

74LVC1GU04-Q100

Unbuffered inverter

Rev. 2 — 13 December 2016

Product data sheet

1. General description

The 74LVC1GU04-Q100 is a single unbuffered inverter.

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.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
 - ◆ Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- Wide supply voltage range from 1.65 V to 5.5 V
- High noise immunity
- ESD protection:
 - ◆ MIL-STD-883, method 3015 exceeds 2000 V
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V ($C = 200\text{ pf}$, $R = 0\text{ }\Omega$)
- $\pm 24\text{ mA}$ output drive ($V_{CC} = 3.0\text{ V}$)
- CMOS low power consumption
- Latch-up performance exceeds 250 mA
- Input accepts voltages up to 5 V

3. Ordering information

Table 1. Ordering information

| Type number | Package | | | |
|-------------------|---|--------|--|----------|
| | Temperature range | Name | Description | Version |
| 74LVC1GU04GW-Q100 | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | TSSOP5 | plastic thin shrink small outline package; 5 leads; body width 1.25 mm | SOT353-1 |
| 74LVC1GU04GV-Q100 | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SC-74A | plastic surface-mounted package; 5 leads | SOT753 |

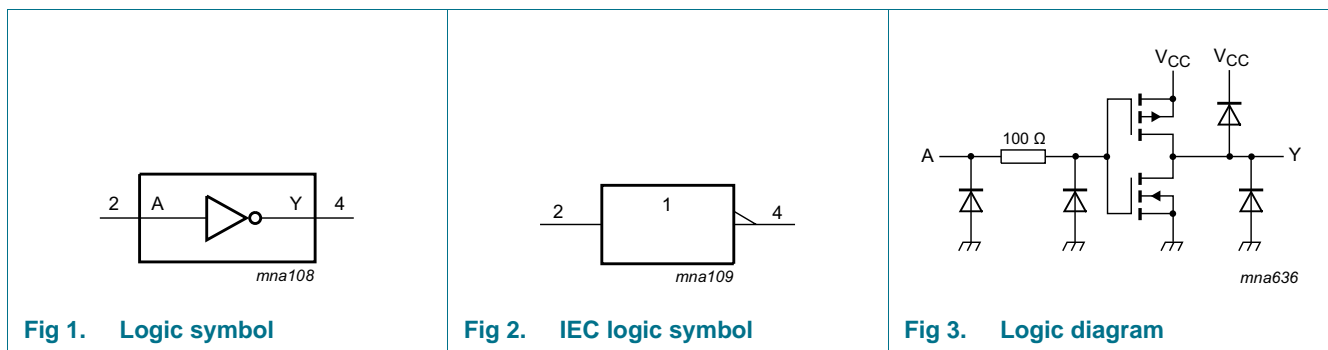
4. Marking

Table 2. Marking codes

| Type number | Marking ^[1] |
|-------------------|------------------------|
| 74LVC1GU04GW-Q100 | VD |
| 74LVC1GU04GV-Q100 | VU4 |

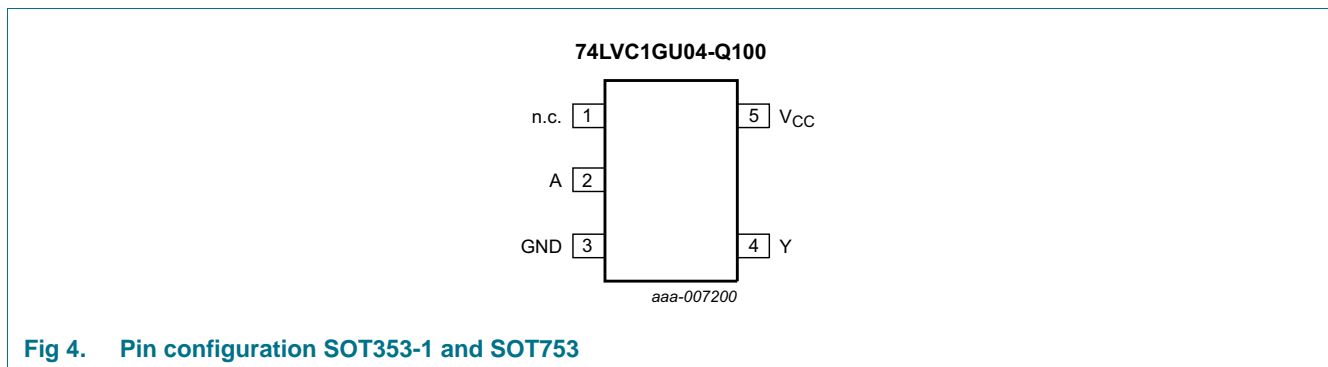
[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

