

# 74HC04; 74HCT04

## Hex inverter

Rev. 4 — 3 August 2012

Product data sheet

## 1. General description

The 74HC04; 74HCT04 is a hex inverter. The inputs include clamp diodes that enable the use of current limiting resistors to interface inputs to voltages in excess of  $V_{CC}$ .

## 2. Features and benefits

- Complies with JEDEC standard JESD7A
- Complies with JEDEC standard JESD8-1A
- Input levels:
  - ◆ For 74HC04: CMOS level
  - ◆ For 74HCT04: TTL level
- ESD protection:
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from  $-40\text{ °C}$  to  $+85\text{ °C}$  and from  $-40\text{ °C}$  to  $+125\text{ °C}$

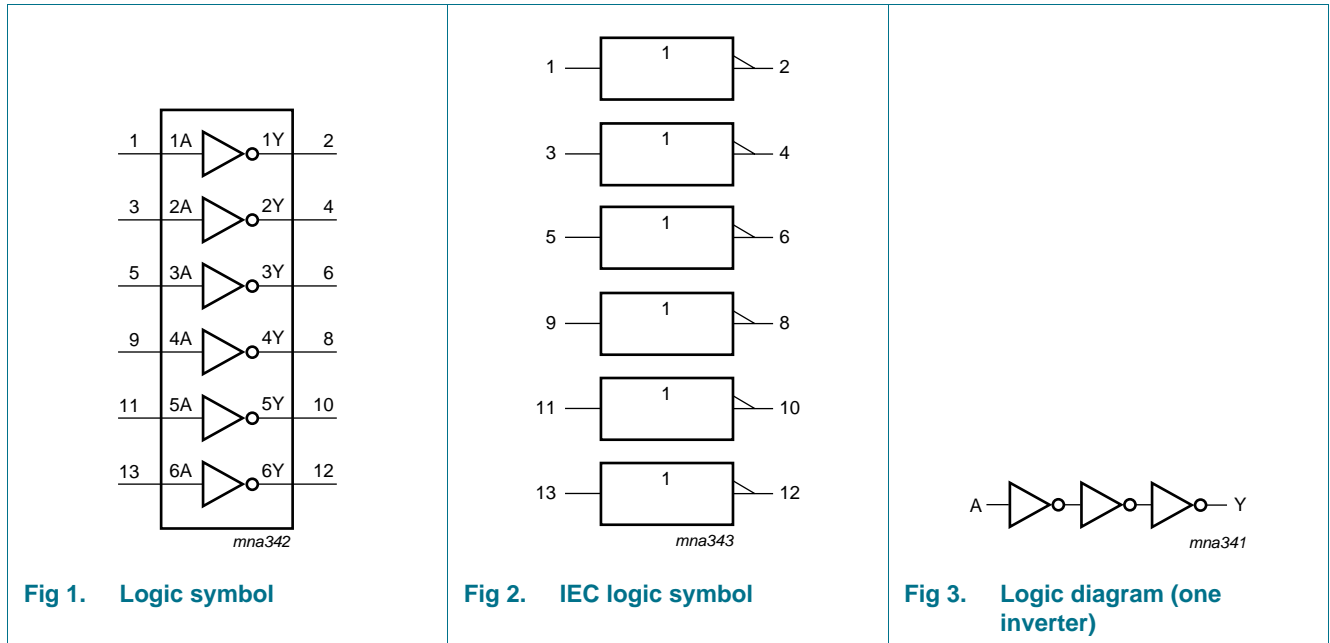
## 3. Ordering information

Table 1. Ordering information

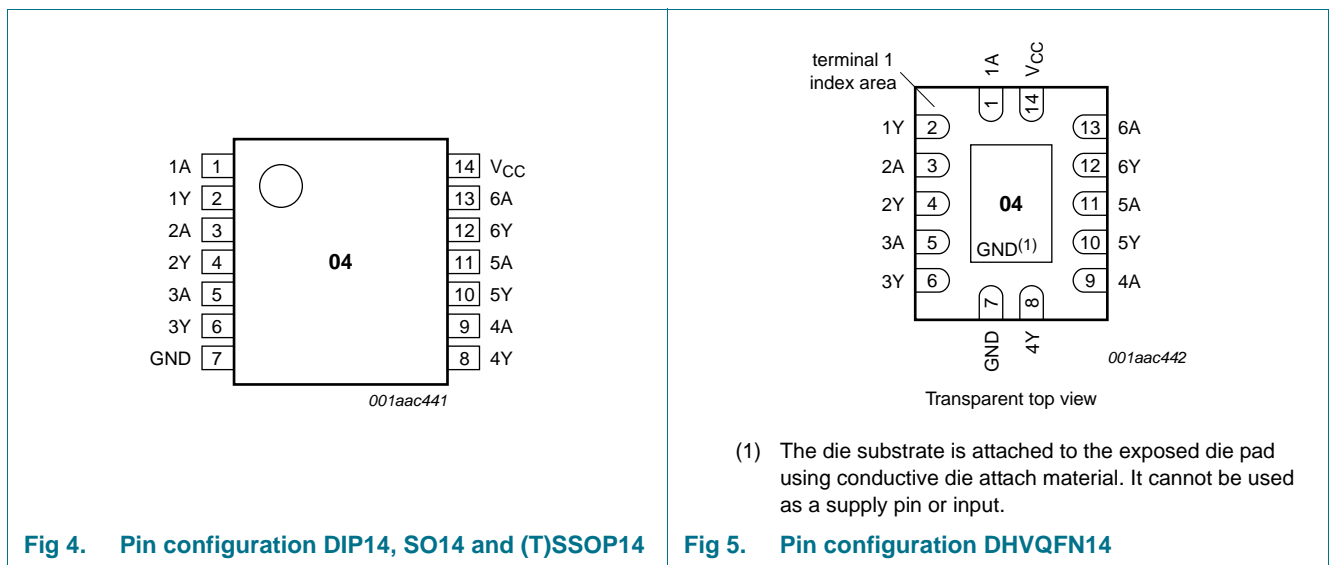
| Type number           | Package                             |          |   |          |
|-----------------------|-------------------------------------|----------|---|----------|
|                       | Temperature range                   | Name     | Description   | Version  |
| 74HC04N<br>74HCT04N   | $-40\text{ °C}$ to $+125\text{ °C}$ | DIP14    | plastic dual in-line package; 14 leads (300 mil)  | SOT27-1  |
| 74HC04D<br>74HCT04D   | $-40\text{ °C}$ to $+125\text{ °C}$ | SO14     | plastic small outline package; 14 leads; body width 3.9 mm  | SOT108-1 |
| 74HC04DB<br>74HCT04DB | $-40\text{ °C}$ to $+125\text{ °C}$ | SSOP14   | plastic shrink small outline package; 14 leads; body width 5.3 mm   | SOT337-1 |
| 74HC04PW<br>74HCT04PW | $-40\text{ °C}$ to $+125\text{ °C}$ | TSSOP14  | plastic thin shrink small outline package; 14 leads; body width 4.4 mm  | SOT402-1 |
| 74HC04BQ<br>74HCT04BQ | $-40\text{ °C}$ to $+125\text{ °C}$ | DHVQFN14 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body $2.5 \times 3 \times 0.85\text{ mm}$ | SOT762-1 |



## 4. Functional diagram



## 5. Pinning information



## 5.1 Pin description

**Table 2.** Pin description

| Symbol          | Pin | Description    |
|-----------------|-----|----------------|
| 1A              | 1   | data input     |
| 1Y              | 2   | data output    |
| 2A              | 3   | data input     |
| 2Y              | 4   | data output    |
| 3A              | 5   | data input     |
| 3Y              | 6   | data output    |
| GND             | 7   | ground (0 V)   |
| 4Y              | 8   | data output    |
| 4A              | 9   | data input     |
| 5Y              | 10  | data output    |
| 5A              | 11  | data input     |
