

# 74HC161-Q100

Presettable synchronous 4-bit binary counter; asynchronous reset

Rev. 3 — 16 March 2021

Product data sheet

## 1. General description

The 74HC161-Q100 is a synchronous presettable binary 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 (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 (MR) sets Q0 to Q3 LOW regardless of the levels at input pins CP, 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:

$$f_{\max} = \frac{1}{t_{P(\max)}(\text{CP to TC}) + t_{\text{SU}}(\text{CEP to CP})}$$

Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{\text{CC}}$ .

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

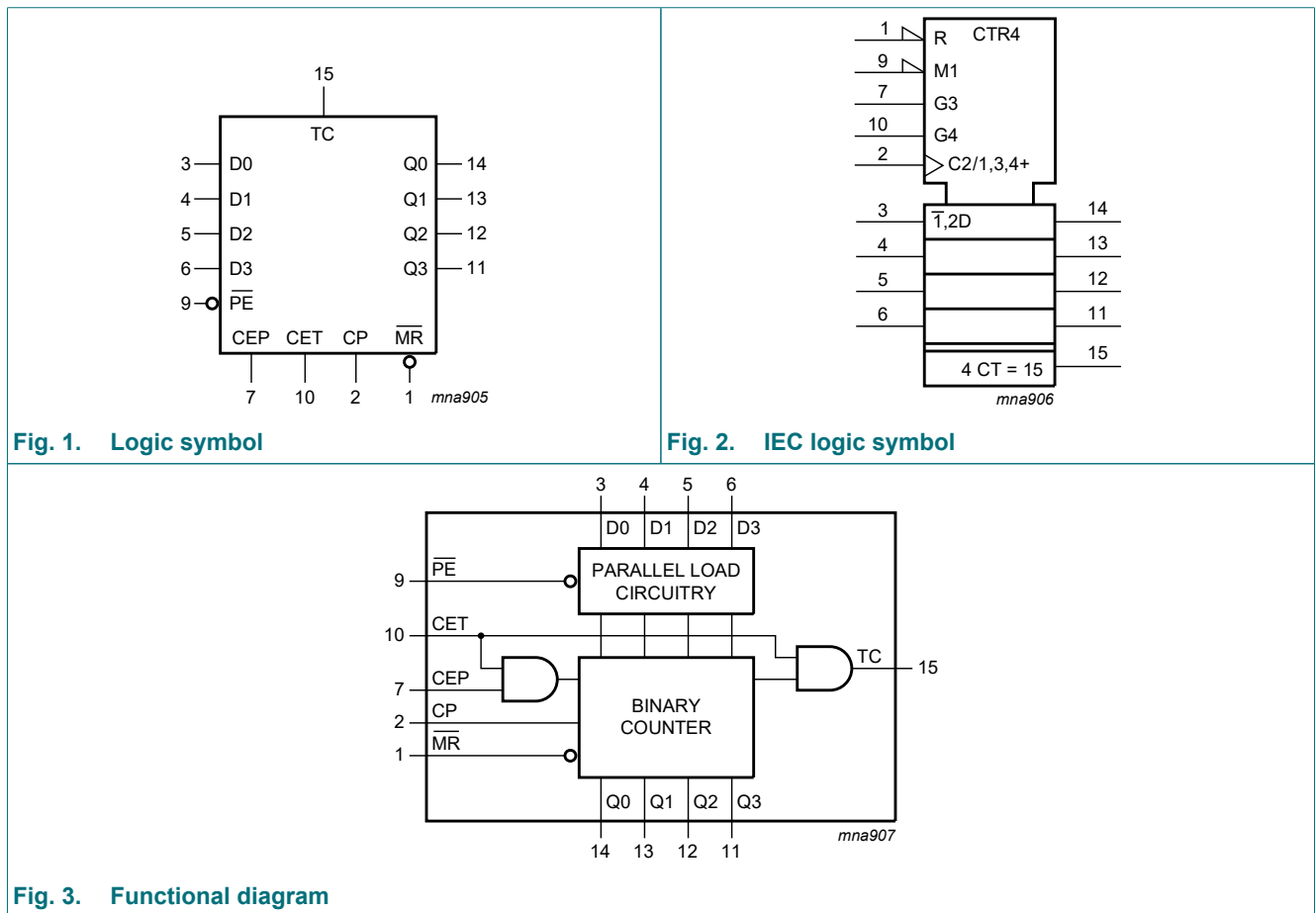
- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - Specified from -40 °C to +85 °C and from -40 °C to +125 °C
- Wide supply voltage range from 2.0 V to 6.0 V
- CMOS low power dissipation
- High noise immunity
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- Complies with JEDEC standards:
  - JESD8C (2.7 V to 3.6 V)
  - JESD7A (2.0 V to 6.0 V)
- CMOS input levels
- Synchronous counting and loading
- 2 count enable inputs for n-bit cascading
- Asynchronous reset
- Positive-edge triggered clock
- 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 pF, R = 0 Ω)

