

CMOS 8-Bit Microcontroller

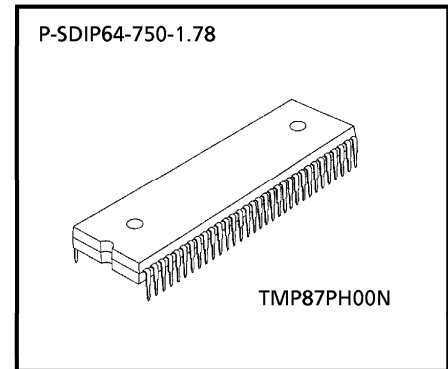
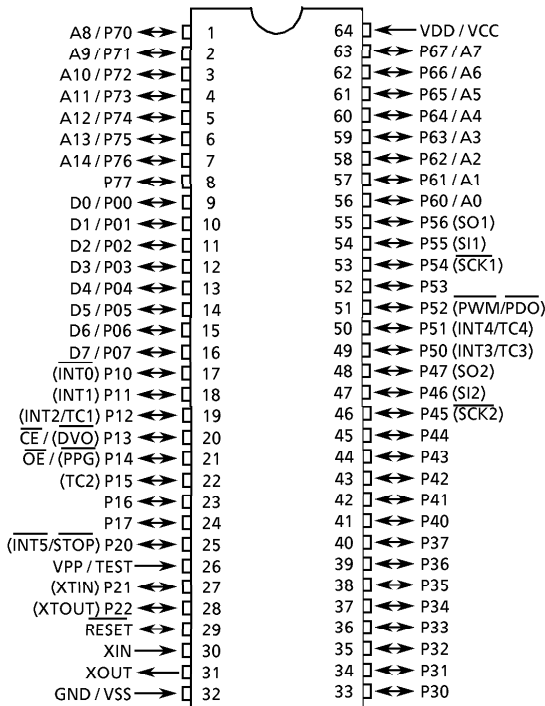
TMP87PH00N
TMP87PH00F
TMP87PH00DF
TMP87PH00LF

The 87PH00 is a One-Time PROM microcontroller with low-power 128 K bits (16 Kbytes) electrically programmable read only memory for the 87C800/CH00 system evaluation. The 87PH00 is pin compatible with the 87C800/CH00. The operations possible with the 87C800/CH00 can be performed by writing programs to PROM. The 87PH00 can write and verify in the same way as the TMM27256AD using an adaptor socket BM1136/BM1137/BM1173 and an EPROM programmer.

Part No.	OTP	RAM	Package	Adapter Socket
TMP87PH00N	16 K × 8-bit	256 × 8-bit	P-SDIP64-750-1.78	BM1136
TMP87PH00F			P-QFP64-1420-1.00A	BM1137
TMP87PH00DF			P-QFP64-1414-0.80A	BM1173
TMP87PH00LF				

Pin Assignments (Top View)

P-SDIP64-750-1.78

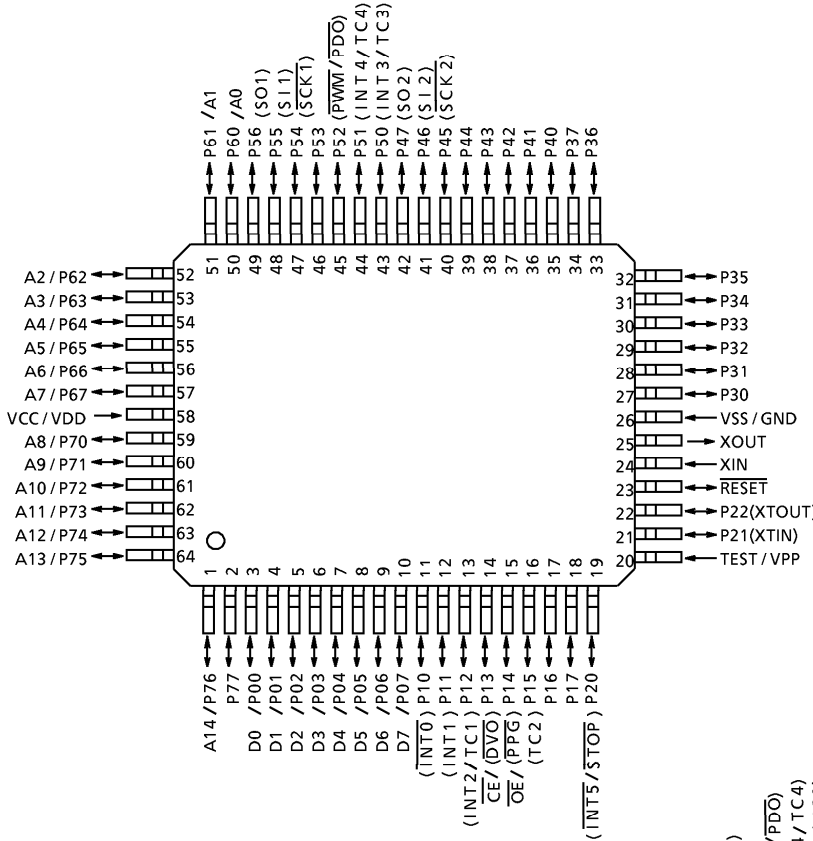


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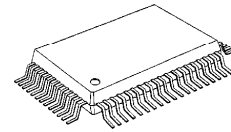
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Pin Assignments (Top View)

