

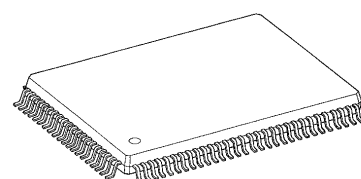
## CMOS 8-Bit Microcontroller

**TMP86PS64F**

The TMP86PS64F is a OTP type MCU which includes 60 Kbytes One-time PROM. It is a pin compatible with a mask ROM product of the TMP86CS64F. Writing the program to built-in PROM, the TMP86PS64F operates as the same way as the TMP86CS64F. Using the Adapter socket, you can write and verify the data for the TMP86PS64F with a general-purpose PROM programmer same as TC571000D/AD.

| Product No. | ROM           | RAM          | Package             | Adapter Socket |
|-------------|---------------|--------------|---------------------|----------------|
| TMP86PS64F  | 60 K × 8 bits | 2 K × 8 bits | P-QFP100-1420-0.65A | BM11190        |

P-QFP100-1420-0.65A



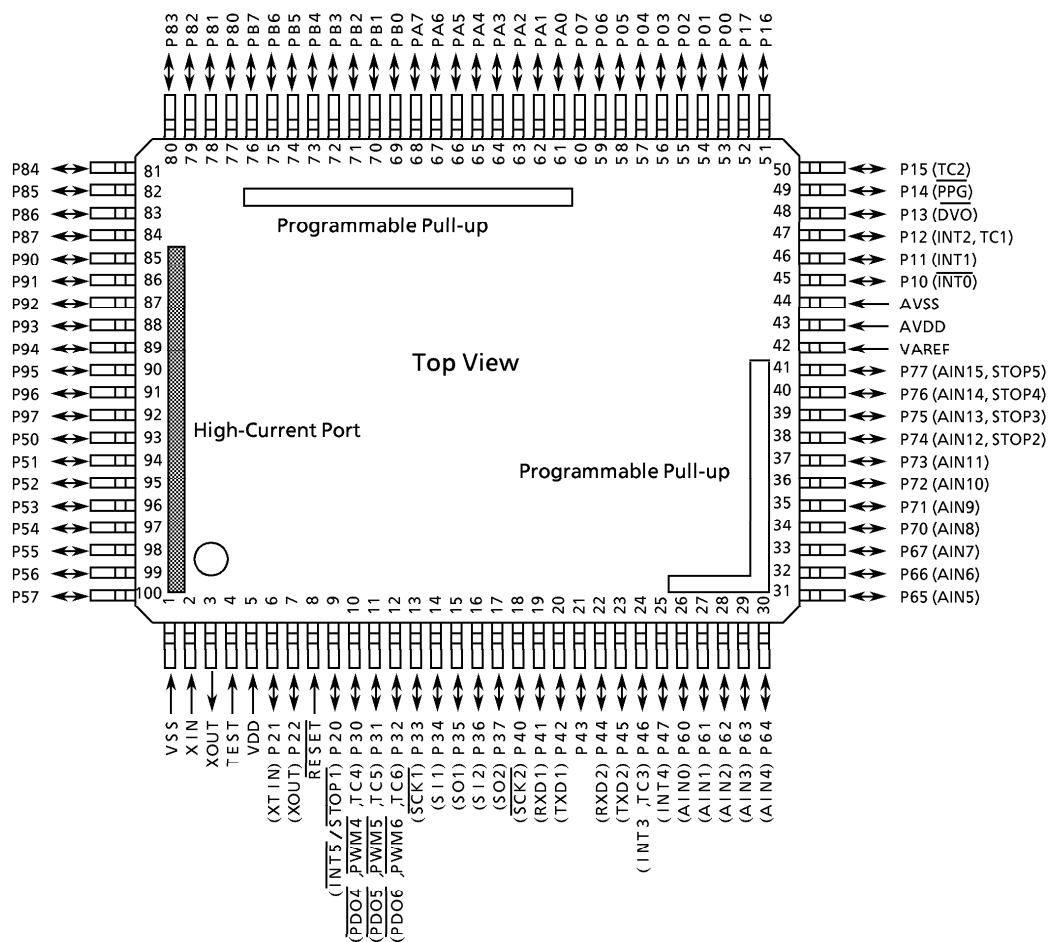
TMP86PS64F

000707EBP1

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## Pin Assignments (Top View)

P-QFP100-1420-0.65A



## Pin Function

The TMP86PS64 has MCU mode and PROM mode.

