

CMOS 8-BIT MICROCONTROLLER

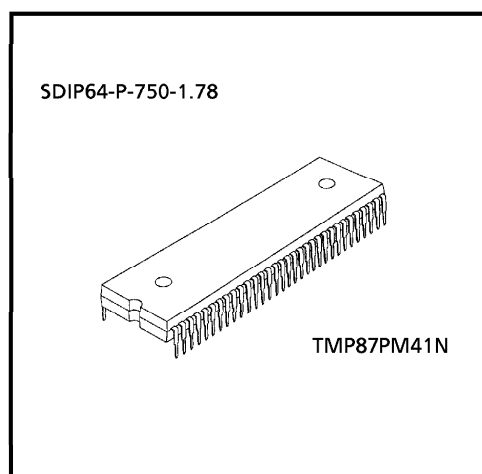
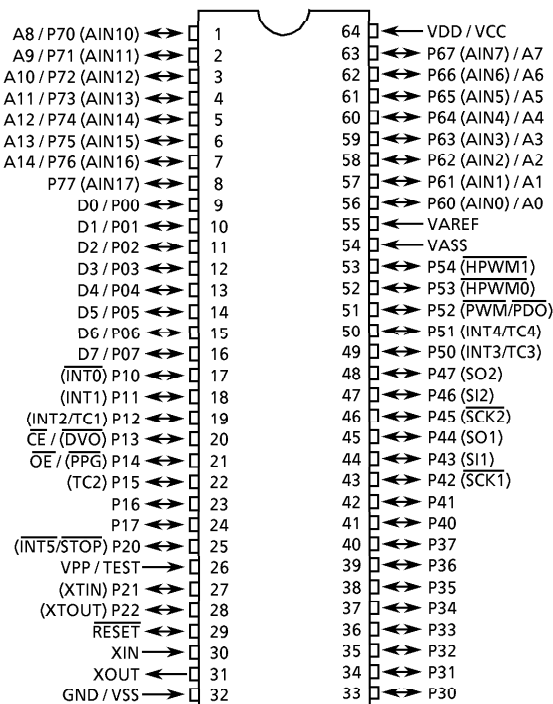
TMP87PM41N, TMP87PM41F, TMP87PM41U

The 87PM41 is a One-Time PROM microcontroller with low-power 256K bits (32K bytes) electrically programmable read only memory for the 87C841/CC41/CH41/CK41/CM41 system evaluation. The 87PM41 is pin compatible with the 87C841/CC41/CH41/CK41/M41. The operations possible with the 87C841/CC41/CH41/CK41/M41 can be performed by writing programs to PROM. The 87PM41 can write and verify in the same way as the TC57256AD using an adaptor socket BM1136/BM1137/BM1121 and an EPROM programmer.

