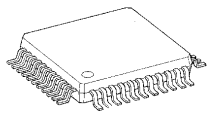
CMOS 8-Bit Microcontroller

TMP86PS44U

The TMP86PS44 is a OTP type MCU which includes 60-Kbyte One-time PROM. It is a pin compatible with a mask ROM product of the TMP86CS44. Writing the program to built-in PROM, the TMP86PS44 operates as the same way as the TMP86CS44. Using the Adapter socket, you can write and verify the data for the TMP86PS44 with a general-purpose PROM programmer same as TC57100D/AD.

Product No.	OTP	RAM	Package	Adapter Socket
TMP86PS44U	60 K × 8 bits	1 K × 8 bits	P-LQFP44-1010-0.80A	BM11187

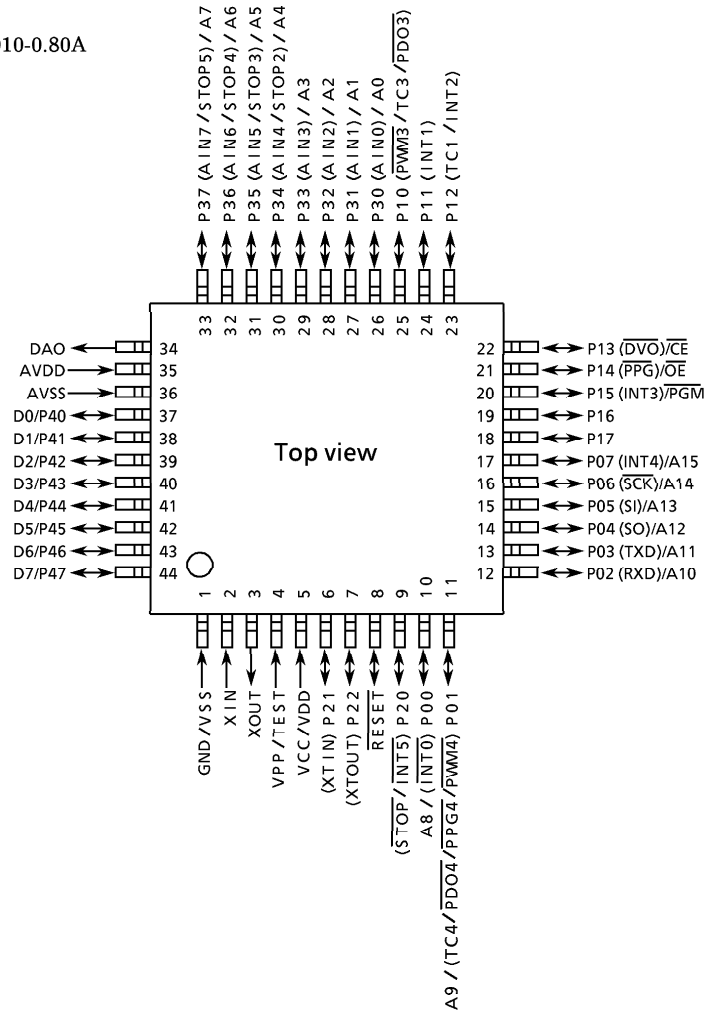
P-LQFP44-1010-0.80A



TMP86PS44U

Pin Assignments (Top View)

P-LQFP44-1010-0.80A



Pin Function

The TMP86PS44 has MCU mode and PROM mode.

(1) MCU mode

In the MCU mode, the TMP86PS44 is a pin compatible with the TMP86CS44 (Make sure to fix the TEST pin to low level).

(2) PROM mode

Pin Name	Input/Output	Functions	Pin Name (MCU mode)
A15 to A8	Input	Input of Memory address for program	P07 to P00
A7 to A0			P37 to P30
D7 to D0	I/O	Input/Output of Memory data for program	P47 to P40
$\overline{CE}$	Input	Chip enable	P13
$\overline{OE}$		Output enable	P14
$\overline{PGM}$		Program control	P15
VPP	Power supply	+ 12.75 V/5 V (Power supply of program)	TEST
VCC, AVDD		+ 6.25 V/5 V	VDD, AVDD
GND, AVSS, DAO		0 V	VSS, AVSS, DAO
P11, P21	I/O	PROM mode setting pin. Fix to high.	
P10, P12, P22, P20		PROM mode setting pin. Fix to low.	
$\overline{RESET}$			
P17, P16	I/O	Open	
XIN	Input	Self oscillation with resonator (8 MHz).	
XOUT	Output		

Note: No pin is applied to A16 input.