## (1) MCU mode

In the MCU mode, the TMP86PS64F is a pin compatible with the TMP86CS64F (Mask sure to fix the TEST pin to “L” level).

## (2) PROM mode

| Pin Name                        | Input/Output | Functions                                 | Pin Name (MCU mode) |
|---------------------------------|--------------|-------------------------------------------|---------------------|
| A16 to A15                      | Input        | Input of Memory address for program       | P17 to P16          |
| A14 to A7                       |              |                                           | P77 to P70          |
| A6 to A0                        |              |                                           | P67 to P61          |
| D7 to D0                        | I/O          | Input/Output of Memory data for program   | P57 to P50          |
| $\overline{\text{CE}}$          | Input        | Chip enable                               | P13                 |
| $\overline{\text{OE}}$          |              | Output enable                             | P14                 |
| $\overline{\text{PGM}}$         |              | Program control                           | P15                 |
| VPP                             | Power supply | + 12.75V/5V (Power supply of program)     | TEST                |
| VCC                             |              | + 6.25V/5V                                | VDD                 |
| GND                             |              | 0V                                        | VSS                 |
| P11, P21, AVDD                  | I/O          | PROM mode setting pin. Fix to “H”.        |                     |
| P00, P10, P20, P22, AVSS, VAREF |              | PROM mode setting pin. Fix to “L”.        |                     |
| $\overline{\text{RESET}}$       |              |                                           |                     |
| P07 to P01                      | I/O          | Open                                      |                     |
| P37 to P30                      |              |                                           |                     |
| P47 to P40                      |              |                                           |                     |
| P87 to P80                      |              |                                           |                     |
| P97 to P90                      |              |                                           |                     |
| PA7 to PA0                      |              |                                           |                     |
| PB7 to PB0                      |              |                                           |                     |
| XIN                             | Input        | Self oscillation with resonator (16 MHz). |                     |
| XOUT                            | Output       |                                           |                     |

## Operation

This section describes the functions and basic operational blocks of TMP86PS64F.

The TMP86PS64F has PROM in place of the mask ROM which is included in the TMP86CS64F. The configuration and function are same as the TMP86CS64F. For TMP86CS64F, however, some functions have been partially changed or deleted. For the function of TMP86PS64F in details, see the section of TMP86CS64F

In addition, TMP86PS64F operates as the single clock mode when releasing reset.

When using the dual clock mode, oscillate a low-frequency clock by SET. XTEN command at the beginning of program.

### 1. Operating Mode

The TMP86PS64F has MCU mode and PROM mode.

#### 1.1 MCU Mode

The MCU mode is set by fixing the TEST/VPP pin to the “L” level (TEST/VPP pin cannot be used open because it has no built-in pull-down resistor).

##### 1.1.1 Program memory

The TMP86PS64F has a 60 Kbyte built-in one time PROM (addresses 1000 to FFFFH in the MCU mode, addresses 0000 to EFFFH in the PROM mode).

When using TMP86PS64F for evaluation of TMP86CS64F, the program is written in the program storing area shown in Figure 1-1.

