



**THE DATASHEET OF  
74HC4538D,653**



# 74HC4538

## Dual retriggerable precision monostable multivibrator

Rev. 5 — 17 March 2017

Product data sheet

## 1 General description

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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

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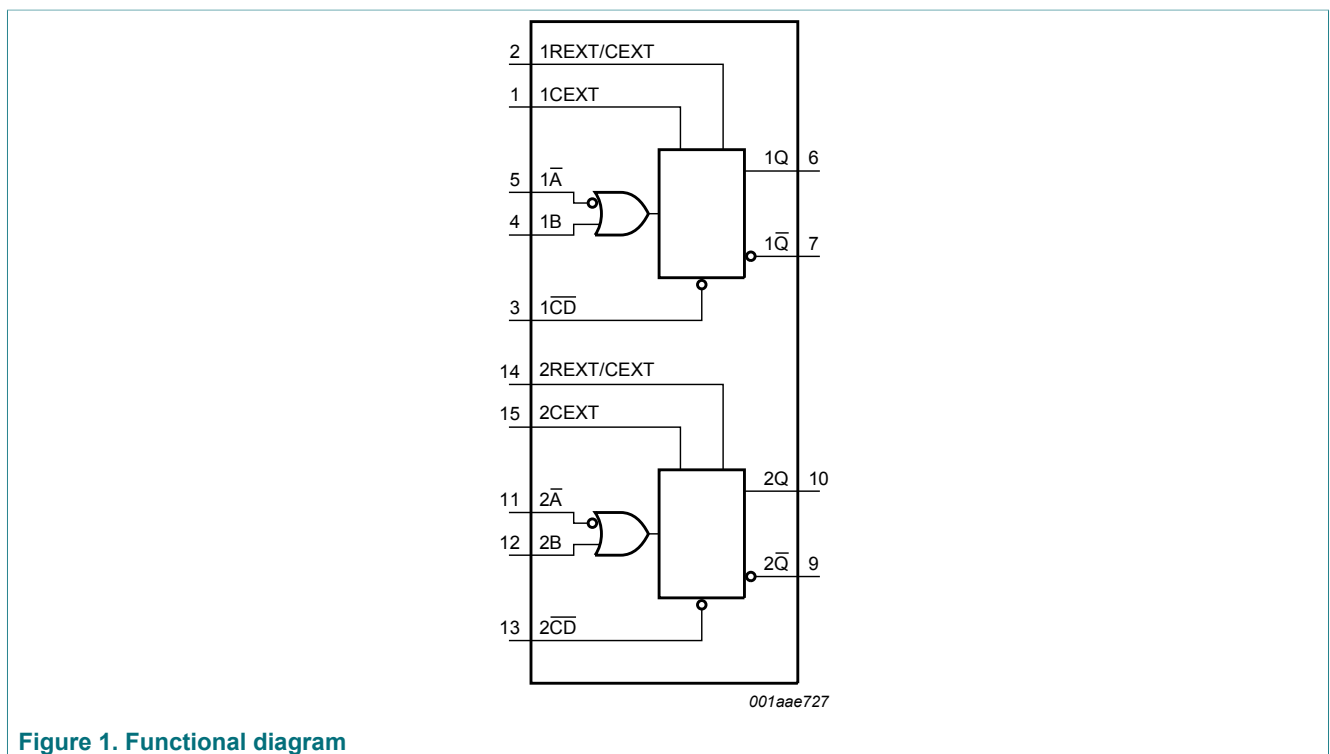
- Tolerant of slow trigger rise and fall times
- Separate reset inputs
- Triggering from falling or rising edge
- Complies with JEDEC standard no. 7A
- CMOS input levels:
- ESD protection:
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from  $-40\text{ }^\circ\text{C}$  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			Version
	Temperature range	Name	Description	
74HC4538D	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC4538DB	-40 °C to +125 °C	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74HC4538PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

