

# HEF4538B-Q100

## Dual precision monostable multivibrator

Rev. 4 — 4 March 2022

Product data sheet

## 1. General description

The HEF4538B-Q100 is a dual retriggerable-resettable monostable multivibrator. Each multivibrator has an active LOW trigger/retrigger input ( $n\bar{A}$ ), an active HIGH trigger/retrigger input ( $nB$ ), an overriding active LOW direct reset input ( $n\bar{CD}$ ), an output ( $nQ$ ) and its complement ( $n\bar{Q}$ ), 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  $\pm 0.2\%$ .

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  $\mu$ s 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  $n\bar{CD}$  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.

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
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Wide supply voltage range from 3.0 V to 15.0 V
- CMOS low power dissipation
- High noise immunity
- Standardized symmetrical output characteristics
- ESD protection:
  - MIL-STD-883, method 3015 exceeds 2000 V
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V ( $C = 200\text{ pF}$ ;  $R = 0\text{ }\Omega$ )
- Complies with JEDEC standard JESD 13-B

## 3. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
HEF4538BT-Q100	$-40\text{ }^\circ\text{C}$ to $+125\text{ }^\circ\text{C}$	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

### 4. Functional diagram

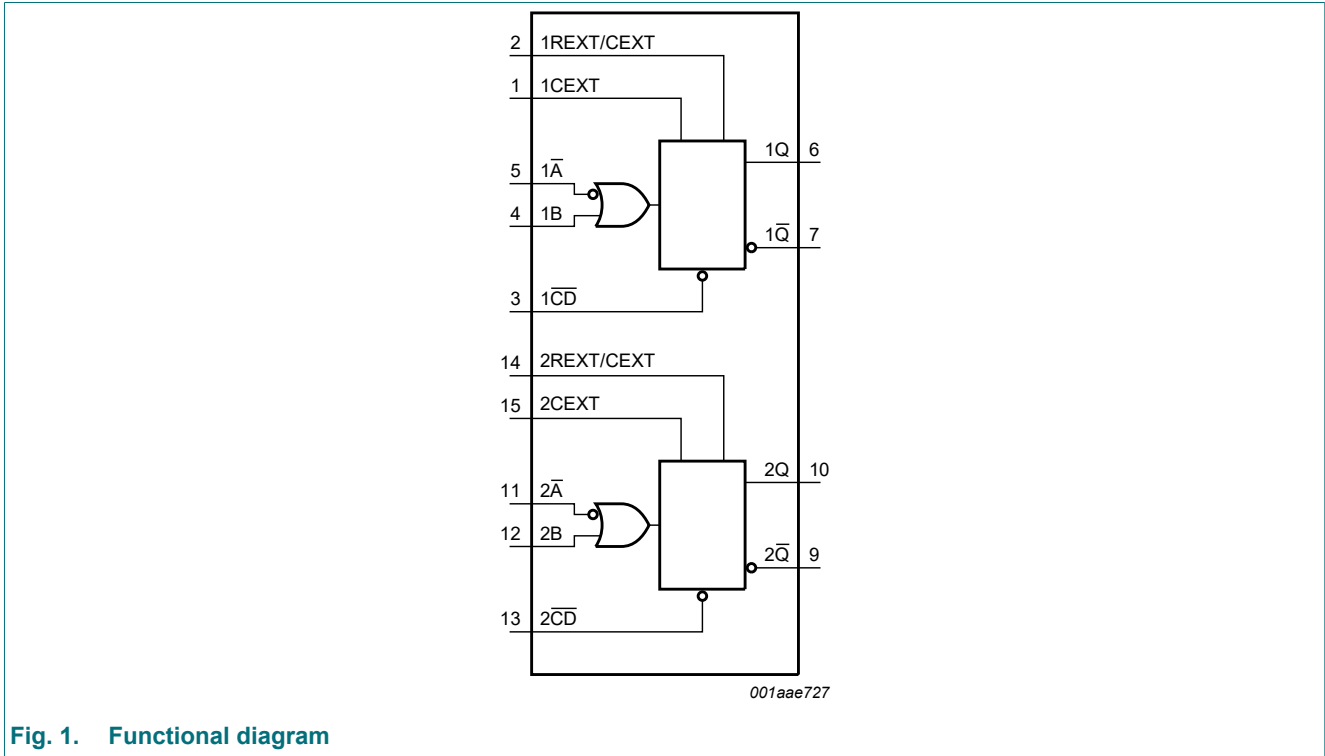


Fig. 1. Functional diagram

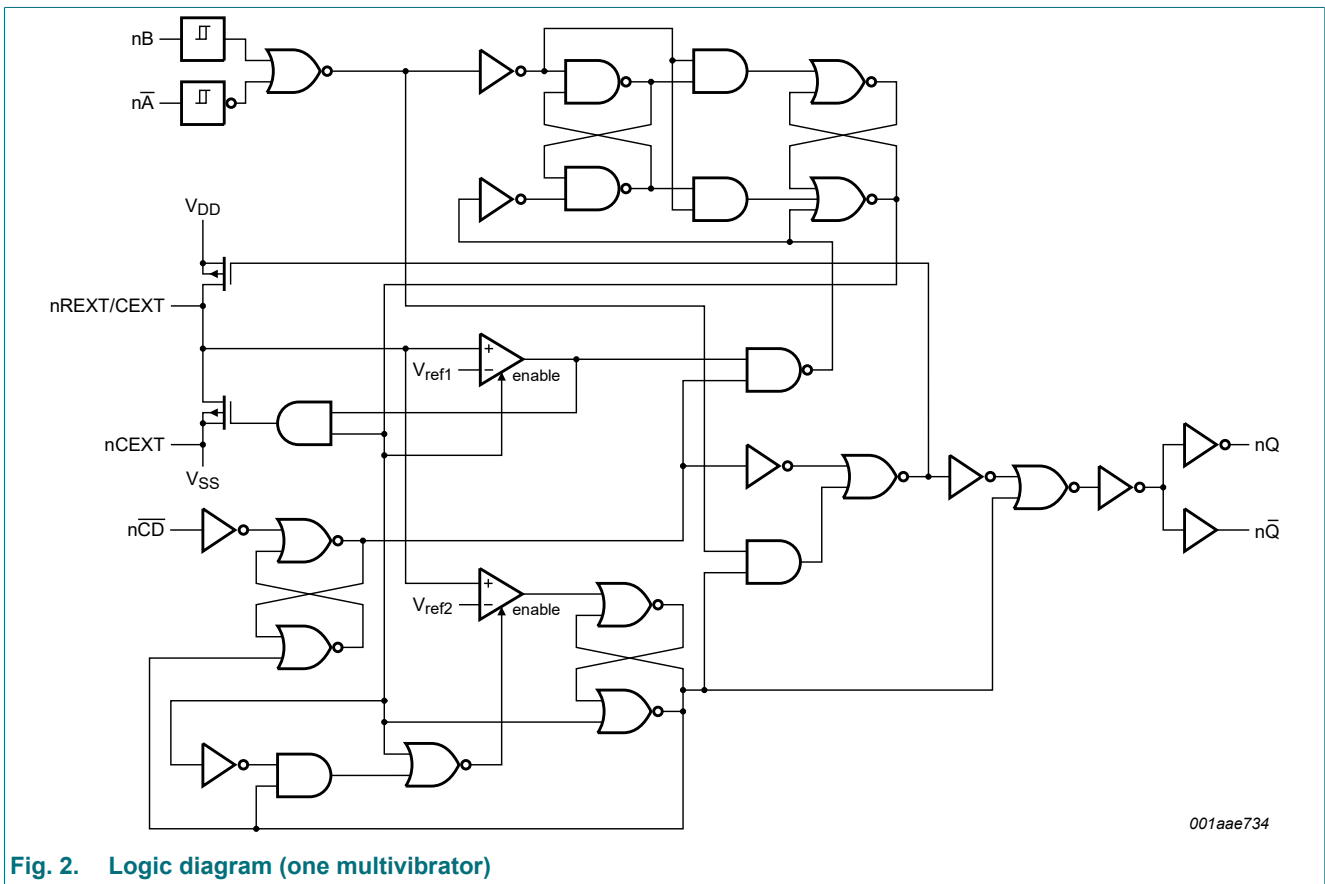


Fig. 2. Logic diagram (one multivibrator)

## 5. Pinning information

### 5.1. Pinning

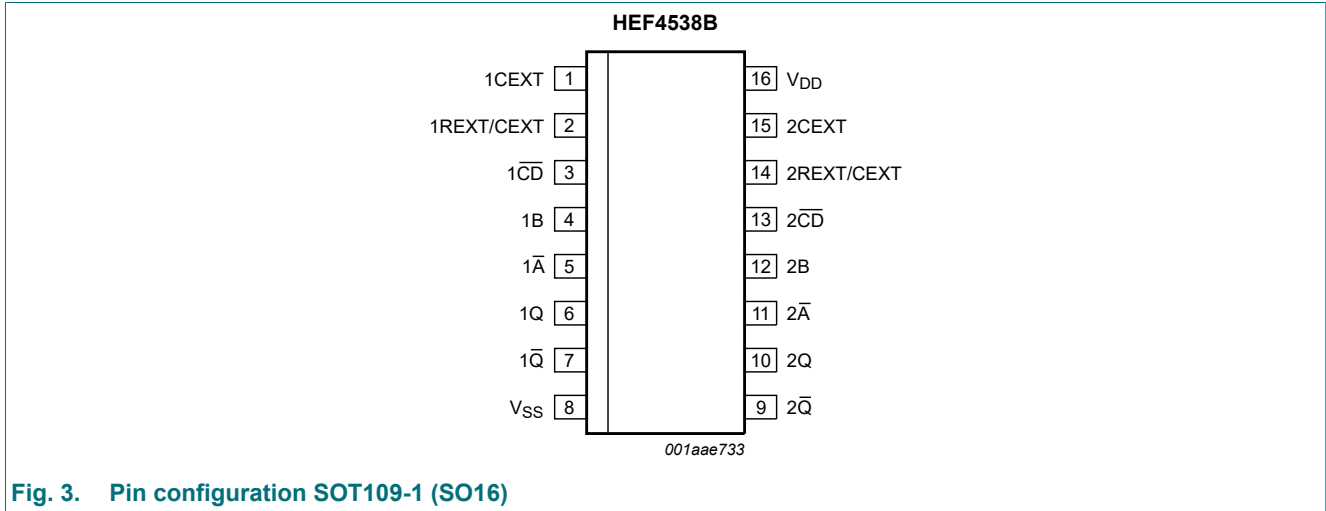


Fig. 3. Pin configuration SOT109-1 (SO16)

