

**PRELIMINARY**

Notice: This is not a final specification.  
Some parametric limits are subject to change.

# MITSUBISHI MICROCOMPUTERS M37735S4BFP

16-BIT CMOS MICROCOMPUTER

## DESCRIPTION

The M37735S4BFP is a microcomputer using the 7700 Family core. This microcomputer has a CPU and a bus interface unit. The CPU is a 16-bit parallel processor that can be an 8-bit parallel processor, and the bus interface unit enhances the memory access efficiency to execute instructions fast. This microcomputer also includes a 32 kHz oscillation circuit, in addition to the RAM, multiple-function timers, serial I/O, A-D converter, and so on.

## FEATURES

- Number of basic instructions ..... 103
- Memory size     RAM ..... 2048 bytes
- Instruction execution time  
    The fastest instruction at 25 MHz frequency ..... 160 ns
- Single power supply ..... 5 V ± 10%
- Low power dissipation (at 25 MHz frequency)  
    ..... 47.5 mW (Typ.)
- Interrupts ..... 19 types, 7 levels
- Multiple-function 16-bit timer ..... 5 + 3
- Serial I/O (UART or clock synchronous).....3

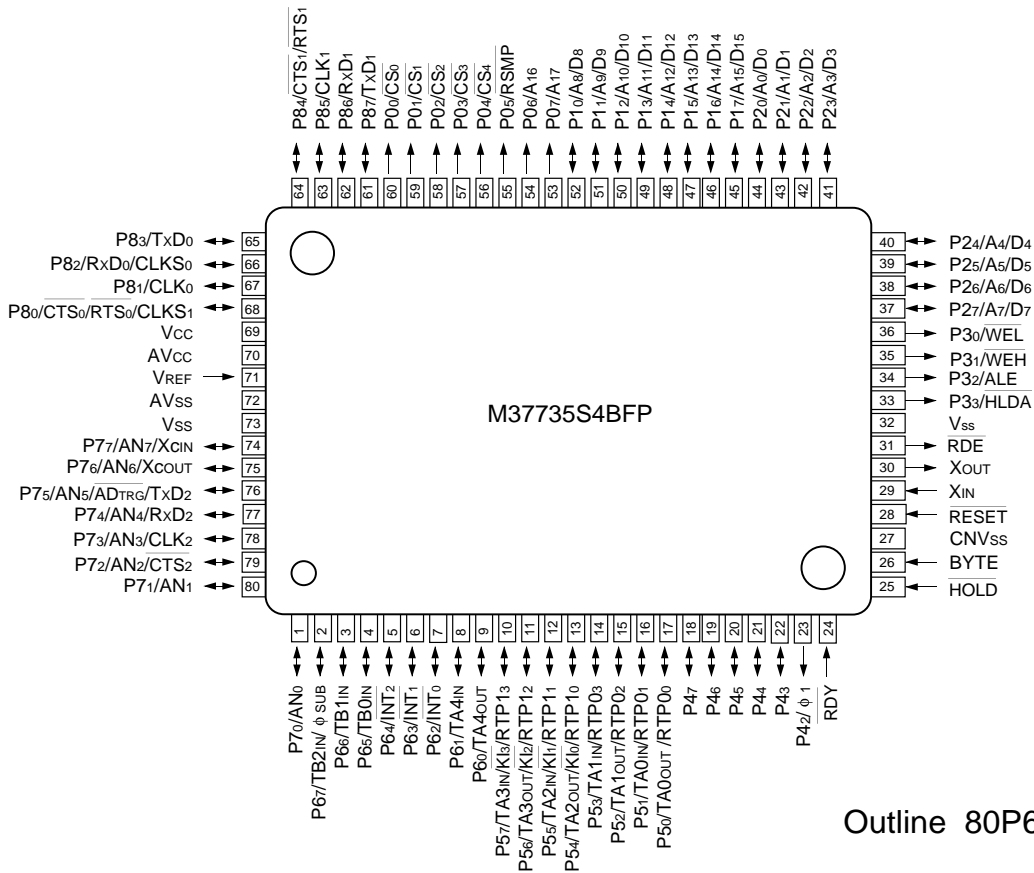
- 10-bit A-D converter .....8-channel inputs
- 12-bit watchdog timer
- Programmable input/output  
    (ports P4, P5, P6, P7, P8) .....37
- Clock generating circuit ..... 2 circuits built-in

## APPLICATION

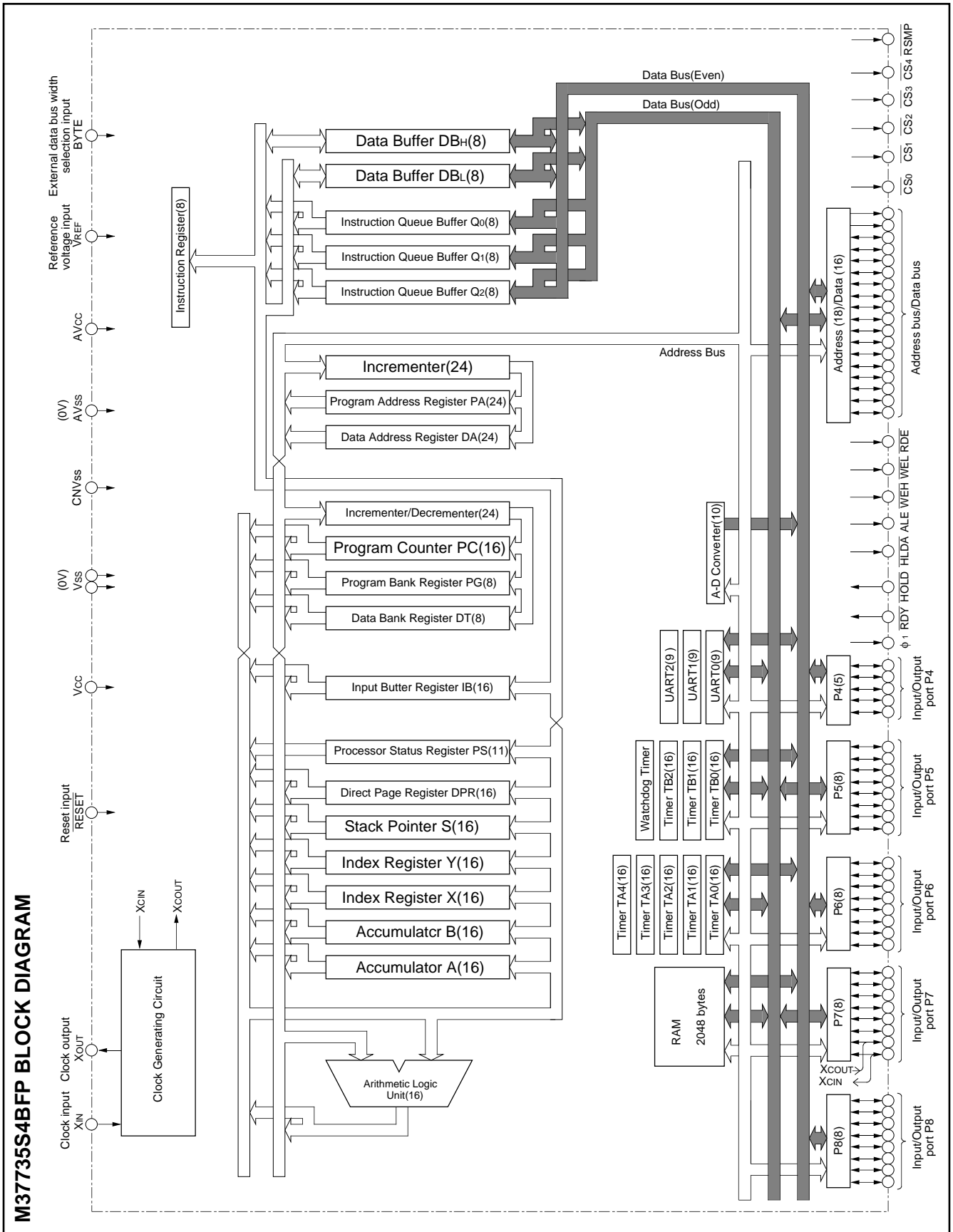
Control devices for general commercial equipment such as office automation, office equipment, and so on.

Control devices for general industrial equipment such as communication equipment, and so on.

## PIN CONFIGURATION (TOP VIEW)



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**FUNCTIONS OF M37735S4BFP**

Parameter		Functions
Number of basic instructions		103
Instruction execution time		160ns (the fastest instruction at external clock 25 MHz frequency)
Memory size	RAM	2048 bytes
Input/Output ports	P5 – P8	8-bit X 4
	P4	5-bit X 1
Multi-function timers	TA0, TA1, TA2, TA3, TA4	16-bit X 5
	TB0, TB1, TB2	16-bit X 3
Serial I/O		(UART or clock synchronous serial I/O) X 3
A-D converter		10-bit X 1 (8 channels)
Watchdog timer		12-bit X 1
Interrupts		3 external types, 16 internal types Each interrupt can be set to the priority level (0 – 7.)
Clock generating circuit		2 circuits built-in (externally connected to a ceramic resonator or a quartz-crystal oscillator)
Supply voltage		5 V ± 10%
Power dissipation		47.5 mW (at external clock 25 MHz frequency)
Input/Output characteristic	Input/Output voltage	5 V
	Output current	5 mA
Memory expansion		Maximum 1 Mbytes
Operating temperature range		-20 to 85 °C
Device structure		CMOS high-performance silicon gate process
Package		80-pin plastic molded QFP (80P6N-A)

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**PIN DESCRIPTION**

Pin	Name	Input/Output	Functions
Vcc, Vss	Power source		Apply 5 V ± 10% to Vcc and 0 V to Vss.
CNVss	CNVss input	Input	Connect to Vcc.
RESET	Reset input	Input	When "L" level is applied to this pin, the microcomputer enters the reset state.
XIN	Clock input	Input	These are pins of main-clock generating circuit. Connect a ceramic resonator or a quartz-crystal oscillator between XIN and XOUT. When an external clock is used, the clock source should be connected to the XIN pin, and the XOUT pin should be left open.
XOUT	Clock output	Output	
RDE	Read enable output	Output	When data/instruction read is performed, output level of RDE signal is "L".
BYTE	Bus width selection input	Input	This pin determines whether the external data bus has an 8-bit width or a 16-bit width. The data bus has a 16-bit width when "L" signal is input and an 8-bit width when "H" signal is input.
AVcc, AVss	Analog power source input		Power source input pin for the A-D converter. Externally connect AVcc to Vcc and AVss to Vss.
VREF	Reference voltage input	Input	This is reference voltage input pin for the A-D converter.
P00/CS0 – P04/CS4	Chip selection output	Output	When the specified external memory area is accessed, CS0 – CS4 signals are "L".
P05/RSMP	Ready sampling output	Output	The timing signal to be input to the RDY pin is output.
P06/A16, P07/A17	Address output	Output	An address (A16, A17) is output.
P10/A8/D8 – P17/A15/D15	Address output /data (high-order) I/O	I/O	When the BYTE pin is set to "L" and external data bus has a 16-bit width, high-order data (D8 – D15) is input/output or an address (A8 – A15) is output. When the BYTE pin is "H" and an external data bus has an 8-bit width, only address (A8 – A15) is output.
P20/A0/D0 – P27/A7/D7	Address output /data (low-order) I/O	I/O	Low-order data (D0 – D7) is input/output or an address (A0 – A7) is output.
P30/WEL	Write enable output	Output	When the BYTE pin is "L" and writing to an even address is performed, output level of WEL signal is "L". When the BYTE pin is "H" and writing to an even address or an odd address is performed, output level of WEL signal is "L".
P31/WEH	Write enable high output	Output	When the BYTE pin is "L" and writing to an odd address is performed, output level of WEH signal is "L". When the BYTE pin is "H", WEH signal is always "H".
P32/ALE	Address latch enable output	Output	This is used to retrieve only the address from the multiplex signal which consists of address and data.
P33/HLDA	Hold acknowledge output	Output	This outputs "L" level when the microcomputer enters hold state after a hold request is accepted.
HOLD	Hold request input	Input	This is an input pin for HOLD request signal. The microcomputer enters hold state while this signal is "L".
RDY	Ready input	Input	This is an input pin for RDY signal. The microcomputer enters ready state while this signal is "L".
P42/ φ 1	Clock output	Output	This pin outputs the clock φ 1.
P43 – P47	I/O port P4	I/O	These pins become a 5-bit I/O port. An I/O direction register is available so that each pin can be programmed for input or output. These ports are in the input mode when reset.
P50 – P57	I/O port P5	I/O	In addition to having the same functions as port P4, these pins also function as I/O pins for timers A0 to A3 and input pins for key input interrupt input (KI0 – KI3).
P60 – P67	I/O port P6	I/O	In addition to having the same functions as port P4, these pins also function as I/O pins for timer A4, input pins for external interrupt input (INT0 – INT2) and input pins for timers B0 to B2. P67 also functions as sub-clock φ SUB output pin.
P70 – P77	I/O port P7	I/O	In addition to having the same functions as port P4, these pins function as input pins for A-D converter. P72 to P75 also function as I/O pins for UART2. Additionally, P76 and P77 have the function as the output pin (XCOUT) and the input pin (XCIN) of the sub-clock (32 kHz) oscillation circuit, respectively. When P76 and P77 are used as the Xcout and Xcin pins, connect a resonator or an oscillator between the both.
P80 – P87	I/O port P8	I/O	In addition to having the same functions as port P4, these pins also function as I/O pins for UART 0 and UART 1.

**BASIC FUNCTION BLOCKS**

The M37735S4BFP has the same functions as the M37735MHBXXXFP except for the following:

- (1) The memory map is different.
- (2) The processor mode is different.
- (3) The reset circuit is different.
- (4) Pulse output port mode of timer A is available.
- (5) The function of ROM area modification is not available.

Refer to the section on the M37735MHBXXXFP, except for above (1)–(5).

**MEMORY**

The memory map is shown in Figure 1. The address space has a capacity of 16 Mbytes and is allocated to addresses from 0<sub>16</sub> to FFFFFFF<sub>16</sub>. The address space is divided by 64-Kbyte unit called bank. The banks are numbered from 0<sub>16</sub> to FF<sub>16</sub>. However, banks 10<sub>16</sub>–FF<sub>16</sub> of the M37735S4BFP cannot be accessed.

Built-in RAM and control registers for internal peripheral devices are assigned to bank 0<sub>16</sub>.

Addresses FFD6<sub>16</sub> to FFFF<sub>16</sub> are the RESET and interrupt vector addresses and contain the interrupt vectors. Use ROM for memory of this address.

The 2048-byte area allocated to addresses from 80<sub>16</sub> to 87F<sub>16</sub> is the built-in RAM. In addition to storing data, the RAM is used as stack during a subroutine call or interrupts.

Peripheral devices such as I/O ports, A-D converter, serial I/O, timer, and interrupt control registers are allocated to addresses from 0<sub>16</sub> to 7F<sub>16</sub>.

A 256-byte direct page area can be allocated anywhere in bank 0<sub>16</sub> by using the direct page register (DPR). In the direct page addressing mode, the memory in the direct page area can be accessed with two words. Hence program steps can be reduced.

