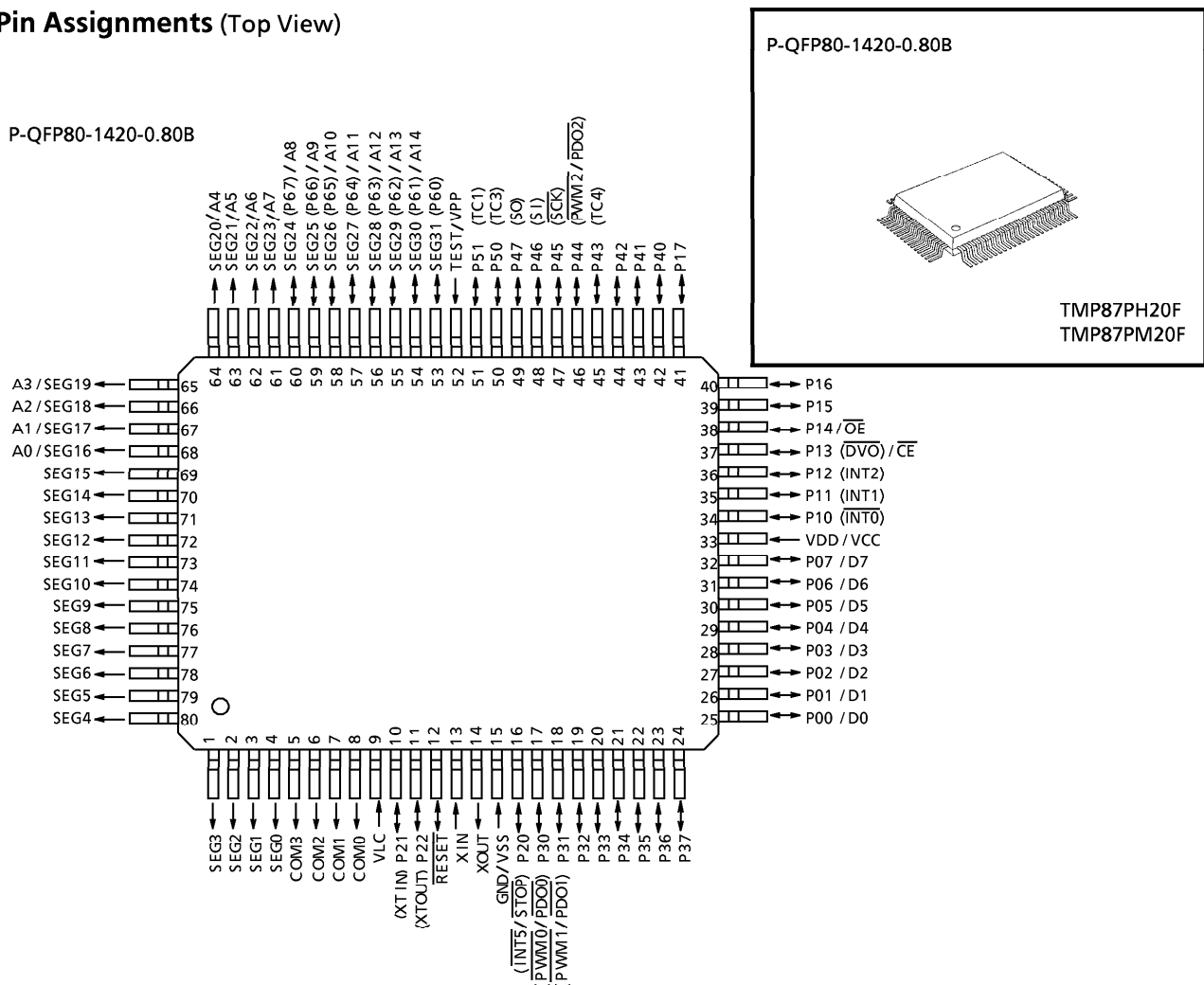


CMOS 8-Bit Microcontroller
TMP87PH20F, TMP87PM20F

The 87PH20 is an One-Time PROM microcontroller with low-power 128K bits (16 Kbytes) electrically programmable read only memory, the 87PM20 is an One-Time PROM microcontroller with low-power 256K bits (32 Kbytes) 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	16 K x 8-bit	512 x 8-bit	P-QFP80-1420-0.80B	BM1138
TMP87PM20F	32 K x 8-bit	1 K x 8-bit		

Pin Assignments (Top View)



980910EBP2

- For a discussion of how the reliability of microcontrollers can be predicted, please refer to Section 1.3 of the chapter entitled Quality and Reliability Assurance/Handling Precautions.
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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	+ 12.5 V / 5 V (Program supply voltage)	TEST
VCC		+ 5 V	VDD
GND		0 V	VSS
P37 to P30	I/O	Pull-up with resistance 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 written to the program memory area as shown in figure 1-1.

