

# HEF40106B-Q100

## Hex inverting Schmitt trigger

Rev. 2 — 22 November 2021

Product data sheet

## 1. General description

The HEF40106B is a hex inverter with Schmitt-trigger inputs. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{DD}$ .

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

## 3. Applications

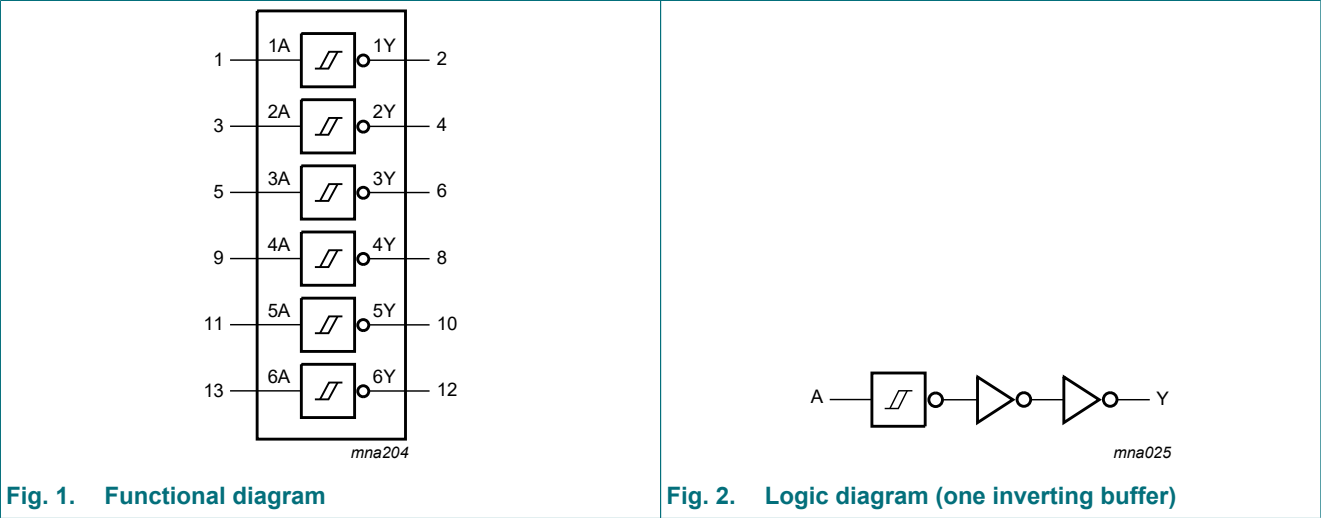
- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

## 4. Ordering information

Table 1. Ordering information

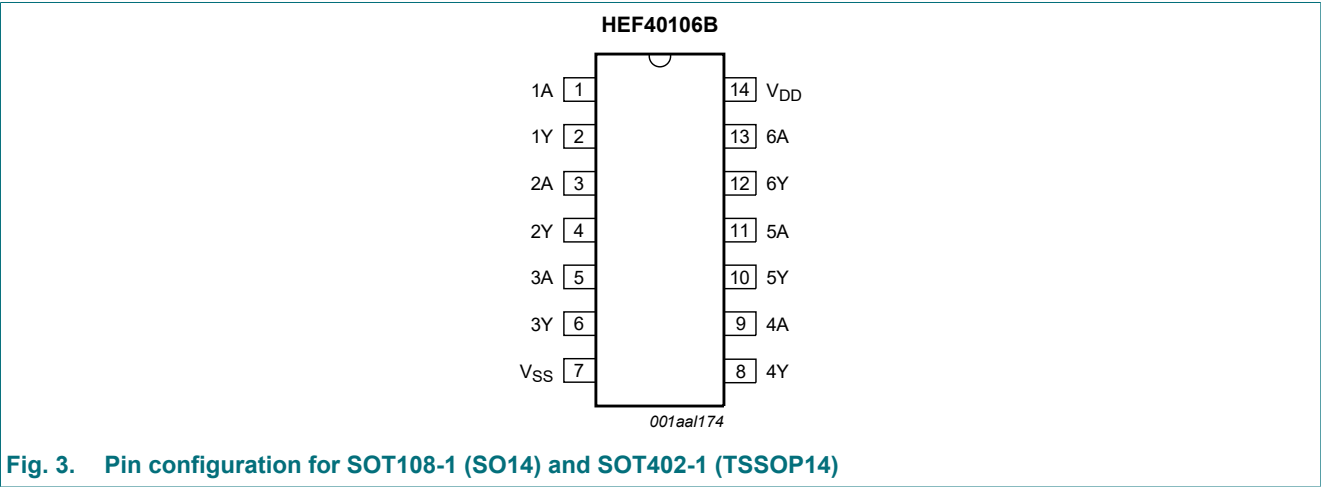
Type number	Package			
	Temperature range	Name	Description	Version
HEF40106BT-Q100	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
HEF40106BTT-Q100	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1

