CMOS 8-Bit Microcontroller

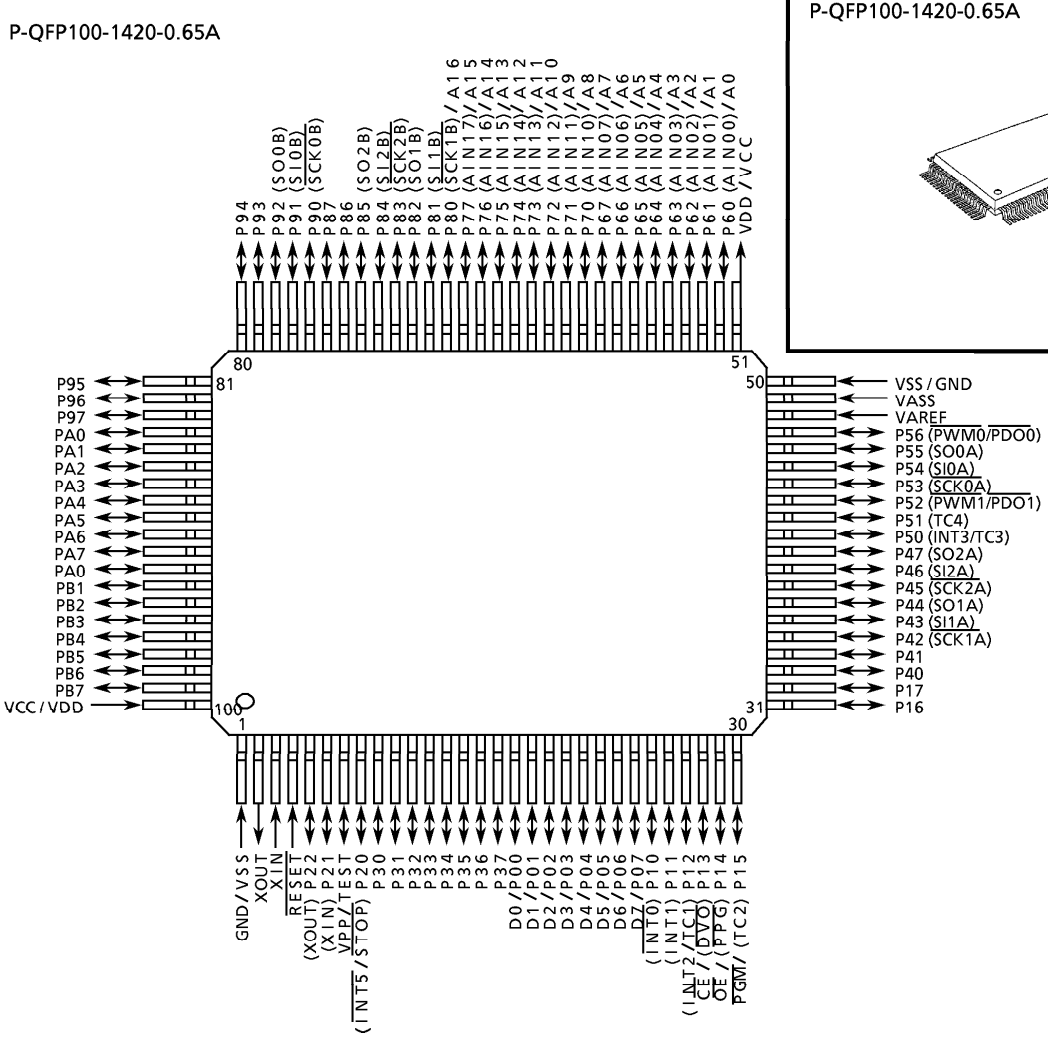
TMP87PS64F

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 × 8-bit	2K × 8-bit	P-QFP100-1420-0.65A	BM1185A

Pin Assignments (Top View)

