#### **CMOS 8-Bit Microcontroller**

## **TMP86PM47U**

The TMP86PM47 is a OTP type MCU which includes 32 Kbyte One-time PROM. It is a pin compatible with a mask ROM product of the TMP86C845/847/H47/M47. Writing the program to built-in PROM, the TMP86PM47 operates as the same way as the TMP86C847/H47/M47. About elaboration, please refer to later "Difference between TMP86C845 and TMP86Cx47". Using the Adapter socket, you can write and verify the data for the TMP86PM47 with a general-purpose PROM programmer same as TC57100D/AD.

Product No.	OTP	RAM	Package	Adapter Socket
TMP86PM47U	32 K x 8 bits	1 K 🗙 8 bits	P-QFP44-1010-0.80J	BM11187

P-QFP44-1010-0.80J
TMP86PM47U

000707E	21

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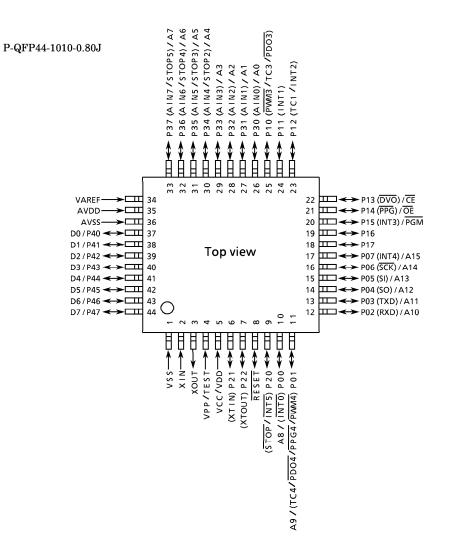
## Difference Between TMP86C845 and TMP86Cx47

			TMP86Cx47U		TMP86C845U			
		TMP86C847U	TMP86CH47U	TMP86CM47U				
ROM (byt	e)	8K	16K	32K	8К			
RAM (byt	e)	512	512	1K	256			
I/O			35		35			
Package (	Body size)		QFP44 (10 × 10 mm)		QFP44 (10 × 10 mm)			
Min Instru	uction		0.25 ps (at 16 MHz)	(at 16 MHz) 0.5 µs (at 8 MHz)				
Supply Vc	ltage	2.7 to 5.	to 5.5 V at 4.2 MHz/32.768 kHz to 5.5 V at 8.0 MHz/32.768 kHz to 5.5 V at 8.0 MHz/32.768 kHz to 5.5 V at 16 MHz/32.768 kHz					
16-bit tim	er/counter		1 ch	-				
8-bit timer/counter			2 ch	2 ch				
Time base	timer		1 ch	1 ch 1 ch				
Watchdo	g timer		1 ch		1 ch			
AD conve	rter		8 ch		8 ch			
Serial I/O		Clocked	Clocked synchronous: 1 ch, UART: 1 ch		Clocked synchronous: 1 ch			
Key on wa	ake up		4 ch		<b>-</b>			
Warm-up	counter		6		4			
10	Hysteresis inputc		P0, P1, P2 port		Port2, P00, P05, P06, P07, P10, P11, P12, P15 pin			
I/O Circuitry input		P3, P4 port			Port3, Port4, P01, P02, P03, P04, P13, P14 P16, P17 pin			
RESET		Watchdog timer,	Adress trap, System o	lock reset output	Input only			
Operatior	n Temp.		– 40 to 85 °C		– 40 to 85 °C			

are difference points between TMP86C845 and TMP86Cx47.

Please refer to "Input/output Circutry" of TMP86C847/H47/M47 and TMP86C845 for details.

## Pin Assignments (Top View)



## **Pin Function**

The TMP86PM47 has MCU mode and PROM mode.

(1) MCU mode

In the MCU mode, the TMP86PM47 is a pin compatible with the TMP86C845/847/H47/M47 (Make sure to fix the TEST pin to low level).