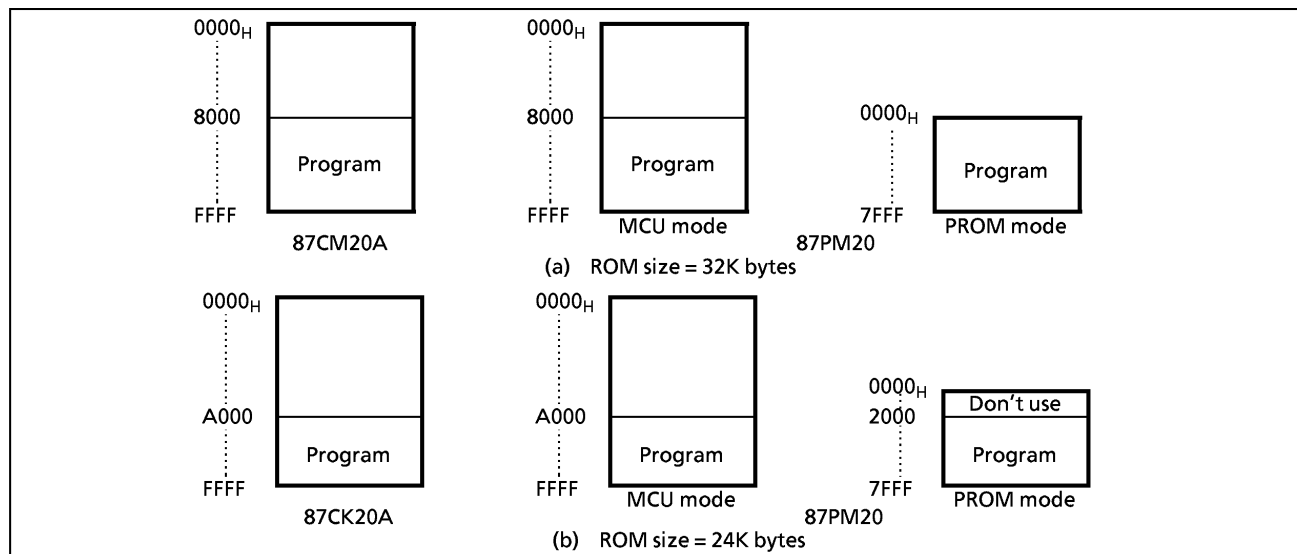


Figure 1-1. Program Memory Area (a), (b)

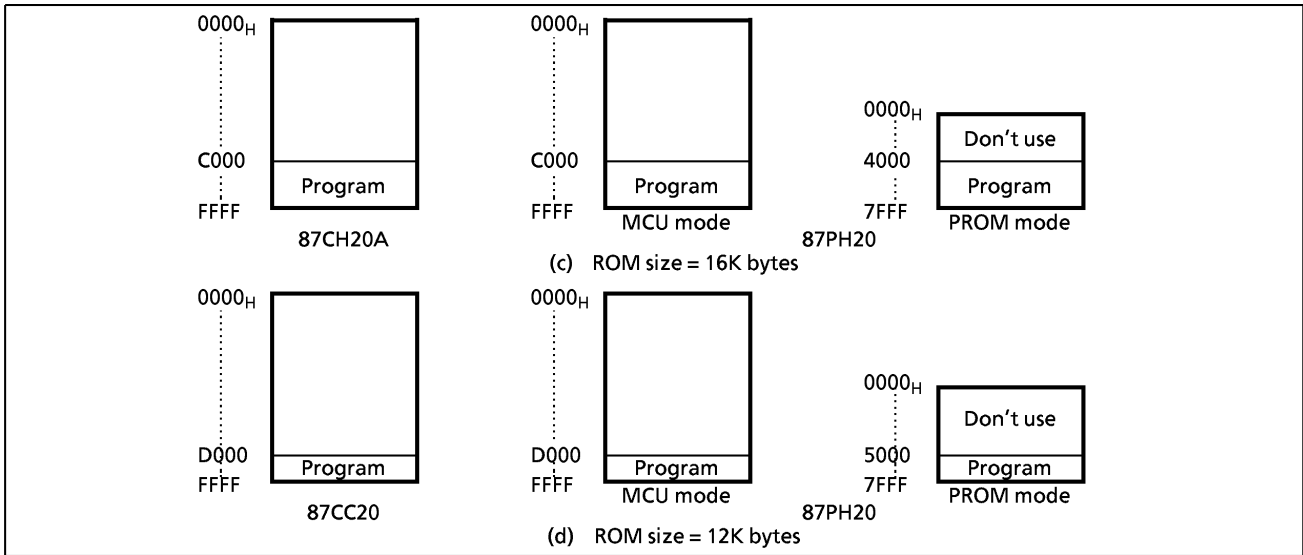


Figure 1-1. Program Memory Area (c), (d)

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.

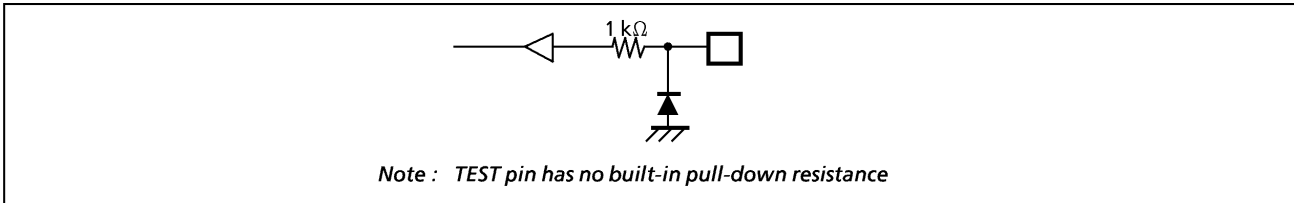


Figure 1-2. TEST pin

(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.

