74HC14; 74HCT14

Hex inverting Schmitt trigger

Rev. 9 — 13 August 2021

Product data sheet

1. General description

The 74HC14; 74HCT14 is a hex inverter with Schmitt-trigger inputs. This device features reduced input threshold levels to allow interfacing to TTL logic levels. Inputs also include clamp diodes, this enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} . Schmitt trigger inputs transform slowly changing input signals into sharply defined jitter-free output signals.

2. Features and benefits

- Wide supply voltage range from 2.0 to 6.0 V
- CMOS low power dissipation
- · High noise immunity
- · Unlimited input rise and fall times
- 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)
- 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. Applications

- Wave and pulse shapers
- Astable multivibrators
- · Monostable multivibrators

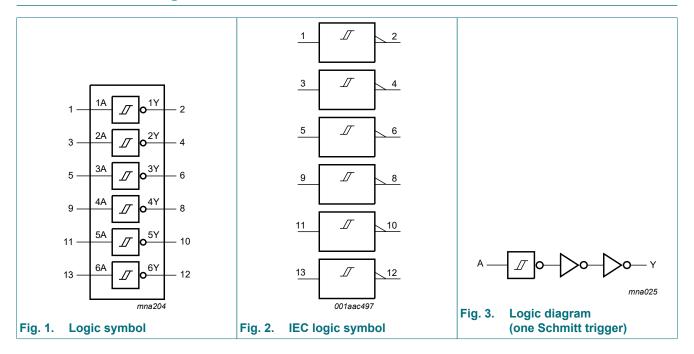
4. Ordering information

Table 1. Ordering information

Type number	Package										
	Temperature range	Name	Description	Version							
74HC14D	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads;	SOT108-1							
74HCT14D			body width 3.9 mm								
74HC14PW	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads;	SOT402-1							
74HCT14PW			body width 4.4 mm								
74HC14BQ	-40 °C to +125 °C	DHVQFN14	plastic dual in-line compatible thermal enhanced	SOT762-1							
74HCT14BQ	-		very thin quad flat package; no leads; 14 terminals; body 2.5 × 3 × 0.85 mm								

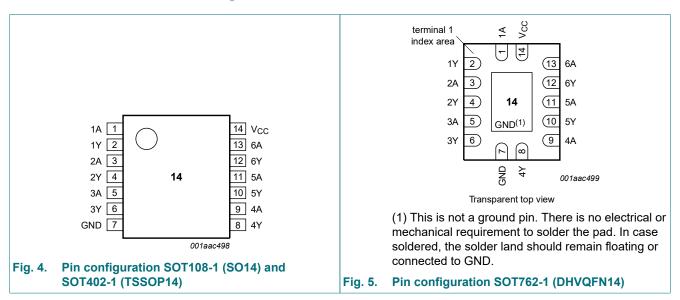


5. Functional diagram



6. Pinning information

6.1. Pinning



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6.2. 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

7. Functional description

Table 3. Function table

 $H = HIGH \ voltage \ level; \ L = LOW \ voltage \ level.$

Input	Output
nA	nY
L	Н
Н	L

8. 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	$V_1 < -0.5 \text{ V or } V_1 > V_{CC} + 0.5 \text{ V}$ [1]	-	±20	mA
I _{OK}	output clamping current	$V_O < -0.5 \text{ V or } V_O > V_{CC} + 0.5 \text{ V}$ [1]	-	±20	mA
Io	output current	$-0.5 \text{ V} < \text{V}_{\text{O}} < \text{V}_{\text{CC}} + 0.5 \text{ V}$	-	±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	[2]	-	500	mW

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

For SOT402-1 (TSSOP14) package: Ptot derates linearly with 7.3 mW/K above 81 °C.

For SOT762-1 (DHVQFN14) package: Ptot derates linearly with 9.6 mW/K above 98 °C.

9. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions		74HC14			Unit		
			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 _{amb}	ambient temperature		-40	+25	+125	-40	+25	+125	°C

^[2] For SOT108-1 (SO14) package: Ptot derates linearly with 10.1 mW/K above 100 °C.

10. Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	Ta	_{imb} = 25	°C		-40 °C 35 °C	T _{amb} = -40 °C to +125 °C		Unit
			Min	Тур	Max	Min	Max	Min	Max	
74HC14					•					
V _{OH}	HIGH-level	$V_I = V_{T+}$ or V_{T-}								
	output voltage	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	$V_I = V_{T+}$ or V_{T-}								
	output voltage	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	$V_1 = V_{CC}$ or GND; $V_{CC} = 6.0 \text{ V}$	-	-	±0.1	-	±1.0	-	±1.0	μΑ
I _{CC}	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 6.0 \text{ V}$	-	-	2.0	-	20	-	40	μΑ
C _I	input capacitance		-	3.5	-	-	-	-	-	pF
74HCT1	4						'		'	
V _{OH}	HIGH-level	$V_{I} = V_{T+} \text{ or } V_{T-}; V_{CC} = 4.5 \text{ V}$								
	output voltage	Ι _Ο = -20 μΑ	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -4.0 mA	3.98	4.32	-	3.84	-	3.7	-	V
V _{OL}	LOW-level	$V_{I} = V_{T+} \text{ or } V_{T-}; V_{CC} = 4.5 \text{ V}$								
	output voltage	I _O = 20 μA;	-	0	0.1	-	0.1	-	0.1	V
		I _O = 4.0 mA;	-	0.15	0.26	-	0.33	-	0.4	V
I _I	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 5.5 \text{ V}$	-	-	±0.1	-	±1.0	-	±1.0	μΑ
I _{CC}	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 5.5 \text{ V}$	-	-	2.0	-	20	-	40	μΑ
ΔI _{CC}	additional supply current	per input pin; $V_I = V_{CC} - 2.1 \text{ V}$; other pins at V_{CC} or GND; $I_O = 0 \text{ A}$; $V_{CC} = 4.5 \text{ V}$ to 5.5 V	-	30	108	-	135	-	147	μΑ
Cı	input capacitance		-	3.5	-	-	-	-	-	pF

11. Dynamic characteristics

Table 7. Dynamic characteristics

GND = 0 V; C_L = 50 pF; for test circuit see Fig. 7.

Symbol	Parameter	Conditions	Ta	_{mb} = 25	°C		: -40 °C 85 °C	T _{amb} = -40 °C to +125 °C		Unit
			Min	Тур	Max	Min	Max	Min	Max	
74HC14										
t _{pd}	propagation	nA to nY; see Fig. 6 [1]								
	delay	V _{CC} = 2.0 V	-	41	125	-	155	-	190	ns
		V _{CC} = 4.5 V	-	15	25	-	31	-	38	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	12	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	12	21	-	26	-	32	ns
t _t	transition time	see <u>Fig. 6</u> [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	-	15	-	19	ns
C _{PD}	power dissipation capacitance	per package; $V_I = GND$ to V_{CC} [3]	-	7	-	-	-	-	-	pF
74HCT1	4								1	
t _{pd}	propagation	nA to nY; see Fig. 6 [1]								
	delay	V _{CC} = 4.5 V	-	20	34	-	43	-	51	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	17	-	-	-	-	-	ns
t _t	transition time	V _{CC} = 4.5 V; see <u>Fig. 6</u> [2]	-	7	15	-	19	-	22	ns
C _{PD}	power dissipation capacitance	per package; [3] V _I = GND to V _{CC} - 1.5 V	-	8	-	-	-	-	-	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 μ W): $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum (C_L \times V_{CC}^2 \times f_o)$ where:

$$P_D = C_{DD} \times V_{CO}^2 \times f_1 \times N + \sum_{i=1}^{n} (C_1 \times V_{CO}^2 \times f_2)$$
 where

f_i = input frequency in MHz;

f_o = output frequency in MHz;

