

# DATA SHEET

## **74LVC1GU04**

### **Inverter**

Product specification  
Supersedes data of 2004 Jun 28

2004 Sep 21

## Inverter

## 74LVC1GU04

## FEATURES

- Wide supply voltage range from 1.65 V to 5.5 V
- High noise immunity
- $\pm 24$  mA output drive ( $V_{CC} = 3.0$  V)
- CMOS low power consumption
- Latch-up performance exceeds 250 mA
- Input accepts voltages up to 5 V
- Multiple package options
- ESD protection:
  - HBM EIA/JESD22-A114-B exceeds 2000 V
  - MM EIA/JESD22-A115-A exceeds 200 V.
- Specified from  $-40$  °C to  $+85$  °C and  $-40$  °C to  $+125$  °C.

## DESCRIPTION

The 74LVC1GU04 is a high-performance, low-power, low-voltage, Si-gate CMOS device, superior to most advanced CMOS compatible TTL families.

The input can be driven from either 3.3 V or 5 V devices. This feature allows the use of this device in a mixed 3.3 V and 5 V environment.

Schmitt-trigger action at all inputs makes the circuit tolerant for slower input rise and fall time.

The 74LVC1GU04 provides the inverting single state unbuffered function.

## QUICK REFERENCE DATA

Ground = 0 V;  $T_{amb} = 25$  °C;  $t_r = t_f \leq 2.5$  ns.

| SYMBOL            | PARAMETER                     | CONDITIONS                                            | TYPICAL | UNIT |
|-------------------|-------------------------------|-------------------------------------------------------|---------|------|
| $t_{PHL}/t_{PLH}$ | propagation delay A to Y      | $V_{CC} = 1.8$ V; $C_L = 30$ pF; $R_L = 1$ k $\Omega$ | 1.7     | ns   |
|                   |                               | $V_{CC} = 2.5$ V; $C_L = 30$ pF; $R_L = 500$ $\Omega$ | 1.3     | ns   |
|                   |                               | $V_{CC} = 2.7$ V; $C_L = 50$ pF; $R_L = 500$ $\Omega$ | 1.7     | ns   |
|                   |                               | $V_{CC} = 3.3$ V; $C_L = 50$ pF; $R_L = 500$ $\Omega$ | 1.6     | ns   |
|                   |                               | $V_{CC} = 5.0$ V; $C_L = 50$ pF; $R_L = 500$ $\Omega$ | 1.3     | ns   |
| $C_I$             | input capacitance             |                                                       | 6       | pF   |
| $C_{PD}$          | power dissipation capacitance | $V_{CC} = 3.3$ V; notes 1 and 2                       | 14.9    | pF   |

## Notes

1.  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu$ W).

$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$  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 Volts;

$N$  = total load switching outputs;

$\Sigma(C_L \times V_{CC}^2 \times f_o)$  = sum of the outputs.

2. The condition is  $V_I = \text{GND to } V_{CC}$ .

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FUNCTION TABLE

See note 1.

| INPUT | OUTPUT |
|-------|--------|
| A     | Y      |
| L     | H      |
| H     | L      |

Note

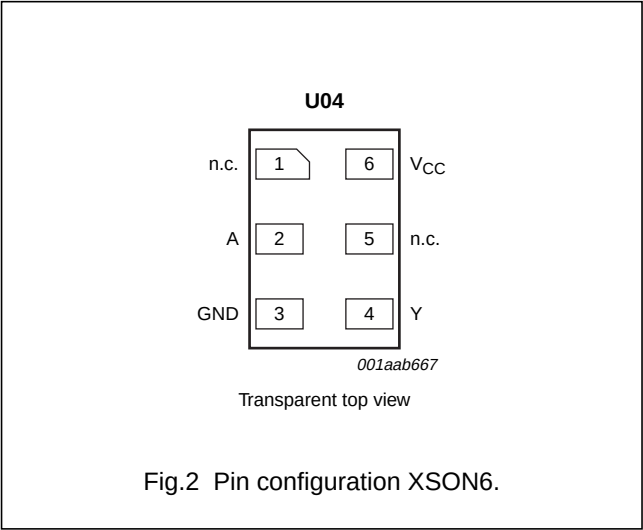
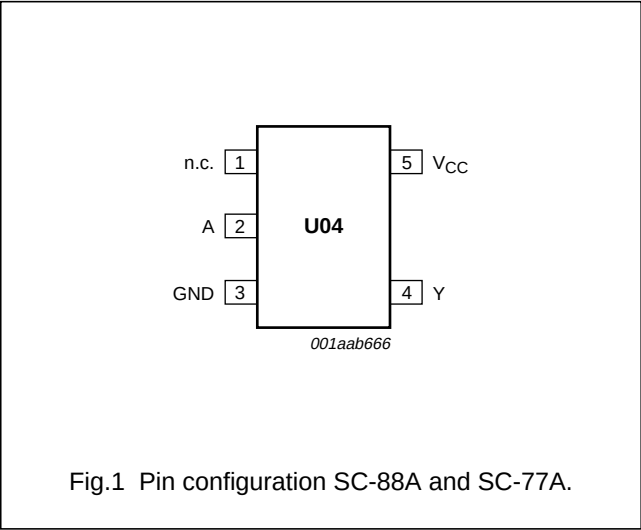
1. H = HIGH voltage level;
- L = LOW voltage level.

