

74HC4538

Dual retriggerable precision monostable multivibrator

Rev. 7 — 26 March 2024

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: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2000 V
 - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 1000 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

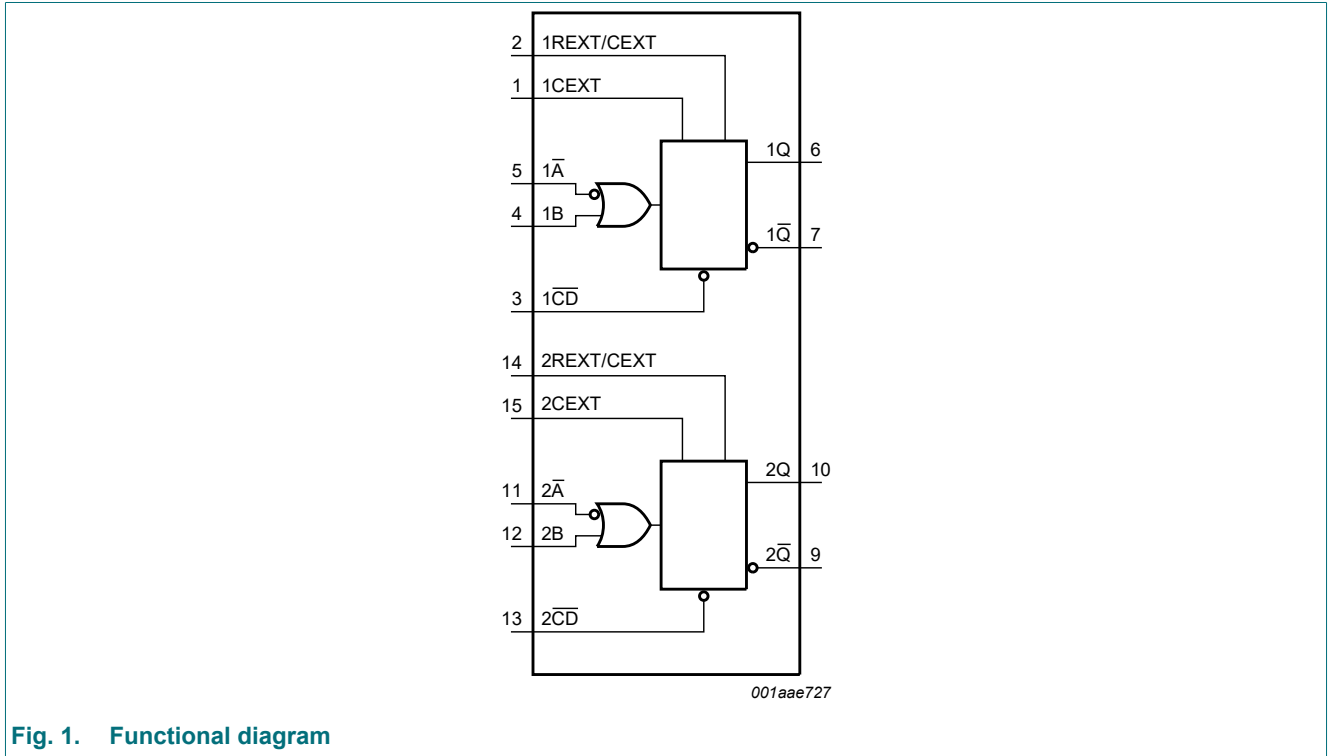


Fig. 1. Functional diagram

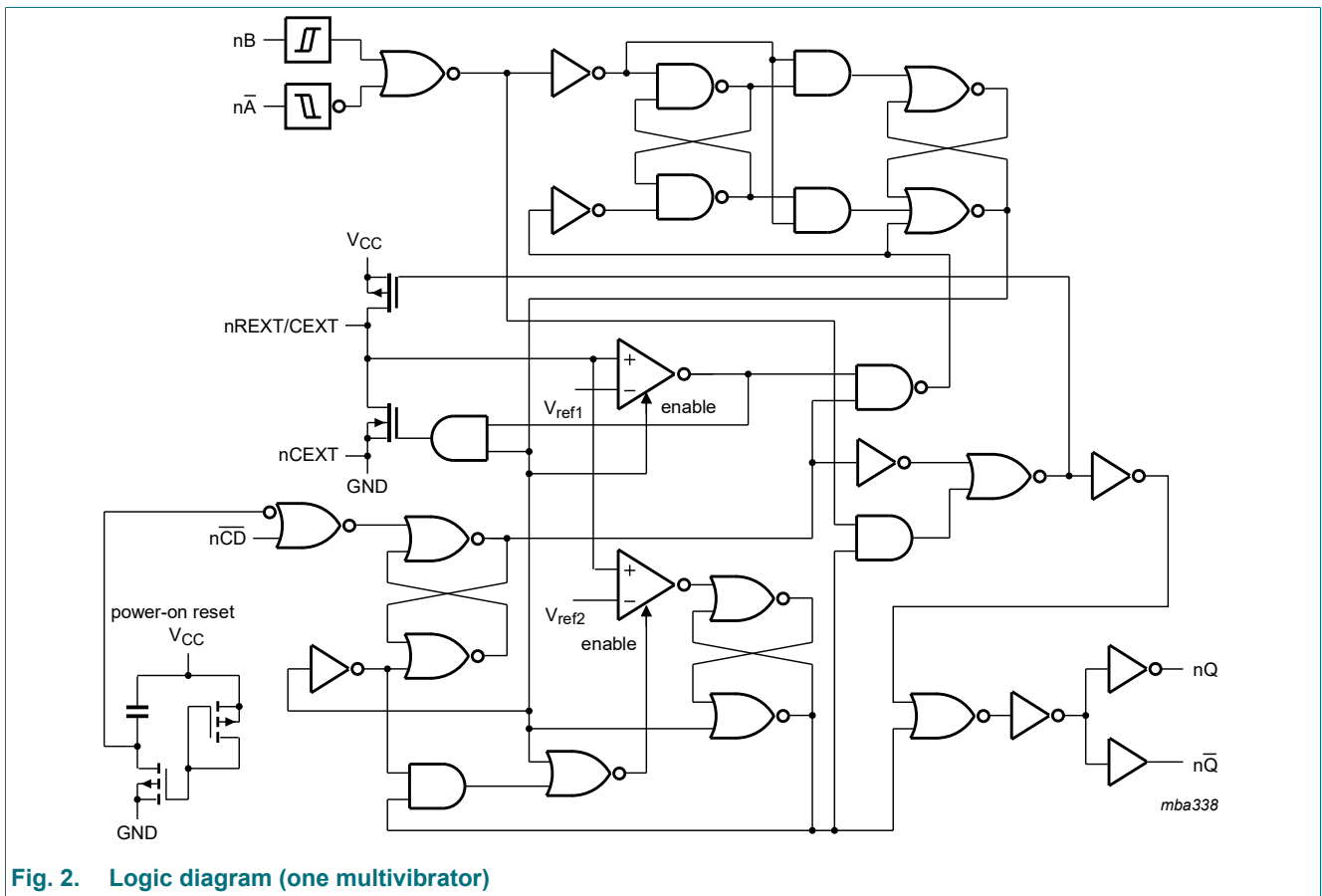


Fig. 2. Logic diagram (one multivibrator)

