

# DATA SHEET

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## 74LVCU04A Hex inverter

Product specification

1998 Jul 29

## Hex inverter

## 74LVCU04A

## FEATURES

- Wide supply voltage range of 1.2 V to 3.6 V
- In accordance with JEDEC standard no. 8-1A.
- Inputs accept voltages up to 5.5 V
- CMOS low power consumption
- Direct interface with TTL levels

## DESCRIPTION

The 74LVCU04A is a high-performance, low-power, low-voltage, Si-gate CMOS device and superior to most advanced CMOS compatible TTL families.

The 74LVCU04A is a general purpose hex inverter. Each of the six inverters is a single stage with unbuffered outputs.

## QUICK REFERENCE DATA

GND = 0 V;  $T_{amb} = 25^{\circ}\text{C}$ ;  $t_r = t_f \leq 2.5 \text{ ns}$

SYMBOL	PARAMETER	CONDITIONS	TYPICAL	UNIT
$t_{PHL}/t_{PLH}$	Propagation delay nA to nY	$C_L = 50 \text{ pF}$ ; $V_{CC} = 3.3 \text{ V}$	4.3	ns
$C_I$	Input capacitance		7.8	pF
$C_{PD}$	Power dissipation capacitance per gate	Notes 1 and 2	16.8	pF

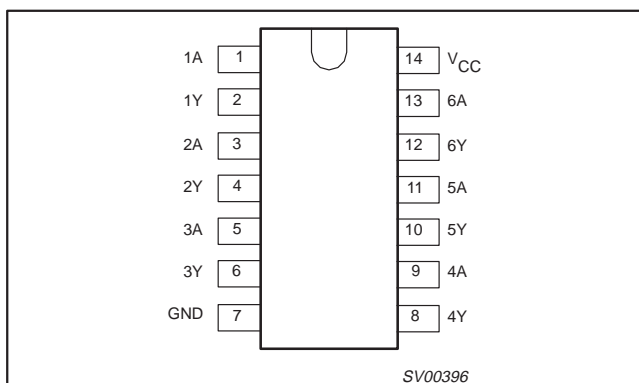
## NOTES:

- $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ )  
 $P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o)$  where:  
 $f_i$  = input frequency in MHz;  $C_L$  = output load capacity in pF;  
 $f_o$  = output frequency in MHz;  $V_{CC}$  = supply voltage in V;  
 $\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of the outputs.
- The condition is  $V_I = \text{GND to } V_{CC}$ .

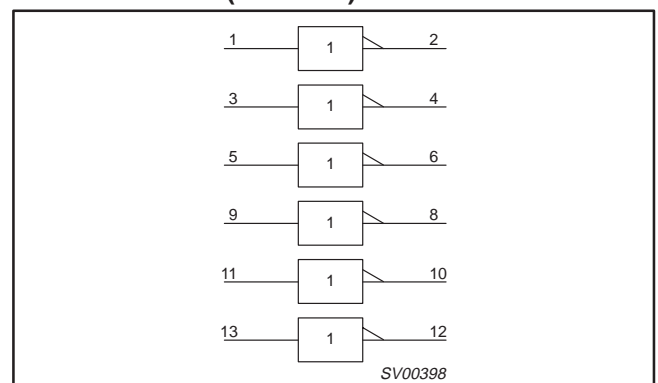
## ORDERING INFORMATION

PACKAGES	TEMPERATURE RANGE	OUTSIDE NORTH AMERICA	NORTH AMERICA	PKG. DWG. #
14-Pin Plastic SO	$-40^{\circ}\text{C to } +85^{\circ}\text{C}$	74LVCU04A D	74LVCU04A D	SOT108-1
14-Pin Plastic SSOP Type II	$-40^{\circ}\text{C to } +85^{\circ}\text{C}$	74LVCU04A DB	74LVCU04A DB	SOT337-1
14-Pin Plastic TSSOP Type I	$-40^{\circ}\text{C to } +85^{\circ}\text{C}$	74LVCU04A PW	74LVCU04APW DH	SOT402-1

