

# 74HC3GU04

## Inverter

Rev. 04. — 11 January 2010

Product data sheet

## 1. General description

The 74HC3GU04 is a high-speed Si-gate CMOS device. This device provides three inverter gates with unbuffered outputs.

The 74HC3GU04 has CMOS input switching levels and supply voltage range 2 V to 6 V.

## 2. Features

- Wide supply voltage range from 2.0 V to 6.0 V
- Symmetrical output impedance
- High noise immunity
- Low-power dissipation
- Balanced propagation delays
- Multiple package options
- ESD protection:
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$  and  $-40\text{ }^{\circ}\text{C}$  to  $+125\text{ }^{\circ}\text{C}$

## 3. Ordering information

Table 1. Ordering information

| Type number | Package   |        |  |          |
|-------------|---|--------|--|----------|
|             | Temperature range   | Name   | Description  | Version  |
| 74HC3GU04DP | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | TSSOP8 | plastic thin shrink small outline package; 8 leads; body width 3 mm; lead length 0.5 mm                          | SOT505-2 |
| 74HC3GU04DC | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | VSSOP8 | plastic very thin shrink small outline package; 8 leads; body width 2.3 mm                                       | SOT765-1 |
| 74HC3GU04GD | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | XSON8U | plastic extremely thin small outline package; no leads; 8 terminals; UTLP based; body $3 \times 2 \times 0.5$ mm | SOT996-2 |

## 4. Marking

Table 2. Marking

| Type number | Marking code |
|-------------|--------------|
| 74HC3GU04DP | HU4          |
| 74HC3GU04DC | HU4          |
| 74HC3GU04GD | HU4          |

## 5. Functional diagram

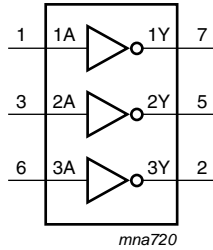


Fig 1. Logic symbol

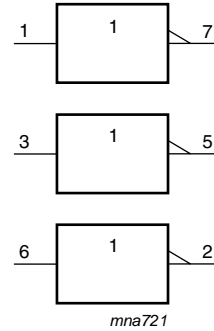


Fig 2. IEC logic symbol

## 6. Pinning information

### 6.1 Pinning

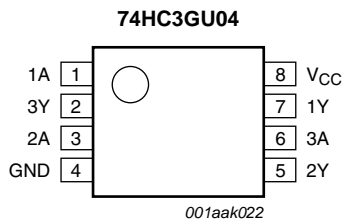


Fig 3. Pin configuration SOT505-2 (TSSOP8) and SOT765-1 (VSSOP8)

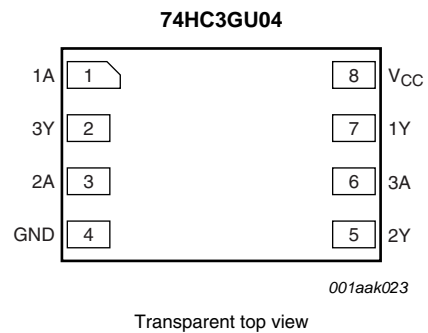


Fig 4. Pin configuration SOT996-2 (XSON8U)

### 6.2 Pin description

Table 3. Pin description

| Symbol          | Pin     | Description    |
|-----------------|---------|----------------|
| 1A, 2A, 3A      | 1, 3, 6 | data input     |
| 1Y, 2Y, 3Y      | 7, 5, 2 | data output    |
| GND             | 4       | ground (0 V)   |
| V <sub>CC</sub> | 8       | supply voltage |

## 7. Functional description

**Table 4.** Function table [1]

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

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

## 8. Limiting values

**Table 5.** 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 |
|-----------|--------------------------|--|---------|----------|------|
| $V_{CC}$  | supply voltage           |  | -0.5    | +7.0     | V    |
| $I_{IK}$  | input clamping current   | $V_I < -0.5\text{ V}$ or $V_I > V_{CC} + 0.5\text{ V}$ | [1] -   | $\pm 20$ | mA   |
| $I_{OK}$  | output clamping current  | $V_O < -0.5\text{ V}$ or $V_O > V_{CC} + 0.5\text{ V}$ | [1] -   | $\pm 20$ | mA   |
| $I_O$     | output current           | $V_O = -0.5\text{ V}$ to $(V_{CC} + 0.5\text{ V})$     | [1] -   | $\pm 25$ | mA   |
| $I_{CC}$  | quiescent supply current |  | [1] -   | 50       | mA   |
| $I_{GND}$ | ground current           |  | [1] -50 | -        | mA   |
| $T_{stg}$ | storage temperature      |  | -65     | +150     | °C   |
| $P_{tot}$ | total power dissipation  | $T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$          | [2] -   | 300      | mW   |

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

[2] For TSSOP8 package: above 55 °C the value of  $P_{tot}$  derates linearly with 2.5 mW/K.  
 For VSSOP8 package: above 110 °C the value of  $P_{tot}$  derates linearly with 8 mW/K.  
 For XSON8U package: above 118 °C the value of  $P_{tot}$  derates linearly with 7.8 mW/K.

