CMOS 8-BIT MICROCONTROLLER

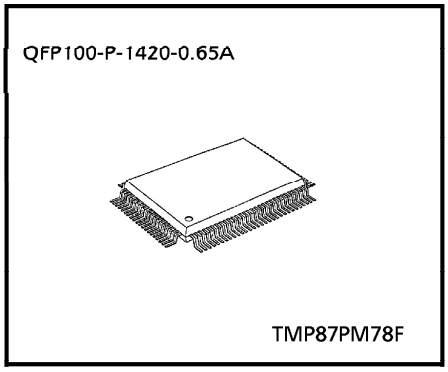
TMP87PM78F

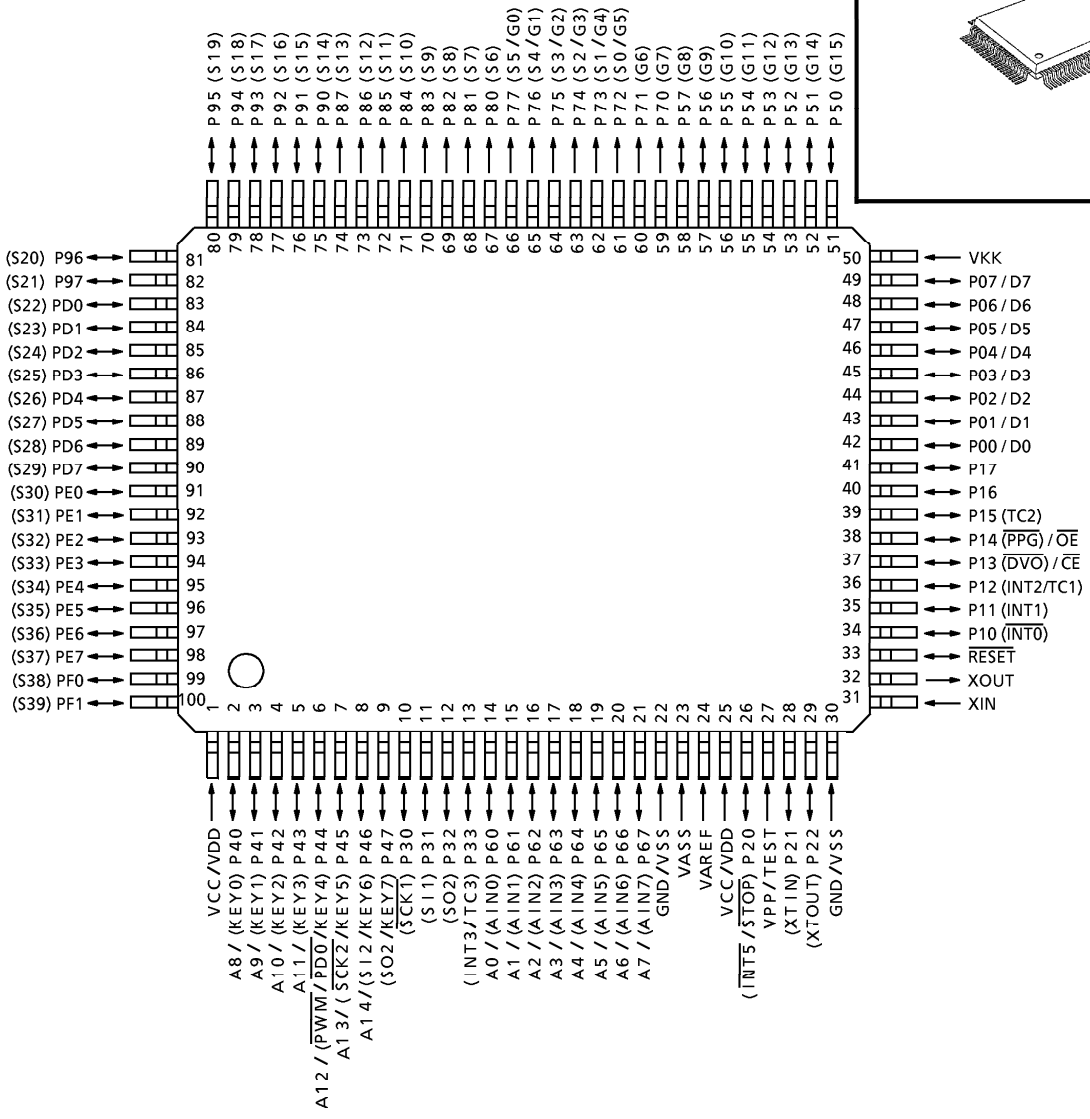
The 87PM78 is a One-Time PROM microcontroller with low-power 256K bits (32K bytes) electrically programmable read only memory for the 87CC78/CH78/CK78/CM78 system evaluation. The 87PM78 is pin compatible with the 87CC78/CH78/CK78/CM78. The operations possible with the 87CC78/CH78/CK78/CM78 can be performed by writing programs to PROM. The 87PM78 can write and verify in the same way as the TC57256AD using an adaptor socket BM1188 and an EPROM programmer.

