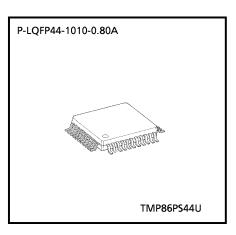
CMOS 8-Bit Microcontroller

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



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.

Quality and Reliability Assurance / Handling Precautions.

TOSHIBA is continually working to improve the quality and 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 comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products 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 TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..

The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk

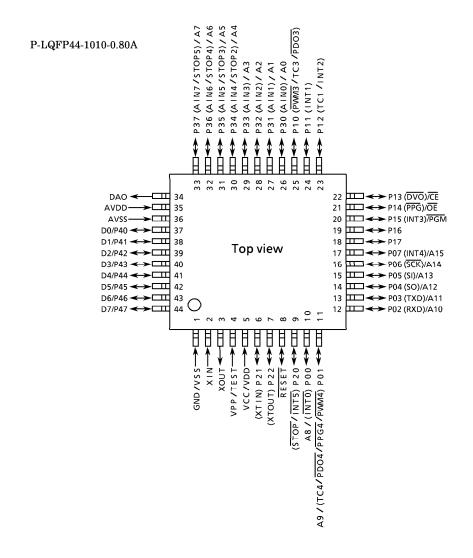
The products described in this document are subject to the foreign exchange and foreign trade laws.

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

86PS44-1 2002-10-31

Pin Assignments (Top View)



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 A7 to A0	Input	Input of Memory address for program	P07 to P00 P37 to P30			
D7 to D0	I/O	Input/Output of Memory data for program	P47 to P40			
CE		Chip enable	P13			
ŌĒ	Input	Output enable	P14			
PGM	1	Program control	P15			
VPP		+ 12.75 V/5 V (Power supply of program)	TEST			
VCC, AVDD	Power supply	+ 6.25 V/5 V	VDD, AVDD			
GND, AVSS, DAO		0 V	VSS, AVSS, DAO			
P11, P21		PROM mode setting pin. Fix to high.				
P10, P12, P22, P20	I/O					
RESET	1	PROM mode setting pin. Fix to low.				
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 $_{\rm H}$ in the MCU mode, addresses 0000 to EFFF $_{\rm H}$ 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.

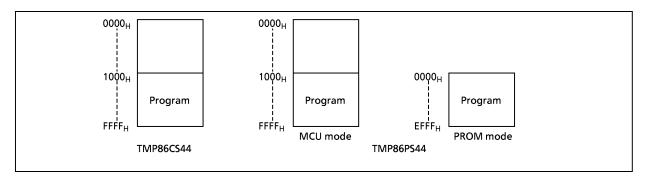


Figure 1-1. Program Memory Area

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.

86PS44-4 2002-10-31

Electrical Characteristics

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

Parameter	Symbol	Pins	Rating	Unit
Supply Voltage	V_{DD}		- 0.3 to 6.5	
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	
	I _{OUT1}	P1, P3, P4 Port	- 1.8	
Output Current (Per 1 pin)	I _{OUT2}	P1, P3 Port	3.2	
	I _{OUT3}	P0, P2, P4 Port	30	mA
Output Compant (Tatal)	Σl _{OUT1}	P1, P3 Port	60	
Output Current (Total)	ΣI _{OUT2}	P0, P2, P4 Port	80	
Power Dissipation [T _{opr} = 85℃]	PD		250	mW
Soldering Temperature (time)	Tsld		260 (10 s)	
Storage Temperature	Tstg		– 55 to 125	°c
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

 $(V_{SS} = 0 \text{ V, Topr} = -40 \text{ to } 85^{\circ}\text{C})$

Parameter	Symbol	Pins	С	ondition	Min	Max	Unit	
				NORMAL1, 2 mode	4.5			
			fc = 16 MHz	IDLE0, 1, 2 mode	4.5			
			C- 0.0411	NORMAL1, 2 mode				
			fc = 8 MHz	IDLE0, 1, 2 mode				
Supply Voltage	V _{DD}			NORMAL1, 2 mode		5.5		
			fc = 4.2 MHz	IDLE0, 1, 2 mode	2.7			
			fs =	SLOW1, 2 mode				
			32.768 kHz	SLEEP0, 1, 2 mode				
				STOP mode	2.0		V	
	V _{IH1}	Except Hysteresis input	V	> 4 E \/	$V_{DD} \times 0.70$] `	
Input high Level	V _{IH2}	Hysteresis input	$V_{DD} \ge 4.5 V$		$V_{DD} \times 0.75$	V_{DD}		
	V _{IH3}		V _D	_{DD} < 4.5 V	$V_{DD} \times 0.90$			
	V _{IL1}	Except Hysteresis input	\/_	_{DD} ≧ 4.5 V		$V_{DD} \times 0.30$		
Input low Level	V_{IL2}	Hysteresis input	v _D	5D ≅ 4.5 V	0	$V_{DD} \times 0.25$		
	V _{IL3}		V _D	_{DD} < 4.5 V		$V_{DD} \times 0.10$		
		VIN VOUT	V _{DD} =	$V_{DD} = 2.7 \text{ to } 5.5 \text{ V}$		8.0	MHz	
Clock Frequency	fc	XIN, XOUT	V _{DD} =	= 4.5 to 5.5 V	1.0	16.0	IVIDZ	
	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