### 4 Functional diagram



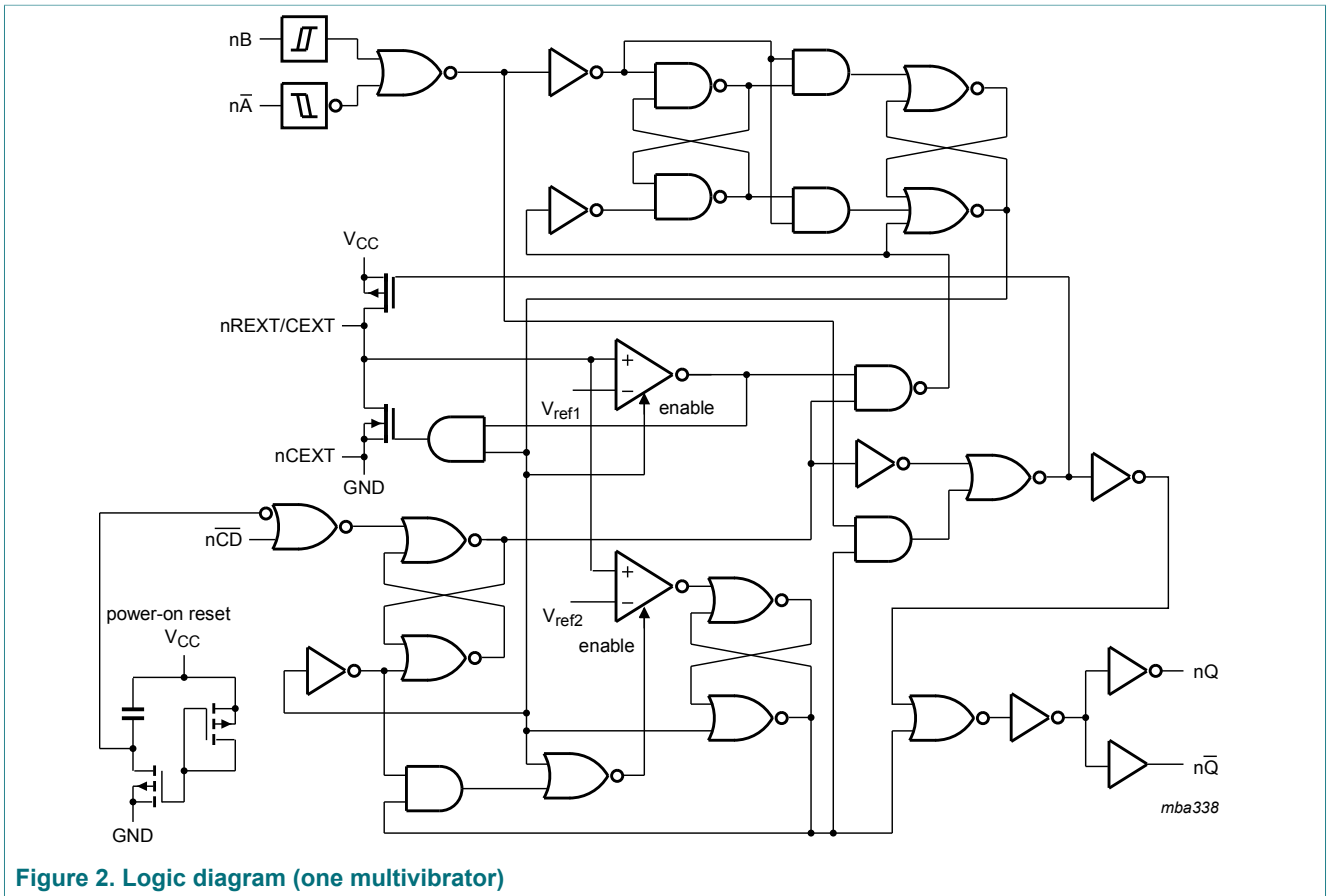


Figure 2. Logic diagram (one multivibrator)

## 5 Pinning information

### 5.1 Pinning

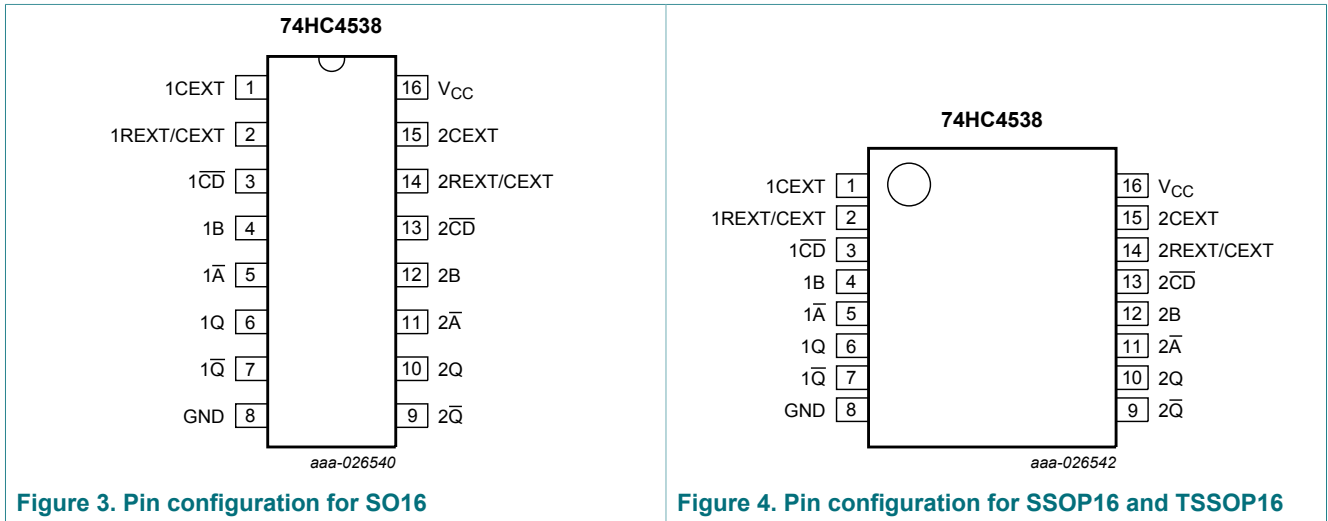


Figure 3. Pin configuration for SO16

Figure 4. Pin configuration for SSOP16 and TSSOP16

### 5.2 Pin description

Table 2. Pin description

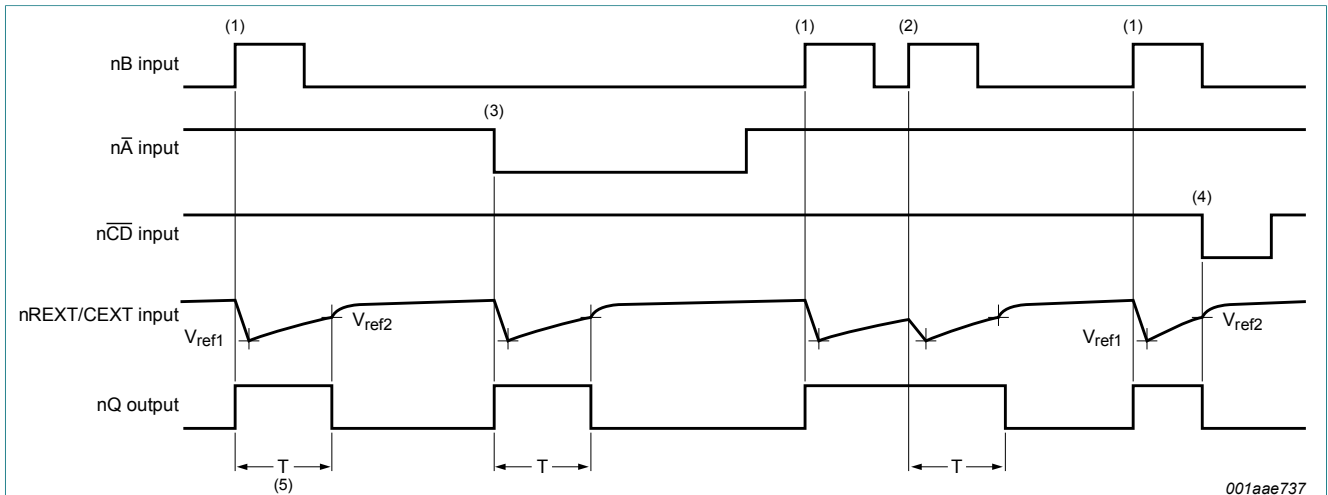
Symbol	Pin	Description
1CEXT, 2CEXT	1, 15	external capacitor connection (always connected to ground)
1REXT/CEXT, 2REXT/CEXT	2, 14	external capacitor/resistor connection
1CD, 2CD	3, 13	direct reset input (active LOW)
1B, 2B	4, 12	input (LOW to HIGH triggered)
1A, 2A	5, 11	input (HIGH to LOW triggered)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

## 6 Functional description

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

Inputs			Outputs	
n $\bar{A}$	nB	n $\bar{CD}$	nQ	n $\bar{Q}$
↓	L	H		
H	↑	H		
X	X	L	L	H

