

PRELIMINARY
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 Some parametric limits are subject to change.

MITSUBISHI MICROCOMPUTERS M37736EHLXXXHP

PROM VERSION OF M37736MHLXXXHP

DESCRIPTION

The M37736EHLXXXHP is a single-chip microcomputer using the 7700 Family core. This single-chip 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 PROM, 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.

In the M37736MHLXXXHP, as the multiplex method of the external bus, either of 2 types can be selected.

The M37736EHLXXXHP has the same function as the M37736MHLXXXHP except that the built-in ROM is PROM. (Refer to the basic function blocks description.)

FEATURES

- Number of basic instructions 103
- Memory size PROM 124 Kbytes
 RAM 3968 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)
 9 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, output

(ports P0, P1, P2, P3, P4, P5, P6, P7, P8, P9, P10) 84

● Clock generating circuit 2 circuits built-in

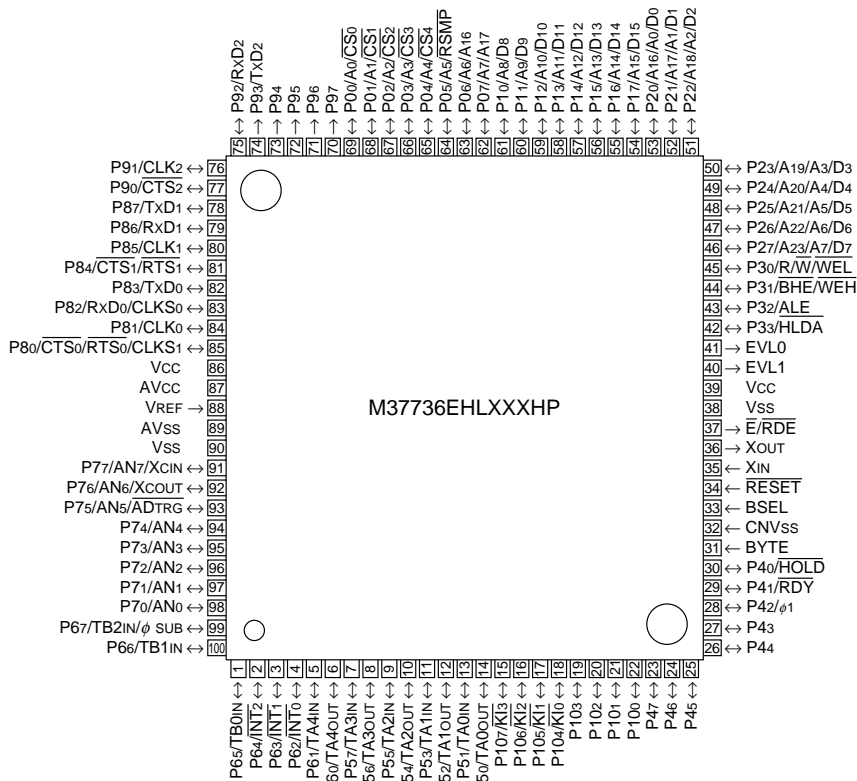
● Small package 100-pin plastic molded fine-pitch QFP
 (100P6Q-A; 0.5 mm lead pitch)

APPLICATION

Control devices for general commercial equipment such as office automation, office equipment, personal information equipment, and others.

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

PIN CONFIGURATION (TOP VIEW)

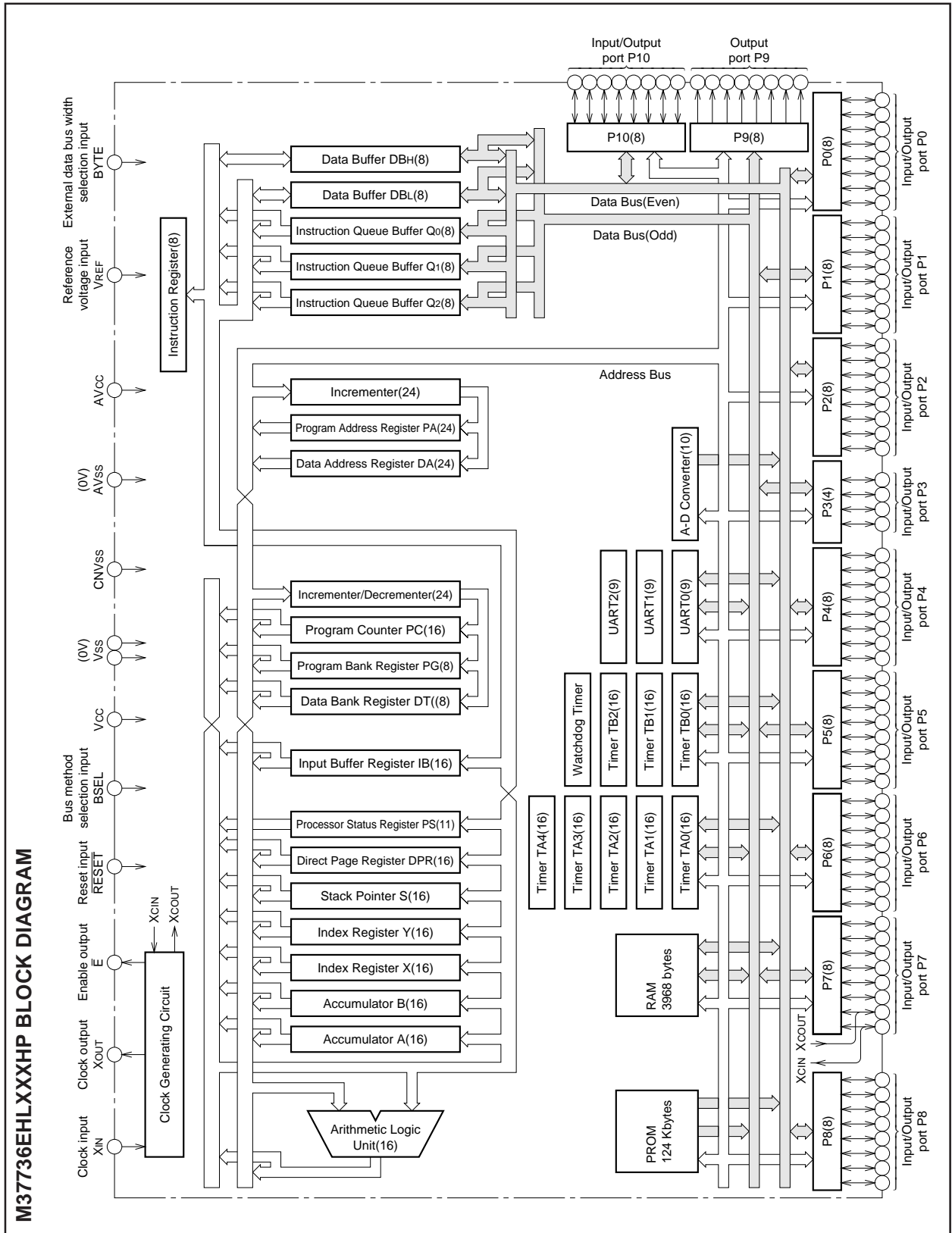


Outline 100P6Q-A

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FUNCTIONS OF M37736EHLXXXHP

Parameter		Functions
Number of basic instructions		103
Instruction execution time		333 ns (the fastest instruction at external clock 12 MHz frequency)
Memory size	PROM	124 Kbytes
	RAM	3968 bytes
Input/Output ports	P0 – P2, P4 – P8, P10	8-bit X 9
	P3	4-bit X 1
Output port	P9	8-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		9 mW (at 3 V supply voltage, external clock 12 MHz frequency) 22.5 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		External bus mode A; maximum 16 Mbytes, External bus mode B; maximum 1 Mbytes
Operating temperature range		–40 to 85 °C
Device structure		CMOS high-performance silicon gate process
Package		100-pin plastic molded fine-pitch QFP (100P6Q-A;0.5 mm lead pitch)

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	This pin controls the processor mode. Connect to Vss for the single-chip mode and the memory expansion mode, and to Vcc for the microprocessor mode.
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	
E	Enable output	Output	This pin functions as the enable signal output pin which indicates the access status in the internal bus. In the external bus mode B and the memory expansion mode or the microprocessor mode, this pin output signal RDE.
BYTE	External data bus width selection input	Input	In the memory expansion mode or the microprocessor mode, 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.
BSEL	Bus method select input	Input	In the memory expansion mode or the microprocessor mode, this pin determines the external bus mode. The bus mode becomes the external bus mode A when "H" signal is input, and the external bus mode B when "L" 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.
P0 ₀ – P0 ₇	I/O port P0	I/O	In the single-chip mode, port P0 becomes an 8-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. In the memory expansion mode or the microprocessor mode, these pins output address (A ₀ – A ₇) at the external bus mode A, and these pins output signals CS ₀ – CS ₄ and RSMP, and addresses (A ₁₆ , A ₁₇) at the external bus mode B.
P1 ₀ – P1 ₇	I/O port P1	I/O	In the single-chip mode, these pins have the same functions as port P0. When the BYTE pin is set to "L" in the memory expansion mode or the microprocessor mode 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.
P2 ₀ – P2 ₇	I/O port P2	I/O	In the single-chip mode, these pins have the same functions as port P0. In the memory expansion mode or the microprocessor mode, low-order data (D ₀ – D ₇) is input/output or an address is output. When using the external bus mode A, the address is A ₁₆ – A ₂₃ . When using the external bus mode B, the address is A ₀ – A ₇ .
P3 ₀ – P3 ₃	I/O port P3	I/O	In the single-chip mode, these pins have the same function as port P0. In the memory expansion mode or the microprocessor mode, R/W, BHE, ALE, and HLDA signals are output at the external bus mode A, and WEL, WEH, ALE, and HLDA signals are output at the external bus mode B.
P4 ₀ – P4 ₇	I/O port P4	I/O	In the single-chip mode, these pins have the same functions as port P0. In the memory expansion mode or the microprocessor mode, P4 ₀ , P4 ₁ , and P4 ₂ become HOLD and RDY input pins, and a clock φ ₁ output pin, respectively. Functions of the other pins are the same as in the single-chip mode. However, in the memory expansion mode, P4 ₂ can be selected as an I/O port.
P5 ₀ – P5 ₇	I/O port P5	I/O	In addition to having the same functions as port P0 in the single-chip mode, these pins also function as I/O pins for timers A0 to A3.
P6 ₀ – P6 ₇	I/O port P6	I/O	In addition to having the same functions as port P0 in the single-chip mode, 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. P6 ₇ also functions as sub-clock φ _{SUB} output pin.
P7 ₀ – P7 ₇	I/O port P7	I/O	In addition to having the same functions as port P0 in the single-chip mode, these pins function as input pins for A-D converter. Additionally, P7 ₆ and P7 ₇ have the function as the output pin (XCOUT) and the input pin (XCIN) of the sub-clock (32 kHz) oscillation circuit, respectively. When P7 ₆ and P7 ₇ are used as the XCOUT and XCIN pins, connect a resonator or an oscillator between the both.
P8 ₀ – P8 ₇	I/O port P8	I/O	In addition to having the same functions as port P0 in the single-chip mode, these pins also function as I/O pins for UART 0 and UART 1.
P9 ₀ – P9 ₇	Output port P9	Output	Port P9 is an 8-bit I/O port. These ports are floating when reset. When writing to the port latch, these ports become the output mode. P9 ₀ – P9 ₃ also function as I/O port for UART 2.
P10 ₀ – P10 ₇	I/O port P10	I/O	In addition to having the same functions as port P0 in the single-chip mode. P10 ₄ – P10 ₇ also function as input pins for key input interrupt input (KI ₀ – KI ₃).
EVL0, EVL1	———	Output	These pins should be left open.

BASIC FUNCTION BLOCKS

The M37736EHLXXXHP has the same functions as the M37736MHBXXXGP except for the following :

- (1) The built-in ROM is PROM.
- (2) The package is different.
- (3) The reset circuit is different.

Refer to the section on the M37736MHBXXXGP.

