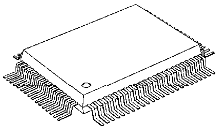
CMOS 8-BIT MICROCONTROLLER

TMP87PM70F

The 87PM70 is a One-Time PROM microcontroller with low-power 256K bits (32K bytes) electrically programmable read only memory for the 87CH70B/CM70B system evaluation. The 87PM70 is pin compatible with the 87CH70B/CM70B. The operations possible with the 87CH70B/CM70B can be performed by writing programs to PROM. The 87PM70 can write and verify in the same way as the TC57256AD using an adaptor socket BM1150 and an EPROM programmer.

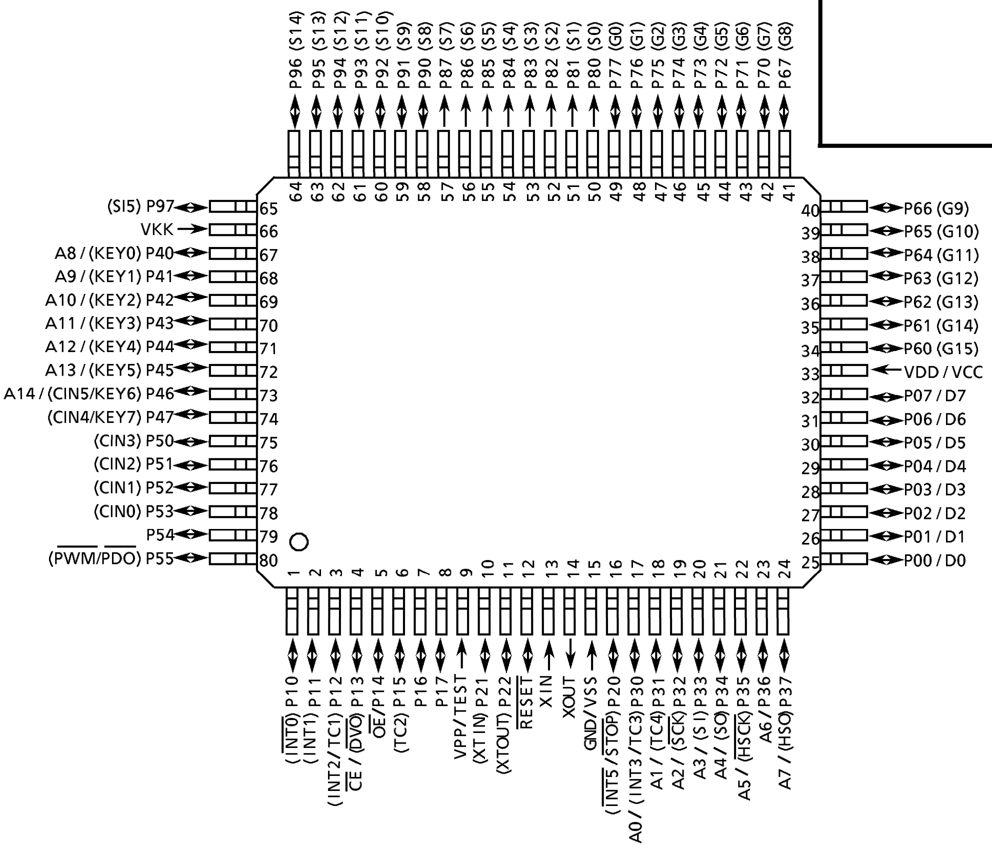
PART No.	OTP	RAM	PACKAGE	ADAPTER SOCKET
TMP87PM70F	32K × 8-bit	512 × 8-bit	QFP80	BM1150B

QFP80-P-1420B



TMP87PM70F

PIN ASSIGNMENTS (TOP VIEW)



PIN FUNCTION

The 87PM70 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PM70 is pin compatible with the 87CH70B/CM70B (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	P46 to P40
A7 to A0			P37 to P30
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
VPP	Power supply	+ 12.5 V / 5 V (Program supply voltage)	TEST
VCC		+ 5 V	VDD
GND		0 V	VSS
P55 to P50	I/O	Pull-down with resistance for input processing	
P11		PROM mode setting pin. Be fixed at high level.	
P21			
P47			
P17 to P15		PROM mode setting pin. Be fixed at low level.	
P12, P10			
P22, P20			
$\overline{RESET}$			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		
VKK	VFT power supply	GND	
P97 to P90	I/O	Open	
P87 to P80	Output		
P77 to P70	I/O		
P67 to P60			

