

## CMOS 8-Bit Microcontroller

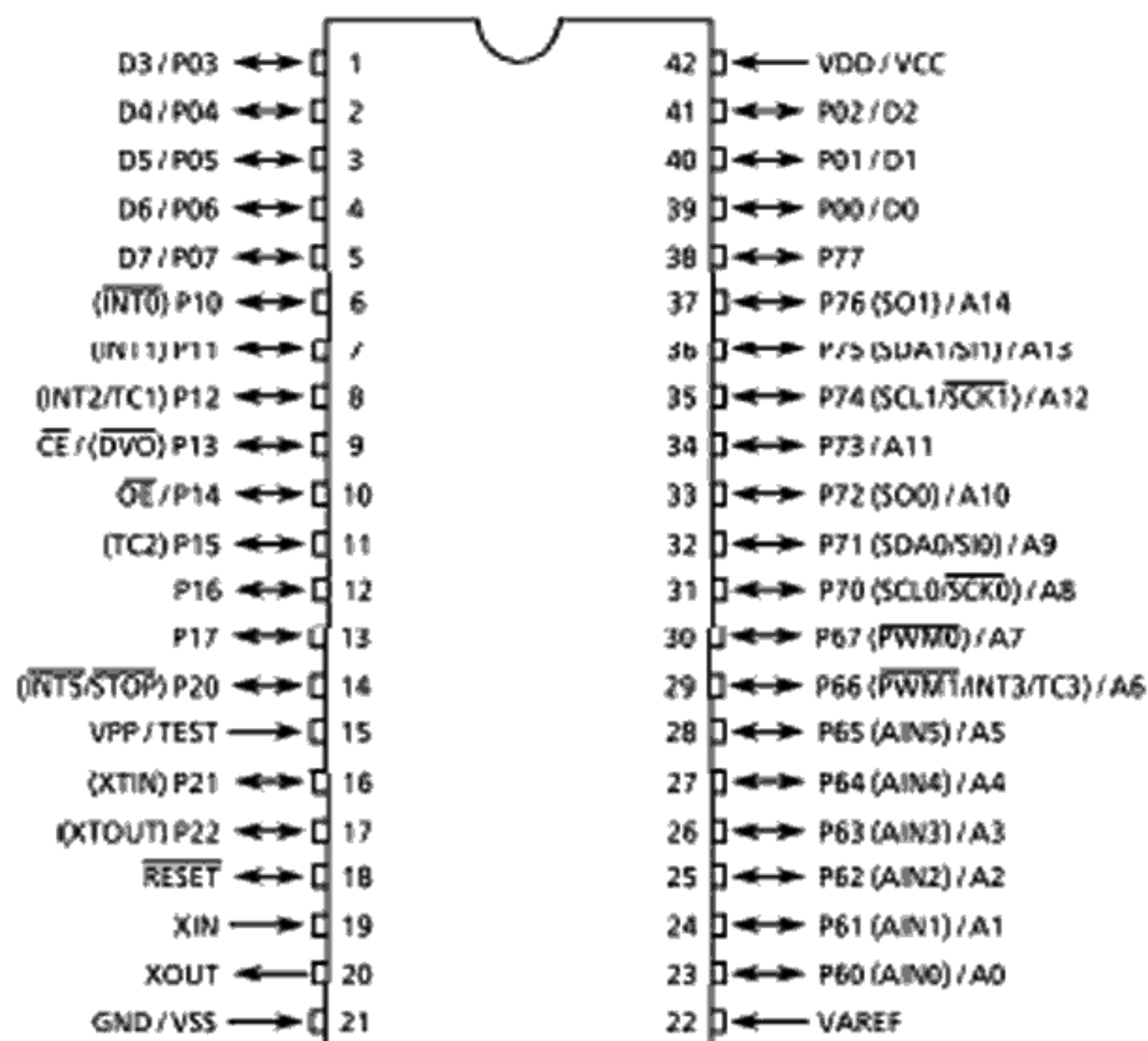
## TMP87PM43N

The 87PM43 is a One-Time PROM microcontroller with low-power 256K bits (a 32 Kbytes program memory) electrically programmable read only memory for the 87CK43/M43 system evaluation. The 87PM43 is pin compatible with the 87CK43/M43. The operations possible with the 87CK43/M43 can be performed by writing programs to PROM. The 87PM43 can write and verify in the same way as the TC57256AD using an adaptor socket BM1163 and an EPROM programmer.

