

# 74LCX04FT

## 1. Functional Description

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

## 2. General

The 74LCX04FT 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.

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.

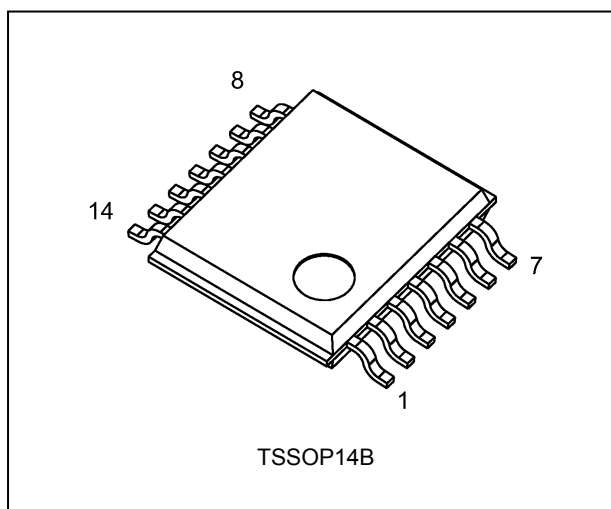
All inputs are equipped with protection circuits against static discharge.

## 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:  $t_{pd} = 6.0$  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.) 04 type

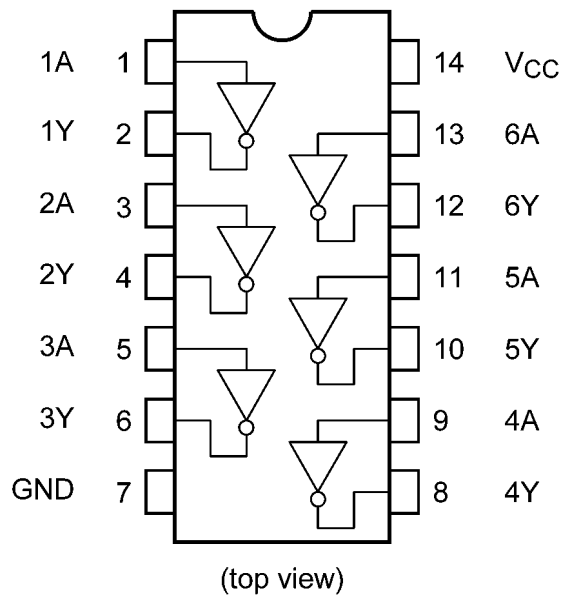
Note 1: This device is compliant with the reliability requirements of AEC-Q100. For details, contact your Toshiba sales representative.

