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

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	D OFBOO 1430 0 00B	TN4D47D047\/F
TMP47C847F	8192 × 8-bit	512 × 4-bit	P-QFP80-1420-0.80B	TMP47P847VF

Features

- ◆4-bit signal chip mocrocomputer
- ◆Instruction execution time:

1.3 μ s (at 6 MHz), 244 μ s (at 32.8 kHz)

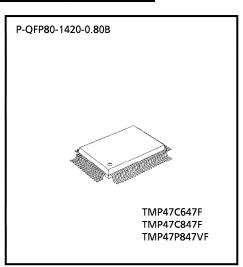
- ◆92 basic instrutions
 - Table look-up instructions
 - 5-bit to 8-bit data conversion instruction
- ◆Subroutine nesting: 15 levels max.
- ◆6 interrupt sources (External: 2. Internal: 4)

All sources have independent latchs each, and multiple interrupt control is available.

- ♦I/O port (35 pins)
 - Input 5 pins 2 ports 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



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- ◆8-bit successive approximate type AD converter
 - With sample and hold
 - 8 analog inputs
 - Conversion time: 32 μ s (at 6 MHz)
- **♦**Pluse Output

Output frequency select

♦ High current outputs

LED direct drive is available (typ. 10 mA x 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

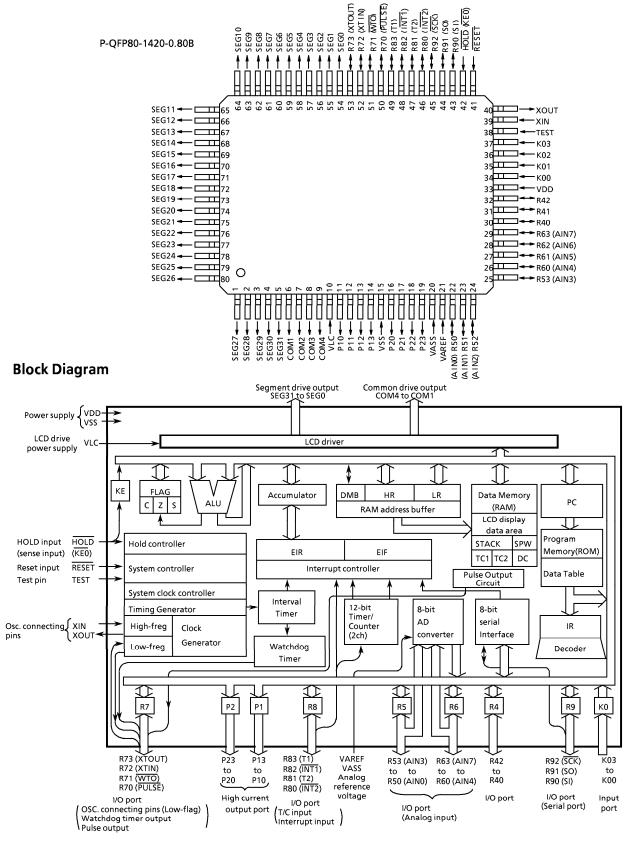
High-speed/Low-power-consumption operating mode

◆Hold function

Battery/Capacitor back-up

- **♦**SLEEP function
 - Battery/Capacitor back-up
 - LCD is displaying
- ◆Real Time Emulator: BM47C847F0A

Pin Assignments (Top View)



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Pin Function

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

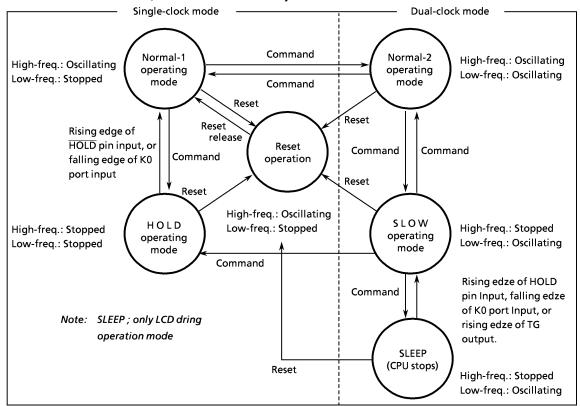


Figure 2-1. Operating mode transition diagram

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	
Outrout Valtage	V _{OUT1}	Except sink open drain pin	- 0.3 to V _{DD} + 0.3		
Output Voltage	V _{OUT2}	Sink open drain pin	- 0.3 to 10	V	
Output Compant (Pau 1 min)	I _{OUT1}	Ports P1, P2	15	4	
Output Current (Per 1 pin)	I _{OUT2}	Ports R4 to R9	3.2	mA	
Output Current (Total)	Σ I _{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

