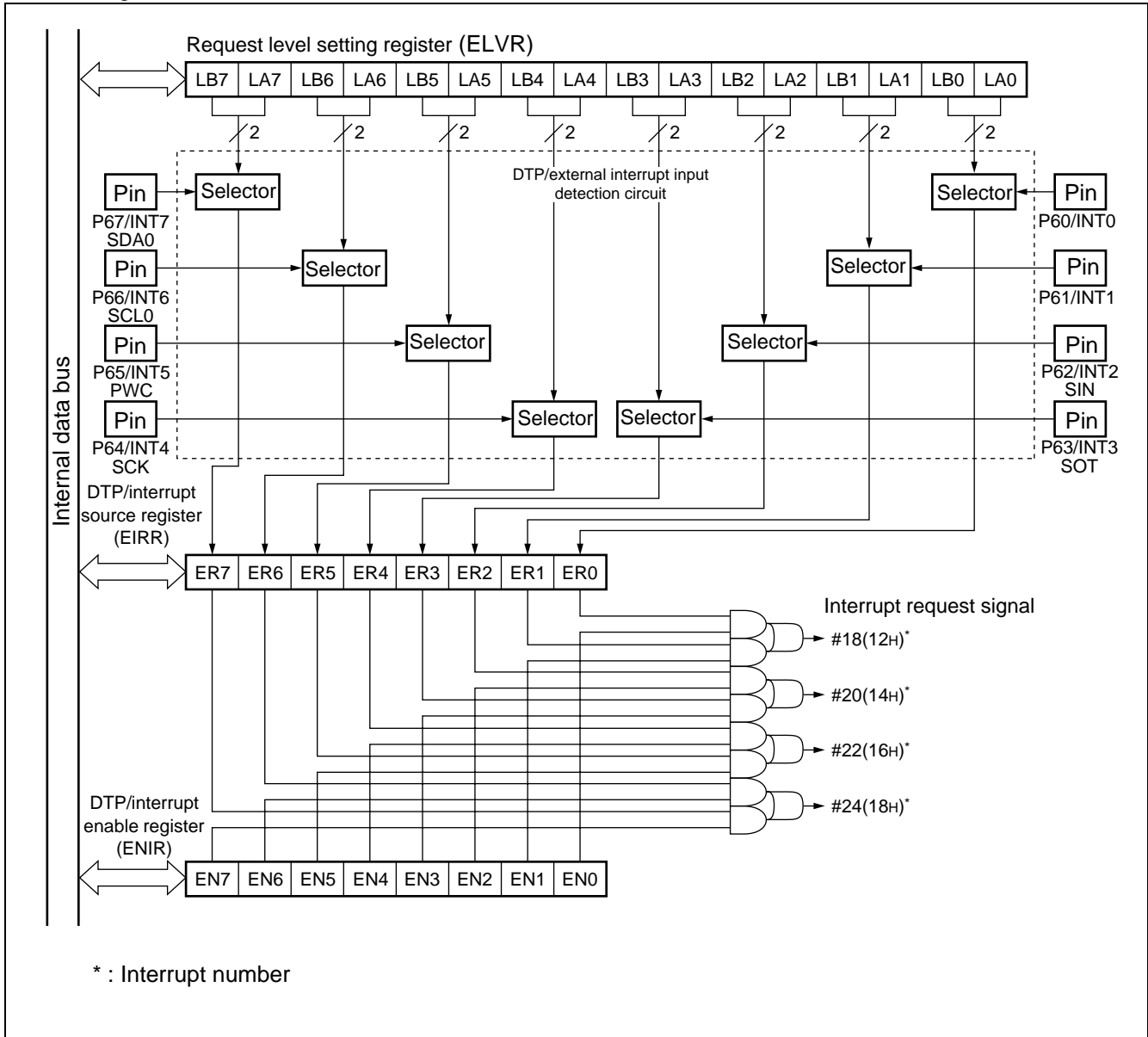
14. Interrupt controller

The interrupt control register is located inside the interrupt controller; it exists for every I/O having an interrupt function. This register has the following functions.
• Setting of the interrupt levels of relevant resources

• Register list

Interrupt control register (ICR01, ICR03, ICR05, ICR07, ICR09, ICR11, ICR13, ICR15)

Initial Value
00000111_B

Address : ICR01 : $0000B1_H$
ICR03 : $0000B3_H$
ICR05 : $0000B5_H$
ICR07 : $0000B7_H$
ICR09 : $0000B9_H$
ICR11 : $0000BB_H$
ICR13 : $0000BD_H$
ICR15 : $0000BF_H$

15	14	13	12	11	10	9	8	
ICS3	ICS2	ICS1	ICS0	ISE	IL2	IL1	IL0	
(W)	(W)	(W)	(W)	(R/W)	(R/W)	(R/W)	(R/W)	

Interrupt control register (ICR00, ICR02, ICR04, ICR06, ICR08, ICR10, ICR12, ICR14)

Initial Value
00000111_B

Address : ICR00 : $0000B0_H$
ICR02 : $0000B2_H$
ICR04 : $0000B4_H$
ICR06 : $0000B6_H$
ICR08 : $0000B8_H$
ICR10 : $0000BA_H$
ICR12 : $0000BC_H$
ICR14 : $0000BE_H$

7	6	5	4	3	2	1	0	
ICS3	ICS2	ICS1	ICS0	ISE	IL2	IL1	IL0	
(W)	(W)	(W)	(W)	(R/W)	(R/W)	(R/W)	(R/W)	

Note : Do not access interrupt control registers using any read modify write instruction because it causes a malfunction.

• Block Diagram

15. μDMAC
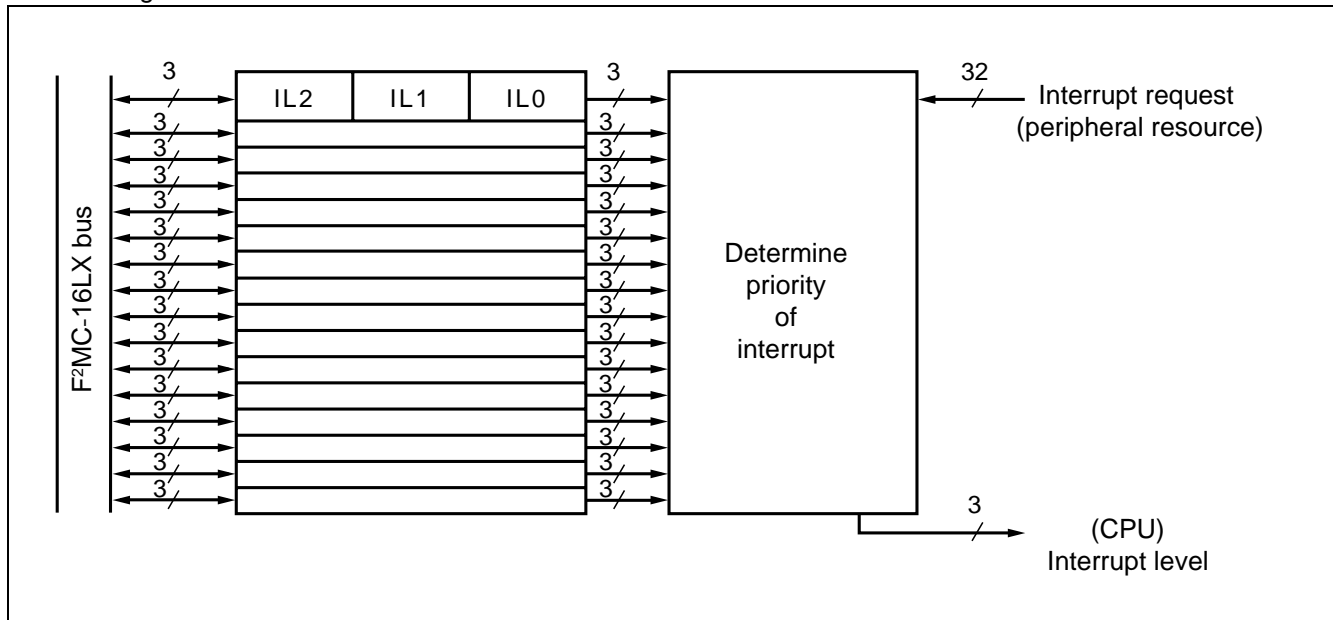
μDMAC is simple DMA with the function equal with EI²OS. It has 16 channels DMA transfer channels with the following features.
- Performs automatic data transfer between the peripheral resource (I/O) and memory
- The program execution of CPU stops in the DMA start-up
- Capable of selecting whether to increment the transfer source and destination addresses
- DMA transfer is controlled by the DMA enable register, DMA stop status register, DMA status register, and descriptor.
- A STOP request is available for stopping DMA transfer from the resource.
  Upon completion of DMA transfer, the flag bit corresponding to the transfer completed channel in the DMA status register is set and a termination interrupt is output to the transfer controller.

• Register list

DMA enable register upper (DERH)

	15	14	13	12	11	10	9	8
Address : 0000AD_H	EN15	EN14	EN13	EN12	EN11	EN10	EN9	EN8
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value 00000000_B

DMA enable register lower (DERL)

	7	6	5	4	3	2	1	0
Address : 0000AC_H	EN7	EN6	EN5	EN4	EN3	EN2	EN1	EN0
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value 00000000_B

DMA stop status register (DSSR)

	7	6	5	4	3	2	1	0
Address : 0000A4_H	STP7 STP15	STP6 STP14	STP5 STP13	STP4 STP12	STP3 STP11	STP2 STP10	STP1 STP9	STP0 STP8
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value 00000000_B

*

DMA status register upper (DSRH)

	15	14	13	12	11	10	9	8
Address : 00009D_H	DTE15	DTE14	DTE13	DTE12	DTE11	DTE10	DTE9	DTE8
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value 00000000_B

DMA status register lower (DSRL)

	7	6	5	4	3	2	1	0
Address : 00009C_H	DTE7	DTE6	DTE5	DTE4	DTE3	DTE2	DTE1	DTE0
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value 00000000_B

DMA descriptor channel specification register (DCSR)

	15	14	13	12	11	10	9	8
Address : 00009B_H	STP	Reserved	Reserved	Reserved	DCSR3	DCSR2	DCSR1	DCSR0
	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value 00000000_B

* : The DSSR is lower when the STP bit of DCSR in the DSSR is "0".
  The DSSR is upper when the STP bit of DCSR in the DSSR is "1".

(Continued)

(Continued)

DMA buffer address pointer lower 8-bit (DBAPL)

Address : 007920H

7	6	5	4	3	2	1	0
DBAPL	DBAPL	DBAPL	DBAPL	DBAPL	DBAPL	DBAPL	DBAPL
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXX$_B$

DMA buffer address pointer middle 8-bit (DBAPM)

Address : 007921H

15	14	13	12	11	10	9	8
DBAPM	DBAPM	DBAPM	DBAPM	DBAPM	DBAPM	DBAPM	DBAPM
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXX$_B$

DMA buffer address pointer upper 8-bit (DBAPH)

Address : 007922H

7	6	5	4	3	2	1	0
DBAPH	DBAPH	DBAPH	DBAPH	DBAPH	DBAPH	DBAPH	DBAPH
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXX$_B$

DMA control register (DMACS)

Address : 007923H

15	14	13	12	11	10	9	8
RDY2	RDY1	BYTEL	IF	BW	BF	DIR	SE
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXX$_B$

DMA I/O register address pointer lower 8-bit (DIOAL)

Address : 007924H

7	6	5	4	3	2	1	0
A07	A06	A05	A04	A03	A02	A01	A00
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXX$_B$

DMA I/O register address pointer upper 8-bit (DIOAH)

Address : 007925H

15	14	13	12	11	10	9	8
A15	A14	A13	A12	A11	A10	A09	A08
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXX$_B$

DMA data counter lower 8-bit (DDCTL)

Address : 007926H

7	6	5	4	3	2	1	0
B07	B06	B05	B04	B03	B02	B01	B00
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXX$_B$

DMA data counter upper 8-bit (DDCTH)

Address : 007927H

15	14	13	12	11	10	9	8
B15	B14	B13	B12	B11	B10	B09	B08
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
XXXXXXXX$_B$

Note : The above register is switched for each channel depending on the DCSR.

16. External bus pin control circuit

The external bus pin control circuit controls external bus pins to extend the CPU address and data buses to externals.

• Register list

• Automatic ready function selection register (ARSR)

Address : 0000A5$_H$

15	14	13	12	11	10	9	8
ICR1	ICR0	HMR1	HMR0	—	—	LMR1	LMR0
(W)	(W)	(W)	(W)	(—)	(—)	(W)	(W)

Initial Value
0011- - 00$_B$

• External address output control register (HACR)

Address : 0000A6$_H$

7	6	5	4	3	2	1	0
E23	E22	E21	E20	E19	E18	E17	E16
(W)	(W)	(W)	(W)	(W)	(W)	(W)	(W)

Initial Value
* * * * * * * * $_B$
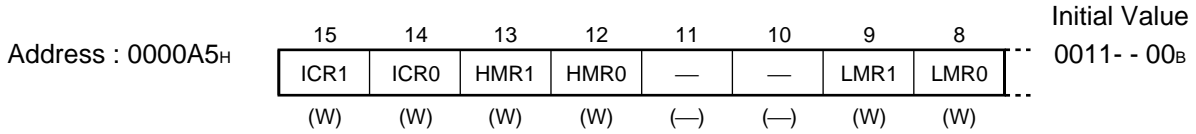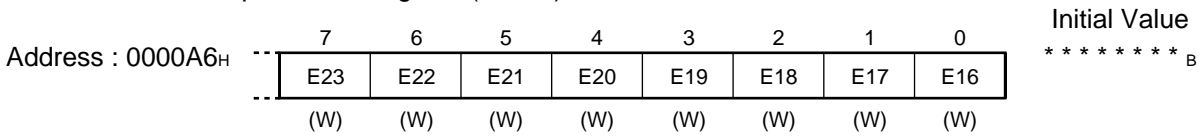
• Bus control signal selection register (EPCR)

Address : 0000A7$_H$

15	14	13	12	11	10	9	8
CKE	RYE	HDE	Reserved	HMBS	(W)RE	LMBS	—
(W)	(W)	(W)	(W)	(W)	(W)	(W)	(—)

