

# 74HC14-Q100; 74HCT14-Q100

## Hex inverting Schmitt trigger

Rev. 5 — 1 December 2015

Product data sheet

## 1. General description

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The 74HC14-Q100; 74HCT14-Q100 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.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

## 2. Features and benefits

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- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - ◆ Specified from  $-40\text{ °C}$  to  $+85\text{ °C}$  and from  $-40\text{ °C}$  to  $+125\text{ °C}$
- Complies with JEDEC standard no. 7A
- Low-power dissipation
- ESD protection:
  - ◆ MIL-STD-883, method 3015 exceeds 2000 V
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V ( $C = 200\text{ pF}$ ,  $R = 0\ \Omega$ )
- Multiple package options

## 3. Applications

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- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

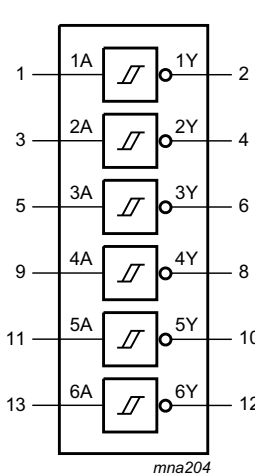


## 4. Ordering information

Table 1. Ordering information

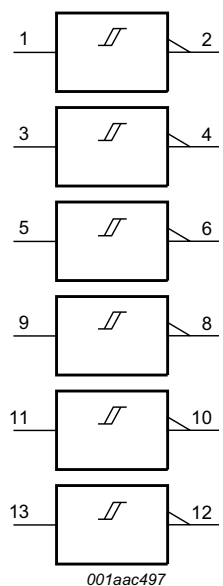
Type number	Package			Version
	Temperature range	Name	Description	
74HC14D-Q100 74HCT14D-Q100	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74HC14PW-Q100 74HCT14PW-Q100				-40 °C to +125 °C
74HC14BQ-Q100 74HCT14BQ-Q100	-40 °C to +125 °C	DHVQFN14	plastic dual 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



