

# 74HC04D

## 1. Functional Description

- Hex Inverter

## 2. General

The 74HC04D is a high speed CMOS INVERTER fabricated with silicon gate C<sup>2</sup>MOS technology.

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

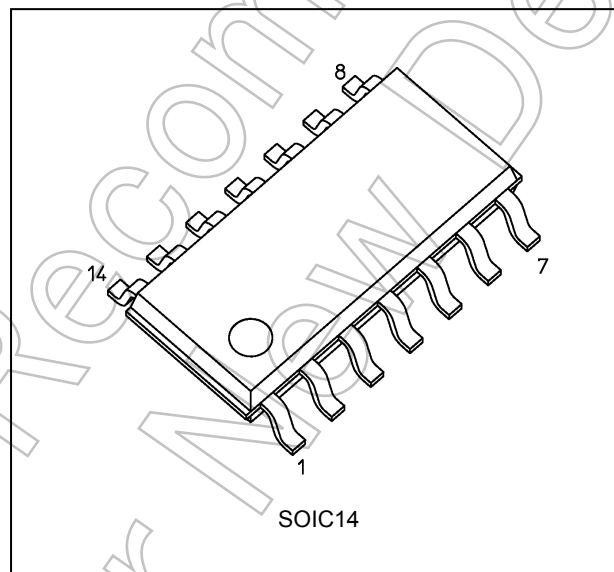
The internal circuit is composed of 3 stages, including buffered output, which provide high noise immunity and stable output.

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

## 3. Features

- (1) High speed:  $t_{pd} = 6 \text{ ns (typ.)}$  at  $V_{CC} = 5 \text{ V}$
- (2) Low power dissipation:  $I_{CC} = 1.0 \mu\text{A (max)}$  at  $T_a = 25 \text{ }^\circ\text{C}$
- (3) Balanced propagation delays:  $t_{PLH} \approx t_{PHL}$
- (4) Wide operating voltage range:  $V_{CC(opr)} = 2.0 \text{ to } 6.0 \text{ V}$

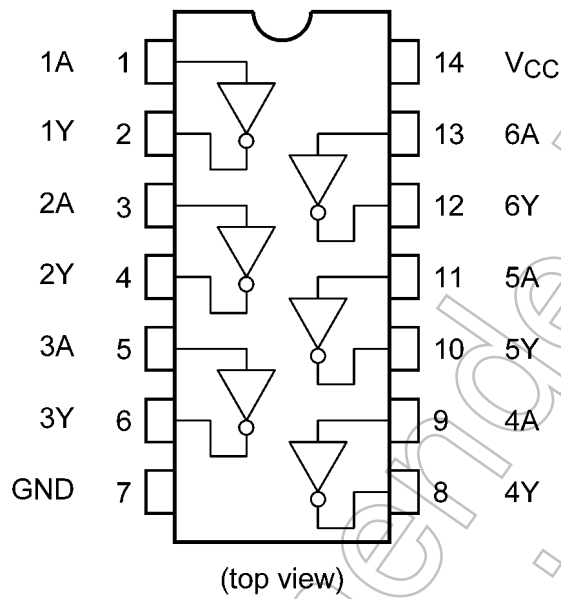
## 4. Packaging



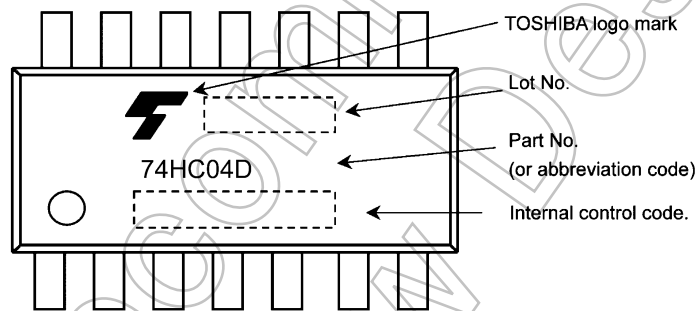
Start of commercial production

2016-05

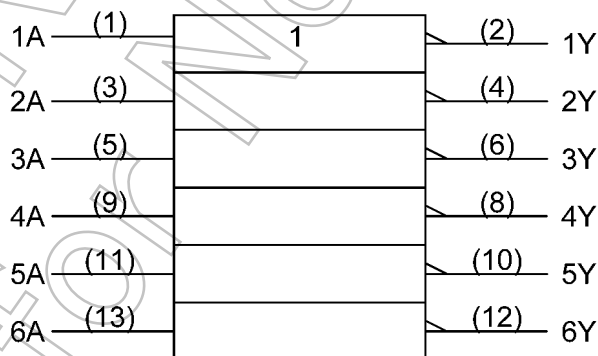
**5. Pin Assignment**



**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	$I_{IK}$		$\pm 20$	mA
Output diode current	$I_{OK}$		$\pm 20$	mA
Output current	$I_{OUT}$		$\pm 25$	mA
$V_{CC}$ /ground current	$I_{CC}$		$\pm 50$	mA
Power dissipation	$P_D$	(Note 1)	500	mW
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:  $P_D$  derates linearly with -8 mW/ $^{\circ}C$  above 85  $^{\circ}C$