OPERATIONAL DESCRIPTION

The following explains the 87PM70 hardware configuration and operation. The configuration and functions of the 87PM70 are the same as those of the 87CH70B/CM70B, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PM70 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 87PM70 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 87CH70B/CM70B (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PM70 has a 32K × 8-bit (addresses 8000_H-$FFFF_H$ in the MCU mode, addresses 0000_H-$7FFF_H$ in the PROM mode) of program memory (OTP).

To use the 87PM70 as the system evaluation for the 87CH70B/M70B, the program should be written to the program memory area as shown in Figure 1-1.

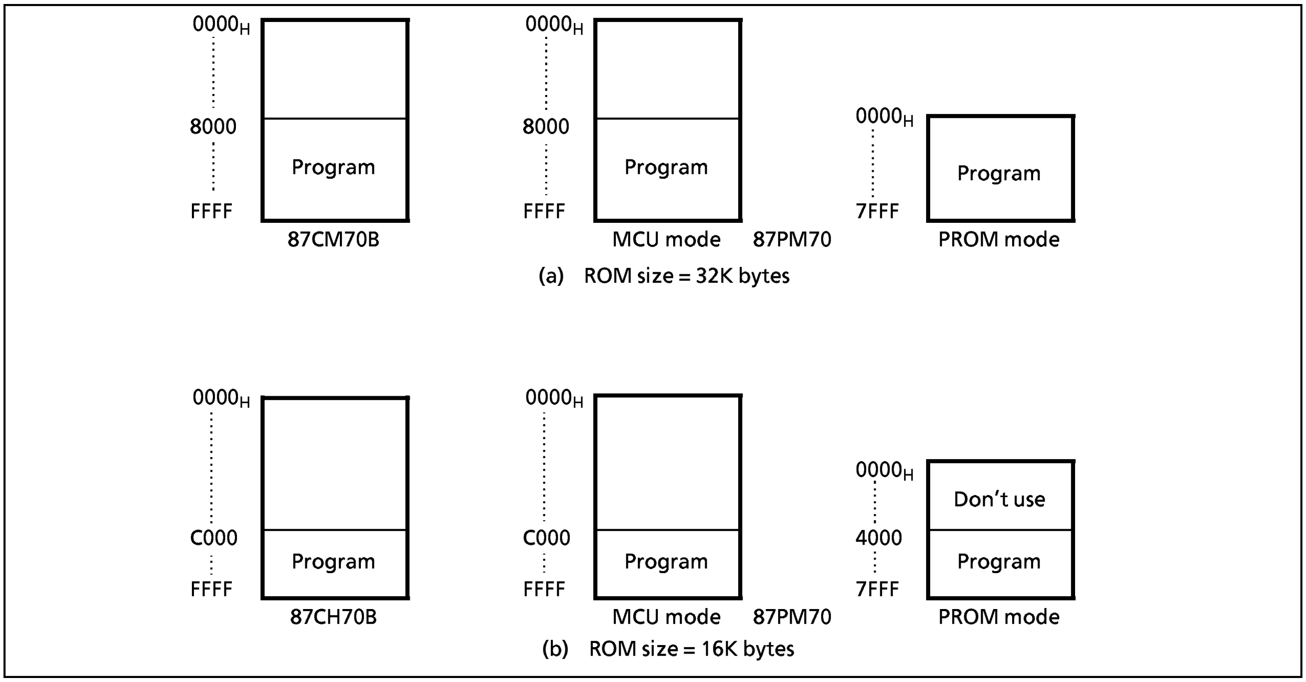


Figure 1-1. Program Memory Area

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

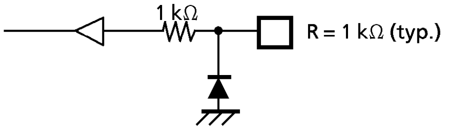
1.1.2 Data Memory

The 87PM70 has an on-chip 512 × 8-bit data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 87PM70 are the same as those of the 87CH70B/CM70B except that the TEST pin has is no built-in pull-down resistance.



