

CMOS 8-BIT MICROCONTROLLER

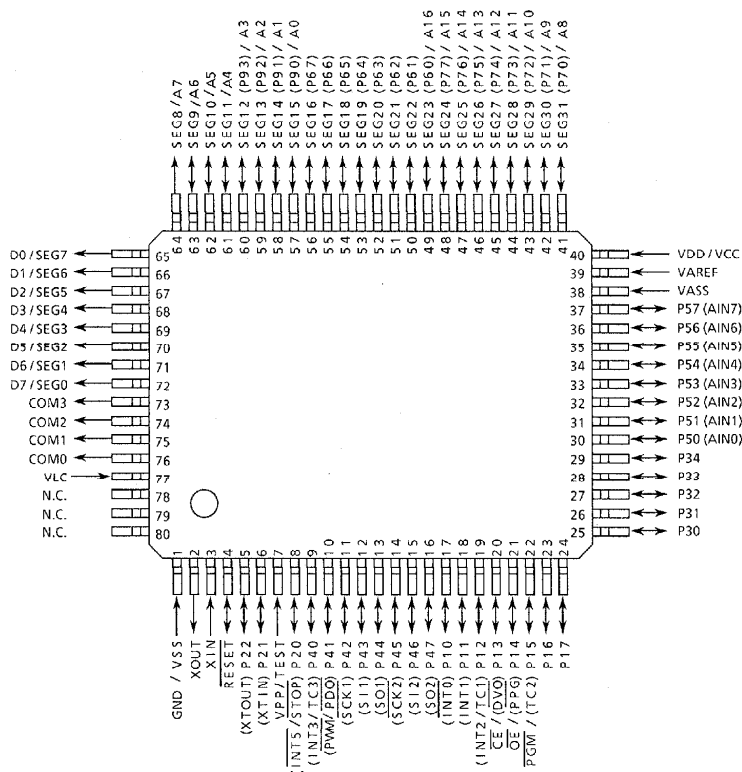
TMP87PP21F
TMP87PP21DF

The 87PP21 is a One-Time PROM microcontroller with low-power 384K bits electrically programmable read only memory for the 87CH21/CM21 system evaluation. The 87PP21 is pin compatible with the 87CH21/CM21. The operations possible with the 87CH21/CM21 can be performed by writing programs to PROM. The 87PP21 can write and verify in the same way as the TC571000D using an adaptor socket BM11104/BM11105 and an EPROM programmer.

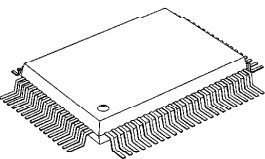
PART No.	OTP	RAM	PACKAGE	OTP ADAPTER
TMP87PP21F	48K x 8-bit	2K x 8-bit	QFP80-P-1420-0.80B	BM11104
TMP87PP21DF			LQFP80-P-1212-0.50A	BM11105

PIN ASSIGNMENTS (TOP VIEW)

