

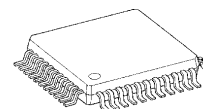
CMOS 8-Bit Microcontroller

TMP86PM47AUG

The TMP86PM47A is a OTP type MCU which includes 32 Kbyte One-time PROM. It is a pin compatible with a mask ROM product of the TMP86C845/847/H47/M47. Writing the program to built-in PROM, the TMP86PM47A operates as the same way as the TMP86C847/H47/M47. About elaboration, please refer to later "Difference between TMP86C845 and TMP86Cx47". Using the Adapter socket, you can write and verify the data for the TMP86PM47A with a general-purpose PROM programmer same as TC57100D/AD.

Product No.	OTP	RAM	Package	Adapter Socket
TMP86PM47AUG	32 K × 8 bits	1 K × 8 bits	P-LQFP44-1010-0.80A	BM11687

P-LQFP44-1010-0.80A



TMP86PM47AUG

030519EBP1

- The information contained herein is subject to change without notice.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA CORPORATION for any infringements of intellectual property or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any intellectual property or other rights of TOSHIBA CORPORATION or others.
- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the "Handling Guide for Semiconductor Devices," or "TOSHIBA Semiconductor Reliability Handbook" etc..
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.). These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in this document shall be made at the customer's own risk.
- The products described in this document are subject to the foreign exchange and foreign trade laws.
- TOSHIBA products should not be embedded to the downstream products which are prohibited to be produced and sold, under any law and regulations.
- 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.

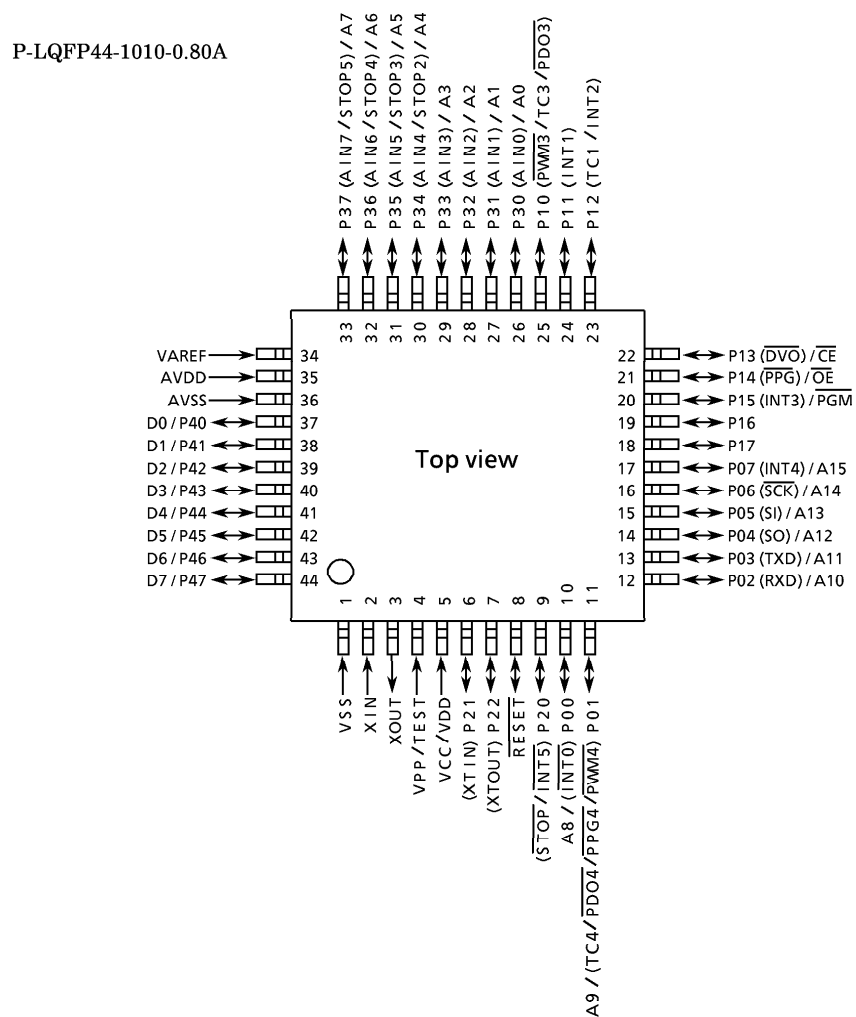
Difference Between TMP86C845 and TMP86Cx47

