

74HC14; 74HCT14

Hex inverting Schmitt trigger

Rev. 7 — 19 November 2015

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

- Complies with JEDEC standard no. 7A
- Low-power dissipation
- ESD protection:
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from -40 °C to $+85\text{ °C}$ and from -40 °C to $+125\text{ °C}$

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; body width 3.9 mm	SOT108-1
74HCT14D				
74HC14DB	-40 °C to +125 °C	SSOP14	plastic shrink small outline package; 14 leads; body width 5.3 mm	SOT337-1
74HCT14DB				
74HC14PW	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74HCT14PW				
74HC14BQ	-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
74HCT14BQ				

5. Functional diagram

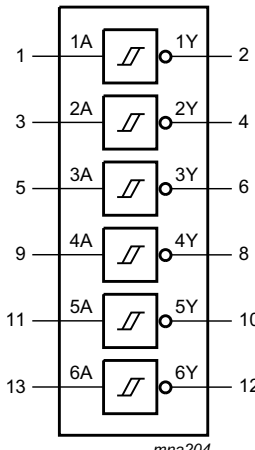


Fig 1. Logic symbol

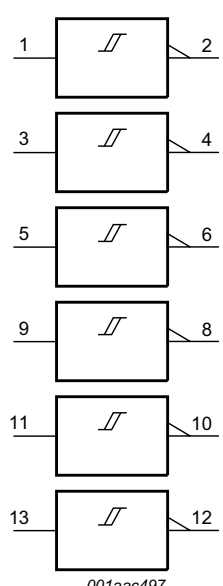


Fig 2. IEC logic symbol

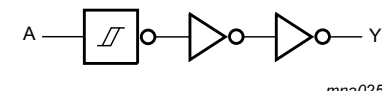


Fig 3. Logic diagram (one Schmitt trigger)

6. Pinning information

6.1 Pinning

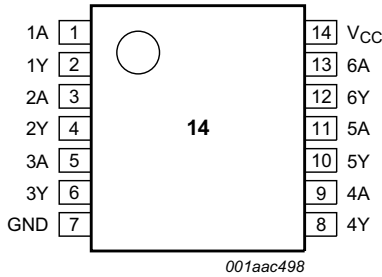
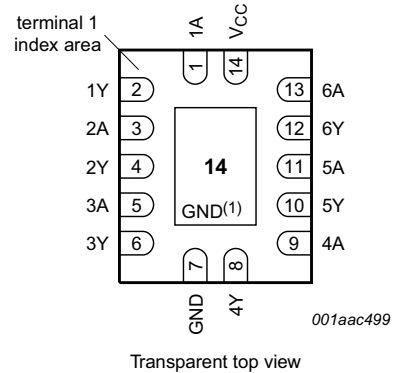


Fig 4. Pin configuration SO14 and (T)SSOP14



- (1) This is not a supply pin. The substrate is attached to this pad using conductive die attach material. There is no electrical or mechanical requirement to solder this pad. However, if it is soldered, the solder land should remain floating or be connected to GND.

Fig 5. Pin configuration DHVQFN14

6.2 Pin description

Table 2. Pin description

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

7. Functional description

Table 3. Function table^[1]

Input	Output
nA	nY
L	H
H	L

[1] H = HIGH voltage level;
L = LOW voltage level.

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	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$ [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
I_O	output current	$-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$	-	± 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	SO14, (T)SSOP14 and DHVQFN14 packages [2]	-	500	mW

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

[2] 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: P_{tot} derates linearly with 4.5 mW/K above 60 °C.

9. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC14			74HCT14			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

10. Static characteristics

Table 6. Static characteristics

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

Symbol	Parameter	Conditions	T _{amb} = 25 °C			T _{amb} = -40 °C to +85 °C		T _{amb} = -40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC14										
V _{OH}	HIGH-level output voltage	V _I = V _{T+} or V _{T-}								
		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 _{T+} or V _{T-}								
		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	-	±1.0	-	±1.0	μA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V	-	-	2.0	-	20	-	40	μA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF
74HCT14										
V _{OH}	HIGH-level output voltage	V _I = V _{T+} or V _{T-} ; V _{CC} = 4.5 V								
		I _O = -20 μA	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 output voltage	V _I = V _{T+} or V _{T-} ; V _{CC} = 4.5 V								
		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 V	-	-	±0.1	-	±1.0	-	±1.0	μA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V	-	-	2.0	-	20	-	40	μA
ΔI _{CC}	additional supply current	per input pin; V _I = V _{CC} - 2.1 V; other pins at V _{CC} or GND; I _O = 0 A; V _{CC} = 4.5 V to 5.5 V	-	30	108	-	135	-	147	μA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

11. Dynamic characteristics

Table 7. Dynamic characteristics

$GND = 0\text{ V}$; $C_L = 50\text{ pF}$; for test circuit see [Figure 7](#).