5. Pinning information

5.1. Pinning

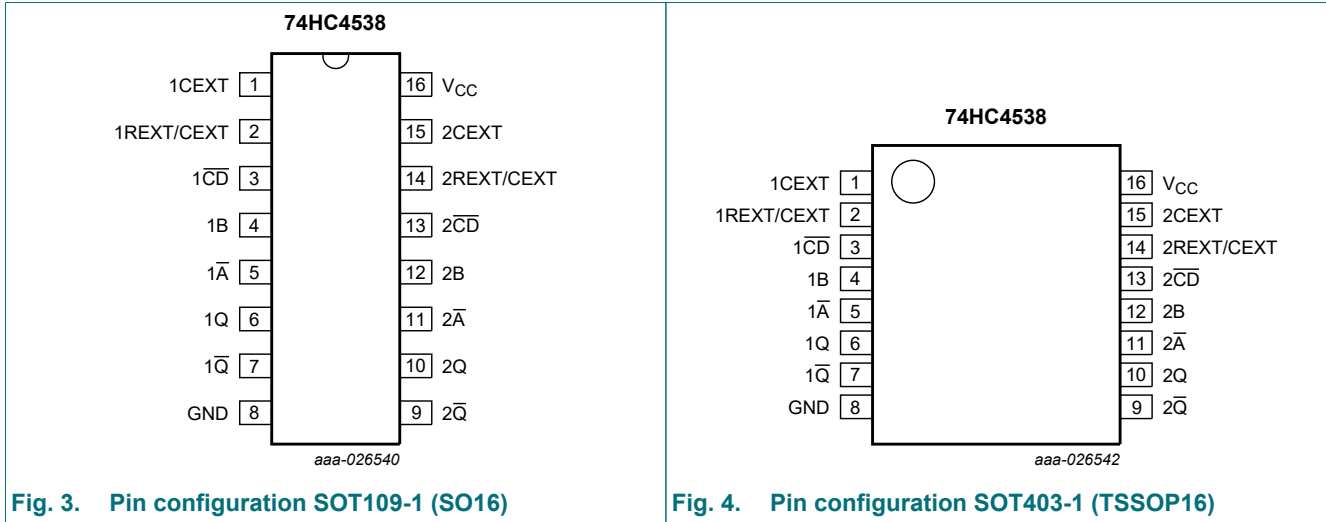


Fig. 3. Pin configuration SOT109-1 (SO16)

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) |
| V _{CC} | 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_{EXT} and R_{EXT};

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

| Inputs | | | Outputs | |
|--------|----|-----|---------|----|
| nA | nB | nCD | nQ | nQ |
| ↓ | L | H | | |
| H | ↑ | H | | |
| X | X | L | L | H |

