CMOS 8–Bit Microcontrollers

TMP90PH02P/TMP90PH02M

1. Outline and Characteristics

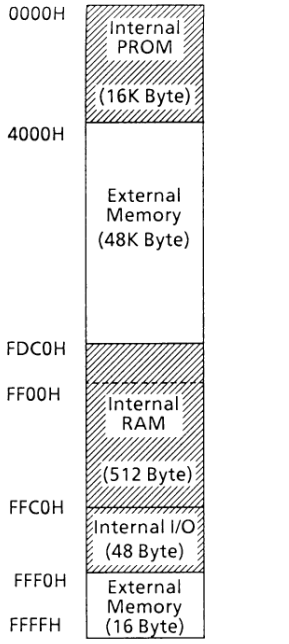
The TMP90PH02 is a system evaluation LSI having a built in One-Time PROM for TMP90CH02.

A programming and verification for internal PROM is achieved by using a general EPROM programmer with an adapter socket.

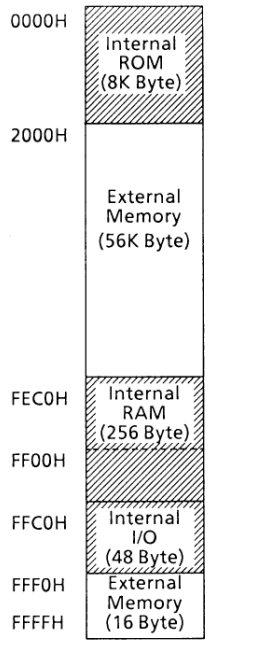
The function of this device is exactly same as the TMP90CH02 and TMP90C802A by programming to the internal PROM.

The differenes between TMP90PH02 and TMP90C802A are the internal RAM size, and the internal PROM size.

The following are the memory map of TMP90PH02 and TMP90C802A.



TMP90PH02 Memory Map



TMP90C802A Memory Map

Parts No.	ROM	RAM	Package	Adapter Socket No.
TMP90PH02P	OTP 16384 x 8bit	512 x 8bit	40-DIP	BM1158
TMP90PH02M			40-SOP	BM1159

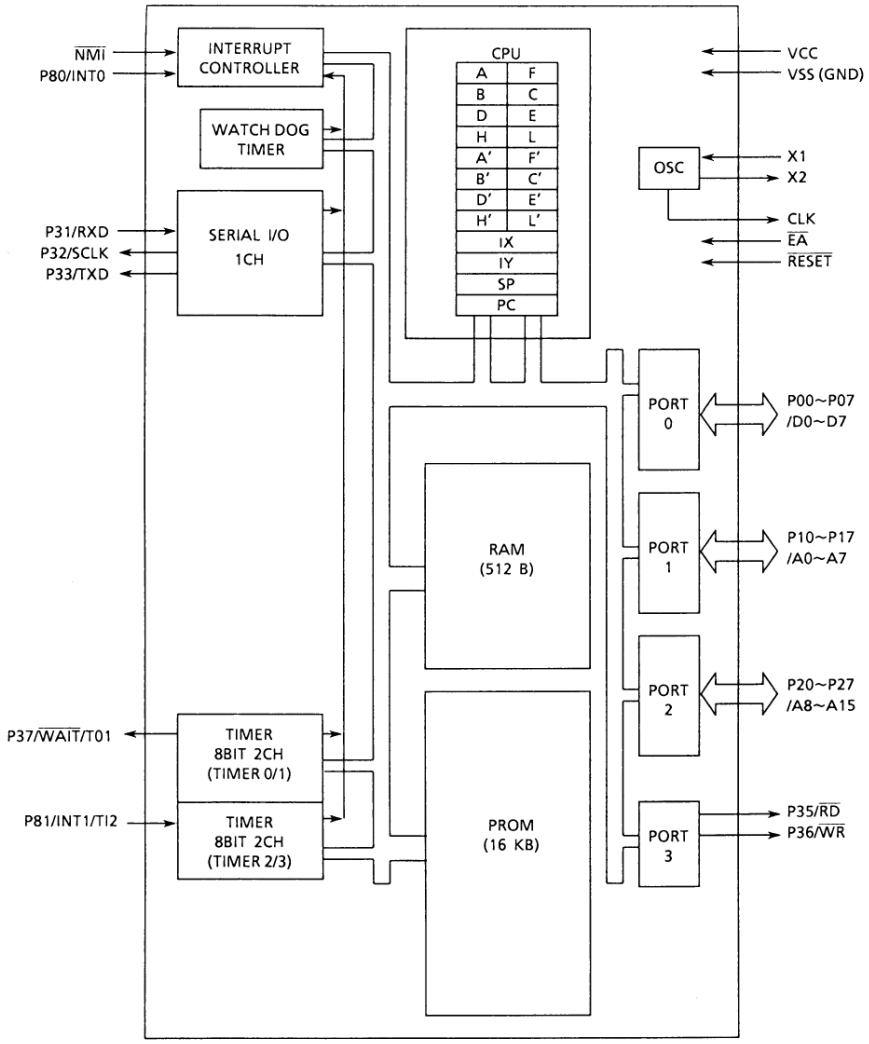


Figure 1. TMP90PH02 Block Diagram

2. Pin Assignment and Functions

The assignment of input/output pins, their names and functions are described below.

