

CMOS 8-Bit Microcontroller

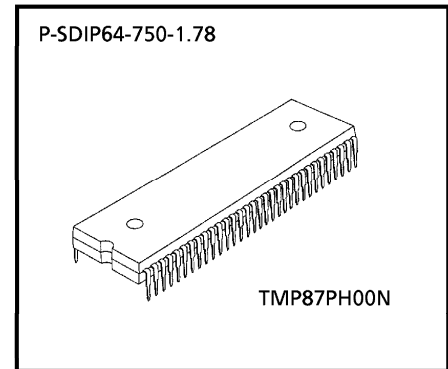
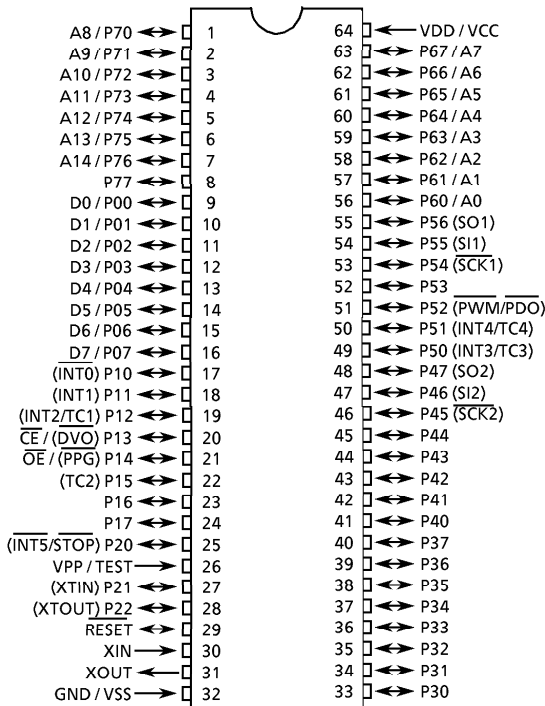
TMP87PH00N
TMP87PH00F
TMP87PH00DF
TMP87PH00LF

The 87PH00 is a One-Time PROM microcontroller with low-power 128 K bits (16 Kbytes) electrically programmable read only memory for the 87C800/CH00 system evaluation. The 87PH00 is pin compatible with the 87C800/CH00. The operations possible with the 87C800/CH00 can be performed by writing programs to PROM. The 87PH00 can write and verify in the same way as the TMM27256AD using an adaptor socket BM1136/BM1137/BM1173 and an EPROM programmer.

| Part No. | OTP | RAM | Package | Adapter Socket |
|-------------|--------------|-------------|--------------------|----------------|
| TMP87PH00N | 16 K × 8-bit | 256 × 8-bit | P-SDIP64-750-1.78 | BM1136 |
| TMP87PH00F | | | P-QFP64-1420-1.00A | BM1137 |
| TMP87PH00DF | | | P-QFP64-1414-0.80A | BM1173 |
| TMP87PH00LF | | | | |

Pin Assignments (Top View)

P-SDIP64-750-1.78

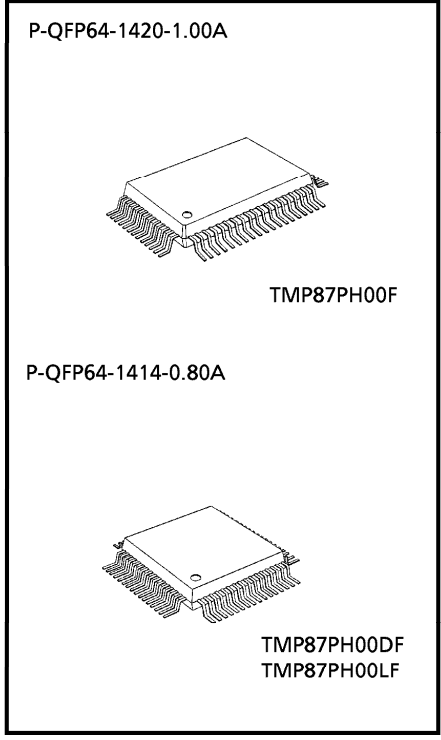
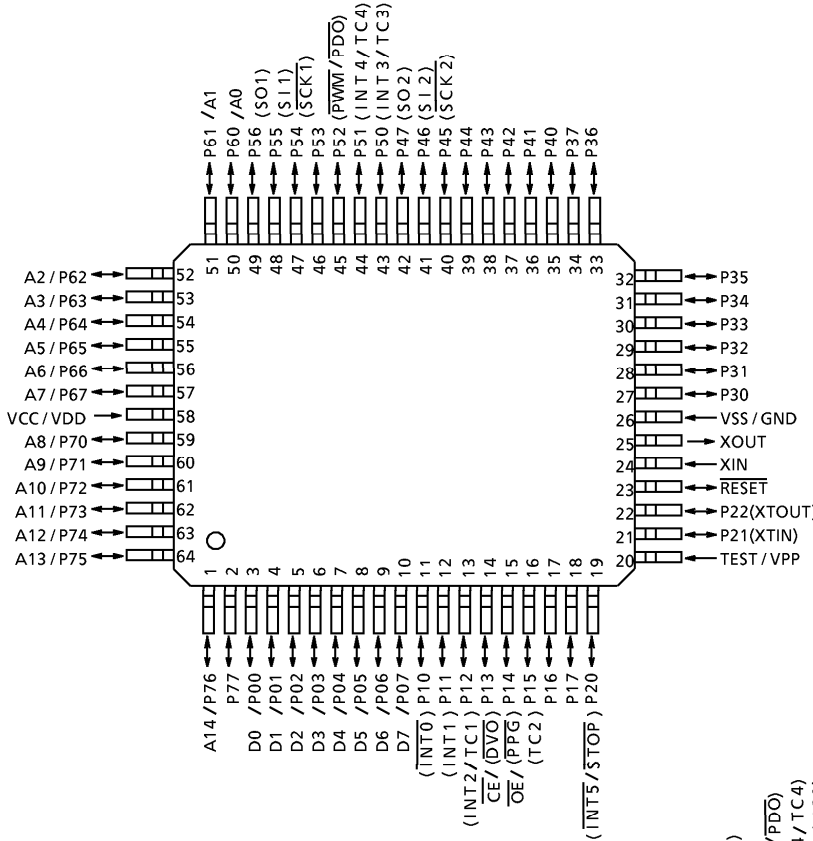


