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Kind regards,

Team Nexperia

# 74HCT221

Dual non-retriggerable monostable multivibrator with reset

Rev. 3 — 26 October 2016

Product data sheet

## 1. General description

The 74HCT221 is a dual non-retriggerable monostable multivibrator. Each multivibrator features edge-triggered inputs ( $\overline{nA}$  and  $nB$ ), either of which can be used as an enable input. Pulse triggering occurs at a particular voltage level and is not directly related to the transition time of the input pulse. Schmitt-trigger input circuitry for the  $nB$  inputs allow jitter-free triggering from inputs with slow transition rates, providing the circuit with excellent noise immunity. Once triggered, the outputs ( $nQ$ ,  $\overline{nQ}$ ) are independent of further transitions of  $\overline{nA}$  and  $nB$  inputs. The output pulse width is defined by the following relationship:  $t_W = 0.7 \times C_{EXT} \times R_{EXT}$ . The output pulses can be terminated by the active LOW reset inputs ( $\overline{nRD}$ ). Pulse width stability is achieved through internal compensation and is virtually independent of  $V_{CC}$  and temperature. In most applications pulse stability will only be limited by the accuracy of the external timing components. 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 74HCT221: TTL level
- Pulse width variance is typically less than  $\pm 5\%$
- Direct reset terminates output pulse
- Schmitt-trigger action on  $nB$  inputs
- 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 from  $-40\text{ }^\circ\text{C}$  to  $+125\text{ }^\circ\text{C}$

## 3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HCT221D	$-40\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1



