

# 74LV86

## Quad 2-input exclusive-OR gate

Rev. 03 — 27 November 2007

Product data sheet

### 1. General description

The 74LV86 is a low-voltage Si-gate CMOS device that is pin and function compatible with 74HC86 and 74HCT86.

The 74LV86 provides a quad 2-input exclusive-OR function.

### 2. Features

- Wide operating voltage: 1.0 V to 5.5 V
- Optimized for low voltage applications: 1.0 V to 3.6 V
- Accepts TTL input levels between  $V_{CC} = 2.7$  V and  $V_{CC} = 3.6$  V
- Typical output ground bounce < 0.8 V at  $V_{CC} = 3.3$  V and  $T_{amb} = 25$  °C
- Typical HIGH-level output voltage ( $V_{OH}$ ) undershoot: > 2 V at  $V_{CC} = 3.3$  V and  $T_{amb} = 25$  °C
- ESD protection:
  - ◆ HBM JESD22-A114E exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

### 3. Ordering information

Table 1. Ordering information

| Type number | Package           |          |  |          |
|-------------|-------------------|----------|--|----------|
|             | Temperature range | Name     | Description  | Version  |
| 74LV86N     | -40 °C to +125 °C | DIP14    | plastic dual in-line package; 14 leads (300 mil)   | SOT27-1  |
| 74LV86D     | -40 °C to +125 °C | SO14     | plastic small outline package; 14 leads;<br>body width 3.9 mm  | SOT108-1 |
| 74LV86DB    | -40 °C to +125 °C | SSOP14   | plastic shrink small outline package; 14 leads;<br>body width 5.3 mm   | SOT337-1 |
| 74LV86PW    | -40 °C to +125 °C | TSSOP14  | plastic thin shrink small outline package; 14 leads;<br>body width 4.4 mm  | SOT402-1 |
| 74LV86BQ    | -40 °C to +125 °C | DHVQFN14 | plastic dual in-line compatible thermal enhanced very<br>thin quad flat package; no leads; 14 terminals;<br>body 2.5 × 3 × 0.85 mm | SOT762-1 |

### 4. Functional diagram

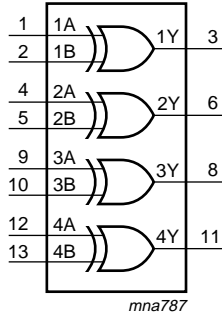


Fig 1. Logic symbol

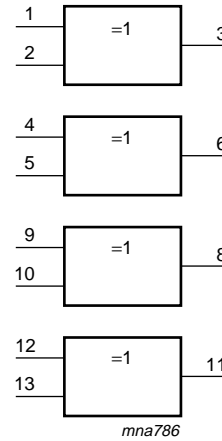


Fig 2. IEC logic symbol

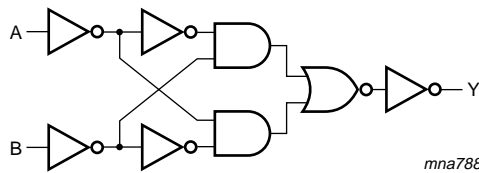


Fig 3. Logic diagram (one gate)

### 5. Pinning information

#### 5.1 Pinning

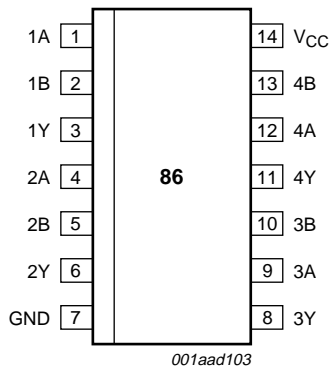
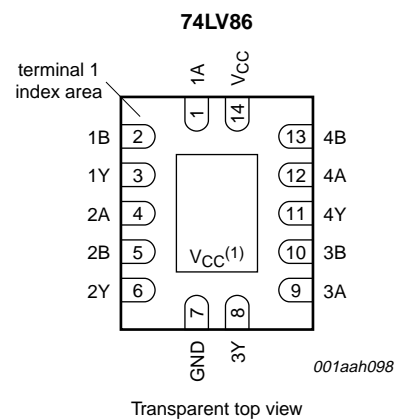


Fig 4. Pin configuration DIP14, SO14 and (T)SSOP14



(1) The die substrate is attached to this pad using conductive die attach material. It can not be used as a supply pin or input.