## 9. Recommended operating conditions

**Table 6.** Recommended operating conditions

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

| Symbol              | Parameter                           | Conditions              | Min | Typ  | Max      | Unit |
|---------------------|-------------------------------------|-------------------------|-----|------|----------|------|
| $V_{CC}$            | supply voltage                      |                         | 2.0 | 5.0  | 6.0      | V    |
| $V_I$               | input voltage                       |                         | 0   | -    | $V_{CC}$ | V    |
| $V_O$               | output voltage                      |                         | 0   | -    | $V_{CC}$ | V    |
| $T_{amb}$           | ambient temperature                 |                         | -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      | ns/V |
|                     |                                     | $V_{CC} = 6.0\text{ V}$ | -   | -    | 83       | ns/V |

## 10. Static characteristics

**Table 7. 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> = 2.0 V   | 1.7              | 1.1                | -    | 1.7               | -    | V    |
|                 |                           | V <sub>CC</sub> = 4.5 V   | 3.6              | 2.4                | -    | 3.6               | -    | V    |
|                 |                           | V <sub>CC</sub> = 6.0 V   | 4.8              | 3.1                | -    | 4.8               | -    | V    |
| V <sub>IL</sub> | LOW-level input voltage   | V <sub>CC</sub> = 2.0 V   | -                | 0.9                | 0.3  | -                 | 0.3  | V    |
|                 |                           | V <sub>CC</sub> = 4.5 V   | -                | 2.1                | 0.9  | -                 | 0.9  | V    |
|                 |                           | V <sub>CC</sub> = 6.0 V   | -                | 2.9                | 1.2  | -                 | 1.2  | 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> = -20 μA; V <sub>CC</sub> = 2.0 V  | 1.9              | 2.0                | -    | 1.9               | -    | V    |
|                 |                           | I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 4.5 V  | 4.4              | 4.5                | -    | 4.4               | -    | V    |
|                 |                           | I <sub>O</sub> = -20 μA; V <sub>CC</sub> = 6.0 V  | 5.9              | 6.0                | -    | 5.9               | -    | V    |
|                 |                           | I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 4.5 V   | 4.13             | 4.32               | -    | 3.7               | -    | 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> = 20 μA; V <sub>CC</sub> = 2.0 V   | -                | 0                  | 0.1  | -                 | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 4.5 V   | -                | 0                  | 0.1  | -                 | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 20 μA; V <sub>CC</sub> = 6.0 V   | -                | 0                  | 0.1  | -                 | 0.1  | V    |
|                 |                           | I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V  | -                | 0.15               | 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                                      | -                | -                  | ±1.0 | -                 | ±1.0 | μA   |
|                 |                           | I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V   | -                | -                  | 10   | -                 | 20   | μA   |
| I <sub>CC</sub> | supply current            | per input pin; V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V | -                | -                  | 10   | -                 | 20   | μA   |
| C <sub>I</sub>  | input capacitance         |   | -                | 3.0                | -    | -                 | -    | pF   |

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

## 11. Dynamic characteristics

**Table 8. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V); for test circuit see [Figure 6](#).

| 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 to nY; see <a href="#">Figure 5</a> <sup>[2]</sup> |                  |                    |     |                   |     |      |
|                 |                   | V <sub>CC</sub> = 2.0 V                               | -                | 13                 | 75  | -                 | 90  | ns   |
|                 |                   | V <sub>CC</sub> = 4.5 V                               | -                | 6                  | 15  | -                 | 18  | ns   |
|                 |                   | V <sub>CC</sub> = 6.0 V                               | -                | 5                  | 13  | -                 | 15  | ns   |

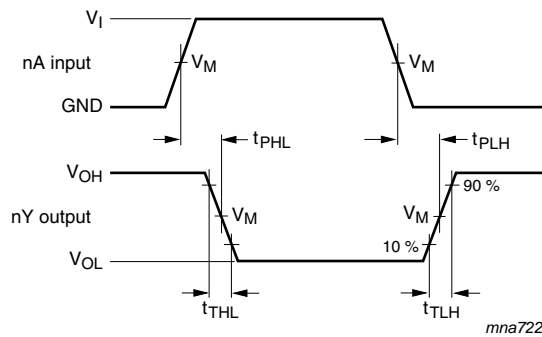
**Table 8. Dynamic characteristics ...continued**

Voltages are referenced to GND (ground = 0 V); for test circuit see [Figure 6](#).

| Symbol          | Parameter                     | Conditions   | -40 °C to +85 °C |                    |     | -40 °C to +125 °C |     | Unit |
|-----------------|-------------------------------|--|------------------|--------------------|-----|-------------------|-----|------|
|                 |                               |  | Min              | Typ <sup>[1]</sup> | Max | Min               | Max |      |
| t <sub>t</sub>  | transition time               | nY; see <a href="#">Figure 5</a> <span style="float:right">[3]</span>        |                  |                    |     |                   |     |      |
|                 |                               | V <sub>CC</sub> = 2.0 V  | -                | 18                 | 95  | -                 | 125 | ns   |
|                 |                               | V <sub>CC</sub> = 4.5 V  | -                | 6                  | 19  | -                 | 25  | ns   |
|                 |                               | V <sub>CC</sub> = 6.0 V  | -                | 5                  | 16  | -                 | 20  | ns   |
| C <sub>PD</sub> | power dissipation capacitance | V <sub>I</sub> = GND to V <sub>CC</sub> <span style="float:right">[4]</span> | -                | 5                  | -   | -                 | -   | 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] t<sub>t</sub> is the same as t<sub>TLH</sub> and t<sub>THL</sub>.
- [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;  
 Σ(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of outputs.