4. Functional diagram

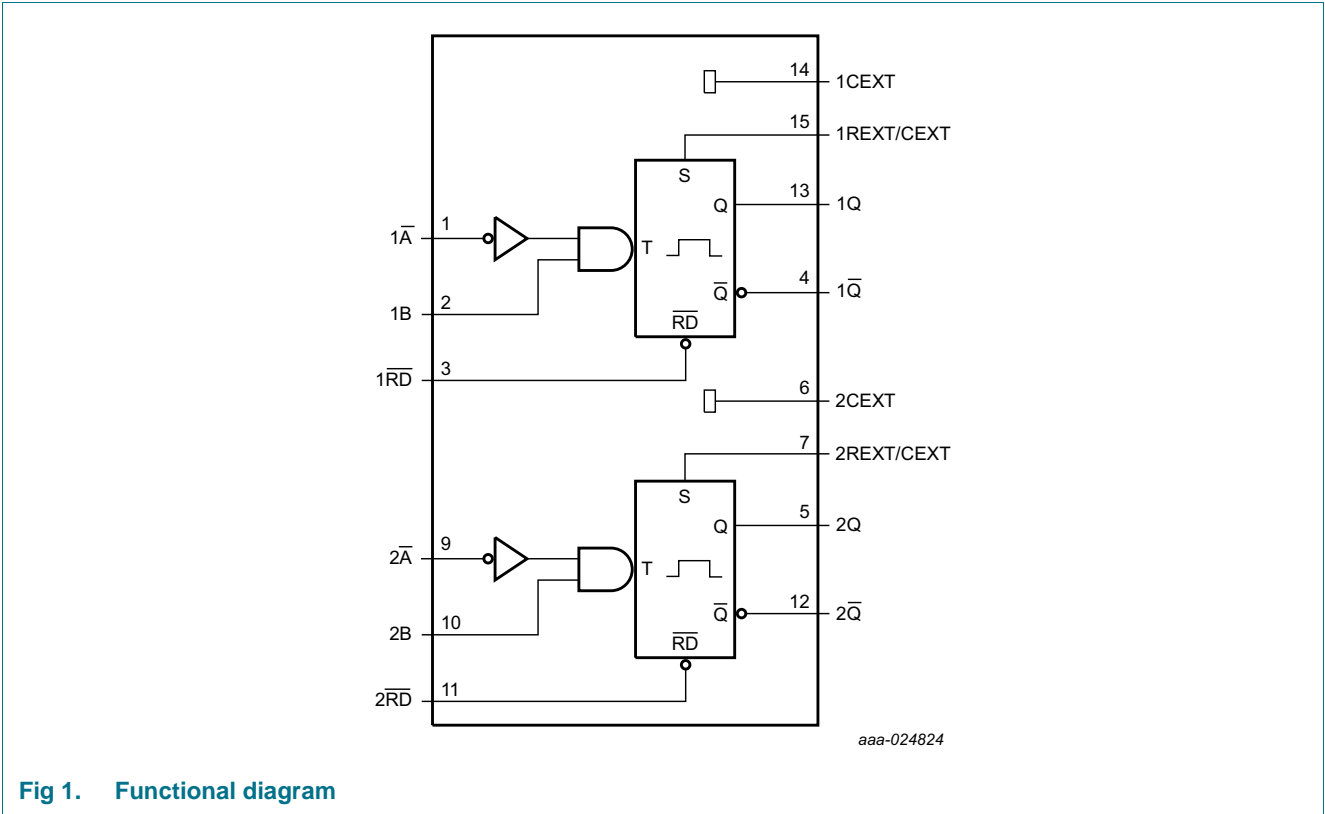


Fig 1. Functional diagram

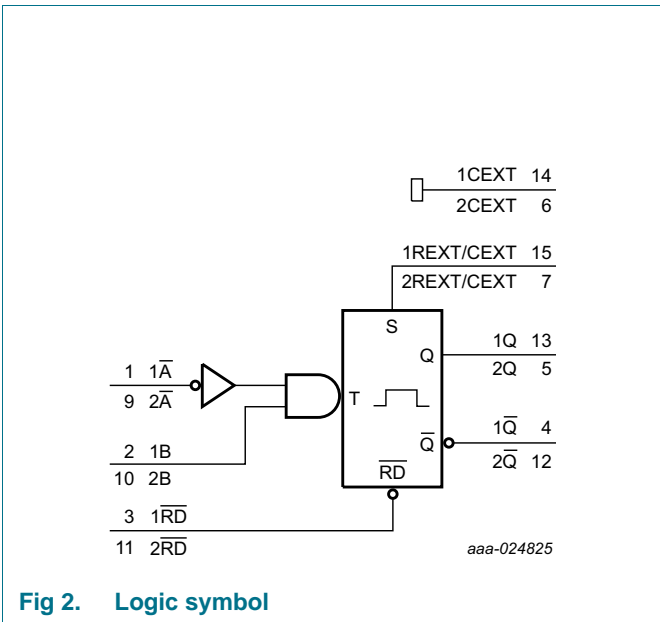


Fig 2. Logic symbol

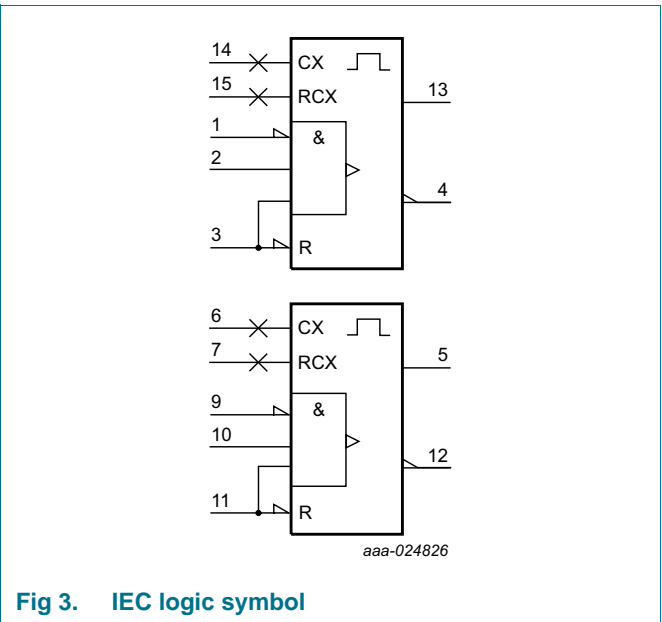


Fig 3. IEC logic symbol

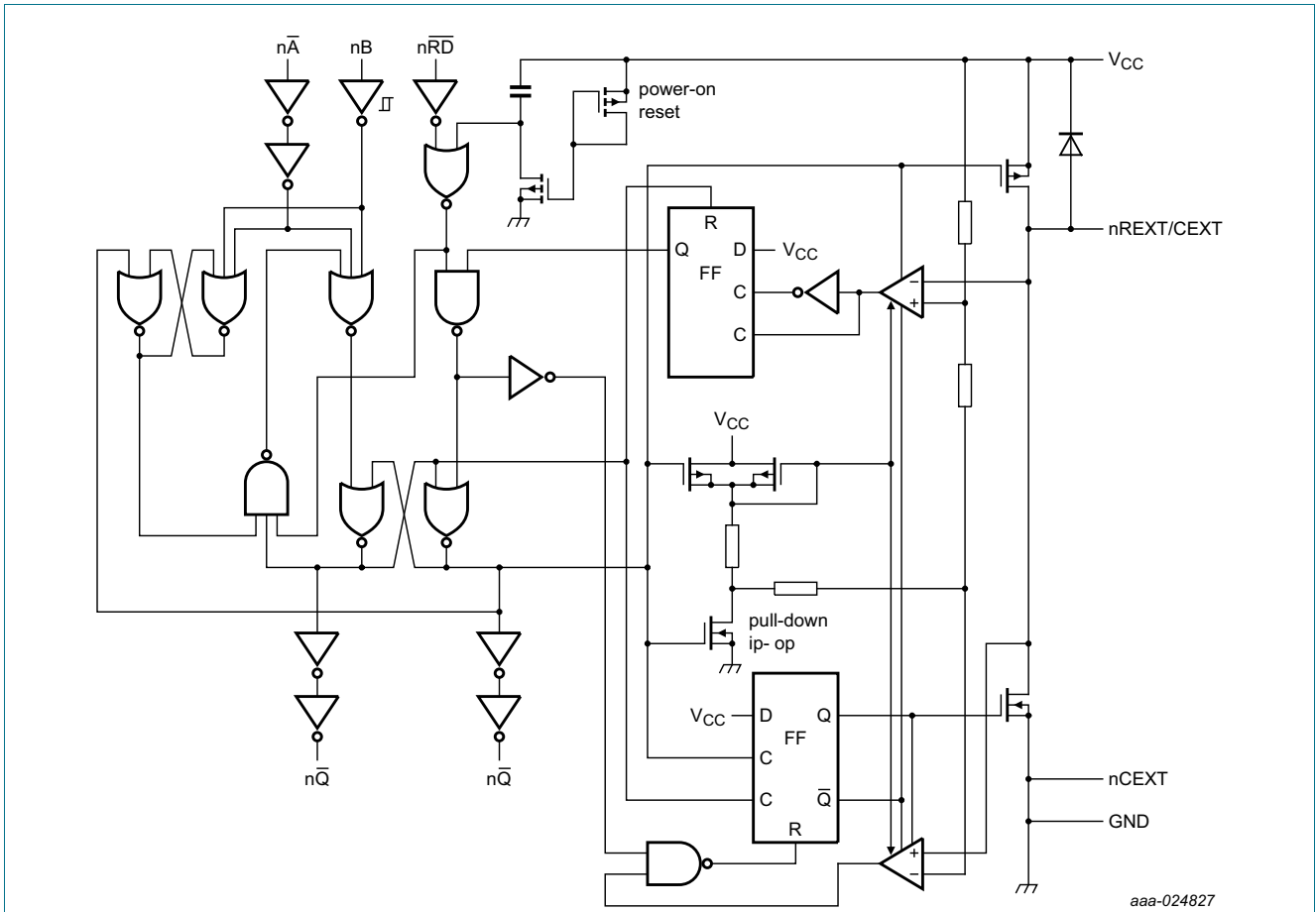
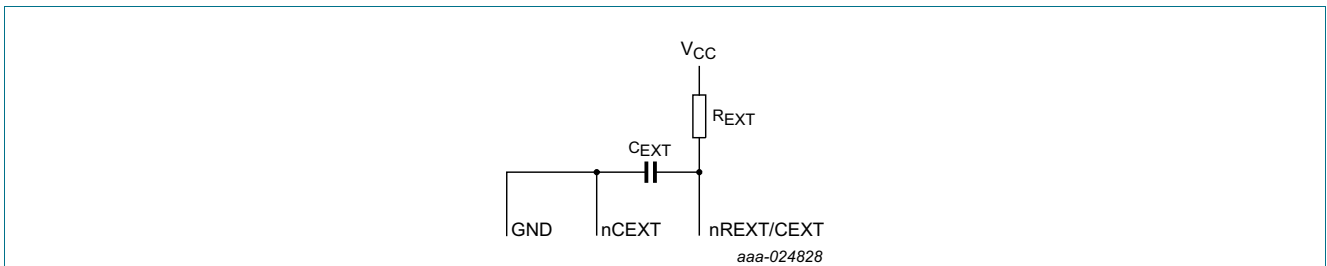


