

CMOS 8-Bit Microcontroller

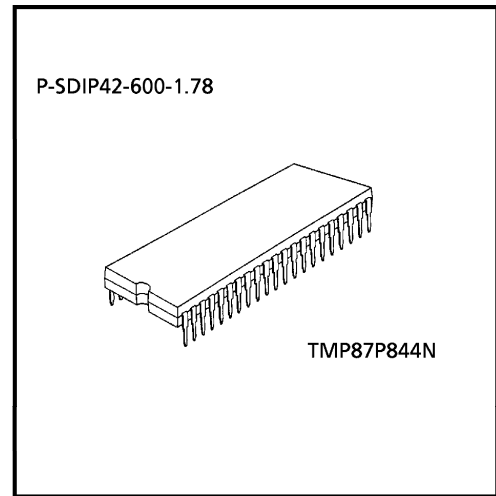
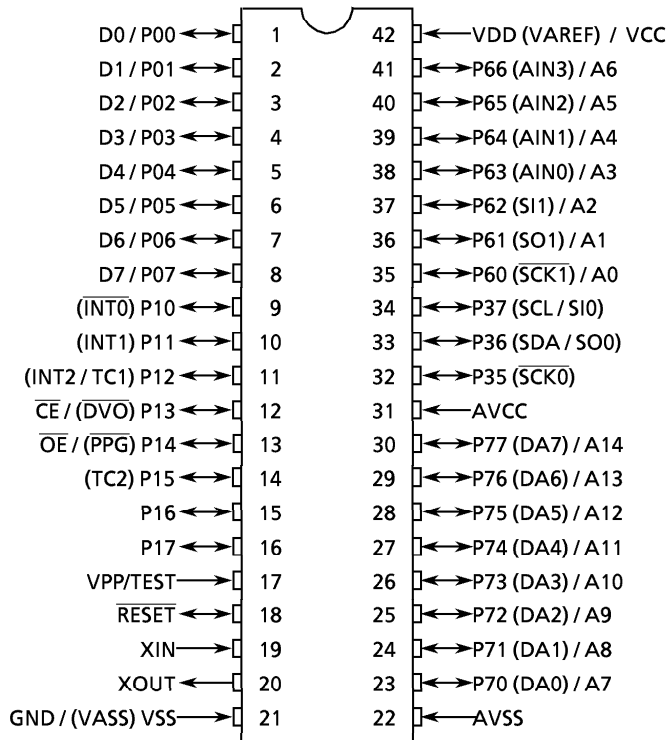
TMP87P844N

The 87P844 are a One-Time PROM microcontroller with low-power 64K bits (8 Kbytes) electrically programmable read only memory for the 87C444/844 system evaluation. The 87P844 is pin compatible with the 87C444/844. The operations possible with the 87C444/844 can be performed by writing programs to PROM. The 87P844 can write and verify in the same way as the TMM27256AD using an adaptor socket BM11108 and an EPROM programmer.

Part No	OTP	RAM	Package	Adaptor socket
TMP87P844N	8 K x 8-bit	256 x 8-bit	P-SDIP42-600-1.78	BM11108

Pin Assignments (Top View)

P-SDIP42-600-1.78



980910EBP1

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Pin Function

The 87P844 have two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87P844 is pin compatible with the 87C844/444 and the 87P844 are pin compatible with the 87C844/444 (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A14 ~ A7	Input	PROM address inputs	P76 to P70
A6 ~ A0			P67 to P60
D7 ~ 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
P11	I/O	PROM mode setting pins. Be fixed at high level.	
P36			
P12			
P10			
P17 ~ P15			
P37 , P35			
RESET			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		
AVCC	Power Supply	+ 5 V	
AVSS		0 V (GND)	

OPERATIONAL DESCRIPTION

The following explains the 87P844 hardware configuration and operation. The configuration and functions of the 87P844 are the same as those of the 87C444/844, except in that a one-time PROM is used instead of an on-chip mask ROM.

1. OPERATING MODE

The 87P844 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 87C444/844 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87P844 have a 8K×8-bit (addresses E000_H-FFFF_H in the MCU mode, addresses 6000_H-7FFF_H in the PROM mode) of program memory (OTP).

