TOSHIBA   TMP87P808/808L
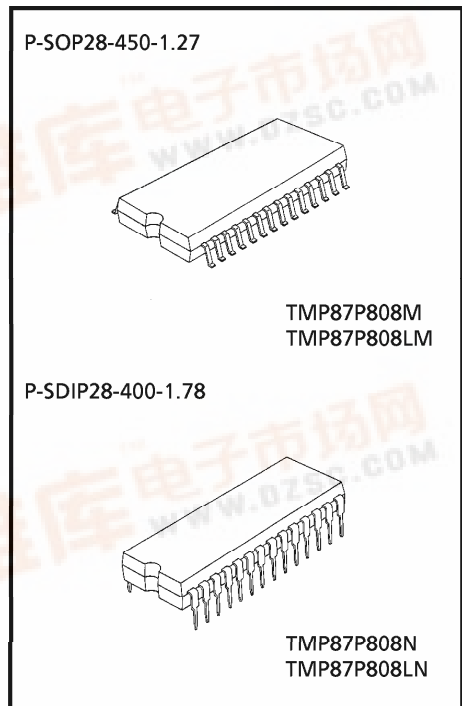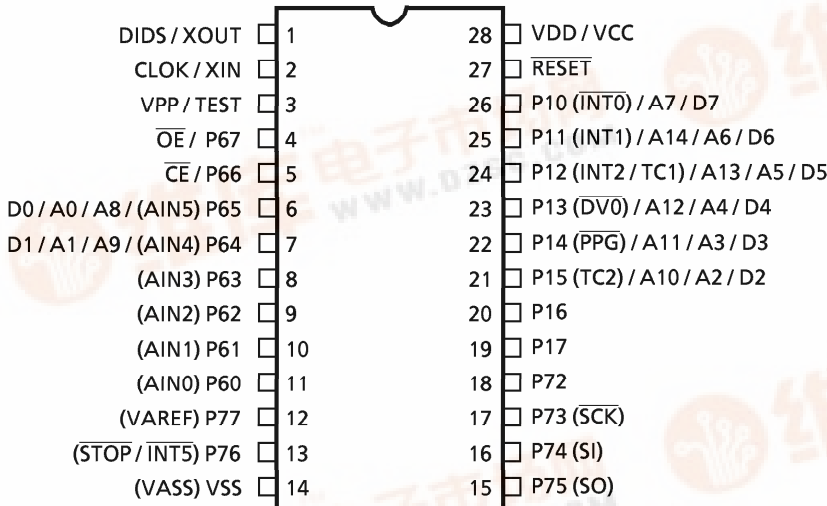
CMOS 8-Bit Microcontroller

TMP87P808M, TMP87P808N
TMP87P808LM, TMP87P808LN

The 87P808/808L is a high-speed, high-performance 8-bit single chip microcomputer, which has 64K bits One-Time PROM. The 87P808/808L is pin compatible with the 87C408/808/408L/808L. The operations possible with the 87C408/808/408L/808L can be performed by writing programs to PROM. The 87P808/808L can write and verify in the same way as the TC57256AD using an adapter socket and a general-purpose PROM programmer.

Part No.	ROM	RAM	Package	Adapter socket	Operation Voltage Range
TMP87P808M			P-SOP28-450-1.27	BM11116	2.7 V to 5.5 V at 4.2 MHz
TMP87P808N			P-SDIP28-400-1.78	BM11122	4.5 V to 5.5 V at 8 MHz
TMP87P808LM	8 K × 8-bit	256 × 8-bit	P-SOP28-450-1.27	BM11116	1.8 V to 4.0 V at 4.2 MHz
TMP87P808LN			P-SDIP28-400-1.78	BM11122	

Pin Assignments (Top View)

P-SOP28-400-1.78 / P-SDIP28-450-1.27

DIDS / XOUT — 1	28 — VDD / VCC
CLOK / XIN — 2	27 — $\overline{RESET}$
VPP / TEST — 3	26 — P10 ($\overline{INT0}$) / A7 / D7
$\overline{OE}$ / P67 — 4	25 — P11 (INT1) / A14 / A6 / D6
$\overline{CE}$ / P66 — 5	24 — P12 (INT2 / TC1) / A13 / A5 / D5
D0 / A0 / A8 / (AIN5) P65 — 6	23 — P13 ($\overline{DV0}$) / A12 / A4 / D4
D1 / A1 / A9 / (AIN4) P64 — 7	22 — P14 ($\overline{PPG}$) / A11 / A3 / D3
(AIN3) P63 — 8	21 — P15 (TC2) / A10 / A2 / D2
(AIN2) P62 — 9	20 — P16
(AIN1) P61 — 10	19 — P17
(AIN0) P60 — 11	18 — P72
(VAREF) P77 — 12	17 — P73 ($\overline{SCK}$)
($\overline{STOP}$ / $\overline{INT5}$) P76 — 13	16 — P74 (SI)
(VASS) VSS — 14	15 — P75 (SO)

P-SOP28-450-1.27

TMP87P808M
TMP87P808LM

P-SDIP28-400-1.78

TMP87P808N
TMP87P808LN

000707EBP1

Pin Function

The 87P808/808L has two modes: MCU and PROM.