## (2) PROM mode

Pin Name	Input/Output	Functions	Pin Name (MCU mode)
A15 to A8	lagut	Input of Momory address for program	P07 to P00
A7 to A0	Input	Input of Memory address for program	P37 to P30
D7 to D0	I/O	Input/Output of Memory data for program	P47 to P40
CE		Chip enable	P13
OE	Input	Output enable	P14
PGM		Program control	P15
VPP		+ 12.75 V/5 V (Power supply of program)	TEST
VCC, AVDD	Power supply	+ 6.25 V/5 V	VDD, AVDD
GND, VAREF, AVSS		0 V	VSS, VAREF, AVSS
P11, P21		PROM mode setting pin. Fix to high.	
P10, P12, P22, P20	I/O		
RESET		PROM mode setting pin. Fix to low.	
P17, P16	I/O	Open	
XIN	Input	Self oscillation with resonator (8 MHz).	
XOUT	Output		

Note: No pin is applied to A16 input.

## Operation

This section describes the functions and basic operational blocks of TMP86PM47.

The TMP86PM47 has PROM in place of the mask ROM which is included in the TMP86C845/847/H47/M47. The configuration and function are the same as the TMP86C847/H47/M47. For TMP86C845, however, some functions have been partially changed or deleted. For the functions of TMP86PM47 in details, see the section of TMP86C845/847/H47/M47.

## 1. Operating Mode

The TMP86PM47 has MCU mode and PROM mode.

## 1.1 MCU Mode

The MCU mode is set by fixing the TEST/VPP pin to the low level.

In the MCU mode, the operation is the same as the TMP86C845/847/H47/M47 (TEST/VPP pin cannot be used open because it has no built-in pull-down resister).

#### 1.1.1 Program memory

The TMP86PM47 has a 32-Kbyte built-in one time PROM (addresses 8000 to  $\rm FFFF_{H}$  in the MCU mode, addresses 0000 to  $\rm 7FFF_{H}$  in the PROM mode).

When using TMP86PM47 for evaluation of TMP86C845/847/H47/M47, the program is written in the program storing area shown in Figure 1-1.

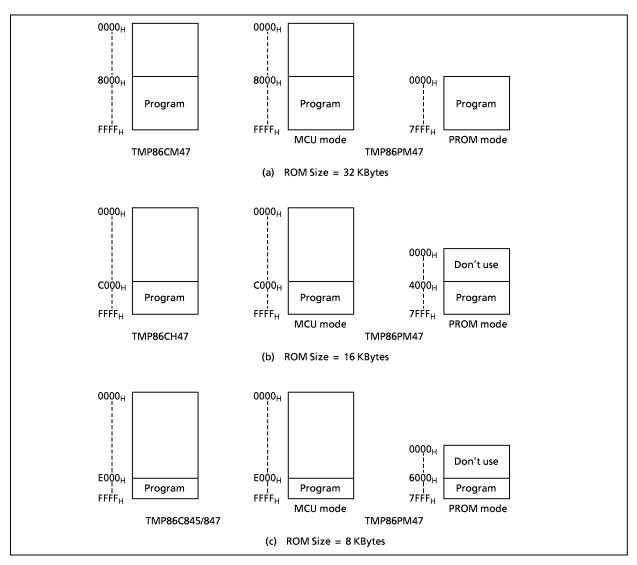


Figure 1-1. Program Memory Area

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.

#### **Electrical Characteristics**

Absolute Maximum Ratings	$(V_{SS} = 0 V)$
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Parameter	Symbol	Pins	Rating	Unit
Supply Voltage	V <sub>DD</sub>		– 0.3 to 6.5	
Program Voltage	V <sub>PP</sub>	TEST/V <sub>PP</sub>	– 0.3 to 13.0	
Input Voltage	V <sub>IN</sub>		– 0.3 to V <sub>DD</sub> + 0.3	7 °
Output Voltage	V <sub>OUT1</sub>	P21, P22, RESET, Tri-state Port	- 0.3 to V <sub>DD</sub> + 0.3	1
Output Current (Per 1 pin)	I <sub>OUT1</sub>	P1, P3, P4 Port	- 1.8	
	I <sub>OUT2</sub>	P1, P3 Port	3.2	
	I <sub>OUT3</sub>	P0, P2, P4 Port	30	mA
	ΣI <sub>OUT1</sub>	P1, P3 Port	60	1
Output Current (Total)	Σl <sub>OUT2</sub>	P0, P2, P4 Port	80	1
Power Dissipation [T <sub>opr</sub> = 85°C]	PD		250	mW
Soldering Temperature (time)	Tsld		260 (10 s)	
Storage Temperature	Tstg		– 55 to 125	°⊂
Operating Temperature	Topr		– 40 to 85	1

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.