## 12. Waveforms

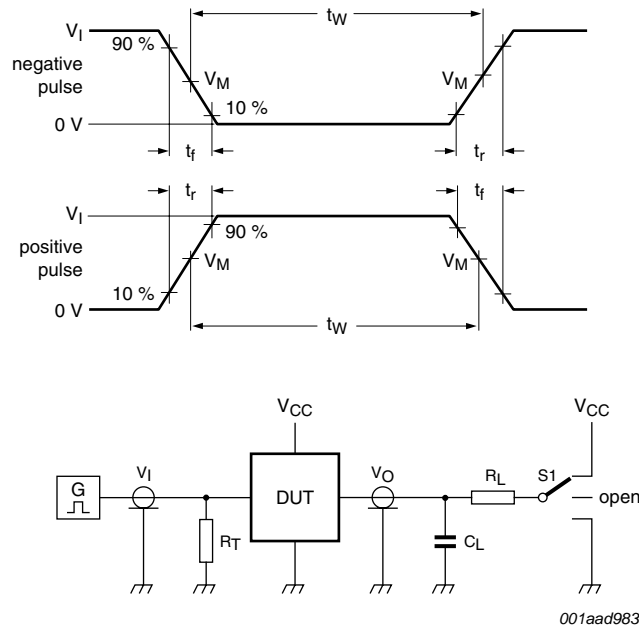


Measurement points are given in [Table 9](#).

**Fig 5. Propagation delay data input (nA) to data output (nY) and transition time output (nY)**

**Table 9. Measurement points**

| Type      | Input                 | Output                |
|-----------|-----------------------|-----------------------|
|           | V <sub>M</sub>        | V <sub>M</sub>        |
| 74HC3GU04 | 0.5 × V <sub>CC</sub> | 0.5 × V <sub>CC</sub> |



Test data is given in [Table 10](#).

Definitions for 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.

$R_L$  = Load resistance.

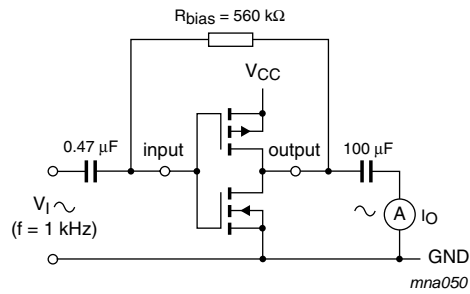
S1 = Test selection switch.

**Fig 6. Test circuit for measuring switching times**

**Table 10. Test data**

| Type      | Input           |             | Load  |              | S1 position        |
|-----------|-----------------|-------------|-------|--------------|--------------------|
|           | $V_I$           | $t_r, t_f$  | $C_L$ | $R_L$        | $t_{PHL}, t_{PLH}$ |
| 74HC3GU04 | GND to $V_{CC}$ | $\leq 6$ ns | 50 pF | 1 k $\Omega$ | open               |

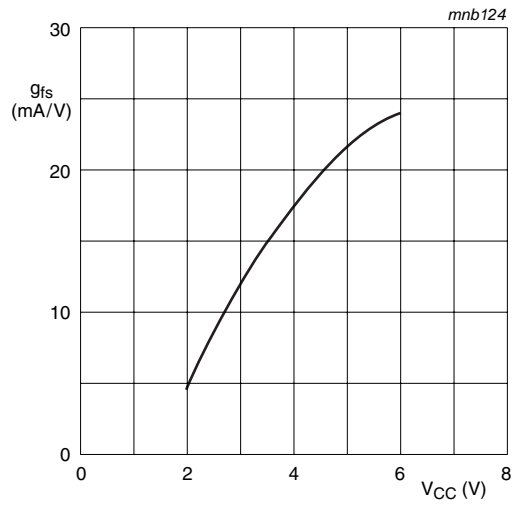
12.1 Additional characteristics



$$g_{fs} = \frac{\Delta I_o}{\Delta V_i}$$

$V_O$  is constant.

