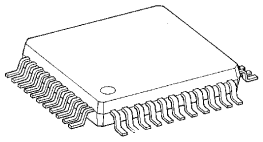
CMOS 8-Bit Microcontroller

# 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 × 8 bits | 1 K × 8 bits | P-LQFP44-1010-0.80B | BM11187 |

P-LQFP44-1010-0.80B

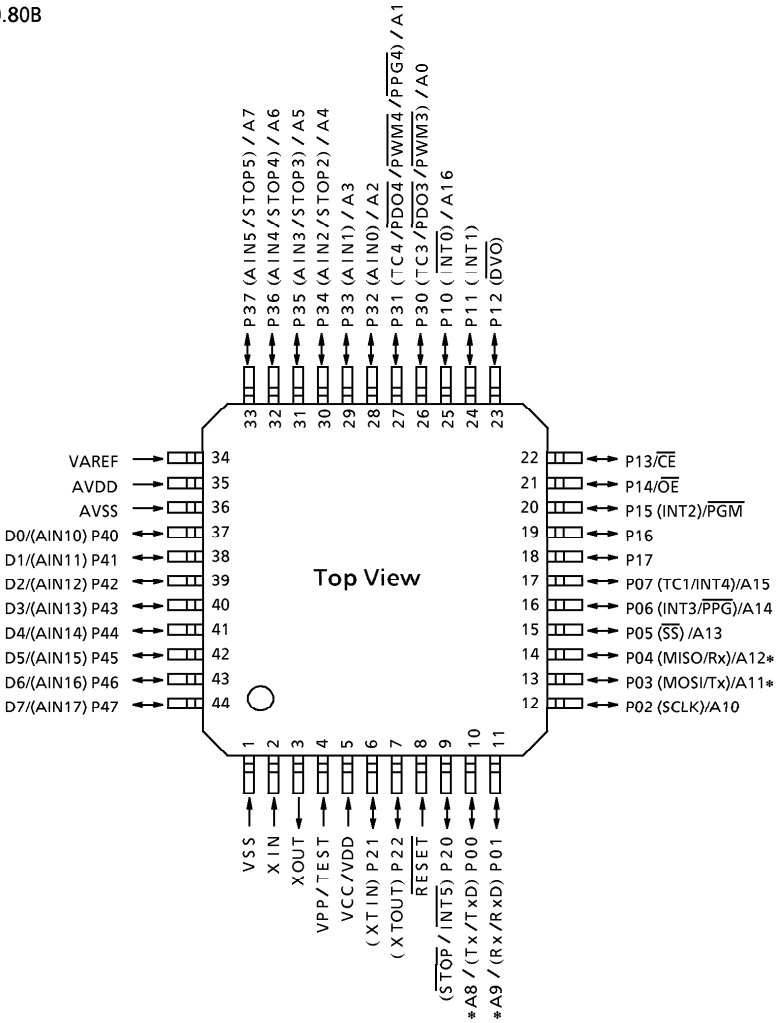


TMP86PM87U

000707EBA1

## 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. | |
| $\overline{RESET}$ | | | |
| 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.