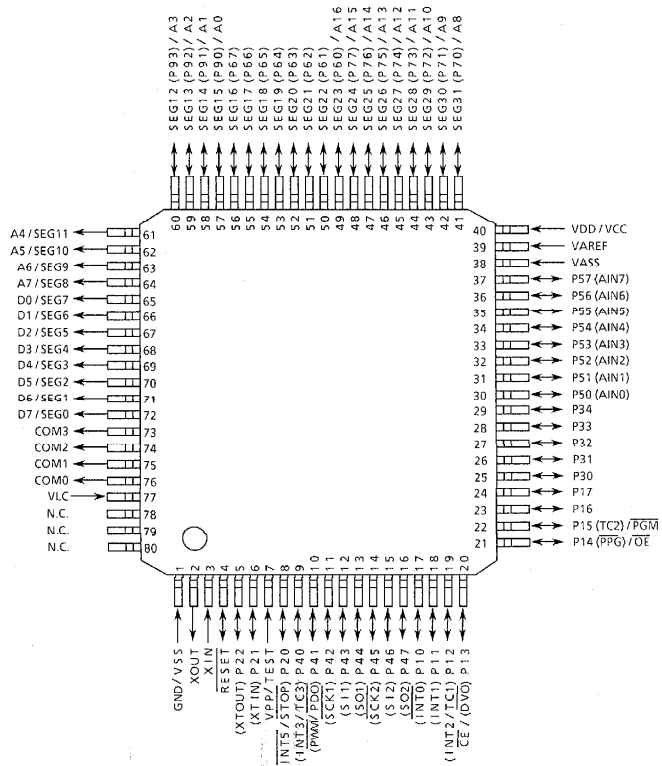
QFP80-P-1420-0.80B



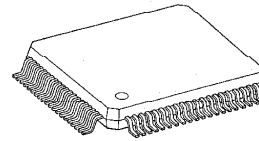
QFP80-P-1420-0.80B



LQFP80-P-1212-0.50A



LQFP80-P-1212-0.50A



PIN FUNCTION

The 87PP21 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PP21 is pin compatible with the 87CH21/CM21 (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		0V	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 8MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power supply	0 V (GND)	
VASS			
COM3 to COM0	Output	Open	
VLC	Power supply		

OPERATIONAL DESCRIPTION

The following explains the 87PP21 hardware configuration and operation. The configuration and functions of the 87PP21 are the same as those of the 87CH21/CM21, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PP21 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 87PP21 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 87CH21/CM21 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PP21 has a 48K × 8-bit (addresses 4000_H-FFFF_H in the MCU mode, addresses 14000_H-1FFFF_H in the PROM mode) of program memory (OTP).

When the 87PP21 is used as a system evaluation of the 87CH21/CM21, the data is written to the program storage area shown in figure 1-1.