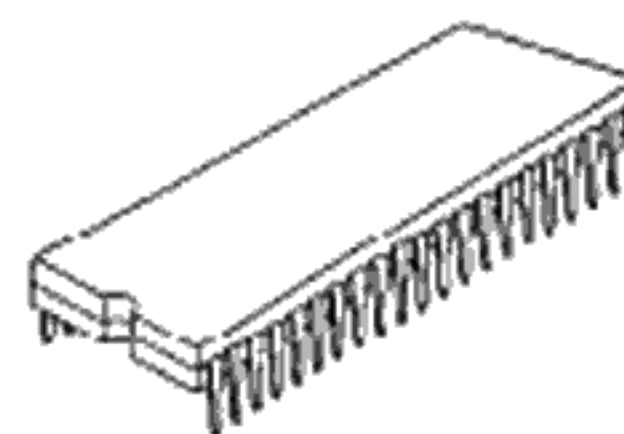
Part No.	OTP	RAM	Package	Adaptor socket
TMP87PM43N	32 Kbytes	1 Kbytes	P-SDIP42-600-1.78	BM1163

## Pin Assignments (Top View)

P-SDIP42-600-1.78



P-SDIP42-600-1.78



TMP87PM43N

980910EBP1

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**Pin Function**

The 87PM43 has two modes: MCU and PROM.

## (1) MCU mode

In this mode, the 87PM43 is pin compatible with the 87CK43/M43 (fix the TEST pin at low level).

## (2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A14 to A8	Input	PROM address inputs	P76 to P70
A7 to A0			P67 to P60
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
VPP	Power supply	+ 12.5 V / 5 V (Program supply voltage)	TEST
VCC		+ 5 V	VDD
GND		0 V	VSS
P11	I/O	PROM mode setting pin. Be fixed at high level.	
P21			
P77			
P12, P10			
P17 to P15			
P22, P20			
$\overline{\text{RESET}}$			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power supply	0 V (GND)	



## OPERATIONAL DESCRIPTION

The following explains the 87PM43 hardware configuration and operation. The configuration and functions of the 87PM43 are the same as those of the 87CK43/M43, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PM43 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 87PM43 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 87CK43/M43 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

##### 1.1.1 Program Memory

The 87PM43 has a 32 Kbytes (addresses 8000<sub>H</sub> to FFFF<sub>H</sub> in the MCU mode, addresses 0000<sub>H</sub> to 7FFF<sub>H</sub> in the PROM mode) of program memory (OTP).

When the 87PM43 is used as a system evaluation of the 87CK43/M43, the data is written to the program storage area shown in Figure 1-1.

