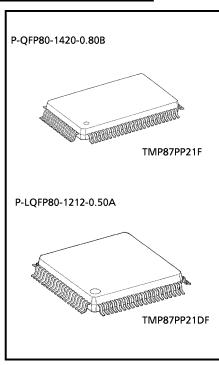
CMOS 8-Bit Microcontroller

# TMP87PP21F TMP87PP21DF

The TMP87PP21 is a One-Time PROM microcontroller with low-power 48 K x 8 bits electrically programmable read only memory for the TMP87CH21C/M21C/P21C system evaluation. The TMP87PP21 is pin compatible with the TMP87CH21C/M21C/P21C. The operations possible with the TMP87CH21C/M21C/P21C can be performed by writing programs to PROM. The TMP87PP21 can write and verify in the same way as the TC571000D using an adaptor socket BM11104/BM11105 and an EPROM programmer.

Product No.	OTP	RAM	Package	OTP Adapter
TMP87PP21F	40 K 0 h i + a	2 K 0 la ita	P-QFP80-1420-0.80B	BM11104
TMP87PP21DF	48 K × 8 bits	2 K × 8 bits	P-LQFP80-1212-0.50A	BM11105



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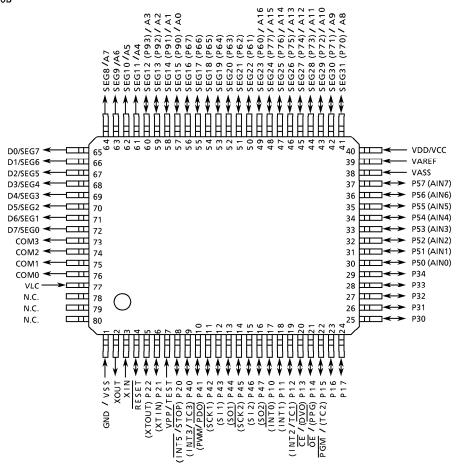
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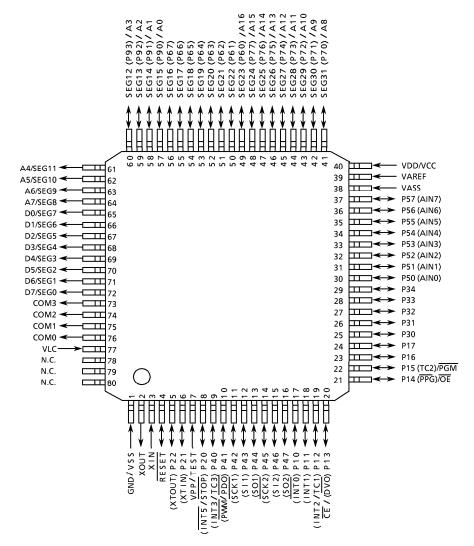
## Pin Assignments (Top View)

P-QFP80-1420-0.80B



Note: Always keep N.C. pins open.

P-LQFP80-1212-0.50A



Note: Always keep N.C. pins open.

## **Pin Functions**

The TMP87PP21 has two modes: MCU and PROM.

(1) MCU mode
In this mode, the TMP87PP21 is pin compatible with the TMP87CH21C/M21C/P21C (fix the TEST pin at low level.)

