

# 74HC14; 74HCT14

Hex inverting Schmitt trigger

Rev. 4 — 17 January 2011

Product data sheet

## 1. General description

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The 74HC14; 74HCT14 is a high-speed Si-gate CMOS device and is pin compatible with Low-power Schottky TTL (LSTTL). It is specified in compliance with JEDEC standard No. 7A.

The 74HC14; 74HCT14 provides six inverting buffers with Schmitt-trigger action. They are capable of transforming slowly changing input signals into sharply defined, jitter-free output signals.

## 2. Features and benefits

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- Low-power dissipation
- ESD protection:
  - ◆ HBM EIA/JESD22-A114F exceeds 2000 V
  - ◆ MM EIA/JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

## 3. Applications

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- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators



## 4. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC14N 74HCT14N	-40 °C to +125 °C	DIP14	plastic dual in-line package; 14 leads (300 mil)	SOT27-1
74HC14D 74HCT14D	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74HC14DB 74HCT14DB	-40 °C to +125 °C	SSOP14	plastic shrink small outline package; 14 leads; body width 5.3 mm	SOT337-1
74HC14PW 74HCT14PW	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74HC14BQ 74HCT14BQ	-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

## 5. Functional diagram

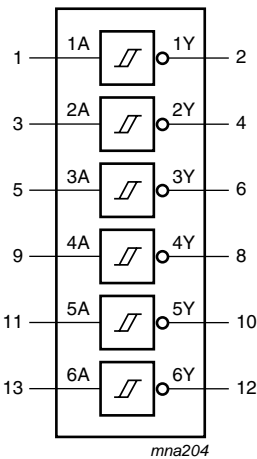


Fig 1. Logic symbol

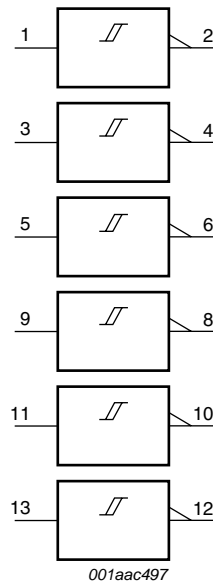


Fig 2. IEC logic symbol

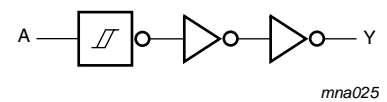


Fig 3. Logic diagram (one Schmitt-trigger)

## 6. Pinning information

### 6.1 Pinning

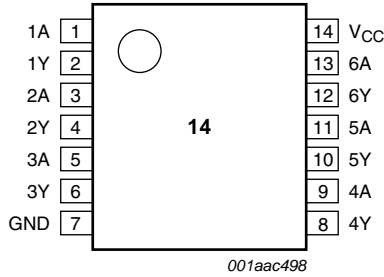
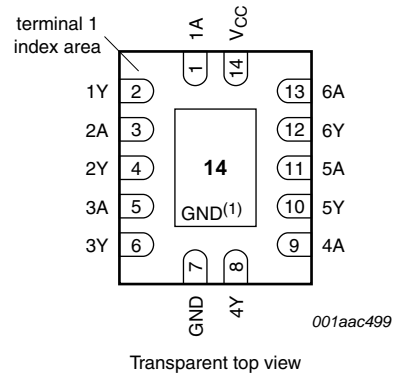


Fig 4. Pin configuration DIP14, SO14 and (T)SSOP14



- (1) The die substrate is attached to this pad using conductive die attach material. It can not be used as a supply pin or input.

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 <sub>CC</sub>	14	supply voltage

## 7. Functional description

Table 3. Function table<sup>[1]</sup>

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 <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]		
	DIP14 package		-	750	mW
	SO14, (T)SSOP14 and DHVQFN14 packages		-	500	mW

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

[2] For DIP14 package: P<sub>tot</sub> derates linearly with 12 mW/K above 70 °C.  
 For SO14 package: P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C.  
 For (T)SSOP14 packages: P<sub>tot</sub> derates linearly with 5.5 mW/K above 60 °C.  
 For DHVQFN14 packages: P<sub>tot</sub> 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 <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 load circuit see [Figure 7](#).

