

74HCT04D

1. Functional Description

- Hex Inverter

2. General

The 74HCT04D is a high speed CMOS INVERTER fabricated with silicon gate C²MOS technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

This device may be used as a level converter for interfacing TTL or NMOS to High Speed CMOS. The inputs are compatible with TTL, NMOS and CMOS output voltage levels.

The internal circuit is composed of 3 stages including buffer output, which provide high noise immunity and stable output.

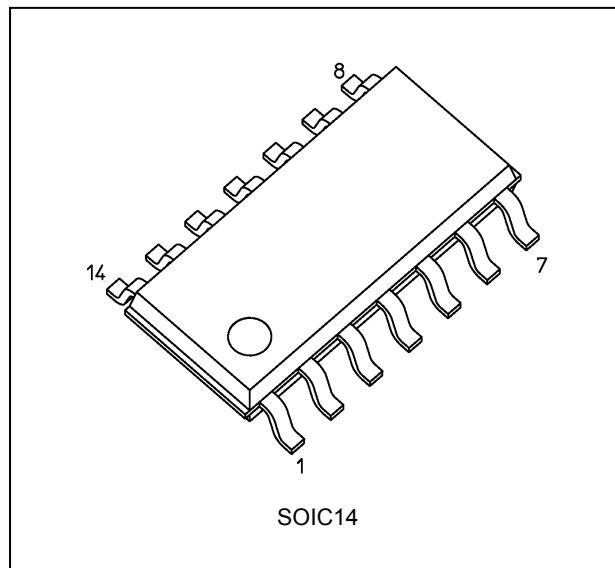
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

3. Features

- (1) Wide operating temperature range: $T_{opr} = -40$ to 125 °C (Note 1)
- (2) High speed: $t_{pd} = 8$ ns (typ.) at $V_{CC} = 5$ V
- (3) Low power dissipation: $I_{CC} = 1.0$ μ A (max) at $T_a = 25$ °C
- (4) Compatible with TTL outputs: $V_{IH} = 2.0$ V (min)
: $V_{IL} = 0.8$ V (max)
- (5) Wide interfacing ability: LSTTL, NMOS, CMOS
- (6) Balanced propagation delays: $t_{PLH} \approx t_{PHL}$

Note 1: Operating Range spec of $T_{opr} = -40$ °C to 125 °C is applicable only for the products which manufactured after July 2020.

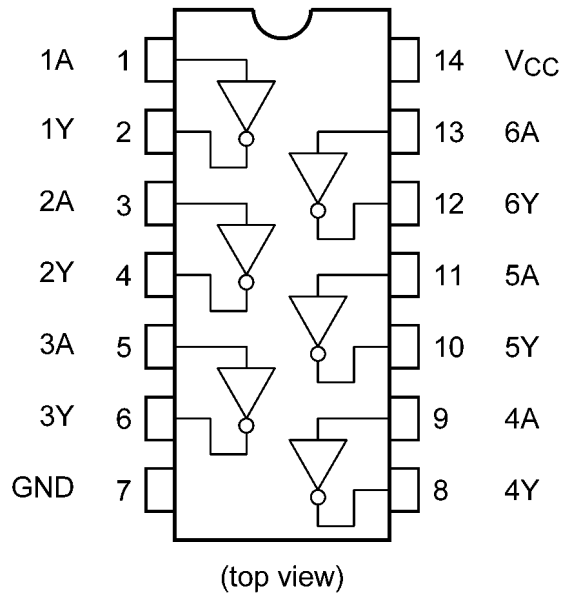
4. Packaging



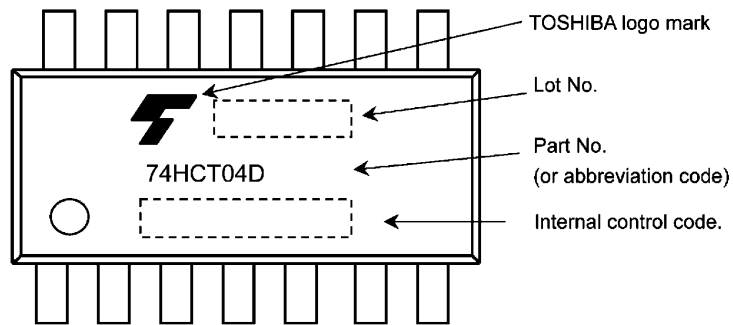
Start of commercial production

2020-07

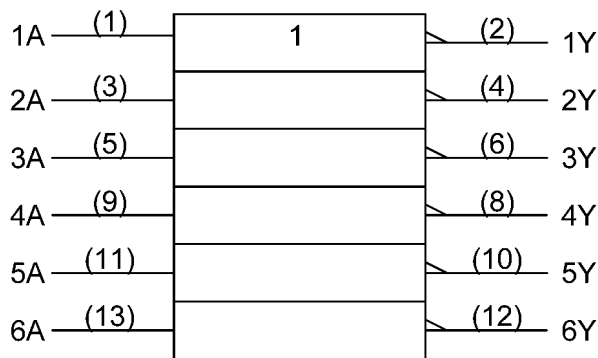
5. Pin Assignment



6. Marking



7. IEC Logic Symbol



8. Truth Table

A	Y
L	H
H	L

9. Absolute Maximum Ratings (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		-0.5 to 7.0	V
Input voltage	V_{IN}		-0.5 to $V_{CC} + 0.5$	V
Output voltage	V_{OUT}		-0.5 to $V_{CC} + 0.5$	V
Input diode current	I_{IK}		± 20	mA
Output diode current	I_{OK}		± 20	mA
Output current	I_{OUT}		± 25	mA
V_{CC} /ground current	I_{CC}		± 50	mA
Power dissipation	P_D	(Note 1)	500	mW
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: P_D derates linearly with -8 mW/°C above 85 °C

10. Operating Ranges (Note)

Characteristics	Symbol	Note	Rating	Unit
Supply voltage	V_{CC}		4.5 to 5.5	V
Input voltage	V_{IN}		0 to V_{CC}	V
Output voltage	V_{OUT}		0 to V_{CC}	V
Operating temperature	T_{opr}	(Note 1)	-40 to 125	°C
Input rise and fall times	t_r, t_f		0 to 500	ns

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: Operating Range spec of $T_{opr} = -40$ °C to 125 °C is applicable only for the products which manufactured after July 2020.

