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 TLCS-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 μs (at 6 MHz), 244 μs (at 32.8 kHz)

◆92 basic instructions
- Table look-up instructions
- 5-bit to 8-bit data conversion instruction

◆Subroutine nesting: 15 levels max.

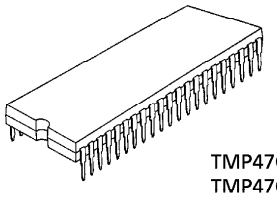
◆6 interrupt sources (External: 2, Internal: 4)
All sources have independent latches each, and multiple interrupt control is available.

◆I/O port (34 pins)
- Input 2 ports 5 pins
- Output 2 ports 8 pins
- I/O 6 ports 21 pins

◆Interval Timer

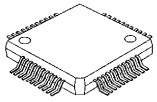
◆Two 12-bit Timer / Counters 2 channel
Timer, event counter,and pulse width measurement mode

P-SDIP42-600-1.78



TMP47C640N
TMP47C840N
TMP47P840VN

P-QFP44-1414-0.80D



TMP47C640F
TMP47C840F
TMP47P840VF

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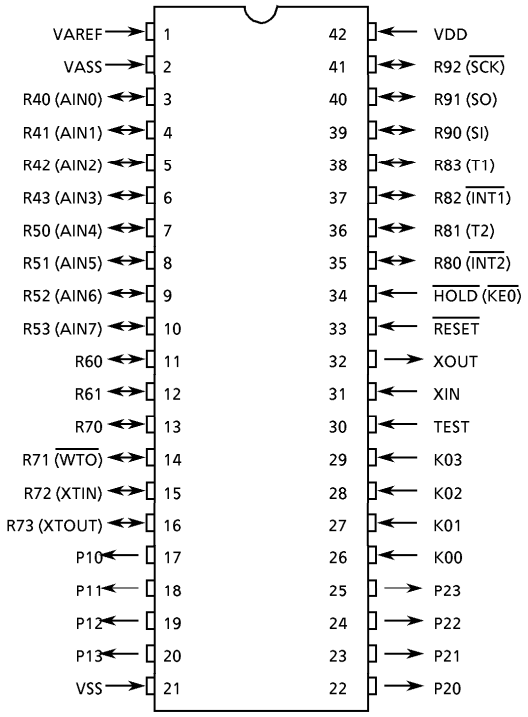
◆Watchdog Timer
◆Serial Interface with 8-bit buffer
- Simultaneous transmission and reception capability
- 8/4-bit transfer, external/internal clock, and leading / trailing edge shift mode

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

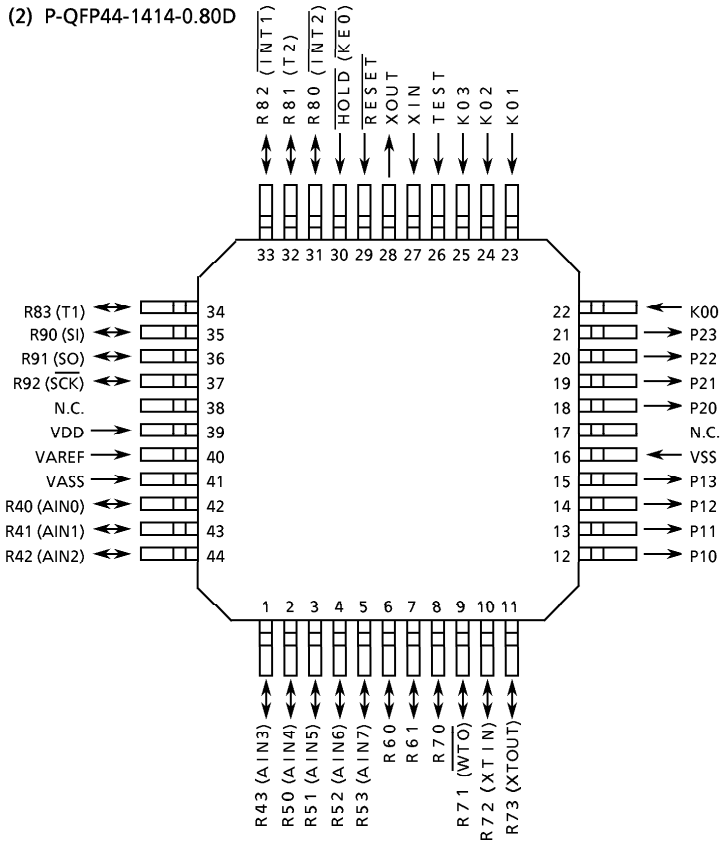
◆Remote control signal pre-processing capability
◆High current outputs
LED direct drive capability (typ. 20mA × 8 bits)
◆Dual-clock operation
High-speed/Low-power-consumption operating mode
◆Hold function
Battery/Capacitor back-up
◆Real Time Emulator: BM47C860A + BM1174

