

# 74HC74-Q100; 74HCT74-Q100

Dual D-type flip-flop with set and reset; positive edge-trigger

Rev. 1 — 7 August 2012

Product data sheet

## 1. General description

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The 74HC74-Q100; 74HCT74-Q100 are dual positive edge triggered D-type flip-flop with individual data (nD), clock (nCP), set (nSD) and reset (nRD) inputs, and complementary nQ and nQ outputs. Data at the nD-input, that meets the set-up and hold time requirements on the LOW-to-HIGH clock transition, will be stored in the flip-flop and appear at the nQ output. The Schmitt-trigger action in the clock input, makes the circuit highly tolerant to slower clock rise and fall times. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

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  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$
- Input levels:
  - ◆ For 74HC74-Q100: CMOS level
  - ◆ For 74HCT74-Q100: TTL level
- Symmetrical output impedance
- Low power dissipation
- High noise immunity
- Balanced propagation delays
- Specified in compliance with JEDEC standard no. 7A
- ESD protection:
  - ◆ MIL-STD-883, method 3015 exceeds 2000 V
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V ( $C = 200\text{ pF}$ ,  $R = 0\text{ }\Omega$ )
- Multiple package options



### 3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC74D-Q100 74HCT74D-Q100	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74HC74PW-Q100 74HCT74PW-Q100	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74HC74BQ-Q100 74HCT74BQ-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