To use the 87P844 as the system evaluation for the 87C444/844, the program should be written to the program memory area as shown in Figure 1-1.

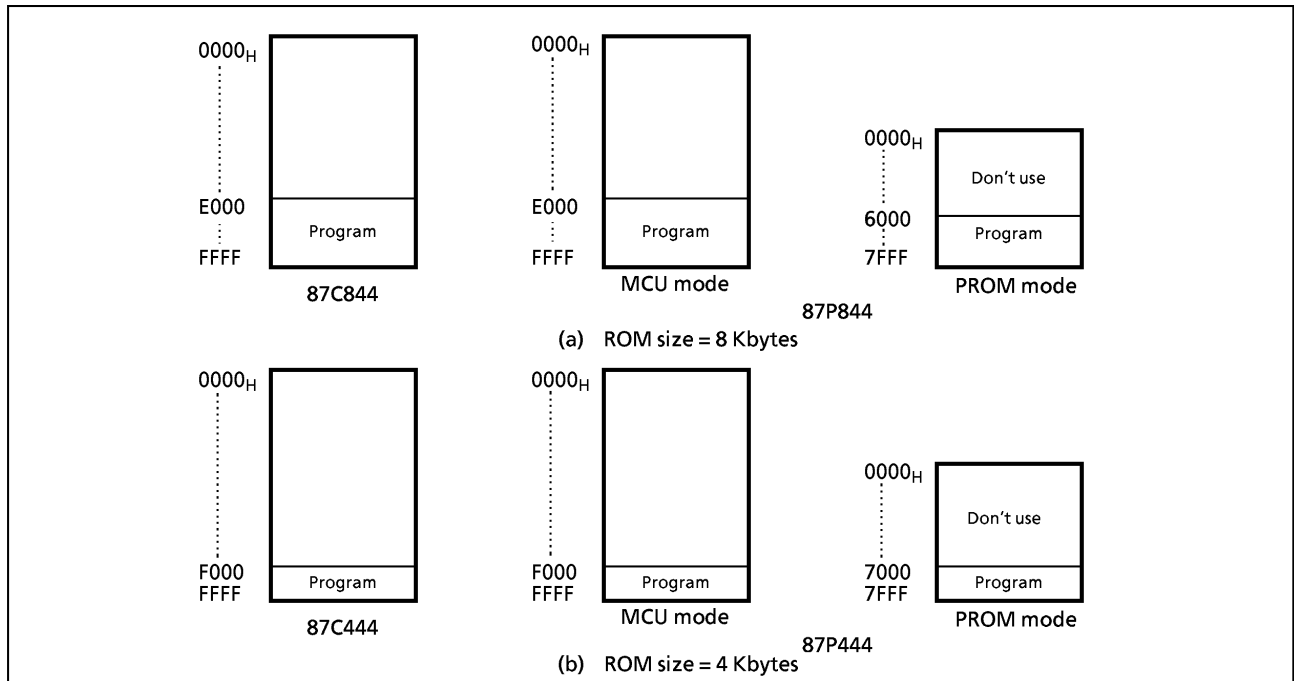


Figure 1-1. Program Memory Area

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 87P844 have an on-chip 256 × 8-bit data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 87P844 are the same as those of the 87C444/844 except that the TEST pin has no built-in pull-down resistance.

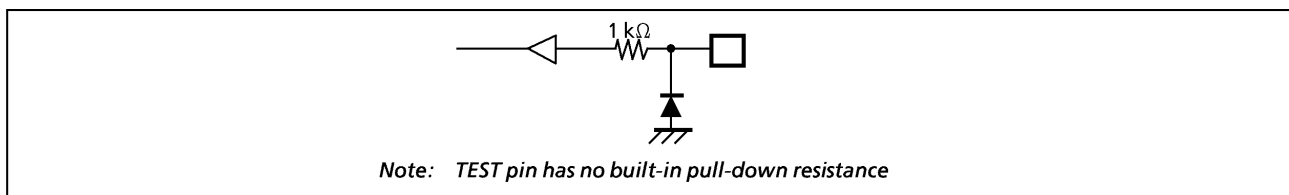


Figure 1-2. TEST pin

(2) I/O ports

The I/O circuitries of 87P844 I/O ports are the same I/O circuitries of the 87C444/844.