PART No.	OTP	RAM	PACKAGE	ADAPTOR SOCKET
TMP87PM78F	32K × 8-bit	1K × 8-bit	QFP100-P-1420-0.65A	BM1188

PIN ASSIGNMENTS (TOP VIEW)

QFP100-P-1420-0.65A





PIN FUNCTION

The 87PM78 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PM78 is pin compatible with the 87CC78/CH78/CK78/CM78 (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	P46 to P40
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	+ 12.5V / 5V (Program supply voltage)	TEST
VCC		+ 5V	VDD
GND		0V	VSS
P33, P32	I/O	Pull-up with resistance for input processing	
P11, P15			
P21		PROM mode setting pin. Be fixed at high level.	
P47			
P12, P10		PROM mode setting pin. Be fixed at low level.	
P17, P16			
P22, P20			
$\overline{RESET}$			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		
VKK	Power supply	GND	
VAREF			
VASS			
PF1 to PF0	I/O	Open	
PE7 to PE0			
PD7 to PD0			
P97 to P90			
P87 to P80	Output		
P77 to P70			
P57 to P50	I/O		

OPERATIONAL DESCRIPTION

The following explains the 87PM78 hardware configuration and operation. The configuration and functions of the 87PM78 are the same as those of the 87CC78/CH78/CK78/CM78, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PM78 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 87PM78 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 87CC78/CH78/CK78/CM78 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.2 Data Memory

The 87PM78 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 87PM78 are the same as those of the 87CC78/CH78/CK78/CM78 except that the TEST pin has is no built-in pull-down resistance.

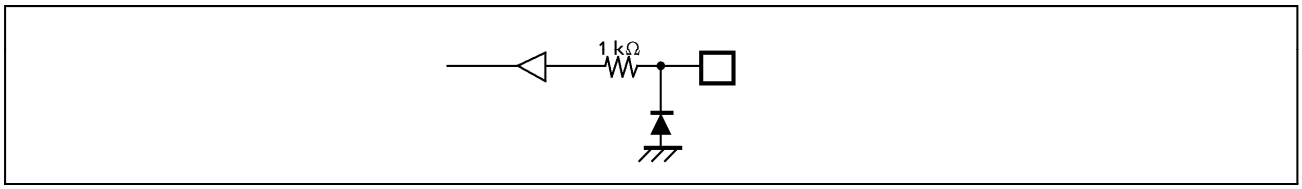


Figure 1-2. TEST Pin

(2) I/O ports

The I/O circuitries of 87PM78 I/O ports are the same as the code A type I/O circuitries of the 87CC78/CH78/CK78/CM78.

Whe using as an evaluator of other I/O codes (B, C, D), external pull-down resistors are required.

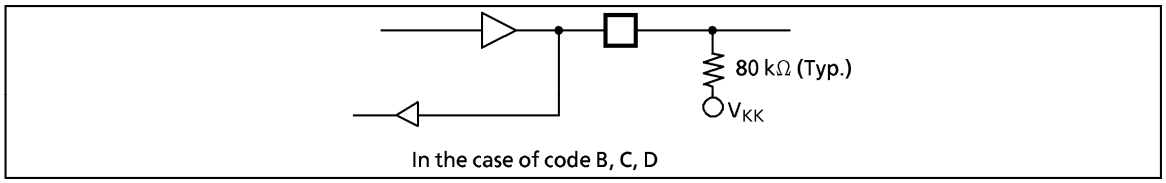


Figure 1-3. I/O Circuitry Code and External Circuitry

1.2 PROM Mode

The PROM mode is activated by setting the pins TEST, $\overline{\text{RESET}}$ and the ports P17-P10, P31-P30 and P47 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 87PM78 is not supported an electric signature mode, so the ROM type must be set to TMM27256 AD.
Set the adaptor socket switch to "N".

