

74HC4538-Q100; 74HCT4538-Q100

Dual retriggerable precision monostable multivibrator

Rev. 1 — 2 August 2012

Product data sheet

1. General description

The 74HC4538-Q100; 74HCT4538-Q100 are high-speed Si-gate CMOS devices and are pin compatible with Low-power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard no. 7A.

The 74HC4538-Q100; 74HCT4538-Q100 are dual retriggerable-resettable monostable multivibrators. Each multivibrator has:

- an active LOW trigger/retrigger input (\overline{nA})
- an active HIGH trigger/retrigger input (nB)
- an overriding active LOW direct reset input (\overline{nCD})
- an output (nQ) and its complement (\overline{nQ})
- two pins ($nREXT/CEXT$ and $nCEXT$) for connecting the external timing components C_{EXT} and R_{EXT}

Typical pulse width variation over the specified temperature range is $\pm 0.2\%$.

The multivibrator 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 \overline{nCD} terminates the output pulse immediately. Schmitt trigger action on pins \overline{nA} and nB makes the circuit highly tolerant of slower rise and fall times.

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 $-40\text{ }^\circ\text{C}$ to $+85\text{ }^\circ\text{C}$ and from $-40\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$
- Tolerant of slow trigger rise and fall times
- Separate reset inputs
- Triggering from falling or rising edge
- ESD protection:
 - ◆ MIL-STD-883, method 3015 exceeds 2000 V
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V ($C = 200\text{ pF}$, $R = 0\ \Omega$)
- Multiple package options



3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC4538D-Q100 74HCT4538D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC4538PW-Q100 74HCT4538PW-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

