

## CMOS 8-Bit Microcontroller

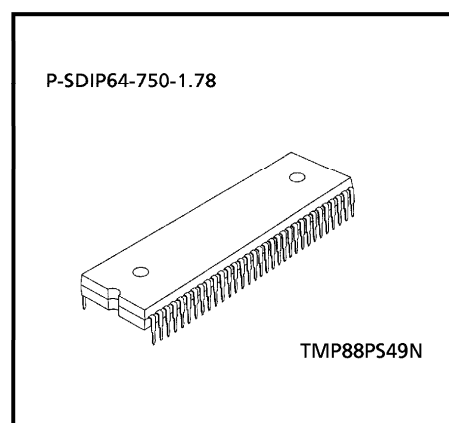
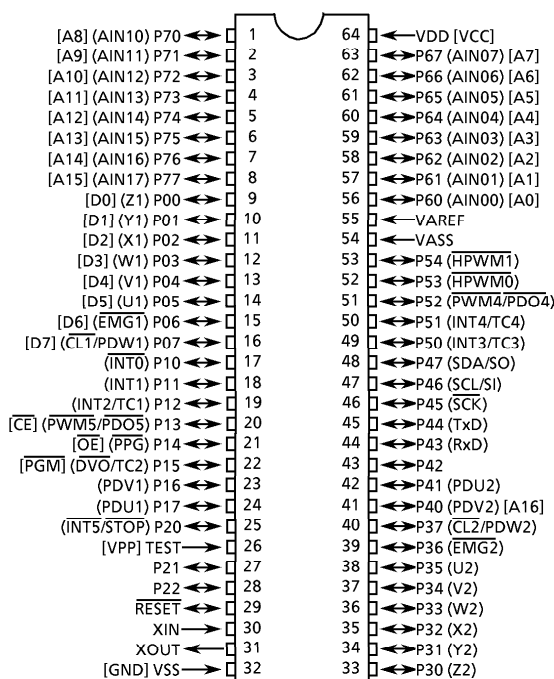
## TMP88PS49N, TMP88PS49F

The TMP88PS49 is a One-Time PROM microcontroller with low-power 514 Kbits (64 Kbytes + 256 bytes) electrically programmable read only memory for the TMP88CK49/CM49 system evaluation. The TMP88PS49 is pin compatible with the TMP88CK49/CM49/CS48A/CK48/CM48. The operations possible with the TMP88CK49/CM49/CS48A/CK48/CM48 can be performed by writing programs to PROM. However, when it is used as TMP88CK48/CM48 please do not use the second Programmable motor driver (PMD2), Timer / Counter 5 (TC5), Timer / Counter 6 (TC6) and High-speed PWM (HPWM1), and as TMP88CS48A please do not use the second Programmable motor driver (PMD2). The TMP88PS49 can write and verify in the same way as the TC571000 using an adaptor socket BM11110A/BM11111A and an EPROM programmer.

| Part No.   | OTP                   | RAM      | Package            | Adaptor Scket |
|------------|-----------------------|----------|--------------------|---------------|
| TMP88PS49N | 64 Kbytes + 256 bytes | 2 Kbytes | P-SDIP64-750-1.78  | BM11110A      |
| TMP88PS49F |                       |          | P-QFP64-1420-1.00A | BM11111A      |

