

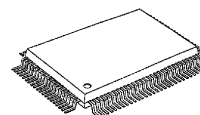
CMOS 8-Bit Microcontroller

TMP87PM78F

The 87PM78 is a One-Time PROM microcontroller with low-power 256 K bits (32 Kbytes) 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	32 K × 8-bit	1 K × 8-bit	P-QFP100-1420-0.65A	BM1188

P-QFP100-1420-0.65A



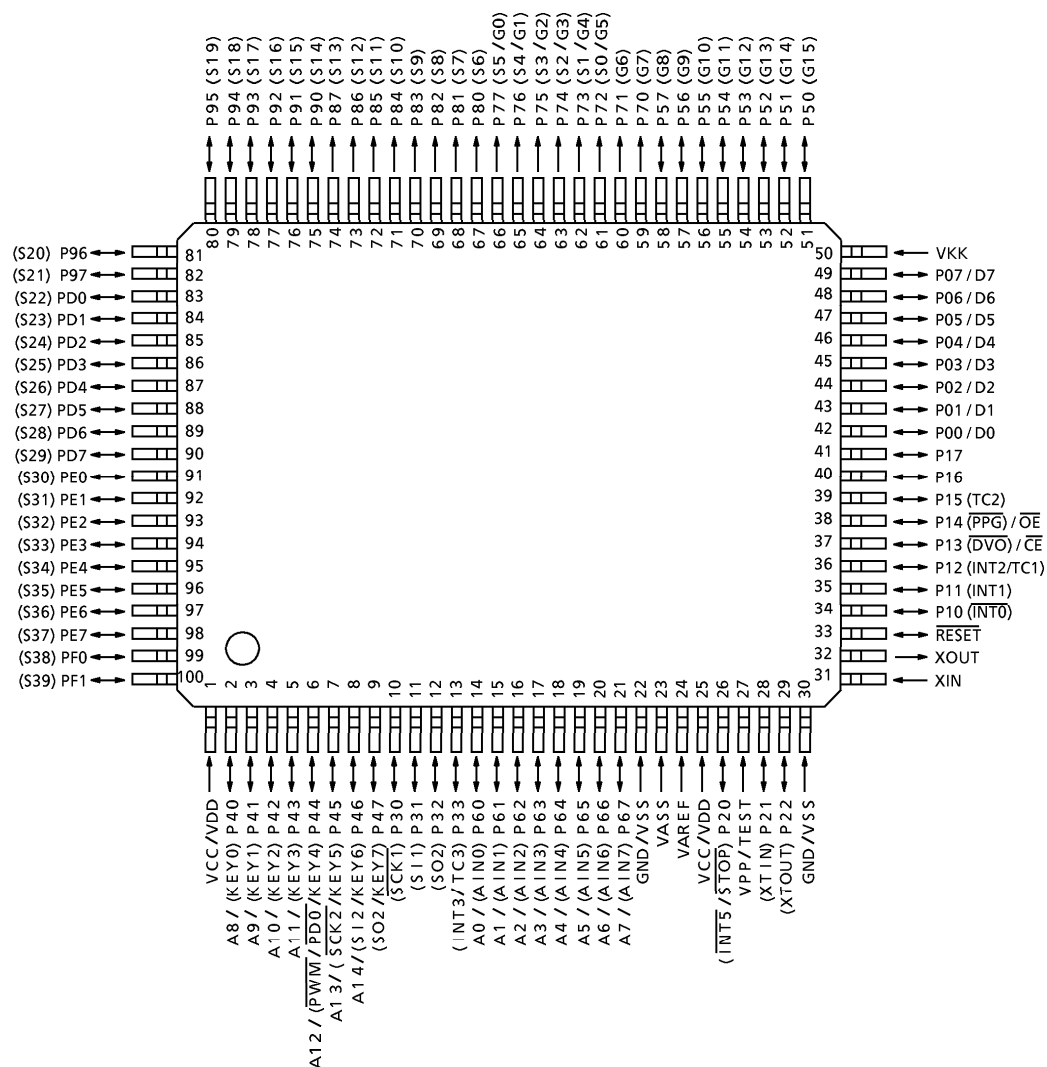
TMP87PM78F

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Pin Assignments (Top View)

P-QFP100-1420-0.65A



Note: All VDDs should be connected externally for keeping the same voltage level.

