

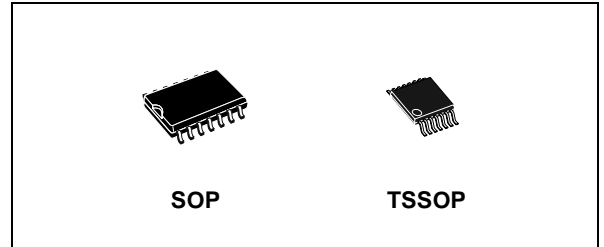
## HEX INVERTER (SINGLE STAGE)

- HIGH SPEED:  $t_{PD} = 3.5 \text{ ns}$  (TYP.) at  $V_{CC} = 5V$
- LOW POWER DISSIPATION:  
 $I_{CC} = 2 \mu\text{A}$  (MAX.) at  $T_A = 25^\circ\text{C}$
- HIGH NOISE IMMUNITY:  
 $V_{NIH} = V_{NIL} = 10\% V_{CC}$  (MIN.)
- POWER DOWN PROTECTION ON INPUTS
- SYMMETRICAL OUTPUT IMPEDANCE:  
 $|I_{OH}| = I_{OL} = 8 \text{ mA}$  (MIN)
- BALANCED PROPAGATION DELAYS:  
 $t_{PLH} \cong t_{PHL}$
- OPERATING VOLTAGE RANGE:  
 $V_{CC(OPR)} = 2V \text{ to } 5.5V$
- PIN AND FUNCTION COMPATIBLE WITH 74 SERIES 04
- IMPROVED LATCH-UP IMMUNITY
- LOW NOISE:  $V_{OLP} = 0.8V$  (MAX.)

### DESCRIPTION

The 74VHCU04 is an advanced high-speed CMOS HEX INVERTER fabricated with sub-micron silicon gate and double-layer metal wiring C<sup>2</sup>MOS technology.

As the internal circuit is composed of a single stage inverter, it can be used in analog applications such as crystal oscillator.



**Table 1: Order Codes**

PACKAGE	T & R
SOP	74VHCU04MTR
TSSOP	74VHCU04TTR

Power down protection is provided on all inputs and outputs and 0 to 7V can be accepted on inputs with no regard to the supply voltage. This device can be used to interface 5V to 3V since all inputs are equipped with TTL threshold.

