74LVC2GU04

Dual inverter
Rev. 8 — 3 July 2012

Product data sheet

1. **General description**

The 74LVC2GU04 provides two inverters. Each inverter is a single stage with unbuffered output.

The inputs 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.

Features and benefits 2.

- Wide supply voltage range from 1.65 V to 5.5 V
- 5 V tolerant input/output for interfacing with 5 V logic
- High noise immunity
- ESD protection:
 - ◆ HBM JESD22-A114F exceeds 2000 V
 - ◆ MM JESD22-A115-A exceeds 200 V
- \blacksquare ±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
- Specified from -40 °C to +85 °C and -40 °C to +125 °C

Ordering information 3.

Table 1. **Ordering information**

Type number	Package						
	Temperature range	Name	Description	Version			
74LVC2GU04GW	−40 °C to +125 °C	SC-88	plastic surface-mounted package; 6 leads	SOT363			
74LVC2GU04GV	–40 °C to +125 °C	TSOP6	plastic surface-mounted package (TSOP6); 6 leads	SOT457			
74LVC2GU04GM	–40 °C to +125 °C	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1 \times 1.45 \times 0.5 mm	SOT886			
74LVC2GU04GF	–40 °C to +125 °C	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1 \times 1 \times 0.5 mm	SOT891			
74LVC2GU04GN	–40 °C to +125 °C	XSON6	extremely thin small outline package; no leads; 6 terminals; body $0.9 \times 1.0 \times 0.35$ mm	SOT1115			
74LVC2GU04GS	–40 °C to +125 °C	XSON6	extremely thin small outline package; no leads; 6 terminals; body 1.0 \times 1.0 \times 0.35 mm	SOT1202			



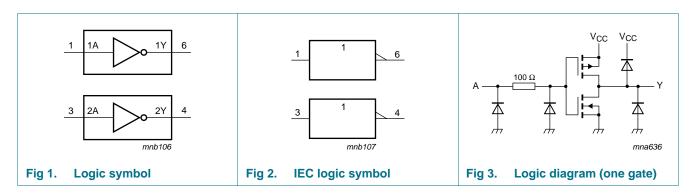
4. Marking

Table 2. Marking codes

Type number	Marking[1]
74LVC2GU04GW	YD
74LVC2GU04GV	VU4
74LVC2GU04GM	YD
74LVC2GU04GF	YD
74LVC2GU04GN	YD
74LVC2GU04GS	YD

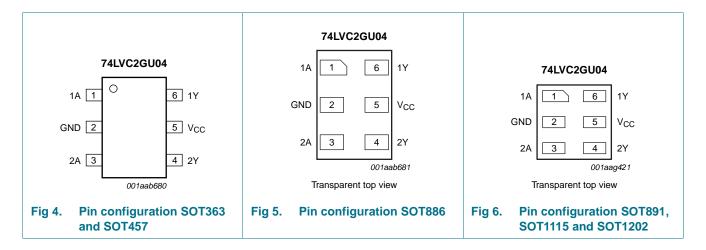
^[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

5. Functional diagram



6. Pinning information

6.1 Pinning



6.2 Pin description

Table 3. Pin description

Symbol	Pin	Description
1A	1	data input
GND	2	ground (0 V)
2A	3	data input
2Y	4	data output
V _{CC}	5	supply voltage
1Y	6	data output

7. Functional description

Table 4. Function table[1]

Input	Output
nA	nY
L	Н
Н	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
VI	input voltage		<u>[1]</u> -0.5	+6.5	V
I _{OK}	output clamping current	V _O < 0 V	-50	-	mA
Vo	output voltage	Active mode	[<u>1][2]</u> -0.5	$V_{CC} + 0.5$	V
Io	output current	$V_O = 0 V \text{ to } V_{CC}$	-	±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	$T_{amb} = -40 ^{\circ}\text{C} \text{ to } +125 ^{\circ}\text{C}$	[3] _	250	mW