### 3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC161D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC161PW-Q100	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

### 4. Functional diagram



Presetable synchronous 4-bit binary counter; asynchronous reset

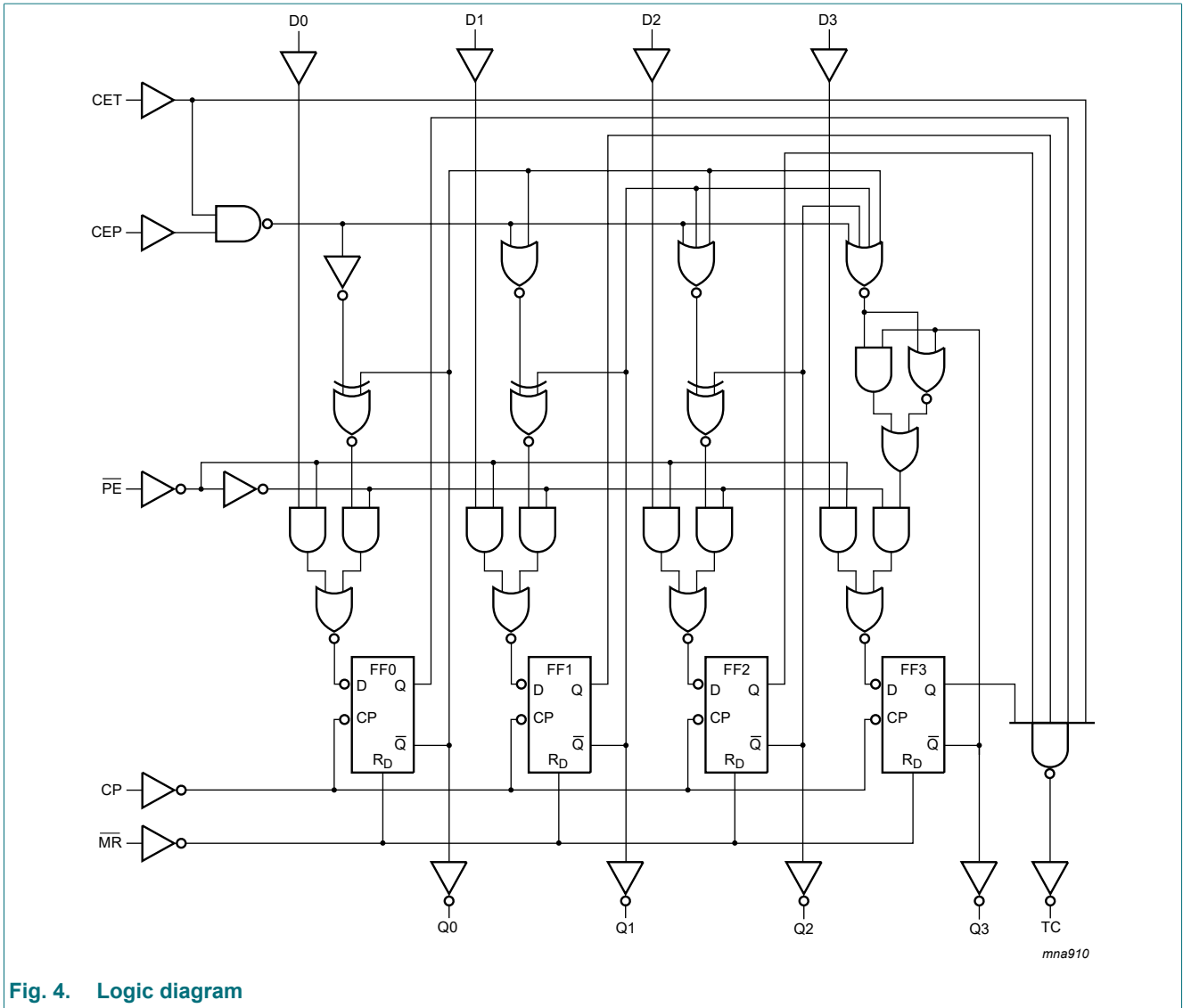


Fig. 4. Logic diagram

## 5. Pinning information

### 5.1. Pinning

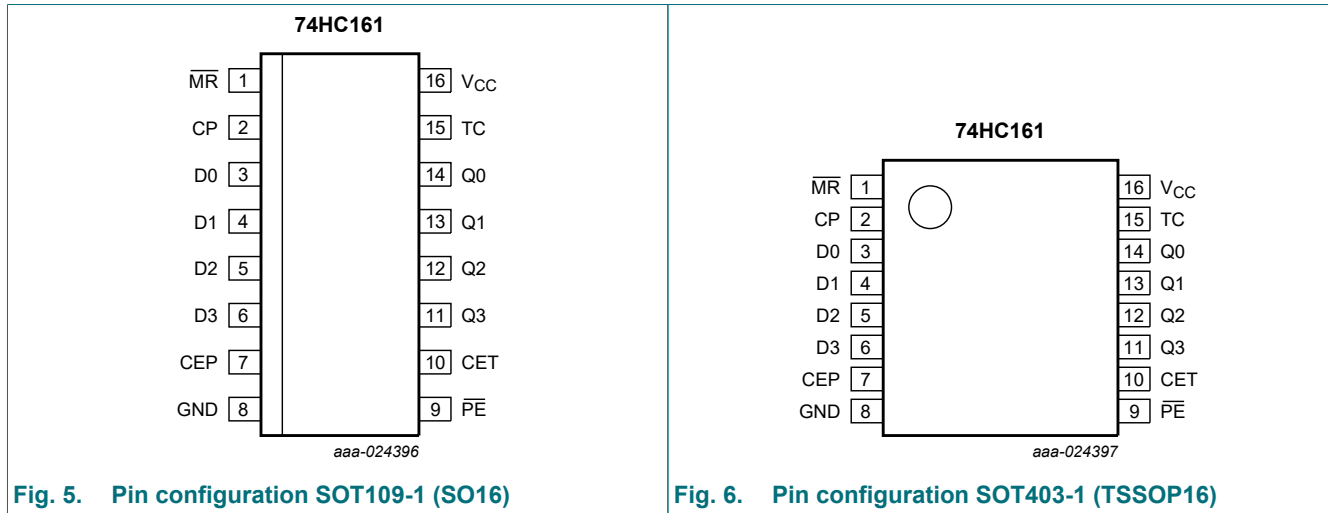


Fig. 5. Pin configuration SOT109-1 (SO16)

Fig. 6. Pin configuration SOT403-1 (TSSOP16)

### 5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
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)
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

