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Kind regards,

Team Nexperia

74HC161-Q100

Presettable synchronous 4-bit binary counter; asynchronous reset

Rev. 1 — 3 January 2017

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 (\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 74HC161-Q100: 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			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

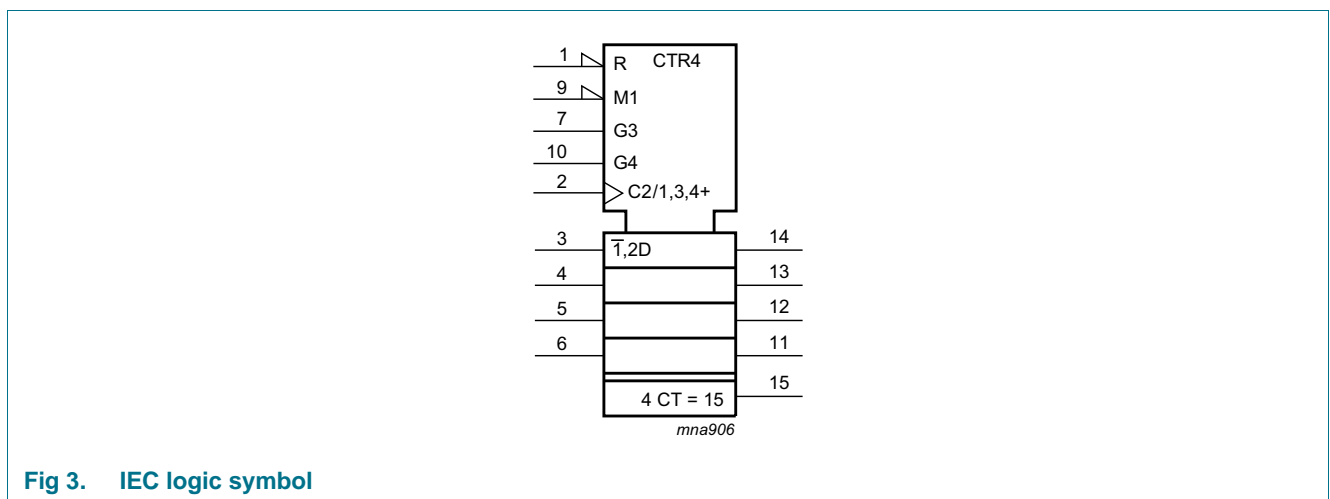
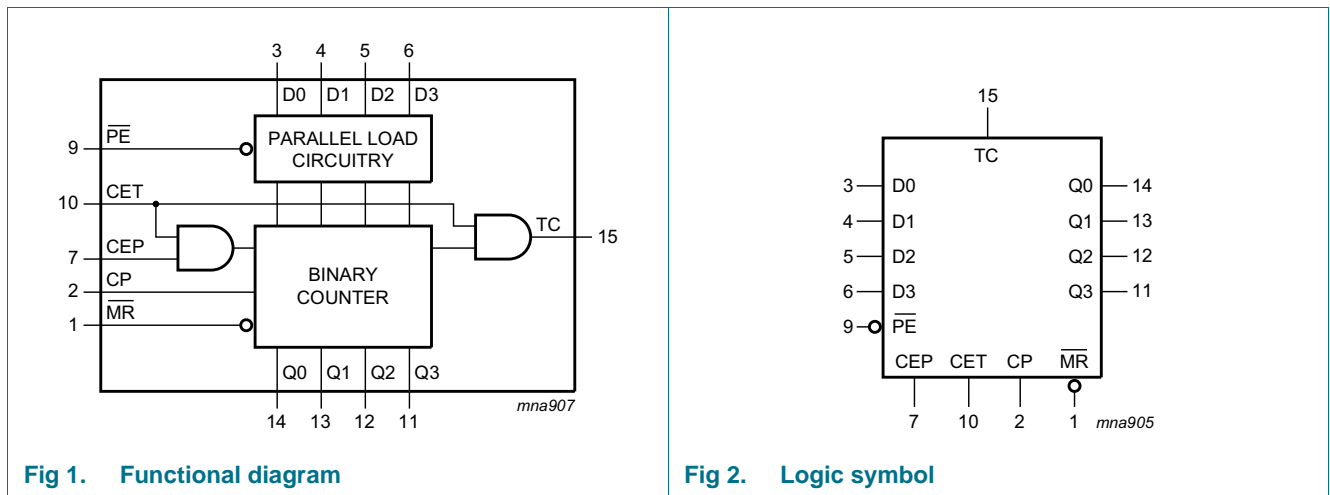