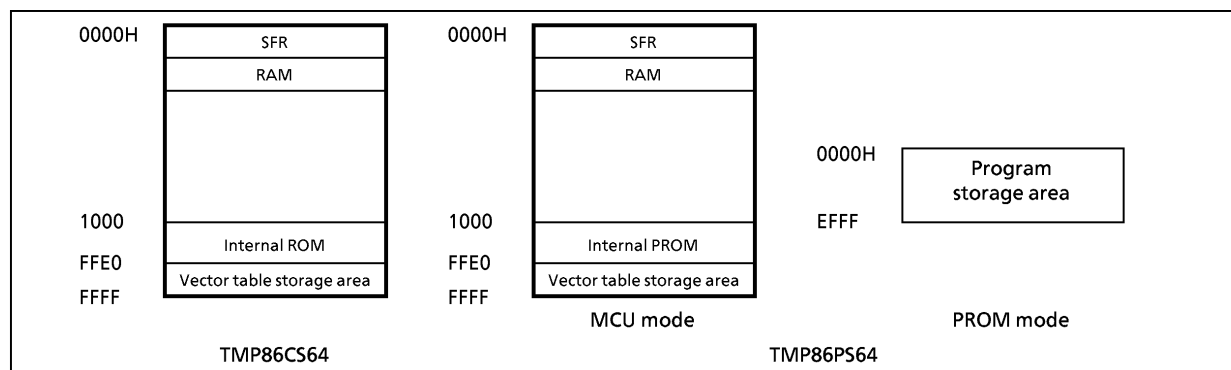


Figure 1-1. Program Memory Area

*Note: The area that is not in use should be set data to FFH, or a general-purpose PROM programmer should be set only in the program memory area to access.*

#### 1.1.2 Data Memory

TMP86PS64 has a built-in 2-Kbyte data memory (static RAM).

#### 1.1.3 Input/Output Circuitry

##### (1) Control pins

The control pins of the TMP86PS64 are the same as those the TMP86CS64 except that the TEST pin does not have a built-in pull-down resistor.

##### (2) I/O ports

The I/O circuitries of TMP86PS64 I/O ports are the same as those of TMP86CS64.

## Electrical Characteristics

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

| Parameter                                    | Symbol             | Pins               | Ratings                        | Unit |
|----------------------------------------------|--------------------|--------------------|--------------------------------|------|
| Supply Voltage                               | V <sub>DD</sub>    |                    | – 0.3 to 6.5                   | V    |
| Programming Voltage                          | V <sub>PP</sub>    |                    | – 0.3 to 13                    |      |
| Input Voltage                                | V <sub>IN</sub>    |                    | – 0.3 to V <sub>DD</sub> + 0.3 |      |
| Output Voltage                               | V <sub>OUT</sub>   |                    | – 0.3 to V <sub>DD</sub> + 0.3 |      |
| Output Current (Per 1 pin)                   | I <sub>OUTH</sub>  | Except Open-drain  | – 3.2                          | mA   |
|                                              | I <sub>OUT1</sub>  | Except Port P5, P9 | 3.2                            |      |
|                                              | I <sub>OUT2</sub>  | Port P5            | 30                             |      |
|                                              | I <sub>OUT3</sub>  | Port P9            |                                |      |
| Output Current (Total)                       | ΣI <sub>OUT1</sub> | Except Port P5, P9 | 60                             |      |
|                                              | ΣI <sub>OUT2</sub> | Port P5            |                                |      |
|                                              | ΣI <sub>OUT3</sub> | Port P9            |                                |      |
| Power Dissipation [T <sub>opr</sub> = 85 °C] | PD                 |                    | 250                            | mW   |
| Soldering Temperature (time)                 | Tsld               |                    | 260 (10 s)                     | °C   |
| Storage Temperature                          | Tstg               |                    | – 55 to 125                    |      |
| 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 ( $V_{SS} = 0\text{ V}$ ,  $T_{opr} = -40\text{ to }85^\circ\text{C}$ )

