

# HEF40106B

Hex inverting Schmitt trigger

Rev. 7 — 21 November 2011

Product data sheet

## 1. General description

The HEF40106B provides six inverting buffers. Each input has a Schmitt trigger circuit. The inverting buffer switches at different points for positive-going and negative-going signals. The difference between the positive voltage ( $V_{T+}$ ) and the negative voltage ( $V_{T-}$ ) is defined as hysteresis voltage ( $V_H$ ).

The HEF40106B may be used for enhanced noise immunity or to “square up” slowly changing waveforms.

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.

## 2. Features and benefits

- Schmitt trigger input discrimination
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B

## 3. Applications

- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

## 4. Ordering information

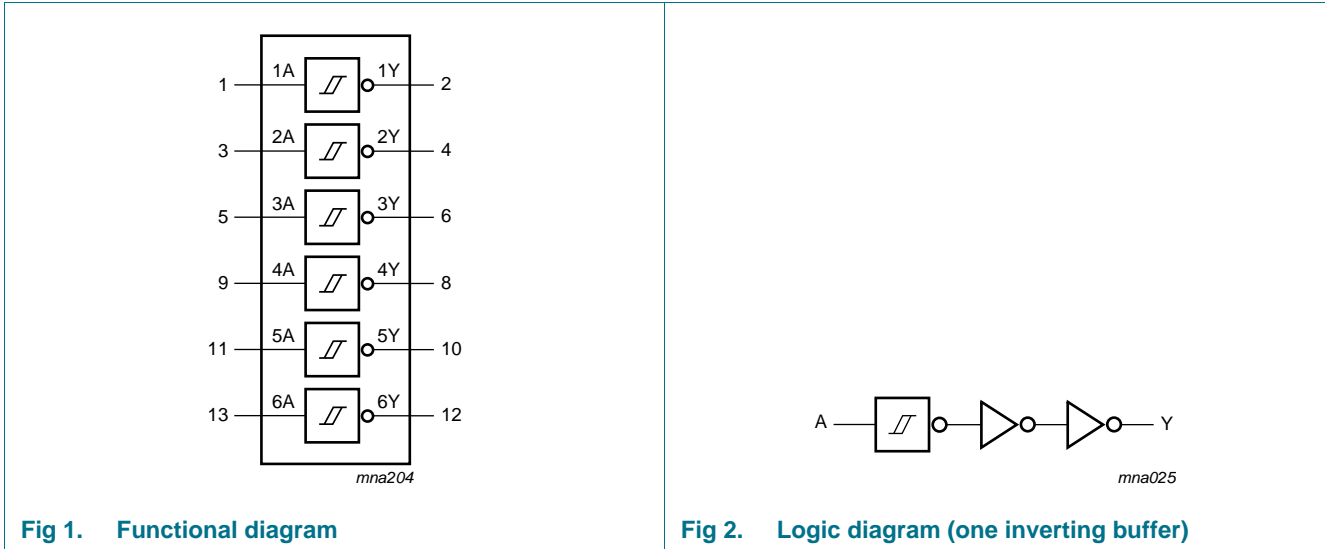
**Table 1. Ordering information**

All types operate from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

Type number	Package		
	Name	Description	Version
HEF40106BP	DIP14	plastic dual in-line package; 14 leads (300 mil)	SOT27-1
HEF40106BT	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
HEF40106BTT	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1