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

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

^[3] For SC-88 and SC-74 packages: above 87.5 °C the value of P_{tot} derates linearly with 4.0 mW/K. For XSON6 packages: 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	Тур	Max	Unit
V_{CC}	supply voltage		1.65	-	5.5	V
VI	input voltage		0	-	5.5	V
Vo	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	-	-	20	ns/V
		V _{CC} = 2.7 V to 5.5 V	-	-	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	Тур	Max	Unit
T _{amb} = -	40 °C to +85 °C[1]					
V _{IH}	HIGH-level input voltage	V _{CC} = 1.65 V to 5.5 V	$0.75 \times V_{CC}$	-	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 1.65 V to 5.5 V	-	-	$0.25 \times V_{CC}$	V
V_{OH}	HIGH-level output voltage	$V_I = V_{IH}$ or V_{IL}				
	$I_O = -100 \mu A;$ $V_{CC} = 1.65 \text{ V to } 5.5 \text{ V}$	V _{CC} - 0.1	-	-	V	
		$I_O = -4 \text{ mA}; V_{CC} = 1.65 \text{ V}$	1.2	-	-	V
		$I_{O} = -8 \text{ mA}; V_{CC} = 2.3 \text{ V}$	1.9	-	-	V
		$I_{O} = -12 \text{ mA}; V_{CC} = 2.7 \text{ V}$	2.2	-	-	V
		$I_{O} = -24 \text{ mA}; V_{CC} = 3.0 \text{ V}$	2.3	-	-	V
		$I_{O} = -32 \text{ mA}; V_{CC} = 4.5 \text{ V}$	3.8	-	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH}$ or V_{IL}				
		$I_O = 100 \mu A;$ $V_{CC} = 1.65 \text{ V to } 5.5 \text{ V}$	-	-	0.1	V
		$I_O = 4 \text{ mA}; V_{CC} = 1.65 \text{ V}$	-	-	0.45	V
		$I_{O} = 8 \text{ mA}; V_{CC} = 2.3 \text{ V}$	-	-	0.3	V
		$I_{O} = 12 \text{ mA}; V_{CC} = 2.7 \text{ V}$	-	-	0.4	V
		$I_{O} = 24 \text{ mA}; V_{CC} = 3.0 \text{ V}$	-	-	0.55	V
		$I_{O} = 32 \text{ mA}; V_{CC} = 4.5 \text{ V}$	-	-	0.55	V
I _I	input leakage current	$V_I = 5.5 \text{ V or GND};$ $V_{CC} = 0 \text{ V to } 5.5 \text{ V}$	[2] _	±0.1	±5	μΑ
I _{CC}	supply current	$V_I = 5.5 \text{ V or GND}; I_O = 0 \text{ A};$ $V_{CC} = 1.65 \text{ V to } 5.5 \text{ V}$	-	0.1	10	μА
Cı	input capacitance	V_{CC} = 3.3 V; V_{I} = GND to V_{CC}	-	5	-	pF

 Table 7.
 Static characteristics ...continued

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

Symbol	Parameter	Conditions	Min	Тур	Max	Unit
Γ _{amb} = –	40 °C to +125 °C					
V _{IH}	HIGH-level input voltage	V _{CC} = 1.65 V to 5.5 V	$0.8 \times V_{CC}$	-	-	V
V_{IL}	LOW-level input voltage	V _{CC} = 1.65 V to 5.5 V	-	-	$0.2 \times V_{CC}$	V
VoH	HIGH-level output voltage	$V_I = V_{IH}$ or V_{IL}				
	$I_O = -100 \mu A;$ $V_{CC} = 1.65 \text{ V to } 5.5 \text{ V}$	V _{CC} - 0.1	-	-	V	
	$I_{O} = -4 \text{ mA}; V_{CC} = 1.65 \text{ V}$	0.95	-	-	V	
	$I_{O} = -8 \text{ mA}; V_{CC} = 2.3 \text{ V}$	1.7	-	-	V	
		$I_{O} = -12 \text{ mA}; V_{CC} = 2.7 \text{ V}$	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
V _{OL}	LOW-level output voltage	$V_I = V_{IH}$ or V_{IL}				
		$I_O = 100 \mu A;$ $V_{CC} = 1.65 \text{ V to } 5.5 \text{ V}$	-	-	0.1	V
		$I_O = 4 \text{ mA}; V_{CC} = 1.65 \text{ V}$	-	-	0.7	V
		$I_O = 8 \text{ mA}; V_{CC} = 2.3 \text{ V}$	-	-	0.45	V
		$I_{O} = 12 \text{ mA}; V_{CC} = 2.7 \text{ V}$	-	-	0.6	V
		$I_O = 24 \text{ mA}; V_{CC} = 3.0 \text{ V}$	-	-	0.8	V
		$I_{O} = 32 \text{ mA}; V_{CC} = 4.5 \text{ V}$	-	-	0.8	V
I	input leakage current	V _I = 5.5 V or GND; V _{CC} = 0 V to 5.5 V	-	-	±20	μΑ
СС	supply current	$V_I = 5.5 \text{ V or GND}; I_O = 0 \text{ A};$ $V_{CC} = 1.65 \text{ V to } 5.5 \text{ V}$	-	-	40	μΑ

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

^[2] These typical values are measured at V_{CC} = 3.3 V.