**10. Operating Ranges (Note)**

Characteristics	Symbol	Test Condition	Rating	Unit
Supply voltage	$V_{CC}$	—	2.0 to 6.0	V
Input voltage	$V_{IN}$	—	0 to $V_{CC}$	V
Output voltage	$V_{OUT}$	—	0 to $V_{CC}$	V
Operating temperature	$T_{opr}$	—	-40 to 125	$^{\circ}C$
Input rise and fall times	$t_r, t_f$	—	0 to 50	$\mu s$

Note: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs and bus inputs must be tied to either  $V_{CC}$  or GND.

**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	$V_{IH}$	—		2.0	1.50	—	—	V
				4.5	3.15	—	—	
				6.0	4.20	—	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	—	0.50	V
				4.5	—	—	1.35	
				6.0	—	—	1.80	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -20\text{ }\mu\text{A}$	2.0	1.9	2.0	—	V
				4.5	4.4	4.5	—	
			6.0	5.9	6.0	—		
			$I_{OH} = -4\text{ mA}$	4.5	4.18	4.31	—	
			$I_{OH} = -5.2\text{ mA}$	6.0	5.68	5.80	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 20\text{ }\mu\text{A}$	2.0	—	0.0	0.1	V
				4.5	—	0.0	0.1	
				6.0	—	0.0	0.1	
			$I_{OL} = 4\text{ mA}$	4.5	—	0.17	0.26	
			$I_{OL} = 5.2\text{ mA}$	6.0	—	0.18	0.26	
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		6.0	—	—	$\pm 0.1$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		6.0	—	—	1.0	$\mu\text{A}$

**11.2. 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	$V_{IH}$	—		2.0	1.50	—	V
				4.5	3.15	—	
				6.0	4.20	—	
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V
				4.5	—	1.35	
				6.0	—	1.80	
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -20\text{ }\mu\text{A}$	2.0	1.9	—	V
				4.5	4.4	—	
			6.0	5.9	—		
			$I_{OH} = -4\text{ mA}$	4.5	4.13	—	
			$I_{OH} = -5.2\text{ mA}$	6.0	5.63	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 20\text{ }\mu\text{A}$	2.0	—	0.1	V
				4.5	—	0.1	
				6.0	—	0.1	
			$I_{OL} = 4\text{ mA}$	4.5	—	0.33	
			$I_{OL} = 5.2\text{ mA}$	6.0	—	0.33	
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		6.0	—	$\pm 1.0$	$\mu\text{A}$
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		6.0	—	10.0	$\mu\text{A}$

**11.3. 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	$V_{IH}$	—		2.0	1.50	—	V	
				4.5	3.15	—		
				6.0	4.20	—		
Low-level input voltage	$V_{IL}$	—		2.0	—	0.50	V	
				4.5	—	1.35		
				6.0	—	1.80		
High-level output voltage	$V_{OH}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OH} = -20$ $\mu$ A	2.0	1.9	—	V	
				4.5	4.4	—		
				6.0	5.9	—		
			$I_{OH} = -4$ mA	4.5	3.7	—		
				6.0	$I_{OH} = -5.2$ mA	5.2		—
					—	—		—
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 20$ $\mu$ A	2.0	—	0.1	V	
				4.5	—	0.1		
				6.0	—	0.1		
			$I_{OL} = 4$ mA	4.5	—	0.4		
				6.0	$I_{OL} = 5.2$ mA	—		0.4
					—	—		—
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND		6.0	—	$\pm 1.0$	$\mu$ A	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND		6.0	—	40.0	$\mu$ A	

**11.4. AC Characteristics**

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

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$	—	—	4	8	ns
Propagation delay time	$t_{PLH}, t_{PHL}$	—	—	6	12	ns

**11.5. AC Characteristics**

(Unless otherwise specified,  $C_L = 50$  pF,  $T_a = 25$  °C, Input:  $t_r = t_f = 6$  ns)

Characteristics	Symbol	Note	$V_{CC}$ (V)	Min	Typ.	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$		2.0	—	30	75	ns
			4.5	—	8	15	
			6.0	—	7	13	
Propagation delay time	$t_{PLH}, t_{PHL}$		2.0	—	27	75	ns
			4.5	—	9	15	
			6.0	—	8	13	
Input capacitance	$C_{IN}$		—	—	3	—	pF
Power dissipation capacitance	$C_{PD}$	(Note 1)	—	—	7	—	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,  $C_L = 50$  pF,  $T_a = -40$  to  $85$  °C, Input:  $t_r = t_f = 6$  ns)

