

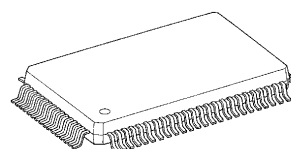
CMOS 8-Bit Microcontroller

TMP87PP21F **TMP87PP21DF**

The TMP87PP21 is a One-Time PROM microcontroller with low-power 48 K × 8 bits electrically programmable read only memory for the TMP87CH21C/M21C/P21C system evaluation. The TMP87PP21 is pin compatible with the TMP87CH21C/M21C/P21C. The operations possible with the TMP87CH21C/M21C/P21C can be performed by writing programs to PROM. The TMP87PP21 can write and verify in the same way as the TC571000D using an adaptor socket BM11104/BM11105 and an EPROM programmer.

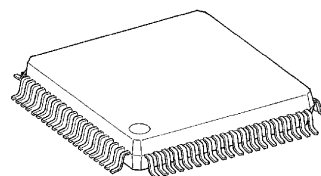
Product No.	OTP	RAM	Package	OTP Adapter
TMP87PP21F	48 K × 8 bits	2 K × 8 bits	P-QFP80-1420-0.80B	BM11104
TMP87PP21DF			P-LQFP80-1212-0.50A	BM11105

P-QFP80-1420-0.80B



TMP87PP21F

P-LQFP80-1212-0.50A



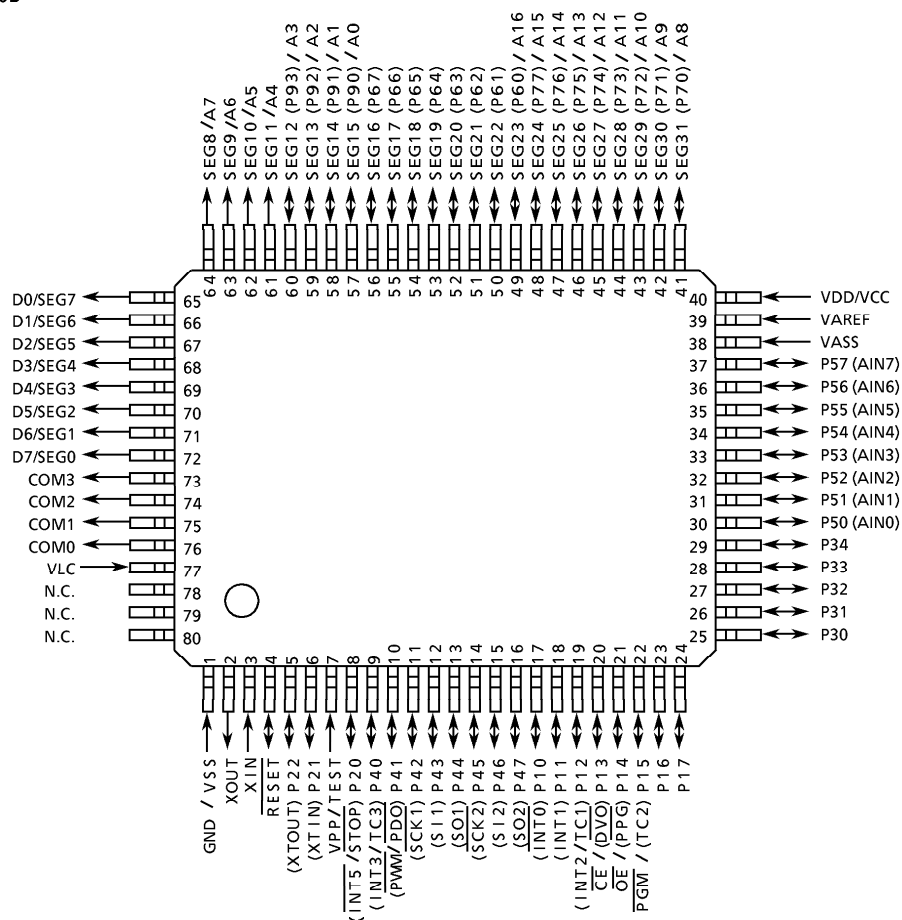
TMP87PP21DF

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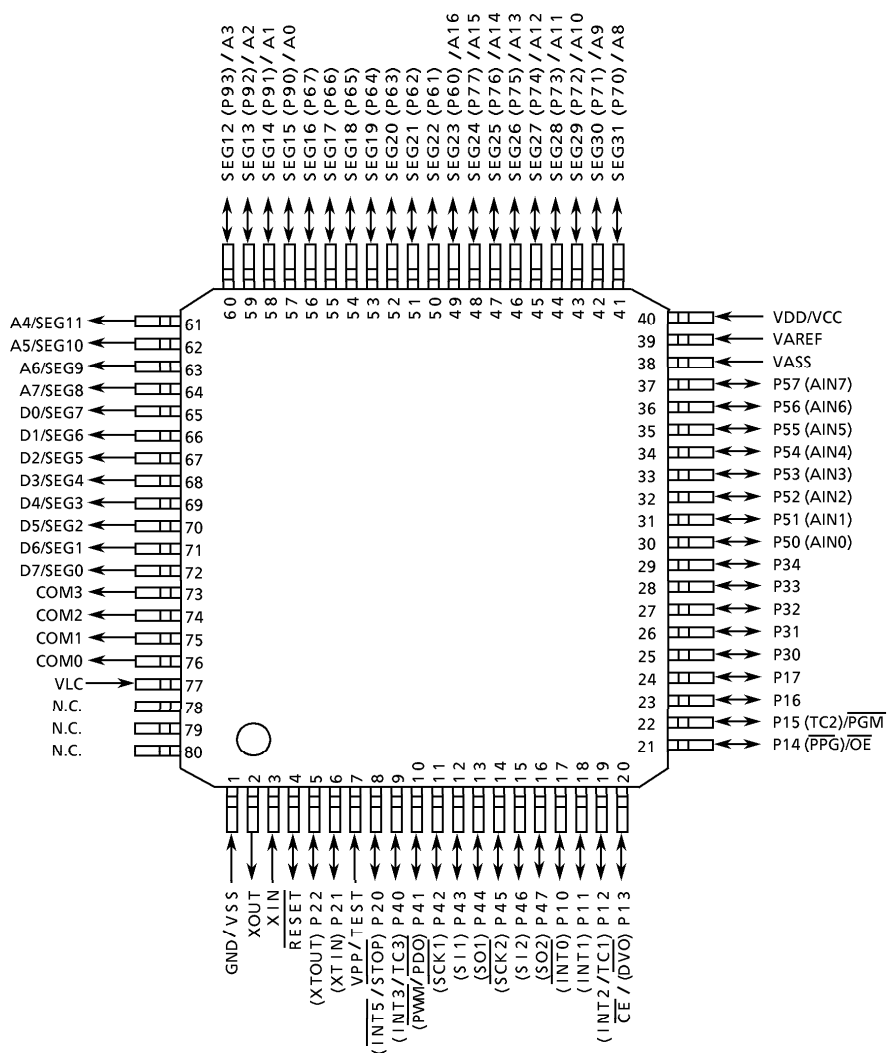
Pin Assignments (Top View)

P-QFP80-1420-0.80B



Note: Always keep N.C. pins open.

P-LQFP80-1212-0.50A



Note: Always keep N.C. pins open.

Pin Functions

The TMP87PP21 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the TMP87PP21 is pin compatible with the TMP87CH21C/M21C/P21C (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	P60
A15 to A8			P77 to P70
A7 to A0			SEG8 to 11, P93 to P90
D7 to D0	I/O	PROM data input/outputs	SEG0 to SEG7
$\overline{CE}$	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
GND		0 V	VSS
P37 to P32, P30	I/O	Pull-up with resistance for input processing.	
P47 to P40			
P57 to P50			
P67 to P62			
P11		PROM mode setting pin. Be fixed at high level.	
P21			
P31			
P61			
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	0 V (GND)	
VASS			
COM3 to COM0	Output	Open	
VLC	LCD driver Power supply		

Operational Description

The following explains the TMP87PP21 hardware configuration and operation. The configuration and functions of the TMP87PP21 are the same as those of the TMP87CH21C/M21C/P21C, except in that a one-time PROM is used instead of an on-chip mask ROM.

