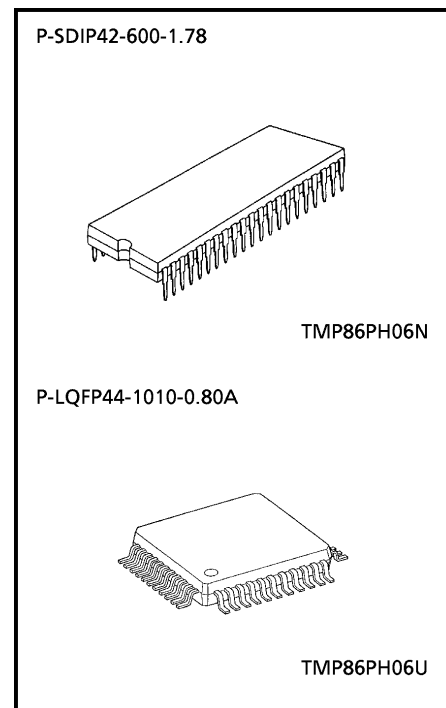# TOSHIBA

CMOS 8-Bit Microcontroller

TMP86PH06N/TMP86PH06U

The TMP86PH06 is a OTP type MCU which includes 16 Kbyte One-time PROM. It is a pin compatible with a mask ROM product of the TMP86CH06. Writing the program to built-in PROM, the TMP86PH06 operates as the same way as the TMP86CH06. Using the Adapter socket, you can write and verify the data for the TMP86PH06 with a general-purpose PROM programmer same as TC57100D/AD.

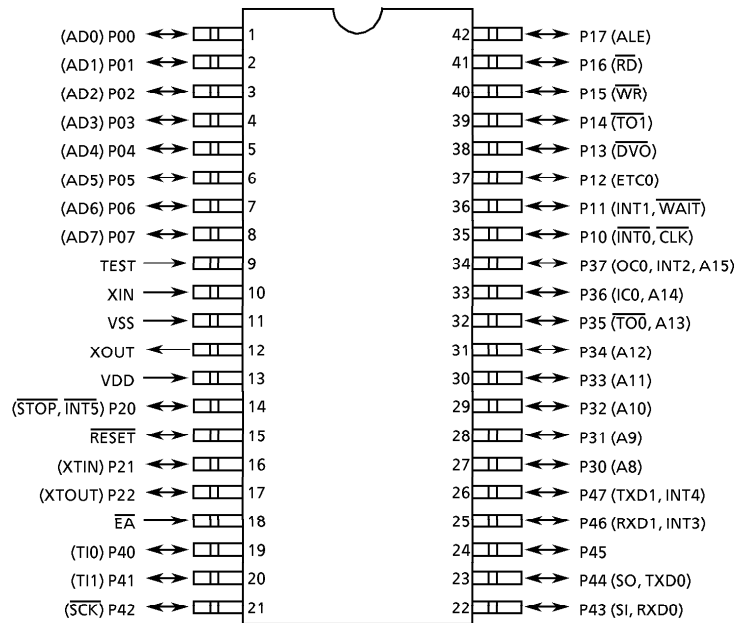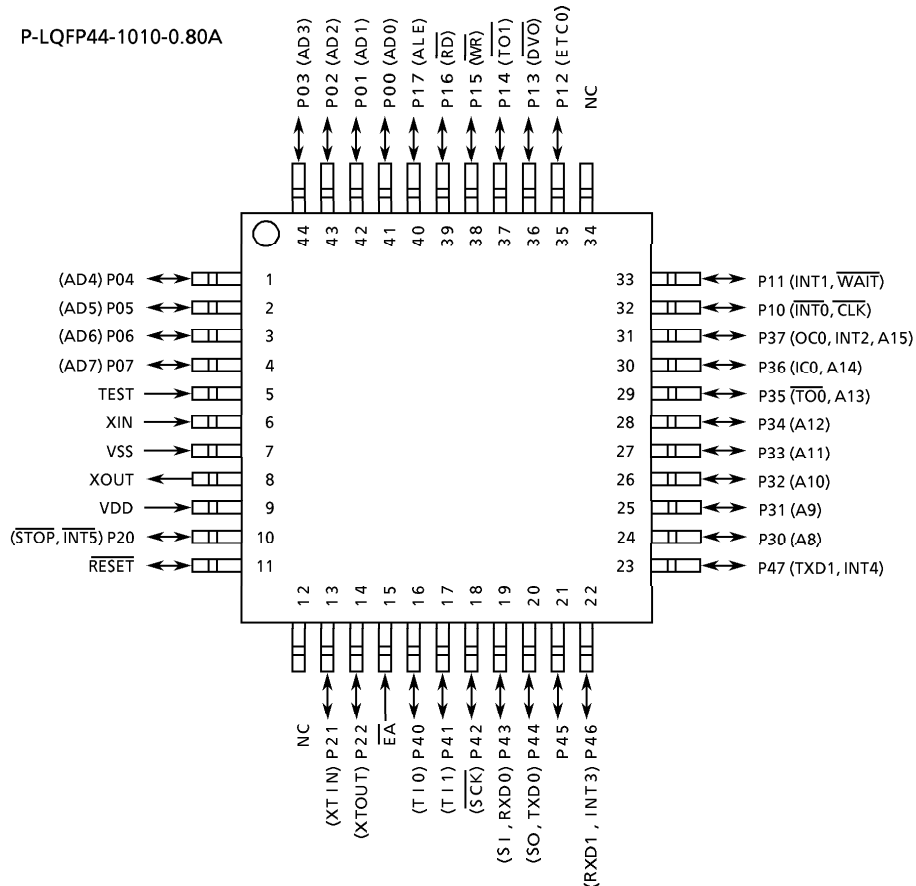| Product No.	OTP	RAM	Package	Adapter Socket
TMP86PH06N	16 K × 8 bit	512 × 8 bit	P-SDIP42-600-1.78	BM11155
TMP86PH06U	16 K × 8 bit	512 × 8 bit	P-LQFP44-1010-0.80A	BM11156