## PIN CONFIGURATION



## LOGIC SYMBOL (IEEE/IEC)



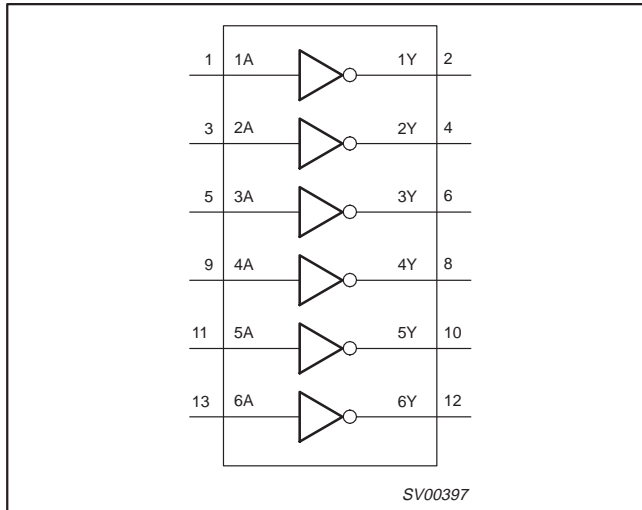
## PIN DESCRIPTION

PIN NUMBER	SYMBOL	NAME AND FUNCTION
1, 3, 5, 9, 11, 13	1A – 6A	Data inputs
2, 4, 6, 8, 10, 12	1Y – 6Y	Data outputs
7	GND	Ground (0 V)
14	$V_{CC}$	Positive supply voltage

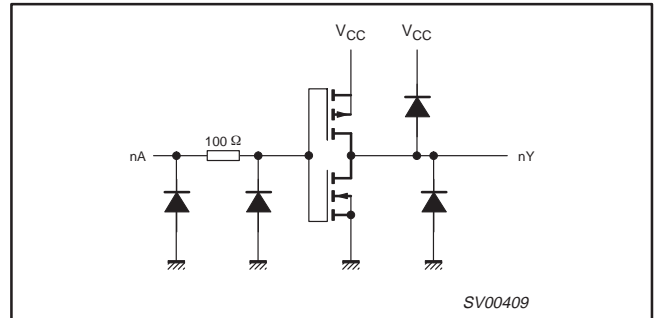
# Hex inverter

# 74LVCU04A

### LOGIC SYMBOL



### LOGIC DIAGRAM (ONE INVERTER)



### FUNCTION TABLE

INPUTS	OUTPUTS
nA	nY
L	H
H	L

NOTES:  
 H = HIGH voltage level  
 L = LOW voltage level

### RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	LIMITS		UNIT
			MIN	MAX	
$V_{CC}$	DC supply voltage (for max. speed performance)		2.7	3.6	V
$V_{CC}$	DC supply voltage (for low-voltage applications)		1.2	3.6	V
$V_I$	DC input voltage range		0	5.5	V
$V_{I/O}$	DC output voltage range; output HIGH or LOW state		0	$V_{CC}$	V
	DC input voltage range; output 3-State		0	5.5	
$T_{amb}$	Operating free-air temperature range		-40	+85	°C
$t_r, t_f$	Input rise and fall times	$V_{CC} = 1.2$ to $2.7V$	0	20	ns/V
		$V_{CC} = 2.7$ to $3.6V$	0	10	

## Hex inverter

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**ABSOLUTE MAXIMUM RATINGS<sup>1</sup>**

In accordance with the Absolute Maximum Rating System (IEC 134).

Voltages are referenced to GND (ground = 0V).

