CMOS 8-BIT MICROCONTROLLER

TMP87PH00N
TMP87PH00F
TMP87PH00DF
*TMP87PH00LF

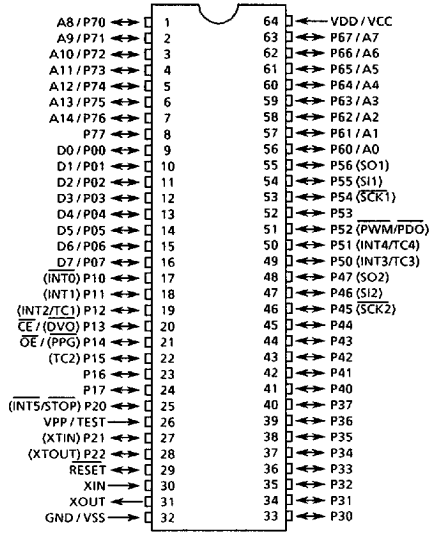
The 87PH00 is a One-Time PROM microcontroller with low-power 128K bits (16K bytes) electrically programmable read only memory for the 87C800/CH00 system evaluation. The 87PH00 is pin compatible with the 87C800/CH00. The operations possible with the 87C800/CH00 can be performed by writing programs to PROM. The 87PH00 can write and verify in the same way as the TMM27256AD using an adaptor socket BM1136/BM1137 and an EPROM programmer.

PART No.	OTP	RAM	PACKAGE
TMP87PH00N	16K × 8-bit	256 × 8-bit	SDIP64
TMP87PH00F			QFP64
TMP87PH00DF			QFP64 (14 × 14mm)
*TMP87PH00LF			

*, Under development

PIN ASSIGNMENTS (TOP VIEW)

SDIP64-P-750



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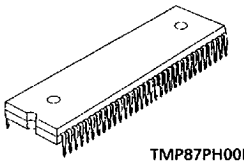
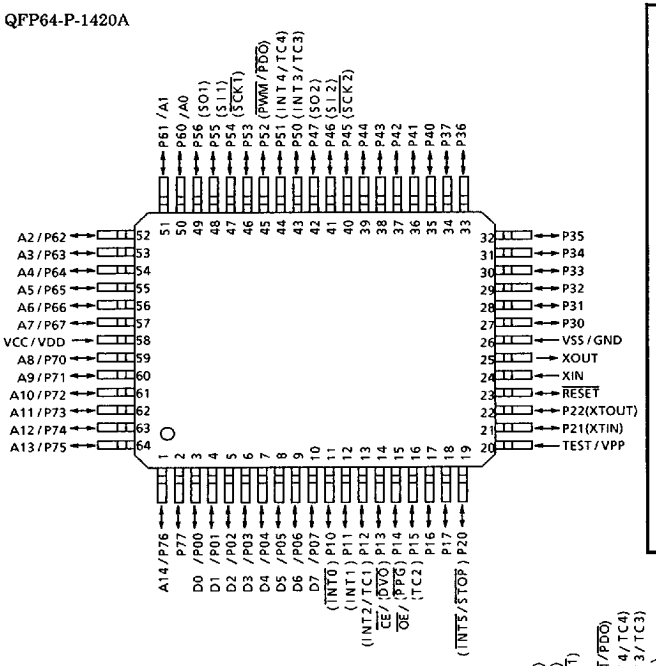


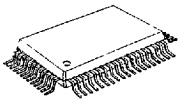
TMP87PH00N

PIN ASSIGNMENTS (TOP VIEW)