Fig 5. Pin configuration DHVQFN14

## 5.2 Pin description

**Table 2.** Pin description

| Symbol          | Pin | Description    |
|-----------------|-----|----------------|
| 1A              | 1   | data input     |
| 1B              | 2   | data input     |
| 1Y              | 3   | data output    |
| 2A              | 4   | data input     |
| 2B              | 5   | data input     |
| 2Y              | 6   | data output    |
| GND             | 7   | ground (0 V)   |
| 3Y              | 8   | data output    |
| 3A              | 9   | data input     |
| 3B              | 10  | data input     |
| 4Y              | 11  | data output    |
| 4A              | 12  | data input     |
| 4B              | 13  | data input     |
| V <sub>CC</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  | L      |
| 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 GND (ground = 0 V).

| Symbol           | Parameter               | Conditions   | Min   | Max  | Unit |
|------------------|-------------------------|--|-------|------|------|
| V <sub>CC</sub>  | supply voltage          |  | -0.5  | +7.0 | V    |
| I <sub>IK</sub>  | input clamping current  | $V_I < -0.5 \text{ V}$ or $V_I > V_{CC} + 0.5 \text{ V}$ | [1] - | ±20  | mA   |
| I <sub>OK</sub>  | output clamping current | $V_O < -0.5 \text{ V}$ or $V_O > V_{CC} + 0.5 \text{ V}$ | [1] - | ±50  | mA   |
| I <sub>O</sub>   | output current          | $V_O = -0.5 \text{ V}$ to $(V_{CC} + 0.5 \text{ V})$     | -     | ±25  | mA   |
| I <sub>CC</sub>  | supply current          |  | -     | 50   | mA   |
| I <sub>GND</sub> | ground current          |  | -50   | -    | mA   |
| T <sub>stg</sub> | storage temperature     |  | -65   | +150 | °C   |

**Table 4. Limiting values ...continued**

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

| Symbol           | Parameter               | Conditions                           | Min   | Max | Unit |
|------------------|-------------------------|--------------------------------------|-------|-----|------|
| P <sub>tot</sub> | total power dissipation | T <sub>amb</sub> = -40 °C to +125 °C |       |     |      |
|                  | DIP14 package           |                                      | [2] - | 750 | mW   |
|                  | SO14 package            |                                      | [3] - | 500 | mW   |
|                  | (T)SSOP14 package       |                                      | [4] - | 500 | mW   |
|                  | DHVQFN14 package        |                                      | [5] - | 500 | mW   |

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] P<sub>tot</sub> derates linearly with 12 mW/K above 70 °C.

[3] P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C.

[4] P<sub>tot</sub> derates linearly with 5.5 mW/K above 60 °C.

[5] P<sub>tot</sub> derates linearly with 4.5 mW/K above 60 °C.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

Voltages are referenced to GND (ground = 0 V).

| Symbol           | Parameter                           | Conditions                       | Min | Typ | Max             | Unit |
|------------------|-------------------------------------|----------------------------------|-----|-----|-----------------|------|
| V <sub>CC</sub>  | supply voltage <sup>[1]</sup>       |                                  | 1.0 | 3.3 | 5.5             | V    |
| V <sub>I</sub>   | input voltage                       |                                  | 0   | -   | V <sub>CC</sub> | V    |
| V <sub>O</sub>   | output voltage                      |                                  | 0   | -   | V <sub>CC</sub> | V    |
| T <sub>amb</sub> | ambient temperature                 |                                  | -40 | +25 | +125            | °C   |
| Δt/ΔV            | input transition rise and fall rate | V <sub>CC</sub> = 1.0 V to 2.0 V | -   | -   | 500             | ns/V |
|                  |                                     | V <sub>CC</sub> = 2.0 V to 2.7 V | -   | -   | 200             | ns/V |
|                  |                                     | V <sub>CC</sub> = 2.7 V to 3.6 V | -   | -   | 100             | ns/V |
|                  |                                     | V <sub>CC</sub> = 3.6 V to 5.5 V | -   | -   | 50              | ns/V |

[1] The static characteristics are guaranteed from V<sub>CC</sub> = 1.2 V to V<sub>CC</sub> = 5.5 V, but LV devices are guaranteed to function down to V<sub>CC</sub> = 1.0 V (with input levels GND or V<sub>CC</sub>).

## 9. Static characteristics

**Table 6. Static characteristics**

Voltages are referenced to GND (ground = 0 V).