Symbol	Parameter	Conditions	$T_{amb} = 25\text{ °C}$			$T_{amb} = -40\text{ °C to }+125\text{ °C}$		Unit
			Min	Typ	Max	Max (85 °C)	Max (125 °C)	
<b>74HC14</b>								
$t_{pd}$	propagation delay	nA to nY; see <a href="#">Figure 6</a> <a href="#">[1]</a>						
		$V_{CC} = 2.0\text{ V}$	-	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="#">Figure 6</a> <a href="#">[2]</a>						
		$V_{CC} = 2.0\text{ V}$	-	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; $V_I = GND\text{ to }V_{CC}$ <a href="#">[3]</a>	-	7	-	-	-	pF
<b>74HCT14</b>								
$t_{pd}$	propagation delay	nA to nY; see <a href="#">Figure 6</a> <a href="#">[1]</a>						
		$V_{CC} = 4.5\text{ V}$	-	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="#">Figure 6</a> <a href="#">[2]</a>	-	7	15	19	22	ns
$C_{PD}$	power dissipation capacitance	per package; $V_I = GND\text{ to }V_{CC} - 1.5\text{ V}$ <a href="#">[3]</a>	-	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;

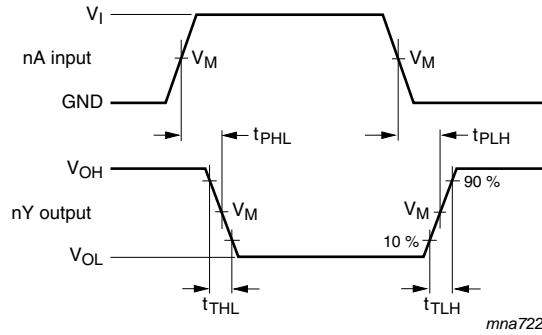
$C_L$  = output load capacitance in pF;

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

$N$  = number of inputs switching;

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

12. Waveforms

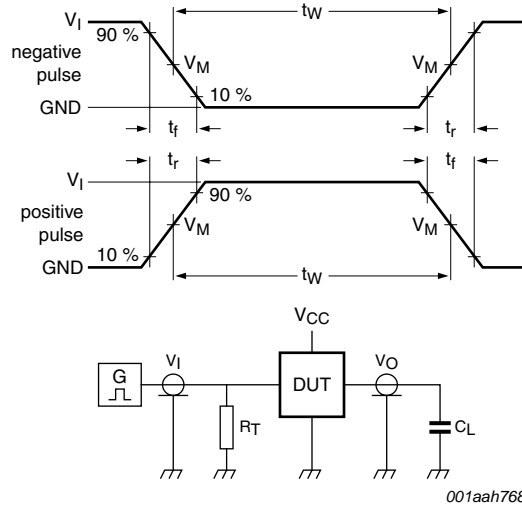


Measurement points are given in [Table 8](#).  
 VOL and VOH are typical voltage output levels that occur with the output load.

Fig 6. Input to output propagation delays

Table 8. Measurement points

Type	Input	Output		
	VM	VM	VX	VY
74HC14	0.5VCC	0.5VCC	0.1VCC	0.9VCC
74HCT14	1.3 V	1.3 V	0.1VCC	0.9VCC



Test data is given in [Table 9](#).  
 Definitions test circuit:  
 RT = termination resistance should be equal to output impedance ZO of the pulse generator.  
 CL = load capacitance including jig and probe capacitance.

Fig 7. Load circuitry 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	
<b>74HC14</b>										
$V_{T+}$	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
<b>74HCT14</b>										
$V_{T+}$	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

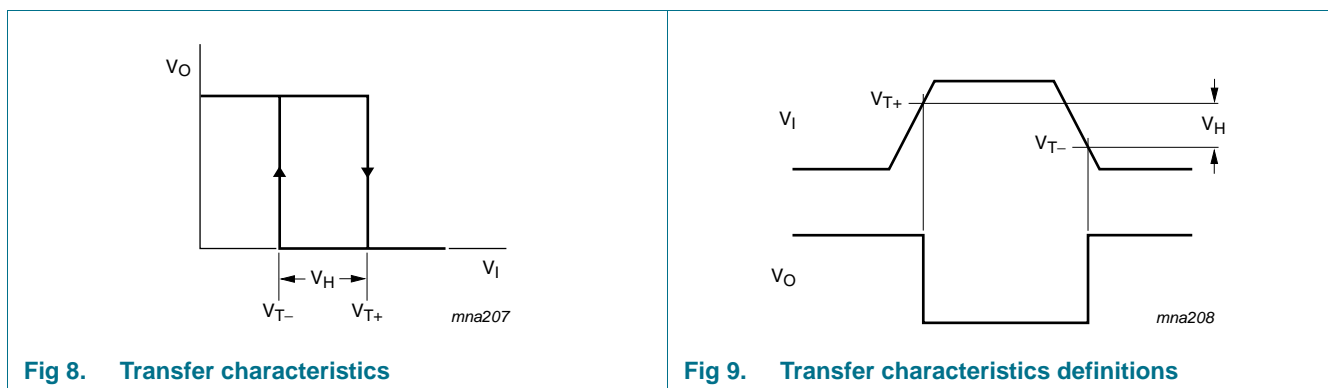
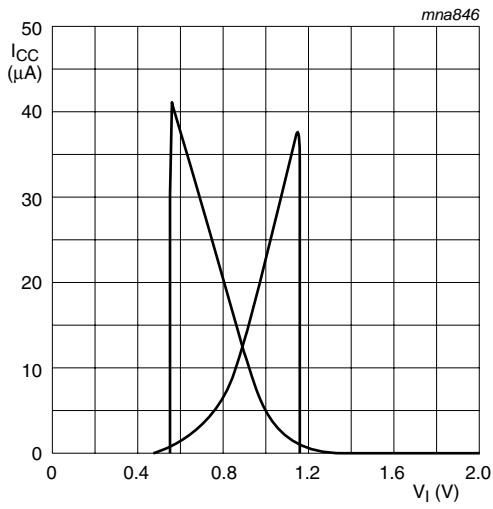


