

74HC04; 74HCT04

Hex inverter

Rev. 9 — 9 February 2023

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_{CC} .

2. Features and benefits

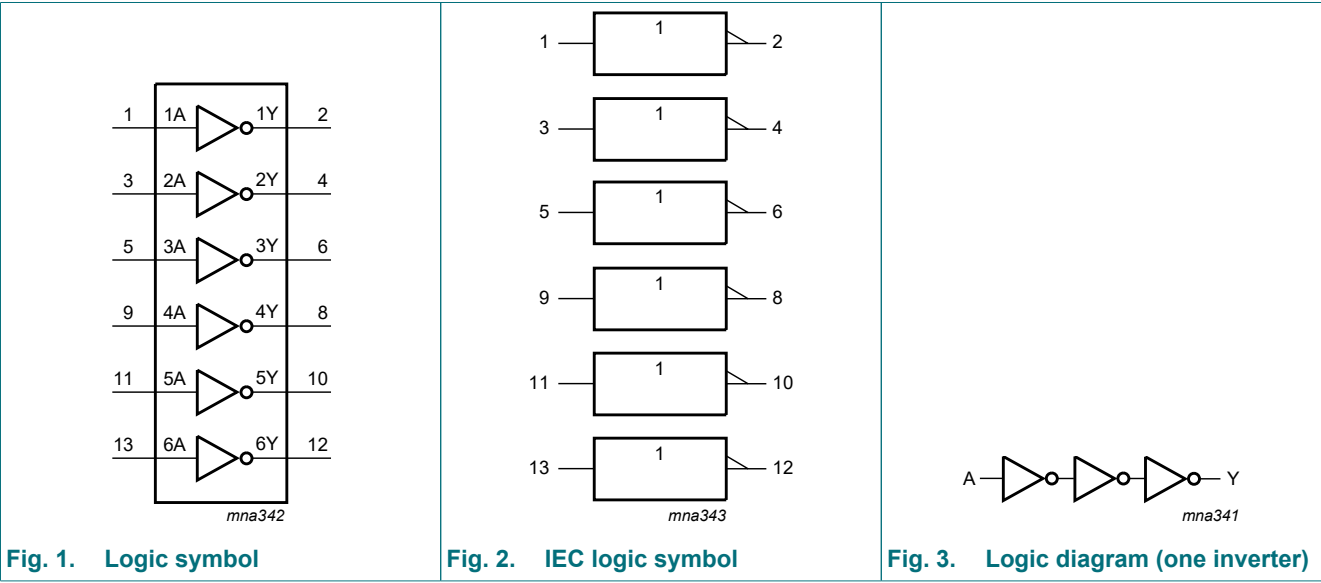
- Wide supply voltage range from 2.0 V to 6.0 V
- CMOS low power dissipation
- High noise immunity
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- Complies with JEDEC standards:
 - JESD8C (2.7 V to 3.6 V)
 - JESD7A (2.0 V to 6.0 V)
- Input levels:
 - For 74HC04: CMOS level
 - For 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

3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC04D	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74HCT04D				
74HC04PW	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74HCT04PW				
74HC04BQ	-40 °C to +125 °C	DHVQFN14	plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 × 3 × 0.85 mm	SOT762-1
74HCT04BQ				
74HC04BZ	-40 °C to +125 °C	DHXQFN14	plastic, leadless dual in-line compatible thermal enhanced extreme thin quad flat package; no leads; 14 terminals; 0.4 mm pitch; body 2 mm × 2 mm × 0.48 mm	SOT8014-1
74HCT04BZ				

4. Functional diagram



5. Pinning information

5.1. Pinning

D package
SOT108-1 (SO14)

1A 1 14 V_{CC}
1Y 2 13 6A
2A 3 12 6Y
2Y 4 11 5A
3A 5 10 5Y
3Y 6 9 4A
GND 7 8 4Y

aaa-035254

PW package
SOT402-1 (TSSOP14)