2.1 Pin Assignment

Figure 2.1 (1) shows pin assignment of the TMP90PH02.

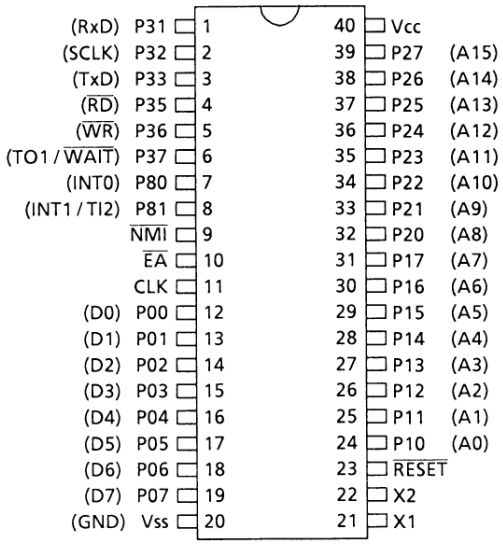


Figure 2.1 (1). Pin Assignment

2.2 Pin Names and Functions

The TMP90PH02P has MCU mode and PROM mode.

(1) MCU Mode (The TMP90PH02 and the TMP90C802A are pin compatible).

Table 2.2 Pin Names and Functions

Pin Name	No. of pins	I/O 3 states	Function
P00 ~ P07 /D0 ~ D7	8	I/O	Port 0: 8-bit I/O port that allows selection of input/output on byte basis
		3 states	Data Bus: Also functions as 8-bit bidirectional data bus for external memory
P10 ~ P17 /A0 ~ A7	8	I/O	Port 1: 8-bit I/O port that allows selection on byte basis
		Output	Addrress Bus: The lower 8 bits address bus for external memory
P20 ~ P27 /A8 ~ A 15	8	I/O	Port 2: 8-bit I/O port that allows selection on byte basis
		Output	Addrress Bus: The uppper 8 bits address bus for external memory
P31 /RxD	1	Input	Port 31: 1-bit input port
			Receives serial data
P32 /TxD /$\overline{\text{RTS}}$ /SCLK	1	Output	Port 32: 1-bit output port
			Serial clock output
P33 /TxD	1	Output	Port 33: 1-bit output port
			Transmits serial data
P35 /$\overline{\text{RD}}$	1	Output	Port 35: 1-bit output port
			Read: Generates strobe signal for reading external memory
P36 /$\overline{\text{WR}}$	1	Output	Port 36: 1-bit output port
			Writes: Generates strobe signal for writing external memory
P37 /$\overline{\text{WAIT}}$ TO1	1	Input	Port 37: 1-bit input port
			Wait: Input pin for connecting slow speed memory or peripheral LSI
		Output	Timer Output 1: Output of Timer 0 or 1
P80 /INT0	1	Input	Port 80: 1-bit input port
			Interrupt request pin 0: Interrupt request pin (Level/rising edge is programmable) 
P81 /INT1 /TI4	1	Input	Port 81: 1-bit input port
			Interrupt request pin 1: Interrupt request pin (Rising/falling edge is programmable) 
			Timer input 2: Counter/capture trigger signal for Timer 2
$\overline{\text{NMI}}$	1	Input	Non-maskable interrupt request pin: Falling edge interrupt request pin 
CLK	1	Output	Clock output: Generates clock pulse at 1/4 frequency of clock oscillation. It is Pulled up internally during resetting.
$\overline{\text{EA}}$	1	Input	Connects with V_{CC} pin .
$\overline{\text{RESET}}$	1	Input	Reset: Initializes the TMP90PH02 (Built-in pull-up resistor)
X1/X2	2	Input/ Output	Pin for quartz crystal or ceramic resonator (1 ~ 16.0MHz)
V_{CC}	1	–	Power supply (+5V)
V_{SS} (GND)	1	–	Ground (0V)