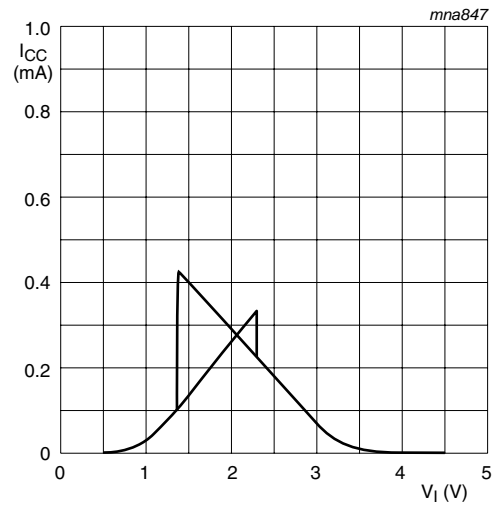
Fig 8. Transfer characteristics

Fig 9. Transfer characteristics definitions

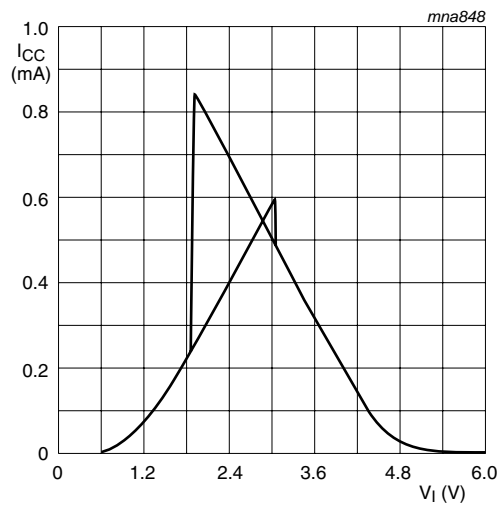




a.  $V_{CC} = 2.0\text{ V}$

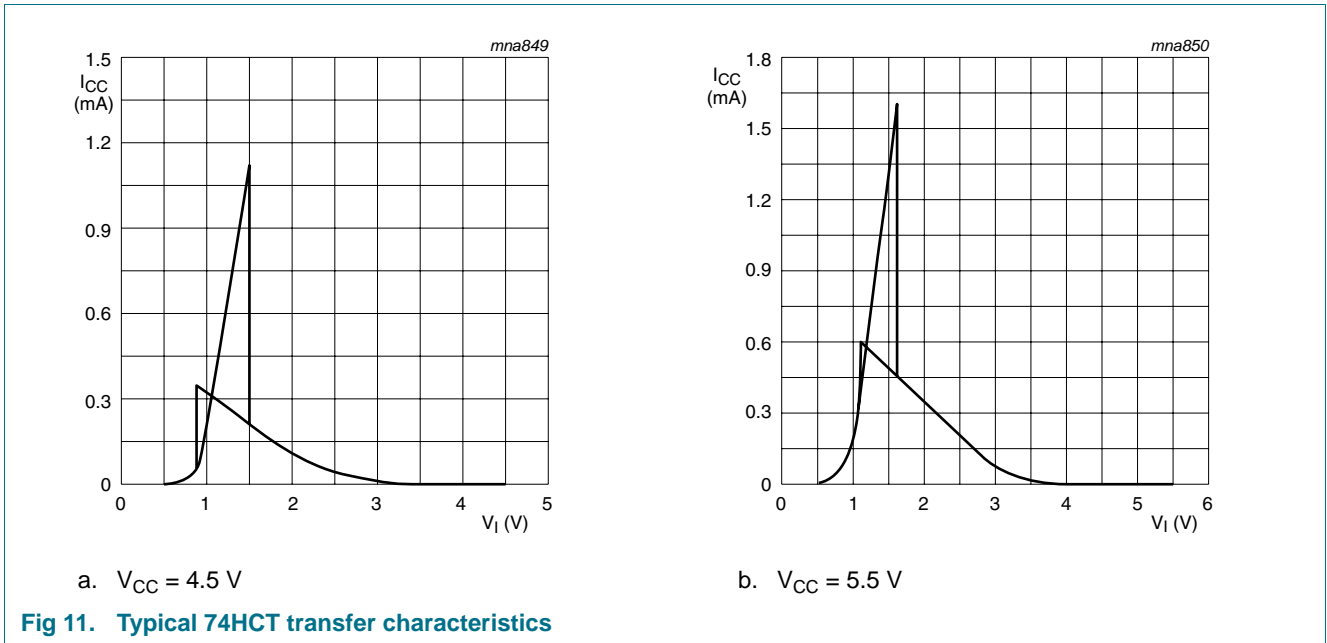


b.  $V_{CC} = 4.5\text{ V}$



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:

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

$P_{add}$  = additional power dissipation ( $\mu$ W);

$f_i$  = input frequency (MHz);

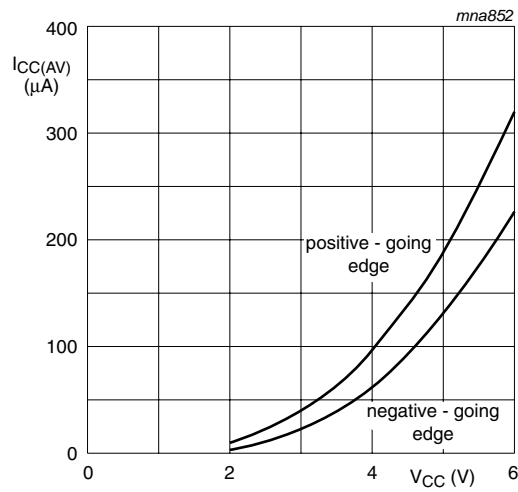
$t_r$  = rise time (ns); 10 % to 90 %;

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

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

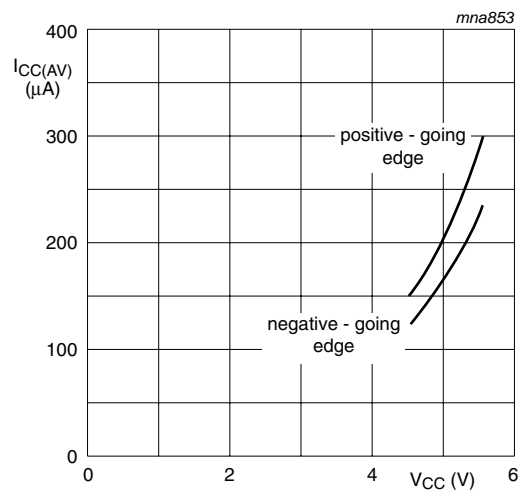
Average  $\Delta I_{CC(AV)}$  differs with positive or negative input transitions, as shown in [Figure 12](#) and [Figure 13](#).

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



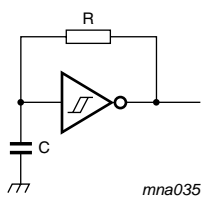
- (1) Positive-going edge.
- (2) Negative-going edge.

