

74LVCU04A

Hex inverter

Rev. 7 — 17 November 2011

Product data sheet

1. General description

The 74LVCU04A is a general purpose hex 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 °C to +85 °C and –40 °C to +125 °C

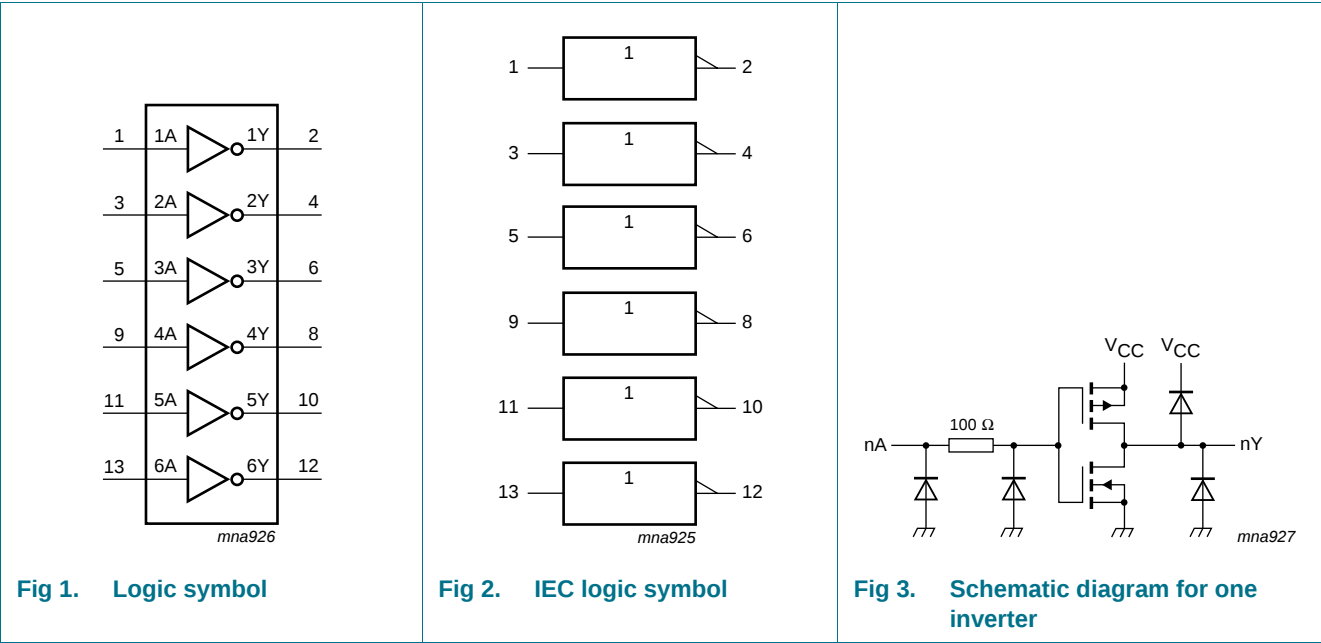
3. Ordering information

Table 1. Ordering information

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

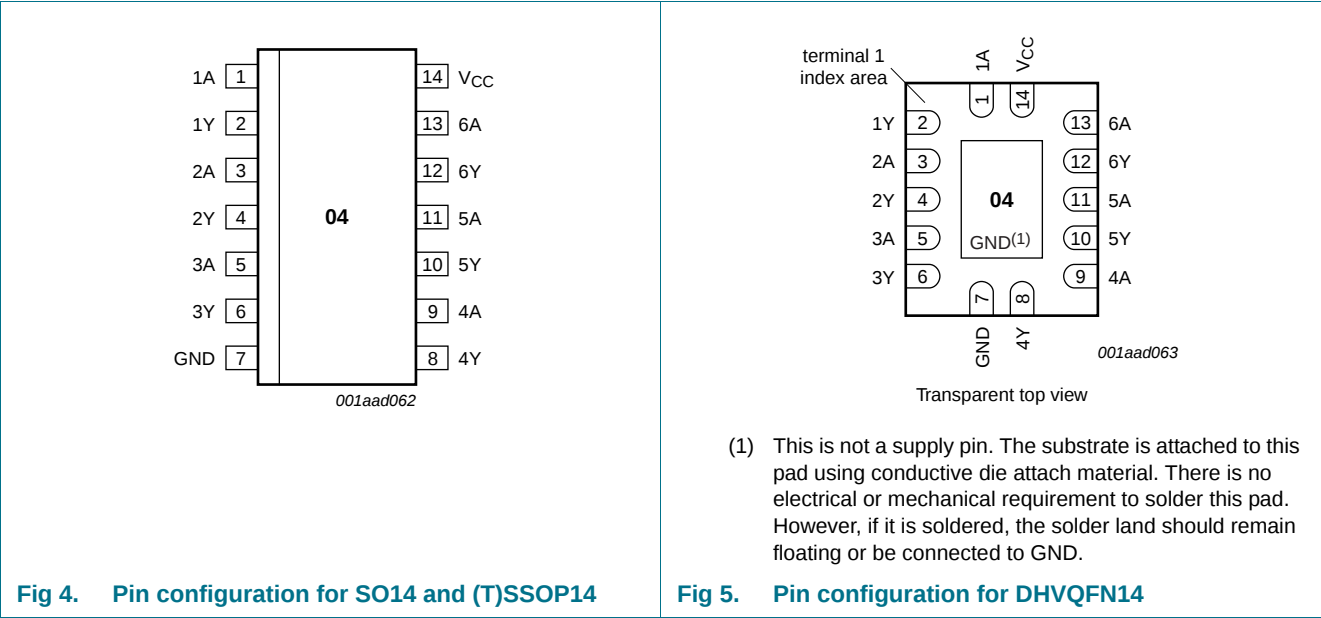


4. Functional diagram



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		^[1] -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		^[2] -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	^[3] -	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
$\Delta t/\Delta V$	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 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 _{CC} = 3.6 V	2.4	-	-	2.8	-	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 _{CC} = 3.6 V	-	-	1.2	-	0.7	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 characteristicsVoltages 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 ^[2]						