		TMP86Cx47U			TMP86C845U
		TMP86C847U	TMP86CH47U	TMP86CM47U	
ROM (Byte)		8K	16K	32K	8K
RAM (Byte)		512	512	1K	256
I/O		35			35
Package (Body size)		QFP44 (10 × 10 mm)			QFP44 (10 × 10 mm)
Min instruction		0.25 μ s (at 16 MHz)			0.5 μ s (at 8 MHz)
Supply voltage		1.8 to 5.5 V at 4.2 MHz/32.768 kHz 2.7 to 5.5 V at 8.0 MHz/32.768 kHz 4.5 to 5.5 V at 16 MHz/32.768 kHz			2.7 to 5.5 V at 8.0 MHz/32.768 kHz
16-bit timer/counter		1 ch			–
8-bit timer/counter		2 ch			2 ch
Time base timer		1 ch			1 ch
Watchdog timer		1 ch			1 ch
AD converter		8 ch			8 ch
Serial I/O		Clocked synchronous: 1 ch, UART: 1 ch			Clocked synchronous: 1 ch
Key on wake up		4 ch			–
Warm-up counter		6			4
I/O circuitry	Hysteresis input	P0, P1, P2 port			Port2, P00, P05, P06, P07, P10, P11, P12, P15 pin
	CMOS input	P3, P4 port			Port3, Port4, P01, P02, P03, P04, P13, P14, P16, P17 pin
	RESET	Watchdog timer, Address trap, System clock reset output			Input only
Operation temp.		– 40 to 85 °C			– 40 to 85 °C

 are difference points between TMP86C845 and TMP86Cx47.

Please refer to “Input/Output Circuitry” of TMP86C847/H47/M47 and TMP86C845 for details.

Pin Assignments (Top view)



Pin Function

The TMP86PM47A has MCU mode and PROM mode.

(1) MCU mode

In the MCU mode, the TMP86PM47A is a pin compatible with the TMP86C845/847/H47/M47 (Make sure to fix the TEST pin to low level).

(2) PROM mode

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

Note: No pin is applied to A16 input.

Operation

This section describes the functions and basic operational blocks of TMP86PM47A.

The TMP86PM47A has PROM in place of the mask ROM which is included in the TMP86C845/847/H47/M47. The configuration and function are the same as the TMP86C847/H47/M47. For TMP86C845, however, some functions have been partially changed or deleted. For the functions of TMP86PM47A in details, see the section of TMP86C845/847/H47/M47.

1. Operating Mode

The TMP86PM47A 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 TMP86C845/847/H47/M47 (TEST/VPP pin cannot be used open because it has no built-in pull-down resistor).

1.1.1 Program memory

The TMP86PM47A has a 32-Kbyte built-in one time PROM (addresses 8000 to FFFF_H in the MCU mode, addresses 0000 to 7FFF_H in the PROM mode).

When using TMP86PM47A for evaluation of TMP86C845/847/H47/M47, the program is written in the program storing area shown in Figure 1-1.