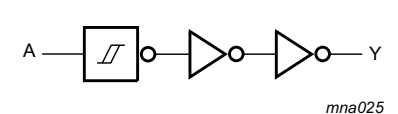
*mna204*

**Fig 1. Logic symbol**



*001aac497*

**Fig 2. IEC logic symbol**

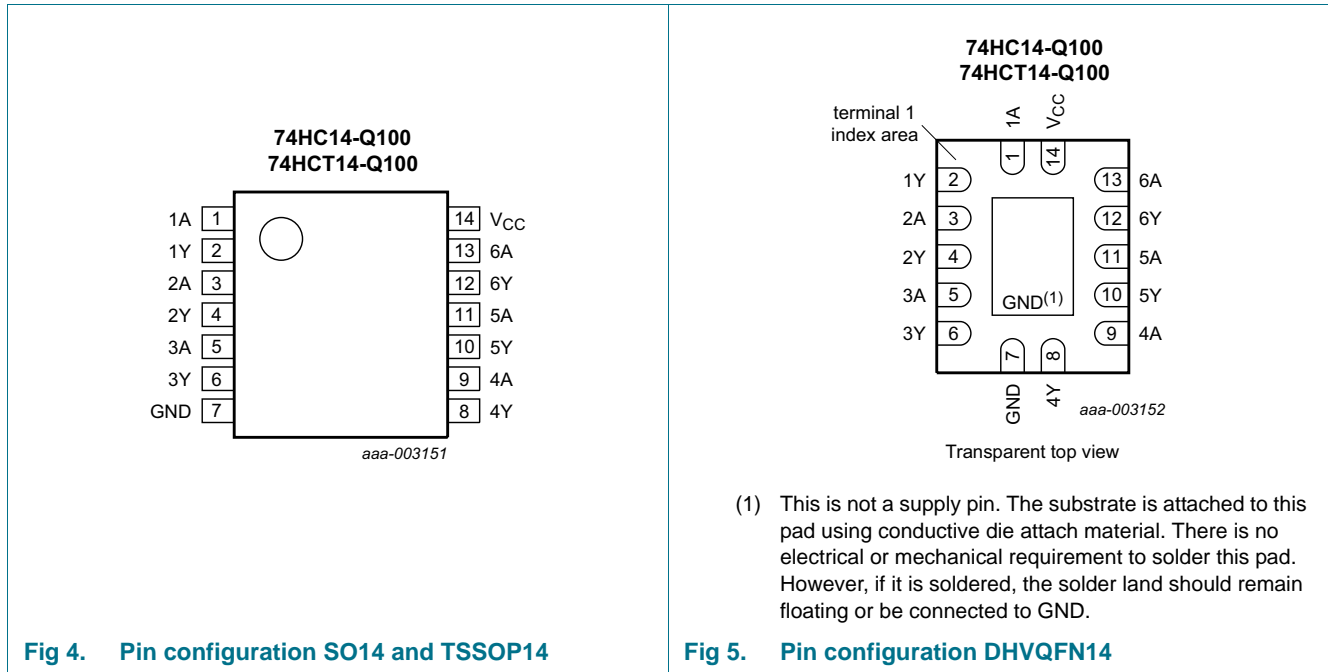


*mna025*

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

## 6. Pinning information

### 6.1 Pinning



### 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
$V_{CC}$	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]	-	$\pm 20$	mA
$I_{OK}$	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ [1]	-	$\pm 20$	mA
$I_O$	output current	$-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$	-	$\pm 25$	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, TSSOP14 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 TSSOP14 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-Q100			74HCT14-Q100			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 <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-Q100</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-Q100</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-Q100</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-Q100</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;

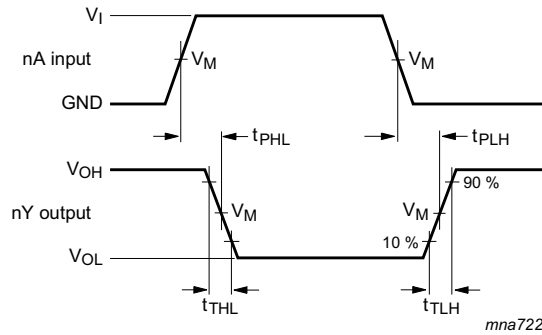
$C_L$  = output load capacitance in pF;

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

$N$  = number of inputs switching;

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

12. Waveforms

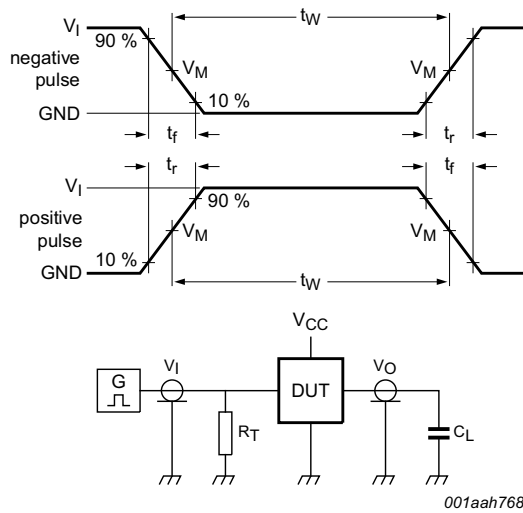


Measurement points are given in [Table 8](#).  
 $V_{OL}$  and  $V_{OH}$  are typical voltage output levels that occur with the output load.

Fig 6. Input to output propagation delays

Table 8. Measurement points

Type	Input	Output		
	$V_M$	$V_M$	$V_X$	$V_Y$
74HC14-Q100	$0.5V_{CC}$	$0.5V_{CC}$	$0.1V_{CC}$	$0.9V_{CC}$
74HCT14-Q100	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-Q100	$V_{CC}$	6.0 ns	15 pF, 50 pF	$t_{PLH}, t_{PHL}$
74HCT14-Q100	3.0 V	6.0 ns	15 pF, 50 pF	$t_{PLH}, t_{PHL}$