(1) MCU mode

In this mode, the 87P808/808L is pin compatible with the 87C408/808/408L/808L (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	Program memory address inputs	P10 to P15, P64, P65
A7 to A0			P10 to P15, P64, P65
D7 to D0	I/O	Program memory data input/outputs	P10 to P15, P64, P65
$\overline{CE}$	Input	Chip enable signal input	P66
$\overline{OE}$		Output enable signal input	P67
VPP	Power supply	+ 12.5 V / 5 V (Program supply voltage)	TEST
VCC		+ 5 V	VDD
GND		0 V	VSS
P17 to P16	I/O	PROM mode setting pins. Be fixed at low level.	
P63 to P60			
P77 to P72			
$\overline{RESET}$			
XIN	Input	Connect an 8 MHz oscillator to stabilize the internal state.	
XOUT	Output		
VAREF	Power supply	0 V (GND)	
VASS			

Operational Description

The configuration and function of the 87P808/808L are the same as those of the 87C408/808/408L/808L, except in that a one-time PROM is used instead of an on-chip mask ROM.

1. Operating Mode

The 87P808/808L 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 87C408/808/408L/808L (TEST/VPP pin cannot be used open because it has no built in pull-down resistance.)

1.1.1 Program Memory

The 87P808/808L have an 8 Kbytes (addresses E000 to FFFF$_H$ in the MCU mode, addresses 6000 to 7FFF$_H$ in the PROM mode) one-time PROM.

When the 87P808/808L is used as a system evaluation of the 87C408/808/408L/808L, the data is written to the program storage area shown in Figure 1-1.
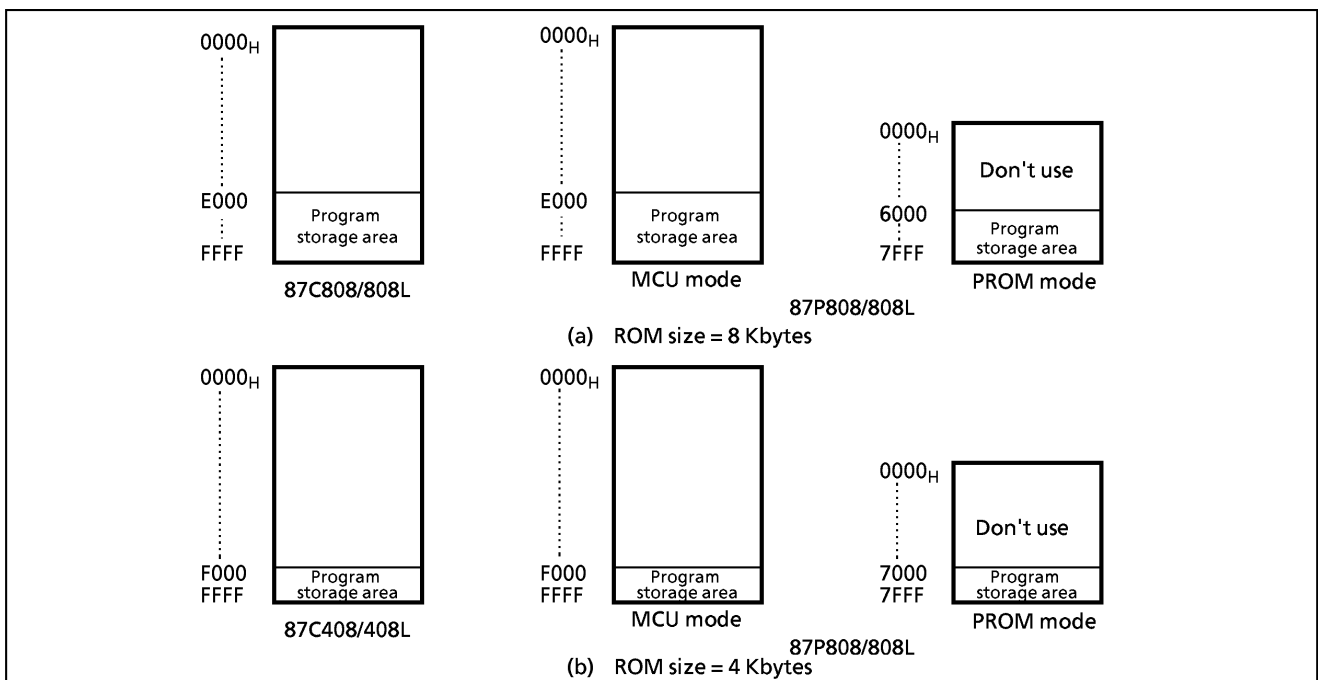

Figure 1-1. Program Memory Area

> Note: Either write the data FFH to the unused area or set the general-purpose PROM programmer to access only the
> program storage area

1.1.2 Data Memory

The 87P808/808L has an 256 bytes data memory (static RAM).

