# 74HC3GU04

## Inverter

**Rev. 03 — 11 May 2009**                    **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-A114E exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V
- Specified from −40 °C to +85 °C and −40 °C to +125 °C

## 3. Ordering information

**Table 1.    Ordering information**

| Type number | Package | | | |
| --- | --- | --- | --- | --- |
| | Temperature range | Name | Description | Version |
| 74HC3GU04DP | −40 °C to +125 °C | TSSOP8 | plastic thin shrink small outline package; 8 leads; body width 3 mm; lead length 0.5 mm | SOT505-2 |
| 74HC3GU04DC | −40 °C to +125 °C | VSSOP8 | plastic very thin shrink small outline package; 8 leads; body width 2.3 mm | SOT765-1 |
| 74HC3GU04GD | −40 °C to +125 °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 | HU04 |
| 74HC3GU04DC | HU4 |
| 74HC3GU04GD | HU4 |

founded by Philips

## 5. Functional diagram
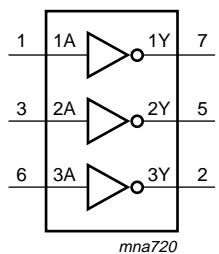
Fig 1.    Logic symbol
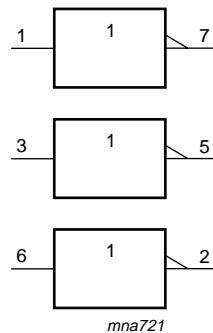
Fig 2.    IEC logic symbol

## 6. Pinning information

### 6.1 Pinning

**74HC3GU04**
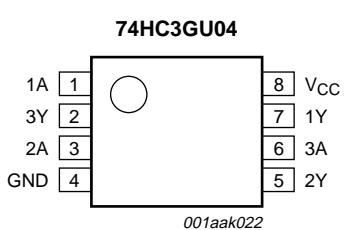
Fig 3.    **Pin configuration SOT505-2 (TSSOP8) and SOT765-1 (VSSOP8)**

**74HC3GU04**

Transparent top view
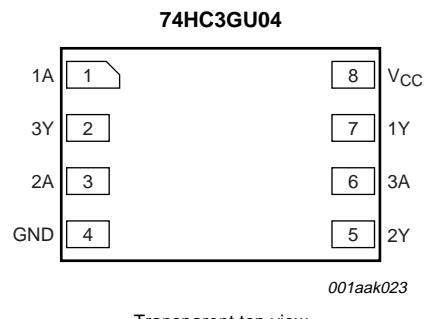
Fig 4.    **Pin configuration SOT996-2 (XSON8U)**