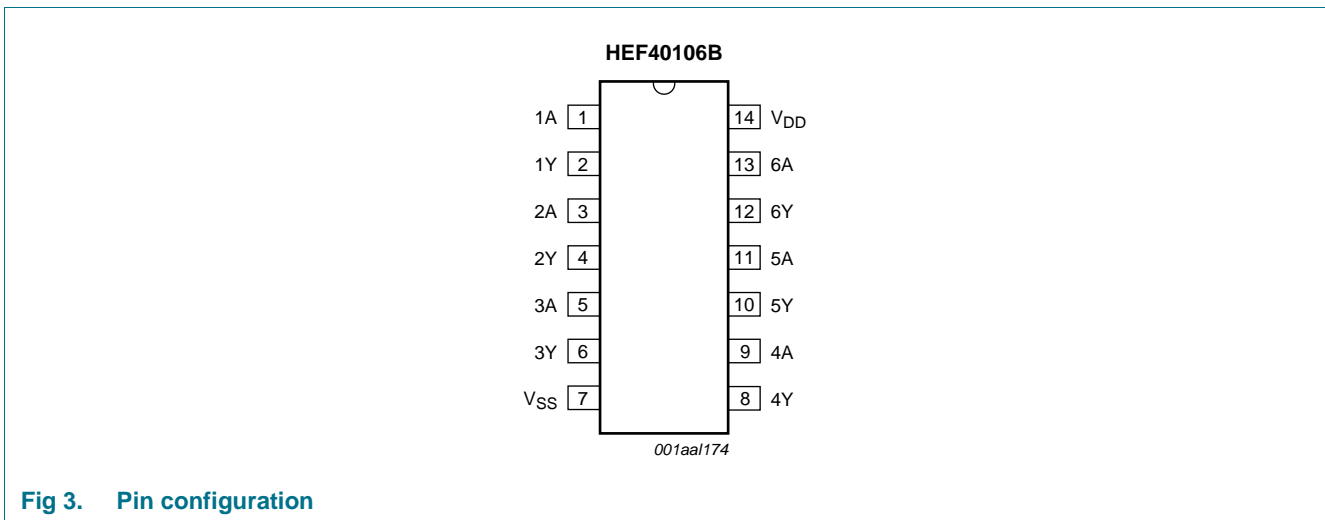


## 5. Functional diagram



## 6. Pinning information

### 6.1 Pinning



**Fig 3. Pin configuration**

## 6.2 Pin description

**Table 2.** Pin description

Symbol	Pin	Description
1A to 6A	1, 3, 5, 9, 11, 13	input
1Y to 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<sup>[1]</sup>

Input	Output
nA	nY
L	H
H	L

[1] H = HIGH voltage level; L = LOW voltage level.

## 8. Limiting values

**Table 4.** Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to V<sub>SS</sub> = 0 V (ground).

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DD</sub>	supply voltage		-0.5	+18	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>DD</sub> + 0.5 V	-	±10	mA
V <sub>I</sub>	input voltage		-0.5	V <sub>DD</sub> + 0.5	V
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < -0.5 V or V <sub>O</sub> > V <sub>DD</sub> + 0.5 V	-	±10	mA
I <sub>I/O</sub>	input/output current		-	±10	mA
I <sub>DD</sub>	supply current		-	50	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
T <sub>amb</sub>	ambient temperature		-40	+125	°C
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = -40 °C to +125 °C			
		DIP14	[1] -	750	mW
		SO14	[2] -	500	mW
		TSSOP14	[3] -	500	mW
P	power dissipation	per output	-	100	mW

[1] For DIP14 packages: above T<sub>amb</sub> = 70 °C, P<sub>tot</sub> derates linearly with 12 mW/K.

[2] For SO14 packages: above T<sub>amb</sub> = 70 °C, P<sub>tot</sub> derates linearly with 8 mW/K.

[3] For TSSOP14 packages: above T<sub>amb</sub> = 60 °C, P<sub>tot</sub> derates linearly with 5.5 mW/K.

## 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$ $\mu$ 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$ $\mu$ 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	$V_O = 2.5$ 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
$I_{OL}$	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		15 V	-	$\pm 0.1$	-	$\pm 0.1$	-	$\pm 1.0$	-	$\pm 1.0$	$\mu$ A
$I_{DD}$	supply current	all valid input combinations; $I_O = 0$ A	5 V	-	0.25	-	0.25	-	7.5	-	7.5	$\mu$ A
			10 V	-	0.5	-	0.5	-	15.0	-	15.0	$\mu$ A
			15 V	-	1.0	-	1.0	-	30.0	-	30.0	$\mu$ A
$C_I$	input capacitance			-	-	-	7.5	-	-	-	pF	

## 11. Dynamic characteristics

**Table 7. Dynamic characteristics**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $C_L = 50\text{ pF}$ ;  $t_r = t_f \leq 20\text{ ns}$ ; wave forms see [Figure 4](#); test circuit see [Figure 5](#); unless otherwise specified.