P-QFP64-1420-1.00A

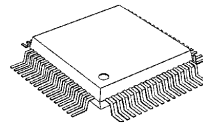


P-QFP64-1420-1.00A



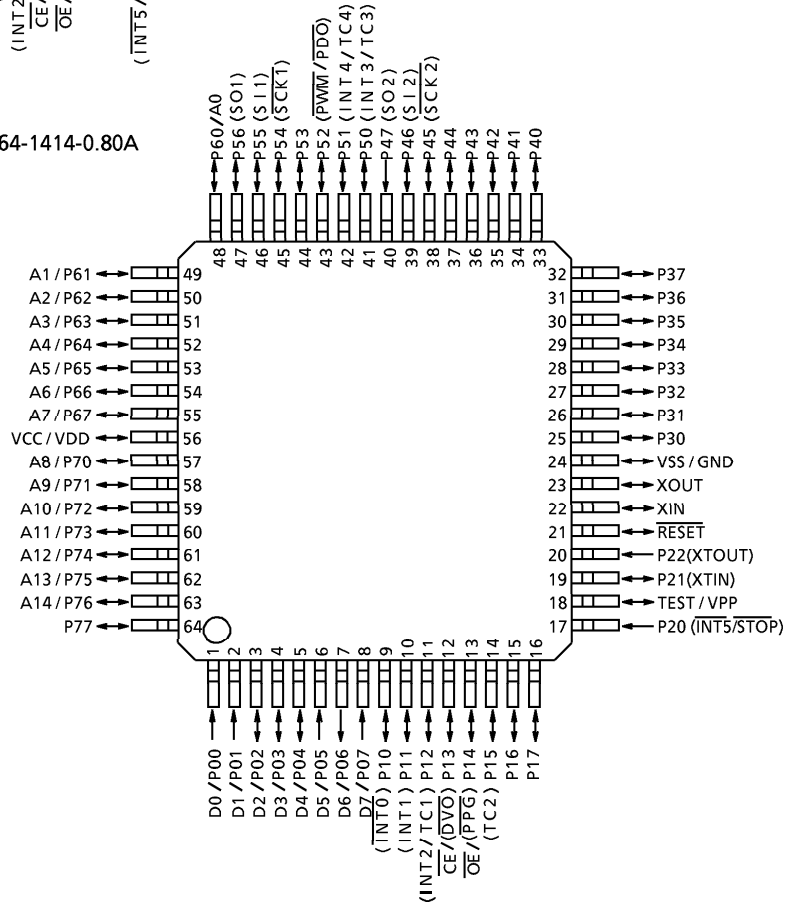
TMP87PH00F

P-QFP64-1414-0.80A



TMP87PH00DF
TMP87PH00LF

P-QFP64-1414-0.80A



Pin Function

The 87PH00 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PH00 is pin compatible with the 87C800/CH00 (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A14 to A8	Input	PROM address inputs	P76 to P70
A7 to A0			P67 to P60
D7 to D0	I/O	PROM data input/outputs	P07 to P00
\overline{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			
P56 to P50			
P11		PROM mode setting pin. Be fixed at high level.	
P21			
P77			
P17 to P15		PROM mode setting pin. Be fixed at low level.	
P12, P10			
P22, P20			
\overline{RESET}			
XIN	Input	Connect an 8MHz oscillator to stabilize the internal state.	
XOUT	Output		

Operational Description

The following explains the 87PH00 hardware configuration and operation. The configuration and functions of the 87PH00 are the same as those of the 87C800/CH00, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PH00 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 87PH00 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 87C800/CH00 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PH00 has a 16 K × 8-bit (addresses C000_H to FFFF_H in the MCU mode, addresses 4000_H to 7FFF_H in the PROM mode) of program memory (OTP).

To use the 87PH00/PH00L as the system evaluation for the 87C800/CH00/CH00L, the program should be written to the program memory area as shown in Figure 1-1.

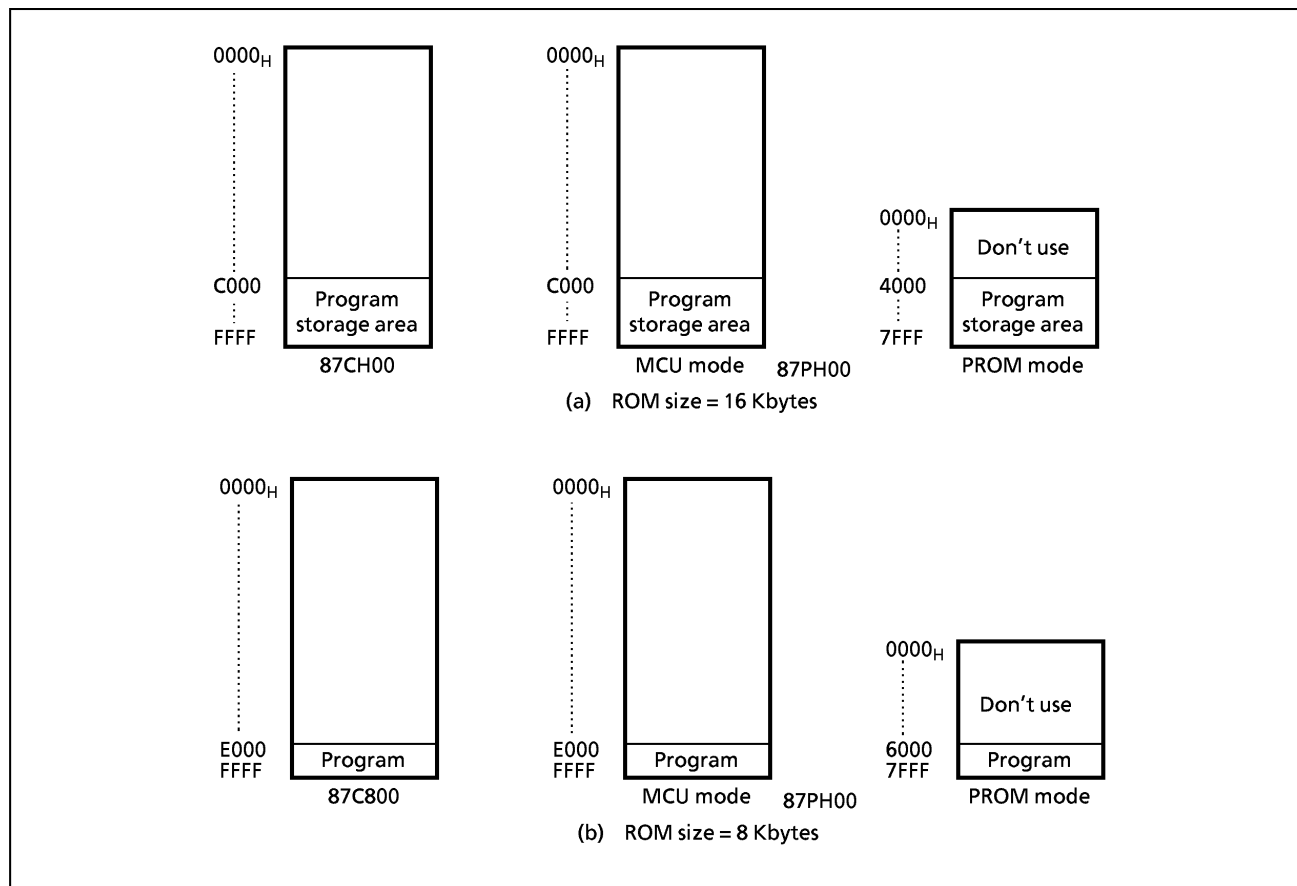


Figure 1-1. Program Memory Area

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

1.1.2 Data Memory

The 87PH00 has an on-chip 256 × 8-bit data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 87PH00 are the same as those of the 87C800/CH00 except that the TEST pin has no built-in pull-down resistance.