Initial Value
1000*10 -$_B$
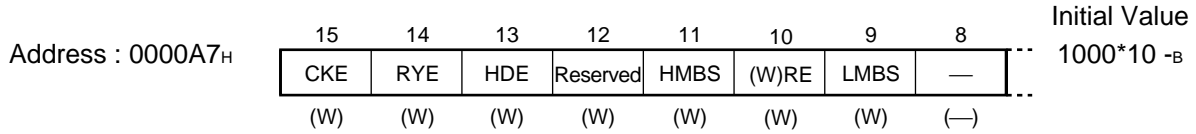
W   :Write only
−   :Unused
*   :"1" or "0"

• Block Diagram
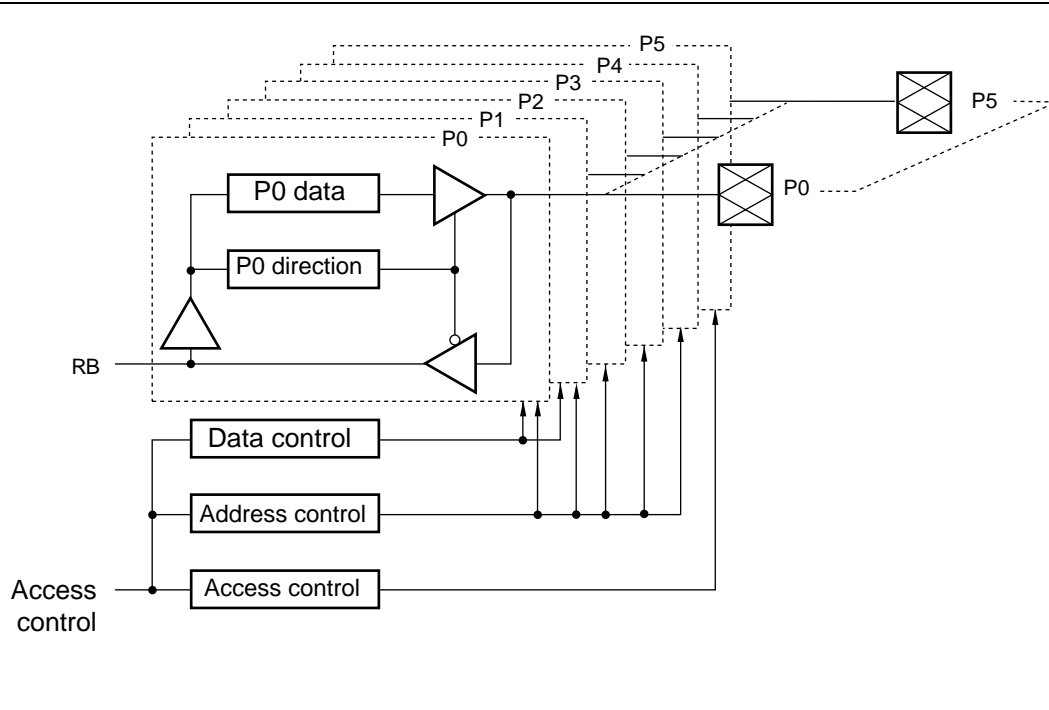
17. Address matching detection function

When the address is equal to the value set in the address detection register, the instruction code to be read into the CPU is forcibly replaced with the INT9 instruction code (01_H). As a result, the CPU executes the INT9 instruction when executing the set instruction. By performing processing by the INT#9 interrupt routine, the program patch function is enabled.

2 address detection registers are provided, for each of which there is an interrupt enable bit. When the address matches the value set in the address detection register with the interrupt enable bit set to 1, the instruction code to be read into the CPU is forcibly replaced with the INT9 instruction code.

• Register list

• Program address detect register 0 to 2 (PADR0)

PADR0 (lower)

Address : $001FF0_H$

7	6	5	4	3	2	1	0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
$XXXXXXXX_B$

PADR0 (middle)

Address : $001FF1_H$

15	14	13	12	11	10	9	8
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
$XXXXXXXX_B$

PADR0 (upper)

Address : $001FF2_H$

7	6	5	4	3	2	1	0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
$XXXXXXXX_B$
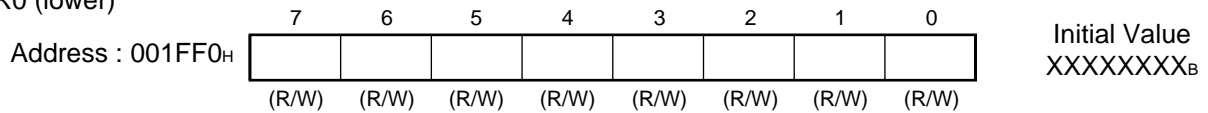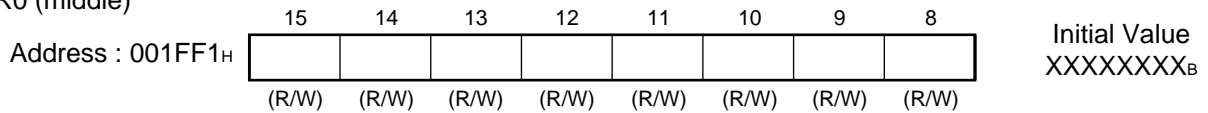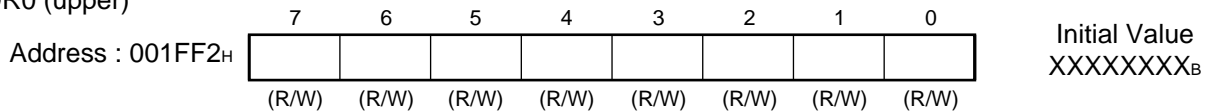
• Program address detect register 3 to 5 (PADR1)

PADR1 (lower)

Address : $001FF3_H$

15	14	13	12	11	10	9	8
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
$XXXXXXXX_B$

PADR1 (middle)

Address : $001FF4_H$

7	6	5	4	3	2	1	0
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
$XXXXXXXX_B$

PADR1 (upper)

Address : $001FF5_H$

15	14	13	12	11	10	9	8
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
$XXXXXXXX_B$
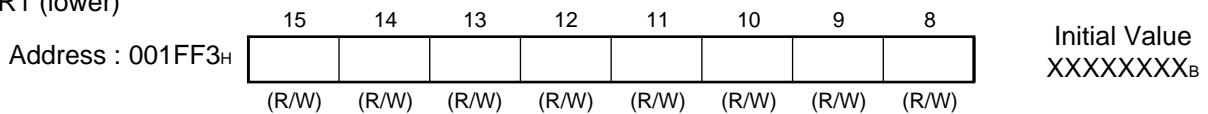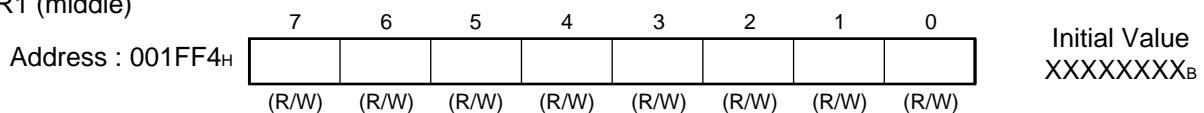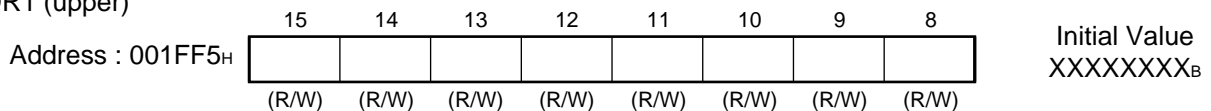
• Program address detection control status register (PACSR)

PACSR

Address : $00009E_H$

7	6	5	4	3	2	1	0
Reserved	Reserved	Reserved	Reserved	ADIE	Reserved	ADDE	Reserved
(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00000000_B
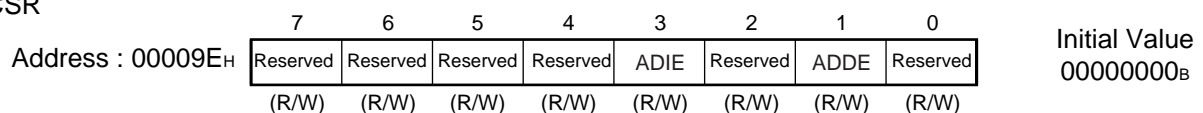
R/W : Readable and Writable
X   : Undefined

18. Delay interrupt generator module

The delay interrupt generation module is a module that generates interrupts for switching tasks. A hardware interrupt can be generated by software.

● **Delay interrupt generator module function**

	Function and control
Interrupt source	● Setting the R0 bit in the delayed interrupt request generation/release register to 1 (DIRR: R0 = 1) generates a delayed interrupt request. ● Setting the R0 bit in the delayed interrupt request generation/release register to 0 (DIRR: R0 = 0) cancels the delayed interrupt request.
Interrupt control	No setting of permission register is provided.
Interrupt flag	Set in bit R0 of the delayed interrupt request generation /clear register (DIRR : R0)
EI^{2}OS support	Not ready for extended intelligent I/O service (EI^{2}OS).

● Block Diagram

Internal data bus

Delay interrupt factor generation/release register(DIRR)

— : Undefined

S Interrupt request
R latch

Interrupt request signal
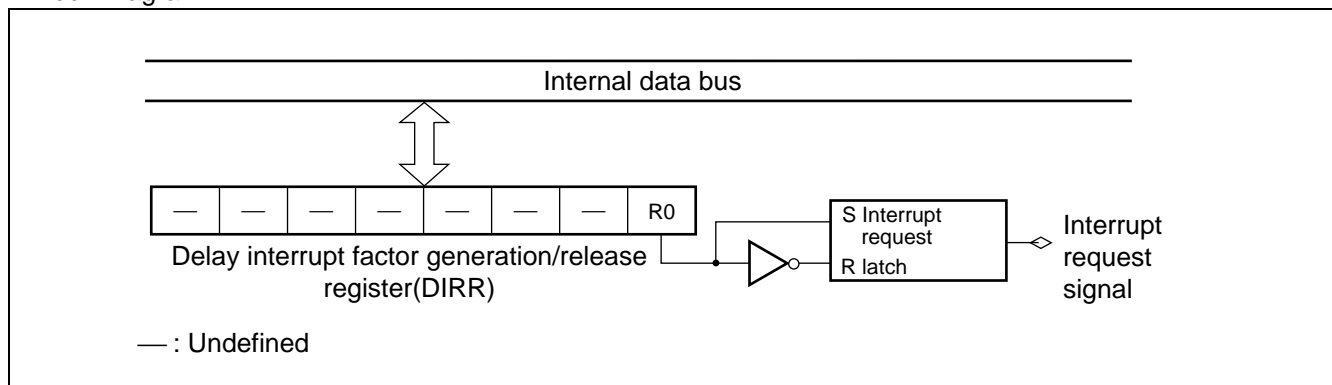
19. ROM mirror function selection module

The ROM mirror function select module can make a setting so that ROM data located in bank FF can be read by accessing bank 00.

• ROM mirroring function selection module function

	Description
Mirror setting address	FFFFFF$_H$ to FF8000$_H$ in the FF bank can be read through 00FFFF$_H$ to 008000$_H$ in the 00 bank.
Interrupt source	None.
EI²OS support	Not ready for extended intelligent I/O service (EI²OS) .

• Block Diagram
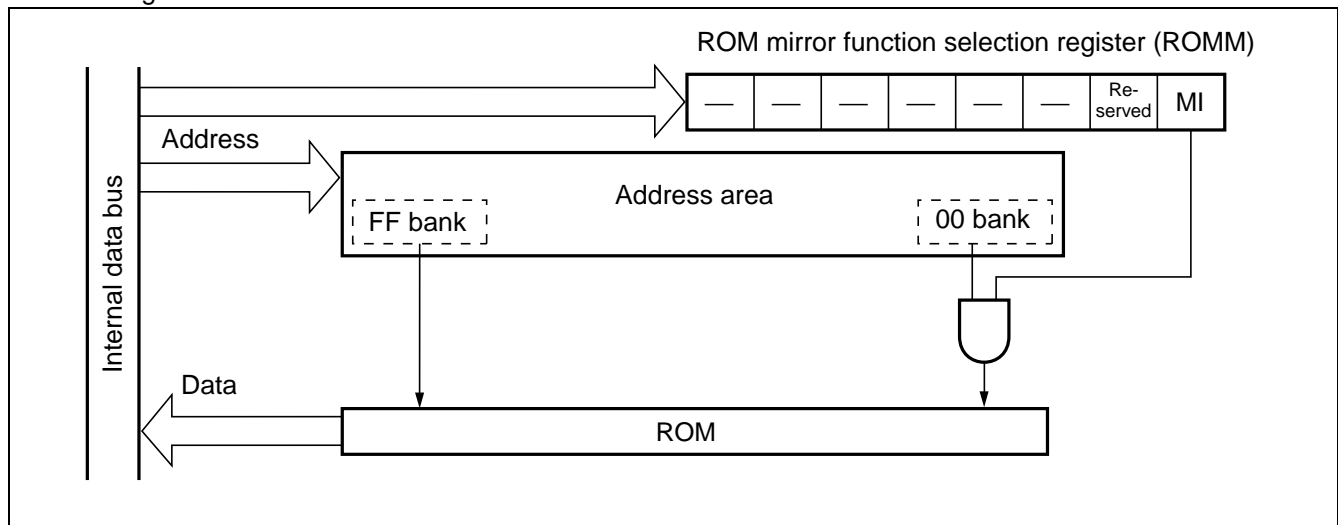
20. Low power consumption (standby) mode

The F[2]MC-16LX can be set to save power consumption by selecting and setting the low power consumption mode.

- CPU operation mode and functional description

CPU operating clock	Operation mode	Description
PLL clock	Normal run	The CPU and peripheral resources operate at the clock frequency obtained by PLL multiplication of oscillator clock (HCLK) frequency.
	Sleep	Only peripheral resources operate at the clock frequency obtained by PLL multiplication of the oscillator clock (HCLK) .
	Time-base timer	Only the time-base timer operates at the clock frequency obtained by PLL multiplication of the oscillator clock (HCLK) frequency.
	Stop	The CPU and peripheral resources are suspended with the oscillator clock stopped.
Main clock	Normal run	The CPU and peripheral resources operate at the clock frequency obtained by dividing the oscillator clock (HCLK) frequency by two.
	Sleep	Only peripheral resources operate at the clock frequency obtained by dividing the oscillator clock (HCLK) frequency by two.
	Time-base timer	Only the time-base timer operates at the clock frequency obtained by dividing the oscillator clock (HCLK) frequency by two.
	Stop	The CPU and peripheral resources are suspended with the oscillator clock stopped.
Sub clock	Normal run	The CPU and peripheral resources operate at the clock frequency obtained by dividing the subclock (SCLK) frequency by four.
	Sleep	Only peripheral resources operate at the clock frequency obtained by dividing the subclock (SCLK) frequency by four.
	Watch mode	Only the watch timer operates at the clock frequency obtained by dividing the subclock (SCLK) frequency by four.
	Stop	The CPU and peripheral resources are suspended with the subclock stopped.
CPU intermittent operation mode	Normal run	The halved or PLL-multiplied oscillator clock (HCLK) frequency or the subclock (SCLK) frequency is used for operation while being decimated in a certain period.

