

TOSHIBA

TOSHIBA Original CMOS 8-Bit Microcontroller

TLCS-870 Series

TMP87PM14NG

TMP87PM14FG

Not Recommended
for New Design

TOSHIBA CORPORATION

Semiconductor Company

Document Change Notification

The purpose of this notification is to inform customers about the launch of the Pb-free version of the device. The introduction of a Pb-free replacement affects the datasheet. Please understand that this notification is intended as a temporary substitute for a revision of the datasheet.

Changes to the datasheet may include the following, though not all of them may apply to this particular device.

1. Part number

Example: TMPxxxxxxF TMPxxxxxxFG

All references to the previous part number were left unchanged in body text. The new part number is indicated on the prelims pages (cover page and this notification).

2. Package code and package dimensions

Example: LQFP100-P-1414-0.50C LQFP100-P-1414-0.50F

All references to the previous package code and package dimensions were left unchanged in body text. The new ones are indicated on the prelims pages.

3. Addition of notes on lead solderability

Now that the device is Pb-free, notes on lead solderability have been added.

4. RESTRICTIONS ON PRODUCT USE

The previous (obsolete) provision might be left unchanged on page 1 of body text. A new replacement is included on the next page.

5. Publication date of the datasheet

The publication date at the lower right corner of the prelims pages applies to the new device.

1. Part number
2. Package code and dimensions

Previous Part Number (in Body Text)	Previous Package Code (in Body Text)	New Part Number	New Package Code	OTP
TMP87PM14N	SDIP64-P-750-1.78	TMP87PM14NG	SDIP64-P-750-1.78	—
TMP87PM14F	QFP64-P-1420-1.00A	TMP87PM14FG	QFP64-P-1420-1.00A	—

*: For the dimensions of the new package, see the attached Package Dimensions diagram.

3. Addition of notes on lead solderability

The following solderability test is conducted on the new device.

Lead solderability of Pb-free devices (with the G suffix)

Test	Test Conditions	Remark
Solderability	(1) Use of Lead (Pb) ·solder bath temperature = 230°C ·dipping time = 5 seconds ·the number of times = once ·use of R-type flux (2) Use of Lead (Pb)-Free ·solder bath temperature = 245°C ·dipping time = 5 seconds ·the number of times = once ·use of R-type flux	Leads with over 95% solder coverage till lead forming are acceptable.

4. RESTRICTIONS ON PRODUCT USE

The following replaces the “RESTRICTIONS ON PRODUCT USE” on page 1 of body text.

RESTRICTIONS ON PRODUCT USE

20070701-EN

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- For a discussion of how the reliability of microcontrollers can be predicted, please refer to Section 1.3 of the chapter entitled Quality and Reliability Assurance/Handling Precautions.

5. Publication date of the datasheet

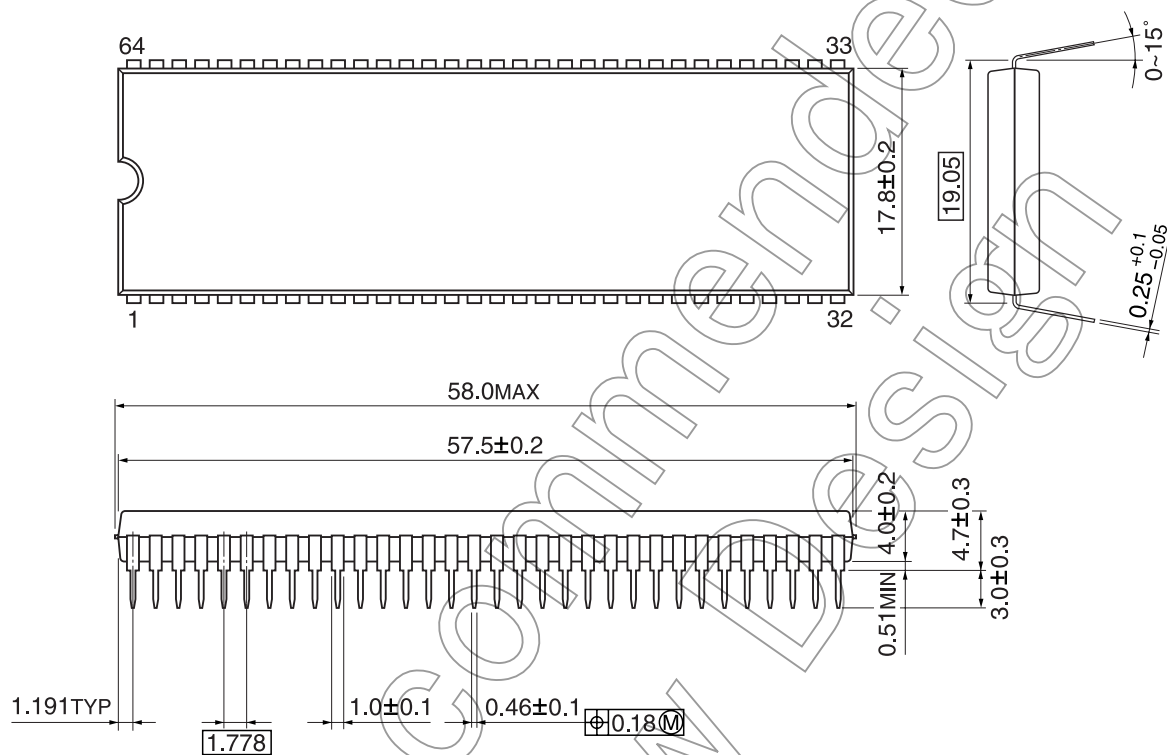
The publication date of this datasheet is printed at the lower right corner of this notification.

