CMOS 8-BIT MICROCONTROLLER

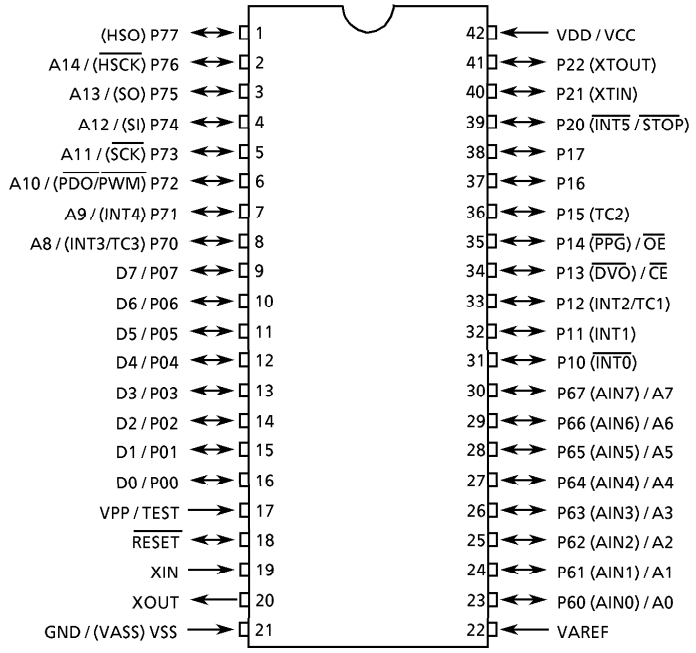
TMP87PH46N, TMP87PH47U, TMP87PH47LU

The 87PH46/47/47L are a One-Time PROM microcontroller with low-power 128K bits (16K bytes) electrically programmable read only memory for the 87C446/846/H46/447/847/H47/847L/H47L system evaluation. The 87PH46 is pin compatible with the 87C446/846/H46. The 87PH47/47L are pin compatible with the 87C447/847/H47/847L/H47L. The operations possible with the 87C446/846/H46/447/847/H47/847L/H47L can be performed by writing programs to PROM. The 87PH46/47/47L can write and verify in the same way as the TMM27256AD using an adaptor socket BM1193/BM1194B and an EPROM programmer.

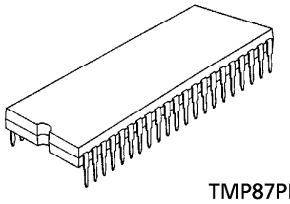
PART No	OTP	RAM	PACKAGE	Adaptor socket
TMP87PH46N	16K × 8-bit	512 × 8-bit	SDIP42-P-600-1.78	BM1193
TMP87PH47U TMP87PH47LU			QFP44-P-1010-0.80	BM1194C

PIN ASSIGNMENTS (TOP VIEW) - (1)

SDIP42-P-600-1.78



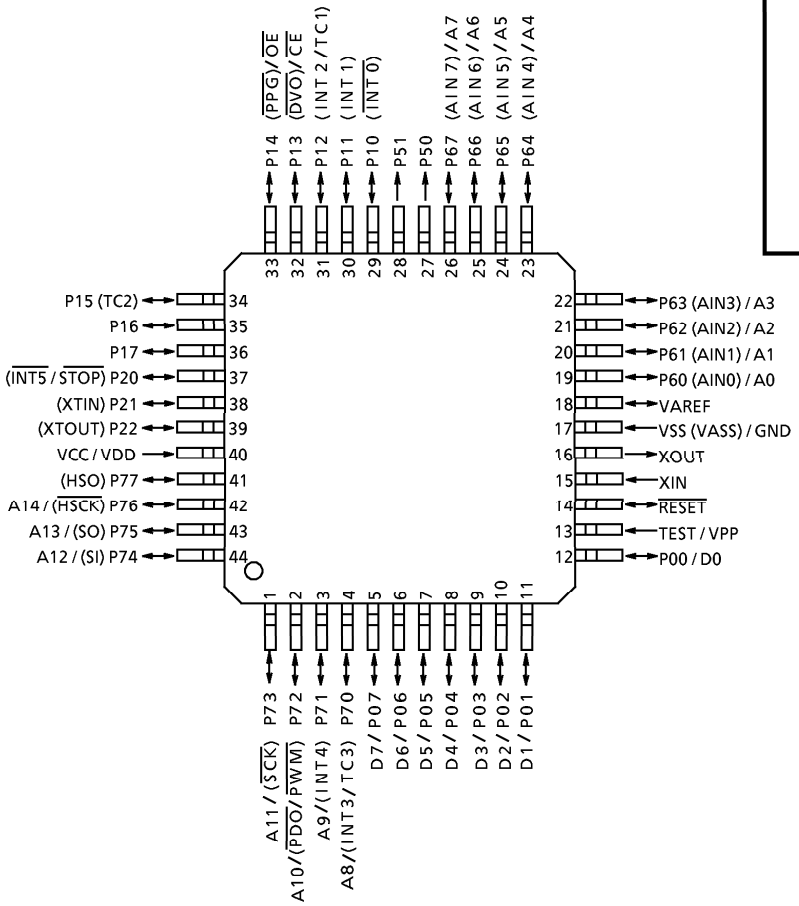
SDIP42-P-600-1.78



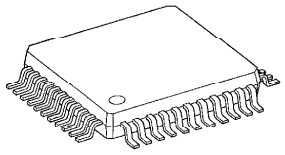
TMP87PH46N

PIN ASSIGNMENTS (TOP VIEW) - (2)

QFP44-P-1010-0.80



QFP44-P-1010-0.80



TMP87PH47U
TMP87PH47LU

PIN FUNCTION

The 87PH46/47/47L have two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PH46 is pin compatible with the 87C446/846/H46L and the 87PH47/47L are pin compatible with the 87C447/847/H47/H47L (fix the TEST pin at low level).