The TMP87PP21 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 TMP87PP21 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 TMP87CH21C/M21C/P21C (the TEST/VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The TMP87PP21 has a 48K × 8 bits (addresses 4000_H to FFFF_H in the MCU mode, addresses 14000_H to 1FFFF_H in the PROM mode) of program memory (OTP).

When the TMP87PP21 is used as a system evaluation of the TMP87CH21C/M21C/P21C, the data is written to the program storage area shown in Figure 1-1.

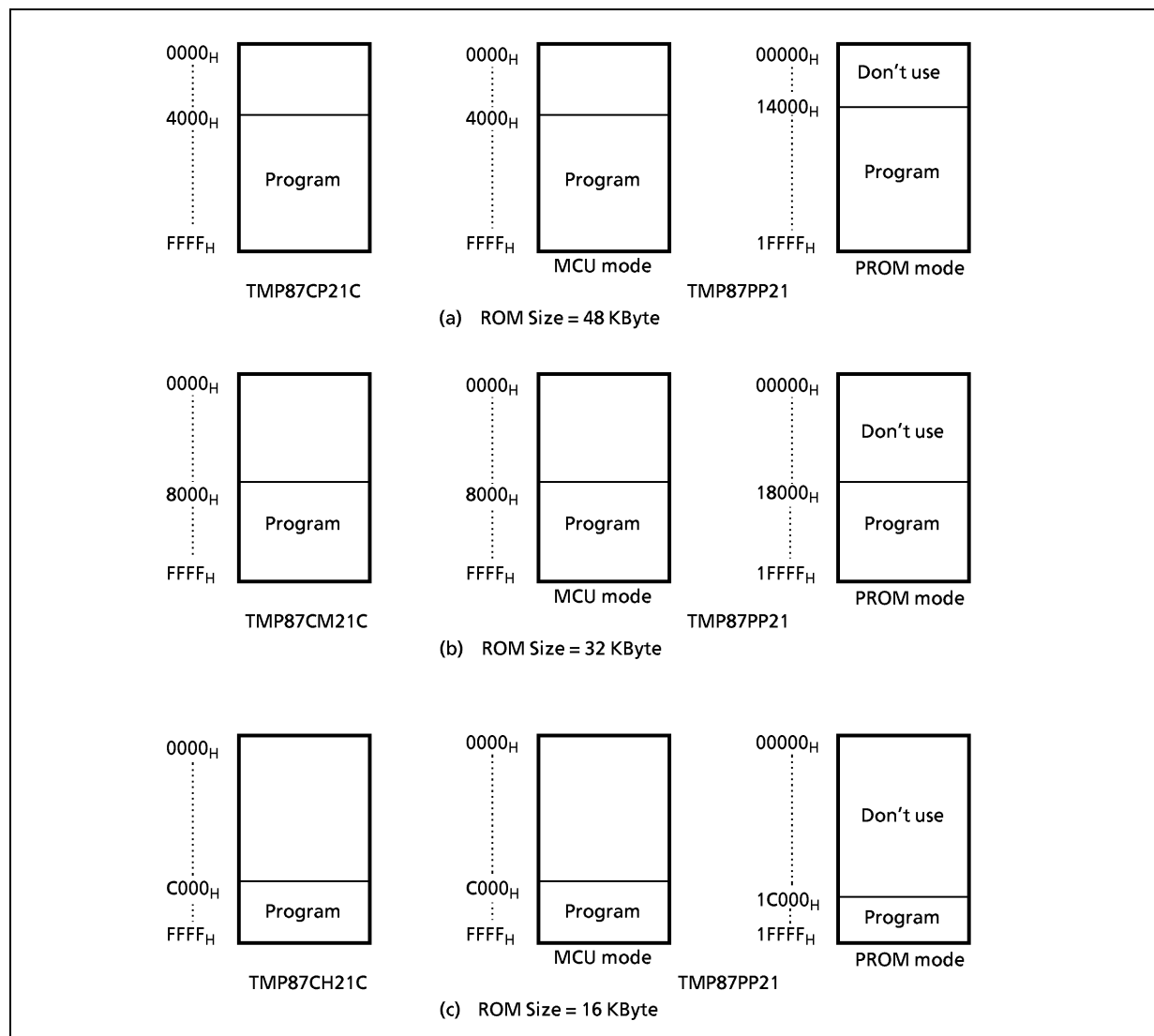


Figure 1-1. Program Storage Area

Note: Either write the data FF_H to the unused area or set the PROM programmer to access only the program storage area.

1.1.2 Data Memory

The TMP87PP21 has an on-chip 2 K × 8 bits data memory (static RAM).

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/V _{PP}	– 0.3 to 13.0	
Input Voltage	V _{IN}		– 0.3 to V _{DD} + 0.3	
Output Voltage	V _{OUT}		– 0.3 to V _{DD} + 0.3	
Output Current (Per 1 pin)	I _{OUT1}	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	3.2	mA
	I _{OUT2}	P41	30	
Output Current (Total)	Σ I _{OUT1}	Ports P0, P1, P2, P3, P5, P6, P7, P8, P9, P4 (except P41)	120	
	Σ I _{OUT2}	P41	30	
Power Dissipation [T _{opr} = 70°C]	PD		350	mW
Soldering Temperature (time)	T _{slid}		260 (10 s)	°C
Storage Temperature	T _{stg}		– 55 to 125	
Operating Temperature	T _{opr}		– 30 to 70	

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, T_{opr} = – 30 to 70°C)

Parameter	Symbol	Pins	Conditions		Min	Max	Unit
Supply Voltage	V _{DD}		f _c = 8 MHz	NORMAL1, 2 mode	4.5	5.5	
				IDLE1, 2 mode			
			f _c = 4.2 MHz	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			f _s = 32.768 kHz	SLOW mode			