### 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) |
| $V_{CC}$ | 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 V or $V_I$ > $V_{CC}$ + 0.5 V | [1] | - | ±20 | mA |
| $I_{OK}$ | output clamping current | $V_O$ < −0.5 V or $V_O$ > $V_{CC}$ + 0.5 V | [1] | - | ±20 | mA |
| $I_O$ | output current | $V_O$ = −0.5 V to ($V_{CC}$ + 0.5 V) | [1] | - | ±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 °C to +125 °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 V | - | - | 625 | ns/V |
| | | $V_{CC}$ = 4.5 V | - | 1.67 | 139 | ns/V |
| | | $V_{CC}$ = 6.0 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[1] | Max | Min | Max | |
| $V_{IH}$ | HIGH-level input voltage | $V_{CC}$ = 2.0 V | 1.7 | 1.1 | - | 1.7 | - | V |
| | | $V_{CC}$ = 4.5 V | 3.6 | 2.4 | - | 3.6 | - | V |
| | | $V_{CC}$ = 6.0 V | 4.8 | 3.1 | - | 4.8 | - | V |
| $V_{IL}$ | LOW-level input voltage | $V_{CC}$ = 2.0 V | - | 0.9 | 0.3 | - | 0.3 | V |
| | | $V_{CC}$ = 4.5 V | - | 2.1 | 0.9 | - | 0.9 | V |
| | | $V_{CC}$ = 6.0 V | - | 2.9 | 1.2 | - | 1.2 | V |
| $V_{OH}$ | HIGH-level output voltage | $V_I$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $I_O$ = −20 µA; $V_{CC}$ = 2.0 V | 1.9 | 2.0 | - | 1.9 | - | V |
| | | $I_O$ = −20 µA; $V_{CC}$ = 4.5 V | 4.4 | 4.5 | - | 4.4 | - | V |
| | | $I_O$ = −20 µA; $V_{CC}$ = 6.0 V | 5.9 | 6.0 | - | 5.9 | - | V |
| | | $I_O$ = −4.0 mA; $V_{CC}$ = 4.5 V | 4.13 | 4.32 | - | 3.7 | - | V |
| | | $I_O$ = −5.2 mA; $V_{CC}$ = 6.0 V | 5.63 | 5.81 | - | 5.2 | - | V |
| $V_{OL}$ | LOW-level output voltage | $V_I$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $I_O$ = 20 µA; $V_{CC}$ = 2.0 V | - | 0 | 0.1 | - | 0.1 | V |
| | | $I_O$ = 20 µA; $V_{CC}$ = 4.5 V | - | 0 | 0.1 | - | 0.1 | V |
| | | $I_O$ = 20 µA; $V_{CC}$ = 6.0 V | - | 0 | 0.1 | - | 0.1 | V |
| | | $I_O$ = 4.0 mA; $V_{CC}$ = 4.5 V | - | 0.15 | 0.33 | - | 0.4 | V |
| | | $I_O$ = 5.2 mA; $V_{CC}$ = 6.0 V | - | 0.16 | 0.33 | - | 0.4 | V |
| $I_I$ | input leakage current | $V_I$ = $V_{CC}$ or GND; $V_{CC}$ = 6.0 V | - | - | ±1.0 | - | ±1.0 | µA |
| $I_{CC}$ | supply current | per input pin; $V_I$ = $V_{CC}$ or GND; $I_O$ = 0 A; $V_{CC}$ = 6.0 V | - | - | 10 | - | 20 | µA |
| $C_I$ | input capacitance | | - | 3.0 | - | - | - | pF |

[1]    All typical values are measured at $T_{amb}$ = 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[1] | Max | Min | Max | |
| $t_{pd}$ | propagation delay | nA to nY; see Figure 5 [2] | | | | | | |
| | | $V_{CC}$ = 2.0 V | - | 13 | 75 | - | 90 | ns |
| | | $V_{CC}$ = 4.5 V | - | 6 | 15 | - | 18 | ns |
| | | $V_{CC}$ = 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[1] | Max | Min | Max | |
| $t_t$ | transition time | nY; see Figure 5 | [3] | | | | | | |
| | | $V_{CC}$ = 2.0 V | | - | 18 | 95 | - | 125 | ns |
| | | $V_{CC}$ = 4.5 V | | - | 6 | 19 | - | 25 | ns |
| | | $V_{CC}$ = 6.0 V | | - | 5 | 16 | - | 20 | ns |
| $C_{PD}$ | power dissipation capacitance | $V_I$ = GND to $V_{CC}$ | [4] | - | 5 | - | - | - | pF |

[1]  All typical values are measured at $T_{amb}$ = 25 °C.

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

[3]  $t_t$ is the same as $t_{TLH}$ and $t_{THL}$.

[4]  $C_{PD}$ is used to determine the dynamic power dissipation ($P_D$ in μW).
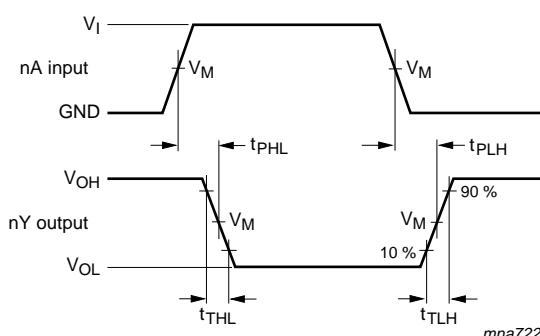
$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$ where:

$f_i$ = input frequency in MHz;

$f_o$ = output frequency in MHz;

$C_L$ = output load capacitance in pF;