P-SDIP42-600-1.78

TMP86PH06N

P-LQFP44-1010-0.80A

TMP86PH06U

000707EBP1

Pin Assignments (Top View)

P-SDIP42-600-1.78

(AD0) P00	1 ... 42	P17 (ALE)
(AD1) P01	2 ... 41	P16 ($\overline{RD}$)
(AD2) P02	3 ... 40	P15 ($\overline{WR}$)
(AD3) P03	4 ... 39	P14 ($\overline{TO1}$)
(AD4) P04	5 ... 38	P13 ($\overline{DVO}$)
(AD5) P05	6 ... 37	P12 (ETC0)
(AD6) P06	7 ... 36	P11 (INT1, $\overline{WAIT}$)
(AD7) P07	8 ... 35	P10 ($\overline{INT0}$, CLK)
TEST	9 ... 34	P37 (OC0, INT2, A15)
XIN	10 ... 33	P36 (IC0, A14)
VSS	11 ... 32	P35 ($\overline{TO0}$, A13)
XOUT	12 ... 31	P34 (A12)
VDD	13 ... 30	P33 (A11)
($\overline{STOP}$, $\overline{INT5}$) P20	14 ... 29	P32 (A10)
$\overline{RESET}$	15 ... 28	P31 (A9)
(XTIN) P21	16 ... 27	P30 (A8)
(XTOUT) P22	17 ... 26	P47 (TXD1, INT4)
$\overline{EA}$	18 ... 25	P46 (RXD1, INT3)
(TI0) P40	19 ... 24	P45
(TI1) P41	20 ... 23	P44 (SO, TXD0)
($\overline{SCK}$) P42	21 ... 22	P43 (SI, RXD0)

P-LQFP44-1010-0.80A

Top pins (44-34):
P03 (AD3), P02 (AD2), P01 (AD1), P00 (AD0), P17 (ALE), P16 ($\overline{RD}$), P15 ($\overline{WR}$), P14 ($\overline{TO1}$), P13 ($\overline{DVO}$), P12 (ETC0), NC