| Symbol           | Parameter                 | Conditions  | -40 °C to +85 °C   |                    |                    | -40 °C to +125 °C  |                    | Unit |
|------------------|---------------------------|---|--------------------|--------------------|--------------------|--------------------|--------------------|------|
|                  |                           |   | Min                | Typ <sup>[1]</sup> | Max                | Min                | Max                |      |
| V <sub>IH</sub>  | HIGH-level input voltage  | V <sub>CC</sub> = 1.2 V   | 0.9                | -                  | -                  | 0.9                | -                  | V    |
|                  |                           | V <sub>CC</sub> = 2.0 V   | 1.4                | -                  | -                  | 1.4                | -                  | V    |
|                  |                           | V <sub>CC</sub> = 2.7 V to 3.6 V  | 2.0                | -                  | -                  | 2.0                | -                  | V    |
|                  |                           | V <sub>CC</sub> = 4.5 V to 5.5 V  | 0.7V <sub>CC</sub> | -                  | -                  | 0.7V <sub>CC</sub> | -                  | V    |
| V <sub>IL</sub>  | LOW-level input voltage   | V <sub>CC</sub> = 1.2 V   | -                  | -                  | 0.3                | -                  | 0.3                | V    |
|                  |                           | V <sub>CC</sub> = 2.0 V   | -                  | -                  | 0.6                | -                  | 0.6                | V    |
|                  |                           | V <sub>CC</sub> = 2.7 V to 3.6 V  | -                  | -                  | 0.8                | -                  | 0.8                | V    |
|                  |                           | V <sub>CC</sub> = 4.5 V to 5.5 V  | -                  | -                  | 0.3V <sub>CC</sub> | -                  | 0.3V <sub>CC</sub> | V    |
| V <sub>OH</sub>  | HIGH-level output voltage | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                       |                    |                    |                    |                    |                    |      |
|                  |                           | I <sub>O</sub> = -100 μA; V <sub>CC</sub> = 1.2 V   | -                  | 1.2                | -                  | -                  | -                  | V    |
|                  |                           | I <sub>O</sub> = -100 μA; V <sub>CC</sub> = 2.0 V   | 1.8                | 2.0                | -                  | 1.8                | -                  | V    |
|                  |                           | I <sub>O</sub> = -100 μA; V <sub>CC</sub> = 2.7 V   | 2.5                | 2.7                | -                  | 2.5                | -                  | V    |
|                  |                           | I <sub>O</sub> = -100 μA; V <sub>CC</sub> = 3.0 V   | 2.8                | 3.0                | -                  | 2.8                | -                  | V    |
|                  |                           | I <sub>O</sub> = -100 μA; V <sub>CC</sub> = 4.5 V   | 4.3                | 4.5                | -                  | 4.3                | -                  | V    |
|                  |                           | I <sub>O</sub> = -6 mA; V <sub>CC</sub> = 3.0 V   | 2.4                | 2.82               | -                  | 2.2                | -                  | V    |
|                  |                           | I <sub>O</sub> = -12 mA; V <sub>CC</sub> = 4.5 V  | 3.6                | 4.2                | -                  | 3.5                | -                  | V    |
| V <sub>OL</sub>  | LOW-level output voltage  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                       |                    |                    |                    |                    |                    |      |
|                  |                           | I <sub>O</sub> = 100 μA; V <sub>CC</sub> = 1.2 V  | -                  | 0                  | -                  | -                  | -                  | V    |
|                  |                           | I <sub>O</sub> = 100 μA; V <sub>CC</sub> = 2.0 V  | -                  | 0                  | 0.2                | -                  | 0.2                | V    |
|                  |                           | I <sub>O</sub> = 100 μA; V <sub>CC</sub> = 2.7 V  | -                  | 0                  | 0.2                | -                  | 0.2                | V    |
|                  |                           | I <sub>O</sub> = 100 μA; V <sub>CC</sub> = 3.0 V  | -                  | 0                  | 0.2                | -                  | 0.2                | V    |
|                  |                           | I <sub>O</sub> = 100 μA; V <sub>CC</sub> = 4.5 V  | -                  | 0                  | 0.2                | -                  | 0.2                | V    |
|                  |                           | I <sub>O</sub> = 6 mA; V <sub>CC</sub> = 3.0 V  | -                  | 0.25               | 0.40               | -                  | 0.50               | V    |
|                  |                           | I <sub>O</sub> = 12 mA; V <sub>CC</sub> = 4.5 V   | -                  | 0.35               | 0.55               | -                  | 0.65               | V    |
| I <sub>I</sub>   | input leakage current     | V <sub>I</sub> = V <sub>CC</sub> or GND;<br>V <sub>CC</sub> = 5.5 V                       | -                  | -                  | 1.0                | -                  | 1.0                | μA   |
| I <sub>CC</sub>  | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A;<br>V <sub>CC</sub> = 5.5 V | -                  | -                  | 20.0               | -                  | 40                 | μA   |
| ΔI <sub>CC</sub> | additional supply current | per input; V <sub>I</sub> = V <sub>CC</sub> - 0.6 V;<br>V <sub>CC</sub> = 2.7 V to 3.6 V  | -                  | -                  | 500                | -                  | 850                | μA   |
| C <sub>I</sub>   | input capacitance         |   | -                  | 3.5                | -                  | -                  | -                  | pF   |

[1] Typical values are measured at T<sub>amb</sub> = 25 °C.

