

# DATA SHEET

## **74LV04** Hex inverter

Product specification  
IC24 Data Handbook

1997 Feb 03

# Hex inverter

# 74LV04

## FEATURES

- Wide operating voltage: 1.0 to 5.5 V
- Optimized for low voltage applications: 1.0 to 5.5 V
- Accepts TTL input levels between  $V_{CC} = 2.7$  V and  $V_{CC} = 3.6$  V
- Typical  $V_{OLP}$  (output ground bounce) < 0.8 V at  $V_{CC} = 3.3$  V,  $T_{amb} = 25^{\circ}\text{C}$
- Typical  $V_{OHV}$  (output  $V_{OH}$  undershoot) > 2 V at  $V_{CC} = 3.3$  V,  $T_{amb} = 25^{\circ}\text{C}$
- Output capability: standard
- $I_{CC}$  category: SSI

## DESCRIPTION

The 74LV04 is a low-voltage Si-gate CMOS device that is pin and function compatible with 74HC/HCT04.  
The 74LV04 provides six inverting buffers.

## QUICK REFERENCE DATA

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

SYMBOL	PARAMETER	CONDITIONS	TYPICAL	UNIT
$t_{PHL}$ $t_{PLH}$	Propagation delay nA to nY	$C_L = 15$ pF; $V_{CC} = 3.3$ V	6	ns
$C_I$	Input capacitance		3.5	pF
$C_{PD}$	Power dissipation capacitance per gate	See Notes 1 and 2	21	pF

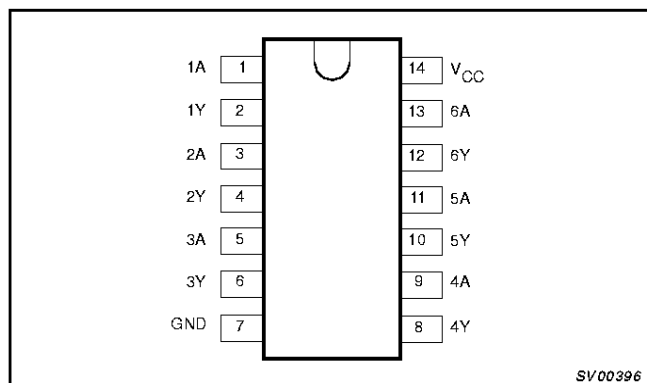
### NOTES:

1.  $C_{PD}$  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.
2. The condition is  $V_1$  is  $V_1 = \text{GND to } V_{CC}$ .

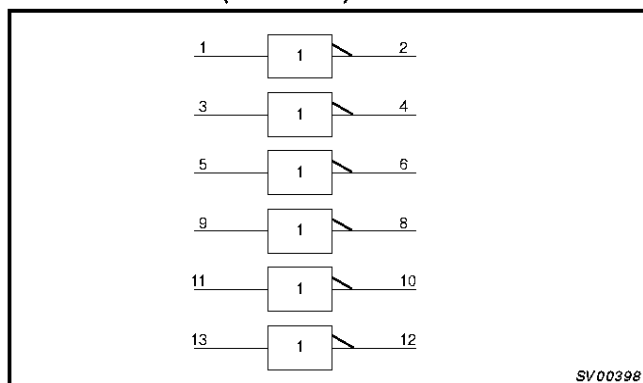
## ORDERING INFORMATION

PACKAGES	TEMPERATURE RANGE	OUTSIDE NORTH AMERICA	NORTH AMERICA	PKG. DWG. #
14-Pin Plastic DIL	-40°C to +125°C	74LV04 N	74LV04 N	SOT27-1
14-Pin Plastic SO	-40°C to +125°C	74LV04 D	74LV04 D	SOT108-1
14-Pin Plastic SSOP Type II	-40°C to +125°C	74LV04 DB	74LV04 DB	SOT337-1
14-Pin Plastic TSSOP Type I	-40°C to +125°C	74LV04 PW	74LV04PW DH	SOT402-1