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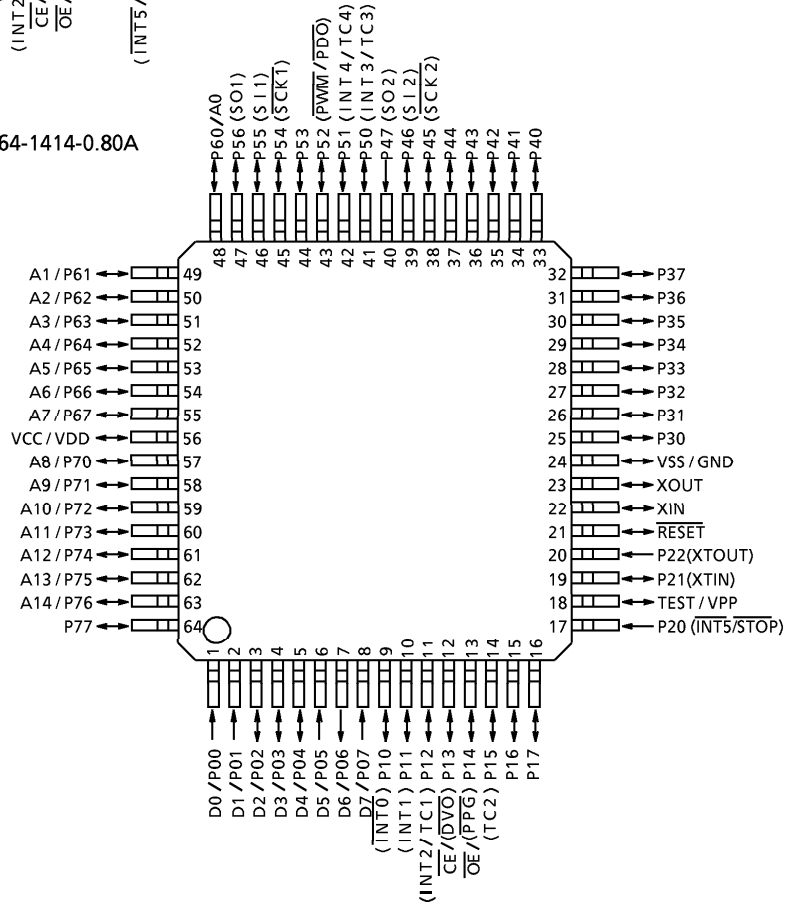
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Pin Assignments (Top View)

P-QFP64-1420-1.00A



P-QFP64-1414-0.80A



Pin Function

The 87PH00 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PH00 is pin compatible with the 87C800/CH00 (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 |
| \overline{CE} | Input | Chip enable signal input (active low) | P13 |
| \overline{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 |
| P37 to P30 | I/O | Pull-up with resistance for input processing | PROM mode setting pin. Be fixed at high level. |
| P47 to P40 | | | |
| P56 to P50 | | | |
| P11 | | PROM mode setting pin. Be fixed at low level. | |
| P21 | | | |
| P77 | | | |
| P17 to P15 | | | |
| P12, P10 | | | |
| P22, P20 | | | |
| \overline{RESET} | | | |
| XIN | Input | Connect an 8MHz oscillator to stabilize the internal state. | |
| XOUT | Output | | |

Operational Description

The following explains the 87PH00 hardware configuration and operation. The configuration and functions of the 87PH00 are the same as those of the 87C800/CH00, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PH00 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 87PH00 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 87C800/CH00 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PH00 has a 16 K × 8-bit (addresses C000_H to FFFF_H in the MCU mode, addresses 4000_H to 7FFF_H in the PROM mode) of program memory (OTP).

To use the 87PH00/PH00L as the system evaluation for the 87C800/CH00/CH00L, the program should be written to the program memory area as shown in Figure 1-1.

