

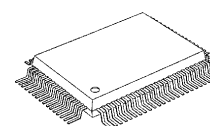
## CMOS 8-Bit Microcontroller

## TMP87PS71F

The TMP87PS71 is a One-Time PROM microcontroller with low-power 480 K bits (60 Kbytes) electrically programmable read only memory for the TMP87CS71 system evaluation. The TMP87PS71 is pin compatible with the TMP87CS71. The operations possible with the TMP87CS71 can be performed by writing programs to PROM. The TMP87PS71 can write and verify in the same way as the TC571000D using an adaptor socket BM11107 and an EPROM programmer.

Part No	OTP	RAM	Package	Adapter Socket
TMP87PS71F	60 K x 8-bit	2.0 K x 8-bit	P-QFP80-1420-0.80B	BM11107

P-QFP80-1420-0.80B



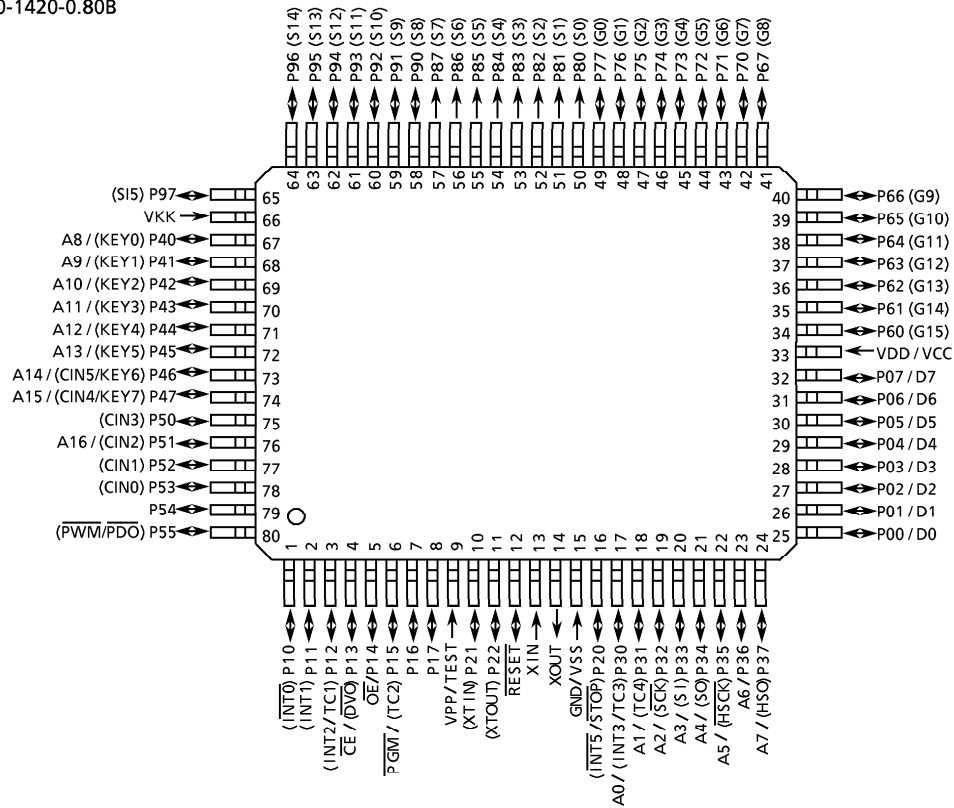
TMP87PS71F

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Pin Assignments (Top View)

P-QFP80-1420-0.80B



## Pin Function

The TMP87PS71 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the TMP87PS71 is pin compatible with the TMP87CS71 (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input / Output	Functions	Pin Name (MCU mode)
A16	Input	PROM address inputs	P51
A15 to A8			P47 to P40
A7 to A0			P37 to P30
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 control input (active low)	P15
VPP	Power supply	+ 12.75 V / 5 V (Program supply voltage)	TEST
VCC		+ 6.25 V / 5 V	VDD
GND		0 V	VSS
P55 to P52	I/O	Pull-down with resistance for input processing	
P11		PROM mode setting pin. Be fixed at high level.	
P21			
P50			
P17, P16			
P12, P10		PROM mode setting pin. Be fixed at low level.	
P22, P20			
RESET			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		
VKK	VFT power supply	GND	
P97 to P90	I/O	Open	
P87 to P80	Output		
P77 to P70	I/O		
P67 to P60			

## Operational Description

The following explains the TMP87PS71 hardware configuration and operation. The configuration and functions of the TMP87PS71 are the same as those of the TMP87CS71, except in that a one-time PROM is used instead of an on-chip mask ROM.