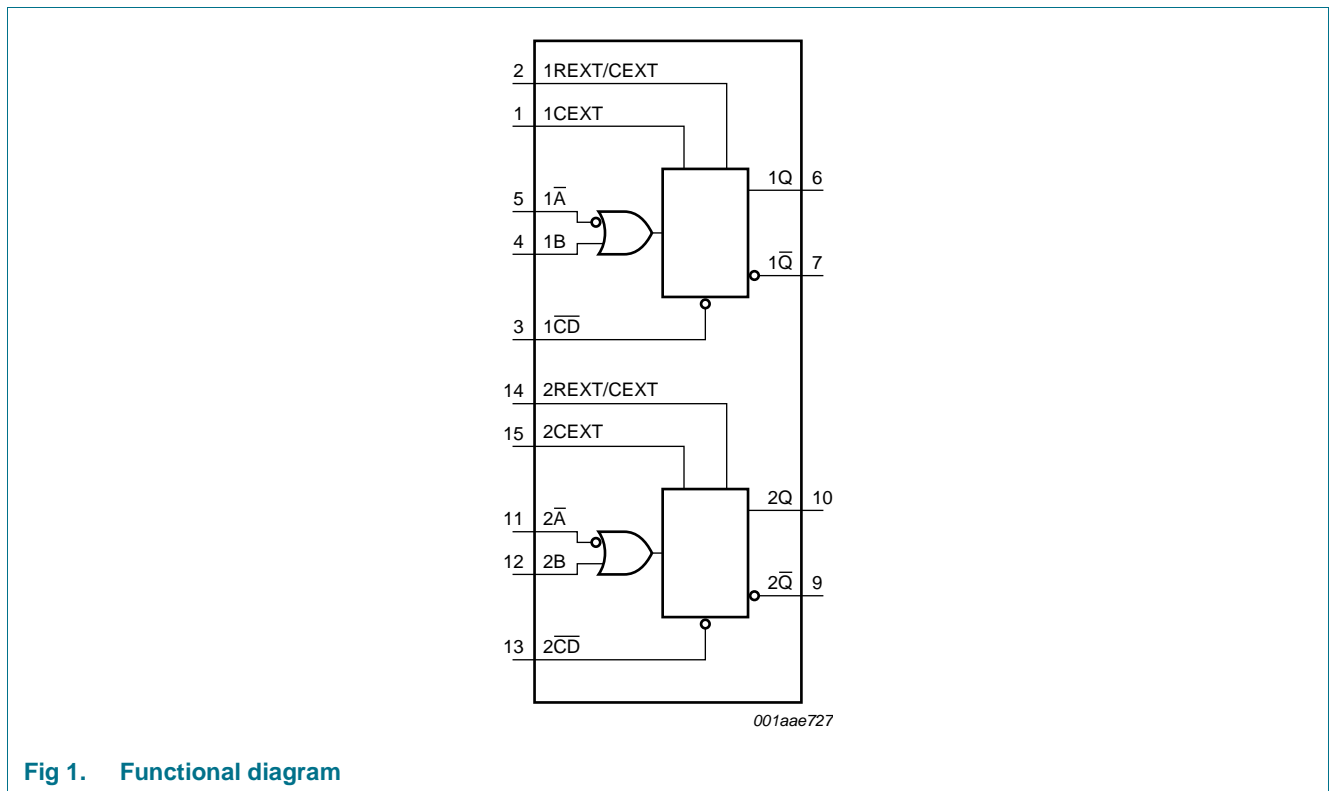


Fig 1. Functional diagram

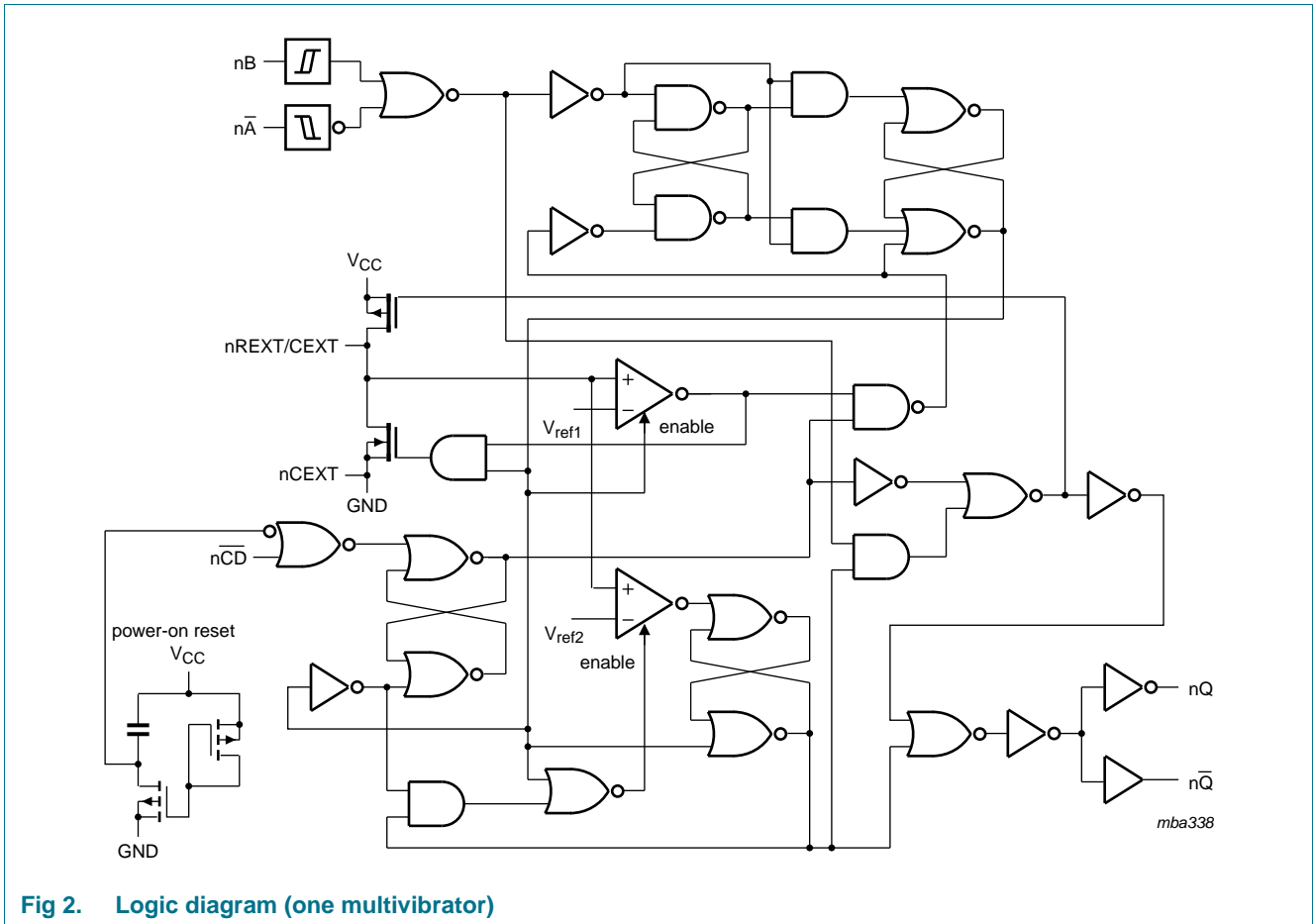


Fig 2. Logic diagram (one multivibrator)

5. Pinning information

5.1 Pinning

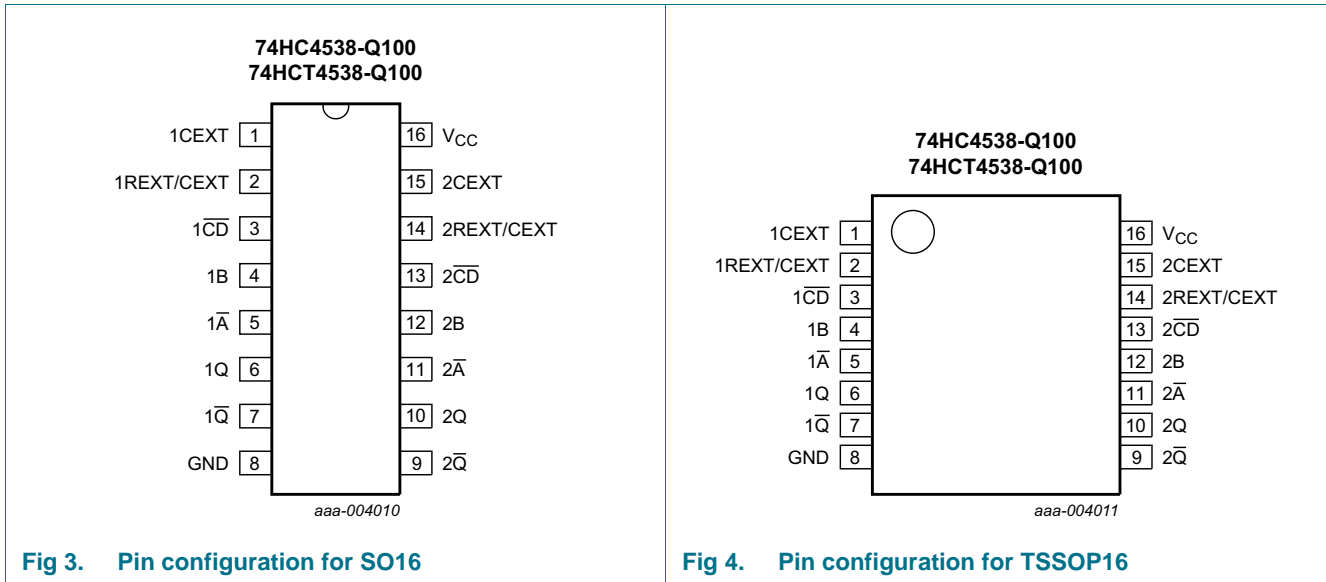


Fig 3. Pin configuration for SO16

Fig 4. Pin configuration for 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
1 \overline{CD} , 2 \overline{CD}	3, 13	direct reset input (active LOW)
1B, 2B	4, 12	input (LOW to HIGH triggered)
1 \overline{A} , 2 \overline{A}	5, 11	input (HIGH to LOW triggered)
1Q, 2Q	6, 10	output
1 \overline{Q} , 2 \overline{Q}	7, 9	complementary output (active LOW)
GND	8	ground (0 V)
V _{CC}	16	supply voltage

6. Functional description

Table 3. Function table

Inputs			Outputs	
nA	nB	nCD	nQ	nQ
↓	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_{EXT} and R_{EXT};

= one LOW level output pulse, with the pulse width determined by C_{EXT} and R_{EXT}.