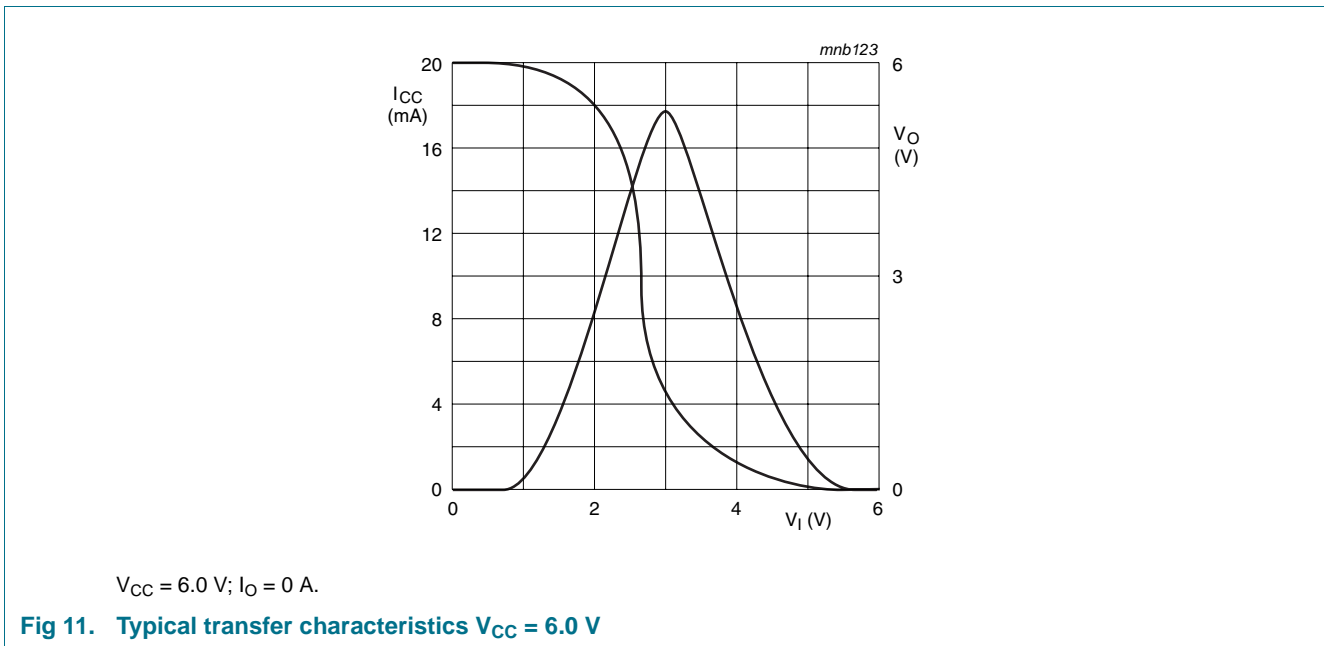
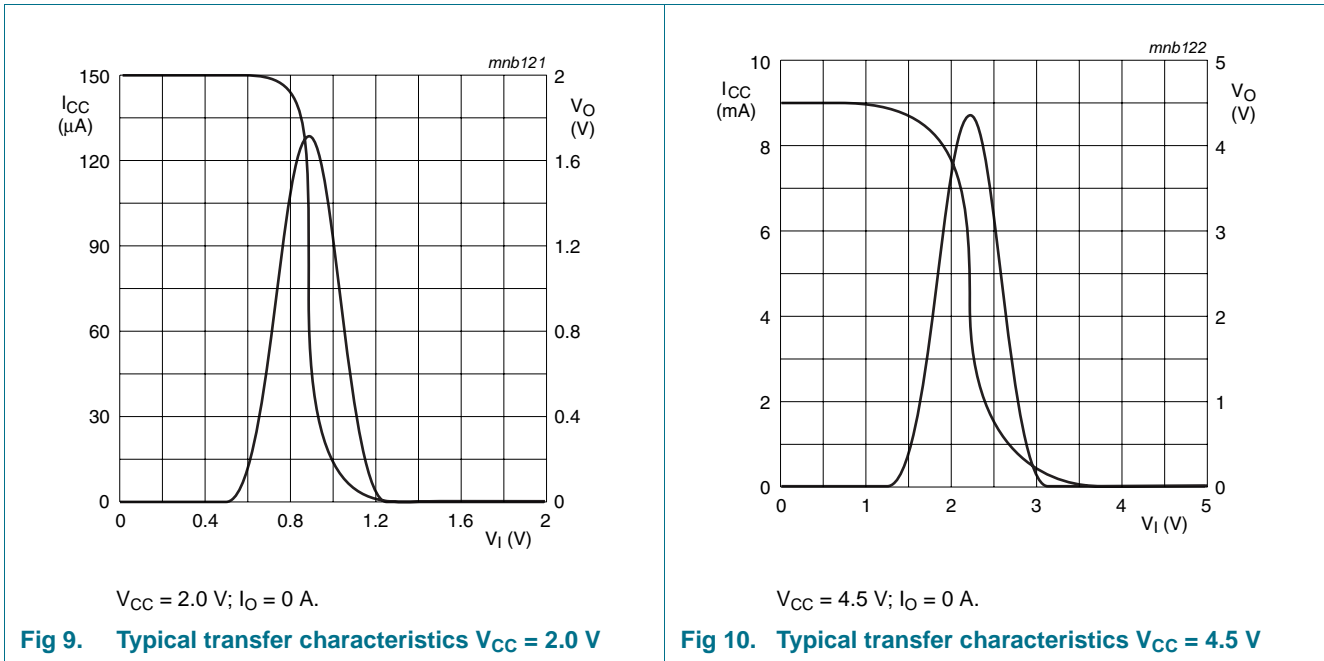
Fig 7. Test set-up for measuring forward transconductance



T<sub>amb</sub> = 25 °C.

