

74LVCU04A

Hex unbuffered inverter

Rev. 8 — 18 December 2015

Product data sheet

1. General description

The 74LVCU04A is a general purpose hex unbuffered inverter. Each of the six inverters is a single stage with unbuffered outputs.

2. Features and benefits

- Wide supply voltage range from 1.2 V to 3.6 V
- Inputs accept voltages up to 5.5 V
- CMOS low power consumption
- Direct interface with TTL levels
- Complies with JEDEC standard:
 - ◆ JESD8-7A (1.65 V to 1.95 V)
 - ◆ JESD8-5A (2.3 V to 2.7 V)
 - ◆ JESD8-C/JESD36 (2.7 V to 3.6 V)
- ESD protection:
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-B exceeds 200 V
 - ◆ CDM JESD22-C101E exceeds 1000 V
- Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$

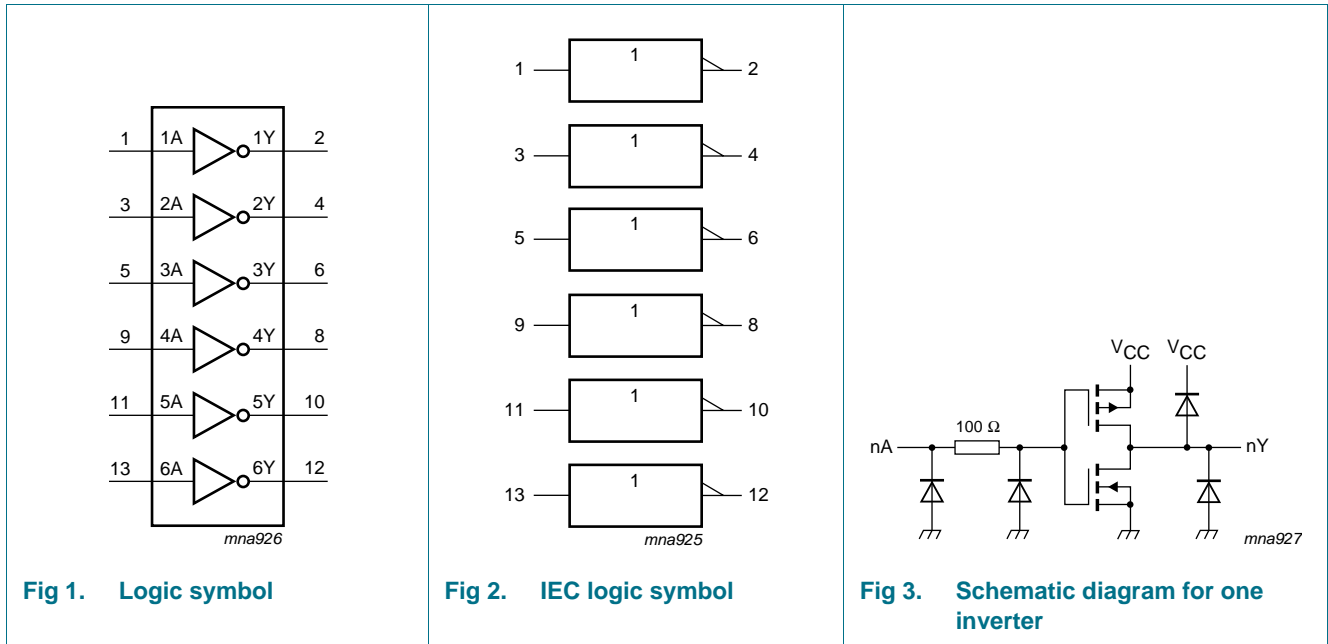
3. Ordering information

Table 1. Ordering information

| Type number | Package | | | |
|-------------|---|----------|---|----------|
| | Temperature range | Name | Description | Version |
| 74LVCU04AD | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SO14 | plastic small outline package; 14 leads; body width 3.9 mm | SOT108-1 |
| 74LVCU04ADB | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SSOP14 | plastic shrink small outline package; 14 leads; body width 5.3 mm | SOT337-1 |
| 74LVCU04APW | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | TSSOP14 | plastic thin shrink small outline package; 14 leads; body width 4.4 mm | SOT402-1 |
| 74LVCU04ABQ | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | DHVQFN14 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body $2.5 \times 3 \times 0.85\text{ mm}$ | SOT762-1 |