1A 1 14 V_{CC}
1Y 2 13 6A
2A 3 12 6Y
2Y 4 11 5A
3A 5 10 5Y
3Y 6 9 4A
GND 7 8 4Y

aaa-035585

BQ package
SOT762-1 (DHVQFN14)

terminal 1
index area

1A V_{CC}
1Y 2 13 6A
2A 3 12 6Y
2Y 4 11 5A
3A 5 10 5Y
3Y 6 9 4A
GND(1)
GND 7 8 4Y

aaa-035256

Transparent top view

BZ package
SOT8014-1 (DHXQFN14)

terminal 1
index area

1A V_{CC}
1Y 2 13 6A
2A 3 12 6Y
2Y 4 11 5A
3A 5 10 5Y
3Y 6 9 4A
GND(1)
GND 7 8 4Y

aaa-035600

Transparent top view

(1) This is not a ground pin. There is no electrical or mechanical requirement to solder the pad. In case soldered, the solder land should remain floating or connected to GND.

5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
1A, 2A, 3A, 4A, 5A, 6A	1, 3, 5, 9, 11, 13	data input
1Y, 2Y, 3Y, 4Y, 5Y, 6Y	2, 4, 6, 8, 10, 12	data output
GND	7	ground (0 V)
V _{CC}	14	supply voltage

6. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level

Input	Output
nA	nY
L	H
H	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 _{IK}	input clamping current	V _I < -0.5 V or V _I > V _{CC} + 0.5 V [1]	-	±20	mA
I _{OK}	output clamping current	V _O < -0.5 V or V _O > V _{CC} + 0.5 V [1]	-	±20	mA
I _O	output current	-0.5 V < V _O < V _{CC} + 0.5 V	-	±25	mA
I _{CC}	supply current		-	50	mA
I _{GND}	ground current		-50	-	mA
T _{stg}	storage temperature		-65	+150	°C
P _{tot}	total power dissipation	SOT108-1 SOT402-1 SOT762-1 [2]	-	500	mW
		SOT8014-1	-	250	mW

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] For SOT108-1 (SO14) package: P_{tot} derates linearly with 10.1 mW/K above 100 °C.
For SOT402-1 (TSSOP14) package: P_{tot} derates linearly with 7.3 mW/K above 81 °C.
For SOT762-1 (DHVQFN14) package: P_{tot} derates linearly with 9.6 mW/K above 98 °C.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC04			74HCT04			Unit
			Min	Typ	Max	Min	Typ	Max	
V _{CC}	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V _I	input voltage		0	-	V _{CC}	0	-	V _{CC}	V
V _O	output voltage		0	-	V _{CC}	0	-	V _{CC}	V
T _{amb}	ambient temperature		-40	+25	+125	-40	+25	+125	°C
Δt/ΔV	input transition rise and fall rate	V _{CC} = 2.0 V	-	-	625	-	-	-	ns/V
		V _{CC} = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V _{CC} = 6.0 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 +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC04										
V _{IH}	HIGH-level input voltage	V _{CC} = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
		V _{CC} = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V _{CC} = 6.0 V	4.2	3.2	-	4.2	-	4.2	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V _{CC} = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V _{CC} = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = -20 µA; V _{CC} = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I _O = -20 µA; V _{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -20 µA; V _{CC} = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I _O = -4.0 mA; V _{CC} = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
		I _O = -5.2 mA; V _{CC} = 6.0 V	5.48	5.81	-	5.34	-	5.2	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = 20 µA; V _{CC} = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 µA; V _{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 µA; V _{CC} = 6.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 4.0 mA; V _{CC} = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
		I _O = 5.2 mA; V _{CC} = 6.0 V	-	0.16	0.26	-	0.33	-	0.4	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 6.0 V	-	-	±0.1	-	±1	-	±1	µA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V	-	-	2	-	20	-	40	µA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HCT04										
V _{IH}	HIGH-level input voltage	V _{CC} = 4.5 V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 4.5 V to 5.5 V	-	1.2	0.8	-	0.8	-	0.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = -20 µA	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -4.0 mA	3.84	4.32	-	3.84	-	3.7	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = 20 µA	-	0	0.1	-	0.1	-	0.1	V
		I _O = 5.2 mA	-	0.15	0.26	-	0.33	-	0.4	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 5.5 V	-	-	±0.1	-	±1	-	±1	µA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V	-	-	2	-	20	-	40	µA
ΔI _{CC}	additional supply current	per input pin; V _I = V _{CC} - 2.1 V; I _O = 0 A; other inputs at V _{CC} or GND; V _{CC} = 4.5 V to 5.5 V	-	120	432	-	540	-	590	µA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

10. Dynamic characteristics

Table 7. Dynamic characteristics

$GND = 0\text{ V}$; $C_L = 50\text{ pF}$; for test circuit see Fig. 5.