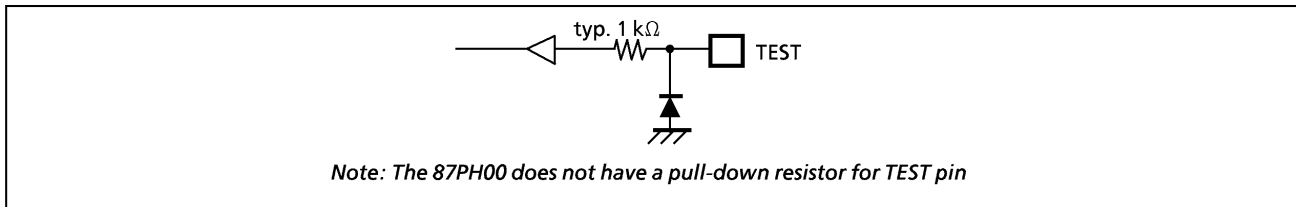


Figure 1-2. TEST Pin

(2) I/O ports

The I/O circuitries of 87PH00 I/O ports are the same as the code A type I/O circuitries of the 87C800/CH00.

When using as an evaluator of other I/O codes (C, D, G), external pull-up resistors are required.

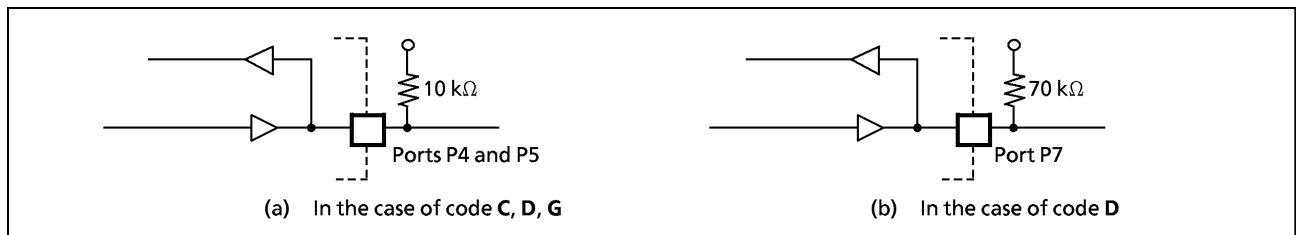


Figure 1-3. I/O Circuitry Code and External Circuitry

1.2 PROM Mode

The PROM mode is activated by setting the TEST, $\overline{\text{RESET}}$ pin and the ports P17 to P10, P22 to P20 and P77 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. The 87PH00 is not supported an *electric signature* mode, so the ROM type must be set to TC57256 AD. Set the adaptor socket switch to "P".

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

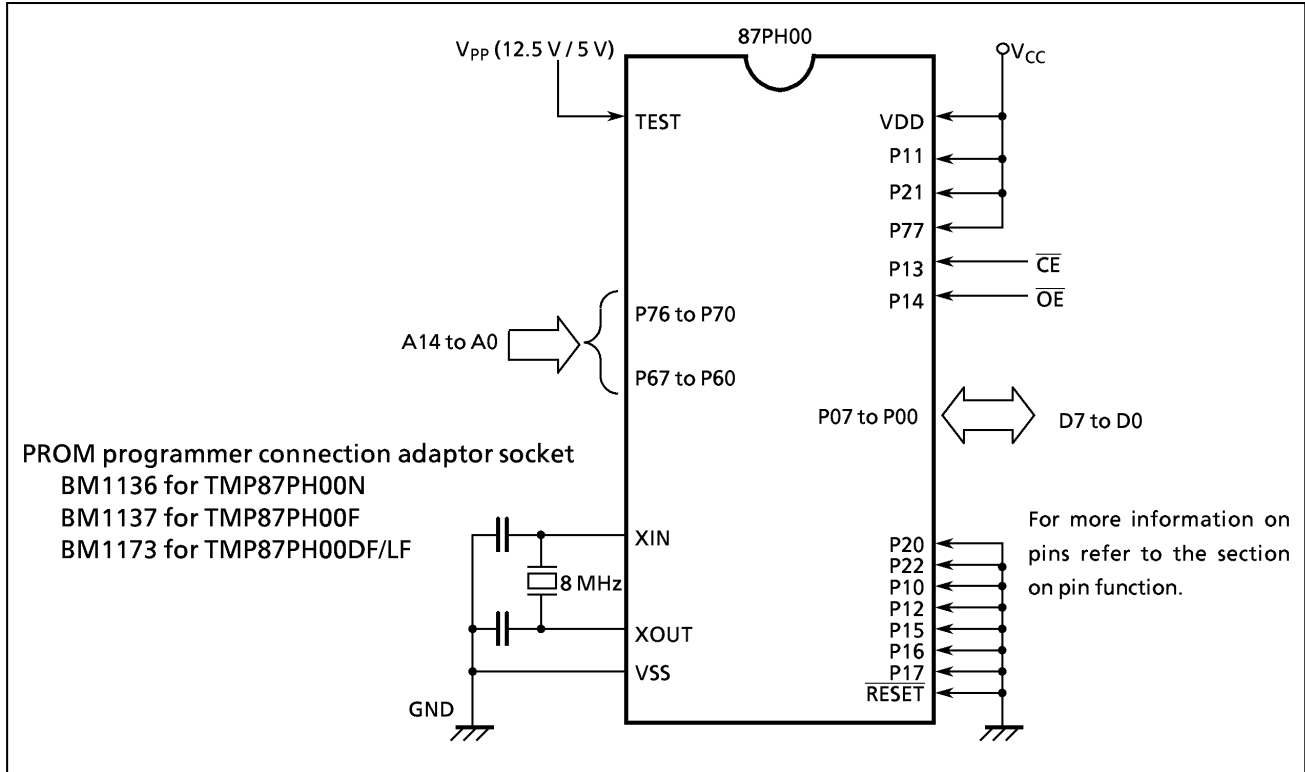


Figure 1-4. Setting for PROM Mode

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 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.

