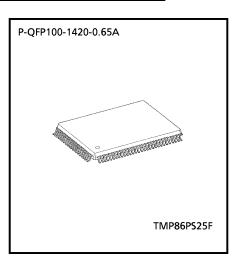
CMOS 8-Bit Microcontroller

TMP86PS25F

The TMP86PS25 is a OTP type MCU which includes 60-Kbyte one-time PROM. It is a pin compatible with a mask ROM product of the TMP86CM25/S25. Writing the program to built-in PROM, the TMP86PS25 operates as the same way as the TMP86CM25/S25. Using the Adapter socket, you can write and verify the data for the TMP86PS25 with a general-purpose PROM programmer same as TC571000D/AD.

Product No.	Product No. OTP		Package	Adapter Socket
TMP86PS25F	60 K × 8 bits	2 K × 8 bits	P-QFP100-1420-0.65A	BM11172



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 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

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. 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

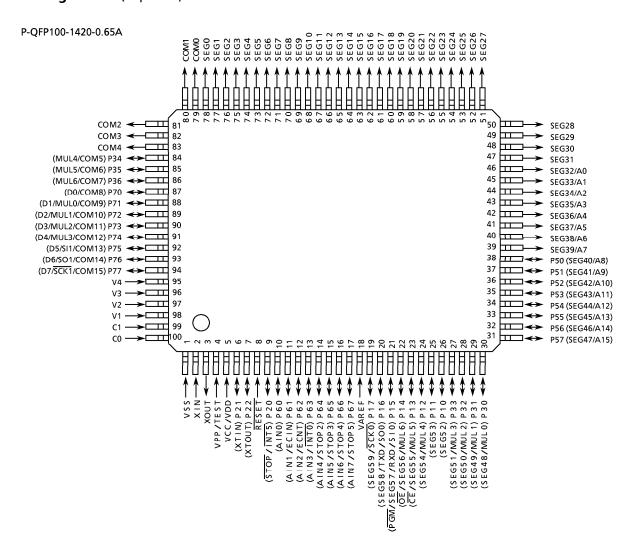
The products described in this document are subject to the foreign exchange and foreign trade laws.

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.

86PS25-1 2002-10-10

Pin Assignments (Top View)



Note: Ports assigned as MUL6 to MUL0 can switch pin assignment by the multifunction register (MULSEL). For functions assigned to each pin, see the table below.

Pin name	Function	Pin assignment
MUL0	DVO	P30 or P71
MUL1	PWM3, PDO3, TC3	P31 or P72
MUL2	PPG4, PWM4, PDO4, TC4	P32 or P73
MUL3	PPG6, PWM6, PDO6, TC6	P33 or P74
MUL4	INT1	P12 or P34
MUL5	INT2	P13 or P35
MUL6	INT3	P14 or P36

Pin Function

The TMP86PS25 has MCU mode and PROM mode.

(1) MCU mode

In the MCU mode, the TMP86PS25 is a pin compatible with the TMP86CM25/S25 (Make sure to fix the TEST pin to low level).

(2) PROM mode

Pin Name	Input/Output	Function	Pin Name (MCU mode)
A15 to A8	Input	Input of Memory address for program	P57 to P50
A7 to A0	mpac	input or memory address for program	SEG39 to SEG32
D7 to D0	I/O	Input/Output of Memory data for program	P77 to P70
CE		Chip enable	P13
ŌĒ	Input	Output enable	P14
PGM		Program control	P15
VPP		+ 12.75 V/5 V (Power supply of program)	TEST
vcc	Power supply	+ 6.25 V/5 V	VDD
GND, VAREF		0 V	VSS, VAREF
P11, P21		PROM mode setting pin. Fix to high.	·
P10, P22, P20, P61	I/O	22014	
RESET		PROM mode setting pin. Fix to low.	
P64, P65, P67	Output	Output pin for PROM operation test. Open or release.	
P17, P16, P12			
P66, P63, P62, P60			
P36 to P30			
COM4 to COM0	I/O	Open	
SEG31 to SEG0			
V4 to V1			
C1, C0			
XIN	Input	Self oscillation with resonator (8 MHz).	
XOUT	Output	Jen oscination with resonator (o Minz).	

Note: No pin is applied to A16 input.

Operation

This section describes the functions and basic operational blocks of TMP86PS25.

The TMP86PS25 has PROM in place of the mask ROM which is included in the TMP86CM25/S25. The configuration and function are the same as the TMP86CM25/S25. For the functions of TMP86PS25 in details, see the section of TMP86CM25/S25.

In addition, TMP86PS25 operates as the single clock mode when releasing reset.

When using the dual clock mode, oscillate a low-frequency clock by SET. XTEN command at the beginning of program.

1. Operating Mode

The TMP86PS25 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 TMP86CM25/S25 (TEST/VPP pin cannot be used open because it has no built-in pull-down resister).