## Pin Assignments (Top View)

P-SDIP64-750-1.78

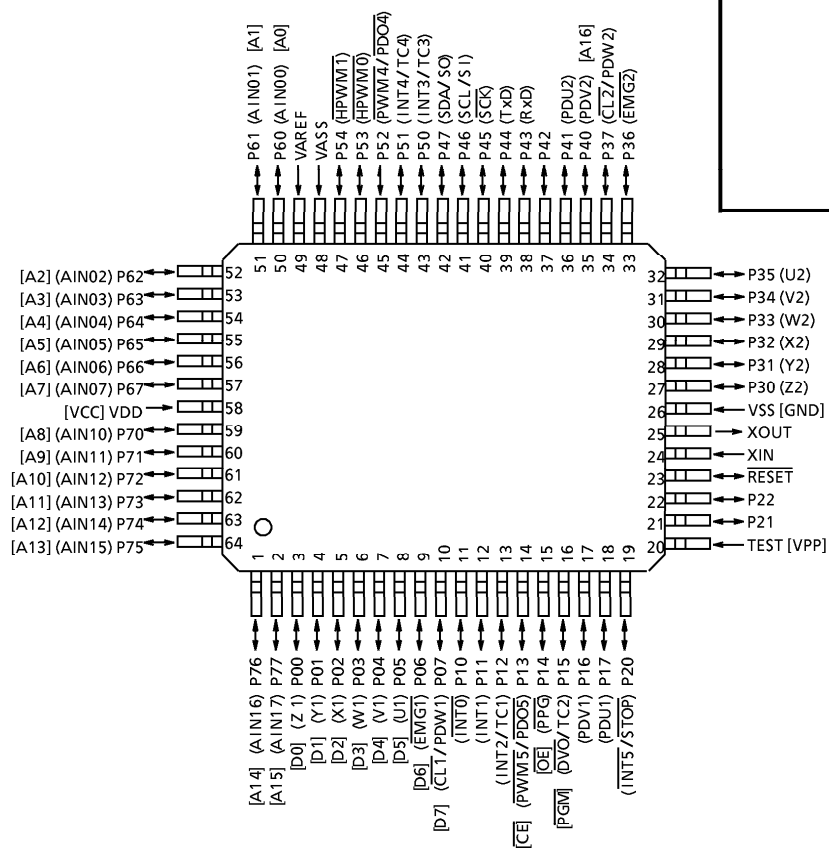


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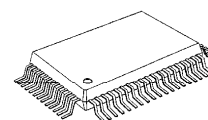
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## Pin Assignments (Top View)

P-QFP64-1420-1.00A



P-QFP64-1420-1.00A



TMP88PS49F

## Pin Function

The TMP88PS49 has two modes: MCU and PROM.

### (1) MCU mode

In this mode, the TMP88PS49 is pin compatible with the TMP88CK49/CM49/CS48A/CK48/CM48 (fix the TEST pin at "L" level).

### (2) PROM mode

| Pin Name<br>(PROM mode)   | Input / Output | Functions                                                     | Pin Name<br>(MCU mode)                        |  |
|---------------------------|----------------|---------------------------------------------------------------|-----------------------------------------------|--|
| A16                       | Input          | PROM address inputs                                           | P40                                           |  |
| A15 to A8                 |                |                                                               | P77 to P70                                    |  |
| A7 to A0                  |                |                                                               | P67 to P60                                    |  |
| D7 to D0                  | I/O            | PROM data input/outputs                                       | P07 to P00                                    |  |
| $\overline{\text{CE}}$    | Input          | Chip enable signal input (active low)                         | P13                                           |  |
| $\overline{\text{OE}}$    |                | Output enable signal input (active low)                       | P14                                           |  |
| $\overline{\text{PGM}}$   |                | Program enable signal input                                   | P15                                           |  |
| VPP                       | Power suppluy  | + 12.75 V/5 V (Program supply voltage)                        | TEST                                          |  |
| VCC                       |                | + 6.25 V/5 V                                                  | VDD                                           |  |
| GND                       |                | 0 V                                                           | VSS                                           |  |
| P37 to P30                | I/O            | Pull-up with resistance for input processing                  | PROM mode setting pin. Be fixed at "H" level. |  |
| P47 to P41                |                |                                                               |                                               |  |
| P54 to P50                |                |                                                               |                                               |  |
| P11                       |                | PROM mode setting pin. Be fixed at "L" level.                 |                                               |  |
| P21                       |                |                                                               |                                               |  |
| P12 , P10                 |                |                                                               |                                               |  |
| P17 to P16                |                |                                                               |                                               |  |
| P22 , P20                 |                |                                                               |                                               |  |
| $\overline{\text{RESET}}$ |                |                                                               |                                               |  |
| XIN                       | Input          | Connect an 16 MHz oscillator to stabilize the internal state. |                                               |  |
| XOUT                      | Output         |                                                               |                                               |  |
| VAREF                     | Power Suppluy  | 0 V (GND)                                                     |                                               |  |
| VASS                      |                |                                                               |                                               |  |