Fig 4. Logic diagram



It is recommended to connect pins nCEXT externally to the GND pin.

Fig 5. Timing component connections

## 5. Pinning information

### 5.1 Pinning

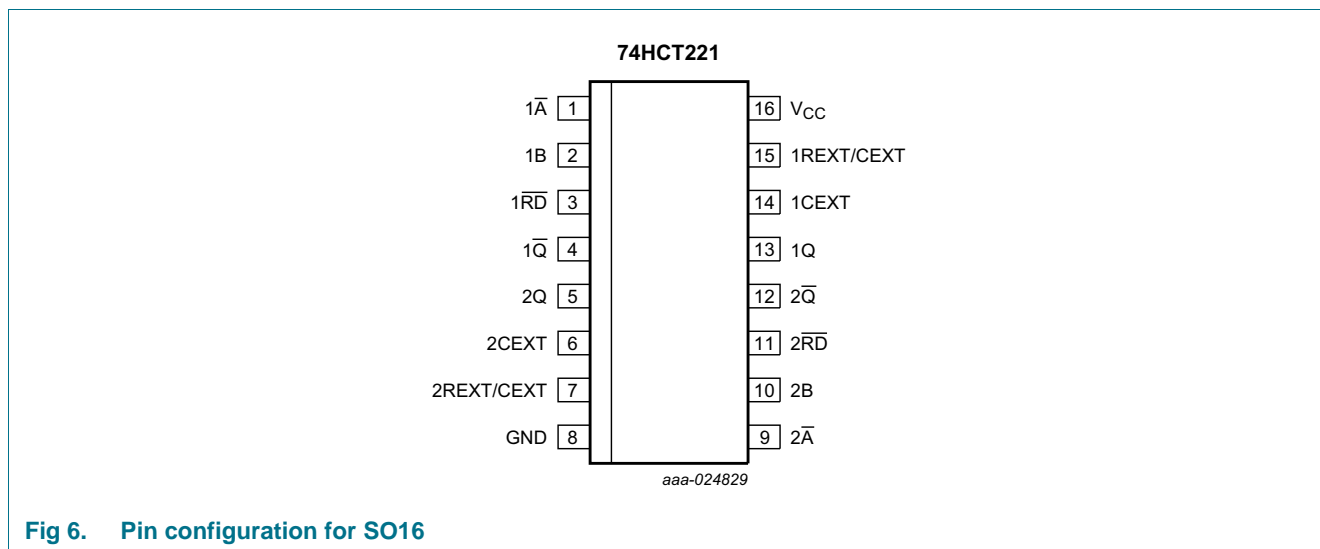


Fig 6. Pin configuration for SO16







### 5.2 Pin description

Table 2. Pin description



Symbol	Pin	Description
1Ā	1	negative-edge triggered input 1
1B	2	positive-edge triggered input 1
1RD̄	3	direct reset LOW and positive-edge triggered input 1
1Q̄	4	active LOW output 1
2Q	5	active HIGH output 2
2CEXT	6	external capacitor connection 2
2REXT/CEXT	7	external resistor and capacitor connection 2
GND	8	ground (0 V)
2Ā	9	negative-edge triggered input 2
2B	10	positive-edge triggered input 2
2RD̄	11	direct reset LOW and positive-edge triggered input 2
2Q̄	12	active LOW output 2
1Q	13	active HIGH output 1
1CEXT	14	external capacitor connection 1
1REXT/CEXT	15	external resistor and capacitor connection 1
V <sub>CC</sub>	16	supply voltage

## 6. Functional description

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

Input			Output	
nRD	nA	nB	nQ	nQ
L	X	X	L	H
X	H	X	L <sup>[2]</sup>	H <sup>[2]</sup>
X	X	L	L <sup>[2]</sup>	H <sup>[2]</sup>
H	L	↑		
H	↓	H		
↑	L	H	 <sup>[3]</sup>	 <sup>[3]</sup>

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = LOW-to-HIGH transition; ↓ = HIGH-to-LOW transition;

 = one HIGH level output pulse;  = one LOW level output pulse.

[2] If the monostable was triggered before this condition was established, the pulse will continue as programmed.

[3] For this combination the reset input must be LOW and the following sequence must be used:

pin nA must be set HIGH or pin nB set LOW; then pin nA must be LOW and pin nB set HIGH. Now the reset input goes from LOW-to-HIGH and the device will be triggered.

## 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 <sub>CC</sub>	supply voltage		-0.5	+7	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>CC</sub> + 0.5 V	-	±20	mA
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < -0.5 V or V <sub>O</sub> > V <sub>CC</sub> + 0.5 V	-	±20	mA
I <sub>O</sub>	output current	except for pins nREXT/CEXT; V <sub>O</sub> = -0.5 V to (V <sub>CC</sub> + 0.5 V)	-	±25	mA
I <sub>CC</sub>	supply current		-	50	mA
I <sub>GND</sub>	ground current		-50	-	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
P <sub>tot</sub>	total power dissipation	SO16 package <sup>[1]</sup>	-	500	mW

[1] For SO16 package: P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C.

