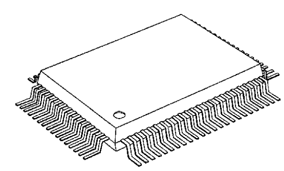
CMOS 8-Bit Microcontroller

TMP87PM53F

The 87PM53 is a One-Time PROM microcontroller with low-power 256 K bits electrically programmable read only memory for the 87CM53 system evaluation. The 87PM53 is pin compatible with the 87CM53. The operations possible with the 87CM53 can be performed by writing programs to PROM. The 87PM53 can write and verify in the same way as the TC571000D using an adaptor socket BM11104 and an EPROM programmer.

Part No.	OTP	RAM	Package	OTP Adapter
TMP87PM53F	32 K × 8-bit	1 K × 8-bit	P-QFP80-1420-0.80B	BM11104

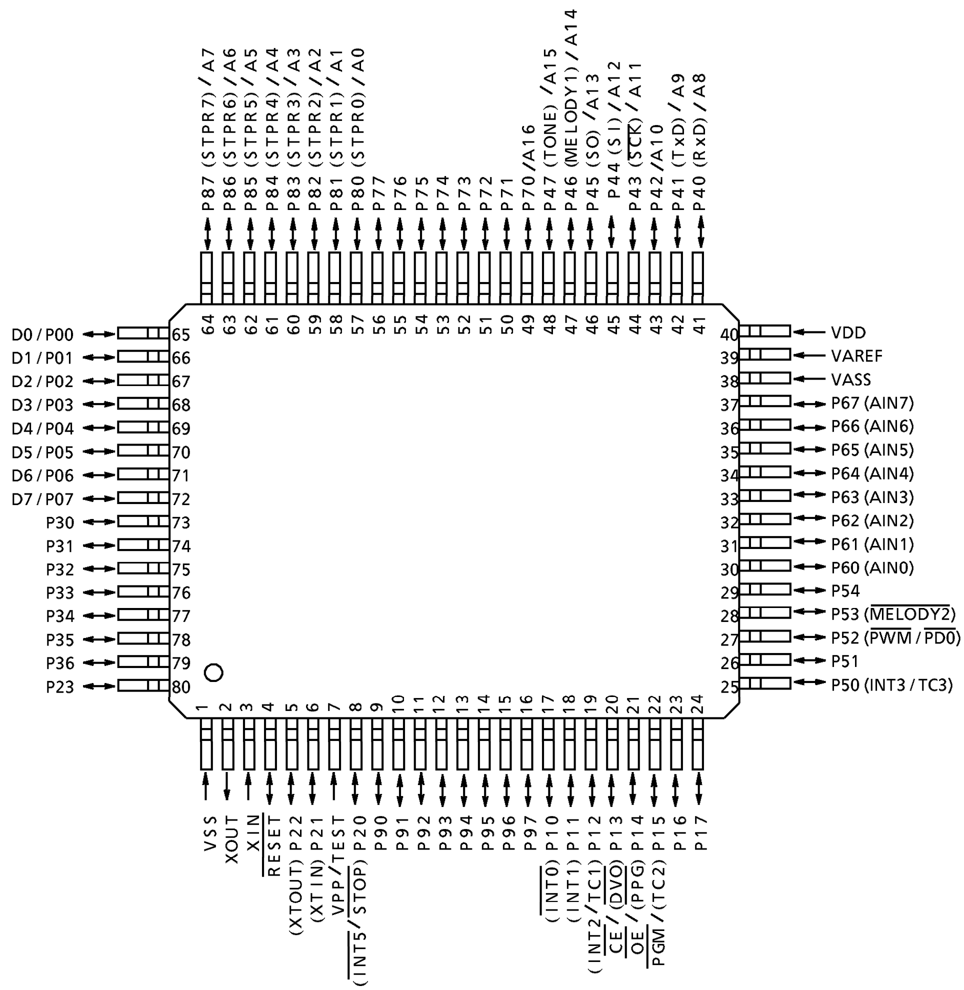
P-QFP80-1420-0.80B



980910EBP1

Pin Assignments (Top View)

P-QFP80-1420-0.80B



Pin Function

The 87PM53 has two modes: MCU and PROM.

