

# 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

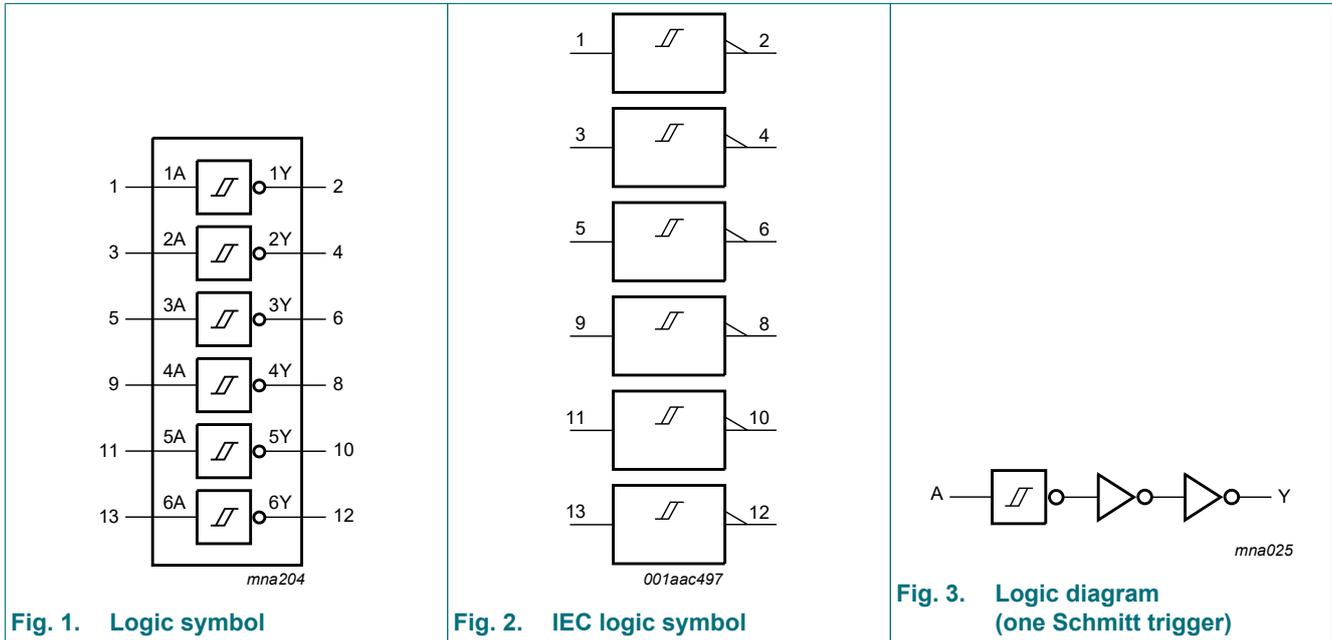
- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

## 4. Ordering information

Table 1. Ordering information

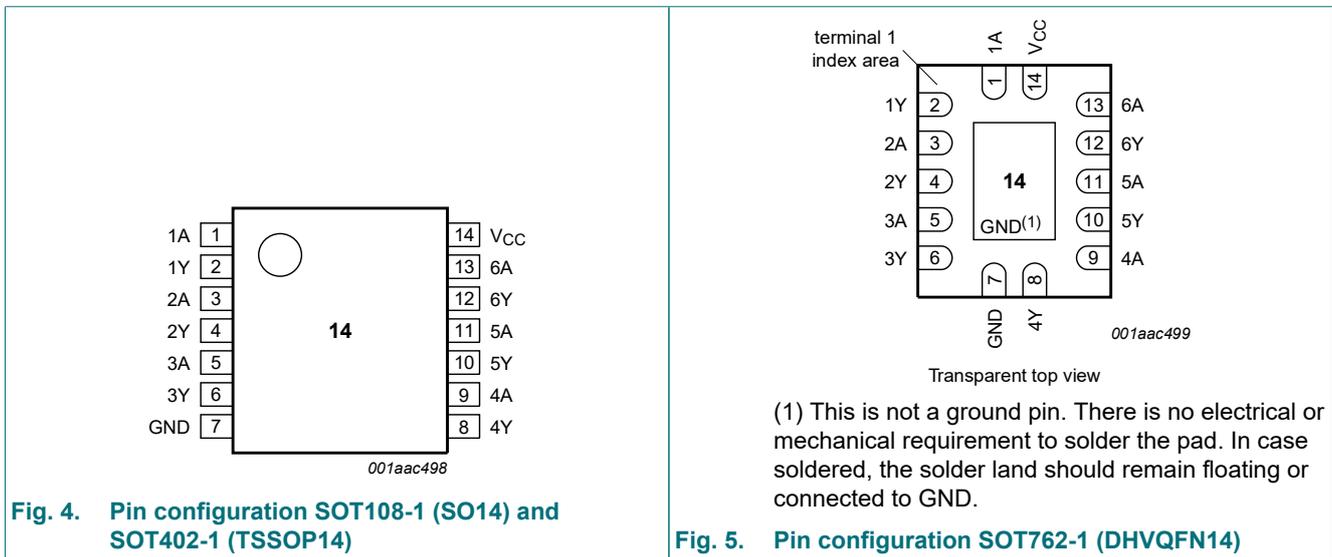
Type number	Package			Version
	Temperature range	Name	Description	
74HC14D	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74HCT14D				
74HC14PW	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74HCT14PW				
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