<b>Recommended Operating Condition</b>	$(V_{SS} = 0 V, Topr = -40 to 85^{\circ}C)$
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Parameter	Symbol	Pins	Condition		Min	Max	Uni	
				NORMAL1, 2 mode	4.5			
			fc = 16 MHz	IDLE0, 1, 2 mode	4.5			
Supply Voltage V			(	NORMAL1, 2 mode	2.7			
			fc = 8 MHz	IDLE0, 1, 2 mode	2.7			
	V <sub>DD</sub>		NORMAL1, 2 mode		5.5			
			fc = 4.2 MHz	IDLE0, 1, 2 mode			v	
				SLOW1, 2 mode	1.8			
				SLEEP0, 1, 2 mode				
				STOP mode				
	V <sub>IH1</sub>	Except Hysteresis input	$V_{DD} \ge 4.5 V$ $V_{DD} < 4.5 V$		$V_{DD} \times 0.70$			
Input high Level	V <sub>IH2</sub>	Hysteresis input			V <sub>DD</sub> × 0.75	V <sub>DD</sub>		
	V <sub>IH3</sub>				V <sub>DD</sub> × 0.90			
	V <sub>IL1</sub>	Except Hysteresis input	$V_{DD} \ge 4.5 V$			$V_{DD} \times 0.30$		
Input low Level	V <sub>IL2</sub>	Hysteresis input			$v_{DD} = 4.3 v$		0	$V_{DD} \times 0.25$
	V <sub>IL3</sub>		V <sub>D</sub>	$V_{DD}$ < 4.5 V		$V_{DD} \times 0.10$		
			V <sub>DD</sub> =	= 1.8 to 5.5 V		4.2		
Clock Frequency	fc	fc XIN, XOUT		V <sub>DD</sub> = 2.7 to 5.5 V		8.0	MHz	
			V <sub>DD</sub> =	= 4.5 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 Char	acteristics	(V <sub>SS</sub> = 0 V, T	opr = - 40 to 85°C)				
Parameter	Symbol	Pins	Condition	Min	Тур.	Max	Unit
Hysteresis Voltage	V <sub>HS</sub>	Hysteresis input		-	0.9	-	V
	I <sub>IN1</sub>	TEST					
Input Current	I <sub>IN2</sub>	Sink Open Drain, Tri-state	$V_{DD} = 5.5 V, V_{IN} = 5.5 V/0 V$	-	-	± 2	μA
	I <sub>IN3</sub>	RESET, STOP					
Input Resistance	R <sub>IN2</sub>	RESET Pull-Up		100	220	450	kΩ
Output Leakage	I <sub>LO1</sub>	Sink Open Drain	$V_{DD} = 5.5 V, V_{OUT} = 5.5 V$	-	-	2	
Current	I <sub>LO2</sub>	Tri-state	$V_{DD}$ = 5.5 V, $V_{OUT}$ = 5.5 V/0 V	-	-	± 2	μΑ
Output High Voltage	V <sub>OH1</sub>	Tri-st Port	$V_{DD} = 4.5 \text{ V}, I_{OH} = -0.7 \text{ mA}$	4.1	-	-	
Output Low Voltage	V <sub>OL</sub>	Except XOUT and P0, P2, P4 Port	$V_{DD} = 4.5 V$ , $I_{OL} = 1.6 mA$	-	-	0.4	V
Output Low Current	I <sub>OL</sub>	High Current Port (P0, P2, P4 Port)	$V_{DD} = 4.5 V, V_{OL} = 1.0 V$	-	20	-	
Supply Current in NORMAL 1, 2 mode			$V_{DD} = 5.5 V$ $V_{IN} = 5.3/0.2 V$ fc = 16 MHz fs = 32.768 kHz	-	7.5	9	mA
Supply Current in IDLE 0, 1, 2 mode				-	5.5	6.5	
Supply Current in SLOW 1 mode				-	18	42	
Supply Current in SLEEP 1 mode	V <sub>DD</sub>		$V_{DD} = 3.0 V$ $V_{IN} = 2.8 V/0.2 V$ fs = 32.768  kHz	-	16	25	
Supply Current in SLEEP 0 mode				-	12	20	μΑ
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 Topr =  $25^{\circ}$ C,  $V_{DD} = 5 V$ 