Symbol	Parameter	Conditions	V <sub>DD</sub>	Extrapolation formula <sup>[1]</sup>	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

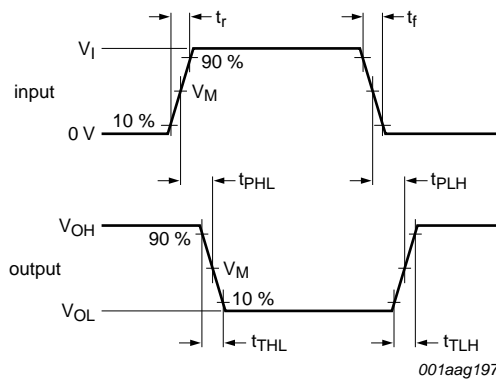
[1] Typical value of the propagation delay and output transition time can be calculated with the extrapolation formula (C<sub>L</sub> in pF).

**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	$P_D = 2300 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ (μW)	f <sub>i</sub> = input frequency in MHz;
		10 V	$P_D = 9000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ (μW)	f <sub>o</sub> = output frequency in MHz;
		15 V	$P_D = 20000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$ (μW)	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.

12. Waveforms

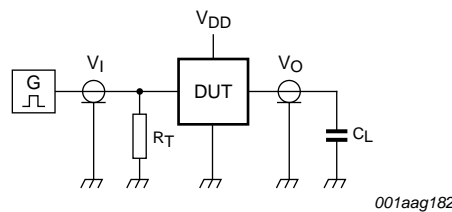


Measurement points are given in [Table 9](#).  
 Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.  
 $t_r$ ,  $t_f$  = input rise and fall times.

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



Test data given in [Table 10](#).  
 Definitions for test circuit:  
 DUT = Device Under Test.  
 $C_L$  = 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

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

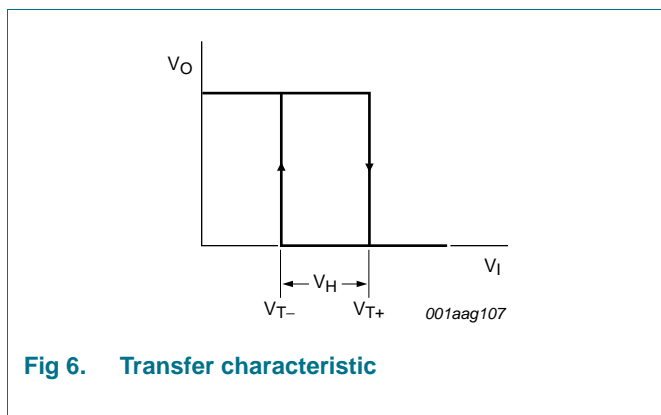
### 13. Transfer characteristics

**Table 11. Transfer characteristics**

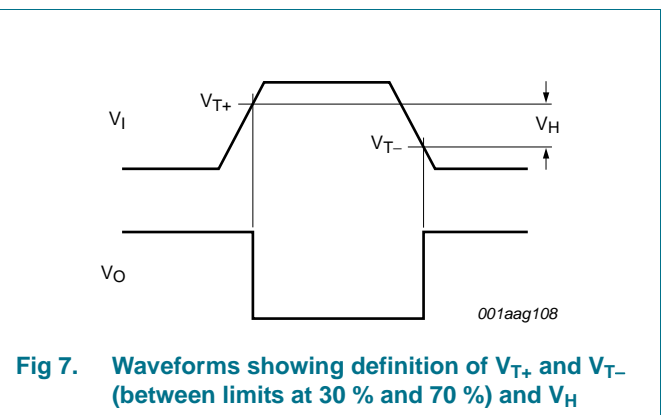
$V_{SS} = 0\text{ V}$ ; see [Figure 6](#) and [Figure 7](#).

