

# 74HC160

Presettable synchronous BCD decade counter;  
asynchronous reset

Rev. 3 — 27 September 2016

Product data sheet

## 1. General description

The 74HC160 is a synchronous presettable decade counter with an internal look-ahead carry. Synchronous operation is provided by having all flip-flops clocked simultaneously on the positive-going edge of the clock (CP). The outputs (Q0 to Q3) of the counters may be preset HIGH or LOW. A LOW at the parallel enable input ( $\overline{PE}$ ) disables the counting action and causes the data at the data inputs (D0 to D3) to be loaded into the counter on the positive-going edge of the clock. Preset takes place regardless of the levels at count enable inputs (CEP and CET). A LOW at the master reset input ( $\overline{MR}$ ) sets Q0 to Q3 LOW regardless of the levels at input pins CP,  $\overline{PE}$ , CET and CEP (thus providing an asynchronous clear function). The look-ahead carry simplifies serial cascading of the counters. Both CEP and CET must be HIGH to count. The CET input is fed forward to enable the terminal count output (TC). The TC output thus enabled will produce a HIGH output pulse of a duration approximately equal to a HIGH output of Q0. This pulse can be used to enable the next cascaded stage. The maximum clock frequency for the cascaded counters is determined by the CP to TC propagation delay and CEP to CP set-up time, according to the following formula:

$$f_{max} = \frac{1}{t_{P(max)}(CPtoTC) + t_{SU}(CEPtoCP)}$$

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

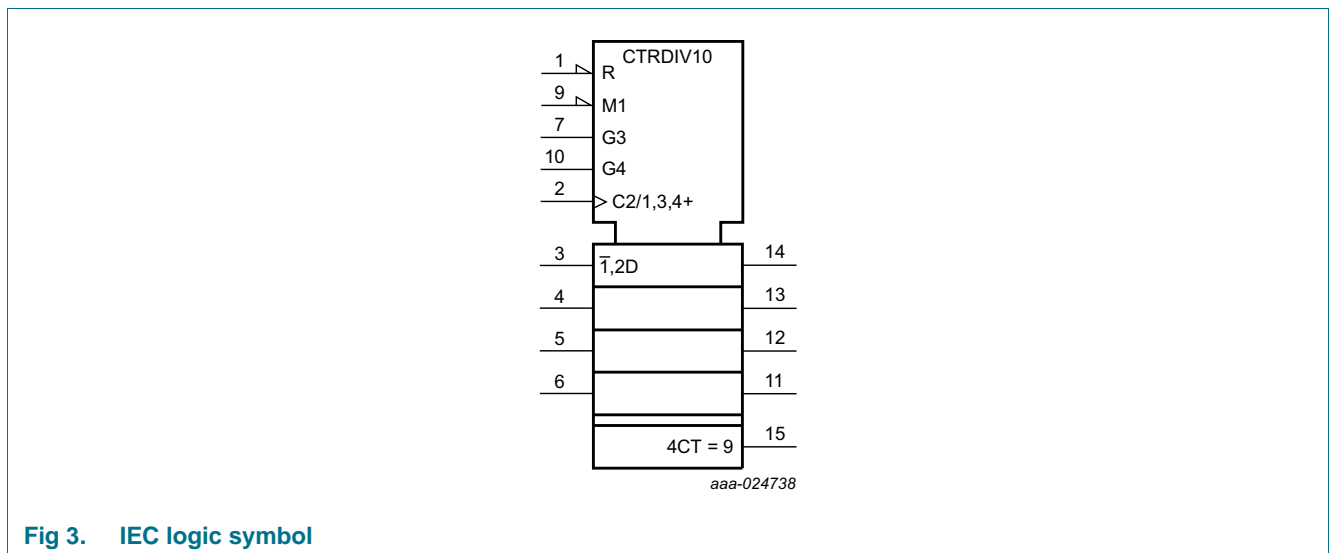
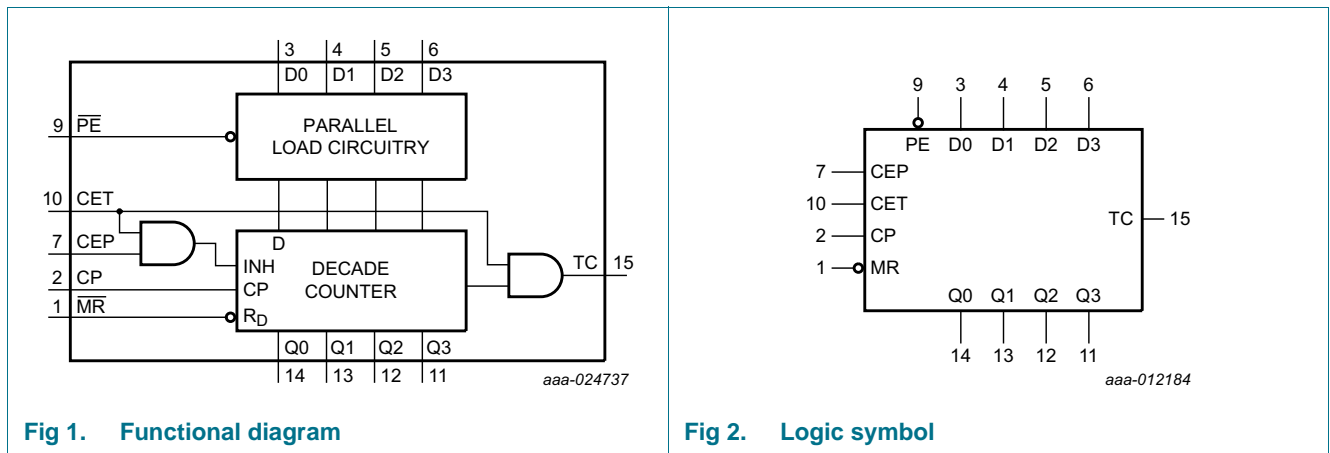
- Complies with JEDEC standard no. 7A
- Input levels:
  - ◆ For 74HC160: CMOS level
- Synchronous counting and loading
- 2 count enable inputs for n-bit cascading
- Asynchronous reset
- Positive-edge triggered clock
- ESD protection:
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