1.1.1 Program Memory

The TMP86PS25 has a 60-Kbyte built-in one time PROM (addresses 1000H to FFFFH in the MCU mode, addresses 0000H to EFFFH in the PROM mode).

When using TMP86PS25 for evaluation of TMP86CM25/S25, the program is written in the program storing area shown in Figure 1-1.

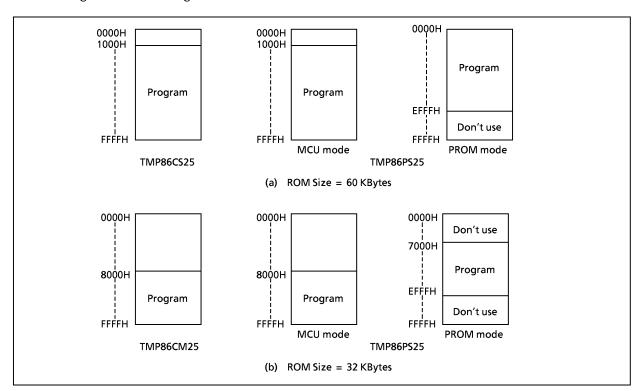


Figure 1-1. Program Memory Area

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.

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	1
	I _{OUT1}	P6 Port	- 1.8	
Output Current (Per 1 pin)	I _{OUT2}	P1, P2, P34 to P36, P5, P6, P7 Port	3.2	
	I _{OUT3}	P30 to P33 Port	30	mA
Output Compant (Tatal)	Σl _{OUT1}	P1, P2, P34 to P36, P5, P6, P7 Port	60	1
Output Current (Total)	ΣI _{OUT2}	P30 to P33 Port	80	1
Power Dissipation [T _{opr} = 85°C]	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10 μ)	
Storage Temperature	Tstg		– 55 to 125	°c
Operating Temperature	Topr		- 40 to 85	1

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.

86PS25-9 2002-10-10

Recommended Operating Condition

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

Parameter	Symbol	Pins	С	ondition	Min	Max	Unit
			6 46 8411	NORMAL1, 2 mode	4.5		
			fc = 16 MHz	IDLE0, 1, 2 mode	4.5		
			6 0 0 0 0 1	NORMAL1, 2 mode	2.7		
			fc = 8 MHz	IDLE0, 1, 2 mode	2.7		
Supply Voltage	V_{DD}			NORMAL1, 2 mode		5.5	
			fc = 4.2 MHz	IDLE0, 1, 2 mode			
			fs =	SLOW1, 2 mode	1.8		
			32.768 kHz	SLEEP0, 1, 2 mode			
				STOP mode			
	V _{IH1}	Except Hysteresis input	$V_{DD} \ge 4.5 V$	V > 4 F.V			
Input high Level	V _{IH2}	Hysteresis input	VDD = 4.3 V		$V_{DD} \times 0.75$	V_{DD}	V
	V _{IH3}		$V_{DD} < 4.5 V$		$V_{DD} \times 0.90$		
	V _{IL1}	Except Hysteresis input	$V_{DD} \ge 4.5 V$			$V_{DD} \times 0.30$	
Input low Level	V _{IL2}	Hysteresis input			0	$V_{DD} \times 0.25$	
	V _{IL3}		$V_{DD} < 4.5 V$			$V_{DD} \times 0.10$	
	V1 _{IN}	V1			1.0	1.375	
LCD reference	V2 _{IN}	V2	LCDCTL1 <ri< td=""><td>EFV > = "1"</td><td>2.0</td><td>2.750</td><td></td></ri<>	EFV > = "1"	2.0	2.750	
voltage range	V3 _{IN}	V3	VDD< V4 (N	ote 2)	3.0	4.125	
	V4 _{IN}	V4			4.0	5.500	
	V4 _{IN}	V4 (Note 3)	LCDCTL1 <ri< td=""><td>EFV>="0"</td><td>-</td><td>VDD</td><td></td></ri<>	EFV>="0"	-	VDD	
			$V_{DD} = 1.8 \text{ to}$	V _{DD} = 1.8 to 5.5 V		4.2	
Clock Frequency	fc	XIN, XOUT	$V_{DD} = 2.7 \text{ to}$	V _{DD} = 2.7 to 5.5 V		8.0	MHz
Clock Frequency			$V_{DD} = 4.5 \text{ to}$	V _{DD} = 4.5 to 5.5 V		16.0	
	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: When LCDCTL1 < REFV > is set to "1", always keep the condition of $V_{DD} < V4$. Note 3: When LCDCTL1 < REFV > is set to "0", always supply the reference voltage from V4 pin.

