CMOS 8-Bit Microcontroller

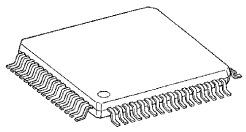
TMP86PM23U, TMP86PS23U

The TMP86PM23 is a OTP type MCU which includes 32-Kbyte one-time PROM; the TMP86PS23 is a OTP type MCU which includes 60-Kbyte one-time PROM. These are a pin compatible with a mask ROM product of the TMP86CM23/CP23. Writing the program to built-in PROM, the TMP86PM23/PS23 operates as the same way as the TMP86CM23/CP23. Using the Adapter socket, you can write and verify the data for the TMP86PM23 with a general-purpose PROM programmer same as TC571000D/AD.

Product No.	OTP	RAM	Package	Adapter Socket
TMP86PM23U	32 K × 8 bits	1.5 K × 8 bits	P-LQFP64-1010-0.50	*BM11198
*TMP86PS23U	60 K × 8 bits	2.0 K × 8 bits		

* Under Development

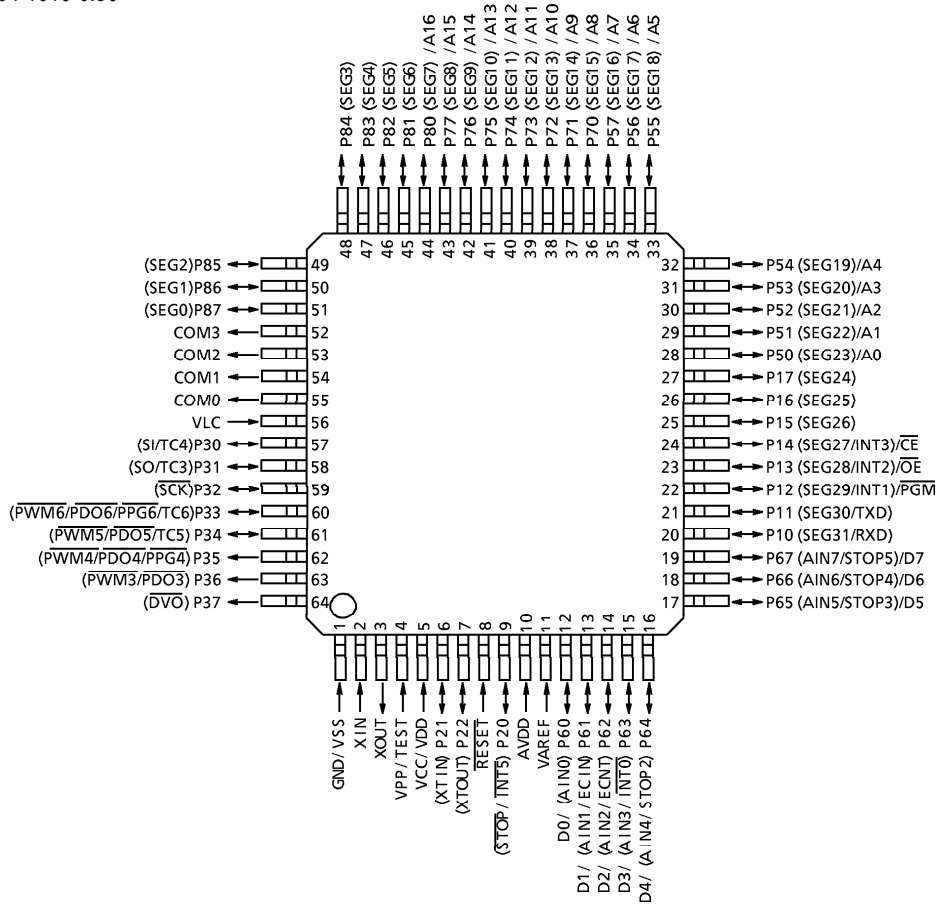
P-LQFP64-1010-0.50



TMP86PM23U
TMP86PS23U

Pin Assignments (Top View)

P-LQFP64-1010-0.50



Pin Functions

The TMP86PM23/PS23 have MCU mode and PROM mode.

(1) MCU mode

In the MCU mode, the TMP86PM23/PS23 are a pin compatible with the TMP86CM23/CP23 (Make sure to fix the TEST pin to low level).