| Parameter        | Symbol    | Pins                    | Condition                                              | Min                  | Max                  | Unit |
|------------------|-----------|-------------------------|--------------------------------------------------------|----------------------|----------------------|------|
| Supply Voltage   | $V_{DD}$  |                         | $f_c = 1\text{ to }16\text{ MHz}$ Each operation modes | 4.5                  | 5.5                  | V    |
|                  |           |                         | $f_c = 1\text{ to }8\text{ MHz}$ Each operation modes  | 2.7                  | 5.5                  |      |
|                  |           |                         | $f_s = 32.768\text{ kHz}$ Each operation modes         | 2.7                  | 5.5                  |      |
|                  |           |                         | STOP mode                                              | 2.0                  | 5.5                  |      |
| Input high Level | $V_{IH1}$ | 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 Level  | $V_{IL1}$ | Except hysteresis input | $V_{DD} \geq 4.5\text{ V}$                             | 0                    | $V_{DD} \times 0.30$ |      |
|                  | $V_{IL2}$ | Hysteresis input        |                                                        |                      | $V_{DD} \times 0.25$ |      |
|                  | $V_{IL3}$ |                         | $V_{DD} < 4.5\text{ V}$                                |                      | $V_{DD} \times 0.10$ |      |
| Clock Frequency  | $f_c$     | XIN, XOUT               | $V_{DD} = 4.5\text{ to }5.5\text{ V}$                  | 1.0                  | 16.0                 | MHz  |
|                  |           |                         | $V_{DD} = 2.7\text{ to }5.5\text{ V}$                  |                      | 8.0                  |      |
|                  | $f_s$     | XTIN, XTOUT             |                                                        | 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 Characteristics | (V <sub>SS</sub> = 0 V, T <sub>opr</sub> = – 40 to 85°C) |
|--------------------|----------------------------------------------------------|

| Parameter                          | Symbol            | Pins                                  | Condition                                                                                                          | Min | Typ. | Max | Unit |
|------------------------------------|-------------------|---------------------------------------|--------------------------------------------------------------------------------------------------------------------|-----|------|-----|------|
| Hysteresis Voltage                 | V <sub>HS</sub>   | Hysteresis input                      |                                                                                                                    | –   | 0.9  | –   | V    |
| Input Current                      | I <sub>IN1</sub>  | TEST                                  | V <sub>DD</sub> = 5.5 V, V <sub>IN</sub> = 5.5 V/0 V                                                               | –   | –    | ± 2 | μA   |
|                                    | I <sub>IN2</sub>  | Sink Open Drain, Tri-state port       |                                                                                                                    |     |      |     |      |
|                                    | I <sub>IN3</sub>  | STOP, RESET                           |                                                                                                                    |     |      |     |      |
| Input Resistance                   | R <sub>IN1</sub>  | RESET                                 | V <sub>DD</sub> = 5.5 V                                                                                            | 100 | 220  | 450 | kΩ   |
|                                    | R <sub>IN2</sub>  | Programmable pull up (P6, P7, PA, PB) |                                                                                                                    | 40  | 80   | 200 |      |
| OSC. Feedback resistance           | R <sub>fx</sub>   | XIN-XOUT                              |                                                                                                                    | –   | 1.2  | –   | MΩ   |
|                                    | R <sub>fx</sub> t | XTIN-XTOUT                            |                                                                                                                    | –   | 6    | –   |      |
| Output Leakage Current             | I <sub>LO1</sub>  | Sink Open Drain port                  | V <sub>DD</sub> = 5.5 V, V <sub>OUT</sub> = 5.5 V                                                                  | –   | –    | 2   | μA   |
|                                    | I <sub>LO2</sub>  | Tri-state port                        | V <sub>DD</sub> = 5.5 V, V <sub>OUT</sub> = 5.5 V/0 V                                                              | –   | –    | ± 2 |      |
| "H" output Voltage                 | V <sub>OH</sub>   | Tri-state port                        | V <sub>DD</sub> = 4.5 V, I <sub>OH</sub> = – 0.7 mA                                                                | 4.1 | –    | –   | V    |
| "L" output Voltage                 | V <sub>OL3</sub>  | Except XOUT, P5, P9                   | V <sub>DD</sub> = 4.5 V, I <sub>OL</sub> = 1.6 mA                                                                  | –   | –    | 0.4 |      |
| "L" output Current                 | I <sub>OL1</sub>  | Except XOUT, P5, P9                   | V <sub>DD</sub> = 4.5 V, V <sub>OL</sub> = 0.4 V                                                                   | –   | 1.6  | –   | mA   |
|                                    | I <sub>OL3</sub>  | High current port (P5, P9)            | V <sub>DD</sub> = 4.5 V, V <sub>OL</sub> = 1.0 V                                                                   | –   | 20   | –   |      |
| Supply Current in Normal 1, 2 mode | I <sub>DD</sub>   |                                       | V <sub>DD</sub> = 5.5 V<br>V <sub>IN</sub> = 5.3 V/0.2 V<br>f <sub>c</sub> = 16 MHz<br>f <sub>s</sub> = 32.768 kHz | –   | 9    | 10  |      |
| Supply Current in IDLE 1, 2 mode   |                   |                                       |                                                                                                                    | –   | 5    | 6   |      |
| Supply Current in SLOW 1 mode      |                   |                                       | V <sub>DD</sub> = 3.0 V<br>V <sub>IN</sub> = 2.8 V/0.2 V<br>f <sub>s</sub> = 32.768 kHz                            | –   | 20   | 30  | μA   |
| Supply Current in SLEEP 0, 1 mode  |                   |                                       |                                                                                                                    | –   | 10   | 20  |      |
| 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  | 10  |      |

