

CMOS 8-Bit Microcontroller

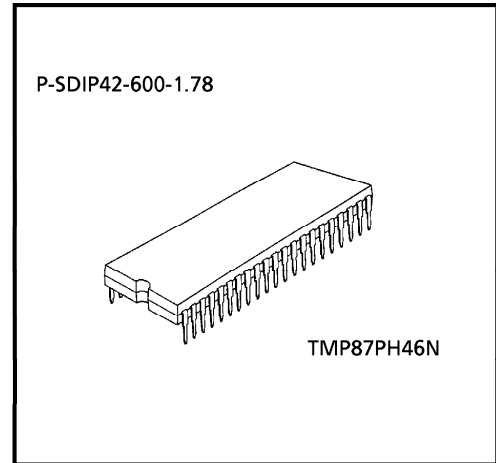
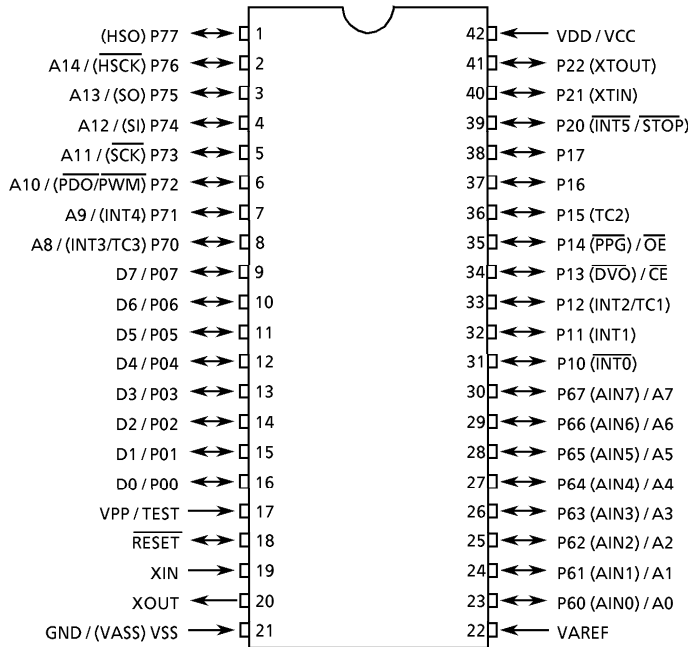
TMP87PH46N, TMP87PH47U, TMP87PH47LU

The 87PH46/47/47L are a One-Time PROM microcontroller with low-power 128 K bits (16 Kbytes) 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/BM1194C and an EPROM programmer.

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

Pin Assignments (Top View) - (1)

P-SDIP42-600-1.78

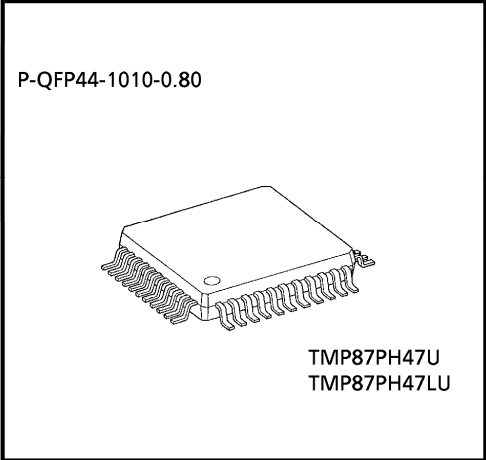
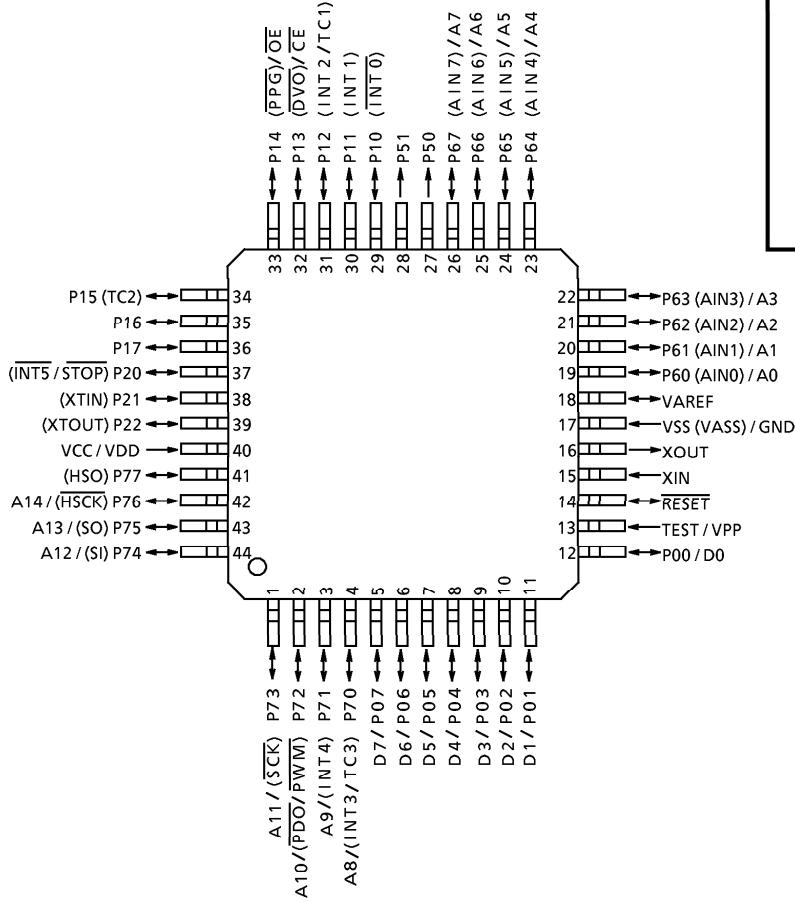