(Annex)

Package Dimensions

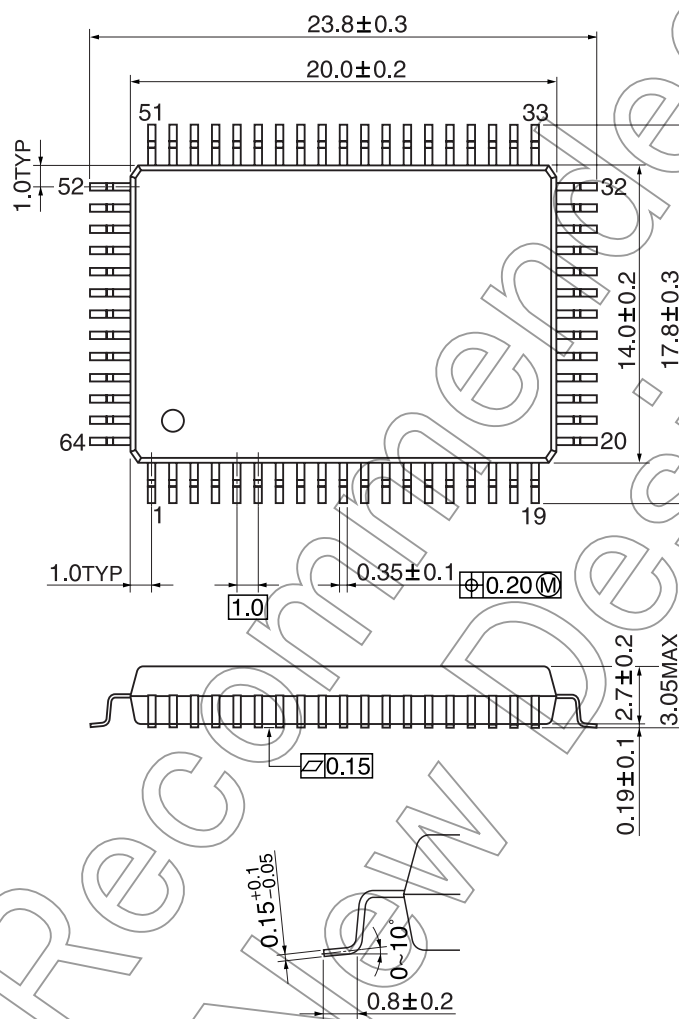
SDIP64-P-750-1.78

Unit: mm



QFP64-P-1420-1.00A

Unit: mm



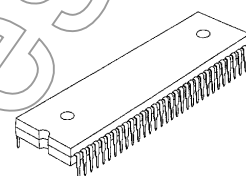
CMOS 8-Bit Microcontroller

TMP87PM14N/F

The 87PM14 is a One-Time PROM microcontroller with low-power 256 K bits (32 Kbytes) electrically programmable read only memory for the 87C814/CH14/CK14/CM14 system evaluation. The 87PM14 is pin compatible with the 87C814/CH14/CK14/CM14. The operations possible with the 87C814/CH14/CK14/CM14 can be performed by writing programs to PROM. The 87PM14 can write and verify in the same way as the TC27256 using an adaptor socket BM1198/BM1199 and an EPROM programmer.

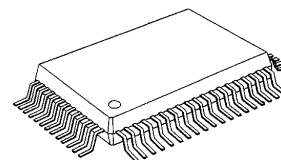
Part No.	OTP	RAM	Package	Adaptor socket
TMP87PM14N	32K × 8-bit	1K × 8-bit	P-SDIP64-750-1.78	BM1198
TMP87PM14F			P-QFP64-1420-1.00A	BM1199