### 6. Pinning information

#### 6.1. Pinning



## 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 <sub>CC</sub>	14	supply voltage

## 7. Functional description

Table 3. Function table

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

Input	Output
nA	nY
L	H
H	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 <sub>CC</sub>	supply voltage		-0.5	+7	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>CC</sub> + 0.5 V [1]	-	±20	mA
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < -0.5 V or V <sub>O</sub> > V <sub>CC</sub> + 0.5 V [1]	-	±20	mA
I <sub>O</sub>	output current	-0.5 V < V <sub>O</sub> < V <sub>CC</sub> + 0.5 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]	-	500	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<sub>tot</sub> derates linearly with 10.1 mW/K above 100 °C.

For SOT402-1 (TSSOP14) package: P<sub>tot</sub> derates linearly with 7.3 mW/K above 81 °C.

For SOT762-1 (DHVQFN14) package: P<sub>tot</sub> 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			74HCT14			Unit
			Min	Typ	Max	Min	Typ	Max	
V <sub>CC</sub>	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V <sub>I</sub>	input voltage		0	-	V <sub>CC</sub>	0	-	V <sub>CC</sub>	V
V <sub>O</sub>	output voltage		0	-	V <sub>CC</sub>	0	-	V <sub>CC</sub>	V
T <sub>amb</sub>	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 <sub>amb</sub> = 25 °C			T <sub>amb</sub> = -40 °C to +85 °C		T <sub>amb</sub> = -40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
<b>74HC14</b>										
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>T+</sub> or V <sub>T-</sub>								
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
		I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V	5.48	5.81	-	5.34	-	5.2	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>T+</sub> or V <sub>T-</sub>								
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
		I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V	-	0.16	0.26	-	0.33	-	0.4	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V	-	-	±0.1	-	±1.0	-	±1.0	μA
I <sub>CC</sub>	supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V	-	-	2.0	-	20	-	40	μA
C <sub>I</sub>	input capacitance		-	3.5	-	-	-	-	-	pF
<b>74HCT14</b>										
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>T+</sub> or V <sub>T-</sub> ; V <sub>CC</sub> = 4.5 V								
		I <sub>O</sub> = -20 μA	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -4.0 mA	3.98	4.32	-	3.84	-	3.7	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>T+</sub> or V <sub>T-</sub> ; V <sub>CC</sub> = 4.5 V								
		I <sub>O</sub> = 20 μA;	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 4.0 mA;	-	0.15	0.26	-	0.33	-	0.4	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V	-	-	±0.1	-	±1.0	-	±1.0	μA
I <sub>CC</sub>	supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 5.5 V	-	-	2.0	-	20	-	40	μA
ΔI <sub>CC</sub>	additional supply current	per input pin; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V; other pins at V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 4.5 V to 5.5 V	-	30	108	-	135	-	147	μA
C <sub>I</sub>	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 [Fig. 7](#).

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

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

$f_i$  = input frequency in MHz;

$f_o$  = output frequency in MHz;

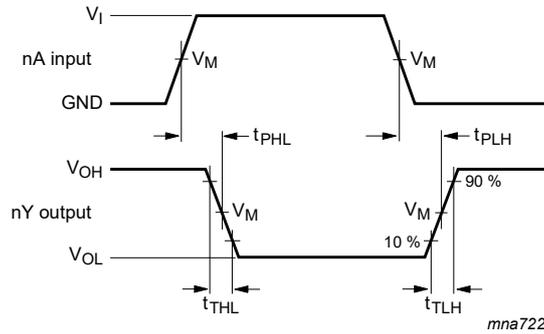
$C_L$  = output load capacitance in pF;

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

$N$  = number of inputs switching;

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

11.1. Waveforms and test circuit



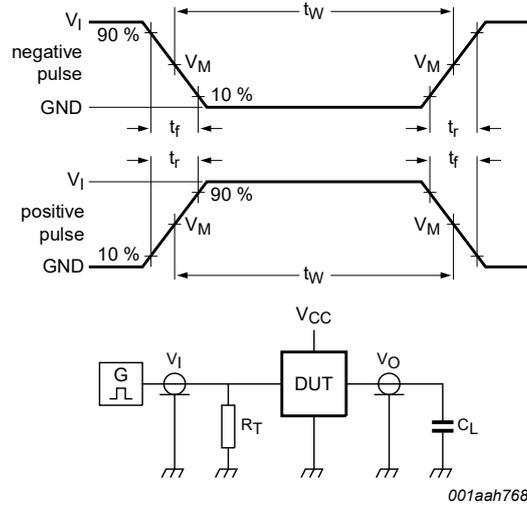
Measurement points are given in [Table 8](#).

