

## CMOS 8-Bit Microcontroller

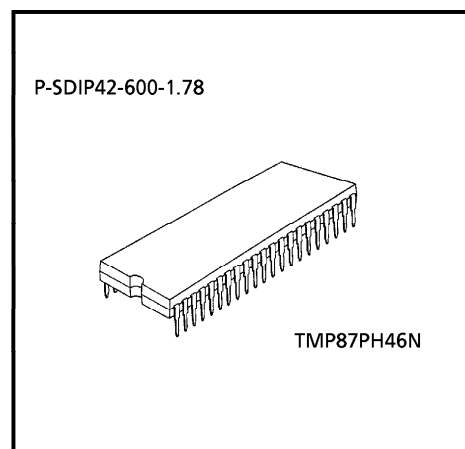
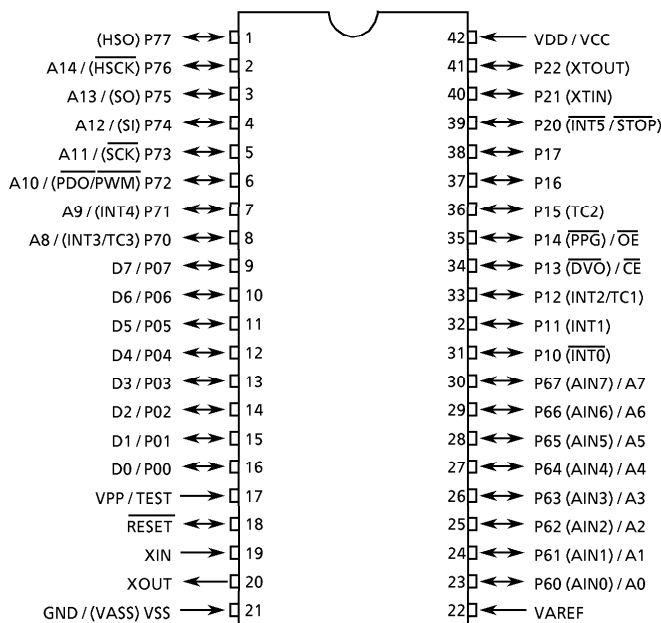
## TMP87PH46N

The 87PH46 is a One-Time PROM microcontroller with low-power 128 K bits (16 Kbytes) electrically programmable read only memory for the 87C446/846/H46 system evaluation. The 87PH46 is pin compatible with the 87C446/846/H46. The operations possible with the 87C446/846/H46 can be performed by writing programs to PROM. The 87PH46 can write and verify in the same way as the TMM27256AD using an adaptor socket BM1193 and an EPROM programmer.

Part No	OTP	RAM	Package	Adaptor socket
TMP87PH46N	16 K × 8-bit	512 × 8-bit	P-SDIP42-600-1.78	BM1193

## Pin Assignments (Top View)

P-SDIP42-600-1.78



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## Pin Function

The 87PH46 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PH46 is pin compatible with the 87C446/846/H46L (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A14 to A8	Input	PROM address inputs	P76 to P70
A7 to A0			P67 to P60
D7 to D0	I/O	PROM data input/outputs	P07 to P00
CE	Input	Chip enable signal input (active low)	P13
OE		Output enable signal input (active low)	P14
VPP	Power supply	+ 12.5 V / 5 V (Program supply voltage)	TEST
VCC		+ 5 V	VDD
GND		0 V	VSS
P11	I/O	PROM mode setting pins. Be fixed at high level.	
P21			
P77			
P12 , P10		PROM mode setting pins. Be fixed at low level.	
P17 to P15			
P22 , P20			
RESET			
XIN	Input	Connect an 8MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power Supply	0 V (GND)	
VASS			

## Operational Description

The following explains the 87PH46 hardware configuration and operation. The configuration and functions of the 87PH46 are the same as those of the 87C446/846/H46, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PH46 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 87PH46 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 87C446/846/H46 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

##### 1.1.1 Program Memory

The 87PH46 has a 16 K × 8-bit (addresses C000<sub>H</sub> to FFFF<sub>H</sub> in the MCU mode, addresses 4000<sub>H</sub> to 7FFF<sub>H</sub> in the PROM mode) of program memory (OTP).

To use the PH46 as the system evaluation for the 87C446/846/H46, the program should be written to the program memory area as shown in Figure 1-1.