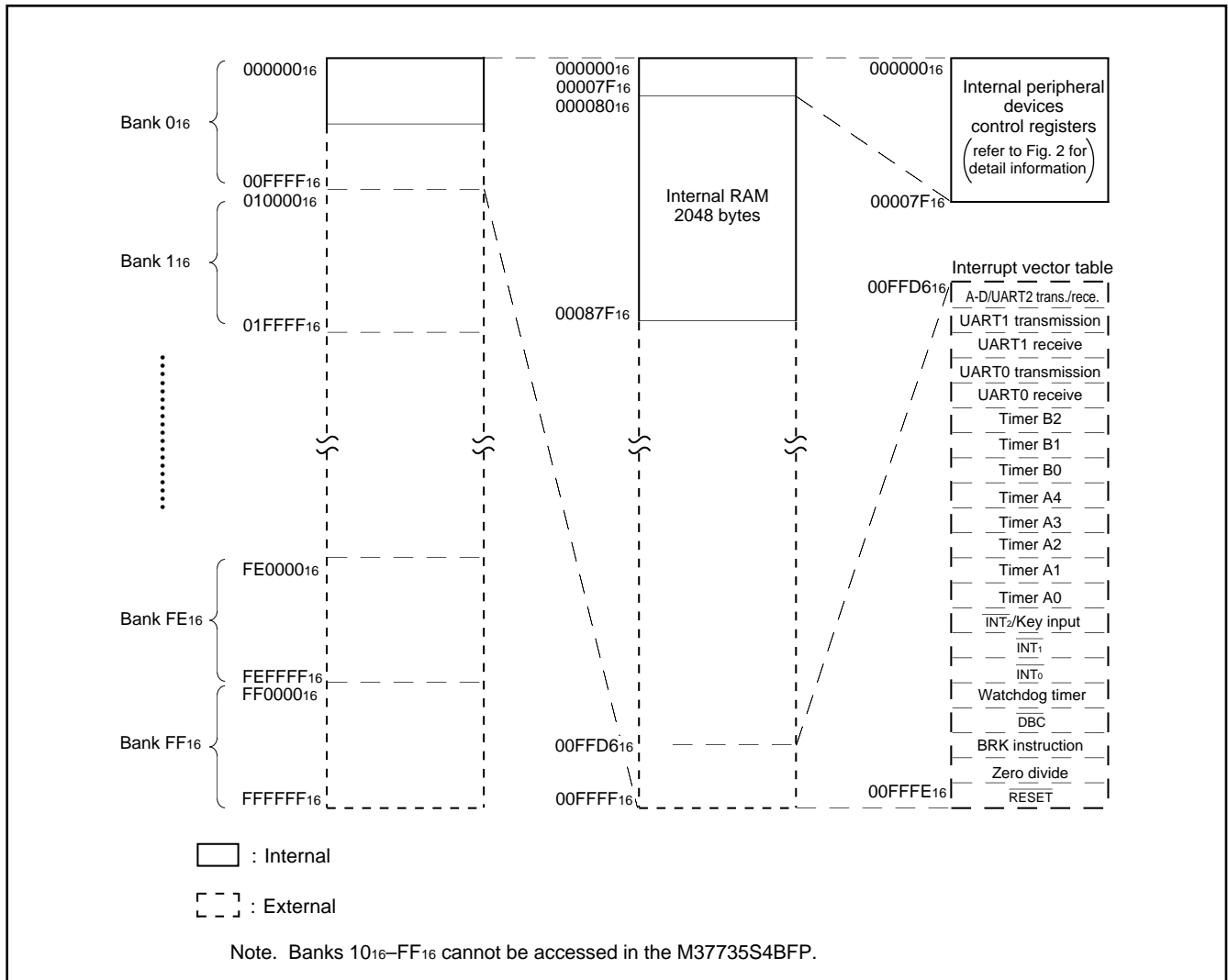


Fig. 1 Memory map

Address (Hexadecimal notation)		Address (Hexadecimal notation)	
000000		000040	Count start flag
000001		000041	
000002	Port P0 register	000042	One-shot start flag
000003	Port P1 register	000043	
000004	Port P0 direction register	000044	Up-down flag
000005	Port P1 direction register	000045	
000006	Port P2 register	000046	Timer A0 register
000007	Port P3 register	000047	
000008	Port P2 direction register	000048	Timer A1 register
000009	Port P3 direction register	000049	
00000A	Port P4 register	00004A	Timer A2 register
00000B	Port P5 register	00004B	
00000C	Port P4 direction register	00004C	Timer A3 register
00000D	Port P5 direction register	00004D	
00000E	Port P6 register	00004E	Timer A4 register
00000F	Port P7 register	00004F	
000010	Port P6 direction register	000050	Timer B0 register
000011	Port P7 direction register	000051	
000012	Port P8 register	000052	Timer B1 register
000013		000053	
000014	Port P8 direction register	000054	Timer B2 register
000015		000055	
000016		000056	Timer A0 mode register
000017		000057	Timer A1 mode register
000018		000058	Timer A2 mode register
000019		000059	Timer A3 mode register
00001A		00005A	Timer A4 mode register
00001B		00005B	Timer B0 mode register
00001C	Pulse output data register 1	00005C	Timer B1 mode register
00001D	Pulse output data register 0	00005D	Timer B2 mode register
00001E	A-D control register 0	00005E	Processor mode register 0
00001F	A-D control register 1	00005F	Processor mode register 1
000020		000060	Watchdog timer register
000021	A-D register 0	000061	Watchdog timer frequency selection flag
000022		000062	Waveform output mode register
000023	A-D register 1	000063	Reserved area ( <b>Note</b> )
000024		000064	UART2 transmit/receive mode register
000025	A-D register 2	000065	UART2 baud rate register (BRG2)
000026		000066	UART2 transmission buffer register
000027	A-D register 3	000067	
000028		000068	UART2 transmit/receive control register 0
000029	A-D register 4	000069	UART2 transmit/receive control register 1
00002A		00006A	
00002B	A-D register 5	00006B	UART2 receive buffer register
00002C		00006C	Oscillation circuit control register 0
00002D	A-D register 6	00006D	Port function control register
00002E		00006E	Serial transmit control register
00002F	A-D register 7	00006F	Oscillation circuit control register 1
000030	UART 0 transmit/receive mode register	000070	A-D/UART2 trans./rece. interrupt control register
000031	UART 0 baud rate register (BRG0)	000071	UART 0 transmission interrupt control register
000032		000072	UART 0 receive interrupt control register
000033	UART 0 transmission buffer register	000073	UART 1 transmission interrupt control register
000034	UART 0 transmit/receive control register 0	000074	UART 1 receive interrupt control register
000035	UART 0 transmit/receive control register 1	000075	Timer A0 interrupt control register
000036		000076	Timer A1 interrupt control register
000037	UART 0 receive buffer register	000077	Timer A2 interrupt control register
000038	UART 1 transmit/receive mode register	000078	Timer A3 interrupt control register
000039	UART 1 baud rate register (BRG1)	000079	Timer A4 interrupt control register
00003A		00007A	Timer B0 interrupt control register
00003B	UART 1 transmission buffer register	00007B	Timer B1 interrupt control register
00003C	UART 1 transmit/receive control register 0	00007C	Timer B2 interrupt control register
00003D	UART 1 transmit/receive control register 1	00007D	INT <sub>0</sub> interrupt control register
00003E		00007E	INT <sub>1</sub> interrupt control register
00003F	UART 1 receive buffer register	00007F	INT <sub>2</sub> /Key input interrupt control register

**Note.** Writing to reserved area is disabled.

Fig. 2 Location of internal peripheral devices and interrupt control registers

**Pulse output port mode**

The pulse motor drive waveform can be output by using plural internal timer A.

Figure 3 shows a block diagram for pulse output port mode. In the pulse output port mode, two pairs of four-bit pulse output ports are used. Whether using pulse output port or not can be selected by waveform output selection bit (bit 0, bit 1) of waveform output mode register (62<sub>16</sub> address) shown in Figure 4. When bit 0 of waveform output selection bit is set to "1", RTP10, RTP11, RTP12, and RTP13 are used as pulse output ports, and when bit 1 of waveform output selection bit is set to "1", RTP00, RTP01, RTP02, and RTP03 are used as pulse output ports. When bits 1 and 0 of waveform output selection bit are set to "1", RTP10, RTP11, RTP12, and RTP13, and RTP00, RTP01, RTP02, and RTP03 are used as pulse output ports. The ports not used as pulse output ports can be used as normal parallel ports, timer input/output or key input interrupt input.

In the pulse output port mode, set timers A0 and A2 to timer mode as timers A0 and A2 are used. Figure 5 shows the bit configuration of timer A0, A2 mode registers in pulse output port mode.

Data can be set in each bit of the pulse output data register corresponding to four ports selected as pulse output ports. Figure 6

shows the bit configuration of the pulse output data register. The contents of the pulse output data register 1 (low-order four bits of 1C<sub>16</sub> address) corresponding to RTP10, RTP11, RTP12, and RTP13 is output to the ports each time the counter of timer A2 becomes 0000<sub>16</sub>. The contents of the pulse output data register 0 (low-order four bits of 1D<sub>16</sub> address) corresponding to RTP00, RTP01, RTP02, and RTP03 is output to the ports each time the counter of timer A0 becomes 0000<sub>16</sub>.

Figure 7 shows example of waveforms in pulse output port mode. When "0" is written to a specified bit of the pulse output data register, "L" level is output to the corresponding pulse output port when the counter of corresponding timer becomes 0000<sub>16</sub>, and when "1" is written, "H" level is output to the pulse output port.

Pulse width modulation can be applied to each pulse output port. Since pulse width modulation involves the use of timers A1 and A3, activate these timers in pulse width modulation mode.

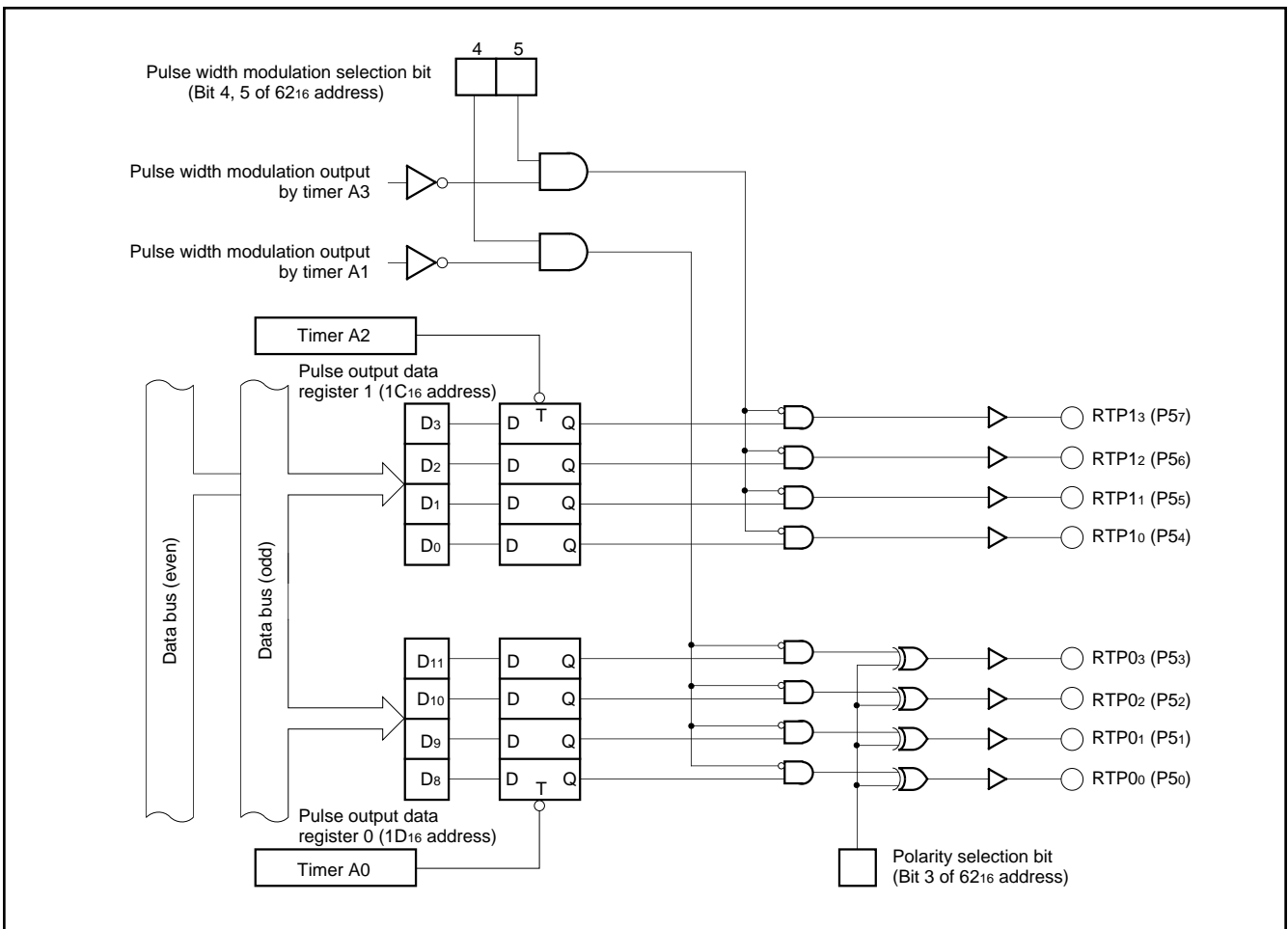


Fig. 3 Block diagram for pulse output port mode

RTP10, RTP11, RTP12, and RTP13 are applied pulse width modulation by timer A3 by setting the pulse width modulation selection bit by timer A3 (bit 5) of the waveform output mode register to "1".

RTP00, RTP01, RTP02, and RTP03 are applied pulse width modulation by timer A1 by setting the pulse width modulation selection bit by timer A1 (bit 4) of the waveform output mode register to "1".

The contents of the pulse output data register 0 can be reversed and output to pulse output ports RTP00, RTP01, RTP02, and RTP03 by the polarity selection bit (bit 3) of the waveform output mode register. When the polarity selection bit is "0", the contents of the pulse output data register 0 is output unchangeably, and when "1", the contents of the pulse output data register 0 is reversed and output. When pulse width modulation is applied, likewise the polarity reverse to pulse width modulation can be selected by the polarity selection bit.