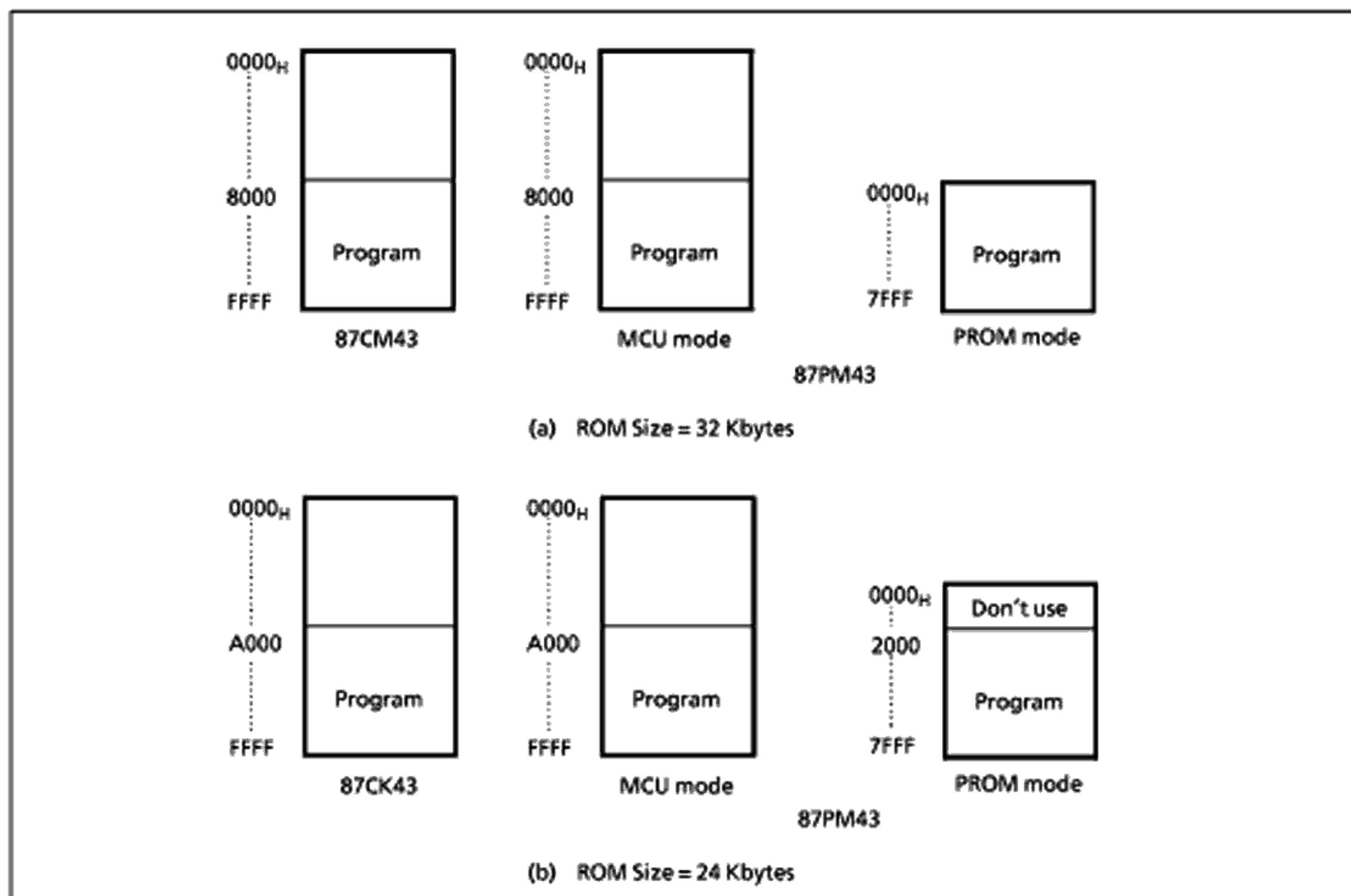


Figure 1-1. Program Memory Area

**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	Conditions	Ratings	Unit
Supply Voltage	V <sub>DD</sub>		- 0.3 to 6.5	V
Program Voltage	V <sub>pp</sub>	TEST / VPP	- 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>OUT1</sub>	Ports P0, P1, P21, P22, P60 to P65, RESET, XOUT	- 0.3 to V <sub>DD</sub> + 0.3	V
	V <sub>OUT2</sub>	Ports P20, P66, P67, P7	- 0.3 to V <sub>DD</sub> + 0.3	
Output Current (Per 1 pin)	I <sub>OUT1</sub>	Ports P0, P1, P2, P6, P7	3.2	mA
Output Current (Total)	Σ I <sub>OUT1</sub>	Ports P0, P1, P2, P6, P7	120	mA
Power Dissipation [Topr = 70°C]	PD		600	mW
Soldering Temperature (time)	T <sub>sld</sub>		260 (10s)	°C
Storage Temperature	T <sub>stg</sub>		- 55 to 125	°C
Operating Temperature	Topr		- 30 to 70	°C

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 Conditions		(V <sub>SS</sub> = 0 V, Topr = - 30 to 70°C)					
Parameter	Symbol	Pins	Conditions	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>s</sub> = 32.768 kHz	SLOW mode	2.7		
				SLEEP mode			
		STOP mode	2.0				
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	2.0	8.0	MHz	
	f <sub>s</sub>	XTIN, XTOUT	V <sub>DD</sub> = 2.7 to 5.5 V	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: f<sub>c</sub>: The condition of power supply voltage is limited to NORMAL1, NORMAL2, IDLE1, and IDLE2 mode.