Symbol	Parameter	Conditions	$T_{\text{amb}} = 25\text{ °C}$			$T_{\text{amb}} = -40\text{ °C to }+125\text{ °C}$		Unit
			Min	Typ	Max	Max (85 °C)	Max (125 °C)	
74HC14								
t_{pd}	propagation delay	nA to nY; see Figure 6 [1]						
		$V_{\text{CC}} = 2.0\text{ V}$	-	41	125	155	190	ns
		$V_{\text{CC}} = 4.5\text{ V}$	-	15	25	31	38	ns
		$V_{\text{CC}} = 5.0\text{ V}$; $C_L = 15\text{ pF}$	-	12	-	-	-	ns
		$V_{\text{CC}} = 6.0\text{ V}$	-	12	21	26	32	ns
t_t	transition time	see Figure 6 [2]						
		$V_{\text{CC}} = 2.0\text{ V}$	-	19	75	95	110	ns
		$V_{\text{CC}} = 4.5\text{ V}$	-	7	15	19	22	ns
		$V_{\text{CC}} = 6.0\text{ V}$	-	6	13	15	19	ns
C_{PD}	power dissipation capacitance	per package; $V_I = GND$ to V_{CC} [3]	-	7	-	-	-	pF
74HCT14								
t_{pd}	propagation delay	nA to nY; see Figure 6 [1]						
		$V_{\text{CC}} = 4.5\text{ V}$	-	20	34	43	51	ns
		$V_{\text{CC}} = 5.0\text{ V}$; $C_L = 15\text{ pF}$	-	17	-	-	-	ns
t_t	transition time	$V_{\text{CC}} = 4.5\text{ V}$; see Figure 6 [2]	-	7	15	19	22	ns
C_{PD}	power dissipation capacitance	per package; $V_I = GND$ to $V_{\text{CC}} - 1.5\text{ V}$ [3]	-	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 μW):

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

f_i = input frequency in MHz;

f_o = output frequency in MHz;

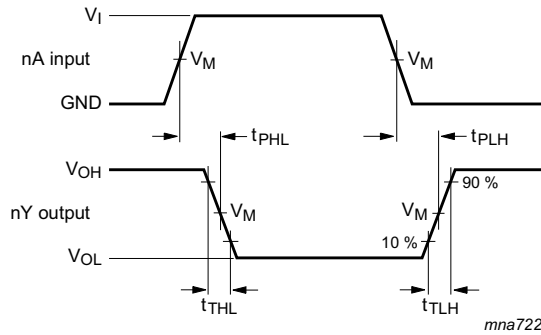
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

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

12. Waveforms

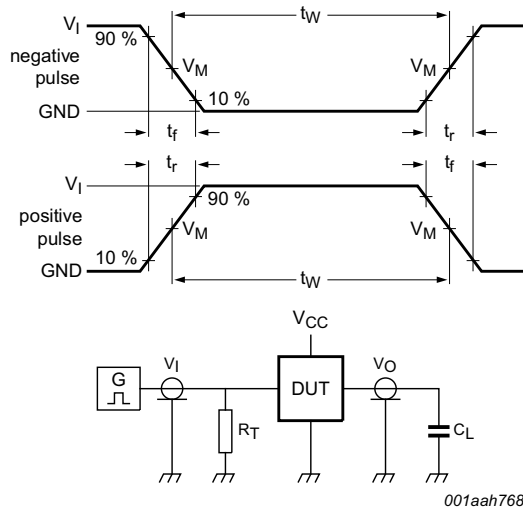


Measurement points are given in [Table 8](#).
 V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Fig 6. Input to output propagation delays

Table 8. Measurement points

Type	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

Type	Input		Load	Test
	V_I	t_r, t_f	C_L	
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}

13. Transfer characteristics

Table 10. Transfer characteristics

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

Symbol	Parameter	Conditions	$T_{amb} = 25\text{ }^{\circ}\text{C}$			$T_{amb} = -40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$		$T_{amb} = -40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC14										
V_{T+}	positive-going threshold voltage	$V_{CC} = 2.0\text{ V}$	0.7	1.18	1.5	0.7	1.5	0.7	1.5	V
		$V_{CC} = 4.5\text{ V}$	1.7	2.38	3.15	1.7	3.15	1.7	3.15	V
		$V_{CC} = 6.0\text{ V}$	2.1	3.14	4.2	2.1	4.2	2.1	4.2	V
V_{T-}	negative-going threshold voltage	$V_{CC} = 2.0\text{ V}$	0.3	0.52	0.9	0.3	0.9	0.3	0.9	V
		$V_{CC} = 4.5\text{ V}$	0.9	1.4	2.0	0.9	2.0	0.9	2.0	V
		$V_{CC} = 6.0\text{ V}$	1.2	1.89	2.6	1.2	2.6	1.2	2.6	V
V_H	hysteresis voltage	$V_{CC} = 2.0\text{ V}$	0.2	0.66	1.0	0.2	1.0	0.2	1.0	V
		$V_{CC} = 4.5\text{ V}$	0.4	0.98	1.4	0.4	1.4	0.4	1.4	V
		$V_{CC} = 6.0\text{ V}$	0.6	1.25	1.6	0.6	1.6	0.6	1.6	V
74HCT14										
V_{T+}	positive-going threshold voltage	$V_{CC} = 4.5\text{ V}$	1.2	1.41	1.9	1.2	1.9	1.2	1.9	V
		$V_{CC} = 5.5\text{ V}$	1.4	1.59	2.1	1.4	2.1	1.4	2.1	V
V_{T-}	negative-going threshold voltage	$V_{CC} = 4.5\text{ V}$	0.5	0.85	1.2	0.5	1.2	0.5	1.2	V
		$V_{CC} = 5.5\text{ V}$	0.6	0.99	1.4	0.6	1.4	0.6	1.4	V
V_H	hysteresis voltage	$V_{CC} = 4.5\text{ V}$	0.4	0.56	-	0.4	-	0.4	-	V
		$V_{CC} = 5.5\text{ V}$	0.4	0.6	-	0.4	-	0.4	-	V