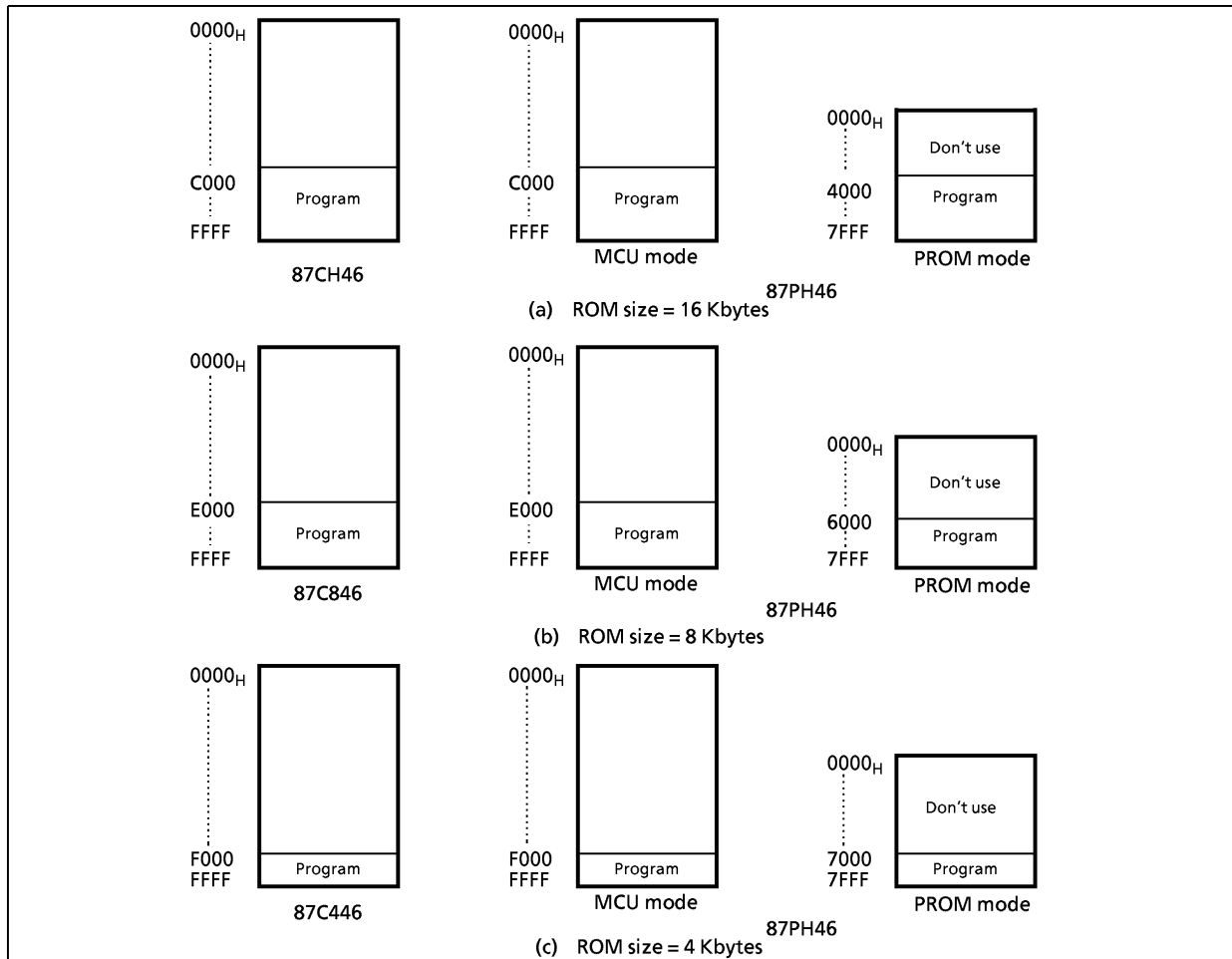


Figure 1-1. Program Memory Area

*Note:* Either write the data FF<sub>H</sub> to the unused area or set the PROM programmer to access only the program storage area.

### 1.1.2 Data Memory

The 87PH46 has an on-chip 512 × 8-bit data memory (static RAM).

### 1.1.3 Input/Output Circuitry

#### (1) Control pins

The control pins of the 87PH46 is the same as those of the 87C446/846/H46 except that the TEST pin has no built-in pull-down resistance.

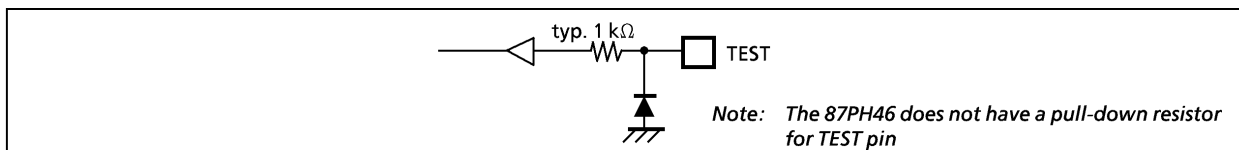


Figure 1-2. TEST Pin

#### (2) I/O ports

The I/O circuitries of 87PH46 I/O ports the are the same as the code A type I/O circuitries of the 87C446/846/H46.

## 1.2 PROM Mode

The PROM mode is activated by setting the TEST,  $\overline{\text{RESET}}$  pin and the ports P17-P10, P22-P20 and P77 as shown in Figure 1-3. The PROM mode is used to write and verify programs with a general-purpose PROM programmer. The high-speed programming mode can be used for program operation.

The 87PH46 is not supported an *electric signature mode*, so the ROM type must be set to TC57256AD. Set the adaptor socket switch to "N".