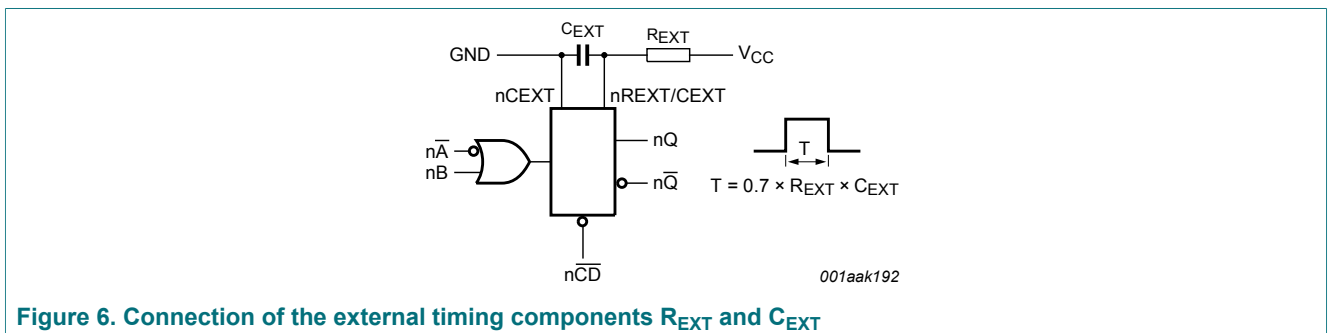
- [1] H = HIGH voltage level; L = LOW voltage level; X = don't care;  
 ↑ = positive-going transition; ↓ = negative-going transition;  
 = one HIGH level output pulse, with the pulse width determined by C<sub>EXT</sub> and R<sub>EXT</sub>;  
 = one LOW level output pulse, with the pulse width determined by C<sub>EXT</sub> and R<sub>EXT</sub>.



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- (1) Positive edge triggering.
- (2) Positive edge re-triggering (pulse lengthening).
- (3) Negative edge triggering.
- (4) Reset (pulse shortening).
- (5)  $T_W = 0.7 \times R_{EXT} \times C_{EXT}$  (see also [Figure 6](#)).

Figure 5. Timing diagram



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Figure 6. Connection of the external timing components R<sub>EXT</sub> and C<sub>EXT</sub>

## 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	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$			
		SO16 package [2]	-	500	mW
		(T)SSOP16 package [3]	-	500	mW

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

[2]  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.

[3]  $P_{tot}$  derates linearly with 5.5 mW/K above 60 °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 <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 2.0 V	1.5	1.2	-	1.5	-	1.5	-	V
		V <sub>CC</sub> = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V <sub>CC</sub> = 6.0 V	4.2	3.2	-	4.2	-	4.2	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V <sub>CC</sub> = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V <sub>CC</sub> = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>								
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>								
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V	-	0	0.1	-	0.1	-	0.1	V
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	0.15	0.26	-	0.33	-	0.4	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V	-	-	±0.1	-	±1	-	±1	μA
		pin nREXT/CEXT; V <sub>I</sub> = 2.0 V or GND; other inputs at V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V <sup>[1]</sup>	-	-	±50	-	±500	-	±500	nA
I <sub>CC</sub>	supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V	-	-	8.0	-	80	-	160	μA
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 [Figure 9](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	Min	Max	
t <sub>PLH</sub>	LOW to HIGH propagation delay	n $\bar{A}$ , nB to nQ; see <a href="#">Figure 7</a>								
		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 $\bar{C}\bar{D}$ to n $\bar{Q}$ ; see <a href="#">Figure 7</a>								
		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 <a href="#">Figure 7</a>								
		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 $\bar{C}\bar{D}$ to nQ; see <a href="#">Figure 7</a>								
		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 <a href="#">Figure 7</a> <sup>[2]</sup>								
		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
t <sub>w</sub>	pulse width	n $\bar{A}$ LOW; see <a href="#">Figure 8</a>								
		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 <a href="#">Figure 8</a>								
		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 <a href="#">Figure 8</a>								
		V <sub>CC</sub> = 2.0 V	80	19	-	100	-	120	-	ns

## Dual retriggerable precision monostable multivibrator

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	Min	Max	
		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 nQ̄ HIGH or LOW; see <a href="#">Figure 8</a>								
		V <sub>CC</sub> = 5.0 V; C <sub>EXT</sub> = 0.1 μF; R <sub>EXT</sub> = 10 kΩ	630	700	770	602	798	595	805	μs
t <sub>rec</sub>	recovery time	nCD to nA, nB; see <a href="#">Figure 8</a>								
		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	nA, nB; see <a href="#">Figure 8</a> ; 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	-	-	-	-	kΩ
		V <sub>CC</sub> = 5.0 V	2	-	1000	-	-	-	-	kΩ
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>	<sup>[3]</sup>	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>r</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).

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

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

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

Σ(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of the outputs;

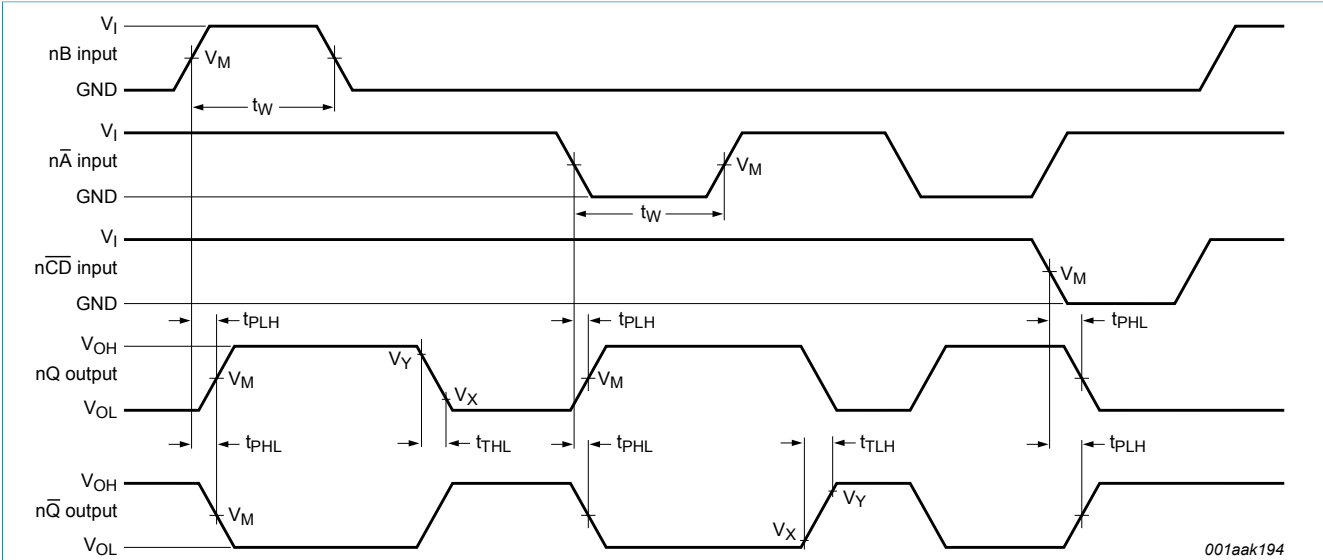
C<sub>L</sub> = output load capacitance in pF;