Note 2: Input current (I<sub>IN1</sub>, I<sub>IN2</sub>); The current through pull-up or pull-down resistor is not included.

Note 3: IDD does not include IREF current.

Note 4: The supply currents of SLOW 2 and SLEEP 2 modes are equivalent to IDLE 0, 1, 2.

#### AD Conversion Characteristics

 $(V_{SS} = 0.0 \text{ V}, 4.5 \text{ V} \le V_{DD} \le 5.5 \text{ V}, \text{Topr} = -40 \text{ to } 85^{\circ}\text{C})$ 

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
Analog Reference Voltage	V <sub>AREF</sub>		A <sub>VDD</sub> - 1.0	-	A <sub>VDD</sub>	
Power Supply Voltage of Analog Control Circuit	A <sub>VDD</sub>			V <sub>DD</sub>		v
Analog Reference Voltage Range (Note 4)	$\Delta v_{AREF}$		3.5	-	_	
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>	$V_{DD} = A_{VDD} = V_{AREF} = 5.5 V$ $V_{SS} = AVSS = 0.0 V$	-	0.6	1.0	mA
Non linearity Error			-	-	± 2	
Zero Point Error		$V_{DD} = A_{VDD} = 5.0 V,$	-	-	± 2	
Full Scale Error		$V_{SS} = AVSS = 0.0 V$ $V_{ARFF} = 5.0 V$	-	-	± 2	LSB
Total Error			-	-	±2	

#### $(V_{SS} = 0.0 \text{ V}, 2.7 \text{ V} \le V_{DD} < 4.5 \text{ V}, \text{Topr} = -40 \text{ to } 85^{\circ}\text{C})$

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
Analog Reference Voltage	V <sub>AREF</sub>		A <sub>VDD</sub> - 1.0	-	A <sub>VDD</sub>	
Power Supply Voltage of Analog Control Circuit	A <sub>VDD</sub>			V <sub>DD</sub>		v
Analog Reference Voltage Range (Note 4)	$\Delta v_{AREF}$		2.5	-	-	1
Analog Input Voltage	V <sub>AIN</sub>		V <sub>SS</sub>	-	VAREF	
Power Supply Current of Analog Reference Voltage	I <sub>REF</sub>	$V_{DD} = A_{VDD} = V_{AREF} = 4.5 V$ $V_{SS} = AVSS = 0.0 V$	-	0.5	0.8	mA
Non linearity Error			-	-	± 2	
Zero Point Error		$V_{DD} = A_{VDD} = 2.7 V,$	-	-	± 2	
Full Scale Error		$V_{SS} = AVSS = 0.0 V$ $V_{ARFF} = 2.7 V$	-	_	± 2	LSB
Total Error			-	-	± 2	1

# $(V_{SS}$ = 0.0 V, 2.0 V $\leq V_{DD}$ <2.7 V, Topr = - 40 to 85°C) Note 5 (V\_{SS} = 0.0 V, 1.8 V $\leq V_{DD}$ <2.0 V, Topr = - 10 to 85°C) Note 5

