

HEF4093B

Quad 2-input NAND Schmitt trigger

Rev. 10 — 25 February 2022

Product data sheet

1. General description

The HEF4093B is a quad 2-input NAND gate with Schmitt-trigger inputs. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of V_{DD} . Schmitt trigger inputs transform slowly changing input signals into sharply defined jitter-free output signals.

2. Features and benefits

- Schmitt trigger input discrimination
- 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
- Complies with JEDEC standard JESD 13-B
- ESD protection:
 - HBM JESD22-A114F exceeds 2000 V
 - MM JESD22-A115-B exceeds 200 V
- Specified from -40 °C to +85 °C and -40 °C to +125 °C

3. Applications

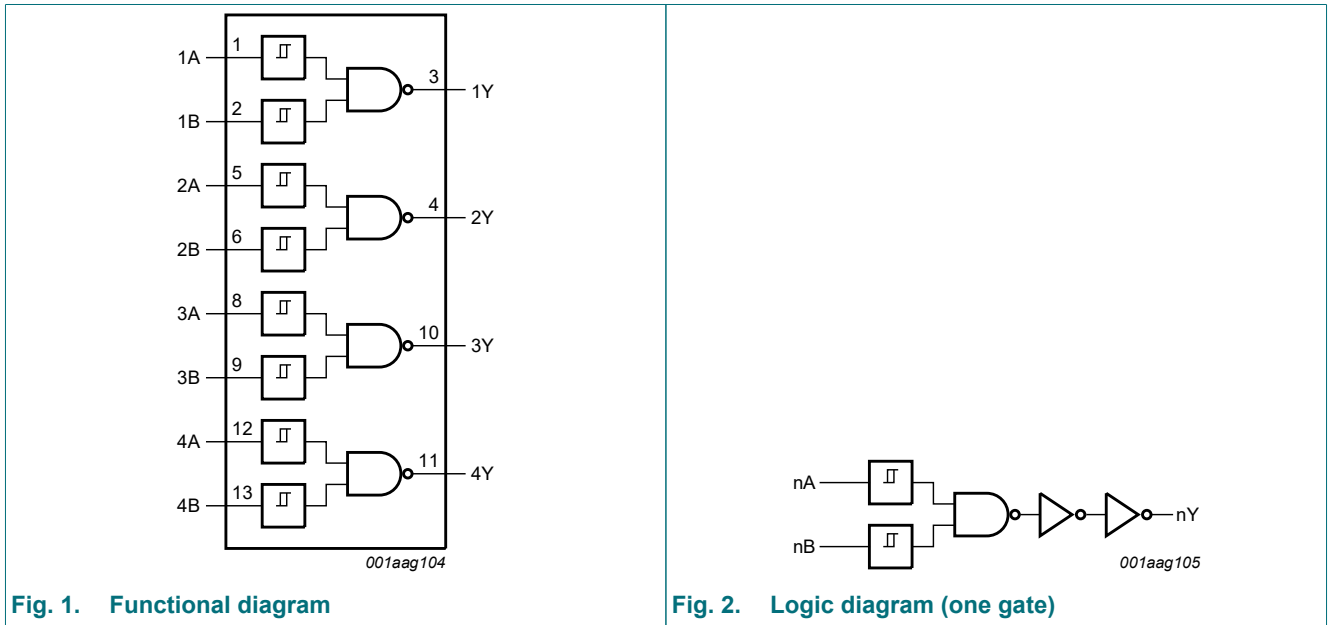
- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

