CMOS 4-Bit Microcontroller

TMP47C241N
TMP47C241M

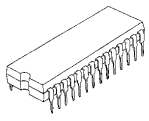
The TMP47C241 are high speed and high performance 4-bit single chip micro computers, integrating 8-bit AD converter, watchdog timer and serial Interface based on the TLCS-47 series.

Part No.	ROM	RAM	Rackage	OTP
TMP47C241N	2048 × 8-bit	128 × 4-bit	P-SDIP28-400-1.78	TMP47P241VN
TMP47C241M			P-SOP28-450-1.27	TMP47P241VM

Features

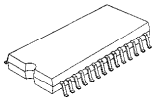
◆4-bit single chip microcomputer
◆Instruction execution time: 1.3 μs (at 6 MHz)
◆Low voltage operation: 2.7 V (at 4.2 MHz)
◆90 basic instructions
  ●Table look-up instructions
◆Subroutine nesting: 15 levels max
◆6 interrupt sources (External: 2, Internal: 4)
  All sources have independent latches each, and multiple interrupt control is available
◆I/O port (21 pins)
  - Input 2 ports 5 pins
  - Output 2 ports 5 pins
  - I/O 4 ports 11 pins
◆Two 12-bit Timer / Counters
  Timer, event counter, and pulse width measurement mode
◆Interval timer
◆Watchdog Timer
◆Serial Interface with 4-bit buffer
  External / internal clock, and leading / trailing edge shift mode

P-SDIP28-400-1.78



TMP47C241N
TMP47P241VN

P-SOP28-450-1.27



TMP47C241M
TMP47P241VM

◆8-bit successive approximate type AD converter
(With sample and hold)
- 4 analog inputs
- Converting time: 48 μs (4 MHz)

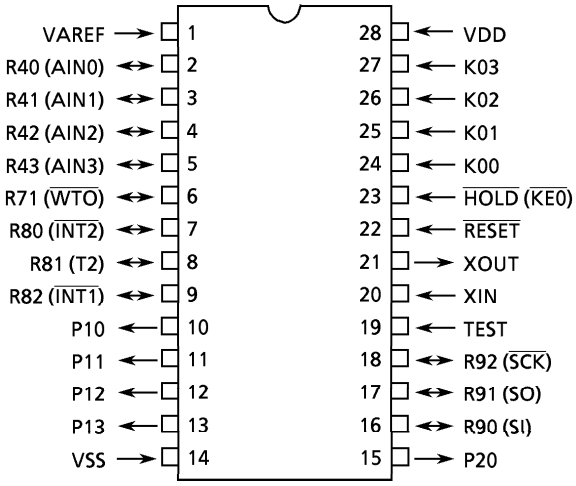
◆High current outputs
LED direct drive capability: typ. 20 mA × 5 bits (Ports P1, P2)
typ. 7 mA × 3 bits (Port R9)