11. Dynamic characteristics

Table 8. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V). For test circuit see Figure 8.

Symbol	Parameter	Conditions		-40	°C to +85	5 °C	-40 °C to	o +125 °C	Unit
				Min	Typ[1]	Max	Min	Max	
t_{pd}	propagation delay	nA to nY; see Figure 7	[2]						
	$V_{CC} = 1.65 \text{ V to } 1.95 \text{ V}$		0.5	2.3	5.0	0.5	6.3	ns	
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$		0.3	1.8	4.0	0.3	5.0	ns
		$V_{CC} = 2.7 \text{ V}$		0.3	2.6	4.5	0.3	5.6	ns
		$V_{CC} = 3.0 \text{ V to } 3.6 \text{ V}$		0.3	2.3	3.7	0.3	4.5	ns
		$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$		0.3	1.7	3.0	0.3	3.8	ns
C_{PD}	power dissipation capacitance	$V_I = GND \text{ to } V_{CC}; V_{CC} = 3.3 \text{ V}$	[3]	-	7.8	-			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).

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

 f_i = input frequency in MHz;

f_o = output frequency in MHz;

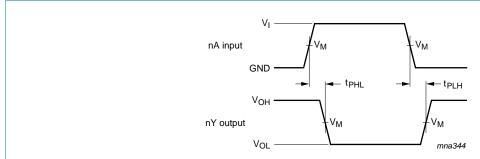
C_L = output load capacitance in pF;

 V_{CC} = supply voltage in V;

N = number of inputs switching;

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

12. Waveforms



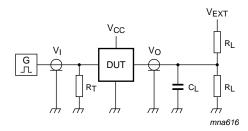
Measurement points are given in Table 9.

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

Fig 7. The input (nA) to output (nY) propagation delay times

Table 9. Measurement points

Supply voltage	Input	Output
V _{CC}	V _M	V _M
1.65 V to 1.95 V	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$
2.3 V to 2.7 V	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$
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	$0.5 \times V_{CC}$	0.5 × V _{CC}



Test data is given in Table 10.

Definitions for test circuit:

R_L = Load resistance.

 C_L = Load capacitance including jig and probe capacitance.

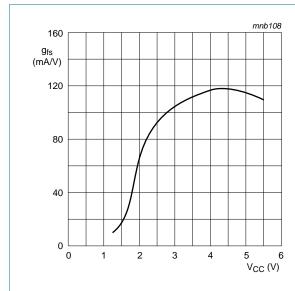
 R_T = Termination resistance should be equal to the output impedance Z_0 of the pulse generator.

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

Fig 8. Test circuit for measuring switching times

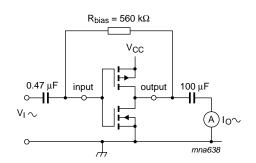
Table 10. Test data

Supply voltage	Input		Load		V _{EXT}
V _{CC}	V _I	$t_r = t_f$	CL	R _L	t _{PLH} , t _{PHL}
1.65 V to 1.95 V	V _{CC}	≤ 2.0 ns	30 pF	1 kΩ	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



 $T_{amb} = 25 \, ^{\circ}C.$

Fig 9. Typical forward transconductance as a function of supply voltage



$$g_{fs} = \frac{\Delta I_O}{\Delta V_s}$$

 $f_i = 1 \text{ kHz}.$

V_O is constant.

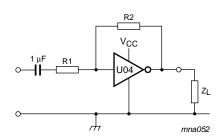
Fig 10. Test set-up for measuring forward transconductance

13. Application information

Some applications are:

- Linear amplifier (see Figure 11)
- In crystal oscillator design (see Figure 12)

Remark: All values given are typical unless otherwise specified.