5. Functional diagram



6. Pinning information

6.1. Pinning



6.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
1A, 2A, 3A, 4A, 5A, 6A	1, 3, 5, 9, 11, 13	input
1Y, 2Y, 3Y, 4Y, 5Y, 6Y	2, 4, 6, 8, 10, 12	output
V <sub>DD</sub>	14	supply voltage
V <sub>SS</sub>	7	ground (0 V)

## 7. Functional description

**Table 3. Function table**

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

Input	Output
nA	nY
L	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	-	$\pm 10$	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	-	$\pm 10$	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 SOT108-1 (SO14) package:  $P_{tot}$  derates linearly with 10.1 mW/K above 100 °C.  
 For SOT402-1 (TSSOP14) package:  $P_{tot}$  derates linearly with 7.3 mW/K above 81 °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**

$V_{SS} = 0\text{ V}$ ;  $V_I = V_{SS}$  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	
$V_{OH}$	HIGH-level output voltage	$ I_O  < 1\text{ }\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\text{ }\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		15 V	-	$\pm 0.1$	-	$\pm 0.1$	-	$\pm 1.0$	-	$\pm 1.0$	$\mu\text{A}$
$I_{DD}$	supply current	all valid input combinations; $I_O = 0\text{ A}$	5 V	-	0.25	-	0.25	-	7.5	-	7.5	$\mu\text{A}$
			10 V	-	0.5	-	0.5	-	15.0	-	15.0	$\mu\text{A}$
			15 V	-	1.0	-	1.0	-	30.0	-	30.0	$\mu\text{A}$
$C_I$	input capacitance			-	-	-	7.5	-	-	-	-	pF

## 11. Dynamic characteristics

**Table 7. Dynamic characteristics**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $C_L = 50\text{ pF}$ ;  $t_r = t_f \leq 20\text{ ns}$  unless otherwise specified.

For waveforms see Fig. 4; for test circuit see Fig. 5;

Symbol	Parameter	Conditions	V <sub>DD</sub>	Extrapolation formula [1]	Min	Typ	Max	Unit
t <sub>PHL</sub>	HIGH to LOW propagation delay	nA or nB to nY	5 V	63 ns + (0.55 ns/pF)C <sub>L</sub>	-	90	180	ns
			10 V	29 ns + (0.23 ns/pF)C <sub>L</sub>	-	35	70	ns
			15 V	22 ns + (0.16 ns/pF)C <sub>L</sub>	-	30	60	ns
t <sub>PLH</sub>	LOW to HIGH propagation delay	nA or nB to nY	5 V	58 ns + (0.55 ns/pF)C <sub>L</sub>	-	75	150	ns
			10 V	29 ns + (0.23 ns/pF)C <sub>L</sub>	-	35	70	ns
			15 V	22 ns + (0.16 ns/pF)C <sub>L</sub>	-	30	60	ns
t <sub>THL</sub>	HIGH to LOW output transition time	nY to LOW	5 V	10 ns + (1.00 ns/pF)C <sub>L</sub>	-	60	120	ns
			10 V	9 ns + (0.42 ns/pF)C <sub>L</sub>	-	30	60	ns
			15 V	6 ns + (0.28 ns/pF)C <sub>L</sub>	-	20	40	ns
t <sub>TLH</sub>	LOW to HIGH output transition time	nA or nB to HIGH	5 V	10 ns + (1.00 ns/pF)C <sub>L</sub>	-	60	120	ns
			10 V	9 ns + (0.42 ns/pF)C <sub>L</sub>	-	30	60	ns
			15 V	6 ns + (0.28 ns/pF)C <sub>L</sub>	-	20	40	ns