(2) PROM mode

PIN NAME (PROM mode)	INPUT/OUTPUT	FUNCTIONS	PIN NAME (MCU mode)
A14 to A8	Input	PROM address inputs	P76 to P70
A7 to A0			P67 to P60
D7 to D0	I/O	PROM data input/outputs	P07 to P00
CE	Input	Chip enable signal input (active low)	P13
OE		Output enable signal input (active low)	P14
VPP	Power supply	+ 12.5V / 5V (Program supply voltage)	TEST
VCC		+ 5V	VDD
GND		0V	VSS
* P51 to P50	I/O	Pull-up with resistance for input processing	
P11		PROM mode setting pins. Be fixed at high level.	
P21			
P77			
P12 , P10		PROM mode setting pins. Be fixed at low level.	
P17 to P15			
P22 , P20			
RESET			
XIN	Input	Connect an 8MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power Supply	0V (GND)	
VASS			

*: 87PH47/47L only

OPERATIONAL DESCRIPTION

The following explains the 87PH46/47/47L hardware configuration and operation. The configuration and functions of the 87PH46 are the same as those of the 87C446/846/H46, except in that a one-time PROM is used instead of an on-chip mask ROM. The configuration and function of the 87PH47/47L are the same as those of the 87C447/847/H47/847L/H47L, except in that a one-time PROM is used instead of an on-chip mask ROM.
The 87PH47L are fully compatible with the TMP87PH47 except that operating voltage range is extencled from 1.8V to 4.0V.
The 87PH46/47/47L 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 87PH46/47/47L have 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 87C446/846/H46/447/847/H47/847L/H47L (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PH46/47/47L have a 16K × 8-bit (addresses $C000_H$-$FFFF_H$ in the MCU mode, addresses 4000_H-$7FFF_H$ in the PROM mode) of program memory (OTP).
To use the PH46/47/47L as the system evaluation for the 87C447/C847/H47/847L/H47L, the program should be written to the program memory area as shown in Figure 1-1.

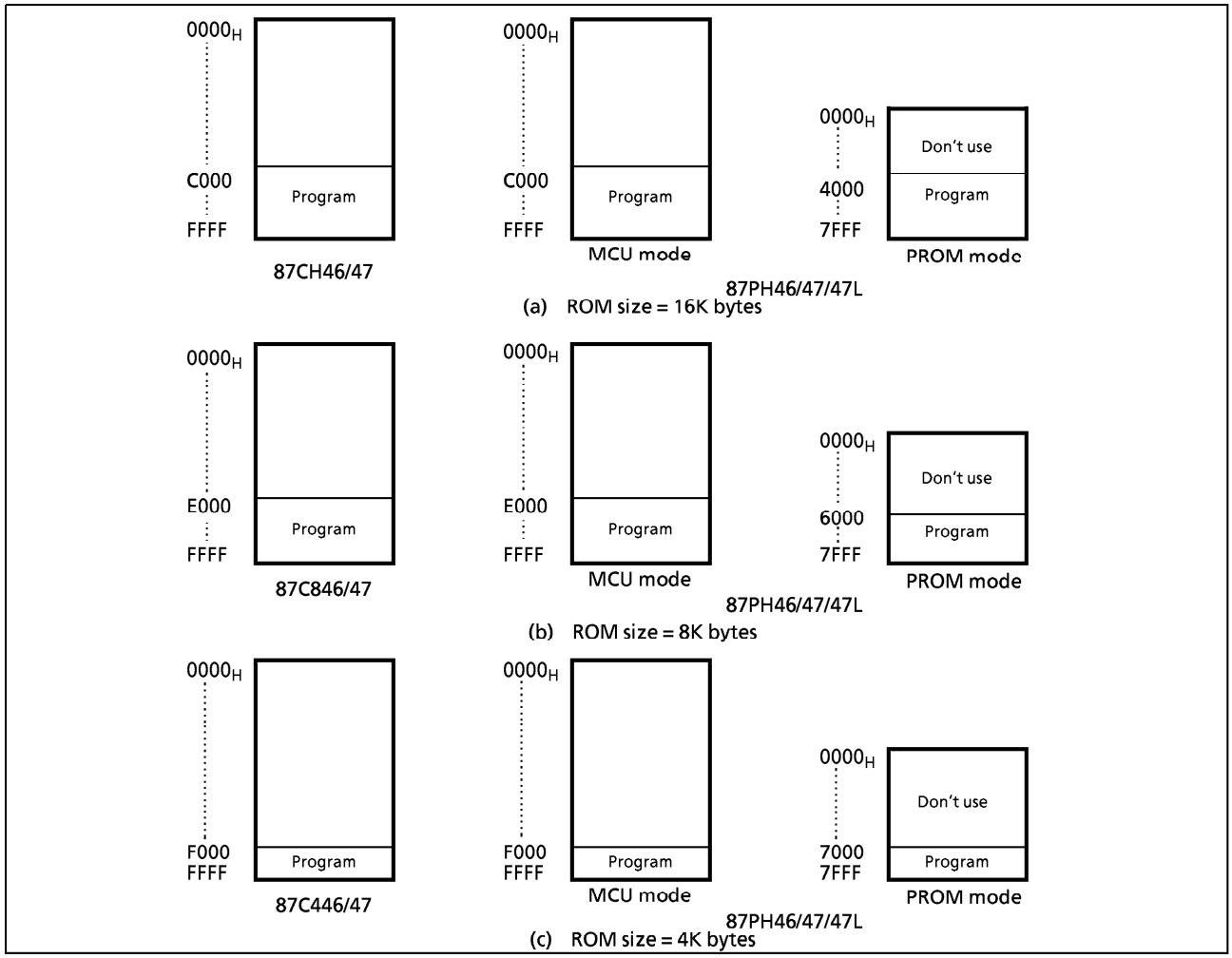


Figure 1-1. Program Memory Area

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

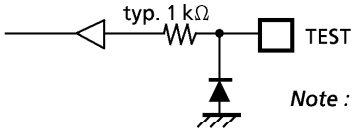
1.1.2 Data Memory

The 87PH46/47/47L have an on-chip 512 × 8-bit data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 87PH46/47/47L are the same as those of the 87C446/846/H46/447/847/H47/847L/H47L except that the TEST pin has is no built-in pull-down resistance.



Note : The 87PH46/47/47L do not have a pull-down resistor for TEST pin

Figure 1-2. TEST Pin

(2) I/O ports

The I/O circuitries of 87PH46/47/47L I/O ports the are the same as the code A type I/O circuitries of the 87C446/846/H46/447/847/H47/847L/H47L.