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

$$A_u = -\frac{G_{OL}}{I + \frac{RI}{R2}(I + G_{OL})} \label{eq:au}$$

 G_{OL} = open loop gain.

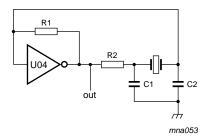
A_u = voltage amplification.

 $R1 \ge 3 \text{ k}\Omega, R2 \le 1 \text{ M}\Omega.$

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

Typical unity gain bandwidth product is 5 MHz.

Fig 11. Linear amplifier configuration



C1 = 47 pF (typical).

C2 = 22 pF (typical).

R1 = 1 M Ω to 10 M Ω (typical).

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 V and f = 10 MHz).

Fig 12. Crystal oscillator configuration

14. Package outline

Plastic surface-mounted package; 6 leads

SOT363

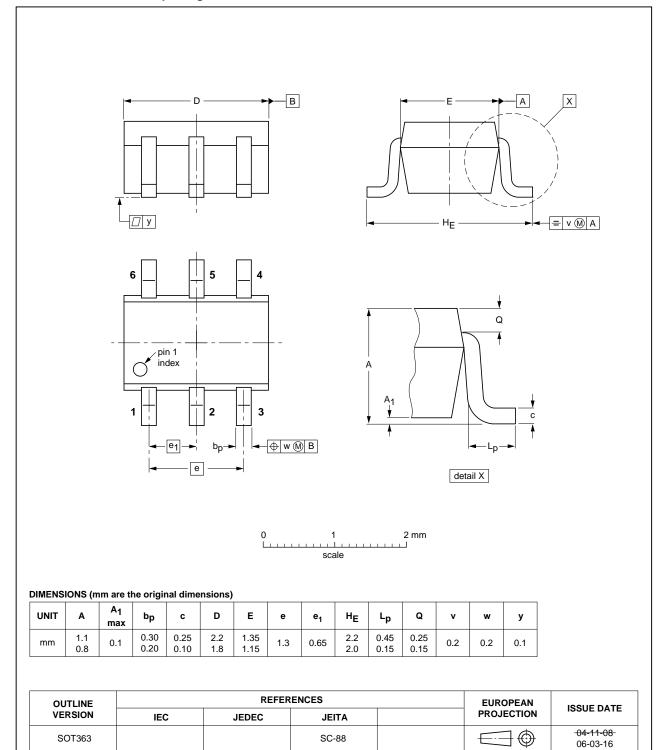


Fig 13. Package outline SOT363 (SC-88)

74LVC2GU04

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Plastic surface-mounted package (TSOP6); 6 leads

SOT457

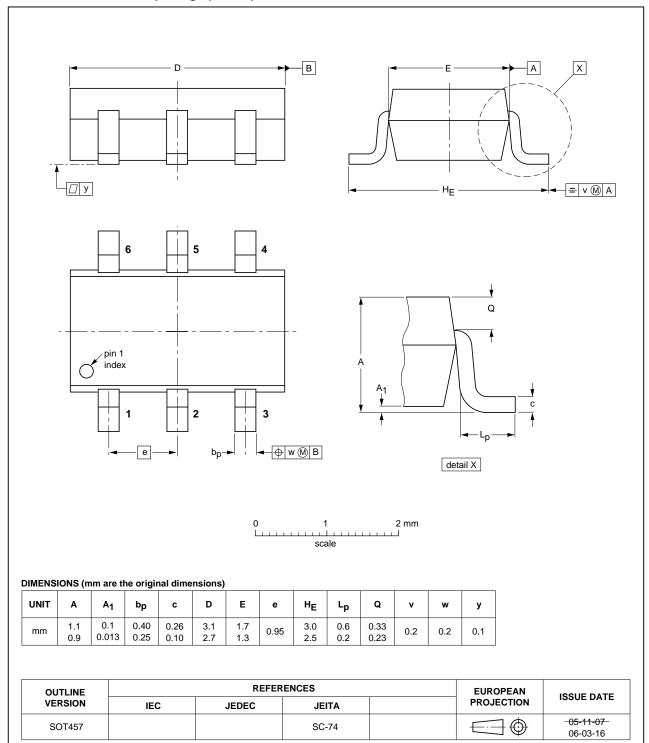


Fig 14. Package outline SOT457 (TSOP6)

