

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74LCX05F, TC74LCX05FK

Low-Voltage HEX Inverter with 5-V Tolerant Inputs and Outputs (open-drain)

The TC74LCX05 is a high-performance CMOS inverter.

Designed for use in 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

Pin configuration and function are the same as the TC74LCX04, but the TC74LCX05F/FK has high performance MOS N-channel transistor. (open-drain outputs)

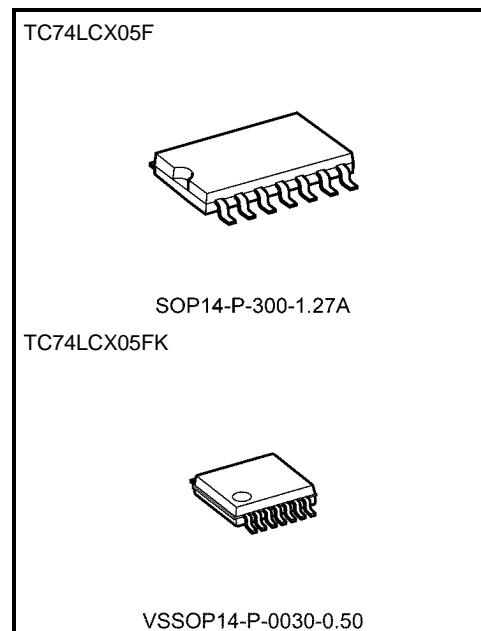
The device is designed for low-voltage (3.3 V) VCC applications, but it could be used to interface to 5-V supply\* environment for inputs.

All inputs are equipped with protection circuits against static discharge.

\*IOUT absolute maximum rating must be observed.

## Features

- Low-voltage operation: VCC = 1.65 to 5.5 V
- High-speed operation: t<sub>pz</sub> = 5.0 ns (max) (VCC = 3.0 to 3.6 V)
- Output current: I<sub>OL</sub> = 24 mA (min) (VCC = 3.0 V)
- Available in JEITA SOP, VSSOP (US)
- Open-drain outputs
- Power-down protection is provided on all inputs and outputs
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 05 type



Weight

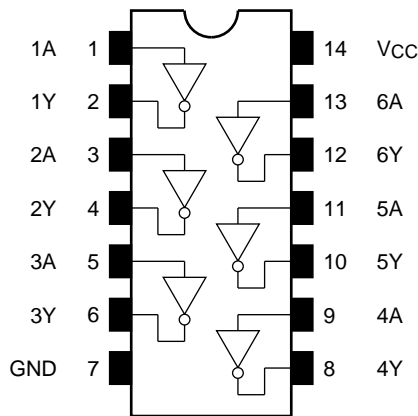
SOP14-P-300-1.27A : 0.18 g ( typ.)

VSSOP14-P-0030-0.50 : 0.02 g ( typ.)

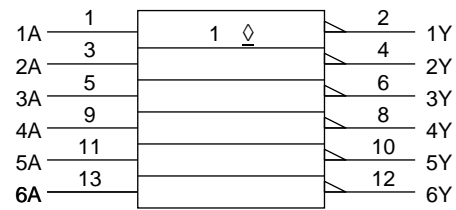
Note: The Electrical Characteristics of VCC = 1.8 ± 0.15 V and that of VCC = 5.0 ± 0.5 V are only applicable for products which manufactured from January 2009 onward.

Start of commercial production  
1999-10

### Pin Assignment (top view)



### IEC Logic Symbol

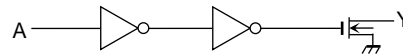


### Truth Table

Inputs	Outputs
A	Y
L	Z
H	L

Z: High impedance

### System Diagram (per gate)



### Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	$V_{CC}$	-0.5 to 7.0	V
DC input voltage	$V_{IN}$	-0.5 to 7.0	V
DC output voltage	$V_{OUT}$	-0.5 to 7.0 (Note 2)	V
Input diode current	$I_{IK}$	-50	mA
Output diode current	$I_{OK}$	-50 (Note 3)	mA
DC output current	$I_{OUT}$	50	mA
Power dissipation	$P_D$	180	mW
DC $V_{CC}$ /ground current	$I_{CC}/I_{GND}$	$\pm 100$	mA
Storage temperature	$T_{stg}$	-65 to 150	$^{\circ}C$

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 2: Output in OFF state.  $I_{OUT}$  absolute maximum rating must be observed (Output in low state)

Note 3:  $V_{OUT} < GND$

### Operating Ranges (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	VCC	1.65 to 5.5	V
		1.5 to 5.5 (Note 2)	
Input voltage	V <sub>IN</sub>	0 to 5.5	V
Output voltage	V <sub>OUT</sub>	0 to 5.5	V
Output current	I <sub>OL</sub>	32 (Note 3)	mA
		24 (Note 4)	
		12 (Note 5)	
Operating temperature	T <sub>opr</sub>	-40 to 85	°C
Input rise and fall time	dt/dv	0 to 10 (Note 6)	ns/V

Note 1: The operating ranges must be maintained to ensure the normal operation of the device.  
Unused inputs must be tied to either VCC or GND.