ORDERING INFORMATION

| TYPE NUMBER  | PACKAGE           |      |         |          |        |         |
|--------------|-------------------|------|---------|----------|--------|---------|
|              | TEMPERATURE RANGE | PINS | PACKAGE | MATERIAL | CODE   | MARKING |
| 74LVC1GU04GW | −40 °C to +125 °C | 5    | SC-88A  | plastic  | SOT353 | VD      |
| 74LVC1GU04GV | −40 °C to +125 °C | 5    | SC-74A  | plastic  | SOT753 | VU4     |
| 74LVC1GU04GM | −40 °C to +125 °C | 6    | XSON6   | plastic  | SOT886 | VD      |

PINNING

| PIN SC-88A; SC-74A | PIN XSON6 | SYMBOL          | DESCRIPTION    |
|--------------------|-----------|-----------------|----------------|
| 1                  | 1         | n.c.            | not connected  |
| 2                  | 2         | A               | data input A   |
| 3                  | 3         | GND             | ground (0 V)   |
| 4                  | 4         | Y               | data output Y  |
| -                  | 5         | n.c.            | not connected  |
| 5                  | 6         | V <sub>CC</sub> | supply voltage |



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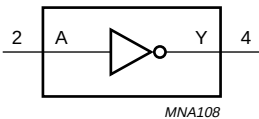


Fig.3 Logic symbol.

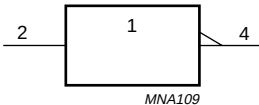


Fig.4 IEEE logic symbol.

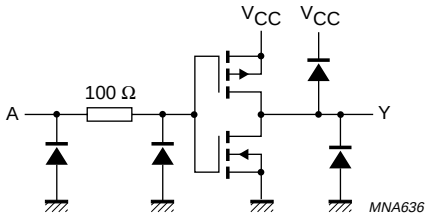


Fig.5 Logic diagram.

## Inverter

## 74LVC1GU04

## RECOMMENDED OPERATING CONDITIONS

| SYMBOL     | PARAMETER                     | CONDITIONS                                  | MIN. | MAX.     | UNIT |
|------------|-------------------------------|---------------------------------------------|------|----------|------|
| $V_{CC}$   | supply voltage                |                                             | 1.65 | 5.5      | V    |
| $V_I$      | input voltage                 |                                             | 0    | 5.5      | V    |
| $V_O$      | output voltage                |                                             | 0    | $V_{CC}$ | V    |
| $T_{amb}$  | operating ambient temperature |                                             | -40  | +125     | °C   |
| $t_r, t_f$ | input rise and fall times     | $V_{CC} = 1.65 \text{ V to } 2.7 \text{ V}$ | 0    | 20       | ns/V |
|            |                               | $V_{CC} = 2.7 \text{ V to } 5.5 \text{ V}$  | 0    | 10       | ns/V |

## 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 | +6.5           | V    |
| $I_{IK}$          | input diode current           | $V_I < 0 \text{ V}$                                     | –    | -50            | mA   |
| $V_I$             | input voltage                 | note 1                                                  | -0.5 | +6.5           | V    |
| $I_{OK}$          | output diode current          | $V_O > V_{CC}$ or $V_O < 0 \text{ V}$                   | –    | ±50            | mA   |
| $V_O$             | output voltage                | active mode; note 1                                     | -0.5 | $V_{CC} + 0.5$ | V    |
| $I_O$             | output source or sink current | $V_O = 0 \text{ V to } V_{CC}$                          | –    | ±50            | mA   |
| $I_{CC}, I_{GND}$ | $V_{CC}$ or GND current       |                                                         | –    | ±100           | mA   |
| $T_{stg}$         | storage temperature           |                                                         | -65  | +150           | °C   |
| $P_{tot}$         | power dissipation             | $T_{amb} = -40 \text{ °C to } +125 \text{ °C}$ ; note 2 | –    | 200            | mW   |

## Notes

1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. Above 55 °C the value of  $P_{tot}$  derates linearly with 4.5 mW/K.