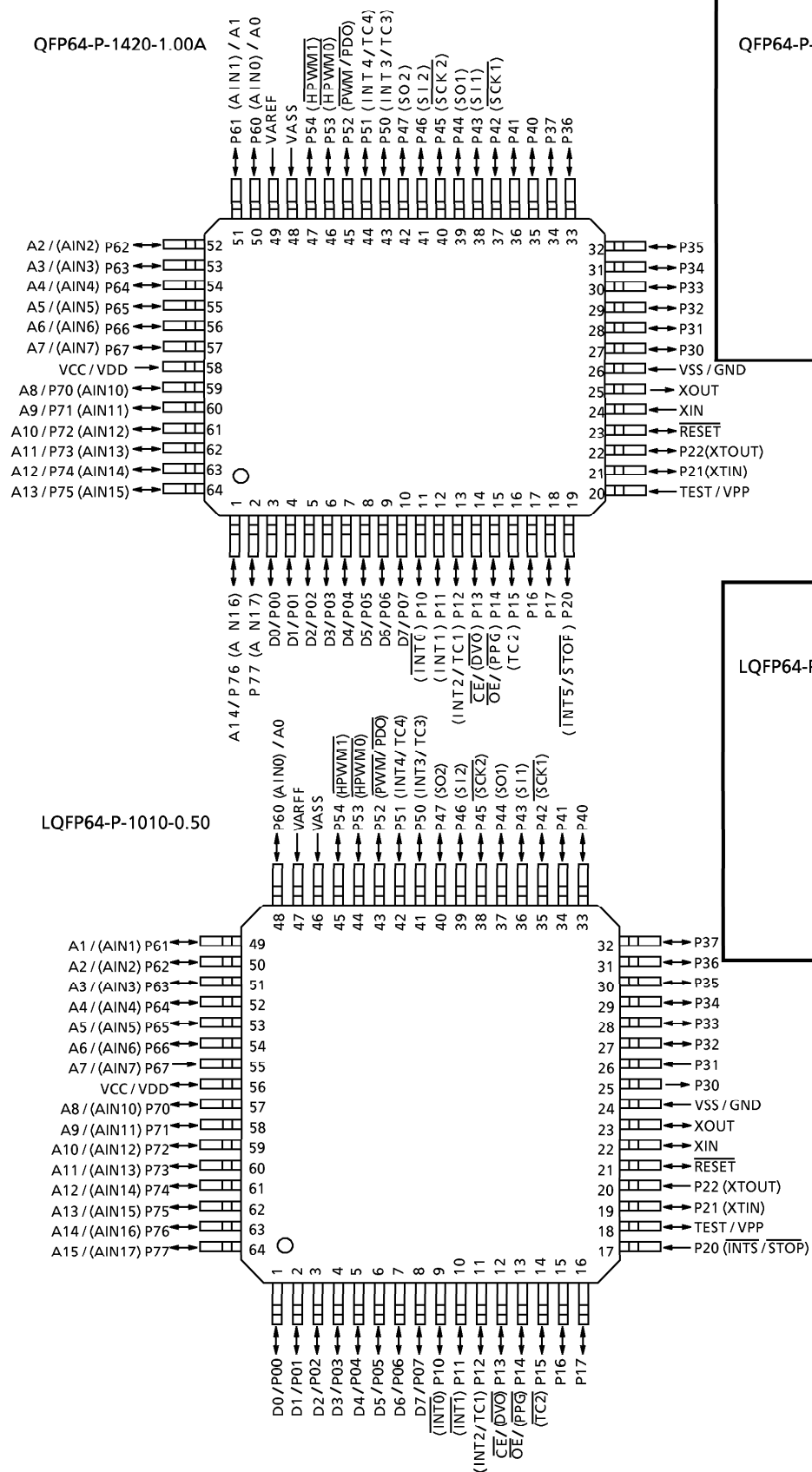
PART No.	OTP	RAM	PACKAGE	ADAPTOR SOCKET
TMP87PM41N	32K × 8-bit	1K × 8-bit	SDIP64-P-750-1.78	BM1136
TMP87PM41F			QFP64-P-1420A	BM1137
TMP87PM41U			LQFP64-P-1010	BM11121

PIN ASSIGNMENTS (TOP VIEW)

SDIP64-P-750-1.78



PIN ASSIGNMENTS (TOP VIEW)



PIN FUNCTION

The 87PM41 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PM41 is pin compatible with the 87C841/CC41/CH41/CK41/CM41 (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	PROM mode setting pin. Be fixed at high level.
P47 to P40			
P54 to P50			
P11		PROM mode setting pin. Be fixed at low level.	
P21			
P77			
P17 to P15			
P12, P10		PROM mode setting pin. Be fixed at low level.	
P22, P20			
$\overline{RESET}$			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power Supply	0 V (GND)	
VASS			

OPERATIONAL DESCRIPTION

The following explains the 87PM41 hardware configuration and operation. The configuration and functions of the 87PM41 are the same as those of the 87C841/CC41/CH41/CK41/CM41, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PM41 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 87PM41 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 87C841/CC41/CH41/CK41/CM41 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PM41 has a 32 K × 8-bit (addresses 8000_H to FFFF_H in the MCU mode, addresses 0000_H to 7FFF_H in the PROM mode) of program memory (OTP).

To use the 87PM41 as the system evaluation for the 87C841/CC41/CH41/CK41/CM41 the program should be written to the program memory area as shown the Figure 1-1.

