

To all our customers

Regarding the change of names mentioned in the document, such as Mitsubishi Electric and Mitsubishi XX, to Renesas Technology Corp.

The semiconductor operations of Hitachi and Mitsubishi Electric were transferred to Renesas Technology Corporation on April 1st 2003. These operations include microcomputer, logic, analog and discrete devices, and memory chips other than DRAMs (flash memory, SRAMs etc.) Accordingly, although Mitsubishi Electric, Mitsubishi Electric Corporation, Mitsubishi Semiconductors, and other Mitsubishi brand names are mentioned in the document, these names have in fact all been changed to Renesas Technology Corp. Thank you for your understanding. Except for our corporate trademark, logo and corporate statement, no changes whatsoever have been made to the contents of the document, and these changes do not constitute any alteration to the contents of the document itself.

Note : Mitsubishi Electric will continue the business operations of high frequency & optical devices and power devices.

Renesas Technology Corp.
Customer Support Dept.
April 1, 2003

New product

MITSUBISHI MICROCOMPUTERS

M37735S4LHP

16-BIT CMOS MICROCOMPUTER

DESCRIPTION

The M37735S4LHP 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.

Its strong points are the low power dissipation, the low supply voltage, and the small package.

FEATURES

- Number of basic instructions 103
- Memory size RAM 2048 bytes
- Instruction execution time
The fastest instruction at 12 MHz frequency 333 ns
- Single power supply 2.7 – 5.5 V
- Low power dissipation (At 3 V supply voltage, 12 MHz frequency)
..... 10.8 mW (Typ.)

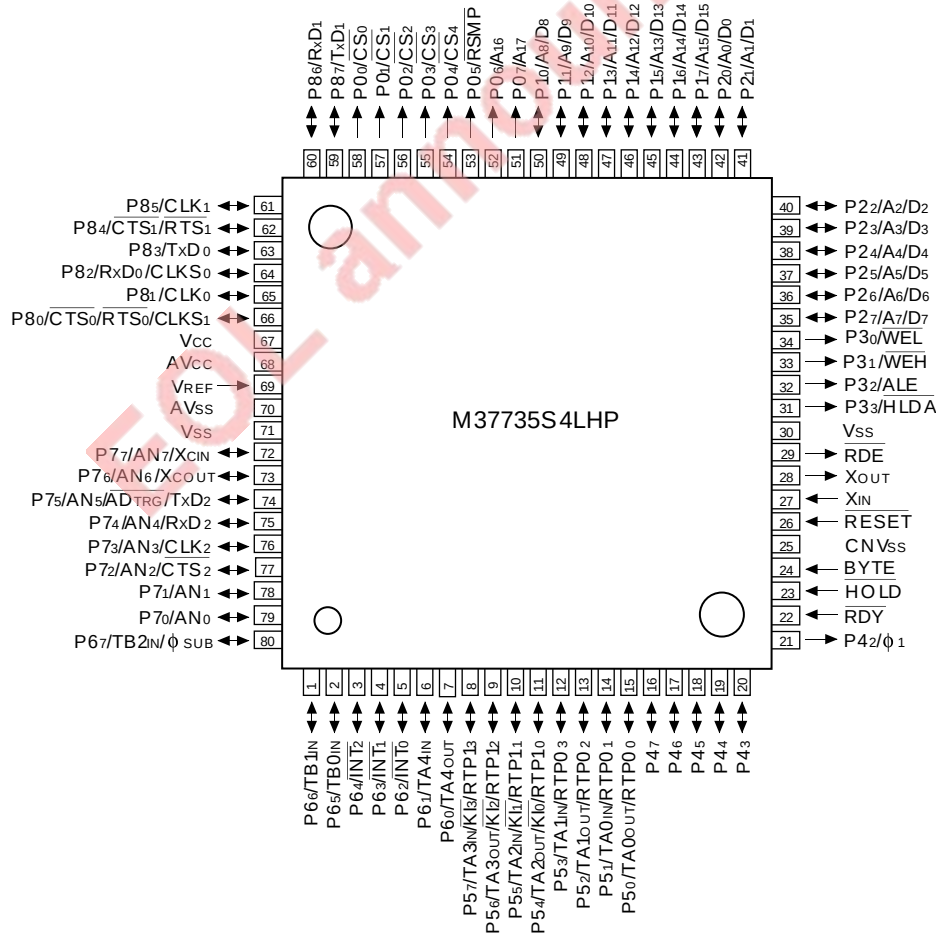
- Interrupts 19 types, 7 levels
- Multiple-function 16-bit timer 5 + 3
- Serial I/O (UART or clock synchronous) 3
- 10-bit A-D converter 8-channel inputs
- 12-bit watchdog timer
- Programmable input/output
(ports P4, P5, P6, P7, P8) 37
- Clock generating circuit 2 circuits built-in
- Small package 80-pin plastic molded fine-pitch QFP
(80P6D-A; 0.5 mm lead pitch)

APPLICATION

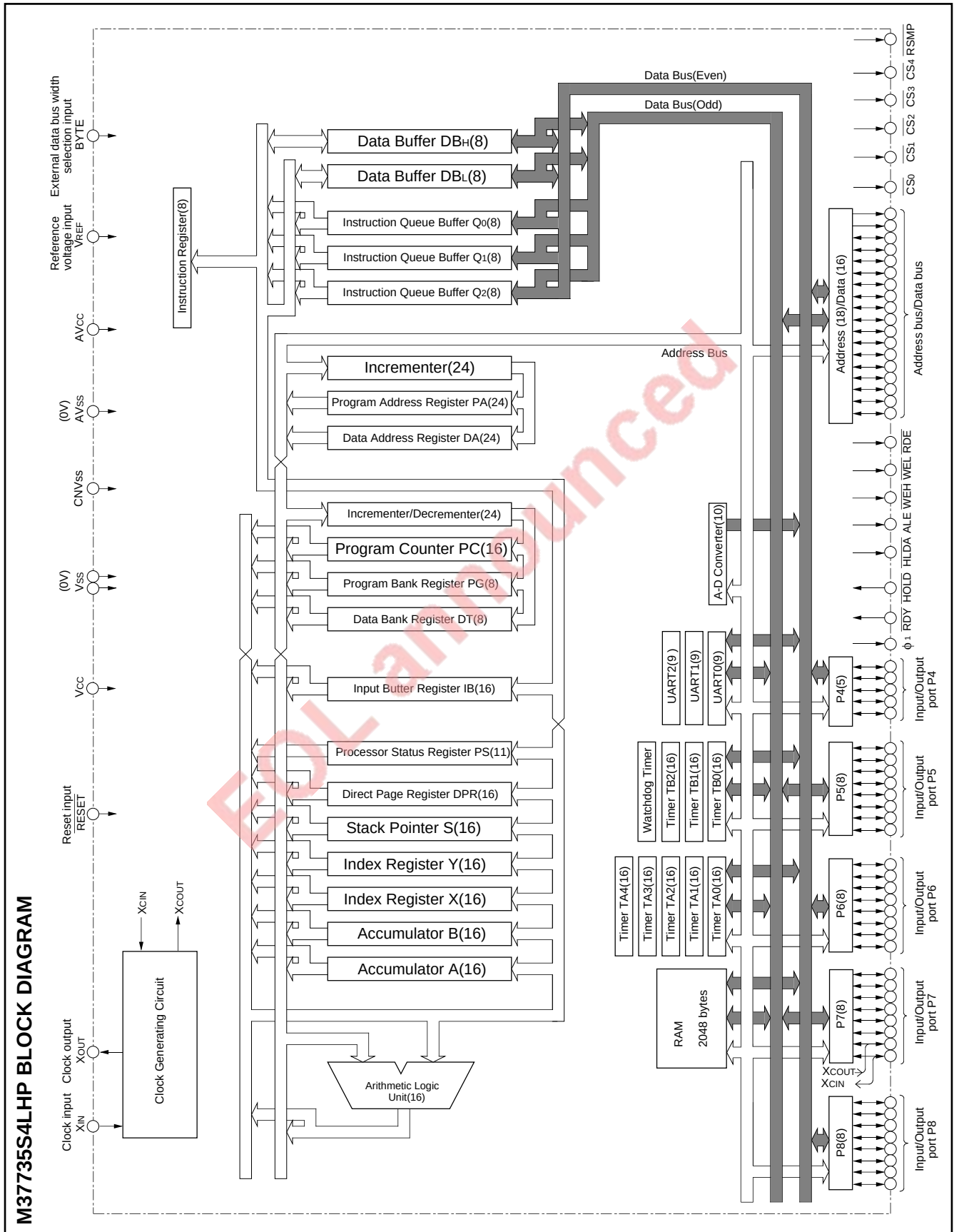
Control devices for general commercial equipment such as office automation, office equipment, and so on.

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

PIN CONFIGURATION (TOP VIEW)



Outline 80P6D-A



New product

FUNCTIONS OF M37735S4LHP

Parameter		Functions
Number of basic instructions		103
Instruction execution time		333 ns (the fastest instruction at external clock 12 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		2.7 – 5.5 V
Power dissipation		10.8 mW (at 3 V supply voltage, external clock 12 MHz frequency) 27 mW (at 5 V supply voltage, external clock 12 MHz frequency)
Input/Output characteristic	Input/Output voltage	5 V
	Output current	5 mA
Memory expansion		Maximum 1 Mbytes
Operating temperature range		–40 to 85 °C
Device structure		CMOS high-performance silicon gate process
Package		80-pin plastic molded fine-pitch QFP (80P6D-A; 0.5 mm lead pitch)

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PIN DESCRIPTION

Pin	Name	Input/Output	Functions
Vcc, Vss	Power source		Apply 2.7 – 5.5 V 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/CS ₀ – P04/CS ₄	Chip selection output	Output	When the specified external memory area is accessed, CS ₀ – CS ₄ signals are “L”.
P05/RSMP	Ready sampling output	Output	The timing signal to be input to the RDY pin is output.
P06/A ₁₆ , P07/A ₁₇	Address output	Output	An address (A ₁₆ , A ₁₇) is output.
P10/A ₈ /D ₈ – P17/A ₁₅ /D ₁₅	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 (D ₈ – D ₁₅) is input/output or an address (A ₈ – A ₁₅) is output. When the BYTE pin is “H” and an external data bus has an 8-bit width, only address (A ₈ – A ₁₅) is output.
P20/A ₀ /D ₀ – P27/A ₇ /D ₇	Address output /data (low-order) I/O	I/O	Low-order data (D ₀ – D ₇) is input/output or an address (A ₀ – A ₇) 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/HLD _A	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 (KI ₀ – KI ₃).
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 (INT ₀ – INT ₂) 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. P7 ₂ to P7 ₅ also function as I/O pins for UART2. Additionally, P7 ₆ and P7 ₇ have the function as the output pin (XCO _{UT}) and the input pin (XCIN) of the sub-clock (32 kHz) oscillation circuit, respectively. When P7 ₆ and P7 ₇ are used as the XCO _{UT} 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.

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BASIC FUNCTION BLOCKS

The M37735S4LHP 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 0₁₆ to FFFFF₁₆. The address space is divided by 64-Kbyte unit called bank. The banks are numbered from 0₁₆ to FF₁₆.

However, banks 10₁₆–FF₁₆ of the M37735S4LHP cannot be accessed.

Built-in RAM and control registers for internal peripheral devices are assigned to bank 0₁₆.

Addresses FFD6₁₆ to FFFF₁₆ 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 80₁₆ to 87F₁₆ 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 0₁₆ to 7F₁₆.

A 256-byte direct page area can be allocated anywhere in bank 0₁₆ 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.