Note 1: Typical values show those at T<sub>opr</sub> = 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 for I<sub>REF</sub>.

## AD Conversion Characteristics

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

| Parameter                                        | Symbol             | Condition                                                                                                             | Min                    | Typ. | Max               | Unit |
|--------------------------------------------------|--------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------|------|-------------------|------|
| Analog Reference Voltage                         | V <sub>AREF</sub>  |                                                                                                                       | A <sub>VDD</sub> – 1.0 | –    | A <sub>VDD</sub>  | V    |
| Power Supply Voltage of Analog Control Circuit   | A <sub>VDD</sub>   |                                                                                                                       | V <sub>DD</sub>        |      |                   |      |
|                                                  | A <sub>VSS</sub>   |                                                                                                                       | V <sub>SS</sub>        |      |                   |      |
| Analog Reference of Voltage Range (Note 4)       | △V <sub>AREF</sub> |                                                                                                                       | 3.5                    | –    | V <sub>DD</sub>   |      |
| Analog Input Voltage                             | V <sub>AIN</sub>   |                                                                                                                       | V <sub>SS</sub>        | –    | V <sub>AREF</sub> |      |
| Power Supply Current of Analog Reference Voltage | I <sub>REF</sub>   | V <sub>DD</sub> = A <sub>VDD</sub> = V <sub>AREF</sub> = 5.5 V<br>V <sub>SS</sub> = A <sub>VSS</sub> = 0.0 V          | –                      | 0.6  | 1.0               | mA   |
| Non linearity Error                              |                    | V <sub>DD</sub> = A <sub>VDD</sub> = 5.0 V<br>V <sub>SS</sub> = A <sub>VSS</sub> = 0.0 V<br>V <sub>AREF</sub> = 5.0 V | –                      | –    | ± 2               | LSB  |
| Zero Point Error                                 |                    |                                                                                                                       | –                      | –    | ± 2               |      |
| Full Scale Error                                 |                    |                                                                                                                       | –                      | –    | ± 2               |      |
| Total Error                                      |                    |                                                                                                                       | –                      | –    | ± 4               |      |

