

CMOS 8-Bit Microcontroller

TMP87PH40AN, TMP87PH40AF, TMP87PM40AN, TMP87PM40AF

The 87PH40A is a One-Time PROM microcontroller with low-power 128 K bits (16 Kbytes) electrically programmable read only memory for the 87C840/CC40/CH40 system evaluation. The 87PM40A is a One-time PROM microcontroller with low-power 256 K bits (32 Kbytes) electrically programmable read only memory for the 87CK40A/M40A system evaluation. The 87PH40A/PM40A are pin compatible with the 87C840/CC40/CH40/CK40A/CM40A. The operations possible with the 87C840/CC40/CH40/CK40A/CM40A can be performed by writing programs to PROM. The 87PH40A/PM40A can write and verify in the same way as the TC57256AD using an adaptor socket BM1136/BM1137 and an EPROM programmer.

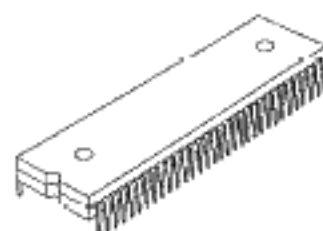
Part No	OTP	RAM	Package	Adapter socket
TMP87PH40AN	16 K × 8-bit	512 × 8-bit	P-SDIP64-750-1.78	BM1136
TMP87PH40AF			P-QFP64-1420-1.00A	BM1137
TMP87PM40AN	32 K × 8-bit	1K × 8-bit	P-SDIP64-750-1.78	BM1136
TMP87PM40AF			P-QFP64-1420-1.00A	BM1137

Pin Assignments (Top View) - (1)

P-SDIP64-750-1.78

A8 / P70	1	64	VDD / VCC
A9 / P71	2	63	P67 (AIN7) / A7
A10 / P72	3	62	P66 (AIN6) / A6
A11 / P73	4	61	P65 (AIN5) / A5
A12 / P74	5	60	P64 (AIN4) / A4
A13 / P75	6	59	P63 (AIN3) / A3
A14 / P76	7	58	P62 (AIN2) / A2
P77	8	57	P61 (AIN1) / A1
D0 / P00	9	56	P60 (AIN0) / A0
D1 / P01	10	55	VAREF
D2 / P02	11	54	VASS
D3 / P03	12	53	P54
D4 / P04	13	52	P53
D5 / P05	14	51	P52 (PWM/PDO)
D6 / P06	15	50	P51 (INT4/TC4)
D7 / P07	16	49	P50 (INT3/TC3)
(WSTO) P10	17	48	P47 (SO2)
(INT1) P11	18	47	P46 (SI2)
(INT2/TC1) P12	19	46	P45 (SCK2)
CE / (DVO) P13	20	45	P44 (SO1)
OE / (PPG) P14	21	44	P43 (SI1)
(TC2) P15	22	43	P42 (SCK1)
P16	23	42	P41
P17	24	41	P40
(INT5/STOP) P20	25	40	P37
VPP / TEST	26	39	P36
(XTIN) P21	27	38	P35
(XTOUT) P22	28	37	P34
RESET	29	36	P33
XIN	30	35	P32
XOUT	31	34	P31
GND / VSS	32	33	P30