## 8. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{CC}$	supply voltage		4.5	5.0	5.5	V
$V_I$	input voltage		0	-	$V_{CC}$	V
$V_O$	output voltage		0	-	$V_{CC}$	V
$\Delta t/\Delta V$	input transition rise and fall rate	nA, $\overline{nRD}$ input				
		$V_{CC} = 4.5\text{ V}$	-	1.67	139	ns/V
$T_{amb}$	ambient temperature		-40	+25	+125	°C

## 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	$V_{CC} = 4.5\text{ V to }5.5\text{ V}$	2.0	1.6	-	2.0	-	2.0	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 4.5\text{ V to }5.5\text{ V}$	-	1.2	0.8	-	0.8	-	0.8	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 4.5\text{ V}$								
		$I_O = -20\ \mu\text{A}$	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -4\text{ mA}$	3.98	4.32	-	3.84	-	3.7	-	V
$V_{OL}$	LOW-level output voltage	$V_I = V_{IH}$ or $V_{IL}$ ; $V_{CC} = 4.5\text{ V}$								
		$I_O = 20\ \mu\text{A}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 4.0\text{ mA}$	-	0.15	0.26	-	0.33	-	0.4	V
$I_I$	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 5.5\text{ V}$	-	-	$\pm 0.1$	-	$\pm 1.0$	-	$\pm 1.0$	$\mu\text{A}$
$I_{CC}$	supply current	$V_I = V_{CC}$ or GND; $I_O = 0\text{ A}$ ; $V_{CC} = 5.5\text{ V}$	-	-	8.0	-	80	-	160	$\mu\text{A}$
$\Delta I_{CC}$	additional supply current	per input pin; $I_O = 0\text{ A}$ ; $V_I = V_{CC} - 2.1\text{ V}$ ; other inputs at $V_{CC}$ or GND; $V_{CC} = 4.5\text{ V to }5.5\text{ V}$								
		pin nB	-	30	108	-	135	-	147	$\mu\text{A}$
		pins $\overline{nA}$ , $\overline{nRD}$	-	50	180	-	225	-	245	$\mu\text{A}$
$C_I$	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 15](#).

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>PLH</sub>	LOW to HIGH propagation delay	C <sub>EXT</sub> = 0 pF; R <sub>EXT</sub> = 5 kΩ; see <a href="#">Figure 7</a> and <a href="#">Figure 8</a>								
		n $\bar{A}$ , n $\bar{RD}$ to nQ (trigger)								
		V <sub>CC</sub> = 4.5 V	-	30	50	-	63	-	75	ns
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	36	-	-	-	-	-	ns
		nB to nQ (trigger)								
		V <sub>CC</sub> = 4.5 V	-	24	42	-	53	-	63	ns
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	36	-	-	-	-	-	ns
		n $\bar{RD}$ to n $\bar{Q}$ (reset)								
V <sub>CC</sub> = 4.5 V	-	31	51	-	64	-	77	ns		
V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	36	-	-	-	-	-	ns		
t <sub>PHL</sub>	HIGH to LOW propagation delay	C <sub>EXT</sub> = 0 pF; R <sub>EXT</sub> = 5 kΩ; see <a href="#">Figure 7</a> and <a href="#">Figure 8</a>								
		n $\bar{A}$ to n $\bar{Q}$ (trigger)								
		V <sub>CC</sub> = 4.5 V	-	26	44	-	55	-	75	ns
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	32	-	-	-	-	-	ns
		nB to n $\bar{Q}$ (trigger)								
		V <sub>CC</sub> = 4.5 V	-	21	35	-	44	-	53	ns
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	32	-	-	-	-	-	ns
		n $\bar{RD}$ to n $\bar{Q}$ (trigger)								
		V <sub>CC</sub> = 4.5 V	-	26	43	-	54	-	65	ns
		V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	32	-	-	-	-	-	ns
		n $\bar{RD}$ to nQ (reset)								
		V <sub>CC</sub> = 4.5 V	-	26	43	-	54	-	65	ns
V <sub>CC</sub> = 5 V; C <sub>L</sub> = 15 pF	-	32	-	-	-	-	-	ns		
t <sub>t</sub>	transition time	V <sub>CC</sub> = 4.5 V; see <a href="#">Figure 7</a> <sup>[1]</sup>	-	7	15	-	19	-	22	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 15](#).

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>w</sub>	pulse width	n $\bar{A}$ LOW; nB HIGH; (trigger); see <a href="#">Figure 7</a>								
		V <sub>CC</sub> = 4.5 V	20	13	-	25	-	30	-	ns
		n $\bar{RD}$ LOW; see <a href="#">Figure 10</a>								
		V <sub>CC</sub> = 4.5 V	22	13	-	28	-	33	-	ns
		nQ HIGH and n $\bar{Q}$ LOW; see <a href="#">Figure 8</a>								
		V <sub>CC</sub> = 5 V; C <sub>EXT</sub> = 100 nF; R <sub>EXT</sub> = 10 k $\Omega$	630	700	770	602	798	595	805	$\mu$ s
		nQ or n $\bar{Q}$ (trigger); see <a href="#">Figure 8</a>								
		V <sub>CC</sub> = 4.5 V; C <sub>EXT</sub> = 28 pF; R <sub>EXT</sub> = 2 k $\Omega$	-	140	-	-	-	-	-	ns
		V <sub>CC</sub> = 4.5 V; C <sub>EXT</sub> = 1 nF; R <sub>EXT</sub> = 2 k $\Omega$	-	1.5	-	-	-	-	-	$\mu$ s
		V <sub>CC</sub> = 4.5 V; C <sub>EXT</sub> = 1 nF; R <sub>EXT</sub> = 10 k $\Omega$	-	7	-	-	-	-	-	$\mu$ s
t <sub>rec</sub>	recovery time	n $\bar{RD}$ to n $\bar{A}$ , nB; see <a href="#">Figure 11</a>	20	12	-	25	-	30	-	ns
R <sub>EXT</sub>	external timing resistor	V <sub>CC</sub> = 5.0 V; see <a href="#">Figure 13</a>	2	-	1000	-	-	-	-	k $\Omega$
C <sub>EXT</sub>	external timing capacitor	V <sub>CC</sub> = 5.0 V; see <a href="#">Figure 13</a>	no limits							pF