Left pins (1-11):
(AD4) P04	1
(AD5) P05	2
(AD6) P06	3
(AD7) P07	4
TEST	5
XIN	6
VSS	7
XOUT	8
VDD	9
($\overline{STOP}$, $\overline{INT5}$) P20	10
$\overline{RESET}$	11

Right pins (33-23):
33	P11 (INT1, $\overline{WAIT}$)
32	P10 ($\overline{INT0}$, CLK)
31	P37 (OC0, INT2, A15)
30	P36 (IC0, A14)
29	P35 ($\overline{TO0}$, A13)
28	P34 (A12)
27	P33 (A11)
26	P32 (A10)
25	P31 (A9)
24	P30 (A8)
23	P47 (TXD1, INT4)

Bottom pins (12-22):
NC, (XTIN) P21, (XTOUT) P22, $\overline{EA}$, (TI0) P40, (TI1) P41, ($\overline{SCK}$) P42, (SI, RXD0) P43, (SO, TXD0) P44, P45, (RXD1, INT3) P46

Pin Function

The TMP86PH06 has MCU mode and PROM mode.

(1)   MCU mode

In the MCU mode, the TMP86PH06 is a pin compatible with the TMP86CH06 (Make sure to fix the TEST pin to low level).

(2)   PROM mode

Pin Name (PROM mode)	Input/Output	Functions	Pin Name (MCU mode)
A15 to A8	Input	Input of Memory address for program	P30 to P37
A7 to A0			P40 to P47
D7 to D0	I/O	Input/Output of Memory data for program	P00 to P07
$\overline{CE}$	Input	Chip enable	P13
$\overline{OE}$		Output enable	P14
$\overline{PGM}$		Program control	P15
VPP	Power supply	+ 12.75 V/5 V (Power supply of program)	TEST
VCC		+ 6.25 V/5 V	VDD
GND		0 V	VSS
$\overline{EA}$, P11, P21	I/O	PROM mode setting pin. Fix to high.	
P12, P10, P22, P20		PROM mode setting pin. Fix to low.	
$\overline{RESET}$			
P16, P17	Output	Output pin for PROM operation test. Open or release.	
XIN	Input	Self oscillation with resonator (8 MHz).	
XOUT	Output		

Note: No pin is applied to A16 input.

Operational Description

This section describes the functions and basic operational blocks of TMP86PH06.

The TMP86PH06 has PROM in place of the mask ROM which is included in the TMP86CH06. The configuration and function are the same as the TMP86CH06. For the functions of TMP86PH06 in details, see the section of TMP86CH06.

In addition, TMP86PH06 operates as the single clock mode when releasing reset.

When using the dual clock mode, oscillate a low-frequency clock by SET (SYSCR2). XTEN command at the beginning of program.

1.   Operating Mode

The TMP86PH06 has MCU mode and PROM mode.

1.1   MCU mode

The MCU mode is set by fixing the TEST/VPP pin to the low level.

In the MCU mode, the operation is the same as the TMP86CH06 (TEST/VPP pin cannot be used open because it has no built-in pull-down resister).

1.1.1 Program Memory

The TMP86PH06 has a 16-Kbyte built-in one time PROM (addresses C000 to $FFFF_H$ in the MCU mode, addresses 0000 to $3FFF_H$ in the PROM mode).