1.2 PROM mode

The PROM mode is activated by setting the TEST, $\overline{\text{RESET}}$ pin and the ports P17-P10, P37-P35 and P77 as shown in Figure 1-2. 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 87P844 are not supported an *electric signature* mode, so the ROM type must be set to TC57256AD. Set the adaptor socket switch to "N".

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

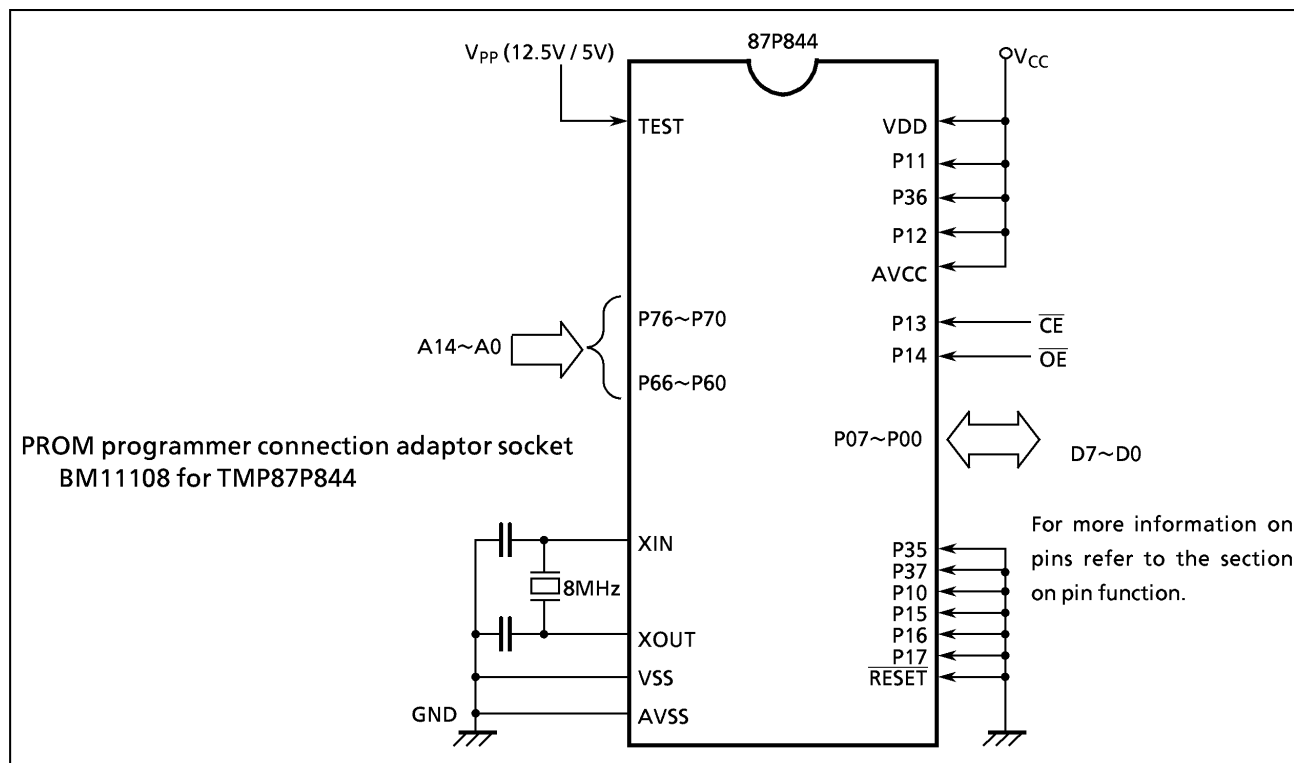


Figure 1-3. Setting for PROM Mode

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

The high-speed programming mode is achieved by applying the program voltage (+ 12.5V) 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.