### 4. Functional diagram

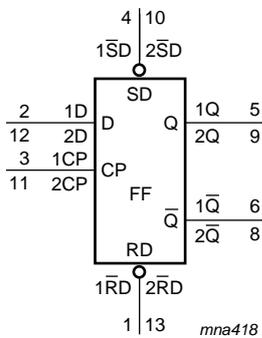


Fig 1. Logic symbol

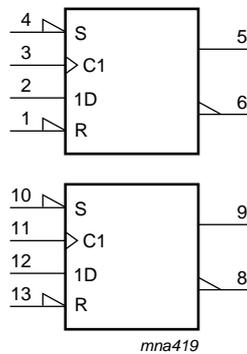


Fig 2. IEC logic symbol

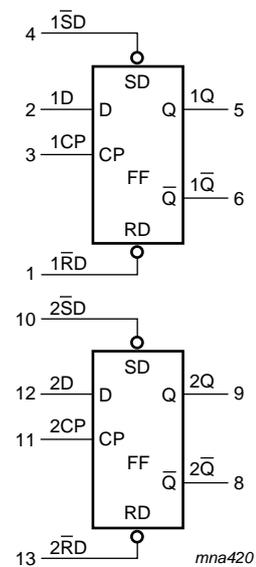


Fig 3. Functional diagram

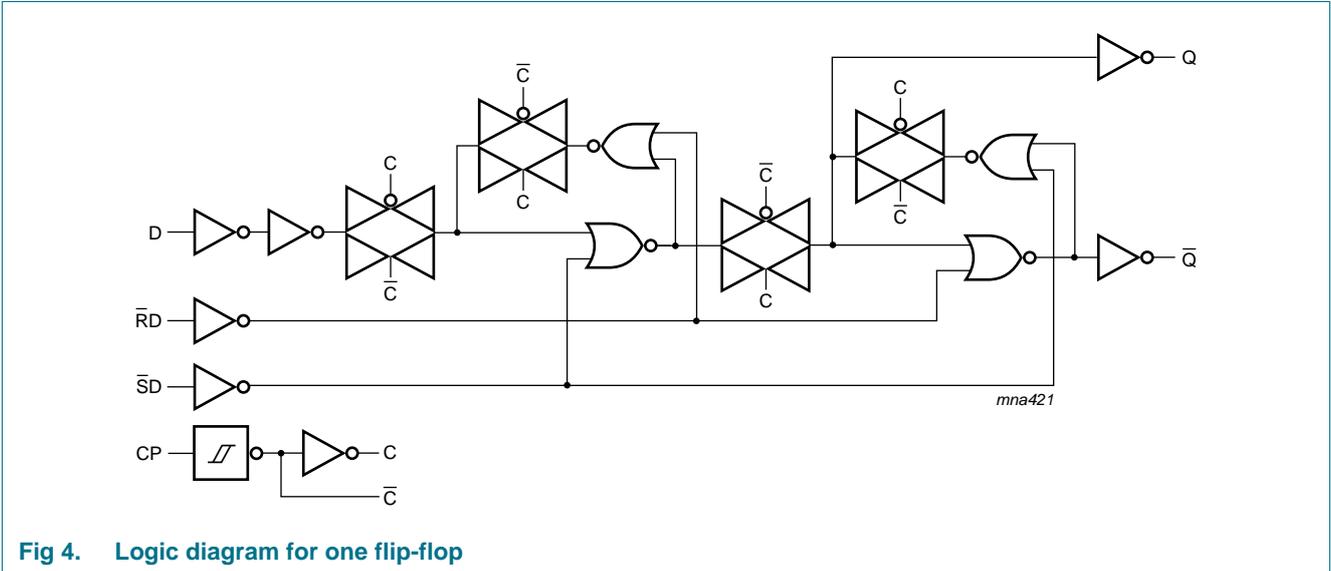


Fig 4. Logic diagram for one flip-flop

## 5. Pinning information

### 5.1 Pinning

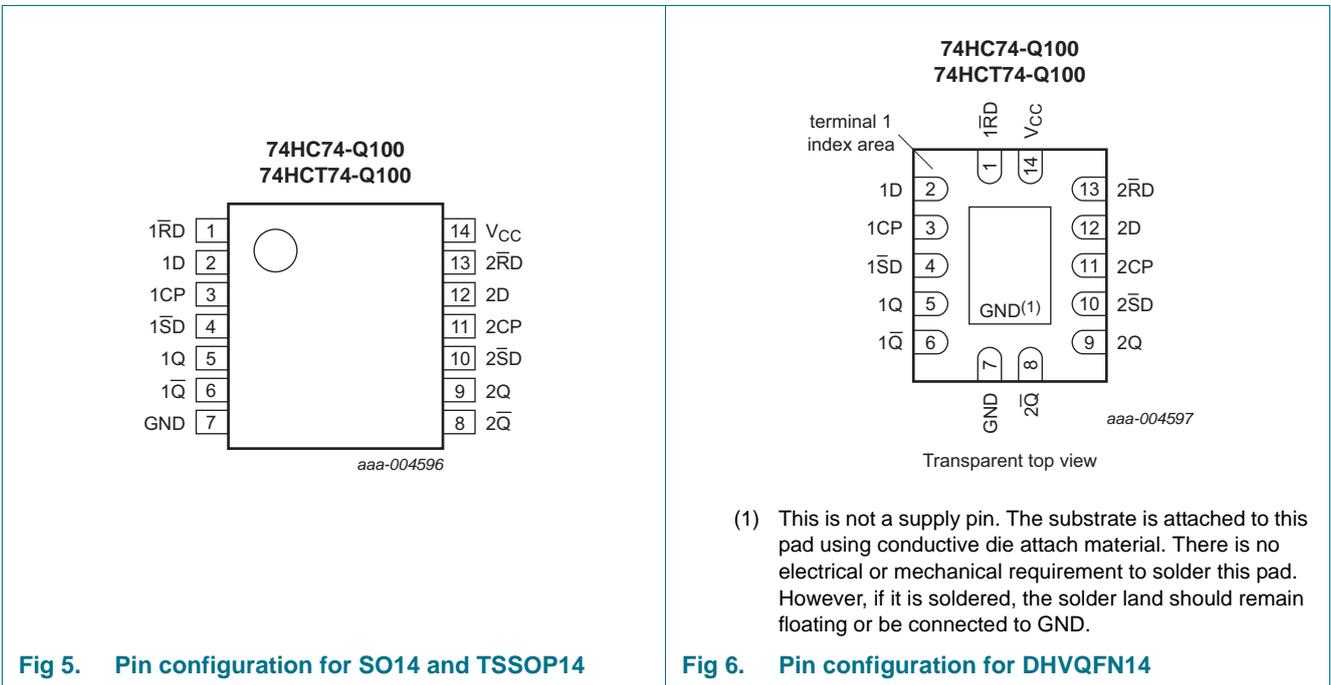


Fig 5. Pin configuration for SO14 and TSSOP14

Fig 6. Pin configuration for DHVQFN14

## 5.2 Pin description

**Table 2. Pin description**

Symbol	Pin	Description
1 $\overline{RD}$	1	asynchronous reset-direct input (active LOW)
1D	2	data input
1CP	3	clock input (LOW-to-HIGH, edge-triggered)
1 $\overline{SD}$	4	asynchronous set-direct input (active LOW)
1Q	5	output
1 $\overline{Q}$	6	complement output
GND	7	ground (0 V)
2 $\overline{Q}$	8	complement output
2Q	9	output
2 $\overline{SD}$	10	asynchronous set-direct input (active LOW)
2CP	11	clock input (LOW-to-HIGH, edge-triggered)
2D	12	data input
2 $\overline{RD}$	13	asynchronous reset-direct input (active LOW)
V <sub>CC</sub>	14	supply voltage

## 6. Functional description

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

Input				Output	
n $\overline{SD}$	n $\overline{RD}$	nCP	nD	nQ	n $\overline{Q}$
L	H	X	X	H	L
H	L	X	X	L	H
L	L	X	X	H	H

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care.

**Table 4. Function table<sup>[1]</sup>**

Input				Output	
n $\overline{SD}$	n $\overline{RD}$	nCP	nD	nQ <sub>n+1</sub>	n $\overline{Q}$ <sub>n+1</sub>
H	H	↑	L	L	H
H	H	↑	H	H	L

[1] H = HIGH voltage level; L = LOW voltage level; ↑ = LOW-to-HIGH transition; Q<sub>n+1</sub> = state after the next LOW-to-HIGH CP transition; X = don't care.

## 7. Limiting values

**Table 5. 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	-	±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	-	±20	mA
I <sub>O</sub>	output current	V <sub>O</sub> = -0.5 V to (V <sub>CC</sub> + 0.5 V)	-	±25	mA
I <sub>CC</sub>	supply current		-	+100	mA
I <sub>GND</sub>	ground current		-100	-	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
P <sub>tot</sub>	total power dissipation		[1] -	500	mW

- [1] For SO14 packages: P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C.  
 For TSSOP14 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.

