



**THE DATASHEET OF  
HEF40106BT**



# HEF40106B

Hex inverting Schmitt trigger

Rev. 10 — 7 October 2022

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  $V_{DD}$ .

## 2. Features and benefits

- 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
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C
- Complies with JEDEC standard JESD 13-B
- ESD protection:
  - HBM JESD22-A114F exceeds 2 kV
  - MM JESD22-A115-B exceeds 200 V

## 3. Applications

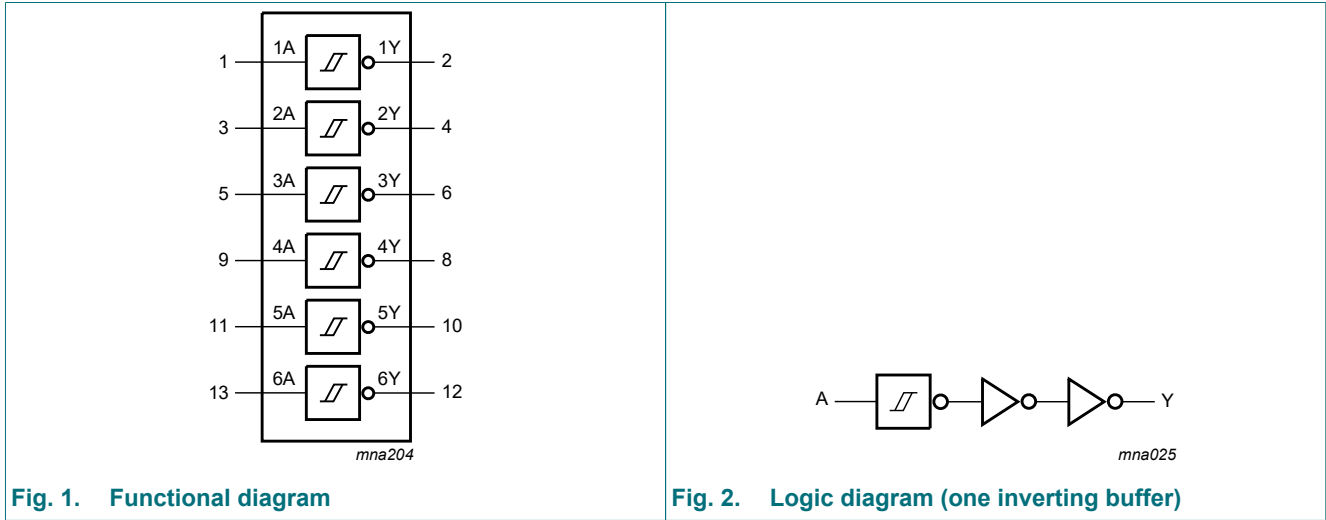
- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

## 4. Ordering information

Table 1. Ordering information

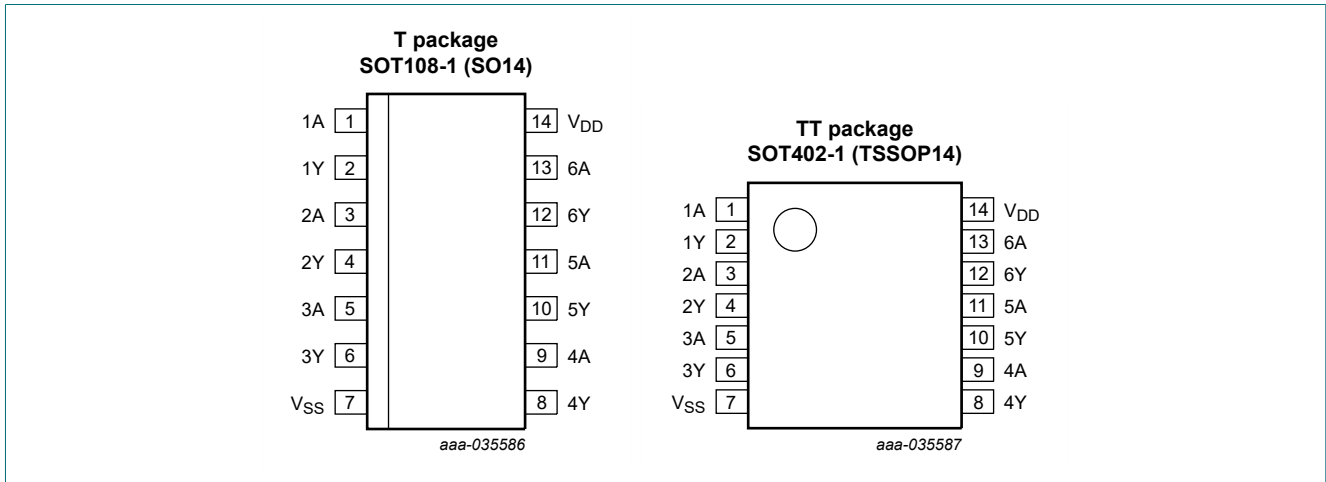
Type number	Package			
	Temperature range	Name	Description	Version
<a href="#">HEF40106BT</a>	-40 °C to +125 °C	SO14	plastic small outline package; 14 leads; body width 3.9 mm	<a href="#">SOT108-1</a>
<a href="#">HEF40106BTT</a>	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14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