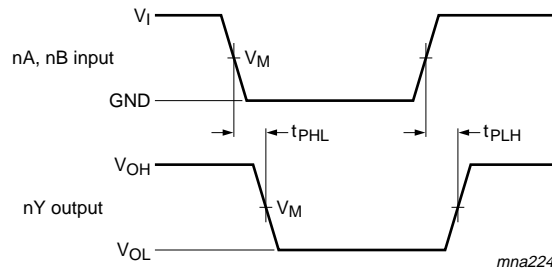
## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**  
*GND = 0 V; For test circuit see Figure 7.*

| Symbol          | Parameter                     | Conditions   | -40 °C to +85 °C |                    |     | -40 °C to +125 °C |     | Unit |
|-----------------|-------------------------------|--|------------------|--------------------|-----|-------------------|-----|------|
|                 |                               |  | Min              | Typ <sup>[1]</sup> | Max | Min               | Max |      |
| t <sub>pd</sub> | propagation delay             | nA, nB to nY; see Figure 6 <sup>[2]</sup>  |                  |                    |     |                   |     |      |
|                 |                               | V <sub>CC</sub> = 1.2 V  | -                | 70                 | -   | -                 | -   | ns   |
|                 |                               | V <sub>CC</sub> = 2.0 V  | -                | 24                 | 32  | -                 | 41  | ns   |
|                 |                               | V <sub>CC</sub> = 2.7 V  | -                | 18                 | 24  | -                 | 30  | ns   |
|                 |                               | V <sub>CC</sub> = 3.0 V to 3.6 V; C <sub>L</sub> = 15 pF <sup>[3]</sup>                                | -                | 11                 | -   | -                 | -   | ns   |
|                 |                               | V <sub>CC</sub> = 3.0 V to 3.6 V <sup>[3]</sup>  | -                | 13                 | 19  | -                 | 24  | ns   |
|                 |                               | V <sub>CC</sub> = 4.5 V to 5.5 V   | -                | -                  | 16  | -                 | 20  | ns   |
| C <sub>PD</sub> | power dissipation capacitance | C <sub>L</sub> = 50 pF; f <sub>i</sub> = 1 MHz; V <sub>i</sub> = GND to V <sub>CC</sub> <sup>[4]</sup> | -                | 30                 | -   | -                 | -   | pF   |

- [1] All typical values are measured at T<sub>amb</sub> = 25 °C.
- [2] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.
- [3] Typical values are measured at nominal supply voltage (V<sub>CC</sub> = 3.3 V).
- [4] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).  
 $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$  where:  
 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  
 V<sub>CC</sub> = supply voltage in V  
 N = number of inputs switching  
 $\Sigma(C_L \times V_{CC}^2 \times f_o)$  = sum of the outputs.

## 11. Waveforms



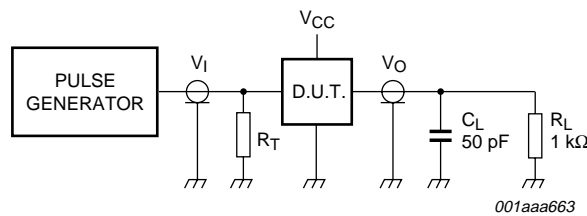
Measurement points are given in [Table 8](#).

$V_{OL}$  and  $V_{OH}$  are typical voltage output levels that occur with the output load.

**Fig 6. The input (nA, nB) to output (nY) propagation delays**

**Table 8. Measurement points**

| Supply voltage<br>$V_{CC}$ | Input<br>$V_M$ | Output<br>$V_M$ |
|----------------------------|----------------|-----------------|
| < 2.7 V                    | $0.5V_{CC}$    | $0.5V_{CC}$     |
| 2.7 V to 3.6 V             | 1.5 V          | 1.5 V           |
| $\geq 4.5$ V               | $0.5V_{CC}$    | $0.5V_{CC}$     |



Test data is given in [Table 9](#).

Definitions test circuit:

$R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator.

$R_L$  = Load resistance.

$C_L$  = Load capacitance including jig and probe capacitance.

**Fig 7. Load circuit for switching times**

**Table 9. Test data**

| Supply voltage<br>$V_{CC}$ | Input<br>$V_I$ | $t_r, t_f$    |
|----------------------------|----------------|---------------|
| < 2.7 V                    | $V_{CC}$       | $\leq 2.5$ ns |
| 2.7 V to 3.6 V             | 2.7 V          | $\leq 2.5$ ns |
| $\geq 4.5$ V               | $V_{CC}$       | $\leq 2.5$ ns |

