

# 74HC393; 74HCT393

## Dual 4-bit binary ripple counter

Rev. 5 — 1 April 2014

Product data sheet

## 1. General description

The 74HC393; 7474HCT393 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  $V_{CC}$ .

## 2. Features and benefits

- Input levels:
  - ◆ For 74HC393: CMOS level
  - ◆ For 74HCT393: TTL level
- Complies with JEDEC standard no. 7A
- ESD protection:
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V.
- 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			
	Temperature range	Name	Description	Version
74HC393N	-40 °C to +125 °C	DIP14	plastic dual in-line package; 14 leads (300 mil)	SOT27-1
74HCT393N				
74HC393D	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
74HCT393D				
74HC393DB	-40 °C to +125 °C	SSOP14	plastic shrink small outline package; 14 leads; body width 5.3 mm	SOT337-1
74HCT393DB				
74HC393PW	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1
74HCT393PW				
74HC393BQ	-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				



## 4. Functional diagram

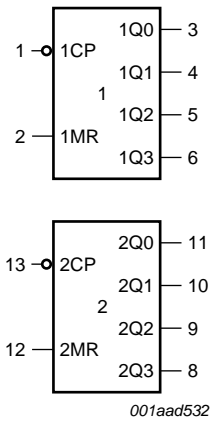


Fig 1. Logic symbol

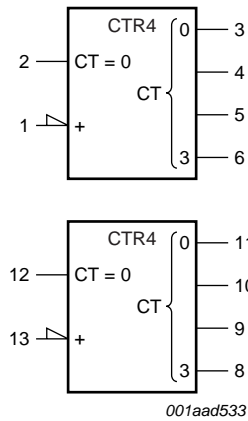


Fig 2. IEC logic symbol

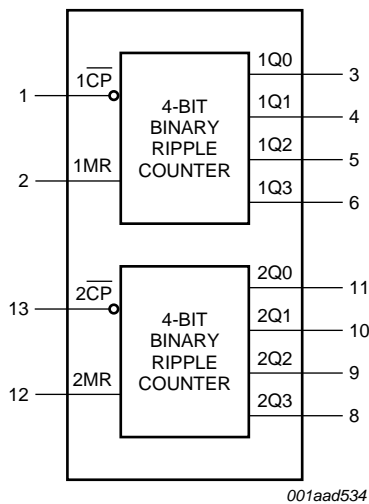


Fig 3. Functional diagram

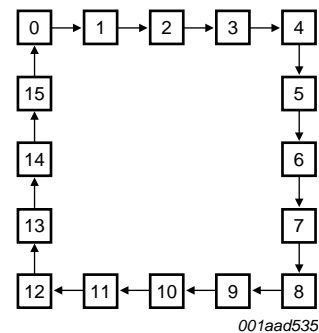


Fig 4. State diagram

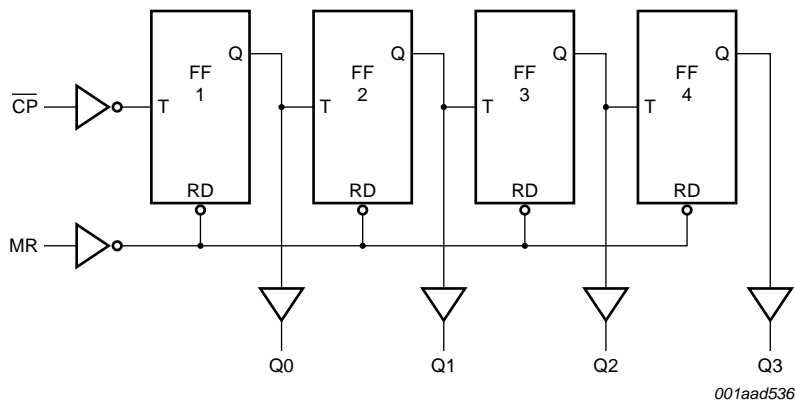


Fig 5. Logic diagram (one counter)