◆Hold function
Battery / Capacitor back-up

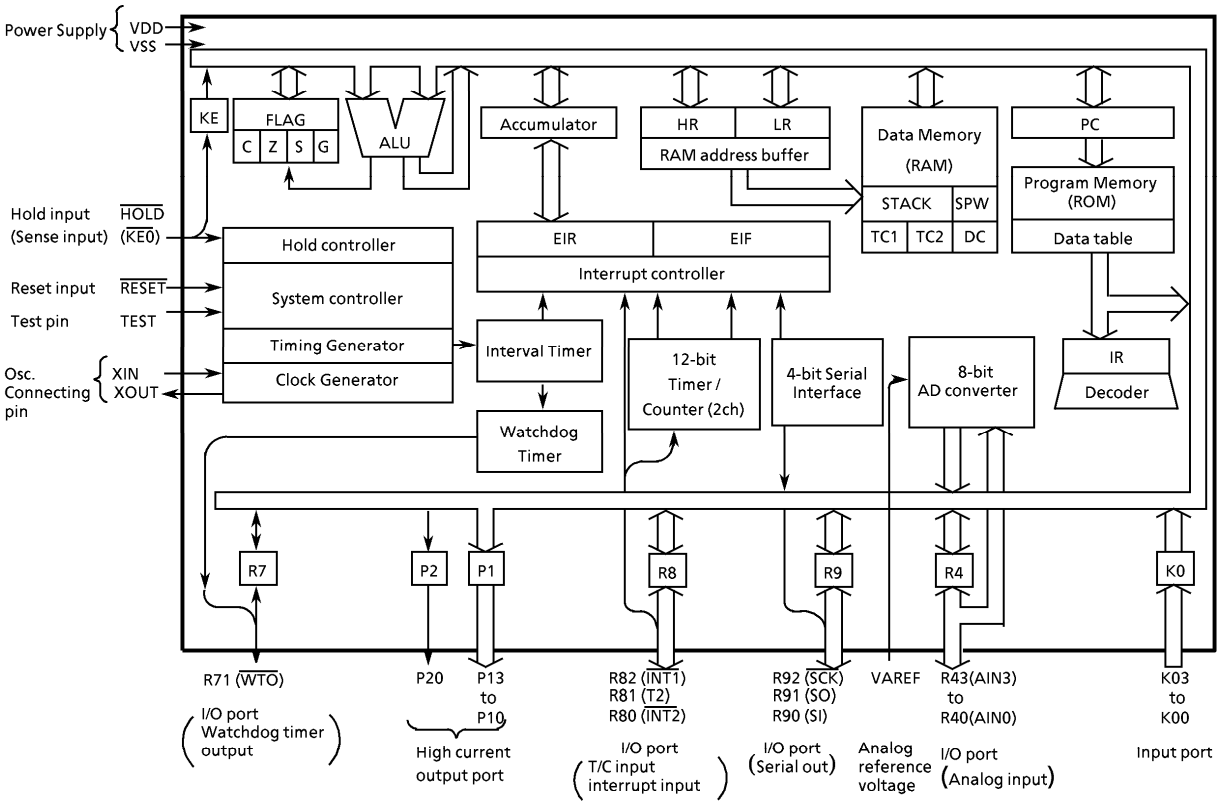
◆Real Time Emulator: BM47214A + BM1152 (SDIP)

Pin Assignment (Top View)

P-SDIP28-400-1.78 / P-SOP28-450-1.27



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.	
P20		1-bit output port with latch.	
R43 (AIN3) to R40 (AIN0)	I/O (Input)	4-bit I/O port with latch. When using as input port, the latch must be set to "1".	AD converter analog input
R71 ($\overline{WTO}$)	I/O (Output)	1-bit I/O port with latch. When using as input port or watchdog timer output, the latch must be set to "1".	Watchdog timer output
R82 ($\overline{INT1}$)	I/O (Input)	3-bit I/O port with latch. When using as input port, external interrupt input pin, or timer / counter external input pin, the latch must be set to "1".	External interrupt 1 input
R81 (T2)			Timer / Counter 2 external input
R80 ($\overline{INT2}$)			External interrupt 2 input
R92 ($\overline{SCK}$)	I/O (I/O)	3-bit I/O port with latch. When using 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. 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	Sense 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)	AD converter analog reference voltage (GND)
VAREF		AD converter analog reference voltage	

Operational Description

Conserning the TMP47C241, the hardware configuration and operation are described.
The configuration of basic machine instruction for TMP47C241 is same as TLCS-47 Series.

1. System Configuration

(1) Internal CPU Function

These as the same as the TMP47C203.

(2) Peripheral Hardware Function

① I/O Ports	④ AD converter
② Interval Timer	⑤ Watchdog Timer
③ Timer/Counters	⑥ Serial Interface

2. Peripheral Hardware Function

2.1 Ports

The TMP47C241 has 8 I/O ports (21 pins) each as follows:

① K0	;	4-bit input	
② P1	;	4-bit output	
③ P2	;	1-bit output	
④ R4	;	4-bitinput / output	(shared by the AD converter analog inputs)
⑤ R7	;	1-bit input / output	(shared by the watchdog timer output)
⑥ R8	;	3-bit input / output	shared by external interrupt request input and timer / counter input)
⑦ R9	;	3-bit input / output	(shared by serial port)
⑧ KE	;	1-bit sense input	(shared by hold request / release signal input)

5 pins (typ. 20 mA) of P1, P2 ports and 3pins (typ. 7 mA) of R9 port are high current output ports which can directly drive LEDs.
Table 2-3 lists the port address assignments and the I/O instructions that can access the ports.
The 5-bit to 8-bit data conversion instruction [OUTB @HL] is invalid.