4. Ordering information

Table 1. Ordering information

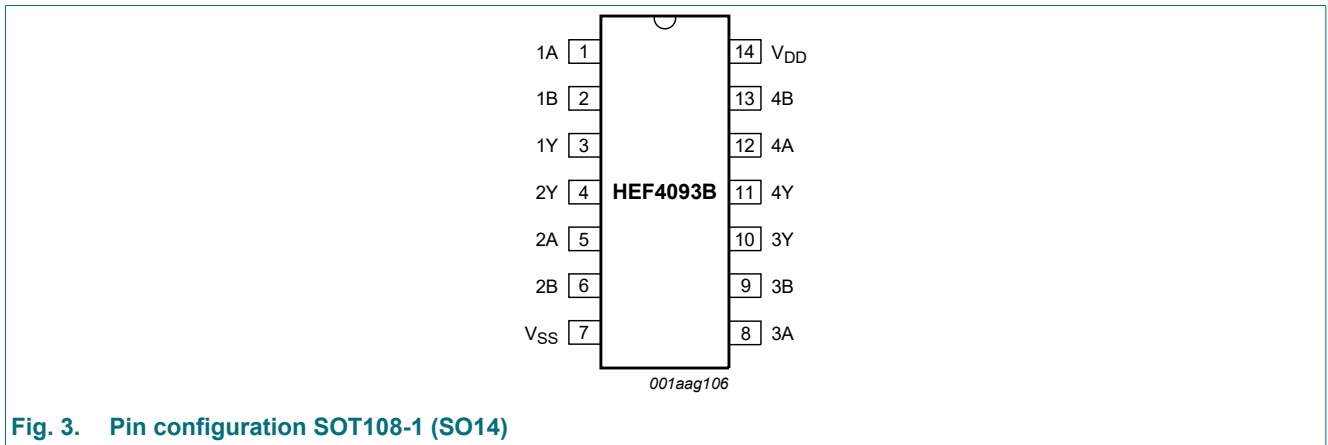
Type number	Package			
	Temperature range	Name	Description	Version
HEF4093BT	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1

5. Functional diagram



6. Pinning information

6.1. Pinning



6.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
1A, 2A, 3A, 4A	1, 5, 8, 12	input
1B, 2B, 3B, 4B	2, 6, 9, 13	input
1Y, 2Y, 3Y, 4Y	3, 4, 10, 11	output
V _{DD}	14	supply voltage
V _{SS}	7	ground (0 V)

7. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level.

Input		Output
nA	nB	nY
L	L	H
L	H	H
H	L	H
H	H	L

8. 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	$V_O < -0.5$ V or $V_O > V_{DD} + 0.5$ V	-	± 10	mA
I_{IO}	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 SOT108-1 (SO14) package: P_{tot} derates linearly with 10.1 mW/K above 100 °C.

9. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	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

10. 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_{OH}	HIGH-level output voltage	$ I_O < 1$ μ 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

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 _{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
			5 V	-	-0.64	-	-0.5	-	-0.36	-	-0.36	mA
			10 V	-	-1.6	-	-1.3	-	-0.9	-	-0.9	mA
			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
			10 V	1.6	-	1.3	-	0.9	-	0.9	-	mA
			15 V	4.2	-	3.4	-	2.4	-	2.4	-	mA
I _I	input leakage current		15 V	-	±0.1	-	±0.1	-	±1.0	-	±1.0	μA
I _{DD}	supply current	all valid input combinations; I _O = 0 A	5 V	-	0.25	-	0.25	-	7.5	-	7.5	μA
			10 V	-	0.5	-	0.5	-	15.0	-	15.0	μA
			15 V	-	1.0	-	1.0	-	30.0	-	30.0	μA
C _I	input capacitance			-	-	-	7.5	-	-	-	pF	

11. Dynamic characteristics

Table 7. Dynamic characteristics

T_{amb} = 25 °C; C_L = 50 pF; t_r = t_f ≤ 20 ns; unless otherwise specified. For waveforms see Fig. 4; for test circuit see Fig. 5.

Symbol	Parameter	Conditions	V _{DD}	Extrapolation formula [1]	Min	Typ	Max	Unit
t _{PHL}	HIGH to LOW propagation delay	nA or nB to nY	5 V	63 ns + (0.55 ns/pF)C _L	-	90	185	ns
			10 V	29 ns + (0.23 ns/pF)C _L	-	40	80	ns
			15 V	22 ns + (0.16 ns/pF)C _L	-	30	60	ns
t _{PLH}	LOW to HIGH propagation delay	nA or nB to nY	5 V	58 ns + (0.55 ns/pF)C _L	-	85	170	ns
			10 V	29 ns + (0.23 ns/pF)C _L	-	40	80	ns
			15 V	22 ns + (0.16 ns/pF)C _L	-	30	60	ns
t _{THL}	HIGH to LOW output transition time	nY to LOW	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 _{TLH}	LOW to HIGH output transition time	nA or nB to HIGH	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

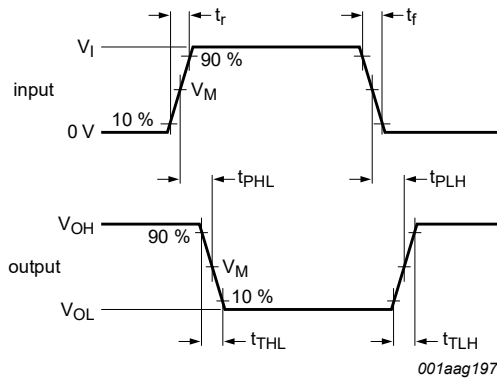
[1] Typical value of the propagation delay and output transition time can be calculated with the extrapolation formula (C_L in pF).