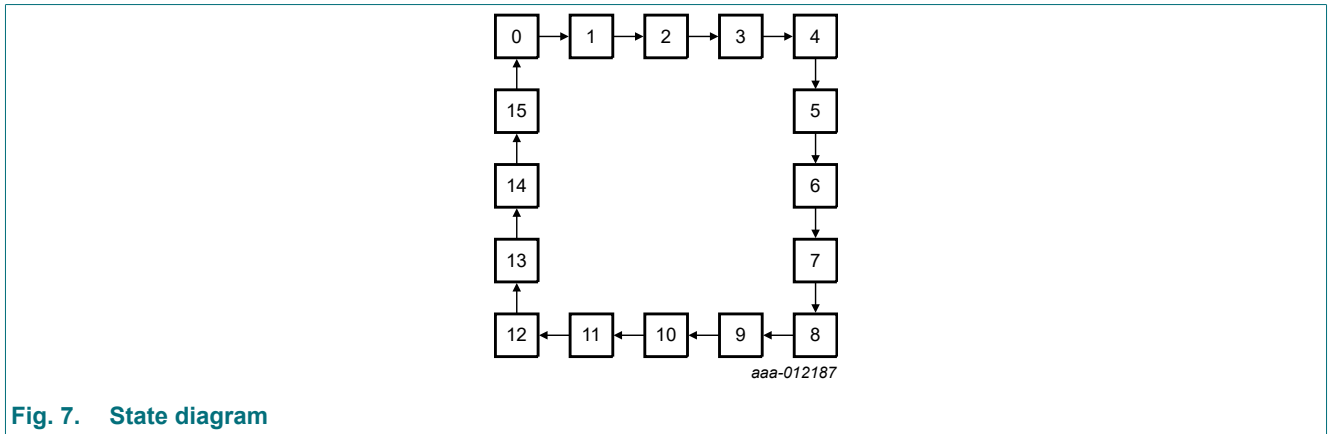
## 6. Functional description

**Table 3. Function table**

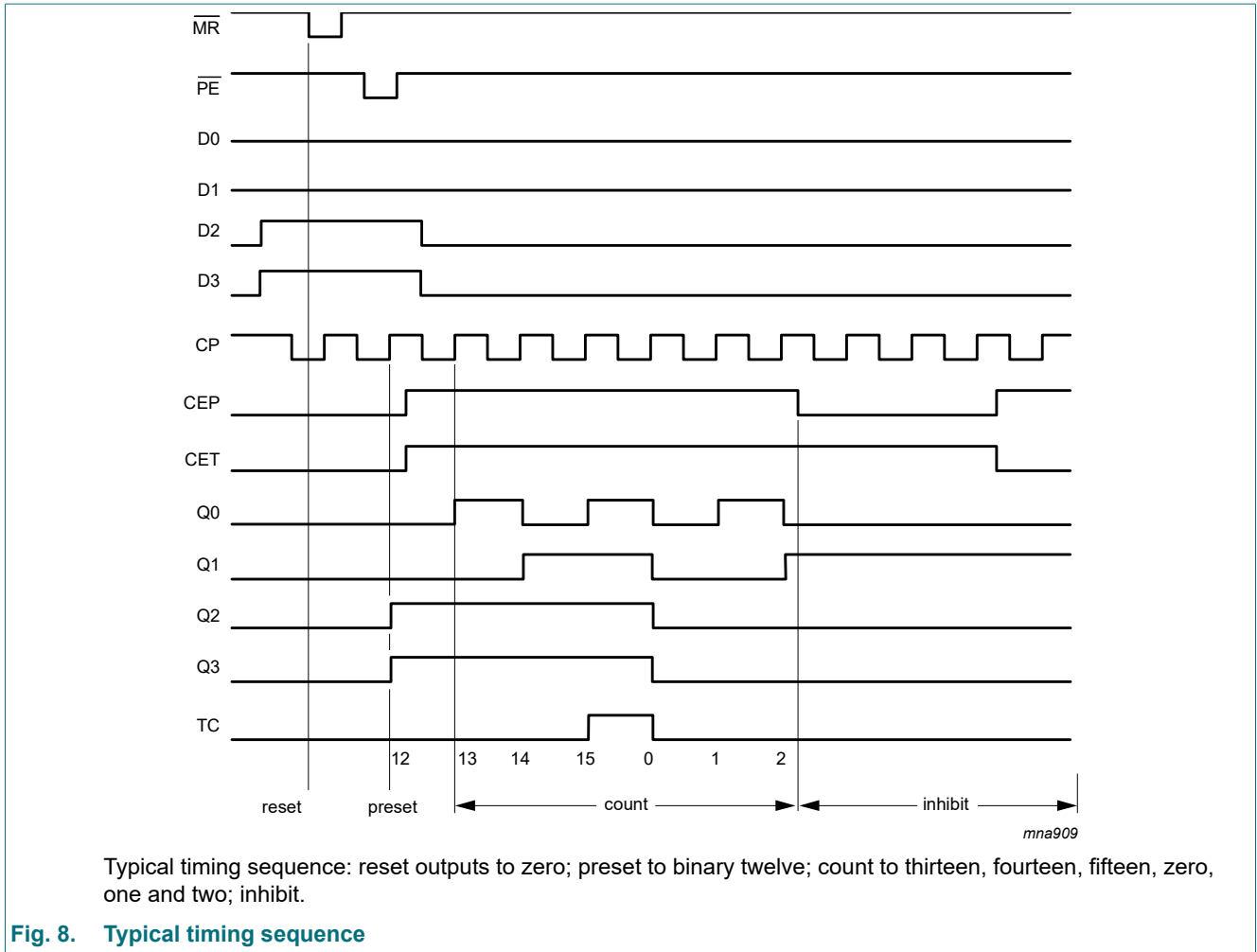
*H = HIGH voltage level; h = HIGH voltage level one set-up time prior to the LOW-to-HIGH clock transition;  
 L = LOW voltage level; l = LOW voltage level one set-up time prior to the LOW-to-HIGH clock transition;  
 q<sub>n</sub> = lower case letters indicate the state of the referenced output one set-up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

Operating modes	Input						Output	
	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	[1]
Count	H	↑	h	h	h	X	count	[1]
Hold (do nothing)	H	X	l	X	h	X	q <sub>n</sub>	[1]
	H	X	X	l	h	X	q <sub>n</sub>	L

[1] The TC output is HIGH when CET is HIGH and the counter is at terminal count (HHHH)



**Fig. 7. State diagram**



## 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	$V_O = -0.5\text{ V}$ to $V_{CC} + 0.5\text{ V}$	-	$\pm 25$	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	[1]	-	500	mW

[1] For SOT109-1 (SO16) package:  $P_{tot}$  derates linearly with 12.4 mW/K above 110 °C.  
 For SOT403-1 (TSSOP16) package:  $P_{tot}$  derates linearly with 8.5 mW/K above 91 °C.

## 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 Fig. 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 Fig. 9 [1]								
		$V_{CC} = 2.0$ V	-	61	190	-	240	-	285	ns