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 2.7 – 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 1 shows an example of a reset circuit. When 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. When 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.

The status of the internal registers during reset is the same as the M37736MHBXXXGP's.

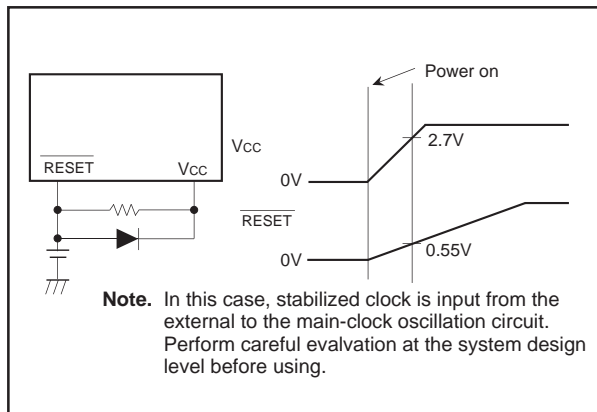


Fig. 1 Example of a reset circuit

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PIN DESCRIPTION (EPROM MODE)

Pin	Name	Input/Output	Functions
VCC, VSS	Power supply		Supply 5V±10% to Vcc and 0V to Vss.
CNVSS	VPP input	Input	Connect to VPP when programming or verifying.
BYTE	VPP input	Input	Connect to VPP when programming or verifying.
RESET	Reset input	Input	Connect to Vss.
XIN	Clock input	Input	Connect a ceramic resonator between XIN and XOUT.
XOUT	Clock output	Output	
E	Enable output	Output	Keep open.
AVCC, AVSS	Analog supply input		Connect AVCC to Vcc and AVSS to Vss.
VREF	Reference voltage input	Input	Connect to Vss.
P00 – P07	Address input (A0 – A7)	Input	Port P0 functions as the lower 8 bits address input (A0 – A7).
P10 – P17	Address input (A8 – A15)	Input	Port P1 functions as the higher 8 bits address input (A8 – A15).
P20 – P27	Data I/O (D0 – D7)	I/O	Port P2 functions as the 8 bits data bus(D0 – D7).
P30	Address input (A16)	Input	P30 functions as the most significant bit address input (A16).
P31 – P33	Input port P3	Input	Connect to Vss.
P40 – P47	Input port P4	Input	Connect to Vss.
P50 – P57	Control signal input	Input	P50, P51 and P52 function as PGM, OE and CE input pins respectively. Connect P53, P54, P55 and P56 to Vcc. Connect P57 to Vss.
P60 – P67	Input port P6	Input	Connect to Vss.
P70 – P77	Input port P7	Input	Connect to Vss.
P80 – P87	Input port P8	Input	Connect to Vss.
P90 – P97	Input port P9	Input	Connect to Vss.
P100 – P107	Input port P10	Input	Connect to Vss.
BSEL	—	Input	Connect to Vcc.
EVL0,EVL1	—	Output	Keep open.

EPROM MODE

The M37736EHLXXXHP features an EPROM mode in addition to its normal modes. When the RESET signal level is "L", the chip automatically enters the EPROM mode. Table 1 list the correspondence between pins and Figure 2 shows the pin connections in the EPROM mode.

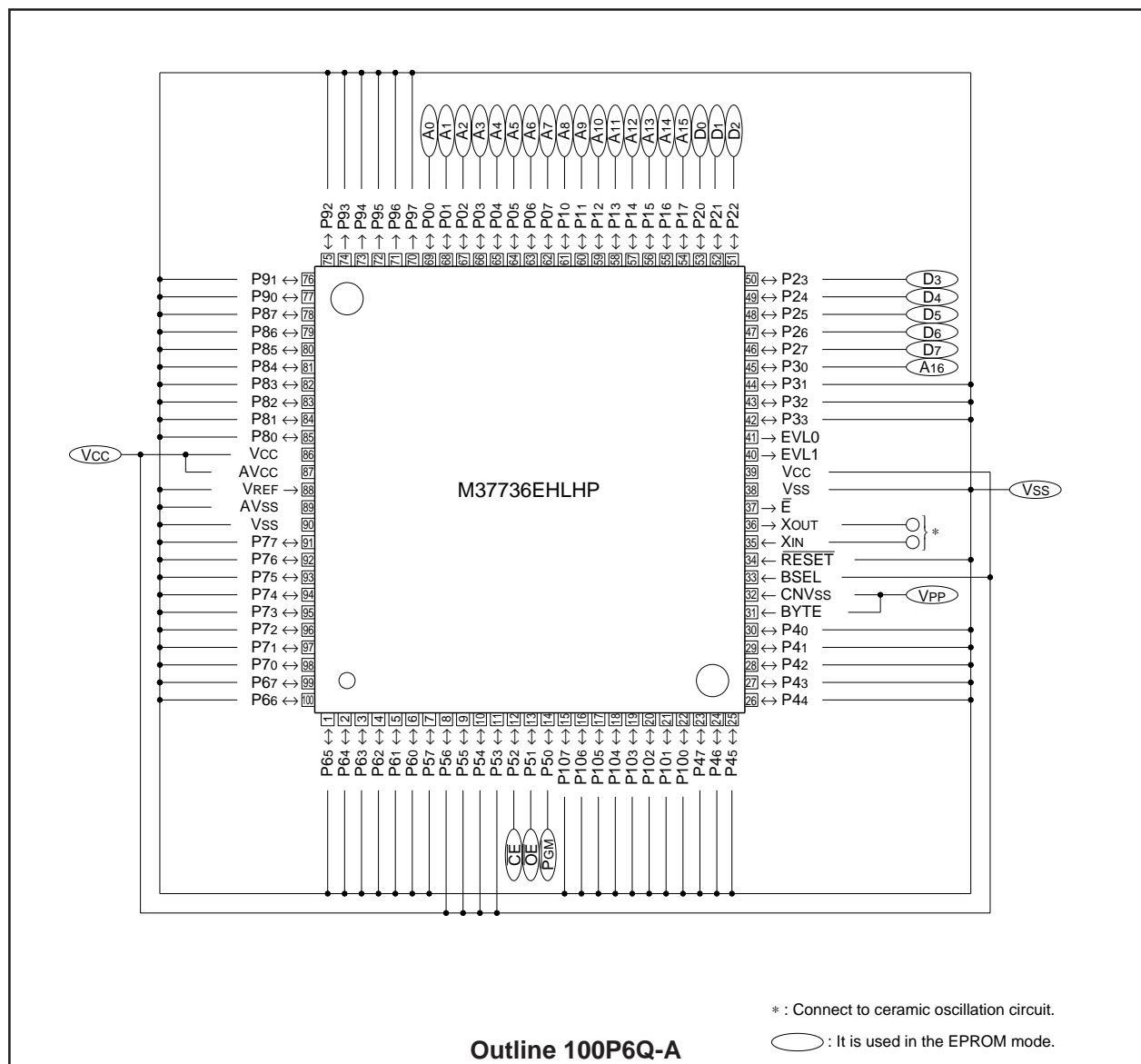
The EPROM mode is the 1M mode for the EPROM that is equivalent to the M5M27C101K.

When in the EPROM mode, ports P0, P1, P2, P30, P50, P51, P52, CNVss and BYTE are used for the EPROM (equivalent to the

M5M27C101K). When in this mode, the built-in PROM can be programmed or read from using these pins in the same way as with the M5M27C101K.

This chip does not have Device Identifier Mode, so that set the corresponding program algorithm. The program area should specify address 0100016 – 1FFFF16.

Connect the clock which is either ceramic resonator or external clock to XIN pin and XOUT pin.



* : Connect to ceramic oscillation circuit.
 ○ : It is used in the EPROM mode.

Fig. 2 Pin connection in EPROM mode

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Table 1 Pin function in EPROM mode

	M37736EHLXXXHP	M5M27C101K
VCC	VCC	VCC
VPP	CNVSS, BYTE	VPP
VSS	VSS	VSS
Address input	Ports P0, P1, P30	A0 – A16
Data I/O	Port P2	D0 – D7
$\overline{\text{CE}}$	P52	$\overline{\text{CE}}$
$\overline{\text{OE}}$	P51	$\overline{\text{OE}}$
PGM	P50	PGM

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FUNCTION IN EPROM MODE
1M mode (equivalent to the M5M27C101K)

Reading

To read the EPROM, set the \overline{CE} and \overline{OE} pins to a "L" level. Input the address of the data ($A_0 - A_{16}$) to be read, and the data will be output to the I/O pins $D_0 - D_7$. The data I/O pins will be floating when either the \overline{CE} or \overline{OE} pins are in the "H" state.

Programming

Programming must be performed in 8 bits by a byte program. To program to the EPROM, set the \overline{CE} pin to a "L" level and the \overline{OE} pin to a "H" level. The CPU will enter the programming mode when 12.5 V is applied to the V_{PP} pin. The address to be programmed to is selected with pins $A_0 - A_{16}$, and the data to be programmed is input to pins $D_0 - D_7$. Set the \overline{PGM} pin to a "L" level to being programming.

Programming operation

To program the M37736EHLXXXHP, first set $V_{CC} = 6\text{ V}$, $V_{PP} = 12.5\text{ V}$, and set the address to 0100016. Apply a 0.2 ms programming pulse, check that the data can be read, and if it cannot be read OK, repeat the procedure, applying a 0.2 ms programming pulse and checking that the data can be read until it can be read OK. Record the accumulated number of pulse applied (X) before the data can be read OK, and then write the data again, applying a further once this number of pulses ($0.2 \times X\text{ ms}$).

When this series of programming operations is complete, increment the address, and continue to repeat the procedure above until the last address has been reached.

Finally, when all addresses have been programmed, read with $V_{CC} = V_{PP} = 5\text{ V}$ (or $V_{CC} = V_{PP} = 5.5\text{ V}$).

Table 2. I/O signal in each mode

Mode	Pin					
	\overline{CE}	\overline{OE}	\overline{PGM}	V_{PP}	V_{CC}	Data I/O
Read-out	V_{IL}	V_{IL}	X	5 V	5 V	Output
Output	V_{IL}	V_{IH}	X	5 V	5 V	Floating
Disable	V_{IH}	X	X	5 V	5 V	Floating
Programming	V_{IL}	V_{IH}	V_{IL}	12.5 V	6 V	Input
Programming Verify	V_{IL}	V_{IL}	V_{IH}	12.5 V	6 V	Output
Program Disable	V_{IH}	V_{IH}	V_{IH}	12.5 V	6 V	Floating

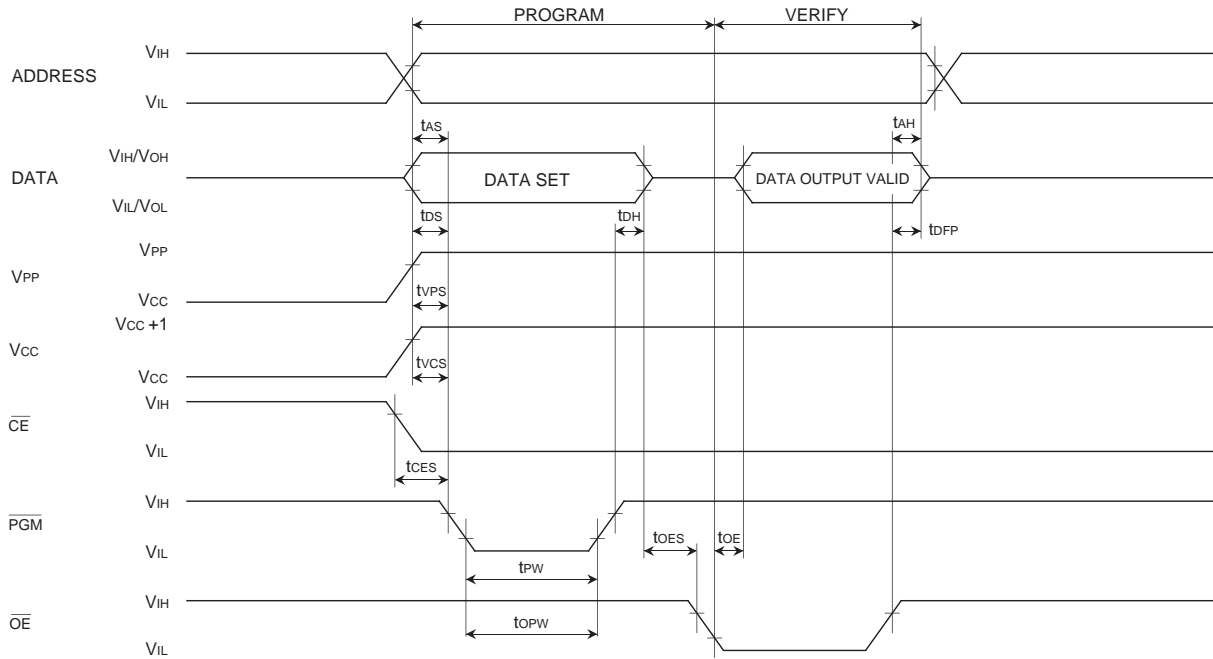
Note 1 : An X indicates either V_{IL} or V_{IH} .