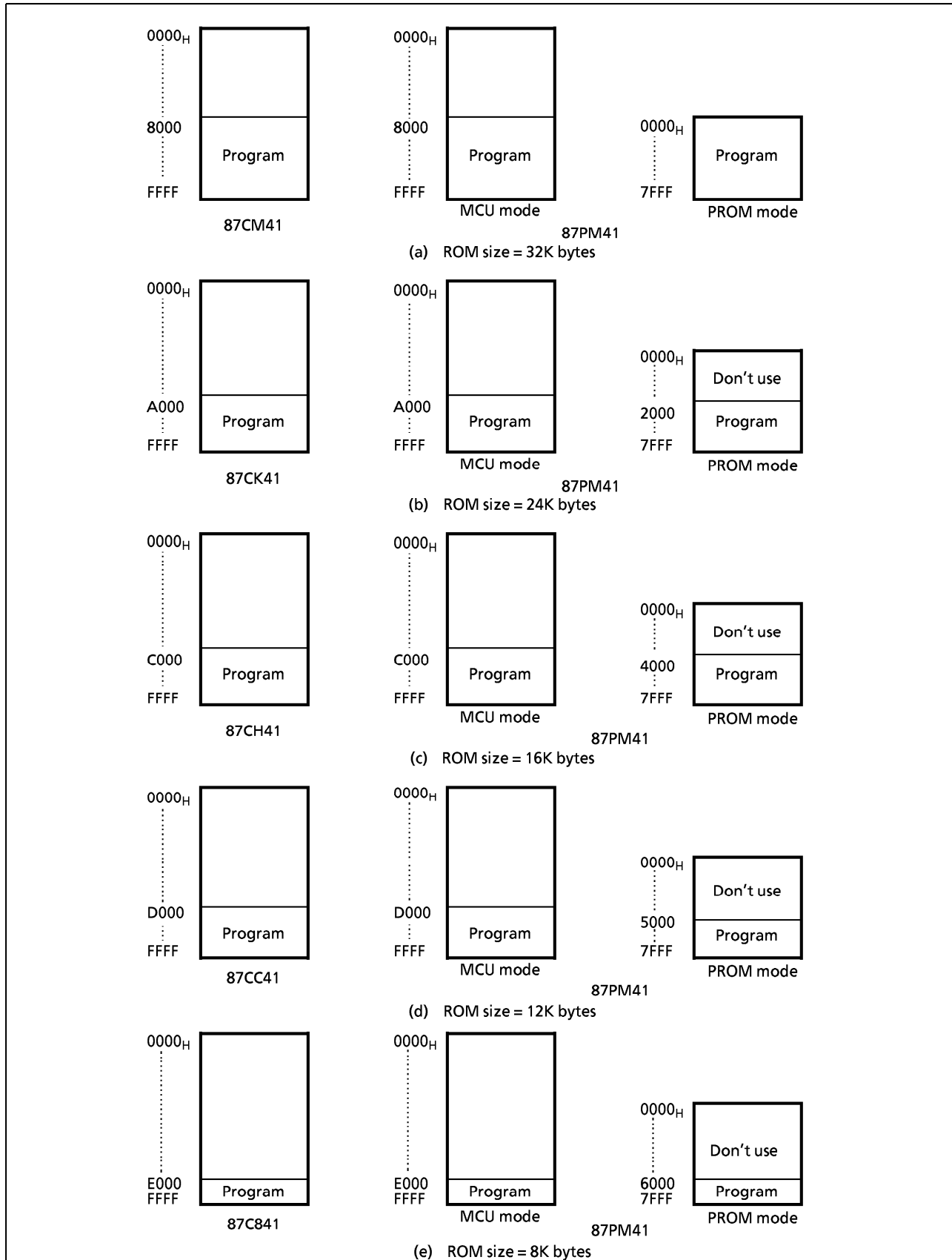


Figure 1-1. Program Memory Area

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

1.1.2 Data Memory

The 87PM41 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 87PM41 are the same as those of the 87C841/CC41/CH41/CK41/CM41 except that the TEST pin has no built-in pull-down resistance.

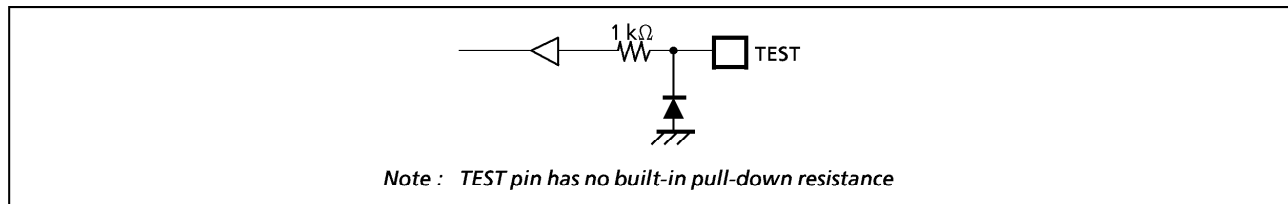


Figure 1-2. TEST Pin

(2) I/O ports

The I/O circuitries of 87PM41 I/O ports are the same as the code A type I/O circuitries of the 87C841/CC41/CH41/CK41/CM41.

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 1-3. 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 87PM41 is not supported an *electric signature mode*, so the ROM type must be set to TC57256AD. Set the adaptor socket switch to "P".

