

## CMOS 4-Bit Microcontroller

**TMP47C640N, TMP47C840N  
TMP47C640F, TMP47C840F**

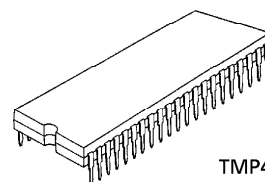
The TMP47C640/840 are high speed and high performance 4-bit single chip microcomputers based on the TLC5-470 series with a 8-bit AD converter.

Part No.	ROM	RAM	Package	OTP
TMP47C640N	6144 × 8-bit	384 × 4-bit	P-SDIP42-600-1.78	TMP47P840VN
TMP47C640F			P-QFP44-1414-0.80D	TMP47P840VF
TMP47C840N	8192 × 8-bit	512 × 4-bit	P-SDIP42-600-1.78	TMP47P840VN
TMP47C840F			P-QFP44-1414-0.80D	TMP47P840VF

**Features**

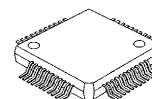
- ◆ 4-bit single chip microcomputer
- ◆ Instruction execution time:
  - 1.3  $\mu$ s (at 6 MHz), 244  $\mu$ s (at 32.8 kHz)
- ◆ 92 basic instructions
  - Table look-up instructions
  - 5-bit to 8-bit data conversion instruction
- ◆ Subroutine nesting: 15 levels max.
- ◆ 6 interrupt sources (External: 2, Internal: 4)
  - All sources have independent latches each, and multiple interrupt control is available.
- ◆ I/O port (34 pins)
  - Input     2 ports     5 pins
  - Output   2 ports     8 pins
  - I/O       6 ports    21 pins
- ◆ Interval Timer
- ◆ Two 12-bit Timer / Counters   2 channel
  - Timer, event counter, and pulse width measurement mode

P-SDIP42-600-1.78



TMP47C640N  
TMP47C840N  
TMP47P840VN

P-QFP44-1414-0.80D



TMP47C640F  
TMP47C840F  
TMP47P840VF

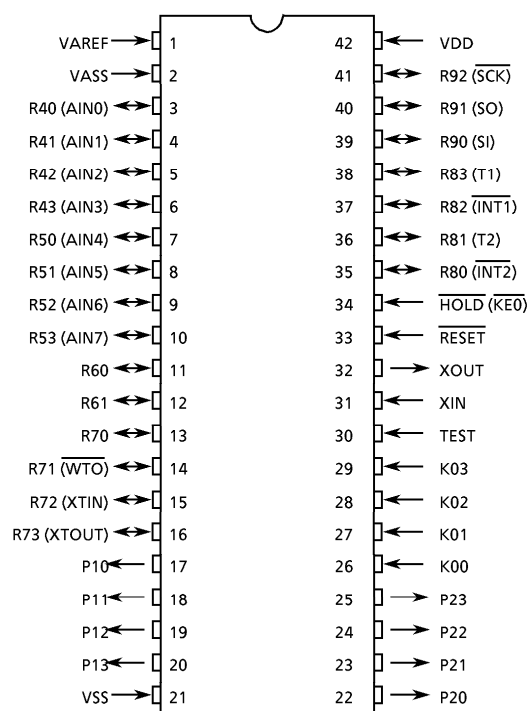
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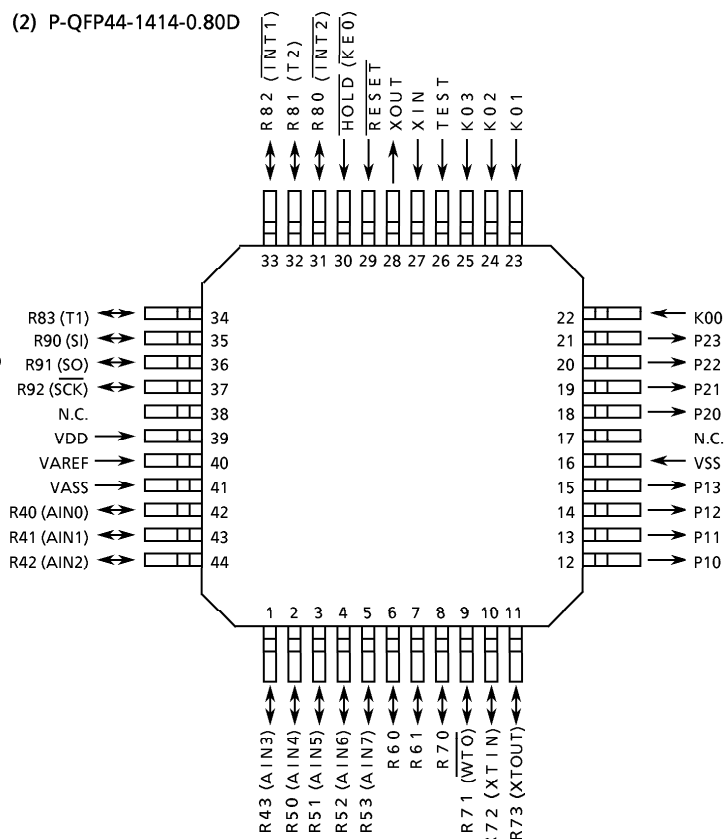
- ◆ Watchdog Timer
- ◆ Serial Interface with 8-bit buffer
  - Simultaneous transmission and reception capability
  - 8/4-bit transfer, external/internal clock, and leading / trailing edge shift mode
- ◆ 8-bit successive approximate type AD converter
  - With sample and hold
  - 8 analog inputs
  - Conversion time: 32  $\mu$ s (at 6 MHz)
- ◆ Remote control signal pre-processing capability
- ◆ High current outputs
  - LED direct drive capability (typ. 20mA  $\times$  8 bits)
- ◆ Dual-clock operation
  - High-speed/Low-power-consumption operating mode
- ◆ Hold function
  - Battery/Capacitor back-up
- ◆ Real Time Emulator: BM47C860A + BM1174