14. Transfer characteristics waveforms

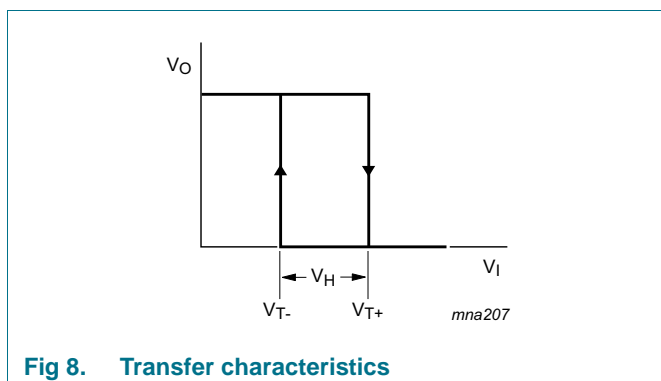


Fig 8. Transfer characteristics

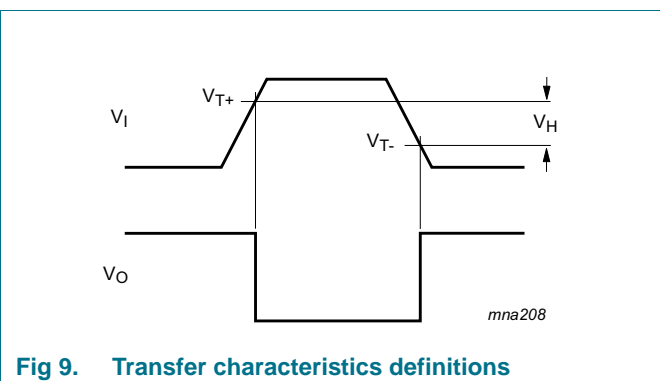
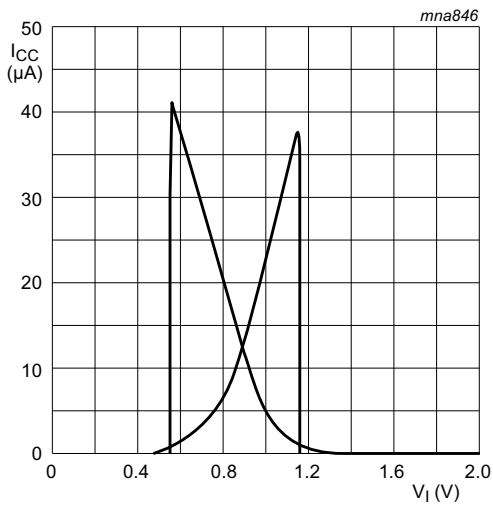
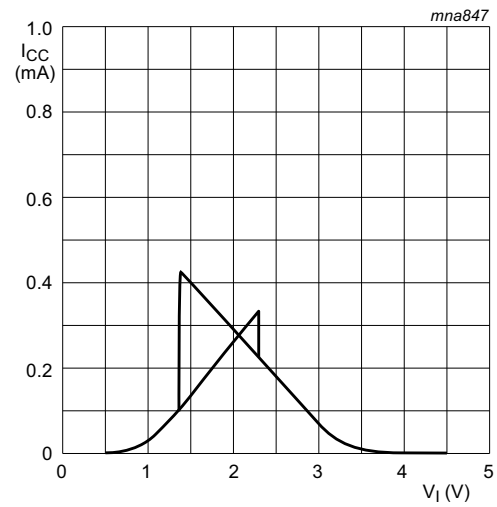


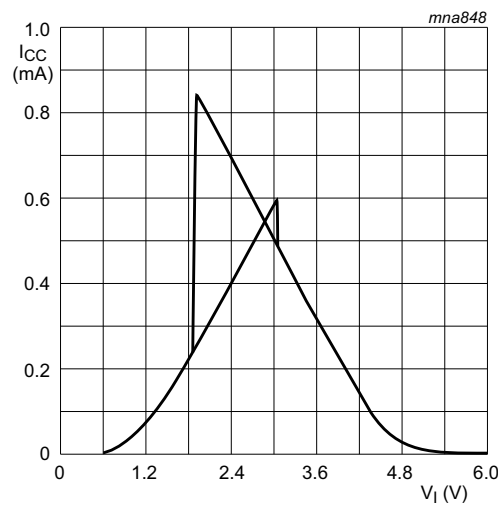
Fig 9. Transfer characteristics definitions