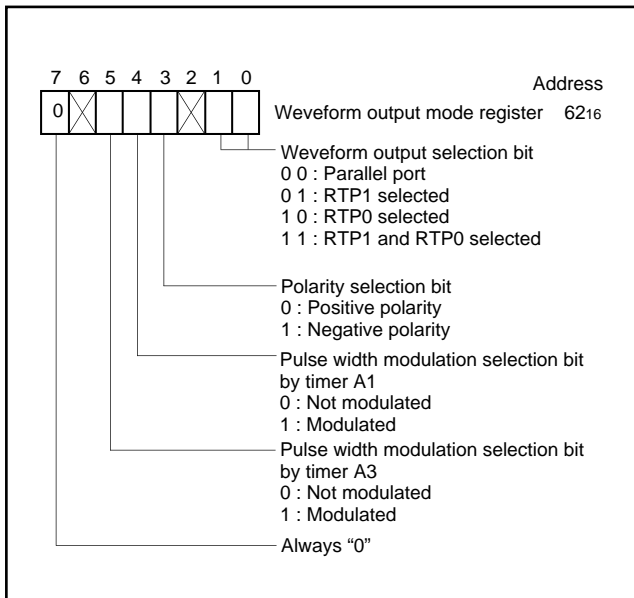


Fig. 4 Waveform output mode register bit configuration

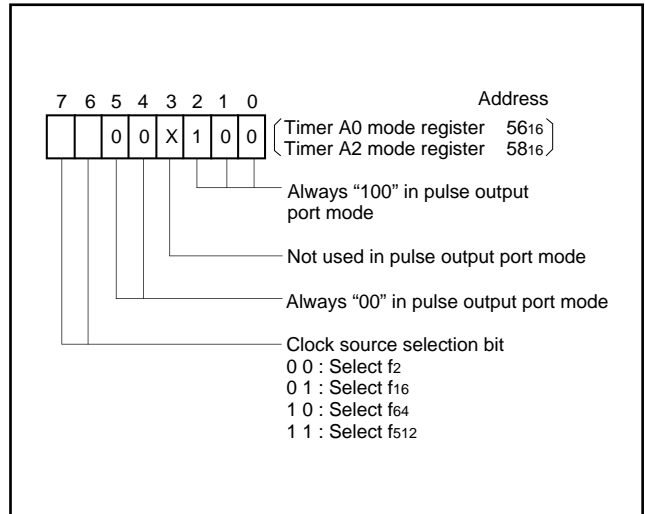


Fig. 5 Timer A0, A2 mode register bit configuration in pulse output port mode

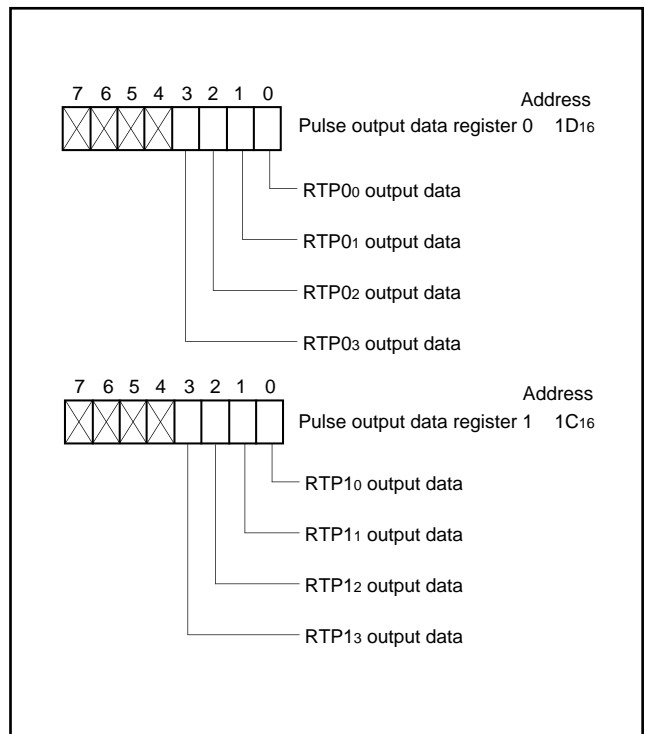


Fig. 6 Pulse output data register bit configuration



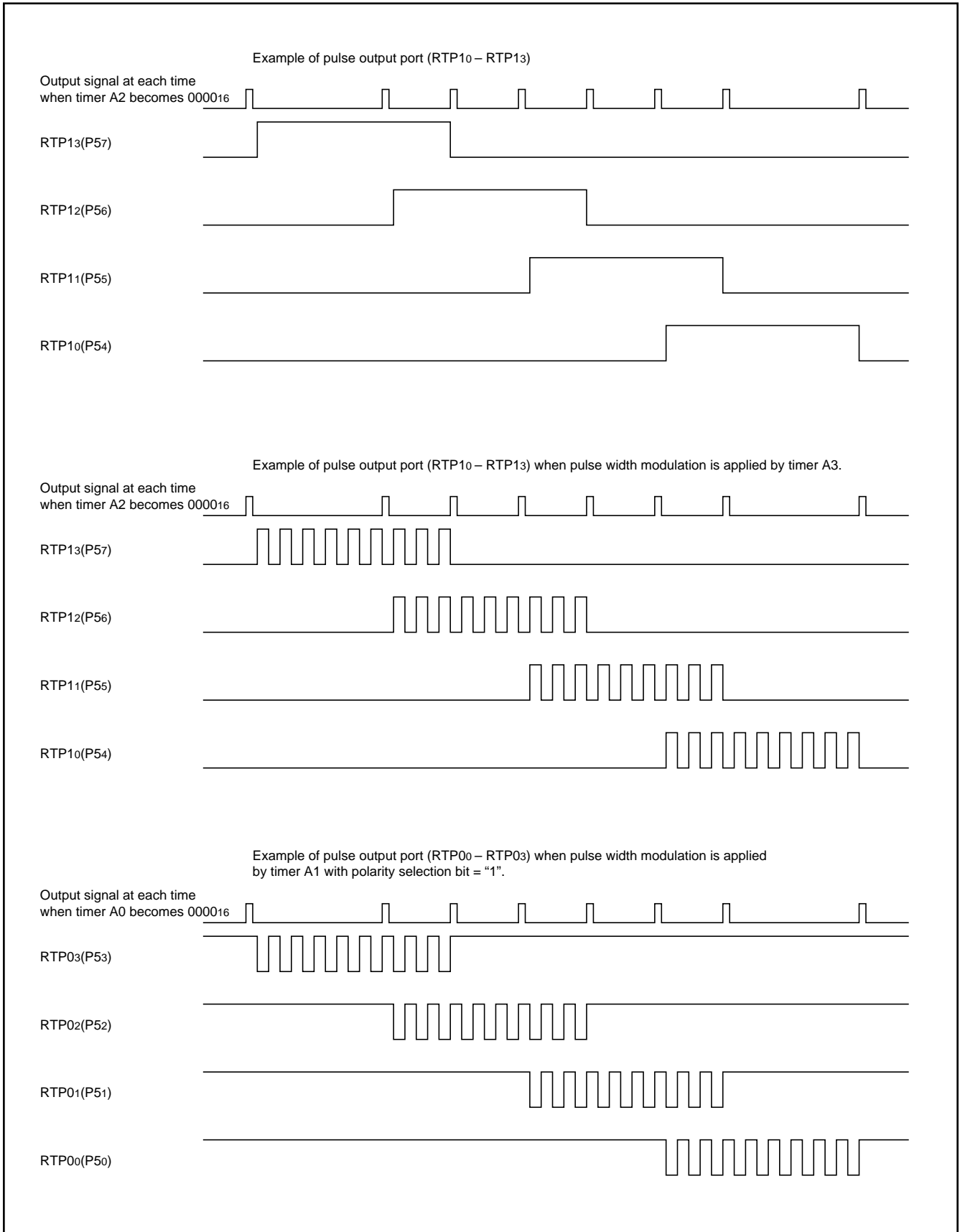


Fig. 7 Example of waveforms in pulse output port mode

**PROCESSOR MODE**

Only the microprocessor mode can be selected.  
 Figure 9 shows the functions of pins P00/CS0 – P47 in the microprocessor mode.  
 Figure 10 shows external memory area for the microprocessor mode. Access to the external memory is affected by the BYTE pin, the wait bit (bit 2 of the processor mode register 0 at address 5E16), and the wait selection bit (bit 0 of the processor mode register 1 at address 5F16) .

**• BYTE pin**

When accessing the external memory, the level of the BYTE pin is used to determine whether to use the data bus as 8-bit width or 16-bit width.

The data bus has a width of 8 bits when level of the BYTE pin is "H", and pins P20/A0/D0 – P27/A7/D7 are the data I/O pins.

The data bus has a width of 16 bits when the level of the BYTE pin is "L", and pins P20/A0/D0 – P27/A7/D7 and pins P10/A8/D8 – P17/A15/D15 are the data I/O pins.

When accessing the internal memory, the data bus always has a width of 16 bits regardless of the BYTE pin level.

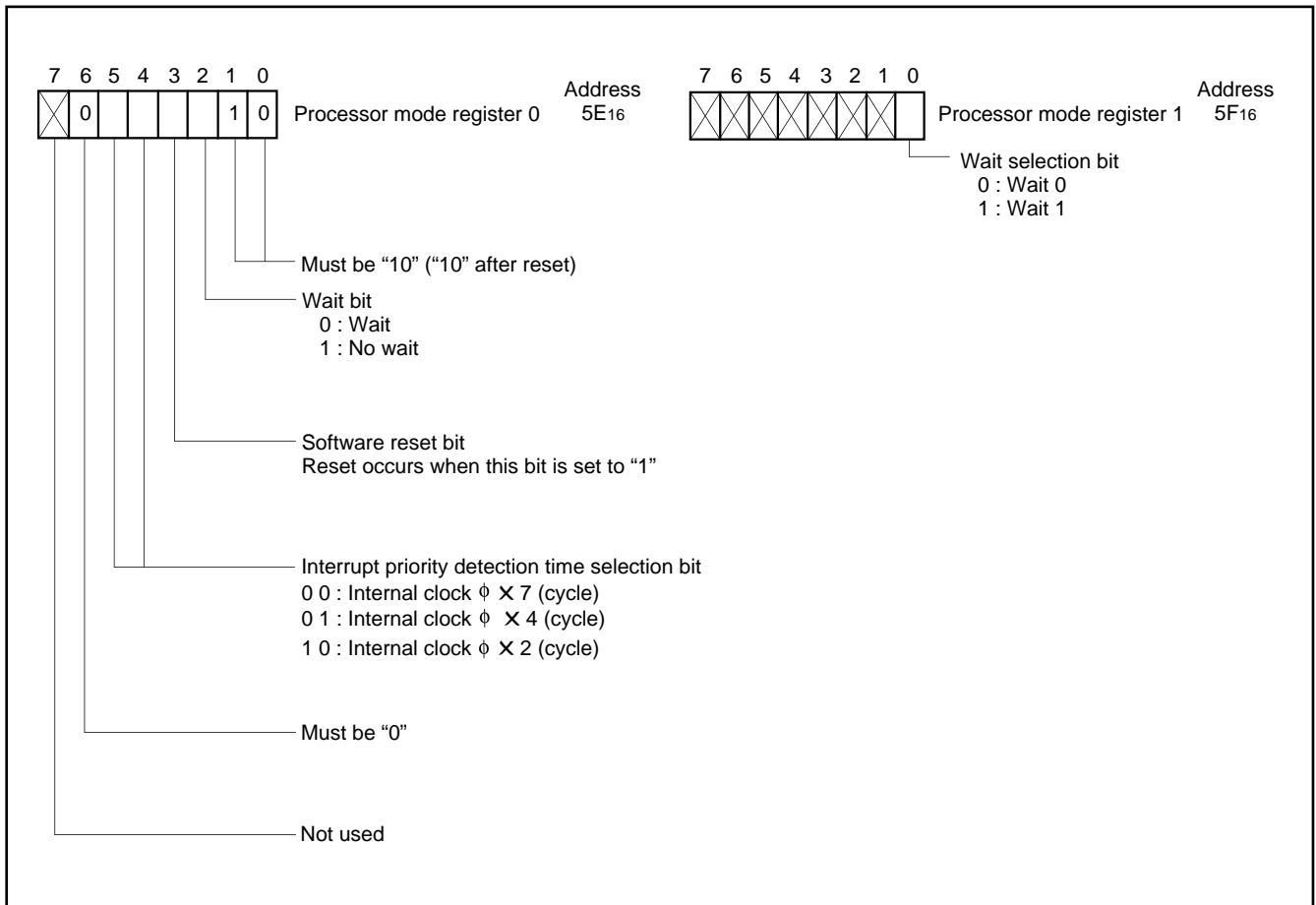


Fig. 8 Processor mode register bit configuration

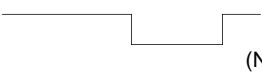
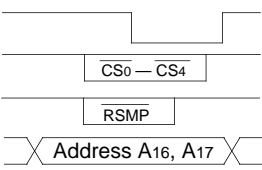
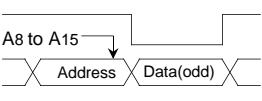
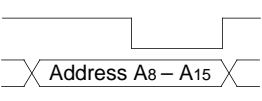
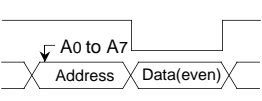
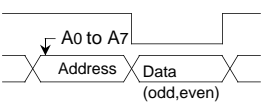
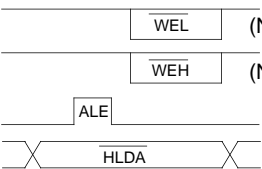
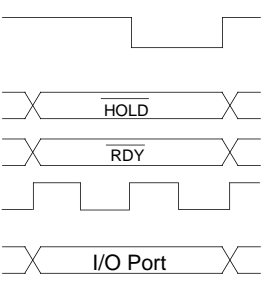
Pin		PM <sub>1</sub>	1
		PM <sub>0</sub>	0
		Mode	Microprocessor mode
$\overline{\text{RDE}}$		$\overline{\text{RDE}}$	 (Note)
$\overline{\text{CS}}_0$ to $\overline{\text{CS}}_4$ RSMP, A <sub>16</sub> , A <sub>17</sub>		( $\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ ) P <sub>00</sub> / $\overline{\text{CS}}_0$ to P <sub>04</sub> / $\overline{\text{CS}}_4$ P <sub>05</sub> /RSMP P <sub>06</sub> /A <sub>16</sub> P <sub>07</sub> /A <sub>17</sub>	
P <sub>10</sub> /A <sub>8</sub> /D <sub>8</sub> to P <sub>17</sub> /A <sub>15</sub> /D <sub>15</sub>	BYTE = "L"	( $\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ ) P <sub>10</sub> /A <sub>8</sub> /D <sub>8</sub> to P <sub>17</sub> /A <sub>15</sub> /D <sub>15</sub>	
	BYTE = "H"	( $\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ ) P <sub>10</sub> /A <sub>8</sub> /D <sub>8</sub> to P <sub>17</sub> /A <sub>15</sub> /D <sub>15</sub>	
P <sub>20</sub> /A <sub>0</sub> /D <sub>0</sub> to P <sub>27</sub> /A <sub>7</sub> /D <sub>7</sub>	BYTE = "L"	( $\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ ) P <sub>20</sub> /A <sub>0</sub> /D <sub>0</sub> to P <sub>27</sub> /A <sub>7</sub> /D <sub>7</sub>	
	BYTE = "H"	( $\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ ) P <sub>20</sub> /A <sub>0</sub> /D <sub>0</sub> to P <sub>27</sub> /A <sub>7</sub> /D <sub>7</sub>	
P <sub>30</sub> / $\overline{\text{WEL}}$ , P <sub>31</sub> / $\overline{\text{WEH}}$ , P <sub>32</sub> /ALE, P <sub>33</sub> /HLDA		P <sub>30</sub> / $\overline{\text{WEL}}$ P <sub>31</sub> / $\overline{\text{WEH}}$ P <sub>32</sub> /ALE P <sub>33</sub> /HLDA	
$\overline{\text{HOLD}}$ , $\overline{\text{RDY}}$ , P <sub>42</sub> / $\phi$ 1, Ports P <sub>43</sub> to P <sub>47</sub>		( $\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ ) $\overline{\text{HOLD}}$ $\overline{\text{RDY}}$ P <sub>42</sub> / $\phi$ 1 P <sub>43</sub> to P <sub>47</sub>	

Fig. 9 Functions of pins P<sub>00</sub>/ $\overline{\text{CS}}_0$  to P<sub>47</sub> in microprocessor mode

**Note.** The signal output disable selection bit (bit 6 of the oscillation circuit control register 0) can stop the  $\phi$  1 output in the microprocessor mode. In this mode, signals  $\overline{\text{RDE}}$ ,  $\overline{\text{WEL}}$ ,  $\overline{\text{WEH}}$  can also be fixed to "H" when the internal memory area is accessed.

**• Wait bit**

As shown in Figure 11, when the external memory area is accessed with the wait bit (bit 2 of the processor mode register 0 at address 5E16) cleared to "0", the access time can be extended compared with no wait (the wait bit is "1").

The access time is extended in two ways and this is selected with the wait selection bit (bit 0 of the processor mode register 1 at address 5F16).

When this bit is "1", the access time is 1.5 times compared to that for no wait. When this bit is "0", the access time is twice compared to that for no wait.

At reset, the wait bit and the wait selection bit are "0".

Access to internal memory area is always performed in the no wait mode regardless of the wait bit.

The processor modes are described below.