Programming operation (equivalent to the M5M27C101K)

AC ELECTRICAL CHARACTERISTICS ($T_a = 25 \pm 5\text{ }^\circ\text{C}$, $V_{CC} = 6\text{ V} \pm 0.25\text{ V}$, $V_{PP} = 12.5 \pm 0.3\text{ V}$, unless otherwise noted)

Symbol	Parameter	Test conditions	Limits			Unit
			Min.	Typ.	Max.	
tAS	Address setup time		2			μs
tOES	\overline{OE} setup time		2			μs
tDS	Data setup time		2			μs
tAH	Address hold time		0			μs
tDH	Data hold time		2			μs
tDFP	Output enable to output float delay		0		130	ns
tVCS	V_{CC} setup time		2			μs
tVPS	V_{PP} setup time		2			μs
tPW	\overline{PGM} pulse width		0.19	0.2	0.21	ms
tOPW	\overline{PGM} over program pulse width		0.19		5.25	ms
tCES	\overline{CE} setup time		2			μs
tOE	Data valid from \overline{OE}				150	ns

AC waveforms



Test conditions for A.C. characteristics

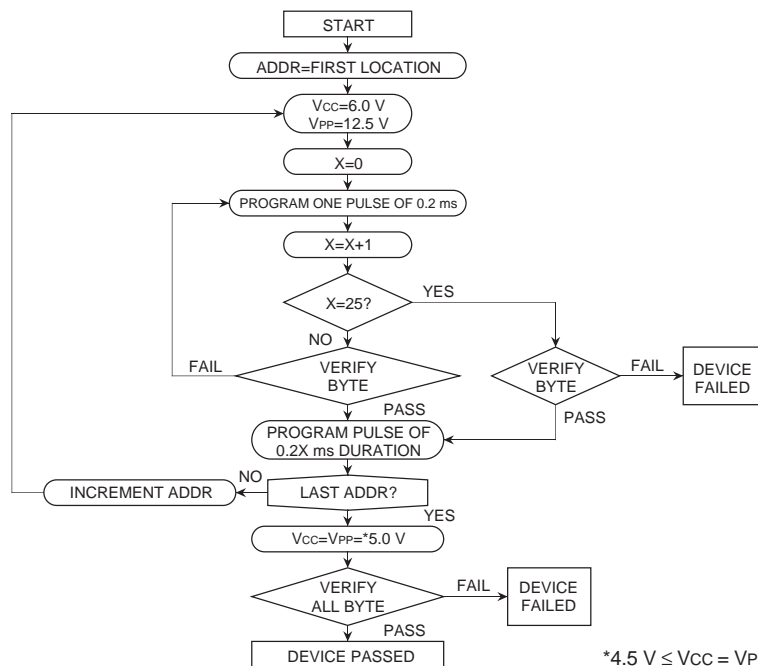
Input voltage : $V_{IL} = 0.45 \text{ V}$, $V_{IH} = 2.4 \text{ V}$

Input rise and fall times (10% – 90%) : $\leq 20 \text{ ns}$

Reference voltage at timing measurement : Input, Output

"L" = 0.8 V, "H" = 2 V

Programming algorithm flow chart

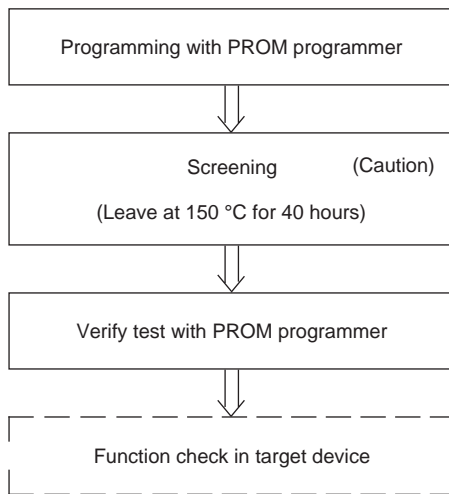


*4.5 V \leq VCC = VPP \leq 5.5 V

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SAFETY INSTRUCTIONS

- (1) A high voltage is used for programming. Take care that over-voltage is not applied. Take care especially at power on.
- (2) The programmable M37736EHLHP that is shipped in blank is also provided. For the M37736EHLHP, Mitsubishi Electric corp. does not perform PROM programming test and screening following the assembly processes. To improve reliability after programming, performing programming and test according to the flow below before use is recommended.



Caution : Never expose to 150 °C exceeding 100 hours.

ADDRESSING MODES

The M37736EHLXXXHP has 28 powerful addressing modes. Refer to the "7700 Family Software Manual" for the details.

MACHINE INSTRUCTION LIST

The M37736EHLXXXHP has 103 machine instructions. Refer to the "7700 Family Software Manual" for the details.

DATA REQUIRED FOR PROM ORDERING

Please send the following data for writing to PROM.

- (1) M37736EHLXXXHP writing to PROM order confirmation form
- (2) 100P6Q mark specification form (100P6D mark specification form is substituted.)
- (3) ROM data (EPROM 3 sets)

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, CNV _{ss} , BYTE		-0.3 to +12(Note)	V
V _i	Input voltage P00 – P07, P10 – P17, P20 – P27, P30 – P33, P40 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P92, P100 – P107, V _{REF} , X _{IN} , BSEL		-0.3 to V _{cc} + 0.3	V
V _o	Output voltage P00 – P07, P10 – P17, P20 – P27, P30 – P33, P40 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P97, P100 – P107, X _{OUT} , E		-0.3 to V _{cc} + 0.3	V
P _d	Power dissipation	T _a = 25 °C	200	mW
T _{opr}	Operating temperature		-40 to +85	°C
T _{stg}	Storage temperature		-65 to +150	°C

Note. When the EPROM is programmed, input voltage of pins CNV_{ss} and BYTE is 13 V respectively.

RECOMMENDED OPERATING CONDITIONS (V_{cc} = 2.7 – 5.5 V, T_a = -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
		f(X _{IN}) : Stopped, f(X _{CIN}) = 32.768 kHz	2.7		5.5	
AV _{cc}	Analog power source voltage			V _{cc}		V
V _{ss}	Power source voltage			0		V
AV _{ss}	Analog power source voltage			0		V
V _{IH}	High-level input voltage P00 – P07, P30 – P33, P40 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P92, P100 – P107, X _{IN} , RESET, CNV _{ss} , BYTE, BSEL, X _{CIN} (Note 3)		0.8 V _{cc}		V _{cc}	V
V _{IH}	High-level input voltage P10 – P17, P20 – P27 (in single-chip mode)		0.8 V _{cc}		V _{cc}	V
V _{IH}	High-level input voltage P10 – P17, P20 – P27 (in memory expansion mode and microprocessor mode)		0.5 V _{cc}		V _{cc}	V
V _{IL}	Low-level input voltage P00 – P07, P30 – P33, P40 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P92, P100 – P107, X _{IN} , RESET, CNV _{ss} , BYTE, BSEL, X _{CIN} (Note 3)		0		0.2V _{cc}	V
V _{IL}	Low-level input voltage P10 – P17, P20 – P27 (in single-chip mode)		0		0.2V _{cc}	V
V _{IL}	Low-level input voltage P10 – P17, P20 – P27 (in memory expansion mode and microprocessor mode)		0		0.16V _{cc}	V
I _{OH(peak)}	High-level peak output current P00 – P07, P10 – P17, P20 – P27, P30 – P33, P40 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P97, P100 – P107				-10	mA
I _{OH(avg)}	High-level average output current P00 – P07, P10 – P17, P20 – P27, P30 – P33, P40 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P97, P100 – P107				-5	mA
I _{OL(peak)}	Low-level peak output current P00 – P07, P10 – P17, P20 – P27, P30 – P33, P40 – P43, P54 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P97, P104 – P107				10	mA
I _{OL(peak)}	Low-level peak output current P44 – P47, P100 – P103				16	mA
I _{OL(avg)}	Low-level average output current P00 – P07, P10 – P17, P20 – P27, P30 – P33, P40 – P43, P50 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P97, P104 – P107				5	mA
I _{OL(avg)}	Low-level average output current P44 – P47, P100 – P103				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 P0, P1, P2, P3, P8, and P9 must be 80 mA or less, the sum of I_{OH(peak)} for ports P0, P1, P2, P3, P8, and P9 must be 80 mA or less, the sum of I_{OL(peak)} for ports P4, P5, P6, P7, and P10 must be 100 mA or less, and the sum of I_{OH(peak)} for ports P4, P5, P6, P7, and P10 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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PROM VERSION OF M37736MHLXXXHP

