

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74LCX14F, TC74LCX14FK

## Low-Voltage Hex Schmitt Inverter with 5-V Tolerant Inputs and Outputs

The TC74LCX14 is a high-performance CMOS schmitt inverter. Designed for use in 3.3-V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

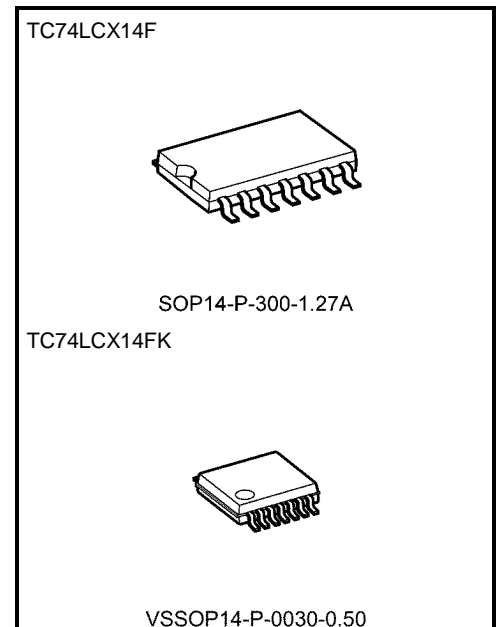
The device is designed for low-voltage (3.3 V)  $V_{CC}$  applications, but it could be used to interface to 5-V supply environment for inputs.

Pin configuration and function are the same as the TC74LCX04 but the inputs have hysteresis and with Schmitt trigger function, the TC74LCX14 can be used as line receivers which will receive slow input signals.

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:  $t_{pd} = 6.5$  ns (max) ( $V_{CC} = 3.0$  to  $3.6$  V)
- Output current:  $|I_{OH}|/I_{OL} = 24$  mA (min) ( $V_{CC} = 3.0$  V)
- Latch-up performance:  $> \pm 500$  mA
- 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.) 14 type

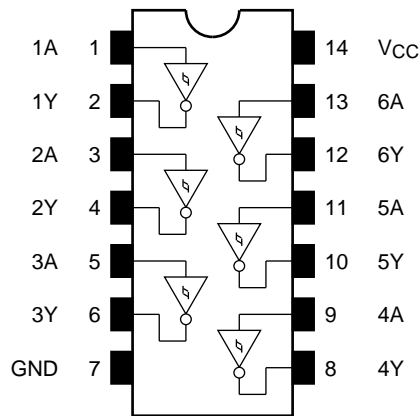


Weight	
SOP14-P-300-1.27A	: 0.18 g ( typ.)
VSSOP14-P-0030-0.50	: 0.02 g ( typ.)

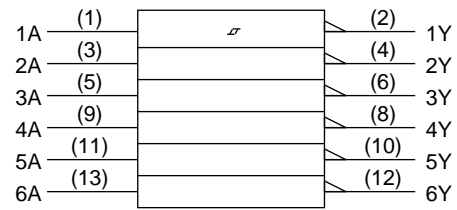
Note: The Electrical Characteristics of  $V_{CC} = 1.8 \pm 0.15$  V is only applicable for products which manufactured from January 2009 onward.

Start of commercial production  
1995-02

### Pin Assignment (top view)



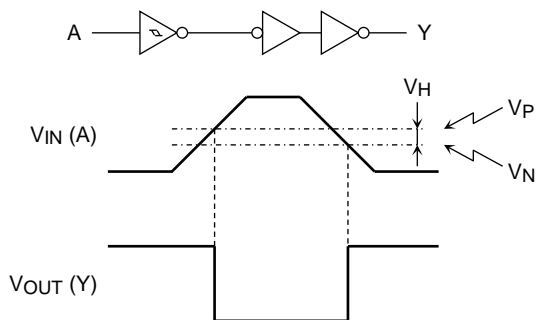
### IEC Logic Symbol



### Truth Table

Inputs	Outputs
A	Y
L	H
H	L

### System Diagram and waveform



## Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Power supply voltage	V <sub>CC</sub>	-0.5 to 7.0	V
DC input voltage	V <sub>IN</sub>	-0.5 to 7.0	V
DC output voltage	V <sub>OUT</sub>	-0.5 to 7.0 (Note 2)	V
		-0.5 to V <sub>CC</sub> + 0.5 (Note 3)	
Input diode current	I <sub>IK</sub>	-50	mA
Output diode current	I <sub>OK</sub>	±50 (Note 4)	mA
DC output current	I <sub>OUT</sub>	±50	mA
Power dissipation	P <sub>D</sub>	180	mW
DC V <sub>CC</sub> /ground current	I <sub>CC</sub> /I <sub>GND</sub>	±100	mA
Storage temperature	T <sub>stg</sub>	-65 to 150	°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<sub>CC</sub> = 0 V

Note 3: High or low state. I<sub>OUT</sub> absolute maximum rating must be observed.