The TMP87PS71 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 TMP87PS71 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 TMP87CS71 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

##### 1.1.1 Program Memory

The TMP87PS71 has a 60 K×8-bit (addresses 1100<sub>H</sub> to FFFF<sub>H</sub> in the MCU mode, addresses 11100<sub>H</sub> to 1FFFF<sub>H</sub> in the PROM mode) of program memory (OTP).

To use the TMP87PS71 as the system evaluation for the TMP87CM71/N71/P71/S71, the program should be written to the program memory area as shown in Figure 1-1.

*Note: When accessing addresses 00000<sub>H</sub> to 110FF<sub>H</sub> of program memory in the PROM mode, blank, read or verify mode may not be guaranteed the operation; use addresses 11100<sub>H</sub> to 1FFFF<sub>H</sub>.*

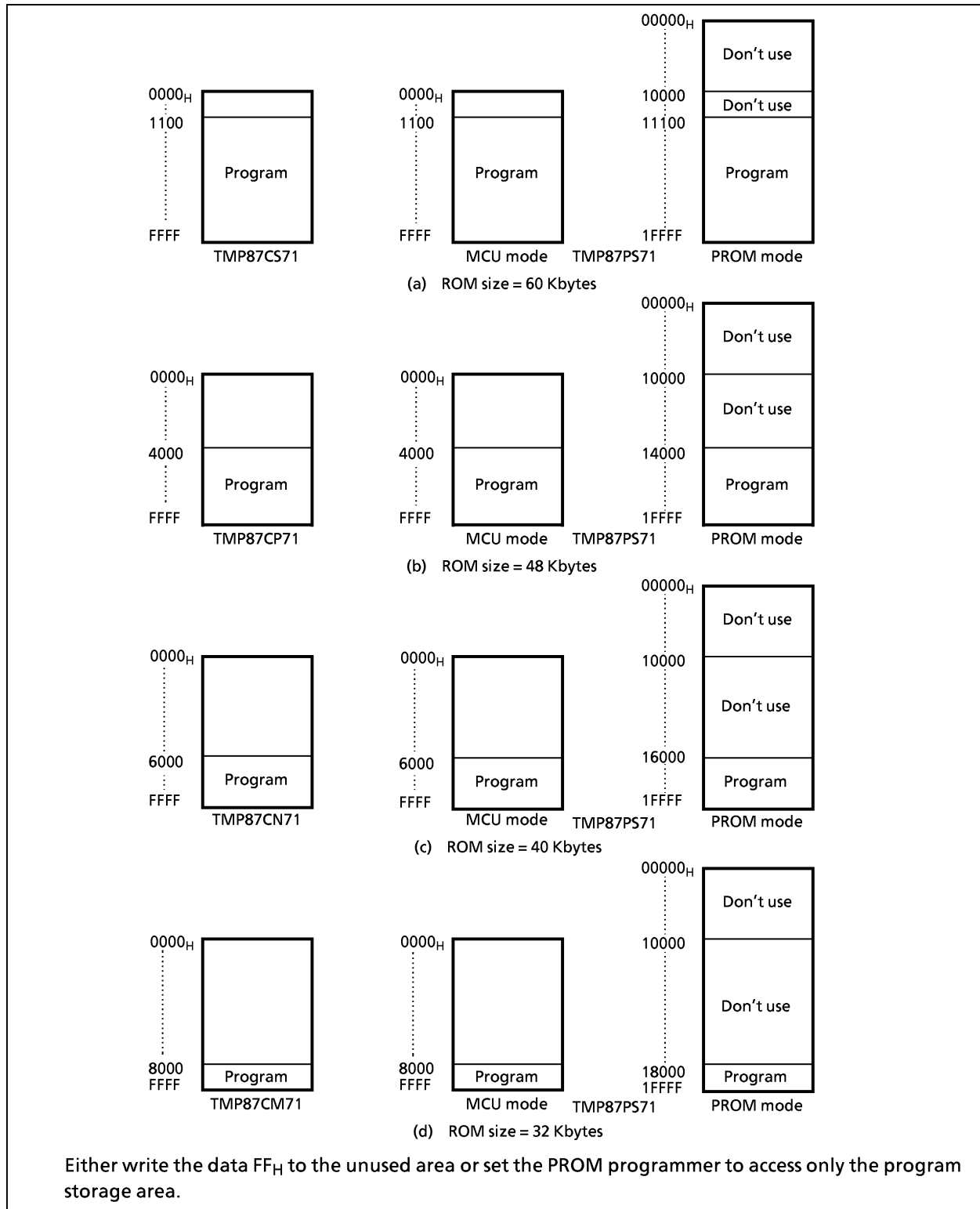


Figure 1-1. Program Memory Area

## Electrical Characteristics

## Absolute Maximum Ratings

(V<sub>SS</sub> = 0 V)