ELECTRICAL CHARACTERISTICS ($V_{CC} = 5\text{ V}$, $V_{SS} = 0\text{ V}$, $T_a = -40$ 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 P00 – P07, P10 – P17, P20 – P27, P33, P40 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P97, P100 – P107	V _{CC} = 5 V, I _{OH} = –10 mA	3			V	
		V _{CC} = 3 V, I _{OH} = –1 mA	2.5				
V _{OH}	High-level output voltage P00 – P07, P10 – P17, P20 – P27, P33	V _{CC} = 5 V, I _{OH} = –400 μ A	4.7			V	
V _{OH}	High-level output voltage P30 – P32	V _{CC} = 5 V, I _{OH} = –10 mA	3.1			V	
		V _{CC} = 5 V, I _{OH} = –400 μ A	4.8				
		V _{CC} = 3 V, I _{OH} = –1 mA	2.6				
V _{OH}	High-level output voltage \bar{E}	V _{CC} = 5 V, I _{OH} = –10 mA	3.4			V	
		V _{CC} = 5 V, I _{OH} = –400 μ A	4.8				
		V _{CC} = 3 V, I _{OH} = –1 mA	2.6				
V _{OL}	Low-level output voltage P00 – P07, P10 – P17, P20 – P27, P33, P40 – P43, P50 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P97, P104 – P107	V _{CC} = 5 V, I _{OL} = 10 mA			2	V	
		V _{CC} = 3 V, I _{OL} = 1 mA			0.5		
V _{OL}	Low-level output voltage P44 – P47, P100 – P103	V _{CC} = 5 V, I _{OL} = 16 mA			1.8	V	
		V _{CC} = 3 V, I _{OL} = 10 mA			1.5		
V _{OL}	Low-level output voltage P00 – P07, P10 – P17, P20 – P27, P33	V _{CC} = 5 V, I _{OL} = 2 mA			0.45	V	
		V _{CC} = 3 V, I _{OL} = 1 mA			0.4		
V _{OL}	Low-level output voltage P30 – P32	V _{CC} = 5 V, I _{OL} = 10 mA			1.9	V	
		V _{CC} = 5 V, I _{OL} = 2 mA			0.43		
		V _{CC} = 3 V, I _{OL} = 1 mA			0.4		
V _{OL}	Low-level output voltage \bar{E}	V _{CC} = 5 V, I _{OL} = 10 mA			1.6	V	
		V _{CC} = 5 V, I _{OL} = 2 mA			0.4		
		V _{CC} = 3 V, I _{OL} = 1 mA			0.4		
V _{T+} – V _{T–}	Hysteresis HOLD, RDY, TA0IN – TA4IN, TB0IN – TB2IN, INT0 – INT2, ADTRG, CTS0, CTS1, CTS2, CLK0, CLK1, CLK2, K10 – K13	V _{CC} = 5 V	0.4		1	V	
		V _{CC} = 3 V	0.1		0.7		
V _{T+} – V _{T–}	Hysteresis $\bar{\text{RESET}}$	V _{CC} = 5 V	0.2		0.5	V	
		V _{CC} = 3 V	0.1		0.4		
V _{T+} – V _{T–}	Hysteresis X _{IN}	V _{CC} = 5 V	0.1		0.4	V	
		V _{CC} = 3 V	0.06		0.26		
V _{T+} – V _{T–}	Hysteresis X _{CIN} (When external clock is input)	V _{CC} = 5 V	0.1		0.4	V	
		V _{CC} = 3 V	0.06		0.26		
I _{IH}	High-level input current P00 – P07, P10 – P17, P20 – P27, P30 – P33, P40 – P47, P50 – P57, P60 – P67, P70 – P77, P80 – P87, P90 – P92, P100 – P107, X _{IN} , $\bar{\text{RESET}}$, CNV _{SS} , BYTE, BSEL	V _{CC} = 5 V, V _I = 5 V			5	μ A	
		V _{CC} = 3 V, V _I = 3 V			4		
I _{IL}	Low-level input current P00 – P07, P10 – P17, P20 – P27, P30 – P33, P40 – P47, P50 – P53, P60, P61, P65 – P67, P70 – P77, P80 – P87, P90 – P92, P100 – P103, X _{IN} , $\bar{\text{RESET}}$, CNV _{SS} , BYTE, BSEL	V _{CC} = 5 V, V _I = 0 V			–5	μ A	
		V _{CC} = 3 V, V _I = 0 V			–4		
I _{IL}	Low-level input current P62 – P64, P104 – P107	V _I = 0 V, without a pull-up transistor	V _{CC} = 5 V			–5	μ A
			V _{CC} = 3 V			–4	
		V _I = 0 V, with a pull-up transistor	V _{CC} = 5 V	–0.25	–0.5	–1.0	mA
			V _{CC} = 3 V	–0.08	–0.18	–0.35	
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 single-chip mode, 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)		4.5	9	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	mA	
			V _{CC} = 3 V, f(X _{IN}) = 12 MHz (square waveform), f(f ₂) = 0.75 MHz, f(X _{CIN}) : Stopped, in operating		0.4	0.8	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	μA	
			V _{CC} = 3 V, f(X _{IN}) : Stopped, f(X _{CIN}) = 32.768 kHz, in operating (Note 3)		30	60	μA	
			V _{CC} = 3 V, f(X _{IN}) : Stopped, f(X _{CIN}) = 32.768 kHz, when a WIT instruction is executed (Note 4)		3	6	μA	
			T _a = 25 °C, when clock is stopped				1	μA
			T _a = 85 °C, when clock is stopped				20	μA

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".

- This applies when the main clock external input selection bit = "1" and the system clock stop bit at wait state = "1".
- This applies when CPU and the clock timer are operating with the sub clock (32.768 kHz) selected as the system clock.
- 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	kΩ
t _{CONV}	Conversion time		19.6			μs
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(f₂) = 6 MHz.

TIMING REQUIREMENTS ($V_{CC} = 2.7 - 5.5 \text{ V}$, $V_{SS} = 0 \text{ V}$, $T_a = -40 \text{ to } +85 \text{ }^\circ\text{C}$, $f(X_{IN}) = 12 \text{ MHz}$, unless otherwise noted (Note 1))

Notes 1. This applies when the main clock division selection bit = "0" and $f(f_2) = 6 \text{ MHz}$.

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 3)	83		ns
$t_{w(H)}$	External clock input high-level pulse width (Note 4)	33		ns
$t_{w(L)}$	External clock input low-level pulse width (Note 4)	33		ns
t_r	External clock rise time		15	ns
t_f	External clock fall time		15	ns

Notes 3. When the main clock division selection bit = "1", the minimum value of $t_c = 166 \text{ ns}$.

4. 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.

Single-chip mode

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{su(P0D-E)}$	Port P0 input setup time	200		ns
$t_{su(P1D-E)}$	Port P1 input setup time	200		ns
$t_{su(P2D-E)}$	Port P2 input setup time	200		ns
$t_{su(P3D-E)}$	Port P3 input setup time	200		ns
$t_{su(P4D-E)}$	Port P4 input setup time	200		ns
$t_{su(P5D-E)}$	Port P5 input setup time	200		ns
$t_{su(P6D-E)}$	Port P6 input setup time	200		ns
$t_{su(P7D-E)}$	Port P7 input setup time	200		ns
$t_{su(P8D-E)}$	Port P8 input setup time	200		ns
$t_{su(P10D-E)}$	Port P10 input setup time	200		ns
$t_{h(E-P0D)}$	Port P0 input hold time	0		ns
$t_{h(E-P1D)}$	Port P1 input hold time	0		ns
$t_{h(E-P2D)}$	Port P2 input hold time	0		ns
$t_{h(E-P3D)}$	Port P3 input hold time	0		ns
$t_{h(E-P4D)}$	Port P4 input hold time	0		ns
$t_{h(E-P5D)}$	Port P5 input hold time	0		ns
$t_{h(E-P6D)}$	Port P6 input hold time	0		ns
$t_{h(E-P7D)}$	Port P7 input hold time	0		ns
$t_{h(E-P8D)}$	Port P8 input hold time	0		ns
$t_{h(E-P10D)}$	Port P10 input hold time	0		ns

Memory expansion mode and microprocessor mode

Symbol	Parameter	Limits		Unit
		Min.	Max.	
$t_{su(D-E)}$	Data input setup time (external bus mode A)	50		ns
$t_{su(D-RDE)}$	Data input setup time (external bus mode B)	50		ns
$t_{su(RDY-\phi_1)}$	RDY input setup time	80		ns
$t_{su(HOLD-\phi_1)}$	HOLD input setup time	80		ns
$t_{h(E-D)}$	Data input hold time (external bus mode A)	0		ns
$t_{h(RDE-D)}$	Data input hold time (external bus mode B)	0		ns
$t_{h(\phi_1-RDY)}$	RDY input hold time	0		ns
$t_{h(\phi_1-HOLD)}$	HOLD input hold time	0		ns

Timer A input (Count input in event counter mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
t _c (TA)	TAiIN input cycle time	250		ns
t _w (TAH)	TAiIN input high-level pulse width	125		ns
t _w (TAL)	TAiIN input low-level pulse width	125		ns

Timer A input (Gating input in timer mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
t _c (TA)	TAiIN input cycle time (Note)	666		ns
t _w (TAH)	TAiIN input high-level pulse width (Note)	333		ns
t _w (TAL)	TAiIN 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)	TAiIN input cycle time (Note)	666		ns
t _w (TAH)	TAiIN input high-level pulse width	166		ns
t _w (TAL)	TAiIN 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)	TAiIN input high-level pulse width	166		ns
t _w (TAL)	TAiIN 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)	TAiOUT input cycle time	3333		ns
t _w (UPH)	TAiOUT input high-level pulse width	1666		ns
t _w (UPL)	TAiOUT input low-level pulse width	1666		ns
t _{su} (UP-T _{IN})	TAiOUT input setup time	666		ns
t _h (T _{IN} -UP)	TAiOUT 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)	TAjIN input cycle time	2000		ns
t _{su} (TAjIN-TAjOUT)	TAjIN input setup time	500		ns
t _{su} (TAjOUT-TAjIN)	TAjOUT input setup time	500		ns

Timer B input (Count input in event counter mode)

Symbol	Parameter	Limits		Unit
		Min.	Max.	
t _c (TB)	TBiN input cycle time (one edge count)	250		ns
t _w (TBH)	TBiN input high-level pulse width (one edge count)	125		ns
t _w (TBL)	TBiN input low-level pulse width (one edge count)	125		ns
t _c (TB)	TBiN input cycle time (both edges count)	500		ns
t _w (TBH)	TBiN input high-level pulse width (both edges count)	250		ns
t _w (TBL)	TBiN 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)	TBiN input cycle time (Note)	666		ns
t _w (TBH)	TBiN input high-level pulse width (Note)	333		ns
t _w (TBL)	TBiN 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)	TBiN input cycle time (Note)	666		ns
t _w (TBH)	TBiN input high-level pulse width (Note)	333		ns
t _w (TBL)	TBiN 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)	AD _{TRG} input cycle time (minimum allowable trigger)	1333		ns
t _w (ADL)	AD _{TRG} input low-level pulse width	166		ns

Serial I/O

Symbol	Parameter	Limits		Unit
		Min.	Max.	
t _c (CK)	CLK _i input cycle time	333		ns
t _w (CKH)	CLK _i input high-level pulse width	166		ns
t _w (CKL)	CLK _i input low-level pulse width	166		ns
t _d (C-Q)	TxD _i output delay time		100	ns
t _h (C-Q)	TxD _i hold time	0		ns
t _{su} (D-C)	RxD _i input setup time	65		ns
t _h (C-D)	RxD _i input hold time	75		ns

External interrupt INT_i input, key input interrupt K_i input

Symbol	Parameter	Limits		Unit
		Min.	Max.	
t _w (INH)	INT _i input high-level pulse width	250		ns
t _w (INL)	INT _i input low-level pulse width	250		ns
t _w (KIL)	K _i 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 "M37736MHBXXXGP".

SWITCHING CHARACTERISTICS

(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))

Single-chip mode

Symbol	Parameter	Test conditions	Limits		Unit
			Min.	Max.	
td(E–P0Q)	Port P0 data output delay time	Fig. 3		300	ns
td(E–P1Q)	Port P1 data output delay time			300	ns
td(E–P2Q)	Port P2 data output delay time			300	ns
td(E–P3Q)	Port P3 data output delay time			300	ns
td(E–P4Q)	Port P4 data output delay time			300	ns
td(E–P5Q)	Port P5 data output delay time			300	ns
td(E–P6Q)	Port P6 data output delay time			300	ns
td(E–P7Q)	Port P7 data output delay time			300	ns
td(E–P8Q)	Port P8 data output delay time			300	ns
td(E–P9Q)	Port P9 data output delay time			300	ns
td(E–P10Q)	Port P10 data output delay time			300	ns

Note. This applies when the main clock division selection bit = “0” and f(f₂) = 6 MHz.

