

# 74VHC14; 74VHCT14

Hex inverting Schmitt trigger

Rev. 01 — 17 August 2009

Product data sheet

## 1. General description

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The 74VHC14; 74VHCT14 are a high-speed Si-gate CMOS devices and are pin compatible with Low-power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard No. 7A.

The 74VHC14; 74VHCT14 provide 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

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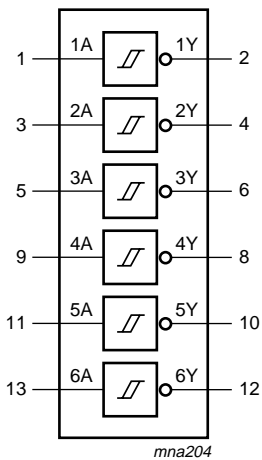
- Balanced propagation delays
- All inputs have Schmitt-trigger action
- Inputs accept voltages higher than  $V_{CC}$
- Input levels:
  - ◆ The 74VHC14 operates with CMOS input level
  - ◆ The 74VHCT14 operates with TTL input level
- ESD protection:
  - ◆ HBM EIA/JESD22-A114E exceeds 2000 V
  - ◆ MM EIA/JESD22-A115-A exceeds 200 V
  - ◆ CDM EIA/JESD22-C101C exceeds 1000 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. Ordering information

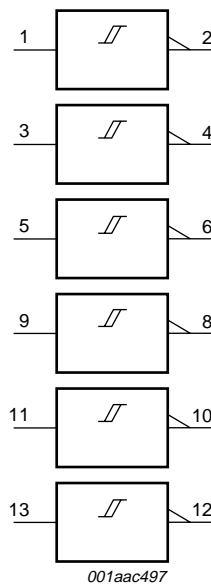
**Table 1. Ordering information**

Type number	Package			Version
	Temperature range	Name	Description	
74VHC14D 74VHCT14D	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74VHC14PW 74VHCT14PW	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74VHC14BQ 74VHCT14BQ	-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