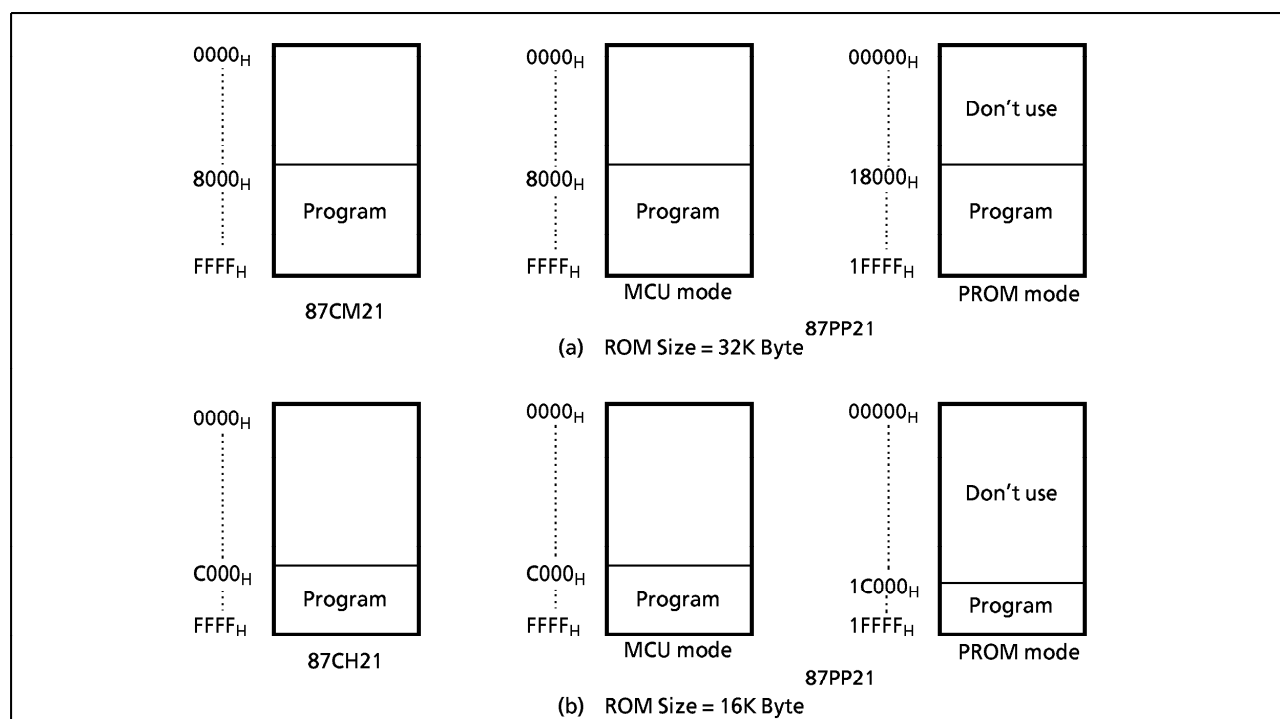


Figure 1.1 Program Memory Area

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 87PP21 has an on-chip 2K × 8-bit data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 87PP21 are the same as those of the 87CH21/CM21 except that the TEST pin has no built-in pull-down resistance.

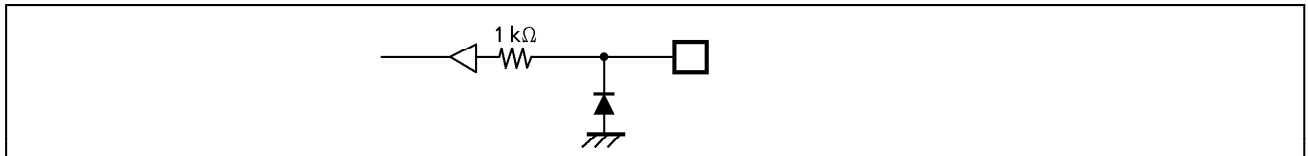


Figure 1-2. TEST pin

(2) I/O ports

The I/O circuits of 87PP21 I/O ports are the same as the code A type I/O circuitries of the 87CH21/CM21.

1.2 PROM mode

The PROM mode is activated by setting the TEST, $\overline{\text{RESET}}$ pin and the ports P17 to P10, P22 to P20 and P31, P61 as shown in Figure 1-3. The PROM mode is used to write and verify programs with a general-purpose PROM programmer.

Note : The high-speed programming mode can be used for program operation.
The 87PP21 is not supported an electric signature mode, so the ROM type must be set to TC571000D.