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
Analog Reference Voltage	V <sub>AREF</sub>		A <sub>VDD</sub> - 0.9	-	A <sub>VDD</sub>	
Power Supply Voltage of Analog Control Circuit	A <sub>VDD</sub>			$V_{DD}$		]
Analog Reference Voltage Range (Note 4)		$1.8 \text{ V} \leq \text{V}_{\text{DD}} < 2.0 \text{ V}$	1.8	-	-	
	$\Delta v_{AREF}$	$2.0V \leqq V_{DD} < 2.7V$	2.0	-	-	
Analog Input Voltage	V <sub>AIN</sub>		V <sub>SS</sub>	-	VAREF	
Power Supply Current of Analog Reference Voltage	I <sub>REF</sub>	$V_{DD} = A_{VDD} = V_{AREF} = 2.7 V$ $V_{SS} = AVSS = 0.0 V$	-	0.3	0.5	mA
Non linearity Error			-	-	±4	
Zero Point Error		$V_{DD} = A_{VDD} = 1.8 V,$ $V_{SS} = AVSS = 0.0 V$ $V_{AREF} = 1.8 V$	-	-	±4	LSB
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.

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:  $\triangle V_{AREF} = V_{AREF} - V_{SS}$ Note 5: When AD is used with  $V_{DD} < 2.7 V$ , the guaranteed temperature range varies with the operating voltage.

#### **AC** Characteristics

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

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
Machine Cycle Time		NORMAL 1, 2 mode			4	
	tau	IDLE 0, 1, 2 mode	0.25	-		μs
	tcy	SLOW 1, 2 mode	447.0	-	133.3	
		SLEEP 0, 1, 2 mode	117.6			
High Level Clock Pulse Width	twcH	For external clock operation (XIN input)	-	31.25	-	ns
Low Level Clock Pulse Width	twcL	fc = 16 MHz				115
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input)		15.26		
Low Level Clock Pulse Width	twcL	fc = 32.768 kHz	-		-	μs

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

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
Machine Cycle Time		NORMAL 1, 2 mode		-	4	
	tov	IDLE 0, 1, 2 mode	0.5			
	tcy	SLOW 1, 2 mode	117.0	-	133.3	- μ <b>s</b>
		SLEEP 0, 1, 2 mode	117.6			
High Level Clock Pulse Width	twcH	For external clock operation (XIN input)	-	62.5	-	ns
Low Level Clock Pulse Width	twcL	fc = 8 MHz				115
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input)		15.26	_	
Low Level Clock Pulse Width	twcL	fc = 32.768 kHz	-			μS

## $(V_{SS} = 0 V, V_{DD} = 1.8 \text{ to } 2.7 V, \text{Topr} = -40 \text{ to } 85^{\circ}\text{C})$

Parameter	Symbol	Condition	Min	Тур.	Max	Unit
Machine Cycle Time		NORMAL 1, 2 mode			4	
	tav	IDLE 0, 1, 2 mode	0.95	-		
	tcy	SLOW 1, 2 mode	1170	-	133.3	μs
		SLEEP 0, 1, 2 mode	117.6			
High Level Clock Pulse Width	twcH	For external clock operation (XIN input)		119.05	-	ns
Low Level Clock Pulse Width	twcL	fc = 4.2 MHz	-			115
High Level Clock Pulse Width	twcH	For external clock operation (XTIN input)		15.20		
Low Level Clock Pulse Width	twcL	fc = 32.768 kHz	_	15.26	-	μs

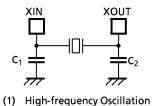
Recommended Oscillating Conditions - 1			$(V_{SS} = 0 V, V_{DD} = 4.5 \text{ to } 5.5 V, \text{ Topr} = -40 \text{ to } 85^{\circ}\text{C})$					
		Oscillatio				Recommended Consta		
PARAMETER	Oscillator	Frequenc	:y	Recommended Oscillator		<b>C</b> <sub>1</sub>	C <sub>2</sub>	
		16 MHz		MURATA	CSA16.00MXZ040	10 pF	10 pF	
	Ceramic Resonator	8 MHz		MURATA	CSA8.00MTZ	30 pF	30 pF	
High-frequency					CST8.00MTW	30 pF (built-in)	30 pF (built-in)	
Oscillation			_	MURATA	CSA4.19MG	30 pF	30 pF	
		4.19 MH:	z		CST4.19MGW	30 pF (built-in)	30 pF (built-in)	
Low-frequency Oscillation	Crystal Oscillator	32.768 k⊦	łz	SII	VT-200	6 pF	6 pF	