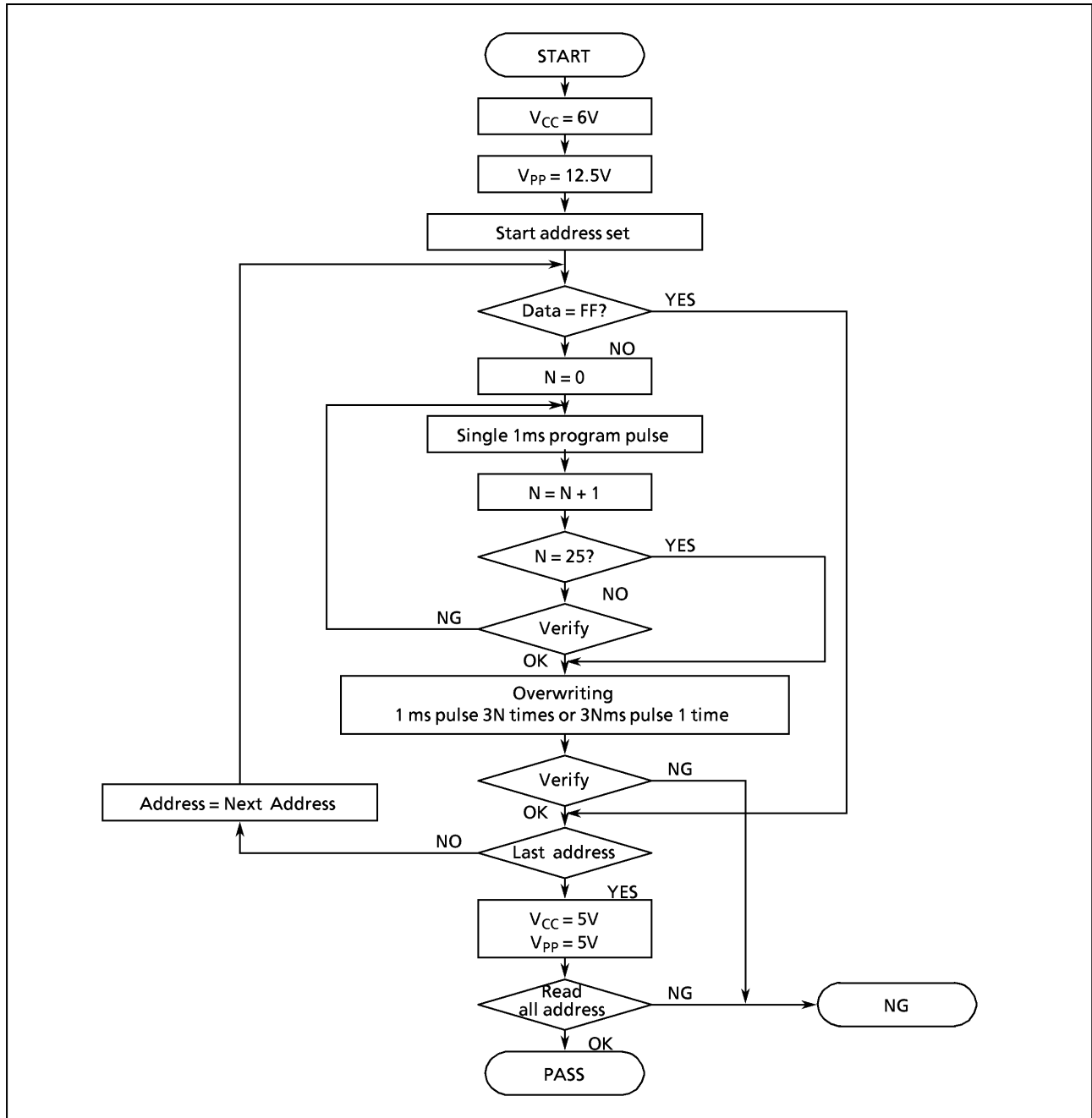


Figure 1-4. Flow Chart of High-speed Programming Mode - I

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 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 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.