(1) MCU mode
In this mode, the 87PM53 is pin compatible with the 87CM53 (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	P70
A15 to A8			P47 to P40
A7 to A0			P87 to P80
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
$\overline{PGM}$		Program mode signal input	P15
VPP	Power supply	+ 12.75 V / 5 V (Program supply voltage)	TEST
VCC		+ 6.25 V / 5 V	VDD
GND		0 V	VSS
P36 to P30	I/O	Pull-up with resistance for input processing.	
P54 to P50			
P67 to P60			
P77 to P72			
P11		PROM mode setting pin. Be fixed at high level.	
P21			
P71			
P17, P16, P12, P10 P22, P20		PROM mode setting pin. Be fixed at low level.	
$\overline{RESET}$			
XIN	Input	Connect an 8MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power supply	0 V (GND)	
VASS			

OPERATIONAL DESCRIPTION

The following explains the 87PM53 hardware configuration and operation. The configuration and functions of the 87PM53 are the same as those of the 87CM53, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PM53 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 87PM53 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 87CM53 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PM53 has a 32K × 8-bit (addresses 8000_H-$FFFF_H$ in the MCU mode, addresses 18000_H-$1FFFF_H$ in the PROM mode) of program memory (OTP).

When the 87PM53 is used as a system evaluation of the 87CM53, the data is written to the program storage area shown in Figure 1-1.

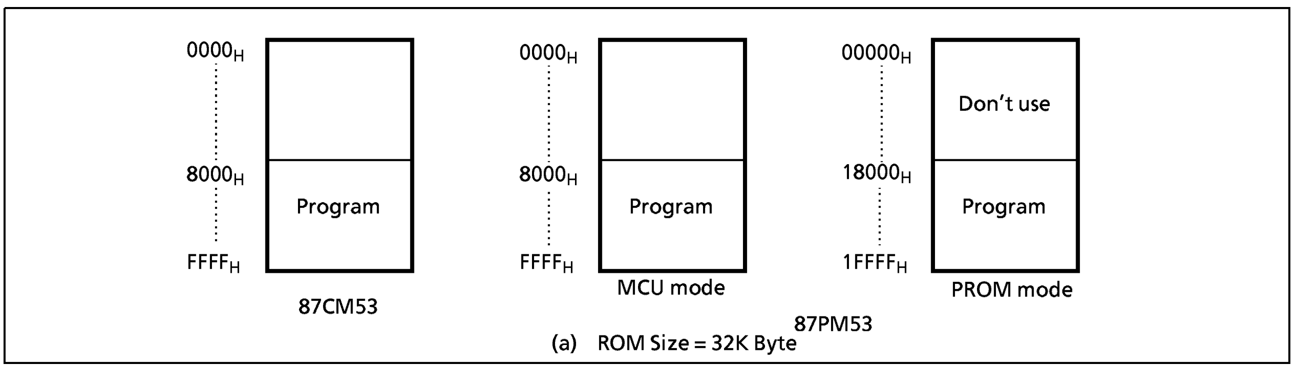


Figure 1.1 Program Memory Area

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

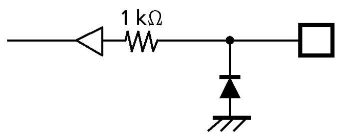
1.1.2 Data Memory

The 87PM53 has an on-chip 1K × 8-bit data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 87PM53 are the same as those of the 87CM53 except that the TEST pin has no built-in pull-down resistance.