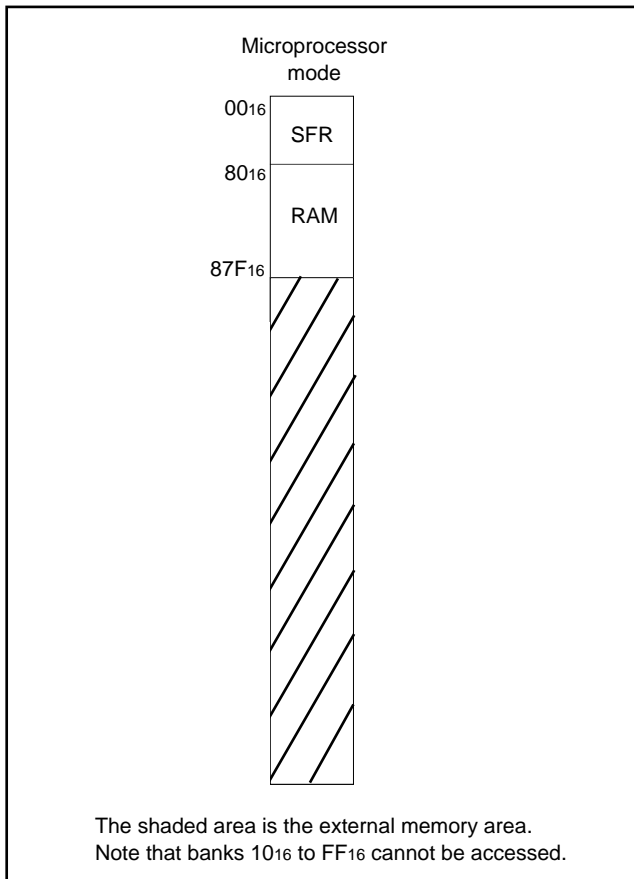


Fig. 10 External memory area for microprocessor mode

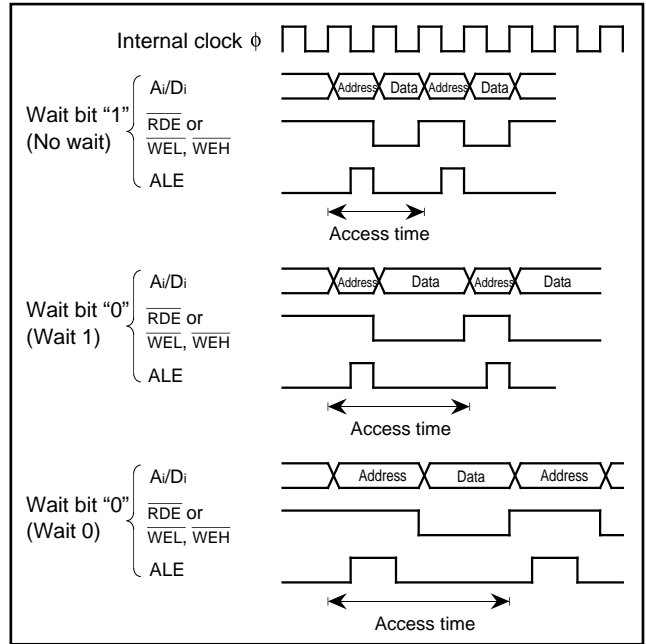


Fig. 11 Relationship between wait bit, wait selection bit, and access time

**(1) Microprocessor mode [10]**

The microcomputer enters the microprocessor mode after connecting the CNVss pin to Vcc and starting from reset.

Pin RDE is the output pin for the read enable signal (RDE).

RDE is "L" during the data read term in the read cycle. When the internal memory area is read, RDE can be fixed to "H" by setting the signal output disable selection bit (bit 6 of the oscillation circuit control register 0) to "1".

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 Notice: This is not a final specification.  
 Some parametric limits are subject to change.

$\overline{CS}_0$  to  $\overline{CS}_4$  are the chip select signals and are "L" when the address shown in Table 2 is accessed. RSMP is the ready-sampling signal which is output for the RDY input described later when the external memory area is accessed. By inputting logical AND of RSMP and  $\overline{CS}_n$  ( $n = 0$  to 4) to the  $\overline{RDY}$  pin, read/write term for any address areas can be extended by 1 cycle of clock  $\phi_1$ . In addition, the read/write term can also be extended by 2 cycles of clock  $\phi_1$  if the above function and wait 0/1 function specified with the wait bit are used together.

Pins P10/A8/D8 — P17/A15/D15 have two functions depending on the level of the BYTE pin.

When the BYTE pin level is "L", pins P10/A8/D8 — P17/A15/D15 function as address (A8 to A15) output pins while  $\overline{RDE}$  or  $\overline{WEL}$ ,  $\overline{WEH}$  are "H" and as odd address data I/O pins while these signals are "L". However, if an internal memory is read, external data is ignored while  $\overline{RDE}$  is "L".

When the BYTE pin level is "H", pins P10/A8/D8 — P17/A15/D15 function as address (A8 to A15) output pins.

Pins P20/A0/D0 — P27/A7/D7 have two functions depending on the level of the BYTE pin.

When the BYTE pin level is "L", pins P20/A0/D0 — P27/A7/D7 function as address (A0 to A7) output pins while  $\overline{RDE}$  or  $\overline{WEL}$ ,  $\overline{WEH}$  are "H" and as even address data I/O pins while these signals are "L". However, if an internal memory is read, external data is ignored while  $\overline{RDE}$  is "L".

When the BYTE pin level is "H", pins P20/A0/D0 — P27/A7/D7 function as address (A0 to A7) output pins while  $\overline{RDE}$  or  $\overline{WEL}$ ,  $\overline{WEH}$  are "H" and as even and odd address data I/O pins while these signals are "L". However, if an internal memory is read, external data is ignored while  $\overline{RDE}$  is "L".

$\overline{WEL}$ ,  $\overline{WEH}$  are the write-enable low signal and the write-enable high signal, respectively. These signals are "L" during the data write term of the write cycle, but their operations differ depending on the BYTE pin level.

In the case the BYTE pin level is "L",  $\overline{WEL}$  is "L" when writing to an even address,  $\overline{WEH}$  is "L" when writing to an odd address, and both  $\overline{WEL}$  and  $\overline{WEH}$  are "L" when writing to even and odd addresses. In the case the BYTE pin level is "H", regardless of address, only  $\overline{WEL}$  is "L", and  $\overline{WEH}$  retains "H".  $\overline{WEL}$  and  $\overline{WEH}$  can also be fixed to "H" when the internal memory is accessed, same as  $\overline{RDE}$ , by writing "1" to the signal output disable selection bit.

ALE is an address latch enable signal used to latch the address signal from a multiplexed signal of address and data. The latch is transparent while ALE is "H" to let the address signal pass through and held while ALE is "L".

$\overline{HLDA}$  is a hold acknowledge signal and is used to notify externally when the microcomputer receives  $\overline{HOLD}$  input and enters into hold state.

$\overline{HOLD}$  is a hold request signal. It is an input signal used to put the microcomputer in hold state.  $\overline{HOLD}$  input is accepted when the internal clock  $\phi$  falls from "H" level to "L" level while the bus is not used.

Pins P00/ $\overline{CS}_0$  — P31/ $\overline{WEH}$  and  $\overline{RDE}$  are floating while the microcomputer stays in hold state. After  $\overline{HLDA}$  signal changes to "L" level and one cycle of internal clock  $\phi$  passed, these ports become floating. After  $\overline{HLDA}$  signal changes to "H" level and one cycle of internal clock  $\phi$  passed, these ports are released from floating state.

$\overline{RDY}$  is a ready signal. If this signal goes "L", the internal clock  $\phi$  stops at "L".  $\overline{RDY}$  is used when slow external memory is attached. P42/ $\phi_1$  pin is an output pin for clock  $\phi_1$ . The  $\phi_1$  output is independent of  $\overline{RDY}$  and does not stop even when internal clock  $\phi$  stops because of "L" input to the  $\overline{RDY}$  pin.

As shown in Table 3,  $\phi_1$  output can be stopped with the signal output disable selection bit = "1". In this case, write "1" to the port P42 direction register.

Table 1 shows the relationship between the CNVss pin input level and the processor mode.

Table 1. Relationship between CNVss pin input levels and processor mode

CNVss	Mode	Description
Vcc	• Microprocessor	Microprocessor mode upon starting after reset.

Table 2. Relationship between access addresses and chip-select signals  $\overline{CS}_0$  to  $\overline{CS}_4$

Chip-select signal	Area	Access address
		Microprocessor mode
$\overline{CS}_0$	The first half of bank 00 <sub>16</sub> except internal memory area	00 0880 <sub>16</sub> to 00 7FFF <sub>16</sub>
$\overline{CS}_1$	The latter half of bank 00 <sub>16</sub> except internal memory area and banks 01 <sub>16</sub> to 03 <sub>16</sub> .	00 8000 <sub>16</sub> to 03 FFFF <sub>16</sub>
$\overline{CS}_2$	Banks 04 <sub>16</sub> to 07 <sub>16</sub>	04 0000 <sub>16</sub> to 07 FFFF <sub>16</sub>
$\overline{CS}_3$	Banks 08 <sub>16</sub> to 0B <sub>16</sub>	08 0000 <sub>16</sub> to 0B FFFF <sub>16</sub>
$\overline{CS}_4$	Banks 0C <sub>16</sub> to 0F <sub>16</sub>	0C 0000 <sub>16</sub> to 0F FFFF <sub>16</sub>

Table 3. Function of signal output disable selection bit CM<sub>6</sub> (bit 6 of oscillation circuit control register 0)

Processor mode	Pin	Function	
		CM <sub>6</sub> = "0"	CM <sub>6</sub> = "1"
Microprocessor mode	RDE, WEL, WEH	RDE, WEL, WEH are output when the internal/external memory area is accessed.	RDE, WEL, WEH are output only when the external memory area is accessed.
	$\overline{RDE}$	After WIT/STP instruction is executed, "H" is output.	"L" is output after WIT/STP instruction is executed * Standby state selection bit (bit 0 of port function control register) must be set to "1".
	$\phi_1$	Clock $\phi_1$ is output independent of $\phi_1$ output selection bit.	"H" or "L" is output. (Contents of P42 port latch is output.) * Port P42 direction register must be set to "1".

**Note.** Functions shown in Table 3 cannot be emulated with a debugger. For the oscillation circuit control register 0 and port function control register, refer to Figures 64 and 11 in data sheet "M37735MHBXXXFP", respectively.

**RESET CIRCUIT**

The microcomputer is released from the reset state when the  $\overline{\text{RESET}}$  pin is returned to "H" level after holding it at "L" level with the power source voltage at  $5\text{ V} \pm 10\%$ . Program execution starts at the address formed by setting address  $A_{23} - A_{16}$  to  $00_{16}$ ,  $A_{15} - A_8$  to the contents of address  $\text{FFF}_{16}$ , and  $A_7 - A_0$  to the contents of address  $\text{FFE}_{16}$ . Figure 13 shows an example of a reset circuit. If the stabilized clock is input from the external to the main-clock oscillation circuit, the reset

input voltage must be 0.9 V or less when the power source voltage reaches 4.5 V. If a resonator/oscillator is connected to the main-clock oscillation circuit, change the reset input voltage from "L" to "H" after the main-clock oscillation is fully stabilized.

Figure 12 shows the status of the internal registers during reset.

	Address		Address		
Port P0 direction register	(04) <sub>16</sub> ...	00 <sub>16</sub>	Watchdog timer frequency selection flag	(61) <sub>16</sub> ...	XXXXXXXXXX0
Port P1 direction register	(05) <sub>16</sub> ...	00 <sub>16</sub>	Waveform output mode register	(62) <sub>16</sub> ...	0X000X00
Port P2 direction register	(08) <sub>16</sub> ...	00 <sub>16</sub>	UART2 transmit/receive mode register	(64) <sub>16</sub> ...	X0000000
Port P3 direction register	(09) <sub>16</sub> ...	XXXXX000	UART2 transmit/receive control register 0	(68) <sub>16</sub> ...	XXXXX1000
Port P4 direction register	(0C) <sub>16</sub> ...	00 <sub>16</sub>	UART2 transmit/receive control register 1	(69) <sub>16</sub> ...	00000010
Port P5 direction register	(0D) <sub>16</sub> ...	00 <sub>16</sub>	Oscillation circuit control register 0	(6C) <sub>16</sub> ...	X00000X1
Port P6 direction register	(10) <sub>16</sub> ...	00 <sub>16</sub>	Port function control register	(6D) <sub>16</sub> ...	00 <sub>16</sub>
Port P7 direction register	(11) <sub>16</sub> ...	00 <sub>16</sub>	Serial transmit control register	(6E) <sub>16</sub> ...	XX00XXXX
Port P8 direction register	(14) <sub>16</sub> ...	00 <sub>16</sub>	Oscillation circuit control register 1	(6F) <sub>16</sub> ...	0XXXX0000
A-D control register 0	(1E) <sub>16</sub> ...	00000???	A-D/UART2 trans./rece. interrupt control register	(70) <sub>16</sub> ...	XXXXX0000
A-D control register 1	(1F) <sub>16</sub> ...	XX000X11	UART 0 transmission interrupt control register	(71) <sub>16</sub> ...	XXXXX0000
UART 0 transmit/receive mode register	(30) <sub>16</sub> ...	00 <sub>16</sub>	UART 0 receive interrupt control register	(72) <sub>16</sub> ...	XXXXX0000
UART 1 transmit/receive mode register	(38) <sub>16</sub> ...	00 <sub>16</sub>	UART 1 transmission interrupt control register	(73) <sub>16</sub> ...	XXXXX0000
UART 0 transmit/receive control register 0	(34) <sub>16</sub> ...	00001000	UART 1 receive interrupt control register	(74) <sub>16</sub> ...	XXXXX0000
UART 1 transmit/receive control register 0	(3C) <sub>16</sub> ...	00001000	Timer A0 interrupt control register	(75) <sub>16</sub> ...	XXXXX0000
UART 0 transmit/receive control register 1	(35) <sub>16</sub> ...	00000010	Timer A1 interrupt control register	(76) <sub>16</sub> ...	XXXXX0000
UART 1 transmit/receive control register 1	(3D) <sub>16</sub> ...	00000010	Timer A2 interrupt control register	(77) <sub>16</sub> ...	XXXXX0000
Count start flag	(40) <sub>16</sub> ...	00 <sub>16</sub>	Timer A3 interrupt control register	(78) <sub>16</sub> ...	XXXXX0000
One-shot start flag	(42) <sub>16</sub> ...	XXXX0000	Timer A4 interrupt control register	(79) <sub>16</sub> ...	XXXXX0000
Up-down flag	(44) <sub>16</sub> ...	00 <sub>16</sub>	Timer B0 interrupt control register	(7A) <sub>16</sub> ...	XXXXX0000
Timer A0 mode register	(56) <sub>16</sub> ...	00 <sub>16</sub>	Timer B1 interrupt control register	(7B) <sub>16</sub> ...	XXXXX0000
Timer A1 mode register	(57) <sub>16</sub> ...	00 <sub>16</sub>	Timer B2 interrupt control register	(7C) <sub>16</sub> ...	XXXXX0000
Timer A2 mode register	(58) <sub>16</sub> ...	00 <sub>16</sub>	$\overline{\text{INT}}_0$ interrupt control register	(7D) <sub>16</sub> ...	XX000000
Timer A3 mode register	(59) <sub>16</sub> ...	00 <sub>16</sub>	$\overline{\text{INT}}_1$ interrupt control register	(7E) <sub>16</sub> ...	XX000000
Timer A4 mode register	(5A) <sub>16</sub> ...	00 <sub>16</sub>	$\overline{\text{INT}}_2$ /key input interrupt control register	(7F) <sub>16</sub> ...	XX000000
Timer B0 mode register	(5B) <sub>16</sub> ...	00100000	Processor status register (PS)		000??0001??
Timer B1 mode register	(5C) <sub>16</sub> ...	001X0000	Program bank register (PG)		00 <sub>16</sub>
Timer B2 mode register	(5D) <sub>16</sub> ...	001X0000	Program counter (PC <sub>H</sub> )		Content of FFF <sub>16</sub>
Processor mode register 0	(5E) <sub>16</sub> ...	00 <sub>16</sub>	Program counter (PC <sub>L</sub> )		Content of FFE <sub>16</sub>
Processor mode register 1	(5F) <sub>16</sub> ...	XXXXXX0	Direct page register (DPR)		0000 <sub>16</sub>
Watchdog timer register	(60) <sub>16</sub> ...	FFF <sub>16</sub>	Data bank register (DT)		00 <sub>16</sub>

Contents of other registers and RAM are undefined during reset. Initialize them by software.