## PIN CONFIGURATION



## LOGIC SYMBOL (IEEE/IEC)



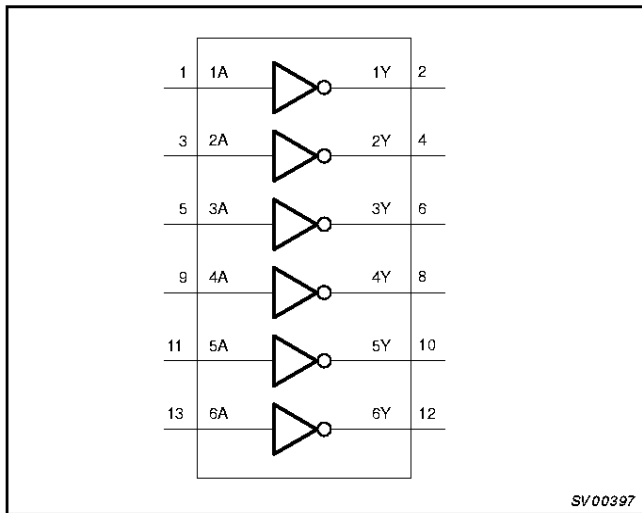
# Hex inverter

74LV04

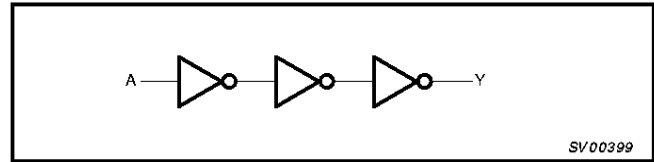
## PIN DESCRIPTION

PIN NUMBER	SYMBOL	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 <sub>CC</sub>	Positive supply voltage

## 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

## Hex inverter

74LV04

**ABSOLUTE MAXIMUM RATINGS<sup>1, 2</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 +7.0	V
$\pm I_{IK}$	DC input diode current	$V_I < -0.5$ or $V_I > V_{CC} + 0.5V$	20	mA
$\pm I_{OK}$	DC output diode current	$V_O < -0.5$ or $V_O > V_{CC} + 0.5V$	50	mA
$\pm I_O$	DC output source or sink current – standard outputs – bus driver outputs	$-0.5V < V_O < V_{CC} + 0.5V$	25 35	mA
$\pm I_{GND}$ , $\pm I_{CC}$	DC $V_{CC}$ or GND current for types with – standard outputs – bus driver outputs		50 70	mA
$T_{stg}$	Storage temperature range		-65 to +150	°C
$P_{TOT}$	Power dissipation per package – plastic DIL – plastic mini-pack (SO) – plastic shrink mini-pack (SSOP and TSSOP)	for temperature range: -40 to +125°C above +70°C derate linearly with 12 mW/K above +70°C derate linearly with 8 mW/K above +60°C derate linearly with 5.5 mW/K	750 500 400	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.

**RECOMMENDED OPERATING CONDITIONS**

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
$V_{CC}$	DC supply voltage	See Note <sup>1</sup>	1.0	3.3	5.5	V
$V_I$	Input voltage		0	–	$V_{CC}$	V
$V_O$	Output voltage		0	–	$V_{CC}$	V
$T_{amb}$	Operating ambient temperature range in free air	See DC and AC characteristics per device	-40 -40		+85 +125	°C
$t_r$ , $t_f$	Input rise and fall times except for Schmitt-trigger inputs	$V_{CC} = 1.0V$ to $2.0V$ $V_{CC} = 2.0V$ to $2.7V$ $V_{CC} = 2.7V$ to $3.6V$ $V_{CC} = 3.6V$ to $5.5V$	– – – –	– – – –	500 200 100 50	ns/V

**NOTE:**

- The LV is guaranteed to function down to  $V_{CC} = 1.0V$  (input levels GND or  $V_{CC}$ ); DC characteristics are guaranteed from  $V_{CC} = 1.2V$  to  $V_{CC} = 5.5V$ .