## 5. Pinning information

### 5.1 Pinning

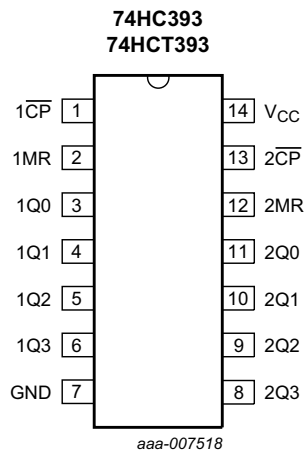
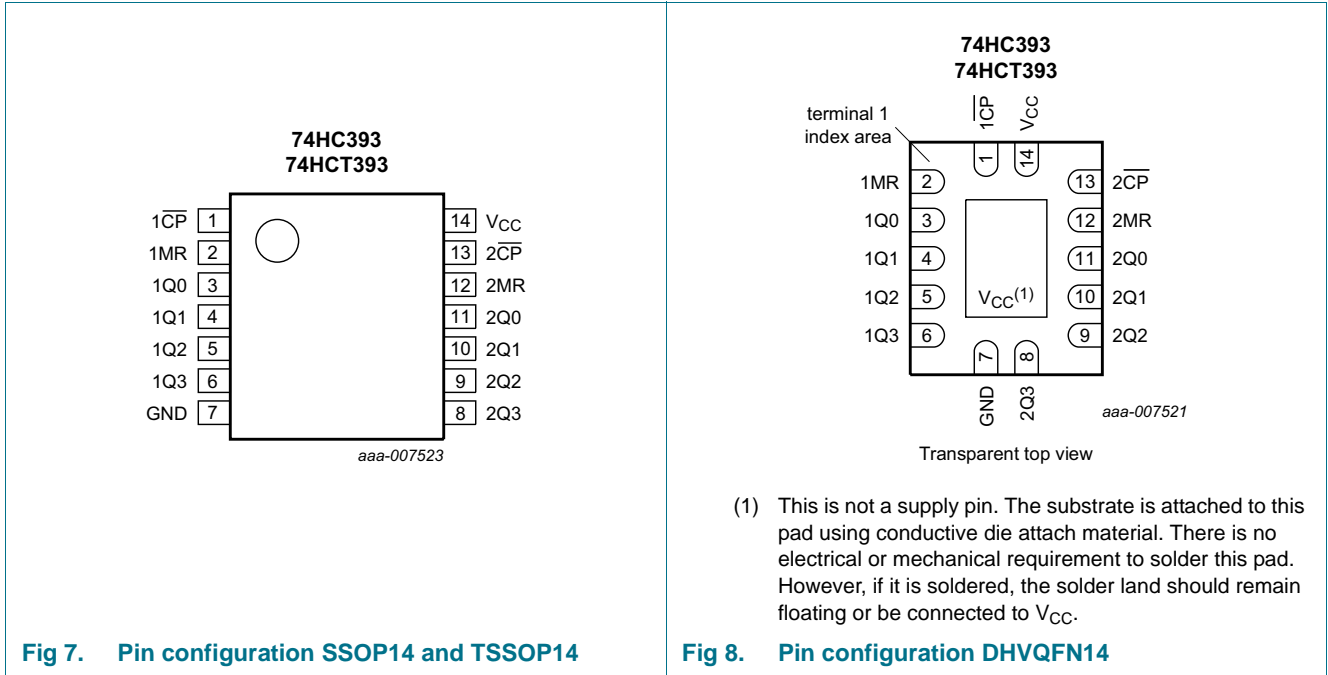


Fig 6. Pin configuration DIP14 and SO14



## 5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1CP	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)
2CP	13	clock input (HIGH-to-LOW, edge-triggered)
V <sub>CC</sub>	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 $V_I > V_{CC} + 0.5\text{ V}$	-	$\pm 20$	mA
$I_{OK}$	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$	-	$\pm 20$	mA
$I_O$	output current	$V_O = -0.5\text{ V}$ to $V_{CC} + 0.5\text{ V}$	-	$\pm 25$	mA
$I_{CC}$	supply current		-	$\pm 50$	mA
$I_{GND}$	ground current		-	$\pm 50$	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	DIP14 package [1]	-	750	mW
		SO14, SSOP14, TSSOP14 and DHVQFN14 package [2]	-	500	mW

[1] For DIP14 package:  $P_{tot}$  derates linearly with 12 mW/K above 70 °C.

[2] For SO14 package:  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.