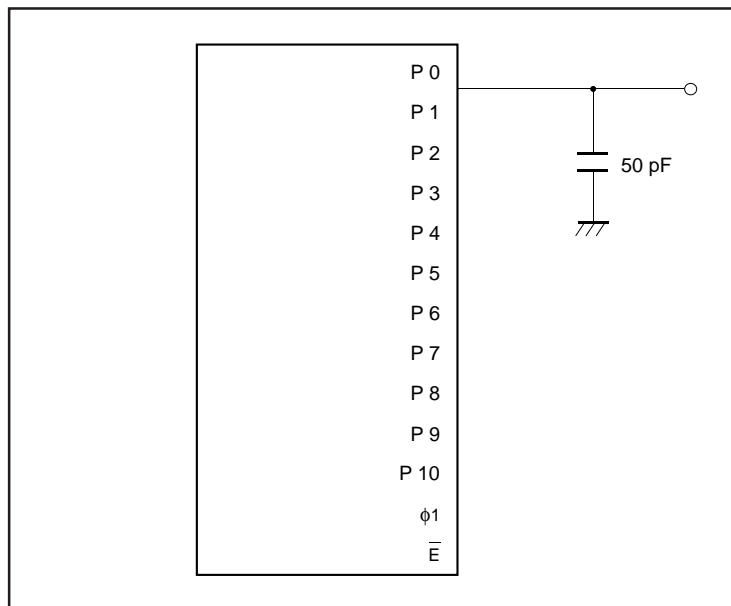


Fig. 3 Measuring circuit for ports P0 – P10 and phi1

**[External bus mode A]
 Memory expansion mode and microprocessor mode**

(VCC = 2.7 – 5.5 V, VSS = 0 V, Ta = –40 to +85°C, f(XIN) = 12 MHz (Note 1), unless otherwise noted)

Symbol	Parameter	(Note 2) Wait mode	Test conditions	Limits		Unit
				Min.	Max.	
td(An–E)	Address output delay time	No wait	Fig. 3	20		ns
		Wait 1				
		Wait 0		182		ns
td(A–E)	Address output delay time	No wait		20		ns
		Wait 1				
		Wait 0		162		ns
th(E–An)	Address hold time			40		ns
tw(ALE)	ALE pulse width	No wait		40		ns
		Wait 1				
		Wait 0		123		ns
tsu(A–ALE)	Address output setup time	No wait		10		ns
		Wait 1				
		Wait 0		93		ns
th(ALE–A)	Address hold time	No wait		9		ns
		Wait 1				
		Wait 0	40		ns	
td(ALE–E)	ALE output delay time	No wait	4		ns	
		Wait 1				
		Wait 0	40		ns	
td(E–DQ)	Data output delay time			90	ns	
th(E–DQ)	Data hold time		40		ns	
tw(EL)	E pulse width	No wait	131		ns	
		Wait 1				
		Wait 0	298		ns	
tpxz(E–DZ)	Floating start delay time			10	ns	
tpzx(E–DZ)	Floating release delay time		53		ns	
td(BHE–E)	BHE output delay time	No wait	20		ns	
		Wait 1				
		Wait 0	182		ns	
td(R/W–E)	R/W output delay time	No wait	20		ns	
		Wait 1				
		Wait 0	182		ns	
th(E–BHE)	BHE hold time		33		ns	
th(E–R/W)	R/W hold time		33		ns	
td(E–φ1)	φ1 output delay time		0	30	ns	
td(φ1–HLDA)	HLDA output delay time			120	ns	

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

[External bus mode A]
Memory expansion mode and microprocessor mode

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

Symbol	Parameter	Wait mode	Limits		Unit
			Min.	Max.	
td(An-E)	Address output delay time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 63	ns
		Wait 1			
		Wait 0	$\frac{3 \times 10^9}{2 \cdot f(f_2)}$	- 68	
td(A-E)	Address output delay time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 63	ns
		Wait 1			
		Wait 0	$\frac{3 \times 10^9}{2 \cdot f(f_2)}$	- 88	
th(E-An)	Address hold time		$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 43	ns
tw(ALE)	ALE pulse width	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 43	ns
		Wait 1			
		Wait 0	$\frac{2 \times 10^9}{2 \cdot f(f_2)}$	- 43	
tsu(A-ALE)	Address output setup time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 73	ns
		Wait 1			
		Wait 0	$\frac{2 \times 10^9}{2 \cdot f(f_2)}$	- 73	
th(ALE-A)	Address hold time	No wait	9		ns
		Wait 1			
		Wait 0	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 43	
td(ALE-E)	ALE output delay time	No wait	4		ns
		Wait 1			
		Wait 0	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 43	
td(E-DQ)	Data output delay time			90	ns
th(E-DQ)	Data hold time		$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 43	ns
tw(EL)	\bar{E} pulse width	No wait	$\frac{2 \times 10^9}{2 \cdot f(f_2)}$	- 35	ns
		Wait 1			
		Wait 0	$\frac{4 \times 10^9}{2 \cdot f(f_2)}$	- 35	
tpxz(E-DZ)	Floating start delay time			10	ns
tpzx(E-DZ)	Floating release delay time		$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 30	ns
td(BHE-E)	$\overline{\text{BHE}}$ output delay time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 63	ns
		Wait 1			
		Wait 0	$\frac{3 \times 10^9}{2 \cdot f(f_2)}$	- 68	
td(R/W-E)	$\overline{\text{R/W}}$ output delay time	No wait	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 63	ns
		Wait 1			
		Wait 0	$\frac{3 \times 10^9}{2 \cdot f(f_2)}$	- 68	
th(E-BHE)	$\overline{\text{BHE}}$ hold time		$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 50	ns
th(E-R/W)	$\overline{\text{R/W}}$ hold time		$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 50	ns
td(E-φ1)	φ1 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 "M37736MHBXXXGP".

**[External bus mode B]
 Memory expansion mode and microprocessor mode**

(VCC = 2.7 – 5.5 V, VSS = 0 V, Ta = –40 to +85 °C, f(XIN) = 12 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.3	20		ns
		Wait 1		182		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		20		ns
		Wait 1		182		ns
		Wait 0				
td(A–WE) td(A–RDE)	Address output delay time	No wait		20		ns
		Wait 1		162		ns
		Wait 0				
th(WE–An) th(RDE–An)	Address hold time			40		ns
tw(ALE)	ALE pulse width	No wait		40		ns
		Wait 1	123		ns	
		Wait 0				
tsu(A–ALE)	Address output setup time	No wait	10		ns	
		Wait 1	93		ns	
		Wait 0				
th(ALE–A)	Address hold time	No wait	9		ns	
		Wait 1	40		ns	
		Wait 0				
td(ALE–WE) td(ALE–RDE)	ALE output delay time	No wait	4		ns	
		Wait 1	40		ns	
		Wait 0				
td(WE–DQ)	Data output delay time			90	ns	
th(WE–DQ)	Data hold time			40	ns	
tw(WE)	$\overline{\text{WEL}}/\overline{\text{WEH}}$ pulse width	No wait	131		ns	
		Wait 1	298		ns	
		Wait 0				
tpxz(RDE–DZ)	Floating start delay time			10	ns	
tpzx(RDE–DZ)	Floating release delay time			53	ns	
tw(RDE)	$\overline{\text{RDE}}$ pulse width	No wait	128		ns	
		Wait 1	295		ns	
		Wait 0				
td(RSMP–WE) td(RSMP–RDE)	RSMP output delay time		25		ns	
th(ϕ_1 –RSMP)	RSMP hold time		0		ns	
td(WE– ϕ_1) td(RDE– ϕ_1)	ϕ_1 output delay time		0	30	ns	
td(ϕ_1 –HLDA)	HLDA output delay time			120	ns	

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".

[External bus mode B]

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	
		Wait 0	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 68	ns
$t_{h(WE-CS)}$ $t_{h(RDE-CS)}$	Chip-select hold time		4		ns
$t_{d(A_n-WE)}$ $t_{d(A_n-RDE)}$	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	
		Wait 0	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 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	
		Wait 0	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 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	
		Wait 0	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 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	
		Wait 0	$\frac{1 \times 10^9}{2 \cdot f(f_2)}$	- 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	
		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	
		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
$t_w(WE)$	$\overline{WEL}/\overline{WEH}$ 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	
		Wait 0	$\frac{2 \times 10^9}{2 \cdot f(f_2)}$	- 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	
		Wait 0	$\frac{2 \times 10^9}{2 \cdot f(f_2)}$	- 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

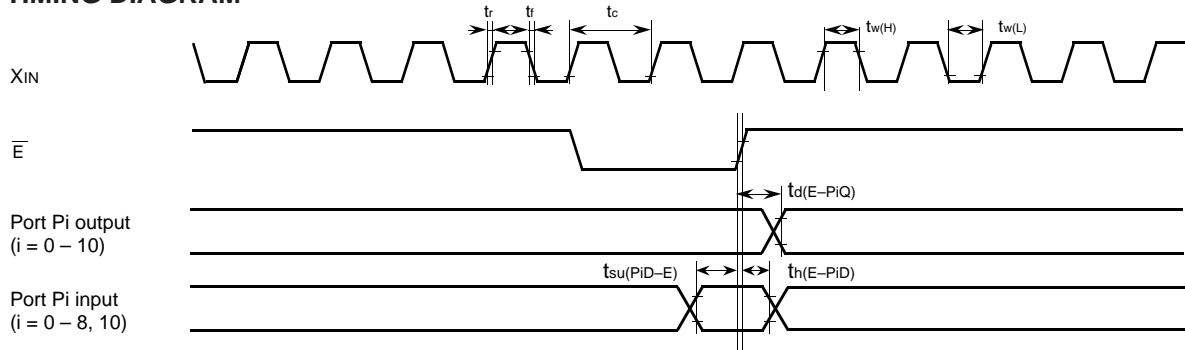
Notes 1. This applies when the main clock division selection bit = "0".

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

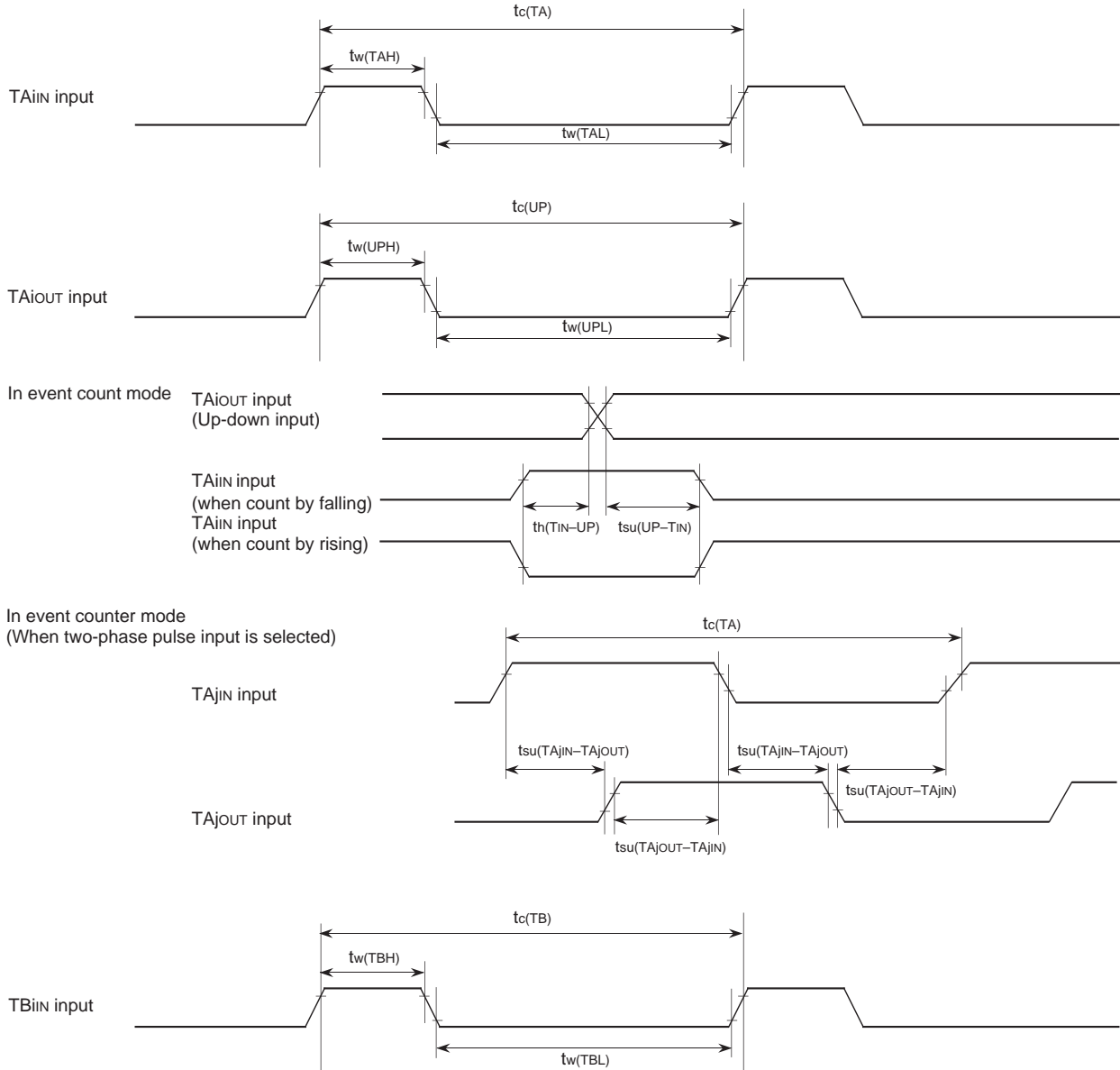
For the relation to the main clock and sub clock, refer to Table 10 in data sheet "M37736MHBXXXGP".