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

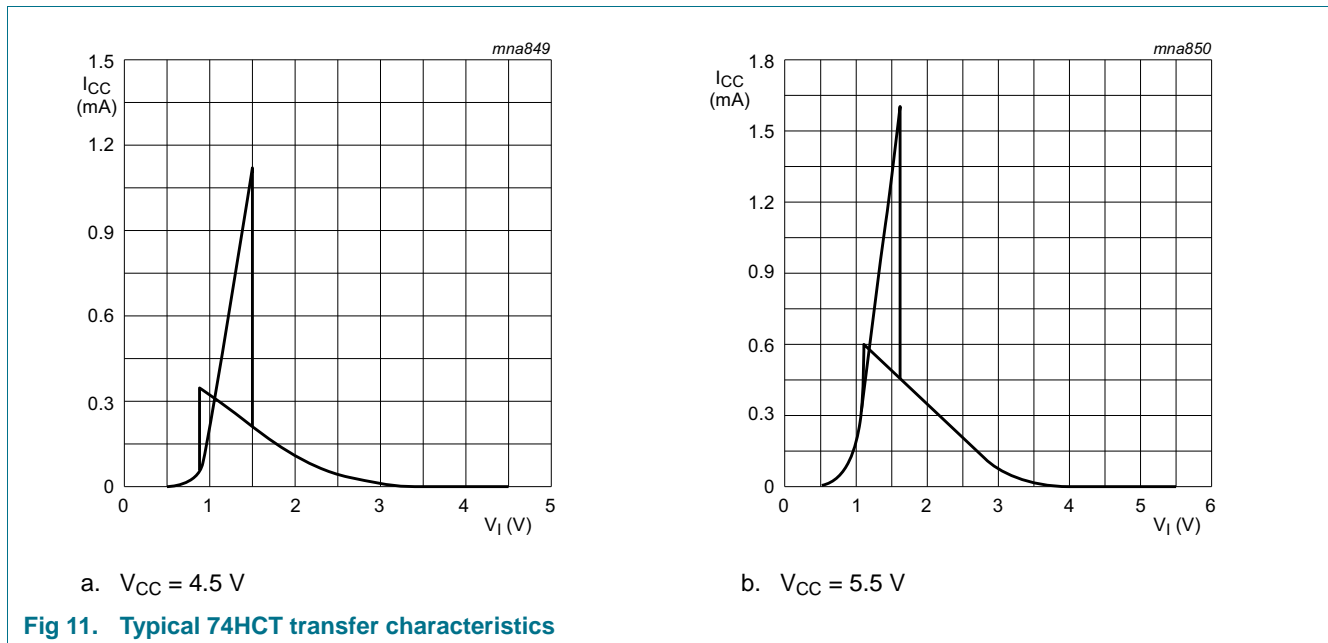


b. $V_{CC} = 4.5\text{ V}$



c. $V_{CC} = 6.0\text{ V}$

Fig 10. Typical 74HC transfer characteristics



15. Application information

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

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

P_{add} = additional power dissipation (μW);

f_i = input frequency (MHz);

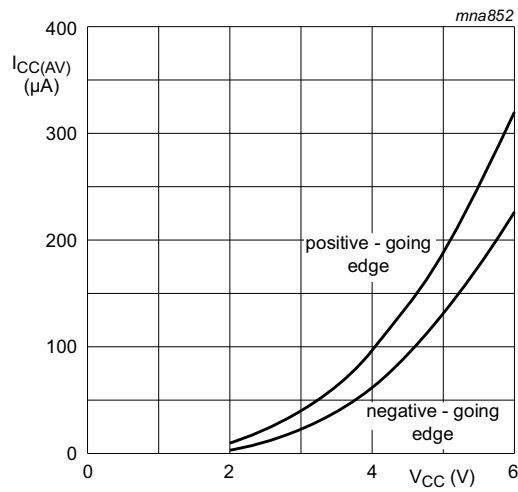
t_r = rise time (ns); 10 % to 90 %;

t_f = fall time (ns); 90 % to 10 %;

$\Delta I_{CC(\text{AV})}$ = average additional supply current (μA).