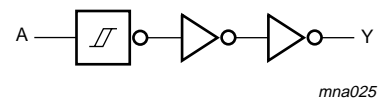
## 4. Functional diagram



**Fig 1. Logic symbol**



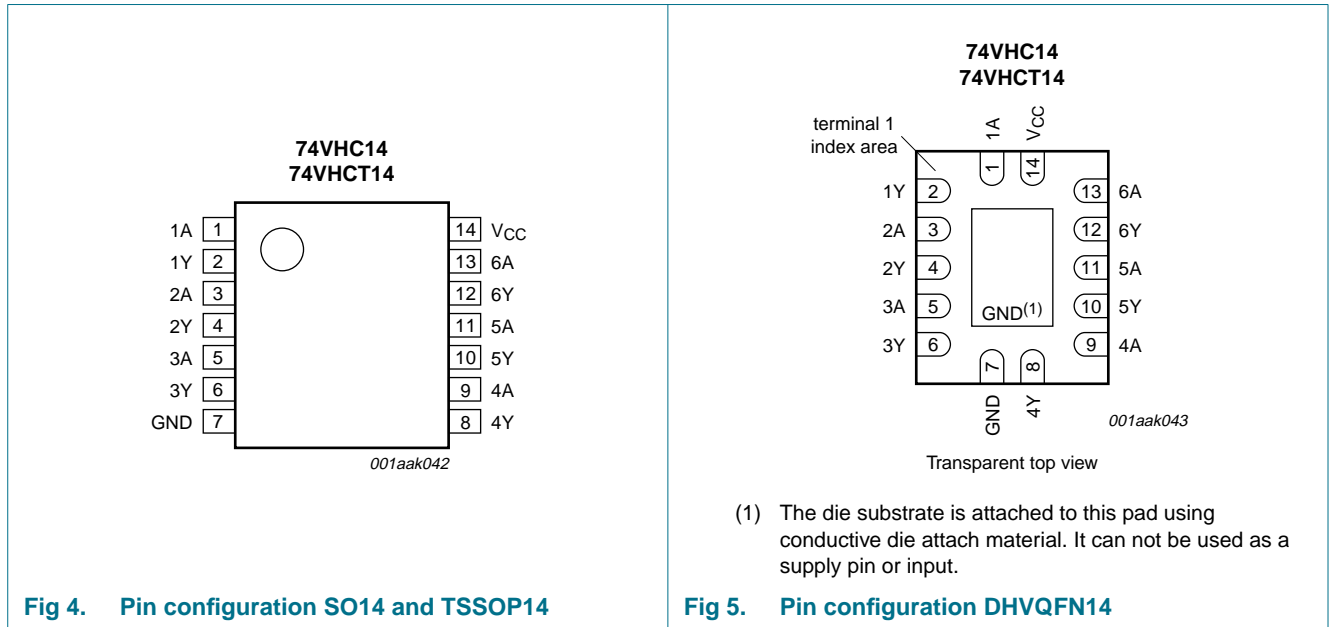
**Fig 2. IEC logic symbol**



**Fig 3. Logic diagram (one Schmitt-trigger)**

## 5. Pinning information

### 5.1 Pinning



### 5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1A	1	data input 1
1Y	2	data output 1
2A	3	data input 2
2Y	4	data output 2
3A	5	data input 3
3Y	6	data output 3
GND	7	ground (0 V)
4Y	8	data output 4
4A	9	data input 4
5Y	10	data output 5
5A	11	data input 5
6Y	12	data output 6
6A	13	data input 6
V <sub>CC</sub>	14	supply voltage

## 6. 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.

## 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	+7.0	V
$V_I$	input voltage		-0.5	+7.0	V
$I_{IK}$	input clamping current	$V_I < -0.5$ V	<sup>[1]</sup> -20	-	mA
$I_{OK}$	output clamping current	$V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V	<sup>[1]</sup> -20	+20	mA
$I_O$	output current	$V_O = -0.5$ V to $(V_{CC} + 0.5)$ V	-25	+25	mA
$I_{CC}$	supply current		-	+75	mA
$I_{GND}$	ground current		-75	-	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40$ °C to +125 °C	<sup>[2]</sup> -	500	mW

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

- [2] For SO14 packages: above 70 °C the value of  $P_{tot}$  derates linearly at 8 mW/K.  
For TSSOP14 packages: above 60 °C the value of  $P_{tot}$  derates linearly at 5.5 mW/K.  
For DHVQFN14 packages: above 60 °C the value of  $P_{tot}$  derates linearly at 4.5 mW/K.

## 8. Recommended operating conditions

Table 5. Operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>74VHC14</b>						
$V_{CC}$	supply voltage		2.0	5.0	5.5	V
$V_I$	input voltage		0	-	5.5	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature		-40	+25	+125	°C
<b>74VHCT14</b>						
$V_{CC}$	supply voltage		4.5	5.0	5.5	V
$V_I$	input voltage		0	-	5.5	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature		-40	+25	+125	°C

## 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	
<b>74VHC14</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> = -50 μA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I <sub>O</sub> = -50 μA; V <sub>CC</sub> = 3.0 V	2.9	3.0	-	2.9	-	2.9	-	V
		I <sub>O</sub> = -50 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 3.0 V	2.58	-	-	2.48	-	2.40	-	V
		I <sub>O</sub> = -8.0 mA; V <sub>CC</sub> = 4.5 V	3.94	-	-	3.80	-	3.70	-	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> = 50 μA; V <sub>CC</sub> = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 50 μA; V <sub>CC</sub> = 3.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 50 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 3.0 V	-	-	0.36	-	0.44	-	0.55	V
		I <sub>O</sub> = 8.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.36	-	0.44	-	0.55	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = 5.5 V or GND; V <sub>CC</sub> = 0 V to 5.5 V	-	-	0.1	-	1.0	-	2.0	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
C <sub>I</sub>	input capacitance		-	3	10	-	10	-	10	pF
C <sub>O</sub>	output capacitance		-	4	-	-	-	-	-	pF
<b>74VHCT14</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> = -50 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -8.0 mA; V <sub>CC</sub> = 4.5 V	3.94	-	-	3.80	-	3.70	-	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> = 50 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 8.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.36	-	0.44	-	0.55	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = 5.5 V or GND; V <sub>CC</sub> = 0 V to 5.5 V	-	-	0.1	-	1.0	-	2.0	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	-	-	1.35	-	1.5	-	1.5	mA
C <sub>I</sub>	input capacitance		-	3	10	-	10	-	10	pF
C <sub>O</sub>	output capacitance		-	4	-	-	-	-	-	pF