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

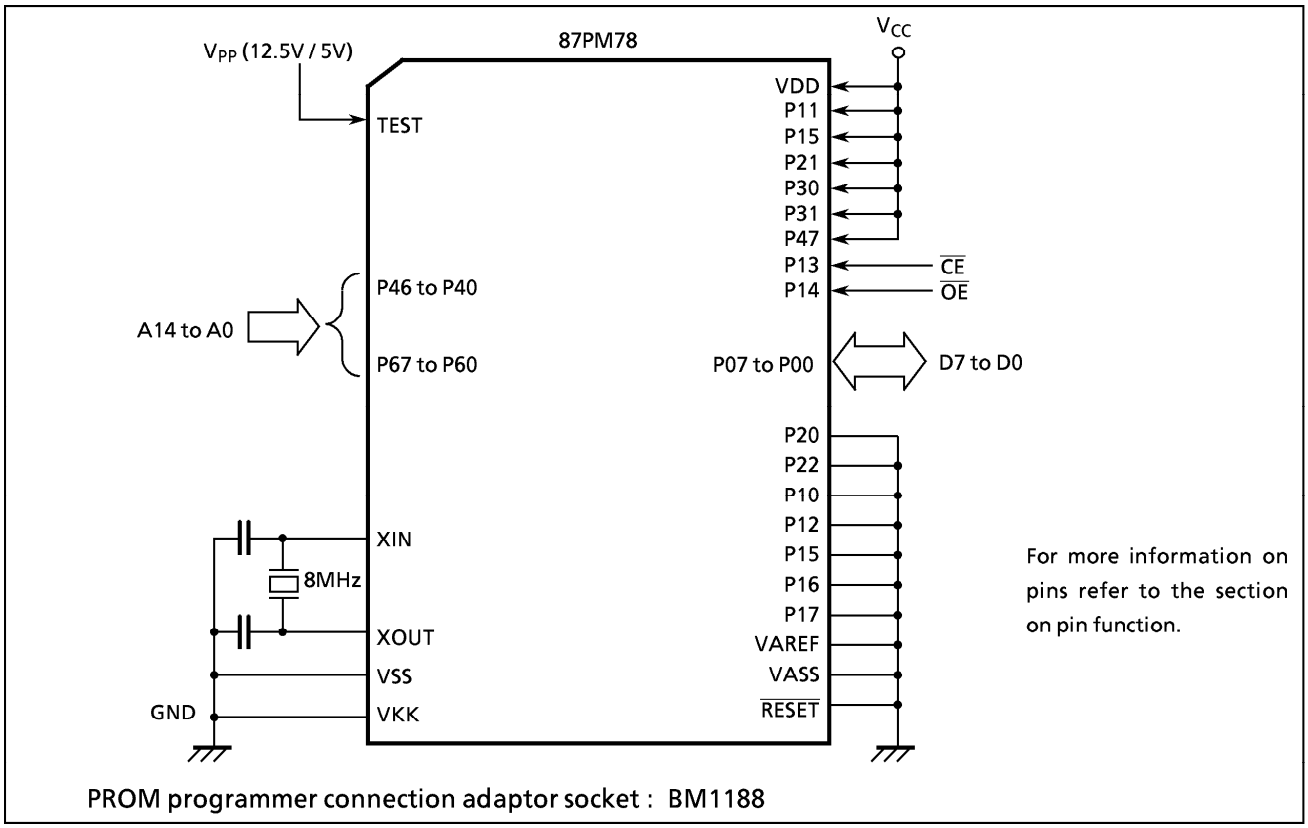


Figure 1-4. Setting for PROM Mode

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

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