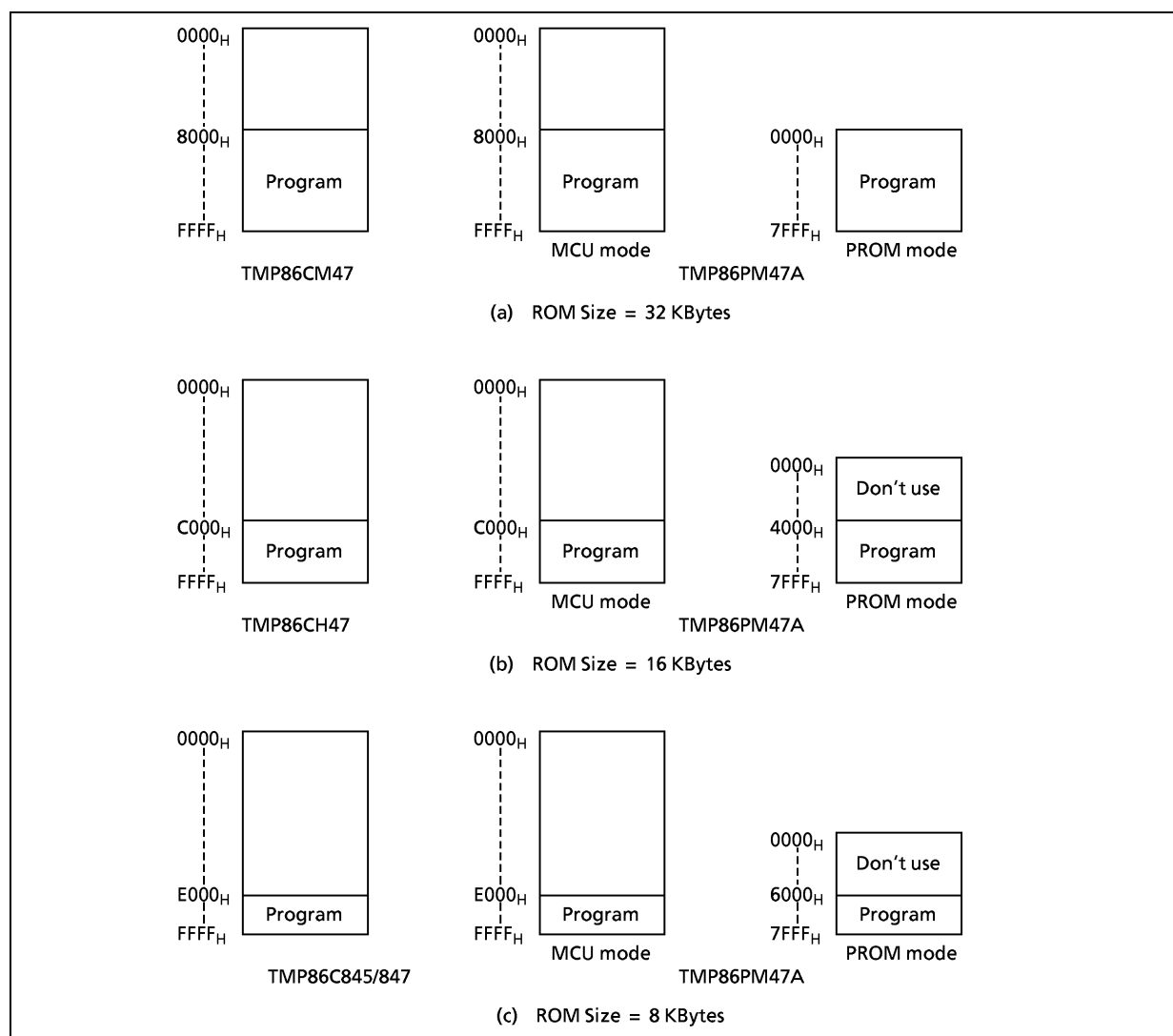


Figure 1-1. Program Memory Area

Note: The area that is not in use should be set data to FFH, or a general-purpose PROM programmer should be set only in the program memory area to access.

Electrical Characteristics

Absolute Maximum Ratings

(V_{SS} = 0 V)

Parameter	Symbol	Pins	Rating	Unit
Supply voltage	V _{DD}		– 0.3 to 6.5	V
Program 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 _{OUT1}	P21, P22, RESET, Tri-state port	– 0.3 to V _{DD} + 0.3	
Output current (Per 1 pin)	I _{OUT1}	P1, P3, P4 port	– 1.8	mA
	I _{OUT2}	P1, P3 port	3.2	
	I _{OUT3}	P0, P2, P4 port	30	
Output current (Total)	ΣI _{OUT1}	P1, P3 port	60	
	ΣI _{OUT2}	P0, P2, P4 port	80	
Power dissipation [T _{opr} = 85°C]	PD		250	mW
Soldering temperature (time)	T _{sld}		260 (10 s)	°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 Condition	($V_{SS} = 0\text{ V}$, $T_{opr} = -40\text{ to }85^{\circ}\text{C}$)
---------------------------------	--