(V<sub>SS</sub> = 0 V, 2.7 V ≤ V<sub>DD</sub> < 4.5 V, Topr = –40 to 85°C)

| Parameter                                        | Symbol              | Condition                                                                                                             | Min                    | Typ. | Max               | Unit |
|--------------------------------------------------|---------------------|-----------------------------------------------------------------------------------------------------------------------|------------------------|------|-------------------|------|
| Analog Reference Voltage                         | V <sub>AREF</sub>   |                                                                                                                       | A <sub>VDD</sub> – 1.0 | –    | A <sub>VDD</sub>  | V    |
| Power Supply Voltage of Analog Control Circuit   | A <sub>VDD</sub>    |                                                                                                                       | V <sub>DD</sub>        |      |                   |      |
|                                                  | A <sub>VSS</sub>    |                                                                                                                       | V <sub>SS</sub>        |      |                   |      |
| Analog Reference of Voltage Range (Note 4)       | △ V <sub>AREF</sub> |                                                                                                                       | 2.5                    | –    | V <sub>DD</sub>   |      |
| Analog Input Voltage                             | V <sub>AIN</sub>    |                                                                                                                       | V <sub>SS</sub>        | –    | V <sub>AREF</sub> |      |
| Power Supply Current of Analog Reference Voltage | I <sub>REF</sub>    | V <sub>DD</sub> = A <sub>VDD</sub> = V <sub>AREF</sub> = 4.5 V<br>V <sub>SS</sub> = A <sub>VSS</sub> = 0.0 V          | –                      | 0.5  | 0.8               | mA   |
| Non linearity Error                              |                     | V <sub>DD</sub> = A <sub>VDD</sub> = 2.7 V<br>V <sub>SS</sub> = A <sub>VSS</sub> = 0.0 V<br>V <sub>AREF</sub> = 2.7 V | –                      | –    | ± 2               | LSB  |
| Zero Point Error                                 |                     |                                                                                                                       | –                      | –    | ± 2               |      |
| Full Scale Error                                 |                     |                                                                                                                       | –                      | –    | ± 2               |      |
| Total Error                                      |                     |                                                                                                                       | –                      | –    | ± 4               |      |

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 "2.14.2 Register Framing".

Note 3: Please use input voltage to AIN input Pin in limit of V<sub>AREF</sub> – V<sub>SS</sub>.  
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: ΔV<sub>AREF</sub> = V<sub>AREF</sub> – A<sub>VSS</sub>

## AC Characteristics

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

| Parameter                    | Symbol           | Condition                                                    | Min   | Typ.  | Max   | Unit |
|------------------------------|------------------|--------------------------------------------------------------|-------|-------|-------|------|
| Machine Cycle Time           | t <sub>cy</sub>  | 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 | t <sub>WCH</sub> | For external clock operation (XIN input)<br>fc = 16 MHz      | –     | 31.25 | –     | ns   |
| Low Level Clock Pulse Width  | t <sub>WCL</sub> |                                                              |       |       |       |      |
| High Level Clock Pulse Width | t <sub>WSH</sub> | For external clock operation (XTIN input)<br>fs = 32.768 kHz | –     | 15.26 | –     | μs   |
| Low Level Clock Pulse Width  | t <sub>WSL</sub> |                                                              |       |       |       |      |

(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 2.7 to 4.5 V, Topr = – 40 to 85°C)

| Parameter                    | Symbol           | Condition                                                    | Min   | Typ.  | Max   | Unit |
|------------------------------|------------------|--------------------------------------------------------------|-------|-------|-------|------|
| Machine Cycle Time           | t <sub>cy</sub>  | 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 | t <sub>WCH</sub> | For external clock operation (XIN input)<br>fc = 8 MHz       | –     | 62.5  | –     | ns   |
| Low Level Clock Pulse Width  | t <sub>WCL</sub> |                                                              |       |       |       |      |
| High Level Clock Pulse Width | t <sub>WSH</sub> | For external clock operation (XTIN input)<br>fs = 32.768 kHz | –     | 15.26 | –     | μs   |
| Low Level Clock Pulse Width  | t <sub>WSL</sub> |                                                              |       |       |       |      |