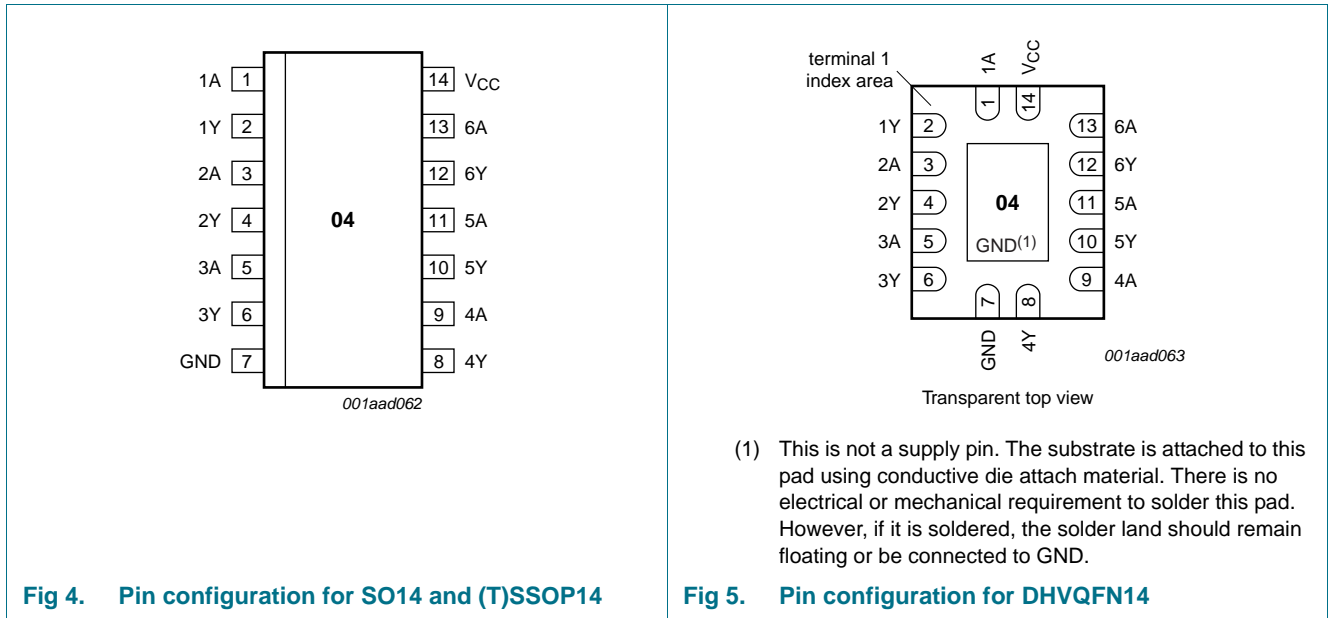


4. Functional diagram



5. Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

| Symbol | Pin | Description |
|------------------------|--------------------|----------------|
| 1A, 2A, 3A, 4A, 5A, 6A | 1, 3, 5, 9, 11, 13 | data input |
| 1Y, 2Y, 3Y, 4Y, 5Y, 6Y | 2, 4, 6, 8, 10, 12 | data output |
| GND | 7 | ground (0 V) |
| V _{CC} | 14 | supply voltage |

6. Functional description

Table 3. Function table^[1]

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

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

7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | Min | Max | Unit |
|------------------|-------------------------|--|------|-----------------------|------|
| V _{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 | | -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 |
| T _{stg} | storage temperature | | -65 | +150 | °C |
| P _{tot} | total power dissipation | T _{amb} = -40 °C to +125 °C | - | 500 | mW |

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

[2] The output voltage ratings may be exceeded if the output current ratings are observed.

[3] For SO14 packages: above 70 °C the value of P_{tot} derates linearly with 8 mW/K.
 For (T)SSOP14 packages: above 60 °C the value of P_{tot} derates linearly with 5.5 mW/K.
 For DHVQFN14 packages: above 60 °C the value of P_{tot} derates linearly with 4.5 mW/K.

