Hex inverting Schmitt trigger Rev. 4 — 17 January 2011

#### **General description** 1.

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.

#### **Features and benefits** 2.

- 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 °C to +85 °C and from –40 °C to +125 °C

## 3. Applications

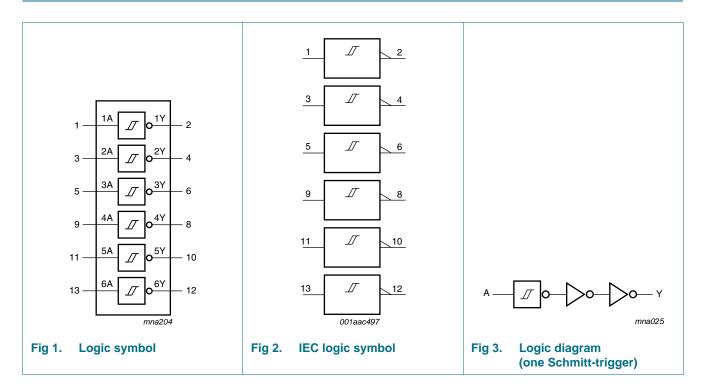
- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators



## 4. Ordering information

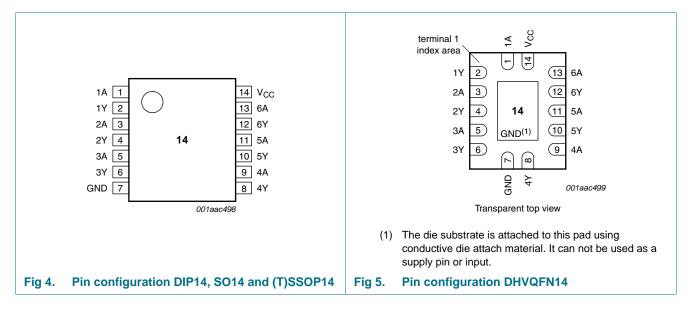
Table 1. Ord	lering information										
Type number	Package										
	Temperature range	Name	Description	Version							
74HC14N	–40 °C to +125 °C	DIP14	plastic dual in-line package; 14 leads (300 mil)	SOT27-1							
74HCT14N											
74HC14D	–40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width	SOT108-7							
74HCT14D			3.9 mm								
74HC14DB	–40 °C to +125 °C	SSOP14	plastic shrink small outline package; 14 leads; body	SOT337-1							
74HCT14DB			width 5.3 mm								
74HC14PW	–40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads;	SOT402-1							
74HCT14PW			body width 4.4 mm								
74HC14BQ	–40 °C to +125 °C	DHVQFN14	plastic dual in-line compatible thermal enhanced very	SOT762-1							
74HCT14BQ			thin quad flat package; no leads; 14 terminals; body $2.5 \times 3 \times 0.85$ mm								

