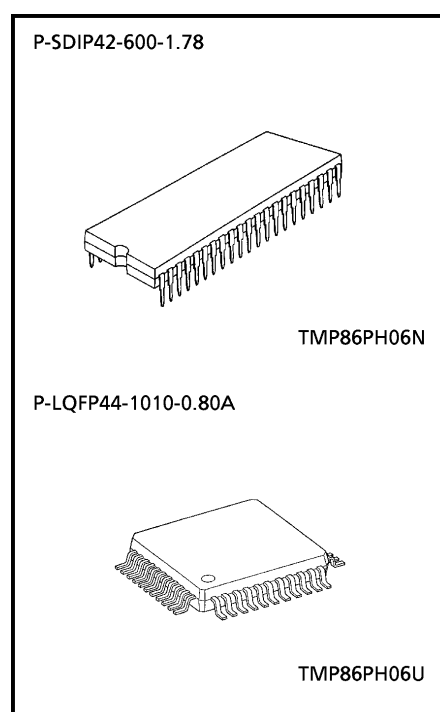


CMOS 8-Bit Microcontroller

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	BM111155
TMP86PH06U	16 K × 8 bit	512 × 8 bit	P-LQFP44-1010-0.80A	BM111156

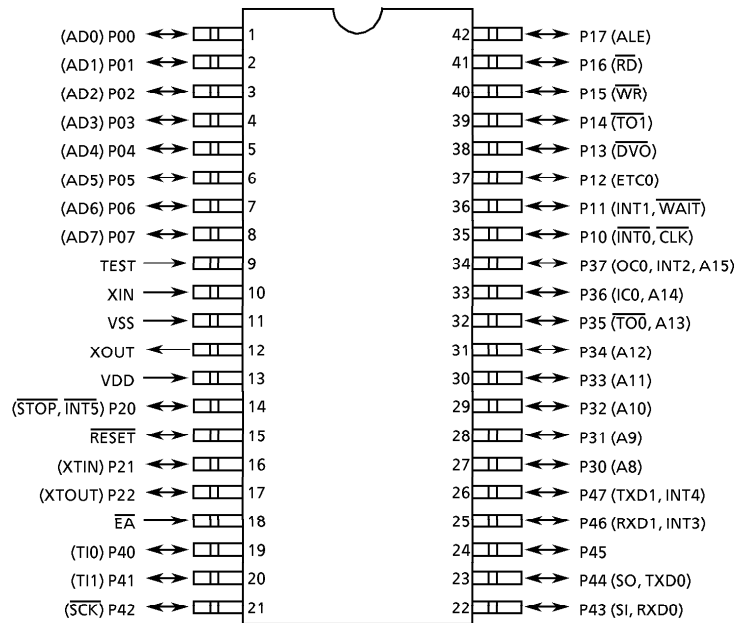


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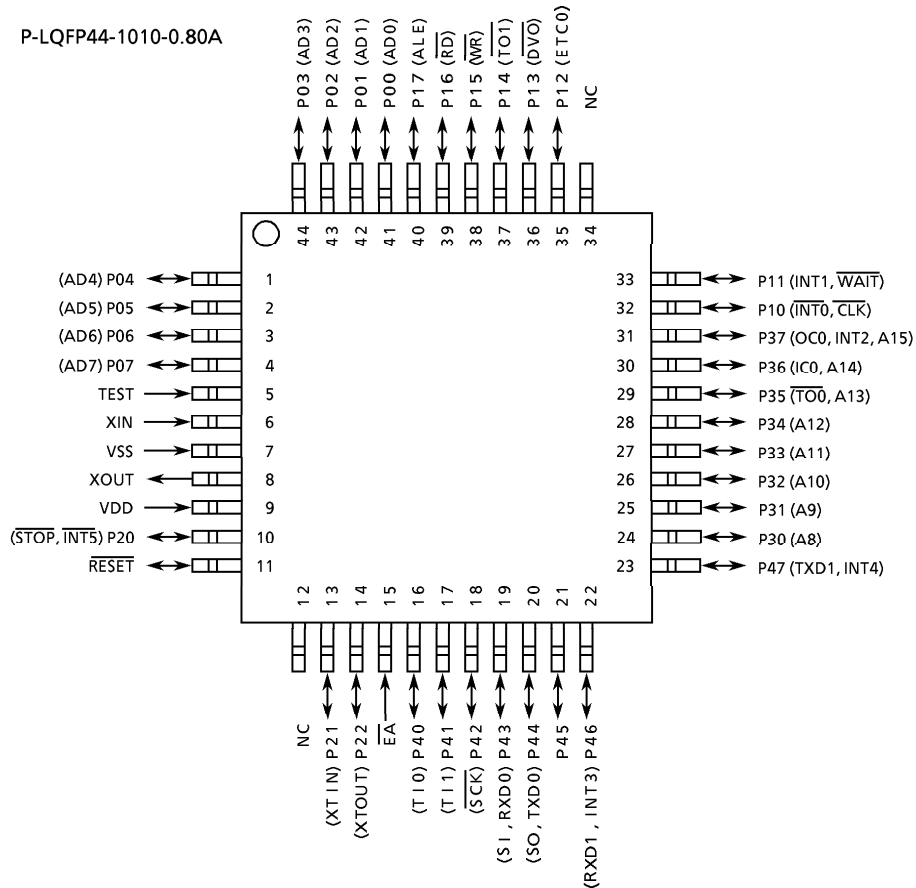
- For a discussion of how the reliability of microcontrollers can be predicted, please refer to Section 1.3 of the chapter entitled Quality and Reliability Assurance / Handling Precautions.
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- The products described in this document are subject to the foreign exchange and foreign trade laws.
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- The information contained herein is subject to change without notice.

Pin Assignments (Top View)

P-SDIP42-600-1.78



P-LQFP44-1010-0.80A



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

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 resistor).

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.