SYMBOL	PARAMETER	CONDITIONS	RATING	UNIT
$V_{CC}$	DC supply voltage		-0.5 to +6.5	V
$I_{IK}$	DC input diode current	$V_I < 0$	-50	mA
$V_I$	DC input voltage	Note 2	-0.5 to +6.5	V
$I_{OK}$	DC output diode current	$V_O > V_{CC}$ or $V_O < 0$	$\pm 50$	mA
$V_{I/O}$	DC output voltage; output HIGH or LOW	Note 2	-0.5 to $V_{CC} + 0.5$	V
	DC input voltage; output 3-State	Note 2	-0.5 to 6.5	
$I_O$	DC output source or sink current	$V_O = 0$ to $V_{CC}$	$\pm 50$	mA
$I_{GND}, I_{CC}$	DC $V_{CC}$ or GND current		$\pm 100$	mA
$T_{stg}$	Storage temperature range		-65 to +150	°C
$P_{TOT}$	Power dissipation per package			
	- plastic mini-pack (SO) - plastic shrink mini-pack (SSOP and TSSOP)	above +70°C derate linearly with 8 mW/K above +60°C derate linearly with 5.5 mW/K	500 500	mW

**NOTES:**

- Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

**DC ELECTRICAL CHARACTERISTICS**

Over recommended operating conditions. Voltages are referenced to GND (ground = 0V).

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			Temp = -40°C to +85°C			
			MIN	TYP <sup>1</sup>	MAX	
$V_{IH}$	HIGH level Input voltage	$V_{CC} = 1.2\text{ V}; V_{OL}(\text{max}) = 0.5\text{ V}; I_O = -100\ \mu\text{A}$	$V_{CC}$			V
		$V_{CC} = 2.0\text{ V}; V_{OL}(\text{max}) = 0.5\text{ V}; I_O = -100\ \mu\text{A}$	1.2			
		$V_{CC} = 2.7\text{ V}; V_{OL}(\text{max}) = 0.5\text{ V}; I_O = -100\ \mu\text{A}$	1.8			
		$V_{CC} = 3.0\text{ V}; V_{OL}(\text{max}) = 0.5\text{ V}; I_O = -100\ \mu\text{A}$	2.0			
		$V_{CC} = 3.6\text{ V}; V_{OL}(\text{max}) = 0.5\text{ V}; I_O = -100\ \mu\text{A}$	2.4			
$V_{IL}$	LOW level Input voltage	$V_{CC} = 1.2\text{ V}; V_{OH}(\text{min}) = V_{CC} - 0.5\text{ V}; I_O = 100\ \mu\text{A}$			GND	V
		$V_{CC} = 2.0\text{ V}; V_{OH}(\text{min}) = V_{CC} - 0.5\text{ V}; I_O = 100\ \mu\text{A}$			0.6	
		$V_{CC} = 2.7\text{ V}; V_{OH}(\text{min}) = V_{CC} - 0.5\text{ V}; I_O = 100\ \mu\text{A}$			0.6	
		$V_{CC} = 3.0\text{ V}; V_{OH}(\text{min}) = V_{CC} - 0.5\text{ V}; I_O = 100\ \mu\text{A}$			1.0	
		$V_{CC} = 3.6\text{ V}; V_{OH}(\text{min}) = V_{CC} - 0.5\text{ V}; I_O = 100\ \mu\text{A}$			1.2	
$V_{OH}$	HIGH level output voltage	$V_{CC} = 2.7\text{ V}; V_{CC}$ or GND; $I_O = -12\text{ mA}$	$V_{CC} - 0.5$			V
		$V_{CC} = 3.0\text{ V}; V_{CC}$ or GND; $I_O = -100\ \mu\text{A}$	$V_{CC} - 0.2$	$V_{CC}$		
		$V_{CC} = 3.0\text{ V}; V_{CC}$ or GND; $I_O = -12\text{ mA}$	$V_{CC} - 0.6$			
		$V_{CC} = 3.0\text{ V}; V_{CC}$ or GND; $I_O = -24\text{ mA}$	$V_{CC} - 1.0$			
$V_{OL}$	LOW level output voltage	$V_{CC} = 2.7\text{ V}; V_{CC}$ or GND; $I_O = 12\text{ mA}$			0.40	V
		$V_{CC} = 3.0\text{ V}; V_{CC}$ or GND; $12\text{ mA}; I_O = 100\ \mu\text{A}$			0.20	
		$V_{CC} = 3.0\text{ V}; V_{CC}$ or GND; $I_O = 24\text{ mA}$			0.55	
$I_I$	Input leakage current	$V_{CC} = 3.6\text{ V}; 5.5\text{ V}$ or GND; Not for I/O pins		$\pm 0.1$	$\pm 5$	$\mu\text{A}$
$I_{CC}$	Quiescent supply current	$V_{CC} = 3.6\text{ V}; V_{CC}$ or GND; $I_O = 0$		0.1	10	$\mu\text{A}$