 $(V_{SS} = 0 \text{ V}, \text{ Topr} = -40 \text{ to } 70^{\circ}\text{C})$

Parameter	Symbol	Pins	Conditions	Min	Max	Unit
			In the Normal mode	4.5		
			In the SLOW mode	2.7	6.0	l v
Supply Voltage	V _{DD}		In the SLEEP mode	2.7		
			In the HOLD mode	2.0		Ì
Input High Voltage	V _{IH1}	Except Hysteresis Input	V > 4.5V	$V_{DD} \times 0.7$		
	V_{IH2}	Hysteresis Input	$V_{DD} \ge 4.5V$	$V_{DD} \times 0.75$	V_{DD}	V
	V _{IH3}		V_{DD} < 4.5V	$V_{DD} \times 0.9$		
	V_{IL1}	Except Hysteresis Input	V > 4.EV		$V_{DD} \times 0.3$	
Input Low Voltage	V_{IL2}	Hysteresis Input	$V_{DD} \ge 4.5V$	0	$V_{DD} \times 0.25$	V
	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.

 $(V_{SS} = 0 \text{ V}, \text{ Topr} = -40 \text{ to } 70^{\circ}\text{C})$

Parameter	Symbol	Pins	Conditions	Min	Тур.	Max	Unit
Hysteresis Voltage	V _{HS}	Hysteresis Input		_	0.7	_	V
	I _{IN1}	Port K0, TEST, RESET, HOLD	V _{DD} = 5.5 V,				
Input Current	I _{IN2}	Open drain R port	V _{IN} = 5.5 V / 0 V		_	± 2	μΑ
Input Low Current	I _{IL}	Push-pull R port	$V_{DD} = 5.5 \text{ V}, \ V_{IN} = 0.4 \text{ V}$	_	_	- 2	mA
	R _{IN1}	Port K0 with pull-up / pull- down resistor		30	70	150	
Input Resistance	R _{IN2}	RESET		100	220	450	kΩ
Output Leakage Current	I _{LO}	Open drain ports P, R	V _{DD} = 5.5 V, V _{OUT} = 5.5 V	_	_	2	μΑ
Output High Voltage	V _{OH}	Push-pull R port	$V_{DD} = 4.5 \text{ V}, I_{OH} = -200 \mu\text{A}$	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					
Common Output Low	P	COM pip		-	20	_	

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

COM pin

SEG pin

COM pin

SEG / COM pin

 R_{OC1}

 R_{OS2}

 R_{OC2}

 $V_{O2/3}$

V_{O1/2}

 $V_{O1/3}$

 I_{DD}

 I_{DDS}

Resistance

Resistance

Resistance

Segment Output High

Common Output High

Segment / Common

(in the Normal mode)

(in the SLOW mode)

(in the HOLD mode)

Output Voltage

Supply Current

Supply Current

Supply Current

DC Characteristics

Note 2: Input Current IIN1; The current through resistor is not included, when the input resistor (pull-up / pulldown) 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} ; $V_{IN} = 5.3 \text{ V}/0.2 \text{ V}$

The KO port is open when the input resistor is contained.

The voltage applied to the R port is within the valid range.