Electrical Characteristics
(1) 87P808

Absolute Maximum Ratings	(V_{SS} = 0 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_{OUT}			– 0.3 to V_{DD} + 0.3	V
Output Current (Per 1 pin)	IOL	I_{OUT1}		P1, P6		3.2	mA
		I_{OUT2}		P7 (Middle current port)		15	mA
	IOH	I_{OUT3}		P1, P6, P7		– 1.8	mA
Output Current (Total)	IOL	ΣI_{OUT1}		P1, P6		50	mA
		ΣI_{OUT2}		P7 (Middle current port)		60	mA
	IOH	ΣI_{OUT3}		P1, P6, P7		30	mA
Power Dissipation [Topr = 70°C]			PD		SDIP	300	mW
					SOP	180	
Soldering Temperature (time)			Tsld			260 (10 s)	°C
Storage Temperature			Tstg			– 55 to 125	°C
Operating Temperature			Topr			– 30 to 70	°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 V, Topr = –30 to 70°C)

Parameter	Symbol	Pins	Conditions		Min	Max	Unit
Supply Voltage	V_{DD}		fc = 8 MHz	NORMAL mode	4.5	5.5	V
				IDLE mode			
			fc = 4.2 MHz	NORMAL mode	2.7		
				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
	V_{IH2}	Hysteresis input				$V_{DD} \times 0.75$	
	V_{IH3}		2.7 V $\leqq V_D < 4.5$ V			$V_{DD} \times 0.90$	
	V_{IH4}		$V_{DD} < 2.7$ V			$V_{DD} \times 0.95$	
Input Low Voltage	V_{IL1}	Except hysteresis input	$V_{DD} \geqq 4.5$ V			$V_{DD} \times 0.30$	V
	V_{IL2}	Hysteresis input			0	$V_{DD} \times 0.25$	
	V_{IL3}		2.7 V $\leqq V_{DD} < 4.5$ V			$V_{DD} \times 0.10$	
Clock Frequency	fc	XIN, XOUT	$V_{DD} = 4.5$ to 5.5 V		1.0	8.0	MHz
			$V_{DD} = 2.7$ to 5.5 V			4.2	

> *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: Supply voltage range is specified in NORMAL mode and IDLE mode.*
> *Note 3: Minimum of clock frequency: 1 MHz $\leqq$ fcgck*

D.C. Characteristics

(V_{SS} = 0 V, 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} = 5.5 V V_{IN} = 5.5 V / 0 V			–2	–	2	μA
	I_{IN2}	Tri-state ports							
	I_{IN3}	RESET, STOP							
Input Resistance	R_{IN1}	TEST				30	70	150	kΩ
	R_{IN2}	RESET				100	220	450	
	R_{IN3}	STOPi	i = 2 to 5			30	130	250	
Output Leak Current	I_{LO}	Tri-state ports	V_{DD} = 5.5 V, V_{OUT} = 5.5 V / 0V			–2	–	2	μA
Output High Voltage	V_{OH2}	Tri-state ports Ports P1, P6	V_{DD} = 4.5 V, I_{OH} = – 0.7 mA			4.1	–	–	V
Low Output Voltage	V_{OL}	Except XOUT and P7	V_{DD} = 4.5V, I_{OL} = 1.6 mA			–	–	0.4	V
Low Output Current	I_{OL3}	P7	V_{DD} = 4.5 V, V_{OL} = 1.0 V			–	7	–	mA
Supply Current in NORMAL mode	I_{DD}		V_{DD} = 5.5 V fc = 8 MHz V_{IN} = 5.3 V / 0.2V	fcgck	fc	–	7.0	11	mA
					fc/2	–	4.4	7.0	
					fc/4	–	2.8	5.1	
					fc/8	–	2.2	4.5	
Supply Current in IDLE mode				fcgck	fc	–	3.6	5.5	
					fc/2	–	2.6	4.2	
					fc/4	–	2.0	3.7	
					fc/8	–	1.7	3.5	
Supply Current in NORMAL mode			V_{DD} = 3.0 V fc = 4.19 MHz V_{IN} = 2.8 V / 0.2V	fcgck	fc	–	1.7	2.8	
					fc/2	–	1.1	2.0	
					fc/4	–	0.7	1.4	
Supply Current in IDLE mode				fcgck	fc	–	0.9	1.6	
					fc/2	–	0.7	1.4	
					fc/4	–	0.5	1.0	
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, VDD = 5 V.
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.
Note 3: I_{DD} ; Except for I_{REF}

A/D Conversion Characteristics

(V_{SS} = 0 V, 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 Range	V_{AIN}		V_{ASS}	–	V_{AREF}	V
Analog Reference Current	I_{REF}	V_{AREF} = 5.5 V, V_{ASS} (V_{SS}) = 0.0 V	–	0.8	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_{AREF} = 2.700 V V_{ASS} (V_{SS}) = 0.000 V	–	–	± 1	LSB
Zero Point Error			–	–	± 1	
Full Scale Error			–	–	± 1	
Total Error			–	–	± 2	

Note: Quantizing error is not contained in those errors.

