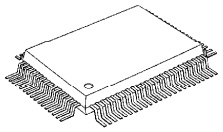
CMOS 8-BIT MICROCONTROLLER

TMP87PH20F, TMP87PM20F

The 87PH20 is an One-Time PROM microcontroller with low-power 128K bits (16K bytes) electrically programmable read only memory, the 87PM20 is an One-Time PROM microcontroller with low-power 256K bits (32K bytes) electrically programmable read only memory for 87CC20/CH20/CK20A/CM20A system evaluation. The 87PH20/PM20 are pin-compatible with 87CC20/CH20/CK20A/CM20A. The operations possible with the 87CC20/CH20/CK20A/CM20A can be performed by writing programs to PROM. The 87PH20/PM20 can write and verify in the same way as the TC57256AD using an adaptor socket BM1138 and an EPROM programmer.

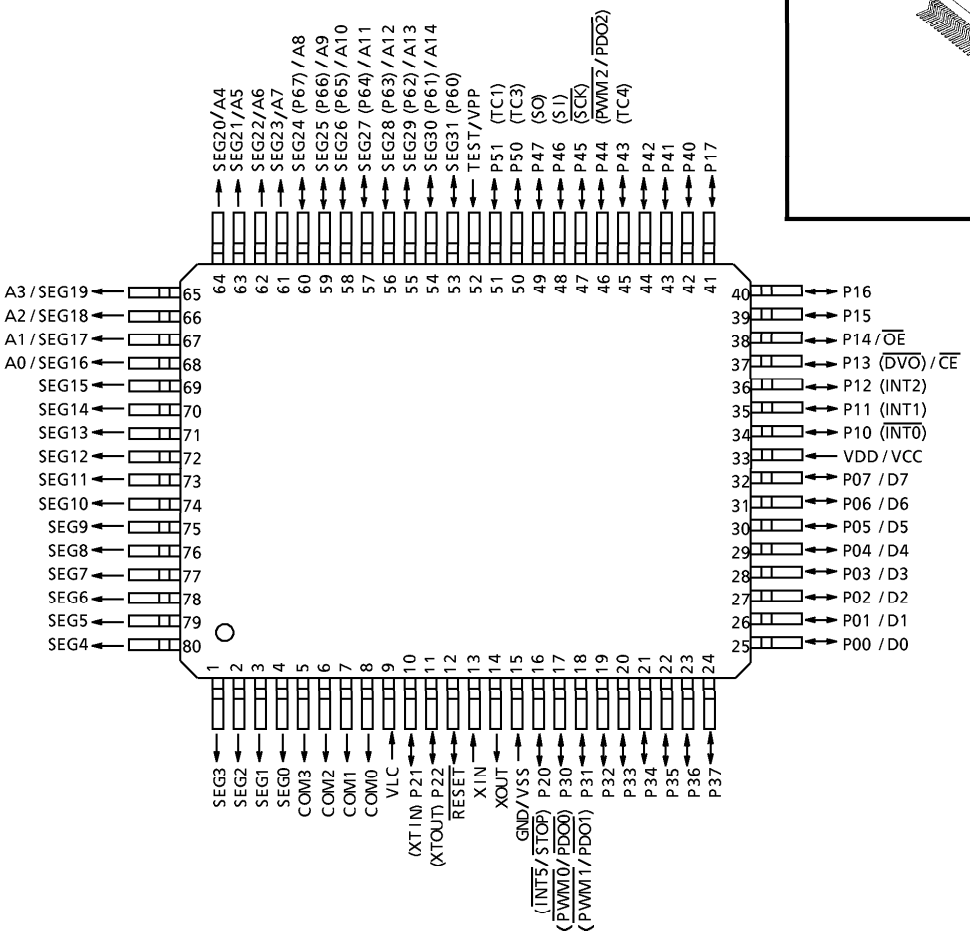
PART No.	ROM	RAM	PACKAGE	Adapter socket
TMP87PH20F	16K × 8-bit	512 × 8-bit	QFP80-P-1420-0.80B	BM1138
TMP87PM20F	32K × 8-bit	1K × 8-bit		

QFP80-P-1420-0.80B



TMP87PH20F
TMP87PM20F

PIN ASSIGNMENTS (TOP VIEW)



PIN FUNCTION

The 87PH20/PM20 have two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PH20/PM20 are pin-compatible with the 87CC20/CH20/CK20A/CM20A (fix the TEST / VPP 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	P61 to P67
A7 to A0			SEG23 to SEG16
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	+ 12.5V / 5V (Program supply voltage)	TEST
VCC		+ 5V	VDD
GND		0V	VSS
P37 to P30	I/O	Pull-up with resisteance for input processing.	
P47 to P40			
P51 to P50			
P11		PROM mode setting pins. Fix at high level.	
P21			
P60			
P12, P10		PROM mode setting pins. Fix at low level.	
P22, P20			
P17 to P15			
$\overline{RESET}$			
XIN	Input	Connect an 8MHz oscillator to stabilize the internal state.	
XOUT	Output		
SEG15 to SEG0	Output	Open.	
COM3 to COM0			
VLC	LCD power supply		

OPERATIONAL DESCRIPTION

The following explains the 87PH20/PM20 hardware configuration and operation. The configuration and functions of the 87PH20/PM20 are the same as those of the 87CC20/CH20/CK20A/CM20A, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PH20/PM20 are 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. OPERATION MODE

The 87PH20/PM20 have 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 87CC20/CH20/CK20A/CM20A (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PH20 has a 16K × 8-bit (addresses $C000_H$ - $FFFF_H$ in the MCU mode, addresses 4000_H - $7FFF_H$ in the PROM mode), the 87PM20 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 87PM20 as the system evaluation for the 87CK20A/CM20A, the program should be writen to the program memory area as shown in figure 1-1.