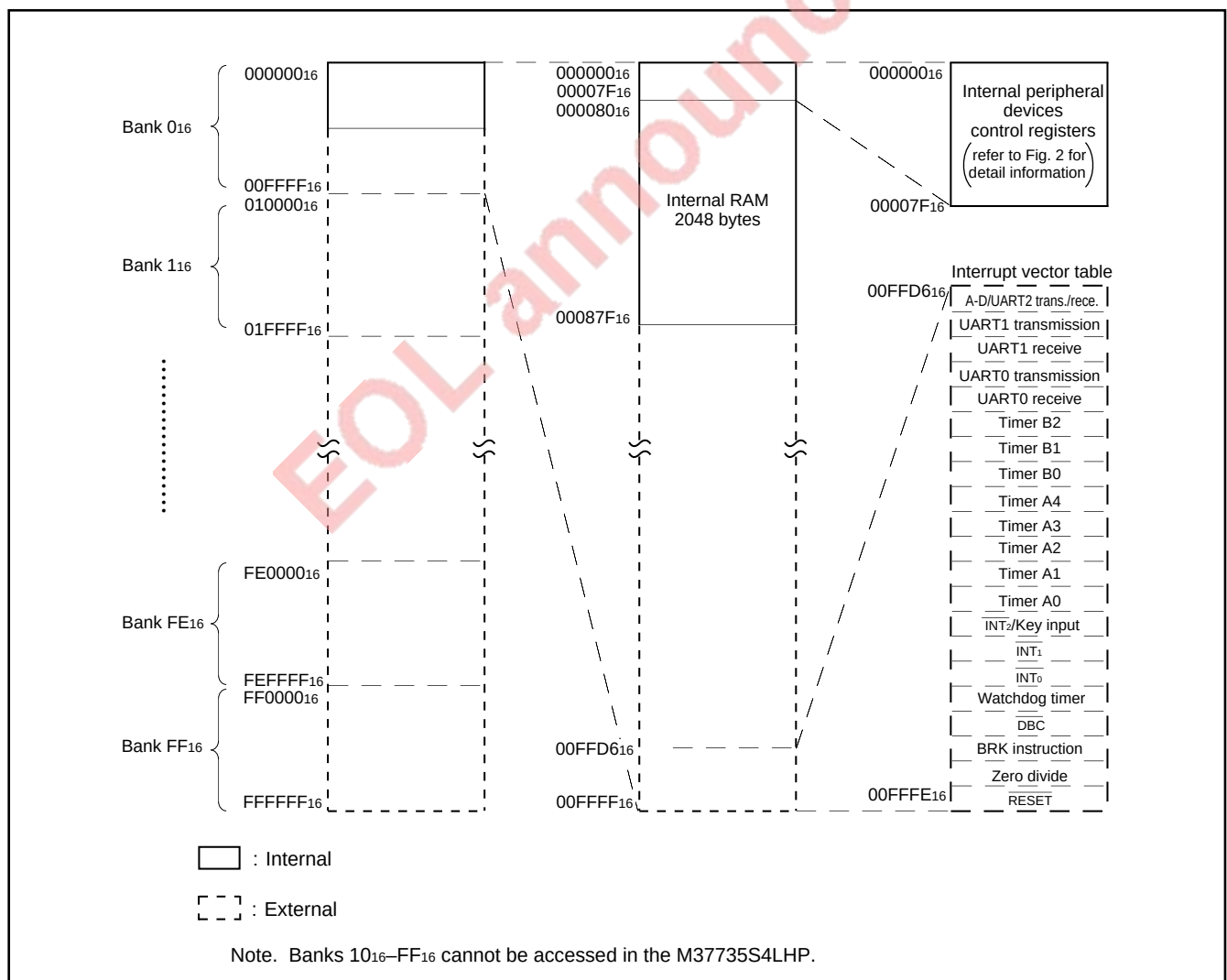


Fig. 1 Memory map

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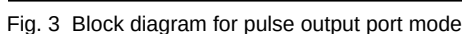
Address (Hexadecimal notation)		Address (Hexadecimal notation)	
000000		000040	Count start flag
000001		000041	
000002	Port P0 register	000042	One-shot start flag
000003	Port P1 register	000043	
000004	Port P0 direction register	000044	Up-down flag
000005	Port P1 direction register	000045	
000006	Port 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	A-D register 0	000060	Watchdog timer register
000021		000061	Watchdog timer frequency selection flag
000022	A-D register 1	000062	Waveform output mode register
000023		000063	Reserved area (Note)
000024	A-D register 2	000064	UART2 transmit/receive mode register
000025		000065	UART2 baud rate register (BRG2)
000026	A-D register 3	000066	UART2 transmission buffer register
000027		000067	UART2 transmit/receive control register 0
000028	A-D register 4	000068	UART2 transmit/receive control register 1
000029		000069	
00002A	A-D register 5	00006A	UART2 receive buffer register
00002B		00006B	
00002C	A-D register 6	00006C	Oscillation circuit control register 0
00002D		00006D	Port function control register
00002E	A-D register 7	00006E	Serial transmit control register
00002F		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	UART 0 transmission buffer register	000072	UART 0 receive interrupt control register
000033		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	UART 0 receive buffer register	000076	Timer A1 interrupt control register
000037		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	UART 1 transmission buffer register	00007A	Timer B0 interrupt control register
00003B		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	INT0 interrupt control register
00003E		00007E	INT1 interrupt control register
00003F	UART 1 receive buffer register	00007F	INT2/Key input interrupt control register

Note. Writing to reserved area is disabled.

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

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

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.



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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.

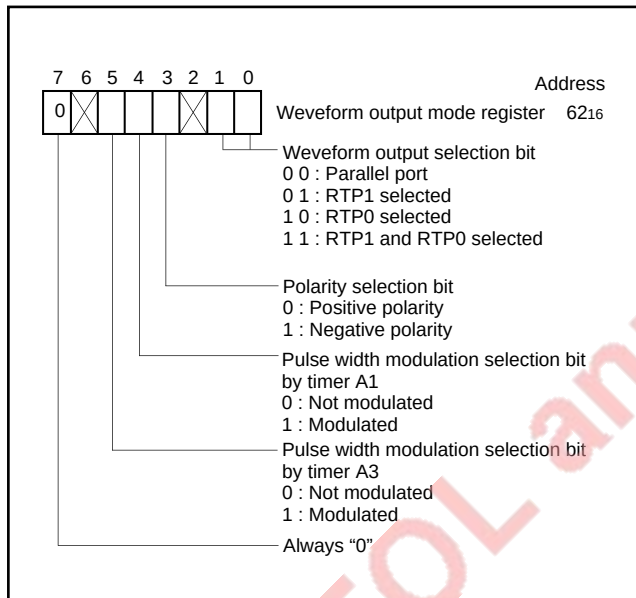


Fig. 4 Waveform output mode register bit configuration

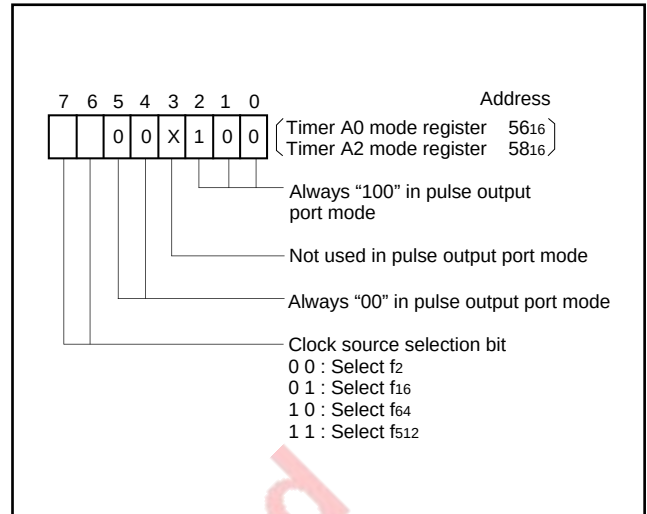


Fig. 5 Timer A0, A2 mode register bit configuration in pulse output port mode

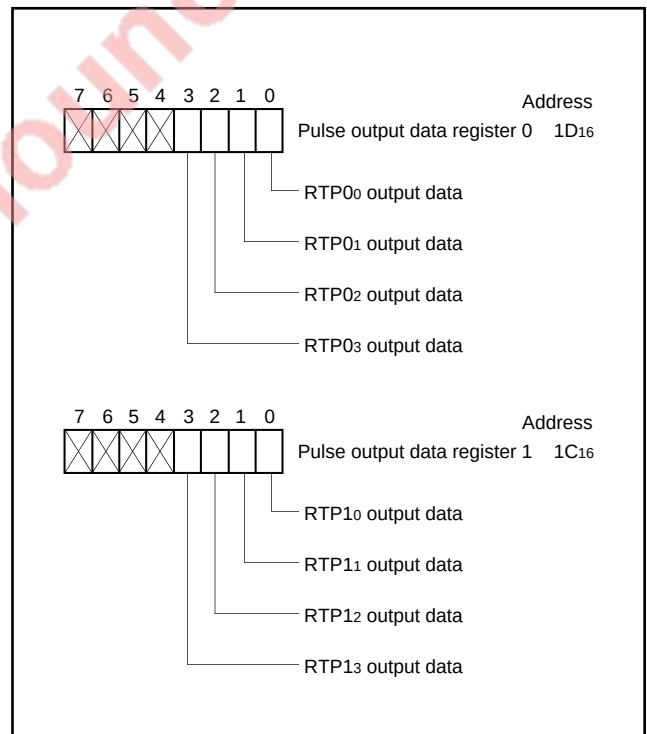


Fig. 6 Pulse output data register bit configuration

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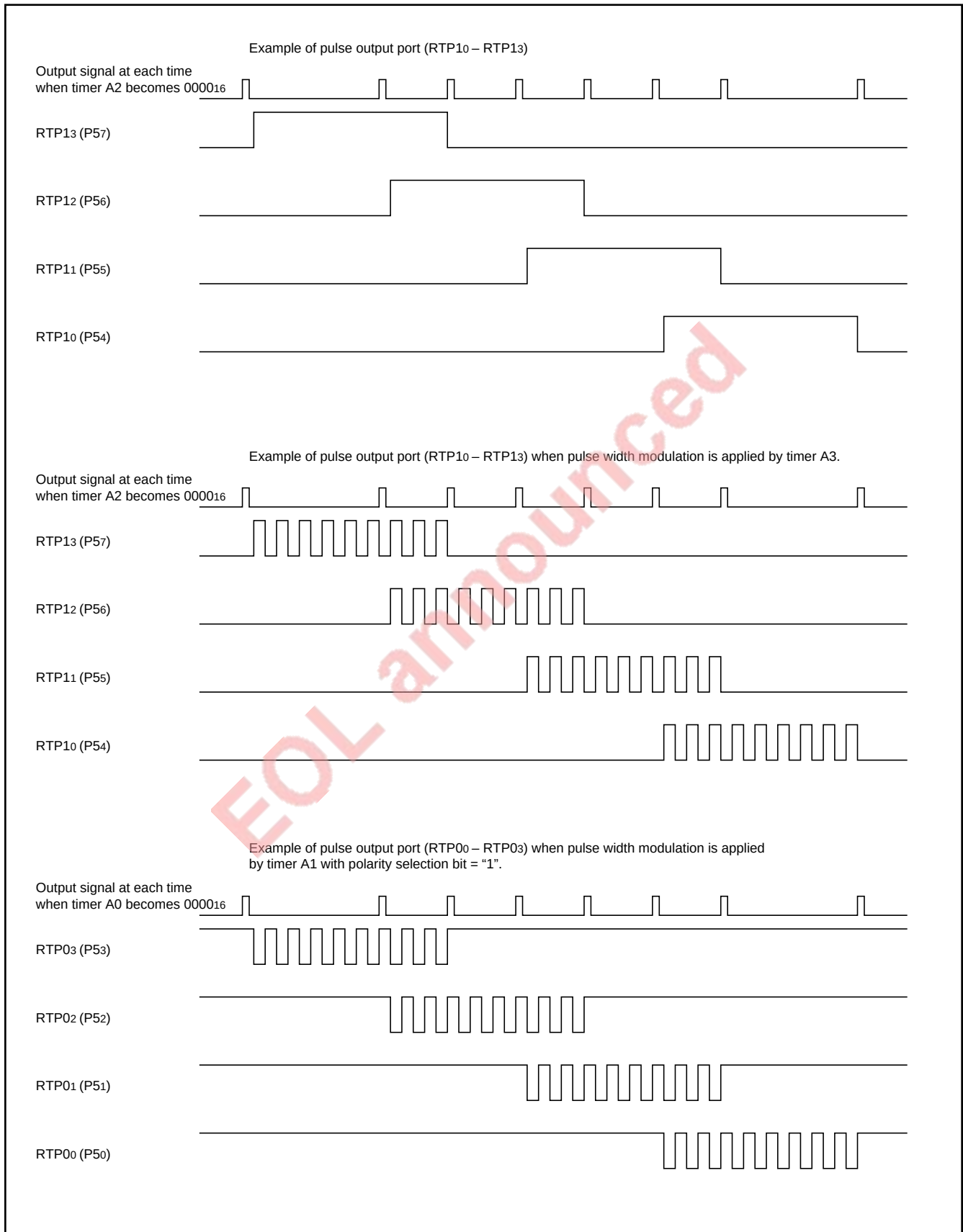


Fig. 7 Example of waveforms in pulse output port mode

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16-BIT CMOS MICROCOMPUTER

PROCESSOR MODE

Only the microprocessor mode can be selected.
Figure 9 shows the functions of pins P00/ $\overline{CS_0}$ – 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.