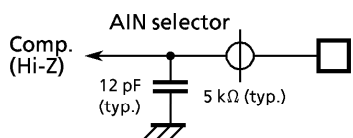| A.C. Characteristics (I) | | (V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, Topr = −30 to 70°C) | | | | | |

Parameter	Symbol	Conditions		Min	Typ.	Max	Unit
Machine Cycle Timer	t_{cy}	In NORMAL mode		0.5	–	4	μs
		In IDLE mode					
High Level Clock Pulse Width	t_{WCH}	For external clock operation		50	–	–	ns
Low Level Clock Pulse Width	t_{WCL}	fc = 8 MHz					
A/D Conversion Time	t_{ADC}	ACK = 0		–	46	–	tcy
		ACK = 1			184		
A/D Sampling Time	t_{AIN}			–	4	–	

| A.C. Characteristics (II) | | (V_{SS} = 0 V, V_{DD} = 2.7 to 5.5 V, Topr = − 30 to 70°C) | | | | | |

Parameter	Symbol	Conditions		Min	Typ.	Max	Unit
Machine Cycle Time	t_{cy}	In NORMAL mode		0.95	–	4	μs
		In IDLE mode					
High Level Clock Pulse Width	t_{WCH}	For external clock operation		110	–	–	ns
Low Level Clock Pulse Width	t_{WCL}	fc = 4.2 MHz					
A/D Conversion Time	t_{ADC}	ACK = 0		–	46	–	
		ACK = 1			184		tcy
A/D Sampling Time	t_{AIN}			–	4		

Note: A/D conversion timing:
     Internal circuit for AIN0 to 5

A/D conversion timing

AIN selector

Comp. (Hi-Z)

12 pF (typ.)   5 kΩ (typ.)

※ To maintain a precision of A/D conversion, internal condenser must be charged until t_{AIN} is over.

ADS
EOCF
AIN selector t_{AIN}
A/D conversion t_{ADC}

Recommended Oscillating Conditions (I) $(V_{SS} = 0\,V,\ V_{DD} = 4.5\ to\ 5.5\,V,\ Topr = -30\ to\ 70°C)$

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator		Recommended Conditions	
					C_1	C_2
High-frequency Oscillation	Ceramic Resonator	8 MHz (VDD = 4.5 to 5.5 V)	KYOCERA	KBR8.0M	30 pF	30 pF
			MURATA	CSAC8.00MT	30 pF	30 pF
			MURATA	CSA8.00MTZ CST8.00MTW CSTS8.00MT	—	—
		4.19 MHz (VDD = 2.7 to 5.5 V)	MURATA	CSA4.19MG	30 pF	30 pF
			MURATA	CST4.19MGW	—	—
		4 MHz (VDD = 2.7 to 5.5 V)	KYOCERA	KBR4.0MS	30 pF	30 pF
	Crystal Oscillator	8 MHz (VDD = 4.5 to 5.5 V)	TOYOCOM	210B 8.0000	20 pF	20 pF
		4 MHz (VDD = 2.7 to 5.5 V)	TOYOCOM	204B 4.000		

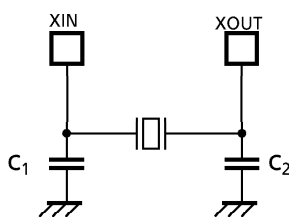## Recommended Oscillating Conditions (II) $(V_{SS} = 0\,V,\ V_{DD} = 2.7\ to\ 5.5\,V,\ Topr = -30\ to\ 70°C)$

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator		Recommended Conditions	
					C_1	C_2
High-frequency Oscillation	Ceramic Resonator	4.19 MHz (VDD = 2.7 to 5.5 V)	MURATA	CSA4.19MG	30 pF	30 pF
			MURATA	CST4.19MGW	—	—
		4 MHz (VDD = 2.7 to 5.5 V)	MURATA	CSA4.00MG	30 pF	30 pF
				CSA4.00MGC	—	—
			MURATA	CST4.00MGW	—	—
				CSTC4.00MG		
			MURATA	CSTCS4.00MG	—	—

