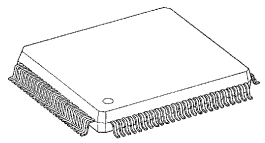
CMOS 8-Bit Microcontroller

TMP87PP24AF

The TMP87PP24A is a One-Time PROM microcontroller with low-power 384 Kbits electrically programmable read only memory for the TMP87CM24A/CP24A system evaluation. The TMP87PP24A is pin compatible with the TMP87CM24A/CP24A. The operations possible with the TMP87CM24A/CP24A can be performed by writing programs to PROM. The TMP87PP24A can write and verify in the same way as the TMM571000D using an adaptor socket BM11127 and an EPROM programmer.

Product No.	OTP	RAM	Package	OTP Adapter
TMP87PP24AF	48 K × 8 bits	2 K × 8 bits	P-LQFP100-1414-0.50C	BM11127

P-LQFP100-1414-0.50C



TMP87PP24AF

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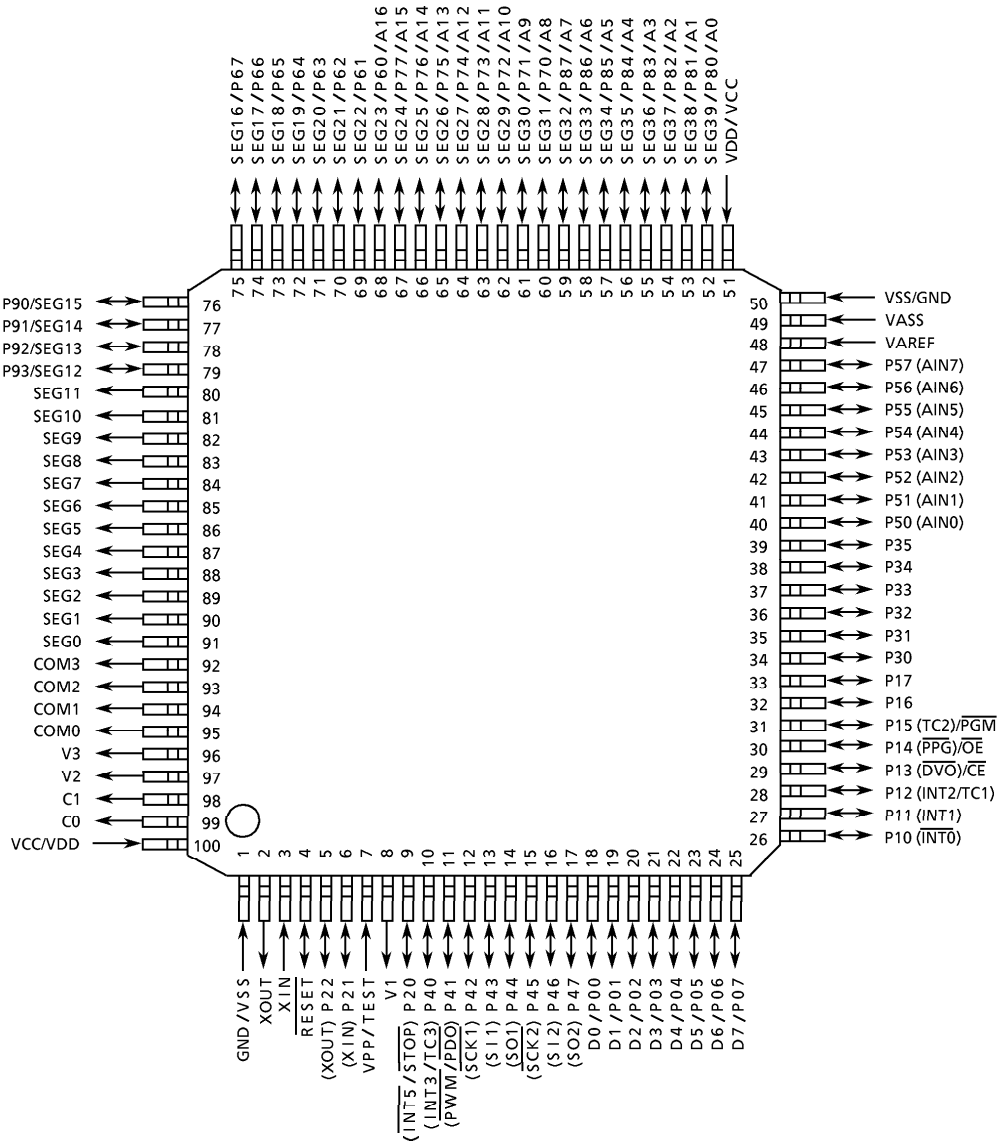
Pin Assignments (Top View)

P-LQFP100-1414-0.50C



Pin Function

The TMP87PP24A has two modes: MCU and PROM.