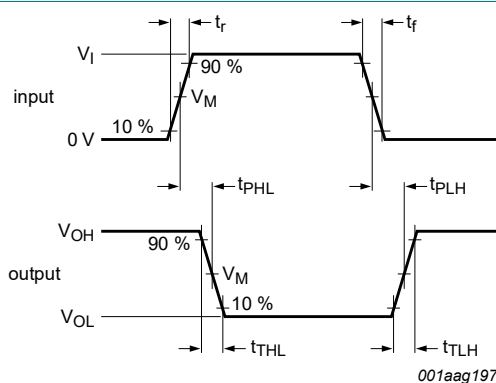
[1] Typical value of the propagation delay and output transition time can be calculated with the extrapolation formula (C<sub>L</sub> in pF).

**Table 8. Dynamic power dissipation**

$V_{SS} = 0\text{ V}$ ;  $t_r = t_f \leq 20\text{ ns}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Symbol	Parameter	V <sub>DD</sub>	Typical formula	where:
P <sub>D</sub>	dynamic power dissipation	5 V	$P_D = 2300 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$	f <sub>i</sub> = input frequency in MHz; f <sub>o</sub> = output frequency in MHz; C <sub>L</sub> = output load capacitance in pF; Σ(f <sub>o</sub> × C <sub>L</sub> ) = sum of the outputs; V <sub>DD</sub> = supply voltage in V.
		10 V	$P_D = 9000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$	
		15 V	$P_D = 20000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$	

### 11.1. Waveforms and test circuit



Measurement points are given in Table 9.

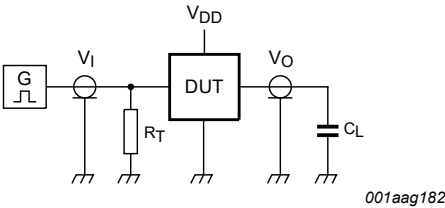
Logic levels: V<sub>OL</sub> and V<sub>OH</sub> are typical output voltage levels that occur with the output load.

t<sub>r</sub>, t<sub>f</sub> = 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	$0.5 V_{DD}$	$0.5 V_{DD}$



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 $V_{DD}$	50 pF

12. Transfer characteristics

Table 11. Transfer characteristics

$V_{SS} = 0\text{ V}$ ; see [Fig. 6](#) and [Fig. 7](#).

Symbol	Parameter	Conditions	$V_{DD}$	$T_{amb} = -40\text{ }^{\circ}\text{C to }+85\text{ }^{\circ}\text{C}$			$T_{amb} = -40\text{ }^{\circ}\text{C to }+125\text{ }^{\circ}\text{C}$		Unit
				Min	Typ [1]	Max	Min	Max	
$V_{T+}$	positive-going threshold voltage		5 V	2.0	3.0	3.5	2.0	3.5	V
			10 V	3.7	5.8	7.0	3.7	7.0	V
			15 V	4.9	8.3	11.0	4.9	11.0	V
$V_{T-}$	negative-going threshold voltage		5 V	1.5	2.2	3.0	1.5	3.0	V
			10 V	3.0	4.5	6.3	3.0	6.3	V
			15 V	4.0	6.5	10.1	4.0	10.1	V
$V_H$	hysteresis voltage		5 V	0.5	0.8	-	0.5	-	V
			10 V	0.7	1.3	-	0.7	-	V
			15 V	0.9	1.8	-	0.9	-	V

[1] All typical values are measured at  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