QFP64-P-1420A

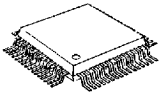


QFP64-P-1420A



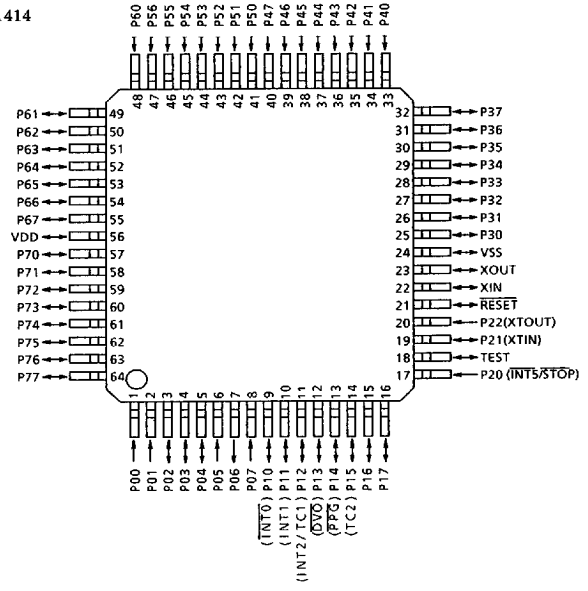
TMP87PH00F

QFP64-P-1414



TMP87PH00DF
*TMP87PH00LF

QFP64-P-1414



PIN FUNCTION

The 87PH00 has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87PH00 is pin compatible with the 87C800/CH00 (fix the TEST pin at low level).

(2) PROM mode

PIN NAME (PROM mode)	INPUT/OUTPUT	FUNCTIONS	PIN NAME (MCU mode)
A14 ~ A8 A7 ~ A0	Input	PROM address inputs	P76 ~ P70 P67 ~ P60
D7 ~ D0	I/O	PROM data input/outputs	P07 ~ P00
$\overline{CE}$	Input	Chip enable signal input (active low)	P13
$\overline{OE}$		Output enable signal input (active low)	P14
VPP	Power supply	+ 12.5V / 5V (Program supply voltage)	TEST
VCC		+ 5V	VDD
GND		0V	VSS
P37 ~ P30 P47 ~ P40 P56 ~ P50	I/O	Pull-up with resistance for input processing	
P11 P21 P77		PROM mode setting pin. Be fixed at high level.	
P17 ~ P15 P12, P10 P22, P20 $\overline{RESET}$		PROM mode setting pin. Be fixed at low level.	
XIN	Input	Connect an 8MHz oscillator to stabilize the internal state.	
XOUT	Output		

OPERATIONAL DESCRIPTION

The following explains the 87PH00 hardware configuration and operation. The configuration and functions of the 87PH00 are the same as those of the 87C800/CH00, except in that a one-time PROM is used instead of an on-chip mask ROM.

The 87PH00 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 87PH00 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 87C800/CH00 (the TEST / VPP pin cannot be used open because it has no built-in pull-down resistance).

1.1.1 Program Memory

The 87PH00 has 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).

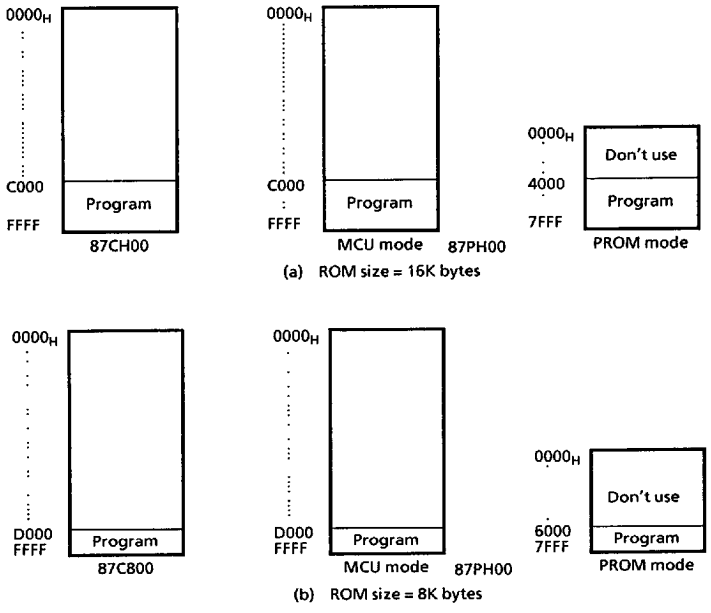


Figure 1-1. Program Memory Area

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 87PH00 has an on-chip 256 × 8-bit data memory (static RAM).

1.1.3 Input/Output Circuitry

(1) Control pins

The control pins of the 87PH00 are the same as those of the 87C800/CH00 except that the TEST pin has is no built-in pull-down resistance.

(2) I/O ports

The I/O circuitries of 87PH00 I/O ports the are the same as the code A type I/O circuitries of the 87C800/CH00.

When using as an evaluator of other I/O codes (C, D, G), external pull-up resistors are required.

(a) In the case of code **C, D, G** (b) In the case of code **D**

Figure 1-2. I/O Circuitry Code and External Circuitry

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 87PH00 is not supported an *electric signature* mode, so the ROM type must be set to TMM27256 AD. Set the adaptor socket switch to "P".

