

# 74LCX14FT

## 1. Functional Description

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

## 2. General

The 74LCX14FT 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 74LCX04FT but the inputs have hysteresis and with Schmitt trigger function, the 74LCX14FT can be used as a line receivers which will receive slow input signals.

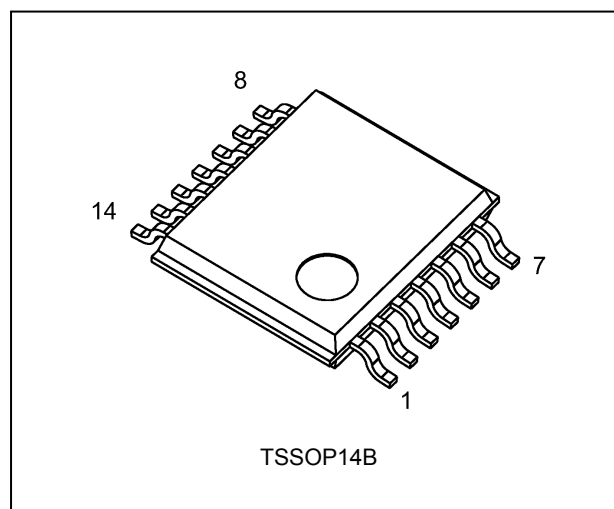
All inputs are equipped with protection circuits against static discharge.

## 3. Features

- (1) AEC-Q100 (Rev. H) (Note 1)
- (2) Wide operating temperature range:  $T_{opr} = -40$  to  $125$  °C
- (3) Low-voltage operation:  $V_{CC} = 1.65$  to  $3.6$  V
- (4) High-speed operation:  $t_{pd} = 7.5$  ns (max) ( $V_{CC} = 3.3 \pm 0.3$  V)
- (5) Output current:  $|I_{OH}|/I_{OL} = 24$  mA (min) ( $V_{CC} = 3.0$  V)
- (6) Power-down protection provided on all inputs and outputs
- (7) Pin and function compatible with the 74 series (74LVC/ALVC etc.) 14 type

Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

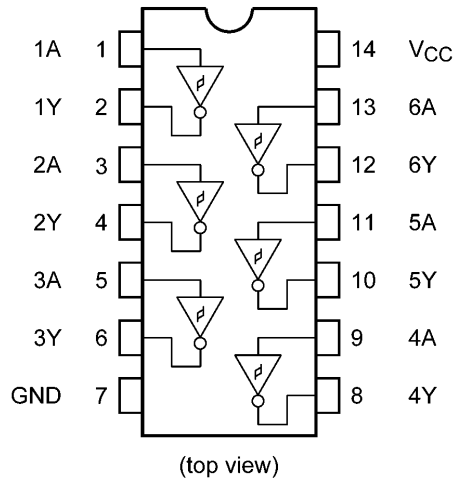
## 4. Packaging



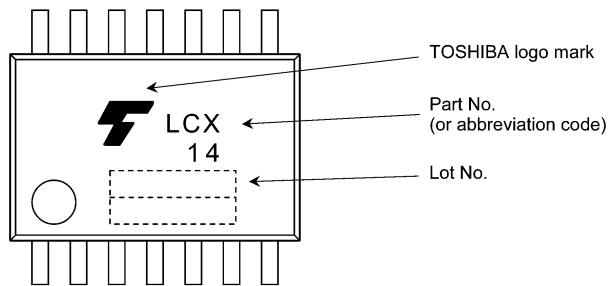
Start of commercial production

2014-07

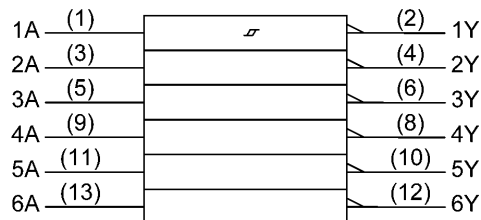
**5. Pin Assignment**



**6. Marking**



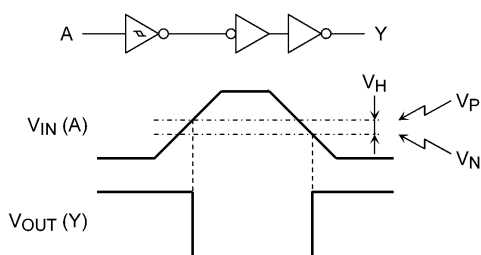
**7. IEC Logic Symbol**



**8. Truth Table**

Inputs A	Outputs Y
L	H
H	L

**9. System Diagram and Waveform**



**10. Absolute Maximum Ratings (Note)**

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	$V_{CC}$		-0.5 to 6.5	V
Input voltage	$V_{IN}$		-0.5 to 6.5	V
Output voltage	$V_{OUT}$	(Note 1)	-0.5 to 6.5	V
		(Note 2)	-0.5 to $V_{CC} + 0.5$	
Input diode current	$I_{IK}$		-50	mA
Output diode current	$I_{OK}$	(Note 3)	$\pm 50$	mA
Output current	$I_{OUT}$		$\pm 50$	mA
Power dissipation	$P_D$	(Note 4)	180	mW
$V_{CC}$ /ground current	$I_{CC}/I_{GND}$		$\pm 100$	mA
Storage temperature	$T_{stg}$		-65 to 150	$^{\circ}C$

Note: 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 1:  $V_{CC} = 0\text{ V}$

Note 2: High or low state.  $I_{OUT}$  absolute maximum rating must be observed.

Note 3:  $V_{OUT} < GND$ ,  $V_{OUT} > V_{CC}$

Note 4: 180 mW in the range of  $T_a = -40$  to  $85\text{ }^{\circ}C$ . From  $T_a = 85$  to  $125\text{ }^{\circ}C$  a derating factor of  $-3.25\text{ mW}/^{\circ}C$  shall be applied until 50 mW.

**11. Operating Ranges (Note)**

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	$V_{CC}$		1.65 to 3.6	V
		(Note 1)	1.5 to 3.6	
Input voltage	$V_{IN}$		0 to 5.5	V
Output voltage	$V_{OUT}$	(Note 2)	0 to 5.5	V
		(Note 3)	0 to $V_{CC}$	
Output current	$I_{OH}, I_{OL}$	(Note 4)	$\pm 24$	mA
		(Note 5)	$\pm 12$	
Operating temperature	$T_{opr}$		-40 to 125	$^{\circ}C$

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either  $V_{CC}$  or GND.

Note 1: Data retention only

Note 2:  $V_{CC} = 0\text{ V}$

Note 3: High or low state

Note 4:  $V_{CC} = 3.0$  to  $3.6\text{ V}$

Note 5:  $V_{CC} = 2.7$  to  $3.0\text{ V}$

**12. Electrical Characteristics**

**12.1. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $85$  °C)**

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit	
Positive threshold voltage	$V_P$	—	1.65	0.7	1.35	V	
			2.3	0.95	1.7		
			3.0	1.2	2.2		
Negative threshold voltage	$V_N$	—	1.65	0.3	0.8	V	
			2.3	0.45	1.15		
			3.0	0.6	1.5		
Hysteresis voltage	$V_H$	—	1.65	0.3	0.8	V	
			2.3	0.35	1.0		
			3.0	0.4	1.2		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IL}$	$I_{OH} = -100 \mu A$	1.65 to 3.6	$V_{CC}-0.2$	—	V
			$I_{OH} = -4$ mA	1.65	1.05	—	
			$I_{OH} = -8$ mA	2.3	1.7	—	
			$I_{OH} = -12$ mA	2.7	2.2	—	
			$I_{OH} = -18$ mA	3.0	2.4	—	
			$I_{OH} = -24$ mA	3.0	2.2	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$	$I_{OL} = 100 \mu A$	1.65 to 3.6	—	0.2	V
			$I_{OL} = 4$ mA	1.65	—	0.45	
			$I_{OL} = 8$ mA	2.3	—	0.7	
			$I_{OL} = 12$ mA	2.7	—	0.4	
			$I_{OL} = 16$ mA	3.0	—	0.4	
			$I_{OL} = 24$ mA	3.0	—	0.55	
Input leakage current	$I_{IN}$	$V_{IN} = 0$ to $5.5$ V	1.65 to 3.6	—	$\pm 5.0$	$\mu A$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN}/V_{OUT} = 5.5$ V	0	—	10.0	$\mu A$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	1.65 to 3.6	—	10.0	$\mu A$	
		$V_{IN} = 3.6$ to $5.5$ V	1.65 to 3.6	—	$\pm 10.0$		
Quiescent supply current	$\Delta I_{CC}$	$V_{IH} = V_{CC} - 0.6$ V (per 1 input)	2.7 to 3.6	—	500	$\mu A$	