$V_{OL}$  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

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	$t_{PLH}, t_{PHL}$

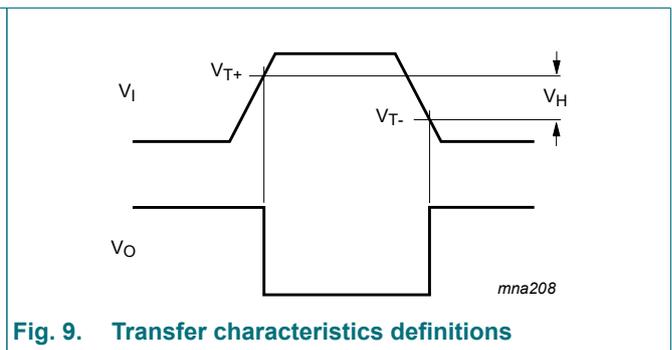
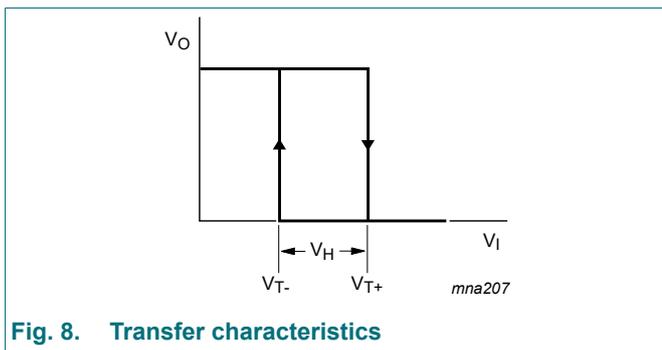
## 12. Transfer characteristics

**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	T <sub>amb</sub> = 25 °C			T <sub>amb</sub> = -40 °C to +85 °C		T <sub>amb</sub> = -40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
<b>74HC14</b>										
V <sub>T+</sub>	positive-going threshold voltage	V <sub>CC</sub> = 2.0 V	0.7	1.18	1.5	0.7	1.5	0.7	1.5	V
		V <sub>CC</sub> = 4.5 V	1.7	2.38	3.15	1.7	3.15	1.7	3.15	V
		V <sub>CC</sub> = 6.0 V	2.1	3.14	4.2	2.1	4.2	2.1	4.2	V
V <sub>T-</sub>	negative-going threshold voltage	V <sub>CC</sub> = 2.0 V	0.3	0.52	0.9	0.3	0.9	0.3	0.9	V
		V <sub>CC</sub> = 4.5 V	0.9	1.4	2.0	0.9	2.0	0.9	2.0	V
		V <sub>CC</sub> = 6.0 V	1.2	1.89	2.6	1.2	2.6	1.2	2.6	V
V <sub>H</sub>	hysteresis voltage	V <sub>CC</sub> = 2.0 V	0.2	0.66	1.0	0.2	1.0	0.2	1.0	V
		V <sub>CC</sub> = 4.5 V	0.4	0.98	1.4	0.4	1.4	0.4	1.4	V
		V <sub>CC</sub> = 6.0 V	0.6	1.25	1.6	0.6	1.6	0.6	1.6	V
<b>74HCT14</b>										
V <sub>T+</sub>	positive-going threshold voltage	V <sub>CC</sub> = 4.5 V	1.2	1.41	1.9	1.2	1.9	1.2	1.9	V
		V <sub>CC</sub> = 5.5 V	1.4	1.59	2.1	1.4	2.1	1.4	2.1	V
V <sub>T-</sub>	negative-going threshold voltage	V <sub>CC</sub> = 4.5 V	0.5	0.85	1.2	0.5	1.2	0.5	1.2	V
		V <sub>CC</sub> = 5.5 V	0.6	0.99	1.4	0.6	1.4	0.6	1.4	V
V <sub>H</sub>	hysteresis voltage	V <sub>CC</sub> = 4.5 V	0.4	0.56	-	0.4	-	0.4	-	V
		V <sub>CC</sub> = 5.5 V	0.4	0.6	-	0.4	-	0.4	-	V