## D.C. Characteristics

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

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Hysteresis Voltage	$V_{HS}$	Hysteresis inputs		-	0.9	-	V
Input Current	$I_{IN1}$	TEST	$V_{DD} = 5.5\text{ V}$ $V_{IN} = 5.5\text{ V} / 0\text{ V}$	-	-	$\pm 2$	$\mu\text{A}$
	$I_{IN2}$	Open drain ports, Tri-state ports					
	$I_{IN3}$	RESET, STOP					
Input Resistance	$R_{IN2}$	RESET		100	220	450	$\text{k}\Omega$
Output Leakage Current	$I_{LO}$	Sink open drain ports	$V_{DD} = 5.5\text{ V}, V_{OUT} = 5.5\text{ V}$	-	-	2	$\mu\text{A}$
Output High Voltage	$V_{OH2}$	Tri-state ports	$V_{DD} = 4.5\text{ V}, I_{OH} = -0.7\text{ mA}$	4.1	-	-	V
Output Low Voltage	$V_{OL}$	Except XOUT	$V_{DD} = 4.5\text{ V}, I_{OL} = 1.6\text{ mA}$	-	-	0.4	V
Supply Current in NORMAL 1, 2 modes	$I_{DD}$		$V_{DD} = 5.5\text{ V}$ $f_c = 8\text{ MHz}$ $f_s = 32.768\text{ kHz}$ $V_{IN} = 5.3\text{ V} / 0.2\text{ V}$	-	12	18	mA
Supply Current in IDLE 1, 2 modes				-	4.5	6	
Supply Current in SLOW mode			$V_{DD} = 3.0\text{ V}$ $f_s = 32.768\text{ kHz}$ $V_{IN} = 2.8\text{ V} / 0.2\text{ V}$	-	30	60	$\mu\text{A}$
Supply Current in SLEEP mode				-	15	30	
Supply Current in STOP mode			$V_{DD} = 5.5\text{ V}$ $V_{IN} = 5.3\text{ V} / 0.2\text{ V}$	-	0.5	10	$\mu\text{A}$

Note 1: Typical values show those at  $T_{opr} = 25^{\circ}\text{C}$ ,  $V_{DD} = 5\text{ V}$ .

Note 2: Input Current  $I_{IN1}, I_{IN3}$ : The current through resistor is not included, when the input register (pull-up or pull-down) is contained.

## A / D Conversion Characteristics

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

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	$V_{AREF}$	$V_{DD} \geq 4.5\text{ V}, V_{SS} = 0\text{ V}$	$V_{DD} - 1.5$	-	$V_{DD}$	V
Analog Reference Voltage Range	$\Delta V_{AREF}$		3.0	-	-	V
Analog Input Voltage Range	$V_{AIN}$		$V_{SS}$	-	$V_{AREF}$	V
Analog Supply Current	$I_{REF}$		-	0.5	1.0	mA
Nonlinearity Error		$V_{DD} = 5.0\text{ V}, V_{SS} = 0.000\text{ V}$ $V_{AREF} = 5.000\text{ V}$	-	-	$\pm 1$	LSB
Zero Point Error			-	-	$\pm 1$	
Full Scale Error			-	-	$\pm 1$	
Total Error			-	-	$\pm 2$	

Note 1:  $\Delta V_{AREF} = V_{AREF} - V_{SS}$

Note 2: Quantizing error is not contained in those errors.

**A.C. Characteristics**

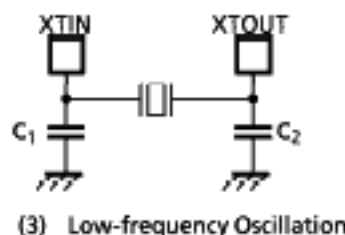
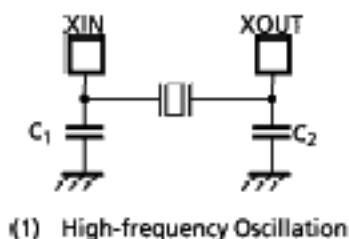
( $V_{SS} = 0\text{ V}$ ,  $V_{DD} = 4.5\text{ to }5.5\text{ V}$ ,  $T_{opr} = -30\text{ to }70^\circ\text{C}$ )