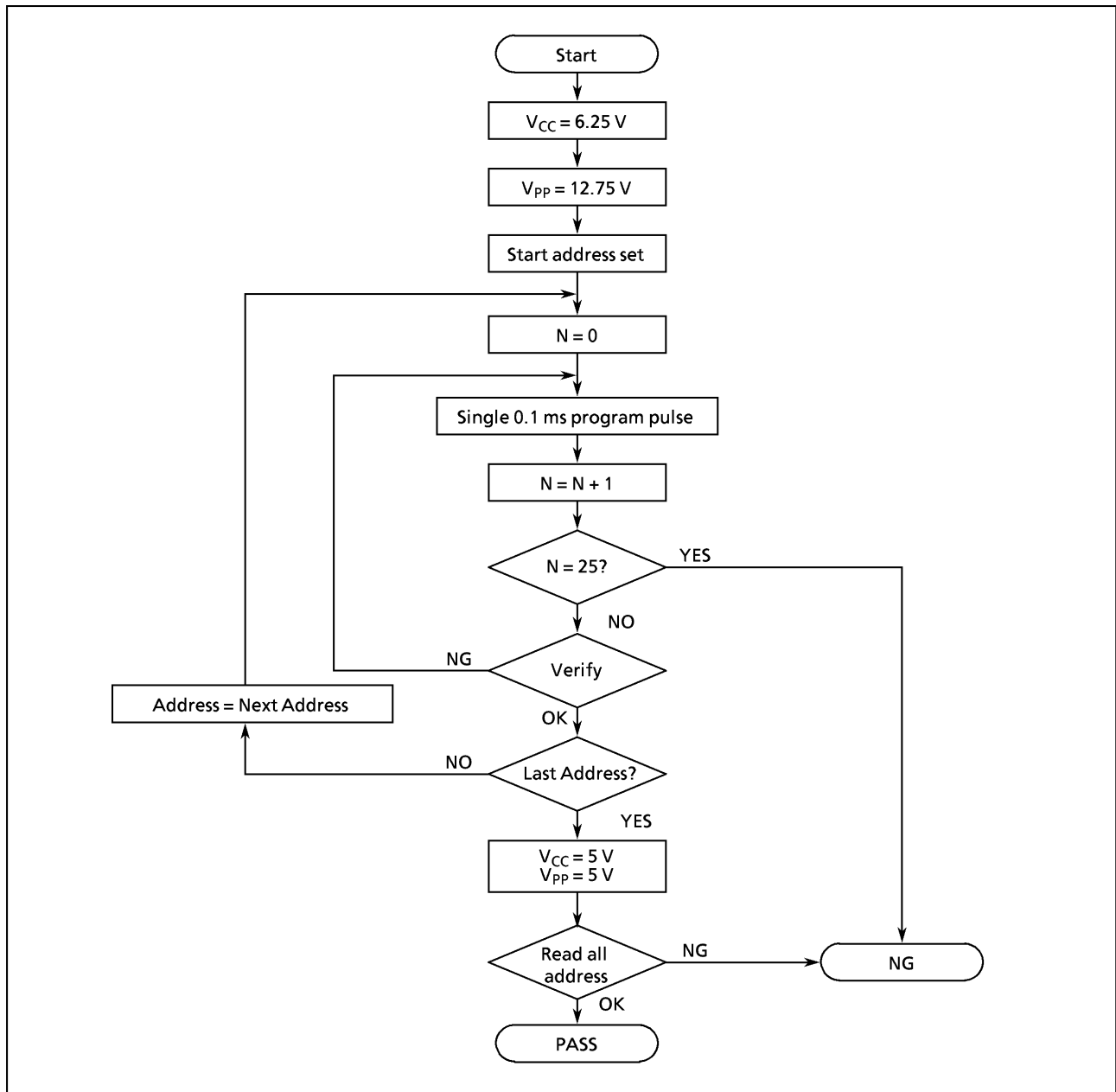


Figure 1-5. Flowchart of High-speed Programming Mode - II

1.2.3 Writing method for general-purpose PROM program

- (1) Adapters
BM11108: TMP87P844N
- (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 TMP87P844, EPROM is within the addresses 6000 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 8KB: transferred addresses E000 to FFFFH to addresses 6000 to 7FFFH
 - iii) Writing address is specified. (note 1)
Start address: 6000H
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 5FFFH 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: TMP87P844 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 $12V \pm 0.5V$ to the address pin 9 (A9). The signature must not be used.