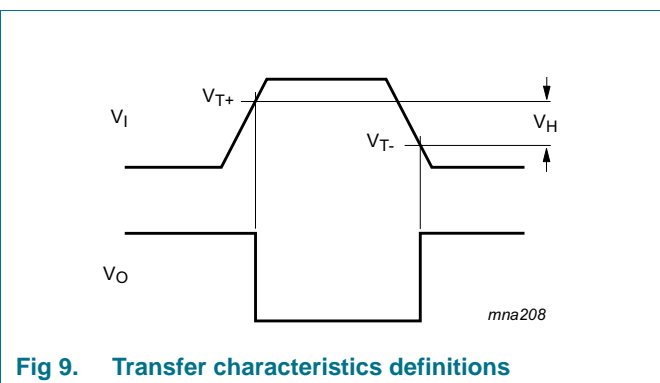
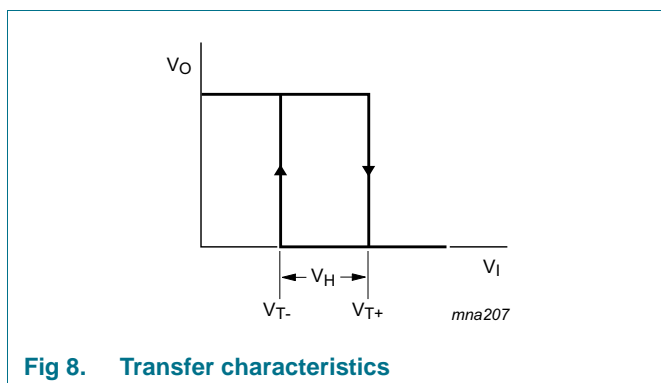
## 13. Transfer characteristics

**Table 10. Transfer characteristics**

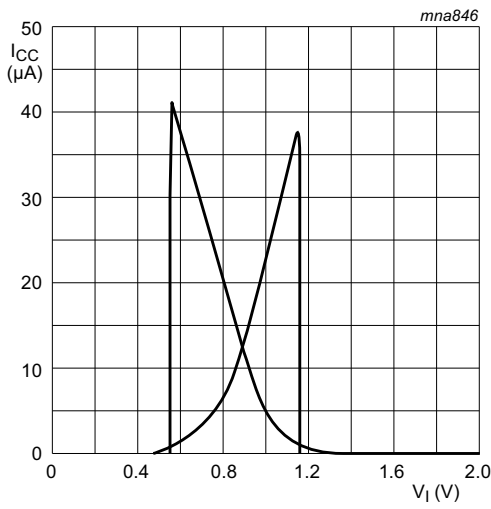
At recommended operating conditions; voltages are referenced to GND (ground = 0 V); see [Figure 8](#) and [Figure 9](#).

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-Q100</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-Q100</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

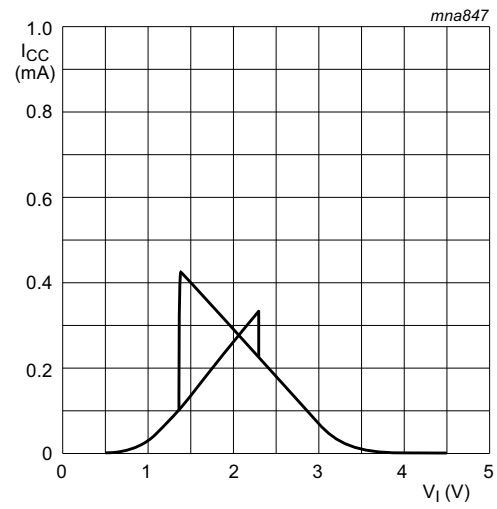
## 14. Transfer characteristics waveforms



