CMOS Digital Integrated Circuits Silicon Monolithic

74LCX05FT

1. Functional Description

- Low-Voltage Hex Inverter with 5-V Tolerant Inputs and Outputs (Open Drain)

2. General

The 74LCX05FT is a high-performance CMOS inverter. Designed for use in 3.3 V systems and 5 V systems, it achieves high-speed operation while maintaining the CMOS low power dissipation.

Pin configuration and function are the same as the 74LCX04FT, but the 74LCX05FT has high performance MOS N-channel transistor. (open-drain outputs)

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.

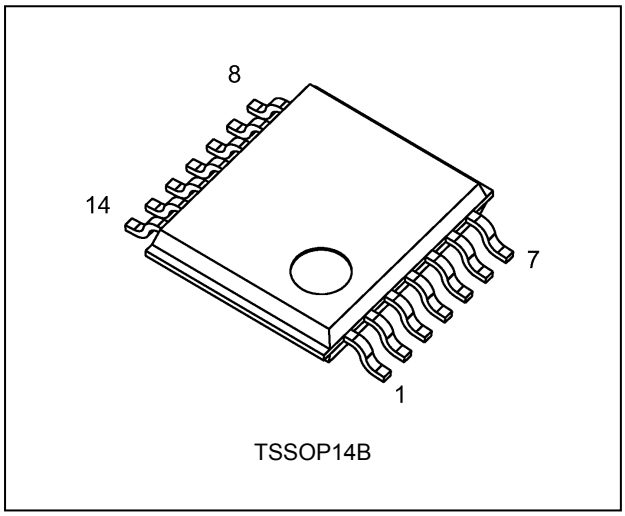
*I_{OUT} absolute maximum rating must be observed.

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 5.5 V
(4) High-speed operation: t_{pZ} = 5.5 ns (max) (V_{CC} = 3.3 ± 0.3 V)
(5) Output current: I_{OL} = 24 mA (min) (V_{CC} = 3.0 V)
(6) Open-drain outputs
(7) Power-down protection provided on all inputs and outputs
(8) Pin and function compatible with the 74 series
(74LVC/ALVC etc.) 05 type

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

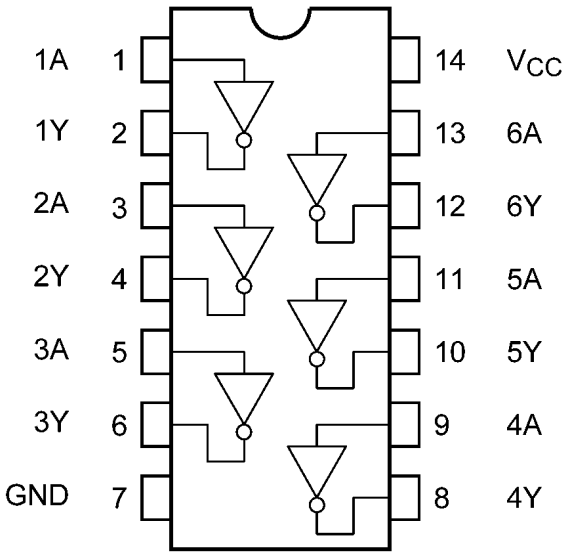
4. Packaging



TSSOP14B

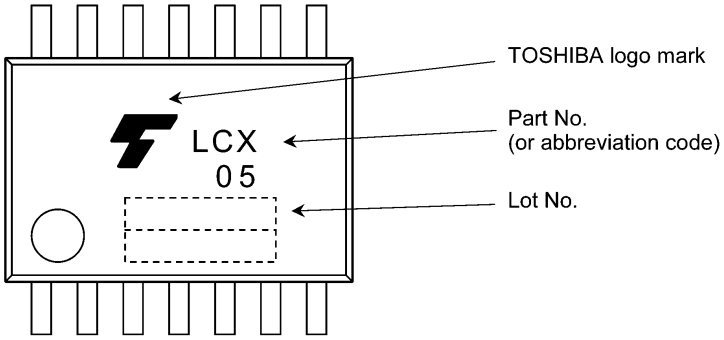
Start of commercial production
2014-08

5. Pin Assignment

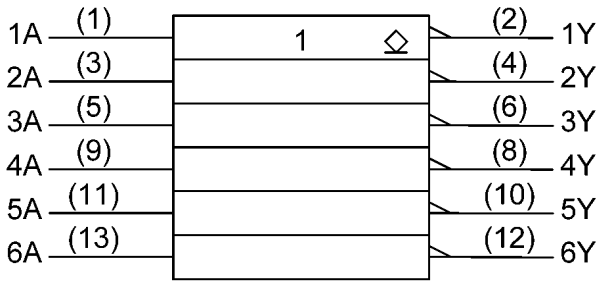


(top view)

