



LOW VOLTAGE CMOS HEX INVERTER HIGH PERFORMANCE

- **■** 5V TOLERANT INPUTS
- HIGH SPEED: $t_{PD} = 4.5$ ns (MAX.) at $V_{CC} = 3V$
- POWER DOWN PROTECTION ON INPUTS AND OUTPUTS
- SYMMETRICAL OUTPUT IMPEDANCE: |I_{OH}| = I_{OI} = 24mA (MIN) at V_{CC} = 3V
- PCI BUS LEVELS GUARANTEED AT 24 mA
- BALANCED PROPAGATION DELAYS: tpi h ≅ tphi
- OPERATING VOLTAGE RANGE:
 V_{CC}(OPR) = 1.65V to 3.6V (1.2V Data Retention)
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 00
- LATCH-UP PERFORMANCE EXCEEDS 500mA (JESD 17)
- ESD PERFORMANCE: HBM > 2000V (MIL STD 883 method 3015); MM > 200V

DESCRIPTION

The 74LVC04A is a low voltage CMOS HEX INVERTER fabricated with sub-micron silicon gate and double-layer metal wiring $\rm C^2MOS$ technology. It is ideal for 1.65 to 3.6 $\rm V_{CC}$

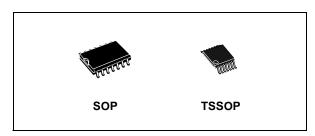


Table 1: Order Codes

PACKAGE	T & R
SOP	74LVC04AMTR
TSSOP	74LVC04ATTR

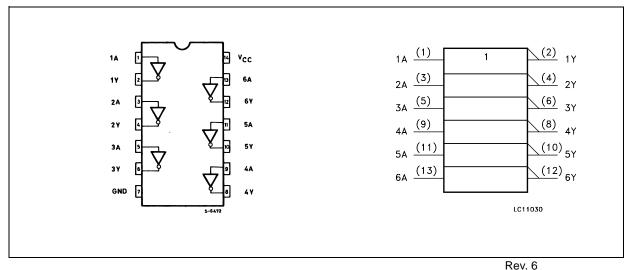
operations and low power and low noise applications.

It can be interfaced to 5V signal environment for inputs in mixed 3.3/5V system.

It has more speed performance at 3.3V than 5V AC/ACT family, combined with a lower power consumption.

All inputs and outputs are equipped with protection circuits against static discharge, giving them 2KV ESD immunity and transient excess voltage.

Figure 1: Pin Connection And IEC Logic Symbols



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Figure 2: Input And Output Equivalent Circuit

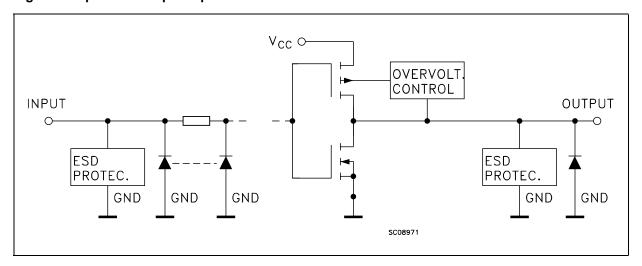


Table 2: Pin Description

PIN N°	SYMBOL	NAME AND FUNCTION
1,3,5,9,11,13	1A to 6A	Data Inputs
2, 4, 6, 8, 10, 12	1Y to 6Y	Data Outputs
7	GND	Ground (0V)
14	V_{CC}	Positive Supply Voltage

Table 3: Truth Table

Α	Y
L	Н
Н	L

Table 4: Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
V _{CC}	Supply Voltage	-0.5 to +7.0	V
V _I	DC Input Voltage	-0.5 to +7.0	V
Vo	DC Output Voltage (V _{CC} = 0V)	-0.5 to +7.0	V
Vo	DC Output Voltage (High or Low State) (note 1)	-0.5 to V _{CC} + 0.5	V
I _{IK}	DC Input Diode Current	- 50	mA
I _{OK}	DC Output Diode Current (note 2)	- 50	mA
Io	DC Output Current	± 50	mA
I _{CC} or I _{GND}	DC V _{CC} or Ground Current per Supply Pin	± 100	mA
T _{stg}	Storage Temperature	-65 to +150	°C
T _L	Lead Temperature (10 sec)	300	°C

