

CMOS 8-BIT MICROCONTROLLER

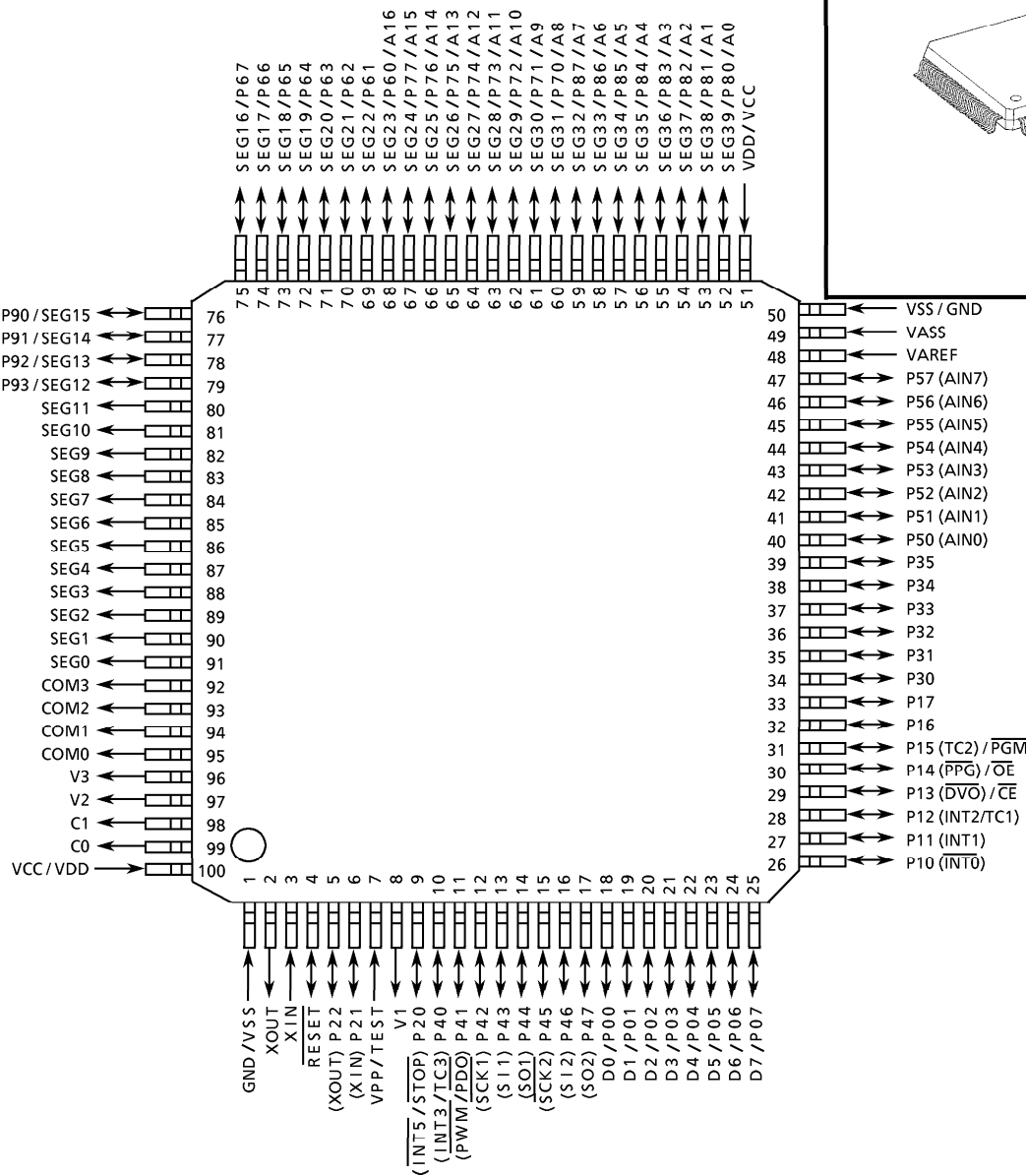
TMP87PP24F

The 87PP24 is a One-Time PROM microcontroller with low-power 384K bits electrically programmable read only memory for the 87CM24A/CP24A system evaluation. The 87PP24 is pin compatible with the 87CM24A/CP24A. The operations possible with the 87CM24A/CP24A can be performed by writing programs to PROM. The 87PP24 can write and verify in the same way as the TMM571000D using an adaptor socket BM11127 and an EPROM programmer.

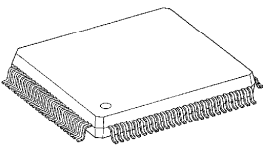
PART No.	OTP	RAM	PACKAGE	OTP ADAPTER
TMP87PP24F	48K × 8-bit	2K × 8-bit	LQFP100-P-1414-0.50C	BM11127

PIN ASSIGNMENTS (TOP VIEW)

LQFP100-P-1414-0.50C



LQFP100-P-1414-0.50C



TMP87PP24F

PIN FUNCTION

The 87PP24 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PP24 is pin compatible with the 87CM24A/CP24A (fix the TEST pin at low level.)

(2) PROM mode

PIN NAME (PROM mode)	INPUT/OUTPUT	FUNCTIONS	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
$\overline{\text{CE}}$	Input	Chip enable signal input (active low)	P13
$\overline{\text{OE}}$		Output enable signal input (active low)	P14
$\overline{\text{PGM}}$		Program mode signal input	P15
VPP	Power supply	+ 12.75V / 5V (Program supply voltage)	TEST
VCC		+ 6.25V / 5V	VDD
GND		0V	VSS
P35 to P30	I/O	Pull-up with resistance for input processing.	
P47 to P40			
P57 to P50			
P67 to P62			
P93 to P90			
P11		PROM mode setting pin. Be fixed at high level.	
P21			
P31			
P61		PROM mode setting pin. Be fixed at low level.	
P17, P16, P12, P10			
P22, P20			
RESET			
XIN	Input	Connect an 8MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power supply	0V (GND)	
VASS			
COM3 to COM0	Output	Open	
SEG11 to SEG0			
C0, C1, V1, V2, V3	Power supply		

OPERATIONAL DESCRIPTION

The following explains the 87PP24 hardware configuration and operation. The configuration and functions of the 87PP24 are the same as those of the 87CM24A/CP24A, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PP24 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 87PP24 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 87CM24A/CP24A (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PP24 has a 48K × 8-bit (addresses 4000_H-FFFF_H in the MCU mode, addresses 14000_H-1FFFF_H in the PROM mode) of program memory (OTP).

When the 87PP24 is used as a system evaluation of the 87CM24A/CP24A, the data is written to the program storage area show in Figure 1-1.