## 4. Packaging

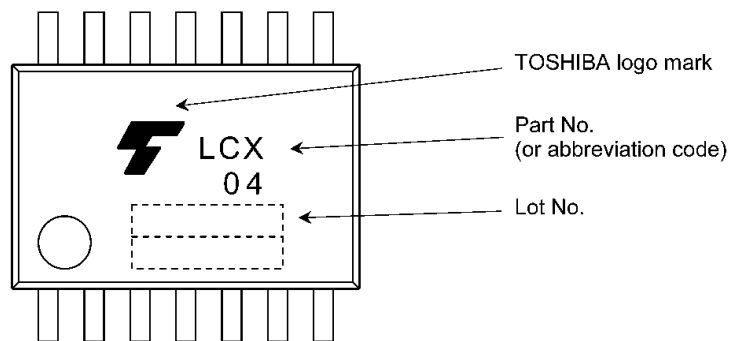


Start of commercial production  
2014-07

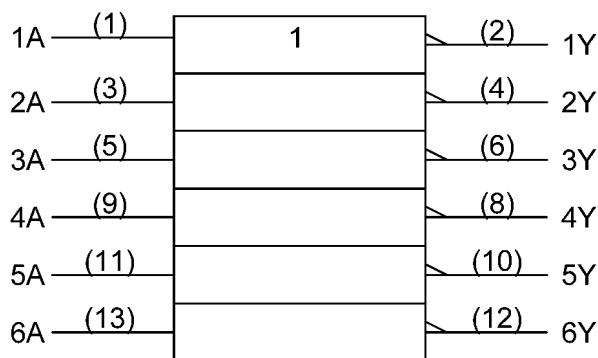
**5. Pin Assignment**



**6. Marking**



**7. IEC Logic Symbol**



**8. Truth Table**

Inputs A	Outputs Y
L	H
H	L

**9. 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.

**10. 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	$^{\circ}C$
Input rise and fall times	$dt/dv$	(Note 6)	0 to 10	ns/V

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  $3.0\text{ V}$

Note 6:  $V_{IN} = 0.8$  to  $2.0\text{ V}, V_{CC} = 3.0\text{ V}$

**11. Electrical Characteristics**

**11.1. DC Characteristics (Unless otherwise specified,  $T_a = -40$  to  $85\text{ }^\circ\text{C}$ )**

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit	
High-level input voltage	$V_{IH}$		1.65 to 2.3	$V_{CC} \times 0.9$	—	V	
			2.3 to 2.7	1.7	—		
			2.7 to 3.6	2.0	—		
Low-level input voltage	$V_{IL}$		1.65 to 2.3	—	$V_{CC} \times 0.1$	V	
			2.3 to 2.7	—	0.7		
			2.7 to 3.6	—	0.8		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IL}$	$I_{OH} = -100\text{ }\mu\text{A}$	1.65 to 3.6	$V_{CC} - 0.2$	—	V
			$I_{OH} = -4\text{ mA}$	1.65	1.05	—	
			$I_{OH} = -8\text{ mA}$	2.3	1.7	—	
			$I_{OH} = -12\text{ mA}$	2.7	2.2	—	
			$I_{OH} = -18\text{ mA}$	3.0	2.4	—	
			$I_{OH} = -24\text{ mA}$	3.0	2.2	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$	$I_{OL} = 100\text{ }\mu\text{A}$	1.65 to 3.6	—	0.2	V
			$I_{OL} = 4\text{ mA}$	1.65	—	0.45	
			$I_{OL} = 8\text{ mA}$	2.3	—	0.7	
			$I_{OL} = 12\text{ mA}$	2.7	—	0.4	
			$I_{OL} = 16\text{ mA}$	3.0	—	0.4	
			$I_{OL} = 24\text{ mA}$	3.0	—	0.55	
Input leakage current	$I_{IN}$	$V_{IN} = 0$ to $5.5\text{ V}$	1.65 to 3.6	—	$\pm 5.0$	$\mu\text{A}$	
Power-OFF leakage current	$I_{OFF}$	$V_{IN}/V_{OUT} = 5.5\text{ V}$	0	—	10.0	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	1.65 to 3.6	—	10.0	$\mu\text{A}$	
		$V_{IN} = 3.6$ to $5.5\text{ V}$	1.65 to 3.6	—	$\pm 10.0$		
Quiescent supply current	$\Delta I_{CC}$	$V_{IH} = V_{CC} - 0.6\text{ V}$ (per 1 input)	2.7 to 3.6	—	500	$\mu\text{A}$	

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

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Min	Max	Unit	
High-level input voltage	$V_{IH}$	—	1.65 to 2.3	$V_{CC} \times 0.9$	—	V	
			2.3 to 2.7	1.7	—		
			2.7 to 3.6	2.0	—		
Low-level input voltage	$V_{IL}$	—	1.65 to 2.3	—	$V_{CC} \times 0.1$	V	
			2.3 to 2.7	—	0.7		
			2.7 to 3.6	—	0.8		
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	

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

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
Propagation delay time	$t_{PLH}, t_{PHL}$		See 11.7 AC Test Circuit, Fig. 11.8.1, Table 11.8.1	$1.8 \pm 0.15$	—	20.0	ns
				$2.5 \pm 0.2$	—	7.0	
				2.7	—	6.0	
				$3.3 \pm 0.3$	1.5	5.2	
Output skew	$t_{osLH}, t_{osHL}$	(Note 1)	—	2.7	—	—	ns
				$3.3 \pm 0.3$	—	1.0	

