

**TOSHIBA**

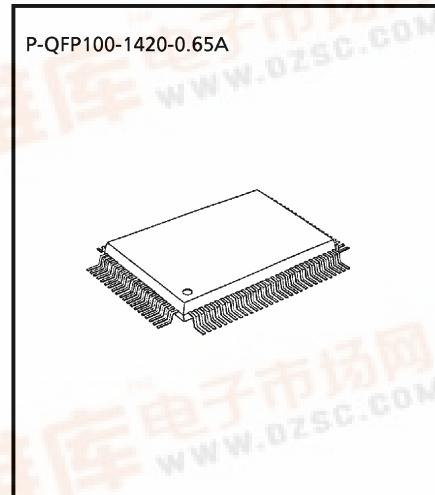
**TMP87PP23**

CMOS 8-Bit Microcontroller

**TMP87PP23F**

The TMP87PP23 is a One-Time PROM microcontroller with low-power 384K bits electrically programmable read only memory for the TMP87CM23A/CP23 system evaluation. The TMP87PP23 is pin compatible with the TMP87CM23A/CP23. The operations possible with the TMP87CM23A/CP23 can be performed by writing programs to PROM. The TMP87PP23 can write and verify in the same way as the TC571000D using an adapter socket BM1185A and an EPROM programmer.

Product No.	OTP	RAM	Package	OTP Adapter
TMP87PP23F	48K × 8-bit	2K × 8-bit	P-QFP100-1420-0.65A	BM1185A



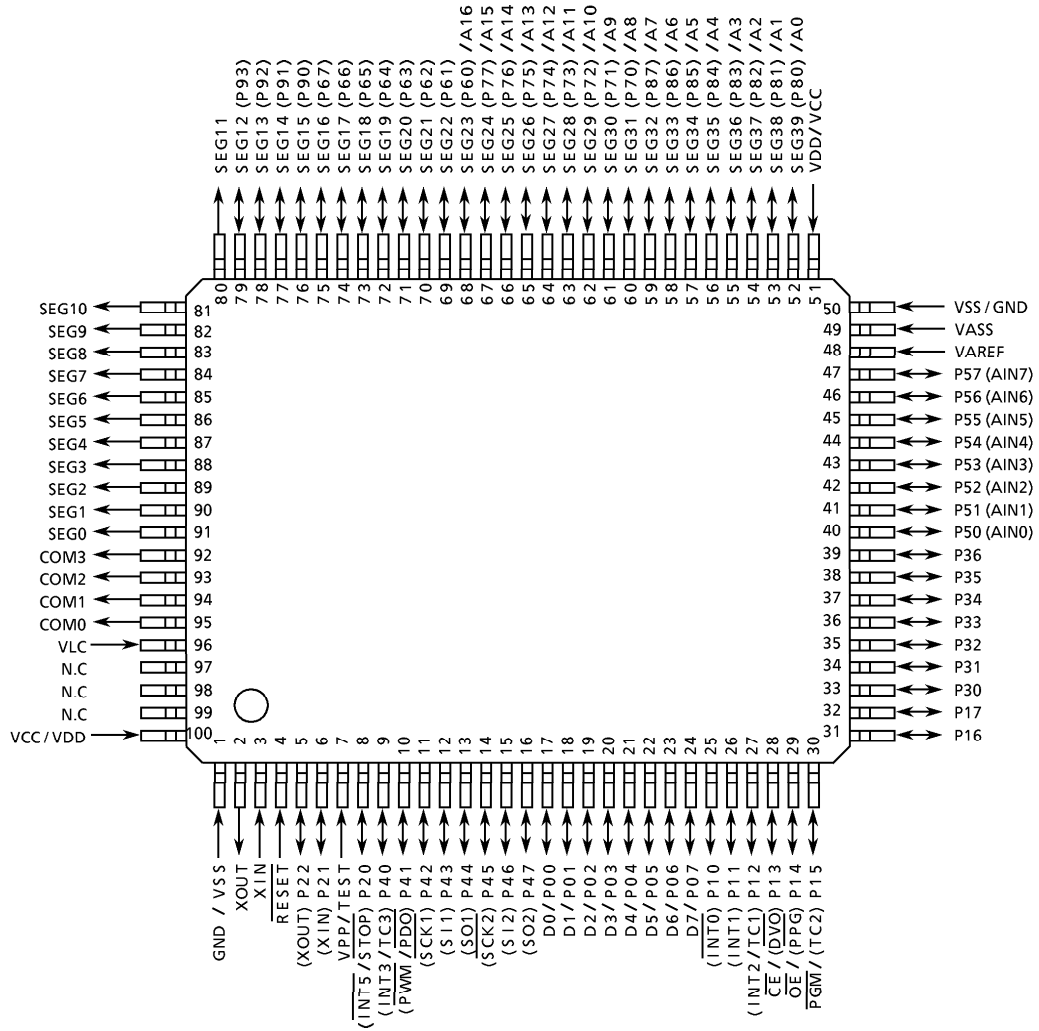
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Pin Assignments (Top View)

