

CMOS 8-Bit Microcontroller

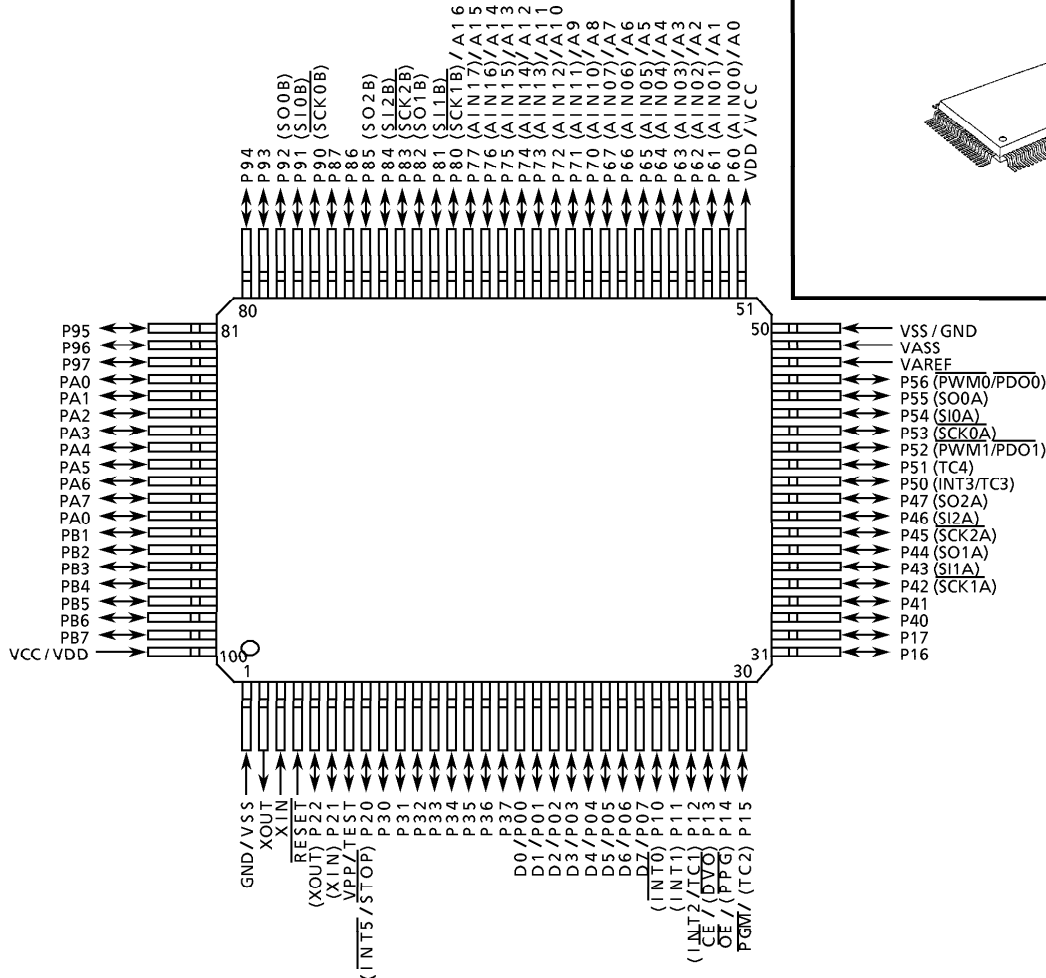
TMP87PS64F

The 87PS64 is a One-Time PROM microcontroller with low-power 480 K bits electrically programmable read only memory for the 87CS64/CP64/CM64 system evaluation. The 87PS64 is pin compatible with the 87CS64/CP64/CM64. The operations possible with the 87CS64/CP64/CM64 can be performed by writing programs to PROM. The 87PS64 can write and verify in the same way as the TMM571000D using an adaptor socket BM1185A and an EPROM programmer.

Part No.	OTP	RAM	Package	OTP Adapter
TMP87PS64F	60 K x 8-bit	2K x 8-bit	P-QFP100-1420-0.65A	BM1185A

Pin Assignments (Top View)

P-QFP100-1420-0.65A



980910EBP2

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Pin Function

The 87PS64 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PS64 is pin compatible with the 87CS64/CP64/CM64 (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)	
A16	Input	PROM address inputs	P80	
A15 to A8			P77 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	
PGM		Program mode signal input	P15	
VPP	Power supply	+ 12.75 V / 5 V (Program supply voltage)	TEST	
VCC		+ 6.25 V / 5 V	VDD (51, 100)	
GND		0 V	VSS (1, 50)	
P37 to P30	I/O	Pull-up with resistance for input processing		
P47 to P40				
P56 to P50				
P87 to P82				
P97 to P90				
PA7 to PA0				
PB7 to PB0				
P11				PROM mode setting pin. Be fixed at high level.
P21				
P81				PROM mode setting pin. Be fixed at low level.
P17, P16, P12, P10				
P22, P20				
\overline{RESET}				
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.		
XOUT	Output			
VAREF	Power Supply	0V (GND)		
VASS				