Fig 8. Typical forward transconductance as a function of supply voltage

### 13. Typical transfer characteristics



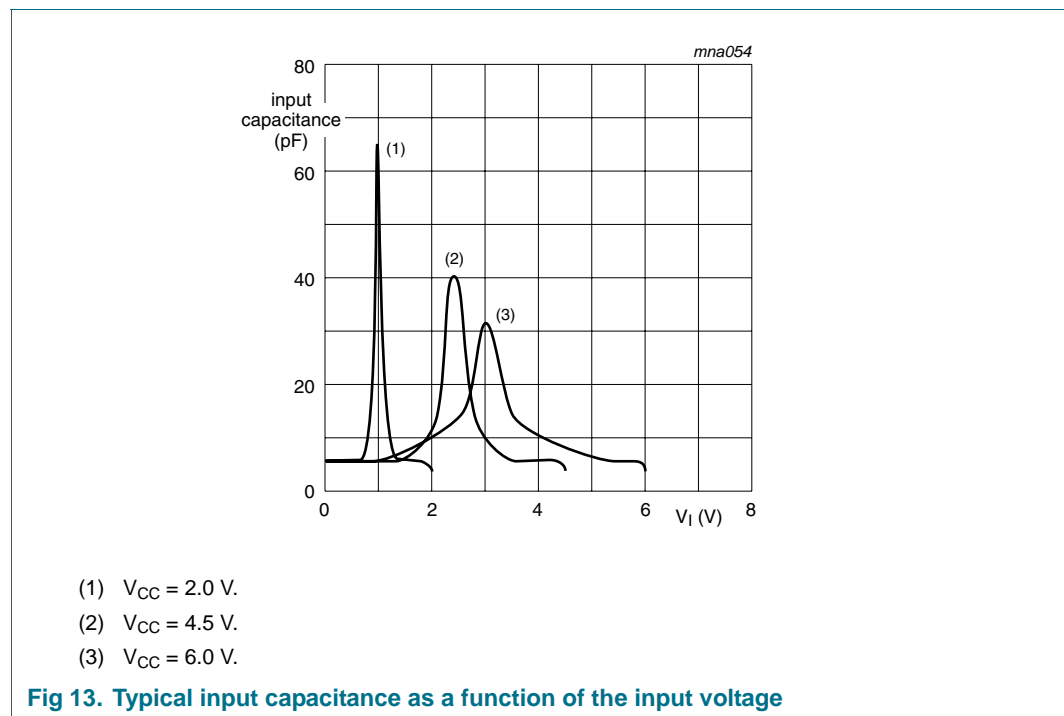
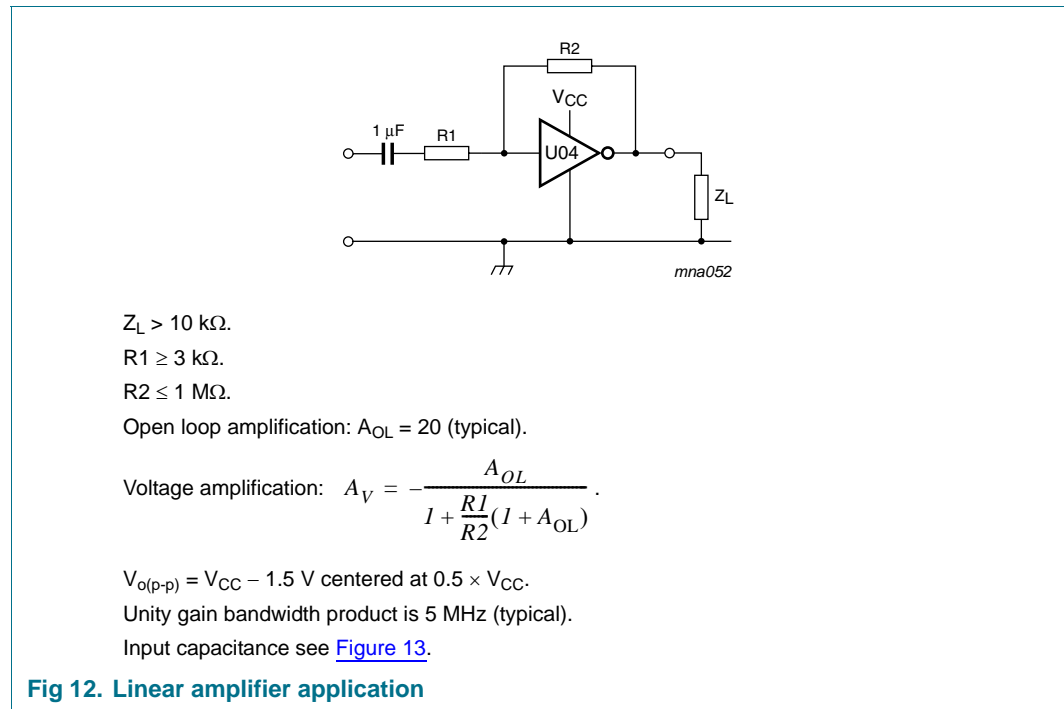
### 14. Application information

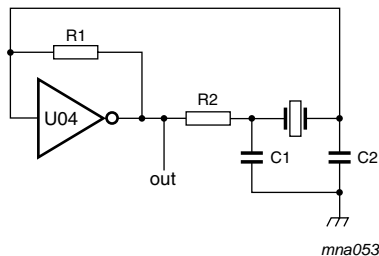
Some applications for the 74HC3GU04 are:

- Linear amplifier (see [Figure 12](#))
- Crystal oscillator (see [Figure 14](#)).