12. Package outline

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

SOT27-1

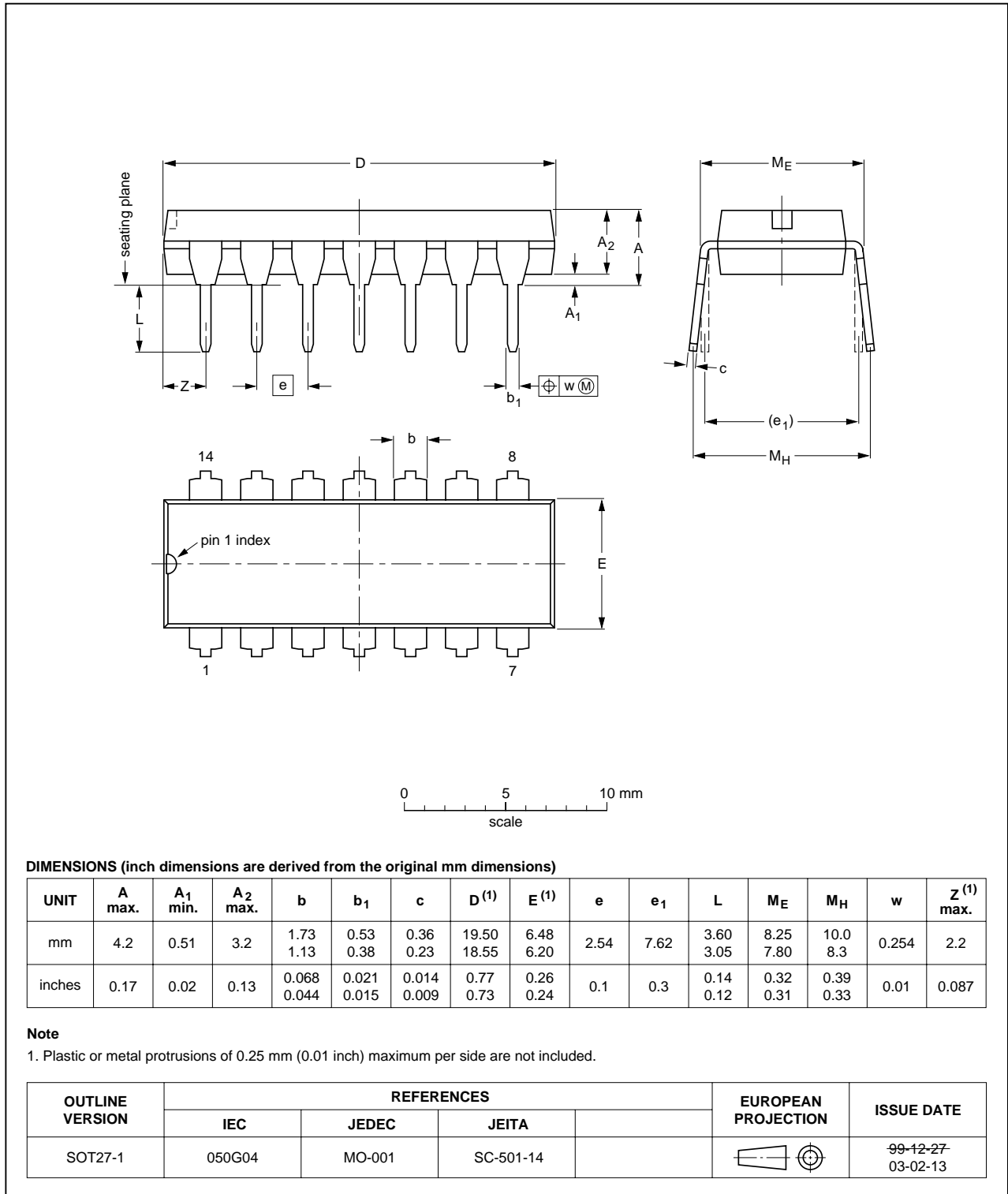


Fig 8. Package outline SOT27-1 (DIP14)