## 5. Functional diagram



## 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	Н
Н	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	$V_{\rm I} < -0.5$ V or $V_{\rm I} > V_{\rm CC}$ + 0.5 V	<u>[1]</u> -	±20	mA
I <sub>OK</sub>	output clamping current	$V_{\rm O}$ < –0.5 V or $V_{\rm O}$ > $V_{\rm CC}$ + 0.5 V	<u>[1]</u> -	±20	mA
lo	output current	$-0.5 \text{ V} < \text{V}_{\text{O}} < \text{V}_{\text{CC}} + 0.5 \text{ V}$	-	±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		
			Min	Тур	Max	Min	Тур	Max	
V <sub>CC</sub>	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
VI	input voltage		0	-	$V_{CC}$	0	-	$V_{CC}$	V
Vo	output voltage		0	-	$V_{CC}$	0	-	$V_{CC}$	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>ar</sub>	<sub>nb</sub> = 25	°C		= –40 °C 85 °C	T <sub>amb</sub> = −40 °C to +125 °C		Unit
			Min	Тур	Max	Min	Max	Min	Max	
74HC14										
V <sub>ОН</sub>	HIGH-level	$V_{I} = V_{T+}$ or $V_{T-}$								
	output voltage	$I_{O} = -20 \ \mu A; \ V_{CC} = 2.0 \ V$	1.9	2.0	-	1.9	-	1.9	-	V
		$I_{O} = -20 \ \mu A; \ V_{CC} = 4.5 \ V$	4.4	4.5	-	4.4	-	4.4	-	V
		$I_{O} = -20 \ \mu A; \ V_{CC} = 6.0 \ V$	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
		$I_{O} = -5.2 \text{ mA}; V_{CC} = 6.0 \text{ V}$	5.48	5.81	-	5.34	-	5.2	-	V
V <sub>OL</sub> LOW-level		$V_{I} = V_{T+}$ or $V_{T-}$								
	output voltage	$I_{O} = 20 \ \mu A; \ V_{CC} = 2.0 \ V$	-	0	0.1	-	0.1	-	0.1	V
		$I_{O} = 20 \ \mu A; V_{CC} = 4.5 \ V$	-	0	0.1	-	0.1	-	0.1	V
		$I_{O} = 20 \ \mu A; \ V_{CC} = 6.0 \ V$	-	0	0.1	-	0.1	-	0.1	V
		$I_0 = 4.0 \text{ mA}; V_{CC} = 4.5 \text{ V}$	-	0.15	0.26	-	0.33	-	0.4	V
		$I_0 = 5.2 \text{ mA}; V_{CC} = 6.0 \text{ V}$	-	0.16	0.26	-	0.33	-	0.4	V
I	input leakage current	$V_{I} = V_{CC} \text{ or GND}; V_{CC} = 6.0 \text{ V}$	-	-	±0.1	-	±1.0	-	±1.0	μA
I <sub>CC</sub>	supply current		-	-	2.0	-	20	-	40	μA
Cı	input capacitance		-	3.5	-	-	-	-	-	pF
74HCT14	4									
V <sub>он</sub>	HIGH-level	$V_{I} = V_{T+}$ or $V_{T-}$ ; $V_{CC} = 4.5 \text{ V}$								
	output voltage	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	$V_{I} = V_{T+}$ or $V_{T-}$ ; $V_{CC} = 4.5 \text{ V}$								
	output voltage	I <sub>O</sub> = 20 μA;	-	0	0.1	-	0.1	-	0.1	V
		l <sub>O</sub> = 4.0 mA;	-	0.15	0.26	-	0.33	-	0.4	V
I	input leakage current	$V_{I} = V_{CC}$ or GND; $V_{CC} = 5.5$ V	-	-	±0.1	-	±1.0	-	±1.0	μA
cc	supply current	$V_1 = V_{CC}$ or GND; $I_0 = 0$ A; $V_{CC} = 5.5$ V	-	-	2.0	-	20	-	40	μA
VI <sub>CC</sub>	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
CI	input capacitance		-	3.5	-	-	-	-	-	pF

## **11. Dynamic characteristics**

#### Table 7. Dynamic characteristics

GND = 0 V;  $C_L = 50$  pF; for load circuit see <u>Figure 7</u>.

Symbol	Parameter	ameter Conditions		T <sub>amb</sub> = 25 °C				-40 °C to 5 °C	Unit
			-	Min	Тур	Max	Max (85 °C)	Max (125 °C)	_
74HC14			1						
t <sub>pd</sub>	propagation delay	nA to nY; see Figure 6	<u>[1]</u>						
		$V_{CC} = 2.0 V$		-	41	125	155	190	ns
		$V_{CC} = 4.5 V$		-	15	25	31	38	ns
		$V_{CC} = 5.0 \text{ V}; \text{ C}_{L} = 15 \text{ pF}$		-	12	-	-	-	ns
		$V_{CC} = 6.0 V$		-	12	21	26	32	ns
t <sub>t</sub>	transition time	see <u>Figure 6</u>	[2]						
		$V_{CC} = 2.0 V$		-	19	75	95	110	ns
		$V_{CC} = 4.5 V$		-	7	15	19	22	ns
		$V_{CC} = 6.0 V$		-	6	13	15	19	ns
C <sub>PD</sub>	power dissipation capacitance	per package; $V_I = GND$ to $V_{CC}$	<u>[3]</u>	-	7	-	-	-	pF
74HCT14	4								
t <sub>pd</sub>	propagation delay	nA to nY; see <u>Figure 6</u>	<u>[1]</u>						
		$V_{CC} = 4.5 V$		-	20	34	43	51	ns
		$V_{CC} = 5.0 \text{ V}; \text{ C}_{L} = 15 \text{ pF}$		-	17	-	-	-	ns
t <sub>t</sub>	transition time	$V_{CC} = 4.5 \text{ V}; \text{ see } \frac{\text{Figure 6}}{1000}$	[2]	-	7	15	19	22	ns
C <sub>PD</sub>	power dissipation capacitance	per package; V <sub>I</sub> = GND to V <sub>CC</sub> – 1.5 V	<u>[3]</u>	-	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  $_{\text{PD}}$  is used to determine the dynamic power dissipation (P  $_{\text{D}}$  in  $\mu\text{W})$ :