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V); for test circuit see [Figure 7](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	Min	Max	
<b>74VHC14</b>										
$t_{pd}$	propagation delay	nA to nY; see <a href="#">Figure 6</a> <a href="#">[2]</a>								
		$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$								
		$C_L = 15 \text{ pF}$	-	4.3	12.8	1.0	15.0	1.0	16.0	ns
		$C_L = 50 \text{ pF}$	-	5.8	16.3	1.0	18.0	1.0	20.5	ns
		$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$								
		$C_L = 15 \text{ pF}$	-	3.2	8.6	1.0	10.0	1.0	11.0	ns
		$C_L = 50 \text{ pF}$	-	4.2	10.6	1.0	12.0	1.0	13.5	ns
$C_{PD}$	power dissipation capacitance	$f_i = 1 \text{ MHz}; V_I = \text{GND to } V_{CC}$ <a href="#">[3]</a>	-	10	-	-	-	-	-	pF
<b>74VHCT14</b>										
$t_{pd}$	propagation delay	nA to nY; see <a href="#">Figure 6</a> <a href="#">[2]</a>								
		$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$								
		$C_L = 15 \text{ pF}$	-	4.0	7.0	1.0	8.0	1.0	9.0	ns
		$C_L = 50 \text{ pF}$	-	5.4	8.0	1.0	9.0	1.0	10.0	ns
$C_{PD}$	power dissipation capacitance	$f_i = 1 \text{ MHz}; V_I = \text{GND to } V_{CC}$ <a href="#">[3]</a>	-	12	-	-	-	-	-	pF

[1] Typical values are measured at nominal supply voltage ( $V_{CC} = 3.3 \text{ V}$  and  $V_{CC} = 5.0 \text{ V}$ ).

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

[3]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ).

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

$f_i$  = input frequency in MHz;

$f_o$  = output frequency in MHz;

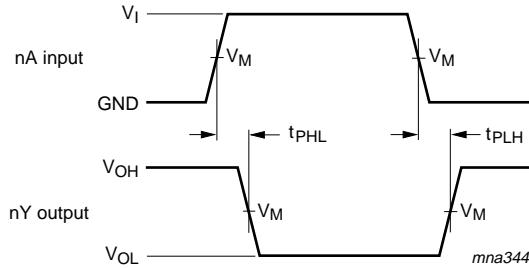
$C_L$  = output load capacitance in pF;

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

$N$  = number of inputs switching;

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

## 11. Waveforms

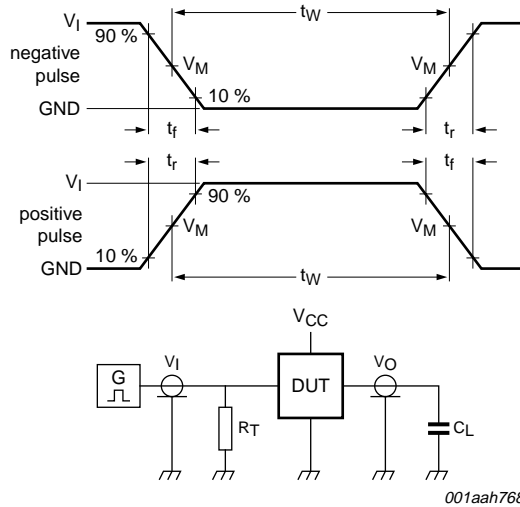


Measurement points are given in [Table 8](#).  
 $V_{OL}$  and  $V_{OH}$  are typical voltage output levels that occur with the output load.