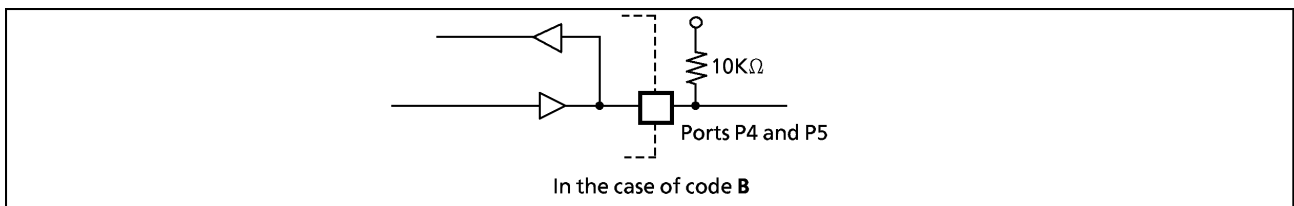


Figure 1-3. I/O Circuitry Code and External Circuitry

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".

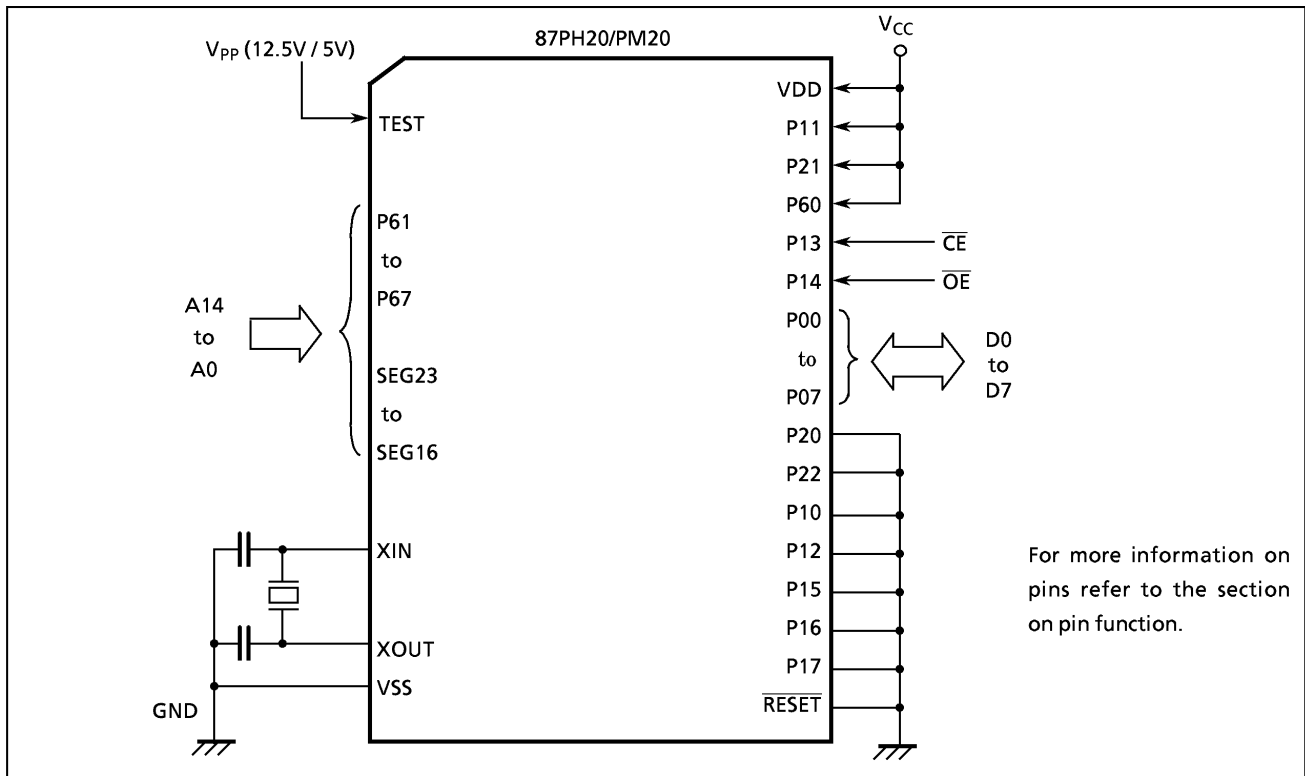


Figure 1-4. Setting for PROM Mode

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 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 \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.