**12.2. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $125$  °C)**

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit	
Positive threshold voltage	$V_P$	—	1.65	0.7	1.35	V	
			2.3	0.95	1.7		
			3.0	1.2	2.2		
Negative threshold voltage	$V_N$	—	1.65	0.3	0.8	V	
			2.3	0.45	1.15		
			3.0	0.6	1.5		
Hysteresis voltage	$V_H$	—	1.65	0.3	0.8	V	
			2.3	0.35	1.0		
			3.0	0.4	1.2		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IL}$	$I_{OH} = -100 \mu A$	1.65 to 3.6	$V_{CC} - 0.2$	—	V
			$I_{OH} = -4 \text{ mA}$	1.65	0.9	—	
			$I_{OH} = -8 \text{ mA}$	2.3	1.55	—	
			$I_{OH} = -12 \text{ mA}$	2.7	2.0	—	
			$I_{OH} = -18 \text{ mA}$	3.0	2.2	—	
			$I_{OH} = -24 \text{ mA}$	3.0	2.0	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$	$I_{OL} = 100 \mu A$	1.65 to 3.6	—	0.2	V
			$I_{OL} = 4 \text{ mA}$	1.65	—	0.65	
			$I_{OL} = 8 \text{ mA}$	2.3	—	0.9	
			$I_{OL} = 12 \text{ mA}$	2.7	—	0.6	
			$I_{OL} = 16 \text{ mA}$	3.0	—	0.6	
			$I_{OL} = 24 \text{ mA}$	3.0	—	0.75	
Input leakage current	$I_{IN}$	$V_{IN} = 0$ to $5.5 \text{ V}$	1.65 to 3.6	—	$\pm 20.0$	$\mu A$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN}/V_{OUT} = 5.5 \text{ V}$	0	—	40.0	$\mu A$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	1.65 to 3.6	—	40.0	$\mu A$	
		$V_{IN} = 3.6$ to $5.5 \text{ V}$	1.65 to 3.6	—	$\pm 40.0$		
Quiescent supply current	$\Delta I_{CC}$	$V_{IH} = V_{CC} - 0.6 \text{ V}$ (per 1 input)	2.7 to 3.6	—	5.0	mA	

**12.3. AC Characteristics (Unless otherwise specified, T<sub>a</sub> = -40 to 85 °C)**

Characteristics	Symbol	Note	Test Condition	V <sub>CC</sub> (V)	Min	Max	Unit
Propagation delay time	t <sub>PLH</sub> , t <sub>PHL</sub>		See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1	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 skew	t <sub>osLH</sub> , t <sub>osHL</sub>	(Note 1)		2.7	—	—	ns
				3.3 ± 0.3	—	1.0	

Note 1: 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>|)

**12.4. AC Characteristics (Unless otherwise specified, T<sub>a</sub> = -40 to 125 °C)**

Characteristics	Symbol	Note	Test Condition	V <sub>CC</sub> (V)	Min	Max	Unit
Propagation delay time	t <sub>PLH</sub> , t <sub>PHL</sub>		See 12.7 AC Test Circuit, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	—	27.5	ns
				2.5 ± 0.2	—	9.5	
				2.7	—	8.5	
				3.3 ± 0.3	1.5	7.5	
Output skew	t <sub>osLH</sub> , t <sub>osHL</sub>	(Note 1)	—	2.7	—	—	ns
				3.3 ± 0.3	—	1.0	

Note 1: 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>|)

**12.5. Dynamic Switching Characteristics**

(Unless otherwise specified, T<sub>a</sub> = 25 °C, Input: t<sub>r</sub> = t<sub>f</sub> = 2.5 ns, C<sub>L</sub> = 50 pF, R<sub>L</sub> = 500 Ω)

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

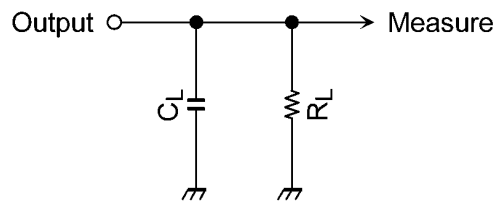
**12.6. Capacitive Characteristics (Unless otherwise specified, T<sub>a</sub> = 25°C)**

Characteristics	Symbol	Note	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	C <sub>PD</sub>	(Note 1)	f <sub>IN</sub> = 10 MHz	3.3	25	pF

Note 1: C<sub>PD</sub> 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.

$$I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/6 \text{ (per 1 gate)}$$

