

74HC393-Q100; 74HCT393-Q100

Dual 4-bit binary ripple counter

Rev. 1 — 19 June 2014

Product data sheet

1. General description

The 74HC393-Q100; 7474HCT393-Q100 is a dual 4-stage binary ripple counter. Each counter features a clock input (\overline{nCP}), an overriding asynchronous master reset input (nMR) and 4 buffered parallel outputs ($nQ0$ to $nQ3$). The counter advances on the HIGH-to-LOW transition of \overline{nCP} . A HIGH on nMR clears the counter stages and forces the outputs LOW, independent of the state of \overline{nCP} . 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

- 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 74HC393-Q100: CMOS level
 - ◆ For 74HCT393-Q100: TTL level
- Complies 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 ($C = 200\text{ pF}$, $R = 0\text{ }\Omega$)
- Two 4-bit binary counters with individual clocks
- Divide by any binary module up to 28 in one package
- Two master resets to clear each 4-bit counter individually

3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC393D-Q100	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74HCT393D-Q100				
74HC393PW-Q100	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74HCT393PW-Q100				
74HC393BQ-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
74HCT393BQ-Q100				

4. Functional diagram

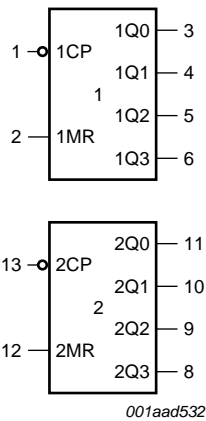


Fig 1. Logic symbol

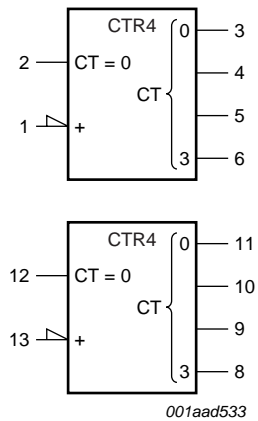


Fig 2. IEC logic symbol

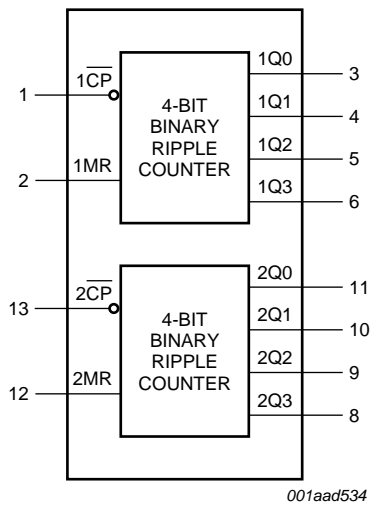


Fig 3. Functional diagram

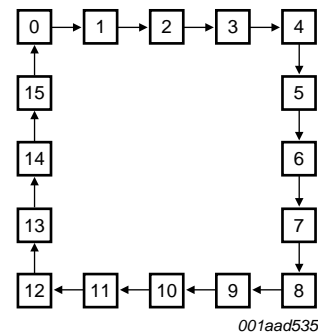


Fig 4. State diagram

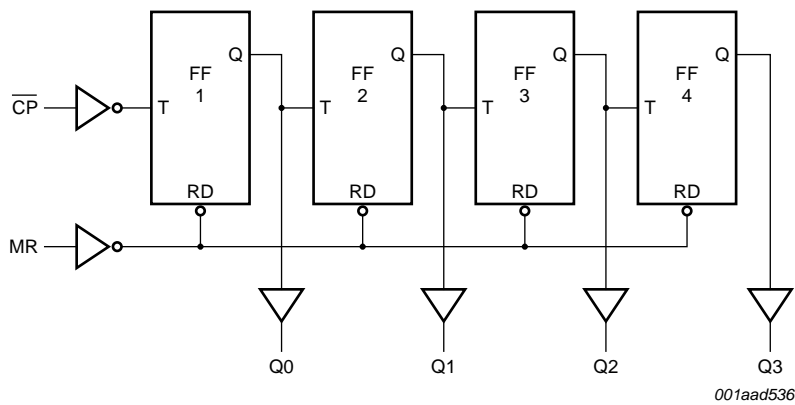


Fig 5. Logic diagram (one counter)