2) PROM Mode

Table 2.2.2

Pin Function Name	No. of pins	I/O	Function	Pin Name (MCU mode)
A7 ~ A0	8	Input	Address Input	P17 ~ P10 P24 ~ P20
A12 ~ A8	5	Input		
A15 ~ A13	3	Input	Be fixed to "L" level.	P27 ~ P25
D7 ~ D0	8	I/O	Data Input/Output	P07 ~ P00
$\overline{OE}$	1	Input	Output Enable Input	P35
$\overline{CE}$	1	Input	Chip Enable Input	P36
VPP	1	Power Supply	12.5V/5V (Programming Power Supply)	$\overline{EA}$
VCC	1	Power Supply	5V	
VSS	1	Power Supply	0V	
Pin Name	**No. of pins**	**I/O**	**Pin Setting**	
P31	1	Input	Be fixed level.	
P32 ~ P34	3	Output	Open	
P37	1	Input	Be fixed level.	
P80 , P81	2	Input	Be fixed to "H" level.	
$\overline{NMI}$	1	Input	Be fixed to level.	
$\overline{RESET}$	1	Input	Be fixed to "L" level.	
CLK	1	Input	Be fixed to "L" level.	
X1	1	Input	Resonator connection pin	
X2	1	Output		

3. Operation

The TMP90PH02 is the OTP version of the TMP90CH02 that is replaced an internal ROM from Mask ROM to EPROM.

The function of TMP90PH02 is exactly same as that of TMP90C802A.

Refer to the TMP90CH02 except the functions which are not described this section.

The following is an explanation of the hardware configuration and operation in the relation to the TMP90PH02.

The TMP90PH02 has an MCU mode and a PROM mode.

3.1 MCU Mode

(1) Mode Setting and Function

The MCU mode is set by opening the CLK pin (Output status).

In the MCU mode, the operation is the same as that of TMP90CH02.

(2) Memory Map

Figure 3.1 shows the memory map of TMP90PH02, and the accessing area by the respective addressing mode.

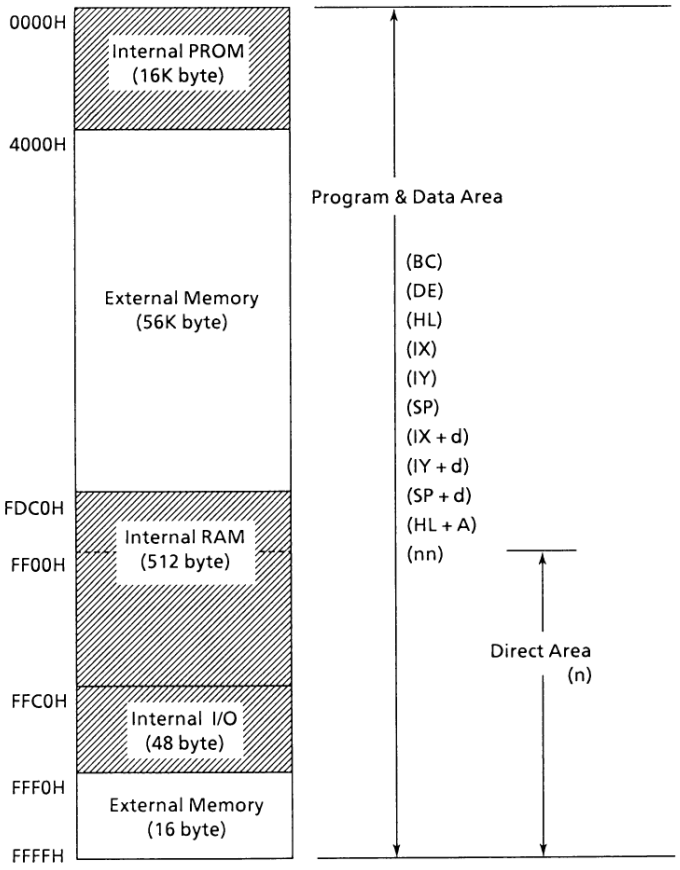


Figure 3.1. TMP90PH02 Memory Map

3.2 PROM Mode

(1) Mode Setting and Function

PROM mode is set by setting the $\overline{\text{RESET}}$ and CLK pins to the "L" level.

The programming and verification for the internal PROM is achieved by using a general PROM programmer with the adaptor socket. The device selection (ROM Type) should be "27256" with following conditions.
size : 256Kbit (32K x 8-bit) VPP: 12.5V TPW: 1ms
Figure 3.2 shows the setting of pins in PROM mode.