Note 2: Data retention only

Note 3: VCC = 4.5 to 5.5 V

Note 4: VCC = 3.0 to 3.6 V

Note 5: VCC = 2.7 to 3.0 V

Note 6: VCC = 1.65 to 5.5 V

### Electrical Characteristics

#### DC Characteristics (Ta = -40 to 85°C)

Characteristics		Symbol	Test Condition	V <sub>CC</sub> (V)	Min	Max	Unit
Input voltage	H-level	V <sub>IH</sub>	—	1.65 to 2.3	V <sub>CC</sub> × 0.9	—	V
				2.3 to 2.7	1.7	—	
				2.7 to 3.6	2.0	—	
				4.5 to 5.5	V <sub>CC</sub> × 0.7	—	
	L-level	V <sub>IL</sub>	—	1.65 to 2.3	—	V <sub>CC</sub> × 0.1	
				2.3 to 2.7	—	0.7	
				2.7 to 3.6	—	0.8	
				4.5 to 5.5	—	V <sub>CC</sub> × 0.3	
Output voltage	L-level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub>	I <sub>OL</sub> = 100 μA	1.65 to 5.5	—	0.2
				I <sub>OL</sub> = 4 mA	1.65	—	0.45
				I <sub>OL</sub> = 8 mA	2.3	—	0.7
				I <sub>OL</sub> = 12 mA	2.7	—	0.4
				I <sub>OL</sub> = 16 mA	3.0	—	0.4
				I <sub>OL</sub> = 24 mA	3.0	—	0.55
				I <sub>OL</sub> = 32 mA	4.5	—	0.55
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 5.5 V	1.65 to 5.5	—	±5.0	μA
Output OFF state current		I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> , V <sub>OUT</sub> = 0 to 5.5 V	1.65 to 5.5	—	±5.0	μA
Power-off leakage current		I <sub>OFF</sub>	V <sub>IN</sub> /V <sub>OUT</sub> = 5.5 V	0	—	10.0	μA
Quiescent supply current		I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	1.65 to 5.5	—	10.0	μA
Increase in I <sub>CC</sub> per input		ΔI <sub>CC</sub>	V <sub>IH</sub> = V <sub>CC</sub> - 0.6 V (per 1 input)	2.7 to 3.6	—	500	
				4.5 to 5.5	—	1	mA

### AC Characteristics (Ta = -40 to 85°C)

Characteristics	Symbol	Test Condition	VCC (V)	Min	Max	Unit
Output enable time	tpZL	Figure 1, Figure 2	1.8 ± 0.15	1.5	26.0	ns
			2.5 ± 0.2	1.2	13.0	
			2.7	1.0	6.0	
			3.3 ± 0.3	0.8	5.0	
			5.0 ± 0.5	0.5	4.0	
Output disable time	tpLZ	Figure 1, Figure 2	1.8 ± 0.15	1.5	26.0	ns
			2.5 ± 0.2	1.2	13.0	
			2.7	1.0	6.0	
			3.3 ± 0.3	0.8	5.0	
			5.0 ± 0.5	0.5	4.0	
Output to output skew	tosZL	(Note)	2.7	—	—	ns
			3.3 ± 0.3	—	1.0	

Note: Parameter guaranteed by design.  
(tosZL = |tpZLm - tpZLn|)

### Dynamic Switching Characteristics (Ta = 25°C, input: tr = tf = 2.5 ns, CL = 50 pF, RL = 500 Ω)

Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Quiet output maximum dynamic VOL	VOLP	VIH = 3.3 V, VIL = 0 V	3.3	0.8	V
Quiet output minimum dynamic VOL	VOLV	VIH = 3.3 V, VIL = 0 V	3.3	0.8	V

