

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74LCX02F, TC74LCX02FK

Low-Voltage Quad 2-Input NOR Gate with 5-V Tolerant Inputs and Outputs

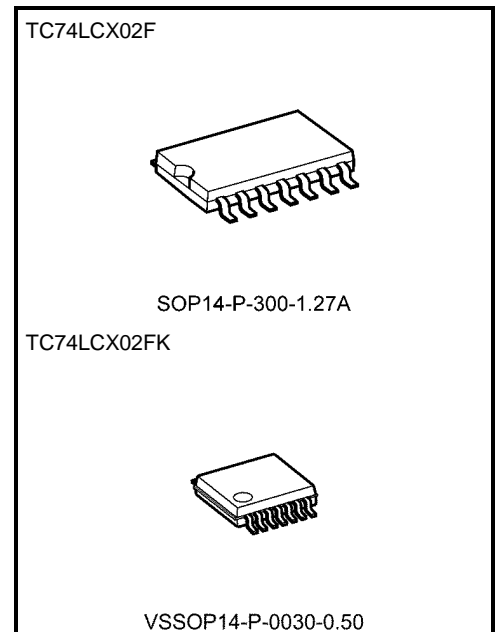
The TC74LCX02 is a high-performance CMOS 2-input NOR gate. Designed for use in 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

The device is designed for low-voltage (3.3 V)  $V_{CC}$  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.

### Features

- Low-voltage operation:  $V_{CC} = 1.65$  to  $3.6$  V
- High-speed operation:  $t_{pd} = 5.2$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)
- Output current:  $|I_{OH}|/I_{OL} = 24$  mA (min) ( $V_{CC} = 3.0$  V)
- Available in JEITA SOP, VSSOP(US)
- Power-down protection provided on all inputs and outputs
- Pin and function compatible with the 74 series (74AC/VHC/HC/F/ALS/LS etc.) 02 type



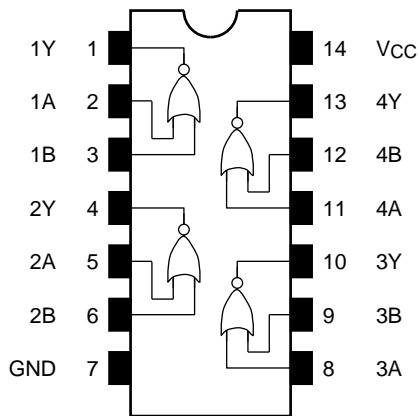
Weight

SOP14-P-300-1.27A	: 0.18 g (typ.)
VSSOP14-P-0030-0.50	: 0.02 g (typ.)

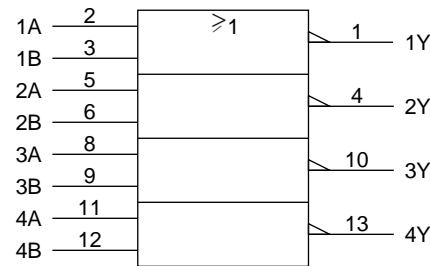
Note: The Electrical Characteristics of  $V_{CC} = 1.8 \pm 0.15$  V is only applicable for products which manufactured from January 2009 onward.

Start of commercial production  
1994-10

### Pin Assignment (top view)



### IEC Logic Symbol



### Truth Table

Inputs		Outputs
A	B	Y
L	L	H
L	H	L
H	L	L
H	H	L

### 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
		-0.5 to $V_{CC} \square 0.5$ (Note 3)	
Input diode current	$I_{IK}$	-50	mA
Output diode current	$I_{OK}$	$\pm 50$ (Note 4)	mA
DC output current	$I_{OUT}$	$\pm 50$	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:  $V_{CC} = 0\text{ V}$

Note 3: High or low state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 4:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

### Operating Ranges (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V <sub>CC</sub>	1.65 to 3.6	V
		1.5 to 3.6 (Note 2)	
Input voltage	V <sub>IN</sub>	0 to 5.5	V
Output voltage	V <sub>OUT</sub>	0 to 5.5 (Note 3)	V
		0 to V <sub>CC</sub> (Note 4)	
Output current	I <sub>OH</sub> /I <sub>OL</sub>	±24 (Note 5)	mA
		±12 (Note 6)	
Operating temperature	T <sub>opr</sub>	-40 to 85	°C
Input rise and fall time	dt/dv	0 to 10 (Note 7)	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 V<sub>CC</sub> or GND.

Note 2: Data retention only

Note 3: V<sub>CC</sub> = 0 V

Note 4: High or low state (However, it can not exceed I<sub>OUT</sub> of absolute maximum ratings.)