## Hex inverter

74LV04

**DC ELECTRICAL CHARACTERISTICS**

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

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS					UNIT
			-40°C to +85°C			-40°C to +125°C		
			MIN	TYP. <sup>1</sup>	MAX	MIN	MAX	
V <sub>IH</sub>	HIGH level Input voltage	V <sub>CC</sub> = 1.2V	V <sub>CC</sub>	0.6		V <sub>CC</sub>		V
		V <sub>CC</sub> = 2.0V	1.4			1.4		
		V <sub>CC</sub> = 2.7 to 3.6V	2.0			2.0		
		V <sub>CC</sub> = 4.5 to 5.5V	0.7 * V <sub>CC</sub>			0.7 * V <sub>CC</sub>		
V <sub>IL</sub>	LOW level Input voltage	V <sub>CC</sub> = 1.2V		0.4	GND		GND	V
		V <sub>CC</sub> = 2.0V			0.6		0.6	
		V <sub>CC</sub> = 2.7 to 3.6V			0.8		0.8	
		V <sub>CC</sub> = 4.5 to 5.5			0.3 * V <sub>CC</sub>		0.3 * V <sub>CC</sub>	
V <sub>OH</sub>	HIGH level output voltage; all outputs	V <sub>CC</sub> = 1.2V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; -I <sub>O</sub> = 100µA		1.2				V
		V <sub>CC</sub> = 2.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; -I <sub>O</sub> = 100µA	1.8	2.0		1.8		
		V <sub>CC</sub> = 2.7V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; -I <sub>O</sub> = 100µA	2.5	2.7		2.5		
		V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; -I <sub>O</sub> = 100µA	2.8	3.0		2.8		
		V <sub>CC</sub> = 4.5V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; -I <sub>O</sub> = 100µA	4.3	4.5		4.3		
V <sub>OH</sub>	HIGH level output voltage; STANDARD outputs	V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; -I <sub>O</sub> = 6mA	2.40	2.82		2.20		V
		V <sub>CC</sub> = 4.5V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; -I <sub>O</sub> = 12mA	3.60	4.20		3.50		
V <sub>OH</sub>	HIGH level output voltage; BUS driver outputs	V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; -I <sub>O</sub> = 8mA	2.40	2.82		2.20		V
		V <sub>CC</sub> = 4.5V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; -I <sub>O</sub> = 16mA	3.60	4.20		3.50		
V <sub>OL</sub>	LOW level output voltage; all outputs	V <sub>CC</sub> = 1.2V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 100µA		0				V
		V <sub>CC</sub> = 2.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 100µA		0	0.2		0.2	
		V <sub>CC</sub> = 2.7V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 100µA		0	0.2		0.2	
		V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 100µA		0	0.2		0.2	
		V <sub>CC</sub> = 4.5V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 100µA		0	0.2		0.2	
V <sub>OL</sub>	LOW level output voltage; STANDARD outputs	V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 6mA		0.25	0.40		0.50	V
		V <sub>CC</sub> = 4.5V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 12mA		0.35	0.55		0.65	
V <sub>OL</sub>	LOW level output voltage; BUS driver outputs	V <sub>CC</sub> = 3.0V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 8mA		0.20	0.40		0.50	V
		V <sub>CC</sub> = 4.5V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; I <sub>O</sub> = 16mA		0.35	0.55		0.65	
I <sub>I</sub>	Input leakage current	V <sub>CC</sub> = 5.5V; V <sub>I</sub> = V <sub>CC</sub> or GND			1.0		1.0	µA
I <sub>OZ</sub>	3-State output OFF-state current	V <sub>CC</sub> = 5.5V; V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>O</sub> = V <sub>CC</sub> or GND			5		10	µA
I <sub>CC</sub>	Quiescent supply current; SSI	V <sub>CC</sub> = 5.5V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0			20.0		40	µA
	Quiescent supply current; flip-flops	V <sub>CC</sub> = 5.5V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0			20.0		80	
I <sub>CC</sub>	Quiescent supply current; MSI	V <sub>CC</sub> = 5.5V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0			20.0		160	µA
	Quiescent supply current; LSI	V <sub>CC</sub> = 5.5V; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0			500		1000	
ΔI <sub>CC</sub>	Additional quiescent supply current	V <sub>CC</sub> = 2.7V to 3.6V; V <sub>I</sub> = V <sub>CC</sub> - 0.6V			500		850	µA