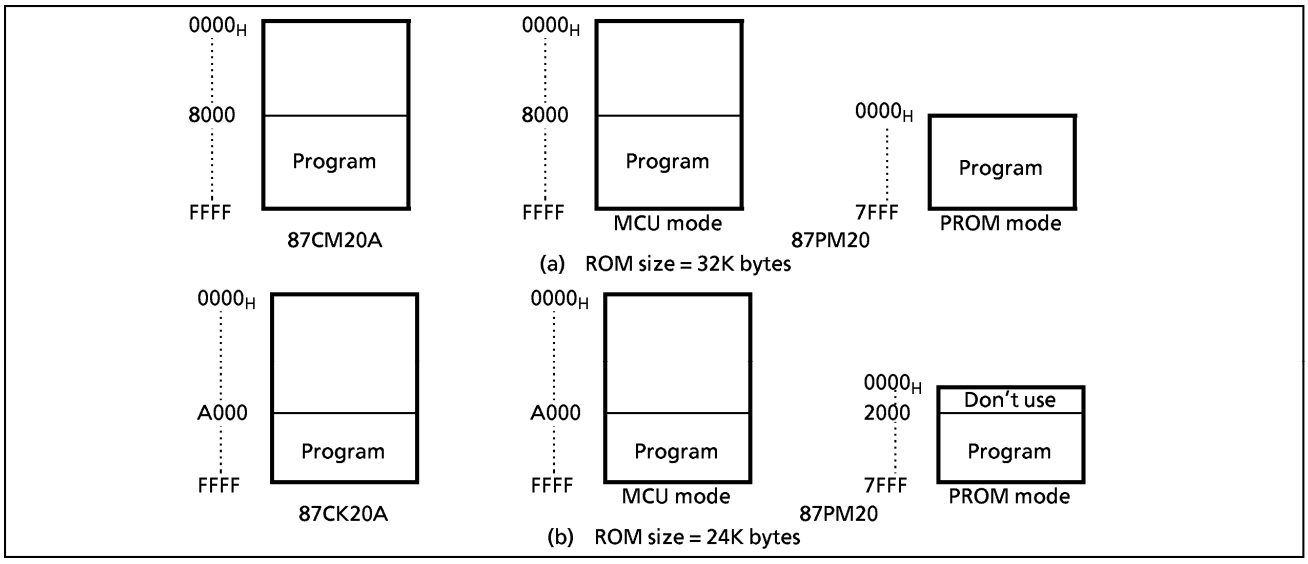


Figure 1-1. Program Memory Area (a), (b)

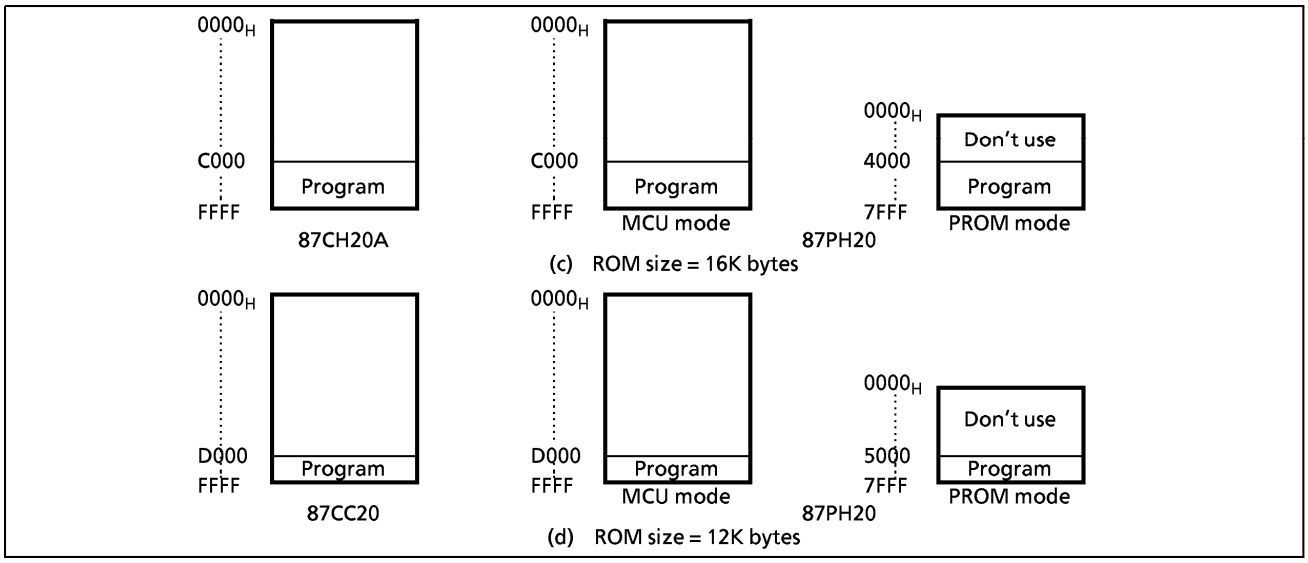


Figure 1-1. Program Memory Area (c), (d)

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

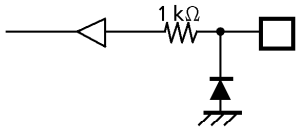
1.1.2 Data Memory

The 87PH20 has an on-chip 512 × 8-bit, the 87PM20 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 87PH20/PM20 are the same as those of the 87CC20/CH20/CK20A/CM20A except in that the TEST pin has no built-in pull-down resistance.



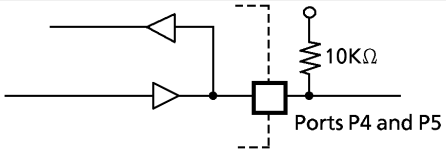
Note : TEST pin has no built-in pull-down resistance

Figure 1-2. TEST pin

(2) I/O ports

The I/O circuitries of the 87PH20/PM20 I/O ports are the same as code A type circuitries of the 87CC20/CH20/CK20A/CM20A.

When using as an evaluator of the other I/O code B, external pull-up resistors are required.



In the case of code **B**

Figure 1-3. I/O Circuitry Code and External Circuitry

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 P60 as shown in Figure 1-4. 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 (Please set the high-speed programming mode according to each manual of PROM programmer). The 87PH20/PM20 are not supported an electric signature mode, so the ROM type must be set to TC57256AD.
Set the writer adaptor socket switch to "P".