Note : TEST pin has no built-in pull-down resistance

Figure 1-2. TEST pin

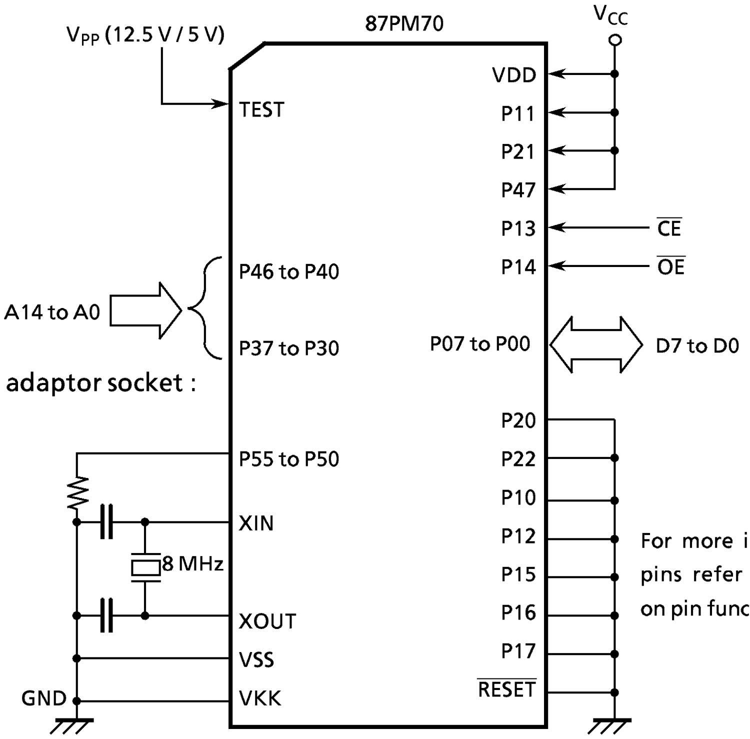
(2) I/O ports

The 87PM70 I/O ports of the I/O circuitry is the same as that of the 87CH70B/CM70B.

1.2 PROM mode

The PROM mode is activated by setting the pins TEST, $\overline{\text{RESET}}$ and the ports P17-P10, P22-P20 and P47 as shown in Figure 1-2. The PROM mode is used to write and verify programs with a general-purpose PROM programmer. The high-speed programming mode can be used for program operation.
The 87PM70 is not supported an electric signature mode, so the ROM type must be set to TC57256AD.
Set the adaptor socket switch to “N”.

Note : Please set the high-speed programming mode according to each manual of PROM programmer.



For more information on pins refer to the section on pin function.

PROM programmer connection adaptor socket :
BM1150B

Figure 1-3. Setting for PROM Mode

1.2.1 Programming Flowchart (High-speed Programming Mode-I)

The high-speed programming mode is achieved by applying the program voltage (+ 12.5 V) to the Vpp pin when Vcc = 6 V. After the address and input data are stable, the data is programmed by applying a single 1ms program pulse to the $\overline{CE}$ input. The programmed data is verified. If incorrect, another 1ms program pulse is applied and then the programmed data is verified. This process should be repeated (up to 25 times) until the program operates correctly. Programming for one address is ended by applying additional program pulse with width 3 times that needed for initial programming (number of programmed times × 1 ms). 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 Vcc = Vpp = 5 V.