P-QFP100-1420-0.65A



P-QFP100-1420-0.65A

TMP87PS64F

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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
$\overline{PGM}$		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			
P17, P16, P12, P10 P22, P20		PROM mode setting pin. Be fixed at low level.	
$\overline{RESET}$			
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 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 [Topr = 70°C]	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 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	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			fc = 4.2 MHz	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			fs = 32.768 kHz	SLOW mode			
				SLEEP mode			
				STOP mode	2.0		
Input High Voltage	V_{IH1}	Except hysteresis input	$V_{DD} \geqq 4.5$ V		$V_{DD} \times 0.70$	V_{DD}	V
	V_{IH2}	Hysteresis input			$V_{DD} \times 0.75$		
	V_{IH3}		$V_{DD} < 4.5$ V		$V_{DD} \times 0.90$		
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geqq 4.5$ V		0	$V_{DD} \times 0.30$	V
	V_{IL2}	Hysteresis input				$V_{DD} \times 0.25$	
	V_{IL3}		$V_{DD} < 4.5$ V			$V_{DD} \times 0.10$	
Clock Frequency	fc	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	
	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.

Note2: Clock frequency fc: Supply voltage range is specified in NORMAL1/2 mode and IDLE1/2 mode.

D.C. Characteristics

(V_{SS} = 0 V, Topr = – 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}	$\overline{RESET}$, $\overline{STOP}$					
Input Low Current	I_{IL}	Push-pull ports	V_{DD} = 5.5 V, V_{IN} = 0.4 V	–	–	– 2	mA
Input Resistance	R_{IN2}	$\overline{RESET}$		100	220	450	kΩ
Output Leakage Current	I_{LO1}	Open drain ports	V_{DD} = 5.5 V, VOUT = 5.5 V	–	–	2	μA
	I_{LO2}	tri-state ports	V_{DD} = 5.5 V, VOUT = 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 fc = 8 MHz fs = 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 fc = 4.19 MHz fs = 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 fs = 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 Topr = 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}	$V_{AREF} - V_{ASS} \geqq 2.5$ 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 V_{ASS} = 0.000 V or V_{DD} = 2.7 V, V_{SS} = 0.0 V V_{AREF} = 2.700 V V_{ASS} = 0.000 V	–	–	± 1	LSB
Zero Point Error			–	–	± 1	
Full Scale Error			–	–	± 1	
Total Error			–	–	± 2	

Note : Total Error = total number of each type error excluding guantization 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), fc = 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), fs = 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), fc = 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), fs = 32.768 kHz	14.7	–	–	μs
Low Level Clock Pulse Width	t_{WSL}					

Recomended Oscillating Condition-1

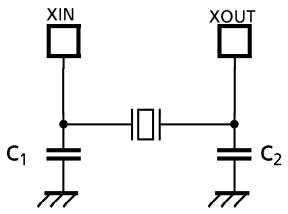
(VSS = 0 V, VDD = 4.5 to 5.5 V, Topr = – 30 to 70°C)

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
		4 MHz	KYOCERA	KBR4.0MS	30 pF	30 pF
	Crystal Oscillator	8 MHz	TOYOCOM	210B 8.0000	20 pF	20 pF
		4 MHz	TOYOCOM	204B 4.0000		
Low-frequency	Crystal Oscillator	32.768 kHz	NDK	MX-38T	15 pF	15 pF

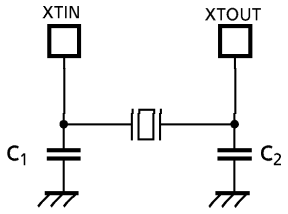
Recomended Oscillating Condition-2

(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	CSA4.00MG	30 pF	30 pF
			(MURATA)	CST4.00MGW	built-in 30 pF	built-in 30 pF
			Standard/SMD Type (MURATA)	CSA4.00MGC CSAC4.00MGCM CSTC4.00MG	30 pF	30 pF
					built-in 30 pF	built-in 30 pF
			Standard/Small Chip Type	CSTCS4.00MG	built-in 10 pF	built-in 10 pF



