CMOS 8-Bit Microcontroller

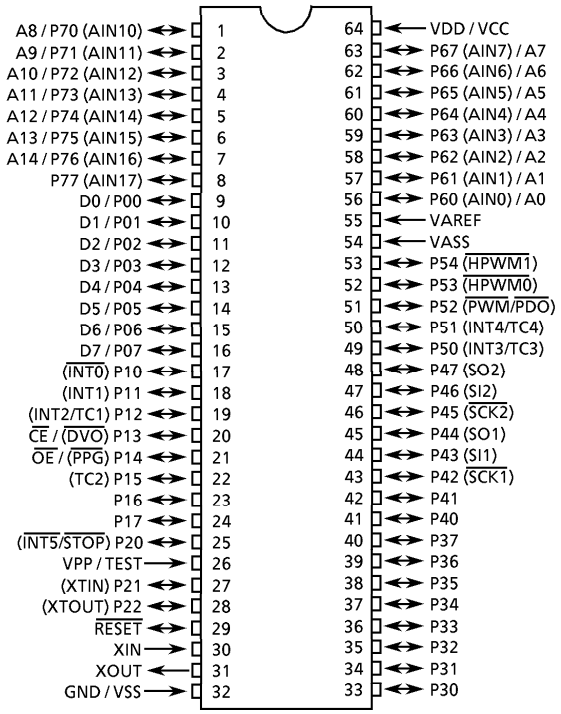
TMP87PM41N, TMP87PM41F, TMP87PM41U

The 87PM41 is a One-Time PROM microcontroller with low-power 256K bits (32 Kbytes) electrically programmable read only memory for the 87C841/CC41/CH41/CK41/CM41 system evaluation. The 87PM41 is pin compatible with the 87C841/CC41/CH41/CK41/M41. The operations possible with the 87C841/CC41/CH41/CK41/M41 can be performed by writing programs to PROM. The 87PM41 can write and verify in the same way as the TC57256AD using an adaptor socket BM1136/BM1137/BM1121 and an EPROM programmer.

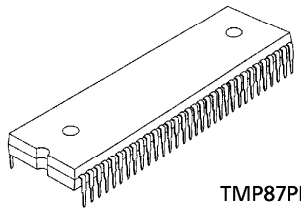
Part No.	ROM	RAM	Package	Adaptor Soket
TMP87PM41N	32 K × 8-bit	1 K × 8-bit	P-SDIP64-750-1.78	BM1136
TMP87PM41F			P-QFP64-1420A	BM1137
TMP87PM41U			P-LQFP64-1010	BM11121

Pin Assignments (Top View)

P-SDIP64-750-1.78



P-SDIP64-750-1.78



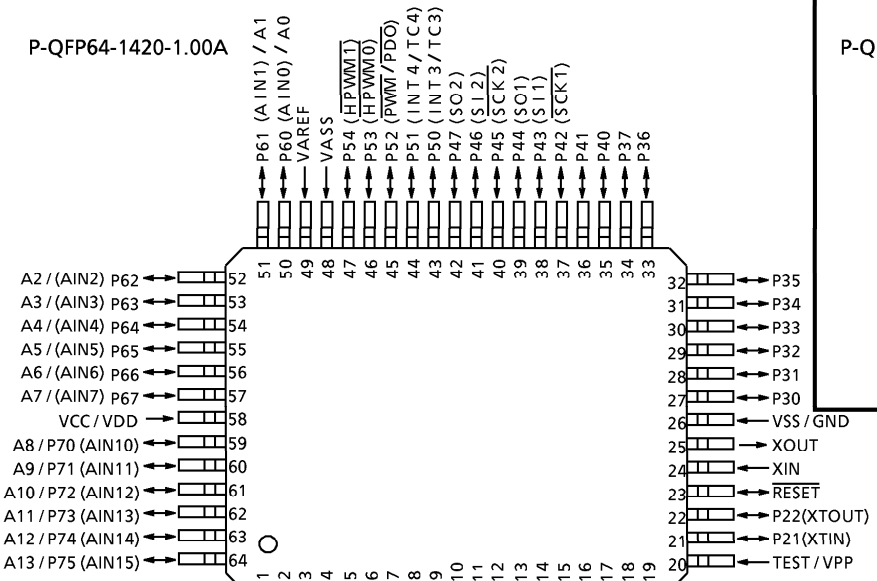
TMP87PM41N

980910EBP1

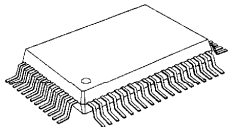
- For a discussion of how the reliability of microcontrollers can be predicted, please refer to Section 1.3 of the chapter entitled Quality and Reliability Assurance / Handling Precautions.
- TOSHIBA is continually working to improve the quality and the reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to observe standards of safety, and to avoid situations in which a malfunction or failure of a TOSHIBA product could cause loss of human life, bodily injury or damage to property. In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent products specifications. Also, please keep in mind the precautions and conditions set forth in the TOSHIBA Semiconductor Reliability Handbook.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- The information contained herein is subject to change without notice.