5. Pinning information

5.1 Pinning

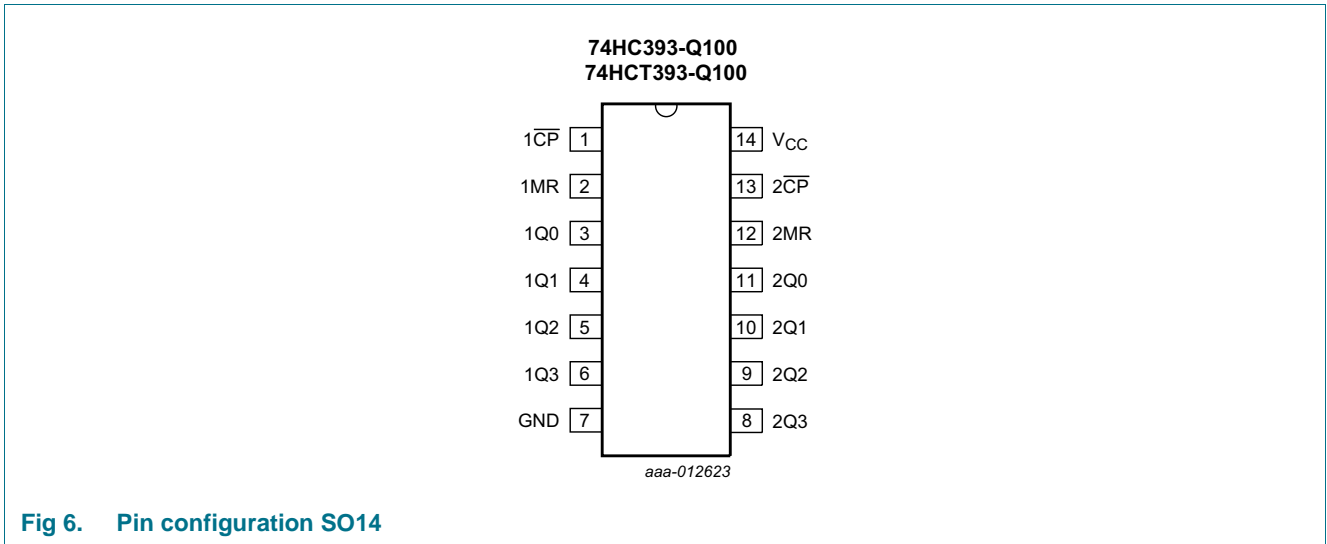


Fig 6. Pin configuration SO14

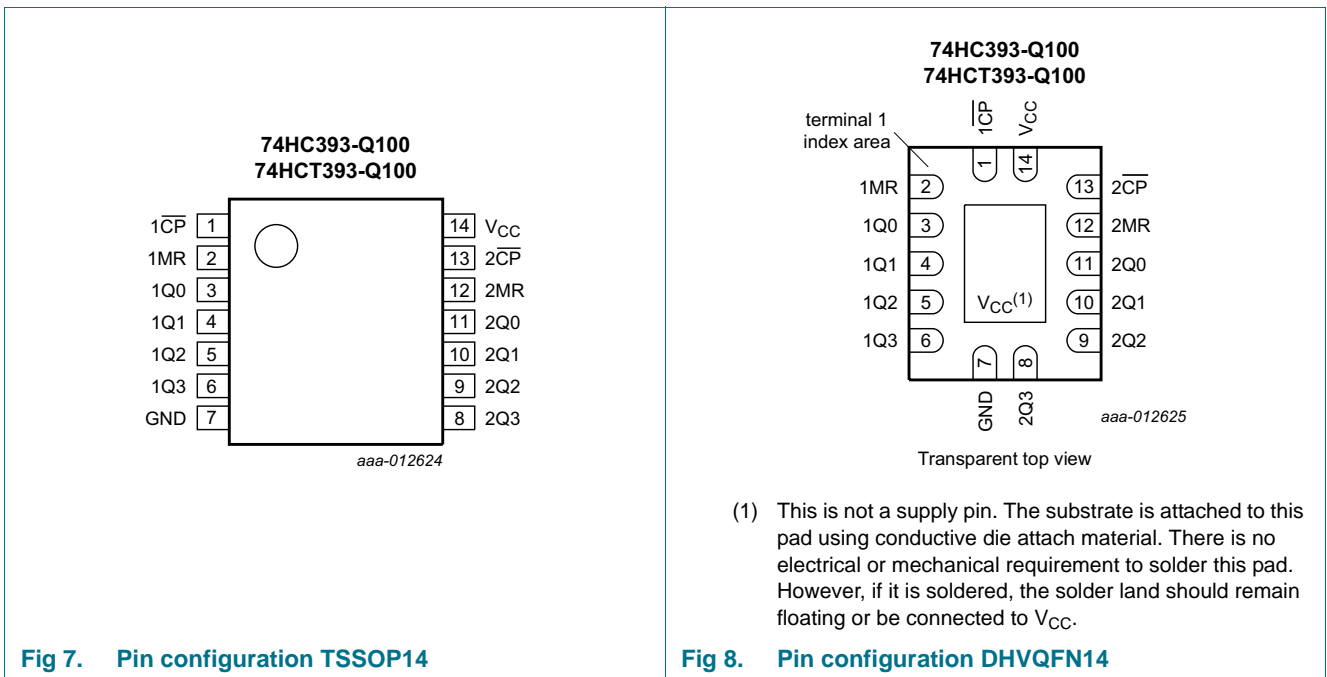
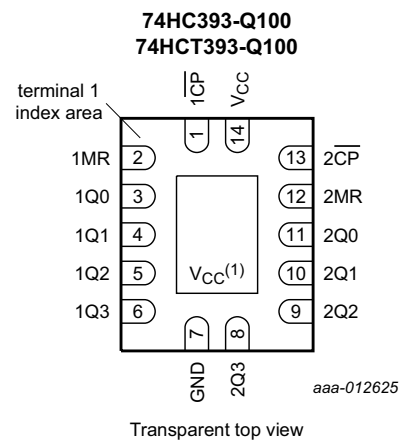