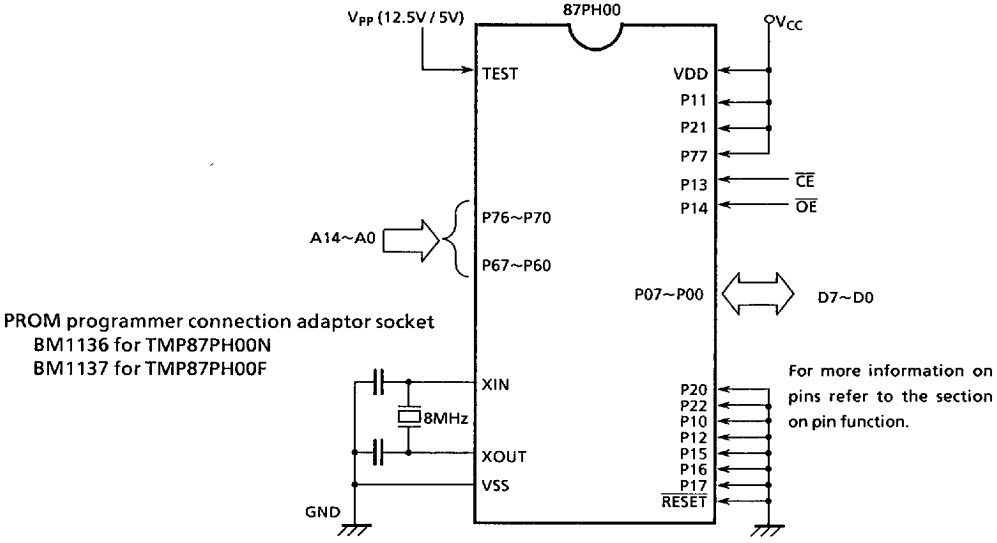


Figure 1-3. Setting for PROM Mode

1.2.1 Programming Flowchart (High-speed Programming Mode)

The high-speed programming mode is achieved by applying the program voltage (+ 12.5V) to the VPP pin when Vcc = 6V. 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 x 1ms). 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 = 5V.