- Register list

Low power consumption mode control register (LPMCR)

Address : 0000A0$_H$

	7	6	5	4	3	2	1	0
	STP	SLP	SPL	RST	TMD	CG1	CG0	Reserved
	(W)	(W)	(R/W)	(W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
00011000$_B$

21. Clock

The clock generator controls the internal clock as the operating clock for the CPU and peripheral resources. The internal clock is referred to as machine clock whose one cycle is defined as machine cycle. The clock based on source oscillation is referred to as oscillator clock while the clock based on internal PLL oscillation is referred to as PLL clock.

• Register list

Clock selection register (CKSCR)

Address : 0000A1$_H$

15	14	13	12	11	10	9	8
SCM	MCM	WS1	WS0	SCS	MCS	CS1	CS0
(R)	(R)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)	(R/W)

Initial Value
11111100$_B$

22. 3 Mbits flash memory

The description that follows applies to the flash memory built in the MB90F334A; it is not applicable to evaluation ROM or masked ROM.

The flash memory is located in bank FF in the CPU memory map.

• Function to flash memory

	Description
Memory capacity	3072 Kbits (384 KB)
Memory configuration	384 Kwords × 8 bits/192 Kwords × 16 bits
Sector configuration	64 KB × 5 + 32 KB + 8 KB × 2 + 16 KB
Sector protect function	Possibility that set up with a recommendation parallel writer
Program algorithm	Automatic program algorithm (Embedded Algorithm* : Similar to MBM29LV400TC)
Operation command	• Compatibility with the JEDEC standard-type command • Built-in deletion pause/deletion resume function • Detection of programming/erasure completion using data polling and the toggle bit • Capable of erasing data sector by sector (in arbitrary combination of sectors)
Program/Erase cycle	At least 10,000 times guaranteed

How to program and erase memory	• Parallel programmer available for programming and erasure
	  (Ando Denki : AF9708, AF9709, AF9709B)
	• Can be written and erased using a dedicated serial writer
	  (Yokogawa Digital Computer Corporation : AF220/AF210/AF120/AF110)
	• Write/delete operation by program execution

Interrupt source	Programming/erasure completion sources
EI²OS supports	Not ready for expanded intelligent I/O service (EI²OS).

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

• Sector configuration of flash memory

Flash Memory   CPU address   Writer address *

	CPU address	Writer address *
Prohibited	F80000$_H$ F8FFFF$_H$	00000$_H$ 0FFFF$_H$
SA0 (64 KB)	F90000$_H$ F9FFFF$_H$	10000$_H$ 1FFFF$_H$
SA1 (64 KB)	FA0000$_H$ FAFFFF$_H$	20000$_H$ 2FFFF$_H$
SA2 (64 KB)	FB0000$_H$ FBFFFF$_H$	30000$_H$ 3FFFF$_H$
Prohibited	FC0000$_H$ FCFFFF$_H$	40000$_H$ 4FFFF$_H$
SA3 (64 KB)	FD0000$_H$ FDFFFF$_H$	50000$_H$ 5FFFF$_H$
SA4 (64 KB)	FE0000$_H$ FEFFFF$_H$	60000$_H$ 6FFFF$_H$
SA5 (32 KB)	FF0000$_H$ FF7FFF$_H$	70000$_H$ 77FFF$_H$
SA6 (8 KB)	FF8000$_H$ FF9FFF$_H$	78000$_H$ 79FFF$_H$
SA7 (8 KB)	FFA000$_H$ FFBFFF$_H$	7A000$_H$ 7BFFF$_H$
SA8 (16 KB)	FFC000$_H$ FFFFFF$_H$	7C000$_H$ 7FFFF$_H$

* :   The writer address is relative to the CPU address when data is programmed into flash memory by a parallel programmer. Programming and erasing by the general-purpose parallel programmer are executed based on writer addresses.

• Register list

Flash memory control register (FMCS)

Address : 0000AE$_H$

7	6	5	4	3	2	1	0
INTE	RDYINT	WE	RDY	Reserved	LPM1	Reserved	LPM0
(R/W)	(R/W)	(R/W)	(R)	(W)	(R/W)	(W)	(R/W)

Initial Value
000X0000$_B$

• Standard configuration for Fujitsu standard serial on-board writing

The flash microcontroller programmer (AF220/AF210/AF120/AF110) made by Yokogawa Digital Computer Corporation is used for Fujitsu standard serial on-board writing.
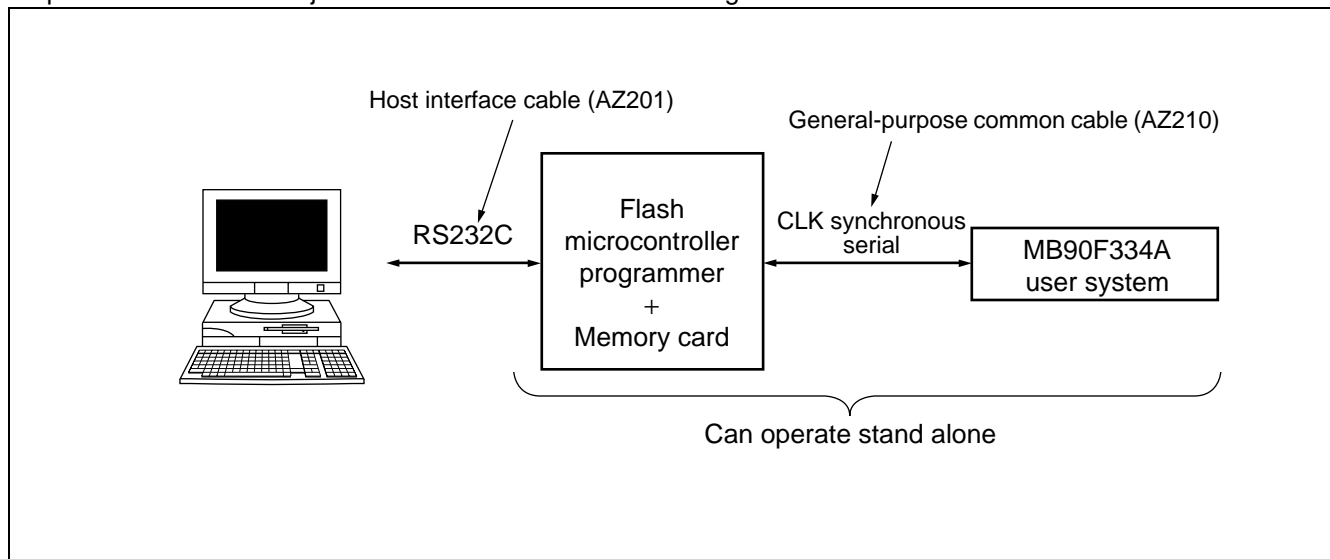
Note : Inquire of Yokogawa Digital Computer Corporation for details about the functions and operations of the AF220, AF210, AF120 and AF110 flash microcontroller programmer, general-purpose common cable for connection (AZ210) and connectors.

• Pins Used for Fujitsu Standard Serial On-board Programming

Pin	Function	Description
MD2, MD1, MD0	Mode input pin	The device enters the serial program mode by setting MD2=1, MD1=1 and MD0 =0.
X0, X1	Oscillation pin	Because the internal CPU operation clock is set to be the 1 multiplication PLL clock in the serial write mode, the internal operation clock frequency is the same as the oscillation clock frequency.
P60, P61	Programming program start pins	Input a Low level to P60 and a High level to P61.
$\overline{RST}$	Reset input pin	—
SIN0	Serial data input pin.	UART0 is used as CLK synchronous mode. In program mode, the pins used for the UART0 CLK synchronous mode are SIN0, SOT0 and SCK0.
SOT0	Serial data output pin	
SCK0	Serial clock input pin	
V_{CC}	Power source input pin	When supplying the write voltage (MB90F334A : 3.3 V $\pm$ 0.3 V) from the user system, connection with the flash microcontroller programmer is not necessary. When connecting, do not short-circuit with the user power supply.
V_{SS}	GND Pin	Share GND with the flash microcontroller programmer.

The control circuit shown in the figure is required for using the P60, P61, SIN0, SOT0 and SCK0 pins on the user system. Isolate the user circuit during serial on-board writing, with the TICS signal of the flash microcontroller programmer.

AF220/AF210/AF120/AF110 program control pin

AF220/AF210/AF120/AF110/ TICS pin

10 kΩ

MB90F334A program control pin

User
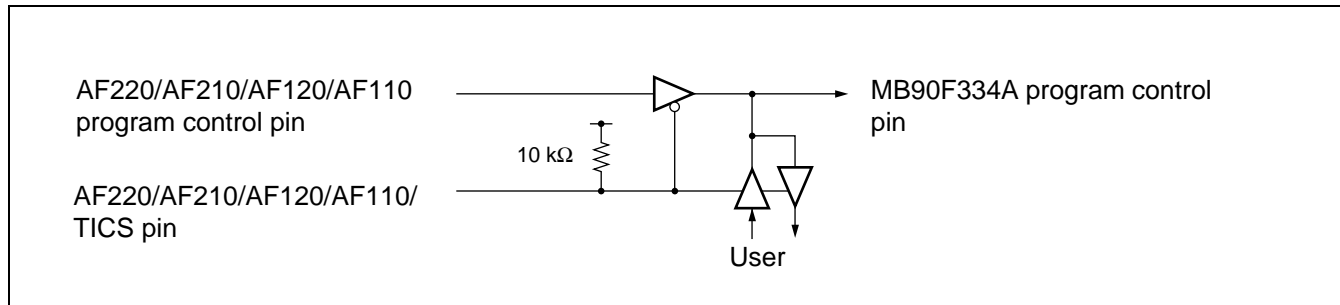
Control circuit

The MB90F334A serial clock frequency that can be input is determined by the following expression:
Use the flash microcontroller programmer to change the serial clock input frequency setting depending on the oscillator clock frequency to be used.

Inputable serial clock frequency = 0.125 × oscillation clock frequency.

- Maximum serial clock frequency

Oscillation clock frequency	Maximum serial clock frequency acceptable to the microcontroller	Maximum serial clock frequency that can be set with the AF220, AF210, AF120 or AF110	Maximum serial clock frequency that can be set with the AF200
At 6 MHz	750 kHz	500 kHz	500 kHz

- System configuration of the flash microcontroller programmer (AF220/AF210/AF120/AF110) (made by Yokogawa Digital Computer Corporation)

Part number		Function
Unit	AF220/AC4P	Model with internal Ethernet interface /100 V to 220 V power adapter
	AF210/AC4P	Standard model /100 V to 220 V power adapter
	AF120/AC4P	Single key internal Ethernet interface mode /100 V to 220 V power adapter
	AF110/AC4P	Single key model /100 V to 220 V power adapter
AZ221		PC/AT RS232C cable for writer
AZ210		Standard target probe (a) length : 1 m
FF201		Control module for Fujitsu F^{2}MC-16LX flash microcontroller control module
AZ290		Remote controller
/P4		4 MB PC Card (option) Flash memory capacity to 512 KB correspondence

Contact to : Yokogawa Digital Computer Corporation TEL : 81-423-33-6224

Note : The AF200 flash microcontroller programmer is a retired product, but it can be supported using control module FF201.

■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

Parameter	Symbol	Rating Min	Rating Max	Unit	Remarks
Power supply voltage*1	V_{CC}	$V_{SS} - 0.3$	$V_{SS} + 4.0$	V	
	AV_{CC}	$V_{SS} - 0.3$	$V_{SS} + 4.0$	V	$V_{CC} \geq AV_{CC}$*2
	AVRH	$V_{SS} - 0.3$	$V_{SS} + 4.0$	V	$AV_{CC} \geq AVR \geq 0$ V*3
Input voltage*1	V_I	$V_{SS} - 0.3$	$V_{SS} + 4.0$	V	*4
		$V_{SS} - 0.3$	$V_{SS} + 6.0$	V	Nch open-drain (Withstand voltage of 5 V I/O)*5
		$- 0.5$	$V_{SS} + 4.5$	V	USB I/O
Output voltage*1	V_O	$V_{SS} - 0.3$	$V_{SS} + 4.0$	V	*4
		$- 0.5$	$V_{SS} + 4.5$	V	USB I/O
Maximum clamp current	I_{CLAMP}	$- 2.0$	$+2.0$	mA	*6
Total maximum clamp current	$\Sigma \lvert I_{CLAMP} \rvert$	—	20	mA	*6
"L" level maximum output current	I_{OL1}	—	10	mA	Other than USB I/O*7
	I_{OL2}	—	43	mA	USB I/O*7
"L" level average output current	I_{OLAV}	—	3	mA	*8
"L" level maximum total output current	ΣI_{OL}	—	60	mA	
"L" level average total output current	ΣI_{OLAV}	—	30	mA	*9
"H" level maximum output current	I_{OH1}	—	$- 10$	mA	Other than USB I/O*7
	I_{OH2}	—	$- 43$	mA	USB I/O*7
"H" level average output current	I_{OHAV}	—	$- 3$	mA	*8
"H" level maximum total output current	ΣI_{OH}	—	$- 60$	mA	
"H" level average total output current	ΣI_{OHAV}	—	$- 30$	mA	*9
Power consumption	Pd	—	340	mW	
Operating temperature	T_A	$- 40$	$+ 85$	°C	
Storage temperature	Tstg	$- 55$	$+ 150$	°C	
		$- 55$	$+ 125$	°C	USB I/O

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

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

*3 : Be careful not to let AVRH exceed AVcc.

*4 : V_I and V_O must not exceed Vcc + 0.3 V. However, if the maximum current to/from an input is limited by some means with external components, the I_{CLAMP} rating supersedes the V_I rating.

*5 : Applicable to pins : P60 to P67, P96, PA0 to PA7, PB0 to PB4, VBUS

*6 : • Applicable to pins: P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P50 to P57, P70 to P77, P80 to P87, P90 to P95, PB5, PB6
    • Use within recommended operating conditions.
    • Use at DC voltage (current)
    • The +B signal should always be applied a limiting resistance placed between the +B signal and the microcontroller.