6. Marking



7. IEC Logic Symbol

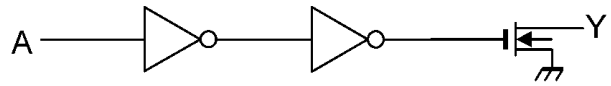


8. Truth Table

Inputs A	Outputs Y
L	Z
H	L

Z: High impedance

9. System Diagram(per gate)



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
Input diode current	I_{IK}		-50	mA
Output diode current	I_{OK}	(Note 2)	-50	mA
Output current	I_{OUT}		50	mA
Power dissipation	P_D	(Note 3)	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: Output in OFF state. I_{OUT} absolute maximum rating must be observed. (Output in low state)

Note 2: V_{OUT} < GND

Note 3: 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 5.5	V
		(Note 1)	1.5 to 5.5	
Input voltage	V_{IN}		0 to 5.5	V
Output voltage	V_{OUT}		0 to 5.5	V
Output current	I_{OL}	(Note 2)	32	mA
		(Note 3)	24	
		(Note 4)	12	
Operating temperature	T_{opr}		-40 to 125	°C
Input rise and fall times	dt/dv	(Note 5)	0 to 10	ns/V

Note: The operating ranges are required 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} = 4.5 to 5.5 V

Note 3: V_{CC} = 3.0 to 3.6 V

Note 4: V_{CC} = 2.7 to 3.0 V

Note 5: V_{CC} = 1.65 to 5.5 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
High-level input voltage	V_{IH}			1.65 to 2.3	V_{CC} × 0.9	—	V
				2.3 to 2.7	1.7	—	
				2.7 to 3.6	2.0	—	
				4.5 to 5.5	V_{CC} × 0.7	—	
Low-level input voltage	V_{IL}			1.65 to 2.3	—	V_{CC} × 0.1	V
				2.3 to 2.7	—	0.7	
				2.7 to 3.6	—	0.8	
				4.5 to 5.5	—	V_{CC} × 0.3	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH}	I_{OL} = 100 μA	1.65 to 5.5	—	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	
			I_{OL} = 32 mA	4.5	—	0.55	
Input leakage current	I_{IN}	V_{IN} = 0 to 5.5 V		1.65 to 5.5	—	±5.0	μA
Output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} V_{OUT} = 0 to 5.5 V		1.65 to 5.5	—	±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 5.5	—	10.0	μA
Quiescent supply current	ΔI_{CC}	V_{IH} = V_{CC} - 0.6 V (per 1 input)		2.7 to 3.6	—	500	μA
				4.5 to 5.5	—	1.0	mA

12.2. 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} × 0.9	—	V
				2.3 to 2.7	1.7	—	
				2.7 to 3.6	2.0	—	
				4.5 to 5.5	V_{CC} × 0.7	—	
Low-level input voltage	V_{IL}	—		1.65 to 2.3	—	V_{CC} × 0.1	V
				2.3 to 2.7	—	0.7	
				2.7 to 3.6	—	0.8	
				4.5 to 5.5	—	V_{CC} × 0.3	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH}	I_{OL} = 100 μA	1.65 to 5.5	—	0.2	V
			I_{OL} = 4 mA	1.65	—	0.6	
			I_{OL} = 8 mA	2.3	—	0.85	
			I_{OL} = 12 mA	2.7	—	0.6	
			I_{OL} = 16 mA	3.0	—	0.6	
			I_{OL} = 24 mA	3.0	—	0.8	
			I_{OL} = 32 mA	4.5	—	0.8	
Input leakage current	I_{IN}	V_{IN} = 0 to 5.5 V		1.65 to 5.5	—	±20.0	μA
Output OFF-state leakage current	I_{OZ}	V_{IN} = V_{IH} V_{OUT} = 0 to 5.5 V		1.65 to 5.5	—	±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 5.5	—	40.0	μA
Quiescent supply current	ΔI_{CC}	V_{IH} = V_{CC} - 0.6 V (per 1 input)		2.7 to 3.6	—	5.0	mA
				4.5 to 5.5	—	5.0	mA