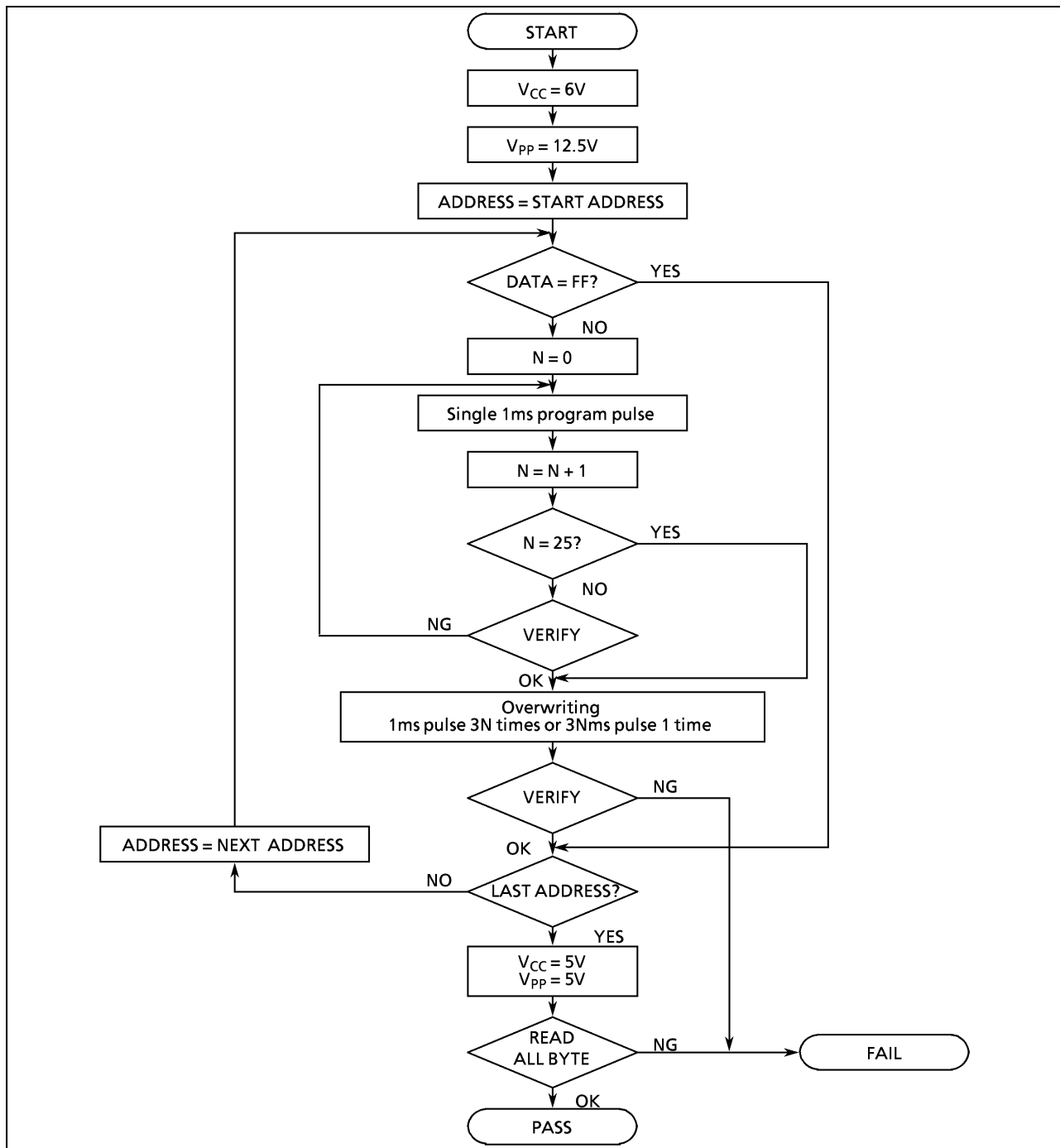


Figure 1-5. Flowchart of High-speed Programming Mode-I

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.