Note : Either write the data FF_H to the unused area or set the *PROM* programmer to access only the program storage area.

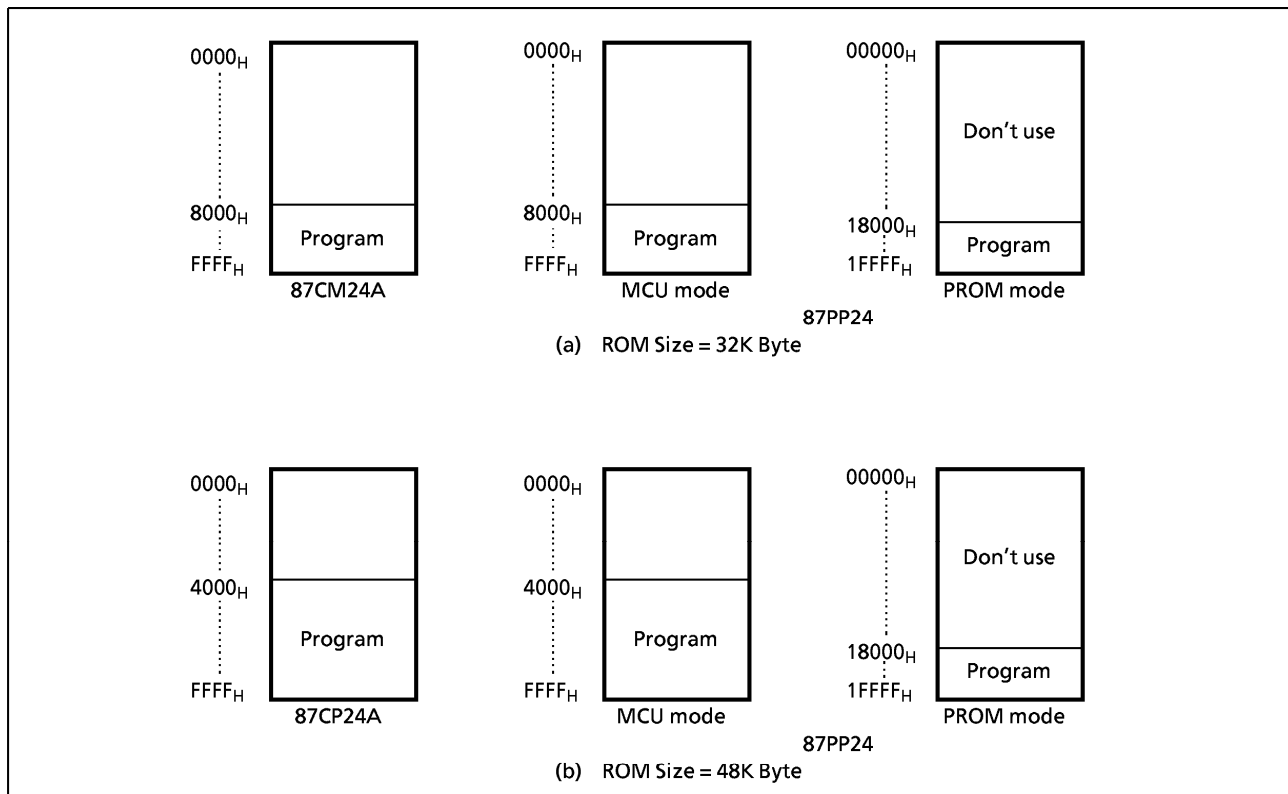


Figure 1-1. Program Memory Area

1.1.2 Data Memory

The 87PP24 has an on-chip 2K × 8-bit data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 87PP24 are the same as those of the 87CM24A/CP24A except that the TEST pin has no built-in pull-down resistance.

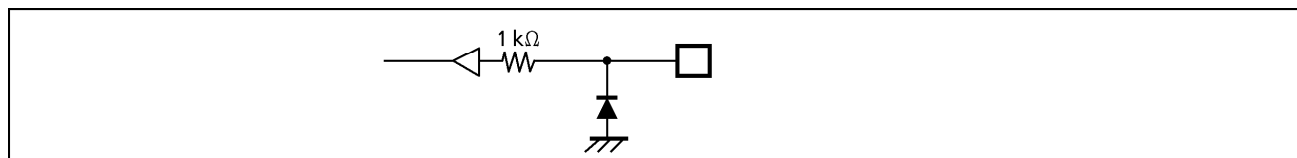


Figure 1-2. TEST Pin

(2) I/O ports

The I/O circuits of 87PP24 I/O ports are the same as the code A type I/O circuitries of the 87CM24A/CP24A. (except for I/O or segment output PORT P6, P7, P8, P9)

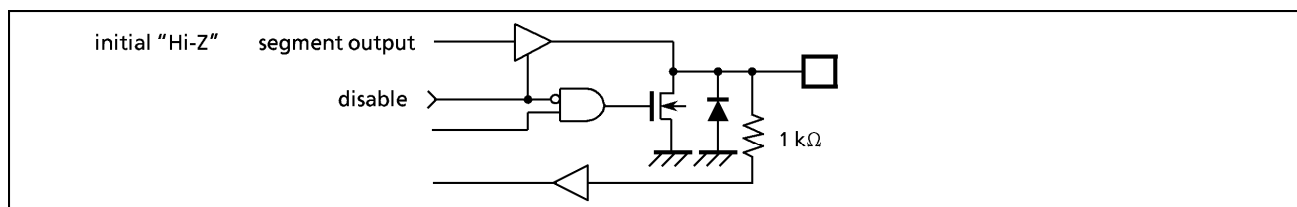


Figure 1-3. P6 to P9 port

1.2 PROM Mode

The PROM mode is activated by setting the TEST, $\overline{\text{RESET}}$ pin and the ports P17-P10, P22-P20 and P61 as shown in Figure 1-4. The PROM mode is used to write and verify programs with a general-purpose PROM programmer.

Note : The high-speed programming mode can be used for program operation.

The 87PP24 is not supported an electric signature mode, so the ROM type must be set to TC571000D.