For (T)SSOP14 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			74HCT393			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 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>74HC393</b>										
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
		V <sub>CC</sub> = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V <sub>CC</sub> = 6.0 V	4.2	3.2	-	4.2	-	4.2	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V <sub>CC</sub> = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V <sub>CC</sub> = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
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> = -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
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> = 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>l</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V	-	-	±0.1	-	±0.1	-	±0.1	μA
		V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 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 <sub>I</sub>	input capacitance		-	3.5	-					pF
<b>74HCT393</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	-	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	-	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> = -20 μA	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -6 mA	3.98	4.32	-	3.84	-	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> = 20 μA	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 6.0 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	-	-	8.0	-	80	-	160	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; nCP	-	40	144	-	180	-	196	μA
		per input pin; nMR	-	100	360	-	450	-	490	μA
C <sub>I</sub>	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	
<b>74HC393</b>										
$t_{pd}$	propagation delay	$\overline{nCP}$ to nQ0; see <a href="#">Figure 9</a> [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 <a href="#">Figure 9</a> [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 <a href="#">Figure 10</a>								
		$V_{CC} = 2.0$ 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 <a href="#">Figure 9</a> [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 <a href="#">Figure 9</a>								
		$V_{CC} = 2.0$ 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 <a href="#">Figure 10</a>								
		$V_{CC} = 2.0$ 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 <a href="#">Figure 10</a>								
		$V_{CC} = 2.0$ 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 <sub>clk(max)</sub>	maximum clock frequency	see <a href="#">Figure 9</a>								
		V <sub>CC</sub> = 2.0 V	6	30	-	5	-	4	-	MHz
		V <sub>CC</sub> = 4.5 V	30	90	-	24	-	20	-	MHz
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	99	-	-	-	-	-	MHz
		V <sub>CC</sub> = 6.0 V	35	107	-	28		24	-	MHz
C <sub>PD</sub>	power dissipation capacitance	C <sub>L</sub> = 50 pF; f = 1 MHz; V <sub>I</sub> = GND to V <sub>CC</sub> <a href="#">[3]</a>	-	23	-	-	-	-	-	pF
<b>74HCT393</b>										
t <sub>pd</sub>	propagation delay	nCP to nQ0; see <a href="#">Figure 9</a> <a href="#">[1]</a>								
		V <sub>CC</sub> = 4.5 V	-	15	25	-	31	-	38	ns
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	20	-	-	-	-	-	ns
		nQx to nQ(x+1); see <a href="#">Figure 9</a> <a href="#">[1]</a>								
		V <sub>CC</sub> = 4.5 V	-	6	10	-	13	-	15	ns
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	6	-	-	-	-	ns	
t <sub>PHL</sub>	HIGH to LOW propagation delay	nMR to nQx; see <a href="#">Figure 10</a>								
		V <sub>CC</sub> = 4.5 V	-	18	32	-	40	-	48	ns
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	15	-	-	-	-	-	ns
t <sub>t</sub>	transition time	Qn; see <a href="#">Figure 9</a> <a href="#">[2]</a>								
		V <sub>CC</sub> = 4.5 V	-	7	15	-	19	-	22	ns
t <sub>w</sub>	pulse width	nCP HIGH or LOW; see <a href="#">Figure 9</a>								
		V <sub>CC</sub> = 4.5 V	19	11	-	24	-	29	-	ns
		nMR HIGH; see <a href="#">Figure 10</a>								
		V <sub>CC</sub> = 4.5 V	16	6	-	20	-	24	-	ns
t <sub>rec</sub>	recovery time	nMR to nCP; see <a href="#">Figure 10</a>								
		V <sub>CC</sub> = 4.5 V	5	0	-	5	-	5	-	ns
f <sub>clk(max)</sub>	maximum clock frequency	see <a href="#">Figure 9</a>								
		V <sub>CC</sub> = 4.5 V	27	48	-	22	-	18	-	MHz
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	53	-	-	-	-	-	MHz

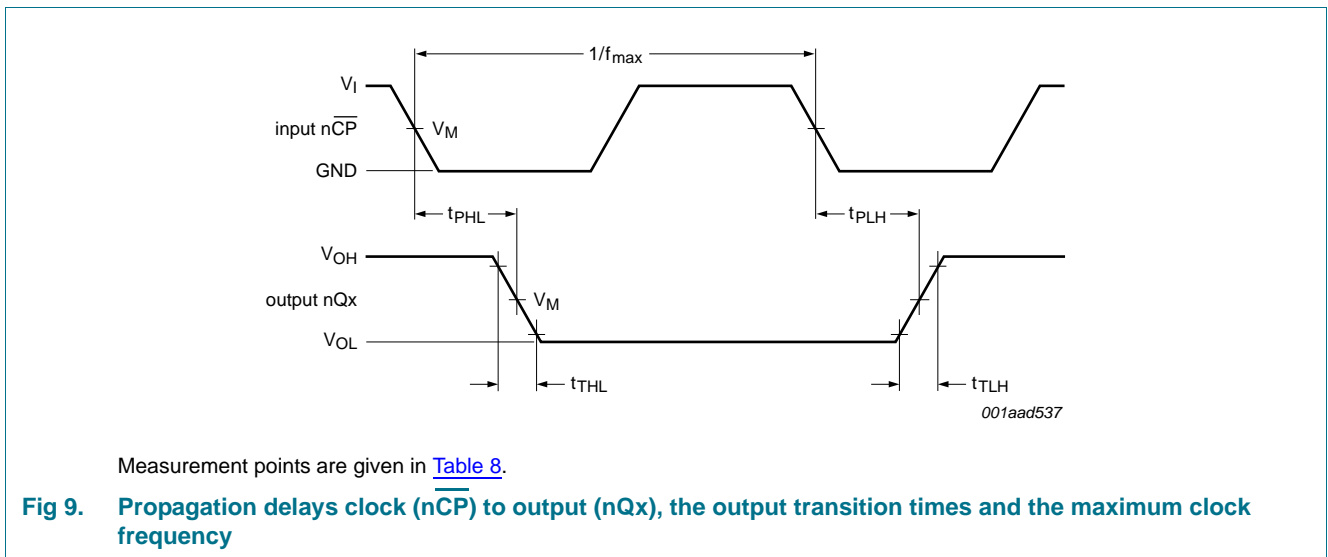
**Table 7. Dynamic characteristics ...continued**