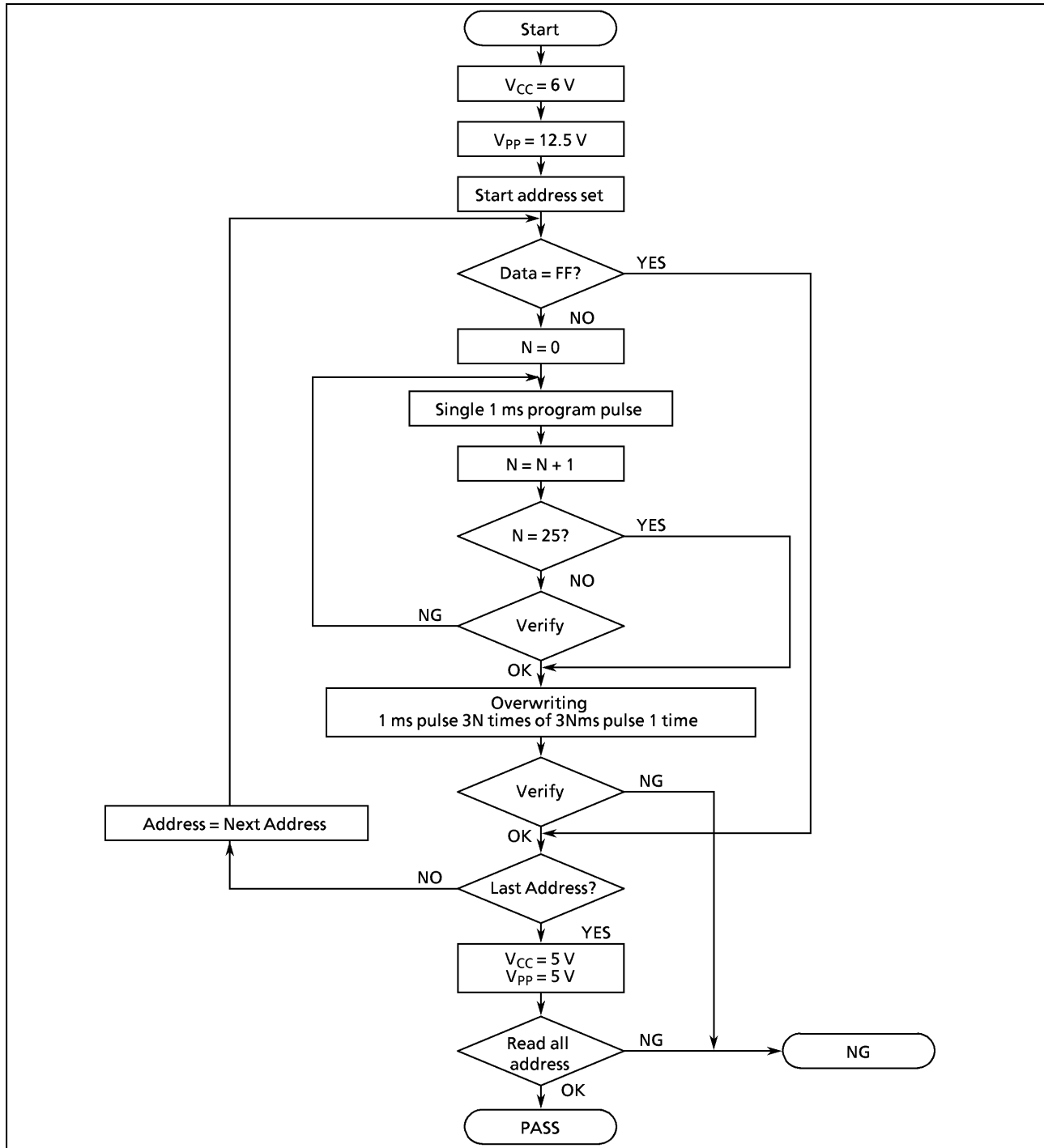


Figure 1-5. Flowchart of High-speed Programming Mode - I

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.