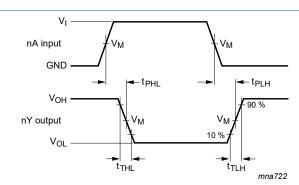
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

 $\Sigma (C_L \times V_{CC}^2 \times f_0) = \text{sum of outputs.}$

11.1. Waveforms and test circuit



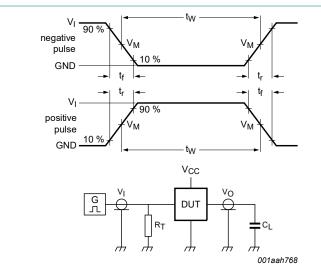
Measurement points are given in Table 8.

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

Fig. 6. Input to output propagation delays

Table 8. Measurement points

			1111 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1								
Туре	Input	Output									
	V _M	V _M	V_X	V _Y							
74HC14	0.5V _{CC}	0.5V _{CC}	0.1V _{CC}	0.9V _{CC}							
74HCT14	1.3 V	1.3 V	0.1V _{CC}	0.9V _{CC}							



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_L = load capacitance including jig and probe capacitance.

Fig. 7. Test circuit for measuring switching times

Table 9. Test data

Туре	Input		Load	Test
	VI	t _r , t _f	CL	
74HC14	V _{CC}	6.0 ns	15 pF, 50 pF	t _{PLH} , t _{PHL}
74HCT14	3.0 V	6.0 ns	15 pF, 50 pF	t _{PLH} , t _{PHL}

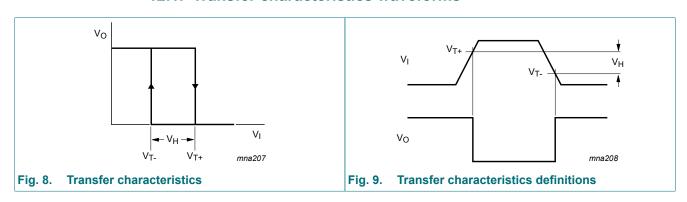
12. Transfer characteristics

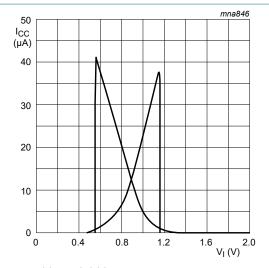
Table 10. Transfer characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); see Fig. 8 and Fig. 9.

Symbol	Parameter	Conditions	Ta	_{amb} = 25	°C		-40 °C 35 °C		-40 °C 25 °C	Unit
			Min	Тур	Max	Min	Max	Min	Max	
74HC14	1	'	<u> </u>	'						
V _{T+}	positive-going	V _{CC} = 2.0 V	0.7	1.18	1.5	0.7	1.5	0.7	1.5	V
	threshold voltage	V _{CC} = 4.5 V	1.7	2.38	3.15	1.7	3.15	1.7	3.15	V
		V _{CC} = 6.0 V	2.1	3.14	4.2	2.1	4.2	2.1	4.2	V
V _{T-}	negative-going	V _{CC} = 2.0 V	0.3	0.52	0.9	0.3	0.9	0.3	0.9	V
	threshold voltage	V _{CC} = 4.5 V	0.9	1.4	2.0	0.9	2.0	0.9	2.0	V
		V _{CC} = 6.0 V	1.2	1.89	2.6	1.2	2.6	1.2	2.6	V
V _H	hysteresis voltage	V _{CC} = 2.0 V	0.2	0.66	1.0	0.2	1.0	0.2	1.0	V
		V _{CC} = 4.5 V	0.4	0.98	1.4	0.4	1.4	0.4	1.4	V
		V _{CC} = 6.0 V	0.6	1.25	1.6	0.6	1.6	0.6	1.6	V
74HCT1	4		-	'	'	,	'	-	,	
V _{T+}	positive-going	V _{CC} = 4.5 V	1.2	1.41	1.9	1.2	1.9	1.2	1.9	V
	threshold voltage	V _{CC} = 5.5 V	1.4	1.59	2.1	1.4	2.1	1.4	2.1	V
V _{T-}	negative-going	V _{CC} = 4.5 V	0.5	0.85	1.2	0.5	1.2	0.5	1.2	V
	threshold voltage	V _{CC} = 5.5 V	0.6	0.99	1.4	0.6	1.4	0.6	1.4	V
V _H	hysteresis voltage	V _{CC} = 4.5 V	0.4	0.56	-	0.4	-	0.4	-	V
		V _{CC} = 5.5 V	0.4	0.6	-	0.4	-	0.4	-	V