## (2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)		
A16			P60		
A15 to A8	Input	PROM address inputs	P77 to P70		
A7 to A0		PROM address inputs  PROM data input/outputs  Chip enable signal input (active low)  Output enable signal input (active low)  Program mode signal input  + 12.75 V/5 V (Program supply voltage)  + 6.25 V/5 V  O V  Pull-up with resistance for input processing.  PROM mode setting pin. Be fixed at high level  PROM mode setting pin. Be fixed at low level.  Connect an 8 MHz oscillator to stabilize the interpretation of the process of the proces	SEG8 to 11, P93 to P90		
D7 to D0	1/0	PROM data input/outputs	SEG0 to SEG7		
CE		Chip enable signal input (active low)	P13		
ŌĒ	Input	Output enable signal input (active low)	P14		
PGM		Program mode signal input	P15		
VPP		+ 12.75 V/5 V (Program supply voltage)	TEST		
vcc	Power supply	+ 6.25 V/5 V	VDD		
GND		0 V	VSS		
P37 to P32, P30					
P47 to P40					
P57 to P50		Pull-up with resistance for input processing.			
P67 to P62					
P11					
P21	I/O				
P31		PROM mode setting pin. Be fixed at high level.			
P61					
P17, P16, P12, P10 P22, P20					
RESET		PROM mode setting pin. Be fixed at low level.			
XIN	Input				
XOUT	Output	Connect an 8 MHz oscillator to stabilize the inter	rnal state.		
VAREF					
VASS	Power supply	0 V (GND)			
COM3 to COM0	Output				
VLC	LCD driver Power supply	Open			

## **Operational Description**

The following explains the TMP87PP21 hardware configuration and operation. The configuration and functions of the TMP87PP21 are the same as those of the TMP87CH21C/M21C/P21C, except in that a one-time PROM is used instead of an on-chip mask ROM.

The TMP87PP21 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 TMP87PP21 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 TMP87CH21C/M21C/P21C (the TEST/VPP pin cannot be used open because it has no built-in pull-down resistance).

## 1.1.1 Program Memory

The TMP87PP21 has a  $48K \times 8$  bits (addresses  $4000_H$  to FFFF<sub>H</sub> in the MCU mode, addresses  $14000_H$  to 1FFFF<sub>H</sub> in the PROM mode) of program memory (OTP).

When the TMP87PP21 is used as a system evaluation of the TMP87CH21C/M21C/P21C, the data is written to the program storage area shown in Figure 1-1.

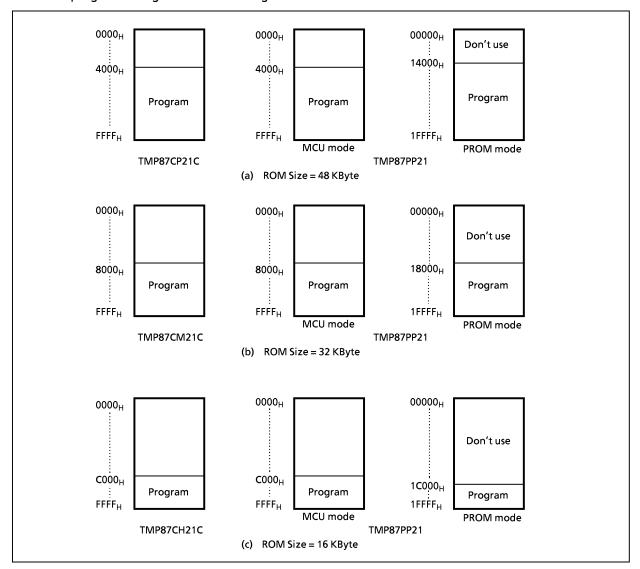


Figure 1-1. Program Storage Area

Note: Either write the data  $FF_H$  to the unused area or set the PROM programmer to access only the program storage area.

## 1.1.2 Data Memory

The TMP87PP21 has an on-chip 2 K  $\times$  8 bits data memory (static RAM).

# **Electrical Characteristics**

Absolute Maximum Ratings

 $(V_{SS} = 0 V)$ 

Parameter	Symbol	Pins	Ratings	Unit
Supply Voltage	$V_{DD}$		- 0.3 to 6.5	
Program Voltage	$V_{PP}$	TEST/V <sub>PP</sub>	- 0.3 to 13.0	l
Input Voltage	V <sub>IN</sub>		- 0.3 to V <sub>DD</sub> + 0.3	\ \
Output Voltage	V <sub>OUT</sub>		- 0.3 to V <sub>DD</sub> + 0.3	
Output Current (Per 1 pin)	I <sub>OUT1</sub>	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	3.2	
	I <sub>OUT2</sub>	P41	30	
Output Current (Total)	Σ l <sub>OUT1</sub>	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	120	mA
	Σ I <sub>OUT2</sub>	P41	30	
Power Dissipation [Topr = 70°C]	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10 s)	
Storage Temperature	Tstg		– 55 to 125	°c
Operating Temperature	Topr		- 30 to 70	]