Electrical Characteristics

Absolute Maximum Ratings

(V_{SS} = 0 V)

Parameter	Symbol	Conditions	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}	Except sink open drain pin, but include RESET	- 0.3 to V _{DD} + 0.3	V
	V _{OUT2}	Sink open drain pin except RESET	- 0.3 to 5.5	
Output Current (Per 1 pin)	I _{OUT1}	Ports P0, P1, P3, P6, P7	3.2	mA
Output Current (Total)	Σ I _{OUT1}	Ports P0, P1, P3, P6, P7	120	mA
Power Dissipation [Topr = 70°C]	PD		600	mW
Soldering Temperature (time)	T _{sld}		260 (10s)	°C
Storage Temperature	T _{stg}		- 55 to 125	°C
Operating Temperature	Topr		- 30 to 70	°C

Note: The absolute maximum ratings are rated values which must not be exceeded during operation, even for an instant. Any one of the ratings must not be exceeded. If any absolute maximum rating is exceeded, a device may break down or its performance may be degraded, causing it to catch fire or explode resulting in injury to the user. Thus, when designing products which include this device, ensure that no absolute maximum rating value will ever be exceeded.

Recommended Operating Conditions

(V_{SS} = 0 V, Topr = - 30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit	
Supply Voltage	V _{DD}		fc = 8 MHz	NORMAL mode	4.5	5.5	V
				IDLE 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			
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		
Clock Frequency	fc	XIN, XOUT	V _{DD} = 4.5 to 5.5 V	1	8.0	MHz	

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

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Hysteresis Voltage	V_{HS}	Hysteresis inputs		-	0.9	-	V
Input Current	I_{IN1}	TEST	$V_{DD} = 5.5\text{ V}$, $V_{IN} = 5.5\text{ V} / 0\text{ V}$	-	-	± 2	μA
	I_{IN2}	Open drain ports and Tri-state ports					
	I_{IN3}	RESET					
Input Resistance	R_{IN2}	RESET		100	220	450	$\text{k}\Omega$
	R_{IN3}	Port P7		4	6	10	
Output Leakage Current	I_{LO1}	Open drain ports	$V_{DD} = 5.5\text{ V}$, $V_{OUT} = 5.5\text{ V}$	-	-	2	μA
	I_{LO2}	Tri-state ports	$V_{DD} = 5.5\text{ V}$, $V_{OUT} = 5.5\text{ V} / 0\text{ V}$	-	-	± 2	
Output High Voltage	V_{OH1}	Tri-state ports	$V_{DD} = 4.5\text{ V}$, $I_{OH} = -0.7\text{ mA}$	4.1	-	-	V
	V_{OH2}	Port P7	$V_{DD} = 4.5\text{ V}$, $I_{OH} = -0.2\text{ mA}$				
Output Low Voltage	V_{OL}	Except XOUT	$V_{DD} = 4.5\text{ V}$, $I_{OL} = 1.6\text{ mA}$	-	-	0.4	V
Supply Current in NORMAL mode			$V_{DD} = 5.5\text{ V}$ $V_{IN} = 5.3\text{ V} / 0.2\text{ V}$	-	8	14	mA
Supply Current in IDLE mode			$f_c = 8\text{ MHz}$	-	4	6	mA

Note 1: Typical values show those at $T_{opr} = 25^\circ\text{C}$, $V_{DD} = 5\text{ V}$.
 Note 2: Input Current: I_{IN1} , I_{IN3} ; The current through pull-up or pull-down resistor is not included.
 Note 3: I_{DD} does not include I_{AREF} / I_{DREF} .