### 12.1. Transfer characteristics waveforms



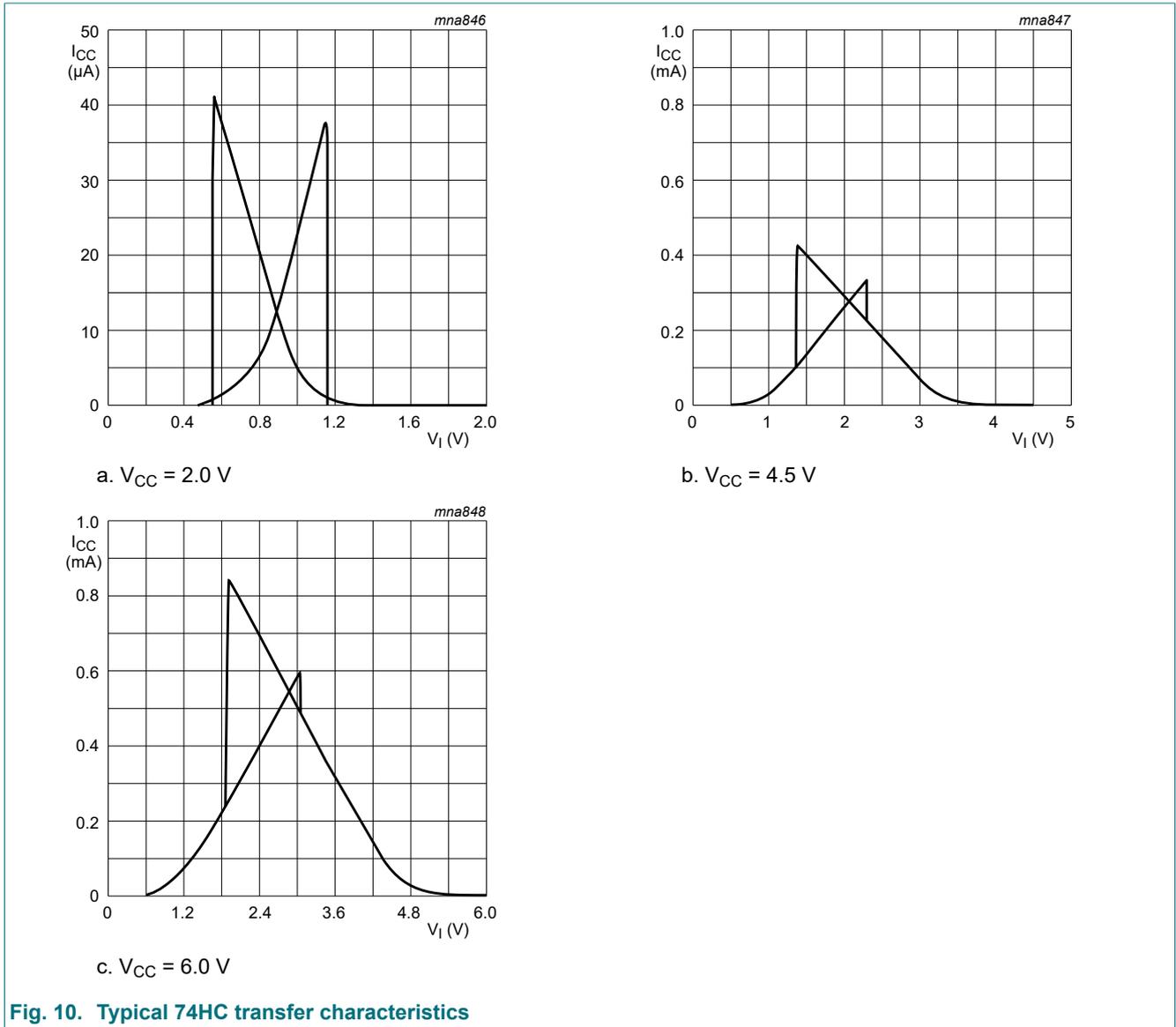


Fig. 10. Typical 74HC transfer characteristics

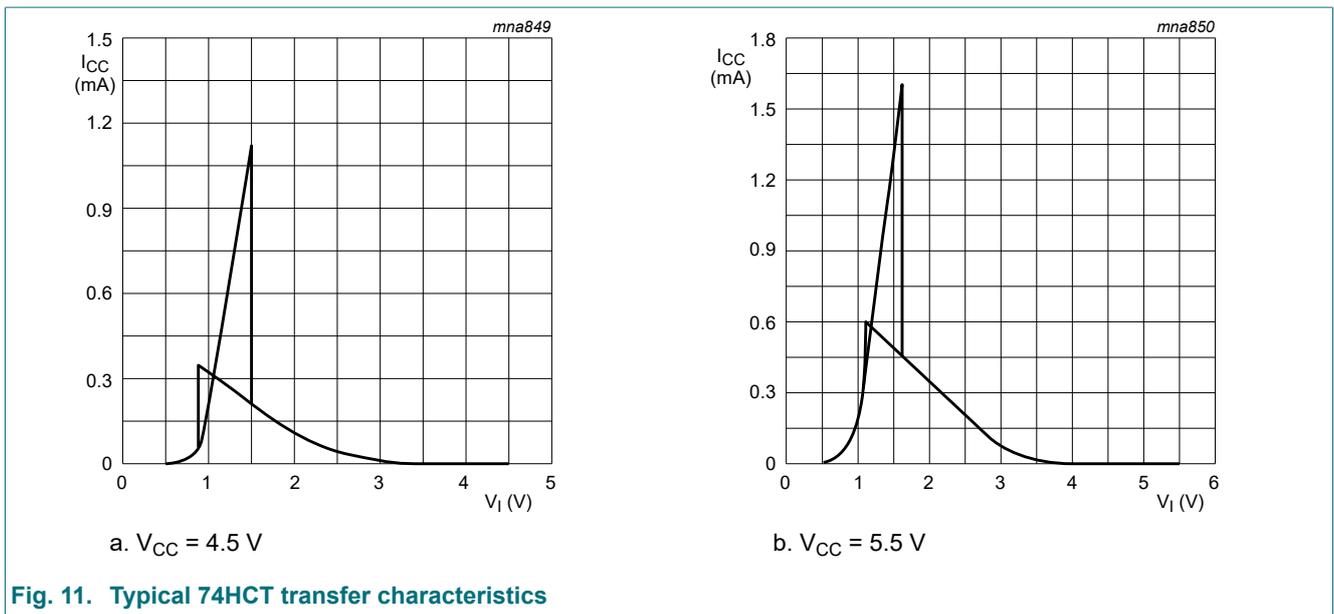


Fig. 11. Typical 74HCT transfer characteristics

### 13. Application information

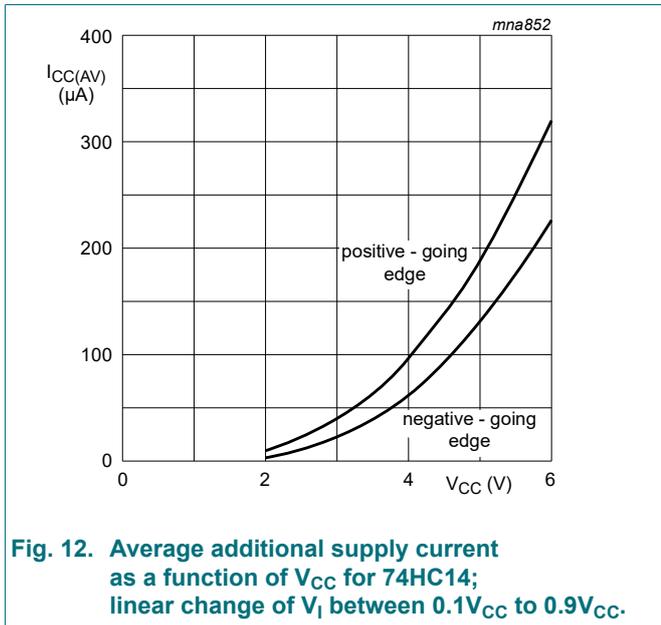
The slow input rise and fall times cause additional power dissipation, this can be calculated using the following formula:

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