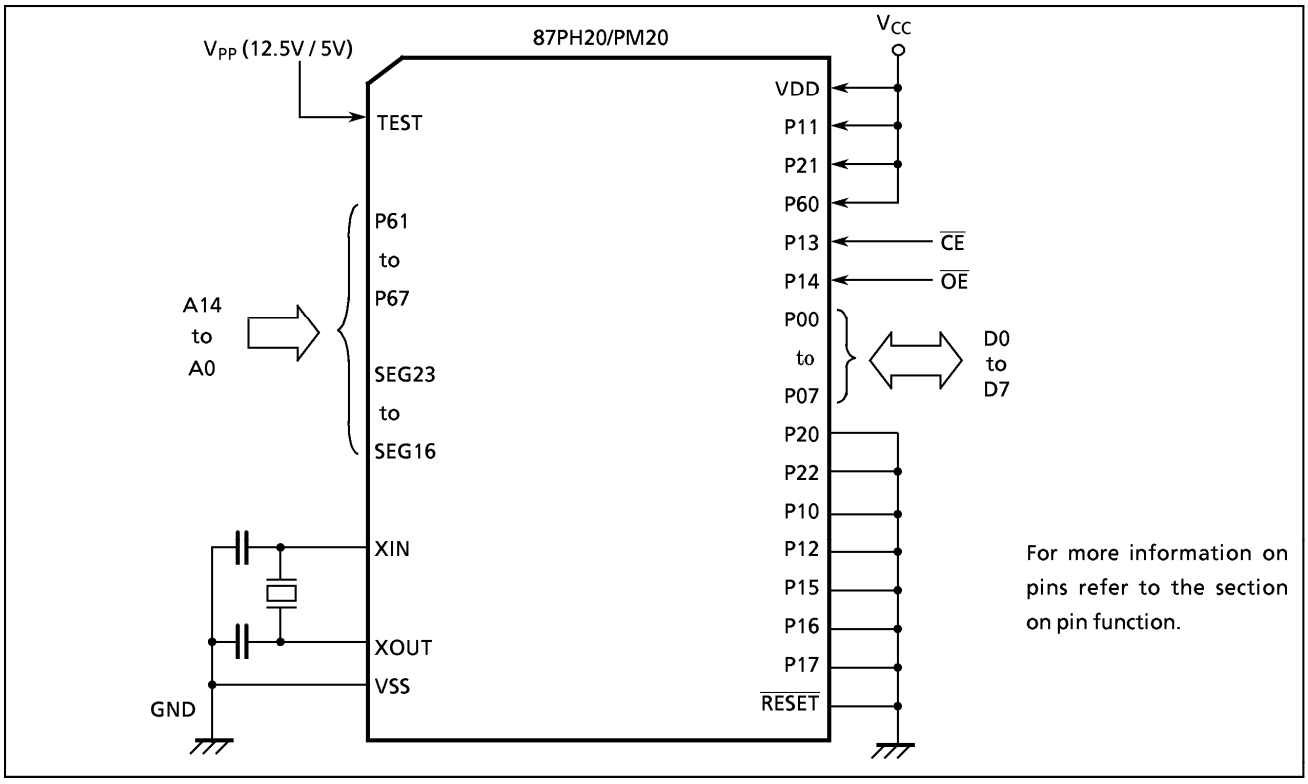


Figure 1-4. Setting for PROM Mode

PROM programmer connection adaptor socket: BM1138

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

The high-speed programming mode is achieved by applying the program voltage (+ 12.5V) to the VPP pin when Vcc = 6V. 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 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 × 1ms). 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 = 5V and verify all addresses.

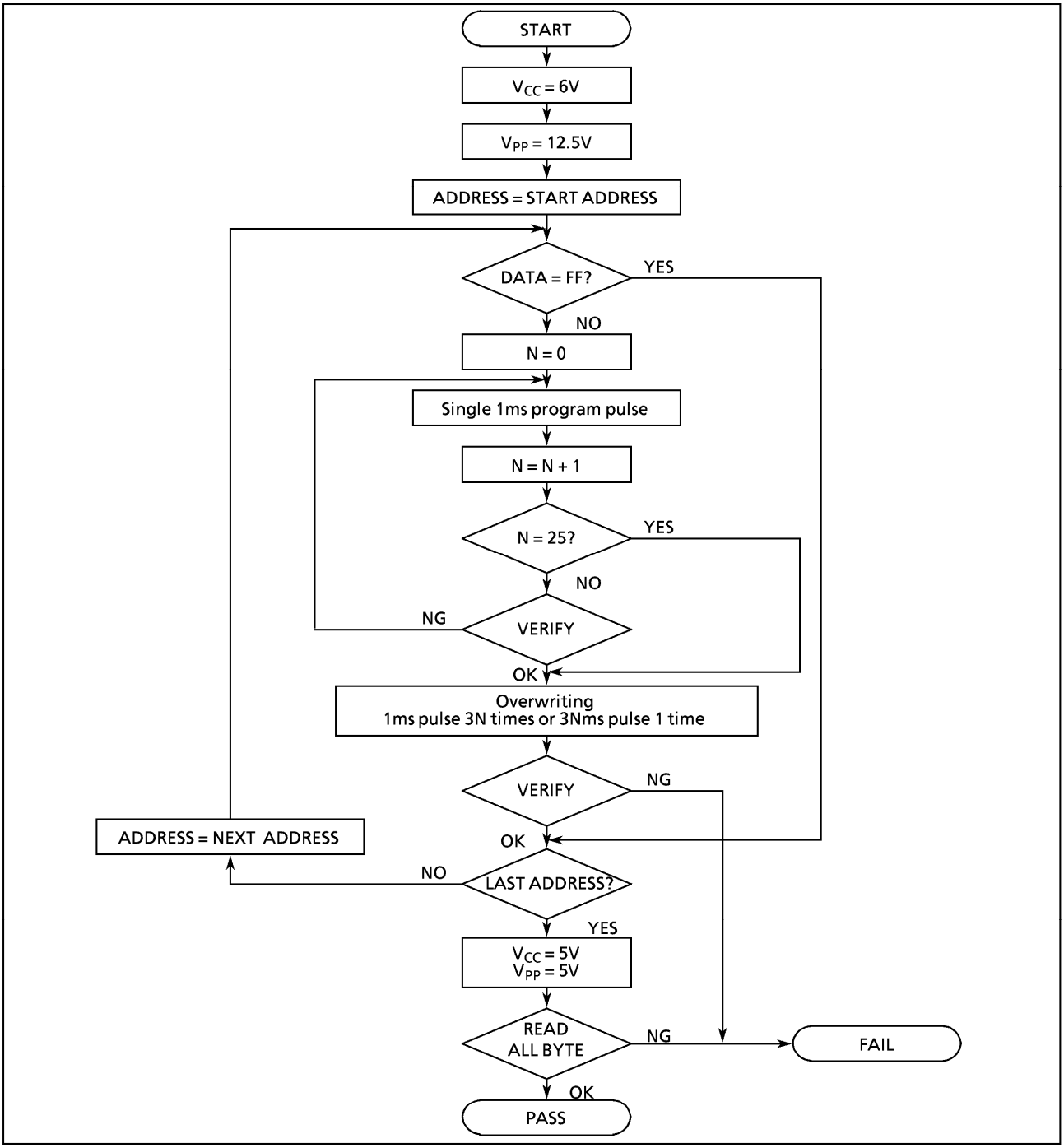


Figure 1-5. Flowchart of High-speed Programming Mode- I

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 $\overline{CE}$ 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.