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Pin Assignments (Top View) - (2)

P-QFP44-1010-0.80



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	+ 12.5 V / 5 V (Program supply voltage)	TEST
VCC		+ 5 V	VDD
GND		0 V	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	0 V (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 extended from 1.8 V to 4.0 V.

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 16 K × 8-bit (addresses C000_H to FFFF_H in the MCU mode, addresses 4000_H to 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.

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 RESET	- 0.3 to $V_{DD} + 0.3$	V
	V_{OUT2}	Sink open drain pin except port P2, 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 [$T_{opr} = 70^{\circ}C$]	PD	87PH46	600	mW
		87PH47/47L	350	
Soldering Temperature (time)	T_{sld}		260 (10 s)	$^{\circ}C$
Storage Temperature	T_{stg}		- 55 to 125	$^{\circ}C$
Operating Temperature	T_{opr}		- 30 to 70	$^{\circ}C$

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

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

Parameter	Symbol	Pins	Conditions	Min	Max	Unit	
Supply Voltage	V_{DD}		$f_c = 8 \text{ MHz}$	NORMAL1, 2 mode	4.5	5.5	V
				IDLE1, 2 mode			
			$f_c = 4.2 \text{ MHz}$	NORMAL1, 2 mode	2.7		
				IDLE1, 2 mode			
			$f_s = 32.768 \text{ kHz}$	SLOW mode	2.0		
SLEEP mode							
Input High Voltage	V_{IH1}	Except hysteresis input	$V_{DD} \geq 4.5 \text{ V}$	$V_{DD} \times 0.70$	V_{DD}	V	
	V_{IH2}	Hysteresis input		$V_{DD} \times 0.75$			
	V_{IH3}			$V_{DD} < 4.5 \text{ V}$			$V_{DD} \times 0.90$
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geq 4.5 \text{ V}$	0	$V_{DD} \times 0.30$	V	
	V_{IL2}	Hysteresis input			$V_{DD} \times 0.25$		
	V_{IL3}				$V_{DD} < 4.5 \text{ V}$		$V_{DD} \times 0.10$
Clock Frequency	f_c	XIN, XOUT	$V_{DD} = 4.5 \text{ to } 5.5 \text{ V}$	1.0	8.0	MHz	
			$V_{DD} = 2.7 \text{ to } 5.5 \text{ V}$		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 f_c ; Supply voltage range is specified in NORMAL mode and IDLE mode.

D.C. Characteristics

(V_{SS} = 0V, T_{opr} = -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}	RESET, STOP					
Input Resistance	R _{IN2}	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 f _c = 8MHz f _s = 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 f _c = 4.19 MHz f _s = 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 f _s = 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 T_{opr} = 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, T_{opr} = -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	–	–	± 1	LSB
Zero Point Error		V _{ASS} (V _{SS}) = 0.000 V or V _{DD} = 2.7 V, V _{SS} = 0 V	–	–	± 1	
Full Scale Error		V _{AREF} = 2.700 V	–	–	± 1	
Total Error		V _{ASS} (V _{SS}) = 0.000 V	–	–	± 2	

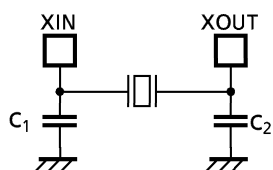
Note: Quantizing error is not contained in Total Error.