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

D = duty cycle factor in %;

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

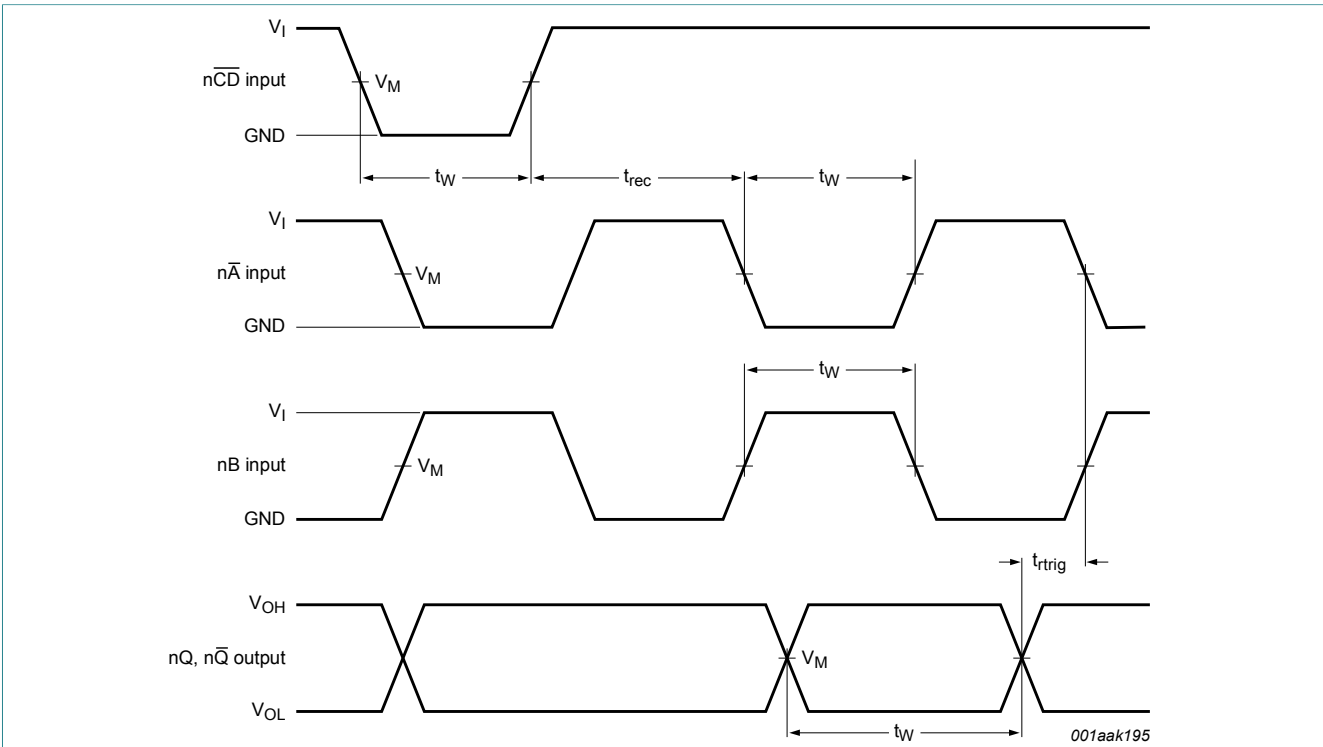
10.1 Waveforms and test circuit



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

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

Figure 7. Waveforms showing propagation delays and transition times



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

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

Figure 8. Waveforms showing  $n\bar{A}$ ,  $nB$ ,  $nQ$ ,  $n\bar{Q}$  pulse widths, recovery and retrigger times

