



# HEF4011B

## Quad 2-input NAND gate

Rev. 7 — 23 July 2024

Product data sheet

### 1. General description

The HEF4011B is a quad 2-input NAND gate. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

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

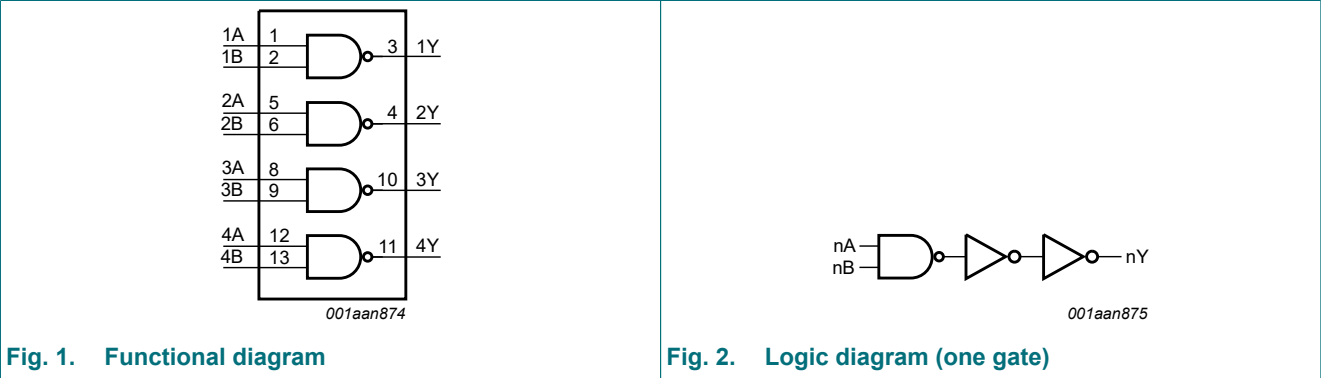
- Wide supply voltage range from 3.0 V to 15.0 V
- CMOS low power dissipation
- High noise immunity
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Complies with JEDEC standard JESD 13-B
- Inputs and outputs are protected against electrostatic effects
- ESD protection:
  - HBM: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2000 V
  - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 1000 V
- Specified from -40 °C to +125 °C

### 3. Ordering information

Table 1. Ordering information

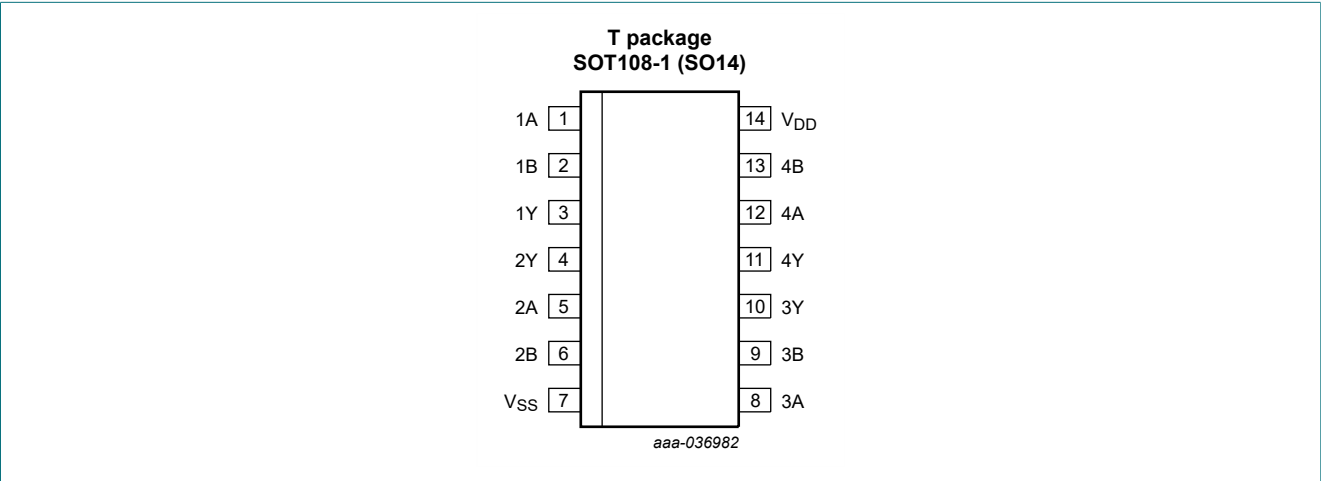
| Type number               | Package           |      |  |                          |
|---------------------------|-------------------|------|--|--------------------------|
|                           | Temperature range | Name | Description  | Version                  |
| <a href="#">HEF4011BT</a> | -40 °C to +125 °C | SO14 | plastic small outline package; 14 leads; body width 3.9 mm | <a href="#">SOT108-1</a> |

