CMOS 4-Bit Microcontroller

TMP47C647F, TMP47C847F

The TMP47C647/847 are high speed and high performance 4-bit single chip microcomputers based on the TLCS-470 series with a LCD driver, AD converter and the pulse output circuit used for drive of the buzzer and so on.
The TMP47C647/847 is possible to stop the CPU at the standby period and decrease the power consumption in the Home electric appliance.

Part No.	ROM	RAM	Package	EPROM
TMP47C647F	6144 × 8-bit	384 × 4-bit	P-QFP80-1420-0.80B	TMP47P847VF
TMP47C847F	8192 × 8-bit	512 × 4-bit		

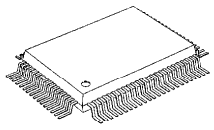
Features

◆4-bit signal chip mocrocomputer
◆Instruction execution time:
1.3 μs (at 6 MHz), 244 μs (at 32.8 kHz)
◆92 basic instrutions
- Table look-up instructions
- 5-bit to 8-bit data conversion instruction

◆Subroutine nesting: 15 levels max.
◆6 interrupt sources (External: 2, Internal: 4)
All sources have independent latchs each, and multiple interrupt control is available.
◆I/O port (35 pins)
- Input 2 ports 5 pins
- Output 2 ports 8 pins
- I/O 6 ports 22 pins

◆Interval Timer
◆Two 12-bit Timer / Counters
Timer, event counter, and pulse width measurement mode
◆Watchdog Timer
◆Serial Interface with 8-bit buffer
- Simutltaneous transmission and reception is available.
- External / internal clock, leading / trailing edge, and 4/8-bit mode

P-QFP80-1420-0.80B



TMP47C647F
TMP47C847F
TMP47P847VF

000707EBA1

◆8-bit successive approximate type AD converter
- With sample and hold
- 8 analog inputs
- Conversion time: 32 μs (at 6 MHz)

◆Pluse Output
Output frequency select

◆High current outputs
LED direct drive is available (typ. 10 mA × 8 bits)

◆LCD driver
- LCD direct drive is available (max 12-digit display at 1/4 duty LCD)
- 1/4, 1/3, 1/2 duties or static drive are programmably selectable.

◆Dual-clock operation
High-speed/Low-power-consumption operating mode

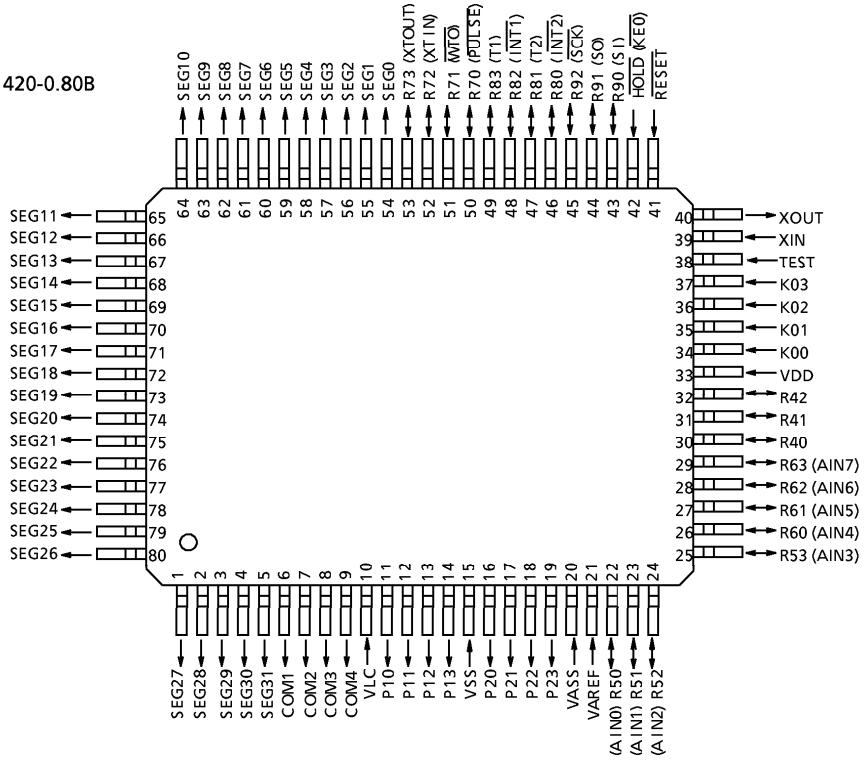
◆Hold function
Battery/Capacitor back-up