$V_{CC}$ = supply voltage in V;
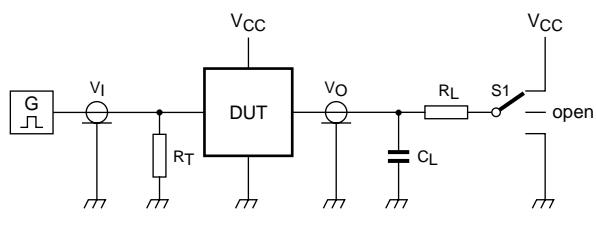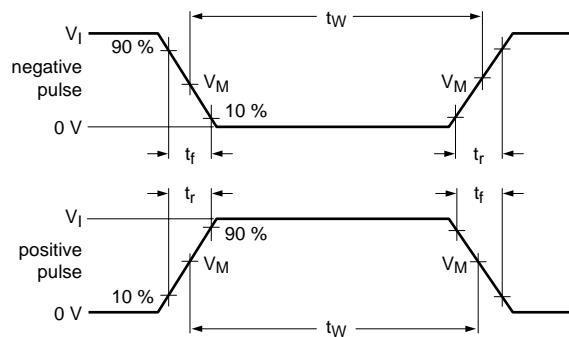
N = number of inputs switching;

$\Sigma(C_L \times V_{CC}^2 \times f_o)$ = 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 |
|---|---|---|
| | $V_M$ | $V_M$ |
| 74HC3GU04 | $0.5 \times V_{CC}$ | $0.5 \times V_{CC}$ |

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Test data is given in Table 10.

Definitions for test circuit:
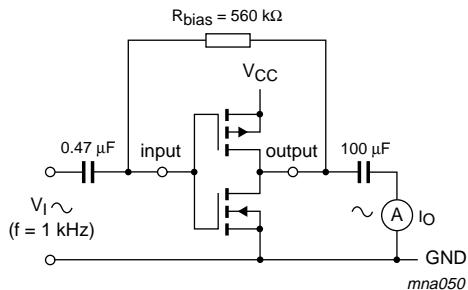
$R_T$ = Termination resistance should be equal to output impedance $Z_o$ of the pulse generator.

$C_L$ = 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 $V_{CC}$ | ≤ 6 ns | 50 pF | 1 kΩ | open |

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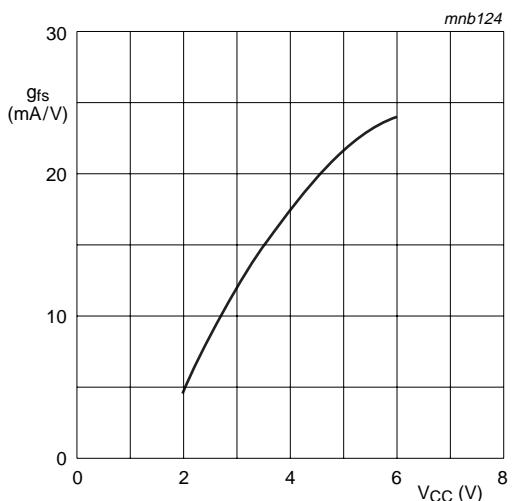
## 12.1 Additional characteristics



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

$V_O$ is constant.
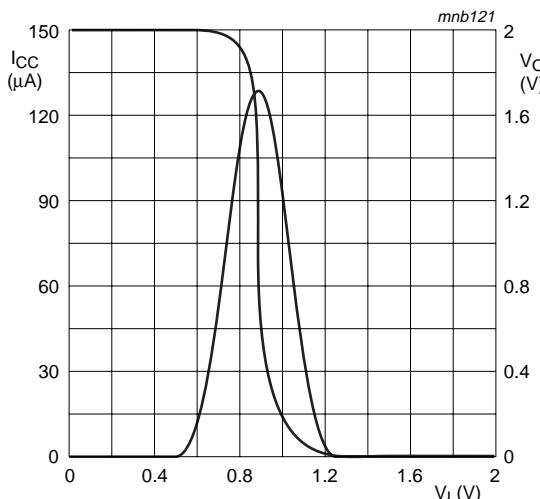
**Fig 7.  Test set-up for measuring forward transconductance**