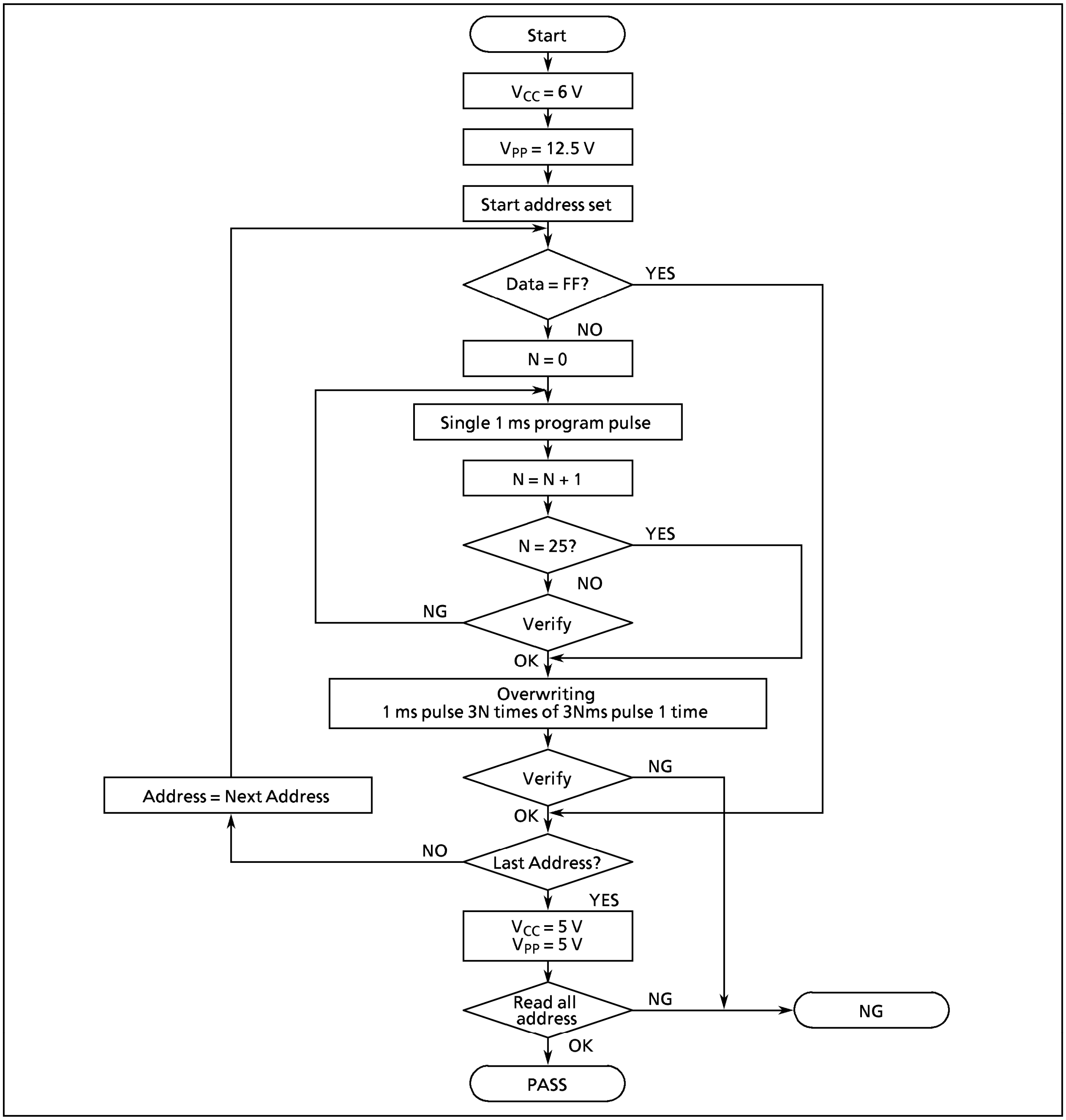


Figure 1-4. Flowchart of High-speed Programming Mode - I

1.2.2 Programming Flowchart (High-speed Programming Mode-II)

The high-speed programming mode is achieved by applying the program voltage (+ 12.75 V) to the Vpp pin when Vcc = 6.25 V. After the address and input data are stable, the data is programmed by applying a single 0.1ms program pulse to the $\overline{\text{CE}}$ input. The programmed data is verified. If incorrect, another 0.1ms program pulse is applied and then the programmed data is verified. 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 Vcc = Vpp = 5 V.