### 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
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)
V <sub>SS</sub>	8	ground supply voltage
V <sub>DD</sub>	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

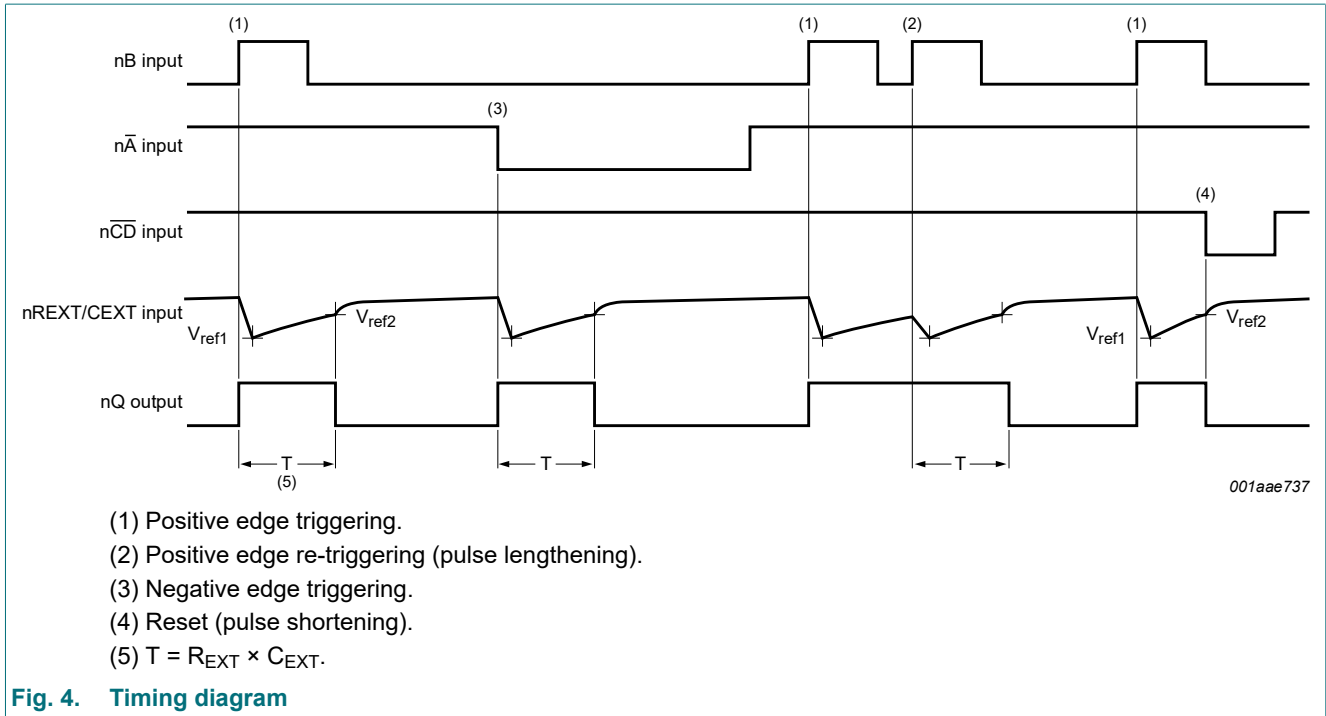


Fig. 4. Timing diagram

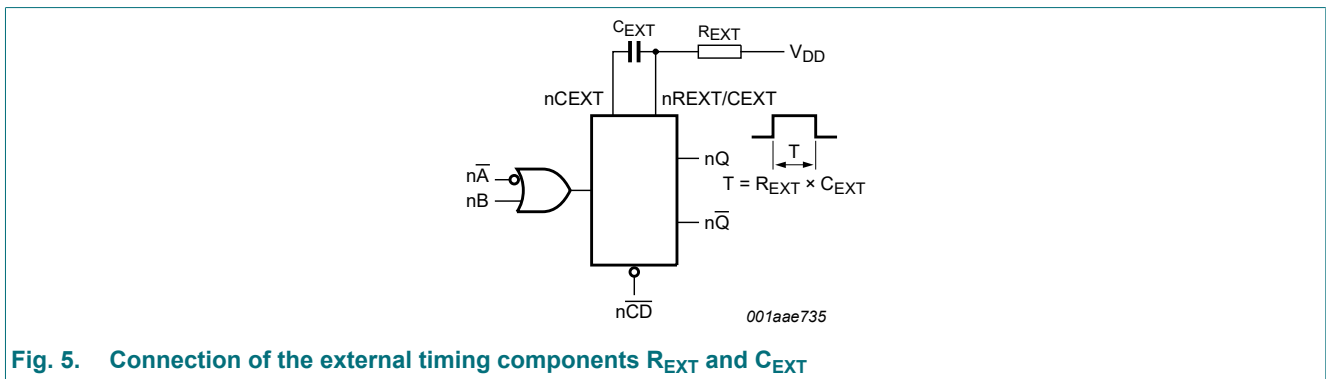


Fig. 5. Connection of the external timing components  $R_{EXT}$  and  $C_{EXT}$

## 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	-	$\pm 10$	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	-	$\pm 10$	mA
$I_{I/O}$	input/output current		-	$\pm 10$	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 SOT109-1 (SO16) package:  $P_{tot}$  derates linearly with 12.4 mW/K above 110 °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
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{DD} = 5\text{ V}$	-	-	3.75	$\mu\text{s/V}$
		$V_{DD} = 10\text{ V}$	-	-	0.5	$\mu\text{s/V}$
		$V_{DD} = 15\text{ V}$	-	-	0.08	$\mu\text{s/V}$

## 9. Static characteristics

Table 6. Static characteristics

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

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

Table 7. Typical static characteristics

 $V_{SS} = 0\text{ V}$ ;  $V_I = V_{SS}$  or  $V_{DD}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ .