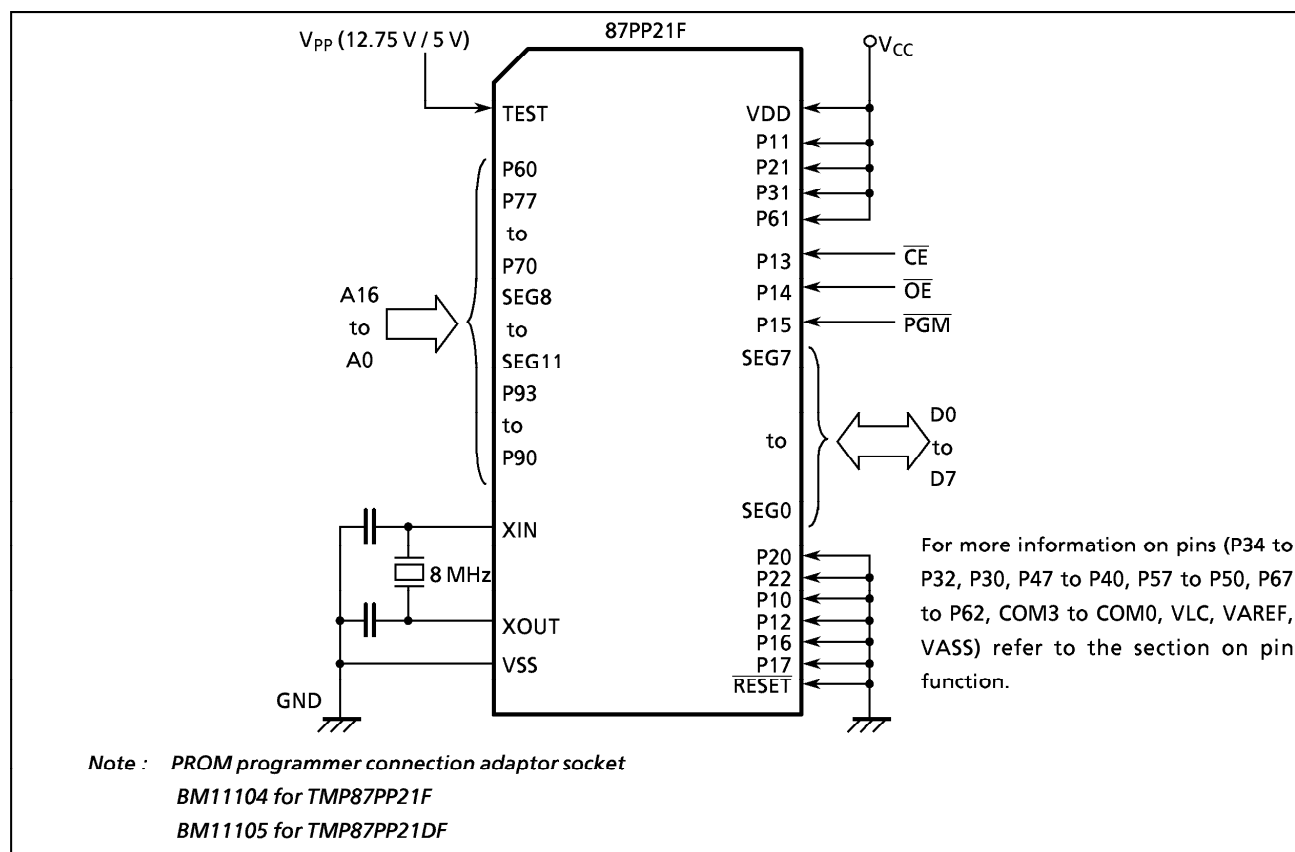


Figure 1-3. Setting for PROM Mode

1.2.1 Programming Flowchart (High-speed Programming Mode)

The high-speed programming mode is achieved by applying the program voltage (+ 12.75 V) to the VPP pin when $V_{CC} = 6.25$ V. After the address and input data are stable, the data is programmed by applying a single 0.1ms program pulse to the $\overline{PGM}$ input. The programmed data is verified. If incorrect, another 0.1 ms program pulse is applied. 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 $V_{CC} = V_{pp} = 5$ V.