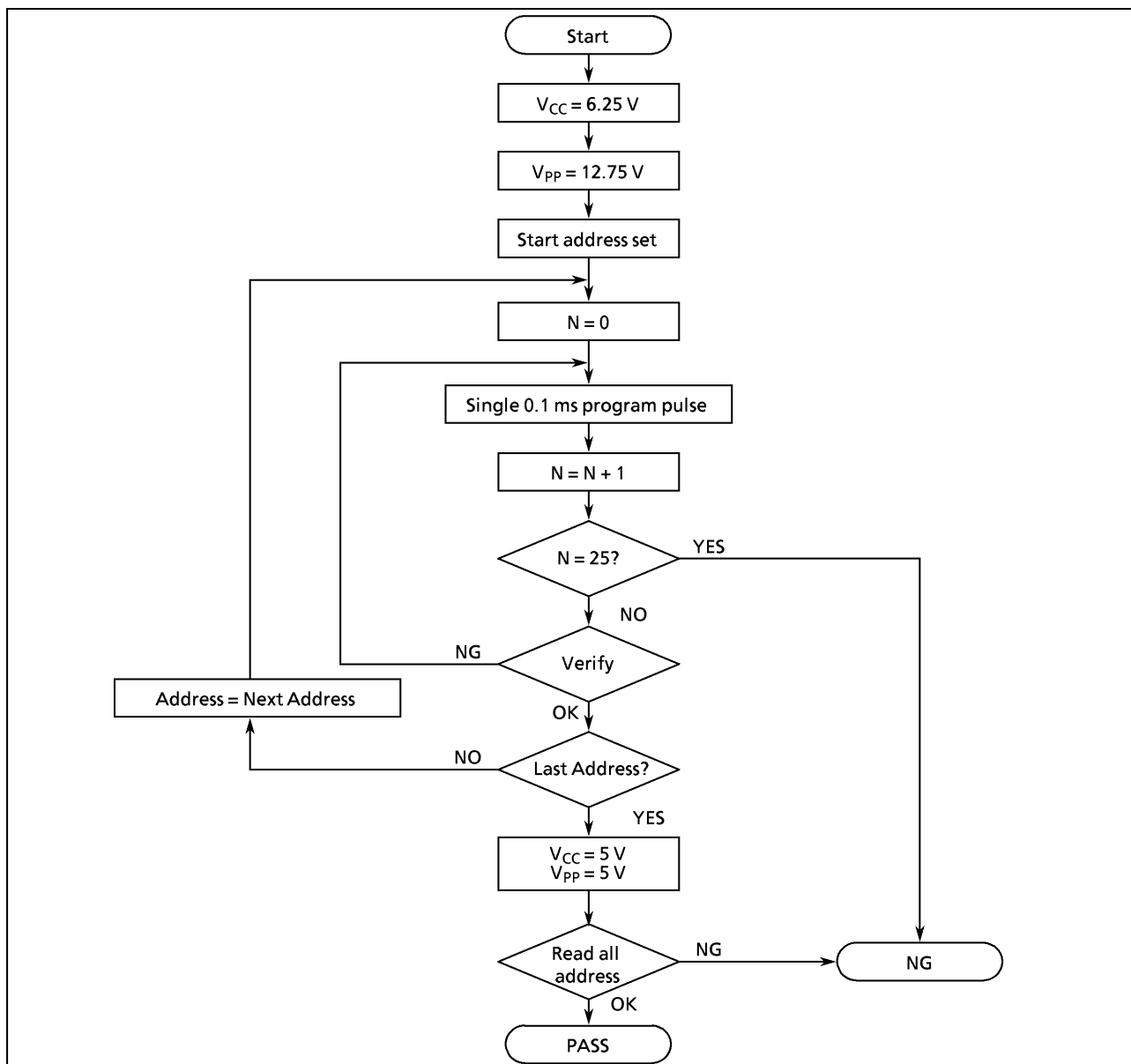


Figure 1-6. Flowchart of High-speed Programming Mode - II

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 programmer 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.

Electrical Characteristics

(1) 87PH20

Absolute Maximum Ratings

 $(V_{SS} = 0\text{ V})$

Parameter	Symbol	Condition	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 $V_{DD} + 0.3$	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 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 [$T_{opr} = 70^{\circ}\text{C}$]	PD		350	mW
Soldering Temperature (time)	T_{sld}		260 (10 s)	$^{\circ}\text{C}$
Storage Temperature	T_{stg}		- 55 to 125	$^{\circ}\text{C}$
Operating Temperature	T_{opr}		- 30 to 70	$^{\circ}\text{C}$

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

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

Parameter	Symbol	Pins	Conditions	Min	Max	Unit	
Supply Voltage	V_{DD}		$f_c = 8\text{ MHz}$	NORMAL 1, 2 mode	4.5	6.0	V
				IDLE1, 2 mode			
			$f_c = 4.2\text{ MHz}$	NORMAL 1, 2 mode	2.7		
				IDLE1, 2 mode			
			$f_s = 32.768\text{ kHz}$	SLOW mode	2.0		
SLEEP mode							
		STOP mode					
Input High Voltage	V_{IH1}	Except hysteresis input	$V_{DD} \geq 4.5\text{ V}$	$V_{DD} \times 0.70$	V_{DD}	V	
	V_{IH2}	Hysteresis input		$V_{DD} \times 0.75$			
	V_{IH3}			$V_{DD} < 4.5\text{ V}$			$V_{DD} \times 0.90$
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geq 4.5\text{ V}$	0	$V_{DD} \times 0.30$	V	
	V_{IL2}	Hysteresis input		$V_{DD} \times 0.25$			
	V_{IL3}			$V_{DD} < 4.5\text{ V}$	$V_{DD} \times 0.10$		
Clock Frequency	f_c	XIN, XOUT	$V_{DD} = 4.5\text{ to }6\text{ V}$	0.4	8.0	MHz	
			$V_{DD} = 2.7\text{ to }6\text{ V}$		4.2		
	f_s	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 f_c : Supply voltage range is specified in NORMAL 1/2 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 input		-	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 port and tri-state port					
	I _{IN3}	RESET, STOP					
Input Resistance	R _{IN2}	RESET		100	220	450	kΩ
Output Leakage Current	I _{LO}	Open drain port and	V _{DD} = 5.5 V, V _{OUT} = 5.5 V	-	-	2	μA
		tri-state port	V _{DD} = 5.5 V, V _{OUT} = 5.5 V / 0 V	-	-	± 2	
Output High Voltage	V _{OH2}	Tri- state port	V _{DD} = 4.5 V, I _{OH} = - 0.7 mA	4.1	-	-	V
Output Low Voltage	V _{OL}	Except XOUT and P30, P31	V _{DD} = 4.5 V, I _{OL} = 1.6 mA	-	-	0.4	V
Output Low Current	I _{OL3}	Only P30, P31	V _{DD} = 4.5 V, V _{OL} = 1.0 V	-	20	-	mA
Supply Current in NORMAL 1, 2 mode	I _{DD}		V _{DD} = 5.5 V, V _{IN} = 5.3 V / 0.2 V f _c = 8 MHz f _s = 32.768 kHz	-	8	14	mA
Supply Current in IDLE 1, 2 mode				-	4	6	mA
Supply Current in NORMAL 1, 2 mode			V _{DD} = 3.0 V, V _{IN} = 2.8 V / 0.2 V f _c = 4.19 MHz f _s = 32.768 kHz	-	2.5	3.5	mA
Supply Current in IDLE 1, 2 mode				-	1.5	2.0	mA
Supply Current in SLOW mode			V _{DD} = 3.0 V f _s = 32.768 kHz	-	30	60	μA
Supply Current in SLEEP mode			V _{IN} = 2.8 V / 0.2 V LCD driver is not enable	-	15	30	μA
Supply Current in STOP mode			V _{DD} = 5.5 V V _{IN} = 5.3 V / 0.2 V	-	0.5	10	μA
Segment Output Low Resistance	R _{OS1}	SEG31 to SEG0	V _{DD} = 5 V V _{DD} - V _{LC} = 3 V	-	20	-	kΩ
Common Output Low Resistance	R _{OC1}	COM3 to COM0		-	200	-	kΩ
Segment Output High Resistance	R _{OS2}	SEG31 to SEG0		-	200	-	kΩ
Common Output High Resistance	R _{OC2}	COM3 to COM0		-	200	-	kΩ
Segment /Common Output Voltage	V _{O 2/3}	SEG31 to SEG0 and COM3 to 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} = 5 V.