		$V_{CC} = 4.5$ V	-	22	38	-	48	-	57	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	19	-	-	-	-	-	ns
		$V_{CC} = 6.0$ V	-	18	32	-	41	-	48	ns
		CP to TC; see Fig. 9								
		$V_{CC} = 2.0$ 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	37	-	46	-	55	ns
		CET to TC; see Fig. 10								
		$V_{CC} = 2.0$ V	-	33	150	-	190	-	225	ns
		$V_{CC} = 4.5$ V	-	12	30	-	38	-	45	ns
$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	10	-	-	-	-	-	ns		
$V_{CC} = 6.0$ V	-	10	26	-	38	-	31	ns		
$t_{PHL}$	HIGH to LOW propagation delay	MR to Qn; see Fig. 11								
		$V_{CC} = 2.0$ V	-	63	210	-	265	-	315	ns
		$V_{CC} = 4.5$ V	-	23	42	-	53	-	63	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	20	-	-	-	-	-	ns
		$V_{CC} = 6.0$ V	-	18	36	-	45	-	54	ns
		MR to TC; see Fig. 11								
		$V_{CC} = 2.0$ V	-	63	220	-	275	-	330	ns
		$V_{CC} = 4.5$ V	-	23	44	-	55	-	66	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	20	-	-	-	-	-	ns
$V_{CC} = 6.0$ V	-	18	37	-	47	-	56	ns		
$t_t$	transition time	see Fig. 9 and Fig. 10 [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 Fig. 9								
		$V_{CC} = 2.0$ 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
		MR; LOW; see Fig. 11								
		$V_{CC} = 2.0$ 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		



