

# HEF4011B

## Quad 2-input NAND gate

Rev. 5 — 21 November 2011

Product data sheet

### 1. General description

The HEF4011B is a quad 2-input NAND gate. The outputs are fully buffered for the highest noise immunity and pattern insensitivity to output impedance.

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

- 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
- Inputs and outputs are protected against electrostatic effects

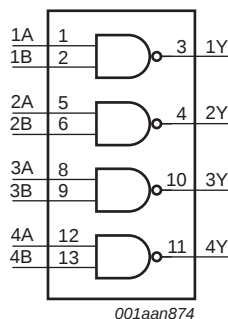
### 3. Ordering information

**Table 1.** Ordering information

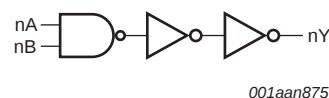
All types operate from  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

| Type number | Package |                                                            | Version  |
|-------------|---------|------------------------------------------------------------|----------|
|             | Name    | Description                                                |          |
| HEF4011BP   | DIP14   | plastic dual in-line package; 14 leads (300 mil)           | SOT27-1  |
| HEF4011BT   | SO14    | plastic small outline package; 14 leads; body width 3.9 mm | SOT108-1 |

### 4. Functional diagram



**Fig 1.** Functional diagram



**Fig 2.** Logic diagram (one gate)



5. Pinning information

5.1 Pinning

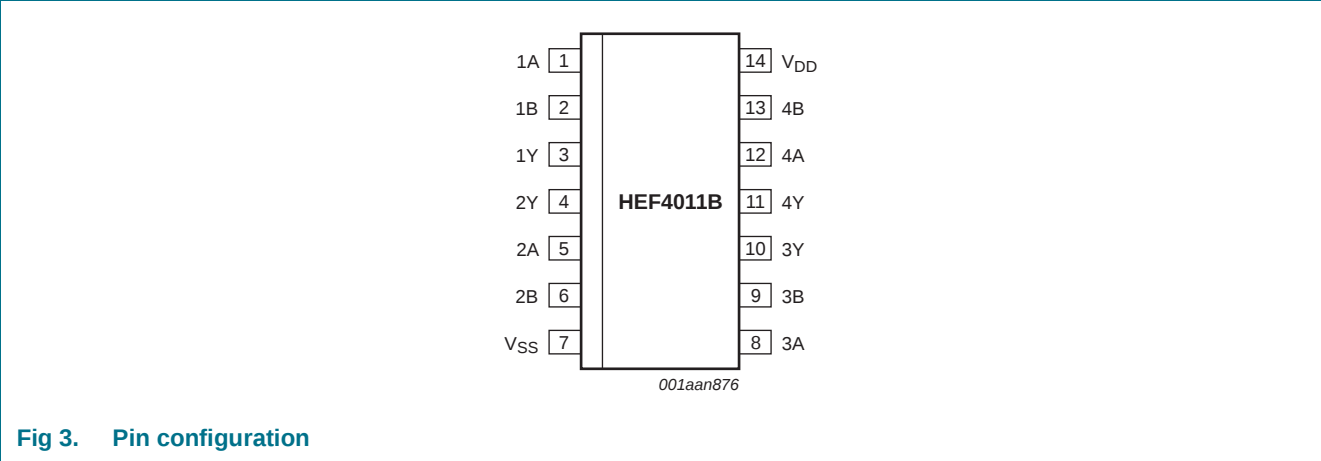


Fig 3. Pin configuration

5.2 Pin description

Table 2. Pin description

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

6. Functional description

Table 3. Function table<sup>[1]</sup>

| Input |    | Output |
|-------|----|--------|
| nA    | nB | nY     |
| L     | L  | H      |
| L     | H  | H      |
| H     | L  | H      |
| H     | H  | L      |

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

## 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 | -                     | $\pm 10$       | 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   |
| $I_{IO}$  | 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          |                       |                |      |
|           |                         | DIP14                                    | <a href="#">[1]</a> - | 750            | mW   |
|           |                         | SO14                                     | <a href="#">[2]</a> - | 500            | mW   |
| P         | power dissipation       | per output                               | -                     | 100            | mW   |

[1] For DIP14 packages: above  $T_{amb} = 70$  °C,  $P_{tot}$  derates linearly with 12 mW/K.

[2] For SO14 packages: above  $T_{amb} = 70$  °C,  $P_{tot}$  derates linearly with 8 mW/K.