Pin Assignments (Top View)

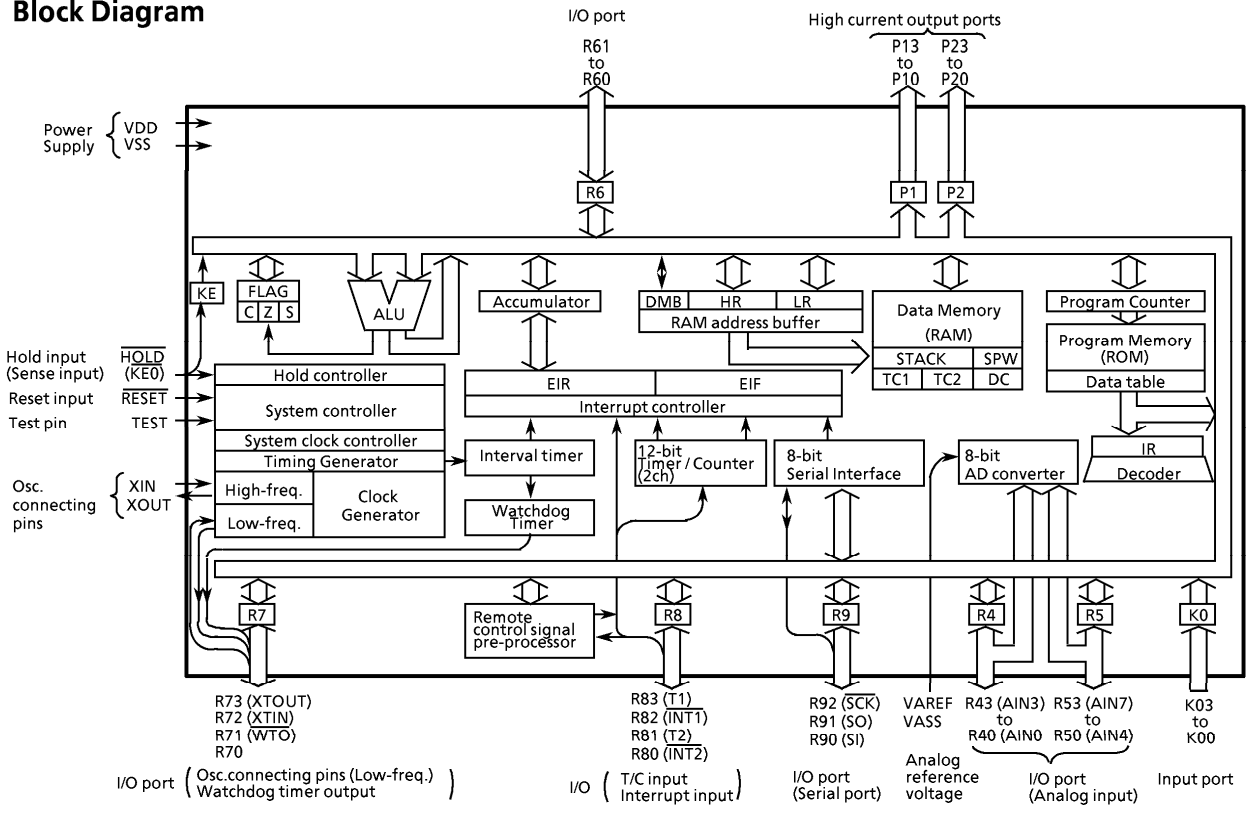
(1) P-SDIP42-600-1.78



(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". Set to Dual-clock operating mode, when R73,R72 pin use as clock generator. Can be set, cleared, and tested for each bit as specified by L register indirect addressing bit manipulation instructions.	AD converter analog input
R61, R60	I/O		
R73 (XTOUT)	I/O (Output)		Resonator connecting pin (Low-freq.). For inputting external clock, XTIN is used and XTOUT is opened.
R72 (XTIN)	I/O (Input)		
R71 ($\overline{WTO}$)	I/O (Output)		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 ($\overline{INT1}$)			External interrpt 1 input
R81 (T2)			Timer / Counter 2 external input
R80 ($\overline{INT2}$)			External interrpt 2 or REMO-COM input
R92 ($\overline{SCK}$)	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		
$\overline{RESET}$	Input	Reset signal input	
$\overline{HOLD}$ ($\overline{KE0}$)	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.

