

## CMOS 4-Bit Microcontroller

**TMP47C101P, TMP47C201P  
TMP47C101M, TMP47C201M**

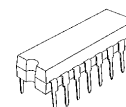
The TMP47C101/201 are high speed and high performance 4-bit single chip microcomputers, integrating ROM, RAM, input / output ports and timer/counters on a chip. The TMP47C101/201 are the standard LSI in the TLCS-47E series. In addition, they have the output port with LED direct drive capability.

Part No.	ROM	RAM	Package	OTP
TMP47C101P	1024 × 8-bit	64 × 4-bit	P-DIP16-300-2.54A	TMP47P201VP
TMP47C101M			P-SOP16-300-1.27	—
TMP47C201P	2048 × 8-bit	128 × 4-bit	P-DIP16-300-2.54A	TMP47P201VP
TMP47C201M			P-SOP16-300-1.27	—

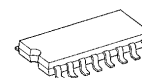
**Features**

- ◆ 4-bit single chip microcomputer
- ◆ Instruction execution time: 1.3  $\mu$ s (at 6 MHz)
- ◆ Low voltage operation: 2.2 V (at 2 MHz RC)
- ◆ 89 basic instructions
  - ROM table look-up instructions
- ◆ Subroutine nesting: 15 levels max
- ◆ 5 interrupt sources (External: 2, Internal: 3)
  - All sources have independent latches each, and multiple interrupt control is available.
- ◆ I/O port (11 pins)
- ◆ 12-bit Timer / Counters (TC2)
  - Timer, event counter, and pulse width measurement mode
- ◆ 12-bit programmable Timer (TC1)
- ◆ Interval Timer
- ◆ High current outputs
  - LED direct drive capability: typ. 20 mA × 4 bits (Port R4)
- ◆ Hold function
  - Battery / Capacitor back-up
- ◆ Real Time Emulator: BM4721A + BM1160 (for DIP)