*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; $V_I = GND$ to $V_{CC} - 1.5$ V	-	25	-	-	-	-	-	pF

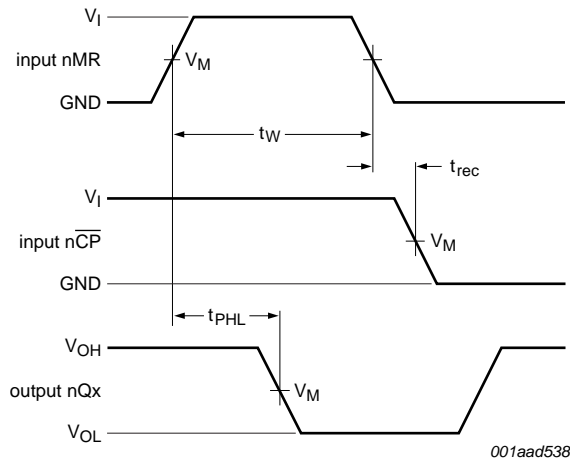
- [1]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .
- [2]  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$ .
- [3]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu W$ ).  
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o)$  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.

**10.1 Waveforms**



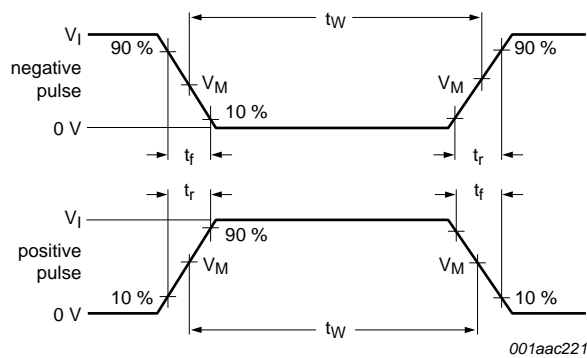
**Table 8. Measurement points**

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



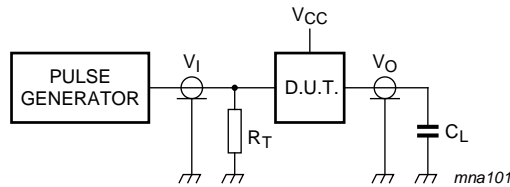
Measurement points are given in [Table 8](#).

**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	$V_{CC}$	6 ns	15 pF, 50 pF
74HCT393	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