Fig 7. Pin configuration TSSOP14



- (1) This is not a supply pin. The substrate is attached to this pad using conductive die attach material. There is no electrical or mechanical requirement to solder this pad. However, if it is soldered, the solder land should remain floating or be connected to V_{CC}.

Fig 8. Pin configuration DHVQFN14

5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1 $\overline{\text{CP}}$	1	clock input (HIGH-to-LOW, edge-triggered)
1MR	2	asynchronous master reset input (active HIGH)
1Q0	3	flip-flop output
1Q1	4	flip-flop output
1Q2	5	flip-flop output
1Q3	6	flip-flop output
GND	7	ground (0 V)
2Q3	8	flip-flop output
2Q2	9	flip-flop output
2Q1	10	flip-flop output
2Q0	11	flip-flop output
2MR	12	asynchronous master reset input (active HIGH)
2 $\overline{\text{CP}}$	13	clock input (HIGH-to-LOW, edge-triggered)
V _{CC}	14	supply voltage

6. Functional description

Table 3. Count sequence for one counter [1]

Count	Output			
	nQ0	nQ1	nQ2	nQ3
0	L	L	L	L
1	H	L	L	L
2	L	H	L	L
3	H	H	L	L
4	L	L	H	L
5	H	L	H	L
6	L	H	H	L
7	H	H	H	L
8	L	L	L	H
9	H	L	L	H
10	L	H	L	H
11	H	H	L	H
12	L	L	H	H
13	H	L	H	H
14	L	H	H	H
15	H	H	H	H

[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	V
I_{IK}	input clamping current	$V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$	-	± 20	mA
I_{OK}	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$	-	± 20	mA
I_O	output current	$V_O = -0.5\text{ V}$ to $V_{CC} + 0.5\text{ V}$	-	± 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		[1]	500	mW

- [1] 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.

8. Recommended operating conditions

Table 5. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC393-Q100			74HCT393-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
Δt/ΔV	input transition rise and fall rate	V _{CC} = 2.0 V	-	-	625	-	-	-	ns/V
		V _{CC} = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V _{CC} = 6.0 V	-	-	83	-	-	-	ns/V

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	
74HC393-Q100										
V _{IH}	HIGH-level input voltage	V _{CC} = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
		V _{CC} = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V _{CC} = 6.0 V	4.2	3.2	-	4.2	-	4.2	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V _{CC} = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V _{CC} = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = -20 μA; V _{CC} = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I _O = -20 μA; V _{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -20 μA; 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 mA; V _{CC} = 6.0 V	5.48	5.81	-	5.34	-	5.2	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = 20 μA; V _{CC} = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 μA; V _{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 μA; V _{CC} = 6.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 4.0 mA; V _{CC} = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
		I _O = 5.2 mA; V _{CC} = 6.0 V	-	0.16	0.26	-	0.33	-	0.4	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 6.0 V	-	-	±0.1	-	±0.1	-	±0.1	μA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V	-	-	8.0	-	80	-	160	μA

Table 6. Static characteristics ...continued

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	
C _I	input capacitance		-	3.5	-					pF
74HCT393-Q100										
V _{IH}	HIGH-level input voltage	V _{CC} = 4.5 V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 4.5 V to 5.5 V	-	1.2	0.8	-	0.8	-	0.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = -20 µA	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -6 mA	3.98	4.32	-	3.84	-	3.7	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = 20 µA	-	0	0.1	-	0.1	-	0.1	V
		I _O = 6.0 mA	-	0.15	0.26	-	0.33	-	0.4	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 5.5 V	-	-	±0.1	-	±1.0	-	±1.0	µA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V	-	-	8.0	-	80	-	160	µA
ΔI _{CC}	additional supply current	V _I = V _{CC} - 2.1 V; other inputs at V _{CC} or GND; V _{CC} = 4.5 V to 5.5 V; I _O = 0 A								
		per input pin; nCP	-	40	144	-	180	-	196	µA
		per input pin; nMR	-	100	360	-	450	-	490	µA
C _I	input capacitance		-	3.5	-					pF