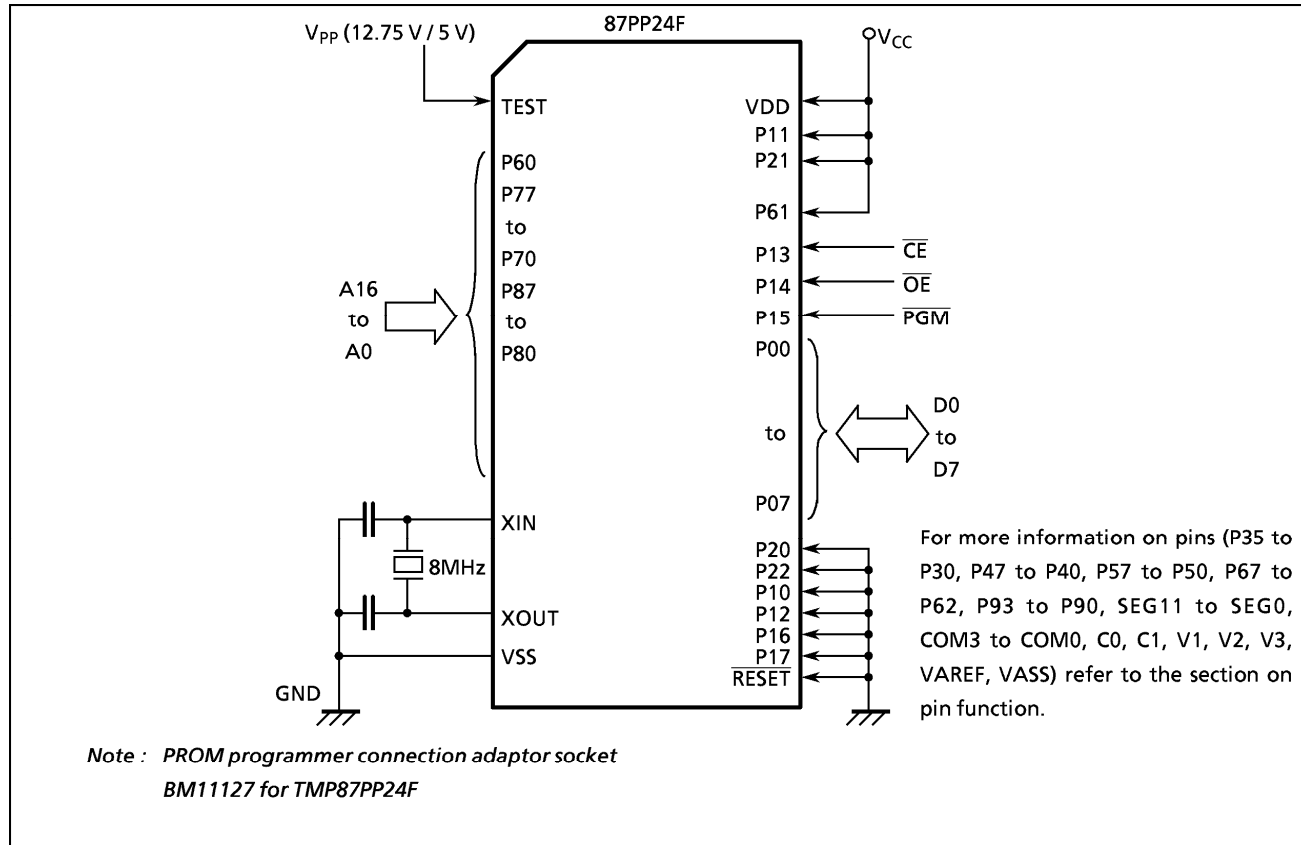


Figure 1-4. Setting for PROM Mode

1.2.1 Programming Flowchart (High-speed Programming Mode)

The high-speed programming mode is achieved by applying the program voltage (+ 12.75 V) to the VPP pin when $V_{CC} = 6.25$ V. After the address and input data are stable, the data is programmed by applying a single 0.1 ms program pulse to the $\overline{PGM}$ input. The programmed data is verified. If incorrect, another 0.1 ms program pulse is applied. This process should be repeated (up to 25 times) until the program operates correctly. After that, change the address and input data, and program as before. When programming has been completed, the data in all addresses should be verified with $V_{CC} = V_{PP} = 5$ V.