(2) PROM mode

Pin Name	Input/Output	Function	Pin Name (MCU mode)
A16	Input	Input of Memory address for program	P80
A15 to A8			P77 to P70
A7 to A0			P57 to P50
D7 to D0	I/O	Input/Output of Memory data for program	P67 to P60
$\overline{CE}$	Input	Chip enable	P14
$\overline{OE}$		Output enable	P13
$\overline{PGM}$		Program mode control	P12
VPP	Power supply	+ 12.75 V/5 V (Power supply of program)	TEST
VCC		+ 6.25 V/5 V	VDD
GND		0 V	VSS
AVDD		Be pull-up to High level.	AVDD
VAREF		Be pull-down to Low level.	VAREF
VLC		Open or release.	VLC
P11, P21	Input	PROM mode setting pin. Be pull-up to High level.	
P15, P20, P22		PROM mode setting pin. Be fixed at Low level.	
$\overline{RESET}$			
P10	Input	Be fixed at Low level.	
P16, P17	Output	Output pin for PROM operation test. Open or release.	
P87 to P81	I/O	Open or release.	
P37 to P30			
COM3 to COM0	Output		
XIN	Input	Self oscillation with resonator (16 MHz).	
XOUT	Output		

Operation

This section describes the functions and basic operational blocks of TMP86PM23.
The TMP86PM23/PS23 have PROM in place of the mask ROM which is included in the TMP86CM23/CP23. The configuration and function are the same as the mask ROM products.
In addition, TMP86PM23/PS23 operate 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 TMP86PM23/PS23 have MCU mode and PROM mode.

1.1 MCU Mode

The MCU mode is set by fixing the TEST/VPP pin to the low level. (TEST/VPP pin cannot be used open because it has no built-in pull-down resister) and the TMP86PS23 has a 60Kbyte built-in one time PROM (addresses 1000 to $FFFF_H$ in MCU mode, addresses 0000 to $EFFF_H$ in the PROM mode).

1.1.1 Program memory

The TMP86PM23 has a 32 Kbyte built-in one time PROM (addresses 8000 to $FFFF_H$ in the MCU mode, addresses 0000 to $7FFF_H$ in the PROM mode) and the TMP86PS23 has a 60-Kbyte built-in one time PROM (addressed 1000 to $FFFF_H$ in MCU mode, addresses 0000 to $EFFF_H$ in the PROM mode).
When using TMP86PM23/PS23 for evaluation of mask ROM products, the program is written in the program storing area shown in Figure 1-1.