(1) MCU mode

In this mode, the TMP87PP24A is pin compatible with the TMP87CM24A/CP24A (fix the TEST pin at low level.)

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Function	Pin Name (MCU mode)
A16	Input	PROM address inputs	P60
A15 to A8			P77 to P70
A7 to A0			P87 to P80
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
$\overline{PGM}$		Program mode signal input	P15
VPP	Power supply	+ 12.75 V/5 V (Program supply voltage)	TEST
VCC		+ 6.25 V/5 V	VDD
GND		0 V	VSS
P35 to P30	I/O	Pull-up with resistance for input processing.	
P47 to P40			
P57 to P50			
P67 to P62			
P93 to P90			
P11		PROM mode setting pin. Be fixed at high level.	
P21			
P31			
P61			
P17, P16, P12, P10 P22, P20		PROM mode setting pin. Be fixed at low level.	
$\overline{RESET}$			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power supply	0 V (GND)	
VASS			
COM3 to COM0	Output	Open	
SEG11 to SEG0			
C0, C1, V1, V2, V3	Power supply		

Operational Description

The following explains the TMP87PP24A hardware configuration and operation. The configuration and functions of the TMP87PP24A are the same as those of the TMP87CM24A/CP24A, except in that a one-time PROM is used instead of an on-chip mask ROM.

The TMP87PP24A 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 TMP87PP24A 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 TMP87CM24A/CP24A (the TEST/VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The TMP87PP24A has a 48K × 8-bit (addresses 4000_H to $FFFF_H$ in the MCU mode, addresses 14000_H to $1FFFF_H$ in the PROM mode) of program memory (OTP).

When the TMP87PP24A is used as a system evaluation of the TMP87CM24A/CP24A, the data is written to the program storage area show in Figure 1-1.