P-SDIP64-750-1.78



TMP87PM14N

P-QFP64-1420-1.00A



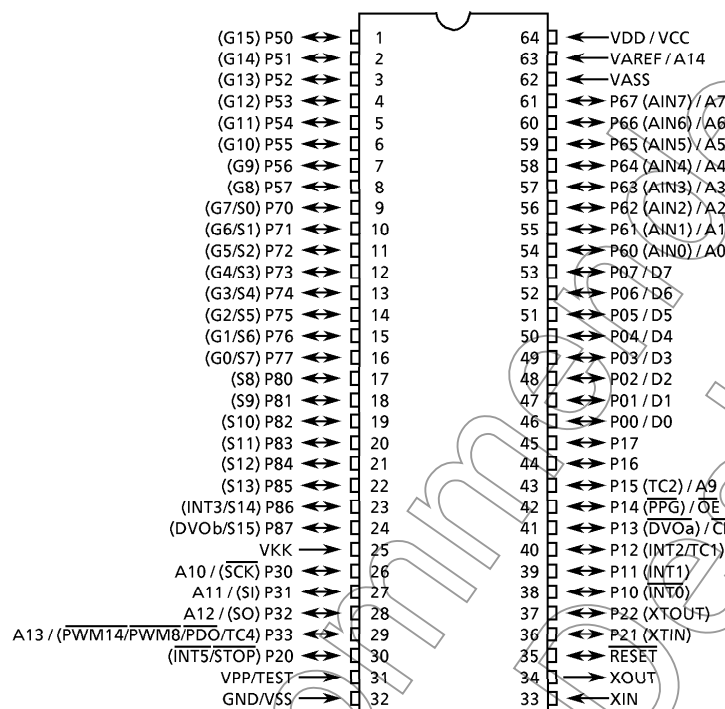
TMP87PM14F

980910EBP1

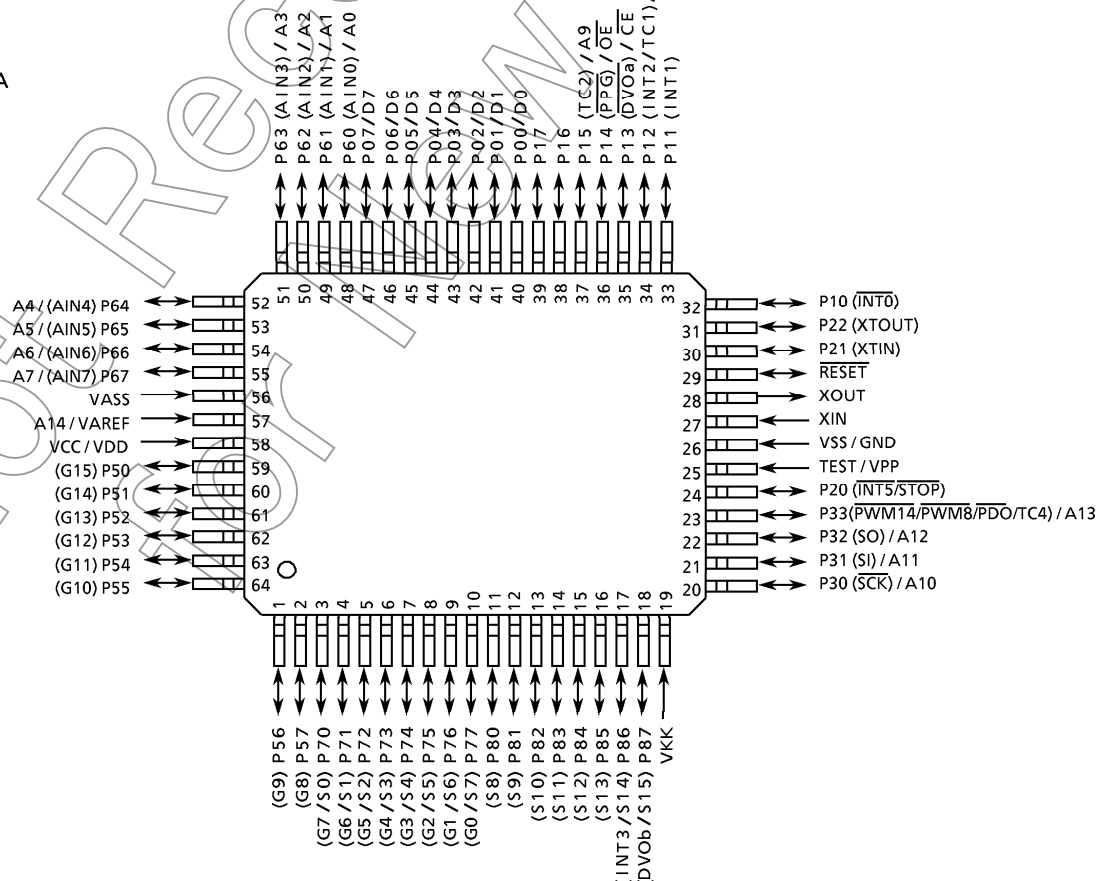
- For a discussion of how the reliability of microcontrollers can be predicted, please refer to Section 1.3 of the chapter entitled Quality and Reliability Assurance/Handling Precautions.
- TOSHIBA is continually working to improve the quality and the reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to observe standards of safety, and to avoid situations in which a malfunction or failure of a TOSHIBA product could cause loss of human life, bodily injury or damage to property. In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent products specifications. Also, please keep in mind the precautions and conditions set forth in the TOSHIBA Semiconductor Reliability Handbook.
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Pin Assignments (Top View)

P-SDIP64-750-1.78



P-QFP64-1420-1.00A



Pin Function

The 87PM14 has two modes two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PM14 is pin compatible with the 87C814/CH14/CK14/CM14 (fix the TEST pin at low level).

(2) PROM mode

Pin Name (PROM mode)	Input / Output	Functions	Pin Name (MCU mode)
A14	Input	PROM address inputs	VAREF
A13 to A10			P33 to P30
A9			P15
A8			P12
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
VPP	Power supply	+12.5 V / 5 V (Program supply voltage)	TEST
VCC		+5 V	VDD
GND		0 V	VSS
P11	I/O	PROM mode setting pin. Be fixed at high level.	
P21			
P87		PROM mode setting pin. Be fixed at low level.	
P10, P16, P17			
P22, P20			
RESET			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	output		
P57 to P50	I/O	Open	
P77 to P70			
P86 to P80			
VASS	Power supply	Open	
VKK	VFT Power supply	0 V (GND)	

OPERATIONAL DESCRIPTION

The following explains the 87PM14 hardware configuration and operation. The configuration and functions of the 87PM14 are the same as those of the 87C814/CH14/CK14/CM14, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PM14 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 87PM14 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 87C814/CH14/CK14/CM14 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

Not Recommended
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1.1.1 Program Memory

The 87PM14 has a 32K×8-bit (addresses 8000_H-FFFF_H in the MCU mode, addresses 0000_H-7FFF_H in the PROM mode) of program memory (OTP). To use the 87PM14 as the system evaluation for the 87C814/CH14/CK14/CM14 the program should be written to the program memory area as shown in Figure 1-1.