- The value of the limiting resistance should be set so that when the +B signal is applied the input current to the microcontroller pin does not exceed rated values, either instantaneously or for prolonged periods.
- Note that when the microcontroller drive current is low, such as in the power saving modes, the +B input potential may pass through the protective diode and increase the potential at the 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 supply 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 +B input pin open.
- Note that analog system input/output pins other than P60 to P67, P96, PA0 to PA7, PB0 to PB4, DVP, DVM, HVP, HVM, VBUS, HCON
- Sample recommended circuits:

- Input/output equivalent circuits
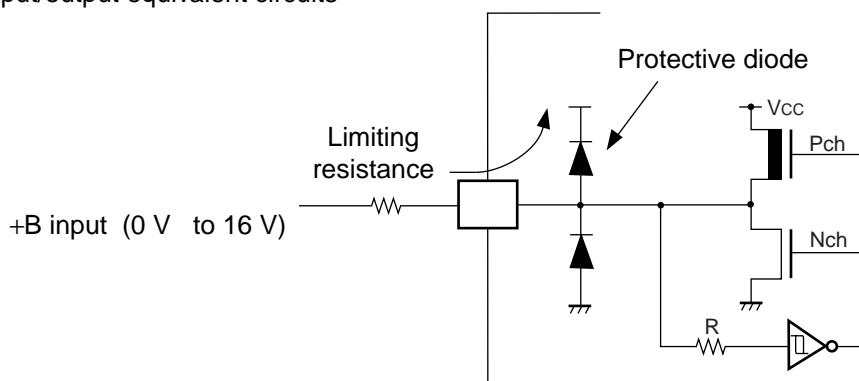
*7 : A peak value of an applicable one pin is specified as a maximum output current.

*8 : The average output current specifies the mean value of the current flowing in the relevant single pin during a period of 100 ms.

*9 : The average total output current specifies the mean value of the currents flowing in all of the relevant pins during a period of 100 ms.

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

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

Parameter	Symbol	Value Min	Value Max	Unit	Remarks
Power supply voltage	V_{CC}	3.0	3.6	V	At normal operation (when using USB)
		2.7	3.6	V	At normal operation (when not using USB)
		1.8	3.6	V	Hold state of stop operation
Input "H" voltage	V_{IH}	$0.7 V_{CC}$	$V_{CC} + 0.3$	V	CMOS input pin
	V_{IHS1}	$0.8 V_{CC}$	$V_{CC} + 0.3$	V	CMOS hysteresis input pin
	V_{IHS2}	$0.8 V_{CC}$	$V_{SS} + 5.3$	V	Nch open-drain (Withstand voltage of 5 V I/O)*
	V_{IHM}	$V_{CC} - 0.3$	$V_{CC} + 0.3$	V	MD pin input
	V_{IHUSB}	2.0	$V_{CC} + 0.3$	V	USB pin input
Input "L" voltage	V_{IL}	$V_{SS} - 0.3$	$0.3 V_{CC}$	V	CMOS input pin
	V_{ILS}	$V_{SS} - 0.3$	$0.2 V_{CC}$	V	CMOS hysteresis input pin
	V_{ILM}	$V_{SS} - 0.3$	$V_{SS} + 0.3$	V	MD pin input
	V_{ILUSB}	V_{SS}	0.8	V	USB pin input
Differential input sensitivity	V_{DI}	0.2	—	V	USB pin input
Differential common mode input voltage range	V_{CM}	0.8	2.5	V	USB pin input
Series resistance	R_S	25	30	Ω	Recommended value $= 27 \Omega$ at using USB
Operating temperature	T_A	$- 40$	$+ 85$	°C	When not using USB
		0	$+ 70$	°C	When using USB

* : Applicable to pins : P60 to P67, P96, PA0 to PA7, PB0 to PB4, VBUS

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

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

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

3. DC Characteristics

$(V_{CC} = AV_{CC} = 3.3\ V \pm 0.3\ V,\ V_{SS} = AV_{SS} = 0.0\ V,\ T_A = -40\ °C\ to\ +85\ °C)$

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Output "H" voltage	V_{OH}	Output pins other than P60 to P67, P96, PA0 to PA7, PB0 to PB4, HVP, HVM, DVP, DVM	$I_{OH} = -4.0\ mA$	$V_{CC} - 0.5$	—	Vcc	V	
		HVP, HVM, DVP, DVM	$RL = 15\ k\Omega \pm 5\%$	2.8	—	3.6	V	
Output "L" voltage	V_{OL}	Output pins other than HVP, HVM, DVP, DVM	$I_{OL} = 4.0\ mA$	Vss	—	Vss + 0.4	V	
		HVP, HVM, DVP, DVM	$RL = 1.5\ k\Omega \pm 5\%$	0	—	0.3	V	
Input leak current	I_{IL}	Output pins other than P60 to P67, P96, PA0 to PA7, PB0 to PB4, HVP, HVM, DVP, DVM	$V_{CC} = 3.3\ V$, $Vss < V_I < V_{CC}$	− 10	—	+ 10	μA	
		HVP, HVM, DVP, DVM	—	− 5	—	+ 5	μA	
Pull-up resistance	R_{PULL}	P00 to P07, P10 to P17	$V_{CC} = 3.3\ V$, $T_A = +25\ °C$	25	50	100	kΩ	
Open drain output current	I_{LIOD}	P60 to P67, P96, PA0 to PA7, PB0 to PB4,	—	—	0.1	10	μA	
Power supply current	I_{CC}	Vcc	$V_{CC} = 3.3\ V$, Internal frequency 24 MHz, At normal operating At USB operating (USTP = 0)	—	75	85	mA	MB90F334A
				—	65	75	mA	MB90333A
			$V_{CC} = 3.3\ V$, Internal frequency 24 MHz, At normal operating At non-operating USB (USTP = 1)	—	70	80	mA	MB90F334A
				—	60	70	mA	MB90333A
	I_{CCS}		$V_{CC} = 3.3\ V$, Internal frequency 24 MHz, At sleep mode	—	27	40	mA	
	I_{CTS}		$V_{CC} = 3.3\ V$, Internal frequency 24 MHz, At timer mode	—	3.5	10	mA	
			$V_{CC} = 3.3\ V$, Internal frequency 3 MHz, At timer mode	—	1	2	mA	
	I_{CCL}		$V_{CC} = 3.3\ V$, Internal frequency 8 kHz, At subclock operation, $(T_A = +25\ °C)$	—	25	150	μA	

(Continued)

MB90330 Series

(Continued)

$(V_{CC} = AV_{CC} = 3.3$ V $\pm$ 0.3 V, $V_{SS} = AV_{SS} = 0.0$ V, $T_A = -40$ °C to $+85$ °C)

Parameter	Symbol	Pin name	Conditions	Value			Unit	Remarks
				Min	Typ	Max		
Power supply current	I_{CCLS}	V_{CC}	$V_{CC} = 3.3$ V, Internal frequency 8 kHz, At sub clock, At sleep operating, $(T_A = +25$ °C)	—	10	50	μA	
	I_{CCT}		$V_{CC} = 3.3$ V, Internal frequency 8 kHz, Watch mode, $(T_A = +25$ °C)	—	1.5	40	μA	
	I_{CCH}		$T_A = +25$ °C, At stop	—	1	40	μA	
Input capacitance	C_{IN}	Other than AVcc, AVss, Vcc, Vss	—	—	5	15	pF	
Pull-up resistor	R_{up}	$\overline{RST}$	—	25	50	100	kΩ	

Note : P60 to P67, P96, PA0 to PA7, and PB0 to PB4 are Nch open-drain pins usually used as CMOS.

4. AC Characteristics

(1)Clock input timing

$(V_{CC} = AV_{CC} = 3.3\ V \pm 0.3\ V,\ V_{SS} = AV_{SS} = 0.0\ V,\ T_A = -40\ °C\ to +85\ °C)$

Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Clock frequency	f_{CH}	X0, X1	—	6	—	MHz	External crystal oscillation
			6	—	24	MHz	External clock input
	f_{CL}	X0A, X1A	—	32.768	—	kHz	
Clock cycle time	t_{HCYL}	X0, X1	—	166.7	—	ns	External crystal oscillation
			166.7	—	41.7	ns	External clock input
	t_{LCYL}	X0A, X1A	—	30.5	—	s	
Input clock pulse width	P_{WH} P_{WL}	X0	10	—	—	ns	A reference duty ratio is 30% to 70%.
	P_{WHL} P_{WLL}	X0A	—	15.2	—	s	
Input clock rise time and fall time	tcr tcf	X0	—	—	5	ns	At external clock
Internal operating clock frequency	f_{CP}	—	3	—	24	MHz	When main clock is used
	f_{CPL}	—	—	8.192	—	kHz	When sub clock is used
Internal operating clock cycle time	t_{CP}	—	42	—	333	ns	When main clock is used
	t_{CPL}	—	—	122.1	—	s	When sub clock is used

• Clock Timing

93
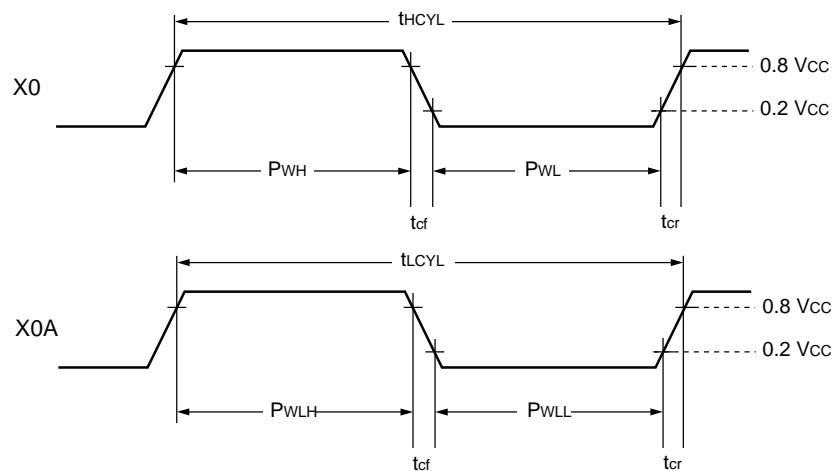
• PLL operation guarantee range

Relation between internal operation clock frequency and power supply voltage
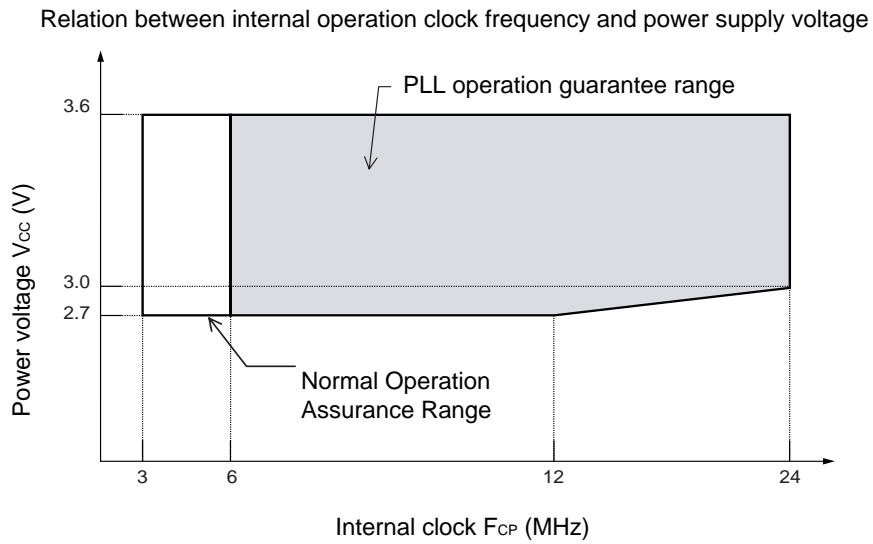
Note : When the USB is used, operation is guaranteed at voltages between 3.0 V and 3.6 V.

Relation between oscillation frequency and internal operation clock frequency
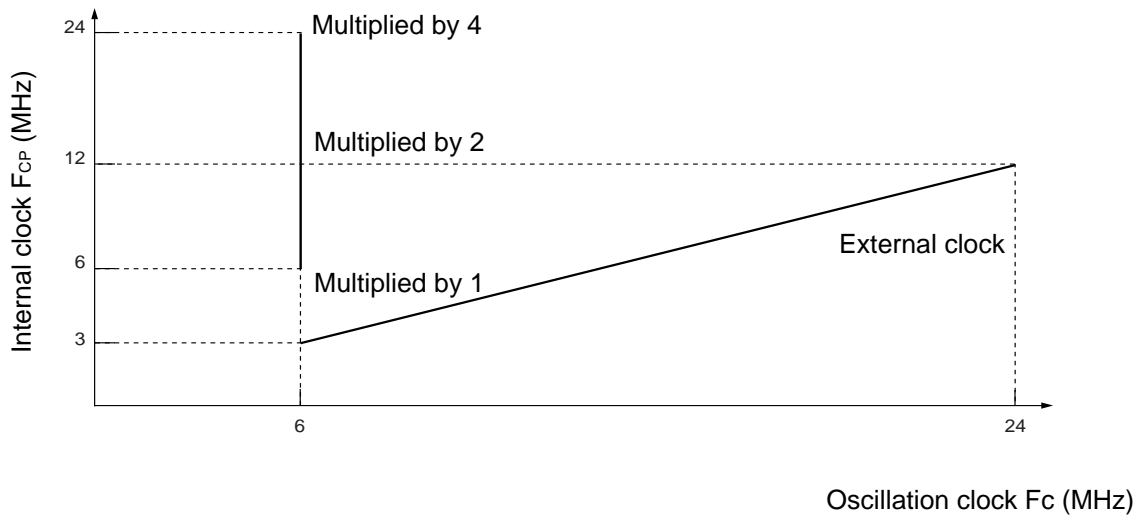
The AC standards assume the following measurement reference voltages.