10. Dynamic characteristics

Table 7. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); $C_L = 50$ pF unless otherwise specified; for test circuit see [Figure 11](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC393-Q100										
t_{pd}	propagation delay	\overline{nCP} to nQ0; see Figure 9 [1]								
		$V_{CC} = 2.0$ V	-	41	125	-	155	-	190	ns
		$V_{CC} = 4.5$ V	-	15	25	-	31	-	38	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	12	-	-	-	-	-	ns
		$V_{CC} = 6.0$ V	-	12	21	-	26	-	32	ns
		nQx to nQ(x+1); see Figure 9 [1]								
		$V_{CC} = 2.0$ V	-	14	45	-	55	-	70	ns
		$V_{CC} = 4.5$ V	-	5	9	-	11	-	14	ns
$V_{CC} = 5$ V; $C_L = 15$ pF	-	5	-	-	-	-	-	ns		
$V_{CC} = 6.0$ V	-	4	8	-	9	-	12	ns		
t_{PHL}	HIGH to LOW propagation delay	nMR to nQx; see Figure 10								
		$V_{CC} = 2.0$ V	-	39	140	-	175	-	210	ns
		$V_{CC} = 4.5$ V	-	14	28	-	35	-	42	ns
		$V_{CC} = 5$ V; $C_L = 15$ pF	-	11	-	-	-	-	-	ns
$V_{CC} = 6.0$ V	-	11	24	-	30	-	36	ns		
t_t	transition time	Qn; see Figure 9 [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	-	16	-	19	ns
t_w	pulse width	\overline{nCP} HIGH or LOW; see Figure 9								
		$V_{CC} = 2.0$ V	80	17	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	6	-	20	-	24	-	ns
		$V_{CC} = 6.0$ V	14	5	-	17	-	20	-	ns
		nMR HIGH; see Figure 10								
		$V_{CC} = 2.0$ V	80	19	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	7	-	20	-	24	-	ns
$V_{CC} = 6.0$ V	14	6	-	17	-	20	-	ns		
t_{rec}	recovery time	nMR to \overline{nCP} ; see Figure 10								
		$V_{CC} = 2.0$ V	5	3	-	5	-	5	-	ns
		$V_{CC} = 4.5$ V	5	1	-	5	-	5	-	ns
		$V_{CC} = 6.0$ V	5	1	-	5	-	5	-	ns

Table 7. Dynamic characteristics ...continued

Voltages are referenced to GND (ground = 0 V); $C_L = 50$ pF unless otherwise specified; for test circuit see [Figure 11](#).

Symbol	Parameter	Conditions	25 °C			−40 °C to +85 °C		−40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$f_{\text{clk(max)}}$	maximum clock frequency	see Figure 9								
		$V_{\text{CC}} = 2.0$ V	6	30	-	5	-	4	-	MHz
		$V_{\text{CC}} = 4.5$ V	30	90	-	24	-	20	-	MHz
		$V_{\text{CC}} = 5$ V; $C_L = 15$ pF	-	99	-	-	-	-	-	MHz
		$V_{\text{CC}} = 6.0$ V	35	107	-	28	-	24	-	MHz
C_{PD}	power dissipation capacitance	$C_L = 50$ pF; $f = 1$ MHz; $V_I = \text{GND to } V_{\text{CC}}$ [3]	-	23	-	-	-	-	-	pF
74HCT393-Q100										
t_{pd}	propagation delay	$\overline{\text{nCP}}$ to nQ0 ; see Figure 9 [1]								
		$V_{\text{CC}} = 4.5$ V	-	15	25	-	31	-	38	ns
		$V_{\text{CC}} = 5$ V; $C_L = 15$ pF	-	20	-	-	-	-	-	ns
		nQx to nQ(x+1) ; see Figure 9 [1]								
		$V_{\text{CC}} = 4.5$ V	-	6	10	-	13	-	15	ns
		$V_{\text{CC}} = 5$ V; $C_L = 15$ pF	-	6	-	-	-	-	ns	
t_{PHL}	HIGH to LOW propagation delay	nMR to nQx ; see Figure 10								
		$V_{\text{CC}} = 4.5$ V	-	18	32	-	40	-	48	ns
		$V_{\text{CC}} = 5$ V; $C_L = 15$ pF	-	15	-	-	-	-	-	ns
t_t	transition time	Qn ; see Figure 9 [2]								
		$V_{\text{CC}} = 4.5$ V	-	7	15	-	19	-	22	ns
t_{W}	pulse width	nCP HIGH or LOW; see Figure 9								
		$V_{\text{CC}} = 4.5$ V	19	11	-	24	-	29	-	ns
		nMR HIGH; see Figure 10								
		$V_{\text{CC}} = 4.5$ V	16	6	-	20	-	24	-	ns
t_{rec}	recovery time	nMR to nCP ; see Figure 10								
		$V_{\text{CC}} = 4.5$ V	5	0	-	5	-	5	-	ns
$f_{\text{clk(max)}}$	maximum clock frequency	see Figure 9								
		$V_{\text{CC}} = 4.5$ V	27	48	-	22	-	18	-	MHz
		$V_{\text{CC}} = 5$ V; $C_L = 15$ pF	-	53	-	-	-	-	-	MHz