◆ Periheral Hardware Function

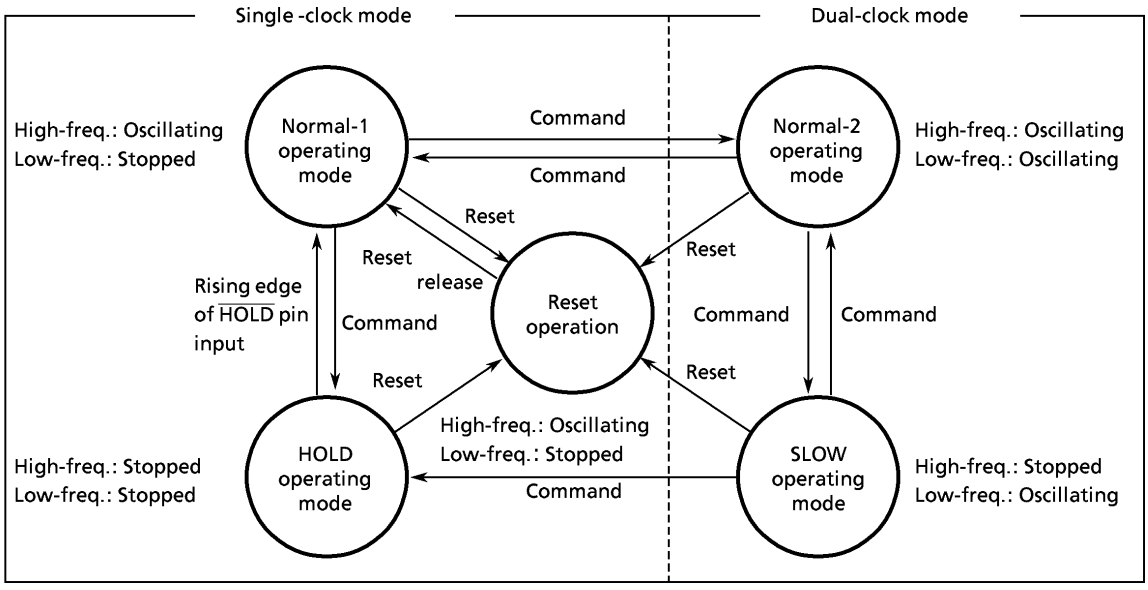
① I/O Ports
② Interval Timer
③ Timer/Counters (TC1, TC2)
④ Watchdog Timer
⑤ Remote control pulse detector
⑥ AD converter
⑦ Serial Interface

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_{SS} = 0 V)

Parameter	Symbol	Pins	Ratings	Unit
Supply Voltage	V_{DD}		– 0.3 to 6.5	V
Input Voltage	V_{IN}		– 0.3 to V_{DD} + 0.3	V
Output Voltage	V_{OUT}		– 0.3 to V_{DD} + 0.3	V
Output Current (per 1 pin)	I_{OUT1}	Ports R	3.2	mA
	I_{OUT2}	Ports P1, P2	30	
Output Current (total)	ΣI_{OUT}	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 Opeating Conditions (V_{SS} = 0 V, Topr = – 40 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit
Supply Voltage	V_{DD}		fc = 6 MHz	4.5	5.5	V
			fc = 4.2 MHz	2.7		
			In the SLOW mode	2.7		
			In the HOLD mode	2.0		
Input High Voltage	V_{IH1}	Except Hysteresis Input	$V_{DD} \geqq 4.5$ V	$V_{DD} \times 0.7$	V_{DD}	V
	V_{IH2}	Hysteresis Input		$V_{DD} \times 0.75$		
	V_{IH3}		$V_{DD} < 4.5$ V	$V_{DD} \times 0.9$		
Input Low Voltage	V_{IL1}	Except Hysteresis Input	$V_{DD} \geqq 4.5$ V	0	$V_{DD} \times 0.3$	V
	V_{IL2}	Hysteresis Input			$V_{DD} \times 0.25$	
	V_{IL3}		$V_{DD} < 4.5$ V		$V_{DD} \times 0.1$	
Clock Frequency	fc	XIN, XOUT		0.4	6.0	MHz
	fs	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_{IH3}, V_{IL3}: In the SLOW or HOLD mode.