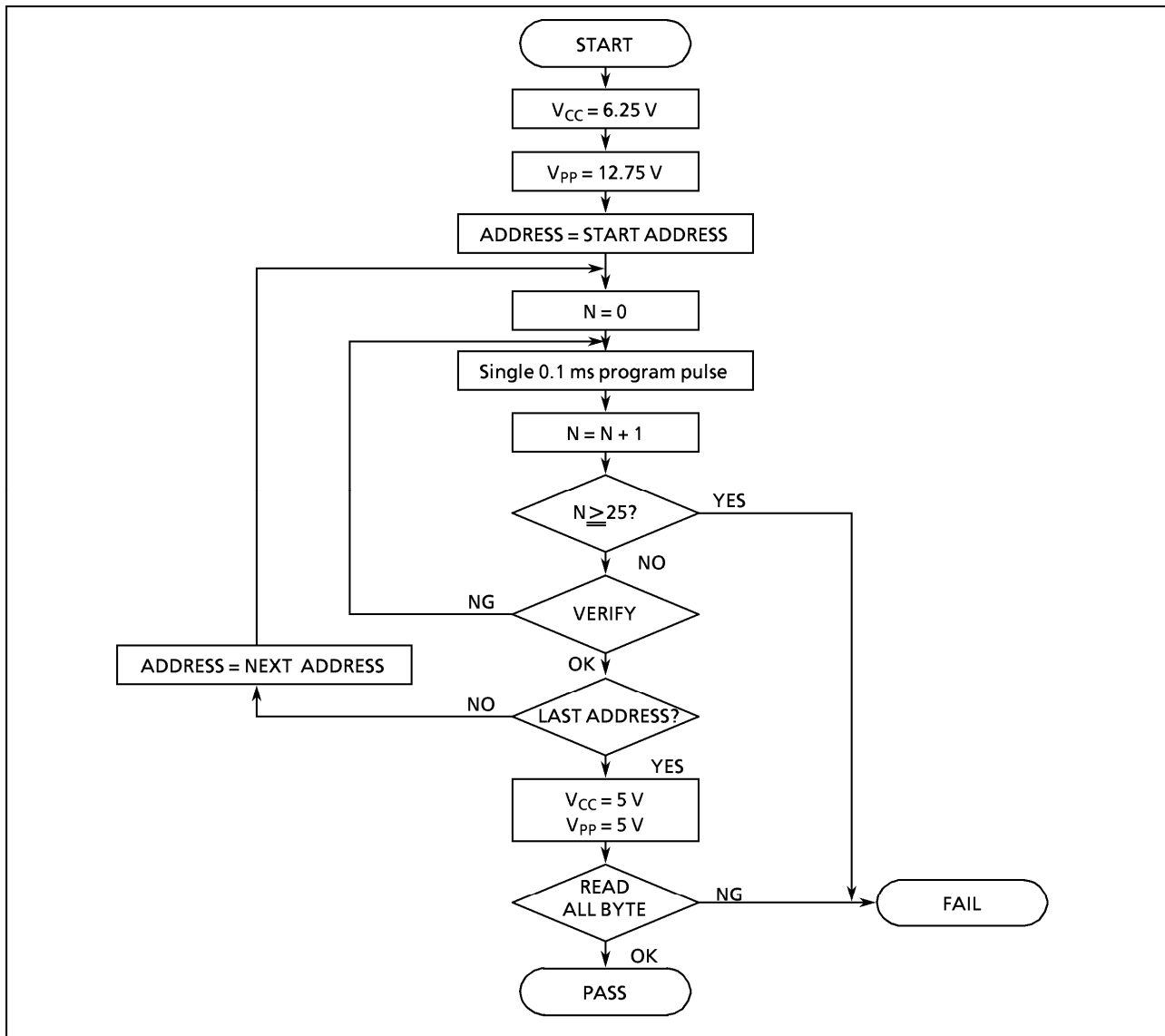


Figure 1-5. Flow Chart of High-speed Programming

1.2.2 Writing Method for General-purpose PROM Program

(1) Adapters

BM11127 : TMP87PP24F

(2) Adapter setting

Switch (SW1) is set to side N.

(3) PROM programmer specifying

i) PROM type is specified to TC571000D.

Writing voltage : 12.75 V (high-speed program mode)

ii) Data transfer (copy) (note 1)

In the TMP87PP24, EPROM is within the addresses 14000_H to 1FFFF_H. Data is required to be transferred (copied) to the addresses where it is possible to write. The program area in MCU mode and PROM mode is referred to "Program memory area" in Figure 1-1.

Ex. In the block transfer (copy) mode, executed as below.

ROM capacity of 48KB : transferred addresses 04000_H to 0FFFF_H to addresses 14000 to 1FFFF_H

iii) Writing address is specified. (note 1)

Start address : 14000_H

End address : 1FFFF_H

(4) Writing

Writing/Verifying is required to be executed in accordance with PROM programmer operating procedure.

Note 1 : The specifying method is referred to the PROM programmer description. Either write the data FF_H to the unused area or set the PROM programmer to access only the program storage area.

Note 2 : When MCU is set to an adapter or the adapter is set to PROM programmer, a position of pin 1 must be adjusted. If the setting is reversed, MCU, the adapter and PROM program is damaged.

Note 3 : The TMP87PP24 does not support the electric signature mode (hereinafter referred to as "signature"). If the signature is used in PROM program, a device is damaged due to applying 12V ± 0.5V to the address pin 9 (A9). The signature must not be used.

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

(V_{SS} = 0V)

PARAMETER	SYMBOL	PINS	RATINGS	UNIT
Supply Voltage	V _{DD}		– 0.3 to 6.5	V
Input Voltage	V _{IN}		– 0.3 to V _{DD} + 0.3	V
Output Voltage	V _{OUT}		– 0.3 to V _{DD} + 0.3	V
Output Current (Per 1 pin)	I _{OUT1}	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	3.2	mA
	I _{OUT2}	P41	30	
Output Current (Total)	Σ I _{OUT1}	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	120	mA
	Σ I _{OUT2}	P41	30	
Power Dissipation [Topr = 70°C]	PD		350	mW
Soldering Temperature (time)	T _{sl}		260 (10 s)	°C
Storage Temperature	T _{stg}		– 55 to 125	°C
Operating Temperature	Topr		– 10 to 70	°C

RECOMMENDED OPERATING CONDITIONS

(V_{SS} = 0V, Topr = – 10 to 70°C)

PARAMETER	SYMBOL	PINS	CONDITIONS		Min.	Max.	UNIT
Supply Voltage	V _{DD}		f _c = 8 MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			f _c = 4.2 MHz	NORMAL1, 2 mode	2.2		
				IDLE1, 2 mode			
			f _s = 32.768 kHz	SLOW mode			
				SLEEP mode			
	STOP mode	2.0					
Input High Voltage	V _{IH1}	Except hysteresis input	V _{DD} ≥ 4.5V		V _{DD} × 0.70	V _{DD}	V
	V _{IH2}	Hysteresis input			V _{DD} × 0.75		
	V _{IH3}		V _{DD} < 4.5V	V _{DD} × 0.90			
Input Low Voltage	V _{IL1}	Except hysteresis input	V _{DD} ≥ 4.5V		0	V _{DD} × 0.30	V
	V _{IL2}	Hysteresis input				V _{DD} × 0.25	
	V _{IL3}		V _{DD} < 4.5V	V _{DD} × 0.10			
Clock Frequency	f _c	XIN, XOUT	V _{DD} = 4.5 to 5.5V		0.4	8.0	MHz
			V _{DD} = 2.2 to 5.5V			4.2	
	f _s	XTIN, XTOUT			30.0	34.0	kHz

Note : Clock frequency fc : Supply voltage range is specified in NORMAL1/2 mode and IDLE1/2 mode.

1.2.2 Writing Method for General-purpose PROM Program

(1) Adapters

BM11127 : TMP87PP24F

(2) Adapter setting

Switch (SW1) is set to side N.

(3) PROM programmer specifying

i) PROM type is specified to TC571000D.

Writing voltage : 12.75 V (high-speed program mode)

ii) Data transfer (copy) (note 1)

In the TMP87PP24, EPROM is within the addresses 14000_H to 1FFFF_H. Data is required to be transferred (copied) to the addresses where it is possible to write. The program area in MCU mode and PROM mode is referred to "Program memory area" in Figure 1-1.

Ex. In the block transfer (copy) mode, executed as below.

ROM capacity of 48KB : transferred addresses 04000_H to 0FFFF_H to addresses 14000 to 1FFFF_H

iii) Writing address is specified. (note 1)

Start address : 14000_H

End address : 1FFFF_H

(4) Writing

Writing/Verifying is required to be executed in accordance with PROM programmer operating procedure.

Note 1 : The specifying method is referred to the PROM programmer description. Either write the data FF_H to the unused area or set the PROM programmer to access only the program storage area.

Note 2 : When MCU is set to an adapter or the adapter is set to PROM programmer, a position of pin 1 must be adjusted. If the setting is reversed, MCU, the adapter and PROM program is damaged.

Note 3 : The TMP87PP24 does not support the electric signature mode (hereinafter referred to as "signature"). If the signature is used in PROM program, a device is damaged due to applying 12V ± 0.5V to the address pin 9 (A9). The signature must not be used.