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )

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

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	Min	Max	Unit
Propagation delay time	$t_{PLH}, t_{PHL}$		See 11.7 AC Test Circuit, Fig. 11.8.1, Table 11.8.1	$1.8 \pm 0.15$	—	22.0	ns
				$2.5 \pm 0.2$	—	8.0	
				2.7	—	7.0	
				$3.3 \pm 0.3$	1.5	6.0	
Output skew	$t_{osLH}, t_{osHL}$	(Note 1)	—	2.7	—	—	ns
				$3.3 \pm 0.3$	—	1.0	

Note 1: Parameter guaranteed by design. ( $t_{osLH} = |t_{PLHM} - t_{PLHN}|$ ,  $t_{osHL} = |t_{PHLM} - t_{PHLN}|$ )

**11.5. Dynamic Switching Characteristics**

(Unless otherwise specified,  $T_a = 25\text{ }^\circ\text{C}$ , Input:  $t_r = t_f = 2.5\text{ ns}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 500\text{ }\Omega$ )

Characteristics	Symbol	Test Condition	$V_{CC}$ (V)	Typ.	Unit
Quiet output maximum dynamic $V_{OL}$	$V_{OLP}$	$V_{IH} = 3.3\text{ V}, V_{IL} = 0\text{ V}$	3.3	0.8	V
Quiet output minimum dynamic $V_{OL}$	$ V_{OLV} $	$V_{IH} = 3.3\text{ V}, V_{IL} = 0\text{ V}$	3.3	0.8	V

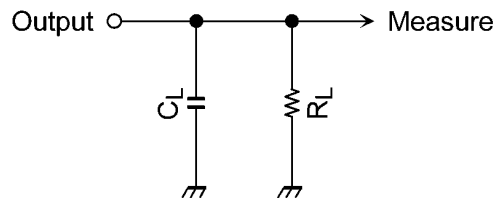
**11.6. Capacitive Characteristics(Unless otherwise specified,  $T_a = 25\text{ }^\circ\text{C}$ )**

Characteristics	Symbol	Note	Test Condition	$V_{CC}$ (V)	Typ.	Unit
Input capacitance	$C_{IN}$			3.3	7	pF
Output capacitance	$C_{OUT}$			0	8	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)	$f_{IN} = 10\text{ MHz}$	3.3	25	pF

Note 1:  $C_{PD}$  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.