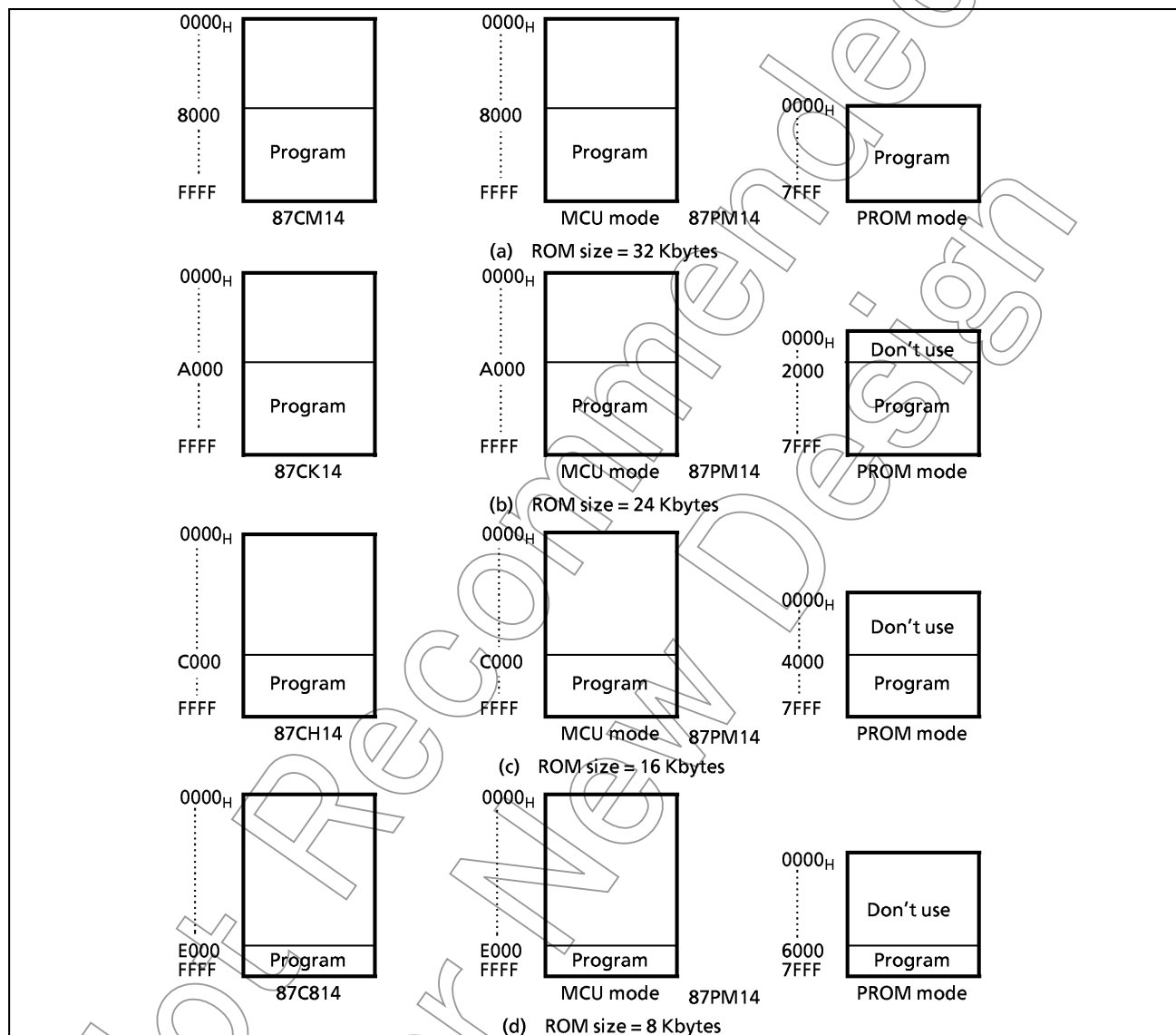


Figure 1-1. Program Memory Area

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 87PM14 has an on-chip 1k × 8-bit data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 87PM14 are the same as those of the 87C814/CH14/CK14/CM14 except that the TEST pin has no built-in pull-down resistance.

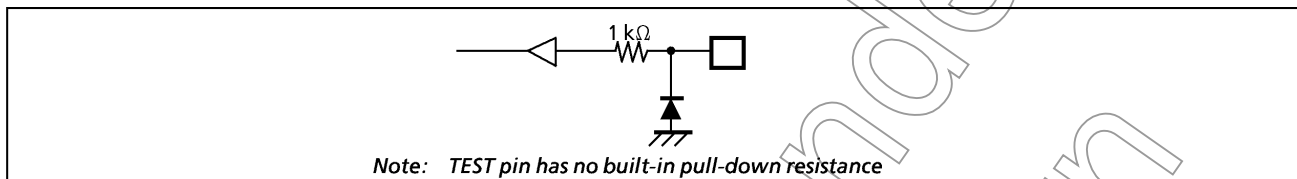


Figure 1-2. TEST Pin

(2) I/O ports

The I/O circuitries of 87PM14 I/O ports are the same as the code A type I/O circuitries of the 87C814/CH14/CK14/CM14.

1.2 PROM Mode

The PROM mode is activated by setting the pins TEST, RESET and the ports P17-P10, P22-P20 and P87 as shown in Figure 1-3. The PROM mode is used to write and verify programs with a general-purpose PROM programmer. The high-speed programming mode can be used for program operation.

The 87PM14 is not supported an electric signature mode, so the ROM type must be set to TC27256.