(1) High-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.
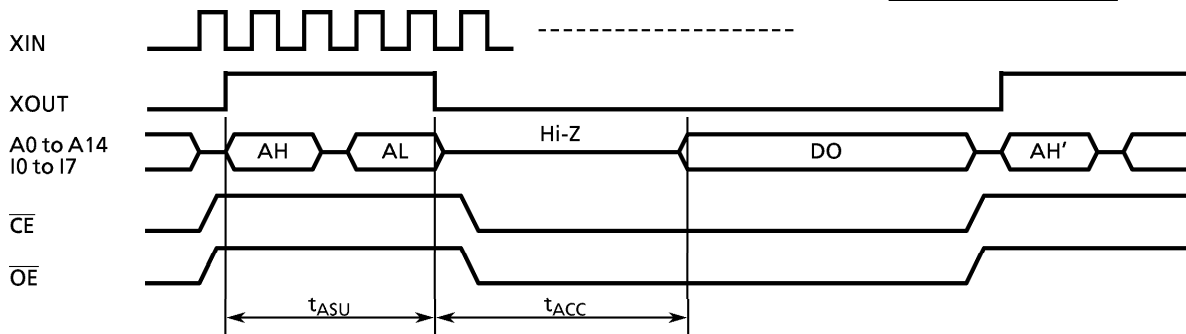
D.C. Characteristics, A.C. Characteristics ($V_{SS} = 0$ V)
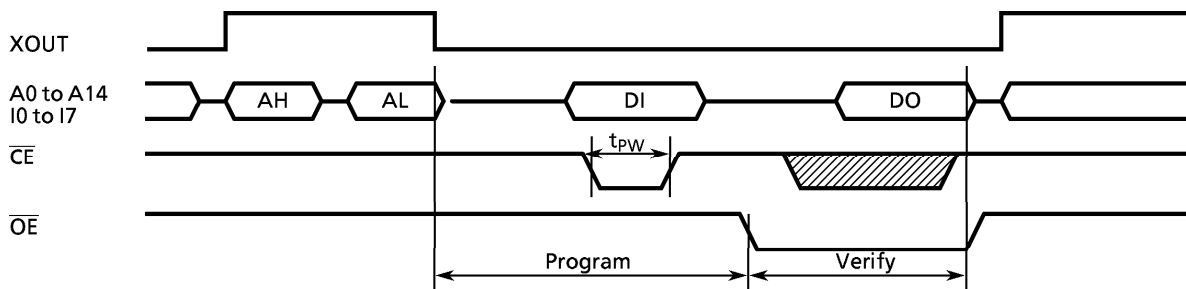
(1) Read Operation (T_{opr} = 0 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.67$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.3$	V
Supply Voltage	V_{CC}		4.75	5.00	5.25	V
Program Supply Voltage	V_{PP}		$V_{CC} - 0.6$	V_{CC}	$V_{CC + 0.6}$	
Address Set-up Time	t_{ASU}		400	–	–	ns
Address Access Time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25$ V	–	5tcyc	–	ns

Note: tcyc = 400 ns

(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
Supply Voltage	V_{CC}		5.75	6.0	6.25	V
Program Supply Voltage	V_{PP}		12.0	12.5	13.0	V
Initial Program Pulse Width	t_{PW}	$V_{CC} = 6.0$ V $\pm$ 0.25 V, $V_{PP} = 12.5$ V $\pm$ 0.25 V	0.95	1.0	1.05	ms

Note: DO ; Data output (I0 to I7)   AL ; Address input (A0 to A7)
         DI ; Data input (I0 to I7)   AH ; Address input (A8 to A14)

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 V ± 0.5 V) 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}	$V_{CC} = 6.25\,V \pm 0.25\,V$, $V_{PP} = 12.75\,V \pm 0.25\,V$	0.095	0.1	0.105	ms

XOUT

A0 to A14
I0 to I7 — AH — AL — DI — DO

$\overline{CE}$; t_{PW}
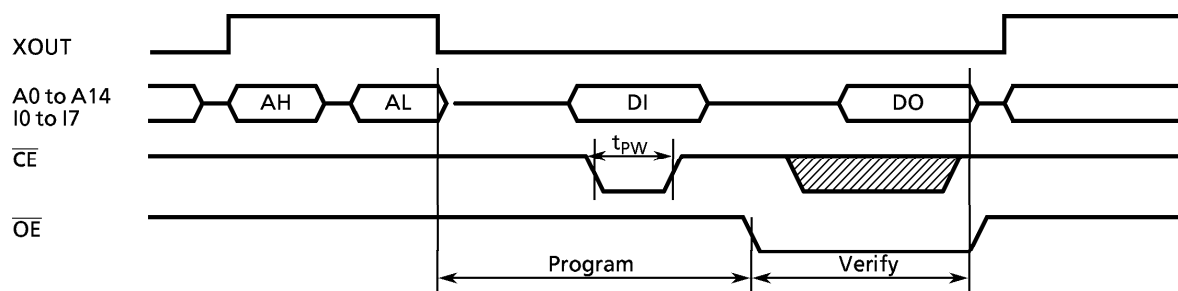
$\overline{OE}$

Program   Verify

> *Note:*   *DO ; Data output (I0 to I7)*   *AL ; Address input (A0 to A7)*
> *DI ; Data input (I0 to I7)*   *AH ; Address input (A8 to A14)*

> *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 V ± 0.5 V) 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.*

Recommended EPROM Programmer

DATA I/O   UNISTTE (SITE40)
ADVANTEST   R4945A
AVAL DATA   PECKER11   MARK-II (version 5.5)