Note : No built-in pull-down pesistor

Figure 1-2. TEST pin

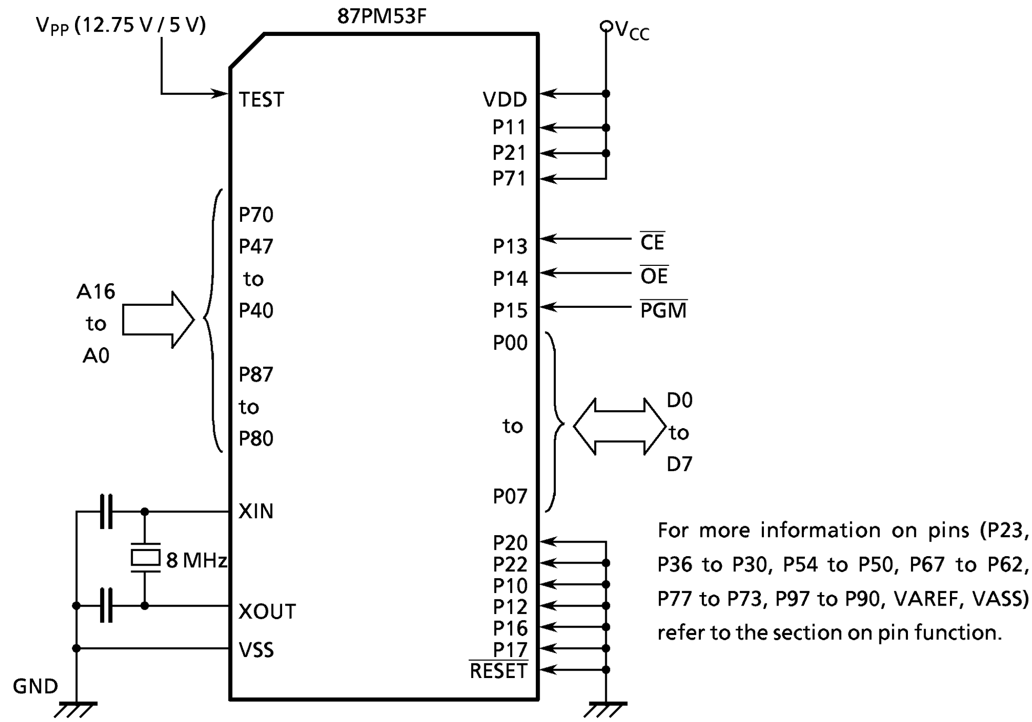
(2) I/O ports

The I/O circuits of 87PM53 I/O ports the are the same as I/O circuitries of the 87CM53.

1.2 PROM Mode

The PROM mode is activated by setting the TEST, $\overline{\text{RESET}}$ pin and the ports P17 to P10, P22 to P20 and P71, as shown in Figure 1-3. 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 87PM53 is not supported an electric signature mode, so the ROM type must be set to TC571000D. (The settings may differ depending on the type of PROM programmer is use. Refer to the PROM programmer operation manual.



Note : PROM programmer connection adaptor socket BM11104 for TMP87PM53F

Figure 1-3. 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 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 $\overline{PGM}$ 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 Vcc = Vpp = 5 V.

