CMOS Digital Integrated Circuits Silicon Monolithic

74LCX14FT

1. Functional Description

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

2. General

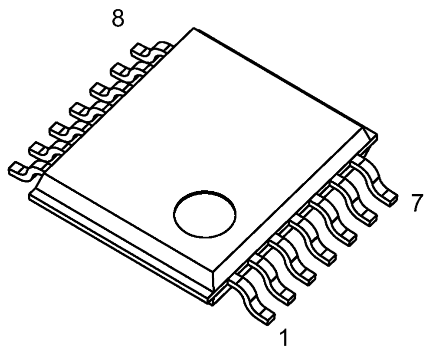
The 74LCX14FT is a high-performance CMOS schmitt inverter. Designed for use in 3.3 V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.
The device is designed for low-voltage (3.3 V) V_{CC} applications, but it could be used to interface to 5-V supply environment 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 ± 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.

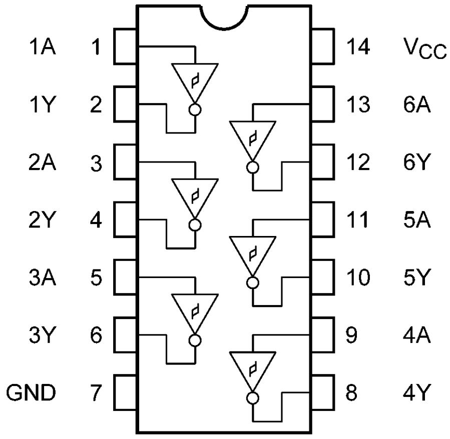
4. Packaging



TSSOP14B

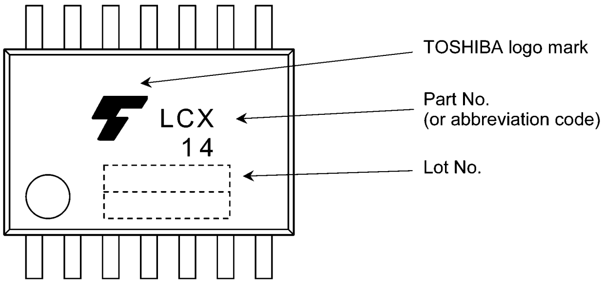
Start of commercial production
2014-07

5. Pin Assignment

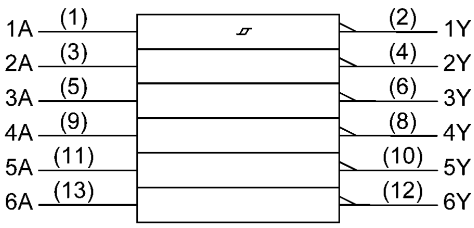


(top view)

6. Marking



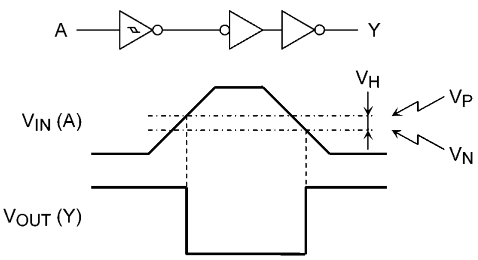
7. IEC Logic Symbol



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)	±50	mA
Output current	I_{OUT}		±50	mA
Power dissipation	P_D	(Note 4)	180	mW
V_{CC}/ground current	I_{CC}/I_{GND}		±100	mA
Storage temperature	T_{stg}		-65 to 150	°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 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 °C. From T_a = 85 to 125 °C a derating factor of -3.25 mW/°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)	±24	mA
		(Note 5)	±12	
Operating temperature	T_{opr}		-40 to 125	°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 V

Note 3: High or low state

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

Note 5: V_{CC} = 2.7 to 3.0 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 μA	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 μA	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	—	±5.0	μA
Power-OFF leakage current	I_{OFF}	V_{IN}/V_{OUT} = 5.5 V		0	—	10.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		1.65 to 3.6	—	10.0	μA
		V_{IN} = 3.6 to 5.5V		1.65 to 3.6	—	±10.0	
Quiescent supply current	ΔI_{CC}	$V_{IH} = V_{CC}$ - 0.6 V (per 1 input)		2.7 to 3.6	—	500	μA

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 μA	1.65 to 3.6	V_{CC} - 0.2	—	V
			I_{OH} = -4 mA	1.65	0.9	—	
			I_{OH} = -8 mA	2.3	1.55	—	
			I_{OH} = -12 mA	2.7	2.0	—	
			I_{OH} = -18 mA	3.0	2.2	—	
			I_{OH} = -24 mA	3.0	2.0	—	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$	I_{OL} = 100 μA	1.65 to 3.6	—	0.2	V
			I_{OL} = 4 mA	1.65	—	0.65	
			I_{OL} = 8 mA	2.3	—	0.9	
			I_{OL} = 12 mA	2.7	—	0.6	
			I_{OL} = 16 mA	3.0	—	0.6	
			I_{OL} = 24 mA	3.0	—	0.75	
Input leakage current	I_{IN}	V_{IN} = 0 to 5.5 V		1.65 to 3.6	—	±20.0	μA
Power-OFF leakage current	I_{OFF}	V_{IN}/V_{OUT} = 5.5 V		0	—	40.0	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		1.65 to 3.6	—	40.0	μA
		V_{IN} = 3.6 to 5.5 V		1.65 to 3.6	—	±40.0	
Quiescent supply current	ΔI_{CC}	$V_{IH} = V_{CC}$ - 0.6 V (per 1 input)		2.7 to 3.6	—	5.0	mA