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 resistor R_{OS1/2}, R_{OC1/2}.

Note 8: R_{OS1}, R_{OC1}: On time of the lower output resistor is 2⁶/f_c, 2/f_s [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

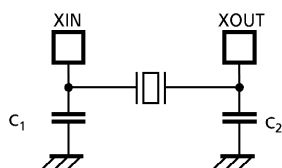
($V_{SS} = 0\text{ V}$, $V_{DD} = 4.5\text{ to }6.0\text{ V}$, $T_{opr} = -30\text{ to }70^\circ\text{C}$)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t_{cy}	In NORMAL1, 2 modes	0.5	-	10	μs
		In IDLE 1, 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	-	-	μs
Low Level Clock Pulse Width	t_{WSL}					
Frequency of TC1 input	t_{TC1}	Frequency Measurement mode	-	-	f_c	MHz

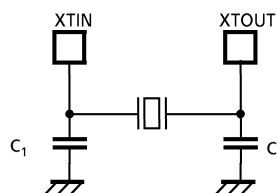
Recommended Oscillating Condition

($V_{SS} = 0\text{ V}$, $V_{DD} = 4.5\text{ to }6.0\text{ V}$, $T_{opr} = -30\text{ to }70^\circ\text{C}$)

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

 $(V_{SS} = 0\text{ V})$

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)	ΣI_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P3 (except P30, P31)	120	mA
	ΣI_{OUT2}	Only P30, P31	60	
Power Dissipation [$T_{opr} = 70^{\circ}\text{C}$]	PD		350	mW
Soldering Temperature (time)	T_{sld}		260 (10 s)	$^{\circ}\text{C}$
Storage Temperature	T_{stg}		- 55 to 125	$^{\circ}\text{C}$
Operating Temperature	T_{opr}		- 30 to 70	$^{\circ}\text{C}$

