# HEF4538B

## Dual precision monostable multivibrator

Rev. 11 — 19 October 2018 Product data sheet

## 1. General description

The HEF4538B is a dual retriggerable-resettable monostable multivibrator. Each multivibrator has an active LOW trigger/retrigger input (n$\overline{A}$), an active HIGH trigger/retrigger input (nB), an overriding active LOW direct reset input (n$\overline{CD}$), an output (nQ) and its complement (n$\overline{Q}$), and two pins (nREXT/CEXT, and nCEXT, always connected to ground) for connecting the external timing components $C_{EXT}$ and $R_{EXT}$. Typical pulse width variation over the specified temperature range is ±0.2 %.

The multivibrator may be triggered by either the positive or the negative edges of the input pulse and will produce an accurate output pulse with a pulse width range of 10 µs to infinity. 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 $R_{EXT} \times C_{EXT}$. The linear design techniques in LOCMOS (Local Oxide CMOS) guarantee precise control of the output pulse width. A LOW level at n$\overline{CD}$ terminates the output pulse immediately. The trigger inputs' Schmitt trigger action makes the circuit highly tolerant of slower rise and fall times.

It operates over a recommended $V_{DD}$ power supply range of 3 V to 15 V referenced to $V_{SS}$ (usually ground). Unused inputs must be connected to $V_{DD}$, $V_{SS}$, or another input.

## 2. Features and benefits

- Tolerant of slow trigger rise and fall times
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from -40 °C to +85 °C and -40 °C to +125 °C
- Complies with JEDEC standard JESD 13-B

## 3. Ordering information

**Table 1. Ordering information**

| Type number | Package | | | |
|---|---|---|---|---|
| | Temperature range | Name | Description | Version |
| HEF4538BT | -40 °C to +125 °C | SO16 | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |

## 4. Functional diagram

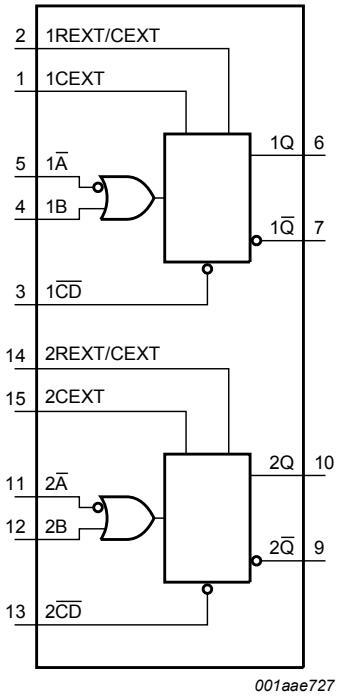



**Fig. 1. Functional diagram**

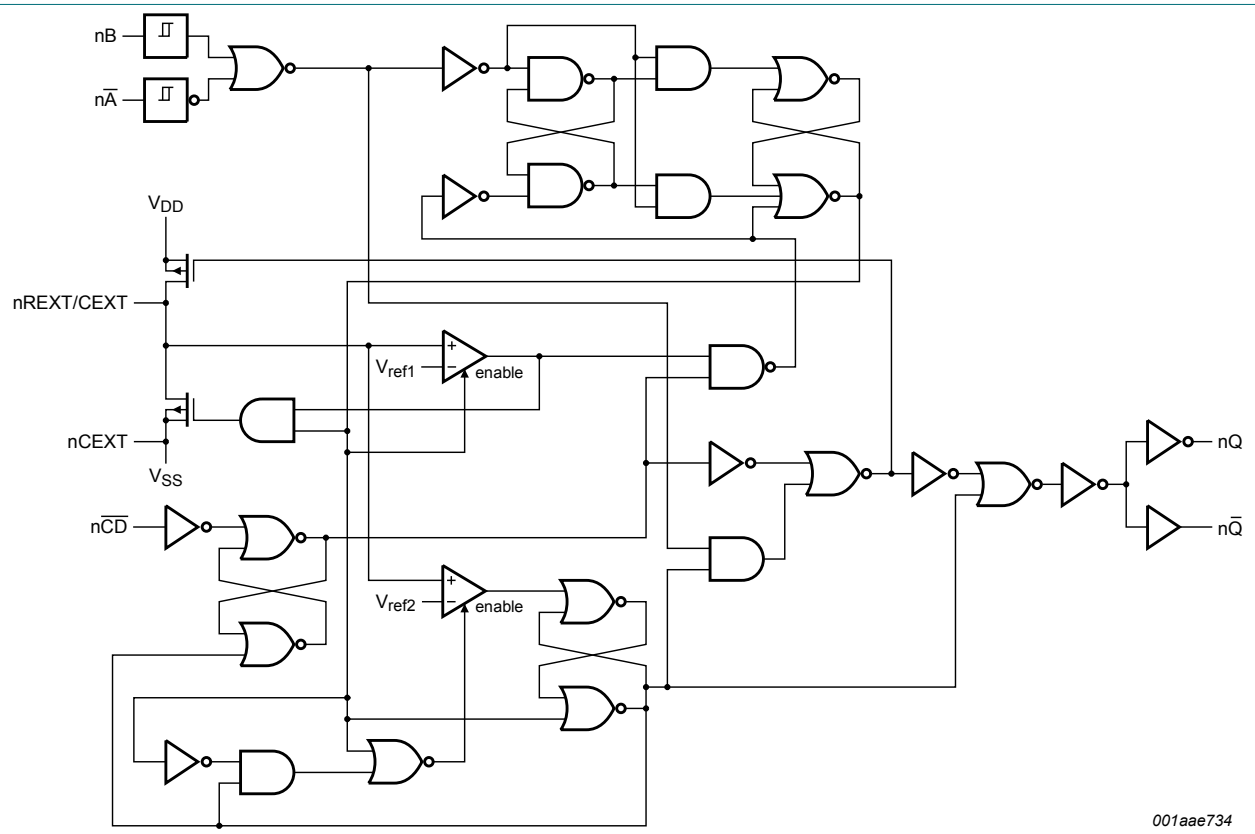



**Fig. 2. Logic diagram (one multivibrator)**

# 5. Pinning information

## 5.1. Pinning

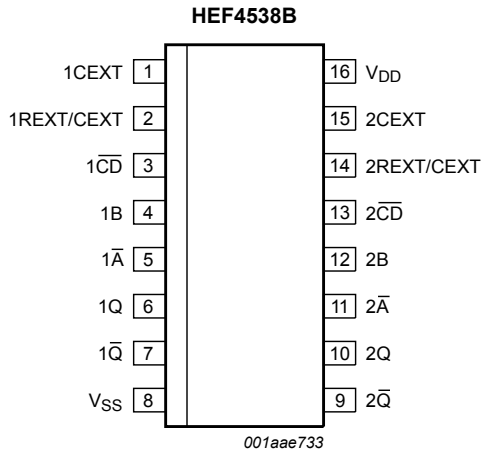



**Fig. 3. Pin configuration SOT109-1 (SO16)**

## 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) |
| $V_{SS}$ | 8 | ground supply voltage |
| $V_{DD}$ | 16 | supply voltage |

# 6. Functional description

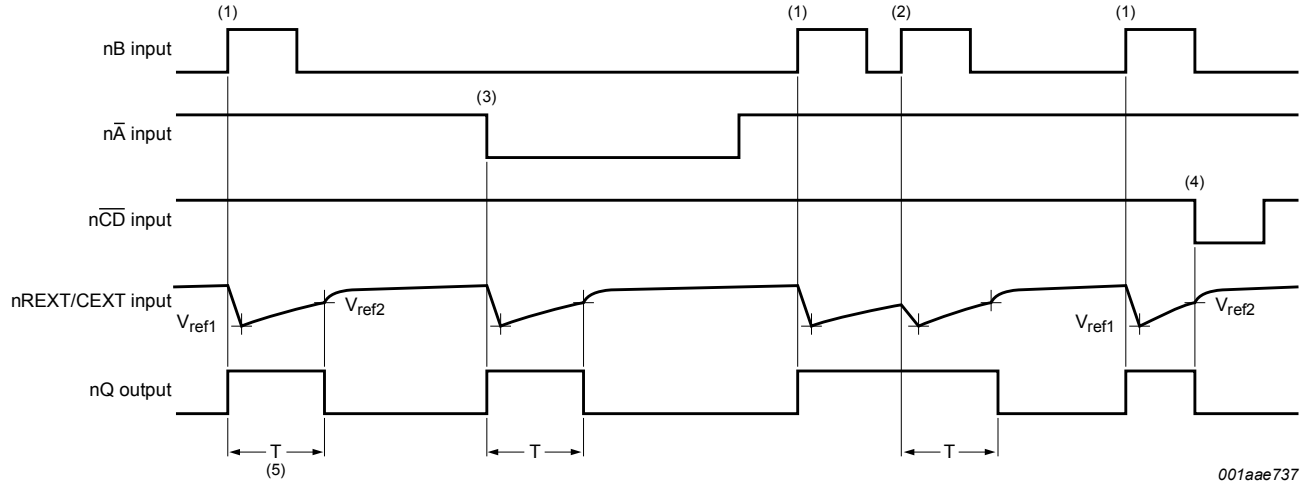
**Table 3. Function table**

*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 | |
|---|---|---|---|---|
| $n\overline{A}$ | nB | $n\overline{CD}$ | nQ | $n\overline{Q}$ |
| ↓ | L | H | ⎍ | ⎎ |
| H | ↑ | H | ⎍ | ⎎ |
| X | X | L | L | H |




(1) Positive edge triggering.
(2) Positive edge re-triggering (pulse lengthening).
(3) Negative edge triggering.
(4) Reset (pulse shortening).
(5) $T = R_{EXT} \times C_{EXT}$.