## Pin Assignments (Top View)

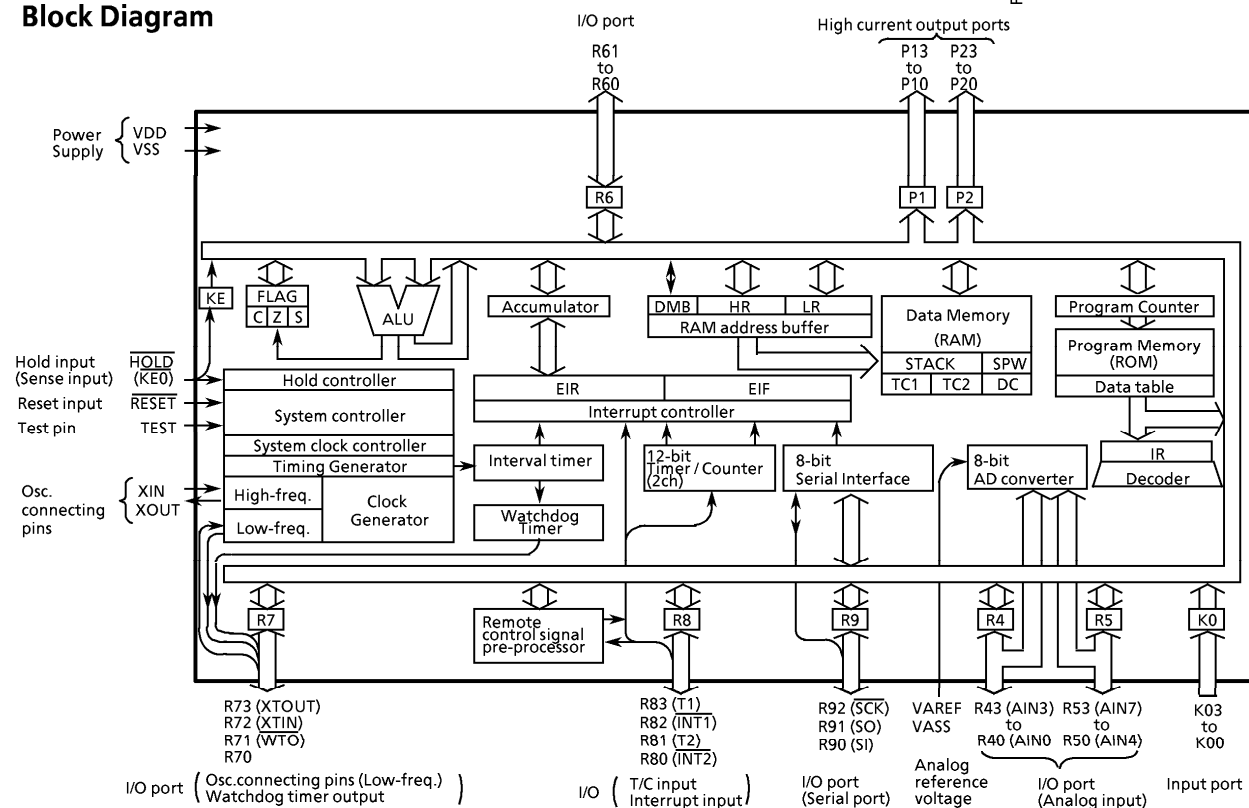
(1) P-SDIP42-600-1.78



(2) P-QFP44-1414-0.80D



## 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.	
P23 to P20		8-bit data are output by the 5-bit to 8-bit data conversion instruction [OUTB @HL].	
R53 (AIN7) to R40 (AIN0)	I/O (Input)	4-bit I/O port with latch. When used as input port, watchdog timer output or analog input, the latch must be set to "1".	AD converter analog input
R61, R60	I/O		
R73 (XTOUT)	I/O (Output)	Set to Dual-clock operating mode, when R73, R72 pin use as clock generator.	Resonator connecting pin (Low-freq.). For inputting external clock, XTIN is used and XTOUT is opened.
R72 (XTIN)	I/O (Input)		
R71 (WTO)	I/O (Output)	Can be set, cleared, and tested for each bit as specified by L register indirect addressing bit manipulation instructions.	Watchdog timer output
R70	I/O		
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 (INT1)			External interrupt 1 input
R81 (T2)			Timer / Counter 2 external input
R80 (INT2)			External interrupt 2 or REMO-COM input