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** 

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

Parameter	Symbol	Pins		Conditions	Min	Max	Unit
			f- 0.0411-	NORMAL1, 2 mode	4.5		
			fc = 8 MHz	IDLE1, 2 mode	4.5		
			f- 4.2 NALL-	NORMAL1, 2 mode			
Supply Voltage	$V_{DD}$		fc = 4.2 MHz	IDLE1, 2 mode	3.7	5.5	
			fs =	SLOW mode	2.7		
			32.768 kHz	SLEEP mode			
	V Event hysteresis in			STOP mode	2.0		
	V <sub>IH1</sub>	Except hysteresis input	V <sub>DD</sub> ≧ 4.5 V		V <sub>DD</sub> × 0.70		٧
Input High Voltage	V <sub>IH2</sub>	Hysteresis input			V <sub>DD</sub> × 0.75	V <sub>DD</sub>	
	V <sub>IH3</sub>		V	<sub>DD</sub> <4.5 V	V <sub>DD</sub> × 0.90		
	V <sub>IL1</sub>	Except hysteresis input		> 1 = 1/		$V_{DD} \times 0.30$	
Input Low Voltage	$V_{IL2}$	Hysteresis input	\ 	<sub>DD</sub> ≧ 4.5 V	0	$V_{DD} \times 0.25$	
	$V_{IL3}$	V <sub>IL3</sub> V <sub>DD</sub> <		<sub>DD</sub> <4.5 V		$V_{DD} \times 0.10$	
	fc	f- VIN YOUT		V <sub>DD</sub> = 4.5 to 5.5 V		8.0	MHz
Clock Frequency	١,	XIN, XOUT	$V_{DD} = 2.7 \text{ to } 5.5 \text{ V}$		0.4	4.2	IVITZ
Input Low Voltage	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: Clock frequency fc: Supply voltage range is specified in NORMAL1/2 mode and IDLE1/2 mode.