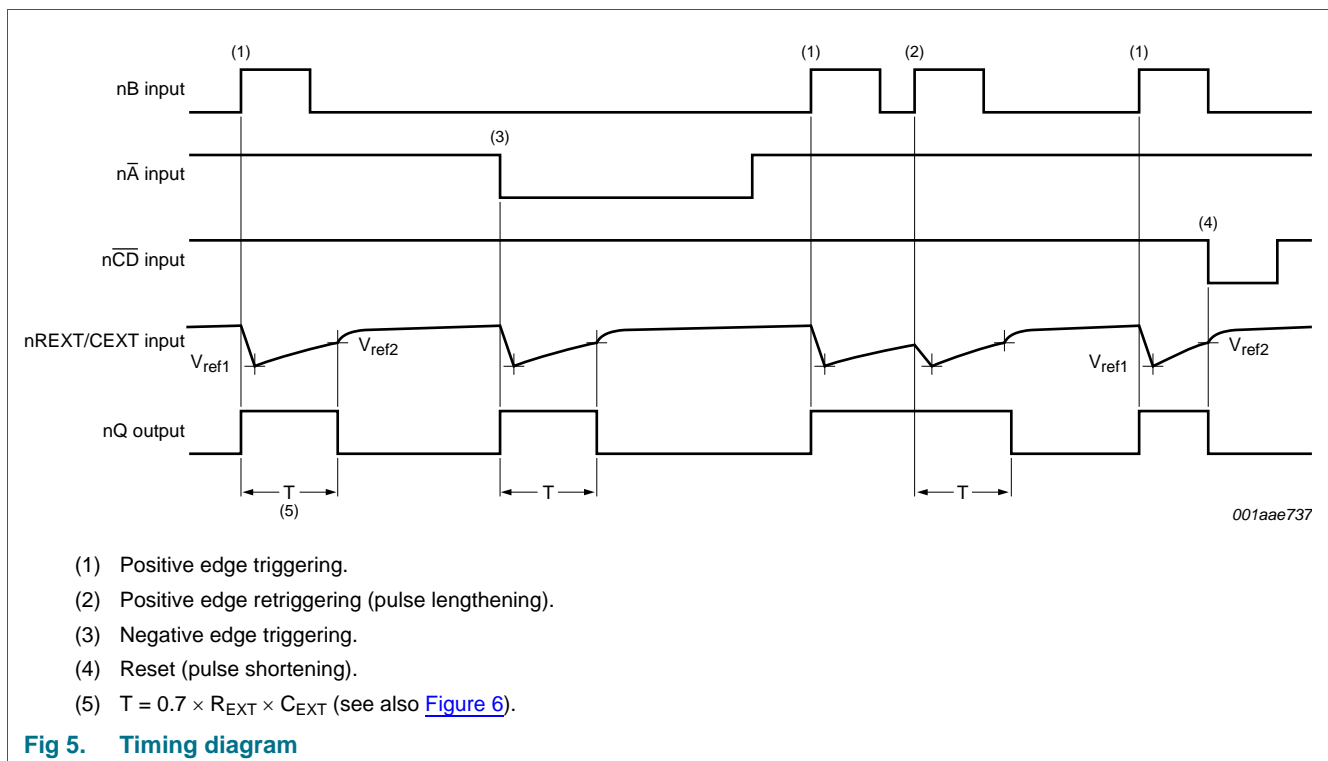


Fig 5. Timing diagram

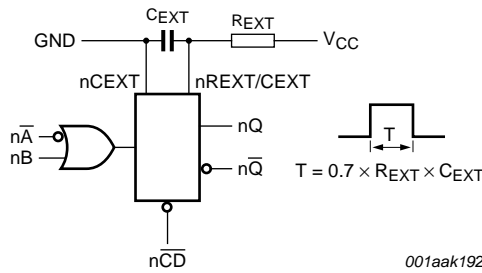


Fig 6. Connection of the external timing components R_{EXT} and C_{EXT}

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] -	± 20	mA
I_{OK}	output clamping current	$V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$	[1] -	± 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	$T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$			
		SO16 package	[2] -	500	mW
		TSSOP16 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	74HC4538-Q100			74HCT4538-Q100			Unit
			Min	Typ	Max	Min	Typ	Max	
V _{CC}	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V _I	input voltage		0	-	V _{CC}	0	-	V _{CC}	V
V _O	output voltage		0	-	V _{CC}	0	-	V _{CC}	V
T _{amb}	ambient temperature		-40	-	+125	-40	-	+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	-	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	
74HC4538-Q100										
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 mA; V _{CC} = 4.5 V	3.98	4.32	-	3.84	-	3.7	-	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 _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 6.0 V	-	-	±0.1	-	±1	-	±1	μA
		pin nREXT/CEXT; V _I = 2.0 V or GND; other inputs at V _{CC} or GND; V _{CC} = 6.0 V [1]	-	-	±0.5	-	±5	-	±10	μA

Table 6. Static characteristics ...continued

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	
I_{CC}	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 6.0$ V	-	-	8.0	-	80	-	160	μ A
C_I	input capacitance		-	3.5	-	-	-	-	-	pF
74HCT4538-Q100										
V_{IH}	HIGH-level input voltage	$V_{CC} = 4.5$ V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 4.5$ V to 5.5 V	-	1.2	0.8	-	0.8	-	0.8	V
V_{OH}	HIGH-level output voltage	$V_I = V_{IH}$ or V_{IL} ; $V_{CC} = 4.5$ V								
		$I_O = -20$ μ A	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -4.0$ mA	3.98	4.32	-	3.84	-	3.7	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH}$ or V_{IL} ; $V_{CC} = 4.5$ V								
		$I_O = 20$ μ A; $V_{CC} = 4.5$ 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_I	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 5.5$ V	-	-	± 0.1	-	± 1	-	± 1	μ A
		pin nREXT/CEXT; $V_I = 2.0$ V or GND; other inputs at V_{CC} or GND; $V_{CC} = 5.5$ V [1]	-	-	± 0.5	-	± 5	-	± 10	μ A
I_{CC}	supply current	$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 5.5$ V	-	-	8.0	-	80	-	160	μ A
ΔI_{CC}	additional supply current	$V_I = V_{CC} - 2.1$ V; $I_O = 0$ A; other inputs at V_{CC} or GND; $V_{CC} = 4.5$ V to 5.5 V								
		pin nA, nB	-	50	180	-	225	-	245	μ A
		pin nCD	-	65	234	-	293	-	319	μ A
C_I	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 ^[1]	Max	Min	Max	Min	Max	
74HC4538-Q100										
t _{PLH}	LOW to HIGH propagation delay	n \bar{A} , nB to nQ; see Figure 7								
		V _{CC} = 2.0 V	-	85	265	-	330	-	400	ns
		V _{CC} = 4.5 V	-	31	53	-	66	-	80	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	27	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	25	45	-	56	-	68	ns
		n \bar{CD} to n \bar{Q} ; see Figure 7								
		V _{CC} = 2.0 V	-	83	265	-	340	-	400	ns
t _{PHL}	HIGH to LOW propagation delay	n \bar{A} , nB to n \bar{Q} ; see Figure 7								
		V _{CC} = 2.0 V	-	83	265	-	330	-	400	ns
		V _{CC} = 4.5 V	-	30	53	-	66	-	80	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	27	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	24	45	-	56	-	68	ns
		n \bar{CD} to nQ; see Figure 7								
		V _{CC} = 2.0 V	-	80	265	-	330	-	400	ns
t _t	transition time	nQ and n \bar{Q} ; see Figure 7 ^[2]								
		V _{CC} = 2.0 V	-	19	75	-	95	-	119	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); for test circuit see [Figure 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 _W	pulse width	n \bar{A} LOW; see Figure 8								
		V _{CC} = 2.0 V	80	17	-	100	-	120	-	ns
		V _{CC} = 4.5 V	16	6	-	20	-	24	-	ns
		V _{CC} = 6.0 V	14	5	-	17	-	20	-	ns
		nB HIGH; see Figure 8								
		V _{CC} = 2.0 V	80	17	-	100	-	120	-	ns
		V _{CC} = 4.5 V	16	6	-	20	-	24	-	ns
		V _{CC} = 6.0 V	14	5	-	17	-	20	-	ns
		n \overline{CD} LOW; see Figure 8								
		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
		nQ and n \overline{Q} HIGH or LOW; see Figure 8								
		V _{CC} = 5.0 V; C _{EXT} = 0.1 μF; R _{EXT} = 10 kΩ	630	700	770	602	798	595	805	μs
		t _{rec}	recovery time	n \overline{CD} to n \bar{A} , nB; see Figure 8						
V _{CC} = 2.0 V	35			6	-	45	-	55	-	ns
V _{CC} = 4.5 V	7			2	-	9	-	11	-	ns
V _{CC} = 6.0 V	6			2	-	8	-	9	-	ns
t _{trig}	retrigger time	n \bar{A} , nB; see Figure 8 ; X = C _{EXT} / (4.5 × V _{CC})								
		V _{CC} = 2.0 V	-	455 + X	-	-	-	-	-	ns
		V _{CC} = 4.5 V	-	80 + X	-	-	-	-	-	ns
		V _{CC} = 6.0 V	-	55 + X	-	-	-	-	-	ns
R _{EXT}	external resistance	V _{CC} = 2.0 V	10	-	1000	-	-	-	-	kΩ
		V _{CC} = 5.0 V	2	-	1000	-	-	-	-	kΩ
C _{EXT}	external capacitance				no limits					
C _{PD}	power dissipation capacitance	per multivibrator; V _I = GND to V _{CC}	^[3]	-	136	-	-	-	-	pF