Fig 3. IEC logic symbol

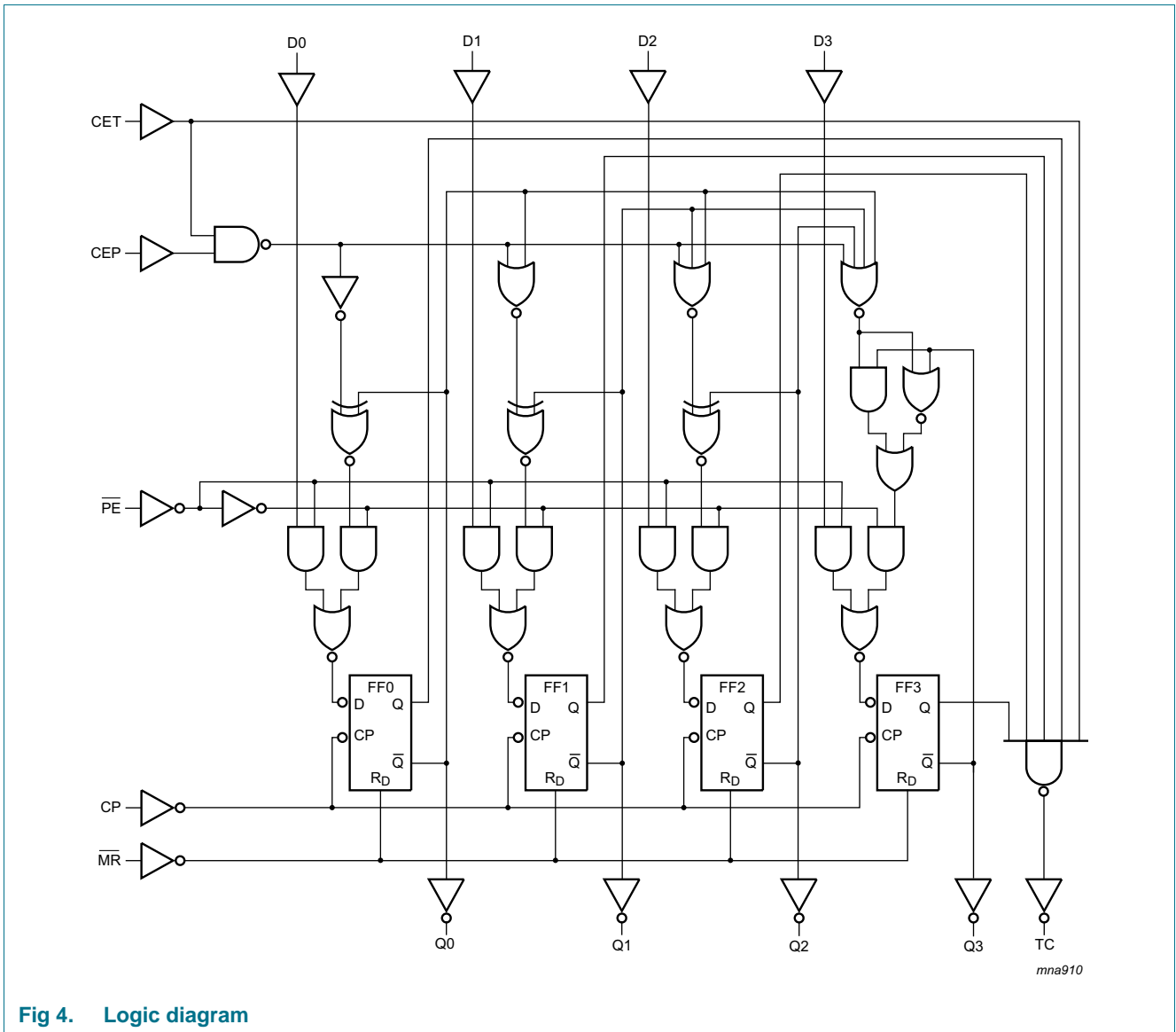


Fig 4. Logic diagram

5. Pinning information

5.1 Pinning

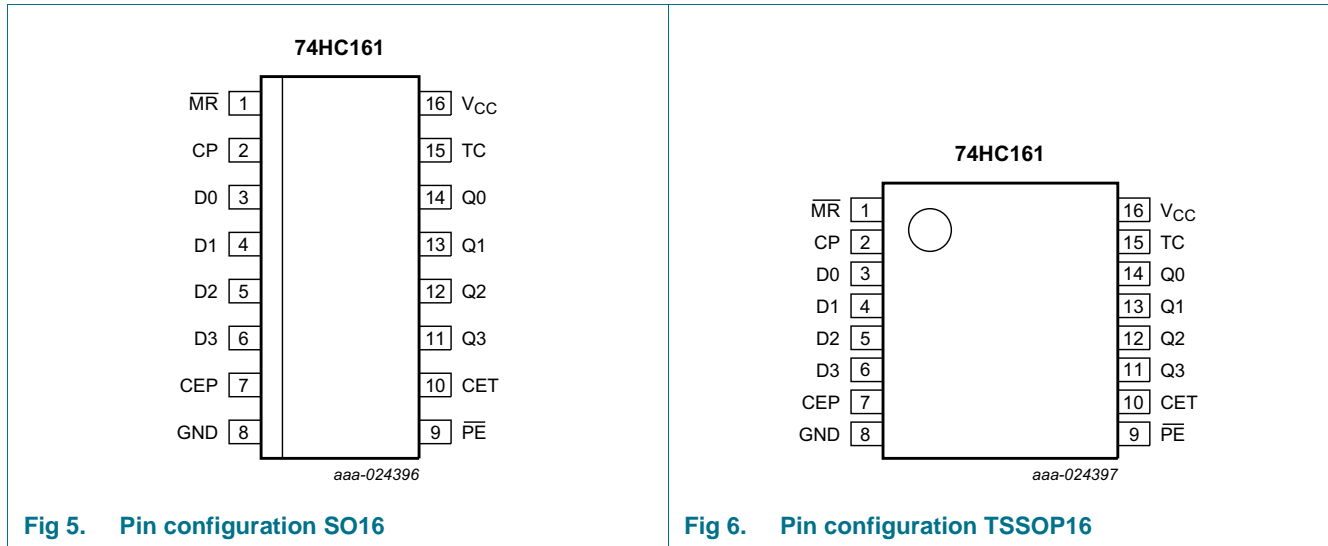


Fig 5. Pin configuration SO16

Fig 6. Pin configuration TSSOP16

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 _{CC}	16	supply voltage

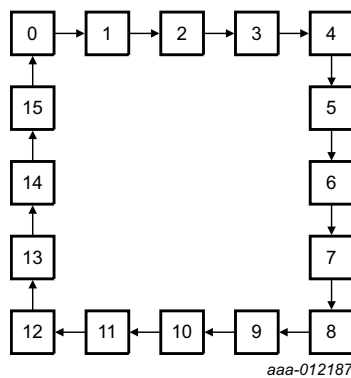
6. Functional description

Table 3. Function table^[1]

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	[2]
Count	H	↑	h	h	h	X	count	[2]
Hold (do nothing)	H	X	l	X	h	X	q _n	[2]
	H	X	X	l	h	X	q _n	L

- [1] 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_n = 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