$T_{amb}$ = 25 °C.
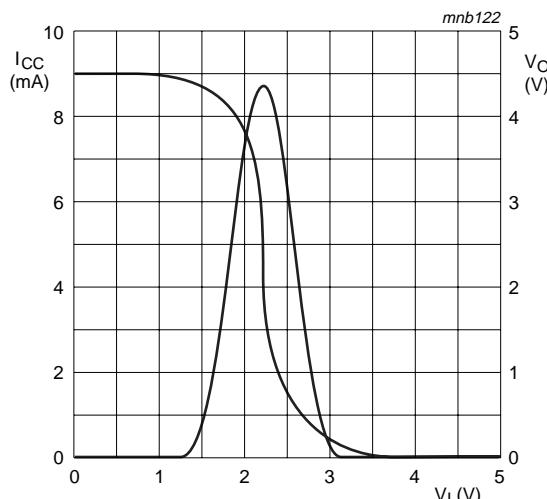
**Fig 8.  Typical forward transconductance as a function of supply voltage**

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## 13. Typical transfer characteristics
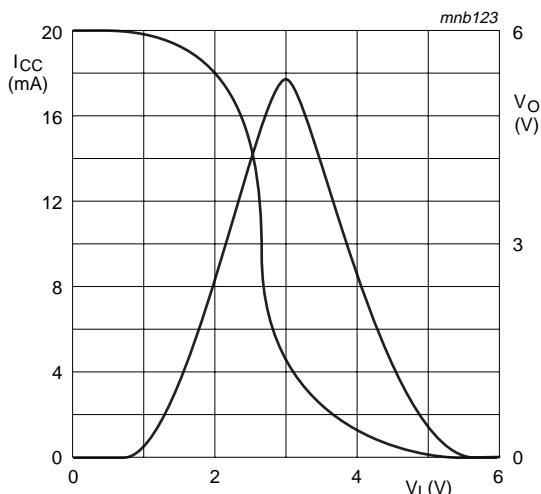
$V_{CC}$ = 2.0 V; $I_O$ = 0 A.

**Fig 9.    Typical transfer characteristics $V_{CC}$ = 2.0 V**

$V_{CC}$ = 4.5 V; $I_O$ = 0 A.

**Fig 10.    Typical transfer characteristics $V_{CC}$ = 4.5 V**

$V_{CC}$ = 6.0 V; $I_O$ = 0 A.
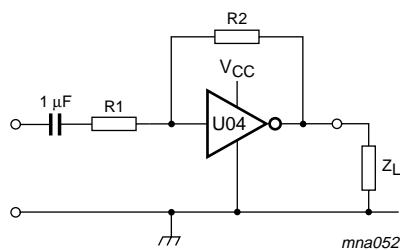
**Fig 11.    Typical transfer characteristics $V_{CC}$ = 6.0 V**

## 14. Application information

Some applications for the 74HC3GU04 are:

• Linear amplifier (see Figure 12)

• Crystal oscillator (see Figure 14).

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



$Z_L > 10$ kΩ.

$R1 \geq 3$ kΩ.

$R2 \leq 1$ MΩ.

Open loop amplification: $A_{OL} = 20$ (typical).
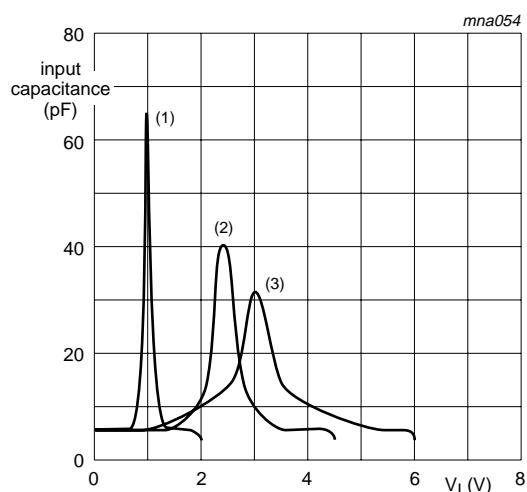
Voltage amplification: $A_V = -\dfrac{A_{OL}}{1 + \dfrac{R1}{R2}(1 + A_{OL})}$.

$V_{o(p-p)} = V_{CC} - 1.5$ V centered at $0.5 \times V_{CC}$.

Unity gain bandwidth product is 5 MHz (typical).

Input capacitance see Figure 13.