Table 8. Dynamic power dissipation

V_{SS} = 0 V; t_r = t_f ≤ 20 ns; T_{amb} = 25 °C.

Symbol	Parameter	V _{DD}	Typical formula	where:
P _D	dynamic power dissipation	5 V	P _D = 1300 × f _i + Σ(f _o × C _L) × V _{DD} ² (μW)	f _i = input frequency in MHz; f _o = output frequency in MHz; C _L = output load capacitance in pF; Σ(f _o × C _L) = sum of the outputs; V _{DD} = supply voltage in V.
		10 V	P _D = 6400 × f _i + Σ(f _o × C _L) × V _{DD} ² (μW)	
		15 V	P _D = 18700 × f _i + Σ(f _o × C _L) × V _{DD} ² (μW)	

11.1. Waveforms and test circuit



Measurement points are given in [Table 9](#).

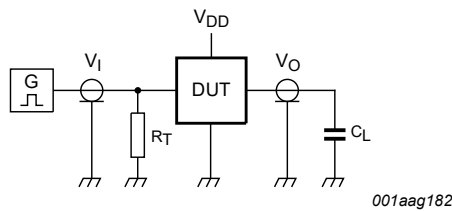
Logic levels: V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

t_r , t_f = input rise and fall times.

Fig. 4. Propagation delay and output transition time

Table 9. Measurement points

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



Test data 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. 5. 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}	≤ 20 ns
		50 pF

12. Transfer characteristics

Table 11. Transfer characteristics

$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$; see Fig. 6 and Fig. 7.

Symbol	Parameter	Conditions	V_{DD}	Min	Typ	Max	Unit
V_{T+}	positive-going threshold voltage		5 V	1.9	2.9	3.5	V
			10 V	3.6	5.2	7	V
			15 V	4.7	7.3	11	V
V_{T-}	negative-going threshold voltage		5 V	1.5	2.2	3.1	V
			10 V	3	4.2	6.4	V
			15 V	4	6.0	10.3	V
V_H	hysteresis voltage		5 V	0.4	0.7	-	V
			10 V	0.6	1.0	-	V
			15 V	0.7	1.3	-	V

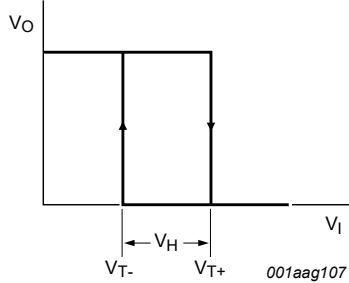


Fig. 6. Transfer characteristic

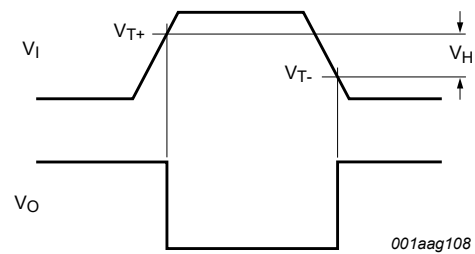


Fig. 7. Waveforms showing definition of V_{T+} and V_{T-} (between limits at 30 % and 70 %) and V_H