Electrical Characteristics
(1) 87P808L

Absolute Maximum Ratings		(V_{SS} = 0 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_{OUT}			– 0.3 to V_{DD} + 0.3	V
Output Current (Per 1 pin)	IOL	I_{OUT1}	P1, P6		3.2	mA
		I_{OUT2}	P7 (Middle current port)		15	mA
	IOL	I_{OUT3}	P1, P6, P7		– 1.8	mA
Output Current (Total)	IOL	ΣI_{OUT1}	P1, P6		50	mA
		ΣI_{OUT2}	P7 (Middle current port)		60	mA
	IOL	ΣI_{OUT3}	P1, P6, P7		30	mA
Power Dissipation [Topr = 70°C]		PD		SDIP	300	mW
				SOP	180	
Soldering Temperature (time)		Tsld			260 (10 s)	°C
Storage Temperature		Tstg			– 55 to 125	°C
Operating Temperature		Topr			– 30 to 70	°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 V, Topr = –30 to 70°C)				
Parameter	Symbol	Pins	Conditions		Min	Max	Unit
Supply Voltage	V_{DD}		fc = 4.2 MHz	NORMAL mode	1.8	4.0	V
				IDLE mode			
			STOP mode				
Input High Voltage	V_{IH}				$V_{DD} \times 0.90$	V_{DD}	V
Input Low Voltage	V_{IL}				0	$V_{DD} \times 0.10$	V
Clock Frequency	fc	XIN, XOUT	V_{DD} = 1.8 to 4.0 V		1.0	4.2	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: Supply voltage range is specified in NORMAL mode and IDLE mode.
Note 3: Minimum of clock frequency: 1 MHz ≦ fcgck

D.C. Characteristics	(V$_{SS}$ = 0 V, 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$_{DD}$ = 4.0 V			−2	−	2	μA
	I$_{IN2}$	Tri-state ports		V$_{IN}$ = 4.0 V / 0 V						
	I$_{IN3}$	RESET, STOP								
Input Resistance	R$_{IN1}$	TEST					30	70	150	kΩ
	R$_{IN2}$	RESET					100	220	450	
	R$_{IN3}$	STOPi		i = 2 to 5			30	130	250	
Output Leakl Current	I$_{LO}$	Tri-state ports		V$_{DD}$ = 4.0 V, V$_{OUT}$ = 4.0 V / 0V			−2	−	2	μA
Output High Voltage	V$_{OH2}$	Tri-state ports		V$_{DD}$ = 4.0 V, I$_{OH}$ = − 0.5 mA			3.6	−	−	V
Output Low Voltage	V$_{OL}$	Except XOUT and P7		V$_{DD}$ = 4.0V, I$_{OL}$ = 1.3 mA			−	−	0.4	V
Output Low Current	I$_{OL3}$	P7		V$_{DD}$ = 4.0 V, V$_{OL}$ = 1.0 V			−	6	−	mA
Supply Current in NORMAL mode	I$_{DD}$			V$_{DD}$ = 4 V fc = 4.19 MHz V$_{IN}$ = 3.8 V / 0.2V	fcgck	fc	−	2.25	3.6	mA
						fc/2	−	1.35	2.5	
						fc/4	−	0.9	1.9	
						fc/8	−	0.7	1.65	
Supply Current in IDLE mode					fcgck	fc	−	1.2	1.9	
						fc/2	−	0.9	1.7	
						fc/4	−	0.7	1.5	
						fc/8	−	0.6	1.4	
Supply Current in NORMAL mode				V$_{DD}$ = 3.0 V fc = 4.19 MHz V$_{IN}$ = 2.8 V / 0.2V	fcgck	fc	−	1.5	2.5	
						fc/2	−	0.85	1.6	
						fc/4	−	0.6	1.2	
						fc/8	−	0.4	1.0	
Supply Current in IDLE mode					fcgck	fc	−	0.8	1.4	
						fc/2	−	0.55	1.1	
						fc/4	−	0.45	0.9	
						fc/8	−	0.35	0.85	
Supply Current in NORMAL mode				V$_{DD}$ = 1.8 V fc = 4.19 MHz V$_{IN}$ = 1.6 V / 0.2V	fcgck	fc	−	0.9	1.3	
						fc/2	−	0.5	0.8	
						fc/4	−	0.3	0.45	
						fc/8	−	0.2	0.35	
Supply Current in IDLE mode					fcgck	fc	−	0.35	0.5	
						fc/2	−	0.23	0.35	
						fc/4	−	0.17	0.26	
						fc/8	−	0.14	0.24	
Supply Current in STOP mode				V$_{DD}$ = 4.0 V V$_{IN}$ = 3.8 V / 0.2 V			−	0.5	10	μA

Note 1:   Typical values show those at Topr = 25°C, VDD = 4 V.

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.