5. Functional diagram



6. Pinning information

6.1 Pinning



6.2 Pin description

Table 3. Pin description

| Symbol | Pin | Description |
|-----------------|-----|----------------|
| n.c. | 1 | not connected |
| A | 2 | data input |
| GND | 3 | ground (0 V) |
| Y | 4 | data output |
| V _{CC} | 5 | supply voltage |

7. Functional description

Table 4. Function table^[1]

| Input (A) | Output (Y) |
|-----------|------------|
| 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 | +6.5 | V |
| I_{IK} | input clamping current | $V_I < 0$ V | - | -50 | mA |
| V_I | input voltage | | -0.5 | +6.5 | V |
| I_{OK} | output clamping current | $V_O > V_{CC}$ or $V_O < 0$ V | - | ±50 | mA |
| V_O | output voltage | Active mode | -0.5 | $V_{CC} + 0.5$ | V |
| I_O | output current | $V_O = 0$ V to V_{CC} | - | ±50 | mA |
| I_{CC} | supply current | | - | +100 | mA |
| I_{GND} | ground current | | - | -100 | mA |
| P_{tot} | total power dissipation | $T_{amb} = -40$ °C to $+125$ °C | - | 250 | mW |
| T_{stg} | storage temperature | | -65 | +150 | °C |

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

[2] When $V_{CC} = 0$ V (Power-down mode), the output voltage can be 5.5 V in normal operation.

[3] For TSSOP5 and SC-74A packages: above 87.5 °C the value of P_{tot} derates linearly with 4.0 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 | | 1.65 | - | 5.5 | V |
| V_I | input voltage | | 0 | - | 5.5 | V |
| V_O | output voltage | Active mode | 0 | - | V_{CC} | V |
| T_{amb} | ambient temperature | | -40 | - | +125 | °C |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 1.65$ V to 2.7 V | 0 | - | 20 | ns/V |
| | | $V_{CC} = 2.7$ V to 5.5 V | 0 | - | 10 | ns/V |