Parameter	Symbol	Pins	Condition		Min	Max	Unit
Supply voltage	V _{DD}		fc = 16 MHz	NORMAL1, 2 modes	4.5	5.5	V
				IDLE0, 1, 2 modes			
			fc = 8 MHz	NORMAL1, 2 modes	2.7		
				IDLE0, 1, 2 modes			
			fc = 4.2 MHz	NORMAL1, 2 modes	1.8		
				IDLE0, 1, 2 modes			
			fs = 32.768 kHz	SLOW1, 2 modes			
				SLEEP0, 1, 2 modes			
	STOP mode						
Input high level	V _{IH1}	Except hysteresis input	V _{DD} ≥ 4.5 V		V _{DD} × 0.70	V _{DD}	
	V _{IH2}	Hysteresis input			V _{DD} × 0.75		
	V _{IH3}		V _{DD} < 4.5 V	V _{DD} × 0.90			
Input low level	V _{IL1}	Except hysteresis input	V _{DD} ≥ 4.5 V		0	V _{DD} × 0.30	
	V _{IL2}	Hysteresis input				V _{DD} × 0.25	
	V _{IL3}		V _{DD} < 4.5 V	V _{DD} × 0.10			
Clock frequency	fc	XIN, XOUT	V _{DD} = 1.8 to 5.5 V		1.0	4.2	MHz
			V _{DD} = 2.7 to 5.5 V			8.0	
			V _{DD} = 4.5 to 5.5 V			16.0	
	fs	XTIN, XTOUT			30.0	34.0	kHz

Note: 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.

DC Characteristics

(V_{SS} = 0 V, T_{opr} = – 40 to 85°C)

Parameter	Symbol	Pins	Condition	Min	Typ.	Max	Unit
Hysteresis voltage	V _{HS}	Hysteresis input		–	0.9	–	V
Input current	I _{IN1}	TEST	V _{DD} = 5.5 V, V _{IN} = 5.5 V/0 V	–	–	± 2	μA
	I _{IN2}	Sink open drain, Tri-state					
	I _{IN3}	RESET, STOP					
Input resistance	R _{IN2}	RESET pull-up		100	220	450	kΩ
Output leakage current	I _{LO1}	Sink open drain	V _{DD} = 5.5 V, V _{OUT} = 5.5 V	–	–	2	μA
	I _{LO2}	Tri-state	V _{DD} = 5.5 V, V _{OUT} = 5.5 V/0 V	–	–	± 2	
Output high voltage	V _{OH1}	Tri-st port	V _{DD} = 4.5 V, I _{OH} = – 0.7 mA	4.1	–	–	V
Output low voltage	V _{OL}	Except XOUT and P0, P2, P4 port	V _{DD} = 4.5 V, I _{OL} = 1.6 mA	–	–	0.4	
Output low current	I _{OL}	High current port (P0, P2, P4 port)	V _{DD} = 4.5 V, V _{OL} = 1.0 V	–	20	–	mA
Supply current in NORMAL 1, 2 modes	V _{DD}		V _{DD} = 5.5 V V _{IN} = 5.3/0.2 V f _c = 16 MHz f _s = 32.768 kHz	–	7.5	9	
Supply current in IDLE 0, 1, 2 modes				–	5.5	6.5	
Supply current in SLOW 1 mode			V _{DD} = 3.0 V V _{IN} = 2.8 V/0.2 V f _s = 32.768 kHz	–	18	42	μA
Supply current in SLEEP 1 mode				–	16	25	
Supply current in SLEEP 0 mode				–	12	20	
Supply current in STOP mode			V _{DD} = 5.5 V V _{IN} = 5.3 V/0.2 V	–	0.5	10	

Note 1: Typical values show those at T_{opr} = 25°C, V_{DD} = 5 V

Note 2: Input current (I_{IN1}, I_{IN2}); The current through pull-up or pull-down resistor is not included.

Note 3: I_{DD} does not include I_{REF} current.

Note 4: The supply currents of SLOW 2 and SLEEP 2 modes are equivalent to IDLE 0, 1, 2.