(1) Port K0 (K03 to K00)

Port K0 is a 4-bit input-only port. A pull-up or pull-down resistor can be contained by the mask option.

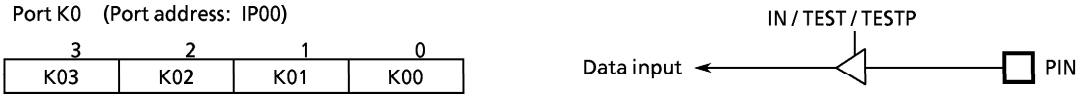


Figure 2-1. Port K0

(2) Ports P1 (P13 to P10)

Ports P1 is 4-bit high current output ports which can directly drive LEDs, with 4-bit latches. When an input instruction is executed, the latch data is read in these ports. The latch is initialized to "1" during reset.

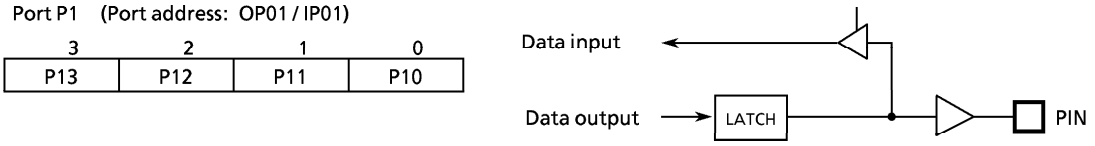


Figure 2-2. Ports P1

Electrical Characteristics

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

Parameter	Symbol	Pins	Ratings	Unit
Supply Voltage	V_{DD}		– 0.3 to 7	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}	Ports P1, P2, R7 to R9	– 0.3 to 10	
	V_{OUT3}	Analog inputs	– 0.3 to V_{DD} + 0.3	
Output Current (Per 1 pin)	I_{OUT1}	Ports P1, P2	30	mA
	I_{OUT2}	Port R9	15	
	I_{OUT3}	Ports R4, R7, R8	3.2	
Output Current (Total)	ΣI_{OUT1}	Ports P1, P2, R9	120	mA
Power Dissipation [Topr = 70°C]	PD		300	mW
Soldering Temperature (time)	Tsld		260 (10 s)	°C
Storage Temperature	Tstg		– 55 to 125	°C
Operating Temperature	Topr		– 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_{SS} = 0 V, Topr = – 30 to 70°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit
Supply Voltage	V_{DD}		fc = 6.0 MHz	4.5	6.0	V
			fc = 4.2 MHz	2.7		
			In the HOLD mode	2.0		
Input High Voltage	V_{IH1}	Except Hysteresis Input	In the normal operating area	V_{DD} × 0.7	V_{DD}	V
	V_{IH2}	Hysteresis Input		V_{DD} × 0.75		
	V_{IH3}		In the HOLD mode	V_{DD} × 0.9		
Input Low Voltage	V_{IL1}	Except Hysteresis Input	In the normal operating area	0	V_{DD} × 0.3	V
	V_{IL2}	Hysteresis Input			V_{DD} × 0.25	
	V_{IL3}		In the HOLD mode		V_{DD} × 0.1	
Clock Frequency	fc		V_{DD} = 4.5 V to 6.0 V	0.4	6.0	MHz
			V_{DD} = 2.7 V to 6.0 V		4.2	
			In the RC oscillation		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_{SS} = 0 V, Topr = – 30 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} = 5.5V, V_{IN} = 5.5V / 0V	—	—	± 2	μA
	I_{IN2}	Ports R (open drain)					
Input Resistance	R_{IN1}	Port K0 with pull-up/pull-down		30	70	150	kΩ
	R_{IN2}	$\overline{RESET}$		100	220	450	
Output Leakage Current	I_{LO}	Ports R, P (open drain)	V_{DD} = 5.5 V, V_{OUT} = 5.5 V	—	—	2	μA
Output Low Voltage	V_{OL2}	Except XOUT, ports P	V_{DD} = 4.5 V, I_{OL} = 1.6 mA	—	—	0.4	V
Low Output Current	I_{OL1}	Ports P1, P2	V_{DD} = 4.5 V, V_{OL} = 1.0 V	—	20	—	mA
	I_{OL2}	Port R9		—	7	—	
Supply Current (in the Normal mode)	I_{DD}		V_{DD} = 5.5 V, fc = 4 MHz	—	2	4	mA
			V_{DD} = 3.0 V, fc = 4 MHz	—	1	2	
			V_{DD} = 3.0 V, fc = 400 kHz	—	0.5	1	
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 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 (V_{DD} = 5.5 V), 2.8 V / 0.2 V (V_{DD} = 3.0 V)