Table 7. Dynamic characteristics ...continued

Voltages are referenced to GND (ground = 0 V); $C_L = 50$ pF unless otherwise specified; for test circuit see [Figure 11](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
C_{PD}	power dissipation capacitance	$C_L = 50$ pF; $f = 1$ MHz; $V_I = \text{GND to } V_{CC} - 1.5$ V	-	25	-	-	-	-	-	pF

- [1] t_{pd} is the same as t_{PLH} and t_{PHL} .
- [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 μW).
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o)$ 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.

10.1 Waveforms

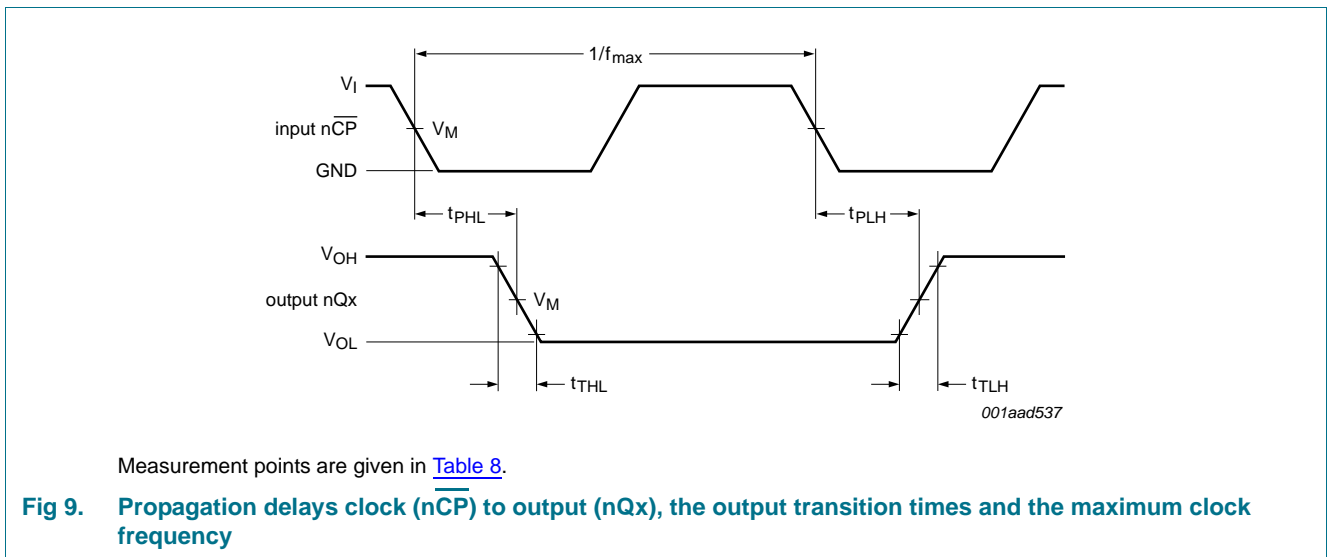
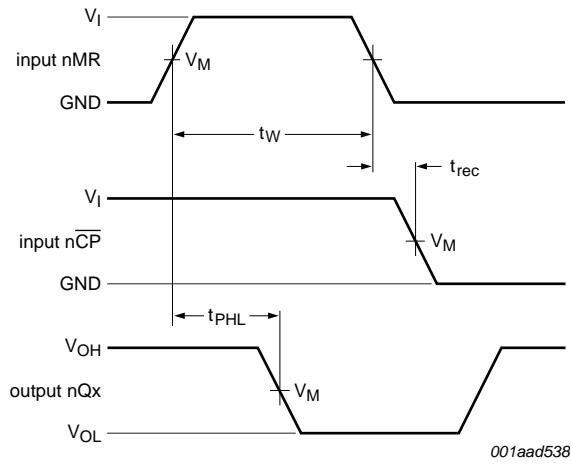