				SLEEP mode			
	STOP mode	2.0					
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 _{IL2}	Hysteresis input				V _{DD} × 0.25	
	V _{IL3}		V _{DD} < 4.5 V	V _{DD} × 0.10			
Clock Frequency	f _c	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	
	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 fc: Supply voltage range is specified in NORMAL1/2 mode and IDLE1/2 mode.

DC 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		—	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 _{LO}	Open drain ports Tri-state ports	V _{DD} = 5.5 V, V _{OUT} = 5.5 V	—	—	2	μA
Output High Voltage	V _{OH1}	Push-pull ports P4 ports	V _{DD} = 4.5 V, I _{OH} = – 200 μA	2.4	—	—	V
	V _{OH2}	Tri- state ports P1, P5 ports	V _{DD} = 4.5 V, I _{OH} = – 0.7 mA	4.1	—	—	
Output Low Voltage	V _{OL}	Except XOUT and P41	V _{DD} = 4.5 V, I _{OL} = 1.6 mA	—	—	0.4	
Output Low Current	I _{OL3}	P41	V _{DD} = 4.5 V, V _{OL} = 1.0 V	—	20	—	
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	—	12	18	mA
Supply Current in IDLE 1, 2 mode				—	6	10	
Supply Current in SLOW mode			V _{DD} = 3.0 V f _s = 32.768 kHz V _{IN} = 2.8 V/0.2 V LCD driver is not enable	—	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	
Segment Output Low Resistance	R _{OS1}	SEG31 to SEG0	V _{DD} = 5 V V _{DD} – V _{LC} = 3 V	—	20	—	kΩ
Common Output Low Resistance	R _{OC1}	COM3 to COM0					
Segment Output High Resistance	R _{OS2}	SEG31 to SEG0		—	200	—	
Common Output High Resistance	R _{OC2}	COM3 to COM0					
Segment/Common Output Voltage	V _{O 2/3}	SEG31 to SEG0 and COM3 to COM0		3.8	4.0	4.2	V
	V _{O 1/2}		3.3	3.5	3.7		
	V _{O 1/3}		2.8	3.0	3.2		

Note 1: Typical values show those at T_{opr} = 25°C, V_{DD} = 5 V.