◆SLEEP function
- Battery/Capacitor back-up
- LCD is displaying

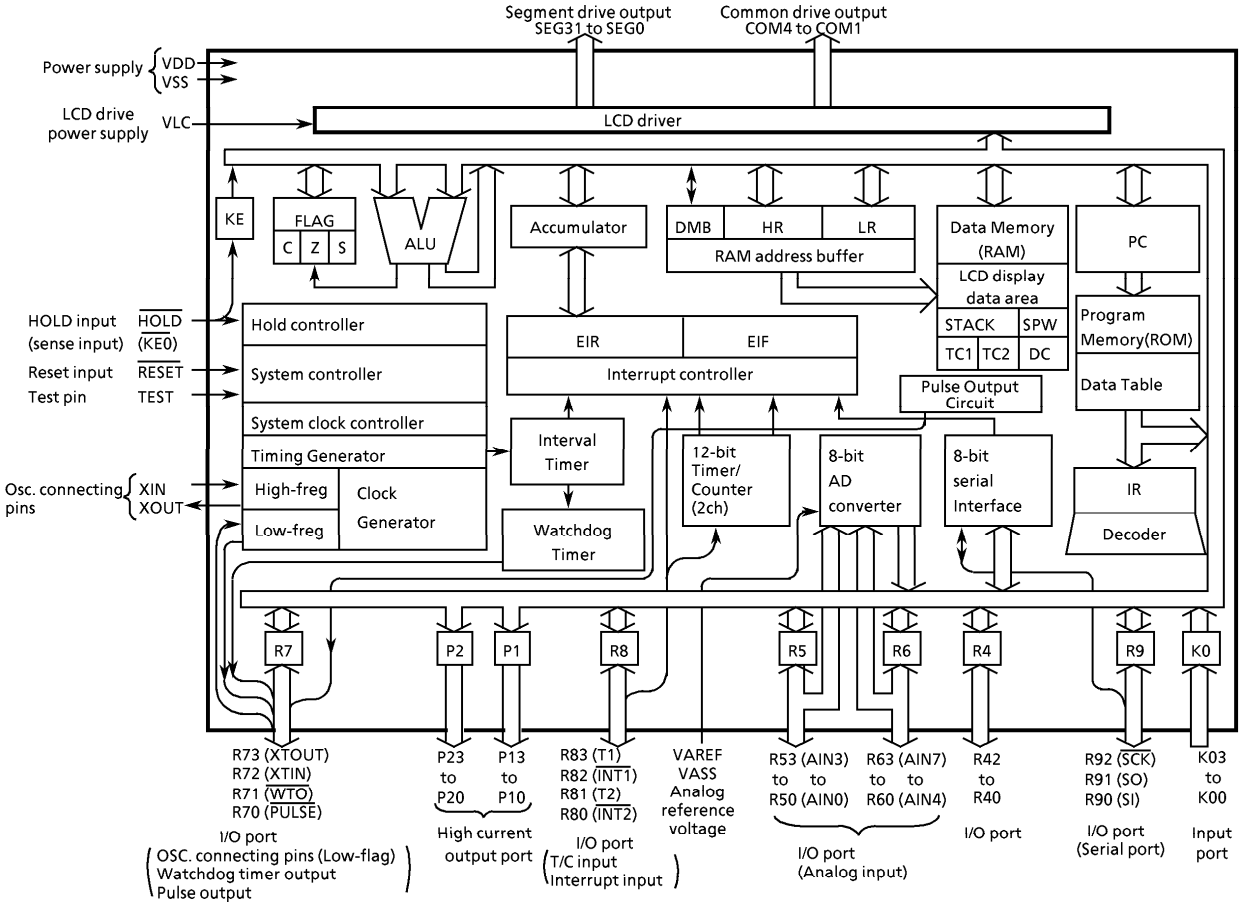
◆Real Time Emulator: BM47C847F0A

Pin Assignments (Top View)