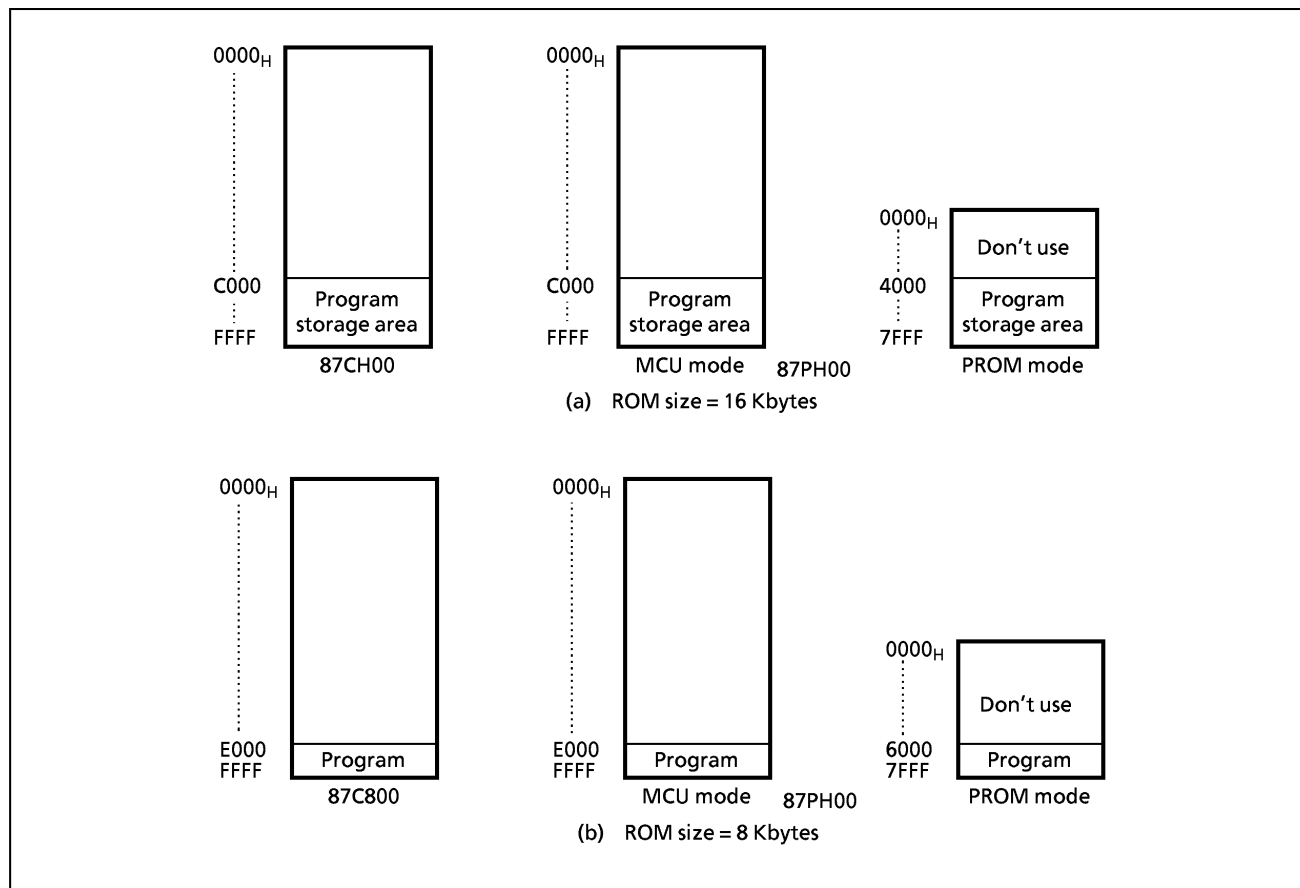


Figure 1-1. Program Memory Area

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

Electrical Characteristics

Absolute Maximum Ratings

 $(V_{SS} = 0 \text{ V})$

| Parameter | Symbol | Conditions | Ratings | Unit |
|--|-------------------|---|-------------------------|------------------|
| Supply Voltage | V_{DD} | | - 0.3 to 7 | V |
| Program Voltage | V_{PP} | TEST / VPP | - 0.3 to 13.0 | V |
| Input Voltage | V_{IN} | | - 0.3 to $V_{DD} + 0.3$ | V |
| Output Voltage | V_{OUT1} | P0, P1, P2, P6, P7, XOUT, $\overline{\text{RESET}}$ | - 0.3 to $V_{DD} + 0.3$ | V |
| | V_{OUT2} | P3, P4, P5 | - 0.3 to 10 | |
| Output Current (Per 1 pin) | I_{OUT1} | P0, P1, P2, P4, P5, P6, P7 | 3.2 | mA |
| | I_{OUT2} | P3 | 30 | |
| Output Current (Total) | ΣI_{OUT1} | P0, P1, P2, P4, P5, P6, P7 | 120 | mA |
| | ΣI_{OUT2} | P3 | 120 | |
| Power Dissipation [$T_{opr} = 70^\circ\text{C}$] | PD | TMP87PH00N | 600 | mW |
| | | TMP87PH00F / PH00DF | 350 | |
| Soldering Temperature (time) | T_{sld} | | 260 (10 s) | $^\circ\text{C}$ |
| Storage Temperature | T_{stg} | | - 55 to 125 | $^\circ\text{C}$ |
| Operating Temperature | T_{opr} | | - 30 to 70 | $^\circ\text{C}$ |