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

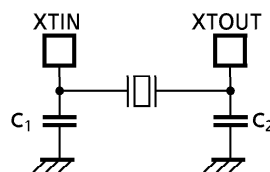
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t_{cy}	In NORMAL1, 2 modes	0.5	-	4	μs
		In IDLE1, 2 modes				
		In SLOW mode	117.6	-	133.3	
		In SLEEP mode				
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XIN input), $f_c = 8 \text{ MHz}$	50.5	-	-	ns
High Level 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_{WCL}					
Low Level Clock Pulse Width	t_{WSL}					

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

Parameter	Oscillator	Frequency	Recommended Oscillator	Recommended Condition	
				C_1	C_2
High-frequency	Ceramic Resonator	8 MHz	KYOCERA KBR8.0M MURATA CSA8.00MTz CSACS8.00MT CSTCS8.00MT	30 pF	30 pF
		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

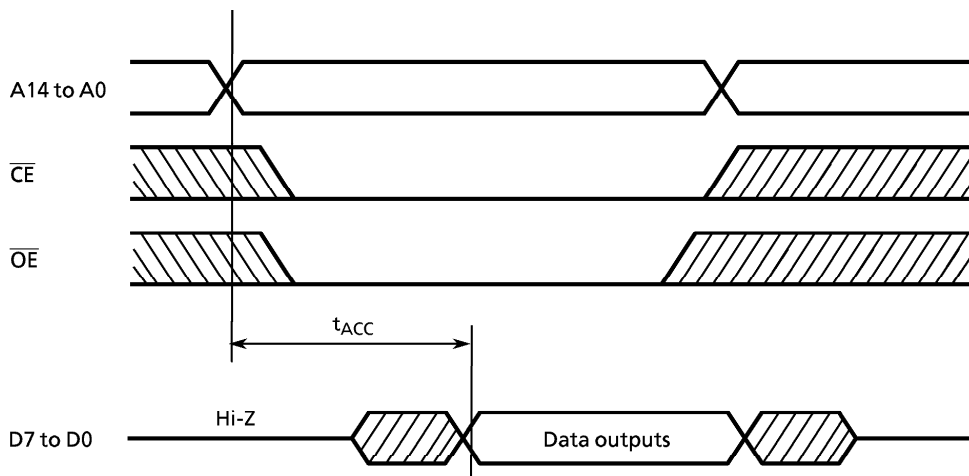
Note: When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

D.C./A.C. Characteristics (PROM mode) ($V_{SS} = 0\text{ V}$)

(1) READ OPERATION ($T_{opr} = -30$ to 70°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}		4.75	–	6.0	V
Program Power Supply Voltage	V_{PP}					V
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5t_{cyc} + 300$	–	ns

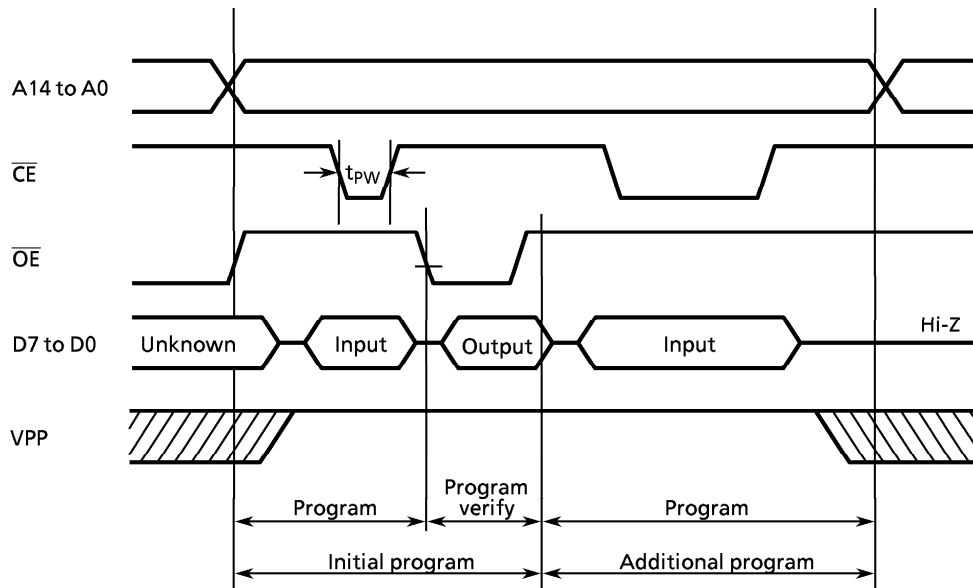
Note: $t_{cyc} = 500\text{ ns}$ at 8 MHz