AD Conversion Characteristics

(V_{SS} = 0.0 V, 4.5 V ≤ V_{DD} ≤ 5.5 V, Topr = –40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog reference voltage	V _{AREF}		A _{VDD} – 1.0	–	A _{VDD}	V
Power supply voltage of analog control circuit	A _{VDD}		V _{DD}			
	A _{VSS}		V _{SS}			
Analog reference voltage range (Note 4)	△V _{AREF}		3.5	–	–	
Analog input voltage	V _{AIN}		V _{SS}	–	V _{AREF}	
Power supply current of analog reference voltage	I _{REF}	V _{DD} = A _{VDD} = V _{AREF} = 5.5 V V _{SS} = A _{VSS} = 0.0 V	–	0.6	1.0	mA
Non linearity error			–	–	± 2	LSB
Zero point error		V _{DD} = A _{VDD} = 5.0 V	–	–	± 2	
Full scale error		V _{SS} = A _{VSS} = 0.0 V	–	–	± 2	
Total error		V _{AREF} = 5.0 V	–	–	± 2	

(V_{SS} = 0.0 V, 2.7 V ≤ V_{DD} < 4.5 V, Topr = –40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog reference voltage	V _{AREF}		A _{VDD} – 1.0	–	A _{VDD}	V
Power supply voltage of analog control circuit	A _{VDD}		V _{DD}			
	A _{VSS}		V _{SS}			
Analog reference voltage range (Note 4)	ΔV _{AREF}		2.5	–	–	
Analog input voltage	V _{AIN}		V _{SS}	–	V _{AREF}	
Power supply current of analog reference voltage	I _{REF}	V _{DD} = A _{VDD} = V _{AREF} = 4.5 V V _{SS} = A _{VSS} = 0.0 V	–	0.5	0.8	mA
Non linearity error			–	–	± 2	LSB
Zero point error		V _{DD} = A _{VDD} = 2.7 V	–	–	± 2	
Full scale error		V _{SS} = A _{VSS} = 0.0 V	–	–	± 2	
Total error		V _{AREF} = 2.7 V	–	–	± 2	

(V_{SS} = 0.0 V, 2.0 V ≤ V_{DD} < 2.7 V, Topr = –40 to 85°C) Note 5(V_{SS} = 0.0 V, 1.8 V ≤ V_{DD} < 2.0 V, Topr = –10 to 85°C) Note 5

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Analog reference voltage	V _{AREF}		A _{VDD} – 0.9	–	A _{VDD}	V
Power supply voltage of analog control circuit	A _{VDD}		V _{DD}			
	A _{VSS}		V _{SS}			
Analog reference voltage range (Note 4)	ΔV _{AREF}	1.8 V ≤ V _{DD} < 2.0 V	1.8	–	–	
		2.0 V ≤ V _{DD} < 2.7 V	2.0	–	–	
Analog input voltage	V _{AIN}		V _{SS}	–	V _{AREF}	
Power supply current of analog reference voltage	I _{REF}	V _{DD} = A _{VDD} = V _{AREF} = 2.7 V V _{SS} = A _{VSS} = 0.0 V	–	0.3	0.5	mA
Non linearity error		V _{DD} = A _{VDD} = 1.8 V V _{SS} = A _{VSS} = 0.0 V V _{AREF} = 1.8 V	–	–	± 4	LSB
Zero point error			–	–	± 4	
Full scale error			–	–	± 4	
Total error			–	–	± 4	

Note 1: The total error includes all errors except a quantization error, and is defined as a maximum deviation from the ideal conversion line.

Note 2: Conversion time is different in recommended value by power supply voltage.

Note 3: Please use input voltage to AIN input Pin in limit of V_{AREF} – V_{SS}.

When voltage of range outside is input, conversion value becomes unsettled and gives affect to other channel conversion value.

Note 4: Analog Reference Voltage Range: ΔV_{AREF} = V_{AREF} – A_{VSS}

Note 5: When AD is used with V_{DD} < 2.7 V, the guaranteed temperature range varies with the operating voltage.

Note 6: When AD converter is not used, fix the A_{VDD} pin on the V_{DD} level.