Pin Assignments (Top View)

P-QFP64-1420-1.00A

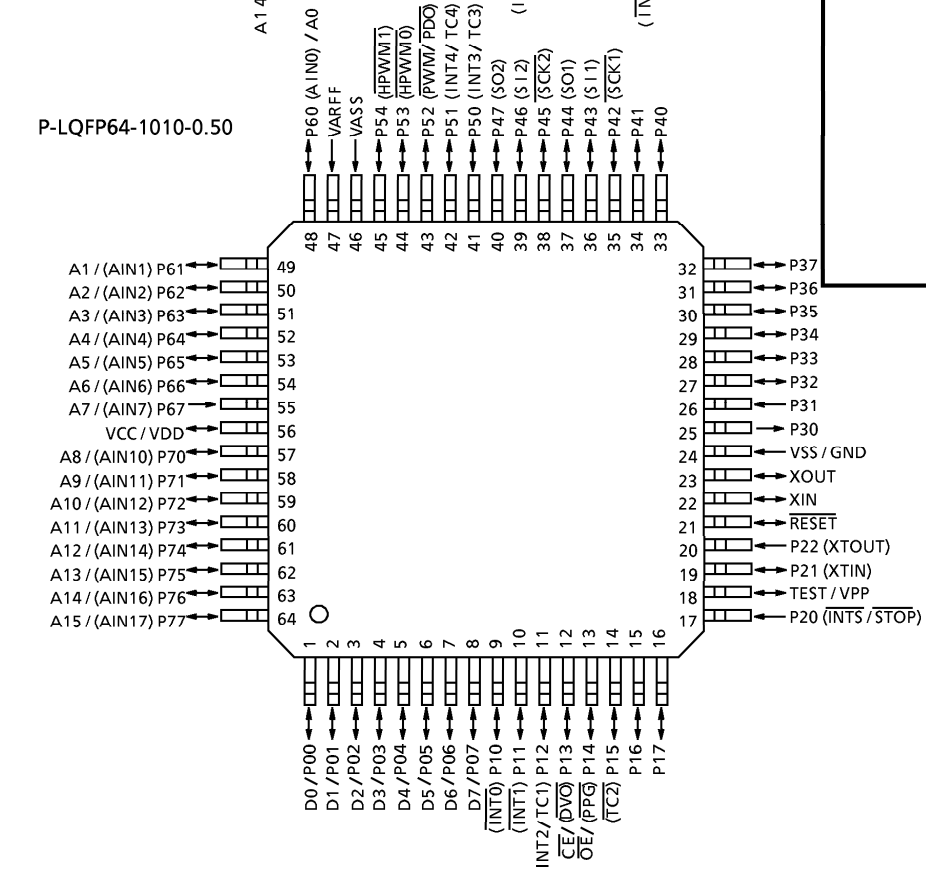


P-QFP64-1420-1.00A

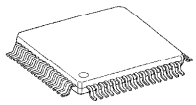


TMP87PM41F

P-LQFP64-1010-0.50



P-LQFP64-1010-0.50



TMP87PM41U

Pin Function

The 87PM41 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PM41 is pin compatible with the 87C841/CC41/CH41/CK41/CM41 (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			P67 to P60
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 P30	I/O	Pull-up with resistance for input processing	
P47 to P40			
P54 to P50			
P11		PROM mode setting pin. Be fixed at high level.	
P21			
P77			
P17 to P15		PROM mode setting pin. Be fixed at low level.	
P12, P10			
P22, P20			
$\overline{RESET}$			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power Supply	0 V (GND)	
VASS			

Operational Description

The following explains the 87PM41 hardware configuration and operation. The configuration and functions of the 87PM41 are the same as those of the 87C841/CC41/CH41/CK41/CM41, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PM41 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 87PM41 has 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 87C841/CC41/CH41/CK41/CM41 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PM41 has a 32 K × 8-bit (addresses 8000_H to $FFFF_H$ in the MCU mode, addresses 0000_H to $7FFF_H$ in the PROM mode) of program memory (OTP).

To use the 87PM41 as the system evaluation for the 87C841/CC41/CH41/CK41/CM41 the program should be written to the program memory area as shown the Figure 1-1.