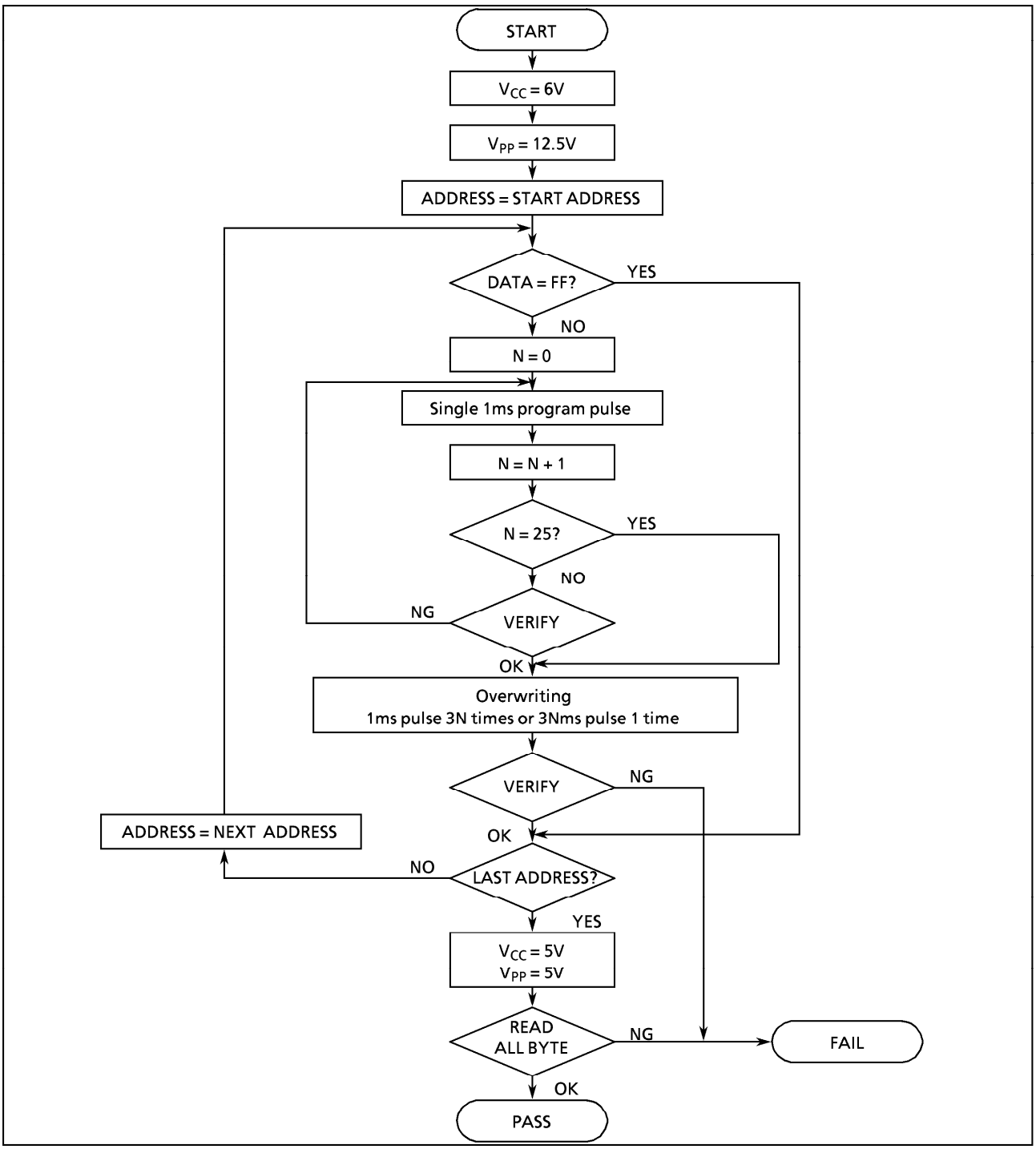


Figure 1-5. Flow Chart of High-speed Programming Mode - I

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 $\overline{CE}$ 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.

