

# 74HC4538

## Dual retriggerable precision monostable multivibrator

Rev. 6 — 16 July 2021

Product data sheet

### 1. General description

The 74HC4538 is a dual retriggerable-resettable monostable multivibrator. Each multivibrator has two trigger/retrigger inputs ( $n\bar{A}$  and  $nB$ ), a direct reset input ( $n\bar{CD}$ ), two complementary outputs ( $nQ$  and  $n\bar{Q}$ ), and two pins ( $nREXT/CEXT$  and  $nCEXT$ ) for connecting the external timing components  $C_{EXT}$  and  $R_{EXT}$ . Typical pulse width variation over temperature range is  $\pm 0.2\%$ . The device may be triggered by either the positive or the negative edges of the input pulse. The duration and accuracy of the output pulse are determined by the external timing components  $C_{EXT}$  and  $R_{EXT}$ . The output pulse width ( $T_W$ ) is equal to  $0.7 \times R_{EXT} \times C_{EXT}$ . The linear design techniques guarantee precise control of the output pulse width. A LOW level at  $n\bar{CD}$  terminates the output pulse immediately. Schmitt-trigger action in the trigger inputs makes the circuit highly tolerant to slower rise and fall times. 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

- Wide supply voltage range from 2.0 to 6.0 V
- CMOS low power dissipation
- CMOS input levels
- High noise immunity
- Tolerant of slow trigger rise and fall times
- Separate reset inputs
- Triggering from falling or rising edge
- 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)
- 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
74HC4538D	$-40\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC4538PW	$-40\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