 $V_{DD} = 5 V, V_{DD} - V_{LC} = 3 V$

 $V_{DD} = 5.5 \text{ V}, \ V_{LC} = V_{SS}$

 $V_{DD} = 3.0 \text{ V}, \ V_{LC} = V_{SS}$

fc = 4 MHz

 $V_{DD} = 5.5 V$

 $fs = 32.768 \, kHz$

VIN = 2.8 V / 0.2 V Only low frequency clock is only oscillated (connecting XTIN, Supply Current I_{DDS}

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} : $1/(n \cdot f_F)$

(1/n: duty, f_F : frame frequency)

 $\mathbf{k}\Omega$

٧

mΑ

 μ A

 μA

200

4.0

3.5

3.0

3

30

15

0.5

3.7

3.2

6

60

30

10

3.8

3.3

2.8

_

AD Conversion Characteristics

 $(Topr = -40 \text{ to } 70^{\circ}C)$

Parameter	Symbol	Conditions	Min	Тур.	Max	Unit
Analog Reference Voltage	V _{AREF}		V _{DD} _ 1.5	_	V_{DD}	
Arialog Reference voltage	V _{ASS}		V _{SS}	_	1.5	V
Analog Reference Voltage Range	$_{\Delta}V_{AREF}$	V _{AREF} -V _{ASS}	2.5	_	_	\ \
Analog Input Voltage	V _{AIN}		V _{ASS}	_	V _{AREF}	V
Analog Supply Current	I _{REF}		_	0.5	1.0	mA
Nonlinearity Error			_	_	± 1	
Zero Point Error		$V_{DD} = 4.5 \text{ to } 6.0 \text{V}, V_{SS} = 0.0 \text{V}$	_	_	± 1	LCD
Full Scale Error		$V_{AREF} = V_{DD} \pm 0.001V$	_	_	± 1	LSB
Total Error		$V_{ASS} = 0.000V$	_	_	± 2	

AC Characteristics

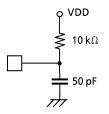
 $(V_{SS} = 0 \text{ V}, V_{DD} = 4.5 \text{ to } 6.0 \text{ V}, Topr = -40 \text{ to } 70^{\circ}\text{C})$

Parameter	Symbol	Conditions	Min	Тур.	Max	Unit
Instruction Cycle Time	tov	In the Normal mode	1.3	_	20	μS
instruction cycle rime	tcy	In the SLOW mode	235	_	267	μs
High Level Clock Pulse Width	t _{WCH}	For outomod alock an areation	80			
Low Level Clock Pulse Width	t _{WCL}	For external clock operation	80		_	ns
Shift data Hold Time	t _{SDH}		0.5 tcy – 0.3	_	_	μs
AD Sampling Time	t _{AIN}	fc = 4 MHz	_	4	_	μs

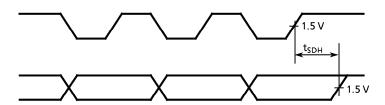
Note: Shift data Hold time:

External circuit for SCK pin and SO pin

Serial port (completion of transmission)



 $\overline{\mathsf{SCK}}$ SO



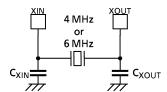
Recommended Oscillating Conditions

 $(V_{SS} = 0 \text{ V}, V_{DD} = 4.5 \text{ to } 6.0 \text{ V}, T_{opr} = -40 \text{ to } 70^{\circ}\text{C})$

(1) 6 MHz

Ceramic Resonator

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

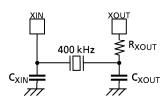


(2) 4 MHz

Ceramic Resonator

 $\begin{array}{lll} \text{CSA4.00MG} & \text{(MURATA)} & \text{C}_{\text{XIN}} = \text{C}_{\text{XOUT}} = 30 \text{ pF} \\ \text{KBR-4.00MS} & \text{(KYOCERA)} & \text{C}_{\text{XIN}} = \text{C}_{\text{XOUT}} = 30 \text{ pF} \\ \text{FCR4.0M5} & \text{(TDK)} & \text{C}_{\text{XIN}} = \text{C}_{\text{XOUT}} = 33 \text{ pF} \\ \text{Crystal Oscillator} \end{array}$

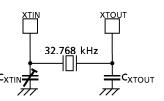
204B-6F 4.0000 (TOYOCOM) $C_{XIN} = C_{XOUT} = 20 \text{ pF}$



(3) 400 kHz

Ceramic Resonator

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



(4) 32.768 kHz (Vss = 0 V, V_{DD} = 2.7 to 6.0 V, T_{opr} = -30 to 70°C)

Crystal Oscillator CXTIN, CXTOUT; 10 to 33 pF

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

Typical Characteristics