R92 (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
XIN	Input	Resonator connecting pin (High-frequency). For inputting external clock, XIN is used and XOUT is opened.	
XOUT	Output		
RESET	Input	Reset signal input	
HOLD (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	+ 5V	
VSS		0V (GND)	
VAREF		AD converter analog reference voltage (High)	
VASS		AD converter analog reference voltage (Low)	

## Operational DESCRIPTION

Concerning the TMP47C640/840 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

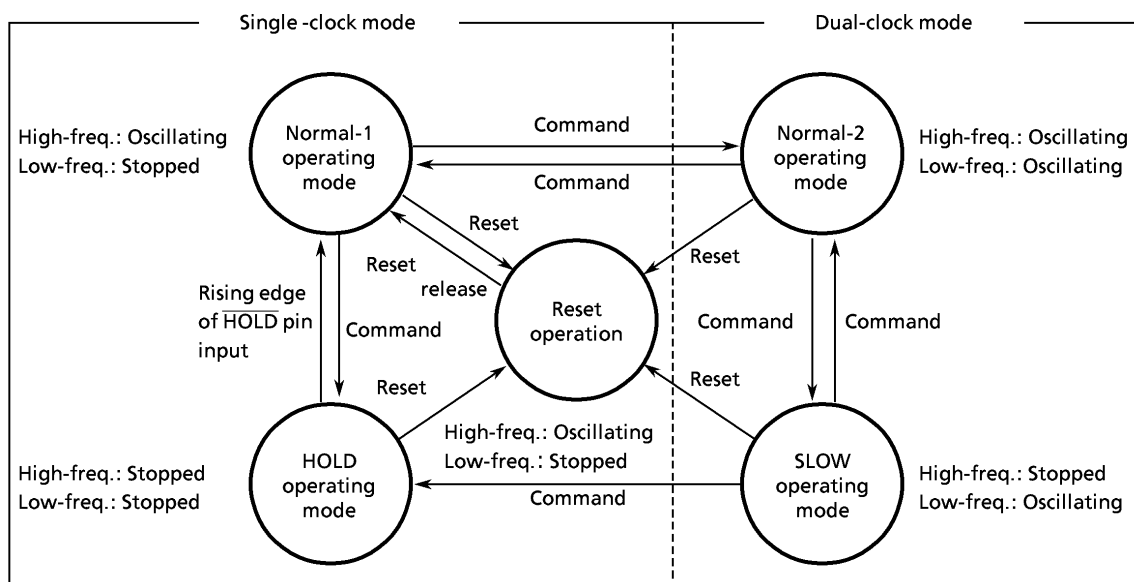
- |                             |                                 |
|-----------------------------|---------------------------------|
| ① I/O Ports                 | ⑤ Remote control pulse detector |
| ② Interval Timer            | ⑥ AD converter                  |
| ③ Timer/Counters (TC1, TC2) | ⑦ Serial Interface              |
| ④ Watchdog Timer            |                                 |

The description has been provided with priority on the function (①) changed from the TMP47C660/860, and the system clock control circuit.