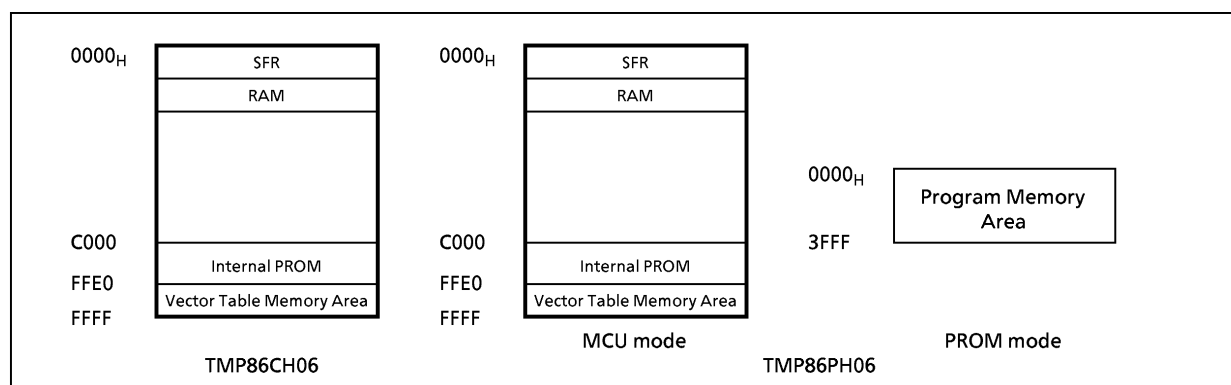


Figure 1-1. Program Memory Area

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

Electrical Characteristics

Absolute Maximum Rating

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

Parameter	Symbol	Pins	Rating	Unit
Supply Voltage	V_{DD}		- 0.3 to 6.5	V
Programing Voltage	V_{PP}	TEST/ V_{PP}	- 0.3 to 13.0	
Input Voltage	V_{IN}		- 0.3 to $V_{DD} + 0.3$	
Output Voltage	V_{OUT}		- 0.3 to $V_{DD} + 0.3$	
Output Current	I_{OUT1}	P1 to P4	3.2	mA
	I_{OUT3}	P0	30	
Output Current	ΣI_{OUT1}		80	
	ΣI_{OUT3}		120	
Power Dissipation ($T_{opr} = 85^{\circ}\text{C}$)	PD	TMP86PH06N	600	mW
		TMP86PH06U	350	
Soldering Temperature (Time)	T_{sld}		260 (10 s)	$^{\circ}\text{C}$
Storage Temperature	T_{stg}		- 55 to 125	
Operating Temperature	T_{opr}		- 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 V, Topr = - 40 to 85°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit	
Supply Voltage	V _{DD}		f _c = 16 MHz	NORMAL1, 2 mode	4.5	5.5	V
				IDLE0, 1, 2 mode			
			f _c = 8 MHz	NORMAL1, 2 mode	2.7		
				IDLE0, 1, 2 mode			
			f _c = 4.2 MHz	NORMAL1, 2 mode	1.8		
				IDLE0, 1, 2 mode			
f _s = 32.768 kHz	SLOW1, 2 mode	1.8					
	SLEEP0, 1, 2 mode						
	STOP mode	1.8					
Input High Voltage	V _{IH1}	Except hysteresis and TTL input	V _{DD} ≥ 4.5 V	V _{DD} × 0.70	V _{DD}	V	
	V _{IH2}	Hysteresis input		V _{DD} × 0.75			
	V _{IH3}	Except TTL input	V _{DD} < 4.5 V	V _{DD} × 0.90			
	V _{IH4}	TTL input (Data bus)	V _{DD} = 5 V	2.2			
	V _{IH5}		V _{DD} = 1.8 V	V _{DD} - 0.2			
Input Low Voltage	V _{IL1}	Except hysteresis and TTL input	V _{DD} ≥ 4.5 V	0	V _{DD} × 0.30	V	
	V _{IL2}	Hysteresis input			V _{DD} × 0.25		
	V _{IL3}	Except TLL input	V _{DD} < 4.5 V		V _{DD} × 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	f _c	XIN, XOUT	V _{DD} = 4.5 V to 5.5 V	1.0	16	MHz	
			V _{DD} = 2.7 V to 5.5 V		8		
			V _{DD} = 1.8 V to 5.5 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; The condition of supply voltage range is the value under NORMAL1/2 and IDLE0/1/2 mode.