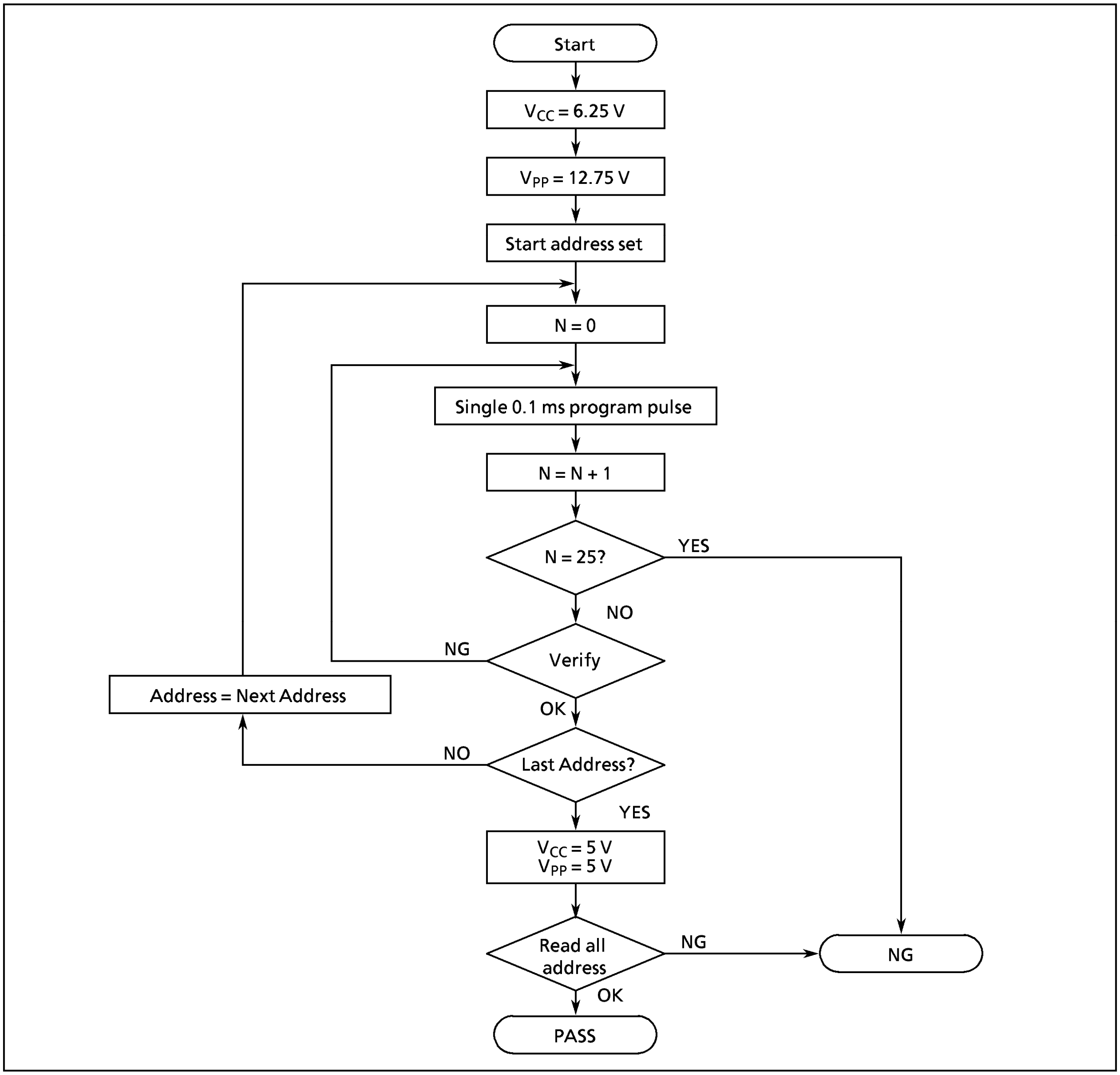


Figure 1-5. Flowchart of High-speed Programming Mode - II

1.2.3 Writing Method for General-purpose PROM Program

(1) Adapters
BM1150B : TMP87PM70F

(2) Adapter setting
Switch (SW1) is set to side N.
Switch (SW2) is set to side PM70.