Electrical Characteristics

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

Parameter	Symbol	Pins	Ratings	Unit
Supply Voltage	V_{DD}		– 0.3 to 6.5	V
Program Voltage	V_{PP}	TEST/VPP	– 0.3 to 13.0	V
Input Voltage	V_{IN}		– 0.3 to V_{DD} + 0.3	V
Output Voltage	V_{OUT1}		– 0.3 to V_{DD} + 0.3	V
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 [Topr = 70°C]	PD	TMP87PM41N	600	mW
		TMP87PM41F, TMP87PM41U	350	
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 40 to 85	°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		–	0.9	–	V
Input Current	I_{IN1}	TEST	V_{DD} = 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 Low Current	I_{IL}	Push pull ports	V_{DD} = 5.5 V, V_{IN} = 0.4 V	–	–	– 2	mA
Input Resistance	R_{IN2}	$\overline{RESET}$		90	220	510	kΩ
Output Leakage Current	I_{LO}	Sink open drain ports Tri-state ports	V_{DD} = 5.5 V, V_{OUT} = 5.5 V	–	–	2	μA
Output High Voltage	V_{OH1}	Tri-state ports	V_{DD} = 4.5 V, I_{OH} = – 0.7 mA	4.1	–	–	V
Output Low Voltage	V_{OL}	Except XOUT and P3	V_{DD} = 4.5 V, I_{OL} = 1.6 mA	–	–	0.4	V
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	–	10	16	mA
Supply Current in IDLE 1, 2 modes			fc = 8 MHz fs = 32.768 kHz	–	4.5	6	mA
Supply Current in SLOW mode			V_{DD} = 3.0 V V_{IN} = 2.8 V / 0.2 V	–	30	60	μA
Supply Current in SLEEP mode			fs = 32.768 kHz	–	15	30	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 , V_{DD} = 5 V.
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 I_{REF}.

AD Conversion Characteristics

(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	1.0			mA
Nonlinearity Error		V_{DD} = 5.0 V, V_{SS} = 0.0 V V_{AREF} = 5.000 V V_{ASS} = 0.000 V OR V_{DD} = 2.7 V, V_{SS} = 0.0 V V_{AREF} = 2.700 V V_{ASS} = 0.000 V	–	–	± 1	± 3	± 2	LSB
Zero Point Error			–	–	± 1	± 3	± 2	
Full Scale Error			–	–	± 1	± 3	± 2	
Total Error			–	–	± 2	± 6	± 4	

Note 1: $\triangle V_{AREF} = V_{AREF} - V_{ASS}$
Note 2: ADCDR1 ; 8 bit – AD conversion result (1LSB = $\triangle V_{AREF}$ / 256)
ADCDR2 ; 10 bit – AD conversion result (1LSB = $\triangle V_{AREF}$ / 1024)

A.C. Characteristics

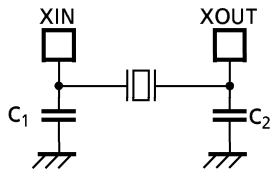
(V_{SS} = 0 V, V_{DD} = 2.7 / 4.5 to 5.5 V, Topr = – 40 to 85°C)

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), fc = 8 MHz	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	14.7	–	–	μs
Low Level Clock Pulse Width	t_{WSL}					

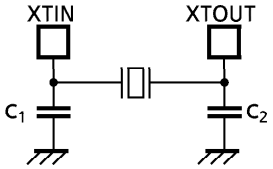
Recommended Oscillating Conditions

(V_{SS} = 0 V, V_{DD} = 2.7 / 4.5 to 5.5 V, Topr = – 40 to 85°C)

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



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

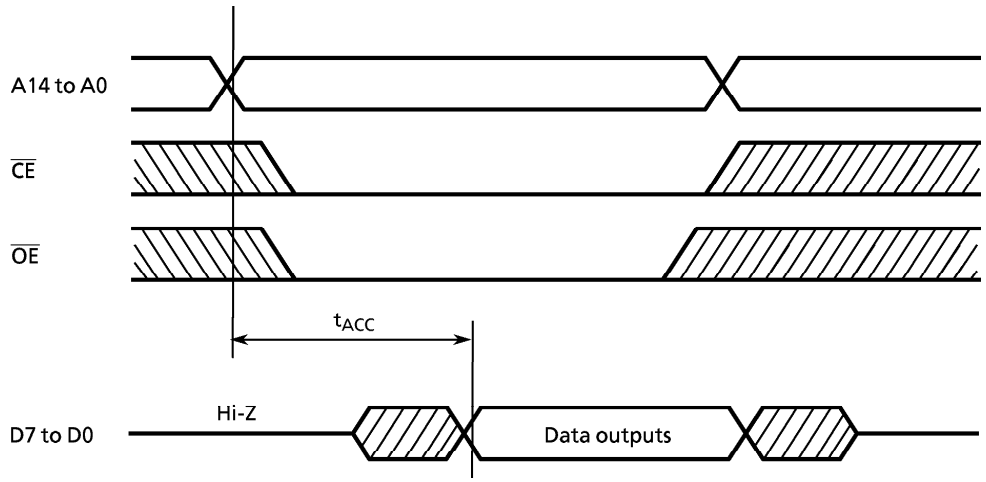
Note: When it is used in high electrical field, an electrical shield of the package is recommended to retain normal operations.