10. Static characteristics

Table 7. Static characteristics

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

| Symbol | Parameter | Conditions | Min | Typ ^[1] | Max | Unit |
|--|---------------------------|---|------------------------|--------------------|------------------------|------|
| T_{amb} = -40 °C to +85 °C | | | | | | |
| V _{IH} | HIGH-level input voltage | V _{CC} = 1.65 V to 5.5 V | 0.75 × V _{CC} | - | - | V |
| V _{IL} | LOW-level input voltage | V _{CC} = 1.65 V to 5.5 V | - | - | 0.25 × V _{CC} | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} | | | | |
| | | I _O = -100 μA; V _{CC} = 1.65 V to 5.5 V | V _{CC} - 0.1 | - | - | V |
| | | I _O = -4 mA; V _{CC} = 1.65 V | 1.2 | - | - | V |
| | | I _O = -8 mA; V _{CC} = 2.3 V | 1.9 | - | - | V |
| | | I _O = -12 mA; V _{CC} = 2.7 V | 2.2 | - | - | V |
| | | I _O = -24 mA; V _{CC} = 3.0 V | 2.3 | - | - | V |
| | | I _O = -32 mA; V _{CC} = 4.5 V | 3.8 | - | - | V |
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} | | | | |
| | | I _O = 100 μA; V _{CC} = 1.65 V to 5.5 V | - | - | 0.1 | V |
| | | I _O = 4 mA; V _{CC} = 1.65 V | - | - | 0.45 | V |
| | | I _O = 8 mA; V _{CC} = 2.3 V | - | - | 0.3 | V |
| | | I _O = 12 mA; V _{CC} = 2.7 V | - | - | 0.4 | V |
| | | I _O = 24 mA; V _{CC} = 3.0 V | - | - | 0.55 | V |
| | | I _O = 32 mA; V _{CC} = 4.5 V | - | - | 0.55 | V |
| I _I | input leakage current | V _I = 5.5 V or GND; V _{CC} = 0 V to 5.5 V | - | ±0.1 | ±1 | μA |
| I _{CC} | supply current | V _I = 5.5 V or GND; I _O = 0 A; V _{CC} = 1.65 V to 5.5 V | - | 0.1 | 4 | μA |
| C _I | input capacitance | V _{CC} = 3.3 V; V _I = GND to V _{CC} | - | 6 | - | pF |
| T_{amb} = -40 °C to +125 °C | | | | | | |
| V _{IH} | HIGH-level input voltage | V _{CC} = 1.65 V to 5.5 V | 0.8 × V _{CC} | - | - | V |
| V _{IL} | LOW-level input voltage | V _{CC} = 1.65 V to 5.5 V | - | - | 0.2 × V _{CC} | V |
| V _{OH} | HIGH-level output voltage | V _I = V _{IH} or V _{IL} | | | | |
| | | I _O = -100 μA; V _{CC} = 1.65 V to 5.5 V | V _{CC} - 0.1 | - | - | V |
| | | I _O = -4 mA; V _{CC} = 1.65 V | 0.95 | - | - | V |
| | | I _O = -8 mA; V _{CC} = 2.3 V | 1.7 | - | - | V |
| | | I _O = -12 mA; V _{CC} = 2.7 V | 1.9 | - | - | V |
| | | I _O = -24 mA; V _{CC} = 3.0 V | 2.0 | - | - | V |
| | | I _O = -32 mA; V _{CC} = 4.5 V | 3.4 | - | - | V |

Table 7. Static characteristics ...continued

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

| Symbol | Parameter | Conditions | Min | Typ ^[1] | Max | Unit |
|-----------------|--------------------------|---|-----|--------------------|------|------|
| V _{OL} | LOW-level output voltage | V _I = V _{IH} or V _{IL} | | | | |
| | | I _O = 100 μA; V _{CC} = 1.65 V to 5.5 V | - | - | 0.1 | V |
| | | I _O = 4 mA; V _{CC} = 1.65 V | - | - | 0.7 | V |
| | | I _O = 8 mA; V _{CC} = 2.3 V | - | - | 0.45 | V |
| | | I _O = 12 mA; V _{CC} = 2.7 V | - | - | 0.6 | V |
| | | I _O = 24 mA; V _{CC} = 3.0 V | - | - | 0.80 | V |
| | | I _O = 32 mA; V _{CC} = 4.5 V | - | - | 0.80 | V |
| I _I | input leakage current | V _I = 5.5 V or GND; V _{CC} = 0 V to 5.5 V | - | ±0.1 | ±1 | μA |
| I _{CC} | supply current | V _I = 5.5 V or GND; I _O = 0 A; V _{CC} = 1.65 V to 5.5 V | - | - | 4 | μA |

[1] All typical values are measured at V_{CC} = 3.3 V and T_{amb} = 25 °C.

11. Dynamic characteristics

Table 8. Dynamic characteristicsVoltages are referenced to GND (ground = 0 V). For test circuit, see [Figure 8](#).

| Symbol | Parameter | Conditions | -40 °C to +85 °C | | | -40 °C to +125 °C | | Unit |
|-----------------|-------------------------------|---|------------------|--------------------|-----|-------------------|-----|------|
| | | | Min | Typ ^[1] | Max | Min | Max | |
| t _{pd} | propagation delay | A to Y; see Figure 5 ^[2] | | | | | | |
| | | V _{CC} = 1.65 V to 1.95 V | 0.3 | 1.7 | 5.0 | 0.3 | 6.5 | ns |
| | | V _{CC} = 2.3 V to 2.7 V | 0.3 | 1.3 | 4.0 | 0.3 | 5.5 | ns |
| | | V _{CC} = 2.7 V | 0.5 | 1.7 | 5.0 | 0.5 | 6.5 | ns |
| | | V _{CC} = 3.0 V to 3.6 V | 0.5 | 1.6 | 3.7 | 0.5 | 5.0 | ns |
| | | V _{CC} = 4.5 V to 5.5 V | 0.5 | 1.3 | 3.0 | 0.5 | 4.0 | ns |
| C _{PD} | power dissipation capacitance | V _I = GND to V _{CC} ; V _{CC} = 3.3 V ^[3] | - | 14.9 | - | - | - | pF |