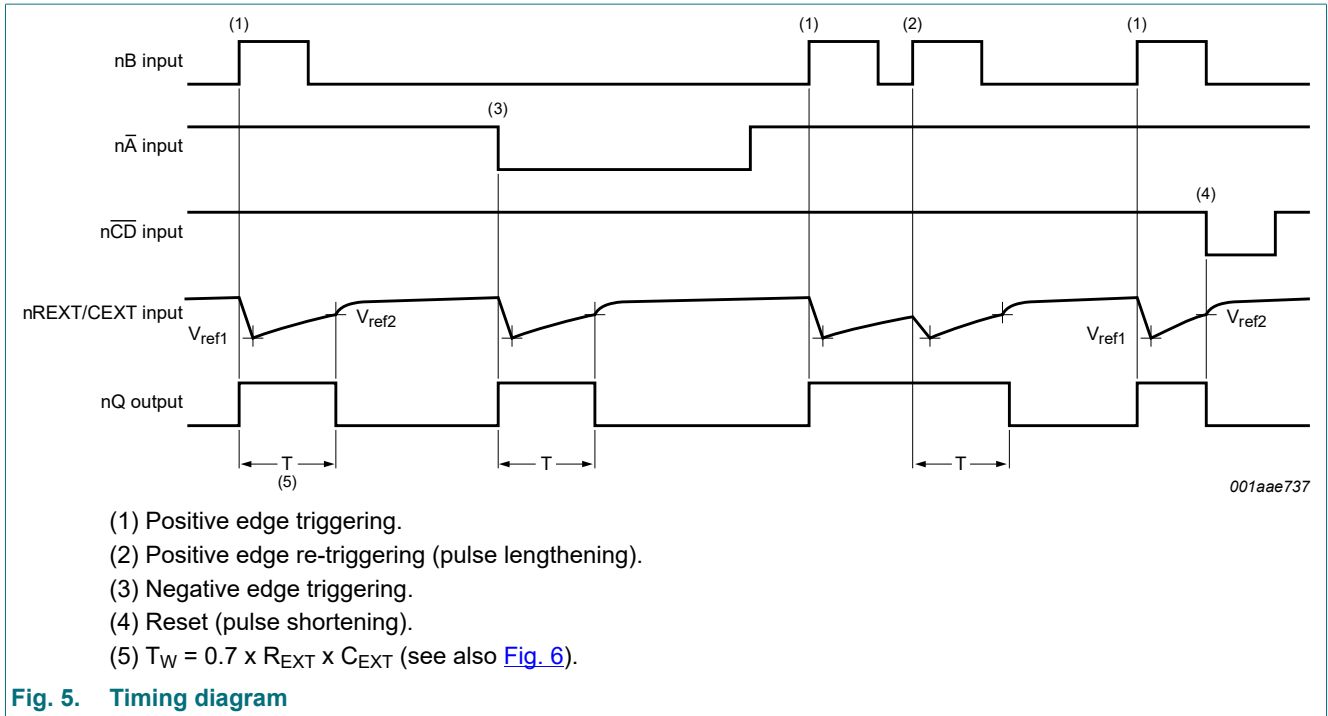


Fig. 5. Timing diagram

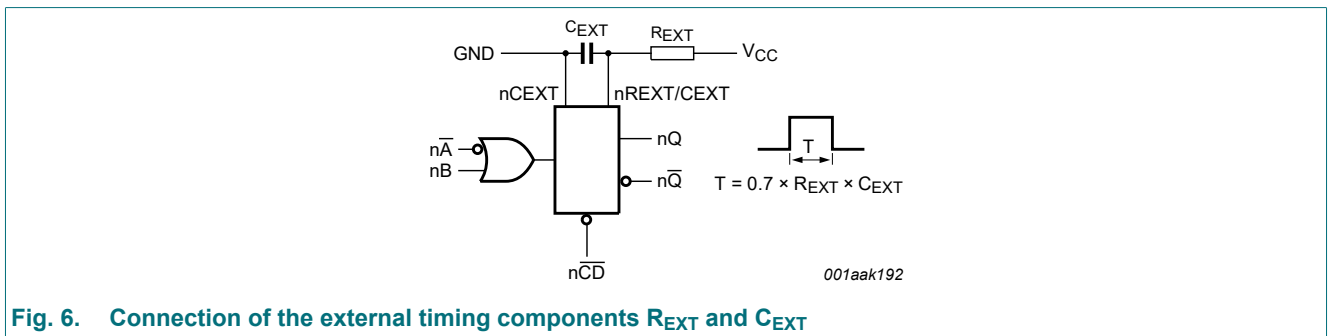


Fig. 6. Connection of the external timing components R_{EXT} and C_{EXT}

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] | - | ± 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 | $^{\circ}\text{C}$ |
| 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; $V_{CC} = 6.0\text{ V}$ | - | - | ± 0.1 | - | ± 1 | - | ± 1 | μA |
| | | 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] | - | - | ± 50 | - | ± 500 | - | ± 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 | μA |

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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 _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 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 _{PLH} | LOW to HIGH propagation delay | n \bar{A} , nB to nQ; see Fig. 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 $\bar{C}\bar{D}$ to n \bar{Q} ; see Fig. 7 | | | | | | | | |
| | | V _{CC} = 2.0 V | - | 83 | 265 | - | 340 | - | 400 | ns |
| | | V _{CC} = 4.5 V | - | 30 | 53 | - | 68 | - | 80 | ns |
| t _{PHL} | HIGH to LOW propagation delay | n \bar{A} , nB to n \bar{Q} ; see Fig. 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 $\bar{C}\bar{D}$ to nQ; see Fig. 7 | | | | | | | | |
| | | V _{CC} = 2.0 V | - | 80 | 265 | - | 330 | - | 400 | ns |
| | | V _{CC} = 4.5 V | - | 29 | 53 | - | 66 | - | 80 | ns |
| t _t | transition time | nQ and n \bar{Q} ; see Fig. 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 |

Dual retriggerable precision monostable multivibrator

| 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 Fig. 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 Fig. 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 $\bar{C}\bar{D}$ LOW; see Fig. 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 \bar{Q} HIGH or LOW; see Fig. 8 | | | | | | | | | | | |
| V _{CC} = 5.0 V; C _{EXT} = 0.1 μ F; R _{EXT} = 10 k Ω | 630 | 700 | 770 | 602 | 798 | 595 | 805 | μ s | | | |
| t _{rec} | recovery time | n $\bar{C}\bar{D}$ to n \bar{A} , nB; see Fig. 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 Fig. 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 timing resistor | V _{CC} = 2.0 V | 10 | - | 1000 | - | - | - | - | k Ω | |
| | | V _{CC} = 5.0 V | 2 | - | 1000 | - | - | - | - | k Ω | |
| C _{EXT} | external timing capacitor | | no limits | | | | | | | | |
| C _{PD} | power dissipation capacitance | per multivibrator; V _I = GND to V _{CC} | [3] | - | 136 | - | - | - | - | - | pF |

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

[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 μ 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_i = input frequency in MHz;

f_o = output frequency in MHz;