• Input signal waveform

Hysteresis input pin

0.8 Vcc

0.2 Vcc

Hysteresis input/other than MD input pin

0.7 Vcc

0.3 Vcc

• Output signal waveform

Output pin

2.4 V

0.8 V
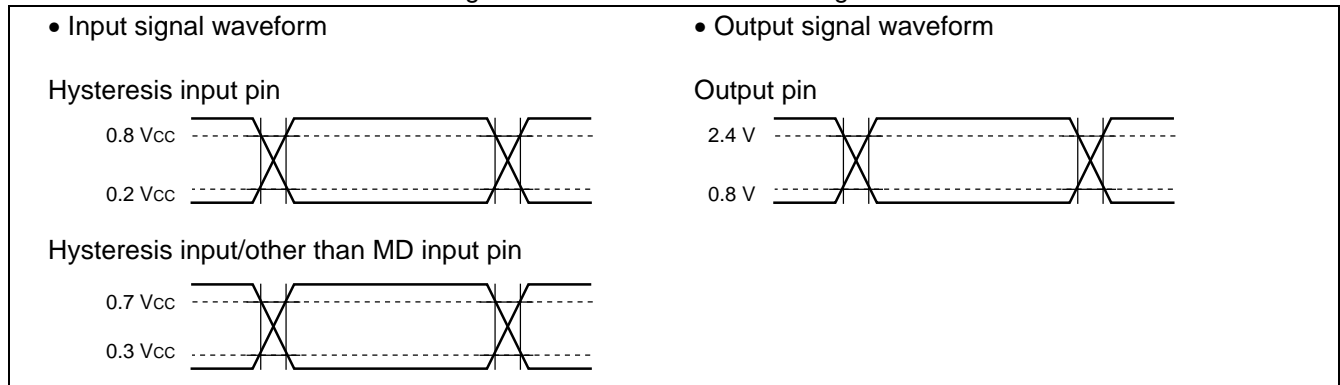
(2)Clock output timing

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

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	**Max**		
Cycle time	t_{CYC}	CLK	—	t_{CP}	—	ns	
CLK↑→CLK↓	t_{CHCL}	CLK	$V_{CC} = 3.0$ V to 3.6 V	$t_{CP}/2 - 15$	$t_{CP}/2 + 15$	ns	At $f_{cp} = 24$ MHz
				$t_{CP}/2 - 20$	$t_{CP}/2 + 20$	ns	At $f_{cp} = 12$ MHz
				$t_{CP}/2 - 64$	$t_{CP}/2 + 64$	ns	At $f_{cp} = 6$ MHz

Note : t_{CP} : See " (1) Clock input timing".

(3) Reset

$(V_{CC} = AV_{CC} = 3.3\ V \pm 0.3\ V, V_{SS} = AV_{SS} = 0.0\ V, T_A = -40\ °C\ to + 85\ °C)$

Parameter	Sym-bol	Pin name	Condi-tions	Value		Unit	Remarks
				Min	Max		
Reset input time	t_{RSTL}	$\overline{RST}$	—	500	—	ns	At normal operating, At time base timer mode, At main sleep mode, At PLL sleep mode
				Oscillation time of oscillator* + 500 ns	—	µs	At stop mode, At sub clock mode, At sub sleep mode, At watch mode

* : Oscillation time of oscillator is the time that the amplitude reaches 90 %. It takes several milliseconds to several dozens of milliseconds on a crystal oscillator, several hundreds of microseconds to several milliseconds on a FAR/ceramic oscillator, and 0 milliseconds on an external clock.

• During normal operation, time-base timer mode, main sleep mode and PLL sleep mode

t_{RSTL}

$\overline{RST}$

0.2 V_{CC} 0.2 V_{CC}
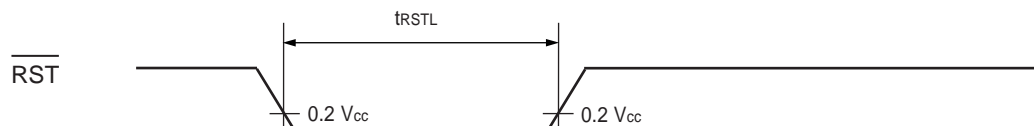
• During stop mode, subclock mode, sub-sleep mode and watch mode

t_{RSTL}

$\overline{RST}$

0.2 V_{CC} 0.2 V_{CC}

X0

90% of amplitude

Internal operation clock

Oscillation time of oscillator   500 ns

Oscillation stabilization wait time   Execute instruction

Internal reset
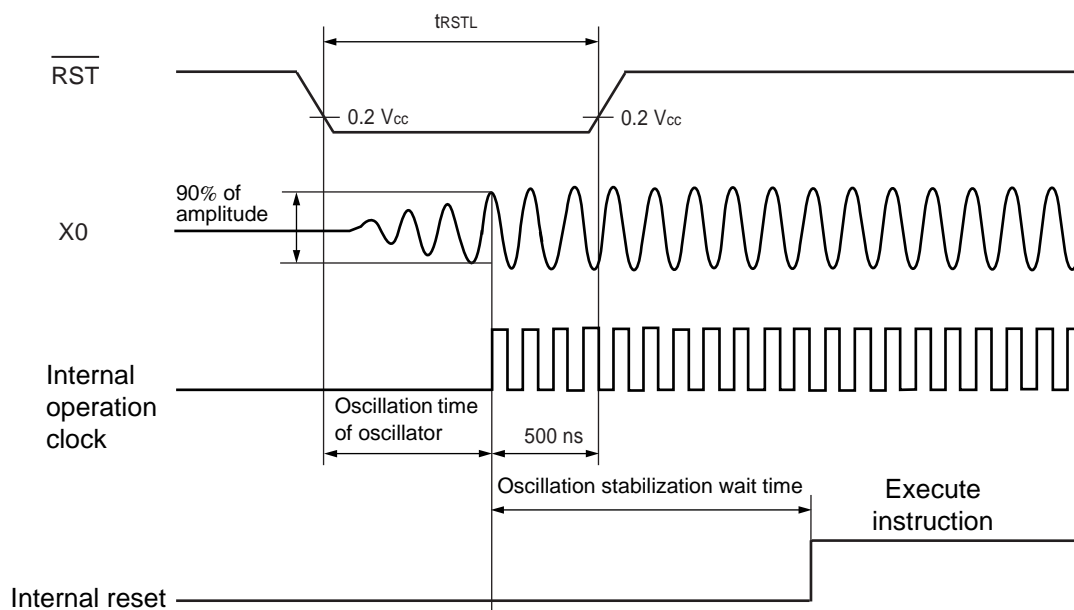
(4) Power-on reset

$(V_{CC} = AV_{CC} = 3.3\ V \pm 0.3\ V,\ V_{SS} = AV_{SS} = 0.0\ V,\ T_A = -40\ °C\ to\ +85\ °C)$

Parameter	Symbol	Pin name	Condi-tions	Value Min	Value Max	Unit	Remarks
Power supply rising time	t_R	V_{CC}	—	—	30	ms	
Power supply shutdown time	t_{OFF}	V_{CC}		1	—	ms	For repeated operation

Notes : • V_{CC} must be lower than 0.2 V before the power supply is turned on.
　　　　• The above standard is a value for performing a power-on reset.
　　　　• In the device, there are internal registers which is initialized only by a power-on reset.
　　　　　When the initialization of these items is expected, turn on the power supply according to the standards.
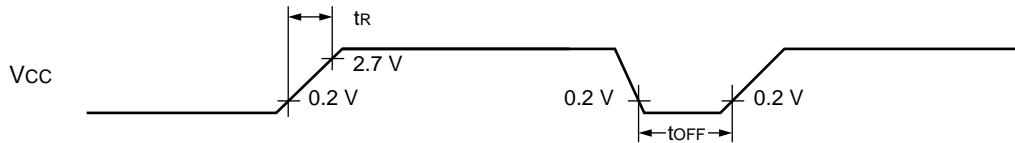
Sudden change of power supply voltage may activate the power-on reset function.
When changing the power supply voltage during operation as illustrated below, voltage fluctuation should be minimized so that the voltage rises as smoothly as possible. When raising the power, do not use PLL clock. However, if voltage drop is 1 V/s or less, use of PLL clock is allowed during operation.

The rising edge should be 50 mV/ms or less.

RAM data hold
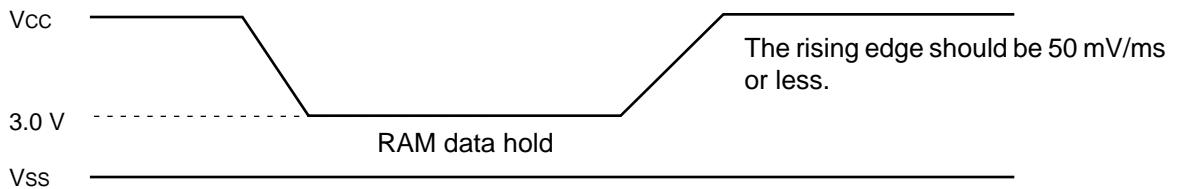
(5) UART0, 1, 2, 3 I/O extended serial timing

$(V_{CC} = AV_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, V_{SS} = AV_{SS} = 0.0 \text{ V}, T_A = -40 \text{ °C to} +85 \text{ °C})$

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
Serial clock cycle time	t_{SCYC}	SCKx	Internal shift clock mode output pin is : $C_L = 80 \text{ pF} + 1\text{TTL}$	8 t_{CP}	—	ns	
SCK↓→SOT delay time	t_{SLOV}	SCKx, SOTx		– 80	+ 80	ns	
Valid SIN→SCK↑	t_{IVSH}	SCKx, SINx		100	—	ns	
SCK↑→valid SIN hold time	t_{SHIX}	SCKx, SINx		60	—	ns	
Serial clock H pulse width	t_{SHSL}	SCKx, SINx	External shift clock mode output pin is : $C_L = 80 \text{ pF} + 1\text{TTL}$	4 t_{CP}	—	ns	
Serial clock L pulse width	t_{SLSH}	SCKx, SINx		4 t_{CP}	—	ns	
SCK↓→SOT delay time	t_{SLOV}	SCKx, SOTx		—	150	ns	
Valid SIN→SCK↑	t_{IVSH}	SCKx, SINx		60	—	ns	
SCK↑→valid SIN hold time	t_{SHIX}	SCKx, SINx		60	—	ns	

Notes : • Above rating is the case of CLK synchronous mode.
• C_L is a load capacitance value on pins for testing.
• t_{CP} : See " (1) Clock input timing".

• Internal shift clock mode
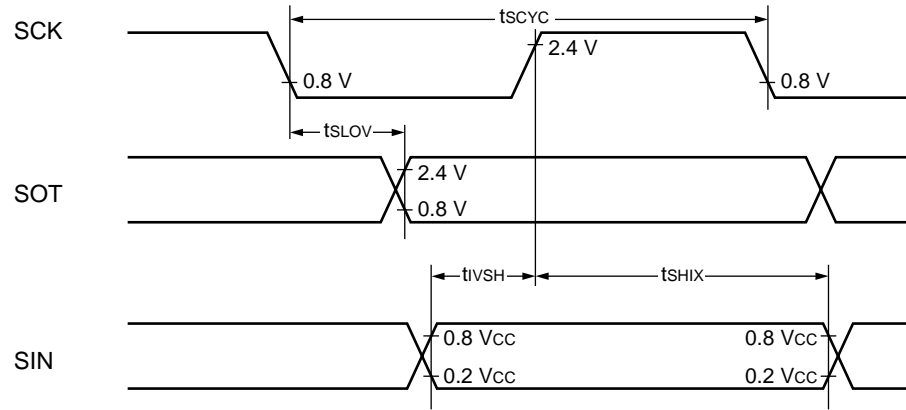
• External shift clock mode
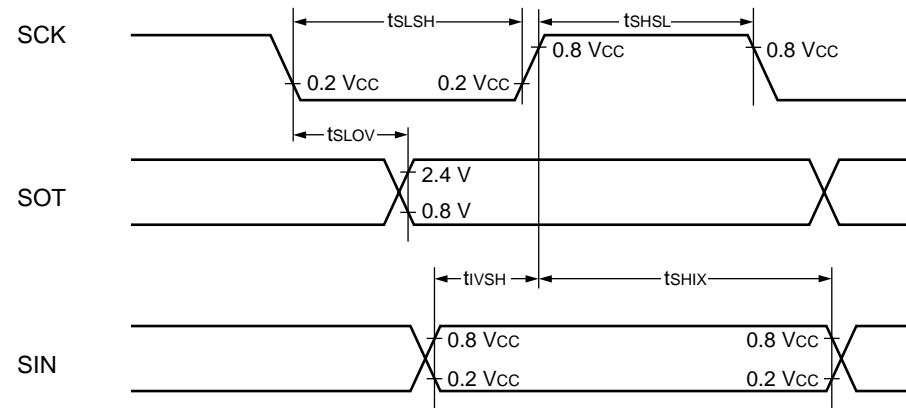
(6) I²C timing

$(V_{CC} = AV_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, V_{SS} = AV_{SS} = 0.0 \text{ V}, T_A = -40 \text{ °C to } +85 \text{ °C})$

Parameter	Symbol	Conditions	Value Min	Value Max	Unit
SCL clock frequency	t_{SCL}	Power-supply voltage of external pull-up resistor at 5.0 V. $R = 1.2 \text{ k}\Omega$, $C = 50 \text{ pF}^{*2}$ Power-supply voltage of external pull-up resistor at 3.6 V. $R = 1.0 \text{ k}\Omega$, $C = 50 \text{ pF}^{*2}$	0	100	kHz
(Repeat) [start] condition hold time SDA ↓ → SCL ↓	t_{HDSTA}		4.0	—	µs
SCL clock "L" width	t_{LOW}		4.7	—	µs
SCL clock "H" width	t_{HIGH}		4.0	—	µs
Repeat [start] condition setup time SCL ↑ → SDA ↓	t_{SUSTA}		4.7	—	µs
Data hold time SCL ↓ → SDA ↓ ↑	t_{HDDAT}		0	3.45*3	µs
Data setup time SDA ↓ ↑ → SCL ↑	t_{SUDAT}	Power-supply voltage of external pull-up resistor at 5.0 V. $f_{CP}^{*1} \leq 20 \text{ MHz}$, $R = 1.2 \text{ k}\Omega$, $C = 50 \text{ pF}^{*2}$ Power-supply voltage of external pull-up resistor at 3.6 V. $f_{CP}^{*1} \leq 20 \text{ MHz}$, $R = 1.0 \text{ k}\Omega$, $C = 50 \text{ pF}^{*2}$	250	—	ns
		Power-supply voltage of external pull-up resistor at 5.0 V. $f_{CP}^{*1} > 20 \text{ MHz}$, $R = 1.2 \text{ k}\Omega$, $C = 50 \text{ pF}^{*2}$ Power-supply voltage of external pull-up resistor at 3.6 V. $f_{CP}^{*1} > 20 \text{ MHz}$, $R = 1.0 \text{ k}\Omega$, $C = 50 \text{ pF}^{*2}$	200	—	
[Stop] condition setup time SCL ↑ → SDA ↑	t_{SUSTO}	Power-supply voltage of external pull-up resistor at 5.0 V. $R = 1.2 \text{ k}\Omega$, $C = 50 \text{ pF}^{*2}$ Power-supply voltage of external pull-up resistor at 3.6 V. $R = 1.0 \text{ k}\Omega$, $C = 50 \text{ pF}^{*2}$	4.0	—	µs
Bus free time between [stop] condition and [start] condition	t_{BUS}		4.7	—	µs

*1 : f_{CP} is internal operating clock frequency. See " (1) Clock input timing".