**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:  $f = \frac{1}{T} \approx \frac{1}{0.8 \times RC}$

For 74HCT14:  $f = \frac{1}{T} \approx \frac{1}{0.67 \times RC}$

**Fig 14. Relaxation oscillator**

16. Package outline

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

SOT27-1

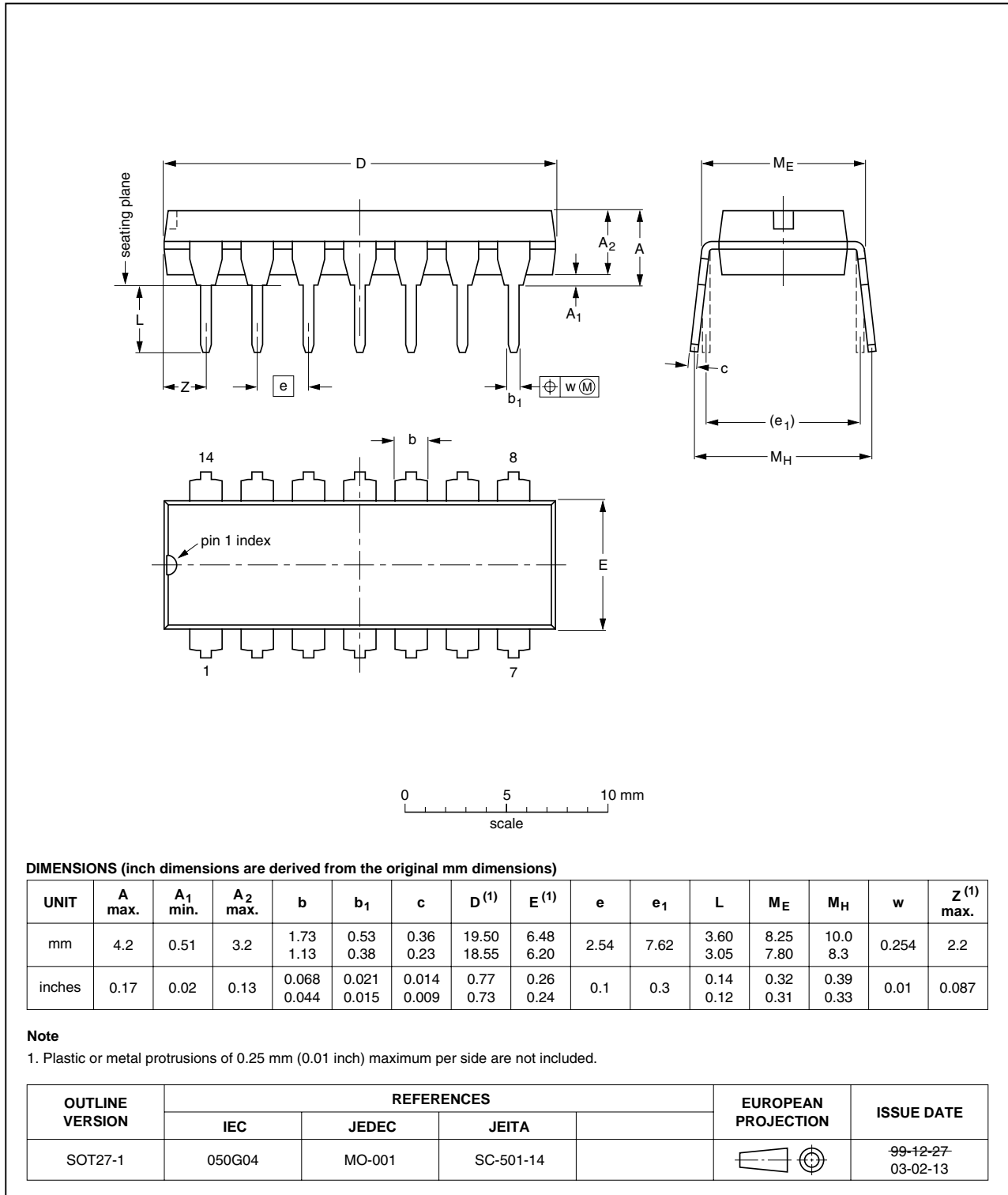


Fig 15. Package outline SOT27-1 (DIP14)