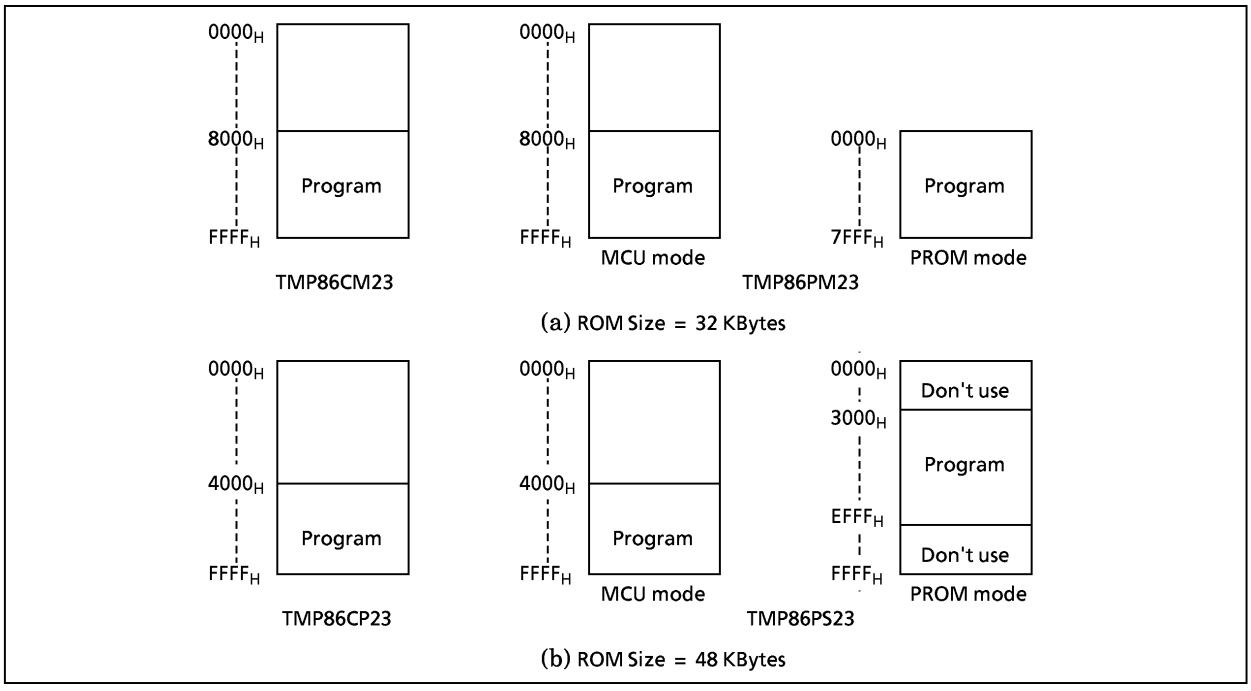


Figure 1-1. Program Memory Area

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

TMP86PM23 has a built-in 1.5 Kbyte Data memory and TMP86PS23 has a built-in 2-Kbyte data memory (static RAM).

Electrical Characteristics

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

Parameter	Symbol	Pins	Rating	Unit
Supply Voltage	V_{DD}		– 0.3 to 6.5	V
Program Voltage	V_{PP}	TEST/V_{PP}	– 0.3 to 13.0	
Input Voltage	V_{IN}		– 0.3 to V_{DD} + 0.3	
Output Voltage	V_{OUT1}		– 0.3 to V_{DD} + 0.3	
Output Current (Per 1 pin)	I_{OUT1}	P1, P30 to P34, P5, P6, P7, P8 Port	– 1.8	mA
	I_{OUT2}	P1, P2, P30 to P32, P5, P6, P7, P8 Port	3.2	
	I_{OUT3}	P33 to P37 Port	30	
Output Current (Total)	ΣI_{OUT1}	P1, P30 to P34, P5, P6, P7, P8 Port	– 30	
	ΣI_{OUT2}	P33 to P37 Port	80	
	ΣI_{OUT3}	P1, P2, P30 to P32, P5, P6, P7, P8 Port	60	
Power Dissipation [T_{opr} = 85°C]	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10 μ)	°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 V, Topr = – 40 to 85°C)

Parameter	Symbol	Pins	Condition		Min	Max	Unit
Supply Voltage	V_{DD}		fc = 16 MHz	NORMAL1, 2 mode	3.5	5.5	V
				IDLE0, 1, 2 mode			
			fc = 8 MHz	NORMAL1, 2 mode	2.7		
				IDLE0, 1, 2 mode			
			fc = 4.2 MHz	NORMAL1, 2 mode	1.8		
				IDLE0, 1, 2 mode			
			fs = 32.768 kHz	SLOW1, 2 mode			
				SLEEP0, 1, 2 mode			
				STOP mode			
Input high Level	V_{IH1}	Except Hysteresis input	$V_{DD} \geqq 4.5$ V		$V_{DD} \times 0.70$	V_{DD}	
	V_{IH2}	Hysteresis input			$V_{DD} \times 0.75$		
	V_{IH3}		$V_{DD} < 4.5$ V		$V_{DD} \times 0.90$		
Input low Level	V_{IL1}	Except Hysteresis input	$V_{DD} \geqq 4.5$ V		0	$V_{DD} \times 0.30$	
	V_{IL2}	Hysteresis input				$V_{DD} \times 0.25$	
	V_{IL3}		$V_{DD} < 4.5$ V			$V_{DD} \times 0.10$	
Clock Frequency	fc	XIN, XOUT	V_{DD} = 1.8 to 5.5 V		1.0	4.2	MHz
			V_{DD} = 2.7 to 5.5 V			8.0	
			V_{DD} = 3.5 to 5.5 V			16.0	
	fs	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_{SS} = 0 V, Topr = – 40 to 85°C)