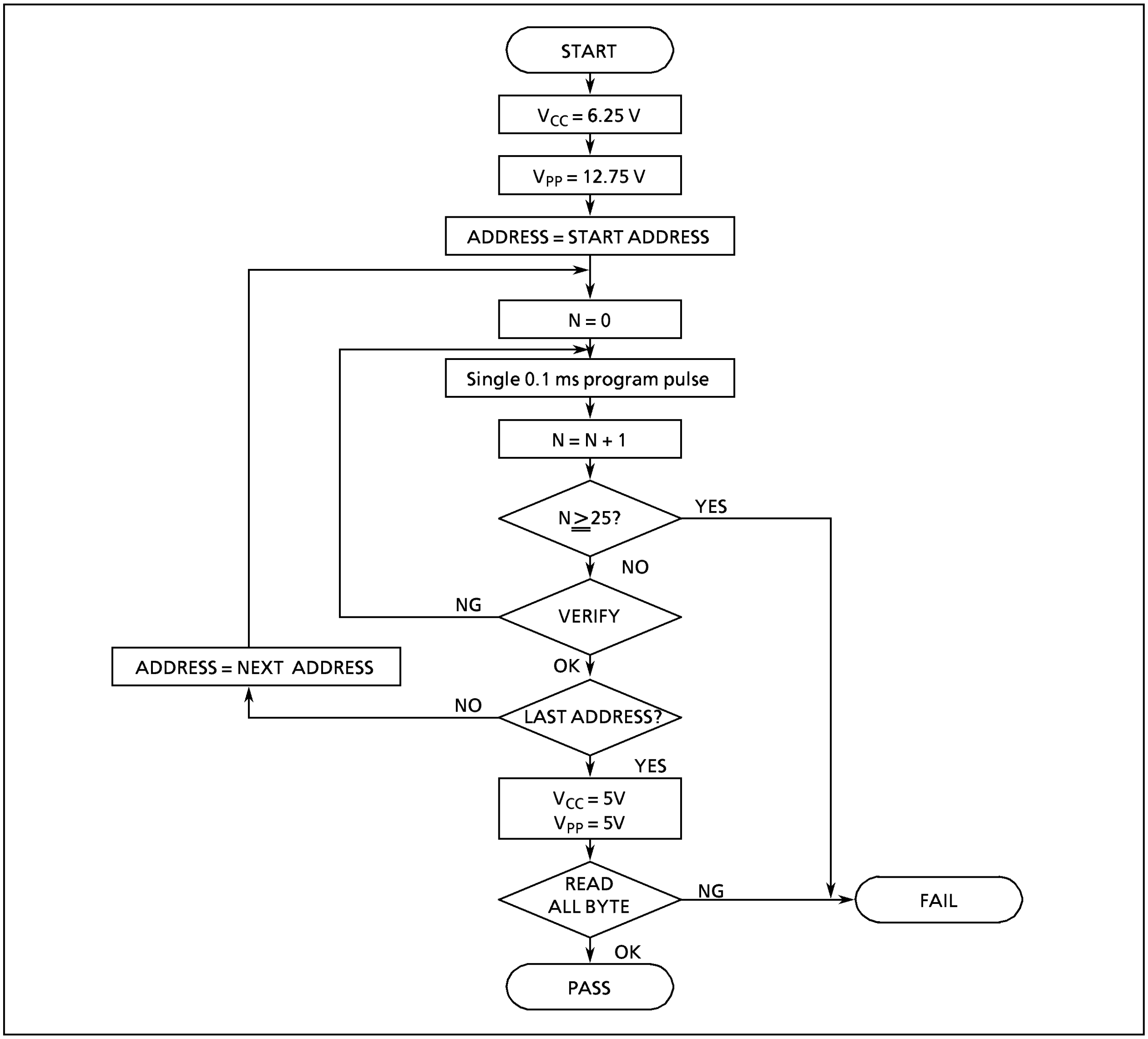


Figure 1-4. Flow Chart of High-speed Programming

1.2.2 Writing Method for General-purpose PROM Program

(1) Adapters
BM11104 : TMP87PM53F

(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 TMP87PM53, EPROM is within the addresses 18000_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 32KB : transferred addresses 08000_H to $0FFFF_H$ to addresses 18000 to $1FFFF_H$

iii) Writing address is specified. (note 1)
Start address : 18000_H
End address : $1FFFF_H$

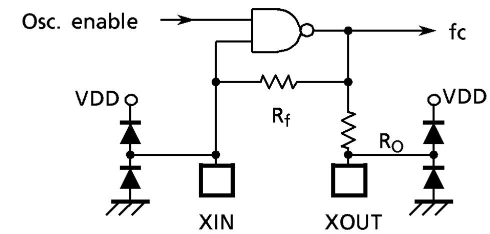
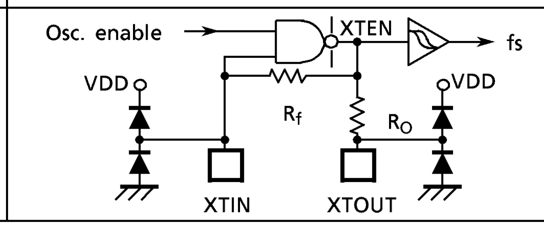
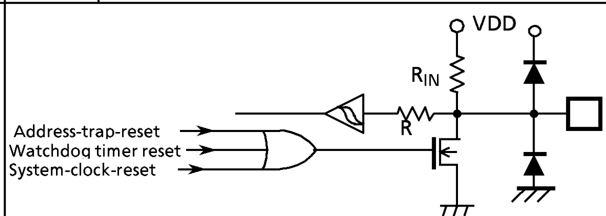
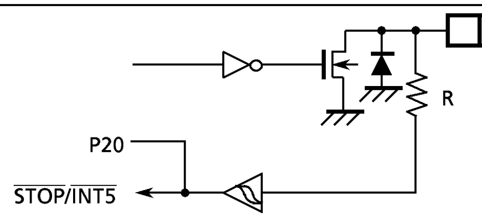
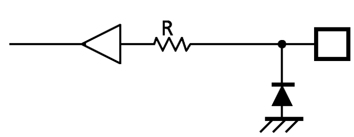
(4) Writing
Writing/Verifying is required to be executed in accordance with PROM programmer operating procedure.