**Fig 12. Linear amplifier application**
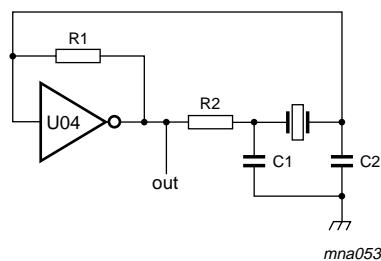


(1)  $V_{CC} = 2.0$ V.

(2)  $V_{CC} = 4.5$ V.

(3)  $V_{CC} = 6.0$ V.

**Fig 13. Typical input capacitance as a function of the input voltage**

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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 mA at $V_{CC}$ = 3.0 V and f = 1 MHz)

**Fig 14. Crystal oscillator application**

**Table 11.    External components for resonator (f < 1 MHz)**
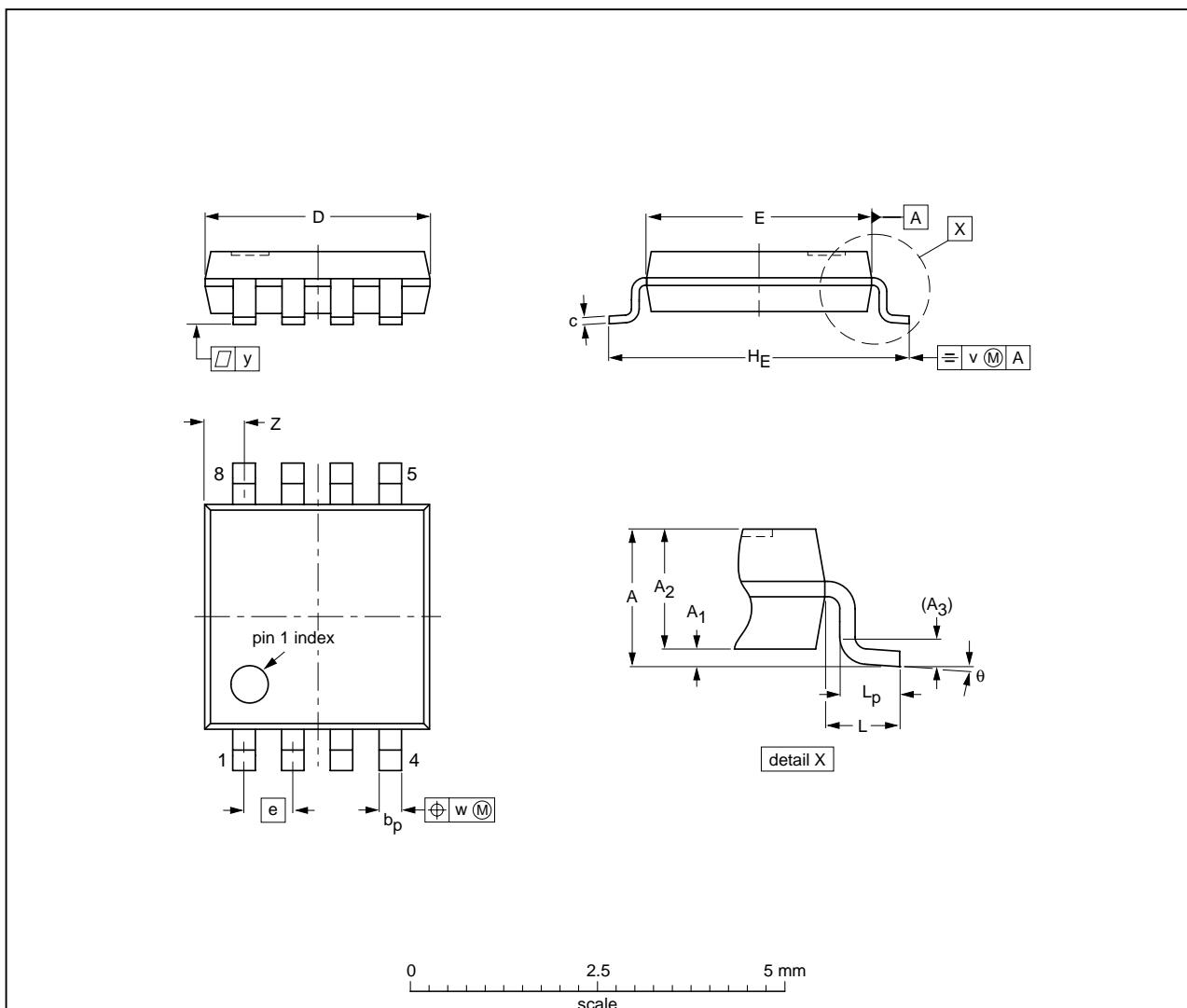
| Frequency | R1 | R2 | C1 | C2 |
|---|---|---|---|---|
| 10 kHz to 15.9 kHz | 2.2 MΩ | 220 kΩ | 56 pF | 20 pF |
| 16 kHz to 24.9 kHz | 2.2 MΩ | 220 kΩ | 56 pF | 10 pF |
| 25 kHz to 54.9 kHz | 2.2 MΩ | 100 kΩ | 56 pF | 10 pF |
| 55 kHz to 129.9 kHz | 2.2 MΩ | 100 kΩ | 47 pF | 5 pF |
| 130 kHz to 199.9 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