		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 ^[3]	-	-	1.0	-	1.5	ns
C _{PD}	power dissipation capacitance	per inverter; V _I = GND to V _{CC} ^[4]						
		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.

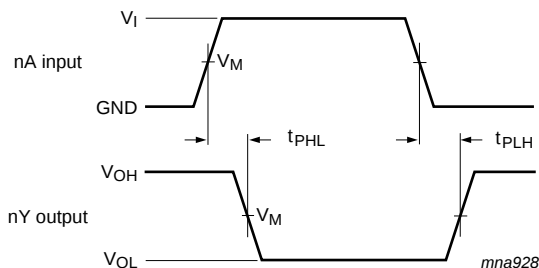
[4] C_{PD} is used to determine the dynamic power dissipation (P_D in µW).P_D = C_{PD} × V_{CC}² × f_i × N + Σ(C_L × V_{CC}² × f_o) where:f_i = input frequency in MHz; f_o = output frequency in MHzC_L = output load capacitance in pF

V_{CC} = supply voltage in Volts

N = number of inputs switching

$\Sigma(C_L \times V_{CC}^2 \times f_0)$ = sum of the outputs

11. Waveforms

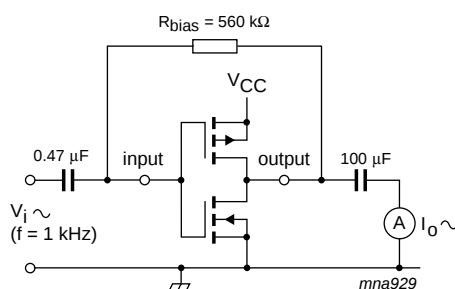


$V_M = 1.5 \text{ V}$ at $V_{CC} \geq 2.7 \text{ V}$;

$V_M = 0.5 \times V_{CC}$ at $V_{CC} < 2.7 \text{ V}$;