**Fig 6. Input to output propagation delays**

**Table 8. Measurement points**

Type	Input	Output
	$V_M$	$V_M$
74VHC14	$0.5V_{CC}$	$0.5V_{CC}$
74VHCT14	1.5 V	$0.5V_{CC}$



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. Load circuitry for measuring switching times**

Table 9. Test data

Type	Input		Load	Test
	$V_I$	$t_r, t_f$	$C_L$	
74VHC14	$V_{CC}$	$\leq 3.0$ ns	50 pF, 15 pF	$t_{PLH}, t_{PHL}$
74VHCT14	3.0 V	$\leq 3.0$ ns	50 pF, 15 pF	$t_{PLH}, t_{PHL}$

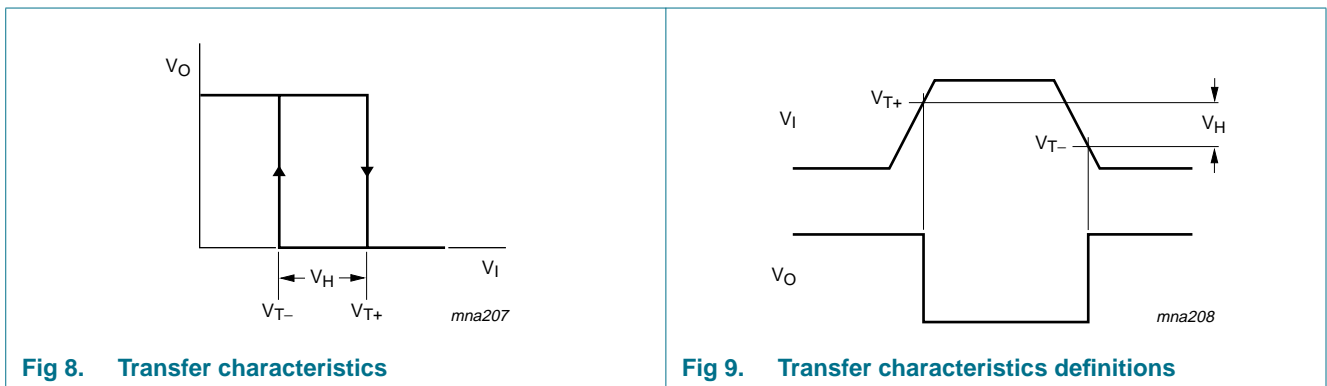
## 12. Transfer characteristics

Table 10. Transfer characteristics

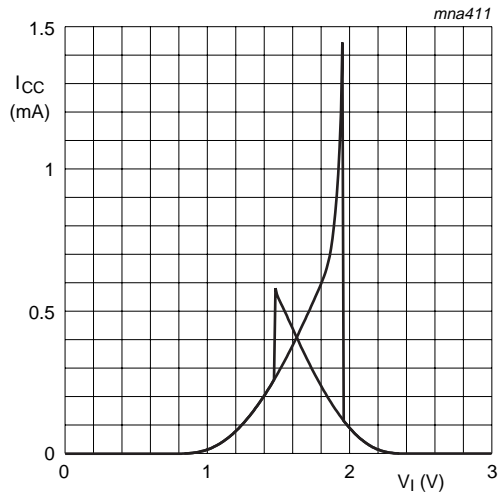
At recommended operating conditions; voltages are referenced to GND (ground = 0 V); see Figure 8 and Figure 9.

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
<b>74VHC14</b>										
$V_{T+}$	positive-going threshold voltage	$V_{CC} = 3.0$ V	-	-	2.2	-	2.2	-	2.2	V
		$V_{CC} = 4.5$ V	-	-	3.15	-	3.15	-	3.15	V
		$V_{CC} = 5.5$ V	-	-	3.85	-	3.85	-	3.85	V
$V_{T-}$	negative-going threshold voltage	$V_{CC} = 3.0$ V	0.9	-	-	0.9	-	0.9	-	V
		$V_{CC} = 4.5$ V	1.35	-	-	1.35	-	1.35	-	V
		$V_{CC} = 5.5$ V	1.65	-	-	1.65	-	1.65	-	V
$V_H$	hysteresis voltage	$V_{CC} = 3.0$ V	0.3	-	1.2	0.3	1.2	0.25	1.2	V
		$V_{CC} = 4.5$ V	0.4	-	1.4	0.4	1.4	0.35	1.4	V
		$V_{CC} = 5.5$ V	0.5	-	1.6	0.5	1.6	0.45	1.6	V
<b>74VHCT14</b>										
$V_{T+}$	positive-going threshold voltage	$V_{CC} = 4.5$ V	-	-	1.9	-	1.9	-	1.9	V
		$V_{CC} = 5.5$ V	-	-	2.1	-	2.1	-	2.1	V
$V_{T-}$	negative-going threshold voltage	$V_{CC} = 4.5$ V	0.5	-	-	0.5	-	0.5	-	V
		$V_{CC} = 5.5$ V	0.6	-	-	0.6	-	0.6	-	V
$V_H$	hysteresis voltage	$V_{CC} = 4.5$ V	0.4	-	1.4	0.4	1.4	0.35	1.4	V
		$V_{CC} = 5.5$ V	0.4	-	1.5	0.4	1.5	0.35	1.5	V

