CMOS 4-Bit Microcontroller

TMP47C456ADF

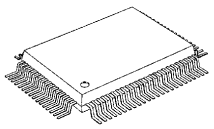
The TMP47C456A is a high speed and high performance 4-bit single chip microcomputer based on the TLCS-47 CMOS series. The TMP47C456A has LCD driver, DTMF generator and large-capacity RAM for repertory dial, which is suitable for application in telephones. The TMP47C456A has two oscillation circuits. It is possible to switch the operating mode ; high speed operation and low power consumption operation.

Part No.	ROM	RAM	Package	Piggyback
TMP47C456ADF	4096 × 8-bit	768 × 4-bit	P-QFP80-1420-0.80B	TMP47C956AG

Features

- ◆4-bit single chip microcomputer
- ◆Instruction execution time:
  8.3 μs (at 960 kHz), 244 μs (at 32.8 kHz)
- ◆Low voltage operation: 2.7 V min
- ◆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 (34 pins)
  - Input 1 port 4 pins
  - I/O 7 ports 27 pins
  - Output 1 port 3 pins
- ◆Interval Timer
- ◆Two 12-bit Timer / Counters
  Timer, event counter, and pulse width measurement mode
- ◆Watchdog Timer
- ◆Serial Interface with 4-bit buffer
  External/internal clock, and leading/trailing edge shift mode

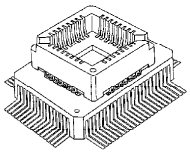
P-QFP80-1420-0.80B



TMP47C456ADF

Note: Refer to PACKAGE of chapter 9.

QFC80



TMP47C956AG

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◆LCD driver (automatic display)
- LCD direct drive (Max 16-digit display at 1/4 duty LCD)
- 1/4, 1/3, 1/2 duties or static drive are programmably selectable.

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- LCD direct drive (Max 16-digit display at 1/4 duty LCD)
- 1/4, 1/3, 1/2 duties or static drive are programmably selectable.

◆DTMF (Dual Tone Multi Frequency) output
- DTMF output with one instruction
- Single tone output function

