

CMOS 8-Bit Microcontroller

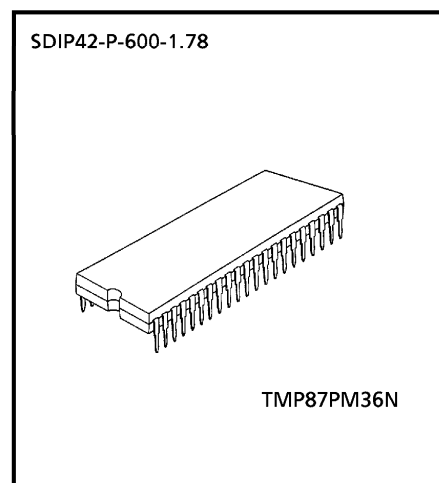
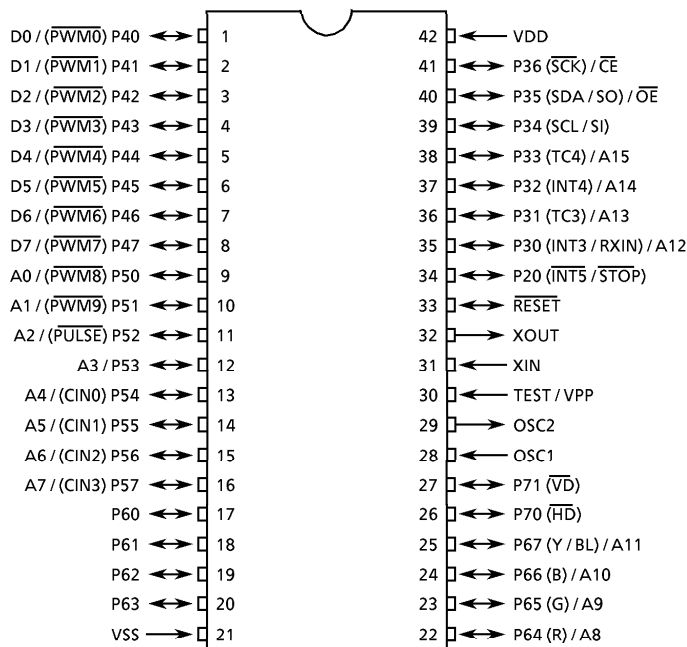
**TMP87PM36N**

The 87PM36 is a One-Time PROM microcontroller with low-power 287.5 Kbits (a 32 Kbytes program memory and a 128 characters OSD font memory) electrically programmable read only memory for the 87CM36 system evaluation. The 87PM36 is pin compatible with the 87CM36. The operations possible with the 87CM36 can be performed by writing programs and OSD character data to PROM. The 87PM36 can write and verify in the same way as the TC57256AD using an adaptor socket BM1183A and an EPROM programmer.

| Part No.   | OTP                            | RAM      | Package           | Adaptor Socket |
|------------|--------------------------------|----------|-------------------|----------------|
| TMP87PM36N | 32 Kbytes + 14 × 18 × 128 bits | 1 Kbytes | SDIP42-P-600-1.78 | BM1183A        |

**Pin Assignments (Top View)**

SDIP42-P-600-1.78



980910EBP1

- 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 the 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 observe standards of safety, and to avoid situations in which a malfunction or failure of a TOSHIBA product 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 products specifications. Also, please keep in mind the precautions and conditions set forth in the TOSHIBA Semiconductor Reliability Handbook.
- 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.



Purchase of TOSHIBA I<sup>2</sup>C components conveys a license under the Philips I<sup>2</sup>C Patent Rights to use these components in an I<sup>2</sup>C system, provided that the system conforms to the I<sup>2</sup>C Standard Specification as defined by Philips.

**Pin Function**

The 87PM36 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PM36 is pin compatible with the 87CM36 (fix the TEST pin at low level).