Table 8. Measurement points

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

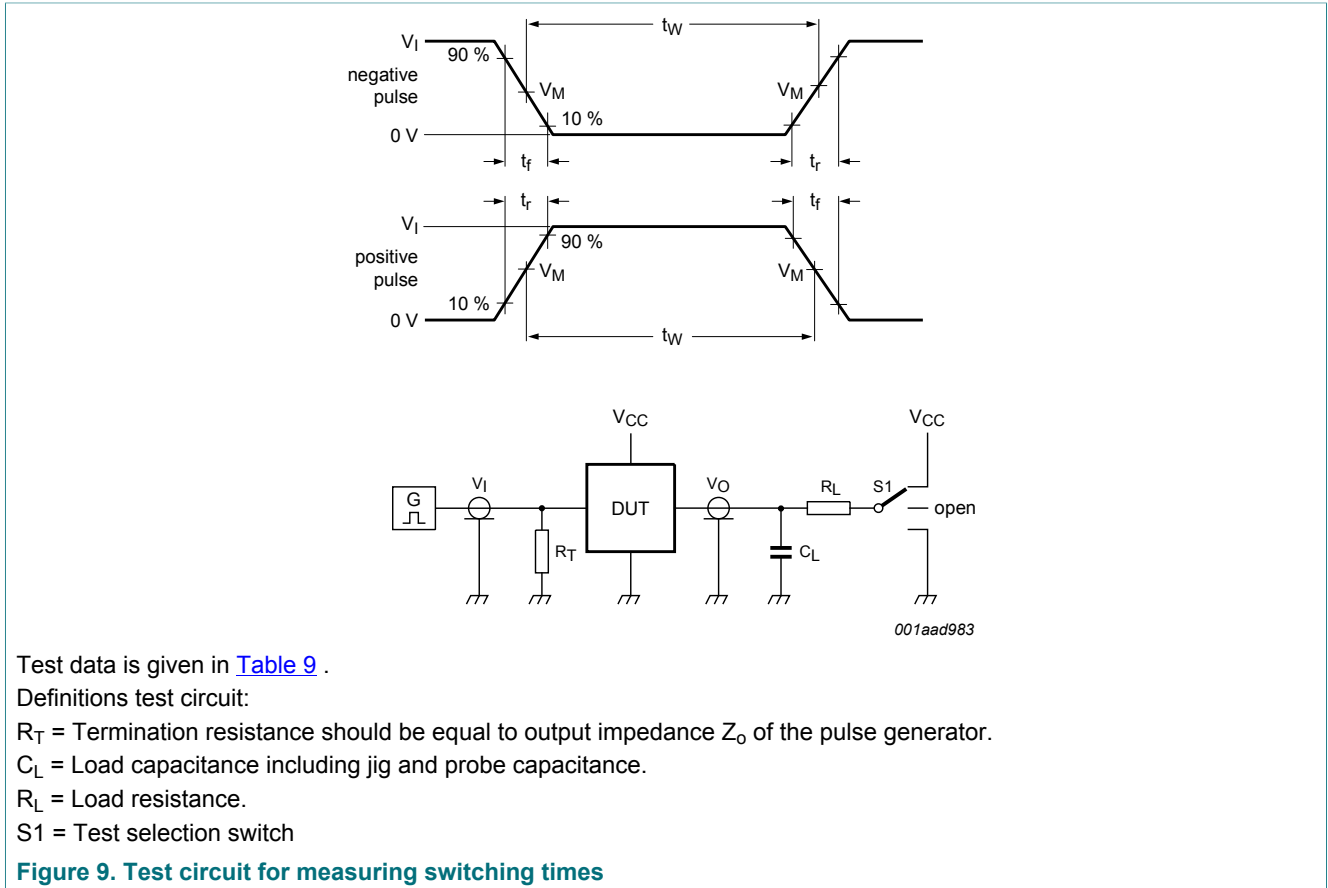


Figure 9. Test circuit for measuring switching times

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 [Figure 10](#)

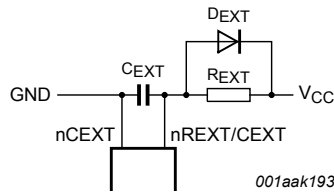
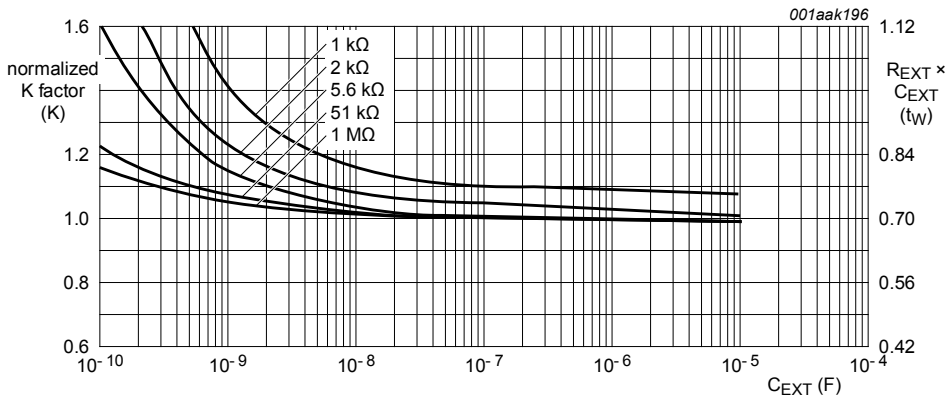