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied

1) I_O absolute maximum rating must be observed
2) V_O < GND

Table 5: Recommended Operating Conditions

Symbol	Parameter	Value	Unit
V _{CC}	Supply Voltage (note 1)	1.65 to 3.6	V
V _I	Input Voltage	0 to 5.5	V
Vo	Output Voltage (V _{CC} = 0V)	0 to 5.5	V
Vo	Output Voltage (High or Low State)	0 to V _{CC}	V
I _{OH} , I _{OL}	High or Low Level Output Current (V _{CC} = 3.0 to 3.6V)	± 24	mA
I _{OH} , I _{OL}	High or Low Level Output Current (V _{CC} = 2.7 to 3.0V)	± 12	mA
I _{OH} , I _{OL}	High or Low Level Output Current (V _{CC} = 2.3 to 2.7V)	± 8	mA
I _{OH} , I _{OL}	High or Low Level Output Current (V _{CC} = 1.65 to 2.3V)	± 4	mA
T_{op}	Operating Temperature	-55 to 125	°C
dt/dv	Input Rise and Fall Time (note 2)	0 to 10	ns/V

¹⁾ Truth Table guaranteed: 1.2V to 3.6V 2) V_{IN} from 0.8V to 2V at V_{CC} = 3.0V

Table 6: DC Specifications

		Test Condition						
Symbol	Parameter	V _{CC}	V _{CC}		-40 to 85 °C -55 to		125 °C Uni	
		(V)		Min.	Max.	Min.	Max.	
V _{IH}	High Level Input	1.65 to 1.95		0.65V _{CC}		0.65V _{CC}		
	Voltage	2.3 to 2.7		1.7		1.7		V
		2.7 to 3.6		2		2		
V_{IL}	Low Level Input	1.65 to 1.95			0.35V _{CC}		0.35V _{CC}	
	Voltage	2.3 to 2.7			0.7		0.7	V
		2.7 to 3.6			8.0		0.8	
V_{OH}	High Level Output	1.65 to 3.6	I _O =-100 μA	V _{CC} -0.2		V _{CC} -0.2		
	Voltage	1.65	I _O =-4 mA	1.2		1.2		
		2.3	I _O =-8 mA	1.7		1.7		
		2.7	I _O =-12 mA	2.2		2.2		V
		3.0	I _O =-18 mA	2.4		2.4		
		3.0	I _O =-24 mA	2.2		2.2		
V _{OL}	Low Level Output	1.65 to 3.6	I _O =100 μA		0.2		0.2	
	Voltage	1.65	I _O =4 mA		0.45		0.45	
		2.3	I _O =8 mA		0.7		0.7	V
		2.7	I _O =12 mA		0.4		0.4	
		3.0	I _O =24 mA		0.55		0.55	
l _l	Input Leakage Current	3.6	$V_{I} = 0 \text{ to } 5.5V$		± 5		± 5	μΑ
I _{off}	Power Off Leakage Current	0	V_I or $V_O = 5.5V$		100		100	μΑ
Icc	Quiescent Supply		$V_I = V_{CC}$ or GND		10		10	
	Current	3.6	$V_{I} \text{ or } V_{O} = 3.6 \text{ to}$ 5.5V		± 10		± 10	μΑ
ΔI_{CC}	I _{CC} incr. per Input	2.7 to 3.6	$V_{IH} = V_{CC}$ -0.6V		500		500	μΑ

Table 7: Dynamic Switching Characteristics

		Tes	st Condition		Value		
Symbol Parameter		v _{cc}		7	Γ _A = 25 °0		Unit
		(V)		Min.	Тур.	Max.	
V _{OLP}	Dynamic Low Level Quiet	3.3	C _L = 50pF		0.8		V
V_{OLV}	Output (note 1)	3.3	$V_{IL} = 0V, V_{IH} = 3.3V$		-0.8		V

¹⁾ Number of output defined as "n". Measured with "n-1" outputs switching from HIGH to LOW or LOW to HIGH. The remaining output is measured in the LOW state.

Table 8: AC Electrical Characteristics

		Test Condition			Value					
Symbol	Parameter	V _{cc}	C _L R _L t _s = t _r -40 to 85 °C -55 to 125 °C		R _L t _s = t _r -40 to 85 °C		-55 to 125 °C		Unit	
		(V) (pF)			(ns)	Min.	Max.	Min.	Max.	
t _{PLH} t _{PHL}	Propagation Delay	1.65 to 1.95	30	1000	2.0		9.5		12.5	
	Time	2.3 to 2.7	30	500	2.0		7.0		10	
		2.7	50	500	2.5		5.5		6.6	ns
		3.0 to 3.6	50	500	2.5	1	4.5	1	5.4	
t _{OSLH} t _{OSHL}	Output To Output Skew Time (note1, 2)	2.7 to 3.6					1		1	ns