**NOTE:**

- All typical values are at  $V_{CC} = 3.3\text{ V}$  and  $T_{amb} = 25^\circ\text{C}$ .

# Hex inverter

# 74LVCU04A

## AC CHARACTERISTICS

GND = 0 V;  $t_r = t_f \leq 2.5$  ns;  $C_L = 50$  pF;  $R_L = 500\Omega$ ;  $T_{amb} = -40^\circ\text{C}$  to  $+85^\circ\text{C}$

SYMBOL	PARAMETER	WAVEFORM	LIMITS						UNIT
			$V_{CC} = 3.3V \pm 0.3V$			$V_{CC} = 2.7V$		$V_{CC} = 1.2V$	
			MIN	TYP <sup>1</sup>	MAX	MIN	MAX	TYP	
$t_{PHL}/t_{PLH}$	Propagation delay nA to nY	Figure 1	-	2.7	4.3	-	5.3	-	ns

**NOTE:**

1. These typical values are at  $V_{CC} = 3.3V$  and  $T_{amb} = 25^\circ\text{C}$ .

## AC WAVEFORM

$V_M = 1.5$  V at  $V_{CC} \geq 2.7$  V

$V_M = 0.5 \cdot V_{CC}$  at  $V_{CC} < 2.7$  V

$V_{OL}$  and  $V_{OH}$  are the typical output voltage drop that occur with the output load.

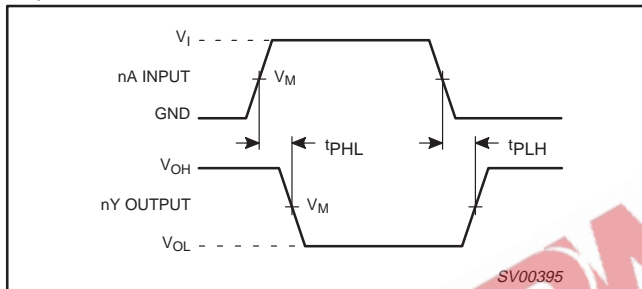


Figure 1. Input (nA) to output (nY) propagation delays.

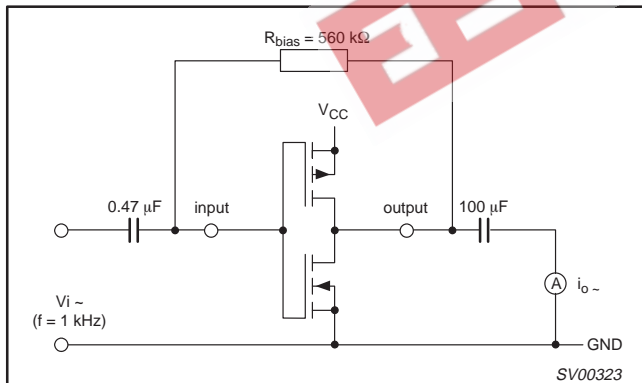


Figure 2. Test set-up for measuring forward transconductance  $g_{fs} = di_o/dv_i$  at  $v_o$  is constant (see also graph Figure 3).