Fig. 12 Microcomputer internal status during reset

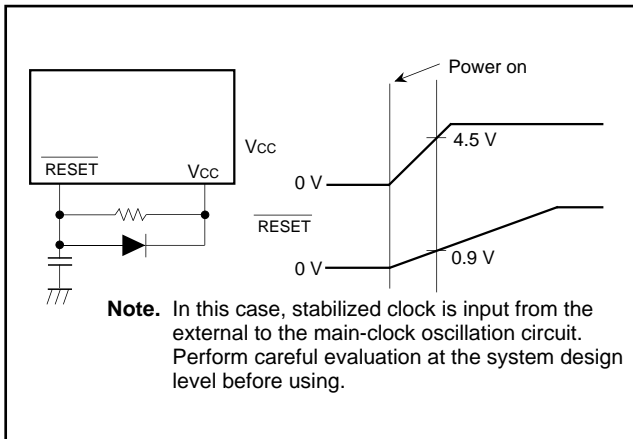


Fig. 13 Example of a reset circuit

**ADDRESSING MODES**

The M37735S4BFP has 28 powerful addressing modes. Refer to the MITSUBISHI SEMICONDUCTORS DATA BOOK SINGLE-CHIP 16-BIT MICROCOMPUTERS for the details of each addressing mode.

**MACHINE INSTRUCTION LIST**

The M37735S4BFP has 103 machine instructions. Refer to the MITSUBISHI SEMICONDUCTORS DATA BOOK SINGLE-CHIP 16-BIT MICROCOMPUTERS for details.



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Conditions	Ratings	Unit
V <sub>cc</sub>	Power source voltage		-0.3 to +7	V
AV <sub>cc</sub>	Analog power source voltage		-0.3 to +7	V
V <sub>I</sub>	Input voltage RESET, CNV <sub>ss</sub> , BYTE		-0.3 to +12	V
V <sub>I</sub>	Input voltage P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, V <sub>REF</sub> , X <sub>IN</sub> , HOLD, RDY		-0.3 to V <sub>cc</sub> + 0.3	V
V <sub>O</sub>	Output voltage P00/CS <sub>0</sub> – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLDA, P42/ φ 1, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, X <sub>OUT</sub> , RDE		-0.3 to V <sub>cc</sub> + 0.3	V
P <sub>d</sub>	Power dissipation	T <sub>a</sub> = 25 °C	300	mW
T <sub>opr</sub>	Operating temperature		-20 to +85	°C
T <sub>stg</sub>	Storage temperature		-40 to +150	°C

**RECOMMENDED OPERATING CONDITIONS** (V<sub>cc</sub> = 5 V ± 10%, T<sub>a</sub> = -20 to +85 °C, unless otherwise noted)

Symbol	Parameter	Limits			Unit	
		Min.	Typ.	Max.		
V <sub>cc</sub>	Power source voltage	f(X <sub>IN</sub> ) : Operating	4.5	5.0	5.5	V
		f(X <sub>IN</sub> ) : Stopped, f(X <sub>CIN</sub> ) = 32.768 kHz	2.7		5.5	
AV <sub>cc</sub>	Analog power source voltage		V <sub>cc</sub>		V	
V <sub>ss</sub>	Power source voltage		0		V	
AV <sub>ss</sub>	Analog power source voltage		0		V	
V <sub>IH</sub>	High-level input voltage HOLD, RDY, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, X <sub>IN</sub> , RESET, CNV <sub>ss</sub> , BYTE, X <sub>CIN</sub> (Note 3)	0.8 V <sub>cc</sub>		V <sub>cc</sub>	V	
V <sub>IH</sub>	High-level input voltage P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7	0.5 V <sub>cc</sub>		V <sub>cc</sub>	V	
V <sub>IL</sub>	Low-level input voltage HOLD, RDY, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, X <sub>IN</sub> , RESET, CNV <sub>ss</sub> , BYTE, X <sub>CIN</sub> (Note 3)	0		0.2V <sub>cc</sub>	V	
V <sub>IL</sub>	Low-level input voltage P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7	0		0.16V <sub>cc</sub>	V	
I <sub>OH(peak)</sub>	High-level peak output current P00/CS <sub>0</sub> – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLDA, P42/ φ 1, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87			-10	mA	
I <sub>OH(avg)</sub>	High-level average output current P00/CS <sub>0</sub> – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLDA, P42/ φ 1, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87			-5	mA	
I <sub>OL(peak)</sub>	Low-level peak output current P00/CS <sub>0</sub> – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLDA, P42/ φ 1, P43, P54 – P57, P60 – P67, P70 – P77, P80 – P87			10	mA	
I <sub>OL(peak)</sub>	Low-level peak output current P44 – P47, P50 – P53			20	mA	
I <sub>OL(avg)</sub>	Low-level average output current P00/CS <sub>0</sub> – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLDA, P42/ φ 1, P43, P54 – P57, P60 – P67, P70 – P77, P80 – P87			5	mA	
I <sub>OL(avg)</sub>	Low-level average output current P44 – P47, P50 – P53			15	mA	
f(X <sub>IN</sub> )	Main-clock oscillation frequency (Note 4)			25	MHz	
f(X <sub>CIN</sub> )	Sub-clock oscillation frequency		32.768	50	kHz	

**Notes 1.** Average output current is the average value of a 100 ms interval.

**2.** The sum of I<sub>OL(peak)</sub> for ports P00/CS<sub>0</sub> – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLDA and P8 must be 80 mA or less, the sum of I<sub>OH(peak)</sub> for ports P00/CS<sub>0</sub> – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLDA and P8 must be 80 mA or less, the sum of I<sub>OL(peak)</sub> for ports P4, P5, P6, and P7 must be 100 mA or less, and the sum of I<sub>OH(peak)</sub> for ports P4, P5, P6, and P7 must be 80 mA or less.

**3.** Limits V<sub>IH</sub> and V<sub>IL</sub> for X<sub>CIN</sub> are applied when the sub clock external input selection bit = "1".

**4.** The maximum value of f(X<sub>IN</sub>) = 12.5 MHz when the main clock division selection bit = "1".

**ELECTRICAL CHARACTERISTICS** ( $V_{CC} = 5\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = -20\text{ to }+85\text{ }^\circ\text{C}$ ,  $f(X_{IN}) = 25\text{ MHz}$ , unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
$V_{OH}$	High-level output voltage $P00/\overline{CS_0} - P07/A_{17}$ , $P10/A_8/D_8 - P17/A_{15}/D_{15}$ , $P20/A_0/D_0 - P27/A_7/D_7$ , $P33/\overline{HLDA}$ , $P42/\phi_1$ , $P43 - P47$ , $P50 - P57$ , $P60 - P67$ , $P70 - P77$ , $P80 - P87$	$I_{OH} = -10\text{ mA}$	3			V
$V_{OH}$	High-level output voltage $P00/\overline{CS_0} - P07/A_{17}$ , $P10/A_8/D_8 - P17/A_{15}/D_{15}$ , $P20/A_0/D_0 - P27/A_7/D_7$ , $P33/\overline{HLDA}$ , $P42/\phi_1$	$I_{OH} = -400\ \mu\text{A}$	4.7			V
$V_{OH}$	High-level output voltage $P30/\overline{WEL}$ , $P31/\overline{WEH}$ , $P32/\overline{ALE}$	$I_{OH} = -10\text{ mA}$ $I_{OH} = -400\ \mu\text{A}$	3.1 4.8			V
$V_{OH}$	High-level output voltage $\overline{RDE}$	$I_{OH} = -10\text{ mA}$ $I_{OH} = -400\ \mu\text{A}$	3.4 4.8			V
$V_{OL}$	Low-level output voltage $P00/\overline{CS_0} - P07/A_{17}$ , $P10/A_8/D_8 - P17/A_{15}/D_{15}$ , $P20/A_0/D_0 - P27/A_7/D_7$ , $P33/\overline{HLDA}$ , $P42/\phi_1$ , $P43$ , $P54 - P57$ , $P60 - P67$ , $P70 - P77$ , $P80 - P87$	$I_{OL} = 10\text{ mA}$			2	V
$V_{OL}$	Low-level output voltage $P44 - P47$ , $P50 - P53$	$I_{OL} = 20\text{ mA}$			2	V
$V_{OL}$	Low-level output voltage $P00/\overline{CS_0} - P07/A_{17}$ , $P10/A_8/D_8 - P17/A_{15}/D_{15}$ , $P20/A_0/D_0 - P27/A_7/D_7$ , $P33/\overline{HLDA}$ , $P42/\phi_1$	$I_{OL} = 2\text{ mA}$			0.45	V
$V_{OL}$	Low-level output voltage $P30/\overline{WEL}$ , $P31/\overline{WEH}$ , $P32/\overline{ALE}$	$I_{OL} = 10\text{ mA}$ $I_{OL} = 2\text{ mA}$			1.9 0.43	V
$V_{OL}$	Low-level output voltage $\overline{RDE}$	$I_{OL} = 10\text{ mA}$ $I_{OL} = 2\text{ mA}$			1.6 0.4	V
$V_{T+} - V_{T-}$	Hysteresis $\overline{HOLD}$ , $\overline{RDY}$ , $\overline{TA0IN} - \overline{TA4IN}$ , $\overline{TB0IN} - \overline{TB2IN}$ , $\overline{INT_0} - \overline{INT_2}$ , $\overline{ADTRG}$ , $\overline{CTS_0}$ , $\overline{CTS_1}$ , $\overline{CTS_2}$ , $\overline{CLK_0}$ , $\overline{CLK_1}$ , $\overline{CLK_2}$ , $\overline{Kl_0} - \overline{Kl_3}$		0.4		1	V
$V_{T+} - V_{T-}$	Hysteresis $\overline{RESET}$		0.2		0.5	V
$V_{T+} - V_{T-}$	Hysteresis $\overline{XIN}$		0.1		0.4	V
$V_{T+} - V_{T-}$	Hysteresis $\overline{XCIN}$ (When external clock is input)		0.1		0.4	V
$I_{IH}$	High-level input current $P10/A_8/D_8 - P17/A_{15}/D_{15}$ , $P20/A_0/D_0 - P27/A_7/D_7$ , $P43 - P47$ , $P50 - P57$ , $P60 - P67$ , $P70 - P77$ , $P80 - P87$ , $\overline{XIN}$ , $\overline{RESET}$ , $\overline{CNVss}$ , $\overline{BYTE}$	$V_I = 5\text{ V}$			5	$\mu\text{A}$
$I_{IL}$	Low-level input current $P10/A_8/D_8 - P17/A_{15}/D_{15}$ , $P20/A_0/D_0 - P27/A_7/D_7$ , $P43 - P47$ , $P50 - P53$ , $P60$ , $P61$ , $P65 - P67$ , $P70 - P77$ , $P80 - P87$ , $\overline{XIN}$ , $\overline{RESET}$ , $\overline{CNVss}$ , $\overline{BYTE}$	$V_I = 0\text{ V}$			-5	$\mu\text{A}$
$I_{IL}$	Low-level input current $P54 - P57$ , $P62 - P64$	$V_I = 0\text{ V}$ , without a pull-up transistor			-5	$\mu\text{A}$
		$V_I = 0\text{ V}$ , with a pull-up transistor	-0.25	-0.5	-1.0	mA
$V_{RAM}$	RAM hold voltage	When clock is stopped.	2			V

**ELECTRICAL CHARACTERISTICS** ( $V_{CC} = 5\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = -20\text{ to }+85\text{ }^\circ\text{C}$ , unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit	
			Min.	Typ.	Max.		
I <sub>CC</sub>	Power source current	When external bus is in use, output pins are open, and other pins are V <sub>SS</sub> .	V <sub>CC</sub> = 5 V, f(X <sub>IN</sub> ) = 25 MHz (square waveform), f(f <sub>2</sub> ) = 12.5 MHz, f(X <sub>CIN</sub> ) = 32.768 kHz, in operating (Note 1)		11.4	22.8	mA
			V <sub>CC</sub> = 5 V, f(X <sub>IN</sub> ) = 25 MHz (square waveform), f(f <sub>2</sub> ) = 1.5625 MHz, f(X <sub>CIN</sub> ): Stopped in operating (Note 1)		1.6	3.2	mA
			V <sub>CC</sub> = 5 V, f(X <sub>IN</sub> ) = 25 MHz (square waveform), f(X <sub>CIN</sub> ) = 32.768 kHz, when a WIT instruction is executed (Note 2)		10	20	μA
			V <sub>CC</sub> = 5 V, f(X <sub>IN</sub> ): Stopped, f(X <sub>CIN</sub> ) = 32.768 kHz, in operating (Note 3)		60	120	μA
			V <sub>CC</sub> = 5 V, f(X <sub>IN</sub> ): Stopped, f(X <sub>CIN</sub> ) = 32.768 kHz, when a WIT instruction is executed (Note 4)		5	10	μA
			T <sub>a</sub> = 25 °C, when clock is stopped			1	μA
			T <sub>a</sub> = 85 °C, when clock is stopped				20

- Notes**
1. This applies when the main clock external input selection bit = "1", the main clock division selection bit = "0", and the signal output stop bit = "1".
  2. This applies when the main clock external input selection bit = "1" and the system clock stop bit at wait state = "1".
  3. This applies when CPU and the clock timer are operating with the sub clock (32.768 kHz) selected as the system clock.
  4. This applies when the X<sub>COUT</sub> drivability selection bit = "0" and the system clock stop bit at wait state = "1".

**A-D CONVERTER CHARACTERISTICS**

( $V_{CC} = AV_{CC} = 5\text{ V}$ ,  $V_{SS} = AV_{SS} = 0\text{ V}$ ,  $T_a = -20\text{ to }+85\text{ }^\circ\text{C}$ ,  $f(X_{IN}) = 25\text{ MHz}$ , unless otherwise noted (Note))

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
—	Resolution	V <sub>REF</sub> = V <sub>CC</sub>			10	Bits
—	Absolute accuracy	V <sub>REF</sub> = V <sub>CC</sub>			± 3	LSB
RLADDER	Ladder resistance	V <sub>REF</sub> = V <sub>CC</sub>	10		25	kΩ
t <sub>CONV</sub>	Conversion time		9.44			μs
V <sub>REF</sub>	Reference voltage		2		V <sub>CC</sub>	V
V <sub>IA</sub>	Analog input voltage		0		V <sub>REF</sub>	V

**Note.** This applies when the main clock division selection bit = "0" and f(f<sub>2</sub>) = 12.5 MHz.

**TIMING REQUIREMENTS** ( $V_{CC} = 5\text{ V} \pm 10\%$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = -20\text{ to }+85\text{ }^\circ\text{C}$ ,  $f(X_{IN}) = 25\text{ MHz}$ , unless otherwise noted (Note 1))

**Notes 1.** This applies when the main clock division selection bit = "0" and  $f(f_2) = 12.5\text{ MHz}$ .

**2.** Input signal's rise/fall time must be 100 ns or less, unless otherwise noted.

**External clock input**

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_c$	External clock input cycle time (Note 1)	40		ns
$t_{w(H)}$	External clock input high-level pulse width (Note 2)	15		ns
$t_{w(L)}$	External clock input low-level pulse width (Note 2)	15		ns
$t_r$	External clock rise time		8	ns
$t_f$	External clock fall time		8	ns

**Notes 1.** When the main clock division selection bit = "1", the minimum value of  $t_c = 80\text{ ns}$ .

**2.** When the main clock division selection bit = "1", values of  $t_{w(H)} / t_c$  and  $t_{w(L)} / t_c$  must be set to values from 0.45 through 0.55.

