



High Speed CMOS Logic – 54HC04

Hex Inverter Gate Logic IC in bare die form

Rev 1.0
22/04/19

Description

The 54HC04 hex inverter gate is fabricated on a .35µm advanced CMOS process combining high speed LSTTL performance with CMOS low power. The device contains six independent inverters with standard push-pull outputs which perform the Boolean function $Y = \bar{A}$ in positive logic. Internal circuitry comprises of three stages and includes buffered output for high noise immunity and stability. Inputs are compatible with standard CMOS outputs; with pull-up resistors, they are compatible with LSTTL outputs. The product die size is significantly smaller than industry peers due to its re-design and production using a more advanced CMOS process.

Features:

- Output Drive Capability: 10 LSTTL Loads
- Low Input Current: 1µA
- Outputs directly interface CMOS, NMOS and TTL
- Operating Voltage Range: 2V to 6V
- Function compatible with 54LS04
- High Noise Immunity CMOS process
- Full Military Temperature Range.

Ordering Information

The following part suffixes apply:

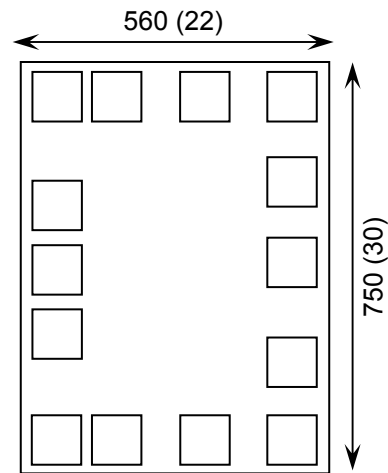
- No suffix - MIL-STD-883 /2010B Visual Inspection
- "H" - MIL-STD-883 /2010B Visual Inspection
+ MIL-PRF-38534 Class H LAT
- "K" - MIL-STD-883 /2010A Visual Inspection (Space)
+ MIL-PRF-38534 Class K LAT

LAT = Lot Acceptance Test.

For further information on LAT process flows see below.

www.siliconsupplies.com/quality/bare-die-lot-qualification

Die Dimensions in µm (mils)



Supply Formats:

- Default – Die in Waffle Pack (400 per tray capacity)
- Sawn Wafer on Tape – On request
- Unsawn Wafer – On request
- Die Thickness <=> 350µm(14 Mils) – On request
- Assembled into Ceramic Package – On request

Mechanical Specification

Die Size (Unsawn)	560 x 750 22 x 30	µm mils
Minimum Bond Pad Size	90 x 90 3.54 x 3.54	µm mils
Die Thickness	350 (±20) 13.78 (±0.79)	µm mils
Top Metal Composition	Al 1%Si 1.1µm	
Back Metal Composition	N/A – Bare Si	

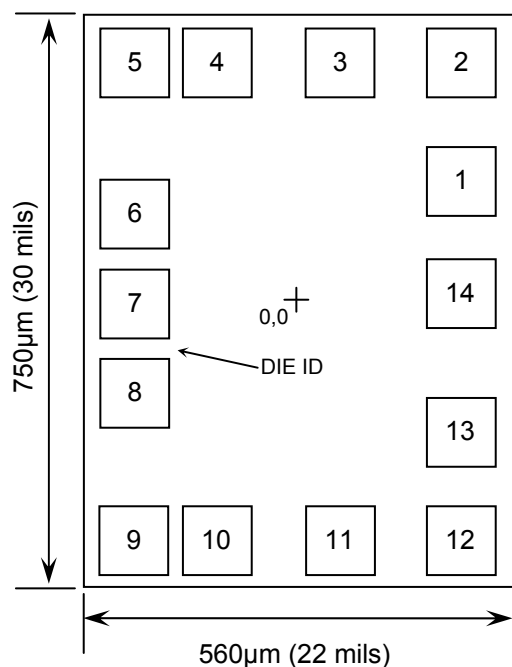




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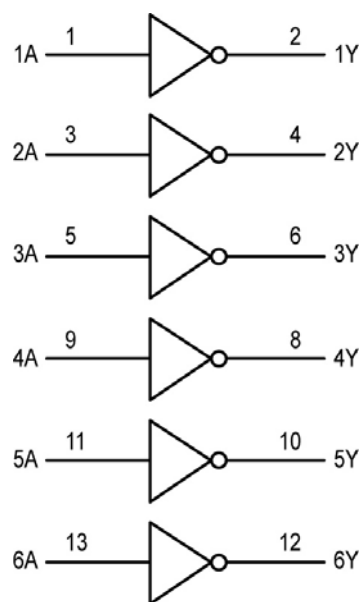
Pad Layout and Functions