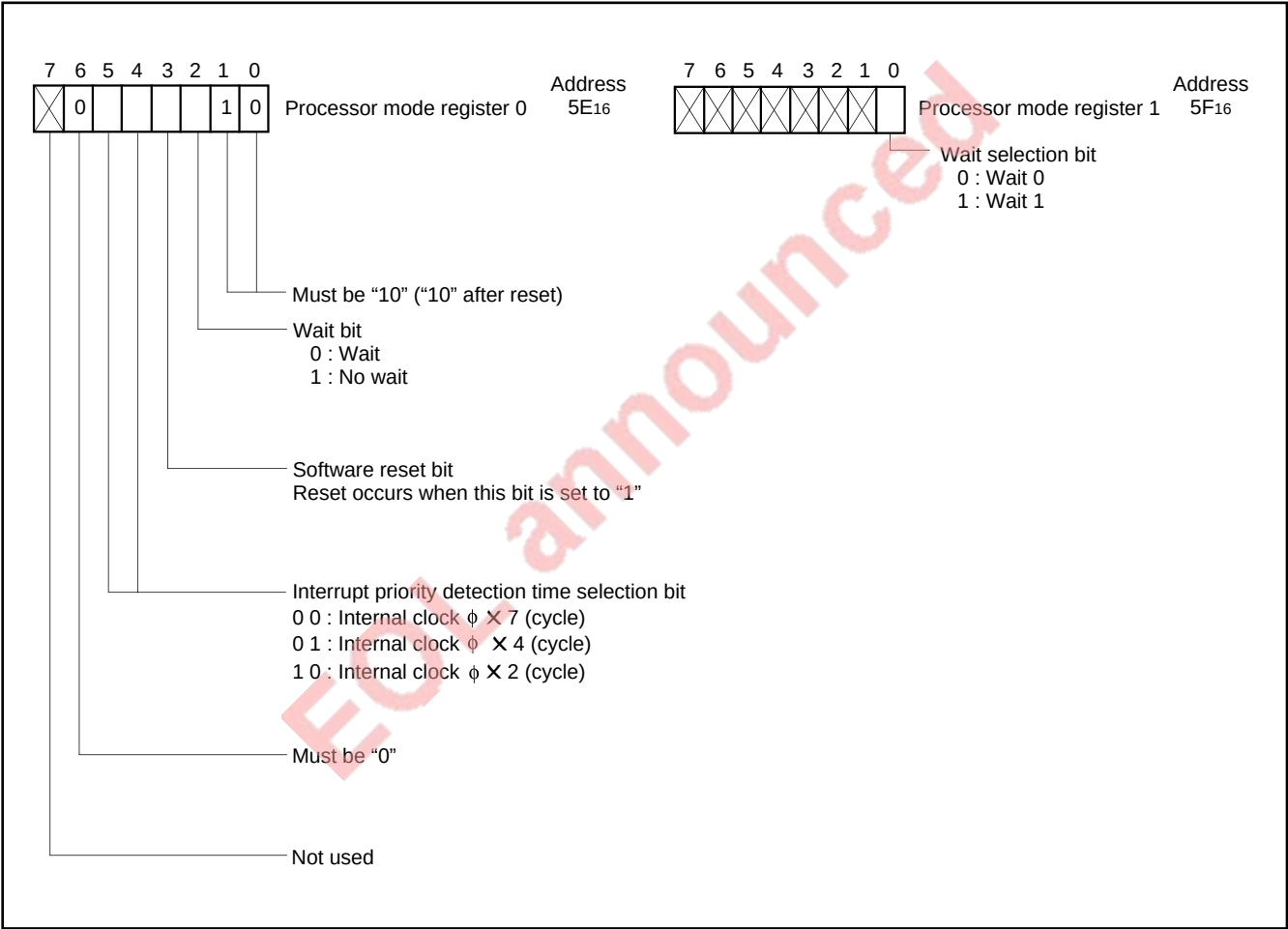


Fig. 8 Processor mode register bit configuration

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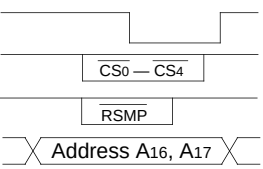
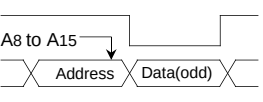
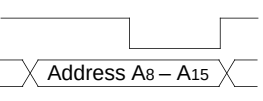
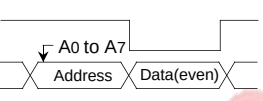
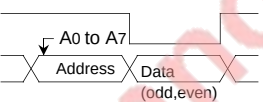
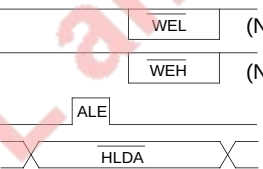
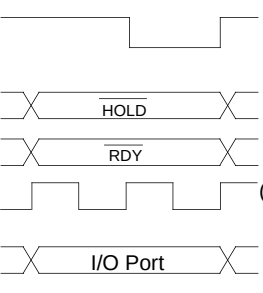
Pin		PM1	1
		PM0	0
Mode		Microprocessor mode	
$\overline{\text{RDE}}$		$\overline{\text{RDE}}$	 (Note)
$\overline{\text{CS}}_0$ to $\overline{\text{CS}}_4$ $\overline{\text{RSMP}}$, $\text{A}_{16}, \text{A}_{17}$		($\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ $\text{P}_{00}/\overline{\text{CS}}_0$ to $\text{P}_{04}/\overline{\text{CS}}_4$ $\text{P}_{05}/\overline{\text{RSMP}}$ $\text{P}_{06}/\text{A}_{16}$ $\text{P}_{07}/\text{A}_{17}$	
$\text{P}_{10}/\text{A}_8/\text{D}_8$ to $\text{P}_{17}/\text{A}_{15}/\text{D}_{15}$	BYTE = "L"	($\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ $\text{P}_{10}/\text{A}_8/\text{D}_8$ to $\text{P}_{17}/\text{A}_{15}/\text{D}_{15}$	
	BYTE = "H"	($\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ $\text{P}_{10}/\text{A}_8/\text{D}_8$ to $\text{P}_{17}/\text{A}_{15}/\text{D}_{15}$	
$\text{P}_{20}/\text{A}_0/\text{D}_0$ to $\text{P}_{27}/\text{A}_7/\text{D}_7$	BYTE = "L"	($\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ $\text{P}_{20}/\text{A}_0/\text{D}_0$ to $\text{P}_{27}/\text{A}_7/\text{D}_7$	
	BYTE = "H"	($\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ $\text{P}_{20}/\text{A}_0/\text{D}_0$ to $\text{P}_{27}/\text{A}_7/\text{D}_7$	
$\text{P}_{30}/\overline{\text{WEL}}$, $\text{P}_{31}/\overline{\text{WEH}}$, P_{32}/ALE , $\text{P}_{33}/\text{HLDA}$		$\text{P}_{30}/\overline{\text{WEL}}$ $\text{P}_{31}/\overline{\text{WEH}}$ P_{32}/ALE $\text{P}_{33}/\text{HLDA}$	
$\overline{\text{HOLD}}$, $\overline{\text{RDY}}$, $\text{P}_{42}/\phi 1$, Ports P_{43} to P_{47}		($\overline{\text{RDE}}, \overline{\text{WEL}}, \overline{\text{WEH}}$ $\overline{\text{HOLD}}$ $\overline{\text{RDY}}$ $\text{P}_{42}/\phi 1$ P_{43} to P_{47}	

 Fig. 9 Functions of pins $\text{P}_{00}/\overline{\text{CS}}_0$ to P_{47} 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.

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• 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.

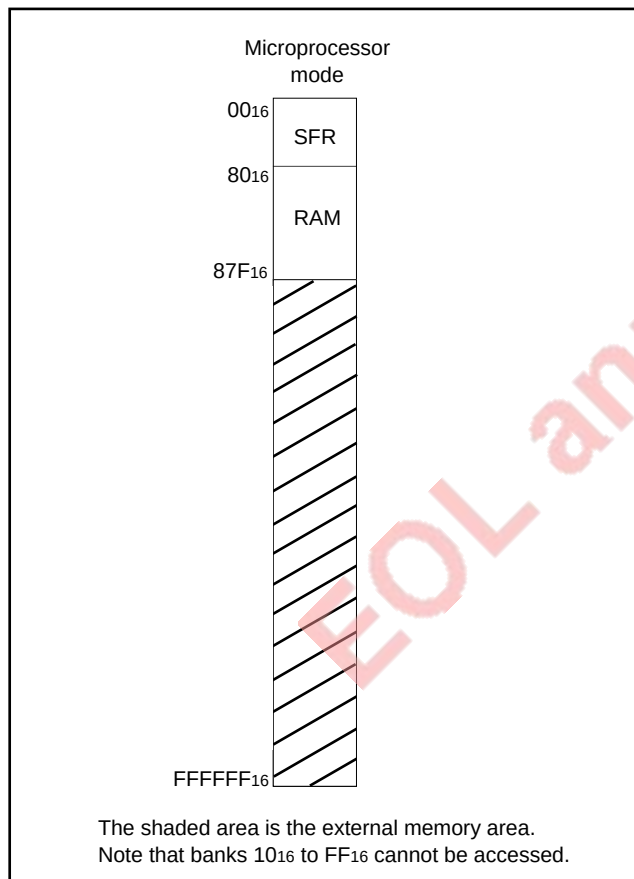


Fig. 10 External memory area for microprocessor mode

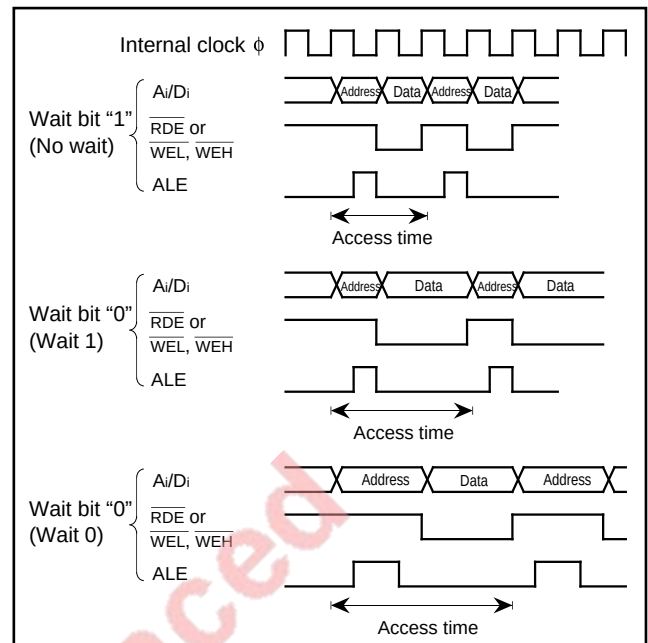


Fig. 11 Relationship between wait bit, wait selection bit, and access time

(1) Microprocessor mode [10]

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

Pin $\overline{RD\overline{E}}$ is the output pin for the read enable signal ($\overline{RD\overline{E}}$).

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

$\overline{CS_0}$ to $\overline{CS_4}$ are the chip select signals and are "L" when the address shown in Table 2 is accessed. $\overline{RSMP}$ is the ready-sampling signal which is output for the $\overline{RDY}$ input described later when the external memory area is accessed. By inputting logical AND of $\overline{RSMP}$ 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 ϕ_1 . In addition, the read/write term can also be extended by 2 cycles of clock ϕ_1 if the above function and wait 0/1 function specified with the wait bit are used together.

Pins $P_{10}/A_8/D_8$ — $P_{17}/A_{15}/D_{15}$ have two functions depending on the level of the BYTE pin.

When the BYTE pin level is "L", pins $P_{10}/A_8/D_8$ — $P_{17}/A_{15}/D_{15}$ function as address (A_8 to A_{15}) 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 $P_{10}/A_8/D_8$ — $P_{17}/A_{15}/D_{15}$ function as address (A_8 to A_{15}) output pins.

Pins $P_{20}/A_0/D_0$ — $P_{27}/A_7/D_7$ have two functions depending on the level of the BYTE pin.

When the BYTE pin level is "L", pins $P_{20}/A_0/D_0$ — $P_{27}/A_7/D_7$ function as address (A_0 to A_7) 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 $P_{20}/A_0/D_0$ — $P_{27}/A_7/D_7$ function as address (A_0 to A_7) 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 ϕ falls from "H" level to "L" level while the bus is not used.

Pins $P_{00}/\overline{CS_0}$ — $P_{31}/\overline{WEH}$ 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 ϕ passed, these ports become floating. After $\overline{HLDA}$ signal changes to "H" level and one cycle of internal clock ϕ passed, these ports are released from floating state.

$\overline{RDY}$ is a ready signal. If this signal goes "L", the internal clock ϕ stops at "L". $\overline{RDY}$ is used when slow external memory is attached. P_{42}/ϕ_1 pin is an output pin for clock ϕ_1 . The ϕ_1 output is independent of $\overline{RDY}$ and does not stop even when internal clock ϕ stops because of "L" input to the $\overline{RDY}$ pin.