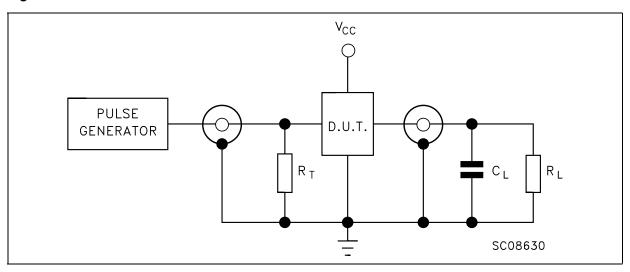
¹⁾ Skew is defined as the absolute value of the difference between the actual propagation delay for any two outputs of the same device switching in the same direction, either HIGH or LOW (t_{OSLH} = | t_{PLHm} - t_{PLHn}|, t_{OSHL} = | t_{PHLm} - t_{PHLn}| 2) Parameter guaranteed by design

Table 9: Capacitive Characteristics

		Tes	Value				
Symbol	Parameter	V _{CC}		T _A = 25 °C		Unit	
		(V)		Min.	Тур.	Max.	
C _{IN}	Input Capacitance				4		pF
C _{PD}	Power Dissipation Capacitance	1.8	f _{IN} = 10MHz		37		
	(note 1)	2.5			37		pF
		3.3			41		

¹⁾ C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/n$ (per circuit)

Figure 3: Test Circuit

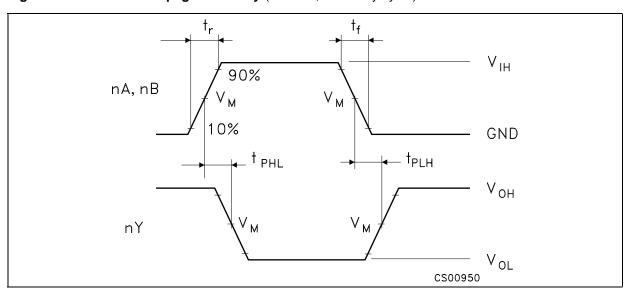


 $R_T = Z_{OUT}$ of pulse generator (typically 50 Ω)

Table 10: Test Circuit And Waveform Symbol Value

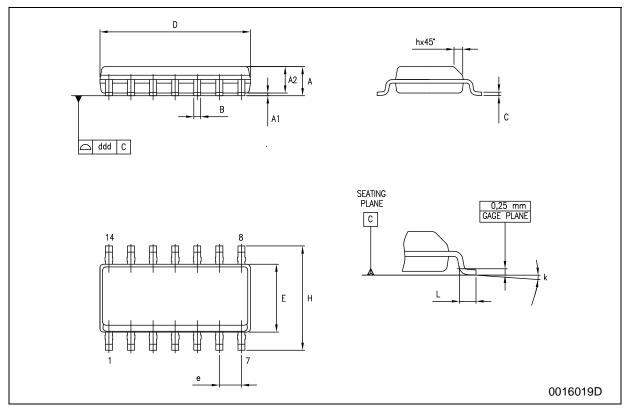
Symbol		V _{CC}							
Зушьог	1.65 to 1.95V	2.3 to 2.7V	2.7V	3.0 to 3.6V					
C _L	30pF	30pF	50pF	50pF					
R_L	1000Ω	500Ω	500Ω	500Ω					
V _{IH}	V _{CC}	V _{CC}	2.7V	2.7V					
V _M	V _{CC} /2	V _{CC} /2	1.5V	1.5V					
V _{OH}	V _{CC}	V _{CC}	3.0V	3.0V					
$t_r = t_r$	<2.0ns	<2.0ns	<2.5ns	<2.5ns					

Figure 4: Waveform - Propagation Delay (f=1MHz; 50% duty cycle)



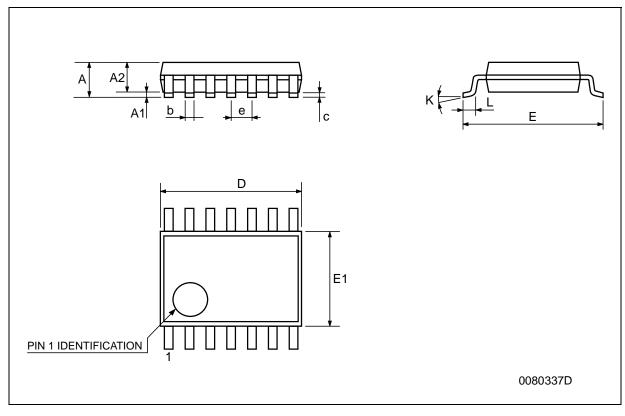
SO-14 MECHANICAL DATA

DIM		mm.		inch		
DIM.	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
А	1.35		1.75	0.053		0.069
A1	0.1		0.25	0.004		0.010
A2	1.10		1.65	0.043		0.065
В	0.33		0.51	0.013		0.020
С	0.19		0.25	0.007		0.010
D	8.55		8.75	0.337		0.344
Е	3.8		4.0	0.150		0.157
е		1.27			0.050	
Н	5.8		6.2	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.4		1.27	0.016		0.050
k	0°		8°	0°		8°
ddd			0.100			0.004