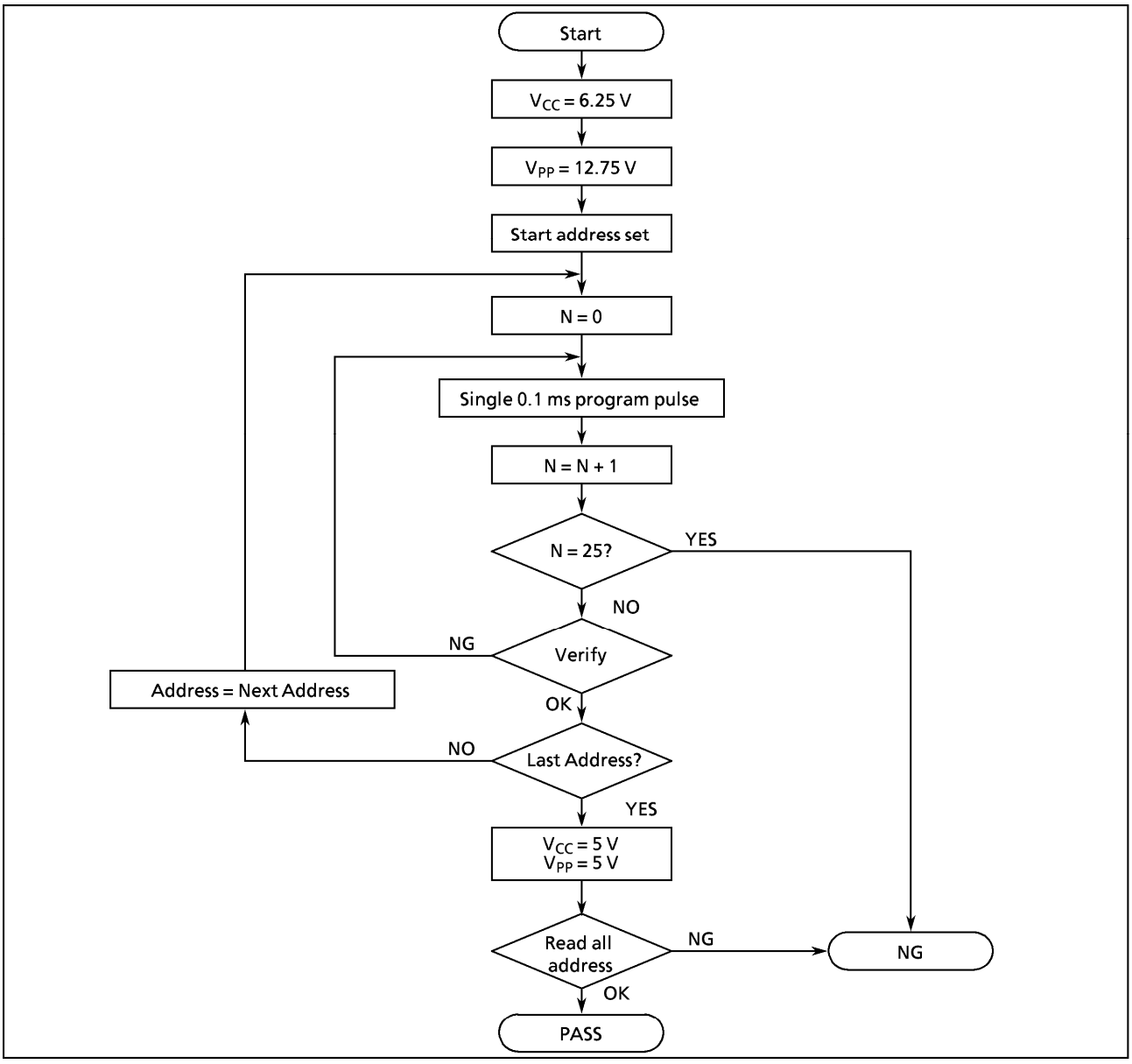


Figure 1-6. Flowchart of High-speed Programming Mode - II

1.2.3 Writing Method for General-purpose PROM Program

(1) Adapters
BM1138 : TMP87PH20F, 87PM20F

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

(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 TMP87PH20, EPROM is within the addresses 4000 to $7FFF_H$. In TMP87PM20, EPROM is within the addresses 0000 to $7FFF_H$. 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 16kB : transferred addresses C000 to $FFFF_H$ to addresses 4000 to $7FFF_H$
ROM capacity of 32kB : transferred addresses 8000 to $FFFF_H$ to addresses 0000 to $7FFF_H$

iii) Writing address is specified. (note 1)
Start address : 4000_H (87PM20 : 0000_H)
End address : $7FFF_H$

(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. In TMP87PH20, the data in addresses 0000 to $3FFF_H$ 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 programer is damaged.

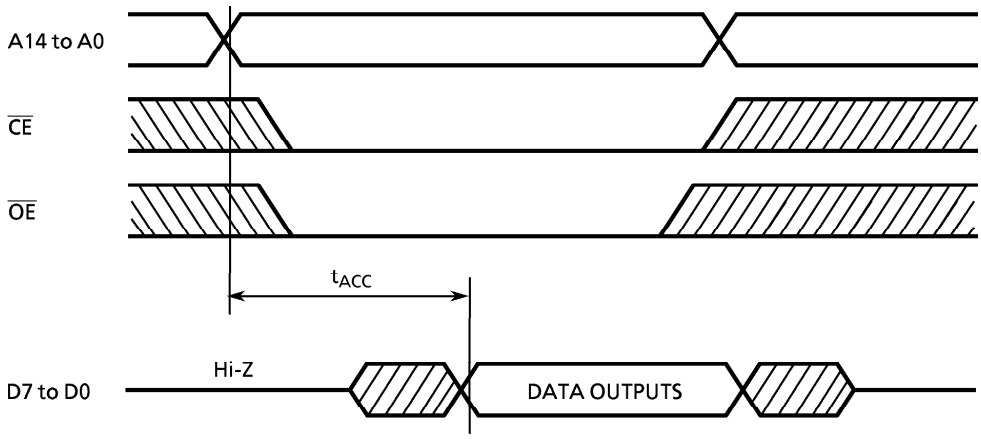
Note 3 : TMP87PH20/PM20 do not support the electric signature mode (hereinafter referred to as "signature"). If the signature is used in PROM program, a device is damaged due to applying 12V ± 0.5V to the address pin 9 (A9). The signature must not be used.

