FUJITSU SEMICONDUCTOR
DATA SHEET

DS07-13602-4E

16-bit Proprietary Microcontroller

CMOS

F²MC-16L MB90670/675 Series

MB90671/672/673/T673/P673 (MB90670 Series)
MB90676/677/678/T678/P678 (MB90675 Series)

■ DESCRIPTION

The MB90670/675 series is a member of 16-bit proprietary single-chip microcontroller F²MC*1-16L family designed to be combined with an ASIC (Application Specific IC) core. The MB90670/675 series is a high-performance
general-purpose 16-bit microcontroller for high-speed real-time processing in various industrial equipment, OA equipment, and process control.

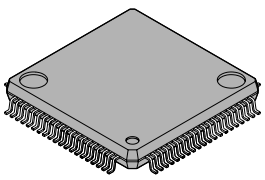
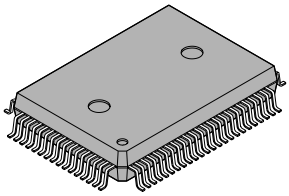
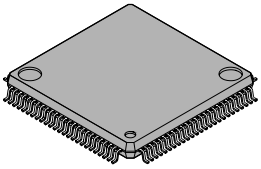
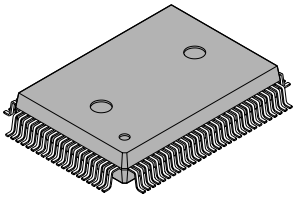
The instruction set of F²MC-16L CPU core inherits AT architecture of F²MC-8 family with additional instruction sets for high-level languages, extended addressing mode, enhanced multiplication/division instructions, and enhanced bit manipulation instructions. The microcontroller has a 32-bit accumulator for processing long word data (32-bit).

The MB90670/675 series has peripheral resources of UART0, UART1(SCI), an 8/10-bit A/D converter, an 8/16-bit PPG timer, a 16-bit reload timer, a 24-bit free-run timer, an output compare (OCU), an input capture (ICU), DTP/external interrupt circuit, an I²C*2 interface (in MB90675 series only). Embedded peripheral resources performs data transmission with an intelligent I/O service function without the intervention of the CPU, enabling real-time control in various applications.

*1: F²MC stands for FUJITSU Flexible Microcontroller.

*2: 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.

■ PACKAGE

80-pin Plastic LQFP	80-pin Plastic QFP	100-pin Plastic LQFP	100-pin Plastic QFP
			
(FPT-80P-M05)	(FPT-80P-M06)	(FPT-100P-M05)	(FPT-100P-M06)

MB90670/675 Series

■ FEATURES

- Clock
  Embedded PLL clock multiplication circuit
  Operating clock (PLL clock) can be selected from divided-by-2 of oscillation or one to four times the oscillation (at oscillation of 4 MHz, 4 MHz to 16 MHz).
  Minimum instruction execution time of 62.5 ns (at oscillation of 4 MHz, four times the PLL clock, operation at Vcc of 5.0 V)
- CPU addressing space of 16 Mbytes
  Internal addressing of 24-bit
  External accessing can be performed by selecting 8/16-bit bus width (external bus mode)
- Instruction set optimized for controller applications
  Rich data types (bit, byte, word, long word)
  Rich addressing mode (23 types)
  High code efficiency
  Enhanced precision calculation realized by the 32-bit accumulator
- Instruction set designed for high level language (C) and multi-task operations
  Adoption of system stack pointer
  Enhanced pointer indirect instructions
  Barrel shift instructions
- Enhanced execution speed
  4-byte instruction queue
- Enhanced interrupt function
  8 levels, 32 factors
- Automatic data transmission function independent of CPU operation
  Extended intelligent I/O service function (EI^{2}OS)
- Low-power consumption (standby) mode
  Sleep mode (mode in which CPU operating clock is stopped)
  Timebase timer mode (mode in which other than oscillation and timebase timer are stopped)
  Stop mode (mode in which oscillation is stopped)
  CPU intermittent operation mode
  Hardware standby mode
- Process
  CMOS technology
- I/O port
  MB90670 series: Maximum of 65 ports
  MB90675 series: Maximum of 84 ports
- Timer
  Timebase timer/watchdog timer: 1 channel
  8/16-bit PPG timer: 8-bit × 2 channels or 16-bit × 1 channel
  16-bit reload timer: 2 channels
  24-bit free-run timer: 1 channel
- Input capture (ICU)
  Generates an interrupt request by latching a 24-bit free-run timer counter value upon detection of an edge input to the pin.
- Output compare (OCU)
  Generates an interrupt request and reverse the output level upon detection of a match between the 24-bit free-run timer counter value and the compare setting value.
- I^{2}C interface (in MB90675 series only)
  Serial I/O port for supporting Inter IC BUS

(Continued)

(Continued)

- UART0
  With full-duplex double buffer (8-bit length)
  Clock asynchronized or clock synchronized transmission (with start and stop bits) can be selectively used.
- UART1 (SCI)
  With full-duplex double buffer (8-bit length)
  Clock asynchronized or clock synchronized serial transmission (I/O extended serial) can be selectively used.
- DTP/external interrupt circuit (4 channels)
  A module for starting extended intelligent I/O service (EI^{2}OS) and generating an external interrupt triggered by an external input.
- Wake-up interrupt
  Receives external interrupt requests and generates an interrupt request upon an “L” level input.
- Delayed interrupt generation module
  Generates an interrupt request for switching tasks.
- 8/10-bit A/D converter (8 channels)
  8-bit or 10-bit resolution can be selectively used.
  Starting by an external trigger input.

MB90670/675 Series

■ PRODUCT LINEUP

- **MB90670 series**

Item \ Part number	MB90671	MB90672	MB90673	MB90T673	MB90P673
Classification	Mask ROM products			External ROM product	One-time PROM product
ROM size	16 Kbytes	32 Kbytes	48 Kbytes	External ROM	48 Kbytes
RAM size	640 bytes	1.64 Kbytes	2 Kbytes		
CPU functions	Number of instructions: 340 Instruction bit length: 8 bits, 16 bits Instruction length: 1 byte to 7 bytes Data bit length: 1 bit, 8 bits, 16 bits Minimum execution time: 62.5 ns (at machine clock of 16 MHz) Interrupt processing time: 1.5 µs (at machine clock of 16 MHz, minimum value)				
Ports	General-purpose I/O ports (CMOS output): 57 General-purpose I/O ports (N-ch open-drain output): 8 Total: 65				
UART0	Clock synchronized transmission (500 Kbps to 2 Mbps) Clock asynchronized transmission (4800 Kbps to 500 kbps) Transmission can be performed by bi-directional serial transmission or by master/ slave connection.				
UART1 (SCI)	Clock synchronized transmission (500 Kbps to 2 Mbps) Clock asynchronized transmission (2400 Kbps to 62500 bps) Transmission can be performed by bi-directional serial transmission or by master/ slave connection.				
8/10-bit A/D converter	Conversion precision: 10-bit or 8-bit selectable Number of inputs: 8 One-shot conversion mode (converts selected channel only once) Continuous conversion mode (converts selected channel continuously) Stop conversion mode (converts selected channel and stop operation repeatedly)				
8/16-bit PPG timer	Number of channels: 2 8-bit or 16-bit PPG operation A pulse wave of given intervals and given duty ratios can be output. Pulse cycle: 125 ns to 16.78 s (at oscillation of 4 MHz, machine clock of 16 MHz)				
16-bit reload timer	Number of channels: 2 16-bit reload timer operation Interval: 125 ns to 131 ms (at machine clock of 16 MHz) External event count can be performed.				
24-bit free-run timer	Number of channel :1 Overflow interrupts or intermediate bit interrupts may be generated.				
Output compare unit (OCU)	Number of channels: 8 Pin input factor: A match signal of compare register				

(Continued)

(Continued)

Part number / Item	MB90671	MB90672	MB90673	MB90T673	MB90P673
Input capture unit (ICU)	Number of channels: 4 Rewriting a register value upon a pin input (rising, falling, or both edges)				
DTP/external interrupt circuit	Number of inputs: 4 Started by a rising edge, a falling edge, an “H” level input, or an “L” level input. External interrupt circuit or extended intelligent I/O service (EI^{2}OS) can be used.				
Wake-up interrupt	Number of inputs: 8 Started by an “L” level input.				
Delayed interrupt generation module	An interrupt generation module for switching tasks used in real-time operating systems.				
I^{2}C interface	None				
Timebase timer	18-bit counter Interrupt interval: 1.024 ms, 4.096 ms, 16.384 ms, 131.072 ms (at oscillation of 4 MHz)				
Watchdog timer	Reset generation interval: 3.58 ms, 14.33 ms, 57.23 ms, 458.75 ms (at oscillation of 4 MHz, minimum value)				
Low-power consumption (standby) mode	Sleep/stop/CPU intermittent operation/timebase timer/hardware stand-by				
Process	CMOS				
Operating voltage*	2.7 V to 5.5 V				

* : Varies with conditions such as the operating frequency. (See section “■ Electrical Characteristics.”)

MB90670/675 Series

- **MB90675 series**

Part number / Item	MB90676	MB90677	MB90678	MB90T678	MB90P678	MB90V670
Classification	Mask ROM products			External ROM product	One-time PROM product	Evaluation product
ROM size	32 Kbytes	48 Kbytes	64 Kbytes	None	64 Kbytes	—
RAM size	1.64 Kbytes	2 Kbytes	3 Kbytes			4 Kbytes
CPU functions	The number of instructions: 340 Instruction bit length: 8 bits, 16 bits Instruction length: 1 byte to 7 bytes Data bit length: 1 bit, 8 bits, 16 bits Minimum execution time: 62.5 ns (at machine clock of 16 MHz) Interrupt processing time: 1.5 µs (at machine clock of 16 MHz, minimum value)					
Ports	General-purpose I/O ports (CMOS output): 74 General-purpose I/O ports (N-ch open-drain output): 10 Total: 84					
UART0	Clock synchronized transmission (500 Kbps to 2 Mbps) Clock asynchronized transmission (4800 Kbps to 500 Kbps) Transmission can be performed by bi-directional serial transmission or by master/slave connection.					
UART1 (SCI)	Clock synchronized transmission (500 Kbps to 2 Mbps) Clock asynchronized transmission (2400 Kbps to 62500 bps) Transmission can be performed by bi-directional serial transmission or by master/slave connection.					
8/10-bit A/D converter	Conversion precision: 10-bit or 8-bit can be selectively used. Number of inputs: 8 One-shot conversion mode (converts selected channel only once) Continuous conversion mode (converts selected channel continuously) Stop conversion mode (converts selected channel and stop operation repeatedly)					
8/16-bit PPG timer	Number of channels: 2 PPG operation of 8-bit or 16-bit Pulse of given intervals and given duty ratios can be output Pulse interval 125 ns to 16.78 s (at oscillation of 4 MHz, machine clock of 16 MHz)					
16-bit reload timer	Number of channels: 2 16-bit reload timer operation Interval: 125 ns to 131 ms (at machine clock of 16 MHz) External event count can be performed.					
24-bit free-run timer	Number of channel :1 Overflow interrupts or intermediate bit interrupts may be generated.					
Output compare (OCU)	Number of channels: 8 Pin input factor: a match signal of compare register					

(Continued)

(Continued)

Item \ Part number	MB90676	MB90677	MB90678	MB90T678	MB90P678	MB90V670
Input capture (ICU)	Number of channels: 4 Rewriting a register value upon a pin input (rising, falling, or both edges)					
DTP/external interrupt circuit	Number of inputs: 4 Started by a rising edge, a falling edge, an “H” level input, or an “L” level input. External interrupt circuit or extended intelligent I/O service (EI^{2}OS) can be used.					
Wake-up interrupt	Number of inputs: 8 Started by an “L” level input.					
Delayed interrupt generation module	An interrupt generation module for switching tasks used in real-time operating systems.					
I^{2}C interface	Serial I/O port for supporting Inter IC BUS					
Timebase timer	18-bit counter Interrupt interval: 1.024 ms, 4.096 ms, 16.384 ms, 131.072 ms (at oscillation of 4 MHz)					
Watchdog timer	Reset generation interval: 3.58 ms, 14.33 ms, 57.23 ms, 458.75 ms (at oscillation of 4 MHz, minimum value)					
Low-power consumption (stand-by) mode	Sleep/stop/CPU intermittent operation/timebase timer/hardware stand-by					
Process	CMOS					
Power supply voltage for operation*	2.7 V to 5.5 V					

* : Varies with conditions such as the operating frequency. (See section “■ Electrical Characteristics.”) Assurance for the MB90V670 is given only for operation with a tool at a power voltage of 2.7 V to 5.5 V, an operating temperature of 0°C to 70°C, and an operating frequency of 1.5 MHz to 16 MHz.

■ PACKAGE AND CORRESPONDING PRODUCTS

Package	MB90671 MB90672 MB90673 MB90T673	MB90P673	MB90676 MB90677 MB90678 MB90T678	MB90P678	MB90V670
FPT-80P-M05	○	○	×	×	×
FPT-80P-M06	○	○	×	×	×
FPT-100P-M05	×	×	○	○	×
FPT-100P-M06	×	×	○	○	×

○ : Available × : Not available

Note: For more information about each package, see section “■ Package Dimensions.”

■ DIFFERENCES AMONG PRODUCTS

1. Memory Size

In evaluation with an evaluation product, note the difference between the evaluation chip and the chip actually used. The following items must be taken into consideration.

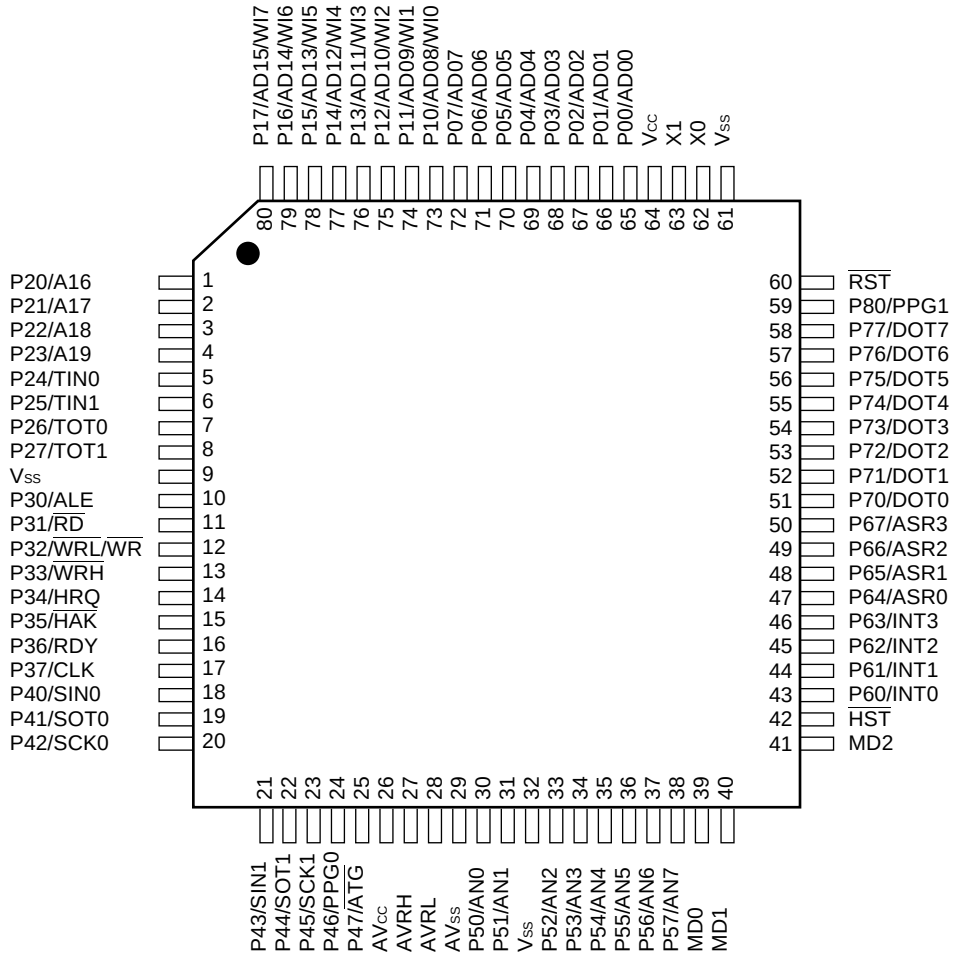
- The MB90V670 does not have an internal ROM, however, operations equivalent to chips with an internal ROM can be evaluated by using a dedicated development tool, enabling selection of ROM size by settings of the development tool.
- In the MB90V670, images from $FF4400_H$ to $FFFFFF_H$ are mapped to bank 00, and $FE0000_H$ to $FF3FFF_H$ to mapped to bank FE and FF only. (This setting can be changed by configuring the development tool.)
- In the MB90678/MB90P678, images from $FF4000_H$ to $FFFFFF_H$ are mapped to bank 00, and $FF0000_H$ to $FF3FFF_H$ to bank FF only.

2. Mask Options

Functions selected by optional settings and methods for setting the options are dependent on the product types. Refer to “■ Mask Options” for detailed information.
Note that mask option is fixed in MB90V670 series.

■ PIN ASSIGNMENT

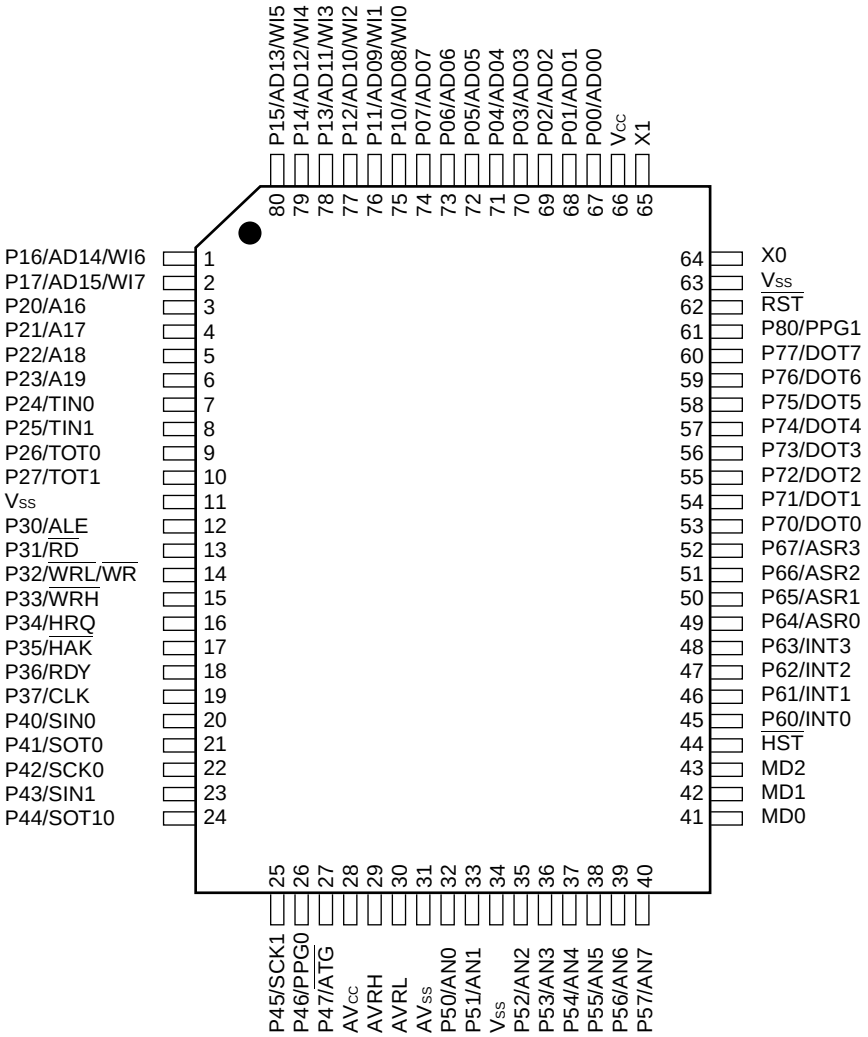
(Top view)



(FPT-80P-M05)

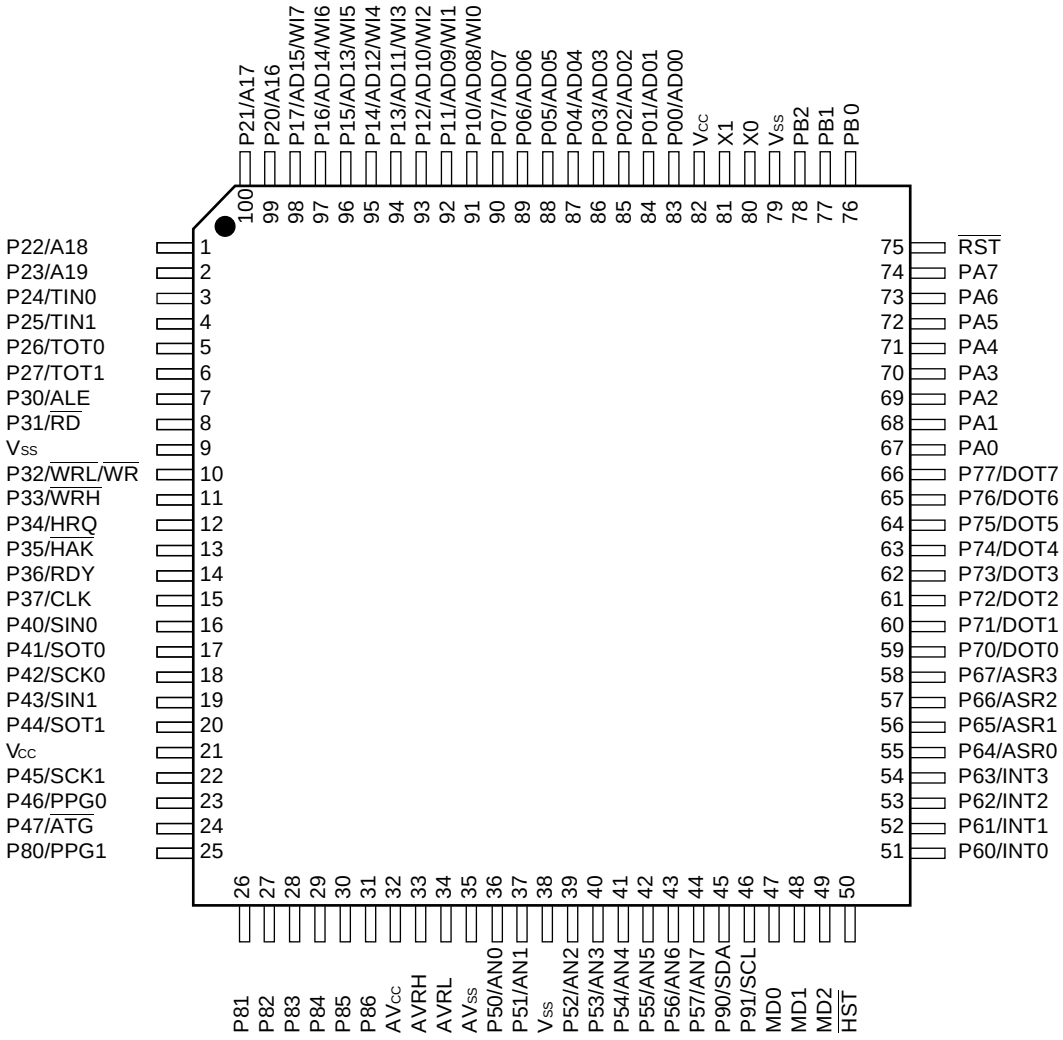
MB90670/675 Series

(Top view)



(FPT-80P-M06)

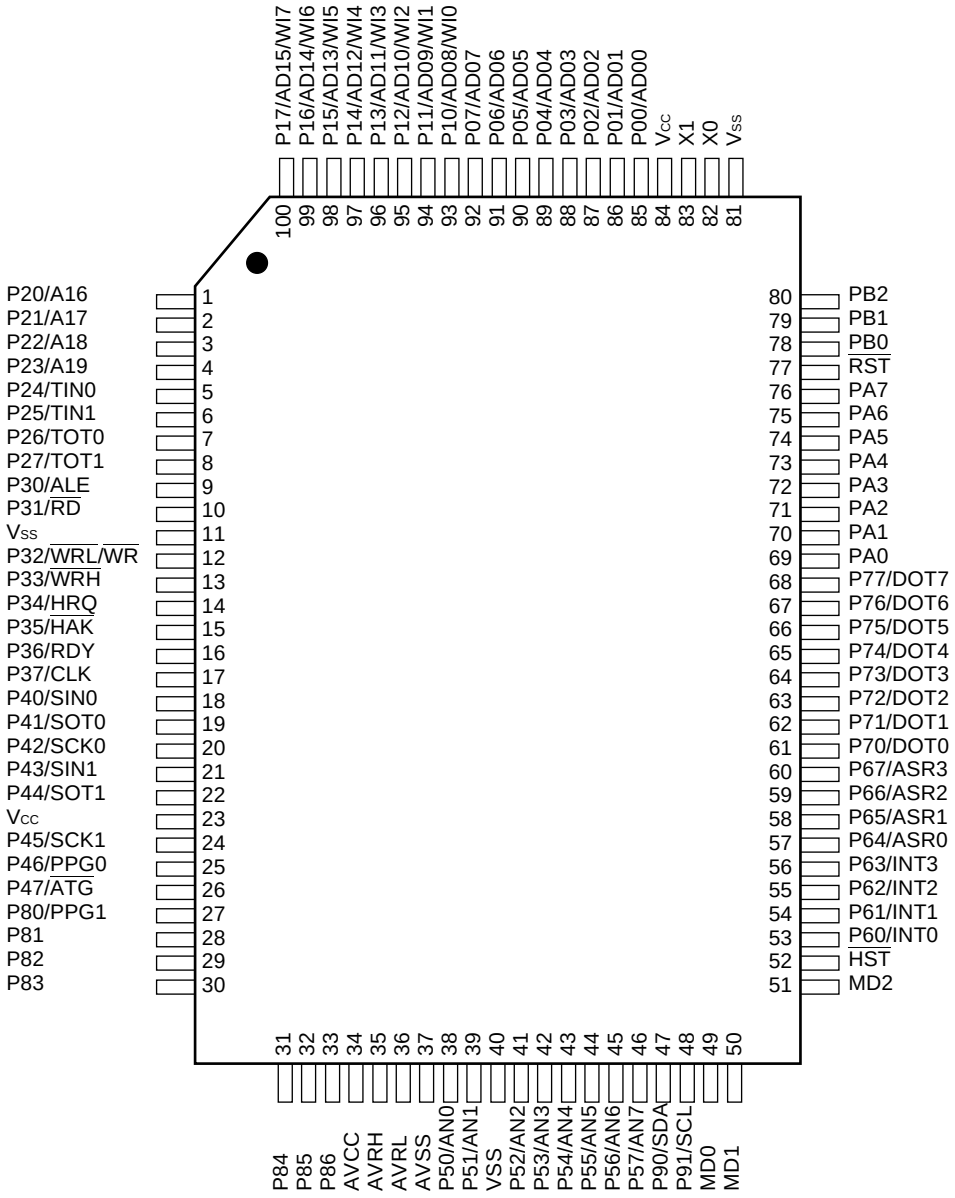
(Top view)



(FPT-100P-M05)

MB90670/675 Series

(Top view)



(FPT-100P-M06)

■ PIN DESCRIPTION

Pin no.				Pin name	Circuit type	Function
LQFP -80*1	QFP -80*2	LQFP -100*3	QFP -100*4			
62	64	80	82	X0	A (Oscillation)	Crystal oscillator pins
63	65	81	83	X1		
39 to 41	41 to 43	47 to 49	49 to 51	MD0 to MD2	F (CMOS)	Input pins for selecting operation modes Connect directly to V_{CC} or V_{SS}.
60	62	75	77	$\overline{RST}$	H (CMOS/H)	External reset request input
42	44	50	52	$\overline{HST}$	G (CMOS/H)	Hardware standby input pin
65 to 72	67 to 74	83 to 90	85 to 92	P00 to P07	B (CMOS)	General-purpose I/O port This function is valid in the single-chip mode.
				AD00 to AD07		I/O pins for the lower 8-bit of the external address data bus This function is valid in the mode where the external bus is valid.
73 to 78, 79, 80	75 to 80, 1, 2	91 to 96, 97, 98	93 to 98, 99, 100	P10 to P15, P16, P17	B (CMOS)	General-purpose I/O port This function is valid in the single-chip mode.
				AD08 to AD13, AD14, AD15		I/O pins for the upper 8-bit of the external address data bus This function is valid in the mode where the external bus is valid.
				WI0 to WI5, WI6, WI7		I/O pins for wake-up interrupts This function is valid in the single-chip mode. Because the input of the DTP/external interrupt circuit is used as required when the DTP/external interrupt circuit is enabled, and it is necessary to stop outputs by other functions unless such outputs are made intentionally.
1, 2, 3, 4	3, 4, 5, 6	99, 100, 1, 2	1, 2, 3, 4	P20, P21, P22, P23	B (CMOS)	General-purpose I/O port This function becomes valid in the single-chip mode or the external address output control register is set to select a port.
				A16, A17, A18, A19		Output pins for the external address bus of A16 to A19 This function is valid in the mode where the external bus is valid and the upper address control register is set to select an address.

*1: FPT-80P-M05
*2: FPT-80P-M06
*3: FPT-100P-M05
*4: FPT-100P-M06

(Continued)

Pin no.				Pin name	Circuit type	Function
LQFP -80*1	QFP -80*2	LQFP -100*3	QFP -100*4			
5, 6	7, 8	3, 4	5, 6	P24, P25	E (CMOS/H)	General-purpose I/O port This function is always valid.
				TIN0, TIN1		Event input pins of 16-bit reload timer 0 and 1 Because this input is used as required when the 16-bit reload timer is performing input operations, and it is necessary to stop outputs by other functions unless such outputs are made intentionally.
7, 8	9, 10	5, 6	7, 8	P26, P27	E (CMOS/H)	General-purpose I/O port This function is valid when outputs from 16-bit reload timer 0 and 1 are disabled.
				TOT0, TOT1		Output pins for 16-bit reload timer 0 and 1 This function is valid when output from 16-bit reload timer 0 and 1 are enabled.
10	12	7	9	P30	B (CMOS)	General-purpose I/O port This function is valid in the single-chip mode.
				ALE		Address latch enable output pin This function is valid in the mode where the external bus is valid.
11	13	8	10	P31	B (CMOS)	General-purpose I/O port This function is valid in the single-chip mode.
				RD		Read strobe output pin for the data bus This function is valid in the mode where the external bus is valid.
12	14	10	12	P32	B (CMOS)	General-purpose I/O port This function is valid in the single-chip mode or $\overline{WRL}/\overline{WR}$ pin output is disabled.
				$\overline{WRL}$		Write strobe output pin for the data bus This function is valid when $\overline{WRL}/\overline{WR}$ pin output is enabled in the mode where external bus is valid. $\overline{WRL}$ is used for holding the lower 8-bit for write strobe in 16-bit access operations, while $\overline{WR}$ is used for holding 8-bit data for write strobe in 8-bit access operations.
				$\overline{WR}$		
13	15	11	13	P33	B (CMOS)	General-purpose I/O port This function is valid in the single-chip mode, in the external bus 8-bit mode, or $\overline{WRH}$ pin output is disabled.
				$\overline{WRH}$		Write strobe output pin for the upper 8-bit of the data bus This function is valid when the external bus 16-bit mode is selected in the mode where the external bus is valid, and $\overline{WRH}$ output pin is enabled.

*1: FPT-80P-M05
*2: FPT-80P-M06
*3: FPT-100P-M05
*4: FPT-100P-M06

(Continued)

Pin no.				Pin name	Circuit type	Function
LQFP -80*1	QFP -80*2	LQFP -100*3	QFP -100*4			
14	16	12	14	P34	B (CMOS)	General-purpose I/O port This function is valid when both the single-chip mode and the hold function are disabled.
				HRQ		Hold request input pin This function is valid in the mode where the external bus is valid or when the hold function is enabled.
15	17	13	15	P35	B (CMOS)	General-purpose I/O port This function is valid when both the single-chip mode and the hold function are disabled.
				$\overline{\text{HAK}}$		Hold acknowledge output pin This function is valid in the mode where the external bus is valid or when the hold function is enabled.
16	18	14	16	P36	B (CMOS)	General-purpose I/O port This function is valid when both the single-chip mode and the external ready function are disabled.
				RDY		Ready input pin This function is valid when the external ready function is enabled in the mode where the external bus is valid.
17	19	15	17	P37	B (CMOS)	General-purpose I/O port This function is valid in the single-chip mode or when the CLK output is disabled.
				CLK		CLK output pin This function is valid when CLK output is disabled in the mode where the external bus is valid.
18	20	16	18	P40	E (CMOS/H)	General-purpose I/O port This function is always valid.
				SIN0		Serial data input pin of UART0 Because this input is used as required when UART0 is performing input operations, and it is necessary to stop outputs by other functions unless such outputs are made intentionally.
19	21	17	19	P41	E (CMOS/H)	General-purpose I/O port This function is valid when serial data output from UART0 is disabled.
				SOT0		Serial data output pin of UART0 This function is valid when serial data output from UART0 is enabled.

*1: FPT-80P-M05
*2: FPT-80P-M06
*3: FPT-100P-M05
*4: FPT-100P-M06

(Continued)

Pin no.				Pin name	Circuit type	Function
LQFP -80*1	QFP -80*2	LQFP -100*3	QFP -100*4			
20	22	18	20	P42	E (CMOS/H)	General-purpose I/O port This function is valid when clock output from UART0 is disabled.
				SCK0		Clock I/O pin of UART0 This function is valid when clock output from UART0 is enabled. Because this input is used as required when UART0 is performing input operations, and it is necessary to stop outputs by other functions unless such outputs are made intentionally.
21	23	19	21	P43	E (CMOS/H)	General-purpose I/O port This function is always valid.
				SIN1		Serial data input pin of UART1 (SCI) Because this input is used as required when UART1 (SCI) is performing input operations, and it is necessary to stop outputs by other functions unless such outputs are made intentionally.
22	24	20	22	P44	E (CMOS/H)	General-purpose I/O port This function is valid when serial data output from UART1 (SCI) is disabled.
				SOT1		Serial data output pin of UART1 (SCI) This function is valid when serial data output from UART1 (SCI) is enabled.
23	25	22	24	P45	E (CMOS/H)	General-purpose I/O port This function is valid when clock output from UART1 (SCI) is disabled.
				SCK1		Clock I/O pin of UART1 (SCI) This function is valid when clock output from UART1 (SCI) is enabled. Because this input is used as required when UART1 (SCI) is performing input operations, and it is necessary to stop outputs by other functions unless such outputs are made intentionally.
24	26	23	25	P46	E (CMOS/H)	General-purpose I/O port This function is valid when waveform output from 8/16-bit PPG timer 0 is disabled.
				PPG0		Output pin of 8/16-bit PPG timer 0 This function is valid when waveform output from 8/16-bit PPG timer 0 is enabled.

*1: FPT-80P-M05
*2: FPT-80P-M06
*3: FPT-100P-M05
*4: FPT-100P-M06

(Continued)

Pin no.				Pin name	Circuit type	Function
LQFP -80*1	QFP -80*2	LQFP -100*3	QFP -100*4			
25	27	24	26	P47	E (CMOS/H)	General-purpose I/O port This function is always valid.
				$\overline{\text{ATG}}$		Trigger input pin of the 8/10-bit A/D converter Because this input is used as requited when the 8/10-bit A/D converter is performing input operations, and it is necessary to stop outputs by other functions unless such outputs are made intentionally.
30, 31, 33, 34, 35 to 38	32, 33, 35, 36, 37 to 40	36, 37, 38, 39, 41 to 44	38, 39, 40, 41, 43 to 46	P50, P51, P52, P53, P54 to P57	C (CMOS/H)	I/O port of an open-drain type The input function is valid when the analog input enable register is set to select a port.
				AN0, AN1, AN2, AN3, AN4 to AN7		Analog input pins of the 8/10-bit A/D converter This function is valid when the analog input enable register is set to select AD.
43 to 46	45 to 48	51 to 54	53 to 56	P60 to P63	E (CMOS/H)	General-purpose I/O port This function is always valid.
				INT0 to INT3		Request input pins of the DTP/external interrupt circuit Because this input is used as required when the DTP/external interrupt circuit is performing input operations, and it is necessary to stop outputs from other functions unless such outputs are made intentionally.
47 to 50	49 to 52	55 to 58	57 to 60	P64 to P67	E (CMOS/H)	General-purpose I/O port This function is always valid.
				ASR0 to ASR3		Sample data input pins for ICU0 to ICU3 Because this input is used as required when the input capture (ICU) is performing input operations, and it is necessary to stop outputs from other functions unless such outputs are made intentionally.
51 to 58	53 to 60	59 to 66	61 to 68	P70 to P77	E (CMOS/H)	General-purpose I/O port This function is valid when waveform output from the output compare (OCU) is disabled.
				DOT0 to DOT7		Waveform output pins of OCU0 and OCU1 This function is valid when waveform output from the output compare (OCU) is enabled and output from the port is selected.

*1: FPT-80P-M05
*2: FPT-80P-M06
*3: FPT-100P-M05
*4: FPT-100P-M06

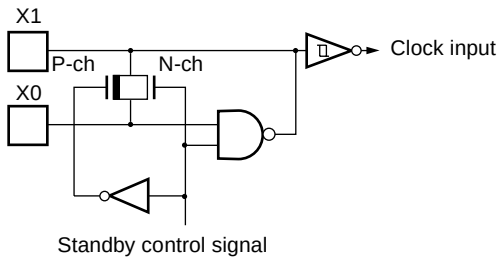
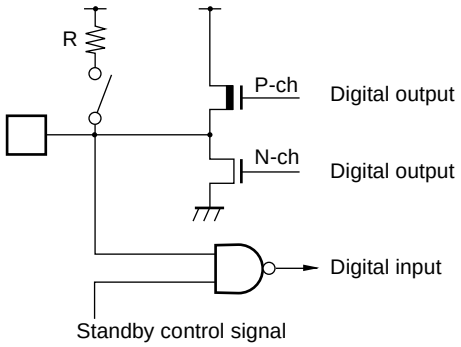
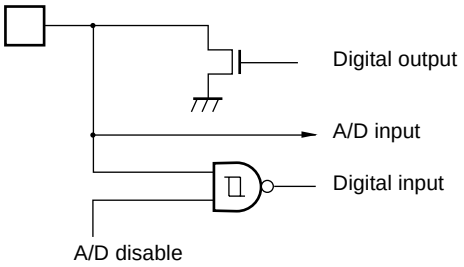
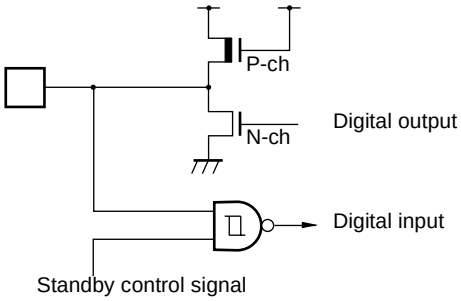
(Continued)

(Continued)

Pin no.				Pin name	Circuit type	Function
LQFP -80*1	QFP -80*2	LQFP -100*3	QFP -100*4			
59	61	25	27	P80	E (CMOS/H)	General-purpose I/O port This function is valid when waveform output from 8/16-bit PPG timer 1 is disabled.
				PPG1		Output pin of 8/16-bit PPG timer 1 This function is valid when waveform output from 8/16-bit PPG timer 1 is enabled.
—	—	26 to 31	28 to 33	P81 to P86	E (CMOS/H)	General-purpose I/O port This function is always valid.
—	—	45	47	P90	D (NMOS/H)	I/O port of an open-drain type This function is always valid.
				SDA		I/O pin of the I^2C interface This function is valid when operation of the I^2C interface is enabled. Hold the port output in the high-impedance status (PDR = 1) when the I^2C interface is in operation.
—	—	46	48	P91	D (NMOS/H)	I/O port of an open-drain type This function is always valid.
				SCL		Clock I/O pin of the I^2C interface This function is valid when operation of the I^2C interface is enabled. Hold the port output in the high-impedance status (PDR = 1) when the I^2C interface is in operation.
—	—	67 to 74	69 to 76	PA0 to PA7	E (CMOS/H)	General-purpose I/O port This function is always valid.
—	—	76 to 78	78 to 80	PB0 to PB2	E (CMOS/H)	General-purpose I/O port This function is always valid.
64	66	21, 82	23, 84	V_{CC}	Power supply	Power supply to the digital circuit
9, 32, 61	11, 34, 63	9, 40, 79	11, 42, 81	V_{SS}	Power supply	Ground level of the digital circuit
26	28	32	34	AV_{CC}	Power supply	Power supply to the analog circuit Make sure to turn on/turn off this power supply with a voltage exceeding AV_{CC} applied to V_{CC}.
27	29	33	35	AVRH	Power supply	Reference voltage input to the analog circuit Make sure to turn on/turn off this power supply with a voltage exceeding AVRH applied to AV_{CC}.
28	30	34	36	AVRL	Power supply	Reference voltage input to the analog circuit
29	31	35	37	AV_{SS}	Power supply	Ground level of the analog circuit

*1: FPT-80P-M05
*2: FPT-80P-M06
*3: FPT-100P-M05
*4: FPT-100P-M06

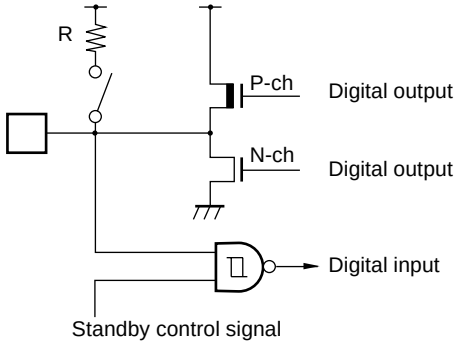
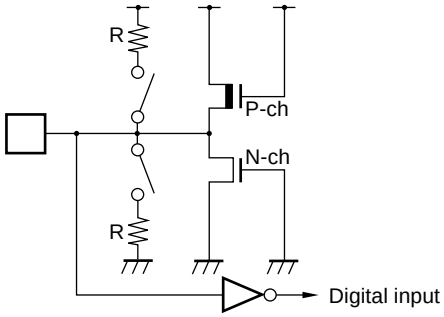
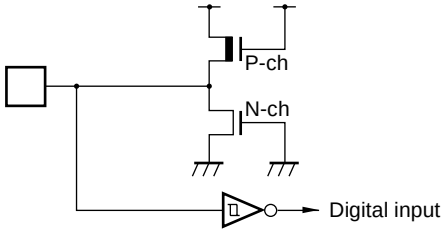
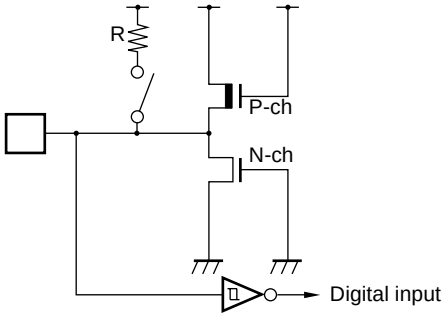
■ I/O CIRCUIT TYPE

Type	Circuit	Remarks
A		• External clock frequency 3 MHz to 32 MHz • Oscillation feedback resistor approx. 1MΩ
B		• CMOS level input/output (with standby control) • Pull-up option selectable (with standby control) • No pull-up resistor in the MB90V670
C		• N-ch open-drain output • CMOS level hystheresis input (with A/D control)
D		• NMOS open-drain output • CMOS level hysteresis input (with standby control)

(Continued)

MB90670/675 Series

(Continued)

Type	Circuit	Remarks
E		• CMOS level output • CMOS level hysteresis input (with standby control) • Pull-up option selectable (with standby control) • No pull-up resistor in the MB90V670
F		• CMOS level input/output (without standby control) • Pull-up/pull-down option selectable (without stand-by control) • In mask ROM versions, MD2 pin is fixed to pull-down resistor, and optionally selectable the resistor in other pins. • The MB90V670 has no pull-up/pull-down resistors.
G		• CMOS level hysteresis input (without standby control)
H		• CMOS level hysteresis input (without standby control) • Pull-up option selectable (without standby control) • No pull-up resistor in the MB90V670

■ HANDLING DEVICES

1. Make Sure that the Voltage not Exceed the Maximum Rating (to Avoid a Latch-up).

In CMOS ICs, a latch-up phenomenon is caused when an voltage exceeding V_{CC} or an voltage below V_{SS} is applied to input or output pins or a voltage exceeding the rating is applied across V_{CC} and V_{SS}.