**Fig. 4. Timing diagram**

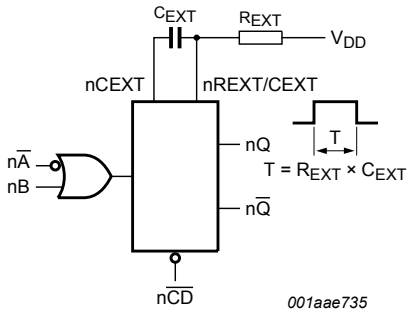



**Fig. 5. Connection of the external timing components $R_{EXT}$ and $C_{EXT}$**

# 7. Limiting values

**Table 4. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to $V_{SS}$ = 0 V (ground)*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{DD}$ | supply voltage | | -0.5 | +18 | V |
| $I_{IK}$ | input clamping current | $V_I$ < -0.5 V or $V_I$ > $V_{DD}$ + 0.5 V | - | ±10 | mA |
| $V_I$ | input voltage | | -0.5 | $V_{DD}$ + 0.5 | V |
| $I_{OK}$ | output clamping current | $V_I$ < -0.5 V or $V_I$ > $V_{DD}$ + 0.5 V | - | ±10 | mA |
| $I_{I/O}$ | input/output current | | - | ±10 | mA |
| $I_{DD}$ | supply current | | - | 50 | mA |
| $T_{stg}$ | storage temperature | | -65 | +150 | °C |
| $T_{amb}$ | ambient temperature | | -40 | +125 | °C |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = -40 °C to +125 °C [1] | - | 500 | mW |
| P | power dissipation | per output | - | 100 | mW |

[1] For SO16 package: $P_{tot}$ 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 |
|---|---|---|---|---|---|---|
| $V_{DD}$ | supply voltage | | 3 | - | 15 | V |
| $V_I$ | input voltage | | 0 | - | $V_{DD}$ | V |
| $T_{amb}$ | ambient temperature | in free air | -40 | - | +125 | °C |
| Δt/ΔV | input transition rise and fall rate | $V_{DD}$ = 5 V | - | - | 3.75 | µs/V |
| | | $V_{DD}$ = 10 V | - | - | 0.5 | µs/V |
| | | $V_{DD}$ = 15 V | - | - | 0.08 | µs/V |

# 9. Static characteristics

**Table 6. Static characteristics**

*$V_{SS}$ = 0 V; $V_I$ = $V_{SS}$ or $V_{DD}$ unless otherwise specified.*

| Symbol | Parameter | Conditions | $V_{DD}$ | $T_{amb}$ = -40 °C | | $T_{amb}$ = 25 °C | | $T_{amb}$ = 85 °C | | $T_{amb}$ = 125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Max | Min | Max | Min | Max | Min | Max | |
| $V_{IH}$ | HIGH-level input voltage | $\|I_O\|$ < 1 µA | 5 V | 3.5 | - | 3.5 | - | 3.5 | - | 3.5 | - | V |
| | | | 10 V | 7.0 | - | 7.0 | - | 7.0 | - | 7.0 | - | V |
| | | | 15 V | 11.0 | - | 11.0 | - | 11.0 | - | 11.0 | - | V |
| $V_{IL}$ | LOW-level input voltage | $\|I_O\|$ < 1 µA | 5 V | - | 1.5 | - | 1.5 | - | 1.5 | - | 1.5 | V |
| | | | 10 V | - | 3.0 | - | 3.0 | - | 3.0 | - | 3.0 | V |
| | | | 15 V | - | 4.0 | - | 4.0 | - | 4.0 | - | 4.0 | V |
| $V_{OH}$ | HIGH-level output voltage | $\|I_O\|$ < 1 µA | 5 V | 4.95 | - | 4.95 | - | 4.95 | - | 4.95 | - | V |
| | | | 10 V | 9.95 | - | 9.95 | - | 9.95 | - | 9.95 | - | V |
| | | | 15 V | 14.95 | - | 14.95 | - | 14.95 | - | 14.95 | - | V |
| $V_{OL}$ | LOW-level output voltage | $\|I_O\|$ < 1 µA | 5 V | - | 0.05 | - | 0.05 | - | 0.05 | - | 0.05 | V |
| | | | 10 V | - | 0.05 | - | 0.05 | - | 0.05 | - | 0.05 | V |
| | | | 15 V | - | 0.05 | - | 0.05 | - | 0.05 | - | 0.05 | V |
| $I_{OH}$ | HIGH-level output current | $V_O$ = 2.5 V | 5 V | - | -1.7 | - | -1.4 | - | -1.1 | - | -1.1 | mA |
| | | $V_O$ = 4.6 V | 5 V | - | -0.64 | - | -0.5 | - | -0.36 | - | -0.36 | mA |
| | | $V_O$ = 9.5 V | 10 V | - | -1.6 | - | -1.3 | - | -0.9 | - | -0.9 | mA |
| | | $V_O$ = 13.5 V | 15 V | - | -4.2 | - | -3.4 | - | -2.4 | - | -2.4 | mA |
| $I_{OL}$ | LOW-level output current | $V_O$ = 0.4 V | 5 V | 0.64 | - | 0.5 | - | 0.36 | - | 0.36 | - | mA |
| | | $V_O$ = 0.5 V | 10 V | 1.6 | - | 1.3 | - | 0.9 | - | 0.9 | - | mA |
| | | $V_O$ = 1.5 V | 15 V | 4.2 | - | 3.4 | - | 2.4 | - | 2.4 | - | mA |
| $I_I$ | input leakage current | $n\bar{A}$, nB | 15 V | - | ±0.1 | - | ±0.1 | - | ±1.0 | - | ±1.0 | µA |
| | | nREXT/CEXT | 15 V | - | ±0.3 | - | ±0.1 | - | ±1.0 | - | ±1.0 | µA |
| $C_I$ | input capacitance | | - | - | - | - | 7.5 | - | - | - | - | pF |