A/D Conversion Characteristics ($T_{opr} = -30\text{ to }70^\circ\text{C}$: $V_{SS} = V_{ASS} = 0\text{ V}$)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}	$V_{DD} = V_{AREF}$	4.5	-	5.5	V
Analog Input Voltage	V_{AIN}		V_{ASS}	-	V_{AREF}	V
Analog Supply Current	I_{AREF}		-	0.5	1.0	mA
Nonlinearity Error		$V_{AREF} = V_{DD} = 5.000\text{ V}$ $V_{ASS} = V_{SS} = 0.000\text{ V}$	-	-	± 2	LSB
Zero point Error			-	-	± 2	
Full Scale Error			-	-	± 2	
Total Error			-	-	± 3	

D/A Conversion Characteristics

($V_{SS} = A_{VSS} = 0$, $V_{DD} = 4.5$ to 5.5 V, $T_{opr} = -30$ to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	A_{VCC}		4.5	-	V_{DD}	V
Current Dissipation	I_{DREF}	No Loading, All channel operating	-	-	25	mA
Resolution			-	-	8	bits
Accuracy	Nonlinearity Error	$A_{VCC} = 5.000$ V: $A_{VSS} = 0.000$ V	-	-	± 2.0	LSB
	Differential Nonlinearity Error	Monotonicity Guarantee (Note)	-	-	$\pm 3/4$	
Settling time	T_{SU}	Loading condition: $c = 15$ pF	-	-	20	ms
OP-Amp output Voltage Range	V_{AO}	No Loading	0.03	-	$A_{VCC} - 0.25$	V
		$I_{AO} = 1.2$ mA / $I_{AO} = -200$ μ A	0.3	-	$A_{VCC} - 0.3$	
OP-Amp output Drive Range	I_{AO}	$A_{VCC} - 0.5$ to 0.5 V	-	+2/-1	-	mA
Maximum Capacitors connected to D/A output	C_{OL}		-	-	15	pF

Note: Differential nonlinearity error does not include quantizing error.

A.C. Characteristics

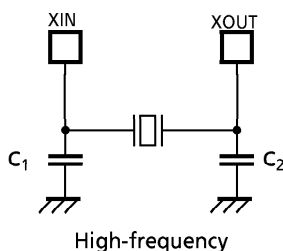
($V_{SS} = 0$ V, $V_{DD} = 4.5$ to 5.5 V, $T_{opr} = -30$ to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t _{cy}	In NORMAL mode	0.5	-	4	μ s
		In NORMAL 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}					

Recommended Oscillating Condition

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

Parameter	Oscillator	Frequency	Recommended Oscillator	Recommended Conditions	
				C ₁	C ₂
High-frequency	Ceramic Resonator	8 MHz	KYOCERA KBR8.0M	30 pF	30 pF
	Crystal Oscillator	8 MHz	TOYOKOM 210B 8.0000	20 pF	20 pF



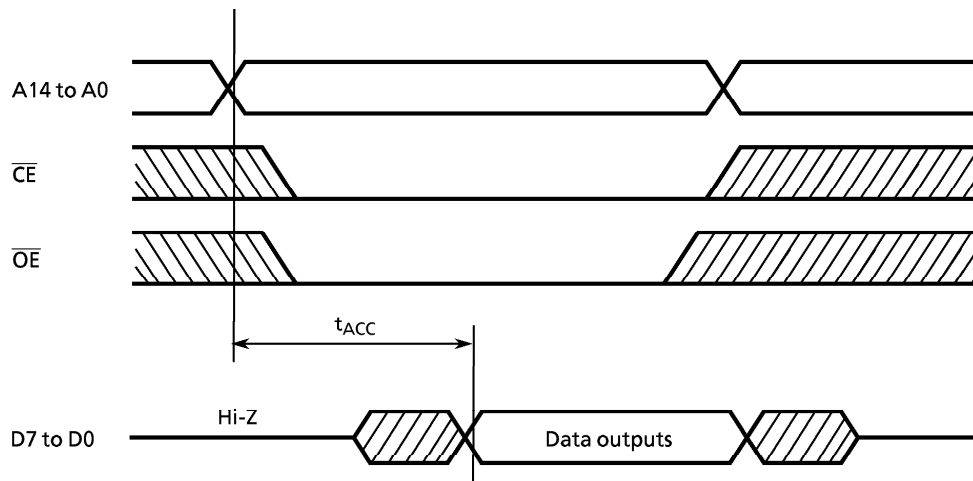
Note: To keep reliable operation, shield the device electrically with the metal plate on its package mold surface against the high electric field, for example, by CRT (Cathode Ray Tube).