AC Characteristics

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

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine cycle time	tcy	NORMAL 1, 2 modes	0.25	–	4	μ s
		IDLE 0, 1, 2 modes				
		SLOW 1, 2 modes	117.6	–	133.3	
		SLEEP 0, 1, 2 modes				
High level clock pulse width	twcH	For external clock operation (XIN input) fc = 16 MHz	–	31.25	–	ns
Low level clock pulse width	twcL					
High level clock pulse width	twcH	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μ s
Low level clock pulse width	twcL					

(V_{SS} = 0 V, V_{DD} = 2.7 to 4.5 V, T_{opr} = – 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine cycle time	tcy	NORMAL 1, 2 modes	0.5	–	4	μ s
		IDLE 0, 1, 2 modes				
		SLOW 1, 2 modes	117.6	–	133.3	
		SLEEP 0, 1, 2 modes				
High level clock pulse width	twcH	For external clock operation (XIN input) fc = 8 MHz	–	62.5	–	ns
Low level clock pulse width	twcL					
High level clock pulse width	twcH	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μ s
Low level clock pulse width	twcL					

(V_{SS} = 0 V, V_{DD} = 1.8 to 2.7 V, T_{opr} = – 40 to 85°C)

Parameter	Symbol	Condition	Min	Typ.	Max	Unit
Machine cycle time	tcy	NORMAL 1, 2 modes	0.95	–	4	μ s
		IDLE 0, 1, 2 modes				
		SLOW 1, 2 modes	117.6	–	133.3	
		SLEEP 0, 1, 2 modes				
High level clock pulse width	twcH	For external clock operation (XIN input) fc = 4.2 MHz	–	119.05	–	ns
Low level clock pulse width	twcL					
High level clock pulse width	twcH	For external clock operation (XTIN input) fc = 32.768 kHz	–	15.26	–	μ s
Low level clock pulse width	twcL					

Recommended Oscillating Conditions - 1

(V_{SS} = 0 V, V_{DD} = 4.5 to 5.5 V, T_{opr} = – 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 CST8.00MTW	30 pF 30 pF (built-in)	30 pF 30 pF (built-in)
		4.19 MHz	MURATA CSA4.19MG CST4.19MGW	30 pF 30 pF (built-in)	30 pF 30 pF (built-in)
Low-frequency oscillation	Crystal oscillator	32.768 kHz	SII VT-200	6 pF	6 pF

Recommended Oscillating Conditions - 2

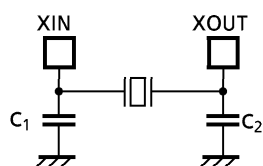
(V_{SS} = 0 V, V_{DD} = 2.7 to 5.5 V, T_{opr} = – 40 to 85°C)

PARAMETER	Oscillator	Oscillation Frequency	Recommended Oscillator	Recommended Constant	
				C ₁	C ₂
High-frequency oscillation	Ceramic resonator	8 MHz	MURATA CSA8.00MTZ CST8.00MTW	30 pF 30 pF (built-in)	30 pF 30 pF (built-in)
		4.19 MHz	MURATA CSA4.19MG CST4.19MGW	30 pF 30 pF (built-in)	30 pF 30 pF (built-in)

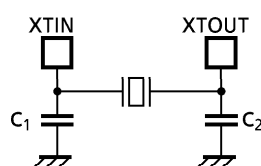
Recommended Oscillating Conditions - 3

(V_{SS} = 0 V, V_{DD} = 1.8 to 5.5 V, T_{opr} = – 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 CST4.19MGW	30 pF 30 pF (built-in)	30 pF 30 pF (built-in)



(1) High-frequency Oscillation



(2) Low-frequency Oscillation

Note 1: Use of a quartz oscillator for high-frequency oscillation is allowed only when V_{DD} is 2.7 V or higher. When V_{DD} is lower than 2.7 V, use a ceramic resonator.

Note 2: When using the device (Oscillator) in places exposed to high electric fields such as cathode-ray tubes, we recommend electrically shielding the package in order to maintain normal operating condition.

Note 3: To ensure stable oscillation, the resonator position, load capacitance, etc. must be appropriate. Because these factors are greatly affected by board patterns, please be sure to evaluate operation on the board on which the device will actually be mounted.