Note 4: V<sub>OUT</sub> < GND, V<sub>OUT</sub> > V<sub>CC</sub>

## 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

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

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

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

### Electrical Characteristics

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

Characteristics		Symbol	Test Condition	VCC (V)	Min	Max	Unit	
Threshold voltage	H-level	V <sub>P</sub>	—	1.65	0.7	1.35	V	
				2.3	0.95	1.7		
				3.0	1.2	2.2		
	L-level	V <sub>N</sub>	—	1.65	0.3	0.8		
				2.3	0.45	1.15		
				3.0	0.6	1.5		
Hysteresis voltage		V <sub>H</sub>	—	1.65	0.3	0.8	V	
				2.3	0.35	1.0		
				3.0	0.4	1.2		
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>	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	VCC (V)	Min	Max	Unit
Propagation delay time	tpLH tpHL	Figure 1, Figure 2	1.8 ± 0.15	—	25.0	ns
			2.5 ± 0.2	—	8.5	
			2.7	—	7.5	
			3.3 ± 0.3	1.5	6.5	
Output to output skew	tosLH tosHL	(Note)	2.7	—	—	ns
			3.3 ± 0.3	—	1.0	

Note: Parameter guaranteed by design.  
 (tosLH = |tpLHm - tpLHn|, tosHL = |tpHLm - tpHLn|)

### 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)

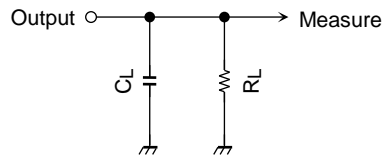
Characteristics	Symbol	Test Condition	VCC (V)	Typ.	Unit
Input capacitance	CIN	—	3.3	7	pF
Output capacitance	COU	—	0	8	pF
Power dissipation capacitance	CPD	fIN = 10 MHz	(Note) 3.3	25	pF

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:

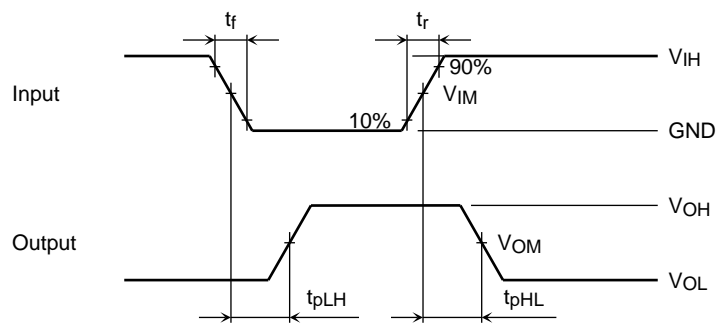
$$I_{CC}(\text{opr}) = CPD \cdot V_{CC} \cdot f_{IN} + I_{CC}/6 \text{ (per gate)}$$