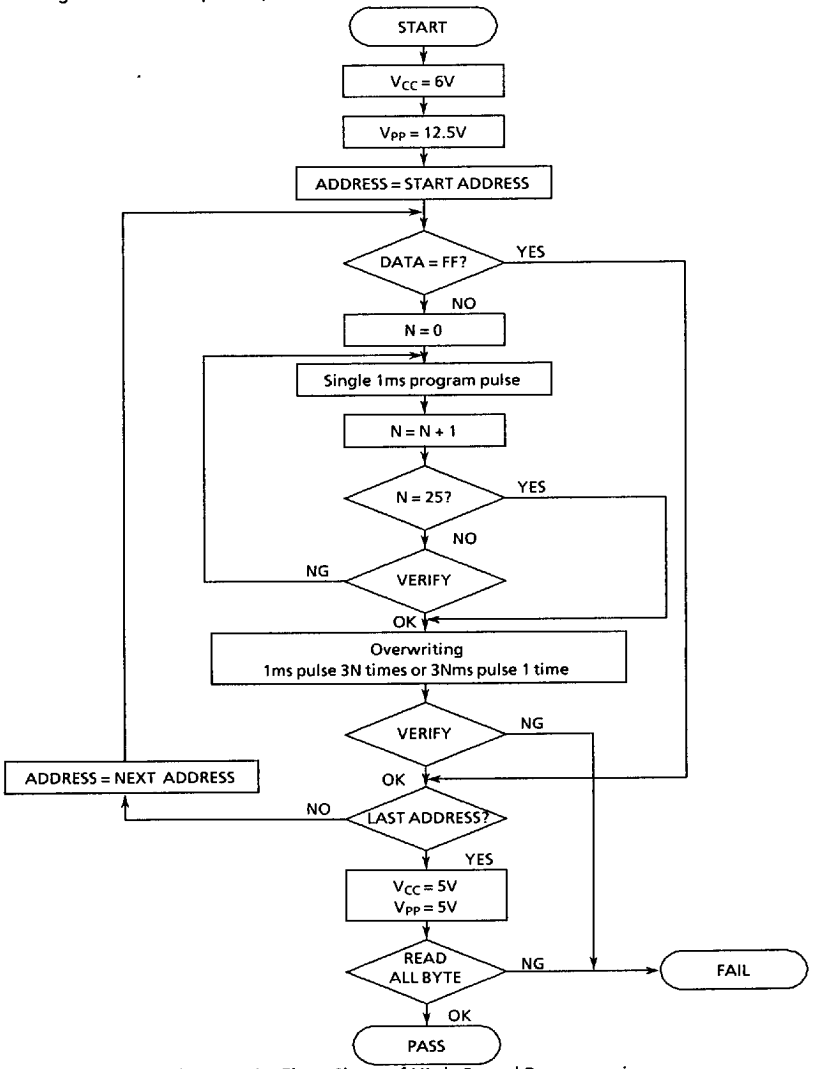


Figure 1-4. Flow Chart of High-Speed Programming

ELECTRICAL CHARACTERISTICS

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

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNIT
Supply Voltage	V_{DD}		− 0.3~7	V
Program Voltage	V_{PP}	TEST / VPP	− 0.3~13.0	V
Input Voltage	V_{IN}		− 0.3~V_{DD} + 0.3	V
Output Voltage	V_{OUT1}	P0, P1, P2, P6, P7, XOUT, $\overline{RESET}$	− 0.3~V_{DD} + 0.3	V
	V_{OUT2}	P3, P4, P5	− 0.3~10	
Output Current (Per 1 pin)	I_{OUT1}	P0, P1, P2, P4, P5, P6, P7	3.2	mA
	I_{OUT2}	P3	30	
Output Current (Total)	ΣI_{OUT1}	P0, P1, P2, P4, P5, P6, P7	120	mA
	ΣI_{OUT2}	P3	120	
Power Dissipation [Topr = 70°C]	PD	TMP87PH00N	600	mW
		TMP87PH00F / PH00DF	350	
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		− 55~125	°C
Operating Temperature	Topr		− 30~70	°C

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

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Max.	UNIT
Supply Voltage	V_{DD}		NORMAL1, 2 modes	4.5	6.0	V
			IDLE1, 2 modes			
			SLOW mode	2.7		
			SLEEP mode			
			STOP mode	2 0		
Input High Voltage	V_{IH1}	Except hysteresis input	$V_{DD} \geqq$ 4.5V	V_{DD} × 0 70	V_{DD}	V
	V_{IH2}	Hysteresis input		V_{DD} × 0.75		
	V_{IH3}		V_{DD} < 4 5V	V_{DD} × 0.90		
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geqq$ 4 5V	0	V_{DD} × 0.30	V
	V_{IL2}	Hysteresis input			V_{DD} × 0 25	
	V_{IL3}		V_{DD} < 4.5V		V_{DD} × 0 10	
Clock Frequency	fc	XIN, XOUT		0 4	8.0	MHz
	fs	XTIN, XTOUT		30 0	34.0	kHz

Note 1 : Power supply voltage V_{DD}: At fc = 8MHz, fs = 32.768kHz

Note 2 : Input Voltage V_{IH3} V_{IL3}; In the SLOW, SLEEP or STOP 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		–	0.9	–	V
Input Current	I_{IN1}	TEST	V_{DD} = 5.5V V_{IN} = 5.5V/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_{LO1}	Sink open drain ports	V_{DD} = 5.5V, V_{OUT} = 5.5V	–	–	2	μA
	I_{LO2}	Tri-state ports	V_{DD} = 5.5V, V_{OUT} = 5 5V/0V	–	–	± 2	
Output High Voltage	V_{OH2}	Tri-state ports	V_{DD} = 4.5V, I_{OH} = – 0.7mA	4.1	–	–	V
Output Low Voltage	V_{OL}	Except XOUT and P3	V_{DD} = 4.5V, I_{OL} = 1.6mA	–	–	0.4	V
Output Low current	I_{OL3}	P3	V_{DD} = 4.5V, V_{OL} = 1.0V	–	20	–	mA
Supply Current in NORMAL 1, 2 modes	I_{DD}		V_{DD} = 5.5V fc = 8MHz	–	8.5	12	mA
Supply Current in IDLE 1, 2 modes			fs = 32.768kHz V_{IN} = 5.3V/0.2V	–	3.5	5	
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} = 5.5V V_{IN} = 5 3V/0.2V	–	0.5	10	μA

Note 1 : Typical value show those at Topr = 25°C, V_{DD} = 5V.