12.3. AC Characteristics (Unless otherwise specified, T_a = -40 to 85 ℃)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Min	Max	Unit
Propagation delay time	t_{PLH},t_{PHL}		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_{osLH},t_{osHL}	(Note 1)		2.7	—	—	ns
				3.3 ± 0.3	—	1.0	

Note 1: Parameter guaranteed by design. (t_{osLH} = $|t_{PLH}m-t_{PLH}n|$, t_{osHL} = $|t_{PHL}m-t_{PHL}n|$)

12.4. AC Characteristics (Unless otherwise specified, T_a = -40 to 125 ℃)

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Min	Max	Unit
Propagation delay time	t_{PLH},t_{PHL}		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_{osLH},t_{osHL}	(Note 1)	—	2.7	—	—	ns
				3.3 ± 0.3	—	1.0	

Note 1: Parameter guaranteed by design. (t_{osLH} = $|t_{PLH}m-t_{PLH}n|$, t_{osHL} = $|t_{PHL}m-t_{PHL}n|$)

12.5. Dynamic Switching Characteristics
(Unless otherwise specified, T_a = 25 ℃, Input: t_r = t_f = 2.5 ns, C_L = 50 pF, R_L = 500 Ω)

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

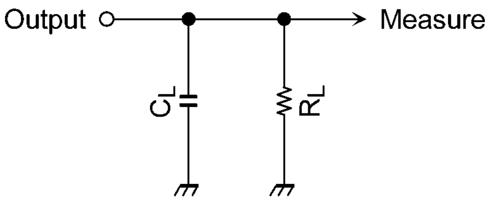
12.6. Capacitive Characteristics (Unless otherwise specified, T_a = 25℃)

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 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.

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

12.7. AC Test Circuit



12.8. AC Waveform

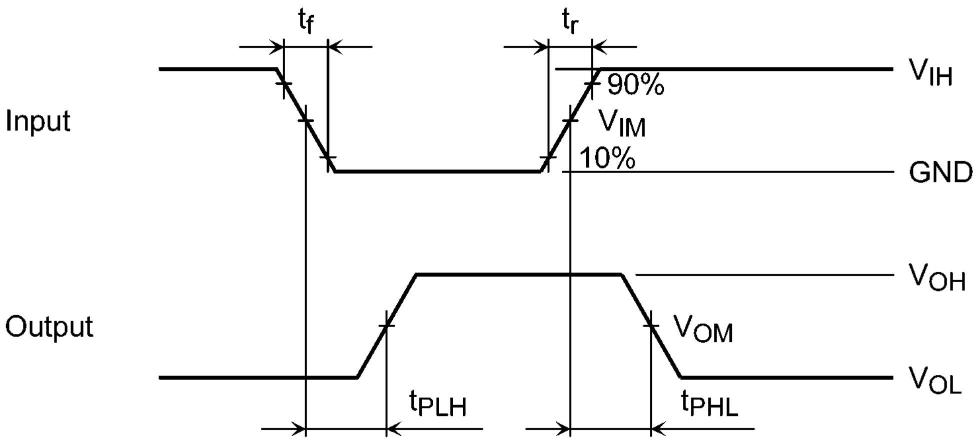


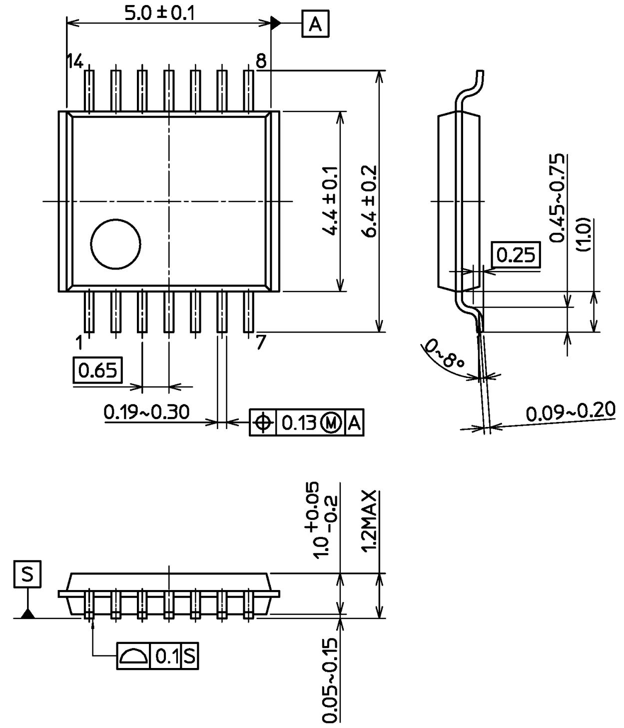
Fig. 12.8.1 t_{PLH},t_{PHL}

Table 12.8.1 AC Waveform Symbols

	Symbol	V_{CC} = 3.3 ± 0.3 V V_{CC} = 2.7 V	V_{CC} = 2.5 ± 0.2 V	V_{CC} = 1.8 ± 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 Ω	500 Ω	1 kΩ

Package Dimensions

Unit: mm



Weight: 0.054 g (typ.)

Package Name(s)
Nickname: TSSOP14B

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