| 6Y              | 12  | data output    |
| 6A              | 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    | nY     |
| L     | 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   | 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]  | -    | ±20 mA |
| I <sub>O</sub>   | output current                        | $-0.5\text{ V} < V_O < V_{CC} + 0.5\text{ V}$          | -    | ±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     |
| P <sub>tot</sub> | total power dissipation               |  | [2]  |      |        |
|                  | DIP14 package                         |  | -    | 750  | mW     |
|                  | SO14, (T)SSOP14 and DHVQFN14 packages |  | -    | 500  | mW     |

- [1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
- [2] For DIP14 package:  $P_{tot}$  derates linearly with 12 mW/K above 70 °C.  
 For SO14 package:  $P_{tot}$  derates linearly with 8 mW/K above 70 °C.  
 For (T)SSOP14 packages:  $P_{tot}$  derates linearly with 5.5 mW/K above 60 °C.  
 For DHVQFN14 packages:  $P_{tot}$  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              | 74HC04 |      |          | 74HCT04 |      |          | Unit |
|---------------------|-------------------------------------|-------------------------|--------|------|----------|---------|------|----------|------|
|                     |                                     |                         | Min    | Typ  | Max      | Min     | Typ  | Max      |      |
| $V_{CC}$            | supply voltage                      |                         | 2.0    | 5.0  | 6.0      | 4.5     | 5.0  | 5.5      | V    |
| $V_I$               | input voltage                       |                         | 0      | -    | $V_{CC}$ | 0       | -    | $V_{CC}$ | V    |
| $V_O$               | output voltage                      |                         | 0      | -    | $V_{CC}$ | 0       | -    | $V_{CC}$ | V    |
| $T_{amb}$           | ambient temperature                 |                         | -40    | +25  | +125     | -40     | +25  | +125     | °C   |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 2.0\text{ V}$ | -      | -    | 625      | -       | -    | -        | ns/V |
|                     |                                     | $V_{CC} = 4.5\text{ V}$ | -      | 1.67 | 139      | -       | 1.67 | 139      | ns/V |
|                     |                                     | $V_{CC} = 6.0\text{ V}$ | -      | -    | 83       | -       | -    | -        | ns/V |