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

(1) Read Operation

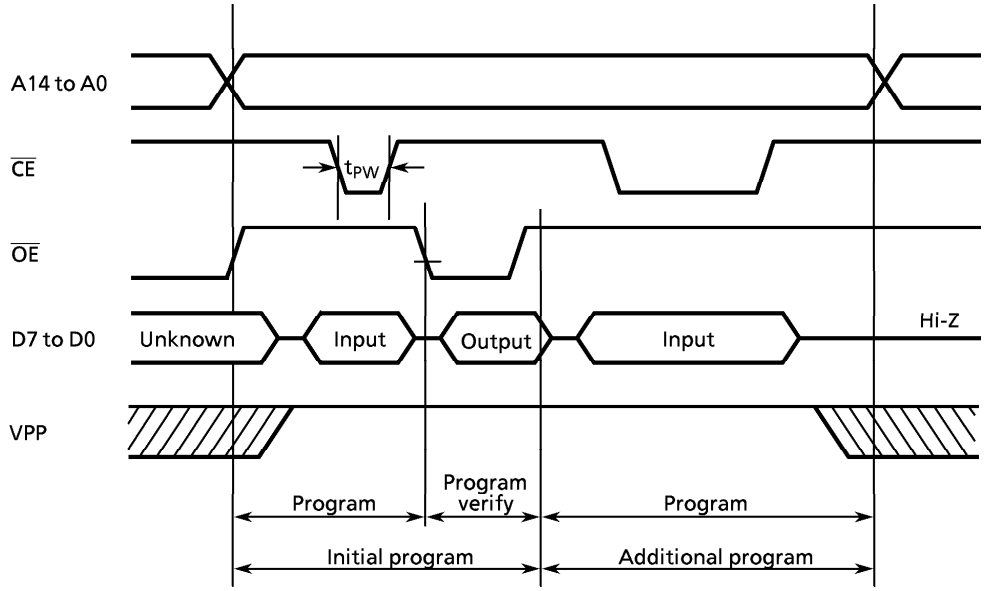
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		4.75	–	6.5	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	V_{CC} = 5.0 ± 0.25 V	–	1.5tcyc + 300	–	ns

Note: tcyc = 500 ns at 8 MHz



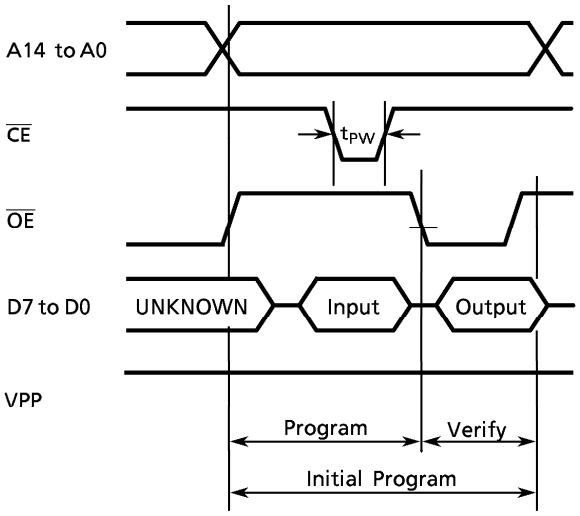
(2) Program Operation (High speed write mode-Ⅰ) (Topr = 25 ± 5°C)

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	–	6.5	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 ± 0.25 V V_{PP} = 12.5 V ± 0.5 V	0.95	1.0	1.05	ms



(3) Program Operation (High speed write mode - II) (Topr = 25 ± 5°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 V ± 0.25 V, V_{PP} = 12.75 V ± 0.25 V	0.095	0.1	0.105	ms



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 V ± 0.5 V) to the V_{pp} pin as the device is damaged.
Note 3: 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.