Operation

This section describes the functions and basic operational blocks of TMP86PS44.
The TMP86PS44 has PROM in place of the mask ROM which is included in the TMP86CS44. The configuration and function are the same as the TMP86CS44.

1. Operating Mode

The TMP86PS44 has MCU mode and PROM mode.

1.1 MCU Mode

The MCU mode is set by fixing the TEST/VPP pin to the low level.
In the MCU mode, the operation is the same as the TMP86CS44 (TEST/VPP pin cannot be used open because it has no built-in pull-down resistor).

1.1.1 Program memory

The TMP86PS44 has a 60 Kbyte built-in one time PROM (addresses 1000 to $FFFF_H$ in the MCU mode, addresses 0000 to $EFFF_H$ in the PROM mode).
When using TMP86PS44 for evaluation of TMP86CS44, the program is written in the program storing area shown in Figure 1-1.

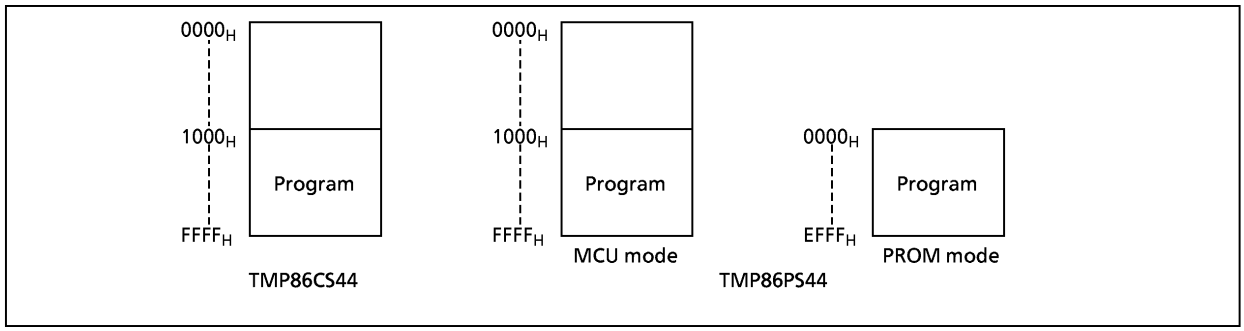


Figure 1-1. Program Memory Area

Note: The area that is not in use should be set data to FFH, or a general-purpose PROM programmer should be set only in the program memory area to access.

1.1.2 Data Memory

TMP86PS44 has a built-in 1 Kyte Data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the TMP86PS44 are the same as those of the TMP86CS44 except that the TEST pin does not have a built-in pull-down resistor.

(2) I/O ports

The I/O circuitries of TMP86PS44 I/O ports are the same as the those of TMP86CS44.

Electrical Characteristics

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

Parameter	Symbol	Pins	Rating	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}		– 0.3 to V_{DD} + 0.3	
Output Current (Per 1 pin)	I_{OUT1}	P1, P3, P4 Port	– 1.8	mA
	I_{OUT2}	P1, P3 Port	3.2	
	I_{OUT3}	P0, P2, P4 Port	30	
Output Current (Total)	ΣI_{OUT1}	P1, P3 Port	60	
	ΣI_{OUT2}	P0, P2, P4 Port	80	
Power Dissipation [T_{opr} = 85°C]	PD		250	mW
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	
Operating Temperature	Topr		– 40 to 85	