4. Functional diagram

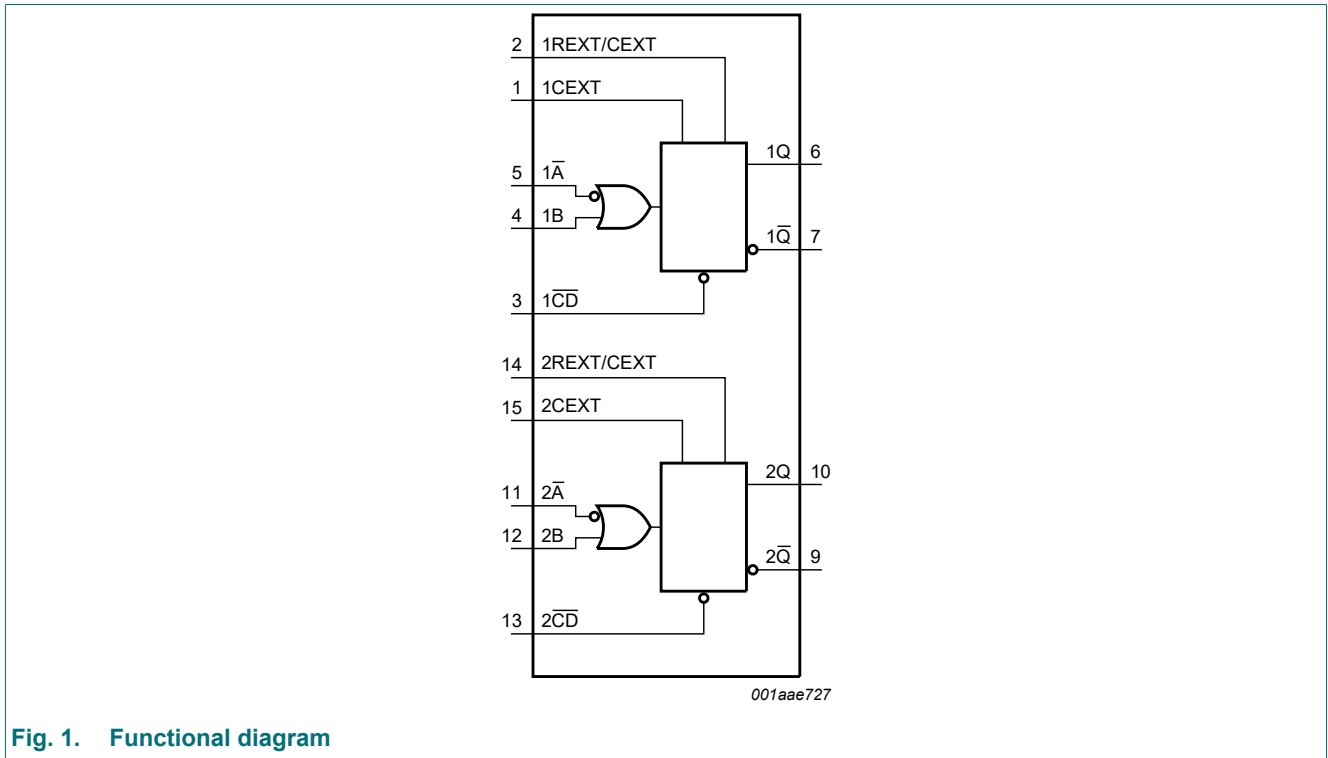


Fig. 1. Functional diagram

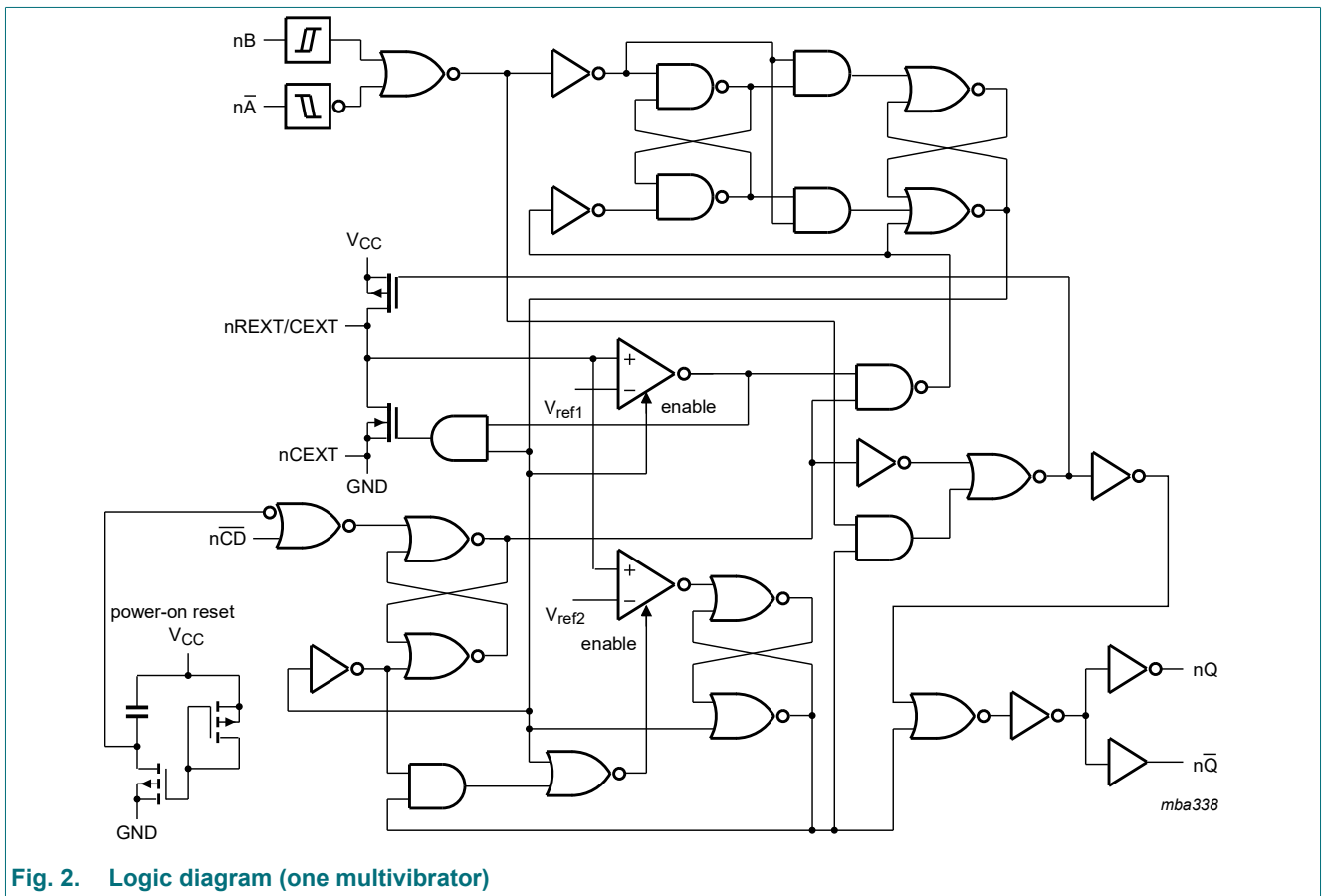


Fig. 2. Logic diagram (one multivibrator)

## 5. Pinning information

### 5.1. Pinning

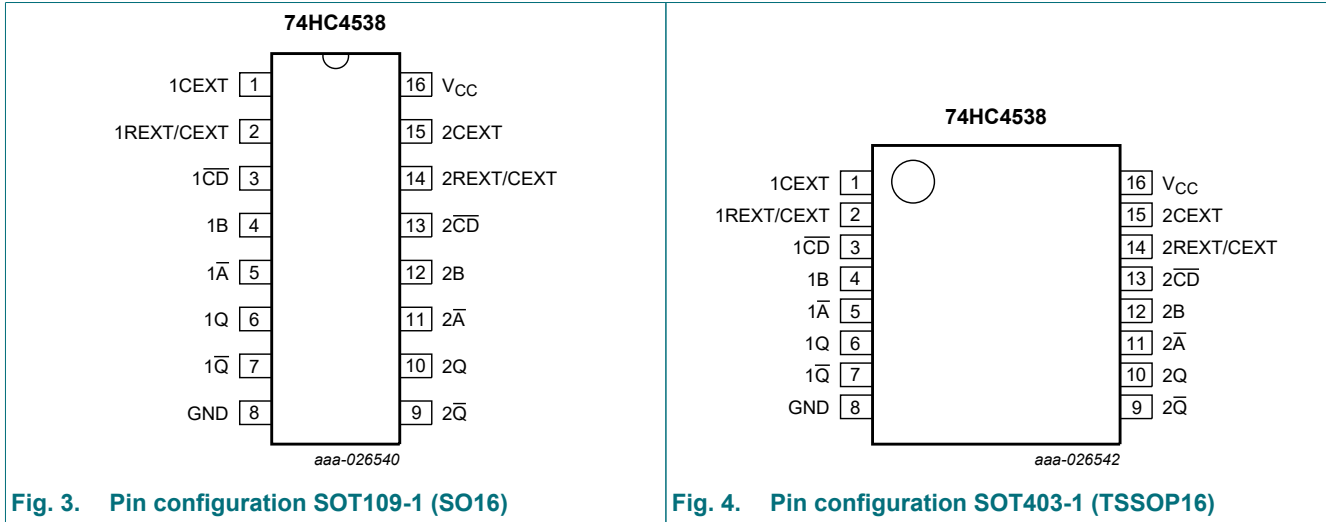


Fig. 3. Pin configuration SOT109-1 (SO16)

Fig. 4. Pin configuration SOT403-1 (TSSOP16)

### 5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
1CEXT, 2CEXT	1, 15	external capacitor connection (always connected to ground)
1REXT/CEXT, 2REXT/CEXT	2, 14	external capacitor/resistor connection
1CD, 2CD	3, 13	direct reset input (active LOW)
1B, 2B	4, 12	input (LOW to HIGH triggered)
1A, 2A	5, 11	input (HIGH to LOW triggered)
1Q, 2Q	6, 10	output
1Q, 2Q	7, 9	complementary output (active LOW)
GND	8	ground (0 V)
VCC	16	supply voltage

## 6. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level; X = don't care;

↑ = positive-going transition; ↓ = negative-going transition;

⎓ = one HIGH level output pulse, with the pulse width determined by C<sub>EXT</sub> and R<sub>EXT</sub>;

⎓ = one LOW level output pulse, with the pulse width determined by C<sub>EXT</sub> and R<sub>EXT</sub>.

