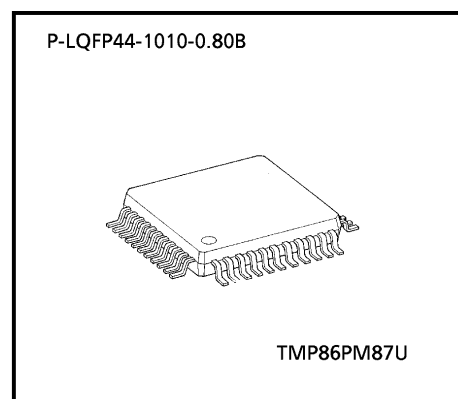


CMOS 8-Bit Microcontroller

TMP86PM87U

The TMP86PM87 is a high-speed, high-performance 8-bit single chip microcomputer, which has 32 K bits One-Time PROM. The TMP86PM87 is pin compatible with the TMP86CH87/M87. The operations possible with the TMP86CH87/M87 can be performed by writing programs to PROM. The TMP86PM87 can write and verify in the same way as the TC571000D/AD using an adapter socket and a general-purpose PROM programmer.

Product No.	OTP	RAM	Package	Adapter socket
TMP86PM87U	32 K x 8 bits	1 K x 8 bits	P-LQFP44-1010-0.80B	BM11187

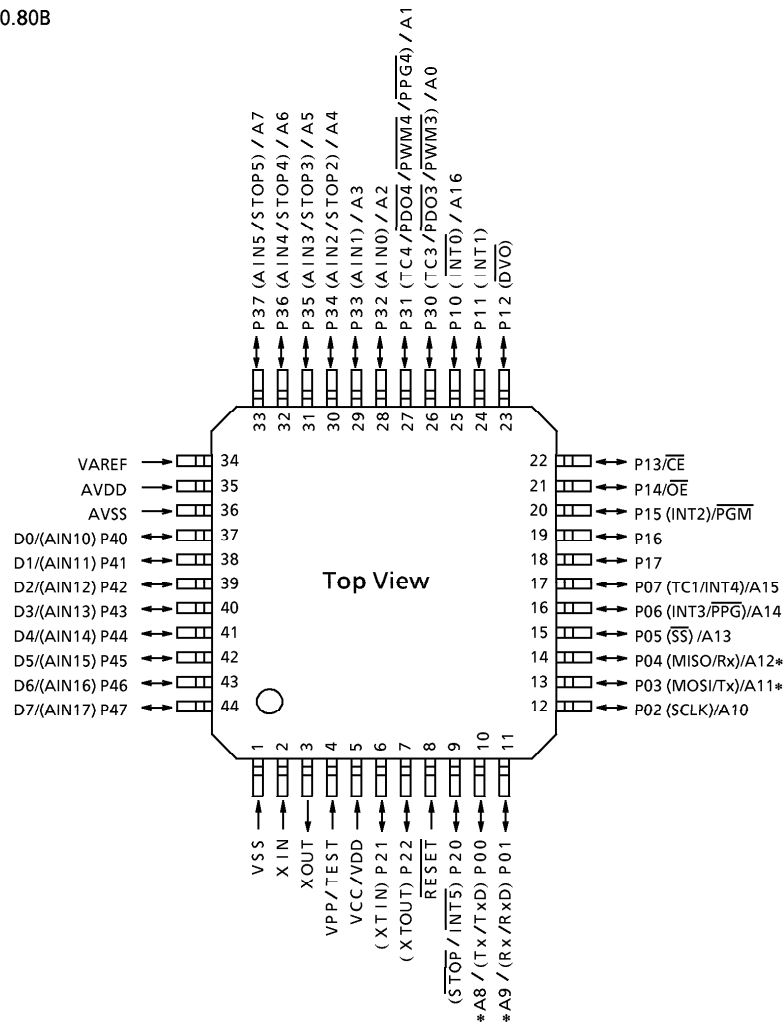


000707EBA1

- 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 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.