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

(1) Read Operation (Topr = – 30 to 70°C)

PARAMETER	SYMBOL	CONDITION	Min.	Typ.	Max.	UNIT
Input High Voltage	V_{IH4}		V_{CC} × 0.7	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	V_{CC} × 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 ± 0.25V	–	1.5tcyc + 300	–	ns

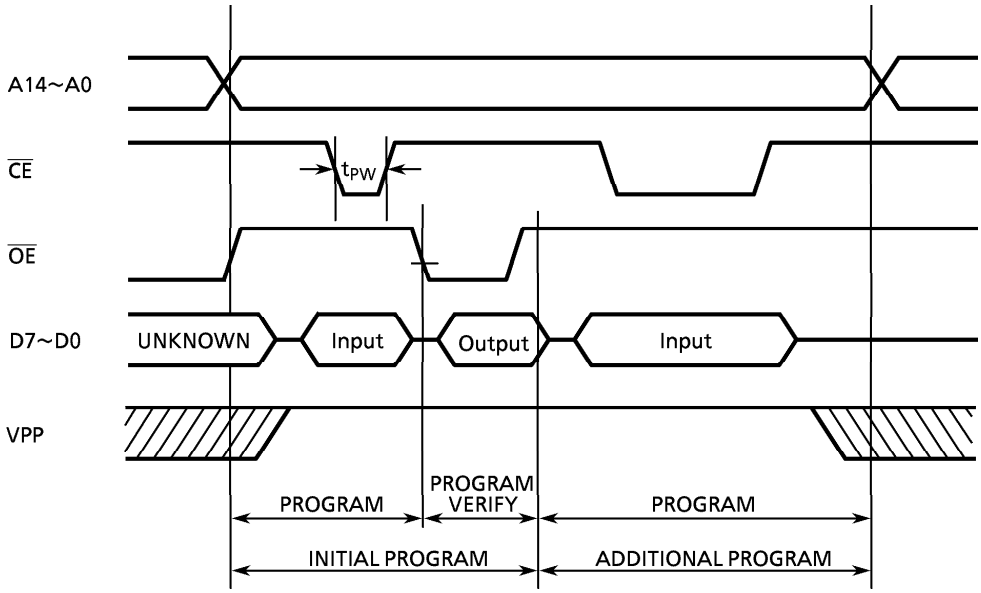
Note: tcyc = 500ns at 8MHz



TIMING WAVEFORMS OF READ OPERATION

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

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



TIMING WAVEFORMS OF PROGRAMMING OPERATION

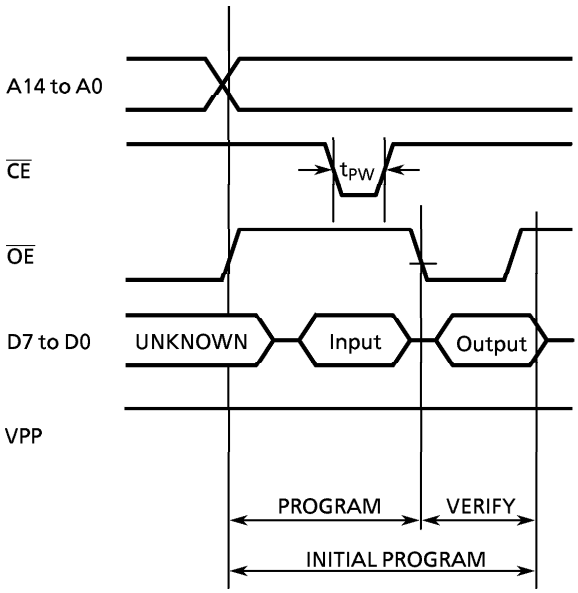
Note 1: When V_{cc} power supply is turned on or after, V_{pp} must be increased.
When V_{cc} power supply is turned off or before, V_{pp} must be decreased.

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

Note 3: 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 write 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 V ± 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 (12.75V ± 0.25V) to the V_{pp} pin as the device is damaged.
Note 3: 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.

ELECTRICAL CHARACTERISTICS

(1) 87PH20

ABSOLUTE MAXIMUM RATINGS (V_{SS} = 0V)

PARAMETER	SYMBOL	CONDTION	RATINGS	UNIT
Supply Voltage	V_{DD}		– 0.3 to 7	V
Program Voltage	V_{PP}	TEST/VPP pin	– 0.3 to 13.0	V
Input Voltage	V_{IN}		– 0.3 to V_{DD} + 0.3	
Output Voltage	V_{OUT1}	Ports P0, P1, P21, P22, P6 and $\overline{RESET}$	– 0.3 to V_{DD} + 0.3	V
	V_{OUT2}	Ports P20, P3, P4, P5	– 0.3 to 10	
Output Current (Per 1 pin)	I_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P3 (except P30, P31)	3.2	mA
	I_{OUT2}	Only P30 and P31	30	
Output Current (Total)	ΣI_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P3 (except P30, P31)	120	mA
	ΣI_{OUT2}	Only P30, P31	60	
Power Dissipation [Topr = 70°C]	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 30 to 70	°C

RECOMMENDED OPERATING CONDITIONS (V_{SS} = 0V, Topr = – 30 to 70°C)

PARAMETER	SYMBOL	PINS	CONDITIONS		Min.	Max.	UNIT
Supply Voltage	V_{DD}		fc = 8MHz	NORMAL1, 2 mode	4.5	6.0	V
				IDLE1, 2 mode			
			fc = 4.2MHz	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			fs = 32.768kHz	SLOW mode			
				SLEEP mode			
				STOP mode	2.0		
Input High Voltage	V_{IH1}	Except hysteresis input	$V_{DD} \geqq 4.5V$		$V_{DD} \times 0.70$	V_{DD}	V
	V_{IH2}	Hysteresis input			$V_{DD} \times 0.75$		
	V_{IH3}		$V_{DD} < 4.5V$		$V_{DD} \times 0.90$		
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geqq 4.5V$		0	$V_{DD} \times 0.30$	V
	V_{IL2}	Hysteresis input				$V_{DD} \times 0.25$	
	V_{IL3}		$V_{DD} < 4.5V$			$V_{DD} \times 0.10$	
Clock Frequency	fc	XIN, XOUT	V_{DD} = 4.5 to 6V		0.4	8.0	MHz
			V_{DD} = 2.7 to 6V			4.2	
	fs	XTIN, XTOUT			30.0	34.0	kHz

Note : Clock frequency fc : Supply voltage range is specified in NORMAL 1/2 mode.