**NOTE:**1. All typical values are measured at T<sub>amb</sub> = 25°C.

# Hex inverter

74LV04

## AC CHARACTERISTICS

GND = 0V;  $t_r = t_f = 2.5\text{ns}$ ;  $C_L = 50\text{pF}$ ;  $R_L = 500\Omega$

SYMBOL	PARAMETER	WAVEFORM	CONDITION	LIMITS					UNIT
				-40 to +85°C			-40 to +125°C		
				MIN	TYP <sup>1</sup>	MAX	MIN	MAX	
$t_{PHL}/t_{PLH}$	Propagation delay nA to nY	Figure 1	$V_{CC}(V)$						ns
			1.2		40				
			2.0		14	20		25	
			2.7		10	15		19	
			3.0 to 3.6		8 <sup>2</sup>	12		15	
4.5 to 5.5			9		11				

**NOTES:**

1. Unless otherwise stated, all typical values are measured at  $T_{amb} = 25^\circ\text{C}$
2. Typical values are measured at  $V_{CC} = 3.3\text{V}$ .

## AC WAVEFORMS

$V_M = 1.5\text{V}$  at  $V_{CC} \geq 2.7\text{V}$  and  $\leq 3.6\text{V}$ ;

$V_M = 0.5\text{V} \times V_{CC}$  at  $< 2.7\text{V}$  and  $\geq 4.5\text{V}$ ;

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

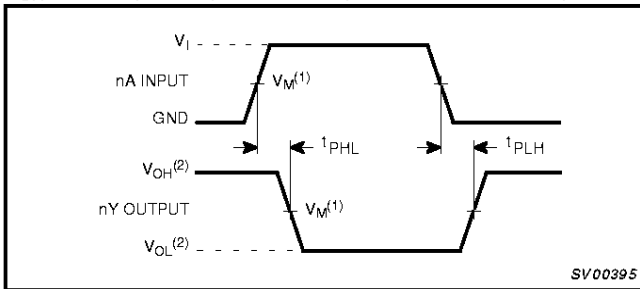


Figure 1. Input (nA) to output (nY) propagation delays and output transition times.