When a latch-up is caused, the power supply current may be dramatically increased causing resultant thermal break-down of devices. To avoid the latch-up, make sure that the voltage not exceed the maximum rating.

In turning on/turning off the analog power supply, make sure the analog power voltage (AV_{CC}, AVRH) and analog input voltages not exceed the digital voltage (V_{CC}).

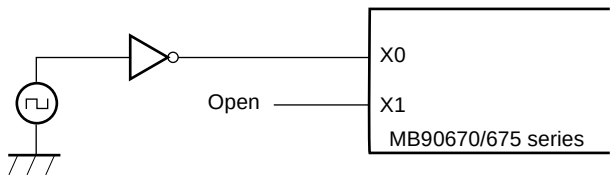
2. Connection of Unused Pins

Leaving unused pins open may result in abnormal operations. Clamp the pin level by connecting it to a pull-up or a pull-down resistor.

3. Notes on Using External Clock

In using the external clock, drive X0 pin only and leave X1 pin unconnected.

- **Using external clock**



4. Power Supply Pins

In products with multiple V_{CC} or V_{SS} pins, the pins of a same potential are internally connected in the device to avoid abnormal operations including latch-up. However, connect the pins external power and ground lines to lower the electro-magnetic emission level and abnormal operation of strobe signals caused by the rise in the ground level, and to conform to the total current rating.

Make sure to connect V_{CC} and V_{SS} pins via lowest impedance to power lines.

It is recommended to provide a bypass capacitor of around 0.1 µF between V_{CC} and V_{SS} pin near the device.

5. Crystal Oscillator Circuit

Noises around X0 or X1 pins may be possible causes of abnormal operations. Make sure to provide bypass capacitors via shortest distance from X0, X1 pins, crystal oscillator (or ceramic resonator) and ground lines, and make sure, to the utmost effort, that lines of oscillation circuit not cross the lines of other circuits.

It is highly recommended to provide a printed circuit board art work surrounding X0 and X1 pins with an grand area for stabilizing the operation.

6. Turning-on Sequence of Power Supply to A/D Converter and Analog Inputs

Make sure to turn on the A/D converter power supply (AV_{CC}, AVRH, AVRL) and analog inputs (AN0 to AN7) after turning-on the digital power supply (V_{CC}).

Turn-off the digital power after turning off the A/D converter supply and analog inputs. In this case, make sure that the voltage not exceed AVRH or AV_{CC} (turning on/off the analog and digital power supplies simultaneously is acceptable).

7. Connection of Unused Pins of A/D Converter

Connect unused pins of A/D converter to $AV_{CC} = V_{CC}$, $AV_{SS} = AVRH = V_{SS}$.

8. “MOV @AL, AH”, “MOVW @AL, AH” Instructions

When the above instruction is performed to I/O space, an unnecessary writing operation (#FF, #FFFF) may be performed in the internal bus.
Use the compiler function for inserting an NOP instruction before the above instructions to avoid the writing operation.
Accessing RAM space with the above instruction does not cause any problem.

9. Initialization

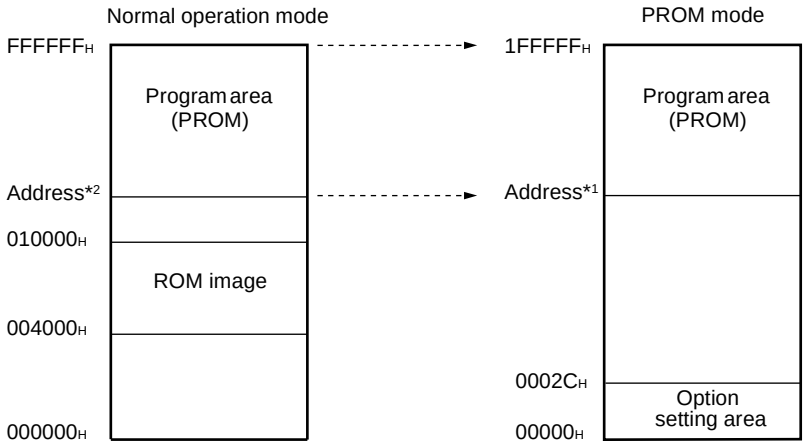
In the device, there are internal registers which is initialized only by a power-on reset. To initialize these registers, turning on the power again.

■ PROGRAMMING TO THE ONE-TIME PROM ON THE MB90P673/P678

The MB90P673 and MB90P678 has a PROM mode for emulation operation of the MBM27C1000/1000A, to which writing codes by a general-purpose ROM writer can be done via a dedicated adapter. Please note that the device is not compatible with the electronic signature (device ID code) mode.

1. Writing Sequence

The memory map for the PROM mode is shown as follows. Write option data to the option setting area according by referring to “7. PROM Option Bit Map”.



Type	Address*1	Address*2	Number of bytes
MB90P673	14000H	FF4000H	48 Kbytes
MB90P678	10000H	FF0000H	64 Kbytes

Note: The ROM image size for bank 00 is 48 Kbytes (ROM image for between FF4000H to FFFFFFH).

Write data to the one-time PROM microcontrollers according to the following sequence.

(1) Set the PROM programer to select the MBM27C1000/1000A.

(2) Load the program data to the ROM programer address *1 to 1FFFFH. To select a PROM option, load the option data from 00000H to 0002CH referring to “7. PROM Option Bit Map”.

(3) Set the chip to the adapter socket and load the socket to the ROM programer. Make sure that the device and adapter socket are properly oriented.

(4) Program from 00000H to 1FFFFH.

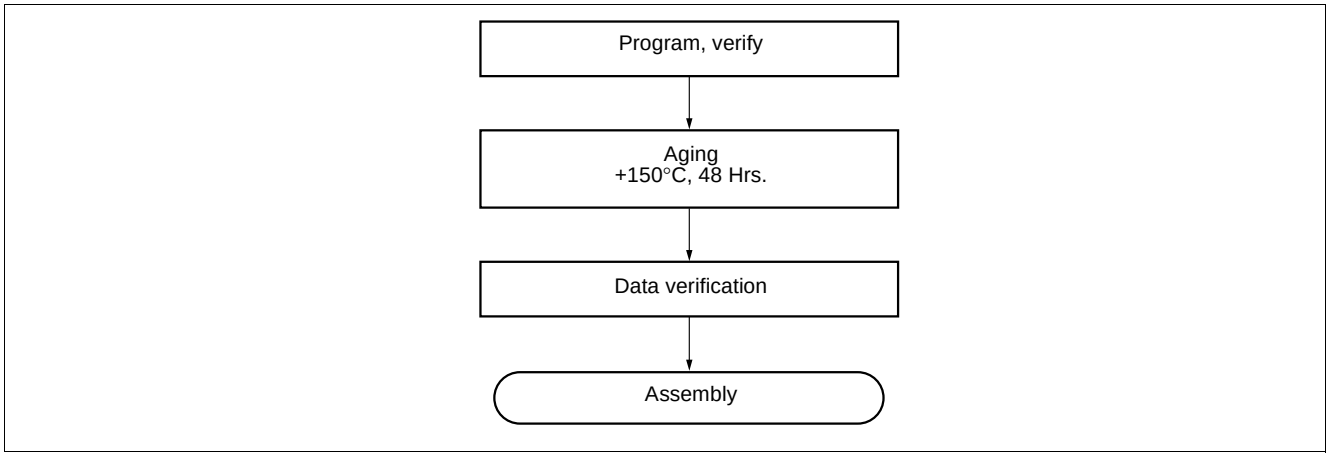
Notes: • In mask-ROM products, there is no PROM mode and it is impossible to read data by a ROM programer.
• Contact sales personnel when purchasing a ROM programer.

2. Program Mode

In the MB90P673/P678, all the bits are set to “1” upon shipping from FUJITSU or erasing operation. To write data, set desired bit selectively to “0”. However it is impossible to write electronically to the bits.

3. Recommended Screening Conditions

High-temperature aging is recommended as the pre-assembly screening precedure for a product with a blanked One-time PROM microcomputer program.



4. Programming Yield

All bits cannnot be programmed at Fujitsu shipping test to a blanked One-time PROM microcomputer, due to its nature. For this reason, a programming yield of 100% cannnot be assured at all times.

5. EPROM Programmer Socket Adapter and Recommended Programmer Manufacturer

Part no.			MB90P673PF	MB90P673PFV	MB90P678PF	MB90P678PFV
Package			QFP-80	LQFP-80	QFP-100	LQFP-100
Compatible socket adapter Sun Hayato Co., Ltd.			ROM-80QF-32DP-16L	ROM-80SQF-32DP-16L	ROM-100QF-32DP-16L	ROM-100SQF-32DP-16L
Recommended programmer manufacturer and programmer name	Minato Electronics Inc.	1890A	—	—	—	Recommended
		1891	—	—	—	Recommended
		1930	—	—	—	Recommended
	Data I/O Co., Ltd.	UNISITE	—	—	—	Recommended
		3900	—	—	—	Recommended
		2900	—	—	—	Recommended

Inquiry: San Hayato Co., Ltd.: TEL: (81)-3-3986-0403
FAX: (81)-3-5396-9106

Minato Electronics Inc.: TEL: USA (1)-916-348-6066
JAPAN (81)-45-591-5611

Data I/O Co., Ltd.: TEL: USA/ASIA (1)-206-881-6444
EUROPE (49)-8-985-8580

6. Pin Assignment for EPROM Mode

- **MBM27C1000/1000A pin compatible**

MBM27C1000/1000A		MB90P673/MB90P678	
Pin no.	Pin name	Pin no.	Pin name
1	V_{PP}	Refer to pin assignments.	MD2
2	OE		P32
3	A15		P17
4	A12		P14
5	A07		P27
6	A06		P26
7	A05		P25
8	A04		P24
9	A03		P23
10	A02		P22
11	A01		P21
12	A00		P20
13	D00		P00
14	D01		P01
15	D02		P02
16	GND		V_{SS}

MBM27C1000/1000A		MB90P673/MB90P678	
Pin no.	Pin name	Pin no.	Pin name
32	V_{CC}	Refer to pin assignments.	V_{CC}
31	PGM		P33
30	N.C.		—
29	A14		P16
28	A13		P15
27	A08		P10
26	A09		P11
25	A11		P13
24	A16		P30
23	A10		P12
22	CE		P31
21	D07		P07
20	D06		P06
19	D05		P05
18	D04		P04
17	D03		P03

- **Pin assignments for products not compatible with MBM27C1000/1000A**

Pin no.	Pin name	processing
Refer to pin assignments.	MD0 MD1 X0	Connect a pull-up resistor of 4.7 kΩ.
	X1	OPEN
	AV_{CC} AVRH P37 P40 to P47 P50 to P57 P60 to P67 P70 to P77 P80 to P86 P90 P91 PA0 to PA7 PB0 to PB2	Connect a pull-up resistor having a resistance of approximately 1 MΩ to each pin.

- **Power supply, GND connected pin**

Type	Pin no.	Pin name
Power supply	Refer to pin assignments.	$\overline{HST}$ V_{CC}
GND	Refer to pin assignments.	P34 P35 $\overline{P36}$ $\overline{RST}$ AVRL AV_{SS} V_{SS}

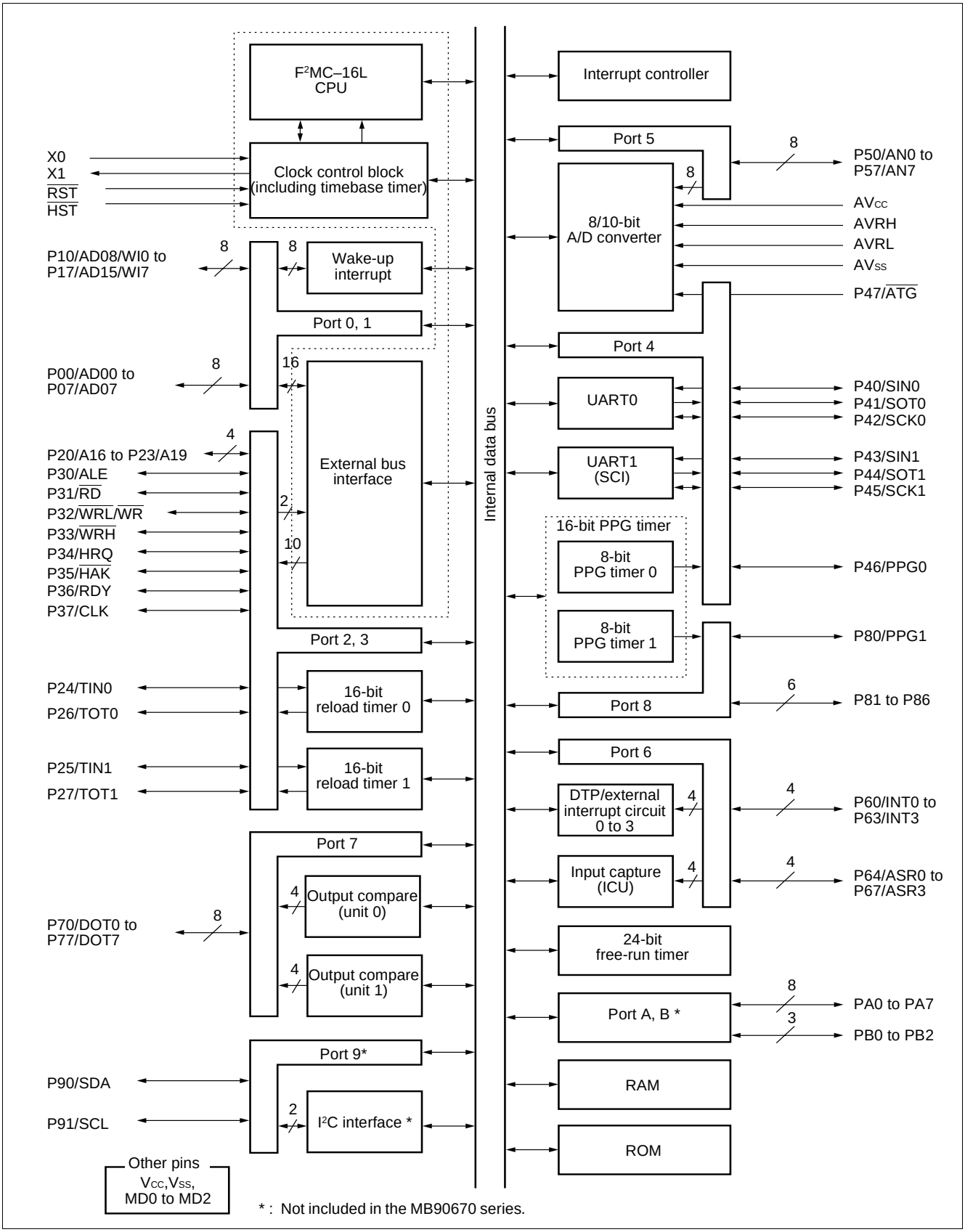
Note: Only MB90675 series has P81 to P86, P90, P91, PA0 to PA7, PB0 to PB2 pins.

7. PROM Option Bit Map

Address	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
00000H	Vacancy	$\overline{\text{RST}}$ Pull-up 1: No 0: Yes	Vacancy	MD1 Pull-up 1: No 0: Yes	MD1 Pull-down 1: No 0: Yes	MD0 Pull-up 1: No 0: Yes	MD0 Pull-down 1: No 0: Yes	Vacancy
00004H	P07 Pull-up 1: No 0: Yes	P06 Pull-up 1: No 0: Yes	P05 Pull-up 1: No 0: Yes	P04 Pull-up 1: No 0: Yes	P03 Pull-up 1: No 0: Yes	P02 Pull-up 1: No 0: Yes	P01 Pull-up 1: No 0: Yes	P00 Pull-up 1: No 0: Yes
00008H	P17 Pull-up 1: No 0: Yes	P16 Pull-up 1: No 0: Yes	P15 Pull-up 1: No 0: Yes	P14 Pull-up 1: No 0: Yes	P13 Pull-up 1: No 0: Yes	P12 Pull-up 1: No 0: Yes	P11 Pull-up 1: No 0: Yes	P10 Pull-up 1: No 0: Yes
0000CH	P27 Pull-up 1: No 0: Yes	P26 Pull-up 1: No 0: Yes	P25 Pull-up 1: No 0: Yes	P24 Pull-up 1: No 0: Yes	P23 Pull-up 1: No 0: Yes	P22 Pull-up 1: No 0: Yes	P21 Pull-up 1: No 0: Yes	P20 Pull-up 1: No 0: Yes
00010H	P37 Pull-up 1: No 0: Yes	P36 Pull-up 1: No 0: Yes	P35 Pull-up 1: No 0: Yes	P34 Pull-up 1: No 0: Yes	P33 Pull-up 1: No 0: Yes	P32 Pull-up 1: No 0: Yes	P31 Pull-up 1: No 0: Yes	P30 Pull-up 1: No 0: Yes
00014H	P47 Pull-up 1: No 0: Yes	P46 Pull-up 1: No 0: Yes	P45 Pull-up 1: No 0: Yes	P44 Pull-up 1: No 0: Yes	P43 Pull-up 1: No 0: Yes	P42 Pull-up 1: No 0: Yes	P41 Pull-up 1: No 0: Yes	P40 Pull-up 1: No 0: Yes
0001CH	P67 Pull-up 1: No 0: Yes	P66 Pull-up 1: No 0: Yes	P65 Pull-up 1: No 0: Yes	P64 Pull-up 1: No 0: Yes	P63 Pull-up 1: No 0: Yes	P62 Pull-up 1: No 0: Yes	P61 Pull-up 1: No 0: Yes	P60 Pull-up 1: No 0: Yes
00020H	P77 Pull-up 1: No 0: Yes	P76 Pull-up 1: No 0: Yes	P75 Pull-up 1: No 0: Yes	P74 Pull-up 1: No 0: Yes	P73 Pull-up 1: No 0: Yes	P72 Pull-up 1: No 0: Yes	P71 Pull-up 1: No 0: Yes	P70 Pull-up 1: No 0: Yes
00024H	Vacancy	P86 Pull-up 1: No 0: Yes	P85 Pull-up 1: No 0: Yes	P84 Pull-up 1: No 0: Yes	P83 Pull-up 1: No 0: Yes	P82 Pull-up 1: No 0: Yes	P81 Pull-up 1: No 0: Yes	P80 Pull-up 1: No 0: Yes
00028H	PA5 Pull-up 1: No 0: Yes	PA4 Pull-up 1: No 0: Yes	PA3 Pull-up 1: No 0: Yes	PA2 Pull-up 1: No 0: Yes	PA1 Pull-up 1: No 0: Yes	PA0 Pull-up 1: No 0: Yes	Vacancy	Vacancy
0002CH	Vacancy	Vacancy	Vacancy	PB2 Pull-up 1: No 0: Yes	PB1 Pull-up 1: No 0: Yes	PB0 Pull-up 1: No 0: Yes	PA7 Pull-up 1: No 0: Yes	PA6 Pull-up 1: No 0: Yes

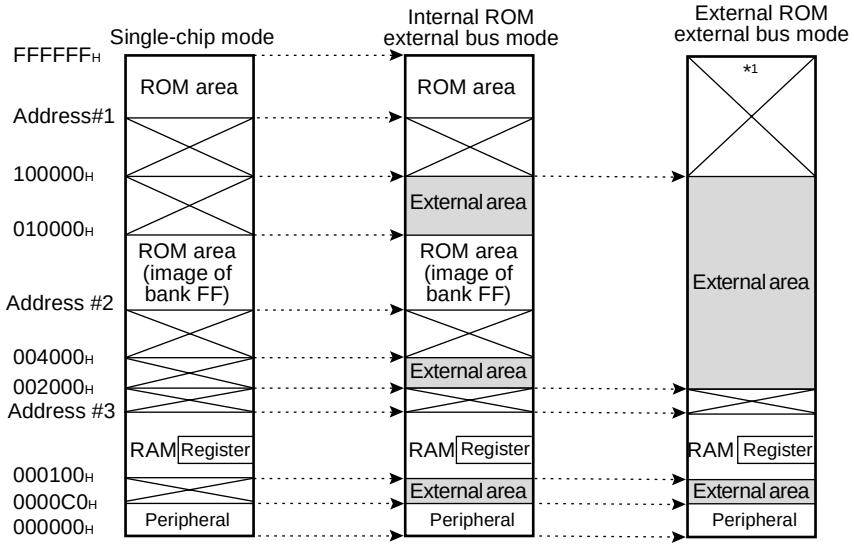
Notes:
- Data “1” must be programed to the reserved bits and address other than listed above.
- Only MB90P678 has pull-up options for P81 to P86, PA0 to PA7, and PB0 to PB2 pins.
- Data “1” must be programed for the MB90P673.

■ BLOCK DIAGRAM



* : Not included in the MB90670 series.

■ MEMORY MAP



Part number	Address #1*2	Address #2*2	Address #3*2
MB90671	FFC000H	00C000H	000380H
MB90672	FF8000H	008000H	000780H
MB90673	FF4000H	004000H	000900H
MB90T673	—	—	000900H
MB90P673	FF4000H	004000H	000900H
MB90676	FF8000H	008000H	000780H
MB90677	FF4000H	004000H	000900H
MB90678	FF0000H	004000H	000D00H
MB90T678	—	—	000D00H
MB90P678	FF0000H	004000H	000D00H

: Internal access memory

: Enternal access memory

: Inhibited area

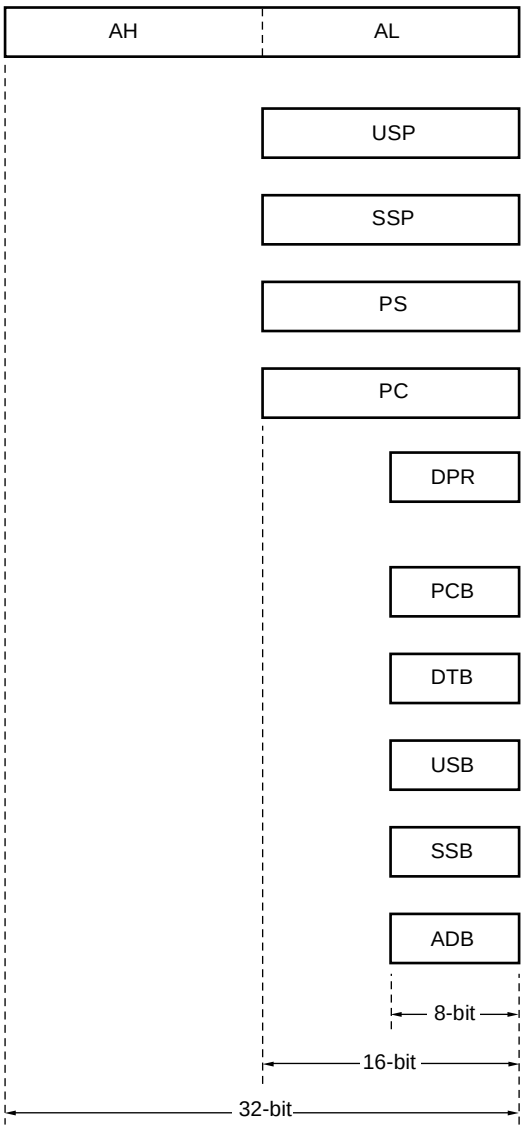
*1: The same external memory is accessed for bank 0F, 1F, 2F through FF.
*2: Addresses #1, #2 and #3 are unique to the product type.

Notes: • The ROM data of bank FF is reflected in the upper address of bank 00, realizing effective use of the C compiler small model. The lower 16-bit of bank FF and the lower 16-bit of bank 00 is assigned to the same address, enabling reference of the table on the ROM without stating “far”.
However, the ROM area of the MB90678/P678 exceeds 48 Kbytes, and for this reason, the image from FF4000H to FFFFFFH is reflected on bank 00 and image from FF0000H to FF3FFFH bank FF only.

- In the MB90670/675 series, the upper 4-bit of the address are not output to the external bus. For this reason, the maximum area accessible is 1 Mbyte. The same address is accessed through different banks in different images.
For example, accessing “A00000H” and “B00000H” accesses the same address on the external bus.
- To prevent the memory or I/O from being accessed through images, and the data from being destroyed, it is recommended to limit number of banks to a maximum of 16 so that the banks are mapped without interfering each other. Caution must be also taken when masking the upper address with the external address output control register (HACR).

■ F²MC-16L CPU PROGRAMMING MODEL

(1) Dedicated Registers



: Accumlator (A)
Dual 16-bit register used for storing results of calculation etc. The two 16-bit registers can be combined to be used as a 32-bit register.

: User stack pointer (USP)
The 16-bit pointer indicating a user stack address.

: System stack pointer (SSP)
The 16-bit pointer indicating the status of the system stack address.

: Processor status (PS)
The 16-bit register indicating the system status.

: Program counter (PC)
The 16-bit register indicating storing location of the current instruction code.

: Direct page register (DPR)
The 8-bit register for specifying bit 8 through 15 of the operand address in the short direct addressing mode.

: Program bank register (PCB)
The 8-bit register indicating the program space.

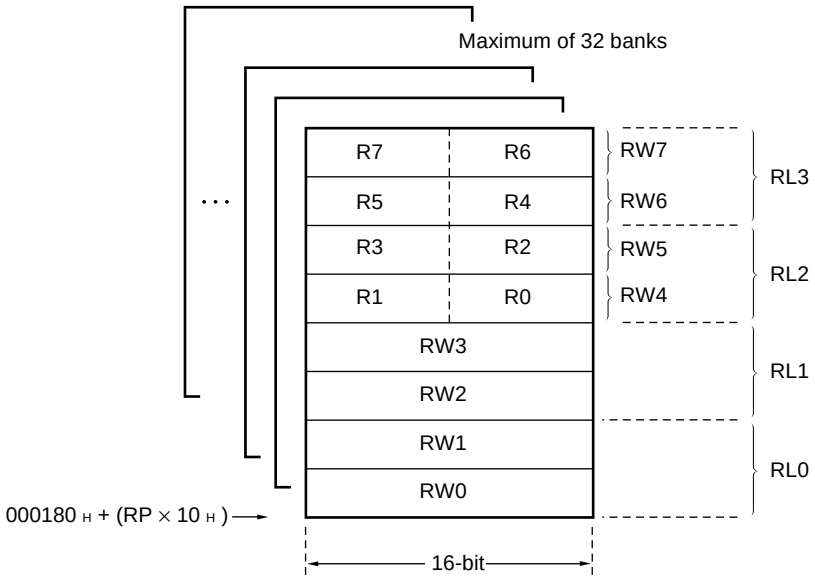
: Data bank register (DTB)
The 8-bit register indicating the data space.

: User stack bank register (USB)
The 8-bit register indicating the user stack space.

: System stack bank register (SSB)
The 8-bit register indicating the system stack space.

: Additional data bank register (ADB)
The 8-bit register indicating the additional space.

(2) General-purpose Registers



(3) Processor Status (PS)

	ILM			RP					CCR							
	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
PS	ILM2	ILM1	ILM0	B4	B3	B2	B1	B0	—	I	S	T	N	Z	V	C
Initial value	0	0	0	0	0	0	0	0	—	0	1	X	X	X	X	X

— : Unused
X : Indeterminate

■ I/O MAP

Address	Abbreviated register name	Register name	Read/ write	Resource name	Initial value
000000H	PDR0	Port 0 data register	R/W	Port 0	XXXXXXXXB
000001H	PDR1	Port 1 data register	R/W	Port 1	XXXXXXXXB
000002H	PDR2	Port 2 data register	R/W	Port 2	XXXXXXXXB
000003H	PDR3	Port 3 data register	R/W	Port 3	XXXXXXXXB
000004H	PDR4	Port 4 data register	R/W	Port 4	XXXXXXXXB
000005H	PDR5	Port 5 data register	R/W	Port 5	11111111B
000006H	PDR6	Port 6 data register	R/W	Port 6	XXXXXXXXB
000007H	PDR7	Port 7 data register	R	Port 7	XXXXXXXXB
000008H	PDR8	Port 8 data register	R/W	Port 8*5	–XXXXXXXB
000009H	PDR9	Port 9 data register	R/W	Port 9*5	––––––11B
00000AH	PDRA	Port A data register	R/W	Port A*5	XXXXXXXXB
00000BH	PDRB	Port B data register	R/W	Port B*5	–––––XXXB
00000CH to 00000EH	(Vacancy)*3				
00000FH	EIFR	Wake-up interrupt flag register	R/W	Wake-up interrupt	–––––––0B
000010H	DDR0	Port 0 data direction register	R/W	Port 0	00000000B
000011H	DDR1	Port 1 data direction register	R/W	Port 1	00000000B
000012H	DDR2	Port 2 data direction register	R/W	Port 2	00000000B
000013H	DDR3	Port 3 data direction register	R/W	Port 3	00000000B
000014H	DDR4	Port 4 data direction register	R/W	Port 4	00000000B
000015H	ADER	Analog input enable register	R/W	Port 5, analog input	11111111B
000016H	DDR6	Port 6 data direction register	R/W	Port 6	00000000B
000017H	DDR7	Port 7 data direction register	R/W	Port 7	00000000B
000018H	DDR8	Port 8 data direction register	R/W	Port 8*5	–0000000B
000019H	(Vacancy)*3				
00001AH	DDRA	Port A data direction register	R/W	Port A*5	00000000B
00001BH	DDRB	Port B data direction register	R/W	Port B*5	–––––000B
00001CH to 00001EH	(Vacancy)*3				
00001FH	EICR	Wake-up interrupt enable register	W	Wake-up interrupt	00000000B

(Continued)

Address	Abbreviated register name	Register name	Read/ write	Resource name	Initial value
000020H	UMC0	Mode control register 0	R/W!	UART0	0 0 0 0 0 1 0 0 B
000021H	USR0	Status register 0	R/W!		0 0 0 1 0 0 0 0 B
000022H	UIDR0/ UODR0	Input data register 0/ output data register 0	R/W		X X X X X X X X B
000023H	URD0	Rate and data register 0	R/W		0 0 0 0 0 0 0 0 B
000024H	SMR1	Mode register 1	R/W	UART1 (SCI)	0 0 0 0 0 0 0 0 B
000025H	SCR1	Control register 1	R/W!		0 0 0 0 0 1 0 0 B
000026H	SIDR1/ SODR1	Input data register 1/ output data register 1	R/W		X X X X X X X X B
000027H	SSR1	Status register 1	R/W!		0 0 0 0 1 – 0 0 B
000028H	ENIR	DTP/interrupt enable register	R/W	DTP/external interrupt circuit	– – – – 0 0 0 0 B
000029H	EIRR	DTP/interrupt factor register	R/W		– – – – 0 0 0 0 B
00002AH	ELVR	Request level setting register	R/W		0 0 0 0 0 0 0 0 B
00002BH	(Vacancy)*3				
00002CH	ADCS	A/D convertor control status register	R/W!	8/10-bit A/D converter	0 0 0 0 0 0 0 0 B
00002DH					0 0 0 0 0 0 0 0 B
00002EH	ADCR	A/D convertor data register	R/W!*4		X X X X X X X X B
00002FH					0 0 0 0 0 0 X X B
000030H	PPGC0	PPG0 operating mode control register	R/W!	8/16-bit PPG timer 0	0 – 0 0 0 0 0 1 B
000031H	PPGC1	PPG1 operating mode control register	R/W!	8/16-bit PPG timer 1	0 0 0 0 0 0 0 0 B
000032H	(Vacancy)*3				
000033H					
000034H	PRLL0	PPG0 reload register	R/W	8/16-bit PPG timer 0	X X X X X X X X B
000035H	PRLH0		R/W		X X X X X X X X B
000036H	PRLL1	PPG1 reload register	R/W	8/16-bit PPG timer 1	X X X X X X X X B
000037H	PRLH1		R/W		X X X X X X X X B
000038H	TMCSR0	Timer control status register 0	R/W!	16-bit reload timer 0	0 0 0 0 0 0 0 0 B
000039H					– – – – 0 0 0 0 B
00003AH	TMR0/ TMRLR0	16-bit timer register 0/ 16-bit reload register 0	R/W		X X X X X X X X B
00003BH					X X X X X X X X B
00003CH	TMCSR1	Timer control status register 1	R/W!	16-bit reload timer 1	0 0 0 0 0 0 0 0 B
00003DH					– – – – 0 0 0 0 B
00003EH	TMR1/ TMRLR1	16-bit timer register 1/ 16-bit reload register 1	R/W		X X X X X X X X B
00003FH					X X X X X X X X B

(Continued)

Address	Abbreviated register name	Register name	Read/ write	Resource name	Initial value
000040H	IBSR	I²C bus status register	R	I²C interface*6	0 0 0 0 0 0 0 0 B
000041H	IBCR	I²C bus control register	R/W		0 0 0 0 0 0 0 0 B
000042H	ICCR	I²C bus clock control register	R/W		– – 0 X X X X X B
000043H	IADR	I²C bus address register	R/W		– X X X X X X X B
000044H	IDAR	I²C bus data register	R/W		X X X X X X X X B
000045H to 00004FH	(Vacancy)*3				
000050H	TCCR	Free-run timer control register	R/W!	24-bit free-run timer	1 1 0 0 0 0 0 0 B
000051H					– – 1 1 1 1 1 1 B
000052H	ICC	ICU control register	R/W	Input capture (ICU)	0 0 0 0 0 0 0 0 B
000053H					0 0 0 0 0 0 0 0 B
000054H	TCRL	Free-run timer lower data register	R	24-bit free-run timer	0 0 0 0 0 0 0 0 B
000055H					0 0 0 0 0 0 0 0 B
000056H	TCRH	Free-run timer upper data register	R		0 0 0 0 0 0 0 0 B
000057H					0 0 0 0 0 0 0 0 B
000058H	CCR00	OCU control register 00	R/W	Output compare (OCU) (unit 0)	1 1 1 1 0 0 0 0 B
000059H					– – – – 0 0 0 0 B
00005AH	CCR01	OCU control register 01	R/W		– – – – 0 0 0 0 B
00005BH					0 0 0 0 0 0 0 0 B
00005CH	CCR10	OCU control register 10	R/W	Output compare (OCU) (unit 1)	1 1 1 1 0 0 0 0 B
00005DH					– – – – 0 0 0 0 B
00005EH	CCR11	OCU control register 11	R/W		– – – – 0 0 0 0 B
00005FH					0 0 0 0 0 0 0 0 B
000060H	ICDR0L	ICU lower data register 0	R	Input capture (ICU)	X X X X X X X X B
000061H					X X X X X X X X B
000062H	ICDR0H	ICU upper data register 0	R		X X X X X X X X B
000063H					0 0 0 0 0 0 0 0 B
000064H	ICDR1L	ICU lower data register 1	R		X X X X X X X X B
000065H					X X X X X X X X B
000066H	ICDR1H	ICU upper data register 1	R		X X X X X X X X B
000067H					0 0 0 0 0 0 0 0 B
000068H	ICDR2L	ICU lower data register 2	R		X X X X X X X X B
000069H					X X X X X X X X B

(Continued)

Address	Abbreviated register name	Register name	Read/ write	Resource name	Initial value
00006AH	ICDR2H	ICU upper data register 2	R	Input capture (ICU)	XXXXXXXXB
00006BH					00000000B
00006CH	ICDR3L	ICU lower data register 3	R		XXXXXXXXB
00006DH					XXXXXXXXB
00006EH	ICDR3H	ICU upper data register 3	R		XXXXXXXXB
00006FH					00000000B
000070H	CPR00L	OCU compare lower data register 0	R/W	Output compare (OCU) (unit 0)	00000000B
000071H					00000000B
000072H	CPR00H	OCU compare upper data register 0	R/W		00000000B
000073H					00000000B
000074H	CPR01L	OCU compare lower data register 1	R/W		00000000B
000075H					00000000B
000076H	CPR01H	OCU compare upper data register 1	R/W		00000000B
000077H					00000000B
000078H	CPR02L	OCU compare lower data register 2	R/W		00000000B
000079H					00000000B
00007AH	CPR02H	OCU compare upper data register 2	R/W		00000000B
00007BH					00000000B
00007CH	CPR03L	OCU compare lower data register 3	R/W		00000000B
00007DH					00000000B
00007EH	CPR03H	OCU compare upper data register 3	R/W		00000000B
00007FH					00000000B
000080H	CPR04L	OCU compare lower data register 4	R/W	Output compare (OCU) (unit 1)	00000000B
000081H					00000000B
000082H	CPR04H	OCU compare upper data register 4	R/W		00000000B
000083H					00000000B
000084H	CPR05L	OCU compare lower data register 5	R/W		00000000B
000085H					00000000B
000086H	CPR05H	OCU compare upper data register 5	R/W		00000000B
000087H					00000000B
000088H	CPR06L	OCU compare lower data register 6	R/W		00000000B
000089H					00000000B
00008AH	CPR06H	OCU compare upper data register 6	R/W		00000000B
00008BH					00000000B

(Continued)

Address	Abbreviated register name	Register name	Read/ write	Resource name	Initial value
00008CH	CPR07L	OCU compare lower data register 7	R/W	Output compare (OCU) (unit 1)	0 0 0 0 0 0 0 0 B
00008DH					0 0 0 0 0 0 0 0 B
00008EH	CPR07H	OCU compare upper data register 7	R/W		0 0 0 0 0 0 0 0 B
00008FH					0 0 0 0 0 0 0 0 B
000090H to 00009EH	(System reservation area)*1				
00009FH	DIRR	Delayed interrupt factor generation/ cancellation register	R/W	Delayed interrupt generation module	– – – – – – – 0 B
0000A0H	LPMCR	Low-power consumption mode control register	R/W!	Low-power consumption (stand-by) mode	0 0 0 1 1 0 0 0 B
0000A1H	CKSCR	Clock selection register	R/W!	Low-power consumption (stand-by) mode	1 1 1 1 1 1 0 0 B
0000A2H to 0000A4H	(Vacancy)*3				
0000A5H	ARSR	Automatic ready function select register	W	External bus pin	0 0 1 1 – – 0 0 B
0000A6H	HACR	Upper address control register	W	External bus pin	– – – – 0 0 0 0 B
0000A7H	EPCR	Bus control signal select register	W	External bus pin	0 0 0 0 * 0 0 – B
0000A8H	WDTC	Watchdog timer control register	R/W!	Watchdog timer	X X X X X 1 1 1 B
0000A9H	TBTC	Timebase timer control register	R/W!	Timebase timer	1 – – 0 0 1 0 0 B
0000AAH to 0000AFH	(Vacancy)*3				
0000B0H	ICR00	Interrupt control register 00	R/W!	Interrupt controller	0 0 0 0 0 1 1 1 B
0000B1H	ICR01	Interrupt control register 01	R/W!		0 0 0 0 0 1 1 1 B
0000B2H	ICR02	Interrupt control register 02	R/W!		0 0 0 0 0 1 1 1 B
0000B3H	ICR03	Interrupt control register 03	R/W!		0 0 0 0 0 1 1 1 B
0000B4H	ICR04	Interrupt control register 04	R/W!		0 0 0 0 0 1 1 1 B
0000B5H	ICR05	Interrupt control register 05	R/W!		0 0 0 0 0 1 1 1 B
0000B6H	ICR06	Interrupt control register 06	R/W!		0 0 0 0 0 1 1 1 B
0000B7H	ICR07	Interrupt control register 07	R/W!		0 0 0 0 0 1 1 1 B
0000B8H	ICR08	Interrupt control register 08	R/W!		0 0 0 0 0 1 1 1 B
0000B9H	ICR09	Interrupt control register 09	R/W!		0 0 0 0 0 1 1 1 B

(Continued)

(Continued)

Address	Abbreviated register name	Register name	Read/ write	Resource name	Initial value
0000BA$_H$	ICR10	Interrupt control register 10	R/W!	Interrupt controller	0 0 0 0 0 1 1 1 $_B$
0000BB$_H$	ICR11	Interrupt control register 11	R/W!		0 0 0 0 0 1 1 1 $_B$
0000BC$_H$	ICR12	Interrupt control register 12	R/W!		0 0 0 0 0 1 1 1 $_B$
0000BD$_H$	ICR13	Interrupt control register 13	R/W!		0 0 0 0 0 1 1 1 $_B$
0000BE$_H$	ICR14	Interrupt control register 14	R/W!		0 0 0 0 0 1 1 1 $_B$
0000BF$_H$	ICR15	Interrupt control register 15	R/W!		0 0 0 0 0 1 1 1 $_B$
0000C0$_H$ to 0000FF$_H$	(External area)*2				

Descriptions for read/write

R/W: Readable and writable
R: Read only
W: Write only
R/W!: Bits for reading operation only or writing operation only are included. Refer to the register lists for specific resource for detailed information.