**DC Characteristics** 

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

Parameter	Symbol	Pins	Conditions	Min	Тур.	Max	Unit
Hysteresis Voltage	$V_{HS}$	Hysteresis inputs		_	0.9	_	٧
	I <sub>IN1</sub>	TEST					
Input Current	I <sub>IN2</sub>	Open drain ports and tri-state ports	V <sub>DD</sub> = 5.5 V, V <sub>IN</sub> = 5.5 V/0 V	_	_	± 2	μΑ
	I <sub>IN3</sub>	RESET, STOP					
Input Low Current	I <sub>IL</sub>	Push-pull ports	$V_{DD} = 5.5 \text{ V}, V_{IN} = 0.4 \text{ V}$	_	_	- 2	mA
Input Resistance	R <sub>IN2</sub>	RESET		100	220	450	kΩ
Output Leakage Current	I <sub>LO</sub>	Open drain ports Tri-state ports	$V_{DD} = 5.5 \text{ V}, V_{OUT} = 5.5 \text{ V}$	_	_	2	μA
Output High Voltage	V <sub>OH1</sub>	Push-pull ports P4 ports	$V_{DD} = 4.5 \text{ V}, I_{OH} = -200 \ \mu\text{A}$	2.4	_	_	
Output High voltage	V <sub>OH2</sub>	Tri- state ports P1, P5 ports	$V_{DD} = 4.5 \text{ V}, I_{OH} = -0.7 \text{ mA}$	4.1	_	_	v
Output Low Voltage	V <sub>OL</sub>	Except XOUT and P41	$V_{DD} = 4.5 \text{ V}, I_{OL} = 1.6 \text{ mA}$	_	_	0.4	
Output Low Current	I <sub>OL3</sub>	P41	V <sub>DD</sub> = 4.5 V, V <sub>OL</sub> = 1.0 V	_	20	_	
Supply Current in NORMAL 1 , 2 mode			V <sub>DD</sub> = 5.5 V fc = 8 MHz	_	12	18	mA
Supply Current in IDLE 1, 2 mode			fs = 32.768 kHz V <sub>IN</sub> = 5.3 V/0.2 V	_	6	10	
Supply Current in SLOW mode	I <sub>DD</sub>		V <sub>DD</sub> = 3.0 V fs = 32.768 kHz V <sub>IN</sub> = 2.8 V/0.2 V LCD driver is not enable	_	30	60	
Supply Current in SLEEP mode				_	15	30	μΑ
Supply Current in STOP mode			V <sub>DD</sub> = 5.5 V V <sub>IN</sub> = 5.3 V/0.2 V	_	0.5	10	
Segment Output Low Resistance	R <sub>OS1</sub>	SEG31 to SEG0			20		
Common Output Low Resistance	R <sub>OC1</sub>	COM3 to COM0		_	20	_	
Segment Output High Resistance	R <sub>OS2</sub>	SEG31 to SEG0	V <sub>DD</sub> = 5 V		200		kΩ
Common Output High Resistance	R <sub>OC2</sub>	COM3 to COM0	$V_{DD} - V_{LC} = 3 V$	_	200	_	_
	V <sub>O 2/3</sub>		1	3.8	4.0	4.2	
Segment/Common Output Voltage	V <sub>O 1/2</sub>	SEG31 to SEG0 and COM3 to COM0		3.3	3.5	3.7	
- Lipat Follage	V <sub>O 1/3</sub>			2.8	3.0	3.2	

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

Note 2: Input Current; The current through pull-up or pull-down resistor is not included.

Note 3: IDD: Except for IREF

Note 4: Output resistors Ros, Roc indicate "on" when switching levels.

Note 5:  $V_{O2/3}$  indicates an output voltage at the 2/3 level when operating in the 1/4 or 1/3 duty mode.

Note 6:  $V_{O1/2}$  indicates an output voltage at the 1/2 level when operating in the 1/2 duty or static mode.

Note 7:  $V_{O1/3}$  indicates an output voltage at the 1/3 level when operating in the 1/4 or 1/3 duty mode.

Note 8: When using LCD, it is necessary to consider values of Ros1/2 and Roc1/2.

Note 9: Times for SEG/COM output switching on: Ros1, Roc1: 26/fc, 2/fs (s)

Ros2, Roc2: 1/(n, f<sub>F</sub>)

(1/n: duty,  $f_F$ : frame frequency)

## **AD Conversion Characteristics**

 $(V_{SS} = 0 \text{ V}, V_{DD} = 2.7 \text{ to } 5.5 \text{ V}, Topr = -30 \text{ to } 70^{\circ}\text{C})$ 

Parameter	Symbol	Conditions	Min	Тур.	Max	Unit
Analan Bafaran sa Valta sa	V <sub>AREF</sub>	V > 25V	2.7	_	$V_{DD}$	
Analog Reference Voltage	V <sub>ASS</sub>	$V_{AREF} - V_{ASS} \ge 2.5 V$	V <sub>SS</sub>	_	1.5	V
Analog Input Voltage	$V_{AIN}$		V <sub>ASS</sub>	_	V <sub>AREF</sub>	
Analog Supply Current	I <sub>REF</sub>	$V_{AREF} = 5.5 \text{ V}, \ V_{ASS} = 0.0 \text{ V}$	-	0.5	1.0	mA
Nonlinearity Error		$V_{DD} = 5.0 \text{ V}, V_{SS} = 0.0 \text{ V}$	_	_	± 1	
Zero Point Error		V <sub>AREF</sub> = 5.000 V V <sub>ASS</sub> = 0.000 V	_	_	± 1	
Full Scale Error		or $V_{DD} = 2.7 \text{ V}, V_{SS} = 0.0 \text{ V}$	_	_	± 1	LSB
Total Error		V <sub>AREF</sub> = 2.700 V V <sub>ASS</sub> = 0.000 V	_	_	± 2	

Note: Quantizing error is not contained in those errors.