When using TMP86PH06 for evaluation of TMP86CH06, the program is written in the program storing area shown in Figure 1-1.
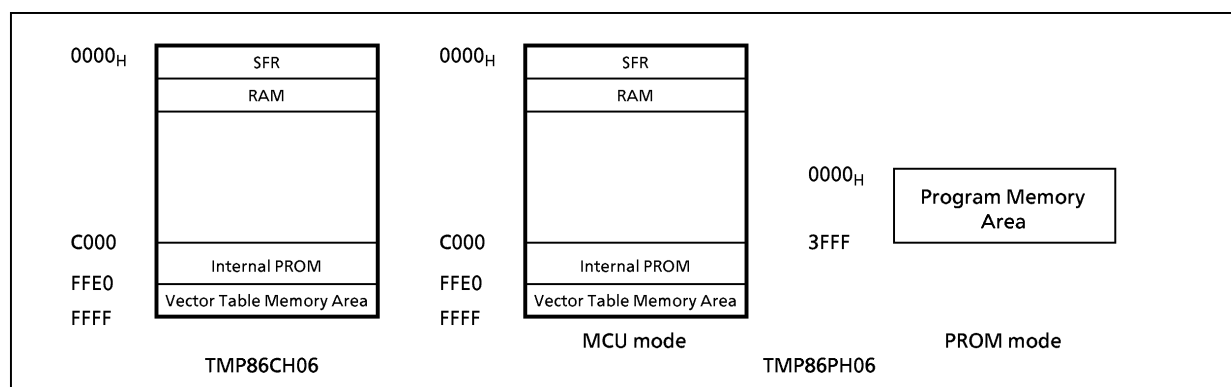

Figure 1-1. Program Memory Area

Note: A general-purpose PROM programmer should be set only in the program memory area to access.

Electrical Characteristics

| Absolute Maximum Rating | ($V_{SS} = 0$ V) |

Parameter	Symbol	Pins	Rating	Unit
Supply Voltage	V_{DD}		− 0.3 to 6.5	
Programing Voltage	V_{PP}	TEST/V_{PP}	− 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	
Output Current	I_{OUT1}	P1 to P4	3.2	
	I_{OUT3}	P0	30	mA
Output Current	ΣI_{OUT1}		80	
	ΣI_{OUT3}		120	
Power Dissipation (Topr = 85°C)	PD	TMP86PH06N	600	mW
		TMP86PH06U	350	
Soldering Temperature (Time)	Tsld		260 (10 s)	
Storage Temperature	Tstg		− 55 to 125	°C
Operating Temperature	Topr		− 40 to 85	

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 | | | $(V_{SS} = 0 \text{ V, Topr} = -40 \text{ to } 85°C)$ | | | | |

Parameter	Symbol	Pins	Conditions		Min	Max	Unit
Supply Voltage	V_{DD}		$fc = 16$ MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE0, 1, 2 mode			
			$fc = 8$ MHz	NORMAL1, 2 mode	2.7		
				IDLE0, 1, 2 mode			
			$fc = 4.2$ MHz	NORMAL1, 2 mode	1.8		
				IDLE0, 1, 2 mode			
			$fs = 32.768$ kHz	SLOW1, 2 mode			
				SLEEP0, 1, 2 mode			
				STOP mode	1.8		
Input High Voltage	V_{IH1}	Except hysteresis and TTL input	$V_{DD} \geqq 4.5$ V			$V_{DD} \times 0.70$	V
	V_{IH2}	Hysteresis input				$V_{DD} \times 0.75$	
	V_{IH3}	Except TTL input	$V_{DD} < 4.5$ V			$V_{DD} \times 0.90$	
	V_{IH4}	TTL input (Data bus)	$V_{DD} = 5$ V			2.2	V_{DD}
	V_{IH5}		$V_{DD} = 1.8$ V			$V_{DD} - 0.2$	
Input Low Voltage	V_{IL1}	Except hysteresis and TTL 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}	Except TLL input	$V_{DD} < 4.5$ V			$V_{DD} \times 0.10$	
	V_{IL4}	TTL input (Data bus)	$V_{DD} = 5$ V			0.8	
	V_{IL5}		$V_{DD} = 1.8$ V			0.2	
Clock Frequency	fc	XIN, XOUT	$V_{DD} = 4.5$ V to 5.5 V			16	MHz
			$V_{DD} = 2.7$ V to 5.5 V		1.0	8	
			$V_{DD} = 1.8$ V to 5.5 V			4.2	
	fs	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 fc ; The condition of supply voltage range is the value under NORMAL1/2 and IDLE0/1/2 mode.