### Capacitive Characteristics (Ta = 25°C)

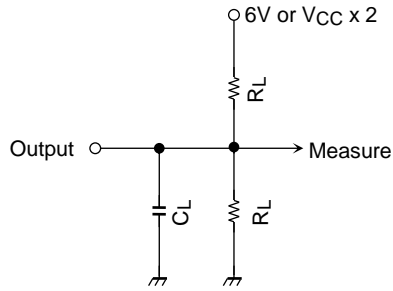
Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	CIN	—	3.3	7	pF
Output capacitance	COU		3.3	8	pF
Power dissipation capacitance	CPD	fIN = 10 MHz (Note)	3.3	5	pF

Note: CPD is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

$$I_{CC}(\text{opr}) = CPD \cdot V_{CC} \cdot f_{IN} + I_{CC}/6 \text{ (per gate)}$$

### AC Test Circuit



Parameter	Switch
$t_{pLZ}$ , $t_{pZL}$	6.0 V @ $V_{CC} = 3.3 \pm 0.3$ V @ $V_{CC} = 2.7$ V
	$V_{CC} \times 2$ @ $V_{CC} = 5.0 \pm 0.5$ V @ $V_{CC} = 2.5 \pm 0.2$ V @ $V_{CC} = 1.8 \pm 0.15$ V