[1] Typical values are measured at T_{amb} = 25 °C and V_{CC} = 1.8 V, 2.5 V, 2.7 V, 3.3 V and 5.0 V respectively.[2] t_{pd} is the same as t_{PLH} and t_{PHL}.[3] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

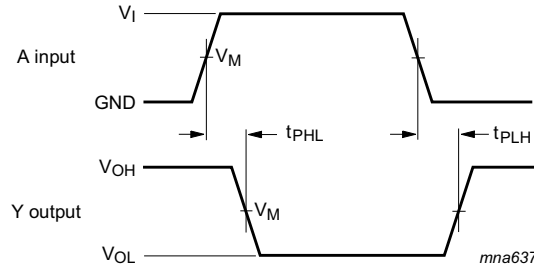
$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

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;

Σ(C_L × V_{CC}² × f_o) = sum of outputs.

12. Waveforms

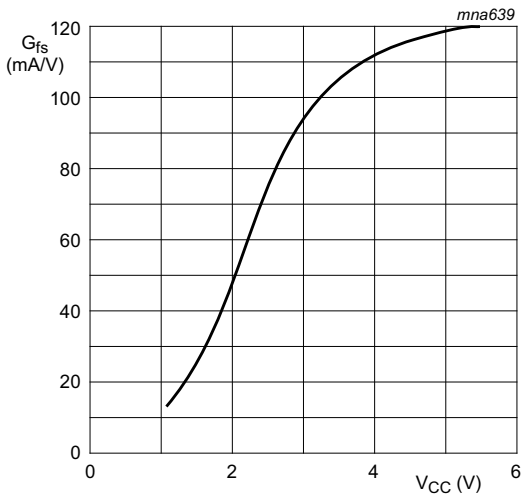


Measurement points are given in [Table 9](#).
 V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig 5. The input A to output Y propagation delay times

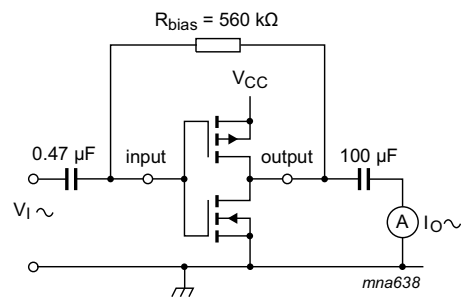
Table 9. Measurement points

| Supply voltage | Input | Output |
|------------------|-----------------------|-----------------------|
| V _{CC} | V _M | V _M |
| 1.65 V to 1.95 V | 0.5 × V _{CC} | 0.5 × V _{CC} |
| 2.3 V to 2.7 V | 0.5 × V _{CC} | 0.5 × V _{CC} |
| 2.7 V | 1.5 V | 1.5 V |
| 3.0 V to 3.6 V | 1.5 V | 1.5 V |
| 4.5 V to 5.5 V | 0.5 × V _{CC} | 0.5 × V _{CC} |



T_{amb} = 25 °C.

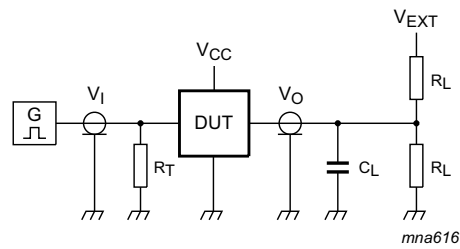
Fig 6. Typical forward transconductance as a function of supply voltage



$$G_{fs} = \frac{\Delta I_o}{\Delta V_I}$$

f_i = 1 kHz at V_O is constant

Fig 7. Test set-up for measuring forward transconductance



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

Definitions for test circuit:

R_L = Load resistance.