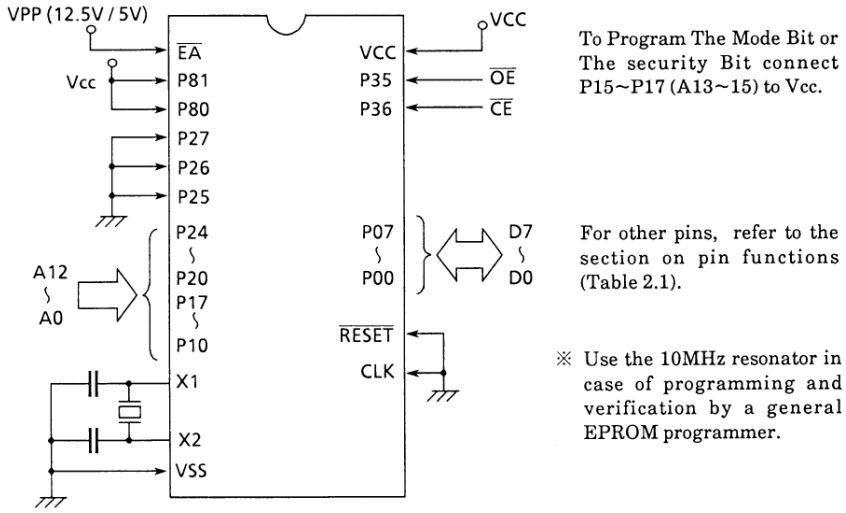


Figure 3.2. PROM Mode Pin Setting

(2) Programming Flow Chart

The programming mode is set by applying 12.5V (programming voltage) to the VPP pin when the following pins are set as follows,

(Vcc : 6.0V) *These conditions can be
($\overline{\text{RESET}}$: "L" level) obtained by using adaptor
(CLK : "L" level) socket.

After the address and data have been fixed, a data on the Data Bus is programmed when the $\overline{\text{CE}}$ pin is set to "Low" (1ms plus is required).

General Programming procedure of an EPROM programmer is as follows,

- Write a data to a specified address for 1ms.
- Verify the data. If the read-out data does not match the expected data, another writing is performed until the correct data is written (Max. 25 times).

After the correct data is written, an additional writing is performed by using three times longer programming pulse width (1ms x programming times), or using three times more programming pulse number. Then, verify the data and increment the address.

The verification for all data is done under the condition of Vpp = Vcc = 5V after all data were written.

Figure 3.3 shows the programming flow chart.

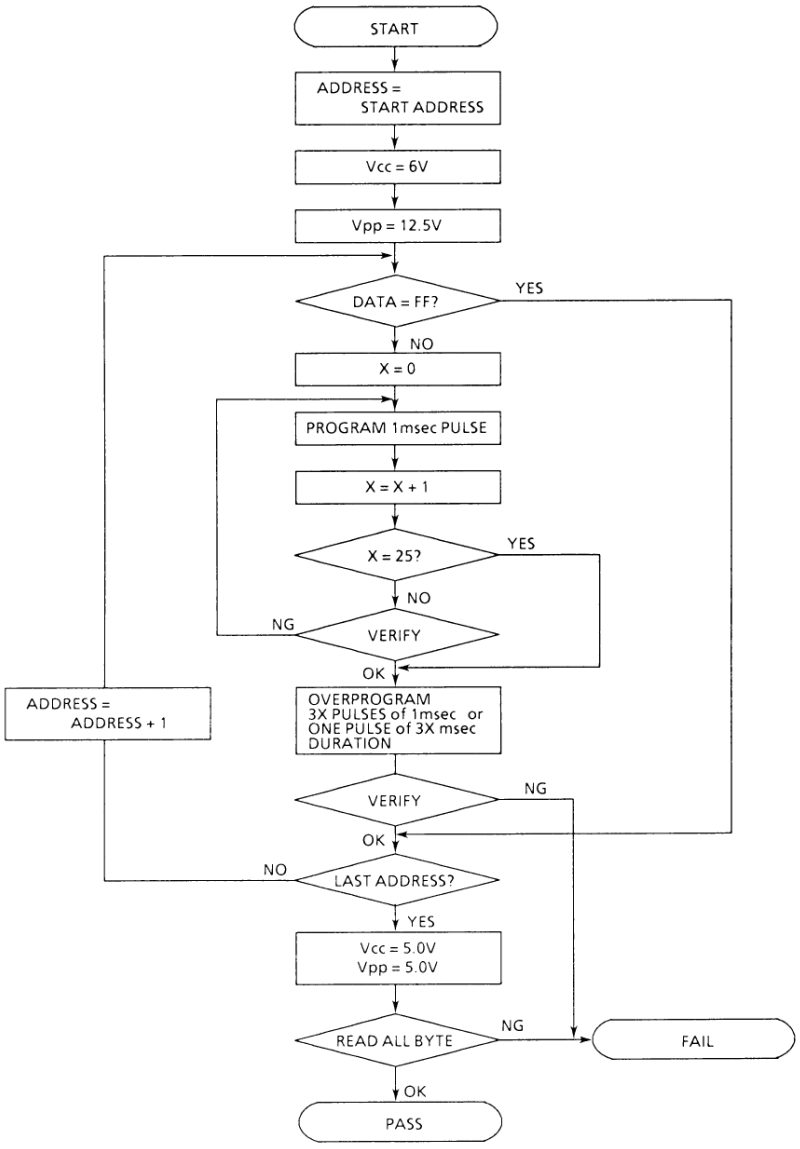


Figure 3.1. TMP90PH02 Memory Map

(3) The Security Bit

The TMP90PH02 has the Security Bit in PROM cell. If the Sercuity Bit is programmed to "0", the content of the PROM is disable to read in PROM mode.