(2) PROM mode

| Pin Name<br>(PROM mode) | Input/Output | Functions  | Pin Name<br>(MCU mode) |
|-------------------------|--------------|--|------------------------|
| A15 to A12              | Input        | PROM address inputs  | P33 to P30             |
| A11 to A8               |              |  | P67 to P64             |
| A7 to A0                |              |  | P57 to P50             |
| D7 to D0                | I/O          | PROM data input/outputs                                      | P47 to P40             |
| $\overline{CE}$         | Input        | Chip enable signal input (active low)                        | P36                    |
| $\overline{OE}$         |              | Output enable signal input (active low)                      | P35                    |
| VPP                     | Power supply | + 12.5 V / 5 V (Program supply voltage)                      | TEST                   |
| VCC                     |              | + 5 V  | VDD                    |
| GND                     |              | 0V   | VSS                    |
| P36                     | I/O          | Pull-up with resistance for input processing                 |                        |
| P61                     |              | PROM mode setting pin. Be fixed at high level.               |                        |
| P70                     |              |  |                        |
| P20                     |              |  |                        |
| P63, P62, P60           |              | PROM mode setting pin. Be fixed at low level.                |                        |
| P71                     |              |  |                        |
| $\overline{RESET}$      |              |  |                        |
| XIN                     | Input        | Connect an 8 MHz oscillator to stabilize the internal state. |                        |
| XOUT                    | Output       |  |                        |
| OSC1                    | Input        | Non connection   |                        |
| OSC2                    | Output       |  |                        |

**Operational Description**

The following explains the 87PM36 hardware configuration and operation. The configuration and functions of the 87PM36 are the same as those of the 87CM36, except in that a one-time PROM is used instead of an on-chip mask ROM.

**1. Operating Mode**

The 87PM36 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 87CM36 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

**1.1.1 Program memory and OSD character font memory**

The 87PM36 has a 32 Kbytes of program memory and a 14 × 18 × 128 bits of OSD character font memory.

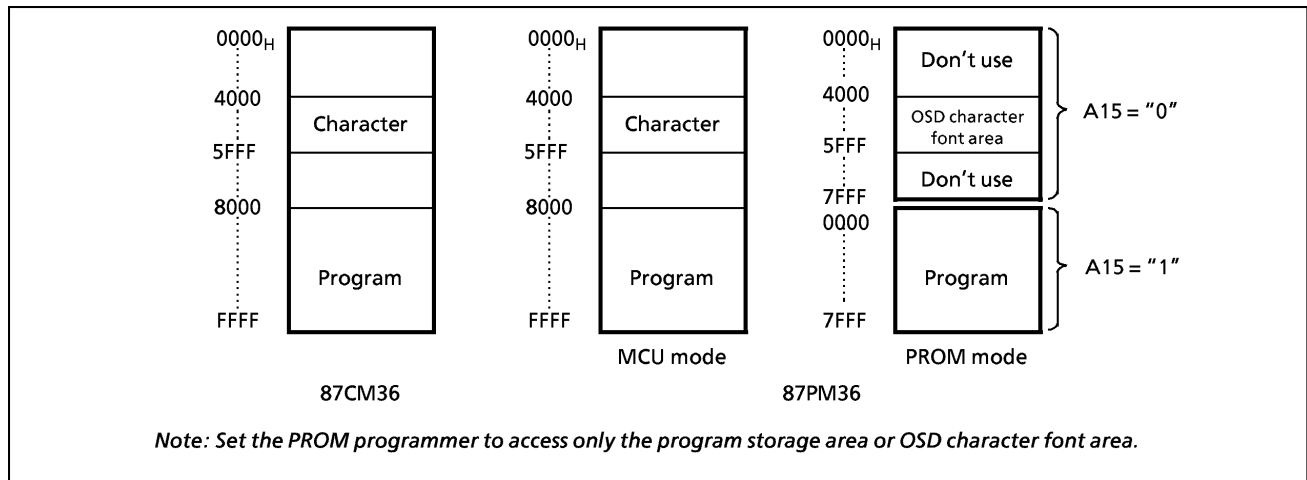


Figure 1-1. Program Memory Area

**1.1.2 Data memory**

The 87PM36 has an on-chip 1 Kbytes data memory (static RAM).

**1.1.3 Input/output circuitry**

(1) Control pins

The control pins of the 87PM36 are the same as those of the 87CM36 except that the TEST pin has no built-in pull-down resistance.