**Table 7. Typical static characteristics**

*$V_{SS}$ = 0 V; $V_I$ = $V_{SS}$ or $V_{DD}$; $T_{amb}$ = +25 °C.*

| Symbol | Parameter | Conditions | $V_{DD}$ | Typ | Unit |
|---|---|---|---|---|---|
| $I_{DD}$ | supply current | active state | 5 V [1] | 55 | µA |
| | | | 10 V | 150 | µA |
| | | | 15 V | 220 | µA |
| $C_I$ | input capacitance | nREXT/CEXT | - | 15 | pF |

[1] Only one monostable is switching: for the specified current during the output pulse (output nQ is HIGH).

# 10. Dynamic characteristics

**Table 8. Dynamic characteristics**

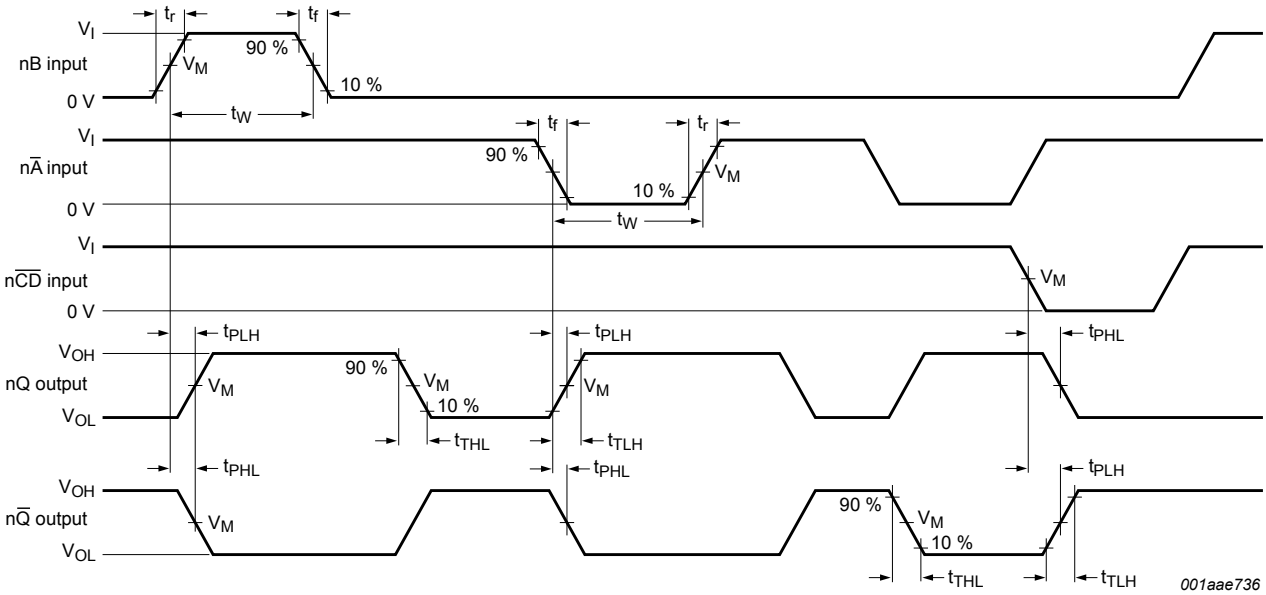
*$V_{SS}$ = 0 V; $T_{amb}$ = 25 °C; for test circuit see Fig. 11.*