1.2 PROM Mode

The PROM mode is activated by setting the TEST, $\overline{\text{RESET}}$ pin and the ports P17-P10, P22-P20 and P77 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 87PH46/47/47L are not supported an *electric signature* mode, so the ROM type must be set to TC57256AD.

Set the adaptor socket switch to "N".

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

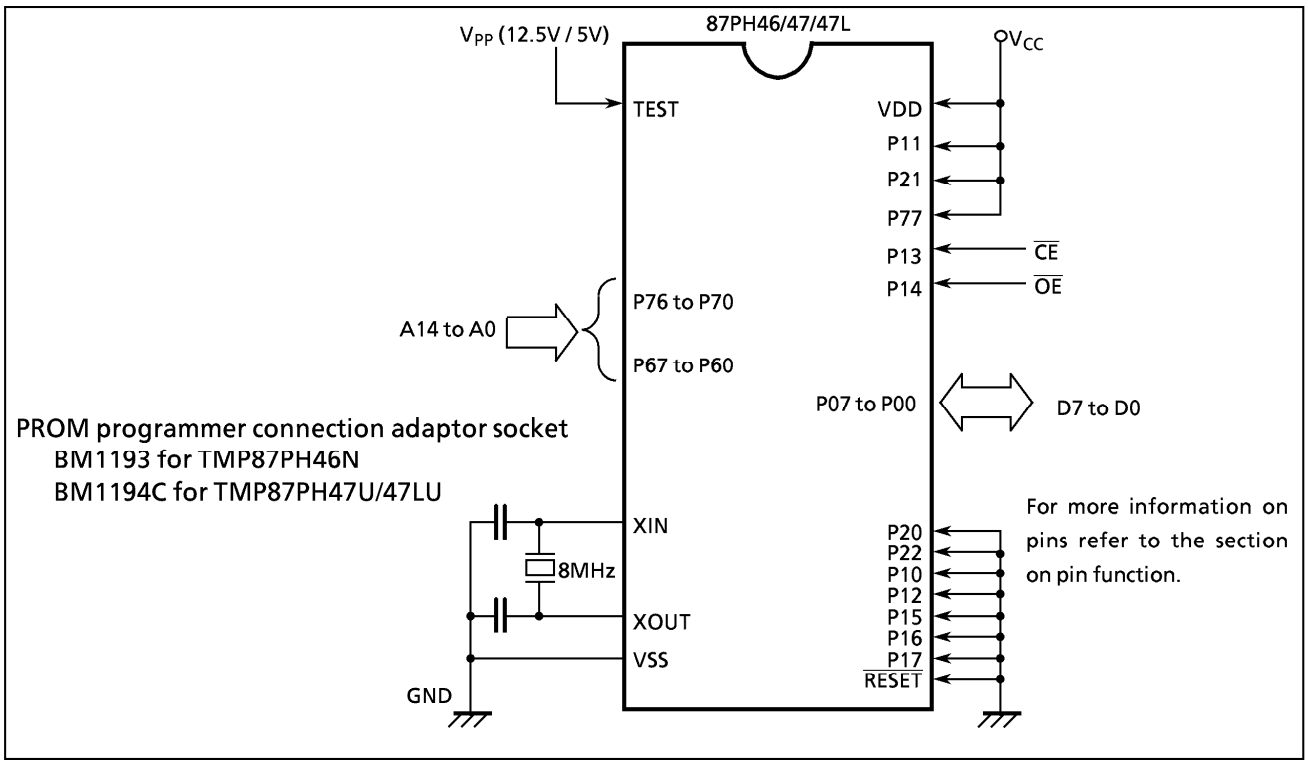


Figure 1-3. Setting for PROM Mode

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 $\overline{CE}$ 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.