## AC Characteristics - 1

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

Parameter	Symbol	Conditions	Min	Тур.	Max	Unit
		In NORMAL 1, 2 mode	٥٦		10	
Machine Cycle Time	Ι.	In IDLE 1, 2 mode	0.5	_	10	_
	t <sub>cy</sub>	In SLOW mode	117.6	_	133.3	$\mu$ S
		In SLEEP mode	117.6			
High Level Clock Pulse Width	t <sub>WCH</sub>	For external clock operation	60.5			
Low Level Clock Pulse Width	t <sub>WCL</sub>	(XIN input), fc = 8 MHz	62.5	_	_	ns
High Level Clock Pulse Width	t <sub>WSH</sub>	For external clock operation	14.7			
Low Level Clock Pulse Width	t <sub>WSL</sub>	(XTIN input), fs = 32.768 kHz	14.7	I	-	μS

# AC Characteristics - 2

 $(V_{SS} = 0 \text{ V}, V_{DD} = 2.7 \text{ to } 5.5 \text{ V}, Topr = -30 \text{ to } 70^{\circ}\text{C})$ 

Parameter	Symbol	Conditions	Min	Тур.	Max	Unit
		In NORMAL 1, 2 mode	0.05		10	
Machine Cycle Time	t <sub>cy</sub>	In IDLE 1, 2 mode	0.95	_		μ\$
		In SLOW mode	117.6		133.3	
		In SLEEP mode	117.6	_		133.3
High Level Clock Pulse Width	t <sub>WCH</sub>	For external clock operation	440			
Low Level Clock Pulse Width	t <sub>WCL</sub>	(XIN input), fc = 4.2 MHz	110	_	_	ns
High Level Clock Pulse Width	t <sub>WSH</sub>	For external clock operation	14.7			
Low Level Clock Pulse Width	t <sub>WSL</sub>	(XTIN input), fs = 32.768 kHz	14.7	_	_	$\mu$ S

## **Recomended Oscillating Condition-1**

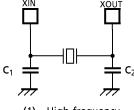
 $(VSS = 0 \text{ V}, \text{ VDD} = 4.5 \text{ to } 5.5 \text{ V}, \text{ Topr} = -30 \text{ to } 70^{\circ}\text{C})$ 

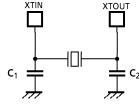
Parameter	Osillator	Frequency	Recommender	Oscillator	Recomn Cond		
					C <sub>1</sub>	C <sub>2</sub>	
			KYOCERA	KBR8.0M	30 pF	30 pF	
			Standard/Lead Type	CSA8.00MTZ	built-in	built-in	
			(MURATA)	CST8.00MTW	30 pF	30 pF	
	Ceramic Resonator	8 MHz	Standard/SMP Type	CSAC8.00MT	30 pF	30 pF	
		0101112	(MURATA)		30 pr		
High-frequency			Standard/Small ChipType	CSTC8.00MT	built-in	built-in	
riigh-frequency			(MURATA)		30 pF	30 pF	
		4 MHz	KYOCERA	KBR4.0MS	30 pF	30 pF	
		8 MHz	тоуосом	210B 8.0000			
Crystal Oscillator	4 MHz	тоуосом	204B 4.0000	20 pF	20 pF		
Low-frequency	Crystal Oscillator	32.768 kHz	NDK	MX-38T	15 pF	15 pF	