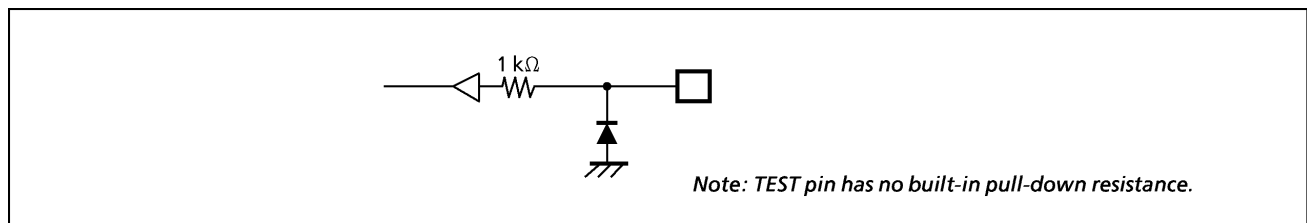


Figure 1-2. TEST Pin

(2) I/O ports

The I/O circuitries of 87PM36 I/O ports are the same as those of the 87CM36.

## Electrical Characteristics

| Absolute Maximum Ratings        |                     | (V <sub>SS</sub> = 0 V)              |                                |      |
|---------------------------------|---------------------|--------------------------------------|--------------------------------|------|
| Parameter                       | Symbol              | Pins                                 | Ratings                        | Unit |
| Supply Voltage                  | V <sub>DD</sub>     |                                      | - 0.3 to 6.5                   | V    |
| Program Voltage                 | V <sub>PP</sub>     | TEST / VPP                           | - 0.3 to 13.0                  | V    |
| Input Voltage                   | V <sub>IN</sub>     |                                      | - 0.3 to V <sub>DD</sub> + 0.3 | V    |
| Output Voltage                  | V <sub>OUT1</sub>   |                                      | - 0.3 to V <sub>DD</sub> + 0.3 | V    |
| Output Current (Per 1 pin)      | I <sub>OUT1</sub>   | Ports P2, P3, P4, P5, P64 to P67, P7 | 3.2                            | mA   |
|                                 | I <sub>OUT2</sub>   | Ports P60 to P63                     | 30                             |      |
| Output Current (Total)          | ∑ I <sub>OUT1</sub> | Ports P2, P3, P4, P5, P64 to P67, P7 | 120                            | mA   |
|                                 | ∑ I <sub>OUT2</sub> | Ports P60 to P63                     | 120                            |      |
| Power Dissipation [Topr = 70°C] | PD                  |                                      | 600                            | mW   |
| Soldering Temperature (time)    | T <sub>sld</sub>    |                                      | 260 (10 s)                     | °C   |
| Storage Temperature             | T <sub>stg</sub>    |                                      | - 55 to 125                    | °C   |
| Operating Temperature           | Topr                |                                      | - 30 to 70                     | °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 <sub>SS</sub> = 0 V, Topr = - 30 to 70°C) |   |                        |  |      |   |
|----------------------------------|------------------|--|---|------------------------|--|------|---|
| Parameter                        | Symbol           | Pins   | Conditions  | Min                    | Max  | Unit |   |
| Supply Voltage                   | V <sub>DD</sub>  |  | f <sub>c</sub> = 8MHz   | NORMAL mode            | 4.5  | 5.5  | V |
|                                  |                  |  |   | IDLE mode              |  |      |   |
|                                  |                  |  | STOP mode   | 2.0                    |  |      |   |
| Input High Voltage               | V <sub>IH1</sub> | Except hysteresis input                      |   | V <sub>DD</sub> × 0.70 | V <sub>DD</sub>                                  | V    |   |
|                                  | V <sub>IH2</sub> | Hysteresis input                             |   | V <sub>DD</sub> × 0.75 |  |      |   |
| Input Low Voltage                | V <sub>IL1</sub> | Except hysteresis input                      |   | 0                      | V <sub>DD</sub> × 0.30                           | V    |   |
|                                  | V <sub>IL2</sub> | Hysteresis input                             |   |                        | V <sub>DD</sub> × 0.25                           |      |   |
| Clock Frequency                  | f <sub>c</sub>   | XIN, XOUT                                    | V <sub>DD</sub> = 4.5 to 5.5 V                                      | 4.0                    | 8.0  | MHz  |   |
|                                  | f <sub>OSC</sub> | OSC1, OSC2                                   | Normal frequency mode<br>(FORS = 0, V <sub>DD</sub> = 4.5 to 5.5 V) | 4.0                    | f <sub>OSC</sub> ≤ f <sub>c</sub> ×<br>1.2 ≤ 8.0 |      |   |
|                                  |                  |  | Double frequency mode<br>(FORS = 1, V <sub>DD</sub> = 4.5 to 5.5 V) | 2.0                    | f <sub>OSC</sub> ≤ f <sub>c</sub> ×<br>0.6 ≤ 4.0 |      |   |

*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<sub>c</sub>; The condition of supply voltage range is the value in NORMAL and IDLE modes.