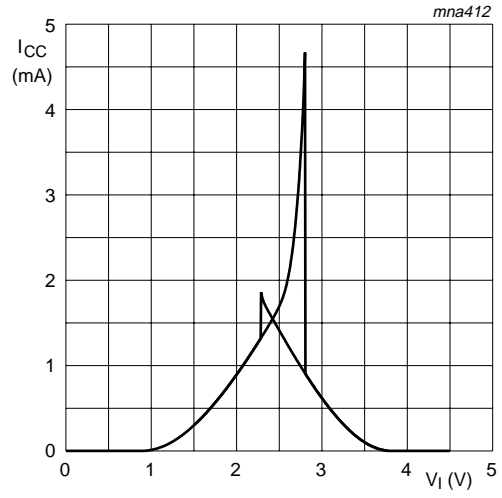
## 13. Transfer characteristics waveforms



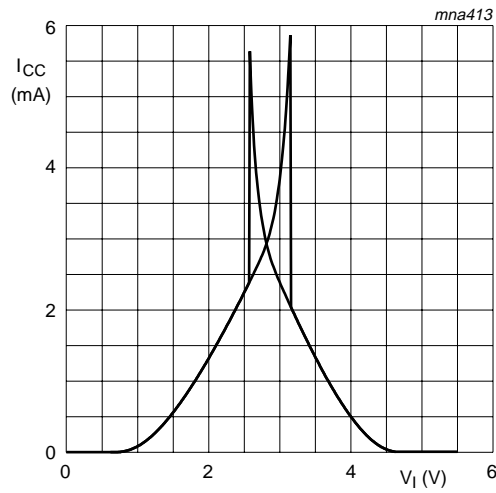




a.  $V_{CC} = 3.0\text{ V}$

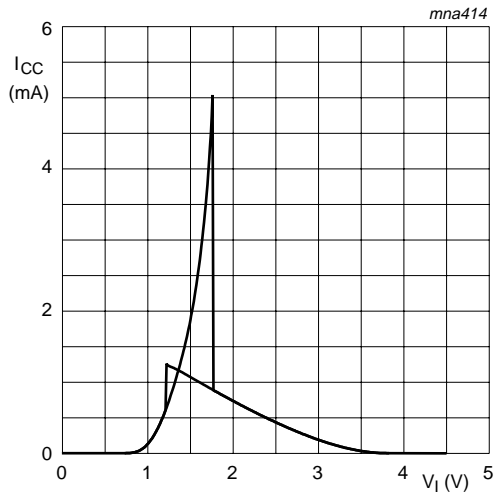


b.  $V_{CC} = 4.5\text{ V}$

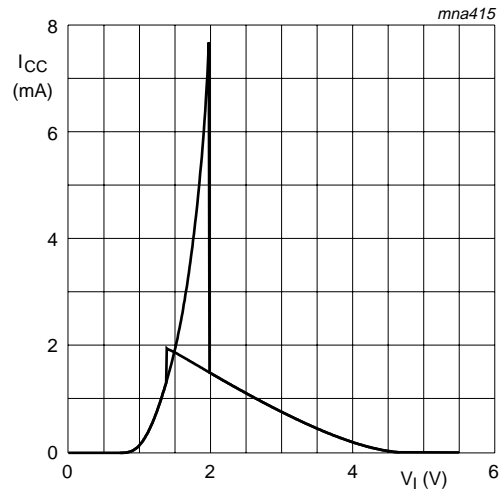


c.  $V_{CC} = 5.5\text{ V}$

**Fig 10. Typical 74VHC transfer characteristics**



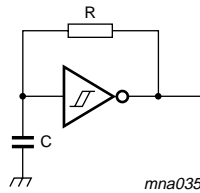
a.  $V_{CC} = 4.5\text{ V}$