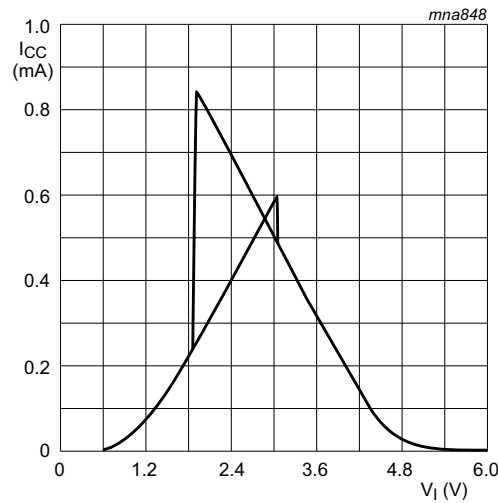




a.  $V_{CC} = 2.0\text{ V}$

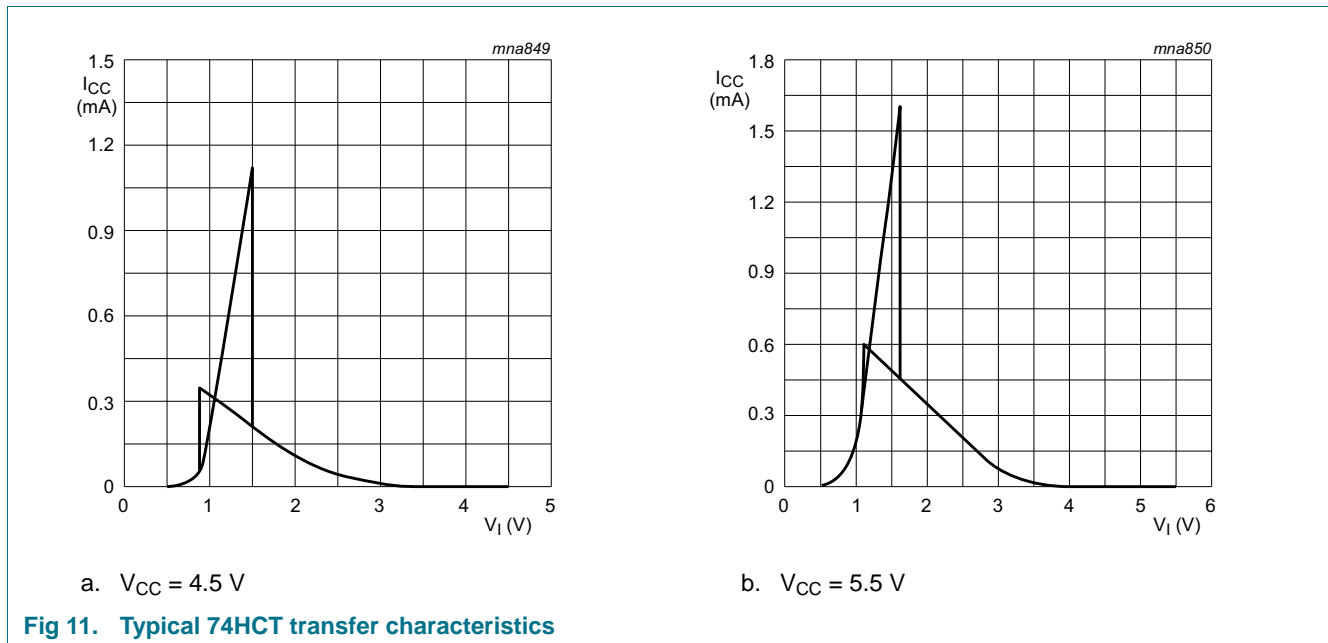


b.  $V_{CC} = 4.5\text{ V}$



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);

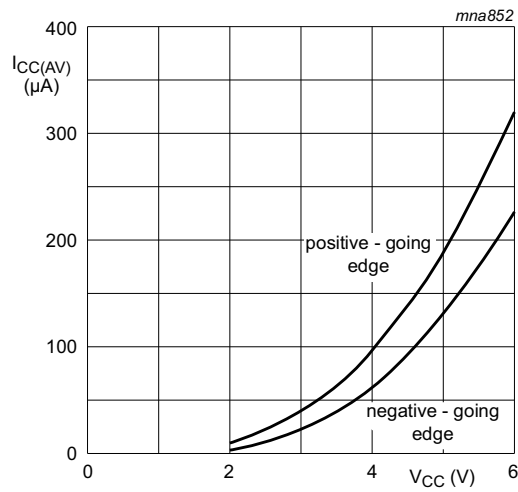
$t_r$  = rise time (ns); 10 % to 90 %;

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

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

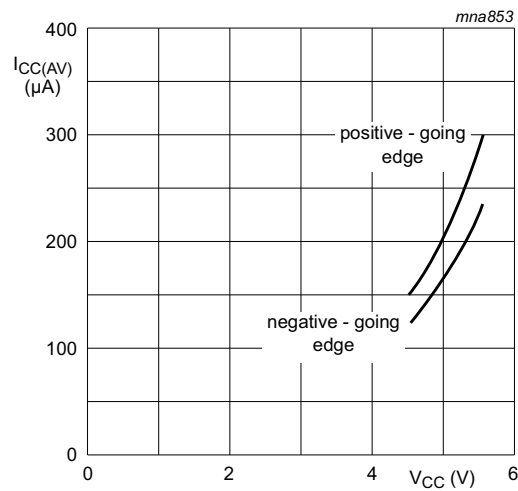
Average  $\Delta I_{CC(AV)}$  differs with positive or negative input transitions, as shown in [Figure 12](#) and [Figure 13](#).

An example of a relaxation circuit using the 74HC14-Q100; 74HCT14-Q100 is shown in [Figure 14](#).