## 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     | $\mu\text{s/V}$ |
|                     |                                     | $V_{DD} = 10$ V | -   | -   | 0.5      | $\mu\text{s/V}$ |
|                     |                                     | $V_{DD} = 15$ V | -   | -   | 0.08     | $\mu\text{s/V}$ |

## 9. 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       |               |
| $V_{IH}$ | HIGH-level input voltage  | $ I_O  < 1\text{ }\mu\text{A}$                      | 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\text{ }\mu\text{A}$                      | 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\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;<br>$I_O = 0\text{ A}$ | 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            |

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ; for waveforms see [Figure 4](#); for test circuit see [Figure 5](#); unless otherwise specified.

| Symbol           | Parameter                          | Extrapolation formula <sup>[1]</sup> | V <sub>DD</sub> | Min              | Typ | Max | Unit |
|------------------|------------------------------------|--------------------------------------|-----------------|------------------|-----|-----|------|
| t <sub>pd</sub>  | propagation delay                  | $28 + 0.55 \times C_L$               | 5 V             | <sup>[2]</sup> - | 55  | 110 | ns   |
|                  |                                    | $14 + 0.23 \times C_L$               | 10 V            | -                | 25  | 45  | ns   |
|                  |                                    | $12 + 0.16 \times C_L$               | 15 V            | -                | 20  | 35  | ns   |
| t <sub>THL</sub> | HIGH to LOW output transition time | $10 + 1.00 \times C_L$               | 5 V             | -                | 60  | 120 | ns   |
|                  |                                    | $9 + 0.42 \times C_L$                | 10 V            | -                | 30  | 60  | ns   |
|                  |                                    | $6 + 0.28 \times C_L$                | 15 V            | -                | 20  | 40  | ns   |
| t <sub>TLH</sub> | LOW to HIGH output transition time | $10 + 1.00 \times C_L$               | 5 V             | -                | 60  | 120 | ns   |
|                  |                                    | $9 + 0.42 \times C_L$                | 10 V            | -                | 30  | 60  | ns   |
|                  |                                    | $6 + 0.28 \times C_L$                | 15 V            | -                | 20  | 40  | ns   |

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

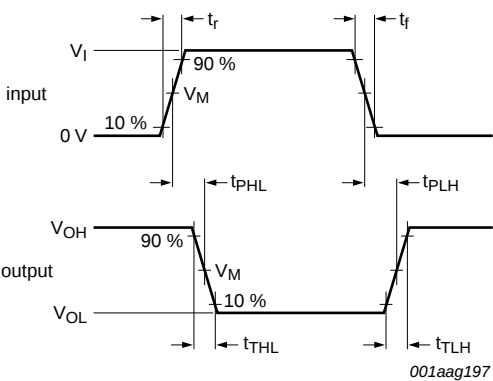
[2] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.

**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             | $P_D = 1300 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$  | f <sub>i</sub> = input frequency in MHz;<br>f <sub>o</sub> = output frequency in MHz;<br>C <sub>L</sub> = output load capacitance in pF;<br>$\Sigma(f_o \times C_L)$ = sum of the outputs;<br>V <sub>DD</sub> = supply voltage in V. |
|                |                           | 10 V            | $P_D = 6000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$  |                                                                                                                                                                                                                                      |
|                |                           | 15 V            | $P_D = 20100 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$ |                                                                                                                                                                                                                                      |

11. Waveforms

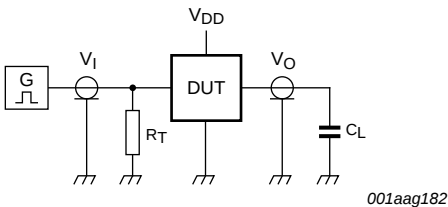


Measurement points are given in [Table 9](#).  
Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

Fig 4. Propagation delay, 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 is 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 for measuring switching times

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 $V_{DD}$ | $\leq 20$ ns | 50 pF |