## 9. Static characteristics

**Table 6. Static characteristics**

*At recommended operating conditions; voltages are referenced to GND (ground = 0 V).*

| Symbol        | Parameter                                     | Conditions                                      | 25 °C |      |      | -40 °C to +85 °C |      | -40 °C to +125 °C |      | Unit |
|---------------|---|---|-------|------|------|------------------|------|-------------------|------|------|
|               |   |   | Min   | Typ  | Max  | Min              | Max  | Min               | Max  |      |
| <b>74HC04</b> |   |   |       |      |      |                  |      |                   |      |      |
| $V_{IH}$      | HIGH-level input voltage                      | $V_{CC} = 2.0\text{ V}$                         | 1.5   | 1.2  | -    | 1.5              | -    | 1.5               | -    | V    |
|               |   | $V_{CC} = 4.5\text{ V}$                         | 3.15  | 2.4  | -    | 3.15             | -    | 3.15              | -    | V    |
|               |   | $V_{CC} = 6.0\text{ V}$                         | 4.2   | 3.2  | -    | 4.2              | -    | 4.2               | -    | V    |
| $V_{IL}$      | LOW-level input voltage                       | $V_{CC} = 2.0\text{ V}$                         | -     | 0.8  | 0.5  | -                | 0.5  | -                 | 0.5  | V    |
|               |   | $V_{CC} = 4.5\text{ V}$                         | -     | 2.1  | 1.35 | -                | 1.35 | -                 | 1.35 | V    |
|               |   | $V_{CC} = 6.0\text{ V}$                         | -     | 2.8  | 1.8  | -                | 1.8  | -                 | 1.8  | V    |
| $V_{OH}$      | HIGH-level output voltage                     | $V_I = V_{IH}$ or $V_{IL}$                      |       |      |      |                  |      |                   |      |      |
|               |   | $I_O = -20\ \mu\text{A}; V_{CC} = 2.0\text{ V}$ | 1.9   | 2.0  | -    | 1.9              | -    | 1.9               | -    | V    |
|               |   | $I_O = -20\ \mu\text{A}; V_{CC} = 4.5\text{ V}$ | 4.4   | 4.5  | -    | 4.4              | -    | 4.4               | -    | V    |
|               |   | $I_O = -20\ \mu\text{A}; V_{CC} = 6.0\text{ V}$ | 5.9   | 6.0  | -    | 5.9              | -    | 5.9               | -    | V    |
|               |   | $I_O = -4.0\text{ mA}; V_{CC} = 4.5\text{ V}$   | 3.98  | 4.32 | -    | 3.84             | -    | 3.7               | -    | V    |
|               | $I_O = -5.2\text{ mA}; V_{CC} = 6.0\text{ V}$ | 5.48  | 5.81  | -    | 5.34 | -                | 5.2  | -                 | V    |      |

**Table 6. Static characteristics ...continued**

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

| Symbol           | Parameter                 | Conditions  | 25 °C |      |      | -40 °C to +85 °C |      | -40 °C to +125 °C |     | Unit |
|------------------|---------------------------|---|-------|------|------|------------------|------|-------------------|-----|------|
|                  |                           |   | Min   | Typ  | Max  | Min              | Max  | Min               | Max |      |
| 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> = 20 μA; V <sub>CC</sub> = 2.0 V   | -     | 0    | 0.1  | -                | 0.1  | -                 | 0.1 | V    |
|                  |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V   | -     | 0    | 0.1  | -                | 0.1  | -                 | 0.1 | V    |
|                  |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V   | -     | 0    | 0.1  | -                | 0.1  | -                 | 0.1 | V    |
|                  |                           | I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V  | -     | 0.15 | 0.26 | -                | 0.33 | -                 | 0.4 | V    |
|                  |                           | I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V  | -     | 0.16 | 0.26 | -                | 0.33 | -                 | 0.4 | V    |
| I <sub>I</sub>   | input leakage current     | V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V  | -     | -    | ±0.1 | -                | ±1   | -                 | ±1  | μA   |
| I <sub>CC</sub>  | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V  | -     | -    | 2    | -                | 20   | -                 | 40  | μA   |
| C <sub>I</sub>   | input capacitance         |   | -     | 3.5  | -    | -                | -    | -                 | -   | pF   |
| <b>74HCT04</b>   |                           |   |       |      |      |                  |      |                   |     |      |
| V <sub>IH</sub>  | HIGH-level input voltage  | V <sub>CC</sub> = 4.5 V to 5.5 V  | 2.0   | 1.6  | -    | 2.0              | -    | 2.0               | -   | V    |
| V <sub>IL</sub>  | LOW-level input voltage   | V <sub>CC</sub> = 4.5 V to 5.5 V  | -     | 1.2  | 0.8  | -                | 0.8  | -                 | 0.8 | V    |
| V <sub>OH</sub>  | HIGH-level output voltage | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V   |       |      |      |                  |      |                   |     |      |
|                  |                           | I <sub>O</sub> = -20 μA   | 4.4   | 4.5  | -    | 4.4              | -    | 4.4               | -   | V    |
|                  |                           | I <sub>O</sub> = -4.0 mA  | 3.84  | 4.32 | -    | 3.84             | -    | 3.7               | -   | V    |
| V <sub>OL</sub>  | LOW-level output voltage  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; V <sub>CC</sub> = 4.5 V   |       |      |      |                  |      |                   |     |      |
|                  |                           | I <sub>O</sub> = 20 μA  | -     | 0    | 0.1  | -                | 0.1  | -                 | 0.1 | V    |
|                  |                           | I <sub>O</sub> = 5.2 mA   | -     | 0.15 | 0.26 | -                | 0.33 | -                 | 0.4 | V    |
| I <sub>I</sub>   | input leakage current     | V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V  | -     | -    | ±0.1 | -                | ±1   | -                 | ±1  | μA   |
| I <sub>CC</sub>  | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 5.5 V  | -     | -    | 2    | -                | 20   | -                 | 40  | μA   |
| ΔI <sub>CC</sub> | additional supply current | per input pin; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V; I <sub>O</sub> = 0 A; other inputs at V <sub>CC</sub> or GND; V <sub>CC</sub> = 4.5 V to 5.5 V | -     | 120  | 432  | -                | 540  | -                 | 590 | μA   |
| C <sub>I</sub>   | input capacitance         |   | -     | 3.5  | -    | -                | -    | -                 | -   | pF   |