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

*Voltages are referenced to GND (ground = 0 V);  $C_L = 50 \text{ pF}$  unless otherwise specified; for test circuit see [Figure 15](#).*

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	per monostable; $V_I = \text{GND to } V_{CC} - 1.5 \text{ V}$	-	96	-	-	-	-	-	pF

[1]  $t_t$  is the same as  $t_{THL}$  and  $t_{TLH}$

[2]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum(C_L \times V_{CC}^2 \times f_o) + 0.33 \times C_{EXT} \times V_{CC}^2 \times f_o + D \times 28 \times V_{CC}$$

$f_i$  = input frequency in MHz;

$f_o$  = output frequency in MHz;

$D$  = duty factor in %;

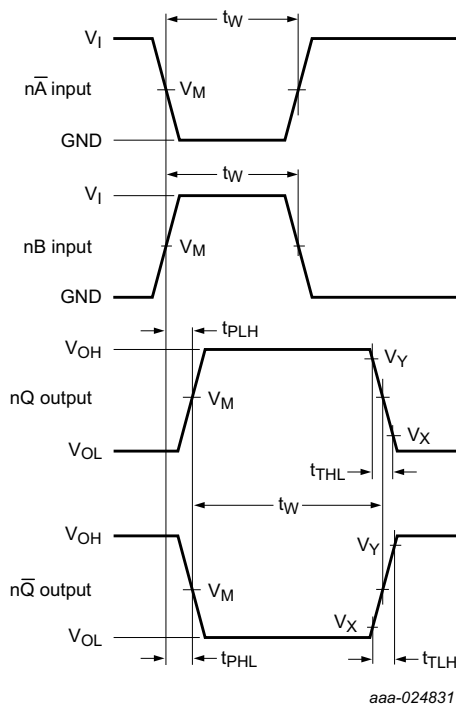
$C_L$  = output load capacitance in pF;

$V_{CC}$  = supply voltage in V;

$C_{EXT}$  = timing capacitance in pF;

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

## 11. Waveforms and graphs



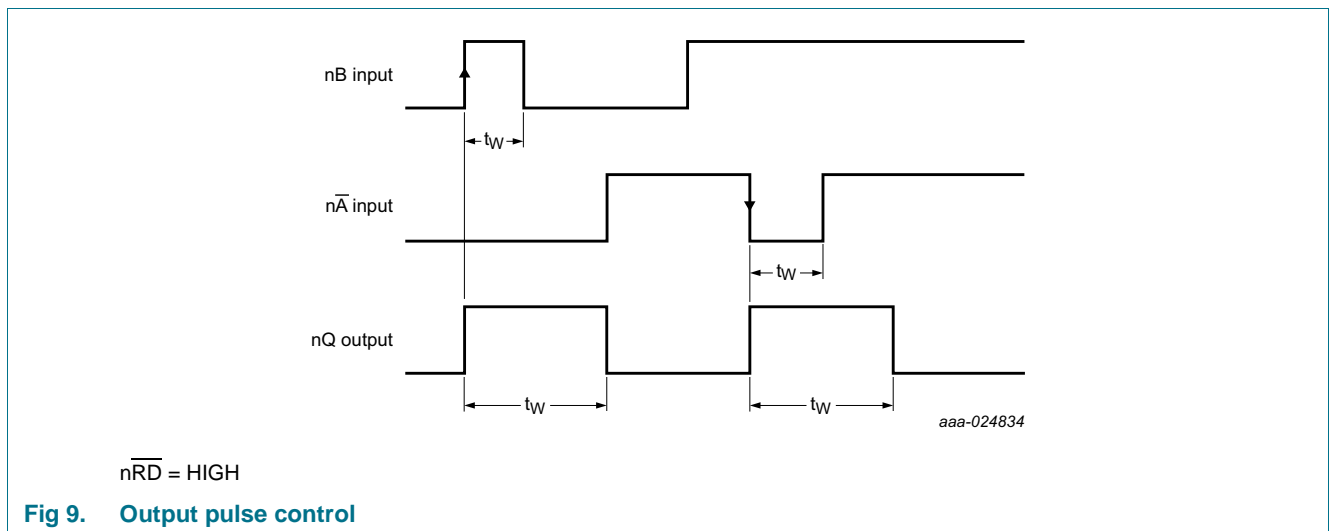
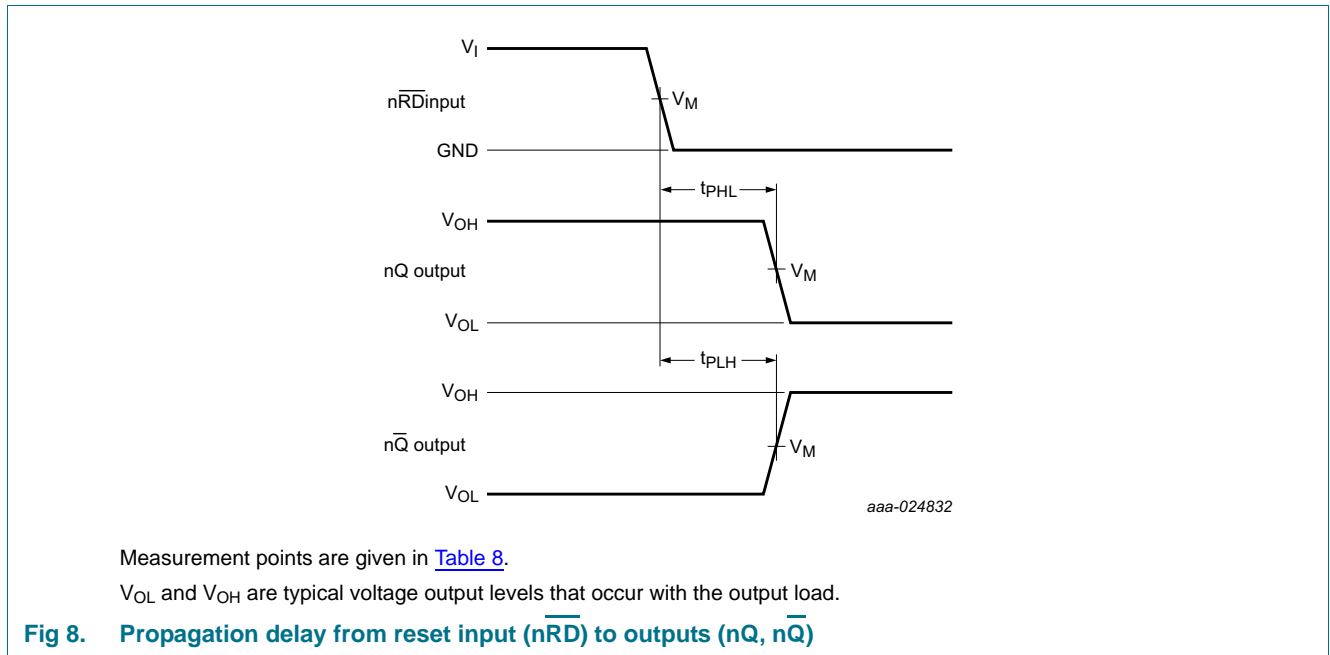
Measurement points are given in [Table 8](#).