*2 : R and C are pull-up resistance of SCL and SDA lines and load capacitance.

*3 : The maximum t_{HDDAT} only has to be met if the device does not stretch the "L" width (t_{LOW}) of the SCL signal.
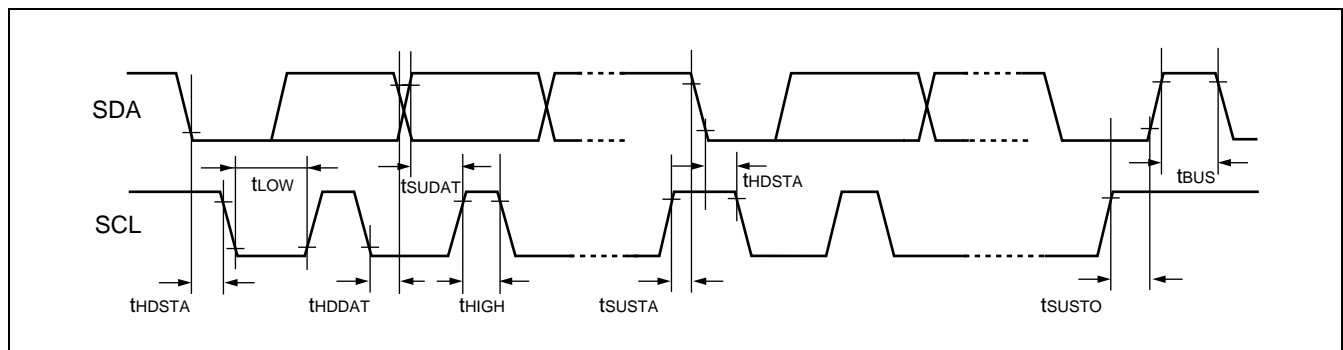
(7) Timer input timing

$(V_{CC} = AV_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, V_{SS} = AV_{SS} = 0.0 \text{ V}, T_A = -40 \text{ °C to} +85 \text{ °C})$

Parameter	Symbol	Pin name	Condi-tions	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TIWH} t_{TIWL}	FRCK, INx, TINx PWC	—	$4\ t_{CP}$	—	ns	

Note : t_{CP} : See " (1) Clock input timing".
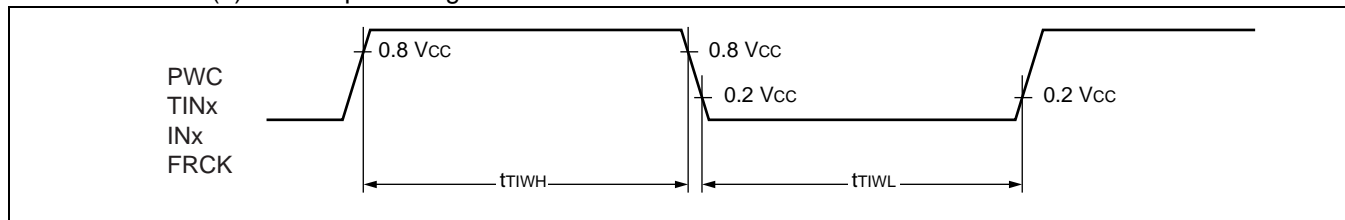
(8) Timer output timing

$(V_{CC} = AV_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, V_{SS} = AV_{SS} = 0.0 \text{ V}, T_A = -40 \text{ °C to} +85 \text{ °C})$

Parameter	Sym-bol	Pin name	Condi-tions	Value		Unit	Remarks
				Min	Max		
CLK↑→T_{OUT} change time PPG0 to PPG5 change time OUT0 to OUT3 change time	t_{TO}	TOTx, PPGx, OUTx	—	30	—	ns	
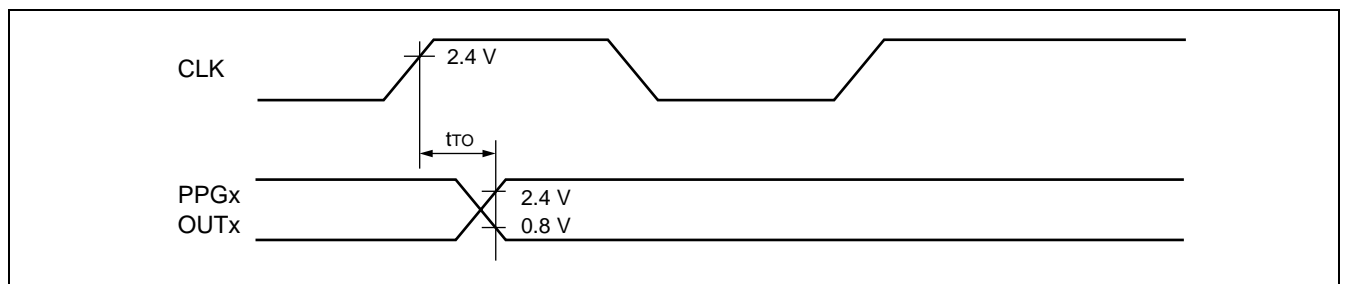
(9) Trigger input timing

$(V_{CC} = AV_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, V_{SS} = AV_{SS} = 0.0 \text{ V}, T_A = -40 \text{ °C to} +85 \text{ °C})$

Parameter	Symbol	Pin name	Condi-tions	Value		Unit	Remarks
				Min	Max		
Input pulse width	t_{TRGH} t_{TRGL}	INTx, ADTG	—	$5\ t_{CP}$	—	ns	At normal operating
				1	—	μs	In Stop mode

Note : t_{CP} : See " (1) Clock input timing".
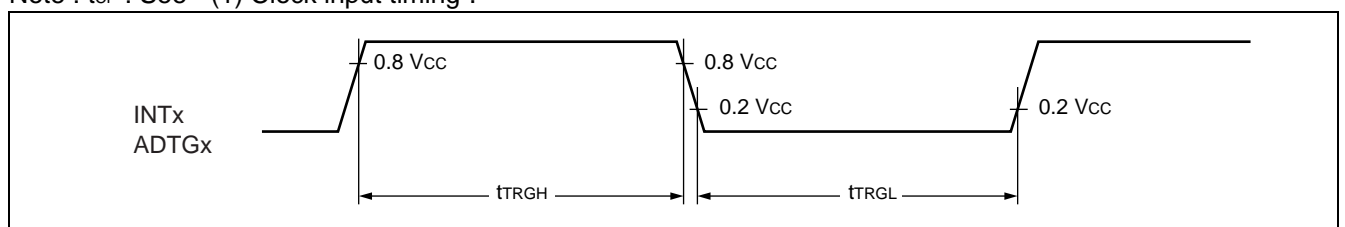
(10) Bus read timing

$(V_{CC} = AV_{CC} = 3.3\ V \pm 0.3\ V, V_{SS} = AV_{SS} = 0.0\ V, T_A = 0\ °C\ to + 70\ °C)$

Parameter	Symbol	Pin name	Conditions	Value		Unit	Remarks
				Min	Max		
ALE pulse width	t_{LHLL}	ALE	—	$t_{CP}/2 - 15$	—	ns	At $f_{cp} = 24$ MHz
				$t_{CP}/2 - 20$	—	ns	At $f_{cp} = 12$ MHz
				$t_{CP}/2 - 35$	—	ns	At $f_{cp} = 6$ MHz
Valid address→ALE↓time	t_{AVLL}	Address, ALE	—	$t_{CP}/2 - 17$	—	ns	
				$t_{CP}/2 - 40$	—	ns	At $f_{cp} = 6$ MHz
ALE↓→Address valid time	t_{LLAX}	ALE, Address	—	$t_{CP}/2 - 12$	—	ns	
Valid address→$\overline{RD}$↓time	t_{AVRL}	$\overline{RD}$, Address	—	$t_{CP} - 25$	—	ns	
Valid address→valid data input	t_{AVDV}	Address/data	—	—	$5\ t_{CP}/2 - 55$	ns	
				—	$5\ t_{CP}/2 - 80$	ns	At $f_{cp} = 6$ MHz
$\overline{RD}$ pulse width	t_{RLRH}	$\overline{RD}$	—	$3\ t_{CP}/2 - 25$	—	ns	At $f_{cp} = 24$ MHz
				$3\ t_{CP}/2 - 20$	—	ns	At $f_{cp} = 12$ MHz
$\overline{RD}$↓→valid data input	t_{RLDV}	$\overline{RD}$, Data	—	—	$3\ t_{CP}/2 - 55$	ns	
				—	$3\ t_{CP}/2 - 80$	ns	At $f_{cp} = 6$ MHz
$\overline{RD}$↓→data hold time	t_{RHDX}	$\overline{RD}$, Data	—	0	—	ns	
$\overline{RD}$↑→ALE↑time	t_{RHLH}	$\overline{RD}$, ALE	—	$t_{CP}/2 - 15$	—	ns	
$\overline{RD}$↑→address valid time	t_{RHAX}	Address, $\overline{RD}$	—	$t_{CP}/2 - 10$	—	ns	
Valid address→CLK↑time	t_{AVCH}	Address, CLK	—	$t_{CP}/2 - 17$	—	ns	
$\overline{RD}$↓→CLK↑time	t_{RLCH}	$\overline{RD}$, CLK	—	$t_{CP}/2 - 17$	—	ns	
ALE↓→$\overline{RD}$↓time	t_{LLRL}	$\overline{RD}$, ALE	—	$t_{CP}/2 - 15$	—	ns	

Note : t_{CP} : See " (1) Clock input timing".
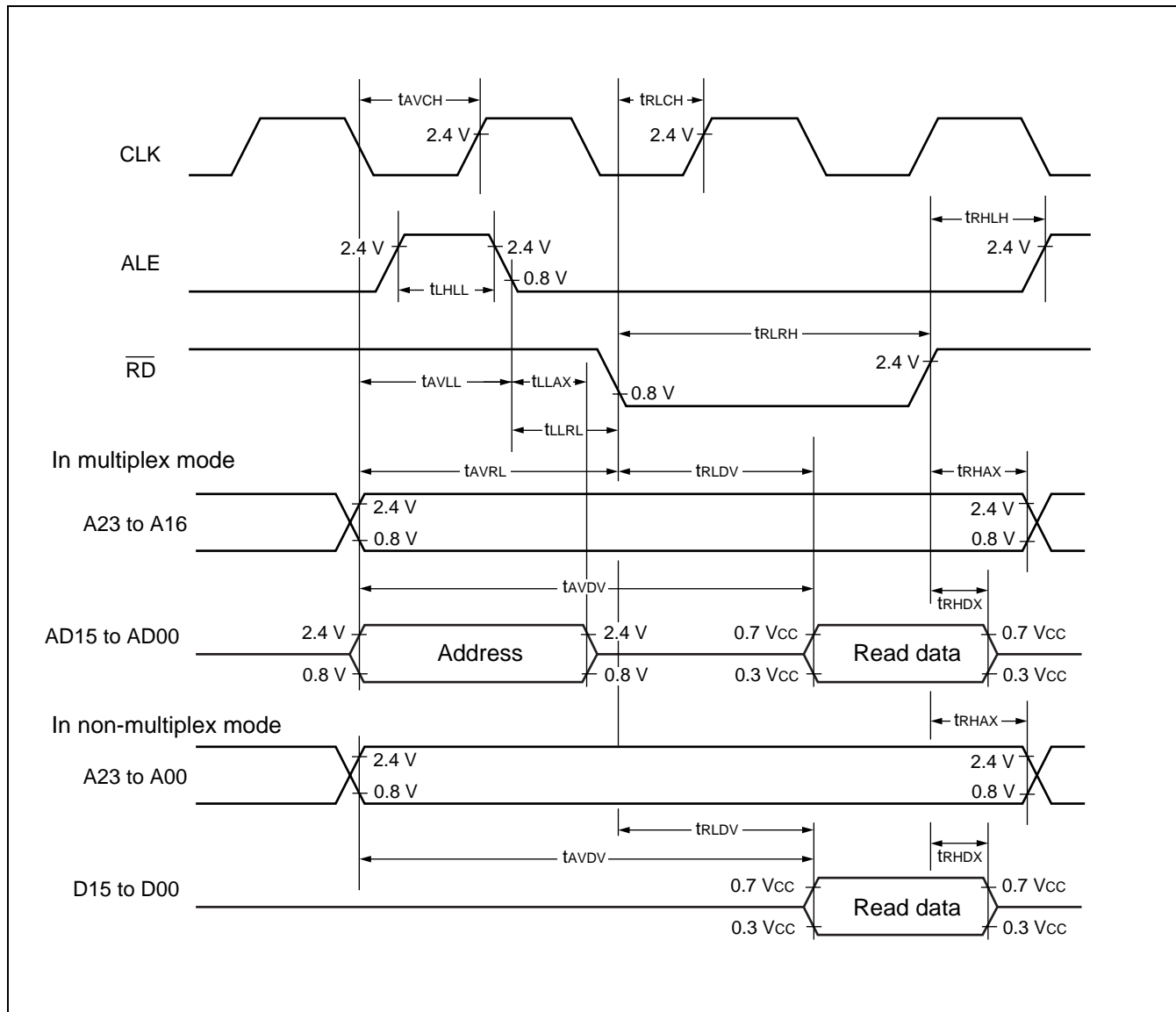
(11) Bus write timing