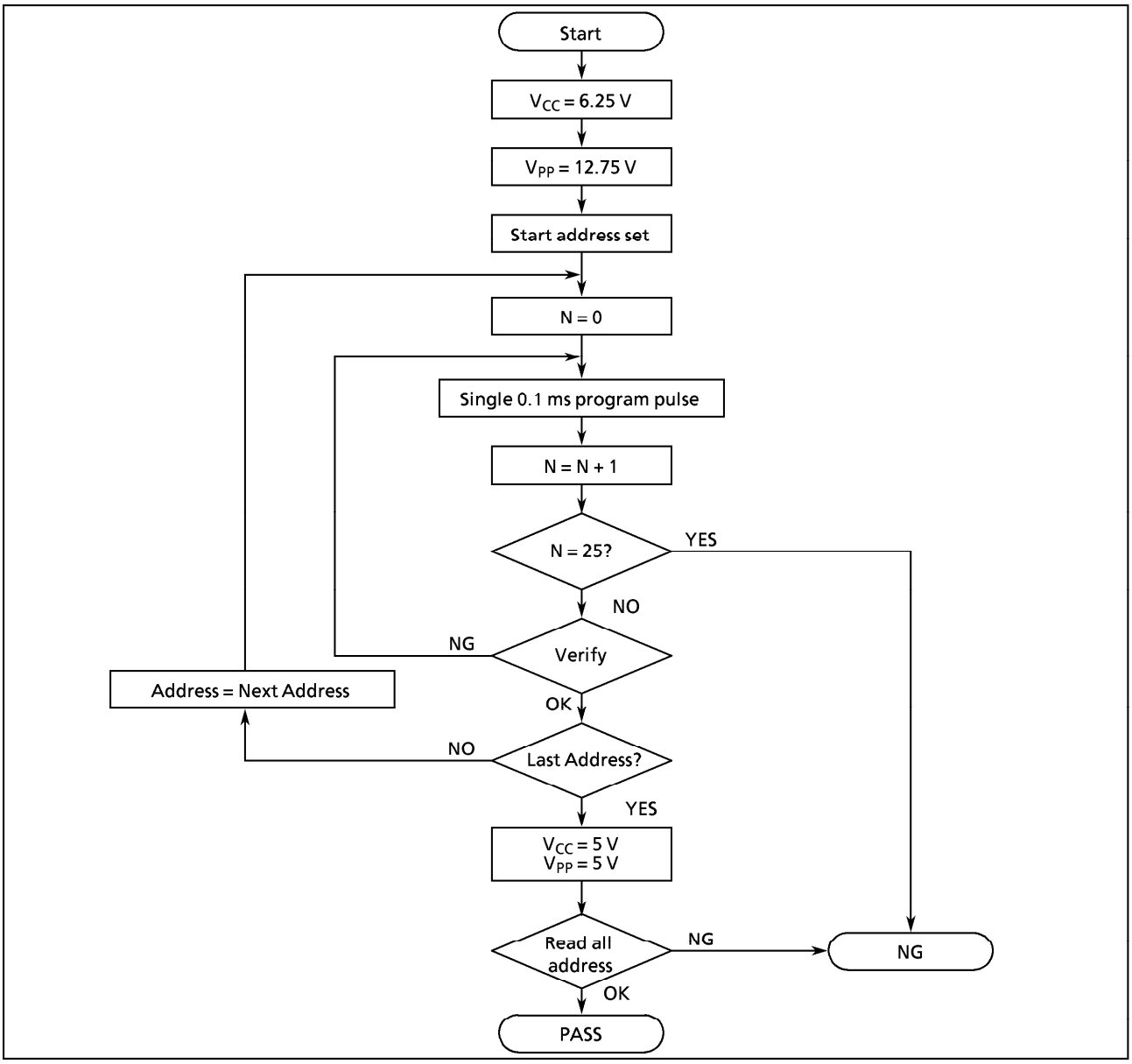


Figure 1-6. Flowchart of High-speed Programming Mode - II

1.2.3 Writing Method for General-purpose PROM Program

(1) Adapters
BM1188 : TMP87PM78F

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

(3) PROM programmer specifying
i) PROM type is specified to TC27256.
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 TMP87PM78, 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 32KB : transferred addresses 8000_H to $FFFF_H$ to addresses 0000 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 TMP87PM78 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} = 0V)

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}	P2, P3, P4, P5, P6, XOUT, $\overline{RESET}$	– 0.3 to V_{DD} + 0.3	V
	V_{OUT2}	Source open drain ports	V_{DD} – 40 to V_{DD} + 0.3	
Output Current (Per 1 pin)	I_{OUT1}	P0, P1, P2, P3, P4, P5, P6	3.2	mA
	I_{OUT3}	P8, P9, PD, PE, PF	– 12	
	I_{OUT4}	P5, P7	– 25	
Output Current (Total)	ΣI_{OUT1}	P0, P1, P2, P3, P4, P6	120	mA
	ΣI_{OUT2}	P5, P7, P8, P9, PD, PE, PF	– 120	
Power Dissipation [Topr = 25 °C]	PD	note	600	mW
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 30 to 70	°C

Note : Power Dissipation (PD) ; For PD, it is necessary to decrease 14.3 mW/°C.