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	-	٧
	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	μA
	I _{IN3}	RESET, STOP	OP				
Input Resistance	R _{IN2}	RESET Pull-Up		100	220	450	kΩ
Output Leakage Current	I _{LO}	Sink Open Drain, Tri-state	V _{DD} = 5.5 V, V _{OUT} = 5.5 V/0 V	-	-	± 2	μΑ
Output High Voltage	V _{OH2}	Tri-st Port	$V_{DD} = 4.5 \text{ V}, I_{OH} = -0.7 \text{ mA}$	4.1	-	-	
Output Low Voltage	V _{OL}	Except XOUT P30 to P33 Port	$V_{DD} = 4.5 \text{ V}, I_{OL} = 1.6 \text{mA}$	-	-	0.4	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \
Output Low Current	l _{OL}	High Current Port (P30 to P33 Port)	$V_{DD} = 4.5 \text{ V}, V_{OL} = 1.0 \text{ V}$	-	20	-	
Supply Current in NORMAL 1, 2 mode			V _{DD} = 5.5 V V _{IN} = 5.3/0.2 V	-	6.2	9.0	mA
Supply Current in IDLE 0, 1, 2 mode			fc = 16 MHz fs = 32.768 kHz	-	3.7	6.5	
Supply Current in SLOW 1 mode]			-	10	25	
Supply Current in SLEEP 1 mode	V _{DD}		$V_{DD} = 3.0 \text{ V}$ $V_{IN} = 2.8 \text{ V}/0.2 \text{ V}$ $fs = 32.768 \text{ kHz}$	_	4.5	15	
Supply Current in SLEEP 0 mode			LCD driver is not enable.	-	3.5	13	μΑ
Supply Current in STOP mode			$V_{DD} = 5.5 \text{ V}$ $V_{IN} = 5.3 \text{ V}/0.2 \text{ V}$	_	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: 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

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

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
Analog Reference Voltage	V_{AREF}		V _{DD} – 1.5	-	V_{DD}	
Analog Reference Voltage Range (Note 4)	ΔV_{AREF}		3.0	-	-	V
Analog Input Voltage	V _{AIN}		V _{SS}	-	V _{AREF}	
Power Supply Current of Analog Reference Voltage	I _{REF}	$V_{DD} = V_{AREF} = 5.5 \text{ V}$ $V_{SS} = 0.0 \text{ V}$	-	0.6	1.0	mA
Non linearity Error			-	-	± 1	
Zero Point Error		$V_{DD} = 5.0 \text{ V}, V_{SS} = 0.0 \text{ V}$	_	-	± 1	LSB
Full Scale Error		V _{AREF} = 5.0 V	_	-	± 1] [36
Total Error			_	-	± 2	

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

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
Analog Reference Voltage	V _{AREF}		V _{DD} – 1.5	-	V _{DD}	
Analog Reference Voltage Range (Note 4)	ΔV_{AREF}		2.5	-	-	\ \ \
Analog Input Voltage	V _{AIN}		V _{SS}	-	V _{AREF}	
Power Supply Current of Analog Reference Voltage	I _{REF}	$V_{DD} = V_{AREF} = 4.5 \text{ V}$ $V_{SS} = 0.0 \text{ V}$	-	0.5	0.8	mA
Non linearity Error			_	-	± 1	
Zero Point Error		$V_{DD} = 2.7 \text{ V}, V_{SS} = 0.0 \text{ V}$	_	-	± 1	LSB
Full Scale Error		$V_{DD} = 2.7 \text{ V}, V_{SS} = 0.0 \text{ V}$ $V_{AREF} = 2.7 \text{ V}$	_	-	± 1	LOB
Total Error			_	-	± 2	

(V_{SS} = 0.0 V, 2.0 V \leq V_{DD} < 2.7 V, Topr = -40 to 85°C) Note 5 (V_{SS} = 0.0 V, 1.8 V \leq V_{DD} < 2.0 V, Topr = -10 to 85°C) Note 5

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
Analog Reference Voltage	V _{AREF}		V _{DD} - 0.9	-	V _{DD}	
Analog Reference Voltage Range (Note 4)	ΔV_{AREF}	$1.8 \text{ V} \le \text{V}_{DD} < 2.0 \text{ V}$	1.8	_	_	V
Analog Reference Voltage Range (Note 4)	△ V AREF	$2.0 \text{ V} \le \text{V}_{DD} < 2.7 \text{ V}$	2.0	-	_] '
Analog Input Voltage	V _{AIN}		V _{SS}	-	V _{AREF}	
Power Supply Current of Analog Reference Voltage	I _{REF}	$V_{DD} = V_{AREF} = 2.7 V$ $V_{SS} = 0.0 V$	-	0.3	0.5	mA
Non linearity Error			_	-	± 2	
Zero Point Error		$V_{DD} = 1.8 \text{ V}, V_{SS} = 0.0 \text{ V}$	_	-	± 2	LSB
Full Scale Error		V _{AREF} = 1.8 V	_	-	± 2	136
Total Error			_	-	± 4	

- Note 1: The total error includes all errors except a quantization error, and is defined as 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 "2.11.2 Register Configuration".
- 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: $\Delta V_{AREF} = V_{AREF} V_{SS}$
- Note 5: When AD is used with $V_{DD} < 2.7 V$, the guaranteed temperature range varies with the operating voltage.