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 TMP87PM53 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.*

INPUT / OUTPUT CIRCUITRY

(1) Control pins

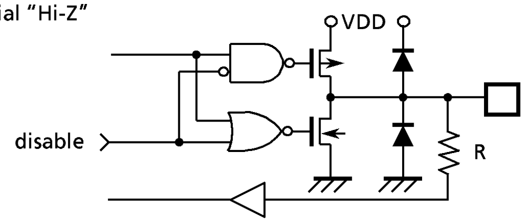
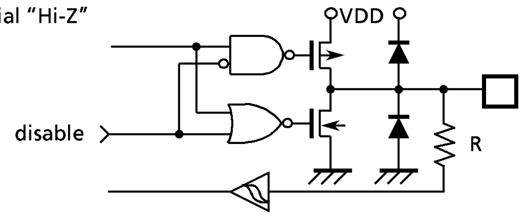
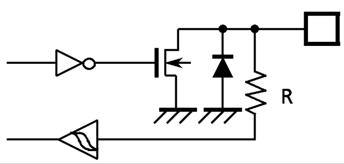
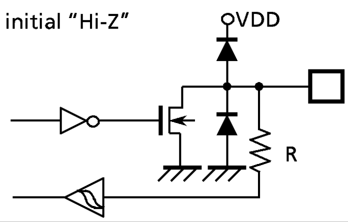
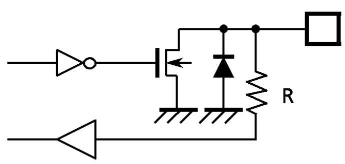
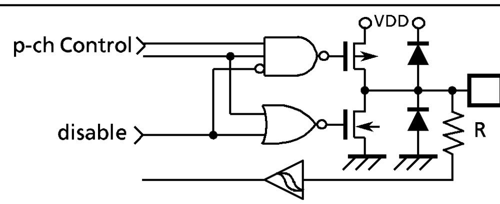
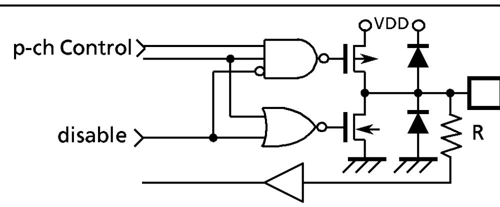
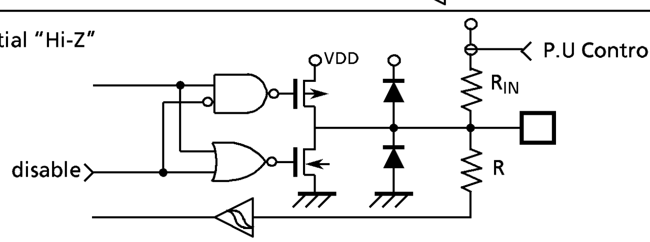
The input / output circuitries of the 87PM53 control pins are shown below.

CONTROL PIN	I/O	INPUT / OUTPUT CIRCUITRY and CODE	REMARKS
XIN XOUT	Input Output		Resonator connecting pins (high-frequency) R_f = 1.2 MΩ (typ.) R_o = 1.5 kΩ (typ.)
XTIN (P21) XTOUT (P22)	Input Output	NM1: Refer to port P2 NM2: 	Resonator connecting pins (low-frequency) R_f = 6 MΩ (typ.) R_o = 220 kΩ (typ.) In only dual-clock mode
$\overline{\text{RESET}}$	I/O		Sink open drain output Hysteresis input Pull-up resistor R_{IN} = 220 kΩ (typ.) R = 1 kΩ (typ.)
$\overline{\text{STOP}}/\overline{\text{INT5}}$ (P20)	Input		Hysteresis input R = 1 kΩ (typ.)
TEST	Input		R = 1 kΩ (typ.)

Note1 : The TEST pin of the 87PM53 does not have a pull-down resistor. Be sure to fix the TEST pin to low in MCU mode.
Note2 : The 87PM53 is placed in the single-clock mode during reset. (NM1)

(2) Input/output ports

The input/output circuitries of the 87PM53 input/output ports are shown below.