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

PARAMETER	SYMBOL	PINS	CONDITIONS		Min.	Max.	UNIT
Supply Voltage	V_{DD}		fc = 8 MHz	NORMAL1, 2 modes	4.5	5.5	V
				IDLE1, 2 modes			
			fs = 32.768 kHz	SLOW mode	2.7		
				SLEEP mode			
				STOP mode	2.0		
Output Voltage	V_{OUT3}	Source open drain ports			V_{DD} – 38	V_{DD}	V
Input High Voltage	V_{IH1}	Except hysteresis input	$V_{DD} \geqq 4.5V$		$V_{DD} \times 0.70$	V_{DD}	V
	V_{IH2}	Hysteresis input			$V_{DD} \times 0.75$		
	V_{IH3}		$V_{DD} < 4.5V$		$V_{DD} \times 0.90$		
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geqq 4.5V$		0	$V_{DD} \times 0.30$	V
	V_{IL2}	Hysteresis input				$V_{DD} \times 0.25$	
	V_{IL3}		$V_{DD} < 4.5V$			$V_{DD} \times 0.10$	
Clock Frequency	fc	XIN, XOUT	VDD = 4.5 to 5.5V		0.4	8.0	MHz
			V_{DD} = 2.7 V to 5.5 V			4.2	
	fs	XTIN, XTOUT			30.0	34.0	kHz

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

D.C. CHARACTERISTICS

(V_{SS} = 0V, Topr = – 30 to 70 °C)

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Typ.	Max.	UNIT
Hysteresis Voltage	V_{HS}	Hysteresis input		–	0.9	–	V
Input Current	I_{IN1}	TEST	V_{DD} = 5.5V V_{IN} = 5.5V/0V	–	–	± 2	μA
	I_{IN2}	Open drain ports, Tri-state ports					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
	I_{IN4}	PD, PE, PF ports (Note3)		–	–	80	
Input Resistance	R_{IN1}	Port P4 with pull-down		30	70	150	kΩ
	R_{IN2}	$\overline{RESET}$		100	220	450	
Pull-down Resistance	R_K	Source open drain ports	V_{DD} = 5.5V, V_{KK} = – 30V	50	80	110	
Output Leakage Current	I_{LO1}	Sink open drain ports	V_{DD} = 5.5V, V_{OUT} = 5.5V	–	–	2	μA
	I_{LO2}	Source open drain ports and tri-state ports	V_{DD} = 5.5V, V_{OUT} = – 32V	–	–	– 2	
	I_{LO3}	Tri-state ports	V_{DD} = 5.5V, V_{OUT} = 5.5V/0V	–	–	± 2	
Output High Voltage	V_{OH2}	Tri-state ports	V_{DD} = 4.5V, I_{OH} = – 0.7 mA	4.1	–	–	V
	V_{OH3}	P8, P9, PD, PE, PF	V_{DD} = 4.5V, I_{OH} = – 8 mA	2.4	–	–	
Output Low Voltage	V_{OL}	Except XOUT	V_{DD} = 4.5V, I_{OL} = 1.6 mA	–	–	0.4	V
Output High current	I_{OH}	P5, P7	V_{DD} = 4.5V, V_{OH} = 2.4V	–	– 20	–	mA
Supply Current in NORMAL 1, 2 modes	I_{DD}		V_{DD} = 5.5V fc = 8 MHz	–	12	18	mA
Supply Current in IDLE 1, 2 modes			fs = 32.768 kHz V_{IN} = 5.3V/0.2V	–	6	8	
Supply Current in SLOW mode			V_{DD} = 3.0V fs = 32.768 kHz	–	30	60	μA
Supply Current in SLEEP mode			V_{IN} = 2.8V/0.2V	–	15	30	
Supply Current in STOP mode			V_{DD} = 5.5V V_{IN} = 5.3V/0.2V	–	0.5	10	μA

Note 1 : Typical values show those at Topr = 25 °C, V_{DD} = 5V.
Note 2 : Input Current I_{IN1}, I_{IN3} ; The current through resistor is not included, when the input resistor (pull-up/pull-down) is contained.