12.1. Transfer characteristics waveforms





a. $V_{CC} = 2.0 \text{ V}$

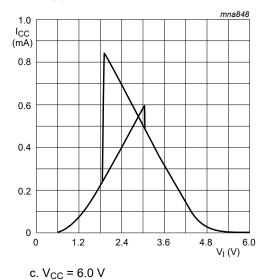
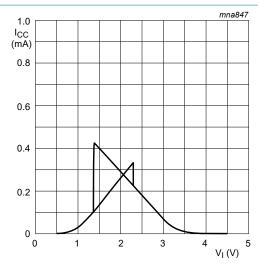
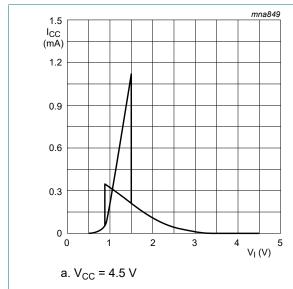


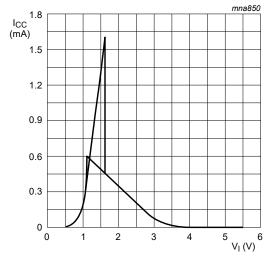
Fig. 10. Typical 74HC transfer characteristics



b. $V_{CC} = 4.5 \text{ V}$







b. V_{CC} = 5.5 V

13. Application information

The slow input rise and fall times cause additional power dissipation, this can be calculated using the following formula:

 $P_{add} = f_i \times (t_r \times \Delta I_{CC(AV)} + t_f \times \Delta I_{CC(AV)}) \times V_{CC}$ where:

- P_{add} = additional power dissipation (μW);
- f_i = input frequency (MHz);
- t_r = rise time (ns); 10 % to 90 %;
- t_f = fall time (ns); 90 % to 10 %;
- ΔI_{CC(AV)} = average additional supply current (µA).

Average $\Delta I_{CC(AV)}$ differs with positive or negative input transitions, as shown in Fig. 12 and Fig. 13.

An example of a relaxation circuit using the 74HC14; 74HCT14 is shown in Fig. 14.

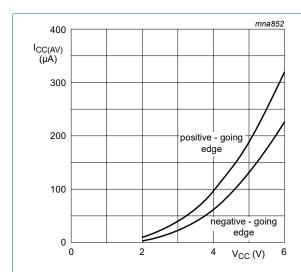


Fig. 12. Average additional supply current as a function of V_{CC} for 74HC14; linear change of V_I between $0.1V_{CC}$ to $0.9V_{CC}$.