Set the adaptor socket switch to "N".

Note: Please set the high-speed programming mode according to each manual of PROM program.

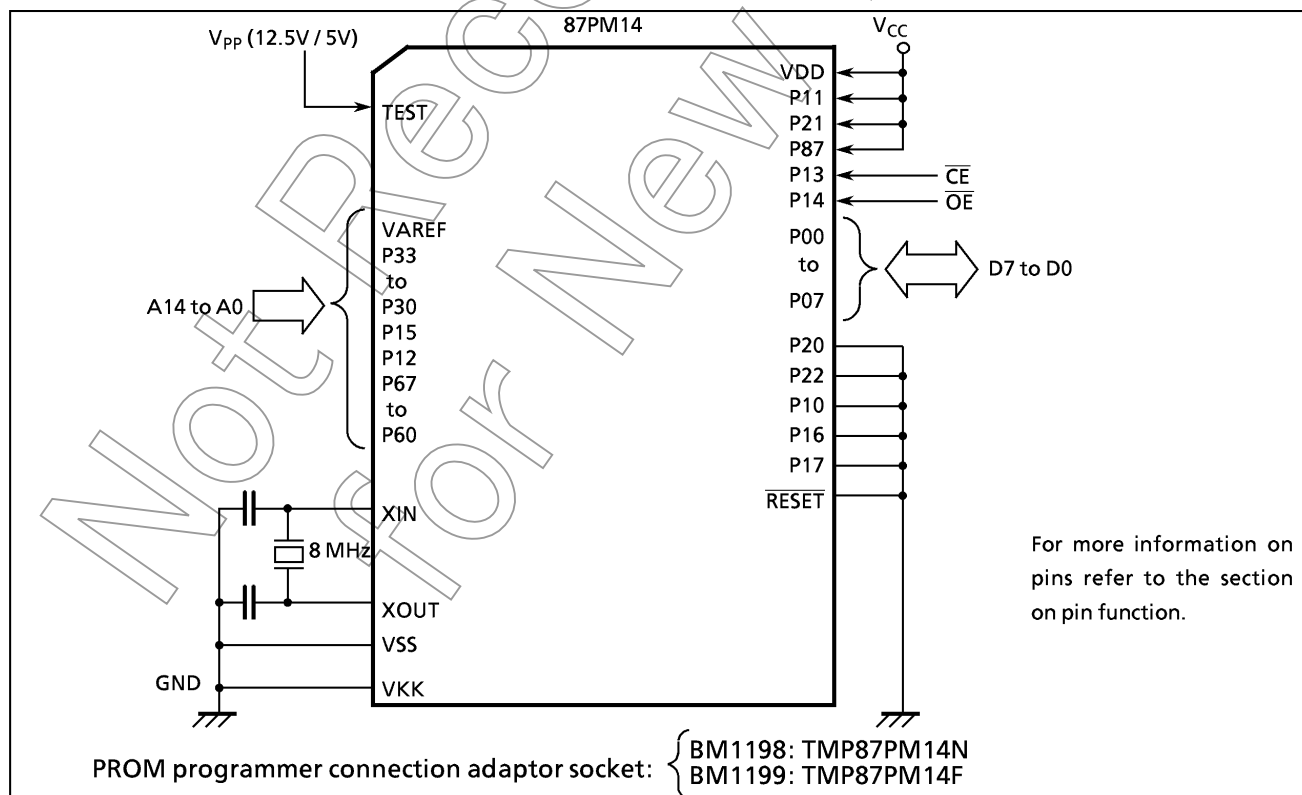


Figure 1-3. Setting for PROM Mode

1.2.1 Programming Flowchart (High-speed Programming Mode-I)

The high-speed programming mode is achieved by applying the program voltage (+ 12.5 V) to the Vpp pin when Vcc = 6 V. After the address and input data are stable, the data is programmed by applying a single 1ms program pulse to the CE input. The programmed data is verified. If incorrect, another 1ms program pulse is applied and then the programmed data is verified. This process should be repeated (up to 25 times) until the program operates correctly. Programming for one address is ended by applying additional program pulse with width 3 times that needed for initial programming (number of programmed times × 1 ms). 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 Vcc = Vpp = 5 V.