 $P_{D}$  =  $C_{PD} \times V_{CC}{}^{2} \times f_{i} \times N$  +  $\sum$  ( $C_{L} \times V_{CC}{}^{2} \times f_{o}$ ) where:

 $f_i$  = input frequency in MHz;

 $f_o$  = output frequency in MHz;

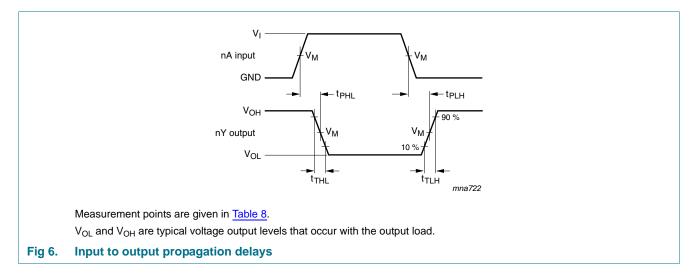
 $C_L$  = output load capacitance in pF;

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

N = number of inputs switching;  $\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs.

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## 12. Waveforms



#### Table 8.Measurement points

Туре	Input	Output			
	V <sub>M</sub>	V <sub>M</sub>	V <sub>X</sub>	V <sub>Y</sub>	
74HC14	0.5V <sub>CC</sub>	0.5V <sub>CC</sub>	0.1V <sub>CC</sub>	0.9V <sub>CC</sub>	
74HCT14	1.3 V	1.3 V	0.1V <sub>CC</sub>	0.9V <sub>CC</sub>	

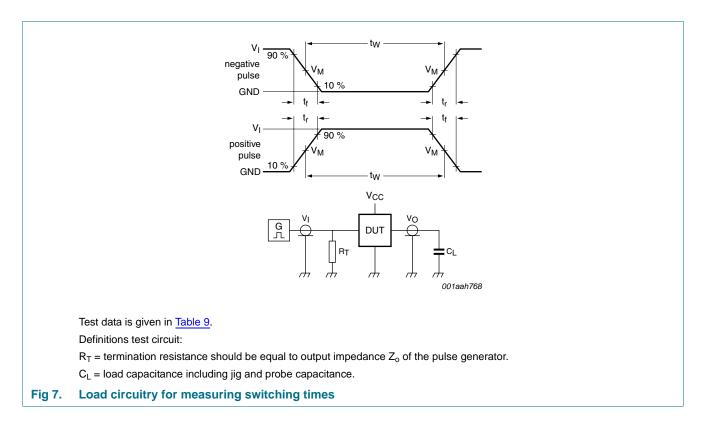


Table 9. Test data				
Туре	Input L		Load	Test
	VI	t <sub>r</sub> , t <sub>f</sub>	CL	
74HC14	V <sub>CC</sub>	6.0 ns	15 pF, 50 pF	t <sub>PLH</sub> , t <sub>PHL</sub>
74HCT14	3.0 V	6.0 ns	15 pF, 50 pF	t <sub>PLH</sub> , t <sub>PHL</sub>