(3) PROM programmer specifying

i) PROM type is specified to TC57256AD.
Writing voltage : 12.5 V (high-speed program I mode)
12.75 V (high-speed program II mode)

ii) Data transfer (copy) (note 1)
In TMP87PM70, EPROM is within the addresses 0000 to 7FFFH. 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 32KB : transferred addresses 8000 to FFFFH to addresses 0000 to 7FFFH

iii) Writing address is specified. (note 1)
Start address : 0000H
End address : 7FFFH

(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. The data in unused area must be specified to FF_H.

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 : TMP87PM70 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 12 V ± 0.5 V to the address pin 9 (A9). The signature must not be used.

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

(V_{SS} = 0 V)

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNIT
Supply Voltage	V_{DD}		– 0.3~7	V
Program Voltage	V_{PP}	TEST / VPP	– 0.3 to 13.0	V
Input Voltage	V_{IN}		– 0.3 to V_{DD} + 0.3	V
Output Voltage	V_{OUT1}	P2, P4, P5, XOUT	– 0.3 to V_{DD} + 0.3	V
	V_{OUT2}	P3	– 0.3 to 10	
	V_{OUT3}	Source open drain ports	V_{DD} – 40 to V_{DD} + 0.3	
Output Current (Per 1 pin)	I_{OUT1}	P0, P1, P2, P3, P4, P5	3.2	mA
	I_{OUT3}	P8, P9 (segment output)	– 12	
	I_{OUT4}	P6, P7 (digit output)	– 25	
Output Current (Total)	Σ I_{OUT1}	P0, P1, P2, P3, P4, P5	120	mA
	Σ I_{OUT2}	P6, P7, P8, P9	– 120	
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		– 30 to 70	°C

RECOMMENDED OPERATING CONDITIONS

(V_{SS} = 0 V, Topr = – 30 to 70 °C)

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Max.	UNIT
Supply Voltage	V_{DD}		NORMAL1, 2 modes	4.5	6.0	V
			IDLE1, 2 modes			
			SLOW mode	2.7		
			SLEEP mode			
			STOP mode	2.0		
Input High Voltage	V_{IH1}	Except hysteresis input	$V_{DD} \geqq 4.5$ V	$V_{DD} \times 0.70$	V_{DD}	V
	V_{IH2}	Hysteresis input		$V_{DD} \times 0.75$		
	V_{IH3}		$V_{DD} < 4.5$ V	$V_{DD} \times 0.90$		
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geqq 4.5$ V	0	$V_{DD} \times 0.30$	V
	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		0.4	8.0	MHz
	fs	XTIN, XTOUT		30.0	34.0	kHz

Note 1 : Power supply voltage V_{DD}: At fc = 8 MHz, fs = 32.768 kHz
Note 2 : Input Voltage V_{IH3} V_{IL3}; In SLOW, SLEEP or STOP mode

D.C. CHARACTERISTICS

(V_{SS} = 0 V, Topr = – 30 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} = 5.5 V V_{IN} = 5.5 V/0 V	–	–	± 2	μA
	I_{IN2}	Open drain ports, Tri-state ports					
	I_{IN3}	$\overline{\text{RESET}}$, $\overline{\text{STOP}}$					
Input Resistance	R_{IN1}	Port P4 with pull-down		30	70	150	kΩ
	R_{IN2}	$\overline{\text{RESET}}$		100	220	450	
Pull-down Resistance	R_K	Source open drain ports	V_{DD} = 5.5 V, V_{KK} = – 30 V	–	80	–	
Output Leakage Current	I_{LO1}	Sink open drain ports	V_{DD} = 5.5 V, V_{OUT} = 5.5 V	–	–	2	μA
	I_{LO2}	Source open drain	V_{DD} = 5.5 V, V_{OUT} = – 32 V	–	–	– 2	
	I_{LO3}	Tri-state ports	V_{DD} = 5.5 V, V_{OUT} = 5.5 V/0 V	–	–	± 2	
Output High Voltage	V_{OH2}	Tri-state ports	V_{DD} = 4.5 V, I_{OH} = – 0.7 mA	4.1	–	–	V
	V_{OH3}	P8, P9	V_{DD} = 4.5 V, I_{OH} = – 5 mA	2.4	–	–	
Output Low Voltage	V_{OL}	Except XOUT	V_{DD} = 4.5 V, I_{OL} = 1.6 mA	–	–	0.4	V
Output High current	I_{OH}	P6, P7	V_{DD} = 4.5 V, V_{OH} = 2.4 V	–	– 15	–	mA
Supply Current in NORMAL 1, 2 modes	I_{DD}		V_{DD} = 5.5 V fc = 8 MHz fs = 32.768 kHz V_{IN} = 5.3 V/0.2 V	–	12	18	mA
Supply Current in IDLE 1, 2 modes				–	4.5	6	
Supply Current in SLOW mode			V_{DD} = 3.0 V fs = 32.768 kHz V_{IN} = 2.8 V/0.2 V	–	30	60	μA
Supply Current in SLEEP mode				–	15	30	
Supply Current in STOP mode			V_{DD} = 5.5 V V_{IN} = 5.3 V/0.2 V	–	0.5	10	μA