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

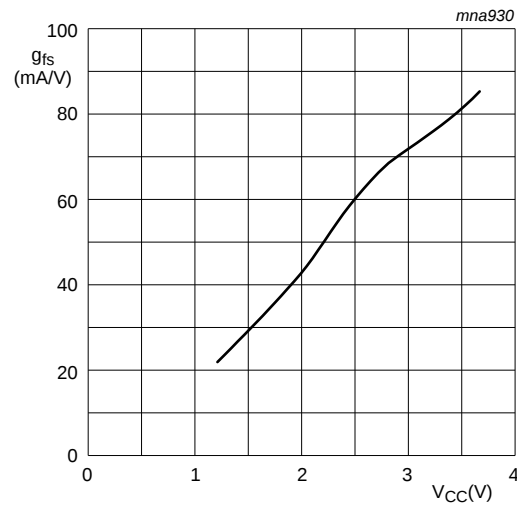
Fig 6. Input (nA) to output (nY) propagation delays



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

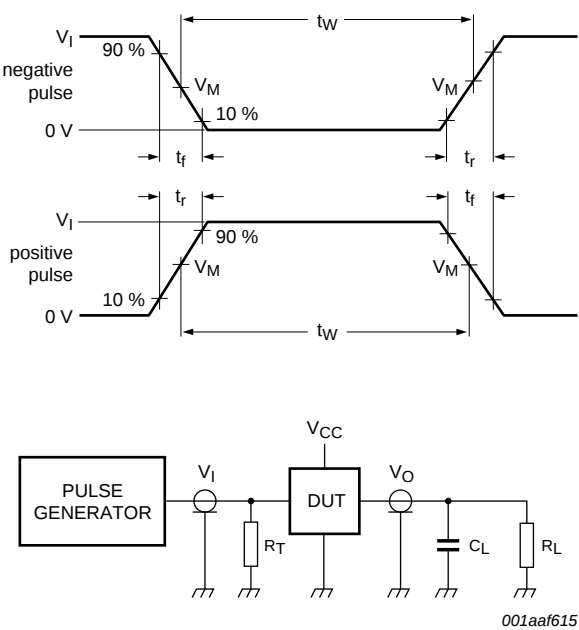
$f_i = 1 \text{ kHz}$ at V_O is constant

Fig 7. Test setup for measuring forward transconductance



$T_{amb} = 25\text{ }^{\circ}\text{C}$

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. Load circuitry for measuring switching times

Table 8. Test data

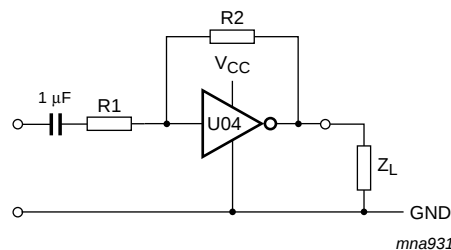
Supply voltage	Input		Load	
	V_I	t_r, t_f	C_L	R_L
1.2 V	V_{CC}	$\leq 2 \text{ ns}$	30 pF	1 k Ω
1.65 V to 1.95 V	V_{CC}	$\leq 2 \text{ ns}$	30 pF	1 k Ω
2.3 V to 2.7 V	V_{CC}	$\leq 2 \text{ ns}$	30 pF	500 Ω
2.7 V	2.7 V	$\leq 2.5 \text{ ns}$	50 pF	500 Ω
3.0 V to 3.6 V	2.7 V	$\leq 2.5 \text{ ns}$	50 pF	500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

12. Application information

12.1 Application diagrams

Some applications for the 74LVCU04 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.

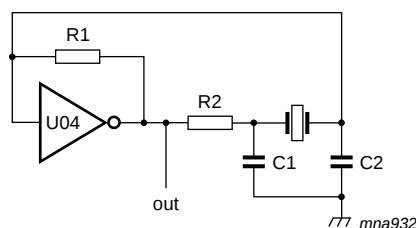
A_u = voltage amplification.

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

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

Typical unity gain bandwidth product is 5 MHz.

Fig 10. 74LVCU04A used as linear amplifier



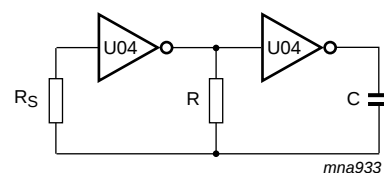
$C_1 = 47 \text{ pF}$ (typical)

$C_2 = 22 \text{ pF}$ (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



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

$R_S \approx 2R$.