## 8. Recommended operating conditions

**Table 6. Recommended operating conditions**

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC74-Q100			74HCT74-Q100			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
Δt/ΔV	input transition rise and fall rate	V <sub>CC</sub> = 2.0 V	-	-	625	-	-	-	ns/V
		V <sub>CC</sub> = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V <sub>CC</sub> = 6.0 V	-	-	83	-	-	-	ns/V

## 9. Static characteristics

**Table 7. Static characteristics**

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	T <sub>amb</sub> = -40 °C to +85 °C			T <sub>amb</sub> = -40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
<b>74HC74-Q100</b>								
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.0 V	1.5	1.2	-	1.5	-	V
		V <sub>CC</sub> = 4.5 V	3.15	2.4	-	3.15	-	V
		V <sub>CC</sub> = 6.0 V	4.2	3.2	-	4.2	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.0 V	-	0.8	0.5	-	0.5	V
		V <sub>CC</sub> = 4.5 V	-	2.1	1.35	-	1.35	V
		V <sub>CC</sub> = 6.0 V	-	2.8	1.8	-	1.8	V

**Table 7. Static characteristics ...continued**

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	T <sub>amb</sub> = -40 °C to +85 °C			T <sub>amb</sub> = -40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>						
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	3.84	4.32	-	3.7	-	V
		I <sub>O</sub> = -5.2 mA; V <sub>CC</sub> = 6.0 V	5.34	5.81	-	5.2	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>						
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	0.15	0.33	-	0.4	V
		I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V	-	0.16	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	-	-	±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	-	-	40	-	80	µA
C <sub>I</sub>	input capacitance			3.5				pF
<b>74HCT74-Q100</b>								
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	2.0	1.6	-	2.0	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 4.5 V to 5.5 V	-	1.2	0.8	-	0.8	V
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V						
		I <sub>O</sub> = -4 mA	3.84	4.32	-	3.7	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V						
		I <sub>O</sub> = 4.0 mA	-	0.15	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	-	-	±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	-	-	40	-	80	µA
ΔI <sub>CC</sub>	additional supply current	V <sub>I</sub> = V <sub>CC</sub> - 2.1 V; other inputs at V <sub>CC</sub> or GND; V <sub>CC</sub> = 4.5 V to 5.5 V; I <sub>O</sub> = 0 A						
		per input pin; nD, nRD inputs	-	70	315	-	343	µA
		per input pin; nSD, nCP input	-	80	360	-	392	µA
C <sub>I</sub>	input capacitance			3.5				pF

[1] All typical values are measured at T<sub>amb</sub> = 25 °C.

## 10. Dynamic characteristics

**Table 8. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V);  $C_L = 50$  pF unless otherwise specified; for test circuit see [Figure 9](#).

Symbol	Parameter	Conditions	$T_{amb} = -40\text{ °C to }+85\text{ °C}$			$T_{amb} = -40\text{ °C to }+125\text{ °C}$		Unit	
			Min	Typ <sup>[1]</sup>	Max	Min	Max		
<b>74HC74-Q100</b>									
$t_{pd}$	propagation delay	nCP to nQ, n $\bar{Q}$ ; see <a href="#">Figure 7</a>	<a href="#">[2]</a>						
		$V_{CC} = 2.0$ V	-	47	220	-	265	ns	
		$V_{CC} = 4.5$ V	-	17	44	-	53	ns	
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	14	-	-	-	ns	
		$V_{CC} = 6.0$ V	-	14	37	-	45	ns	
		n $\bar{S}D$ to nQ, n $\bar{Q}$ ; see <a href="#">Figure 8</a>	<a href="#">[2]</a>						
		$V_{CC} = 2.0$ V	-	50	250	-	300	ns	
		$V_{CC} = 4.5$ V	-	18	50	-	60	ns	
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	15	-	-	-	ns	
		$V_{CC} = 6.0$ V	-	14	43	-	51	ns	
		n $\bar{R}D$ to nQ, n $\bar{Q}$ ; see <a href="#">Figure 8</a>	<a href="#">[2]</a>						
		$V_{CC} = 2.0$ V	-	52	250	-	300	ns	
$V_{CC} = 4.5$ V	-	19	50	-	60	ns			
$V_{CC} = 5$ V; $C_L = 15$ pF	-	16	-	-	-	ns			
$V_{CC} = 6.0$ V	-	15	43	-	51	ns			
$t_t$	transition time	nQ, n $\bar{Q}$ ; see <a href="#">Figure 7</a>	<a href="#">[3]</a>						
		$V_{CC} = 2.0$ V	-	19	95	-	110	ns	
		$V_{CC} = 4.5$ V	-	7	19	-	22	ns	
		$V_{CC} = 6.0$ V	-	6	16	-	19	ns	
$t_W$	pulse width	nCP HIGH or LOW; see <a href="#">Figure 7</a>							
		$V_{CC} = 2.0$ V	100	19	-	120	-	ns	
		$V_{CC} = 4.5$ V	20	7	-	24	-	ns	
		$V_{CC} = 6.0$ V	17	6	-	20	-	ns	
		n $\bar{S}D$ , n $\bar{R}D$ LOW; see <a href="#">Figure 8</a>							
		$V_{CC} = 2.0$ V	100	19	-	120	-	ns	
		$V_{CC} = 4.5$ V	20	7	-	24	-	ns	
		$V_{CC} = 6.0$ V	17	6	-	20	-	ns	
		$t_{rec}$	recovery time	n $\bar{S}D$ , n $\bar{R}D$ ; see <a href="#">Figure 8</a>					
				$V_{CC} = 2.0$ V	40	3	-	45	-
$V_{CC} = 4.5$ V	8			1	-	9	-	ns	
$V_{CC} = 6.0$ V	7			1	-	8	-	ns	

**Table 8. Dynamic characteristics ...continued**

Voltages are referenced to GND (ground = 0 V);  $C_L = 50$  pF unless otherwise specified; for test circuit see [Figure 9](#).