D.C.CHARACTERISTICS (V_{SS} = 0V, Topr = – 30 to 70°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}	Open drain port and tri-state port					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Resistance	R_{IN2}	$\overline{RESET}$		100	220	450	kΩ
Output Leakage Current	I_{LO}	Open drain port and	V_{DD} = 5.5V, V_{OUT} = 5.5V	–	–	2	μA
		tri-state port	V_{DD} = 5.5V, V_{OUT} = 5.5V/0V	–	–	± 2	
Output High Voltage	Vo_{H2}	Tri- state port	V_{DD} = 4.5V, I_{OH} = – 0.7mA	4.1	–	–	
Output Low Voltage	V_{OL}	Except XOUT and P30, P31	V_{DD} = 4.5V, I_{OL} = 1.6mA	–	–	0.4	V
Output Low Current	I_{OL3}	Only P30, P31	V_{DD} = 4.5V, V_{OL} = 1.0V	–	20	–	mA
Supply Current in NORMAL 1 , 2 mode	I_{DD}		V_{DD} = 5.5V, V_{IN} = 5.3V / 0.2V fc = 8MHz fs = 32.768kHz	–	8	14	mA
Supply Current in IDLE 1, 2 mode				–	4	6	mA
Supply Current in NORMAL 1 , 2 mode			V_{DD} = 3.0V, V_{IN} = 2.8V / 0.2V fc = 4.19MHz fs = 32.768kHz	–	2.5	3.5	mA
Supply Current in IDLE 1, 2 mode				–	1.5	2.0	mA
Supply Current in SLOW mode			V_{DD} = 3.0V fs = 32.768kHz V_{IN} = 2.8V / 0.2V LCD driver is not enable	–	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
Segment Output Low Resistance	R_{OS1}	SEG31-SEG0	V_{DD} = 5V V_{DD} – V_{LC} = 3V	–	20	–	kΩ
Common Output Low Resistance	R_{OC1}	COM3-COM0					
Segment Output High Resistance	R_{OS2}	SEG31-SEG0		–	200	–	kΩ
Common Output High Resistance	R_{OC2}	COM3-COM0					
Segment /Common Output Voltage	$V_{O\ 2/3}$	SEG31-SEG0 and COM3-COM0 pins		3.8	4.0	4.2	V
	$V_{O\ 1/2}$			3.3	3.5	3.7	
	$V_{O\ 1/3}$			2.8	3.0	3.2	

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

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

Note 3 : Output resistance R_{OS} and R_{OC} indicate "on" when switching levels.

Note 4 : $V_{O2/3}$ indicates an output current at the 2/3 level when operating in the 1/4 or 1/3 duty mode.

Note 5 : $V_{O1/2}$ indicates an output current at the 1/2 level when operating in the 1/2 duty or static mode.

Note 6 : $V_{O1/3}$ indicates an output current at the 1/3 level when operating in the 1/4 or 1/3 duty mode.

Note 7 : When you use a liquid crystal display (LCD), it is necessary to give carefull consideration to the value of the output resisteor $R_{OS\ 1/2}$, $R_{OC\ 1/2}$.

Note 8 : R_{OS1}, R_{OC1} : On time of the lower output resistor is 2^6/fc, 2/fs [s]

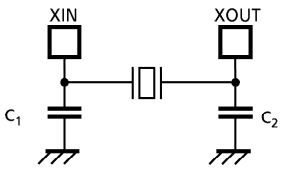
Note 9 : R_{OS2}, R_{OC2} : On time of the higher output resistor is 1/ (n/fF) (1/n duty, fF : frame frequency)

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

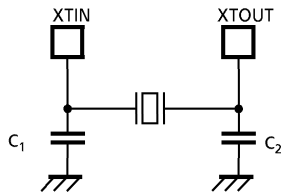
PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t_{cy}	In NORMAL 1, 2 mode	0.5	–	10	μs
		In IDLE 1, 2 mode				
		In SLOW mode	117.6	–	133.3	
		In SLEEP mode				
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XIN input), fc = 8MHz	62.5	–	–	ns
Low Level Clock Pulse Width	t_{WCL}					
High Level Clock Pulse Width	t_{WSH}	For external clock operation (XTIN input), fs = 32.768kHz	14.7	–	–	μs
Low Level Clock Pulse Width	t_{WSL}					
Frequency of TC1 input	t_{TC1}	Frequency Measurement mode	–	–	fc	MHz

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

PARAMETER	OSCILLATOR	FREQUENCY	RECOMMENDED OSCILLATOR		RECOMMENDED CONDITION	
					C_1	C_2
High-frequency	Ceramic Resonator	8MHz	KYOCERA	KBR8.0M	30pF	30pF
		4MHz	KYOCERA	KBR4.0MS		
			MURATA	CSA4.00MG		
	Crystal Oscillator	8MHz	TOYOCOM	210B 8.0000	20pF	20pF
		4MHz	TOYOCOM	204B 4.0000		
Low-frequency	Crystal Oscillator	32.768kHz	NDK	MX-38T	15pF	15pF



(1) High-frequency



(2) Low-frequency

Note : An electrical shield by metal shield plate on the surface of 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.

