CMOS 8-Bit Microcontroller

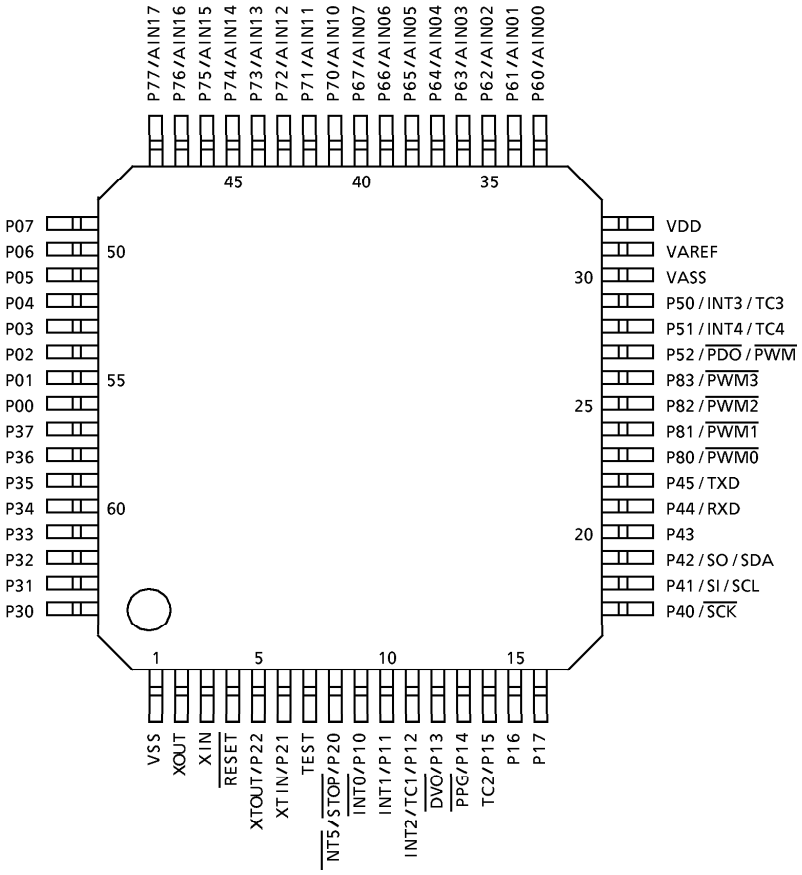
TMP87PH48U / DF

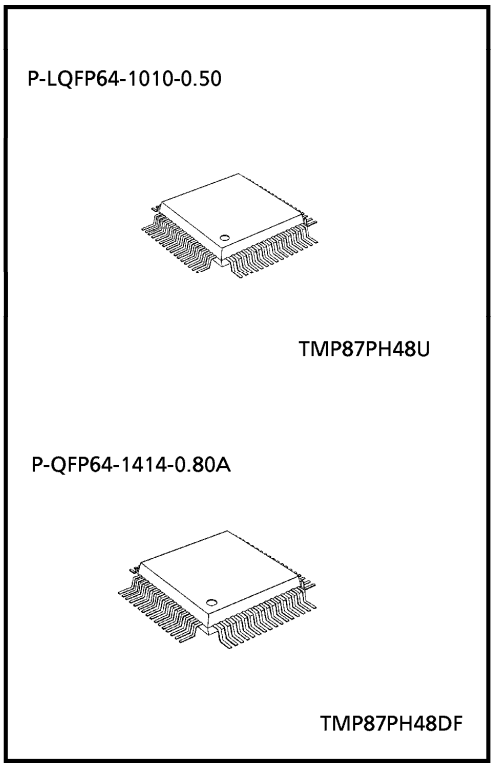
The 87PH48 is a One-Time PROM microcontroller with low-power 128 K bits (16 Kbytes) electrically programmable read only memory for the 87CH48 system evaluation. The 87PH48 is pin compatible with the 87CH48. The operations possible with the 87CH48 can be performed by writing programs to PROM. The 87PH48 can write and verify in the same way as the TC57256AD using an adaptor sockets BM11117/BM11147 and an EPROM programmer.

