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HEF4538B-Q100

Dual precision monostable multivibrator

Rev. 2 — 10 December 2013 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 ($n\overline{A}$) and an active HIGH trigger/retrigger input (nB). It has an overriding active LOW direct reset input ($n\overline{CD}$) and an output (nQ) together with its complement ($n\overline{Q}$). There are also two pins for connecting the external timing components C_{ext} and R_{ext}. These pins, nREXT/CEXT, and nCEXT, are always connected to ground. Typical pulse width variation over the specified temperature range is ±0.2 %.

Either the positive or the negative edges of the input pulse can trigger the multivibrator. The trigger produces an accurate output pulse with a pulse width range of 10 μs to infinity. The external timing components C_{ext} and R_{ext} determine the duration and accuracy of the output pulse. 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 Schmitt trigger action of the trigger inputs, 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 °C to +85 °C and from −40 °C to +125 °C
- Tolerant of slow trigger rise and fall times
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- 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 pF, R = 0 Ω)
- Complies with JEDEC standard JESD 13-B

3. Ordering information

Table 1. Ordering information

All types operate from −40 °C to +125 °C.

Type number	Package		
	Name	Description	Version
HEF4538BT-Q100	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

4. Functional diagram

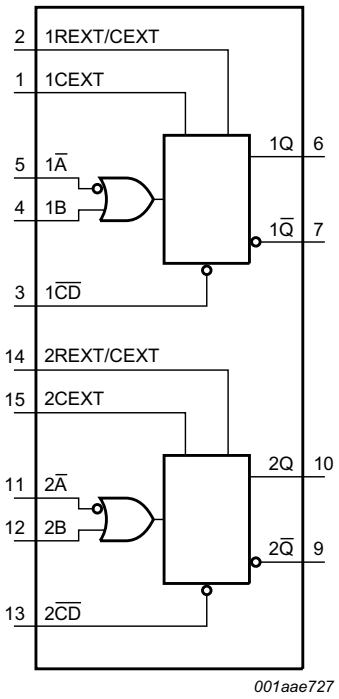


Fig 1. Functional diagram

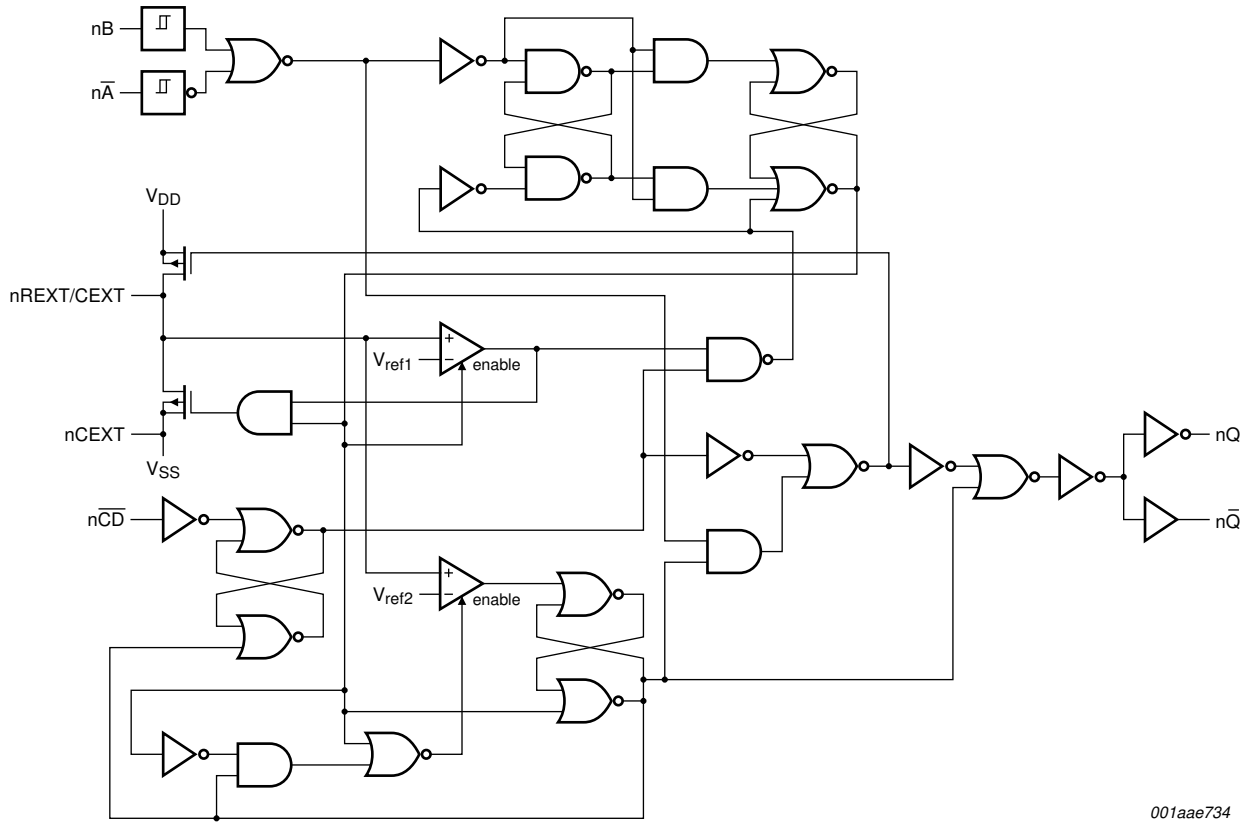


Fig 2. Logic diagram (one multivibrator)

5. Pinning information

5.1 Pinning

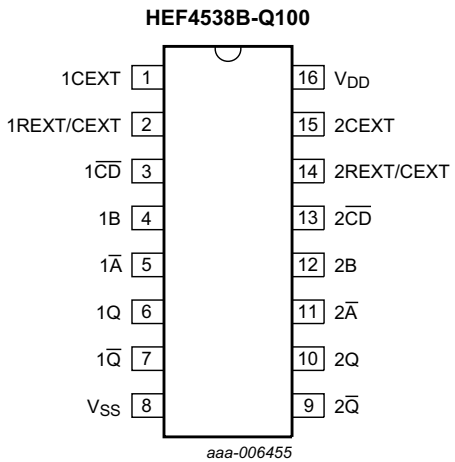


Fig 3. Pin configuration

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

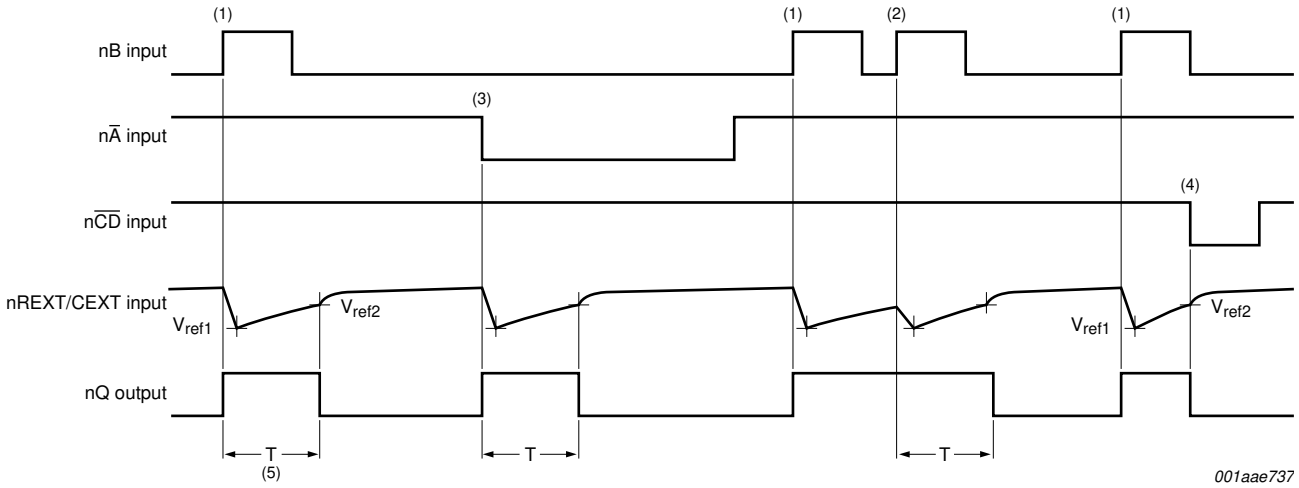
Table 3. Function table

Inputs			Outputs	
$n\overline{A}$	nB	$n\overline{CD}$	nQ	$n\overline{Q}$
↓	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_{ext} and R_{ext};

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



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

Fig 4. Timing diagram

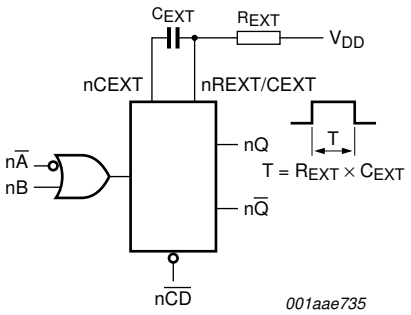


Fig 5. Connection of the external timing components R_{ext} and C_{ext}

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

Table 4. Limiting values *...continued*

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
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
$\Delta t/\Delta V$	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