**Microprocessor mode**

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{su}(P4D-RDE)$	Port P4 input setup time	60		ns
$t_{su}(P5D-RDE)$	Port P5 input setup time	60		ns
$t_{su}(P6D-RDE)$	Port P6 input setup time	60		ns
$t_{su}(P7D-RDE)$	Port P7 input setup time	60		ns
$t_{su}(P8D-RDE)$	Port P8 input setup time	60		ns
$t_h(RDE-P4D)$	Port P4 input hold time	0		ns
$t_h(RDE-P5D)$	Port P5 input hold time	0		ns
$t_h(RDE-P6D)$	Port P6 input hold time	0		ns
$t_h(RDE-P7D)$	Port P7 input hold time	0		ns
$t_h(RDE-P8D)$	Port P8 input hold time	0		ns

**Microprocessor mode**

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{su}(D-RDE)$	Data input setup time	32		ns
$t_{su}(RDY-\phi 1)$	RDY input setup time	55		ns
$t_{su}(HOLD-\phi 1)$	HOLD input setup time	55		ns
$t_h(RDE-D)$	Data input hold time	0		ns
$t_h(\phi 1-RDY)$	RDY input hold time	0		ns
$t_h(\phi 1-HOLD)$	HOLD input hold time	0		ns

**PRELIMINARY**  
 Notice: This is not a final specification.  
 Some parametric limits are subject to change.

**Timer A input** (Count input in event counter mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN input cycle time	80		ns
$t_{w(TAH)}$	TAiIN input high-level pulse width	40		ns
$t_{w(TAL)}$	TAiIN input low-level pulse width	40		ns

**Timer A input** (Gating input in timer mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN input cycle time (Note)	320		ns
$t_{w(TAH)}$	TAiIN input high-level pulse width (Note)	160		ns
$t_{w(TAL)}$	TAiIN input low-level pulse width (Note)	160		ns

**Note.** Limits change depending on  $f(X_{IN})$ . Refer to "DATA FORMULAS".

**Timer A input** (External trigger input in one-shot pulse mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN input cycle time (Note)	320		ns
$t_{w(TAH)}$	TAiIN input high-level pulse width	80		ns
$t_{w(TAL)}$	TAiIN input low-level pulse width	80		ns

**Note.** Limits change depending on  $f(X_{IN})$ . Refer to "DATA FORMULAS".

**Timer A input** (External trigger input in pulse width modulation mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{w(TAH)}$	TAiIN input high-level pulse width	80		ns
$t_{w(TAL)}$	TAiIN input low-level pulse width	80		ns

**Timer A input** (Up-down input in event counter mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(UP)}$	TAiOUT input cycle time	2000		ns
$t_{w(UPH)}$	TAiOUT input high-level pulse width	1000		ns
$t_{w(UPL)}$	TAiOUT input low-level pulse width	1000		ns
$t_{su(UP-TIN)}$	TAiOUT input setup time	400		ns
$t_{h(TIN-UP)}$	TAiOUT input hold time	400		ns

**Timer A input** (Two-phase pulse input in event counter mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TA)}$	TAjIN input cycle time	800		ns
$t_{su(TAjIN-TAjOUT)}$	TAjIN input setup time	200		ns
$t_{su(TAjOUT-TAjIN)}$	TAjOUT input setup time	200		ns

**PRELIMINARY**  
 Notice: This is not a final specification.  
 Some parametric limits are subject to change.

### Timer B input (Count input in event counter mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TB)}$	TBiIN input cycle time (one edge count)	80		ns
$t_{w(TBH)}$	TBiIN input high-level pulse width (one edge count)	40		ns
$t_{w(TBL)}$	TBiIN input low-level pulse width (one edge count)	40		ns
$t_{c(TB)}$	TBiIN input cycle time (both edges count)	160		ns
$t_{w(TBH)}$	TBiIN input high-level pulse width (both edges count)	80		ns
$t_{w(TBL)}$	TBiIN input low-level pulse width (both edges count)	80		ns

### Timer B input (Pulse period measurement mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TB)}$	TBiIN input cycle time (Note)	320		ns
$t_{w(TBH)}$	TBiIN input high-level pulse width (Note)	160		ns
$t_{w(TBL)}$	TBiIN input low-level pulse width (Note)	160		ns

**Note.** Limits change depending on  $f(X_{IN})$ . Refer to "DATA FORMULAS".

### Timer B input (Pulse width measurement mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TB)}$	TBiIN input cycle time (Note)	320		ns
$t_{w(TBH)}$	TBiIN input high-level pulse width (Note)	160		ns
$t_{w(TBL)}$	TBiIN input low-level pulse width (Note)	160		ns

**Note.** Limits change depending on  $f(X_{IN})$ . Refer to "DATA FORMULAS".

### A-D trigger input

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(AD)}$	ADTRG input cycle time (minimum allowable trigger)	1000		ns
$t_{w(ADL)}$	ADTRG input low-level pulse width	125		ns

### Serial I/O

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(CK)}$	CLKi input cycle time	200		ns
$t_{w(CKH)}$	CLKi input high-level pulse width	100		ns
$t_{w(CKL)}$	CLKi input low-level pulse width	100		ns
$t_{d(C-Q)}$	TxDi output delay time		80	ns
$t_{h(C-Q)}$	TxDi hold time	0		ns
$t_{su(D-C)}$	RxDi input setup time	30		ns
$t_{h(C-D)}$	RxDi input hold time	90		ns

### External interrupt $\overline{INT}_i$ input, key input interrupt $\overline{KLi}$ input

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{w(INH)}$	$\overline{INT}_i$ input high-level pulse width	250		ns
$t_{w(INL)}$	$\overline{INT}_i$ input low-level pulse width	250		ns
$t_{w(KIL)}$	$\overline{KLi}$ input low-level pulse width	250		ns

**DATA FORMULAS**

**Timer A input** (Gating input in timer mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN input cycle time	$\frac{8 \times 10^9}{2 \cdot f(f_2)}$		ns
$t_w(TAH)$	TAiIN input high-level pulse width	$\frac{4 \times 10^9}{2 \cdot f(f_2)}$		ns
$t_w(TAL)$	TAiIN input low-level pulse width	$\frac{4 \times 10^9}{2 \cdot f(f_2)}$		ns

**Timer A input** (External trigger input in one-shot pulse mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TA)}$	TAiIN input cycle time	$\frac{8 \times 10^9}{2 \cdot f(f_2)}$		ns

**Timer B input** (In pulse period measurement mode or pulse width measurement mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TB)}$	TBiIN input cycle time	$\frac{8 \times 10^9}{2 \cdot f(f_2)}$		ns
$t_w(TBH)$	TBiIN input high-level pulse width	$\frac{4 \times 10^9}{2 \cdot f(f_2)}$		ns
$t_w(TBL)$	TBiIN input low-level pulse width	$\frac{4 \times 10^9}{2 \cdot f(f_2)}$		ns

**Note.**  $f(f_2)$  represents the clock  $f_2$  frequency.

For the relation to the main clock and sub clock, refer to Table 10 in data sheet "M37735MHBXXXFP".

**SWITCHING CHARACTERISTICS**

(V<sub>CC</sub> = 5 V ± 10%, V<sub>SS</sub> = 0 V, T<sub>a</sub> = -20 to +85°C, f(X<sub>IN</sub>) = 25 MHz, unless otherwise noted (Note))

**Microprocessor mode**

Symbol	Parameter	Test conditions	Limits		Unit
			Min.	Max.	
t <sub>d</sub> (WE-P4Q)	Port P4 data output delay time	Fig. 14		80	ns
t <sub>d</sub> (WE-P5Q)	Port P5 data output delay time			80	ns
t <sub>d</sub> (WE-P6Q)	Port P6 data output delay time			80	ns
t <sub>d</sub> (WE-P7Q)	Port P7 data output delay time			80	ns
t <sub>d</sub> (WE-P8Q)	Port P8 data output delay time			80	ns
t <sub>d</sub> (WE-P8Q)	Port P8 data output delay time			80	ns

**Note.** This applies when the main clock division selection bit = "0" and f(t<sub>2</sub>) = 12.5 MHz.

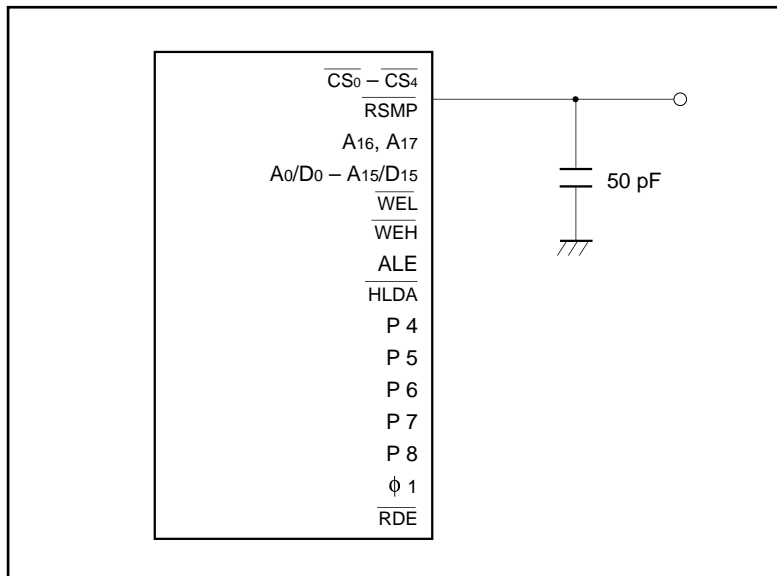


Fig. 14 Measuring circuit for each pin



**Microprocessor mode**

(VCC = 5 V ± 10%, VSS = 0 V, Ta = -20 to +85 °C, f(XIN) = 25 MHz, unless otherwise noted (Note 1))

Symbol	Parameter	(Note 2) Wait mode	Test conditions	Limits		Unit		
				Min.	Max.			
td(CS-WE) td(CS-RDE)	Chip-select output delay time	No wait	Fig. 14	12		ns		
		Wait 1		87		ns		
		Wait 0						
th(WE-CS) th(RDE-CS)	Chip-select hold time			4		ns		
		td(An-WE) td(An-RDE)		Address output delay time	No wait	12		ns
					Wait 1	87		ns
Wait 0								
td(A-WE) td(A-RDE)	Address output delay time	No wait		12		ns		
		Wait 1		75		ns		
		Wait 0						
th(WE-An) th(RDE-An)	Address hold time			18		ns		
		tw(ALE)		ALE pulse width	No wait	22		ns
					Wait 1	57		ns
Wait 0								
tsu(A-ALE)	Address output setup time	No wait		5		ns		
		Wait 1	45		ns			
		Wait 0						
th(ALE-A)	Address hold time	No wait	9		ns			
		Wait 1	15		ns			
		Wait 0						
td(ALE-WE) td(ALE-RDE)	ALE output delay time	No wait	4		ns			
		Wait 1	10		ns			
		Wait 0						
td(WE-DQ)	Data output delay time			45	ns			
th(WE-DQ)	Data hold time		18		ns			
tw(WE)	WE pulse width	No wait	50		ns			
		Wait 1	130		ns			
		Wait 0						
tpxz(RDE-DZ)	Floating start delay time			5	ns			
tpzx(RDE-DZ)	Floating release delay time		20		ns			
tw(RDE)	RDE pulse width	No wait	48		ns			
		Wait 1	128		ns			
		Wait 0						
td(RSMP-WE) td(RSMP-RDE)	RSMP output delay time		10		ns			
		th(φ1-RSMP)	RSMP hold time	0		ns		
td(WE-φ1) td(RDE-φ1)	φ1 output delay time		0	18	ns			
td(φ1-HLDA)	HLDA output delay time			50	ns			

**Notes 1.** This applies when the main clock division selection bit = "0" and f(f2) = 12.5 MHz.

**2.** No wait : Wait bit = "1".

Wait 1 : The external memory area is accessed with wait bit = "0" and wait selection bit = "1".

Wait 0 : The external memory area is accessed with wait bit = "0" and wait selection bit = "0".

**PRELIMINARY**  
 Notice: This is not a final specification.  
 Some parametric limits are subject to change.

**Microprocessor mode**

**Bus timing data formulas** ( $V_{CC} = 5 V \pm 10\%$ ,  $V_{SS} = 0 V$ ,  $T_a = -20$  to  $+85^\circ C$ ,  $f(X_{IN}) = 25$  MHz (Max.), unless otherwise noted (Note1))