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C	-40 °C to +125 °C	Unit
			Min	Typ	Max	Max	Max	
74HC04								
t _{pd}	propagation delay	nA to nY; see Fig. 4 [1]						
		V _{CC} = 2.0 V	-	25	85	105	130	ns
		V _{CC} = 4.5 V	-	9	17	21	26	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	7	-	-	-	ns
		V _{CC} = 6.0 V	-	7	14	18	22	ns
t _t	transition time	see Fig. 4 [2]						
		V _{CC} = 2.0 V	-	19	75	95	110	ns
		V _{CC} = 4.5 V	-	7	15	19	22	ns
		V _{CC} = 6.0 V	-	6	13	16	19	ns
C _{PD}	power dissipation capacitance	per package; V _I = GND to V _{CC} [3]	-	21	-	-	-	pF
74HCT04								
t _{pd}	propagation delay	nA to nY; see Fig. 4 [1]						
		V _{CC} = 4.5 V	-	10	19	24	29	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	8	-	-	-	ns
t _t	transition time	V _{CC} = 4.5 V; see Fig. 4 [2]	-	7	15	19	22	ns
C _{PD}	power dissipation capacitance	per package; V _I = GND to V _{CC} - 1.5 V [3]	-	24	-	-	-	pF

[1] t_{pd} is the same as t_{PHL} and t_{PLH} .

[2] t_t is the same as t_{THL} and t_{TLH} .

[3] C_{PD} is used to determine the dynamic power dissipation (P_D in μW):

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

f_i = input frequency in MHz;

f_o = output frequency in MHz;

C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

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

10.1. Waveforms and test circuit

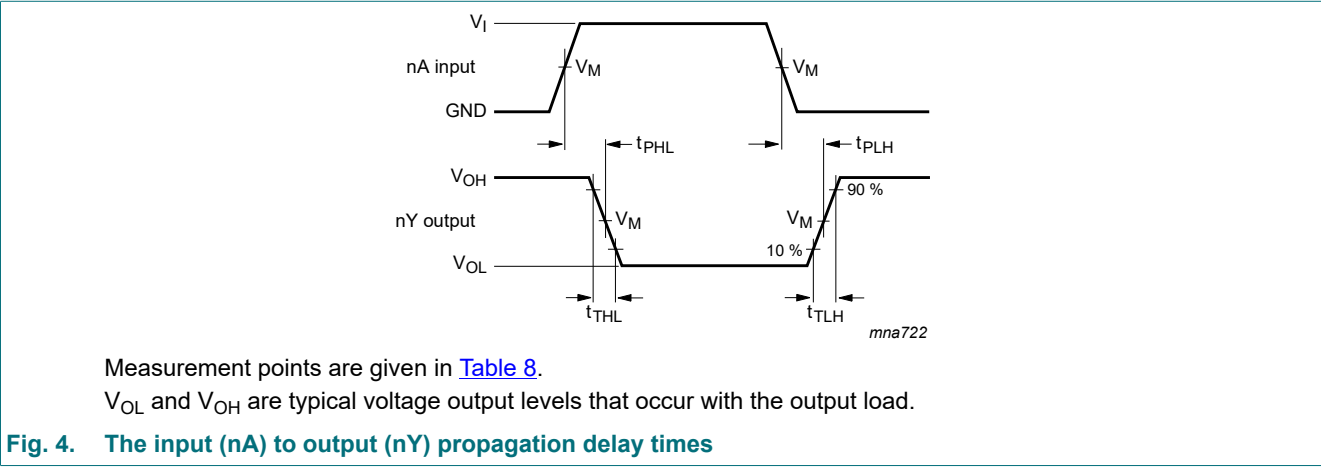


Table 8. Measurement points

Type	Input		Output
	V_M		V_M
74HC04	$0.5V_{CC}$		$0.5V_{CC}$
74HCT04	1.3 V		1.3 V