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



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Fig 7. State diagram

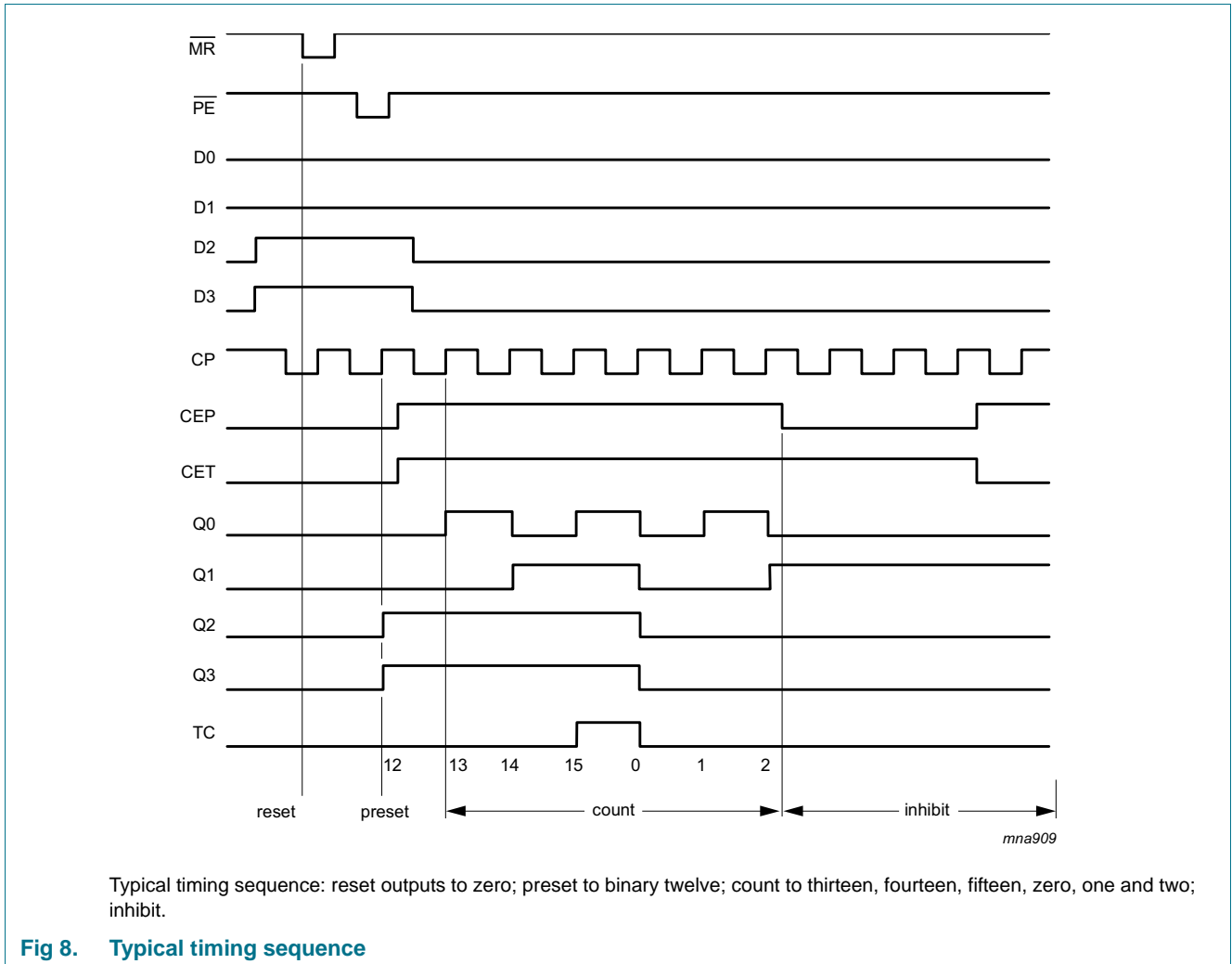


Fig 8. Typical timing sequence

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 $V_I > V_{CC} + 0.5\text{ V}$	-	± 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	SO16 package [1]	-	500	mW
		TSSOP16 package [1]	-	500	mW

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

For TSSOP16 package: 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
Δt/ΔV	input transition rise and fall rate	V _{CC} = 2.0 V	-	-	625	ns/V
		V _{CC} = 4.5 V	-	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	
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; V _{CC} = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
		I _O = -5.2; 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	-	±1.0	-	±1.0	μA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V	-	-	8.0	-	80.0	-	160.0	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 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 Figure 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 Figure 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 Figure 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	\overline{MR} to Qn; see Figure 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
		\overline{MR} to TC; see Figure 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 Figure 9 and Figure 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

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_w	pulse width	CP; HIGH or LOW; see Figure 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
		\overline{MR} ; LOW; see Figure 11								
		$V_{CC} = 2.0$ V	80	19	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	7	-	20	-	24	-	ns
t_{rec}	recovery time	\overline{MR} to CP; see Figure 11								
		$V_{CC} = 2.0$ V	100	19	-	125	-	150	-	ns
		$V_{CC} = 4.5$ V	20	7	-	25	-	30	-	ns
		$V_{CC} = 6.0$ V	17	6	-	21	-	26	-	ns
t_{su}	set-up time	Dn to CP; see Figure 12								
		$V_{CC} = 2.0$ V	80	25	-	100	-	120	-	ns
		$V_{CC} = 4.5$ V	16	9	-	20	-	24	-	ns
		$V_{CC} = 6.0$ V	14	7	-	17	-	20	-	ns
		\overline{PE} to CP; see Figure 12								
		$V_{CC} = 2.0$ 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
		CEP, CET to CP; see Figure 13								
		$V_{CC} = 2.0$ V	170	47	-	215	-	255	-	ns
		$V_{CC} = 4.5$ V	34	17	-	43	-	51	-	ns
$V_{CC} = 6.0$ V	29	14	-	37	-	43	-	ns		
t_h	hold time	Dn, \overline{PE} , CEP, CET to CP; see Figure 12 and Figure 13								
		$V_{CC} = 2.0$ V	0	-14	-	0	-	0	-	ns
		$V_{CC} = 4.5$ V	0	-5	-	0	-	0	-	ns
		$V_{CC} = 6.0$ V	0	-4	-	0	-	0	-	ns
f_{max}	maximum frequency	CP; see Figure 9								
		$V_{CC} = 2.0$ V	4.6	13	-	3.6	-	3.0	-	MHz
		$V_{CC} = 4.5$ V	23	40	-	18	-	15	-	MHz
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	44	-	-	-	-	-	MHz
		$V_{CC} = 6.0$ V	27	48	-	21	-	18	-	MHz