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	$t_{cy}$	In NORMAL1, 2 modes	0.5	-	10	$\mu\text{s}$
		In IDLE1, 2 modes				
		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	-	-	$\mu\text{s}$
Low Level Clock Pulse Width	$t_{WSL}$					

**Recommended Oscillating Conditions**

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

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator	Recommended Constant	
				$C_1$	$C_2$
High-frequency Oscillation	Ceramic Resonator	8 MHz	KYOCERA KBR8.0M	30 pF	30 pF
		4 MHz	KYOCERA KBR4.0MS		
			MURATA CSA4.00MG		
	Crystal Oscillator	8 MHz	TOYOCOM 210B 8.0000	20 pF	20 pF
4 MHz		TOYOCOM 204B 4.0000			
Low-frequency Oscillation	Crystal Oscillator	32.768 kHz	NDK MX-38T	15 pF	15 pF



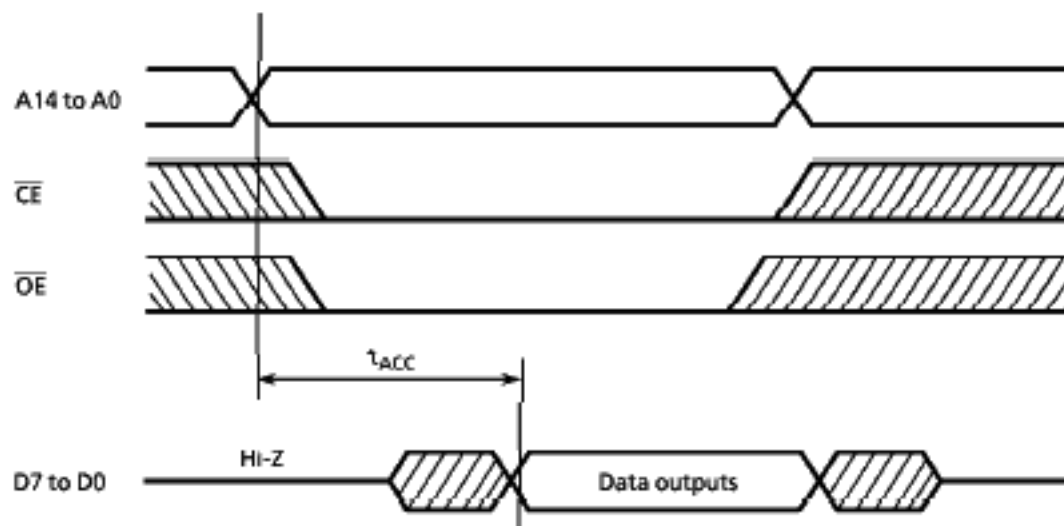
**Note:** An electrical shield by metal shield plate on the surface of the IC package should be recommendable in order to prevent the device from the high electric fieldstress applied from CRT (Cathode Ray Tube) for continuous reliable operation.

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

(1) READ OPERATION ( $T_{opr} = 0\text{ to }70^{\circ}\text{C}$ )

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	$V_{CC}$		4.75	-	6.0	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