(1) High-frequency



(2) Low-frequency

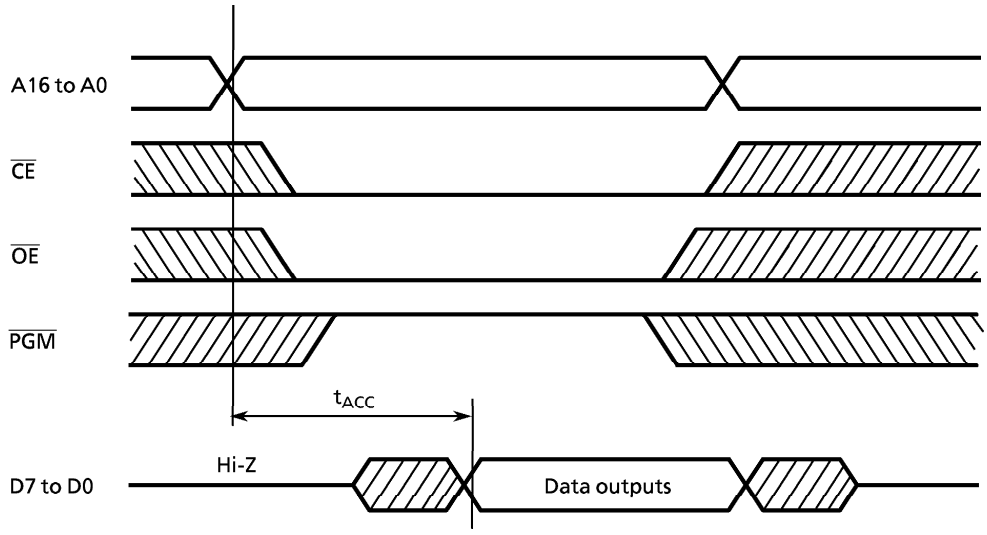
Note: When it is used in high electrical field, an electrical shield of the package is recommended to retain normal operations.

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

(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	5.0	5.25	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	V_{CC} = 5.0 ± 0.25 V	–	1.5 tcyc + 300	–	ns

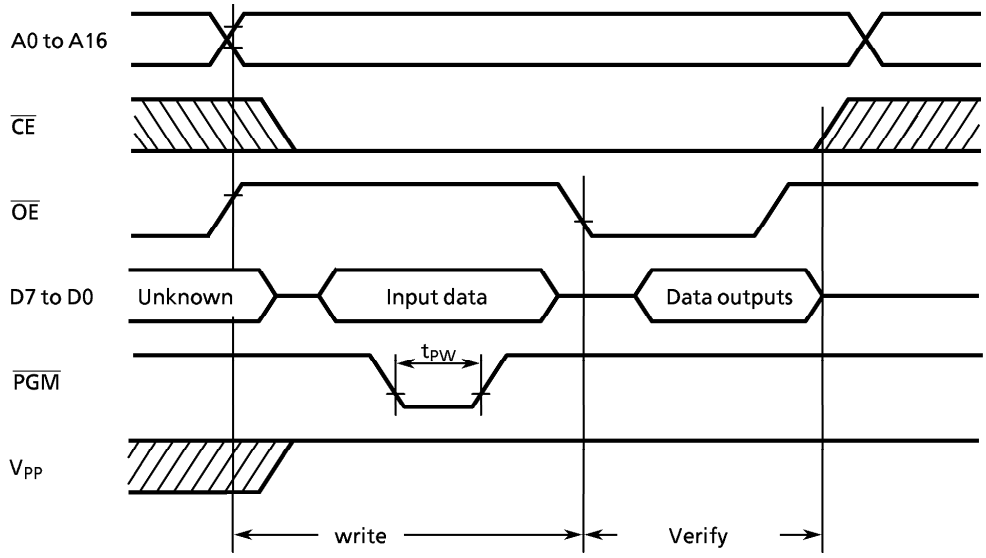
Note: tcyc = 500 ns at 8 MHz



(2) Program Operation (High-Speed Programming Mode) (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}		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 V	0.095	0.1	0.105	ms

High-Speed Programing 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 op from it under applying the program voltage (12.75 V ± 0.25 V) 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.