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

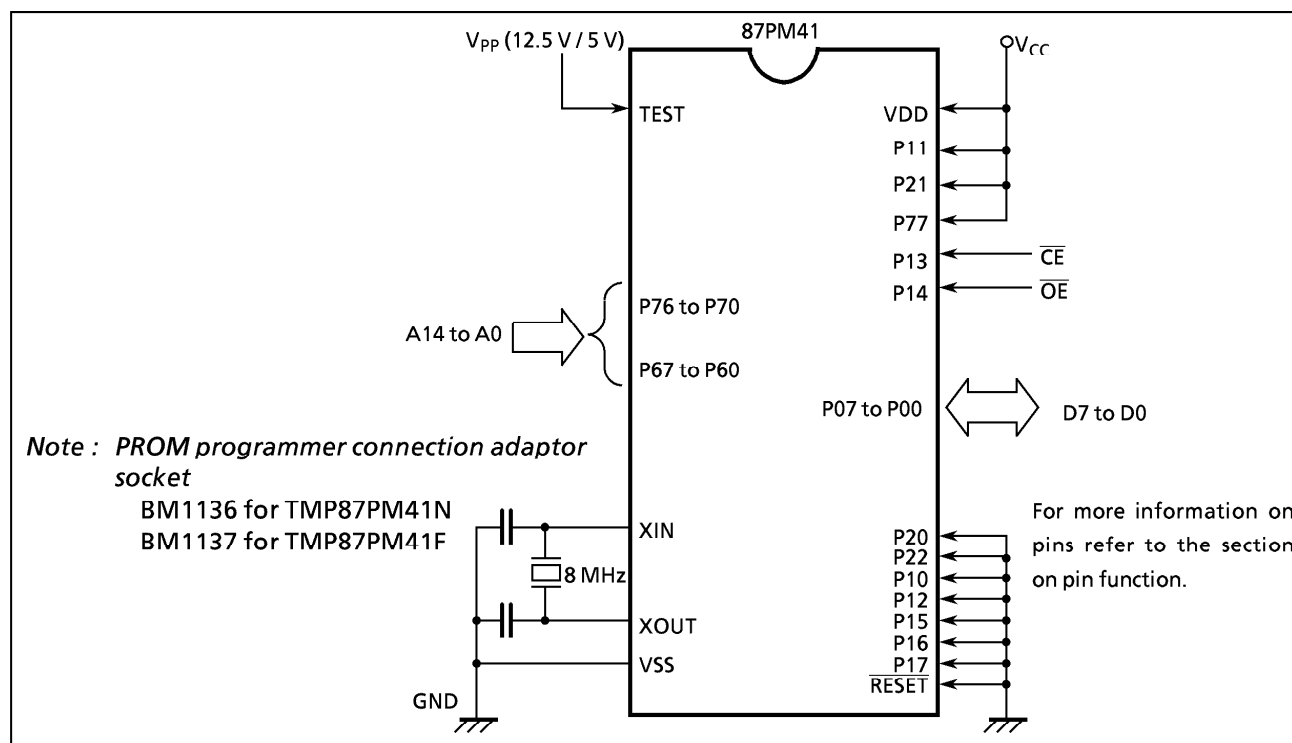


Figure 1-3. Setting for PROM Mode

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

The high-speed programming mode is achieved by applying the program voltage (+ 12.5 V) to the VPP pin when $V_{CC} = 6$ V. After the address and input data are stable, the data is programmed by applying a single 1 ms program pulse to the $\overline{CE}$ input. The programmed data is verified. If incorrect, another 1 ms 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 $\times$ 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 $V_{CC} = V_{pp} = 5$ V.