◆RAM for repartry dial: 768 × 4-bit max

◆BEEP output function

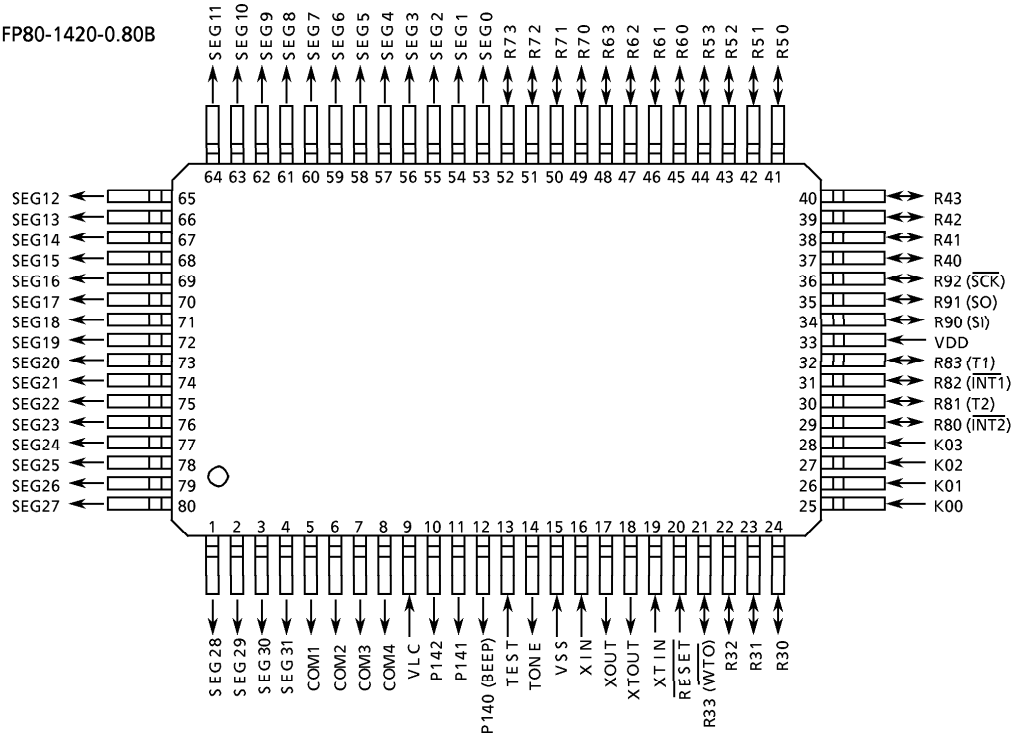
◆Dual-clock operation

High-speed / Low-power-consumption operating mode

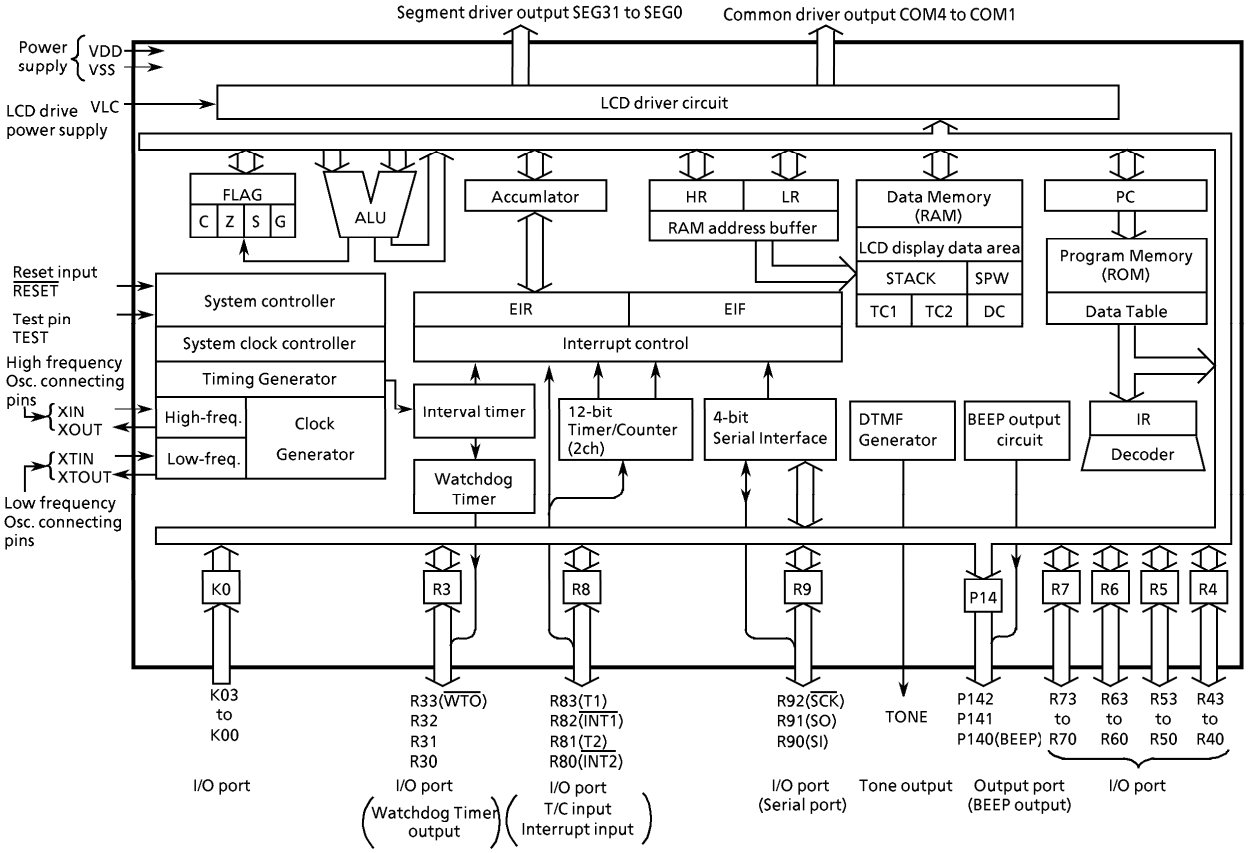
◆Real Time Emulator: BM47216A

Pin Assignment (Top View)