C_L = Load capacitance including jig and probe capacitance.

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

V_{EXT} = External voltage for measuring switching times.

Fig 8. Test circuit for measuring switching times

Table 10. Test data

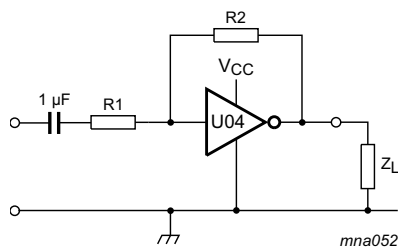
| Supply voltage | Input | | Load | | V_{EXT} |
|------------------|----------|---------------|-------|--------------|--------------------|
| V_{CC} | V_I | $t_r = t_f$ | C_L | R_L | t_{PLH}, t_{PHL} |
| 1.65 V to 1.95 V | V_{CC} | ≤ 2.0 ns | 30 pF | 1 k Ω | open |
| 2.3 V to 2.7 V | V_{CC} | ≤ 2.0 ns | 30 pF | 500 Ω | open |
| 2.7 V | 2.7 V | ≤ 2.5 ns | 50 pF | 500 Ω | open |
| 3.0 V to 3.6 V | 2.7 V | ≤ 2.5 ns | 50 pF | 500 Ω | open |
| 4.5 V to 5.5 V | V_{CC} | ≤ 2.5 ns | 50 pF | 500 Ω | open |

13. Application information

Some applications are:

- Linear amplifier (see [Figure 9](#))
- In crystal oscillator design (see [Figure 10](#))

Remark: All values given are typical unless otherwise specified.



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

$$A_u = -\frac{G_{OL}}{1 + \frac{R1}{R2}(1 + G_{OL})}$$

G_{OL} = loop gain.

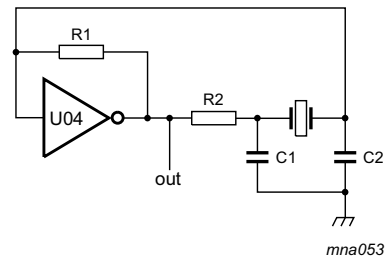
A_u = voltage amplification.

$R1 \geq 3 \text{ k}\Omega$, $R2 \leq 1 \text{ M}\Omega$

$Z_L > 10 \text{ k}\Omega$; $A_{OL} = 20$ (typ.)

Typical unity gain bandwidth product is 5 MHz.