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V <sub>DD</sub>		- 0.3 to 6.5	V
Input Voltage	V <sub>IN</sub>		- 0.3 to V <sub>DD</sub> + 0.3	V
Output Voltage	V <sub>OUT1</sub>	P2, P3, P4, P5, XOUT, RESET	- 0.3 to V <sub>DD</sub> + 0.3	V
	V <sub>OUT2</sub>	Source open drain ports	V <sub>DD</sub> - 40 to V <sub>DD</sub> + 0.3	
Output Current (Per 1 pin)	I <sub>OUT1</sub>	P0, P1, P2, P3, P4, P5	3.2	mA
	I <sub>OUT3</sub>	P8, P9 (segment outputs)	- 12	
	I <sub>OUT4</sub>	P6, P7 (digit outputs)	- 25	
Output Current (Total)	Σ I <sub>OUT1</sub>	P0, P1, P2, P3, P4, P5	120	mA
	Σ I <sub>OUT2</sub>	P6, P7, P8, P9	- 120	
Power Dissipation [T <sub>opr</sub> = 70°C]	PD		350	mW
Soldering Temperature (time)	T <sub>sld</sub>		260 (10 s)	°C
Storage Temperature	T <sub>stg</sub>		- 55 to 125	°C
Operating Temperature	T <sub>opr</sub>		- 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<sub>SS</sub> = 0V, T<sub>opr</sub> = - 30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit	
Supply Voltage	V <sub>DD</sub>		f <sub>c</sub> = 8 MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 modes			
			f <sub>s</sub> = 32.768 kHz	SLOW mode	2.7		
				SLEEP mode			
		STOP mode	2.0				
Output Voltage	V <sub>OUT3</sub>	Source open drain ports		V <sub>DD</sub> - 38	V <sub>DD</sub>	V	
Input High Voltage	V <sub>IH1</sub>	Except hysteresis input	V <sub>DD</sub> ≥ 4.5 V	V <sub>DD</sub> × 0.70	V <sub>DD</sub>	V	
	V <sub>IH2</sub>	Hysteresis input		V <sub>DD</sub> × 0.75			
	V <sub>IH3</sub>			V <sub>DD</sub> < 4.5 V			V <sub>DD</sub> × 0.90
Input Low Voltage	V <sub>IL1</sub>	Except hysteresis input	V <sub>DD</sub> ≥ 4.5 V	0	V <sub>DD</sub> × 0.30	V	
	V <sub>IL2</sub>	Hysteresis input			V <sub>DD</sub> × 0.25		
	V <sub>IL3</sub>				V <sub>DD</sub> < 4.5 V		V <sub>DD</sub> × 0.10
Clock Frequency	f <sub>c</sub>	XIN, XOUT	V <sub>DD</sub> = 4.5 to 5.5V	0.4	8.0	MHz	
	f <sub>s</sub>	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 f<sub>c</sub>: Supply voltage range is specified in NORMAL1/2 mode and IDLE1/2 mode.