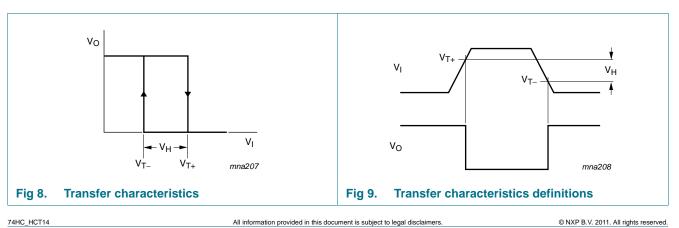
## **13. Transfer characteristics**

#### Table 10. Transfer characteristics

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

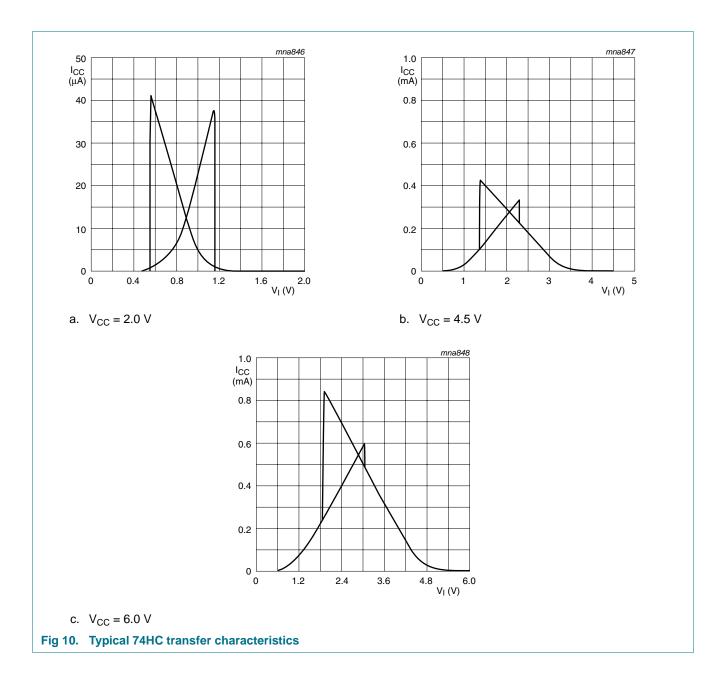
Symbol Paran	Parameter		eter Conditions $T_{amb} = 25 \ ^{\circ}C$			:	T <sub>amb</sub> = −40 °C to +125 °C		Unit	
			Min	Тур	Max	Min	Max	Min	Max	
74HC14									I	
$V_{T+}$		V <sub>CC</sub> = 2.0 V	0.7	1.18	1.5	0.7	1.5	0.7	1.5	V
	threshold voltage	V <sub>CC</sub> = 4.5 V	1.7	2.38	3.15	1.7	3.15	1.7	3.15	V
	voltage	V <sub>CC</sub> = 6.0 V	2.1	3.14	4.2	2.1	4.2	2.1	4.2	V
$V_{T-}$	negative-going	V <sub>CC</sub> = 2.0 V	0.3	0.52	0.9	0.3	0.9	0.3	0.9	V
	threshold	$V_{CC} = 4.5 V$	0.9	1.4	2.0	0.9	2.0	0.9	2.0	V
	voltage	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>		V <sub>CC</sub> = 2.0 V	0.2	0.66	1.0	0.2	1.0	0.2	1.0	V
	voltage	$V_{CC} = 4.5 V$	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
74HCT1	4									
V <sub>T+</sub>	positive-going	$V_{CC} = 4.5 V$	1.2	1.41	1.9	1.2	1.9	1.2	1.9	V
	threshold voltage	$V_{CC} = 5.5 V$	1.4	1.59	2.1	1.4	2.1	1.4	2.1	V
$V_{T-}$	negative-going	$V_{CC} = 4.5 V$	0.5	0.85	1.2	0.5	1.2	0.5	1.2	V
	threshold voltage	$V_{CC} = 5.5 V$	0.6	0.99	1.4	0.6	1.4	0.6	1.4	V
V <sub>H</sub>	hysteresis	V <sub>CC</sub> = 4.5 V	0.4	0.56	-	0.4	-	0.4	-	V
	voltage	V <sub>CC</sub> = 5.5 V	0.4	0.6	-	0.4	-	0.4	-	V