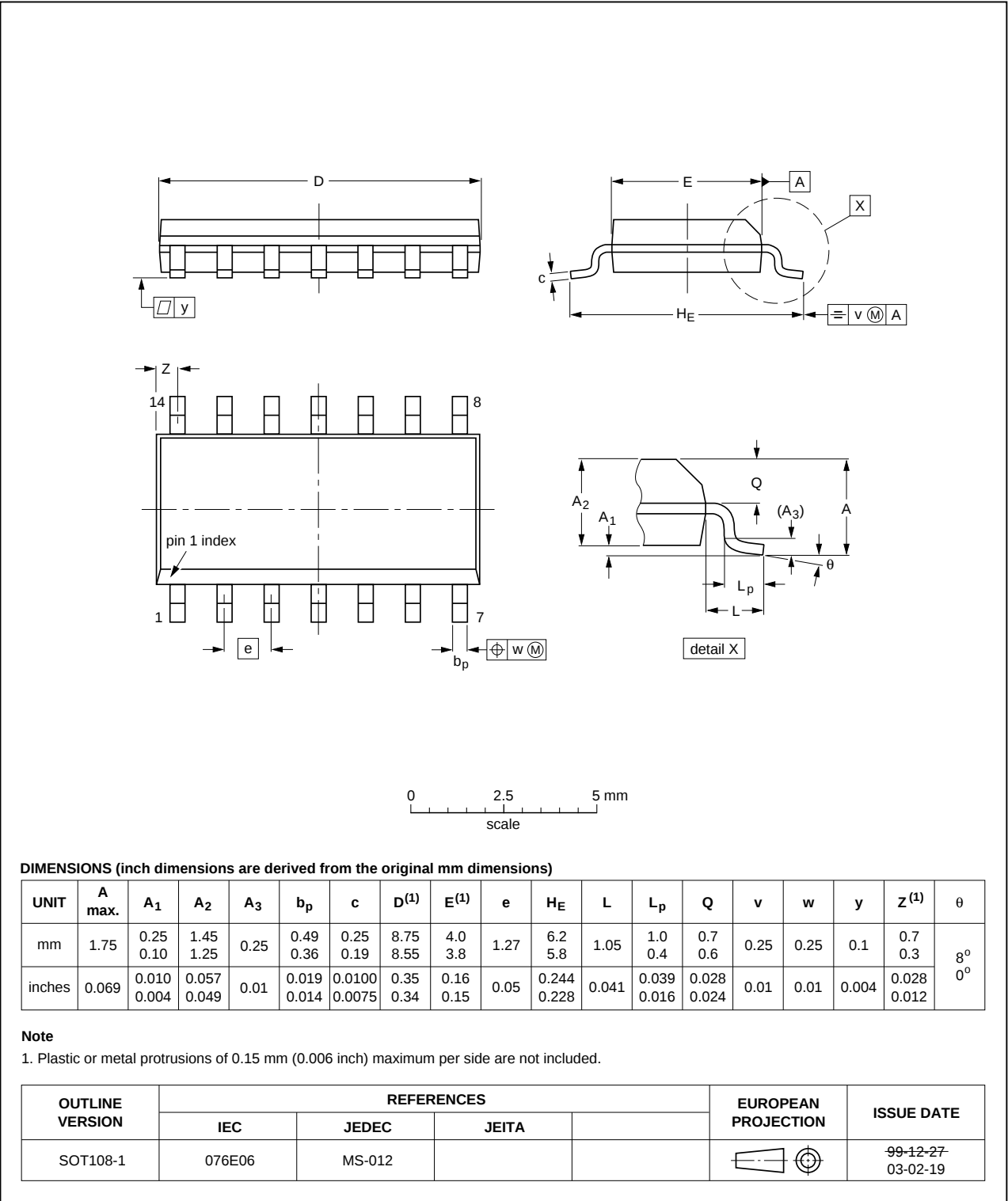
The average I_{CC} is approximately $3.5 + 0.05f \text{ (MHz)} \times C \text{ (pF)}$ [mA] at $V_{CC} = 3.0 \text{ V}$.