### 3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC160D	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC160DB	-40 °C to +125 °C	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1

### 4. Functional diagram



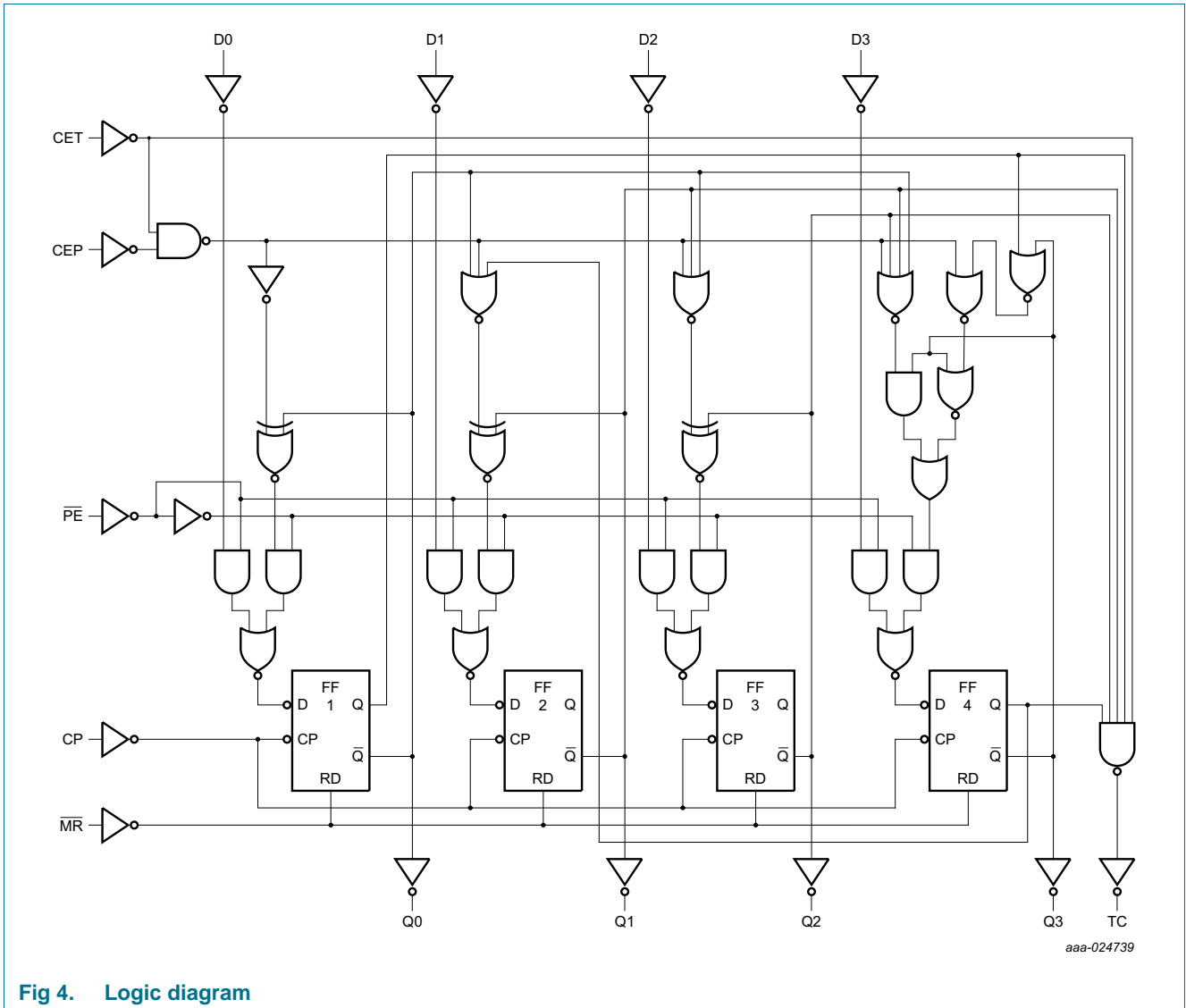


Fig 4. Logic diagram

## 5. Pinning information

### 5.1 Pinning

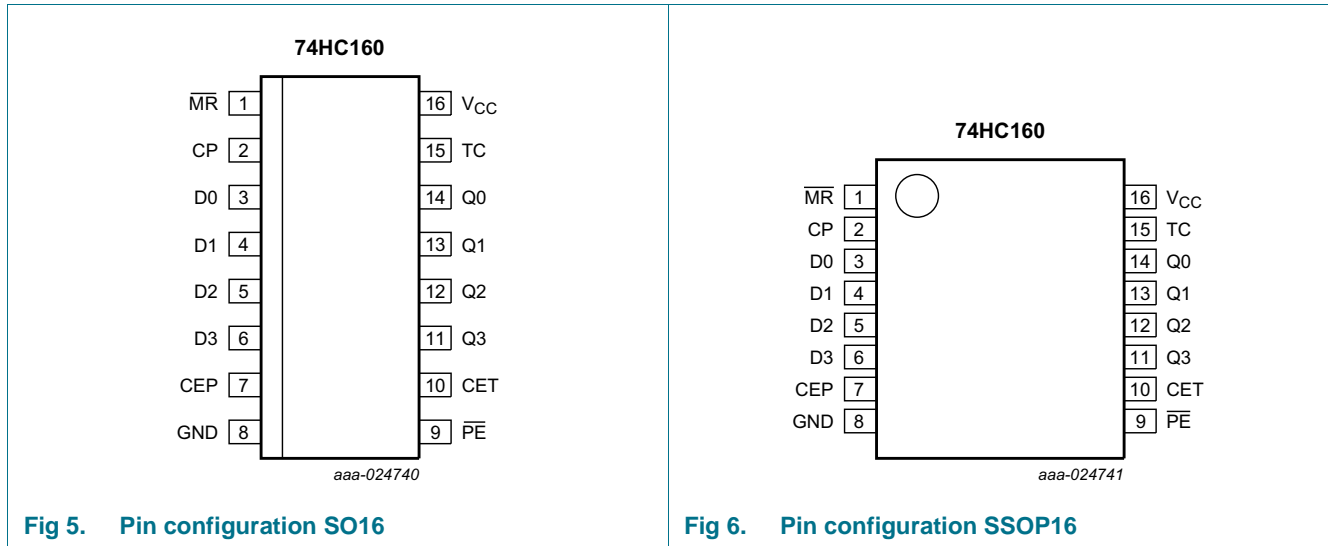


Fig 5. Pin configuration SO16

Fig 6. Pin configuration SSOP16

### 5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$\overline{\text{MR}}$	1	asynchronous master reset (active LOW)
CP	2	clock input (LOW-to-HIGH, edge triggered)
D0, D1, D2, D3	3, 4, 5, 6	data input
CEP	7	count enable input
GND	8	ground (0 V)
$\overline{\text{PE}}$	9	parallel enable input (active LOW)
CET	10	count enable carry input
Q0, Q1, Q2, Q3	14, 13, 12, 11	flip-flop output
TC	15	terminal count output
V <sub>CC</sub>	16	supply voltage

## 6. Functional description

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

Operating mode	Inputs						Outputs	
	MR	CP	CEP	CET	PE	Dn	Qn	TC
Reset (clear)	L	X	X	X	X	X	L	L
Parallel load	H	↑	X	X	l	l	L	L
	H	↑	X	X	l	h	H	[2]
Count	H	↑	h	h	h	X	count	[2]
Hold (do nothing)	H	X	l	X	h	X	q <sub>n</sub>	[2]
	H	X	X	l	h	X	q <sub>n</sub>	L

- [1] H = HIGH voltage level;  
 h = HIGH voltage level one set-up time prior to the LOW-to-HIGH CP transition;  
 L = LOW voltage level;  
 l = LOW voltage level one set-up time prior to the LOW-to-HIGH CP transition;  
 q<sub>n</sub> = lower case letters indicate the state of the referenced output one set-up time prior to the LOW-to-HIGH CP transition;  
 X = don't care;  
 ↑ = LOW-to-HIGH clock transition.

- [2] The TC output is HIGH when CET is HIGH and the counter is at terminal count (HLLH);