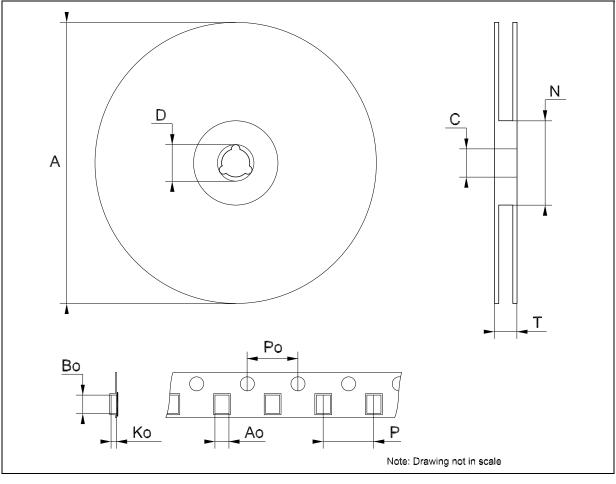
TSSOP14 MECHANICAL DATA

DIM		mm.				
DIM.	MIN.	ТҮР	MAX.	MIN.	TYP.	MAX.
А			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
С	0.09		0.20	0.004		0.0089
D	4.9	5	5.1	0.193	0.197	0.201
Е	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
е		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030



Tape & Reel SO-14 MECHANICAL DATA

mm.			inch		
MIN.	TYP	MAX.	MIN.	TYP.	MAX.
		330			12.992
12.8		13.2	0.504		0.519
20.2			0.795		
60			2.362		
		22.4			0.882
6.4		6.6	0.252		0.260
9		9.2	0.354		0.362
2.1		2.3	0.082		0.090
3.9		4.1	0.153		0.161
7.9		8.1	0.311		0.319
	12.8 20.2 60 6.4 9 2.1 3.9	MIN. TYP 12.8 20.2 60 6.4 9 2.1 3.9	MIN. TYP MAX. 330 12.8 13.2 20.2 60 22.4 6.4 6.6 9 9 9.2 2.1 2.3 3.9 4.1	MIN. TYP MAX. MIN. 330 12.8 13.2 0.504 20.2 0.795 0.795 60 2.362 22.4 6.6 0.252 9 9.2 0.354 2.1 2.3 0.082 3.9 4.1 0.153	MIN. TYP MAX. MIN. TYP. 12.8 13.2 0.504 0.795



Tape & Reel TSSOP14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
А			330			12.992
С	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
Т			22.4			0.882
Ao	6.7		6.9	0.264		0.272
Во	5.3		5.5	0.209		0.217
Ko	1.6		1.8	0.063		0.071
Po	3.9		4.1	0.153		0.161
Р	7.9		8.1	0.311		0.319

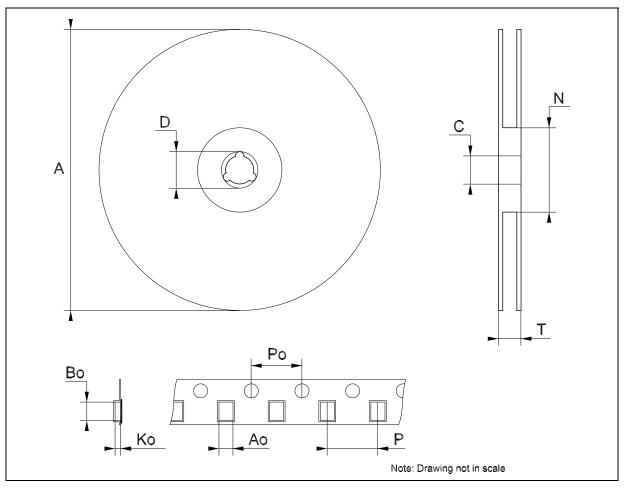


Table 11: Revision History

Date	Revision	Description of Changes
26-Jul-2004	6	Ordering Codes Revision - pag. 1.

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