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

SOT108-1

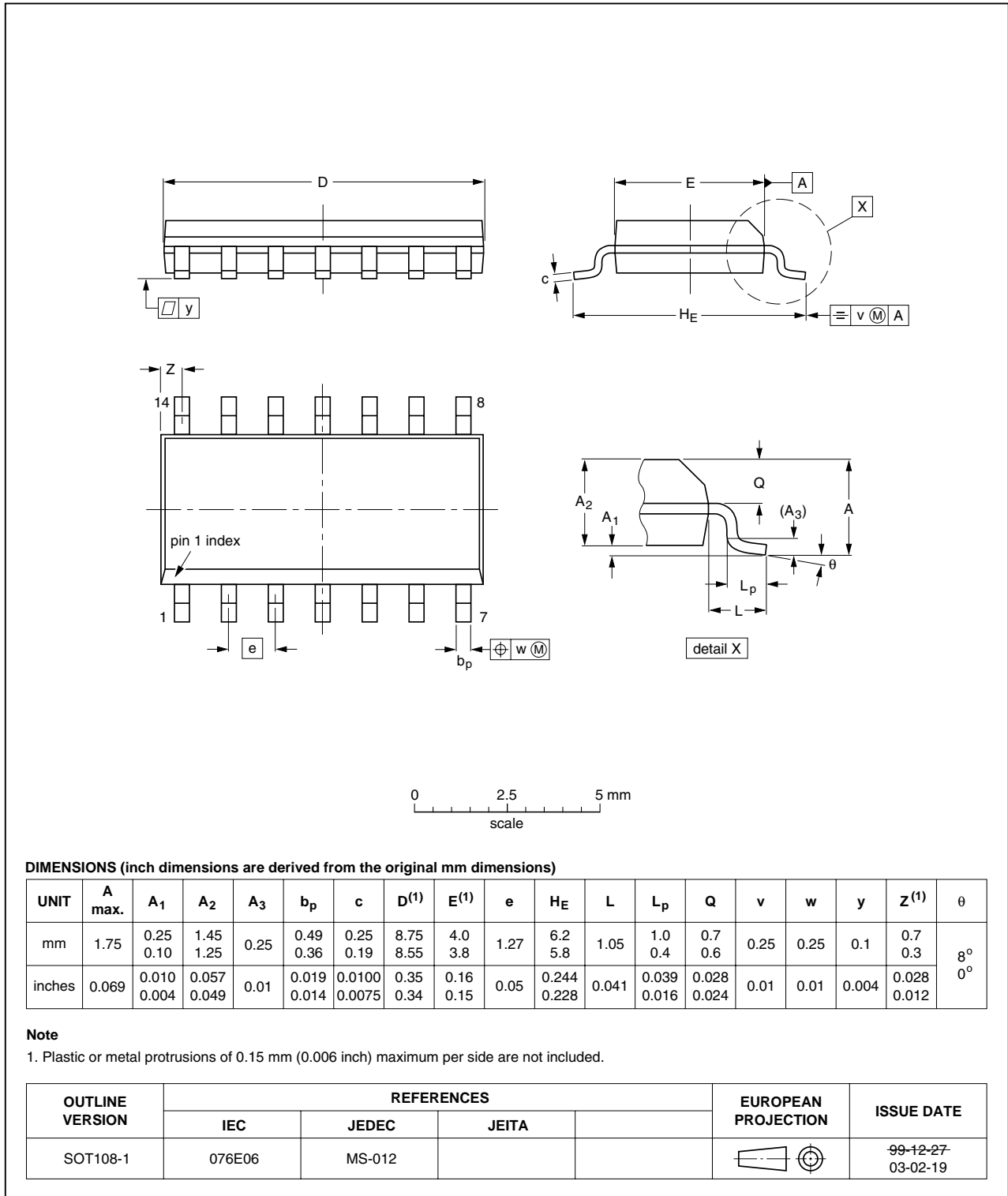


Fig 16. Package outline SOT108-1 (SO14)