Table 7. Dynamic characteristics ...continued

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 ^[1]	Max	Min	Max	Min	Max	
74HCT4538-Q100										
t _{PLH}	LOW to HIGH propagation delay	n \bar{A} , nB to nQ; see Figure 7								
		V _{CC} = 4.5 V	-	35	60	-	75	-	90	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	30	-	-	-	-	-	ns
		n \bar{CD} to n \bar{Q} ; see Figure 7								
t _{PHL}	HIGH to LOW propagation delay	n \bar{A} , nB to n \bar{Q} ; see Figure 7								
		V _{CC} = 4.5 V	-	35	60	-	75	-	90	ns
		V _{CC} = 5.0 V; C _L = 15 pF	-	30	-	-	-	-	-	ns
		n \bar{CD} to nQ; see Figure 7								
t _t	transition time	nQ and n \bar{Q} ; see Figure 7 ^[2]								
		V _{CC} = 4.5 V	-	7	15	-	19	-	21	ns
t _w	pulse width	n \bar{A} LOW; see Figure 8								
		V _{CC} = 4.5 V	20	11	-	25	-	30	-	ns
		nB HIGH; see Figure 8								
		V _{CC} = 4.5 V	16	5	-	20	-	24	-	ns
		n \bar{CD} LOW; see Figure 8								
		V _{CC} = 4.5 V	20	11	-	25	-	30	-	ns
t _{rec}	recovery time	n \bar{CD} to n \bar{A} , nB; see Figure 8								
		V _{CC} = 4.5 V	7	2	-	9	-	11	-	ns
		nQ and n \bar{Q} HIGH or LOW; see Figure 8								
t _{trig}	retrigger time	n \bar{A} , nB; see Figure 8 ; X = C _{EXT} / (4.5 × V _{CC})								
		V _{CC} = 4.5 V	-	80 + X	-	-	-	-	-	ns
R _{EXT}	external resistance	V _{CC} = 5.0 V	2	-	1000	-	-	-	-	kΩ
C _{EXT}	external capacitance	V _{CC} = 5.0 V	no limits							

Table 7. Dynamic characteristics ...continued

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 ^[1]	Max	Min	Max	Min	Max	
C _{PD}	power dissipation capacitance	per multivibrator; V _I = GND to (V _{CC} - 1.5 V)	-	138	-	-	-	-	-	pF

[1] Typical values are measured at nominal supply voltage (V_{CC} = 3.3 V and V_{CC} = 5.0 V).

[2] t_t is the same as t_{THL} and t_{TLH}.

[3] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

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

f_i = input frequency in MHz;

f_o = output frequency in MHz;

Σ(C_L × V_{CC}² × f_o) = sum of the outputs;

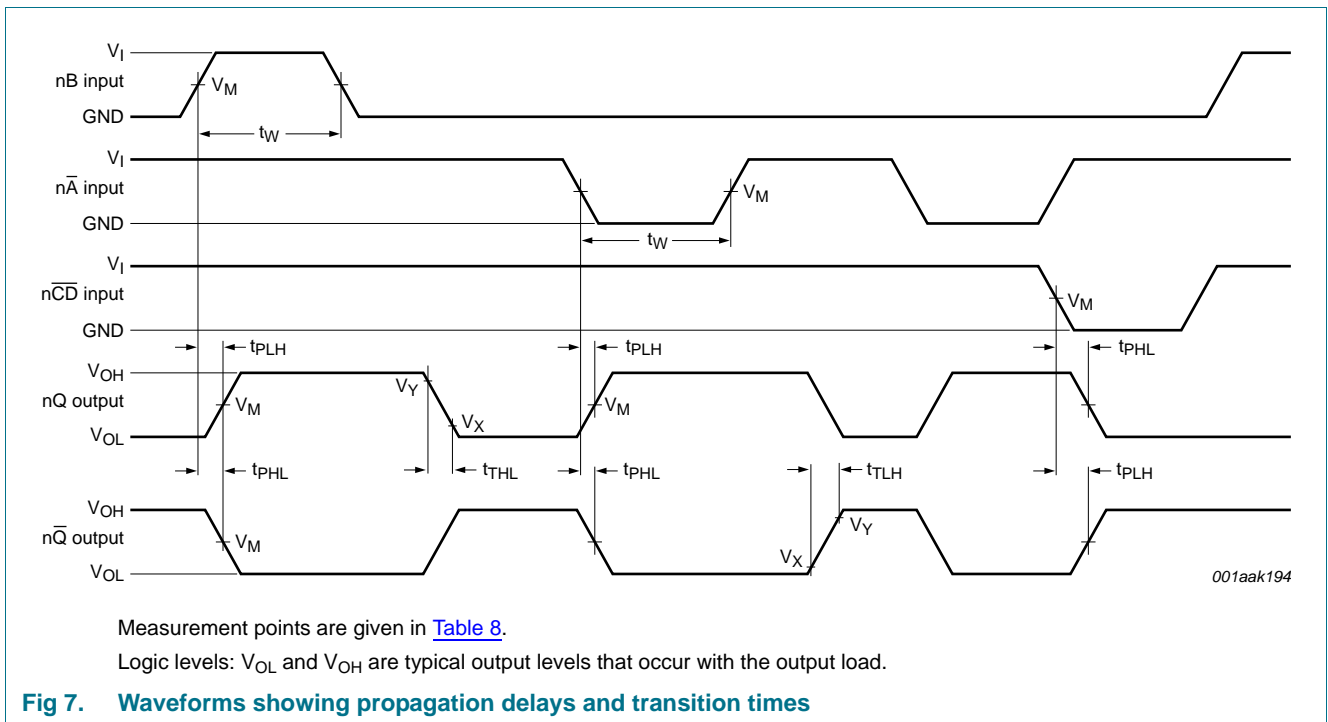
C_L = output load capacitance in pF;