b.  $V_{CC} = 5.5\text{ V}$

**Fig 11. Typical 74VHCT transfer characteristics**

## 14. Application information



For 74VHC14:  $f = \frac{1}{T} \approx \frac{1}{0.55 \times RC}$

For 74VHCT14:  $f = \frac{1}{T} \approx \frac{1}{0.60 \times RC}$

**Fig 12. Relaxation oscillator**

15. Package outline

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

SOT108-1

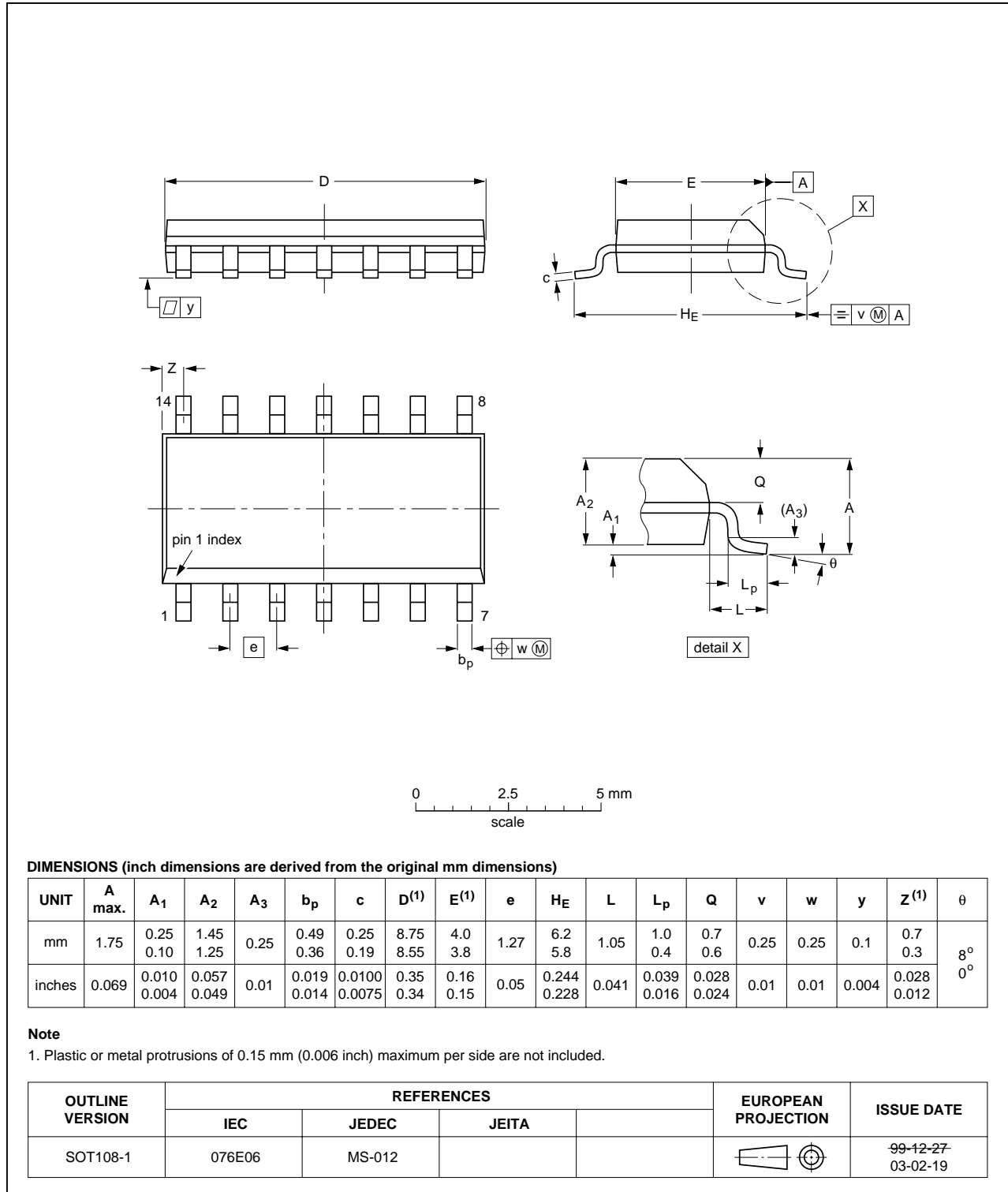


Fig 13. Package outline SOT108-1 (SO14)