How to Program the Security Bit.

1) Connect A15 pins to V_{CC}. [Otherwise connect them to GND to program PROM]
2) Set programming address to 0000H.
3) To program the Security Bit, set D0 to "0".
4) Set D2 ~ D7 to "1" respectively.

The following table shows the 8-bit data to program The Security Bit.

Table 3.1 Data to Program

Bit to Program	D0 ~ D7	A0 ~ A13	A14, A15
The Security Bit	FEH	All "0"	A14 = "0" A15 = "1"
PROM (0000H ~ 3FFFH)	–	–	All "0"

4. Electrical Characteristics

TMP90PH02P/TMP90PH02M

4.1 Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
V_{CC}	Supply voltage	-0.5 ~ + 7	V
V_{IN}	Input voltage	-0.5 ~ V_{CC} + 0.5	V
P_D	Power dissipation (Ta = 85°C)	250	mW
T_{SOLDER}	Soldering temperature (10s)	260	°C
T_{STG}	Storage temperature	-65 ~ 150	°C
T_{OPR}	Operating temperature	-40 ~ 85	°C

4.2 DC Characteristics

V_{CC} = 5V ± 10% TA = -40 ~ 85°C (1 ~ 10MHz)
TA = -20 ~ 70° (1 ~ 16MHz)

Symbol	Parameter	Min	Max	Unit	Test Conditions
V_{IL}	Input Low Voltage (P0)	-0.3	0.8	V	–
V_{IL1}	P1, P2, P3, P8	-0.3	0.3V_{CC}	V	–
V_{IL2}	$\overline{RESET}$, INT0, $\overline{NMI}$	-0.3	0.25V_{CC}	V	–
V_{IL3}	$\overline{EA}$	-0.3	0.3	V	–
V_{IL4}	X1	-0.3	0.2V_{CC}	V	–
V_{IH}	Input Low Voltage (D0 ~ D7)	2.2	V_{CC} + 0.3	V	–
V_{IH1}	P3, P5, P6, P7, P8	0.7V_{CC}	V_{CC} + 0.3	V	–
V_{IH2}	$\overline{RESET}$, INT0, $\overline{NMI}$	0.75V_{CC}	V_{CC} + 0.3	V	–
V_{IH4}	X1	0.8V_{CC}	V_{CC} + 0.3	V	–
V_{OL}	Output Low Voltage	–	0.45	V	I_{OL} = 1.6mA
V_{OH} V_{OH1} V_{OH2}	Output High Voltage	2.4 0.75V_{CC} 0.9V_{CC}	–	V V V	I_{OH} = -400μA I_{OH} = -100μA I_{OH} = -20μA
I_{DAR}	Darlington Drive Current (8 I/O pins)	-1.0	-3.5	mA	V_{EXT} = 1.5V R_{EXT} = 1.1kΩ
I_{LI}	Input Leakage Current	0.02 (Typ)	±5	μA	0.0 ≤ Vin ≤ V_{CC}
I_{LO}	Output Leakage Current	0.05 (Typ)	±10	μA	0.2 ≤ Vin ≤ V_{CC} - 0.2
I_{CC}	Operating Current (RUN) Idle 1 Idle 2	17 (Typ) 1.5 (Typ) 6 (Typ)	30 5 15	mA mA mA	tosc = 10MHz (60% Up @ 16.0MHz)
	STOP (TA = -20 ~ 70°C) STOP (TA = 0 ~ 50°C)	0.2 (Typ)	50 10	μA μA	0.2 ≤ Vin ≤ V_{CC} - 0.2
V_{STOP}	Power Down Voltage (@STOP)	2 RAM BACK UP	6	KΩ	V_{IL2} = 0.2V_{CC}, V_{IH2} = 0.8V_{CC}
R_{RST}	$\overline{RESET}$ Pull Up Register	50	150	KΩ	–
CIO	Pin Capacitance	–	10	pF	testfreq = 1MHz
V_{TH}	Schmitt width $\overline{RESET}$, $\overline{NMI}$, INT0	0.4	1.0 (Typ)	V	–

Note: I_{DAR} is guaranteed for a total of up to 8 optional ports.