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

SOT108-1

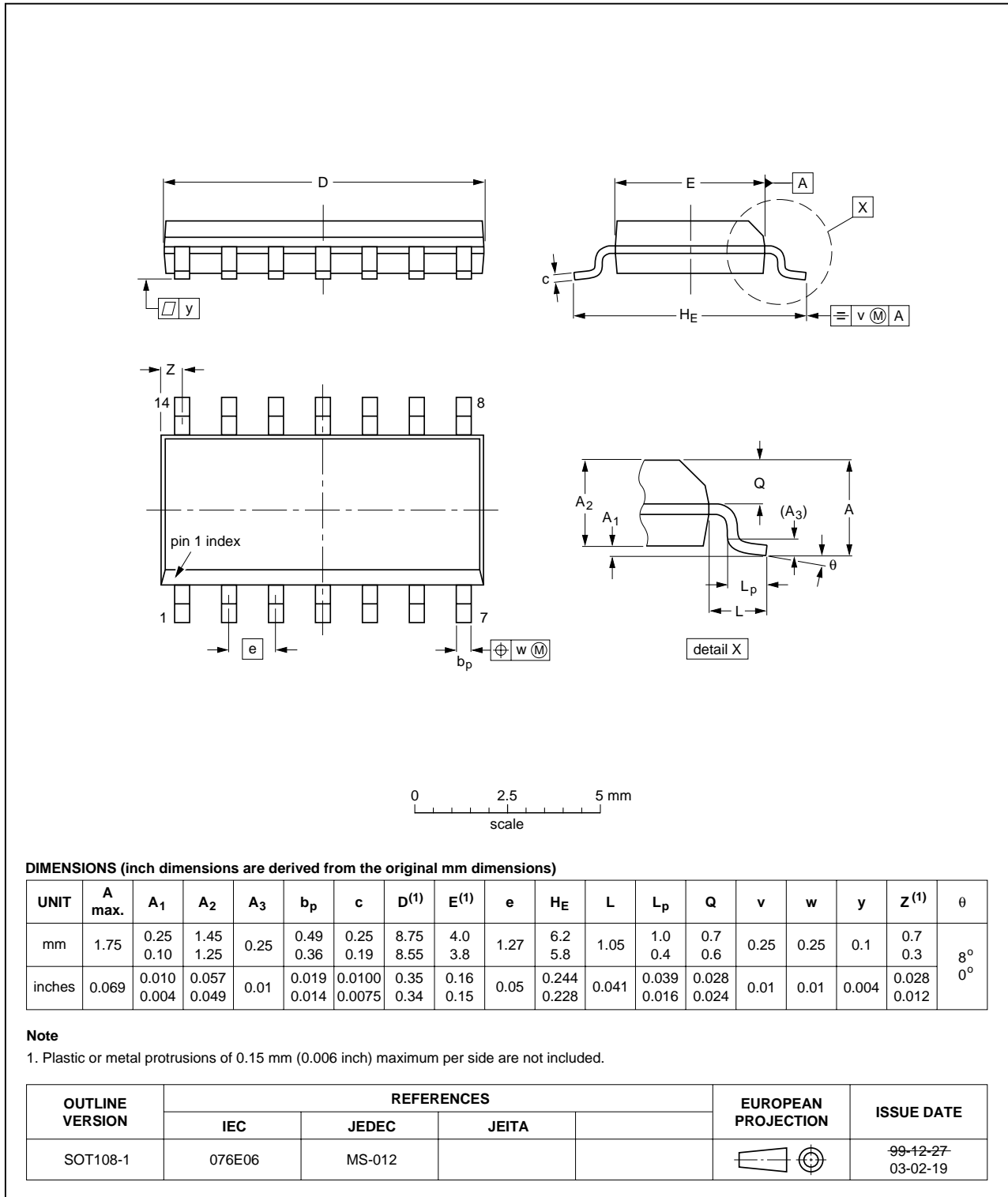


Fig 9. Package outline SOT108-1 (SO14)

