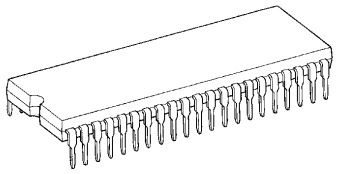
CMOS 8-Bit Microcontroller

TMP88PH47N, TMP88PH47F

The 88PH47 is a One-Time PROM microcontroller with low-power 514 Kbits (16 Kbytes + 256 bytes) electrically programmable read only memory for the 88CH47 system evaluation. The 88PH47 is pin compatible with the 88CH47. The operations possible with the 88CH47 can be performed by writing programs to PROM. The 88PH47 can write and verify in the same way as the TC571000 using an adaptor socket and an EPROM programmer.

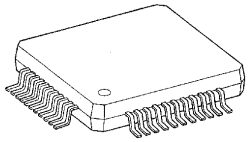
Part No.	OTP	RAM	Package	Adaptor Soket
TMP88PH47N	16 Kbytes	512 Kbytes	P-SDIP42-600-1.78	BM11167
TMP88PH47F			P-QFP44-144-0.80D	BM11168

P-SDIP42-600-1.78



TMP88PH47N

P-QFP44-1414-0.80D



TMP88PH47F

980910EBP1

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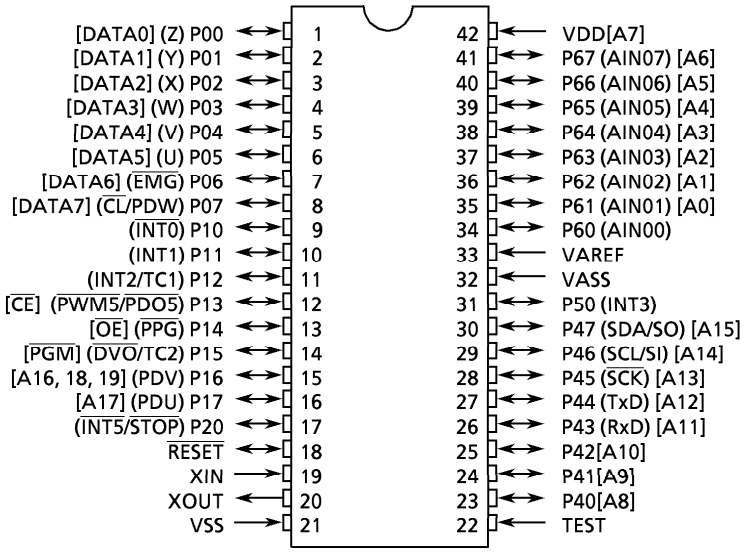
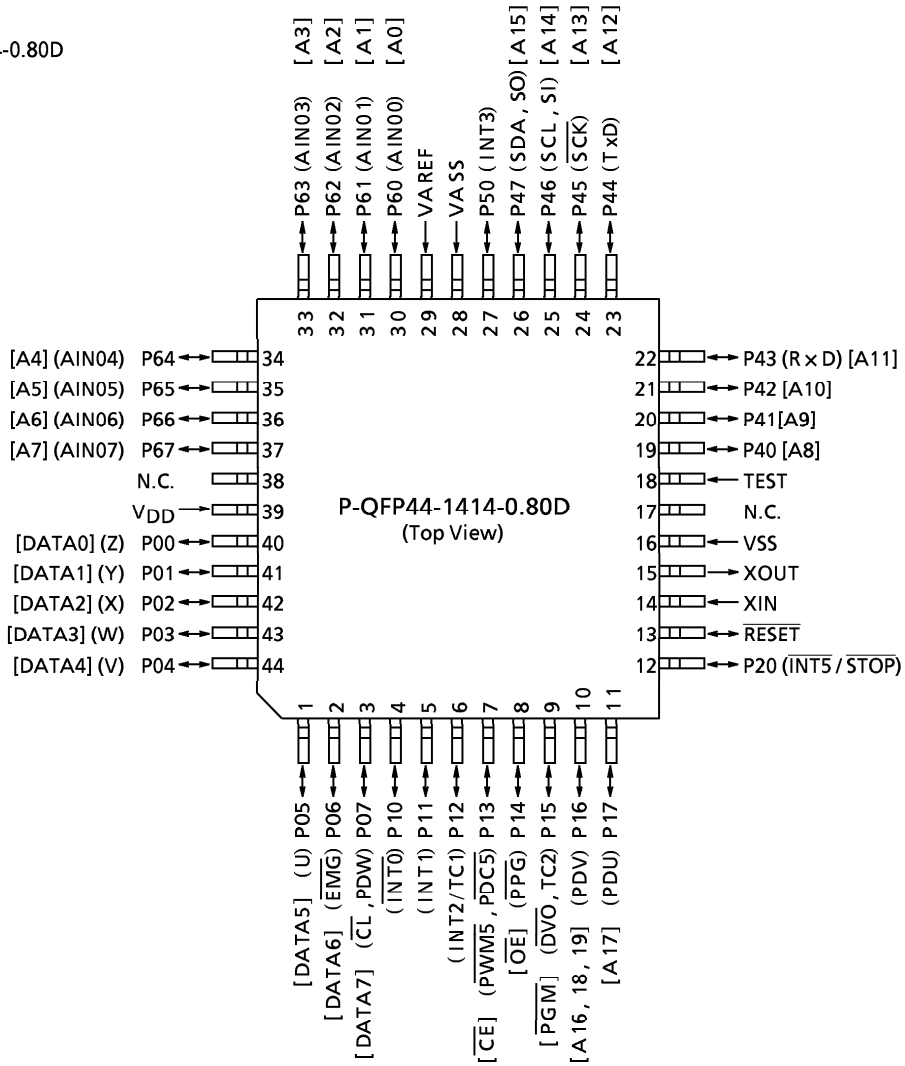
Pin Assignments (Top View)