12. Package outline

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

SOT27-1

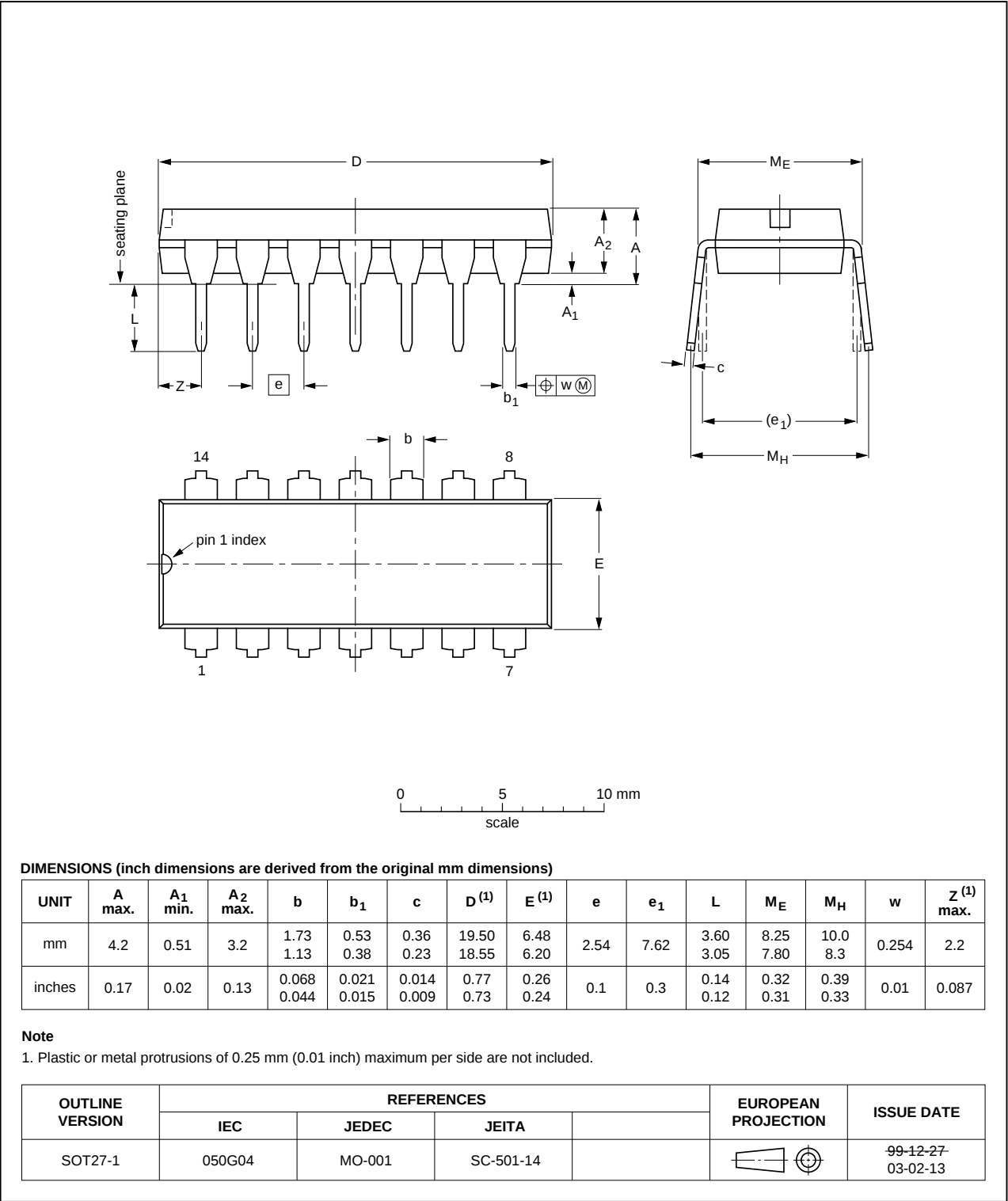


Fig 6. Package outline SOT27-1 (DIP14)