A/D CONVERSION CHARACTERISTICS

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

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Analog Reference Voltage	V_{AREF}	$V_{AREF} - V_{ASS} \geqq 2.5V$	V_{DD} – 1.5	–	V_{DD}	V
	V_{ASS}		V_{SS}	–	1.5	
Analog Reference Voltage Range	$\triangle V_{AREF}$		2.5	–	–	V
Analog Input Voltage	V_{AIN}		V_{ASS}	–	V_{AREF}	V
Analog Supply Current	I_{REF}	V_{AREF} = 5.5V, V_{ASS} = 0.0V	–	0.5	1.0	mA
Nonlinearity Error		V_{DD} = 5.0V, V_{SS} = 0.0V V_{AREF} = 5.000V V_{ASS} = 0.000V	–	–	± 1	LSB
Zero Point Error			–	–	± 1	
Full Scale Error			–	–	± 1	
Total Error			–	–	± 2	

Note : Quantizing error is not contained in those errors.

A.C. CHARACTERISTICS

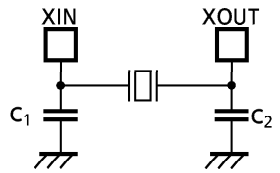
(V_{SS} = 0V, V_{DD} = 4.5 to 5.5V, Topr = – 30 to 70 °C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t_{cy}	In 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), fc = 8 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}					

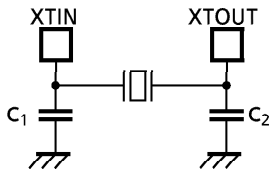
RECOMMENDED OSCILLATING CONDITIONS

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

PARAMETER	Oscillator	Oscillation Frequency	Recommended Oscillator		Recommended Constant C_1	Recommended Constant C_2
High-frequency Oscillation	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 Oscillation	Crystal Oscillator	32.768 kHz	NDK	MX-38T	15pF	15pF



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

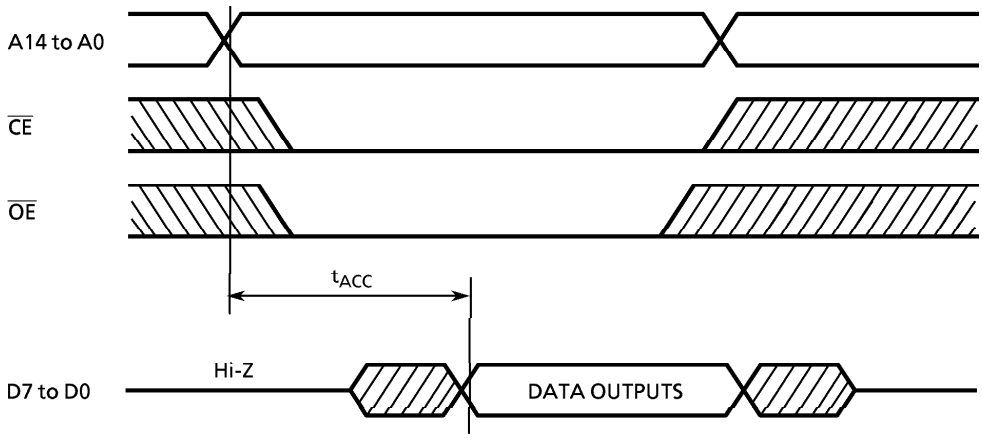
Note : An electrical shield by metal shied plate on the IC package should be recommend able in order to prevent the device from the high electric fieldstress applied for continuous reliable operation.