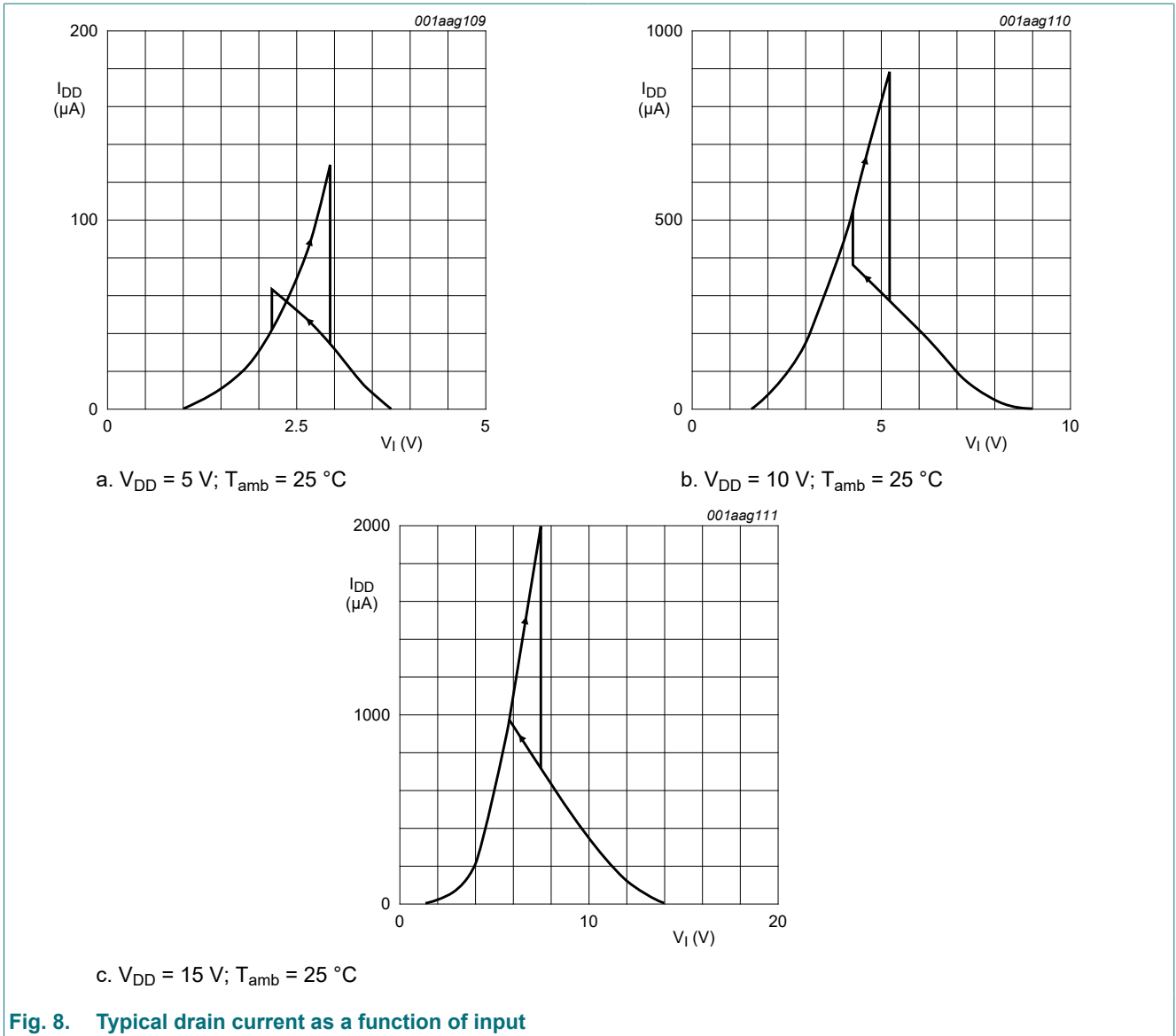


Fig. 8. Typical drain current as a function of input

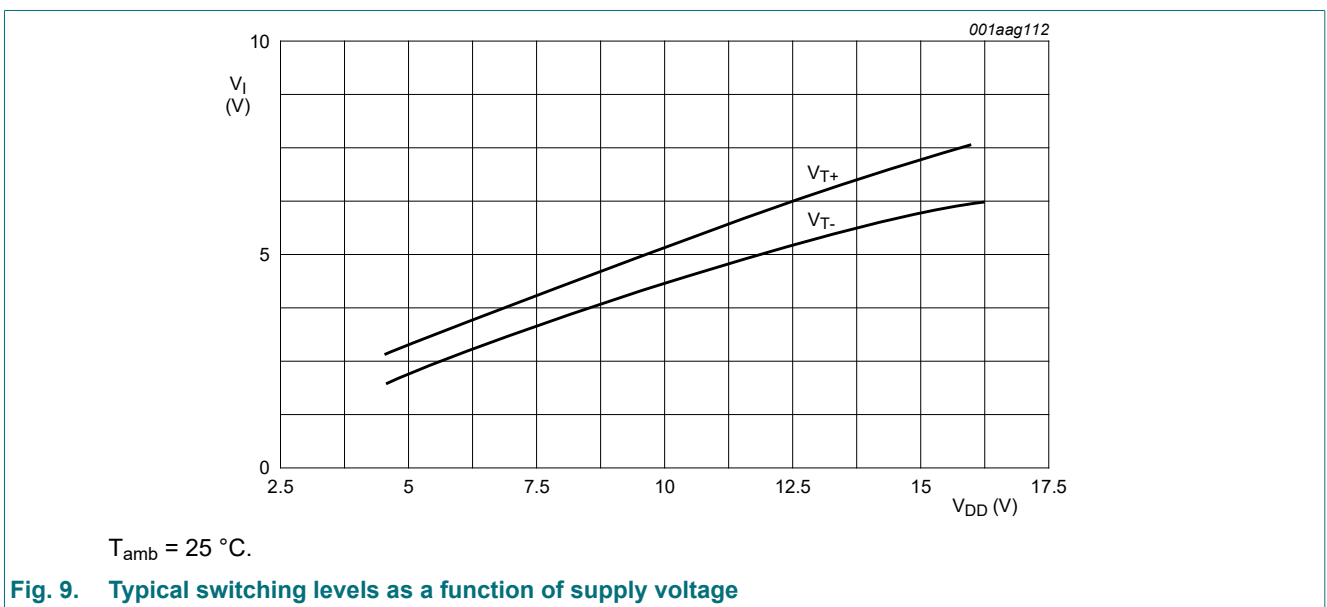


Fig. 9. Typical switching levels as a function of supply voltage

13. Application information

Some examples of applications for the HEF4093B are:

- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

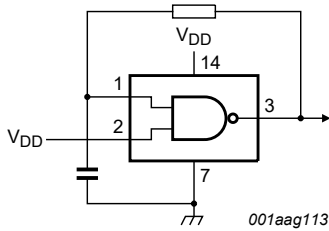


Fig. 10. Astable multivibrator

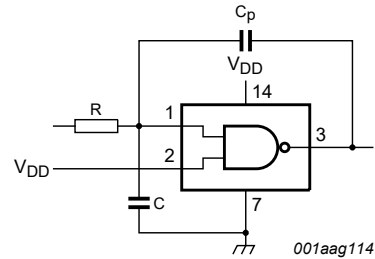


Fig. 11. Schmitt trigger driven via a high-impedance input

If a Schmitt trigger is driven via a high-impedance ($R > 1 \text{ k}\Omega$), then it is necessary to incorporate a capacitor C with a value of $\frac{C}{C_p} > \frac{V_{DD} - V_{SS}}{V_H}$; otherwise oscillation can occur on the edges of a pulse.

C_p is the external parasitic capacitance between inputs and output; the value depends on the circuit board layout.

Remark: The two inputs may be connected together, but this will result in a larger through-current at the moment of switching.