## Presettable synchronous 4-bit binary counter; asynchronous reset

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t <sub>rec</sub>	recovery time	M $\bar{R}$ to CP; see Fig. 11								
		V <sub>CC</sub> = 2.0 V	100	19	-	125	-	150	-	ns
		V <sub>CC</sub> = 4.5 V	20	7	-	25	-	30	-	ns
		V <sub>CC</sub> = 6.0 V	17	6	-	21	-	26	-	ns
t <sub>su</sub>	set-up time	Dn to CP; see Fig. 12								
		V <sub>CC</sub> = 2.0 V	80	25	-	100	-	120	-	ns
		V <sub>CC</sub> = 4.5 V	16	9	-	20	-	24	-	ns
		V <sub>CC</sub> = 6.0 V	14	7	-	17	-	20	-	ns
		PE to CP; see Fig. 12								
		V <sub>CC</sub> = 2.0 V	100	30	-	125	-	150	-	ns
		V <sub>CC</sub> = 4.5 V	20	11	-	25	-	30	-	ns
		V <sub>CC</sub> = 6.0 V	17	9	-	21	-	26	-	ns
		CEP, CET to CP; see Fig. 13								
		V <sub>CC</sub> = 2.0 V	170	47	-	215	-	255	-	ns
		V <sub>CC</sub> = 4.5 V	34	17	-	43	-	51	-	ns
		V <sub>CC</sub> = 6.0 V	29	14	-	37	-	43	-	ns
t <sub>h</sub>	hold time	Dn, PE, CEP, CET to CP; see Fig. 12 and Fig. 13								
		V <sub>CC</sub> = 2.0 V	0	-14	-	0	-	0	-	ns
		V <sub>CC</sub> = 4.5 V	0	-5	-	0	-	0	-	ns
		V <sub>CC</sub> = 6.0 V	0	-4	-	0	-	0	-	ns
f <sub>max</sub>	maximum frequency	CP; see Fig. 9								
		V <sub>CC</sub> = 2.0 V	4.6	13	-	3.6	-	3.0	-	MHz
		V <sub>CC</sub> = 4.5 V	23	40	-	18	-	15	-	MHz
		V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF	-	44	-	-	-	-	-	MHz
		V <sub>CC</sub> = 6.0 V	27	48	-	21	-	18	-	MHz
C <sub>PD</sub>	power dissipation capacitance	V <sub>I</sub> = GND to V <sub>CC</sub> ; V <sub>CC</sub> = 5 V; [3] f <sub>i</sub> = 1 MHz	-	33	-	-	-	-	-	pF

[1] t<sub>pd</sub> is the same as t<sub>PHL</sub> and t<sub>PLH</sub>.

[2] t<sub>i</sub> is the same as t<sub>THL</sub> and t<sub>TLH</sub>.

[3] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW):

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

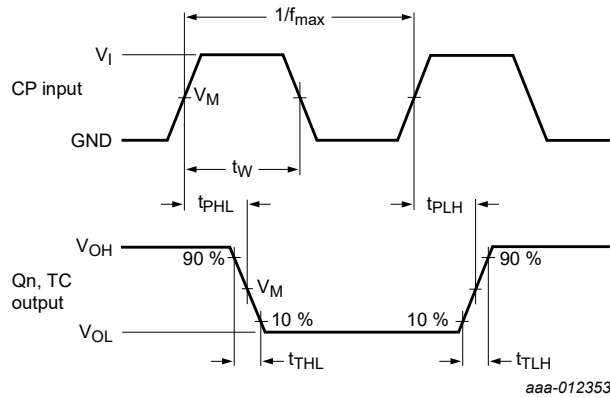
C<sub>L</sub> = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

$\sum (C_L \times V_{CC}^2 \times f_o)$  = sum of outputs.

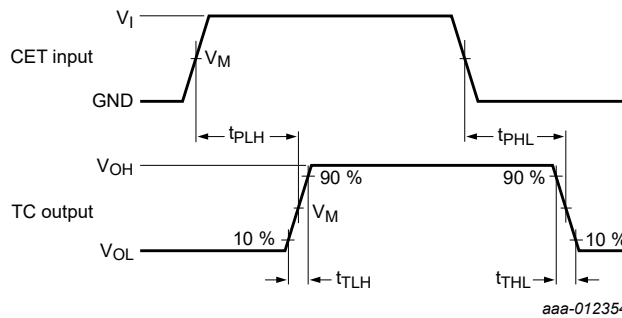
10.1. Waveforms and test circuit



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.

