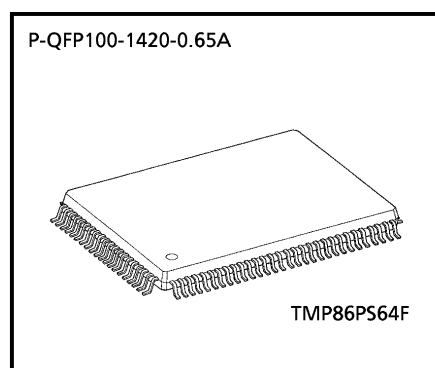


## CMOS 8-Bit Microcontroller

**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 TC57100D/AD.

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

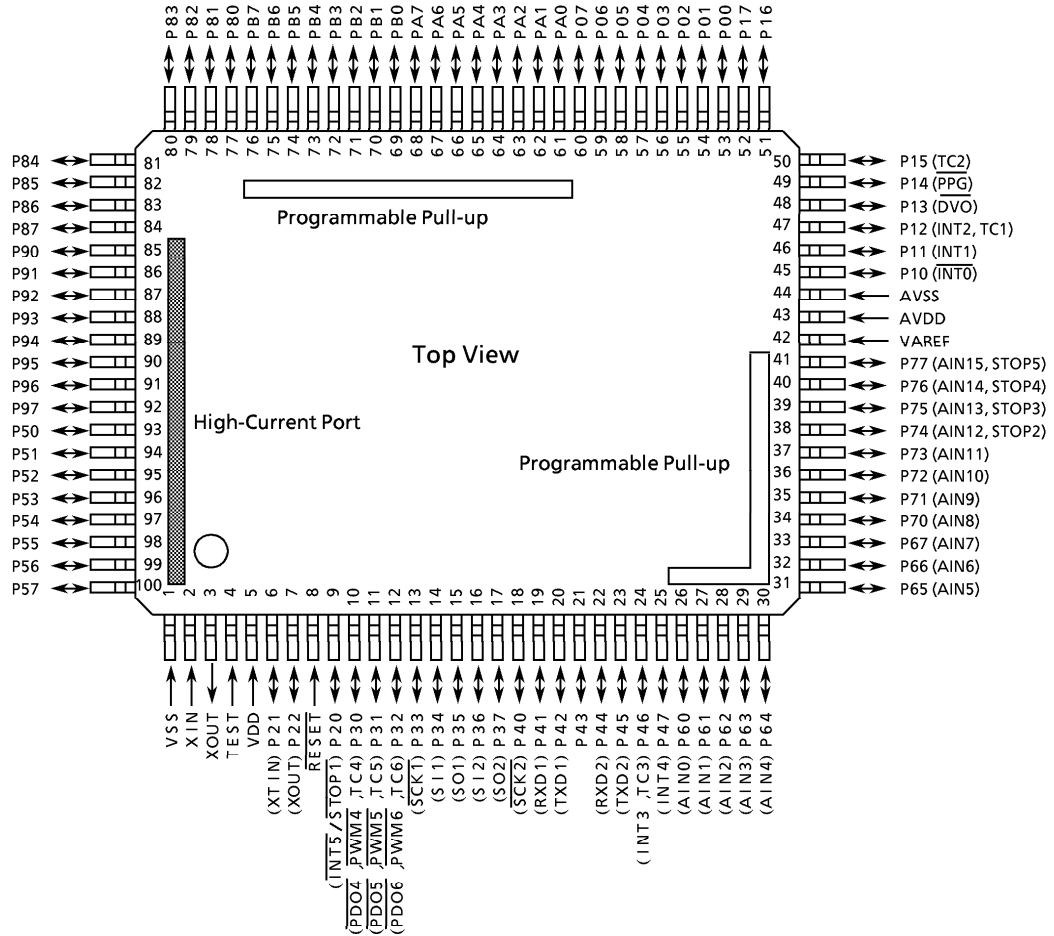


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Pin Assignments (Top View)