12.7. AC Test Circuit



12.8. AC Waveform

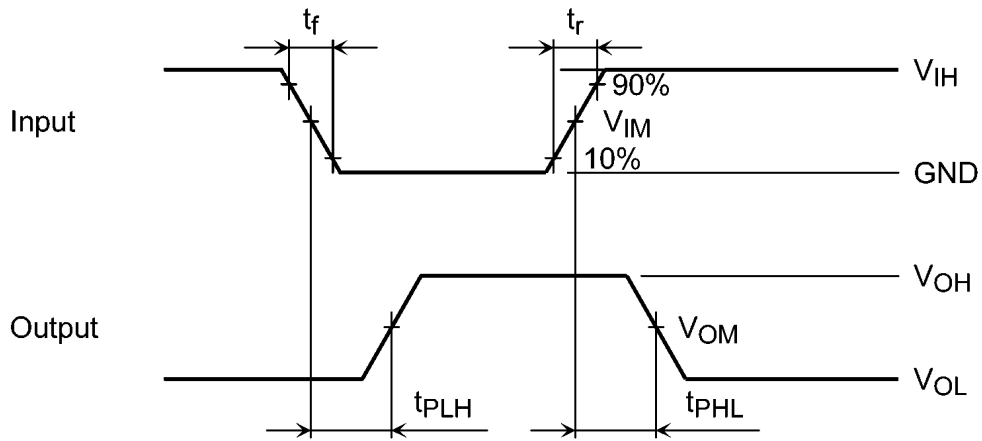


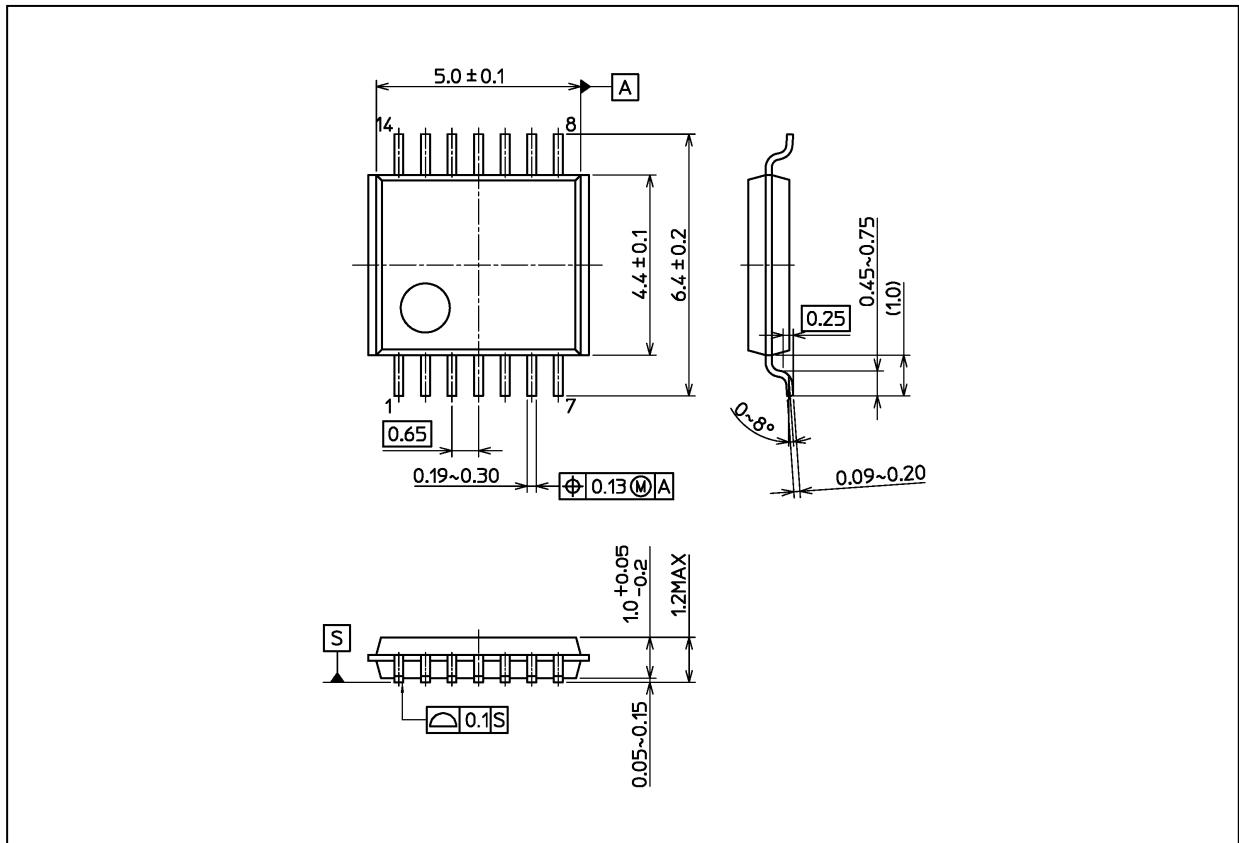
Fig. 12.8.1  $t_{PLH}, t_{PHL}$

Table 12.8.1 AC Waveform Symbols

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

Unit: mm



Weight: 0.054 g (typ.)

Package Name(s)
Nickname: TSSOP14B



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