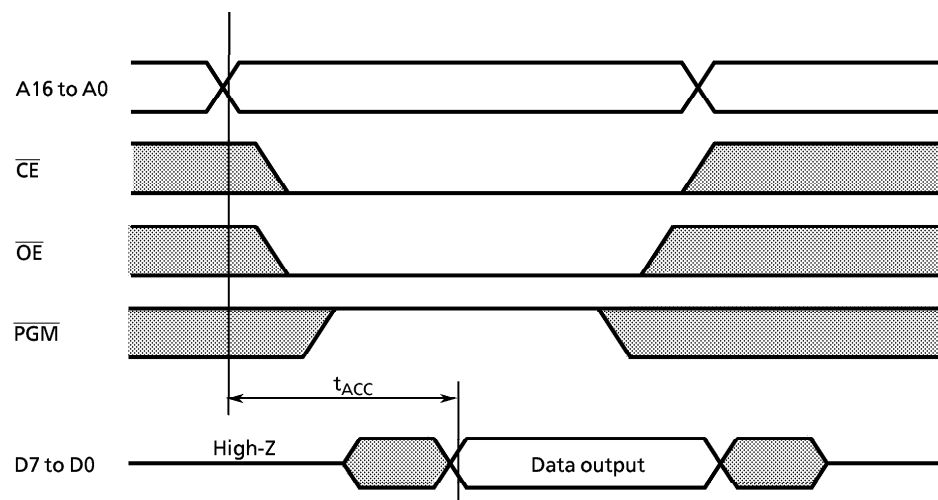


|                                                    |                                                                |
|----------------------------------------------------|----------------------------------------------------------------|
| DC Characteristics, AC Characteristics (PROM Mode) | ( $V_{SS} = 0\text{ V}$ , $T_{opr} = 25 \pm 5^\circ\text{C}$ ) |
|----------------------------------------------------|----------------------------------------------------------------|

## (1) Read operation in PROM mode

| Parameter                      | Symbol           | Conditions                     | Min  | Typ.          | Max             | Unit |
|--------------------------------|------------------|--------------------------------|------|---------------|-----------------|------|
| High level input voltage (TTL) | V <sub>IH4</sub> |                                | 2.2  | –             | V <sub>CC</sub> | V    |
| Low leve input voltage (TTL)   | V <sub>IL4</sub> |                                | 0    | –             | 0.8             |      |
| Power supply                   | V <sub>CC</sub>  |                                | 4.75 | 5.0           | 5.25            |      |
| Power supply of program        | V <sub>PP</sub>  |                                |      |               |                 |      |
| Address access time            | t <sub>ACC</sub> | V <sub>CC</sub> = 5.0 ± 0.25 V | –    | 1.5tcyc + 300 | –               | ns   |

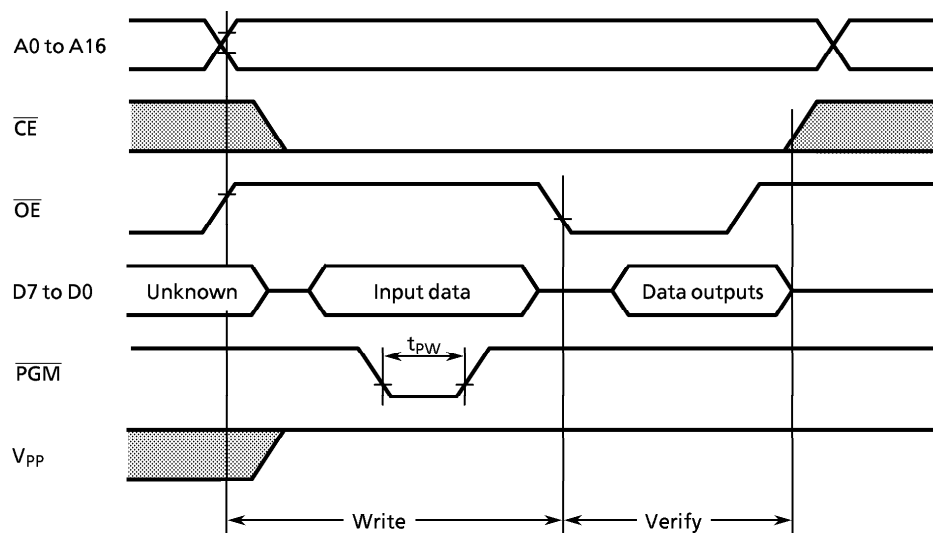
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|-------------------------------------------|
| Note: $t_{cyc} = 250\text{ ns}$ at 16 MHz |
|-------------------------------------------|