Table 6. Static characteristics *...continued*

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	
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	nA, 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 Figure 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 Figure 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 Figure 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 Figure 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 Figure 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 Figure 6	5 V	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 Figure 7	5 V		-	20	40	ns
			10 V		-	10	20	ns
			15 V		-	5	10	ns

Table 8. Dynamic characteristics *...continued*

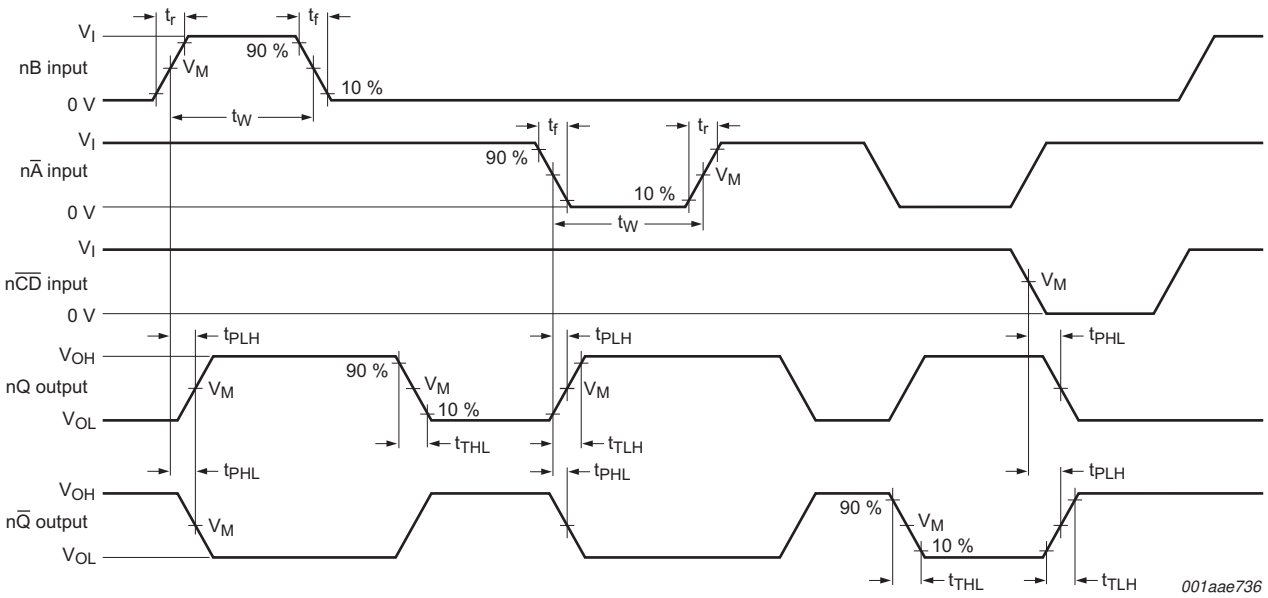
V_{SS} = 0 V; T_{amb} = 25 °C; for test circuit see Figure 11.

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula[1]	Min	Typ	Max	Unit
t_{rtrig}	retrigger time	nQ, n$\overline{Q}$ to n$\overline{A}$, nB; see Figure 7	5 V		0	-	-	ns
			10 V		0	-	-	ns
			15 V		0	-	-	ns
t_W	pulse width	n$\overline{A}$ LOW; minimum width; see Figure 7	5 V		90	45	-	ns
			10 V		30	15	-	ns
			15 V		24	12	-	ns
		nB HIGH; minimum width; see Figure 7	5 V		50	25	-	ns
			10 V		24	12	-	ns
			15 V		20	10	-	ns
		n$\overline{CD}$ LOW; minimum width; see Figure 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 Figure 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 Figure 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 Figure 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
Δt_W	pulse width variation	nQ or n$\overline{Q}$ variation over temperature range; see Figure 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 Figure 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 resistance				5	-	[2]	kΩ
C_{ext}	external capacitance				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] 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 of the HEF4538B-Q100.

