# **74HC04; 74HCT04**Hex inverter Rev. 4 — 3 August 2012

Product data sheet

### 1. **General description**

The 74HC04; 74HCT04 is a hex inverter. The inputs include clamp diodes that enable the use of current limiting resistors to interface inputs to voltages in excess of V<sub>CC</sub>.

### **Features and benefits** 2.

- Complies with JEDEC standard JESD7A
- Complies with JEDEC standard JESD8-1A
- Input levels:
  - ◆ For 74HC04: CMOS level
  - ◆ For 74HCT04: TTL level
- ESD protection:
  - ♦ HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

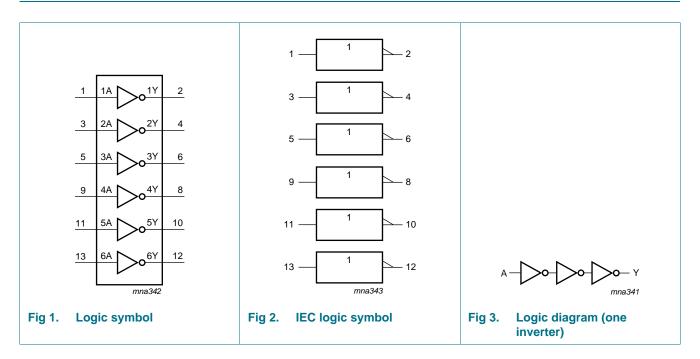
# **Ordering information**

Table 1. **Ordering information** 

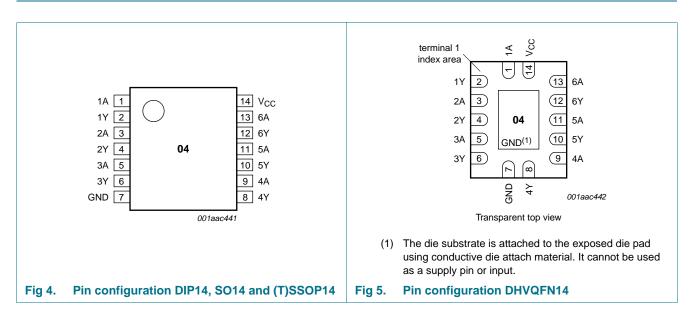
Type number	Package										
	Temperature range	Name	Description	Version							
74HC04N	–40 °C to +125 °C	DIP14	plastic dual in-line package; 14 leads (300 mil)	SOT27-1							
74HCT04N											
74HC04D	–40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width	SOT108-1							
74HCT04D			3.9 mm								
74HC04DB	–40 °C to +125 °C	SSOP14	plastic shrink small outline package; 14 leads; body	SOT337-1							
74HCT04DB			width 5.3 mm								
74HC04PW	–40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads;	SOT402-1							
74HCT04PW			body width 4.4 mm								
74HC04BQ	–40 °C to +125 °C	DHVQFN14	plastic dual in-line compatible thermal enhanced very	SOT762-1							
74HCT04BQ	_		thin quad flat package; no leads; 14 terminals; body $2.5 \times 3 \times 0.85$ mm								



# 4. Functional diagram



# 5. Pinning information



# 5.1 Pin description

Table 2. Pin description

	•	
Symbol	Pin	Description
1A	1	data input
1Y	2	data output
2A	3	data input
2Y	4	data output
3A	5	data input
3Y	6	data output
GND	7	ground (0 V)
4Y	8	data output
4A	9	data input
5Y	10	data output
5A	11	data input
6Y	12	data output
6A	13	data input
V <sub>CC</sub>	14	supply voltage