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**

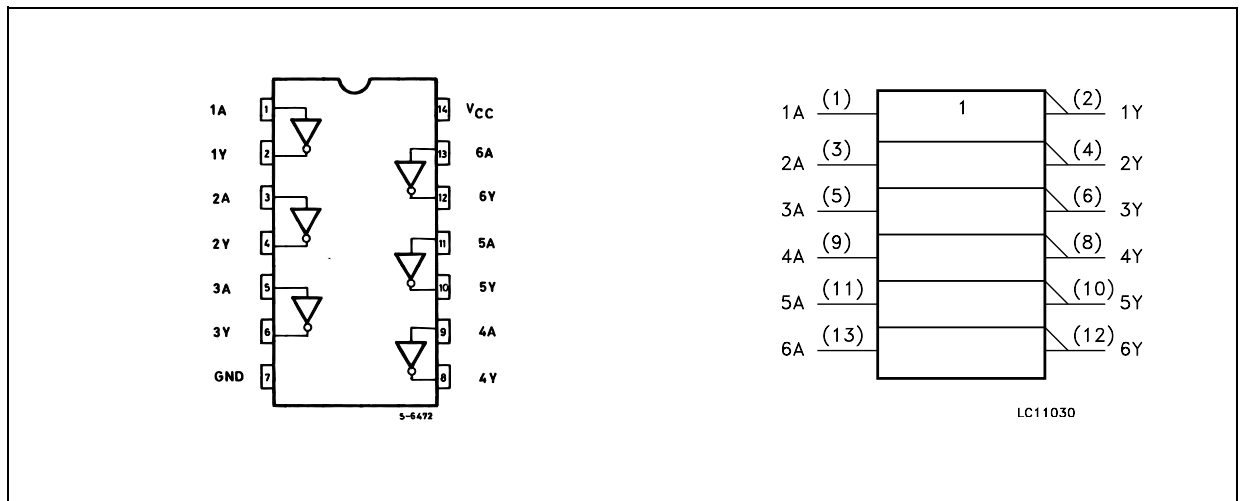


Figure 2: Input Equivalent Circuit

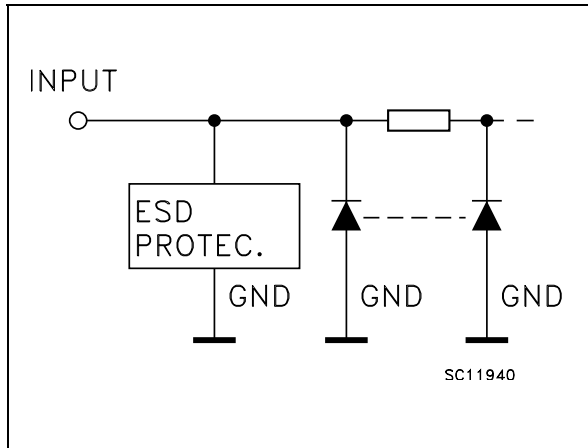


Table 2: Pin Description

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 <sub>CC</sub>	Positive Supply Voltage

Table 3: Truth Table

A	Y
L	H
H	L

Table 4: Absolute Maximum Ratings

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply Voltage	-0.5 to +7.0	V
V <sub>I</sub>	DC Input Voltage	-0.5 to +7.0	V
V <sub>O</sub>	DC Output Voltage	-0.5 to V <sub>CC</sub> + 0.5	V
I <sub>IK</sub>	DC Input Diode Current	- 20	mA
I <sub>OK</sub>	DC Output Diode Current	± 20	mA
I <sub>O</sub>	DC Output Current	± 25	mA
I <sub>CC</sub> or I <sub>GND</sub>	DC V <sub>CC</sub> or Ground Current	± 50	mA
T <sub>stg</sub>	Storage Temperature	-65 to +150	°C
T <sub>L</sub>	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

Table 5: Recommended Operating Conditions

Symbol	Parameter	Value	Unit
V <sub>CC</sub>	Supply Voltage	2.0 to 5.5	V
V <sub>I</sub>	Input Voltage	0 to 5.5	V
V <sub>O</sub>	Output Voltage	0 to V <sub>CC</sub>	V
T <sub>op</sub>	Operating Temperature	-55 to 125	°C
dt/dv	Input Rise and Fall Time (see note 1) (V <sub>CC</sub> =3.3±0.3V) (V <sub>CC</sub> = 5.0 ± 0.5V)	0 to 100 0 to 20	ns/V

1) V<sub>IN</sub> from 30% to 70% of V<sub>CC</sub>

Table 6: DC Specifications

Symbol	Parameter	Test Condition		Value						Unit	
		V <sub>CC</sub> (V)		T <sub>A</sub> = 25°C			-40 to 85°C		-55 to 125°C		
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.
V <sub>IH</sub>	High Level Input Voltage	2.0		1.7			1.7		1.7		V
		3.0 to 5.5		0.8V <sub>CC</sub>			0.8V <sub>CC</sub>		0.8V <sub>CC</sub>		
V <sub>IL</sub>	Low Level Input Voltage	2.0				0.3					V
		3.0 to 5.5				0.2 V <sub>CC</sub>		0.2 V <sub>CC</sub>		0.2 V <sub>CC</sub>	
V <sub>OH</sub>	High Level Output Voltage	2.0	I <sub>O</sub> =-50 μA	1.8	2.0		1.8		1.8		V
		3.0	I <sub>O</sub> =-50 μA	2.7	3.0		2.7		2.7		
		4.5	I <sub>O</sub> =-50 μA	4.0	4.5		4.0		4.0		
		3.0	I <sub>O</sub> =-4 mA	2.58			2.48		2.48		
		4.5	I <sub>O</sub> =-8 mA	3.94			3.8		3.8		
V <sub>OL</sub>	Low Level Output Voltage	2.0	I <sub>O</sub> =50 μA		0.0	0.2		0.2		0.2	V
		3.0	I <sub>O</sub> =50 μA		0.0	0.3		0.3		0.3	
		4.5	I <sub>O</sub> =50 μA		0.0	0.5		0.5		0.5	
		3.0	I <sub>O</sub> =4 mA			0.36		0.44		0.44	
		4.5	I <sub>O</sub> =8 mA			0.36		0.44		0.44	
I <sub>I</sub>	Input Leakage Current	0 to 5.5	V <sub>I</sub> = 5.5V or GND			± 0.1		± 1.0		± 1.0	μA
I <sub>CC</sub>	Quiescent Supply Current	5.5	V <sub>I</sub> = V <sub>CC</sub> or GND			2		20		20	μA