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

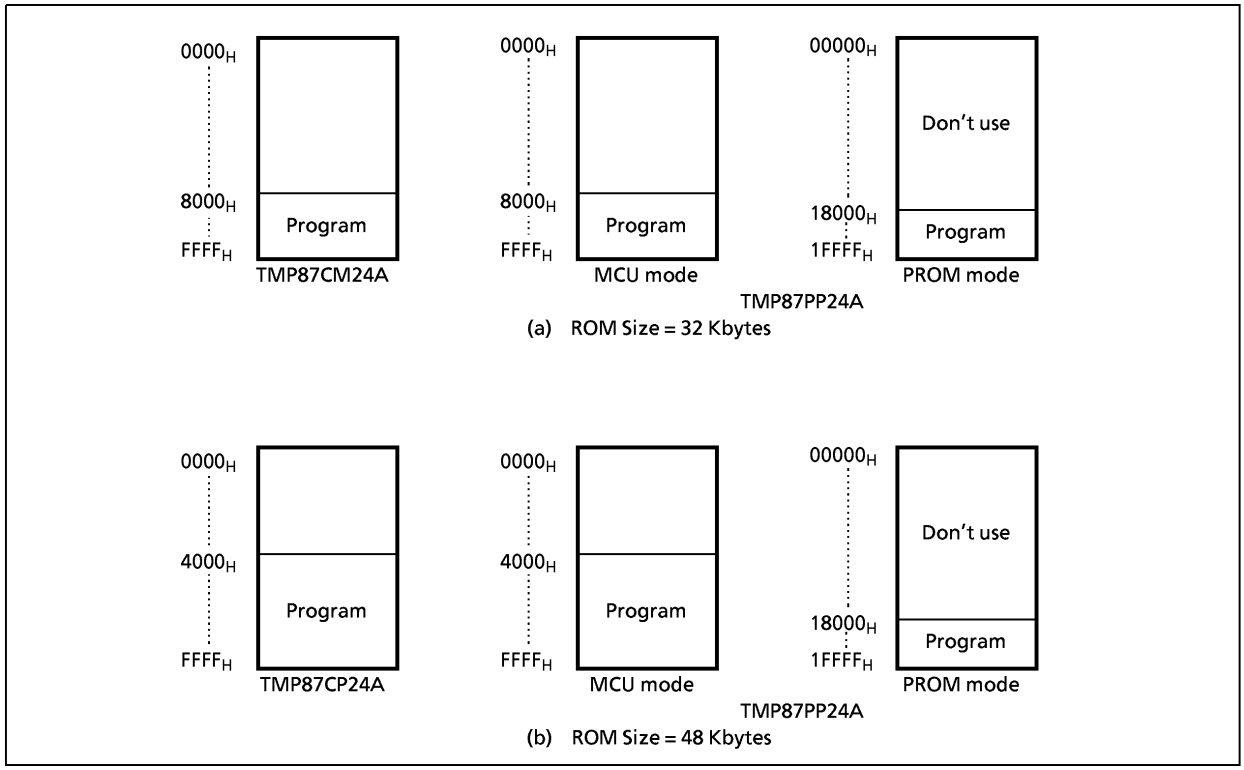


Figure 1-1. Program Memory Area

Electrical Characteristics

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

Parameter	Symbol	Pins	Ratings	Unit
Supply Voltage	V_{DD}		– 0.3 to 6.5	V
Program Voltage	V_{PP}	TEST/V_{PP}	– 0.3 to 13.0	
Input Voltage	V_{IN}		– 0.3 to V_{DD} + 0.3	
Output Voltage	V_{OUT1}	Except P20 and P3 ports	– 0.3 to V_{DD} + 0.3	
	V_{OUT2}	Ports P20, P3	– 0.3 to 5.5	
Output Current (Per 1 pin)	I_{OUT1}	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	3.2	mA
	I_{OUT2}	P41	30	
Output Current (Total)	ΣI_{OUT1}	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	120	
	ΣI_{OUT2}	P41	30	
Power Dissipation [Topr = 70°C]	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	
Operating Temperature	Topr		– 10 to 70	

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, Topr = – 10 to 70°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	2.2		
				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_{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_{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} = 2.2 to 5.5 V			4.2	
	fs	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 NORMAL1/2 mode and IDLE1/2 mode.

DC Characteristics

(V_{SS} = 0 V, Topr = – 10 to 70°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 and tri-state ports					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Resistance	R_{IN2}	$\overline{RESET}$		100	220	450	kΩ
Output Leakage Current	I_{LO1}	Open drain ports	V_{DD} = 5.5 V, V_{OUT} = 5.5 V	—	—	2	μA
	I_{LO2}	Tri-state ports	V_{OUT} = 5.5 V/0 V	—	—	± 2	
Segment/Common Output Voltage	V_{LCD1}	SEG39 to SEG0 and COM3 to COM0		0.75	1.0	1.33	V
	V_{LCD2}			V_{LCD1} × 2			
	V_{LCD3}			V_{LCD1} × 3			
Output High Voltage	V_{OH1}	Push-pull ports (P4 port)	V_{DD} = 4.5 V, I_{OH} = – 200 μA	2.4	—	—	
	V_{OH2}	Tri- state ports (P0, P1, P5 ports)	V_{DD} = 4.5 V, I_{OH} = – 0.7 mA	4.1	—	—	
Output Low Voltage	V_{OL}	Except XOUT and P41	V_{DD} = 4.5 V, I_{OL} = 1.6 mA	—	—	0.4	
Output Low Current	I_{OL3}	P41	V_{DD} = 4.5 V, V_{OL} = 1.0 V	—	20	—	mA
Supply Current in NORMAL 1 , 2 mode	I_{DD}		V_{DD} = 5.5 V fc = 8 MHz fs = 32.768 kHz V_{IN} = 5.3 V/0.2 V	—	12	18	
Supply Current in IDLE 1, 2 mode				—	6	10	
Supply Current in SLOW mode			V_{DD} = 3.0 V fs = 32.768 kHz V_{IN} = 2.8 V/0.2 V Voltage boost frequency = 1 kHz	—	31	70	μA
Supply Current in SLEEP mode				—	16	40	
Supply Current in STOP mode			V_{DD} = 5.5 V V_{IN} = 5.3 V/0.2 V	—	0.5	10	

Note 1: Typical values show those at Topr = 25°C , V_{DD} = 5 V.
Note 2: Input Current ; The current through pull-up or pull-down resistor is not included.
Note 3: I_{DD} ; Except for I_{REF}
Note 4: V_{LCD2} indicates an output voltage at the 2/3 level when operating in the 1/4 or 1/3 duty mode.
Note 5: V_{LCD1} indicates an output voltage at the 1/3 level when operating in the 1/4 or 1/3 duty mode.