## Operational Description

The following explains the TMP88PS49 hardware configuration and operation. The configuration and functions of the TMP88PS49 are the same as those of the TMP88CK49/CM49/CS48A/CK48/CM48, except in that a one-time PROM is used instead of an on-chip mask ROM.

### 1. Operating Mode

The TMP88PS49 has two modes: MCU and PROM.

#### 1.1 MCU mode

The MCU mode is activated by fixing the TEST/VPP pin at "L" level.

In the MCU mode, operation is the same as with the TMP88CK49/CM49/CS48A/CK48/CM48 (the TEST/VPP pin cannot be used open because it has no built-in pull-down resistance).

##### 1.1.1 Program Memory

The TMP88PS49 has a 64 Kbytes (addresses 4000<sub>H</sub> to 13FFF<sub>H</sub> in the MCU mode, addresses 0000<sub>H</sub> to FFFF<sub>H</sub> in the PROM mode) and 256 bytes (addresses FFF00<sub>H</sub> to FFFFF<sub>H</sub> in the MCU mode, addresses 1FF00<sub>H</sub> to 1FFFF<sub>H</sub> in the PROM mode) of program memory (OTP).

If using TMP88PS49 for system evaluation of TMP88CK49/CM49/CS48A/CK48/CM48, write the program to the program memory area shown in figure 1-1.