**Note:** Please set the high-speed programming mode according to each manual of PROM programmer.

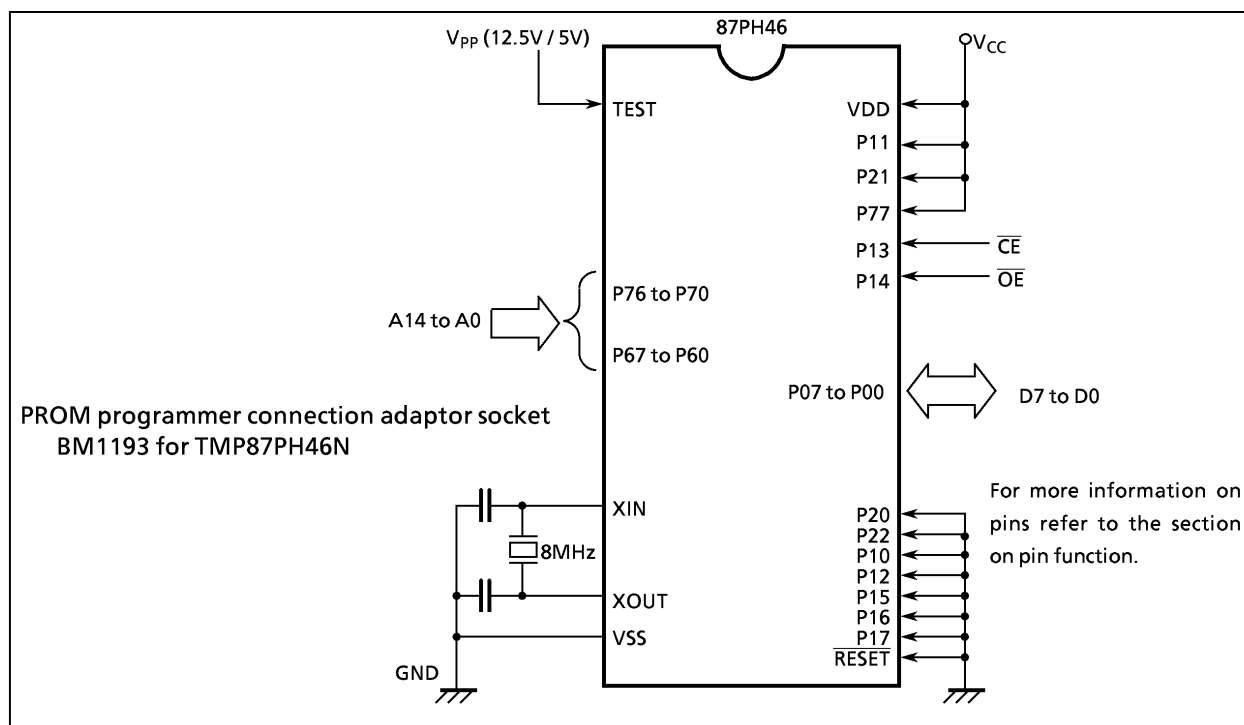


Figure 1-3. Setting for PROM Mode

### 1.2.1 Programming Flowchart (High-speed Programming Mode-I)

The high-speed programming mode is achieved by applying the program voltage (+ 12.5 V) to the Vpp pin when Vcc = 6 V. After the address and input data are stable, the data is programmed by applying a single 1ms program pulse to the  $\overline{CE}$  input. The programmed data is verified. If incorrect, another 1ms program pulse is applied and then the programmed data is verified. This process should be repeated (up to 25 times) until the program operates correctly. Programming for one address is ended by applying additional program pulse with width 3 times that needed for initial programming (number of programmed times  $\times$  1 ms). After that, change the address and input data, and program as before. When programming has been completed, the data in all addresses should be verified with Vcc = Vpp = 5 V. When programming has been completed, the data in all addresses should be verified with Vcc = Vpp = 5 V.