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## DC CHARACTERISTICS

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

| SYMBOL                              | PARAMETER                 | TEST CONDITIONS                                                  |                     | MIN.                   | TYP. <sup>(1)</sup> | MAX.                   | UNIT |
|-------------------------------------|---------------------------|------------------------------------------------------------------|---------------------|------------------------|---------------------|------------------------|------|
|                                     |                           | OTHER                                                            | V <sub>CC</sub> (V) |                        |                     |                        |      |
| T <sub>amb</sub> = −40 °C to +85 °C |                           |                                                                  |                     |                        |                     |                        |      |
| V <sub>IH</sub>                     | HIGH-level input voltage  |                                                                  | 1.65 to 5.5         | 0.75 × V <sub>CC</sub> | –                   | –                      | V    |
| V <sub>IL</sub>                     | LOW-level input voltage   |                                                                  | 1.65 to 5.5         | –                      | –                   | 0.25 × V <sub>CC</sub> | 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                                          | 1.65 to 5.5         | –                      | –                   | 0.1                    | V    |
|                                     |                           | I <sub>O</sub> = 4 mA                                            | 1.65                | –                      | –                   | 0.45                   | V    |
|                                     |                           | I <sub>O</sub> = 8 mA                                            | 2.3                 | –                      | –                   | 0.3                    | V    |
|                                     |                           | I <sub>O</sub> = 12 mA                                           | 2.7                 | –                      | –                   | 0.4                    | V    |
|                                     |                           | I <sub>O</sub> = 24 mA                                           | 3.0                 | –                      | –                   | 0.55                   | V    |
|                                     |                           | I <sub>O</sub> = 32 mA                                           | 4.5                 | –                      | –                   | 0.55                   | 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                                         | 1.65 to 5.5         | V <sub>CC</sub> − 0.1  | –                   | –                      | V    |
|                                     |                           | I <sub>O</sub> = −4 mA                                           | 1.65                | 1.2                    | –                   | –                      | V    |
|                                     |                           | I <sub>O</sub> = −8 mA                                           | 2.3                 | 1.9                    | –                   | –                      | V    |
|                                     |                           | I <sub>O</sub> = −12 mA                                          | 2.7                 | 2.2                    | –                   | –                      | V    |
|                                     |                           | I <sub>O</sub> = −24 mA                                          | 3.0                 | 2.3                    | –                   | –                      | V    |
|                                     |                           | I <sub>O</sub> = −32 mA                                          | 4.5                 | 3.8                    | –                   | –                      | V    |
| I <sub>LI</sub>                     | input leakage current     | V <sub>I</sub> = 5.5 V or GND                                    | 3.6                 | –                      | ±0.1                | ±5                     | μA   |
| I <sub>CC</sub>                     | quiescent supply current  | V <sub>I</sub> = V <sub>CC</sub> or GND;<br>I <sub>O</sub> = 0 A | 5.5                 | –                      | 0.1                 | 10                     | μA   |

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| SYMBOL                               | PARAMETER                 | TEST CONDITIONS                                                  |                     | MIN.                  | TYP. <sup>(1)</sup> | MAX.                  | UNIT |
|--------------------------------------|---------------------------|------------------------------------------------------------------|---------------------|-----------------------|---------------------|-----------------------|------|
|                                      |                           | OTHER                                                            | V <sub>CC</sub> (V) |                       |                     |                       |      |
| T <sub>amb</sub> = −40 °C to +125 °C |                           |                                                                  |                     |                       |                     |                       |      |
| V <sub>IH</sub>                      | HIGH-level input voltage  |                                                                  | 1.65 to 5.5         | 0.8 × V <sub>CC</sub> | –                   | –                     | V    |
| V <sub>IL</sub>                      | LOW-level input voltage   |                                                                  | 1.65 to 5.5         | –                     | –                   | 0.2 × V <sub>CC</sub> | 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                                          | 1.65 to 5.5         | –                     | –                   | 0.1                   | V    |
|                                      |                           | I <sub>O</sub> = 4 mA                                            | 1.65                | –                     | –                   | 0.70                  | V    |
|                                      |                           | I <sub>O</sub> = 8 mA                                            | 2.3                 | –                     | –                   | 0.45                  | V    |
|                                      |                           | I <sub>O</sub> = 12 mA                                           | 2.7                 | –                     | –                   | 0.60                  | V    |
|                                      |                           | I <sub>O</sub> = 24 mA                                           | 3.0                 | –                     | –                   | 0.80                  | V    |
|                                      |                           | I <sub>O</sub> = 32 mA                                           | 4.5                 | –                     | –                   | 0.80                  | 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                                         | 1.65 to 5.5         | V <sub>CC</sub> − 0.1 | –                   | –                     | V    |
|                                      |                           | I <sub>O</sub> = −4 mA                                           | 1.65                | 0.95                  | –                   | –                     | V    |
|                                      |                           | I <sub>O</sub> = −8 mA                                           | 2.3                 | 1.7                   | –                   | –                     | V    |
|                                      |                           | I <sub>O</sub> = −12 mA                                          | 2.7                 | 1.9                   | –                   | –                     | V    |
|                                      |                           | I <sub>O</sub> = −24 mA                                          | 3.0                 | 2.0                   | –                   | –                     | V    |
|                                      |                           | I <sub>O</sub> = −32 mA                                          | 4.5                 | 3.4                   | –                   | –                     | V    |
| I <sub>LI</sub>                      | input leakage current     | V <sub>I</sub> = 5.5 V or GND                                    | 3.6                 | –                     | ±0.1                | ±5                    | μA   |
| I <sub>CC</sub>                      | quiescent supply current  | V <sub>I</sub> = V <sub>CC</sub> or GND;<br>I <sub>O</sub> = 0 A | 5.5                 | –                     | –                   | 200                   | μA   |

**Note**

1. All typical values are measured at V<sub>CC</sub> = 3.3 V and T<sub>amb</sub> = 25 °C.

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## AC CHARACTERISTICS

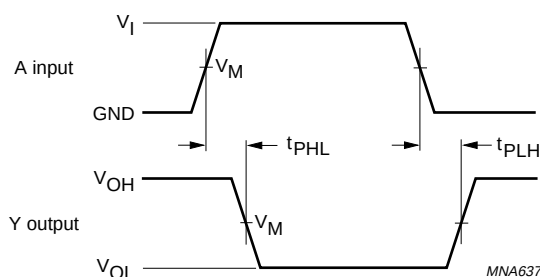
GND = 0 V;  $t_r = t_f \leq 2.0$  ns.