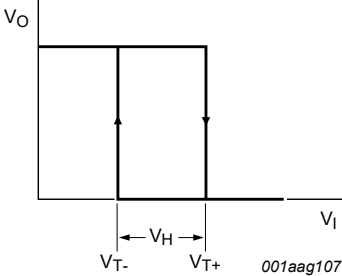


Fig. 6. Transfer characteristic

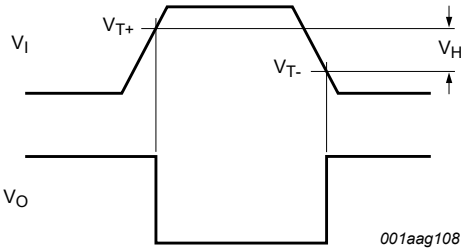


Fig. 7. Waveform defining  $V_{T+}$  and  $V_{T-}$  (between limits at 30% and 70%) and  $V_H$

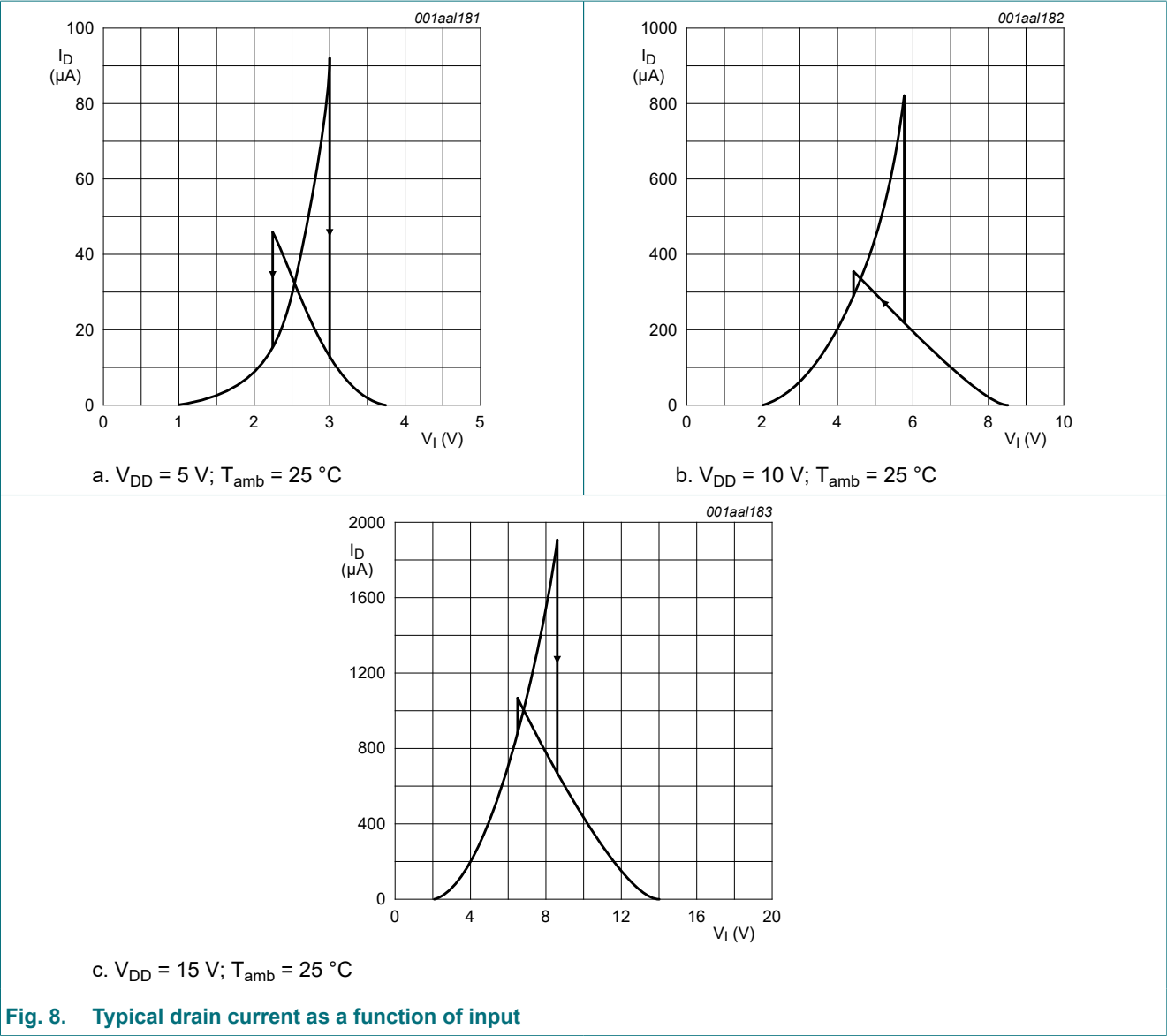


Fig. 8. Typical drain current as a function of input