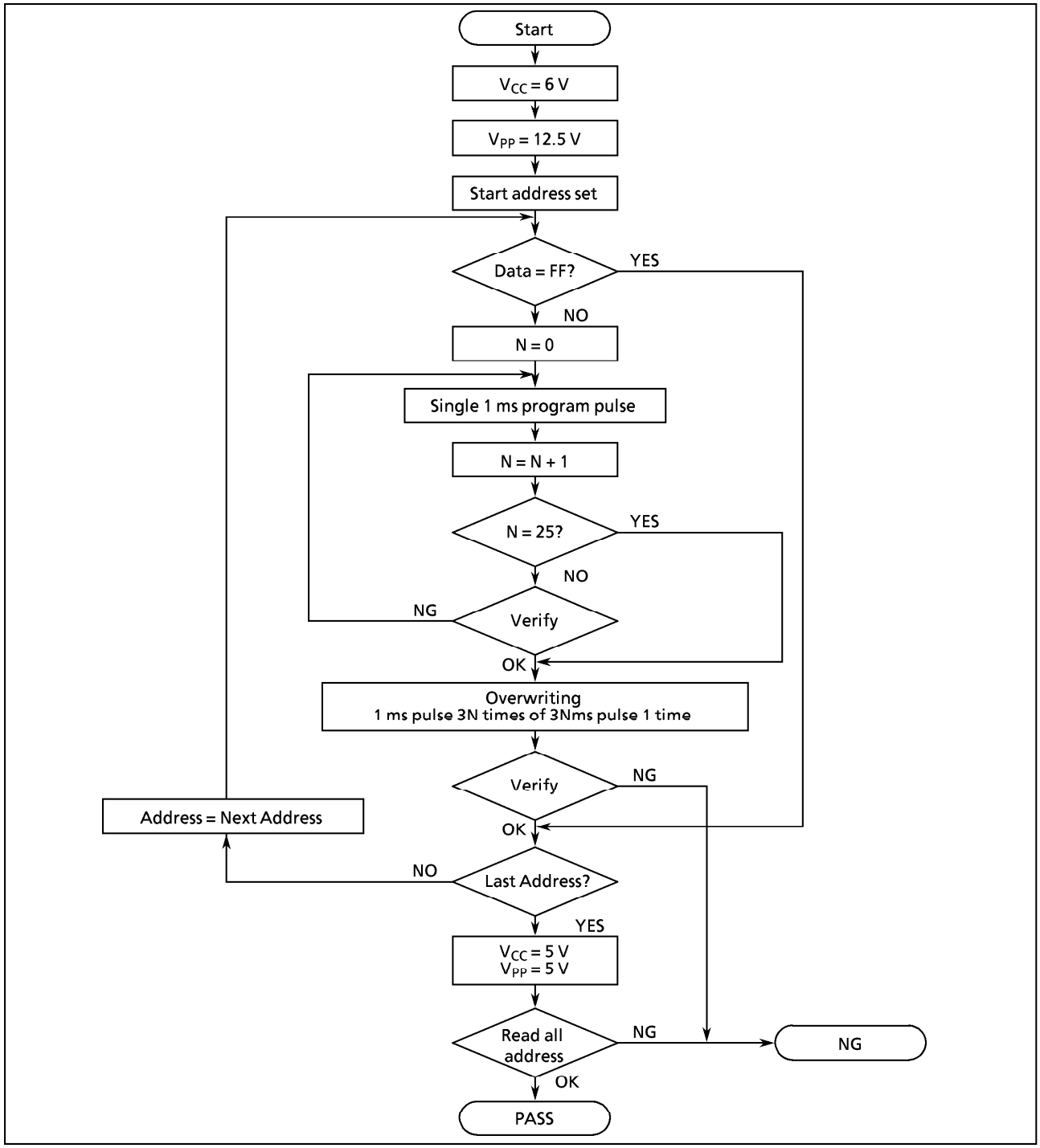


Figure 1-4. Flowchart of High-speed Programming Mode - I

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.

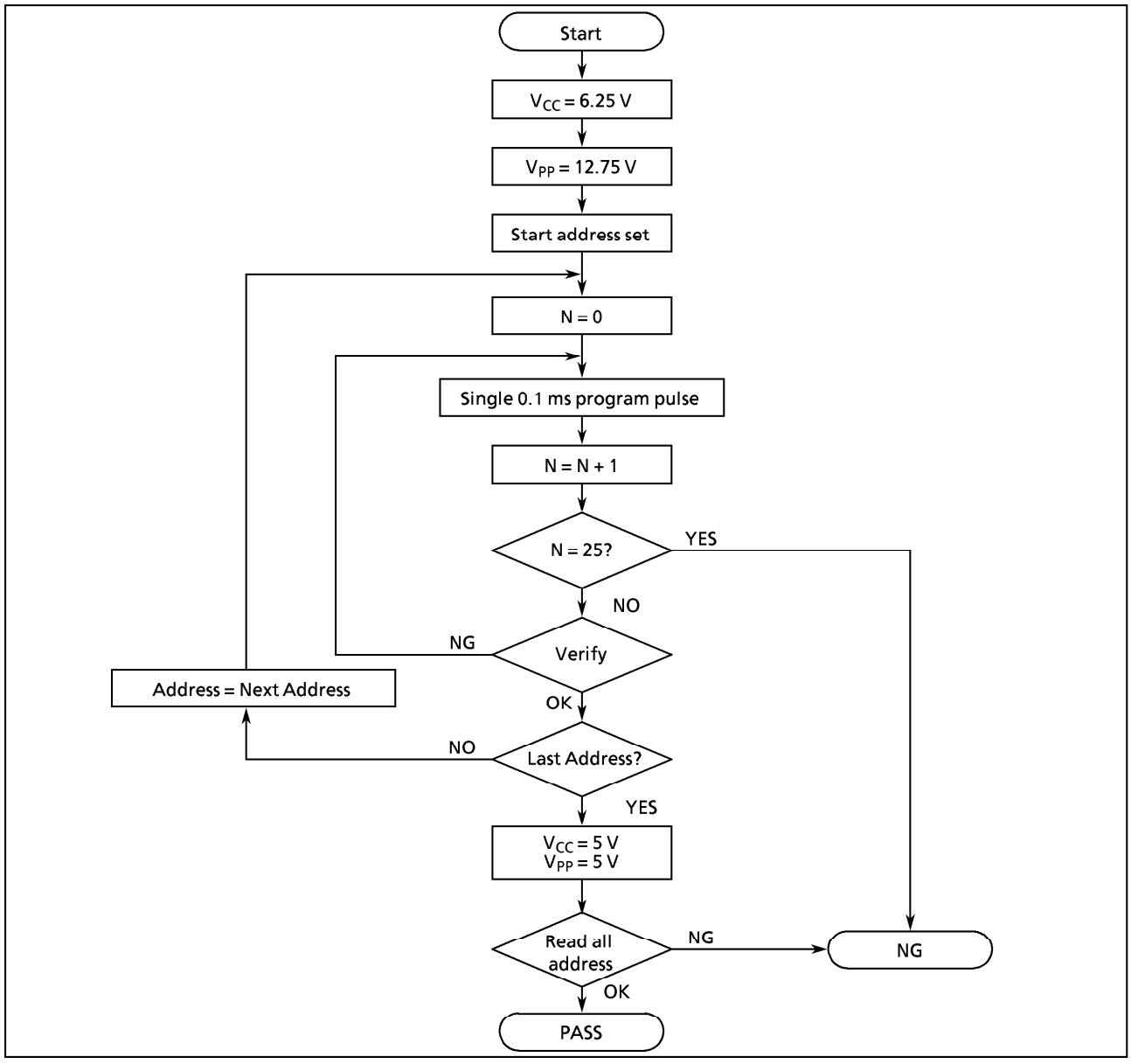


Figure 1-5. Flowchart of High-speed Programming Mode - II

1.2.3 Writing Method for General-purpose PROM Program

(1) Adapters
BM1193 : TMP87PH46N
BM1194B : TMP87PH47U, TMP87PH47LU

(2) Adapter setting
Switch (SW1) is set to side N.

(3) PROM programmer specifying
i) PROM type is specified to TC57256AD.
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 TMP87PH46/47/47L, EPROM is within the addresses 4000 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 16KB : transferred addresses C000 to FFFFH to addresses 4000 to 7FFFH

iii) Writing address is specified. (note 1)
Start address : 4000H
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 addresses 0000 to 3FFFH 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 : TMP87PH46/47/47L do 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 ± 0.5V to the address pin 9 (A9). The signature must not be used.