PORT	I/O	INPUT/OUTPUT CIRCUITRY	REMARKS
P0 P6	I/O	initial "Hi-Z" 	Tri-state I/O R = 1kΩ (typ.)
P1	I/O	initial "Hi-Z" 	Tri-state I/O Hysteresis input R = 1kΩ (typ.)
P2	I/O	P20, P23 initial "Hi-Z"  P21, P22 initial "Hi-Z" 	Sink open drain output Hysteresis input R = 1kΩ (typ.)
P3	I/O	initial "Hi-Z" 	Sink open drain output High current output R = 1kΩ (typ.)
P4 P5	I/O	initial "Hi-Z" 	Sink open drain or Tri-state I/O (Programable port option) Hysterisis input R = 1kΩ (typ.)
P7 P9	I/O	initial "Hi-Z" 	Sink open drain or Tri-state I/O (Programable port option) R = 1kΩ (typ.)
P8	I/O	initial "Hi-Z" 	Tri-state I/O Programable Pull-up resistor R_{IN} = 70kΩ (typ.) R = 1kΩ (typ.) Hysterisis input

Electrical Characteristics

(1) 87PM53

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

Parameter	Symbol	Conditions	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 1pin)	I_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7, P8, P9	3.2	mA
	I_{OUT2}	Port P3	30	
Output Current (Total)	Σ I_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7, P8, P9	160	mA
	Σ I_{OUT2}	Port P3	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 60	°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_{SS} = 0 V, Topr = – 30 to 60°C)

Parameter	Symbol	Pins	Conditions		Min	Max	Unit
Supply Voltage	V_{DD}		fc = 8 MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			fc ≦ 4.2 MHz	NORMAL1, 2 mode	2.2 Note 2		
				IDLE1, 2 mode			
			fs = 32.768 kHz	SLOW mode			
				SLEEP mode			
				STOP mode	2.0		
Input High Voltage	V_{IH1}	Except hysteresis input	V_{DD} ≧ 4.5 V		V_{DD} × 0.70	V_{DD}	V
	V_{IH2}	Hysteresis input			V_{DD} × 0.75		
	V_{IH3}		V_{DD} < 4.5 V		V_{DD} × 0.90		
Input Low Voltage	V_{IL1}	Except hysteresis input	V_{DD} ≧ 4.5 V		0	V_{DD} × 0.30	V
	V_{IL2}	Hysteresis input				V_{DD} × 0.25	
	V_{IL3}		V_{DD} < 4.5 V			V_{DD} × 0.10	
Clock Frequency	fc	XIN, XOUT	V_{DD} = 4.5 to 5.5 V		3.58	8.0	MHz
			V_{DD} = 2.2 to 5.5 V			4.19	
	fs	XTIN, XTOUT			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: Clock frequency fc: The supply voltage ranse of the conditions shows the value in NORMAL1, 2 modes and·IDLE 1,2 modes.
Note 3: When the A/D converter is used, VDD must be set to ≧ 2.7 V.

D.C. Characteristics

(V_{SS} = 0 V, Topr = – 30 to 60°C)

Parameter	Symbol	Pins	Conditions		Min	Typ.	Max	Unit
Hysteresis Voltage	V_{HS}	Hysteresis input			–	0.9	–	V
Input Current	I_{IN1}	TEST	V_{DD} = 5.5V V_{IN} = 5.5V / 0V		–	–	± 2	μA
	I_{IN2}	Sink open drain port and tri-state port						
	I_{IN3}	$\overline{\text{RESET}}$, $\overline{\text{STOP}}$						
Input Resistance	R_{IN2}	$\overline{\text{RESET}}$			100	220	450	kΩ
	R_{IN}	P8 pull-up resistor			30	70	150	
Output Leakage Current	I_{LO}	Sink open drain port	V_{DD} = 5.5V, V_{OUT} = 5.5V		–	–	2	μA
Output High Voltage	V_{OH2}	Try-state port	V_{DD} = 4.5V, I_{OH} = – 0.7mA		4.1	–	–	V
Output Low Voltage	V_{OL}	Except XOUT and P3	V_{DD} = 4.5V, I_{OL} = 1.6mA		–	–	0.4	V
Output Low Current	I_{OL3}	Port P3	V_{DD} = 4.5V, V_{OL} = 1.0V		–	20	–	mA
Supply Current in NORMAL 1, 2 mode	I_{DD}		V_{DD} = 5.5V	TONE no output	–	9	12	mA
			V_{IN} = 5.3V/0.2V	TONE output	–	10.5	13.5	
Supply Currnt in IDLE 1, 2 mode			fc = 8 MHz	TONE no output	–	4.5	6.5	
			fs = 32.768 kHz	TONE output	–	6.0	8.0	
Supply Currnt in NORMAL 1, 2 mode			V_{DD} = 2.2V	TONE no output	–	1.5	2.5	
			V_{IN} = 2.2V/0.2V	TONE output	–	2.0	3.0	
Supply Currnt in IDLE 1, 2 mode			fc = 4.2 MHz	TONE no output	–	0.8	1.8	
			fs = 32.768 kHz	TONE output	–	1.3	2.3	
Supply Current in SLOW mode	I_{DD}		V_{DD} = 3.0V V_{IN} = 2.8V/0.2V fs = 32.768 kHz		–	30	60	μA
Supply Current in SLEEP mode					–	15	30	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 Topr = 25°C, V_{DD} = 5 V.
Note 2: Input current: The current through pull-up or pull-down resistor is not included.