**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | A₁ | A₂ | A₃ | b_p | c | D⁽¹⁾ | E⁽¹⁾ | e | H_E | L | L_p | v | w | y | Z⁽¹⁾ | θ |
|------|--------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|-----|------|-----|------|-----|
| mm | 1.1 | 0.15 0.00 | 0.95 0.75 | 0.25 | 0.38 0.22 | 0.18 0.08 | 3.1 2.9 | 3.1 2.9 | 0.65 | 4.1 3.9 | 0.5 | 0.47 0.33 | 0.2 | 0.13 | 0.1 | 0.70 0.35 | 8° 0° |

**Note**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|------|-------|--|---------------------|------------|
| | IEC | JEDEC | JEITA | | | |
| SOT505-2 | | - - - | | | | 02-01-16 |

**Fig 15.  Package outline SOT505-2 (TSSOP8)**

**VSSOP8: plastic very thin shrink small outline package; 8 leads; body width 2.3 mm**     SOT765-1

**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | A₁ | A₂ | A₃ | bₚ | c | D⁽¹⁾ | E⁽²⁾ | e | H_E | L | Lₚ | Q | v | w | y | Z⁽¹⁾ | θ |
|------|--------|----|----|----|----|----|------|------|----|-----|----|----|----|----|----|----|------|----|
| mm | 1 | 0.15 0.00 | 0.85 0.60 | 0.12 | 0.27 0.17 | 0.23 0.08 | 2.1 1.9 | 2.4 2.2 | 0.5 | 3.2 3.0 | 0.4 | 0.40 0.15 | 0.21 0.19 | 0.2 | 0.13 | 0.1 | 0.4 0.1 | 8° 0° |