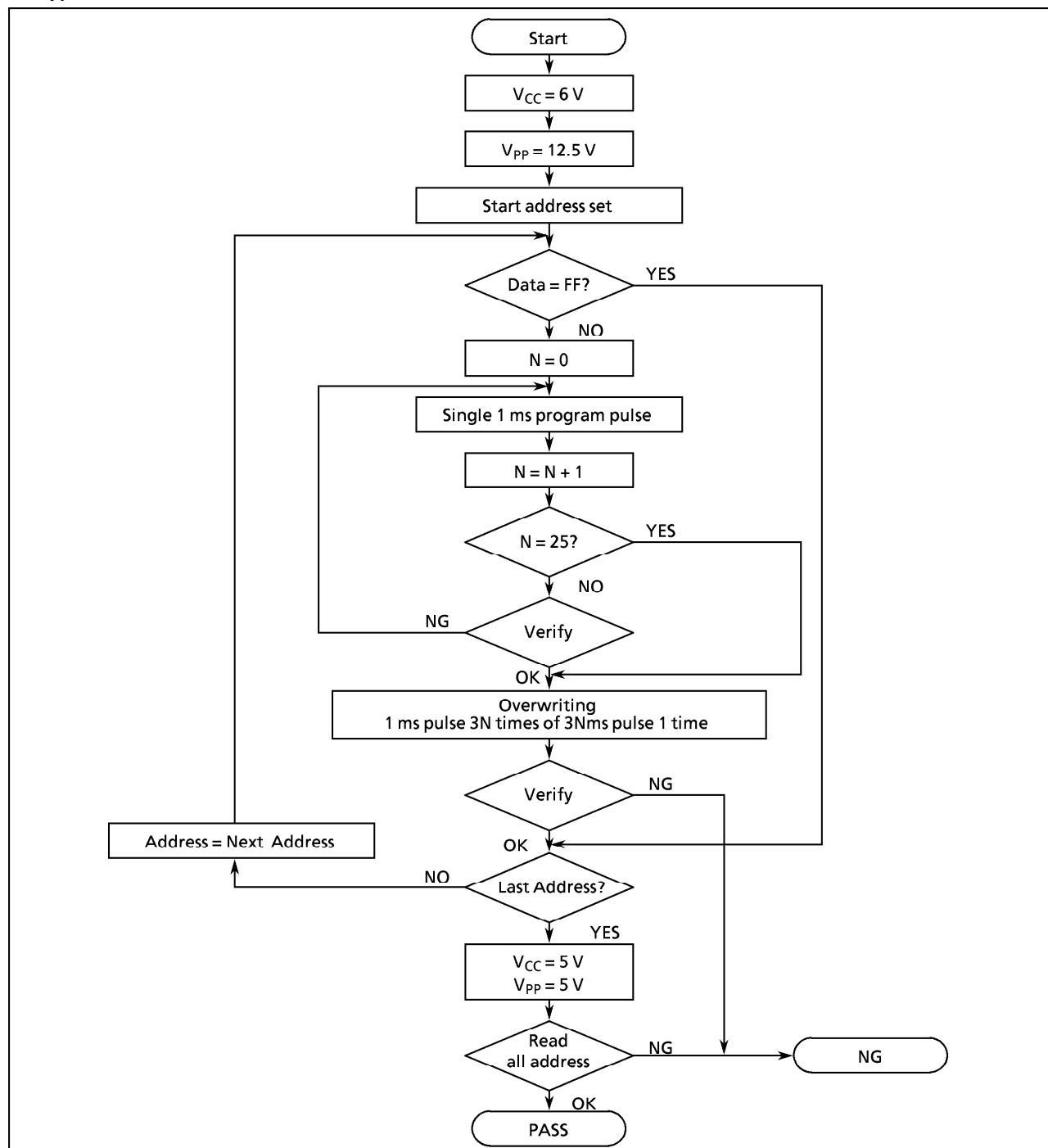


Figure 1-4. Flow chart of High-speed Programming Mode- I

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 V_{pp} pin when V_{cc} = 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 V_{cc} = V_{pp} = 5 V.