4. Functional diagram



5. Pinning information

5.1. Pinning



5.2. 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 <sub>SS</sub> | 7            | ground (0 V)   |
| V <sub>DD</sub> | 14           | supply voltage |

6. 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      |

7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to  $V_{SS} = 0\text{ V}$  (ground).

| Symbol    | Parameter               | Conditions   | Min  | Max            | Unit |
|-----------|-------------------------|--|------|----------------|------|
| $V_{DD}$  | supply voltage          |  | -0.5 | +18            | V    |
| $I_{IK}$  | input clamping current  | $V_I < -0.5\text{ V}$ or $V_I > V_{DD} + 0.5\text{ V}$ | -    | $\pm 10$       | mA   |
| $V_I$     | input voltage           |  | -0.5 | $V_{DD} + 0.5$ | V    |
| $I_{OK}$  | output clamping current | $V_O < -0.5\text{ V}$ or $V_O > V_{DD} + 0.5\text{ V}$ | -    | $\pm 10$       | 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 | $T_{amb} = -40\text{ °C to } +125\text{ °C}$ [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.

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 | $V_{DD} = 5\text{ V}$  | -   | -   | 3.75     | $\mu\text{s/V}$ |
|                     |                                     | $V_{DD} = 10\text{ V}$ | -   | -   | 0.5      | $\mu\text{s/V}$ |
|                     |                                     | $V_{DD} = 15\text{ V}$ | -   | -   | 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 <sub>DD</sub> | T <sub>amb</sub> = -40 °C |       | T <sub>amb</sub> = +25 °C |      | T <sub>amb</sub> = +85 °C |       | T <sub>amb</sub> = +125 °C |       | Unit |
|-----------------|---------------------------|---|-----------------|---------------------------|-------|---------------------------|------|---------------------------|-------|----------------------------|-------|------|
|                 |                           |   |                 | Min                       | Max   | Min                       | Max  | Min                       | Max   | Min                        | Max   |      |
| V <sub>IH</sub> | HIGH-level input voltage  | I <sub>O</sub>   < 1 µA                               | 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 <sub>IL</sub> | LOW-level input voltage   | I <sub>O</sub>   < 1 µA                               | 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 <sub>OH</sub> | HIGH-level output voltage | I <sub>O</sub>   < 1 µA                               | 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 <sub>OL</sub> | LOW-level output voltage  | I <sub>O</sub>   < 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 <sub>OH</sub> | HIGH-level output current | V <sub>O</sub> = 2.5 V                                | 5 V             | -                         | -1.7  | -                         | -1.4 | -                         | -1.1  | -                          | -1.1  | mA   |
|                 |                           | V <sub>O</sub> = 4.6 V                                | 5 V             | -                         | -0.64 | -                         | -0.5 | -                         | -0.36 | -                          | -0.36 | mA   |
|                 |                           | V <sub>O</sub> = 9.5 V                                | 10 V            | -                         | -1.6  | -                         | -1.3 | -                         | -0.9  | -                          | -0.9  | mA   |
|                 |                           | V <sub>O</sub> = 13.5 V                               | 15 V            | -                         | -4.2  | -                         | -3.4 | -                         | -2.4  | -                          | -2.4  | mA   |
| I <sub>OL</sub> | LOW-level output current  | V <sub>O</sub> = 0.4 V                                | 5 V             | 0.64                      | -     | 0.5                       | -    | 0.36                      | -     | 0.36                       | -     | mA   |
|                 |                           | V <sub>O</sub> = 0.5 V                                | 10 V            | 1.6                       | -     | 1.3                       | -    | 0.9                       | -     | 0.9                        | -     | mA   |
|                 |                           | V <sub>O</sub> = 1.5 V                                | 15 V            | 4.2                       | -     | 3.4                       | -    | 2.4                       | -     | 2.4                        | -     | mA   |
| I <sub>I</sub>  | input leakage current     |   | 15 V            | -                         | ±0.1  | -                         | ±0.1 | -                         | ±1.0  | -                          | ±1.0  | µA   |
| I <sub>DD</sub> | supply current            | all valid input combinations;<br>I <sub>O</sub> = 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 <sub>I</sub>  | input capacitance         |   |                 | -                         | -     | -                         | 7.5  | -                         | -     | -                          | -     | pF   |