P-SDIP64-750-1.78

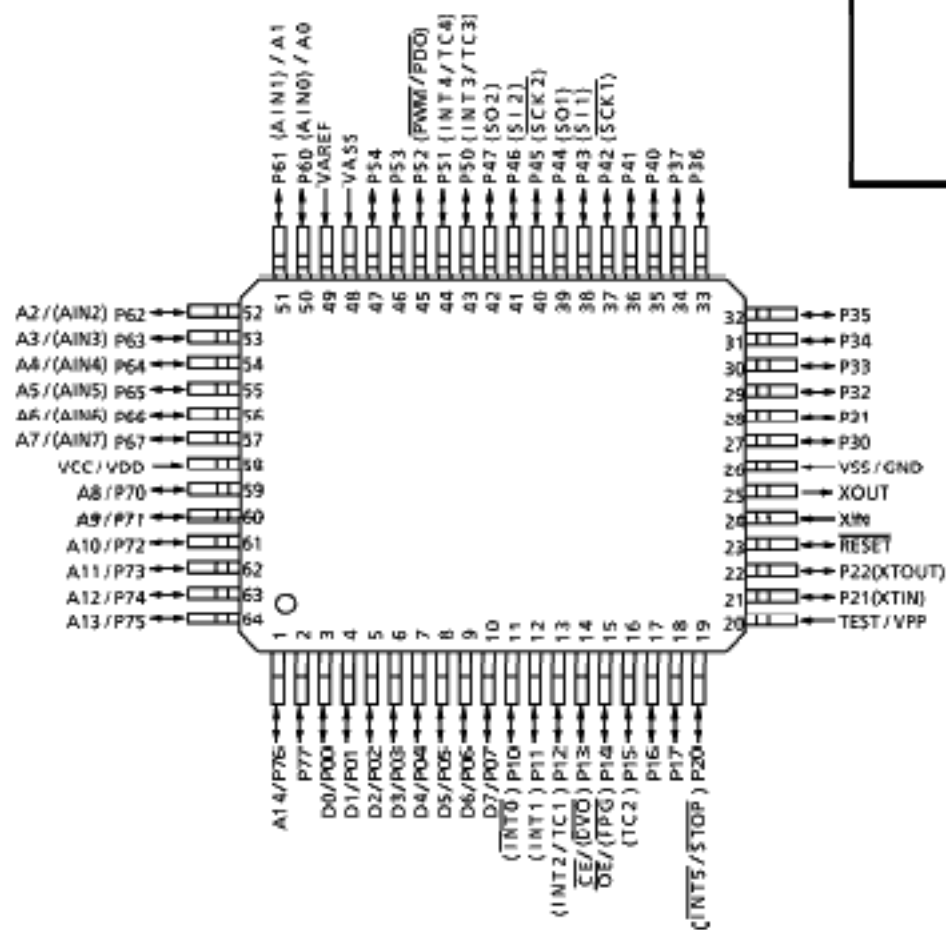
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TMP87PM40AN

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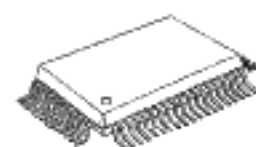
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Pin Assignments (Top View) - (2)

P-QFP64-1420-1.00A



P-QFP64-1420-1.00A

TMP87PH40AF
TMP87PM40AF

Pin Function

The 87PH40A/PM40A have two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PH40A/PM40A are pin compatible with the 87C840/CC40/CH40/CK40A/CM40A (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A14 to A8 A7 to A0	Input	PROM address inputs	P76 to P70 P67 to P60
D7 to D0	I/O	PROM data input/outputs	P07 to P00
CE	Input	Chip enable signal input (active low)	P13
OE		Output enable signal input (active low)	P14
VPP	Power supply	+ 12.5V / 5V (Program supply voltage)	TEST
VCC		+ 5V	VDD
GND		0V	VSS
P37 to P30	I/O	Pull-up with resistance for input processing	PROM mode setting pins. Be fixed at high level.
P47 to P40			
P54 to P50			
P11		PROM mode setting pins. Be fixed at low level.	
P21			
P77			
P17 to P15			
P12, P10			
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 87PH40A/PM40A hardware configuration and operation. The configuration and functions of the 87PH40A are the same as those of the 87C840/CC40/CH40, 87PM40A are the same as those of the 87CK40A/CM40A, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PH40A/PM40A are 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 87PH40A/PM40A 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 87C840/CC40/CH40/CK40A/CM40A (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PH40A has a 16 K × 8-bit (addresses C000_H to FFFF_H in the MCU mode, addresses 4000_H to 7FFF_H in the PROM mode), the 87PM40A has a 32 K × 8-bit (address 8000_H to FFFF_H in the MCU mode, address 0000_H to 7FFF_H in the PROM mode) of program memory (OTP).

To use the 87PH40A/PM40A as the system evaluation for the 87C840/CC40/CH40/CK40A/CM40A, the program should be written to the program memory area as shown in Figure 1-1.

Electrical Characteristics

Absolute Maximum Ratings

(V_{SS} = 0V)

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V _{DD}		– 0.3 to 7	V
Program Voltage	V _{PP}	TEST / V _{PP} pin	– 0.3 to 13.0	V
Input Voltage	V _{IN}		– 0.3 to V _{DD} + 0.3	V
Output Voltage	V _{OUT1}	Except sink open drain pin, but include P2 and RESET	– 0.3 to V _{DD} + 0.3	V
	V _{OUT2}	Sink open drain pin except port P2, RESET	– 0.3 to 10	
Output Current (Per 1 pin)	I _{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7	3.2	mA
	I _{OUT2}	Port P3	30	
Output Current (Total)	Σ I _{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7	120	mA
	Σ I _{OUT2}	Port P3	120	
Power Dissipation [T _{opr} = 70°C]	PD	TMP87PH40AN/PM40AN	600	mW
		TMP87PH40AF/PM40AF	350	
Soldering Temperature (time)	T _{sld}		260 (10s)	°C
Storage Temperature	T _{stg}		– 55 to 125	°C
Operating Temperature	T _{opr}		– 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} = 0V, T_{opr} = – 30 to 70°C)