Parameter	Symbol	Pins	Condition		Min	Typ.	Max	Unit
Hysteresis Voltage	V_{HS}	Hysteresis input			–	0.9	–	V
Input Current	I_{IN1}	TEST	V_{DD} = 5.5 V, V_{IN} = 5.5 V/0 V		–	–	± 2	μA
	I_{IN2}	Sink open drain, Tri-state						
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$						
Input Resistance	R_{IN2}	$\overline{RESET}$ pull-Up			100	220	450	kΩ
Output Leakage Current	I_{LO}	Sink open drain, Tri-state	V_{DD} = 5.5 V, V_{OUT} = 5.5 V/0 V		–	–	± 2	μA
Output High Voltage	V_{OH2}	C-MOS, Tri-st Port	V_{DD} = 4.5 V, I_{OH} = – 0.7 mA		4.1	–	–	V
Output Low Voltage	V_{OL}	Except XOUT and P3 Port	V_{DD} = 4.5 V, I_{OL} = 1.6mA		–	–	0.4	
Output Low Current	I_{OL}	High Current Port (P33 to P37 Port)	V_{DD} = 4.5 V, V_{OL} = 1.0 V		–	20	–	mA
Supply Current in NORMAL 1, 2 mode	V_{DD}		V_{DD} = 5.5 V V_{IN} = 5.3/0.2 V fc = 16 MHz fs = 32.768 kHz	TMP86PM23	–	11.5	16.5	
Supply Current in IDLE 0, 1, 2 mode					–	7.0	11.0	
Supply Current in SLOW 1 mode			V_{DD} = 3.0 V V_{IN} = 2.8 V/0.2 V fs = 32.768 kHz LCD driver is not enable.		–	19	33	μA
Supply Current in SLEEP 1 mode					–	13	26	
Supply Current in SLEEP 0 mode					–	5	14	
Supply Current in NORMAL 1, 2 mode	V_{DD}		V_{DD} = 5.5 V V_{IN} = 5.3/0.2 V fc = 16 MHz fs = 32.768 kHz	TMP86PS23	–	T.B.D	T.B.D	mA
Supply Current in IDLE 0, 1, 2 mode					–	T.B.D	T.B.D	
Supply Current in SLOW 1 mode			V_{DD} = 3.0 V V_{IN} = 2.8 V/0.2 V fs = 32.768 kHz LCD driver is not enable.		–	T.B.D	T.B.D	μA
Supply Current in SLEEP 1 mode					–	T.B.D	T.B.D	
Supply Current in SLEEP 0 mode					–	T.B.D	T.B.D	
Supply Current in STOP mode			V_{DD} = 5.5 V V_{IN} = 5.3 V/0.2 V		–	0.5	10	
Segment Output Low Resistance	R_{OS1}	SEG Pin			–	20	–	kΩ
Common Output Low Resistance	R_{OC1}	COM Pin			–	20	–	
Segment Output High Resistance	R_{OS2}	SEG Pin			–	200	–	
Common Output High Resistance	R_{OC2}	COM Pin			–	200	–	
Segment/Common Output Voltage	$V_{O2/3}$	SEG/COM Pin	V_{DD} = 5.0 V VLC = 2.0 V		3.8	–	4.2	V
	$V_{O1/2}$				3.3		3.7	
	$V_{O1/3}$				2.8		3.2	

Note 1: Typical values show those at Topr = 25°C, V_{DD} = 5 V
Note 2: Input current (I_{IN1}, I_{IN2}); The current through pull-up or pull-down resistor is not included.
Note 3: I_{DD} does not include I_{REF} current.
Note 4: The supply currents of SLOW 2 and SLEEP 2 modes are equivalent to IDLE 0, 1, 2.
Note 5: Output resistors R_{OS} and R_{OC} indicate "ON" when switching levels.
Note 6: $V_{O2/3}$ indicates the output voltage at the 2/3 level when operating in the 1/4 or 1/3 duty mode.
Note 7: $V_{O1/2}$ indicates the output voltage at the 1/2 level when operating in the 1/2 duty or static mode.
Note 8: $V_{O1/3}$ indicates the output voltage at the 1/3 level when operating in the 1/4 or 1/3 duty mode.
Note 9: When using LCD, it is necessary to consider values of Ros 1/2 and Roc 1/2.

AD Conversion Characteristics

(V_{SS} = 0.0 V, 4.5 V ≦ V_{DD} ≦ 5.5 V, Topr = – 40 to 85°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 (Note 6)	A_{VDD}		V_{DD}			
Analog Reference Voltage Range (Note 4)	$\triangle V_{AREF}$		3.5	–	–	
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 V V_{SS} = 0.0 V	–	0.6	1.0	mA
Non linearity Error		$V_{DD} = A_{VDD}$ = 5.0 V, V_{SS} = 0.0 V V_{AREF} = 5.0 V	–	–	± 2	LSB
Zero Point Error			–	–	± 2	
Full Scale Error			–	–	± 2	
Total Error			–	–	± 2	

(V_{SS} = 0.0 V, 2.7 V ≦ V_{DD} < 4.5 V, Topr = – 40 to 85°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 (Note 6)	A_{VDD}		V_{DD}			
Analog Reference Voltage Range (Note 4)	$\triangle V_{AREF}$		2.5	–	–	
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 V V_{SS} = 0.0 V	–	0.5	0.8	mA
Non linearity Error		$V_{DD} = A_{VDD}$ = 2.7 V, V_{SS} = 0.0 V V_{AREF} = 2.7 V	–	–	± 2	LSB
Zero Point Error			–	–	± 2	
Full Scale Error			–	–	± 2	
Total Error			–	–	± 2	