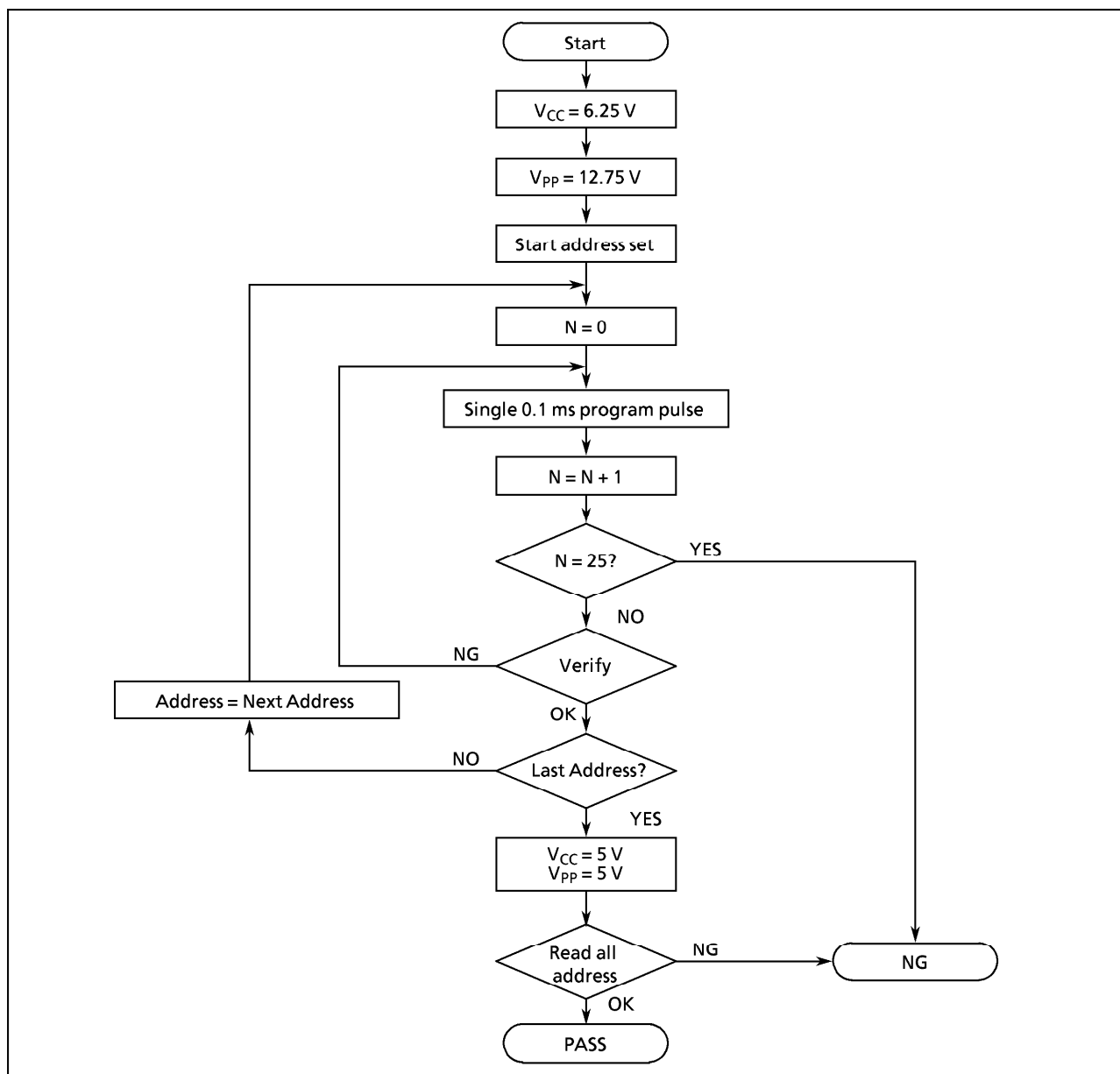


Figure 1-5. Flowchart of High-speed Programming Mode - II

1.2.3 Writing Method for General-purpose PROM Program

(1) Adapters

BM1136 : TMP87PM41N

BM1137 : TMP87PM41F

BM11121 : TMP87PM41U

(2) Adapter setting

Switch (SW1) is set to side N.

(3) PROM programmer specifying

i) PROM type is specified to TC57256D.

Writing voltage: 12.5 V (high-speed program mode-I)

Writing voltage: 12.75 V (high-speed program mode-II)

ii) Data transfer (copy) (note 1)

In the TMP87PM41, EPROM is within the addresses 0000_H 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_H to FFFF_H to addresses 4000 to 7FFF_H

iii) Writing address is specified. (note 1)

Start address : 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. 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 TMP87PP23 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 12V ± 0.5V to the address pin 9 (A9). The signature must not be used.

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

(V_{SS} = 0 V)

PARAMETER	SYMBOL	PINS	RATINGS	UNIT
Supply Voltage	V _{DD}		– 0.3 to 6.5	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}		– 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)	Σ I _{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7	120	mA
	Σ I _{OUT2}	Port P3	120	
Power Dissipation [T _{opr} = 70 °C]	PD	TMP87PM41N	600	mW
		TMP87PM41F, TMP87PM41U	350	
Soldering Temperature (time)	T _{sld}		260 (10 s)	°C
Storage Temperature	T _{stg}		– 55 to 125	°C
Operating Temperature	T _{opr}		– 40 to 85	°C

RECOMMENDED OPERATING CONDITIONS

(V_{SS} = 0 V, T_{opr} = – 40 to 85 °C)

PARAMETER	SYMBOL	PINS	CONDITIONS		Min.	Max.	UNIT
Supply Voltage	V _{DD}		f _c = 8 MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			f _c = 4.2 MHz	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			f _s = 32.768 kHz	SLOW mode	2.0		
				SLEEP mode			
	STOP mode						
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	f _c	XIN, XOUT	V _{DD} = 4.5 to 5.5 V		0.4	8.0	MHz
			V _{DD} = 2.7 to 5.5 V			4.2	
	f _s	XTIN, XTOUT			30.0	34.0	kHz

Note : Clock frequency fc : Supply voltage range is specified in NORMAL1/2 mode and IDLE1/2 mode.