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**
*GND = 0 V; C<sub>L</sub> = 50 pF; for load circuit see [Figure 7](#).*

| Symbol          | Parameter                     | Conditions   | 25 °C |     |     | -40 °C to +125 °C |              | Unit |    |
|-----------------|-------------------------------|--|-------|-----|-----|-------------------|--------------|------|----|
|                 |                               |  | Min   | Typ | Max | Max (85 °C)       | Max (125 °C) |      |    |
| <b>74HC04</b>   |                               |  |       |     |     |                   |              |      |    |
| t <sub>pd</sub> | propagation delay             | nA to nY; see <a href="#">Figure 6</a>                       | [1]   |     |     |                   |              |      |    |
|                 |                               | V <sub>CC</sub> = 2.0 V                                      | -     | 25  | 85  | 105               | 130          | ns   |    |
|                 |                               | V <sub>CC</sub> = 4.5 V                                      | -     | 9   | 17  | 21                | 26           | ns   |    |
|                 |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF              | -     | 7   | -   | -                 | -            | ns   |    |
|                 |                               | V <sub>CC</sub> = 6.0 V                                      | -     | 7   | 14  | 18                | 22           | ns   |    |
| t <sub>t</sub>  | transition time               | see <a href="#">Figure 6</a>                                 | [2]   |     |     |                   |              |      |    |
|                 |                               | V <sub>CC</sub> = 2.0 V                                      | -     | 19  | 75  | 95                | 110          | ns   |    |
|                 |                               | V <sub>CC</sub> = 4.5 V                                      | -     | 7   | 15  | 19                | 22           | ns   |    |
|                 |                               | V <sub>CC</sub> = 6.0 V                                      | -     | 6   | 13  | 16                | 19           | ns   |    |
| C <sub>PD</sub> | power dissipation capacitance | per package; V <sub>I</sub> = GND to V <sub>CC</sub>         | [3]   | -   | 21  | -                 | -            | -    | pF |
| <b>74HCT04</b>  |                               |  |       |     |     |                   |              |      |    |
| t <sub>pd</sub> | propagation delay             | nA to nY; see <a href="#">Figure 6</a>                       | [1]   |     |     |                   |              |      |    |
|                 |                               | V <sub>CC</sub> = 4.5 V                                      | -     | 10  | 19  | 24                | 29           | ns   |    |
|                 |                               | V <sub>CC</sub> = 5.0 V; C <sub>L</sub> = 15 pF              | -     | 8   | -   | -                 | -            | ns   |    |
| t <sub>t</sub>  | transition time               | V <sub>CC</sub> = 4.5 V; see <a href="#">Figure 6</a>        | [2]   | -   | 7   | 15                | 19           | 22   | ns |
| C <sub>PD</sub> | power dissipation capacitance | per package; V <sub>I</sub> = GND to V <sub>CC</sub> - 1.5 V | [3]   | -   | 24  | -                 | -            | -    | pF |

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

[2] t<sub>t</sub> is the same as t<sub>THL</sub> and t<sub>TLH</sub>.

[3] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW):

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

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;

∑ (C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of outputs.

11. Waveforms

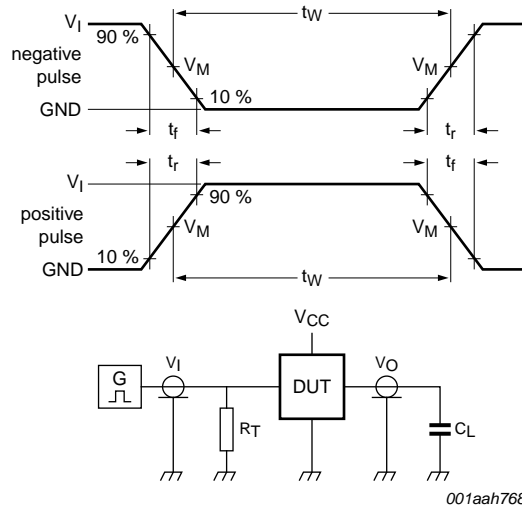


Measurement points are given in [Table 8](#).  
 $V_{OL}$  and  $V_{OH}$  are typical voltage output levels that occur with the output load.