AD Conversion Characteristics

(Topr = – 30 to 70°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Analog Reference Voltage	V_{AREF}		V_{DD} – 1.5	—	V_{DD}	V
Analog Reference Voltage Range	ΔV_{AREF}	V_{AREF} – V_{SS}	2.7	—	—	V
Analog Input Voltage	V_{AIN}		V_{SS}	—	V_{AREF}	V
Analog Supply current	I_{REF}		—	0.5	1.0	mA
Nonlinearity Error		V_{DD} = 5.0 V, V_{SS} = 0.0 V, V_{AREF} = 5.000 V, V_{ASS} = 0.000 V	—	—	± 1	LSB
Zero Point Error			—	—	± 1	
Full Scale Error			—	—	± 1	
Total Error			—	—	± 2	

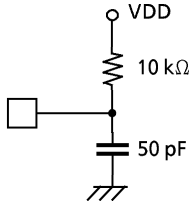
AC Characteristics

(V_{SS} = 0 V, Topr = – 30 to 70°C)

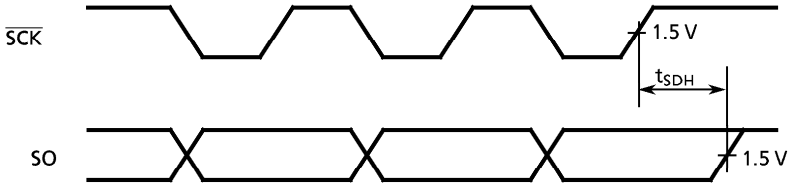
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Instruction Cycle Time	t_{cy}	V_{DD} = 4.5 to 6.0 V	1.3	—	20	μs
		V_{DD} = 2.7 to 6.0 V	1.9			
High level Clock pulse Width	t_{WCH}	External clock mode	80	—	—	ns
Low level Clock pulse Width	t_{WCL}					
AD Sampling Time	t_{AIN}		—	4	—	μs
Shift Data Hold Time	t_{SDH}		0.5 t_{cy} – 0.3	—	—	μs

Note: Shift Data Hold Time

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



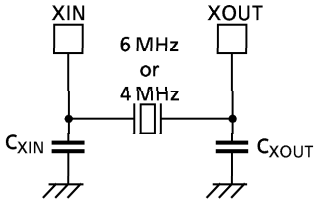
Serial port (completion of transmission)



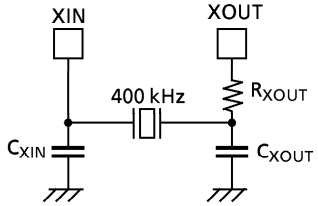
Recommended Oscillating Conditions

(V_{SS} = 0 V, V_{DD} = 2.7 to 6.0 V, Topr = – 30 to 70°C)

(1) 6 MHz
Ceramic Resonator
CSA6. 00MG (MURATA) $C_{XIN} = C_{XOUT}$ = 30 pF
KBR-6. 00MS (KYOCERA) $C_{XIN} = C_{XOUT}$ = 30 pF

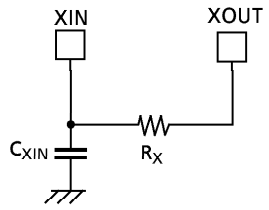


(2) 4 MHz
Ceramic Resonator
CSA4. 00MG (MURATA) $C_{XIN} = C_{XOUT}$ = 30 pF
KBR-4. 00MS (KYOCERA) $C_{XIN} = C_{XOUT}$ = 30 pF
FCR4.0M5 (TDK) $C_{XIN} = C_{XOUT}$ = 33 pF
Crystal Oscillator
204B-6F 4. 0000 (TOYOCOM) $C_{XIN} = C_{XOUT}$ = 20 pF



(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) RC Oscillation (V_{SS} = 0 V, V_{DD} = 5.0 V, Topr = 25°C)
2 MHz (typ.) C_{XIN} = 33 pF, R_X = 10 kΩ
400 kHz (typ.) C_{XIN} = 100 pF, R_X = 26 kΩ



Typical Characteristics