D.C. CHARACTERISTICS

(V_{SS} = 0 V, T_{opr} = -40 to 85 °C)

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Typ.	Max.	UNIT
Hysteresis Voltage	V _{HS}	Hysteresis inputs		–	0.9	–	V
Input Current	I _{IN1}	TEST	V _{DD} = 5.5 V V _{IN} = 5.5 V / 0 V	–	–	± 2	μA
	I _{IN2}	Open drain ports, Tri-state ports					
	I _{IN3}	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 _{IN2}	RESET		90	220	510	kΩ
Output Leakage Current	I _{LO}	Sink open drain ports	V _{DD} = 5.5 V, V _{OUT} = 5.5 V	–	–	2	μA
		Tri-state ports					
Output High Voltage	V _{OH1}	Tri-state ports	V _{DD} = 4.5 V, I _{OH} = – 0.7 mA	4.1	–	–	V
Output Low Voltage	V _{OL}	Except XOUT and P3	V _{DD} = 4.5 V, I _{OL} = 1.6 mA	–	–	0.4	V
Output Low current	I _{OL3}	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 V _{IN} = 5.3 V / 0.2 V	–	10	16	mA
Supply Current in IDLE 1, 2 modes			f _c = 8 MHz f _s = 32.768 kHz	–	4.5	6	mA
Supply Current in SLOW mode			V _{DD} = 3.0 V V _{IN} = 2.8 V / 0.2 V	–	30	60	μA
Supply Current in SLEEP mode			f _s = 32.768 kHz	–	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 values show those at T_{opr} = 25 °C, V_{DD} = 5 V.Note 2 : Input Current I_{IN1}, I_{IN3}; The current through resistor is not included, when the input resistor (pull-up or pull-down) is contained.Note 3 : I_{DD} except I_{REF}.

A/D CONVERSION CHARACTERISTICS

(T_{opr} = -40 to 85 °C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.			UNIT
					ADCDR1	ADCDR2		
						ACK = 0	ACK = 1	
Analog Reference Voltage	V _{AREF}	V _{AREF} – V _{ASS} ≥ 2.5 V	2.7	—	V _{DD}			V
	V _{ASS}		V _{SS}	—	1.5			
Analog Input Voltage	V _{AIN}		V _{ASS}	—	V _{AREF}			V
Analog Supply Current	I _{REF}	V _{AREF} = 5.5 V V _{ASS} = 0.0 V	—	0.5	1.0			mA
Nonlinearity Error		V _{DD} = 5.0 V, V _{SS} = 0.0 V V _{AREF} = 5.000 V	—	—	± 1	± 3	± 2	LSB
Zero Point Error		V _{ASS} = 0.000 V OR	—	—	± 1	± 3	± 2	
Full Scale Error		V _{DD} = 2.7 V, V _{SS} = 0.0 V V _{AREF} = 2.700 V	—	—	± 1	± 3	± 2	
Total Error		V _{ASS} = 0.000 V	—	—	± 2	± 6	± 4	

Note 1 : ΔV_{AREF} = V_{AREF} – V_{ASS}Note 2 : ADCDR1 ; 8 bit – A/D conversion result (1LSB = ΔV_{AREF} / 256)ADCDR2 ; 10 bit – A/D conversion result (1LSB = ΔV_{AREF} / 1024)

A.C. CHARACTERISTICS

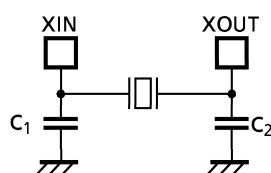
(V_{SS} = 0 V, V_{DD} = 2.7 / 4.5 to 5.5 V, Topr = – 40 to 85 °C)

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	62.5	–	–	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}					

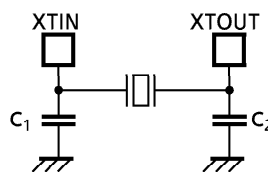
RECOMMENDED OSCILLATING CONDITIONS

(V_{SS} = 0 V, V_{DD} = 2.7 / 4.5 to 5.5 V, Topr = – 40 to 85 °C)