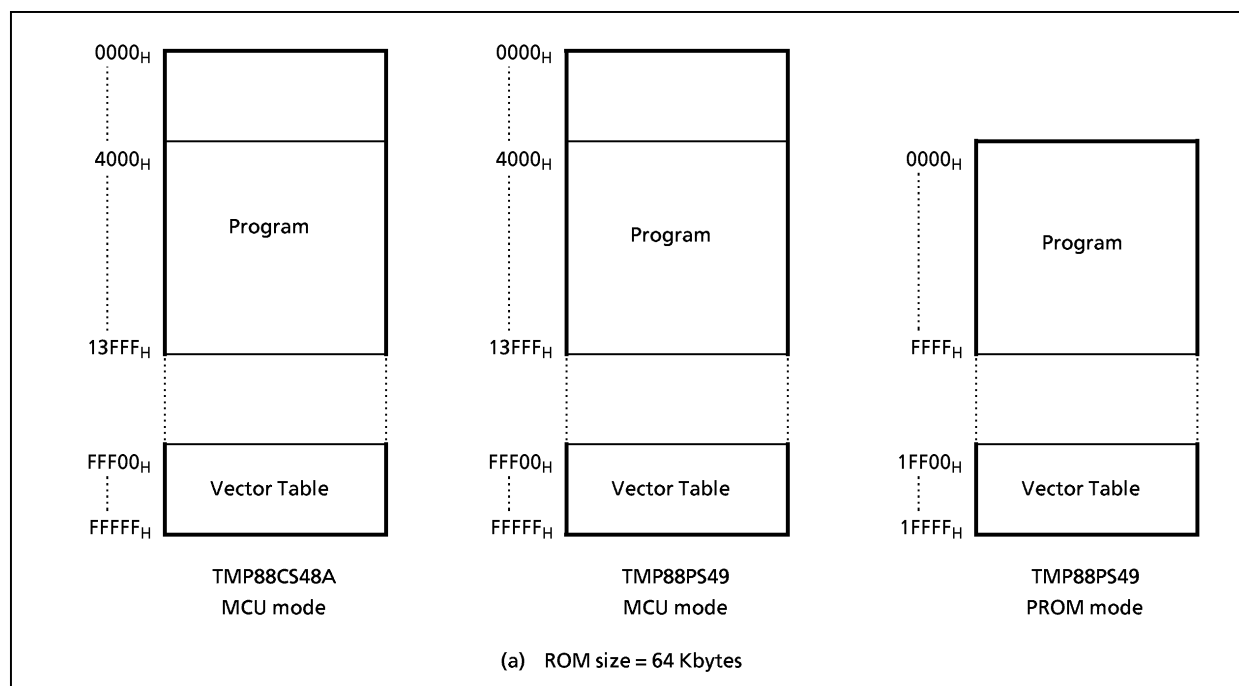


Figure 1-1. Program Memory Area (1/2)

## 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>   | Port P21, P22, RESET, Tri-state port | – 0.3 to V <sub>DD</sub> + 0.3 | V    |
|                                 | V <sub>OUT2</sub>   | Port P20, Sink open drain port       | – 0.3 to 5.5                   |      |
| Output Current                  | I <sub>OUT1</sub>   | Ports P1, P2, P4, P5, P6, P7         | 3.2                            | mA   |
|                                 | I <sub>OUT2</sub>   | Port P0                              | 20                             |      |
|                                 | I <sub>OUT3</sub>   | Port P3                              | 30                             |      |
| Output Current                  | Σ I <sub>OUT1</sub> | Ports P1, P2, P4, P5, P6, P7         | 120                            | mA   |
|                                 | Σ I <sub>OUT2</sub> | Port P0                              | 60                             |      |
|                                 | Σ I <sub>OUT3</sub> | Port P3                              | 120                            |      |
| Power Dissipation [Topr = 70°C] | PD                  | TMP88PS49N                           | 600                            | mW   |
|                                 |                     | TMP88PS49F                           | 350                            |      |
| Soldering Temperature (time)    | Tsld                |                                      | 260 (10 s)                     | °C   |
| Storage Temperature             | Tstg                |                                      | – 55 to 125                    | °C   |
| Operating Temperature           | Topr                |                                      | – 40 to 85                     | °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 = – 40 to 85°C)

| Parameter          | Symbol           | Pins                    | Conditions                     | Min                    | Max                    | Unit |
|--------------------|------------------|-------------------------|--------------------------------|------------------------|------------------------|------|
| Supply Voltage     | V <sub>DD</sub>  |                         | fc = 16 MHz                    | 4.5                    | 5.5                    | V    |
|                    |                  |                         | NORMAL mode                    |                        |                        |      |
|                    |                  |                         | IDLE mode                      | 2.0                    |                        |      |
| Input High Voltage | V <sub>IH1</sub> | Except hysteresis input | V <sub>DD</sub> ≥ 4.5 V        | V <sub>DD</sub> × 0.70 | V <sub>DD</sub>        | V    |
|                    | V <sub>IH2</sub> | Hysteresis input        |                                | V <sub>DD</sub> × 0.75 |                        |      |
|                    | V <sub>IH3</sub> |                         | V <sub>DD</sub> < 4.5 V        | V <sub>DD</sub> × 0.90 |                        |      |
| Input Low Voltage  | V <sub>IL1</sub> | Except hysteresis input | V <sub>DD</sub> ≥ 4.5 V        | 0                      | V <sub>DD</sub> × 0.30 | V    |
|                    | V <sub>IL2</sub> | Hysteresis input        |                                |                        | V <sub>DD</sub> × 0.25 |      |
|                    | V <sub>IL3</sub> |                         | V <sub>DD</sub> < 4.5 V        |                        | V <sub>DD</sub> × 0.10 |      |
| Clock Frequency    | fc               | XIN, XOUT               | V <sub>DD</sub> = 4.5 to 5.5 V | 8.0                    | 16.0                   | MHz  |

**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: The condition of supply voltage range is the value in NORMAL and IDLE modes.