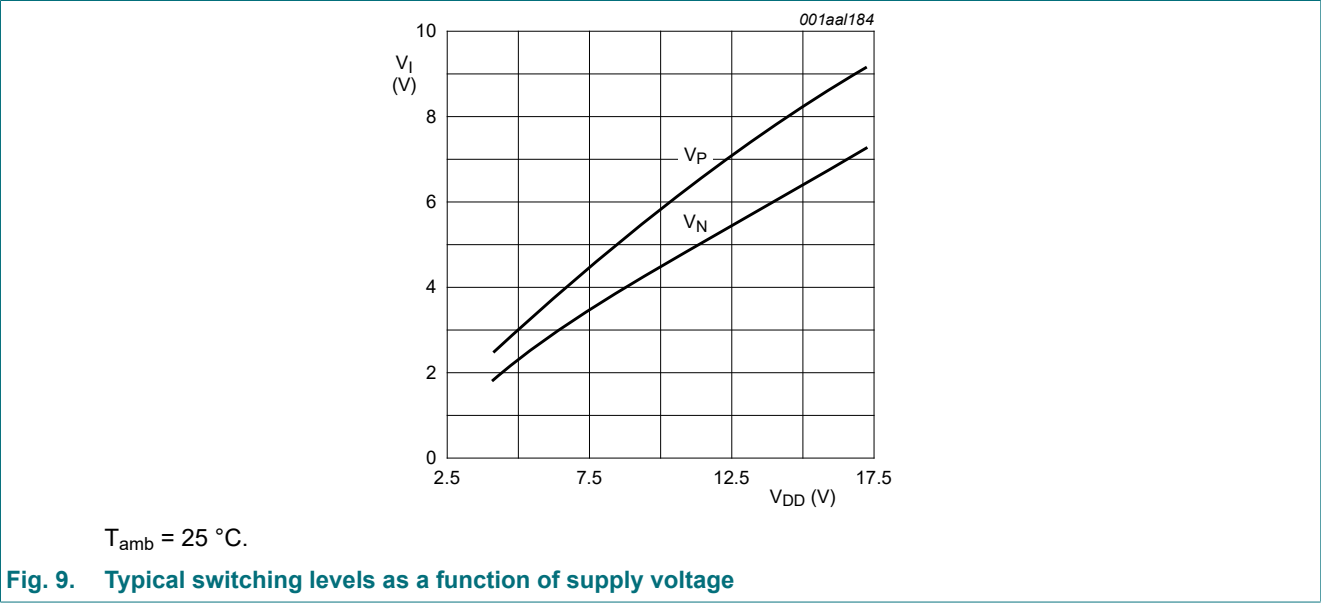
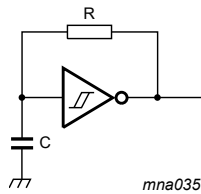


Fig. 9. Typical switching levels as a function of supply voltage

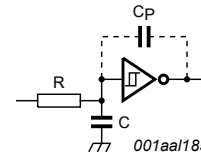
## 13. Application information

Some examples of applications for the HEF40106B-Q100 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.