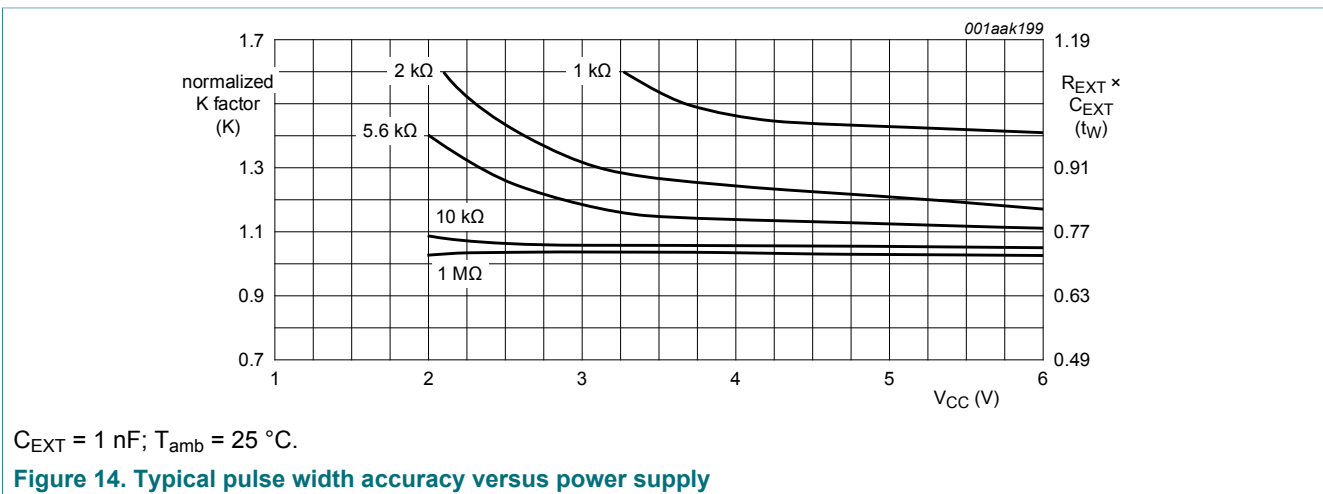
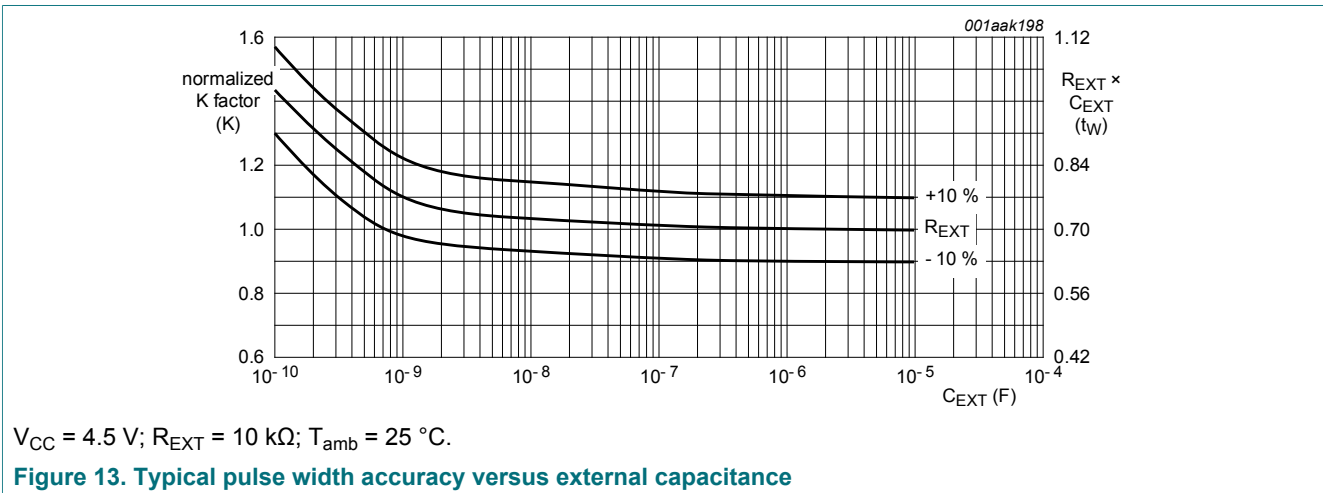
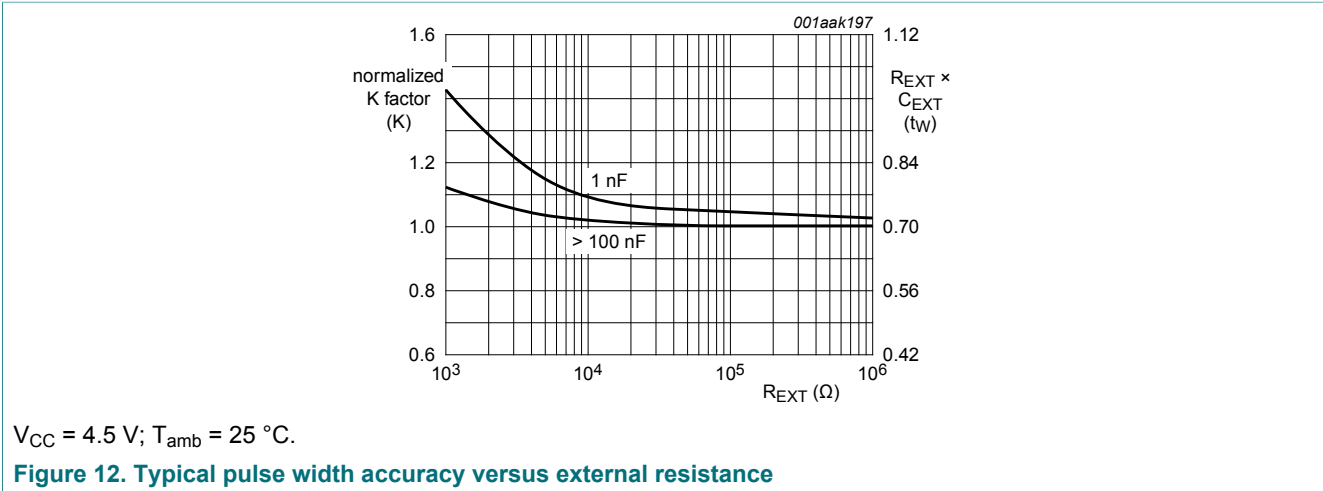
Figure 10. Power-down protection circuit