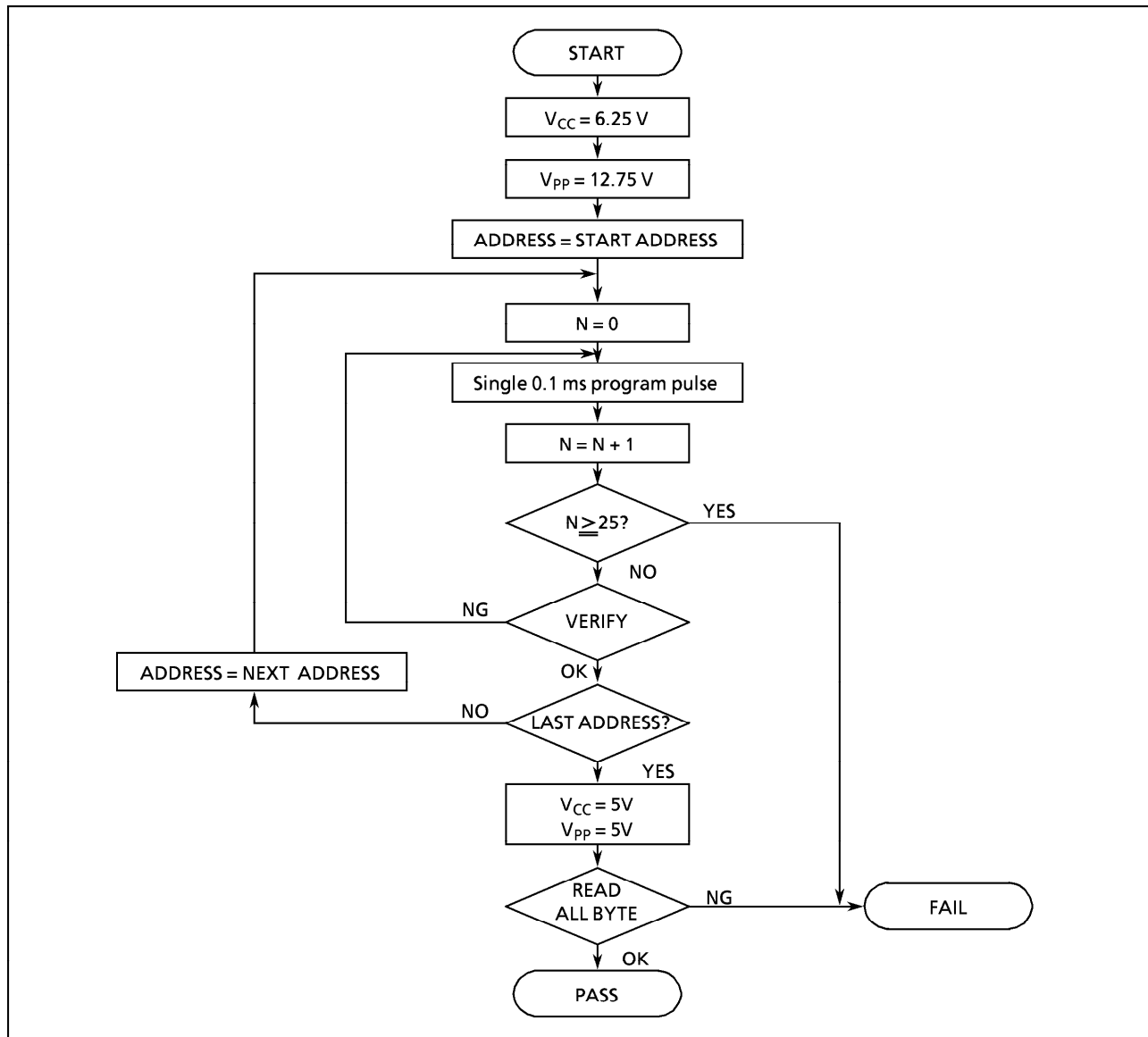


Figure 1-4. Flow Chart of High-speed Programming

1.2.2 Writing method for general-purpose PROM program

(1) Adapters

BM11104 : TMP87PP21F

BM11105 : TMP87PP21DF

(2) Adapter setting

Switch (SW1) is set to side N.

(3) PROM programmer specifying

i) PROM type is specified to TC571000D.

Writing voltage: 12.75 V (high-speed program mode)

ii) Data transfer (copy) (note 1)

In the TMP87PP21, EPROM is within the addresses 14000_H to 1FFFF_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 48KB : transferred addresses 04000_H to 0FFFF_H to addresses 14000 to 1FFFF_H

iii) Writing address is specified. (note 1)

Start address : 14000_H

End address : 1FFFF_H

(4) Writing

Writing/Verifying is required to be executed in accordance with PROM programmer operating procedure.

Caution 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.

Caution 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.

Caution 3 : The TMP87PP21 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 12 V $\pm$ 0.5 V to the address pin 9 (A9). The signature must not be used.