ELECTRICAL CHARACTERISTICS

(2) 87PM20

ABSOLUTE MAXIMUM RATINGS (V_{SS} = 0V)

PARAMETER	SYMBOL	CONDITION	RATINGS	UNIT
Supply Voltage	V_{DD}		– 0.3 to 6.5	V
Program Voltage	V_{PP}	TEST/VPP pin	– 0.3 to 13.0	V
Input Voltage	V_{IN}		– 0.3 to V_{DD} + 0.3	V
Output Voltage	V_{OUT1}	Ports P0,P1,P21,P22,P6 and RESET	– 0.3 to V_{DD} + 0.3	V
	V_{OUT2}	Ports P20,P3,P4,P5	– 0.3 to 5.5	
Output Current (Per 1 pin)	I_{OUT1}	Ports P0,P1,P2,P4,P5,P6,P3 (except P30,P31)	3.2	mA
	I_{OUT2}	Only P30 and P31	30	
Output Current (Total)	Σ I_{OUT1}	Ports P0,P1,P2,P4,P5,P6,P3 (except P30,P31)	120	mA
	Σ I_{OUT2}	Only P30, P31	60	
Power Dissipation [Topr = 70°C]	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 30 to 70	°C

RECOMMENDED OPERATING CONDITIONS (V_{SS} = 0V, Topr = – 30 to 70°C)

PARAMETER	SYMBOL	PINS	CONDITIONS		Min.	Max.	UNIT
Supply Voltage	V_{DD}		fc = 8MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			fc = 4.2MHz	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			fs = 32.768kHz	SLOW mode			
				SLEEP mode			
				STOP mode	2.0		
Input High Voltage	V_{IH1}	Except hysteresis input	$V_{DD} \geqq 4.5V$		$V_{DD} \times 0.70$	V_{DD}	V
	V_{IH2}	Hysteresis input			$V_{DD} \times 0.75$		
	V_{IH3}		$V_{DD} < 4.5V$		$V_{DD} \times 0.90$		
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geqq 4.5V$		0	$V_{DD} \times 0.30$	V
	V_{IL2}	Hysteresis input				$V_{DD} \times 0.25$	
	V_{IL3}		$V_{DD} < 4.5V$			$V_{DD} \times 0.10$	
Clock Frequency	fc	XIN, XOUT	V_{DD} = 4.5 to 5.5V		0.4	8.0	MHz
			V_{DD} = 2.7 to 5.5V			4.2	
	fs	XTIN, XTOUT			30.0	34.0	kHz

Note : Clock frequency fc : Supply voltage range is specified in NORMAL 1/2 mode & IDLE 1/2 mode.

D.C.CHARACTERISTICS (V_{SS} = 0V, Topr = – 30 to 70°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}	Open drain port and tri-state port					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Resistance	R_{IN2}	$\overline{RESET}$		100	220	450	kΩ
Output Leakage Current	I_{LO}	Open drain port	V_{DD} = 5.5V, V_{OUT} = 5.5V	–	–	2	μA
		tri-state port	V_{DD} = 5.5V, V_{OUT} = 5.5V/0V	–	–	± 2	
Output High Voltage	Vo_{H2}	Tri- state port	V_{DD} = 4.5V, I_{OH} = – 0.7mA	4.1	–	–	
Output Low Voltage	V_{OL}	Except XOUT and P30, P31	V_{DD} = 4.5V, I_{OL} = 1.6mA	–	–	0.4	V
Output Low Current	I_{OL3}	Only P30, P31	V_{DD} = 4.5V, V_{OL} = 1.0V	–	20	–	mA
Supply Current in NORMAL 1 , 2 mode	I_{DD}		V_{DD} = 5.5V, V_{IN} = 5.3V / 0.2V fc = 8MHz fs = 32.768kHz	–	12	18	mA
Supply Current in IDLE 1, 2 mode				–	4.5	6	mA
Supply Current in NORMAL 1, 2 mode			V_{DD} = 3.0V, V_{IN} = 2.8V / 0.2V fc = 4.19MHz fs = 32.768kHz	–	3.5	4.5	mA
Supply Current in IDLE 1, 2 mode				–	1.5	2.0	mA
Supply Current in SLOW mode			V_{DD} = 3.0V fs = 32.768kHz V_{IN} = 2.8V / 0.2V LCD driver is not enable	–	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
Segment Output Low Resistance	R_{OS1}	SEG31-SEG0	V_{DD} = 5V V_{DD} – V_{LC} = 3V	–	20	–	kΩ
Common Output Low Resistance	R_{OC1}	COM3-COM0					
Segment Output High Resistance	R_{OS2}	SEG31-SEG0		–	200	–	kΩ
Common Output High Resistance	R_{OC2}	COM3-COM0					
Segment /Common Output Voltage	$V_{O\ 2/3}$	SEG31-SEG0 and COM3-COM0 pins		3.8	4.0	4.2	V
	$V_{O\ 1/2}$			3.3	3.5	3.7	
	$V_{O\ 1/3}$			2.8	3.0	3.2	

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

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

Note 3 : Output resustance R_{OS} and R_{OC} indicate "on" when switching levels.

Note 4 : $V_{O2/3}$ indicates an output current at the 2/3 level when operating in the 1/4 or 1/3 duty mode.

Note 5 : $V_{O1/2}$ indicates an output current at the 1/2 level when operating in the 1/2 duty or static mode.

Note 6 : $V_{O1/3}$ indicates an output current at the 1/3 level when operating in the 1/4 or 1/3 duty mode.

Note 7 : When you use a liquid crystal display (LCD), it is necessary to give carefull consideration to the value of the output resisteor $R_{OS\ 1/2}$, $R_{OC\ 1/2}$.

Note 8 : R_{OS1}, R_{OC1} : On time of the lower output resistor is 2^6/fc, 2/fs [s]

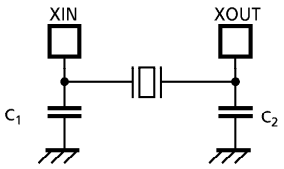
Note 9 : R_{OS2}, R_{OC2} : On time of the higher output resistor is 1/ (n/f_F) (1/n duty, f_F : frame frequency)

A.C. CHARACTERISTICS (V_{SS} = 0V, V_{DD} = 4.5 to 5.5V, Topr = – 30 to 70°C)

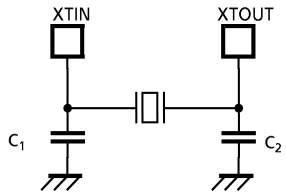
PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t_{cy}	In NORMAL 1, 2 mode	0.5	–	10	μs
		In IDLE 1, 2 mode				
		In SLOW mode	117.6	–	133.3	
		In SLEEP mode				
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XIN input), fc = 8MHz	62.5	–	–	ns
Low Level Clock Pulse Width	t_{WCL}					
High Level Clock Pulse Width	t_{WSH}	For external clock operation (XTIN input), fs = 32.768kHz	14.7	–	–	μs
Low Level Clock Pulse Width	t_{WSL}					
Frequency of TC1 input	t_{TC1}	Frequency Measurement mode	–	–	fc	MHz