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

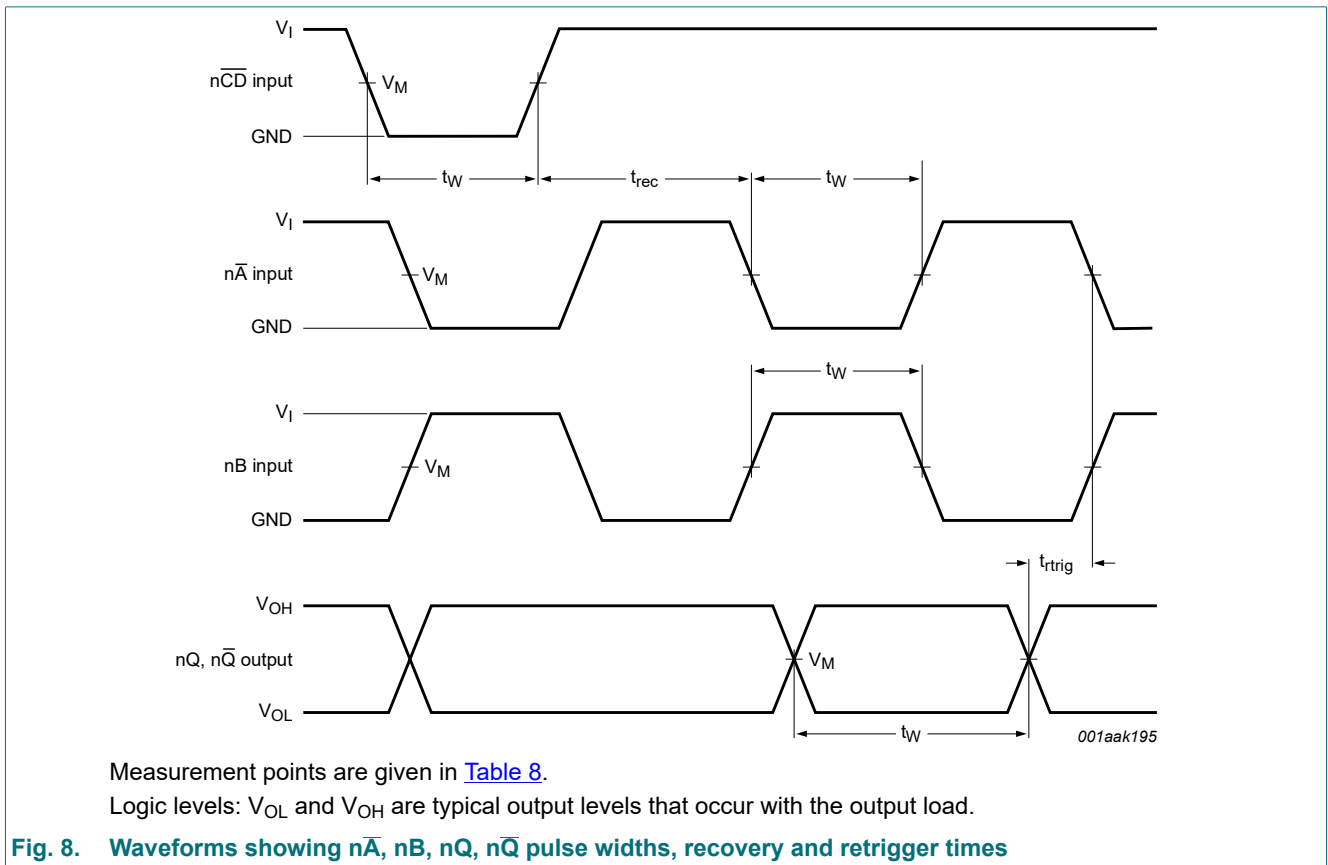
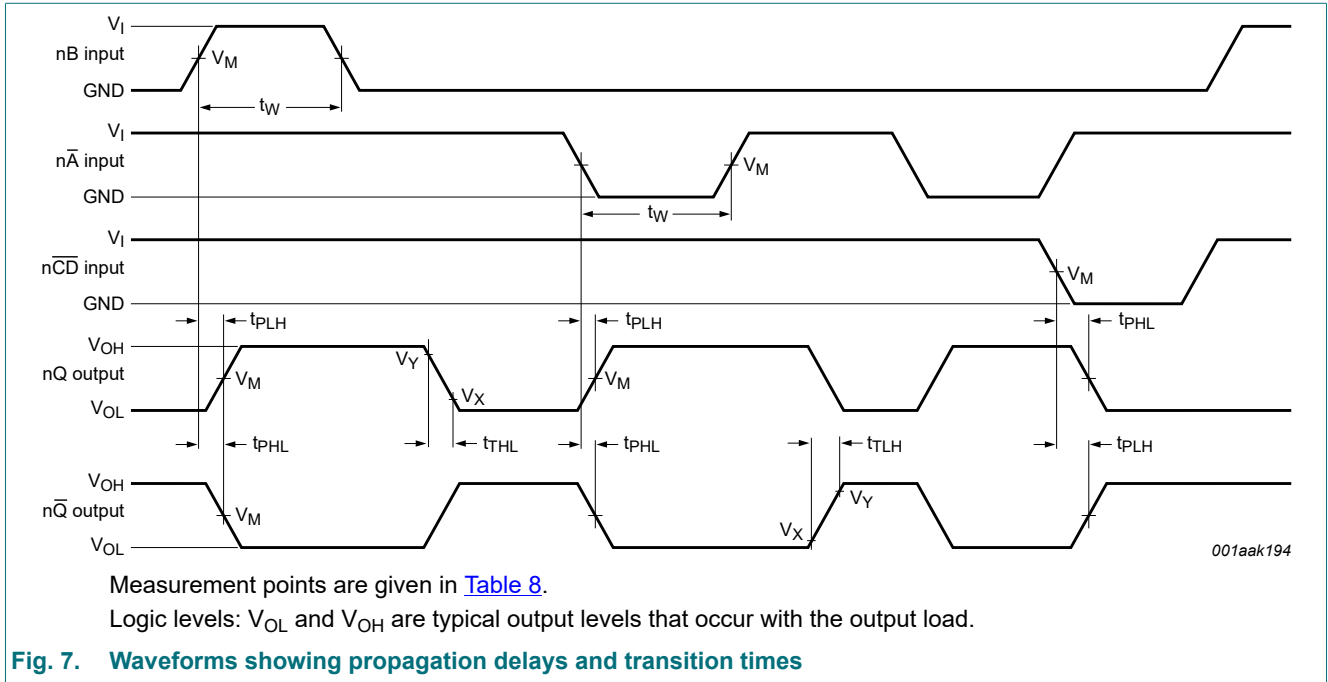
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

D = duty cycle factor in %;

C_{EXT} = external timing capacitance in pF.