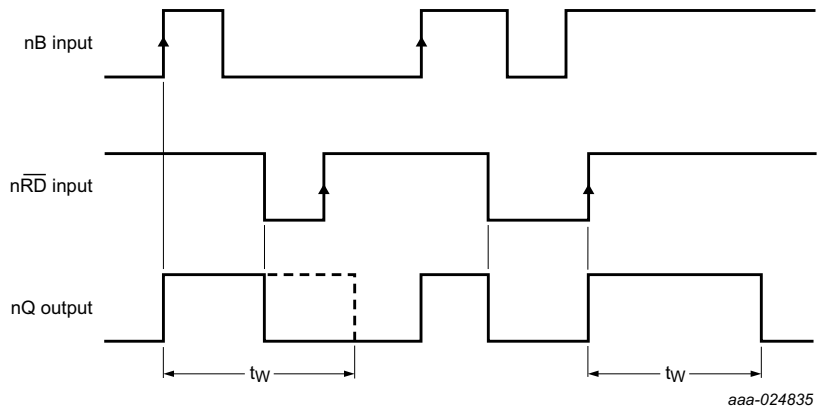
$V_{OL}$  and  $V_{OH}$  are typical voltage output levels that occur with the output load.

**Fig 7. Propagation delay from input ( $\overline{nA}$ ,  $nB$ ) to output ( $nQ$ ,  $\overline{nQ}$ ),  $\overline{nA}$ ,  $nB$  pulse widths and output transition times**

Table 8. Measurement points

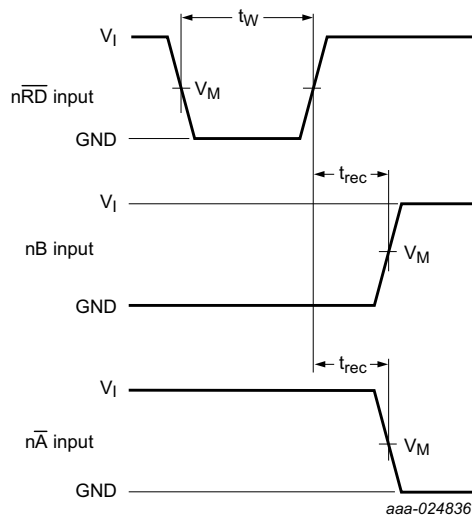
Input	Output		
$V_M$	$V_M$	$V_X$	$V_Y$
1.3 V	1.3 V	$0.1V_{CC}$	$0.9V_{CC}$





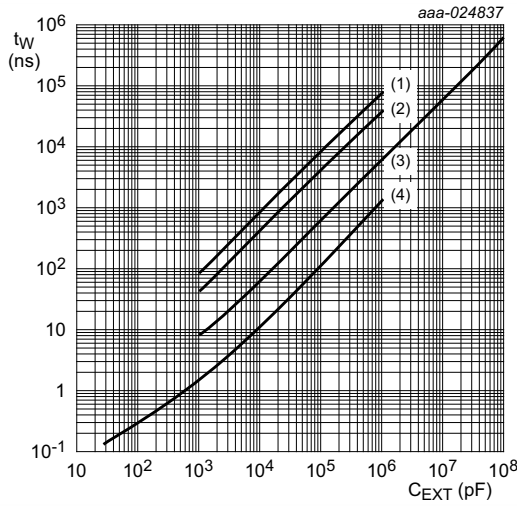
$\overline{nA} = \text{LOW}$

Fig 10. Output pulse control using reset input  $\overline{nRD}$



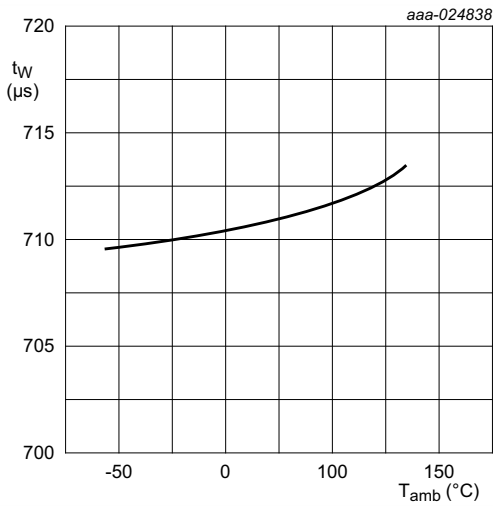
Measurement points are given in [Table 8](#).