P-DIP16-300-2.54A

TMP47C101P  
TMP47C201P  
TMP47P201VP

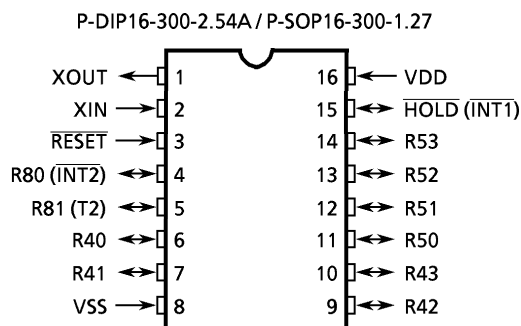
P-SOP16-300-1.27

TMP47C101M  
TMP47C201M

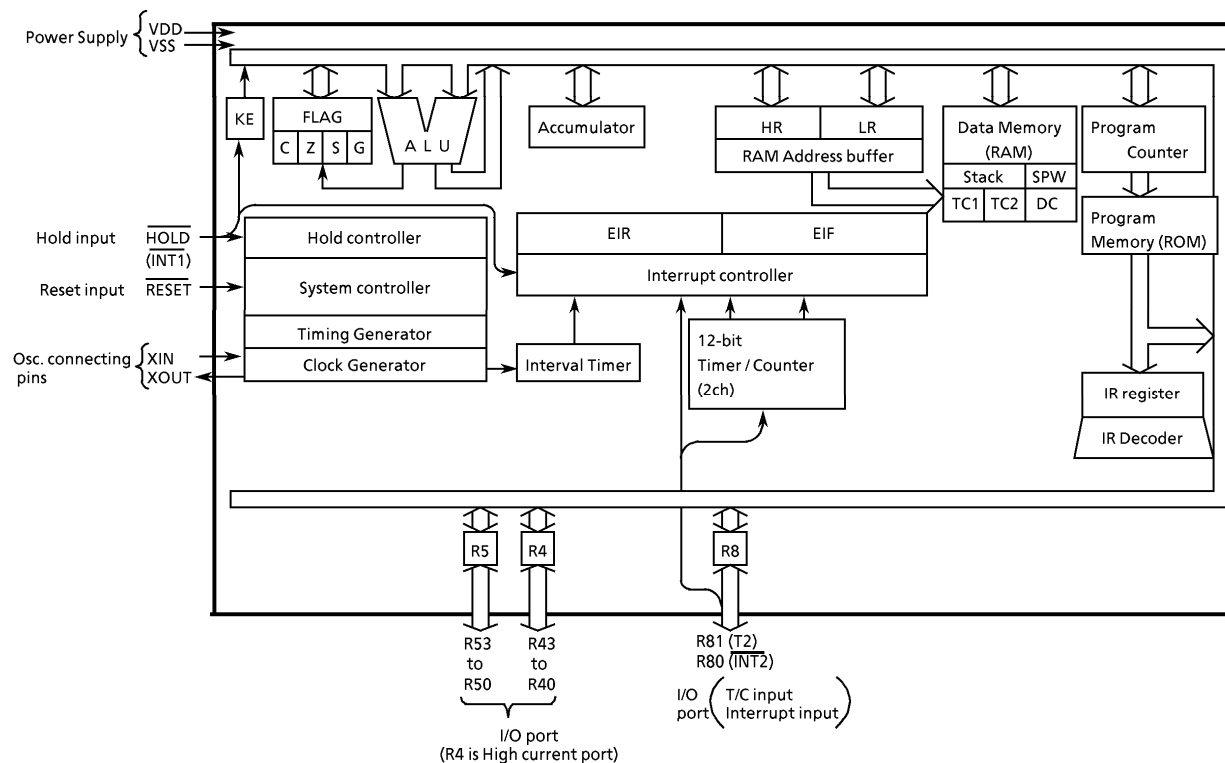
000707EBA1

- 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.
- 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.
- 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.
- The information contained herein is subject to change without notice.

## Pin Assignment (Top View)



## Block Diagram



## Pin Function

Pin Name	Input / Output	Functions	
R43 to R40	I/O	4-bit I/O port with latch. When used as input port, the latch must be set to "1". Every bit data is possible to be set, cleared and tested by the bit manipulation instruction of the L-register indirect addressing.	
R53 to R50			
R81 (T2)	I/O(Input)	2-bit I/O port with latch. When used as input port, external interrupt input pin, or timer / counter external input pin, the latch must be set to "1".	Timer / Counter 2 external input
R80 (INT2)			External interrupt 2 input
XIN	Input	Resonator connecting pins. For inputting external clock, XIN is used and XOUT is opened.	
XOUT	Output		
RESET	Input	Reset signal input	
HOLD (INT1)	I/O (Input)	Hold request / release signal input	External interrupt 1 input and R82 I/O
VDD	Power Supply	+ 5 V	
VSS		0 V (GND)	

**Operational Description**

Concerning the TMP47C101/201, the configuration and functions of hardwares are described. The basic instructions of configuration in the TMP47C101/201 is the same as those of TLCS-47 series.

**1. System Configuration**

- ◆ Internal CPU Function
  - 2.1 Program Counter (PC)
  - 2.2 Program Memory (ROM)
  - 2.3 H Register, L Register
  - 2.4 Data Memory (RAM)
    - Stack
    - Stack Pointer Word (SPW)
    - Data Counter (DC)
  - 2.5 ALU, Accumulator
  - 2.6 Flags
  - 2.7 System Controller
  - 2.8 Interrupt Controller
  - 2.9 Reset Circuit
- ◆ Peripheral Hardware Function
  - 3.1 I/O Ports
  - 3.2 Interval Timer
  - 3.3 Timer / Counters (TC1, TC2)

## 2. Internal CPU Function

### 2.1 Program Counter (PC)

The program counter is a 11-bit binary counter which indicates the address of the program memory storing the next instruction to be executed. Normally, the PC is incremented by the number of bytes of the instruction every time it is fetched. When a branch instruction or a subroutine instruction has been executed or an interrupt has been accepted, the specified values listed in Table 2-1 are set to the PC. The PC is initialized to "0" during reset.