14. Package outline

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1

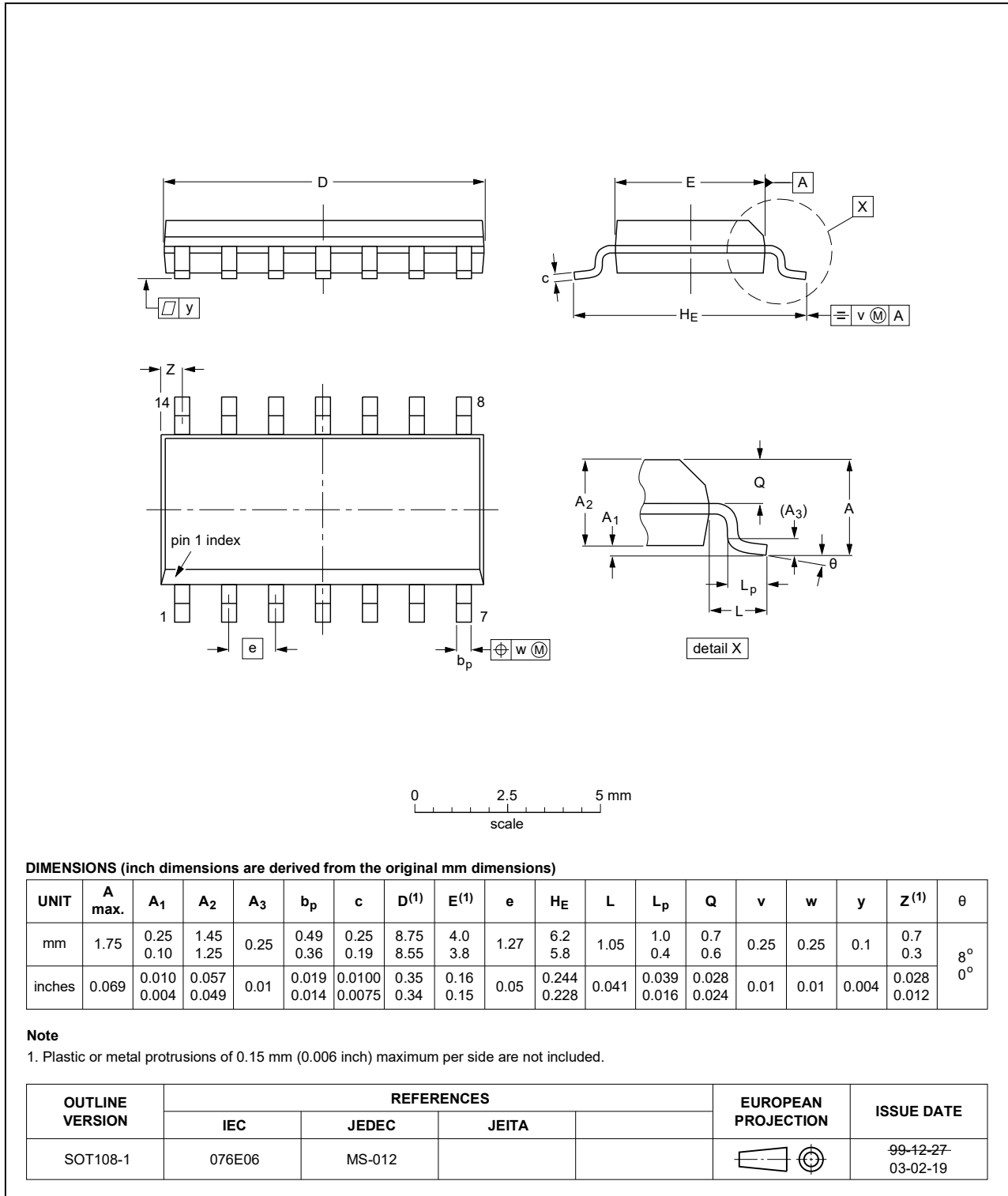


Fig. 12. Package outline SOT108-1 (SO14)

15. Abbreviations

Table 12. Abbreviations

Acronym	Description
CDM	Charged Device Model
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model

16. Revision history

Table 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4093B v.10	20220225	Product data sheet	-	HEF4093B v.9
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. Legal texts have been adapted to the new company name where appropriate. Table 4: Derating values for P_{tot} total power dissipation updated. Section 1, Section 2, and Section 15 updated. 			
HEF4093B v.9	20151215	Product data sheet	-	HEF4093B v.8
Modifications:	<ul style="list-style-type: none"> Type number HEF4093BP (SOT27-1) removed. 			
HEF4093B v.8	20111121	Product data sheet	-	HEF4093B v.7
Modifications:	<ul style="list-style-type: none"> Table 6: I_{OH} minimum values changed to maximum 			
HEF4093B v.7	20100901	Product data sheet	-	HEF4093B v.6
HEF4093B v.6	20091202	Product data sheet	-	HEF4093B v.5
HEF4093B v.5	20090728	Product data sheet	-	HEF4093B v.4
HEF4093B v.4	20080612	Product data sheet	-	HEF4093B_CNV v.3
HEF4093B_CNV v.3	19950101	Product specification	-	HEF4093B_CNV v.2
HEF4093B_CNV v.2	19950101	Product specification	-	-

17. 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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Contents

1. General description	1
2. Features and benefits	1
3. Applications	1
4. Ordering information	1
5. Functional diagram	2
6. Pinning information	2
6.1. Pinning.....	2
6.2. Pin description.....	2
7. Functional description	3
8. Limiting values	3
9. Recommended operating conditions	3
10. Static characteristics	3
11. Dynamic characteristics	4
11.1. Waveforms and test circuit.....	5
12. Transfer characteristics	6
13. Application information	8
14. Package outline	9
15. Abbreviations	10
16. Revision history	10
17. Legal information	11

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