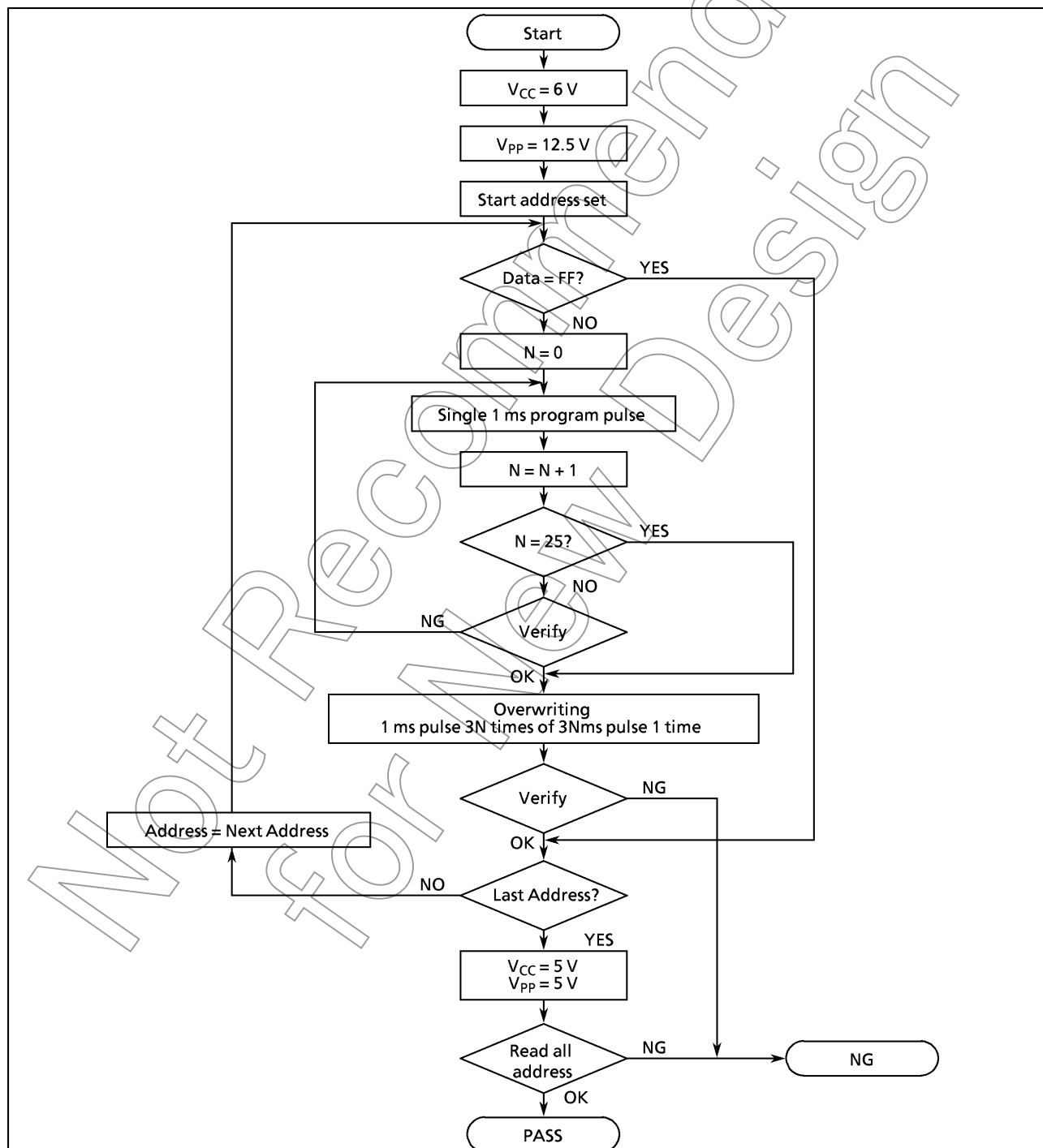


Figure 1-4. Flowchart of High-speed Programming Mode - I

1.2.2 Programming Flowchart (High-speed Programming Mode-II)

The high-speed programming mode is achieved by applying the program voltage (+ 12.75 V) to the Vpp pin when Vcc = 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{CE} input. The programmed data is verified. If incorrect, another 0.1ms program pulse is applied and then the programmed data is verified. 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 Vcc = Vpp = 5 V.