(2) Program operation (High-speed) ( $T_{opr} = 25 \pm 5^{\circ}\text{C}$ )

| Parameter                           | Symbol    | Conditions              | Min   | Typ.  | Max      | Unit |
|-------------------------------------|-----------|-------------------------|-------|-------|----------|------|
| High level input voltage (TTL)      | $V_{IH4}$ |                         | 2.2   | –     | $V_{CC}$ | V    |
| Low level 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 | $t_{PW}$  | $V_{CC} = 6.0\text{ V}$ | 0.095 | 0.1   | 0.105    | ms   |

High-speed program



**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  $V_{PP} = 12.75\text{ V} \pm 0.25\text{ V}$  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 writing.

## Recommended Oscillating Conditions-1

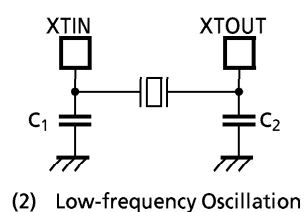
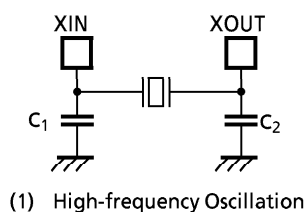
(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 4.5 to 5.5 V, T<sub>opr</sub> = – 40 to 85°C)

| Parameter                  | Oscillator         | Oscillation Frequency | Recommended Oscillator | Recommended Constant |                  |
|----------------------------|--------------------|-----------------------|------------------------|----------------------|------------------|
|                            |                    |                       |                        | C <sub>1</sub>       | C <sub>2</sub>   |
| High-frequency Oscillation | Ceramic Resonator  | 16 MHz                | MURATA CSA16.00MXZ040  | 10 pF                | 10 pF            |
|                            |                    | 8 MHz                 | MURATA CSA8.00MTZ      | 30 pF                | 30 pF            |
|                            |                    |                       | CST8.00MTW             | 30 pF (built-in)     | 30 pF (built-in) |
| Low-frequency Oscillation  | Crystal Oscillator | 32.768 kHz            | MURATA CSA4.19MG       | 30 pF                | 30 pF            |
|                            |                    |                       | CST4.19MGW             | 30 pF (built-in)     | 30 pF (built-in) |

## Recommended Oscillating Conditions-2

(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 2.7 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  | 8 MHz                 | MURATA CSA8.00MTZ      | 30 pF                | 30 pF            |
|                            |                    |                       | CST8.00MTW             | 30 pF (built-in)     | 30 pF (built-in) |
|                            |                    | 4.19 MHz              | MURATA CSA4.19MG       | 30 pF                | 30 pF            |
| Low-frequency Oscillation  | Crystal Oscillator | 32.768 kHz            | MURATA CST4.19MGW      | 30 pF (built-in)     | 30 pF (built-in) |



**Note 1:** An electrical shield by metal shield plate on the surface of IC package is recommended in order to protect the device from the high electric field stress applied from CRT (Cathodic Ray Tube) for continuous reliable operation.

**Note 2:** The product numbers and specifications of the resonators by Murata Manufacturing Co., Ltd. are subject to change. For up-to-date information, please refer to the following URL;  
<http://www.murata.co.jp/search/index.html>