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.C. CHARACTERISTICS

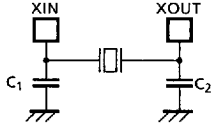
(V_{SS} = 0V, V_{DD} = 4.5 to 6.0V, Topr = – 30 to 70°C)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t_{cy}	In NORMAL1, 2 modes	0.5	–	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 = 8MHz	50	–	–	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}					

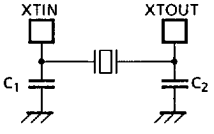
RECOMMENDED OSCILLATING CONDITIONS

(V_{SS} = 0V, V_{DD} = 4.5 to 6 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	8MHz	KYOCERA	KBR8.0M	30pF	30pF
			MURATA	CSA8.00MT		
		4MHz	KYOCERA	KBR4.0MS		
			MURATA	CSA4.00MG		
	Crystal Oscillator	8MHz	TOYOCOM	210B 8.0000	20pF	20pF
		4MHz	TOYOCOM	204B 4.0000		
Low-frequency Oscillation	Crystal Oscillator	32.768kHz	NDK	MX-38T	15pF	15pF



(1) High-frequency Oscillation



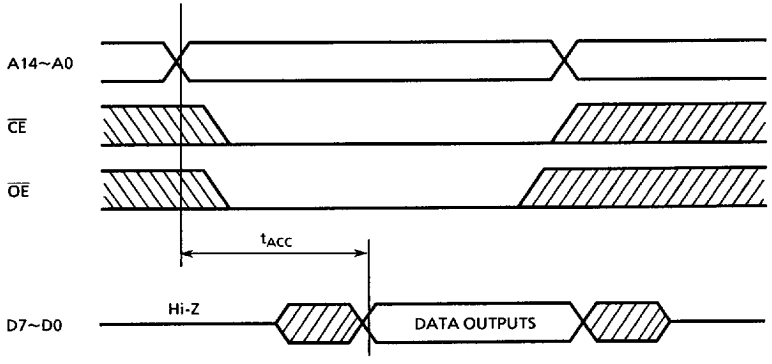
(2) Low-frequency Oscillation

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

(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	–	6.0	V
Program Power Supply Voltage	V_{PP}					
Address Access Time	t_{ACC}	V_{CC} = 5 0 ± 0.25V	–	1.5tcyc + 300	–	ns

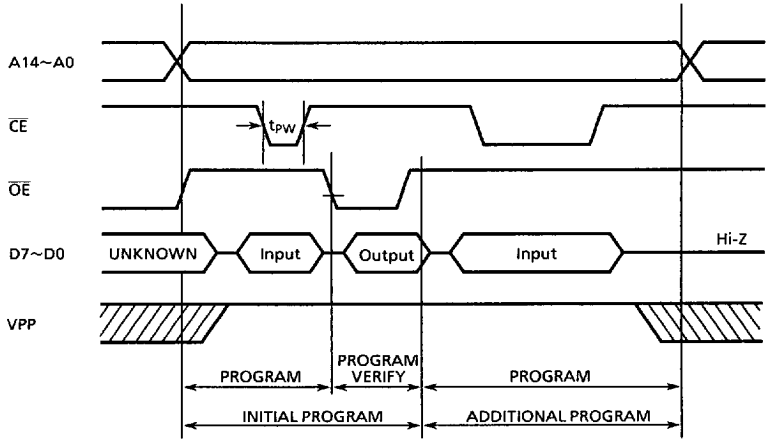
Note : tcyc = 500ns at 8MHz



TIMING WAVEFORMS OF READ OPERATION

(2) High-Speed Programming 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}		5.75	–	6.0	V
Program Power Supply Voltage	V_{PP}		12.0	12 5	13.0	V
Initial Program Pulse Width	t_{PW}	V_{CC} = 6.0V	0.95	1 0	1.05	ms



TIMING WAVEFORMS OF PROGRAMMING OPERATION

ELECTRICAL CHARACTERISTICS

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

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_{OUT}		− 0.3 to V_{DD} + 0.3	V
Output Current (Per 1 pin)	I_{OUT1}	Ports P0, P1, P2, P3, P4, P5, P6, P7	3.2	mA
	I_{OUT2}	Port P3	30	
Output Current (Total)	Σ I_{OUT1}	Ports P0, P1, P2, P4, P5, P6, P7	120	mA
	Σ I_{OUT2}	Port P3	120	
Power Dissipation [Topr = 70°C]	PD		350	mW
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) (Preliminary)