### 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. 3](#); for test circuit see [Fig. 4](#);

Symbol	Parameter	Conditions	V <sub>DD</sub>	Extrapolation formula [1]	Min	Typ	Max	Unit
t <sub>PHL</sub>	HIGH to LOW propagation delay	nA to nY	5 V	$63\text{ ns} + (0.55\text{ ns/pF})C_L$	-	90	180	ns
			10 V	$29\text{ ns} + (0.23\text{ ns/pF})C_L$	-	35	70	ns
			15 V	$22\text{ ns} + (0.16\text{ ns/pF})C_L$	-	30	60	ns
t <sub>PLH</sub>	LOW to HIGH propagation delay	nA to nY	5 V	$58\text{ ns} + (0.55\text{ ns/pF})C_L$	-	75	150	ns
			10 V	$29\text{ ns} + (0.23\text{ ns/pF})C_L$	-	35	70	ns
			15 V	$22\text{ ns} + (0.16\text{ ns/pF})C_L$	-	30	60	ns
t <sub>THL</sub>	HIGH to LOW output transition time	nY to LOW	5 V	$10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	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 <sub>TLH</sub>	LOW to HIGH output transition time	nY to HIGH	5 V	$10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	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

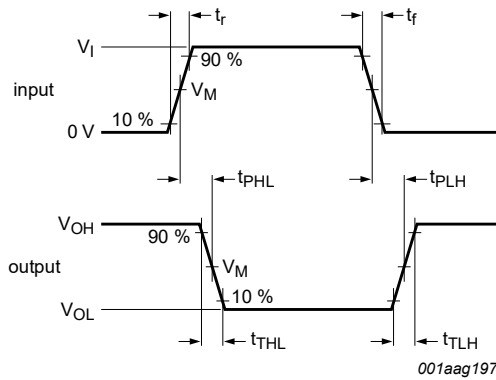
[1] Typical value of the propagation delay and output transition time can be calculated with the extrapolation formula ( $C_L$  in pF).

**Table 8. Dynamic power dissipation**

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

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

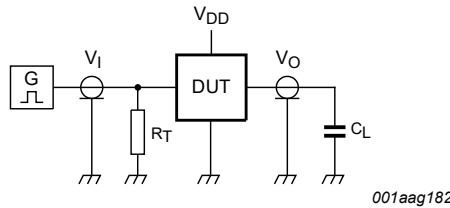


Measurement points are given in [Table 9](#).  
 Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.  
 $t_r$ ,  $t_f$  = input rise and fall times.