10.1. Waveforms and test circuit



Dual retriggerable precision monostable multivibrator

Table 8. Measurement points

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

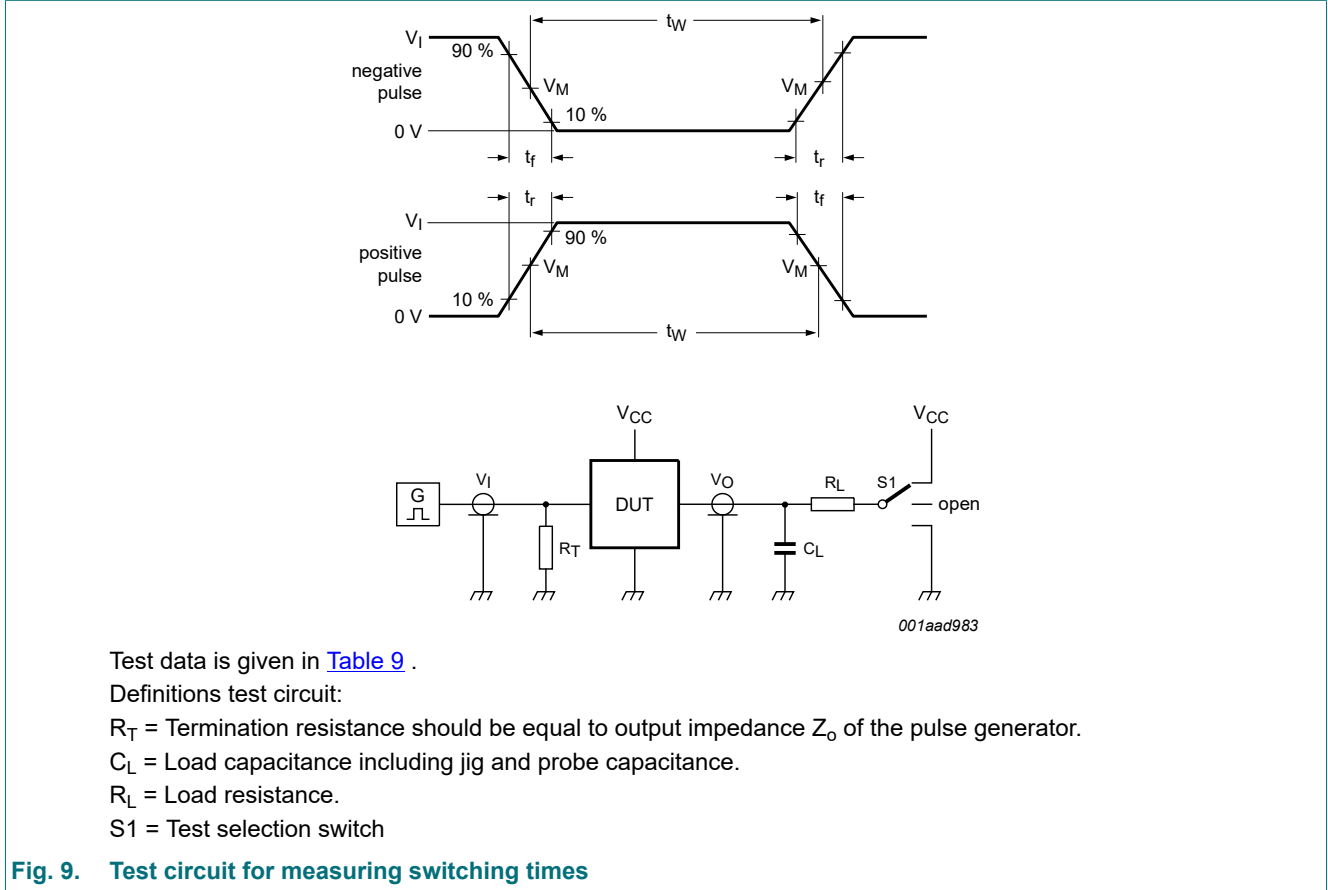


Fig. 9. Test circuit for measuring switching times

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

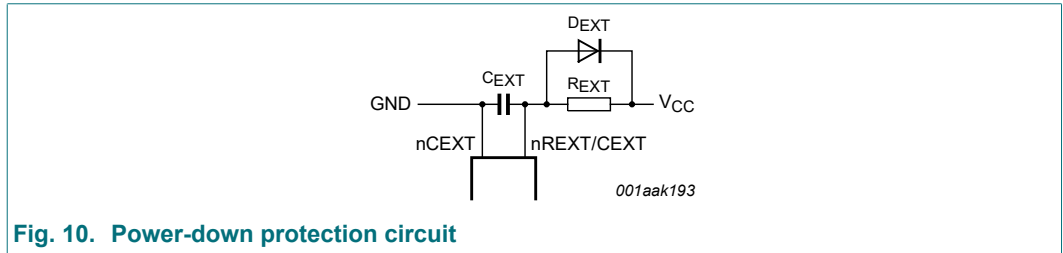


Fig. 10. Power-down protection circuit