| SYMBOL                                     | PARAMETER                | TEST CONDITIONS  |                     | MIN. | TYP. <sup>(1)</sup> | MAX. | UNIT |
|--------------------------------------------|--------------------------|------------------|---------------------|------|---------------------|------|------|
|                                            |                          | WAVEFORMS        | V <sub>CC</sub> (V) |      |                     |      |      |
| <b>T<sub>amb</sub> = −40 °C to +85 °C</b>  |                          |                  |                     |      |                     |      |      |
| t <sub>PHL</sub> /t <sub>PLH</sub>         | propagation delay A to Y | see Figs 6 and 9 | 1.65 to 1.95        | 0.3  | 1.7                 | 5.0  | ns   |
|                                            |                          |                  | 2.3 to 2.7          | 0.3  | 1.3                 | 4.0  | ns   |
|                                            |                          |                  | 2.7                 | 0.5  | 1.7                 | 5.0  | ns   |
|                                            |                          |                  | 3.0 to 3.6          | 0.5  | 1.6                 | 3.7  | ns   |
|                                            |                          |                  | 4.5 to 5.5          | 0.5  | 1.3                 | 3.0  | ns   |
| <b>T<sub>amb</sub> = −40 °C to +125 °C</b> |                          |                  |                     |      |                     |      |      |
| t <sub>PHL</sub> /t <sub>PLH</sub>         | propagation delay A to Y | see Figs 6 and 9 | 1.65 to 1.95        | 0.3  | –                   | 6.5  | ns   |
|                                            |                          |                  | 2.3 to 2.7          | 0.3  | –                   | 5.5  | ns   |
|                                            |                          |                  | 2.7                 | 0.5  | –                   | 6.5  | ns   |
|                                            |                          |                  | 3.0 to 3.6          | 0.5  | –                   | 5.0  | ns   |
|                                            |                          |                  | 4.5 to 5.5          | 0.5  | –                   | 4.0  | ns   |

### Note

1. All typical values are measured at  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

## AC WAVEFORMS



| $V_{CC}$         | $V_M$               | INPUT    |               |
|------------------|---------------------|----------|---------------|
|                  |                     | $V_I$    | $t_r = t_f$   |
| 1.65 V to 1.95 V | $0.5 \times V_{CC}$ | $V_{CC}$ | $\leq 2.0$ ns |
| 2.3 V to 2.7 V   | $0.5 \times V_{CC}$ | $V_{CC}$ | $\leq 2.0$ ns |
| 2.7 V            | 1.5 V               | 2.7 V    | $\leq 2.5$ ns |
| 3.0 V to 3.6 V   | 1.5 V               | 2.7 V    | $\leq 2.5$ ns |
| 4.5 V to 5.5 V   | $0.5 \times V_{CC}$ | $V_{CC}$ | $\leq 2.5$ ns |