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
CE	Input	Chip enable signal input (active low)	P13
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
P33, P32	I/O	Pull-up with resistance for input processing	
P11, P15		PROM mode setting pin. Be fixed at high level.	
P21			
P47		PROM mode setting pin. Be fixed at low level.	
P12, P10			
P17, P16			
P22, P20			
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	Output		
P87 to P80			
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).

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}	P2, P3, P4, P5, P6, XOUT, 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	
	Σ I _{OUT1}	P0, P1, P2, P3, P4, P6	120	
Output Current (Total)	Σ I _{OUT2}	P5, P7, P8, P9, PD, PE, PF	– 120	mA
Power Dissipation [Topr = 25°C]	PD	Note 2	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 1: 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.

Note 2: Power Dissipation (PD) ; For PD, it is necessary to decrease 14.3 mW/°C.

Note 3: All VDDs should be connected externally for keeping the same voltage level.

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 1, 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} ≥ 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} < 4.5V	V _{DD} × 0.10			
Clock Frequency	fc	XIN, XOUT	V _{DD} = 4.5 V to 5.5 V		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 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 fc: Supply voltage range is specified in NORMAL 1/2 mode and IDLE 1/2 mode.

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 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 ports, Tri-state ports					
	I _{IN3}	RESET, STOP					
	I _{IN4}	PD, PE, PF ports (Note3)					
Input Resistance	R _{IN1}	Port P4 with pull-down		30	70	150	kΩ
	R _{IN2}	RESET		100	220	450	
Pull-down Resistance	R _K	Source open drain ports	V _{DD} = 5.5 V, V _{KK} = – 30 V	50	80	110	
Output Leakage Current	I _{LO1}	Sink open drain ports	V _{DD} = 5.5 V, V _{OUT} = 5.5 V	–	–	2	μA
	I _{LO2}	Source open drain ports and tri-state ports	V _{DD} = 5.5 V, V _{OUT} = – 32 V	–	–	– 2	
	I _{LO3}	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} = – 0.7 mA	4.1	–	–	V
	V _{OH3}	P8, P9, PD, PE, PF	V _{DD} = 4.5 V, I _{OH} = – 8 mA	2.4	–	–	
Output Low Voltage	V _{OL}	Except XOUT	V _{DD} = 4.5 V, I _{OL} = 1.6 mA	–	–	0.4	V
Output High Current	I _{OH}	P5, P7	V _{DD} = 4.5 V, V _{OH} = 2.4 V	–	– 20	–	mA
Supply Current in NORMAL 1, 2 modes	I _{DD}		V _{DD} = 5.5 V f _c = 8 MHz f _s = 32.768 kHz V _{IN} = 5.3 V / 0.2 V	–	12	18	mA
Supply Current in IDLE 1, 2 modes				–	6	8	
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	μA
Supply Current in SLEEP mode				–	15	30	
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} = 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, T_{opr} = – 30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V _{AREF}	V _{AREF} – V _{ASS} ≥ 2.5 V	V _{DD} – 1.5	–	V _{DD}	V
	V _{ASS}		V _{SS}	–	1.5	
Analog Reference Voltage Range	ΔV _{AREF}		2.5	–	–	V
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 V _{ASS} = 0.000 V	–	–	± 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

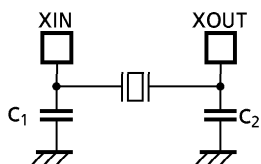
(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, T_{opr} = – 30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t _{cy}	In 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}					