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

Parameter	Symbol	Pins	Condition		Min	Max	Unit
Supply Voltage	V_{DD}		fc = 16 MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE0, 1, 2 mode			
			fc = 8 MHz	NORMAL1, 2 mode	2.7		
				IDLE0, 1, 2 mode			
			fc = 4.2 MHz	NORMAL1, 2 mode			
				IDLE0, 1, 2 mode			
			fs = 32.768 kHz	SLOW1, 2 mode			
				SLEEP0, 1, 2 mode			
				STOP mode	2.0		
Input high Level	V_{IH1}	Except Hysteresis input	$V_{DD} \geqq$ 4.5 V		V_{DD} × 0.70	V_{DD}	
	V_{IH2}	Hysteresis input			V_{DD} × 0.75		
	V_{IH3}		V_{DD} < 4.5 V		V_{DD} × 0.90		
Input low Level	V_{IL1}	Except Hysteresis input	$V_{DD} \geqq$ 4.5 V		0	V_{DD} × 0.30	
	V_{IL2}	Hysteresis input				V_{DD} × 0.25	
	V_{IL3}		V_{DD} < 4.5 V			V_{DD} × 0.10	
Clock Frequency	fc	XIN, XOUT	V_{DD} = 2.7 to 5.5 V		1.0	8.0	MHz
			V_{DD} = 4.5 to 5.5 V			16.0	
	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.

DC Characteristics (V_{SS} = 0 V, Topr = – 40 to 85°C)

Parameter	Symbol	Pins	Condition	Min	Typ.	Max	Unit
Hysteresis Voltage	V_{HS}	Hysteresis input		–	0.9	–	V
Input Current	I_{IN1}	TEST	V_{DD} = 5.5 V, V_{IN} = 5.5 V/0 V	–	–	± 2	μA
	I_{IN2}	Sink Open Drain, Tri-state					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Resistance	R_{IN2}	$\overline{RESET}$ Pull-Up		100	220	450	kΩ
Output Leakage Current	I_{LO1}	Sink Open Drain	V_{DD} = 5.5 V, V_{OUT} = 5.5 V	–	–	2	μA
	I_{LO2}	Tri-state	V_{DD} = 5.5 V, V_{OUT} = 5.5 V/0 V	–	–	± 2	
Output High Voltage	V_{OH2}	Tri-state Port	V_{DD} = 4.5 V, I_{OH} = – 0.7 mA	4.1	–	–	V
Output Low Voltage	V_{OL}	Except XOUT and P0, P2, P4 Port	V_{DD} = 4.5 V, I_{OL} = 1.6mA	–	–	0.4	
Output Low Current	I_{OL}	High Current Port (P0, P2, P4 Port)	V_{DD} = 4.5 V, V_{OL} = 1.0 V	–	20	–	mA
Supply Current in NORMAL 1, 2 mode	V_{DD}		V_{DD} = 5.5 V V_{IN} = 5.3/0.2 V fc = 16 MHz fs = 32.768 kHz	–	12.5	14	
Supply Current in IDLE 0, 1, 2 mode				–	6.0	7.0	
Supply Current in SLOW 1 mode			V_{DD} = 3.0 V V_{IN} = 2.8 V/0.2 V fs = 32.768 kHz	–	13	25	μA
Supply Current in SLEEP 1 mode				–	6	16	
Supply Current in SLEEP 0 mode				–	5	14	
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 (I_{IN1}, I_{IN2}); The current through pull-up or pull-down resistor is not included.

Note 3: I_{DD} does not include I_{REF} current.

Note 4: The supply currents of SLOW 2 and SLEEP 2 modes are equivalent to IDLE 0, 1, 2.

AD Conversion Characteristics

(V_{SS} = 0.0 V, 4.5 V ≦ V_{DD} ≦ 5.5 V, Topr = – 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}	$V_{AREF} = A_{VDD} - A_{VSS}$	A_{VDD}	–	A_{VDD}	V
Power Supply Voltage of Analog Control Circuit	A_{VDD}	$A_{VSS} = V_{SS}$	V_{DD}			
Analog Input Voltage	V_{AIN}	$A_{VSS} = V_{SS}$, $A_{VDD} = V_{DD}$	V_{SS}	–	V_{DD}	
Power Supply Current of Analog Reference Voltage	I_{REF}	$V_{DD} = A_{VDD} = 5.5$ V $V_{SS} = A_{VSS} = 0.0$ V	–	0.6	1.0	mA
Non linearity Error		$V_{DD} = A_{VDD} = 5.0$ V, $V_{SS} = A_{VSS} = 0.0$ V	–	–	± 2	LSB
Zero Point Error			–	–	± 2	
Full Scale Error			–	–	± 2	
Total Error			–	–	± 2	