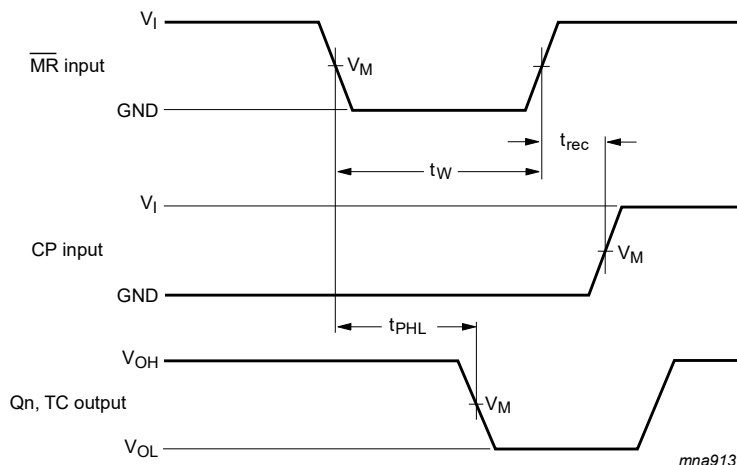
**Fig. 9. The clock (CP) to outputs (Qn, TC) propagation delays, pulse width, output transition times and maximum frequency**



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 (Qn, TC) propagation delays, and the master reset to clock (CP) recovery times**

Presettable synchronous 4-bit binary counter; asynchronous reset

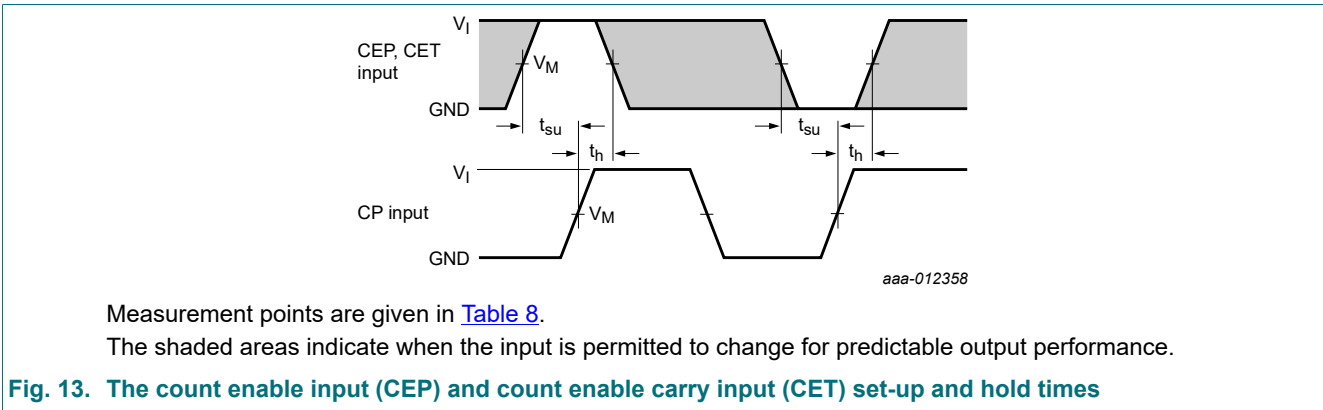
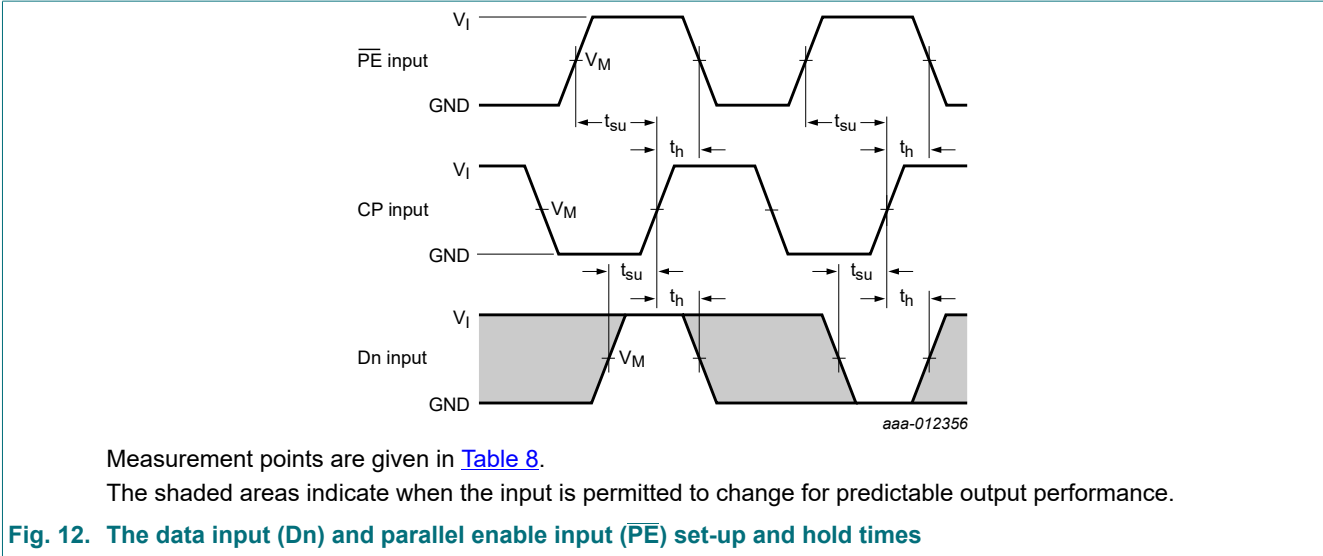