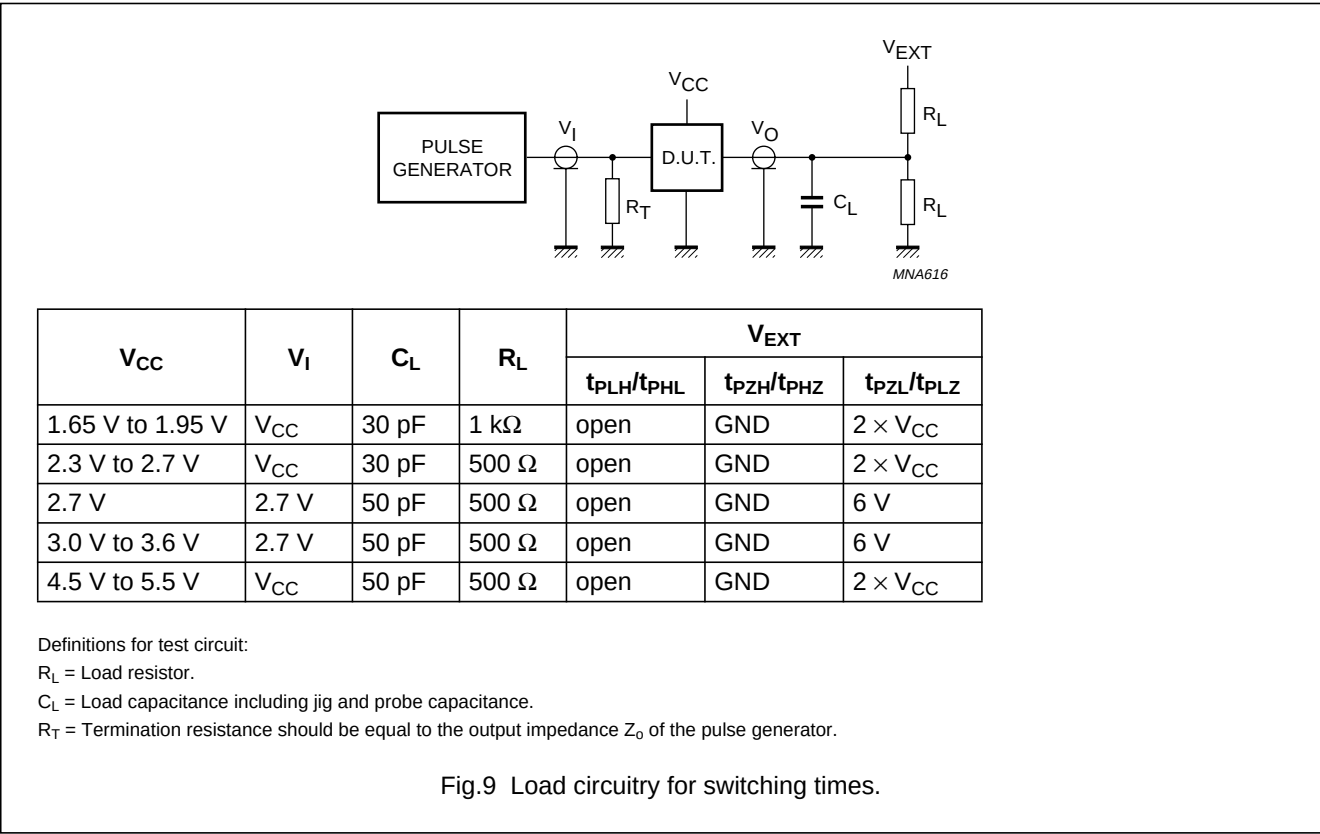
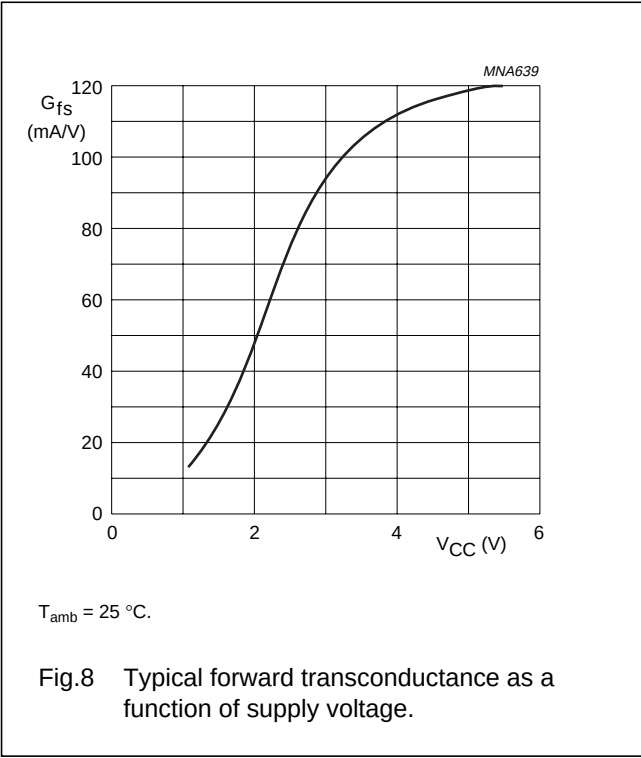
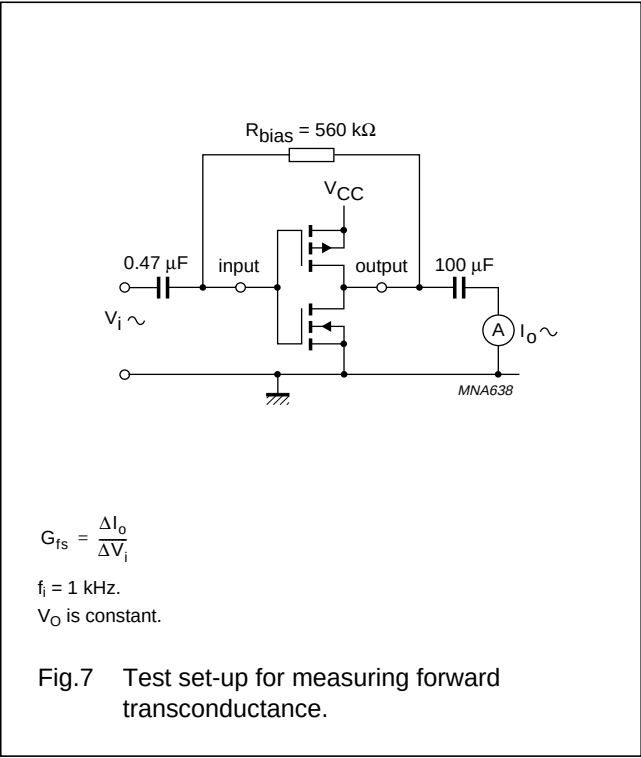
$V_{OL}$  and  $V_{OH}$  are typical output voltage drop that occur with the output load.

Fig.6 Input A to output Y propagation delay times.



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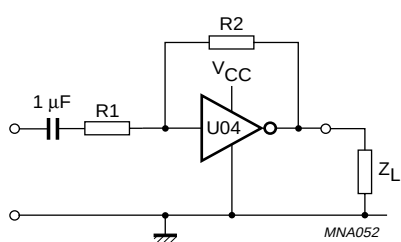
## APPLICATION INFORMATION

Some applications for the 74LVC1GU04 are:

- Linear amplifier (see Fig.10)
- Crystal oscillator (see Fig.11).

## Remark to the application information

All values given are typical values unless otherwise specified.



$Z_L > 10 \text{ k}\Omega$ ,  $R1 \geq 3 \text{ k}\Omega$  and  $R2 \leq 1 \text{ M}\Omega$ .