8. Recommended operating conditions

Table 5. Recommended operating conditions

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|------------------|-------------------------------------|-----------------------------------|------|-----|-----------------|------|
| V _{CC} | supply voltage | | 1.65 | - | 3.6 | V |
| | | functional | 1.2 | - | - | V |
| V _I | input voltage | | 0 | - | 5.5 | V |
| V _O | output voltage | | 0 | - | V _{CC} | V |
| T _{amb} | ambient temperature | in free air | -40 | - | +125 | °C |
| Δt/ΔV | 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 3.6 V | 0 | - | 10 | ns/V |

9. Static characteristics

Table 6. Static characteristics

At recommended operating conditions. 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 _{OL(max)} = 0.5 V; I _O = -100 μA | | | | | | |
| | | V _{CC} = 1.2 V | 1.08 | - | - | 1.12 | - | V |
| | | V _{CC} = 1.65 V to 1.95 V | 1.3 | - | - | 1.5 | - | V |
| | | V _{CC} = 2.3 V to 2.7 V | 1.8 | - | - | 2.0 | - | V |
| | | V _{CC} = 3.0 V | 2.0 | - | - | 2.4 | - | V |
| V _{IL} | LOW-level input voltage | V _{OH(min)} = V _{CC} - 0.5 V; I _O = -100 μA | | | | | | |
| | | V _{CC} = 1.2 V | - | - | 0.12 | - | 0.1 | V |
| | | V _{CC} = 1.65 V to 1.95 V | - | - | 0.6 | - | 0.4 | V |
| | | V _{CC} = 2.3 V to 2.7 V | - | - | 0.6 | - | 0.5 | V |
| | | V _{CC} = 3.0 V | - | - | 1.0 | - | 0.6 | V |
| V _{OH} | HIGH-level output voltage | V _I = GND | | | | | | |
| | | V _{CC} = 3.0 V; I _O = -100 μA | V _{CC} - 0.2 | - | - | V _{CC} - 0.3 | - | V |
| | | V _{CC} = 1.65 V; I _O = -4 mA | 1.2 | - | - | 1.05 | - | V |
| | | V _{CC} = 2.3 V; I _O = -8 mA | 1.8 | - | - | 1.65 | - | V |
| | | V _{CC} = 2.7 V; I _O = -12 mA | 2.2 | - | - | 2.05 | - | V |
| | | V _{CC} = 3.0 V; I _O = -18 mA | 2.4 | - | - | 2.25 | - | V |
| | | V _{CC} = 3.0 V; I _O = -24 mA | 2.2 | - | - | 2.0 | - | V |

Table 6. Static characteristics ...continued

At recommended operating conditions. 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 _{OL} | LOW-level output voltage | V _I = V _{CC} | | | | | | |
| | | V _{CC} = 3.0 V; I _O = 100 μA | - | - | 0.20 | - | 0.60 | V |
| | | V _{CC} = 1.65 V; I _O = 4 mA | - | - | 0.45 | - | 0.65 | V |
| | | V _{CC} = 2.3 V; I _O = 8 mA | - | - | 0.60 | - | 0.80 | V |
| | | V _{CC} = 2.7 V; I _O = 12 mA | - | - | 0.40 | - | 0.30 | V |
| | | V _{CC} = 3.0 V; I _O = 24 mA | - | - | 0.55 | - | 0.80 | V |
| I _I | input leakage current | V _{CC} = 3.6 V; V _I = 5.5 V or GND | - | ±0.1 | ±5 | - | ±20 | μA |
| I _{CC} | supply current | V _{CC} = 3.6 V; V _I = V _{CC} or GND; I _O = 0 A | - | 0.1 | 10 | - | 40 | μA |
| ΔI _{CC} | additional supply current | per input pin; V _{CC} = 2.7 V to 3.6 V; V _I = V _{CC} - 0.6 V; I _O = 0 A | - | 5 | 500 | - | 5000 | μA |
| C _I | input capacitance | V _{CC} = 0 V to 3.6 V; V _I = GND to V _{CC} | - | 5.5 | - | - | - | pF |

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

10. Dynamic characteristics

Table 7. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V). For test circuit see [Figure 9](#).