4.3 AC Characteristics

V_{CC} = 5V ± 10% TA = -40 ~ 85°C (1 ~ 10MHz)
CL = 50pF TA = -20 ~ 70°C (1 ~ 16MHz)

Symbol	Parameter	Variable		12.5MHz Clock		16MHz Clock		Unit
		Min	Max	Min	Max	Min	Max	
t_{OSC}	OSC. Period = x	62.5	1000	80	–	62.5	–	ns
t_{CYC}	CLK Period	4x	4x	320	–	250	–	ns
t_{WL}	CLK Low width	2x - 40	–	120	–	85	–	ns
t_{WH}	CLK High width	2x - 40	–	120	–	85	–	ns
t_{AC}	Address Setup to $\overline{RD}$, $\overline{WR}$	x - 45	–	35	–	18	–	ns
t_{RR}	$\overline{RD}$ Low width	2.5x - 40	–	160	–	117	–	ns
t_{CA}	Address Hold Time After $\overline{RD}$, $\overline{WR}$	0.5x - 30	–	20	–	12	–	ns
t_{AD}	Address to Valid Data In	–	3.5x - 95	–	185	–	123	ns
t_{RD}	$\overline{RD}$ to Valid Data In	–	2.5x - 80	–	120	–	76	ns
t_{HR}	Input Data Hold After $\overline{RD}$	0	–	0	–	0	–	ns
t_{WW}	$\overline{WR}$ Low width	2.5x - 40	–	160	–	117	–	ns
t_{DW}	Data Setup to $\overline{WR}$	2x - 50	–	110	–	75	–	ns
t_{WD}	Data Hold After $\overline{WR}$	20	70	20	70	20	70	ns
t_{CWA}	$\overline{RD}$, $\overline{WR}$ to Valid $\overline{WAIT}$	–	1.5x - 100	–	20	–	13	ns
t_{AWA}	Address to Valid $\overline{WAIT}$	–	2.5x - 130	–	70	–	26	ns
t_{WAS}	$\overline{WAIT}$ Setup to CLK	50	–	50	–	50	–	ns
t_{WAH}	$\overline{WAIT}$ Hold After CLK	0	–	0	–	0	–	ns
t_{RV}	$\overline{RD}$/$\overline{WR}$ Recovery Time	1.5x - 35	–	85	–	59	–	ns
t_{CPW}	CLK to Port Data Output	–	x + 200	–	280	–	262	ns
t_{PRC}	Port Data Setup to CLK	200	–	200	–	200	–	ns
t_{CPR}	Port Data Hold After CLK	100	–	100	–	100	–	ns
t_{CHCL}	$\overline{RD}$/$\overline{WR}$ Hold After CLK	x - 40	–	40	–	23	–	ns
t_{CLC}	$\overline{RD}$/$\overline{WR}$ Setup to CLK	1.5x - 25	–	95	–	69	–	ns
t_{CLHA}	Address Hold After CLK	1.5x - 80	–	40	–	14	–	ns
t_{ACL}	Address Setup to CLK	2.5x - 80	–	120	–	77	–	ns
t_{CLD}	Data Setup to CLK	x - 50	–	30	–	13	–	ns

- AC output level High 2.2V/Low 0.8V
- AC input level High 2.4V/Low 0.45V (D0 – D7)
  High $0.8V_{CC}$/Low $0.2V_{CC}$ (excluding D0 – D7)

4.4 Zero - Cross Characteristics

V_{CC} = 5V ± 10% TA = -40 ~ 85°C (1 ~ 10MHz)
TA = -20 ~ 70°C (1 ~ 16MHz)

Symbol	Parameter	Condition	Min	Max	Unit
V_{ZX}	Zero-cross detection input	AC coupling C = 0.1μF	1	1.8	VAC p - p
A_{ZX}	Zero-cross accuracy	50/60Hz sine wave	–	135	mV
F_{ZX}	Zero-cross detection input frequency	–	0.04	1	kHz

4.5 Serial Channel Timing - I/O Interface Mode

V_{CC} = 5V ± 10% TA = -40 ~ 85°C (1 ~ 10MHz)
CL = 50pF TA = -20 ~ 70°C (1 ~ 16MHz)

Symbol	Parameter	Variable		10MHz Clock		16MHz Clock		Unit
		Min	Max	Min	Max	Min	Max	
t_{SCY}	Serial Port Clock Cycle Time	8x	–	640	–	500	–	ns
t_{OSS}	Output Data Setup SCLK Rising Edge	6x - 150	–	330	–	225	–	ns
t_{OHS}	Output Data Hold After SCLK Rising Edge	2x - 80	–	40	–	45	–	ns
t_{HSR}	Input Data Hold After SCLK Rising Edge	0	–	0	–	0	–	ns
t_{SRD}	SCLK Rising Edge to Input DATA Valid	–	6x - 150	–	330	–	225	ns

4.6 8-bit Event Counter

V_{CC} = 5V ± 10% TA = -40 ~ 85°C (1 ~ 10MHz)
CL = 50pF TA = -20 ~ 70°C (1 ~ 16MHz)