Fig 12. 74LVCU04A used as astable multivibrator

13. Package outline

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

SOT108-1



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

SOT337-1

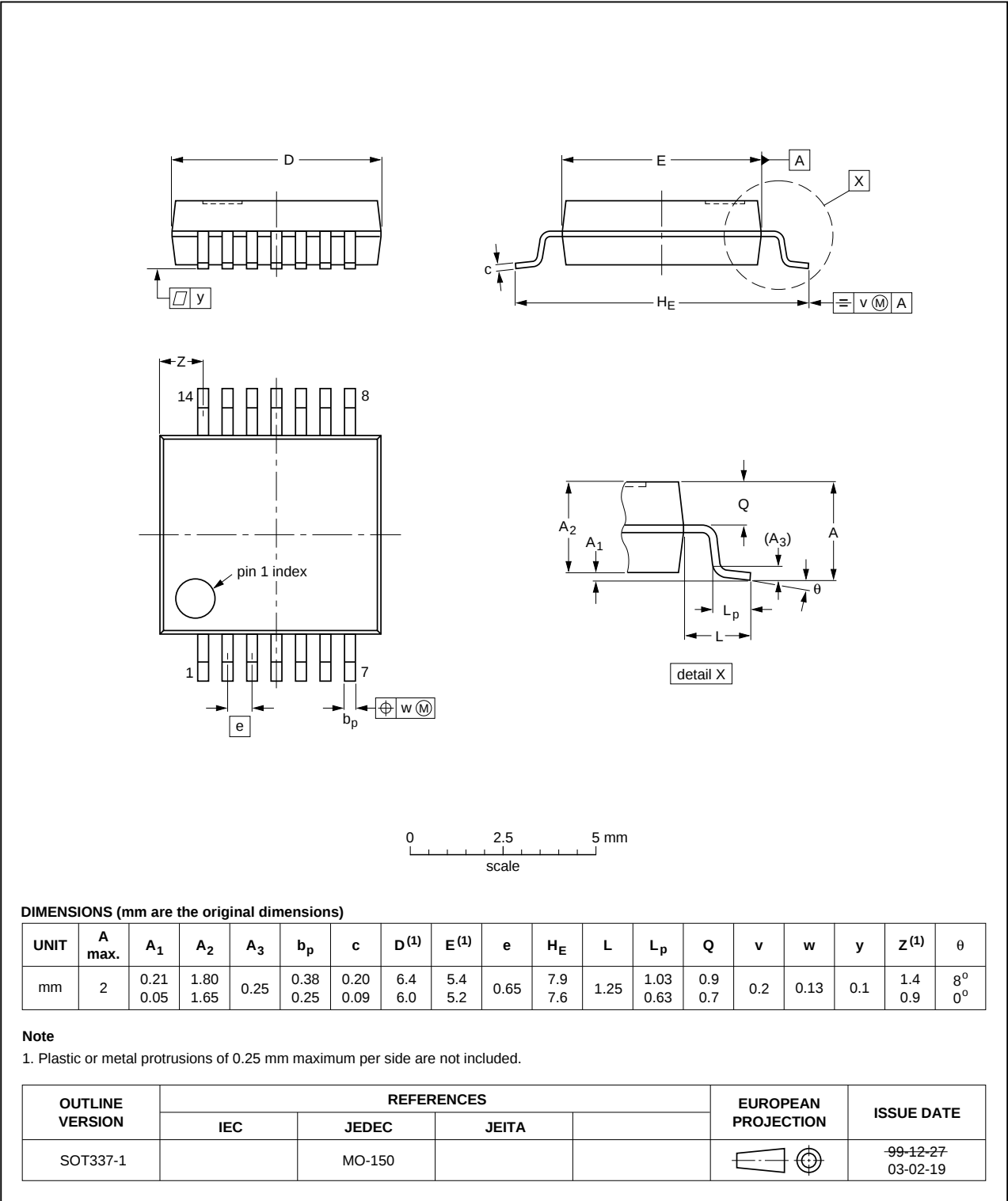


Fig 14. Package outline SOT337-1 (SSOP14)