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

TIMING DIAGRAM



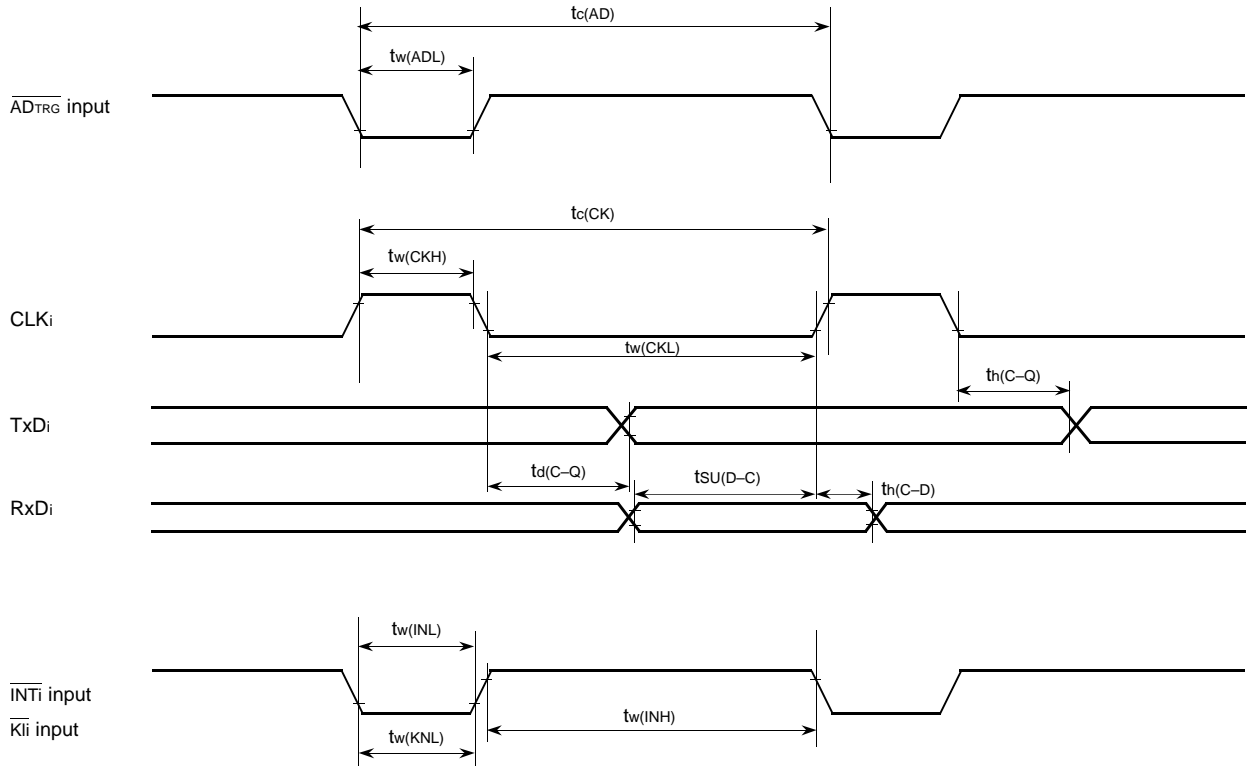
PRELIMINARY
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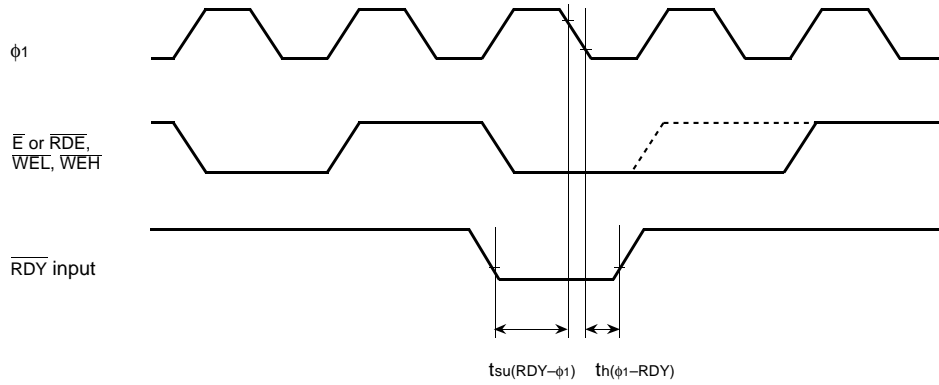
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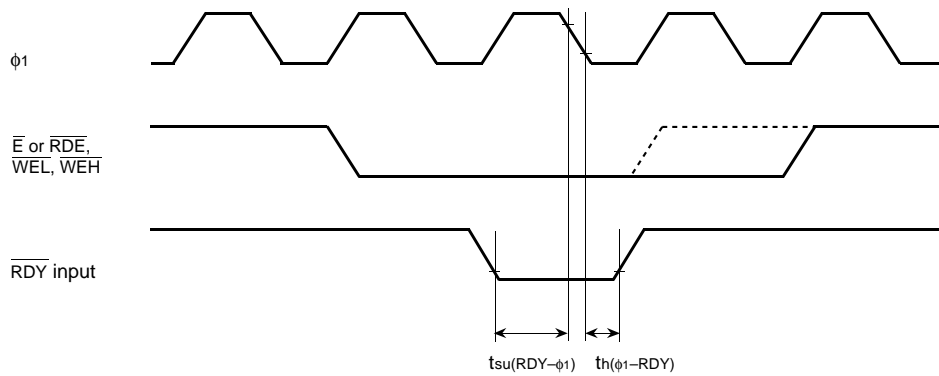


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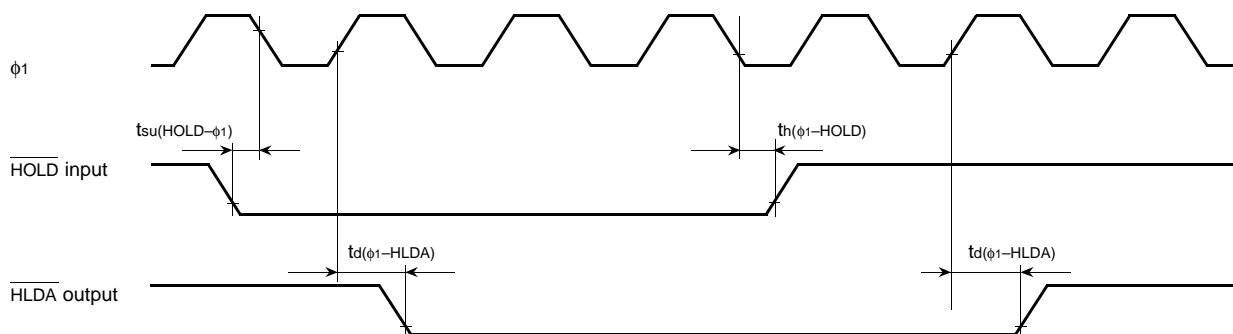
Memory expansion mode and microprocessor mode
 (When wait bit = "1")



(When wait bit = "0")



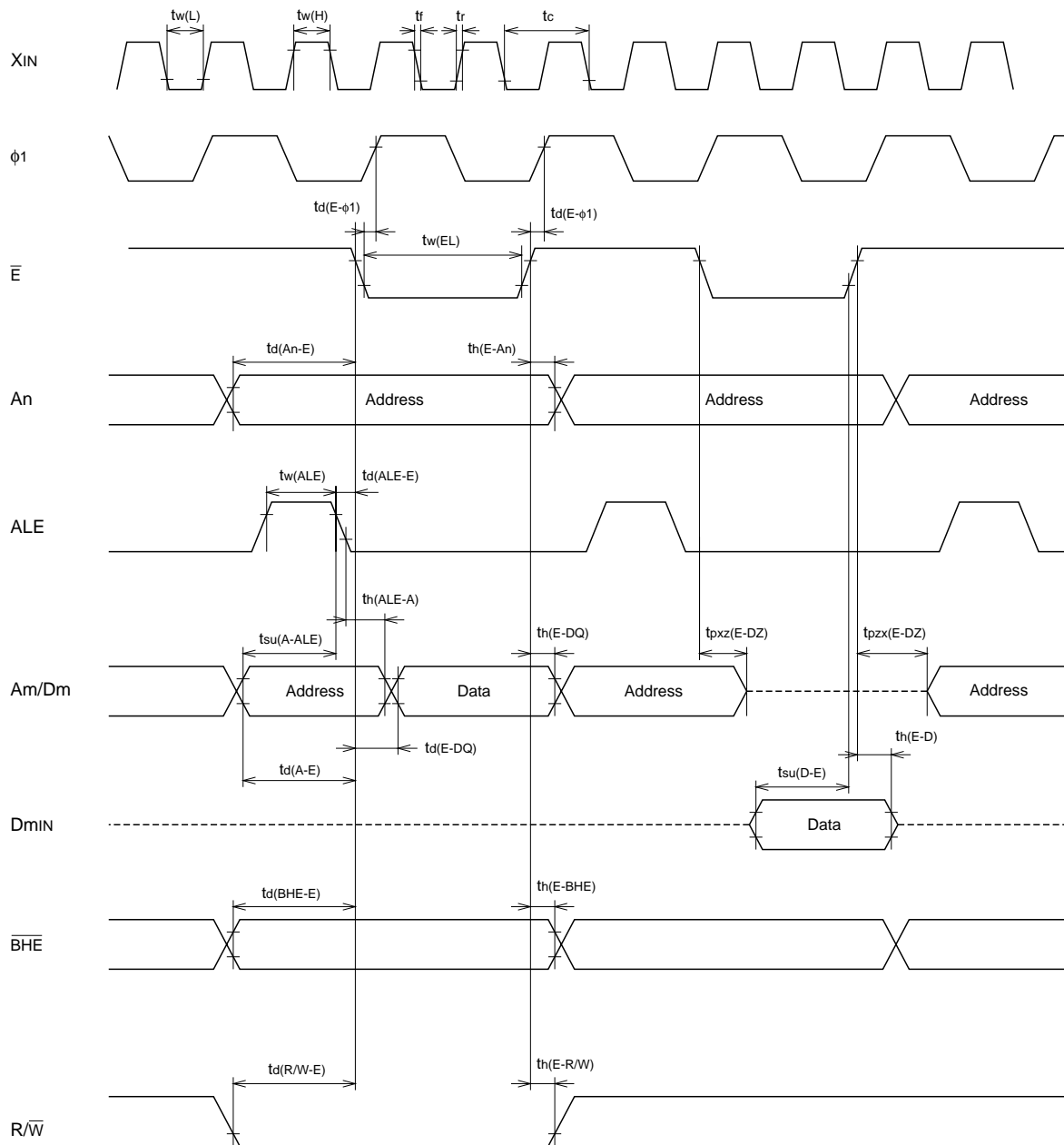
(When wait bit = "1" or "0" in common)



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

[External bus mode A]

Memory expansion mode and microprocessor mode
 (No wait : When wait bit = "1")