Fig 6. The input (nA) to output (nY) propagation delay times

Table 8. Measurement points

| Type    | Input       | Output      |
|---------|-------------|-------------|
|         | $V_M$       | $V_M$       |
| 74HC04  | $0.5V_{CC}$ | $0.5V_{CC}$ |
| 74HCT04 | 1.3 V       | 1.3 V       |



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

Fig 7. Load circuitry for measuring switching times

Table 9. Test data

| Type    | Input           |                                 | Load           | Test                                |
|---------|-----------------|---------------------------------|----------------|-------------------------------------|
|         | V <sub>I</sub>  | t <sub>r</sub> , t <sub>f</sub> | C <sub>L</sub> |                                     |
| 74HC04  | V <sub>CC</sub> | 6.0 ns                          | 15 pF, 50 pF   | t <sub>PLH</sub> , t <sub>PHL</sub> |
| 74HCT04 | 3.0 V           | 6.0 ns                          | 15 pF, 50 pF   | t <sub>PLH</sub> , t <sub>PHL</sub> |



12. Package outline

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

SOT27-1

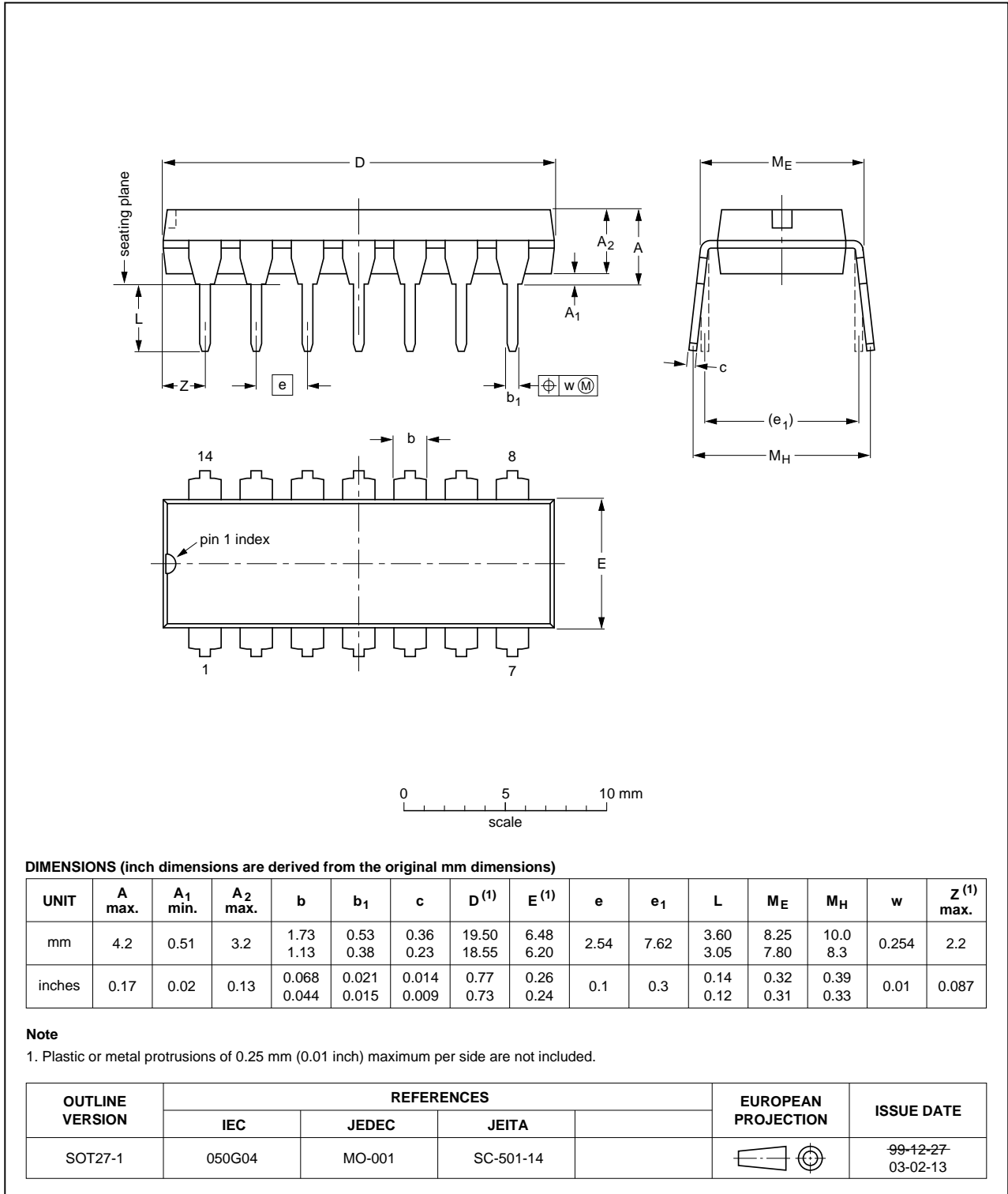


Fig 8. Package outline SOT27-1 (DIP14)