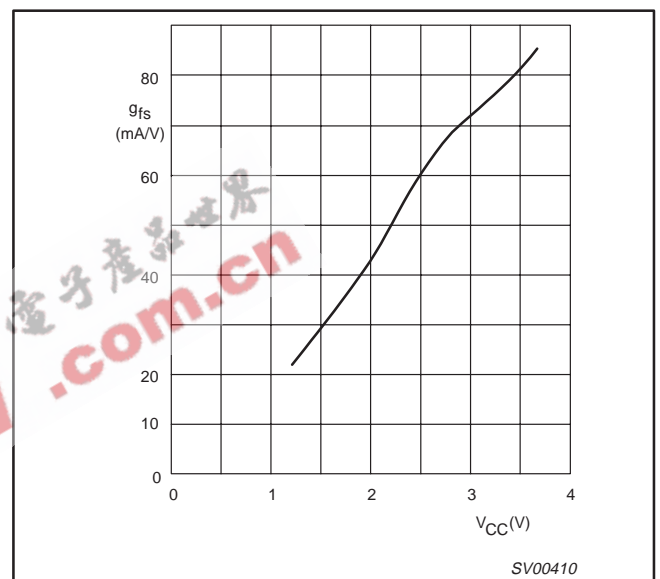


Figure 3. Typical forward transconductance  $g_{fs}$  as a function of the supply voltage  $V_{CC}$  at  $T_{amb} = 25^\circ\text{C}$ .

# Hex inverter

# 74LVCU04A

## APPLICATION INFORMATION

Some applications for the 74LVU04 are:

- Linear amplifier (see Figure 4)
- In crystal oscillator designs (see Figure 5)
- Astable multivibrator (see Figure 6)

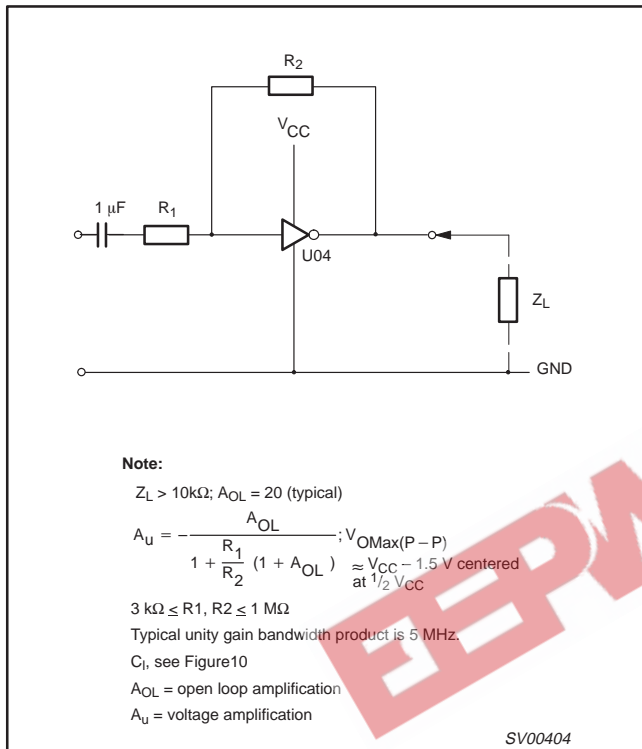


Figure 4. LVU04 used as a linear amplifier.

**Note to Figure 4**

$Z_L > 10\text{ k}\Omega$ ;  $A_{OL} = 20$  (typical)

$$A_u = -\frac{A_{OL}}{1 + \frac{R_1}{R_2}(1 + A_{OL})}; V_{O\text{Max}(P-P)} \approx V_{CC} - 1.5\text{ V centered at } 1/2 V_{CC}$$

$3\text{ k}\Omega \leq R_1, R_2 \leq 1\text{ M}\Omega$

Typical unity gain bandwidth product is 50 MHz.