P-QFP80-1420-0.80B



Block Diagram



Pin Function

Pin Name	Input / Output	Functions	
K03 to K00	Input	4-bit input port	
P13 to P10	Output	4-bit output port with latch. 8-bit data are output by the 5-bit to 8-bit data conversion instruction [OUTB @HL].	
P23 to P20			
P42 to P40	I/O	3-bit I/O port with latch When used as input port, the latch must be set to "1".	
R63 (AIN7) to R50 (AIN0)	I/O (Input)	4-bit I/O port with latch. When used as input port, the latch must be set to "1".	AD converter analog input
R73 (XTOUT)	I/O (Output)	4-bit I/O port with latch. When used as input port, watchdog timer output, the latch must be set to "1".	Resonator connecting pin (Low-freq.). For inputting external clock, XTIN is used and XTOUT is opened.
R72 (XTIN)	I/O (Input)		
R71 ($\overline{\text{WTO}}$)	I/O (Output)		Watchdog timer output
R70 ($\overline{\text{PULSE}}$)	I/O (Output)		Pulse output
R83 (T1)	I/O (Input)	4-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 1 external input
R82 ($\overline{\text{INT1}}$)			External interrpt 1 input
R81 (T2)			Timer/Counter 2 external input
R80 ($\overline{\text{INT2}}$)			External interrpt 2 input
R92 ($\overline{\text{SCK}}$)	I/O(I/O)	3-bit I/O port with latch. When used as input port or serial port, the latch must be set to "1".	Serial clock I/O
R91 (SO)	I/O (Output)		Serial data output
R90 (SI)	I/O (Input)		Serial data input
SEG31 to SEG0	Output	LCD Segment drive output	
COM4 to COM1		LCD Common drive output	
XIN	Input	Resonator connecting pin (High-frequency) . For inputting external clock, XIN is used and XOUT is opened.	
XOUT	Output		
$\overline{\text{RESET}}$	Input	Reset signal input	
$\overline{\text{HOLD}}$ ($\overline{\text{KE0}}$)	Input (Input)	HOLD request/release signal input	Sence input
TEST	Input	Test pin for out-going test. Be opened or fixed to low level.	
VDD	Power supply	+ 5 V	
VSS		0 V (GND)	
VLC		LCD drive power supply	
VAREF		AD converter analog reference voltage (High)	
VASS		AD converter analog reference voltage (Low)	

Operational Description

Concerning the TMP47C647/847 the configuration and functions of hardwares are described. As the description has been provided with priority on those parts differing from the TMP47C660/860, the technical data sheets for the TMP47C660/860 shall also be referred to.

1. System Configuration

◆ Internal CPU Function

Except for the system control circuit, the CPU core functions are the same as those of the TMP47C660/860.

◆ Peripheral Hardware Function

① I/O Ports
② Interval Timer
③ Timer/Counter
④ Watchdog Timer
⑤ Pulse Output
⑥ LCD Driver
⑦ AD Converter
⑧ Serial Interface

The following are explanations of functions (①, ⑤, ⑥ and ⑦) which have been added to the TMP47C647/847 or which are different from those of the TMP47C660/860, and the system clock control circuit.

2. CPU Core Functions

2.1 System Control Circuit

It is possible to switch from SLOW operating mode to SLEEP operating mode which maintains the internal status under low power consumption, and also to HOLD operating mode which reduces power consumption. In SLEEP operating mode, all operations except a timing generator (TG) binary counter and a LCD driver are suspended.

2.1.1 System clock controller

The system clock controller starts or stops the high-frequency and low-frequency clock oscillator and switches between the basic clocks. The operating mode is generally divided into the single-clock mode and the dual-clock mode, which are controlled by command.