ELECTRICAL CHARACTERISTICS

(1) 87PH46/47

ABSOLUTE MAXIMUM RATINGS (V_{SS} = 0V)

PARAMETER	SYMBOL	CONDITIONS	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_{OUT1}	Except sink open drain pin , but include P2 and $\overline{RESET}$	– 0.3 to V_{DD} + 0.3	V
	V_{OUT2}	Sink open drain pin except port P2, $\overline{RESET}$	– 0.3 to V_{DD} + 0.3	
Output Current (Per 1 pin)	I_{OUT1}	Ports P1, P2, P5, P6, P7	3.2	mA
	I_{OUT2}	Port P0	30	
Output Current (Total)	ΣI_{OUT1}	Ports P1, P2, P5, P6, P7	100	mA
	ΣI_{OUT2}	Port P0	120	
Power Dissipation [Topr = 70°C]	PD	87PH46	600	mW
		87PH47/47L	350	
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 30 to 70	°C

RECOMMENDED OPERATING CONDITIONS (V_{SS} = 0V, Topr = – 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	$V_{DD} \geqq 4.5V$		$V_{DD} \times 0.70$	V_{DD}	V
	V_{IH2}	Hysteresis input			$V_{DD} \times 0.75$		
	V_{IH3}		$V_{DD} < 4.5V$		$V_{DD} \times 0.90$		
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geqq 4.5V$		0	$V_{DD} \times 0.30$	V
	V_{IL2}	Hysteresis input				$V_{DD} \times 0.25$	
	V_{IL3}		$V_{DD} < 4.5V$			$V_{DD} \times 0.10$	
Clock Frequency	fc	XIN, XOUT	V_{DD} = 4.5 to 5.5V		1.0	8.0	MHz
			V_{DD} = 2.7 to 5.5V			4.2	
	fs	XTIN, XTOUT			30.0	34.0	kHz

Note 1 : Clock frequency fc ; Supply voltage range is specified in NORMAL mode and IDLE mode.

D.C. CHARACTERISTICS

(V_{SS} = 0V, 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, Tri-state ports					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Resistance	R_{IN2}	$\overline{RESET}$		100	220	450	kΩ
Output Leakage Current	I_{LO1}	Sink 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_{OH2}	Tri-state ports	V_{DD} = 4.5 V, I_{OH} = – 0.7 mA	4.1	–	–	V
Output Low Voltage	V_{OL}	Except XOUT and P0	V_{DD} = 4.5 V, I_{OL} = 1.6 mA	–	–	0.4	V
Output Low current	I_{OL3}	P0	V_{DD} = 4.5 V, V_{OL} = 1.0 V	–	20	–	mA
Supply Current in NORMAL 1, 2 modes	I_{DD}		V_{DD} = 5.5 V V_{IN} = 5.3 V/0.2 V fc = 8MHz fs = 32.768 kHz	–	8	14	mA
Supply Current in IDLE 1, 2 modes				–	4	6	mA
Supply Current in NORMAL 1, 2 modes			V_{DD} = 3.0 V V_{IN} = 2.8 V/0.2 V fc = 4.19 MHz fs = 32.768 kHz	–	2.5	3.5	mA
Supply Current in IDLE 1, 2 modes				–	1.5	2.0	mA
Supply Current in SLOW mode			V_{DD} = 3.0 V V_{IN} = 2.8 V/0.2 V fs = 32.768 kHz	–	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 I_{IN1}, I_{IN3} ; The current through resistor is not included, when the input resistor (pull-up or pull-down) is contained.

A / D CONVERSION CHARACTERISTICS

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

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Analog Reference Voltage	V_{AREF}		2.7	–	V_{DD}	V
	V_{ASS}		V_{SS}			
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_{AREF} = 5.000 V V_{ASS} (V_{SS}) = 0.000 V or V_{DD} = 2.7 V, V_{SS} = 0 V V_{AREF} = 2.700 V V_{ASS} (V_{SS}) = 0.000 V	–	–	± 2	LSB
Zero Point Error			–	–	± 2	
Full Scale Error			–	–	± 2	
Total Error			–	–	± 4	

Note : Quantizing error is not contained in Total Error.

A.C. CHARACTERISTICS

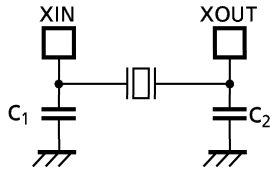
(V_{SS} = 0V, V_{DD} = 4.5 to 5.5V, Topr = – 30 to 70°C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t_{cy}	In NORMAL1, 2 modes	0.5	–	4	μs
		In IDLE1, 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), fc = 8MHz	62.5	–	–	ns
Low Level Clock Pulse Width	t_{WCL}					
High Level Clock Pulse Width	t_{WSH}	For external clock operation (XTIN input), fs = 32.768kHz	14.7	–	–	μs
Low Level Clock Pulse Width	t_{WSL}					

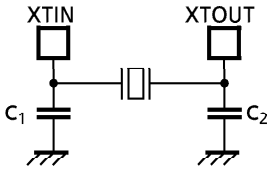
RECOMMENDED OSCILLATING CONDITIONS

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

PARAMETER	OSCILLATOR	FREQUENCY	RECOMMENDED OSCILLATOR		RECOMMENDED CONDITION C_1	RECOMMENDED CONDITION C_2
High-frequency	Ceramic Resonator	8 MHz	KYOCERA	KBR8.0M	30 pF	30 pF
			MURATA	CSA8.00MTz CSACS8.00MT CSTCS8.00MT		
		4 MHz	KYOCERA	KBR4.0MS		
			MURATA	CSAC4.00MGC CSA4.00MG		
	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