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 <sup>[1]</sup>	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

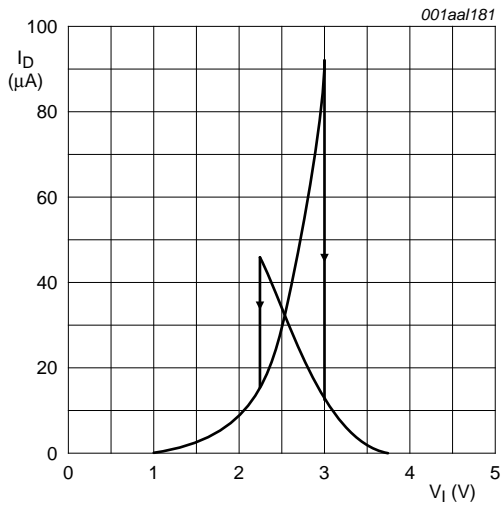
[1] All typical values are at  $T_{amb} = 25\text{ °C}$ .



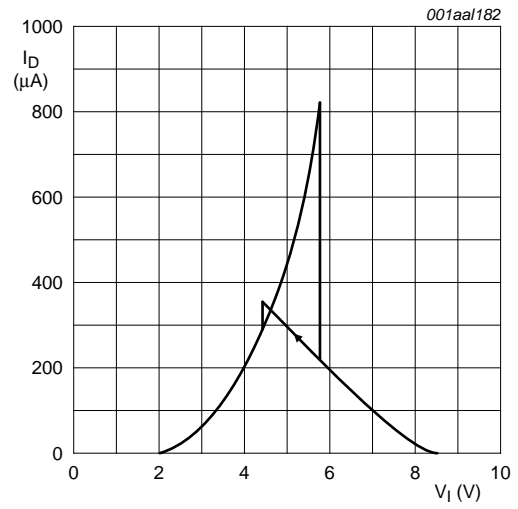
**Fig 6. Transfer characteristic**



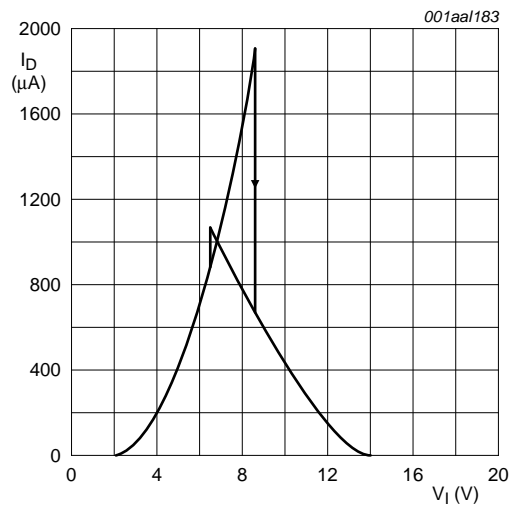
**Fig 7. Waveforms showing definition of  $V_{T+}$  and  $V_{T-}$  (between limits at 30% and 70%) and  $V_H$**



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



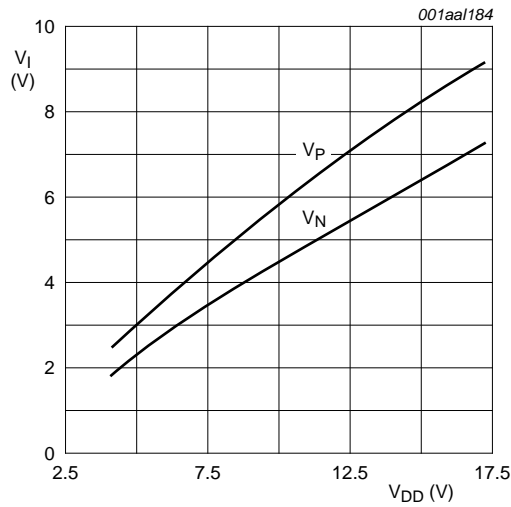
b.  $V_{DD} = 10\text{ V}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$



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

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





T<sub>amb</sub> = 25 °C.

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

## 14. Application information

Some examples of applications for the HEF40106B are:

- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

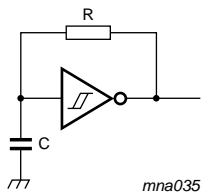


Fig 10. Astable multivibrator

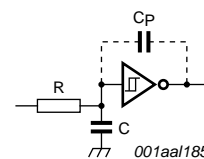


Fig 11. Schmitt trigger driven via a high-impedance input

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.