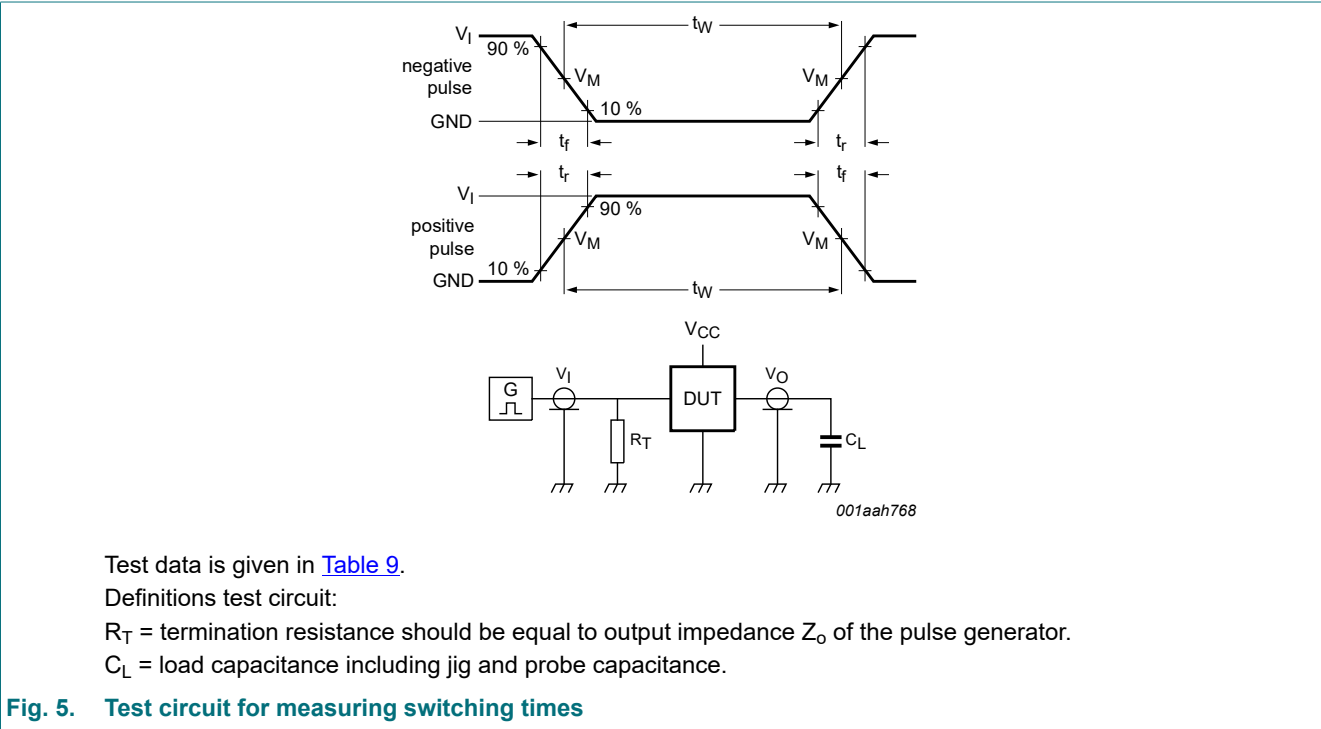


Table 9. Test data

Type	Input		Load	Test
	V_I	t_r, t_f	C_L	
74HC04	V_{CC}	6.0 ns	15 pF, 50 pF	t_{PLH}, t_{PHL}
74HCT04	3.0 V	6.0 ns	15 pF, 50 pF	t_{PLH}, t_{PHL}