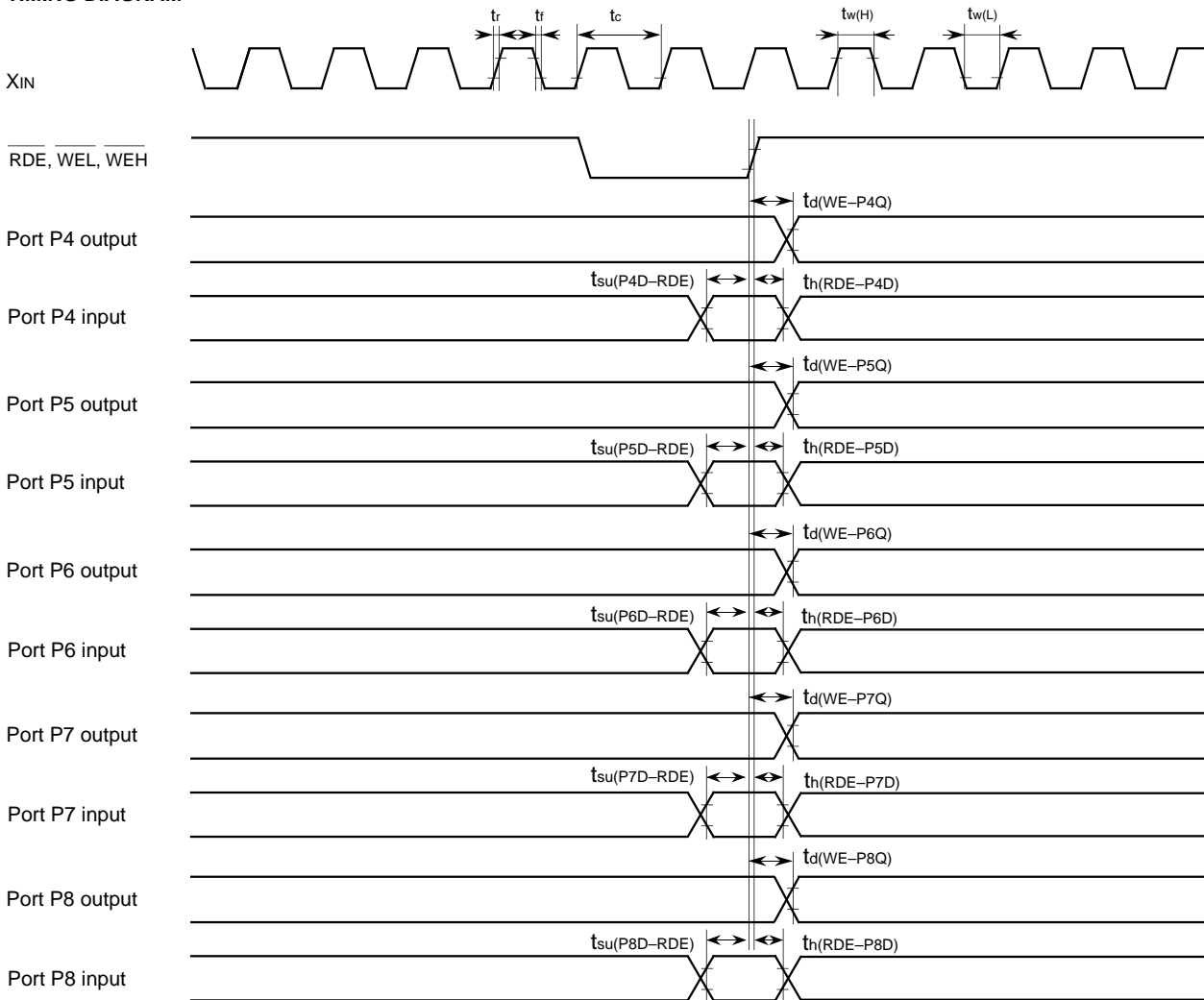
Symbol	Parameter	Wait mode	Limits		Unit
			Min.	Max.	
$t_{d(CS-WE)}$ $t_{d(CS-RDE)}$	Chip-select output delay time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 28		ns
		Wait 1	$\frac{3 \times 10^9}{2 \cdot f(f_2)}$ - 33		
$t_{h(WE-CS)}$ $t_{h(RDE-CS)}$	Chip-select hold time		4		ns
$t_{d(A_n-WE)}$ $t_{d(A_n-RDE)}$	Address output delay time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 28		ns
		Wait 1	$\frac{3 \times 10^9}{2 \cdot f(f_2)}$ - 33		
$t_{d(A-WE)}$ $t_{d(A-RDE)}$	Address output delay time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 28		ns
		Wait 1	$\frac{3 \times 10^9}{2 \cdot f(f_2)}$ - 45		
$t_{h(WE-A_n)}$ $t_{h(RDE-A_n)}$	Address hold time		$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 22		ns
$t_w(ALE)$	ALE pulse width	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 18		ns
		Wait 1	$\frac{2 \times 10^9}{2 \cdot f(f_2)}$ - 23		
$t_{su}(A-ALE)$	Address output setup time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 35		ns
		Wait 1	$\frac{2 \times 10^9}{2 \cdot f(f_2)}$ - 35		
$t_{h}(ALE-A)$	Address hold time	No wait	9		ns
		Wait 1	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 25		
$t_{d}(ALE-WE)$ $t_{d}(ALE-RDE)$	ALE output delay time	No wait	4		ns
		Wait 1	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 30		
$t_{d}(WE-DQ)$	Data output delay time			45	ns
$t_{h}(WE-DQ)$	Data hold time		$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 22		ns
$t_w(WE)$	$\overline{WEL}/\overline{WEH}$ pulse width	No wait	$\frac{2 \times 10^9}{2 \cdot f(f_2)}$ - 30		ns
		Wait 1	$\frac{4 \times 10^9}{2 \cdot f(f_2)}$ - 30		
$t_{pxz}(RDE-DZ)$	Floating start delay time			5	ns
$t_{pzx}(RDE-DZ)$	Floating release delay time		$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 20		ns
$t_w(RDE)$	$\overline{RDE}$ pulse width	No wait	$\frac{2 \times 10^9}{2 \cdot f(f_2)}$ - 32		ns
		Wait 1	$\frac{4 \times 10^9}{2 \cdot f(f_2)}$ - 32		
$t_{d}(RSMP-WE)$ $t_{d}(RSMP-RDE)$	RSMP output delay time		$\frac{1 \times 10^9}{2 \cdot f(f_2)}$ - 30		ns
$t_{h}(\phi_1-RSMP)$	RSMP hold time		0		ns
$t_{d}(WE-\phi_1)$ $t_{d}(RDE-\phi_1)$	$\phi_1$ output delay time		0	18	ns

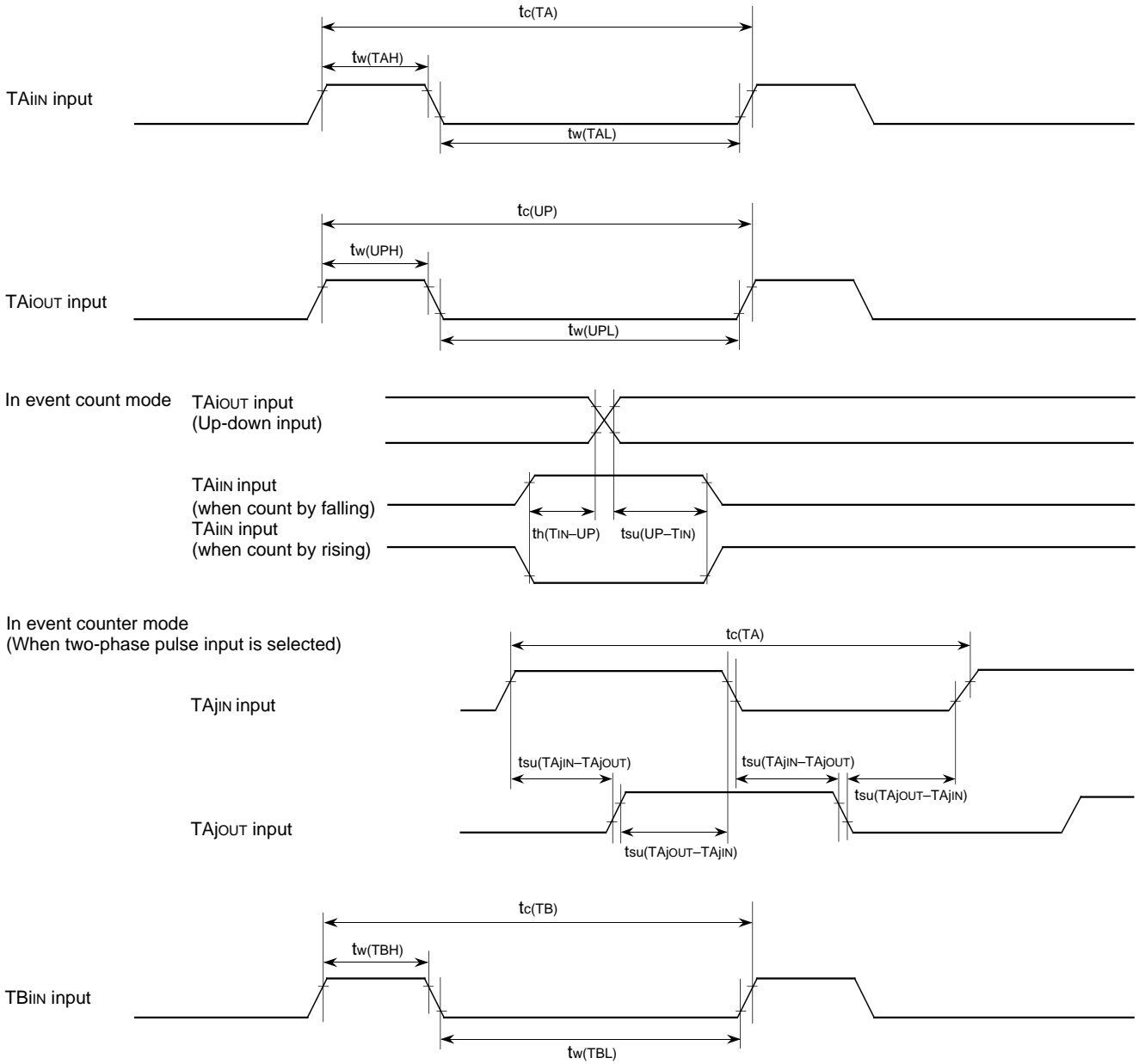
**Notes 1.** This applies when the main clock division selection bit = "0".

**2.**  $f(f_2)$  represents the clock  $f_2$  frequency.

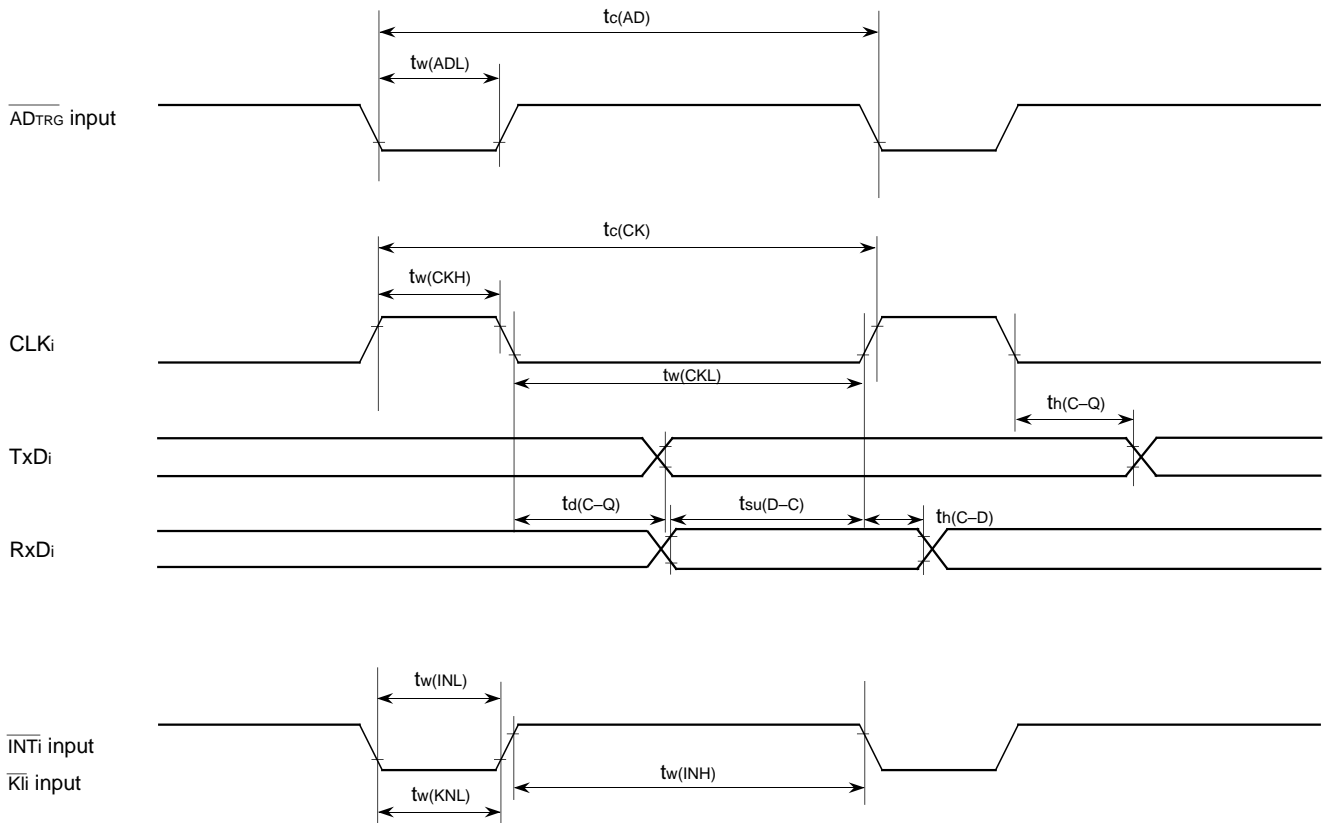
For the relation to the main clock and sub clock, refer to Table 10 in data sheet "M37735MHBXXXFP".

**TIMING DIAGRAM**

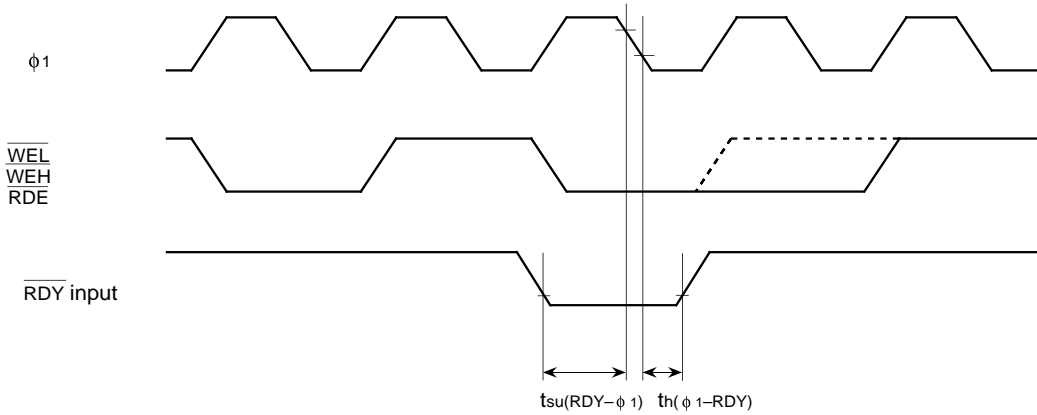




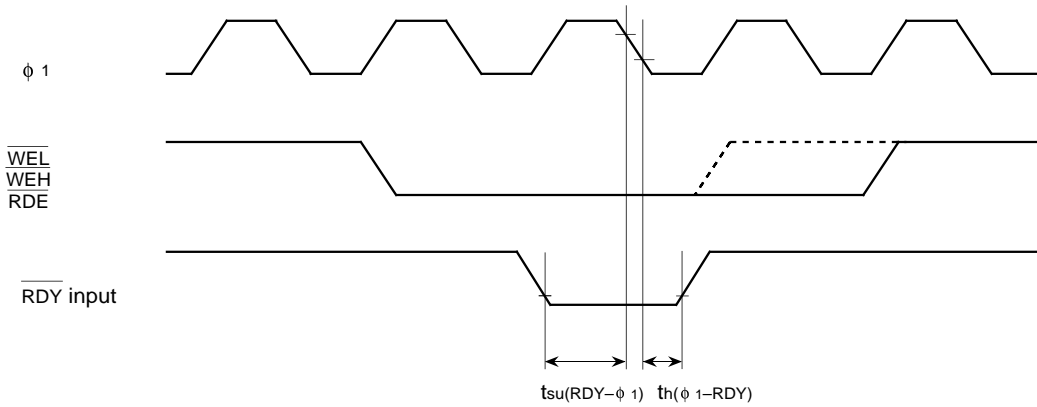
**PRELIMINARY**  
 Notice: This is not a final specification.  
 Some parametric limits are subject to change.