Symbol	Parameter	Conditions	$V_{DD}$	Typ	Unit
$I_{DD}$	supply current	active state	5 V [1]	55	$\mu\text{A}$
			10 V	150	$\mu\text{A}$
			15 V	220	$\mu\text{A}$
$C_I$	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

 $V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$ ; 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	n $\bar{A}$ , nB to n $\bar{Q}$ ; see Fig. 6	5 V	$193\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	220	440	ns
			10 V	$74\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	85	190	ns
			15 V	$52\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	60	120	ns
		n $\bar{C}\bar{D}$ to nQ; see Fig. 6	5 V	$98\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	125	250	ns
			10 V	$44\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	55	110	ns
			15 V	$32\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	40	80	ns
$t_{PLH}$	LOW to HIGH propagation delay	n $\bar{A}$ , nB to nQ; see Fig. 6	5 V	$173\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	200	460	ns
			10 V	$79\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	90	180	ns
			15 V	$52\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	60	120	ns
		n $\bar{C}\bar{D}$ to n $\bar{Q}$ ; see Fig. 6	5 V	$98\text{ ns} + (0.55\text{ ns/pF}) C_L$	-	125	250	ns
			10 V	$44\text{ ns} + (0.23\text{ ns/pF}) C_L$	-	55	110	ns
			15 V	$32\text{ ns} + (0.16\text{ ns/pF}) C_L$	-	40	80	ns
$t_t$	transition time	see Fig. 6	5 V [2]	$10\text{ ns} + (1.00\text{ ns/pF}) C_L$	-	60	120	ns
			10 V	$9\text{ ns} + (0.42\text{ ns/pF}) C_L$	-	30	60	ns
			15 V	$6\text{ ns} + (0.28\text{ ns/pF}) C_L$	-	20	40	ns
$t_{rec}$	recovery time	n $\bar{C}\bar{D}$ to n $\bar{A}$ , nB; see Fig. 7	5 V		-	20	40	ns
			10 V		-	10	20	ns
			15 V		-	5	10	ns
$t_{trig}$	retrigger time	nQ, n $\bar{Q}$ to n $\bar{A}$ , nB; see Fig. 7	5 V		0	-	-	ns
			10 V		0	-	-	ns
			15 V		0	-	-	ns

## Dual precision monostable multivibrator

Symbol	Parameter	Conditions	V <sub>DD</sub>	Extrapolation formula[1]	Min	Typ	Max	Unit	
t <sub>w</sub>	pulse width	n $\bar{A}$ 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 $\bar{C}\bar{D}$ LOW; minimum width; see Fig. 7	5 V		55	25	-	ns	
			10 V		25	12	-	ns	
			15 V		20	10	-	ns	
		nQ or n $\bar{Q}$ ; R <sub>EXT</sub> = 100 k $\Omega$ ; C <sub>EXT</sub> = 2.0 nF; see Fig. 7	5 V		218	230	242	$\mu$ s	
			10 V		213	224	235	$\mu$ s	
			15 V		211	223	234	$\mu$ s	
		nQ or n $\bar{Q}$ ; R <sub>EXT</sub> = 100 k $\Omega$ ; C <sub>EXT</sub> = 0.1 $\mu$ F; 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 $\bar{Q}$ ; R <sub>EXT</sub> = 100 k $\Omega$ ; C <sub>EXT</sub> = 10 $\mu$ F; 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 <sub>w</sub>	pulse width variation	nQ or n $\bar{Q}$ variation over temperature range; see Fig. 8	5 V		-	$\pm$ 0.2	-	%	
			10 V		-	$\pm$ 0.2	-	%	
			15 V		-	$\pm$ 0.2	-	%	
		nQ or n $\bar{Q}$ variation over V <sub>DD</sub> voltage range 5 V to 15 V; see Fig. 9			-	$\pm$ 1.5	-	%	
			nQ or n $\bar{Q}$ variation between monostables in the same device; R <sub>EXT</sub> = 100 k $\Omega$ ; C <sub>EXT</sub> = 2 nF to 10 $\mu$ F	5 V		-	$\pm$ 1	-	%
				10 V		-	$\pm$ 1	-	%
15 V		-		$\pm$ 1	-	%			
R <sub>EXT</sub>	external timing resistor				5	-	[3]	k $\Omega$	
C <sub>EXT</sub>	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<sub>L</sub> in pF).

[2] t<sub>i</sub> is the same as t<sub>THL</sub> and t<sub>TLH</sub>.

[3] The maximum permissible resistance R<sub>EXT</sub>, which holds the specified accuracy of t<sub>w</sub> (nQ, n $\bar{Q}$  output), depends on the leakage current of the capacitor C<sub>EXT</sub> and the leakage current of the HEF4538B.