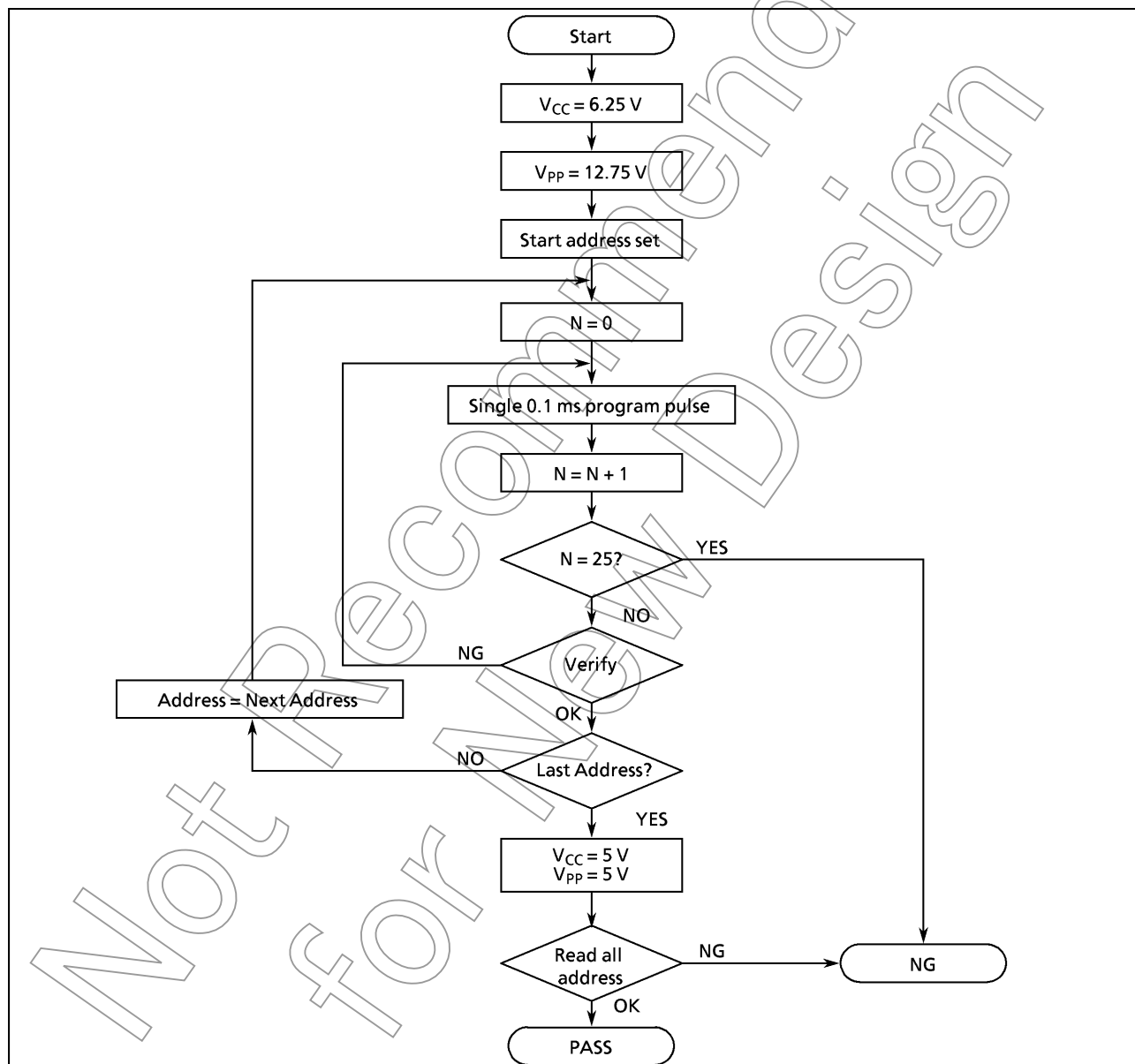


Figure 1-5. Flowchart of High-speed Programming Mode - II

1.2.3 Writing Method for General-purpose PROM Program

(1) Adapters

BM1198: TMP87PM14N

BM1199: TMP87PM14F

(2) Adapter setting

Switch (SW1) is set to side N.

(3) PROM programmer specifying

i) PROM type is specified to TC27256.

Writing voltage: 12.5 V (high-speed program I mode)
12.75 V (high-speed program II mode)

ii) Data transfer (copy) (note 1)

In TMP87PM14, EPROM is within the addresses 0000 to 7FFFH. 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 32KB: transferred addresses 8000 to FFFFH to addresses 0000 to 7FFFH

iii) Writing address is specified. (note 1)

Start address: 0000H

End address: 7FFFH

(4) Writing

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

Note 1: The specifying method is referred to the PROM programmer description. The data in unused area must be specified to FFH.

Note 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.

Note 3: TMP87PM14 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 $12V \pm 0.5V$ 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
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}	P0, P1, P2, P3, 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, P6	3.2	mA
	I _{OUT2}	P8	- 12	
	I _{OUT3}	P5, P7	- 25	
Output Current (Total)	Σ I _{OUT1}	P0, P1, P2, P3, P6	120	mA
	Σ I _{OUT2}	P5, P7, P8	- 120	
Power Dissipation [Topr = 25°C]	PD		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: 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	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 _{OUT2}	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} < 4.5 V	V _{DD} × 0.10			
Clock Frequency	fc	XIN, XOUT	V _{DD} = 4.5 V to 5.5 V		0.4	8.0	MHz
	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	—	—	± 2	μA
	I _{IN2}	Open drain ports, Tri-state ports	V _{IN} = 5.5 V/0 V				
	I _{IN3}	RESET, STOP					
Input Resistance	R _{IN1}	RESET		100	220	450	kΩ
Pull-down Resistance	R ₁	Source open drain ports	V _{DD} = 5.5 V, V _{OUT} = 5.5 V	—	200	—	
	R _K		V _{DD} = 5.5 V, V _{KK} = -30 V	—	80	—	
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	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 _{OH1}	Tri-state ports	V _{DD} = 4.5 V, I _{OH} = -0.7 mA	4.1	—	—	V
	V _{OH2}	P8	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	—	12	18	mA
Supply Current in IDLE 1, 2 modes			f _s = 32.768 kHz V _{IN} = 5.3 V/0.2 V	—	4.5	6	
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	—	15	30	
Supply Current in STOP mode			V _{DD} = 5.5 V V _{IN} = 5.3 V/0.2 V	—	0.5	10	

Note 1: Typical values show those at T_{opr} = 25°C, V_{DD} = 5 V.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} = 0 V, V_{DD} = 4.5 to 5.5 V, 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 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

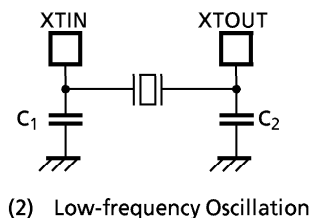
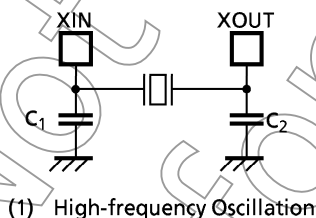
 $(V_{SS} = 0\text{ V}, V_{DD} = 4.5\text{ to }5.5\text{ V}, T_{opr} = -30\text{ to }70^{\circ}\text{C})$

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t_{cy}	In NORMAL1, 2 modes	0.5	—	10	μs
		In IDLE 1, 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), $f_c = 8\text{ MHz}$	50	—	—	ns
Low Level Clock Pulse Width	t_{WCL}					
High Level Clock Pulse Width	t_{WSH}	For external clock operation (XTIN input), $f_s = 32.768\text{ kHz}$	14.7	—	—	μs
Low Level Clock Pulse Width	t_{WSL}					

Recommended Oscillating Conditions

 $(V_{SS} = 0\text{ V}, V_{DD} = 4.5\text{ to }5.5\text{ V}, T_{opr} = -30\text{ to }70^{\circ}\text{C})$

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



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.