Table 7: AC Electrical Characteristics (Input t<sub>r</sub> = t<sub>f</sub> = 3ns)

Symbol	Parameter	Test Condition		Value						Unit	
		V <sub>CC</sub> (V)	C <sub>L</sub> (pF)	T <sub>A</sub> = 25°C			-40 to 85°C		-55 to 125°C		
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.
t <sub>PLH</sub> t <sub>PHL</sub>	Propagation Delay Time	3.3(*)	15		5.0	8.9	1.0	10.5	1.0	10.5	ns
		3.3(*)	50		7.5	11.4	1.0	13.0	1.0	13.0	
		5.0(**)	15		3.5	5.5	1.0	6.5	1.0	6.5	ns
		5.0(**)	50		5.0	7.0	1.0	8.0	1.0	8.0	

(\*) Voltage range is 3.3V ± 0.3V

(\*\*) Voltage range is 5.0V ± 0.5V

Table 8: Capacitive Characteristics

Symbol	Parameter	Test Condition		Value						Unit	
				T <sub>A</sub> = 25°C			-40 to 85°C		-55 to 125°C		
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.
C <sub>IN</sub>	Input Capacitance				5	10		10		10	pF
C <sub>PD</sub>	Power Dissipation Capacitance (note 1)				13						pF

1) C<sub>PD</sub> 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<sub>CC(opr)</sub> = C<sub>PD</sub> × V<sub>CC</sub> × f<sub>IN</sub> + I<sub>CC</sub>/6 (per gate)

Table 9: Dynamic Switching Characteristics

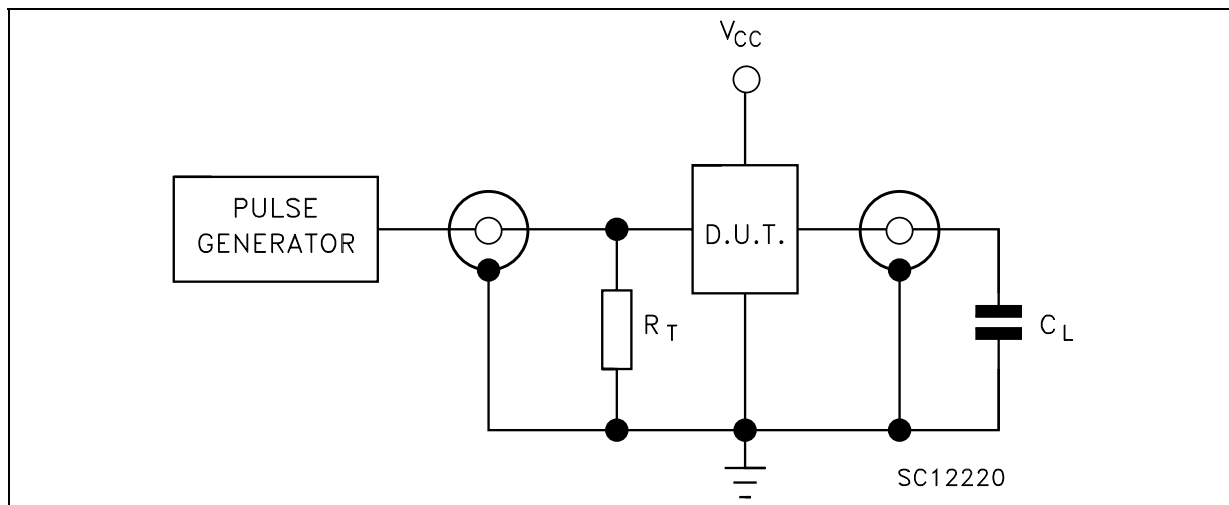
Symbol	Parameter	Test Condition		Value						Unit	
		V <sub>CC</sub> (V)	C <sub>L</sub> = 50 pF	T <sub>A</sub> = 25°C			-40 to 85°C		-55 to 125°C		
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.
V <sub>OLP</sub>	Dynamic Low Voltage Quiet Output (note 1, 2)	5.0	C <sub>L</sub> = 50 pF		0.5	0.8					V
V <sub>OLV</sub>				-0.8	-0.5						
V <sub>IHD</sub>	Dynamic High Voltage Input (note 1, 3)	5.0		4.0							
V <sub>ILD</sub>	Dynamic Low Voltage Input (note 1, 3)	5.0				0.8					