Symbol	Parameter	Conditions	$T_{amb} = -40\text{ °C to }+85\text{ °C}$			$T_{amb} = -40\text{ °C to }+125\text{ °C}$		Unit	
			Min	Typ <sup>[1]</sup>	Max	Min	Max		
$t_{su}$	set-up time	nD to nCP; see <a href="#">Figure 7</a>							
		$V_{CC} = 2.0$ V	75	6	-	90	-	ns	
		$V_{CC} = 4.5$ V	15	2	-	18	-	ns	
		$V_{CC} = 6.0$ V	13	2	-	15	-	ns	
$t_h$	hold time	nD to nCP; see <a href="#">Figure 7</a>							
		$V_{CC} = 2.0$ V	3	-6	-	3	-	ns	
		$V_{CC} = 4.5$ V	3	-2	-	3	-	ns	
		$V_{CC} = 6.0$ V	3	-2	-	3	-	ns	
$f_{max}$	maximum frequency	nCP; see <a href="#">Figure 7</a>							
		$V_{CC} = 2.0$ V	4.8	23	-	4.0	-	MHz	
		$V_{CC} = 4.5$ V	24	69	-	20	-	MHz	
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	76	-	-	-	MHz	
		$V_{CC} = 6.0$ V	28	82	-	24	-	MHz	
$C_{PD}$	power dissipation capacitance	$C_L = 50$ pF; $f = 1$ MHz; $V_1 = \text{GND to } V_{CC}$	[4]	-	24	-	-	-	pF

### 74HCT74-Q100

$t_{pd}$	propagation delay	nCP to nQ, n $\bar{Q}$ ; see <a href="#">Figure 7</a>	[2]					
		$V_{CC} = 4.5$ V	-	18	44	-	53	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	15	-	-	-	ns
		n $\bar{S}D$ to nQ, n $\bar{Q}$ ; see <a href="#">Figure 8</a>	[2]					
		$V_{CC} = 4.5$ V	-	23	50	-	60	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	18	-	-	-	ns
		n $\bar{R}D$ to nQ, n $\bar{Q}$ ; see <a href="#">Figure 8</a>	[2]					
		$V_{CC} = 4.5$ V	-	24	50	-	60	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	18	-	-	-	ns
		$t_t$	transition time	nQ, n $\bar{Q}$ ; see <a href="#">Figure 7</a>	[3]			
$V_{CC} = 4.5$ V	-			7	19	-	22	ns
$t_w$	pulse width	nCP HIGH or LOW; see <a href="#">Figure 7</a>						
		$V_{CC} = 4.5$ V	23	9	-	27	-	ns
		n $\bar{S}D$ , n $\bar{R}D$ LOW; see <a href="#">Figure 8</a>						
		$V_{CC} = 4.5$ V	20	9	-	24	-	ns
$t_{rec}$	recovery time	n $\bar{S}D$ , n $\bar{R}D$ ; see <a href="#">Figure 8</a>						
		$V_{CC} = 4.5$ V	8	1	-	9	-	ns
$t_{su}$	set-up time	nD to nCP; see <a href="#">Figure 7</a>						
		$V_{CC} = 4.5$ V	15	5	-	18	-	ns

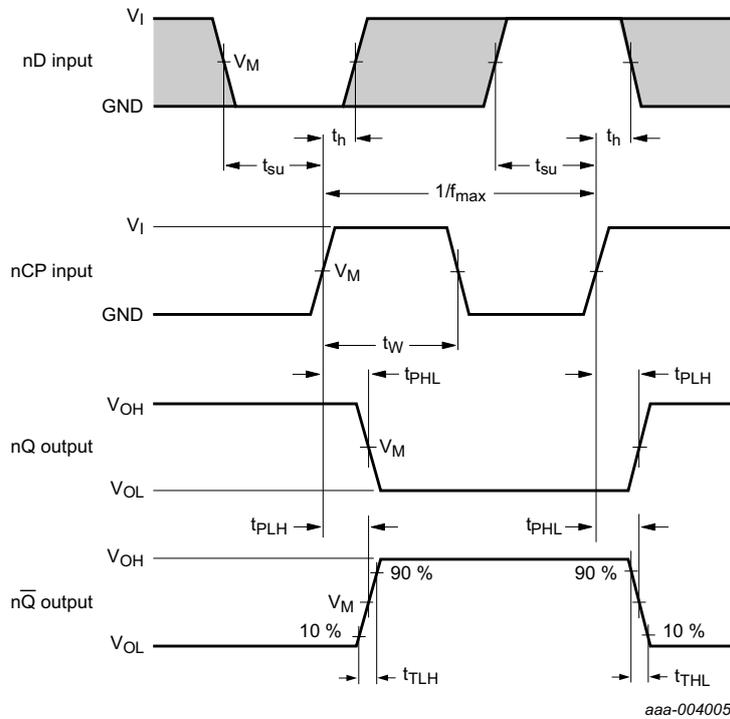
**Table 8. Dynamic characteristics ...continued**

Voltages are referenced to GND (ground = 0 V);  $C_L = 50$  pF unless otherwise specified; for test circuit see [Figure 9](#).