Fig 11. Reset input ( $\overline{nRD}$ ) to inputs  $\overline{nA}$  or nB recovery times



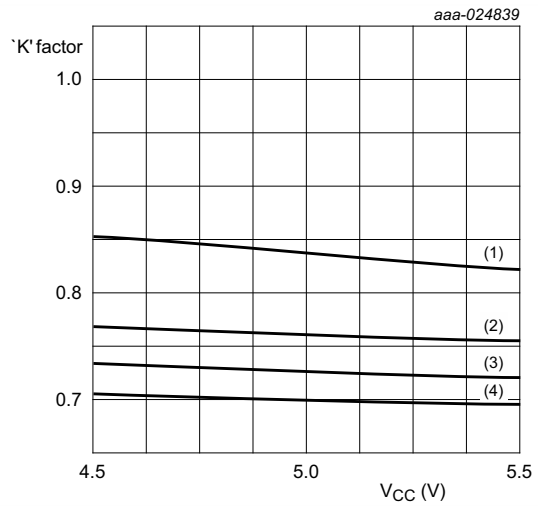
- $V_{CC} = 4.5\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}.$
- (1)  $R_{EXT} = 100\text{ k}\Omega$
  - (2)  $R_{EXT} = 50\text{ k}\Omega$
  - (3)  $R_{EXT} = 10\text{ k}\Omega$
  - (4)  $R_{EXT} = 2\text{ k}\Omega$

Fig 12. Typical output pulse width as a function of the external capacitor



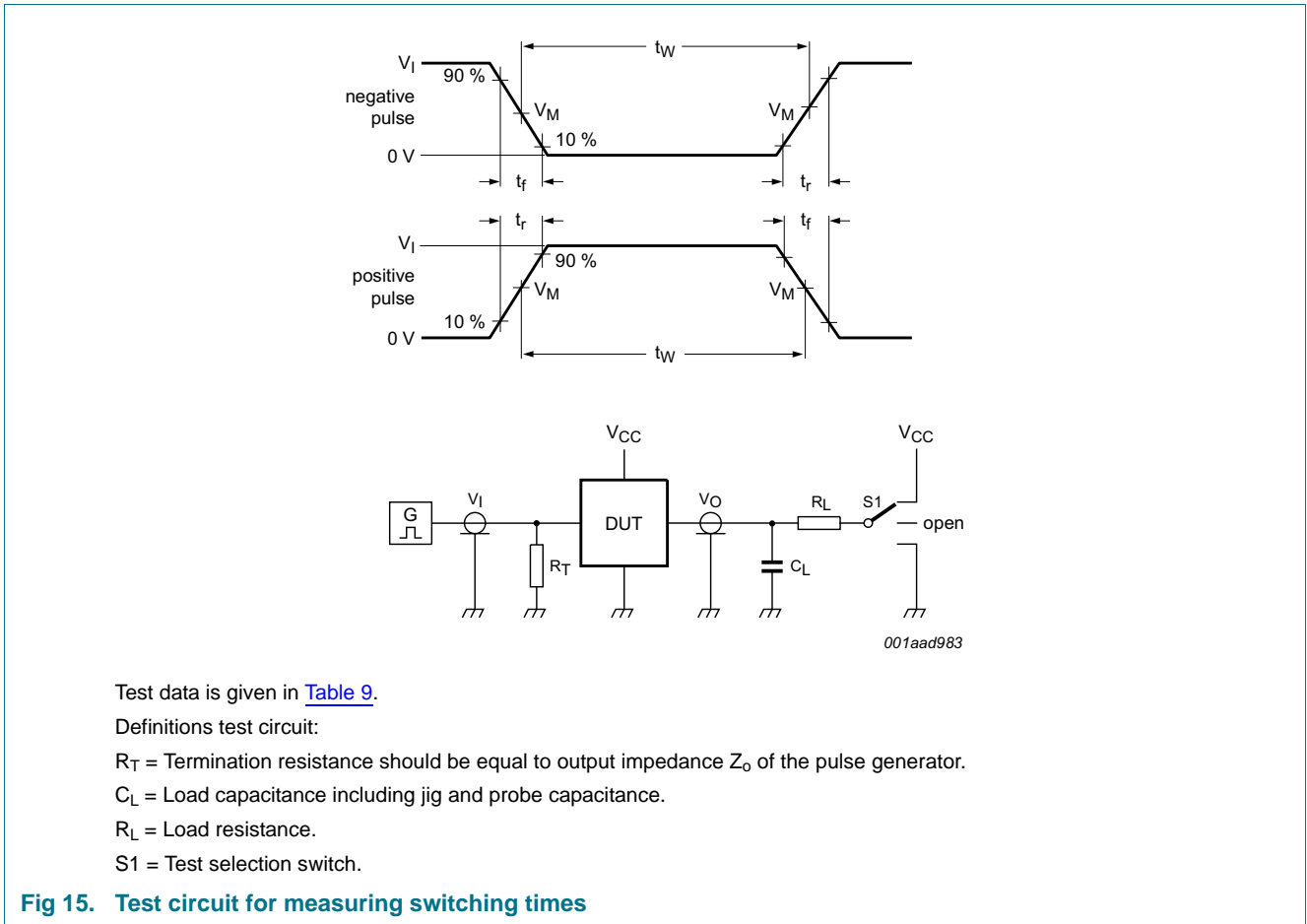
$C_{EXT} = 0.1\text{ }\mu\text{F}; R_{EXT} = 10\text{ k}\Omega.; V_{CC} = 5.0\text{ V}$

Fig 13. Typical output pulse width as a function of the ambient temperature



- $R_{EXT} = 10\text{ k}\Omega; T_{amb} = 25\text{ }^{\circ}\text{C}.$
- (1)  $C_{EXT} = 0.001\text{ }\mu\text{F}$
  - (2)  $C_{EXT} = 0.01\text{ }\mu\text{F}$
  - (3)  $C_{EXT} = 0.1\text{ }\mu\text{F}$
  - (4)  $C_{EXT} = 1\text{ }\mu\text{F}$

Fig 14. "K" factor as function of the supply voltage



**Table 9. Test data**

Input		Load		S1 position
$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PHL}, t_{PLH}$
3 V	6 ns	15 pF, 50 pF	1 kΩ	open

## 12. Application information

### 12.1 Power-down considerations

A large capacitor  $C_{EXT}$  may cause problems when powering-down the monostable due to the energy stored in this capacitor. When a system containing this device is powered-down or a rapid decrease of  $V_{CC}$  to zero occurs, the monostable may sustain damage, due to the capacitor discharging through the input protection diodes. To avoid this possibility, use a damping diode ( $D_{EXT}$ ) preferably a germanium or Schottky type diode able to withstand large current surges and connect as shown in [Figure 16](#).