Part No.	ROM	RAM	Package	OTP version
TMP87PH48U	16K × 8-bit	512 × 8-bit	P-LQFP64-1010-0.50	BM11117
TMP87PH48DF			P-QFP64-1414-0.80A	BM11147

Pin Assignments (Top View)

P-LQFP64-1010-0.50
P-QFP64-1414-0.80A





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Pin Function

The 87PH48 have two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PH48 is pin compatible with the 87CH48 (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A14 to A8	Input	PROM address inputs	P76 to P70
A7 to A0			P81, P80, P45 to P40
D7 to D0	I/O	PROM data input/outputs	P07 to P00
$\overline{CE}$	Input	Chip enable signal input (active low)	P13
$\overline{OE}$		Output enable signal input (active low)	P14
VPP	Power supply	+ 12.5 V / 5 V (Program supply voltage)	TEST
VCC		+ 5 V	VDD
GND		0 V	VSS
P37 to P34	I/O	Open	
P32 to P30		Pull-up with resistance R1 for input processing	
P52 to P50			
P83, P82			
P67 to P60			
P11, P12, P15	I/O	PROM mode setting pins. Be fixed at high level. (Pull-up with resistance R2)	
P21			
P77			
P17, P16, P10		PROM mode setting pins. Be fixed at low level.	
P133			
P22, P20			
RESET			
XIN	Input	Connect an 8MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power Supply	0 V (GND)	
VASS			

OPERATIONAL DESCRIPTION

The following explains the 87PH48 hardware configuration and operation. The configuration and functions of the 87PH48 is the same as those of the 87CH48, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PH48 is placed in the *single-clock* mode during reset. To use the dual-clock mode, the low-frequency oscillator should be turned on by executing [SET (SYSCR2). XTEN] instruction at the beginning of the program.

1. OPERATING MODE

The 87PH48 have two modes: MCU and PROM.

1.1 MCU Mode

The MCU mode is activated by fixing the TEST / VPP pin at low level.

In the MCU mode, operation is the same as with the 87CH48 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PH48 have a 16K × 8-bit (addresses $C000_H$-$FFFF_H$ in the MCU mode, addresses 4000_H-$7FFF_H$ in the PROM mode) of program memory (OTP).

To use the 87PH48 as the system evaluation for the 87CH48, the program should be written to the program memory area as shown in Figure 1-1.

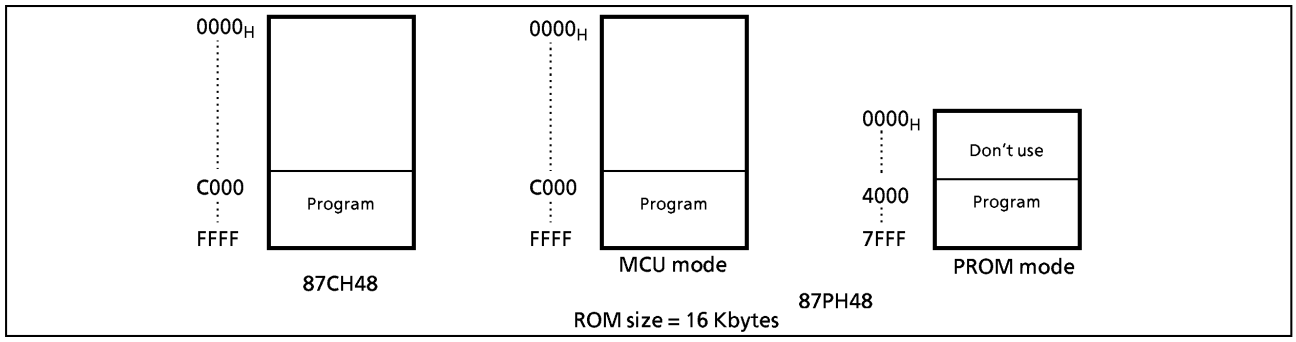


Figure 1-1. Program Memory Area

Note:	*Either write the data FF_H to the unused area or set the PROM programmer to access only the program storage area.*

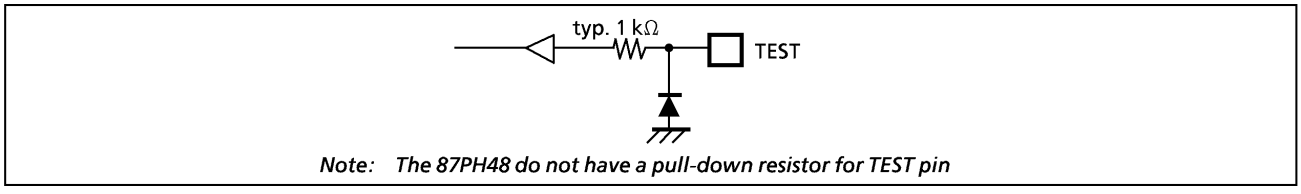
1.1.2 Data Memory

The 87PH48 have an on-chip 512 × 8-bit data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 87PH48 are the same as those of the 87CH48 except that the TEST pin has is no built-in pull-down resistance.