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

(V_{SS} = 0V)

PARAMETER	SYMBOL	PINS	RATINGS	UNIT
Supply Voltage	V _{DD}		– 0.3 to 6.5	V
Input Voltage	V _{IN}		– 0.3 to V _{DD} + 0.3	V
Output Voltage	V _{OUT}		– 0.3 to V _{DD} + 0.3	V
Output Current (Per 1 pin)	I _{OUT1}	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	3.2	mA
	I _{OUT2}	P41	30	
Output Current (Total)	Σ I _{OUT1}	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	120	mA
	Σ I _{OUT2}	P41	30	
Power Dissipation [Topr = 70°C]	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 10 to 70	°C

RECOMMENDED OPERATING CONDITIONS

(V_{SS} = 0V, Topr = – 10 to 70°C)

PARAMETER	SYMBOL	PINS	CONDITIONS		Min.	Max.	UNIT
Supply Voltage	V _{DD}		f _c = 8 MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			f _c = 4.2 MHz	NORMAL1, 2 mode	2.2		
				IDLE1, 2 mode			
			f _s = 32.768 kHz	SLOW mode			
				SLEEP mode			
	STOP mode	2.0					
Input High Voltage	V _{IH1}	Except hysteresis input	V _{DD} ≥ 4.5V		V _{DD} × 0.70	V _{DD}	V
	V _{IH2}	Hysteresis input			V _{DD} × 0.75		
	V _{IH3}		V _{DD} < 4.5V	V _{DD} × 0.90			
Input Low Voltage	V _{IL1}	Except hysteresis input	V _{DD} ≥ 4.5V		0	V _{DD} × 0.30	V
	V _{IL2}	Hysteresis input				V _{DD} × 0.25	
	V _{IL3}		V _{DD} < 4.5V	V _{DD} × 0.10			
Clock Frequency	f _c	XIN, XOUT	V _{DD} = 4.5 to 5.5V		0.4	8.0	MHz
			V _{DD} = 2.2 to 5.5V			4.2	
	f _s	XTIN, XTOUT			30.0	34.0	kHz

Note : Clock frequency fc : Supply voltage range is specified in NORMAL1/2 mode and IDLE1/2 mode.

D.C. CHARACTERISTICS

(V_{SS} = 0V, T_{opr} = -10 to 70 °C)

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Typ.	Max.	UNIT
Hysteresis Voltage	V _{HS}	Hysteresis inputs		—	0.9	—	V
Input Current	I _{IN1}	TEST	V _{DD} = 5.5V, V _{IN} = 5.5V / 0V	—	—	± 2	μA
	I _{IN2}	Open drain ports and tri-state ports					
	I _{IN3}	RESET, STOP					
Input Resistance	R _{IN2}	RESET		100	220	450	kΩ
Output Leakage Current	I _{LO1}	Open drain ports	V _{DD} = 5.5V, V _{OUT} = 5.5V	—	—	2	μA
	I _{LO2}	Tri-state ports	V _{OUT} = 5.5V/0V	—	—	± 2	
Segment/Common Output Voltage	V _{LCD1}	SEG39-SEG0 and COM3-COM0		0.75	1.0	1.33	V
	V _{LCD2}			V _{LCD1} × 2			
	V _{LCD3}			V _{LCD2} × 3			
Output High Voltage	V _{OH1}	Push-pull ports P4 port	V _{DD} = 4.5V, I _{OH} = − 200 μA	2.4	—	—	V
	V _{OH2}	Tri- state ports P0, P1, P5 port	V _{DD} = 4.5V, I _{OH} = − 0.7 mA	4.1	—	—	
Output Low Voltage	V _{OL}	Except XOUT and P41	V _{DD} = 4.5V, I _{OL} = 1.6 mA	—	—	0.4	V
Output Low Current	I _{OL3}	P41	V _{DD} = 4.5V, V _{OL} = 1.0V	—	20	—	mA
Supply Current in NORMAL 1, 2 mode	I _{DD}		V _{DD} = 5.5V f _c = 8 MHz f _s = 32.768 kHz V _{IN} = 5.3V/0.2V	—	12	18	mA
Supply Current in IDLE 1, 2 mode				—	6	10	
Supply Current in SLOW mode			V _{DD} = 3.0V f _s = 32.768 kHz V _{IN} = 2.8V/0.2V Voltage boost frequency = 1 kHz	—	31	70	μA
Supply Current in SLEEP mode				—	16	40	μA
Supply Current in STOP mode			V _{DD} = 5.5V V _{IN} = 5.3V/0.2V	—	0.5	10	μA

Note 1 : Typical values show those at T_{opr} = 25 °C, V_{DD} = 5V.

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

Note 3 : I_{DD} ; Except for I_{REF}

Note 4 : V_{LCD2} indicates an output voltage at the 2/3 level when operating in the 1/4 or 1/3 duty mode.

Note 5 : V_{LCD1} indicates an output voltage at the 1/3 level when operating in the 1/4 or 1/3 duty mode.

A / D CONVERSION CHARACTERISTICS (I)

(V_{SS} = 0V, V_{DD} = 2.7 to 5.5V, T_{opr} = -10 to 70 °C)

PARAMETER	SYMBOL	CONDITIONS	Min	Typ.	Max.	UNIT
Analog Reference Voltage	V _{AREF}		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} = 5.5 V, V _{ASS} = 0.0 V	—	0.5	1.0	mA
Nonlinearity Error		V _{DD} = 5.0 V, V _{SS} = 0.0 V V _{AREF} = 5.000 V V _{ASS} = 0.000 V or V _{DD} = 2.7 V, V _{SS} = 0.0 V V _{AREF} = 2.700 V V _{ASS} = 0.000 V	—	—	± 1	LSB
Zero Point Error			—	—	± 1	
Full Scale Error			—	—	± 1	
Total Error			—	—	± 2	

Note : Quantizing error is not contained in those errors.

A / D CONVERSION CHARACTERISTICS (II)

(V_{SS} = 0V, V_{DD} = 2.2 to 2.7V, T_{opr} = -10 to 70 °C)

PARAMETER	SYMBOL	CONDITIONS	Min	Typ.	Max.	UNIT
Analog Reference Voltage	V _{AREF}		2.2	—	V _{DD}	V
	V _{ASS}		V _{SS}			
Analog Reference Voltage Range	△V _{AREF}		2.2	—	—	V
Analog Input Voltage	V _{AIN}		V _{ASS}	—	V _{AREF}	V
Analog Supply Current	I _{REF}	V _{AREF} = 5.5 V, V _{ASS} = 0.0 V	—	0.5	1.0	mA
Nonlinearity Error		V _{DD} = 2.2 V, V _{SS} = 0.0 V V _{AREF} = 2.200 V V _{ASS} = 0.000 V	—	—	± 2	LSB
Zero Point Error			—	—	± 2	
Full Scale Error			—	—	± 2	
Total Error			—	—	± 4	

Note : Quantizing error is not contained in those errors.