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

SOT108-1

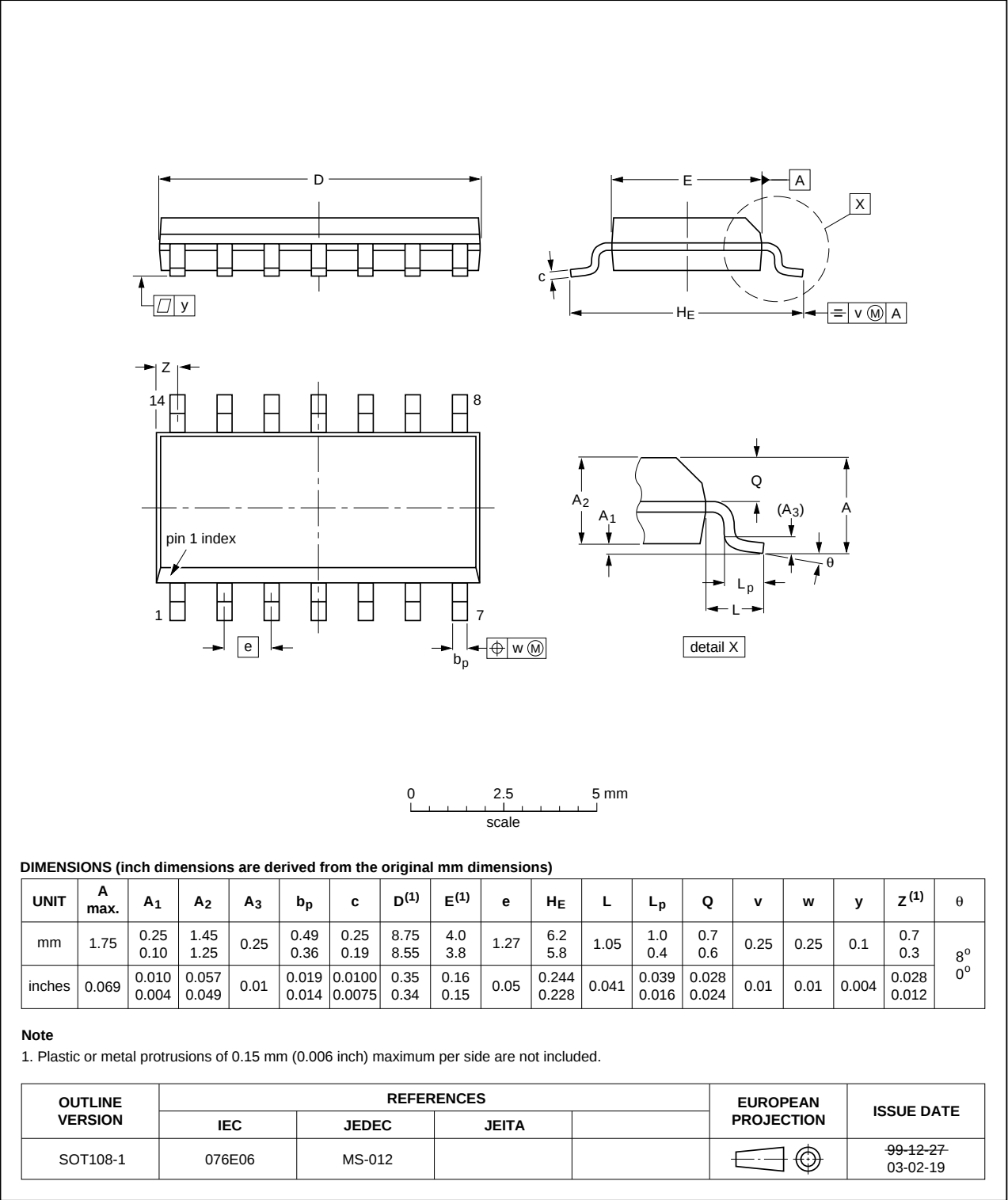


Fig 7. Package outline SOT108-1 (SO14)

## 13. Abbreviations

Table 11. Abbreviations

| Acronym | Description       |
|---------|-------------------|
| DUT     | Device Under Test |

## 14. Revision history

Table 12. Revision history

| Document ID      | Release date                                                                                                                                                                             | Data sheet status     | Change notice | Supersedes       |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------|------------------|
| HEF4011B v.5     | 20111121                                                                                                                                                                                 | Product data sheet    | -             | HEF4011B v.4     |
| Modifications:   | <ul style="list-style-type: none"><li>• Legal pages updated.</li><li>• Changes in “General description” and “Features and benefits”.</li><li>• Section “Applications” removed.</li></ul> |                       |               |                  |
| HEF4011B v.4     | 20110330                                                                                                                                                                                 | Product data sheet    | -             | HEF4011B_CNV v.3 |
| HEF4011B_CNV v.3 | 19950101                                                                                                                                                                                 | Product specification | -             | HEF4011B_CNV v.2 |
| HEF4011B_CNV v.2 | 19950101                                                                                                                                                                                 | Product specification | -             | -                |

## 15. Legal information

### 15.1 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".

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For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

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