## D.C. Characteristics

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

| Parameter                     | Symbol    | Pins                                   | Conditions  | Min | Typ. | Max     | Unit             |
|-------------------------------|-----------|--|---|-----|------|---------|------------------|
| Hysteresis Voltage            | $V_{HS}$  | Hysteresis inputs                      |   | –   | 0.9  | –       | V                |
| Input Current                 | $I_{IN1}$ | TEST                                   | $V_{DD} = 5.5\text{ V}, V_{IN} = 5.5\text{ V} / 0\text{ V}$                               | –   | –    | $\pm 2$ | $\mu\text{A}$    |
|                               | $I_{IN2}$ | Open drain ports                       | $V_{DD} = 5.5\text{ V}, V_{IN} = 5.5\text{ V}$  | –   | –    | 2       |                  |
|                               | $I_{IN3}$ | Tri-state ports                        | $V_{DD} = 5.5\text{ V}, V_{IN} = 5.5\text{ V} / 0\text{ V}$                               | –   | –    | $\pm 2$ |                  |
|                               | $I_{IN4}$ | RESET, STOP                            | $V_{DD} = 5.5\text{ V}, V_{IN} = 5.5\text{ V} / 0\text{ V}$                               | –   | –    | $\pm 2$ |                  |
| Input Resistance              | $R_{IN2}$ | RESET                                  |   | 100 | 220  | 450     | $\text{k}\Omega$ |
| Output Leakage Current        | $I_{LO1}$ | Sink open drain ports                  | $V_{DD} = 5.5\text{ V}, V_{OUT} = 5.5\text{ V}$   | –   | –    | 2       | $\mu\text{A}$    |
|                               | $I_{LO2}$ | Tri-state ports                        | $V_{DD} = 5.5\text{ V}, V_{OUT} = 5.5\text{ V} / 0\text{ V}$                              | –   | –    | $\pm 2$ |                  |
| Output High Voltage           | $V_{OH2}$ | Tri-state port                         | $V_{DD} = 4.5\text{ V}, I_{OH} = -0.7\text{ mA}$  | 4.1 | –    | –       | V                |
| Output Low Voltage            | $V_{OL}$  | Except XOUT, OSC2 and ports P60 to P63 | $V_{DD} = 4.5\text{ V}, I_{OL} = 1.6\text{ mA}$   | –   | –    | 0.4     | V                |
| Output Low Current            | $I_{OL3}$ | Ports P60 to P63                       | $V_{DD} = 4.5\text{ V}, V_{OL} = 1.0\text{ V}$  | –   | 20   | –       | mA               |
| Supply Current in NORMAL mode | $I_{DD}$  |  | $V_{DD} = 5.5\text{ V}$<br>$f_c = 8\text{ MHz}$<br>$V_{IN} = 5.3\text{ V} / 0.2\text{ V}$ | –   | 10   | 16      | mA               |
| Supply Current in IDLE mode   |           |  |   | –   | 6    | 8       | mA               |
| Supply Current in STOP mode   |           |  |   | –   | 0.5  | 10      | $\mu\text{A}$    |

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

Note 2 : Input Current  $I_{IN4}$ ; The current through pull-up resistor is not included.

Note 3 : Typical current consumption during A/D conversion is 1.2mA.

## A/D Conversion Characteristics

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

| Parameter                  | Symbol    | Pins         | Conditions              | Min      | Typ. | Max       | Unit |
|----------------------------|-----------|--------------|-------------------------|----------|------|-----------|------|
| Analog Input Voltage Range | $V_{AIN}$ | CIN3 to CIN0 |                         | $V_{SS}$ | –    | $V_{DD}$  | V    |
| Conversion Error           |           |              | $V_{DD} = 5.0\text{ V}$ | –        | –    | $\pm 1.5$ | LSB  |