 $(V_{SS} = 0 \text{ V, Topr} = -40 \text{ to } 85^{\circ}\text{C})$

Parameter	Symbol	Pins	Condition	Min	Тур.	Max	Unit
Hysteresis Voltage	V _{HS}	Hysteresis input		-	0.9	_	V
	I _{IN1}	TEST					
Input Current	I _{IN2}	Sink Open Drain, Tri-state	$V_{DD} = 5.5 \text{ V}, V_{IN} = 5.5 \text{ V}/0 \text{ V}$	_	_	± 2	μΑ
	I _{IN3}	RESET, STOP					
Input Resistance	R _{IN2}	RESET Pull-Up		100	220	450	kΩ
Output Leakage	I _{LO1}	Sink Open Drain	$V_{DD} = 5.5 V, V_{OUT} = 5.5 V$	-	-	2	
Current	I _{LO2}	Tri-state	$V_{DD} = 5.5 \text{ V}, V_{OUT} = 5.5 \text{ V}/0 \text{ V}$	_	_	± 2	μΑ
Output High Voltage	V _{OH2}	Tri-state Port	$V_{DD} = 4.5 \text{ V}, I_{OH} = -0.7 \text{ mA}$	4.1	-	-	
Output Low Voltage	V _{OL}	Except XOUT and P0, P2, P4 Port	V _{DD} = 4.5 V, I _{OL} = 1.6mA	-	-	0.4	V
Output Low Current	l _{OL}	High Current Port (P0, P2, P4 Port)	V _{DD} = 4.5 V, V _{OL} = 1.0 V	-	20	-	
Supply Current in NORMAL 1, 2 mode			V _{DD} = 5.5 V V _{IN} = 5.3/0.2 V	-	12.5	14	mA
Supply Current in IDLE 0, 1, 2 mode			fc = 16 MHz fs = 32.768 kHz	-	6.0	7.0	
Supply Current in SLOW 1 mode]			-	13	25	
Supply Current in SLEEP 1 mode	V _{DD}		$V_{DD} = 3.0 \text{ V}$ $V_{IN} = 2.8 \text{ V}/0.2 \text{ V}$ $f_{S} = 32.768 \text{ kHz}$	-	6	16	
Supply Current in SLEEP 0 mode			13 – 32.700 KIIZ	-	5	14	μΑ
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, $V_{DD} = 5 \text{ V}$

Note 2: Input current (I_{IN1} , I_{IN2}); The current through pull-up or pull-down resistor is not included.

Note 3: IDD does not include IREF 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 \leq V_{DD} \leq 5.5 V, Topr = -40 to 85°C)

Parameter	Symbol	Symbol Condition		Тур.	Max	Unit
Analog Reference Voltage	V_{AREF}	V _{AREF} = A _{VDD} - A _{VSS}	A _{VDD}	-	A _{VDD}	
Power Supply Voltage of Analog Control Circuit	A _{VDD}	$A_{VSS} = V_{SS}$		V_{DD}		v
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}	$V_{DD} = A_{VDD} = 5.5 \text{ V}$ $V_{SS} = A_{VSS} = 0.0 \text{ V}$	-	0.6	1.0	mA
Non linearity Error			-	-	± 2	
Zero Point Error		$V_{DD} = A_{VDD} = 5.0 \text{ V},$	-	-	± 2	LSB
Full Scale Error		$V_{SS} = A_{VSS} = 0.0 \text{ V}$	-	-	± 2	135
Total Error			_	-	± 2	

$(V_{SS} = 0.0 \text{ V}, 2.7 \text{ V} \le V_{DD} < 4.5 \text{ V}, \text{Topr} = -40 \text{ to } 85^{\circ}\text{C})$