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

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Min	Max	Unit
Output enable time	t_{PZL}		See 12.7. AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	1.5	26.0	ns
				2.5 ± 0.2	1.2	13.0	
				2.7	1.0	6.0	
				3.3 ± 0.3	0.8	5.0	
				5.0 ± 0.5	0.5	4.0	
Output disable time	t_{PLZ}		See 12.7. AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	1.5	26.0	ns
				2.5 ± 0.2	1.2	13.0	
				2.7	1.0	6.0	
				3.3 ± 0.3	0.8	5.0	
				5.0 ± 0.5	0.5	4.0	
Output skew	t_{osZL}	(Note 1)	—	2.7	—	—	ns
				3.3 ± 0.3	—	1.0	

Note 1: Parameter guaranteed by design. (t_{osZL} = $|t_{PZLm}-t_{PZLn}|$)

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

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Min	Max	Unit
Output enable time	t_{PZL}		See 12.7. AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	1.5	29.0	ns
				2.5 ± 0.2	1.2	14.5	
				2.7	1.0	7.0	
				3.3 ± 0.3	0.8	5.5	
				5.0 ± 0.5	0.5	4.5	
Output disable time	t_{PLZ}		See 12.7. AC Test Circuit, Table 12.7.1, Fig. 12.8.1, Table 12.8.1	1.8 ± 0.15	1.5	29.0	ns
				2.5 ± 0.2	1.2	14.5	
				2.7	1.0	7.0	
				3.3 ± 0.3	0.8	5.5	
				5.0 ± 0.5	0.5	4.5	
Output skew	t_{osZL}	(Note 1)	—	2.7	—	—	ns
				3.3 ± 0.3	—	1.0	

Note 1: Parameter guaranteed by design. (t_{osZL} = $|t_{PZLm}-t_{PZLn}|$)

12.5. Dynamic Switching Characteristics (Unless otherwise specified, T_a = 25 °C, 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}	$\|V_{OLV}\|$	V_{IH} = 3.3 V, V_{IL} = 0 V	3.3	0.8	V

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

Characteristics	Symbol	Note	Test Condition	V_{CC} (V)	Typ.	Unit
Input capacitance	C_{IN}			3.3	7	pF
Output capacitance	C_{OUT}			3.3	8	pF
Power dissipation capacitance	C_{PD}	(Note 1)	f_{IN} =10 MHz	3.3	5	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

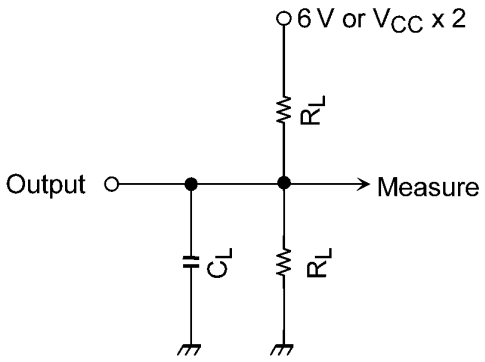


Table 12.7.1 Parameter for AC Test Circuit

Parameter	Switch	Test Condition
t_{PLZ}, t_{PZL}	6.0 V	V_{CC} = 3.3 ± 0.3 V
		V_{CC} = 2.7 V
	V_{CC} × 2	V_{CC} = 5.0 ± 0.5 V
		V_{CC} = 2.5 ± 0.2 V
		V_{CC} = 1.8 ± 0.15 V