RECOMMENDED OSCILLATING CONDITION (V_{SS} = 0V, V_{DD} = 4.5 to 5.5V, Topr = – 30 to 70°C)

PARAMETER	OSCILLATOR	FREQUENCY	RECOMMENDED OSCILLATOR		RECOMMENDED CONDITION	
					C_1	C_2
High-frequency	Ceramic Resonator	8MHz	KYOCERA	KBR8.0M	30pF	30pF
		4MHz	KYOCERA	KBR4.0MS		
			MURATA	CSA4.00MG		
	Crystal Oscillator	8MHz	TOYOCOM	210B 8.0000	20pF	20pF
		4MHz	TOYOCOM	204B 4.0000		
Low-frequency	Crystal Oscillator	32.768kHz	NDK	MX-38T	15pF	15pF



(1) High-frequency



(2) Low-frequency

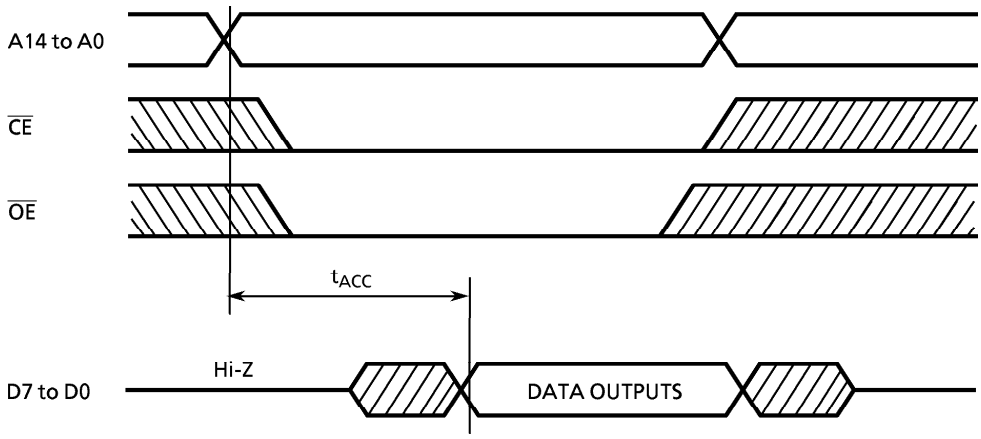
Note : An electrical shield by metal shield plate on the surface of IC package should be recommendable in order to prevent the device from the high electric fieldstress applied from CRT (Cathode Ray Tube) for continuous reliable operation.

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

(1) Read Operation (Topr = – 30 to 70°C)

PARAMETER	SYMBOL	CONDITION	Min.	Typ.	Max.	UNIT
Input High Voltage	V_{IH4}		V_{CC} × 0.7	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	V_{CC} × 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 ± 0.25V	–	1.5tcyc + 300	–	ns

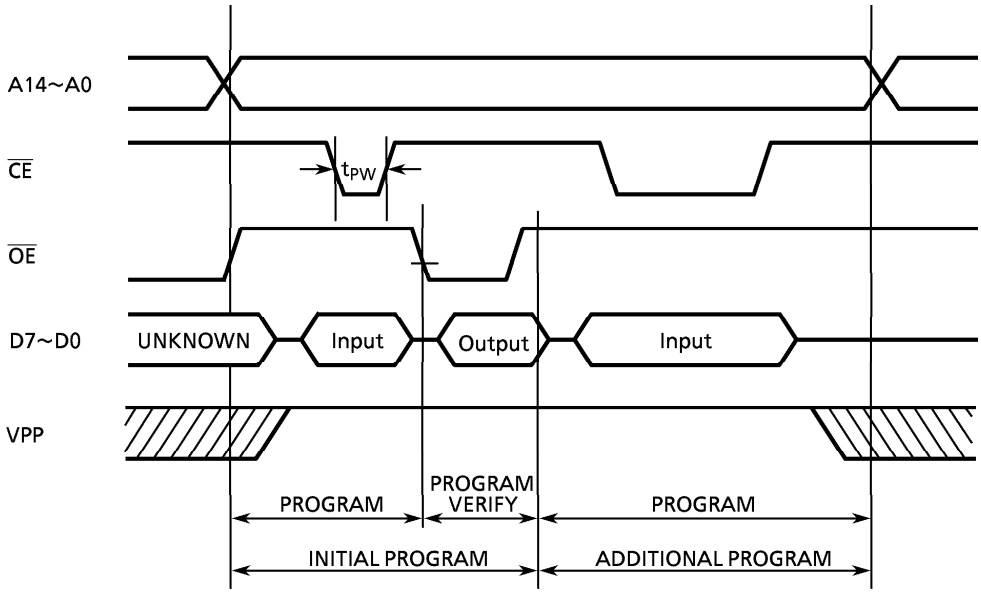
Note: tcyc = 500ns at 8MHz



TIMING WAVEFORMS OF READ OPERATION

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

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



TIMING WAVEFORMS OF PROGRAMMING OPERATION

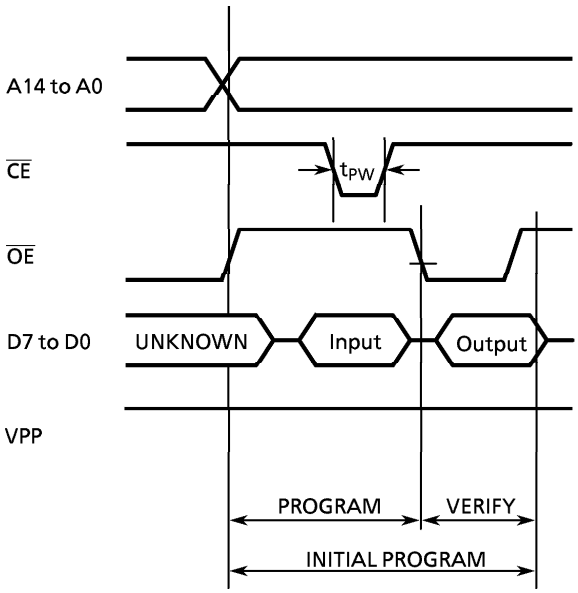
Note 1: When V_{cc} power supply is turned on or after, V_{pp} must be increased.
When V_{cc} power supply is turned off or before, V_{pp} must be decreased.

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

Note 3: 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 write 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 V ± 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 (12.75V ± 0.25V) to the V_{pp} pin as the device is damaged.
Note 3: 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.