Descriptions for initial value

0 : The initial value of this bit is “0”.
1 : The initial value of this bit is “1”.
* : The initial value of this bit is “1” or “0” (decided by levels on pins of MD0 through MD2).
X : The initial value of this bit is indeterminate.
– : This bit is not used. The initial value is indeterminate.

*1: Access prohibited.
*2: This area is the only external access area having an address of 0000FF$_H$ or lower. An access operation to this area is handled as that to external I/O area.
*3: The area corresponding to the “(Vacancy)” on the I/O map is reserved, and accessing operation to this area is handled as that to internal area. No access signal to external devices are generated.
*4: Only bit 15 is writable. Reading bit 10 through bit 15 returns “0” as a reading result.
*5: In the MB90670 series, P81 through P86, P90, P91, PA0 through PA7, PB0 through PB2 are not present. For this reason, bits corresponding to these pins are not used.
*6: The MB90670 series does not have the I^2C interface. For this reason, this area is “(Vacancy)” in the MB90670 series.

Note: For bits that is only allowed to program, the initial value set by the reset operation is listed as an initial value. Note that the values are different from reading results.
For LPMCR/CKSCR/WDTC, there are cases where initialization is performed or not performed, depending on the types of the reset. However initial value for resets that initializes the value are listed.

■ INTERRUPT FACTORS, INTERRUPT VECTORS, INTERRUPT CONTROL REGISTER

Interrupt source	EI²OS support	Interrupt vector			Interrupt control register		Priority*4
		Number		Address	ICR	Address	
Reset	×	# 08	08H	FFFFDCH	—	—	High
INT9 instruction	×	# 09	09H	FFFFD8H	—	—	
Exception	×	# 10	0AH	FFFFD4H	—	—	
DTP/external interrupt circuit Channel 0	△	# 11	0BH	FFFFD0H	ICR00	0000B0H*2	
DTP/external interrupt circuit Channel 1	△	# 12	0CH	FFFFCCH			
DTP/external interrupt circuit Channel 2	△	# 13	0DH	FFFFC8H	ICR01	0000B1H*2	
DTP/external interrupt circuit Channel 3	△	# 14	0EH	FFFFC4H			
Output compare Channel 0	△	# 15	0FH	FFFFC0H	ICR02	0000B2H*2	
Output compare Channel 1	△	# 16	10H	FFFFBCH			
Output compare Channel 2	△	# 17	11H	FFFFB8H	ICR03	0000B3H*2	
Output compare Channel 3	△	# 18	12H	FFFFB4H			
Output compare Channel 4	△	# 19	13H	FFFFB0H	ICR04	0000B4H*2	
Output compare Channel 5	△	# 20	14H	FFFFACH			
Output compare Channel 6	△	# 21	15H	FFFFA8H	ICR05	0000B5H*2	
Output compare Channel 7	△	# 22	16H	FFFFA4H			
24-bit free-run timer Overflow	△	# 23	17H	FFFFA0H	ICR06	0000B6H*2	
24-bit free-run timer Intermediate bit	△	# 24	18H	FFFF9CH			
Input capture Channel 0	△	# 25	19H	FFFF98H	ICR07	0000B7H*2	
Input capture Channel 1	△	# 26	1AH	FFFF94H			
Input capture Channel 2	△	# 27	1BH	FFFF90H	ICR08	0000B8H*2	
Input capture Channel 3	△	# 28	1CH	FFFF8CH			
16-bit reload timer/ 8/16-bit PPG timer 0	△	# 29	1DH	FFFF88H	ICR09	0000B9H*2, *3	
16-bit reload timer/ 8/16-bit PPG timer 1	△	# 30	1EH	FFFF84H			
8/10-bit A/D converter measurement complete	○	# 31	1FH	FFFF80H	ICR10	0000BAH	
Wake-up interrupt	×	# 33	21H	FFFF78H	ICR11	0000BBH*2	
Timebase timer interval interrupt	×	# 34	22H	FFFF74H			Low

(Continued)

(Continued)

Interrupt source	EI²OS support	Interrupt vector			Interrupt control register		Priority*4
		Number		Address	ICR	Address	
UART1 (SCI) transmission complete	△	# 35	23H	FFFF70H	ICR12	0000BCH*2	High
UART0 transmission complete	△	# 36	24H	FFFF6CH			
UART1 (SCI) reception complete	◎	# 37	25H	FFFF68H	ICR13	0000BDH*2	
I²C interface*1	×	# 38	26H	FFFF64H			
UART0 reception complete	◎	# 39	27H	FFFF60H	ICR14	0000BEH	
Delayed interrupt generation module	×	# 42	2AH	FFFF54H	ICR15	0000BFH	Low

○ : Can be used

× : Can not be used

◎ : Can be used. With EI²OS stop function.

△ : Can be used if interrupt request using ICR are not commonly used.

*1: In MB90670 series, this interrupt vector is not used because the series does not have the I²C interface.

*2:
- Interrupt levels for peripherals that commonly use the ICR register are in the same level.
- When the extended intelligent I/O service (EI²OS) is specified in a peripheral device commonly using the ICR register, only one of the functions can be used.
- When the extended intelligent I/O service (EI²OS) is specified for one of the peripheral functions, interrupts can not be used on the other function.

*3: Only 16-bit reload timer conforms to the extended intelligent I/O service (EI²OS). Because the 8/16-bit PPG timer does not conform to the extended intelligent I/O service (EI²OS), disable interrupts of the 8/16-bit PPG timer when using the extended intelligent I/O service (EI²OS) in the 16-bit reload timer.

*4: The level shows priority of same level of interrupt invoked simultaneously.

■ PERIPHERALS

1. I/O Port

(1) Input/output Port

Port 0 to 4, 6, 8, A, and B are general-purpose I/O ports having a combined function as an external bus pin and a resource input. The input output ports function as general-purpose I/O port only in the single-chip mode. In the external bus mode, the ports are configured as external bus pins, and part of pins for port 3 can be configured as general-purpose I/O port by setting the bus control signal select register (ECSR). Each pin corresponding to upper 4-bit of the port 2 can be switched between a resource and a port bitwise.

Only MB90675 series has port A and port B.

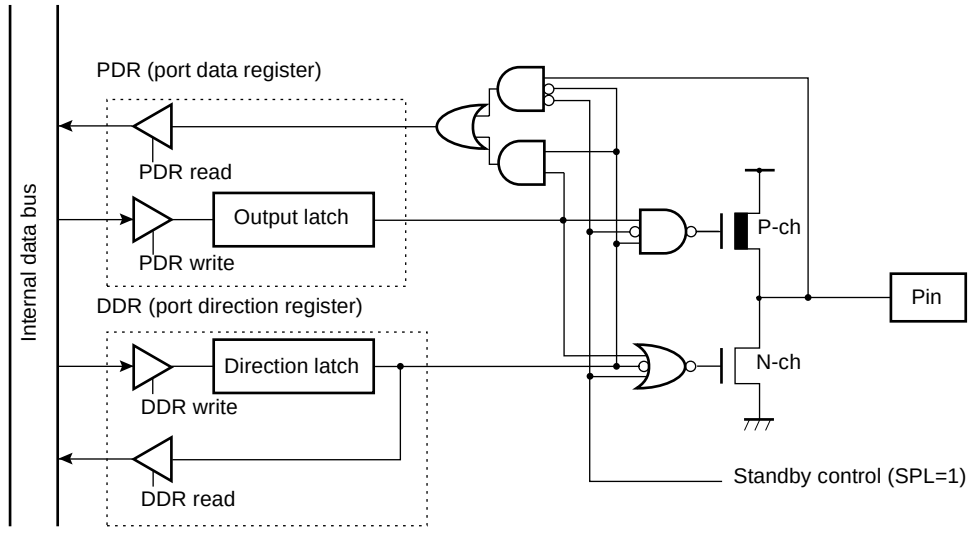
- Operation as output port
  The pin is configured as an output port by setting the corresponding bit of the DDR register to “1”.
  Writing data to PDR register when the port is configured as output, the data is retained in the output latch in the PDR and directly output to the pin.

  The value of the pin (the same value retained in the output latch of PDR) can be read out by reading the PDR register.

Note: When a read-modify-write instruction (e.g. bit set instruction) is performed to the port data register, the destination bit of the operation is set to the specified value, not affecting the bits configured by the DDR register for output, however, values of bits configured by the DDR register as inputs are changed because input values to the pins are written into the output latch. To avoid this situation, configure the pins by the DDR register as output after writing output data to the PDR register when configuring the bit used as input as outputs.

- Operation as input port
  The pin is configured as an input by setting the corresponding bit of the DDR register to “0”.
  When the pin is configured as an input, the output buffer is turned-off and the pin is put into a high-impedance status.
  When a data is written into the PDR register, the data is retained in the output latch of the PDR, but pin outputs are unaffected.
  Reading the PDR register reads out the pin level (“0” or “1”).

- **Block diagram**



Standby control: Stop, timebase timer mode and SPL=1, or hardware standby mode

(2) N-ch Open-drain Port

Port 5 and port 9 are general-purpose I/O ports having a combined function as resource input/output. Each pin can be switched between resource and port bitwise.

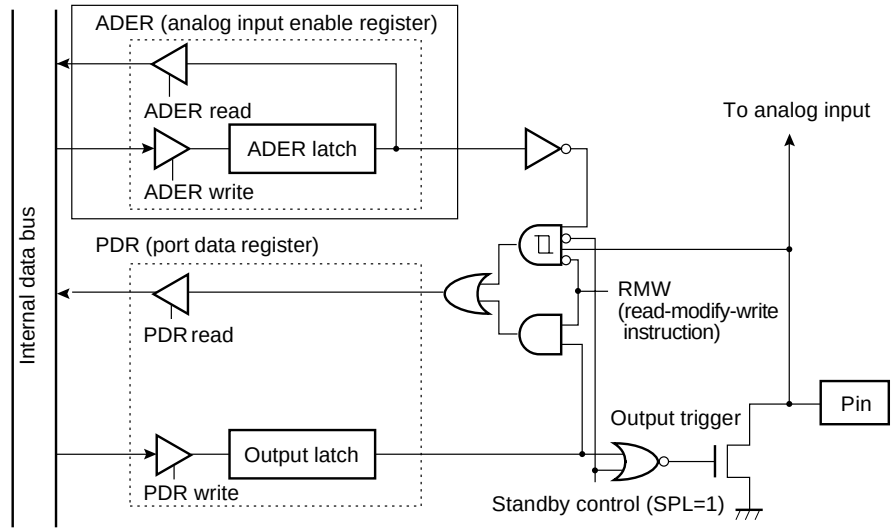
Only MB90675 series has port 9.

- Operation as output port
  When a data is written into the PDR register, the data is latched to the output latch of PDR. When the output latch value is set to “0”, the output transistor is turned on and the pin status is put into an “L” level output, while writing “1” turns off the transistor and put the pin in a high-impedance status.
  If the output pin is pulled-up, setting output latch value to “1” puts the pin in the pull-up status.
  Reading the PDR register returns the pin value (same as the output latch value in the PDR).

Note: Execution of a read-modify-write instruction (e.g. bit set instruction) reads out the output latch value rather than the pin value, leaving output latch that is not manipulated unchanged.

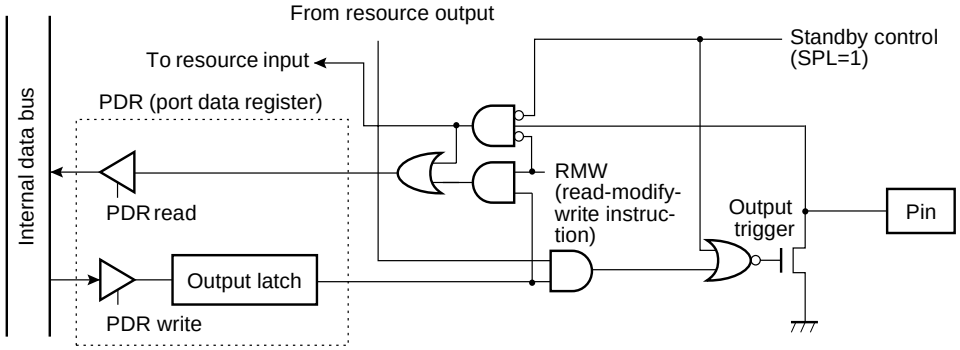
- Operation as input port
  Setting corresponding bit of the PDR register to “1” turns off the output transistor and the pin is put into a high-impedance status.
  Reading the PDR register returns the pin level (“0” or “1”).

- **Block diagram of port 5**



Standby control: Stop, timebase timer mode and SPL=1, or hardware standby mode

- **Block diagram of port 9**



Standby control: Stop, timebase timer mode and SPL=1, or hardware standby mode

(3) Output Port

Port 7 is a general-purpose output port having a combined function as an output compare (OCU) output. Note that only OCU output can be output when the pin is configured as an output, and it is not used for outputting given data by writing to the data register. Each pin can be switched between an output compare output and a port bitwise.

- Operation as output port (operation of OCU output)
  Setting the corresponding bit of the DDR register to “1” configures the pin as an output port. In this case, lower 4-bit of CCR01 and CCR register are output.

  When configured as an output, the output buffer is turned on and data retained in the output latch in the PDR of the output compare is output to the pin.

  Writing data to DOT bit of the OCU control register (CCR01, CCR11) corresponding to each pin writes data in synchronization to a match operation of the output compare and output to the pin.

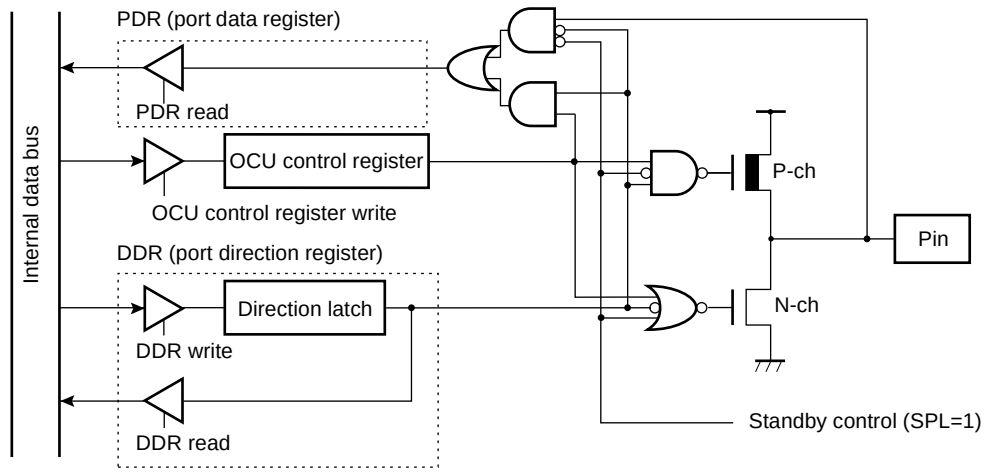
  Reading the PDR register returns the pin level (same as the output latch value of the PDR).

  When output of output compare is enabled, an output value from the output compare can be read out.
- Operation as input port
  Setting corresponding bit of the DDR register to “0” configures the pin as input port.

  When the pin is configured as an input port, the output buffer is turned off and the pin is put into a high-impedance status.

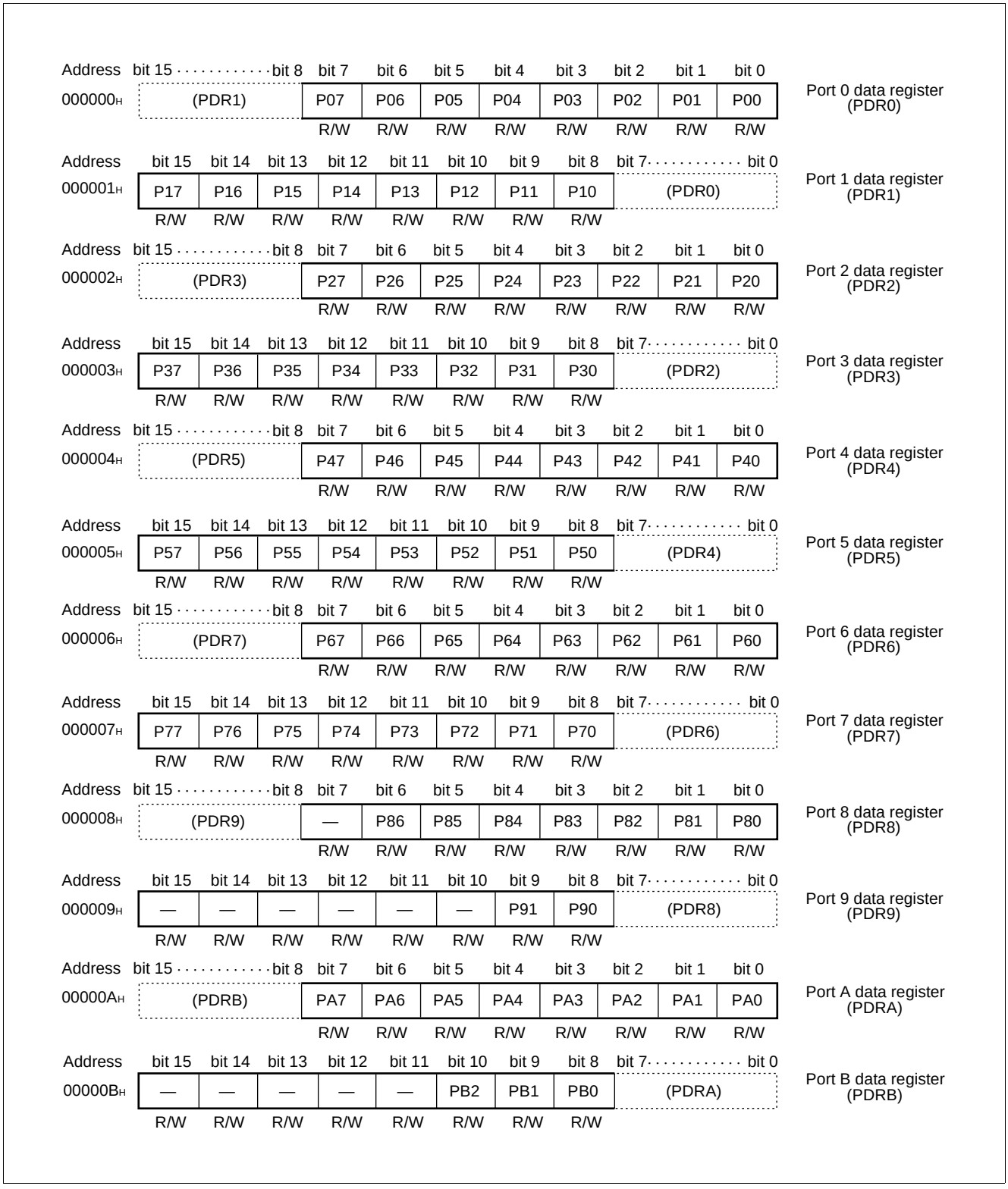
  Reading the PDR register returns the pin level (“0” or “1”).

- **Block diagram**



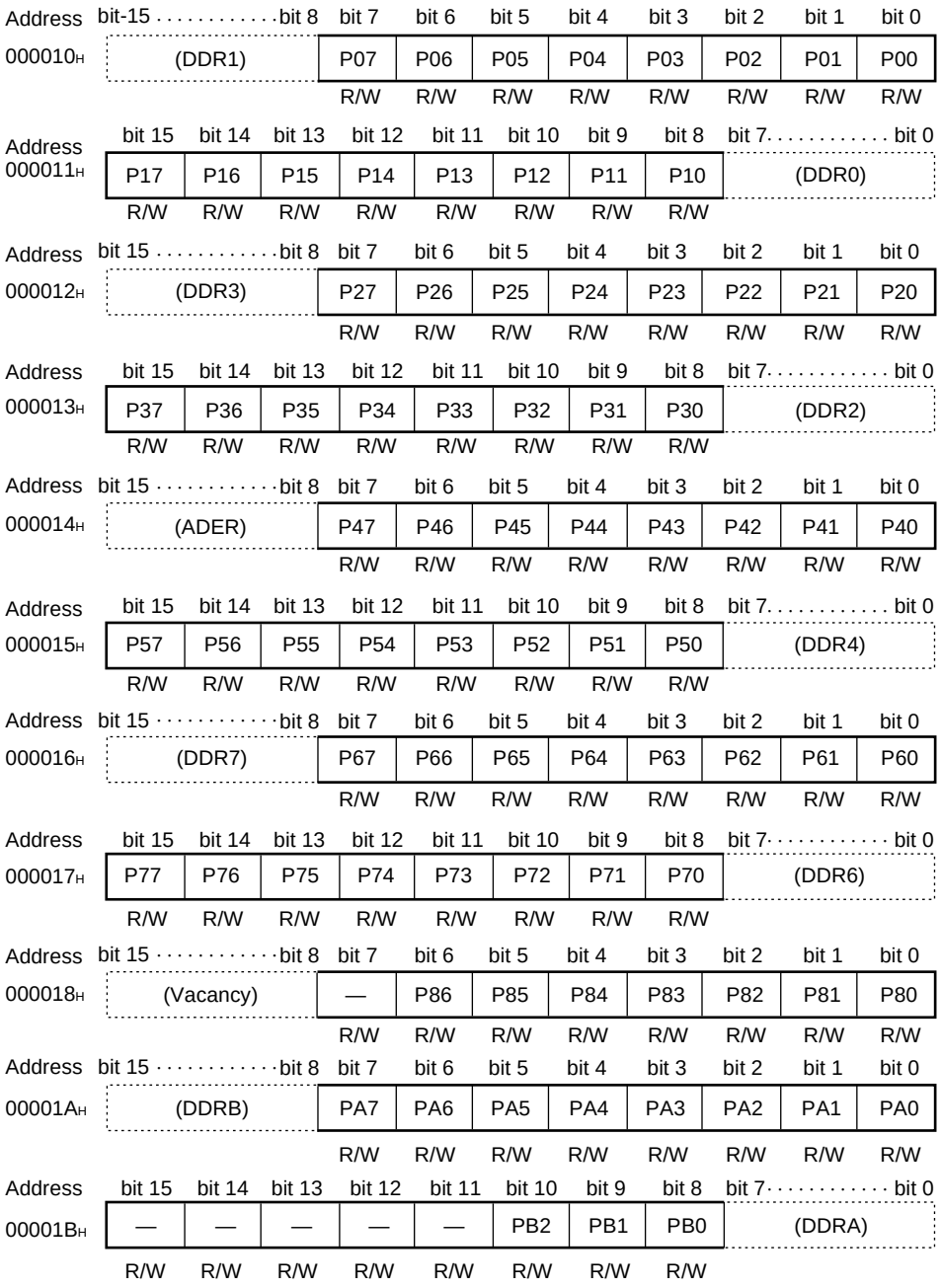
Standby control: Stop, timebase timer mode and SPL=1, or hardware standby mode

(4) Register Configuration



(Continued)

(Continued)



Note: Only MB90675 series has P81 through P86, P90, PA0 through PA7, and PB0 through PB2, and MB90670 series does not have such pins.

2. Timebase Timer

The timebase timer is a 18-bit free-run counter (timebase counter) for counting up in synchronization to the internal count clock (divided-by-2 of oscillation) with an interval timer function for selecting an interval time from four types of 2^{12}/HCLK, 2^{14}/HCLK, 2^{16}/HCLK, and 2^{19}/HCLK.

The timebase timer also has a function for supplying operating clocks for the timer output for the oscillation stabilization time or the watchdog timer etc.

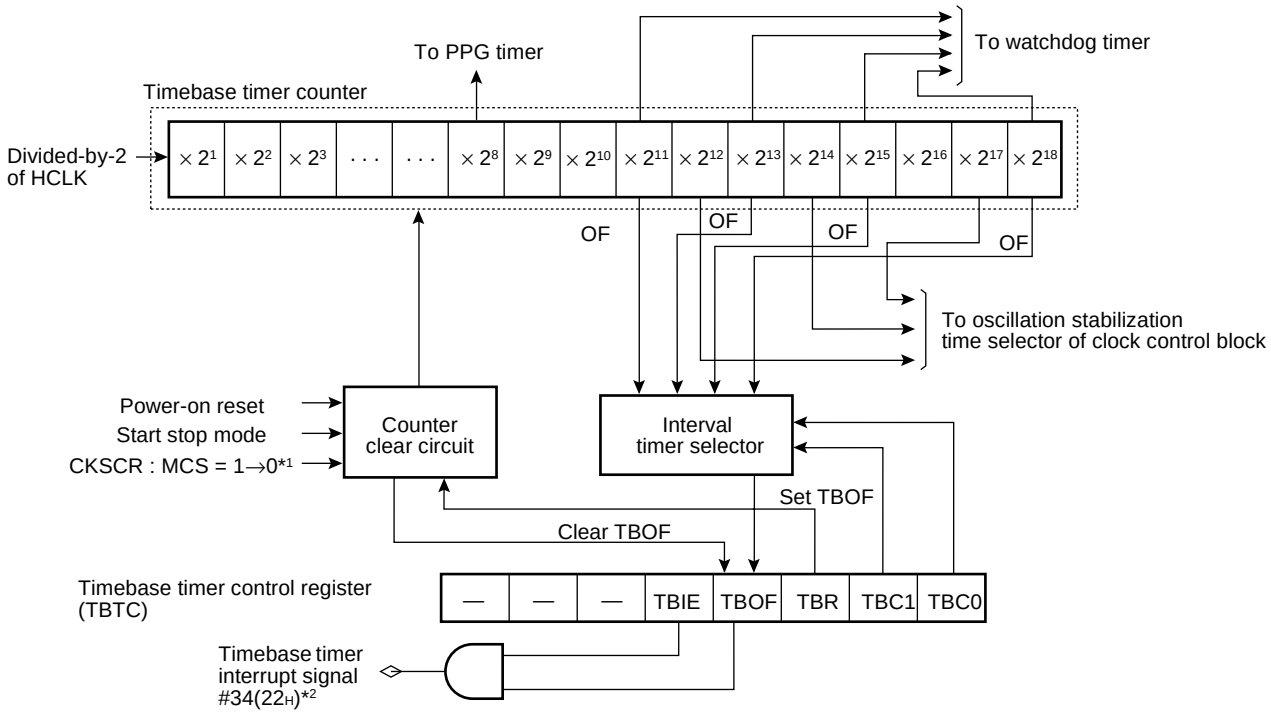
(1) Register Configuration

- Timebase timer control register (TBTC)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
0000A9H	RESV	—	—	TBIE	TBOF	TBR	TBC1	TBC0	(WDTC)	1--00100B
	R/W	—	—	R/W	R/W	W	R/W	R/W		

R/W: Readable and writable
W : Read only
— : Unused

(2) Block Diagram



OF : Overflow
HCLK: Oscillation clock
*1 : Switch machine clock from oscillation clock to PLL clock
*2 : Interrupt number

3. Watchdog Timer

The watchdog timer is a 2-bit counter operating with an output of the timebase timer and resets the CPU when the counter is not cleared for a preset period of time.

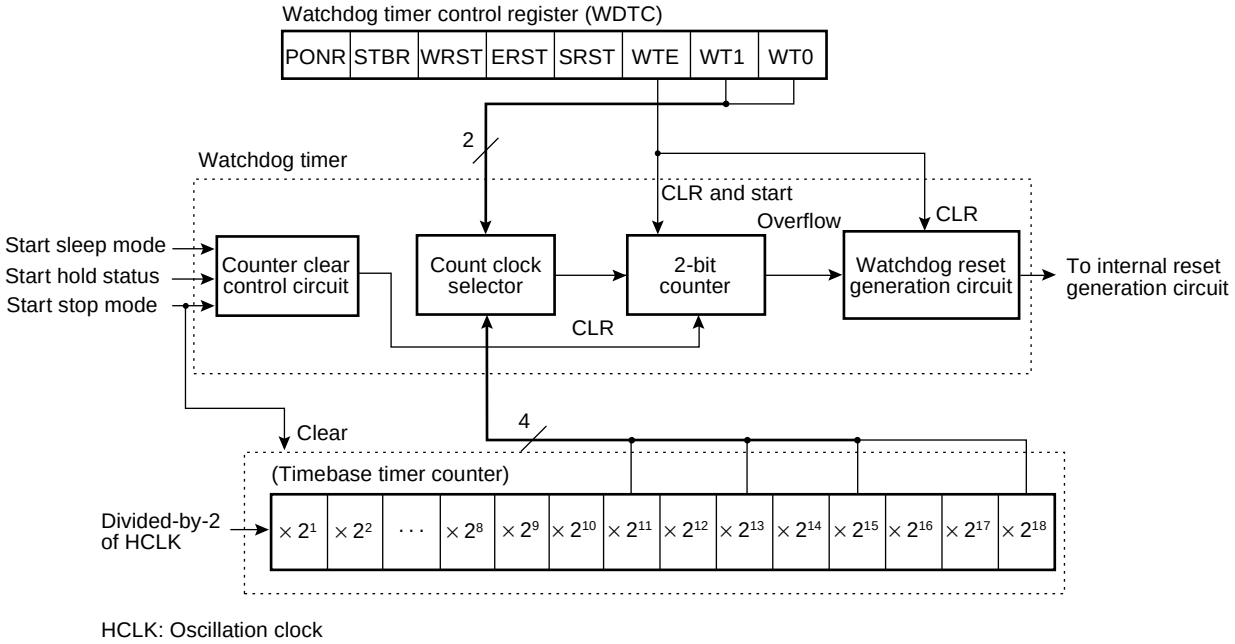
(1) Register Configuration

- Watchdog timer control register (WDTC)

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
0000A8H	(TBTC)	PONR	STBR	WRST	ERST	SRST	WTE	WT1	WT0	XXXXX111B
		R	R	R	R	R	W	W	W	

R : Read only
W: Write only
X : Indeterminate

(2) Block Diagram



HCLK: Oscillation clock

4. 8/16-bit PPG Timer

The 8/16-bit PPG timer is 2-channel reload timer module for outputting pulse having given frequencies/duty ratios.

The two modules performs the following operation by combining functions.

- 8-bit PPG output 2-channel independent operation mode
  This is a mode for operating independent 2-channel 8-bit PPG timer, in which PPG0 and PPG1 pins correspond to outputs from PPG0 and PPG1 respectively.
- 16-bit PPG output operation mode
  In this mode, PPG0 and PPG1 are combined to be operated as a 1-channel 8/16-bit PPG timer operating as a 16-bit timer. Because PPG0 and PPG1 outputs are reversed by an underflow from PPG1 outputting the same output pulses from PPG0 and PPG1 pins.
- 8 + 8-bit PPG output operation mode
  In this mode, PPG0 is operated as an 8-bit prescaler, in which an underflow output of PPG0 is used as a clock source for PPG1. A toggle output of PPG0 and PPG output of PPG1 are output from PPG0 and PPG1 respectively.

The module can also be used as a D/A converter with an external add-on circuit.

(1) Register Configuration

- PPG0 operating mode control register (PPGC0)

Address	bit 15 ··· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000030H	(PPGC1)	PEN0	—	POE0	PIE0	PUF0	PCM1	PCM0	RESV	0-000001B
		R/W	—	R/W	R/W	R/W	R/W	R/W	R/W	

- PPG1 operating mode control register (PPGC 1)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ··· bit 0	Initial value
000031H	PEN1	PCS1	POE1	PIE1	PUF1	MD1	MD0	RESV	(PPGC0)	00000001B
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W		

- PPG reload register (PRLL0,PRLH0,PRLL1,PRLH1)

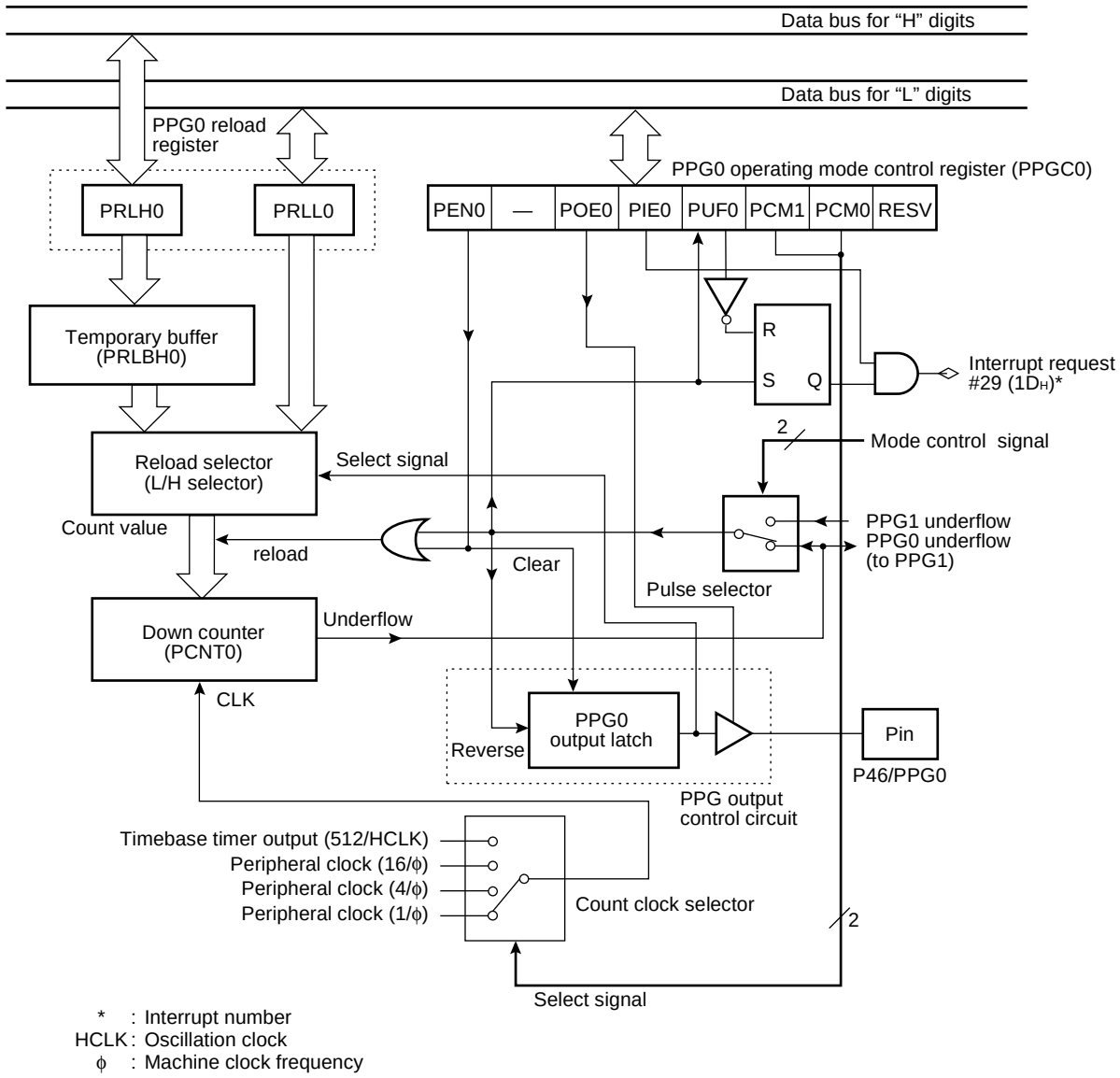
Address	bit 15 ··· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
PRLH0:000035H PRLH1:000037H	(PRLH0,PRLH1)									XXXXXXXXB
		R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ··· bit 0	Initial value
PRLL0:000034H PRLL1:000036H									(PRLL0,PRLL1)	XXXXXXXXB
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W		

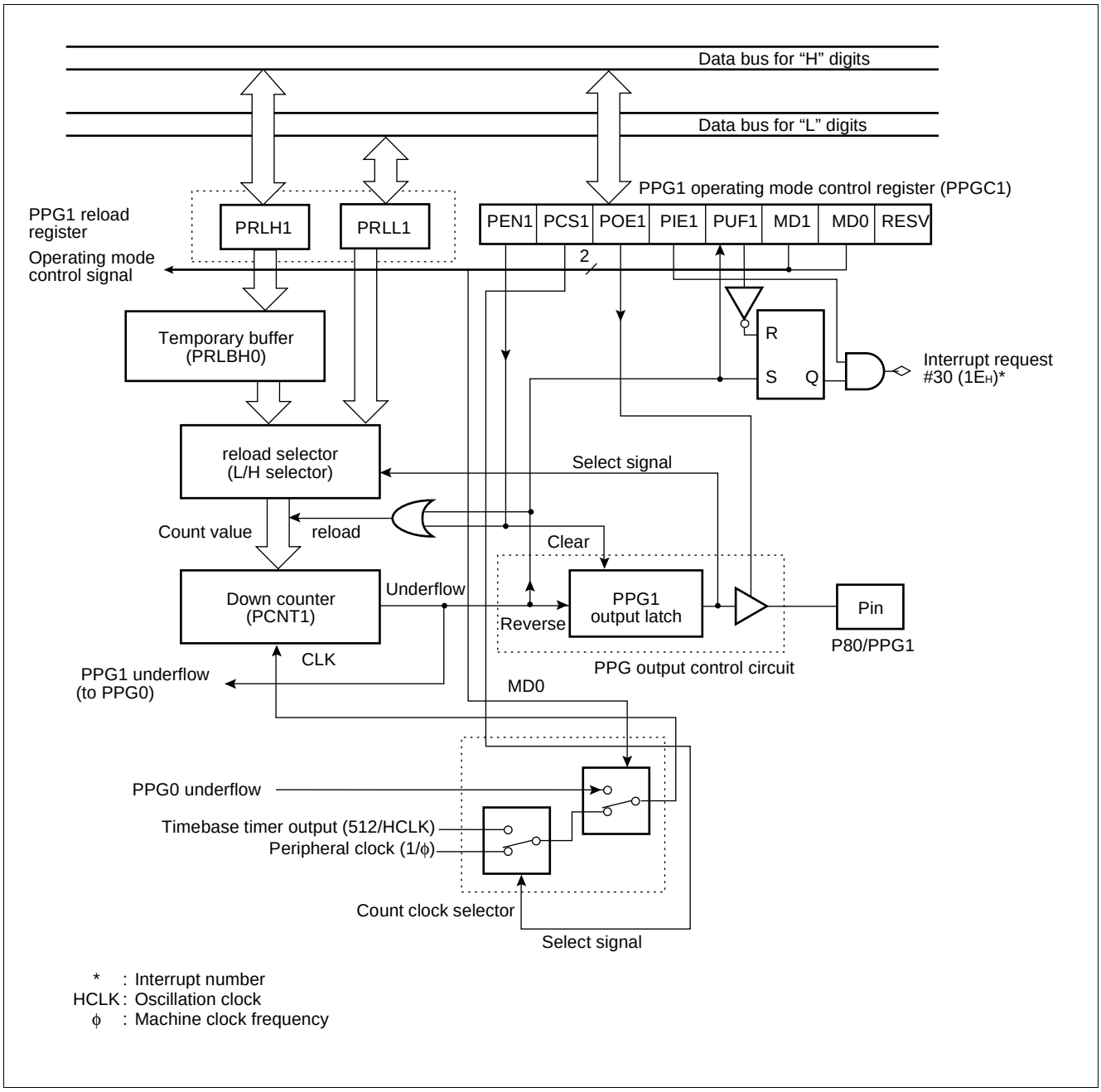
R/W: Readable and writable
— : Unused
X : Indeterminate

(2) Block Diagram

- **Block diagram of 8/16-bit PPG timer 0**



- **Block diagram of 8/16-bit PPG timer 1**



* : Interrupt number
HCLK : Oscillation clock
ϕ : Machine clock frequency

5. 16-bit Reload Timer

The 16-bit reload timer has an internal clock mode for counting down in synchronization to three types of internal clocks and an event count mode for counting down detecting a given edge of the pulse input to the external bus pin, and either of the two functions can be selectively used.

For this timer, an “underflow” is defined as the counter value of “0000_H” to “$FFFF_H$”. According to this definition, an underflow occurs after [reload register setting value + 1] counts.

In operating the counter, the reload mode for repeating counting operation after reloading a counter setting value after an underflow or the one-shot mode for stopping the counting operation after an underflow can be selectively used.

Because the timer can generate an interrupt upon an underflow, the timer conforms to the extended intelligent I/O service (EI^2OS).

The MB90670/675 series has 2 channels of 16-bit reload timers.