ELECTRICAL CHARACTERISTICS

ABSOLUTE MAXIMUM RATINGS

(V_{SS} = 0 V)

PARAMETER	SYMBOL	PINS	RATINGS	UNIT
Supply Voltage	V _{DD}		– 0.3 to 6.5	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, 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	mA
	Σ I _{OUT2}	P41	30	
Power Dissipation [T _{opr} = 70°C]	PD		350	mW
Soldering Temperature (time)	T _{sld}		260 (10 s)	°C
Storage Temperature	T _{stg}		– 55 to 125	°C
Operating Temperature	T _{opr}		– 30 to 70	°C

RECOMMENDED OPERATING CONDITIONS

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

PARAMETER	SYMBOL	PINS	CONDITIONS		Min.	Max.	UNIT
Supply Voltage	V _{DD}		fc = 8MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			fc = 4.2MHz	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			fs = 32.768kHz	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
	V _{IL2}	Hysteresis input				V _{DD} × 0.25	
	V _{IL3}		V _{DD} < 4.5 V	V _{DD} × 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 : Clock frequency fc : 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		—	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
Segment Output Low Resistance	R _{OS1}	SEG31-SEG0	V _{DD} = 5 V V _{DD} – V _{LC} = 3 V	—	20	—	kΩ
Common Output Low Resistance	R _{OC1}	COM3-COM0					
Segment Output High Resistance	R _{OS2}	SEG31-SEG0		—	200	—	kΩ
Common Output High Resistance	R _{OC2}	COM3-COM0					
Segment/Common Output Voltage	V _{O 2/3}	SEG31-SEG0 and COM3-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	
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	V
Output Low Current	I _{OL3}	P41	V _{DD} = 4.5 V, V _{OL} = 1.0 V	—	20	—	mA
Supply Current in NORMAL 1, 2 mode	I _{DD}		V _{DD} = 5.5 V f _c = 8 MHz	—	12	18	mA
Supply Current in IDLE 1, 2 mode			f _s = 32.768 kHz V _{IN} = 5.3 V/0.2 V	—	6	10	
Supply Current in SLOW mode			V _{DD} = 3.0 V f _s = 32.768 kHz	—	30	60	μA
Supply Current in SLEEP mode			V _{IN} = 2.8 V/0.2 V LCD driver is not enable	—	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, 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 R_{os}, R_{oc} 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 R_{os1/2} and R_{bc1/2}.

Note 9 : Times for SEG/COM output switching on : R_{os1}, R_{oc1} : 2⁶/f_c, 2/f_c (s)

R_{os2}, R_{oc2} : 1/(n, f_F)

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

A / D CONVERSION CHARACTERISTICS

(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 : Quantizing error is not contained in those errors.

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 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}					

(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}					

RECOMENDED OSCILLATING CONDITION-1

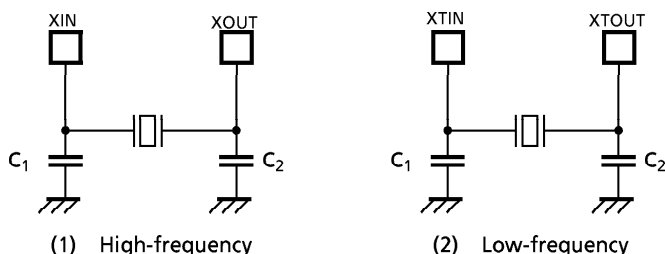
(VSS = 0 V, VDD = 4.5 to 5.5 V, Topr = - 30 to 70 °C)

PARAMETER	OSILLATOR	FREQUENCY	RECOMMENDER OSCILLATOR	RECOMMENDED CONDITION	
				C ₁	C ₂
High-frequency	Ceramic Resonator	8MHz	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 ChipType (MURATA) CSTC8.00MT	built-in 30 pF	built-in 30 pF
	Crystal Oscillator	4MHz	KYOCERA KBR4.0MS	30 pF	30 pF
		8MHz	TOYOCOM 210B 8.0000	20 pF	20 pF
Low-frequency	Crystal Oscillator	4MHz	TOYOCOM 204B 4.0000		
		32.768kHz	NDK MX-38T	15 pF	15 pF

RECOMENDED OSCILLATING CONDITION-2

(VSS = 0 V, VDD = 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	4MHz	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