Inputs			Outputs	
nA	nB	nCD	nQ	nQ
↓	L	H	⎓	⎓
H	↑	H	⎓	⎓
X	X	L	L	H

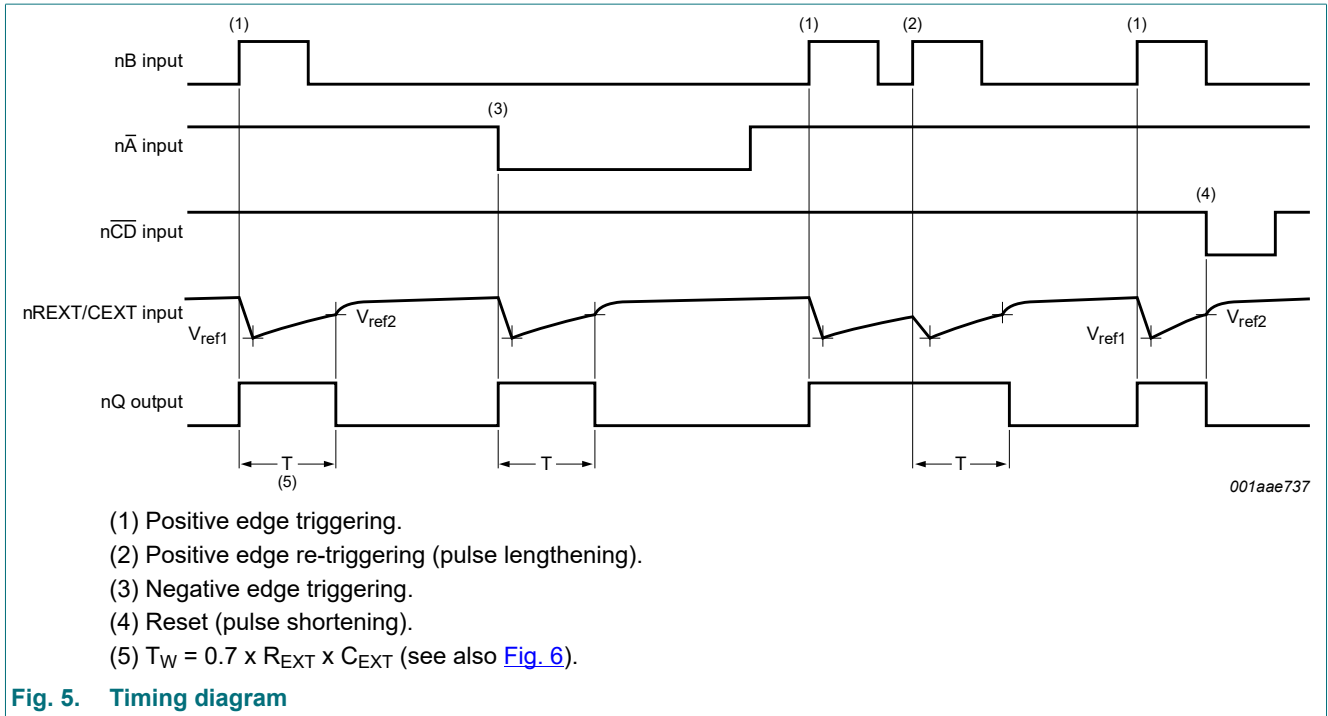


Fig. 5. Timing diagram

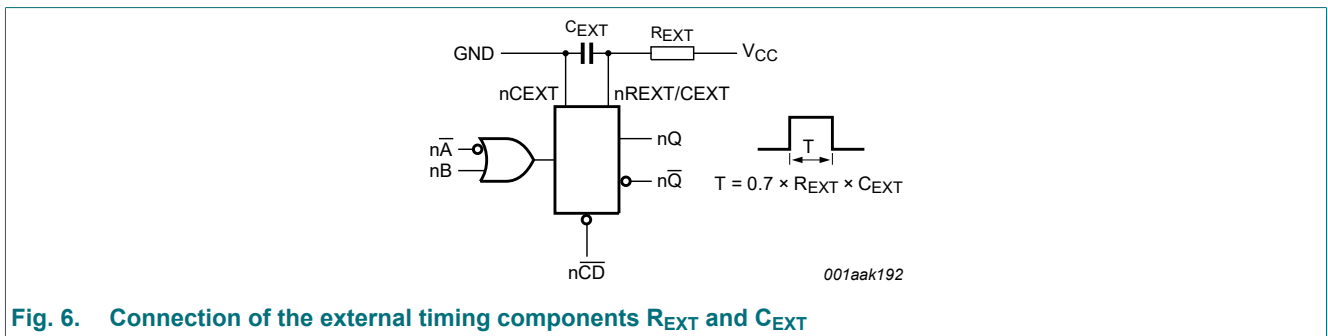


Fig. 6. Connection of the external timing components  $R_{EXT}$  and  $C_{EXT}$

## 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 $V_I > V_{CC} + 0.5 \text{ V}$ [1]	-	$\pm 20$	mA
$I_{OK}$	output clamping current	$V_O < -0.5 \text{ V}$ or $V_O > V_{CC} + 0.5 \text{ V}$ [1]	-	$\pm 20$	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	$^{\circ}\text{C}$
$P_{tot}$	total power dissipation	$T_{amb} = -40 \text{ }^{\circ}\text{C}$ to $+125 \text{ }^{\circ}\text{C}$ [2]	-	500	mW

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] For SOT109-1 (SO16) package:  $P_{tot}$  derates linearly with 12.4 mW/K above 110  $^{\circ}\text{C}$ .

For SOT403-1 (TSSOP16) package:  $P_{tot}$  derates linearly with 8.5 mW/K above 91  $^{\circ}\text{C}$ .

## 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	-	+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 $V_{IL}$								
		$I_O = -20\text{ }\mu\text{A}$ ; $V_{CC} = 2.0\text{ V}$	1.9	2.0	-	1.9	-	1.9	-	V
		$I_O = -20\text{ }\mu\text{A}$ ; $V_{CC} = 4.5\text{ V}$	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -20\text{ }\mu\text{A}$ ; $V_{CC} = 6.0\text{ V}$	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 $V_{IL}$								
		$I_O = 20\text{ }\mu\text{A}$ ; $V_{CC} = 2.0\text{ V}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20\text{ }\mu\text{A}$ ; $V_{CC} = 4.5\text{ V}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20\text{ }\mu\text{A}$ ; $V_{CC} = 6.0\text{ V}$	-	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; $V_{CC} = 6.0\text{ V}$	-	-	$\pm 0.1$	-	$\pm 1$	-	$\pm 1$	$\mu\text{A}$
		pin nREXT/CEXT; $V_I = 2.0\text{ V}$ or GND; other inputs at $V_{CC}$ or GND; $V_{CC} = 6.0\text{ V}$ [1]	-	-	$\pm 50$	-	$\pm 500$	-	$\pm 500$	nA
$I_{CC}$	supply current	$V_I = V_{CC}$ or GND; $I_O = 0\text{ A}$ ; $V_{CC} = 6.0\text{ V}$	-	-	8.0	-	80	-	160	$\mu\text{A}$

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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

[1] This measurement can only be carried out after a trigger pulse is applied.

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 9.

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ[1]	Max	Min	Max	Min	Max	
t <sub>PLH</sub>	LOW to HIGH propagation delay	n $\bar{A}$ , nB to nQ; see Fig. 7								
		V <sub>CC</sub> = 2.0 V	-	85	265	-	330	-	400	ns
		V <sub>CC</sub> = 4.5 V	-	31	53	-	66	-	80	ns
		V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF	-	27	-	-	-	-	-	ns
		V <sub>CC</sub> = 6.0 V	-	25	45	-	56	-	68	ns
		n $\bar{CD}$ to n $\bar{Q}$ ; see Fig. 7								
		V <sub>CC</sub> = 2.0 V	-	83	265	-	340	-	400	ns
		V <sub>CC</sub> = 4.5 V	-	30	53	-	68	-	80	ns
t <sub>PHL</sub>	HIGH to LOW propagation delay	n $\bar{A}$ , nB to n $\bar{Q}$ ; see Fig. 7								
		V <sub>CC</sub> = 2.0 V	-	83	265	-	330	-	400	ns
		V <sub>CC</sub> = 4.5 V	-	30	53	-	66	-	80	ns
		V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF	-	27	-	-	-	-	-	ns
		V <sub>CC</sub> = 6.0 V	-	24	45	-	56	-	68	ns
		n $\bar{CD}$ to nQ; see Fig. 7								
		V <sub>CC</sub> = 2.0 V	-	80	265	-	330	-	400	ns
		V <sub>CC</sub> = 4.5 V	-	29	53	-	66	-	80	ns
t <sub>t</sub>	transition time	nQ and n $\bar{Q}$ ; see Fig. 7 [2]								
		V <sub>CC</sub> = 2.0 V	-	19	75	-	95	-	119	ns
		V <sub>CC</sub> = 4.5 V	-	7	15	-	19	-	22	ns
		V <sub>CC</sub> = 6.0 V	-	6	13	-	16	-	19	ns