15. Package outline

DIP14: plastic dual in-line package; 14 leads (300 mil)

SOT27-1

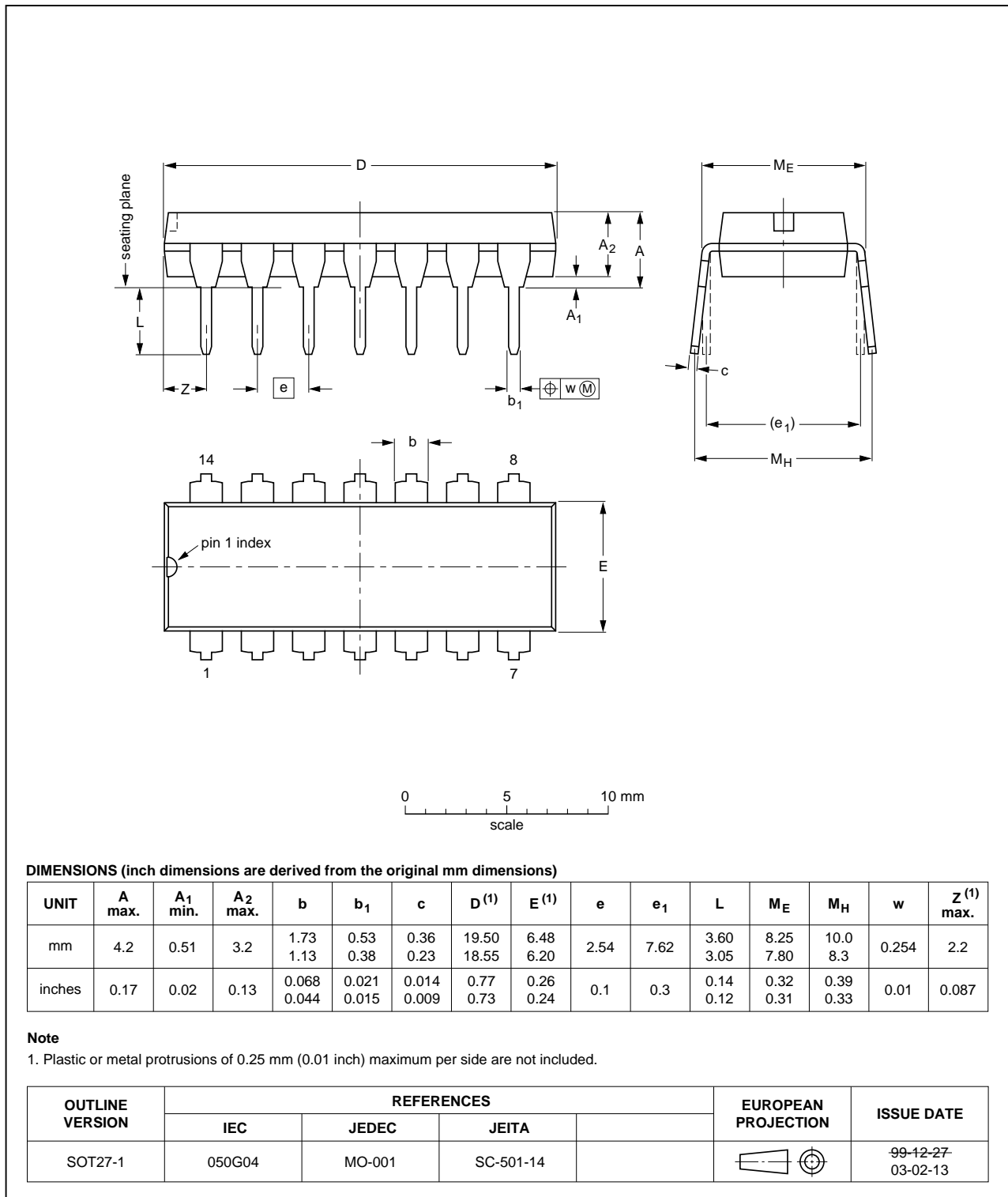


Fig 12. Package outline SOT27-1 (DIP14)