| 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 6 | | | | | | |
| | | V _{CC} = 1.2 V | - | 6.0 | - | - | - | ns |
| | | V _{CC} = 1.65 V to 1.95 V | 0.3 | 3.7 | 7.8 | 0.3 | 9.0 | ns |
| | | V _{CC} = 2.3 V to 2.7 V | 0.5 | 2.2 | 4.4 | 0.5 | 5.2 | ns |
| | | V _{CC} = 2.7 V | 0.5 | 2.0 | 4.5 | 0.5 | 6.0 | ns |
| | | V _{CC} = 3.0 V to 3.6 V | 0.5 | 2.0 | 4.0 | 0.5 | 5.0 | ns |
| t _{sk(o)} | output skew time | V _{CC} = 3.0 V to 3.6 V | - | - | 1.0 | - | 1.5 | ns |
| C _{PD} | power dissipation capacitance | per inverter; V _I = GND to V _{CC} | | | | | | |
| | | V _{CC} = 1.65 V to 1.95 V | - | 2.3 | - | - | - | pF |
| | | V _{CC} = 2.3 V to 2.7 V | - | 5.5 | - | - | - | pF |
| | | V _{CC} = 3.0 V to 3.6 V | - | 8.4 | - | - | - | pF |

[1] Typical values are measured at T_{amb} = 25 °C and V_{CC} = 1.2 V, 1.8 V, 2.5 V, 2.7 V, and 3.3 V respectively.

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

[3] Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.

[4] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

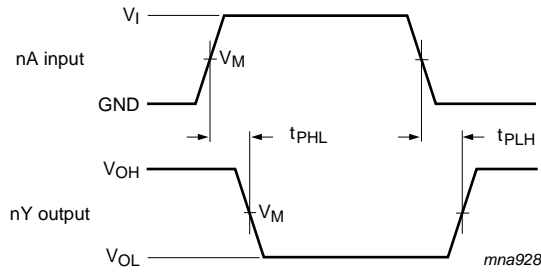
$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz; f_o = output frequency in MHz

C_L = output load capacitance in pF

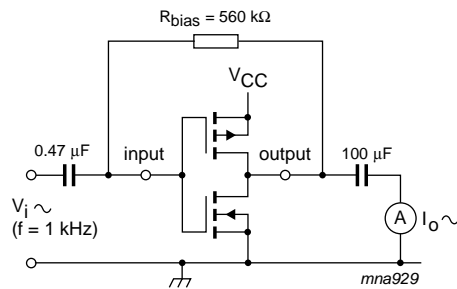
V_{CC} = supply voltage in Volts
 N = number of inputs switching
 $\Sigma(C_L \times V_{CC}^2 \times f_o)$ = sum of the outputs

11. Waveforms



$V_M = 1.5 \text{ V}$ at $V_{CC} \geq 2.7 \text{ V}$;
 $V_M = 0.5 \times V_{CC}$ at $V_{CC} < 2.7 \text{ V}$;
 V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

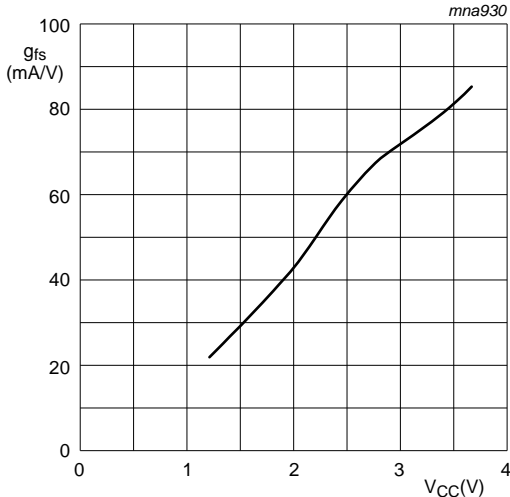
Fig 6. Input (nA) to output (nY) propagation delays



$$g_{fs} = \frac{dI_O}{dV_I}; \text{ at constant } V_O$$

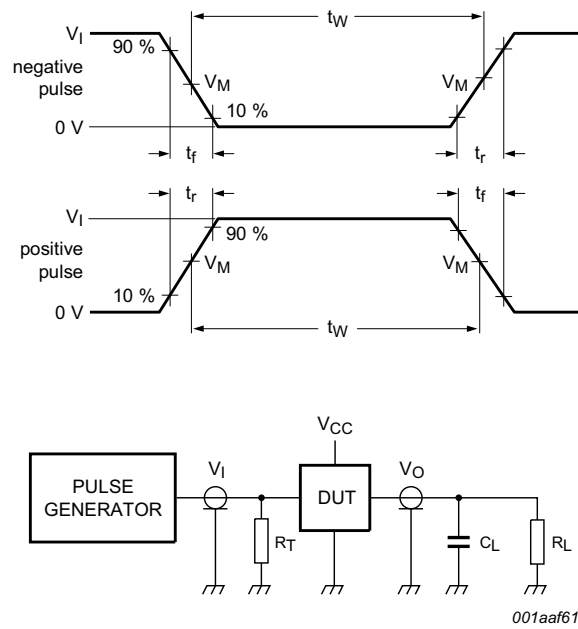
$f_i = 1 \text{ kHz}$ at V_O is constant

Fig 7. Test setup for measuring forward transconductance



T_{amb} = 25 °C

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



Test data is given in [Table 8](#).