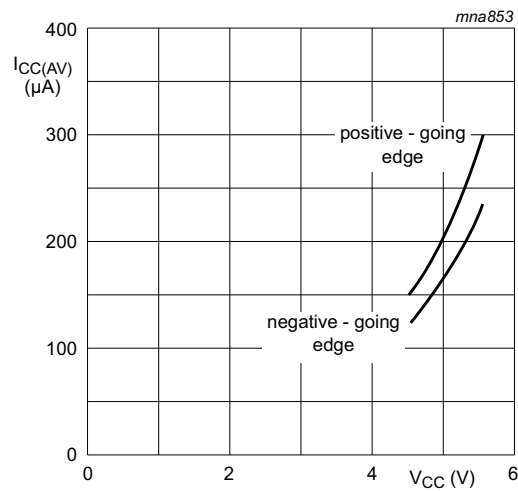
Average $\Delta I_{CC(\text{AV})}$ differs with positive or negative input transitions, as shown in [Figure 12](#) and [Figure 13](#).

An example of a relaxation circuit using the 74HC14; 74HCT14 is shown in [Figure 14](#).



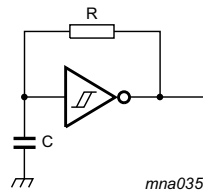
- (1) Positive-going edge.
- (2) Negative-going edge.

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}.



- (1) Positive-going edge.
- (2) Negative-going edge.

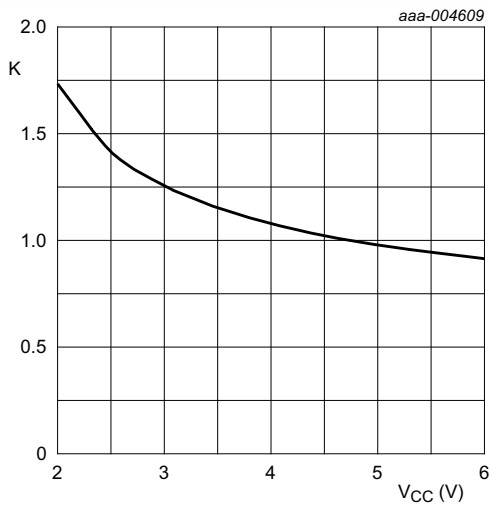
Fig 13. Average additional supply current as a function of V_{CC} for 74HCT14; linear change of V_I between 0.1V_{CC} to 0.9V_{CC}.



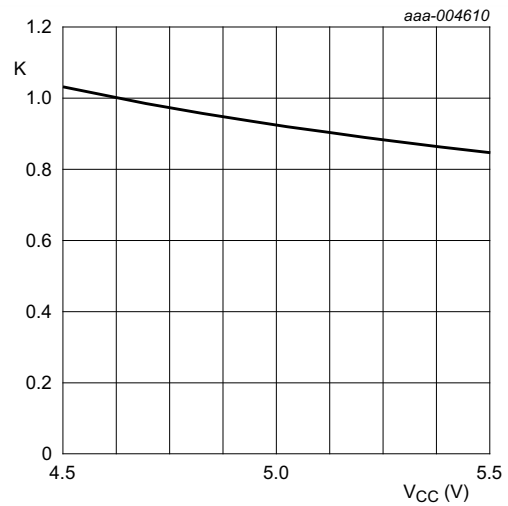
For 74HC14 and 74HCT14: $f = \frac{1}{T} \approx \frac{1}{K \times RC}$

For K-factor see [Figure 15](#)