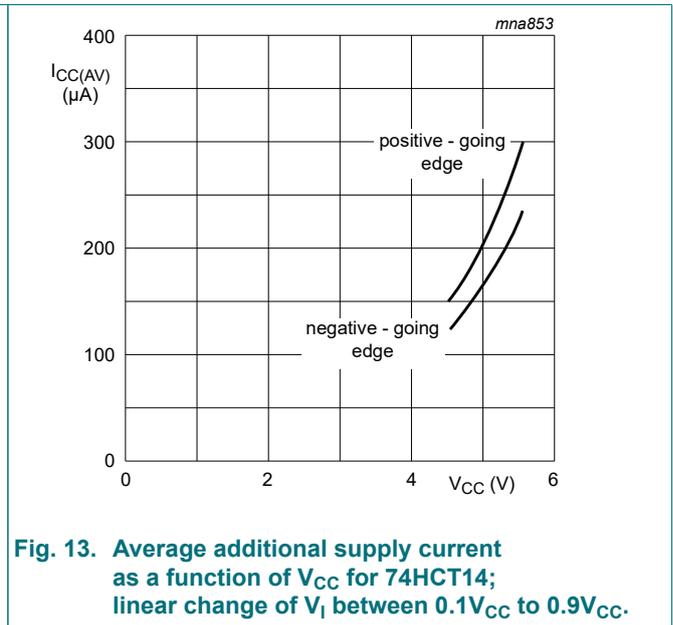
- $P_{add}$  = additional power dissipation ( $\mu\text{W}$ );
- $f_i$  = input frequency (MHz);
- $t_r$  = rise time (ns); 10 % to 90 %;
- $t_f$  = fall time (ns); 90 % to 10 %;
- $\Delta I_{CC(AV)}$  = average additional supply current ( $\mu\text{A}$ ).

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

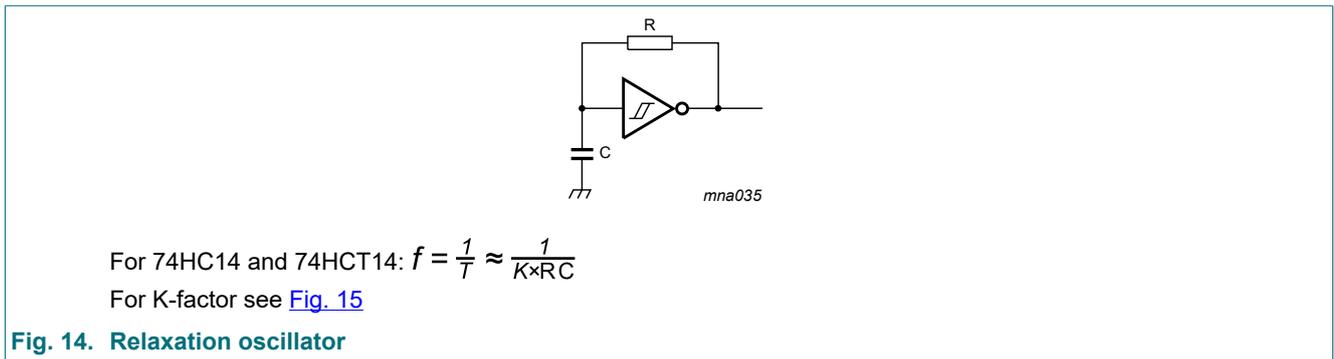
An example of a relaxation circuit using the 74HC14; 74HCT14 is shown in Fig. 14.