Timing Waveforms of Read Operation

(2) Program Operation (High Speed Write Mode - I) ($T_{opr} = 25 \pm 5^\circ\text{C}$)

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}	$V_{CC} = 6.0\text{ V} \pm 0.25\text{ V}$, $V_{PP} = 12.5 \pm 0.5\text{ V}$	0.95	1.0	1.05	ms

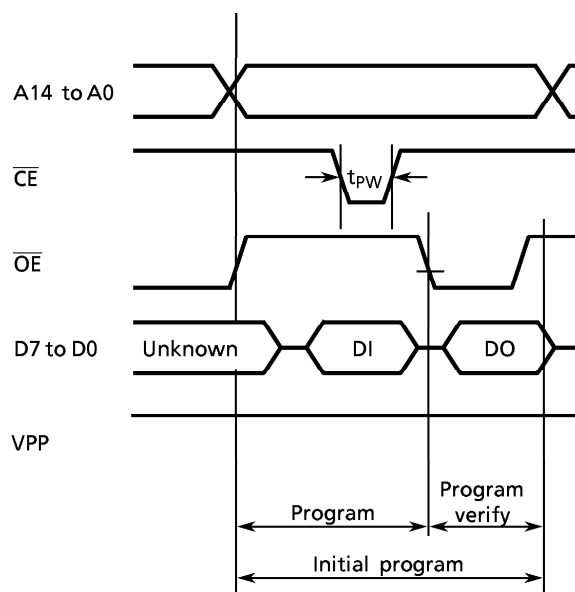


Timing Waveforms of Programming Operation

- 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 ($12.5\text{ V} \pm 0.5\text{ V}$) to the V_{pp} pin as the device is damaged.
- Note 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.

(3) Program Operation (High speed write mode - II) ($T_{opr} = 25 \pm 5^{\circ}\text{C}$)

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}	$V_{CC} = 6.25\text{ V} \pm 0.25\text{ V}$, $V_{PP} = 12.75\text{ V} \pm 0.25\text{ V}$	0.095	0.1	0.105	ms



Note: DO ; Data output (I0 to I7)
DI ; Data input (I0 to I7)

- Note 1: When Vcc power supply is turned on or after, Vpp must be increased.
When Vcc power supply is turned off or before, Vpp 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 ($12.75\text{ V} \pm 0.25\text{ V}$) to the Vpp pin as the device is damaged.
- Note 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.

Electrical Characteristics

(2) 87PH47L

Absolute Maximum Ratings

 $(V_{SS} = 0 \text{ V})$

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 RESET	- 0.3 to $V_{DD} + 0.3$	V
	V_{OUT2}	Sink open drain pin except port P2, $\overline{\text{RESET}}$	- 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 [$T_{opr} = 70^\circ\text{C}$]	PD		350	mW
Soldering Temperature (time)	T_{sld}		260 (10s)	$^\circ\text{C}$
Storage Temperature	T_{stg}		- 55 to 125	$^\circ\text{C}$
Operating Temperature	T_{opr}		- 30 to 70	$^\circ\text{C}$

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

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

Parameter	Symbol	Pins	Conditions	Min	Max	Unit	
Supply Voltage	V_{DD}		$f_c = 4.2 \text{ MHz}$	NORMAL1, 2 mode	1.8	4.0	V
				IDLE1, 2 mode			
			$f_s = 32.768 \text{ kHz}$	SLOW mode			
				SLEEP mode			
Input High Voltage	V_{IH1}	Except hysteresis input		$V_{DD} \times 0.90$	V_{DD}	V	
		Hysteresis input					
Input Low Voltage	V_{IL1}	Except hysteresis input		0	$V_{DD} \times 0.10$	V	
		Hysteresis input					
Clock Frequency	f_c	XIN, XOUT		0.1	4.2	MHz	
		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 f_c ; Supply voltage range is specified in NORMAL mode and IDLE mode.