## DC Characteristics

(V<sub>SS</sub> = 0 V, Topr = – 40 to 85°C)

| Parameter                     | Symbol           | Pins                             | Conditions                                                                | Min | Typ. | Max | Unit |
|-------------------------------|------------------|----------------------------------|---------------------------------------------------------------------------|-----|------|-----|------|
| Hysteresis Voltage            | V <sub>HS</sub>  | Hysteresis inputs                |                                                                           | –   | 0.9  | –   | V    |
| Input Current                 | I <sub>IN1</sub> | TEST                             | V <sub>DD</sub> = 5.5 V<br>V <sub>IN</sub> = 5.5 V/0 V                    | –   | –    | ± 2 | μA   |
|                               | I <sub>IN2</sub> | Sink open drain, Tri-state ports |                                                                           |     |      |     |      |
|                               | I <sub>IN3</sub> | RESET, STOP                      |                                                                           |     |      |     |      |
| Input Resistor (*)            | R <sub>IN</sub>  | RESET                            |                                                                           | 90  | 220  | 510 | kΩ   |
| Output Leakage Current        | I <sub>OL</sub>  | Sink open drain, Tri-state ports | V <sub>DD</sub> = 5.5 V, V <sub>OUT</sub> = 5.5 V/0 V                     | –   | –    | ± 2 | μA   |
| Output High Voltage           | V <sub>OH</sub>  | Tri-state ports                  | V <sub>DD</sub> = 4.5 V, I <sub>OH</sub> = – 0.7 mA                       | 4.1 | –    | –   | V    |
| Output Low Current            | I <sub>OL1</sub> | Except XOUT, Ports P0, P3.       | V <sub>DD</sub> = 4.5 V, V <sub>OL</sub> = 0.4 V                          | –   | 1.6  | –   | mA   |
|                               | I <sub>OL2</sub> | Port P0                          | V <sub>DD</sub> = 4.5 V, V <sub>OL</sub> = 1.0 V                          | 6   | 10   | –   |      |
|                               | I <sub>OL3</sub> | Port P3                          |                                                                           | –   | 20   | –   |      |
| Supply Current in NORMAL Mode |                  |                                  | V <sub>DD</sub> = 5.5 V<br>V <sub>IN</sub> = 5.3 V/0.2 V<br>fc = 16.0 MHz | –   | 32   | 40  | mA   |
| Supply Current in IDLE Mode   |                  |                                  |                                                                           | –   | 24   | 30  | mA   |
| Supply Current in STOP Mode   |                  |                                  | V <sub>DD</sub> = 5.5 V<br>V <sub>IN</sub> = 5.3 V/0.2 V                  | –   | 0.5  | 20  | μA   |

Note 1: Typical values show those at Topr = 25°C, V<sub>DD</sub> = 5 V.Note 2: Input Current I<sub>IN1</sub>, I<sub>IN3</sub>; The current through resistor is not included, when the input resistor (pull-up or pull-down) is contained.Note 3: I<sub>DD</sub> except I<sub>REF</sub>.

## AD Conversion Characteristics

(Topr = – 40 to 85°C)