**Remark:** All values given are typical values unless otherwise specified.





Test data is given in [Table 11](#) and [Table 12](#).

C1 = 47 pF (typical).

C2 = 22 pF (typical).

R1 = 1 MΩ to 10 MΩ (typical).

R2 optimum value depends on the frequency and required stability against changes in  $V_{CC}$  or average minimum  $I_{CC}$  ( $I_{CC} = 2 \text{ mA}$  at  $V_{CC} = 3.0 \text{ V}$  and  $f = 1 \text{ MHz}$ )

**Fig 14. Crystal oscillator application**

**Table 11. External components for resonator (f < 1 MHz)**

| Frequency            | R1     | R2     | C1    | C2    |
|----------------------|--------|--------|-------|-------|
| 10 kHz to 15.9 kHz   | 2.2 MΩ | 220 kΩ | 56 pF | 20 pF |
| 16 kHz to 24.9 kHz   | 2.2 MΩ | 220 kΩ | 56 pF | 10 pF |
| 25 kHz to 54.9 kHz   | 2.2 MΩ | 100 kΩ | 56 pF | 10 pF |
| 55 kHz to 129.9 kHz  | 2.2 MΩ | 100 kΩ | 47 pF | 5 pF  |
| 130 kHz to 199.9 kHz | 2.2 MΩ | 47 kΩ  | 47 pF | 5 pF  |
| 200 kHz to 349.9 kHz | 2.2 MΩ | 47 kΩ  | 47 pF | 5 pF  |
| 350 kHz to 600 kHz   | 2.2 MΩ | 47 kΩ  | 47 pF | 5 pF  |

**Table 12. Optimum value for R2**

| Frequency | R2                                 | Optimum                                     |
|-----------|------------------------------------|---|
| 3 kHz     | 2.0 kΩ                             | minimum required $I_{CC}$                   |
|           | 8.0 kΩ                             | minimum influence due to change in $V_{CC}$ |
| 6 kHz     | 1.0 kΩ                             | minimum required $I_{CC}$                   |
|           | 4.7 kΩ                             | minimum influence by $V_{CC}$               |
| 10 kHz    | 0.5 kΩ                             | minimum required $I_{CC}$                   |
|           | 2.0 kΩ                             | minimum influence by $V_{CC}$               |
| 14 kHz    | 0.5 kΩ                             | minimum required $I_{CC}$                   |
|           | 2.0 kΩ                             | minimum influence by $V_{CC}$               |
| > 14 kHz  | replace R2 by C3 = 35 pF (typical) |   |

15. Package outline

TSSOP8: plastic thin shrink small outline package; 8 leads; body width 3 mm; lead length 0.5 mm SOT505-2