Note: The 87PH48 do not have a pull-down resistor for TEST pin

Figure 1-2. TEST Pin

(2) I/O ports

The I/O circuitries of 87PH48 I/O ports are the same as the 87CH48.

Electrical Characteristics

Absolute Maximum Ratings (V_{SS} = 0 V)

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V_{DD}		– 0.3 to 6.5	V
Input Voltage	V_{IN}		– 0.3 to V_{DD} + 0.3	V
Output Voltage	V_{OUT}		– 0.3 to V_{DD} + 0.3	V
Output Current (Per 1 pin)	I_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7, P8	3.2	mA
	I_{OUT2}	Port P3	30	
Output Current (Total)	ΣI_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7, P8	120	mA
	ΣI_{OUT2}	Port P3	120	
Power Dissipation	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 30 to 70	°C

Note: The absolute maximum ratings are rated values which must not be exceeded during operation, even for an instant. Any one of the ratings must not be exceeded. If any absolute maximum rating is exceeded, a device may break down or its performance may be degraded, causing it to catch fire or explode resulting in injury to the user. Thus, when designing products which include this device, ensure that no absolute maximum rating value will ever be exceeded.

Recommended Operating Conditions (V_{SS} = 0 V, Topr = – 40 to 85°C)

Parameter	Symbol	Pins	Conditions		Min	Max	Unit
Supply Voltage	* V_{DD}		fc = 8 MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			fc = 4.2 MHz	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			fs = 32.768 kHz	SLOW mode			
				SLEEP mode			
				STOP mode	2.0		
Input High Voltage	V_{IH1}	Except hysteresis input	$V_{DD} \geqq 4.5$ V		$V_{DD} \times 0.70$	V_{DD}	V
	V_{IH2}	Hysteresis input			$V_{DD} \times 0.75$		
	V_{IH3}		$V_{DD} < 4.5$ V		$V_{DD} \times 0.90$		
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geqq 4.5$ V		0	$V_{DD} \times 0.30$	V
	V_{IL2}	Hysteresis input				$V_{DD} \times 0.25$	
	V_{IL3}		$V_{DD} < 4.5$ V			$V_{DD} \times 0.10$	
Clock Frequency	fc	XIN, XOUT	V_{DD} = 4.5 to 5.5 V		0.4	8.0	MHz
			V_{DD} = 2.7 to 5.5 V			4.2	
	fs	XTIN, XTOUT			30.0	34.0	kHz

Note: The recommended operating conditions for a device are operating conditions under which it can be guaranteed that the device will operate as specified. If the device is used under operating conditions other than the recommended operating conditions (supply voltage, operating temperature range, specified AC/DC values etc.), malfunction may occur. Thus, when designing products which include this device, ensure that the recommended operating conditions for the device are always adhered to.

D.C. Characteristics

(V_{SS} = 0 V, Topr = – 40 to 85°C)

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Hysteresis Voltage	V_{HS}	Hysteresis inputs	VDD = 5.0 V	–	0.9	–	V
Input Current	I_{IN1}	TEST	VDD = 5.5 V V_{IN} = 5.5 V / 0 V	–	–	± 2	μA
	I_{IN2}	Open drain ports, Tri-state ports					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Resistance	R_{IN2}	$\overline{RESET}$	VDD = 5.0 V	100	220	450	kΩ
Output Leakage Current	I_{LO}	Sink open drain ports	V_{DD} = 5.5 V, V_{OUT} = 5.5 V	–	–	2	μA
		Tri-state ports	V_{DD} = 5.5 V, V_{OUT} = 5.5/0 V	–	–	± 2	
Output High Voltage	V_{OH2}	Tri-state ports	V_{DD} = 4.5 V, I_{OH} = – 0.7 mA	4.1	–	–	V
Output Low Voltage	V_{OL}	Except for XOUT and P3	V_{DD} = 4.5 V, I_{OL} = 1.6 mA	–	–	0.4	mA
Output Low current	I_{OL3}	P3	V_{DD} = 4.5 V, V_{OL} = 1.0 V	–	20	–	mA
Supply Current in NORMAL 1, 2 modes	I_{DD}		V_{DD} = 5.5 V V_{IN} = 5.3 V / 0.2 V fc = 8 MHz fs = 32.768 kHz	–	4.5	5.5	mA
Supply Current in IDLE 1, 2 modes				–	2.5	4.0	mA
Supply Current in NORMAL 1, 2 modes			V_{DD} = 3.0 V, V_{IN} = 2.8V/0.2V V_{IN} = 4.19 MHz fs = 32.768 kHz	–	1.75	3.0	mA
Supply Current in IDLE 1, 2 modes				–	1.25	2.0	mA
Supply Current in SLOW mode			V_{DD} = 3.0 V V_{IN} = 2.8 V / 0.2 V fs = 32.768 kHz	–	20	30	μA
Supply Current in SLEEP mode				–	10	20	μA
Supply Current in STOP mode			V_{DD} = 5.5 V V_{IN} = 5.3 V / 0.2 V	–	0.5	10	μA