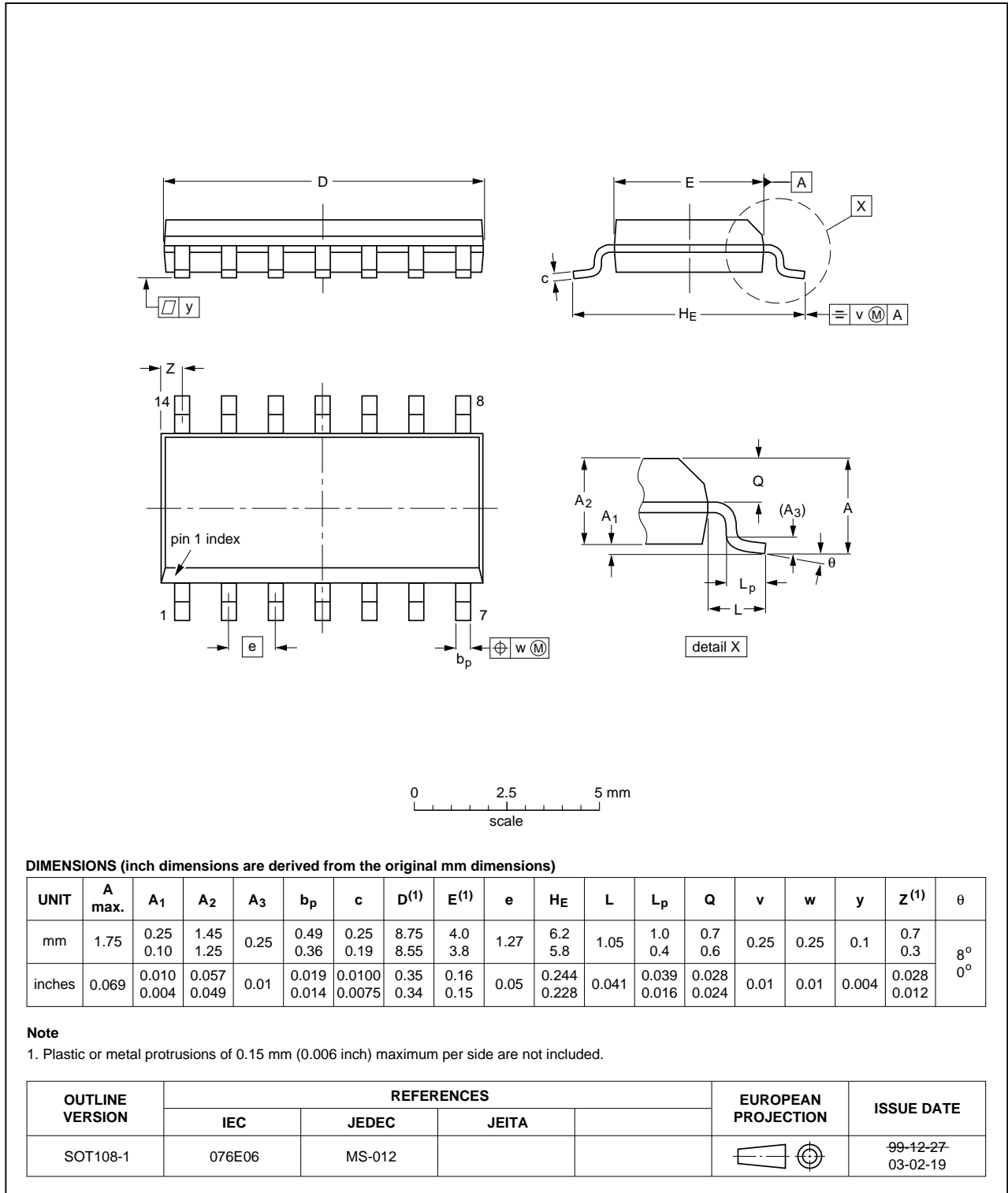


Fig 12. Package outline SOT108-1 (SO14)

DIP14: plastic dual in-line package; 14 leads (300 mil)