1) Worst case package.

2) Max number of outputs defined as (n). Data inputs are driven 0V to 5.0V, (n-1) outputs switching and one output at GND.

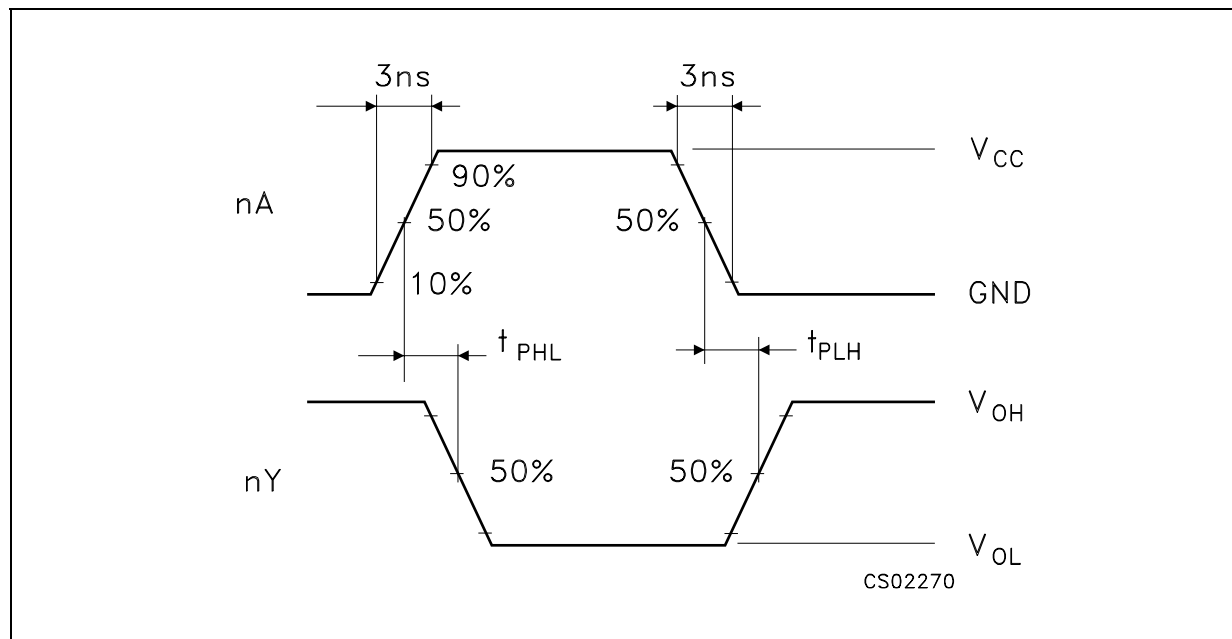
3) Max number of data inputs (n) switching. (n-1) switching 0V to 5.0V. Inputs under test switching: 5.0V to threshold (V<sub>ILD</sub>), 0V to threshold (V<sub>IHD</sub>), f=1MHz.