Note 1: Typical values show those at Topr = 25°C
Note 2: Input Current I_{IN1},I_{IN3} ; The current through resistor is not included, when the input resistor (pull-upor pull-down) is contained.
Note 3: IDD except for I_{REF}.

A/D Conversion Characteristics

(V_{SS} = 0V, V_{DD} = 2.7 to 5.5V, Topr = – 40 to 85°C)

Parameter	Symbol	Conditions	Min	Typ.	Max			Unit
					ADCDR1	ADCDR2		
						ACK = 0	ACK = 1	
Analog Reference Voltage	V_{AREF}	$V_{AREF} - V_{ASS} \geqq 2.5$ V	2.7	—	V_{DD}			V
	V_{ASS}		V_{SS}	—	1.5			
Analog Input Voltage	V_{AIN}		V_{ASS}	—	V_{AREF}			V
Analog Supply Current	I_{REF}	V_{AREF} = 5.5 V, V_{ASS} = 0.0 V	—	0.5	1.2			mA
Nonlinearity Error		V_{DD} = 5.0, V_{SS} = 0.0 V V_{AREF} = 5.000 V V_{ASS} = 0.000 V or V_{DD} = 2.7, V_{SS} = 0.0 V V_{AREF} = 2.700 V V_{ASS} = 0.000 V	—	—	1.0			LSB
Zero Point Error			—	—	± 1	± 3	± 2	
Full Scale Error			—	—	± 1	± 3	± 2	
Total Error			—	—	± 2	± 6	± 4	

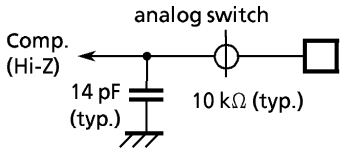
Note 1: $\triangle V_{AREF} = V_{AREF} - V_{ASS}$
ADCDR1 ; 8 bit – A/D conversion result (1LSB = $\triangle V_{AREF}$ / 256)
ADCDR2 ; 10 bit – A/D conversion result (1LSB = $\triangle V_{AREF}$ / 1024)
Note 2: Quantizing error is not contained in those errors.

A.C. Characteristics

(V_{SS} = 0 V, Topr = – 40 to 85°C)

Parameter	Symbol	Conditions	V_{DD}	Min	Typ.	Max	Unit
Machine Cycle Time	t_{cy}	In NORMAL 1, 2 mode	4.5 to 5.5V	0.5	–	10	μs
		In IDLE 1, 2 mode					
		In SLOW mode	2.7 to 5.5V	117.6	–	133.3	
		In SLEEP mode					
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XIN input), fc = 8 MHz	4.5 to 5.5V	50	–	–	ns
Low Level Clock Pulse Width	t_{WCL}						
High Level Clock Pulse Width	t_{WSH}	For external clock operation (XTIN input), fs = 32.768 kHz	2.7 to 5.5V	14.7	–	–	μs
Low Level Clock Pulse Width	t_{WSL}						
A/D Conversion Time	t_{ADC}	ADCCR bit 4 ; ACK = 0	–	–	49 tcy	–	ns
		ADCCR bit 4 ; ACK = 1	–	–	196 tcy	–	