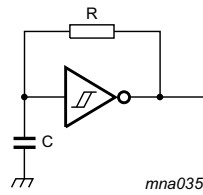
- (1) Positive-going edge.
- (2) Negative-going edge.

**Fig 12. Average additional supply current as a function of V<sub>CC</sub> for 74HC14-Q100; linear change of V<sub>I</sub> between 0.1V<sub>CC</sub> to 0.9V<sub>CC</sub>.**



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

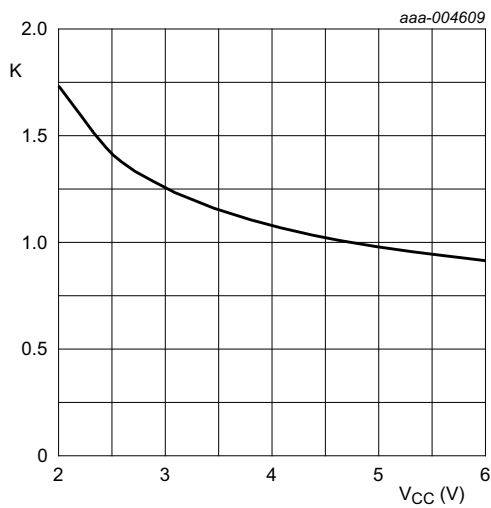
**Fig 13. Average additional supply current as a function of V<sub>CC</sub> for 74HCT14-Q100; linear change of V<sub>I</sub> between 0.1V<sub>CC</sub> to 0.9V<sub>CC</sub>.**



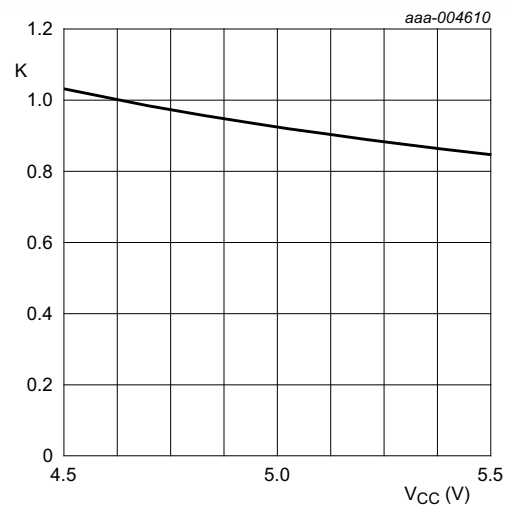
For 74HC14-Q100 and 74HCT14-Q100:  $f = \frac{1}{T} \approx \frac{1}{K \times RC}$