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As shown in Table 3, ϕ_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 ₁₆ except internal memory area	00 0880 ₁₆ to 00 7FFF ₁₆
$\overline{CS}_1$	The latter half of bank 00 ₁₆ except internal memory area and banks 01 ₁₆ to 03 ₁₆ .	00 8000 ₁₆ to 03 FFFF ₁₆
$\overline{CS}_2$	Banks 04 ₁₆ to 07 ₁₆	04 0000 ₁₆ to 07 FFFF ₁₆
$\overline{CS}_3$	Banks 08 ₁₆ to 0B ₁₆	08 0000 ₁₆ to 0B FFFF ₁₆
$\overline{CS}_4$	Banks 0C ₁₆ to 0F ₁₆	0C 0000 ₁₆ to 0F FFFF ₁₆

Table 3. Function of signal output disable selection bit CM₆ (bit 6 of oscillation circuit control register 0)

Processor mode	Pin	Function	
		CM ₆ = "0"	CM ₆ = "1"
Microprocessor mode	$\overline{RDE}$, $\overline{WEL}$, $\overline{WEH}$	$\overline{RDE}$, $\overline{WEL}$, $\overline{WEH}$ are output when the internal/external memory area is accessed.	$\overline{RDE}$, $\overline{WEL}$, $\overline{WEH}$ 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".
	ϕ_1	Clock ϕ_1 is output independent of ϕ_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 RESET pin is returned to "H" level after holding it at "L" level with the power source voltage at 2.7 to 5.5 V. Program execution starts at the address formed by setting address A₂₃ – A₁₆ to 00₁₆, A₁₅ – A₈ to the contents of address FFFF₁₆, and A₇ – A₀ to the contents of address FFFE₁₆. 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 0.55 V or less when the power source voltage reaches 2.7 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 ₁₆)...	00 ₁₆	Watchdog timer frequency selection flag	(61 ₁₆)...	XXXXXXXXXX0
Port P1 direction register	(05 ₁₆)...	00 ₁₆	Waveform output mode register	(62 ₁₆)...	0X000X00
Port P2 direction register	(08 ₁₆)...	00 ₁₆	UART2 transmit/receive mode register	(64 ₁₆)...	X0000000
Port P3 direction register	(09 ₁₆)...	XXXXXX0000	UART2 transmit/receive control register 0	(68 ₁₆)...	XXXXXX1000
Port P4 direction register	(0C ₁₆)...	00 ₁₆	UART2 transmit/receive control register 1	(69 ₁₆)...	000000010
Port P5 direction register	(0D ₁₆)...	00 ₁₆	Oscillation circuit control register 0	(6C ₁₆)...	X00000X1
Port P6 direction register	(10 ₁₆)...	00 ₁₆	Port function control register	(6D ₁₆)...	00 ₁₆
Port P7 direction register	(11 ₁₆)...	00 ₁₆	Serial transmit control register	(6E ₁₆)...	XXXX0XXXXX
Port P8 direction register	(14 ₁₆)...	00 ₁₆	Oscillation circuit control register 1	(6F ₁₆)...	0XXXX00000
A-D control register 0	(1E ₁₆)...	00000???	A-D/UART2 trans./rece. interrupt control register	(70 ₁₆)...	XXXXXX0000
A-D control register 1	(1F ₁₆)...	XXXX000X11	UART 0 transmission interrupt control register	(71 ₁₆)...	XXXXXX0000
UART 0 transmit/receive mode register	(30 ₁₆)...	00 ₁₆	UART 0 receive interrupt control register	(72 ₁₆)...	XXXXXX0000
UART 1 transmit/receive mode register	(38 ₁₆)...	00 ₁₆	UART 1 transmission interrupt control register	(73 ₁₆)...	XXXXXX0000
UART 0 transmit/receive control register 0	(34 ₁₆)...	00001000	UART 1 receive interrupt control register	(74 ₁₆)...	XXXXXX0000
UART 1 transmit/receive control register 0	(3C ₁₆)...	00001000	Timer A0 interrupt control register	(75 ₁₆)...	XXXXXX0000
UART 0 transmit/receive control register 1	(35 ₁₆)...	000000010	Timer A1 interrupt control register	(76 ₁₆)...	XXXXXX0000
UART 1 transmit/receive control register 1	(3D ₁₆)...	000000010	Timer A2 interrupt control register	(77 ₁₆)...	XXXXXX0000
Count start flag	(40 ₁₆)...	00 ₁₆	Timer A3 interrupt control register	(78 ₁₆)...	XXXXXX0000
One-shot start flag	(42 ₁₆)...	XXXX000000	Timer A4 interrupt control register	(79 ₁₆)...	XXXXXX0000
Up-down flag	(44 ₁₆)...	00 ₁₆	Timer B0 interrupt control register	(7A ₁₆)...	XXXXXX0000
Timer A0 mode register	(56 ₁₆)...	00 ₁₆	Timer B1 interrupt control register	(7B ₁₆)...	XXXXXX0000
Timer A1 mode register	(57 ₁₆)...	00 ₁₆	Timer B2 interrupt control register	(7C ₁₆)...	XXXXXX0000
Timer A2 mode register	(58 ₁₆)...	00 ₁₆	INT ₀ interrupt control register	(7D ₁₆)...	XX00000000
Timer A3 mode register	(59 ₁₆)...	00 ₁₆	INT ₁ interrupt control register	(7E ₁₆)...	XX00000000
Timer A4 mode register	(5A ₁₆)...	00 ₁₆	INT ₂ /key input interrupt control register	(7F ₁₆)...	XX00000000
Timer B0 mode register	(5B ₁₆)...	00100000	Processor status register (PS)		000??0001??
Timer B1 mode register	(5C ₁₆)...	001X0000	Program bank register (PG)		00 ₁₆
Timer B2 mode register	(5D ₁₆)...	001X0000	Program counter (PC _H)		Content of FFFF ₁₆
Processor mode register 0	(5E ₁₆)...	00 ₁₆	Program counter (PC _L)		Content of FFFE ₁₆
Processor mode register 1	(5F ₁₆)...	XXXXXXXXXX0	Direct page register (DPR)		0000 ₁₆
Watchdog timer register	(60 ₁₆)...	FFF ₁₆	Data bank register (DT)		00 ₁₆

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

Fig. 12 Microcomputer internal status during reset

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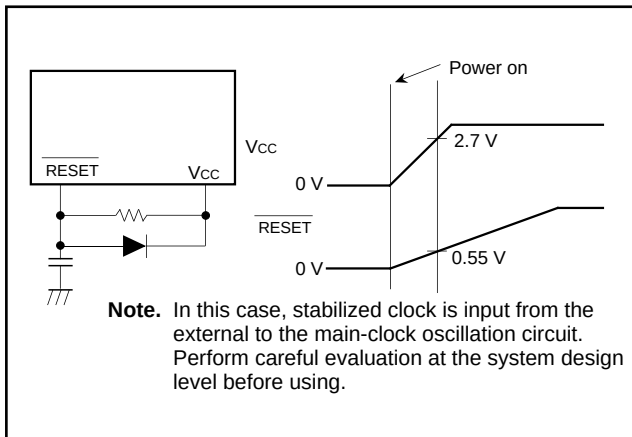


Fig. 13 Example of a reset circuit

ADDRESSING MODES

The M37735S4LHP 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 M37735S4LHP has 103 machine instructions. Refer to the MITSUBISHI SEMICONDUCTORS DATA BOOK SINGLE-CHIP 16-BIT MICROCOMPUTERS for details.

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ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Conditions	Ratings	Unit
V _{cc}	Power source voltage		−0.3 to +7	V
AV _{cc}	Analog power source voltage		−0.3 to +7	V
V _i	Input voltage RESET, CNVss, BYTE		−0.3 to +12	V
V _i	Input voltage P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, VREF, XIN, HOLD, RDY		−0.3 to V _{cc} + 0.3	V
V _o	Output voltage P00/CS0 – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLD, P42/ φ 1, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, XOUT, RDE		−0.3 to V _{cc} + 0.3	V
P _d	Power dissipation	Ta = 25 °C	200	mW
T _{opr}	Operating temperature		−40 to +85	°C
T _{stg}	Storage temperature		−65 to +150	°C

RECOMMENDED OPERATING CONDITIONS (V_{cc} = 2.7 – 5.5 V, Ta = −40 to +85 °C, unless otherwise noted)

Symbol	Parameter	Limits			Unit
		Min.	Typ.	Max.	
V _{cc}	Power source voltage	f(X _{IN}) : Operating 2.7		5.5	V
AV _{cc}	Analog power source voltage	f(X _{IN}) : Stopped, f(X _{CIN}) = 32.768 kHz 2.7		5.5	V
V _{ss}	Power source voltage		V _{cc}		V
AV _{ss}	Analog power source voltage		0		V
V _{IH}	High-level input voltage HOLD, RDY, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, XIN, RESET, CNVss, BYTE, X _{CIN} (Note 3)	0.8 V _{cc}		V _{cc}	V
V _{IH}	High-level input voltage P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7	0.5 V _{cc}		V _{cc}	V
V _{IL}	Low-level input voltage HOLD, RDY, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, XIN, RESET, CNVss, BYTE, X _{CIN} (Note 3)	0		0.2V _{cc}	V
V _{IL}	Low-level input voltage P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7	0		0.16V _{cc}	V
I _{OH(peak)}	High-level peak output current P00/CS0 – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLD, P42/ φ 1, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87			−10	mA
I _{OH(avg)}	High-level average output current P00/CS0 – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLD, P42/ φ 1, P43 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87			−5	mA
I _{OL(peak)}	Low-level peak output current P00/CS0 – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLD, P42/ φ 1, P43, P54 – P57, P60 – P67, P70 – P77, P80 – P87			10	mA
I _{OL(peak)}	Low-level peak output current P44 – P47, P50 – P53			16	mA
I _{OL(avg)}	Low-level average output current P00/CS0 – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLD, P42/ φ 1, P43, P54 – P57, P60 – P67, P70 – P77, P80 – P87			5	mA
I _{OL(avg)}	Low-level average output current P44 – P47, P50 – P53			12	mA
f(X _{IN})	Main-clock oscillation frequency (Note 4)			12	MHz
f(X _{CIN})	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_{OL(peak)} for ports P00/CS0 – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLD and P8 must be 80 mA or less, the sum of I_{OH(peak)} for ports P00/CS0 – P07/A17, P10/A8/D8 – P17/A15/D15, P20/A0/D0 – P27/A7/D7, P30/WEL – P33/HLD and P8 must be 80 mA or less, the sum of I_{OL(peak)} for ports P4, P5, P6, and P7 must be 100 mA or less, and the sum of I_{OH(peak)} for ports P4, P5, P6, and P7 must be 80 mA or less.