11. Package outline

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

SOT108-1

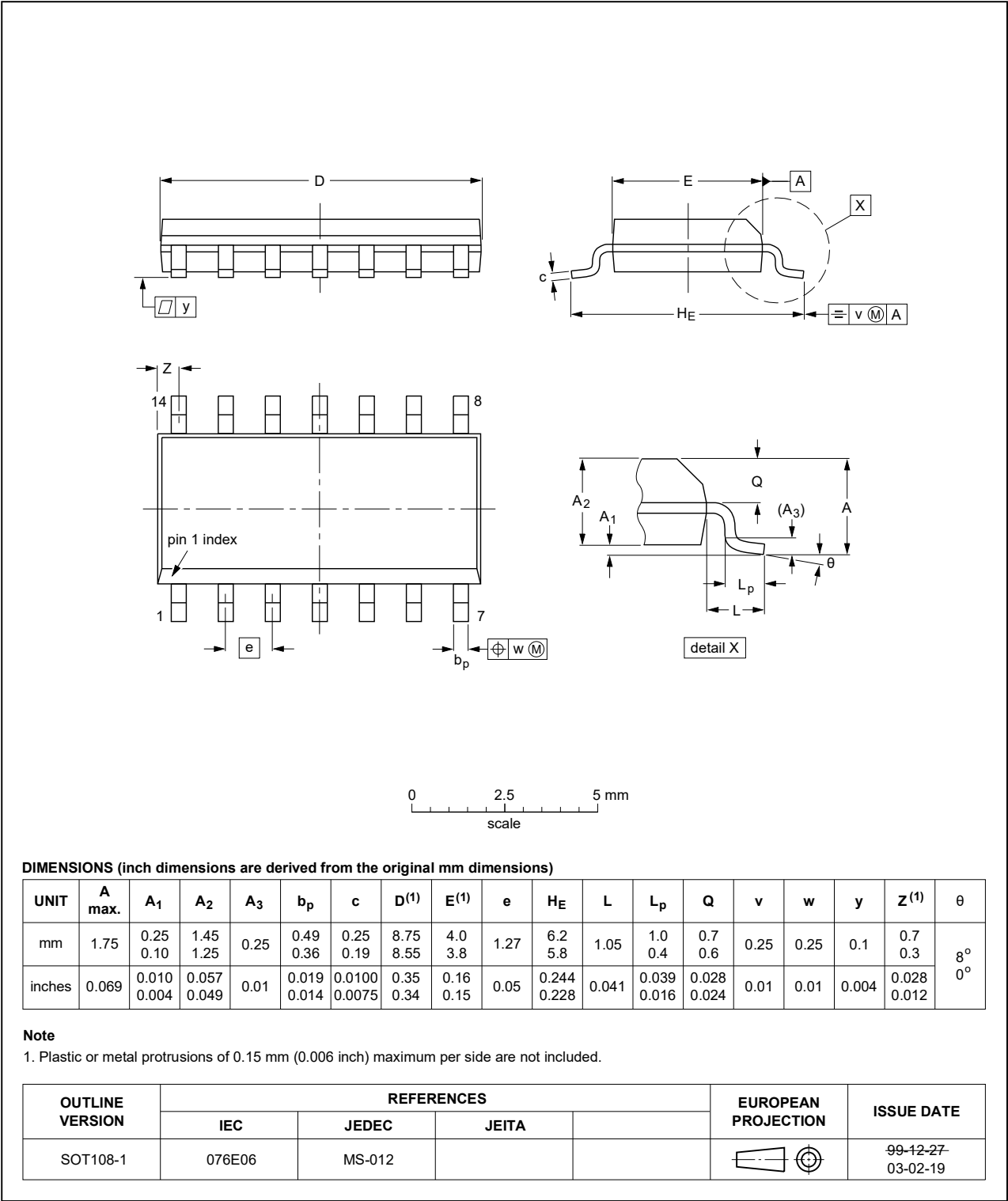


Fig. 6. Package outline SOT108-1 (SO14)