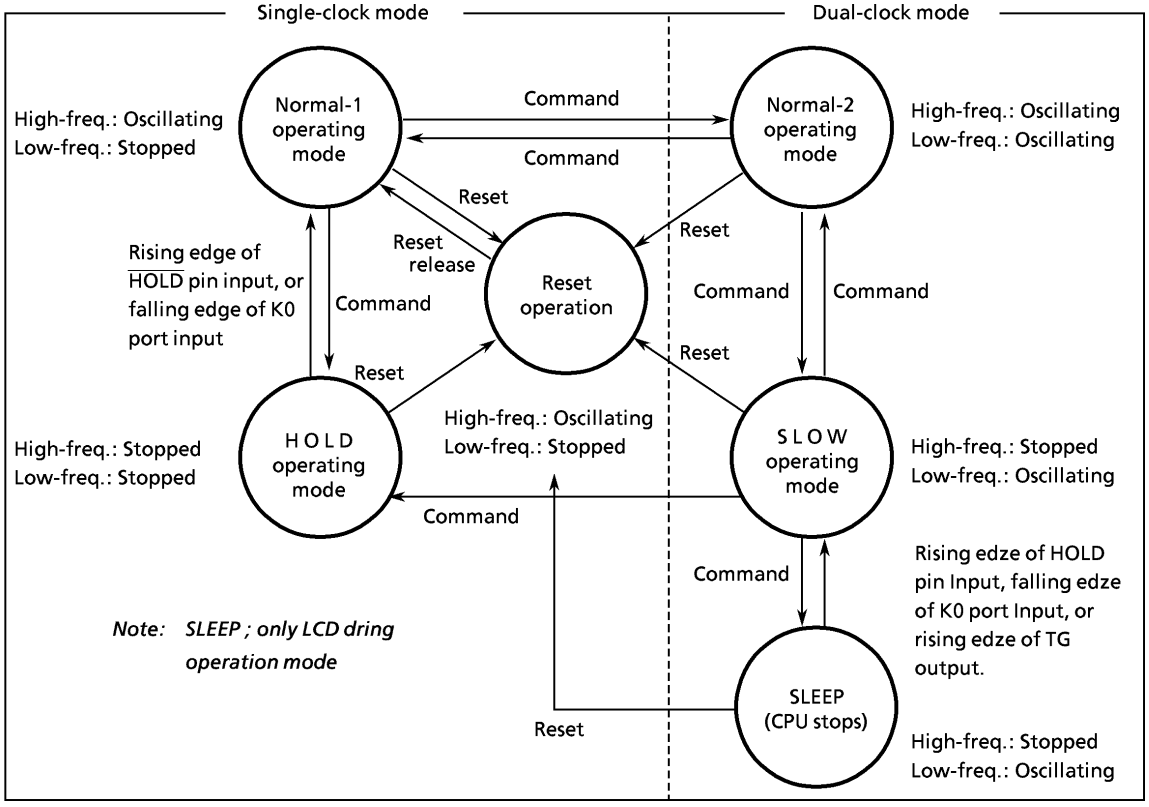


Figure 2-1. Operating mode transition diagram

Electrical Characteristics

Absolute Maximum Ratings (V_{SS} = 0 V)

Parameter	Symbol	Pins	Ratings	Unit
Supply Voltage	V_{DD}		– 0.3 to 7	V
Supply Voltage (LCD drive)	V_{LC}		– 0.3 to V_{DD} + 0.3	V
Input Voltage	V_{IN}		– 0.3 to V_{DD} + 0.3	V
Output Voltage	V_{OUT1}	Except sink open drain pin	– 0.3 to V_{DD} + 0.3	V
	V_{OUT2}	Sink open drain pin	– 0.3 to 10	
Output Current (Per 1 pin)	I_{OUT1}	Ports P1, P2	15	mA
	I_{OUT2}	Ports R4 to R9	3.2	
Output Current (Total)	ΣI_{OUT}	Ports P1, P2	60	mA
Power Dissipation [T_{opr} = 70°C]	PD		600	mW
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 40 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 Opeating Conditions (V_{SS} = 0 V, Topr = – 40 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit
Supply Voltage	V_{DD}		In the Normal mode	4.5	6.0	V
			In the SLOW mode	2.7		
			In the SLEEP mode			
			In the HOLD mode	2.0		
Input High Voltage	V_{IH1}	Except Hysteresis Input	$V_{DD} \geqq 4.5V$	$V_{DD} \times 0.7$	V_{DD}	V
	V_{IH2}	Hysteresis Input		$V_{DD} \times 0.75$		
	V_{IH3}		$V_{DD} < 4.5V$	$V_{DD} \times 0.9$		
Input Low Voltage	V_{IL1}	Except Hysteresis Input	$V_{DD} \geqq 4.5V$	0	$V_{DD} \times 0.3$	V
	V_{IL2}	Hysteresis Input			$V_{DD} \times 0.25$	
	V_{IL3}		$V_{DD} < 4.5V$		$V_{DD} \times 0.1$	
Clock Frequency	fc	XIN, XOUT		0.4	6.0	MHz
	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: Input voltage V_{IH3}, V_{IL3}: In the SLOW or HOLD mode.