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

SOT337-1

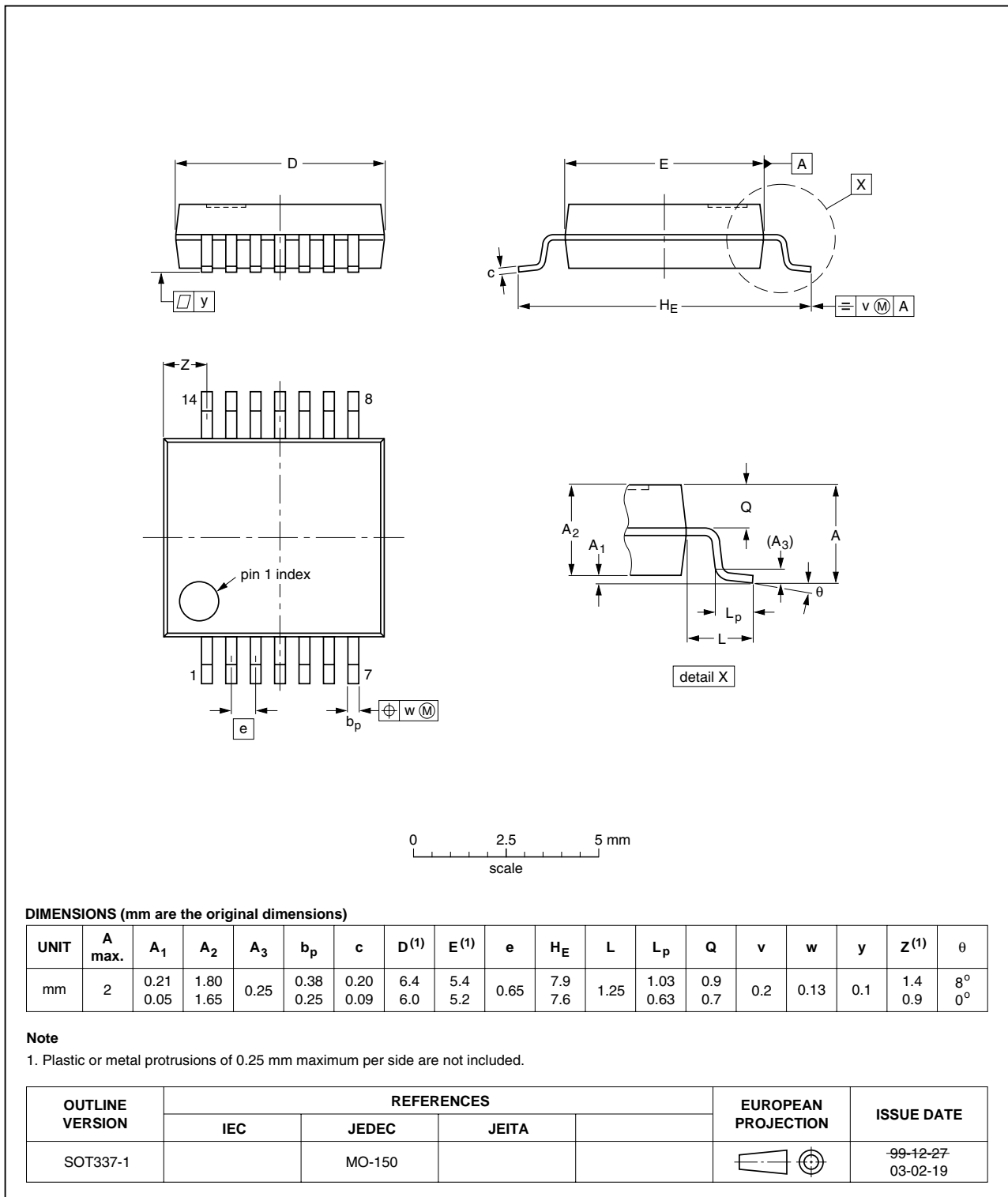


Fig 17. Package outline SOT337-1 (SSOP14)