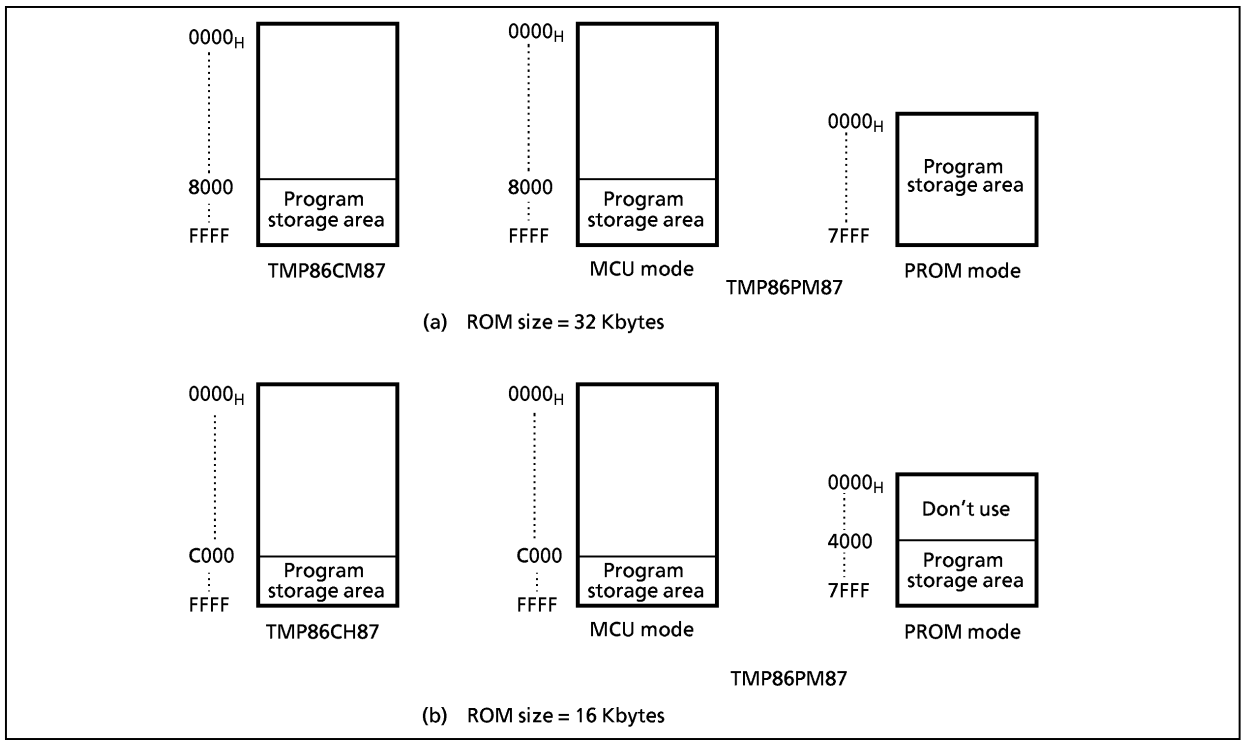



Figure 1-1. Program Memory Area

*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, $\overline{RESET}$, Tri-state Port | – 0.3 to $V_{DD}$ + 0.3 | |
| | $V_{OUT2}$ | P20, Sink Open Drain Port | – 0.3 to 5.5 | |
| Output Current (Per 1 pin) | $I_{OUT1}$ $I_{OH}$ | P0, P1, P3, P4 Port | – 1.8 | mA |
| | $I_{OUT2}$ $I_{OL}$ | P1, P2, P3, P4 Port | 3.2 | |
| | $I_{OUT3}$ $I_{OL}$ | P0 Port | 30 | |
| Output Current (Total) | $\Sigma I_{OUT1}$ | P0, P1, P3, P4 Port | – 30 | |
| | $\Sigma I_{OUT2}$ | P1, P2, P3, P4 Port | 60 | |
| | $\Sigma I_{OUT3}$ | P0 Port | 80 | |
| Power Dissipation [$T_{opr}$ = 85°C] | PD | | 350 | mW |
| Soldering Temperature (time) | Tsld | | 260 (10 s) | °C |
| Storage Temperature | Tstg | | – 55 to 150 | |
| Operating Temperature | Topr | | – 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, Topr = – 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 | $V_{DD} \geqq$ 4.5 V | | $V_{DD}$ × 0.70 | $V_{DD}$ | |
| | $V_{IH2}$ | Hysteresis input | | | $V_{DD}$ × 0.75 | | |
| | $V_{IH3}$ | | $V_{DD} <$ 4.5 V | | $V_{DD}$ × 0.90 | | |
| Input low Level | $V_{IL1}$ | Except Hysteresis input | $V_{DD} \geqq$ 4.5 V | | 0 | $V_{DD}$ × 0.30 | |
| | $V_{IL2}$ | Hysteresis input | | | | $V_{DD}$ × 0.25 | |
| | $V_{IL3}$ | | $V_{DD} <$ 4.5 V | | | $V_{DD}$ × 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 | | | | | |
| | $I_{IN3}$ | $\overline{RESET}$, $\overline{STOP}$ | | | | | |
| Input Resistance | $R_{IN}$ | $\overline{RESET}$ 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<br>$V_{IN}$ = 5.3/0.2 V<br>fc = 16.0 MHz<br>fs = 32.768 kHz<br>When using CAN controller | – | 10 | 15 | |
| Supply Current in IDLE 1, 2 mode | | | | – | 8 | 12 | |
| Supply Current in NORMAL 1, 2 mode | | | $V_{DD}$ = 5.5 V<br>$V_{IN}$ = 5.3/0.2 V<br>fc = 16.0 MHz<br>fs = 32.768 kHz<br>When not using CAN controller | – | 7.5 | 9 | |
| Supply Current in IDLE 0, 1, 2 mode | | | | – | 5.5 | 6.5 | |
| Supply Current in SLOW 1 mode | | | $V_{DD}$ = 5.5 V<br>$V_{IN}$ = 5.3 V/0.2 V<br>fs = 32.768 kHz | – | 15 | 35 | μA |
| Supply Current in SLEEP 1 mode | | | | – | 7 | 25 | |
| Supply Current in SLEEP 0 mode | | | | – | 6 | 25 | |
| Supply Current in STOP mode | | | $V_{DD}$ = 5.5 V<br>$V_{IN}$ = 5.3 V/0.2 V | – | 0.5 | 15 | |

*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, Topr = – 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) | $\Delta V_{AREF}$ | $V_{AREF} - A_{VSS}$ | 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<br>$V_{SS} = A_{VSS}$ = 0.0 V | – | 0.6 | 1.0 | mA |
| Non linearity | | $V_{DD} = A_{VDD}$ = 5.0 V,<br>$V_{AREF}$ = 5.0 V,<br>$A_{VSS}$ = 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: $\Delta V_{AREF} = V_{AREF} - A_{VSS}$*