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

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

Note 3: Typical current consumption during A/D conversion is 1.2 mA.

A/D CONVERSION CHARACTERISTICS

(V_{SS} = 0 V, V_{DD} = 4.5 to 6.0 V, Topr = – 30 to 70 °C)

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Typ.	Max.	UNIT
Analog Input Voltage Range	V_{AIN}	CIN5 to CIN0		V_{SS}	–	V_{DD}	V
Conversion Error			V_{DD} = 5.0 V	–	–	± 1.5	LSB

A.C. CHARACTERISTICS

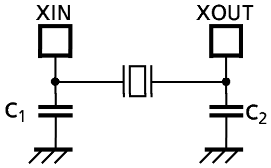
(V_{SS} = 0 V, V_{DD} = 4.5 to 6.0 V, Topr = – 30 to 70 °C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t_{cy}	In NORMAL1, 2 modes	0.5	–	10	μs
		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), fc = 8 MHz	50	–	–	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}					

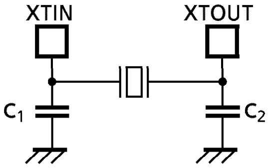
RECOMMENDED OSCILLATING CONDITIONS

(V_{SS} = 0 V, V_{DD} = 4.5 to 6.0 V, Topr = – 30 to 70 °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



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

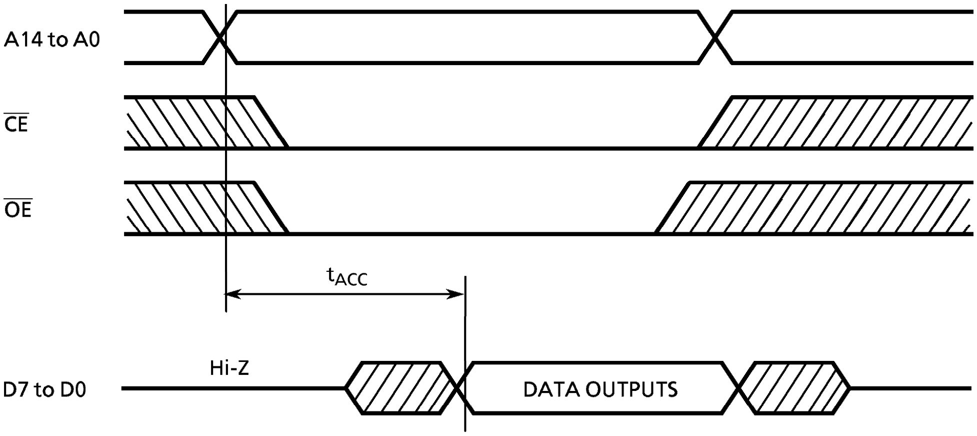
Note : An electrical shield by metal shield plate on the surface of the IC package should be recommendable in order to prevent the device from the high electric fieldstress applied for continuous reliable operation.