## 14. Transfer characteristics waveforms



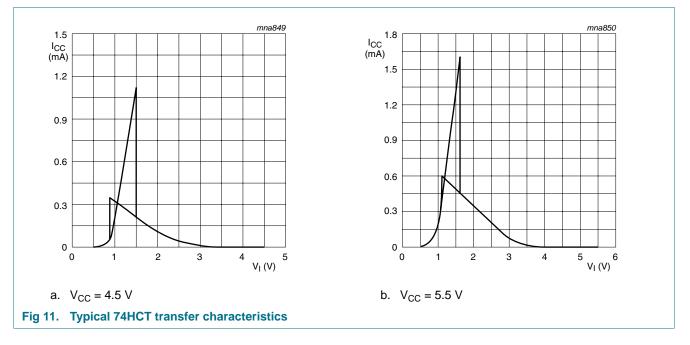
# 74HC14; 74HCT14

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# 74HC14; 74HCT14

Hex inverting Schmitt trigger



## **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 %;

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

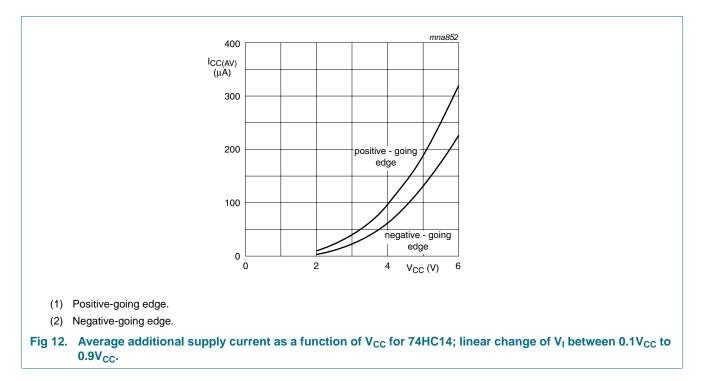
 $\Delta I_{CC(AV)}$  = average additional supply current (µA).

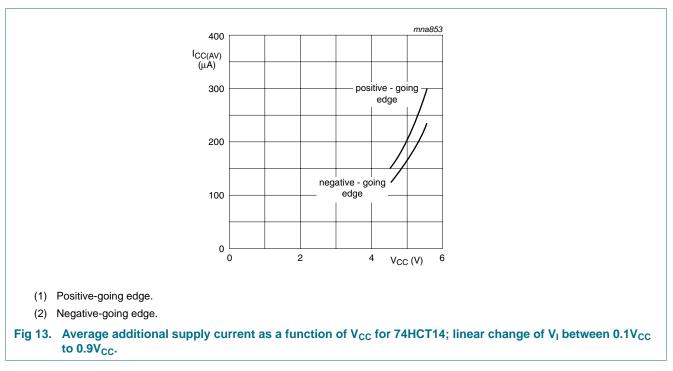
Average  $\Delta I_{CC(AV)}$  differs with positive or negative input transitions, as shown in Figure 12 and Figure 13.