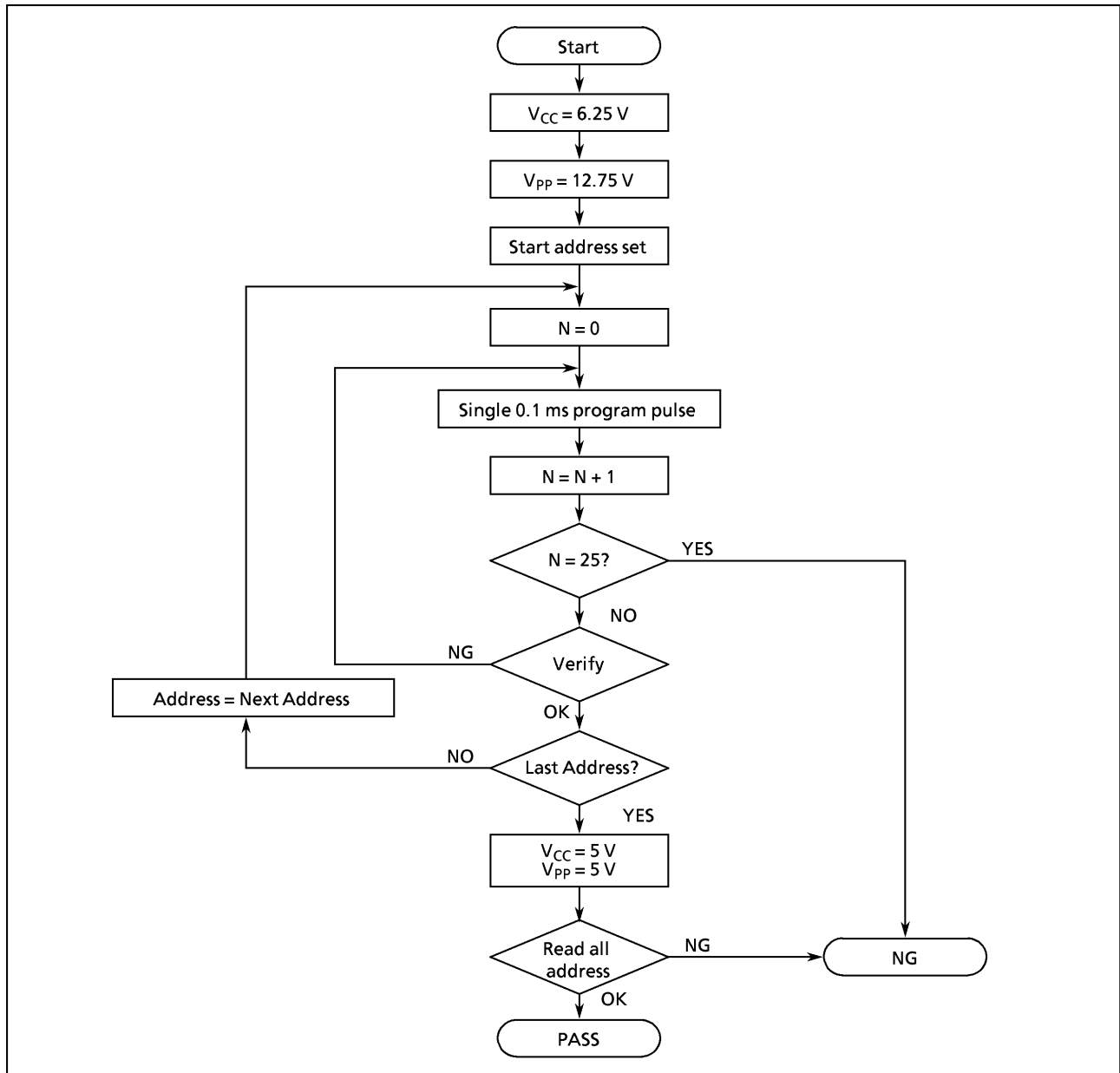


Figure 1-6. Flowchart of High-speed Programming Mode - II

1.2.3 Writing method for general-purpose PROM program

(1) Adapters

BM1136: TMP87PH00N

BM1137: TMP87PH00F

BM1173: TMP87PH00DF, 87PH00LF

(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 TMP87PH00, EPROM is within the addresses 4000 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 16KB: transferred addresses C000 to FFFFH to addresses 4000 to 7FFFH

iii) Writing address is specified. (Caution 1)

Start address: 4000H

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 addresses 0000 to 3FFFH must be specified to FFH.

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: TMP87PH00 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 \pm 0.5 V to the address pin 9 (A9). The signature must not be used.

Electrical Characteristics

Absolute Maximum Ratings

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

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V_{DD}		- 0.3 to 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}	P0, P1, P2, P6, P7, XOUT, $\overline{\text{RESET}}$	- 0.3 to $V_{DD} + 0.3$	V
	V_{OUT2}	P3, P4, P5	- 0.3 to 10	
Output Current (Per 1 pin)	I_{OUT1}	P0, P1, P2, P4, P5, P6, P7	3.2	mA
	I_{OUT2}	P3	30	
Output Current (Total)	ΣI_{OUT1}	P0, P1, P2, P4, P5, P6, P7	120	mA
	ΣI_{OUT2}	P3	120	
Power Dissipation [$T_{opr} = 70^\circ\text{C}$]	PD	TMP87PH00N	600	mW
		TMP87PH00F / PH00DF	350	
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}		$f_c = 8 \text{ MHz}$	NORMAL1, 2 mode	4.5	6.0	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	$V_{DD} = 4.5 \text{ to } 6 \text{ V}$	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 mode and IDLE 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	V _{DD} = 5.0 V	-	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}	RESET, STOP					
Input Resistance	R _{IN2}	RESET	V _{DD} = 5.0 V	100	220	450	kΩ
Output Leakage Current	I _{LO1}	Sink open drain ports	V _{DD} = 5.5 V, V _{OUT} = 5.5 V	-	-	2	μA
	I _{LO2}	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} = -0.7mA	4.1	-	-	V
Output Low Voltage	V _{OL}	Except XOUT and P3	V _{DD} = 4.5 V, I _{OL} = 1.6 mA	-	-	0.4	
Output Low Current	I _{OL3}	Port P3	V _{DD} = 4.5 V, V _{OL} = 1.0 V	-	20	-	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	-	8.5	12	mA
Supply Current in IDLE 1, 2 modes				-	3.5	5	mA
Supply Current in NORMAL 1, 2 modes			V _{DD} = 3.0 V, V _{IN} = 2.8 V / 0.2 V fc = 4.19 kHz fs = 32.768 kHz	-	2.5	3.5	mA
Supply Current in IDLE 1, 2 modes				-	1.5	2.0	mA
Supply Current in SLOW mode			V _{DD} = 3.0 V fs = 32.768 kHz	-	30	60	μA
Supply Current in SLEEP mode			V _{IN} = 2.8 V / 0.2 V	-	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

Note 1: Typical value show those at Topr = 25°C.

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.