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Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit	
			Min	Typ[1]	Max	Min	Max	Min	Max		
t <sub>w</sub>	pulse width	n $\bar{A}$ LOW; see Fig. 8									
		V <sub>CC</sub> = 2.0 V	80	17	-	100	-	120	-	ns	
		V <sub>CC</sub> = 4.5 V	16	6	-	20	-	24	-	ns	
		V <sub>CC</sub> = 6.0 V	14	5	-	17	-	20	-	ns	
		nB HIGH; see Fig. 8									
		V <sub>CC</sub> = 2.0 V	80	17	-	100	-	120	-	ns	
		V <sub>CC</sub> = 4.5 V	16	6	-	20	-	24	-	ns	
		V <sub>CC</sub> = 6.0 V	14	5	-	17	-	20	-	ns	
		n $\bar{C}\bar{D}$ LOW; see Fig. 8									
		V <sub>CC</sub> = 2.0 V	80	19	-	100	-	120	-	ns	
		V <sub>CC</sub> = 4.5 V	16	7	-	20	-	24	-	ns	
		V <sub>CC</sub> = 6.0 V	14	6	-	17	-	20	-	ns	
nQ and n $\bar{Q}$ HIGH or LOW; see Fig. 8											
V <sub>CC</sub> = 5.0 V; C <sub>EXT</sub> = 0.1 $\mu$ F; R <sub>EXT</sub> = 10 k $\Omega$	630	700	770	602	798	595	805	$\mu$ s			
t <sub>rec</sub>	recovery time	n $\bar{C}\bar{D}$ to n $\bar{A}$ , nB; see Fig. 8									
		V <sub>CC</sub> = 2.0 V	35	6	-	45	-	55	-	ns	
		V <sub>CC</sub> = 4.5 V	7	2	-	9	-	11	-	ns	
		V <sub>CC</sub> = 6.0 V	6	2	-	8	-	9	-	ns	
t <sub>trig</sub>	retrigger time	n $\bar{A}$ , nB; see Fig. 8; X = C <sub>EXT</sub> / (4.5 × V <sub>CC</sub> )									
		V <sub>CC</sub> = 2.0 V	-	455+X	-	-	-	-	-	ns	
		V <sub>CC</sub> = 4.5 V	-	80+X	-	-	-	-	-	ns	
		V <sub>CC</sub> = 6.0 V	-	55+X	-	-	-	-	-	ns	
R <sub>EXT</sub>	external timing resistor	V <sub>CC</sub> = 2.0 V	10	-	1000	-	-	-	-	k $\Omega$	
		V <sub>CC</sub> = 5.0 V	2	-	1000	-	-	-	-	k $\Omega$	
C <sub>EXT</sub>	external timing capacitor		no limits								
C <sub>PD</sub>	power dissipation capacitance	per multivibrator; V <sub>I</sub> = GND to V <sub>CC</sub>	[3]	-	136	-	-	-	-	-	pF

[1] Typical values are measured at nominal supply voltage (V<sub>CC</sub> = 3.3 V and V<sub>CC</sub> = 5.0 V).

[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  $\mu$ W).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma(C_L \times V_{CC}^2 \times f_o) + 0.48 \times C_{EXT} \times V_{CC}^2 \times f_o + D \times 0.8 \times V_{CC}$$

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

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

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

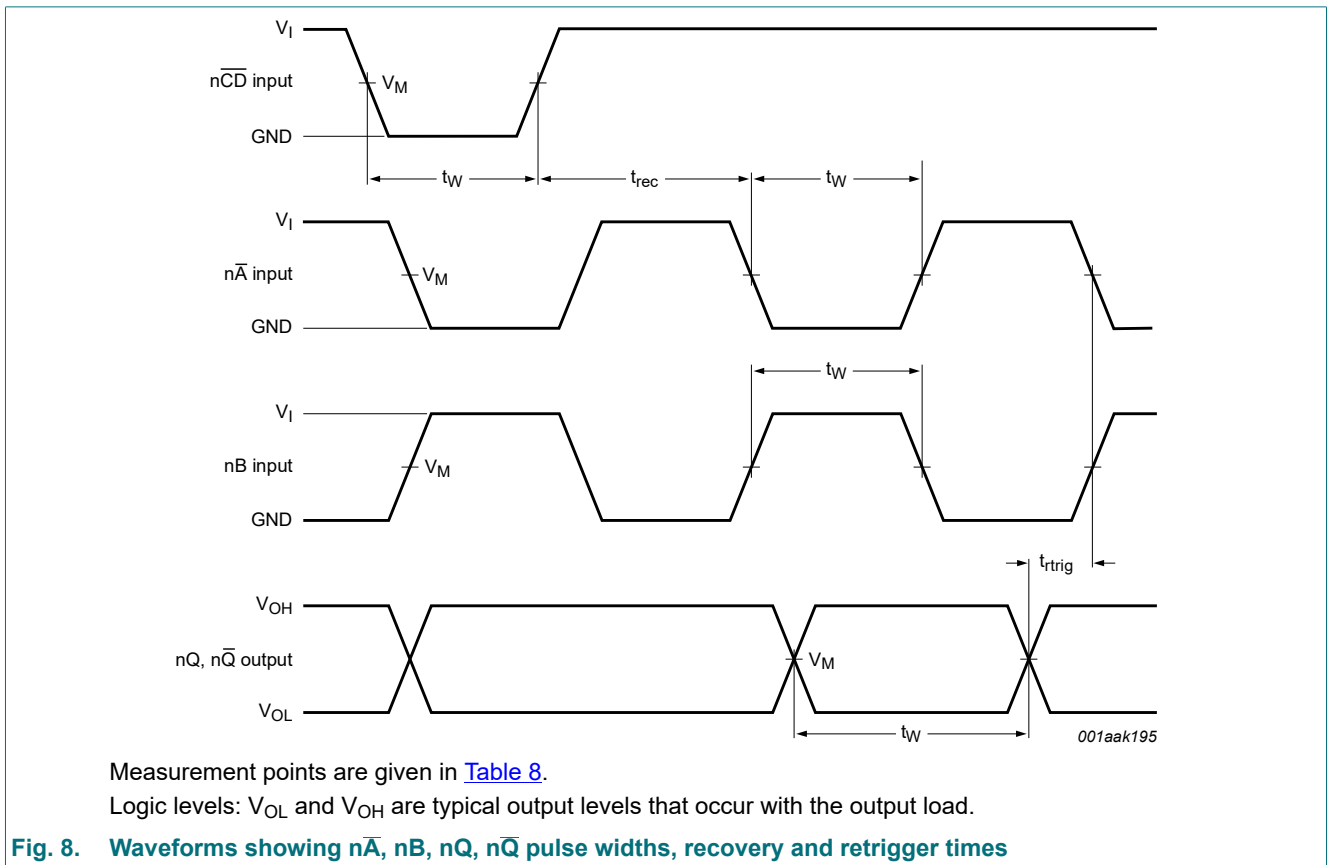
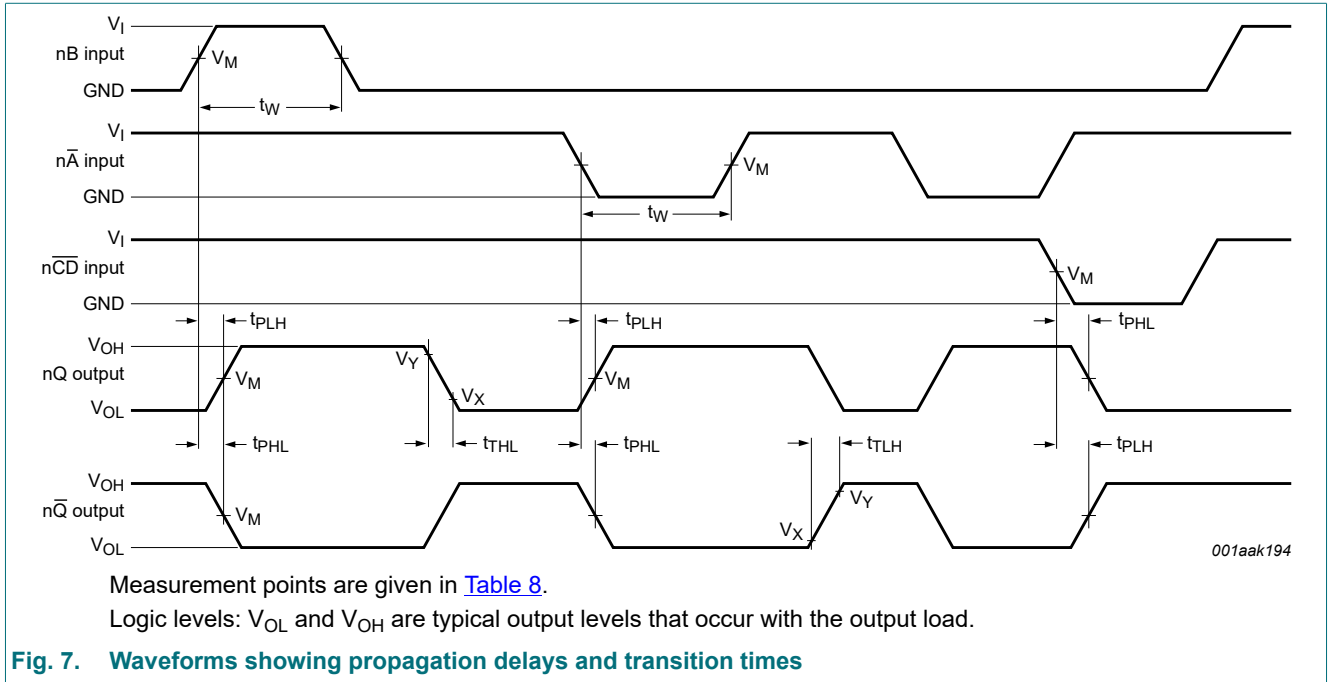
C<sub>L</sub> = output load capacitance in pF;