Figure 1

### AC Waveform

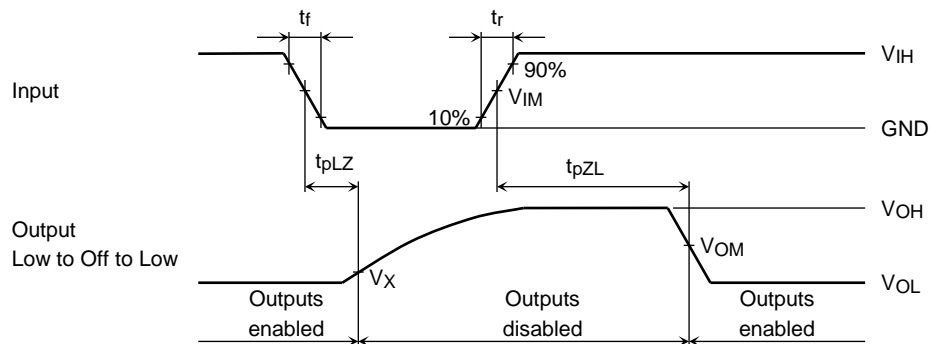


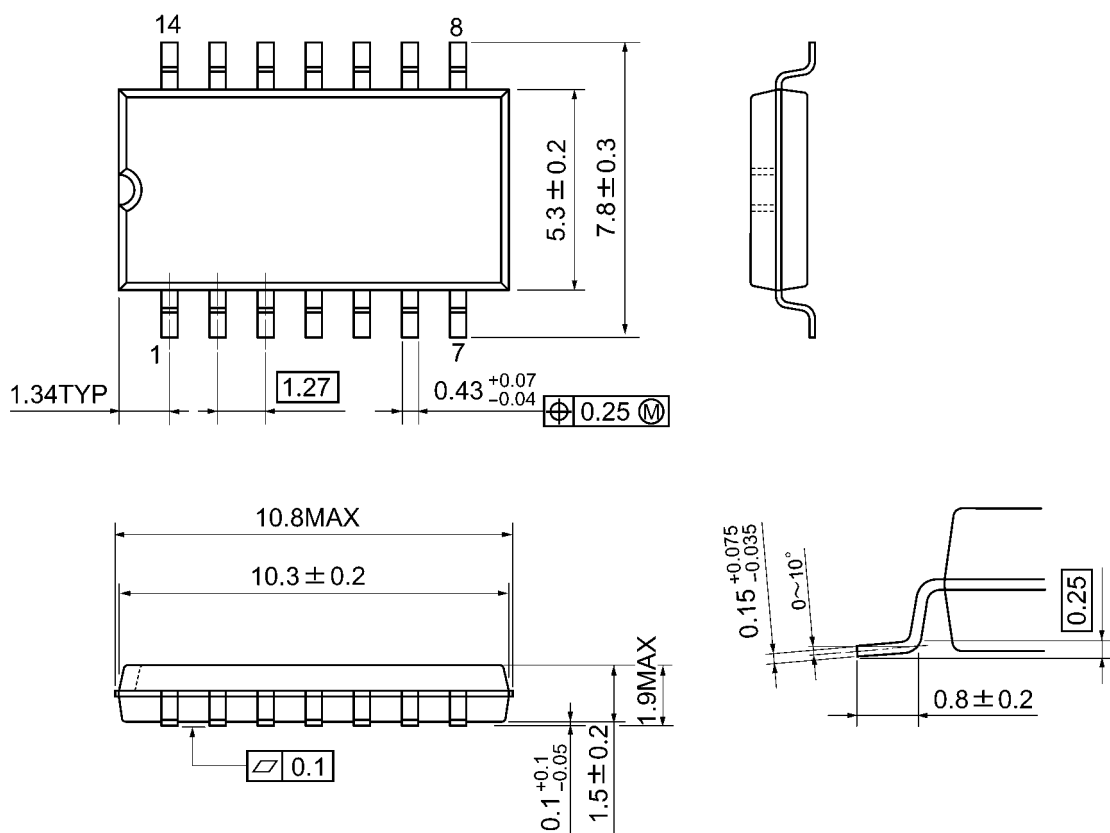
Figure 2  $t_{pLZ}$ ,  $t_{pZL}$

	Symbol	$V_{CC}$			
		$5.0 \pm 0.5$ V	$3.3 \pm 0.3$ V 2.7V	$2.5 \pm 0.2$ V	$1.8 \pm 0.15$ V
Input	$V_{IH}$	$V_{CC}$	2.7 V	$V_{CC}$	$V_{CC}$
	$V_{IM}$	$V_{CC}/2$	1.5 V	$V_{CC}/2$	$V_{CC}/2$
	$t_r$ , $t_f$	2.5 ns	2.5 ns	2.0 ns	2.0 ns
Output	$V_{OM}$	$V_{CC}/2$	1.5V	$V_{OH}/2$	$V_{OH}/2$
	$V_X$	$V_{OL} + 0.3$ V	$V_{OL} + 0.3$ V	$V_{OL} + 0.15$ V	$V_{OL} + 0.15$ V
Load	$C_L$	50 pF	50 pF	30 pF	30 pF
	$R_L$	500 $\Omega$	500 $\Omega$	500 $\Omega$	1 k $\Omega$

### Package Dimensions

SOP14-P-300-1.27A

Unit: mm

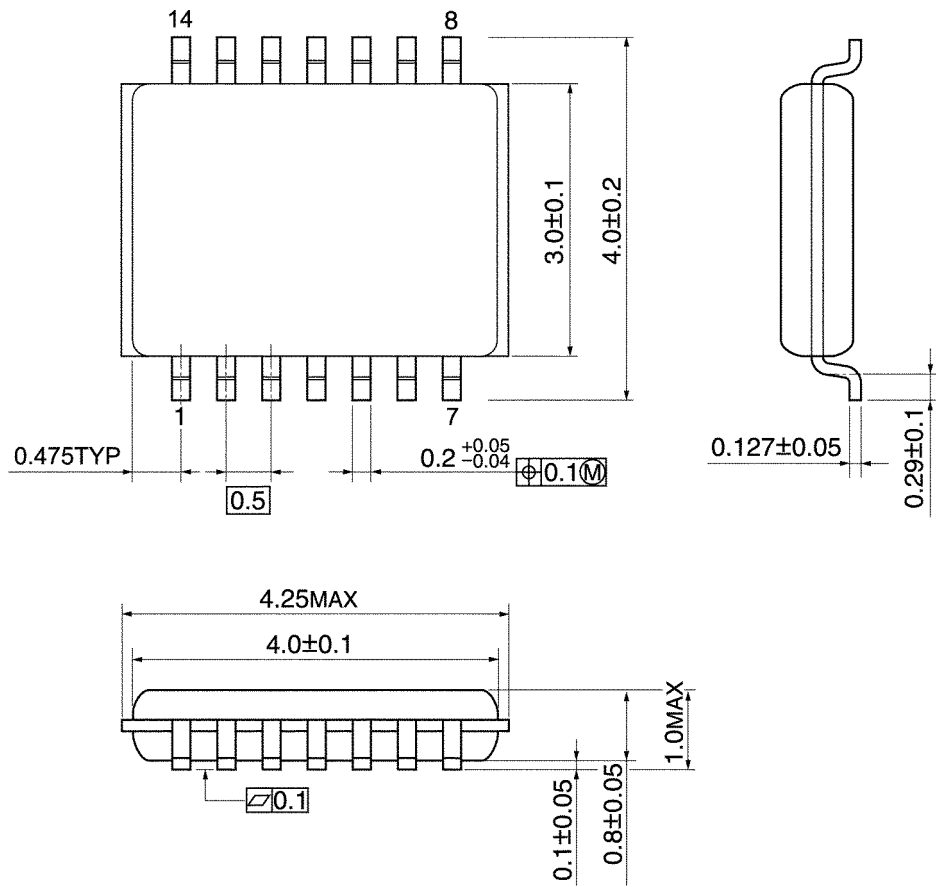


Weight: 0.18 g (typ.)

### Package Dimensions

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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