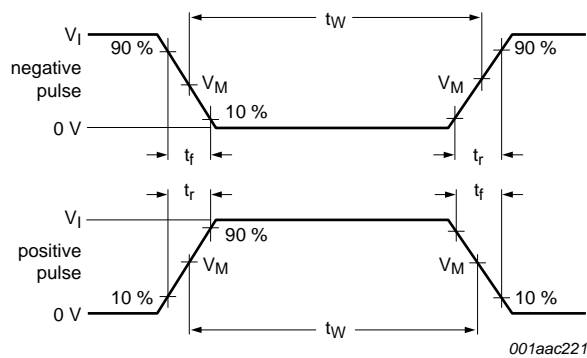
Table 8. Measurement points

Type	Input	Output
	V_M	V_M
74HC393-Q100	$0.5V_{CC}$	$0.5V_{CC}$
74HCT393-Q100	1.3 V	1.3 V



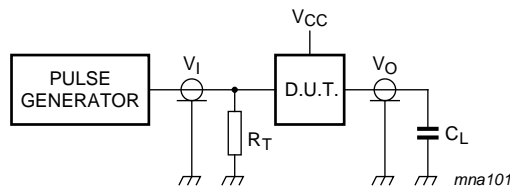
Measurement points are given in [Table 8](#).

Fig 10. Propagation delays clock (nCP) to output (nQx), pulse width master reset (nMR), and recovery time master reset (nMR) to clock (nCP)



Measurement points are given in [Table 8](#).

a. Input pulse definition



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.

b. Test circuit

Fig 11. Test circuit for measuring switching times

Table 9. Test data

Type	Input		Load
	V_I	t_r, t_f	C_L
74HC393-Q100	V_{CC}	6 ns	15 pF, 50 pF
74HCT393-Q100	3 V	6 ns	15 pF, 50 pF