(1) Register Configuration

- Timer control status register upper digits (TMCSR0,TMCSR1 : H)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
TMCSR0:000039H TMCSR1:00003DH	—	—	—	—	CSL1	CSL0	MOD2	MOD1	(TMCSR : L)	----0000B
	—	—	—	—	R/W	R/W	R/W	R/W		

- Timer control status register lower digits (TMCSR0,TMCSR1 : L)

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
TMCSR0:000038H TMCSR1:00003CH	(TMCSR : H)	MOD1	OUTE	OUTL	RELD	INTE	UF	CNTE	TRG	00000000B
		R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

- 16-bit timer register 0, 1 (TMR0,TMR1)

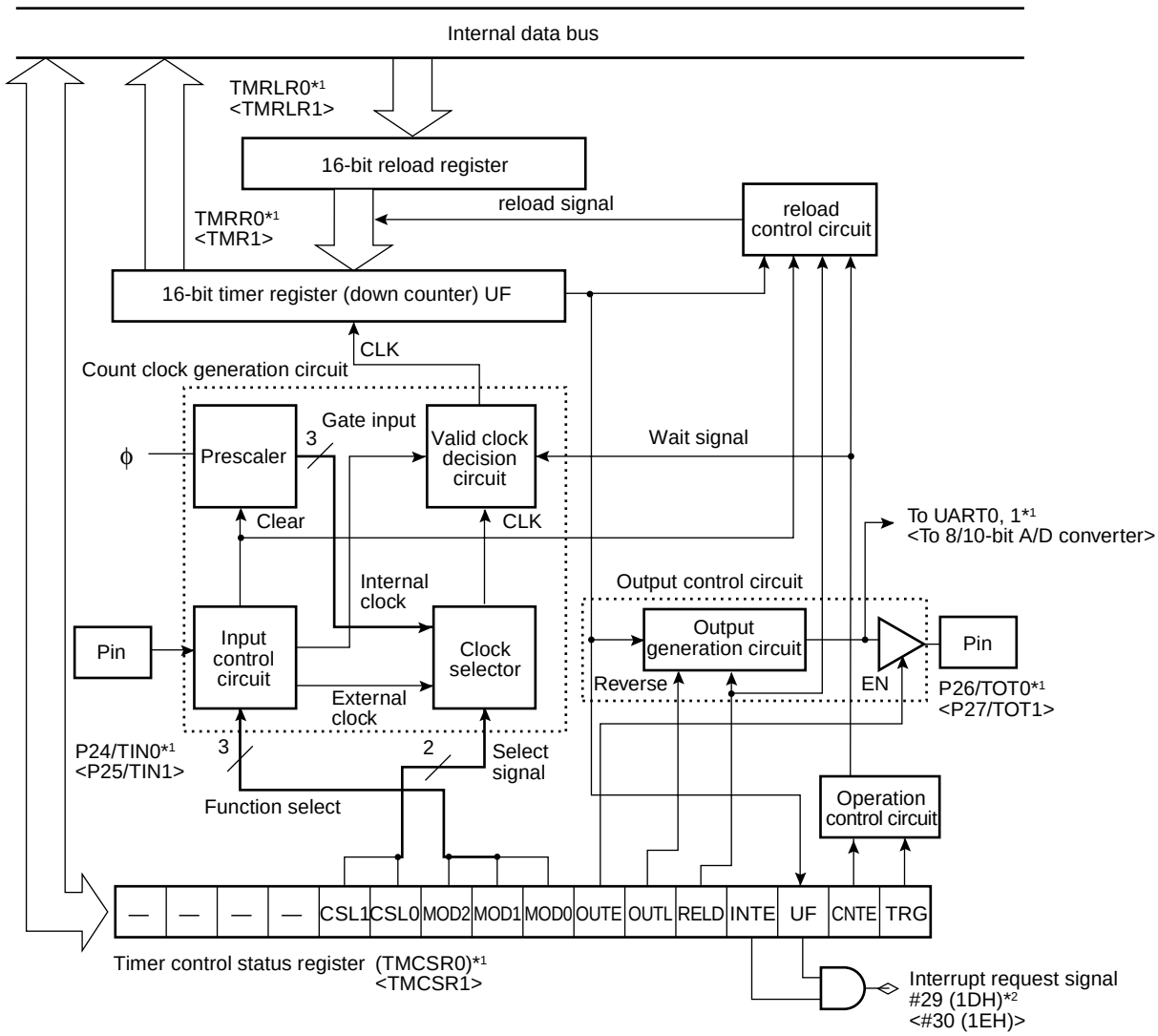
Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
00003AH																	XXXXXXXXB
00003BH																	XXXXXXXXB
00003EH																	XXXXXXXXB
00003FH	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	XXXXXXXXB

- 16-bit reload register 0, 1 (TMRL0,TMRL1)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
00003AH																	XXXXXXXXB
00003BH																	XXXXXXXXB
00003EH																	XXXXXXXXB
00003FH	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	W	XXXXXXXXB

R/W : Readable and writable
R : Read only
W : Write only
— : Unused
X : Indeterminate

(2) Block Diagram



*1: The timer has ch.0 and ch.1, and listed in the parenthesis <> are for ch.1.
*2: Interrupt number
ϕ: Machine clock frequency

6. 24-bit Free-run Timer

The 24-bit free-run timer is a 24-bit up counter for counting up in synchronization to divided-by-3 or divided-by-4 of the machine clock, in which an interrupt factor can be selected from the overflow interrupt and four types of timer intermediate bit interrupt to be operated as an interval timer.

The free-run timer can be used to generating reference timing signals for the input capture (ICU) and output compare (OCU).

(1) Register Configuration

- Free-run timer control register upper digits (TCCR : H)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
000051H	—	—	RESV	RESV	RESV	RESV	RESV	PR0	(TCCR : L)	--111111B
	—	—	R/W	R/W	R/W	R/W	R/W	R/W		

- Free-run timer control register lower digits (TCCR : L)

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000050H	(TCCR : H)	STP	CLR	IVF	IVFE	TIM	TIME	TIS1	TIS0	11000000B
		W	W	R/W	R/W	R/W	R/W	R/W	R/W	

- Free-run timer upper data register (TCRH)

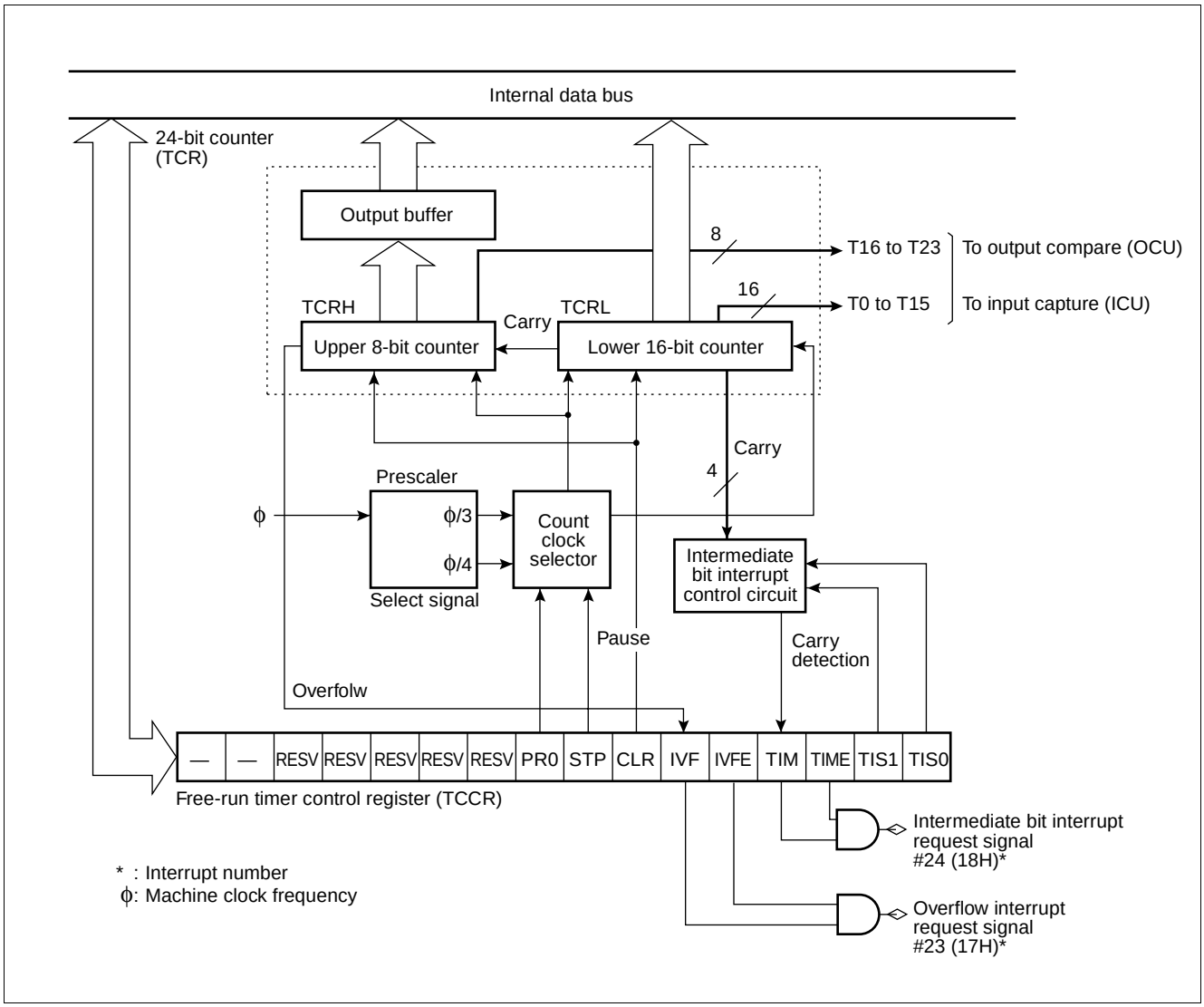
Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000056H	—	—	—	—	—	—	—	—	T23	T22	T21	T20	T19	T18	T17	T16	00000000B
000057H																	00000000B
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	

- Free-run timer lower data register (TCRL)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000054H	T15	T14	T13	T12	T11	T10	T9	T8	T7	T6	T5	T4	T3	T2	T1	T0	00000000B
000055H																	00000000B
	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	

R/W : Readable and writable
R : Read only
W : Write only
— : Unused

(2) Block Diagram



7. Input Capture (ICU)

The input capture (ICU) generates an interrupt request to the CPU simultaneously with a storing operation of current counter value of the 24-bit free-run timer to the ICU data register (ICDR) upon an input of a trigger edge to the external pin.

There are four sets (four channels) of the input capture external pins and ICU data registers (ICDR), enabling measurements of maximum of four events.

- The input capture has four sets of external input pins (ASR0 to ASR3) and ICU registers (ICDR), enabling measurements of maximum of four events.
- A trigger edge direction can be selected from rising/falling/both edges.
- The input capture can be set to generate an interrupt request at the storage timing of the counter value of the 24-bit free-run timer to the ICU data register (ICDR).
- The input compare conforms to the extended intelligent I/O service (EI^2OS).
- The input capture function is suited for measurements of intervals (frequencies) and pulse-widths.

(1) Register Configuration

- ICU control register upper digits (ICC : H)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
000053H	IRE3	IRE2	IRE1	IRE0	IR3	IR2	IR1	IR0	(ICC : L)	00000000B
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W		

- ICU control register lower digits (ICC : L)

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000052H	(ICC : H)	EG3B	EG3A	EG2B	EG2A	EG1B	EG1A	EG0B	EG0A	00000000B
		R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

- ICU upper data register 0 to 3 (ICDR0H to ICDR3H)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	Initial value
ICDR0H : 000063H ICDR1H : 000067H ICDR2H : 00006BH ICDR3H : 00006FH	—	—	—	—	—	—	—	—	00000000B
	R	R	R	R	R	R	R	R	

Address	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
ICDR0H : 000062H ICDR1H : 000066H ICDR2H : 00006AH ICDR3H : 00006EH	D23	D22	D21	D20	D19	D18	D17	D16	XXXXXXXXB
	R	R	R	R	R	R	R	R	

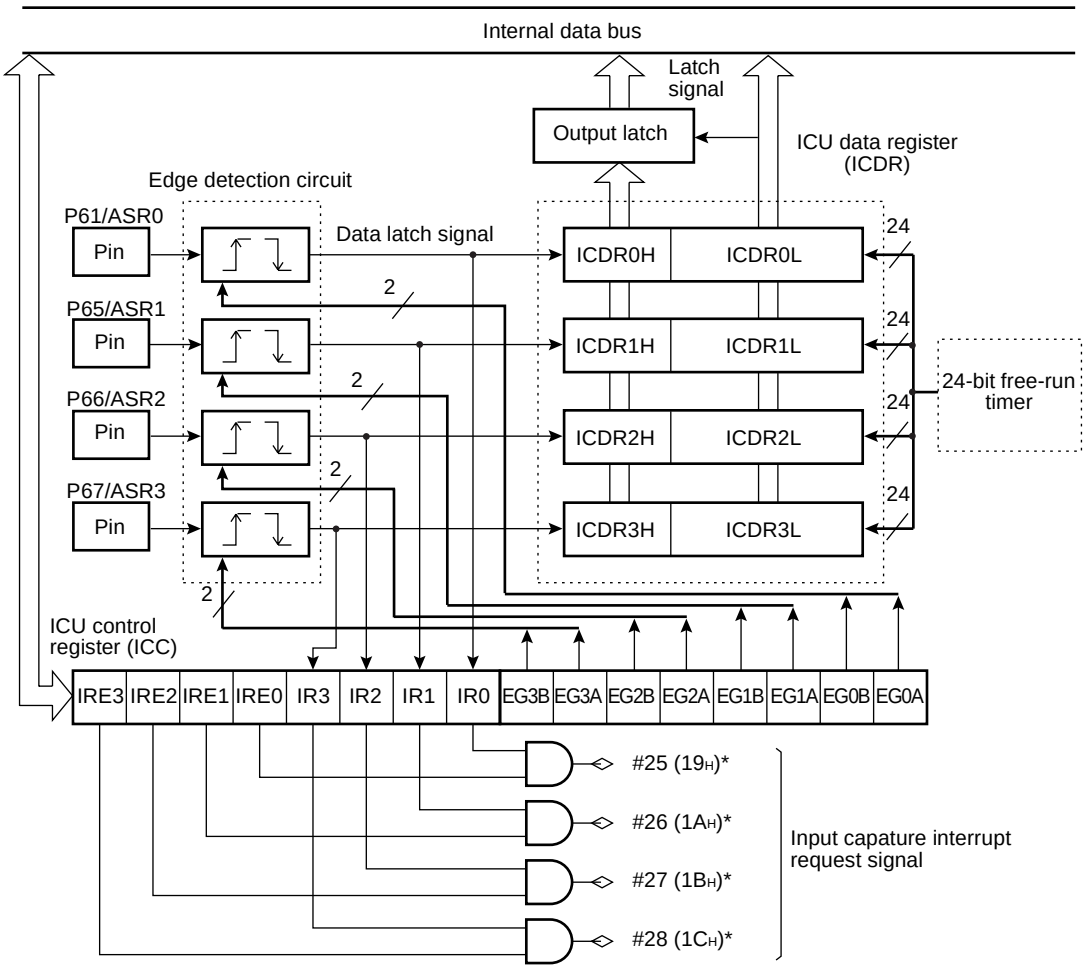
- ICU lower data register 0 to 3 (ICDR0L to ICDR3L)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	Initial value
ICDR0L : 000061H ICDR1L : 000065H ICDR2L : 000069H ICDR3L : 00006DH	D15	D14	D13	D12	D11	D10	D9	D8	XXXXXXXXB
	R	R	R	R	R	R	R	R	

Address	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
ICDR0L : 000060H ICDR1L : 000064H ICDR2L : 000068H ICDR3L : 00006CH	D7	D6	D5	D4	D3	D2	D1	D0	XXXXXXXXB
	R	R	R	R	R	R	R	R	

R/W : Readable and writable
R : Read only
— : Unused
X : Indeterminate

(2) Block Diagram



8. Output Compare (OCU)

The output compare (OCU) is two sets of compare units consisting of four-channel OCU compare data registers, a comparator and a control register.

An interrupt request can be generated for each channel upon a match detection by performing time-division comparison between the OCU compare data register setting value and the counter value of the 24-bit free-run timer.

The DOT pin can be used as a waveform output pin for reversing output upon a match detection or a general-purpose output port for directly outputting the setting value of the DOT bit.

(1) Register Configuration

- OCU control register 00 upper digits (CCR00 : H)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ··· bit 0	Initial value
000059H	—	—	—	—	MD3	MD2	MD1	MD0	(CCR00 : L)	----0000B
	—	—	—	—	R/W	R/W	R/W	R/W		

- OCU control register 00 lower digits (CCR00 : L)

Address	bit 15 ··· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000058H	(CCR00 : H)	RESV	RESV	RESV	RESV	CPE3	CPE2	CPE1	CPE0	11110000B
		R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

- OCU control register 01 upper digits (CCR01 : H)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ··· bit 0	Initial value
00005BH	ICE3	ICE2	ICE1	ICE0	IC3	IC2	IC1	IC0	(CCR01 : L)	00000000B
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W		

- OCU control register 01 lower digits (CCR01 : L)

Address	bit 15 ··· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
00005AH	(CCR01 : H)	—	—	—	—	DOT3	DOT2	DOT1	DOT0	----0000B
		—	—	—	—	R/W	R/W	R/W	R/W	

R/W : Readable and writable
— : Unused

(Continued)

(Continued)

- OCU compare upper data register 0 to 7 (CPR00H to CPR07H)

Address
CPR00H : 000073H
CPR01H : 000077H
CPR02H : 00007BH
CPR03H : 00007FH
CPR04H : 000083H
CPR05H : 000087H
CPR06H : 00008BH
CPR07H : 00008FH

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	Initial value
—	—	—	—	—	—	—	—	00000000B
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

Address
CPR00H : 000072H
CPR01H : 000076H
CPR02H : 00007AH
CPR03H : 00007EH
CPR04H : 000082H
CPR05H : 000086H
CPR06H : 00008AH
CPR07H : 00008EH

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
D23	D22	D21	D20	D19	D18	D17	D16	00000000B
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

- OCU compare lower data register 0 to 7 (CPR00L to CPR07L)

Address
CPR00L : 000071H
CPR01L : 000075H
CPR02L : 000079H
CPR03L : 00007DH
CPR04L : 000081H
CPR05L : 000085H
CPR06L : 000089H
CPR07L : 00008DH

bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	Initial value
D15	D14	D13	D12	D11	D10	D9	D8	00000000B
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

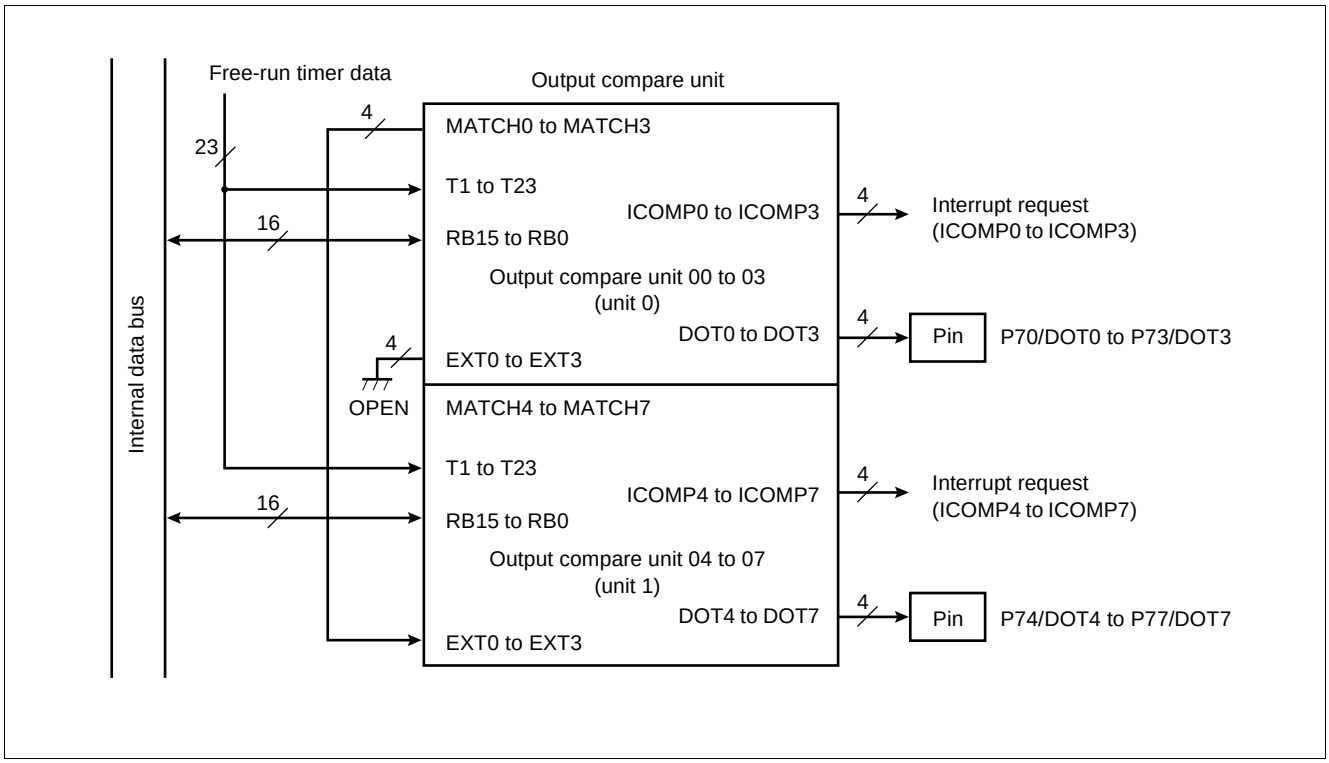
Address
CPR00L : 000070H
CPR01L : 000074H
CPR02L : 000078H
CPR03L : 00007CH
CPR04L : 000080H
CPR05L : 000084H
CPR06L : 000088H
CPR07L : 00008CH

bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
D7	D6	D5	D4	D3	D2	D1	D0	00000000B
R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

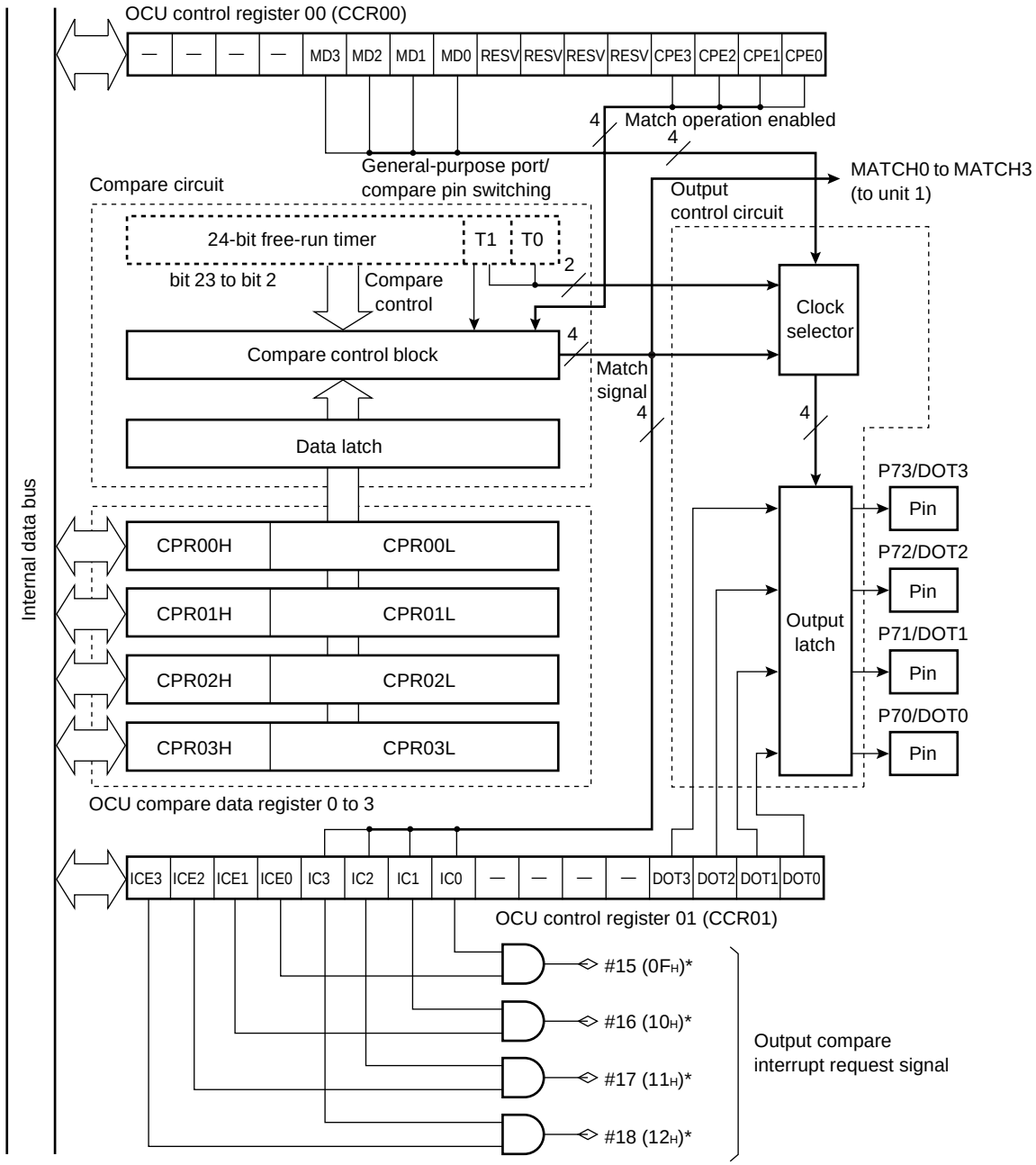
R/W : Readable and writable
— : Unused

(2) Block Diagram of Output Compare (OCU)

- **Overall block diagram**

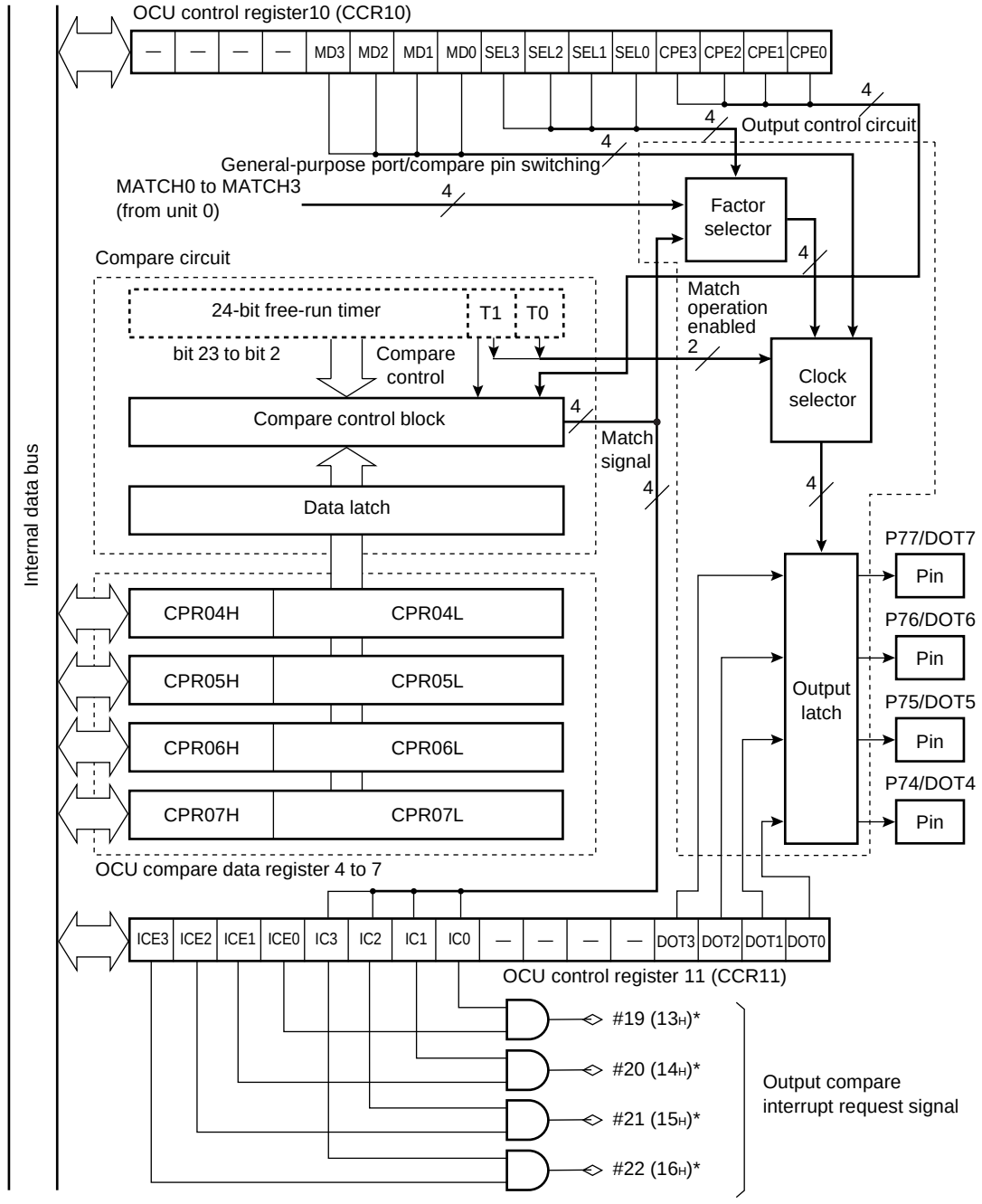


- **Block diagram of unit 0**



* : Interrupt number

- **Block diagram of unit 1**



* : Interrupt number

9. I²C Interface (Included Only in MB90675 Series)

The I²C interface is a serial I/O port supporting Inter IC BUS operating as master/slave devices on I²C bus and has the following features.

- Master/slave transmission/reception
- Arbitration function
- Clock synchronization function
- Slave address/general call address detection function
- Transmission direction detection function
- Repeated generation function start condition and detection function
- Bus error detection function

(1) Register Configuration

- I²C bus status register (IBSR)

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000040H	(IBCR)	BB	RSC	AL	LRB	TRX	AAS	GCA	FBT	00000000B
		R	R	R	R	R	R	R	R	

- I²C bus control register (IBCR)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
000041H	BER	BEIE	SCC	MSS	ACK	GCAA	INTE	INT	(IBSR)	00000000B
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W		

- I²C bus clock control register (ICCR)

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000042H	(IADR)	—	—	EN	CS4	CS3	CS2	CS1	CS0	--0XXXXXB
		—	—	R/W	R/W	R/W	R/W	R/W	R/W	

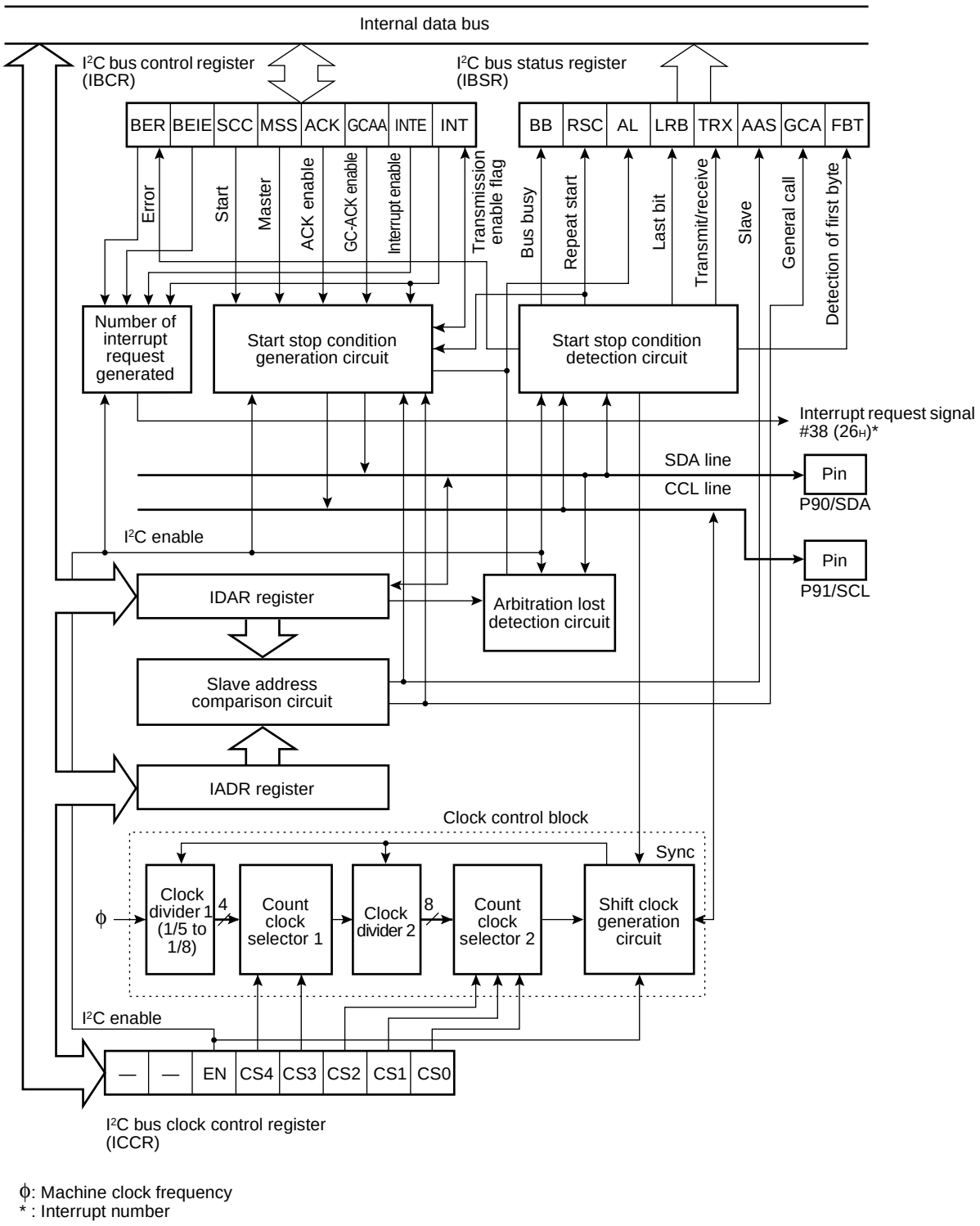
- I²C address register (IADR)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
000043H (IADR)	—	A6	A5	A4	A3	A2	A1	A0	(ICCR)	-XXXXXXXB
	—	R/W	R/W	R/W	R/W	R/W	R/W	R/W		

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000044H (IDAR)	(Reserved area)	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	

R/W: Readable and writable
R : Read only
— : Uunsed
X : Indeterminate

(2) Block Diagram



ϕ: Machine clock frequency
* : Interrupt number

10. UART0

UART0 is a general-purpose serial data communication interface for performing synchronous or asynchronous communication (start-stop synchronization system). In addition to the normal duplex communication function (normal mode), UART0 has a master/slave type communication function (multi-processor mode).

- Data buffer: Full-duplex double buffer
- Transfer mode: Clock synchronized (with start and stop bit)
  Clock asynchronized (start-stop synchronization system)
- Baud rate: With dedicated baud rate generator, selectable from 12 types
  External clock input possible
  Internal clock (a clock supplied from 16-bit reload timer can be used.)
- Data length: 7 bits to 9 bits selective (with a parity bit)
  6 bits to 8 bits selective (without a parity bit)
- Signal format: NRZ (Non Return to Zero) system
- Reception error detection: Framing error
  Overrun error
  Parity error (not available in multi-processor mode)
- Interrupt request: Receive interrupt (reception complete, receive error detection)
  Receive interrupt (transmission complete)
  Transmit/receive conforms to extended intelligent I/O service (EI^{2}OS)
- Master/slave type communication function (multi-processor mode): 1 (master) to n (slave) communication possible

(1) Register Configuration

- Status register 0 (USR0)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ··· bit 0	Initial value
000021H	RDRF	ORFE	PE	TDRE	RIE	TIE	RBF	TBF	(UMC0)	00100000B
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W		

- Mode control register 0 (UMC0)

Address	bit 15 ··· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000020H	(USR0)	PEN	SBL	MC1	MC0	SMDE	RFC	SCKE	SOE	00000100B
		R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

- Rate and data register 0 (URD0)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ··· bit 0	Initial value
000023H	BCH	RC3	RC2	RC1	RC0	BCH0	P	D8	(UIDR0/UODR0)	00000000B
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W		

- Input data register 0 (UIDR0)

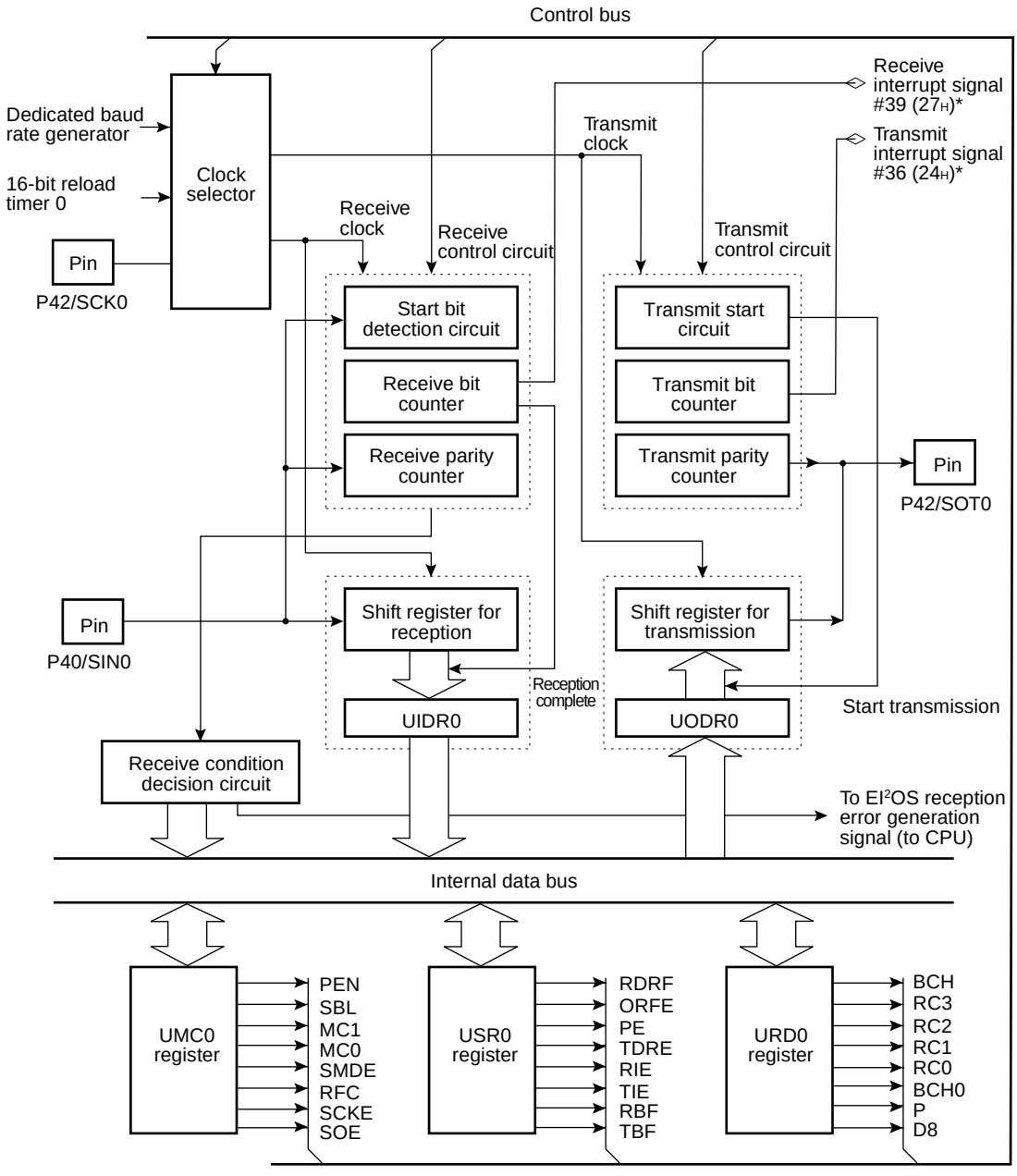
Address	bit 15 ··· bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000022H	(URD0)	D8	D7	D6	D5	D4	D3	D2	D1	D0	XXXXXXXXB
		R	R	R	R	R	R	R	R	R	

- Output data register 0 (UODR)

Address	bit 15 ··· bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000022H	(URD0)	D8	D7	D6	D5	D4	D3	D2	D1	D0	XXXXXXXXB
		W	W	W	W	W	W	W	W	W	

R/W : Readable and writable
R : Read only
W : Write only
X : Indeterminate

(2) Block Diagram



* : Interrupt number

11. UART1 (SCI)

UART1 (SCI) is a general-purpose serial data communication interface for performing synchronous or asynchronous communication (start-stop synchronization system). In addition to the normal duplex communication function (normal mode), UART1 has a master-slave type communication function (multi-processor mode).

- Data buffer: Full-duplex double buffer
- Transfer mode: Clock synchronized (no start or stop bit)
  Clock asynchronized (start-stop synchronization system)
- Baud rate: With dedicated baud rate generator, selectable from 8 types
  External clock input possible
  Internal clock (a internal clock supplied from 16-bit reload timer can be used.)
- Data length: 7 bits (for asynchronous normal mode only)
  8 bits
- Signal format: NRZ (Non Return to Zero) system
- Reception error detection: Framing error
  Overrun error
  Parity error (not available in multi-processor mode)
- Interrupt request: Receive interrupt (receptioncomplete, receive error detection)
  Receive interrupt (transmission complete)
  Transmit/receive conforms to extended intelligent I/O service (EI^{2}OS)
- Master/slave type communication function (multi-processor mode):1 (master) to n (slave) communication possible (supported only for master station)

(1) Register Configuration

- Control register 1 (SCR1)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
000025H	PEN	P	SBL	CL	A/D	REC	RXE	TXE	(SMR1)	00000100B
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W		

- Mode register 1 (SMR1)

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000024H	(SCR1)	MD1	MD0	CS2	CS1	CS0	BCH	SCKE	SOE	00000000B
		R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

- Status register 1 (SSR1)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
000027H	PE	ORE	FRE	RDRF	TDRE	—	RIE	TIE	(SIDR1/SODR1)	00001-00B
	R	R	R	R	R	—	R/W	R/W		

- Input data register 1 (SIDR1)

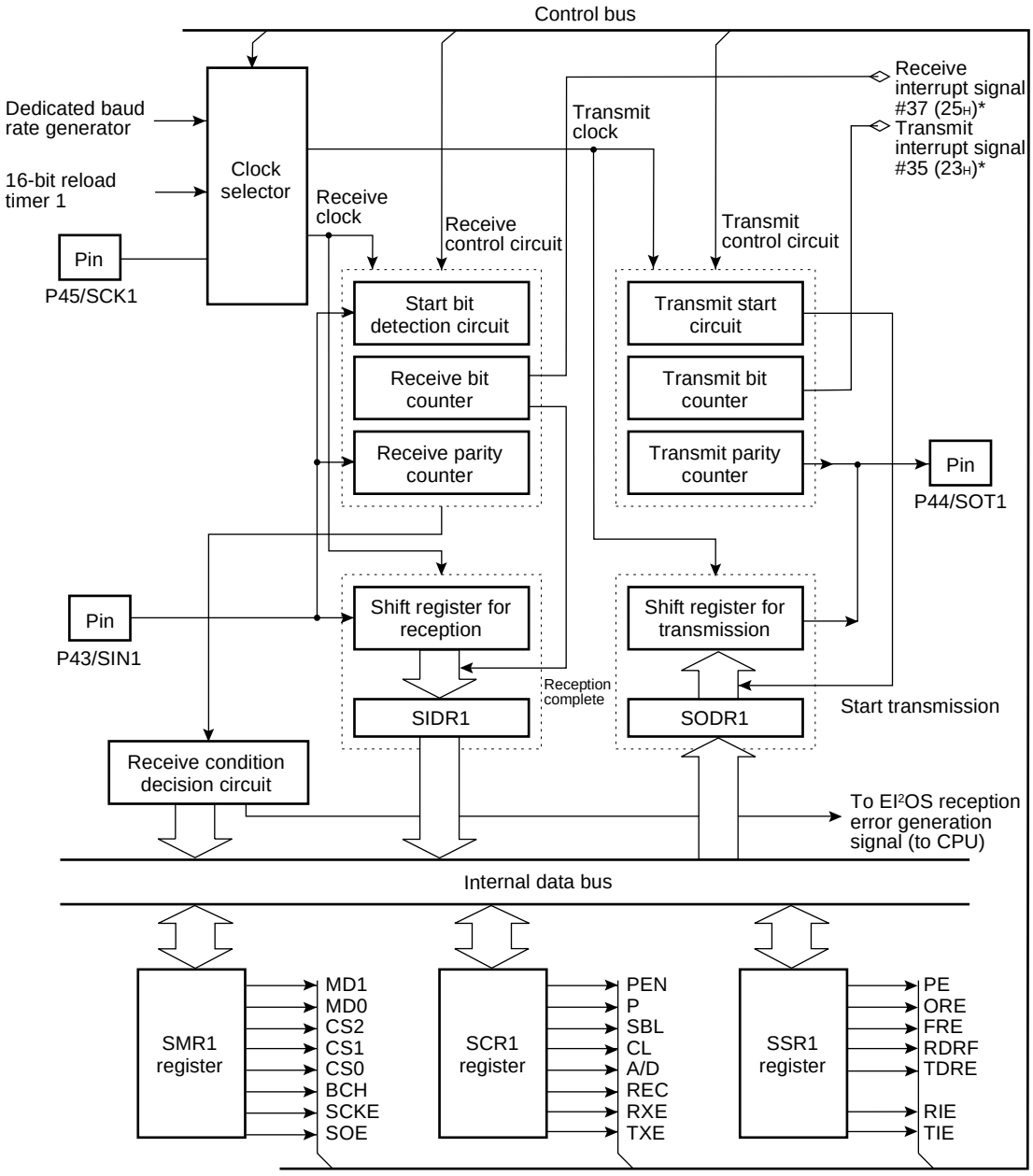
Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000026H	(SSR1)	D7	D6	D5	D4	D3	D2	D1	D0	XXXXXXXXB
		R	R	R	R	R	R	R	R	

- Output data register 1 (SODR1)

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000026H	(SSR1)	D7	D6	D5	D4	D3	D2	D1	D0	XXXXXXXXB
		W	W	W	W	W	W	W	W	

R/W: Readable and writable
R : Read only
W : Write only
— : Unused
X : Indeterminate

(2) Block Diagram



*: Interrupt number

12. DTP/External Interrupt Circuit

The DTP (Data Transfer Peripheral)/external interrupt circuit is located between peripheral equipment connected externally and the F²MC-16L CPU and transmits interrupt requests or data transfer requests generated by peripheral equipment to the CPU, generates external interrupt request and starts the extended intelligent I/O service (EI²OS).