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

**Fig 14. Relaxation oscillator**



K-factor for 74HC14-Q100



K-factor for 74HCT14-Q100

**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

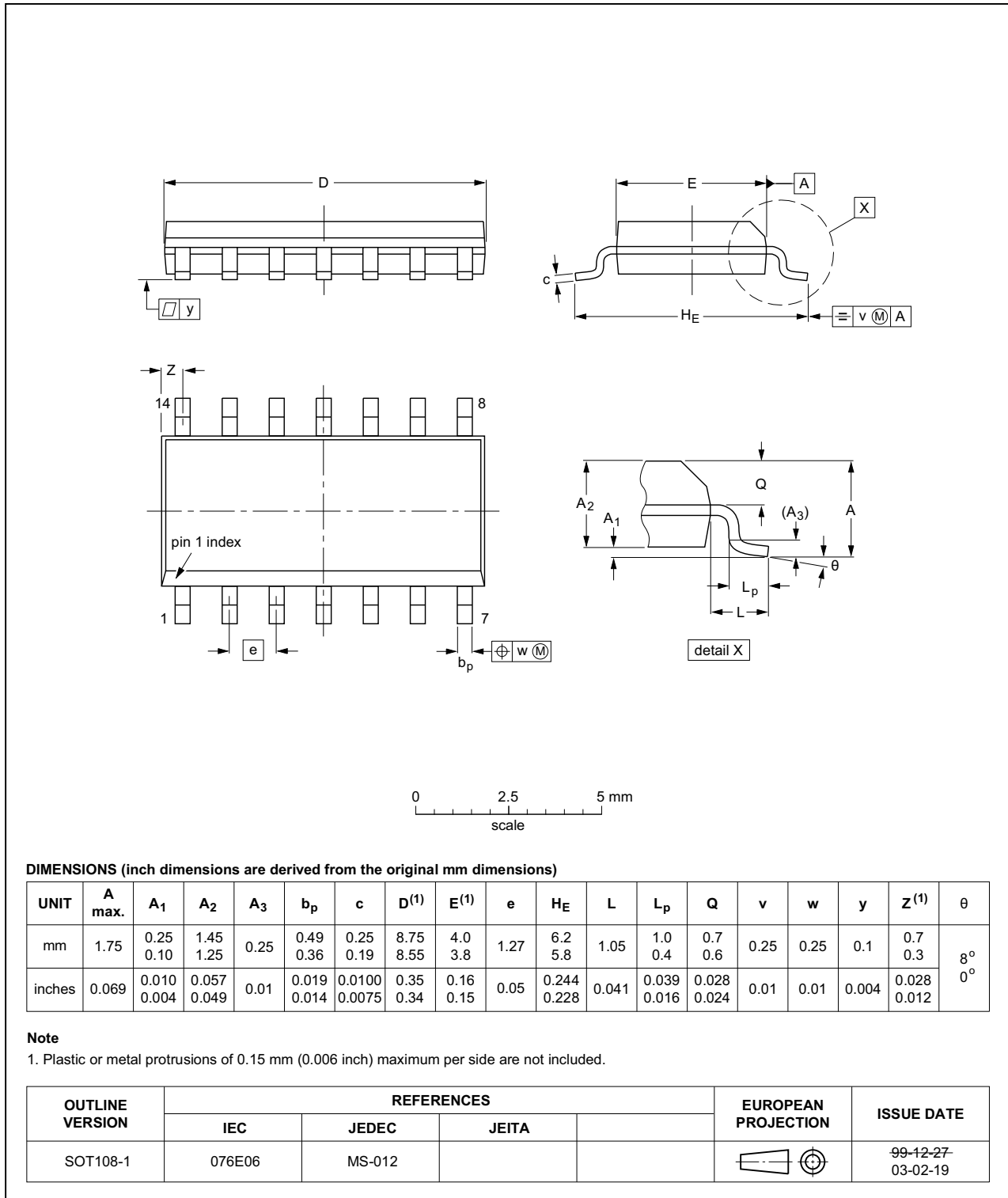


Fig 16. Package outline SOT108-1 (SO14)