(V_{SS} = 0.0 V, 2.0 V ≦ V_{DD} < 2.7 V, Topr = – 40 to 85°C) Note 5
(V_{SS} = 0.0 V, 1.8 V ≦ V_{DD} < 2.0 V, Topr = – 10 to 85°C) Note 5

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}		A_{VDD} – 0.9	–	A_{VDD}	V
Power Supply Voltage of Analog Control Circuit (Note 6)	A_{VDD}		V_{DD}			
Analog Reference Voltage Range (Note 4)	$\triangle V_{AREF}$	1.8 V ≦ V_{DD} < 2.0 V	1.8	–	–	
		2.0 V ≦ V_{DD} < 2.7 V	2.0	–	–	
Analog Input Voltage	V_{AIN}		V_{SS}	–	V_{AREF}	
Power Supply Current of Analog Reference Voltage	I_{REF}	$V_{DD} = A_{VDD} = V_{AREF}$ = 2.7 V V_{SS} = 0.0 V	–	0.3	0.5	mA
Non linearity Error		$V_{DD} = A_{VDD}$ = 1.8 V, V_{SS} = 0.0 V V_{AREF} = 1.8 V	–	–	± 4	LSB
Zero Point Error			–	–	± 4	
Full Scale Error			–	–	± 4	
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 "2.10.2 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: $\triangle V_{AREF} = V_{AREF} - V_{SS}$
Note 5: When AD is used with V_{DD} < 2.7 V, the guaranteed temperature range varies with the operating voltage.
Note 6: The AVDD pin should be fixed on the VDD level even though AD converter is not used.

AC Characteristics

(V_{SS} = 0 V, V_{DD} = 3.5 to 5.5 V, Topr = – 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	tcy	NORMAL 1, 2 mode	0.25	–	4	μs
		IDLE 1, 2 mode				
		SLOW 1, 2 mode	117.6	–	133.3	
		SLEEP 1, 2 mode				
High Level Clock Pulse Width	twcH	For external clock operation (XIN input) fc = 16 MHz	–	31.25	–	ns
Low Level Clock Pulse Width	twcL					
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μs
Low Level Clock Pulse Width	twcL					

(V_{SS} = 0 V, V_{DD} = 2.7 to 5.5 V, Topr = – 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	tcy	NORMAL 1, 2 mode	0.5	–	4	μs
		IDLE 1, 2 mode				
		SLOW 1, 2 mode	117.6	–	133.3	
		SLEEP 1, 2 mode				
High Level Clock Pulse Width	twcH	For external clock operation (XIN input) fc = 8 MHz	–	62.5	–	ns
Low Level Clock Pulse Width	twcL					
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μs
Low Level Clock Pulse Width	twcL					

(V_{SS} = 0 V, V_{DD} = 1.8 to 5.5 V, Topr = – 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine Cycle Time	tcy	NORMAL 1, 2 mode	0.95	–	4	μs
		IDLE 1, 2 mode				
		SLOW 1, 2 mode	117.6	–	133.3	
		SLEEP 1, 2 mode				
High Level Clock Pulse Width	twcH	For external clock operation (XIN input) fc = 4.2 MHz	–	119.05	–	ns
Low Level Clock Pulse Width	twcL					
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μs
Low Level Clock Pulse Width	twcL					

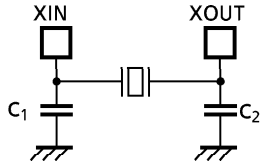
Timer Counter 1 input (ECIN) Characteristics

(V_{SS} = 0 V, Topr = – 40 to 85°C)

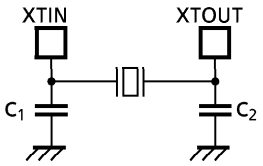
Parameter	Symbol	Condition		Min	Typ.	Max	Unit
TC1 input (ECIN input)	t_{TC1}	Frequency measurement mode V_{DD} = 3.5 to 5.5 V	Single edge count	–	–	16	MHz
			Both edge count	–	–		
		Frequency measurement mode V_{DD} = 2.7 to 5.5 V	Single edge count	–	–	8	
			Both edge count	–	–		
		Frequency measurement mode V_{DD} = 1.8 to 5.5 V	Single edge count	–	–	4.2	
			Both edge count	–	–		

Recommended Oscillating Conditions - 1

(V_{SS} = 0 V, V_{DD} = 1.8 to 5.5 V, Topr = – 40 to 85°C)



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

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.