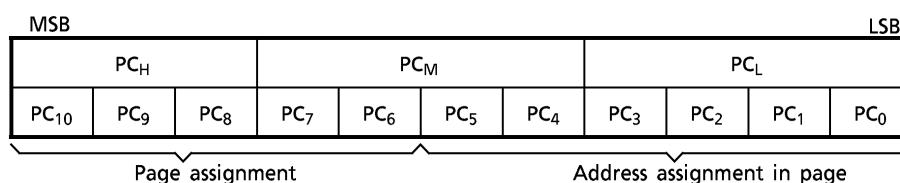


Figure 2-1. Configuration of Program Counter

The PC can directly address a 2048-byte address space. However, with the short branch, the following points must be considered:

- Short branch instruction [BSS a]

In [BSS a] instruction execution, when the branch condition is satisfied, the value specified in the instruction is set to the lower 6 bits of the PC. That is, [BSS a] becomes the in-page branch instruction. When [BSS a] is stored at the last address of the page, the upper 5 bits of the PC point the next page, so that branch is made to the next page.

Table 2-1. Status Change of Program Counter

Instruction or Operation		Condition	Program Counter (PC)											
			PC <sub>10</sub>	PC <sub>9</sub>	PC <sub>8</sub>	PC <sub>7</sub>	PC <sub>6</sub>	PC <sub>5</sub>	PC <sub>4</sub>	PC <sub>3</sub>	PC <sub>2</sub>	PC <sub>1</sub>	PC <sub>0</sub>	
Execution of Instruction	BS    a	SF = 1 (Branch condition is satisfied)		Immediate data specified by the instruction										
		SF = 0 (Branch condition is not satisfied)		+ 2										
	BSS   a	SF = 1	Lower 6-bit address ≠ 111111	Hold				Immediate data specified by the instruction						
			Lower 6-bit address = 111111 (last address in page)	+ 1				Immediate data specified by the instruction						
		SF = 0		+ 1										
	CALL   a			Immediate data specified by the instruction										
	CALLS a			0	0	0	The data generated by the immediate data specified by the instruction					1	1	0
	RET			The return address restored from stack										
	RETI			The return address restored from stack										
	Others			Incremented by the number of bytes in the instruction										
Interrupt acceptance				0	0	0	0	0	0	0	Interrupt vector			0
Reset				0	0	0	0	0	0	0	0	0	0	0

## 2.2 Program Memory (ROM)

Programs and fixed data are stored in the program memory. The instruction to be executed next is read from the address indicated by the contents of the PC.

The fixed data can be read by using the table look-up instructions.

- Table look-up instructions

[LDL A, @DC], [LDH A, @DC +]

The table look-up instructions read the lower and upper 4 bits of the fixed data stored at the address specified in the data counter (DC) to place them into the accumulator. [LDL A, @DC] instruction reads the lower 4 bits of fixed data, and [LDH A, @DC +] instruction reads the upper 4 bits.

The DC is a 12-bit register, allowing it to address the entire program memory space.

In this case, the upper bit of the DC (MSB) is ignored.  
(not effective valid)