## DC Characteristics

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

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Hysteresis Voltage	$V_{HS}$	Hysteresis input		–	0.9	–	V
Input Current	$I_{IN1}$	TEST	$V_{DD} = 5.5\text{ V}$ $V_{IN} = 5.5\text{ V} / 0\text{ V}$	–	–	$\pm 2$	$\mu\text{A}$
	$I_{IN2}$	Open drain ports, Tri-state ports					
	$I_{IN3}$	RESET, STOP					
Input Resistance	$R_{IN1}$	Port P4 with pull-down		30	70	150	k $\Omega$
	$R_{IN2}$	RESET		100	220	450	
Pull-down Resistance	$R_K$	Source open drain ports	$V_{DD} = 5.5\text{ V}, V_{KK} = -30\text{ V}$	–	80	–	
Output Leakage Current	$I_{LO1}$	Sink open drain ports	$V_{DD} = 5.5\text{ V}, V_{OUT} = 5.5\text{ V}$	–	–	2	$\mu\text{A}$
	$I_{LO2}$	Source open drain ports	$V_{DD} = 5.5\text{ V}, V_{OUT} = -32\text{ V}$	–	–	–2	
	$I_{LO3}$	Tri-state ports	$V_{DD} = 5.5\text{ V}, V_{OUT} = 5.5\text{ V} / 0\text{ V}$	–	–	$\pm 2$	
Output High Voltage	$V_{OH2}$	Tri-state ports	$V_{DD} = 4.5\text{ V}, I_{OH} = -0.7\text{ mA}$	4.1	–	–	V
	$V_{OH3}$	P8, P9	$V_{DD} = 4.5\text{ V}, I_{OH} = -5\text{ mA}$	2.4	–	–	
Output Low Voltage	$V_{OL}$	Except XOUT	$V_{DD} = 4.5\text{ V}, I_{OL} = 1.6\text{ mA}$	–	–	0.4	V
Output High current	$I_{OH}$		$V_{DD} = 4.5\text{ V}, V_{OH} = 2.4\text{ V}$	–	–15	–	mA
Supply Current in NORMAL 1, 2 modes	$I_{DD}$		$V_{DD} = 5.5\text{ V}$ $f_c = 8\text{ MHz}$ $f_s = 32.768\text{ kHz}$ $V_{IN} = 5.3\text{ V} / 0.2\text{ V}$	–	12	20	mA
Supply Current in IDLE 1, 2 modes				–	6	10	
Supply Current in SLOW mode			$V_{DD} = 3.0\text{ V}$ $f_s = 32.768\text{ kHz}$ $V_{IN} = 2.8\text{ V} / 0.2\text{ V}$	–	30	60	$\mu\text{A}$
Supply Current in SLEEP mode				–	15	30	
Supply Current in STOP mode			$V_{DD} = 5.5\text{ V}$ $V_{IN} = 5.3\text{ V} / 0.2\text{ V}$	–	0.5	10	$\mu\text{A}$

Note 1: Typical values show those at  $T_{opr} = 25^{\circ}\text{C}$ ,  $V_{DD} = 5\text{ V}$ .

Note 2: Input Current  $I_{IN1}, I_{IN3}$ ; The current through resistor is not included, when the input resistor (pull-up or pull-down) is contained.

Note 3: Typical current consumption during AD conversion is 1.2 mA.

## AD Conversion Characteristics

 $(V_{SS} = 0\text{ V}, V_{DD} = 4.5\text{ to }5.5\text{ V}, T_{opr} = -30\text{ to }70^{\circ}\text{C})$ 

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Analog Input Voltage Range	$V_{CIN}$	CIN5 to CIN0		$V_{SS}$	–	$V_{DD}$	V
Conversion Error			$V_{DD} = 5.0\text{ V}$	–	–	$\pm 1.5$	LSB

AC Characteristics

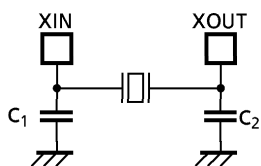
(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 2.7 / 4.5 to 5.5 V, Topr = - 30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t <sub>cy</sub>	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 <sub>WCH</sub>	For external clock operation (XIN input), f <sub>c</sub> = 8 MHz	50	-	-	ns
Low Level Clock Pulse Width	t <sub>WCL</sub>					
High Level Clock Pulse Width	t <sub>WSH</sub>	For external clock operation (XTIN input), f <sub>s</sub> = 32.768 kHz	14.7	-	-	μs
Low Level Clock Pulse Width	t <sub>WSL</sub>					

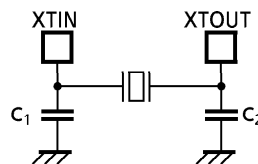
Recommended Oscillating Conditions

(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 2.7 / 4.5 to 5.5 V, Topr = - 30 to 70°C)

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator	Recommended Constant	
				C <sub>1</sub>	C <sub>2</sub>
High-frequency Oscillation	Ceramic Resonator	8 MHz	KYOCERA KBR8.0M	30 pF	30 pF
		4 MHz	KYOCERA KBR4.0MS		
			MURATA CSA4.00MG		
	Crystal Oscillator	Crystal Oscillator	8 MHz	TOYOCOM 210B 8.0000	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: An electrical shield by metal shield plate on the surface of the IC package should be recommendable in order to prevent the device from the high electric fieldstress applied for continuous reliable operation.*