SOT27-1

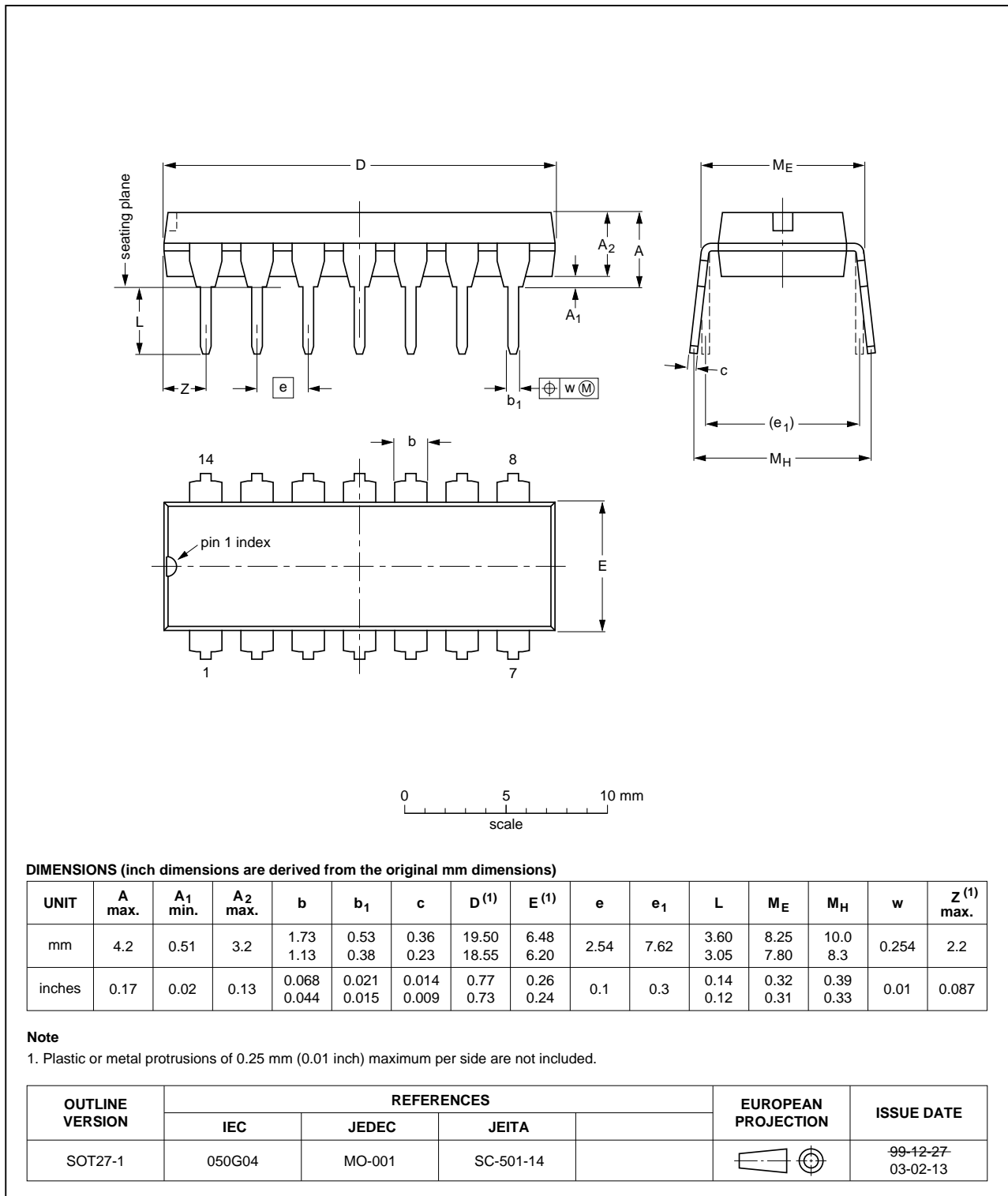


Fig 13. Package outline SOT27-1 (DIP14)