A.C. Characteristics

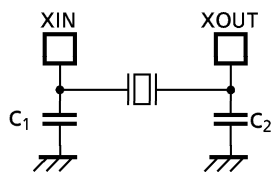
(V_{SS} = 0 V, V_{DD} = 4.5 to 6.0 V, Topr = - 30 to 70°C)

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), f _c = 8 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 kHz	14.7	-	-	μs
Low Level Clock Pulse Width	t _{WSL}					

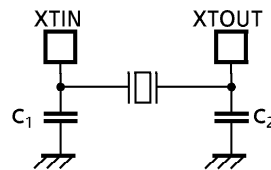
Recommended Oscillating Conditions

(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		
	Crystal Oscillator	8 MHz	MURATA	CSA4.00MG	20 pF	20 pF
		4 MHz	TOYOCOM	210B 8.0000		
Low-frequency Oscillation	Crystal Oscillator	32.768 kHz	TOYOCOM	204B 4.0000	15 pF	15 pF
			NDK	MX-38T		



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

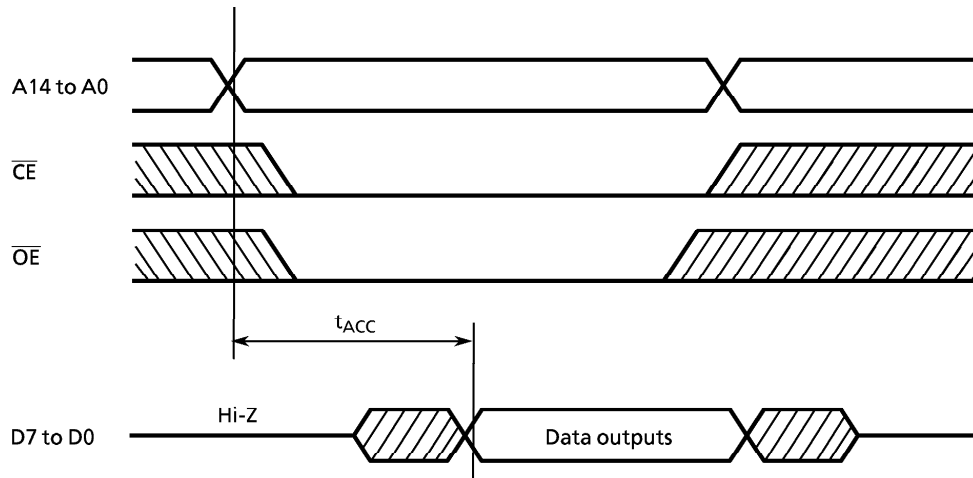
Note: When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

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	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	5.00	5.25	V
Program Power Supply Voltage	V_{PP}		$V_{CC} - 0.6$	V_{CC}	$V_{CC} + 0.6$	
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5\ t_{cyc} + 300$	–	ns

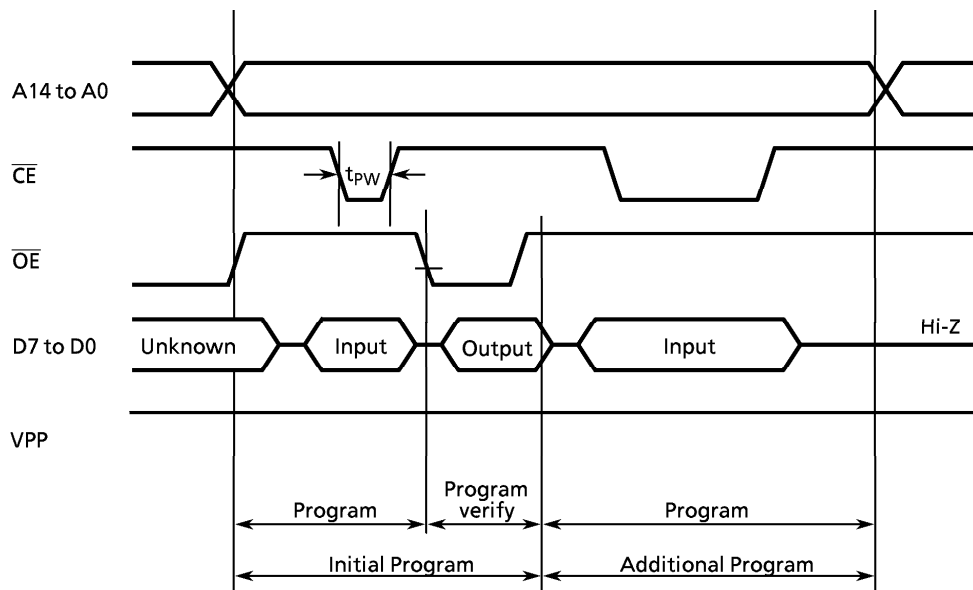
Note: $t_{cyc} = 500\text{ ns at }8\text{ MHz}$



Timing Waveforms of Read Operation

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

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	-	V_{CC}	V
Input Low Voltage	V_{IL4}		0	-	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		5.75	6.0	6.25	V
Program Power Supply Voltage	V_{PP}		12.0	12.5	13.0	V
Initial Program Pulse Width	t_{PW}	$V_{CC} = 6.0\text{ V} \pm 0.25\text{ V}$ $V_{PP} = 12.5 \pm 0.5\text{ V}$	0.95	1.0	1.05	ms

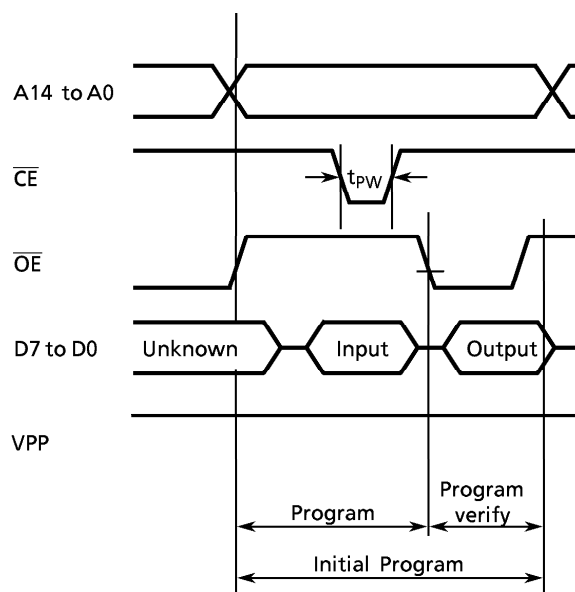


Timing Waveforms of Programming Operation

- 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) ($T_{opr} = 25 \pm 5 \text{ }^\circ\text{C}$)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	V
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.