# 6. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level

Input	Output
nA	nY
L	Н
Н	L

# 7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	Min	Max	Unit
$V_{CC}$	supply voltage		-0.5	+7	V
I <sub>IK</sub>	input clamping current	$V_I < -0.5 \text{ V or } V_I > V_{CC} + 0.5 \text{ V}$	<u>[1]</u> _	±20	mA
I <sub>OK</sub>	output clamping current	$V_O < -0.5 \text{ V or } V_O > V_{CC} + 0.5 \text{ V}$	<u>[1]</u> -	±20	mA
Io	output current	$-0.5 \text{ V} < \text{V}_{\text{O}} < \text{V}_{\text{CC}} + 0.5 \text{ V}$	-	±25	mA
I <sub>CC</sub>	supply current		-	50	mA
I <sub>GND</sub>	ground current		-50	-	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
P <sub>tot</sub>	total power dissipation		[2]		
	DIP14 package		-	750	mW
	SO14, (T)SSOP14 and DHVQFN14 packages		-	500	mW

74HC\_HCT04

- [1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
- [2] For DIP14 package:  $P_{tot}$  derates linearly with 12 mW/K above 70 °C.

For SO14 package:  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.

For (T)SSOP14 packages:  $P_{tot}$  derates linearly with 5.5 mW/K above 60 °C.

For DHVQFN14 packages: Ptot derates linearly with 4.5 mW/K above 60 °C.

# 8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions		)4		74HC1	74HCT04		
			Min	Тур	Max	Min	Тур	Max	
$V_{CC}$	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
VI	input voltage		0	-	$V_{CC}$	0	-	$V_{CC}$	V
Vo	output voltage		0	-	$V_{CC}$	0	-	$V_{CC}$	V
T <sub>amb</sub>	ambient temperature		-40	+25	+125	-40	+25	+125	°C
Δt/ΔV	input transition rise and fall rate	$V_{CC} = 2.0 \text{ V}$	-	-	625	-	-	-	ns/V
		$V_{CC} = 4.5 \text{ V}$	-	1.67	139	-	1.67	139	ns/V
		$V_{CC} = 6.0 \text{ V}$	-	-	83	-	-	-	ns/V

# 9. Static characteristics

### Table 6. Static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions		25 °C		-40 °C to	o +85 °C	–40 °C to	o +125 °C	Unit
			Min	Тур	Max	Min	Max	Min	Max	
74HC04				'			'		'	
111	HIGH-level	$V_{CC} = 2.0 \text{ V}$	1.5	1.2	-	1.5	-	1.5	-	V
	input voltage	$V_{CC} = 4.5 \text{ V}$	3.15	2.4	-	3.15	-	3.15	-	V
	$V_{CC} = 6.0 \text{ V}$	4.2	3.2	-	4.2	-	4.2	-	V	
V <sub>IL</sub> LOW-level	V <sub>CC</sub> = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V	
	input voltage	V <sub>CC</sub> = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		$V_{CC} = 6.0 \text{ V}$	-	2.8	1.8	-	1.8	-	1.8	V
$V_{OH}$	HIGH-level	$V_I = V_{IH}$ or $V_{IL}$								
	output voltage	$I_{O} = -20 \mu A; V_{CC} = 2.0 V$	1.9	2.0	-	1.9	-	1.9	-	V
		$I_O = -20 \mu A$ ; $V_{CC} = 4.5 \text{ V}$	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -20 \mu A; V_{CC} = 6.0 V$	5.9	6.0	-	5.9	-	5.9	-	V
		$I_O = -4.0 \text{ mA}; V_{CC} = 4.5 \text{ V}$	3.98	4.32	-	3.84	-	3.7	-	V
		$I_O = -5.2 \text{ mA}; V_{CC} = 6.0 \text{ V}$	5.48	5.81	-	5.34	-	5.2	-	V