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	1.8	4.5	
				IDLE1, 2 mode			
			fs = 32.768kHz	SLOW mode		5.5	
				SLEEP mode			
				STOP mode			
Input High Voltage	V_{IH1}	Except Hysteresis inputs	$V_{DD} \geq 4.5V$		V_{DD} × 0.7	V_{DD}	V
	V_{IH2}	Hysteresis inputs			V_{DD} × 0.75		
	V_{IH3}		$V_{DD} < 4.5V$		V_{DD} × 0.90		
Input Low Voltage	V_{IL1}	Except Hysteresis inputs	$V_{DD} \geq 4.5V$		0	V_{DD} × 0.28	V
	V_{IL2}	Hysteresis inputs				V_{DD} × 0.25	
	V_{IL3}		$V_{DD} < 4.5V$			V_{DD} × 0.10	
Clock Frequency	fc	XIN, XOUT	V_{DD} = 4.5~5.5V		0.4	8.4	MHz
			V_{DD} = 1.8~4.5V			4.2	
	fs	XTIN, XOUT			30.0	34.0	kHz

D.C. CHARACTERISTICS (V_{SS} = 0V, Topr = − 30 to 70°C) (Preliminary)

PARAMETER	SYMBOL	PINS	CONDITIONS	Min.	Typ.	Max.	UNIT
Hysteresis Voltage	V_{HS}	Hysteresis inputs		−	0.9	−	V
Input Current	I_{IN1}	TEST	V_{DD} = 5.5V V_{IN} = 5.5V / 0V	−	−	± 2	μA
	I_{IN2}	Open drain ports and tri-state ports					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Low Current	I_{IL}	Push-pull ports	V_{DD} = 5.5V, V_{IN} = 0.4V	−	−	− 2	mA
Input Resistance	R_{IN1}	Port P7 with pull-up		30	70	150	kΩ
	R_{IN2}	$\overline{RESET}$		100	220	450	
Output Leakage Current	I_{LO1}	Open drain ports	V_{DD} = 5.5V, V_{OUT} = 5.5V	−	−	2	μA
	I_{LO2}	Tri-state ports	V_{DD} = 5.5V, V_{OUT} = 5.5V/0V	−	−	± 2	
Output High Voltage	V_{OH1}	Push-pull ports	V_{DD} = 4 5V, I_{OH} = − 200μA	2.4	−	−	V
	V_{OH2}	Tri- state ports	V_{DD} = 4.5V, I_{OH} = − 0.7mA	4.1	−	−	
	V_{OH3}	Push- pull ports	V_{DD} = 1.8V, I_{OH} = − 5μA	1 6	−	−	
	V_{OH4}	Tri- state ports	V_{DD} = 1.8V, I_{OH} = − 10μA	1.6	−	−	
Output Low Voltage	V_{OL1}	Except XOUT and port P3	V_{DD} = 4 5V, I_{OL} = 1.6mA	−	−	0.4	V
	V_{OL2}	Except XOUT	V_{DD} = 1 8V, I_{OL} = 20μA	−	−	0.2	
Output Low Current	I_{OL3}	Port P3	V_{DD} = 4 5V, V_{OL} = 1.0V	−	20	−	mA
Supply Current in NORMAL 1 , 2 mode	I_{DD}		V_{DD} = 5.5V fc = 8MHz fs = 32.768kHz V_{IN} = 5.3V / 0 .2V	−	8.5	12	mA
Supply Current in IDLE 1, 2 mode				−	3.5	5	mA
Supply Current in NORMAL 1 , 2 mode			V_{DD} = 1.8V fc = 4 19MHz fs = 32.768kHz V_{IN} = 1 7V / 0 1V	−	1.5	2.5	mA
Supply Current in IDLE 1, 2 mode				−	0.5	1.0	
Supply Current in SLOW mode			V_{DD} = 5.5V fs = 32.768kHz V_{IN} = 5.3V / 0 .2V	−	50	−	μA
Supply Current in SLEEP mode				−	20	−	μA
Supply Current in SLOW mode			V_{DD} = 1.8V fs = 32.768kHz V_{IN} = 1.7V / 0 1V	−	15	30	μA
Supply Current in SLEEP mode				−	10	20	μA
Supply Current in STOP mode			V_{DD} = 5 5V V_{IN} = 5.3V / 0 .2V	−	0.5	10	μA