(1) Register Configuration

- DTP/interrupt factor register (EIRR)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
000029H	—	—	—	—	ER3	ER2	ER1	ER0	(ENIR)	- - - - 0000B
	—	—	—	—	R/W	R/W	R/W	R/W		

- DTP/interrupt enable register (ENIR)

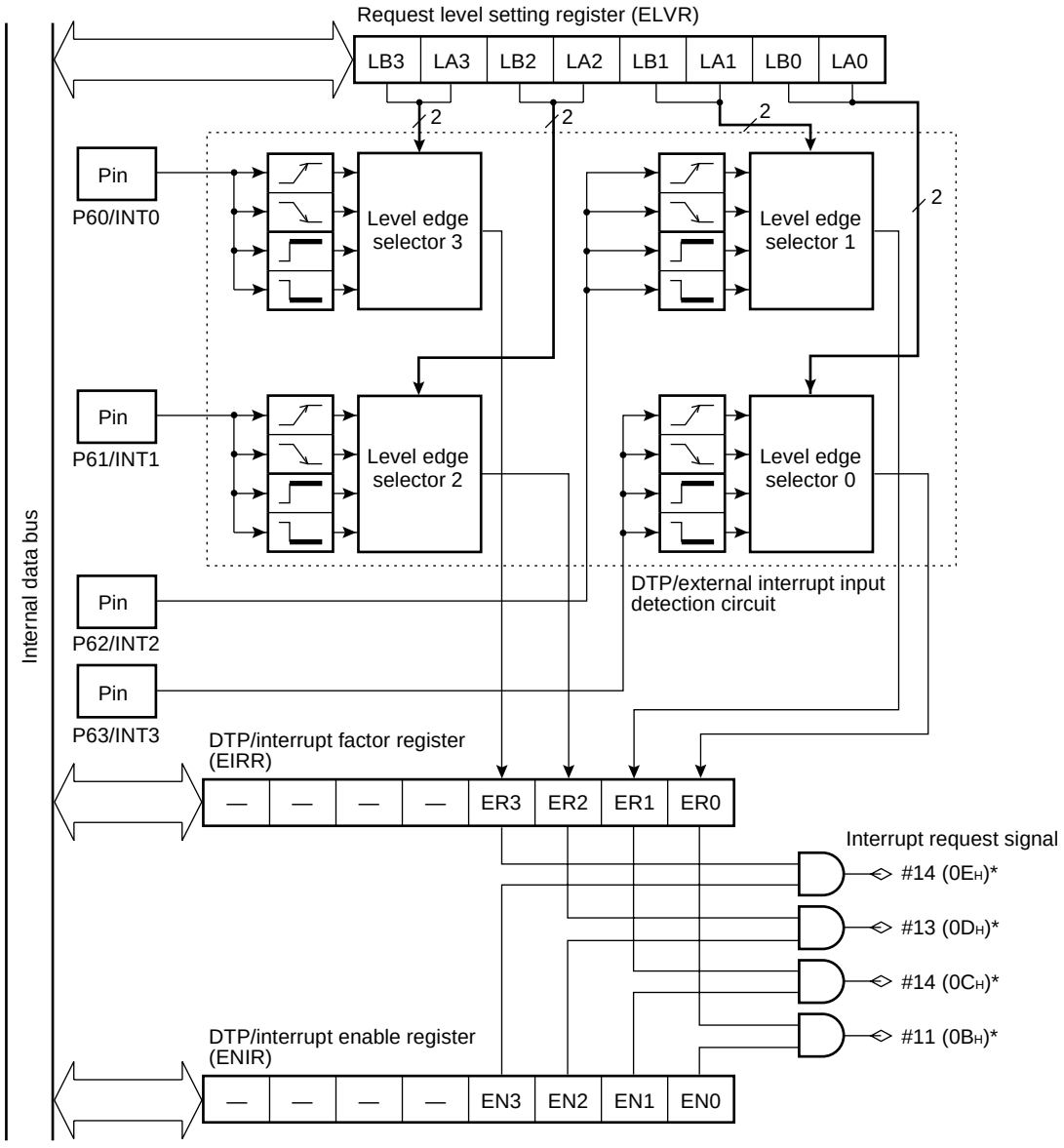
Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
000028H	(EIRR)	—	—	—	—	EN3	EN2	EN1	EN0	- - - - 0000B
		—	—	—	—	R/W	R/W	R/W	R/W	

- Request level setting register (ELVR)

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
00002AH	(Vacancy)	LB3	LA3	LB2	LA2	LB1	LA1	LB0	LA0	00000000B
		R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

R/W: Readable and writable
— : Unused

(2) Block Diagram



13. Wake-up Interrupt

Wake-up interrupts transmits interrupt request (“L” level) generated by peripheral device located between external peripheral devices and the F²MC-16L CPU to the CPU and invokes interrupt processing.

The interrupt does not conform to the extended intelligent I/O service (EI²OS).

(1) Register Configuration

- Wake-up interrupt flag register (EIFR)

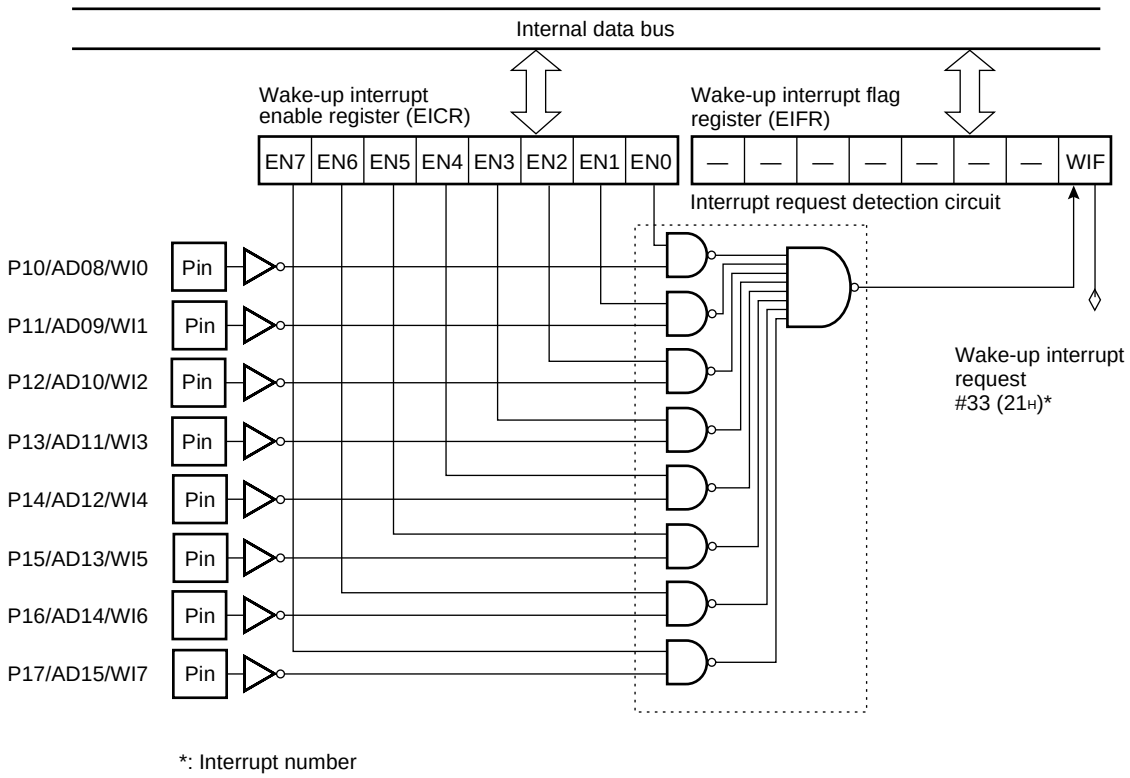
Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
00000F$_H$	—	—	—	—	—	—	—	WIF	(Vacancy)	- - - - - - - 0$_B$
	—	—	—	—	—	—	—	R/W		

- Wake-up interrupt enable register (EICR)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
00001F$_H$	EN7	EN6	EN5	EN4	EN3	EN2	EN1	EN0	(Vacancy)	00000000$_B$
	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W		

R/W: Readable and writable
— : Unused

(2) Block Diagram



*: Interrupt number

14. Delayed Interrupt Generation Module

The delayed interrupt generation module generates interrupts for switching tasks for development on a real-time operating system (REALOS software). The module can be used to generate hardware interrupt requests to the CPU with software and cancel the interrupt requests.

This module does not conform to the extended intelligent I/O service (EI^{2}OS).

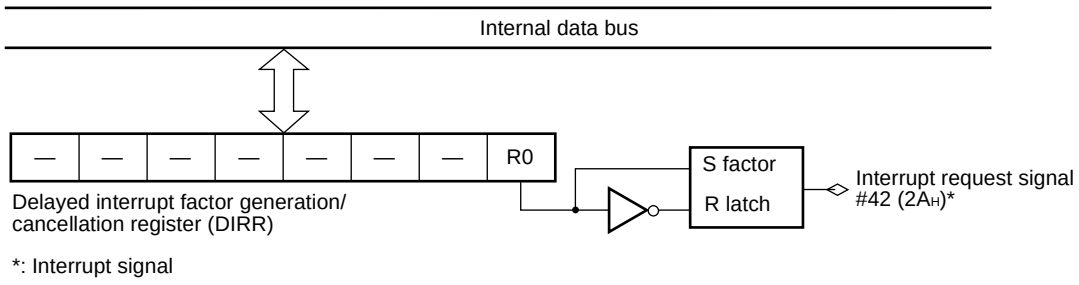
(1) Register Configuration

- Delayed interrupt factor generation/cancellation register (DIRR)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
00009F$_H$	—	—	—	—	—	—	—	R0	(Reserved area)	- - - - - - - 0$_B$
	—	—	—	—	—	—	—	R/W		

R/W: Readable and writable
— : Unused

(2) Block Diagram



*: Interrupt signal

15. 8/10-bit A/D Converter

The 8/10-bit A/D converter has a function of converting analog voltage input to the analog input pins (input voltage) to digital values (A/D conversion) and has the following features.

- Minimum conversion time: 6.13 µs (at machine clock of 16 MHz, including sampling time)
- Minimum sampling time: 3.75 µs (at machine clock of 16 MHz)
- Conversion method: RC successive approximation method with a sample and hold circuit.
- Resolution: 10-bit or 8-bit selective
- Analog input pins: Selectable from eight channels by software

  One-shot conversion mode: Stops conversion after completing a conversion for a stopped channel (one channel only) or for successive channels (maximum of eight channels can be specified)

  Continuous conversion mode: Continues conversions for a specified channel (one channel only) or for successive channels (maximum of eight channels can be specified)

  Stop conversion mode: Stops conversion after completing a conversion for one channel and wait for the next activation.
- Interrupt requests can be generated and the extended intelligent I/O service (EI^{2}OS) can be started after the end of A/D conversion.
- When interrupts are enabled, there is no loss of data even in continuous operations because the conversion data protection function is in effect.
- Starting factors for conversion: Selected from software activation, 16-bit reload timer 1 output (rising edge), and external trigger (falling edge).

(1) Register Configuration

- A/D control status register upper digits (ADCS: H)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
00002DH	BUSY	INT	INTE	PAUS	STS1	STS0	STRT	RESV	(ADCS: L)	00000000B
	R/W	R/W	R/W	R/W	R/W	R/W	W	R/W		

- A/D control status register lower digits (ADCS: L)

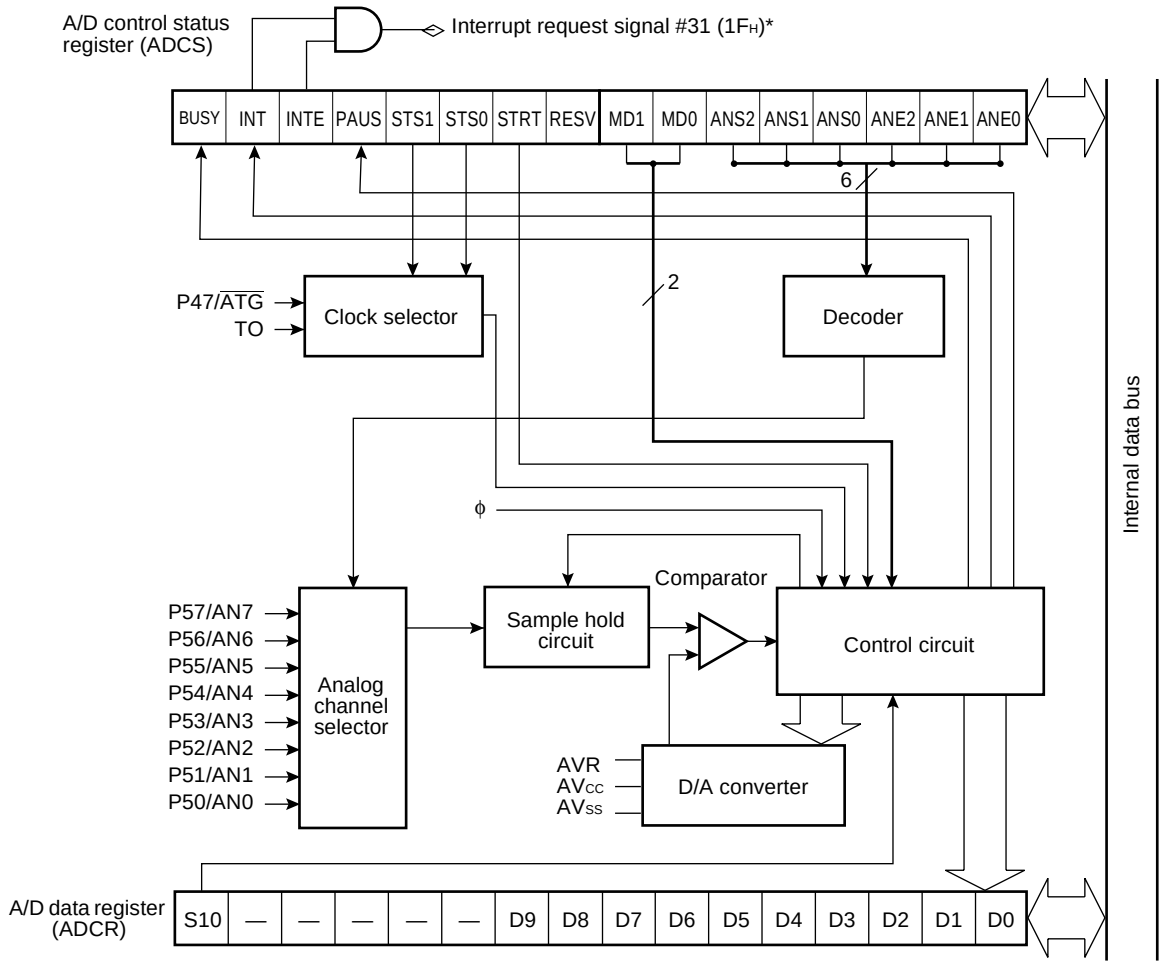
Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
00002CH	(ADCS: H)	MD1	MD0	ANS2	ANS1	ANS0	ANE2	ANE1	ANE0	00000000B
		R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	

- A/D data register (ADCR)

Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
00002EH	S10	—	—	—	—	—	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0	XXXXXXXXB 0000000XB
	R/W	—	—	—	—	—	R	R	R	R	R	R	R	R	R	R	

R/W: Readable and writable
R : Read only
W : Write only
— : Unused
X : Indeterminate

(2) Block Diagram



ϕ : Machine clock frequency
TO : 16-bit reload timer channel 1 output
* : Interrupt number

16. Low-power Consumption (Standby) Mode

The F²MC-16L has the following CPU operating mode configured by selection of an operating clock and clock operation control.

- **Clock mode**
  PLL clock mode: A mode in which the CPU and peripheral equipment are driven by PLL-multiplied oscillation clock (HCLK).
  Main clock mode: A mode in which the CPU and peripheral equipment are driven by divided-by-2 of the oscillation clock (HCLK).
  The PLL multiplication circuits stops in the mainclock mode.
- **CPU intermittent operation mode**
  The CPU intermittent operation mode is a mode for reducing power consumption by operating the CPU intermittently while external bus and peripheral functions are operated at a high-speed.
- **Hardware stand-by mode**
  The hardware standby mode is a mode for reducing power consumption by stopping clock supply (sleep mode) to the CPU by the low-power consumption control circuit, stopping clock supplies to the CPU and peripheral functions (timebase timer mode), and stopping oscillation clock (stop mode, hardware standby mode).
  Of these modes, modes other than the PLL clock mode are power consumption modes.

(1) Register Configuration

- Clock select register (CKSCR)

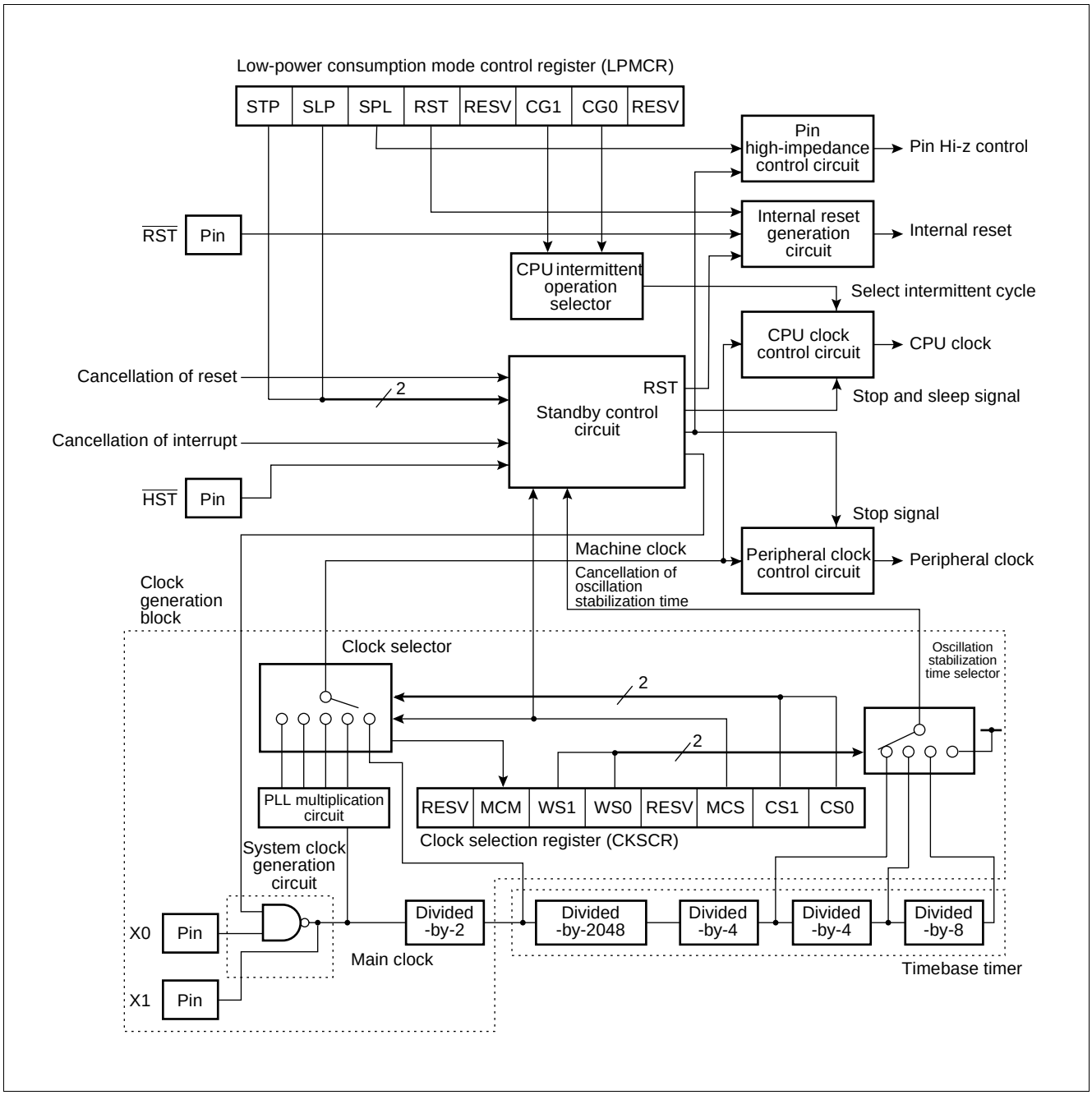
Address	bit 15	bit 14	bit 13	bit 12	bit 11	bit 10	bit 9	bit 8	bit 7 ····· bit 0	Initial value
0000A1H	RESV	MCM	WS1	WS0	RESV	MCS	CS1	CS0	(LPMCR)	11111100B
	R/W	R	R/W	R/W	R/W	R/W	W	R/W		

- Low-power consumption mode control register (LPMCR)

Address	bit 15 ····· bit 8	bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0	Initial value
0000A0H	(CKSCR)	STP	SLP	SPL	RST	RESV	CG1	CG0	RESV	00011000B
		W	W	R/W	W	R/W	R/W	R/W	R/W	

R/W: Readable and writable
R : Read only
W : Write only

(2) Block Diagram



■ ELECTRICAL CHARACTERISTICS

1. Absolute Maximum Ratings

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

Parameter	Symbol	Value		Unit	Remarks
		Min.	Max.		
Power supply voltage	V_{CC}	V_{SS} – 0.3	V_{SS} + 7.0	V	
	AV_{CC}	V_{SS} – 0.3	V_{SS} + 7.0	V	*1
	AVRH, AVRL	V_{SS} – 0.3	V_{SS} + 7.0	V	*1
Input voltage	V_I	V_{SS} – 0.3	V_{CC} + 0.3	V	*2
Output voltage	V_O	V_{SS} – 0.3	V_{CC} + 0.3	V	*2
“L” level maximum output current	I_{OL}	—	15	mA	*3
“L” level average output current	I_{OLAV}	—	4	mA	*4
“L” level total maximum output current	ΣI_{OL}	—	100	mA	
“L” level total average output current	ΣI_{OLAV}	—	50	mA	*5
“H” level maximum output current	I_{OH}	—	–15	mA	*3
“H” level average output current	I_{OHAV}	—	–4	mA	*4
“H” level total maximum output current	ΣI_{OH}	—	–100	mA	
“H” level total average output current	ΣI_{OHAV}	—	–50	mA	*5
Power consumption	P_D	—	400	mW	
Operating temperature	T_A	–40	+85	°C	
Storage temperature	Tstg	–55	+150	°C	

*1: AV_{CC}, AVRH, and AVRL shall never exceed V_{CC}. AVRL shall never exceed AVRH.
*2: V_I and V_O shall never exceed V_{CC} + 0.3 V.
*3: The maximum output current is a peak value for a corresponding pin.
*4: Average output current is an average current value observed for a 100 ms period for a corresponding pin.
*5: Total average current is an average current value observed for a 100 ms period for all corresponding pins.

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

2. Recommended Operating Conditions

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

Parameter	Symbol	Value		Unit	Remarks
		Min.	Max.		
Power supply voltage	V_{CC}	2.7	5.5	V	Normal operation
	V_{CC}	2.0	5.5	V	Retains status at the time of operation stop
Operating temperature	T_A	–40	+85	°C	

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

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

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

3. DC Characteristics

(AV_{CC} = V_{CC} = 2.7 V to 5.5 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40°C to +85°C)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
"H" level input voltage	V_{IH}	Pins other than V_{IHS} and V_{IHM}	—	0.7 V_{CC}	—	V_{CC} + 0.3	V	
	V_{IHS}	Hysteresis input pins P24 to P27, P40 to P47, P60 to P67, P70 to P77, P80, HST, RST		0.8 V_{CC}	—	V_{CC} + 0.3	V	MB90670 series
	V_{IHS}	Hysteresis input pins P24 to P27, P40 to P47, P60 to P67, P70 to P77, P80 to P86, HST, RST, P90, P91, PA0 to PA7, PB0 to PB2		0.8 V_{CC}	—	V_{CC} + 0.3	V	MB90675 series
	V_{IHM}	MD pin input		V_{CC} – 0.3	—	V_{CC} + 0.3	V	
"L" level input voltage	V_{IL}	Pins other than V_{ILS} and V_{ILM}		V_{SS} – 0.3	—	0.3 V_{CC}	V	
	V_{ILS}	Hysteresis input pins P24 to P27, P40 to P47, P60 to P67, P70 to P77, P80, HST, RST		V_{SS} – 0.3	—	0.2 V_{CC}	V	MB90670 series
	V_{ILS}	Hysteresis input pins P24 to P27, P40 to P47, P60 to P67, P70 to P77, P80 to P86, HST, RST, P90, P91, PA0 to PA7, PB0 to PB2		V_{SS} – 0.3	—	0.2 V_{CC}	V	MB90675 series
	V_{ILM}	MD pin input		V_{SS} – 0.3	—	V_{SS} + 0.3	V	
"H" level output voltage	V_{OH}	Other than P50 to P57	V_{CC} = 4.5 V, I_{OH} = –4.0 mA	V_{CC} – 0.5	—	—	V	
	V_{OH}	Other than P50 to P57	V_{CC} = 2.7 V, I_{OH} = –1.6 mA	V_{CC} – 0.3	—	—	V	
"L" level output voltage	V_{OL}	All output pins	V_{CC} = 4.5 V, I_{OL} = 4.0 mA	—	—	0.4	V	
	V_{OL}	All output pins	V_{CC} = 2.7 V, I_{OL} = 2.0 mA	—	—	0.4	V	
Open-drain output leakage current	I_{leak}	P50 to P57, P90, P91*1	—	—	0.1	10	µA	
Input leakage current	I_{IL}	Other than P50 to P57, P90 and P91	V_{CC} = 5.5 V, V_{SS} < V_I < V_{CC}	–10	—	10	µA	
Pull-up resistance	R	—	V_{CC} = 5.0 V	25	45	100	kΩ	
	R	—	V_{CC} = 3.0 V	40	95	200	kΩ	

(Continued)

(Continued)

(AV_{CC} = V_{CC} = 2.7 V to 5.5 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40°C to +85°C)

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Pull-down resistance	R	—	V_{CC} = 5.0 V	25	50	200	kΩ	
	R	—	V_{CC} = 3.0 V	40	100	400	kΩ	
Power supply current	I_{CC}	—	Internal operation at 16 MHz V_{CC} at 5.0 V	—	50	70	mA	Normal operation*2
	I_{CCS}	—	Internal operation at 16 MHz V_{CC} at 5.0 V	—	10	30	mA	In sleep mode*2
	I_{CC}	—	Internal operation at 8 MHz V_{CC} at 3.0 V	—	12	20	mA	Normal operation*2
	I_{CCS}	—	Internal operation at 8 MHz V_{CC} at 3.0 V	—	2.5	10	mA	In sleep mode*2
	I_{CCH}	—	T_A = +25°C	—	0.1	10	μA	In stop mode and hardware standby mode*2
Input capacitance	C_{IN}	Other than AV_{CC}, AV_{SS}, V_{CC}, V_{SS}	—	—	10	—	pF	

*1: Only MB90675 series has P90 and P91 pins.

*2: The current value is preliminary value and may be subject to change for enhanced characteristics without previous notice.

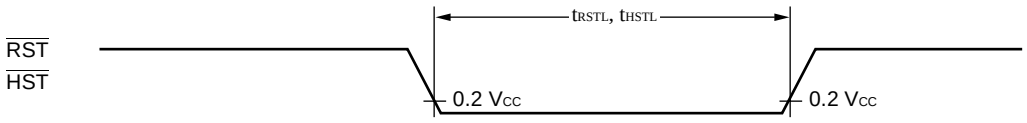
4. AC Characteristics

(1) Reset Input Timing, Hardware Standby Input Timing

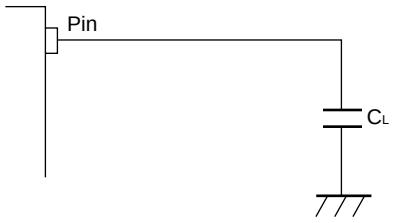
(AV_{CC} = V_{CC} = 2.7 V to 5.5 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40°C to +85°C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
Reset input time	t_{RSTL}	$\overline{RST}$	—	16 t_{CP}*	—	ns	
Hardware standby input time	t_{HSTL}	$\overline{HST}$		16 t_{CP}*	—	ns	

* : For t_{CP} (internal operating clock cycle time), refer to “(3) Clock Timings.”



- **Measurement conditions for AC ratings**



C_L is a load capacitance connected to a pin under test.

CLK, ALE: C_L = 30 pF
Address data bus (AD15 to AD00), $\overline{RD}$, $\overline{WR}$: C_L = 80 pF

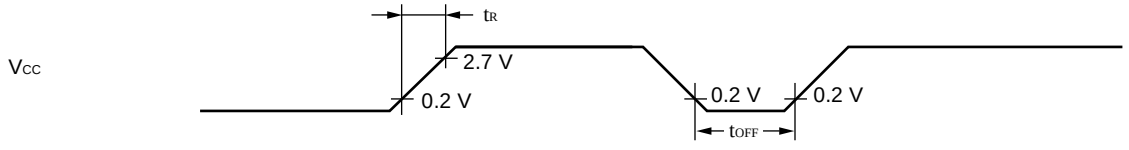
(2) Specification for Power-on Reset

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

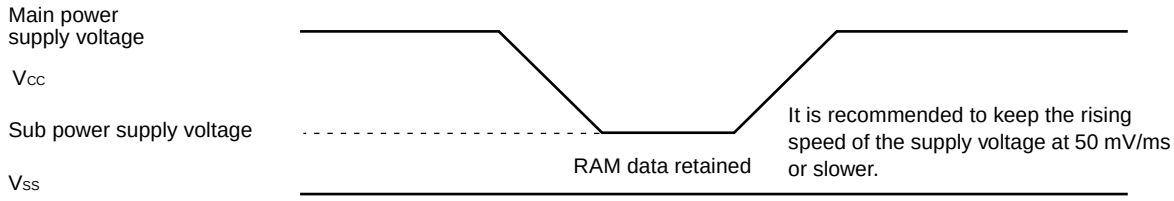
Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
Power supply rising time	t_R	V_{CC}	—	—	30	ms	*
Power supply cut-off time	t_{OFF}	V_{CC}		1	—	ms	Due to repeated operations

* : V_{CC} must be kept lower than 0.2 V before power-on.

Notes:
- The above ratings are values for causing a power-on reset.
- When $\overline{HST}$ is set to “L” level, apply power according to this table to cause a power-on reset irrespective of whether or not a power-on reset is required.
- For built-in resources in the device, re-apply power to the resources to cause a power-on reset.
- There are internal registers which can be initialized only by a power-on reset. Apply power according to this rating to ensure initialization of the registers.



Sudden changes in the power supply voltage may cause a power-on reset.
To change the power supply voltage while the device is in operation, it is recommended to raise the voltage smoothly to suppress fluctuations as shown below.



(3) Clock Timing

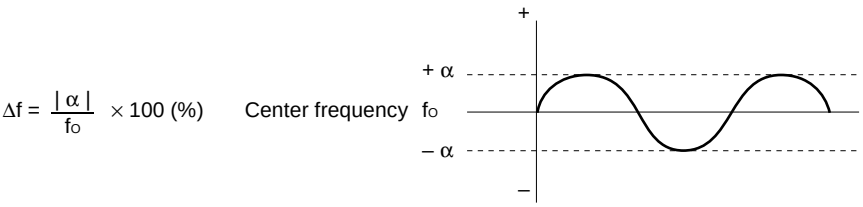
- **Operation at 5.0 V ± 10%**

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

Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Clock frequency	F_C	X0, X1	—	3	—	32	MHz	
Clock cycle time	t_C	X0, X1		31.25	—	333	ns	
Input clock pulse width	P_{WH}, P_{WL}	X0		10	—	—	ns	Recommended duty ratio of 30% to 70%
Input clock rising/falling time	t_{CR}, t_{CF}	X0		—	—	5	ns	
Internal operating clock frequency	f_{CP}	—		1.5	—	16	MHz	
Internal operating clock cycle time	t_{CP}	—		62.5	—	666	ns	
Frequency fluctuation rate locked	Δf	P37/CLK		—	—	3	%	*

* : The frequency fluctuation rate is the maximum deviation rate of the preset center frequency when the multiplied PLL signal is locked.

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



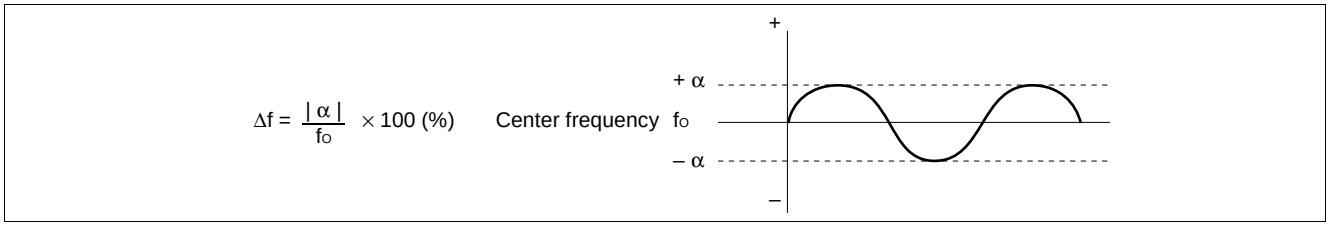
The PLL frequency deviation changes periodically from the preset frequency “(about CLK × (1CYC to 50 CYC)”, thus minimizing the chance of worst values to be repeated (errors are minimal and negligible for pulses with long intervals).

- **Operation at V_{CC} = 2.7 V (minimum value)**

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

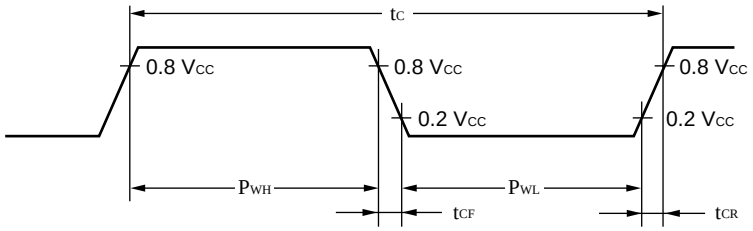
Parameter	Symbol	Pin name	Condition	Value			Unit	Remarks
				Min.	Typ.	Max.		
Clock frequency	F_C	X0, X1		3	—	16	MHz	
Clock cycle time	t_C	X0, X1		62.5	—	333	ns	
Input clock pulse width	P_{WH}, P_{WL}	X0		20	—	—	ns	Recommended duty ratio of 30% to 70%
Input clock rising/falling time	t_{CR}, t_{CF}	X0	—	—	—	5	ns	
Internal operating clock frequency	f_{CP}	—		1.5	—	8	MHz	
Internal operating clock cycle time	t_{CP}	—		125	—	666	ns	
Frequency fluctuation rate locked	Δf	P37/CLK		—	—	3	%	*

* : The frequency fluctuation rate is the maximum deviation rate of the preset center frequency when the multiplied PLL signal is locked.

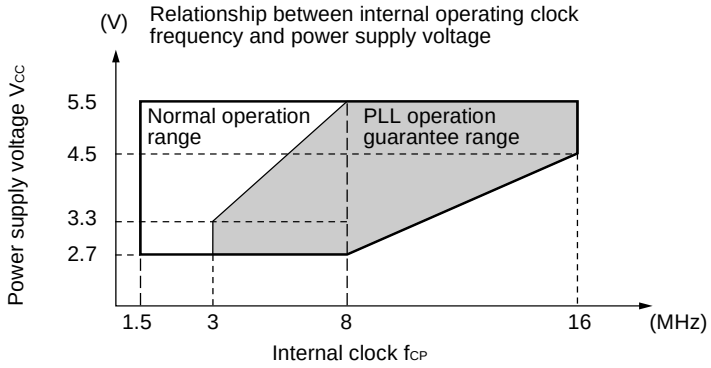


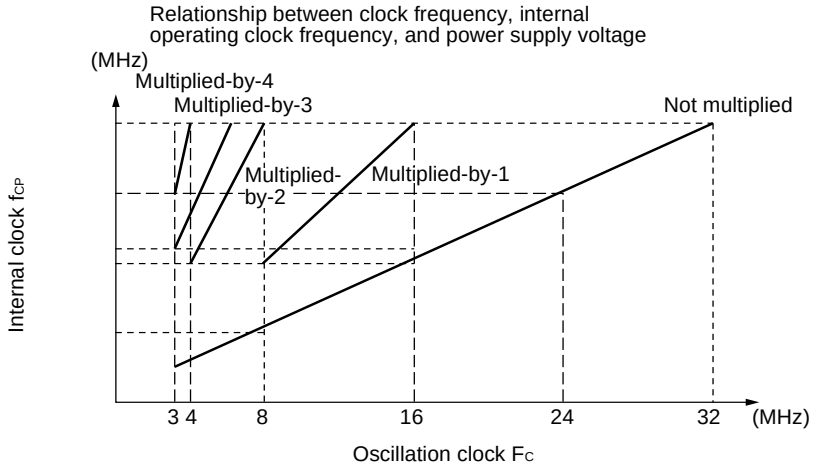
The PLL frequency deviation changes periodically from the preset frequency “(about CLK × (1CYC to 50 CYC)”, thus minimizing the chance of worst values to be repeated (errors are minimal and negligible for pulses with long intervals).

- **Clock timing**



- **PLL operation guarantee range**



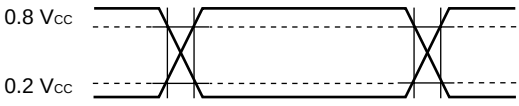


Note: The operation guarantee range on the lower voltage is 2.7 V for the evaluation chips.

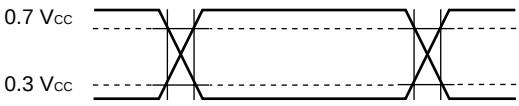
The AC ratings are measured for the following measurement reference voltages.