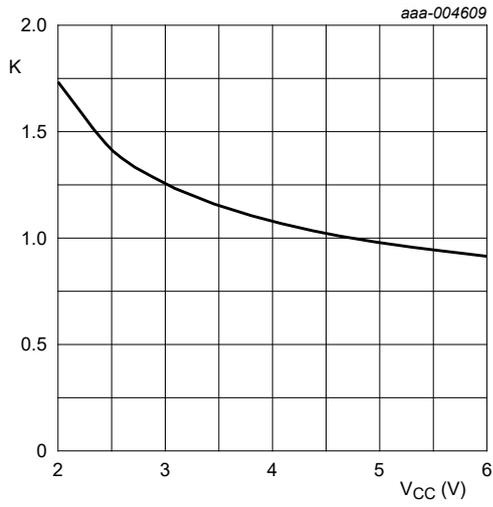
**Fig. 12. Average additional supply current as a function of  $V_{CC}$  for 74HC14; linear change of  $V_I$  between  $0.1V_{CC}$  to  $0.9V_{CC}$ .**



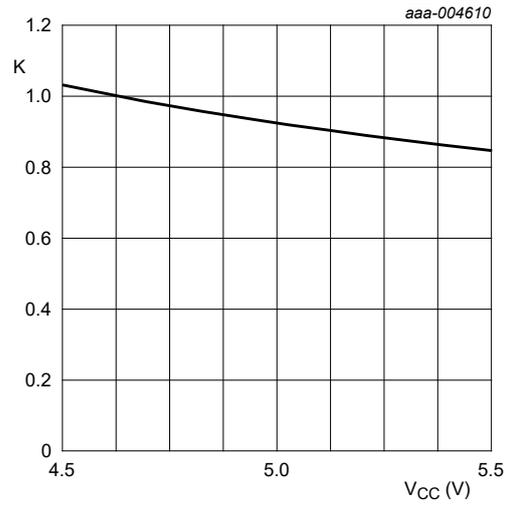
**Fig. 13. Average additional supply current as a function of  $V_{CC}$  for 74HCT14; linear change of  $V_I$  between  $0.1V_{CC}$  to  $0.9V_{CC}$ .**