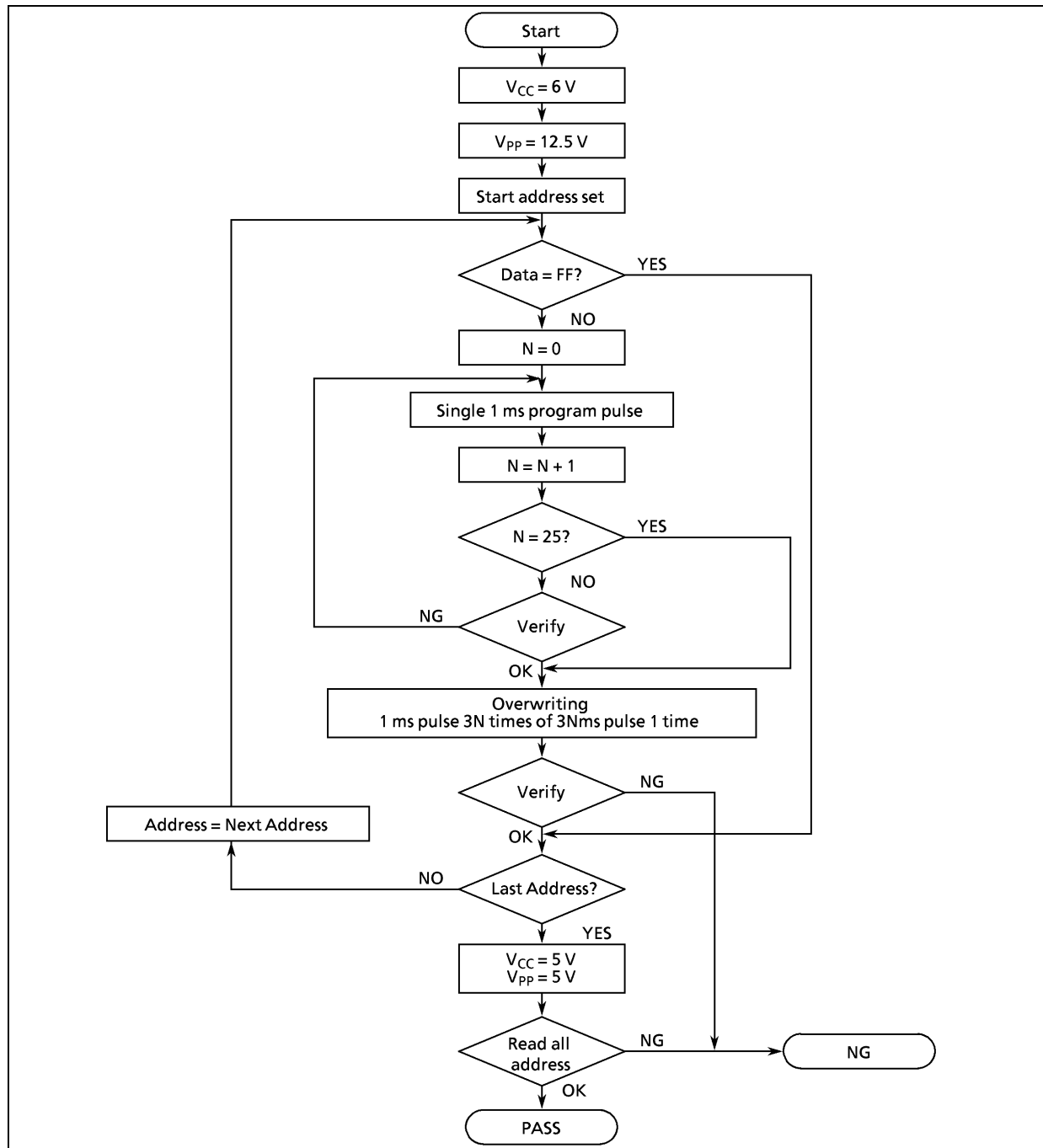


Figure 1-4. Flowchart of High-speed Programming Mode - I

### 1.2.2 Programming Flowchart (High-speed Programming Mode-II)

The high-speed programming mode is achieved by applying the program voltage (+ 12.75 V) to the Vpp pin when Vcc = 6.25 V. After the address and input data are stable, the data is programmed by applying a single 0.1ms program pulse to the  $\overline{CE}$  input. The programmed data is verified. If incorrect, another 0.1ms program pulse is applied and then the programmed data is verified. This process should be repeated (up to 25 times) until the program operates correctly. After that, change the address and input data, and program as before. When programming has been completed, the data in all addresses should be verified with Vcc = Vpp = 5 V.