| Symbol | Parameter | Conditions | $V_{DD}$ | Extrapolation formula[1] | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| $t_{PHL}$ | HIGH to LOW propagation delay | nA, nB to nQ; see Fig. 6 | 5 V | 193 ns + (0.55 ns/pF) $C_L$ | - | 220 | 440 | ns |
| | | | 10 V | 74 ns + (0.23 ns/pF) $C_L$ | - | 85 | 190 | ns |
| | | | 15 V | 52 ns + (0.16 ns/pF) $C_L$ | - | 60 | 120 | ns |
| | | nCD to nQ; see Fig. 6 | 5 V | 98 ns + (0.55 ns/pF) $C_L$ | - | 125 | 250 | ns |
| | | | 10 V | 44 ns + (0.23 ns/pF) $C_L$ | - | 55 | 110 | ns |
| | | | 15 V | 32 ns + (0.16 ns/pF) $C_L$ | - | 40 | 80 | ns |
| $t_{PLH}$ | LOW to HIGH propagation delay | nA, nB to nQ; see Fig. 6 | 5 V | 173 ns + (0.55 ns/pF) $C_L$ | - | 200 | 460 | ns |
| | | | 10 V | 79 ns + (0.23 ns/pF) $C_L$ | - | 90 | 180 | ns |
| | | | 15 V | 52 ns + (0.16 ns/pF) $C_L$ | - | 60 | 120 | ns |
| | | nCD to nQ; see Fig. 6 | 5 V | 98 ns + (0.55 ns/pF) $C_L$ | - | 125 | 250 | ns |
| | | | 10 V | 44 ns + (0.23 ns/pF) $C_L$ | - | 55 | 110 | ns |
| | | | 15 V | 32 ns + (0.16 ns/pF) $C_L$ | - | 40 | 80 | ns |
| $t_t$ | transition time | see Fig. 6 | 5 V [2] | 10 ns + (1.00 ns/pF) $C_L$ | - | 60 | 120 | ns |
| | | | 10 V | 9 ns + (0.42 ns/pF) $C_L$ | - | 30 | 60 | ns |
| | | | 15 V | 6 ns + (0.28 ns/pF) $C_L$ | - | 20 | 40 | ns |
| $t_{rec}$ | recovery time | nCD to nA, nB; see Fig. 7 | 5 V | | - | 20 | 40 | ns |
| | | | 10 V | | - | 10 | 20 | ns |
| | | | 15 V | | - | 5 | 10 | ns |
| $t_{rtrig}$ | retrigger time | nQ, nQ to nA, nB; see Fig. 7 | 5 V | | 0 | - | - | ns |
| | | | 10 V | | 0 | - | - | ns |
| | | | 15 V | | 0 | - | - | ns |

| Symbol | Parameter | Conditions | $V_{DD}$ | Extrapolation formula[1] | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| $t_W$ | pulse width | $n\overline{A}$ LOW; minimum width; see Fig. 7 | 5 V | | 90 | 45 | - | ns |
| | | | 10 V | | 30 | 15 | - | ns |
| | | | 15 V | | 24 | 12 | - | ns |
| | | nB HIGH;minimum width; see Fig. 7 | 5 V | | 50 | 25 | - | ns |
| | | | 10 V | | 24 | 12 | - | ns |
| | | | 15 V | | 20 | 10 | - | ns |
| | | $n\overline{CD}$ LOW; minimum width; see Fig. 7 | 5 V | | 55 | 25 | - | ns |
| | | | 10 V | | 25 | 12 | - | ns |
| | | | 15 V | | 20 | 10 | - | ns |
| | | nQ or $n\overline{Q}$; $R_{EXT}$ = 100 kΩ; $C_{EXT}$ =2.0 nF; see Fig. 7 | 5 V | | 218 | 230 | 242 | µs |
| | | | 10 V | | 213 | 224 | 235 | µs |
| | | | 15 V | | 211 | 223 | 234 | µs |
| | | nQ or $n\overline{Q}$ ; $R_{EXT}$ = 100 kΩ; $C_{EXT}$ = 0.1 µF; see Fig. 7 | 5 V | | 10.3 | 10.8 | 11.3 | ms |
| | | | 10 V | | 10.2 | 10.7 | 11.2 | ms |
| | | | 15 V | | 10.1 | 10.6 | 11.1 | ms |
| | | nQ or $n\overline{Q}$; $R_{EXT}$ = 100 kΩ; $C_{EXT}$ = 10 µF; see Fig. 7 | 5 V | | 1.01 | 1.09 | 1.11 | s |
| | | | 10 V | | 0.99 | 1.04 | 1.09 | s |
| | | | 15 V | | 0.99 | 1.04 | 1.09 | s |
| $\Delta t_W$ | pulse width variation | nQ or $n\overline{Q}$ variation over temperature range; see Fig. 8 | 5 V | | - | ±0.2 | - | % |
| | | | 10 V | | - | ±0.2 | - | % |
| | | | 15 V | | - | ±0.2 | - | % |
| | | nQ or $n\overline{Q}$ variation over $V_{DD}$ voltage range 5 V to 15 V; see Fig. 9 | | | - | ±1.5 | - | % |
| | | nQ or $n\overline{Q}$ variation between monostables in the same device; $R_{EXT}$ = 100 kΩ; $C_{EXT}$ = 2 nF to 10 µF | 5 V | | - | ±1 | - | % |
| | | | 10 V | | - | ±1 | - | % |
| | | | 15 V | | - | ±1 | - | % |
| $R_{EXT}$ | external timing resistor | | | | 5 | - | [3] | kΩ |
| $C_{EXT}$ | external timing capacitor | | | | 2000 | - | no limits | pF |

[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown ($C_L$ in pF).
[2] $t_t$ is the same as $t_{THL}$ and $t_{TLH}$.
[3] The maximum permissible resistance $R_{EXT}$, which holds the specified accuracy of $t_W$ (nQ, $n\overline{Q}$ output), depends on the leakage current of the capacitor $C_{EXT}$ and the leakage current of the HEF4538B.