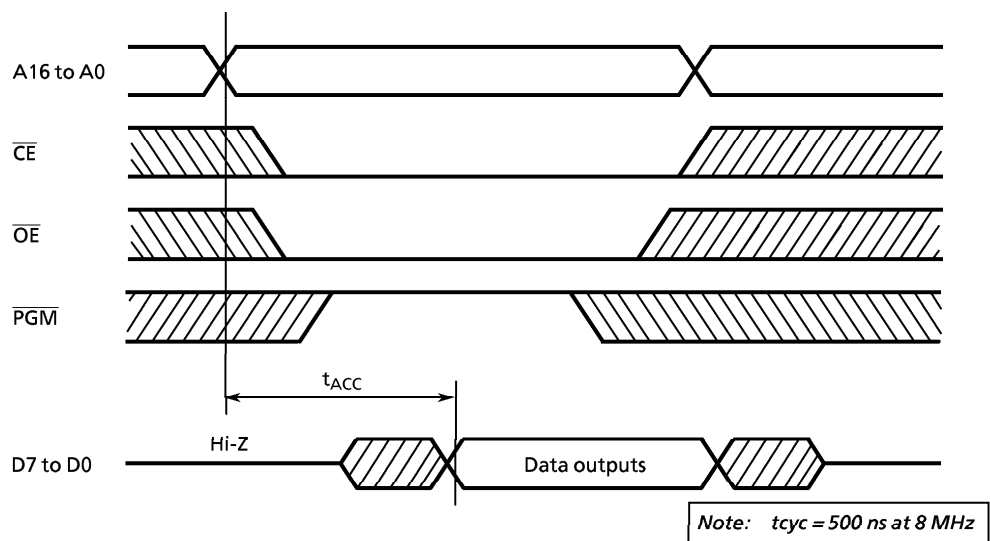


DC/AC Characteristics (PROM mode) ( $V_{SS} = 0\text{ V}$ )

(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	5.0	5.25	V
Program Power Supply Voltage	$V_{PP}$					
Address Access Time	$T_{ACC}$	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5\text{ t}_{cyc} + 300$		ns

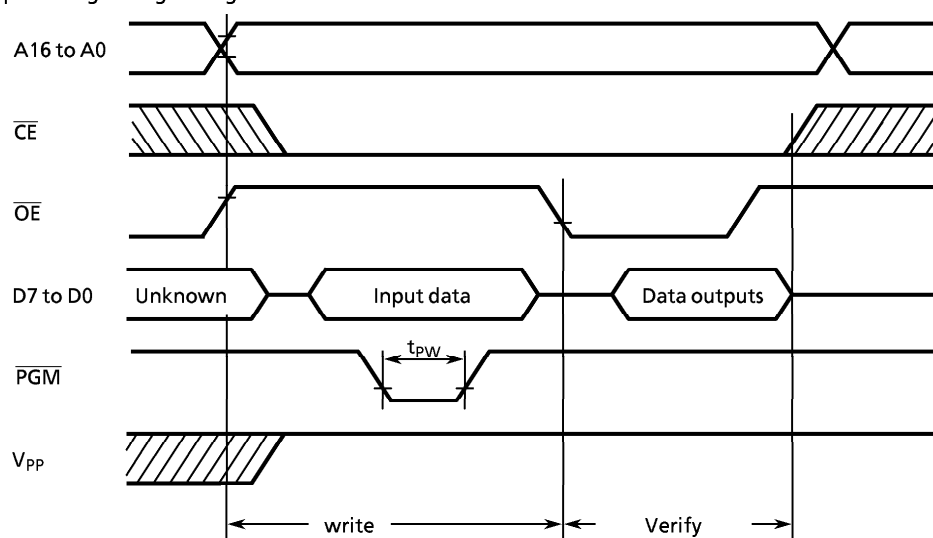
Note:  $t_{cyc} = 500\text{ ns at } 8\text{ MHz}$



(2) Program Operation (High-Speed program mode) ( $T_{opr} = 25 \pm 5^{\circ}\text{C}$ )

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
Power Supply Voltage	$V_{CC}$		6.00	6.25	6.5	V
Program Power Supply Voltage	$V_{PP}$		12.5	12.75	13.0	V
Initial Program Pulse Width	$t_{PW}$	$V_{CC} = 6.25\text{ V}$ $V_{PP} = 12.75 \pm 0.25$	0.095	0.1	0.105	ms

High-Speed Programming Timing



**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 ( $12.5\text{ V} \pm 0.5\text{ V} = V$ ) to the  $V_{PP}$  pin as the device is damaged.

**Note 3:** Do not apply the parameter of program voltage (more than +13 V) including overshoot to the  $V_{PP}$  pin.

**Note 4:** 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.