P-SDIP42-600-1.78



TMP88PH47F

P-QFP44-1414-0.80D



Pin Function

The 88PH47 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 88PH47 is pin compatible with the 88CH47 (fix the TEST pin at "L" level).

(2) PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A17	Input	PROM address inputs	P17
A16, A18, A19			P16
A15 to A8			P47 to P40
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 enable signal input	P15
VPP	Power suppluy	+ 12.75 V/5 V (Program supply voltage)	TEST
VCC		+ 6.25 V/5 V	VDD
GND		0 V	VSS
P37 to P30	I/O	Pull-up with resistance for input processing	
P47 to P41			
P54 to P50			
P11		PROM mode setting pin. Be fixed at "H" level.	
P12, P10		PROM mode setting pin. Be fixed at "L" level.	
P20			
$\overline{RESET}$			
XIN	Input	Connect an 16 MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power Suppluy	0 V (GND)	
VASS			

Operational Description

The following explains the 88PH47 hardware configuration and operation. The configuration and functions of the 88PH47 are the same as those of the 88CH47, except in that a one-time PROM is used instead of an on-chip mask ROM.

1. OPERATING MODE

The 88PH47 has two modes: MCU and PROM.

1.1 MCU mode

The MCU mode is activated by fixing the TEST/VPP pin at "L" level.
In the MCU mode, operation is the same as with the 88CH47 (the TEST/VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 88PH47 has a 16K bytes (addresses 4000_H to $07FFF_H$ in the MCU mode, addresses 0000_H to $3FFF_H$ in the PROM mode) and 256 bytes (addresses $FFF00_H$ to $FFFFF_H$ in the MCU mode, addresses $1FF00_H$ to $1FFFF_H$ in the PROM mode) of program memory (OTP).
If using 88PH47 for system evaluation of 88CH47, write the program to the program storage area shown in Figure 1-1.