14. Package outline

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

SOT108-1

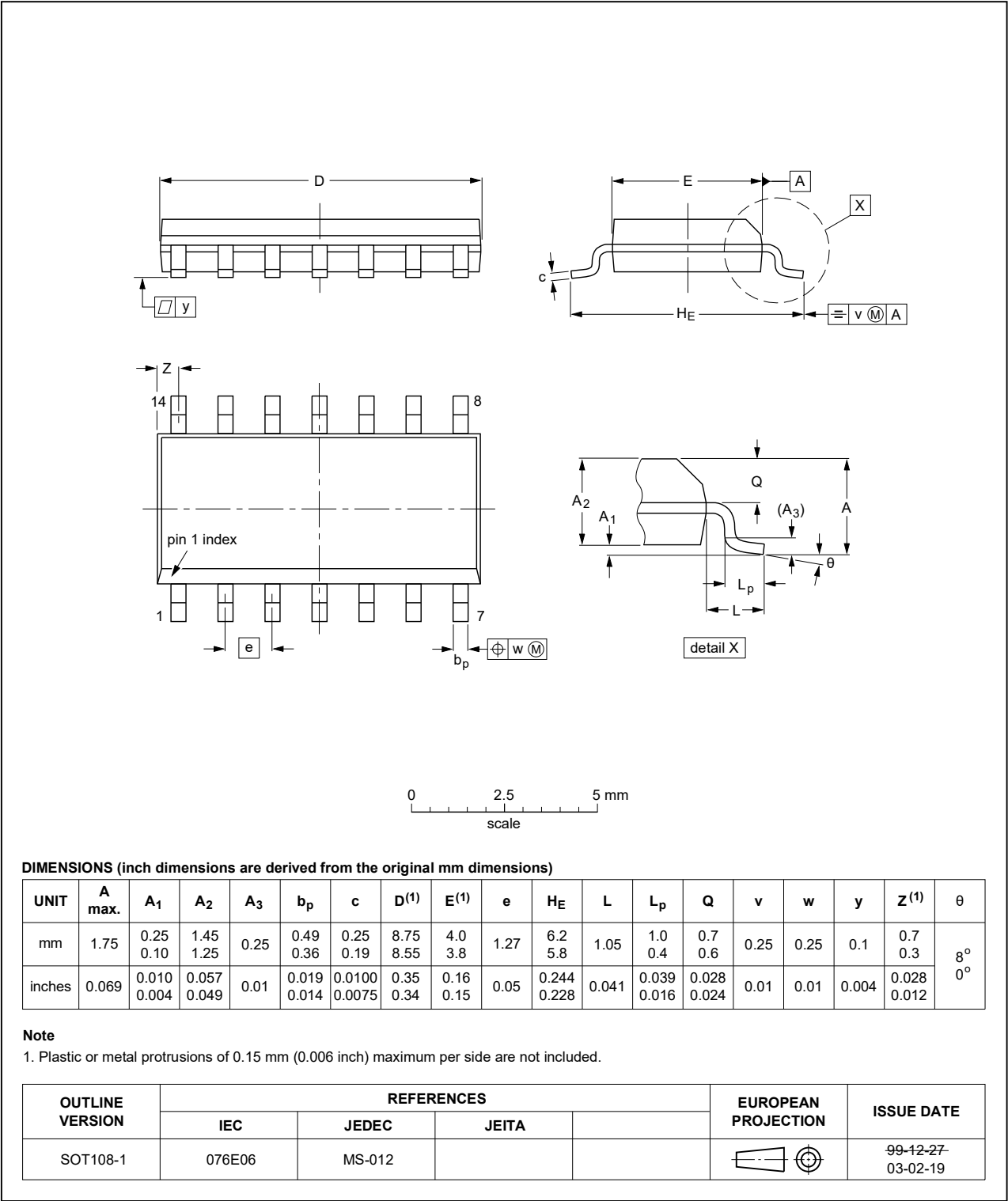


Fig. 12. Package outline SOT108-1 (SO14)