Note 2: Input Current ; The current through pull-up or pull-down resistor is not included.

Note 3: I_{DD}: Except for I_{REF}

Note 4: Output resistors Ros, Roc indicate “on” when switching levels.

Note 5: V_{O2/3} indicates an output voltage at the 2/3 level when operating in the 1/4 or 1/3 duty mode.

Note 6: V_{O1/2} indicates an output voltage at the 1/2 level when operating in the 1/2 duty or static mode.

Note 7: V_{O1/3} indicates an output voltage at the 1/3 level when operating in the 1/4 or 1/3 duty mode.

Note 8: When using LCD, it is necessary to consider values of Ros1/2 and Roc1/2.

Note 9: Times for SEG/COM output switching on: Ros1, Roc1: 26/f_c, 2/f_s (s)

Ros2, Roc2: 1/(n, f_F)

(1/n: duty, f_F: frame frequency)

AD Conversion Characteristics

(V_{SS} = 0 V, V_{DD} = 2.7 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}	
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: Quantizing error is not contained in those errors.

AC Characteristics - 1

(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 NORMAL 1, 2 mode	0.5	—	10	μs
		In IDLE 1, 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 MHz	62.5	—	—	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}					

AC Characteristics - 2

(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 NORMAL 1, 2 mode	0.95	—	10	μs
		In IDLE 1, 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	110	—	—	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

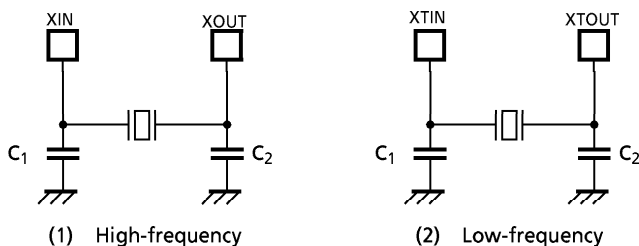
(VSS = 0 V, VDD = 4.5 to 5.5 V, Topr = -30 to 70°C)

Parameter	Oscillator	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) CSAC8.00MT	30 pF	30 pF
			Standard/Small Chip Type (MURATA) CSTC8.00MT	built-in 30 pF	built-in 30 pF
	Crystal Oscillator	4 MHz	KYOCERA KBR4.0MS	30 pF	30 pF
		8 MHz	TOYOCOM 210B 8.0000	20 pF	20 pF
Low-frequency	Crystal Oscillator	4 MHz	TOYOCOM 204B 4.0000		
		32.768 kHz	NDK MX-38T	15 pF	15 pF

Recommended Oscillating Condition-2

(VSS = 0 V, VDD = 2.7 to 5.5 V, Topr = -30 to 70°C)

Parameter	Oscillator	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	30 pF
				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
				10 pF	10 pF



Note1: When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

Note2: The product numbers and specifications of the resonators by Murata Manufacturing Co., Ltd. are subject to change. For up-to-date information, please refer to the following URL;