P-QFP100-1420-0.65A



### Pin Function

The TMP87PP23 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the TMP87PP23 is pin compatible with the TMP87CM23A/CP23 (fix the TEST pin at low level.)

(2) PROM mode

Pin Name (PROM mode)	Input / Output	Function	Pin Name (MCU mode)
A16	Input	PROM address inputs	P60
A15 to A8			P77 to P70
A7 to A0			P87 to P80
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
PGM		Program mode signal input (active low)	P15
VPP	Power supply	+ 12.75 V / 5 V (Program supply voltage)	TEST
VCC		+ 6.25 V / 5 V	VDD
GND		0 V	VSS
P36 to P30	I/O	Pull-up with resistance for input processing.	PROM mode setting pin. Be fixed at high level.
P47 to P40			
P57 to P50			
P67 to P62			
P93 to P90			
P11		PROM mode setting pin. Be fixed at low level.	
P21			
P61			
P17, P16, P12, P10 P22, P20			
RESET			
XIN	Input	Connect an 8MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power supply	0 V (GND)	
VASS			
COM3 to COM0	Output	Open	
SEG11 to SEG0			
VLC	Power supply		

**OPERATIONAL DESCRIPTION**

The following explains the TMP87PP23 hardware configuration and operation. The configuration and functions of the TMP87PP23 are the same as those of the TMP87CM23A/CP23, except in that a one-time PROM is used instead of an on-chip mask ROM.

The TMP87PP23 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 TMP87PP23 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 TMP87CM23A/CP23 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

**1.1.1 Program Memory**

The TMP87PP23 has a 48K × 8-bit (addresses 4000<sub>H</sub>-FFFF<sub>H</sub> in the MCU mode, addresses 14000<sub>H</sub>-1FFFF<sub>H</sub> in the PROM mode) of program memory (OTP).

When the TMP87PP23 is used as a system evaluation of the TMP87CM23A/P23, the data is written to the program storage area shown in figure 1-1.