Note 3: The minimum fc with clock gear is calculated as following formula with the ratio on divider n.
(Min fc) = (ratio on divider n) × 1 [MHz]

DC Characteristics

(V_{SS} = 0 V, Topr = – 40 to 85°C)

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Hysteresis Voltage	V_{HS}	Hysteresis input		–	0.9	–	V
Input Current	I_{IN1}	TEST, $\overline{EA}$	V_{DD} = 5.5 V V_{IN} = 5.5 V/0 V	–	–	± 2	μA
	I_{IN2}	Sink Open Drain, Tri-state Port					
	I_{IN3}	$\overline{RESET}$, $\overline{STOP}$					
Input Resistance	R_{IN2}	$\overline{RESET}$		100	220	450	kΩ
OSC. Feedback Resistance	Rfx	XIN-XOUT		–	1.2	–	MΩ
	Rfxt	XTIN-XTOUT		–	6	–	
Output Leakage Current	I_{LO1}	Sink Open Drain Port	V_{DD} = 5.5 V, V_{OUT} = 5.5 V	–	–	2	μA
	I_{LO2}	Tri-state Port	V_{DD} = 5.5 V, V_{OUT} = 5.5 V/0 V	–	–	± 2	
"H" Output Voltage	V_{OH2}	Tri-state Port	V_{DD} = 4.5 V, I_{OH} = – 0.7 mA	4.1	–	–	V
"L" Output Voltage	V_{OL3}	Except P0 and XOUT	V_{DD} = 4.5 V, I_{OL} = 1.6 mA	–	–	0.4	V
"L" Output Current	I_{OL1}	Except P0 and XOUT	V_{DD} = 4.5 V, V_{OL} = 0.4 V	1.6	–	–	mA
	I_{OL3}	P0	V_{DD} = 4.5 V, V_{OL} = 1.0 V	–	20	–	
Supply Current under NORMAL1, 2 mode	I_{DD}		V_{DD} = 5.5 V V_{IN} = 5.3 V/0.2 V fc = 16 MHz fs = 32.768 kHz	–	5.5	7.0	mA
Supply Current under IDLE1, 2 mode				–	2.8	3.5	
Supply Current under NORMAL1, 2 mode			V_{DD} = 5.5 V V_{IN} = 5.3 V/0.2 V fc = 8 MHz fs = 32.768 kHz	–	4.0	5.0	mA
Supply Current under IDLE1, 2 mode				–	2.0	2.5	
Supply Current under SLOW1 mode			V_{DD} = 3.0 V V_{IN} = 2.8 V/0.2 V fs = 32.768 kHz	–	14	25	μA
Supply Current under SLEEP1 mode				–	7.0	15	μA
Supply Current under SLEEP0 mode				–	6.0	15	μA
Supply Current under STOP mode			V_{DD} = 5.5 V V_{IN} = 5.3 V/0.2 V	–	0.5	10	μA

Note 1: Typical values are shown under Topr = 25°C, V_{DD} = 5 V, while conditions are not state.
Note 2: Input current I_{IN1}, I_{IN3} : The current through pull-up or pull-down resistor is not include.

AC Characteristics

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

① CLOCK

Parameter	Symbol	Conditions		Min	Typ.	Max	Unit
Machine Cycle Time	tcy	NORMAL1, 2 mode		0.25	–	4	μs
		IDLE0, 1, 2 mode					
		SLOW1, 2 mode		117.6	–	133.3	
		SLEEP0, 1, 2 mode					
High Level Clock Pulse Width	t_{WCH}	External clock operation (XIN input) fc = 16 MHz		25	–	–	ns
Low Level Clock Pulse Width	t_{WCL}						
High Level Clock Pulse Width	t_{WSH}	External clock operation (XTIN input) fs = 32.768 kHz		14.7	–	–	μs
Low Level Clock Pulse Width	t_{WSL}						