$(V_{CC} = AV_{CC} = 3.3\ V \pm 0.3\ V,\ V_{SS} = AV_{SS} = 0.0\ V,\ T_A = 0\ °C\ to + 70\ °C)$

Parameter	Symbol	Pin name	Conditions	Value Min	Value Max	Unit	Remarks
Valid address→$\overline{WR}$↓time	t_{AVWL}	Address, $\overline{WR}$	—	$t_{CP} - 15$	—	ns	
$\overline{WR}$ pulse width	t_{WLWH}	$\overline{WRL}$, $\overline{WRH}$	—	$3\ t_{CP}/2 - 25$	—	ns	At f_{cp} = 24 MHz
			—	$3\ t_{CP}/2 - 20$	—	ns	At f_{cp} = 12 MHz
Valid data output→$\overline{WR}$↑time	t_{DVWH}	Data, $\overline{WR}$	—	$3\ t_{CP}/2 - 15$	—	ns	
$\overline{WR}$↑→data hold time	t_{WHDX}	$\overline{WR}$, Data	—	10	—	ns	At f_{cp} = 24 MHz
			—	20	—	ns	At f_{cp} = 12 MHz
			—	30	—	ns	At f_{cp} = 6 MHz
$\overline{WR}$↑→address valid time	t_{WHAX}	$\overline{WR}$, Address	—	$t_{CP}/2 - 10$	—	ns	
$\overline{WR}$↑→ALE↑time	t_{WHLH}	$\overline{WR}$, ALE	—	$t_{CP}/2 - 15$	—	ns	
$\overline{WR}$↓→CLK↑time	t_{WLCH}	$\overline{WR}$, CLK	—	$t_{CP}/2 - 17$	—	ns	

Note : t_{CP} : See " (1) Clock input timing".
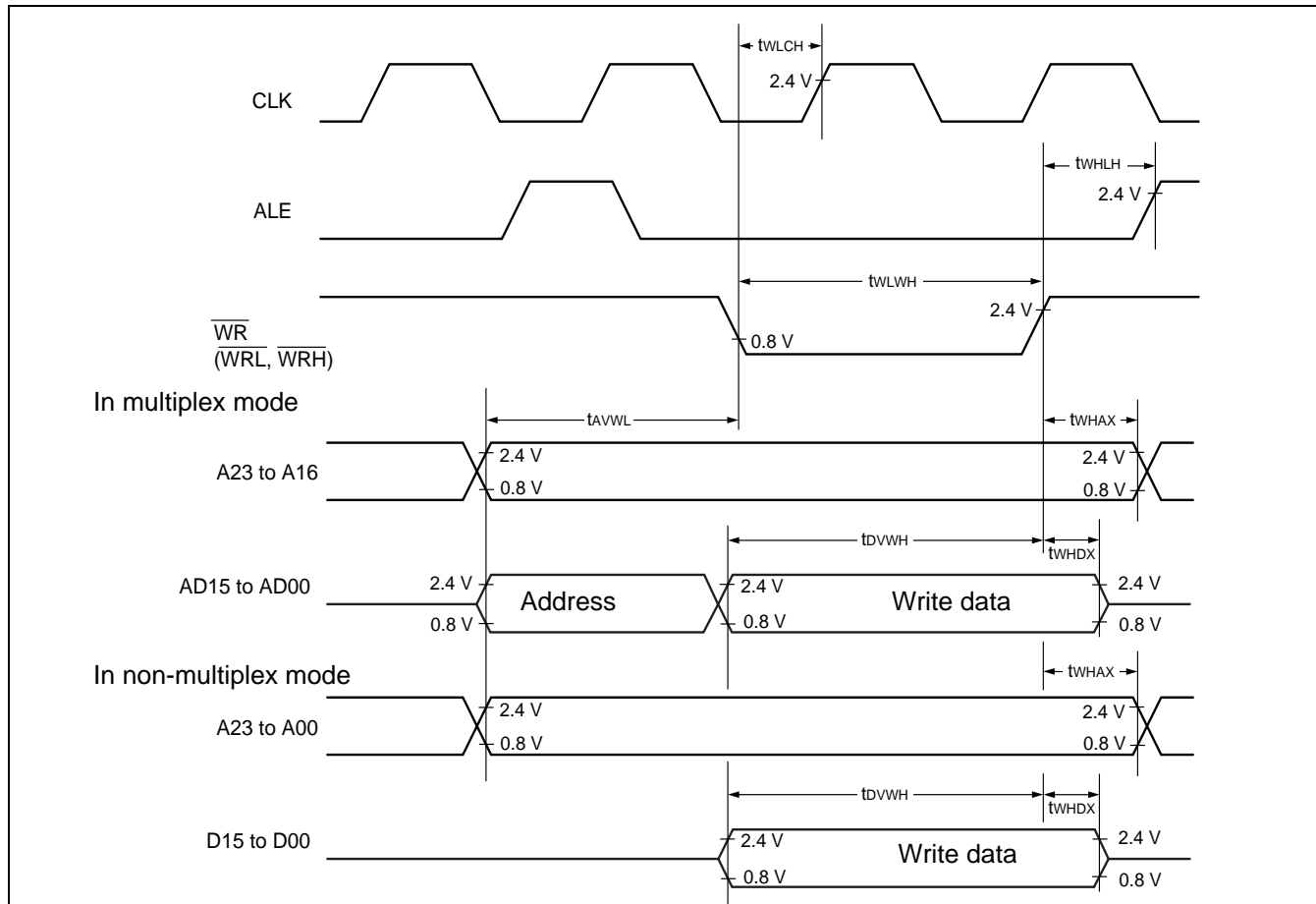
(12) Ready input timing

$(V_{CC} = AV_{CC} = 3.3\ V \pm 0.3\ V,\ V_{SS} = AV_{SS} = 0.0\ V,\ T_A = 0\ °C\ to + 70\ °C)$

Parameter	Symbol	Pin name	Conditions	Value Min	Value Max	Unit	Remarks
RDY set-up time	t_{RYHS}	RDY	—	35	—	ns	
			—	70	—	ns	$f_{cp} = 6$ MHz
RDY hold time	t_{RYHH}		—	0	—	ns	

Notes : • If the RDY set-up time is insufficient, use the auto-ready function.
  • For input from the RDY pin, be careful as failure to satisfy AC standards may cause the chip to run out of control.

(13) Hold timing

$(V_{CC} = AV_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, V_{SS} = AV_{SS} = 0.0 \text{ V}, T_A = 0 \text{ °C to } + 70 \text{ °C})$

Parameter	Symbol	Pin name	Condi-tions	Value		Unit	Remarks
				Min	Max		
Pin floating→$\overline{HAK}$↓time	t_{XHAL}	$\overline{HAK}$	—	30	t_{CP}	ns	
$\overline{HAK}$↓→pin valid time	t_{HAHV}	$\overline{HAK}$		t_{CP}	2 t_{CP}	ns	

Notes : • It takes one cycle or more for $\overline{HAK}$ to change after the HRQ pin is captured.
• t_{CP} : See " (1) Clock input timing".
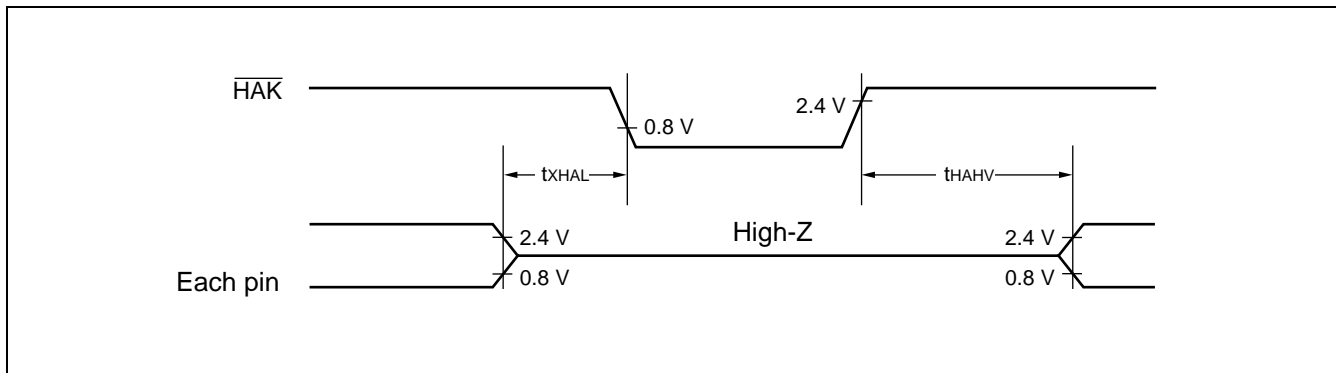
5. Electrical Characteristics for the A/D Converter

$(V_{CC} = AV_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}, V_{SS} = AV_{SS} = 0.0 \text{ V}, T_A = -40 \text{ °C to } +85 \text{ °C})$

Parameter	Symbol	Pin name	Value			Unit	Remarks
			Min	Typ	Max		
Resolution	—	—	—	—	10	bit	
Total error	—	—	—	—	± 3.0	LSB	
Nonlinear error	—	—	—	—	± 2.5	LSB	
Differential linear error	—	—	—	—	± 1.9	LSB	
Zero transition voltage	V_{OT}	AN0 to AN15	$AV_{SS} - 1.5$ LSB	$AV_{SS} + 0.5$ LSB	$AV_{SS} + 2.5$ LSB	mV	1 LSB = AVRH/1024
Full-scale transition voltage	V_{FST}	AN0 to AN15	AVRH – 3.5 LSB	AVRH – 1.5 LSB	AVRH + 0.5 LSB	mV	
Conversion time	—	—	—	176 t_{CP}[*1]	—	ns	
Sampling time	—	—	—	64 t_{CP}[*1]	—	ns	
Analog port input current	I_{AIN}	AN0 to AN15	—	—	10	μA	
Analog input voltage	V_{AIN}	AN0 to AN15	0	—	AVRH	V	
Reference voltage	—	AVRH	2.7	—	AV_{CC}	V	
Power supply current	I_A	AV_{CC}	—	1.4	3.5	mA	
	I_{AH}	AV_{CC}	—	—	5	μA	*2
Reference voltage supplying current	I_R	AVRH	—	95	170	μA	
	I_{RH}	AVRH	—	—	5	μA	*2
Interchannel disparity	—	AN0 to AN15	—	—	4	LSB	

*1 : t_{CP} : See " (1) Clock input timing".

*2 : The current when the CPU is in stop mode and the A/D converter is not operating (For $V_{CC} = AV_{CC} = AVRH = 3.3$ V).

Notes :

● **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 sample and hold capacitor is insufficient, adversely affecting A/D conversion presicion.

● Analog input circuit model
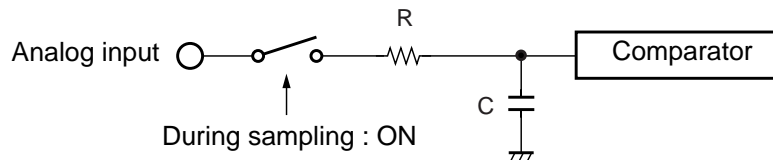
	R	C
MB90333A	1.9 kΩ (Max)	32.3 pF (Max)
MB90F334A	1.9 kΩ (Max)	25.0 pF (Max)
MB90V330A	1.9 kΩ (Max)	32.3 pF (Max)

Note : The values are reference values.

  ● 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.

● The relationship between the external impedance and minimum sampling time

(External impedance = 0 kΩ to 100 kΩ)   (External impedance = 0 kΩ to 20 kΩ)
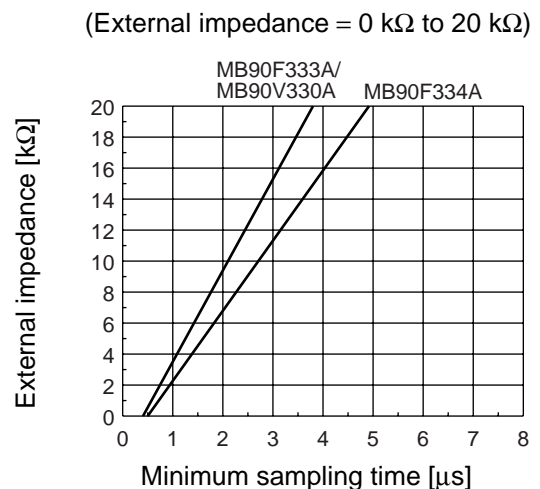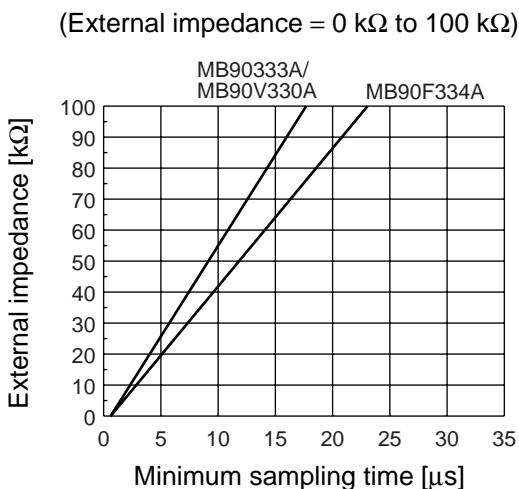
  ● If the sampling time cannot be sufficient, connect a capacitor of about 0.1 μF to the analog input pin.

● **About errors**
  As |AVRH| becomes smaller, values of relative errors grow larger.