10.1. Waveforms and test circuit

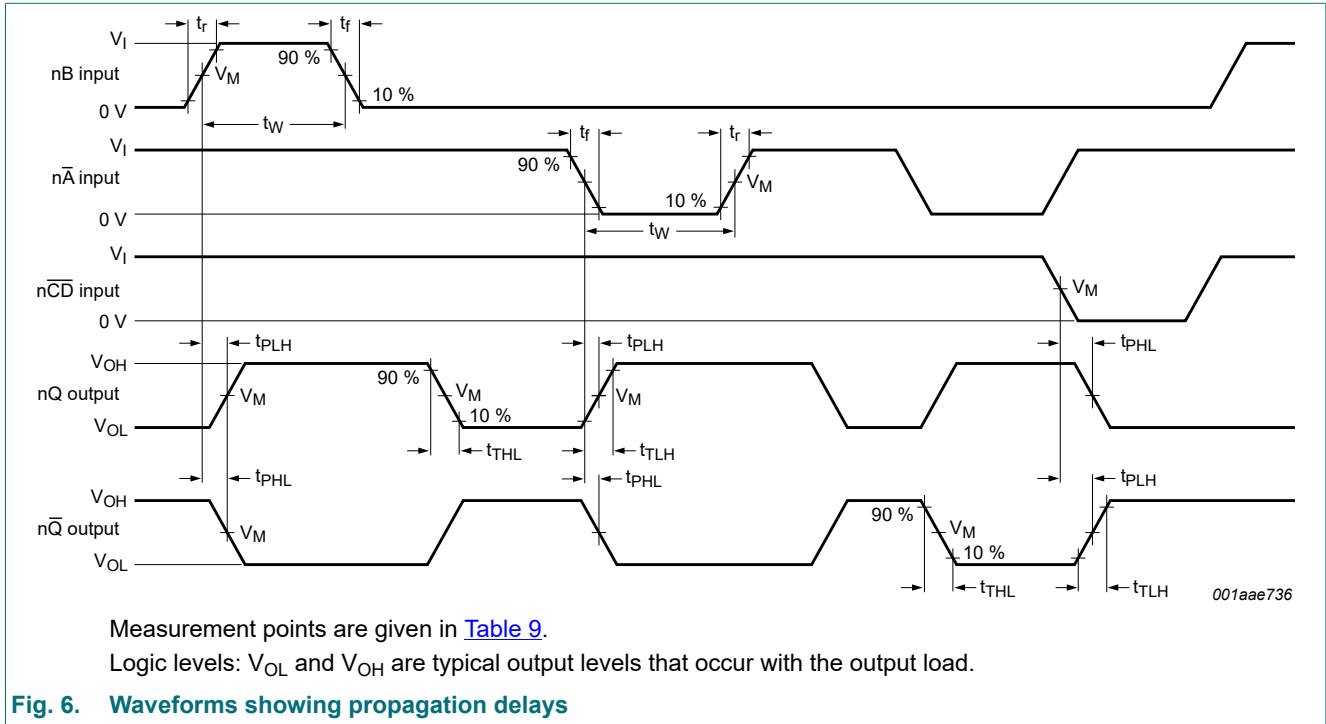