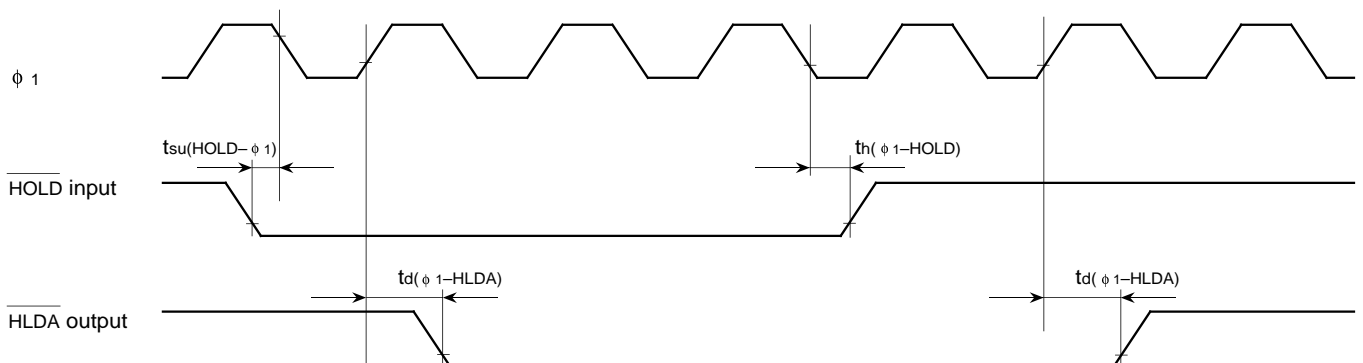
Microprocessor mode  
 (When wait bit = "1")



(When wait bit = "0")



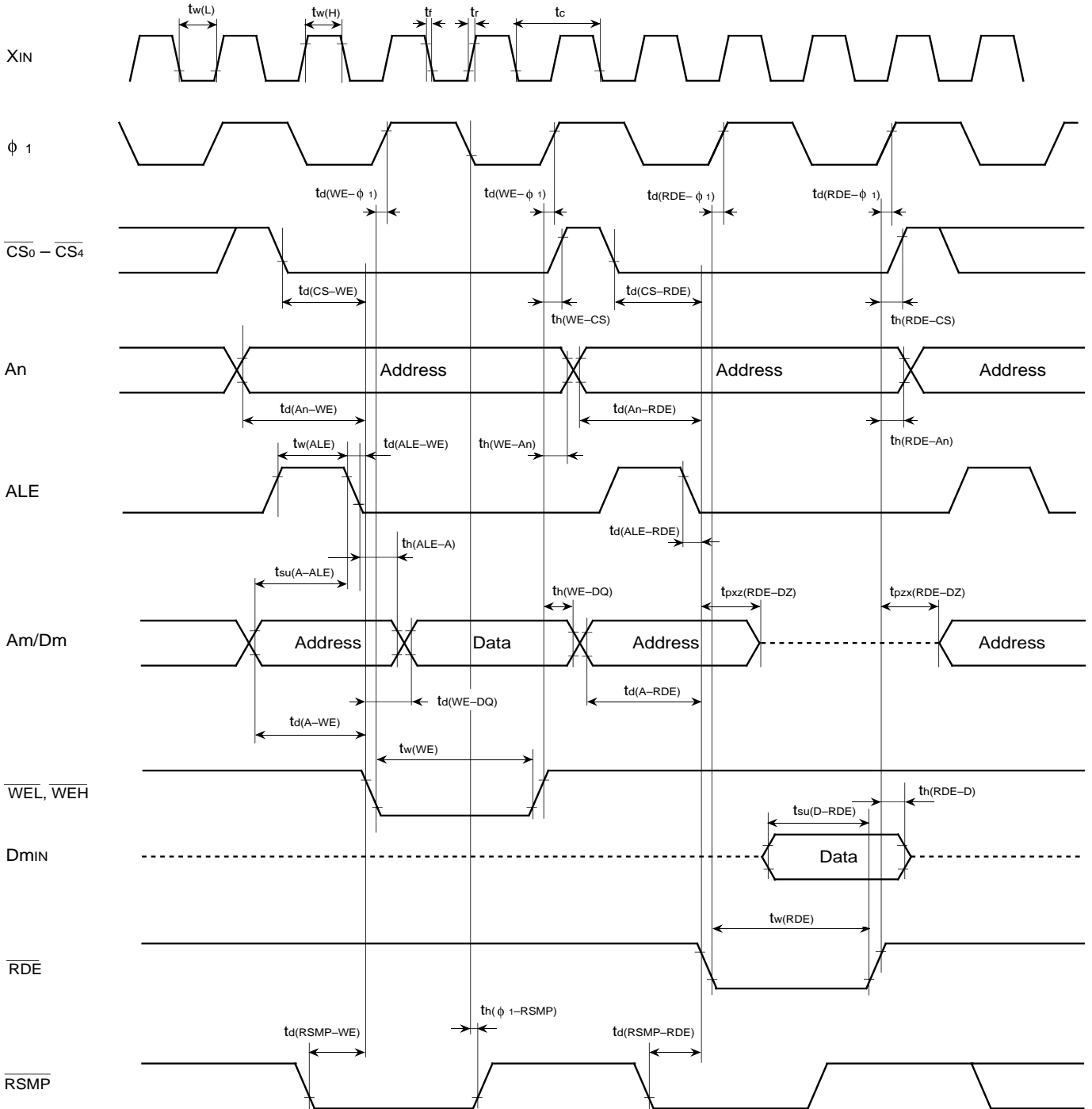
(When wait bit = "1" or "0" in common)



Test conditions

- $V_{CC} = 5\text{ V} \pm 10\%$
- Input timing voltage :  $V_{IL} = 1.0\text{ V}$ ,  $V_{IH} = 4.0\text{ V}$
- Output timing voltage :  $V_{OL} = 0.8\text{ V}$ ,  $V_{OH} = 2.0\text{ V}$

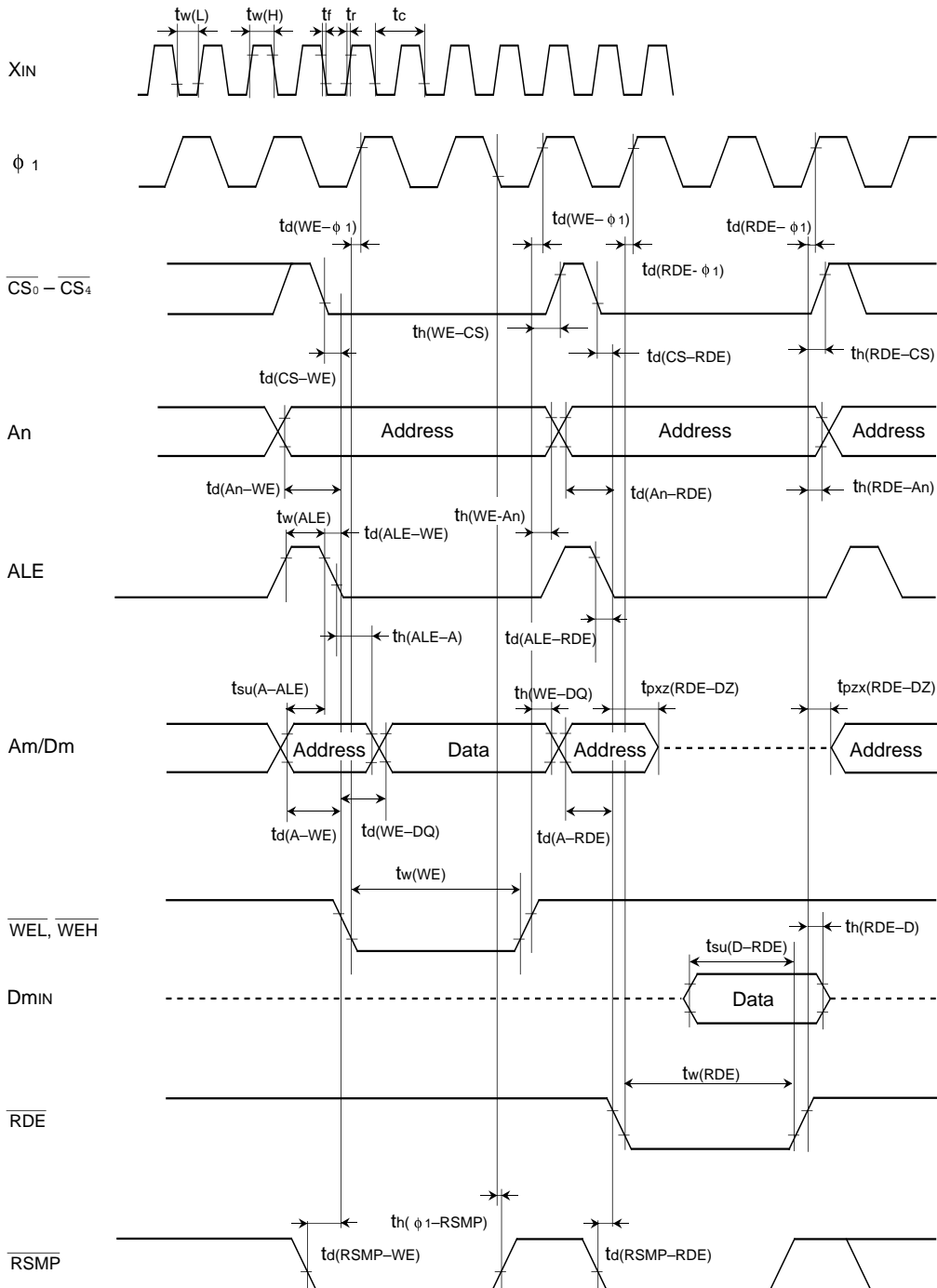
Microprocessor mode  
 (No wait : When wait bit = "1")



- Test condition
- $V_{CC} = 5 V \pm 10\%$
  - Output timing voltage :  $V_{OL} = 0.8 V$ ,  $V_{OH} = 2.0 V$
  - Data input  $D_{min}$  :  $V_{IL} = 0.8 V$ ,  $V_{IH} = 2.5 V$

Microprocessor mode

(Wait 1 : The external area is accessed when wait bit = "0" and wait selection bit = "1".)



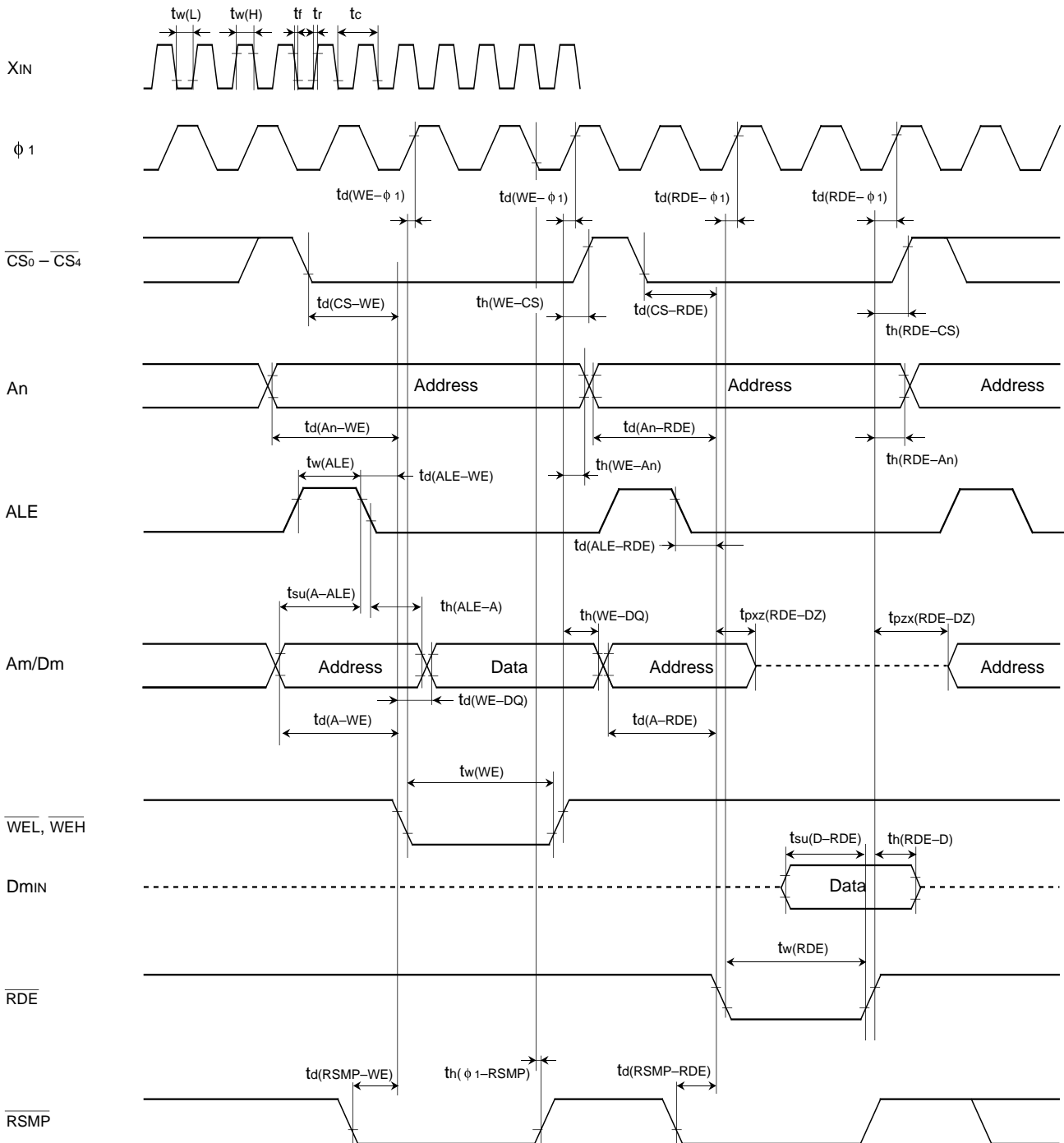
Test condition

- $V_{CC} = 5 V \pm 10\%$
- Output timing voltage :  $V_{OL} = 0.8 V$ ,  $V_{OH} = 2.0 V$
- Data input Dmin :  $V_{IL} = 0.8 V$ ,  $V_{IH} = 2.5 V$



Microprocessor mode

(Wait 0 : The external memory are is accessed when wait bit = "0" and wait selection bit = "0".)



Test conditions

- $V_{cc} = 5 V \pm 10\%$
- Output timing voltage :  $V_{OL} = 0.8 V, V_{OH} = 2.0 V$
- Data input  $D_{min}$  :  $V_{IL} = 0.8 V, V_{IH} = 2.5 V$

**PRELIMINARY**  
 Notice: This is not a final specification.  
 Some parametric limits are subject to change.

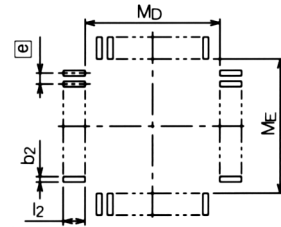
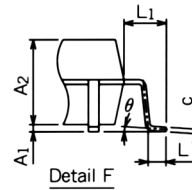
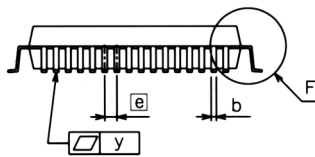
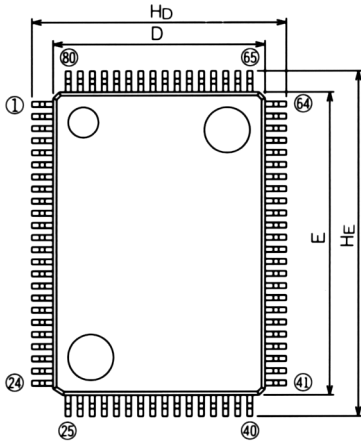
**PACKAGE OUTLINE**

**80P6N-A**

Plastic 80pin 14x20mm body QFP

EIAJ Package Code	JEDEC Code	Weight (g)	Lead Material
QFP80-P-1420-0.80	-	1.58	Alloy 42

Scale : 2/1



Recommended Mount Pad

Symbol	Dimension in Millimeters		
	Min	Nom	Max
A	-	-	3.05
A1	0	0.1	0.2
A2	-	2.8	-
b	0.3	0.35	0.45
c	0.13	0.15	0.2
D	13.8	14.0	14.2
E	19.8	20.0	20.2
e	-	0.8	-
HD	16.5	16.8	17.1
HE	22.5	22.8	23.1
L	0.4	0.6	0.8
L1	-	1.4	-
y	-	-	0.1
theta	0°	-	10°
b2	-	0.5	-
l2	1.3	-	-
MD	-	14.6	-
ME	-	20.6	-

**PRELIMINARY**  
Notice: This is not a final specification.  
Some parametric limits are subject to change.

MEMO

**PRELIMINARY**

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MITSUBISHI MICROCOMPUTERS

**M37735S4BFP**

16-BIT CMOS MICROCOMPUTER

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