| Parameter                | Symbol            | Conditions                                                                                                    | Min                   | Typ. | Max               |         |         | Unit |
|--------------------------|-------------------|---------------------------------------------------------------------------------------------------------------|-----------------------|------|-------------------|---------|---------|------|
|                          |                   |                                                                                                               |                       |      | ADCDR1            | ADCDR2  |         |      |
|                          |                   |                                                                                                               |                       |      |                   | ACK = 0 | ACK = 1 |      |
| Analog Reference Voltage | V <sub>AREF</sub> | V <sub>AREF</sub> – V <sub>ASS</sub> ≥ 3.5 V                                                                  | V <sub>DD</sub> – 1.0 | —    | V <sub>DD</sub>   |         |         | V    |
|                          | V <sub>ASS</sub>  |                                                                                                               | V <sub>SS</sub>       | —    | 1.0               |         |         |      |
| Analog Input Voltage     | V <sub>AIN</sub>  |                                                                                                               | V <sub>ASS</sub>      | —    | V <sub>AREF</sub> |         |         | V    |
| Analog Supply Current    | I <sub>REF</sub>  | V <sub>AREF</sub> = 5.5 V,<br>V <sub>ASS</sub> = 0.0 V                                                        | —                     | 0.5  | 1.0               |         |         | mA   |
| Non-Linearity Error      |                   | V <sub>DD</sub> = 5.0 V, V <sub>SS</sub> = 0.0 V<br>V <sub>AREF</sub> = 5.000 V<br>V <sub>ASS</sub> = 0.000 V | —                     | —    | ± 1               | ± 3     | ± 2     | LSB  |
| Zero Point Error         |                   |                                                                                                               | —                     | —    | ± 1               | ± 3     | ± 2     |      |
| Full Scale Error         |                   |                                                                                                               | —                     | —    | ± 1               | ± 3     | ± 2     |      |
| Total Error              |                   |                                                                                                               | —                     | —    | ± 2               | ± 6     | ± 4     |      |

Note 1: ADCDR1: 8-bit AD conversion result (1LSB = ΔV<sub>AREF</sub>/256)ADCDR2: 10-bit AD conversion result (1LSB = ΔV<sub>AREF</sub>/1024)

Note 2: Total error includes all errors except quantization error.

## AC Characteristics

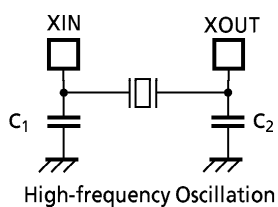
(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 4.5 to 5.5 V, T<sub>opr</sub> = – 40 to 85°C)

| Parameter                   | Symbol           | Conditions                                  | Min   | Typ. | Max  | Unit |
|-----------------------------|------------------|---------------------------------------------|-------|------|------|------|
| Machine Cycle Time          | t <sub>cy</sub>  | NORMAL mode                                 | 0.25  | –    | 0.5  | μs   |
|                             |                  | IDLE mode                                   |       |      |      |      |
| "H" Level Clock Pulse Width | t <sub>WCH</sub> | For external clock operation<br>(XIN input) | 31.25 | –    | 62.5 | ns   |
| "L" Level Clock Pulse Width | t <sub>WCL</sub> |                                             |       |      |      |      |

## Recommended Oscillating Conditions

(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 4.5 to 5.5 V, T<sub>opr</sub> = – 40 to 85°C)

| Parameter                  | Oscillator        | Oscillation Frequency | Recommended Oscillator | Recommended Constant |                |
|----------------------------|-------------------|-----------------------|------------------------|----------------------|----------------|
|                            |                   |                       |                        | C <sub>1</sub>       | C <sub>2</sub> |
| High-frequency Oscillation | Ceramic Resonator | 16 MHz                | MURATA CSA 16.00 MXZ   | 5 pF                 | 5 pF           |
|                            |                   |                       | MURATA CST 16.00 MXZ   | built-in 5 pF        | built-in 5 pF  |