Note 1 : Typical values show those at Topr = 25°C, V_{DD} = 3V
Note 2 : Input Current ; The current though pull-up or pull-down resistor in not included

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

(Preliminary)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t_{cy}	In NORMAL 1, 2 mode	0.48	–	10	μs
		In IDLE 1, 2 mode				
		In SLOW mode	117.6	–	133.3	
		In SLEEP mode				
High Level Clock Pulse Width	t_{WCH}	For external clock operation (XIN input), fc = 8.4MHz	50	–	–	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}					

(V_{SS} = 0V, V_{DD} = 1.8~4.5V, Topr = – 30 to 70°C)

(Preliminary)

PARAMETER	SYMBOL	CONDITIONS	Min.	Typ.	Max.	UNIT
Machine Cycle Time	t_{cy}	In NORMAL 1, 2 mode	0.95	–	10	μs
		In IDLE 1, 2 mode				
		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 CONDITION (V_{SS} = 0V, T_{opr} = – 30 to 70°C)

(Preliminary)

PARAMETER	OSCILLATOR	FREQUENCY	RECOMMENDED OSCILLATOR		RECOMMENDED CONDITIONS C_1	RECOMMENDED CONDITIONS C_2
High-frequency	Ceramic Resonator	4.19MHz (VDD = 1.8 to 5.5V)	MURATA	CSA4.19MG	30pF	30pF
			MURATA	CST4.19MGW	–	–
		8MHz (VDD = 4.5 to 5.5V)	MURATA	CSA8.00MTZ	15pF	15pF
			MURATA	CST8.00MTW	–	–
	Crystal Oscillator	8MHz (VDD = 4.5 to 5.5V)	NDK	AT-51	16pF	16pF
Low-frequency	Crystal Oscillator	32.768kHz (VDD = 1.8 to 5.5V)	NDK	MX-38T	12pF	12pF

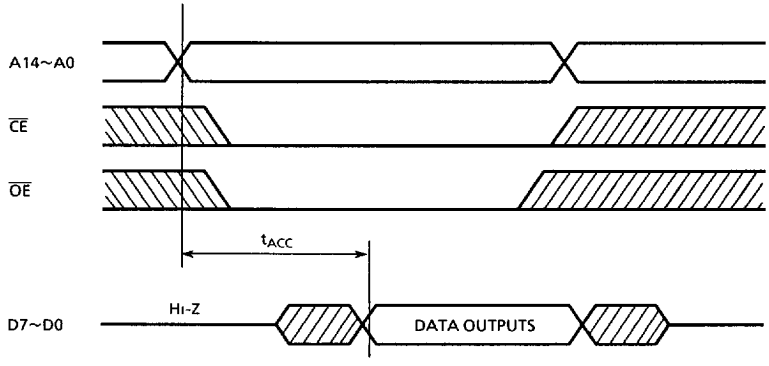
D.C./A.C. CHARACTERISTICS (PROM mode) (V_{SS} = 0V)

(1) Read Operation

(Preliminary)

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

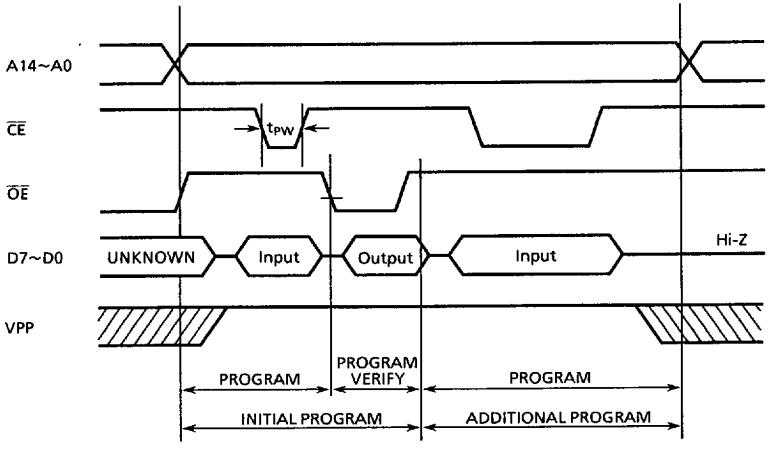


TIMING WAVEFORMS OF READ OPERATION

(2) High-Speed Programming Operation

(Preliminary)

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	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 95	1 0	1 05	ms



TIMING WAVEFORMS OF PROGRAMMING OPERATION