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

D = duty cycle factor in %;

C<sub>EXT</sub> = external timing capacitance in pF.

10.1. Waveforms and test circuit





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Table 8. Measurement points

Input	Output		
$V_M$	$V_M$	$V_X$	$V_Y$
$0.5V_{CC}$	$0.5V_{CC}$	$0.1V_{CC}$	$0.9V_{CC}$

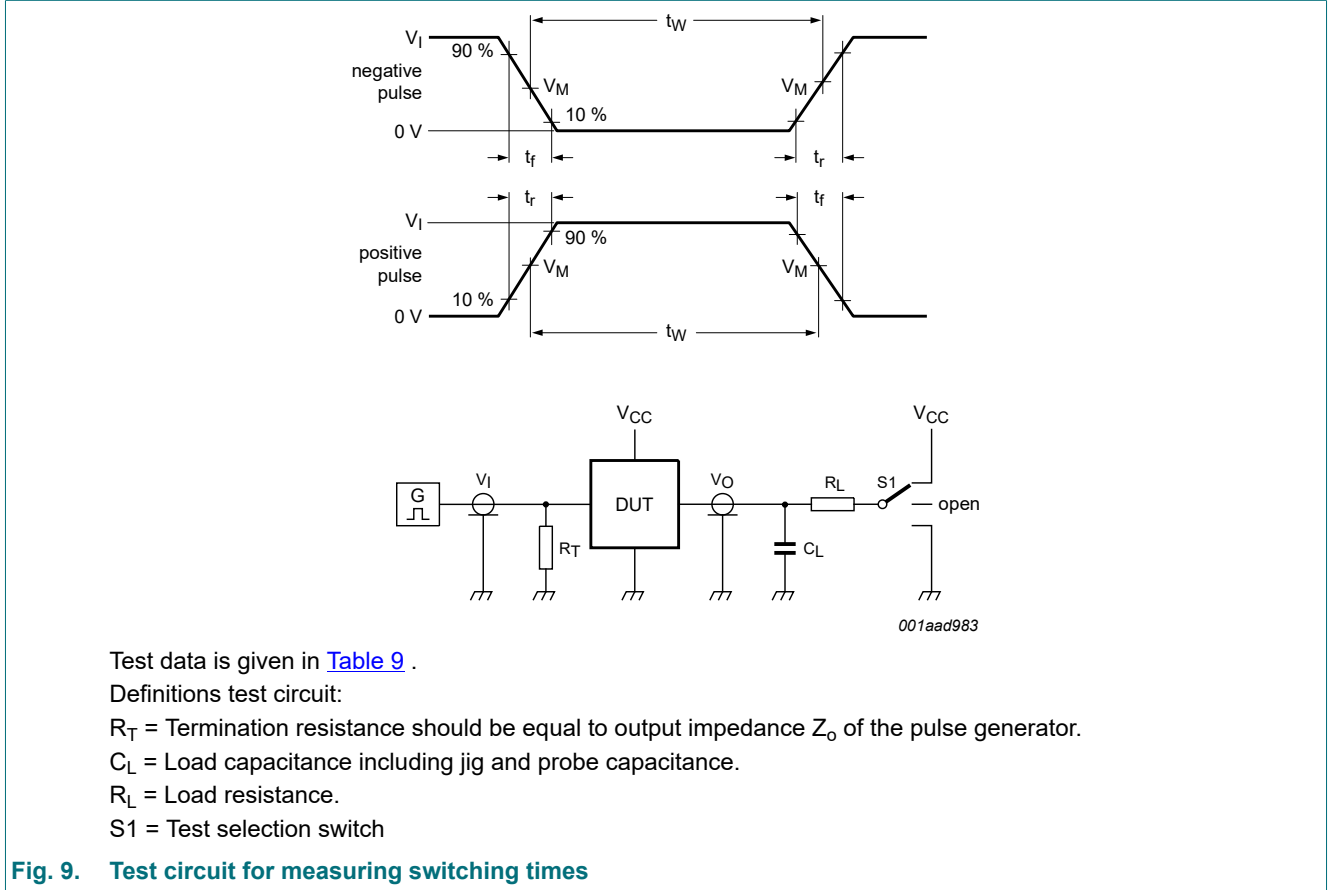


Fig. 9. Test circuit for measuring switching times

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 kΩ	open

## 11. Application information

### 11.1. Power-down considerations

A large capacitor ( $C_{EXT}$ ) may cause problems when powering-down the monostable due to energy stored in this capacitor. When a system containing this device is powered-down or 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 Fig. 10