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

SOT402-1

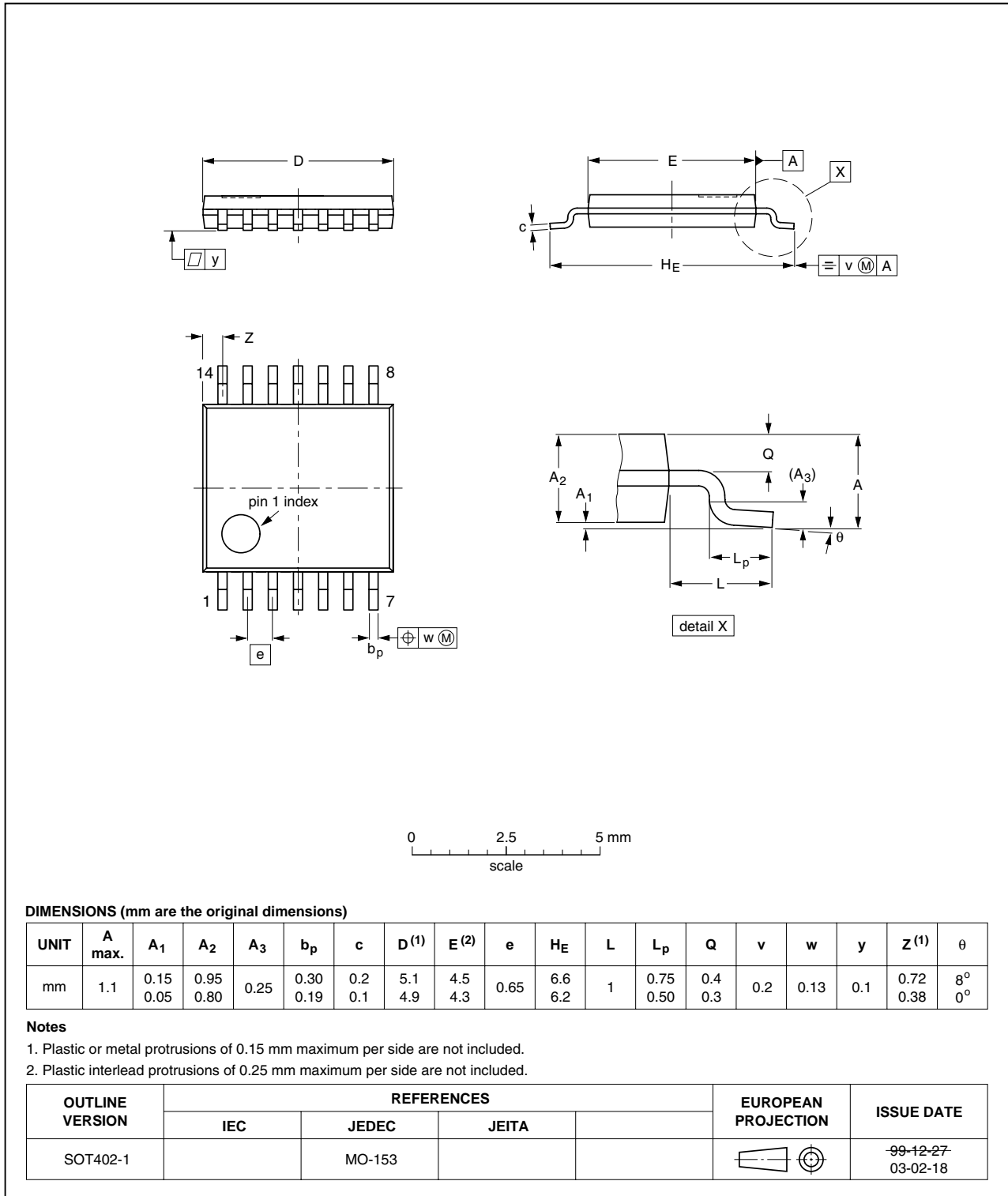


Fig 18. Package outline SOT402-1 (TSSOP14)