Note 3: The minimum f_c with clock gear is calculated as following formula with the ratio on divider n.

$$(\text{Min } f_c) = (\text{ratio on divider } n) \times 1 \text{ [MHz]}$$

DC Characteristics

 $(V_{SS} = 0\text{ V}, T_{opr} = -40\text{ to }85^{\circ}\text{C})$

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

Note 1: Typical values are shown under $T_{opr} = 25^{\circ}\text{C}$, $V_{DD} = 5\text{ V}$, 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

 $(V_{SS} = 0\text{ V}, V_{DD} = 4.5\text{ to }5.5\text{ V}, T_{opr} = -40\text{ to }85^{\circ}\text{C})$

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)	25	–	–	ns
Low Level Clock Pulse Width	t_{WCL}	$f_c = 16\text{ MHz}$				
High Level Clock Pulse Width	t_{WSH}	External clock operation (XTIN input)	14.7	–	–	μs
Low Level Clock Pulse Width	t_{WSL}	$f_s = 32.768\text{ kHz}$				

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 \rightarrow ALE	$0.5t - 15$		16		ns
2	t_{LA}	ALE fall \rightarrow A7 to 0 hold	$0.5t - 20$		11		ns
3	t_{LL}	ALE pulse width	$t - 40$		22		ns
4	t_{LC}	ALE fall \rightarrow \overline{RD} , \overline{WR} fall	$0.5t - 25$		6		ns
5	t_{CL}	\overline{RD} , \overline{WR} rise \rightarrow ALE rise	$0.5t - 20$		11		ns
6	t_{ACL}	A7 to 0 effective \rightarrow \overline{RD} , \overline{WR} fall	$t - 25$		37		ns
7	t_{ACH}	A15 to 8 effective \rightarrow \overline{RD} , \overline{WR} fall	$1.5t - 25$		68		ns
8	t_{CA}	\overline{RD} , \overline{WR} rise \rightarrow A15 to 8 hold	$0.5t - 20$		11		ns
9	t_{ADL}	A7 to 0 effective \rightarrow D7 to 0 input		$3t - 55$		132	ns
10	t_{ADH}	A15 to 8 effective \rightarrow D7 to 0 input		$3.5t - 65$		153	ns
11	t_{RD}	\overline{RD} fall \rightarrow 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 \rightarrow D7 to 0 hold	0		0		ns
14	t_{RAE}	\overline{RD} rise \rightarrow A7 to 0 effective	$t - 15$		47		ns
15	t_{WV}	\overline{WR} pulse width	$2t - 40$		85		ns
16	t_{DW}	D7 to 0 effective \rightarrow \overline{WR} rise	$2t - 40$		85		ns
17	t_{WD}	\overline{WR} rise \rightarrow D7 to 0 hold	$0.5t - 15$		16		ns