A.C. CHARACTERISTICS (I)

(V_{SS} = 0V, V_{DD} = 4.5 to 5.5V, T_{opr} = - 10 to 70 °C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t _{cy}	In NORMAL 1, 2 mode	0.5	—	10	μs
		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 MHz	62.5	—	—	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 kHz	14.7	—	—	μs
Low Level Clock Pulse Width	t _{WSL}					

A.C. CHARACTERISTICS (II)

(V_{SS} = 0V, V_{DD} = 2.2 to 5.5V, T_{opr} = - 10 to 70 °C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t _{cy}	In NORMAL 1, 2 mode	0.95	—	10	μs
		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), fc = 4.2 MHz	110	—	—	ns
Low Level Clock Pulse Width	t _{WCL}					
High Level Clock Pulse Width	t _{WSH}	For external clock operation (XTIN input), fs = 32.768 kHz	14.7	—	—	μs
Low Level Clock Pulse Width	t _{WSL}					

RECOMENDED OSCILLATING CONDITION (I)

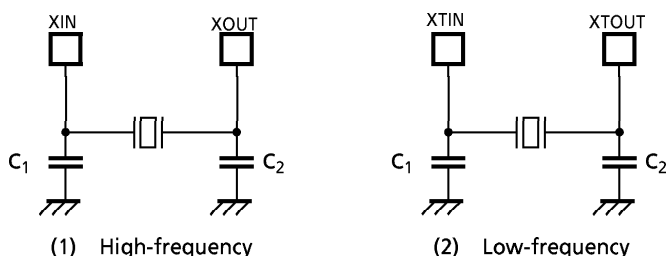
(V_{SS} = 0V, V_{DD} = 4.5 to 5.5V, T_{opr} = - 10 to 70 °C)

PARAMETER	OSILLATOR	FREQUENCY	RECOMMENDER OSCILLATOR	RECOMMENDED CONDITION	
				C ₁	C ₂
High-frequency	Ceramic Resonator	8 MHz	KYOCERA KBR8.0M	30pF	30pF
			Standard/Lead Type CSA8.00MTZ (MURATA) CST8.00MTW	built-in 30pF	built-in 30pF
			Standard/SMP Type CSAC8.00MT (MURATA)	30pF	30pF
			Standard/Small ChipType CSTC8.00MT (MURATA)	built-in 30pF	built-in 30pF
	Crystal Oscillator	4 MHz	KYOCERA KBR4.0MS	30pF	30pF
		8 MHz	TOYOCOM 210B 8.0000	20pF	20pF
Low-frequency	Crystal Oscillator	4 MHz	TOYOCOM 204B 4.0000		
		32.768 kHz	NDK MX-38T	15pF	15pF

RECOMENDED OSCILLATING CONDITION (II)

(V_{SS} = 0V, V_{DD} = 2.2 to 5.5V, T_{opr} = - 10 to 70 °C)

PARAMETER	OSILLATOR	FREQUENCY	RECOMMENDER OSCILLATOR	RECOMMENDED CONDITION	
				C ₁	C ₂
High-frequency	Ceramic Resonator	4 MHz	Standard/Lead Type CSA4.00MG (MURATA) CST4.00MGW	30pF built-in 30pF	30pF built-in 30pF
			Standard/SMD Type CSA4.00MGC (MURATA) CSAC4.00MGCM CSTC4.00MG	30pF built-in 30pF	30pF built-in 30pF
			Standard/Small Chip Type CSTCS4.00MG	built-in 10pF	built-in 10pF

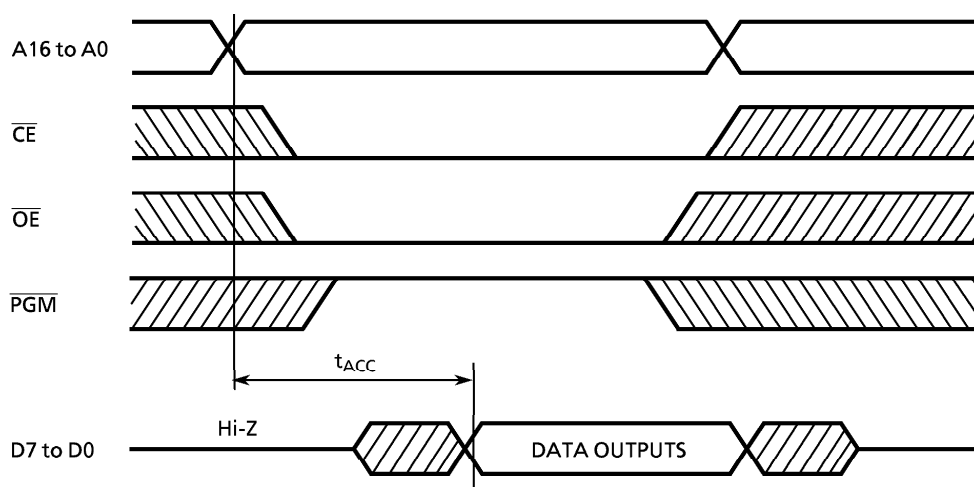


Note : When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

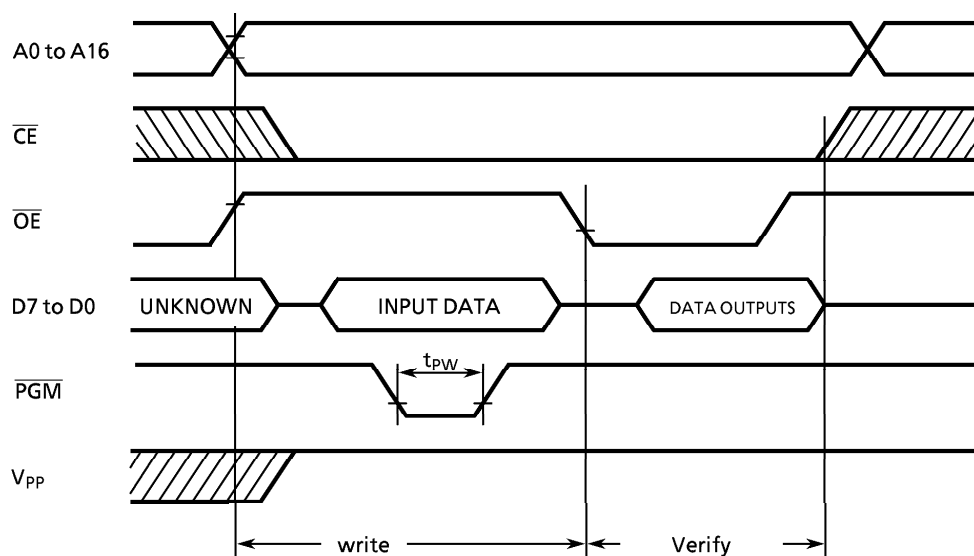
D.C./A.C. CHARACTERISTICS (PROM mode) ($V_{SS} = 0V$)