SSOP14: plastic shrink small outline package; 14 leads; body width 5.3 mm

SOT337-1

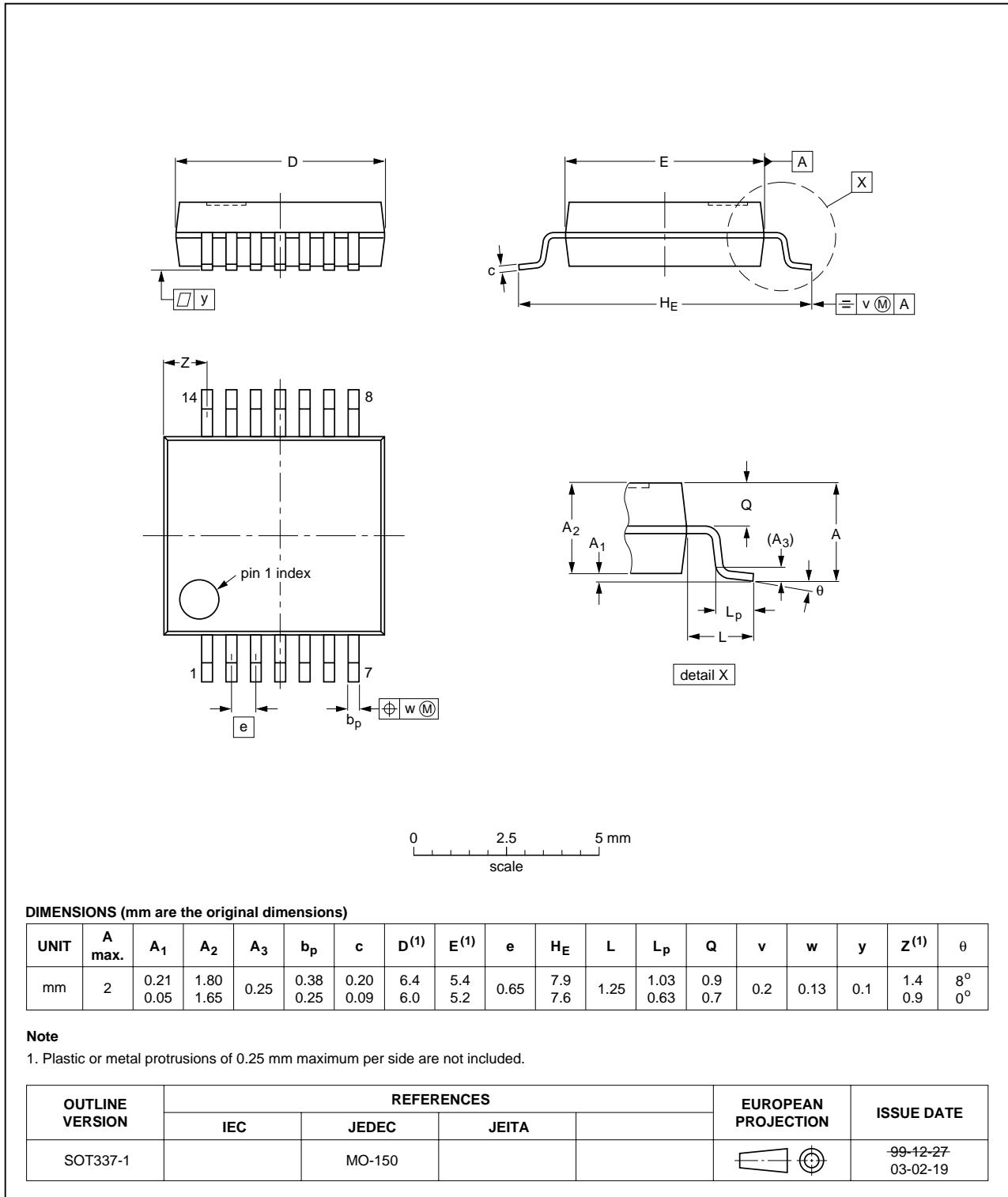


Fig 10. Package outline SOT337-1 (SSOP14)

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

SOT402-1

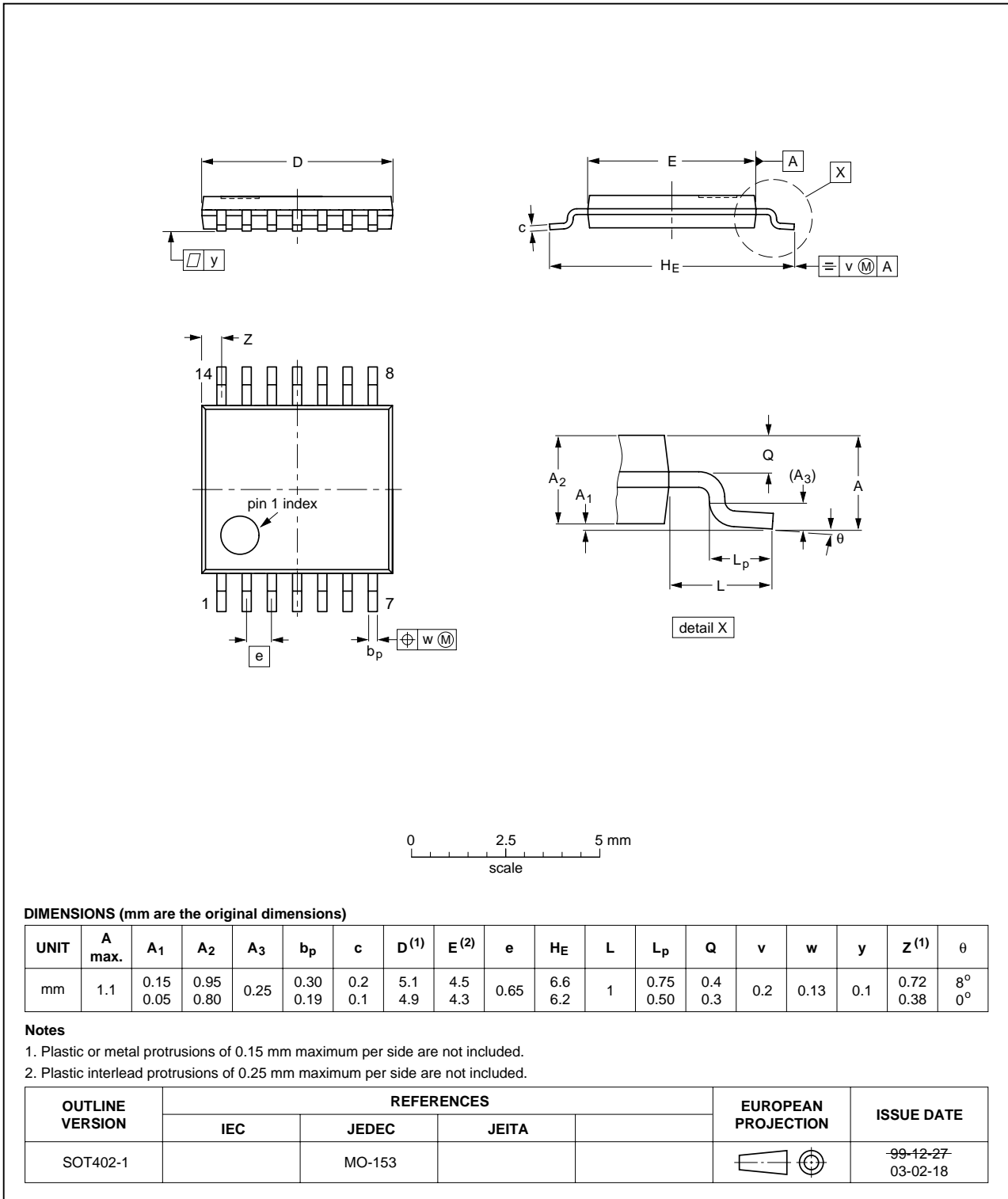


Fig 11. Package outline SOT402-1 (TSSOP14)