Parameter	Symbol	Pins	Conditions		Min	Max	Unit
Supply Voltage	V _{DD}		f _c = 8 MHz	NORMAL1, 2 mode	4.5	6.0	V
				IDLE1, 2 mode			
			f _c = 4.2 MHz	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			f _s = 32.768 kHz	SLOW mode			
				SLEEP mode			
	STOP mode	2.0					
Input High Voltage	V _{IH1}	Except hysteresis input	V _{DD} ≥ 4.5 V		V _{DD} × 0.70	V _{DD}	V
	V _{IH2}	Hysteresis input			V _{DD} × 0.75		
	V _{IH3}		V _{DD} < 4.5 V	V _{DD} × 0.90			
Input Low Voltage	V _{IL1}	Except hysteresis input	V _{DD} ≥ 4.5 V		0	V _{DD} × 0.30	V
	V _{IL2}	Hysteresis input				V _{DD} × 0.25	
	V _{IL3}		V _{DD} < 4.5 V	V _{DD} × 0.10			
Clock Frequency	f _c	XIN, XOUT	V _{DD} = 4.5 to 6 V		0.4	8.0	MHz
			V _{DD} = 2.7 to 6 V			4.2	
	f _s	XTIN, XTOUT			30.0	34.0	kHz

Note 1: 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.

Note 2: Clock frequency fc; Supply voltage range is specified in NORMAL mode and IDLE mode.

D.C. Characteristics

(V_{SS} = 0 V, T_{opr} = -30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit	
Hysteresis Voltage	V _{HS}	Hysteresis inputs	V _{DD} = 5.0V	—	0.9	—	V	
Input Current	I _{IN1}	TEST	V _{DD} = 5.5V V _{IN} = 5.5V/0V	—	—	± 2	μA	
	I _{IN2}	Open drain ports and tri-state ports						
	I _{IN3}	RESET, STOP						
Input Resistance	R _{IN2}	RESET		100	220	450	kΩ	
Output Leakage Current	I _{LO1}	Open drain ports	V _{DD} = 5.5V, V _{OUT} = 5.5V	—	—	2	μA	
	I _{LO2}	Tri-state ports	V _{DD} = 5.5V, V _{OUT} = 5.5V/0V	—	—	± 2		
Output High Voltage	V _{OH2}	Tri-state ports	V _{DD} = 4.5V, I _{OH} = - 0.7mA	4.1	—	—	V	
Output Low Voltage	V _{OL}	Except XOUT and port P3	V _{DD} = 4.5V, I _{OL} = 1.6mA	—	—	0.4	V	
Output Low Current	I _{OL3}	Port P3	V _{DD} = 4.5V, V _{OL} = 1.0V	—	20	—	mA	
Supply Current in NORMAL 1, 2 mode	I _{DD}		V _{DD} = 5.5V f _c = 8 MHz	87PH40A	—	9	14	mA
Supply Current in IDLE 1, 2 mode				87PM40A	—	12	18	
			V _{DD} = 5.5V f _s = 32.768 kHz	87PH40A	—	4	6	mA
87PM40A				—	4.5			
Supply Current in SLOW mode			V _{DD} = 3.0V f _s = 32.768 kHz		—	30	60	μA
Supply Current in SLEEP mode					—	15	30	μA
Supply Current in STOP mode			V _{DD} = 5.5V V _{IN} = 5.3V/0.2V	—	0.5	10	μA	

Note1: Typical values show those at T_{opr} = 25°C.Note2: Input Current I_{IN1}, I_{IN3}; The current through pull-up or pull-down resistor is not included.Note3: I_{DD}; Except for I_{REF}

A / D Conversion Characteristics

(V_{SS} = 0 V, V_{DD} = 2.7 to 5.5 V, T_{opr} = -30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V _{AREF}	V _{AREF} - V _{ASS} ≥ 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	1.0	mA
Nonlinearity Error		V _{DD} = 5.0 V, V _{SS} = 0.0 V V _{AREF} = 5.000 V V _{ASS} = 0.000 V	—	—	± 1	LSB
Zero Point Error		OR V _{DD} = 2.7 V, V _{SS} = 0.0 V V _{AREF} = 2.700 V V _{ASS} = 0.000 V	—	—	± 1	
Full Scale Error			—	—	± 1	
Total Error			—	—	± 2	

Note: The above errors has no quantizing error.