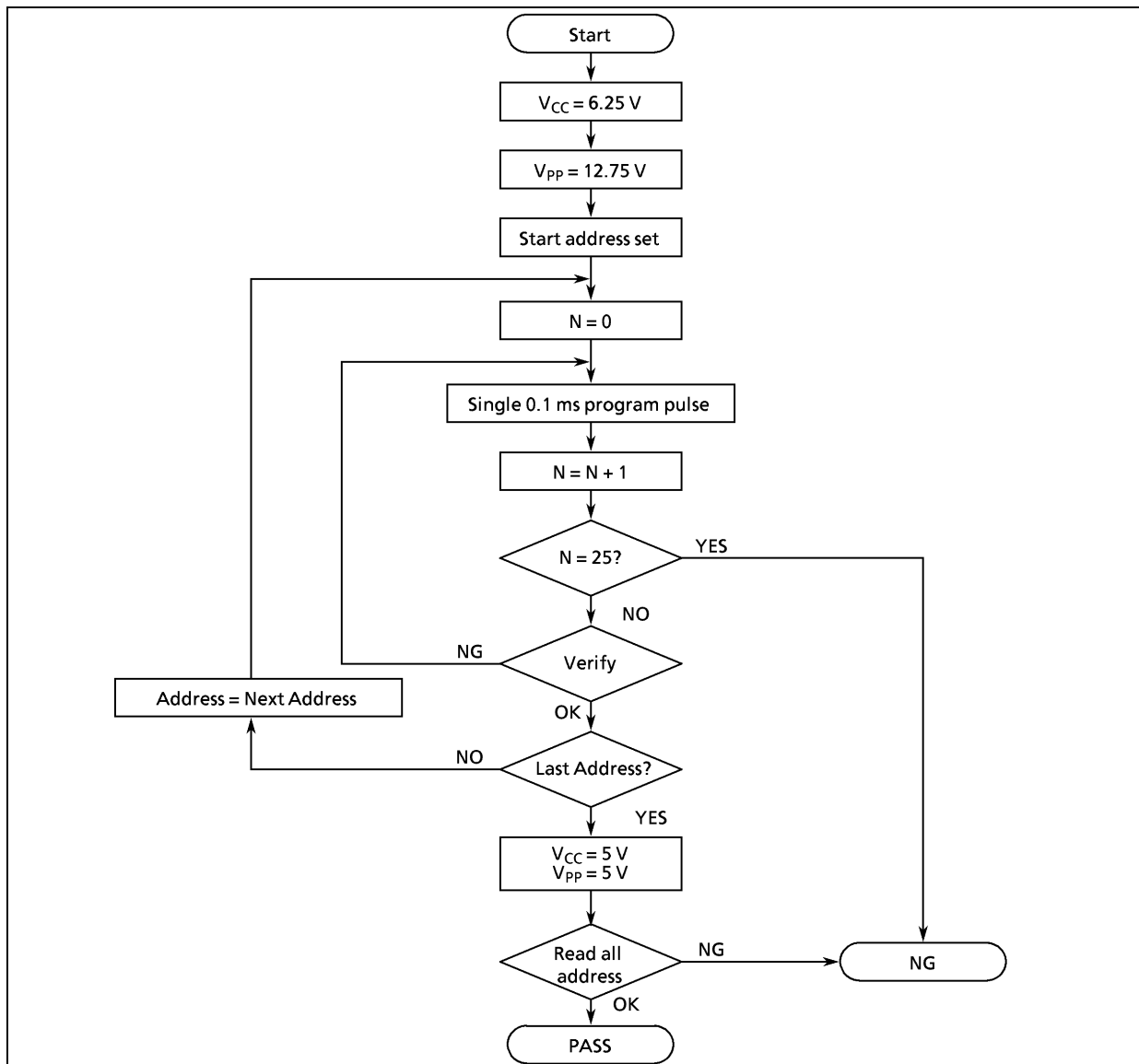


Figure 1-5. Flowchart of High-speed Programming Mode - II

### 1.2.3 Writing Method for General-purpose PROM Program

- (1) Adapters  
BM1193: TMP87PH46N
- (2) Adapter setting  
Switch (SW1) is set to side N.
- (3) PROM programmer specifying
  - i) PROM type is specified to TC57256AD.  
Writing voltage: 12.5 V (high-speed program I mode)  
12.75 V (high-speed program II mode)
  - ii) Data transfer (copy) (note 1)  
In TMP87PH46, EPROM is within the addresses 4000 to 7FFFH. Data is required to be transferred (copied) to the addresses where it is possible to write. The program area in MCU mode and PROM mode is referred to "Program memory area" in figure 1-1.  
  
Ex. In the block transfer (copy) mode, executed as below.  
ROM capacity of 16KB: transferred addresses C000 to FFFFH to addresses 4000 to 7FFFH
  - iii) Writing address is specified. (note 1)  
Start address: 4000H  
End address: 7FFFH
- (4) Writing  
Writing/Verifying is required to be executed in accordance with PROM programmer operating procedure.

*Note 1: The specifying method is referred to the PROM programmer description. The data in addresses 0000 to 3FFFH must be specified to FFH.*

*Note 2: When MCU is set to an adapter or the adapter is set to PROM programmer, a position of pin 1 must be adjusted. If the setting is reversed, MCU, the adapter and PROM program is damaged.*

*Note 3: TMP87PH46 does not support the electric signature mode (hereinafter referred to as "signature"). If the signature is used in PROM program, a device is damaged due to applying 12 V  $\pm$  0.5 V to the address pin 9 (A9). The signature must not be used.*



## Electrical Characteristics

## Absolute Maximum Ratings

 $(V_{SS} = 0V)$ 

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	$V_{DD}$		- 0.3 to 6.5	V
Input Voltage	$V_{IN}$		- 0.3 to $V_{DD} + 0.3$	V
Output Voltage	$V_{OUT1}$	Except sink open drain pin, but include P2 and $\overline{RESET}$	- 0.3 to $V_{DD} + 0.3$	V
	$V_{OUT2}$	Sink open drain pin except port P2, $\overline{RESET}$	- 0.3 to $V_{DD} + 0.3$	
Output Current (Per 1 pin)	$I_{OUT1}$	Ports P1, P2, P6, P7	3.2	mA
	$I_{OUT2}$	Port P0	30	
Output Current (Total)	$\Sigma I_{OUT1}$	Ports P1, P2, P6, P7	100	mA
	$\Sigma I_{OUT2}$	Port P0	120	
Power Dissipation [ $T_{opr} = 70^{\circ}C$ ]	PD	87PH46	600	mW
Soldering Temperature (time)	$T_{sld}$		260 (10 s)	$^{\circ}C$
Storage Temperature	$T_{stg}$		- 55 to 125	$^{\circ}C$
Operating Temperature	$T_{opr}$		- 30 to 70	$^{\circ}C$