11. Waveforms



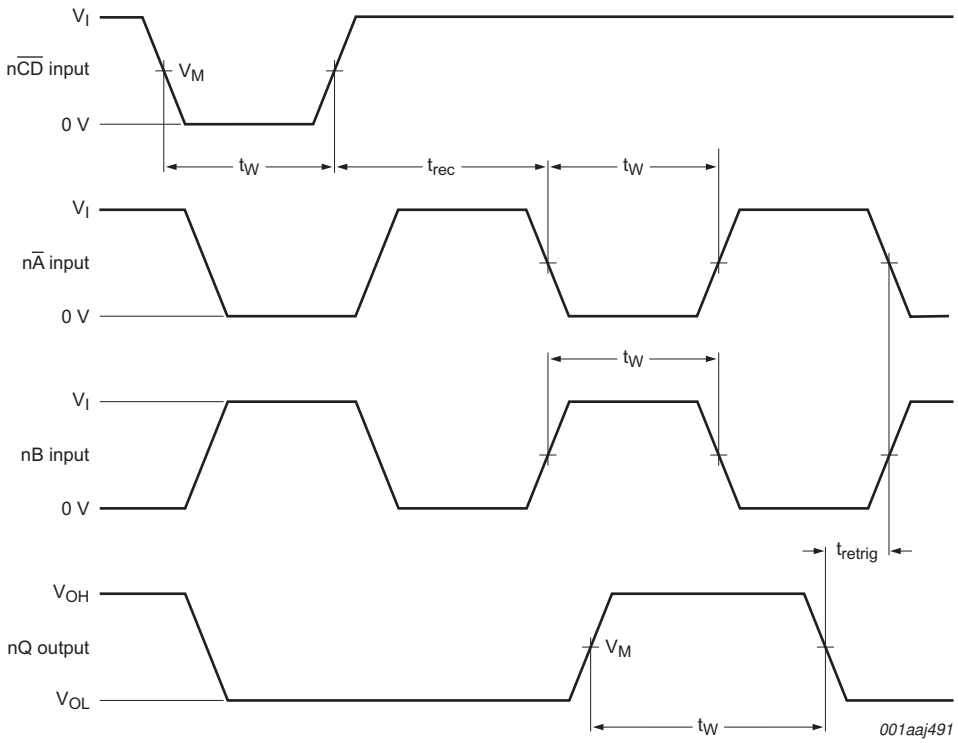
Measurement points are given in Table 9.

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	$0.5V_{DD}$	$0.5V_{DD}$

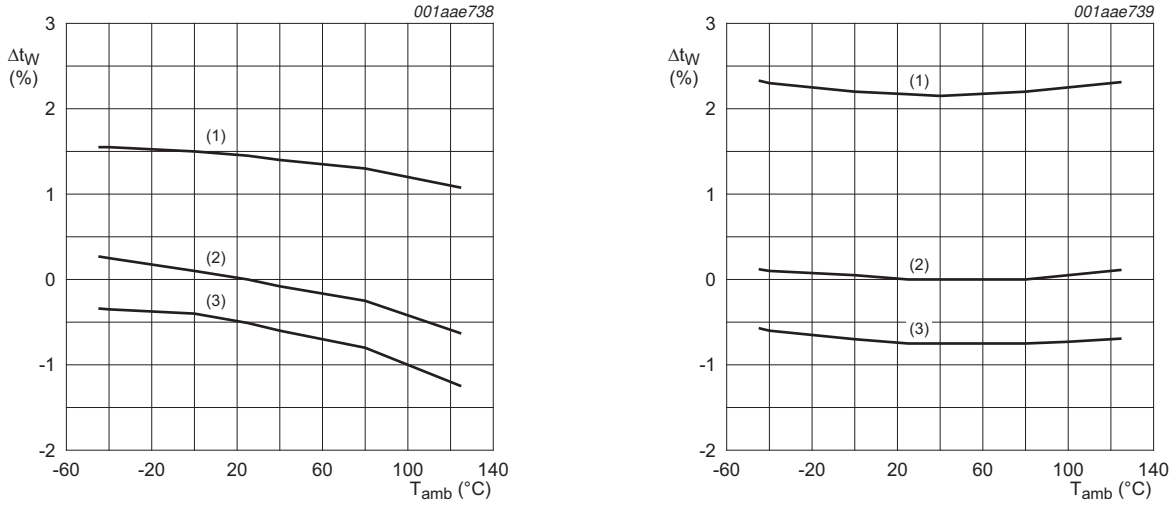


Measurement points are given in Table 9.