11.2. Graphs

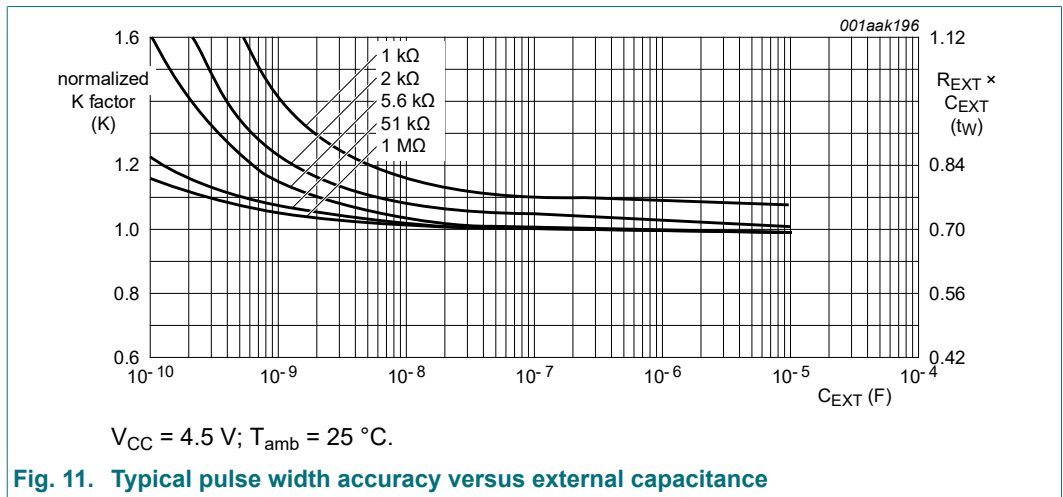


Fig. 11. Typical pulse width accuracy versus external capacitance

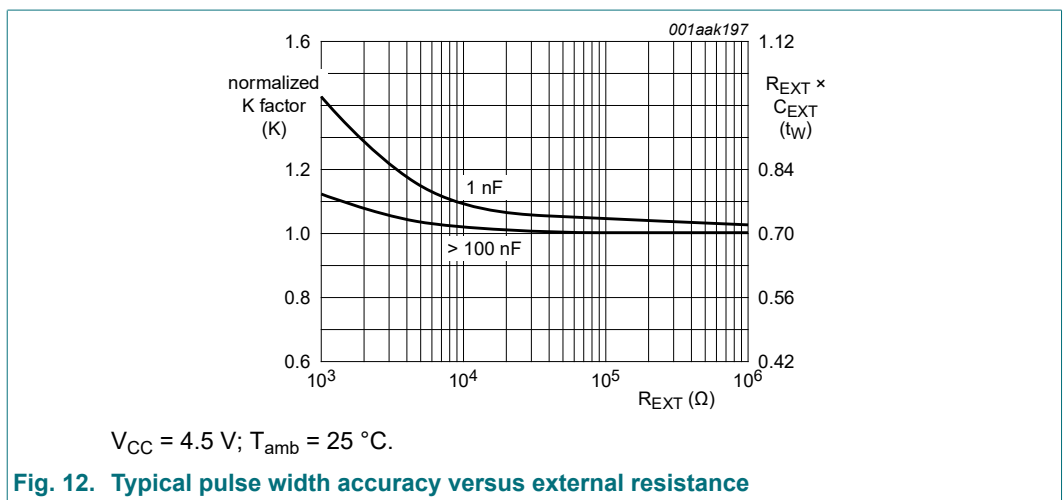
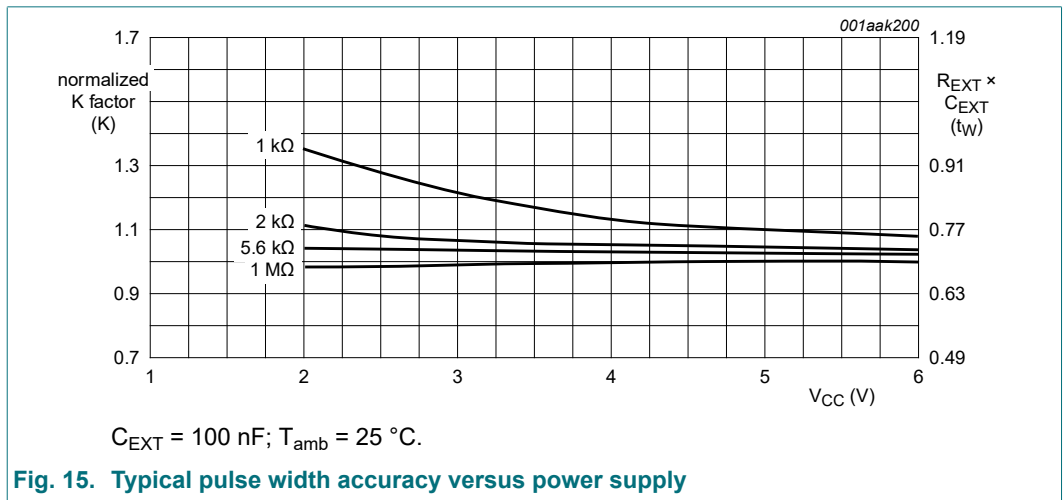
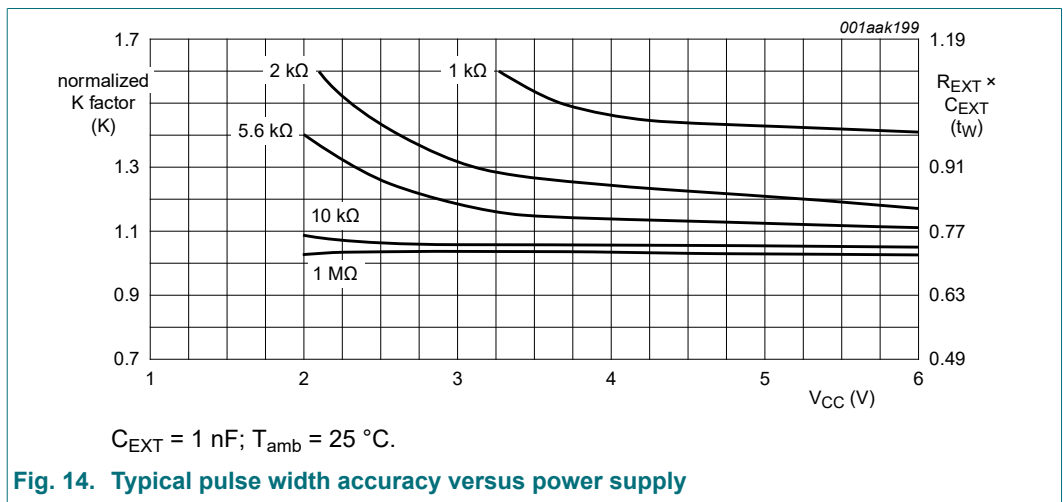
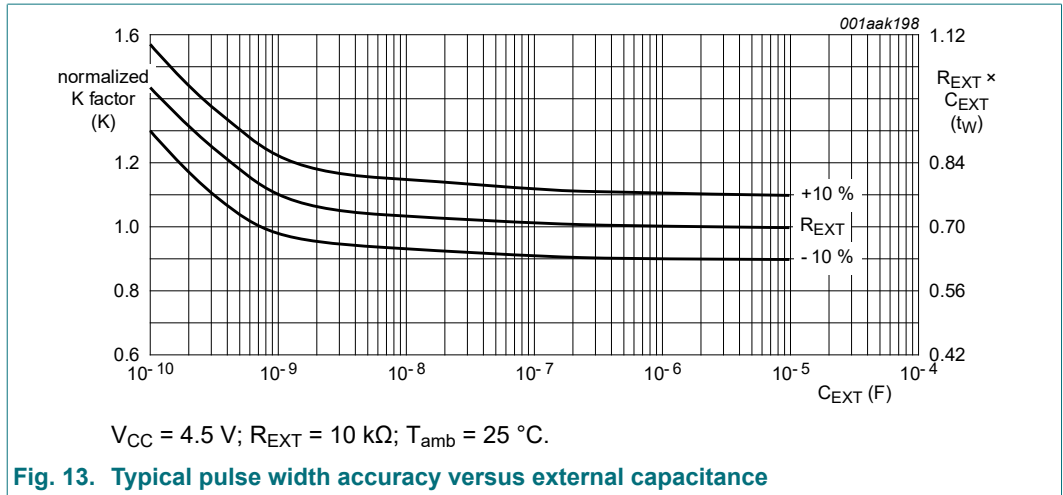
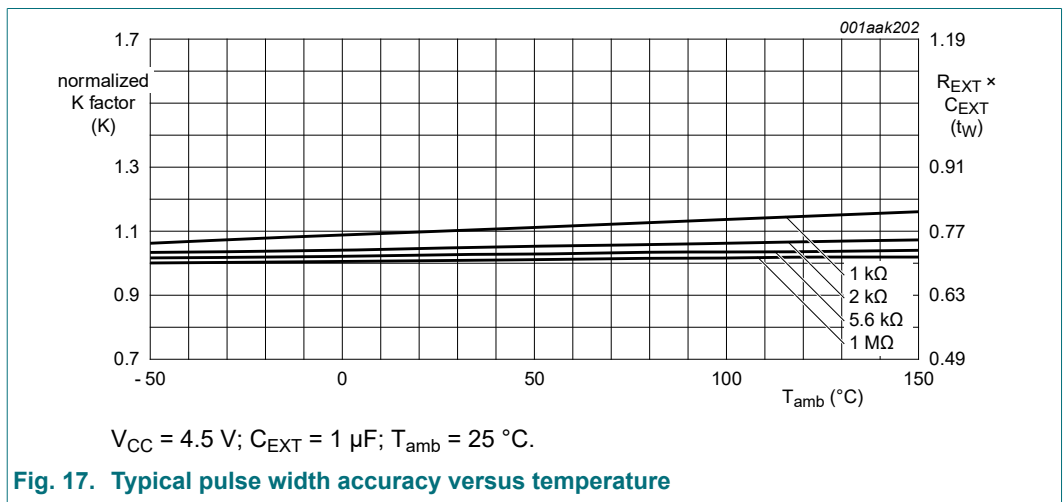
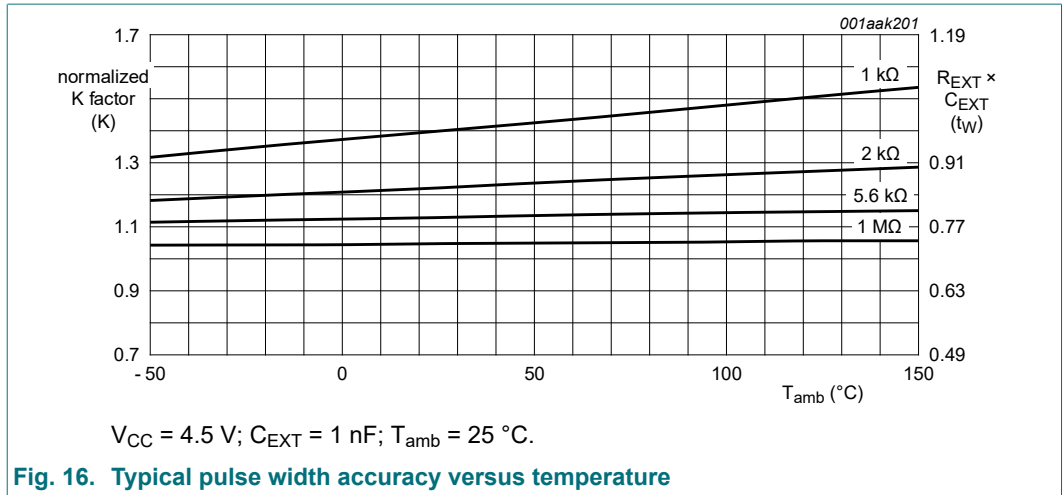