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

SOT402-1

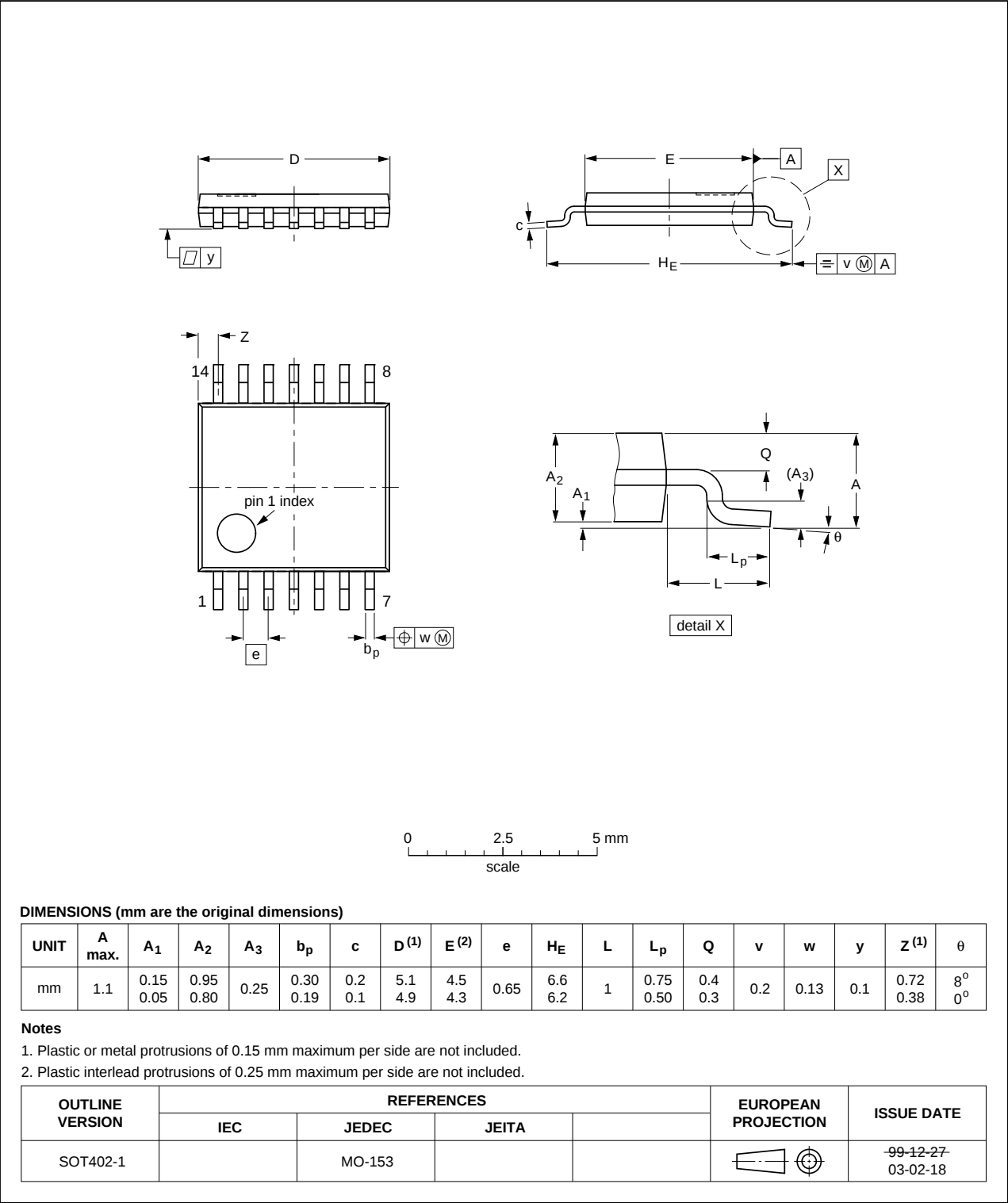


Fig 15. Package outline SOT402-1 (TSSOP14)