② External Memory Interface (Multiplexed Bus)   at $V_{DD} = 4.5$ to 5.5

| No.	Symbol	Parameter	Variable		16 MHz		Unit
			Min	Max	Min	Max	
1	t_{AL}	A7 to 0 effective → ALE	0.5t − 15		16		ns
2	t_{LA}	ALE fall → A7 to 0 hold	0.5t − 20		11		ns
3	t_{LL}	ALE pulse width	t − 40		22		ns
4	t_{LC}	ALE fall → $\overline{RD}$, $\overline{WR}$ fall	0.5t − 25		6		ns
5	t_{CL}	$\overline{RD}$, $\overline{WR}$ rise → ALE rise	0.5t − 20		11		ns
6	t_{ACL}	A7 to 0 effective → $\overline{RD}$, $\overline{WR}$ fall	t − 25		37		ns
7	t_{ACH}	A15 to 8 effective → $\overline{RD}$, $\overline{WR}$ fall	1.5t − 25		68		ns
8	t_{CA}	$\overline{RD}$, $\overline{WR}$ rise → A15 to 8 hold	0.5t − 20		11		ns
9	t_{ADL}	A7 to 0 effective → D7 to 0 input		3t − 55		132	ns
10	t_{ADH}	A15 to 8 effective → D7 to 0 input		3.5t − 65		153	ns
11	t_{RD}	$\overline{RD}$ fall → D7 to 0 input		2t − 60		65	ns
12	t_{RR}	$\overline{RD}$ pulse width	2t − 40		85		ns
13	t_{HR}	$\overline{RD}$ rise → D7 to 0 hold	0		0		ns
14	t_{RAE}	$\overline{RD}$ rise → A7 to 0 effective	t − 15		47		ns
15	t_{WW}	$\overline{WR}$ pulse width	2t − 40		85		ns
16	t_{DW}	D7 to 0 effective → $\overline{WR}$ rise	2t − 40		85		ns
17	t_{WD}	$\overline{WR}$ rise → D7 to 0 hold	0.5t − 15		16		ns

Note: t = tcy/4 (t = 62.5 ns at fcgck = 16 MHz)

A.C. Measurement Condition
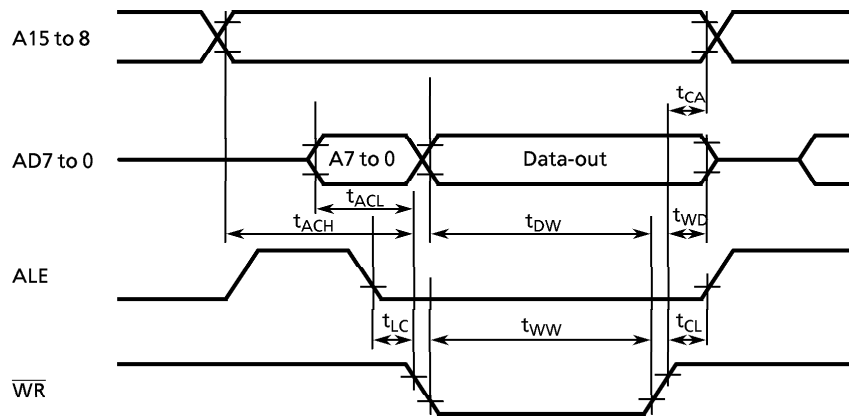   Output Level: High 2.2 V/Low 0.8 V, CL = 50 pF
    Input Level: High 2.4 V/Low 0.4 V (D7 to D0)
                           High 0.8 VDD/Low 0.2 VDD (Except D7 to D0)