Electrical Characteristics

Absolute Maximum Ratings

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

Parameter	Symbol	Conditions	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_{OUT}		- 0.3 to $V_{DD} + 0.3$	V
Output Current (Per 1 pin)	I_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7	3.2	mA
	I_{OUT2}	Port P3	30	
Output Current (Total)	ΣI_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7	120	mA
	ΣI_{OUT2}	Port P3	120	
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}		$f_c = 8\text{ MHz}$	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			$f_c = 4.2\text{ MHz}$	NORMAL1, 2 mode	1.8		
				IDLE1, 2 mode			
			$f_s = 32.768\text{ kHz}$	SLOW mode			
SLEEP mode							
	STOP mode						
Input High Voltage	V_{IH1}	Except Hysteresis inputs	$V_{DD} \geq 4.5\text{ V}$	$V_{DD} \times 0.7$	V_{DD}	V	
	V_{IH2}	Hysteresis inputs		$V_{DD} \times 0.75$			
	V_{IH3}			$V_{DD} < 4.5\text{ V}$			$V_{DD} \times 0.90$
Input Low Voltage	V_{IL1}	Except Hysteresis inputs	$V_{DD} \geq 4.5\text{ V}$	0	$V_{DD} \times 0.28$	V	
	V_{IL2}	Hysteresis inputs		$V_{DD} \times 0.25$			
	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	
			$V_{DD} = 1.8\text{ to }4.5\text{ V}$		4.2		
	f_s	XTIN, XOUT		30.0	34.0	kHz	

Note: 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.

D.C. Characteristics

(V_{SS} = 0 V, T_{opr} = - 30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Hysteresis Voltage	V _{HS}	Hysteresis inputs	V _{DD} = 5.0 V	-	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 and tri-state ports					
	I _{IN3}	RESET, STOP					
Input Low Current	I _{IL}	Push-pull ports	V _{DD} = 5.5 V, V _{IN} = 0.4 V	-	-	- 2	mA
Input Resistance	R _{IN1}	Port P7 with pull-up	V _{DD} = 5.0 V	30	70	150	kΩ
	R _{IN2}	RESET	V _{DD} = 5.0 V	100	220	450	
Output Leakage Current	I _{LO1}	Open drain ports	V _{DD} = 5.5 V, V _{OUT} = 5.5 V	-	-	2	μA
	I _{LO2}	Tri-state ports	V _{DD} = 5.5 V, V _{OUT} = 5.5 V / 0 V	-	-	± 2	
Output High Voltage	V _{OH1}	Push-pull ports	V _{DD} = 4.5 V, I _{OH} = - 200 μA	2.4	-	-	V
	V _{OH2}	Tri-state ports	V _{DD} = 4.5 V, I _{OH} = - 0.7 mA	4.1	-	-	
	V _{OH3}	Push-pull ports	V _{DD} = 1.8 V, I _{OH} = - 5 μA	1.6	-	-	
Output Low Voltage	V _{OH4}	Tri-state ports	V _{DD} = 1.8 V, I _{OH} = - 10 μA	1.6	-	-	
	V _{OL1}	Except XOUT and port P3	V _{DD} = 4.5 V, I _{OL} = 1.6 mA	-	-	0.4	
	V _{OL2}	Except XOUT	V _{DD} = 1.8 V, I _{OL} = 20 μA	-	-	0.2	
Output Low Current	I _{OL3}	Port P3	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 f _c = 8 MHz f _s = 32.768 kHz V _{IN} = 5.3 V / 0.2 V	-	7.0	10	
Supply Current in IDLE 1, 2 mode				-	3.5	5	
Supply Current in NORMAL 1, 2 mode			V _{DD} = 3.0 V f _c = 4.19 MHz f _s = 32.768 kHz V _{IN} = 2.8 V / 0.2 V	-	2.5	3.5	
Supply Current in IDLE 1, 2 mode				-	1.5	2.0	
Supply Current in NORMAL 1, 2 mode			V _{DD} = 1.8 V f _c = 4.19 MHz f _s = 32.768 kHz V _{IN} = 1.7 V / 0.1 V	-	1.0	2.0	
Supply Current in IDLE 1, 2 mode				-	0.5	1.0	
Supply Current in SLOW mode			V _{DD} = 3.0 V f _s = 32.768 kHz V _{IN} = 2.8 V / 0.2 V	-	30	60	
Supply Current in SLEEP mode				-	15	30	
Supply Current in SLOW mode				V _{DD} = 1.8 V f _s = 32.768 kHz V _{IN} = 1.7 V / 0.1 V	-	15	
Supply Current in SLEEP mode					-	10	20
Supply Current in STOP mode	V _{DD} = 5.5 V V _{IN} = 5.3 V / 0.2 V	-	0.5	10			

Note 1: Typical values show those at T_{opr} = 25°C, V_{DD} = 3V.

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

A.C. Characteristics

(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, T_{opr} = - 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 = 8.4 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}					

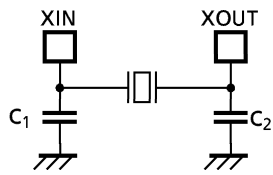
(V_{SS} = 0 V, V_{DD} = 1.8 to 4.5 V, T_{opr} = - 30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t _{cy}	In NORMAL 1, 2 mode	0.95	-	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 = 4.2 MHz	110	-	-	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}					

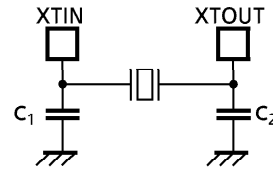
Recommended Oscillating Conditions

(V_{SS} = 0 V, T_{opr} = - 30 to 70°C)

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator		Recommended Constant	
					C ₁	C ₂
High-frequency	Ceramic Resonator	4.19 MHz (V _{DD} = 1.8 to 5.5 V)	MURATA	CSA4.19MG	30 pF	30 pF
			MURATA	CST4.19MGW	-	-
		8 MHz (V _{DD} = 4.5 to 5.5 V)	MURATA	CSA8.00MTZ	15 pF	15 pF
			MURATA	CST8.00MTW	-	-
	Crystal Oscillator	8 MHz (V _{DD} = 4.5 to 5.5 V)	NDK	AT-51	16 pF	16 pF
Low-frequency	Crystal Oscillator	32.768 kHz (V _{DD} = 1.8 to 5.5 V)	NDK	MX-38T	12 pF	12 pF