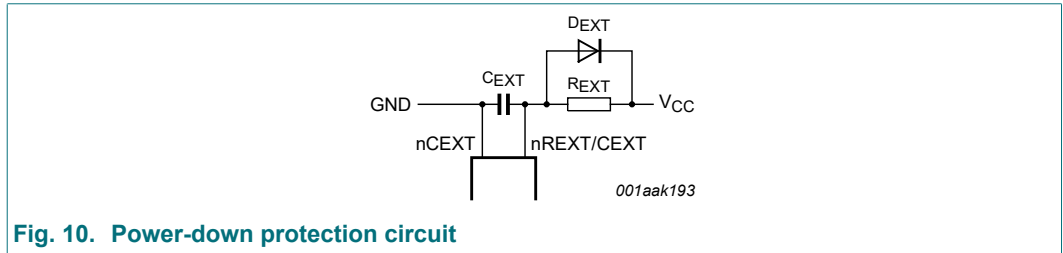


Fig. 10. Power-down protection circuit

### 11.2. Graphs

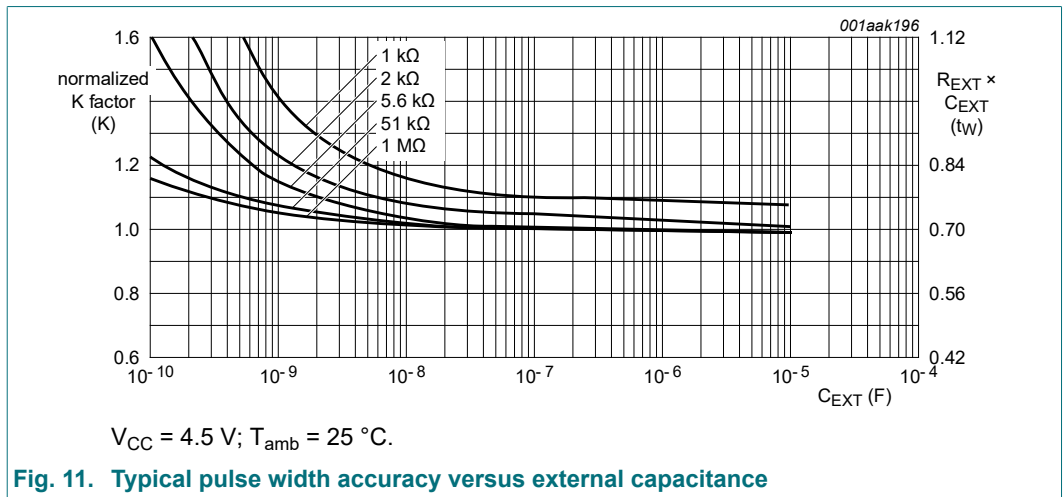


Fig. 11. Typical pulse width accuracy versus external capacitance

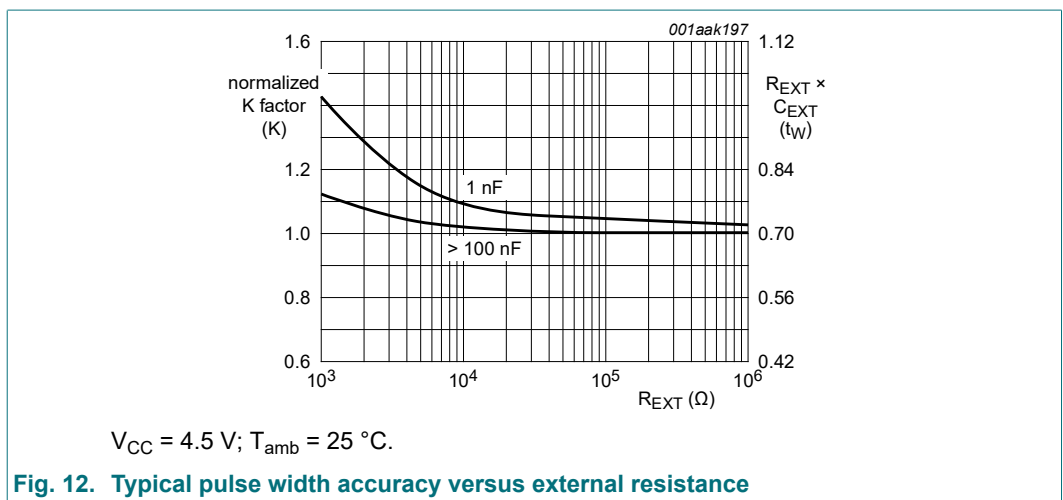


Fig. 12. Typical pulse width accuracy versus external resistance

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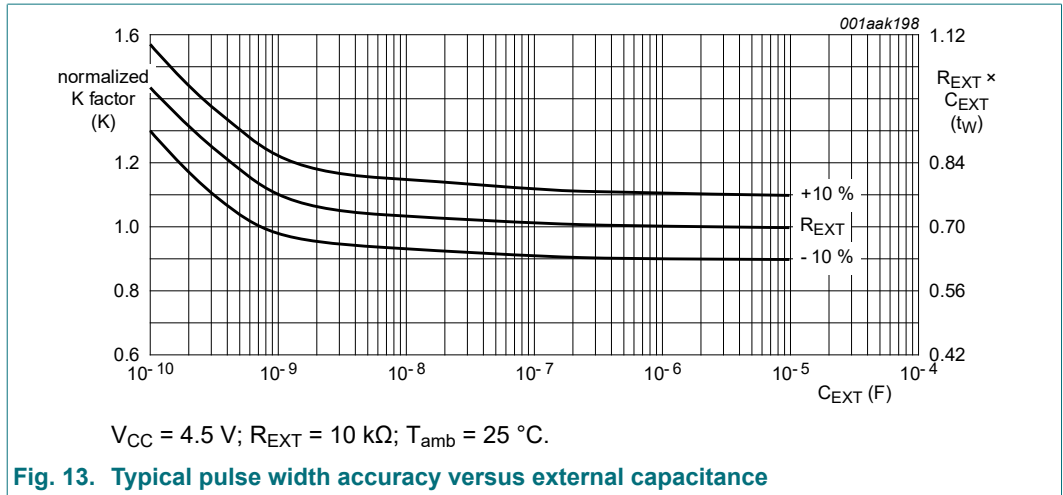