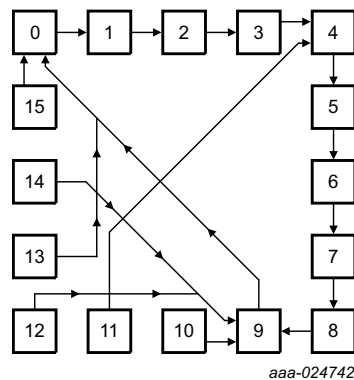
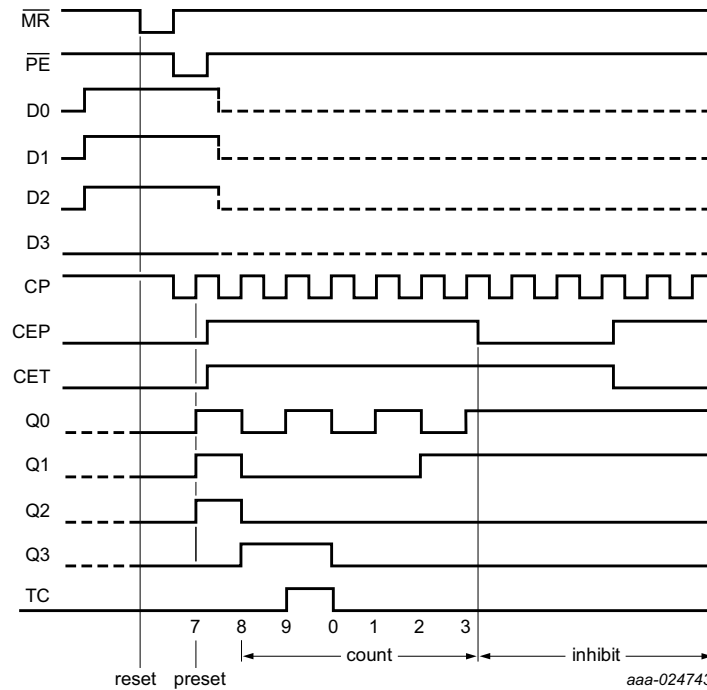


Fig 7. State diagram



**Typical timing sequence:**  
 reset outputs to zero; preset to BCD seven; count to eight, nine, zero, one, two and three; inhibit.

**Fig 8. Typical timing sequence**

## 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	+7.0	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	$-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$	-	$\pm 25$	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	SO16 package <a href="#">[1]</a>	-	500	mW
		SSOP16 package <a href="#">[1]</a>	-	500	mW

[1] For SO16 packages: above 70 °C the value of  $P_{tot}$  derates linearly at 8 mW/K.  
 For SSOP16 packages: above 60 °C the value of  $P_{tot}$  derates linearly at 5.5 mW/K.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CC}$	supply voltage		2.0	5.0	6.0	V
$V_I$	input voltage		0	-	$V_{CC}$	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature		-40	+25	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 2.0\text{ V}$	-	-	625	ns/V
		$V_{CC} = 4.5\text{ V}$	-	1.67	139	ns/V
		$V_{CC} = 6.0\text{ V}$	-	-	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	
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 2.0\text{ V}$	1.5	1.2	-	1.5	-	1.5	-	V
		$V_{CC} = 4.5\text{ V}$	3.15	2.4	-	3.15	-	3.15	-	V
		$V_{CC} = 6.0\text{ V}$	4.2	3.2	-	4.2	-	4.2	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 2.0\text{ V}$	-	0.8	0.5	-	0.5	-	0.5	V
		$V_{CC} = 4.5\text{ V}$	-	2.1	1.35	-	1.35	-	1.35	V
		$V_{CC} = 6.0\text{ V}$	-	2.8	1.8	-	1.8	-	1.8	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$								
		$I_O = -20\ \mu\text{A}$ ; $V_{CC} = 2.0\text{ V}$	1.9	2.0	-	1.9	-	1.9	-	V
		$I_O = -20\ \mu\text{A}$ ; $V_{CC} = 4.5\text{ V}$	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -20\ \mu\text{A}$ ; $V_{CC} = 6.0\text{ V}$	5.9	6.0	-	5.9	-	5.9	-	V
		$I_O = -4.0\text{ mA}$ ; $V_{CC} = 4.5\text{ V}$	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
$V_{OL}$	LOW-level output voltage	$V_I = V_{IH}$ or $V_{IL}$								
		$I_O = 20\ \mu\text{A}$ ; $V_{CC} = 2.0\text{ V}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20\ \mu\text{A}$ ; $V_{CC} = 4.5\text{ V}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20\ \mu\text{A}$ ; $V_{CC} = 6.0\text{ V}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 4.0\text{ mA}$ ; $V_{CC} = 4.5\text{ V}$	-	0.15	0.26	-	0.33	-	0.4	V
		$I_O = 5.2\text{ mA}$ ; $V_{CC} = 6.0\text{ V}$	-	0.16	0.26	-	0.33	-	0.4	V
$I_I$	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 6.0\text{ V}$	-	-	$\pm 0.1$	-	$\pm 1.0$	-	$\pm 1.0$	$\mu\text{A}$
$I_{CC}$	supply current	$V_I = V_{CC}$ or GND; $I_O = 0\text{ A}$ ; $V_{CC} = 6.0\text{ V}$	-	-	8.0	-	80.0	-	160.0	$\mu\text{A}$
$C_I$	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 14](#).