Parameter	Symbol	Symbol Condition		Тур.	Max	Unit
Analog Reference Voltage	V_{AREF}	V _{AREF} = A _{VDD} - A _{VSS}	A _{VDD}	-	A _{VDD}	
Power Supply Voltage of Analog Control Circuit	A _{VDD}	$A_{VSS} = V_{SS}$	V _{DD}			v
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}	$V_{DD} = A_{VDD} = 4.5 \text{ V}$ $V_{SS} = A_{VSS} = 0.0 \text{ V}$	-	0.5	0.8	mA
Non linearity Error			-	_	± 2	
Zero Point Error		$V_{DD} = A_{VDD} = 2.7 V$,	-	-	± 2	LSB
Full Scale Error		$V_{SS} = A_{VSS} = 0.0 \text{ V}$	-	-	± 2	LJB
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 4: Analog Reference Voltage Range: $\triangle V_{AREF} = A_{VDD} - A_{VSS}$

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.

DA Conversion Characteristics

 $(V_{SS} = 0.0 \text{ V}, V_{DD} = 4.5 \text{ to } 5.5 \text{ V}, \text{ Topr} = -40 \text{ to } 85^{\circ}\text{C})$

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
Analog Reference	A _{VDD}	$A_{VDD} = V_{DD}$	4.5	-	5.5	
voltage	A _{VSS}	$A_{VSS} = V_{SS}$	V _{SS}	_	V _{SS}	V
Resolution			-	-	8	Bits
Linearity Error (Note 1)		$A_{VDD} = V_{DD} = 4.5 \text{ to } 5.5 \text{ V}$ $A_{VSS} = V_{SS} = 0 \text{ V}$ Load conditions 5 pF, 10 M Ω	-	-	± 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}	$A_{VDD} = V_{DD} = 4.5 \text{ V}$ $A_{VSS} = V_{SS} = 0 \text{ V}$ No load 0.5 V bias when inputting 7FH	14	19	-	μΑ

DA Conversion Characteristics

 $(V_{SS} = 0.0 \text{ V}, V_{DD} = 2.7 \text{ to } 4.5 \text{ V}, \text{ Topr} = -40 \text{ to } 85^{\circ}\text{C})$

Parameter	Symbol	Conditio	n	Min	Тур.	Max	Unit
Analog Reference	A _{VDD}	$A_{VDD} = V_{DD}$		2.7	-	4.5	
voltage	A _{VSS}	$A_{VSS} = V_{SS}$		V_{SS}	-	V _{SS}	V
Resolution				-	-	8	Bits
		A -\/ -2.7+a.4.5\/	– 10°C≦Ta≦85°C			+ 5	
Lincovity Cones (Nate 1)		$A_{VDD} = V_{DD} = 2.7 \text{ to } 4.5 \text{ V}$	- 10 C= 1a=65 C	_	_	-8	LSB
Linearity Error (Note 1)		$A_{VSS} = V_{SS} = 0 V$	-40°C≦Ta<-10°C	_	_	+ 5	
		Load conditions 5 pF, 10 M Ω				- 26	
Settling Time						6	ms
Reference Current (DA Power Dissipation) (Note 2)	I _{DREF}	No load, V _{DD} = 2.7 V, fc = 8 MH	No load, V _{DD} = 2.7 V, fc = 8 MHz			300	
DAO Output Current (Note 3)	I _{DAO}	$A_{VDD} = V_{DD} = 2.7 \text{ V}$ $A_{VSS} = V_{SS} = 0 \text{ V}$ No load 0.5 V bias when input	ting 7FH	0.4	5.3	-	μ Α

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

 $(V_{SS} = 0 \text{ V}, V_{DD} = 4.5 \text{ to } 5.5 \text{ V}, Topr = -40 \text{ to } 85^{\circ}\text{C})$

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
		NORMAL 1, 2 mode				
Machine Cycle Time	+0.4	IDLE 0, 1, 2 mode	0.25	_	4	
	tcy	SLOW 1, 2 mode	117.6	_	133.3	μS
		SLEEP 0, 1, 2 mode	117.6			
High Level Clock Pulse Width	t _{WCH}	For external clock operation (XIN input)			-	ns
Low Level Clock Pulse Width	t _{WCL}	fc = 16 MHz	_	31.25		113
High Level Clock Pulse Width	t _{WCH}	For external clock operation (XTIN input)		15.26	-	
Low Level Clock Pulse Width	t _{WCL}	fc = 32.768 kHz	_			μS