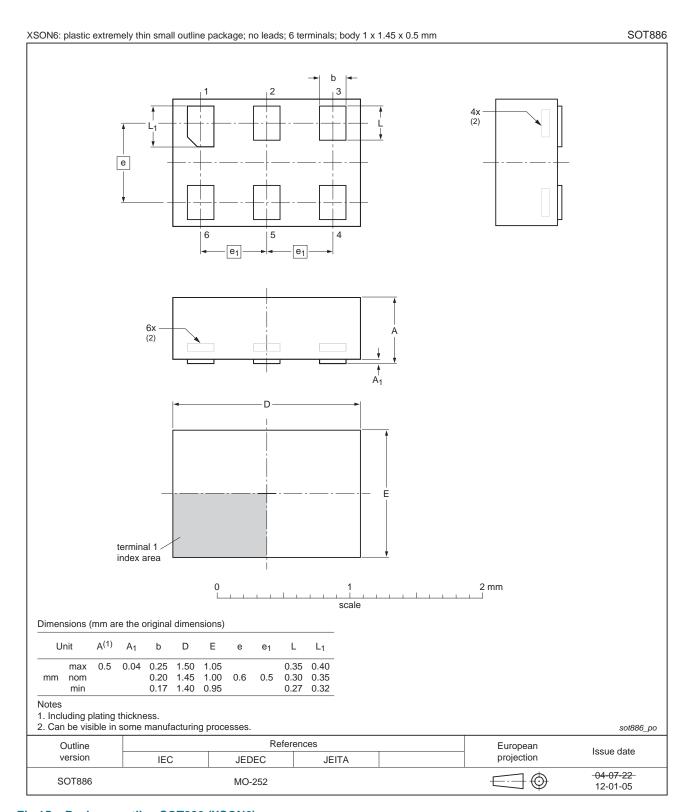


Fig 15. Package outline SOT886 (XSON6)

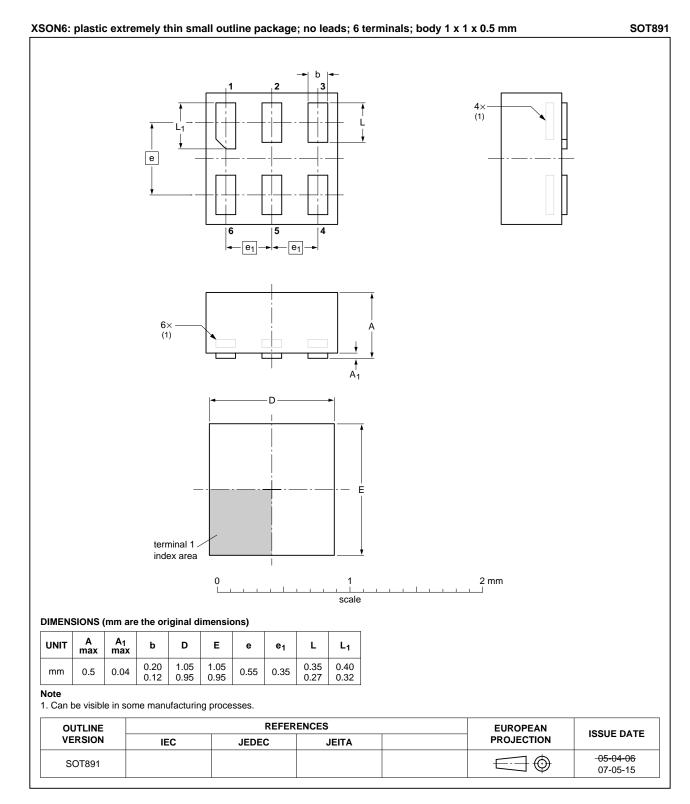


Fig 16. Package outline SOT891 (XSON6)