Symbol	Parameter	Conditions	25 °C			−40 °C to +85 °C		−40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$t_{pd}$	propagation delay	CP to Qn; see <a href="#">Figure 9</a> [1]								
		$V_{CC} = 2.0$ V	-	61	185	-	230	-	280	ns
		$V_{CC} = 4.5$ V	-	22	37	-	46	-	56	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	19	-	-	-	-	-	ns
		$V_{CC} = 6.0$ V	-	18	31	-	39	-	48	ns
		CP to TC; see <a href="#">Figure 9</a>								
		$V_{CC} = 2.0$ V	-	69	215	-	270	-	325	ns
		$V_{CC} = 4.5$ V	-	25	43	-	54	-	65	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	21	-	-	-	-	-	ns
		$V_{CC} = 6.0$ V	-	20	31	-	46	-	55	ns
		CET to TC; see <a href="#">Figure 10</a>								
		$V_{CC} = 2.0$ V	-	47	150	-	190	-	225	ns
		$V_{CC} = 4.5$ V	-	17	30	-	38	-	45	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	14	-	-	-	-	-	ns
$V_{CC} = 6.0$ V	-	14	26	-	33	-	38	ns		
$t_{PHL}$	High to LOW propagation delay	$\overline{MR}$ to Qn; see <a href="#">Figure 11</a>								
		$V_{CC} = 2.0$ V	-	69	210	-	265	-	315	ns
		$V_{CC} = 4.5$ V	-	25	42	-	53	-	63	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	21	-	-	-	-	-	ns
		$V_{CC} = 6.0$ V	-	20	36	-	45	-	54	ns
		$\overline{MR}$ to TC; see <a href="#">Figure 11</a>								
		$V_{CC} = 2.0$ V	-	69	220	-	275	-	330	ns
		$V_{CC} = 4.5$ V	-	25	44	-	55	-	66	ns
$t_t$	transition time	see <a href="#">Figure 9</a> and <a href="#">Figure 10</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	CP HIGH or LOW; see <a href="#">Figure 9</a>								
		$V_{CC} = 2.0$ V	80	22	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	8	-	20	-	24	-	ns
		$V_{CC} = 6.0$ V	14	3	-	17	-	20	-	ns
$t_w$	pulse width	$\overline{MR}$ LOW; see <a href="#">Figure 11</a>								
		$V_{CC} = 2.0$ V	80	28	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	10	-	20	-	24	-	ns
		$V_{CC} = 6.0$ V	14	8	-	17	-	20	-	ns



## Presettable synchronous BCD decade counter; asynchronous reset

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 14](#).

Symbol	Parameter	Conditions	25 °C			−40 °C to +85 °C		−40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$t_{rec}$	recovery time	$\overline{MR}$ to CP; see <a href="#">Figure 11</a>								
		$V_{CC} = 2.0$ V	100	30	-	125	-	150	-	ns
		$V_{CC} = 4.5$ V	20	11	-	25	-	30	-	ns
		$V_{CC} = 6.0$ V	17	9	-	21	-	26	-	ns
$t_{su}$	set-up time	Dn to CP; see <a href="#">Figure 12</a>								
		$V_{CC} = 2.0$ V	80	22	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	8	-	20	-	24	-	ns
		$V_{CC} = 6.0$ V	14	6	-	17	-	20	-	ns
		$\overline{PE}$ to CP; see <a href="#">Figure 12</a>								
		$V_{CC} = 2.0$ V	135	41	-	170	-	205	-	ns
		$V_{CC} = 4.5$ V	27	15	-	34	-	41	-	ns
		$V_{CC} = 6.0$ V	23	12	-	29	-	35	-	ns
		CEP, CET to CP; see <a href="#">Figure 13</a>								
		$V_{CC} = 2.0$ V	200	63	-	250	-	300	-	ns
		$V_{CC} = 4.5$ V	40	23	-	50	-	60	-	ns
		$V_{CC} = 6.0$ V	34	18	-	43	-	51	-	ns
$t_h$	hold time	Dn to CP; see <a href="#">Figure 12</a>								
		$V_{CC} = 2.0$ V	0	−17	-	0	-	0	-	ns
		$V_{CC} = 4.5$ V	0	−6	-	0	-	0	-	ns
		$V_{CC} = 6.0$ V	0	−5	-	0	-	0	-	ns
		$\overline{PE}$ to CP; see <a href="#">Figure 12</a>								
		$V_{CC} = 2.0$ V	0	−41	-	0	-	0	-	ns
		$V_{CC} = 4.5$ V	0	−15	-	0	-	0	-	ns
		$V_{CC} = 6.0$ V	0	−12	-	0	-	0	-	ns
		CEP, CET to CP; see <a href="#">Figure 13</a>								
		$V_{CC} = 2.0$ V	0	−58	-	0	-	0	-	ns
		$V_{CC} = 4.5$ V	0	−21	-	0	-	0	-	ns
		$V_{CC} = 6.0$ V	0	−17	-	0	-	0	-	ns
$f_{max}$	maximum frequency	CP; see <a href="#">Figure 9</a>								
		$V_{CC} = 2.0$ V	6	18	-	4.8	-	4	-	MHz
		$V_{CC} = 4.5$ V	30	55	-	24	-	20	-	MHz
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	61	-	-	-	-	-	MHz
		$V_{CC} = 6.0$ V	35	66	-	28	-	24	-	MHz

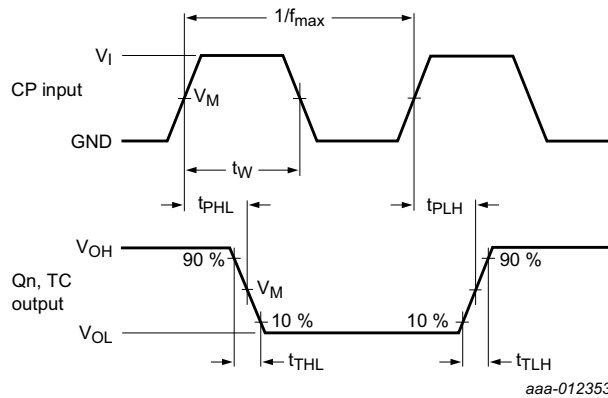
**Table 7. Dynamic characteristics ...continued**

Voltages are referenced to GND (ground = 0 V);  $C_L = 50$  pF unless otherwise specified; for test circuit see [Figure 14](#).