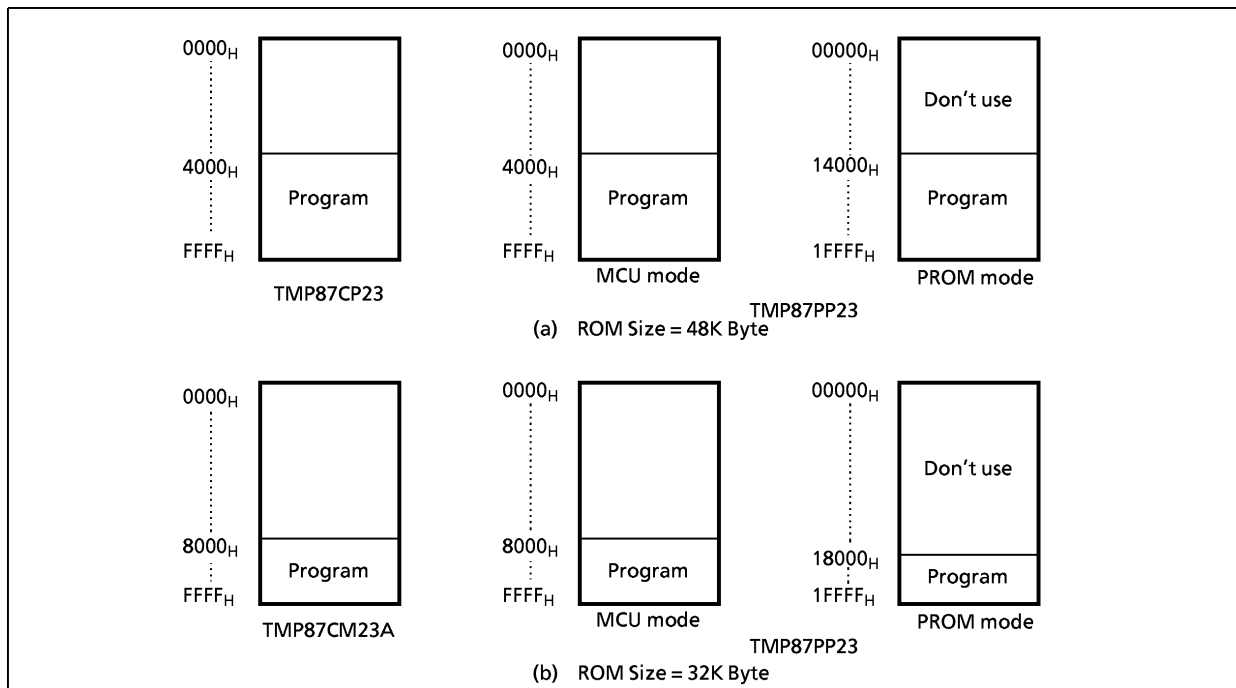


Figure 1-1. Program Memory Area

*Note: Either write the data FF<sub>H</sub> to the unused area or set the PROM programmer to access only the program storage area.*

## Electrical Characteristics

Absolute Maximum Ratings		(V <sub>SS</sub> = 0 V)		
Parameter	Symbol	Pin	Ratings	Unit
Supply Voltage	V <sub>DD</sub>		- 0.3 to 6.5	V
Program Voltage	V <sub>PP</sub>	TEST/V <sub>PP</sub>	- 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>OUT</sub>		- 0.3 to V <sub>DD</sub> + 0.3	V
Output Current (Per 1 pin)	I <sub>OUT1</sub>	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	3.2	mA
	I <sub>OUT2</sub>	P41	30	
Output Current (Total)	Σ I <sub>OUT1</sub>	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	120	mA
	Σ I <sub>OUT2</sub>	P41	30	
Power Dissipation [T <sub>opr</sub> = 70°C]	PD		350	mW
Soldering Temperature (time)	T <sub>sld</sub>		260 (10 s)	°C
Storage Temperature	T <sub>stg</sub>		- 55 to 125	°C
Operating Temperature	T <sub>opr</sub>		- 30 to 70	°C

Note 1: 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.

Note 2: The absolute maximum input/output voltage ratings for the TMP87CM23A/CP23/PP23 are - 0.3 to V<sub>DD</sub> + 0.3 [V] at all I/O ports including sink open drain output ports. (However, the V<sub>PP</sub> pin of TMP87PP23 is not contained in these condition.)

Recommended Operating Conditions		(V <sub>SS</sub> = 0V, T <sub>opr</sub> = - 30 to 70°C)					
Parameter	Symbol	Pin	Condition	Min	Max	Unit	
Supply Voltage	V <sub>DD</sub>		f <sub>c</sub> = 8 MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			f <sub>c</sub> = 4.2 MHz	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			f <sub>s</sub> = 32.768 kHz	SLOW mode	2.0		
SLEEP mode							
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	f <sub>c</sub>	XIN, XOUT	V <sub>DD</sub> = 4.5 to 5.5 V	0.4	8.0	MHz	
			V <sub>DD</sub> = 2.7 to 5.5 V		4.2		
	f <sub>s</sub>	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<sub>c</sub>: Supply voltage range is specified in NORMAL1/2 mode and IDLE1/2 mode.