3. Limits V_{IH} and V_{IL} for X_{CIN} are applied when the sub clock external input selection bit = "1".

4. The maximum value of f(X_{IN}) = 6 MHz when the main clock division selection bit = "1".

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ELECTRICAL CHARACTERISTICS ($V_{CC} = 5\text{ V}$, $V_{SS} = 0\text{ V}$, $T_a = -40\text{ to }+85\text{ }^{\circ}\text{C}$, $f(X_{IN}) = 12\text{ MHz}$, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
V_{OH}	High-level output voltage $P0/\overline{CS_0} - P07/A_{17}$, $P10/A_8/D_8 - P17/A_{15}/D_{15}$, $P20/A_0/D_0 - P27/A_7/D_7$, $P33/\overline{HLDA}$, $P42/\phi_1$, $P43 - P47$, $P50 - P57$, $P60 - P67$, $P70 - P77$, $P80 - P87$	$V_{CC} = 5\text{ V}$, $I_{OH} = -10\text{ mA}$	3			V
		$V_{CC} = 3\text{ V}$, $I_{OH} = -1\text{ mA}$	2.5			
V_{OH}	High-level output voltage $P0/\overline{CS_0} - P07/A_{17}$, $P10/A_8/D_8 - P17/A_{15}/D_{15}$, $P20/A_0/D_0 - P27/A_7/D_7$, $P33/\overline{HLDA}$, $P42/\phi_1$	$V_{CC} = 5\text{ V}$, $I_{OH} = -400\text{ }\mu\text{A}$	4.7			V
V_{OH}	High-level output voltage $P30/\overline{WEL}$, $P31/\overline{WEH}$, $P32/\overline{ALE}$	$V_{CC} = 5\text{ V}$, $I_{OH} = -10\text{ mA}$	3.1			V
		$V_{CC} = 5\text{ V}$, $I_{OH} = -400\text{ }\mu\text{A}$	4.8			
		$V_{CC} = 3\text{ V}$, $I_{OH} = -1\text{ mA}$	2.6			
V_{OH}	High-level output voltage $\overline{RDE}$	$V_{CC} = 5\text{ V}$, $I_{OH} = -10\text{ mA}$	3.4			V
		$V_{CC} = 5\text{ V}$, $I_{OH} = -400\text{ }\mu\text{A}$	4.8			
		$V_{CC} = 3\text{ V}$, $I_{OH} = -1\text{ mA}$	2.6			
V_{OL}	Low-level output voltage $P0/\overline{CS_0} - P07/A_{17}$, $P10/A_8/D_8 - P17/A_{15}/D_{15}$, $P20/A_0/D_0 - P27/A_7/D_7$, $P33/\overline{HLDA}$, $P42/\phi_1$, $P43, P54 - P57$, $P60 - P67$, $P70 - P77$, $P80 - P87$	$V_{CC} = 5\text{ V}$, $I_{OL} = 10\text{ mA}$			2	V
		$V_{CC} = 3\text{ V}$, $I_{OL} = 1\text{ mA}$			0.5	
V_{OL}	Low-level output voltage $P44 - P47$, $P50 - P53$	$V_{CC} = 5\text{ V}$, $I_{OL} = 16\text{ mA}$			1.8	V
		$V_{CC} = 3\text{ V}$, $I_{OL} = 10\text{ mA}$			1.5	
V_{OL}	Low-level output voltage $P0/\overline{CS_0} - P07/A_{17}$, $P10/A_8/D_8 - P17/A_{15}/D_{15}$, $P20/A_0/D_0 - P27/A_7/D_7$, $P33/\overline{HLDA}$, $P42/\phi_1$	$V_{CC} = 5\text{ V}$, $I_{OL} = 2\text{ mA}$			0.45	V
V_{OL}	Low-level output voltage $P30/\overline{WEL}$, $P31/\overline{WEH}$, $P32/\overline{ALE}$	$V_{CC} = 5\text{ V}$, $I_{OL} = 10\text{ mA}$			1.9	V
		$V_{CC} = 5\text{ V}$, $I_{OL} = 2\text{ mA}$			0.43	
		$V_{CC} = 3\text{ V}$, $I_{OL} = 1\text{ mA}$			0.4	
V_{OL}	Low-level output voltage $\overline{RDE}$	$V_{CC} = 5\text{ V}$, $I_{OL} = 10\text{ mA}$			1.6	V
		$V_{CC} = 5\text{ V}$, $I_{OL} = 2\text{ mA}$			0.4	
		$V_{CC} = 3\text{ V}$, $I_{OL} = 1\text{ mA}$			0.4	
$V_{T+} - V_{T-}$	Hysteresis $\overline{HOLD}$, $\overline{RDY}$, $TA0_{IN} - TA4_{IN}$, $TB0_{IN} - TB2_{IN}$, $INT_0 - INT_2$, AD_{TRG} , CTS_0 , CTS_1 , CTS_2 , CLK_0 , CLK_1 , CLK_2 , $KI_0 - KI_3$	$V_{CC} = 5\text{ V}$	0.4		1	V
		$V_{CC} = 3\text{ V}$	0.1		0.7	
$V_{T+} - V_{T-}$	Hysteresis $\overline{RESET}$	$V_{CC} = 5\text{ V}$	0.2		0.5	V
		$V_{CC} = 3\text{ V}$	0.1		0.4	
$V_{T+} - V_{T-}$	Hysteresis X_{IN}	$V_{CC} = 5\text{ V}$	0.1		0.4	V
		$V_{CC} = 3\text{ V}$	0.06		0.26	
$V_{T+} - V_{T-}$	Hysteresis X_{CIN} (When external clock is input)	$V_{CC} = 5\text{ V}$	0.1		0.4	V
		$V_{CC} = 3\text{ V}$	0.06		0.26	
I_{IH}	High-level input current $P10/A_8/D_8 - P17/A_{15}/D_{15}$, $P20/A_0/D_0 - P27/A_7/D_7$, $P43 - P47$, $P50 - P57$, $P60 - P67$, $P70 - P77$, $P80 - P87$, X_{IN} , $\overline{RESET}$, CNV_{SS} , $BYTE$	$V_{CC} = 5\text{ V}$, $V_I = 5\text{ V}$			5	μA
		$V_{CC} = 3\text{ V}$, $V_I = 3\text{ V}$			4	
I_{IL}	Low-level input current $P10/A_8/D_8 - P17/A_{15}/D_{15}$, $P20/A_0/D_0 - P27/A_7/D_7$, $P43 - P47$, $P50 - P53$, $P60, P61, P65 - P67$, $P70 - P77$, $P80 - P87$, X_{IN} , $\overline{RESET}$, CNV_{SS} , $BYTE$	$V_{CC} = 5\text{ V}$, $V_I = 0\text{ V}$			-5	μA
		$V_{CC} = 3\text{ V}$, $V_I = 0\text{ V}$			-4	
I_{IL}	Low-level input current $P54 - P57$, $P62 - P64$	$V_I = 0\text{ V}$, without a pull-up transistor	$V_{CC} = 5\text{ V}$		-5	μA
			$V_{CC} = 3\text{ V}$		-4	
		$V_I = 0\text{ V}$, with a pull-up transistor	$V_{CC} = 5\text{ V}$	-0.25	-0.5	mA
			$V_{CC} = 3\text{ V}$	-0.08	-0.18	
V_{RAM}	RAM hold voltage	When clock is stopped.	2			V

ELECTRICAL CHARACTERISTICS ($V_{CC} = 5\text{ V}$, $V_{SS} = 0\text{ V}$, $T_a = -40\text{ to }+85\text{ }^{\circ}\text{C}$, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit	
			Min.	Typ.	Max.		
I _{CC}	Power source current	When external bus is in use, output pins are open, and other pins are V _{SS} .	V _{CC} = 5 V, f(X _{IN}) = 12 MHz (square waveform), (f(f ₂) = 6 MHz), f(X _{CIN}) = 32.768 kHz, in operating (Note 1)		5.4	10.8	mA
			V _{CC} = 3 V, f(X _{IN}) = 12 MHz (square waveform), (f(f ₂) = 6 MHz), f(X _{CIN}) = 32.768 kHz, in operating (Note 1)		3.6	7.2	mA
			V _{CC} = 3 V, f(X _{IN}) = 12 MHz (square waveform), (f(f ₂) = 0.75 MHz), f(X _{CIN}) : Stopped, in operating		0.5	1.0	mA
			V _{CC} = 3 V, f(X _{IN}) = 12 MHz (square waveform), f(X _{CIN}) = 32.768 kHz, when a WIT instruction is executed (Note 2)		6	12	μ A
			V _{CC} = 3 V, f(X _{IN}) : Stopped, f(X _{CIN}) = 32.768 kHz, in operating (Note 3)		40	80	μ A
			V _{CC} = 3 V, f(X _{IN}) : Stopped, f(X _{CIN}) = 32.768 kHz, when a WIT instruction is executed (Note 4)		3	6	μ A
			T _a = 25 °C, when clock is stopped			1	μ A
			T _a = 85 °C, when clock is stopped			20	μ A

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_{COUT} drivability selection bit = "0" and the system clock stop bit at wait state = "1".

A-D CONVERTER CHARACTERISTICS

($V_{CC} = AV_{CC} = 5\text{ V}$, $V_{SS} = AV_{SS} = 0\text{ V}$, $T_a = -40\text{ to }+85\text{ }^{\circ}\text{C}$, $f(X_{IN}) = 12\text{ MHz}$, unless otherwise noted (Note))

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
—	Resolution	$V_{REF} = V_{CC}$			10	Bits
—	Absolute accuracy	$V_{REF} = V_{CC}$			± 3	LSB
RLADDER	Ladder resistance	$V_{REF} = V_{CC}$	10		25	k Ω
t _{CONV}	Conversion time		19.6			$\mu\text{ s}$
V _{REF}	Reference voltage		2.7		V_{CC}	V
V _{IA}	Analog input voltage		0		V_{REF}	V

Note. This applies when the main clock division selection bit = "0" and $f(f_2) = 6\text{ MHz}$.

New product

TIMING REQUIREMENTS (V_{CC} = 2.7 – 5.5 V, V_{SS} = 0 V, Ta = –40 to +85 °C, f(X_{IN}) = 12 MHz, unless otherwise noted (Note 1))

Notes 1. This applies when the main clock division selection bit = “0” and f(f₂) = 6 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)	83		ns
t _{w(H)}	External clock input high-level pulse width (Note 2)	33		ns
t _{w(L)}	External clock input low-level pulse width (Note 2)	33		ns
t _r	External clock rise time		15	ns
t _f	External clock fall time		15	ns

Notes 1. When the main clock division selection bit = “1”, the minimum value of t_c = 166 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	200		ns
t _{su} (P5D–RDE)	Port P5 input setup time	200		ns
t _{su} (P6D–RDE)	Port P6 input setup time	200		ns
t _{su} (P7D–RDE)	Port P7 input setup time	200		ns
t _{su} (P8D–RDE)	Port P8 input setup time	200		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
t _{su} (D–RDE)	Data input setup time	80		ns
t _{su} (RDY– φ 1)	RDY input setup time	80		ns
t _{su} (HOLD– φ 1)	HOLD input setup time	80		ns
t _h (RDE–D)	Data input hold time	0		ns
t _h (φ 1–RDY)	RDY input hold time	0		ns
t _h (φ 1–HOLD)	HOLD input hold time	0		ns

EOL announced

New product

Timer A input (Count input in event counter mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TA)}$	TA _{IN} input cycle time	250		ns
$t_{w(TAH)}$	TA _{IN} input high-level pulse width	125		ns
$t_{w(TAL)}$	TA _{IN} input low-level pulse width	125		ns

Timer A input (Gating input in timer mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TA)}$	TA _{IN} input cycle time (Note)	666		ns
$t_{w(TAH)}$	TA _{IN} input high-level pulse width (Note)	333		ns
$t_{w(TAL)}$	TA _{IN} input low-level pulse width (Note)	333		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.	
$t_{c(TA)}$	TA _{IN} input cycle time (Note)	333		ns
$t_{w(TAH)}$	TA _{IN} input high-level pulse width	166		ns
$t_{w(TAL)}$	TA _{IN} input low-level pulse width	166		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.	
$t_{w(TAH)}$	TA _{IN} input high-level pulse width	166		ns
$t_{w(TAL)}$	TA _{IN} input low-level pulse width	166		ns

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

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(UP)}$	TA _{IOU} input cycle time	3333		ns
$t_{w(UPH)}$	TA _{IOU} input high-level pulse width	1666		ns
$t_{w(UPL)}$	TA _{IOU} input low-level pulse width	1666		ns
$t_{su(UP-T_{IN})}$	TA _{IOU} input setup time	666		ns
$t_{h(T_{IN}-UP)}$	TA _{IOU} input hold time	666		ns

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

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TA)}$	TA _{JIN} input cycle time	2000		ns
$t_{su(TA_{JIN}-TA_{JOUT})}$	TA _{JIN} input setup time	500		ns
$t_{su(TA_{JOUT}-TA_{JIN})}$	TA _{JOUT} input setup time	500		ns

New product

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)	250		ns
$t_{w(TBH)}$	TBiIN input high-level pulse width (one edge count)	125		ns
$t_{w(TBL)}$	TBiIN input low-level pulse width (one edge count)	125		ns
$t_{c(TB)}$	TBiIN input cycle time (both edges count)	500		ns
$t_{w(TBH)}$	TBiIN input high-level pulse width (both edges count)	250		ns
$t_{w(TBL)}$	TBiIN input low-level pulse width (both edges count)	250		ns

Timer B input (Pulse period measurement mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(TB)}$	TBiIN input cycle time (Note)	666		ns
$t_{w(TBH)}$	TBiIN input high-level pulse width (Note)	333		ns
$t_{w(TBL)}$	TBiIN input low-level pulse width (Note)	333		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)	666		ns
$t_{w(TBH)}$	TBiIN input high-level pulse width (Note)	333		ns
$t_{w(TBL)}$	TBiIN input low-level pulse width (Note)	333		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)	1333		ns
$t_{w(ADL)}$	ADTRG input low-level pulse width	166		ns

Serial I/O

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{c(CK)}$	CLKi input cycle time	333		ns
$t_{w(CKH)}$	CLKi input high-level pulse width	166		ns
$t_{w(CKL)}$	CLKi input low-level pulse width	166		ns
$t_{d(C-Q)}$	TxDi output delay time		100	ns
$t_{h(C-Q)}$	TxDi hold time	0		ns
$t_{su(D-C)}$	RxDi input setup time	65		ns
$t_{h(C-D)}$	RxDi input hold time	75		ns

External interrupt INTi input, key input interrupt KIi input

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{w(INH)}$	INTi input high-level pulse width	250		ns
$t_{w(INL)}$	INTi input low-level pulse width	250		ns
$t_{w(KIL)}$	KIi input low-level pulse width	250		ns

New product

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".

New product

SWITCHING CHARACTERISTICS

($V_{CC} = 2.7 - 5.5$ V, $V_{SS} = 0$ V, $T_a = -40$ to $+85^{\circ}\text{C}$, $f(X_{IN}) = 12$ MHz, unless otherwise noted (Note))

Microprocessor mode

Symbol	Parameter	Test conditions	Limits		Unit
			Min.	Max.	
$t_d(\text{WE}-\text{P4Q})$	Port P4 data output delay time	Fig. 14		300	ns
$t_d(\text{WE}-\text{P5Q})$	Port P5 data output delay time			300	ns
$t_d(\text{WE}-\text{P6Q})$	Port P6 data output delay time			300	ns
$t_d(\text{WE}-\text{P7Q})$	Port P7 data output delay time			300	ns
$t_d(\text{WE}-\text{P8Q})$	Port P8 data output delay time			300	ns

Note. This applies when the main clock division selection bit = "0" and $f(f_2) = 6$ MHz.