Fig. 3. 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. 4. 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 $V_{DD}$	$\leq 20$ ns
		50 pF

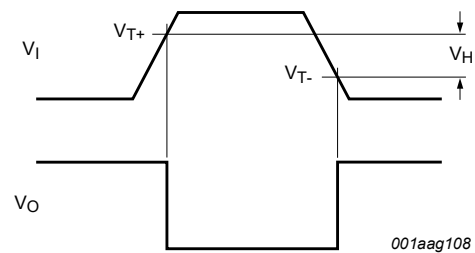
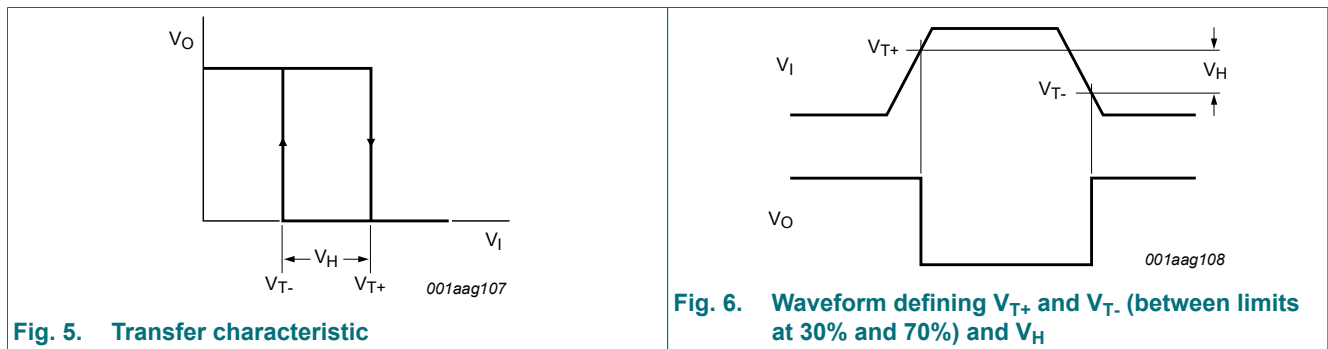
## 12. Transfer characteristics

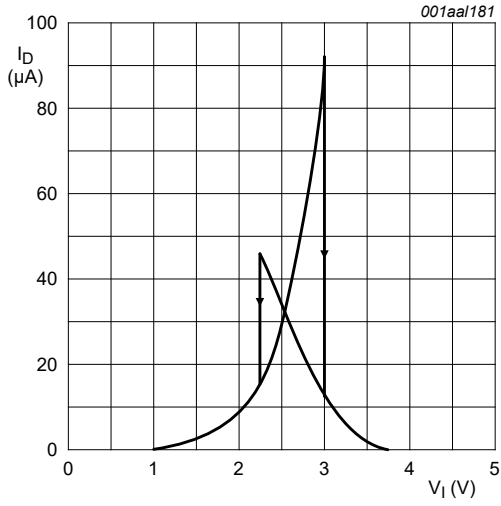
**Table 11. Transfer characteristics**

$V_{SS} = 0\text{ V}$ ; see Fig. 5 and Fig. 6.

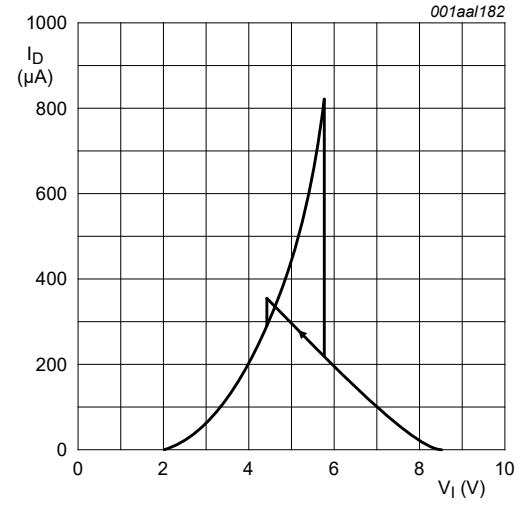
Symbol	Parameter	Conditions	$V_{DD}$	$T_{amb} = -40\text{ °C to }+85\text{ °C}$			$T_{amb} = -40\text{ °C to }+125\text{ °C}$		Unit
				Min	Typ [1]	Max	Min	Max	
$V_{T+}$	positive-going threshold voltage		5 V	2.0	3.0	3.5	2.0	3.5	V
			10 V	3.7	5.8	7.0	3.7	7.0	V
			15 V	4.9	8.3	11.0	4.9	11.0	V
$V_{T-}$	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  $T_{amb} = 25\text{ °C}$ .