A.C. Characteristics

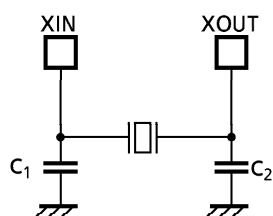
( $V_{SS} = 0\text{ V}$ ,  $V_{DD} = 4.5\text{ to }5.5\text{ V}$ ,  $T_{opr} = -30\text{ to }70^\circ\text{C}$ )

| Parameter                    | Symbol    | Conditions   | Min | Typ. | Max | Unit          |
|------------------------------|-----------|--|-----|------|-----|---------------|
| Machine Cycle Time           | $t_{cy}$  | In NORMAL mode   | 0.5 | -    | 1.0 | $\mu\text{s}$ |
|                              |           | In IDLE mode   |     |      |     |               |
| High Level Clock Pulse Width | $t_{WCH}$ | For external clock operation<br>(XIN input), $f_c = 8\text{MHz}$ | 50  | -    | -   | ns            |
| Low Level Clock Pulse Width  | $t_{WCL}$ |  |     |      |     |               |

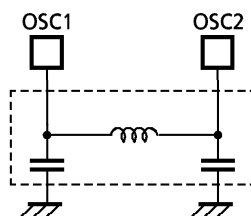
Recommended Oscillating Conditions

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

| Parameter                  | Oscillator         | Oscillation Frequency | Recommended Oscillator               | Recommended Constant |       |
|----------------------------|--------------------|-----------------------|--------------------------------------|----------------------|-------|
|                            |                    |                       |                                      | $C_1$                | $C_2$ |
| High-frequency Oscillation | Ceramic Resonator  | 8 MHz                 | KYOCERA KBR8.0M                      | 30pF                 | 30pF  |
|                            |                    | 4 MHz                 | KYOCERA KBR4.0MS<br>MURATA CSA4.00MG |                      |       |
|                            | Crystal Oscillator | 8 MHz                 | TOYOCOM 210B 8.0000                  | 20pF                 | 20pF  |
|                            |                    | 4 MHz                 | TOYOCOM 204B 4.0000                  |                      |       |
| OSD                        | LC Resonator       | 8 MHz                 | TOKO A285TNIS-11695                  | -                    | -     |
|                            |                    | 7 MHz                 | TOKO TBEKSES-30375FBY                |                      |       |



(1) High-frequency Oscillation



(2) LC Resonator for OSD

*Note : On our OSD circuit, the horizontal display start position is determined by counting the clock from LC oscillator. So, the unstable start of oscillation after the rising edge of Horizontal Sync. Signal will be cause the OSD distortion.  
Generally, smaller C and larger L make clearer wave form at the beginning of oscillation.  
We recommend that the value of LC oscillator should be equal and bigger than  $33\mu\text{H}$ .*

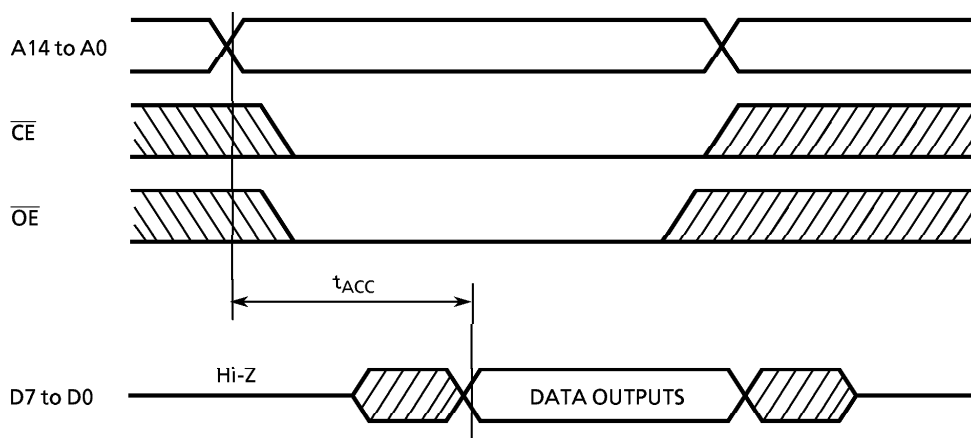
*Note : To keep reliable operation, shield the device electrically with the metal plate on its package mold surface against the high electric field, for example, by CRT (Cathode Ray Tube).*

D.C./A.C. Characteristics (PROM mode) ( $V_{SS} = 0\text{ V}$ )