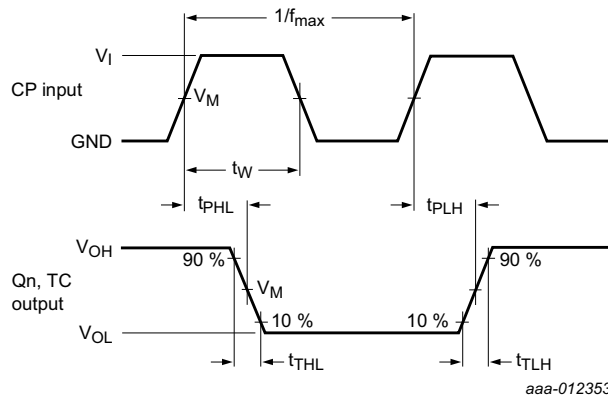
Table 7. Dynamic characteristics ...continued

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	$V_I = \text{GND to } V_{CC}; V_{CC} = 5 \text{ V}; f_i = 1 \text{ MHz}$	-	33	-	-	-	-	-	pF

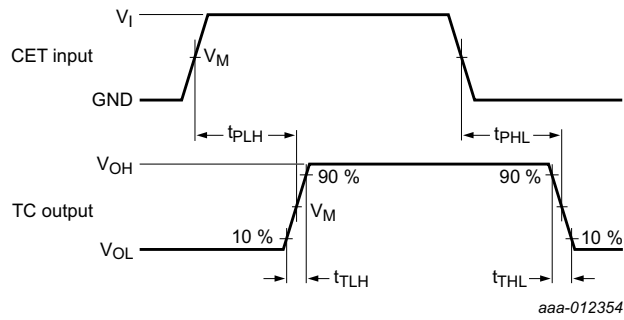
- [1] t_{pd} is the same as t_{PHL} and t_{PLH} .
- [2] t_i is the same as t_{THL} and t_{TLH} .
- [3] C_{PD} is used to determine the dynamic power dissipation (P_D in μW):
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o)$ where:
 f_i = input frequency in MHz;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

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.

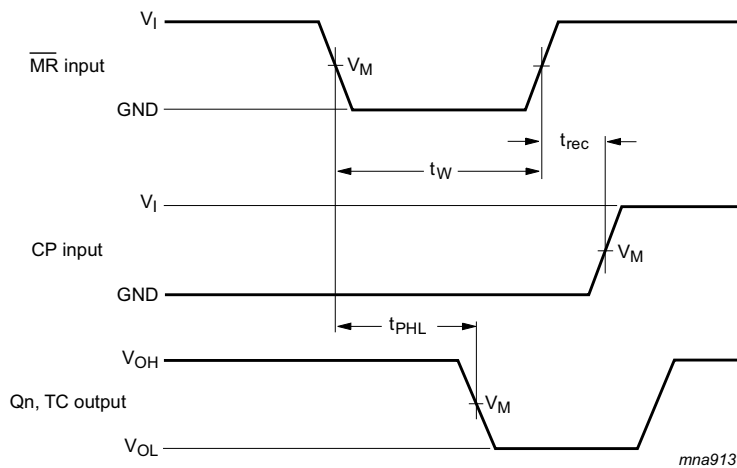
Fig 9. The clock (CP) to outputs (Qn, TC) propagation delays, pulse width, output transition times and maximum frequency



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.

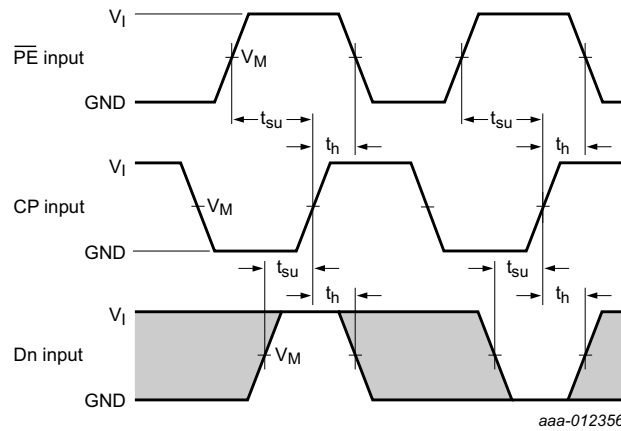
Fig 10. The count enable carry input (CET) to terminal count output (TC) propagation delays and output transition times