11. Package outline

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

SOT108-1

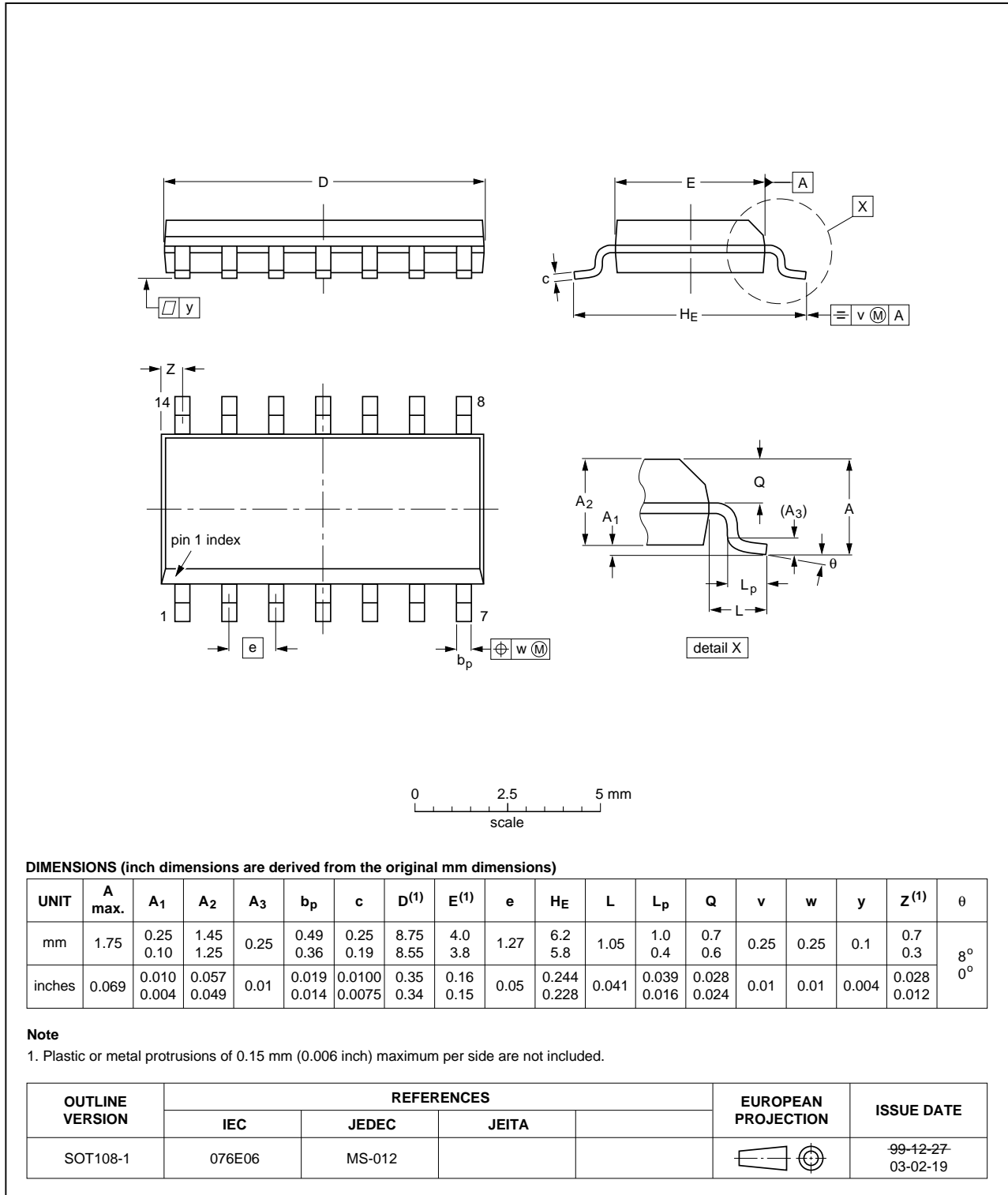


Fig 12. Package outline SOT108-1 (SO14)

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

SOT402-1

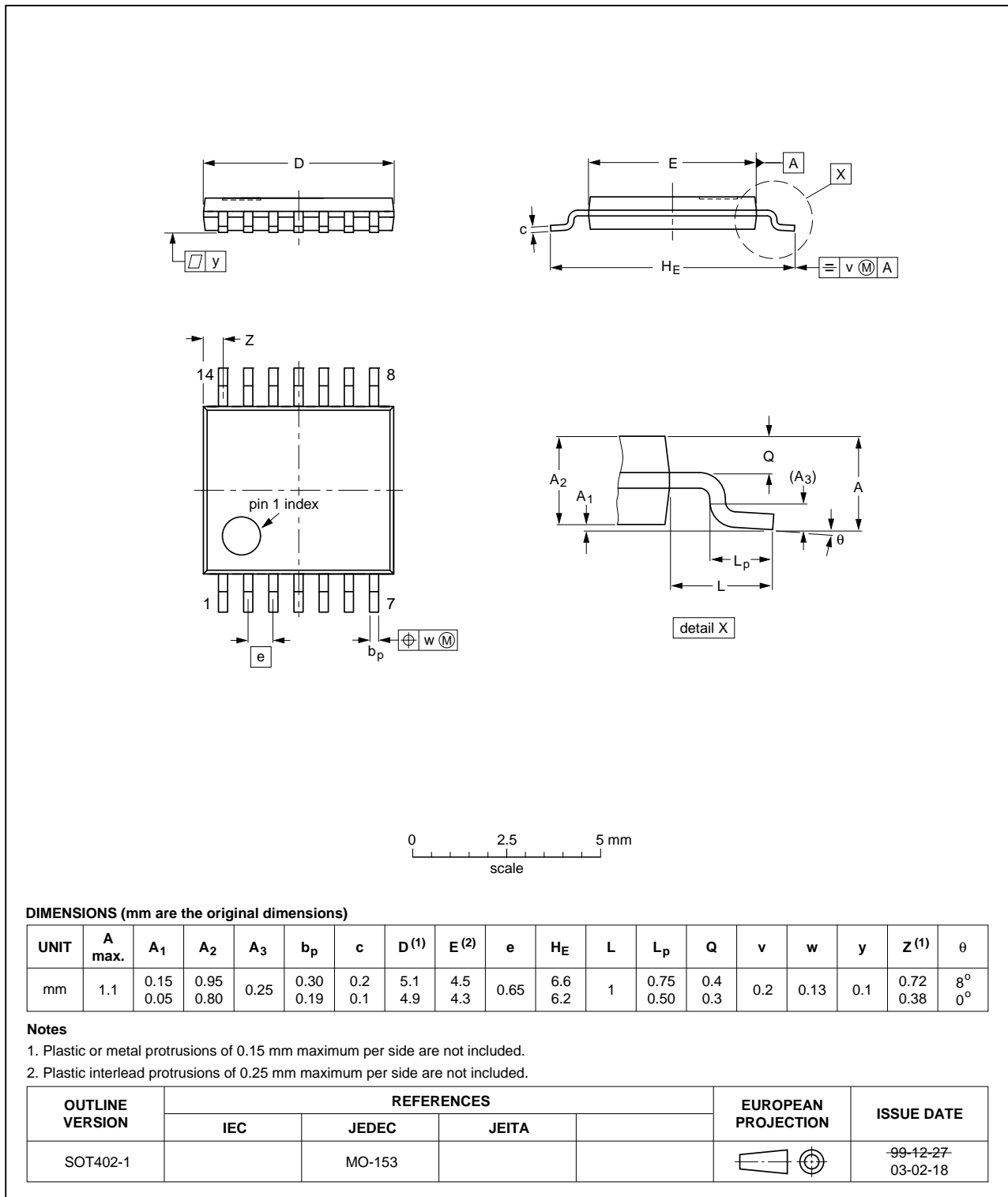


Fig 13. Package outline SOT402-1 (TSSOP14)