Symbol	Parameter	Conditions	$T_{amb} = -40$ °C to $+85$ °C			$T_{amb} = -40$ °C to $+125$ °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
$t_h$	hold time	nD to nCP; see <a href="#">Figure 7</a> $V_{CC} = 4.5$ V	3	-3	-	3	-	ns
$f_{max}$	maximum frequency	nCP; see <a href="#">Figure 7</a> $V_{CC} = 4.5$ V	22	54	-	18	-	MHz
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	59	-	-	-	MHz
$C_{PD}$	power dissipation capacitance	$C_L = 50$ pF; $f = 1$ MHz; $V_1 = GND$ to $V_{CC} - 1.5$ V	[4]	29	-	-	-	pF

- [1] All typical values are measured at  $T_{amb} = 25$  °C.
- [2]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .
- [3]  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$ .
- [4]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu$ 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.

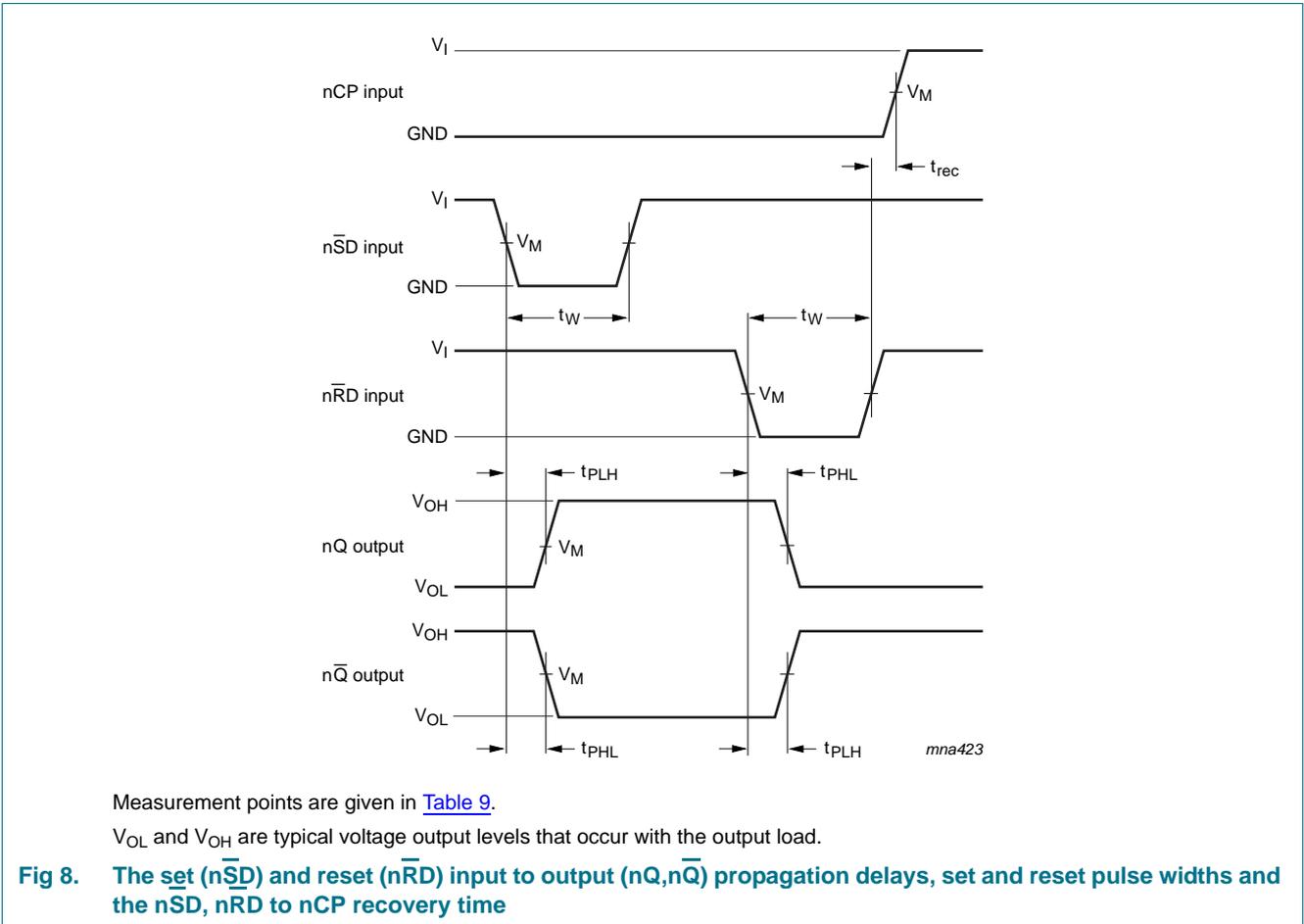
11. Waveforms



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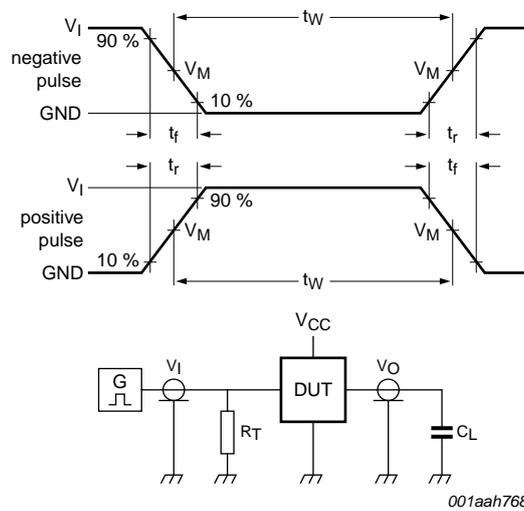
Measurement points are given in [Table 9](#).  
 $V_{OL}$  and  $V_{OH}$  are typical voltage output levels that occur with the output load.

**Fig 7. Propagation delay input (CP) to output (Qn), output transition time, clock input (CP) pulse width and the maximum frequency (CP)**



**Table 9. Measurement points**

Type	Input	Output
	$V_M$	$V_M$
74HC74-Q100	$0.5V_{CC}$	$0.5V_{CC}$
74HCT74-Q100	1.3 V	1.3 V



001aah768

Test data is given in [Table 10](#).

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.

$R_L$  = Load resistance.

S1 = Test selection switch.

**Fig 9. Test circuit for measuring switching times**

**Table 10. Test data**

Type	Input		Load		Test
	$V_I$	$t_r, t_f$	$C_L$	$R_L$	
74HC74-Q100	$V_{CC}$	6 ns	15 pF, 50 pF	1 k $\Omega$	$t_{PLH}, t_{PHL}$
74HCT74-Q100	3 V	6 ns	15 pF, 50 pF	1 k $\Omega$	$t_{PLH}, t_{PHL}$