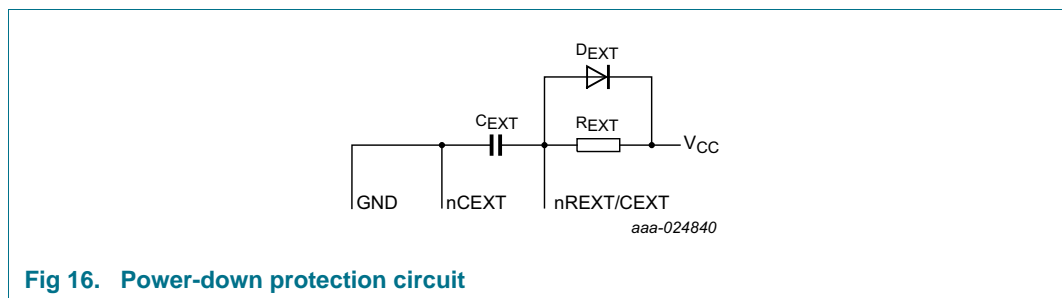


Fig 16. Power-down protection circuit

13. Package outline

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

SOT109-1

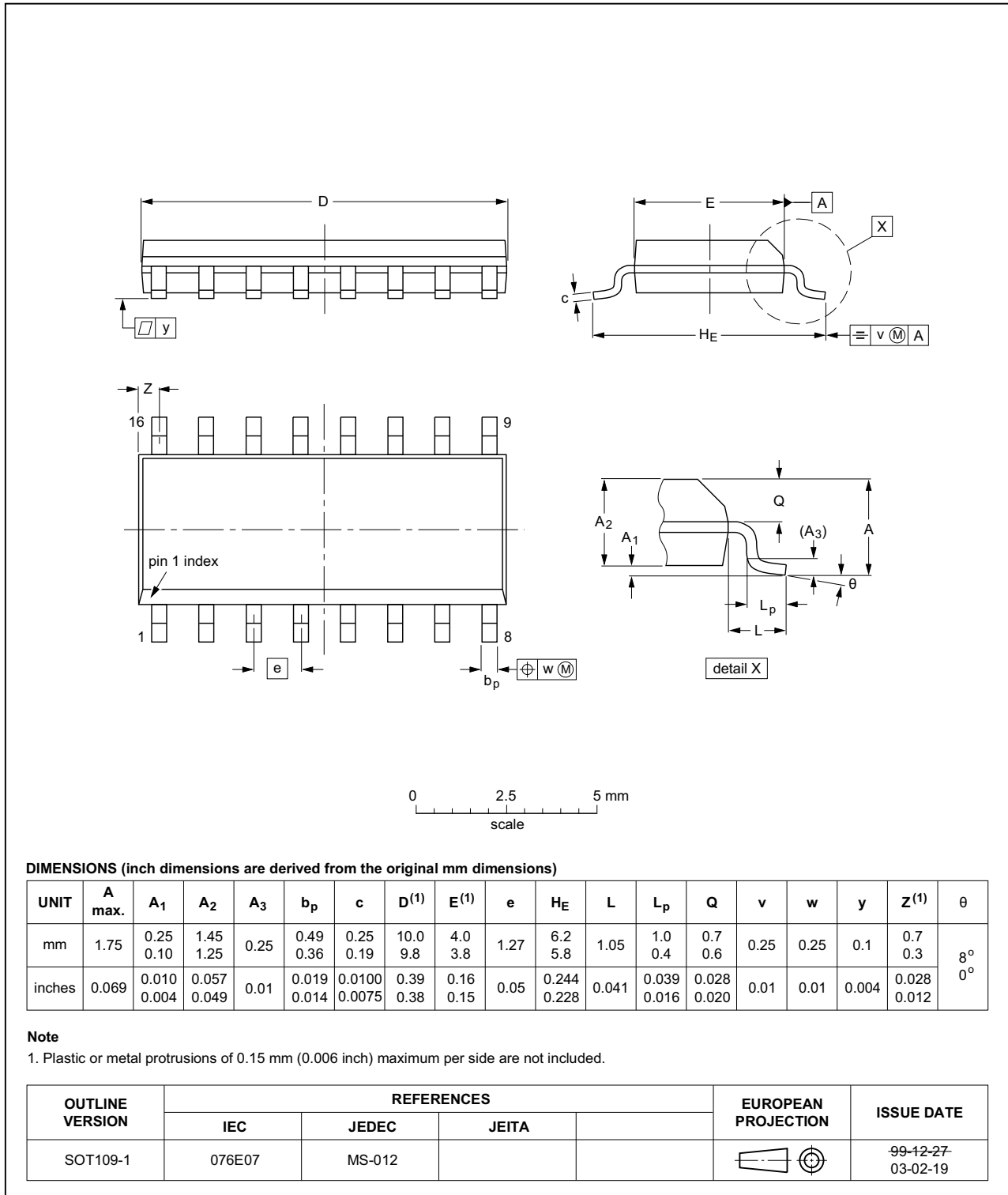


Fig 17. Package outline SOT109-1 (SO16)

## 14. Abbreviations

Table 10. Abbreviations

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

## 15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HCT221 v.3	20161026	Product data sheet	-	74HC_HCT221 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 74HC221N, 74HC221D, 74HC221DB and 74HCT221N removed.</li> </ul>			
74HC_HCT221 v.2	19901201	Product specification	-	-

## 16. Legal information

### 16.1 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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