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

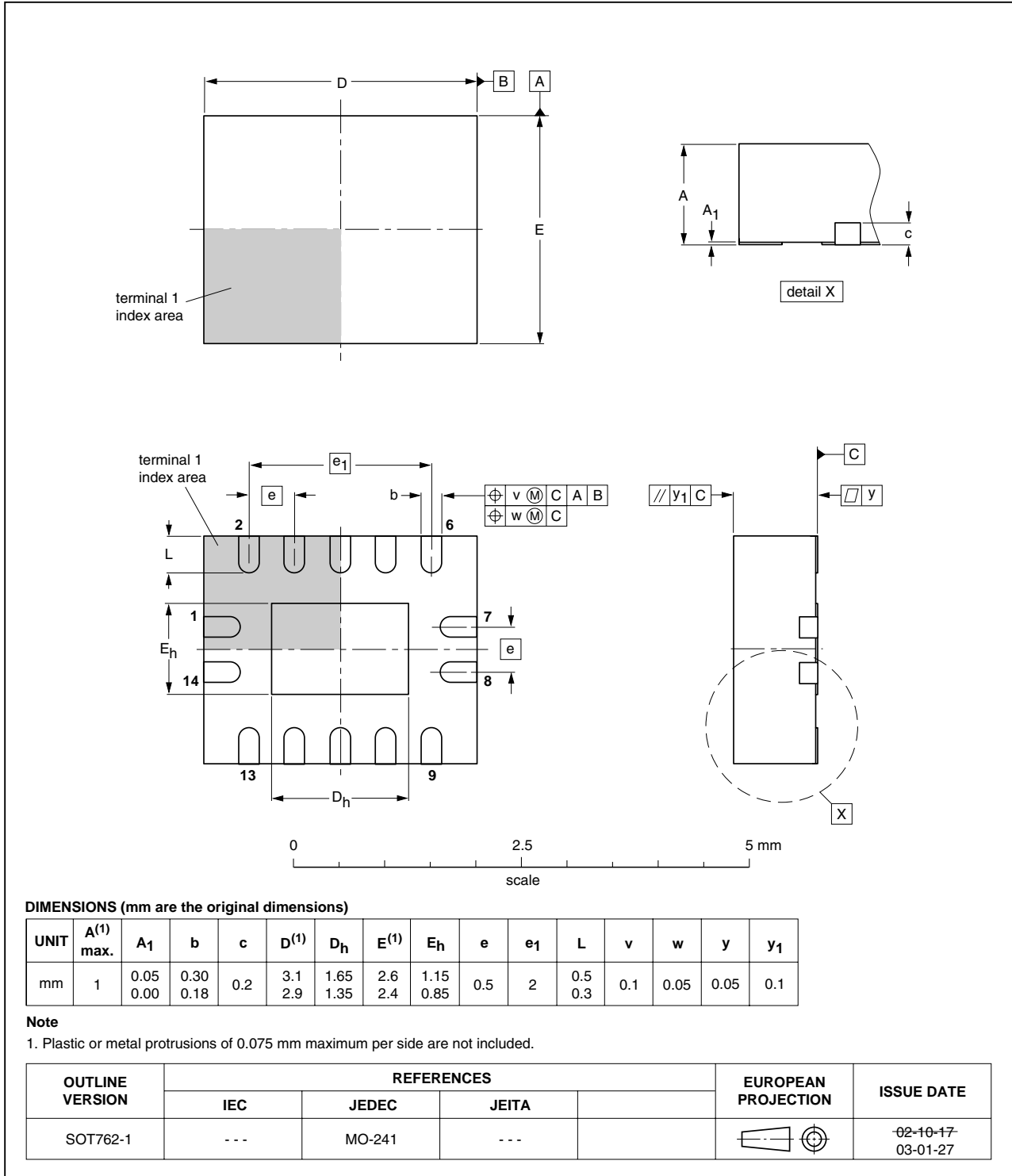


Fig 19. Package outline SOT762-1 (DHVQFN14)

## 17. Abbreviations

Table 11. Abbreviations

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

## 18. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT14 v.4	20110117	Product data sheet	-	74HC_HCT14 v.3
Modifications:	<ul style="list-style-type: none"> <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> <li>• Minimum values propagation delay and transition time moved to maximum value column (errata).</li> </ul>			
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 <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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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