- **Input signal waveform**

Hystheresis input pin

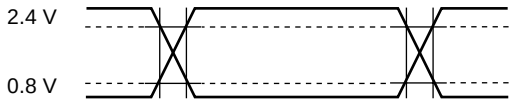


Pins other than hystheresis input/MD input



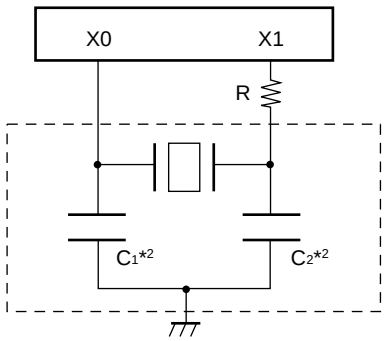
- **Output signal waveform**

Output pin



(4) Recommended Resonator Manufacturers

- **Sample application of piezoelectric resonator (FAR family)**

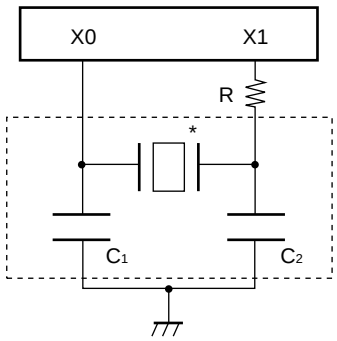


*1: Fujitsu Acoustic Resonator

FAR part number (built-in capacitor type)	Frequency (MHz)	Dumping resistor	Initial deviation of FAR frequency (T_A = +25°C)	Temperature characteristics of FAR frequency (T_A = –20°C to +60°C)	Loading capacitors*2
FAR-C4□C-2000-□20	2.00	510 Ω	±0.5%	±0.5%	Built-in
FAR-C4□A-4000-□01	4.00	—	±0.5%	±0.5%	Built-in
FAR-C4□B-4000-□02	4.00	—	±0.5%	±0.5%	Built-in
FAR-C4□B-4000-□00	4.00	—	±0.5%	±0.5%	Built-in
FAR-C4□B-8000-□02	8.00	—	±0.5%	±0.5%	Built-in
FAR-C4□B-12000-□02	12.00	—	±0.5%	±0.5%	Built-in
FAR-C4□B-16000-□02	16.00	—	±0.5%	±0.5%	Built-in
FAR-C4□B-20000-L14B	20.00	—	±0.5%	±0.5%	Built-in
FAR-C4□B-24000-L14A	24.00	—	±0.5%	±0.5%	Built-in

Inquiry: FUJITSU LIMITED

- **Sample application of ceramic resonator**



- **Mask ROM product**

Resonator manufacturer	Resonator	Frequency (MHz)	C_1 (pF)	C_2 (pF)	R
Kyocera Corporation	KBR-2.0MS	2.00	150	150	Not required
	PBRC-2.00A	2.00	150	150	Not required
	KBR-4.0MSA	4.00	33	33	680 Ω
	KBR-4.0MKS	4.00	Built-in	Built-in	680 Ω
	PBRC4.00A	4.00	33	33	680 Ω
	PBRC4.00B	4.00	Built-in	Built-in	680 Ω
	KBR-6.0MSA	6.00	33	33	Not required
	KBR-6.0MKS	6.00	Built-in	Built-in	Not required
	PBRC6.00A	6.00	33	33	Not required
	PBRC6.00B	6.00	Built-in	Built-in	Not required
	KBR-8.0M	8.00	33	33	560 Ω
	PBRC8.00A	8.00	33	33	Not required
	PBRC8.00B	8.00	Built-in	Built-in	Not required
	KBR-10.0M	10.00	33	33	330 Ω
	PBRC10.00B	10.00	Built-in	Built-in	680 Ω
	KBR-12.0M	12.00	33	33	330 Ω
	PBRC-12.00B	12.00	Built-in	Built-in	680 Ω
Murata Mfg. Co., Ltd.	CSA2.00MG040	2.00	100	100	Not required
	CST2.00MG040	2.00	Built-in	Built-in	Not required
	CSA4.00MG040	4.00	100	100	Not required
	CST4.00MGW040	4.00	Built-in	Built-in	Not required
	CSA6.00MG	6.00	30	30	Not required
	CST6.00MGW	6.00	Built-in	Built-in	Not required
	CSA8.00MTZ	8.00	30	30	Not required
	CST8.00MTW	8.00	Built-in	Built-in	Not required

(Continued)

(Continued)

Resonator manufacturer	Resonator	Frequency (MHz)	C_1 (pF)	C_2 (pF)	R
Murata Mfg. Co., Ltd.	CSA10.0MTZ	10.00	30	30	Not required
	CST10.0MTW	10.00	Built-in	Built-in	Not required
	CSA12.0MTZ	12.00	30	30	Not required
	CST12.0MTW	12.00	Built-in	Built-in	Not required
	CSA16.00MXZ040	16.00	15	15	Not required
	CST16.00MXW0C3	16.00	Built-in	Built-in	Not required
	CSA20.00MXZ040	20.00	10	10	Not required
	CSA24.00MXZ040	24.00	5	5	Not required
	CST24.00MXW0H1	24.00	Built-in	Built-in	Not required
	CSA32.00MXZ040	32.00	5	5	Not required
	CST32.00MXW040	32.00	Built-in	Built-in	Not required
TDK Corporation	FCR4.0MC5	4.00	Built-in	Built-in	Not required

- **One-time product**

Resonator manufacturer	Resonator	Frequency (MHz)	C_1 (pF)	C_2 (pF)	R
Murata Mfg. Co., Ltd.	CSTCS4.00MG0C5	4.0	Built-in	Built-in	Not required
	CST8.00MTW	8.00	Built-in	Built-in	Not required
	CSACS8.00MT	8.00	30	30	Not required
	CSA10.0MTZ	10.00	30	30	Not required
	CST10.0MTW	10.00	Built-in	Built-in	Not required
TDK Corporation	FCR4.0MC5	4.00	Built-in	Built-in	Not required

Inquiry: Kyocera Corporation

- AVX Corporation
  North American Sales Headquarters: TEL 1-803-448-9411
- AVX Limited
  European Sales Headquarters: TEL 44-1252-770000
- AVX/Kyocera H.K. Ltd.
  Asian Sales Headquarters: TEL 852-363-3303

Murata Mfg. Co., Ltd.

- Murata Electronics North America, Inc.: TEL 1-404-436-1300
- Murata Europe Management GmbH: TEL 49-911-66870
- Murata Electronics Singapore (Pte.) Ltd.: TEL 65-758-4233

TDK Corporation

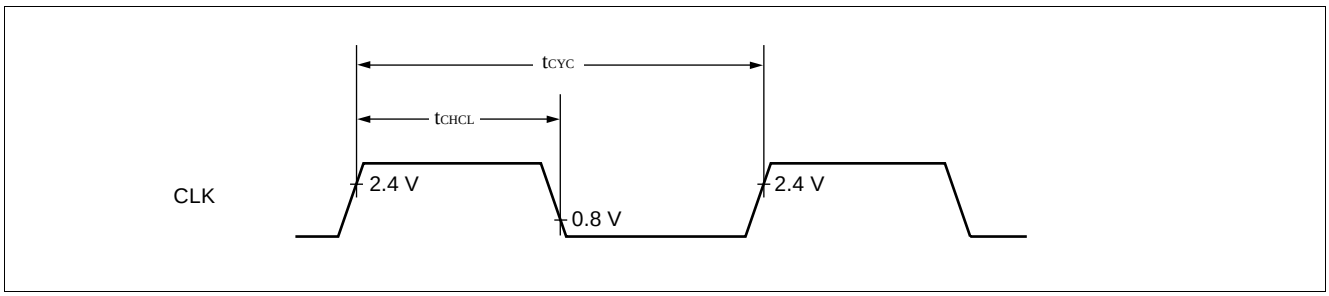
- TDK Corporation of America
  Chicago Regional Office: TEL 1-708-803-6100
- TDK Electronics Europe GmbH
  Components Division: TEL 49-2102-9450
- TDK Singapore (PTE) Ltd.: TEL 65-273-5022
- TDK Hongkong Co., Ltd.: TEL 852-736-2238
- Korea Branch, TDK Corporation: TEL 82-2-554-6633

(5) Clock Output Timing

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

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
Cycle time	t_{CYC}	CLK	—	1 t_{CP}*	—	ns	
CLK ↑ → CLK ↓	t_{CHCL}	CLK		1 t_{CP}*/2 – 20	1 t_{CP}*/2 + 20	ns	

* : For t_{CP} (internal operating clock cycle time), refer to “(3) Clock Timing”.

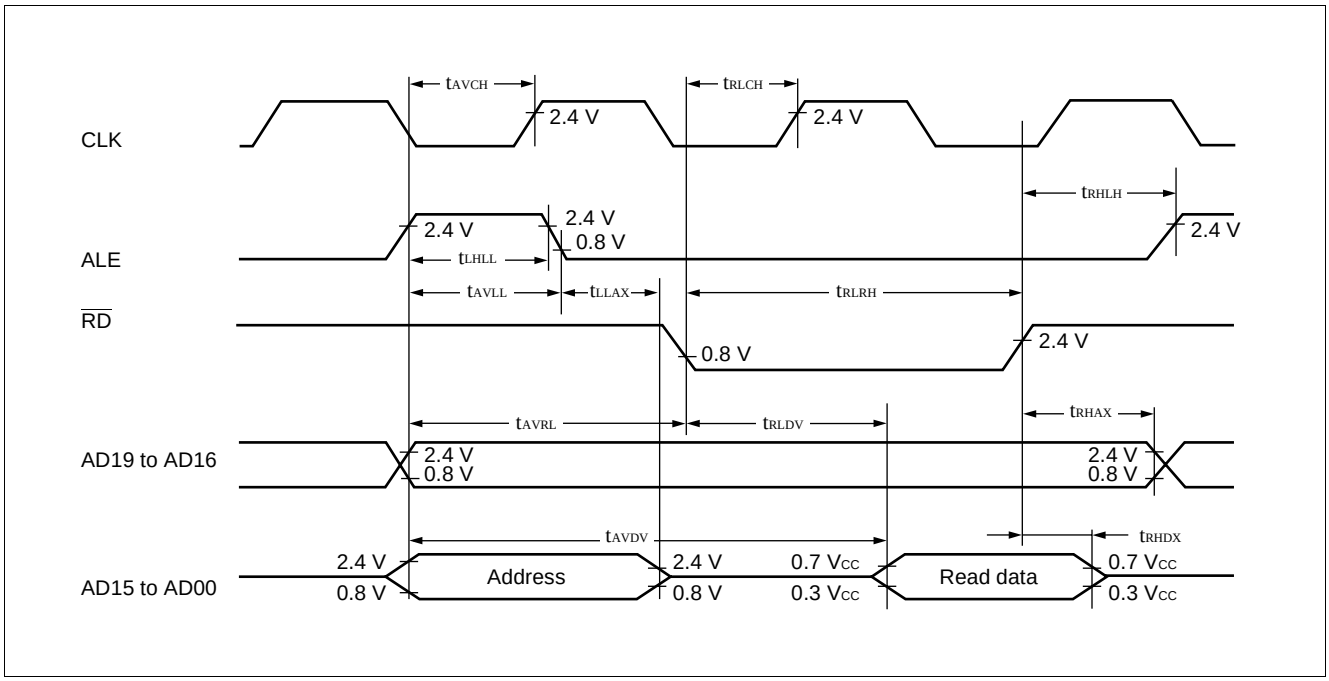


(6) Bus Read Timing

(AV_{CC} = V_{CC} = 2.7 V to 5.5 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40°C to +85°C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
ALE pulse width	t_{LHLL}	ALE	V_{CC} = 5.0 V ±10%	1 t_{CP}*/2 – 20	—	ns	
	t_{LHLL}	ALE	V_{CC} = 3.0 V ±10%	1 t_{CP}*/2 – 35	—	ns	
Effective address → ALE ↓ time	t_{AVLL}	AD15 to AD00	V_{CC} = 5.0 V ±10%	1 t_{CP}*/2 – 25	—	ns	
	t_{AVLL}	AD15 to AD00	V_{CC} = 3.0 V ±10%	1 t_{CP}*/2 – 40	—	ns	
ALE ↓ → address effective time	t_{LLAX}	AD15 to AD00	—	1 t_{CP}*/2 – 15	—	ns	
Effective address → $\overline{RD}$ ↓ time	t_{AVRL}	AD15 to AD00		1 t_{CP}* – 15	—	ns	
Effective address → read data time	t_{AVDV}	AD15 to AD00	V_{CC} = 5.0 V ±10%	—	5 t_{CP}*/2 – 60	ns	
	t_{AVDV}	AD15 to AD00	V_{CC} = 3.0 V ±10%	—	5 t_{CP}*/2 – 80	ns	
$\overline{RD}$ pulse width	t_{RLRH}	$\overline{RD}$	—	3 t_{CP}*/2 – 20	—	ns	
$\overline{RD}$ ↓ → read data time	t_{RLDV}	AD15 to AD00	V_{CC} = 5.0 V ±10%	—	3 t_{CP}*/2 – 60	ns	
	t_{RLDV}	AD15 to AD00	V_{CC} = 3.0 V ±10%	—	3 t_{CP}*/2 – 80	ns	
$\overline{RD}$ ↑ → data hold time	t_{RHDX}	AD15 to AD00	—	0	—	ns	
$\overline{RD}$ ↑ → ALE ↑ time	t_{RHLH}	$\overline{RD}$, ALE		1 t_{CP}*/2 – 15	—	ns	
$\overline{RD}$ ↑ → address disappear time	t_{RHAX}	$\overline{RD}$, A19 to A16		1 t_{CP}*/2 – 10	—	ns	
Effective address → CLK ↑ time	t_{AVCH}	CLK, A19 to A16		1 t_{CP}*/2 – 20	—	ns	
$\overline{RD}$ ↓ → CLK ↑ time	t_{RLCH}	$\overline{RD}$, CLK		1 t_{CP}*/2 – 20	—	ns	

* : For t_{CP} (internal operating clock cycle time), refer to “(3) Clock Timing”.

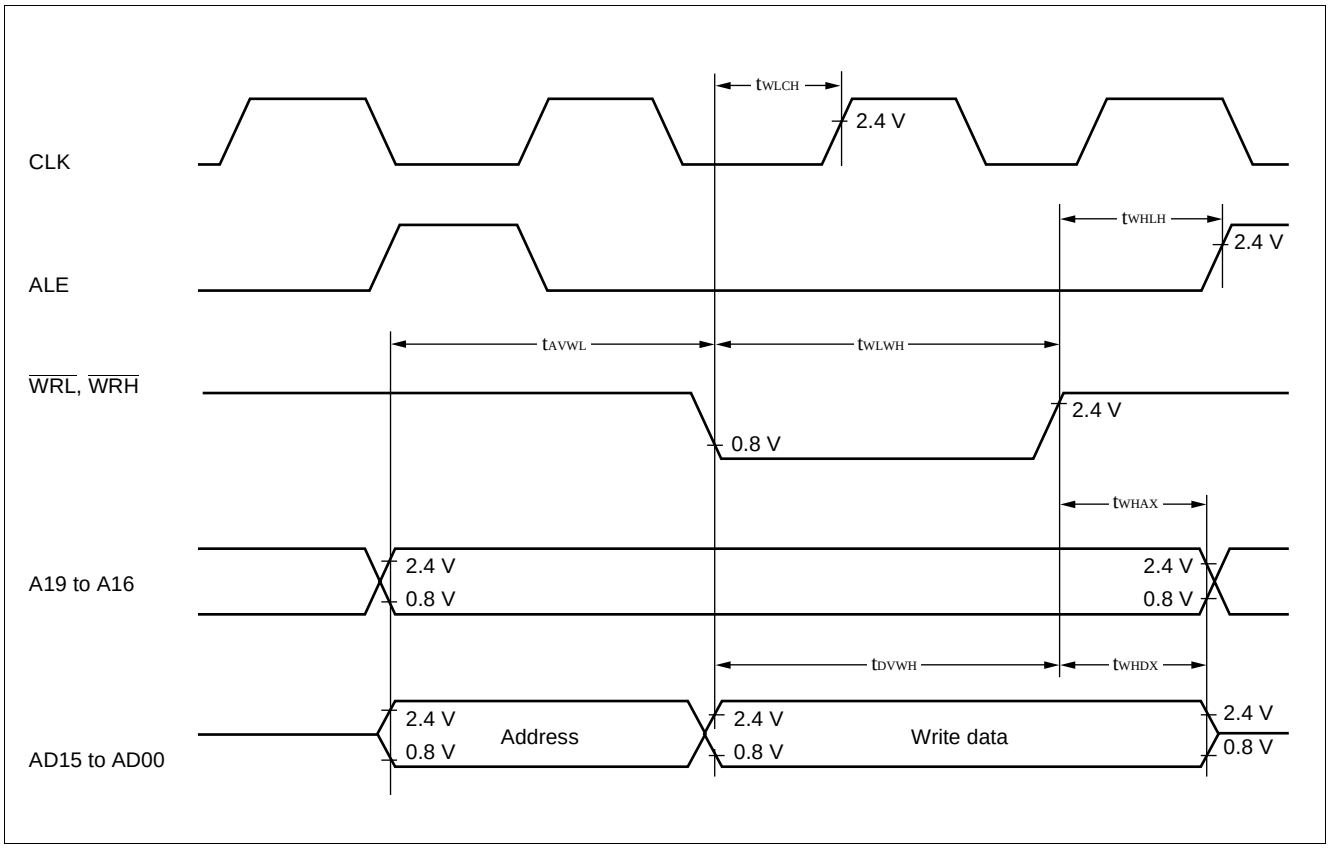

CLK
ALE
RD
AD19 to AD16
AD15 to AD00
tAVCH
tRLCH
tRHLH
tLHLL
tAVLL
tLLAX
tRLRH
tAVRL
tRLDV
tRHAX
tAVDV
tRHDX
2.4 V
0.8 V
Address
Read data
0.7 VCC
0.3 VCC

(7) Bus Write Timing

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

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
Effective address → $\overline{WR}$ ↓ time	t_{AVWL}	A19 to A00	—	1 t_{CP} – 15	—	ns	
$\overline{WR}$ pulse width	t_{WLWH}	$\overline{WR}$		3 t_{CP}*/2 – 20	—	ns	
Write data → $\overline{WR}$ ↑ time	t_{DVWH}	AD15 to AD00		3 t_{CP}*/2 – 20	—	ns	
$\overline{WR}$ ↑ → data hold time	t_{WHDX}	AD15 to AD00	V_{CC} = 5.0 V ±10%	20	—	ns	
	t_{WHDX}	AD15 to AD00	V_{CC} = 3.0 V ±10%	30	—	ns	
$\overline{WR}$ ↑ → address disappear time	t_{WHAX}	A19 to A00	—	1 t_{CP}*/2 – 10	—	ns	
$\overline{WR}$ ↑ → ALE ↑ time	t_{WHLH}	$\overline{WRL}$, ALE		1 t_{CP}*/2 – 15	—	ns	
$\overline{WR}$ ↓ → CLK ↑ time	t_{WLCH}	$\overline{WRH}$, CLK		1 t_{CP}*/2 – 20	—	ns	

* : For t_{CP} (internal operating clock cycle time), refer to “(3) Clock Timing”.

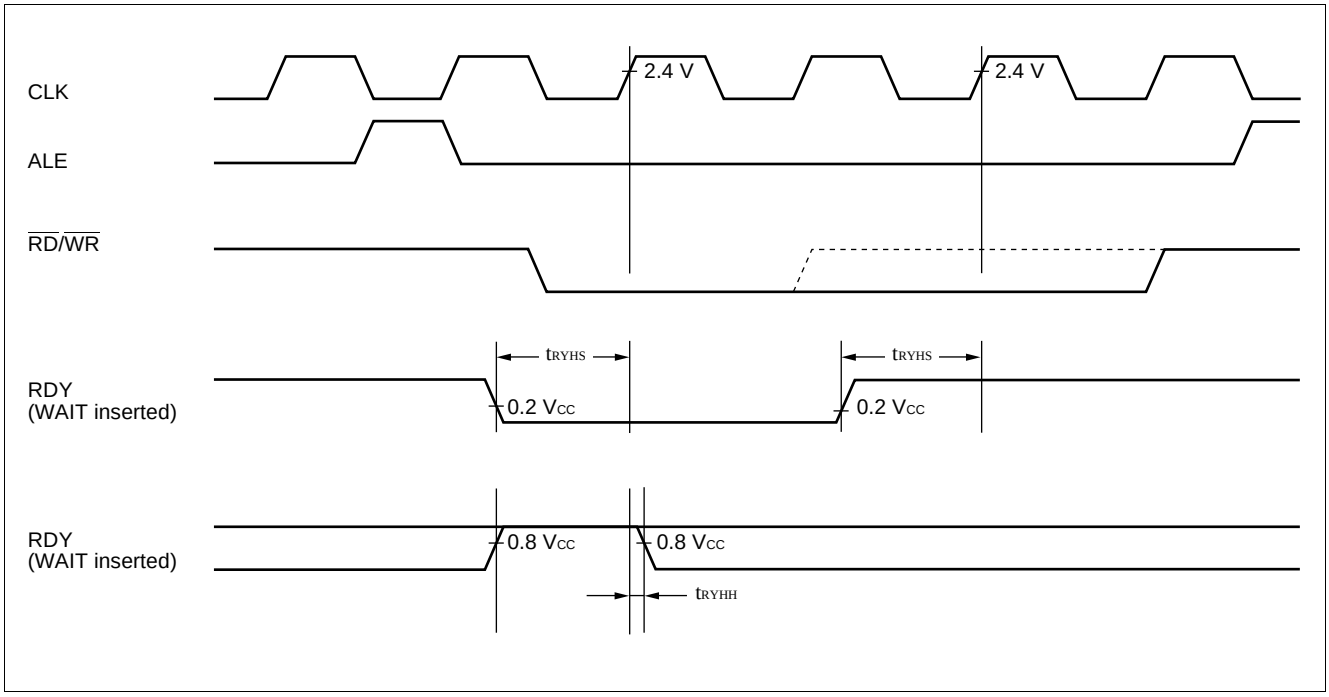


(8) Ready Input Timing

(AV_{CC} = V_{CC} = 2.7 V to 5.5 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40°C to +85°C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
RDY setup time	t_{RYHS}	RDY	V_{CC} = 5.0 V ±10%	45	—	ns	
	t_{RYHS}	RDY	V_{CC} = 3.0 V ±10%	70	—	ns	
RDY hold time	t_{RYHH}	RDY	—	0	—	ns	

Note: Use the auto-ready function when the setup time for the rising of the RDY signal is not sufficient.



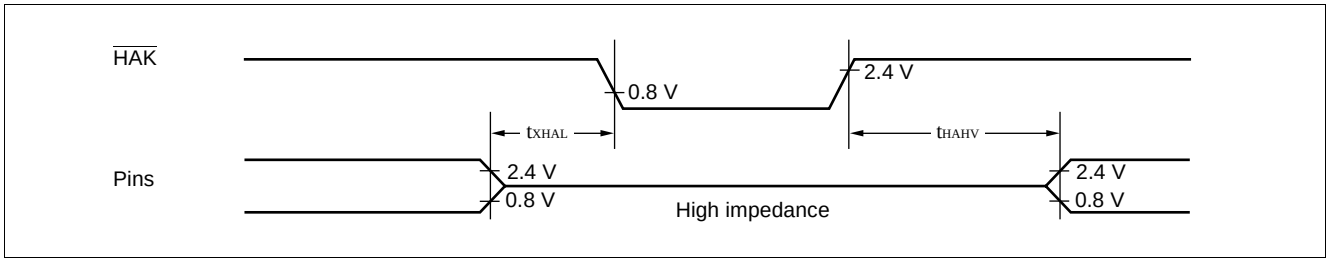
(9) Hold Timing

(AV_{CC} = V_{CC} = 2.7 V to 5.5 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40°C to +85°C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
Pins in floating status → $\overline{HAK}$ ↓ time	t_{XHAL}	$\overline{HAK}$	—	30	1 t_{CP}*	ns	
$\overline{HAK}$ ↑ → pin valid time	t_{HAHV}	$\overline{HAK}$		1 t_{CP}*	2 t_{CP}*	ns	

* : For t_{CP} (internal operating clock cycle time), refer to “(3) Clock Timing”.

Note: More than 1 machine cycle is needed before $\overline{HAK}$ changes after HRQ pin is fetched.



(10) UART0 Timing

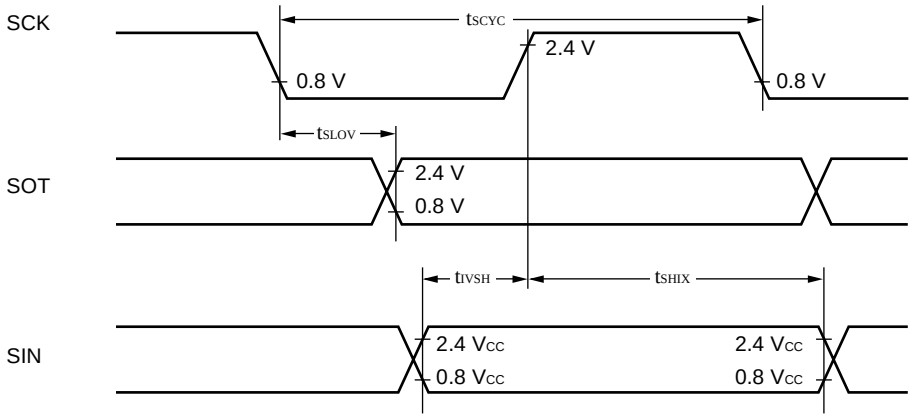
(AV_{CC} = V_{CC} = 5.0 V ±10%, AV_{SS} = V_{SS} = 0.0 V, T_A = –40°C to +85°C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
Serial clock cycle time	t_{SCYC}	—	—	8 t_{CP}*	—	ns	Internal shift clock mode C_L = 80 pF + 1 TTL for an output pin
SCK ↓ → SOT delay time	t_{SLOV}	—	V_{CC} = 5.0 V ±10%	– 80	80	ns	
	t_{SLOV}	—	V_{CC} = 3.0 V ±10%	– 120	120	ns	
Valid SIN → SCK ↑	t_{IVSH}	—	V_{CC} = 5.0 V ±10%	100	—	ns	
	t_{IVSH}	—	V_{CC} = 3.0 V ±10%	200	—	ns	
SCK ↑ → valid SIN hold time	t_{SHIX}	—	—	1 t_{CP}*	—	ns	
Serial clock “H” pulse width	t_{SHSL}	—		4 t_{CP}*	—	ns	External shift clock mode C_L = 80 pF + 1 TTL for an output pin
Serial clock “L” pulse width	t_{SLSH}	—		4 t_{CP}*	—	ns	
SCK ↓ → SOT delay time	t_{SLOV}	—	V_{CC} = 5.0 V ±10%	—	150	ns	
	t_{SLOV}	—	V_{CC} = 3.0 V ±10%	—	200	ns	
Valid SIN → SCK ↑	t_{IVSH}	—	V_{CC} = 5.0 V ±10%	60	—	ns	
	t_{IVSH}	—	V_{CC} = 3.0 V ±10%	120	—	ns	
SCK ↑ → valid SIN hold time	t_{SHIX}	—	V_{CC} = 5.0 V ±10%	60	—	ns	
	t_{SHIX}	—	V_{CC} = 3.0 V ±10%	120	—	ns	

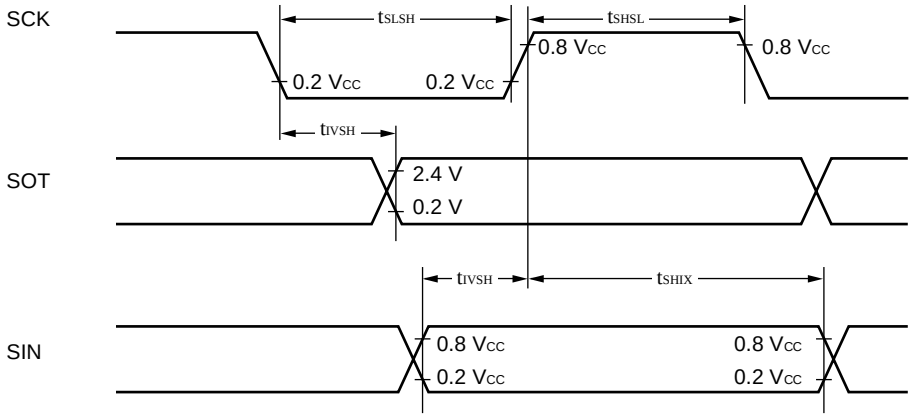
* : For t_{CP} (internal operating clock cycle time), refer to “(3) Clock Timing”.

Notes: • These are AC ratings in the CLK synchronous mode.
• C_L is the load capacitor connected to pins while testing.

- **Internal shift clock mode**



- **External shift clock mode**



(11) UART1 Timing

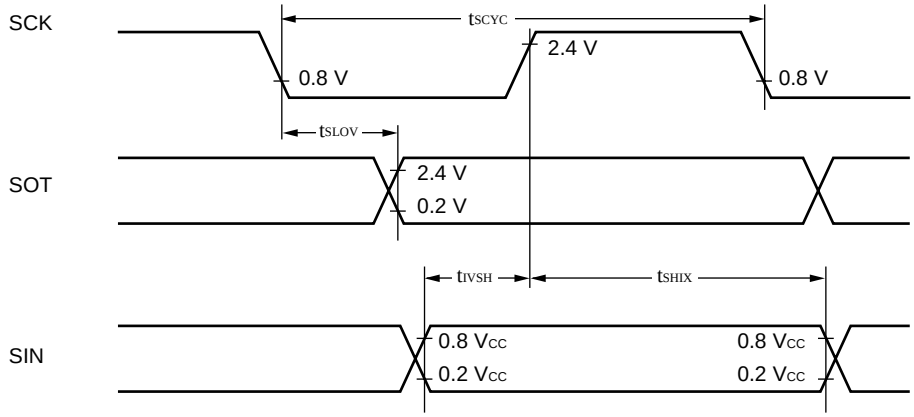
(AV_{CC} = V_{CC} = 5.0 V ±10%, AV_{SS} = V_{SS} = 0.0 V, T_A = –40°C to +85°C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
Serial clock cycle time	t_{SCYC}	—	—	8 t_{CP}*	—	ns	Internal shift clock mode C_L = 80 pF + 1 TTL for an output pin
SCK ↓ → SOT delay time	t_{SLOV}	—	V_{CC} = 5.0 V ±10%	– 80	80	ns	
	t_{SLOV}	—	V_{CC} = 3.0 V ±10%	– 120	120	ns	
Valid SIN → SCK ↑	t_{IVSH}	—	V_{CC} = 5.0 V ±10%	100	—	ns	
	t_{IVSH}	—	V_{CC} = 3.0 V ±10%	200	—	ns	
SCK ↑ → valid SIN hold time	t_{SHIX}	—	—	1 t_{CP}*	—	ns	
Serial clock “H” pulse width	t_{SHSL}	—		4 t_{CP}*	—	ns	External shift clock mode C_L = 80 pF + 1 TTL for an output pin
Serial clock “L” pulse width	t_{SLSH}	—		4 t_{CP}*	—	ns	
SCK ↓ → SOT delay time	t_{SLOV}	—	V_{CC} = 5.0 V ±10%	—	150	ns	
	t_{SLOV}	—	V_{CC} = 3.0 V ±10%	—	200	ns	
Valid SIN → SCK ↑	t_{IVSH}	—	V_{CC} = 5.0 V ±10%	60	—	ns	
	t_{IVSH}	—	V_{CC} = 3.0 V ±10%	120	—	ns	
SCK ↑ → valid SIN hold time	t_{SHIX}	—	V_{CC} = 5.0 V ±10%	60	—	ns	
	t_{SHIX}	—	V_{CC} = 3.0 V ±10%	120	—	ns	

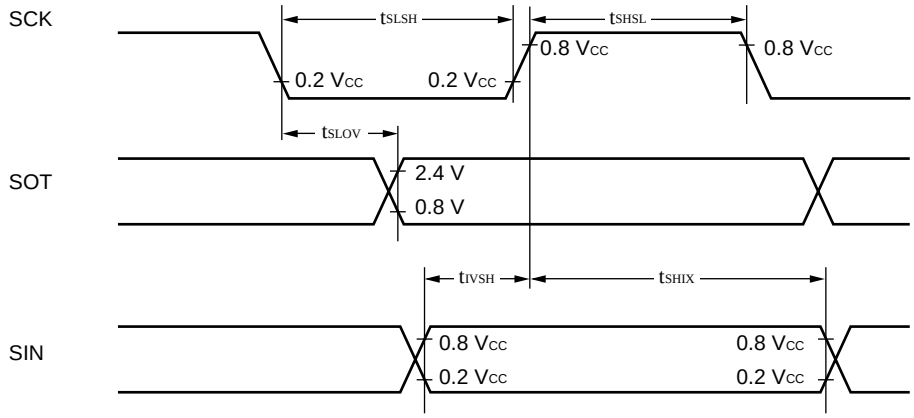
* : For t_{CP} (internal operating clock cycle time), refer to “(3) Clock Timing”.

Notes: • These are AC ratings in the CLK synchronous mode.
• C_L is the load capacitor connected to pins while testing.

- **Internal shift clock mode**



- **External shift clock mode**

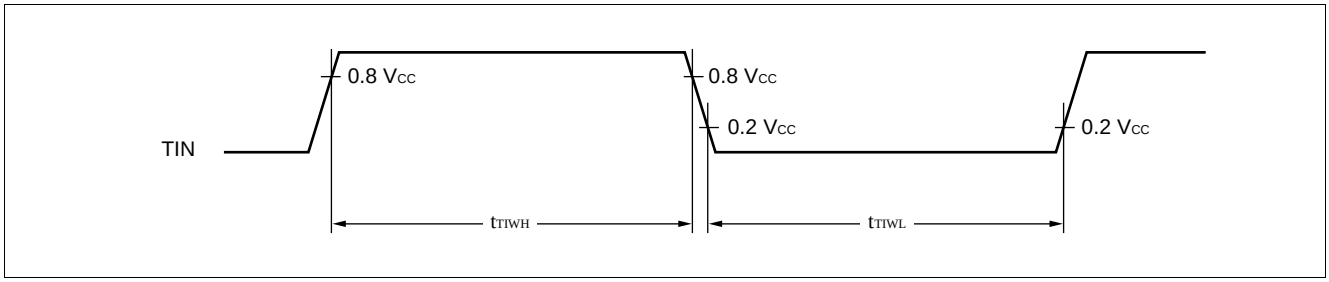


(12) Timer Input Timing

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

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
Input pulse width	t_{TIWH}, t_{TIWL}	TIN0, TON1	—	4 t_{CP}*	—	ns	

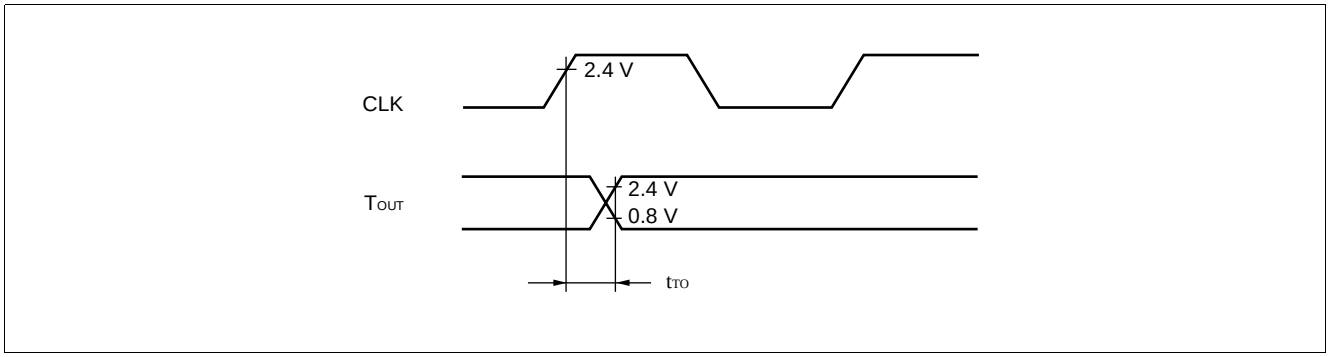
* : For t_{CP} (internal operating clock cycle time), refer to “(3) Clock Timing”.



(13) Timer Output Timing

(AV_{CC} = V_{CC} = 2.7 V to 5.5 V, AV_{SS} = V_{SS} = 0.0 V, T_A = –40°C to +85°C)

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
CLK ↑ → T_{OUT} transition time	t_{TO}	TOT0, TOT1	V_{CC} = 5.0 V ±10%	30	—	ns	
	t_{TO}	TOT0, TOT1	V_{CC} = 3.0 V ±10%	80	—	ns	

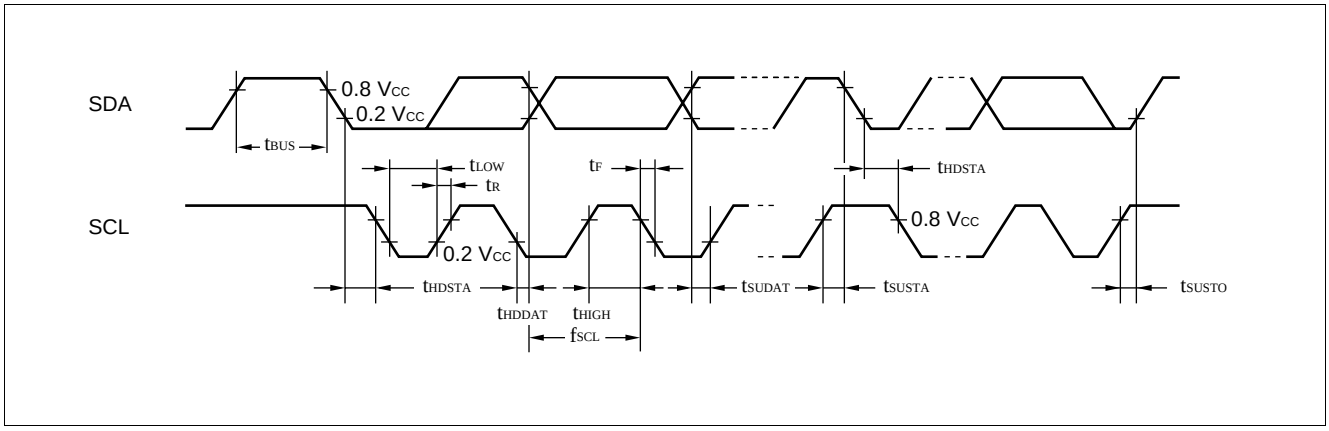


(14) I²C Timing

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

Parameter	Symbol	Pin name	Condition	Value		Unit	Remarks
				Min.	Max.		
SCL clock frequency	f_{SCL}	—	—	0	100	kHz	
Bus free time between stop and start conditions	t_{BUS}	—		4.7	—	µs	
Hold time (re-transmission) start	t_{HDSTA}	—		4.0	—	µs	The first clock pulse is generated after this period.
LOW status hold time of SCL clock	t_{LOW}	—		4.7	—	µs	
HIGH status hold time of SCL clock	t_{HIGH}	—		4.0	—	µs	
Setup time for conditions for starting re-transmission	t_{SUSTA}	—		4.7	—	µs	
Data hold time	t_{HDDAT}	—		0	—	µs	
Data setup time	t_{SUDAT}	—		250	—	ns	
Rising time of SDA and SCL signals	t_R	—		—	1000	ns	
Falling time of SDA and SCL signals	t_F	—		—	300	ns	
Setup time for stop conditions	t_{SUSTO}	—		4.0	—	µs	

Note: Only MB90675 series has I²C.



5. A/D Converter Electrical Characteristics

(AV_{CC} = V_{CC} = 2.7 V to 5.5 V, AV_{SS} = V_{SS} = 0.0 V, 2.7 V ≦ AVRH – AVRL, T_A = –40°C to +85°C)

Parameter	Symbol	Pin name	Condition	Value			Unit
				Min.	Typ.	Max.	
Resolution	—	—	—	—	—	10	bit
Total error	—	—		—	—	±3.0	LSB
Linearity error	—	—		—	—	±2.0	LSB
Differential linearity error	—	—		—	—	±1.5	LSB
Zero transition voltage	V_{OT}	AN0 to AN7		AVRL – 1.5 LSB	AVRL + 0.5 LSB	AVRL + 2.5 LSB	mV
Full-scale transition voltage	V_{FST}	AN0 to AN7		AVRH – 4.5 LSB	AVRH – 1.5 LSB	AVRH + 0.5 LSB	mV
Conversion time	—	—	V_{CC} = 5.0 V ±10% at machine clock of 16 MHz	6.125	—	—	µs
	—	—	V_{CC} = 3.0 V ±10% at machine clock of 8 MHz	12.25	—	—	µs
Analog port input current	I_{AIN}	AN0 to AN7	—	—	0.1	10	µA
Analog input voltage	V_{AIN}	AN0 to AN7		AVRL	—	AVRH	V
Reference voltage	—	AVRH		AVRL – 2.7	—	AV_{CC}	V
	—	AVRL		0	—	AVRH – 2.7	V
Power supply current	I_A	AV_{CC}		—	3	—	mA
	I_{AH}	AV_{CC}	Supply current when CPU stopped and A/D converter not in operation (V_{CC} = AV_{CC} = AVRH = 5.0 V)	—	—	5	µA
Reference voltage supply current	I_R	AVRH	—	—	200	—	µA
	I_{RH}	AVRH	Supply current when CPU stopped and A/D converter not in operation (V_{CC} = AV_{CC} = AVRH = 5.0 V)	—	—	5	µA
Offset between channels	—	AN0 to AN7	—	—	—	4	LSB

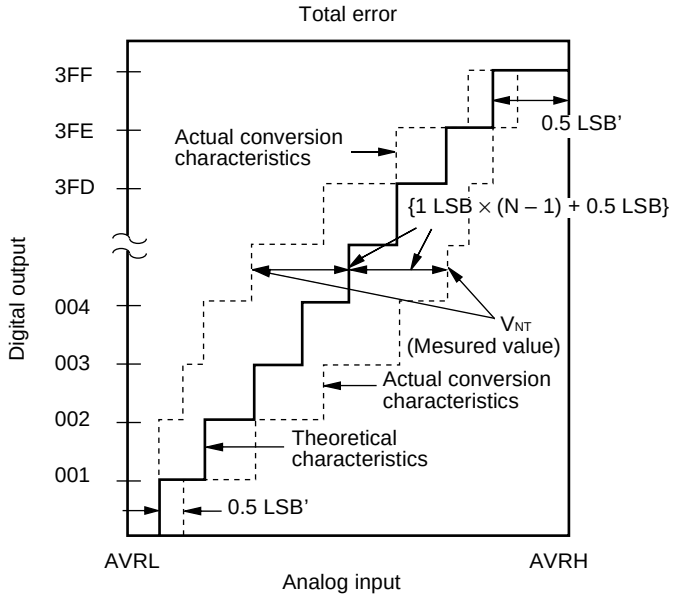
6. A/D Converter Glossary

Resolution: Analog changes that are identifiable with the A/D converter

Linearity error: The deviation of the straight line connecting the zero transition point (“00 0000 0000” ↔ “00 0000 0001”) with the full-scale transition point (“11 1111 1110” ↔ “11 1111 1111”) from actual conversion characteristics

Differential linearity error: The deviation of input voltage needed to change the output code by 1 LSB from the theoretical value

Total error: The total error is defined as a difference between the actual value and the theoretical value, which includes zero-transition error/full-scale transition error and linearity error.