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 output impedance Z_o of the pulse generator.

Fig 9. Test circuit for measuring switching times

Table 8. Test data

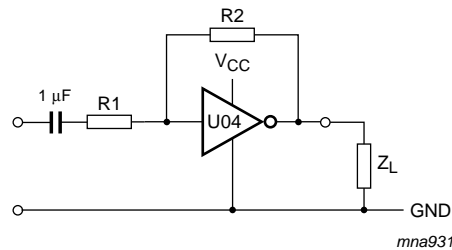
| Supply voltage | Input | | Load | |
|------------------|----------|---------------|-------|--------------|
| | V_I | t_r, t_f | C_L | R_L |
| 1.2 V | V_{CC} | ≤ 2 ns | 30 pF | 1 k Ω |
| 1.65 V to 1.95 V | V_{CC} | ≤ 2 ns | 30 pF | 1 k Ω |
| 2.3 V to 2.7 V | V_{CC} | ≤ 2 ns | 30 pF | 500 Ω |
| 2.7 V | 2.7 V | ≤ 2.5 ns | 50 pF | 500 Ω |
| 3.0 V to 3.6 V | 2.7 V | ≤ 2.5 ns | 50 pF | 500 Ω |

12. Application information

12.1 Application diagrams

Some applications for the 74LVCU04A are:

- Linear amplifier: see [Figure 10](#)
- Crystal oscillator designs; see [Figure 11](#)
- Astable multivibrator; see [Figure 12](#)



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

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

G_{OL} = loop gain.

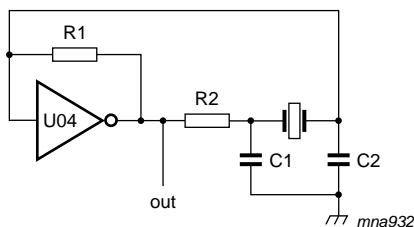
A_u = voltage amplification.

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

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

Typical unity gain bandwidth product is 5 MHz.

Fig 10. 74LVCU04A used as linear amplifier



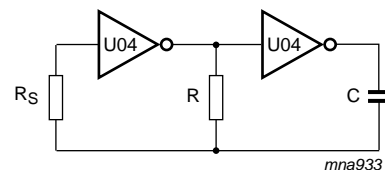
$C_1 = 47 \text{ pF}$ (typical)

$C_2 = 22 \text{ pF}$ (typical)

$R_1 = 1 \text{ to } 10 \text{ M}\Omega$ (typical)

R_2 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 $V_{CC} = 3 \text{ V}$ and $f = 1 \text{ MHz}$)

Fig 11. 74LVCU04A used as crystal oscillator



$$f = \frac{1}{T} \approx \frac{1}{2.2RC}$$

$R_S \approx 2R$.

The average I_{CC} is approximately $3.5 + 0.05f \text{ (MHz)} \times C \text{ (pF)}$ [mA] at $V_{CC} = 3.0 \text{ V}$.

Fig 12. 74LVCU04A used as astable multivibrator

13. Package outline

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

SOT108-1



Fig 13. Package outline SOT108-1 (SO14)

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

SOT337-1



Fig 14. Package outline SOT337-1 (SSOP14)