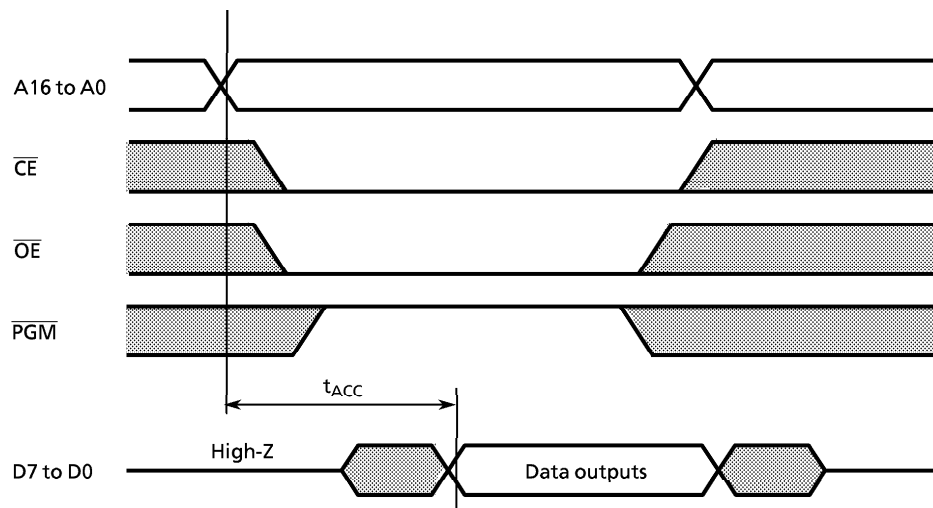
<http://www.murata.co.jp/search/index.html>

DC/AC Characteristics (PROM mode)

(V_{SS} = 0 V)

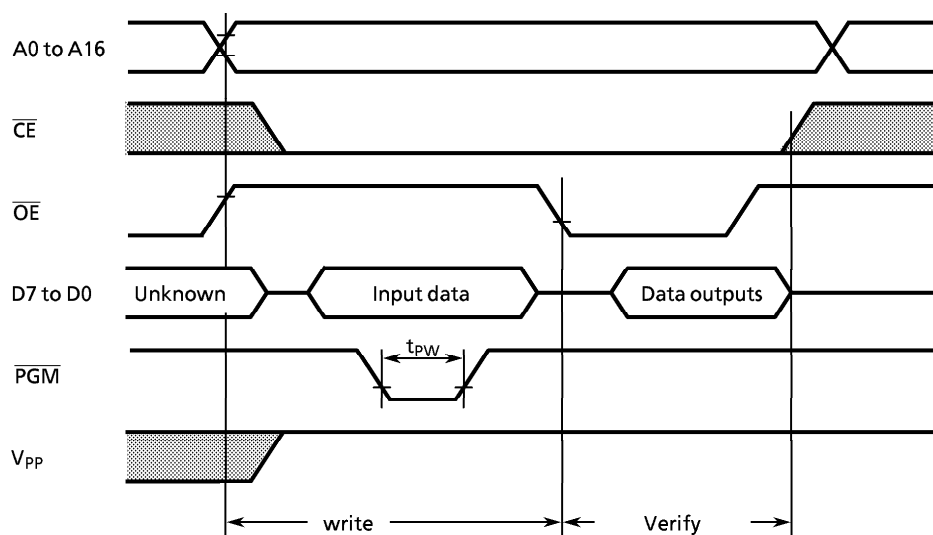
(1) Read Operation

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V _{IH4}		V _{CC} × 0.7	—	V _{CC}	V
Input Low Voltage	V _{IL4}		0	—	V _{CC} × 0.12	
Power Supply Voltage	V _{CC}		4.75	5.0	5.25	
Program Power Supply Voltage	V _{PP}					
Address Access Time	t _{ACC}	V _{CC} = 5.0 ± 0.25 V	—	1.5 t _{cy} + 300	—	ns

Note: t_{cy} = 500 ns at 8 MHz

(2) High-Speed Programming 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	–	$V_{CC} \times 0.12$	
Power Supply Voltage	V_{CC}		6.0	6.25	6.5	
Program Power Supply Voltage	V_{PP}		12.5	12.75	13.0	
Initial Program Pulse Width	t_{PW}	$V_{CC} = 6.0\text{ V}$	0.095	0.1	0.105	ms



Note1: 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.

Note2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ($12.75\text{ V} \pm 0.25\text{ V} = V$) to the V_{PP} pin as the device is damaged.

Note3: 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.