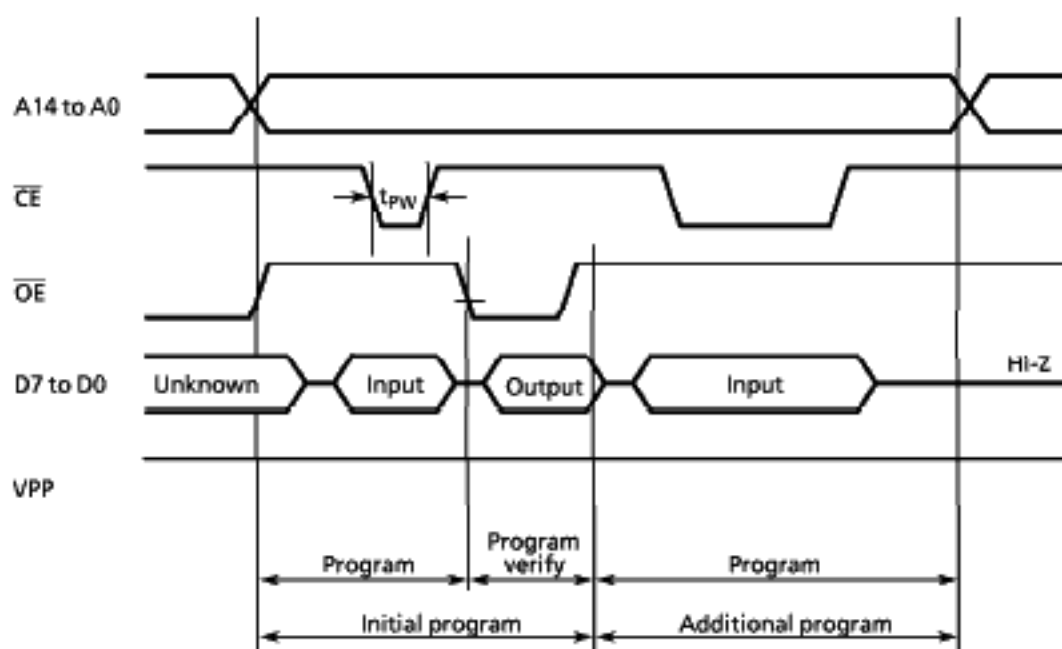
Note:  $t_{cyc} = 500\text{ ns}$  at 8 MHz



Timing Waveforms of Read Operation

(2) High-Speed Programming Operation (High-Speed Programming Mode- I ) ( $T_{opr} = 25 \pm 5^{\circ}\text{C}$ )

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	$V_{CC}$		5.75	6.0	6.25	V
Program Power Supply Voltage	$V_{PP}$		12.0	12.5	13.0	V
Initial Program Pulse Width	$t_{PW}$	$V_{CC} = 6.0 \text{ V} \pm 0.25 \text{ V}$ $V_{PP} = 12.5 \pm 0.25 \text{ V}$	0.95	1.0	1.05	ms



Timing Waveforms of Programming Operation

**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 decreased.

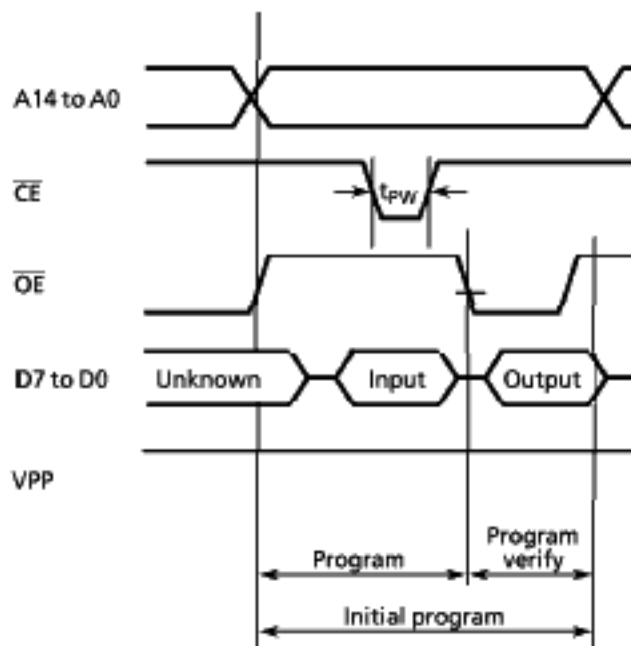
**Note 2:** The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ( $12.5 \text{ V} \pm 0.5 \text{ V}$ ) to the  $V_{PP}$  pin as the device is damaged.

**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.



(3) High-Speed Programming Operation (High-Speed program mode-II) ( $T_{opr} = 25 \pm 5^{\circ}C$ )

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
Supply Voltage	$V_{CC}$		6.00	6.25	6.50	V
Program Supply Voltage	$V_{PP}$		12.50	12.75	13.0	V
Initial Program Pulse Width	$t_{PW}$	$V_{CC} = 6.25 V \pm 0.25 V,$ $V_{PP} = 12.75 \pm 0.25 V$	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 decreased.
- Note 2:** The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ( $12.75 V \pm 0.25 V$ ) 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.