A.C. Characteristics

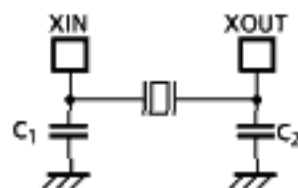
 $(V_{SS} = 0\text{ V}, V_{DD} = 4.5\text{ to }6.0\text{ V}, T_{opr} = -30\text{ to }70^{\circ}\text{C})$

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t _{cy}	In NORMAL1, 2 modes	0.5	—	10	μs
		In IDLE1, 2 modes				
		In SLOW mode	117.6	—	133.3	
		In SLEEP mode				
High Level Clock Pulse Width	t _{WCH}	For external clock operation (XIN input), f _c = 8 MHz	50	—	—	ns
Low Level Clock Pulse Width	t _{WCL}					
High Level Clock Pulse Width	t _{WSH}	For external clock operation (XTIN input), f _s = 32.768 kHz	14.7	—	—	μs
Low Level Clock Pulse Width	t _{WSL}					

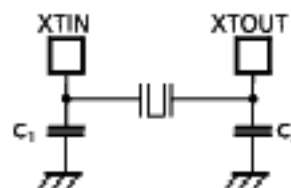
Recommended Oscillating Conditions

 $(V_{SS} = 0\text{ V}, V_{DD} = 4.5\text{ to }6.0\text{ V}, T_{opr} = -30\text{ to }70^{\circ}\text{C})$

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



(1) High-frequency Oscillation

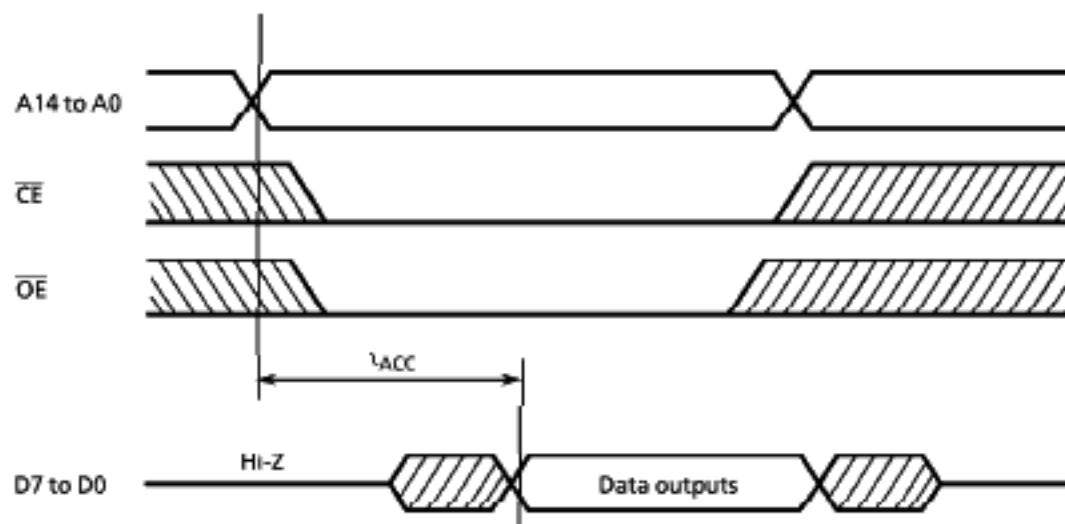


(2) Low-frequency Oscillation

Note: When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

D.C./A.C. Characteristics (PROM mode) ($V_{SS} = 0V$)(1) Read Operation ($T_{opr} = -30$ to $70^{\circ}C$)