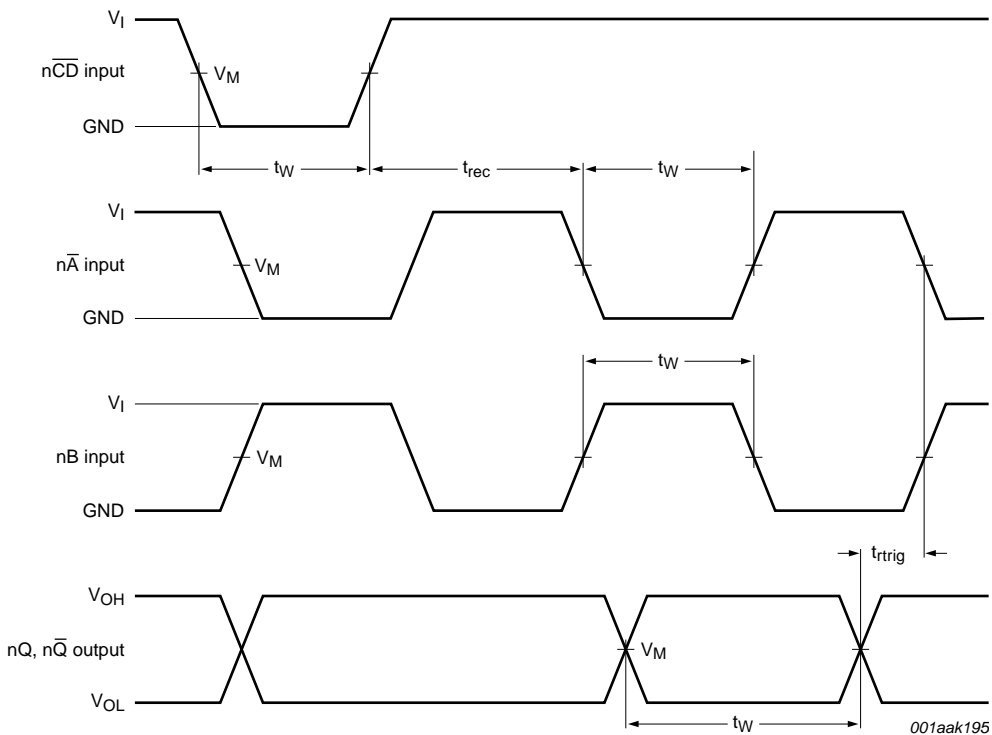
V_{CC} = supply voltage in V;

D = duty cycle factor in %;

C_{EXT} = external timing capacitance in pF.

11. Waveforms





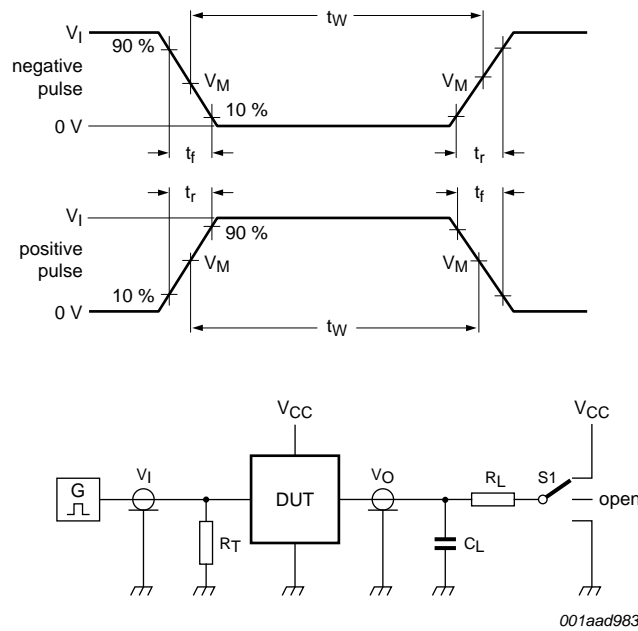
Measurement points are given in [Table 8](#).

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

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

Table 8. Measurement points

Type	Input	Output		
	V_M	V_M	V_X	V_Y
74HC4538-Q100	$0.5V_{CC}$	$0.5V_{CC}$	$0.1V_{CC}$	$0.9V_{CC}$
74HCT4538-Q100	1.3 V	1.3 V	$0.1V_{CC}$	$0.9V_{CC}$



Test data is given in [Table 9](#).

Definitions test circuit:

R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

C_L = Load capacitance including jig and probe capacitance.

R_L = Load resistance.