AD Conversion Characteristics (I)

(V_{SS} = 0 V, V_{DD} = 2.7 to 5.5 V, Topr = – 10 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}		2.7	–	V_{DD}	V
	V_{ASS}		V_{SS}	–	1.5	
Analog Input Voltage	V_{AIN}		V_{ASS}	–	V_{AREF}	
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	LSB
Zero Point Error			–	–	± 1	
Full Scale Error			–	–	± 1	
Total Error			–	–	± 2	

Note: Quantizing error is not contained in those errors.

AD Conversion Characteristics (II)

(V_{SS} = 0V, V_{DD} = 2.2 to 2.7V, Topr = – 10 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}		2.2	–	V_{DD}	V
	V_{ASS}		V_{SS}			
Analog Reference Voltage Range	$\triangle V_{AREF}$		2.2	–	–	
Analog Input Voltage	V_{AIN}		V_{ASS}	–	V_{AREF}	
Analog Supply Current	I_{REF}	V_{AREF} = 5.5 V, V_{ASS} = 0.0 V	–	0.5	1.0	mA
Nonlinearity Error		V_{DD} = 2.2 V, V_{SS} = 0.0 V V_{AREF} = 2.200 V V_{ASS} = 0.000 V	–	–	± 2	LSB
Zero Point Error			–	–	± 2	
Full Scale Error			–	–	± 2	
Total Error			–	–	± 4	

Note: Quantizing error is not contained in those errors.

AC Characteristics (I) (V_{SS} = 0V, V_{DD} = 4.5 to 5.5V, Topr = – 10 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t_{cy}	In NORMAL 1, 2 mode	0.95	–	10	μs
		In IDLE 1, 2 mode				
		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}					

AC Characteristics (II) (V_{SS} = 0 V, V_{DD} = 2.2 to 5.5 V, Topr = – 10 to 70°C)

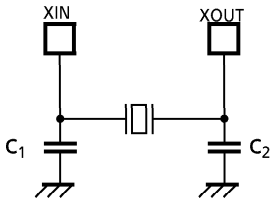
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t_{cy}	In NORMAL 1, 2 mode	0.95	–	10	μs
		In IDLE 1, 2 mode				
		In SLOW mode	117.6	–	133.3	
		In SLEEP mode				
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XIN input), fc = 4.2 MHz	110	–	–	ns
Low Level Clock Pulse 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}					

Recomended Oscillating Condition (Ⅰ) (V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, Topr = − 10 to 70°C)

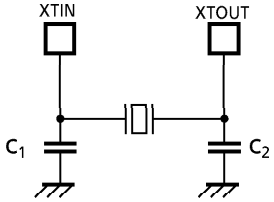
Parameter	Osillator	Frequency	Recommender Oscillator		Recommended Condition C_1	Recommended Condition C_2
High-frequency	Ceramic Resonator	8 MHz	KYOCERA	KBR8.0M	30pF	30pF
			Standard/Lead Type (MURATA)	CSA8.00MTZ CST8.00MTW	built-in 30pF	built-in 30pF
			Standard/SMP Type (MURATA)	CSAC8.00MT	30pF	30pF
			Standard/Small ChipType (MURATA)	CSTC8.00MT	built-in 30pF	built-in 30pF
		4 MHz	KYOCERA	KBR4.0MS	30pF	30pF
	Crystal Oscillator	8 MHz	TOYOCOM	210B 8.0000	20pF	20pF
		4 MHz	TOYOCOM	204B 4.0000		
Low-frequency	Crystal Oscillator	32.768 kHz	NDK	MX-38T	15pF	15pF

Recomended Oscillating Condition (Ⅱ) (V_{SS} = 0 V, V_{DD} = 2.2 to 5.5 V, Topr = − 10 to 70°C)

Parameter	Osillator	Frequency	Recommender Oscillator		Recommended Condition C_1	Recommended Condition C_2
High-frequency	Ceramic Resonator	4 MHz	Standard/Lead Type	CSA4.00MG	30pF	30pF
			(MURATA)	CST4.00MGW	built-in 30pF	built-in 30pF
			Standard/SMD Type (MURATA)	CSA4.00MGC CSAC4.00MGCM	30pF	30pF
				CSTC4.00MG	built-in 30pF	built-in 30pF
			Standard/Small Chip Type	CSTCS4.00MG	built-in 10pF	built-in 10pF