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

## 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.

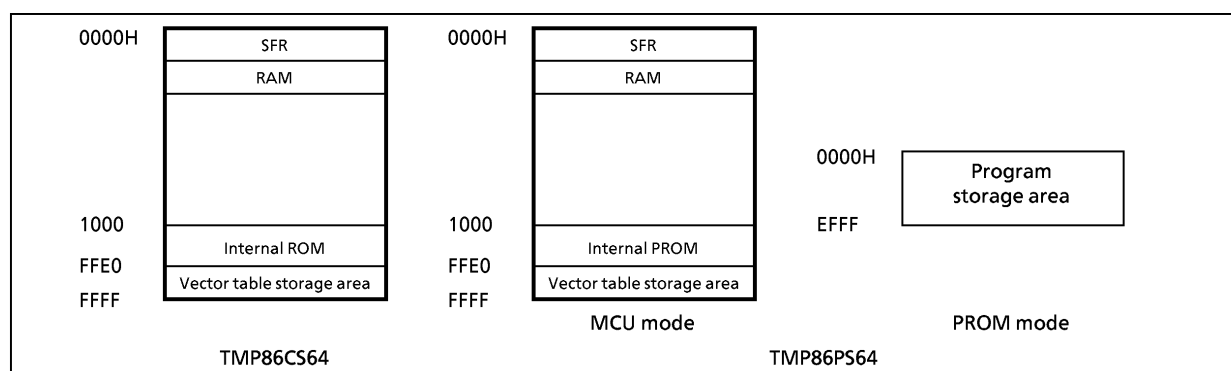


Figure 1-1. Program Memory Area

*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	$V_{DD}$		- 0.3 to 6.5	V
Programming Voltage	$V_{PP}$		- 0.3 to 13	
Input Voltage	$V_{IN}$		- 0.3 to $V_{DD} + 0.3$	
Output Voltage	$V_{OUT}$		- 0.3 to $V_{DD} + 0.3$	
Output Current (Per 1 pin)	$I_{OUTH}$	Except Open-drain	- 3.2	mA
	$I_{OUT1}$	Except Port P5, P9	3.2	
	$I_{OUT2}$	Port P5	30	
	$I_{OUT3}$	Port P9		
Output Current (Total)	$\Sigma I_{OUT1}$	Except Port P5, P9	60	
	$\Sigma I_{OUT2}$	Port P5		
	$\Sigma I_{OUT3}$	Port P9		
Power Dissipation [ $T_{opr} = 85^\circ\text{C}$ ]	PD		250	mW
Soldering Temperature (time)	Tsld		260 (10 s)	$^\circ\text{C}$
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	$V_{DD} \geq 4.5\text{ V}$	$V_{DD} \times 0.70$	$V_{DD}$		
	$V_{IH2}$	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>fxT</sub>	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	-	
	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 V <sub>IN</sub> = 5.3 V/0.2 V	-	9	10	mA
Supply Current in IDLE 1, 2 mode			f <sub>c</sub> = 16 MHz f <sub>s</sub> = 32.768 kHz	-	5	6	
Supply Current in SLOW 1 mode			V <sub>DD</sub> = 3.0 V V <sub>IN</sub> = 2.8 V/0.2 V	-	20	30	μA
Supply Current in SLEEP 0, 1 mode			f <sub>s</sub> = 32.768 kHz	-	10	20	
Supply Current in STOP mode			V <sub>DD</sub> = 5.5 V 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

 $(V_{SS} = 0\text{ V}, 4.5\text{ V} \leq V_{DD} \leq 5.5\text{ V}, T_{opr} = -40\text{ to }85^{\circ}\text{C})$ 