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	$V_I = \text{GND to } V_{CC}; f_i = 1 \text{ MHz}$ <a href="#">[3]</a>	-	39	-	-	-	-	-	pF

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

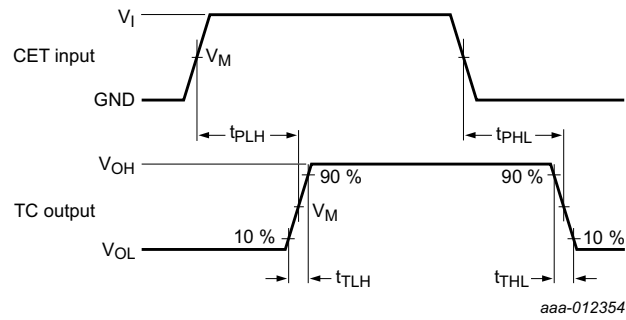
## 11. Waveforms



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

Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

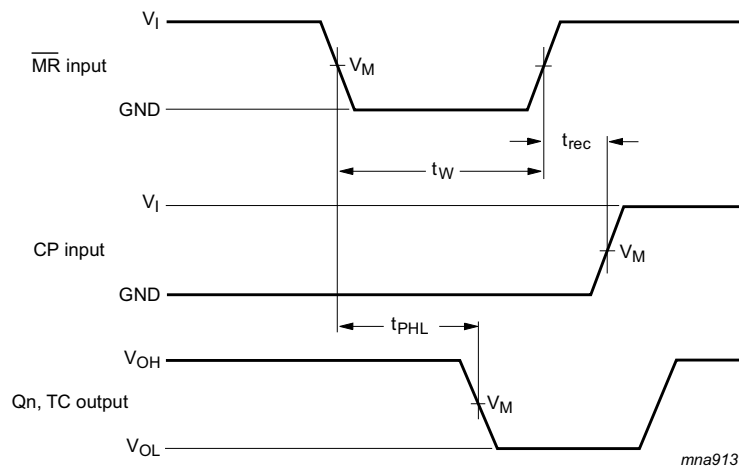
**Fig 9. The clock (CP) to outputs (Qn, TC) propagation delays, pulse width, output transition times and maximum frequency**



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

Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

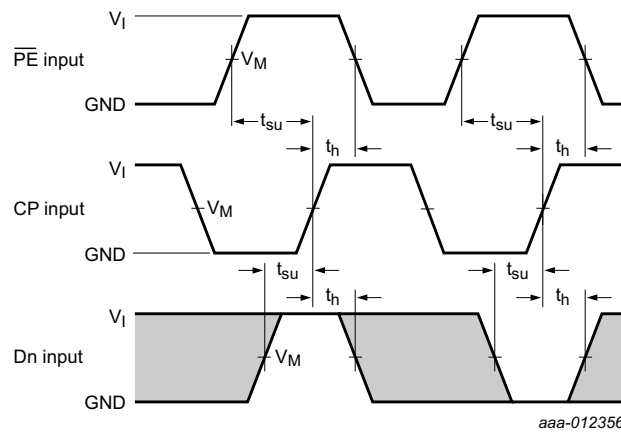
**Fig 10. The count enable carry input (CET) to terminal count output (TC) propagation delays and output transition times**



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

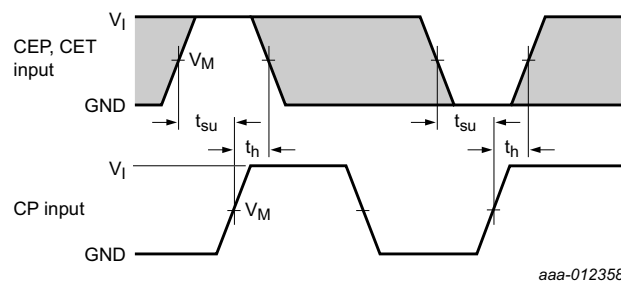
Logic levels  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

**Fig 11. The master reset ( $\overline{MR}$ ) pulse width, master reset to output ( $Q_n, TC$ ) propagation delays, and the master reset to clock (CP) recovery times**



The shaded areas indicate when the input is permitted to change for predictable output performance. Measurement points are given in [Table 8](#).