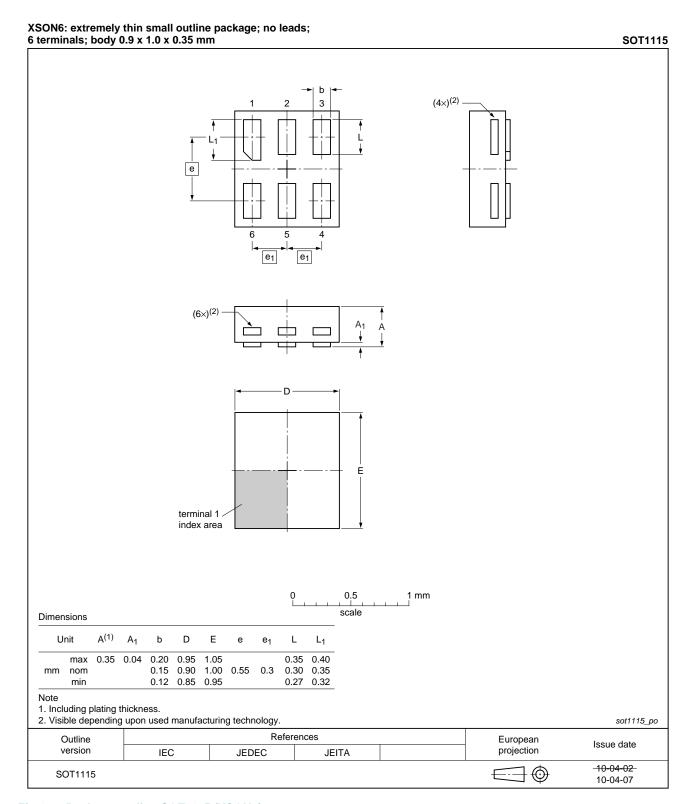


Fig 17. Package outline SOT1115 (XSON6)

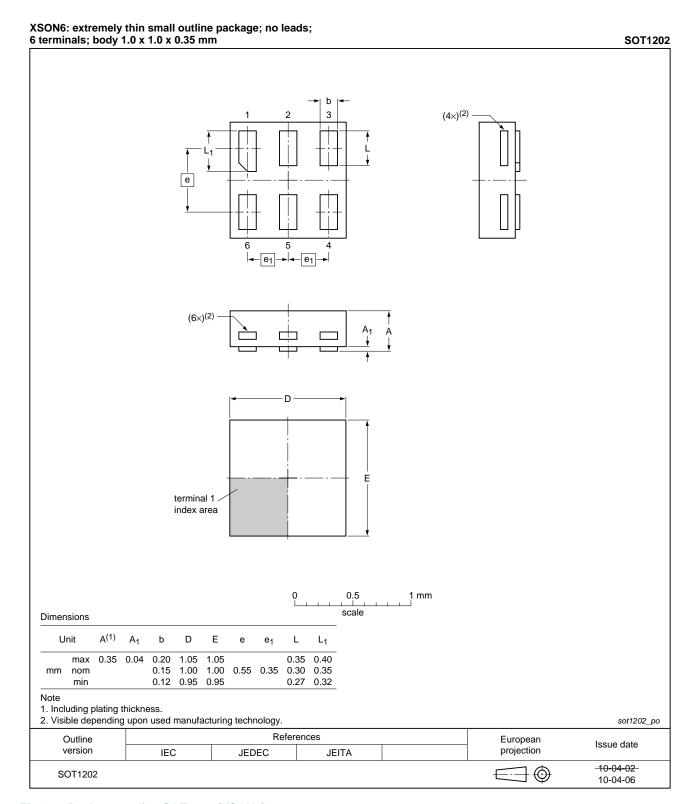


Fig 18. Package outline SOT1202 (XSON6)

15. Abbreviations

Table 11. Abbreviations

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

16. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74LVC2GU04 v.8	20120703	Product data sheet	-	74LVC2GU04 v.7
Modifications:	 Package outline drawing of SOT886 (<u>Figure 15</u>) modified. 			
74LVC2GU04 v.7	20111128	Product data sheet	-	74LVC2GU04 v.6
Modifications:	Legal pages updated.			
74LVC2GU04 v.6	20101027	Product data sheet	-	74LVC2GU04 v.5
74LVC2GU04 v.5	20091027	Product data sheet	-	74LVC2GU04 v.4
74LVC2GU04 v.4	20070521	Product data sheet	-	74LVC2GU04 v.3
74LVC2GU04 v.3	20040921	Product specification	-	74LVC2GU04 v.2
74LVC2GU04 v.2	20040524	Product specification	-	74LVC2GU04 v.1
74LVC2GU04 v.1	20030829	Product specification	-	-

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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17.4 Trademarks

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18. Contact information

For more information, please visit: http://www.nxp.com

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