Note 5: V<sub>CC</sub> = 3.0 to 3.6 V

Note 6: V<sub>CC</sub> = 2.7 to 3.0 V

Note 7: V<sub>IN</sub> = 0.8 to 2.0 V, V<sub>CC</sub> = 3.0 V

### Electrical Characteristics

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

Characteristics		Symbol	Test Condition		VCC (V)	Min	Max	Unit	
Input voltage	H-level	V <sub>IH</sub>	—		1.65 to 2.3	V <sub>CC</sub> ×0.8	—	V	
					2.3 to 2.7	1.7	—		
					2.7 to 3.6	2.0	—		
	L-level	V <sub>IL</sub>	—		1.65 to 2.3	—	V <sub>CC</sub> ×0.2		
					2.3 to 2.7	—	0.7		
					2.7 to 3.6	—	0.8		
Output voltage	H-level	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IL</sub>		I <sub>OH</sub> = -100 μA	1.65 to 3.6	V <sub>CC</sub> -0.2	V	
					I <sub>OH</sub> = -4 mA	1.65	1.05		—
					I <sub>OH</sub> = -8 mA	2.3	1.7		—
					I <sub>OH</sub> = -12 mA	2.7	2.2		—
					I <sub>OH</sub> = -18 mA	3.0	2.4		—
					I <sub>OH</sub> = -24 mA	3.0	2.2		—
	L-level	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>		I <sub>OL</sub> = 100 μA	1.65 to 3.6	—		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
Input leakage current		I <sub>IN</sub>	V <sub>IN</sub> = 0 to 5.5 V		1.65 to 3.6	—	±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 3.6	—	10.0	μA	
			V <sub>IN</sub> = 3.6 to 5.5 V		1.65 to 3.6	—	±10.0		
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		

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

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Min	Max	Unit
Propagation delay time	t <sub>pLH</sub> t <sub>pHL</sub>	Figure 1, Figure 2	1.8 ± 0.15	—	20.0	ns
			2.5 ± 0.2	—	7.0	
			2.7	—	6.0	
			3.3 ± 0.3	1.5	5.2	
Output to output skew	t <sub>osLH</sub> t <sub>osHL</sub>	(Note)	2.7	—	—	ns
			3.3 ± 0.3	—	1.0	

Note: Parameter guaranteed by design.  
(t<sub>osLH</sub> = |t<sub>pLHm</sub> - t<sub>pLHn</sub>|, t<sub>osHL</sub> = |t<sub>pHLm</sub> - t<sub>pHLn</sub>|)

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

Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Typ.	Unit
Quiet output maximum dynamic VOL	VOLP	V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V	3.3	0.8	V
Quiet output minimum dynamic VOL	VOLV	V <sub>IH</sub> = 3.3 V, V <sub>IL</sub> = 0 V	3.3	0.8	V

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

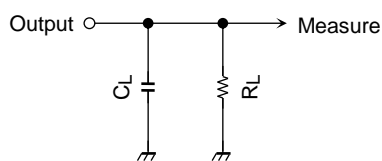
Characteristics	Symbol	Test Condition	V <sub>CC</sub> (V)	Typ.	Unit
Input capacitance	C <sub>IN</sub>	—	3.3	7	pF
Output capacitance	C <sub>OUT</sub>	—	0	8	pF
Power dissipation capacitance	CPD	f <sub>IN</sub> = 10 MHz	(Note) 3.3	25	pF

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:

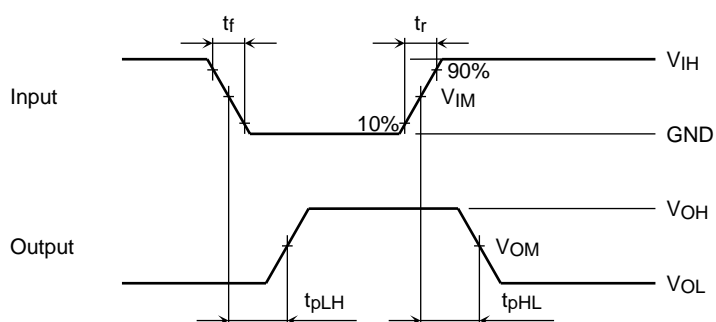
$$I_{CC}(\text{opr}) = CPD \cdot V_{CC} \cdot f_{IN} + I_{CC}/4 \text{ (per gate)}$$