Note3:   IDD ; Except for I$_{REF}$

A/D Conversion Characteristics (I)

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

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}		1.8	–	V_{DD}	V
	V_{ASS}		V_{SS}			
Analog Input Voltage Range	V_{AIN}		V_{ASS}	–	V_{AREF}	V
Nonlinearity Error		1.8 V ≦ V_{AREF} < 2.7 V V_{AREF} ≦ V_{DD} ≦ 4.0 V_{ASS} (V_{SS}) = 0.000V ACK = 1 (Note2)	–	–	± 2	LSB
Zero Point Error			–	–	± 2	
Full Scale Error			–	–	± 2	
Total Error			–	–	± 4	

Note1: Quantizing error is not contained in those errors.
Note2: ACK ; bit5 of ADCCR (#000E$_H$) . conversion time = 184 tcy (175.6 μs / at fcgck = 4.19 MHz)

A/D Conversion Characteristics (II)

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

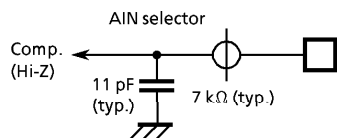| Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}		2.7	–	V_{DD}	V
	V_{ASS}		V_{SS}			
Analog Input Voltage Range	V_{AIN}		V_{ASS}	–	V_{AREF}	V
Analog Reference Current	I_{REF}	V_{AREF} = 4.0V, V_{ASS} (V_{SS}) = 0.0V	–	0.5	1.0	mA
Nonlinearity Error		V_{DD} = 4.0 V V_{AREF} = 4.000V V_{ASS} (V_{SS}) = 0.000V or V_{DD} = 2.7 V V_{AREF} = 2.700V V_{ASS} (V_{SS}) = 0.000V	–	–	± 1	LSB
Zero Point Error			–	–	± 1	
Full Scale Error			–	–	± 1	
Total Error			–	–	± 2	

Note: Quantizing error is not contained in those errors.

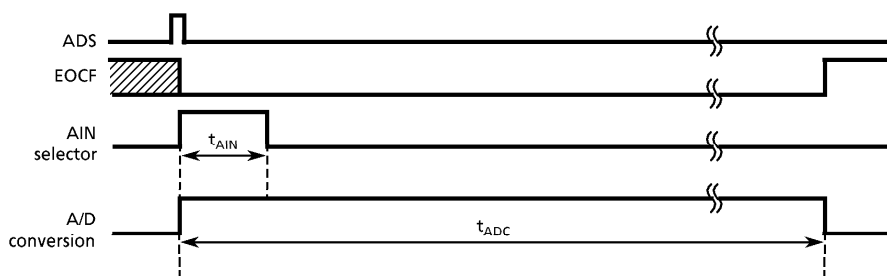| A.C. Characteristics		(V_{SS} = 0 V, V_{DD} = 1.8 to 4.0 V, Topr = − 30 to 70°C)					

Parameter	Symbol	Conditions		Min	Typ.	Max	Unit
Machine Cycle Time	tcy	In NORMAL mode		0.95	–	4	μs
		In IDLE mode					
High Level Clock Pulse Width	t_{WCH}	For external clock operation		110	–	–	ns
Low Level Clock Pulse Width	t_{WCL}	fc = 4.2 MHz					
A/D Conversion Time	t_{ADC}	ACK = 0		–	46	–	
		ACK = 1			184		tcy
A/D Sampling Time	t_{AIN}			–	4		

Note: A/D conversion timing:
Internal circuit for AIN 0 to 5

A/D conversion timing

AIN selector

Comp. (Hi-Z)

11 pF (typ.)   7 kΩ (typ.)

※ To maintain a precision of A/D conversion, internal condenser must be charged until t_{AIN} is over.
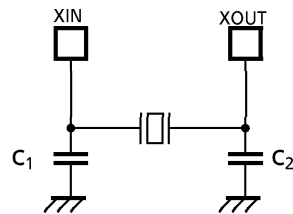
Recommended Oscillating Conditions   (V_{SS} = 0 V, Topr = − 30 to 70°C)

Parameter	Oscillator	Oscillation Frequency	Recommended Oscillator		Recommended Conditions	
					C_1	C_2
High-frequency Oscillation	Ceramic Resonator	4.19 MHz (VDD = 2.7 to 5.5 V)	MURATA	CSA4.19MG	30 pF	30 pF
			MURATA	CST4.19MGW	—	—
		4 MHz (VDD = 2.7 to 5.5 V)	MURATA	CSA4.00MG	30 pF	30 pF
				CSA4.00MGC	—	—
			MURATA	CST4.00MGW CSTC4.00MG	—	—
			MURATA	CSTCS4.00MG	—	—