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

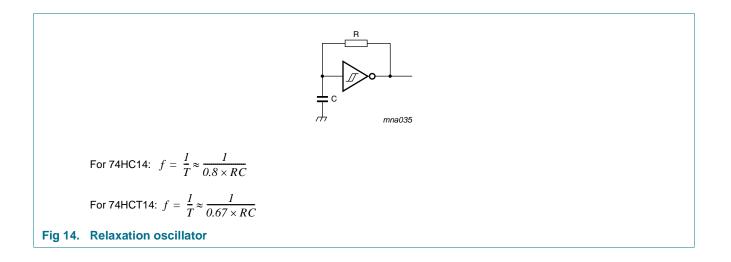
# 74HC14; 74HCT14

Hex inverting Schmitt trigger



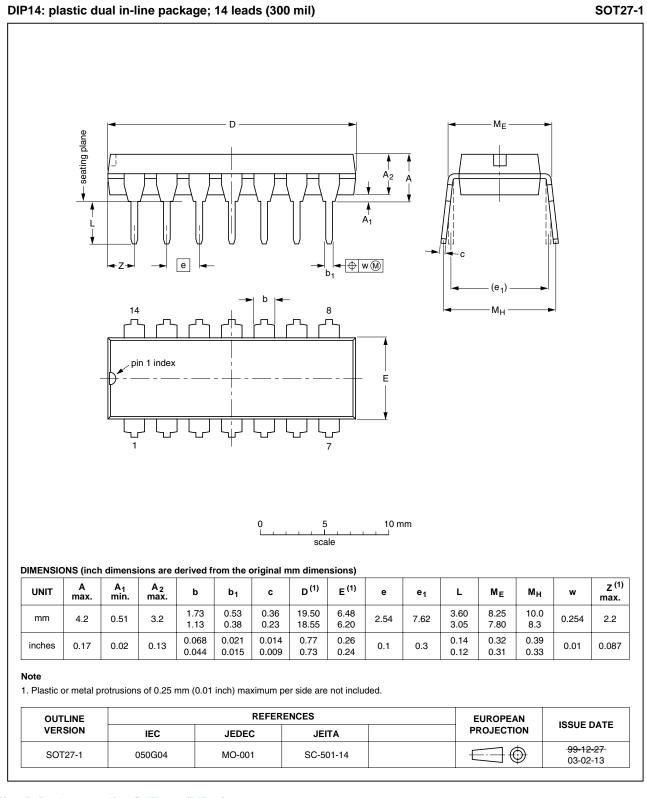


## Hex inverting Schmitt trigger



Hex inverting Schmitt trigger

## 16. Package outline



#### Fig 15. Package outline SOT27-1 (DIP14)

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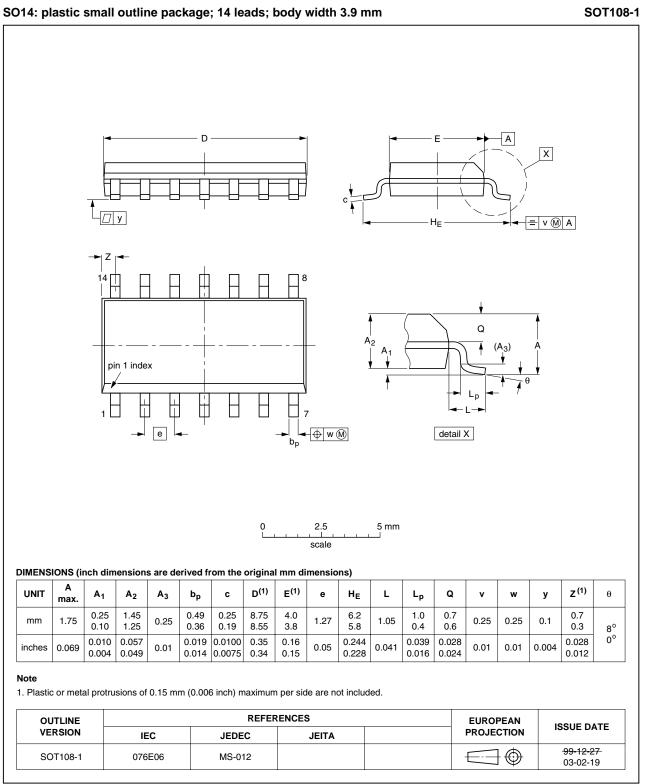
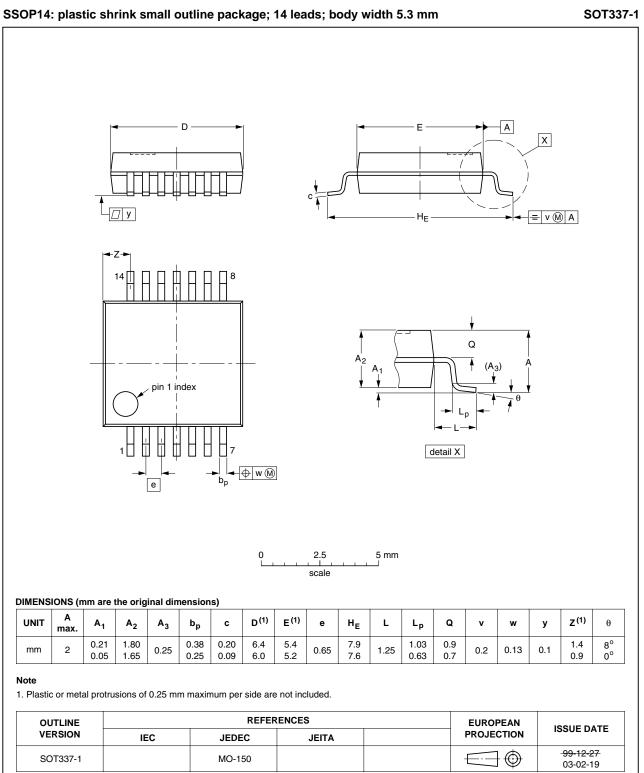


Fig 16. Package outline SOT108-1 (SO14)