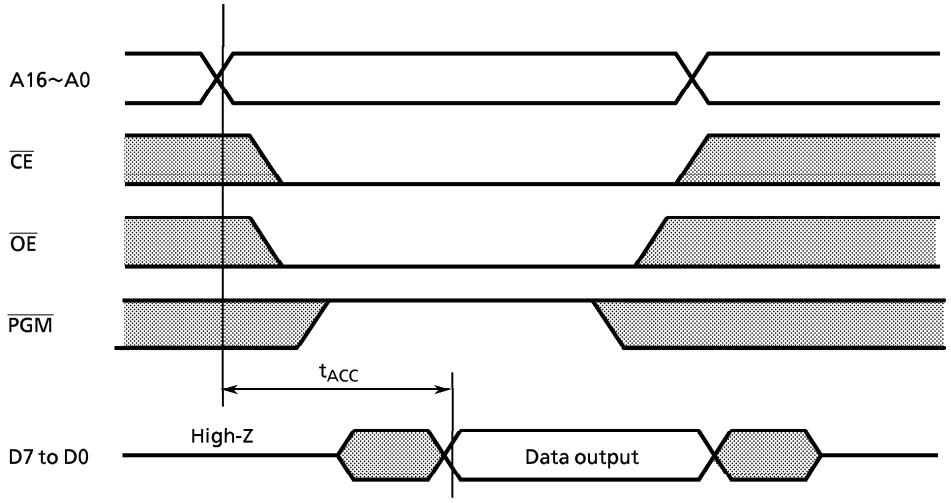
Note 2: The product numbers and specifications of the resonators by Murata Manufacturing Co., Ltd. are subject to change. For up-to-date information, please refer to the following URL:
http://www.murata.co.jp/search/index.html

DC Characteristics, AC Characteristics (PROM Mode) (V_{SS} = 0 V, Topr = – 40 to 85°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 leve 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 ± 0.25 V	–	1.5tcyc + 300	–	ns

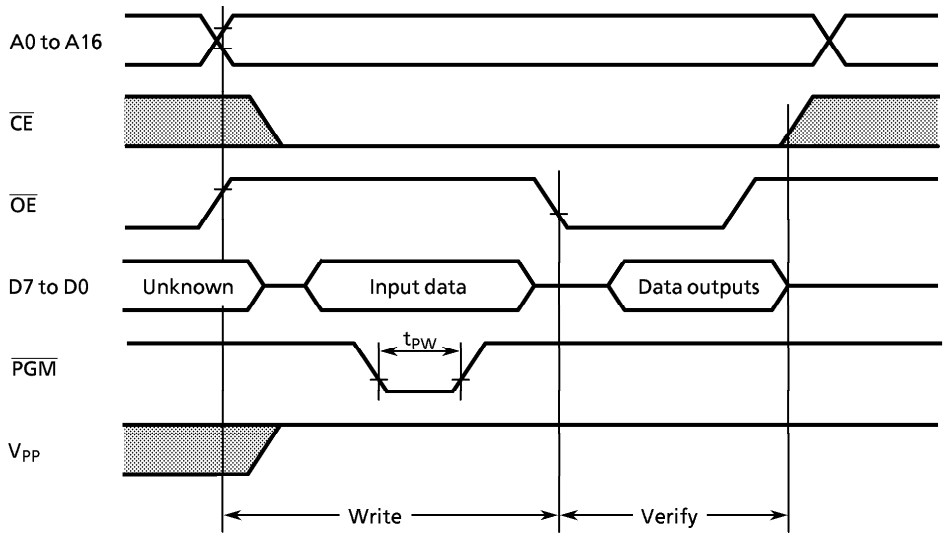
Note: tcyc = 500 ns at 8 MHz



(2) Program operation (High-speed) (Topr = 25 ± 5°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
High level input voltage (TTL)	V_{IH4}		2.2	–	V_{CC}	V
Low leve 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 V	0.095	0.1	0.105	ms

High-speed program writing



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}.

Note2 : The pulling up/down device on the condition of V_{PP} = 12.75 V ± 0.25 V causes a damage for the device. Do not pull up/down at programming.

Note3 : Use the recommended adapter and mode (See 1.2.2 (1) and 1.2.2 (3) i).
Using other than the above condition may cause the trouble of the writting.