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

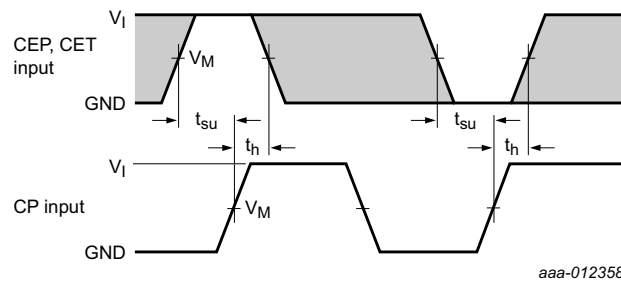
Logic levels V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

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}	$0.5 \times V_{CC}$

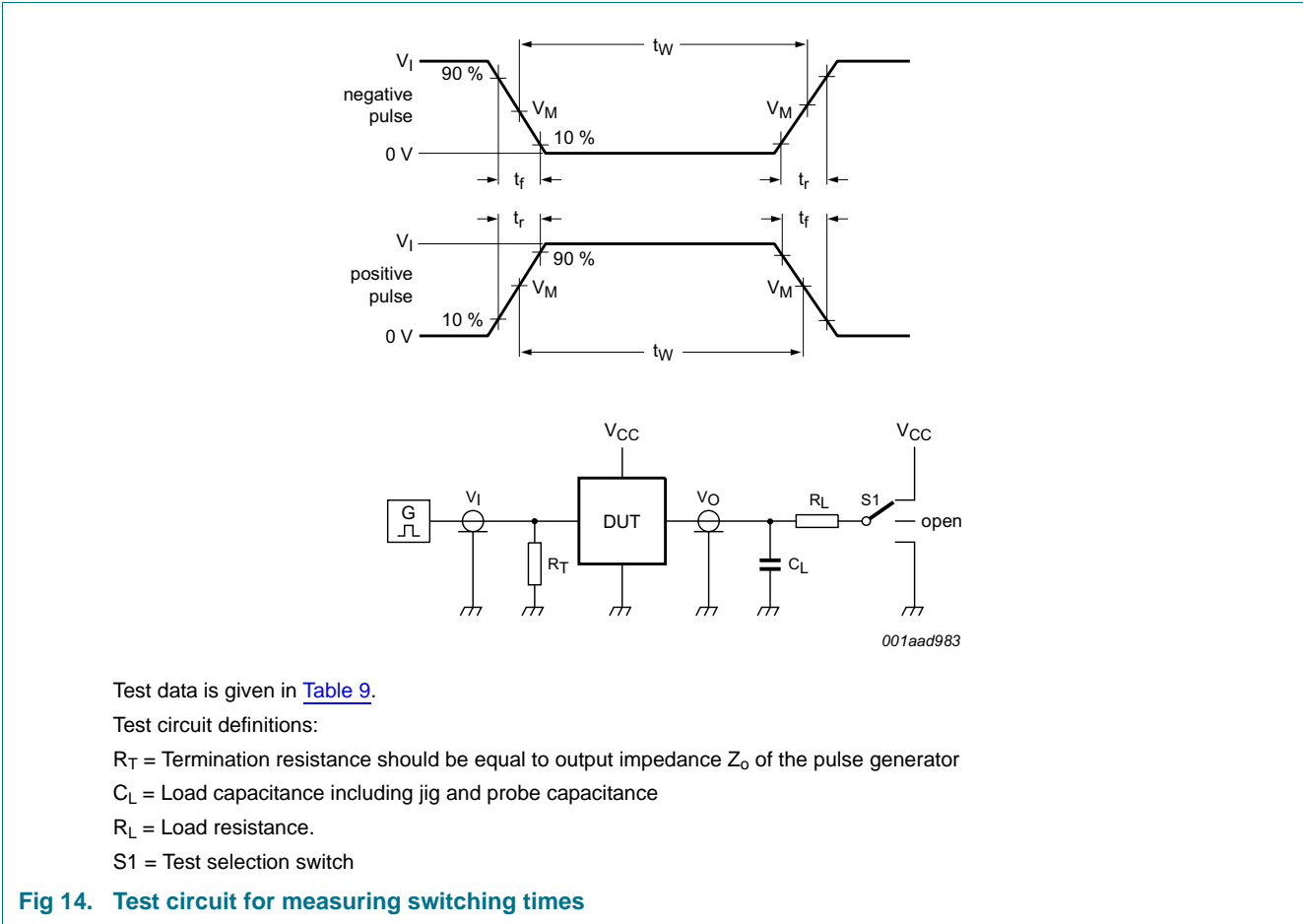