Fig 14. Relaxation oscillator



K-factor for 74HC14



K-factor for 74HCT14

Fig 15. Typical K-factor for relaxation oscillator

16. Package outline

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

SOT108-1

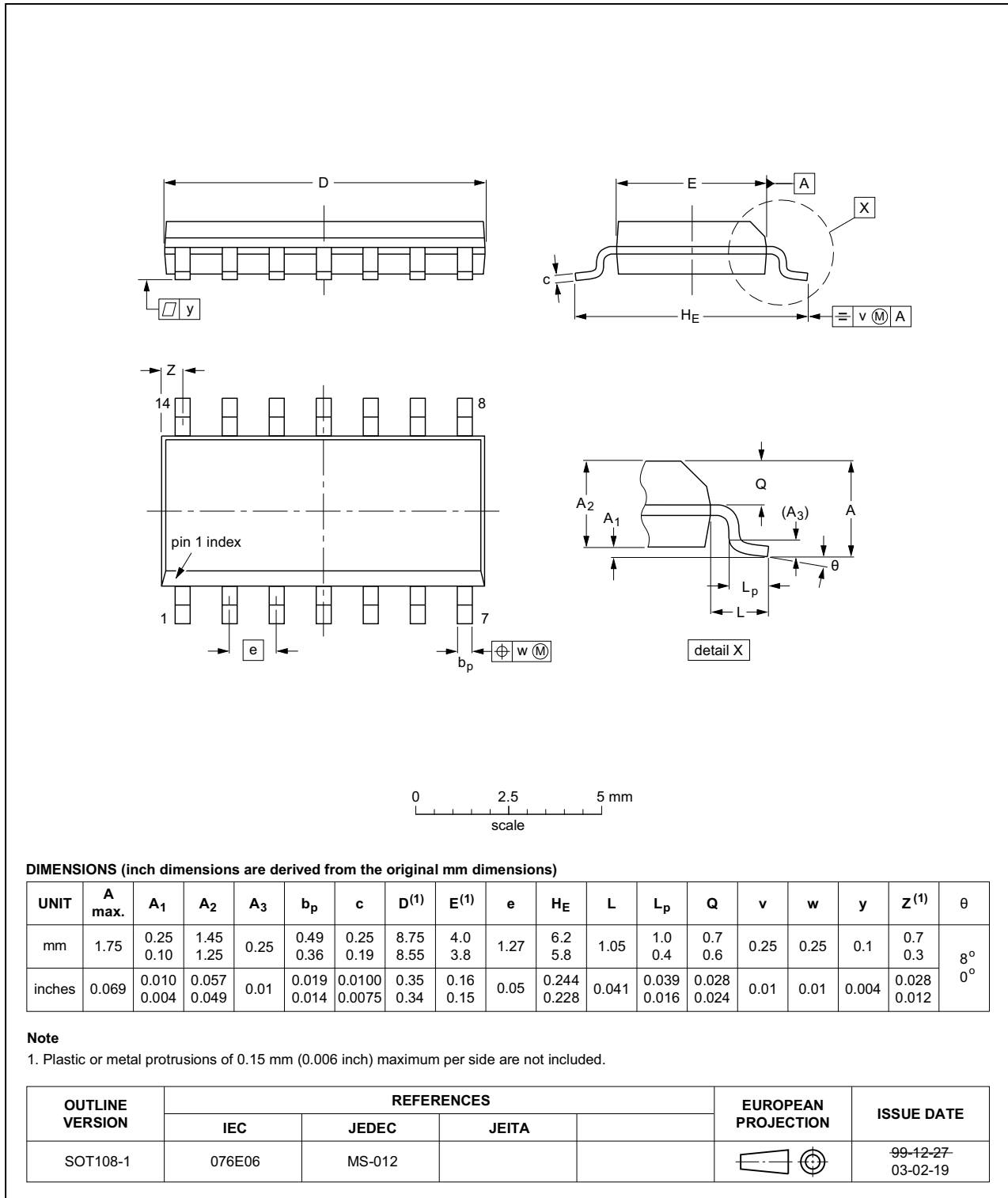


Fig 16. Package outline SOT108-1 (SO14)