#### Fig 17. Package outline SOT337-1 (SSOP14)

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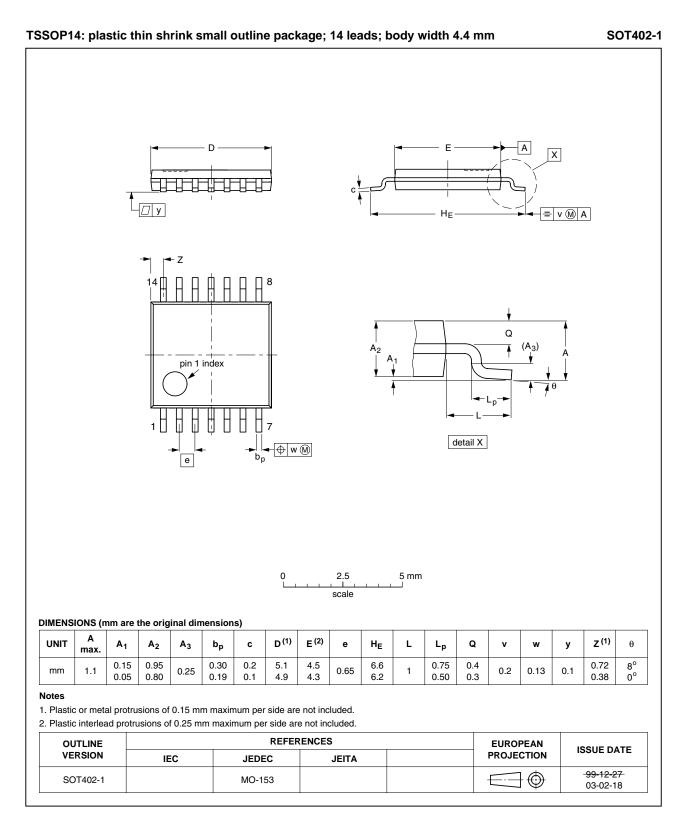
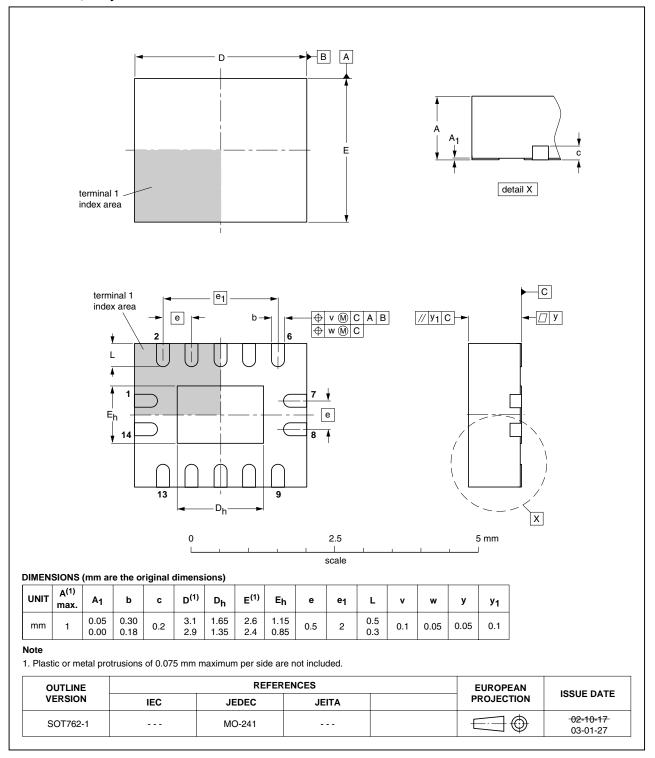


Fig 18. Package outline SOT402-1 (TSSOP14)

74HC\_HCT14

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#### 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)

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## **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

<b>Release date</b> 20110117	Data sheet status Product data sheet	Change notice	Supersedes
20110117	Product data sheet		
		-	74HC_HCT14 v.3
		redesigned to comply w	ith the new identity
<ul> <li>Legal texts h</li> </ul>	have been adapted to the ne	ew company name whe	re appropriate.
<ul> <li>Minimum val (errata).</li> </ul>	lues propagation delay and	transition time moved t	o maximum value column
20031030	Product specification	-	74HC_HCT14_CNV v.2
19970826	Product specification	-	-
	guidelines o Legal texts h Minimum va (errata). 20031030	<ul> <li>guidelines of NXP Semiconductors.</li> <li>Legal texts have been adapted to the new of the index of</li></ul>	<ul> <li>Legal texts have been adapted to the new company name whe</li> <li>Minimum values propagation delay and transition time moved t (errata).</li> <li>20031030 Product specification -</li> </ul>

## **19. Legal information**

#### **19.1 Data sheet status**

Document status[1][2]	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 <a href="http://www.nxp.com">http://www.nxp.com</a>.

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