## TEST CIRCUIT

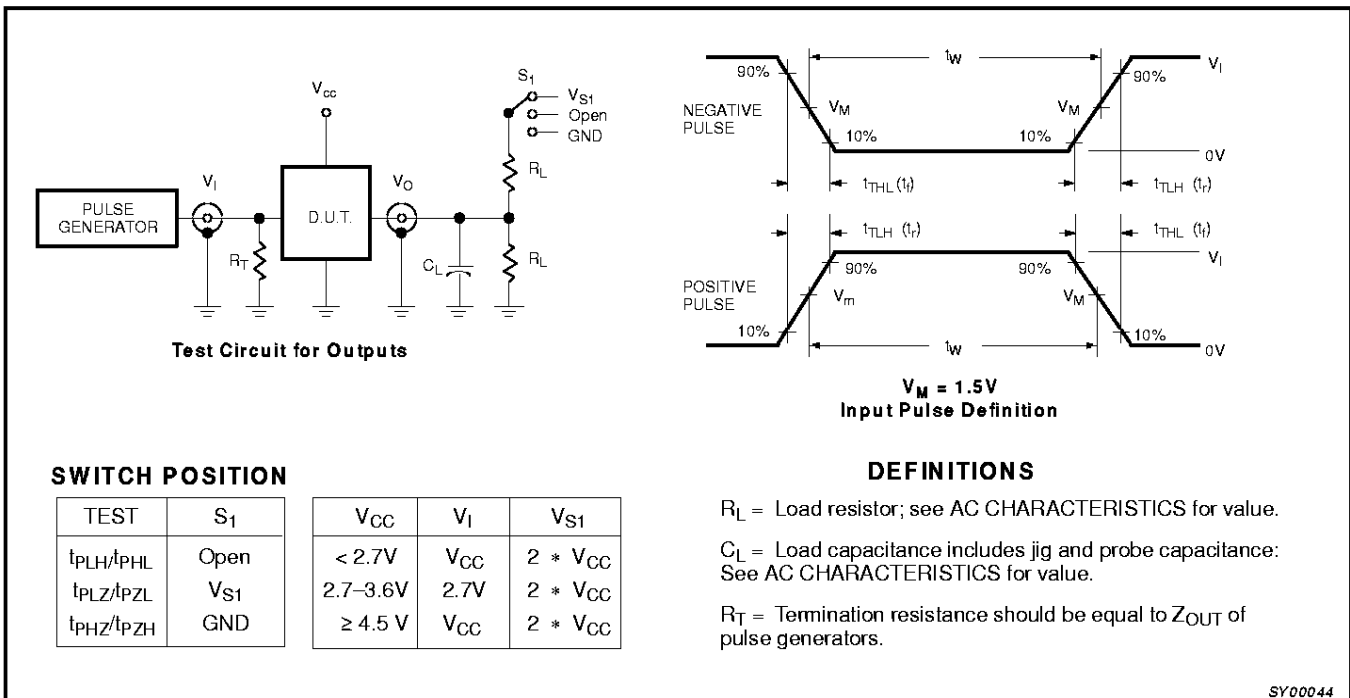


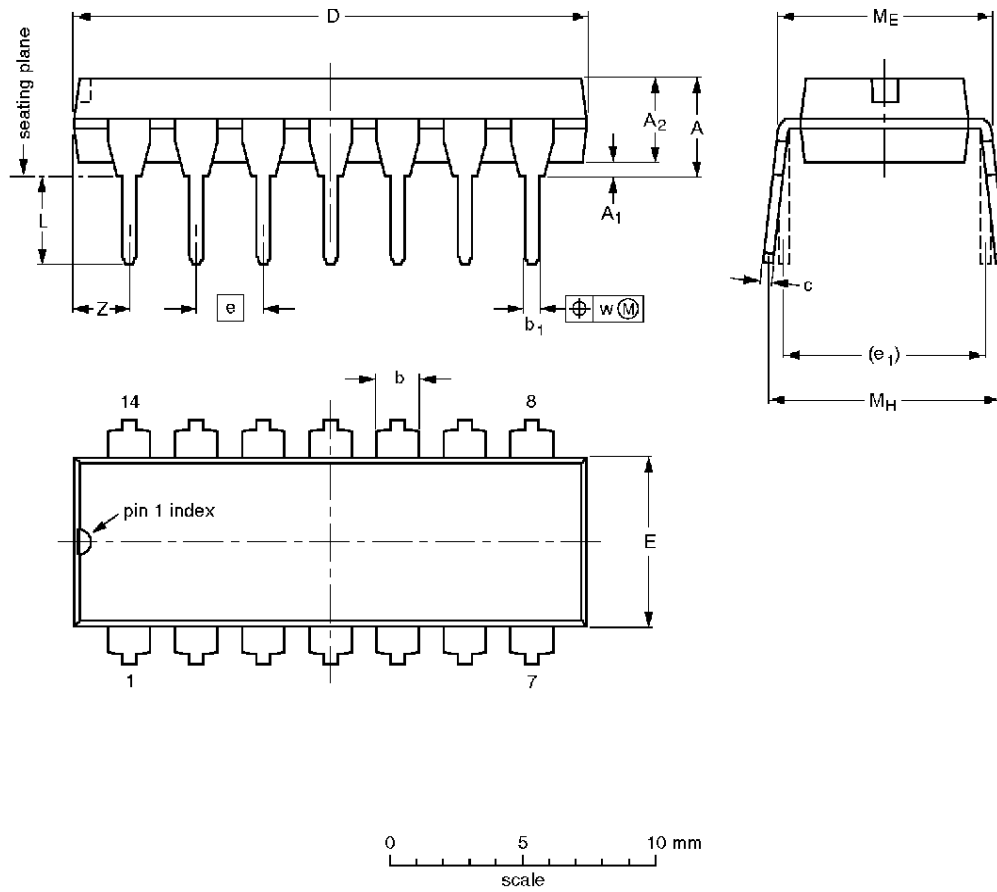
Figure 2. Load circuitry for switching times

# Hex inverter

74LV04

DIP14: plastic dual in-line package; 14 leads (300 mil)