Read Cycle
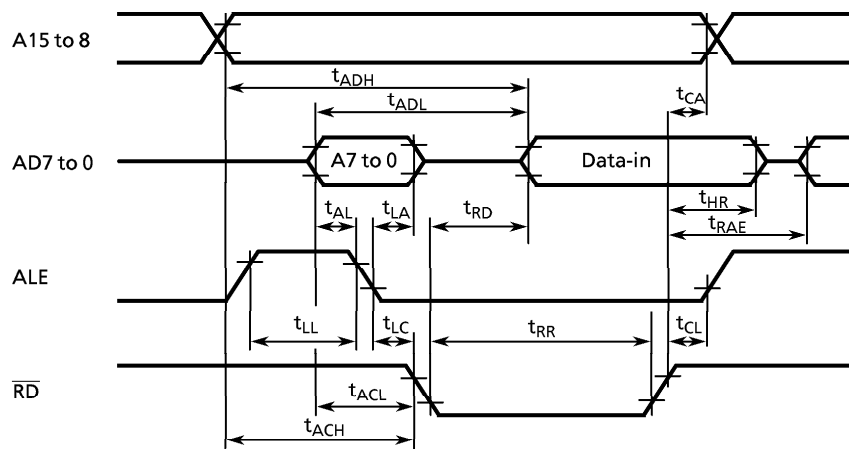
Write Cycle

DC Characteristics, AC Characteristics (PROM mode)   (V_{SS} = 0 V, Topr = 25 ± 5°C)

(1) Read operation in PROM mode

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
High level input voltage (TTL)	V_{IH4}		2.2	–	V_{CC}	V
Low leve input voltage (TTL)	V_{IL4}		0	–	0.8	V
Power supply	V_{CC}		4.75	5.0	5.25	V
Power supply of program	V_{PP}					
Address access time	t_{ACC}	V_{CC} = 5.0 ± 0.25 V	–	1.5 tcyc + 300	–	ns

Note: tcyc = 500 ns at 8 MHz
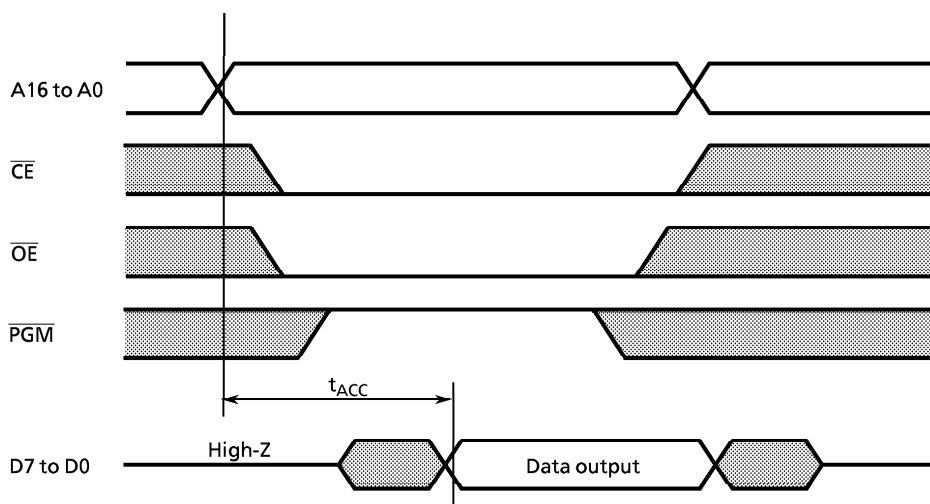
(2)   Program operation (High-speed)   (Topr = 25 ± 5°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
High level input voltage (TTL)	V_{IH4}		2.2	–	V_{CC}	V
Low leve input voltage (TTL)	V_{IL4}		0	–	0.8	V
Power supply	V_{CC}		6.0	6.25	6.5	V
Power supply of program	V_{PP}		12.5	12.75	13.0	V
Pulse width of initializing program	t_{PW}	$V_{CC} = 6.0$ V	0.095	0.1	0.105	ms