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|-----|-------|-------|---|---------------------|------------|
| | IEC | JEDEC | JEITA | | | |
| SOT765-1 | | MO-187 | | | | 02-06-07 |
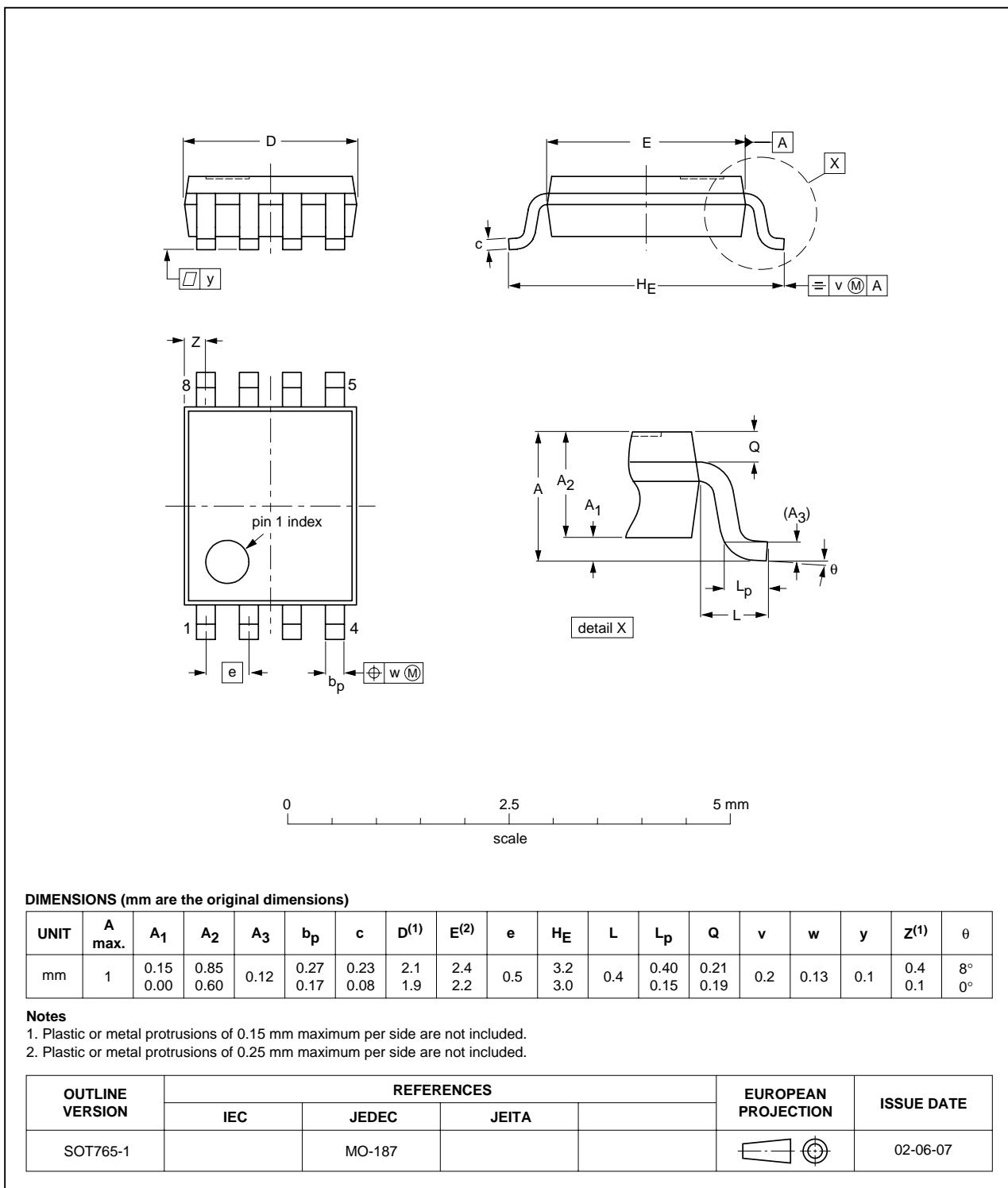
**Fig 16.  Package outline SOT765-1 (VSSOP8)**

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

SOT996-2

terminal 1
index area

detail X

e₁

e

b

L₁

L₂

L

1    4

8    5

| ⊕ | v Ⓜ | C A B |
| ⊕ | w Ⓜ | C |

// y₁ C

□ y

C

X

```
0        1        2 mm
|__|__|__|__|__|__|
        scale
```

**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max | A₁ | b | D | E | e | e₁ | L | L₁ | L₂ | v | w | y | y₁ |
|------|-------|-----|------|-----|-----|-----|-----|-----|------|-----|-----|------|------|------|
| mm | 0.5 | 0.05 0.00 | 0.35 0.15 | 2.1 1.9 | 3.1 2.9 | 0.5 | 1.5 | 0.5 0.3 | 0.15 0.05 | 0.6 0.4 | 0.1 | 0.05 | 0.05 | 0.1 |