Pin Assignments (Top View)

P-LQFP44-1010-0.80B



* The CAN transmit/receive pins have their connected ports changed depending on how the Multifunction Register (MULSEL) is set.

Pin Function

The TMP86PM87 has two modes: MCU and PROM.

(1) MCU mode

In the MCU mode, the TMP86PM87 is a pin compatible with the TMP86CH87/M87 (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A16	Input	Program memory address inputs	P10
A15 to A8			P07 to P00
A7 to A0			P37 to P30
D7 to D0	I/O	Program memory data input/outputs	P47 to P40
\overline{CE}	Input	Chip enable signal input	P13
\overline{OE}		Output enable signal input	P14
\overline{PGM}		Program mode signal input	P15
VPP	Power supply	+ 12.75 V/5 V (Power supply volatge)	TEST
VCC, AVDD		+ 6.25 V/5 V	VDD
GND, VAREF, AVSS		0 V	VSS, VAREF
P11, P21	I/O	PROM mode setting pins. Be fixed at high level.	
P12, P20, P22		PROM mode setting pins. Be fixed at low level.	
RESET			
P16, P17	I/O	Open	
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		

Operational Description

The configuration and function of the TMP86PM87 are the same as those of the TMP86CH87/M87, except in that a one-time PROM is used instead of an on-chip mask ROM.

1. Operating Mode

The TMP86PM87 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 TMP86CH87/M87 (TEST/VPP pin cannot be used open because it has no built in pull-down resistance.)

1.1.1 Program Memory

The TMP86PM87 have an 32 Kbytes (addresses 8000 to FFFF_H in the MCU mode, addresses 0000 to 7FFF_H in the PROM mode) one-time PROM.

When the TMP86PM87 is used as a system evaluation of the TMP86CH87/M87, the data is written to the program storage area shown in Figure 1-1.