## 10.1. Waveforms and test circuit



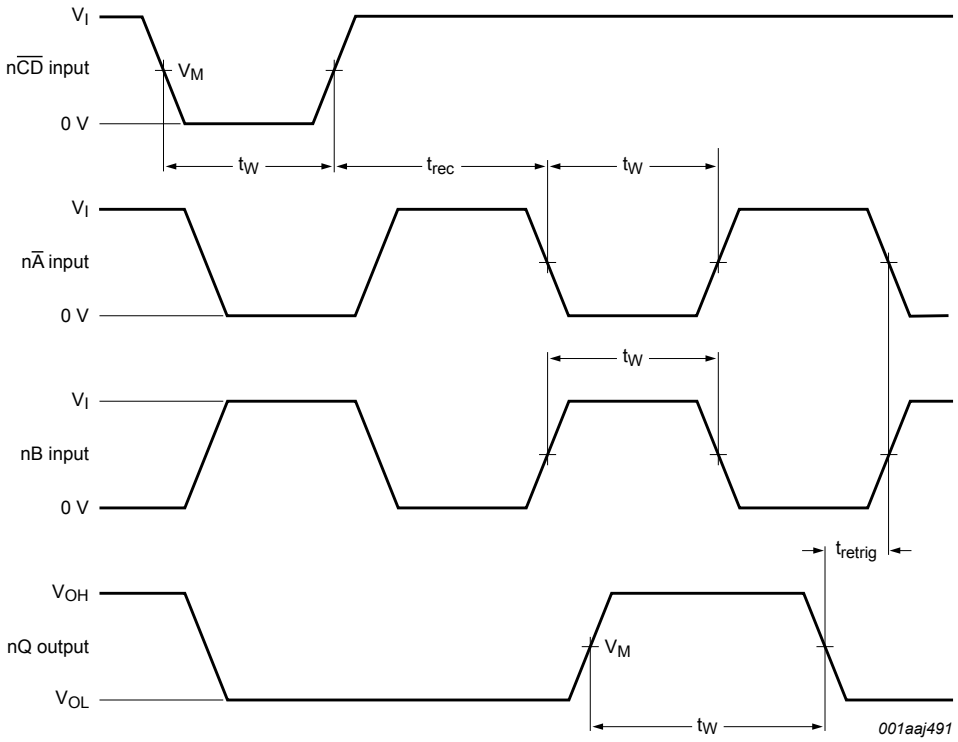

Measurement points are given in Table 9.

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

**Fig. 6. Waveforms showing propagation delays**

**Table 9. Measurement points**

| Supply voltage | Input | Output |
|---|---|---|
| $V_{DD}$ | $V_M$ | $V_M$ |
| 5 V to 15 V | $0.5V_{DD}$ | $0.5V_{DD}$ |

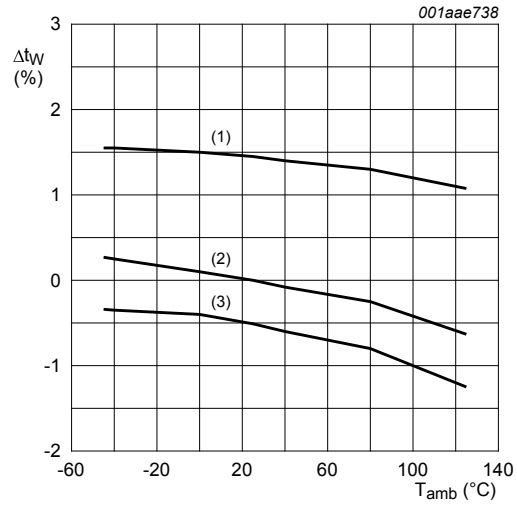



Measurement points are given in Table 9.

Recovery times are shown as positive values but may be specified as negative values.

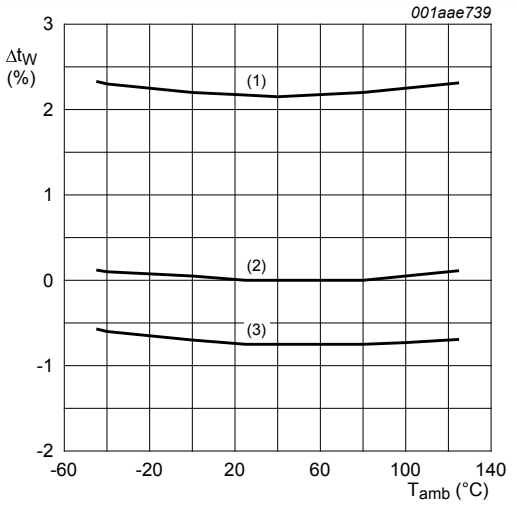
Logic levels: $V_{OL}$ and $V_{OH}$ are typical output levels that occur with the output load.