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			Τ	
Machine Cycle Time	+0.4	IDLE 0, 1, 2 mode	0.25	_	4	
	tcy	SLOW 1, 2 mode	447.6	-	133.3	μS
		SLEEP 0, 1, 2 mode	117.6			
High Level Clock Pulse Width	twcH	For external clock operation (XIN input)				ns
Low Level Clock Pulse Width	twcL	fc = 16 MHz	_	31.25	_	113
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input)		45.00	-	
Low Level Clock Pulse Width	twcL	fc = 32.768 kHz	_	15.26		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	+0.4	IDLE 0, 1, 2 mode	0.5			
	tcy	SLOW 1, 2 mode	447.6	-	133.3	μS
		SLEEP 0, 1, 2 mode	117.6			
High Level Clock Pulse Width	twcH	For external clock operation (XIN input)				ns
Low Level Clock Pulse Width	twcL	fc = 8 MHz	_	62.5	-	115
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input)		45.00		
Low Level Clock Pulse Width	twcL	fc = 32.768 kHz	_	15.26	1	μS

$(V_{SS} = 0 \text{ V}, V_{DD} = 1.8 \text{ to } 2.7 \text{ V}, Topr = -40 \text{ to } 85^{\circ}\text{C})$

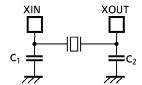
Parameter	Symbol	Condition	Min	Тур.	Max	Unit
		NORMAL 1, 2 mode		-		
Machine Cycle Time	tov	IDLE 0, 1, 2 mode	0.95		4	_ ا
	tcy	SLOW 1, 2 mode	117.6		133.3	μS
		SLEEP 0, 1, 2 mode	117.6			
High Level Clock Pulse Width	twcH	For external clock operation (XIN input)				ns
Low Level Clock Pulse Width	twcL	fc = 4.2 MHz	_	119.05	_	''3
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input)		45.26		
Low Level Clock Pulse Width	twcL	fc = 32.768 kHz	ı	15.26	ı	μS

Timer Counter 1 input (ECIN) Characteristics $(V_{SS} = 0 \text{ V}, \text{Topr} = -40 \text{ to } 85^{\circ}\text{C})$

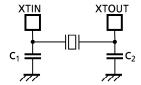
Parameter	Symbol	Condition	Min	Тур.	Max	Unit		
TC1 input (ECIN input)	t _{TC1}	Frequency measurement mode $V_{DD} = 4.5$ to 5.5 V	Single edge count	-	-	1.0		
		Frequency measurement mode $V_{DD} = 2.7 \text{ to } 4.5 \text{ V}$	Single edge count	-	-	0.5	MHz	
		Frequency measurement mode $V_{DD} = 1.8 \text{ to } 2.7 \text{ V}$	Single edge count	ı	-	0.262		

86PS25-13 2002-10-10

Recommended Oscillating Conditions



(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: TOYAMA MURATA MFG. CO., LTD. (JAPAN)

These product numbers and the corresponding specifications are subject to change.

For up-to-date information, please refer to the following URL;

http://www.murata.co.jp/search/index.html

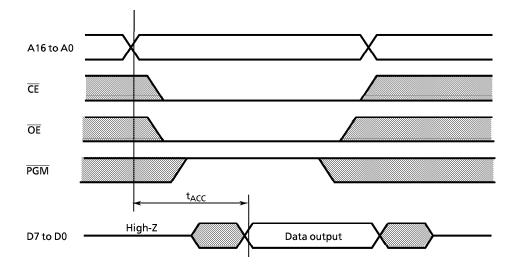
DC Characteristics, AC Characteristics (PROM Mode)

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

(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]
Power supply	V _{CC}		4.75	5.0	5.25	V
Power supply of program	V_{PP}		4.73			
Address access time	t _{ACC}	V _{CC} = 5.0 ± 0.25 V	-	1.5tcyc + 300	-	ns

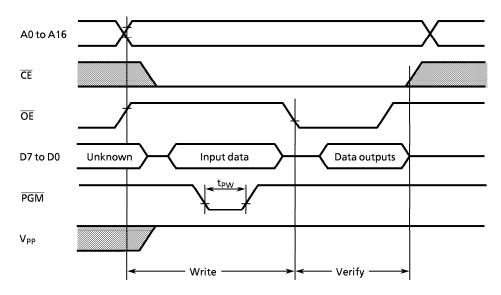
Note: tcyc = 500 ns at 8 MHz



(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.