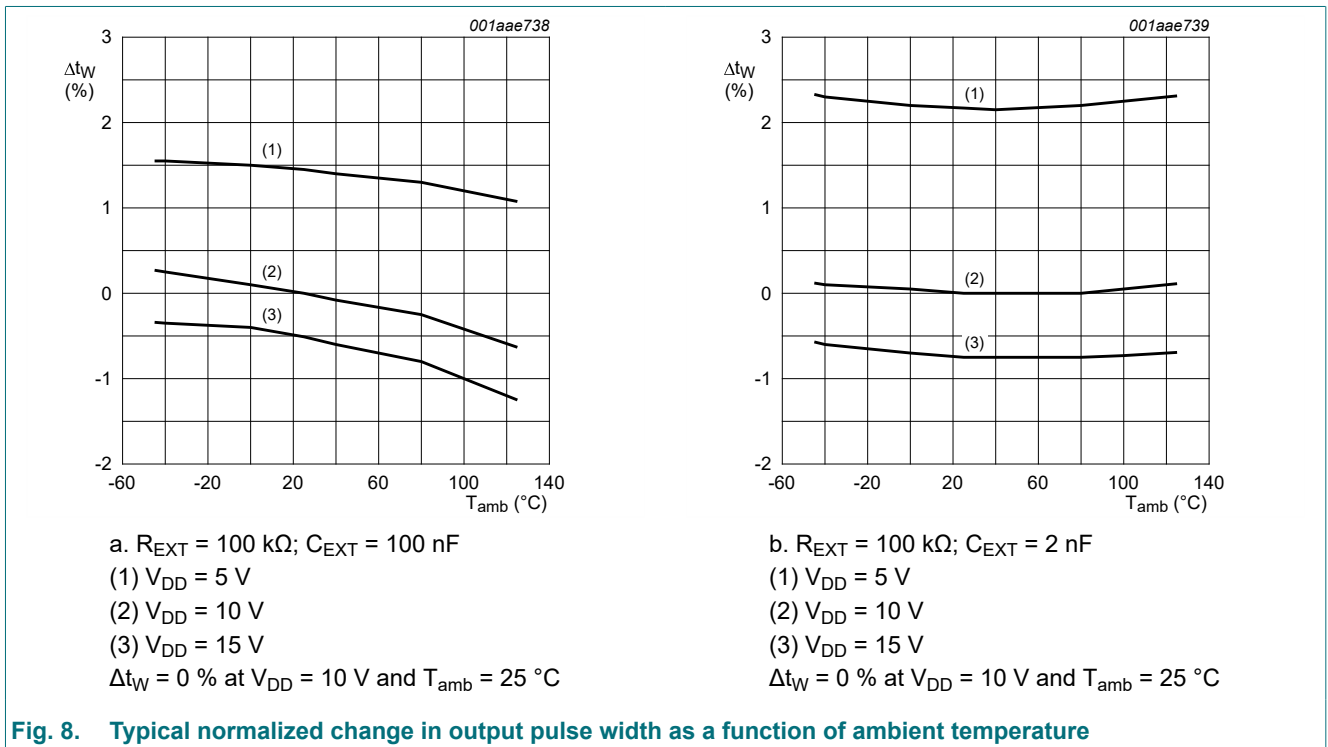
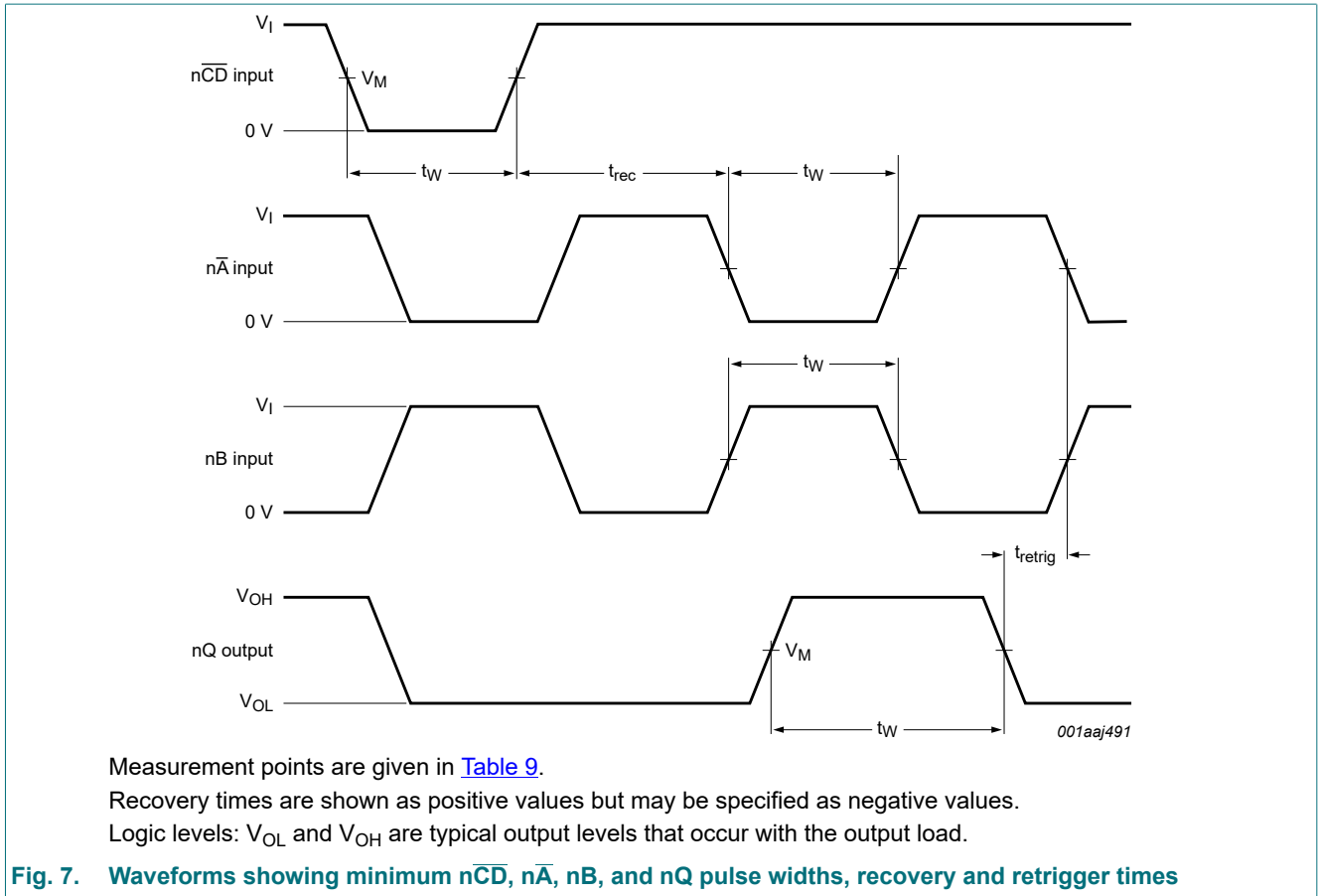