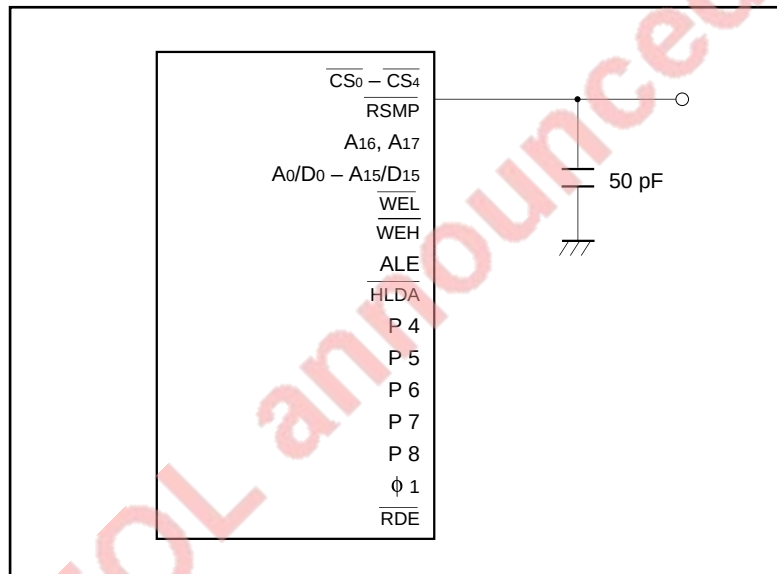


Fig. 14 Measuring circuit for each pin

New product

Microprocessor mode

(V_{CC} = 2.7 – 5.5 V, V_{SS} = 0 V, T_a = –40 to +85 °C, f(X_{IN}) = 12 MHz, unless otherwise noted (Note 1))

Symbol	Parameter	(Note 2) Wait mode	Test conditions	Limits		Unit
				Min.	Max.	
t _d (CS–WE) t _d (CS–RDE)	Chip-select output delay time	No wait	Fig. 14	20		ns
		Wait 1		182		ns
		Wait 0				
t _h (WE–CS) t _h (RDE–CS)	Chip-select hold time	No wait		4		ns
		Wait 1				
		Wait 0				
t _d (A _n –WE) t _d (A _n –RDE)	Address output delay time	No wait		20		ns
		Wait 1		182		ns
		Wait 0				
t _d (A–WE) t _d (A–RDE)	Address output delay time	No wait		20		ns
		Wait 1		162		ns
		Wait 0				
t _h (WE–A _n) t _h (RDE–A _n)	Address hold time	No wait		40		ns
		Wait 1				
		Wait 0				
t _w (ALE)	ALE pulse width	No wait		40		ns
		Wait 1		123		ns
		Wait 0				
t _{su} (A–ALE)	Address output setup time	No wait		10		ns
		Wait 1		93		ns
		Wait 0				
t _h (ALE–A)	Address hold time	No wait		9		ns
		Wait 1		40		ns
		Wait 0				
t _d (ALE–WE) t _d (ALE–RDE)	ALE output delay time	No wait		4		ns
		Wait 1		40		ns
		Wait 0				
t _d (WE–DQ) t _h (WE–DQ)	Data output delay time	No wait			90	ns
		Wait 1		40		ns
		Wait 0				
t _w (WE)	WE pulse width	No wait		131		ns
		Wait 1		298		ns
		Wait 0				
t _{pxz} (RDE–DZ) t _{pzx} (RDE–DZ)	Floating start delay time	No wait			10	ns
		Wait 1		53		ns
		Wait 0				
t _w (RDE)	RDE pulse width	No wait		128		ns
		Wait 1		295		ns
		Wait 0				
t _d (RSMP–WE) t _d (RSMP–RDE)	RSMP output delay time	No wait		25		ns
		Wait 1				
		Wait 0				
t _h (φ ₁ –RSMP)	RSMP hold time	No wait		0		ns
		Wait 1				
		Wait 0				
t _d (WE–φ ₁) t _d (RDE–φ ₁)	φ ₁ output delay time	No wait		0	30	ns
		Wait 1				
		Wait 0				
t _d (φ ₁ –HLDA)	HLDA output delay time	No wait			120	ns
		Wait 1				
		Wait 0				

Notes 1. This applies when the main clock division selection bit = "0" and f(f₂) = 6 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".

New product

Bus timing data formulas ($V_{CC} = 2.7 - 5.5V$, $V_{SS} = 0V$, $T_a = -40$ to $+85^\circ C$, $f(X_{IN}) = 12$ MHz (Max.), unless otherwise noted (Note1))

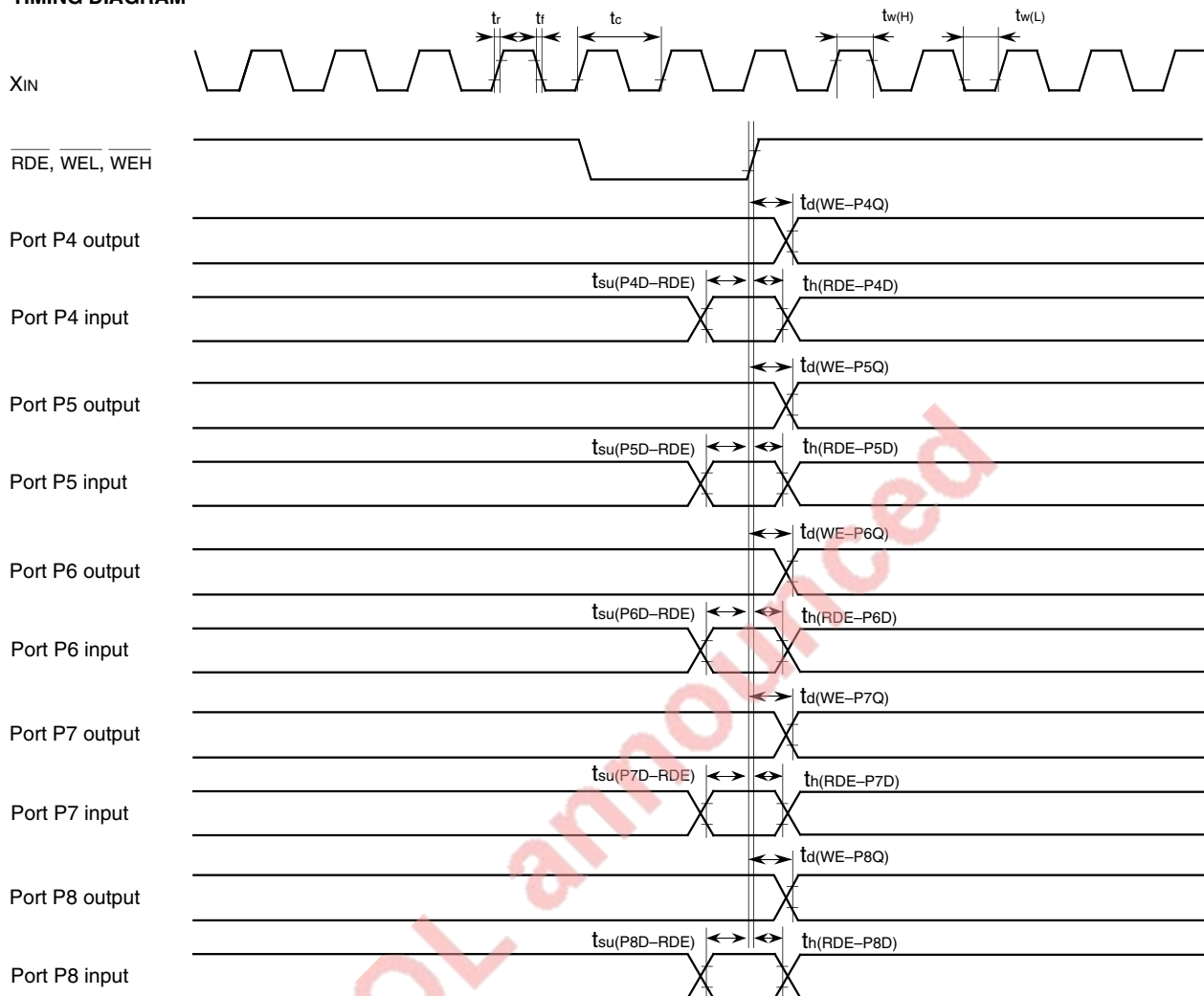
Symbol	Parameter	Wait mode	Limits		Unit
			Min.	Max.	
$t_d(CS-WE)$ $t_d(CS-RDE)$	Chip-select output delay time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 63$		ns
		Wait 1	$\frac{3 \times 10^9}{2 \cdot f(f_2)} - 68$		ns
		Wait 0	$\frac{3 \times 10^9}{2 \cdot f(f_2)} - 68$		ns
$t_h(WE-CS)$ $t_h(RDE-CS)$	Chip-select hold time		4		ns
$t_d(A-WE)$ $t_d(A-RDE)$	Address output delay time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 63$		ns
		Wait 1	$\frac{3 \times 10^9}{2 \cdot f(f_2)} - 68$		ns
		Wait 0	$\frac{3 \times 10^9}{2 \cdot f(f_2)} - 68$		ns
$t_d(A-WE)$ $t_d(A-RDE)$	Address output delay time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 63$		ns
		Wait 1	$\frac{3 \times 10^9}{2 \cdot f(f_2)} - 88$		ns
		Wait 0	$\frac{3 \times 10^9}{2 \cdot f(f_2)} - 88$		ns
$t_h(WE-A_n)$ $t_h(RDE-A_n)$	Address hold time		$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 43$		ns
$t_w(ALE)$	ALE pulse width	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 43$		ns
		Wait 1	$\frac{2 \times 10^9}{2 \cdot f(f_2)} - 43$		ns
		Wait 0	$\frac{2 \times 10^9}{2 \cdot f(f_2)} - 43$		ns
$t_{su}(A-ALE)$	Address output setup time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 73$		ns
		Wait 1	$\frac{2 \times 10^9}{2 \cdot f(f_2)} - 73$		ns
		Wait 0	$\frac{2 \times 10^9}{2 \cdot f(f_2)} - 73$		ns
$t_h(ALE-A)$	Address hold time	No wait	9		ns
		Wait 1	$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 43$		ns
		Wait 0	$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 43$		ns
$t_d(ALE-WE)$ $t_d(ALE-RDE)$	ALE output delay time	No wait	4		ns
		Wait 1	$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 43$		ns
		Wait 0	$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 43$		ns
$t_d(WE-DQ)$	Data output delay time			90	ns
$t_h(WE-DQ)$	Data hold time		$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 43$		ns
$t_w(WE)$	$\overline{WE}/\overline{WEH}$ pulse width	No wait	$\frac{2 \times 10^9}{2 \cdot f(f_2)} - 35$		ns
		Wait 1	$\frac{4 \times 10^9}{2 \cdot f(f_2)} - 35$		ns
		Wait 0	$\frac{4 \times 10^9}{2 \cdot f(f_2)} - 35$		ns
$t_{pxz}(RDE-DZ)$	Floating start delay time			10	ns
$t_{pzx}(RDE-DZ)$	Floating release delay time		$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 30$		ns
$t_w(RDE)$	$\overline{RDE}$ pulse width	No wait	$\frac{2 \times 10^9}{2 \cdot f(f_2)} - 38$		ns
		Wait 1	$\frac{4 \times 10^9}{2 \cdot f(f_2)} - 38$		ns
		Wait 0	$\frac{4 \times 10^9}{2 \cdot f(f_2)} - 38$		ns
$t_d(RSMP-WE)$ $t_d(RSMP-RDE)$	RSMP output delay time		$\frac{1 \times 10^9}{2 \cdot f(f_2)} - 58$		ns
$t_h(\phi_1-RSMP)$	RSMP hold time		0		ns
$t_d(WE-\phi_1)$ $t_d(RDE-\phi_1)$	ϕ_1 output delay time		0	30	ns

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

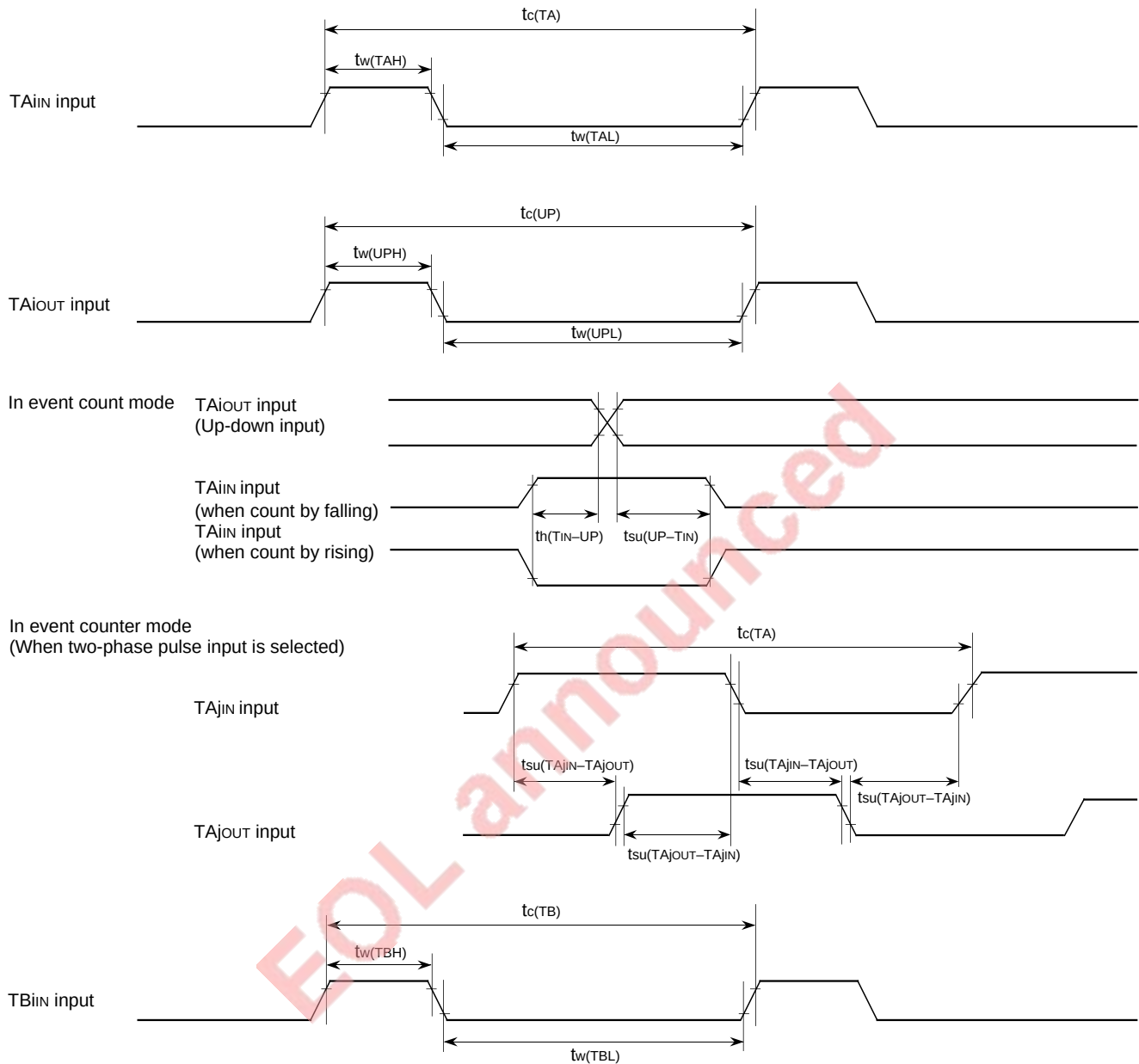
2. $f(f_2)$ represents the clock f_2 frequency.