**Fig. 14. Relaxation oscillator**



K-factor for 74HC14



K-factor for 74HCT14

Fig. 15. Typical K-factor for relaxation oscillator

14. Package outline

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

SOT108-1

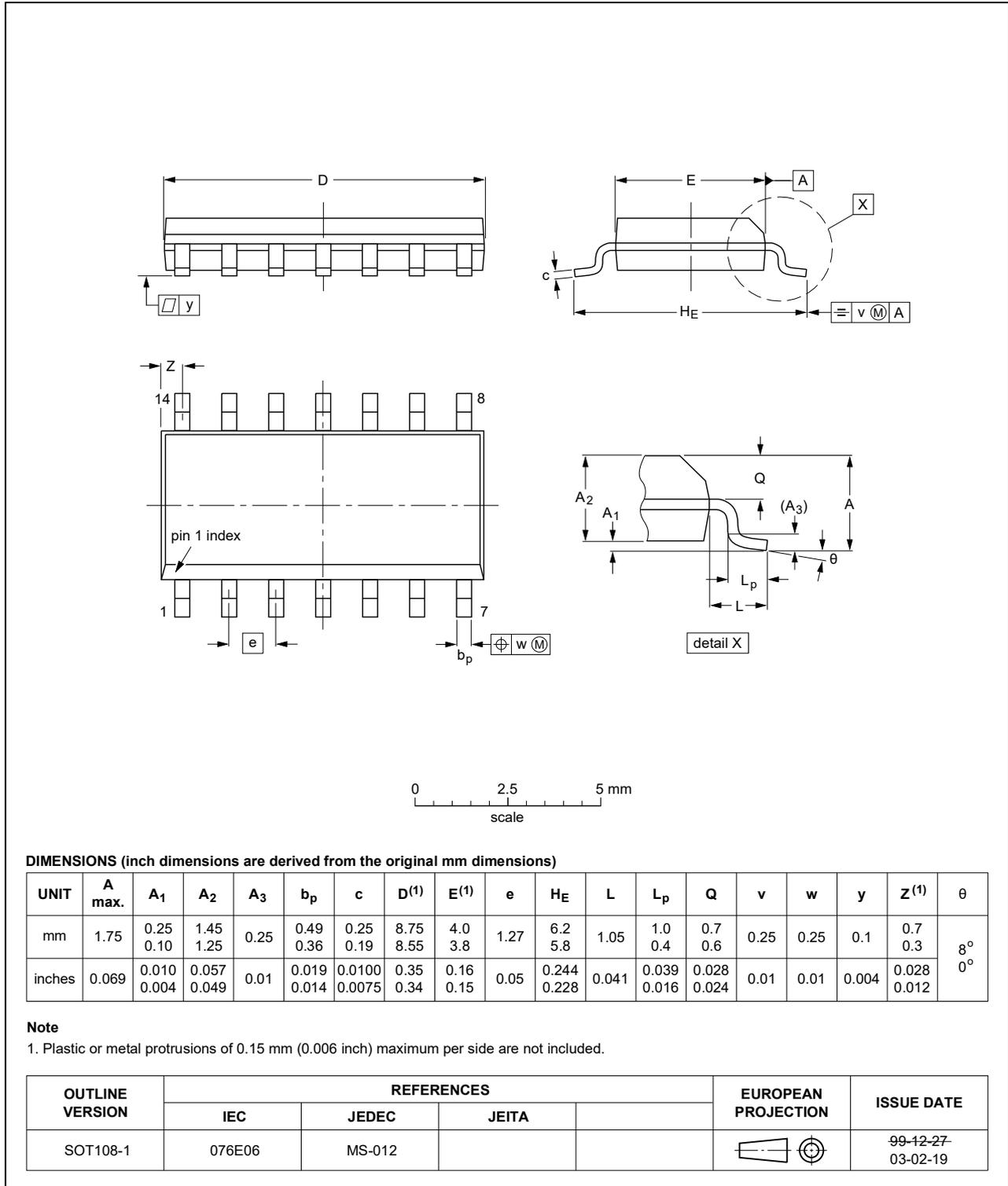


Fig. 16. Package outline SOT108-1 (SO14)

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

SOT402-1

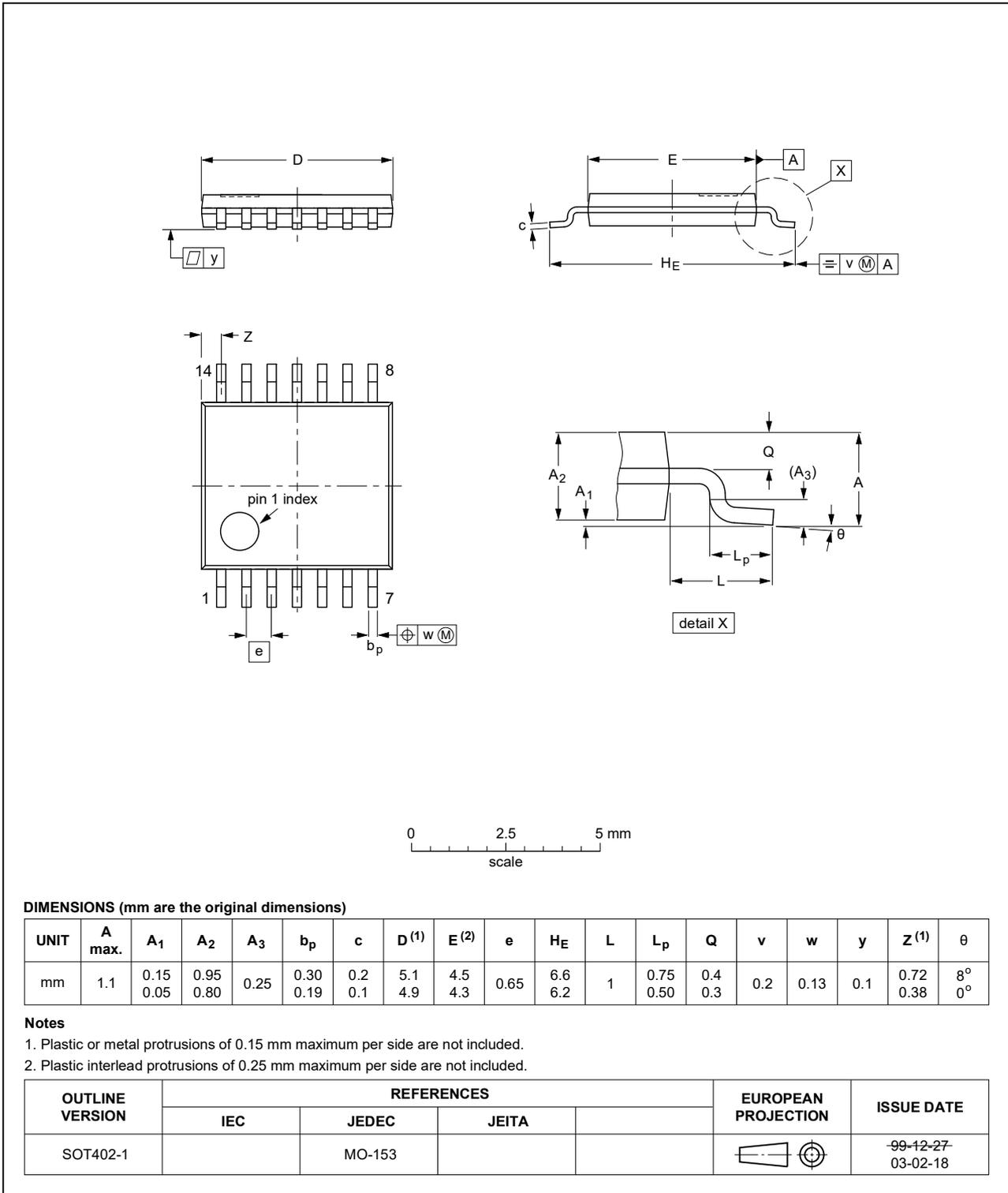


Fig. 17. Package outline SOT402-1 (TSSOP14)