(V_{SS} = 0.0 V, 2.7 V ≦ V_{DD} < 4.5 V, Topr = – 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}	$V_{AREF} = A_{VDD} - A_{VSS}$	A_{VDD}	–	A_{VDD}	V
Power Supply Voltage of Analog Control Circuit	A_{VDD}	$A_{VSS} = V_{SS}$	V_{DD}			
Analog Input Voltage	V_{AIN}	$A_{VSS} = V_{SS}$, $A_{VDD} = V_{DD}$	V_{SS}	–	V_{DD}	
Power Supply Current of Analog Reference Voltage	I_{REF}	$V_{DD} = A_{VDD} = 4.5$ V $V_{SS} = A_{VSS} = 0.0$ V	–	0.5	0.8	mA
Non linearity Error		$V_{DD} = A_{VDD} = 2.7$ V, $V_{SS} = A_{VSS} = 0.0$ V	–	–	± 2	LSB
Zero Point Error			–	–	± 2	
Full Scale Error			–	–	± 2	
Total Error			–	–	± 2	

Note 1: The total error includes all errors except a quantization error, and is defined as a maximum deviation from the ideal conversion line.
Note 2: Conversion time is different in recommended value by power supply voltage.
About conversion time, please refer to Figure 2-64.
Note 3: Please use input voltage to AIN input Pin in limit of V_{AREF} - V_{SS}.
When voltage of range outside is input, conversion value becomes unsettled and gives affect to other channel conversion value.
Note 4: Analog Reference Voltage Range: $\triangle V_{AREF} = A_{VDD} - A_{VSS}$

DA Conversion Characteristics (V_{SS} = 0.0 V, V_{DD} = 4.5 to 5.5 V, Topr = – 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog Reference voltage	A_{VDD}	$A_{VDD} = V_{DD}$	4.5	–	5.5	V
	A_{VSS}	$A_{VSS} = V_{SS}$	V_{SS}	–	V_{SS}	
Resolution			–	–	8	Bits
Linearity Error (Note 1)		$A_{VDD} = V_{DD}$ = 4.5 to 5.5 V $A_{VSS} = V_{SS}$ = 0 V Load conditions 5 pF, 10 MΩ	–	–	± 5	LSB
Settling Time					4	ms
Reference Current (DA Power Dissipation) (Note 2)	I_{DREF}	No load, V_{DD} = 5.5 V, fc = 16 MHz	–	350	500	mA
DAO Output Current (Note 3)	I_{DAO}	$A_{VDD} = V_{DD}$ = 4.5 V $A_{VSS} = V_{SS}$ = 0 V No load 0.5 V bias when inputting 7FH	14	19	–	μA

DA Conversion Characteristics (V_{SS} = 0.0 V, V_{DD} = 2.7 to 4.5 V, Topr = – 40 to 85°C)

Parameter	Symbol	Condition		Min	Typ.	Max	Unit
Analog Reference voltage	A_{VDD}	$A_{VDD} = V_{DD}$		2.7	–	4.5	V
	A_{VSS}	$A_{VSS} = V_{SS}$		V_{SS}	–	V_{SS}	
Resolution				–	–	8	Bits
Linearity Error (Note 1)		$A_{VDD} = V_{DD}$ = 2.7 to 4.5 V $A_{VSS} = V_{SS}$ = 0 V Load conditions 5 pF, 10 MΩ	– 10°C≦Ta≦85°C	–	–	+ 5 – 8	LSB
			– 40°C≦Ta< – 10°C	–	–	+ 5 – 26	
Settling Time						6	ms
Reference Current (DA Power Dissipation) (Note 2)	I_{DREF}	No load, V_{DD} = 2.7 V, fc = 8 MHz		–	200	300	μA
DAO Output Current (Note 3)	I_{DAO}	$A_{VDD} = V_{DD}$ = 2.7 V $A_{VSS} = V_{SS}$ = 0 V No load 0.5 V bias when inputting 7FH		0.4	5.3	–	