For the relation to the main clock and sub clock, refer to Table 10 in data sheet "M37735MHBXXXXFP".

New product

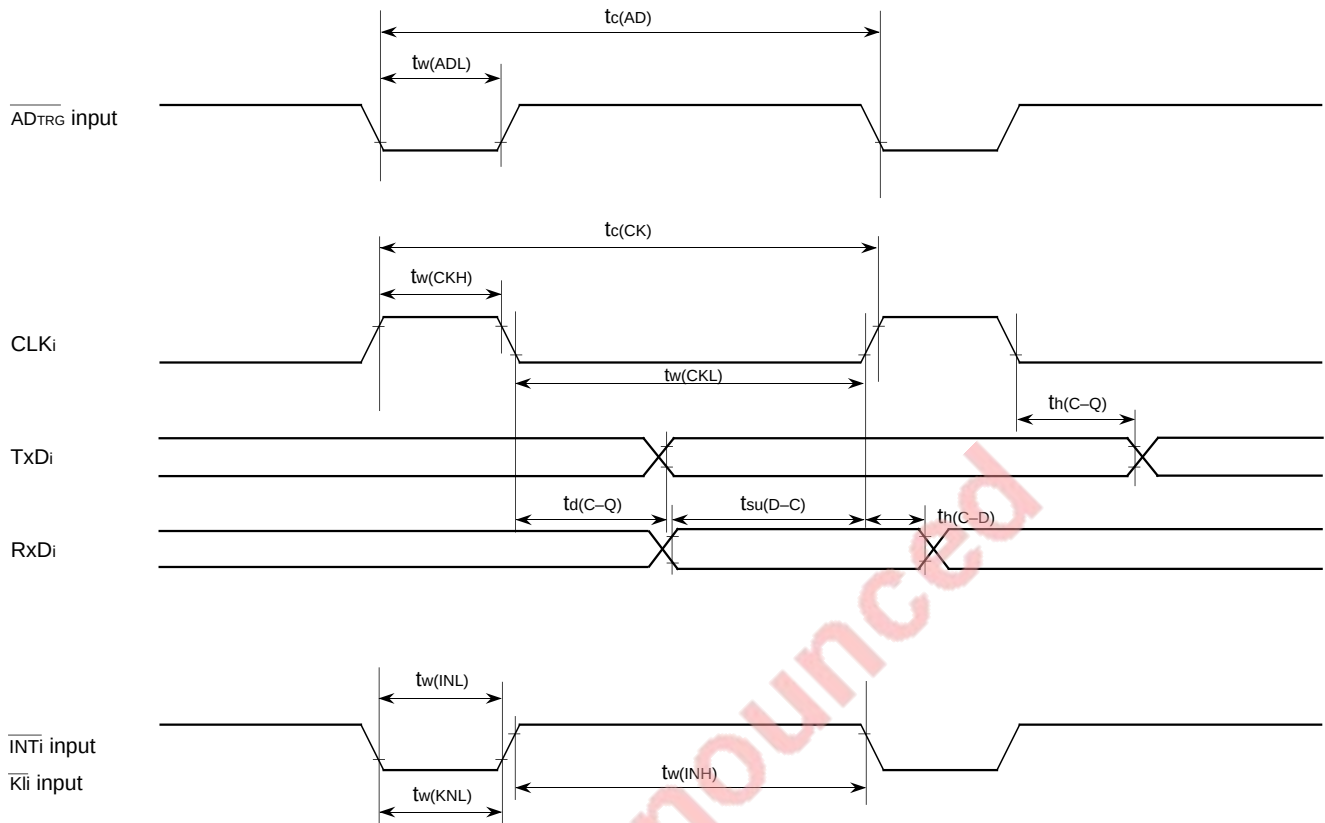
TIMING DIAGRAM

New product



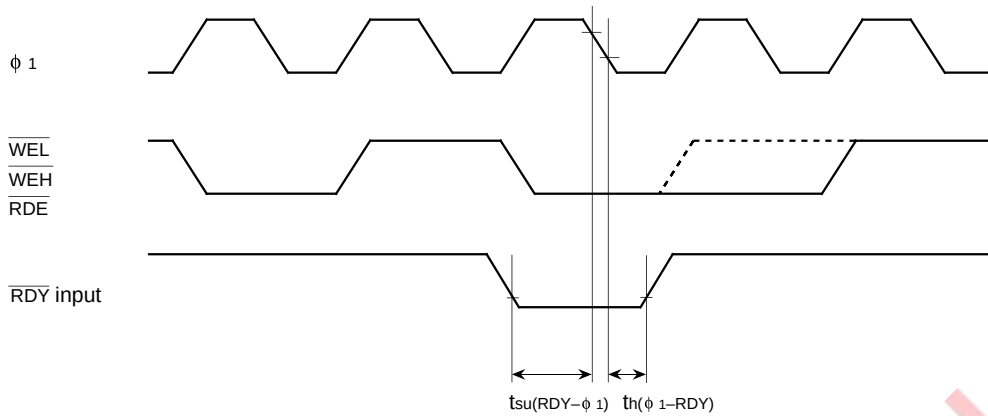
New product

16-BIT CMOS MICROCOMPUTER

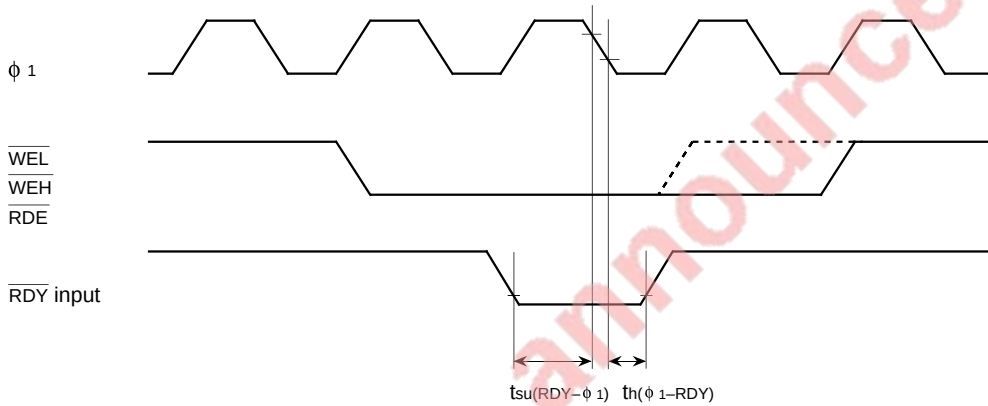


New product

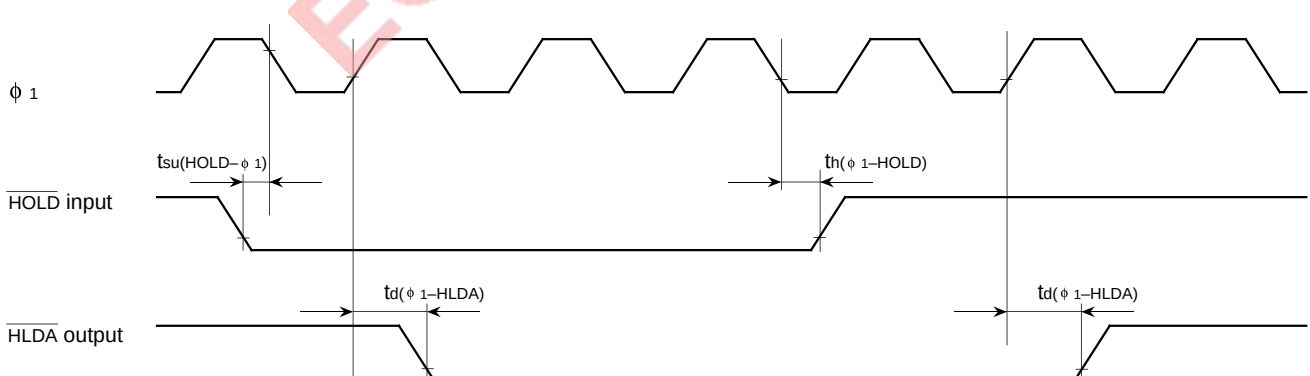
Microprocessor mode
(When wait bit = "1")



(When wait bit = "0")



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



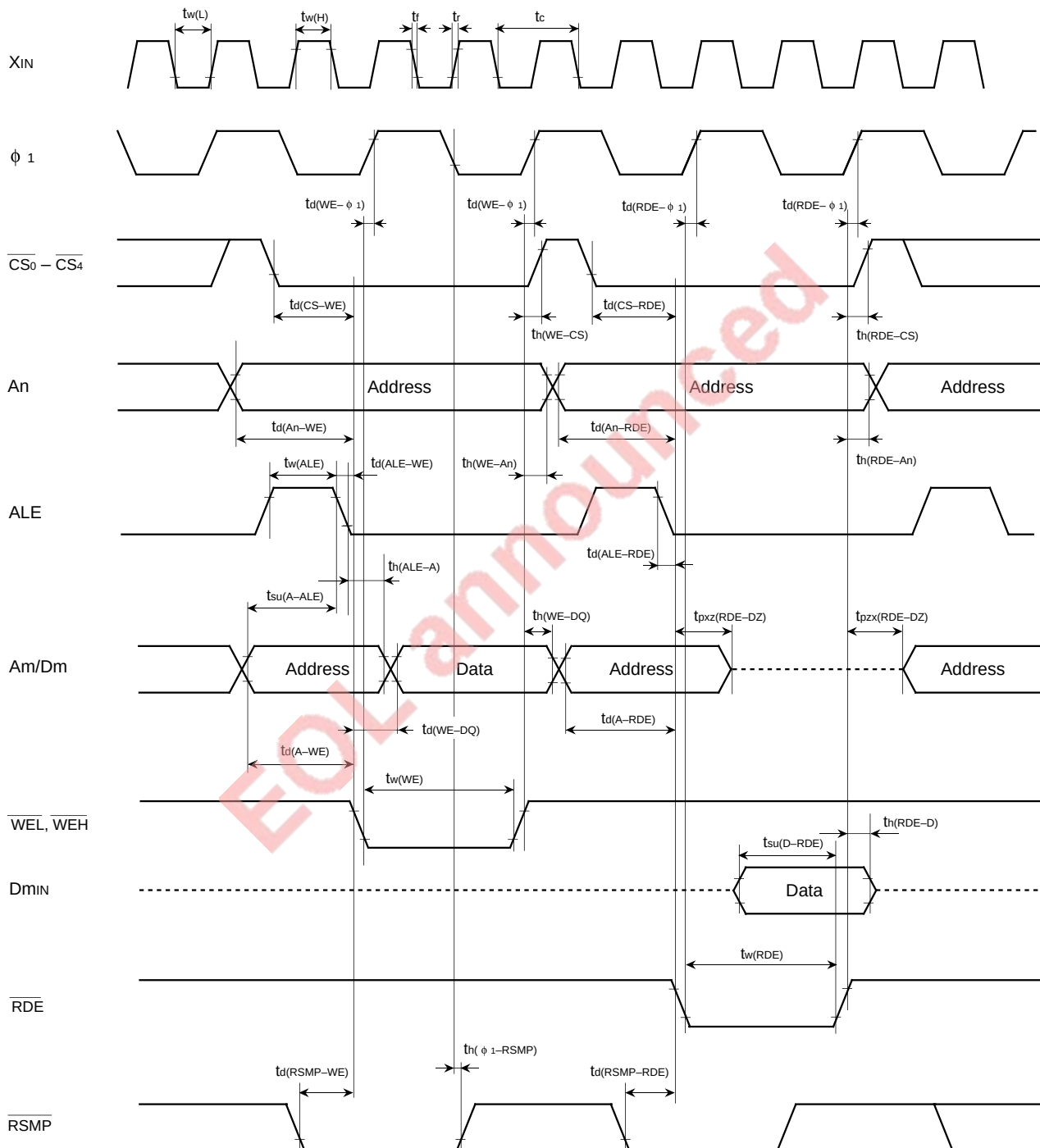
Test conditions

- $V_{CC} = 2.7 - 5.5 \text{ V}$
- Input timing voltage : $V_{IL} = 0.2V_{CC}$, $V_{IH} = 0.8V_{CC}$
- Output timing voltage : $V_{OL} = 0.8 \text{ V}$, $V_{OH} = 2.0 \text{ V}$