**Fig 12. The data input (Dn) and parallel enable input ( $\overline{PE}$ ) set-up and hold times**

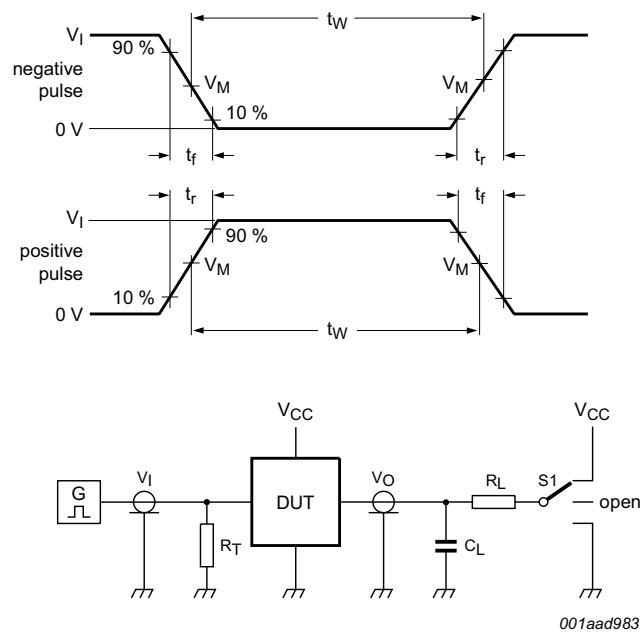


The shaded areas indicate when the input is permitted to change for predictable output performance. Measurement points are given in [Table 8](#).

**Fig 13. The count enable input (CEP) and count enable carry input (CET) set-up and hold times**

**Table 8. Measurement points**

Input		Output
$V_M$	$V_I$	$V_M$
$0.5 \times V_{CC}$	GND to $V_{CC}$	$0.5 \times V_{CC}$



Test data is given in [Table 9](#).

Test circuit definitions:

$R_T$  = 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 14. Test circuit for measuring switching times**

**Table 9. Test data**

Input		Load		S1 position
$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PHL}, t_{PLH}$
$V_{CC}$	6 ns	15 pF, 50 pF	1 k $\Omega$	open

12. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

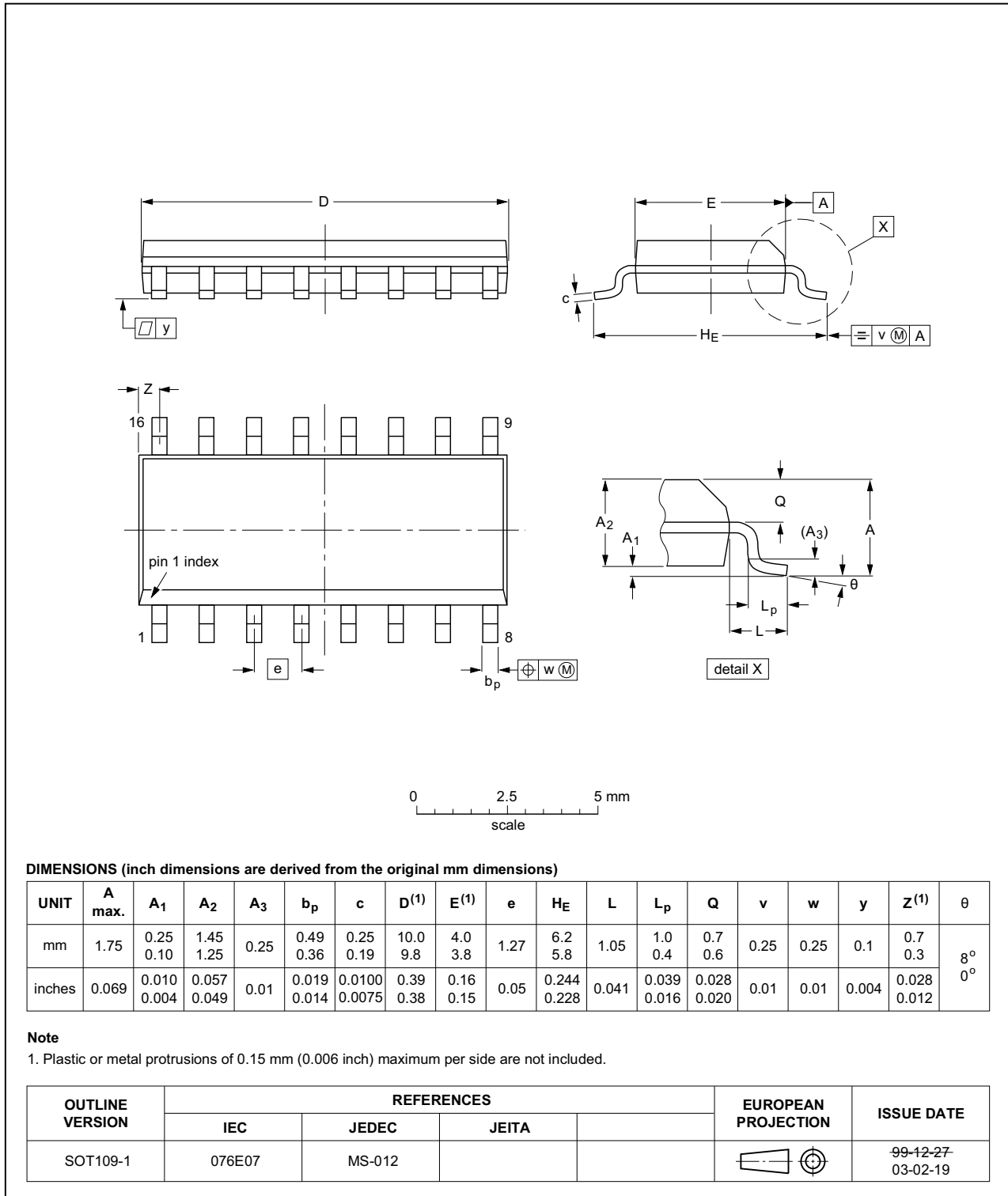


Fig 15. Package outline SOT109-1 (SO16)