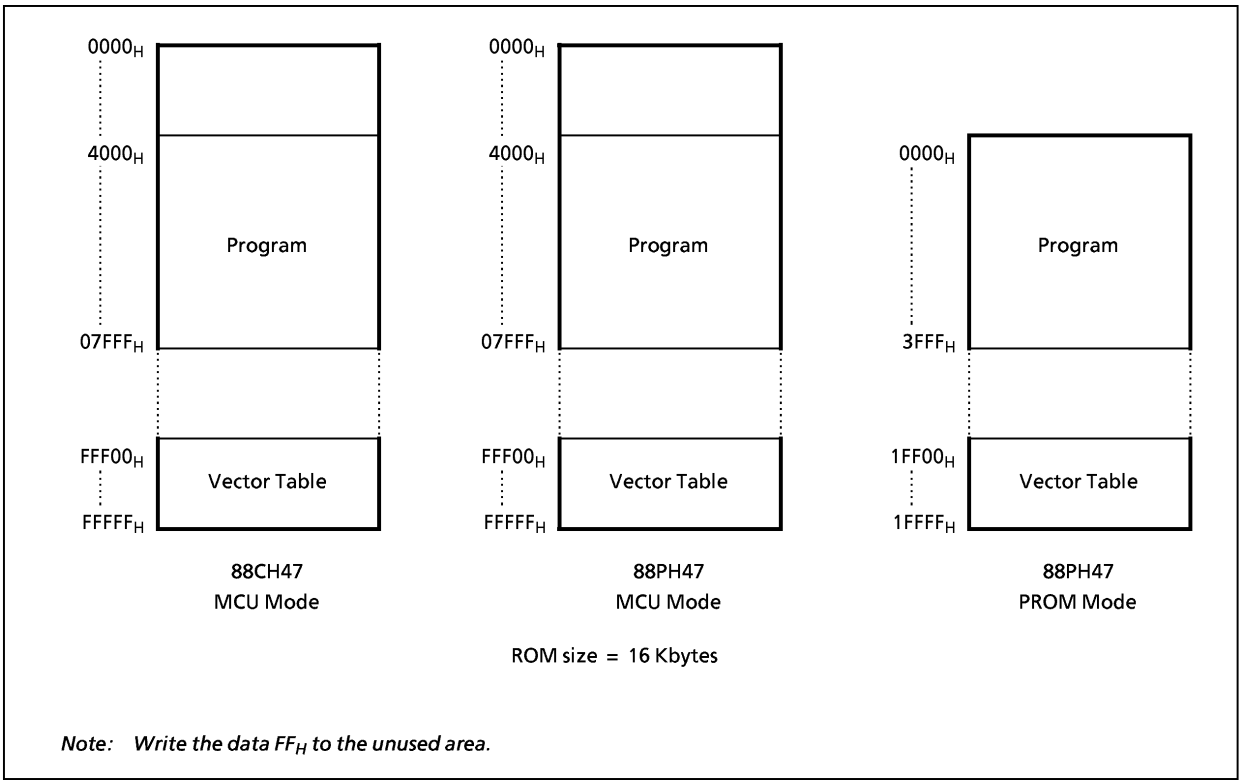


Figure 1-1. Program Memory Area

1.1.2 Data Memory

The 88PH47 has an on-chip 512K data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 88PH47 are same as those of the 88CH47 except that the TEST pin has is no built-in pull-down resistance.

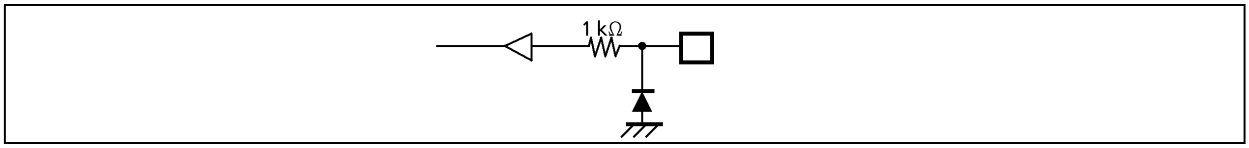


Figure 1-2. TEST Pin

(2) I/O ports

The I/O circuitries of the 88PH47 I/O ports are the same as the I/O circuitries of the 88CH47.

1.2 PROM Mode

The PROM mode is activated by setting the TEST, $\overline{\text{RESET}}$ pin and the ports P12 to P10 and P20 to P20 as shown in Figure 1-3. The PROM mode is used to write and verify programs with general-purpose PROM programmer. The high-speed programming mode can be used for program operation.
The 88PH47 is not supported an *electric signature* mode, so the ROM type must be set to TC571000.
Set the adaptor socket switch to "N".