Symbol	Parameter	Variable		10MHz Clock		16MHz Clock		Unit
		Min	Max	Min	Max	Min	Max	
t_{VCK}	TI2 clock cycle	8x + 100	–	740	–	600	–	ns
t_{VCKL}	TI2 Low clock pulse width	4x + 40	–	360	–	290	–	ns
t_{VCKH}	TI2 High clock pulse width	4x + 40	–	360	–	290	–	ns

4.7 Interrupt Operation

V_{CC} = 5V ± 10% TA = -40 ~ 85°C (1 ~ 10MHz)
CL = 50pF TA = -20 ~ 70°C (1 ~ 16MHz)

Symbol	Parameter	Variable		10MHz Clock		16MHz Clock		Unit
		Min	Max	Min	Max	Min	Max	
t_{INTAL}	$\overline{NMI}$, INT0 Low level pulse width 	4x	–	320	–	250	–	ns
t_{INTAH}	$\overline{NMI}$, INT0 High level pulse width 	4x	–	320	–	250	–	ns
t_{INTBL}	INT1, INT2 Low level pulse width 	8x + 100	–	740	–	600	–	ns
t_{INTBH}	INT1, INT2 High level pulse width 	8x + 100	–	740	–	600	–	ns

4.8 Read Operation (PROM Mode)

DC Characteristic, AC Characterisc

TA = -40 ~ 85°C Vcc = 5V ± 10%

Symbol	Parameter	Condition	Min	Max	Unit
V_{PP}	VPP Read Voltage	–	4.5	5.5	V
V_{IH1}	Input High Voltage (A0 ~ A15, $\overline{CE}$, $\overline{OE}$)	–	0.7 x V_{CC}	Vcc + 0.3	V
V_{IL1}	Input Low Voltage (A ~ A15, $\overline{CE}$, $\overline{OE}$)	–	-0.3	0.3 x V_{CC}	V
t_{ACC}	Address to Output Delay	C_L = 50pF	–	2.25TCYC + α	ns

TCYC = 400ns (10MHz Clock)
α = 200ns

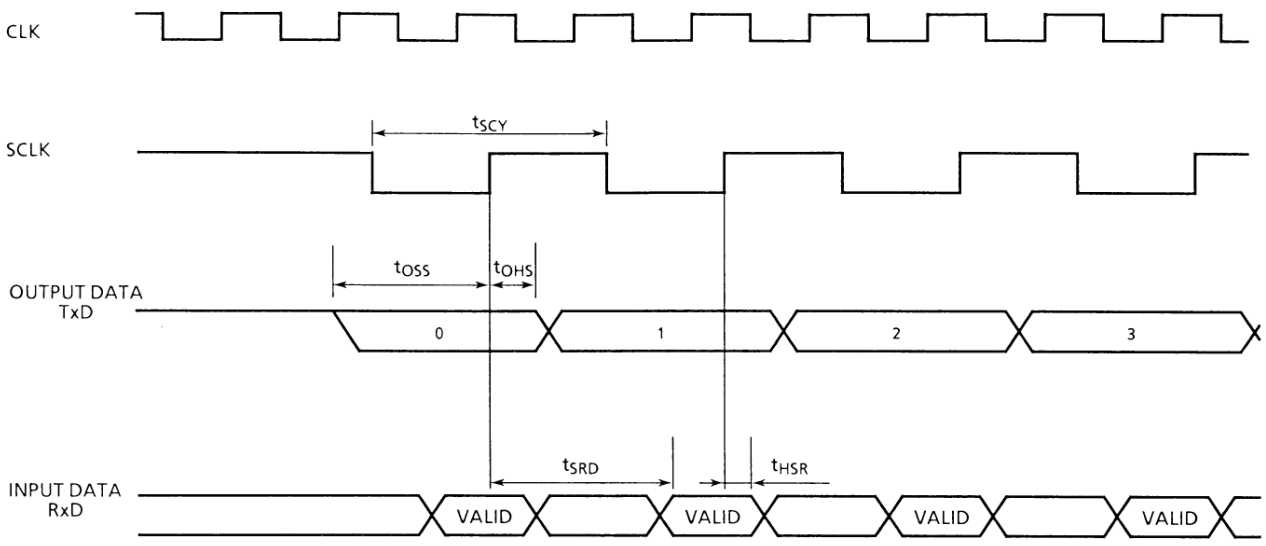
4.9 Programming Operation (PROM Mode)