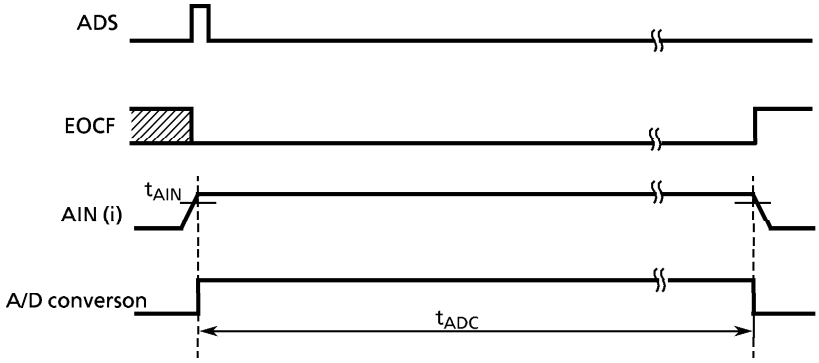
AIN (i) internal circuit



Note 1: V_{AIN} must be kept the voltage level during A/D conversion period (t_{ADC})

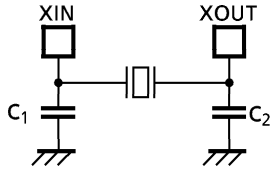
Note 2: i = 17 to 10, 07 to 00

Timing of A/D Conversion

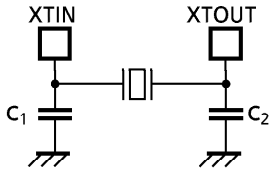


Recommended Oscillating Conditions (V_{SS} = 0 V, Topr = – 40 to 85°C)

Parameter	Oscillator	Oscillation Frequency	VDD	Recommended Oscillator	Recommended Constant	
					C_1	C_2
High-frequency Oscillation	Ceramic Resonator	8 MHz	4.5 to 5.5V	KYOCERA KBR8.0M	30 pF	30 pF
		4 MHz	2.7 to 5.5V	KYOCERA KBR4.0MS		
				MURATA CSA4.00MG		
	Crystal Oscillator	8 MHz	4.5 to 5.5V	TOYOCOM 210B 8.0000	20 pF	20 pF
		4 MHz	2.7 to 5.5V	TOYOCOM 204B 4.0000		
Low-frequency Oscillation	Crystal Oscillator	32.768 kHz	2.7 to 5.5V	NDK MX-38T	15 pF	15 pF



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

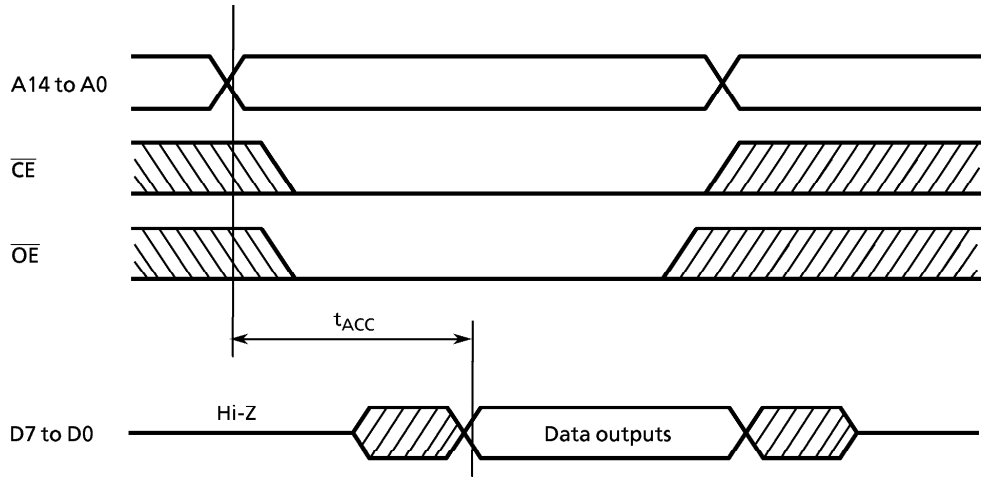
Note: When it is used in high electrical field, an electrical shield of the package is recommended to retain normal operations.

D.C./A.C. Characteristics (PROM mode) (V_{SS} = 0 V)

(1) Read Operation (Topr = – 30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		2.2	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	0.8	V
Power Supply Voltage	V_{CC}		4.75	–	6.5	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	V_{CC} = 5.0 ± 0.25 V	–	1.5 tcyc + 300	–	ns