Fig. 12. Typical pulse width accuracy versus external resistance

Dual retriggerable precision monostable multivibrator



Dual retriggerable precision monostable multivibrator



12. Package outline

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

SOT109-1

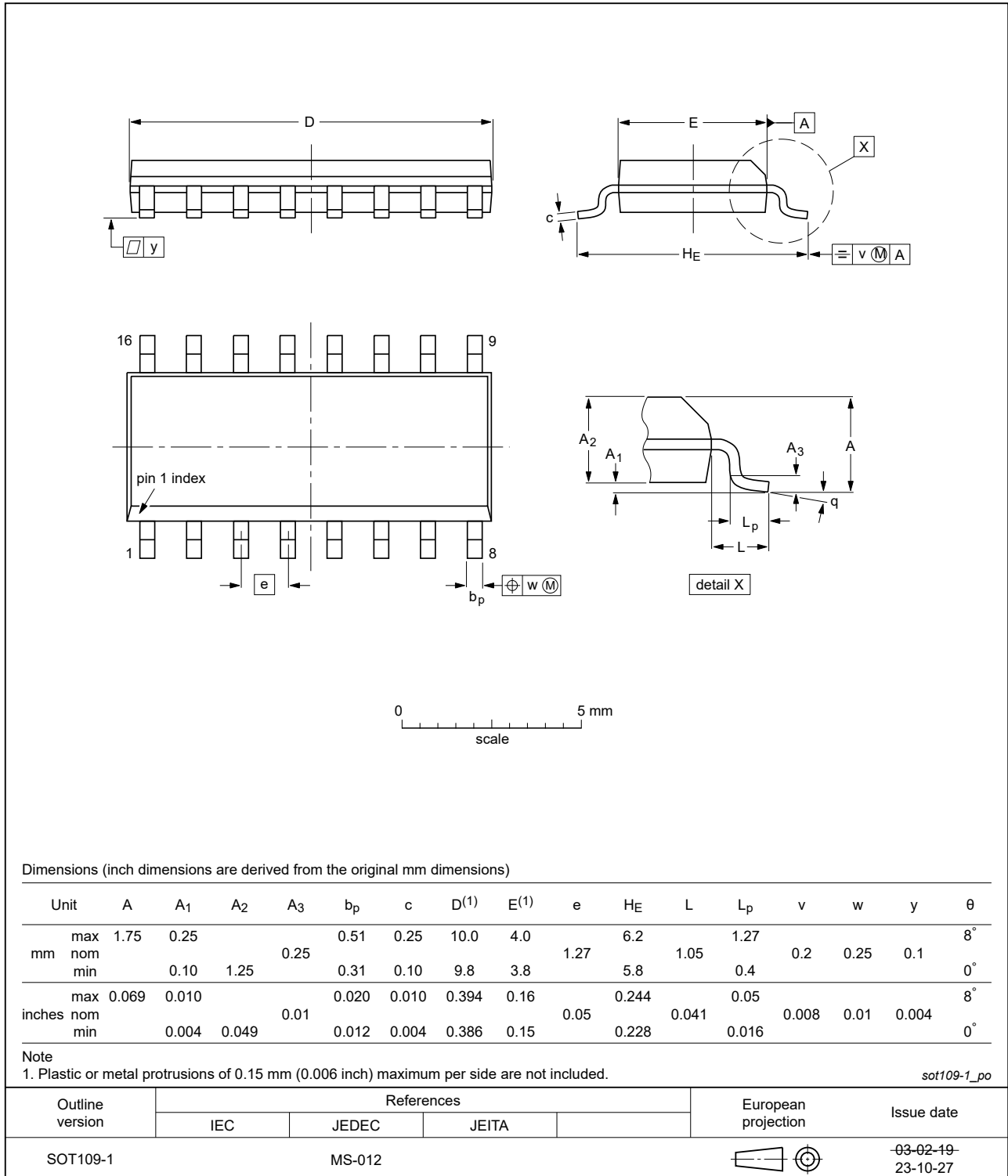


Fig. 18. Package outline SOT109-1 (SO16)