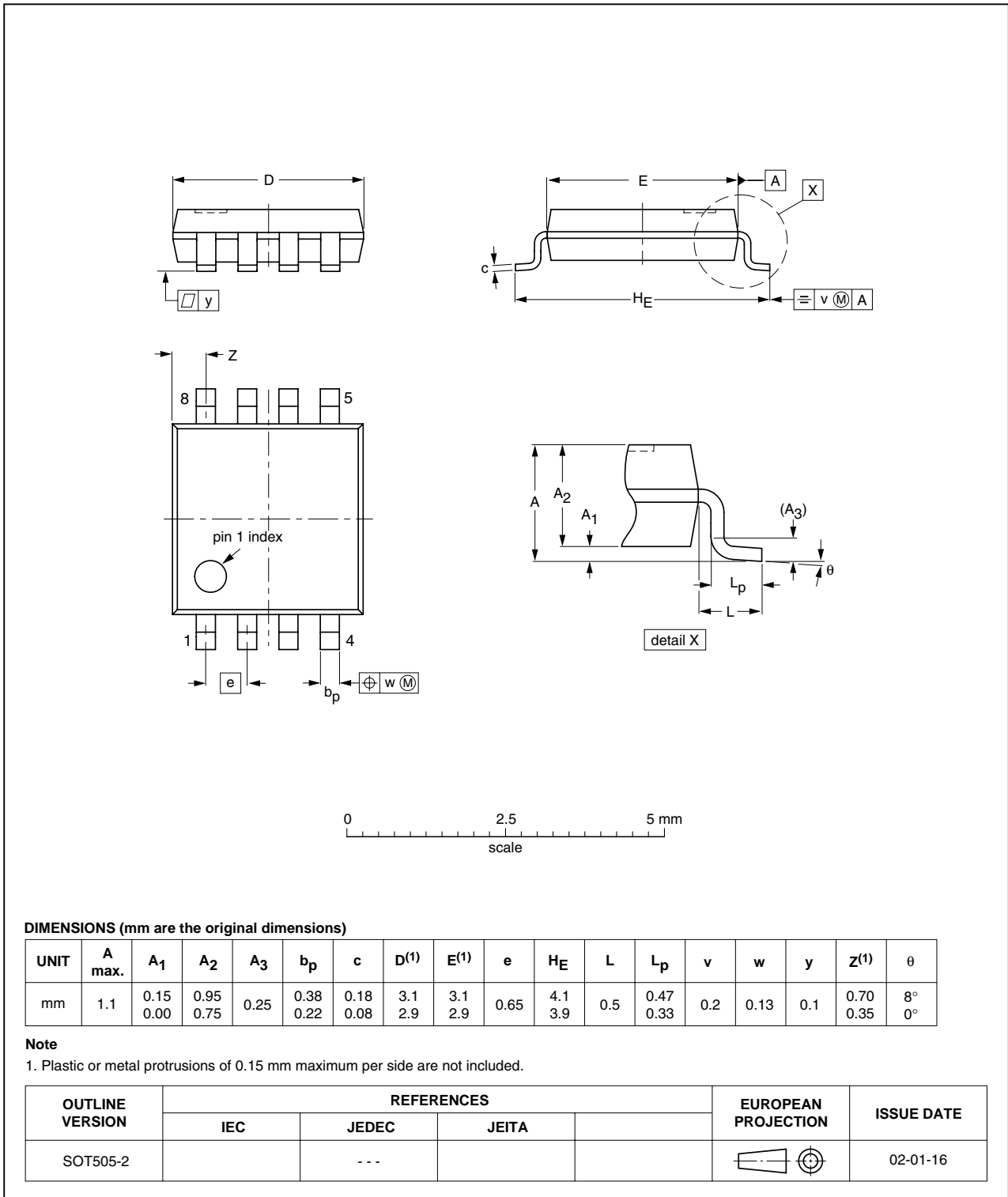


Fig 15. Package outline SOT505-2 (TSSOP8)

VSSOP8: plastic very thin shrink small outline package; 8 leads; body width 2.3 mm

SOT765-1

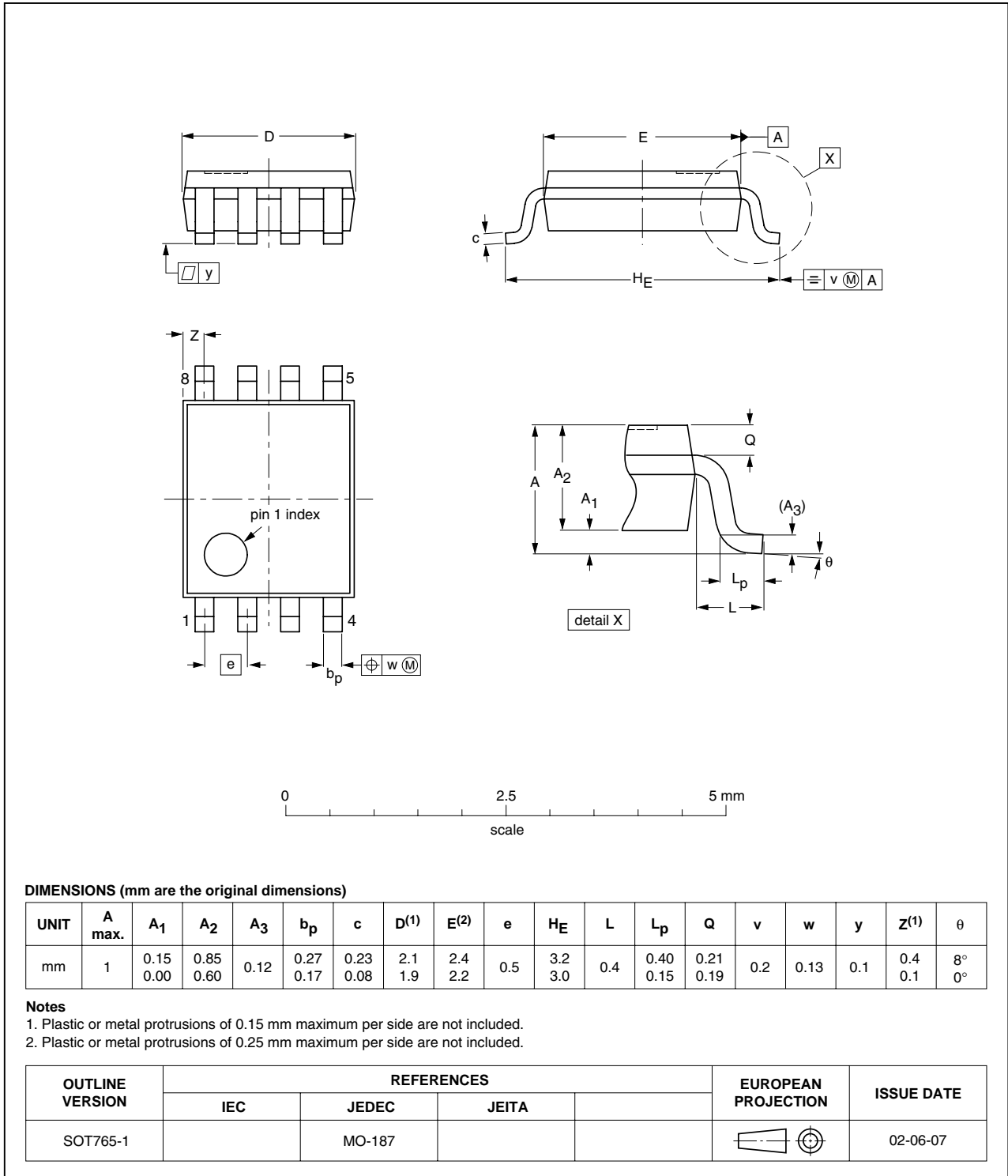


Fig 16. Package outline SOT765-1 (VSSOP8)