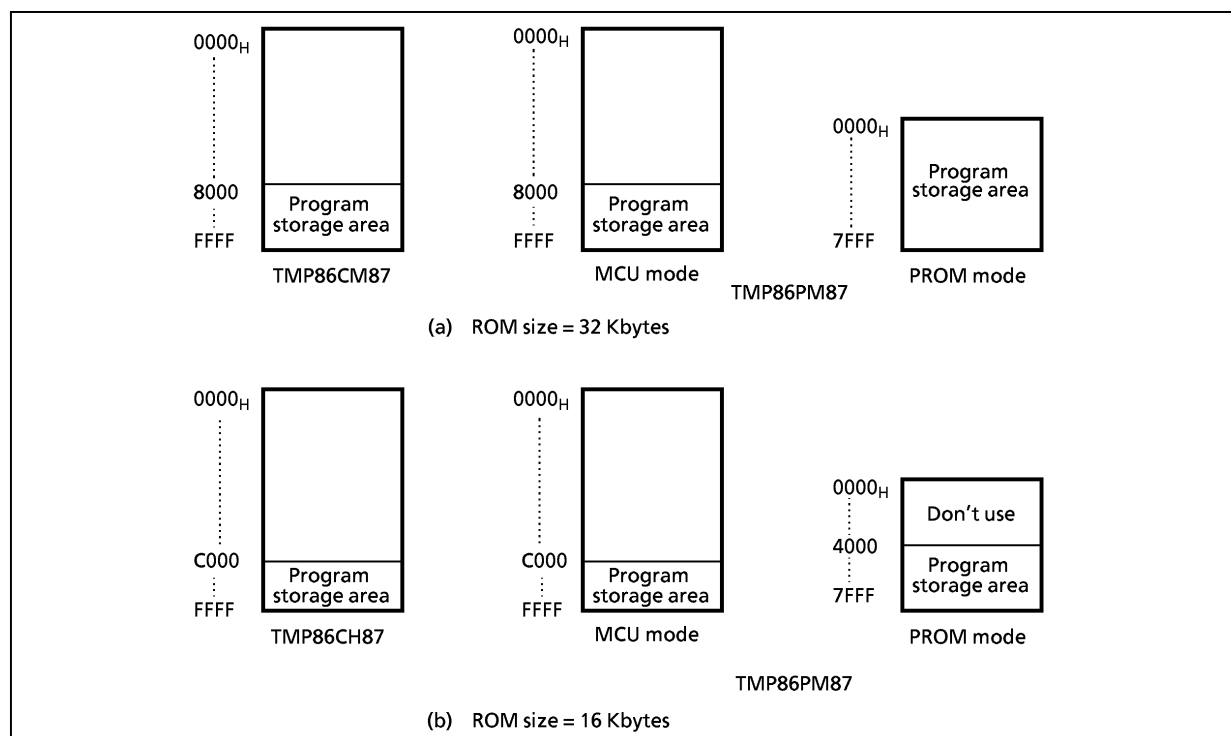


Figure 1-1. Program Memory Area

Note: Either write the data FF_H to the unused area or set the general-purpose PROM programmer to access only the program storage area

Electrical Characteristics

Absolute Maximum Ratings

(V_{SS} = 0 V)

Parameter	Symbol	Pins	Rating	Unit
Supply Voltage	V _{DD}		- 0.3 to 6.5	V
Input Voltage	V _{IN}		- 0.3 to V _{DD} + 0.3	
Output Voltage	V _{OUT1}	P21, P22, $\overline{\text{RESET}}$, Tri-state Port	- 0.3 to V _{DD} + 0.3	
	V _{OUT2}	P20, Sink Open Drain Port	- 0.3 to 5.5	mA
Output Current (Per 1 pin)	I _{OUT1} I _{OH}	P0, P1, P3, P4 Port	- 1.8	
	I _{OUT2} I _{OL}	P1, P2, P3, P4 Port	3.2	
	I _{OUT3} I _{OL}	P0 Port	30	
Output Current (Total)	Σ I _{OUT1}	P0, P1, P3, P4 Port	- 30	
	Σ I _{OUT2}	P1, P2, P3, P4 Port	60	
	Σ I _{OUT3}	P0 Port	80	
Power Dissipation [T _{opr} = 85°C]	PD		350	mW
Soldering Temperature (time)	T _{sld}		260 (10 s)	°C
Storage Temperature	T _{stg}		- 55 to 150	
Operating Temperature	T _{opr}		- 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, T_{opr} = - 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			
				IDLE0, 1, 2 mode			
			fs = 32.768 kHz	SLOW1, 2 mode			
SLEEP0, 1, 2 mode							
STOP mode							
Input high Level	V _{IH1}	Except Hysteresis input	V _{DD} ≥ 4.5 V	V _{DD} × 0.70	V _{DD}		
	V _{IH2}	Hysteresis input		V _{DD} × 0.75			
	V _{IH3}			V _{DD} × 0.90			
Input low Level	V _{IL1}	Except Hysteresis input	V _{DD} ≥ 4.5 V	0	V _{DD} × 0.30		
	V _{IL2}	Hysteresis input		V _{DD} × 0.25			
	V _{IL3}			V _{DD} × 0.10			
Clock Frequency	fc	XIN, XOUT	V _{DD} = 4.5 to 5.5 V	1.0	16.0	MHz	
	fs	XTIN, XTOUT	V _{DD} = 4.5 to 5.5 V	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 Standard (tentatively Standard)