1 LSB’ = (Theoretical value) $\frac{AVRH - AVRL}{1024}$ [V]

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

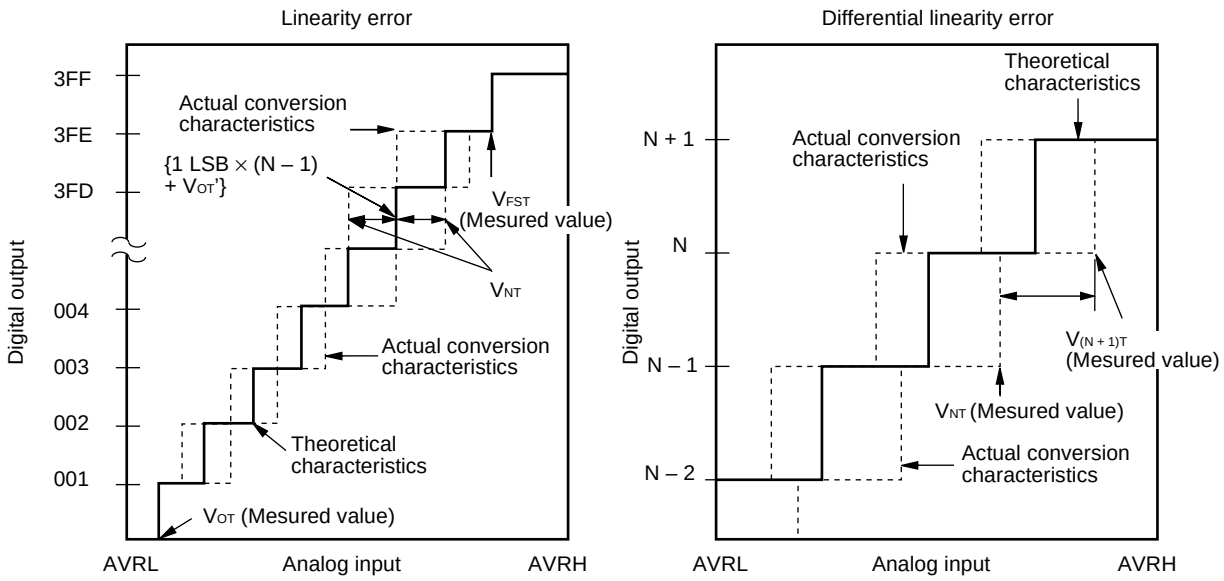
V_{OT}’ (Theoretical value) = AVRL + 0.5 LSB’ [V]

V_{NT}: Voltage at a transition of digital output from (N – 1) to N

V_{FST}’ (Theoretical value) = AVRH – 1.5 LSB’ [V]

(Continued)

(Continued)



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

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

$$1\ \text{LSB} = \frac{\text{AVRH} - \text{AVRL}}{1022}\ [\text{V}]$$

V_{OT}: Voltage at transition of digital output from "000_H" to "001_H"
V_{FST}: Voltage at transition of digital output from "$3FE_H$" to "$3FF_H$"

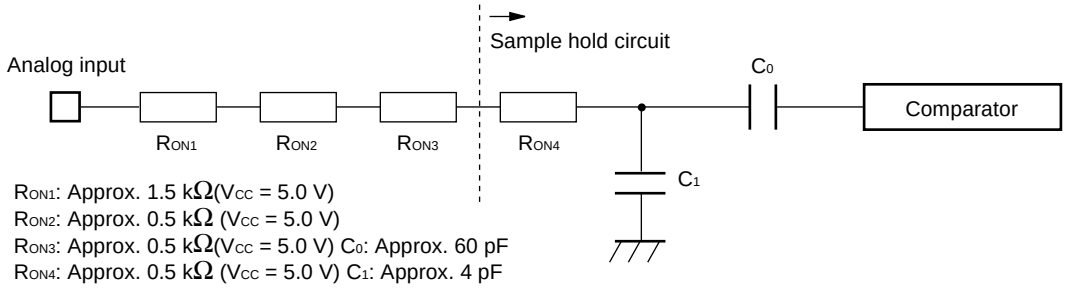
7. Notes on Using A/D Converter

Select the output impedance value for the external circuit of analog input according to the following conditions. Output impedance values of the external circuit of 7 kΩ or lower are recommended.

When capacitors are connected to external pins, the capacitance of several thousand times the internal capacitor value is recommended to minimized the effect of voltage distribution between the external capacitor and internal capacitor.

When the output impedance of the external circuit is too high, the sampling time for analog voltages may not be sufficient (sampling time = 3.75 µs @machine clock of 16 MHz).

- **Block diagram of analog input circuit model**



R_{ON1}: Approx. 1.5 kΩ(V_{CC} = 5.0 V)
R_{ON2}: Approx. 0.5 kΩ (V_{CC} = 5.0 V)
R_{ON3}: Approx. 0.5 kΩ(V_{CC} = 5.0 V) C_0: Approx. 60 pF
R_{ON4}: Approx. 0.5 kΩ (V_{CC} = 5.0 V) C_1: Approx. 4 pF

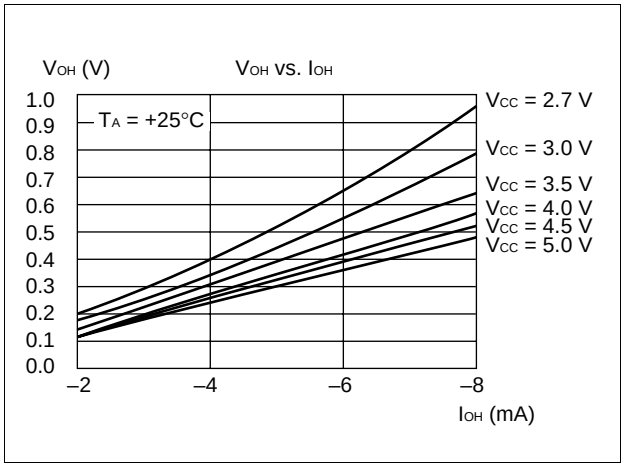
Note: Listed values must be considered as standards.

- **Error**

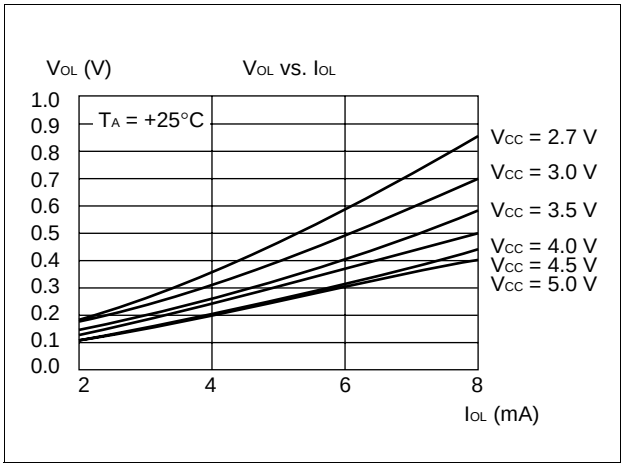
The smaller the | AVRH – AVRL |, the greater the error would become relatively.

■ EXAMPLE CHARACTERISTICS

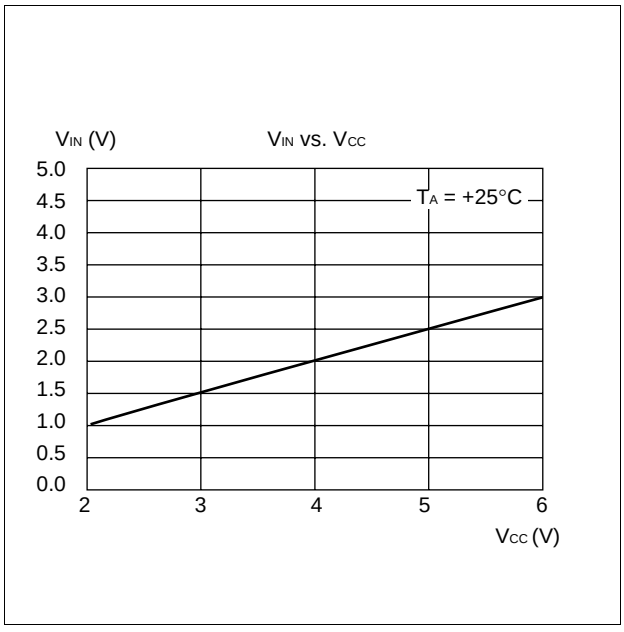
(1) “H” Level Output Voltage



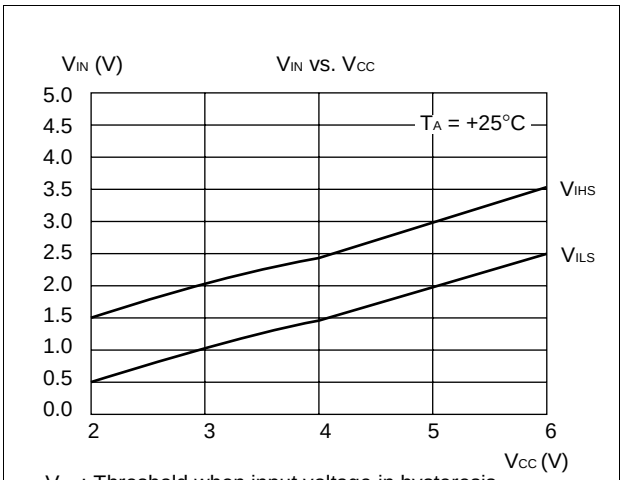
(2) “L” Level Output Voltage



(3) “H” Level Input Voltage/“L” Level Input Voltage (CMOS Input)



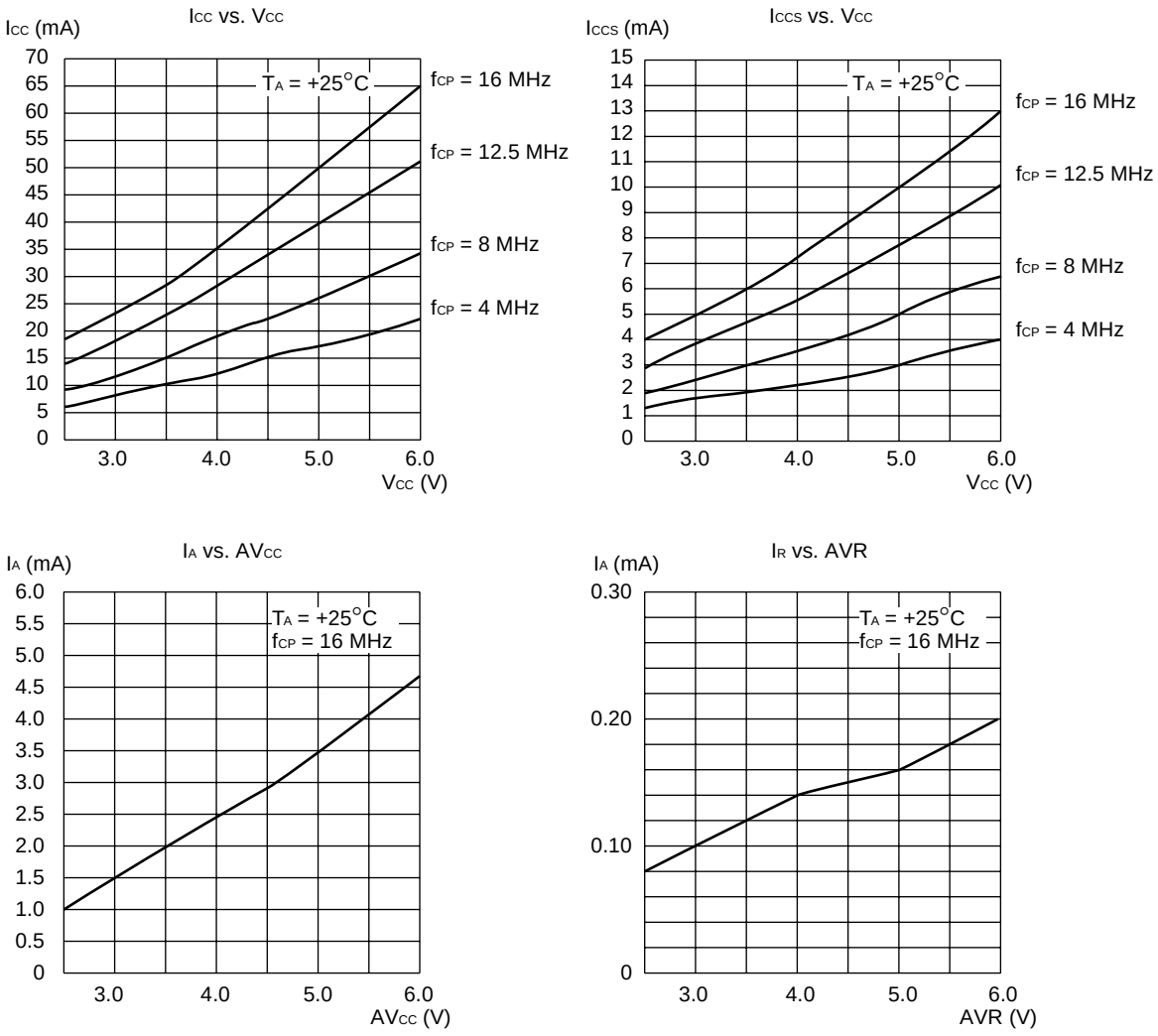
(4) “H” Level Input Voltage/“L” Level Input Voltage (Hysteresis Input)



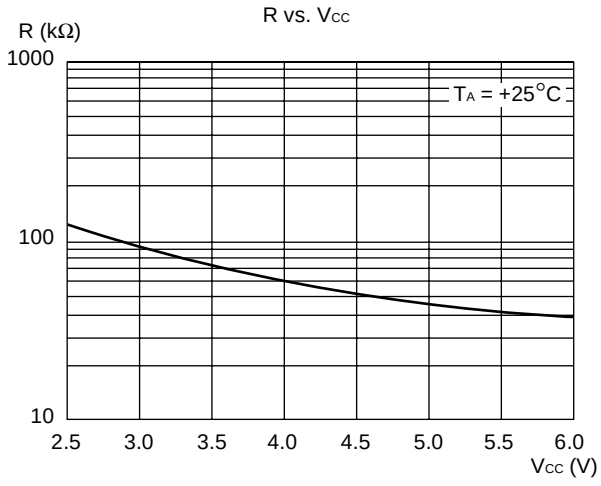
VIHS: Threshold when input voltage in hysteresis characteristics is set to “H” level

VILS: Threshold when input voltage in hysteresis characteristics is set to “L” level

(5) Power Supply Current (f_{CP} = Internal Operating Clock Frequency)



(6) Pull-up Resistance



■ INSTRUCTIONS (340 INSTRUCTIONS)

Table 1 Explanation of Items in Tables of Instructions

Item	Meaning
Mnemonic	Upper-case letters and symbols: Represented as they appear in assembler. Lower-case letters: Replaced when described in assembler. Numbers after lower-case letters: Indicate the bit width within the instruction.
#	Indicates the number of bytes.
~	Indicates the number of cycles. m : When branching n : When not branching See Table 4 for details about meanings of other letters in items.
RG	Indicates the number of accesses to the register during execution of the instruction. It is used calculate a correction value for intermittent operation of CPU.
B	Indicates the correction value for calculating the number of actual cycles during execution of the instruction. (Table 5) The number of actual cycles during execution of the instruction is the correction value summed with the value in the “~” column.
Operation	Indicates the operation of instruction.
LH	Indicates special operations involving the upper 8 bits of the lower 16 bits of the accumulator. Z : Transfers “0”. X : Extends with a sign before transferring. – : Transfers nothing.
AH	Indicates special operations involving the upper 16 bits in the accumulator. * : Transfers from AL to AH. – : No transfer. Z : Transfers 00_H to AH. X : Transfers 00_H or FF_H to AH by signing and extending AL.
I	Indicates the status of each of the following flags: I (interrupt enable), S (stack), T (sticky bit), N (negative), Z (zero), V (overflow), and C (carry). * : Changes due to execution of instruction. – : No change. S : Set by execution of instruction. R : Reset by execution of instruction.
S	
T	
N	
Z	
V	
C	
RMW	Indicates whether the instruction is a read-modify-write instruction. (a single instruction that reads data from memory, etc., processes the data, and then writes the result to memory.) * : Instruction is a read-modify-write instruction. – : Instruction is not a read-modify-write instruction. Note: A read-modify-write instruction cannot be used on addresses that have different meanings depending on whether they are read or written.

Table 2 Explanation of Symbols in Tables of Instructions

Symbol	Meaning
A	32-bit accumulator The bit length varies according to the instruction. Byte : Lower 8 bits of AL Word : 16 bits of AL Long : 32 bits of AL:AH
AH AL	Upper 16 bits of A Lower 16 bits of A
SP	Stack pointer (USP or SSP)
PC	Program counter
PCB	Program bank register
DTB	Data bank register
ADB	Additional data bank register
SSB	System stack bank register
USB	User stack bank register
SPB	Current stack bank register (SSB or USB)
DPR	Direct page register
brg1	DTB, ADB, SSB, USB, DPR, PCB, SPB
brg2	DTB, ADB, SSB, USB, DPR, SPB
Ri	R0, R1, R2, R3, R4, R5, R6, R7
RWi	RW0, RW1, RW2, RW3, RW4, RW5, RW6, RW7
RWj	RW0, RW1, RW2, RW3
RLi	RL0, RL1, RL2, RL3
dir	Compact direct addressing
addr16 addr24 ad24 0 to 15 ad24 16 to 23	Direct addressing Physical direct addressing Bit 0 to bit 15 of addr24 Bit 16 to bit 23 of addr24
io	I/O area (000000H to 0000FFH)
imm4 imm8 imm16 imm32 ext (imm8)	4-bit immediate data 8-bit immediate data 16-bit immediate data 32-bit immediate data 16-bit data signed and extended from 8-bit immediate data
disp8 disp16	8-bit displacement 16-bit displacement
bp	Bit offset
vct4 vct8	Vector number (0 to 15) Vector number (0 to 255)
( )b	Bit address

(Continued)

(Continued)

Symbol	Meaning
rel	Branch specification relative to PC
ear eam	Effective addressing (codes 00 to 07) Effective addressing (codes 08 to 1F)
rlst	Register list

Table 3 Effective Address Fields

Code	Notation	Address format	Number of bytes in address extension *
00 01 02 03 04 05 06 07	R0 RW0 RL0 R1 RW1 (RL0) R2 RW2 RL1 R3 RW3 (RL1) R4 RW4 RL2 R5 RW5 (RL2) R6 RW6 RL3 R7 RW7 (RL3)	Register direct “ea” corresponds to byte, word, and long-word types, starting from the left	—
08 09 0A 0B	@RW0 @RW1 @RW2 @RW3	Register indirect	0
0C 0D 0E 0F	@RW0 + @RW1 + @RW2 + @RW3 +	Register indirect with post-increment	0
10 11 12 13 14 15 16 17	@RW0 + disp8 @RW1 + disp8 @RW2 + disp8 @RW3 + disp8 @RW4 + disp8 @RW5 + disp8 @RW6 + disp8 @RW7 + disp8	Register indirect with 8-bit displacement	1
18 19 1A 1B	@RW0 + disp16 @RW1 + disp16 @RW2 + disp16 @RW3 + disp16	Register indirect with 16-bit displacement	2
1C 1D 1E 1F	@RW0 + RW7 @RW1 + RW7 @PC + disp16 addr16	Register indirect with index Register indirect with index PC indirect with 16-bit displacement Direct address	0 0 2 2

Note: The number of bytes in the address extension is indicated by the “+” symbol in the “#” (number of bytes) column in the tables of instructions.

Table 4 Number of Execution Cycles for Each Type of Addressing

Code	Operand	(a) Number of execution cycles for each type of addressing	Number of register accesses for each type of addressing
00 to 07	Ri RWi RLi	Listed in tables of instructions	Listed in tables of instructions
08 to 0B	@RWj	2	1
0C to 0F	@RWj +	4	2
10 to 17	@RWi + disp8	2	1
18 to 1B	@RWj + disp16	2	1
1C 1D 1E 1F	@RW0 + RW7 @RW1 + RW7 @PC + disp16 addr16	4 4 2 1	2 2 0 0

Note: “(a)” is used in the “~” (number of states) column and column B (correction value) in the tables of instructions.

Table 5 Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles

Operand	(b) byte		(c) word		(d) long	
	Number of cycles	Number of access	Number of cycles	Number of access	Number of cycles	Number of access
Internal register	+0	1	+0	1	+0	2
Internal memory even address Internal memory odd address	+0 +0	1 1	+0 +2	1 2	+0 +4	2 4
Even address on external data bus (16 bits) Odd address on external data bus (16 bits)	+1 +1	1 1	+1 +4	1 2	+2 +8	2 4
External data bus (8 bits)	+1	1	+4	2	+8	4

Notes:
- “(b)”, “(c)”, and “(d)” are used in the “~” (number of states) column and column B (correction value) in the tables of instructions.
- When the external data bus is used, it is necessary to add in the number of wait cycles used for ready input and automatic ready.

Table 6 Correction Values for Number of Cycles Used to Calculate Number of Program Fetch Cycles

Instruction	Byte boundary	Word boundary
Internal memory	—	+2
External data bus (16 bits)	—	+3
External data bus (8 bits)	+3	—

Notes:
- When the external data bus is used, it is necessary to add in the number of wait cycles used for ready input and automatic ready.
- Because instruction execution is not slowed down by all program fetches in actuality, these correction values should be used for “worst case” calculations.

Table 7 Transfer Instructions (Byte) [41 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
MOV A, dir	2	3	0	(b)	byte (A) ← (dir)	Z	*	–	–	–	*	*	–	–	–
MOV A, addr16	3	4	0	(b)	byte (A) ← (addr16)	Z	*	–	–	–	*	*	–	–	–
MOV A, Ri	1	2	1	0	byte (A) ← (Ri)	Z	*	–	–	–	*	*	–	–	–
MOV A, ear	2	2	1	0	byte (A) ← (ear)	Z	*	–	–	–	*	*	–	–	–
MOV A, eam	2+	3+ (a)	0	(b)	byte (A) ← (eam)	Z	*	–	–	–	*	*	–	–	–
MOV A, io	2	3	0	(b)	byte (A) ← (io)	Z	*	–	–	–	*	*	–	–	–
MOV A, #imm8	2	2	0	0	byte (A) ← imm8	Z	*	–	–	–	*	*	–	–	–
MOV A, @A	2	3	0	(b)	byte (A) ← ((A))	Z	–	–	–	–	*	*	–	–	–
MOV A, @RLi+disp8	3	10	2	(b)	byte (A) ←	Z	*	–	–	–	*	*	–	–	–
MOVN A, #imm4	1	1	0	0	((RLi)+disp8) byte (A) ← imm4	Z	*	–	–	–	R	*	–	–	–
MOVX A, dir	2	3	0	(b)		X	*	–	–	–	*	*	–	–	–
MOVX A, addr16	3	4	0	(b)	byte (A) ← (dir)	X	*	–	–	–	*	*	–	–	–
MOVX A, Ri	2	2	1	0	byte (A) ← (addr16)	X	*	–	–	–	*	*	–	–	–
MOVX A, ear	2	2	1	0	byte (A) ← (Ri)	X	*	–	–	–	*	*	–	–	–
MOVX A, eam	2+	3+ (a)	0	(b)	byte (A) ← (ear)	X	*	–	–	–	*	*	–	–	–
MOVX A, io	2	3	0	(b)	byte (A) ← (eam)	X	*	–	–	–	*	*	–	–	–
MOVX A, #imm8	2	2	0	0	byte (A) ← (io)	X	*	–	–	–	*	*	–	–	–
MOVX A, @A	2	3	0	(b)	byte (A) ← imm8	X	–	–	–	–	*	*	–	–	–
MOVX A,@RWi+disp8	2	5	1	(b)	byte (A) ← ((A))	X	*	–	–	–	*	*	–	–	–
MOVX A, @RLi+disp8	3	10	2	(b)	byte (A) ← ((RWi)+disp8)	X	*	–	–	–	*	*	–	–	–
MOV dir, A	2	3	0	(b)	byte (A) ←	–	–	–	–	–	*	*	–	–	–
MOV addr16, A	3	4	0	(b)	((RLi)+disp8)	–	–	–	–	–	*	*	–	–	–
MOV Ri, A	1	2	1	0		–	–	–	–	–	*	*	–	–	–
MOV ear, A	2	2	1	0	byte (dir) ← (A)	–	–	–	–	–	*	*	–	–	–
MOV eam, A	2+	3+ (a)	0	(b)	byte (addr16) ← (A)	–	–	–	–	–	*	*	–	–	–
MOV io, A	2	3	0	(b)	byte (Ri) ← (A)	–	–	–	–	–	*	*	–	–	–
MOV @RLi+disp8, A	3	10	2	(b)	byte (ear) ← (A)	–	–	–	–	–	*	*	–	–	–
MOV Ri, ear	2	3	2	0	byte (eam) ← (A)	–	–	–	–	–	*	*	–	–	–
MOV Ri, eam	2+	4+ (a)	1	(b)	byte (io) ← (A)	–	–	–	–	–	*	*	–	–	–
MOV ear, Ri	2	4	2	0	byte ((RLi) +disp8) ←	–	–	–	–	–	*	*	–	–	–
MOV eam, Ri	2+	5+ (a)	1	(b)	(A)	–	–	–	–	–	*	*	–	–	–
MOV Ri, #imm8	2	2	1	0	byte (Ri) ← (ear)	–	–	–	–	–	*	*	–	–	–
MOV io, #imm8	3	5	0	(b)	byte (Ri) ← (eam)	–	–	–	–	–	–	–	–	–	–
MOV dir, #imm8	3	5	0	(b)	byte (ear) ← (Ri)	–	–	–	–	–	–	–	–	–	–
MOV ear, #imm8	3	2	1	0	byte (eam) ← (Ri)	–	–	–	–	–	*	*	–	–	–
MOV eam, #imm8	3+	4+ (a)	0	(b)	byte (Ri) ← imm8	–	–	–	–	–	–	–	–	–	–
MOV @AL, AH	2	3	0	(b)	byte (io) ← imm8	–	–	–	–	–	*	*	–	–	–
/MOV @A, T					byte (dir) ← imm8 byte (ear) ← imm8										
XCH A, ear	2	4	2	0	byte (eam) ← imm8	Z	–	–	–	–	–	–	–	–	–
XCH A, eam	2+	5+ (a)	0	2× (b)	byte ((A)) ← (AH)	Z	–	–	–	–	–	–	–	–	–
XCH Ri, ear	2	7	4	0		–	–	–	–	–	–	–	–	–	–
XCH Ri, eam	2+	9+ (a)	2	2× (b)		–	–	–	–	–	–	–	–	–	–
					byte (A) ↔ (ear) byte (A) ↔ (eam) byte (Ri) ↔ (ear) byte (Ri) ↔ (eam)										

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 8 Transfer Instructions (Word/Long Word) [38 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
MOVW A, dir	2	3	0	(c)	word (A) ← (dir)	–	*	–	–	–	*	*	–	–	–
MOVW A, addr16	3	4	0	(c)	word (A) ← (addr16)	–	*	–	–	–	*	*	–	–	–
MOVW A, SP	1	1	0	0	word (A) ← (SP)	–	*	–	–	–	*	*	–	–	–
MOVW A, RWi	1	2	1	0	word (A) ← (RWi)	–	*	–	–	–	*	*	–	–	–
MOVW A, ear	2	2	1	0	word (A) ← (ear)	–	*	–	–	–	*	*	–	–	–
MOVW A, eam	2+	3+ (a)	0	(c)	word (A) ← (eam)	–	*	–	–	–	*	*	–	–	–
MOVW A, io	2	3	0	(c)	word (A) ← (io)	–	*	–	–	–	*	*	–	–	–
MOVW A, @A	2	3	0	(c)	word (A) ← ((A))	–	–	–	–	–	*	*	–	–	–
MOVW A, #imm16	3	2	0	0	word (A) ← imm16	–	*	–	–	–	*	*	–	–	–
MOVW A, @RWi+disp8	2	5	1	(c)	word (A) ← ((RWi)	–	*	–	–	–	*	*	–	–	–
MOVW A, @RLi+disp8	3	10	2	(c)	+disp8) word (A) ← ((RLi)	–	*	–	–	–	*	*	–	–	–
MOVW dir, A	2	3	0	(c)	+disp8)	–	–	–	–	–	*	*	–	–	–
MOVW addr16, A	3	4	0	(c)		–	–	–	–	–	*	*	–	–	–
MOVW SP, A	1	1	0	0	word (dir) ← (A)	–	–	–	–	–	*	*	–	–	–
MOVW RWi, A	1	2	1	0	word (addr16) ← (A)	–	–	–	–	–	*	*	–	–	–
MOVW ear, A	2	2	1	0	word (SP) ← (A)	–	–	–	–	–	*	*	–	–	–
MOVW eam, A	2+	3+ (a)	0	(c)	word (RWi) ← (A)	–	–	–	–	–	*	*	–	–	–
MOVW io, A	2	3	0	(c)	word (ear) ← (A)	–	–	–	–	–	*	*	–	–	–
MOVW @RWi+disp8, A	2	5	1	(c)	word (eam) ← (A)	–	–	–	–	–	*	*	–	–	–
MOVW @RLi+disp8, A	3	10	2	(c)	word (io) ← (A)	–	–	–	–	–	*	*	–	–	–
MOVW RWi, ear	2	3	2	(0)	word ((RWi) +disp8) ←	–	–	–	–	–	*	*	–	–	–
MOVW RWi, eam	2+	4+ (a)	1	(c)	(A)	–	–	–	–	–	*	*	–	–	–
MOVW ear, RWi	2	4	2	0	word ((RLi) +disp8) ←	–	–	–	–	–	*	*	–	–	–
MOVW eam, RWi	2+	5+ (a)	1	(c)	(A)	–	–	–	–	–	*	*	–	–	–
MOVW RWi, #imm16	3	2	1	0	word (RWi) ← (ear)	–	–	–	–	–	*	*	–	–	–
MOVW io, #imm16	4	5	0	(c)	word (RWi) ← (eam)	–	–	–	–	–	–	–	–	–	–
MOVW ear, #imm16	4	2	1	0	word (ear) ← (RWi)	–	–	–	–	–	*	*	–	–	–
MOVW eam, #imm16	4+	4+ (a)	0	(c)	word (eam) ← (RWi) word (RWi) ← imm16	–	–	–	–	–	–	–	–	–	–
MOVW AL, AH /MOVW @A, T	2	3	0	(c)	word (io) ← imm16 word (ear) ← imm16 word (eam) ← imm16	–	–	–	–	–	*	*	–	–	–
XCHW A, ear	2	4	2	0		–	–	–	–	–	–	–	–	–	–
XCHW A, eam	2+	5+ (a)	0	2× (c)	word ((A)) ← (AH)	–	–	–	–	–	–	–	–	–	–
XCHW RWi, ear	2	7	4	0		–	–	–	–	–	–	–	–	–	–
XCHW RWi, eam	2+	9+ (a)	2	2× (c)	word (A) ↔ (ear) word (A) ↔ (eam) word (RWi) ↔ (ear) word (RWi) ↔ (eam)	–	–	–	–	–	–	–	–	–	–
MOVL A, ear	2	4	2	0	long (A) ← (ear)	–	–	–	–	–	*	*	–	–	–
MOVL A, eam	2+	5+ (a)	0	(d)	long (A) ← (eam)	–	–	–	–	–	*	*	–	–	–
MOVL A, #imm32	5	3	0	0	long (A) ← imm32	–	–	–	–	–	*	*	–	–	–
MOVL ear, A	2	4	2	0	long (ear) ← (A)	–	–	–	–	–	*	*	–	–	–
MOVL eam, A	2+	5+ (a)	0	(d)	long (eam) ← (A)	–	–	–	–	–	*	*	–	–	–

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 9 Addition and Subtraction Instructions (Byte/Word/Long Word) [42 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
ADD A,#imm8	2	2	0	0	byte (A) ← (A) +imm8	Z	–	–	–	–	*	*	*	*	–
	2	5	0	(b)	byte (A) ← (A) +(dir)	Z	–	–	–	–	*	*	*	*	–
ADD A, dir	2	3	1	0	byte (A) ← (A) +(ear)	Z	–	–	–	–	*	*	*	*	–
ADD A, ear	2+	4+ (a)	0	(b)	byte (A) ← (A) +(eam)	Z	–	–	–	–	*	*	*	*	–
ADD A, eam	2	3	2	0	byte (ear) ← (ear) + (A)	–	–	–	–	–	*	*	*	*	–
ADD ear, A	2+	5+ (a)	0	2× (b)	byte (eam) ← (eam) + (A)	Z	–	–	–	–	*	*	*	*	*
ADD eam, A	1	2	0	0	byte (A) ← (AH) + (AL) + (C)	Z	–	–	–	–	*	*	*	*	–
ADDC A	2	3	1	0	byte (A) ← (A) + (ear) + (C)	Z	–	–	–	–	*	*	*	*	–
ADDC A, ear	2+	4+ (a)	0	(b)	byte (A) ← (A) + (eam) + (C)	Z	–	–	–	–	*	*	*	*	–
ADDC A, eam	1	3	0	0	byte (A) ← (AH) + (AL) + (C)	Z	–	–	–	–	*	*	*	*	–
ADDDC A	2	2	0	0	(decimal)	Z	–	–	–	–	*	*	*	*	–
SUB A,	2	5	0	(b)	byte (A) ← (A) –imm8	Z	–	–	–	–	*	*	*	*	–
#imm8	2	3	1	0	byte (A) ← (A) – (dir)	Z	–	–	–	–	*	*	*	*	–
SUB A, dir	2+	4+ (a)	0	(b)	byte (A) ← (A) – (ear)	Z	–	–	–	–	*	*	*	*	–
SUB A, ear	2	3	2	0	byte (A) ← (A) – (eam)	–	–	–	–	–	*	*	*	*	–
SUB A, eam	2+	5+ (a)	0	2× (b)	byte (ear) ← (ear) – (A)	–	–	–	–	–	*	*	*	*	*
SUB ear, A	1	2	0	0	byte (eam) ← (eam) – (A)	Z	–	–	–	–	*	*	*	*	–
SUB eam, A	2	3	1	0	byte (A) ← (AH) – (AL) – (C)	Z	–	–	–	–	*	*	*	*	–
SUBC A	2+	4+ (a)	0	(b)	byte (A) ← (A) – (ear) – (C)	Z	–	–	–	–	*	*	*	*	–
SUBC A, ear	1	3	0	0	byte (A) ← (A) – (eam) – (C)	Z	–	–	–	–	*	*	*	*	–
SUBC A, eam					byte (A) ← (AH) – (AL) – (C)										
SUBDC A					(decimal)										
ADDW A	1	2	0	0	word (A) ← (AH) + (AL)	–	–	–	–	–	*	*	*	*	–
ADDW A, ear	2	3	1	0	word (A) ← (A) +(ear)	–	–	–	–	–	*	*	*	*	–
ADDW A, eam	2+	4+ (a)	0	(c)	word (A) ← (A) +(eam)	–	–	–	–	–	*	*	*	*	–
ADDW A,	3	2	0	0	word (A) ← (A) +imm16	–	–	–	–	–	*	*	*	*	–
#imm16	2	3	2	0	word (ear) ← (ear) + (A)	–	–	–	–	–	*	*	*	*	–
ADDW ear, A	2+	5+ (a)	0	2× (c)	word (eam) ← (eam) + (A)	–	–	–	–	–	*	*	*	*	*
ADDW eam, A	2	3	1	0	word (A) ← (A) + (ear) + (C)	–	–	–	–	–	*	*	*	*	–
ADDCW A, ear	2+	4+ (a)	0	(c)	word (A) ← (A) + (eam) + (C)	–	–	–	–	–	*	*	*	*	–
ADDCW A, eam	1	2	0	0	word (A) ← (AH) – (AL)	–	–	–	–	–	*	*	*	*	–
SUBW A	2	3	1	0	word (A) ← (A) – (ear)	–	–	–	–	–	*	*	*	*	–
SUBW A, ear	2+	4+ (a)	0	(c)	word (A) ← (A) – (eam)	–	–	–	–	–	*	*	*	*	–
SUBW A, eam	3	2	0	0	word (A) ← (A) –imm16	–	–	–	–	–	*	*	*	*	–
SUBW A,	2	3	2	0	word (ear) ← (ear) – (A)	–	–	–	–	–	*	*	*	*	–
#imm16	2+	5+ (a)	0	2× (c)	word (eam) ← (eam) – (A)	–	–	–	–	–	*	*	*	*	*
SUBW ear, A	2	3	1	0	word (A) ← (A) – (ear) – (C)	–	–	–	–	–	*	*	*	*	–
SUBW eam, A	2+	4+ (a)	0	(c)	word (A) ← (A) – (eam) – (C)	–	–	–	–	–	*	*	*	*	–
SUBCW A, ear															
SUBCW A, eam															
ADDL A, ear	2	6	2	0	long (A) ← (A) + (ear)	–	–	–	–	–	*	*	*	*	–
ADDL A, eam	2+	7+ (a)	0	(d)	long (A) ← (A) + (eam)	–	–	–	–	–	*	*	*	*	–
ADDL A,	5	4	0	0	long (A) ← (A) +imm32	–	–	–	–	–	*	*	*	*	–
#imm32	2	6	2	0	long (A) ← (A) – (ear)	–	–	–	–	–	*	*	*	*	–
SUBL A, ear	2+	7+ (a)	0	(d)	long (A) ← (A) – (eam)	–	–	–	–	–	*	*	*	*	–
SUBL A, eam	5	4	0	0	long (A) ← (A) –imm32	–	–	–	–	–	*	*	*	*	–
SUBL A, #imm32															

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 10 Increment and Decrement Instructions (Byte/Word/Long Word) [12 Instructions]

Mnemonic		#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
INC	ear	2	2	2	0	byte (ear) ← (ear) +1	–	–	–	–	–	*	*	*	–	–
INC	eam	2+	5+ (a)	0	2× (b)	byte (eam) ← (eam) +1	–	–	–	–	–	*	*	*	–	*
DEC	ear	2	3	2	0	byte (ear) ← (ear) –1	–	–	–	–	–	*	*	*	–	–
DEC	eam	2+	5+ (a)	0	2× (b)	byte (eam) ← (eam) –1	–	–	–	–	–	*	*	*	–	*
INCW	ear	2	3	2	0	word (ear) ← (ear) +1	–	–	–	–	–	*	*	*	–	–
INCW	eam	2+	5+ (a)	0	2× (c)	word (eam) ← (eam) +1	–	–	–	–	–	*	*	*	–	*
DECW	ear	2	3	2	0	word (ear) ← (ear) –1	–	–	–	–	–	*	*	*	–	–
DECW	eam	2+	5+ (a)	0	2× (c)	word (eam) ← (eam) –1	–	–	–	–	–	*	*	*	–	*
INCL	ear	2	7	4	0	long (ear) ← (ear) +1	–	–	–	–	–	*	*	*	–	–
INCL	eam	2+	9+ (a)	0	2× (d)	long (eam) ← (eam) +1	–	–	–	–	–	*	*	*	–	*
DECL	ear	2	7	4	0	long (ear) ← (ear) –1	–	–	–	–	–	*	*	*	–	–
DECL	eam	2+	9+ (a)	0	2× (d)	long (eam) ← (eam) –1	–	–	–	–	–	*	*	*	–	*

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 11 Compare Instructions (Byte/Word/Long Word) [11 Instructions]

Mnemonic		#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
CMP	A	1	1	0	0	byte (AH) – (AL)	–	–	–	–	–	*	*	*	*	–
CMP	A, ear	2	2	1	0	byte (A) ← (ear)	–	–	–	–	–	*	*	*	*	–
CMP	A, eam	2+	3+ (a)	0	(b)	byte (A) ← (eam)	–	–	–	–	–	*	*	*	*	–
CMP	A, #imm8	2	2	0	0	byte (A) ← imm8	–	–	–	–	–	*	*	*	*	–
CMPW	A	1	1	0	0	word (AH) – (AL)	–	–	–	–	–	*	*	*	*	–
CMPW	A, ear	2	2	1	0	word (A) ← (ear)	–	–	–	–	–	*	*	*	*	–
CMPW	A, eam	2+	3+ (a)	0	(c)	word (A) ← (eam)	–	–	–	–	–	*	*	*	*	–
CMPW	A, #imm16	3	2	0	0	word (A) ← imm16	–	–	–	–	–	*	*	*	*	–
CMPL	A, ear	2	6	2	0	word (A) ← (ear)	–	–	–	–	–	*	*	*	*	–
CMPL	A, eam	2+	7+ (a)	0	(d)	word (A) ← (eam)	–	–	–	–	–	*	*	*	*	–
CMPL	A, #imm32	5	3	0	0	word (A) ← imm32	–	–	–	–	–	*	*	*	*	–

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 12 Multiplication and Division Instructions (Byte/Word/Long Word) [11 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
DIVU A	1	*1	0	0	word (AH) /byte (AL) Quotient → byte (AL) Remainder →	–	–	–	–	–	–	–	*	*	–
DIVU A, ear	2	*2	1	0	byte (AH) word (A)/byte (ear)	–	–	–	–	–	–	–	*	*	–
	2+	*3	0	*6	Quotient → byte (A) Remainder →	–	–	–	–	–	–	–	*	*	–
DIVU A, eam	2	*4	1	0	byte (ear) word (A)/byte (eam)	–	–	–	–	–	–	–	*	*	–
					Quotient → byte (A) Remainder →										
DIVUW A, ear	2+	*5	0	*7	byte (eam) long (A)/word (ear)	–	–	–	–	–	–	–	*	*	–
					Quotient → word (A) Remainder →										
DIVUW A, eam	1	*8	0	0	word (ear)	–	–	–	–	–	–	–	–	–	–
	2	*9	1	0	long (A)/word (eam)	–	–	–	–	–	–	–	–	–	–
	2+	*10	0	(b)	Quotient → word (A) Remainder → word (eam)	–	–	–	–	–	–	–	–	–	–
MULU A	1	*11	0	0		–	–	–	–	–	–	–	–	–	–
MULU A, ear	2	*12	1	0	byte (AH) *byte (AL) → word (A)	–	–	–	–	–	–	–	–	–	–
	2+	*13	0	(c)	byte (A) *byte (ear) → word (A)	–	–	–	–	–	–	–	–	–	–
MULU A, eam					byte (A) *byte (eam) → word (A)										
					word (AH) *word (AL) → long (A)										
MULUW A					word (A) *word (ear) → long (A)										
MULUW A, ear					word (A) *word (eam) → long (A)										
MULUW A, eam															

*1: 3 when the result is zero, 7 when an overflow occurs, and 15 normally.
*2: 4 when the result is zero, 8 when an overflow occurs, and 16 normally.
*3: 6 + (a) when the result is zero, 9 + (a) when an overflow occurs, and 19 + (a) normally.
*4: 4 when the result is zero, 7 when an overflow occurs, and 22 normally.
*5: 6 + (a) when the result is zero, 8 + (a) when an overflow occurs, and 26 + (a) normally.
*6: (b) when the result is zero or when an overflow occurs, and 2 × (b) normally.
*7: (c) when the result is zero or when an overflow occurs, and 2 × (c) normally.
*8: 3 when byte (AH) is zero, and 7 when byte (AH) is not zero.
*9: 4 when byte (ear) is zero, and 8 when byte (ear) is not zero.
*10: 5 + (a) when byte (eam) is zero, and 9 + (a) when byte (eam) is not 0.
*11: 3 when word (AH) is zero, and 11 when word (AH) is not zero.
*12: 4 when word (ear) is zero, and 12 when word (ear) is not zero.
*13: 5 + (a) when word (eam) is zero, and 13 + (a) when word (eam) is not zero.