**Table 6.** Static characteristics ...continued
At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions		25 °C		-40 °C t	o +85 °C	-40 °C to	o +125 °C	Un
			Min	Тур	Max	Min	Max	Min	Max	
V <sub>OL</sub>	LOW-level	$V_I = V_{IH}$ or $V_{IL}$				I				
	output voltage	$I_O = 20 \mu A; V_{CC} = 2.0 \text{ V}$	-	0	0.1	-	0.1	-	0.1	٧
		$I_O = 20 \mu A; V_{CC} = 4.5 V$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20 \mu A; V_{CC} = 6.0 V$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 4.0 \text{ mA}; V_{CC} = 4.5 \text{ V}$	-	0.15	0.26	-	0.33	-	0.4	V
		$I_{O} = 5.2 \text{ mA}; V_{CC} = 6.0 \text{ V}$	-	0.16	0.26	-	0.33	-	0.4	V
I <sub>I</sub>	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 6.0 \text{ V}$	-	-	±0.1	-	±1	-	±1	μА
I <sub>CC</sub>	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 6.0$ V	-	-	2	-	20	-	40	μΑ
Cı	input capacitance		-	3.5	-	-	-	-	-	pF
74HCT0	4									
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$	2.0	1.6	-	2.0	-	2.0	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$	-	1.2	8.0	-	0.8	-	8.0	V
V <sub>OH</sub>	HIGH-level	$V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 4.5 \text{ V}$								
	output voltage	$I_{O} = -20 \mu A$	4.4	4.5	-	4.4	-	4.4	-	V
		$I_{O} = -4.0 \text{ mA}$	3.84	4.32	-	3.84	-	3.7	-	٧
$V_{OL}$	LOW-level	$V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 4.5 \text{ V}$								
	output voltage	I <sub>O</sub> = 20 μA	-	0	0.1	-	0.1	-	0.1	٧
		$I_0 = 5.2 \text{ mA}$	-	0.15	0.26	-	0.33	-	0.4	٧
l <sub>l</sub>	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 5.5 \text{ V}$	-	-	±0.1	-	±1	-	±1	μА
I <sub>CC</sub>	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 5.5 \text{ V}$	-	-	2	-	20	-	40	μΑ
Δl <sub>CC</sub>	additional supply current	per input pin; $V_I = V_{CC} - 2.1 \text{ V; } I_O = 0 \text{ A;}$ other inputs at $V_{CC}$ or GND; $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$	-	120	432	-	540	-	590	μΑ
Cı	input capacitance		-	3.5	-	-	-	-	-	pF

# 10. Dynamic characteristics

### Table 7. Dynamic characteristics

GND = 0 V;  $C_L = 50 \text{ pF}$ ; for load circuit see <u>Figure 7</u>.

Symbol	Parameter	Conditions			25 °C		-40 °C to	+125 °C	Unit
				Min	Тур	Max	Max (85 °C)	Max (125 °C)	
74HC04									
t <sub>pd</sub>	propagation delay	nA to nY; see Figure 6	[1]						
		V <sub>CC</sub> = 2.0 V		-	25	85	105	130	ns
		V <sub>CC</sub> = 4.5 V		-	9	17	21	26	ns
		$V_{CC} = 5.0 \text{ V}; C_L = 15 \text{ pF}$		-	7	-	-	-	ns
		V <sub>CC</sub> = 6.0 V		-	7	14	18	22	ns
t <sub>t</sub>	transition time	see Figure 6	[2]						
		V <sub>CC</sub> = 2.0 V		-	19	75	95	110	ns
		V <sub>CC</sub> = 4.5 V		-	7	15	19	22	ns
		$V_{CC} = 6.0 \text{ V}$		-	6	13	16	19	ns
$C_{PD}$	power dissipation capacitance	per package; $V_I = GND$ to $V_{CC}$	[3]	-	21	-	-	-	pF
74HCT04	4								
t <sub>pd</sub>	propagation delay	nA to nY; see Figure 6	<u>[1]</u>						
		V <sub>CC</sub> = 4.5 V		-	10	19	24	29	ns
		$V_{CC} = 5.0 \text{ V}; C_L = 15 \text{ pF}$		-	8	-	-	-	ns
t <sub>t</sub>	transition time	V <sub>CC</sub> = 4.5 V; see <u>Figure 6</u>	[2]	-	7	15	19	22	ns
$C_{PD}$	power dissipation capacitance	per package; V <sub>I</sub> = GND to V <sub>CC</sub> – 1.5 V	[3]	-	24	-	-	-	pF

<sup>[1]</sup>  $t_{pd}$  is the same as  $t_{PHL}$  and  $t_{PLH}$ .

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum (C_L \times V_{CC}^2 \times f_o)$$
 where:

$$\sum (C_L \times V_{CC}^2 \times f_o)$$
 = sum of outputs.