Fig. 13. Typical pulse width accuracy versus external capacitance

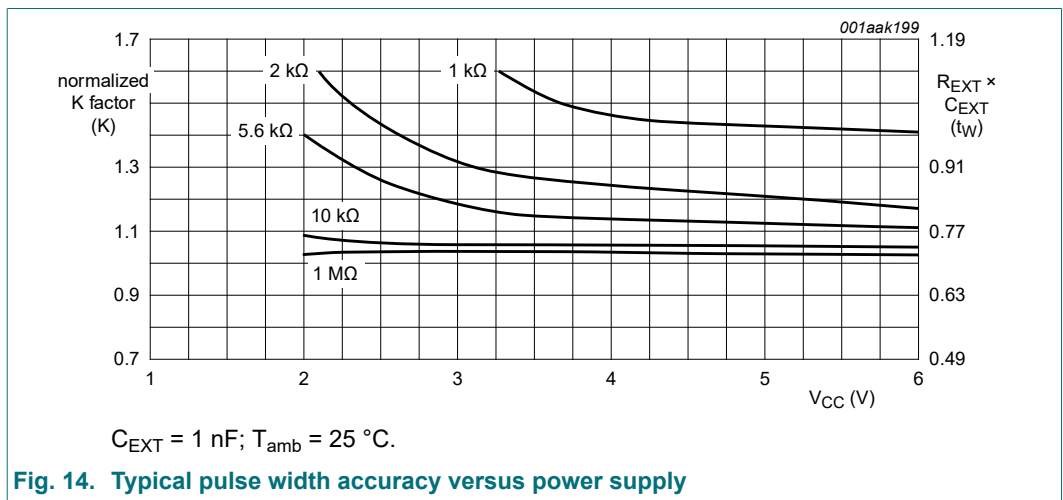


Fig. 14. Typical pulse width accuracy versus power supply

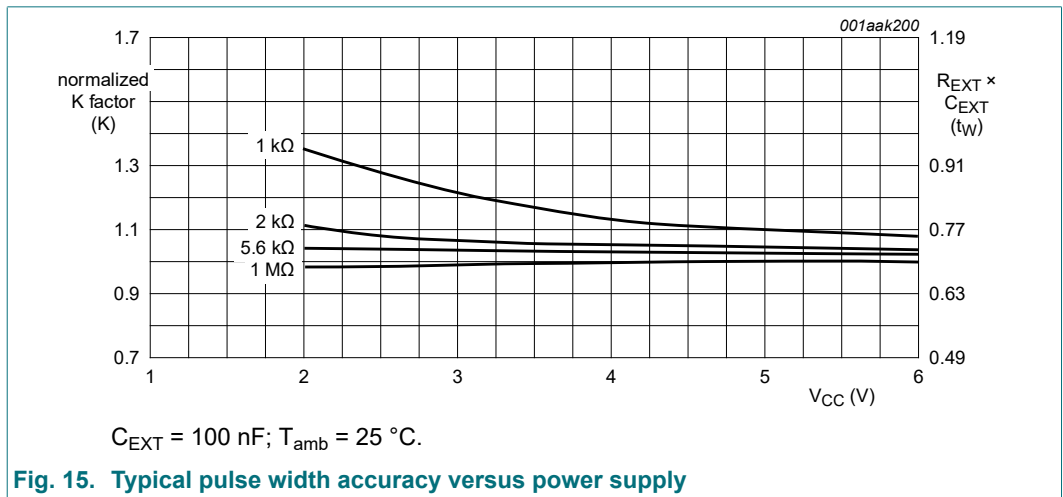
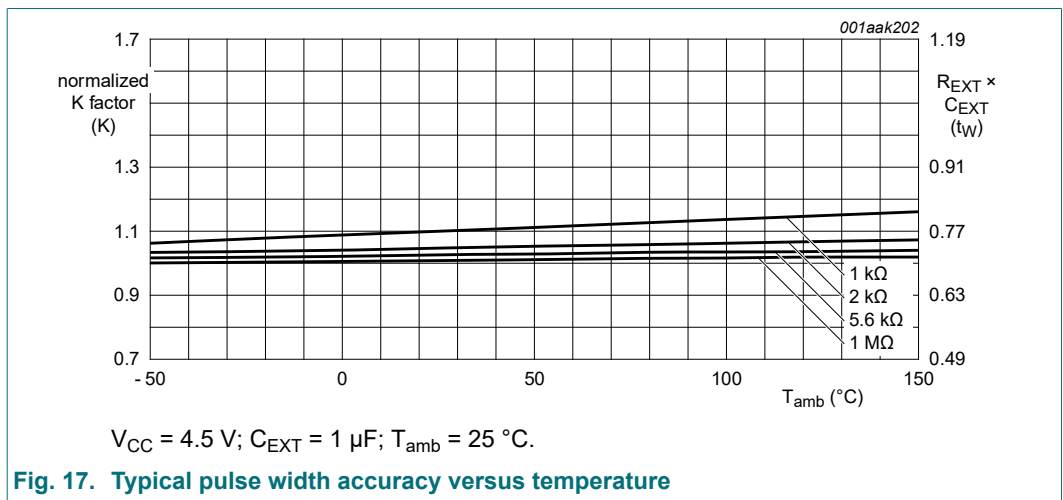
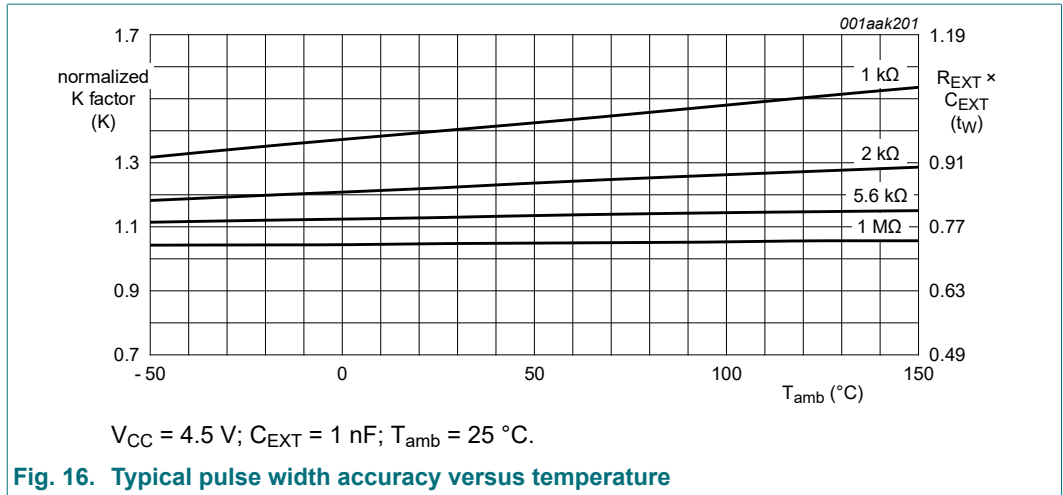