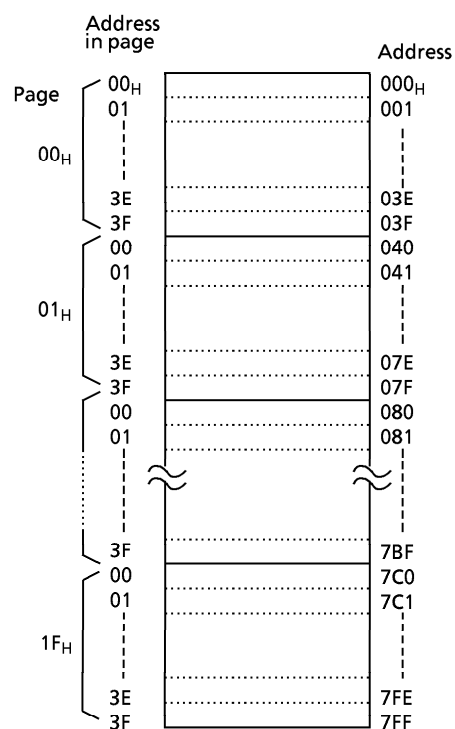


Figure 2-2. Configuration of Program Memory

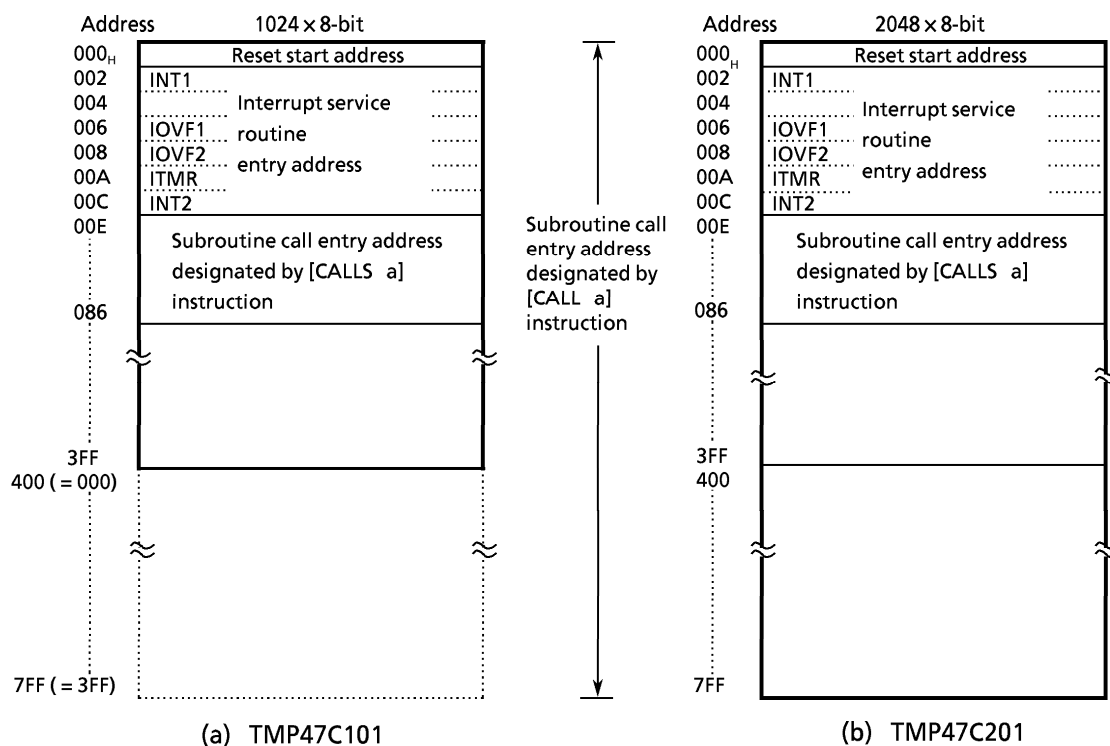
### 2.2.1 Program Memory Capacity

The TMP47C101 has 1024 × 8 bits (addresses 000<sub>H</sub> through 3FF<sub>H</sub>) of program memory (mask ROM), the TMP47C201 has 2048 × 8 bits (addresses 000<sub>H</sub> through 7FF<sub>H</sub>).

Figure 2-3 shows the program memory map. Address 000<sub>H</sub> - 086<sub>H</sub> of the program memory are also used for special purposes.

## 2.2.2 Program Memory Map

On the TMP47C101, no physical program memory exists in the address range 400<sub>H</sub> through 7FF<sub>H</sub>. However, if this space is accessed by program, the most significant bit of each address is always regarded as "0" and the contents of the program memory corresponding to the address 000<sub>H</sub> through 3FF<sub>H</sub> are read.



*Note: Address 004<sub>H</sub> and 005<sub>H</sub> can be used to store ordinary user's processing data.*

Figure 2-3. Program Memory Map

## Electrical Characteristics

## Absolute Maximum Ratings

(V<sub>SS</sub> = 0 V)