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

SOT108-1

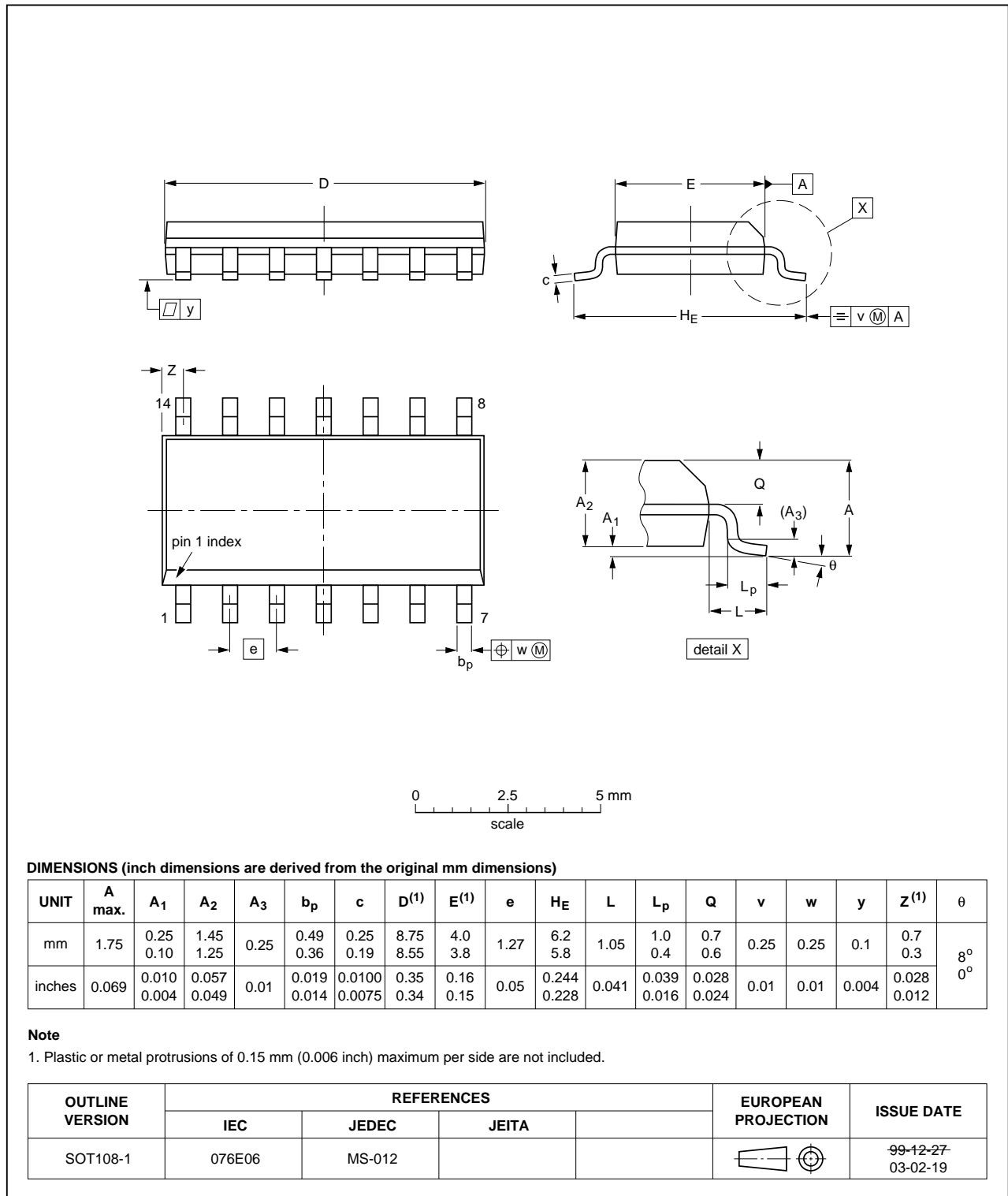


Fig 9. Package outline SOT108-1 (SO14)