Table 9. Test data

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 Ω	open

12. Package outline

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

SOT109-1

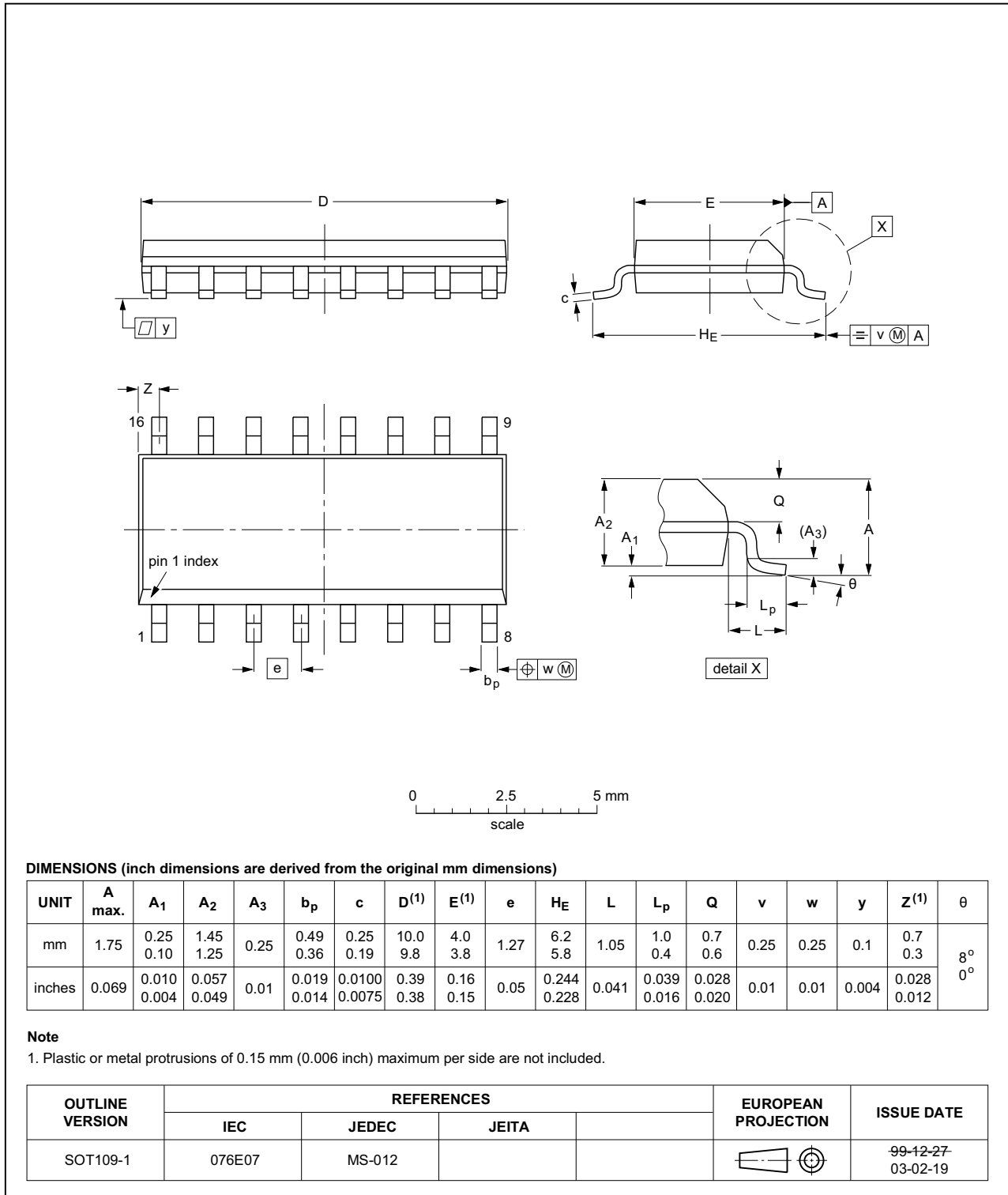


Fig 15. Package outline SOT109-1 (SO16)