Fig 9. Used as a linear amplifier



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

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

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

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

Fig 10. Crystal oscillator configuration

14. Package outline

TSSOP5: plastic thin shrink small outline package; 5 leads; body width 1.25 mm

SOT353-1

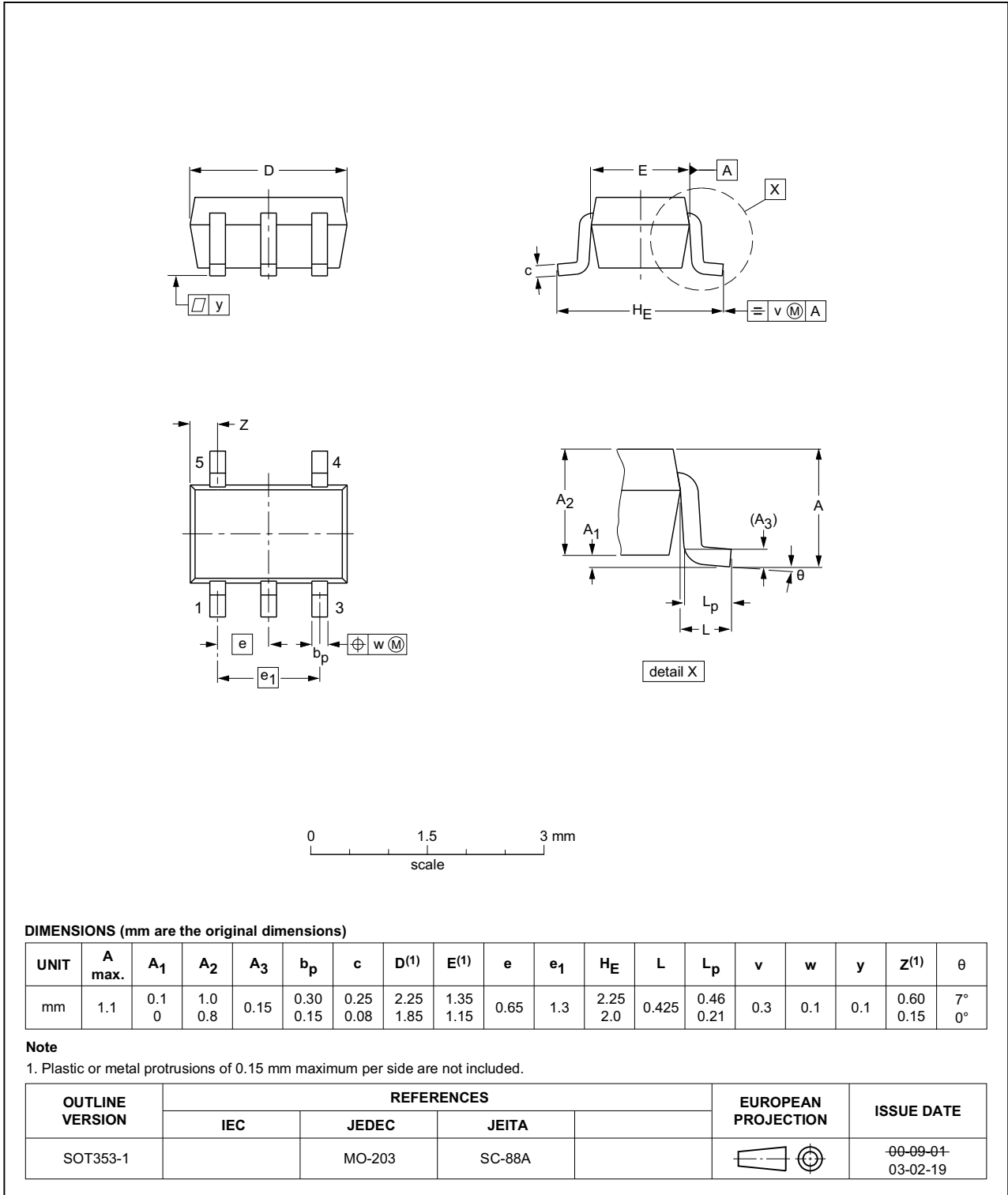


Fig 11. Package outline SOT353-1 (TSSOP5)