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

SOT337-1

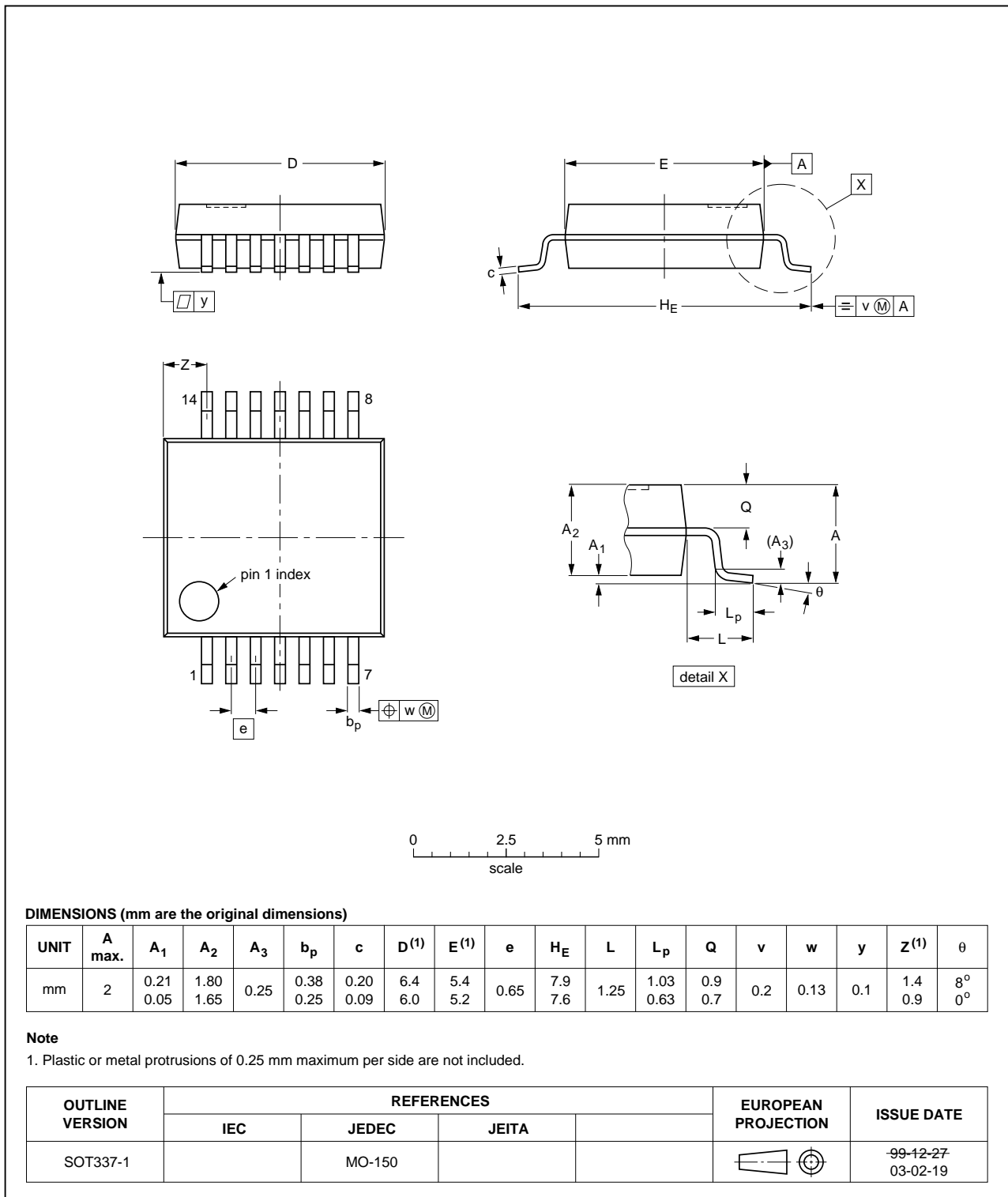


Fig 10. Package outline SOT337-1 (SSOP14)

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

SOT402-1

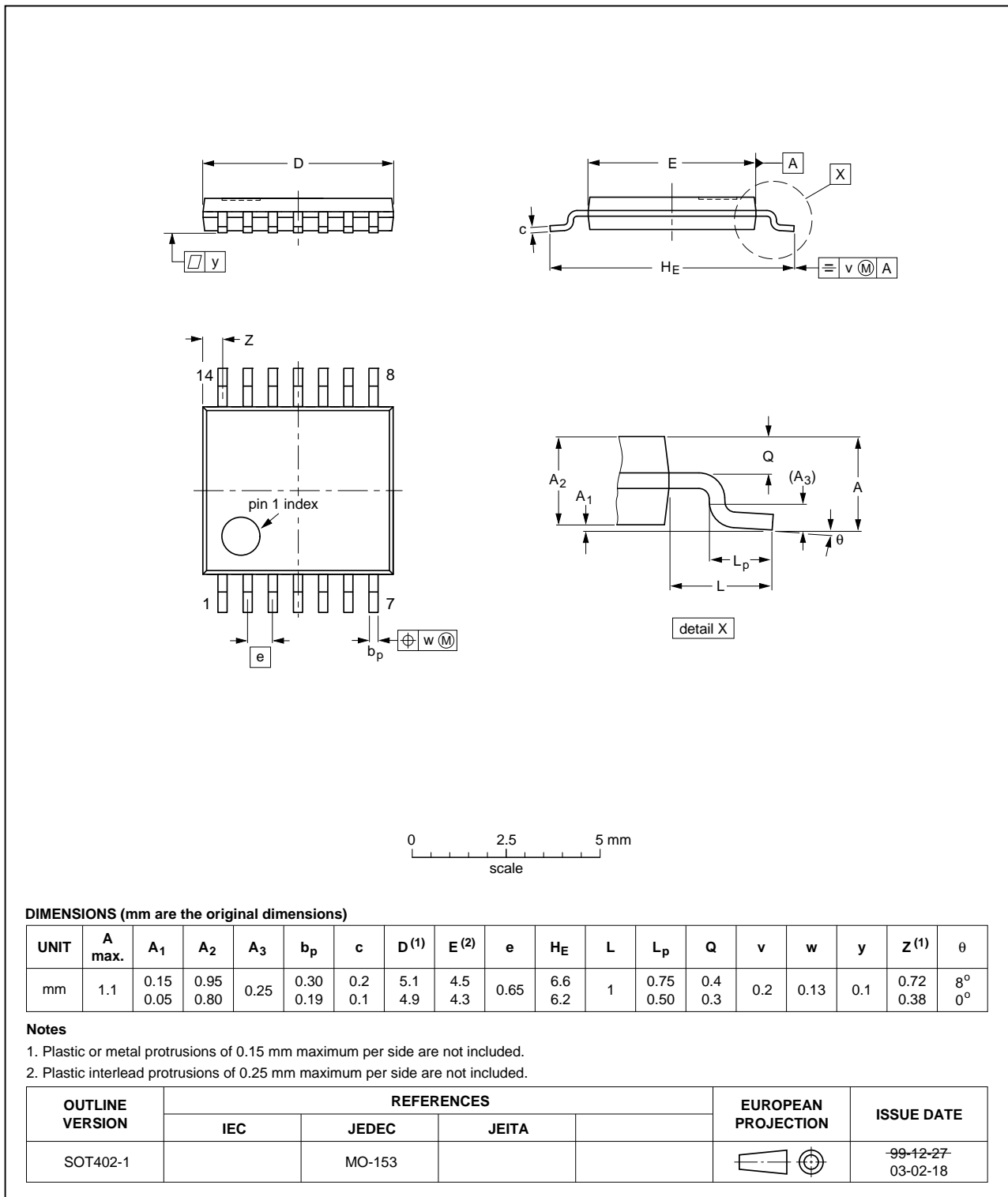


Fig 11. Package outline SOT402-1 (TSSOP14)