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

SOT403-1

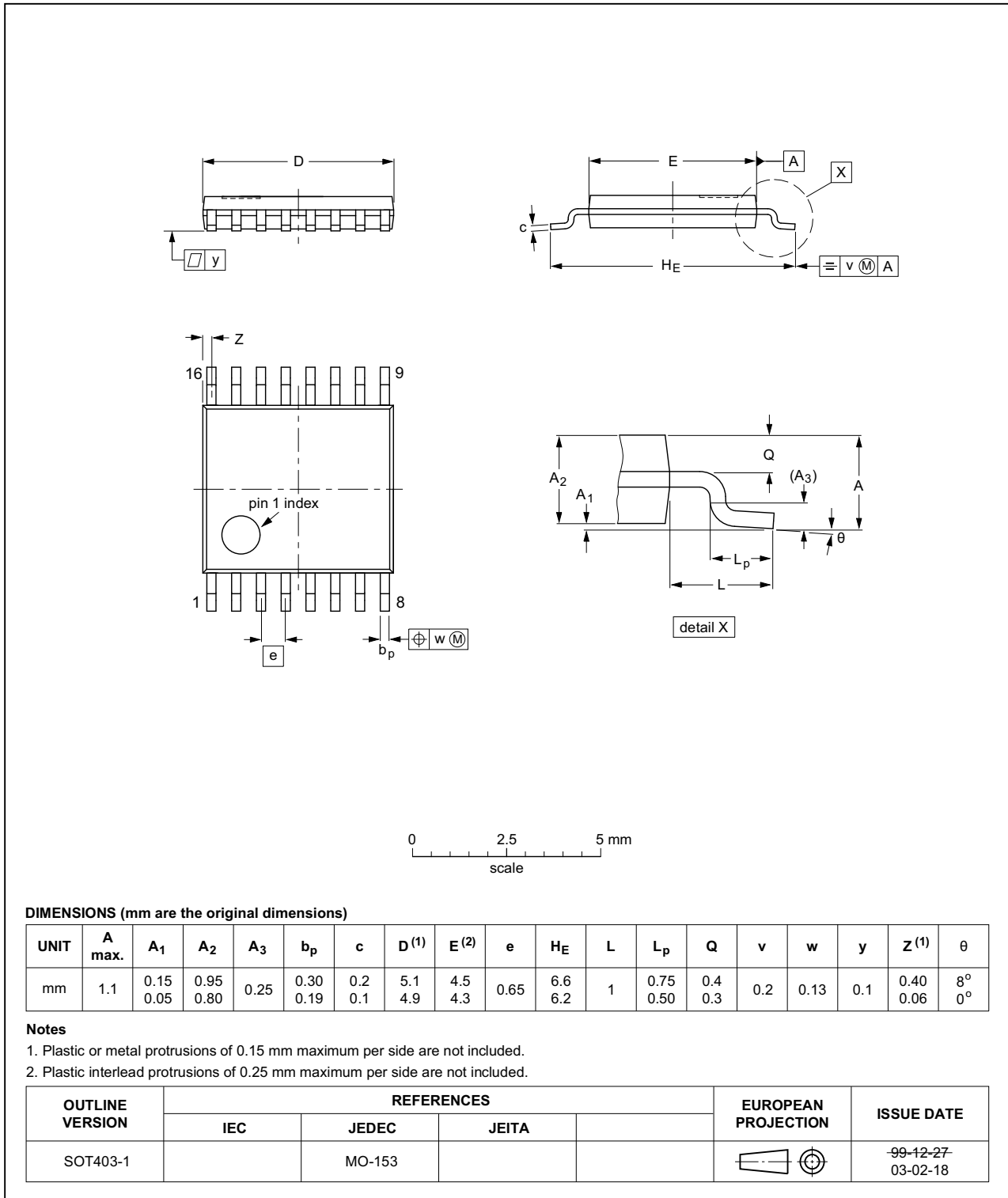


Fig 16. Package outline SOT403-1 (TSSOP16)

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
74HC161_Q100 v.1	20170103	Product data sheet	-	-

15. Legal information

15.1 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.nxp.com>.

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17. Contents

1 General description 1

2 Features and benefits 1

3 Ordering information 2

4 Functional diagram 2

5 Pinning information 4

5.1 Pinning 4

5.2 Pin description 4

6 Functional description 5

7 Limiting values 6

8 Recommended operating conditions 7

9 Static characteristics 7

10 Dynamic characteristics 8

11 Waveforms 10

12 Package outline 14

13 Abbreviations 16

14 Revision history 16

15 Legal information 17

15.1 Data sheet status 17

15.2 Definitions 17

15.3 Disclaimers 17

15.4 Trademarks 18

16 Contact information 18

17 Contents 19

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