(1) Read Operation

PARAMETER	SYMBOL	CONDITIONS	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}					V
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25V$	—	$1.5t_{cyc} + 300$	—	ns

(Note) $t_{cyc} = 500$ ns at 8 MHz(2) High-Speed Programming Operation ($T_{opr} = 25 \pm 5^\circ C$)

PARAMETER	SYMBOL	CONDITIONS	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}	$V_{CC} = 6.0V$	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 ($12.5V \pm 0.5V = V$) 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.

D.C. CHARACTERISTICS

(V_{SS} = 0V, T_{opr} = -10 to 70 °C)

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Typ.	Max.	UNIT
Hysteresis Voltage	V _{HS}	Hysteresis inputs		—	0.9	—	V
Input Current	I _{IN1}	TEST	V _{DD} = 5.5V, V _{IN} = 5.5V / 0V	—	—	± 2	μA
	I _{IN2}	Open drain ports and tri-state ports					
	I _{IN3}	RESET, STOP					
Input Resistance	R _{IN2}	RESET		100	220	450	kΩ
Output Leakage Current	I _{LO1}	Open drain ports	V _{DD} = 5.5V, V _{OUT} = 5.5V	—	—	2	μA
	I _{LO2}	Tri-state ports	V _{OUT} = 5.5V/0V	—	—	± 2	
Segment/Common Output Voltage	V _{LCD1}	SEG39-SEG0 and COM3-COM0		0.75	1.0	1.33	V
	V _{LCD2}			V _{LCD1} × 2			
	V _{LCD3}			V _{LCD2} × 3			
Output High Voltage	V _{OH1}	Push-pull ports P4 port	V _{DD} = 4.5V, I _{OH} = -200 μA	2.4	—	—	V
	V _{OH2}	Tri-state ports P0, P1, P5 port	V _{DD} = 4.5V, I _{OH} = -0.7 mA	4.1	—	—	
Output Low Voltage	V _{OL}	Except XOUT and P41	V _{DD} = 4.5V, I _{OL} = 1.6 mA	—	—	0.4	V
Output Low Current	I _{OL3}	P41	V _{DD} = 4.5V, V _{OL} = 1.0V	—	20	—	mA
Supply Current in NORMAL 1, 2 mode	I _{DD}		V _{DD} = 5.5V f _c = 8 MHz f _s = 32.768 kHz V _{IN} = 5.3V/0.2V	—	12	18	mA
Supply Current in IDLE 1, 2 mode				—	6	10	
Supply Current in SLOW mode			V _{DD} = 3.0V f _s = 32.768 kHz V _{IN} = 2.8V/0.2V	—	31	70	μA
Supply Current in SLEEP mode			Voltage boost frequency = 1 kHz	—	16	40	μA
Supply Current in STOP mode			V _{DD} = 5.5V V _{IN} = 5.3V/0.2V	—	0.5	10	μA

Note 1 : Typical values show those at T_{opr} = 25 °C, V_{DD} = 5V.

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

Note 3 : I_{DD} ; Except for I_{REF}

Note 4 : V_{LCD2} indicates an output voltage at the 2/3 level when operating in the 1/4 or 1/3 duty mode.

Note 5 : V_{LCD1} indicates an output voltage at the 1/3 level when operating in the 1/4 or 1/3 duty mode.

A / D CONVERSION CHARACTERISTICS (I)

(V_{SS} = 0V, V_{DD} = 2.7 to 5.5V, T_{opr} = -10 to 70 °C)

PARAMETER	SYMBOL	CONDITIONS	Min	Typ.	Max.	UNIT
Analog Reference Voltage	V _{AREF}		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} = 5.5 V, V _{ASS} = 0.0 V	—	0.5	1.0	mA
Nonlinearity Error		V _{DD} = 5.0 V, V _{SS} = 0.0 V V _{AREF} = 5.000 V V _{ASS} = 0.000 V or V _{DD} = 2.7 V, V _{SS} = 0.0 V V _{AREF} = 2.700 V V _{ASS} = 0.000 V	—	—	± 1	LSB
Zero Point Error			—	—	± 1	
Full Scale Error			—	—	± 1	
Total Error			—	—	± 2	

Note : Quantizing error is not contained in those errors.

A / D CONVERSION CHARACTERISTICS (II)

(V_{SS} = 0V, V_{DD} = 2.2 to 2.7V, T_{opr} = -10 to 70 °C)

PARAMETER	SYMBOL	CONDITIONS	Min	Typ.	Max.	UNIT
Analog Reference Voltage	V _{AREF}		2.2	—	V _{DD}	V
	V _{ASS}		V _{SS}			
Analog Reference Voltage Range	△V _{AREF}		2.2	—	—	V
Analog Input Voltage	V _{AIN}		V _{ASS}	—	V _{AREF}	V
Analog Supply Current	I _{REF}	V _{AREF} = 5.5 V, V _{ASS} = 0.0 V	—	0.5	1.0	mA
Nonlinearity Error		V _{DD} = 2.2 V, V _{SS} = 0.0 V V _{AREF} = 2.200 V V _{ASS} = 0.000 V	—	—	± 2	LSB
Zero Point Error			—	—	± 2	
Full Scale Error			—	—	± 2	
Total Error			—	—	± 4	

Note : Quantizing error is not contained in those errors.