| OUTLINE VERSION | REFERENCES | | | EUROPEAN PROJECTION | ISSUE DATE |
|-----------------|------------|------|-------|---------------------|------------|
| | IEC | JEDEC | JEITA | | |
| SOT996-2 | - - - | | - - - | | ~~07-12-18~~ 07-12-21 |
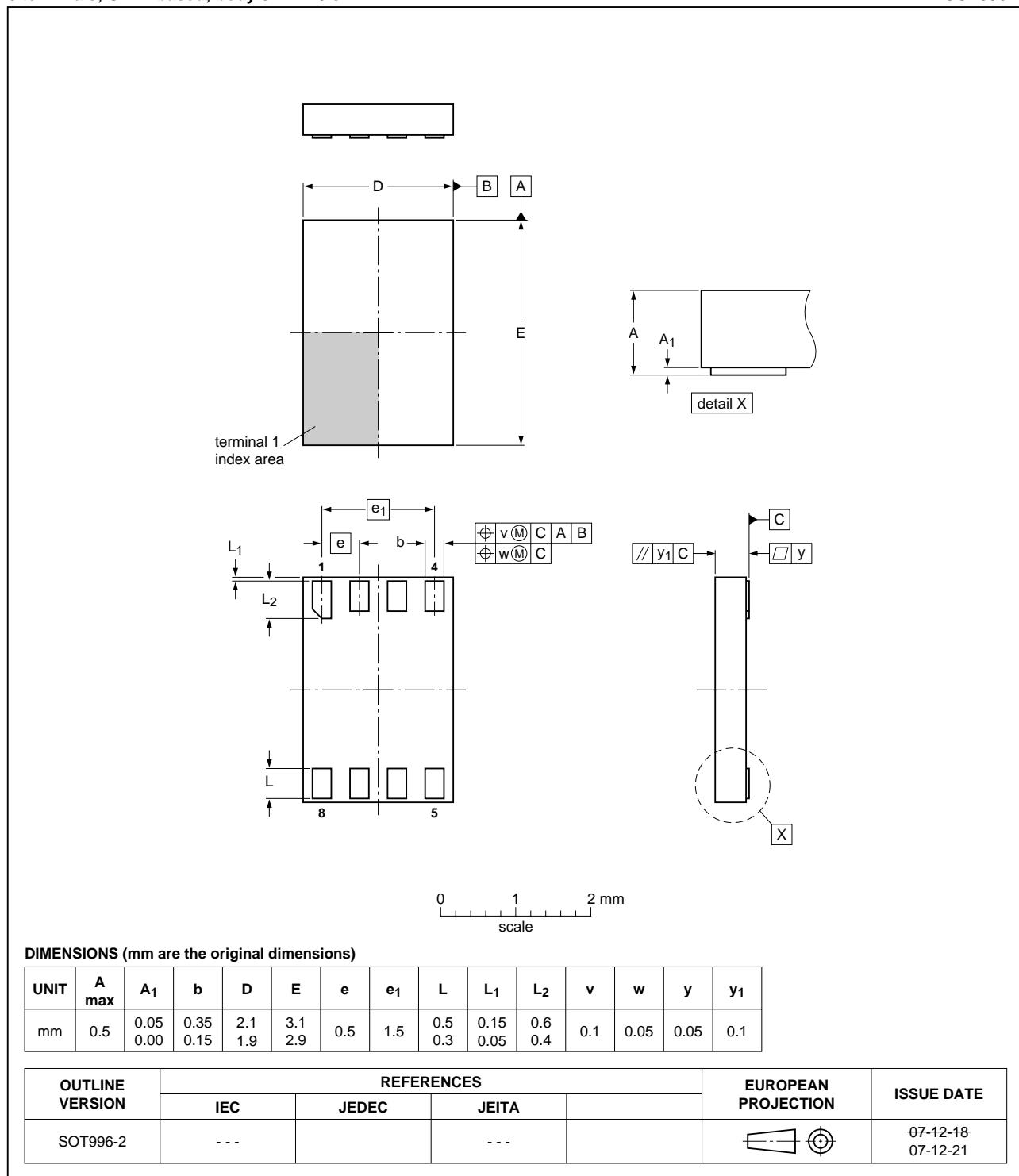
**Fig 17. Package outline SOT996-2 (XSON8U)**

## 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_3 | 20090511 | Product data sheet | - | 74HC3GU04_2 |
| Modifications: | • The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.<br>• Legal texts have been adapted to the new company name where appropriate.<br>• Added type number 74HC3GU04GD (XSON8U package) | | | |
| 74HC3GU04_2 | 20031126 | Product specification | - | 74HC3GU04_1 |
| 74HC3GU04_1 | 20030818 | Product specification | - | - |

## 18. Legal information

### 18.1 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. |
| 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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