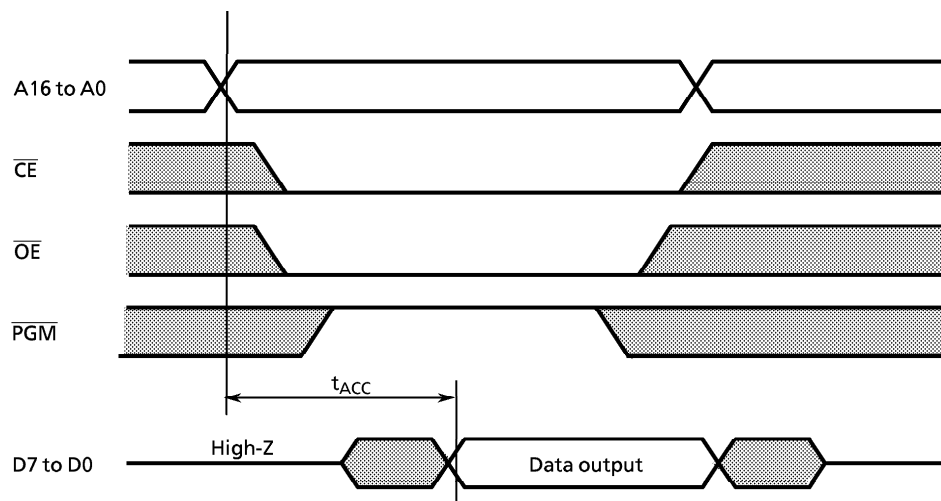
Note 4: The product numbers and specifications of the resonators by Murata Manufacturing Co., Ltd. are subject to change. For up-to-date information, please refer to the following URL;
<http://www.murata.co.jp/search/index.html>

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

(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	
Power supply	V_{CC}		4.75	5.0	5.25	
Power supply of program	V_{PP}					
Address access time	t_{ACC}	$V_{CC} = 5.0 \pm 0.25\text{ V}$	–	$1.5t_{cyc} + 300$	–	ns

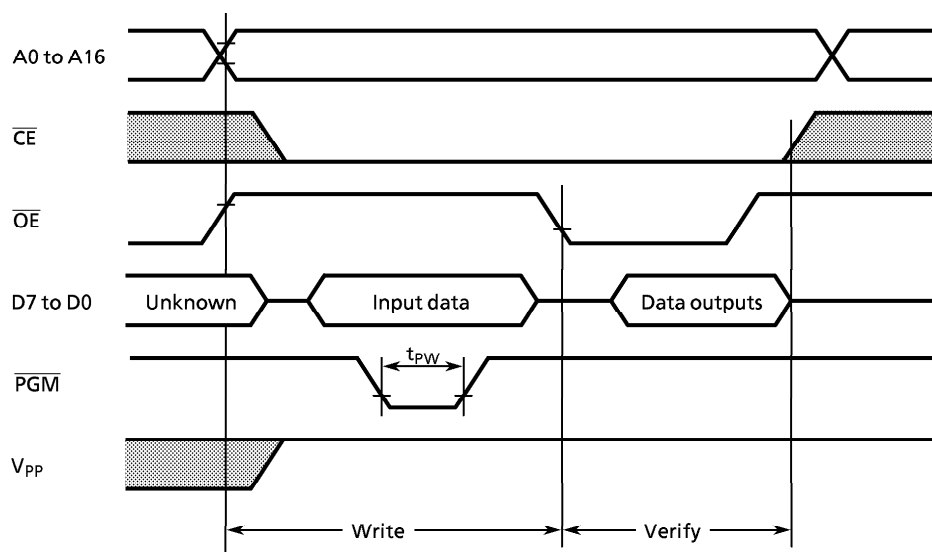
Note: $t_{cyc} = 500\text{ ns}$ at 8 MHz



(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 level input voltage (TTL)	V_{IL4}		0	–	0.8	
Power supply	V_{CC}		6.0	6.25	6.5	
Power supply of program	V_{PP}		12.5	12.75	13.0	
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} .

Note2 : The pull-up/pull-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/pull-down at programming.

Note3 : 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.