**Fig. 7. Waveforms showing minimum nCD, nA, nB, and nQ pulse widths, recovery and retrigger times**




a. $R_{EXT}$ = 100 kΩ; $C_{EXT}$ = 100 nF

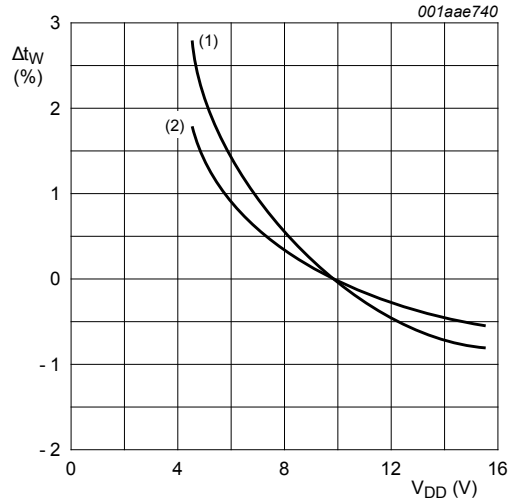
(1) $V_{DD}$ = 5 V
(2) $V_{DD}$ = 10 V
(3) $V_{DD}$ = 15 V
$\Delta t_W$ = 0 % at $V_{DD}$ = 10 V and $T_{amb}$ = 25 °C




b. $R_{EXT}$ = 100 kΩ; $C_{EXT}$ = 2 nF

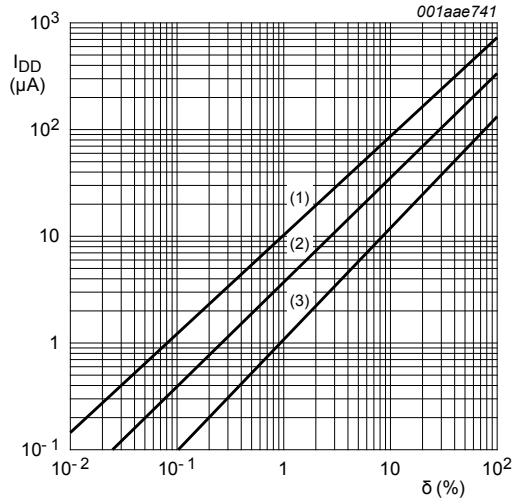
(1) $V_{DD}$ = 5 V
(2) $V_{DD}$ = 10 V
(3) $V_{DD}$ = 15 V
$\Delta t_W$ = 0 % at $V_{DD}$ = 10 V and $T_{amb}$ = 25 °C

**Fig. 8. Typical normalized change in output pulse width as a function of ambient temperature**



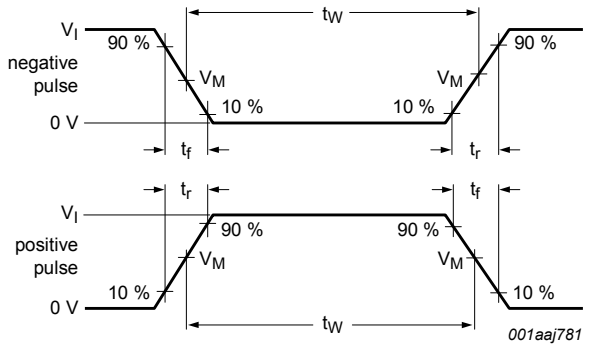

$T_{amb}$ = 25 °C; $\Delta t_W$ = 0 % at $V_{DD}$ = 10 V; $R_{EXT}$ = 100 kΩ
(1) $C_{EXT}$ = 2 nF
(2) $C_{EXT}$ = 100 nF

**Fig. 9. Typical normalized change in output pulse width as a function of the supply voltage**

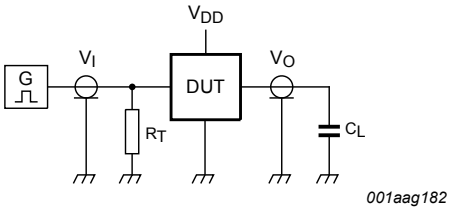



$R_{EXT}$ = 100 kΩ; $C_{EXT}$ = 100 nF; $C_L$ = 50 pF; one monostable multivibrator switching only
(1) $V_{DD}$ = 15 V
(2) $V_{DD}$ = 10 V
(3) $V_{DD}$ = 5 V

**Fig. 10. Total supply current as a function of the output duty factor**




a. Input waveforms




b. Test circuit

Test data is given in Table 10.
Definitions for test circuit:
DUT = Device Under Test.
$C_L$ = load capacitance including jig and probe capacitance.
$R_T$ = termination resistance should be equal to the output impedance $Z_o$ of the pulse generator.