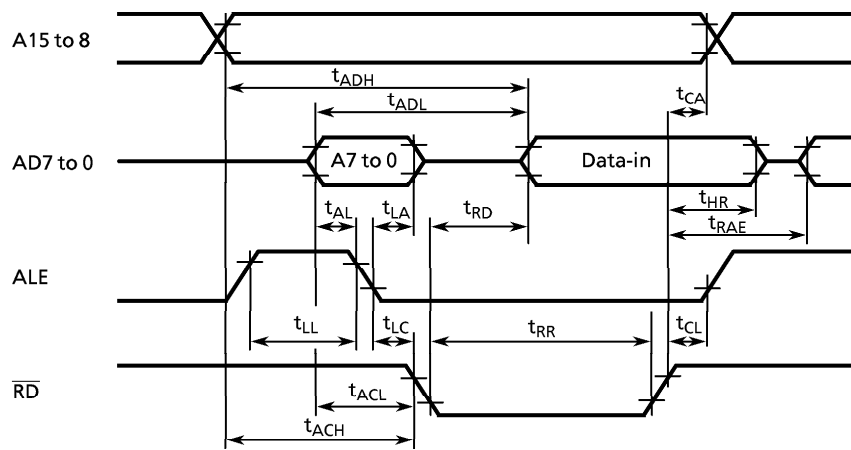
Note: $t = t_{cy}/4$ ($t = 62.5$ ns at $f_{cgck} = 16$ MHz)

A.C. Measurement Condition

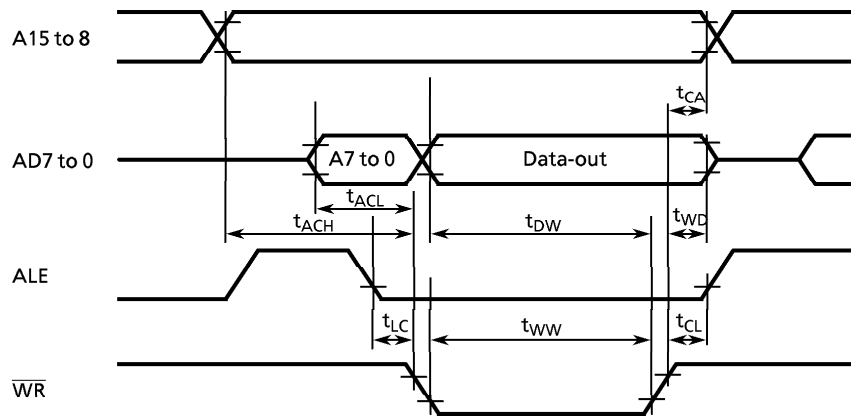
Output Level: High 2.2 V/Low 0.8 V, $CL = 50$ pF