SSOP14: plastic shrink small outline package; 14 leads; body width 5.3 mm

SOT337-1

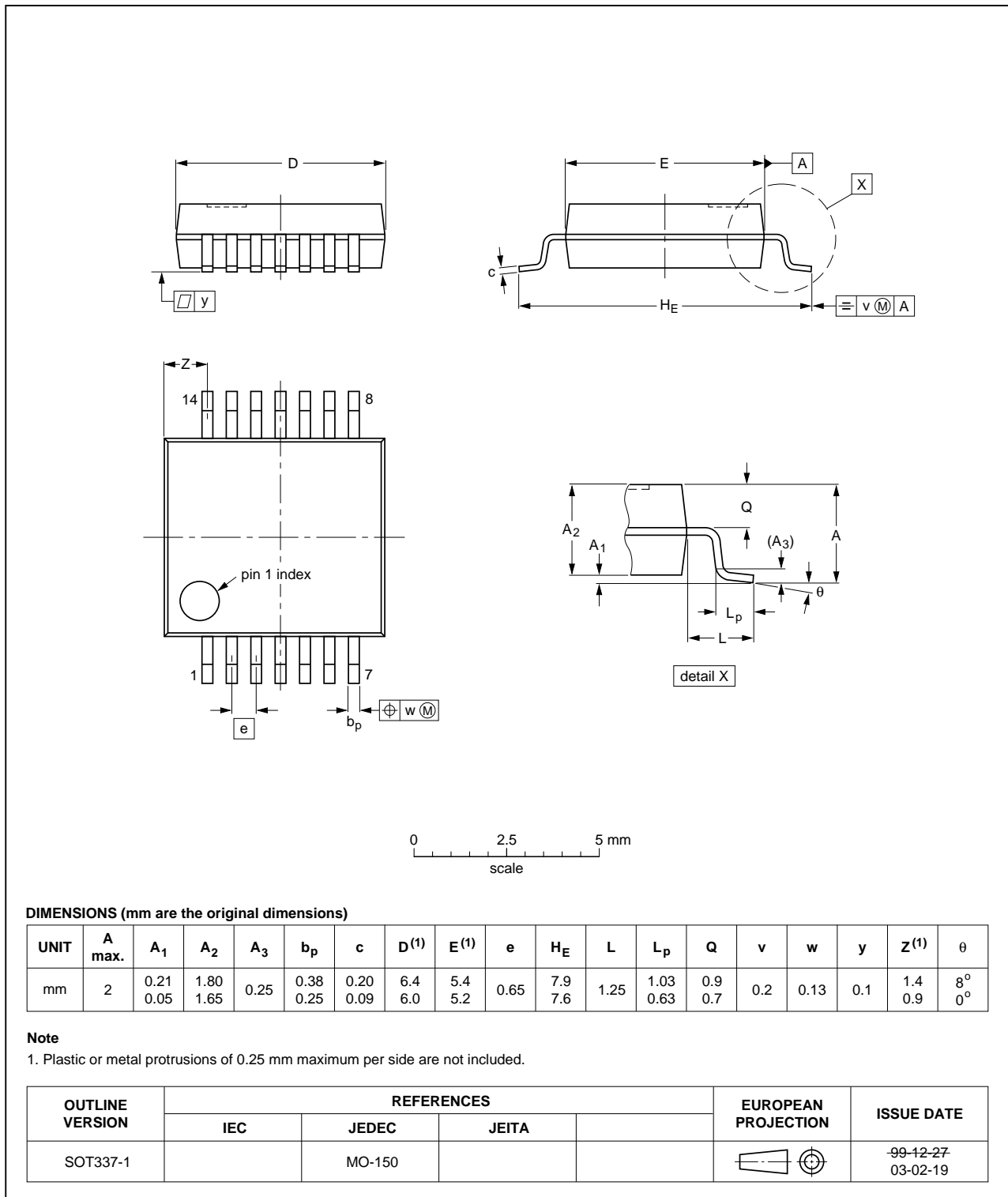


Fig 14. Package outline SOT337-1 (SSOP14)

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

SOT402-1

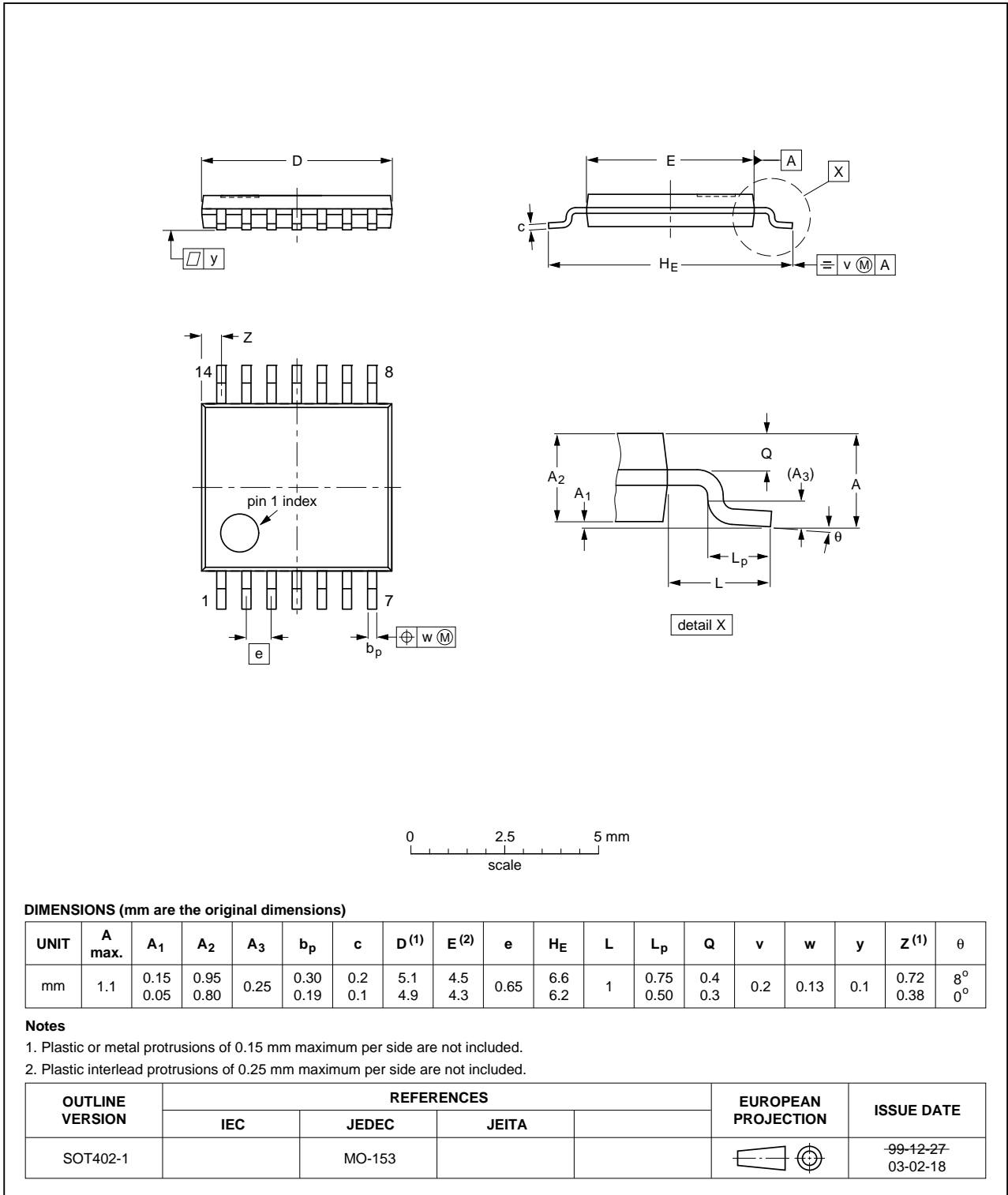


Fig 15. Package outline SOT402-1 (TSSOP14)