Characteristics	Symbol	$V_{CC}$ (V)	Min	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$	2.0	—	95	ns
		4.5	—	19	
		6.0	—	16	
Propagation delay time	$t_{PLH}, t_{PHL}$	2.0	—	95	ns
		4.5	—	19	
		6.0	—	16	

## 11.7. AC Characteristics

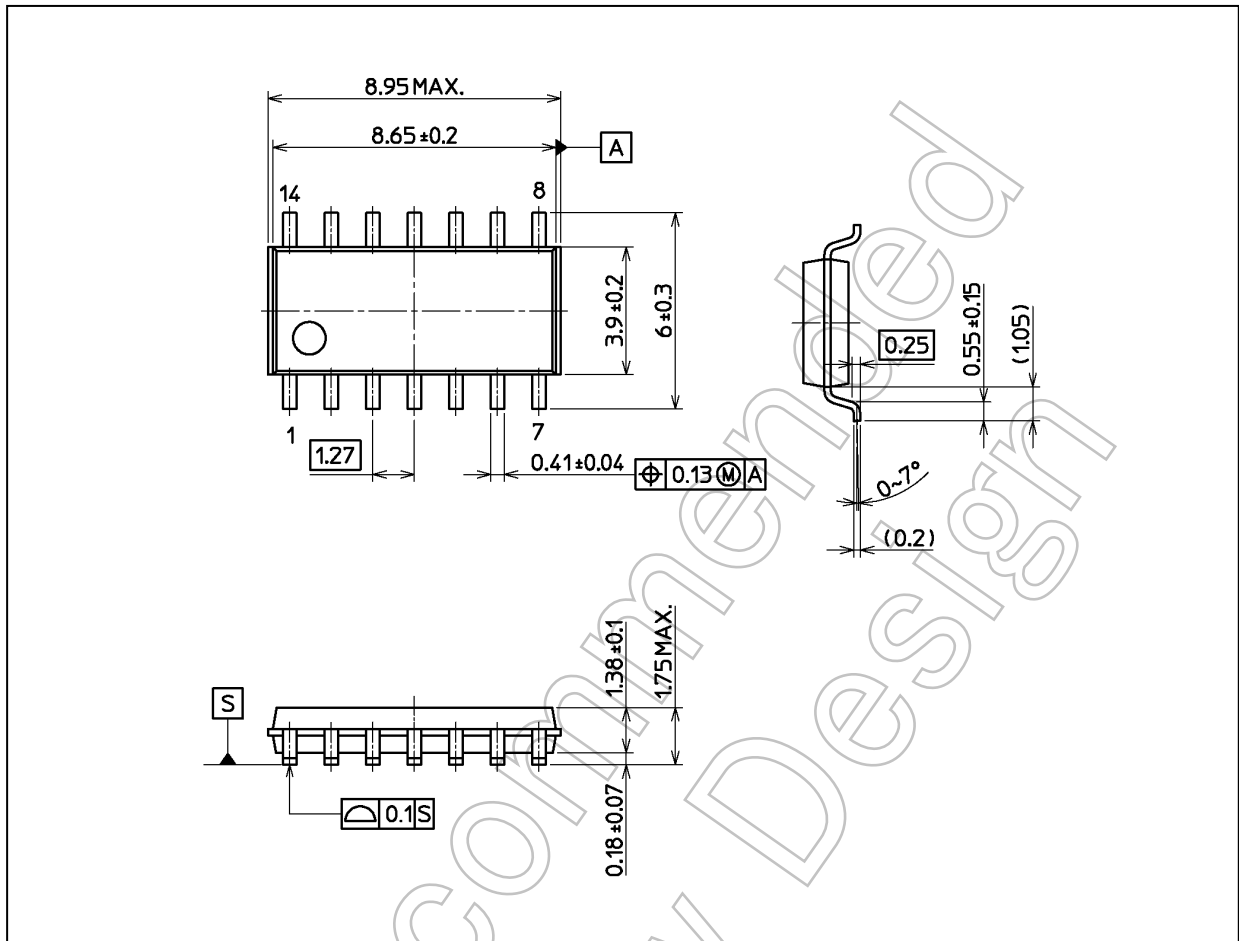
(Unless otherwise specified,  $C_L = 50$  pF,  $T_a = -40$  to  $125$  °C, Input:  $t_r = t_f = 6$  ns)

Characteristics	Symbol	$V_{CC}$ (V)	Min	Max	Unit
Output transition time	$t_{TLH}, t_{THL}$	2.0	—	110	ns
		4.5	—	22	
		6.0	—	19	
Propagation delay time	$t_{PLH}, t_{PHL}$	2.0	—	130	ns
		4.5	—	26	
		6.0	—	22	

Not Recommended for New Design

Package Dimensions

Unit: mm



Weight: 0.13 g (typ.)

Package Name(s)
Nickname: SOIC14

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