Parameter	Symbol	Pins	Ratings	Unit
Supply Voltage	V <sub>DD</sub>		– 0.3 to 6.5	V
Input Voltage	V <sub>IN</sub>		– 0.3 to V <sub>DD</sub> + 0.3	V
Output Voltage	V <sub>OUT</sub>		– 0.3 to V <sub>DD</sub> + 0.3	V
Output Current (Per 1 pin)	I <sub>OUT1</sub>	Port R4	30	mA
	I <sub>OUT2</sub>	Ports R5, R8, $\overline{\text{HOLD}}$	3.2	
Output Current (Total)	$\Sigma I_{\text{OUT}}$	Port R4	60	mA
Power Dissipation [T <sub>opr</sub> = 70°C]	PD	DIP	300	mW
		SOP	180	
Soldering Temperature (time)	T <sub>sld</sub>		260 (10 s)	°C
Storage Temperature	T <sub>stg</sub>		– 55 to 125	°C
Operating Temperature	T <sub>opr</sub>		– 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<sub>SS</sub> = 0 V, T<sub>opr</sub> = – 30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit
Supply Voltage	V <sub>DD</sub>	Normal mode	Crystar or ceramic	f <sub>c</sub> = 6.0 MHz	4.5	V
				f <sub>c</sub> = 4.2 MHz	2.7	
			RC	f <sub>c</sub> = 2.5 MHz	2.2	
		HOLD mode	–	–	2.0	
Input High Voltage	V <sub>IH1</sub>	Except Hysteresis Input	In the normal operating area	V <sub>DD</sub> × 0.7	V <sub>DD</sub>	V
	V <sub>IH2</sub>	Hysteresis Input		V <sub>DD</sub> × 0.75		
	V <sub>IH3</sub>		In the HOLD mode	V <sub>DD</sub> × 0.9		
Input Low Voltage	V <sub>IL1</sub>	Except Hysteresis Input	In the normal operating area	0	V <sub>DD</sub> × 0.3	V
	V <sub>IL2</sub>	Hysteresis Input			V <sub>DD</sub> × 0.25	
	V <sub>IL3</sub>		In the HOLD mode		V <sub>DD</sub> × 0.1	
Clock Frequency	f <sub>c</sub>	XIN, XOUT	V <sub>DD</sub> = 4.5 to 5.5 V	0.4	6.0	MHz
			V <sub>DD</sub> = 2.7 to 5.5 V		4.2	
			V <sub>DD</sub> = 2.2 to 5.5 V (RC)		2.5	

**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<sub>SS</sub> = 0 V, T<sub>opr</sub> = – 30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Hysteresis Voltage	V <sub>HS</sub>	Hysteresis Input		–	0.7	–	V
Input Current	I <sub>IN1</sub>	RESET, HOLD	V <sub>DD</sub> = 5.5 V, V <sub>IN</sub> = 5.5 V / 0 V	–	–	± 2	μA
	I <sub>IN2</sub>	Open drain output ports					
Input Resistance	R <sub>IN</sub>	RESET		100	220	450	kΩ
Input Low Current	I <sub>IL</sub>	Push-pull output ports	V <sub>DD</sub> = 5.5 V, V <sub>IN</sub> = 0.4 V	–	–	– 2	mA
Output Leakage Current	I <sub>LO</sub>	Open drain output ports	V <sub>DD</sub> = 5.5 V, V <sub>OUT</sub> = 5.5 V	–	–	2	μA
Output High Voltage	V <sub>OH</sub>	Push-pull output ports	V <sub>DD</sub> = 4.5 V, I <sub>OH</sub> = – 200 μA	2.4	–	–	V
			V <sub>DD</sub> = 2.2 V, I <sub>OH</sub> = – 5 μA	2.0	–	–	
Output Low Voltage	V <sub>OL</sub>	Except XOUT and port R4	V <sub>DD</sub> = 4.5 V, I <sub>OL</sub> = 1.6 mA	–	–	0.4	V
			V <sub>DD</sub> = 2.2 V, I <sub>OL</sub> = 20 μA	–	–	0.1	
Output Low Current	I <sub>OL1</sub>	Port R4	V <sub>DD</sub> = 4.5 V, V <sub>OL</sub> = 1.0 V	–	20	–	mA
Supply Current (in the Normal operating mode)	I <sub>DD</sub>		V <sub>DD</sub> = 5.5 V, f <sub>c</sub> = 4 MHz	–	2	4	mA
			V <sub>DD</sub> = 3.0 V, f <sub>c</sub> = 4 MHz	–	1	2	
			V <sub>DD</sub> = 3.0 V, f <sub>c</sub> = 400 kHz	–	0.5	1	
Supply Current (in the HOLD operating mode)	I <sub>DDH</sub>		V <sub>DD</sub> = 5.5 V	–	0.5	10	μA

Note 1: Typ. values show those at T<sub>opr</sub> = 25°C, V<sub>DD</sub> = 5 V.