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1

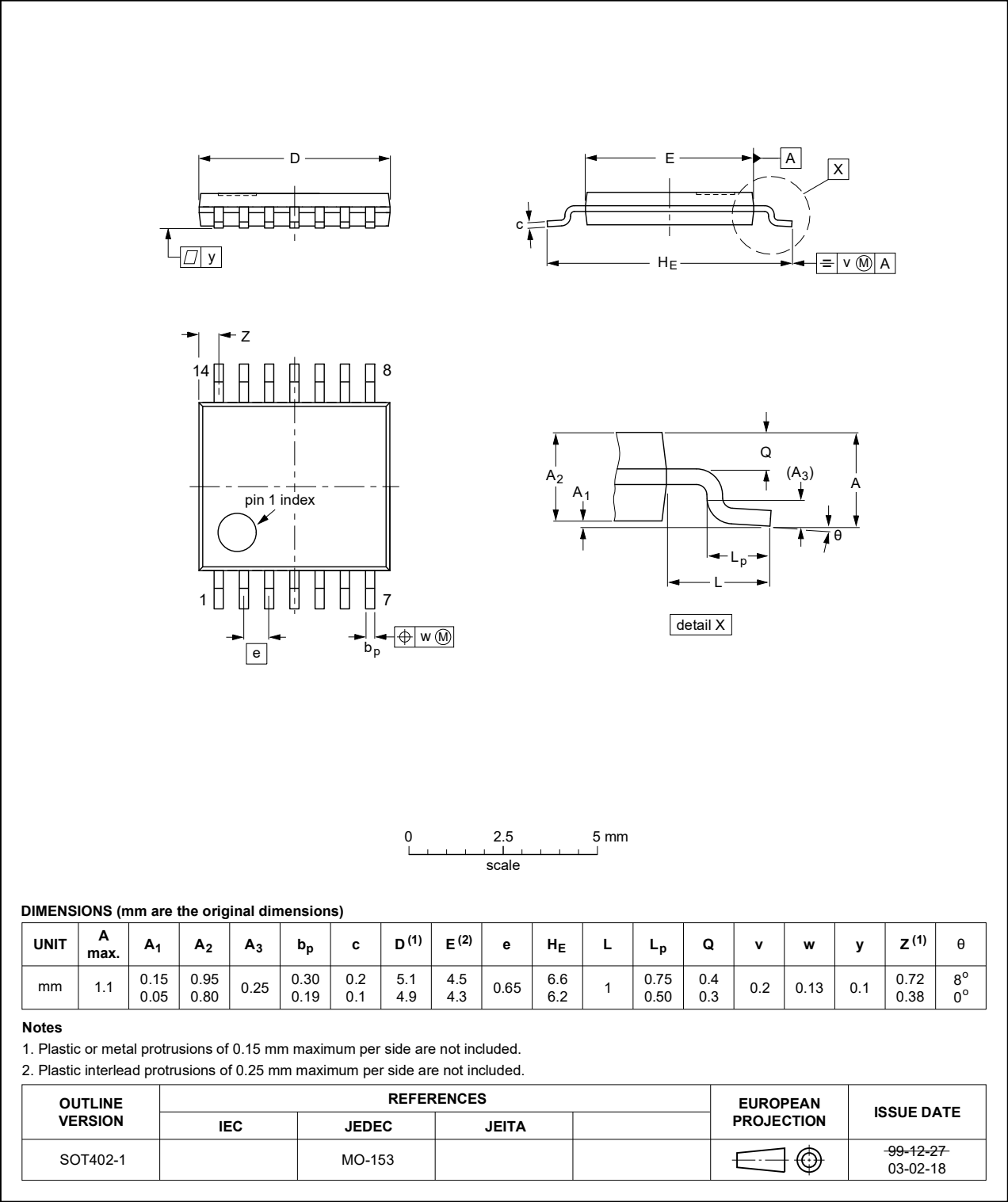


Fig. 13. Package outline SOT402-1 (TSSOP14)

## 15. Abbreviations

Table 12. Abbreviations

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

## 16. Revision history

Table 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF40106B_Q100 v.2	20211122	Product data sheet	-	HEF40106B_Q100 v.1
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><li><a href="#">Section 1</a> and <a href="#">Section 2</a> updated.</li><li><a href="#">Table 4</a>: Derating values for <math>P_{tot}</math> total power dissipation updated.</li></ul>			
HEF40106B_Q100 v.1	20120807	Product data sheet	-	-

## 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.....	4
11. Dynamic characteristics.....	5
11.1. Waveforms and test circuit.....	5
12. Transfer characteristics.....	6
13. Application information.....	8
14. Package outline.....	9
15. Abbreviations.....	11
16. Revision history.....	11
17. Legal information.....	12

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