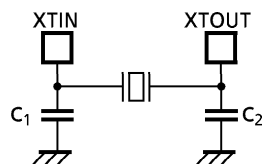
Recommended Oscillating Conditions

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

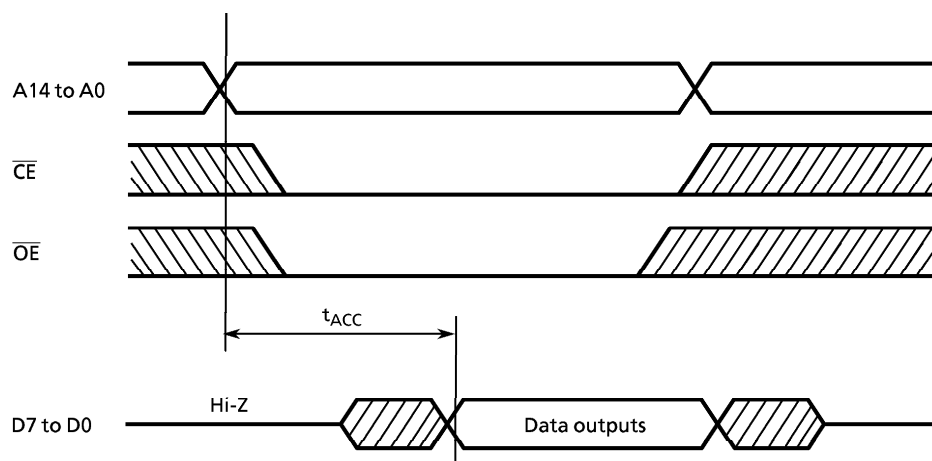


(2) Low-frequency Oscillation

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

D.C./A.C. Characteristics (PROM mode) ($V_{SS} = 0\text{ V}$)(1) Read Operation ($T_{opr} = -30\text{ to }70^{\circ}\text{C}$)

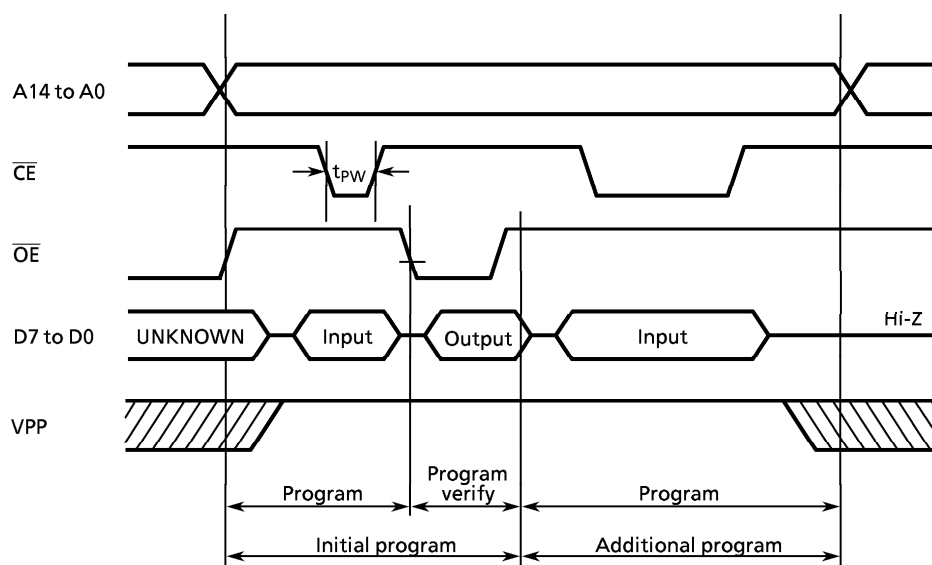
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		4.75	5.00	5.25	V
Program Power Supply Voltage	V_{PP}		$V_{CC} - 0.66\text{ V}$	V_{CC}	$V_{CC} + 6.0$	
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.5\text{ V}$	–	$1.5t_{cyc} + 300$	–	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	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}	$V_{CC} = 6.0\text{V} \pm 0.25\text{V}$ $V_{PP} = 12.5 \pm 0.25\text{V}$	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.

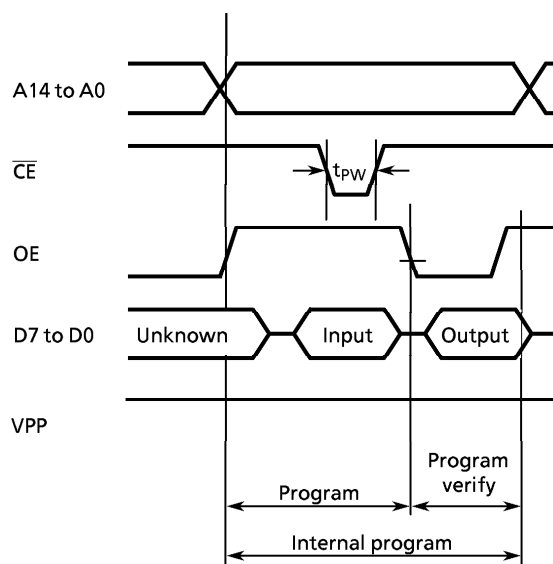
Note 2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ($12.75\text{V} \pm 0.5\text{V}$) to the V_{PP} pin as the device is damaged.

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.

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}	$V_{CC} = 6.25 \text{ V} \pm 0.25 \text{ V}$, $V_{PP} = 12.75 \text{ V} \pm 0.25 \text{ V}$	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 ($12.75 \text{ V} \pm 0.5 \text{ V}$) to the V_{PP} pin as the device is damaged.