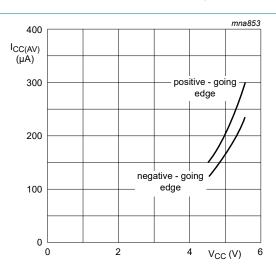
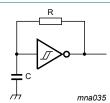


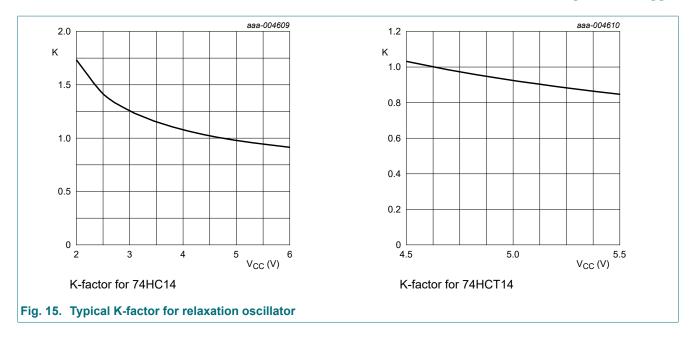
Fig. 13. Average additional supply current as a function of V_{CC} for 74HCT14; linear change of V_I between $0.1V_{CC}$ to $0.9V_{CC}$.



For 74HC14 and 74HCT14: $f = \frac{1}{T} \approx \frac{1}{K \times RC}$

For K-factor see Fig. 15

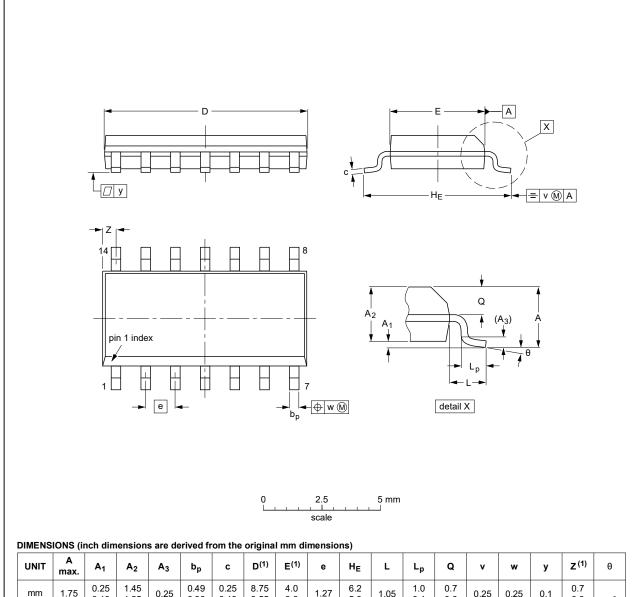
Fig. 14. Relaxation oscillator



14. Package outline

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

SOT108-1



UNIT	A max.	A ₁	A ₂	Α3	bp	С	D ⁽¹⁾	E ⁽¹⁾	е	HE	L	Lp	Q	v	w	у	Z ⁽¹⁾	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		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°

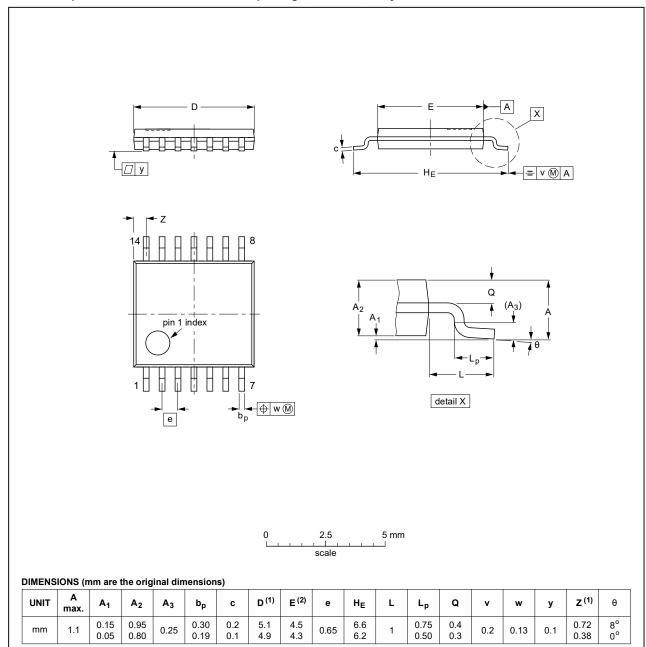
1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