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

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

Parameter	Symbol	Pins	Conditions	Min	Max	Unit	
Supply Voltage	$V_{DD}$		$f_c = 8 \text{ MHz}$	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			$f_c = 4.2 \text{ MHz}$	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			$f_s = 32.768 \text{ kHz}$	SLOW mode	2.0		
SLEEP mode							
Input High Voltage	$V_{IH1}$	Except hysteresis input	$V_{DD} \geq 4.5 \text{ V}$	$V_{DD} \times 0.70$	$V_{DD}$	V	
	$V_{IH2}$	Hysteresis input		$V_{DD} \times 0.75$			
	$V_{IH3}$			$V_{DD} < 4.5 \text{ V}$			$V_{DD} \times 0.90$
Input Low Voltage	$V_{IL1}$	Except hysteresis input	$V_{DD} \geq 4.5 \text{ V}$	0	$V_{DD} \times 0.30$	V	
	$V_{IL2}$	Hysteresis input		$V_{DD} \times 0.25$			
	$V_{IL3}$			$V_{DD} < 4.5 \text{ V}$	$V_{DD} \times 0.10$		
Clock Frequency	$f_c$	XIN, XOUT	$V_{DD} = 4.5 \text{ to } 5.5 \text{ V}$	1.0	8.0	MHz	
			$V_{DD} = 2.7 \text{ to } 5.5 \text{ V}$		4.2		
	$f_s$	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  $f_c$ ; Supply voltage range is specified in NORMAL mode and IDLE mode.

## D.C. Characteristics

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

Parameter	Symbol	PINS	Conditions	Min	Typ.	Max	Unit
Hysteresis Voltage	$V_{HS}$	Hysteresis inputs	$V_{DD} = 5.0V$	–	0.9	–	V
Input Current	$I_{IN1}$	TEST	$V_{DD} = 5.5V$ $V_{IN} = 5.5V / 0V$	–	–	$\pm 2$	$\mu\text{A}$
	$I_{IN2}$	Open drain ports, Tri-state ports					
	$I_{IN3}$	RESET, STOP					
Input Resistance	$R_{IN2}$	RESET		100	220	450	$k\Omega$
Output Leakage Current	$I_{LO1}$	Sink open drain ports	$V_{DD} = 5.5V, V_{OUT} = 5.5V$	–	–	2	$\mu\text{A}$
	$I_{LO2}$	Tri-state ports	$V_{DD} = 5.5V, V_{OUT} = 5.5V / 0V$	–	–	$\pm 2$	
Output High Voltage	$V_{OH2}$	Tri-state ports	$V_{DD} = 4.5V, I_{OH} = -0.7\text{ mA}$	4.1	–	–	V
Output Low Voltage	$V_{OL}$	Except XOUT and P0	$V_{DD} = 4.5V, I_{OL} = 1.6\text{ mA}$	–	–	0.4	V
Output Low current	$I_{OL3}$	P0	$V_{DD} = 4.5V, V_{OL} = 1.0V$	–	20	–	mA
Supply Current in NORMAL 1, 2 modes	$I_{DD}$		$V_{DD} = 5.5V$ $V_{IN} = 5.3V / 0.2V$ $f_c = 8\text{ MHz}$ $f_s = 32.768\text{ kHz}$	–	8	14	mA
Supply Current in IDLE 1, 2 modes			$V_{DD} = 3.0V$ $V_{IN} = 2.8V / 0.2V$ $f_c = 4.19\text{ MHz}$ $f_s = 32.768\text{ kHz}$	–	4	6	mA
Supply Current in NORMAL 1, 2 modes			$V_{DD} = 3.0V$ $V_{IN} = 2.8V / 0.2V$ $f_c = 4.19\text{ MHz}$ $f_s = 32.768\text{ kHz}$	–	2.5	3.5	mA
Supply Current in IDLE 1, 2 modes			$V_{DD} = 3.0V$ $V_{IN} = 2.8V / 0.2V$ $f_s = 32.768\text{ kHz}$	–	1.5	2.0	mA
Supply Current in SLOW mode			$V_{DD} = 3.0V$ $V_{IN} = 2.8V / 0.2V$ $f_s = 32.768\text{ kHz}$	–	30	60	$\mu\text{A}$
Supply Current in SLEEP mode			$V_{DD} = 3.0V$ $V_{IN} = 2.8V / 0.2V$ $f_s = 32.768\text{ kHz}$	–	15	30	$\mu\text{A}$
Supply Current in STOP mode			$V_{DD} = 5.5V$ $V_{IN} = 5.3V / 0.2V$	–	0.5	10	$\mu\text{A}$

Note 1: Typical values show those at  $T_{opr} = 25^\circ\text{C}$ .

Note 2: Input Current  $I_{IN1}, I_{IN3}$ ; The current through resistor is not included, when the input resistor (pull-up or pull-down) is contained.