D.C. Characteristics

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

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

Note 1: Typical values show those at $T_{opr} = 25^\circ\text{C}$.

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)

($V_{SS} = 0\text{ V}$, $V_{DD} = 1.8\text{ to }4.0\text{ V}$, $T_{opr} = -30\text{ to }70^{\circ}\text{C}$)

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		$1.8\text{ V} \leq V_{AREF} < 2.7\text{ V}$ $V_{AREF} \leq V_{DD} \leq 4.0\text{ V}$ $V_{SS} (V_{ASS}) = 0.000\text{ V}$ $ACK = 1$ (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)

($V_{SS} = 0\text{ V}$, $V_{DD} = 2.7\text{ to }4.0\text{ V}$, $T_{opr} = -30\text{ to }70^{\circ}\text{C}$)

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}	$V_{AREF} = 4.0\text{ V}$, $V_{ASS} = 0.0\text{ V}$	-	0.5	1.0	mA
Nonlinearity Error		$V_{DD} = 4.0\text{ V}$ $V_{AREF} = 4.000\text{ V}$ $V_{ASS} (V_{SS}) = 0.000\text{ V}$ or $V_{DD} = 2.7\text{ V}$, $V_{SS} = 0\text{ V}$ $V_{AREF} = 2.700\text{ V}$ $V_{ASS} (V_{SS}) = 0.000\text{ V}$	-	-	± 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

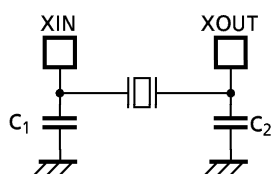
($V_{SS} = 0\text{ V}$, $V_{DD} = 1.8\text{ to }4.0\text{ V}$, $T_{opr} = -30\text{ to }70^\circ\text{C}$)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Machine Cycle Time	t_{cy}	In NORMAL1, 2 modes	0.95	-	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), $f_c = 4.2\text{ MHz}$	110	-	-	ns
Low Level Clock Pulse Width	t_{WCL}					
High Level Clock Pulse Width	t_{WSH}	For external clock operation	14.7	-	-	μs
Low Level Clock Pulse Width	t_{WSL}	(XTIN input), $f_s = 32.768\text{ kHz}$				

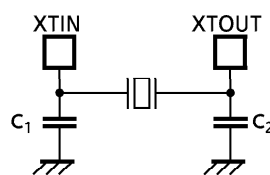
Recommended Oscillating Conditions

($V_{SS} = 0\text{ V}$, $V_{DD} = 1.8\text{ to }4.0\text{ V}$, $T_{opr} = -30\text{ to }70^\circ\text{C}$)

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



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

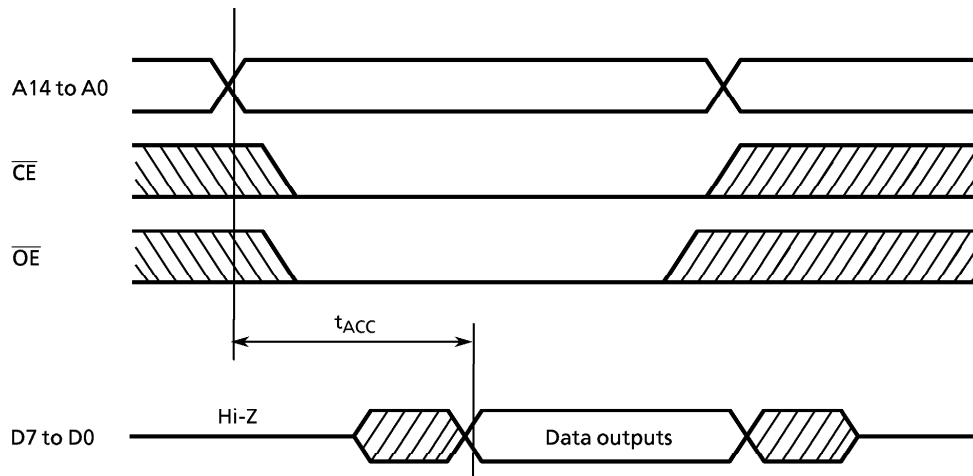
Note: When used in high electric field such as a picture tube, the package is recommended to be electrically shielded to maintain a regular operation.