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

(1) Read Operation (Topr = – 30 to 70 °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} – 0.66V	V_{CC}	V_{CC} + 6.0	
Address Access Time	t_{ACC}	V_{CC} = 5.0 ± 0.5V	–	1.5tcyc + 300	–	ns

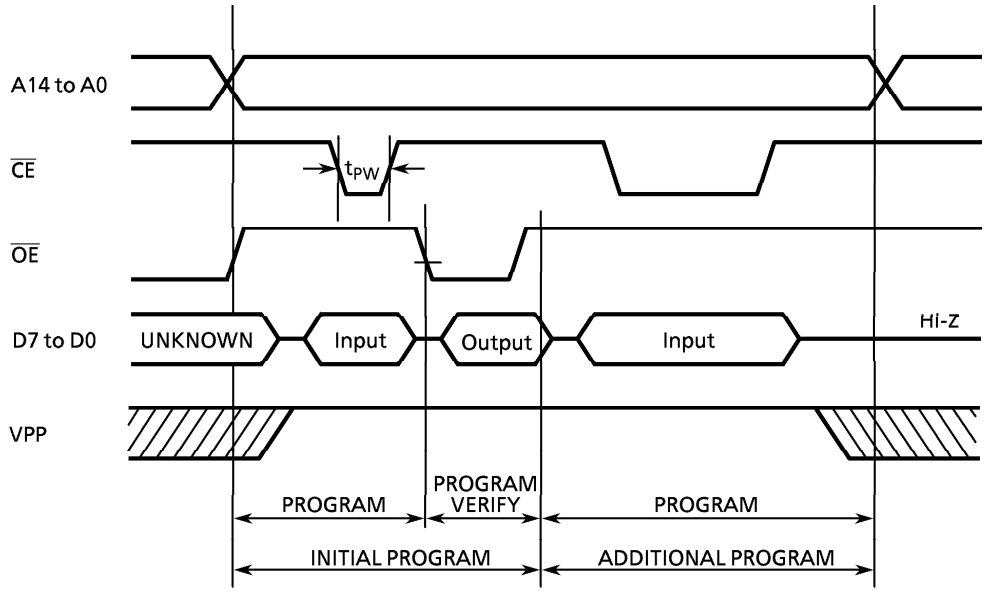
Note : tcyc = 500 ns at 8 MHz



TIMING WAVEFORMS OF READ OPERATION

(2) High-Speed Programming Operation (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
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} = 6.0V ± 0.25V V_{PP} = 12.5 ± 0.25V	0.95	1.0	1.05	ms

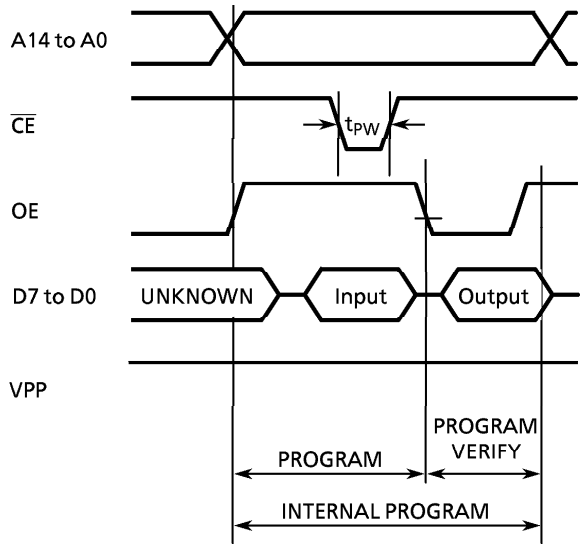


Note 1 : When V_{CC} power supply is turned on or after, V_{PP} must be increased.
When V_{CC} power supply is turned off or before, V_{PP} must be decreased.
Note 2 : The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.75V ± 0.5V) to the V_{PP} pin as the device is damaged.
Note 3 : Be sure to execute the recommended programing mode with the recommended programing adaptor. If a mode or an adaptor except the above, the misoperation sometimes occurs.

TIMING WAVEFORMS OF PROGRAMMING OPERATION

(3) PROGRAM OPERATION (High speed write mode - II) (Topr = 25 ± 5 °C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	V
Supply Voltage	V_{CC}		6.00	6.25	6.50	V
Program Supply Voltage	V_{PP}		12.50	12.75	13.0	V
Initial Program Pulse Width	t_{PW}	V_{CC} = 6.25 V ± 0.25 V, V_{PP} = 12.75 V ± 0.25 V	0.095	0.1	0.105	ms



Note 1 : When V_{cc} power supply is turned on or after, V_{pp} must be increased.
When V_{cc} power supply is turned off or before, V_{pp} must be decreased.
Note 2 : The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.75V ± 0.5V) to the V_{pp} pin as the device is damaged.