P-QFP80-1420-0.80B



Block Diagram



Pin Function

Pin Name	Input/Output	Functions	
K03 to K00	Input	4-bit input port	
R33 ($\overline{WTO}$)	I/O (Output)	4-bit I/O port with latch. When used as the input port, the latch must be set to "1".	Watchdog timer output
R32 to R30	I/O		
R43 to R40	I/O	4-bit I/O port with latch. When used as the input port, the latch must be set to "1".	
R53 to R50			
R63 to R60			
R73 to R70			
R83 (T1)	I/O (Input)	4-bit I/O port with latch. When used as the input port, external interrupt input pin, or timer/counter input pin, the latch must be set to "1".	Timer/Counter 1 external input
R82 ($\overline{INT1}$)			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 used as the 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
P142, P141	Output	3-bit I/O port with latch	
P140 (BEEP)	Output (Output)		BEEP output
SEG31 to SEG0	Output	LCD Segment driver output	
COM4 to COM1		LCD Common driver output	
TONE	Output	Tone output	
XIN	Input	Resonator connecting pins (High-frequency).	
XOUT	Output	For inputting external clock, XIN is used and XOUT is opened.	
XTIN	Input	Resonator connecting pins (Low-frequency).	
XTOUT	Output	For inputting external clock, XIN is used and XOUT is opened.	
$\overline{RESET}$	Input	Reset signal input	
TEST	Input	Test pin for shipping test. Be opened or fixed to low level.	
VDD	Power Supply	+ 2.7 V to 6.0 V	
VSS		0 V (GND)	
VLC		LCD drive power supply	

Operational Description

Concerning the TMP47C456A the configuration and functions of hardwares are described. As the description has been provided with priority on those parts differing from the TMP47C452B, the technical data sheets for the TMP47C452B shall also be referred to.

1. System Configuration

(1) CPU Core Function
The functions are the same as those of the TMP47C452B.

(2) Peripheral Hardware Functions

① I/O Port
② Interval Timer
③ Timer/Counter
④ Watchdog Timer
⑤ LCD Driver
⑥ DTMF Generator
⑦ BEEP Output Circuit
⑧ Serial Interface

2. CPU Core Functions

2.1 Data Memory

The TMP47C456A has a total of 768 × 4bits of data memory. This memory is same as the data memory built into the TMP47C452B, so refer to the technical data sheets for the TMP47C452B for an explanation of the operation.

2.2 System Clock Controller

The TMP47C456A has two oscillation circuits with a high-frequency clock and a low-frequency clock. Power consumption can be decreased by switching to low-speed operation using the low-frequency clock when necessary (dual clock operation) . The high-frequency clock can be obtained by connecting an oscillator to the XIN and XOUT pins; the low-frequency clock can be obtained by connecting the oscillator to the XTIN and XOUT pins.

2.2.1 Circuit configuration

Figure 2-1 shows the configuration of system clock controller.