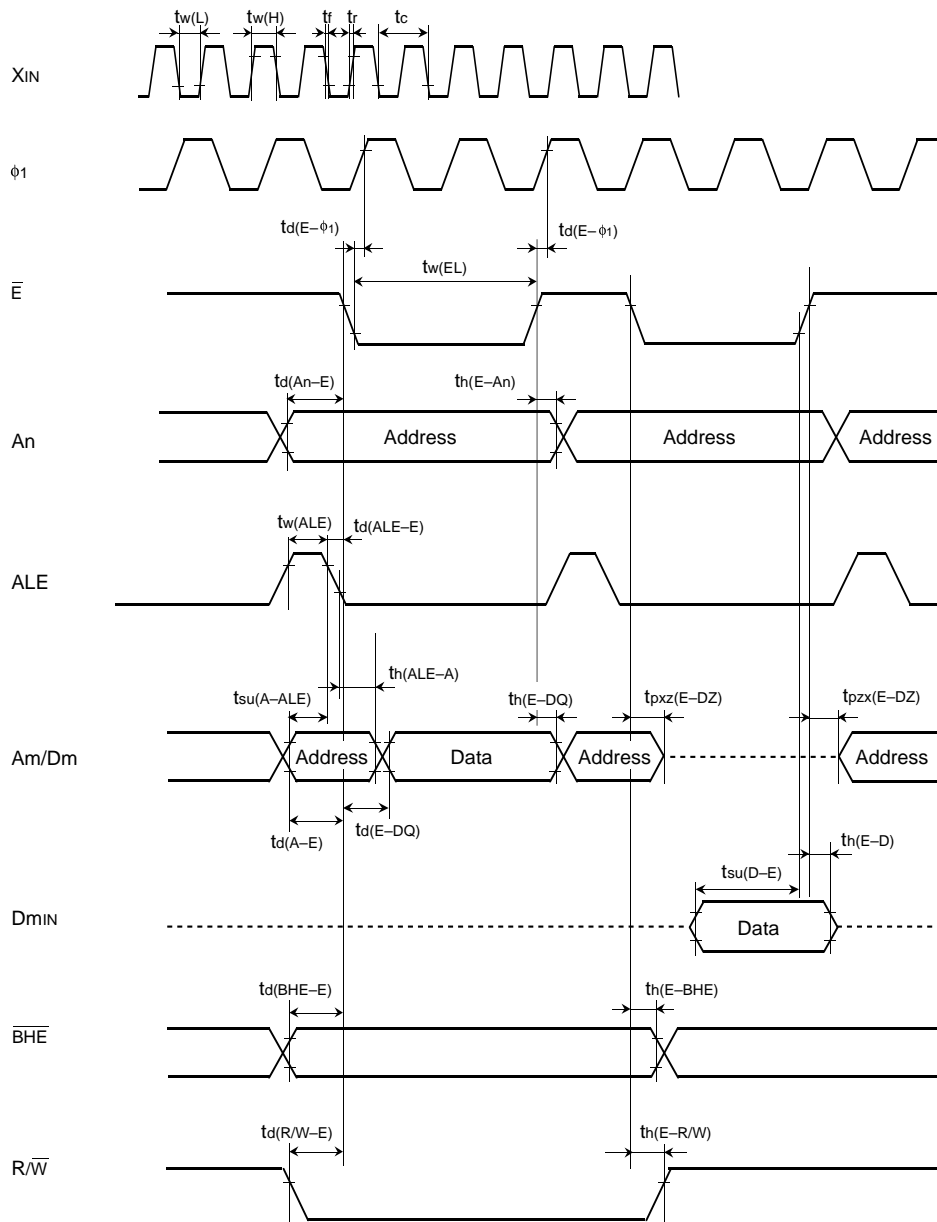
Test conditions

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

[External bus mode A]

Memory expansion mode and microprocessor mode

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



Test conditions

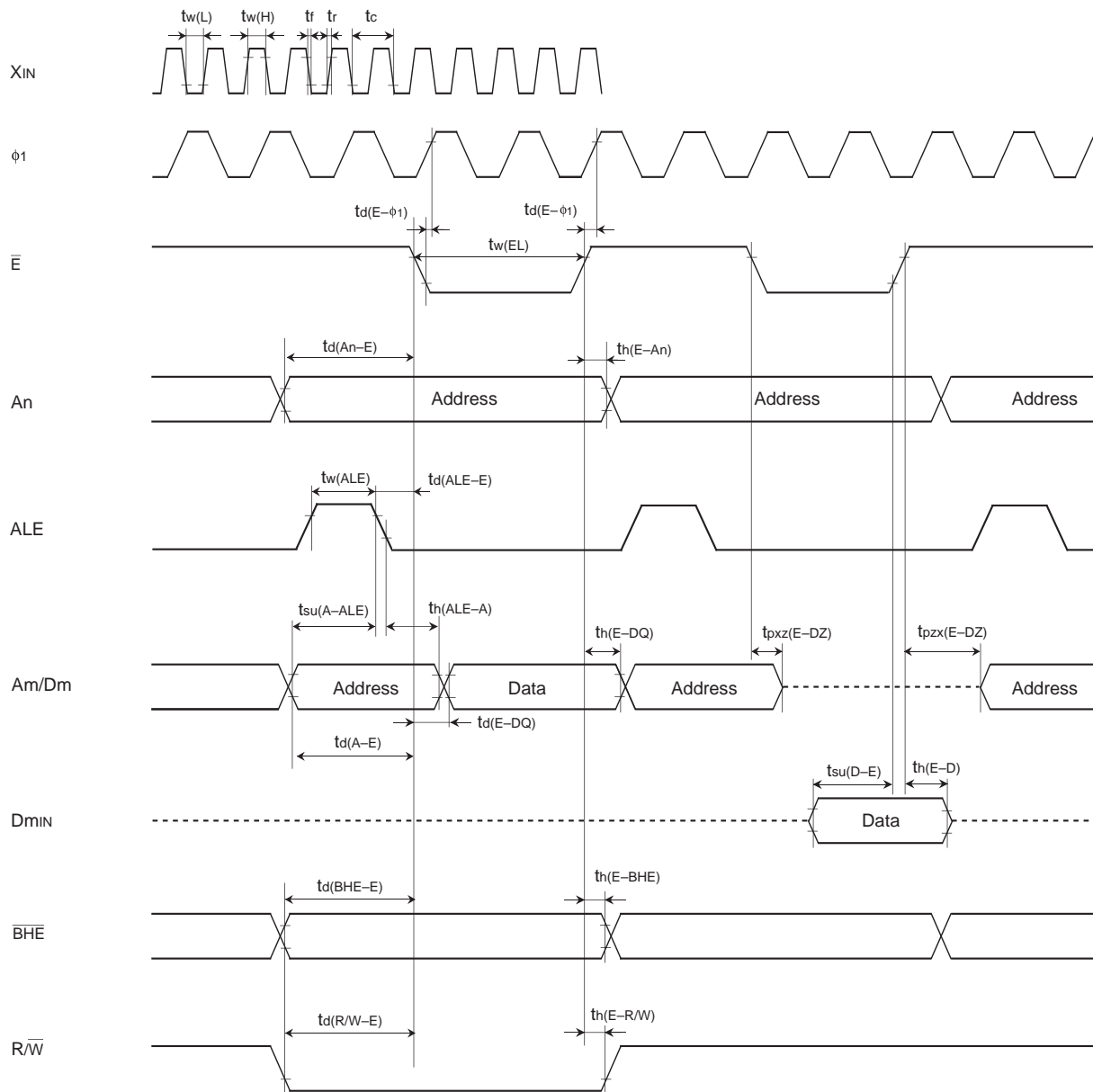
- $V_{CC} = 2.7 - 5.5 V$
- Output timing voltage : $V_{OL} = 0.8 V, V_{OH} = 2.0 V$
- Data input D_{min} : $V_{IL} = 0.16 V_{CC}, V_{IH} = 0.5 V_{CC}$

PRELIMINARY
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[External bus mode A]

Memory expansion mode and microprocessor mode

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

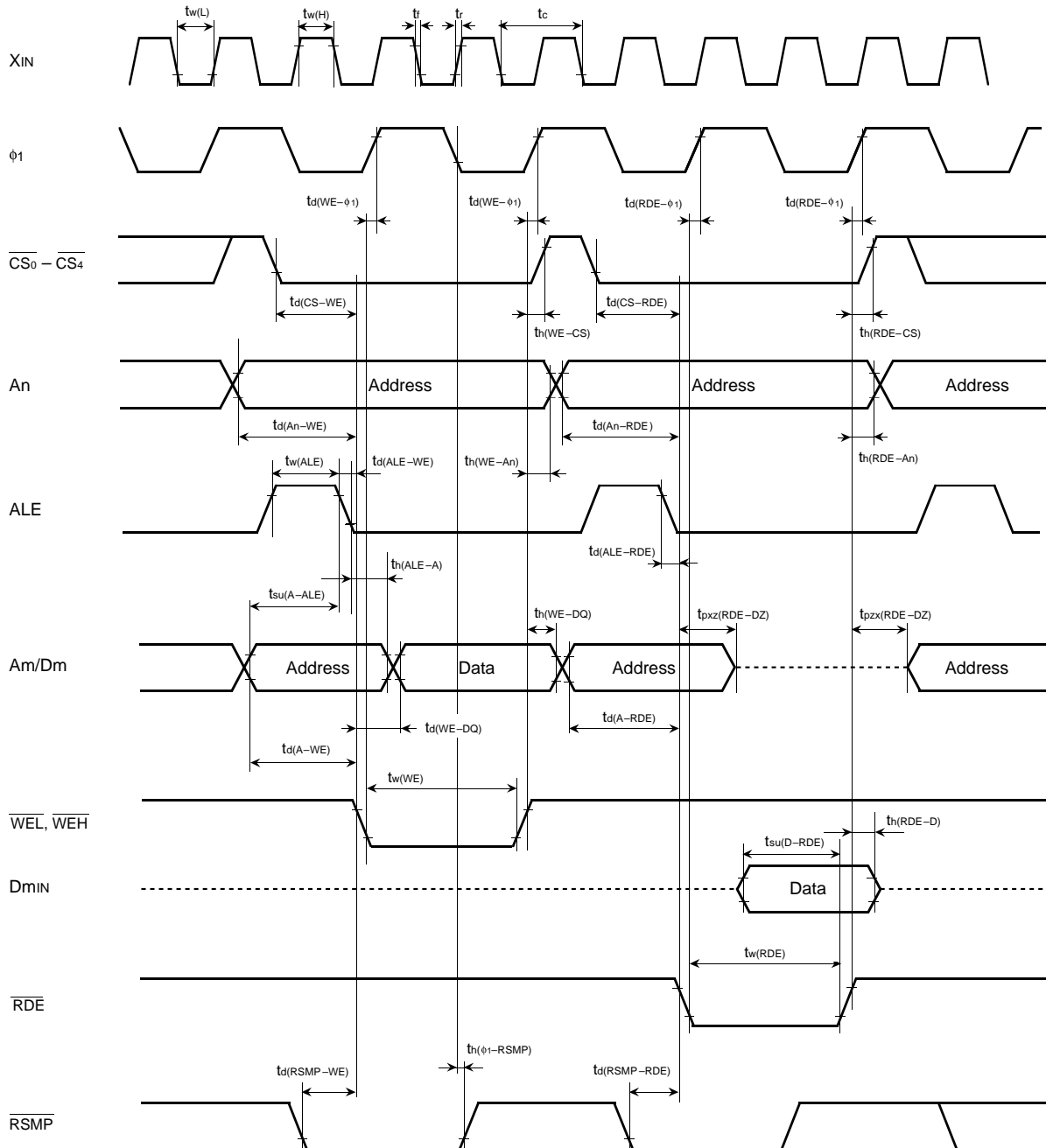


Test conditions

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

[External bus mode B]

Memory expansion and microprocessor mode
 (No wait : When wait bit = "1")