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

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

| Parameter | Symbol | Pins | Conditions | Min | Max | Unit | |
|--------------------|-----------|-------------------------|--|--------------------------|--------------------------|------|----------------------|
| Supply Voltage | V_{DD} | | $f_c = 8 \text{ MHz}$ | NORMAL1, 2 mode | 4.5 | 6.0 | 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 | | | |
| STOP 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 | $V_{DD} = 4.5 \text{ to } 6 \text{ V}$ | 0.4 | 8.0 | MHz | |
| | | | $V_{DD} = 2.7 \text{ to } 6 \text{ V}$ | | 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 ($V_{SS} = 0\text{ V}$, $T_{opr} = -30\text{ to }70^\circ\text{C}$)

| Parameter | Symbol | Pins | Conditions | Min | Typ. | Max | Unit |
|-------------------------------------|-----------|--|--|-----|------|---------|------------------|
| Hysteresis Voltage | V_{HS} | Hysteresis inputs | $V_{DD} = 5.0\text{ V}$ | – | 0.9 | – | V |
| Input Current | I_{IN1} | TEST | $V_{DD} = 5.5\text{ V}$ $V_{IN} = 5.5\text{ V} / 0\text{ V}$ | – | – | ± 2 | μA |
| | I_{IN2} | Open drain ports, tri-state ports | | | | | |
| | I_{IN3} | $\overline{\text{RESET}}$, $\overline{\text{STOP}}$ | | | | | |
| Input Resistance | R_{IN2} | $\overline{\text{RESET}}$ | $V_{DD} = 5.0\text{ V}$ | 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 | μA |
| | I_{LO2} | Tri-state ports | $V_{DD} = 5.5\text{ V}$, $V_{OUT} = 5.5\text{ V} / 0\text{ V}$ | – | – | ± 2 | |
| Output High Voltage | V_{OH2} | Tri-state ports | $V_{DD} = 4.5\text{ V}$, $I_{OH} = -0.7\text{ mA}$ | 4.1 | – | – | V |
| Output Low Voltage | V_{OL} | Except XOUT and P3 | $V_{DD} = 4.5\text{ V}$, $I_{OL} = 1.6\text{ mA}$ | – | – | 0.4 | |
| Output Low Current | I_{OL3} | Port P3 | $V_{DD} = 4.5\text{ V}$, $V_{OL} = 1.0\text{ V}$ | – | 20 | – | mA |
| Supply Current in NORMAL 1, 2 modes | I_{DD} | | $V_{DD} = 5.5\text{ V}$ $f_c = 8\text{ MHz}$ $f_s = 32.768\text{ kHz}$ $V_{IN} = 5.3\text{ V} / 0.2\text{ V}$ | – | 8.5 | 12 | mA |
| Supply Current in IDLE 1, 2 modes | | | | – | 3.5 | 5 | mA |
| Supply Current in NORMAL 1, 2 modes | | | $V_{DD} = 3.0\text{ V}$, $V_{IN} = 2.8\text{ V} / 0.2\text{ V}$ $f_c = 4.19\text{ kHz}$ $f_s = 32.768\text{ kHz}$ | – | 2.5 | 3.5 | mA |
| Supply Current in IDLE 1, 2 modes | | | | – | 1.5 | 2.0 | mA |
| Supply Current in SLOW mode | | | $V_{DD} = 3.0\text{ V}$ $f_s = 32.768\text{ kHz}$ $V_{IN} = 2.8\text{ V} / 0.2\text{ V}$ | – | 30 | 60 | μA |
| Supply Current in SLEEP mode | | | | – | 15 | 30 | μA |
| Supply Current in STOP mode | | | $V_{DD} = 5.5\text{ V}$ $V_{IN} = 5.3\text{ V} / 0.2\text{ V}$ | – | 0.5 | 10 | μA |

Note 1: Typical value 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.C. Characteristics

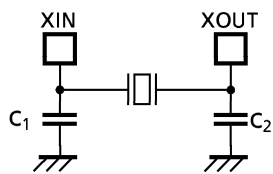
(V_{SS} = 0 V, V_{DD} = 4.5 to 6.0 V, Topr = - 30 to 70°C)

| Parameter | Symbol | Conditions | Min | Typ. | Max | Unit |
|------------------------------|------------------|--|-------|------|-------|------|
| Machine Cycle Time | t _{cy} | In NORMAL1, 2 modes | 0.5 | - | 10 | μs |
| | | 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 (XIN input), f _c = 8 MHz | 50 | - | - | ns |
| Low Level Clock Pulse Width | t _{WCL} | | | | | |
| High Level Clock Pulse Width | t _{WSH} | For external clock operation (XTIN input), f _s = 32.768 kHz | 14.7 | - | - | μs |
| Low Level Clock Pulse Width | t _{WSL} | | | | | |

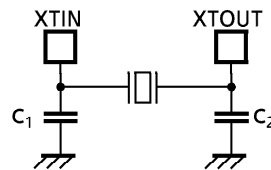
Recommended Oscillating Conditions

(V_{SS} = 0 V, V_{DD} = 4.5 to 6.0 V, Topr = - 30 to 70°C)

| Parameter | Oscillator | Oscillation Frequency | Recommended Oscillator | | Recommended Constant | |
|----------------------------|--------------------|-----------------------|------------------------|-------------|----------------------|----------------|
| | | | | | C ₁ | C ₂ |
| High-frequency Oscillation | Ceramic Resonator | 8 MHz | KYOCERA | KBR8.0M | 30 pF | 30 pF |
| | | 4 MHz | KYOCERA | KBR4.0MS | | |
| | Crystal Oscillator | 8 MHz | MURATA | CSA4.00MG | 20 pF | 20 pF |
| | | 4 MHz | TOYOCOM | 210B 8.0000 | | |
| Low-frequency Oscillation | Crystal Oscillator | 32.768 kHz | TOYOCOM | 204B 4.0000 | 15 pF | 15 pF |
| | | | NDK | MX-38T | | |