Note 1: In linearity error measurements, the first code (00_H, 01_H) and the last code (FE_H, FF_H) are excluded.
Note 2: DA converter power dissipation
Note 3: DAO current drive capability

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

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	tcy	NORMAL 1, 2 mode	0.25	–	4	μs
		IDLE 0, 1, 2 mode				
		SLOW 1, 2 mode	117.6	–	133.3	
		SLEEP 0, 1, 2 mode				
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XIN input) fc = 16 MHz	–	31.25	–	ns
Low Level Clock Pulse Width	t_{WCL}					
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μs
Low Level Clock Pulse Width	t_{WCL}					

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

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	tcy	NORMAL 1, 2 mode	0.5	–	4	μs
		IDLE 0, 1, 2 mode				
		SLOW 1, 2 mode	117.6	–	133.3	
		SLEEP 0, 1, 2 mode				
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XIN input) fc = 8 MHz	–	62.5	–	ns
Low Level Clock Pulse Width	t_{WCL}					
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μs
Low Level Clock Pulse Width	t_{WCL}					

Recommended Oscillating Conditions - 1

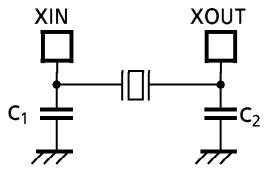
(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, Topr = – 40 to 85°C)

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator		Recommended Constant C_1	Recommended Constant C_2
High-frequency Oscillation	Ceramic Resonator	16 MHz	MURATA	CSA16.00MXZ040	10 pF	10 pF
		8 MHz	MURATA	CSA8.00MTZ	30 pF	30 pF
				CST8.00MTW	30 pF (built-in)	30 pF (built-in)
		4.19 MHz	MURATA	CSA4.19MG	30 pF	30 pF
				CST4.19MGW	30 pF (built-in)	30 pF (built-in)
Low-frequency Oscillation	Crystal Oscillator	32.768 kHz	SII	VT-200	6 pF	6 pF

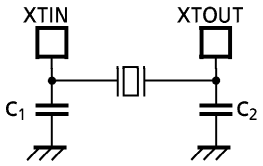
Recommended Oscillating Conditions - 2

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

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator		Recommended Constant C_1	Recommended Constant C_2
High-frequency Oscillation	Ceramic Resonator	8 MHz	MURATA	CSA8.00MTZ	30 pF	30 pF
				CST8.00MTW	30 pF (built-in)	30 pF (built-in)
		4.19 MHz	MURATA	CSA4.19MG	30 pF	30 pF
				CST4.19MGW	30 pF (built-in)	30 pF (built-in)



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

Note 1: An electrical shield by metal shield plate on the surface of IC package is recommended in order to protect the device from the high electric field stress applied from CRT (Cathodic Ray Tube) for continuous reliable operation.

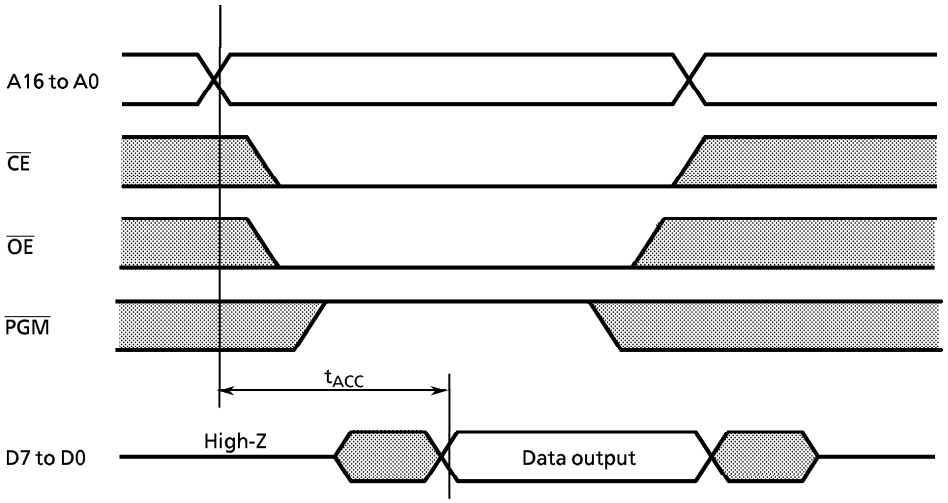
Note 2: The product numbers and specifications of the resonators by Murata Manufacturing Co., Ltd. are subject to change. For up-to-date information, please refer to the following URL;
http://www.murata.co.jp/search/index.html