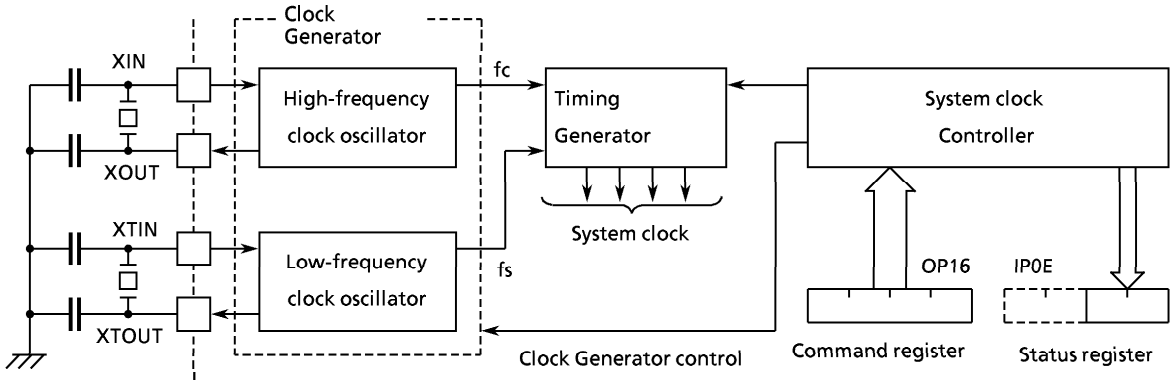


Figure 2-1. System Clock Controller

Electrical Characteristics

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

Parameter	Symbol	Pins	Rating	Unit
Supply Voltage	V_{DD}		– 0.5 to 7	V
Supply Voltage (LCD drive)	V_{LC}		– 0.5 to V_{DD} + 0.5	V
Input Voltage	V_{IN}		– 0.5 to V_{DD} + 0.5	V
Output Voltage	V_{OUT1}	Except sink open drain pin	– 0.5 to V_{DD} + 0.5	V
	V_{OUT2}	Sink open drain pin	– 0.5 to 10	
Output Current (per 1 pin)	I_{OUT}		3.2	mA
Power Dissipation [T_{opr} = 70℃]	PD		600	mW
Soldering Temperature (time)	T_{sld}		260 (10 s)	℃
Storage Temperature	T_{stg}		– 55 to 125	℃
Operating Temperature	T_{opr}		– 30 to 60	℃

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, T_{opr} = – 30 to 60°C)

Parameter	Symbol	Pins	Conditions	Min	Max	Unit
Supply Voltage	V_{DD}		In the Normal mode	2.7	6.0	V
			In the SLOW mode	2.7		
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 (High freq.)	fc	XIN, XOUT		960		kHz
Clock Frequency (Low freq.)	fs	XTIN, XTOUT		30.0	34.0	kHz

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, T_{opr} = – 30 to 60°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 $\overline{RESET}$	V_{DD} = 5.5 V, V_{IN} = 5.5 V / 0 V	—	—	± 2	μA
	I_{IN2}	Ports R (open drain)					
Low Level 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 K0 with pull-up/pull-down		30	70	150	kΩ
	R_{IN2}	$\overline{RESET}$		100	220	450	
Output Leakage Current	I_{LO}	Ports R (open drain)	V_{DD} = 5.5 V, V_{OUT} = 5.5 V	—	—	2	μA
Output Level High Voltage	V_{OH}	Ports R (push-pull)	V_{DD} = 4.5 V, I_{OH} = – 200 μA	2.4	—	—	V
Output Level Low Voltage	V_{OL2}	Except XOUT	V_{DD} = 4.5 V, I_{OL} = 1.6 mA	—	—	0.4	V
Segment Output Resistance	R_{OS}	SEG pin	V_{DD} = 5 V, V_{DD} – V_{LC} = 3 V	—	20	—	kΩ
Common Output Resistance	R_{OC}	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 Nomal mode)	I_{DD}		V_{DD} = 5.5 V, V_{LC} = V_{SS} fc = 960 kHz	—	0.6	1.2	mA
	I_{DDT}		V_{DD} = 5.5 V, V_{LC} = V_{SS} fc = 960 kHz When tone is oscillating	—	2.2	3.5	
Supply Current (in the SLOW mode)	I_{DDS}		V_{DD} = 3 V, V_{LC} = V_{SS} fs = 32.768 kHz	—	15	30	μA

Note 1: Typ. values shows 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: Output Resistance Ros, Roc: 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.
$V_{O1/2}$: Shows 1/2 level output voltage, when the 1/2 duty or static LCD is used.
$V_{O1/3}$: Shows 1/3 level output voltage, when the 1/4 or 1/3 duty LCD is used.

Note 5: Supply Current I_{DD}: V_{IN} = 5.3 V / 0.2 V
The port K0 is open when the input resistor is contained.
The voltage applied to the port R is within the valid range.

Note 6: Supply Current I_{DDS}: V_{IN} = 2.8 V / 0.2 V. Only low frequency clock is only osillated (connecting XTIN, XTOUT).