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

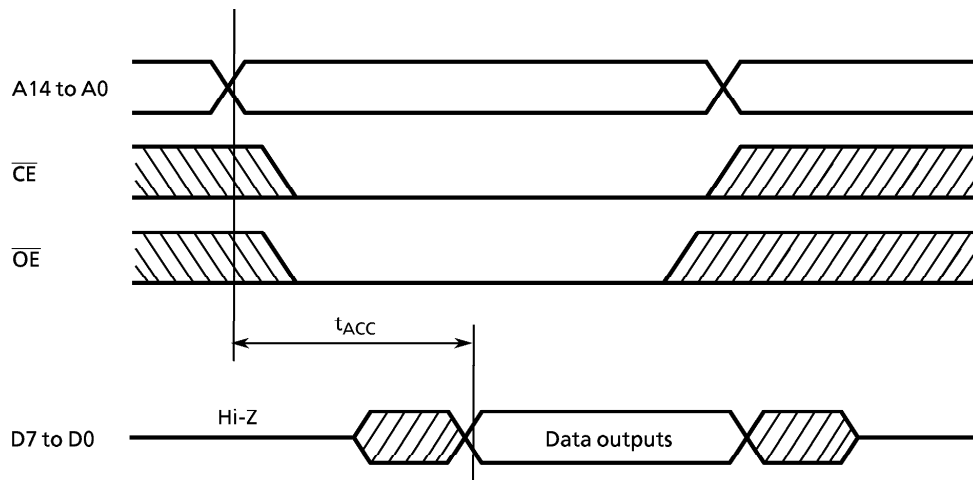
Note: When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

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

(1) Read Operation ($T_{opr} = -30\text{ to }70^\circ\text{C}$)

| 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 | 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} | $V_{CC} = 5.0 \pm 0.25\text{ V}$ | – | $1.5\ t_{cyc} + 300$ | – | ns |

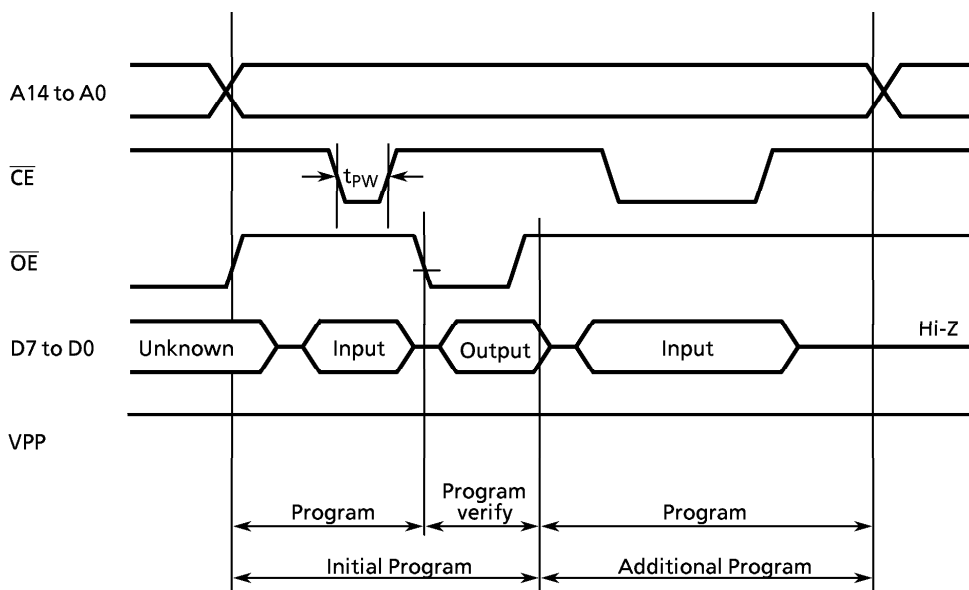
Note: $t_{cyc} = 500\text{ ns at }8\text{ MHz}$



Timing Waveforms of Read Operation

(2) Program Operation (High-Speed Write Mode - I) (Topr = 25 ± 5°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} | $V_{CC} = 6.0 V \pm 0.25 V$ $V_{PP} = 12.5 \pm 0.5 V$ | 0.95 | 1.0 | 1.05 | ms |

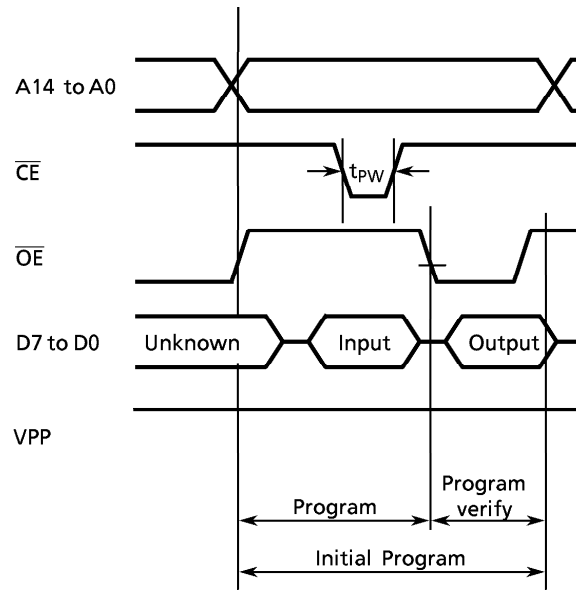


Timing Waveforms of Programming Operation

- 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 ($12.5 V \pm 0.5 V$) 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) ($T_{opr} = 25 \pm 5 \text{ }^\circ\text{C}$)

| 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 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.