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1

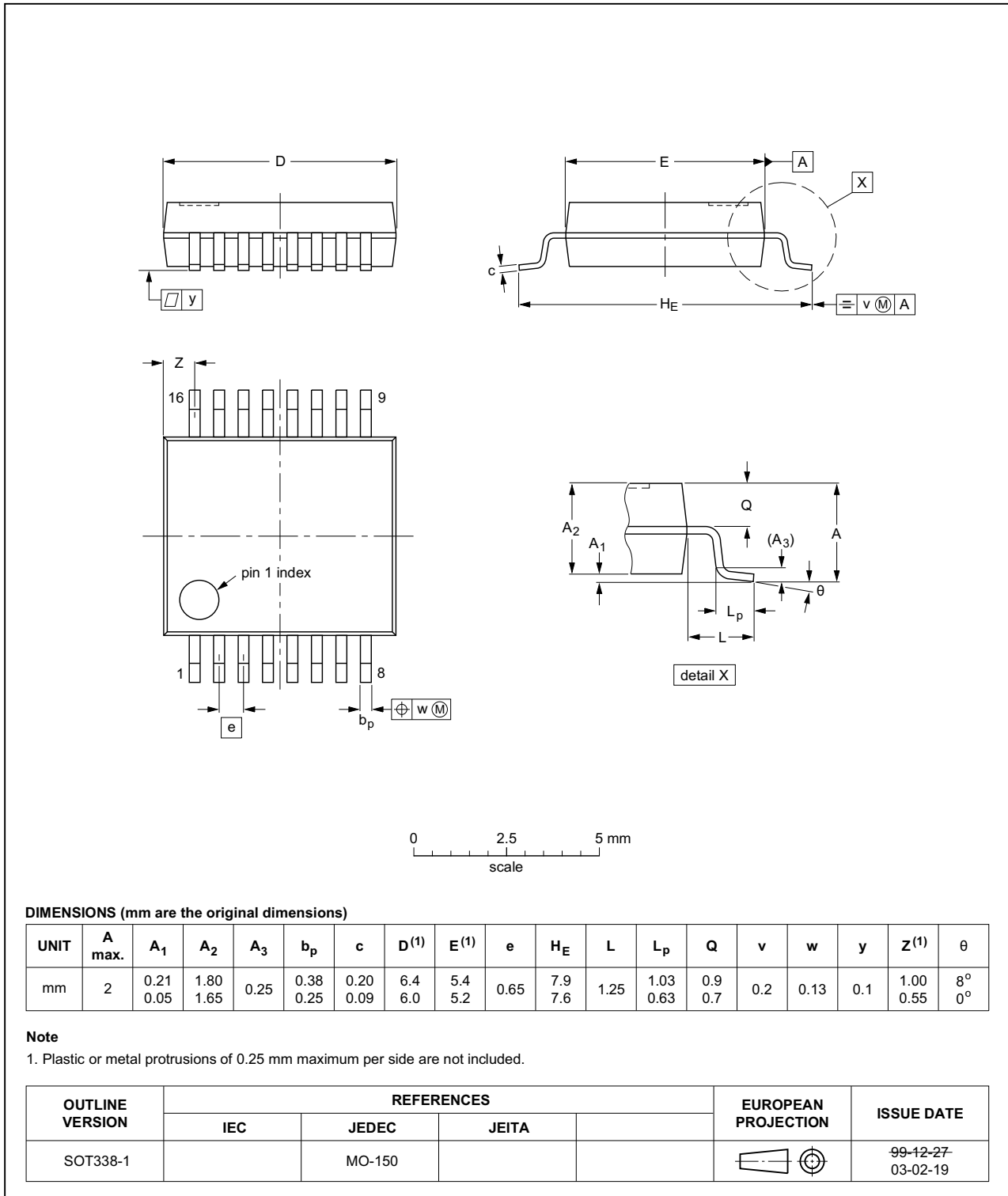


Fig 16. Package outline SOT338-1 (SSOP16)

## 13. 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

## 14. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC160 v.3	20160927	Product data sheet	-	74HC_HCT160 v.2
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> <li>Type numbers 74HCT160D, 74HCT160PW, 74HCT160N, 74HC160N and 74HC160PW removed.</li> </ul>			
74HC_HCT160 v.2	19901201	Product specification	-	-



## 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".

[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>.

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## 16. Contact information

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

For sales office addresses, please send an email to: [salesaddresses@nexperia.com](mailto:salesaddresses@nexperia.com)

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