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

SOT402-1

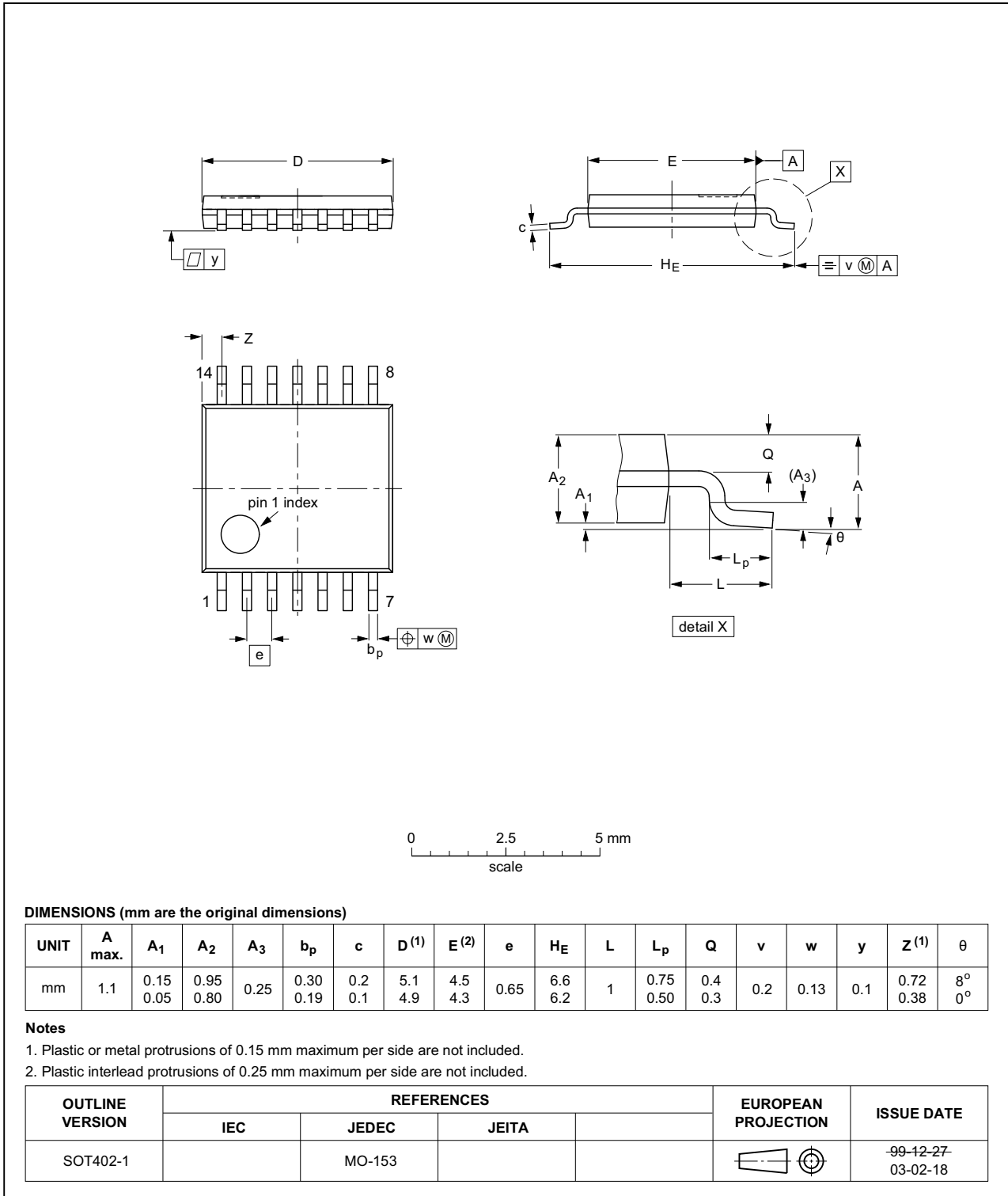


Fig 15. Package outline SOT402-1 (TSSOP14)

DHVQFN14: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads;
14 terminals; body 2.5 x 3 x 0.85 mm