(1) High-frequency



(2) Low-frequency

Note1: When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

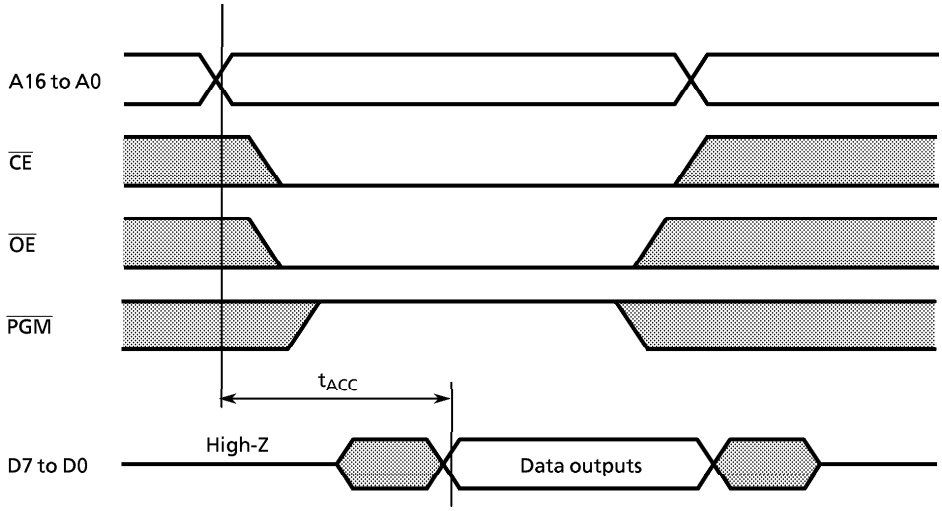
Note2: The product numbers and specifications of the resonators by Murata Manufacturing Co., Ltd. are subject to change. For up-to-date information, please refer to the following URL; http://www.murata.co.jp/search/index.html

DC/AC Characteristics (PROM mode) (V_{SS} = 0 V)

(1) Read Operation

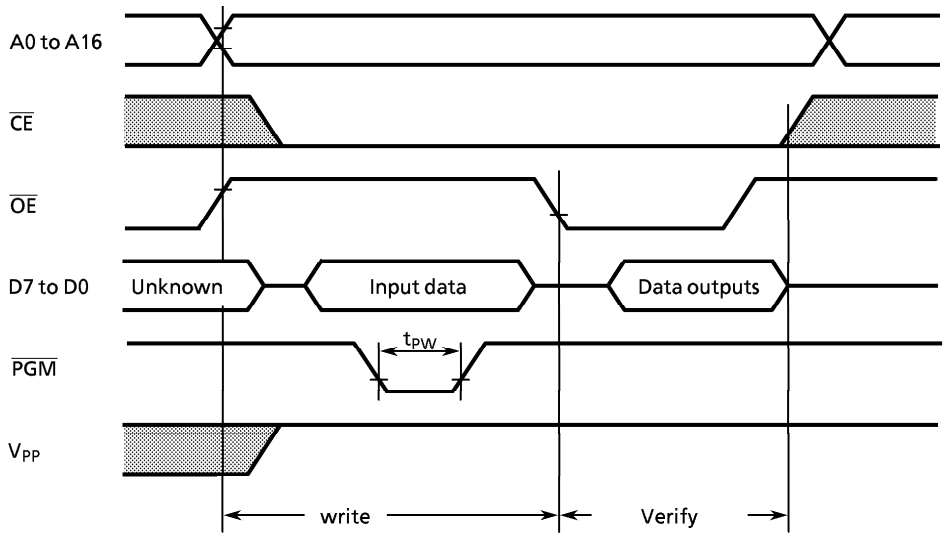
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	
Power Supply Voltage	V_{CC}		4.75	5.0	5.25	
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	V_{CC} = 5.0 ± 0.25V	–	1.5tcyc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

Note: tcyc = 500 ns at 8 MHz



(2) High-Speed Programming Operation (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	–	$V_{CC} \times 0.12$	
Power Supply Voltage	V_{CC}		6.0	6.25	6.5	
Program Power Supply Voltage	V_{PP}		12.5	12.75	13.0	
Initial Program Pulse Width	t_{PW}	V_{CC} = 6.0 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 increased.
Note 2: The device must not be set to the EPROM programmer or picked op from it under applying the program voltage (12.5 V ± 0.5 V = 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.