Note 2: Input Current I<sub>IN1</sub>: The current through resistor is not included.

Note 3: Supply Current: V<sub>IN</sub> = 5.3 V / 0.2 V (V<sub>DD</sub> = 5.5 V) or 2.8 V / 0.2 V (V<sub>DD</sub> = 3.0 V)

## AC Characteristics

(V<sub>SS</sub> = 0 V, T<sub>opr</sub> = –30 to 70°C)

Parameter	Symbol	Conditions		Min	Typ.	Max	Unit
Instruction Cycle Time	t <sub>cy</sub>		V <sub>DD</sub> = 4.5 to 5.5 V	1.3	–	20	μs
			V <sub>DD</sub> = 2.7 to 5.5 V	1.9			
			V <sub>DD</sub> = 2.2 to 5.5 V	3.2			
High level Clock pulse Width	t <sub>WCH</sub>	For external clock operation	V <sub>DD</sub> ≥ 2.7 V	80	–	–	ns
	V <sub>DD</sub> < 2.7 V		160				
Low level Clock pulse Width	t <sub>WCL</sub>		V <sub>DD</sub> ≥ 2.7 V	80			
			V <sub>DD</sub> < 2.7 V	160			

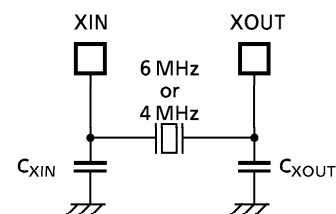
## Recommended Oscillating Conditions

(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 2.7 to 5.5 V, T<sub>opr</sub> = –30 to 70°C)

## (1) 6 MHz

## Ceramic Resonator

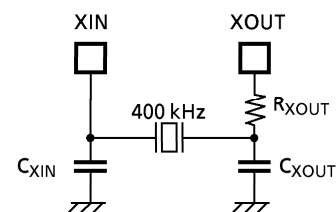
CSA6.00MGU (MURATA) C<sub>XIN</sub> = C<sub>XOUT</sub> = 30 pF  
 KBR-6.00MS (KYOCERA) C<sub>XIN</sub> = C<sub>XOUT</sub> = 30 pF  
 EFOEC6004A4 (NATIONAL) C<sub>XIN</sub> = C<sub>XOUT</sub> = 30 pF



## (2) 4 MHz

## Ceramic Resonator

CSA4.00MG (MURATA) C<sub>XIN</sub> = C<sub>XOUT</sub> = 30 pF  
 KBR-4.00MS (KYOCERA) C<sub>XIN</sub> = C<sub>XOUT</sub> = 30 pF  
 EFOEC4004A4 (NATIONAL) C<sub>XIN</sub> = C<sub>XOUT</sub> = 30 pF



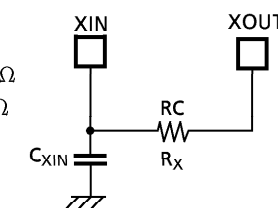
## Crystal Oscillator

204B-6F 4.0000 (TOYOCOM) C<sub>XIN</sub> = C<sub>XOUT</sub> = 20 pF

## (3) 400 kHz

## Ceramic Resonator

CSB400B (MURATA) C<sub>XIN</sub> = C<sub>XOUT</sub> = 220 pF, R<sub>XOUT</sub> = 6.8 kΩ  
 KBR-400B (KYOCERA) C<sub>XIN</sub> = C<sub>XOUT</sub> = 100 pF, R<sub>XOUT</sub> = 10 kΩ  
 EFOA400K04B (NATIONAL) C<sub>XIN</sub> = C<sub>XOUT</sub> = 470 pF, R<sub>XOUT</sub> = 0 Ω

(4) RC Oscillation (V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 5.0 V, T<sub>opr</sub> = 25°C)

2 MHz (Typ.) C<sub>XIN</sub> = 33 pF, R<sub>X</sub> = 10 kΩ  
 400 kHz (Typ.) C<sub>XIN</sub> = 100 pF, R<sub>X</sub> = 30 kΩ

## Typical Characteristics