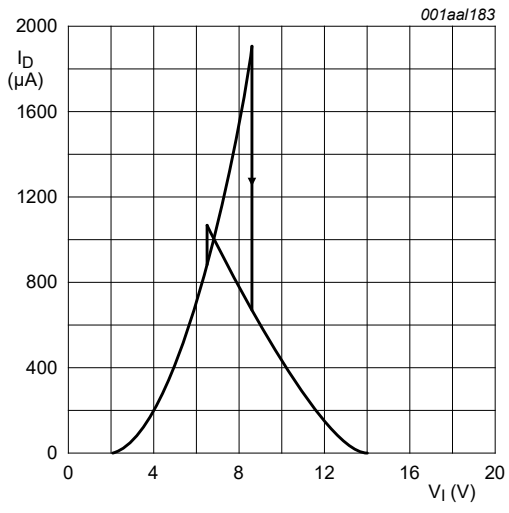




a.  $V_{DD} = 5\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$

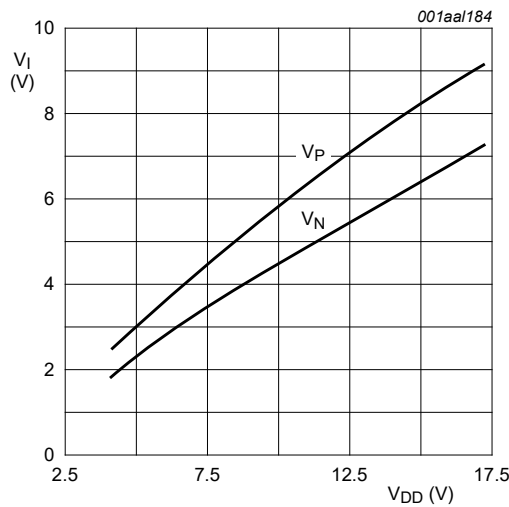


b.  $V_{DD} = 10\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$



c.  $V_{DD} = 15\text{ V}; T_{amb} = 25\text{ }^{\circ}\text{C}$

**Fig. 7. Typical drain current as a function of input**



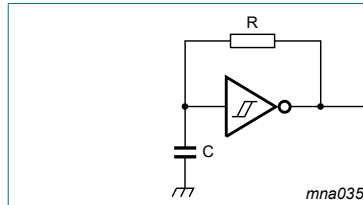
$T_{amb} = 25\text{ }^{\circ}\text{C}.$

**Fig. 8. Typical switching levels as a function of supply voltage**

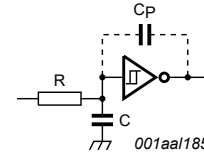
### 13. Application information

Some examples of applications for the HEF40106B are:

- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators



**Fig. 9. Astable multivibrator**



**Fig. 10. 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

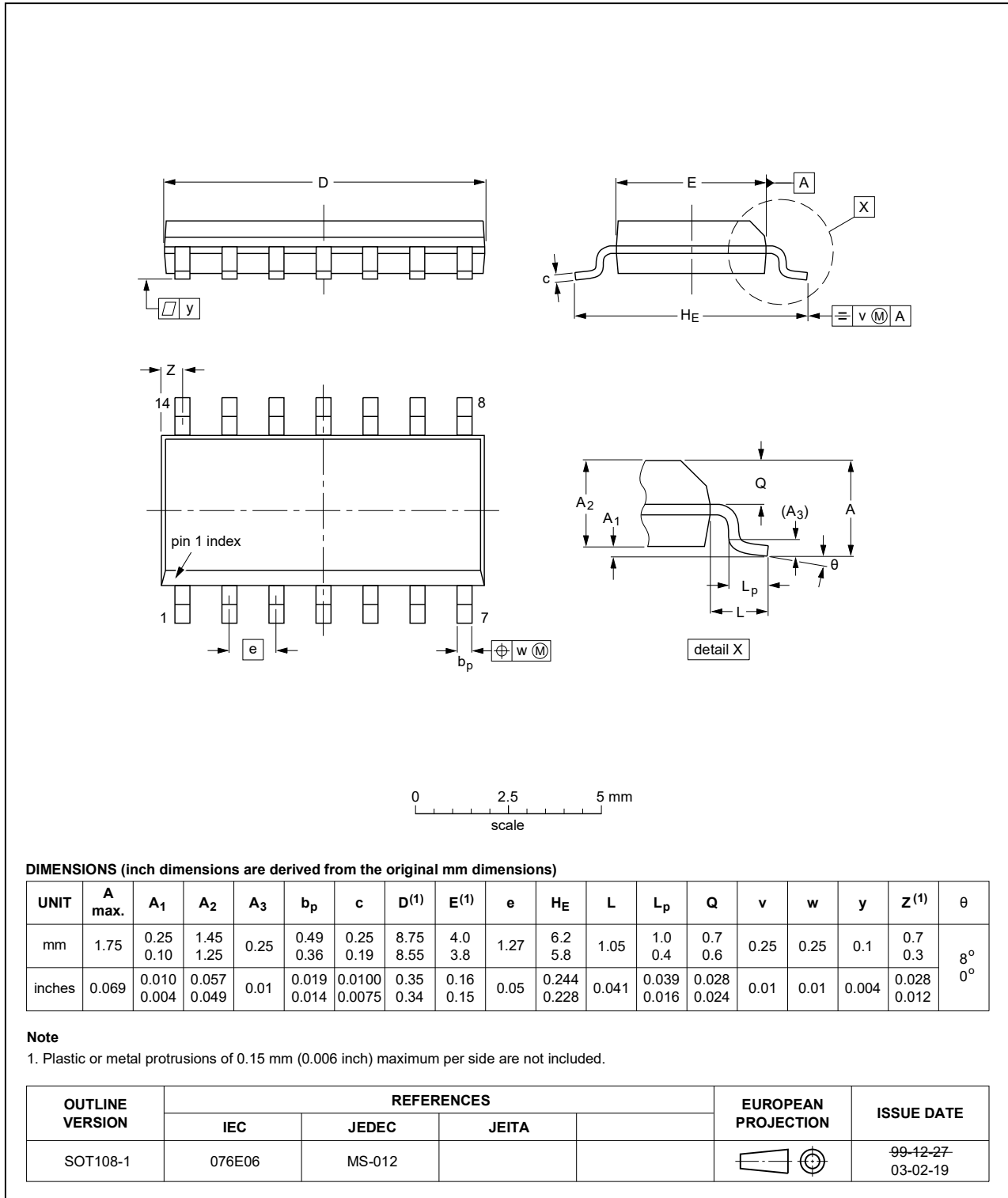


Fig. 11. Package outline SOT108-1 (SO14)