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

SOT402-1

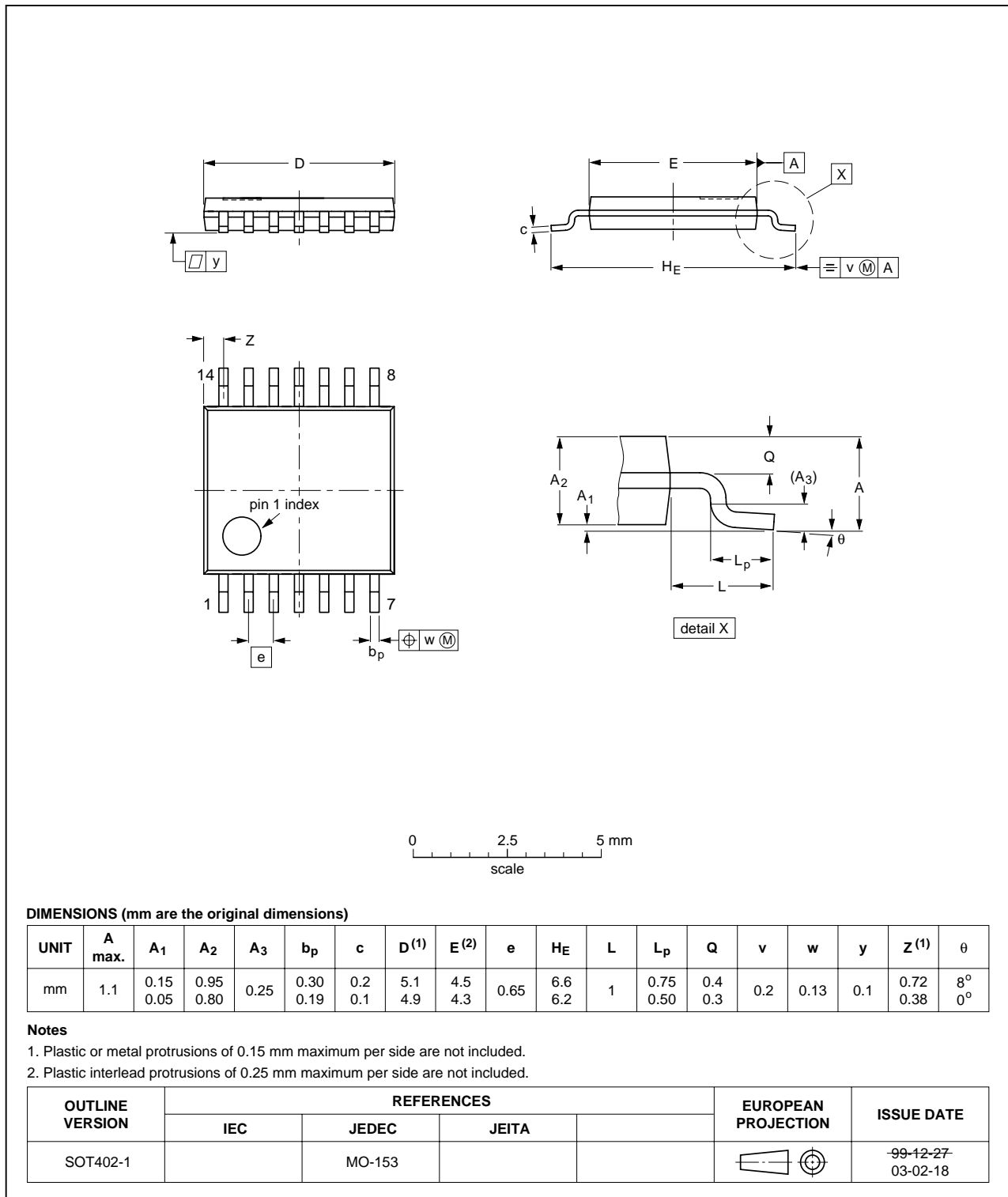


Fig 14. Package outline SOT402-1 (TSSOP14)