OPERATIONAL DESCRIPTION

The following explains the 87PS64 hardware configuration and operation. The configuration and functions of the 87PS64 are the same as those of the 87CS64/CP64/CM64, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PS64 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 87PS64 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 87CS64/CP64/CM64 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PS64 has a 60K × 8-bit (addresses 1100_H-FFFF_H in the MCU mode, addresses 11100_H-1FFFF_H in the PROM mode) of program memory (OTP).

To use the 87PS64 as the system evaluation for the 87CM64/CP64/CS64, the program should be written to the program memory area as shown in Figure 1-1.

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 / V_{PP} 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, P8, P9, PA	3.2	mA
	I_{OUT2}	Port P3, PB	30	
Output Current (Total)	ΣI_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7, P8, P9, PA	175	mA
	ΣI_{OUT2}	Port P3, PB	120, 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	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	$V_{DD} = 4.5\text{ to }5.5\text{ V}$	0.4	8.0	MHz	
			$V_{DD} = 2.7\text{ to }5.5\text{ V}$		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 NORMAL1/2 mode and IDLE1/2 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 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 _{IN2}	RESET		100	220	450	kΩ
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 _{OL1}	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	-	-	
Output Low Voltage	V _{OL}	Except XOUT and port P3, PB	V _{DD} = 4.5 V, I _{OL} = 1.6 mA	-	-	0.4	V
Output Low current	I _{OL3}	Port P3, PB	V _{DD} = 4.5 V, V _{OL} = 1.0 V	-	20	-	V
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	-	11	14	mA
Supply Current in IDLE 1, 2 mode				-	6	9	
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	-	3.5	5.0	mA
Supply Current in IDLE 1, 2 mode				-	2.5	3	
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	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.
 Note 2: Input Current ; The current through pull-up or pull-down resistor is not included.
 Note 3: I_{DD} ; Except for I_{REF}

A / D Conversion Characteristics

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

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
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	LSB
Zero Point Error		V _{ASS} = 0.000 V or	-	-	± 1	
Full Scale Error		V _{DD} = 2.7 V, V _{SS} = 0.0 V V _{AREF} = 2.700 V	-	-	± 1	
Total Error		V _{ASS} = 0.000 V	-	-	± 2	

Note : Total Error = total number of each type error excluding quantization error.

A.C. Characteristics

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

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t _{cy}	In NORMAL1, 2 mode	0.5	-	10	μs
		In IDLE1, 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), f _c = 8.0 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}					

(V_{SS} = 0 V, V_{DD} = 2.7 to 5.5 V, Topr = -30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t _{cy}	In NORMAL1, 2 mode	0.5	-	10	μs
		In IDLE1, 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), f _c = 4.2 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 Condition-1

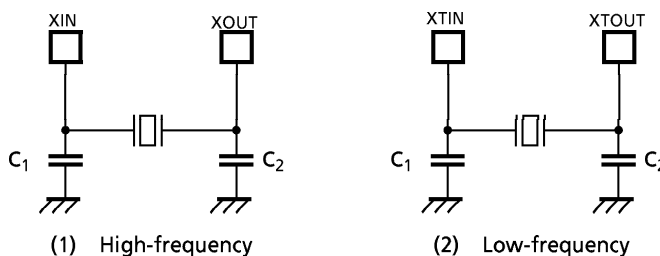
(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, Topr = - 30 to 70°C)

Parameter	Osillator	Frequency	Recommender Oscillator		Recommended Condition	
					C ₁	C ₂
High-frequency	Ceramic Resonator	8 MHz	KYOCERA	KBR8.0M	30 pF	30 pF
			Standard/Lead Type (MURATA)	CSA8.00MTZ CST8.00MTW	built-in 30 pF	built-in 30 pF
			Standard/SMP Type (MURATA)	CSACS8.00MT	30 pF	30 pF
			Standard/Small ChipType (MURATA)	CSTCS8.00MT	built-in 30 pF	built-in 30 pF
	Crystal Oscillator	8 MHz	TOYOCOM	210B 8.0000	20 pF	20 pF
			TOYOCOM	204B 4.0000		
Low-frequency	Crystal Oscillator	32.768 kHz	NDK	MX-38T	15 pF	15 pF