12. Package outline

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

SOT108-1

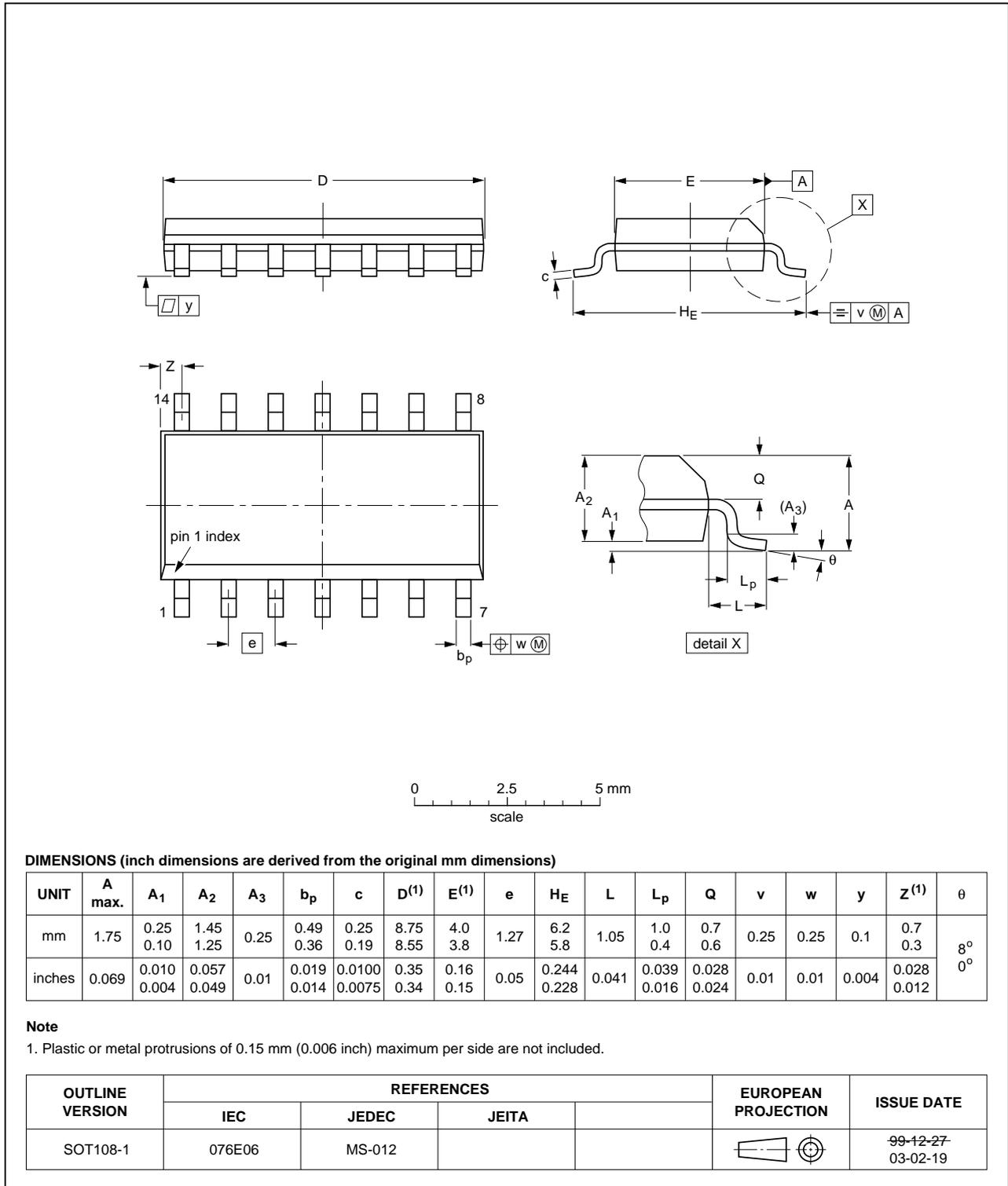


Fig 10. Package outline SOT108-1 (SO14)