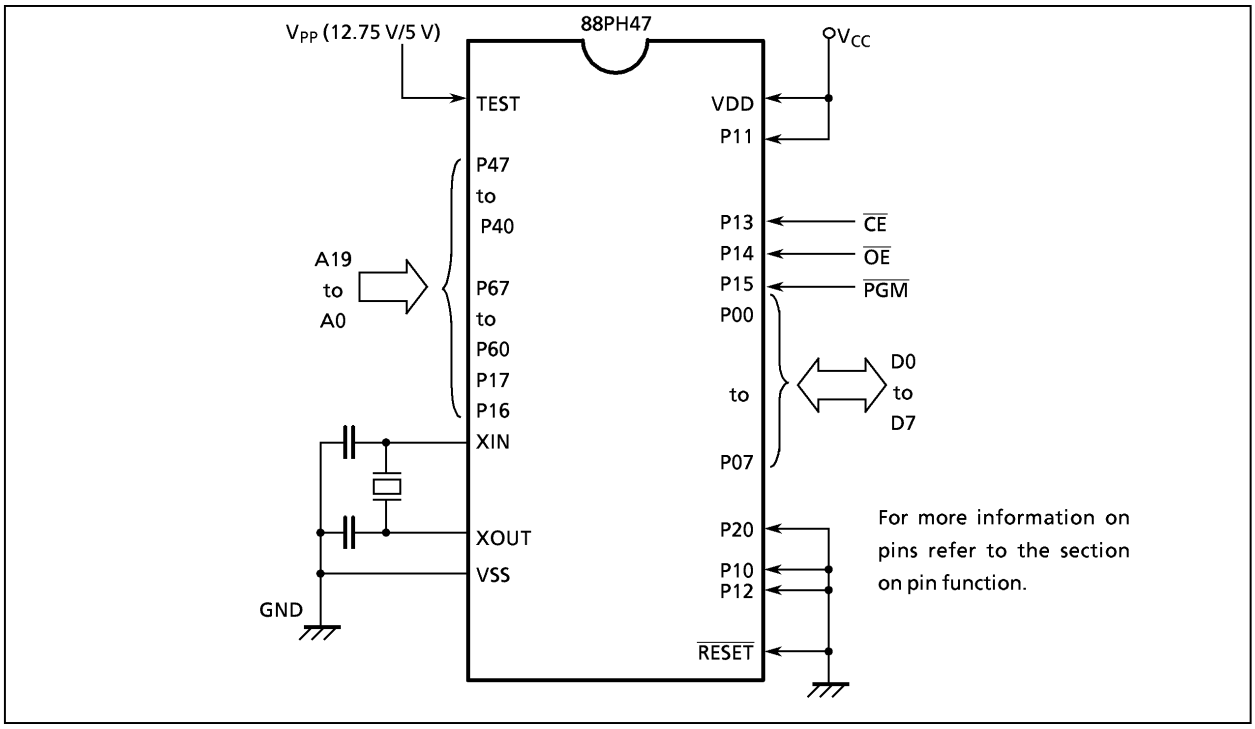


Figure 1-3. Setting for PROM Mode

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 0.1 ms 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.