$A_{OL}$  = open loop amplification

$A_u$  = voltage amplification

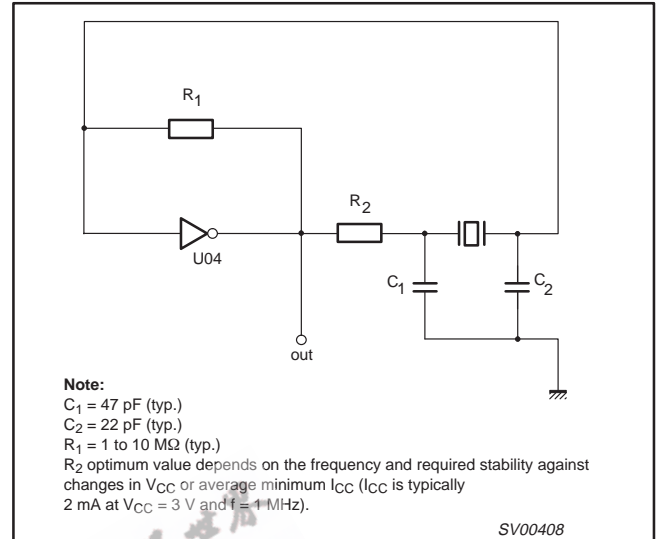


Figure 5. Crystal oscillator configuration.

**Note to Figure 5**

$C_1 = 47\text{ pF}$  (typ.)

$C_2 = 22\text{ pF}$  (typ.)

$R_1 = 1\text{ to }10\text{ M}\Omega$  (typ.)

$R_2$  optimum value depends on the frequency and required stability against changes in  $V_{CC}$  or average minimum  $I_{CC}$ .

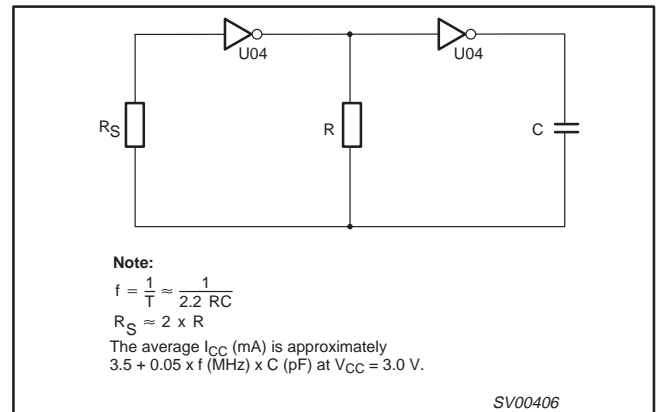


Figure 6. LVCU04 used as an astable multivibrator.