<sup>[2]</sup>  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$ .

<sup>[3]</sup>  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu W$ ):

 $f_i$  = input frequency in MHz;

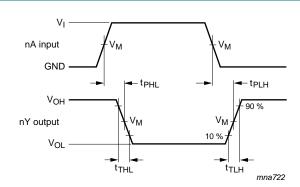
 $f_o$  = output frequency in MHz;

C<sub>L</sub> = output load capacitance in pF;

 $V_{CC}$  = supply voltage in V;

N = number of inputs switching;

## 11. Waveforms



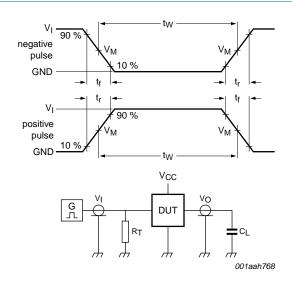
Measurement points are given in Table 8.

 $V_{\mbox{\scriptsize OL}}$  and  $V_{\mbox{\scriptsize OH}}$  are typical voltage output levels that occur with the output load.

Fig 6. The input (nA) to output (nY) propagation delay times

Table 8. Measurement points

Туре	Input	Output		
	V <sub>M</sub>	V <sub>M</sub>		
74HC04	0.5V <sub>CC</sub>	0.5V <sub>CC</sub>		
74HCT04	1.3 V	1.3 V		



Test data is given in Table 9.

Definitions test circuit:

 $R_T$  = termination resistance should be equal to output impedance  $Z_o$  of the pulse generator.

C<sub>L</sub> = load capacitance including jig and probe capacitance.

Fig 7. Load circuitry for measuring switching times

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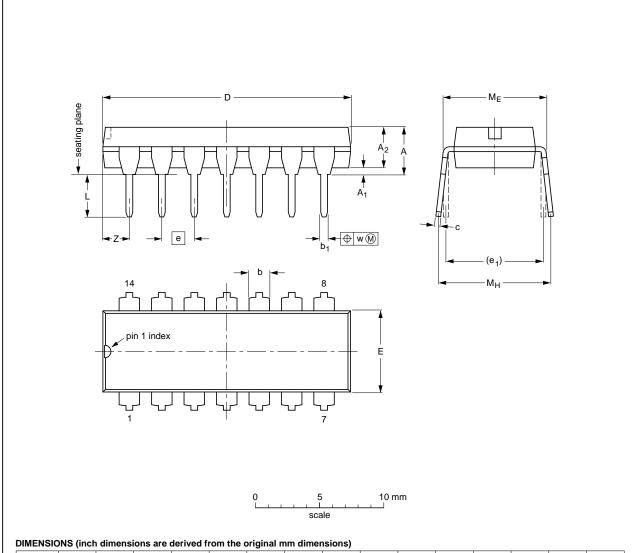
Table 9. Test data

Туре	Input Lo		Load	Test
	VI	t <sub>r</sub> , t <sub>f</sub>	CL	
74HC04	V <sub>CC</sub>	6.0 ns	15 pF, 50 pF	t <sub>PLH</sub> , t <sub>PHL</sub>
74HCT04	3.0 V	6.0 ns	15 pF, 50 pF	t <sub>PLH</sub> , t <sub>PHL</sub>

# 12. Package outline

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

SOT27-1



UNIT	A max.	A <sub>1</sub> min.	A <sub>2</sub> max.	b	b <sub>1</sub>	С	D <sup>(1)</sup>	E <sup>(1)</sup>	е	e <sub>1</sub>	L	ME	Мн	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	0.02	0.13	0.068 0.044	0.021 0.015	0.014 0.009	0.77 0.73	0.26 0.24	0.1	0.3	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 (0.01 inch) maximum per side are not included.