A/D Conversion Characteristics

(V_{SS} = 0V, V_{DD} = 2.7 to 5.5V, Topr = – 30 to 60°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}	$V_{AREF} - V_{ASS} \geqq 2.5V$	2.7	–	V_{DD}	V
	V_{ASS}		V_{SS}	–	1.5	
Analog Input Voltage	V_{AIN}	$V_{DD} = V_{AREF} = 5.0\ V$ $V_{SS} = V_{ASS} = 0.0\ V$	V_{ASS}	–	V_{AREF}	V
Analog Supply Current	I_{REF}		–	0.5	1.0	V
Nonlinearity Error		V_{DD} = 2.7 to 5.5 V	–	–	± 1	mA
Zero Point Error		V_{SS} = 0.0 V	–	–	± 1	
Full Scale Error		V_{AREF} = 2.700 V, 5.000 V	–	–	± 1	LSB
Total Error		V_{ASS} = 0.000 V	–	–	± 2	

Note: Total Error = total number of each type error excluding guantization error.

Tone Output Characteristics

(V_{SS} = 0 V, V_{DD} = 2.2 to 5.5 V, Topr = – 30 to 60°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Tone Output Voltage (ROW)	V_{TONE}	RL ≧ 10 kΩ, V_{DD} = 2.2 V	126	150	178	mVrms
Pre-Emphasis High Band (COL / ROW)	PEHB	PEHB = 20 log (COL /ROW)	1	2	3	dB
Output Distortion	DIS		–	–	5	%
Frequency Stability	△f	fc = 3.84 MHz, 4.00 MHz, 8.00 MHz (Except error of osc. frequency)	–	–	0.70	%
		fc = 3.58 MHz (Except error of osc. frequency)	–	–	0.66	
		fc = 4.19 MHz (Except error of osc. frequency)	–	–	0.93	

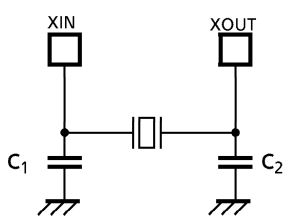
A.C. Characteristics

(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, Topr = – 30 to 60°C)

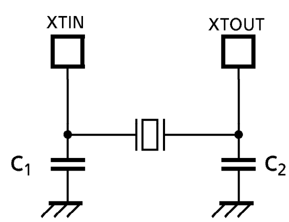
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	tcy	In NORMAL1, 2 mode (gear ratio)	0.5 (1/1)	–	8.9 (1/8)	μs
		In IDLE1, 2 mode (gear ratio)				
		In SLOW mode	117.6		133.3	
		In SLEEP mode				
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XIN input) fc = 8 MHz	50	–	–	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 Condition

Parameter	Oscillator	Frequency	Recommended Oscillator		Recommended Condition	
					C_1	C_2
High-frequency	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	Crystal Oscillator	32.768 kHz	NDK	MX-38T	15 pF	15 pF



(1) High-frequency



(2) Low-frequency

Note: When it is used in high electrical field, an electrical shield of the package is recommended to retain normal operations