$(V_{SS} = 0 \text{ V}, V_{DD} = 2.7 \text{ to } 4.5 \text{ V}, Topr = -40 \text{ to } 85^{\circ}\text{C})$

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
		NORMAL 1, 2 mode			4	
Machine Cycle Time	4	IDLE 0, 1, 2 mode	0.5	_		
	tcy	SLOW 1, 2 mode	117.6	-	133.3	μS
		SLEEP 0, 1, 2 mode	117.6			
High Level Clock Pulse Width	t _{WCH}	For external clock operation (XIN input)				ns
Low Level Clock Pulse Width	t _{WCL}	fc = 8 MHz	_	62.5	_	113
High Level Clock Pulse Width	t _{WCH}	For external clock operation (XTIN input)		45.00	-	c
Low Level Clock Pulse Width	t _{WCL}	fc = 32.768 kHz	-	15.26		μS

Recommended Oscillating Conditions - 1

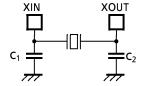
$$(V_{SS} = 0 \text{ V}, V_{DD} = 4.5 \text{ to } 5.5 \text{ V}, \text{ Topr} = -40 \text{ to } 85^{\circ}\text{C})$$

Darameter	Ossillatan	Oscillation	D		Recommended Constant		
Parameter Oscillator		Frequency	Kecom	mended Oscillator	C ₁	C ₂	
		16 MHz	MURATA	CSA16.00MXZ040	10 pF	10 pF	
High fraguency	8 MHz	MURATA	CSA8.00MTZ	30 pF	30 pF		
High-frequency Oscillation	Ceramic Resonator	8 IVITIZ		CST8.00MTW	30 pF (built-in)	30 pF (built-in)	
Oscillation		4.19 MHz	MURATA	CSA4.19MG	30 pF	30 pF	
		4. 19 IVIHZ		CST4.19MGW	30 pF (built-in)	30 pF (built-in)	
Low-frequency	Crystal Oscillator	32.768 kHz	SII	VT-200	6 pF	6 pF	
Oscillation	Crystal Oscillator	32.700 KHZ	311	V 1-200	o pi	o pi	

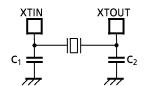
Recommended Oscillating Conditions - 2

$$(V_{SS} = 0 \text{ V}, V_{DD} = 2.7 \text{ to } 5.5 \text{ V}, Topr = -40 \text{ to } 85^{\circ}\text{C})$$

Parameter	Oscillator	Oscillation	Recommended Oscillator		Recommended Constant		
		Frequency			C ₁	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

86PS44-13

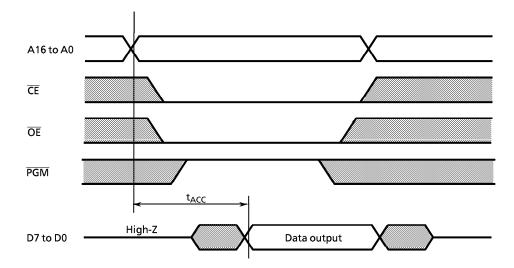
DC Characteristics, AC Characteristics (PROM Mode)

 $(V_{SS} = 0 \text{ V, Topr} = -40 \text{ to } 85^{\circ}\text{C})$

(1) Read operation in PROM mode

Parameter	Symbol	Conditions	Min	Тур.	Max	Unit
High level input voltage (TTL)	V _{IH4}		2.2	-	V _{CC}	
Low leve input voltage (TTL)	V _{IL4}		0	_	0.8	v
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

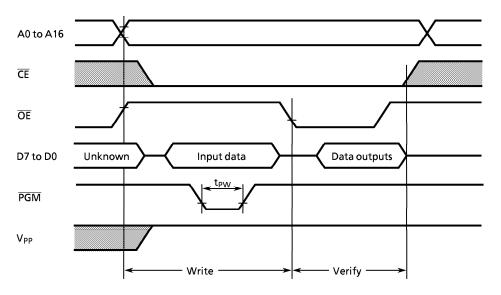
Note: tcyc = 500 ns at 8 MHz



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

Parameter	Symbol	Conditions	Min	Тур.	Max	Unit
High level input voltage (TTL)	V _{IH4}		2.2	_	V _{CC}	
Low leve input voltage (TTL)	V _{IL4}		0	_	0.8	\ ,,
Power supply	V _{CC}		6.0	6.25	6.5	V
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 $V_{PP} = 12.75 \text{ V } \pm 0.25 \text{ V}$ 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.