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 Port					
	I _{IN3}	RESET, STOP					
Input Resistance	R _{IN}	RESET Pull-Up		100	220	450	kΩ
Output Leakage Current	I _{LO}	Sink Open Drain, Tri-state Port	V _{DD} = 5.5 V, V _{OUT} = 5.5 V/0 V	-	-	± 2	μA
Output High Voltage	V _{OH2}	P0, P1, P3, P4 Port	V _{DD} = 4.5 V, I _{OH} = -0.7 mA	4.1	-	-	V
Output Low Voltage	V _{OL}	P1, P2, P3, P4 Port	V _{DD} = 4.5 V, I _{OL} = 1.6 mA	-	-	0.4	
Output Low Current	I _{OL}	High Current Port (P0 Port)	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 V _{IN} = 5.3/0.2 V f _c = 16.0 MHz f _s = 32.768 kHz When using CAN controller	-	10	15	
Supply Current in IDLE 1, 2 mode				-	8	12	
Supply Current in NORMAL 1, 2 mode				-	7.5	9	
Supply Current in IDLE 0, 1, 2 mode			-	5.5	6.5		
Supply Current in SLOW 1 mode			-	15	35		
Supply Current in SLEEP 1 mode			V _{DD} = 5.5 V V _{IN} = 5.3 V/0.2 V f _s = 32.768 kHz	-	7	25	
Supply Current in SLEEP 0 mode				-	6	25	
Supply Current in STOP mode				V _{DD} = 5.5 V V _{IN} = 5.3 V/0.2 V	-	0.5	

Note 1: Typical values show those at Topr = 25°C, V_{DD} = 5 V

Note 2: Input current (I_{IN1}, I_{IN3}); 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 power supply current in STOP2 and SLEEP2 modes each are the same as in IDLE0, 1, and 2 modes.

Note 5: The supply current in NORMAL 1, 2 and IDLE 1, 2 modes varies with use/non-use of the CAN controller.

AD Conversion Characteristics

(V_{SS} = 0.0 V, 4.5 V ≤ V_{DD} ≤ 5.5 V, T_{opr} = -40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog Reference Voltage	V _{AREF}		A _{VDD} - 1.0	-	A _{VDD}	V
Power Supply Voltage of Analog Control Circuit	A _{VDD}		V _{DD}			
	A _{VSS}		V _{SS}			
Analog Reference Voltage Range (Note 4)	ΔV _{AREF}	V _{AREF} - A _{VSS}	3.5	-	-	
Analog Input Voltage	V _{AIN}		A _{VSS}	-	V _{AREF}	
Power Supply Current of Analog Reference Voltage	I _{REF}	V _{DD} = A _{VDD} = V _{AREF} = 5.5 V V _{SS} = A _{VSS} = 0.0 V	-	0.6	1.0	mA
Non linearity		V _{DD} = A _{VDD} = 5.0 V, V _{AREF} = 5.0 V, 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 "2.11.2 Register Configuration".

Note 3: Please use input voltage to AIN input Pin in limit of V_{AREF} - A_{VSS}.
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: ΔV_{AREF} = V_{AREF} - A_{VSS}

SEI Operating Conditions (Slave mode) (V_{SS} = 0.0 V, 4.5 V ≤ V_{DD} ≤ 5.5 V, T_{opr} = -40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Transfer Rate			15.625 k	-	fc/4	bps

AC Characteristics

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

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	twcH	For external clock operation (XIN input)	25	-	-	ns
Low Level Clock Pulse Width	twcL	fc = 16 MHz				
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input)	14.7	-	-	μs
Low Level Clock Pulse Width	twcL	fs = 32.768 kHz				