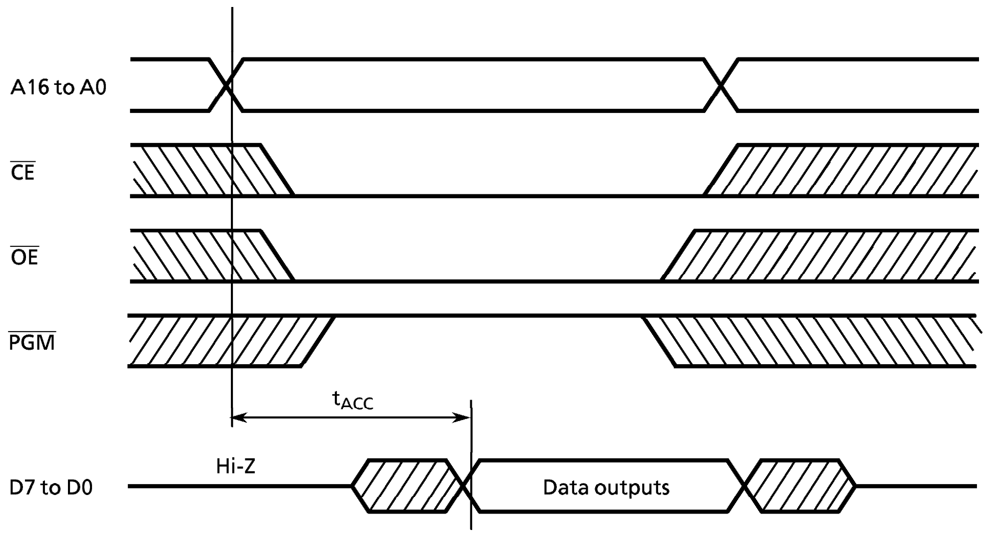
Note: To obtain an accurate oscillating frequency the condenser capacity must be adjusted on the sct.

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

(1) Read Operation

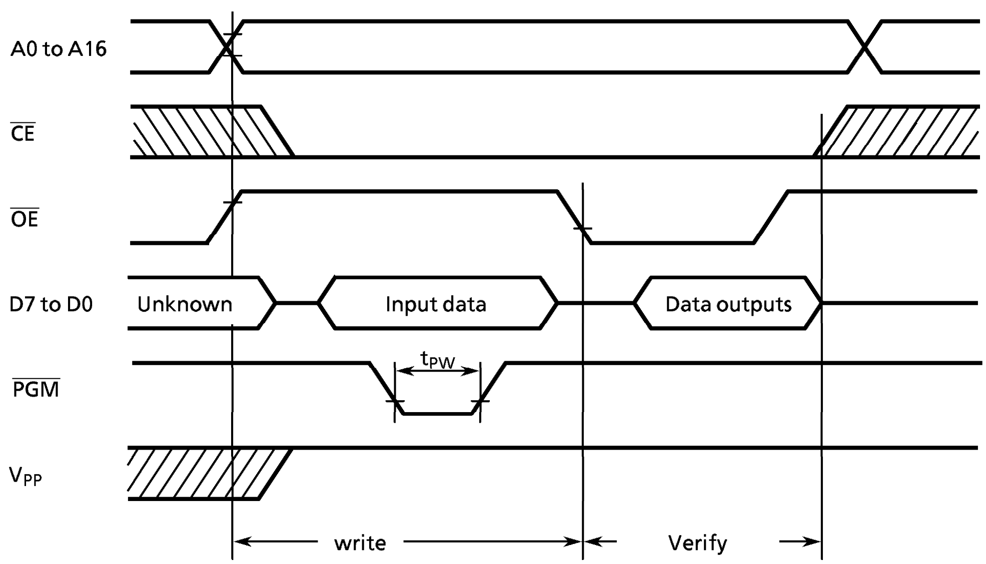
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		2.2	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	0.8	V
Power Supply Voltage	V_{CC}		4.75	5.0	5.25	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	V_{CC} = 5.0 ± 0.25 V	–	1.5 tcyc + 300	–	ns

Note: tcyc = 500 ns at 8 MHz



(2) High-Speed Programming Operation (Topr = 25 ± 5°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		2.2	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	0.8	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} = 6.0 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 increased.
Note2: The device must not be set to the EPROM programmer or picked op from it under applying the program voltage (12.5 V ± 0.5 V = 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.