**Note to Figure 6**

$$f = \frac{1}{T} \approx \frac{1}{2.2 RC}$$

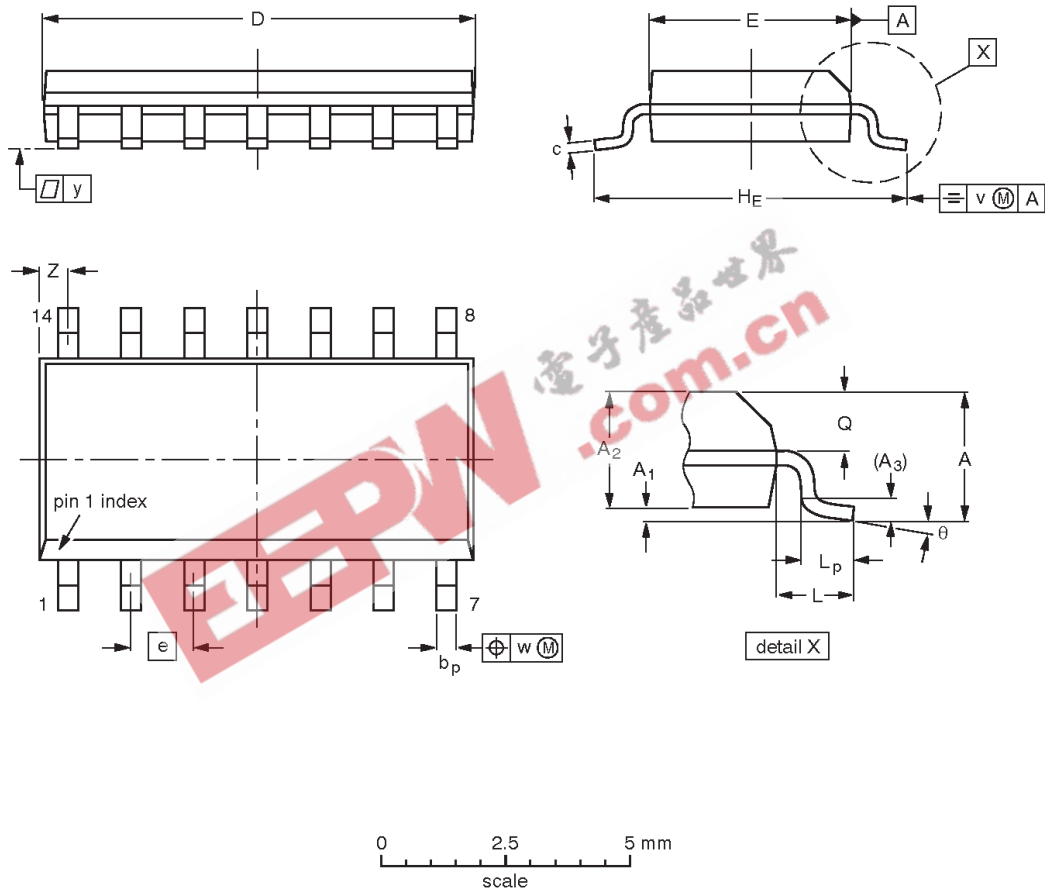
$R_S \approx 2 \times R$

Hex inverter

74LVCU04A

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	8.75 8.55	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.35 0.34	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

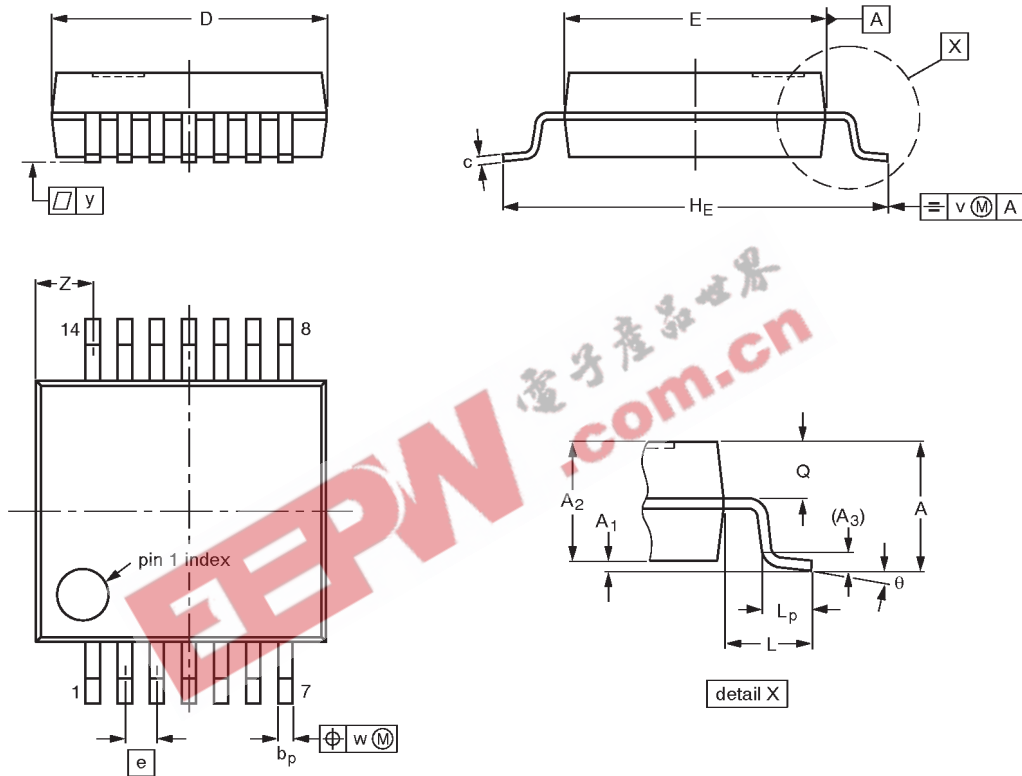
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT108-1	076E06S	MS-012AB				95-01-20 97-05-22