A.C. CHARACTERISTICS (I)

(V_{SS} = 0V, V_{DD} = 4.5 to 5.5V, T_{opr} = - 10 to 70 °C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t _{cy}	In NORMAL 1, 2 mode	0.5	—	10	μs
		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 MHz	62.5	—	—	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 kHz	14.7	—	—	μs
Low Level Clock Pulse Width	t _{WSL}					

A.C. CHARACTERISTICS (II)

(V_{SS} = 0V, V_{DD} = 2.2 to 5.5V, T_{opr} = - 10 to 70 °C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t _{cy}	In NORMAL 1, 2 mode	0.95	—	10	μs
		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 = 4.2 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 kHz	14.7	—	—	μs
Low Level Clock Pulse Width	t _{WSL}					

RECOMENDED OSCILLATING CONDITION (I)

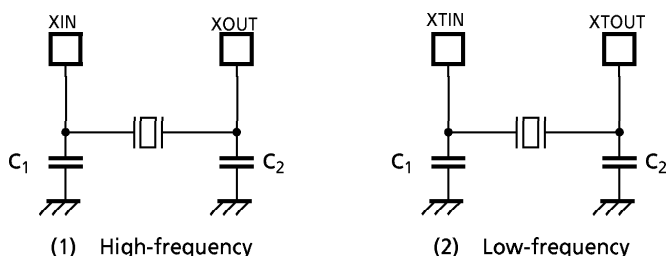
(V_{SS} = 0V, V_{DD} = 4.5 to 5.5V, T_{opr} = - 10 to 70 °C)

PARAMETER	OSILLATOR	FREQUENCY	RECOMMENDER OSCILLATOR	RECOMMENDED CONDITION	
				C ₁	C ₂
High-frequency	Ceramic Resonator	8 MHz	KYOCERA KBR8.0M	30pF	30pF
			Standard/Lead Type CSA8.00MTZ (MURATA) CST8.00MTW	built-in 30pF	built-in 30pF
			Standard/SMP Type CSAC8.00MT (MURATA)	30pF	30pF
			Standard/Small ChipType CSTC8.00MT (MURATA)	built-in 30pF	built-in 30pF
	Crystal Oscillator	4 MHz	KYOCERA KBR4.0MS	30pF	30pF
		8 MHz	TOYOCOM 210B 8.0000	20pF	20pF
Low-frequency	Crystal Oscillator	4 MHz	TOYOCOM 204B 4.0000		
		32.768 kHz	NDK MX-38T	15pF	15pF

RECOMENDED OSCILLATING CONDITION (II)

(V_{SS} = 0V, V_{DD} = 2.2 to 5.5V, T_{opr} = - 10 to 70 °C)

PARAMETER	OSILLATOR	FREQUENCY	RECOMMENDER OSCILLATOR	RECOMMENDED CONDITION	
				C ₁	C ₂
High-frequency	Ceramic Resonator	4 MHz	Standard/Lead Type CSA4.00MG (MURATA) CST4.00MGW	30pF built-in 30pF	30pF built-in 30pF
			Standard/SMD Type CSA4.00MGC (MURATA) CSAC4.00MGCM CSTC4.00MG	30pF built-in 30pF	30pF built-in 30pF
			Standard/Small Chip Type CSTCS4.00MG	built-in 10pF	built-in 10pF

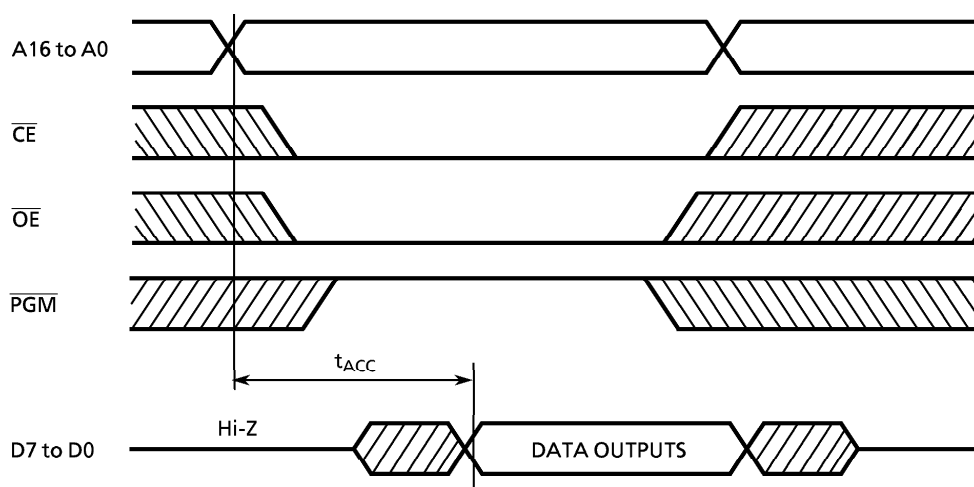


Note : When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

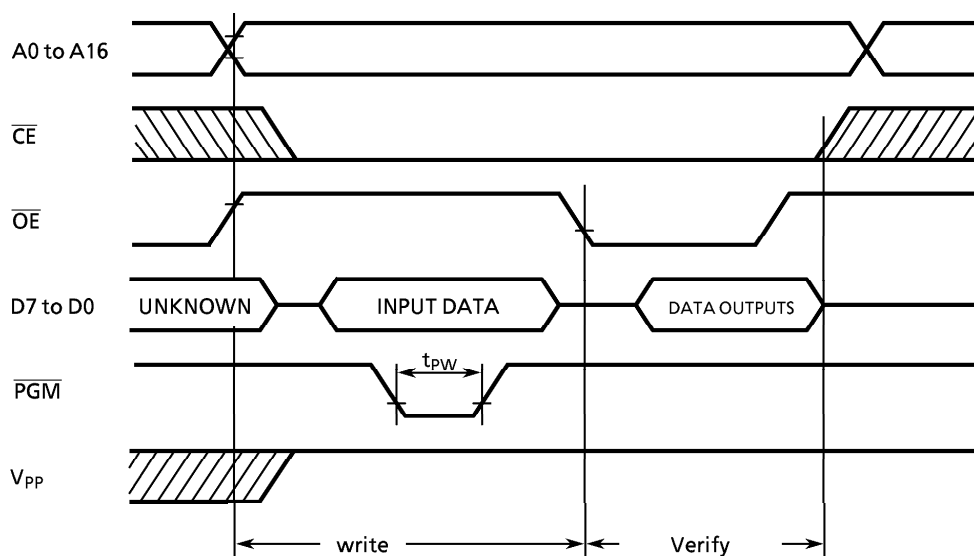
D.C./A.C. CHARACTERISTICS (PROM mode) ($V_{SS} = 0V$)

(1) Read Operation

PARAMETER	SYMBOL	CONDITIONS	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}	$V_{CC} = 5.0 \pm 0.25V$	—	$1.5t_{cyc} + 300$	—	ns

(Note) $t_{cyc} = 500$ ns at 8 MHz(2) High-Speed Programming Operation ($T_{opr} = 25 \pm 5^\circ C$)

PARAMETER	SYMBOL	CONDITIONS	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}	$V_{CC} = 6.0V$	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 ($12.5V \pm 0.5V = V$) 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.