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 of Voltage Range (Note 4)	$\Delta V_{AREF}$		3.5	-	$V_{DD}$	
Analog Input Voltage	$V_{AIN}$		$V_{SS}$	-	$V_{AREF}$	
Power Supply Current of Analog Reference Voltage	$I_{REF}$	$V_{DD} = A_{VDD} = V_{AREF} = 5.5\text{ V}$ $V_{SS} = A_{VSS} = 0.0\text{ V}$	-	0.6	1.0	mA
Non linearity Error		$V_{DD} = A_{VDD} = 5.0\text{ V}$ $V_{SS} = A_{VSS} = 0.0\text{ V}$ $V_{AREF} = 5.0\text{ V}$	-	-	$\pm 2$	LSB
Zero Point Error			-	-	$\pm 2$	
Full Scale Error			-	-	$\pm 2$	
Total Error			-	-	$\pm 4$	

 $(V_{SS} = 0\text{ V}, 2.7\text{ V} \leq V_{DD} < 4.5\text{ V}, T_{opr} = -40\text{ to }85^{\circ}\text{C})$ 

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 of Voltage Range (Note 4)	$\Delta V_{AREF}$		2.5	-	$V_{DD}$	
Analog Input Voltage	$V_{AIN}$		$V_{SS}$	-	$V_{AREF}$	
Power Supply Current of Analog Reference Voltage	$I_{REF}$	$V_{DD} = A_{VDD} = V_{AREF} = 4.5\text{ V}$ $V_{SS} = A_{VSS} = 0.0\text{ V}$	-	0.5	0.8	mA
Non linearity Error		$V_{DD} = A_{VDD} = 2.7\text{ V}$ $V_{SS} = A_{VSS} = 0.0\text{ V}$ $V_{AREF} = 2.7\text{ V}$	-	-	$\pm 2$	LSB
Zero Point Error			-	-	$\pm 2$	
Full Scale Error			-	-	$\pm 2$	
Total Error			-	-	$\pm 4$	

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  $V_{AREF} - V_{SS}$ .  
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:  $\Delta V_{AREF} = V_{AREF} - A_{VSS}$

AC Characteristics	( $V_{SS} = 0\text{ V}$ , $V_{DD} = 4.5\text{ to }5.5\text{ V}$ , $T_{opr} = -40\text{ to }85^{\circ}\text{C}$ )
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Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	t <sub>cy</sub>	NORMAL 1, 2 mode	0.25	-	4	$\mu\text{s}$
		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) f <sub>c</sub> = 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) f <sub>s</sub> = 32.768 kHz	-	15.26	-	$\mu\text{s}$
Low Level Clock Pulse Width	t <sub>wSL</sub>					

( $V_{SS} = 0\text{ V}$ ,  $V_{DD} = 2.7\text{ to }4.5\text{ V}$ ,  $T_{opr} = -40\text{ to }85^{\circ}\text{C}$ )

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	t <sub>cy</sub>	NORMAL 1, 2 mode	0.5	-	4	$\mu\text{s}$
		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) f <sub>c</sub> = 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) f <sub>s</sub> = 32.768 kHz	-	15.26	-	$\mu\text{s}$
Low Level Clock Pulse Width	t <sub>wSL</sub>					

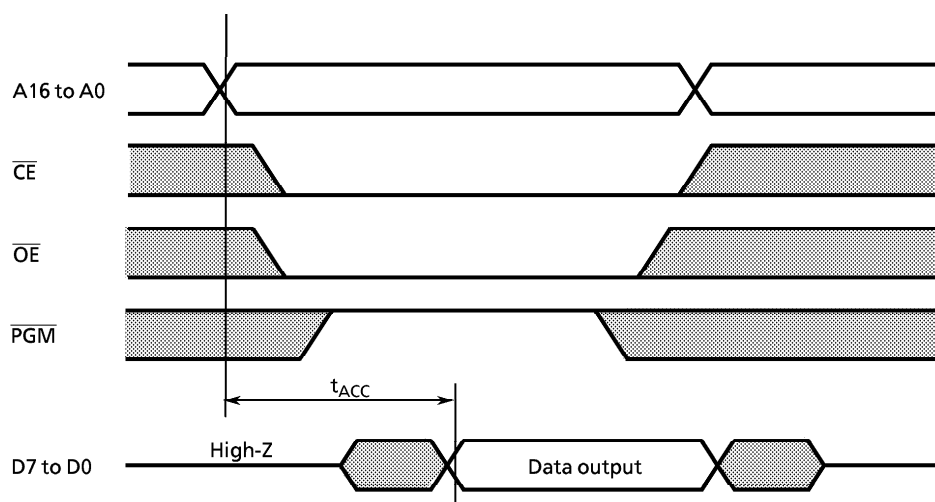


DC Characteristics, AC Characteristics (PROM Mode) ( $V_{SS} = 0\text{ V}$ ,  $T_{opr} = 25 \pm 5^\circ\text{C}$ )