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

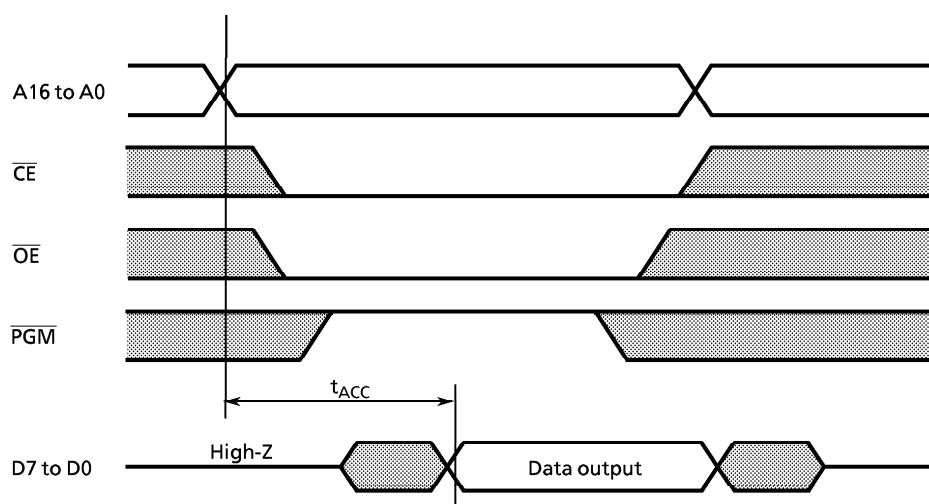


DC Characteristics, AC Characteristics (PROM mode) ($V_{SS} = 0\text{ V}$, $T_{opr} = 25 \pm 5^\circ\text{C}$)

(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 level 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}	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5\ t_{cyc} + 300$	–	ns

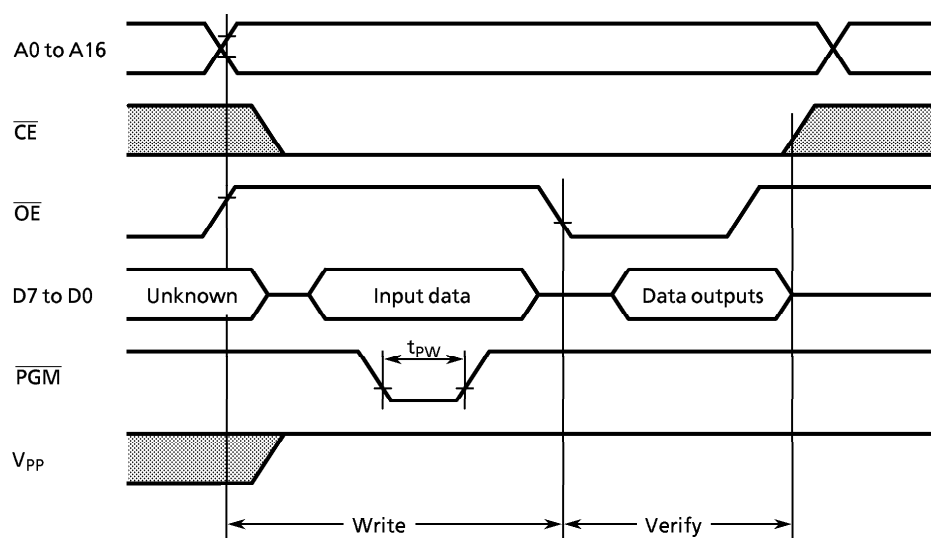
Note: $t_{cyc} = 500\text{ ns}$ at 8 MHz



(2) Program operation (High-speed) ($T_{opr} = 25 \pm 5^{\circ}\text{C}$)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
High level input voltage (TTL)	V_{IH4}		2.2	–	V_{CC}	V
Low level 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}	$V_{CC} = 6.0\text{ V}$	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 $V_{PP} = 12.75\text{ V} \pm 0.25\text{ V}$ 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 writing.

Recommended Oscillating Conditions - 1

 $(V_{SS} = 0\text{ V}, V_{DD} = 4.5\text{ to }5.5\text{ V}, T_{opr} = -40\text{ to }85^{\circ}\text{C})$

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

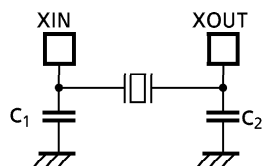
 $(V_{SS} = 0\text{ V}, V_{DD} = 2.7\text{ to }5.5\text{ V}, T_{opr} = -40\text{ to }85^{\circ}\text{C})$

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)	

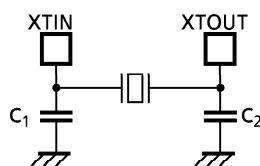
Recommended Oscillating Conditions - 3

 $(V_{SS} = 0\text{ V}, V_{DD} = 1.8\text{ to }5.5\text{ V}, T_{opr} = -40\text{ to }85^{\circ}\text{C})$

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>