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

SOT402-1

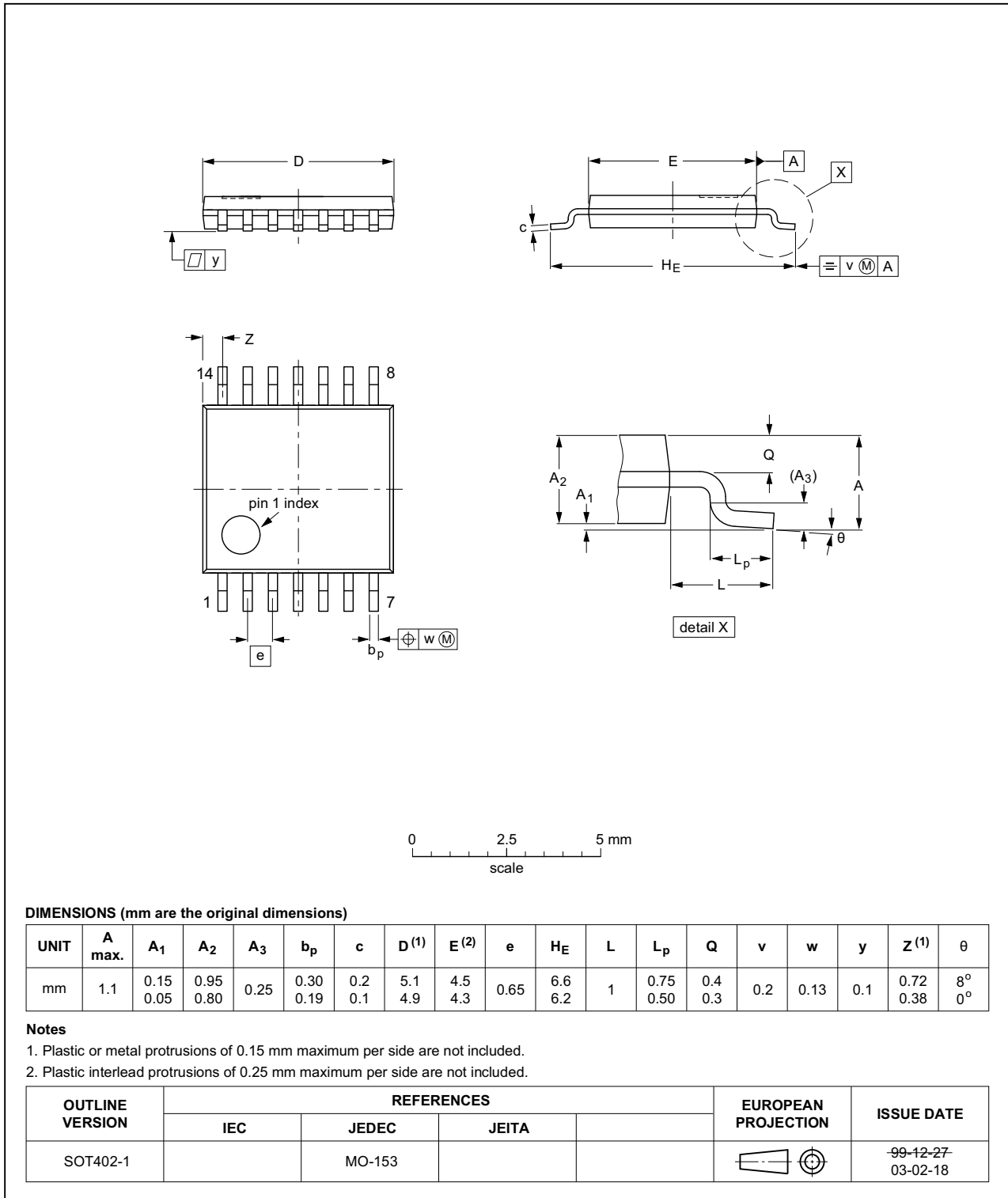
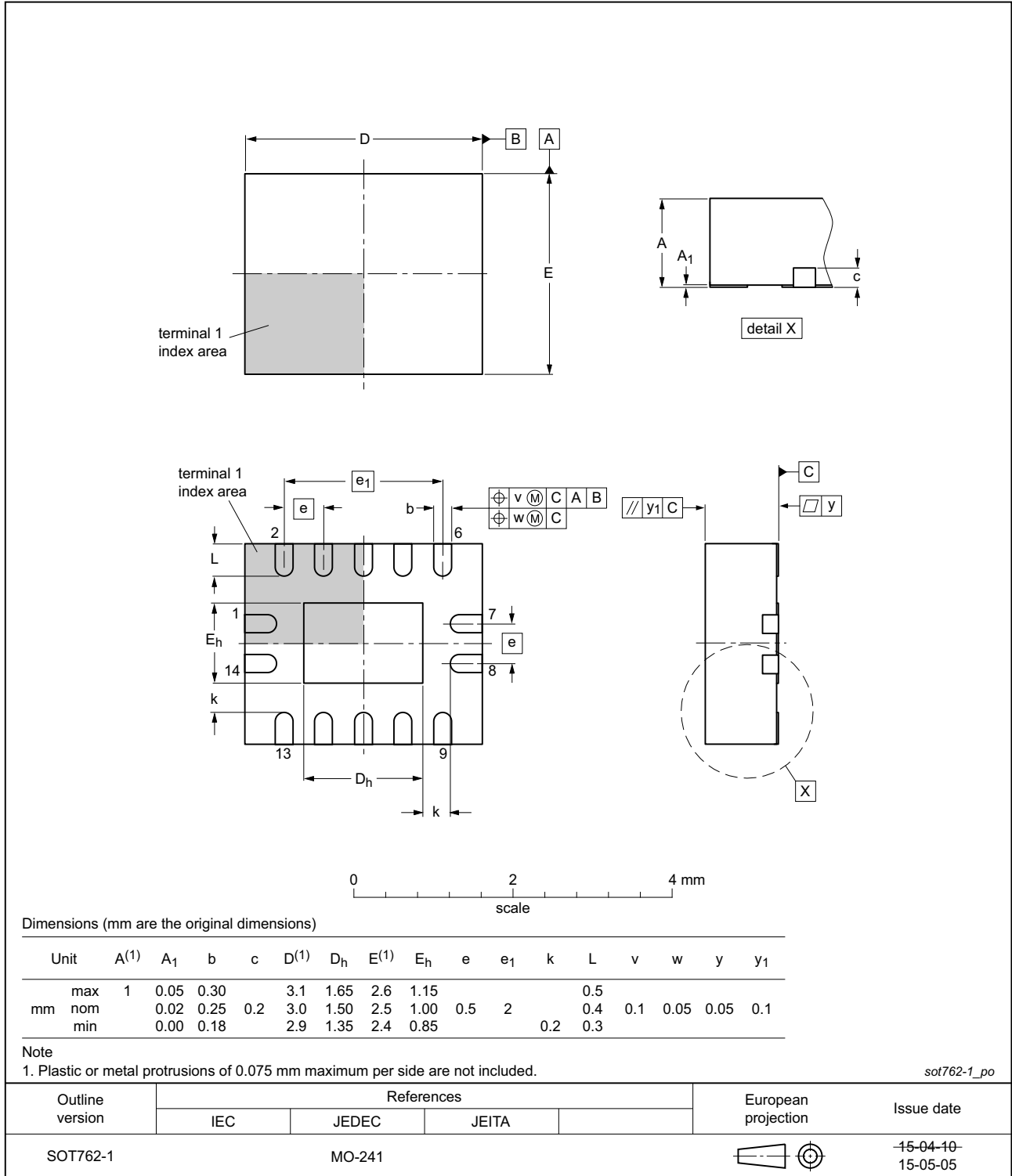