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

SOT402-1

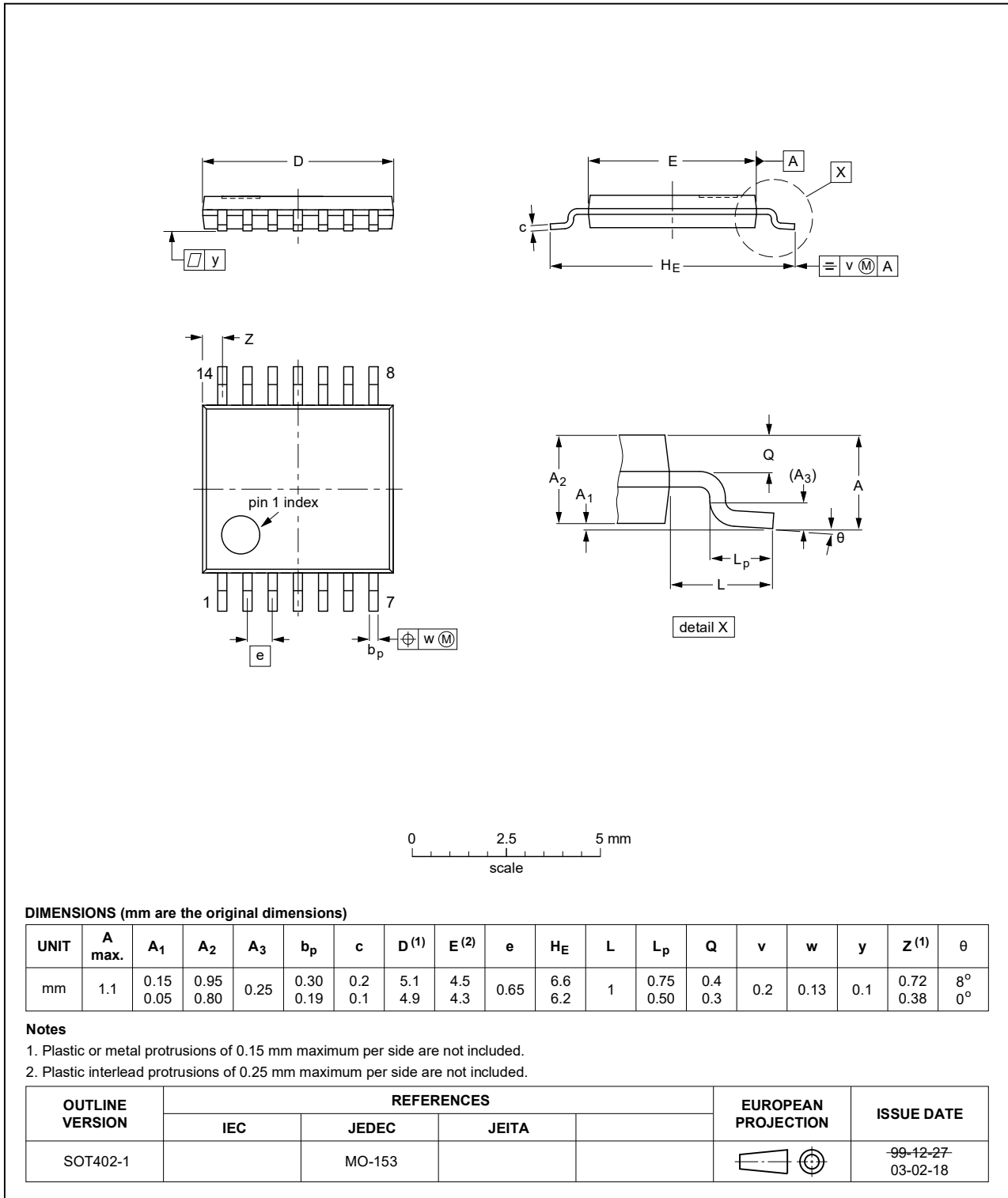


Fig. 12. Package outline SOT402-1 (TSSOP14)

## 15. Abbreviations

Table 12. Abbreviations

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

## 16. Revision history

Table 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF40106B v.10	20221007	Product data sheet	-	HEF40106B v.9
Modifications:	<ul style="list-style-type: none"> <li><a href="#">Table 7</a>: Typo corrected.</li> </ul>			
HEF40106B v.9	20211122	Product data sheet	-	HEF40106B v.8
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 v.8	20151210	Product data sheet	-	HEF40106B v.7
Modifications:	<ul style="list-style-type: none"> <li>Type number HEF40106BP (SOT27-1) removed.</li> </ul>			
HEF40106B v.7	20111121	Product data sheet	-	HEF40106B v.6
Modifications:	<ul style="list-style-type: none"> <li>Legal pages updated.</li> <li>Changes in <a href="#">Section 1</a> and <a href="#">Section 2</a>.</li> </ul>			
HEF40106B v.6	20110823	Product data sheet	-	HEF40106B v.5
HEF40106B v.5	20110511	Product data sheet	-	HEF40106B v.4
HEF40106B v.4	20101115	Product data sheet	-	HEF40106B_CNV v.3
HEF40106B_CNV v.3	19950101	Product specification	-	HEF40106B_CNV v.2
HEF40106B_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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