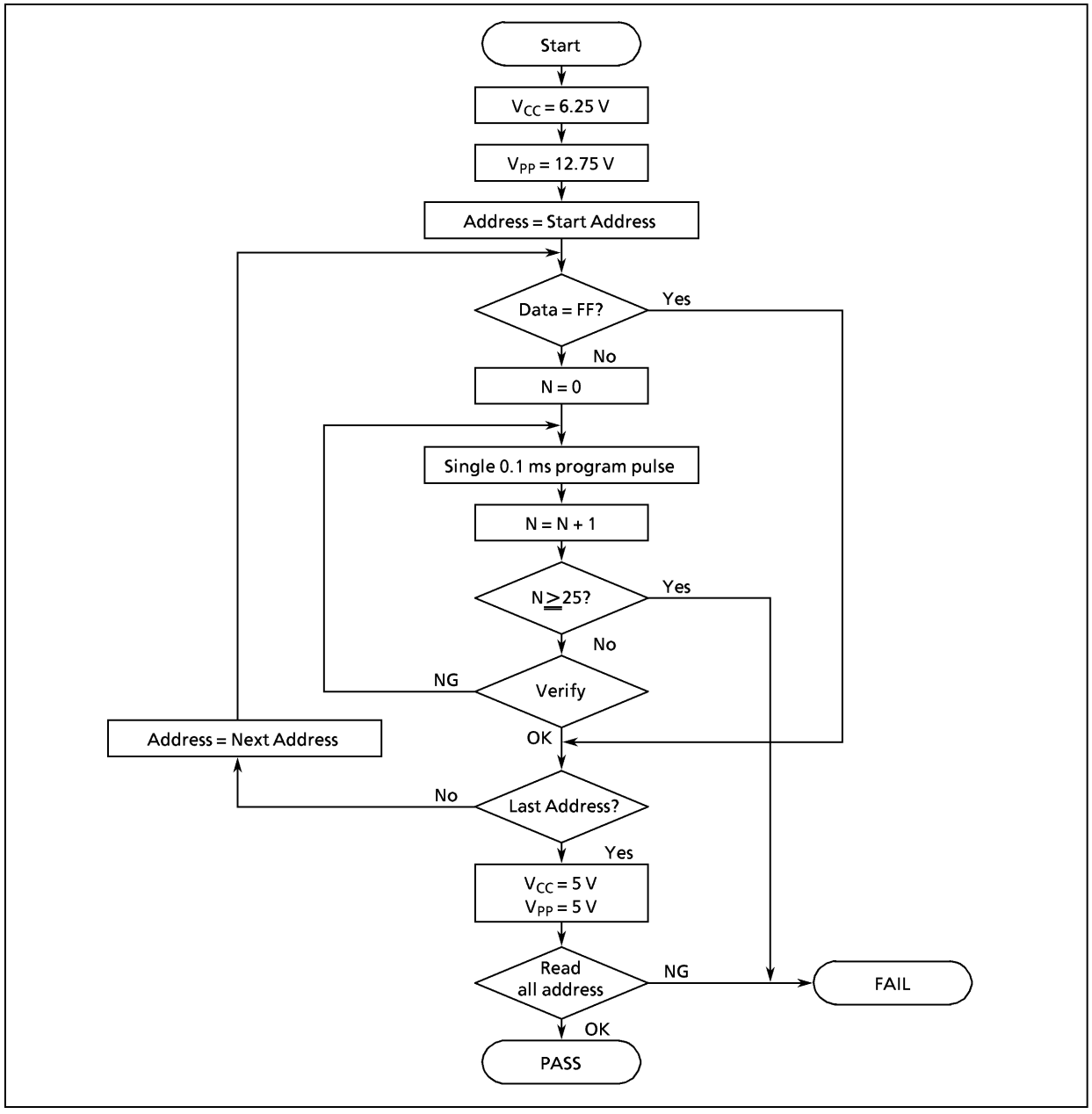


Figure 1-4. Flow Chart of High-Speed Programming Mode

1.2.2 Writing method for General-purpose PROM Program

(1) Adapters
BM11167: TMP88PH47N
BM11168: TMP88PH47F

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

(3) PROM programmer specifying
i) PROM type is specified to TC571000. (Note 1)
Writing voltage: 12.75 V (high-speed program mode)

ii) Data transfer (copy) (Note 2)
In TMP88PH47, EPROM is within the address 00000 to $03FFF_H$ (program memory area), and 1FF00 to $1FFFF_H$ (vector memory area). 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.
Program memory area
Transferred addresses 4000 to $7FFF_H$ to address 0000 to $3FFF_H$.
Vector memory area
Transferred addresses FFF00 to $FFFFF_H$ to address 1FF00 to $1FFFF_H$.

iii) Writing address is specified. (Note 3)
Start address: 00000_H
End address: $1FFFF_H$

(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 unused area must be specified to FF_H.