Fig 17. Package outline SOT402-1 (TSSOP14)

**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)**

## 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
MIL	Military

## 18. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT14_Q100 v.5	20151201	Product data sheet	-	74HC_HCT14_Q100 v.4
Modifications:	<ul style="list-style-type: none"> <li>Type number 74HC14N-Q100 (SOT27-1) removed.</li> </ul>			
74HC_HCT14_Q100 v.4	20130419	Product data sheet	-	74HC_HCT14_Q100 v.3
Modifications:	<ul style="list-style-type: none"> <li>74HCT14N-Q100 removed.</li> </ul>			
74HC_HCT14_Q100 v.3	20130410	Product data sheet	-	74HC_HCT14_Q100 v.2
Modifications:	<ul style="list-style-type: none"> <li>74HC14N-Q100 and 74HCT14N-Q100 added.</li> </ul>			
74HC_HCT14_Q100 v.2	20120810	Product data sheet	-	74HC_HCT14_Q100 v.1
Modifications:	<ul style="list-style-type: none"> <li><a href="#">Figure 15</a> added (typical K-factor for relaxation oscillator).</li> </ul>			
74HC_HCT14_Q100 v.1	20120709	Product data sheet	-	-



## 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.
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[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".

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## 21. Contents

<b>1</b>	<b>General description</b> .....	<b>1</b>
<b>2</b>	<b>Features and benefits</b> .....	<b>1</b>
<b>3</b>	<b>Applications</b> .....	<b>1</b>
<b>4</b>	<b>Ordering information</b> .....	<b>2</b>
<b>5</b>	<b>Functional diagram</b> .....	<b>2</b>
<b>6</b>	<b>Pinning information</b> .....	<b>3</b>
6.1	Pinning .....	3
6.2	Pin description .....	3
<b>7</b>	<b>Functional description</b> .....	<b>3</b>
<b>8</b>	<b>Limiting values</b> .....	<b>4</b>
<b>9</b>	<b>Recommended operating conditions</b> .....	<b>4</b>
<b>10</b>	<b>Static characteristics</b> .....	<b>5</b>
<b>11</b>	<b>Dynamic characteristics</b> .....	<b>6</b>
<b>12</b>	<b>Waveforms</b> .....	<b>7</b>
<b>13</b>	<b>Transfer characteristics</b> .....	<b>8</b>
<b>14</b>	<b>Transfer characteristics waveforms</b> .....	<b>8</b>
<b>15</b>	<b>Application information</b> .....	<b>10</b>
<b>16</b>	<b>Package outline</b> .....	<b>13</b>
<b>17</b>	<b>Abbreviations</b> .....	<b>16</b>
<b>18</b>	<b>Revision history</b> .....	<b>16</b>
<b>19</b>	<b>Legal information</b> .....	<b>17</b>
19.1	Data sheet status .....	17
19.2	Definitions .....	17
19.3	Disclaimers .....	17
19.4	Trademarks .....	18
<b>20</b>	<b>Contact information</b> .....	<b>18</b>
<b>21</b>	<b>Contents</b> .....	<b>19</b>

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Date of release: 1 December 2015  
 Document identifier: 74HC\_HCT14\_Q100