Plastic surface-mounted package; 5 leads

SOT753

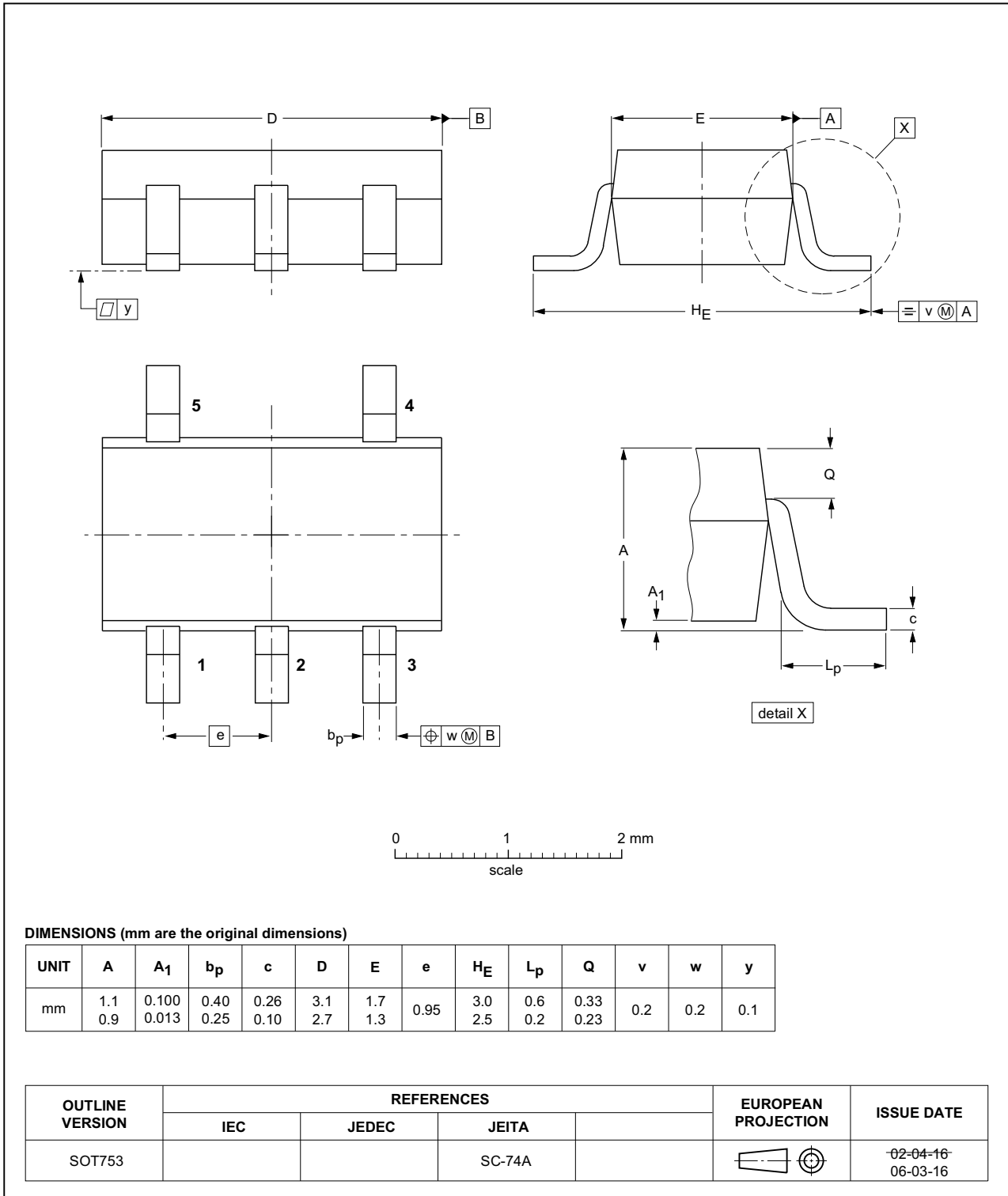


Fig 12. Package outline SOT753 (SC-74A)

15. Abbreviations

Table 11. Abbreviations

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

16. Revision history

Table 12. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---------------------|---|--------------------|---------------|---------------------|
| 74LVC1GU04_Q100 v.2 | 20161213 | Product data sheet | - | 74LVC1GU04_Q100 v.1 |
| Modifications: | • Table 7 : The maximum limits for leakage current and supply current have changed. | | | |
| 74LVC1GU04_Q100 v.1 | 20130514 | Product data sheet | - | - |

17. Legal information

17.1 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".

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19. Contents

| | | |
|-----------|---|-----------|
| 1 | General description | 1 |
| 2 | Features and benefits | 1 |
| 3 | Ordering information | 1 |
| 4 | Marking | 2 |
| 5 | Functional diagram | 2 |
| 6 | Pinning information | 2 |
| 6.1 | Pinning | 2 |
| 6.2 | Pin description | 2 |
| 7 | Functional description | 3 |
| 8 | Limiting values | 3 |
| 9 | Recommended operating conditions | 3 |
| 10 | Static characteristics | 4 |
| 11 | Dynamic characteristics | 5 |
| 12 | Waveforms | 6 |
| 13 | Application information | 8 |
| 14 | Package outline | 9 |
| 15 | Abbreviations | 11 |
| 16 | Revision history | 11 |
| 17 | Legal information | 12 |
| 17.1 | Data sheet status | 12 |
| 17.2 | Definitions | 12 |
| 17.3 | Disclaimers | 12 |
| 17.4 | Trademarks | 13 |
| 18 | Contact information | 13 |
| 19 | Contents | 14 |