## A / D Conversion Characteristics

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

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	$V_{AREF}$		2.7	–	$V_{DD}$	V
	$V_{ASS}$		$V_{SS}$			
Analog Input Voltage	$V_{AIN}$		$V_{ASS}$	–	$V_{AREF}$	V
Analog Supply Current	$I_{REF}$	$V_{AREF} = 5.5V, V_{ASS} = 0.0V$	–	0.5	1.0	mA
Nonlinearity Error		$V_{DD} = 5.0V$ $V_{AREF} = 5.000V$	–	–	$\pm 1$	LSB
Zero Point Error		$V_{ASS} (V_{SS}) = 0.000V$ or	–	–	$\pm 1$	
Full Scale Error		$V_{DD} = 2.7V, V_{SS} = 0V$ $V_{AREF} = 2.700V$	–	–	$\pm 1$	
Total Error		$V_{ASS} (V_{SS}) = 0.000V$	–	–	$\pm 2$	

Note: Quantizing error is not contained in Total Error.

## A.C. Characteristics

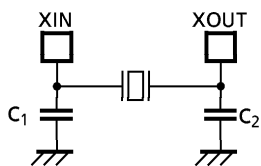
 $(V_{SS} = 0V, V_{DD} = 4.5 \text{ to } 5.5V, T_{opr} = -30 \text{ to } 70^{\circ}C)$ 

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	$t_{cy}$	In NORMAL1, 2 modes	0.5	-	4	$\mu s$
		In IDLE1, 2 modes				
		In SLOW mode	117.6	-	133.3	
		In SLEEP mode				
High Level Clock Pulse Width	$t_{WCH}$	For external clock operation	50.5	-	-	ns
Low Level Clock Pulse Width	$t_{WCL}$	(XIN input), $f_c = 8 \text{ MHz}$				
High Level Clock Pulse Width	$t_{WSH}$	For external clock operation	14.7	-	-	$\mu s$
Low Level Clock Pulse Width	$t_{WSL}$	(XTIN input), $f_s = 32.768 \text{ kHz}$				

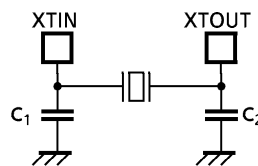
## Recommended Oscillating Conditions

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

Parameter	Oscillator	Frequency	Recommended Oscillator	Recommended Condition	
				$C_1$	$C_2$
High-frequency	Ceramic Resonator	8 MHz	KYOCERA KBR8.0M	30 pF	30 pF
			MURATA CSA8.00MTz CSACS8.00MT CSTCS8.00MT		
		4 MHz	KYOCERA KBR4.0MS		
			MURATA CSAC4.00MGC CSA4.00MG		
Crystal Oscillator	8 MHz	TOYOCOM 210B 8.0000	20 pF	20 pF	
	4 MHz	TOYOCOM 204B 4.0000			
Low-frequency	Crystal Oscillator	32.768 kHz	NDK MX-38T	15 pF	15 pF



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

**Note 1:** When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular 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:

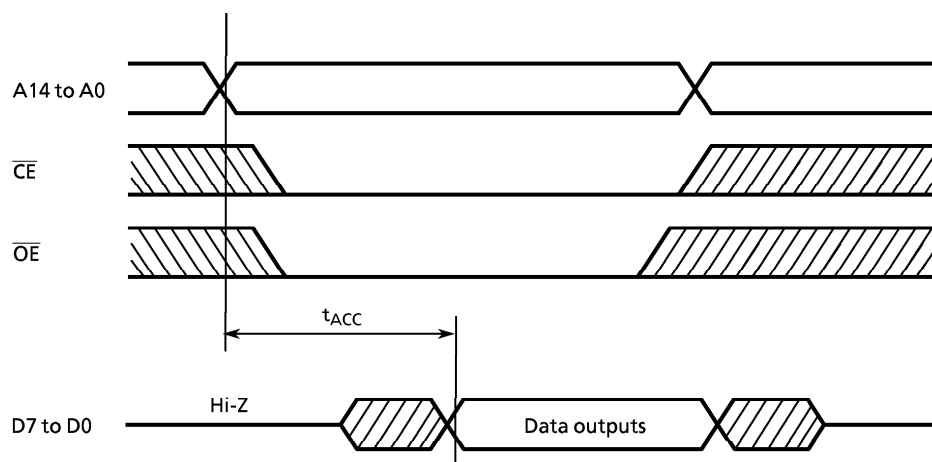
<http://www.murata.co.jp/search/index.html>

D.C./A.C. Characteristics (PROM mode)	( $V_{SS} = 0\text{ V}$ )
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(1) READ OPERATION ( $T_{opr} = -30$  to  $70^\circ\text{C}$ )

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	$V_{IH4}$		$V_{CC} \times 0.7$	–	$V_{CC}$	V
Input Low Voltage	$V_{IL4}$		0	–	$V_{CC} \times 0.12$	V
Power Supply Voltage	$V_{CC}$		4.75	–	6.0	V
Program Power Supply Voltage	$V_{PP}$					V
Address Access Time	$t_{ACC}$	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5t_{cyc} + 300$	–	ns