### AC Test Circuit



**Figure 1**

### AC Waveform



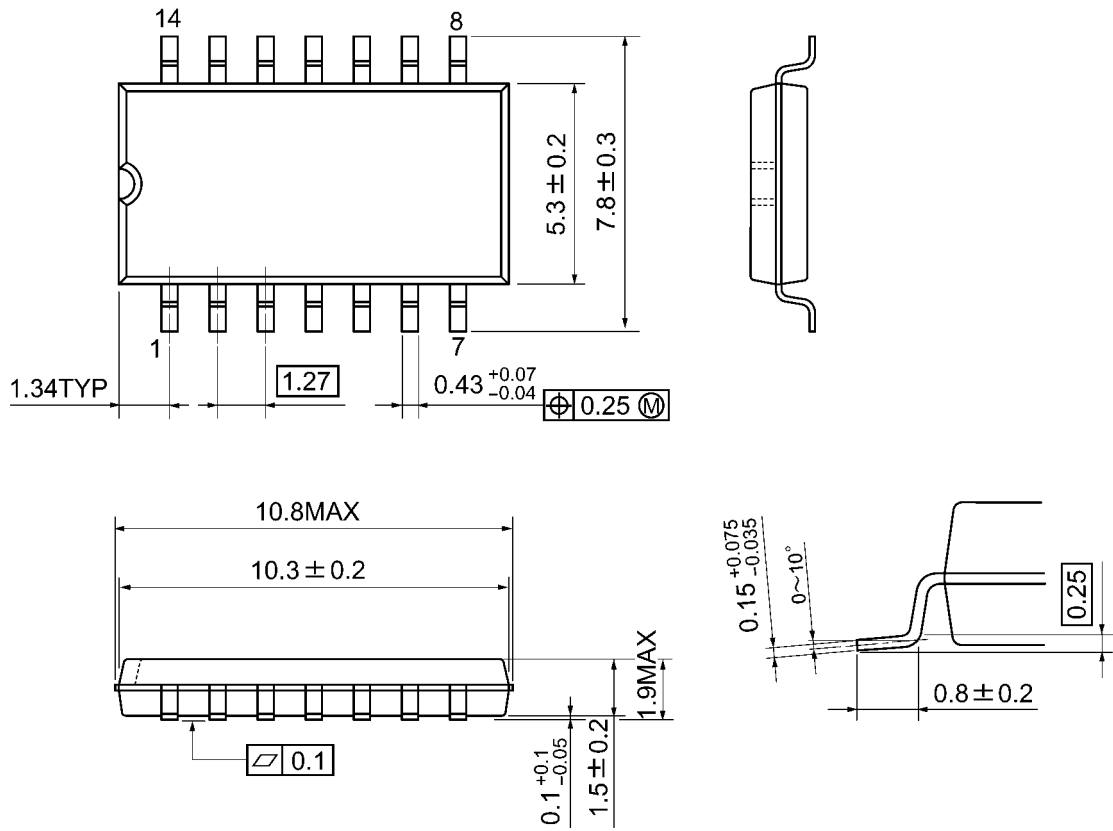
**Figure 2  $t_{pLH}$ ,  $t_{pHL}$**

	Symbol	$V_{CC}$		
		$3.3 \pm 0.3 \text{ V}$ $2.7 \text{ V}$	$2.5 \pm 0.2 \text{ V}$	$1.8 \pm 0.15 \text{ V}$
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

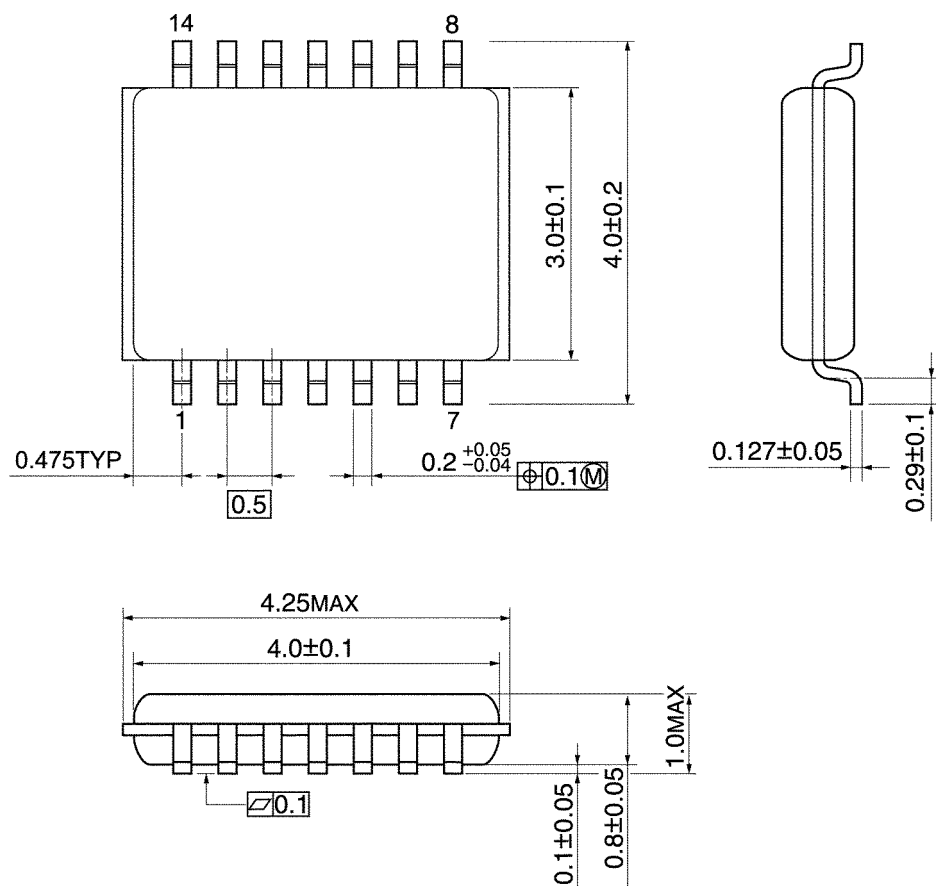


Weight: 0.18 g (typ.)

### Package Dimensions

VSSOP14-P-0030-0.50

Unit: mm



Weight: 0.02 g (typ.)

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