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

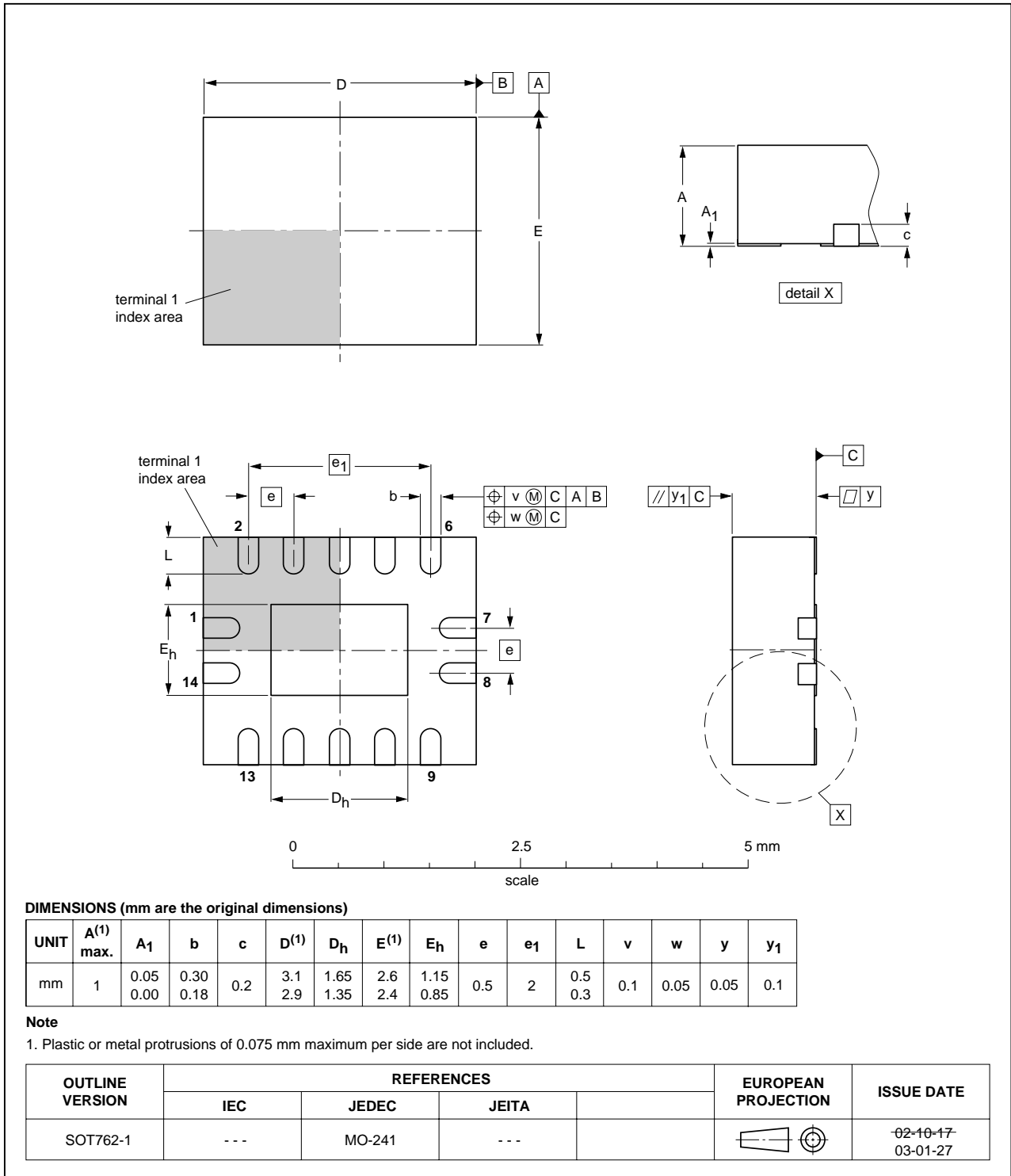


Fig 15. Package outline SOT762-1 (DHVQFN14)

## 16. Abbreviations

Table 11. Abbreviations

Acronym	Description
CDM	Charged Device Model
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

## 17. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74VHC_VHCT14_1	20090817	Product data sheet	-	-

## 18. Legal information

### 18.1 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.nexperia.com>.

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