S1 = Test selection switch

Fig 9. Test circuit for measuring switching times

Table 9. Test data

Type	Input		Load		S1 position
	V_I	t_r, t_f	C_L	R_L	t_{PHL}, t_{PLH}
74HC4538-Q100	V_{CC}	6 ns	15 pF, 50 pF	1 k Ω	open
74HCT4538-Q100	3 V	6 ns	15 pF, 50 pF	1 k Ω	open

12. Application information

12.1 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](#)

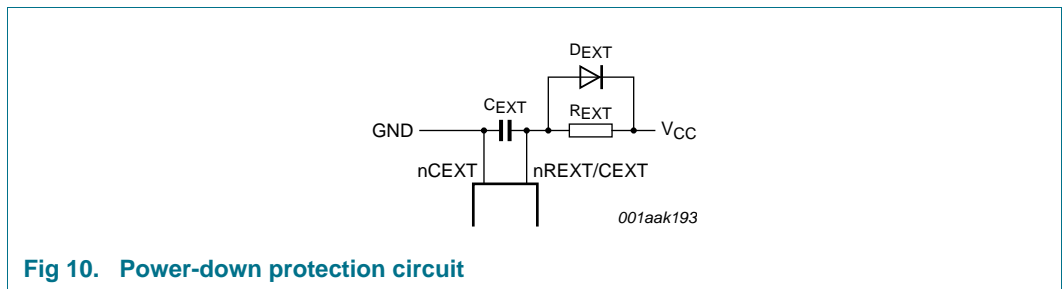


Fig 10. Power-down protection circuit

12.2 Graphs

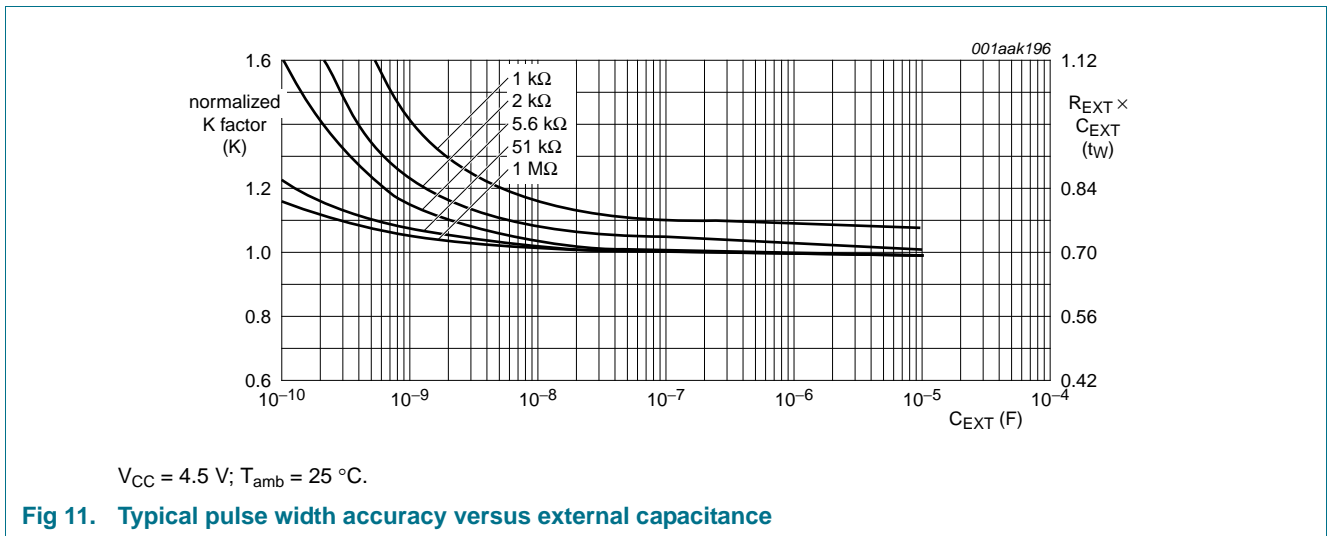
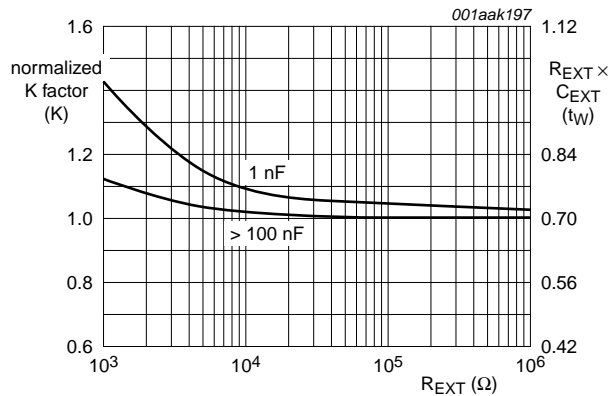
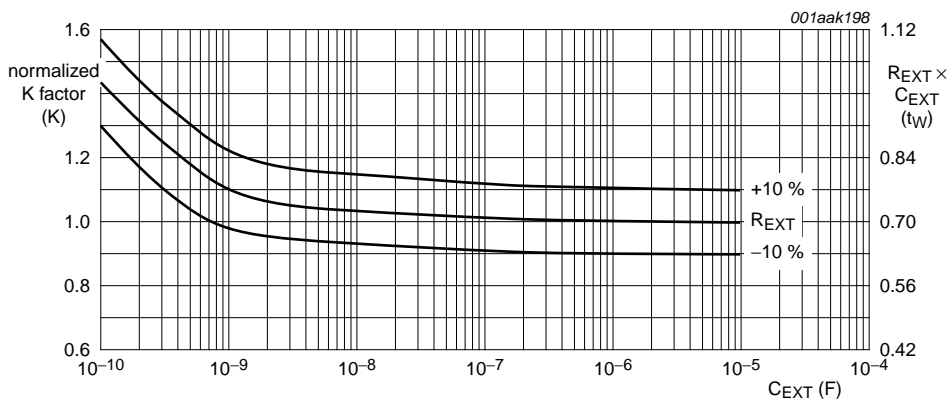


Fig 11. Typical pulse width accuracy versus external capacitance



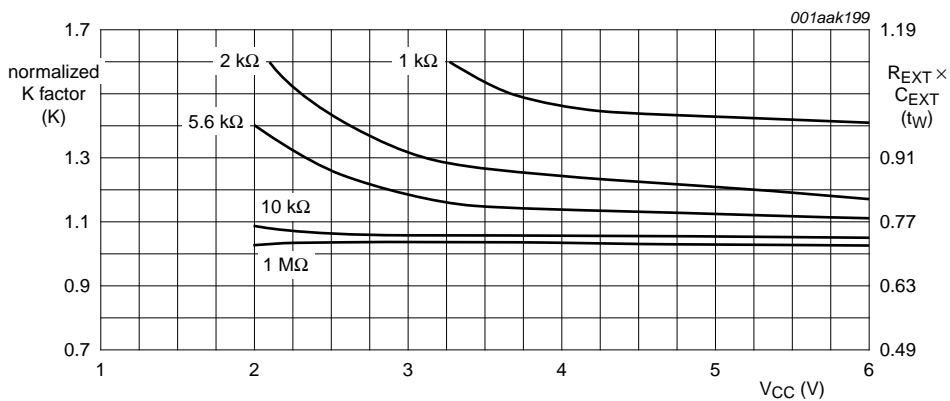
$V_{CC} = 4.5\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}.$