OUTLINE		REFER	ENCES	EUROPEAN	ISSUE DATE
VERSION	IEC	JEDEC	JEITA	PROJECTION	ISSUE DATE
SOT27-1	050G04	MO-001	SC-501-14		<del>99-12-27</del> 03-02-13

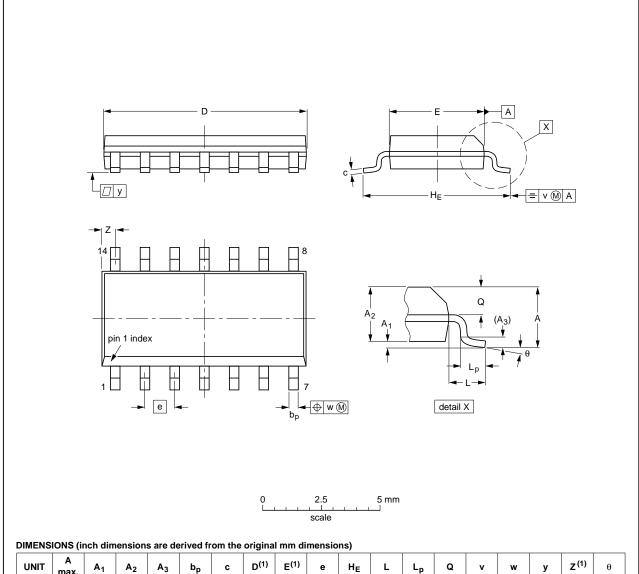
Fig 8. Package outline SOT27-1 (DIP14)

74HC\_HCT04

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

SOT108-1



UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	bp	С	D <sup>(1)</sup>	E <sup>(1)</sup>	е	HE	L	Lp	Q	v	w	у	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°
inches	0.069	0.010 0.004	0.057 0.049	0.01	1	0.0100 0.0075	0.35 0.34	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	0°

### Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE		REFER	EUROPEAN	ISSUE DATE			
VERSION	IEC	JEDEC	JEITA		PROJECTION	ISSUE DATE	
SOT108-1	076E06	MS-012				<del>99-12-27</del> 03-02-19	

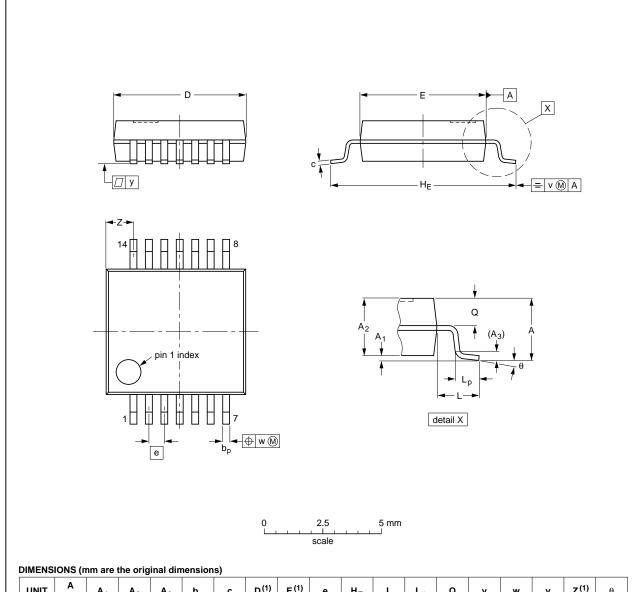
Fig 9. Package outline SOT108-1 (SO14)

74HC\_HCT04

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

SOT337-1



						-,												
UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	bp	С	D <sup>(1)</sup>	E <sup>(1)</sup>	е	HE	L	Lp	Q	v	w	у	Z <sup>(1)</sup>	θ
mm	2	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		REFER	EUROPEAN	ISSUE DATE		
VERSION	IEC	JEDEC	JEITA	PROJECTION	ISSUE DATE	
SOT337-1		MO-150			<del>-99-12-27</del> 03-02-19	