PAD	FUNCTION	COORDINATES (µm)	
		X	Y
1	1A	210	155
2	1Y	210	320
3	2A	60	320
4	2Y	-103	320
5	3A	-210	320
6	3Y	-210	117
7	GND	-210	0
8	4Y	-210	-117
9	4A	-210	-320
10	5Y	-103	-320
11	5A	60	-320
12	6Y	210	-320
13	6A	210	-178
14	V _{CC}	210	9

CONNECT CHIP BACK TO V_{CC} OR FLOAT

Logic Diagram



Pad 14 = V_{CC}
Pad 7 = GND

Truth Table

INPUTS	OUTPUT
A	Y
H	L
L	H

H = High level (steady state)
L = Low level (steady state)





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Absolute Maximum Ratings¹

PARAMETER	SYMBOL	VALUE	UNIT
DC Supply Voltage (Referenced to GND)	V_{CC}	-0.5 to +7.0	V
DC Input Voltage (Referenced to GND)	V_{IN}	-0.5 to $V_{CC} + 0.5$	V
DC Output Voltage (Referenced to GND)	V_{OUT}	-0.5 to $V_{CC} + 0.5$	V
DC Input Current	I_{IN}	±20	mA
DC Output Current, per pad	I_{OUT}	±25	mA
DC Supply Current, V_{CC} or GND	I_{CC}	±50	mA
Power Dissipation in Still Air ²	P_D	750	mW
Storage Temperature Range	T_{STG}	-65 to 150	°C

1. Operation above the absolute maximum rating may cause device failure. Operation at the absolute maximum ratings, for extended periods, may reduce device reliability. 2. Measured in plastic DIP package, results in die form are dependent on die attach and assembly method.

Recommended Operating Conditions³ (Voltages referenced to GND)

PARAMETER	SYMBOL	MIN	MAX	UNITS	
Supply Voltage	V_{CC}	2	6	V	
DC Input or Output Voltage	V_{IN}, V_{OUT}	0	V_{CC}	V	
Operating Temperature Range	T_J	-55	+125	°C	
Input Rise or Fall Times	t_r, t_f	$V_{CC} = 2V$	0	1000	ns
		$V_{CC} = 4.5V$	0	500	
		$V_{CC} = 6.0V$	0	400	

3. This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation, V_{IN} and V_{OUT} should be constrained to the range $GND \leq (V_{IN} \text{ or } V_{OUT}) \leq V_{CC}$. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V_{CC}). Unused outputs must be left open.

DC Electrical Characteristics (Voltages Referenced to GND)

PARAMETER	SYMBOL	V_{CC}	CONDITIONS	LIMITS			UNITS
				25°C	85°C	FULL RANGE ⁴	
Minimum High-Level Input Voltage	V_{IH}	2.0V	$V_{OUT} = 0.1V \text{ or } V_{CC} - 0.1V$ $ I_{OUT} \leq 20\mu A$	1.5	1.5	1.5	V
		3.0V		2.1	2.1	2.1	
		4.5V		3.15	3.15	3.15	
		6.0V		4.2	4.2	4.2	
Maximum Low-Level Input Voltage	V_{IL}	2.0V	$V_{OUT} = 0.1V \text{ or } V_{CC} - 0.1V$ $ I_{OUT} \leq 20\mu A$	0.5	0.5	0.5	V
		3.0V		0.9	0.9	0.9	
		4.5V		1.35	1.35	1.35	
		6.0V		1.8	1.8	1.8	

4. $-55^\circ C \leq T_J \leq +125^\circ C$





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Rev 1.0

22/04/19

DC Electrical Characteristics Continued (Voltages Referenced to GND)