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

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

Parameter	Symbol	Pins	Conditions	Min	Max	Unit	
Supply Voltage	V_{DD}		$f_c = 8\text{ MHz}$	NORMAL 1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			$f_c = 4.2\text{ MHz}$	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
$f_s = 32.768\text{ kHz}$	SLOW mode	2.0					
	SLEEP mode						
Input High Voltage	V_{IH1}	Except hysteresis input	$V_{DD} \geq 4.5\text{ V}$	$V_{DD} \times 0.70$	V_{DD}	V	
	V_{IH2}	Hysteresis input		$V_{DD} \times 0.75$			
	V_{IH3}			$V_{DD} < 4.5\text{ V}$			$V_{DD} \times 0.90$
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geq 4.5\text{ V}$	0	$V_{DD} \times 0.30$	V	
	V_{IL2}	Hysteresis input		$V_{DD} \times 0.25$			
	V_{IL3}			$V_{DD} < 4.5\text{ V}$	$V_{DD} \times 0.10$		
Clock Frequency	f_c	XIN, XOUT	$V_{DD} = 4.5\text{ to }5.5\text{ V}$	0.4	8.0	MHz	
			$V_{DD} = 2.7\text{ to }5.5\text{ V}$		4.2		
	f_s	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 f_c : Supply voltage range is specified in NORMAL 1/2 mode & IDLE 1/2 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 input		-	0.9	-	V
Input Current	I_{IN1}	TEST	$V_{DD} = 5.5\text{ V}$ $V_{IN} = 5.5\text{ V} / 0\text{ V}$	-	-	± 2	μA
	I_{IN2}	Open drain port and tri-state port					
	I_{IN3}	RESET, STOP					
Input Resistance	R_{IN2}	RESET		100	220	450	$\text{k}\Omega$
Output Leakage Current	I_{LO}	Open drain port	$V_{DD} = 5.5\text{ V}, V_{OUT} = 5.5\text{ V}$	-	-	2	μA
		tri-state port	$V_{DD} = 5.5\text{ V}, V_{OUT} = 5.5\text{ V} / 0\text{ V}$	-	-	± 2	
Output High Voltage	V_{OH2}	Tri- state port	$V_{DD} = 4.5\text{ V}, I_{OH} = -0.7\text{ mA}$	4.1	-	-	V
Output Low Voltage	V_{OL}	Except XOUT and P30, P31	$V_{DD} = 4.5\text{ V}, I_{OL} = 1.6\text{ mA}$	-	-	0.4	V
Output Low Current	I_{OL3}	Only P30, P31	$V_{DD} = 4.5\text{ V}, V_{OL} = 1.0\text{ V}$	-	20	-	mA
Supply Current in NORMAL 1, 2 mode	I_{DD}		$V_{DD} = 5.5\text{ V}, V_{IN} = 5.3\text{ V} / 0.2\text{ V}$ $f_c = 8\text{ MHz}$ $f_s = 32.768\text{ kHz}$	-	12	18	mA
Supply Current in IDLE 1, 2 mode				-	4.5	6	mA
Supply Current in NORMAL 1, 2 mode			$V_{DD} = 3.0\text{ V}, V_{IN} = 2.8\text{ V} / 0.2\text{ V}$ $f_c = 4.19\text{ MHz}$ $f_s = 32.768\text{ kHz}$	-	3.5	4.5	mA
Supply Current in IDLE 1, 2 mode				-	1.5	2.0	mA
Supply Current in SLOW mode			$V_{DD} = 3.0\text{ V}$ $f_s = 32.768\text{ kHz}$	-	30	60	μA
Supply Current in SLEEP mode			$V_{IN} = 2.8\text{ V} / 0.2\text{ V}$ LCD driver is not enable	-	15	30	μA
Supply Current in STOP mode			$V_{DD} = 5.5\text{ V}$ $V_{IN} = 5.3\text{ V} / 0.2\text{ V}$	-	0.5	10	μA
Segment Output Low Resistance	R_{OS1}	SEG31 to SEG0	$V_{DD} = 5\text{ V}$ $V_{DD} - V_{LC} = 3\text{ V}$	-	20	-	$\text{k}\Omega$
Common Output Low Resistance	R_{OC1}	COM3 to COM0					
Segment Output High Resistance	R_{OS2}	SEG31 to SEG0		-	200	-	$\text{k}\Omega$
Common Output High Resistance	R_{OC2}	COM3 to COM0					
Segment/Common Output Voltage	$V_{O2/3}$	SEG31 to SEG0 and COM3 to COM0 pins		3.8	4.0	4.2	V
	$V_{O1/2}$			3.3	3.5	3.7	
	$V_{O1/3}$			2.8	3.0	3.2	

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

Note 2: Input Current ; 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 resistor $R_{OS1/2}$, $R_{OC1/2}$.

Note 8: R_{OS1} , R_{OC1} : On time of the lower output resistor is $26/f_c$, $2/f_s$ [s]

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

A.C. Characteristics

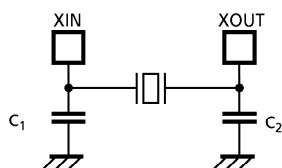
($V_{SS} = 0\text{ V}$, $V_{DD} = 4.5\text{ to }5.5\text{ V}$, $T_{opr} = -30\text{ to }70^\circ\text{C}$)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t_{cy}	In NORMAL1, 2 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), $f_c = 8\text{ MHz}$	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	-	-	μs
Low Level Clock Pulse Width	t_{WSL}					
Frequency of TC1 input	t_{TC1}	Frequency Measurement mode	-	-	fc	MHz

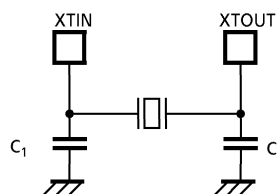
Recommended Oscillating Condition

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

Parameter	Oscillator	Frequency	Recommended Oscillator		Recommended Condition		
					C ₁	C ₂	
High-frequency	Ceramic Resonator	8 MHz	KYOCERA	KBR8.0M	30pF	30pF	
		4 MHz	KYOCERA	KBR4.0MS			
				MURATA	CSA4.00MG		
	Crystal Oscillator	8 MHz	TOYOCOM	210B 8.0000	20pF	20pF	
4 MHz		TOYOCOM	204B 4.0000				
Low-frequency	Crystal Oscillator	32.768 kHz	NDK	MX-38T	15pF	15pF	