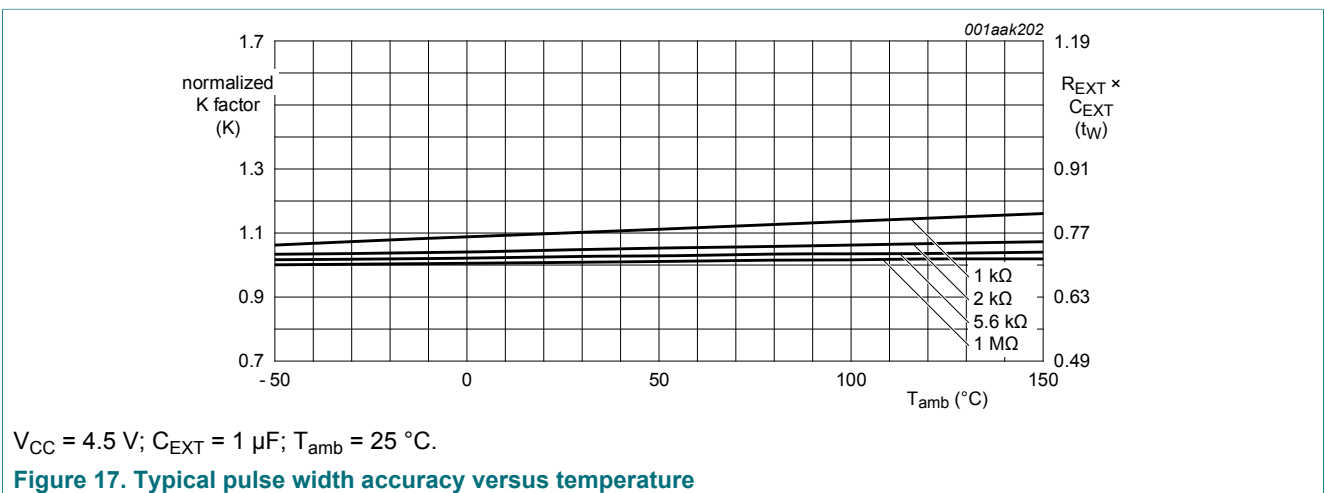
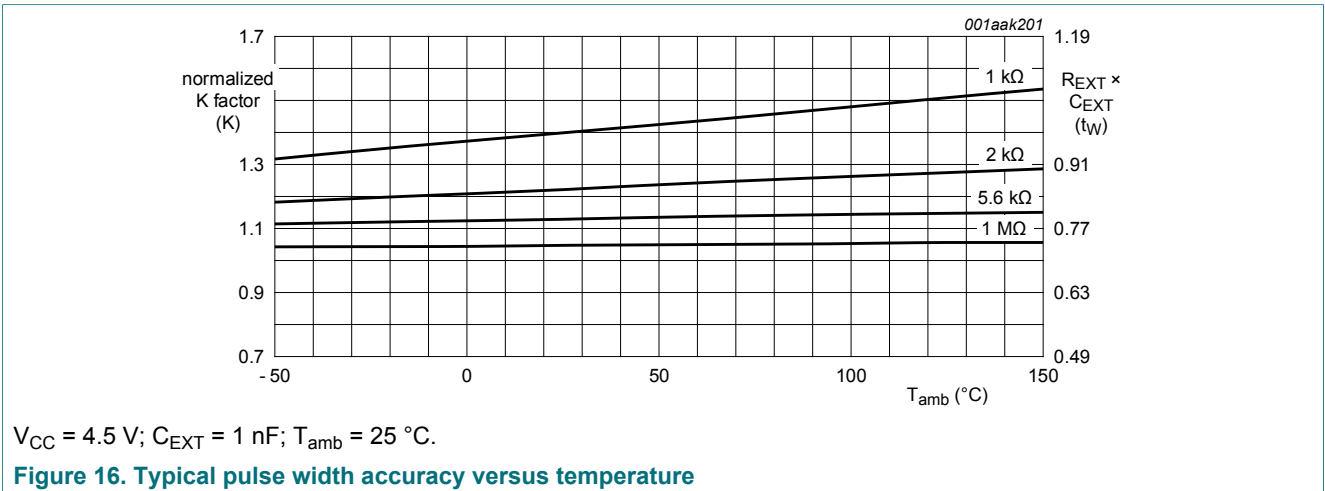
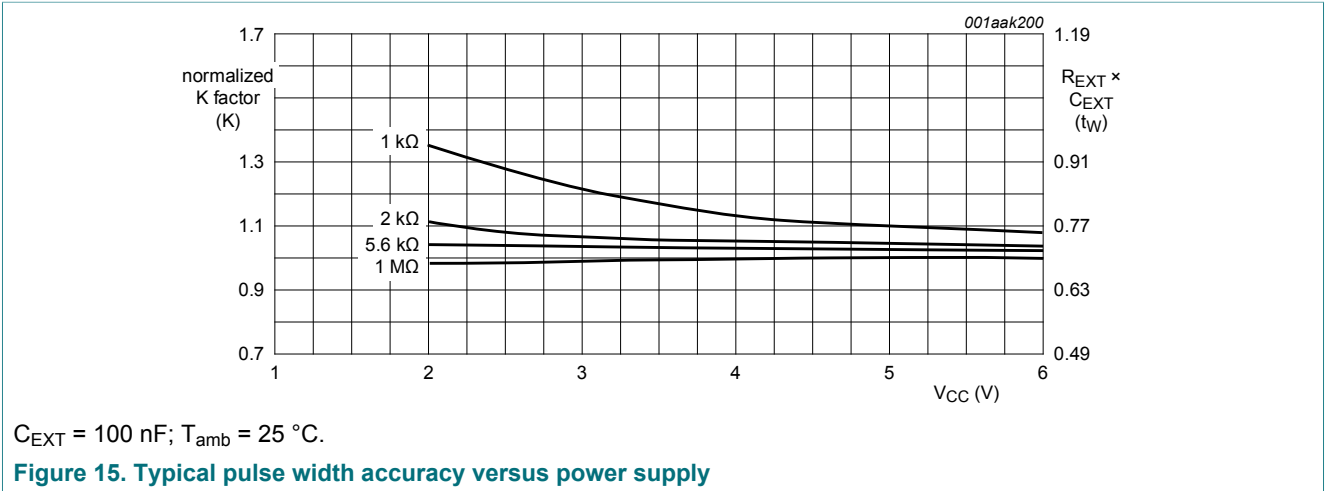
### 11.2 Graphs