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

SOT402-1

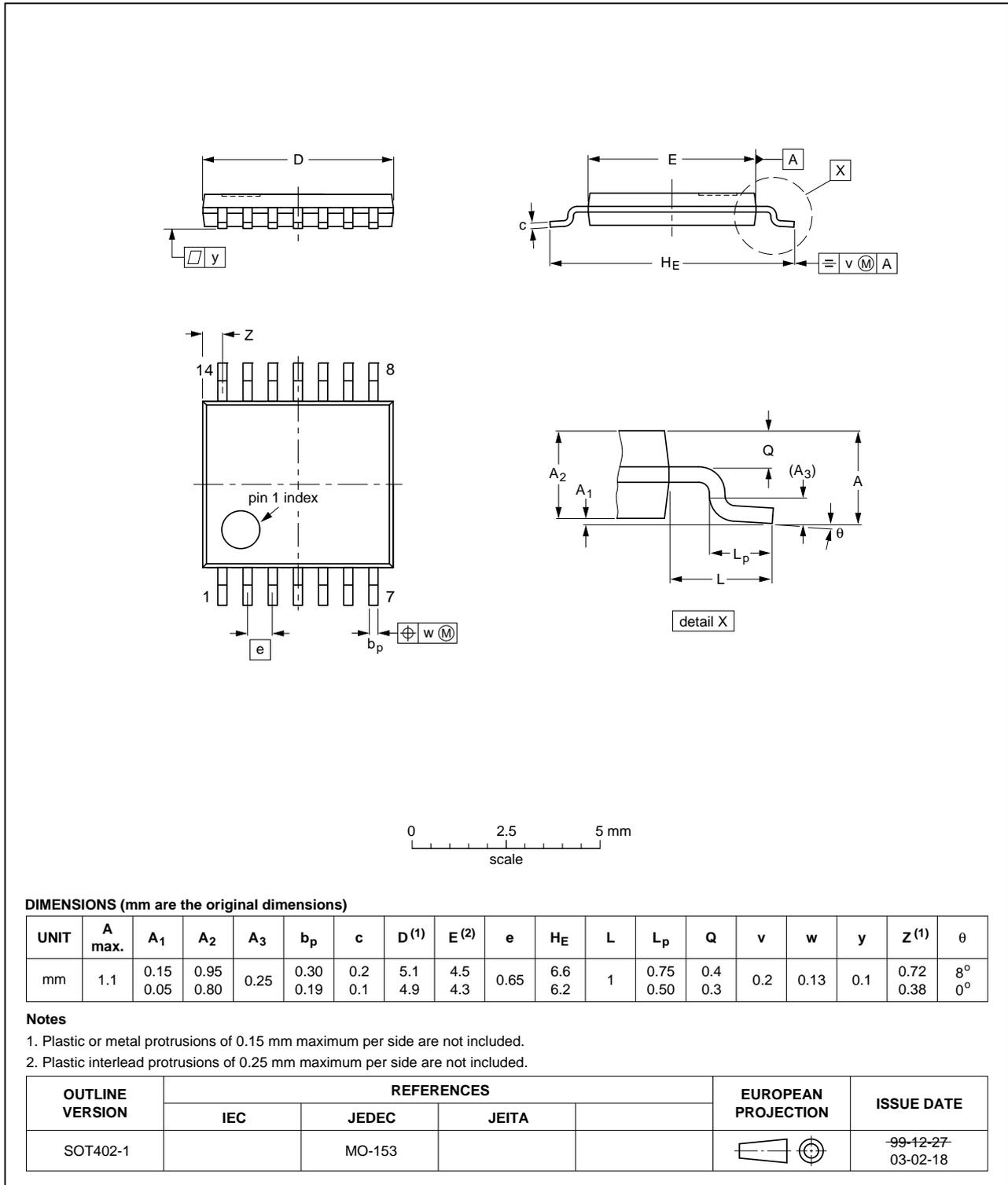
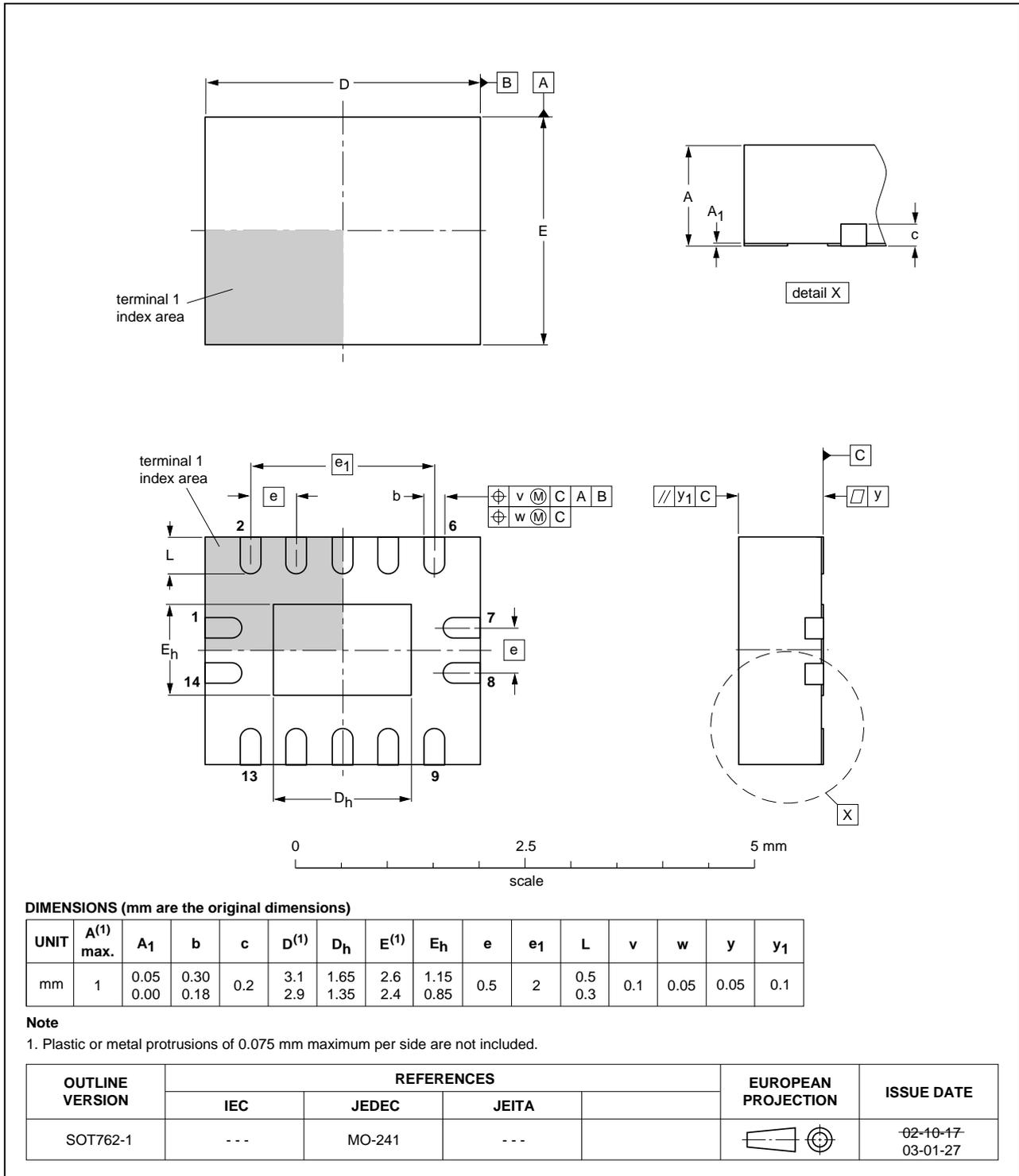