Fig 12. Typical pulse width accuracy versus external resistance



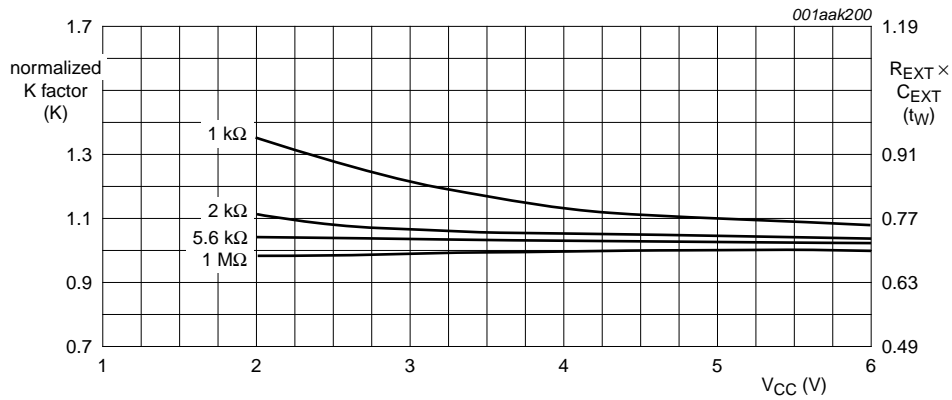
$V_{CC} = 4.5\text{ V}; R_{EXT} = 10\text{ k}\Omega; T_{amb} = 25\text{ }^{\circ}\text{C}.$

Fig 13. Typical pulse width accuracy versus external capacitance



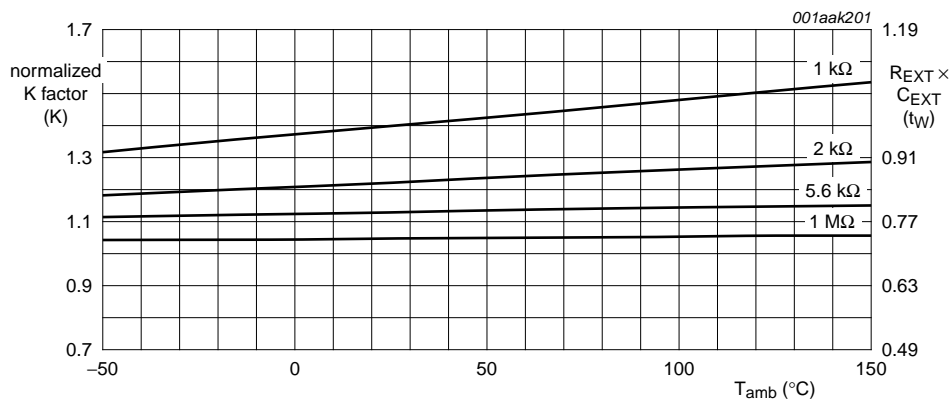
$C_{EXT} = 1\text{ nF}; T_{amb} = 25\text{ }^{\circ}\text{C}.$

Fig 14. Typical pulse width accuracy versus power supply



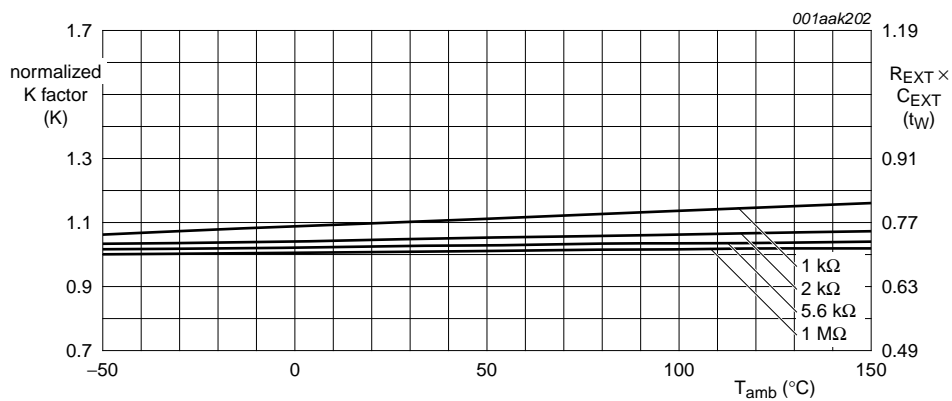
C_{EXT} = 100 nF; T_{amb} = 25 °C.

Fig 15. Typical pulse width accuracy versus power supply



V_{CC} = 4.5 V; C_{EXT} = 1 nF; T_{amb} = 25 °C.

Fig 16. Typical pulse width accuracy versus temperature



V_{CC} = 4.5 V; C_{EXT} = 1 μF; T_{amb} = 25 °C.