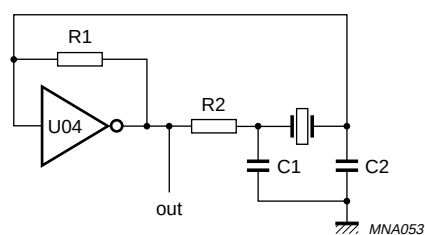
Open loop amplification:  $A_{OL} = 20$  (typical value).

$$\text{Voltage amplification: } A_u = -\frac{A_{OL}}{1 + \frac{R1}{R2}(1 + A_{OL})}$$

Maximum output voltage:  $V_{o(p-p)} \approx V_{CC} - 1.5 \text{ V}$  centered at  $0.5V_{CC}$

Unity gain bandwidth product:  $B = 5 \text{ MHz}$  (typical value).

Fig.10 Used as a linear amplifier.



$C1 = 47 \text{ pF}$  (typical).

$C2 = 22 \text{ pF}$  (typical).

$R1 = 1 \text{ to } 10 \text{ M}\Omega$  (typical).

$R2$  optimum value depends on the frequency and required stability against changes in  $V_{CC}$  or average minimum  $I_{CC}$  [ $I_{CC} = 2 \text{ mA}$  (typical) at  $V_{CC} = 3.3 \text{ V}$  and  $f = 10 \text{ MHz}$ ].

Fig.11 Crystal oscillator configuration.

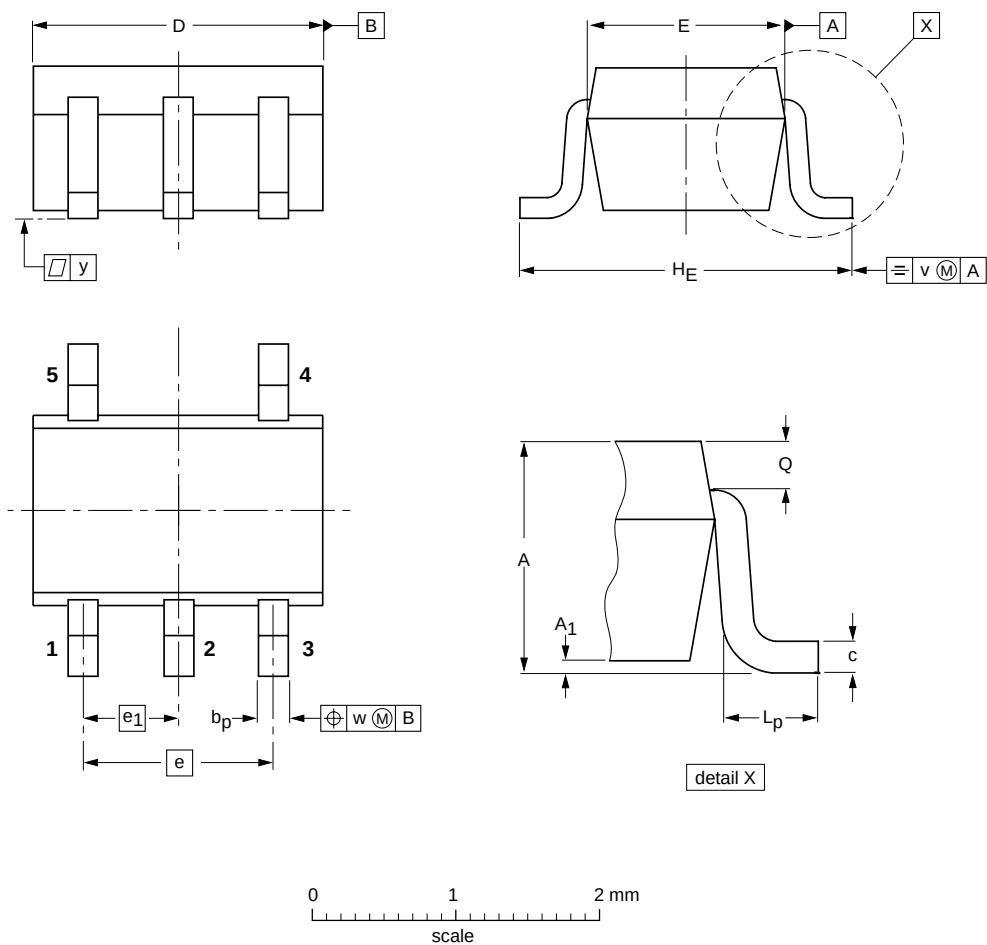
Inverter

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PACKAGE OUTLINES

Plastic surface mounted package; 5 leads

SOT353



DIMENSIONS (mm are the original dimensions)

| UNIT | A          | A <sub>1</sub><br>max | b <sub>p</sub> | c            | D          | E <sup>(2)</sup> | e   | e <sub>1</sub> | H <sub>E</sub> | L <sub>p</sub> | Q            | v   | w   | y   |
|------|------------|-----------------------|----------------|--------------|------------|------------------|-----|----------------|----------------|----------------|--------------|-----|-----|-----|
| mm   | 1.1<br>0.8 | 0.1                   | 0.30<br>0.20   | 0.25<br>0.10 | 2.2<br>1.8 | 1.35<br>1.15     | 1.3 | 0.65           | 2.2<br>2.0     | 0.45<br>0.15   | 0.25<br>0.15 | 0.2 | 0.2 | 0.1 |