SOT27-1



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

UNIT	A max.	A <sub>1</sub> min.	A <sub>2</sub> max.	b	b <sub>1</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	e <sub>1</sub>	L	M <sub>E</sub>	M <sub>H</sub>	w	z <sup>(1)</sup> max.
mm	4.2	0.51	3.2	1.73 1.13	0.53 0.38	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	2.2
inches	0.17	0.020	0.13	0.068 0.044	0.021 0.015	0.014 0.009	0.77 0.73	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.087

**Note**

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

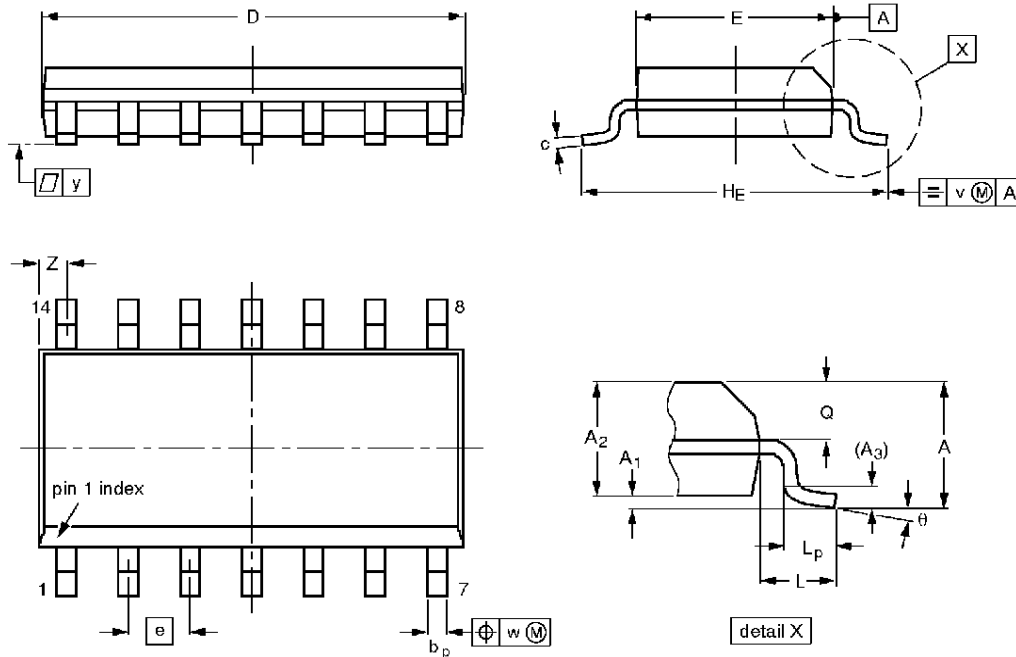
OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT27-1	050G04	MO-001AA				92-11-17 95-03-11

# Hex inverter

# 74LV04

**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	HE	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	0.0098 0.0039	0.057 0.049	0.01	0.019 0.014	0.0098 0.0075	0.35 0.34	0.16 0.15	0.050	0.24 0.23	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				91-08-10 95-01-23