## SEI Operating Conditions (Slave mode)

($V_{SS}$ = 0.0 V, 4.5 V ≦ $V_{DD}$ ≦ 5.5 V, Topr = – 40 to 85°C)

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

## AC Characteristics

($V_{SS}$ = 0 V, $V_{DD}$ = 4.5 to 5.5 V, Topr = – 40 to 85°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) fc = 16 MHz | 25 | – | – | ns |
| Low Level Clock Pulse Width | twcL | | | | | |
| High Level Clock Pulse Width | twcH | For external clock operation (XTIN input) fs = 32.768 kHz | 14.7 | – | – | μs |
| Low Level Clock Pulse Width | twcL | | | | | |

($V_{SS}$ = 0 V, $V_{DD}$ = 2.7 to 4.5 V, Topr = – 40 to 85°C)

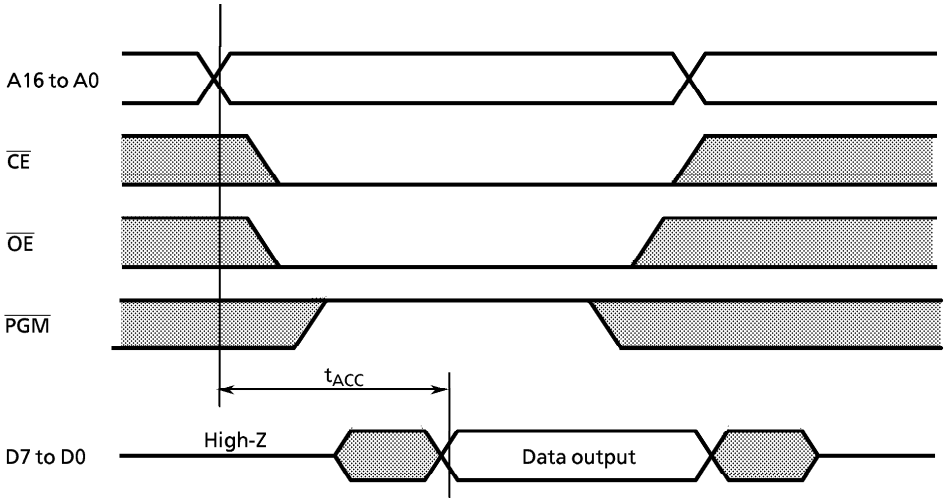
| Parameter | Symbol | Condition | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| Machine Cycle Time | tcy | NORMAL 1, 2 mode | 0.5 | – | 4 | μs |
| | | IDLE 0, 1, 2 mode | | | | |
| | | SLOW 1, 2 mode | 117.6 | – | 133.3 | |
| | | SLEEP 0, 1, 2 mode | | | | |
| High Level Clock Pulse Width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

DC Characteristics, AC Characteristics (PROM mode) ($V_{SS}$ = 0 V, Topr = – 40 to 85°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 leve 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 ± 0.25 V | – | 1.5 tcyc + 300 | – | ns |

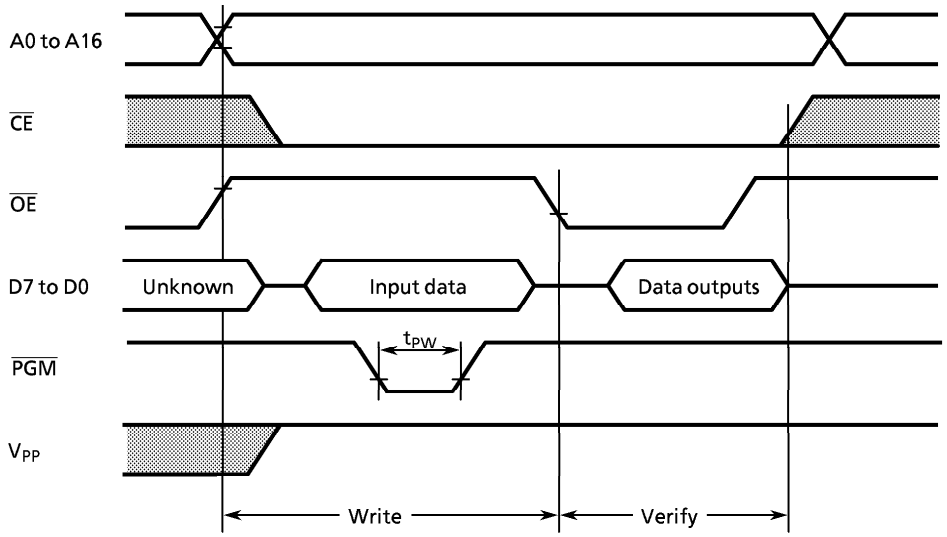
*Note: tcyc = 500 ns at 8 MHz*



(2) Program operation (High-speed) (Topr = 25 ± 5°C)

| Parameter | Symbol | Conditions | Min | Typ. | Max | Unit |
|---|---|---|---|---|---|---|
| High level input voltage (TTL) | $V_{IH4}$ | | 2.2 | – | $V_{CC}$ | V |
| Low leve 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 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 V ± 0.25 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 writting.*