DC Characteristics

(V_{SS} = 0V, 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, RESET, HOLD	V_{DD} = 5.5 V, V_{IN} = 5.5 V / 0 V	–	–	± 2	μA
	I_{IN2}	Ports R (open drain)					
Low Input Current	I_{IL}	Ports R (push-pull)	V_{DD} = 5.5 V, V_{IN} = 0.4 V	–	–	– 2	mA
Input Resistance	R_{IN1}	Port KO with pull-up/pull-down		30	70	150	kΩ
	R_{IN2}	RESET		100	220	450	
Output Leakage Current	I_{LO}	Ports (open drain)	V_{DD} = 5.5 V, V_{OUT} = 5.5 V	–	–	2	μA
Output Low Voltage	V_{OL}	Except XOUT, ports P	V_{DD} = 4.5 V, I_{OL} = 1.6 mA	–	–	0.4	V
Output Low Current	I_{OL}	Ports P1, P2	V_{DD} = 4.5 V, V_{OL} = 1.0 V	–	20	–	mA
Supply Current (in the Normal mode)	I_{DD}		V_{DD} = 5.5 V fc = 4 MHz	–	3	6	mA
Supply Current (in the SLOW mode)	I_{DDS}		V_{DD} = 3.0 V fs = 32.768 kHz	–	30	60	μA
Supply Current (in the HOLD mode)	I_{DDH}		V_{DD} = 5.5 V	–	0.5	10	μA

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

Note 2: Input Current I_{IN1} ; The current through resistor is not included, when the input resistor (pull-up/pull-down) is contained.

Note 3: 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} ; V_{IN} = 2.8 V / 0.2 V
Low frequency clock is only osillated (connecting XTIN, XTOUT).

AD Conversion Characteristics

(T_{opr} = – 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 5.5 V, V_{SS} = 0.0 V V_{AREF} = V_{DD} ± 0.001 V V_{ASS} = 0.000 V	–	–	± 1	LSB
Zero Point Error			–	–	± 1	
Full Scale Error			–	–	± 1	
Total Error			–	–	± 2	

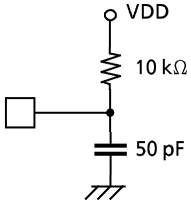
AC Characteristics

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

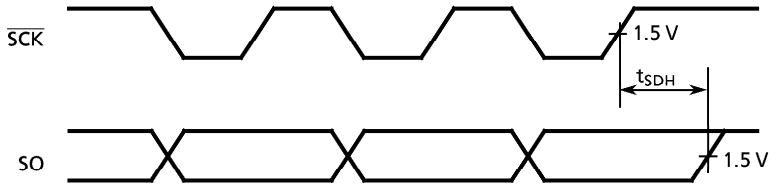
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Instruction Cycle Time	t_{cy}	In the Normal mode	1.3	—	20	μs
		In the SLOW mode	235	—	267	
High level Clock pulse Width	t_{WCH}	External clock mode	80	—	—	ns
Low level Clock pulse Width	t_{WCL}					
A / D Sampling Time	t_{AIN}	fc = 4 MHz	—	4	—	μs
Shift Data Hold Time	t_{SDH}		0.5 tcy – 0.3	—	—	μs

Note: Shift Data Hold Time

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



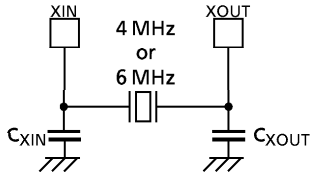
Serial port (completion of transmission)



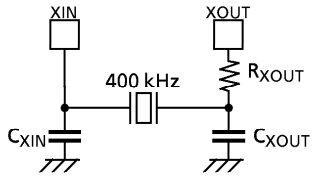
Recommended Oscillating Conditions

(V_{SS} = 0 V, V_{DD} = 4.5 to 6.0 V, Topr = – 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

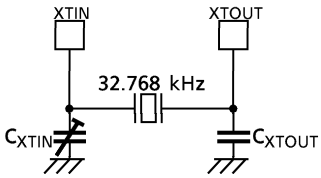


(2) 4 MHz
Ceramic Resonator
CSA4.00MG (MURATA) $C_{XIN} = C_{XOUT}$ = 30 pF
KBR-4.00MS (KYOCERA) $C_{XIN} = C_{XOUT}$ = 30 pF
Crystal Oscillator
204B-6F 4.0000 (TOYOCOM) $C_{XIN} = C_{XOUT}$ = 20 pF



(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 = 0V, V_{DD} = 2.7 to 6.0V, T_{opr} = – 40 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