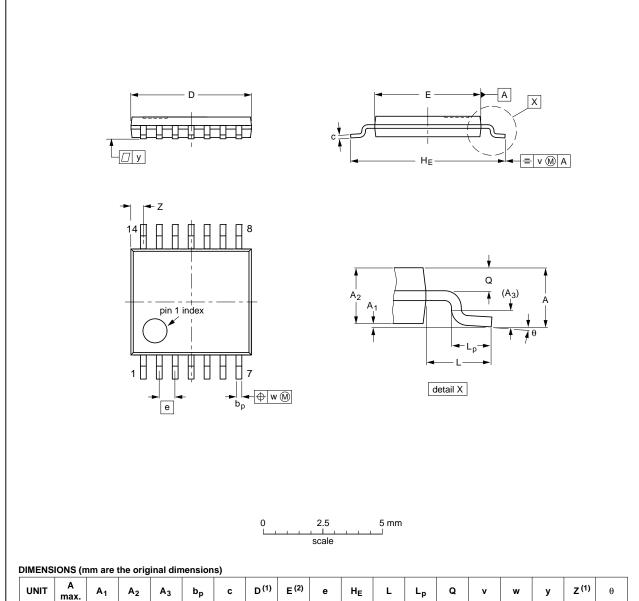
Fig 10. Package outline SOT337-1 (SSOP14)

74HC\_HCT04

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

SOT402-1



UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	bp	С	D <sup>(1)</sup>	E (2)	е	HE	L	Lp	Q	v	w	у	Z <sup>(1)</sup>	θ
mm	1.1	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	0.75 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		REFER	EUROPEAN	ISSUE DATE		
VERSION	IEC	JEDEC	JEITA	PROJECTION	ISSUE DATE	
SOT402-1		MO-153			<del>99-12-27</del> 03-02-18	
		*				

Fig 11. Package outline SOT402-1 (TSSOP14)

74HC\_HCT04

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DHVQFN14: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 x 3 x 0.85 mm SOT762-1

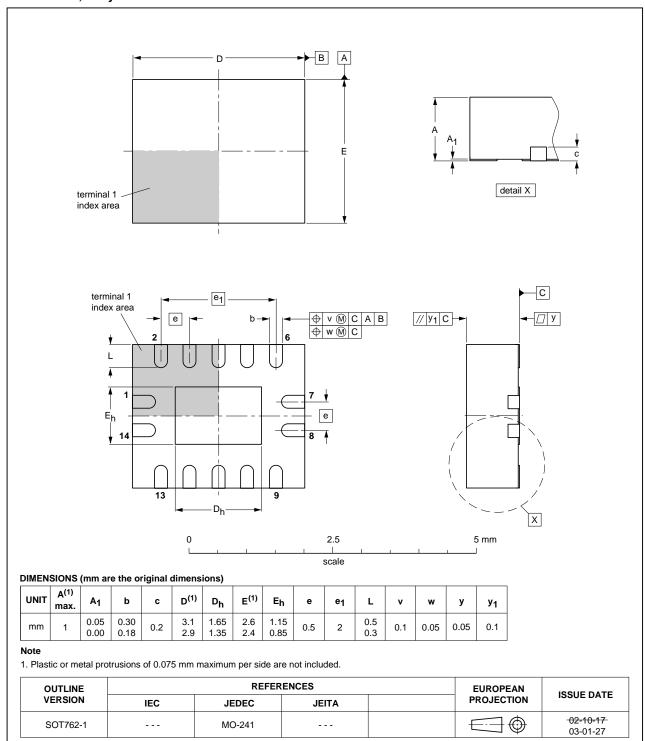


Fig 12. Package outline SOT762-1 (DHVQFN14)

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# 13. Abbreviations

### Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
LSTTL	Low-power Schottky Transistor-Transistor Logic
ESD	ElectroStatic Discharge
НВМ	Human Body Model
MM	Machine Model
CDM	Charge Device Model
TTL	Transistor-Transistor Logic

# 14. Revision history

### Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes			
74HC_HCT04 v.4	20120803	Product data sheet	-	74HC_HCT04 v.3			
Modifications:	<ul> <li>The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> </ul>						
	- Legal texts i	lave been adapted to the new	company name who	не арргорнате.			
74HC_HCT04 v.3	20030723	Product data sheet	-	74HC_HCT04_CNV v.2			
74HC_HCT04_CNV v.2	19970826	Product specification	-	-			

# 15. Legal information

### 15.1 Data sheet status

Document status[1][2]	Product status[3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions"
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nxp.com.

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