$V_{CC} = 4.5 \text{ V}; T_{amb} = 25 \text{ }^\circ\text{C}.$

Figure 11. Typical pulse width accuracy versus external capacitance

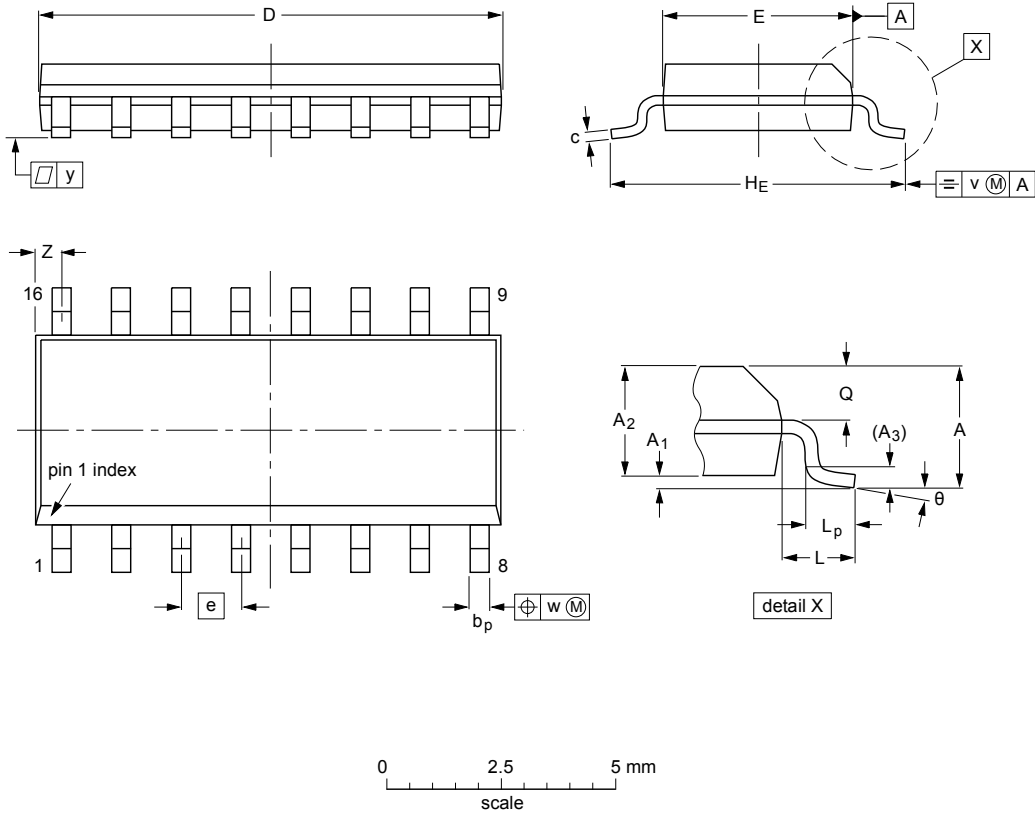




12 Package outline

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

SOT109-1



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

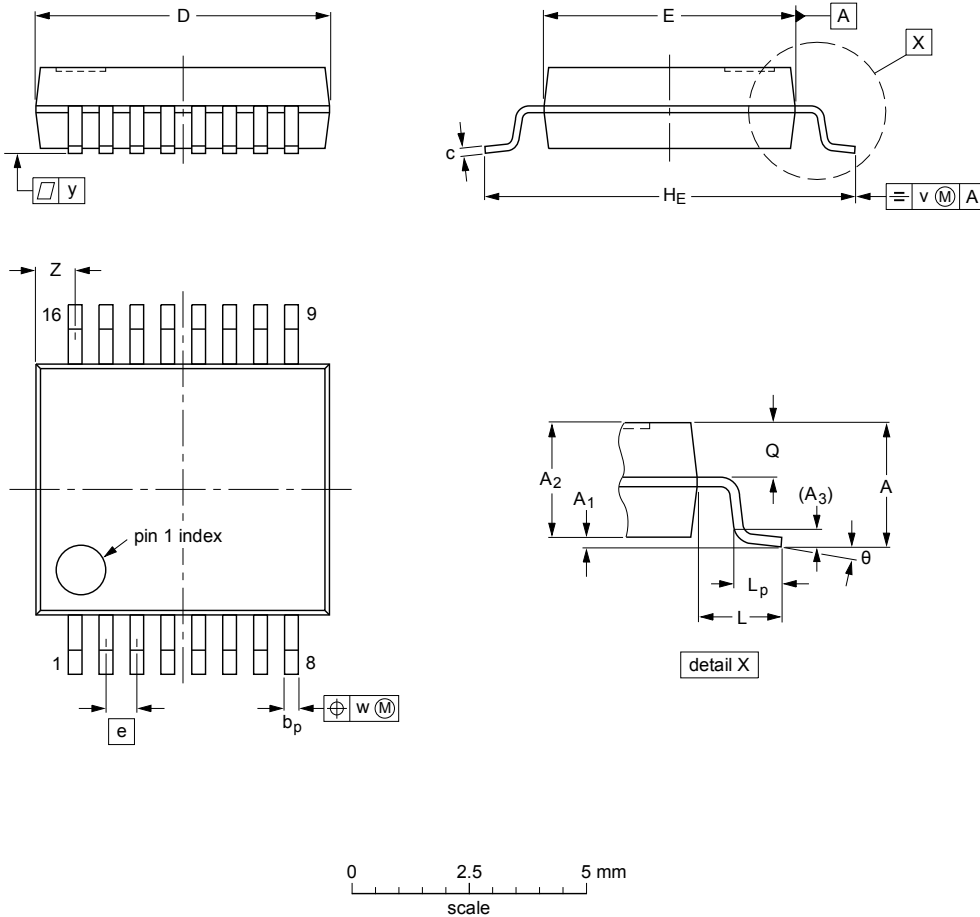
1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA		
SOT109-1	076E07	MS-012			99-12-27 03-02-19

Figure 18. Package outline SOT109-1 (SO16)

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

SOT338-1



**DIMENSIONS (mm are the original dimensions)**

UNIT	A <sub>max.</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	2	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	6.4 6.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.00 0.55	8° 0°

**Note**

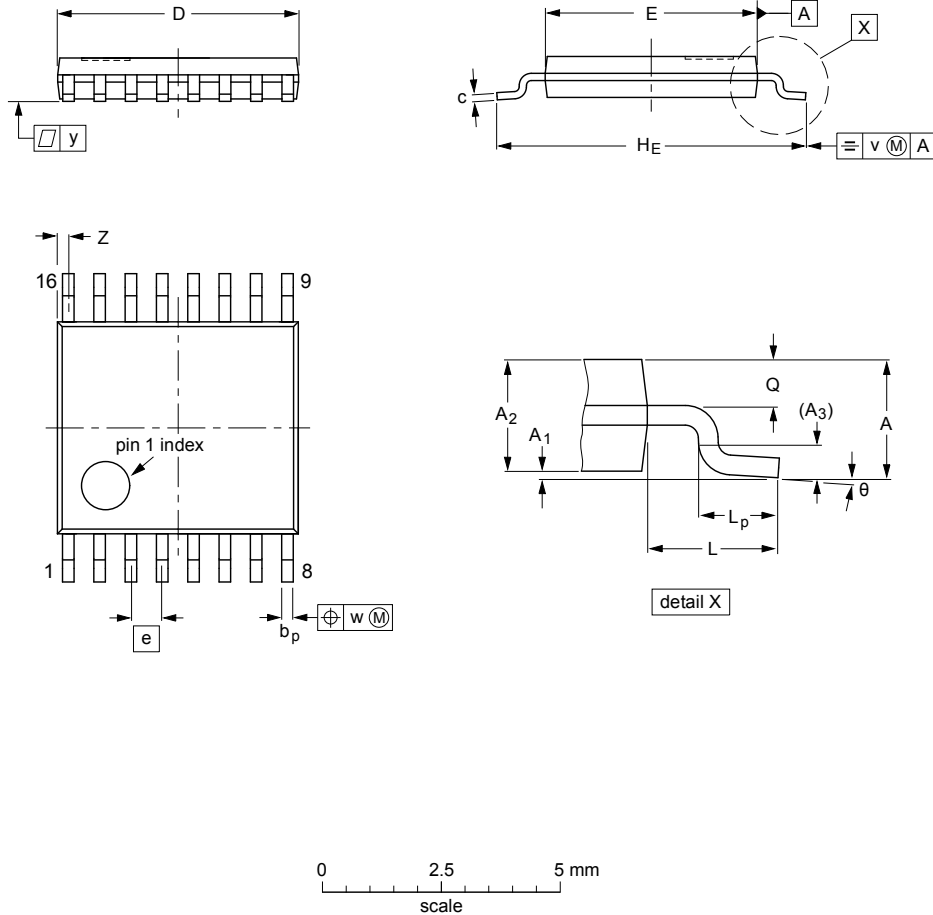
1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT338-1		MO-150				99-12-27 03-02-19

Figure 19. Package outline SOT338-1 (SSOP16)

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

SOT403-1



**DIMENSIONS (mm are the original dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.1	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.40 0.06	8° 0°

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT403-1		MO-153				99-12-27 03-02-18

Figure 20. 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.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 Section 7, Section 8 and Section 9 added, taken from the 74HC/T HCMOS Family characteristics/specification (March 1988).</li> <li>Test circuit added: Figure 9.</li> <li>Quick reference data incorporated in to Section 9 and Section 10.</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

### 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".

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