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

SOT402-1

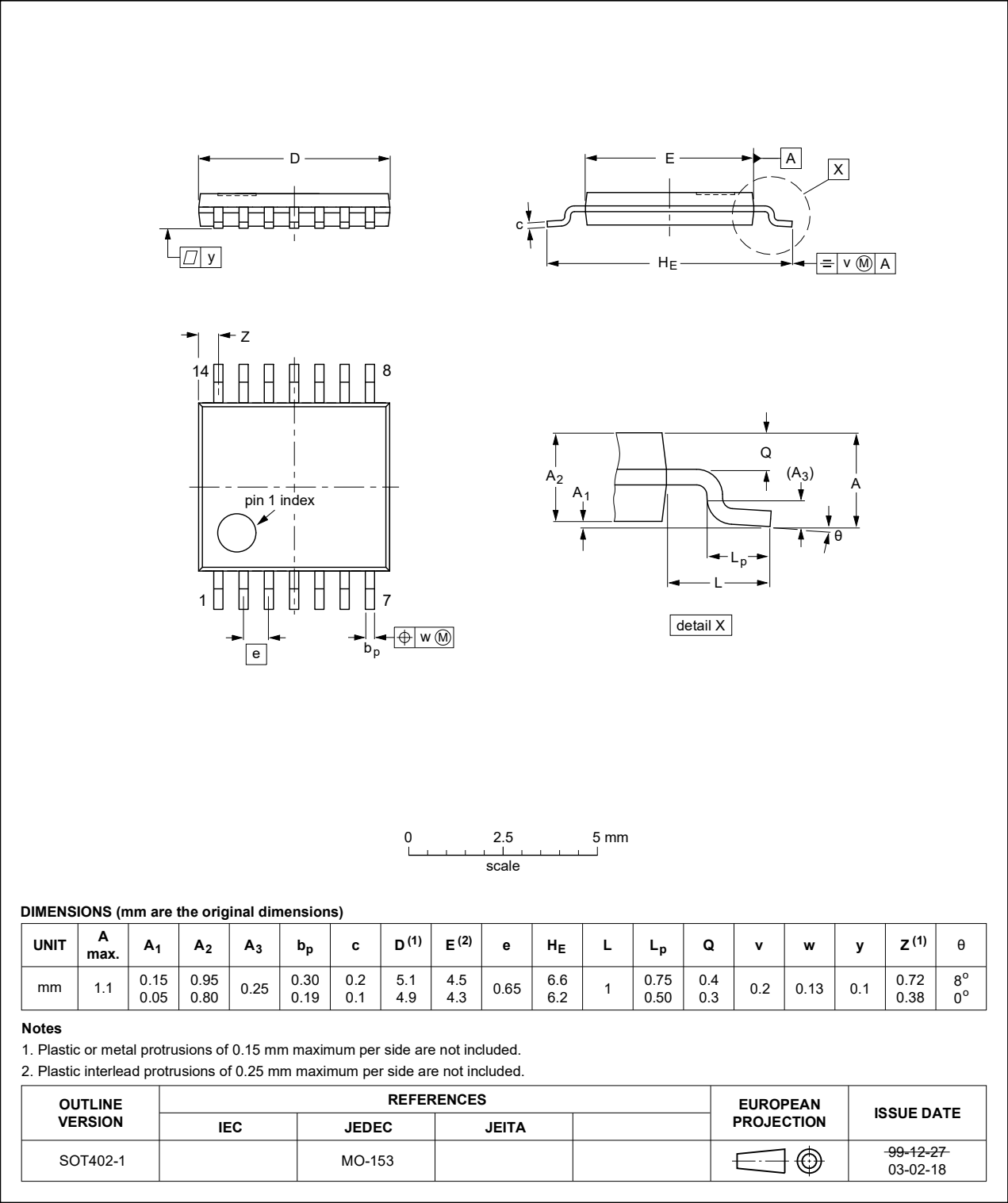


Fig. 7. Package outline SOT402-1 (TSSOP14)