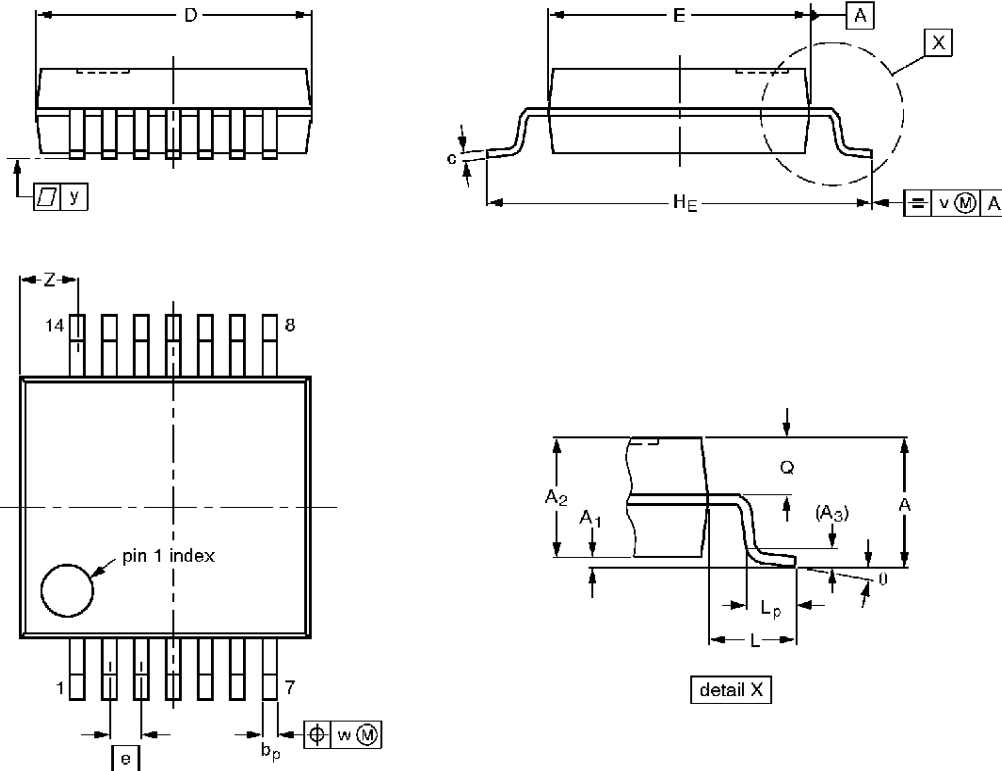


Hex inverter

74LV04

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.

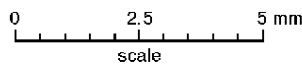
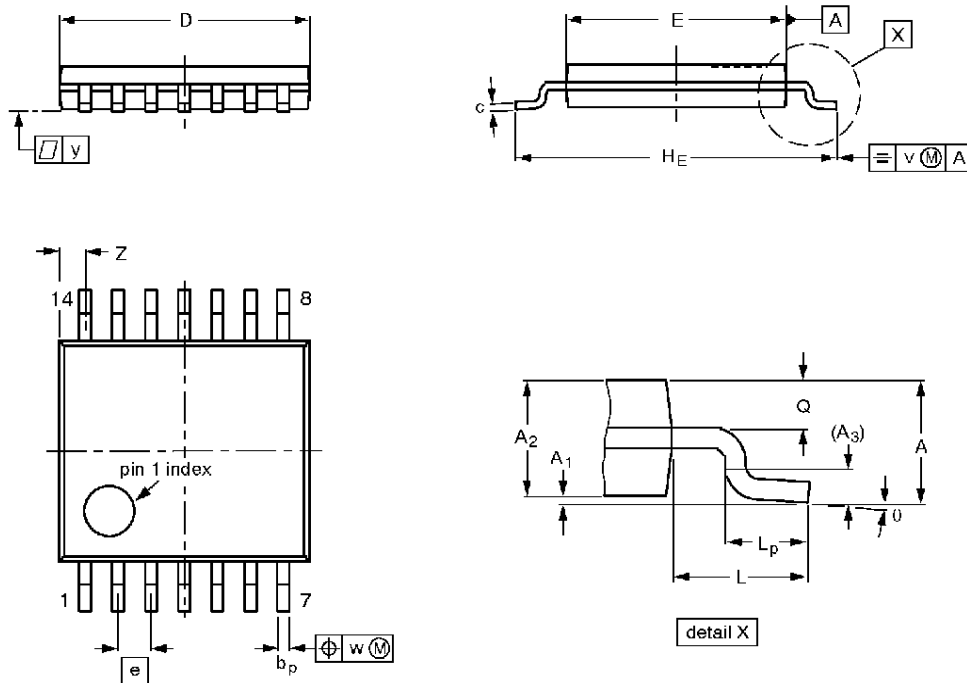
OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ		
SOT337-1		MO-150AB			<del>95-02-04</del> 96-01-18

# Hex inverter

# 74LV04

**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

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Hex inverter

74LV04

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**NOTES**

## Hex inverter

74LV04

## DEFINITIONS

Data Sheet Identification	Product Status	Definition
<i>Objective Specification</i>	<b>Formative or In Design</b>	This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice.
<i>Preliminary Specification</i>	<b>Preproduction Product</b>	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.
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