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

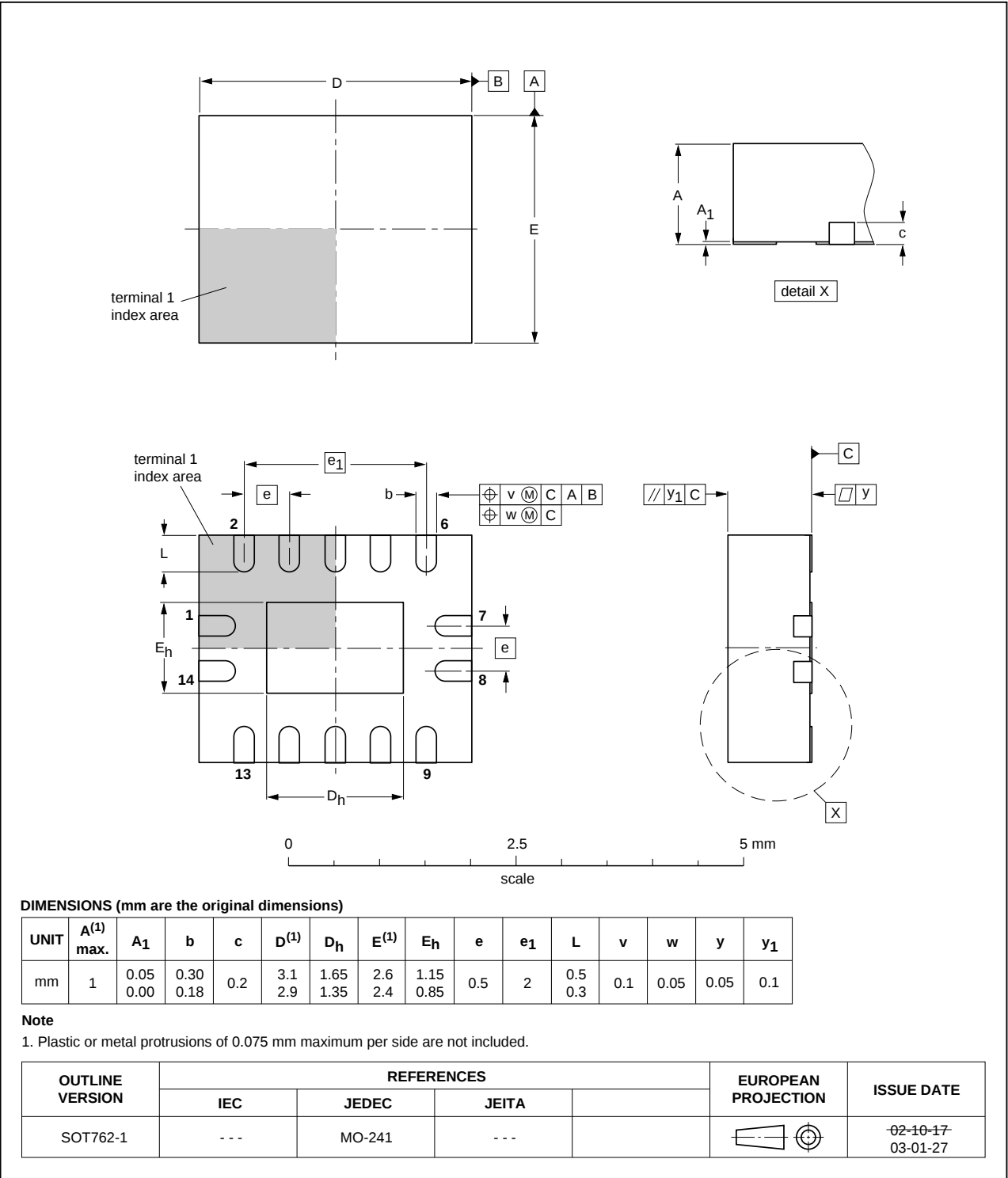


Fig 16. Package outline SOT762-1 (DHVQFN14)

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
74LVCU04 v.7	20111117	Product data sheet	-	74LVCU04A v.6
Modifications:	- Legal pages updated. Table 6, bodyrow ΔI_{CC}: condition V_{CC} changed.			
74LVCU04 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.
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[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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