(1) Read Operation ( $T_a = 25 \pm 5^\circ\text{C}$ )

| 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         | $V_{CC}$  |                                  | 4.75                | 5.00                       | 5.25                 | V    |
| Program Power Supply Voltage | $V_{PP}$  |                                  | $V_{CC} - 0.6$      | $V_{CC}$                   | $V_{CC} + 0.6$       |      |
| Address Access Time          | $t_{ACC}$ | $V_{CC} = 5.0 \pm 0.25\text{ V}$ | –                   | $1.5\text{ t}_{cyc} + 300$ | –                    | ns   |

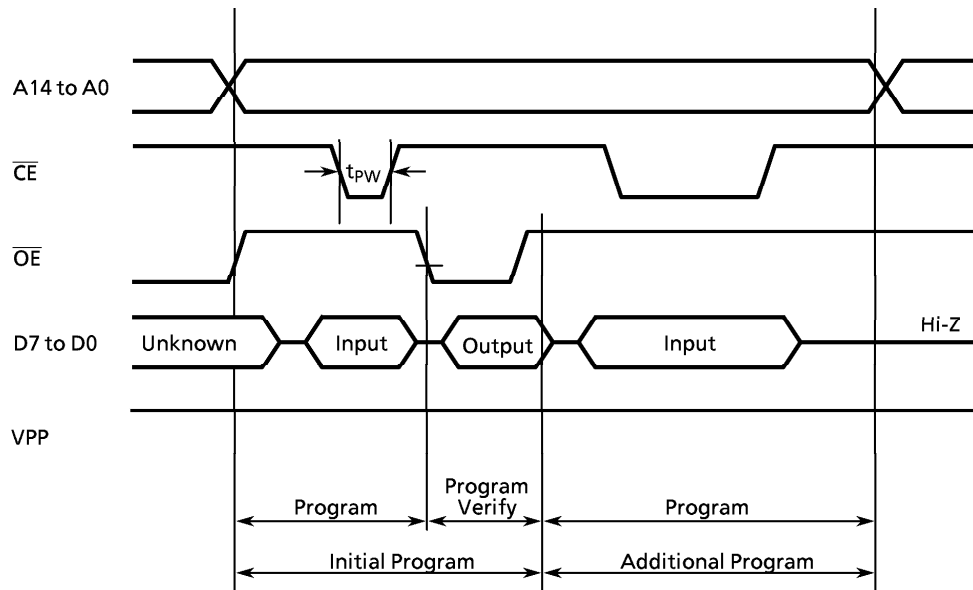
Note :  $t_{cyc} = 500\text{ ns}$  at 8 MHz



Timing Waveforms of Read operation

(2) High-Speed Programming Operation (High speed write mode- I ) ( $T_a = 25 \pm 5^\circ\text{C}$ )

| 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  | $t_{PW}$  | $V_{CC} = 6.0 \pm 0.25\text{ V}$ ,<br>$V_{PP} = 12.5 \pm 0.25\text{ V}$ | 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 increased.

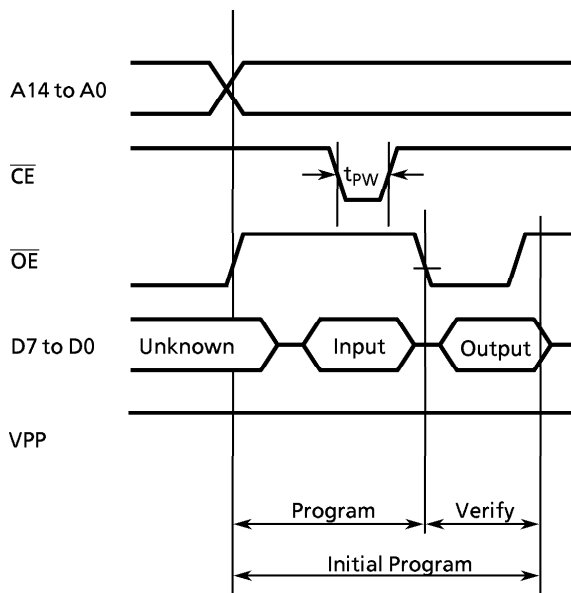
**Note 2:** The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ( $12.5\text{ V} \pm 0.5\text{ V} = V$ ) to the  $V_{pp}$  pin as the device is damaged.

**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 | $t_{PW}$  | $V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$ ,<br>$V_{PP} = 12.75 \text{ V} \pm 0.25 \text{ V}$ | 0.095               | 0.1   | 0.105                | ms   |



- 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 ( $12.75 \text{ V} \pm 0.5 \text{ V}$ ) 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.*