DC Characteristics		(V <sub>SS</sub> = 0 V, T <sub>opr</sub> = -30 to 70°C)					
Parameter	Symbol	Pin	Condition	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, V <sub>IN</sub> = 5.5 V / 0 V	—	—	± 2	μA
	I <sub>IN2</sub>	Open drain ports and tri-state ports					
	I <sub>IN3</sub>	RESET, STOP					
Input Low Current	I <sub>IL</sub>	Push-pull ports	V <sub>DD</sub> = 5.5 V, V <sub>IN</sub> = 0.4 V	—	—	-2	mA
Input Resistance	R <sub>IN2</sub>	RESET		100	220	450	kΩ
Output Leakage Current	I <sub>LO</sub>	Open drain ports	V <sub>DD</sub> = 5.5 V, V <sub>OUT</sub> = 5.5 V	—	—	2	μA
Segment Output Low Resistance	R <sub>OS1</sub>	SEG39 to SEG0	V <sub>DD</sub> = 5 V, V <sub>DD</sub> - V <sub>LC</sub> = 3 V	—	20	—	kΩ
Common Output Low Resistance	R <sub>OC1</sub>	COM3 to COM0					
Segment Output High Resistance	R <sub>OS2</sub>	SEG39 to SEG0					
Common Output High Resistance	R <sub>OC2</sub>	COM3 to COM0					
Segment/Common Output Voltage	V <sub>O 2/3</sub>	SEG39 to SEG0 and COM3 to COM0		3.8	4.0	4.2	V
	V <sub>O 1/2</sub>						
	V <sub>O 1/3</sub>						
Output High Voltage	V <sub>OH1</sub>	Push-pull ports (P4 port)	V <sub>DD</sub> = 4.5 V, I <sub>OH</sub> = -200 μA	2.4	—	—	V
	V <sub>OH2</sub>	Tri-state ports (P0, P1, P5 ports)	V <sub>DD</sub> = 4.5 V, I <sub>OH</sub> = -0.7 mA	4.1	—	—	
Output Low Voltage	V <sub>OL</sub>	Except XOUT and P41	V <sub>DD</sub> = 4.5 V, I <sub>OL</sub> = 1.6 mA	—	—	0.4	V
Output Low Current	I <sub>OL3</sub>	P41	V <sub>DD</sub> = 4.5 V, V <sub>OL</sub> = 1.0 V	—	20	—	mA
Supply Current in NORMAL 1, 2 mode	I <sub>DD</sub>		V <sub>DD</sub> = 5.5 V f <sub>c</sub> = 8 MHz f <sub>s</sub> = 32.768 kHz V <sub>IN</sub> = 5.3 V / 0.2 V	—	12	18	mA
Supply Current in IDLE 1, 2 mode							
Supply Current in SLOW mode							
Supply Current in SLEEP mode							
Supply Current in STOP mode							
			V <sub>DD</sub> = 3.0 V f <sub>s</sub> = 32.768 kHz V <sub>IN</sub> = 2.8 V / 0.2 V LCD driver is not enable	—	30	60	μA
			V <sub>DD</sub> = 5.5 V V <sub>IN</sub> = 5.3 V / 0.2 V	—	15	30	μA
				—	0.5	10	μA

Note 1: Typical values show those at T<sub>opr</sub> = 25°C, V<sub>DD</sub> = 5 V.

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

Note 3: I<sub>DD</sub>; Except for I<sub>REF</sub>

Note 4: Output resistors R<sub>os</sub>, R<sub>oc</sub> indicate "on" when switching levels.

Note 5: V<sub>O2/3</sub> indicates an output voltage at the 2/3 level when operating in the 1/4 or 1/3 duty mode.

Note 6: V<sub>O1/2</sub> indicates an output voltage at the 1/2 level when operating in the 1/2 duty or static mode.

Note 7: V<sub>O1/3</sub> indicates an output voltage at the 1/3 level when operating in the 1/4 or 1/3 duty mode.

Note 8: When using LCD, it is necessary to consider values of R<sub>os1/2</sub> and R<sub>bc1/2</sub>.

Note 9: Times for SEG/COM output switching on: R<sub>os1</sub>, R<sub>oc1</sub>: 2<sup>6</sup>/f<sub>c</sub>, 2/f<sub>c</sub> (s)

R<sub>os2</sub>, R<sub>oc2</sub>: 1/(n, f<sub>F</sub>)

(1/n: duty, f<sub>F</sub>: frame frequency)

## AD Conversion Characteristics

 $(V_{SS} = 0V, V_{DD} = 2.7 \text{ to } 5.5V, T_{opr} = -30 \text{ to } 70^{\circ}C)$ 