11. Electrical Characteristics

11.1. DC Characteristics (Unless otherwise specified, $T_a = 25\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Typ.	Max	Unit	
High-level input voltage	V_{IH}	—	4.5 to 5.5	2.0	—	—	V	
Low-level input voltage	V_{IL}	—	4.5 to 5.5	—	—	0.8	V	
High-level output voltage	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -20\text{ }\mu\text{A}$	4.5	4.4	4.5	—	V
			$I_{OH} = -4\text{ mA}$	4.5	4.18	4.31	—	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 20\text{ }\mu\text{A}$	4.5	—	0.0	0.1	V
			$I_{OL} = 4\text{ mA}$	4.5	—	0.17	0.26	
Input leakage current	I_{IN}	$V_{IN} = V_{CC}$ or GND	5.5	—	—	± 0.1	μA	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	5.5	—	—	1.0	μA	
	I_{CCT}	Per input: $V_{IN} = 0.5\text{ V}$ or 2.4 V Other input: V_{CC} or GND	5.5	—	—	2.0	mA	

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

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit	
High-level input voltage	V_{IH}	—	4.5 to 5.5	2.0	—	V	
Low-level input voltage	V_{IL}	—	4.5 to 5.5	—	0.8	V	
High-level output voltage	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -20\text{ }\mu\text{A}$	4.5	4.4	—	V
			$I_{OH} = -4\text{ mA}$	4.5	4.13	—	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 20\text{ }\mu\text{A}$	4.5	—	0.1	V
			$I_{OL} = 4\text{ mA}$	4.5	—	0.33	
Input leakage current	I_{IN}	$V_{IN} = V_{CC}$ or GND	5.5	—	± 1.0	μA	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	5.5	—	10.0	μA	
	I_{CCT}	Per input: $V_{IN} = 0.5\text{ V}$ or 2.4 V Other input: V_{CC} or GND	5.5	—	2.9	mA	

11.3. DC Characteristics (Note) (Unless otherwise specified, $T_a = -40\text{ to }125\text{ }^\circ\text{C}$)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Min	Max	Unit	
High-level input voltage	V_{IH}	—	4.5 to 5.5	2.0	—	V	
Low-level input voltage	V_{IL}	—	4.5 to 5.5	—	0.8	V	
High-level output voltage	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -20\text{ }\mu\text{A}$	4.5	4.4	—	V
			$I_{OH} = -4\text{ mA}$	4.5	3.7	—	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 20\text{ }\mu\text{A}$	4.5	—	0.1	V
			$I_{OL} = 4\text{ mA}$	4.5	—	0.4	
Input leakage current	I_{IN}	$V_{IN} = V_{CC}$ or GND	5.5	—	± 1.0	μA	
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	5.5	—	20.0	μA	
	I_{CCT}	Per input: $V_{IN} = 0.5\text{ V}$ or 2.4 V Other input: V_{CC} or GND	5.5	—	2.9	mA	

Note: Operating Range spec of $T_{opr} = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ is applicable only for the products which manufactured after July 2020.

11.4. AC Characteristics

(Unless otherwise specified, $C_L = 15 \text{ pF}$, $V_{CC} = 5 \text{ V}$, $T_a = 25 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output transition time	t_{TLH}, t_{THL}	—	—	6	12	ns
Propagation delay time	t_{PLH}, t_{PHL}	—	—	8	15	

11.5. AC Characteristics

(Unless otherwise specified, $C_L = 50 \text{ pF}$, $T_a = 25 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

Characteristics	Symbol	Note	V_{CC} (V)	Min	Typ.	Max	Unit
Output transition time	t_{TLH}, t_{THL}		4.5	—	8	15	ns
			5.5	—	7	13	
Propagation delay time	t_{PLH}, t_{PHL}		4.5	—	11	18	ns
			5.5	—	9	16	
Input capacitance	C_{IN}		—	—	5	—	pF
Power dissipation capacitance	C_{PD}	(Note 1)	—	—	20	—	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.

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

11.6. AC Characteristics

(Unless otherwise specified, $C_L = 50 \text{ pF}$, $T_a = -40 \text{ to } 85 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

Characteristics	Symbol	V_{CC} (V)	Min	Max	Unit
Output transition time	t_{TLH}, t_{THL}	4.5	—	19	ns
		5.5	—	16	
Propagation delay time	t_{PLH}, t_{PHL}	4.5	—	23	ns
		5.5	—	20	

11.7. AC Characteristics (Note)

(Unless otherwise specified, $C_L = 50 \text{ pF}$, $T_a = -40 \text{ to } 125 \text{ }^\circ\text{C}$, Input: $t_r = t_f = 6 \text{ ns}$)

Characteristics	Symbol	V_{CC} (V)	Min	Max	Unit
Output transition time	t_{TLH}, t_{THL}	4.5	—	22	ns
		5.5	—	18	
Propagation delay time	t_{PLH}, t_{PHL}	4.5	—	27	ns
		5.5	—	23	

Note: Operating Range spec of $T_{opr} = -40 \text{ }^\circ\text{C}$ to $125 \text{ }^\circ\text{C}$ is applicable only for the products which manufactured after July 2020.

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