### AC Test Circuit



**Figure 1**

### AC Waveform



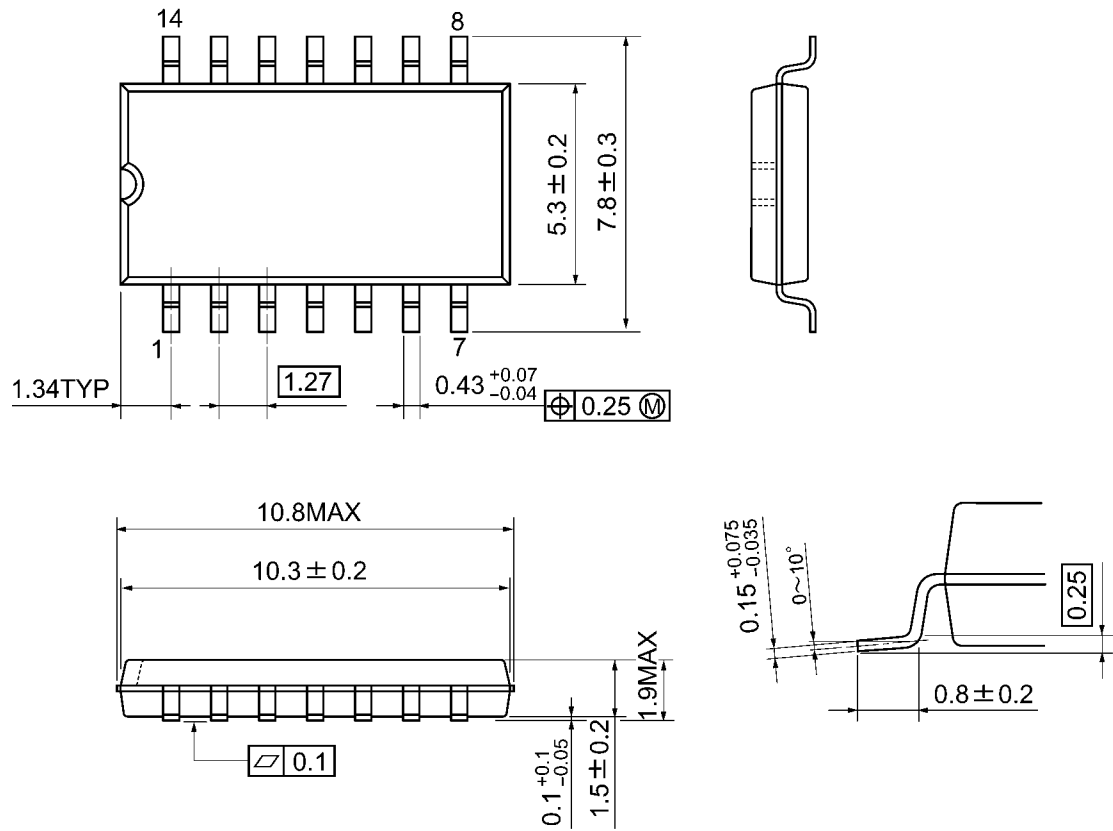
**Figure 2  $t_{pLH}$ ,  $t_{pHL}$**

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

### Package Dimensions

SOP14-P-300-1.27A

Unit: mm

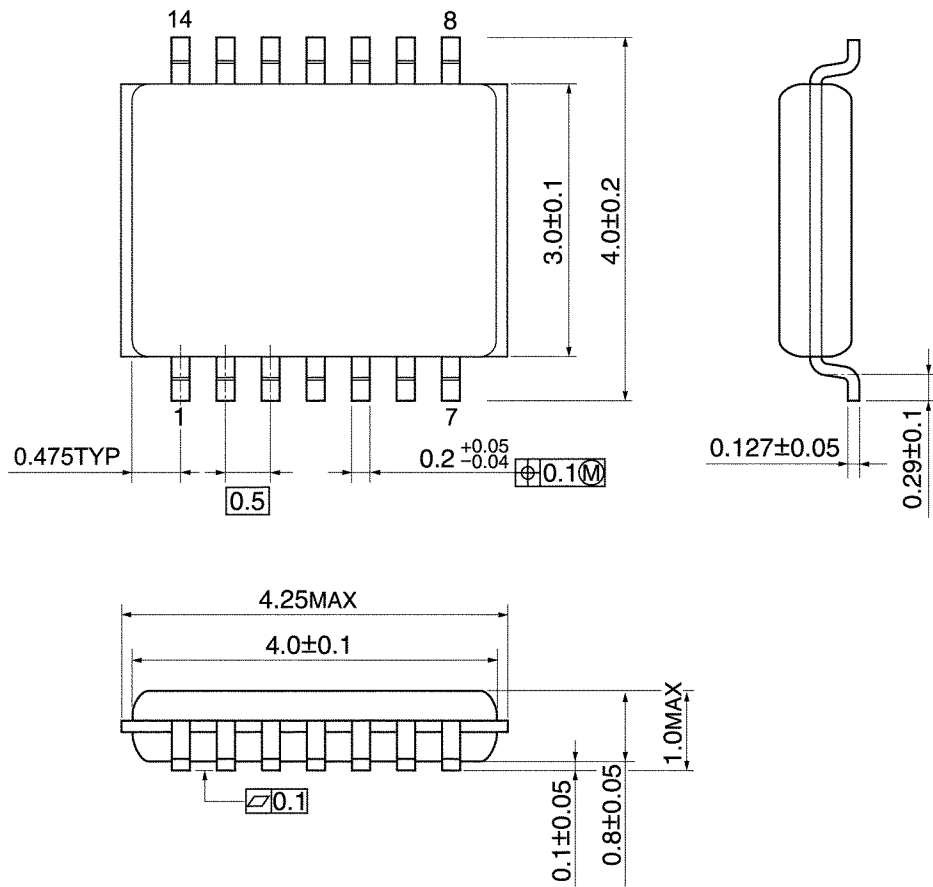


Weight: 0.18 g (typ.)

### Package Dimensions

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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