PARAMETER	SYMBOL	V _{CC}	CONDITIONS	LIMITS			UNITS
				25°C	85°C	FULL RANGE ⁴	
Minimum High-Level Output Voltage	V _{OH}	2.0V	V _{IN} = V _{IH} or V _{IL} I _{OUT} ≤ 20μA	1.9	1.9	1.9	V
		4.5V		4.4	4.4	4.4	
		6.0V		5.9	5.9	5.9	
		3.0V	V _{IN} = V _{IH} or V _{IL} I _{OUT} ≤ 2.4mA	2.48	2.34	2.20	V
		4.5V		3.98	3.84	3.70	
		6.0V		5.48	5.34	5.20	
Maximum Low-Level Output Voltage	V _{OL}	2.0V	V _{IN} = V _{IL} or V _{IL} I _{OUT} ≤ 20μA	0.1	0.1	0.1	V
		4.5V		0.1	0.1	0.1	
		6.0V		0.1	0.1	0.1	
		3.0V	V _{IN} = V _{IL} or V _{IL} I _{OUT} ≤ 2.4mA	0.26	0.33	0.40	V
		4.5V		0.26	0.33	0.40	
		6.0V		0.26	0.33	0.40	
Maximum Input Leakage Current	I _{IN}	6.0V	V _{IN} = V _{CC} or GND	±0.1	±1.0	±1.0	μA
Maximum Quiescent Supply Leakage Current	I _{CC}	6.0V	V _{IN} = V _{CC} or GND I _{OUT} = 0μA	1	10	40	μA

AC Electrical Characteristics⁵

PARAMETER	SYMBOL	V _{CC}	CONDITIONS	LIMITS			UNITS
				25°C	85°C	FULL RANGE ⁴	
Maximum Propagation Delay, Input A or B to Output Y (Figure 1,2)	t _{PLH} , t _{PHL}	2.0V	C _L = 50pF, t _r = t _f = 6ns	75	95	110	ns
		3.0V		30	40	55	
		4.5V		15	19	22	
		6.0V		13	16	19	
Maximum Output Rise and Fall Time, Any Output (Figure 1,2)	t _{TLH} , t _{THL}	2.0V	C _L = 50pF, t _r = t _f = 6ns	75	95	110	ns
		3.0V		27	32	36	
		4.5V		15	19	22	
		6.0V		13	16	19	

5. Not production tested in die form, characterized by chip design and tested in package.





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AC Electrical Characteristics Continued⁵

PARAMETER	SYMBOL	V _{CC}	CONDITIONS	LIMITS			UNITS
				25°C	85°C	FULL RANGE ⁴	
Maximum Input Capacitance	C _{IN}	-	-	10	10	10	pF
Power Dissipation Capacitance Per Gate ⁶	C _{PD}	-	T _A = 25°C, V _{CC} = 5.0V	TYPICAL			pF
				20			

6. Used to determine the no-load dynamic power consumption: $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$.

Switching Waveform

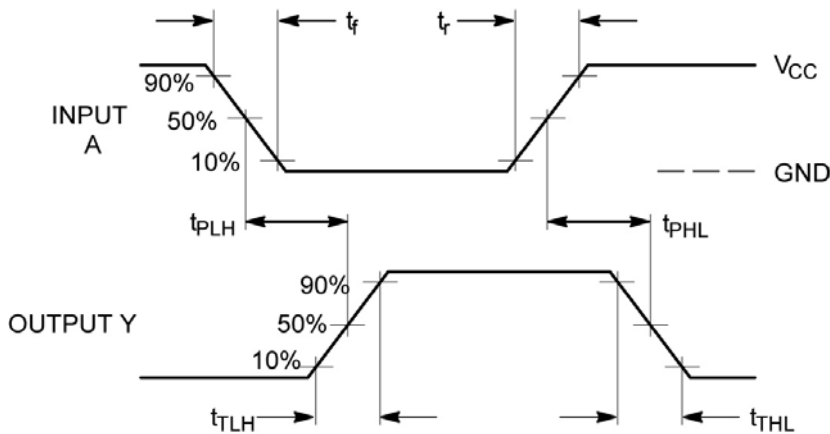
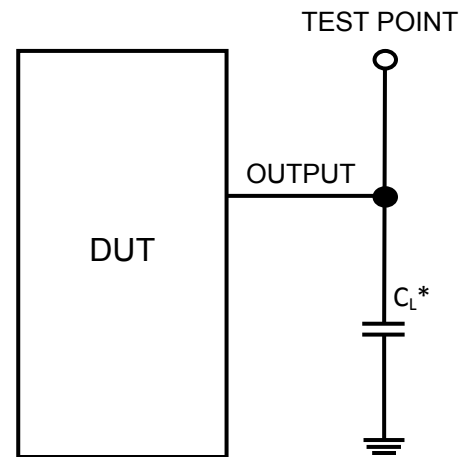


Figure 1 – Propagation Delay & Output Transition Time

Test Circuit



* Includes all probe and jig capacitance

Figure 2

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