DC Characteristics (V_{SS} = 0 V, Topr = – 40 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Typ.	Max	Unit
Hysteresis Voltage	V_{HS}	Hysteresis Input		—	0.7	—	V
Input Current	I_{IN1}	Port K0, TEST, $\overline{RESET}$, $\overline{HOLD}$	V_{DD} = 5.5 V, V_{IN} = 5.5 V / 0 V	—	—	± 2	μA
	I_{IN2}	Open drain R port					
Input Low Current	I_{IL}	Push-pull R port	V_{DD} = 5.5 V, V_{IN} = 0.4 V	—	—	– 2	mA
Input Resistance	R_{IN1}	Port K0 with pull-up / pull-down resistor		30	70	150	kΩ
	R_{IN2}	$\overline{RESET}$		100	220	450	
Output Leakage Current	I_{LO}	Open drain ports P, R	V_{DD} = 5.5 V, V_{OUT} = 5.5 V	—	—	2	μA
Output High Voltage	V_{OH}	Push-pull R port	V_{DD} = 4.5 V, I_{OH} = – 200 μA	2.4	—	—	V
Output Low Voltage	V_{OL2}	Except XOUT XOUT and ports P1, P2	V_{DD} = 4.5 V, I_{OL} = 1.6 mA	—	—	0.4	V
Output Low Current	I_{OL1}	Ports P1, P2	V_{DD} = 4.5 V, I_{OL} = 1.0V	—	10	—	mA
Segment Output Low Resistance	R_{OS1}	SEG pin	V_{DD} = 5 V, V_{DD} – V_{LC} = 3 V	—	20	—	kΩ
Common Output Low Resistance	R_{OC1}	COM pin					
Segment Output High Resistance	R_{OS2}	SEG pin		—	200	—	
Common Output High Resistance	R_{OC2}	COM pin					
Segment / Common Output Voltage	$V_{O2/3}$	SEG / COM pin		3.8	4.0	4.2	V
	$V_{O1/2}$			3.3	3.5	3.7	
	$V_{O1/3}$			2.8	3.0	3.2	
Supply Current (in the Normal mode)	I_{DD}		V_{DD} = 5.5 V, V_{LC} = V_{SS} fc = 4 MHz	—	3	6	mA
Supply Current (in the SLOW mode)	I_{DDS}		V_{DD} = 3.0 V, V_{LC} = V_{SS} fs = 32.768 kHz	—	30	60	μA
				—	15	30	
Supply Current (in the HOLD mode)	I_{DDH}		V_{DD} = 5.5 V	—	0.5	10	μA

Note 1: Typ. values show those at Topr = 25°C, V_{DD} = 5 V.

Note 2: Input Current IIN1 ; The current through resistor is not included, when the input resistor (pull-up / pull-down) is contained.

Note 3: Output Resistance R_{OS}, R_{OC} ; Shows on-resistance at the level switching.

Note 4: $V_{O2/3}$; Shows 2/3 level output voltage, when the 1/4 or 1/3 duty LCD is used.

Note 5: $V_{O1/2}$; Shows 1/2 level output voltage, when the 1/2 duty or static LCD is used.

Note 6: $V_{O1/3}$; Shows 1/3 level output voltage, when the 1/4 or 1/3 duty LCD is used.

Note 7: Supply Current I_{DD}, I_{DDH} ; V_{IN} = 5.3 V / 0.2 V
The K0 port is open when the input resistor is contained.
The voltage applied to the R port is within the valid range.
Supply Current I_{DDS} ; VIN = 2.8 V / 0.2 V Only low frequency clock is only oscillated (connecting XTIN, XTOUT).

Note 8: When using LCD, it is necessary to consider values of $R_{OS1/2}$ and $R_{OC1/2}$.