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

(1) Read Operation

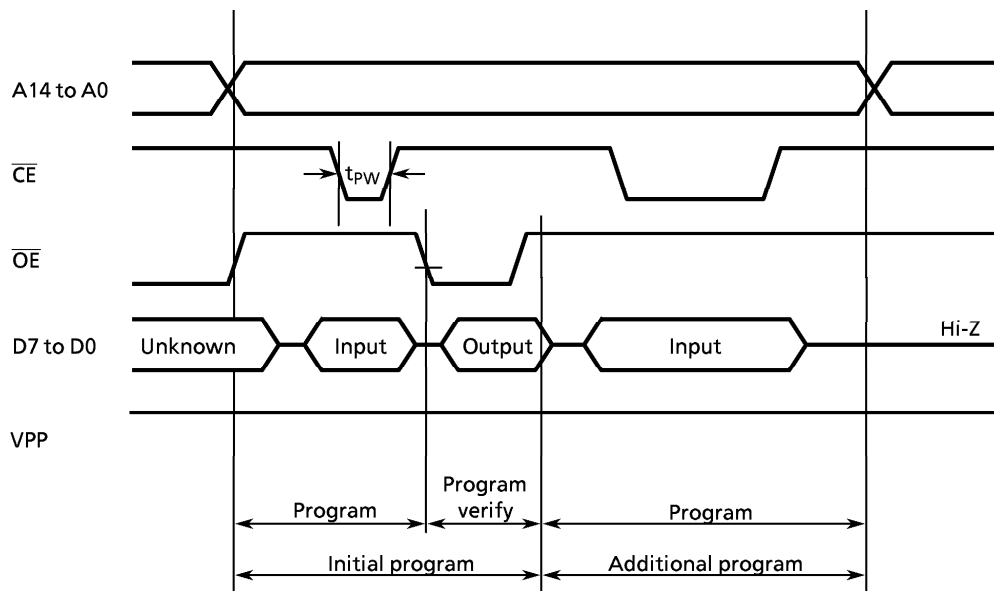
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	-	V_{CC}	V
Input Low Voltage	V_{IL4}		0	-	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		4.75	-	6.0	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25\text{ V}$	-	$1.5t_{cyc} + 300$	-	ns

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



(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



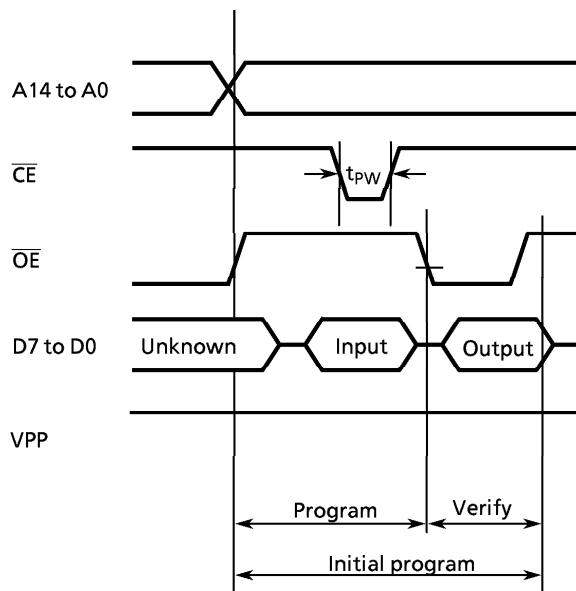
Note 1: When V_{CC} power supply is turned on or after, V_{pp} must be increased.
When V_{CC} power supply is turned off or before, V_{pp} must be decreased.

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