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

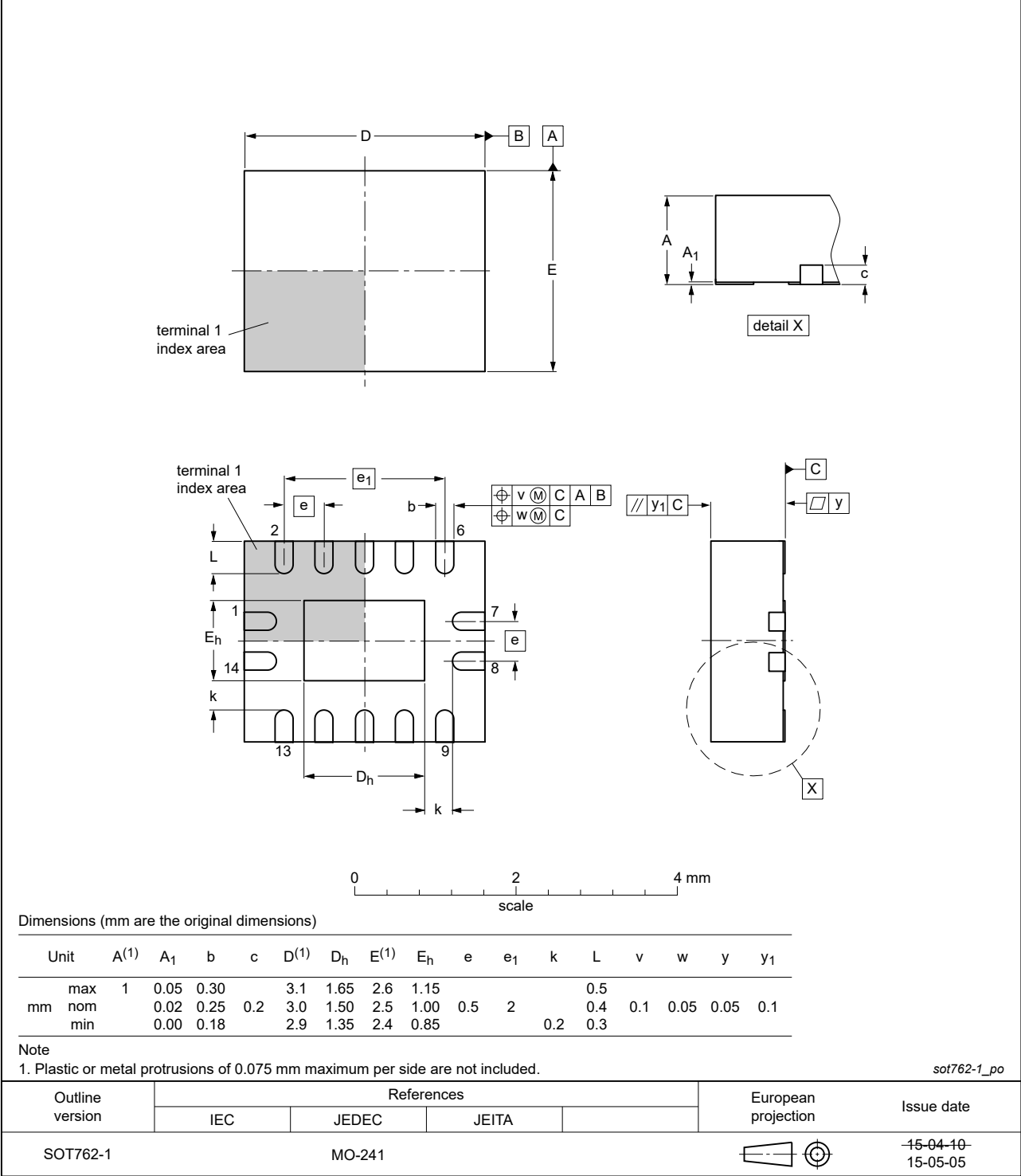


Fig. 8. Package outline SOT762-1 (DHVQFN14)

DHXQFN14: plastic, leadless dual in-line compatible thermal enhanced extreme thin quad flat package;
no leads; 14 terminals; 0.4 mm pitch; body 2 mm x 2 mm x 0.48 mm