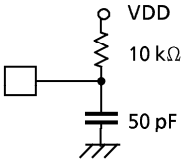
AC Characteristics

(V_{SS} = 0 V, V_{DD} = 2.7 to 6.0 V, T_{opr} = – 30 to 60°C)

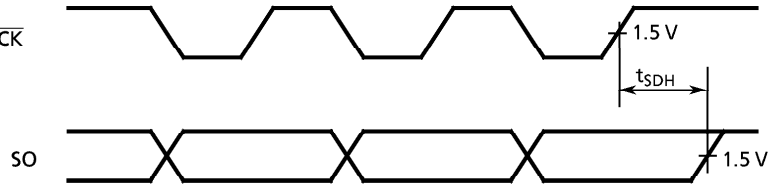
Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Instruction Cycle Time	t_{cy}	In the Normal mode	8.3			μs
		In the SLOW mode	235	—	267	μs
High level Clock pulse Width	t_{WCH}	External clock	80	—	—	ns
Low level Clock pulse Width	t_{WCL}					
Shift Data Hold Time	t_{SDH}		0.5tcy – 0.3	—	—	μs

Note: Shift Data Hold Time:

External Circuit for $\overline{SCK}$ pin and SO pin.



Serial port (completion of transmission)



Tone Output Characteristics

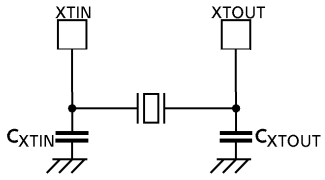
(V_{SS} = 0 V, V_{DD} = 2.7 to 6.0 V, T_{opr} = – 30 to 60°C)

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Tone Output Voltage (ROW)	V_{TONE}	RL ≧ 10 kΩ, V_{DD} = 2.7 V	125	185	250	mVrms
Pre-emphasis High Band (COL / ROW)	PEHB	PEHB = 20 log (COL /ROW)	1	2	3	dB
Output Distortion	DIS		—	—	10	%
Frequency Stability	△f	Except error of osc. frequency	—	—	0.7	%

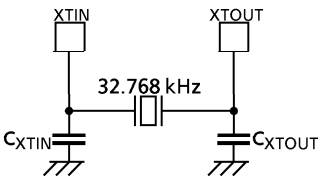
Recommended Oscillating Conditions

(V_{SS} = 0 V, VDD = 2.7 to 6.0 V, Topr = – 30 to 60°C)

(1) 960 kHz
Ceramic Resonator
KBR - 960H3 (KYOCERA) $C_{XIN} = C_{XOUT}$ = 100 pF
CSB960J21 (MURATA) $C_{XIN} = C_{XOUT}$ = 220 pF

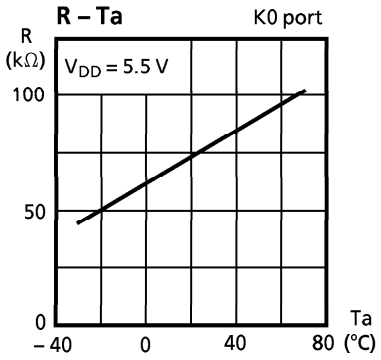


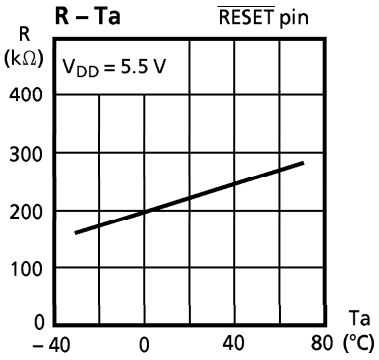
(2) 32.768 kHz
Crystal Oscillator C_{XTIN}, C_{XTOUT} ; 10 to 33 pF

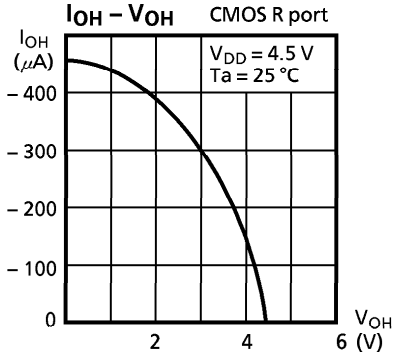


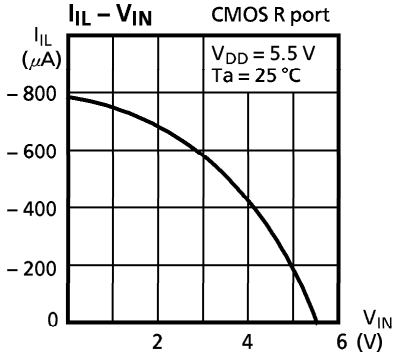
Note: In order to get the accurate oscillation frequency, the adjustment of capacitors must be required.