(1) High-frequency



(2) Low-frequency

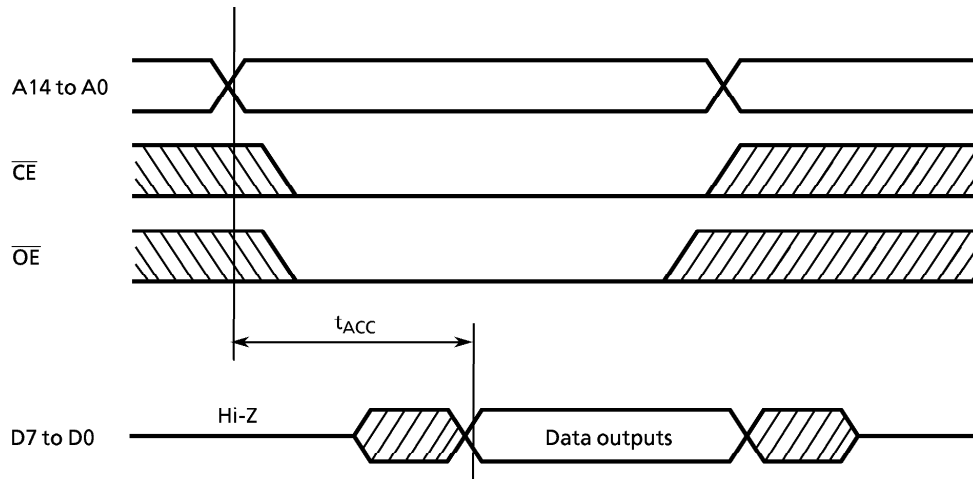
Note: An electrical shield by metal shield plate on the surface of IC package should be recommendable in order to prevent the device from the high electric fieldstress applied from CRT (Cathode Ray Tube) for continuous reliable operation.

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

(1) Read Operation ($T_{opr} = -30\text{ to }70^{\circ}\text{C}$)

Parameter	Symbol	Condition	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}	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5\text{ }t_{cyc} + 300$	–	ns

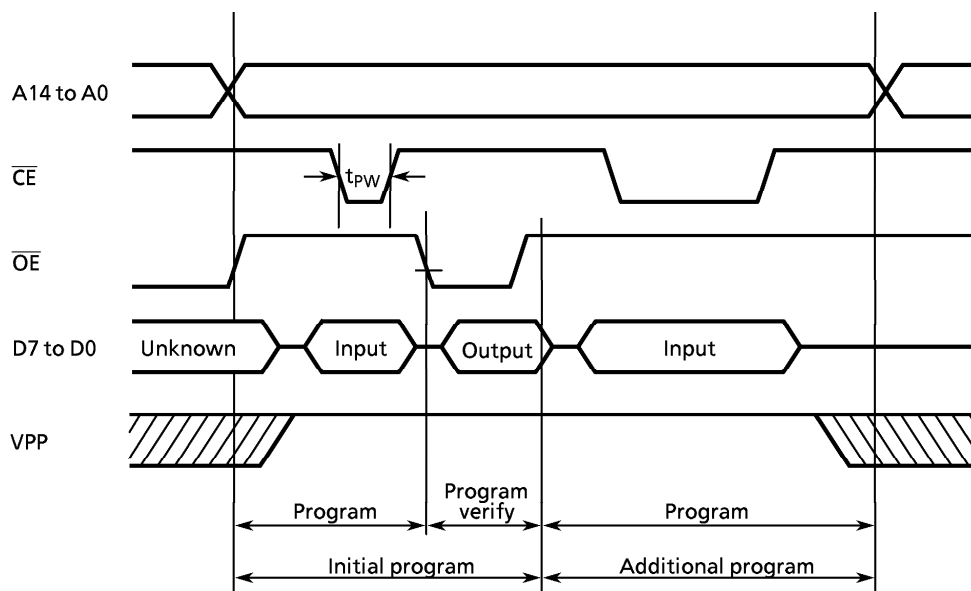
Note: $t_{cyc} = 500\text{ ns}$ at 8 MHz



Timing Waveforms of Read Operation

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

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



Timing Waveforms of Programming Operation

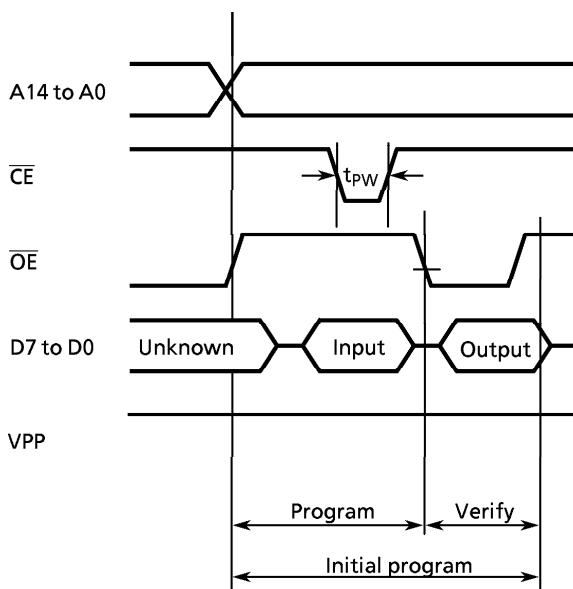
*Note 1: When V_{CC} power supply is turned on or after, V_{pp} must be increased.
When V_{CC} power supply is turned off or before, V_{pp} must be decreased.*

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) Program Operation (High speed write mode - II) ($T_{opr} = 25 \pm 5^{\circ}\text{C}$)

Parameter	Symbol	Condition	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}	$V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$, $V_{PP} = 12.75 \text{ V} \pm 0.25 \text{ V}$	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 ($12.75 \text{ V} \pm 0.25 \text{ V}$) 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.