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

**11.7. AC Test Circuit**



**11.8. AC Waveform**

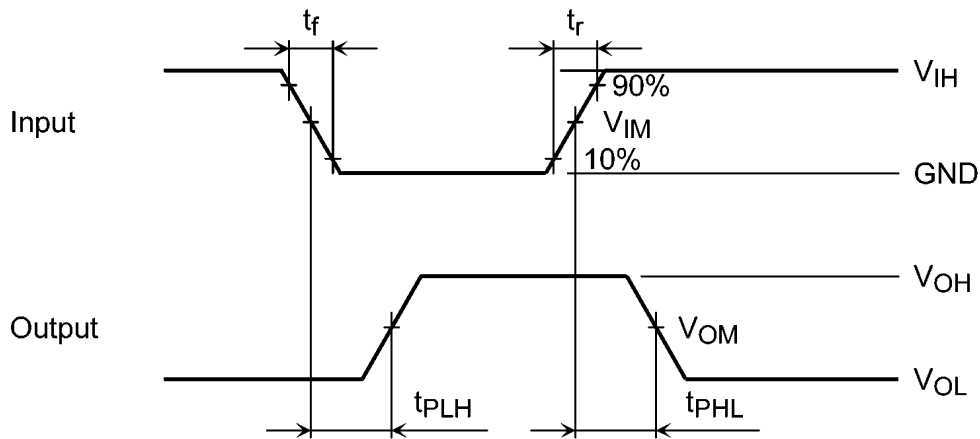


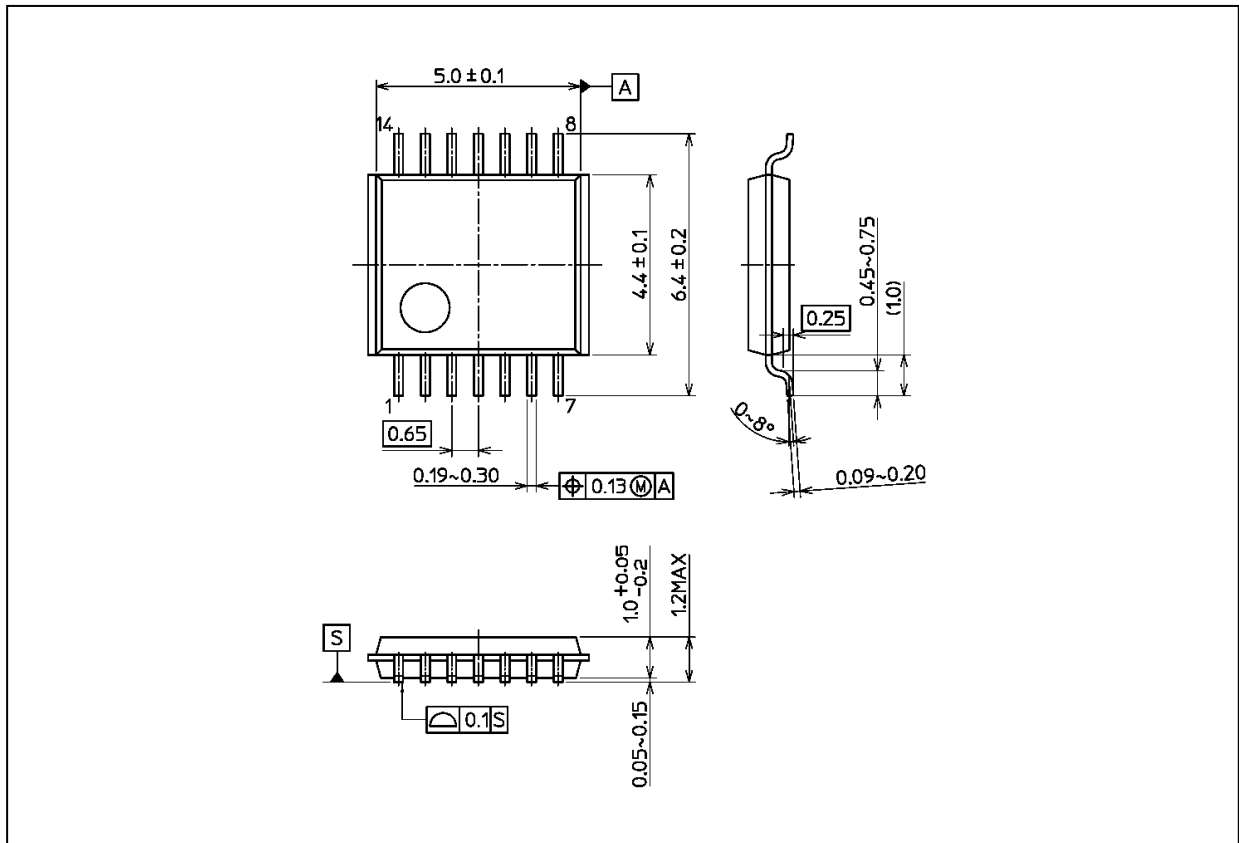
Fig. 11.8.1  $t_{PLH}, t_{PHL}$

Table 11.6.1 AC Waveform Symbols

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

Unit: mm



Weight: 0.054 g (typ.)

Package Name(s)
Nickname: TSSOP14B

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