Set-up and 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 $n\overline{A}$, nB, and nQ pulse widths and set-up, recovery and retrigger times



a. R_{ext} = 100 kΩ; C_{ext} = 100 nF

b. R_{ext} = 100 kΩ; C_{ext} = 2 nF

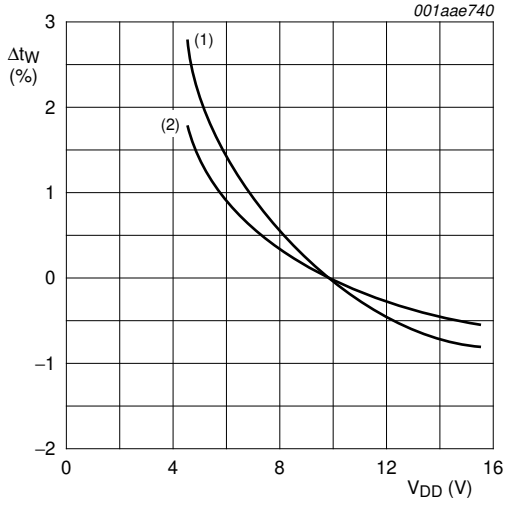
(1) V_{DD} = 5 V.

(2) V_{DD} = 10 V.

(3) V_{DD} = 15 V.

Δt_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

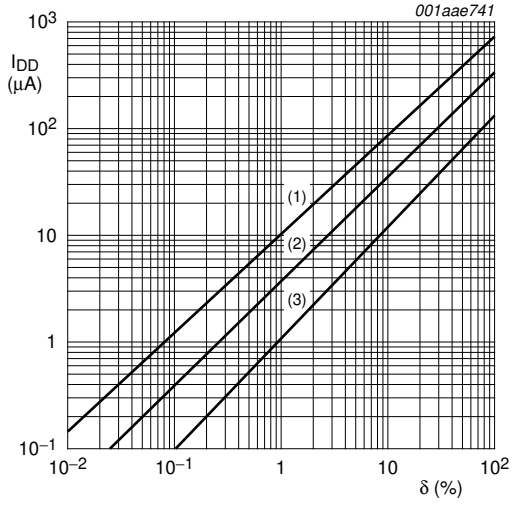


T_{amb} = 25 °C; Δt_W = 0 % at V_{DD} = 10 V; R_{ext} = 100 kΩ

(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



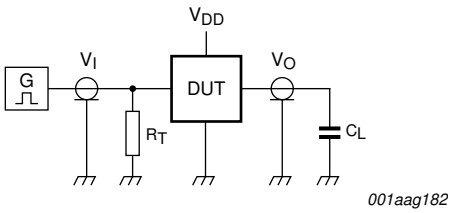
R_{ext} = 100 kΩ; C_{ext} = 100 nF; C_L = 50 pF; one monostable multivibrator switching only

(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



Test data is given in Table 10.

Definitions for test circuit:

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.

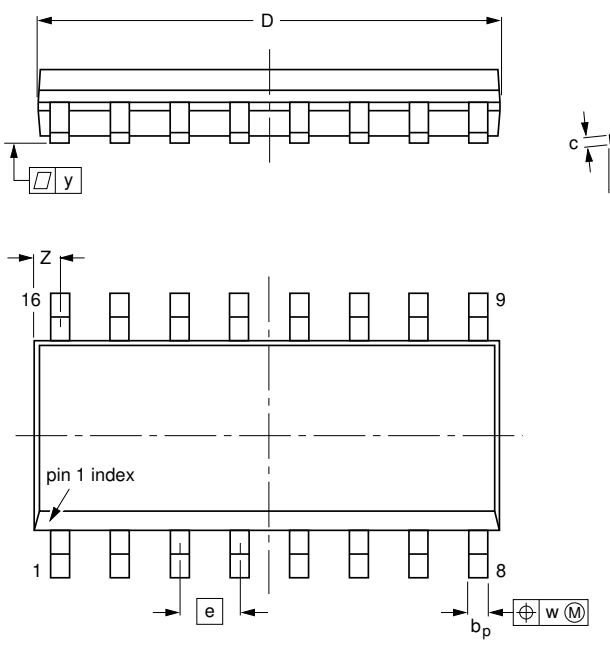
Fig 11. Test circuit

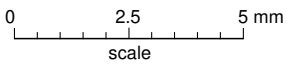
Table 10. Test data

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

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_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 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

Fig 12. Package outline SOT109-1 (SO16)

13. Abbreviations

Table 11. Abbreviations

Acronym	Description
HBM	Human Body Model
ESD	ElectroStatic Discharge
MM	Machine Model
MIL	Military

14. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4538B_Q100 v.2	20131210	Product data sheet	-	HEF4538B_Q100 v.1
Modifications:	• Figure 8 and Figure 9 updated to show output pulse width over full temperature range.			
HEF4538B_Q100 v.1	20130228	Product data sheet	-	-

15. Legal information

15.1 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".

[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 URL http://www.nxp.com.

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17. Contents

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