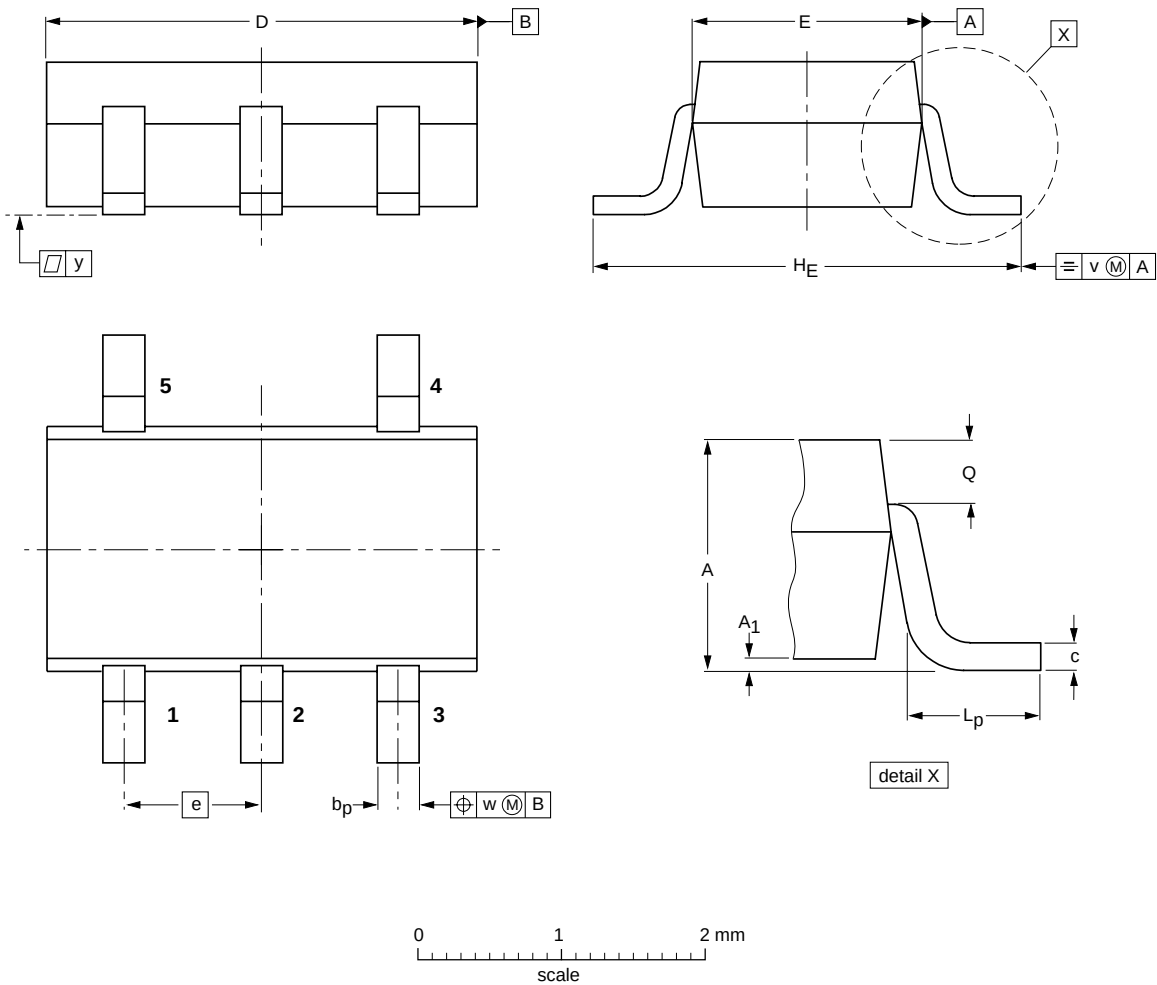
| OUTLINE<br>VERSION | REFERENCES |       |        |  | EUROPEAN<br>PROJECTION | ISSUE DATE |
|--------------------|------------|-------|--------|--|------------------------|------------|
|                    | IEC        | JEDEC | EIAJ   |  |                        |            |
| SOT353             |            |       | SC-88A |  |                        | 97-02-28   |

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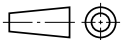
Plastic surface mounted package; 5 leads

SOT753



DIMENSIONS (mm are the original dimensions)

| UNIT | A          | A <sub>1</sub> | b <sub>p</sub> | c            | D          | E          | e    | H <sub>E</sub> | L <sub>p</sub> | Q            | v   | w   | y   |
|------|------------|----------------|----------------|--------------|------------|------------|------|----------------|----------------|--------------|-----|-----|-----|
| mm   | 1.1<br>0.9 | 0.100<br>0.013 | 0.40<br>0.25   | 0.26<br>0.10 | 3.1<br>2.7 | 1.7<br>1.3 | 0.95 | 3.0<br>2.5     | 0.6<br>0.2     | 0.33<br>0.23 | 0.2 | 0.2 | 0.1 |