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

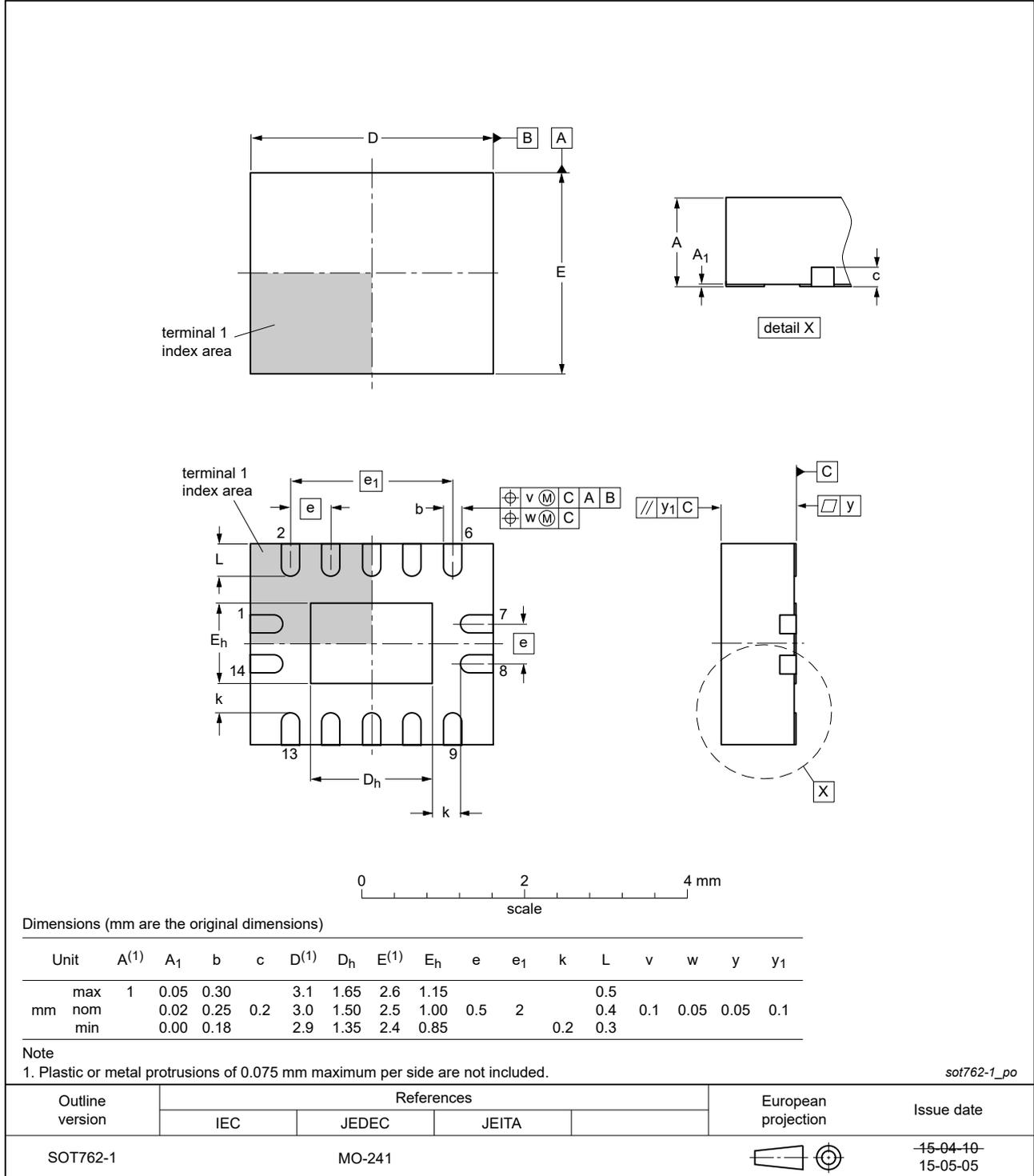


Fig. 18. Package outline SOT762-1 (DHVQFN14)

## 15. Abbreviations

Table 11. Abbreviations

Acronym	Description
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	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:	<ul style="list-style-type: none"> <li><a href="#">Section 2</a> updated.</li> <li>Type numbers 74HC14DB and 74HCT14DB (SOT337-1/SSOP14) removed.</li> </ul>			
74HC_HCT14 v.8	20200522	Product data sheet	-	74HC_HCT14 v.7
Modifications:	<ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> <li><a href="#">Table 4</a>: Derating values for <math>P_{tot}</math> total power dissipation updated.</li> </ul>			
74HC_HCT14 v.7	20151119	Product data sheet	-	74HC_HCT14 v.6
Modifications:	<ul style="list-style-type: none"> <li>Type numbers 74HC14N and 74HCT14N (SOT27-1) removed.</li> </ul>			
74HC_HCT14 v.6	20120919	Product data sheet	-	74HC_HCT14 v.5
Modifications:	<ul style="list-style-type: none"> <li><a href="#">Fig. 15</a> added (typical K-factor for relaxation oscillator).</li> </ul>			
74HC_HCT14 v.5	20111219	Product data sheet	-	74HC_HCT14 v.4
Modifications:	<ul style="list-style-type: none"> <li>Legal pages updated.</li> </ul>			
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.

- [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 <https://www.nexperia.com>.

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Date of release: 13 August 2021