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

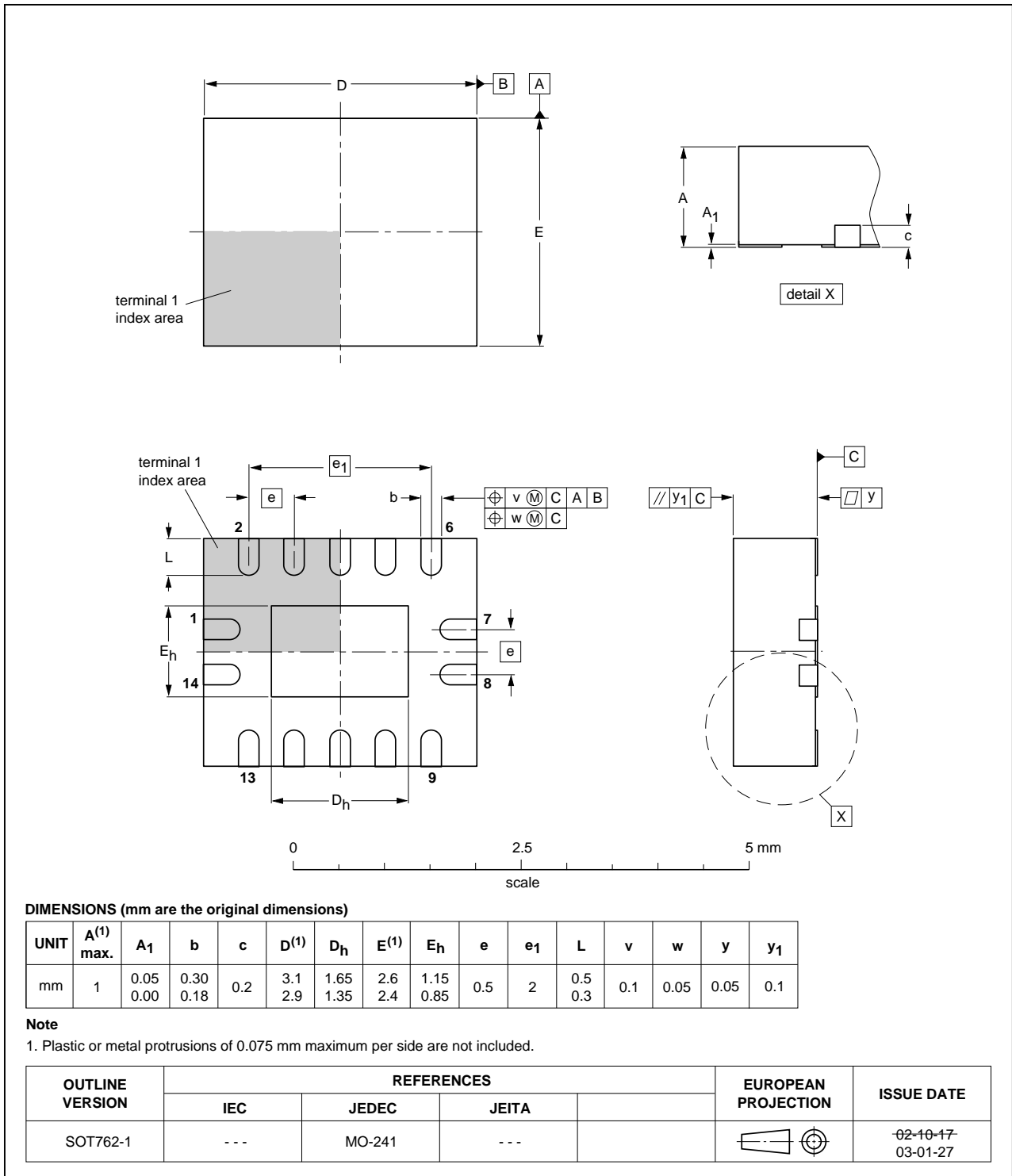


Fig 14. Package outline SOT762-1 (DHVQFN14)

12. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
MM	Machine Model

13. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT393_Q100 v.1	20140619	Product data sheet	-	-

14. Legal information

14.1 Data sheet status

Document status ^{[1][2]}	Product status ^[3]	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>.

14.2 Definitions

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15. Contact information

For more information, please visit: <http://www.nexperia.com>

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