Hex inverter

74LVCU04A

SSOP14: plastic shrink small outline package; 14 leads; body width 5.3 mm

SOT337-1



**DIMENSIONS (mm are the original dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	2.0	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	6.4 6.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.4 0.9	8° 0°

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT337-1		MO-150AB				<del>95-02-04</del> 96-01-18

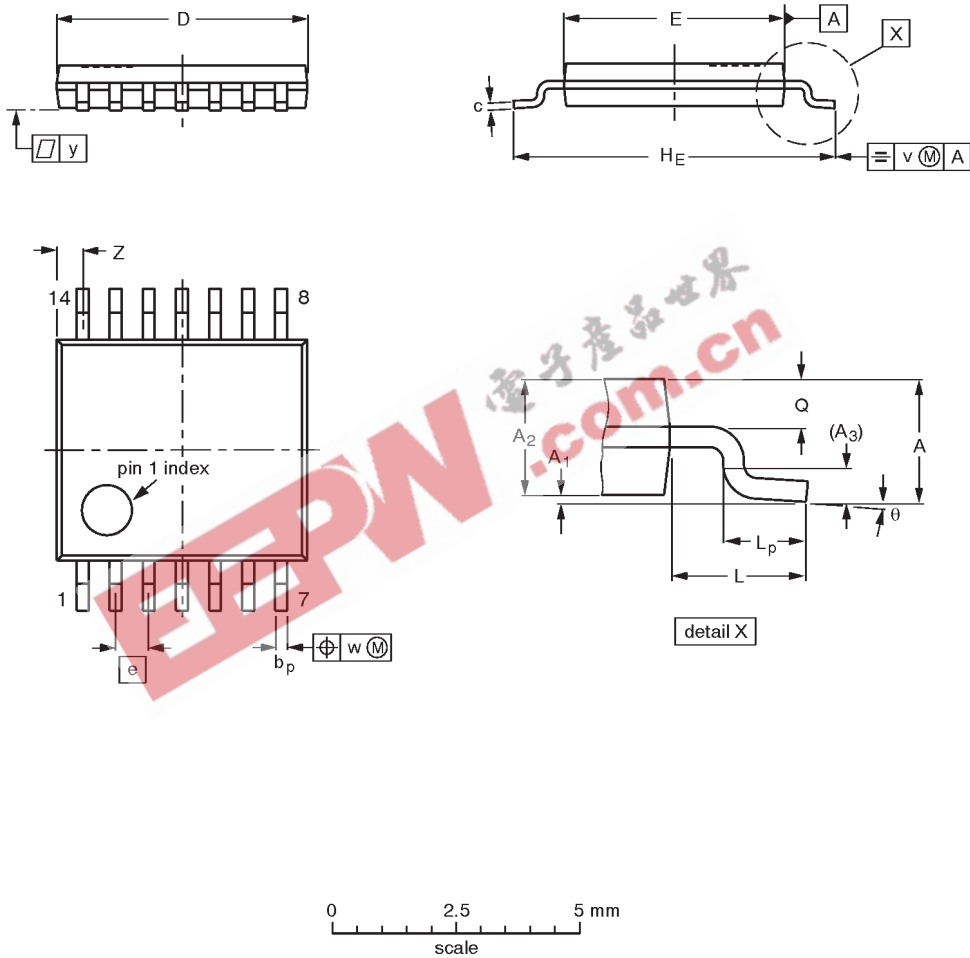


Hex inverter

74LVCU04A

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1



**DIMENSIONS (mm are the original dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.10	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1.0	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.72 0.38	8° 0°

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT402-1		MO-153				-94-07-12- 95-04-04

## Hex inverter

74LVCU04A

## Data sheet status

Data sheet status	Product status	Definition [1]
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

[1] Please consult the most recently issued datasheet before initiating or completing a design.

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**Short-form specification** — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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