DC Characteristic, AC Characteristic

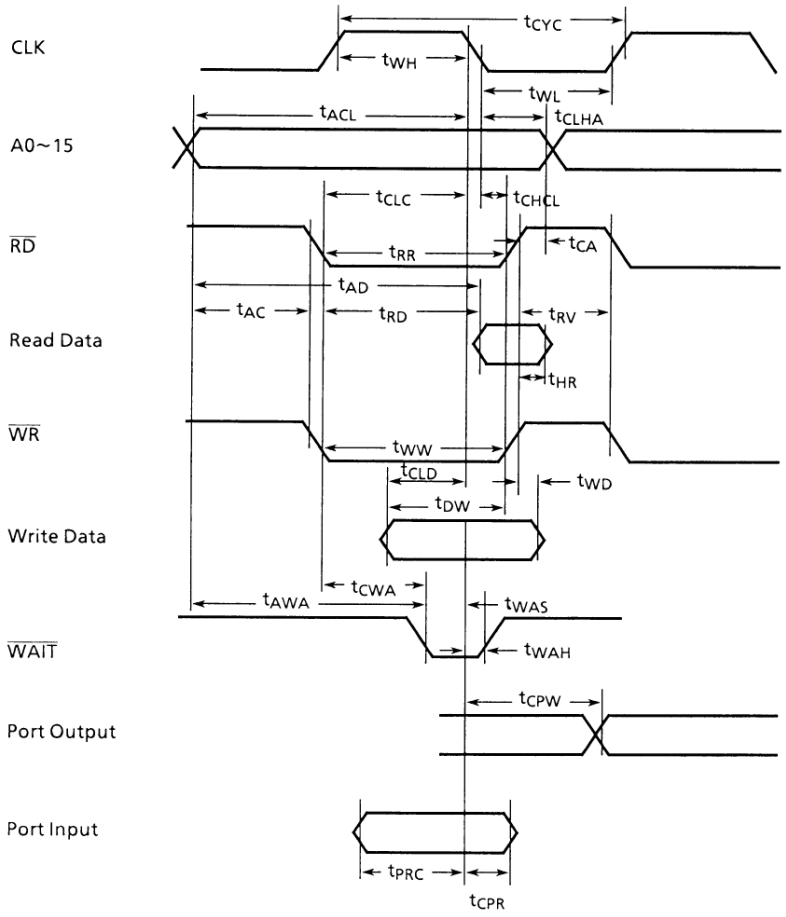
TA = 25 ± 5°C Vcc = 6V ± 0.25V

Symbol	Parameter	Condition	Min	Typ	Max	Unit
V_{PP}	Programming Voltage	–	12.25	12.50	12.75	V
V_{IH}	Input High Voltage (D0 ~ D7)	–	0.2V_{CC} + 1.1		V_{CC} + 0.3	V
V_{IL}	Input Low Voltage (D0 ~ D7)	–	-0.3		0.2V_{CC} - 0.1	V
V_{IH1}	Input High Voltage (A0 ~ A15, $\overline{CE}$, $\overline{OE}$)	–	0.7V_{CC}		V_{CC} + 0.3	V
V_{IL1}	Input Low Voltage (A0 ~ A15, $\overline{CE}$, $\overline{OE}$)	–	-0.3		0.3V_{CC}	V
I_{CC}	V_{CC} Supply Current	f_{OSC} = 10MHz	–		50	mA
I_{PP}	V_{PP} Supply Current	V_{PP} = 13.00V	–		50	mA
t_{PW}	$\overline{CE}$ Programming Pulse Width	C_L = 50pF	0.95	1.00	1.05	ms

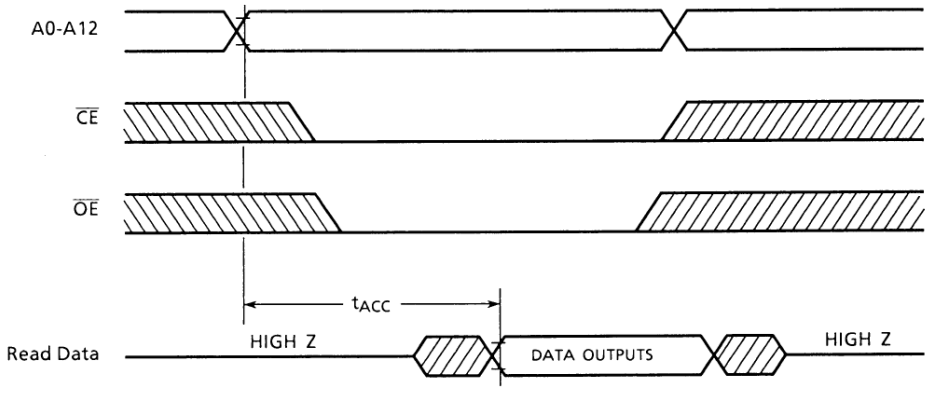
4.10 I/O Interface Mode Timing



4.11 Timing Chart



4.12 Read Operation Timing Chart (PROM Mode)



4.13 Programming Operation Timing Chart (PROM Mode)