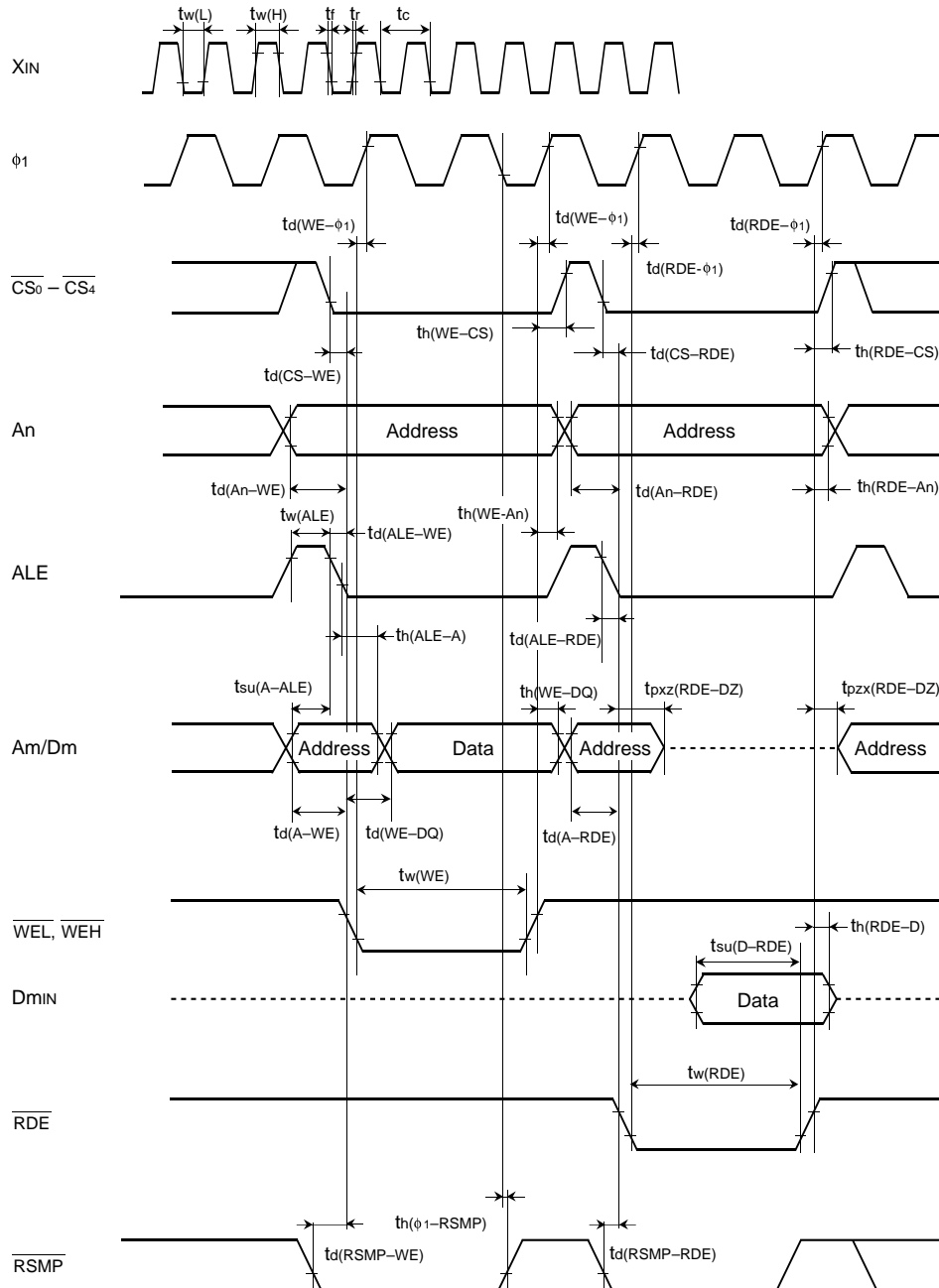
Test conditions

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

[External bus mode B]

Memory expansion and microprocessor mode

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



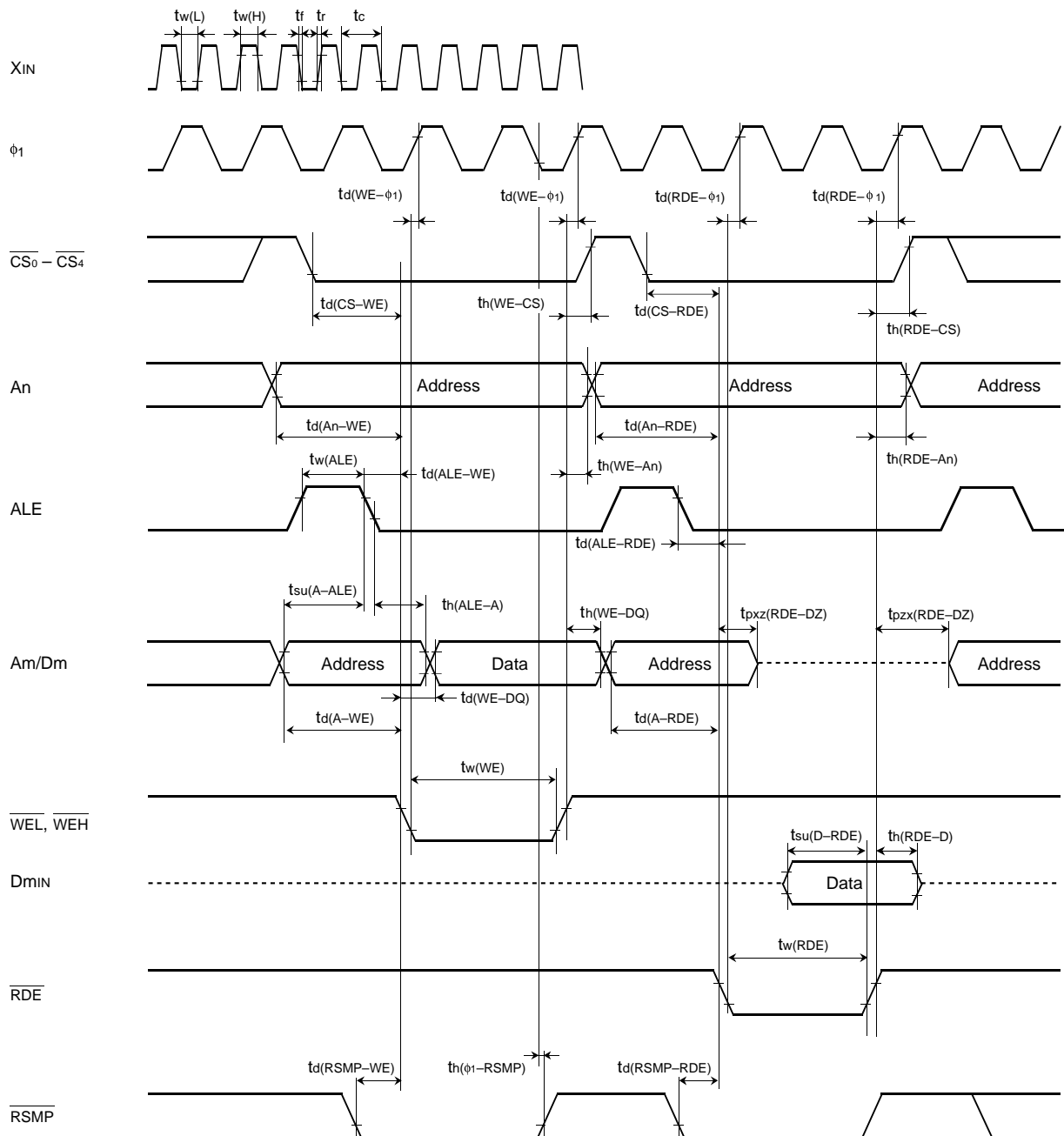
Test conditions

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

[External bus mode B]

Memory expansion and microprocessor mode

(Wait 0 : The external memory are 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 Dmin : $V_{IL} = 0.16 V_{CC}, V_{IH} = 0.5 V_{CC}$

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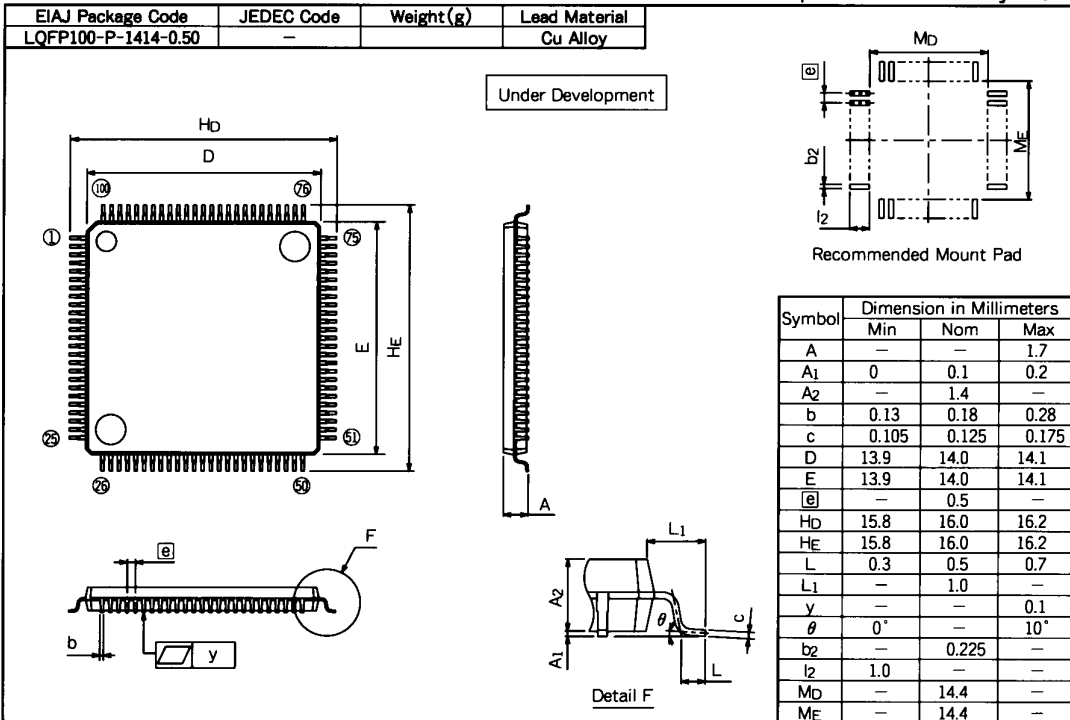
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PACKAGE OUTLINE

100P6Q-A

Plastic 100pin 14X14mm body LQFP



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REVISION DESCRIPTION LIST

M37736EHLXXXHP Datasheet

Rev. No.	Revision Description		Rev. date																	
1.00	First Edition		970611																	
2.00	The following are revised:		980731																	
	Page	Previous Version	Revised Version																	
	P11 Right column Line 2	<p>The M37736EHLXXXHP has 28 powerful addressing modes. Refer to the <u>MITSUBISHI SEMICONDUCTORS DATA BOOK SINGLE-CHIP 16-BIT MICROCOMPUTERS</u> for the details of each addressing mode.</p> <p>MACHINE INSTRUCTION LIST The M37736EHLXXXHP has 103 machine instructions. Refer to the <u>MITSUBISHI SEMICONDUCTORS DATA BOOK SINGLE-CHIP 16-BIT MICROCOMPUTERS</u> for details.</p>	<p>The M37736EHLXXXHP has 28 powerful addressing modes. Refer to the "7700 Family Software Manual" for the details.</p> <p>MACHINE INSTRUCTION LIST The M37736EHLXXXHP has 103 machine instructions. Refer to the "7700 Family Software Manual" for the details.</p>																	
	P15 Memory expansion mode and microprocessor mode	Previous Version																		
		<table border="1"> <thead> <tr> <th rowspan="2">Symbol</th> <th rowspan="2">Parameter</th> <th colspan="2">Limits</th> <th rowspan="2">Unit</th> </tr> <tr> <th>Min.</th> <th>Max.</th> </tr> </thead> <tbody> <tr> <td>tsu(D-E)</td> <td>Data input setup time (external bus mode A)</td> <td>80</td> <td></td> <td>ns</td> </tr> <tr> <td>tsu(D-RDE)</td> <td>Data input setup time (external bus mode B)</td> <td>80</td> <td></td> <td>ns</td> </tr> </tbody> </table>		Symbol	Parameter	Limits		Unit	Min.	Max.	tsu(D-E)	Data input setup time (external bus mode A)	80		ns	tsu(D-RDE)	Data input setup time (external bus mode B)	80		ns
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