New product

16-BIT CMOS MICROCOMPUTER

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

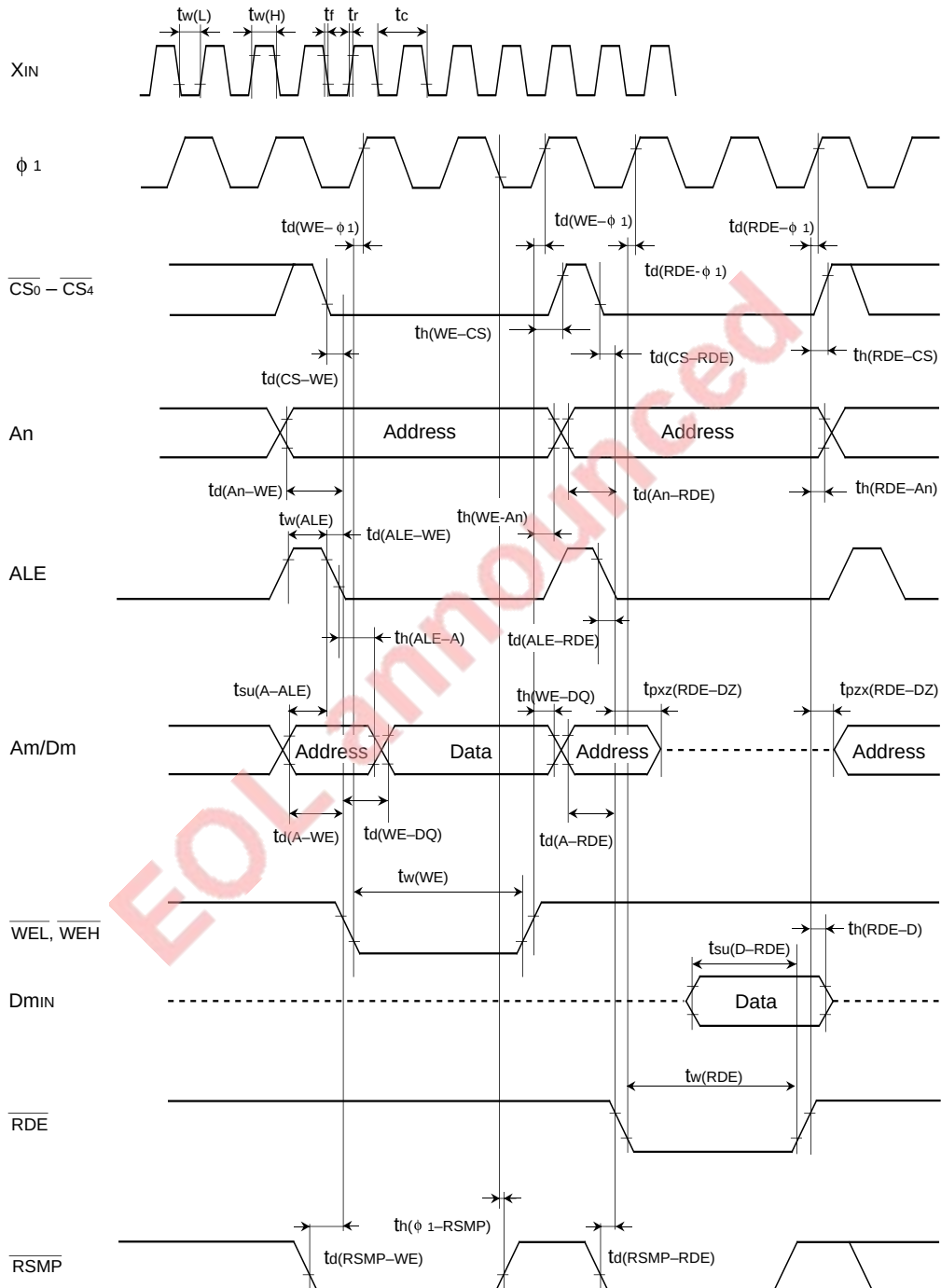


Test conditions

- $V_{CC} = 2.7 - 5.5 \text{ V}$
- Output timing voltage : $V_{OL} = 0.8 \text{ V}$, $V_{OH} = 2.0 \text{ V}$
- Data input D_{min} : $V_{IL} = 0.16 V_{CC}$, $V_{IH} = 0.5 V_{CC}$

Microprocessor mode

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

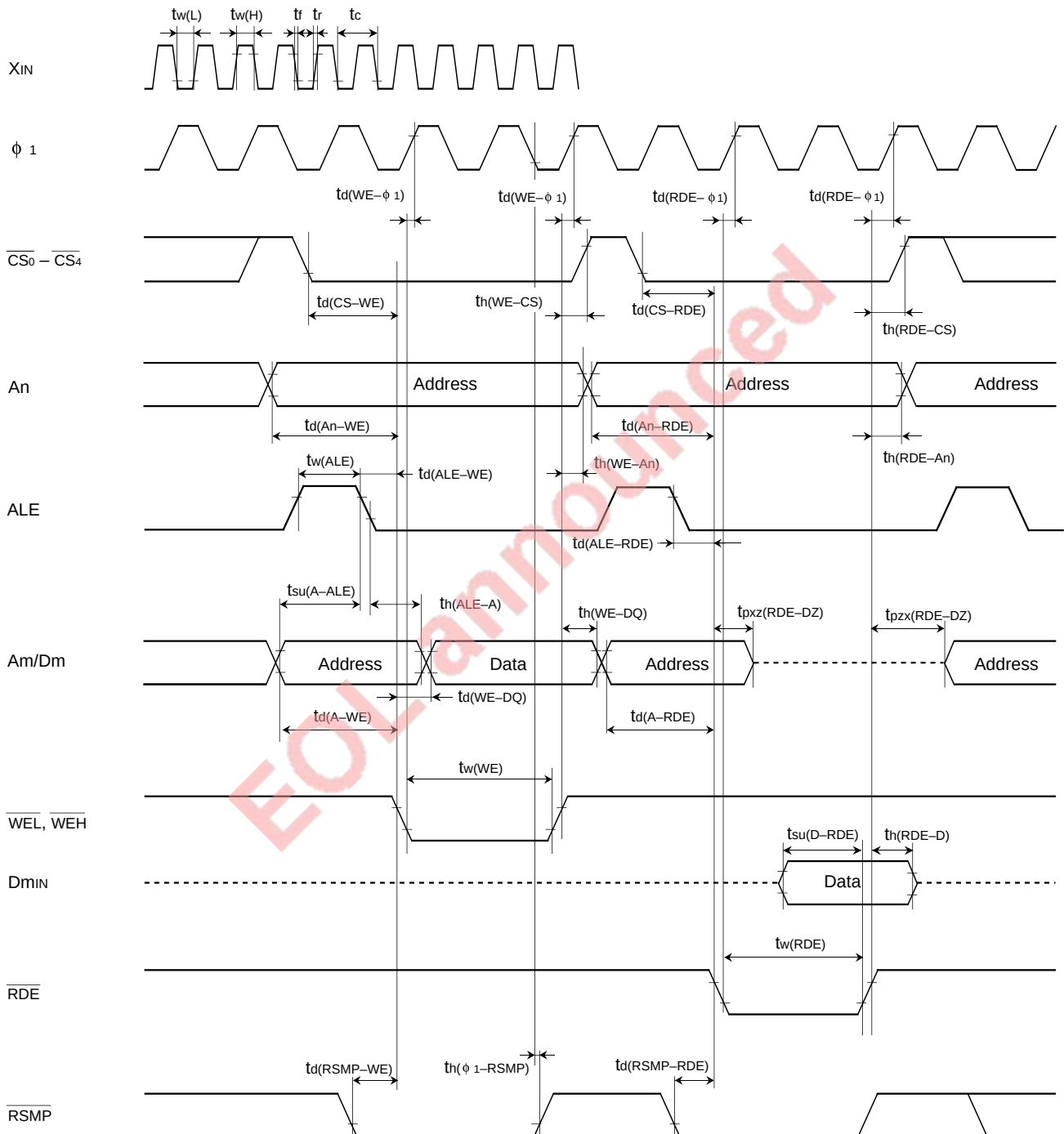


Test conditions

- $V_{CC} = 2.7 - 5.5 \text{ V}$
- Output timing voltage : $V_{OL} = 0.8 \text{ V}$, $V_{OH} = 2.0 \text{ V}$
- Data input D_{min} : $V_{IL} = 0.16 V_{CC}$, $V_{IH} = 0.5 V_{CC}$

Microprocessor mode

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



Test conditions

- $V_{CC} = 2.7 - 5.5 V$
- Output timing voltage : $V_{OL} = 0.8 V$, $V_{OH} = 2.0 V$
- Data input D_{min} : $V_{IL} = 0.16 V_{CC}$, $V_{IH} = 0.5 V_{CC}$

New product

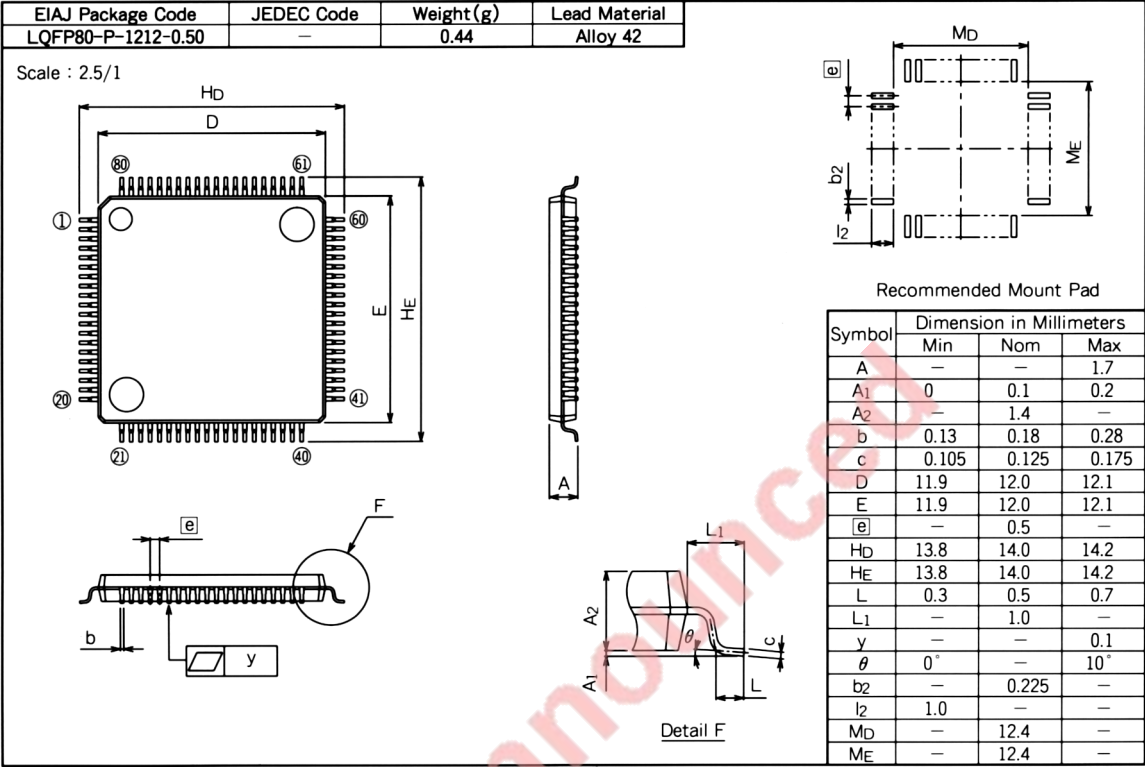
PACKAGE OUTLINE

80P6D-A

Plastic 80pin 12x12mm body LQFP

EIAJ Package Code	JEDEC Code	Weight (g)	Lead Material
LQFP80-P-1212-0.50	—	0.44	Alloy 42

Scale : 2.5/1



New product

16-BIT CMOS MICROCOMPUTER

MEMO

EOL announced

New product

EOL announced

Renesas Technology Corp.

Nippon Bldg., 6-2, Otemachi 2-chome, Chiyoda-ku, Tokyo, 100-0004 Japan

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