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



(1) High-frequency Oscillation



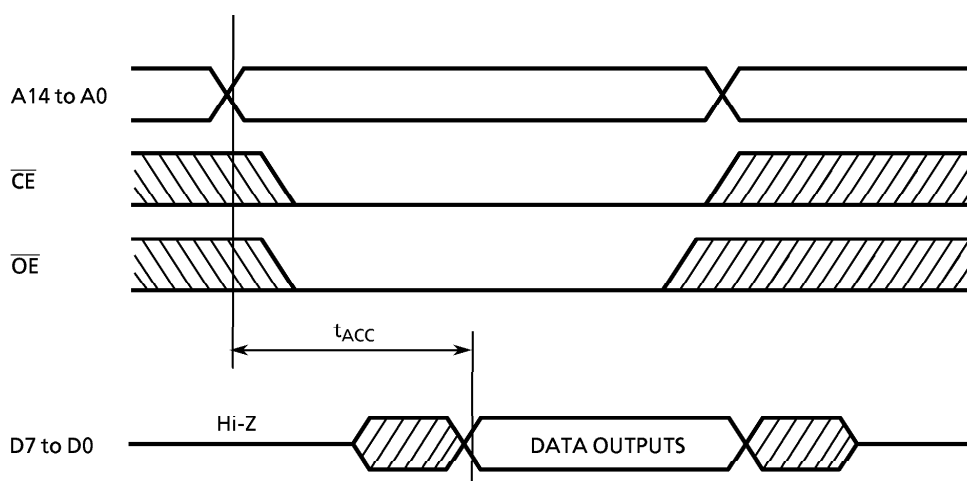
(2) Low-frequency Oscillation

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

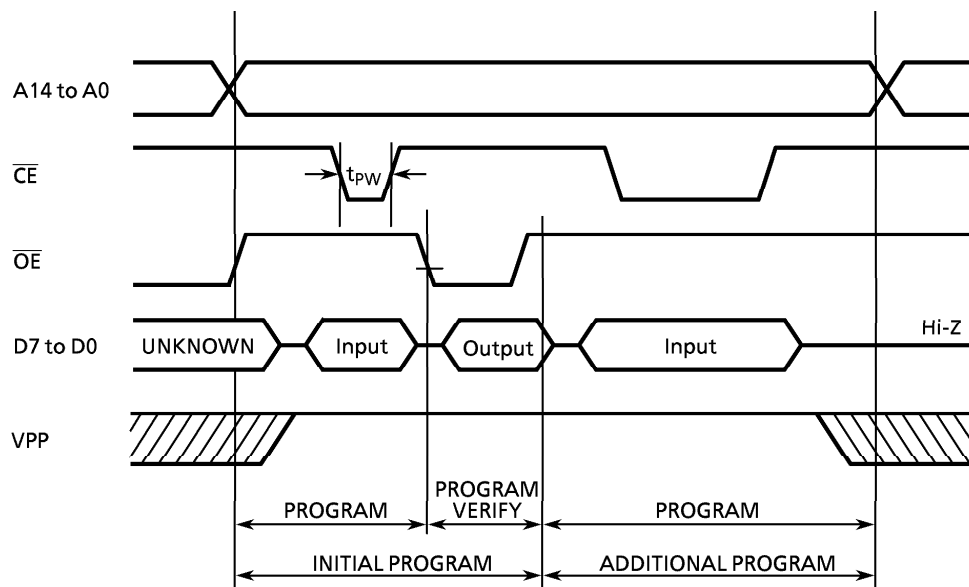
D.C./A.C. CHARACTERISTICS (PROM mode) ($V_{SS} = 0\text{ V}$)

(1) Read Operation

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	—	V_{CC}	V
Input Low Voltage	V_{IL4}		0	—	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		4.75	—	6.5	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25\text{ V}$	—	$1.5t_{cyc} + 300$	—	ns

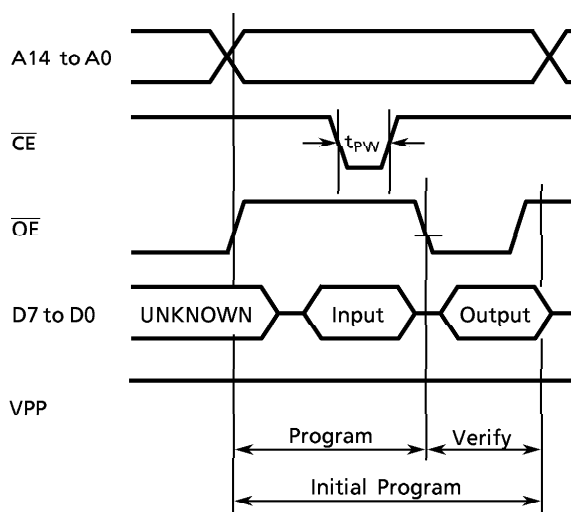
Note : $t_{cyc} = 500\text{ ns}$ at 8 MHz(2) Program Operation (High speed write mode- I) ($T_{opr} = 25 \pm 5^\circ\text{C}$)

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	—	6.5	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



(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



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.