Table 9. Measurement points

Supply voltage	Input	Output
$V_{DD}$	$V_M$	$V_M$
5 V to 15 V	$0.5 \times V_{DD}$	$0.5 \times V_{DD}$





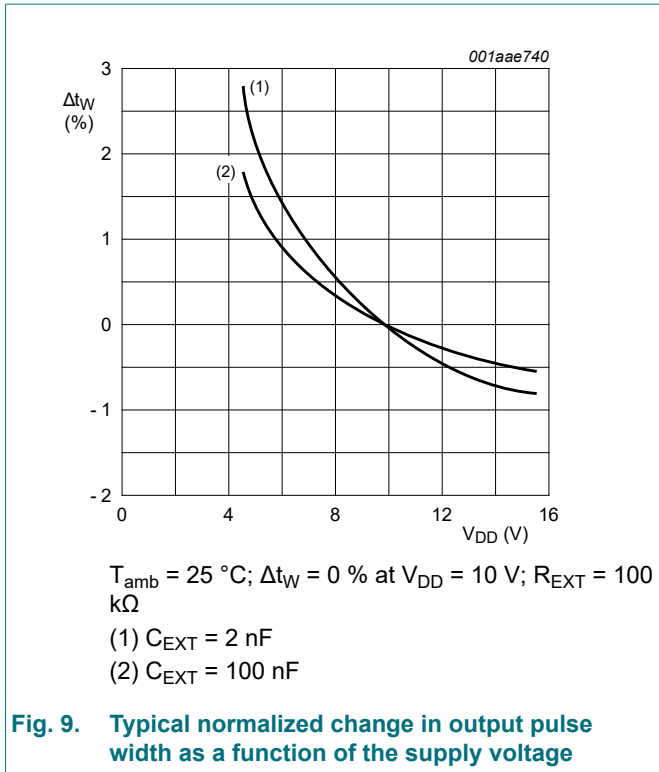


Fig. 9. Typical normalized change in output pulse width as a function of the supply voltage

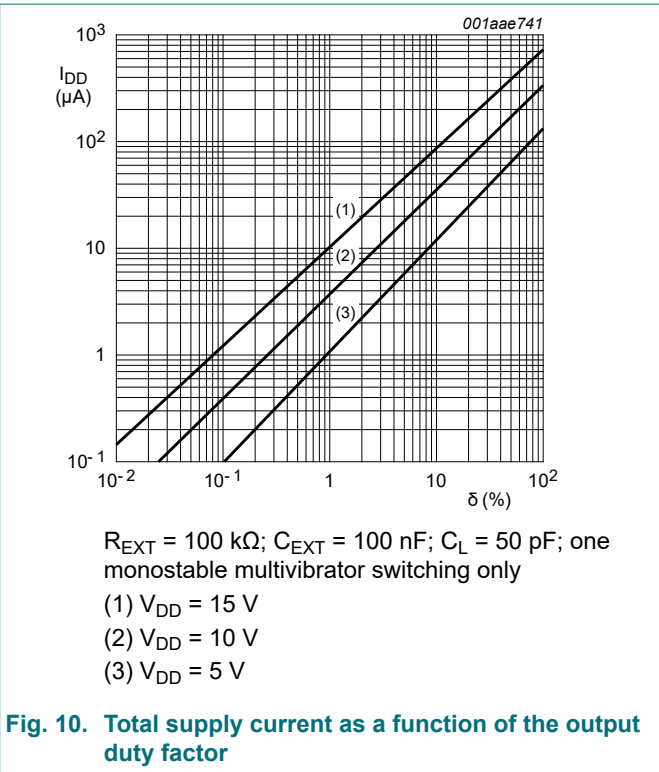


Fig. 10. Total supply current as a function of the output duty factor

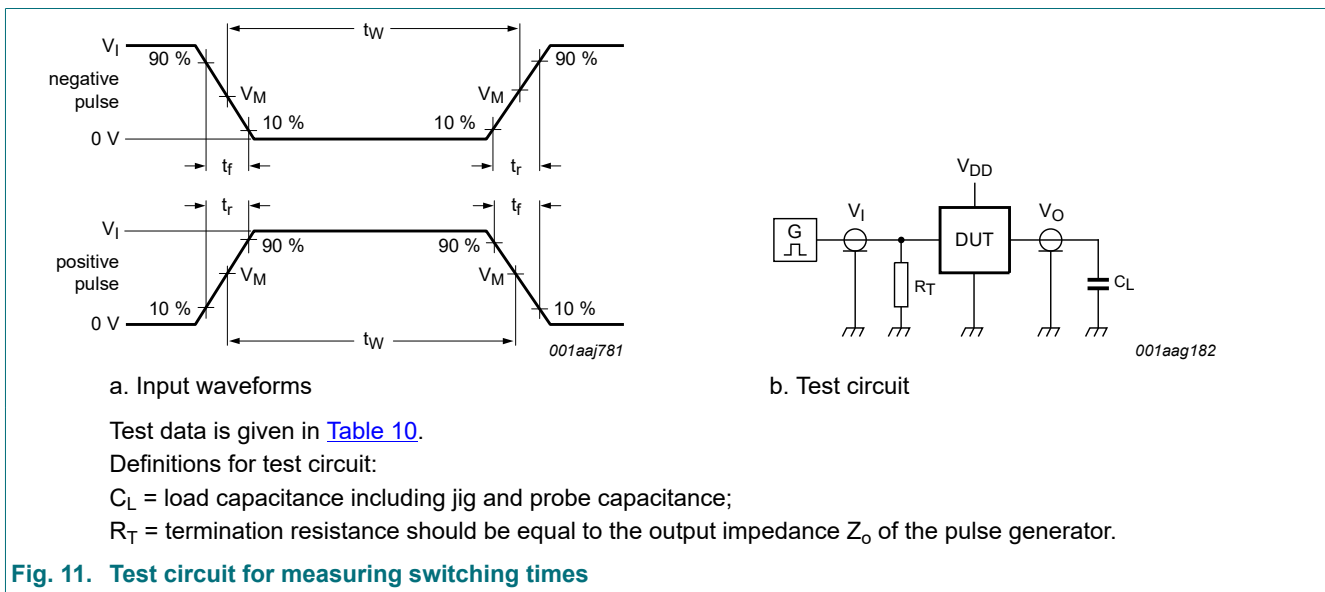


Fig. 11. Test circuit for measuring switching times

Table 10. Test data

Supply voltage	Input	Load
$V_{DD}$	$V_I$	$C_L$
5 V to 15 V	$V_{SS}$ or $V_{DD}$	50 pF