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

SOT108-1

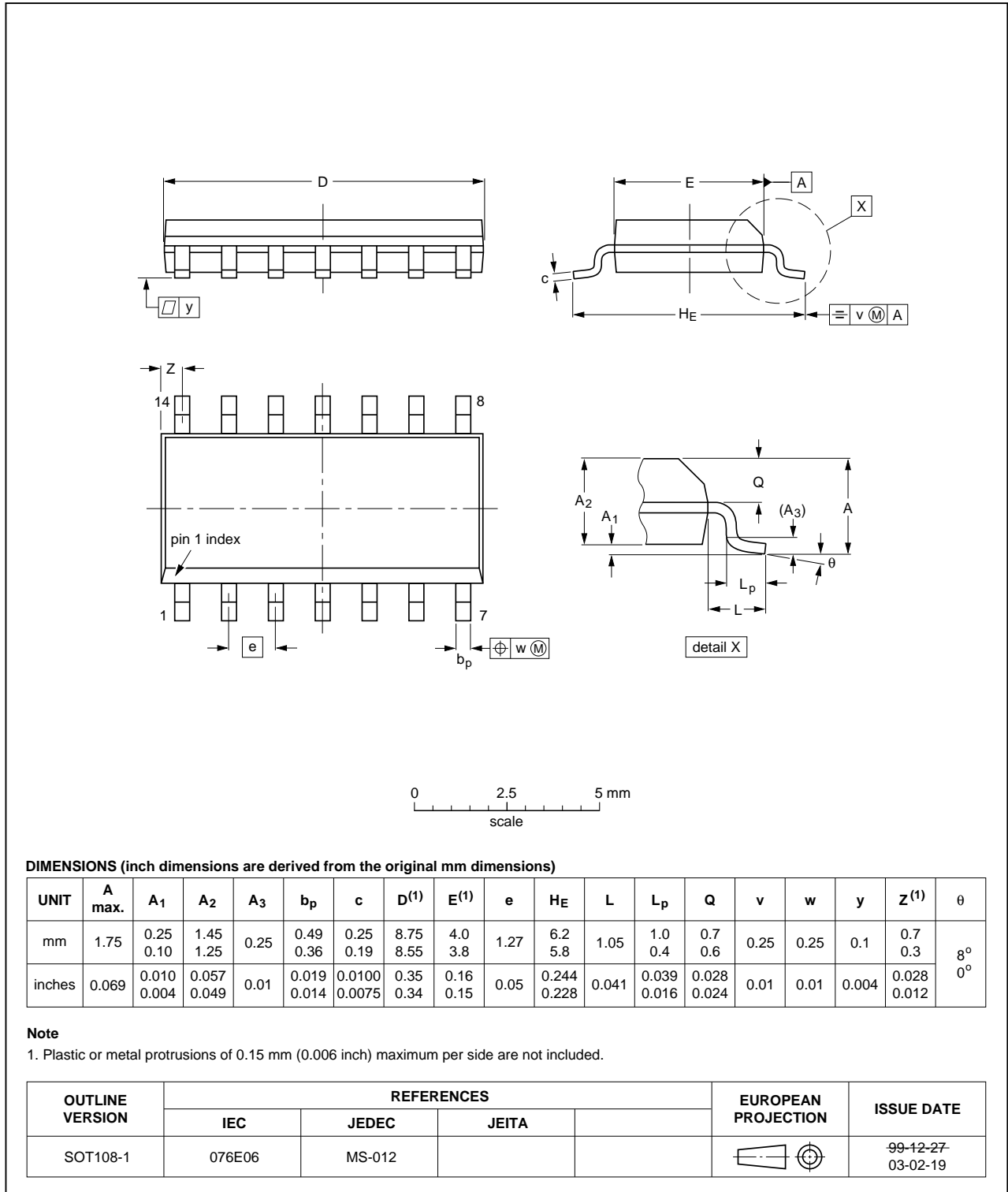


Fig 13. Package outline SOT108-1 (SO14)