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

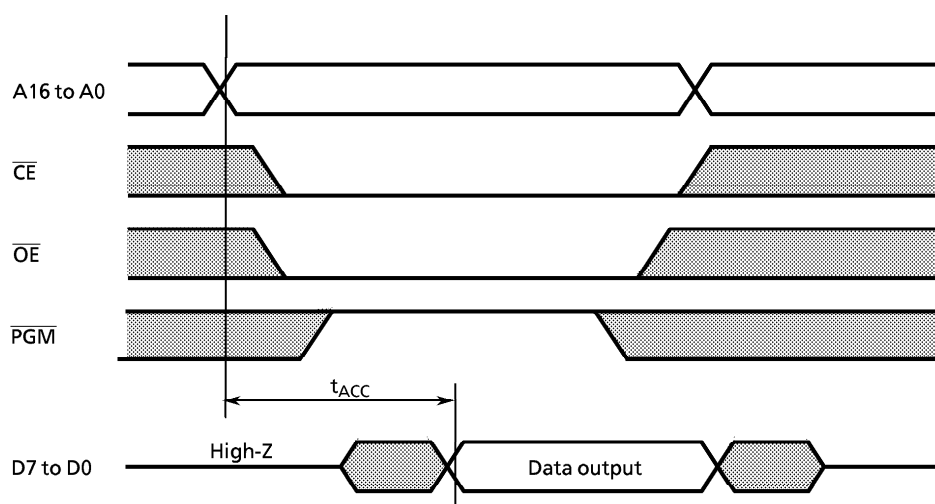
Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	tcy	NORMAL 1, 2 mode	0.5	-	4	μs
		IDLE 0, 1, 2 mode				
		SLOW 1, 2 mode	117.6	-	133.3	
		SLEEP 0, 1, 2 mode				
High Level Clock Pulse Width	twcH	For external clock operation (XIN input)	50	-	-	ns
Low Level Clock Pulse Width	twcL	fc = 8 MHz				
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input)	14.7	-	-	μs
Low Level Clock Pulse Width	twcL	fs = 32.768 kHz				

DC Characteristics, AC Characteristics (PROM mode) ($V_{SS} = 0\text{ V}$, $T_{opr} = -40\text{ to }85^\circ\text{C}$)

(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 level 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}	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5\text{ }t_{cyc} + 300$	–	ns

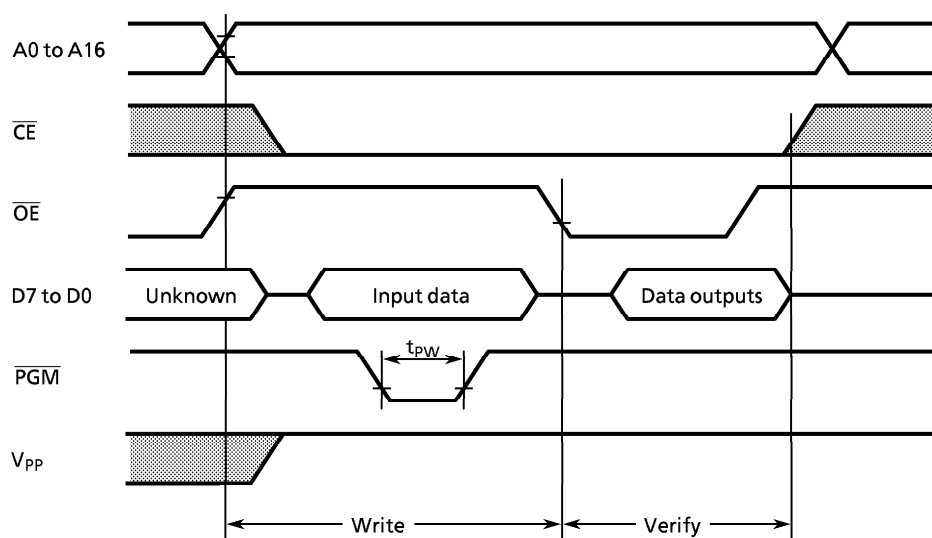
Note: $t_{cyc} = 500\text{ ns}$ at 8 MHz



(2) Program operation (High-speed) ($T_{opr} = 25 \pm 5^\circ\text{C}$)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
High level input voltage (TTL)	V_{IH4}		2.2	–	V_{CC}	V
Low level 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}	$V_{CC} = 6.0\text{ V}$	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} .

Note 2: 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.

Note 3: 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 writing.