Note 9: Times for SEG / COM output switching on ; R_{OS1}, R_{OC1}: 2/fs (s)
R_{OS2}, R_{OC2}: 1/(n · f_F)
(1/n: duty, f_F: frame frequency)

AD Conversion Characteristics

(Topr = – 40 to 70°C)

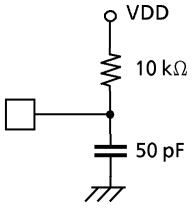
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}		V_{DD} – 1.5	–	V_{DD}	V
	V_{ASS}		V_{SS}	–	1.5	
Analog Reference Voltage Range	ΔV_{AREF}	$V_{AREF} - V_{ASS}$	2.5	–	–	V
Analog Input Voltage	V_{AIN}		V_{ASS}	–	V_{AREF}	V
Analog Supply Current	I_{REF}		–	0.5	1.0	mA
Nonlinearity Error		V_{DD} = 4.5 to 6.0V, V_{SS} = 0.0V V_{AREF} = V_{DD} ± 0.001V V_{ASS} = 0.000V	–	–	± 1	LSB
Zero Point Error			–	–	± 1	
Full Scale Error			–	–	± 1	
Total Error			–	–	± 2	

AC Characteristics

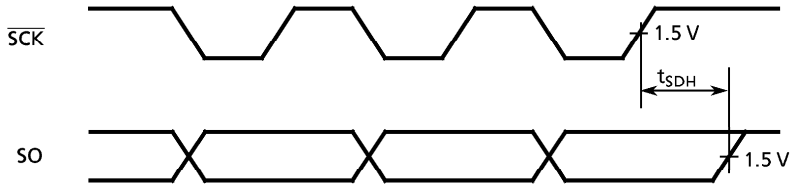
(V_{SS} = 0 V, V_{DD} = 4.5 to 6.0 V, Topr = – 40 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Instruction Cycle Time	tcy	In the Normal mode	1.3	–	20	μs
		In the SLOW mode	235	–	267	μs
High Level Clock Pulse Width	t_{WCH}	For external clock operation	80	–	–	ns
Low Level Clock Pulse Width	t_{WCL}					
Shift data Hold Time	t_{SDH}		0.5 tcy – 0.3	–	–	μs
AD Sampling Time	t_{AIN}	fc = 4 MHz	–	4	–	μs

Note: Shift data Hold time:
External circuit for $\overline{SCK}$ pin and SO pin



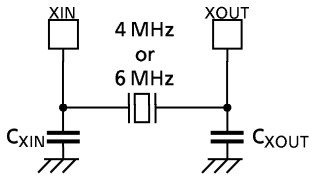
Serial port (completion of transmission)



Recommended Oscillating Conditions (V_{SS} = 0 V, V_{DD} = 4.5 to 6.0 V, T_{opr} = – 40 to 70°C)

(1) 6 MHz
Ceramic Resonator

CSA6.00MGU	(MURATA)	$C_{XIN} = C_{XOUT}$ = 30 pF
KBR-6.00MS	(KYOCERA)	$C_{XIN} = C_{XOUT}$ = 30 pF

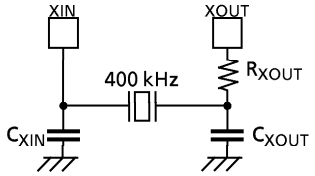


(2) 4 MHz
Ceramic Resonator

CSA4.00MG	(MURATA)	$C_{XIN} = C_{XOUT}$ = 30 pF
KBR-4.00MS	(KYOCERA)	$C_{XIN} = C_{XOUT}$ = 30 pF
FCR4.0M5	(TDK)	$C_{XIN} = C_{XOUT}$ = 33 pF

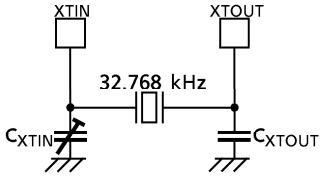
Crystal Oscillator

204B-6F 4.0000	(TOYOCOM)	$C_{XIN} = C_{XOUT}$ = 20 pF



(3) 400 kHz
Ceramic Resonator

CSB400B	(MURATA)	$C_{XIN} = C_{XOUT}$ = 220 pF, R_{XOUT} = 6.8 kΩ
KBR-400B	(KYOCERA)	$C_{XIN} = C_{XOUT}$ = 100 pF, R_{XOUT} = 10 kΩ



(4) 32.768 kHz (Vss = 0 V, V_{DD} = 2.7 to 6.0 V, T_{opr} = – 30 to 70°C)
Crystal Oscillator C_{XTIN}, C_{XTOUT} ; 10 to 33 pF

Note: In order to get the accurate oscillation frequency, the adjustment of capacitors must be required.

Typical Characteristics