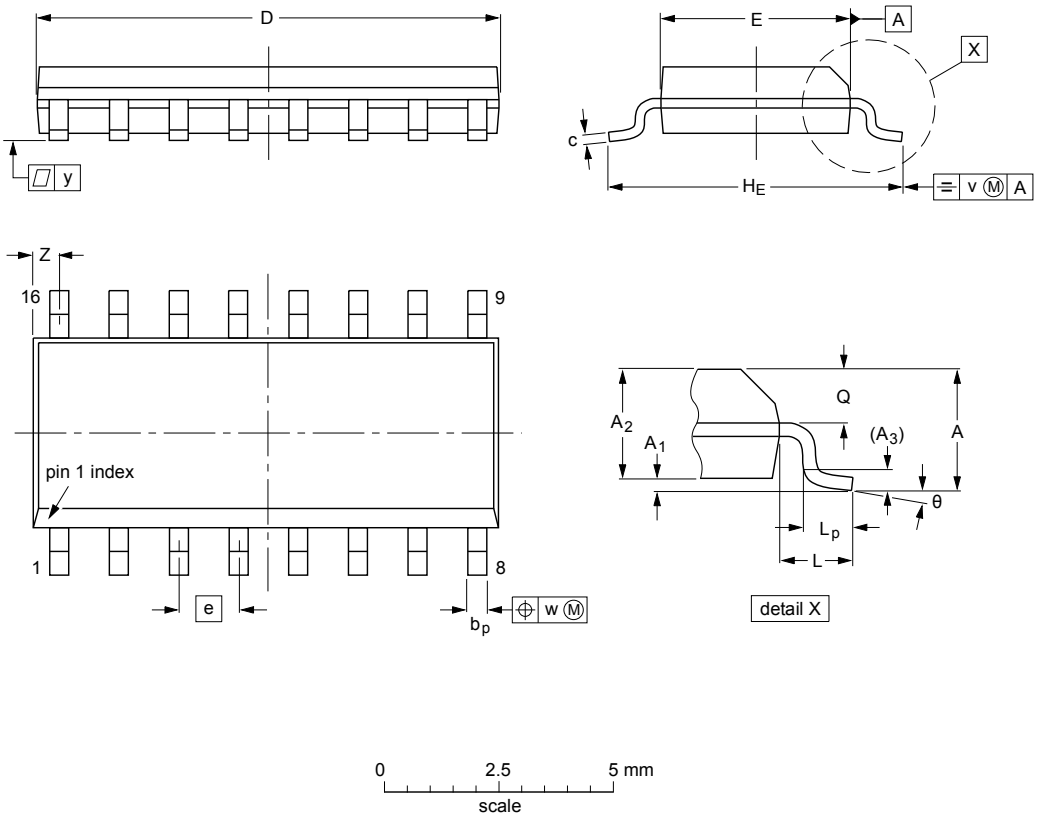
**Fig. 11. Test circuit for measuring switching times**

**Table 10. Test data**

| Supply voltage | Input | | Load |
|---|---|---|---|
| $V_{DD}$ | $V_I$ | $t_r$, $t_f$ | $C_L$ |
| 5 V to 15 V | $V_{SS}$ or $V_{DD}$ | ≤ 20 ns | 50 pF |

# 11. 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. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_E$ | L | $L_p$ | Q | v | w | y | $Z^{(1)}$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.75 | 0.25<br>0.10 | 1.45<br>1.25 | 0.25 | 0.49<br>0.36 | 0.25<br>0.19 | 10.0<br>9.8 | 4.0<br>3.8 | 1.27 | 6.2<br>5.8 | 1.05 | 1.0<br>0.4 | 0.7<br>0.6 | 0.25 | 0.25 | 0.1 | 0.7<br>0.3 | $8^o$<br>$0^o$ |
| inches | 0.069 | 0.010<br>0.004 | 0.057<br>0.049 | 0.01 | 0.019<br>0.014 | 0.0100<br>0.0075 | 0.39<br>0.38 | 0.16<br>0.15 | 0.05 | 0.244<br>0.228 | 0.041 | 0.039<br>0.016 | 0.028<br>0.020 | 0.01 | 0.01 | 0.004 | 0.028<br>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~~<br>03-02-19 |

**Fig. 12. Package outline SOT109-1 (SO16)**

## 12. Abbreviations

**Table 11. Abbreviations**

| Acronym | Description |
|---|---|
| CMOS | Complementary Metal-Oxide Semiconductor |
| DUT | Device Under Test |

## 13. Revision history

**Table 12. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| HEF4538B v.11 | 20181019 | Product data sheet | - | HEF4538B v.10 |
| Modifications: | • The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.<br>• Legal texts have been adapted to the new company name where appropriate. | | | |
| HEF4538B v.10 | 20160401 | Product data sheet | - | HEF4538B v.9 |
| Modifications: | • Type number HEF4538BP (SOT38-4) removed. | | | |
| HEF4538B v.9 | 20131210 | Product data sheet | - | HEF4538B v.8 |
| Modifications: | • Fig. 8 and Fig. 9 updated to show output pulse width over full temperature range. | | | |
| HEF4538B v.8 | 20111116 | Product data sheet | - | HEF4538B v.7 |
| HEF4538B v.7 | 20110217 | Product data sheet | - | HEF4538B v.6 |
| HEF4538B v.6 | 20091102 | Product data sheet | - | HEF4538B v.5 |
| HEF4538B v.5 | 20090304 | Product data sheet | - | HEF4538B v.4 |
| HEF4538B v.4 | 20090206 | Product data sheet | - | HEF4538B_CNV v.3 |
| HEF4538B_CNV v.3 | 19950101 | Product specification | - | HEF4538B_CNV v.2 |
| HEF4538B_CNV v.2 | 19950101 | Product specification | - | - |

# 14. 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".
[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 https://www.nexperia.com.

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