SOT8014-1

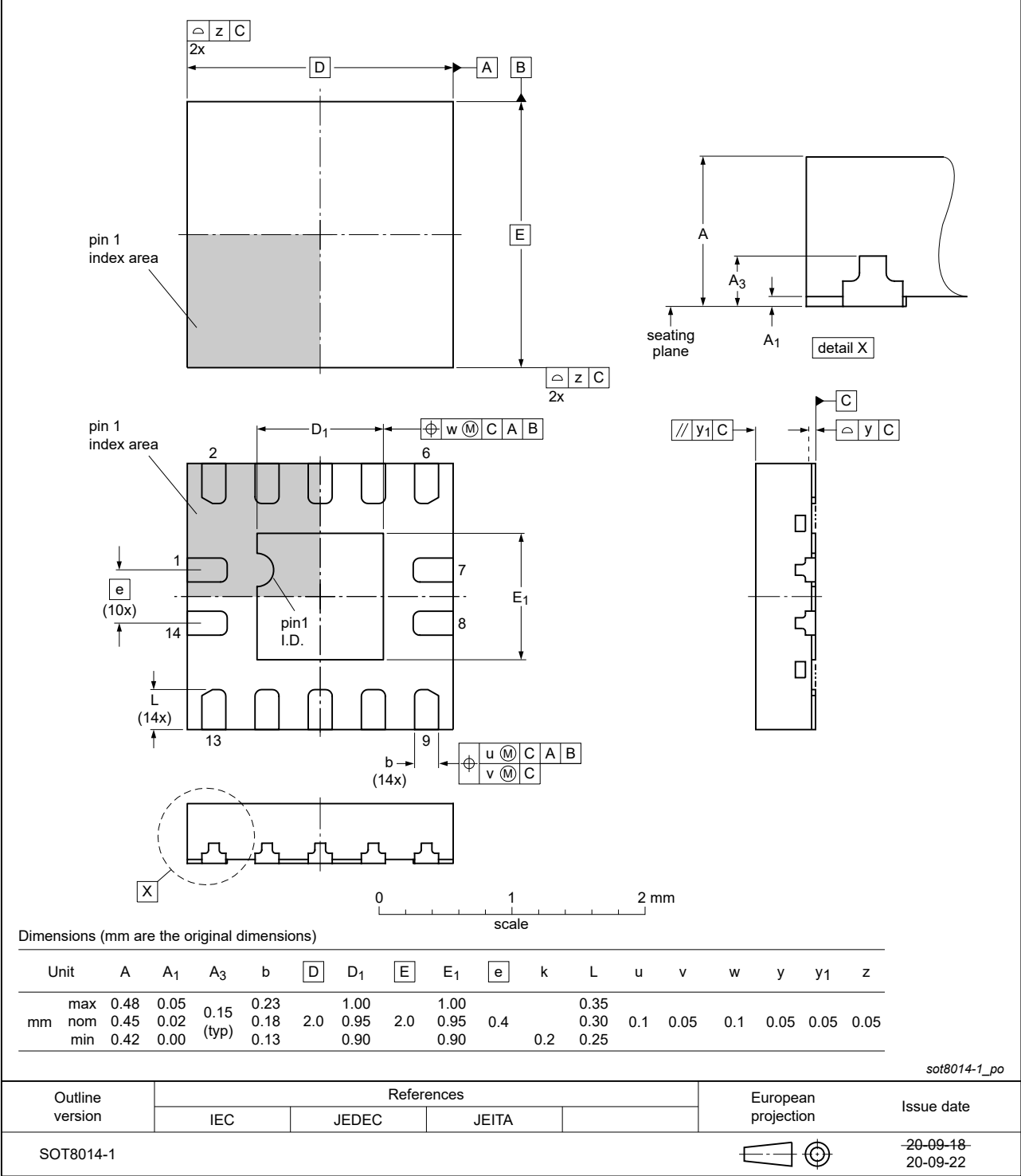


Fig. 9. Package outline SOT8014-1 (DHXQFN14)

12. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model
TTL	Transistor-Transistor Logic

13. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT04 v.9	20230209	Product data sheet	-	74HC_HCT04 v.8
Modifications:	<ul style="list-style-type: none"> Added type numbers 74HC04BZ and 74HCT04BZ (SOT8014-1/DHXQFN14). 			
74HC_HCT04 v.8	20210810	Product data sheet	-	74HC_HCT04 v.7
Modifications:	<ul style="list-style-type: none"> Type number 74HC04DB (SOT337-1/SSOP14) removed. 			
74HC_HCT04 v.7	20210205	Product data sheet	-	74HC_HCT04 v.6
Modifications:	<ul style="list-style-type: none"> Type number 74HCT04DB (SOT337-1/SSOP14) removed. 			
74HC_HCT04 v.6	20200609	Product data sheet	-	74HC_HCT04 v.5
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. Legal texts have been adapted to the new company name where appropriate. Section 2 updated. Table 4: Derating values for P_{tot} total power dissipation have been updated. 			
74HC_HCT04 v.5	20151127	Product data sheet	-	74HC_HCT04 v.4
Modifications:	<ul style="list-style-type: none"> Type numbers 74HC04N and 74HCT04N (SOT27-1) removed. 			
74HC_HCT04 v.4	20120803	Product data sheet	-	74HC_HCT04 v.3
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. Legal texts have been adapted to the new company name where appropriate. 			
74HC_HCT04 v.3	20030723	Product data sheet	-	74HC_HCT04_CNV v.2
74HC_HCT04_CNV v.2	19970826	Product specification	-	-

14. Legal information

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.
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Date of release: 9 February 2023