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog Reference Voltage	$V_{AREF}$	$V_{AREF} - V_{ASS} \geq 2.5V$	2.7	–	$V_{DD}$	V
	$V_{ASS}$		$V_{SS}$	–	1.5	
Analog Input Voltage	$V_{AIN}$		$V_{ASS}$	–	$V_{AREF}$	V
Analog Supply Current	$I_{REF}$	$V_{AREF} = 5.5V, V_{ASS} = 0.0V$	–	0.5	1.0	mA
Nonlinearity Error		$V_{DD} = 5.0V, V_{SS} = 0.0V$ $V_{AREF} = 5.000V$ $V_{ASS} = 0.000V$ or $V_{DD} = 2.7V, V_{SS} = 0.0V$ $V_{AREF} = 2.700V$ $V_{ASS} = 0.000V$	–	–	$\pm 1$	LSB
Zero Point Error			–	–	$\pm 1$	
Full Scale Error			–	–	$\pm 1$	
Total Error			–	–	$\pm 2$	

Note: Quantizing error is not contained in those errors.

## AC Characteristics

 $(V_{SS} = 0V, V_{DD} = 4.5 \text{ to } 5.5V, T_{opr} = -30 \text{ to } 70^{\circ}C)$ 

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	$t_{cy}$	In NORMAL 1, 2 mode	0.95	–	10	$\mu s$
		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), $f_c = 8 \text{ MHz}$	50	–	–	ns
Low Level Clock Pulse Width	$t_{WCL}$					
High Level Clock Pulse Width	$t_{WSH}$	For external clock operation (XTIN input), $f_s = 32.768 \text{ kHz}$	14.7	–	–	$\mu s$
Low Level Clock Pulse Width	$t_{WSL}$					

 $(V_{SS} = 0V, V_{DD} = 2.7 \text{ to } 5.5V, T_{opr} = -30 \text{ to } 70^{\circ}C)$ 

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	$t_{cy}$	In NORMAL 1, 2 mode	0.95	–	10	$\mu s$
		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), $f_c = 8 \text{ MHz}$	110	–	–	ns
Low Level Clock Pulse Width	$t_{WCL}$					
High Level Clock Pulse Width	$t_{WSH}$	For external clock operation (XTIN input), $f_s = 32.768 \text{ kHz}$	14.7	–	–	$\mu s$
Low Level Clock Pulse Width	$t_{WSL}$					

Recommended Oscillating Condition-1

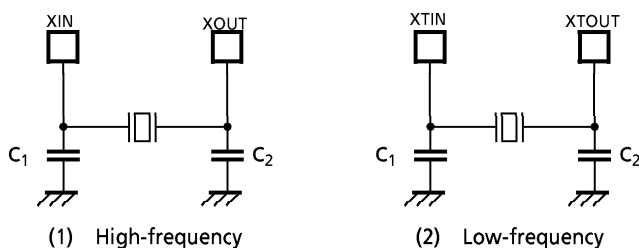
(VSS = 0 V, VDD = 4.5 to 5.5 V, Topr = - 30 to 70°C)

Parameter	Oscillator	Frequency	Recommender Oscillator		Recommended Condition	
					C <sub>1</sub>	C <sub>2</sub>
High-frequency	Ceramic Resonator	8 MHz	KYOCERA	KBR8.0M	30pF	30pF
			Standard/Lead Type (MURATA)	CSA8.00MTZ CST8.00MTW	Built-in 30pF	Built-in 30pF
			Standard/SMP Type (MURATA)	CSAC8.00MT	30pF	30pF
			Standard/Small ChipType (MURATA)	CSTC8.00MT	Built-in 30pF	Built-in 30pF
	Crystal Oscillator	8 MHz	TOYOCOM	210B 8.0000	20pF	20pF
			TOYOCOM	204B 4.0000		
Low-frequency	Crystal Oscillator	32.768 kHz	NDK	MX-38T	15pF	15pF

Recommended Oscillating Condition-2

(VSS = 0 V, VDD = 2.7 to 5.5 V, Topr = - 30 to 70°C)

Parameter	Oscillator	Frequency	Recommender Oscillator		Recommended Condition	
					C <sub>1</sub>	C <sub>2</sub>
High-frequency	Ceramic Resonator	4 MHz	Standard/Lead Type (MURATA)	CSA4.00MG CST4.00MGW	30pF Built-in 30pF	30pF Built-in 30pF
			Standard/SMD Type (MURATA)	CSA4.00MGC CSAC4.00MGCM CSTC4.00MG	30pF Built-in 30pF	30pF Built-in 30pF
			Standard/Small Chip Type	CSTCS4.00MG	Built-in 10pF	Built-in 10pF