Fig. 15. Typical pulse width accuracy versus power supply

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## 12. Package outline

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

SOT109-1

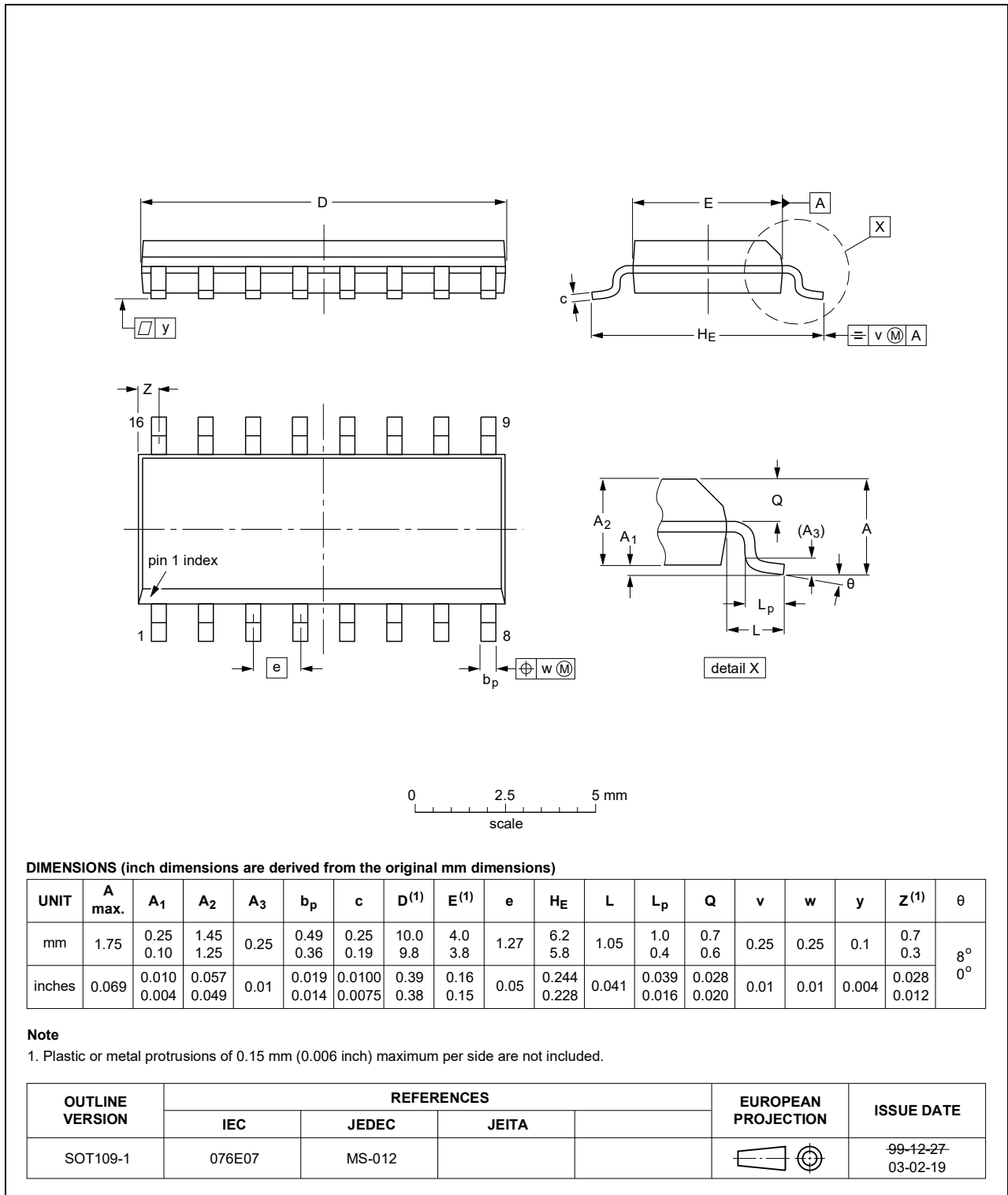


Fig. 18. Package outline SOT109-1 (SO16)

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

SOT403-1

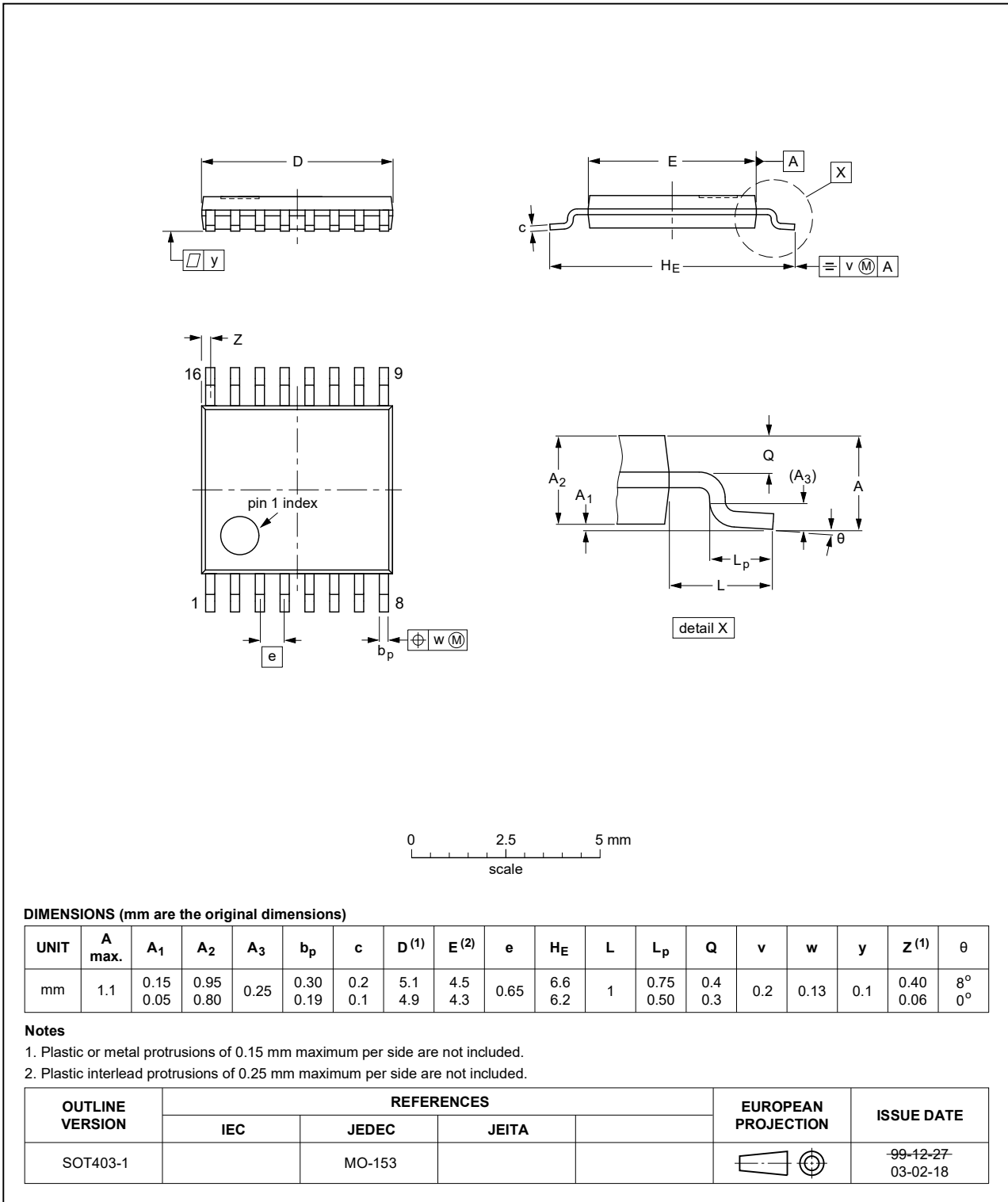


Fig. 19. Package outline SOT403-1 (TSSOP16)

## 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
74HC4538 v.6	20210716	Product data sheet	-	74HC4538 v.5
Modifications:	<ul style="list-style-type: none"> <li>Type number 74HC4538DB (SOT338-1/SSOP16) removed.</li> <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>			
74HC4538 v.5	20170317	Product data sheet	-	74HC_HCT4538 v.4
Modifications:	<ul style="list-style-type: none"> <li>Type numbers 74HCT4538D, 74HCT4538DB, 74HCT4538PW removed.</li> <li><a href="#">Table 6</a>: Maximum input leakage current for pins 1REXT/CEXT and 2REXT/CEXT changed.</li> </ul>			
74HC_HCT4538 v.4	20160224	Product data sheet	-	74HC_HCT4538 v.3
Modifications:	<ul style="list-style-type: none"> <li>Type numbers 74HC4538N and 74HCT4538N (SOT38-4) removed.</li> </ul>			
74HC_HCT4538 v.3	20090608	Product data sheet	-	74HC_HCT4538_CNV 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>Pin names changed throughout.</li> <li>Section <a href="#">Section 7</a>, <a href="#">Section 8</a> and <a href="#">Section 9</a> added, taken from the 74HC/T HCMOS Family characteristics/specification (March 1988).</li> <li>Test circuit added: <a href="#">Fig. 9</a>.</li> <li>Quick reference data incorporated in to <a href="#">Section 9</a> and <a href="#">Section 10</a>.</li> <li>Package information added for DIP16, SO16, SSOP16 and TSSOP16 packages.</li> </ul>			
74HC_HCT4538_CNV v.2	19970902	Product specification	-	-

## 15. 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.
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Date of release: 16 July 2021