(1) Read operation in PROM mode

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
High level input voltage (TTL)	$V_{IH4}$		2.2	–	$V_{CC}$	V
Low level 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	$t_{ACC}$	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5t_{cyc} + 300$	–	ns

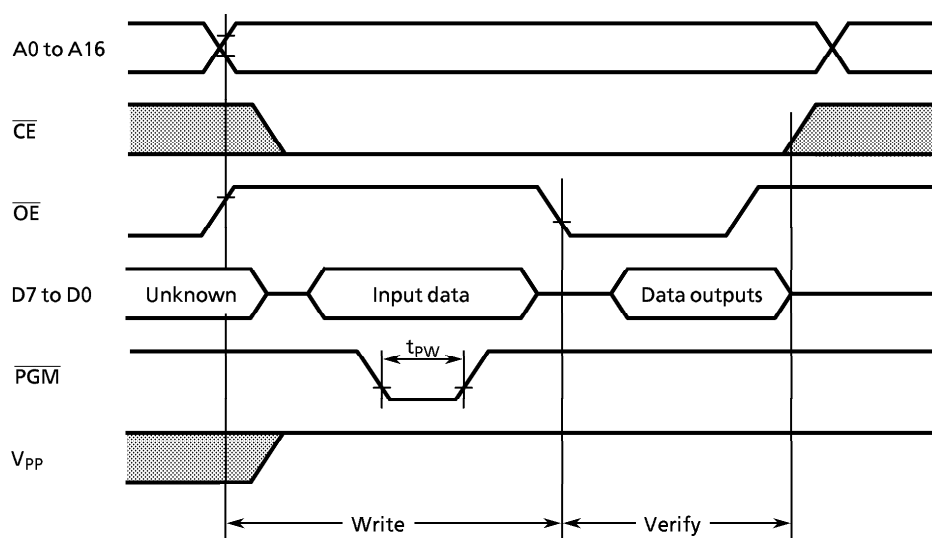
Note:  $t_{cyc} = 250\text{ ns}$  at 16 MHz



(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**

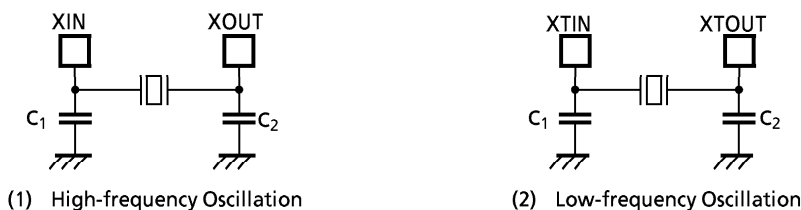
( $V_{SS} = 0\text{ V}$ ,  $V_{DD} = 4.5\text{ to }5.5\text{ V}$ ,  $T_{opr} = -40\text{ to }85^\circ\text{C}$ )

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)
4.19 MHz	MURATA	CSA4.19MG CST4.19MGW	30 pF 30 pF (built-in)	30 pF 30 pF (built-in)		
Low-frequency Oscillation	Crystal Oscillator	32.768 kHz	SII	VT-200	6 pF	6 pF

**Recommended Oscillating Conditions-2**

( $V_{SS} = 0\text{ V}$ ,  $V_{DD} = 2.7\text{ to }5.5\text{ V}$ ,  $T_{opr} = -40\text{ to }85^\circ\text{C}$ )

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 CST4.19MGW	30 pF 30 pF (built-in)	30 pF 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>*