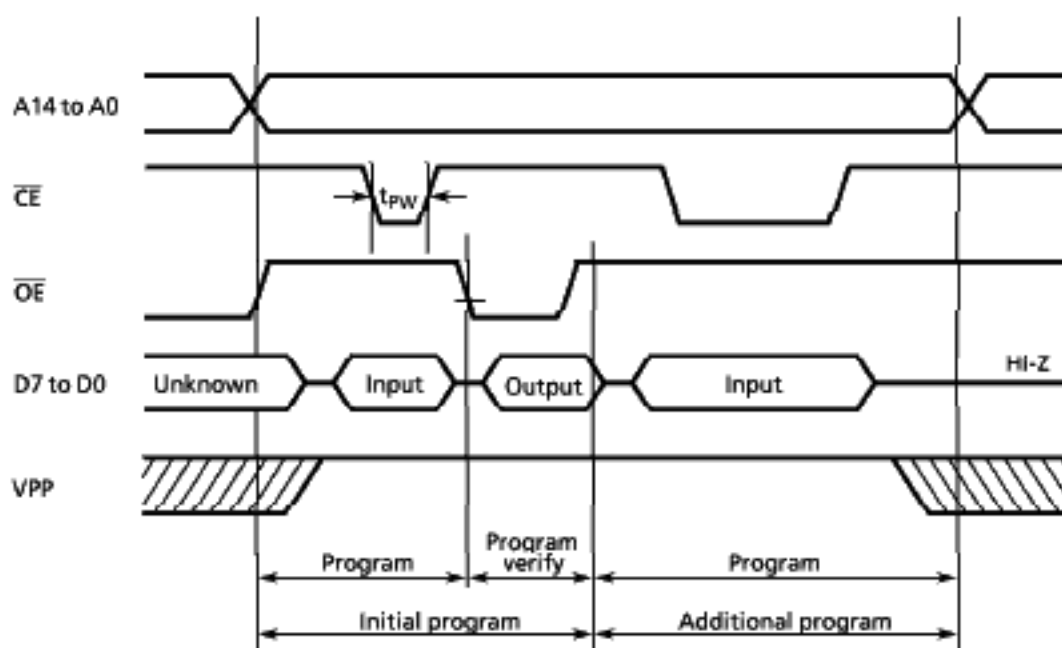
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		4.75	5.00	5.25	V
Program Power Supply Voltage	V_{PP}		$V_{CC} - 0.6$	V_{CC}	$V_{CC} + 0.6$	
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25V$	–	$1.5t_{cyc} + 300$	–	ns

Note: $t_{cyc} = 500$ ns at 8 MHz

Timing Waveforms of Read Operation

(2) Program Operation (High-Speed Write Mode - I) ($T_{opr} = 25 \pm 5^{\circ}C$)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		5.75	6.0	6.25	V
Program Power Supply Voltage	V_{PP}		12.0	12.5	13.0	V
Initial Program Pulse Width	t_{PW}	$V_{CC} = 6.0 V \pm 0.25 V$, $V_{PP} = 12.5 \pm 0.25 V$	0.95	1.0	1.05	ms



Timing Waveforms of Programming Operation

Note 1: When V_{CC} power supply is turned on or after, V_{PP} must be increased.

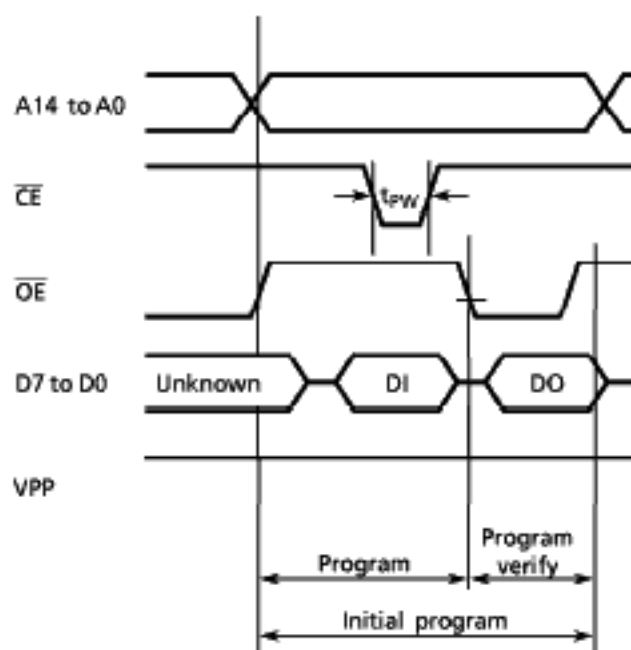
When V_{CC} power supply is turned off or before, V_{PP} must be decreased.

Note 2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ($12.5\text{ V} \pm 0.5\text{ V}$) to the V_{PP} pin as the device is damaged.

Note 3: Be sure to execute the recommended programming mode with the recommended programming adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.

(3) Program Operation (High speed write mode - II) ($T_{opr} = 25 \pm 5^{\circ}\text{C}$)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	—	V_{CC}	V
Input Low Voltage	V_{IL4}		0	—	$V_{CC} \times 0.12$	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}	$V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$, $V_{PP} = 12.75 \text{ V} \pm 0.25 \text{ V}$	0.095	0.1	0.105	ms



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

Note 1: 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.

Note 2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ($12.75 \text{ V} \pm 0.25 \text{ V}$) to the V_{PP} pin as the device is damaged.

Note 3: Be sure to execute the recommended programming mode with the recommended programming adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.