D.C./A.C. Characteristics (PROM mode) ($V_{SS} = 0\text{ V}$)

(1) Read Operation ($T_{opr} = -30\text{ to }70^\circ\text{C}$)

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}		4.75	-	6.0	V
Program Power Supply Voltage	V_{PP}					V
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25\text{V}$	-	$1.5t_{cyc} + 300$	-	ns

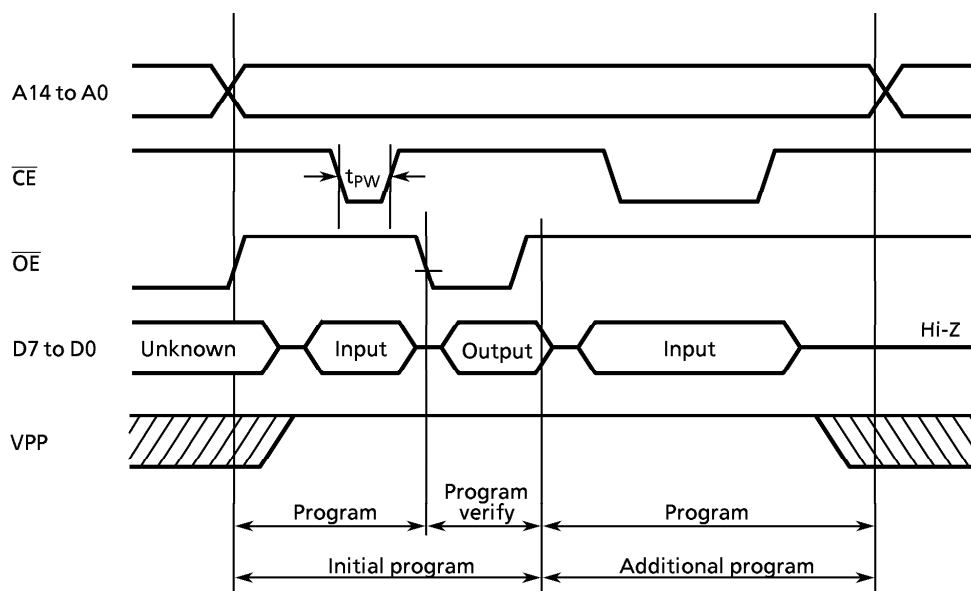
Note: $t_{cyc} = 500\text{ ns at }8\text{ MHz}$



Timing Waveforms of Read Operation

(2) Program Operation (High Speed Write Mode - I) ($T_{opr} = 25 \pm 5^{\circ}\text{C}$)

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}	$V_{CC} = 6.0\text{V} \pm 0.25\text{V}$, $V_{PP} = 12.5 \pm 0.5\text{V}$	0.95	1.0	1.05	ms

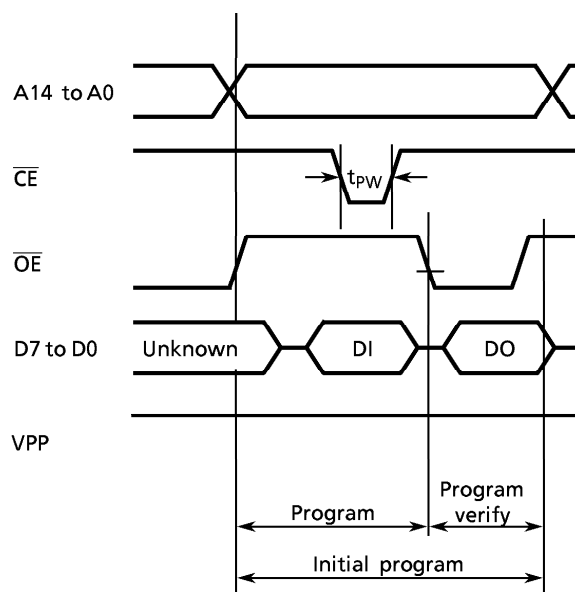


Timing Waveforms of Programming Operation

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 ($12.5\text{V} \pm 0.5\text{V}$) 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.

(3) Program Operation (High speed write mode - II) ($T_{opr} = 25 \pm 5^{\circ}\text{C}$)

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}	$V_{CC} = 6.25\text{ V} \pm 0.25\text{ V}$, $V_{PP} = 12.75\text{ V} \pm 0.25\text{ V}$	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 ($12.75\text{ V} \pm 0.25\text{ V}$) 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.