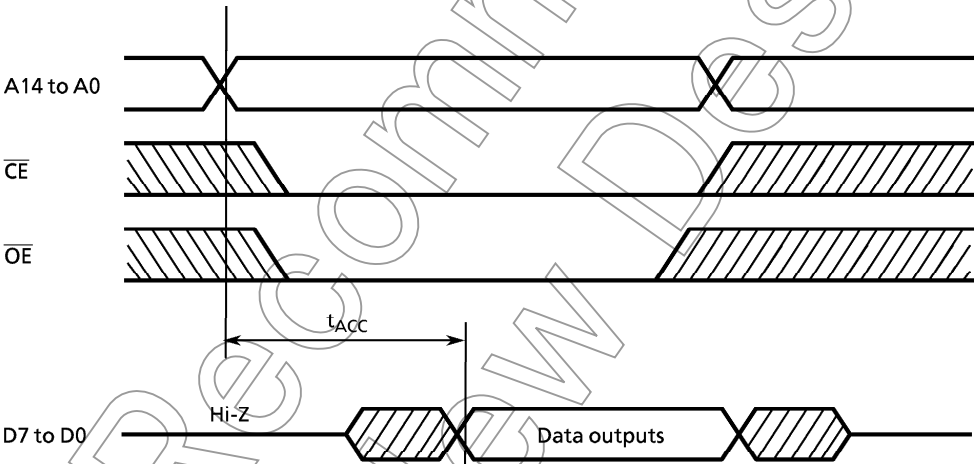
D.C./A.C. Characteristics (PROM mode)

(V_{SS} = 0 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	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 t _{cyc} + 300	–	ns

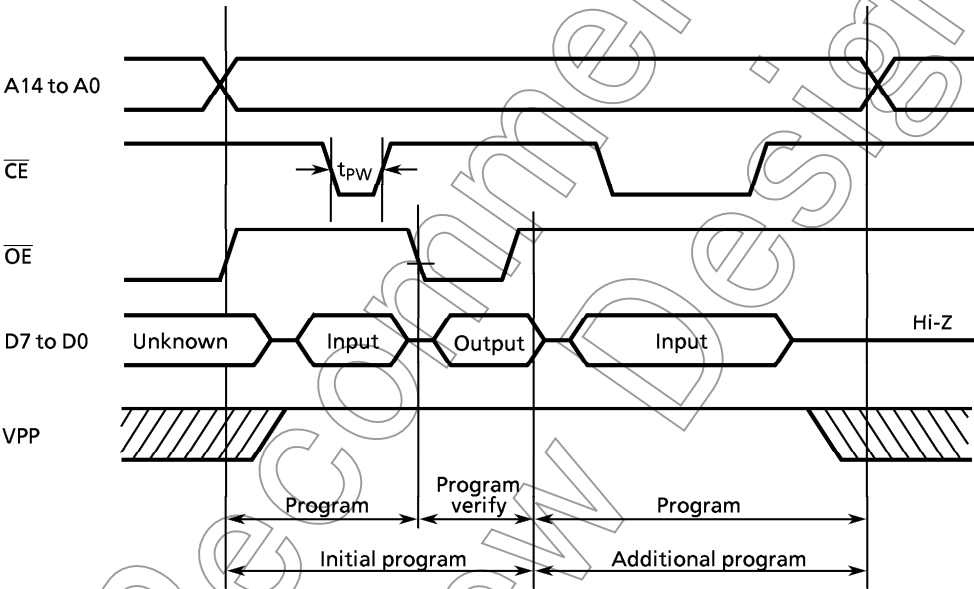
Note: t_{cyc} = 500 ns at 8 MHz



Timing Waveforms of Read Operation

(2) Program Operation (High speed write mode- I) (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}		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}	$V_{CC} = 6.0\text{ V}$	0.95	1.0	1.05	ms



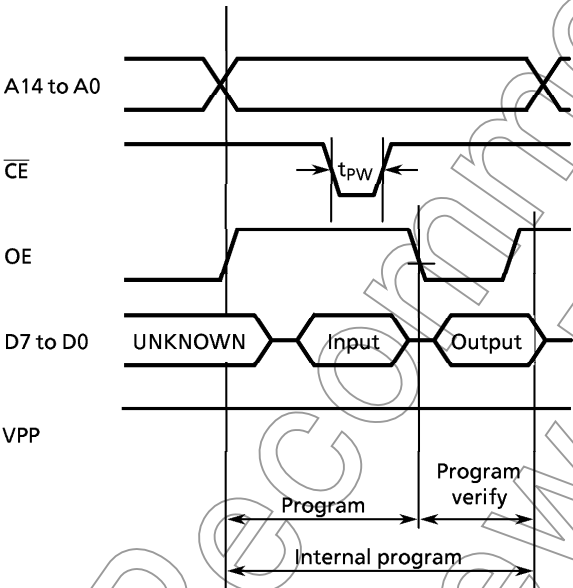
*Note 1: When V_{CC} power supply is turned on or after, V_{pp} must be increased.
When V_{CC} power supply is turned off or before, V_{pp} must be decreased.*

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.

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} × 0.7	–	V _{CC}	V
Input Low Voltage	V _{IL4}		0	–	V _{CC} × 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 V ± 0.25 V, V _{PP} = 12.75 V ± 0.25 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 V ± 0.5 V) to the V_{PP} pin as the device is damaged.

Not Recommended
for New Design