Fig 17. Typical pulse width accuracy versus temperature

13. Package outline

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

SOT109-1

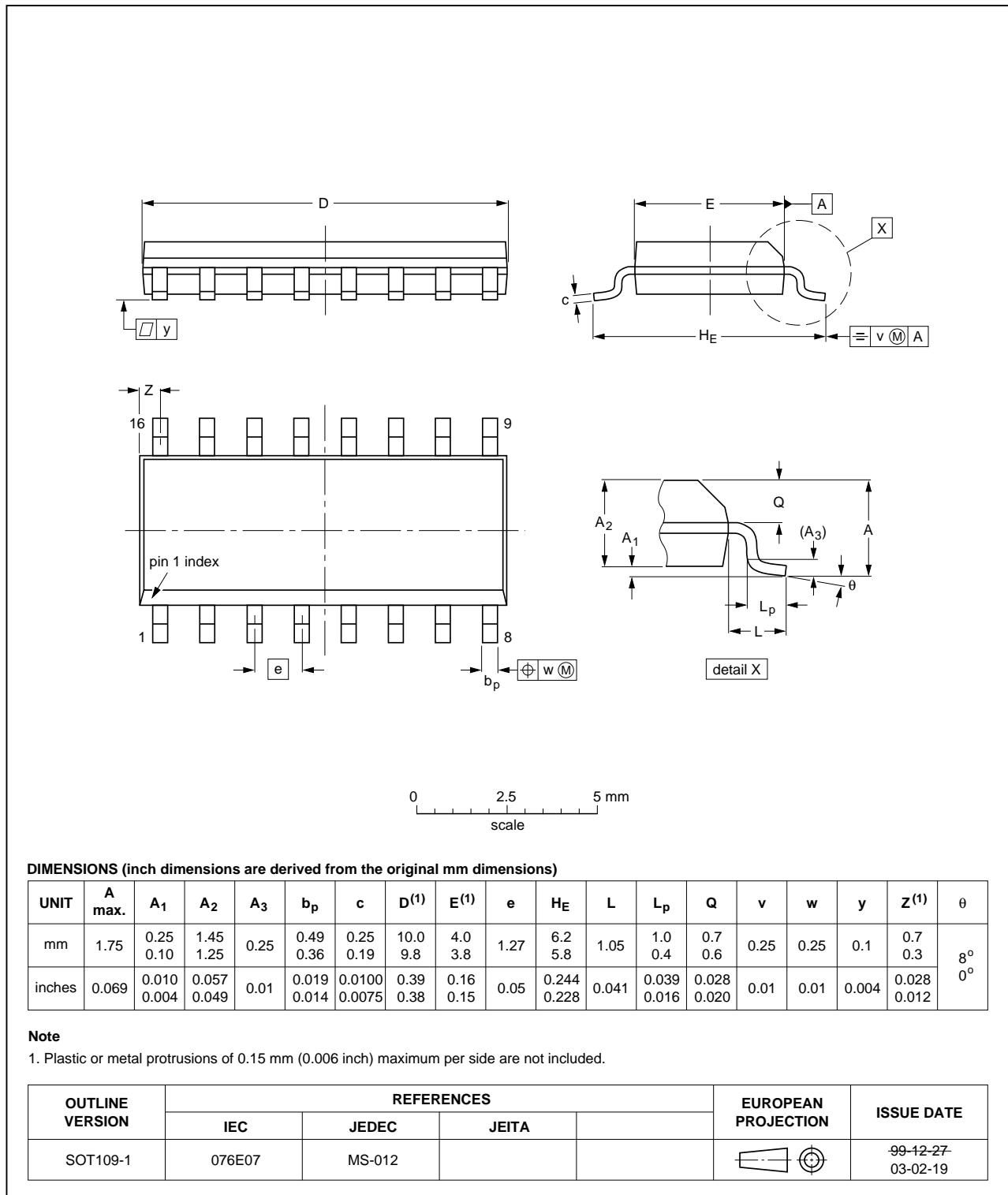


Fig 18. Package outline SOT109-1 (SO16)

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

SOT403-1

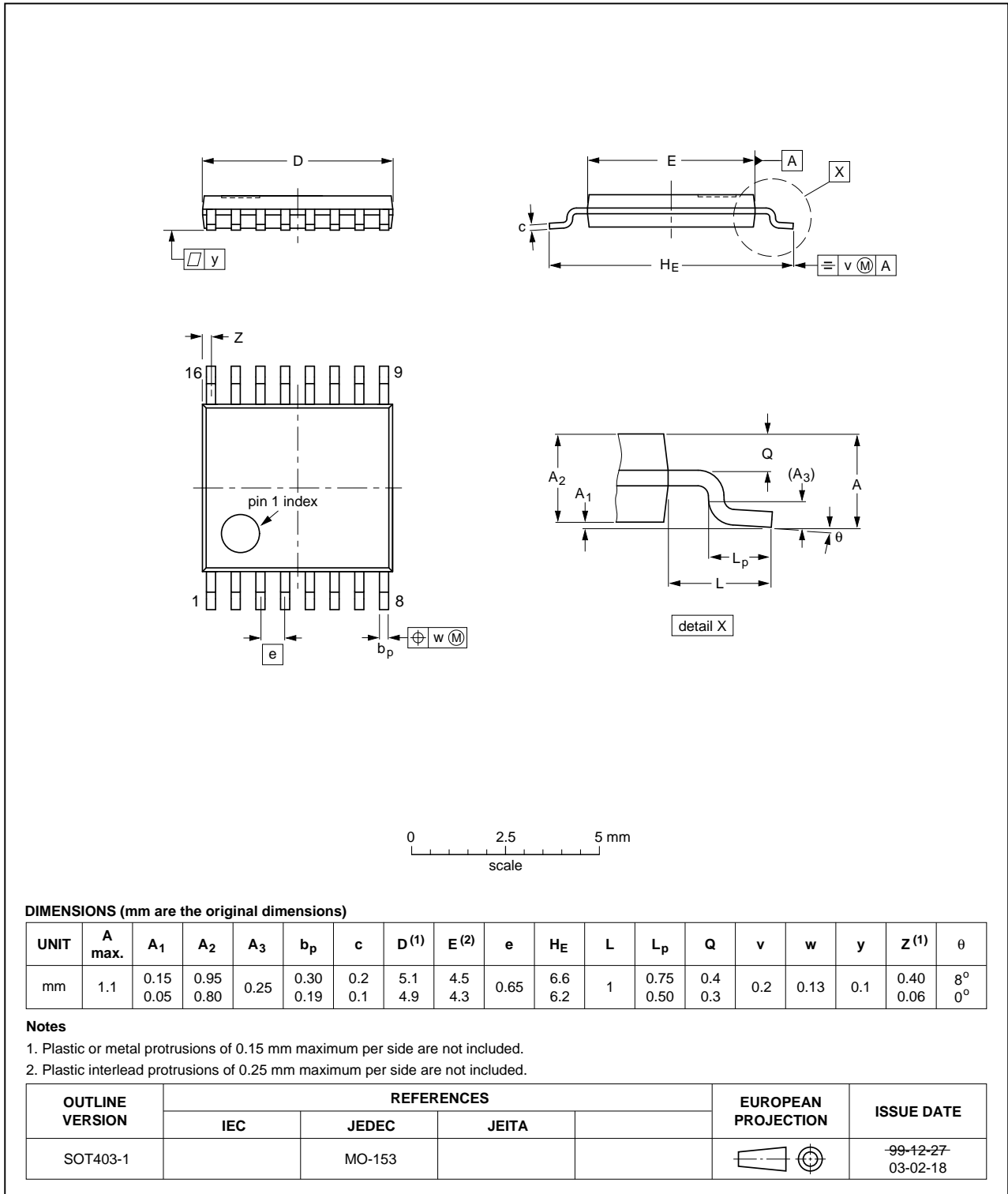


Fig 19. Package outline SOT403-1 (TSSOP16)

14. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
LSTTL	Low-power Schottky Transistor-Transistor Logic
MM	Machine Model
TTL	Transistor-Transistor Logic
MIL	Military

15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT4538_Q100 v.1	20120802	Product data sheet	-	74HC_HCT4538_CNV_2

16. Legal information

16.1 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".

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