SOT762-1

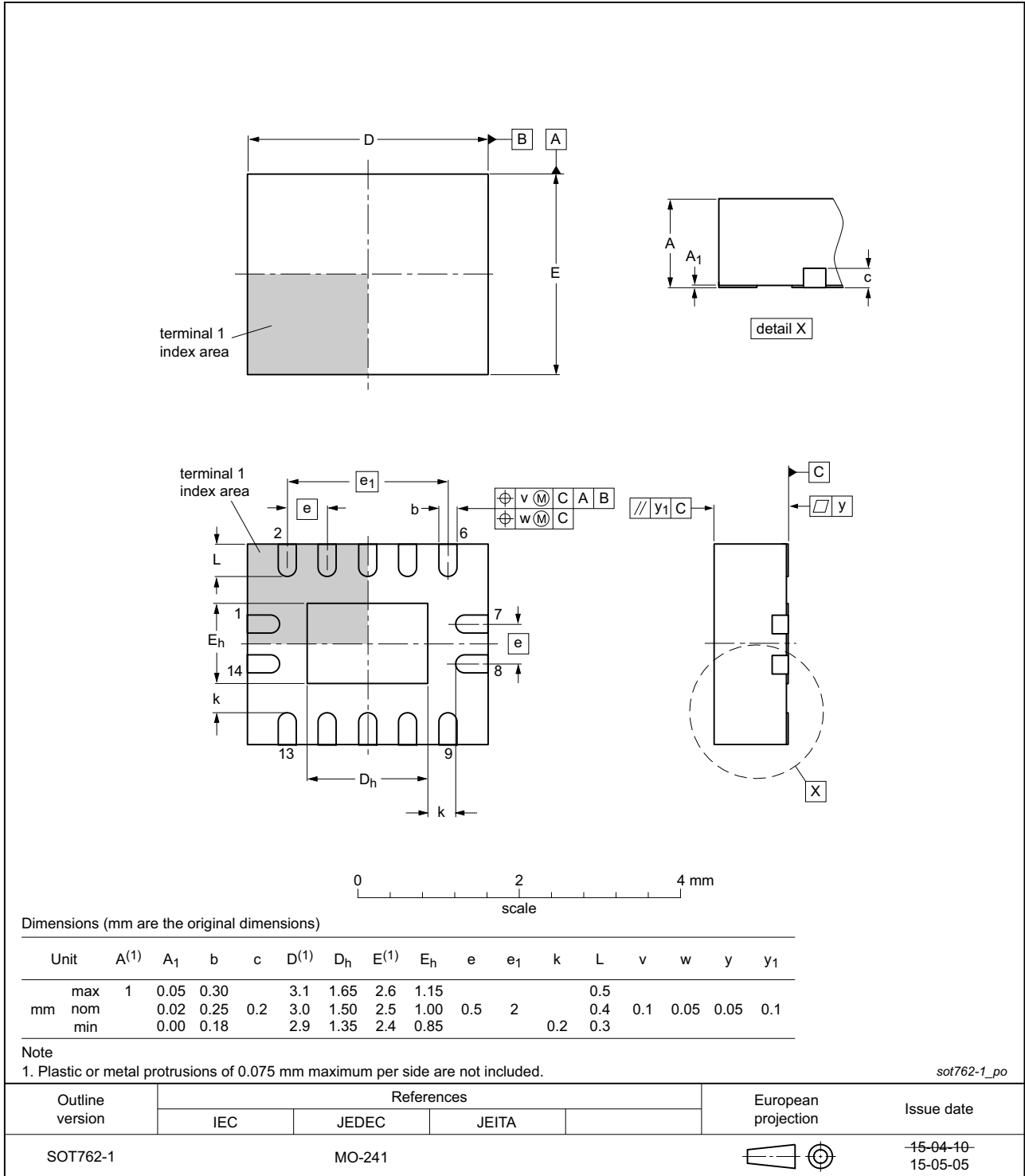


Fig 16. Package outline SOT762-1 (DHVQFN14)

14. Abbreviations

Table 9. Abbreviations

| Acronym | Description |
|---------|-----------------------------|
| CDM | Charged Device Model |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| HBM | Human Body Model |
| MM | Machine Model |
| TTL | Transistor-Transistor Logic |

15. Revision history

Table 10. Revision history

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|----------------|---|-----------------------|---------------|---------------|
| 74LVCU04A v.8 | 20151218 | Product data sheet | - | 74LVCU04A v.7 |
| Modifications: | <ul style="list-style-type: none"> Descriptive title updated. Added "unbuffered" (errata). | | | |
| 74LVCU04A v.7 | 20111117 | Product data sheet | - | 74LVCU04A v.6 |
| Modifications: | <ul style="list-style-type: none"> Legal pages updated. Table 6, bodyrow ΔI_{CC}: condition V_{CC} changed. | | | |
| 74LVCU04A v.6 | 20110809 | Product data sheet | - | 74LVCU04A v.5 |
| 74LVCU04A v.5 | 20040312 | Product specification | - | 74LVCU04A v.4 |
| 74LVCU04A v.4 | 20030901 | Product specification | - | 74LVCU04A v.3 |
| 74LVCU04A v.3 | 19980729 | Product specification | - | 74LVCU04A v.2 |
| 74LVCU04A v.2 | 19980729 | Product specification | - | 74LVCU04A v.1 |
| 74LVCU04A v.1 | 19980729 | Product specification | - | - |

16. Legal information

16.1 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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