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

SOT402-1

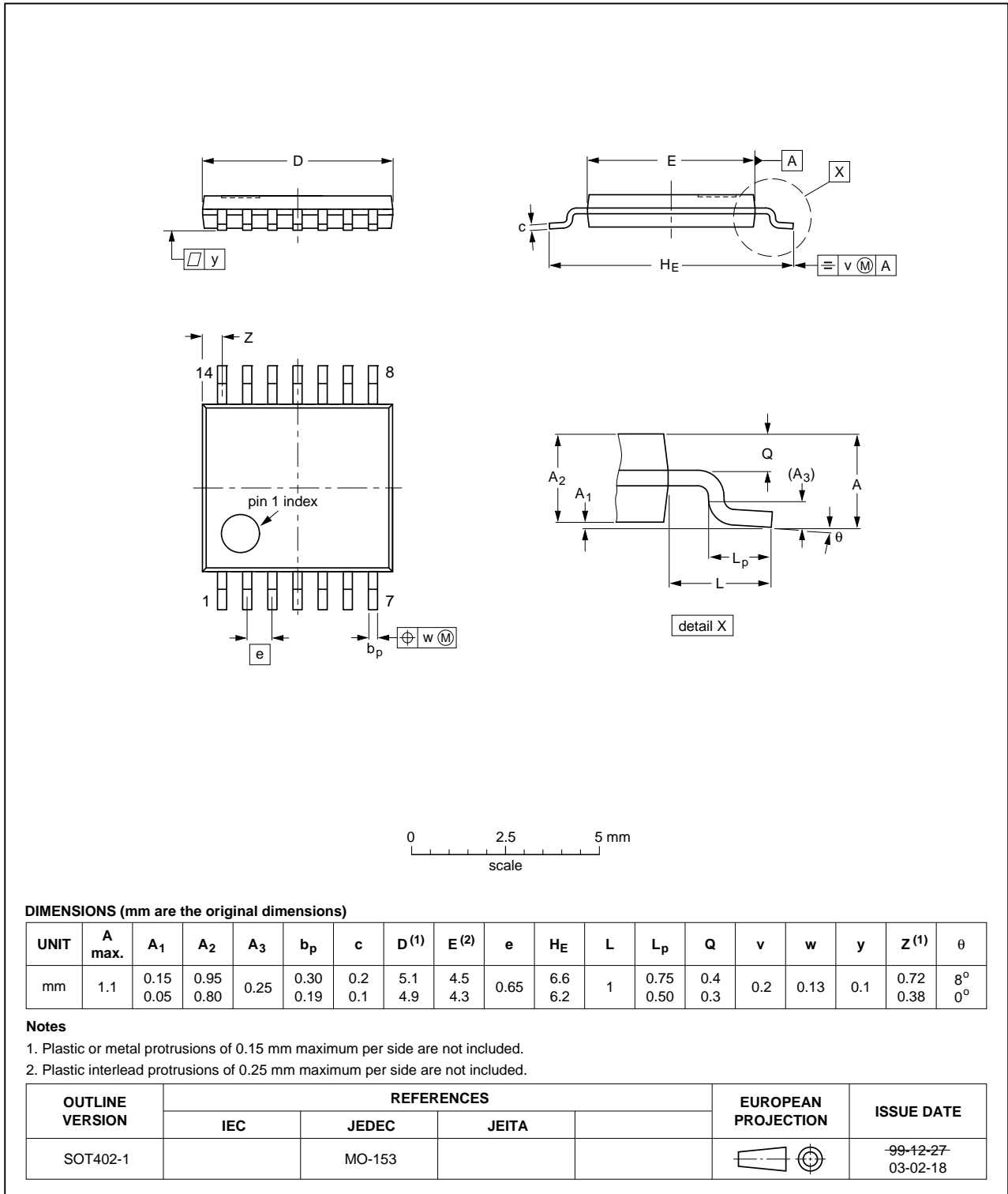


Fig 14. Package outline SOT402-1 (TSSOP14)

## 16. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
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 “General description” and “Features and benefits”.</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

### 17.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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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