6. USB characteristics

$(V_{CC} = AV_{CC} = 3.3\ V \pm 0.3\ V,\ V_{SS} = AV_{SS} = 0.0\ V,\ T_A = 0\ °C\ to + 70\ °C)$

Parameter		Symbol	Value		Unit	Remarks
			Min	Max		
Input characteristics	Input High level voltage	V_{IH}	2.0	—	V	
	Input Low level voltage	V_{IL}	—	0.8	V	
	Differential input sensitivity	V_{DI}	0.2	—	V	
	Differential common mode range	V_{CM}	0.8	2.5	V	
Output characteristics	Output High level voltage	V_{OH}	2.8	3.6	V	$I_{OH} = -\ 200\ \mu A$
	Output Low level voltage	V_{OL}	0.0	0.3	V	$I_{OL} = 2\ mA$
	Cross over voltage	V_{CRS}	1.3	2.0	V	
	Rise time	t_{FR}	4	20	ns	Full Speed
		t_{LR}	75	300	ns	Low Speed
	Fall time	t_{FF}	4	20	ns	Full Speed
		t_{LF}	75	300	ns	Low Speed
	Rising/falling time matching	t_{RFM}	90	111.11	%	(T_{FR}/T_{FF})
		t_{RLM}	80	125	%	(T_{LR}/T_{LF})
	Output resistance	Z_{DRV}	28	44	Ω	Including $Rs = 27\ \Omega$

• Data signal timing (Full Speed)
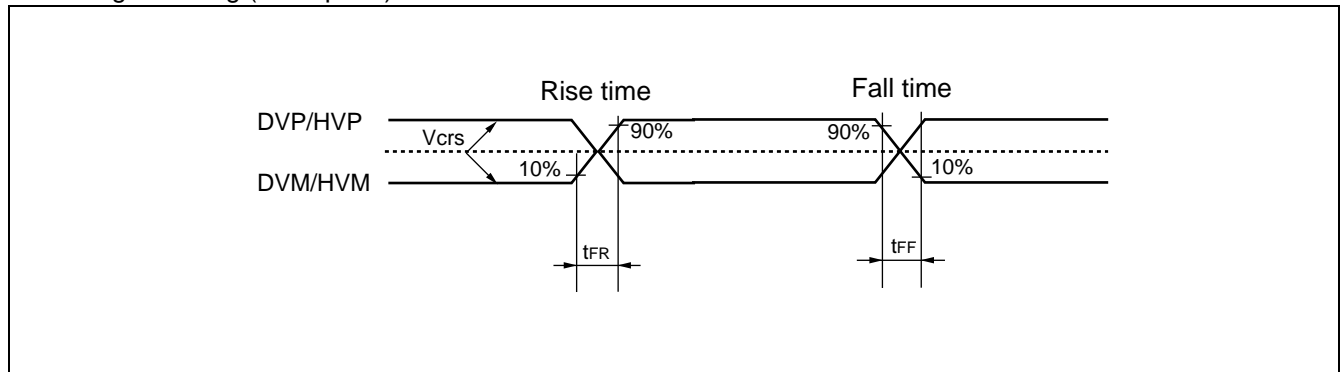
• Data signal timing (Low Speed)
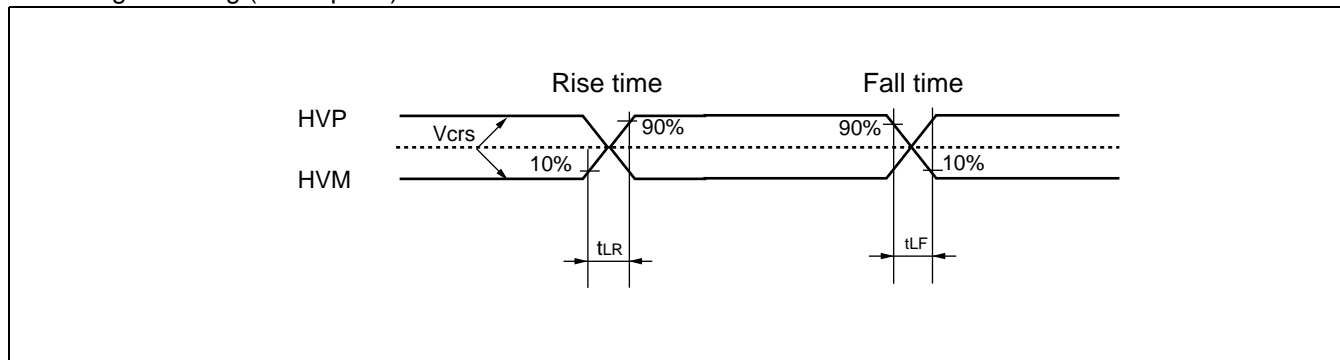
• Load condition (Full Speed)
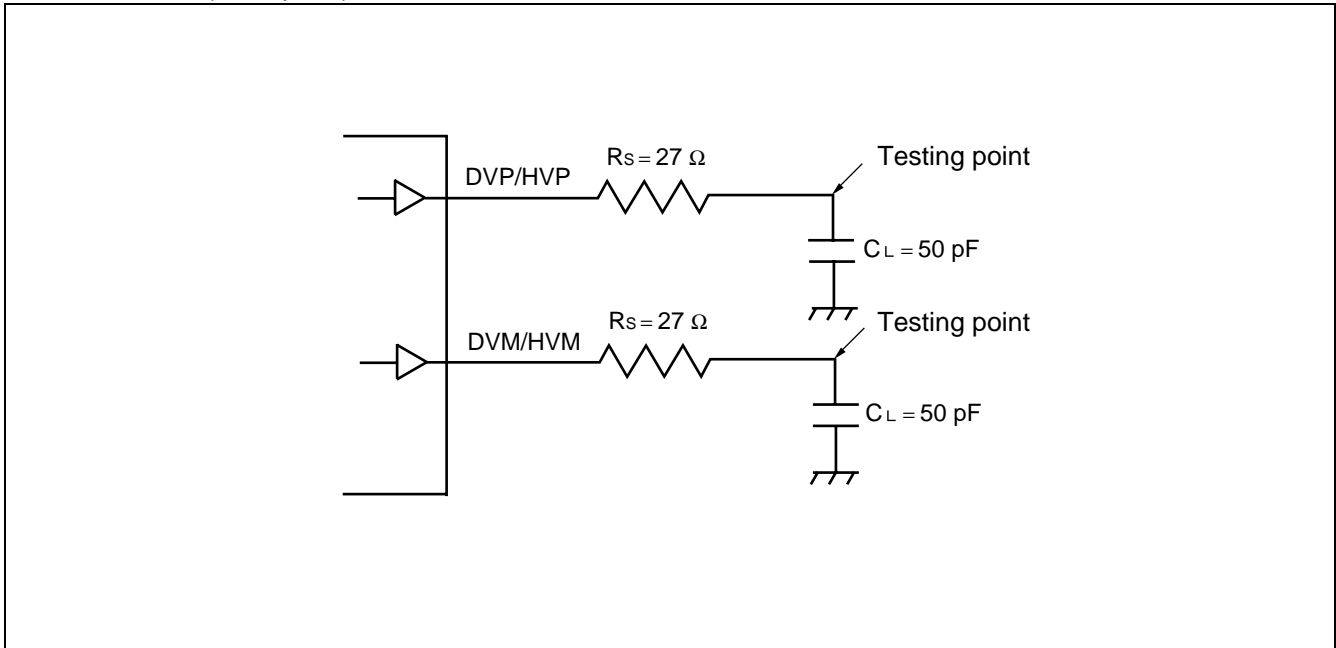
• Load condition (Low Speed)
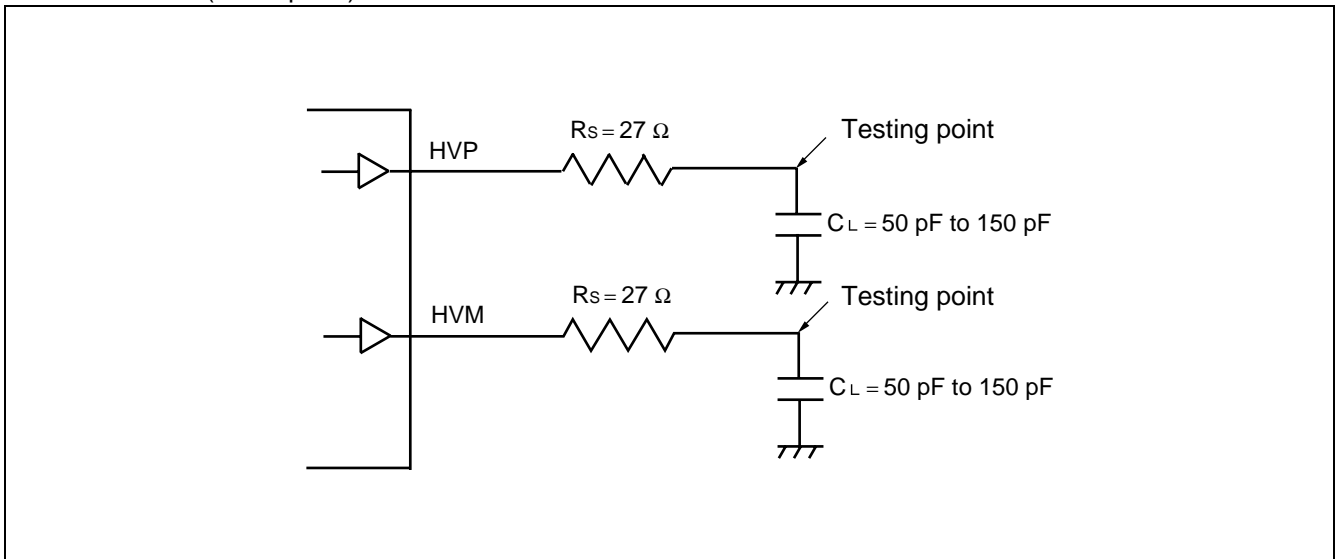
7. Flash memory write/erase characteristics

Parameter	Condition	Value			Unit	Remarks
		Min	Typ	Max		
Sector erase time	$T_A = +25 °C$ $V_{CC} = 3.0$ V	—	1	15	s	Excludes 00$_H$ programming prior to erasure.
Chip erase time		—	9	—	s	Excludes 00$_H$ programming prior to erasure.
Word (16-bit width) programming time		—	16	3,600	μs	Except for over head time of system level
Programming/erase cycle	—	10,000	—	—	cycle	
Flash memory data retaining period	Average $T_A = +85 °C$	20	—	—	year	*

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

■ ORDERING INFORMATION

Part number	Package	Remarks
MB90F334APFF MB90333APFF	120-pin Plastic LQFP (FPT-120P-M05)	
MB90F334APMC MB90333APMC	120-pin Plastic LQFP (FPT-120P-M21)	
MB90V330A	299-pin Ceramic PGA (PGA-299C-A01)	For evaluation

■ PACKAGE DIMENSIONS

120-pin Plastic LQFP
(FPT-120P-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.

16.00±0.20(.630±.008)SQ

*14.00±0.10(.551±.004)SQ

90   61

91   60

0.08(.003)

INDEX

120   31

LEAD No.   1   30

0.40(.016)

0.16±0.03
(.006±.001)

0.07(.003) Ⓜ

"A"

0.145±0.055
(.006±.002)

Details of "A" part

$1.50 ^{+0.20}_{-0.10}$ (Mounting height)
$\left(.059 ^{+.008}_{-.004} \right)$

0~8°

0.50±0.20
(.020±.008)

0.60±0.15
(.024±.006)

0.10±0.10
(.004±.004)
(Stand off)

0.25(.010)
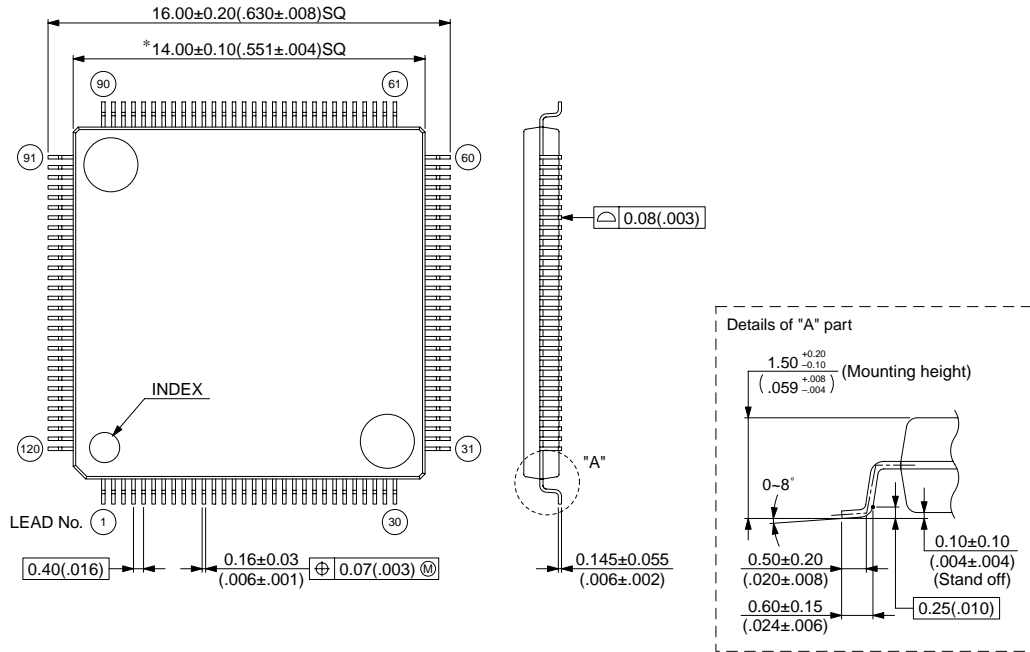
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Dimensions in mm (inches)
Note : The values in parentheses are reference values.

(Continued)

(Continued)

120-pin Plastic LQFP
(FPT-120P-M21)

Note 1) * : These dimensions do not include resin protrusion.
Resin protrusion is +0.26 (.010) MAX (each side) .
Note 2) Pins width and pins thickness include plating thickness.
Note 3) Pins width do not include tie bar cutting remainder.
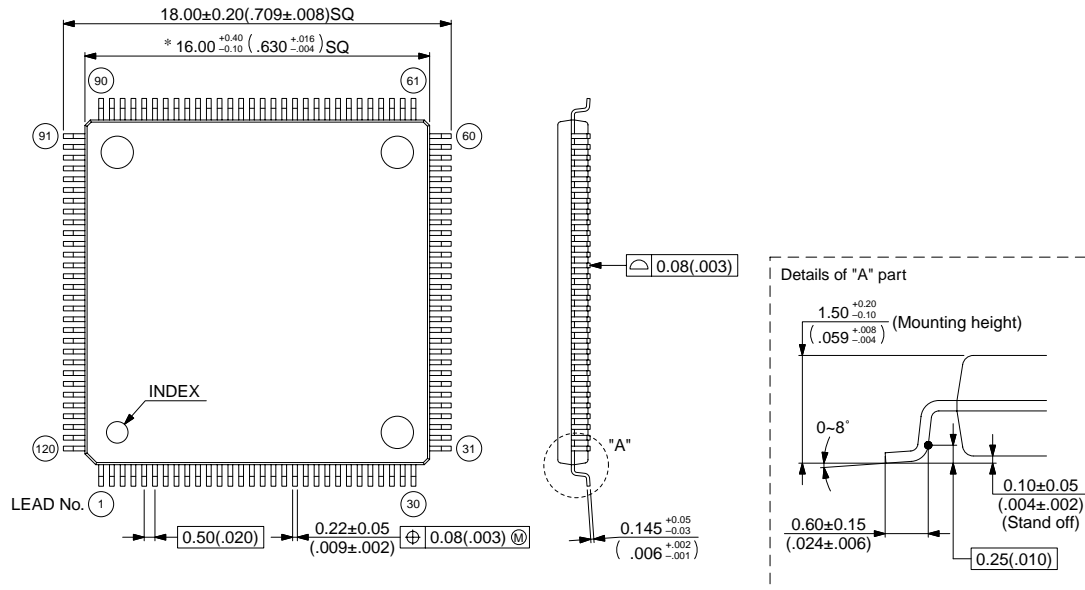
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Dimensions in mm (inches)
Note : The values in parentheses are reference values.

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