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

SOT337-1

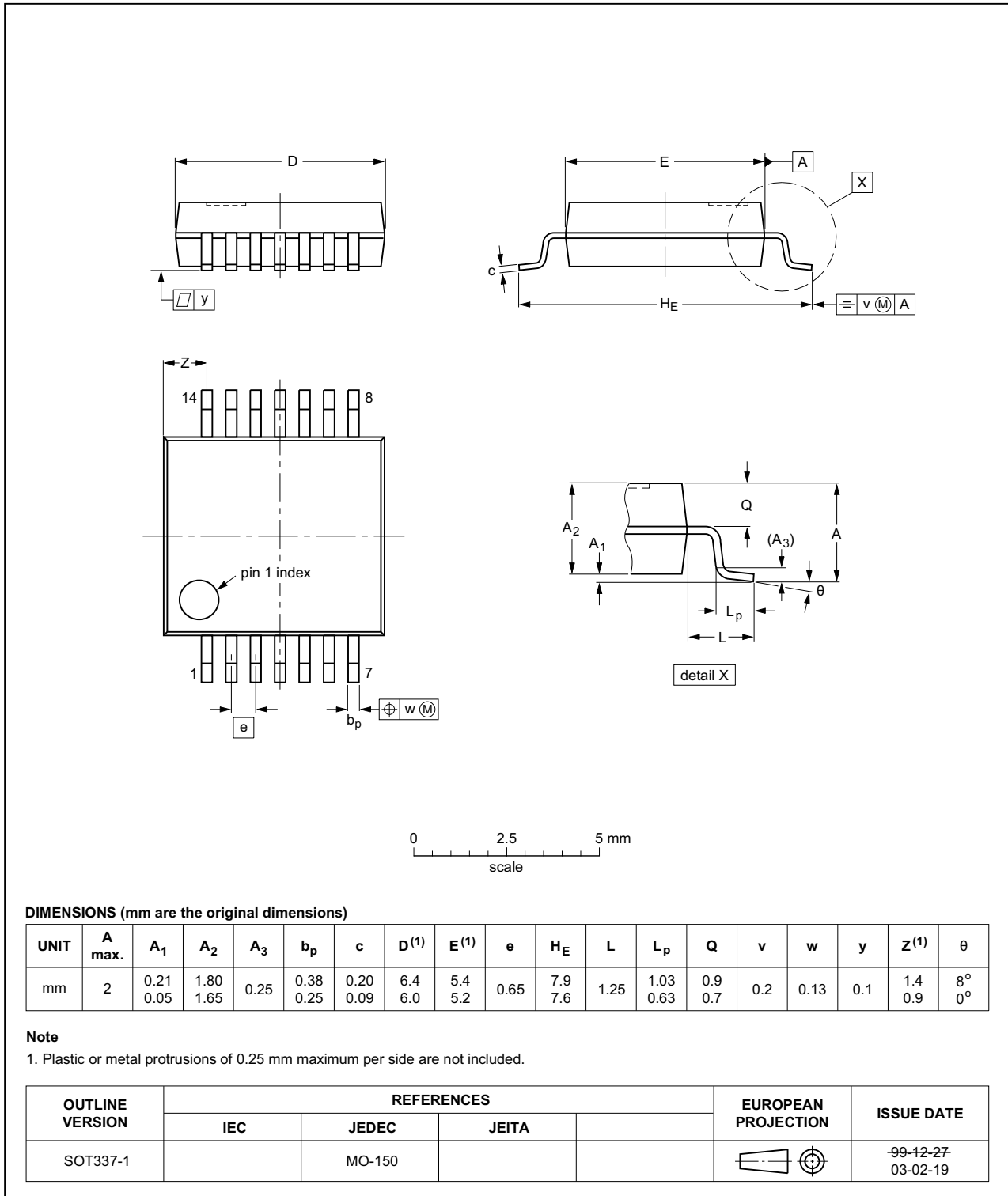


Fig 17. Package outline SOT337-1 (SSOP14)

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

SOT402-1

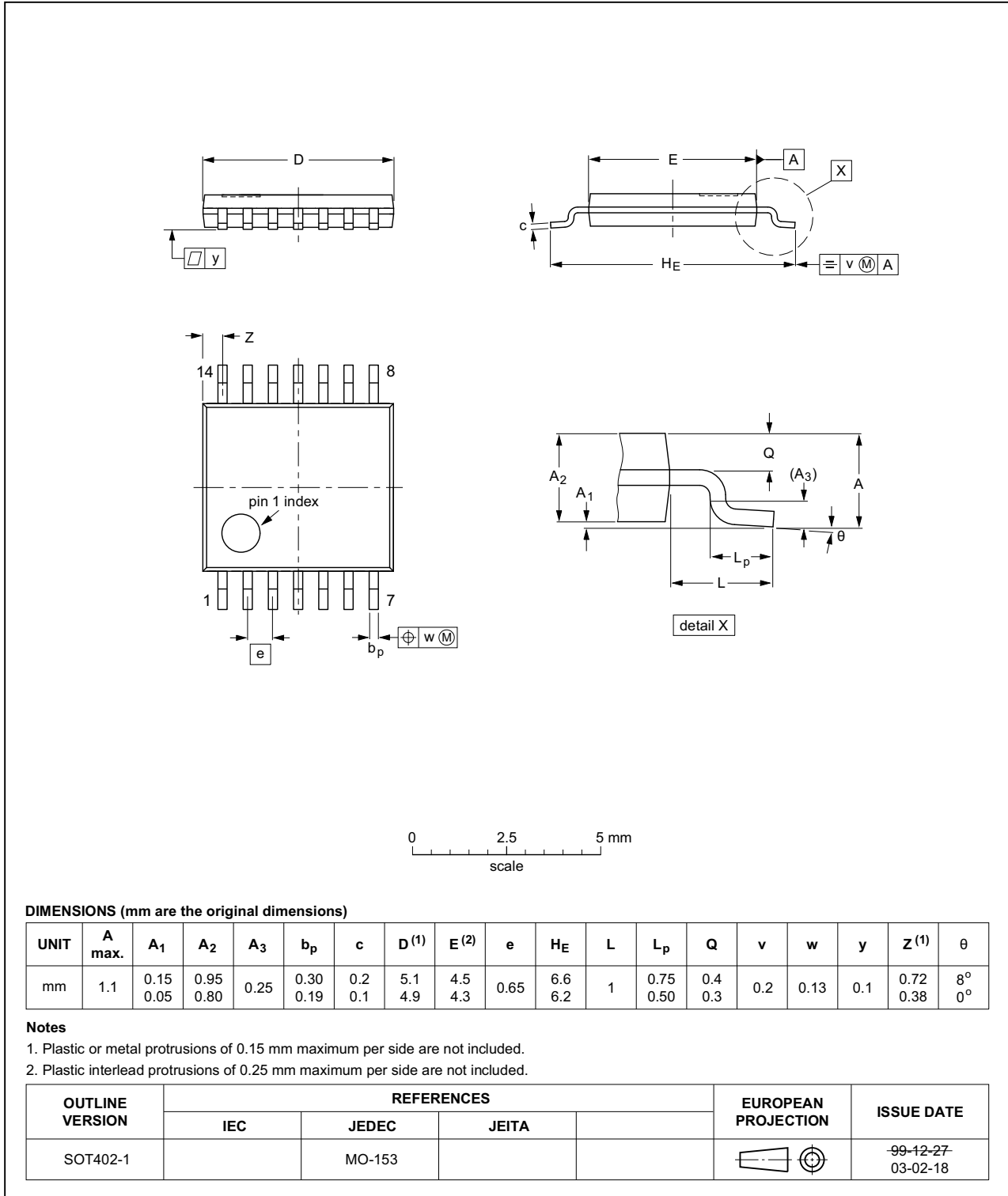


Fig 18. Package outline SOT402-1 (TSSOP14)