11. Package outline

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

SOT109-1

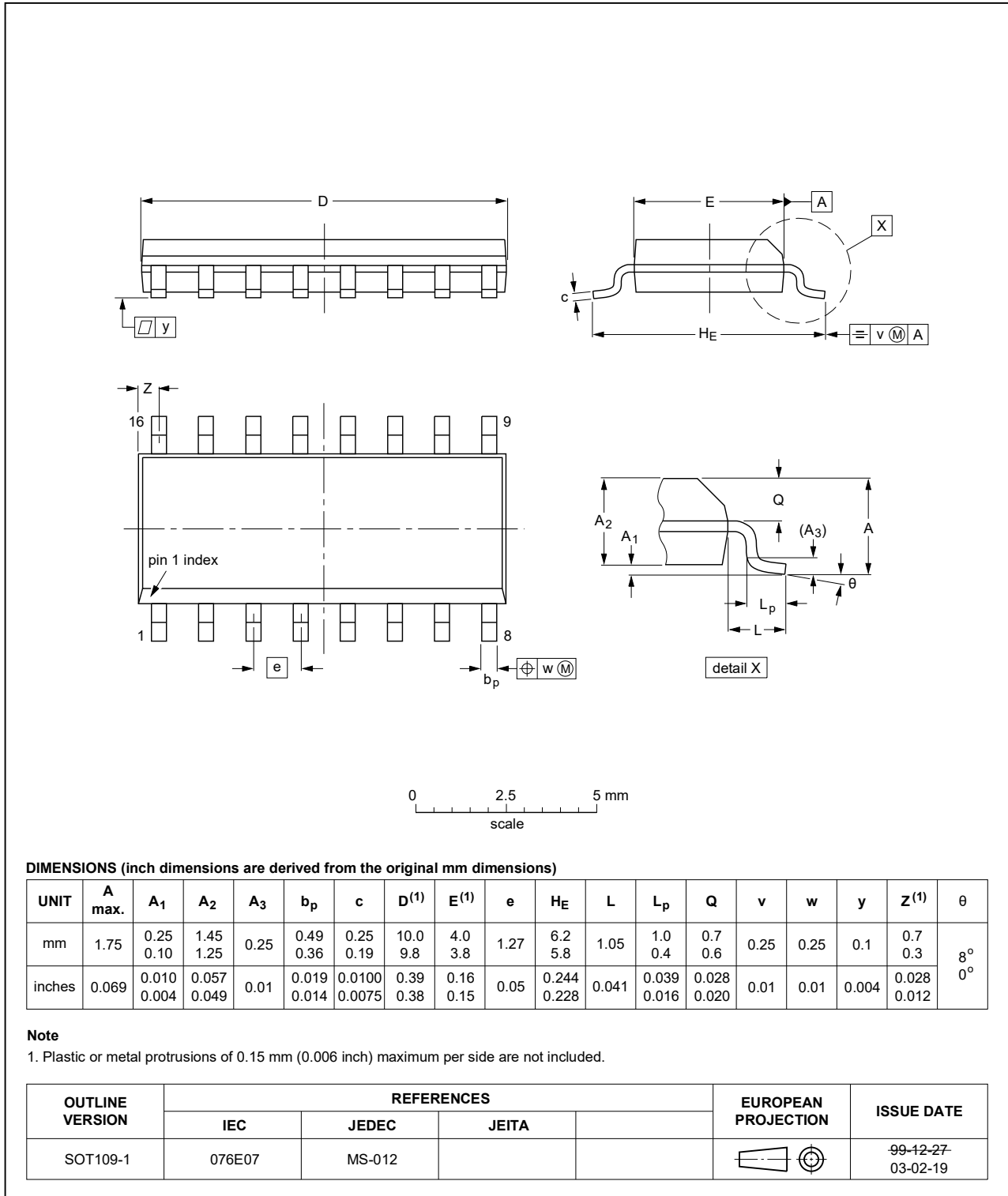


Fig. 12. Package outline SOT109-1 (SO16)

## 12. Abbreviations

Table 11. Abbreviations

Acronym	Description
CDM	Charged Device Model
CMOS	Complementary Metal Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
LOCMOS	Local Oxide Complementary Metal Oxide Semiconductor
MIL	Military
MM	Machine Model

## 13. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4538B_Q100 v.4	20220304	Product data sheet	-	HEF4538B_Q100 v.3
Modifications:	<ul style="list-style-type: none"> <li>• <a href="#">Section 2</a> updated.</li> </ul>			
HEF4538B_Q100 v.3	20181019	Product data sheet	-	HEF4538B_Q100 v.2
Modifications:	<ul style="list-style-type: none"> <li>• The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li> <li>• Legal texts have been adapted to the new company name where appropriate.</li> </ul>			
HEF4538B_Q100 v.2	20131210	Product data sheet	-	HEF4538B_Q100 v.1
Modifications:	<ul style="list-style-type: none"> <li>• <a href="#">Fig. 8</a> and <a href="#">Fig. 9</a> updated to show output pulse width over full temperature range.</li> </ul>			
HEF4538B_Q100 v.1	20130228	Product data sheet	-	-

## 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".
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