DC Characteristics, AC Characteristics (PROM Mode) (V_{SS} = 0 V, Topr = – 40 to 85°C)

(1) Read operation in PROM mode

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
High level input voltage (TTL)	V_{IH4}		2.2	–	V_{CC}	V
Low leve input voltage (TTL)	V_{IL4}		0	–	0.8	
Power supply	V_{CC}		4.75	5.0	5.25	
Power supply of program	V_{PP}					
Address access time	t_{ACC}	V_{CC} = 5.0 ± 0.25 V	–	1.5tcyc + 300	–	ns

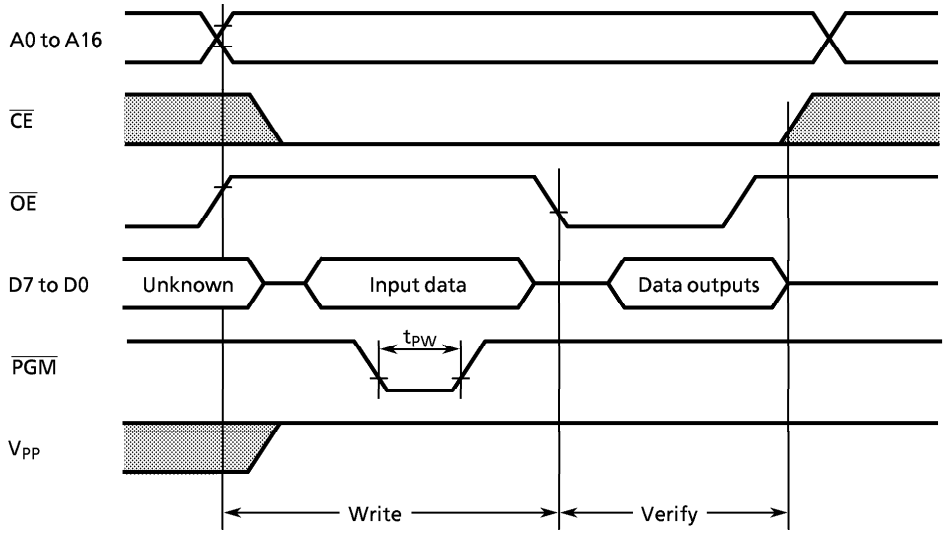
Note: tcyc = 500 ns at 8 MHz



(2) Program operation (High-speed) (Topr = 25 ± 5°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
High level input voltage (TTL)	V_{IH4}		2.2	–	V_{CC}	V
Low leve input voltage (TTL)	V_{IL4}		0	–	0.8	
Power supply	V_{CC}		6.0	6.25	6.5	
Power supply of program	V_{PP}		12.5	12.75	13.0	
Pulse width of initializing program	t_{PW}	V_{CC} = 6.0 V	0.095	0.1	0.105	ms

High-speed program writing



Note 1: The power supply of V_{PP} (12.75 V) must be set power-on at the same time or the later time for a power supply of V_{CC} and must be clear power-on at the same time or early time for a power supply of V_{CC}.

Note2 : The pulling up/down device on the condition of V_{PP} = 12.75 V ± 0.25 V causes a damage for the device. Do not pull up/down at programming.

Note3 : Use the recommended adapter (see 1.2.2 (1)) and mode (see 1.2.2 (3) i).
Using other than the above condition may cause the trouble of the writting.