12.8. AC Waveform

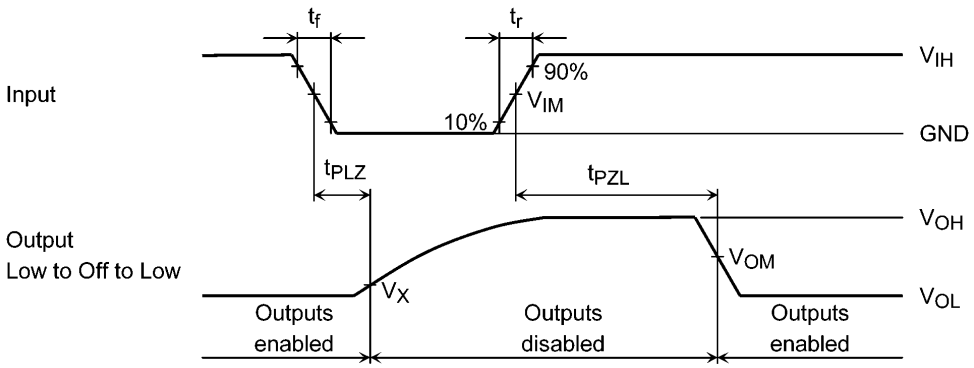


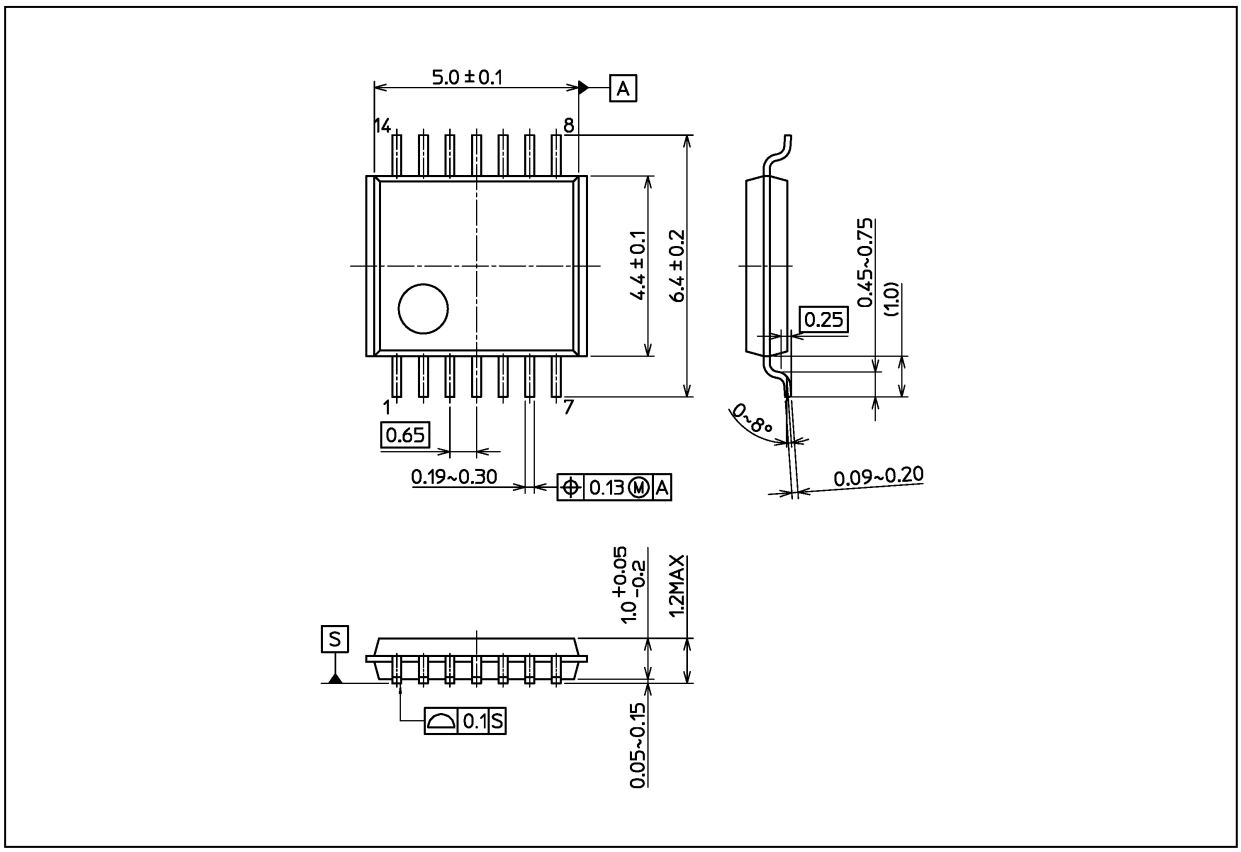
Fig. 12.8.1 t_{PLZ},t_{PZL}

Table 12.8.1 AC Waveform Symbols

	Symbol	V_{CC} = 5.0 ± 0.5 V	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}	V_{CC}	2.7 V	V_{CC}	V_{CC}
	V_{IM}	V_{CC}/2	1.5 V	V_{CC}/2	V_{CC}/2
	t_r, t_f	2.5 ns	2.5 ns	2.0 ns	2.0 ns
Output	V_{OM}	V_{CC}/2	1.5 V	V_{OH}/2	V_{OH}/2
	V_X	V_{OL} + 0.3 V	V_{OL} + 0.3 V	V_{OL} + 0.15 V	V_{OL} + 0.15 V
Load	C_L	50 pF	50 pF	30 pF	30 pF
	R_L	500 Ω	500 Ω	500 Ω	1 kΩ

Package Dimensions

Unit: mm



Weight: 0.054 g (typ.)

Package Name(s)
Nickname: TSSOP14B

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