Electrical Characteristics

Absolute Maximum Ratings

 $(V_{SS} = 0\text{ V})$

| Parameter | Symbol | Conditions | Ratings | Unit |
|--|-------------------|----------------------------------|-------------------------|--------------------|
| Supply Voltage | V_{DD} | | - 0.3 to 6.5 | V |
| Program Voltage | V_{PP} | TEST / VPP pin | - 0.3 to 13.0 | V |
| Input Voltage | V_{IN} | | - 0.3 to $V_{DD} + 0.3$ | V |
| Output Voltage | V_{OUT} | | - 0.3 to $V_{DD} + 0.3$ | V |
| Output Current (Per 1 pin) | I_{OUT1} | Ports P0, P1, P2, P4, P5, P6, P7 | 3.2 | mA |
| | I_{OUT2} | Port P3 | 30 | |
| Output Current (Total) | ΣI_{OUT1} | Ports P0, P1, P2, P4, P5, P6, P7 | 120 | mA |
| | ΣI_{OUT2} | Port P3 | 120 | |
| Power Dissipation [$T_{opr} = 70^{\circ}\text{C}$] | PD | | 350 | mW |
| Soldering Temperature (time) | T_{sld} | | 260 (10 s) | $^{\circ}\text{C}$ |
| Storage Temperature | T_{stg} | | - 55 to 125 | $^{\circ}\text{C}$ |
| Operating Temperature | T_{opr} | | - 30 to 70 | $^{\circ}\text{C}$ |

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

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

| Parameter | Symbol | Pins | Conditions | Min | Max | Unit | |
|--------------------|-----------|--------------------------|---------------------------------------|-------------------------|----------|------|----------------------|
| Supply Voltage | V_{DD} | | $f_c = 8\text{ MHz}$ | NORMAL1, 2 mode | 4.5 | V | |
| | | | | IDLE1, 2 mode | | | |
| | | | $f_c = 4.2\text{ MHz}$ | NORMAL1, 2 mode | 1.8 | | |
| | | | | IDLE1, 2 mode | | | |
| | | | $f_s = 32.768\text{ kHz}$ | SLOW mode | | | |
| SLEEP mode | | | | | | | |
| | | STOP mode | | | | | |
| Input High Voltage | V_{IH1} | Except Hysteresis inputs | $V_{DD} \geq 4.5\text{ V}$ | $V_{DD} \times 0.7$ | V_{DD} | V | |
| | V_{IH2} | Hysteresis inputs | | $V_{DD} \times 0.75$ | | | |
| | V_{IH3} | | | $V_{DD} < 4.5\text{ V}$ | | | $V_{DD} \times 0.90$ |
| Input Low Voltage | V_{IL1} | Except Hysteresis inputs | $V_{DD} \geq 4.5\text{ V}$ | $V_{DD} \times 0.28$ | V | V | |
| | V_{IL2} | Hysteresis inputs | | 0 | | | $V_{DD} \times 0.25$ |
| | V_{IL3} | | | $V_{DD} < 4.5\text{ V}$ | | | $V_{DD} \times 0.10$ |
| Clock Frequency | f_c | XIN, XOUT | $V_{DD} = 4.5\text{ to }5.5\text{ V}$ | 0.4 | 8.0 | MHz | |
| | | | $V_{DD} = 1.8\text{ to }4.5\text{ V}$ | | 4.2 | | |
| | f_s | XTIN, XOUT | | 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.

D.C. Characteristics

(V_{SS} = 0 V, T_{opr} = - 30 to 70°C)

| Parameter | Symbol | Pins | Conditions | Min | Typ. | Max | Unit |
|------------------------------------|--|--------------------------------------|--|-----|------|-----|------|
| Hysteresis Voltage | V _{HS} | Hysteresis inputs | V _{DD} = 5.0 V | - | 0.9 | - | V |
| Input Current | I _{IN1} | TEST | V _{DD} = 5.5 V V _{IN} = 5.5 V / 0 V | - | - | ± 2 | μA |
| | I _{IN2} | Open drain ports and tri-state ports | | | | | |
| | I _{IN3} | RESET, STOP | | | | | |
| Input Low Current | I _{IL} | Push-pull ports | V _{DD} = 5.5 V, V _{IN} = 0.4 V | - | - | - 2 | mA |
| Input Resistance | R _{IN1} | Port P7 with pull-up | V _{DD} = 5.0 V | 30 | 70 | 150 | kΩ |
| | R _{IN2} | RESET | V _{DD} = 5.0 V | 100 | 220 | 450 | |
| Output Leakage Current | I _{LO1} | Open drain ports | V _{DD} = 5.5 V, V _{OUT} = 5.5 V | - | - | 2 | μA |
| | I _{LO2} | Tri-state ports | V _{DD} = 5.5 V, V _{OUT} = 5.5 V / 0 V | - | - | ± 2 | |
| Output High Voltage | V _{OH1} | Push-pull ports | V _{DD} = 4.5 V, I _{OH} = - 200 μA | 2.4 | - | - | V |
| | V _{OH2} | Tri-state ports | V _{DD} = 4.5 V, I _{OH} = - 0.7 mA | 4.1 | - | - | |
| | V _{OH3} | Push-pull ports | V _{DD} = 1.8 V, I _{OH} = - 5 μA | 1.6 | - | - | |
| Output Low Voltage | V _{OH4} | Tri-state ports | V _{DD} = 1.8 V, I _{OH} = - 10 μA | 1.6 | - | - | |
| | V _{OL1} | Except XOUT and port P3 | V _{DD} = 4.5 V, I _{OL} = 1.6 mA | - | - | 0.4 | |
| | V _{OL2} | Except XOUT | V _{DD} = 1.8 V, I _{OL} = 20 μA | - | - | 0.2 | |
| Output Low Current | I _{OL3} | Port P3 | 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 f _c = 8 MHz f _s = 32.768 kHz V _{IN} = 5.3 V / 0.2 V | - | 7.0 | 10 | |
| Supply Current in IDLE 1, 2 mode | | | | - | 3.5 | 5 | |
| Supply Current in NORMAL 1, 2 mode | | | V _{DD} = 3.0 V f _c = 4.19 MHz f _s = 32.768 kHz V _{IN} = 2.8 V / 0.2 V | - | 2.5 | 3.5 | |
| Supply Current in IDLE 1, 2 mode | | | | - | 1.5 | 2.0 | |
| Supply Current in NORMAL 1, 2 mode | | | V _{DD} = 1.8 V f _c = 4.19 MHz f _s = 32.768 kHz V _{IN} = 1.7 V / 0.1 V | - | 1.0 | 2.0 | |
| Supply Current in IDLE 1, 2 mode | | | | - | 0.5 | 1.0 | |
| Supply Current in SLOW mode | | | V _{DD} = 3.0 V f _s = 32.768 kHz V _{IN} = 2.8 V / 0.2 V | - | 30 | 60 | |
| Supply Current in SLEEP mode | | | | - | 15 | 30 | |
| Supply Current in SLOW mode | | | V _{DD} = 1.8 V f _s = 32.768 kHz V _{IN} = 1.7 V / 0.1 V | - | 15 | 30 | |
| Supply Current in SLEEP mode | | | | - | 10 | 20 | |
| Supply Current in STOP mode | V _{DD} = 5.5 V V _{IN} = 5.3 V / 0.2 V | - | 0.5 | 10 | | | |