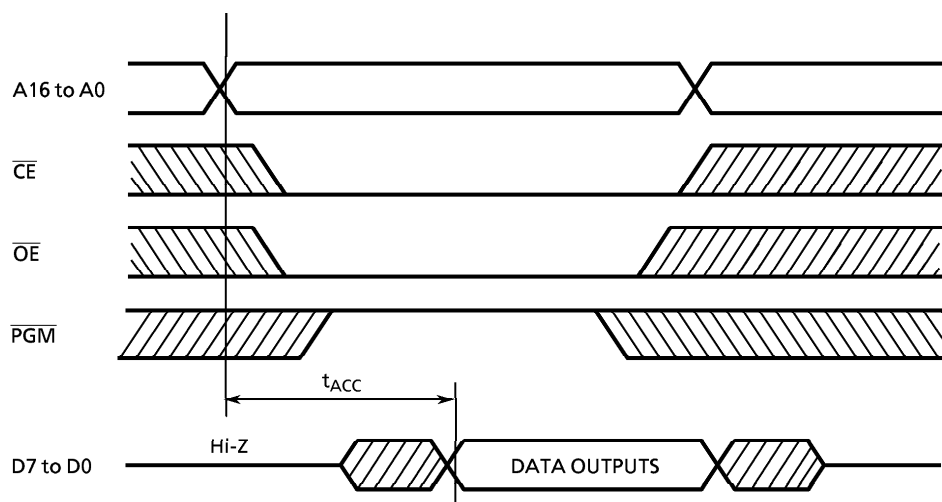
**Note:** An electrical shield by metal shield on the surface of IC package should be recommendable in order to prevent the device from the high electric fieldstress applied from CRT (Cathode Ray Tube) for continuous reliable operation.

## DC/AC Characteristics (PROM mode)

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

## (1) Read Operation

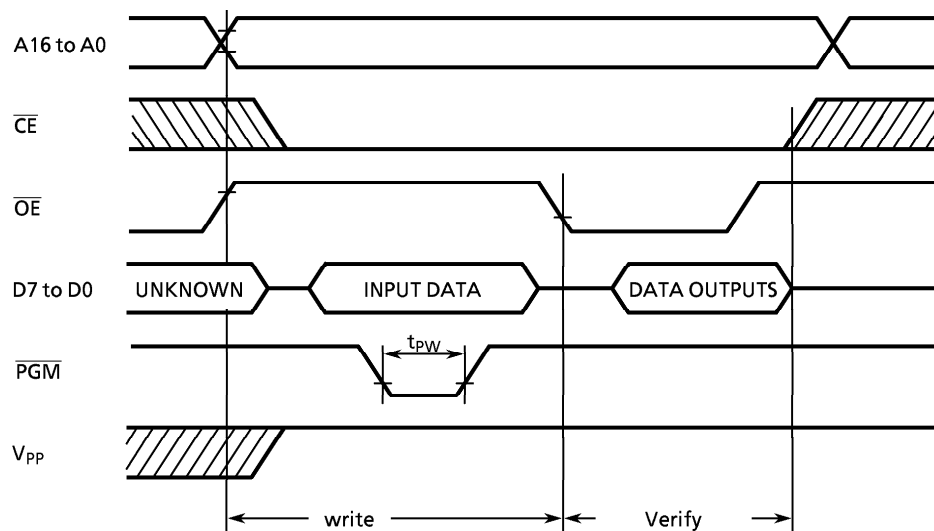
| Parameter                    | Symbol    | Conditions                       | Min                 | Typ.               | Max                  | Unit |
|------------------------------|-----------|----------------------------------|---------------------|--------------------|----------------------|------|
| 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                | 5.0                | 5.25                 | V    |
| Program Power Supply Voltage | $V_{PP}$  |                                  |                     |                    |                      |      |
| Address Access Time          | $t_{ACC}$ | $V_{CC} = 5.0 \pm 0.25\text{ V}$ | –                   | $1.5t_{CYC} + 300$ | –                    | ns   |

Note:  $t_{CYC} = 250\text{ ns}$  at 16 MHz

## (2) High-Speed Programming Operation

| 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         | $V_{CC}$  |                         | 6.0                 | 6.25  | 6.5                  | V    |
| Program Power Supply Voltage | $V_{PP}$  |                         | 12.5                | 12.75 | 13.0                 | V    |
| Initial Program Pulse Width  | $t_{PW}$  | $V_{CC} = 6.0\text{ V}$ | 0.095               | 0.1   | 0.105                | ms   |

High-Speed Programing Timing



**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 ( $2.75\text{ V} \pm 0.5\text{ V} = V$ ) to the  $V_{pp}$  pin as the device is damaged.