10. Dynamic characteristics

Table 7. Dynamic characteristics

$T_{amb} = 25\text{ }^{\circ}\text{C}$  unless otherwise specified; for waveforms see Fig. 3; for test circuit see Fig. 4.

| Symbol           | Parameter                          | Extrapolation formula [1] | V <sub>DD</sub> | Min | Typ | Max | Unit |
|------------------|------------------------------------|---------------------------|-----------------|-----|-----|-----|------|
| t <sub>pd</sub>  | propagation delay [2]              | $28 + 0.55 \times C_L$    | 5 V             | -   | 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).

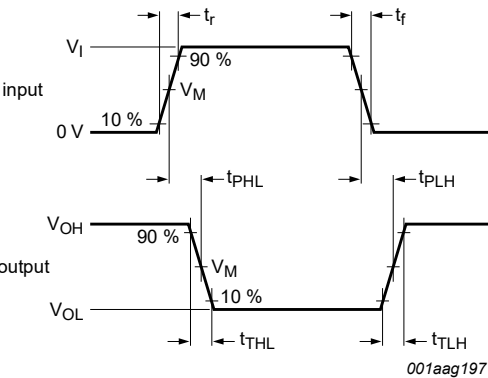
[2]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .

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             | $P_D = 1300 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$  | $f_i$ = input frequency in MHz;<br>$f_o$ = output frequency in MHz;<br>$C_L$ = output load capacitance in pF;<br>$\Sigma(f_o \times C_L)$ = sum of the outputs;<br>$V_{DD}$ = 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            | $P_D = 20100 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$ |  |

10.1. Waveforms and test circuit

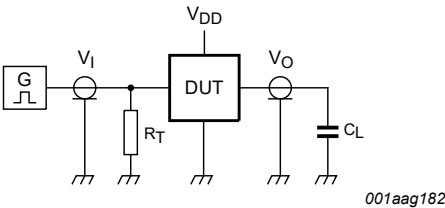


Measurement points are given in [Table 9](#).  
Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

Fig. 3. Propagation delay, output transition time

Table 9. Measurement points

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



Test data is 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  |
|----------------|----------------------|--------------|-------|
| $V_{DD}$       | $V_I$                | $t_r, t_f$   | $C_L$ |
| 5 V to 15 V    | $V_{SS}$ or $V_{DD}$ | $\leq 20$ ns | 50 pF |