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

(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	–	6.0	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25$ V	–	1.5tcyc + 300	–	ns

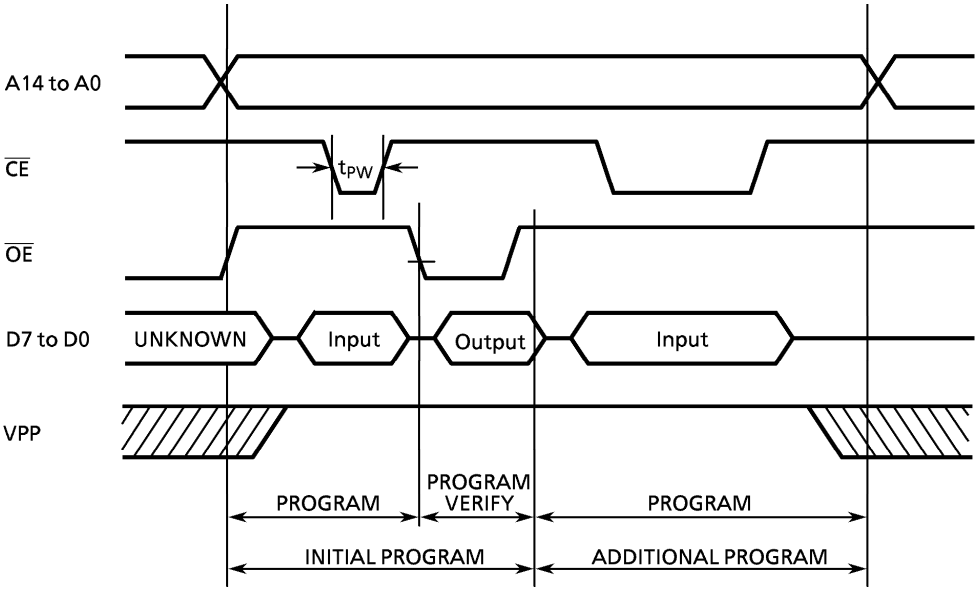
Note : tcyc = 500 ns at 8 MHz



TIMING WAVEFORMS OF READ OPERATION

(2) Program Operation (High-Speed program mode-Ⅰ) (Topr = 25 ± 5 °C)

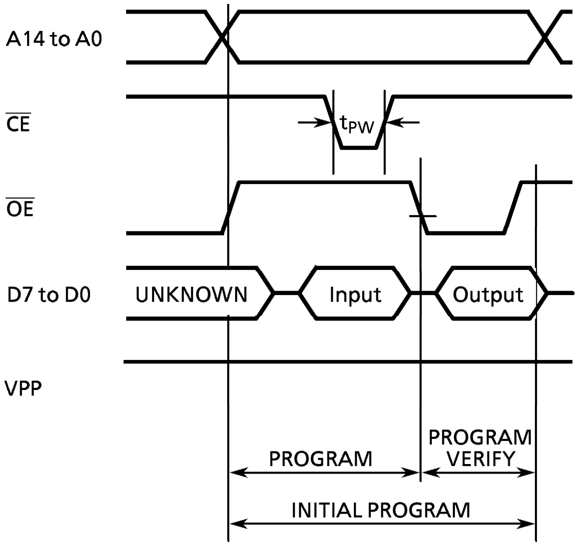
PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		5.75	6.0	6.25	V
Program Power Supply Voltage	V_{PP}		12.0	12.5	13.0	V
Initial Program Pulse Width	t_{PW}	$V_{CC} = 6.0$ V ± 0.25 V $V_{PP} = 12.5 \pm 0.5$ V	0.95	1.0	1.05	ms



Note1:	*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.*
Note2:	*The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.5 V ± 0.5 V) to the V_{pp} pin as the device is damaged.*
Note3:	*Be sure to execute the recommended programing mode with the recommended programing adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.*

(3) Program Operation (High-Speed program mode-II) (Topr = 25 ± 5 °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 ± 0.25 V, V_{PP} = 12.75 ± 0.25 V	0.095	0.1	0.105	ms



Note1: 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.

Note2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.5 V ± 0.5 V) to the V_{pp} pin as the device is damaged.

Note3: Be sure to execute the recommended programing mode with the recommended programing adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.