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: TMP88PH47 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 ± 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
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}	$\overline{RESET}$, Tri-state port	– 0.3 to V_{DD} + 0.3	V
	V_{OUT2}	Port P20, Sink open drain port	– 0.3 to 5.5	V
Output Current	I_{OUT1}	Ports P1, P2, P4, P5, P6	3.2	mA
	I_{OUT2}	Port P0	20	
	I_{OUT3}	Port P3	30	
Output Current	ΣI_{OUT1}	Ports P1, P2, P4, P5, P6	120	mA
	ΣI_{OUT2}	Port P0	60	
Power Dissipation [Topr = 70°C]	PD	TMP88PH47N	600	mW
		TMP88PH47F	350	
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 40 to 85	°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 Opeating ConditionS (V_{SS} = 0 V, Topr = – 40 to 85°C)

Parameter	Symbol	Pins	Conditions		Min	Max	Unit
Supply Voltage	V_{DD}		fc = 16 MHz	NORMAL mode	4.5	5.5	V
				IDLE 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		8.0	16.0	MHz

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: The condition of supply voltage range is the value in NORMAL and IDLE modes.

D.C. Characteristics (V_{SS} = 0 V, Topr = – 40 to 85°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}	Sink open drain, Tri-state ports					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Resistor (*)	R_{IN}	TEST with pull-down		20	70	170	kΩ
	R_{IN}	$\overline{RESET}$		90	220	510	
Output Leakage Current	I_{OL}	Sink open drain, Tri-state ports	V_{DD} = 5.5 V, V_{OUT} = 5.5 V/0 V	–	–	± 2	μA
Output High Voltage	V_{OH}	Tri-state ports	V_{DD} = 4.5 V, I_{OH} = – 0.7 mA	4.1	–	–	V
Output Low Current	I_{OL1}	Except XOUT, Ports P0, P3.	V_{DD} = 4.5 V, V_{OL} = 0.4 V	–	1.6	–	mA
	I_{OL2}	Port P0	V_{DD} = 4.5 V, V_{OL} = 1.0 V	6	10	–	
Supply Current in NORMAL Mode			V_{DD} = 5.5 V V_{IN} = 5.3 V/0.2 V fc = 16.0 MHz	–	32	40	mA
Supply Current in IDLE Mode				–	24	30	mA
Supply Current in STOP Mode			V_{DD} = 5.5 V V_{IN} = 5.3 V/0.2 V	–	0.5	20	μA

Note 1: Typical values show those at Topr = 25°C, V_{DD} = 5 V.
Note 2: Input Current I_{IN1}, I_{IN3}; The current through registor is not included, when the input resistor (pull-up or pull-down) is contained.
Note 3: IDD except I_{REF}.

AD Conversion Characteristics (Topr = – 40 to 85°C)

Parameter	Symbol	Conditions	Min	Typ.	Max			Unit
					ADCDR1	ADCDR2		
						ACK = 0	ACK = 1	
Analog Reference Voltage	V_{AREF}	$V_{AREF} - V_{ASS} \geqq 3.5$ V	V_{DD} – 1.0	—	V_{DD}			V
	V_{ASS}		V_{SS}	—	1.0			
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
Non-Linearity Error		V_{DD} = 5.0 V, V_{SS} = 0.0 V V_{AREF} = 5.000 V V_{ASS} = 0.000 V	—	—	± 1	± 3	± 2	LSB
Zero Point Error			—	—	± 1	± 3	± 2	
Full Scale Error			—	—	± 1	± 3	± 2	
Total Error			—	—	± 2	± 6	± 4	

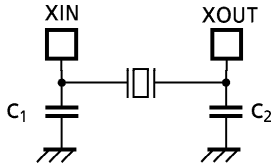
Note 1: ADCDR1: 8-bit AD conversion result (1LSB = ΔV_{AREF}/256)
ADCDR2: 10-bit AD conversion result (1LSB = ΔV_{AREF}/1024)
Note 2: Total error includes all errors except quantization error.