11. Package outline

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

SOT108-1

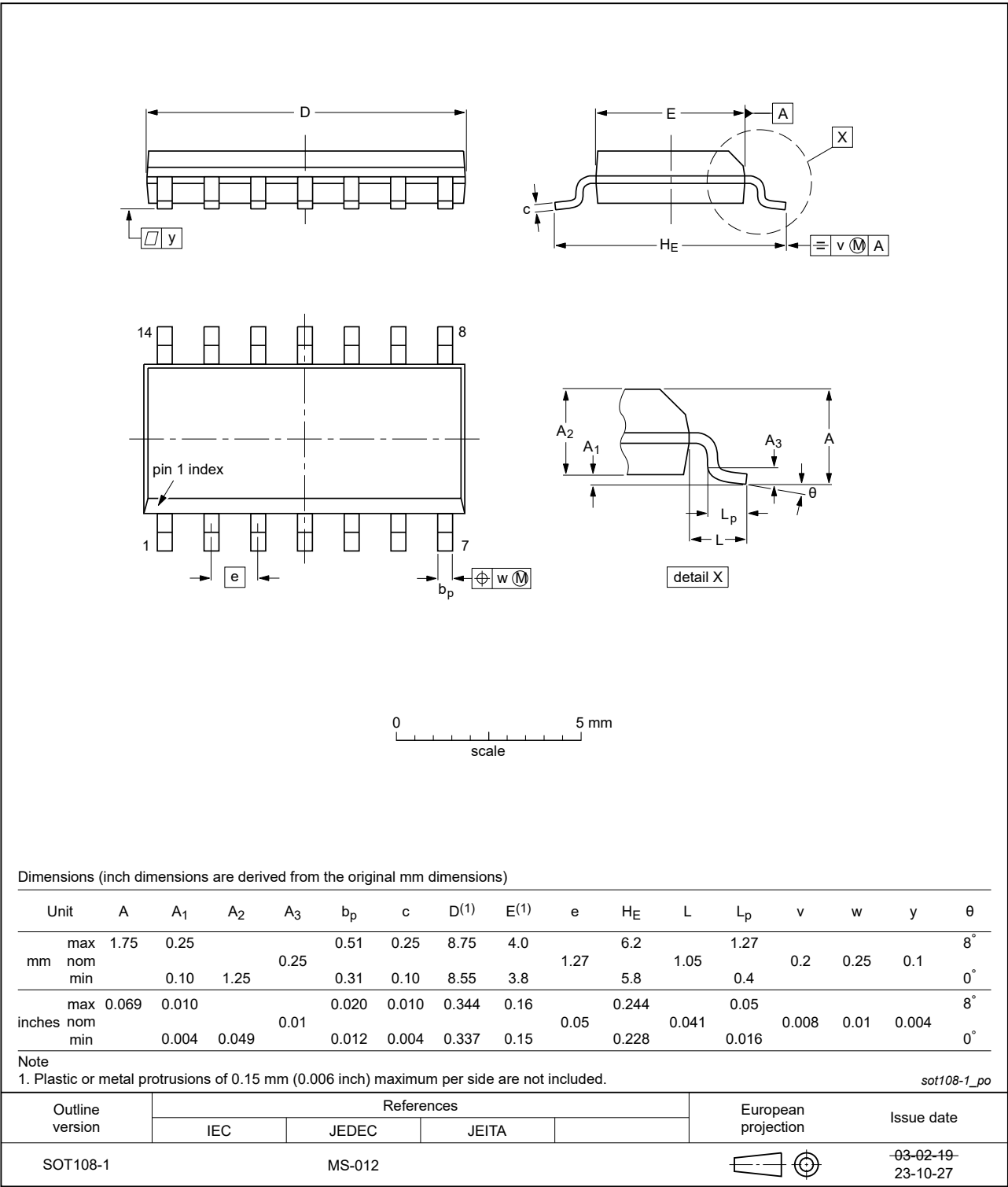


Fig. 5. Package outline SOT108-1 (SO14)

12. Abbreviations

Table 11. Abbreviations

| Acronym | Description                               |
|---------|---|
| ANSI    | American National Standards Institute     |
| CDM     | Charged Device Model                      |
| DUT     | Device Under Test                         |
| ESD     | ElectroStatic Discharge                   |
| ESDA    | ElectroStatic Discharge Association       |
| HBM     | Human Body Model                          |
| JEDEC   | Joint Electron Device Engineering Council |

13. Revision history

Table 12. Revision history

| Document ID      | Release date   | Data sheet status     | Change notice | Supersedes       |
|------------------|--|-----------------------|---------------|------------------|
| HEF4011B v.7     | 20240723   | Product data sheet    | -             | HEF4011B v.6     |
| 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 2</a>: ESD specification updated according to the latest JEDEC standard.</li><li><a href="#">Table 4</a>: Derating values for P<sub>tot</sub> total power dissipation updated.</li><li><a href="#">Fig. 5</a>: Aligned SO package outline drawing to JEDEC MS-012</li></ul> |                       |               |                  |
| HEF4011B v.6     | 20151210   | Product data sheet    | -             | HEF4011B v.5     |
| Modifications:   | <ul style="list-style-type: none"><li>Type number HEF4011BP (SOT27-1) removed.</li></ul>   |                       |               |                  |
| 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 | -             | -                |



## 14. 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. |
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- [1] Please consult the most recently issued document before initiating or completing a design.
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