Note 1: When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular 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>

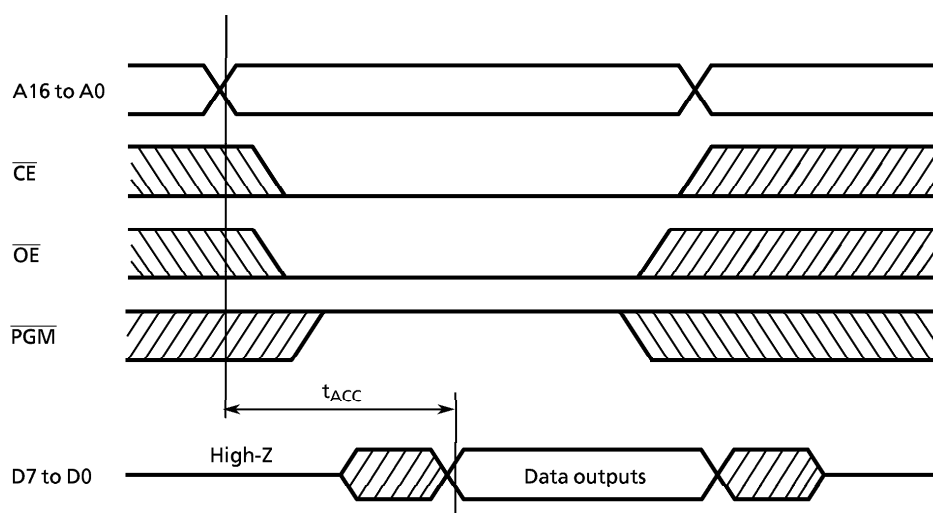


D.C./A.C. Characteristics (PROM mode) ( $V_{SS} = 0\text{ V}$ )

(1) Read Operation

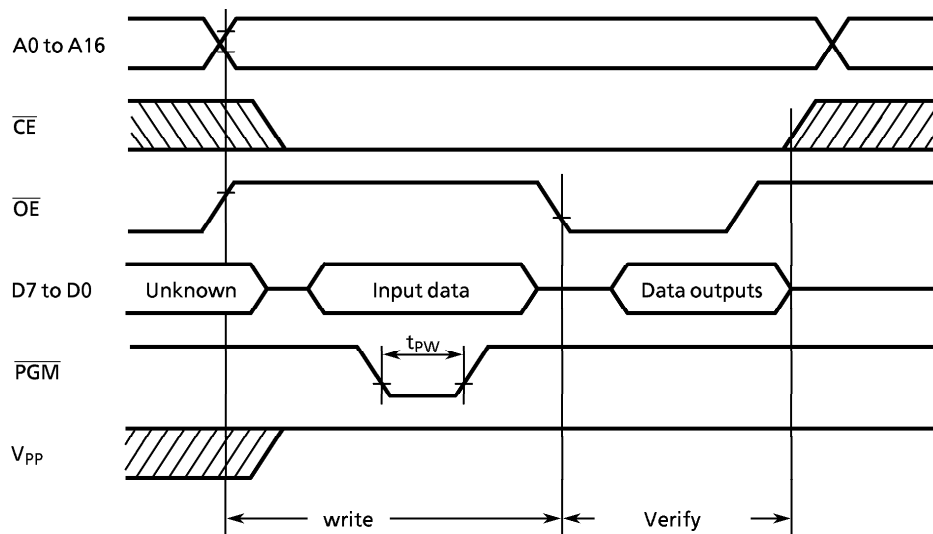
Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Input High Voltage	$V_{IH4}$		$V_{CC} \times 0.7$	–	$V_{CC}$	V
Input Low Voltage	$V_{IL4}$		0	–	$V_{CC} \times 0.12$	V
Power Supply Voltage	$V_{CC}$		4.75	5.0	5.25	V
Program Power Supply Voltage	$V_{PP}$					
Address Access Time	$t_{ACC}$	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5t_{cyc} + 300$	–	ns

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



(2) High-Speed Programming Operation

Parameter	Symbol	Condition	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



**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 ( $12.5\text{ V} \pm 0.5\text{ V} = V$ ) 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.