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 13 Logical 1 Instructions (Byte/Word) [39 Instructions]

Mnemonic		#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
AND	A, #imm8	2	2	0	0	byte (A) ← (A) and imm8	–	–	–	–	–	*	*	R	–	–
AND	A, ear	2	3	1	0	byte (A) ← (A) and (ear)	–	–	–	–	–	*	*	R	–	–
AND	A, eam	2+	4+ (a)	0	(b)	byte (A) ← (A) and (eam)	–	–	–	–	–	*	*	R	–	–
AND	ear, A	2	3	2	0	byte (ear) ← (ear) and (A)	–	–	–	–	–	*	*	R	–	–
AND	eam, A	2+	5+ (a)	0	2× (b)	byte (eam) ← (eam) and (A)	–	–	–	–	–	*	*	R	–	*
OR	A, #imm8	2	2	0	0	byte (A) ← (A) or imm8	–	–	–	–	–	*	*	R	–	–
OR	A, ear	2	3	1	0	byte (A) ← (A) or (ear)	–	–	–	–	–	*	*	R	–	–
OR	A, eam	2+	4+ (a)	0	(b)	byte (A) ← (A) or (eam)	–	–	–	–	–	*	*	R	–	–
OR	ear, A	2	3	2	0	byte (ear) ← (ear) or (A)	–	–	–	–	–	*	*	R	–	–
OR	eam, A	2+	5+ (a)	0	2× (b)	byte (eam) ← (eam) or (A)	–	–	–	–	–	*	*	R	–	*
XOR	A, #imm8	2	2	0	0	byte (A) ← (A) xor imm8	–	–	–	–	–	*	*	R	–	–
XOR	A, ear	2	3	1	0	byte (A) ← (A) xor (ear)	–	–	–	–	–	*	*	R	–	–
XOR	A, eam	2+	4+ (a)	0	(b)	byte (A) ← (A) xor (eam)	–	–	–	–	–	*	*	R	–	–
XOR	ear, A	2	3	2	0	byte (ear) ← (ear) xor (A)	–	–	–	–	–	*	*	R	–	–
XOR	eam, A	2+	5+ (a)	0	2× (b)	byte (eam) ← (eam) xor (A)	–	–	–	–	–	*	*	R	–	*
NOT	A	1	2	0	0	byte (A) ← not (A)	–	–	–	–	–	*	*	R	–	–
NOT	ear	2	3	2	0	byte (ear) ← not (ear)	–	–	–	–	–	*	*	R	–	–
NOT	eam	2+	5+ (a)	0	2× (b)	byte (eam) ← not (eam)	–	–	–	–	–	*	*	R	–	*
ANDW	A	1	2	0	0	word (A) ← (AH) and (A)	–	–	–	–	–	*	*	R	–	–
ANDW	A, #imm16	3	2	0	0	word (A) ← (A) and imm16	–	–	–	–	–	*	*	R	–	–
ANDW	A, ear	2	3	1	0	word (A) ← (A) and (ear)	–	–	–	–	–	*	*	R	–	–
ANDW	A, eam	2+	4+ (a)	0	(c)	word (A) ← (A) and (eam)	–	–	–	–	–	*	*	R	–	–
ANDW	ear, A	2	3	2	0	word (ear) ← (ear) and (A)	–	–	–	–	–	*	*	R	–	–
ANDW	eam, A	2+	5+ (a)	0	2× (c)	word (eam) ← (eam) and (A)	–	–	–	–	–	*	*	R	–	*
ORW	A	1	2	0	0	word (A) ← (AH) or (A)	–	–	–	–	–	*	*	R	–	–
ORW	A, #imm16	3	2	0	0	word (A) ← (A) or imm16	–	–	–	–	–	*	*	R	–	–
ORW	A, ear	2	3	1	0	word (A) ← (A) or (ear)	–	–	–	–	–	*	*	R	–	–
ORW	A, eam	2+	4+ (a)	0	(c)	word (A) ← (A) or (eam)	–	–	–	–	–	*	*	R	–	–
ORW	ear, A	2	3	2	0	word (ear) ← (ear) or (A)	–	–	–	–	–	*	*	R	–	–
ORW	eam, A	2+	5+ (a)	0	2× (c)	word (eam) ← (eam) or (A)	–	–	–	–	–	*	*	R	–	*
XORW	A	1	2	0	0	word (A) ← (AH) xor (A)	–	–	–	–	–	*	*	R	–	–
XORW	A, #imm16	3	2	0	0	word (A) ← (A) xor imm16	–	–	–	–	–	*	*	R	–	–
XORW	A, ear	2	3	1	0	word (A) ← (A) xor (ear)	–	–	–	–	–	*	*	R	–	–
XORW	A, eam	2+	4+ (a)	0	(c)	word (A) ← (A) xor (eam)	–	–	–	–	–	*	*	R	–	–
XORW	ear, A	2	3	2	0	word (ear) ← (ear) xor (A)	–	–	–	–	–	*	*	R	–	–
XORW	eam, A	2+	5+ (a)	0	2× (c)	word (eam) ← (eam) xor (A)	–	–	–	–	–	*	*	R	–	*
NOTW	A	1	2	0	0	word (A) ← not (A)	–	–	–	–	–	*	*	R	–	–
NOTW	ear	2	3	2	0	word (ear) ← not (ear)	–	–	–	–	–	*	*	R	–	–
NOTW	eam	2+	5+ (a)	0	2× (c)	word (eam) ← not (eam)	–	–	–	–	–	*	*	R	–	*

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 14 Logical 2 Instructions (Long Word) [6 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
ANDL A, ear	2	6	2	0	long (A) ← (A) and (ear)	–	–	–	–	–	*	*	R	–	–
ANDL A, eam	2+	7+ (a)	0	(d)	long (A) ← (A) and (eam)	–	–	–	–	–	*	*	R	–	–
ORL A, ear	2	6	2	0	long (A) ← (A) or (ear)	–	–	–	–	–	*	*	R	–	–
ORL A, eam	2+	7+ (a)	0	(d)	long (A) ← (A) or (eam)	–	–	–	–	–	*	*	R	–	–
XORL A, ea	2	6	2	0	long (A) ← (A) xor (ear)	–	–	–	–	–	*	*	R	–	–
XORL A, eam	2+	7+ (a)	0	(d)	long (A) ← (A) xor (eam)	–	–	–	–	–	*	*	R	–	–

Table 15 Sign Inversion Instructions (Byte/Word) [6 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
NEG A	1	2	0	0	byte (A) ← 0 – (A)	X	–	–	–	–	*	*	*	*	–
NEG ear	2	3	2	0	byte (ear) ← 0 – (ear)	–	–	–	–	–	*	*	*	*	–
NEG eam	2+	5+ (a)	0	2× (b)	byte (eam) ← 0 – (eam)	–	–	–	–	–	*	*	*	*	*
NEGW A	1	2	0	0	word (A) ← 0 – (A)	–	–	–	–	–	*	*	*	*	–
NEGW ear	2	3	2	0	word (ear) ← 0 – (ear)	–	–	–	–	–	*	*	*	*	–
NEGW eam	2+	5+ (a)	0	2× (c)	word (eam) ← 0 – (eam)	–	–	–	–	–	*	*	*	*	*

Table 16 Normalize Instruction (Long Word) [1 Instruction]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
NRML A, R0	2	*1	1	0	long (A) ← Shift until first digit is “1” byte (R0) ← Current shift count	–	–	–	–	–	–	*	–	–	–

*1: 4 when the contents of the accumulator are all zeroes, 6 + (R0) in all other cases (shift count).

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 17 Shift Instructions (Byte/Word/Long Word) [18 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
RORC A	2	2	0	0	byte (A) ← Right rotation with carry	–	–	–	–	–	*	*	–	*	–
ROLC A	2	2	0	0	byte (A) ← Left rotation with carry	–	–	–	–	–	*	*	–	*	–
RORC ear	2	3	2	0	byte (ear) ← Right rotation with carry	–	–	–	–	–	*	*	–	*	–
RORC eam	2+	5+	0	2× (b)	byte (eam) ← Right rotation with	–	–	–	–	–	*	*	–	*	*
ROLC ear	2	(a)	2	0	carry	–	–	–	–	–	*	*	–	*	–
ROLC eam	2+	3	0	2× (b)	byte (ear) ← Left rotation with carry	–	–	–	–	–	*	*	–	*	*
		5+			byte (eam) ← Left rotation with carry										
ASR A, R0	2	(a)	1	0		–	–	–	–	*	*	*	–	*	–
LSR A, R0	2		1	0	byte (A) ← Arithmetic right barrel shift (A,	–	–	–	–	*	*	*	–	*	–
LSL A, R0	2	*1	1	0	R0)	–	–	–	–	–	*	*	–	*	–
		*1			byte (A) ← Logical right barrel shift (A, R0)										
		*1			byte (A) ← Logical left barrel shift (A, R0)										
ASRWA	1	2	0	0	word (A) ← Arithmetic right shift (A, 1	–	–	–	–	*	*	*	–	*	–
LSRWA/SHRWA	1	2	0	0	bit)	–	–	–	–	*	R	*	–	*	–
	1	2	0	0	word (A) ← Logical right shift (A, 1 bit)	–	–	–	–	–	*	*	–	*	–
LSLW A/SHLWA	2	*1	1	0	word (A) ← Logical left shift (A, 1 bit)	–	–	–	–	*	*	*	–	*	–
	2	*1	1	0		–	–	–	–	*	*	*	–	*	–
ASRWA, R0	2	*1	1	0	word (A) ← Arithmetic right barrel shift (A,	–	–	–	–	–	*	*	–	*	–
LSRWA, R0					R0)										
LSLW A, R0					word (A) ← Logical right barrel shift (A, R0)										
					word (A) ← Logical left barrel shift (A, R0)										
ASRL A, R0	2	*2	1	0	long (A) ← Arithmetic right shift (A,	–	–	–	–	*	*	*	–	*	–
LSRL A, R0	2	*2	1	0	R0)	–	–	–	–	*	*	*	–	*	–
LSLL A, R0	2	*2	1	0	long (A) ← Logical right barrel shift (A, R0)	–	–	–	–	–	*	*	–	*	–
					long (A) ← Logical left barrel shift (A, R0)										

*1: 6 when R0 is 0, 5 + (R0) in all other cases.
*2: 6 when R0 is 0, 6 + (R0) in all other cases.

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 18 Branch 1 Instructions [31 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
BZ/BEQ rel	2	*1	0	0	Branch when (Z) = 1	–	–	–	–	–	–	–	–	–	–
BNZ/BNE rel	2	*1	0	0	Branch when (Z) = 0	–	–	–	–	–	–	–	–	–	–
BC/BLO rel	2	*1	0	0	Branch when (C) = 1	–	–	–	–	–	–	–	–	–	–
BNC/BHS rel	2	*1	0	0	Branch when (C) = 0	–	–	–	–	–	–	–	–	–	–
BN rel	2	*1	0	0	Branch when (N) = 1	–	–	–	–	–	–	–	–	–	–
BP rel	2	*1	0	0	Branch when (N) = 0	–	–	–	–	–	–	–	–	–	–
BV rel	2	*1	0	0	Branch when (V) = 1	–	–	–	–	–	–	–	–	–	–
BNV rel	2	*1	0	0	Branch when (V) = 0	–	–	–	–	–	–	–	–	–	–
BT rel	2	*1	0	0	Branch when (T) = 1	–	–	–	–	–	–	–	–	–	–
BNT rel	2	*1	0	0	Branch when (T) = 0	–	–	–	–	–	–	–	–	–	–
BLT rel	2	*1	0	0	Branch when (V) xor (N) = 1	–	–	–	–	–	–	–	–	–	–
BGE rel	2	*1	0	0	Branch when (V) xor (N) = 0	–	–	–	–	–	–	–	–	–	–
BLE rel	2	*1	0	0	Branch when ((V) xor (N)) or	–	–	–	–	–	–	–	–	–	–
BGT rel	2	*1	0	0	(Z) = 1	–	–	–	–	–	–	–	–	–	–
BLS rel	2	*1	0	0	Branch when ((V) xor (N)) or	–	–	–	–	–	–	–	–	–	–
BHI rel	2	*1	0	0	(Z) = 0	–	–	–	–	–	–	–	–	–	–
BRA rel	2	*1	0	0	Branch when (C) or (Z) = 1 Branch when (C) or (Z) = 0	–	–	–	–	–	–	–	–	–	–
JMP @A	1	2	0	0	Branch unconditionally	–	–	–	–	–	–	–	–	–	–
JMP addr16	3	3	0	0		–	–	–	–	–	–	–	–	–	–
JMP @ear	2	3	1	0	word (PC) ← (A)	–	–	–	–	–	–	–	–	–	–
JMP @eam	2+	4+ (a)	0	(c)	word (PC) ← addr16	–	–	–	–	–	–	–	–	–	–
JMPP @ear *3	2	5	2	0	word (PC) ← (ear)	–	–	–	–	–	–	–	–	–	–
JMPP @eam *3	2+	6+ (a)	0	(d)	word (PC) ← (eam)	–	–	–	–	–	–	–	–	–	–
JMPP addr24	4	4	0	0	word (PC) ← (ear), (PCB) ← (ear +2)	–	–	–	–	–	–	–	–	–	–
CALL @ear *4	2	6	1	(c)	word (PC) ← (eam), (PCB) ←	–	–	–	–	–	–	–	–	–	–
CALL @eam *4	2+	7+ (a)	0	2× (c)	(eam +2)	–	–	–	–	–	–	–	–	–	–
CALL addr16 *5	3	6	0	(c)	word (PC) ← ad24 0 to 15,	–	–	–	–	–	–	–	–	–	–
CALLV #vct4 *5	1	7	0	2× (c)	(PCB) ← ad24 16 to 23	–	–	–	–	–	–	–	–	–	–
CALLP @ear *6	2	10	2	2× (c)	word (PC) ← (ear) word (PC) ← (eam)	–	–	–	–	–	–	–	–	–	–
CALLP @eam *6	2+	11+ (a)	0	*2	word (PC) ← addr16 Vector call instruction	–	–	–	–	–	–	–	–	–	–
CALLP addr24 *7	4	10	0	2× (c)	word (PC) ← (ear) 0 to 15 (PCB) ← (ear) 16 to 23 word (PC) ← (eam) 0 to 15 (PCB) ← (eam) 16 to 23 word (PC) ← addr0 to 15, (PCB) ← addr16 to 23	–	–	–	–	–	–	–	–	–	–

*1: 4 when branching, 3 when not branching.
*2: (b) + 3 × (c)
*3: Read (word) branch address.
*4: W: Save (word) to stack; R: read (word) branch address.
*5: Save (word) to stack.
*6: W: Save (long word) to W stack; R: read (long word) R branch address.
*7: Save (long word) to stack.

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 19 Branch 2 Instructions [19 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
CBNE A, #imm8, rel	3	*1	0	0	Branch when byte (A) ≠	–	–	–	–	–	*	*	*	*	–
CWBNEA, #imm16, rel	4	*1	0	0	imm8	–	–	–	–	–	*	*	*	*	–
					Branch when word (A) ≠										
CBNE ear, #imm8, rel	4	*2	1	0	imm16	–	–	–	–	–	*	*	*	*	–
CBNE eam, #imm8,	4+	*3	0	(b)		–	–	–	–	–	*	*	*	*	–
rel*9	5	*4	1	0	Branch when byte (ear) ≠	–	–	–	–	–	*	*	*	*	–
CWBNEear, #imm16,	5+	*3	0	(c)	imm8	–	–	–	–	–	*	*	*	*	–
rel					Branch when byte (eam) ≠										
CWBNEeam, #imm16,	3	*5	2	0	imm8	–	–	–	–	–	*	*	*	–	–
rel*9					Branch when word (ear) ≠										
	3+	*6	2	2× (b)	imm16	–	–	–	–	–	*	*	*	–	*
DBNZ ear, rel					Branch when word (eam) ≠										
					imm16										
DBNZ eam, rel	3	*5	2	0		–	–	–	–	–	*	*	*	–	–
					Branch when byte (ear) =										
	3+	*6	2	2× (c)	(ear) – 1, and (ear) ≠ 0	–	–	–	–	–	*	*	*	–	*
DWBNZ ear, rel					Branch when byte (eam) =										
					(eam) – 1, and (eam) ≠ 0										
DWBNZ eam, rel	2	20	0	8× (c)		–	–	R	S	–	–	–	–	–	–
	3	16	0	6× (c)	Branch when word (ear) =	–	–	R	S	–	–	–	–	–	–
	4	17	0	6× (c)	(ear) – 1, and (ear) ≠ 0	–	–	R	S	–	–	–	–	–	–
INT #vct8	1	20	0	8× (c)	Branch when word (eam) =	–	–	R	S	–	–	–	–	–	–
INT addr16	1	15	0	6× (c)	(eam) – 1, and (eam) ≠ 0	–	–	*	*	*	*	*	*	*	–
INTP addr24															
INT9	2	6	0	(c)	Software interrupt	–	–	–	–	–	–	–	–	–	–
RETI					Software interrupt										
					Software interrupt										
LINK #local8					Software interrupt										
	1	5	0	(c)	Return from interrupt	–	–	–	–	–	–	–	–	–	–
					At constant entry, save old										
UNLINK	1	4	0	(c)	frame pointer to stack, set	–	–	–	–	–	–	–	–	–	–
	1	6	0	(d)	new frame pointer, and	–	–	–	–	–	–	–	–	–	–
					allocate local pointer area										
RET *7					At constant entry, retrieve										
RETP *8					old frame pointer from stack.										
					Return from subroutine										
					Return from subroutine										

*1: 5 when branching, 4 when not branching
*2: 13 when branching, 12 when not branching
*3: 7 + (a) when branching, 6 + (a) when not branching
*4: 8 when branching, 7 when not branching
*5: 7 when branching, 6 when not branching
*6: 8 + (a) when branching, 7 + (a) when not branching
*7: Retrieve (word) from stack
*8: Retrieve (long word) from stack
*9: In the CBNE/CWBNE instruction, do not use the RWj+ addressing mode.

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

Table 20 Other Control Instructions (Byte/Word/Long Word) [28 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
PUSHWA	1	4	0	(c)	word (SP) ← (SP) –2, ((SP)) ←	–	–	–	–	–	–	–	–	–	–
PUSHWAH	1	4	0	(c)	(A)	–	–	–	–	–	–	–	–	–	–
PUSHWPS	1	4	0	(c)	word (SP) ← (SP) –2, ((SP)) ←	–	–	–	–	–	–	–	–	–	–
PUSHWrlst	2	*3	*5	*4	(AH)	–	–	–	–	–	–	–	–	–	–
					word (SP) ← (SP) –2, ((SP)) ←										
POPW A	1	3	0	(c)	(PS)	–	*	–	–	–	–	–	–	–	–
POPW AH	1	3	0	(c)	(SP) ← (SP) –2n, ((SP)) ←	–	–	–	–	–	–	–	–	–	–
POPW PS	1	4	0	(c)	(rlst)	–	–	*	*	*	*	*	*	*	–
POPW rlst	2	*2	*5	*4		–	–	–	–	–	–	–	–	–	–
					word (A) ← ((SP)), (SP) ← (SP)										
JCTX @A	1	14	0	6× (c)	+2	–	–	*	*	*	*	*	*	*	–
					word (AH) ← ((SP)), (SP) ←										
AND CCR,	2	3	0	0	(SP) +2	–	–	*	*	*	*	*	*	*	–
#imm8	2	3	0	0	word (PS) ← ((SP)), (SP) ←	–	–	*	*	*	*	*	*	*	–
OR CCR,					(SP) +2										
#imm8	2	2	0	0	(rlst) ← ((SP)), (SP) ← (SP)	–	–	–	–	–	–	–	–	–	–
	2	2	0	0	+2n	–	–	–	–	–	–	–	–	–	–
MOV RP, #imm8															
MOV ILM, #imm8	2	3	1	0	Context switch instruction	–	–	–	–	–	–	–	–	–	–
	2+	2+ (a)	1	0		–	–	–	–	–	–	–	–	–	–
MOVEA RWi, ear	2	1	0	0	byte (CCR) ← (CCR) and imm8	–	*	–	–	–	–	–	–	–	–
MOVEA RWi, eam	2+	1+ (a)	0	0	byte (CCR) ← (CCR) or imm8	–	*	–	–	–	–	–	–	–	–
MOVEA A, ear															
MOVEA A, eam	2	3	0	0	byte (RP) ←imm8	–	–	–	–	–	–	–	–	–	–
	3	3	0	0	byte (ILM) ←imm8	–	–	–	–	–	–	–	–	–	–
ADDSP #imm8															
ADDSP #imm16	2	*1	0	0	word (RWi) ←ear	Z	*	–	–	–	*	*	–	–	–
	2	1	0	0	word (RWi) ←eam	–	–	–	–	–	*	*	–	–	–
MOV A, brgl					word(A) ←ear										
MOV brg2, A	1	1	0	0	word (A) ←eam	–	–	–	–	–	–	–	–	–	–
	1	1	0	0		–	–	–	–	–	–	–	–	–	–
NOP	1	1	0	0	word (SP) ← (SP) +ext (imm8)	–	–	–	–	–	–	–	–	–	–
ADB	1	1	0	0	word (SP) ← (SP) +imm16	–	–	–	–	–	–	–	–	–	–
DTB	1	1	0	0		–	–	–	–	–	–	–	–	–	–
PCB	1	1	0	0	byte (A) ← (brgl)	–	–	–	–	–	–	–	–	–	–
SPB	1	1	0	0	byte (brg2) ← (A)	–	–	–	–	–	–	–	–	–	–
NCC															
CMR					No operation										
					Prefix code for accessing AD space										
					Prefix code for accessing DT space										
					Prefix code for accessing PC space										
					Prefix code for accessing SP space										
					Prefix code for no flag change										
					Prefix code for common register bank										

*1: PCB, ADB, SSB, USB, and SPB : 1 state
DTB, DPR : 2 states

*2: 7 + 3 × (pop count) + 2 × (last register number to be popped), 7 when rlst = 0 (no transfer register)

*3: 29 + (push count) – 3 × (last register number to be pushed), 8 when rlst = 0 (no transfer register)

*4: Pop count × (c), or push count × (c)

*5: Pop count or push count.

Note: For an explanation of "(a)" to "(d)", refer to Table 4, "Number of Execution Cycles for Each Type of Addressing," and Table 5, "Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles."

Table 21 Bit Manipulation Instructions [21 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
MOVB A, dir:bp	3	5	0	(b)	byte (A) ← (dir:bp) b	Z	*	–	–	–	*	*	–	–	–
MOVB A, addr16:bp	4	5	0	(b)	byte (A) ← (addr16:bp) b	Z	*	–	–	–	*	*	–	–	–
MOVB A, io:bp	3	4	0	(b)	byte (A) ← (io:bp) b	Z	*	–	–	–	*	*	–	–	–
	3	7	0	2× (b)	bit (dir:bp) b ← (A)	–	–	–	–	–	*	*	–	–	*
MOVB dir:bp, A	4	7	0	2× (b)	bit (addr16:bp) b ← (A)	–	–	–	–	–	*	*	–	–	*
MOVB addr16:bp, A	3	6	0	2× (b)	bit (io:bp) b ← (A)	–	–	–	–	–	*	*	–	–	*
MOVB io:bp, A	3	7	0	2× (b)	bit (dir:bp) b ← 1	–	–	–	–	–	–	–	–	–	*
	4	7	0	2× (b)	bit (addr16:bp) b ← 1	–	–	–	–	–	–	–	–	–	*
SETB dir:bp	3	7	0	2× (b)	bit (io:bp) b ← 1	–	–	–	–	–	–	–	–	–	*
SETB addr16:bp															
SETB io:bp	3	7	0	2× (b)	bit (dir:bp) b ← 0	–	–	–	–	–	–	–	–	–	*
	4	7	0	2× (b)	bit (addr16:bp) b ← 0	–	–	–	–	–	–	–	–	–	*
CLRB dir:bp	3	7	0	2× (b)	bit (io:bp) b ← 0	–	–	–	–	–	–	–	–	–	*
CLRB addr16:bp															
CLRB io:bp	4	*1	0	(b)	Branch when (dir:bp) b = 0	–	–	–	–	–	–	*	–	–	–
	5	*1	0	(b)	Branch when (addr16:bp) b = 0	–	–	–	–	–	–	*	–	–	–
BBC dir:bp, rel	4	*2	0	(b)	Branch when (io:bp) b = 0	–	–	–	–	–	–	*	–	–	–
BBC addr16:bp, rel	4	*1	0	(b)	Branch when (dir:bp) b = 1	–	–	–	–	–	–	*	–	–	–
BBC io:bp, rel	5	*1	0	(b)	Branch when (addr16:bp) b = 1	–	–	–	–	–	–	*	–	–	–
	4	*2	0	(b)	Branch when (io:bp) b = 1	–	–	–	–	–	–	*	–	–	–
BBS dir:bp, rel															
BBS addr16:bp, rel	5	*3	0	2× (b)	Branch when (addr16:bp) b = 1, bit = 1	–	–	–	–	–	–	*	–	–	*
BBS io:bp, rel	3	*4	0	*5	Wait until (io:bp) b = 1	–	–	–	–	–	–	–	–	–	–
SBBS addr16:bp, rel	3	*4	0	*5	Wait until (io:bp) b = 0	–	–	–	–	–	–	–	–	–	–
WBTS io:bp															
WBTC io:bp															

*1: 8 when branching, 7 when not branching
*2: 7 when branching, 6 when not branching
*3: 10 when condition is satisfied, 9 when not satisfied
*4: Undefined count
*5: Until condition is satisfied

Note: For an explanation of "(a)" to "(d)", refer to Table 4, "Number of Execution Cycles for Each Type of Addressing," and Table 5, "Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles."

Table 22 Accumulator Manipulation Instructions (Byte/Word) [6 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
SWAP	1	3	0	0	byte (A) 0 to 7 ↔ (A) 8 to 15	–	–	–	–	–	–	–	–	–	–
SWAPW/XCHW AL, AH	1	2	0	0	word (AH) ↔ (AL)	–	*	–	–	–	–	–	–	–	–
EXT	1	1	0	0	byte sign extension	X	–	–	–	–	*	*	–	–	–
EXTW	1	2	0	0	word sign extension	–	X	–	–	–	*	*	–	–	–
ZEXT	1	1	0	0	byte zero extension	Z	–	–	–	–	R	*	–	–	–
ZEXTW	1	1	0	0	word zero extension	–	Z	–	–	–	R	*	–	–	–

Table 23 String Instructions [10 Instructions]

Mnemonic	#	~	RG	B	Operation	LH	AH	I	S	T	N	Z	V	C	RMW
MOVS/MOVSI	2	*2	*5	*3	Byte transfer @AH+ ← @AL+, counter	–	–	–	–	–	–	–	–	–	–
MOVSD	2	*2	*5	*3	= RW0	–	–	–	–	–	–	–	–	–	–
					Byte transfer @AH– ← @AL–, counter										
SCEQ/SCEQI	2	*1	*5	*4	= RW0	–	–	–	–	–	*	*	*	*	–
SCEQD	2	*1	*5	*4		–	–	–	–	–	*	*	*	*	–
					Byte retrieval (@AH+) – AL, counter =										
FISL/FILSI	2	6m +6	*5	*3	RW0	–	–	–	–	–	*	*	–	–	–
					Byte retrieval (@AH–) – AL, counter = RW0										
					Byte filling @AH+ ← AL, counter = RW0										
MOVSW/	2	*2	*8	*6	Word transfer @AH+ ← @AL+, counter	–	–	–	–	–	–	–	–	–	–
MOVSWI	2	*2	*8	*6	= RW0	–	–	–	–	–	–	–	–	–	–
MOVSWD					Word transfer @AH– ← @AL–, counter										
	2	*1	*8	*7	= RW0	–	–	–	–	–	*	*	*	*	–
SCWEQ/	2	*1	*8	*7		–	–	–	–	–	*	*	*	*	–
SCWEQI					Word retrieval (@AH+) – AL, counter =										
SCWEQD	2	6m +6	*8	*6	RW0	–	–	–	–	–	*	*	–	–	–
					Word retrieval (@AH–) – AL, counter =										
FILSW/FILSWI					RW0										
					Word filling @AH+ ← AL, counter = RW0										

m: RW0 value (counter value)
n: Loop count

*1: 5 when RW0 is 0, 4 + 7 × (RW0) for count out, and 7 × n + 5 when match occurs
*2: 5 when RW0 is 0, 4 + 8 × (RW0) in any other case
*3: (b) × (RW0) + (b) × (RW0) when accessing different areas for the source and destination, calculate (b) separately for each.
*4: (b) × n
*5: 2 × (RW0)
*6: (c) × (RW0) + (c) × (RW0) when accessing different areas for the source and destination, calculate (c) separately for each.
*7: (c) × n
*8: 2 × (RW0)

Note: For an explanation of “(a)” to “(d)”, refer to Table 4, “Number of Execution Cycles for Each Type of Addressing,” and Table 5, “Correction Values for Number of Cycles Used to Calculate Number of Actual Cycles.”

■ MASK OPTIONS

- **MB90670 series**

No.	Part number	MB90671 MB90672 MB90673	MB90P673	MB90V670
	Specifying procedure	**Specify when ordering masking**	**Set with EPROM programmer**	**Setting not possible**
1	Pull-up resistors P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P60 to P67, P70 to P77, P80, $\overline{RST}$, MD1, MD0	Specify by pin	Specify by pin	Without pull-up resistor
2	Pull-down resistors MD1, MD0	Specify by pin	Specify by pin	Without pull-up resistor

- **MB90675 series**

No.	Part number	MB90676 MB90677 MB90678	MB90P678	MB90V670
	Specifying procedure	**Specify when ordering masking**	**Set with EPROM programmer**	**Setting not possible**
1	Pull-up resistors P00 to P07, P10 to P17, P20 to P27, P30 to P37, P40 to P47, P60 to P67, P70 to P77, P80 to P86, P90, P91, PA0 to PA7, PB0 to PB2, $\overline{RST}$, MD1, MD0	Specify by pin	Specify by pin	Without pull-up resistor
2	Pull-down resistors MD1, MD0	Specify by pin	Specify by pin	Without pull-up resistor

Notes: • The pull-up register configured as a port pin is switched-off in the stop mode and during the hardware standby.
• In turning on power, option settings can not be made until clocks are supplied because 8 machine cycles are needed for option settings for the MB90P670/P675.

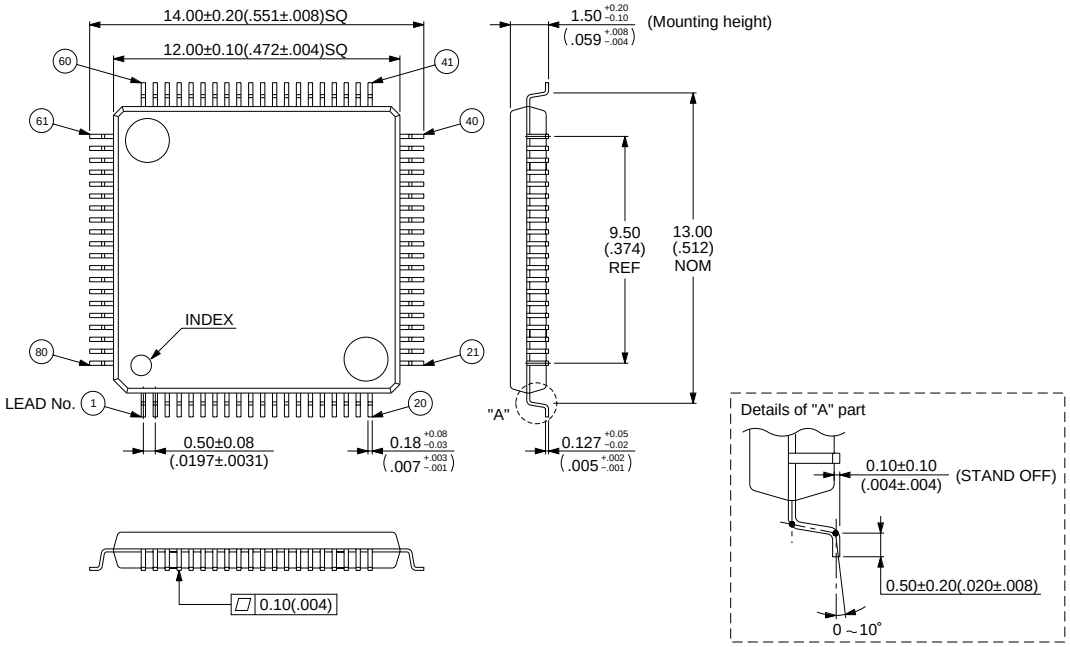
■ ORDERING INFORMATION

Part number	Package	Remarks
MB90671PFV MB90672PFV MB90673PFV MB90T673PFV MB90P673PFV	80-pin Plastic LQFP (FPT-80P-M05)	
MB90671PF MB90672PF MB90673PF MB90T673PF MB90P673PF	80-pin Plastic QFP (FPT-80P-M06)	
MB90676PFV MB90677PFV MB90678PFV MB90T678PFV MB90P678PFV	100-pin Plastic LQFP (FPT-100P-M05)	
MB90676PF MB90677PF MB90678PF MB90T678PF MB90P678PF	100-pin Plastic QFP (FPT-100P-M06)	

MB90670/675 Series

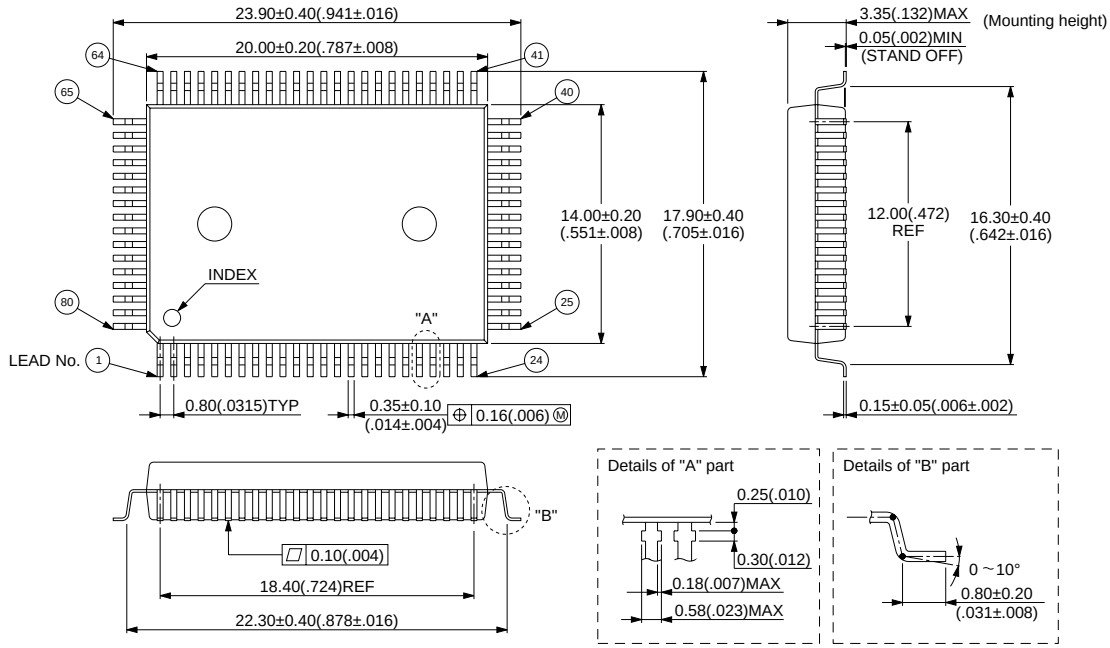
■ PACKAGE DIMENSIONS

80-pin Plastic LQFP
(FPT-80P-M05)



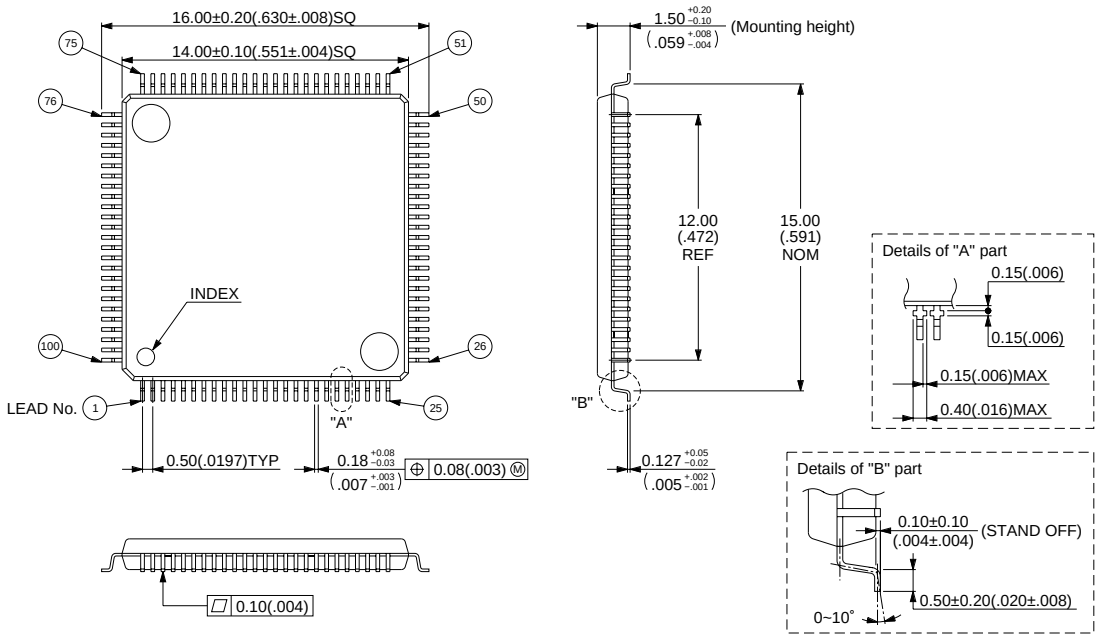
Dimensions in mm (inches)

80-pin Plastic QFP
(FPT-80P-M06)



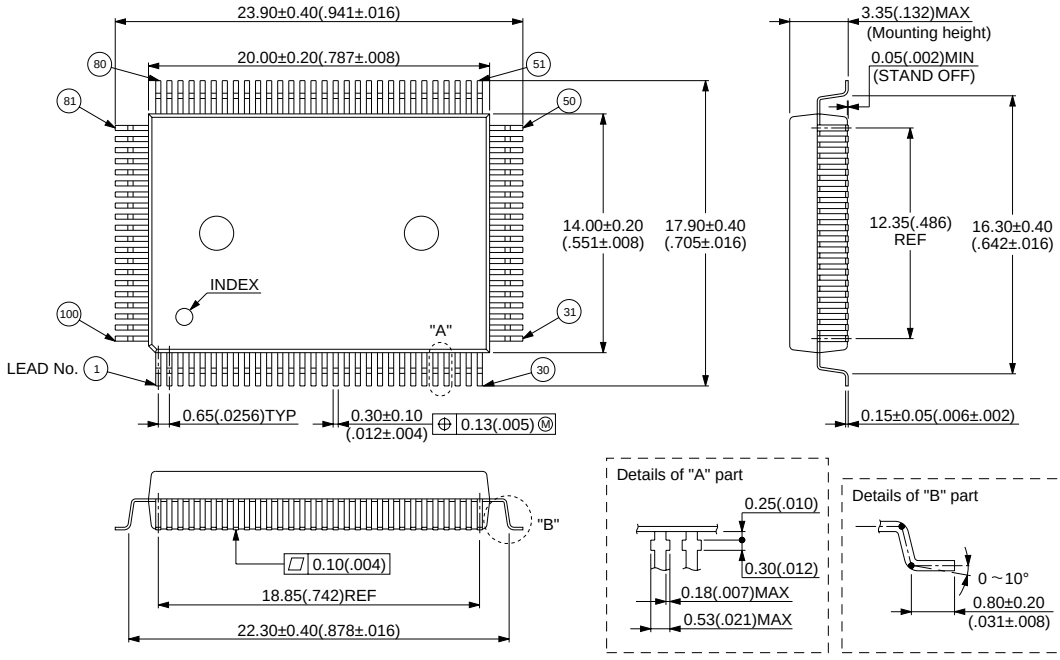
Dimensions in mm (inches)

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



Dimensions in mm (inches)

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



Dimensions in mm (inches)

MB90670/675 Series

FUJITSU LIMITED

For further information please contact:

Japan
FUJITSU LIMITED
Corporate Global Business Support Division
Electronic Devices
KAWASAKI PLANT, 4-1-1, Kamikodanaka
Nakahara-ku, Kawasaki-shi
Kanagawa 211-8588, Japan
Tel: 81(44) 754-3763
Fax: 81(44) 754-3329

http://www.fujitsu.co.jp/

North and South America
FUJITSU MICROELECTRONICS, INC.
Semiconductor Division
3545 North First Street
San Jose, CA 95134-1804, USA
Tel: (408) 922-9000
Fax: (408) 922-9179

Customer Response Center
Mon. - Fri.: 7 am - 5 pm (PST)
Tel: (800) 866-8608
Fax: (408) 922-9179

http://www.fujitsumicro.com/

Europe
FUJITSU MIKROELEKTRONIK GmbH
Am Siebenstein 6-10
D-63303 Dreieich-Buchschlag
Germany
Tel: (06103) 690-0
Fax: (06103) 690-122

http://www.fujitsu-ede.com/

Asia Pacific
FUJITSU MICROELECTRONICS ASIA PTE LTD
#05-08, 151 Lorong Chuan
New Tech Park
Singapore 556741
Tel: (65) 281-0770
Fax: (65) 281-0220

http://www.fmap.com.sg/

F9811

The contents of this document are subject to change without notice. Customers are advised to consult with FUJITSU sales representatives before ordering.

The information and circuit diagrams in this document are presented as examples of semiconductor device applications, and are not intended to be incorporated in devices for actual use. Also, FUJITSU is unable to assume responsibility for infringement of any patent rights or other rights of third parties arising from the use of this information or circuit diagrams.

FUJITSU semiconductor devices are intended for use in standard applications (computers, office automation and other office equipment, industrial, communications, and measurement equipment, personal or household devices, etc.).
CAUTION:
Customers considering the use of our products in special applications where failure or abnormal operation may directly affect human lives or cause physical injury or property damage, or where extremely high levels of reliability are demanded (such as aerospace systems, atomic energy controls, sea floor repeaters, vehicle operating controls, medical devices for life support, etc.) are requested to consult with FUJITSU sales representatives before such use. The company will not be responsible for damages arising from such use without prior approval.

Any semiconductor devices have an inherent chance of failure. You must protect against injury, damage or loss from such failures by incorporating safety design measures into your facility and equipment such as redundancy, fire protection, and prevention of over-current levels and other abnormal operating conditions.

If any products described in this document represent goods or technologies subject to certain restrictions on export under the Foreign Exchange and Foreign Trade Law of Japan, the prior authorization by Japanese government will be required for export of those products from Japan.