(1) High-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.
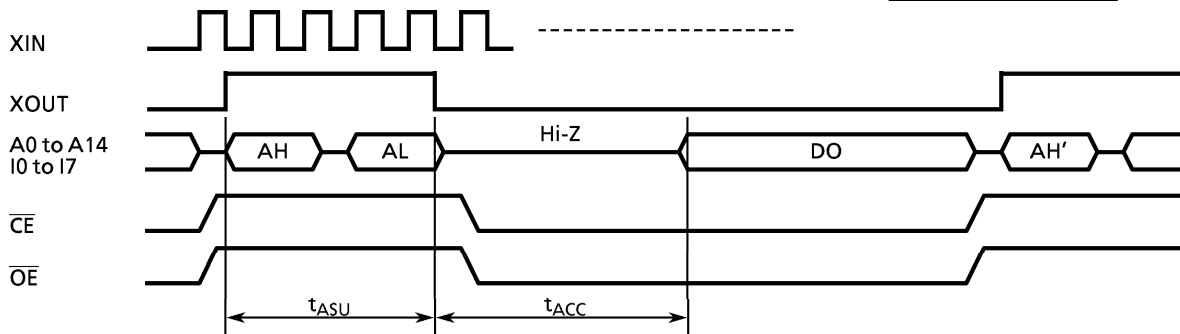
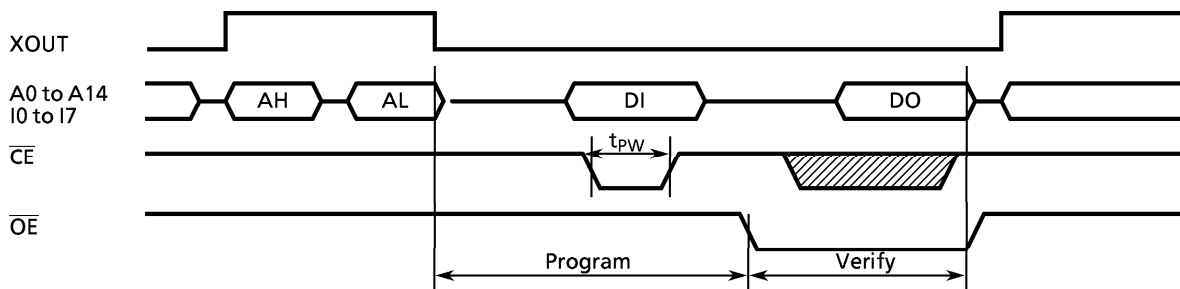| D.C. Characteristics, A.C. Characteristics	(V_{SS} = 0 V)

(1) Read Operation (T_{opr} = 0 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.67$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.3$	V
Supply Voltage	V_{CC}		4.75	5.00	5.25	V
Program Supply Voltage	V_{PP}		$V_{CC} - 0.6$	V_{CC}	$V_{CC + 0.6}$	
Address Set-up Time	t_{ASU}		400	–	–	ns
Address Access Time	t_{ACC}	V_{CC} = 5.0 ± 0.25 V	–	5tcyc	–	ns

Note: tcyc = 400 ns

(2) Program Operation (High speed write mode - I) (Topr = 25 ± 5°C)

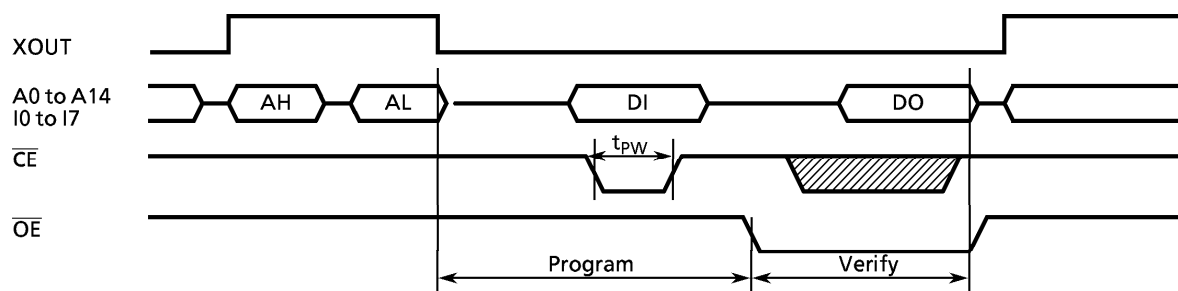| Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Input High Voltage	V_{IH4}		$V_{CC} \times 0.7$	–	V_{CC}	V
Input Low Voltage	V_{IL4}		0	–	$V_{CC} \times 0.12$	V
Supply Voltage	V_{CC}		5.75	6.0	6.25	V
Program Supply Voltage	V_{PP}		12.0	12.5	13.0	V
Initial Program Pulse Width	t_{PW}	V_{CC} = 6.0 V ± 0.25 V, V_{PP} = 12.5 V ± 0.25 V	0.95	1.0	1.05	ms

Note: DO ; Data output (I0 to I7)   AL ; Address input (A0 to A7)
          DI ; Data input (I0 to I7)   AH ; Address input (A8 to A14)

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.

Note2: The device must not be set to the EPROM programmer or picked up from it under applying the program voltage (12.5 V ± 0.5 V) 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}	$V_{CC} = 6.25\,V \pm 0.25\,V$, $V_{PP} = 12.75\,V \pm 0.25\,V$	0.095	0.1	0.105	ms

Note: DO ; Data output (I0 to I7)   AL ; Address input (A0 to A7)
         DI ; Data input (I0 to I7)   AH ; Address input (A8 to A14)

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 V ± 0.5 V) 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.

Recommended EPROM Programmer

DATA I/O   UNISTTE (SITE40)
ADVANTEST   R4945A
AVAL DATA   PECKER11   MARK-II (version 5.5)