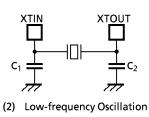
Recommended Oscillati	na Conditions - 2
Neconninentieu Oscinati	ng conunions - z

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

PARAMETER	Oscillator	Oscillation Frequency	Recommended Oscillator		Recommend C <sub>1</sub>	ed Constant C <sub>2</sub>
High-frequency Oscillation Ceramic Resonator	8 MHz	MURATA	CSA8.00MTZ CST8.00MTW	30 pF 30 pF (built-in)	30 pF 30 pF (built-in)	
	Ceramic Resonator	4.19 MHz	MURATA	CSA4.19MG CST4.19MGW	30 pF 30 pF (built-in)	30 pF 30 pF (built-in)

Recommended	d Oscillating Condit	tions - 3	(V <sub>SS</sub> = 0 V, V	/ <sub>DD</sub> = 1.8 to 5.5 V, Topr =	– 40 to 85°C)		
PARAMETER Osc	0	Oscillation			Recommended Constant		
PARAIVIETER	Oscillator	Frequency	Recom	mended Oscillator	C <sub>1</sub>	C <sub>2</sub>	
High-frequency	Ceramic Resonator	4.19 MHz	MURATA	CSA4.19MG	30 pF	30 pF	
Oscillation	Ceramic Resonator	4. 19 IVIHZ		CST4.19MGW	30 pF (built-in)	30 pF (built-in)	





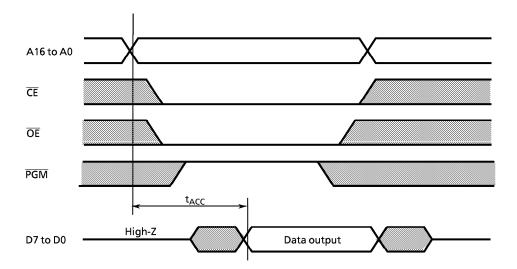
Note 1: An electrical shield by metal shield plate on the surface of IC package is recommended in order to protect the device from the high electric field stress applied from CRT (Cathodic Ray Tube) for continuous reliable operation.

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 DC Characteristics, AC Characteristics (PROM Mode) (V<sub>SS</sub> = 0 V, Topr = -40 to 85°C)

## (1) Read operation in PROM mode

Parameter	Symbol	Conditions	Min	Тур.	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	V
Power supply	V <sub>CC</sub>		4.75	5.0	5.25	v
Power supply of program	V <sub>PP</sub>		4.75	5.0	5.25	v
Address access time	t <sub>ACC</sub>	V <sub>CC</sub> = 5.0 ± 0.25 V	-	1.5tcyc + 300	-	ns

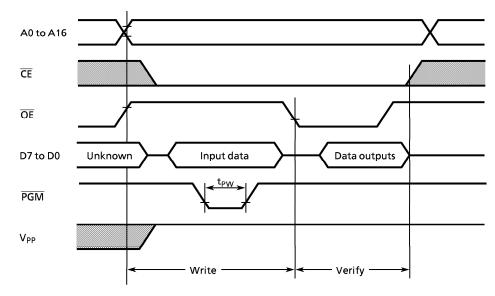
Note: tcyc = 500 ns at 8 MHz



Parameter	Symbol	Conditions	Min	Тур.	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	v
Power supply	V <sub>CC</sub>		6.0	6.25	6.5	V
Power supply of program	V <sub>PP</sub>		12.5	12.75	13.0	V
Pulse width of initializing program	t <sub>PW</sub>	V <sub>CC</sub> = 6.0 V	0.095	0.1	0.105	ms

## (2) Program operation (High-speed) (Topr = $25 \pm 5^{\circ}$ C)

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  $V_{PP} = 12.75 \text{ V} \pm 0.25 \text{ V}$  causes a damage for the device. Do not pull up/down at programming.
- Note3 : 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 writting.