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

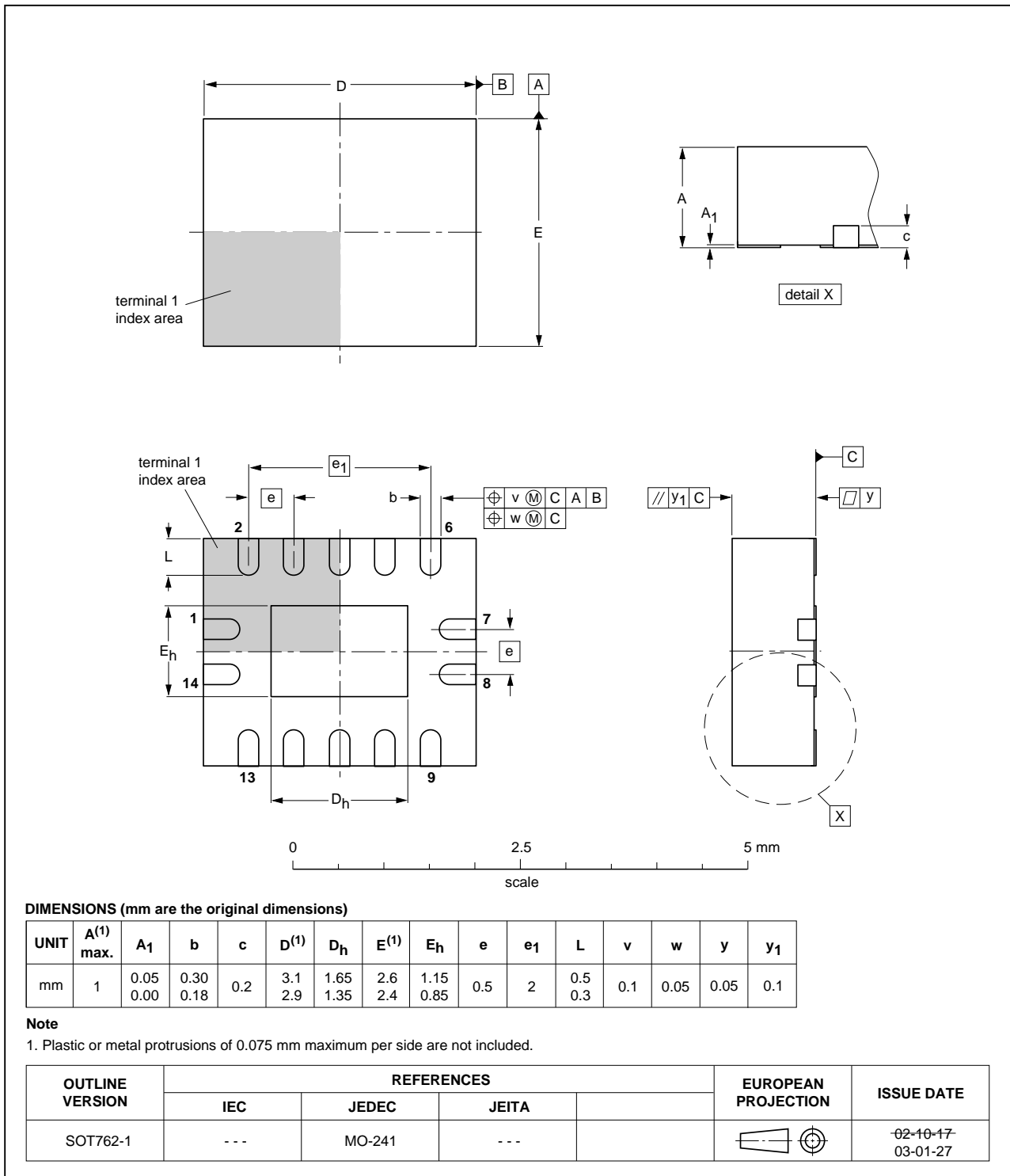


Fig 12. Package outline SOT762-1 (DHVQFN14)

## 13. Abbreviations

Table 10. Abbreviations

| Acronym | Description                                    |
|---------|--|
| CMOS    | Complementary Metal Oxide Semiconductor        |
| LSTTL   | Low-power Schottky Transistor-Transistor Logic |
| ESD     | ElectroStatic Discharge                        |
| HBM     | Human Body Model                               |
| MM      | Machine Model                                  |
| CDM     | Charge Device Model                            |
| TTL     | Transistor-Transistor Logic                    |

## 14. Revision history

Table 11. Revision history

| Document ID        | Release date  | Data sheet status     | Change notice | Supersedes         |
|--------------------|---|-----------------------|---------------|--------------------|
| 74HC_HCT04 v.4     | 20120803  | Product data sheet    | -             | 74HC_HCT04 v.3     |
| 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> </ul> |                       |               |                    |
| 74HC_HCT04 v.3     | 20030723  | Product data sheet    | -             | 74HC_HCT04_CNV v.2 |
| 74HC_HCT04_CNV v.2 | 19970826  | 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>.

### 15.2 Definitions

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