DHVQFN14: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 x 3 x 0.85 mm

SOT762-1

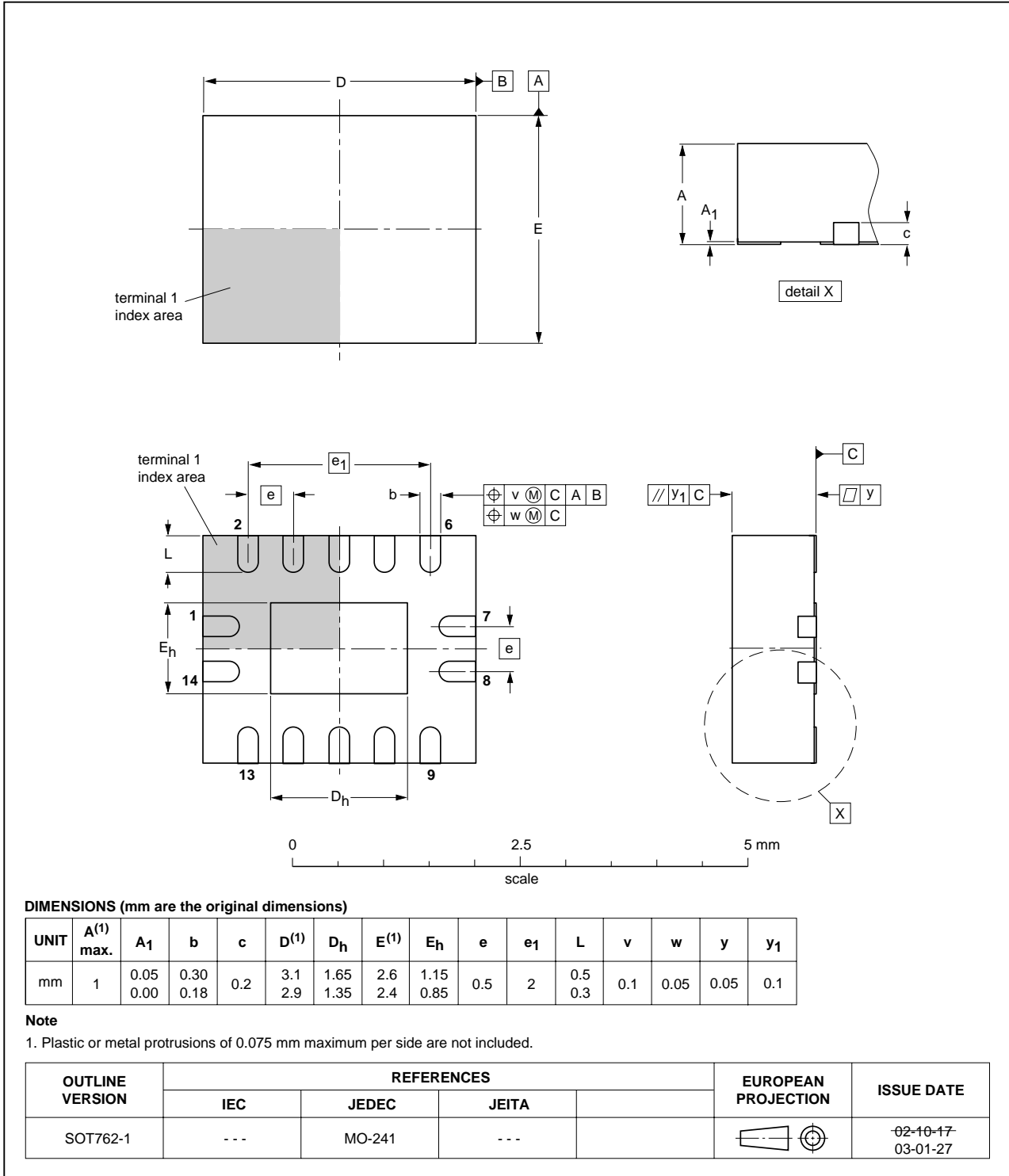


Fig 12. Package outline SOT762-1 (DHVQFN14)

## 13. Abbreviations

Table 10. Abbreviations

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

## 14. Revision history

Table 11. Revision history

| Document ID    | Release date   | Data sheet status     | Change notice | Supersedes |
|----------------|--|-----------------------|---------------|------------|
| 74LV86_3       | 20071127   | Product data sheet    | -             | 74LV86_2   |
| Modifications: | <ul style="list-style-type: none"> <li>• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li> <li>• Legal texts have been adapted to the new company name where appropriate.</li> <li>• <a href="#">Section 3</a>: DHVQFN14 package added.</li> <li>• <a href="#">Section 8</a>: derating values added for DHVQFN14 package.</li> <li>• <a href="#">Section 12</a>: outline drawing added for DHVQFN14 package.</li> </ul> |                       |               |            |
| 74LV86_2       | 19980420   | Product specification | -             | 74LV86_1   |
| 74LV86_1       | 19970203   | 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".

[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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## 17. Contents

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