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

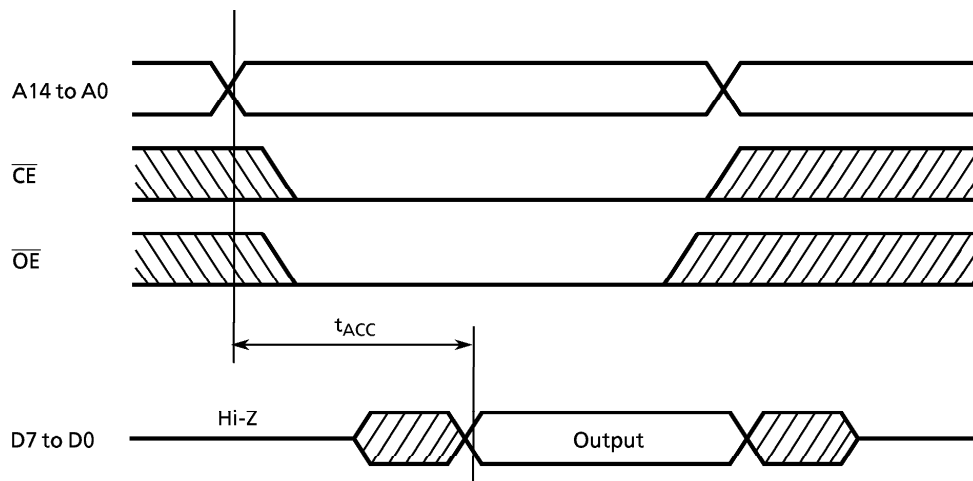
Note: When used in high electric field such as a picture tube, the package is Recommended to be electrically shielded to maintain a regular operation.

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

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

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		4.75	5.00	5.25	V
Program Power Supply Voltage	V_{PP}		$V_{CC} - 0.6$	V_{CC}	$V_{CC} + 0.6$	
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5\ t_{cyc} + 300$	–	ns

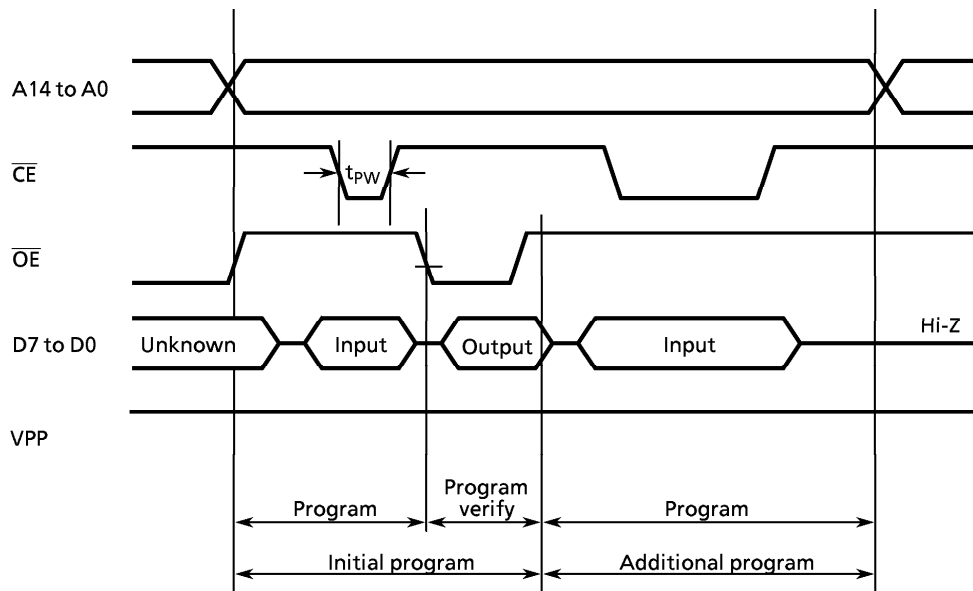
Note: $t_{cyc} = 500\text{ ns at }8\text{ MHz}$



Timing Waveforms of Read Operation

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

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	-	V_{CC}	V
Input Low Voltage	V_{IL4}		0	-	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		5.75	6.0	6.25	V
Program Power Supply Voltage	V_{PP}		12.0	12.5	13.0	V
Initial Program Pulse Width	t_{PW}	$V_{CC} = 6.0\text{ V} \pm 0.25\text{ V}$ $V_{PP} = 12.5\text{ V} \pm 0.5\text{ V}$	0.95	1.0	1.05	ms



Timing Waveforms of Programming Operation

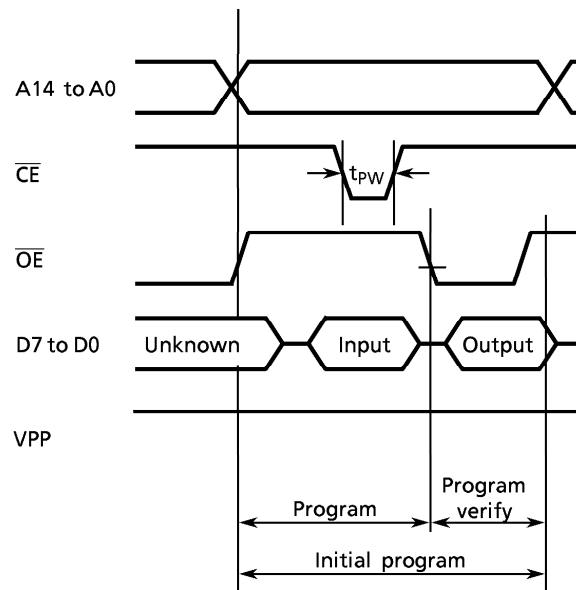
Note1: When V_{CC} power supply is turned on or after, V_{pp} must be increased.
 When V_{CC} power supply is turned off or before, V_{pp} must be decreased.

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

Note3: 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	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}	$V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$, $V_{PP} = 12.75 \text{ V} \pm 0.25 \text{ V}$	0.095	0.1	0.105	ms



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 ($12.75 \text{ V} \pm 0.25 \text{ V}$) to the V_{pp} pin as the device is damaged.

Note3: 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.