XSON8U: plastic extremely thin small outline package; no leads;  
8 terminals; UTLP based; body 3 x 2 x 0.5 mm

SOT996-2

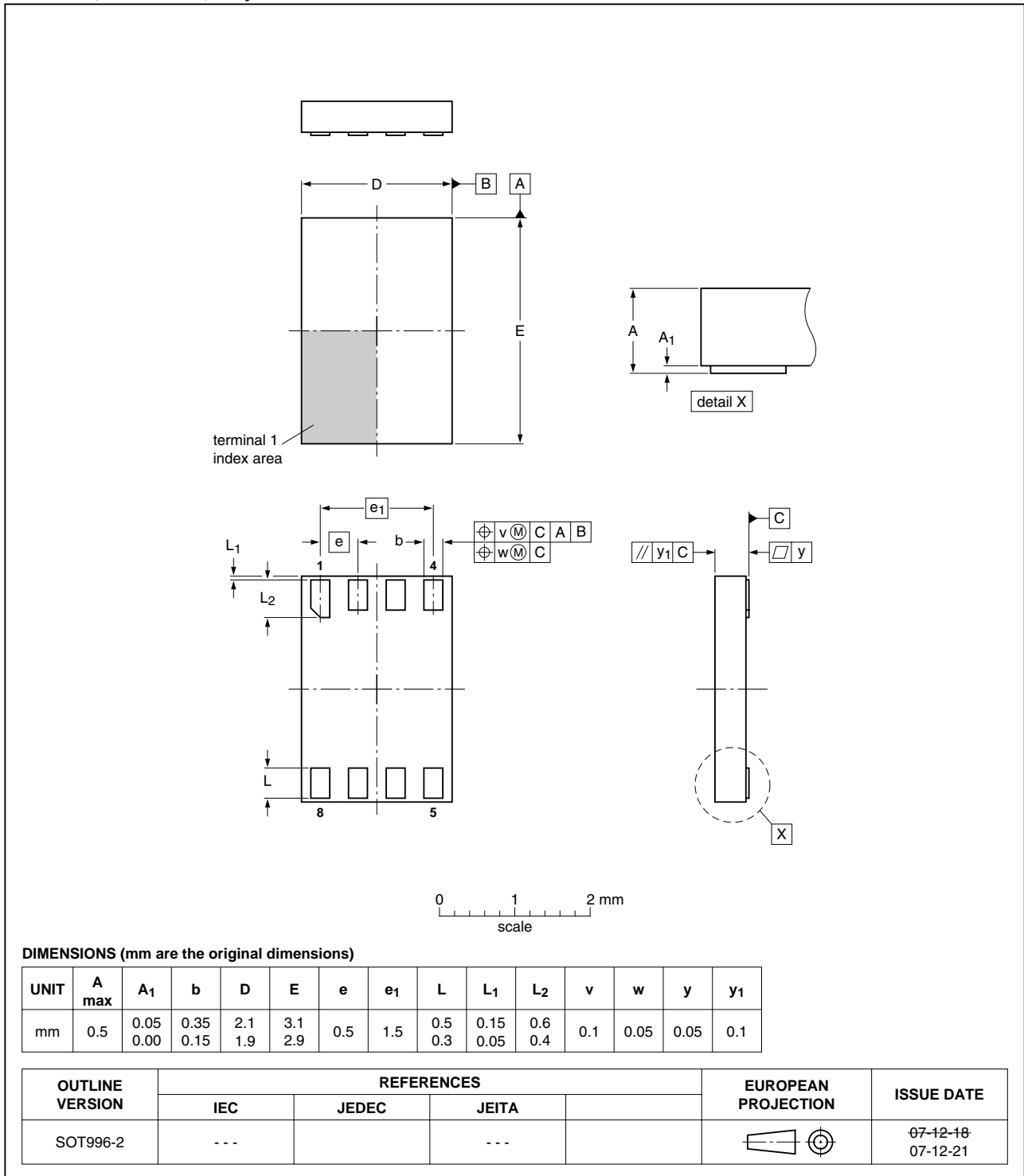


Fig 17. Package outline SOT996-2 (XSON8U)

## 16. Abbreviations

Table 13. 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             |

## 17. Revision history

Table 14. Revision history

| Document ID    | Release date  | Data sheet status     | Change notice | Supersedes  |
|----------------|---|-----------------------|---------------|-------------|
| 74HC3GU04_4    | 20100111  | Product data sheet    | -             | 74HC3GU04_3 |
| Modifications: | • Marking code for 74HC3GU04DP package changed from HU04 to HU4 |                       |               |             |
| 74HC3GU04_3    | 20090511  | Product data sheet    | -             | 74HC3GU04_2 |
| 74HC3GU04_2    | 20031126  | Product specification | -             | 74HC3GU04_1 |
| 74HC3GU04_1    | 20030818  | Product specification | -             | -           |

## 18. Legal information

### 18.1 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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