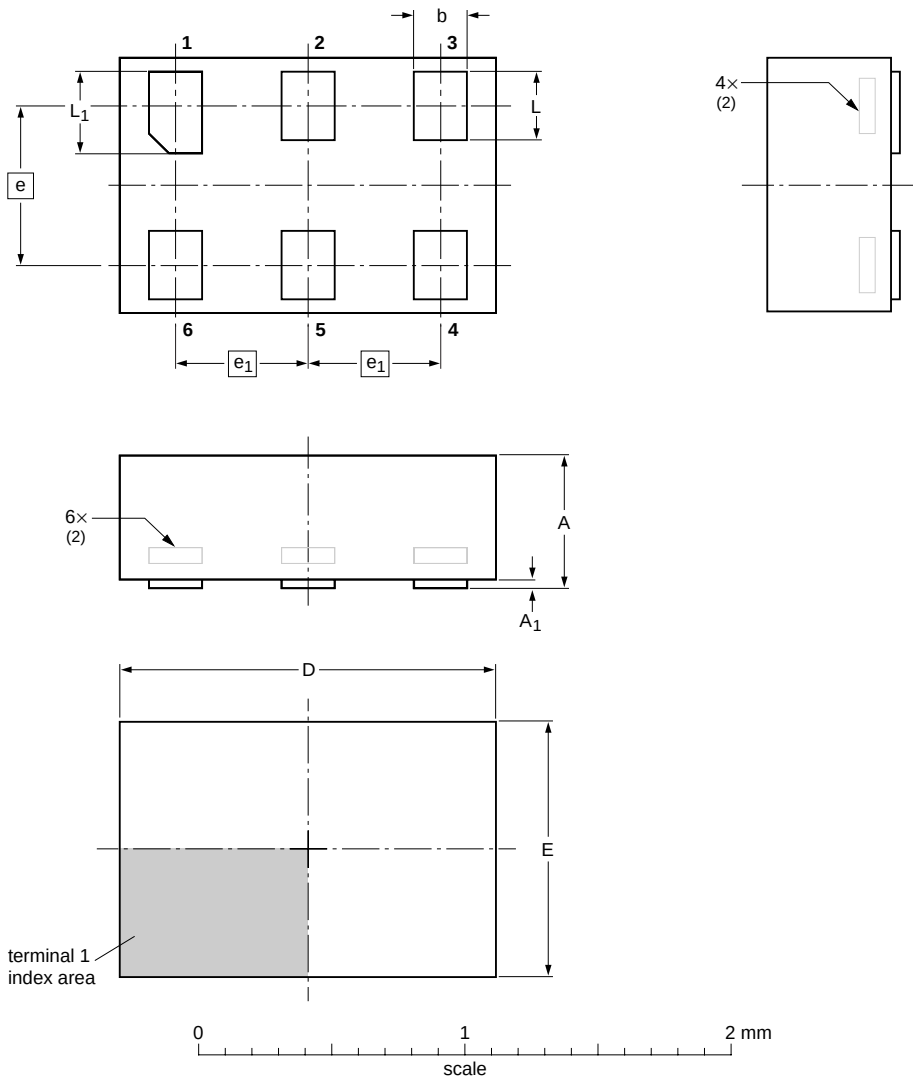
| OUTLINE<br>VERSION | REFERENCES |       |        |  | EUROPEAN<br>PROJECTION                                                                | ISSUE DATE |
|--------------------|------------|-------|--------|--|---------------------------------------------------------------------------------------|------------|
|                    | IEC        | JEDEC | JEITA  |  |                                                                                       |            |
| SOT753             |            |       | SC-74A |  |  | 02-04-16   |

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XSON6: plastic extremely thin small outline package; no leads; 6 terminals; body 1 x 1.45 x 0.5 mm

SOT886



DIMENSIONS (mm are the original dimensions)

| UNIT | A <sup>(1)</sup><br>max | A <sub>1</sub><br>max | b            | D          | E            | e   | e <sub>1</sub> | L            | L <sub>1</sub> |
|------|-------------------------|-----------------------|--------------|------------|--------------|-----|----------------|--------------|----------------|
| mm   | 0.5                     | 0.04                  | 0.25<br>0.17 | 1.5<br>1.4 | 1.05<br>0.95 | 0.6 | 0.5            | 0.35<br>0.27 | 0.40<br>0.32   |

- Notes
- 1. Including plating thickness.
  - 2. Can be visible in some manufacturing processes.

| OUTLINE<br>VERSION | REFERENCES |        |       |  | EUROPEAN<br>PROJECTION | ISSUE DATE           |
|--------------------|------------|--------|-------|--|------------------------|----------------------|
|                    | IEC        | JEDEC  | JEITA |  |                        |                      |
| SOT886             |            | MO-252 |       |  |                        | 04-07-15<br>04-07-22 |

## Inverter

74LVC1GU04

## DATA SHEET STATUS

| LEVEL | DATA SHEET STATUS <sup>(1)</sup> | PRODUCT STATUS <sup>(2)(3)</sup> | DEFINITION                                                                                                                                                                                                                                                                                     |
|-------|----------------------------------|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| I     | Objective data                   | Development                      | This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.                                                                                                    |
| II    | Preliminary data                 | Qualification                    | This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.             |
| III   | Product data                     | Production                       | This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN). |

## Notes

1. Please consult the most recently issued data sheet before initiating or completing a design.
2. The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.
3. For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

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**Short-form specification** — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

**Limiting values definition** — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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## **Contact information**

For additional information please visit <http://www.semiconductors.philips.com>. Fax: **+31 40 27 24825**

For sales offices addresses send e-mail to: [sales.addresses@www.semiconductors.philips.com](mailto:sales.addresses@www.semiconductors.philips.com).

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