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

Fig. 16. Package outline SOT108-1 (SO14)

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

SOT402-1



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	ISSUE DATE
	IEC	JEDEC	JEITA		PROJECTION	ISSUE DATE
SOT402-1		MO-153				99-12-27 03-02-18

Fig. 17. Package outline SOT402-1 (TSSOP14)

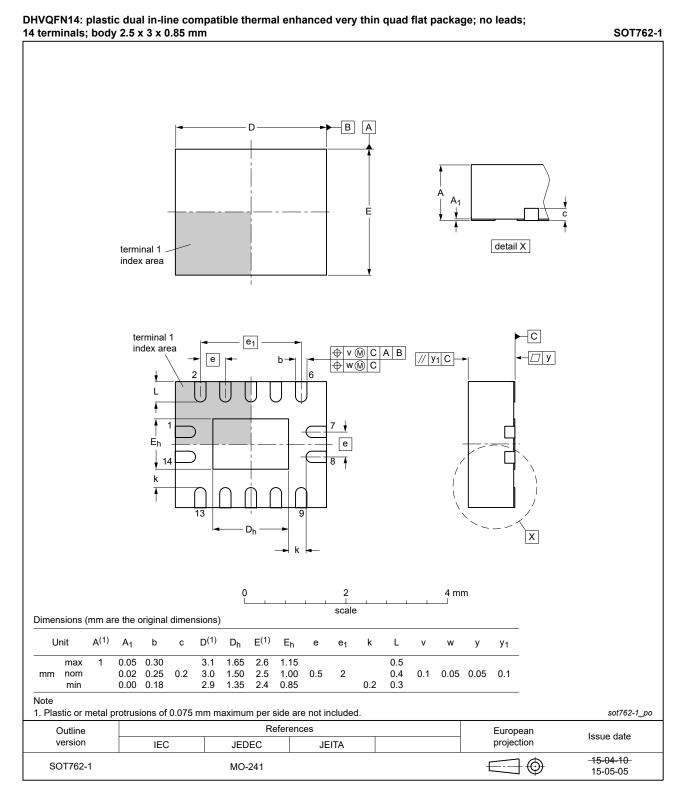


Fig. 18. Package outline SOT762-1 (DHVQFN14)

15. Abbreviations

Table 11. Abbreviations

Acronym	Description
DUT	Device Under Test
ESD	ElectroStatic Discharge
НВМ	Human Body Model
MM	Machine Model
TTL	Transistor-Transistor Logic

16. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes		
74HC_HCT14 v.9	20210813	Product data sheet	-	74HC_HCT14 v.8		
Modifications:		 <u>Section 2</u> updated. Type numbers 74HC14DB and 74HCT14DB (SOT337-1/SSOP14) removed. 				
74HC_HCT14 v.8	20200522	Product data sheet	-	74HC_HCT14 v.7		
Modifications:	guidelines of Legal texts	 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. Table 4: Derating values for P_{tot} total power dissipation updated. 				
74HC_HCT14 v.7	20151119	Product data sheet	-	74HC_HCT14 v.6		
Modifications:	Type numb	Type numbers 74HC14N and 74HCT14N (SOT27-1) removed.				
74HC_HCT14 v.6	20120919	Product data sheet	-	74HC_HCT14 v.5		
Modifications:	• <u>Fig. 15</u> add	Fig. 15 added (typical K-factor for relaxation oscillator).				
74HC_HCT14 v.5	20111219	Product data sheet	-	74HC_HCT14 v.4		
Modifications:	 Legal page 	Legal pages updated.				
74HC_HCT14 v.4	20110117	Product data sheet	-	74HC_HCT14 v.3		
74HC_HCT14 v.3	20031030	Product specification	-	74HC_HCT14_CNV v.2		
74HC_HCT14_CNV v.2	19970826	Product specification	-	-		

17. 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.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

- Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
- 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 https://www.nexperia.com.

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