A.C. Characteristics (V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, Topr = – 40 to 85°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	UNIT
Machine Cycle Time	tcy	NORMAL mode	0.25	–	0.5	μs
		IDLE mode				
"H" Level Clock Pulse Width	t_{WCH}	For external clock operation (XIN input)	31.25	–	62.5	ns
"L" Level Clock Pulse Width	t_{WCL}					

Recommended Oscillating Conditions (V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, Topr = – 40 to 85°C)

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator	Recommended Constant	
				C_1	C_2
High-frequency Oscillation	Ceramic Resonator	16 MHz	MURATA CSA16.00MXZ	5pF	5pF
			MURATA CST16.00MXW	built-in 5pF	built-in 5pF



High-frequency Oscillation

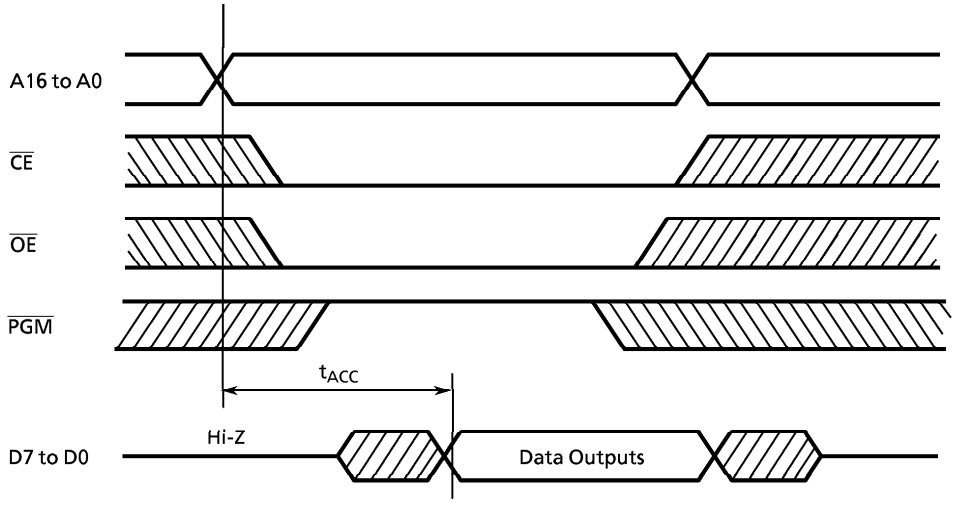
Note: An electrical shield by metal shield on the surface of IC package should be recommendable in order to prevent the device from the high electric fieldstress applied from CRT (Cathode Ray Tube) for continuous reliable operation.

D.C./A.C. Characteristics (PROM mode) (V_{SS} = 0 V, Topr = – 30 to 70°C)

(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 ± 0.25 V	–	1.5tcyc + 300	–	ns

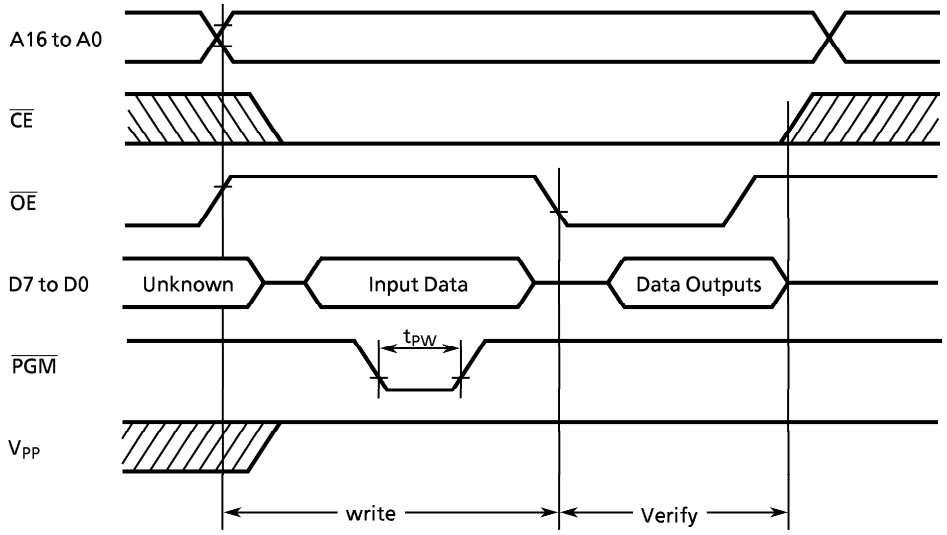
Note: tcyc = 500 ns at 8 MHz



(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	–	$V_{CC} \times 0.12$	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 up from it under applying the program voltage (2.75 V ± 0.5 V = V) to the V_{pp} pin as the device is damaged.