Note 1: Typical values show those at T_{opr} = 25°C, V_{DD} = 3V.

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

A.C. Characteristics

(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, T_{opr} = - 30 to 70°C)

| Parameter | Symbol | Conditions | Min | Typ. | Max | Unit |
|------------------------------|------------------|--|-------|------|-------|------|
| Machine Cycle Time | t _{cy} | In NORMAL 1, 2 mode | 0.5 | - | 10 | μs |
| | | In IDLE 1, 2 mode | | | | |
| | | In SLOW mode | 117.6 | - | 133.3 | |
| | | In SLEEP mode | | | | |
| High Level Clock Pulse Width | t _{WCH} | For external clock operation (XIN input) , fc = 8.4 MHz | 50 | - | - | ns |
| Low Level Clock Pulse Width | t _{WCL} | | | | | |
| High Level Clock Pulse Width | t _{WSH} | For external clock operation (XTIN input), fs = 32.768 kHz | 14.7 | - | - | μs |
| Low Level Clock Pulse Width | t _{WSL} | | | | | |

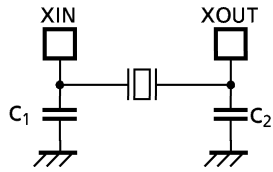
(V_{SS} = 0 V, V_{DD} = 1.8 to 4.5 V, T_{opr} = - 30 to 70°C)

| Parameter | Symbol | Conditions | Min | Typ. | Max | Unit |
|------------------------------|------------------|--|-------|------|-------|------|
| Machine Cycle Time | t _{cy} | In NORMAL 1, 2 mode | 0.95 | - | 10 | μs |
| | | In IDLE 1, 2 mode | | | | |
| | | In SLOW mode | 117.6 | - | 133.3 | |
| | | In SLEEP mode | | | | |
| High Level Clock Pulse Width | t _{WCH} | For external clock operation (XIN input) , fc = 4.2 MHz | 110 | - | - | ns |
| Low Level Clock Pulse Width | t _{WCL} | | | | | |
| High Level Clock Pulse Width | t _{WSH} | For external clock operation (XTIN input), fs = 32.768 kHz | 14.7 | - | - | μs |
| Low Level Clock Pulse Width | t _{WSL} | | | | | |

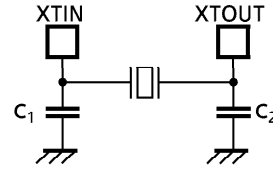
Recommended Oscillating Conditions

(V_{SS} = 0 V, T_{opr} = - 30 to 70°C)

| Parameter | Oscillator | Oscillation Frequency | Recommended Oscillator | | Recommended Constant | |
|----------------|--------------------|--|------------------------|------------|----------------------|----------------|
| | | | | | C ₁ | C ₂ |
| High-frequency | Ceramic Resonator | 4.19 MHz (V _{DD} = 1.8 to 5.5 V) | MURATA | CSA4.19MG | 30 pF | 30 pF |
| | | | MURATA | CST4.19MGW | - | - |
| | | 8 MHz (V _{DD} = 4.5 to 5.5 V) | MURATA | CSA8.00MTZ | 15 pF | 15 pF |
| | | | MURATA | CST8.00MTW | - | - |
| | Crystal Oscillator | 8 MHz (V _{DD} = 4.5 to 5.5 V) | NDK | AT-51 | 16 pF | 16 pF |
| Low-frequency | Crystal Oscillator | 32.768 kHz (V _{DD} = 1.8 to 5.5 V) | NDK | MX-38T | 12 pF | 12 pF |