### 2. Internal CPU Function

#### 2.1 System Control Circuit

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.



*Note: Normal-1 and Normal-2 operating modes are sometimes referred to as the Normal operating mode collectively.*

Figure 2-1. Operating mode transition diagram

## 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>	Ports R	3.2	mA
	I <sub>OUT2</sub>	Ports P1, P2	30	
Output Current (total)	Σ I <sub>OUT</sub>	Ports P1, P2	120	mA
Power Dissipation [Topr = 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 Operating Conditions

(V<sub>SS</sub> = 0 V, Topr = – 40 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit
Supply Voltage	V <sub>DD</sub>		f <sub>c</sub> = 6 MHz	4.5	5.5	V
			f <sub>c</sub> = 4.2 MHz	2.7		
			In the SLOW mode	2.7		
			In the HOLD mode	2.0		
Input High Voltage	V <sub>IH1</sub>	Except Hysteresis Input	V <sub>DD</sub> ≥ 4.5 V	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>		V <sub>DD</sub> < 4.5 V	V <sub>DD</sub> × 0.9		
Input Low Voltage	V <sub>IL1</sub>	Except Hysteresis Input	V <sub>DD</sub> ≥ 4.5 V	0	V <sub>DD</sub> × 0.3	V
	V <sub>IL2</sub>	Hysteresis Input			V <sub>DD</sub> × 0.25	
	V <sub>IL3</sub>		V <sub>DD</sub> < 4.5 V		V <sub>DD</sub> × 0.1	
Clock Frequency	f <sub>c</sub>	XIN, XOUT		0.4	6.0	MHz
	f <sub>s</sub>	XTIN, XTOUT		30	34	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<sub>IH3</sub>, V<sub>IL3</sub>: In the SLOW or HOLD mode.

## DC Characteristics

(V<sub>SS</sub> = 0V, T<sub>opr</sub> = – 40 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>	Port K0, TEST, RESET, HOLD	V <sub>DD</sub> = 5.5 V,	–	–	± 2	μA
	I <sub>IN2</sub>	Ports R (open drain)	V <sub>IN</sub> = 5.5 V / 0 V				
Low Input Current	I <sub>IL</sub>	Ports R (push-pull )	V <sub>DD</sub> = 5.5 V, V <sub>IN</sub> = 0.4 V	–	–	– 2	mA
Input Resistance	R <sub>IN1</sub>	Port K0 with pull-up/pull-down		30	70	150	kΩ
	R <sub>IN2</sub>	RESET		100	220	450	
Output Leakage Current	I <sub>LO</sub>	Ports (open drain)	V <sub>DD</sub> = 5.5 V, V <sub>OUT</sub> = 5.5 V	–	–	2	μA
Output Low Voltage	V <sub>OL</sub>	Except XOUT, ports P	V <sub>DD</sub> = 4.5 V, I <sub>OL</sub> = 1.6 mA	–	–	0.4	V
Output Low Current	I <sub>OL</sub>	Ports P1, P2	V <sub>DD</sub> = 4.5 V, V <sub>OL</sub> = 1.0 V	–	20	–	mA
Supply Current (in the Normal mode)	I <sub>DD</sub>		V <sub>DD</sub> = 5.5 V f <sub>c</sub> = 4 MHz	–	3	6	mA
Supply Current (in the SLOW mode)	I <sub>DDS</sub>		V <sub>DD</sub> = 3.0 V f <sub>s</sub> = 32.768 kHz	–	30	60	μA
Supply Current (in the HOLD 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, when the input resistor (pull-up/pull-down) is contained.

Note 3: Supply Current I<sub>DD</sub>, I<sub>DDH</sub> ; V<sub>IN</sub> = 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<sub>DDS</sub> ; V<sub>IN</sub> = 2.8 V / 0.2 V

Low frequency clock is only osillated (connecting XTIN, XTOUT).