Figure 3: Test Circuit



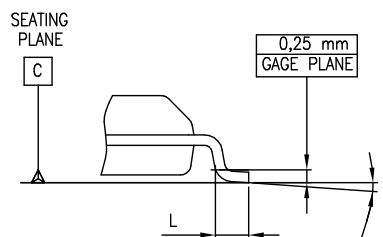
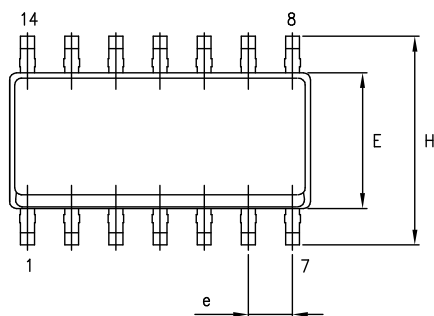
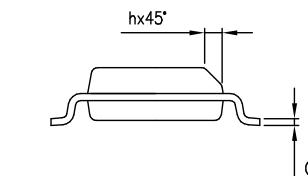
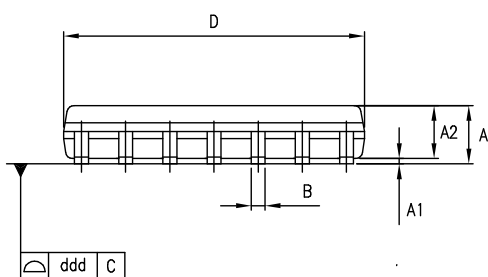
C<sub>L</sub> = 15/50pF or equivalent (includes jig and probe capacitance)

R<sub>T</sub> = Z<sub>OUT</sub> of pulse generator (typically 50Ω)

Figure 4: Waveform - Propagation Delays ( $f=1\text{MHz}$ ; 50% duty cycle)

## SO-14 MECHANICAL DATA

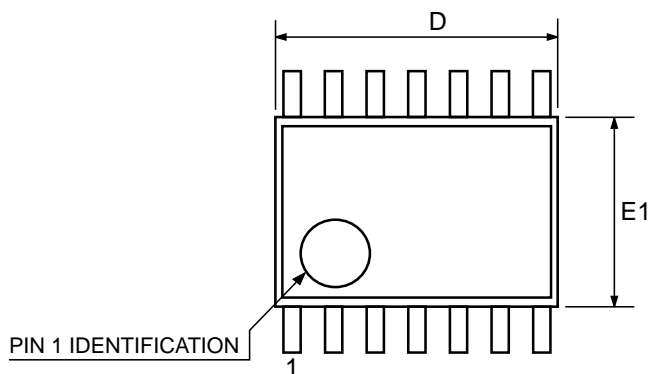
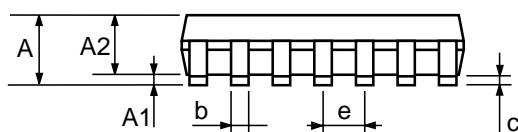
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.1		0.25	0.004		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	8.55		8.75	0.337		0.344
E	3.8		4.0	0.150		0.157
e		1.27			0.050	
H	5.8		6.2	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.4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



0016019D

## TSSOP14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			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
c	0.09		0.20	0.004		0.0089
D	4.9	5	5.1	0.193	0.197	0.201
E	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
e		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030



0080337D

## Tape &amp; Reel SO-14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			330			12.992
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.4		6.6	0.252		0.260
Bo	9		9.2	0.354		0.362
Ko	2.1		2.3	0.082		0.090
Po	3.9		4.1	0.153		0.161
P	7.9		8.1	0.311		0.319





## Tape & Reel TSSOP14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			330			12.992
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.7		6.9	0.264		0.272
Bo	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
P	7.9		8.1	0.311		0.319



**Table 10: Revision History**

<b>Date</b>	<b>Revision</b>	<b>Description of Changes</b>
12-Nov-2004	5	Order Codes Revision - pag. 1.

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