High-speed program writing
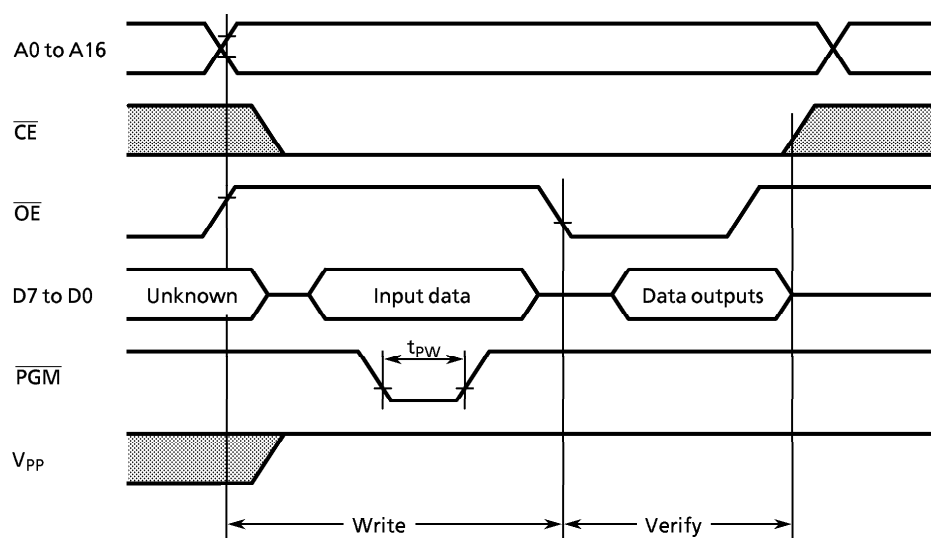
Note 1:   The power supply of V_{PP} (12.75 V) must be set power-on at the same time or the later time for a power supply of V_{CC} and must be clear power-on at the same time or early time for a power supply of V_{CC}.

Note 2:   The pulling up/down device on the condition of $V_{PP} = 12.75$ V ± 0.25 V causes a damage for the device. Do not pull up/down at programming.

Note 3:   Use the recommended adapter (see 1.2.2 (1)) and mode (see 1.2.2 (3) i).
Using other than the above condition may cause the trouble of the writting.

Recommended Oscillating Conditions - 1   ($V_{SS} = 0$ 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	CSA16.00MXZ040	10 pF	10 pF
		8 MHz	MURATA	CSA8.00MTZ	30 pF	30 pF
				CST8.00MTW	30 pF (built-in)	30 pF (built-in)
		4.19 MHz	MURATA	CSA4.19MG	30 pF	30 pF
				CST4.19MGW	30 pF (built-in)	30 pF (built-in)
Low-frequency Oscillation	Crystal Oscillator	32.768 kHz	SII	VT-200	6 pF	6 pF

Recommended Oscillating Conditions - 2   ($V_{SS} = 0$ V, $V_{DD} = 2.7$ 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	8 MHz	MURATA	CSA8.00MTZ	30 pF	30 pF
				CST8.00MTW	30 pF (built-in)	30 pF (built-in)
		4.19 MHz	MURATA	CSA4.19MG	30 pF	30 pF
				CST4.19MGW	30 pF (built-in)	30 pF (built-in)

Recommended Oscillating Conditions - 3   ($V_{SS} = 0$ V, $V_{DD} = 1.8$ 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	4.19 MHz	MURATA	CSA4.19MG	30 pF	30 pF
				CST4.19MGW	30 pF (built-in)	30 pF (built-in)
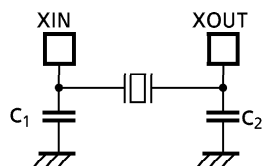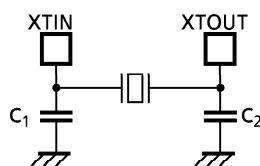
(1) High-frequency Oscillation   (2) Low-frequency Oscillation

Note 1: An electrical shield by metal shield plate on the surface of IC package is recommended in order to protect the device from the high electric field stress applied from CRT (Cathodic Ray Tube) for continuous reliable operation.

Note 2: The product numbers and specifications of the resonators by Murata Manufacturing Co., Ltd. are subject to change. For up-to-date information, please refer to the following URL;

http://www.murata.co.jp/search/index.html