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

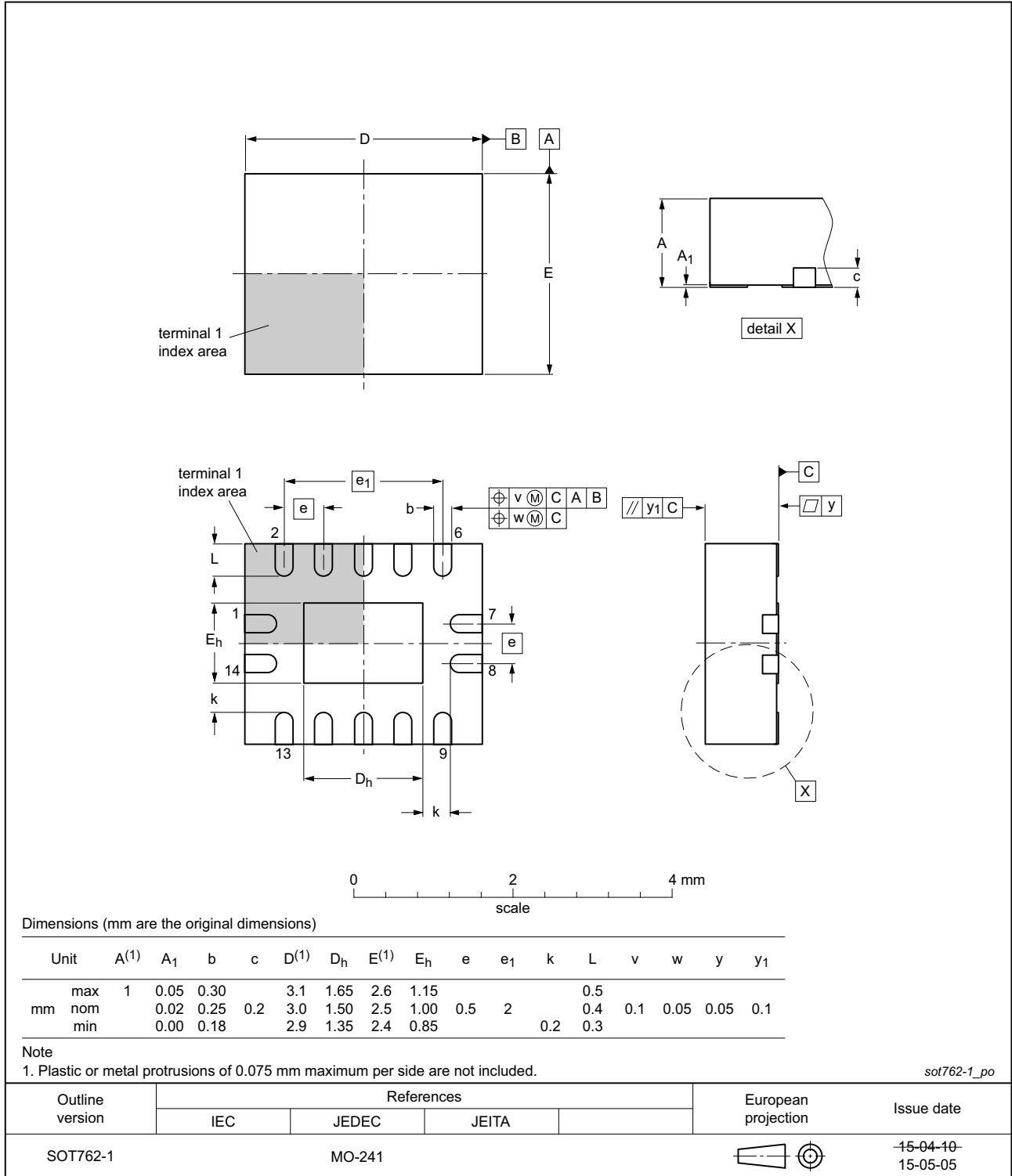


Fig 19. Package outline SOT762-1 (DHVQFN14)

17. Abbreviations

Table 11. 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

18. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT14 v.7	20151119	Product data sheet	-	74HC_HCT14 v.6
Modifications:	<ul style="list-style-type: none"> Type numbers 74HC14N and 74HCT14N (SOT27-1) removed. 			
74HC_HCT14 v.6	20120919	Product data sheet	-	74HC_HCT14 v.5
Modifications:	<ul style="list-style-type: none"> Figure 15 added (typical K-factor for relaxation oscillator). 			
74HC_HCT14 v.5	20111219	Product data sheet	-	74HC_HCT14 v.4
Modifications:	<ul style="list-style-type: none"> 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	-	-

19. Legal information

19.1 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.nexperia.com>.

19.2 Definitions

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20. Contact information

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