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

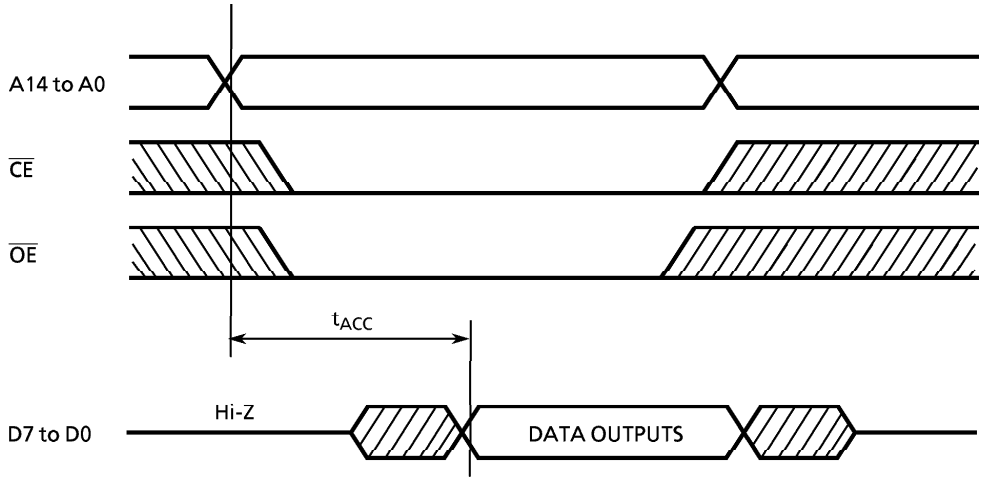
Note : When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

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

(1) READ OPERATION (Topr = – 30 to 70 °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
Power Supply Voltage	V_{CC}		4.75	–	6.0	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	V_{CC} = 5.0 ± 0.25V	–	1.5tcyc + 300	–	ns

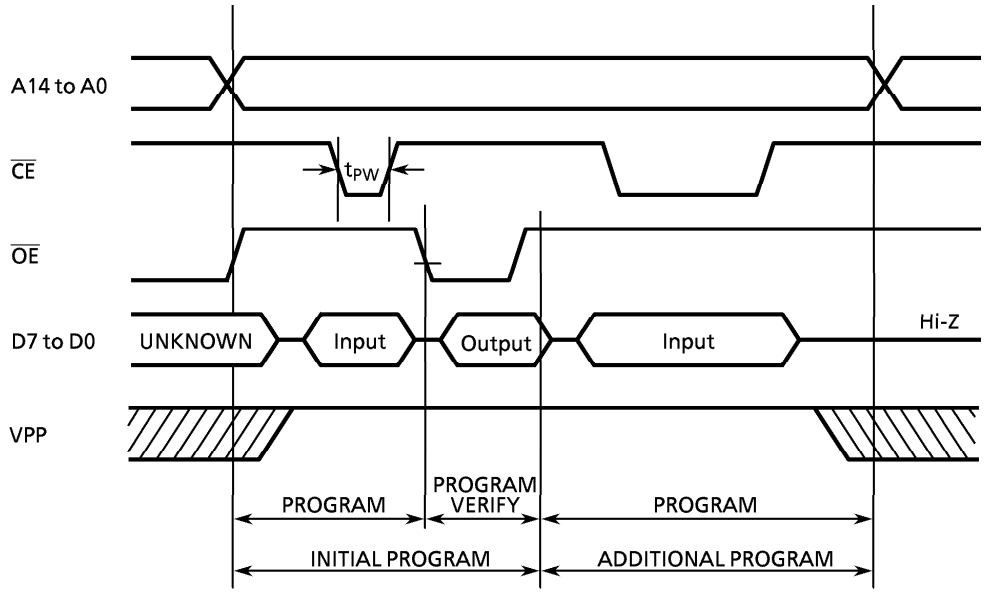
Note : tcyc = 500ns at 8MHz



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} × 0.7	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	V_{CC} × 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} = 6.0V ± 0.25 V, V_{PP} = 12.5 ± 0.5 V	0.95	1.0	1.05	ms



TIMING WAVEFORMS OF PROGRAMMING OPERATION

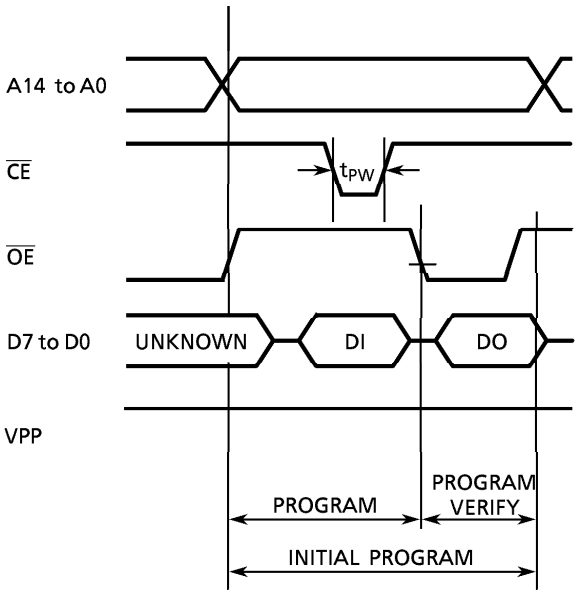
Note 1: When V_{cc} power supply is turned on or after, V_{pp} must be increased.
When V_{cc} power supply is turned off or before, V_{pp} must be decreased.

Note 2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.5V ± 0.5V) 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.

(3) PROGRAM OPERATION (High speed write mode - II) (Topr = 25 ± 5 °C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	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: DO ; Data output (I0 to I7)
DI ; Data input (I0 to I7)

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 (12.75V ± 0.25V) 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.

ELECTRICAL CHARACTERISTICS

(2) 87PH47L

ABSOLUTE MAXIMUM RATINGS (V_{SS} = 0V)

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_{OUT1}	Except sink open drain pin , but include P2 and $\overline{RESET}$	– 0.3 to V_{DD} + 0.3	V
	V_{OUT2}	Sink open drain pin except port P2, $\overline{RESET}$	– 0.3 to V_{DD} + 0.3	
Output Current (Per 1 pin)	I_{OUT1}	Ports P1, P2, P5, P6, P7	3.2	mA
	I_{OUT2}	Port P0	30	
Output Current (Total)	ΣI_{OUT1}	Ports P1, P2, P5, P6, P7	100	mA
	ΣI_{OUT2}	Port P0	120	
Power Dissipation [Topr = 70°C]	PD		350	mW
Soldering Temperature (time)	Tsld		260 (10s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 30 to 70	°C

RECOMMENDED OPERATING CONDITIONS (V_{SS} = 0V, Topr = – 30 to 70°C)

PARAMETER	SYMBOL	PINS	CONDITIONS		Min.	Max.	UNIT
Supply Voltage	V_{DD}		fc = 4.2MHz	NORMAL1, 2 mode	1.8	4.0	V
				IDLE1, 2 mode			
			fs = 32.768kHz	SLOW mode			
				SLEEP mode			
				STOP mode			
Input High Voltage	V_{IH1}	Except hysteresis input			V_{DD} × 0.90	V_{DD}	V
	V_{IH2}	Hysteresis input					
	V_{IH3}						
Input Low Voltage	V_{IL1}	Except hysteresis input			0	V_{DD} × 0.10	V
	V_{IL2}	Hysteresis input					
	V_{IL3}						
Clock Frequency	fc	XIN, XOUT			1.0	4.2	MHz
	fs	XTIN, XTOUT			30.0	34.0	kHz

Note : Clock frequency fc ; Supply voltage range is specified in NORMAL mode and IDLE mode.