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

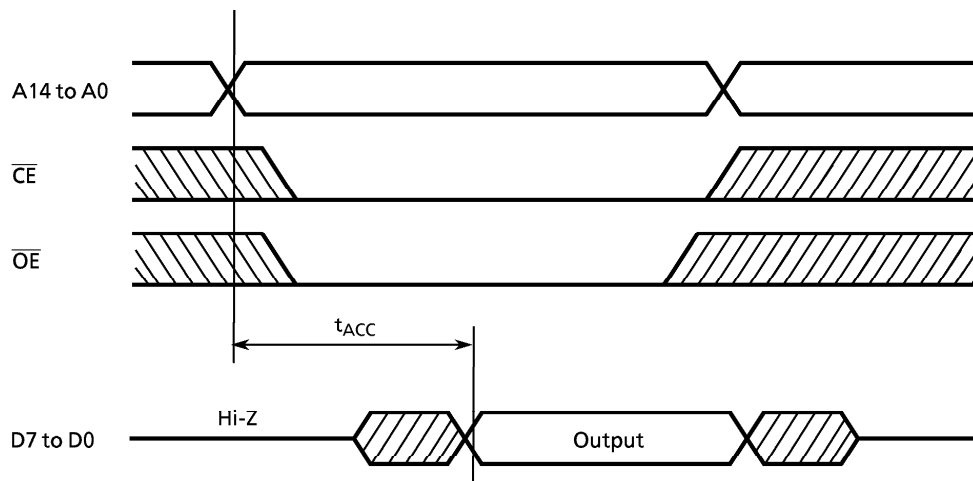
Note: When used in high electric field such as a picture tube, the package is Recommended to be electrically shielded to maintain a regular operation.

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

(1) Read Operation ($T_{opr} = -30\text{ to }70\text{ }^{\circ}\text{C}$)

| 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 |

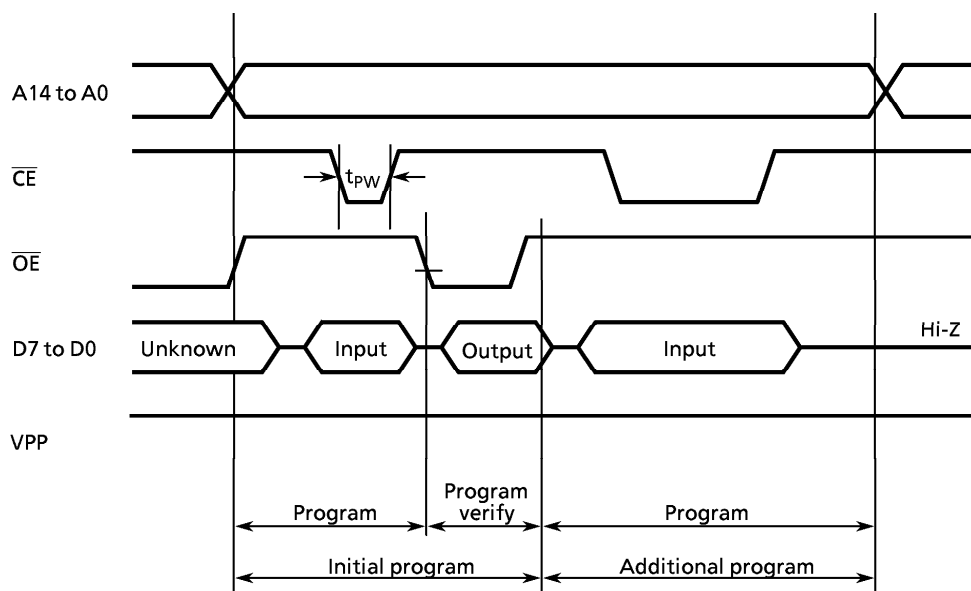
Note: $t_{cyc} = 500\text{ ns at }8\text{ MHz}$



Timing Waveforms of Read Operation

(2) Program Operation (High-Speed Write Mode - I) (Topr = 25 ± 5°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} | $V_{CC} = 6.0 V \pm 0.25 V$ $V_{PP} = 12.5 V \pm 0.5 V$ | 0.95 | 1.0 | 1.05 | ms |



Timing Waveforms of Programming Operation

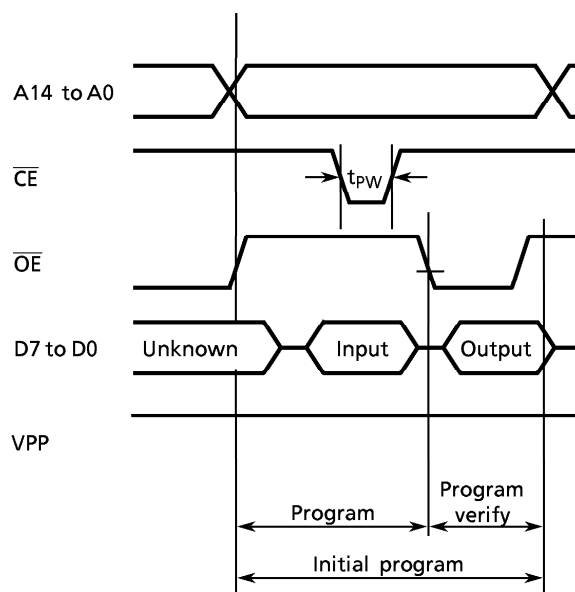
Note1: When V_{CC} power supply is turned on or after, V_{pp} must be increased.
 When V_{CC} power supply is turned off or before, V_{pp} must be decreased.

Note2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ($12.5 V \pm 0.5 V$) to the V_{pp} pin as the device is damaged.

Note3: 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 |



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 decreased.

Note2: 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.

Note3: 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.