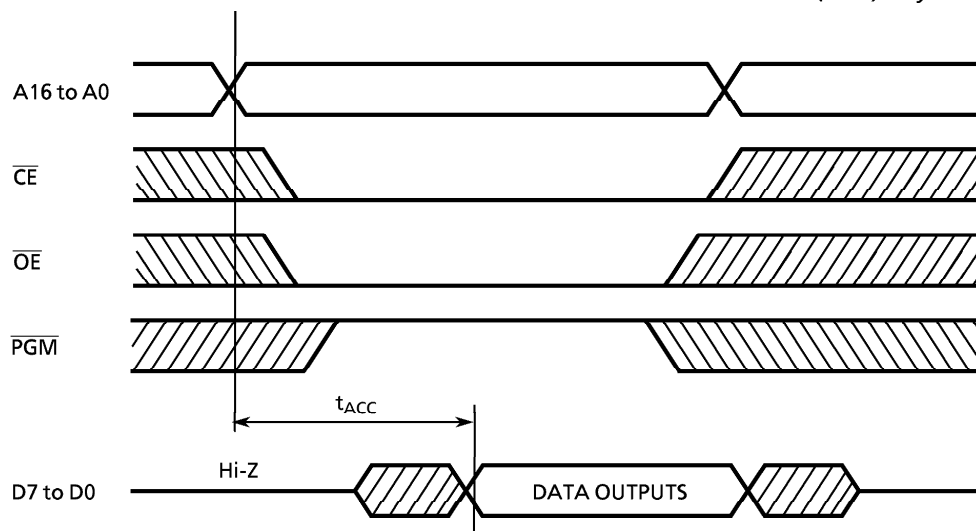


Note : When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

D.C./A.C. CHARACTERISTICS (PROM mode)	($V_{SS} = 0\text{ V}$)
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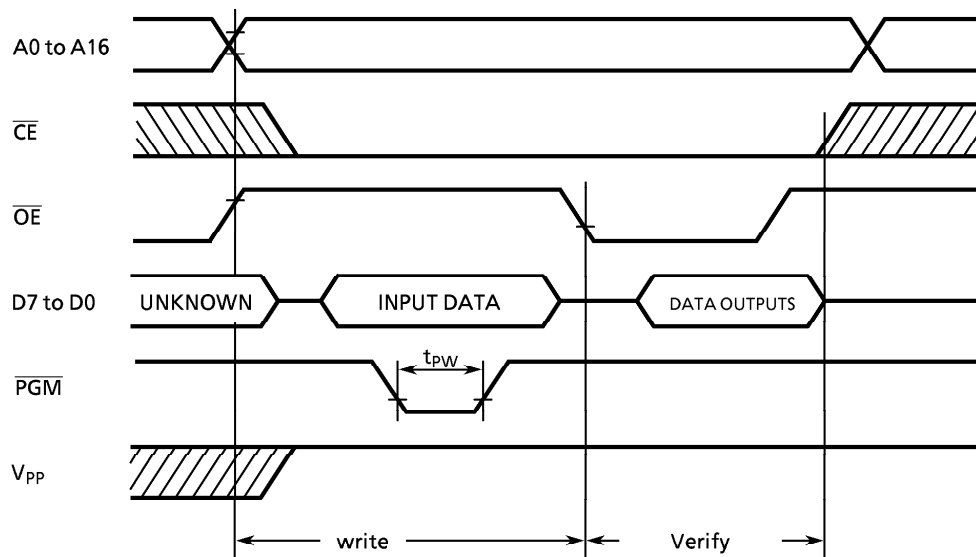
(1) Read Operation

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	—	$V_{CC} \times 0.12$	V
Power Supply Voltage	V_{CC}		4.75	5.0	5.25	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25\text{ V}$	—	$1.5t_{cyc} + 300$	—	ns

(Note) $t_{cyc} = 500\text{ ns}$ 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	—	$V_{CC} \times 0.12$	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



- Caution 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.
- Caution 2:** The device must not be set to the EPROM programmer or picked up from it under applying the program voltage ($12.5V \pm 0.5V = V$) to the V_{PP} pin as the device is damaged.
- Caution 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.