## AD Conversion Characteristics

(T<sub>opr</sub> = – 40 to 70°C)

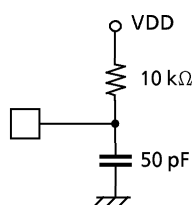
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V <sub>AREF</sub>		V <sub>DD</sub> – 1.5	–	V <sub>DD</sub>	V
	V <sub>ASS</sub>		V <sub>SS</sub>	–	1.5	
Analog Reference Voltage Range	ΔV <sub>AREF</sub>	V <sub>AREF</sub> – V <sub>ASS</sub>	2.5	–	–	V
Analog Input Voltage	V <sub>AIN</sub>		V <sub>ASS</sub>	–	V <sub>AREF</sub>	V
Analog Supply Current	I <sub>REF</sub>		–	0.5	1.0	mA
Nonlinearity Error		V <sub>DD</sub> = 4.5 to 5.5 V, V <sub>SS</sub> = 0.0 V V <sub>AREF</sub> = V <sub>DD</sub> ± 0.001 V V <sub>ASS</sub> = 0.000 V	–	–	± 1	LSB
Zero Point Error			–	–	± 1	
Full Scale Error			–	–	± 1	
Total Error			–	–	± 2	

## AC Characteristics

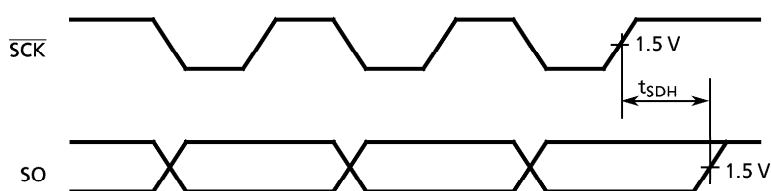
(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 4.5 to 6.0 V, T<sub>opr</sub> = -40 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Instruction Cycle Time	t <sub>cy</sub>	In the Normal mode	1.3	—	20	μs
		In the SLOW mode	235	—	267	
High level Clock pulse Width	t <sub>WCH</sub>	External clock mode	80	—	—	ns
Low level Clock pulse Width	t <sub>WCL</sub>					
A / D Sampling Time	t <sub>AIN</sub>	f <sub>c</sub> = 4 MHz	—	4	—	μs
Shift Data Hold Time	t <sub>SDH</sub>		0.5 t <sub>cy</sub> - 0.3	—	—	μs

Note: Shift Data Hold Time

External circuit for  $\overline{\text{SCK}}$  pin and SO pin

Serial port (completion of transmission)



## Recommended Oscillating Conditions

(V<sub>SS</sub> = 0 V, V<sub>DD</sub> = 4.5 to 6.0 V, T<sub>opr</sub> = -40 to 70°C)

## (1) 6 MHz

Ceramic Resonator

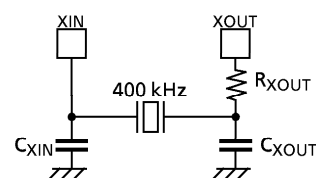
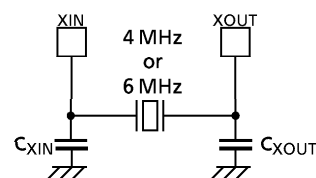
CSA6.00MGU (MURATA) C<sub>XIN</sub> = C<sub>XOUT</sub> = 30 pFKBR-6.00MS (KYOCERA) C<sub>XIN</sub> = C<sub>XOUT</sub> = 30 pF

## (2) 4 MHz

Ceramic Resonator

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

Crystal Oscillator

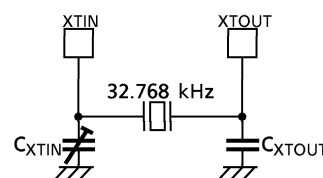
204B-6F 4.0000 (TOYOCOM) C<sub>XIN</sub> = C<sub>XOUT</sub> = 20 pF

## (3) 400 kHz

Ceramic Resonator

CSB400B (MURATA) C<sub>XIN</sub> = C<sub>XOUT</sub> = 220 pF, R<sub>XOUT</sub> = 6.8 kΩKBR-400B (KYOCERA) C<sub>XIN</sub> = C<sub>XOUT</sub> = 100 pF, R<sub>XOUT</sub> = 10 kΩ(4) 32.768 kHz (V<sub>SS</sub> = 0V, V<sub>DD</sub> = 2.7 to 6.0V, T<sub>opr</sub> = -40 to 70°C)Crystal Oscillator C<sub>XTIN</sub>, C<sub>XTOUT</sub>; 10 to 33 pF

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





## Typical Characteristics