D.C. CHARACTERISTICS

(V_{SS} = 0V, Topr = – 30 to 70°C)

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Typ.	Max.	UNIT
Hysteresis Voltage	V_{HS}	Hysteresis inputs	V_{DD} = 4.0V	–	0.9	–	V
Input Current	I_{IN1}	TEST	V_{DD} = 4.05V V_{IN} = 4.0V/0V	–	–	± 2	μA
	I_{IN2}	Open drain ports, Tri-state ports					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Resistance	R_{IN2}	$\overline{RESET}$		100	220	450	kΩ
Output Leakage Current	I_{LO}	Sink open drain ports	V_{DD} = 4.0V, V_{OUT} = 4.0V	–	–	2	μA
Output High Voltage	V_{OH2}	Tri-state ports	V_{DD} = 4.0V, I_{OH} = – 0.5mA	3.0	–	–	V
Output Low Voltage	V_{OL}	Except XOUT and P0	V_{DD} = 4.0V, I_{OL} = 1.3mA	–	–	0.4	V
Output Low current	I_{OL3}	P0	V_{DD} = 4.0V, V_{OL} = 1.0V	–	20	–	mA
Supply Current in NORMAL 1, 2 modes	I_{DD}		V_{DD} = 4.0V fc = 4.2MHz fs = 32.768kHz V_{IN} = 3.8V/0.2V	–	3.0	6.0	mA
Supply Current in IDLE 1, 2 modes				–	2.0	4.0	
Supply Current in NORMAL 1, 2 modes			V_{DD} = 1.8V V_{IN} = 1.7V/0.1V fc = 4.19MHz fs = 32.768kHz	–	1.0	2.0	mA
Supply Current in IDLE 1, 2 modes				–	0.5	1.0	
Supply Current in SLOW mode			V_{DD} = 3.0V fs = 32.768kHz V_{IN} = 2.8V/0.2V	–	30	60	μA
Supply Current in SLEEP mode				–	15	30	
Supply Current in STOP mode			V_{DD} = 4.0V V_{IN} = 3.8V/0.2V	–	0.5	10	μA

Note 1 : Typical values show those at Topr = 25°C .
Note 2 : Input Current I_{IN1},I_{IN3} ; The current through resistor is not included, when the input resistor (pull-up or pull-down) is contained.

A / D CONVERSION CHARACTERISTICS (I)

(V_{SS} = 0V, V_{DD} = 1.8 to 4.0V, Topr = – 30 to 70°C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Analog Reference Voltage	V_{AREF}		1.8	–	V_{DD}	V
	V_{ASS}		V_{SS}			
Analog Input Voltage	V_{AIN}		V_{ASS}	–	V_{AREF}	V
Analog Supply Current	I_{REF}		–	0.5	1.0	mA
Nonlinearity Error		1.8 V ≦ V_{AREF} < 2.7 V V_{AREF} ≦ V_{DD} ≦ 4.0 V V_{SS} (V_{ASS}) = 0.000V ACK = 1 (Note 1)	–	–	± 2	LSB
Zero Point Error			–	–	± 2	
Full Scale Error			–	–	± 2	
Total Error			–	–	± 4	

Note 1 : ACK ; bit 5 of ADCCR (#000E$_H$)
Note 2 : Quantizing Error is not contained in Total Errors.

A / D CONVERSION CHARACTERISTICS (II)

(V_{SS} = 0V, V_{DD} = 2.7 to 4.0V, Topr = – 30 to 70°C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Analog Reference Voltage	V_{AREF}		2.7	–	V_{DD}	V
	V_{ASS}		V_{SS}			
Analog Input Voltage	V_{AIN}		V_{ASS}	–	V_{AREF}	V
Analog Supply Current	I_{REF}	V_{AREF} = 4.0 V, V_{ASS} = 0.0 V	–	0.5	1.0	mA
Nonlinearity Error		V_{DD} = 4.0 V V_{AREF} = 4.000 V V_{ASS} (V_{SS}) = 0.000 V or V_{DD} = 2.7 V, V_{SS} = 0 V V_{AREF} = 2.700 V V_{ASS} (V_{SS}) = 0.000 V	–	–	± 2	LSB
Zero Point Error			–	–	± 2	
Full Scale Error			–	–	± 2	
Total Error			–	–	± 4	

Note : Quantizing Error is not contained in Total Errors.

A.C. CHARACTERISTICS

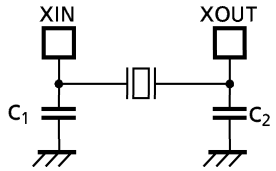
(V_{SS} = 0V, V_{DD} = 1.8 to 4.0V, Topr = – 30 to 70°C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t_{cy}	In NORMAL1, 2 modes	0.95	–	10	μs
		In IDLE1, 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), fc = 4.2MHz	110	–	–	ns
Low Level Clock Pulse Width	t_{WCL}					
High Level Clock Pulse Width	t_{WSH}	For external clock operation (XTIN input), fs = 32.768kHz	14.7	–	–	μs
Low Level Clock Pulse Width	t_{WSL}					

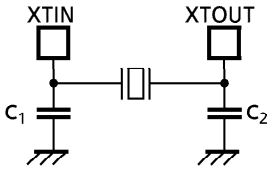
RECOMMENDED OSCILLATING CONDITIONS

(V_{SS} = 0V, V_{DD} = 1.8 to 4.0V, Topr = – 30 to 70°C)