# **Recomended Oscillating Condition-2**

$$(VSS = 0 \text{ V}, VDD = 2.7 \text{ to } 5.5 \text{ V}, Topr = -30 \text{ to } 70^{\circ}\text{C})$$

Parameter	Osillator	Frequency	Recommender Oscillator		Recomm Cond	
					C <sub>1</sub>	C <sub>2</sub>
			Standard/Lead Type	CSA4.00MG	30 pF	30 pF
			(MURATA)	CST4.00MGW	built-in 30 pF	built-in 30 pF
High-frequency	Ceramic Resonator	4 MHz	Standard/SMD Type (MURATA)	CSA4.00MGC CSAC4.00MGCM	30 pF	30 pF
				CSTC4.00MG	built-in	built-in
					30 pF	30 pF
			Standard/Small Chin Type	CSTCS 4 DONAC	built-in	built-in
			Standard/Small Chip Type	C31C34.00IVIG	10 pF	10 pF





(1) High-frequency

(2) Low-frequency

Note1: When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

Note2: 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

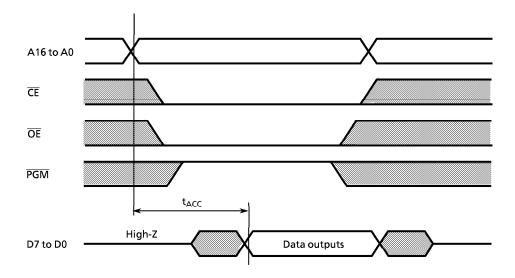
DC/AC Characteristics (PROM mode)

 $(V_{SS} = 0 V)$ 

# (1) Read Operation

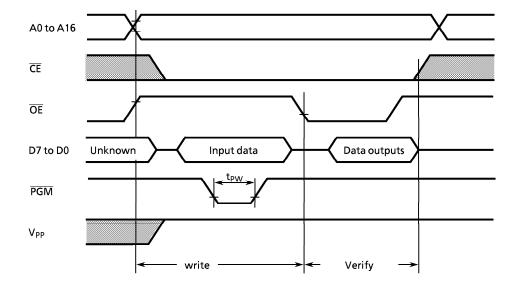
Parameter	Symbol	Conditions	Min	Тур.	Max	Unit
Input High Voltage	V <sub>IH4</sub>		V <sub>CC</sub> × 0.7	_	V <sub>CC</sub>	
Input Low Voltage	V <sub>IL4</sub>		0	_	$V_{CC} \times 0.12$	v
Power Supply Voltage	V <sub>CC</sub>		4.75	5.0	5.25	V
Program Power Supply Voltage	$V_{PP}$		4.75	5.0	5.25	
Address Access Time	t <sub>ACC</sub>	V <sub>CC</sub> = 5.0 ± 0.25 V	_	1.5 tcyc + 300	_	ns

Note: tcyc = 500 ns at 8 MHz



## (2) High-Speed Programming Operation

Parameter	Symbol	Conditions	Min	Тур.	Max	Unit
Input High Voltage	V <sub>IH4</sub>		V <sub>CC</sub> × 0.7	-	V <sub>CC</sub>	
Input Low Voltage	V <sub>IL4</sub>		0	ı	V <sub>CC</sub> × 0.12	v
Power Supply Voltage	V <sub>CC</sub>		6.0	6.25	6.5	\ \ \
Program Power Supply Voltage	V <sub>PP</sub>		12.5	12.75	13.0	
Initial Program Pulse Width	t <sub>PW</sub>	V <sub>CC</sub> = 6.0 V	0.095	0.1	0.105	ms



Note1: 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 increased.

Note2: The device must not be set to the EPROM programmer or picked op from it under applying the program voltage (12.75 V  $\pm$  0.25 V = V) to the  $V_{pp}$  pin as the device is damaged.

Note3: Be sure to execute the recommended programing mode with the recommended programing adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.