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

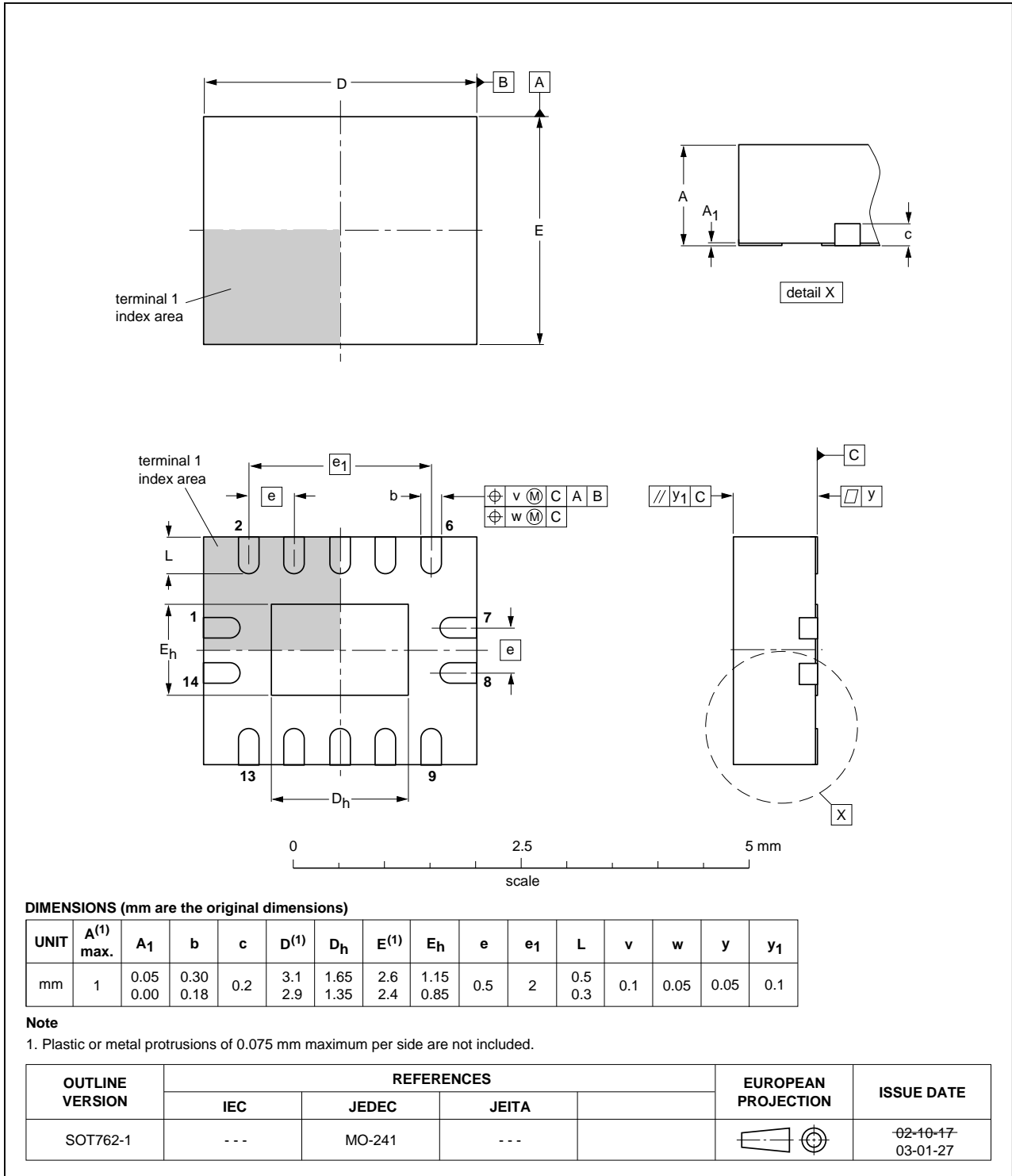


Fig 16. Package outline SOT762-1 (DHVQFN14)

## 12. Abbreviations

Table 10. Abbreviations

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

## 13. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT393 v.5	20140401	Product data sheet	-	74HC_HCT393 v.4
Modifications:	<ul style="list-style-type: none"> <li>The conditions for <math>C_{PD}</math> have been corrected (errata).</li> </ul>			
74HC_HCT393 v.4	20130516	Product data sheet	-	74HC_HCT393 v.3
Modifications:	<ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> </ul>			
74HC_HCT393 v.3	20050906	Product data sheet	-	74HC_HCT393_CNV v.2
74HC_HCT393_CNV v.2	19901201	Product specification	-	-

## 14. Legal information

### 14.1 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.nxp.com>.

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Date of release: 1 April 2014

Document identifier: 74HC\_HCT393

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