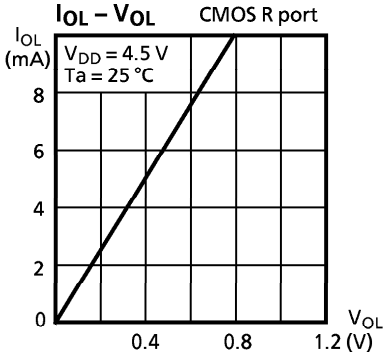
Typical Characteristics

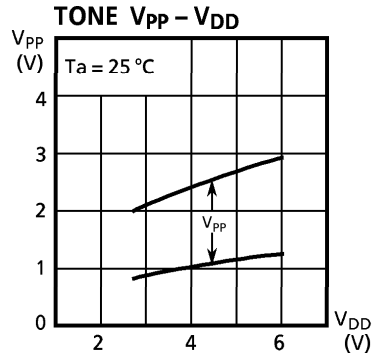


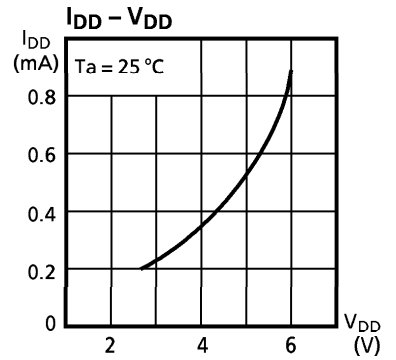


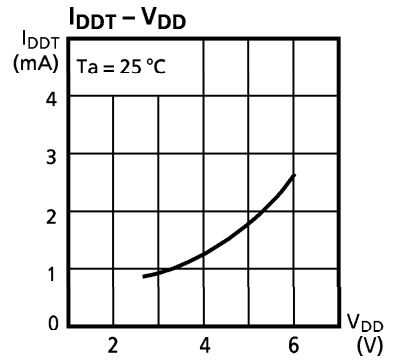












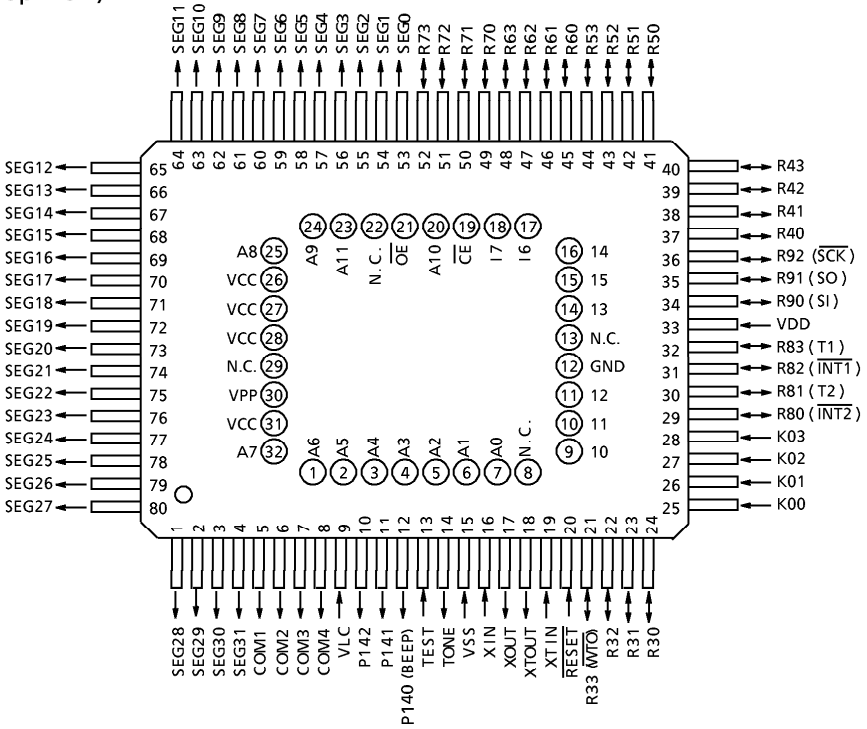
CMOS 4-Bit Microcontroller

TMP47C956AG

The TMP47C956A, which is equipped with an EPROM as program memory, is a piggyback type evaluator chip used for development and operational confirmation of the TMP47C456A application systems (programs). The TMP47C956A is pin compatible with the TMP47C456A which is mask-programmed ROM device.