PARAMETER	Oscillator	Oscillation Frequency	Recommended Oscillator		Recommended Constant C_1	Recommended Constant C_2
High-frequency Oscillation	Ceramic Resonator	4MHz	MURATA	CSAC4.00MGC	30 pF	30 pF
				CSA4.00MG		
Low-frequency Oscillation	Crystal Oscillator	32.768kHz	NDK	MX-38T	12 pF	12 pF



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

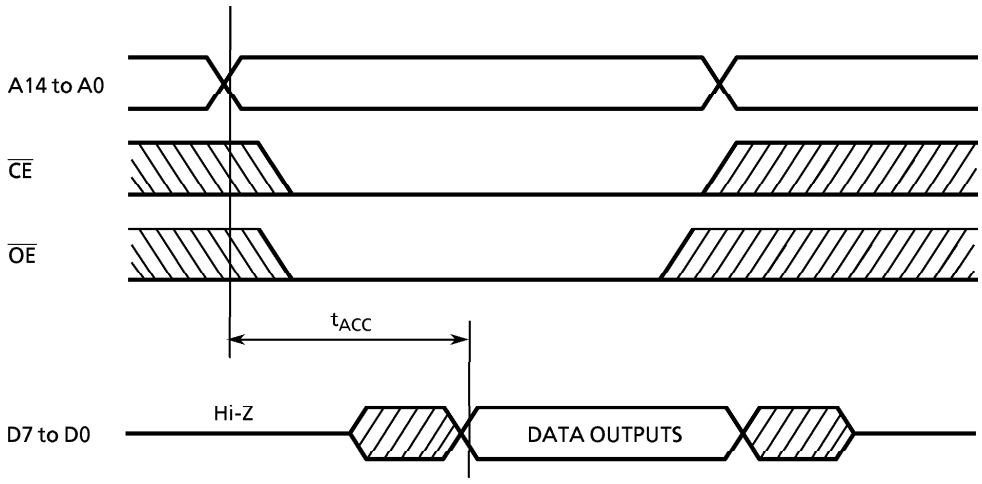
Note : When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

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

(1) READ OPERATION (Topr = – 30 to 70 °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
Power Supply Voltage	V_{CC}		4.75	–	6.0	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	V_{CC} = 5.0 ± 0.25V	–	1.5tcyc + 300	–	ns

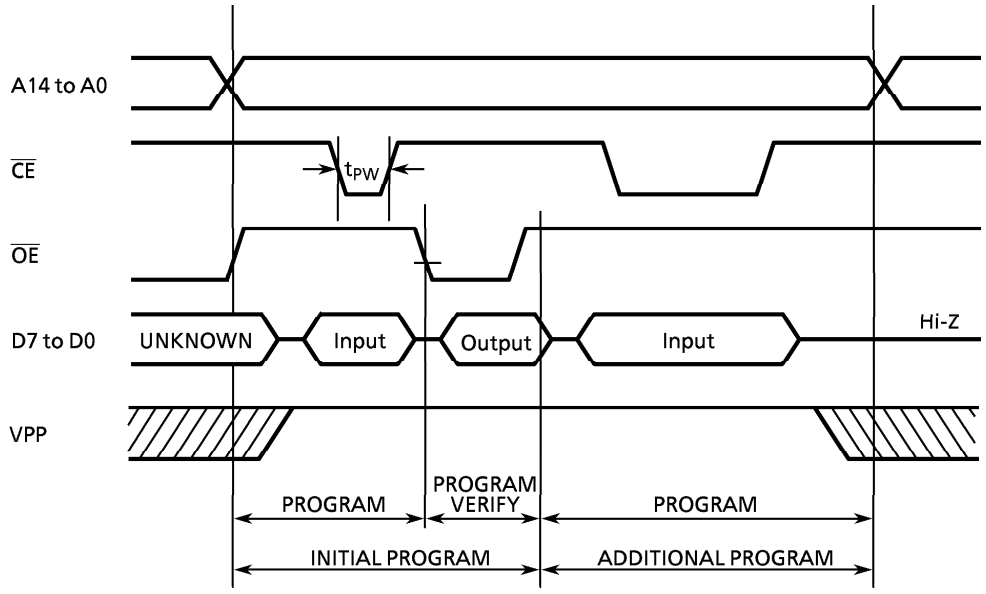
Note : tcyc = 500ns at 8MHz



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} = 6.0V ± 0.25 V, V_{PP} = 12.5 ± 0.5 V	0.95	1.0	1.05	ms

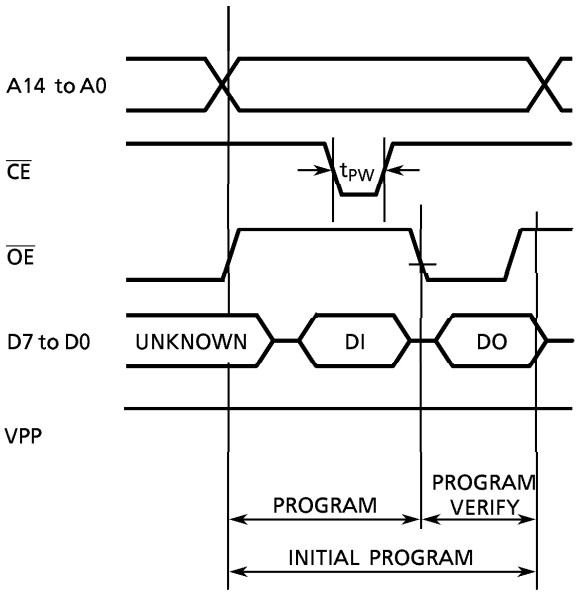


TIMING WAVEFORMS OF PROGRAMMING OPERATION

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 decreased.
Note2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.5V ± 0.5V) to the V_{pp} pin as the device is damaged.
Note3: 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.

(3) PROGRAM OPERATION (High speed write mode - II) (Topr = 25 ± 5 °C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	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: DO ; Data output (I0 to I7)
DI ; Data input (I0 to I7)

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 decreased.
Note2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.75V ± 0.25V) to the V_{pp} pin as the device is damaged.
Note3: 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.