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

SOT403-1

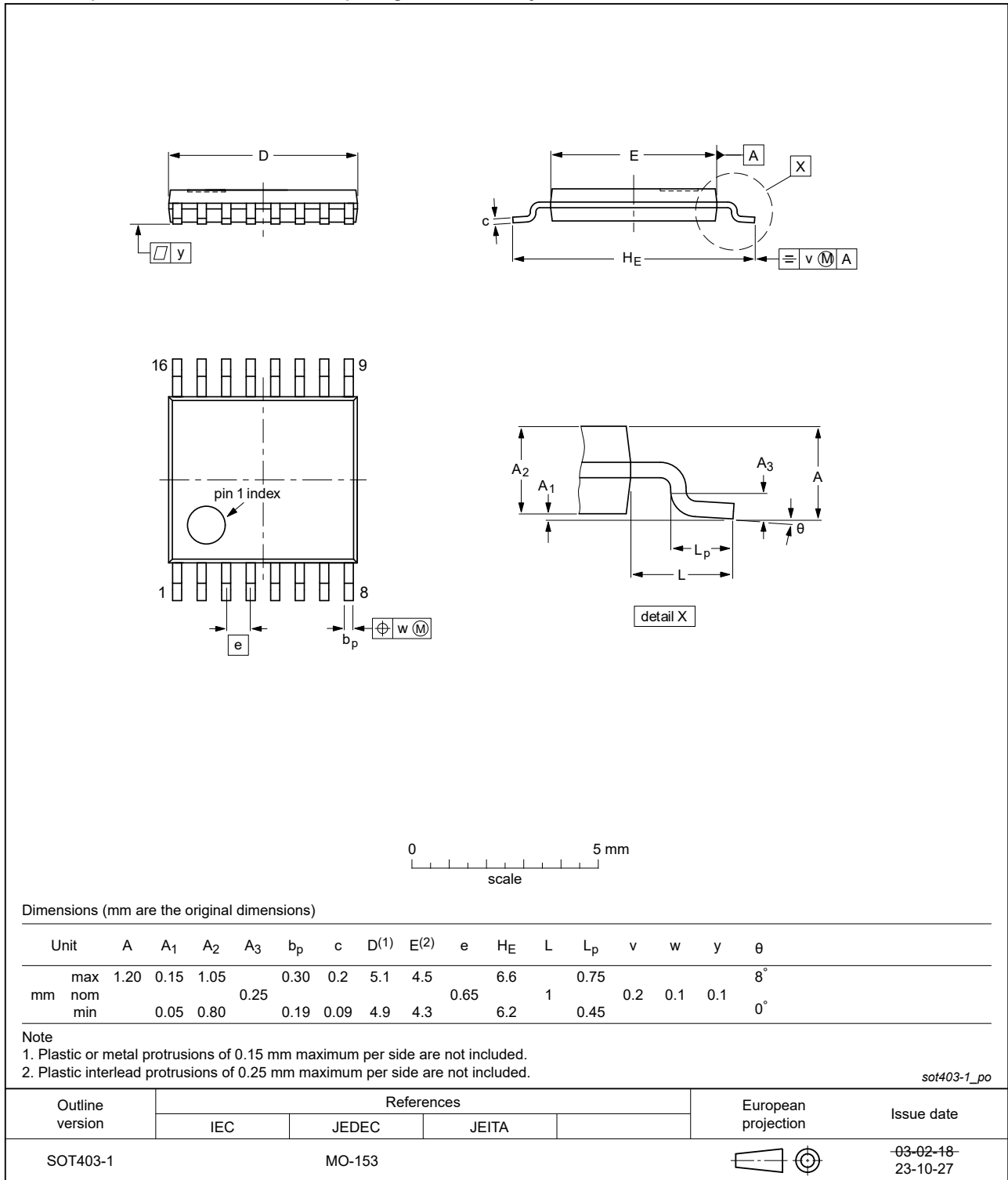


Fig. 19. Package outline SOT403-1 (TSSOP16)

13. Abbreviations

Table 10. Abbreviations

| Acronym | Description |
|---------|---|
| CDM | Charged Device Model |
| CMOS | Complementary Metal-Oxide Semiconductor |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |

14. Revision history

Table 11. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------------|---|-----------------------|---------------|----------------------|
| 74HC4538 v.7 | 20240326 | Product data sheet | - | 74HC4538 v.6 |
| Modifications: | <ul style="list-style-type: none"> • Fig. 18, Fig. 19: Aligned SO and TSSOP package outline drawings to JEDEC MS-012 and MO-153. • Section 2: ESD specification updated according to the latest JEDEC standard. | | | |
| 74HC4538 v.6 | 20210716 | Product data sheet | - | 74HC4538 v.5 |
| Modifications: | <ul style="list-style-type: none"> • Type number 74HC4538DB (SOT338-1/SSOP16) removed. • Section 2 updated. • Section 7: Derating values for P_{tot} total power dissipation updated. | | | |
| 74HC4538 v.5 | 20170317 | Product data sheet | - | 74HC_HCT4538 v.4 |
| Modifications: | <ul style="list-style-type: none"> • Type numbers 74HCT4538D, 74HCT4538DB, 74HCT4538PW removed. • Table 6: Maximum input leakage current for pins 1REXT/CEXT and 2REXT/CEXT changed. | | | |
| 74HC_HCT4538 v.4 | 20160224 | Product data sheet | - | 74HC_HCT4538 v.3 |
| Modifications: | <ul style="list-style-type: none"> • Type numbers 74HC4538N and 74HCT4538N (SOT38-4) removed. | | | |
| 74HC_HCT4538 v.3 | 20090608 | Product data sheet | - | 74HC_HCT4538_CNV v.2 |
| Modifications: | <ul style="list-style-type: none"> • The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • Legal texts have been adapted to the new company name where appropriate. • Pin names changed throughout. • Section 7, Section 8 and Section 9 added, taken from the 74HC/T HCMOS Family characteristics/specification (March 1988). • Test circuit added: Fig. 9. • Quick reference data incorporated in to Section 9 and Section 10. • Package information added for DIP16, SO16, SSOP16 and TSSOP16 packages. | | | |
| 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.
- [2] The term 'short data sheet' is explained in section "Definitions".
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