Pin Assignment (Top View)

QFC80



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- For a discussion of how the reliability of microcontrollers can be predicted, please refer to Section 1.3 of the chapter entitled Quality and Reliability Assurance / Handling Precautions.
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Pin Function (Top of the package)

Pin Name	Input / Output	Functions
A11 to A0	Output	Program memory address output
I7 to I0	Input	Program memory data input
$\overline{CE}$	Output	Chip enable signal output
$\overline{OE}$		Output enable signal output
VCC	Power supply	+ 5 V (connected with VDD)
GND		0 V (connected with VSS)

AC Characteristics

Parameter	Symbol	Conditions	Min	Typ.	Max	Unit
Address Delay Time	t_{AD}	V_{SS} = 0 V, V_{DD} = 2.7 to 6.0 V C_L = 100 pF Topr = − 30 to 60℃	—	—	150	ns
Data Setup Time	t_{IS}		150	—	—	ns
Data Hold Time	t_{IH}		50	—	—	ns

Notes for Use

(1) Program memory
The program area is shown in Figure 1.

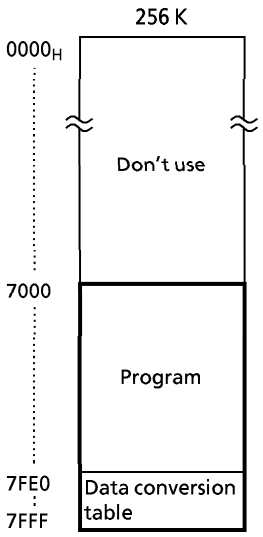

Figure 1. Program area

(2) I/O ports
Input/Output circuitries of the TMP47C956A I/O ports are similar to the code WB of the TMP47C456A.
When this chip is used as evaluator with other I/O code, it is necessary to provide the external resistors.

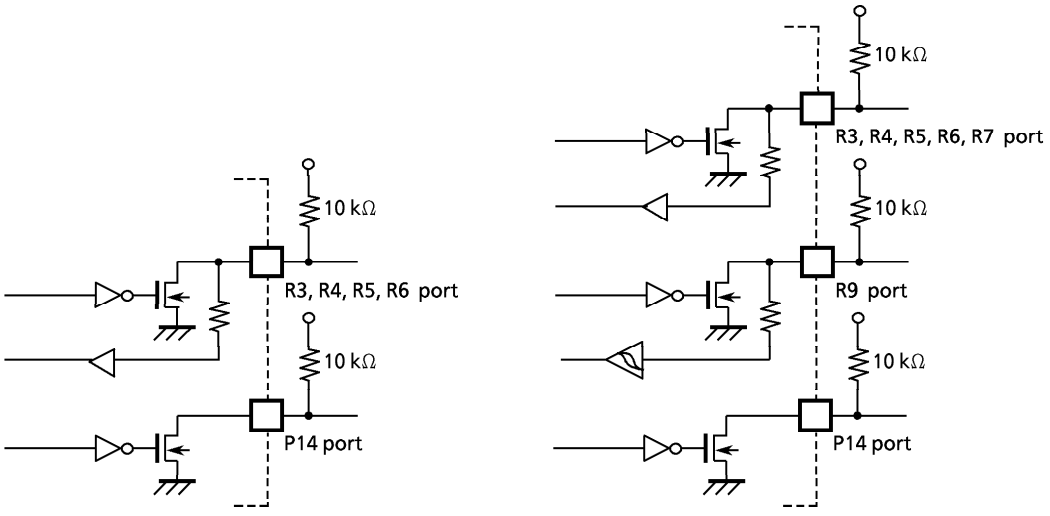

Figure 2. I/O code and external circuity