Fig 11. Package outline SOT402-1 (TSSOP14)

**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 12. Package outline SOT762-1 (DHVQFN14)**

## 13. Abbreviations

Table 11. Abbreviations

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
MM	Machine Model
TTL	Transistor-Transistor Logic

## 14. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT74_Q100 v.1	20120807	Product data sheet	-	-

## 15. Legal information

### 15.1 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".

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## 17. Contents

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<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>Ordering information</b> .....	<b>2</b>
<b>4</b>	<b>Functional diagram</b> .....	<b>2</b>
<b>5</b>	<b>Pinning information</b> .....	<b>3</b>
5.1	Pinning .....	3
5.2	Pin description .....	4
<b>6</b>	<b>Functional description</b> .....	<b>4</b>
<b>7</b>	<b>Limiting values</b> .....	<b>5</b>
<b>8</b>	<b>Recommended operating conditions</b> .....	<b>5</b>
<b>9</b>	<b>Static characteristics</b> .....	<b>5</b>
<b>10</b>	<b>Dynamic characteristics</b> .....	<b>7</b>
<b>11</b>	<b>Waveforms</b> .....	<b>10</b>
<b>12</b>	<b>Package outline</b> .....	<b>13</b>
<b>13</b>	<b>Abbreviations</b> .....	<b>16</b>
<b>14</b>	<b>Revision history</b> .....	<b>16</b>
<b>15</b>	<b>Legal information</b> .....	<b>17</b>
15.1	Data sheet status .....	17
15.2	Definitions .....	17
15.3	Disclaimers .....	17
15.4	Trademarks .....	18
<b>16</b>	<b>Contact information</b> .....	<b>18</b>
<b>17</b>	<b>Contents</b> .....	<b>19</b>

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