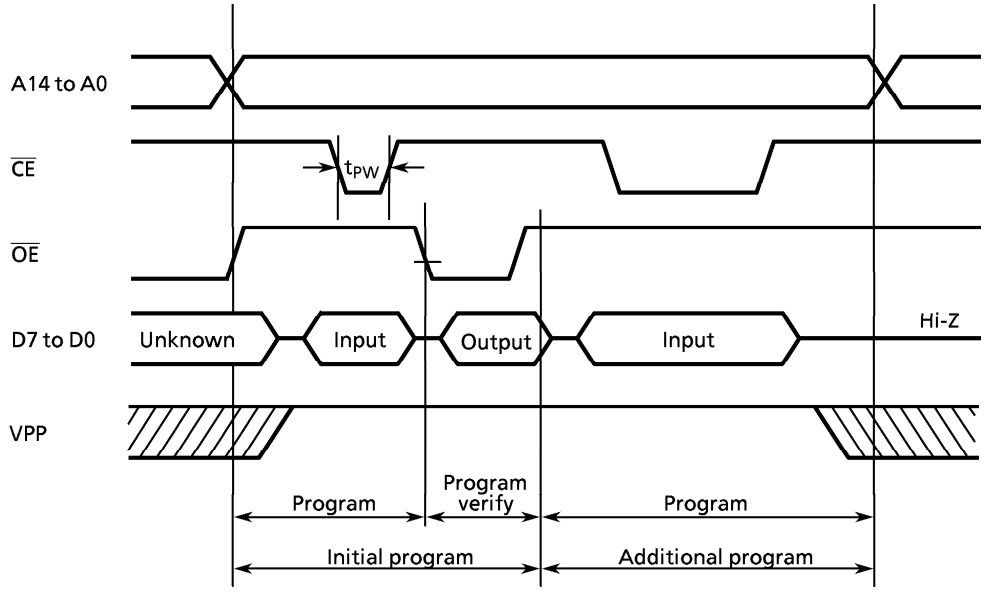
Note: tcyc = 500 ns at 8 MHz



Timing Waveforms of Read Operation

(2) Program Operation (High Speed Write Mode - Ⅰ) (Topr = 25 ± 5°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		2.2	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	0.8	V
Power Supply Voltage	V_{CC}		5.75	–	6.5	V
Program Power Supply Voltage	V_{PP}		12.0	12.5	13.0	V
Initial Program Pulse Width	t_{PW}	V_{CC} = 6.0V ± 0.25 V, V_{PP} = 12.5 ± 0.5 V	0.95	1.0	1.05	ms

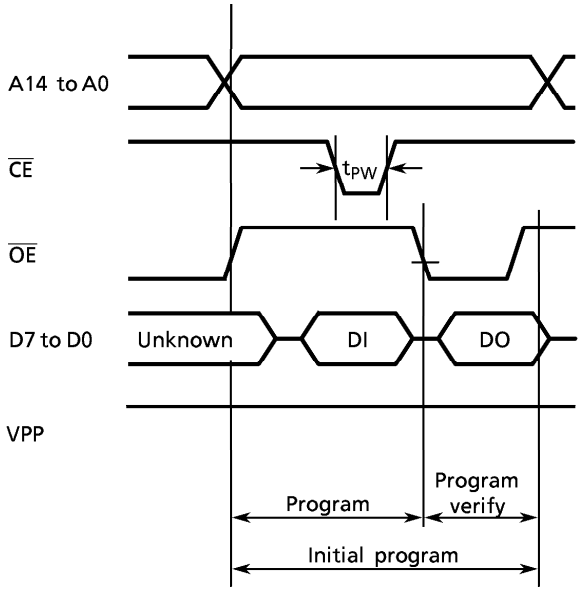


Timing Waveforms of Programming Operation

Note1: When V_{cc} power supply is turned on or after, V_{pp} must be increased.
When V_{cc} power supply is turned off or before, V_{pp} must be decreased.
Note2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.5 V ± 0.5 V) to the V_{pp} pin as the device is damaged.
Note3: Be sure to execute the recommended programing mode with the recommended programing adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.

(3) Program Operation (High speed write mode - II) (Topr = 25 ± 5°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		2.2	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	0.8	V
Supply Voltage	V_{CC}		6.00	6.25	6.50	V
Program Supply Voltage	V_{PP}		12.50	12.75	13.0	V
Initial Program Pulse Width	t_{PW}	V_{CC} = 6.25 V ± 0.25 V, V_{PP} = 12.75 V ± 0.25 V	0.095	0.1	0.105	ms



Note: DO ; Data output (I0 to I7)
DI ; Data input (I0 to I7)

Note1: When V_{cc} power supply is turned on or after, V_{pp} must be increased.
When V_{cc} power supply is turned off or before, V_{pp} must be decreased.
Note2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.75 V ± 0.25 V) to the V_{pp} pin as the device is damaged.
Note3: Be sure to execute the recommended programing mode with the recommended programing adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.