Recommended Oscillating Condition-2

(V_{SS} = 0 V, V_{DD} = 2.7 to 5.5 V, Topr = - 30 to 70°C)

Parameter	Osillator	Frequency	Recommender Oscillator		Recommended Condition	
					C ₁	C ₂
High-frequency	Ceramic Resonator	4 MHz	Standard/Lead Type (MURATA)	CSA4.00MG CST4.00MGW	30 pF built-in 30 pF	30 pF built-in 30 pF
			Standard/SMD Type (MURATA)	CSA4.00MGC CSAC4.00MGCM CSTC4.00MG	30 pF built-in 30 pF	30 pF built-in 30 pF
			Standard/Small Chip Type	CSTCS4.00MG	built-in 10 pF	built-in 10 pF



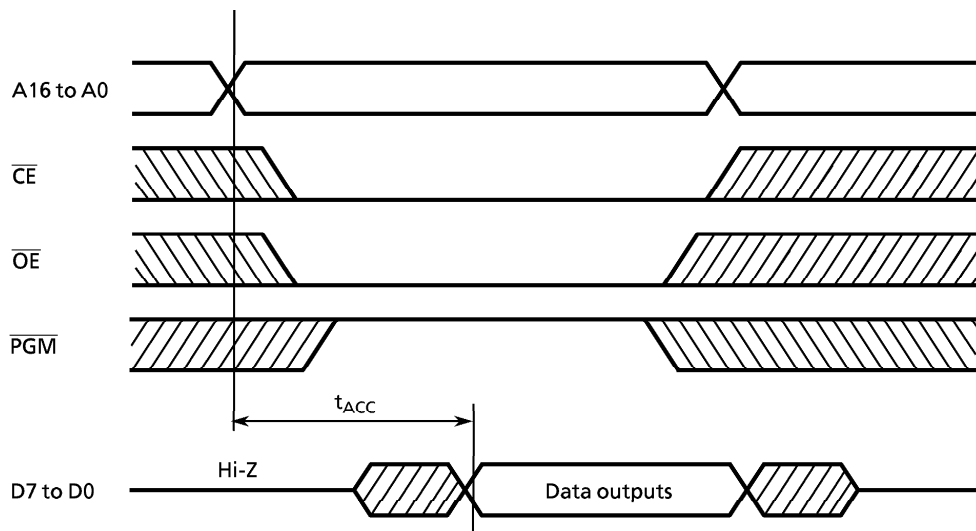
Note: When it is used in high electrical field, an electrical shield of the package is recommended to retain normal operations.

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

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

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

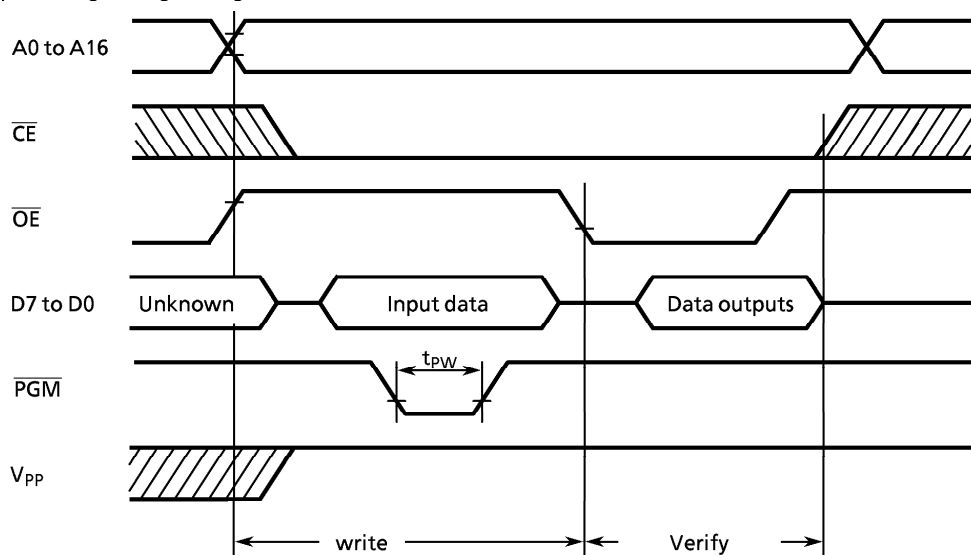
Note: $t_{cyc} = 500\text{ ns at }8\text{ MHz}$



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

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}		6.0	6.25	6.5	V
Program Power Supply Voltage	V_{PP}		12.5	12.75	13.0	V
Initial Program Pulse Width	t_{PW}	$V_{CC} = 6.0\text{ V}$	0.095	0.1	0.105	ms

High-Speed Programming Timing



- 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 increased.
- 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.