Table 8. Measurement points

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

Presettable synchronous 4-bit binary counter; asynchronous reset

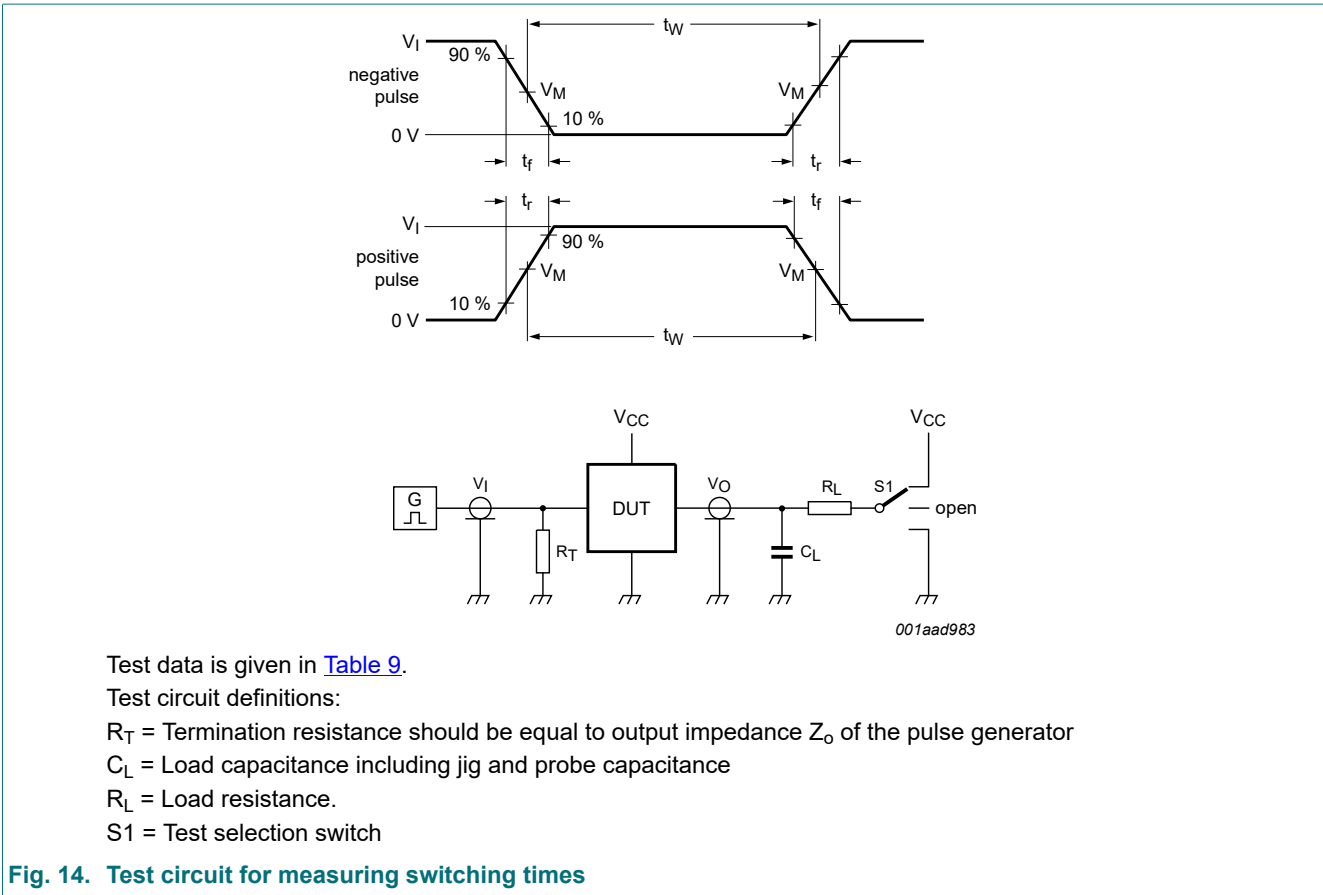


Table 9. Test data

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 kΩ	open

11. Package outline

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

SOT109-1

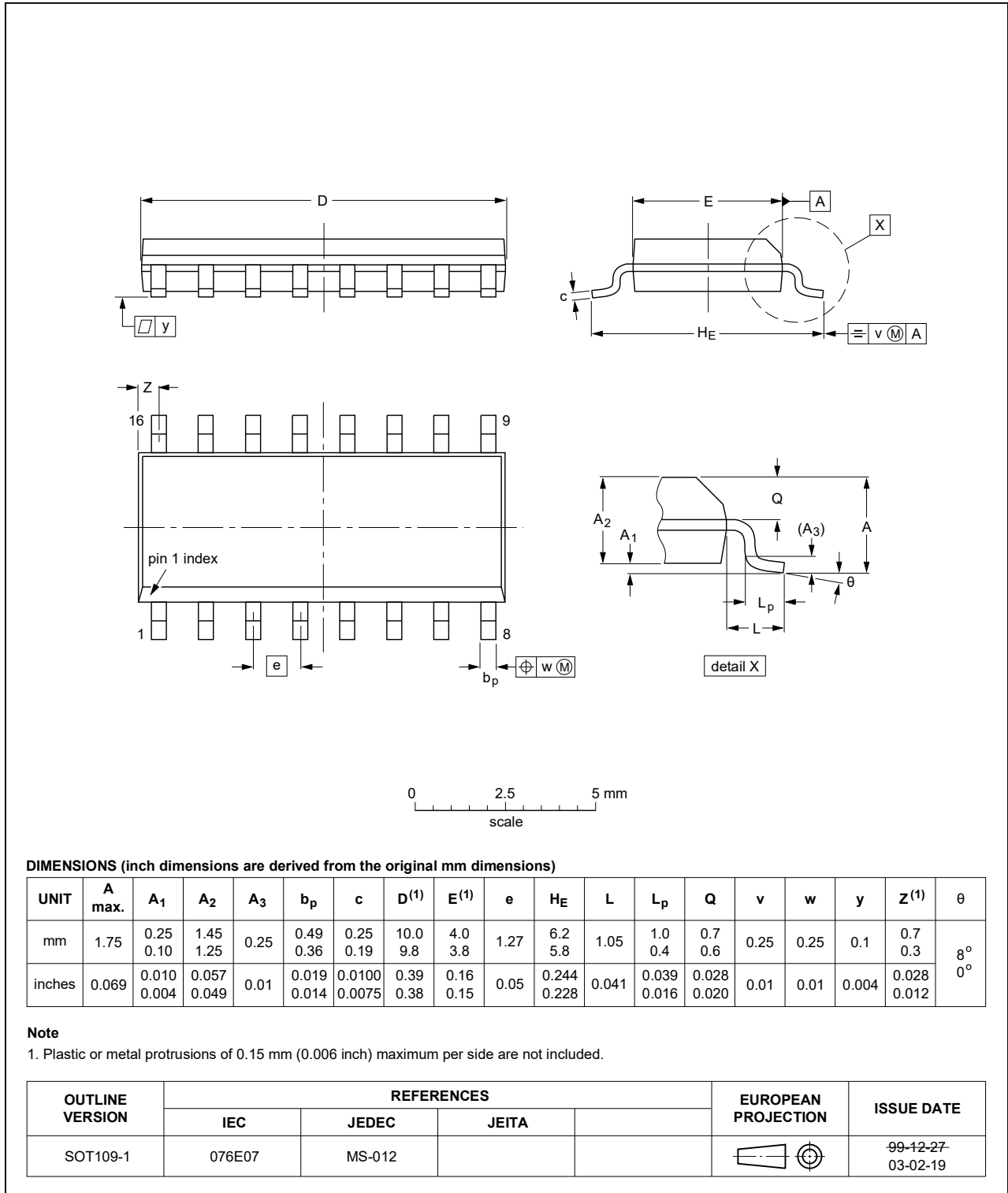


Fig. 15. Package outline SOT109-1 (SO16)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1



Fig. 16. Package outline SOT403-1 (TSSOP16)

## 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
74HC161_Q100 v.3	20210316	Product data sheet	-	74HC161_Q100 v.2
Modifications:	<ul style="list-style-type: none"> <li>• <a href="#">Section 2</a> updated.</li> <li>• <a href="#">Section 7</a>: Derating values for <math>P_{tot}</math> total power dissipation updated.</li> </ul>			
74HC161_Q100 v.2	20181004	Product data sheet	-	74HC161_Q100 v.1
Modifications:	<ul style="list-style-type: none"> <li>• The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li> <li>• Legal texts have been adapted to the new company name where appropriate.</li> </ul>			
74HC161_Q100 v.1	20170103	Product data sheet	-	-

## 14. Legal information

### 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 <https://www.nexperia.com>.

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