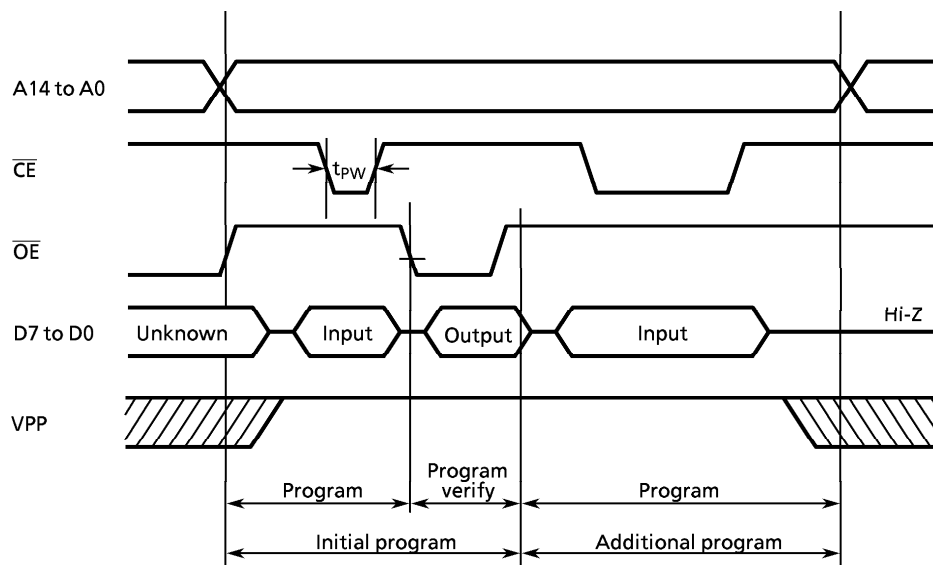
Note: $t_{cyc} = 500\text{ ns}$ at $8\text{ MHz}$
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Timing Waveforms of Read Operation

(2) Program Operation (High Speed Write Mode - I) ( $T_{opr} = 25 \pm 5^\circ\text{C}$ )

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	$V_{IH4}$		$V_{CC} \times 0.7$	–	$V_{CC}$	V
Input Low Voltage	$V_{IL4}$		0	–	$V_{CC} \times 0.12$	V
Power Supply Voltage	$V_{CC}$		5.75	6.0	6.25	V
Program Power Supply Voltage	$V_{PP}$		12.0	12.5	13.0	V
Initial Program Pulse Width	$t_{PW}$	$V_{CC} = 6.0\text{ V} \pm 0.25\text{ V}$ , $V_{PP} = 12.5 \pm 0.5\text{ V}$	0.95	1.0	1.05	ms



Timing Waveforms of Programming Operation

**Note 1:** When  $V_{CC}$  power supply is turned on or after,  $V_{PP}$  must be increased.

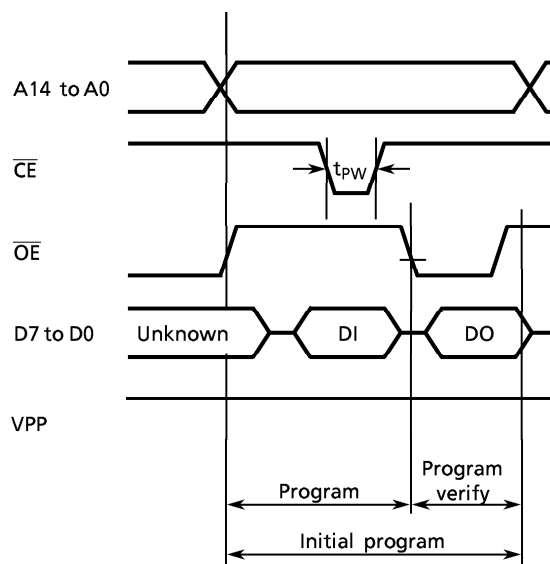
When  $V_{CC}$  power supply is turned off or before,  $V_{PP}$  must be decreased.

**Note 2:** The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ( $12.5\text{ V} \pm 0.5\text{ V}$ ) to the  $V_{PP}$  pin as the device is damaged.

**Note 3:** Be sure to execute the recommended programming mode with the recommended programming adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.

(3) Program Operation (High speed write mode - II) ( $T_{opr} = 25 \pm 5^{\circ}\text{C}$ )

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	$V_{IH4}$		$V_{CC} \times 0.7$	–	$V_{CC}$	V
Input Low Voltage	$V_{IL4}$		0	–	$V_{CC} \times 0.12$	V
Supply Voltage	$V_{CC}$		6.00	6.25	6.50	V
Program Supply Voltage	$V_{PP}$		12.50	12.75	13.0	V
Initial Program Pulse Width	$t_{PW}$	$V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$ , $V_{PP} = 12.75 \text{ V} \pm 0.25 \text{ V}$	0.095	0.1	0.105	ms



Note: DO ; Data output (I0 to I7)  
DI ; Data input (I0 to I7)

**Note 1:** 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 decreased.

**Note 2:** The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ( $12.75 \text{ V} \pm 0.25 \text{ V}$ ) to the  $V_{PP}$  pin as the device is damaged.

**Note 3:** Be sure to execute the recommended programming mode with the recommended programming adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.

Package Dimensions

P-SDIP42-600-1.78

Unit: mm

