

# 74LVC2GU04-Q100

Dual inverter

Rev. 1 — 31 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.

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
- 5 V tolerant input/output for interfacing with 5 V logic
- 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
- Multiple package options

## 3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74LVC2GU04GW-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SC-88	plastic surface-mounted package; 6 leads	SOT363
74LVC2GU04GV-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	TSOP6	plastic surface-mounted package (TSOP6); 6 leads	SOT457



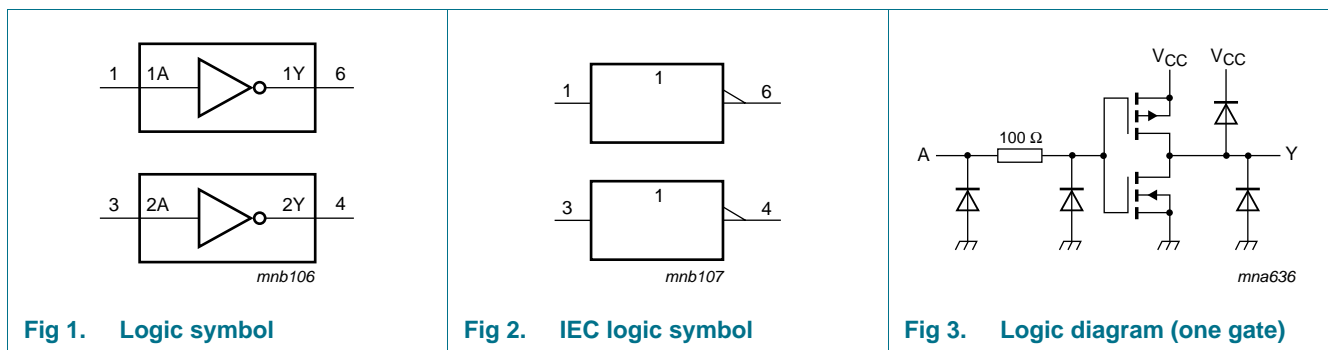
## 4. Marking

Table 2. Marking codes

Type number	Marking <sup>[1]</sup>
74LVC2GU04GW-Q100	YD
74LVC2GU04GV-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

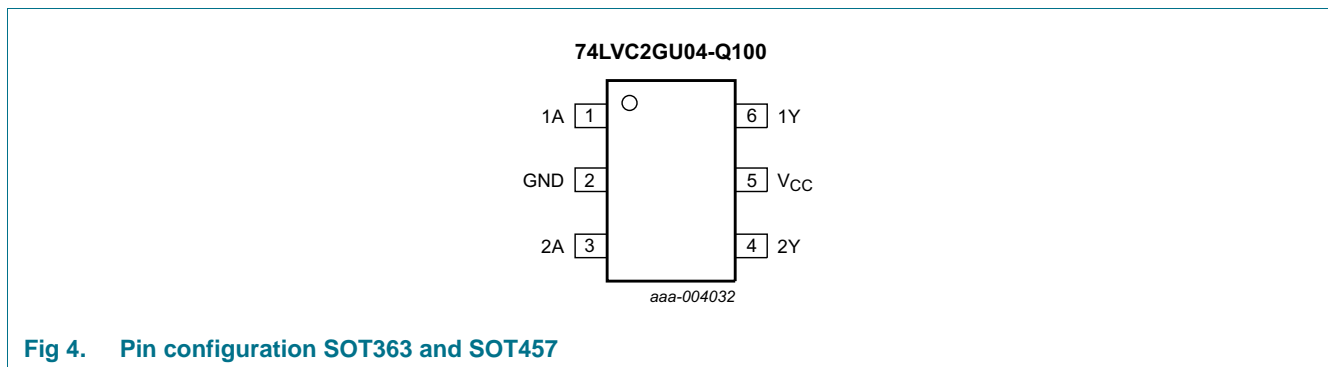


Fig 4. Pin configuration SOT363 and SOT457

## 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 <sub>CC</sub>	5	supply voltage
1Y	6	data output

## 7. Functional description

**Table 4.** Function table<sup>[1]</sup>

Input	Output
nA	nY
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 <sub>CC</sub>	supply voltage		-0.5	+6.5	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < 0 V	-50	-	mA
V <sub>I</sub>	input voltage		<sup>[1]</sup> -0.5	+6.5	V
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < 0 V	-50	-	mA
V <sub>O</sub>	output voltage	Active mode	<sup>[1][2]</sup> -0.5	V <sub>CC</sub> + 0.5	V
I <sub>O</sub>	output current	V <sub>O</sub> = 0 V to V <sub>CC</sub>	-	±50	mA
I <sub>CC</sub>	supply current		-	100	mA
I <sub>GND</sub>	ground current		-100	-	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = -40 °C to +125 °C	<sup>[3]</sup> -	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<sub>CC</sub> = 0 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<sub>tot</sub> 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	$V_{CC} = 1.65\text{ V to }2.7\text{ V}$	-	-	20	ns/V
		$V_{CC} = 2.7\text{ V to }5.5\text{ V}$	-	-	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	Typ	Max	Unit
$T_{amb} = -40\text{ °C to }+85\text{ °C}$ [1]						
$V_{IH}$	HIGH-level input voltage	$V_{CC} = 1.65\text{ V to }5.5\text{ V}$	$0.75 \times V_{CC}$	-	-	V
$V_{IL}$	LOW-level input voltage	$V_{CC} = 1.65\text{ V to }5.5\text{ V}$	-	-	$0.25 \times V_{CC}$	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$				
		$I_O = -100\text{ }\mu\text{A};$ $V_{CC} = 1.65\text{ V to }5.5\text{ V}$	$V_{CC} - 0.1$	-	-	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 $V_{IL}$				
		$I_O = 100\text{ }\mu\text{A};$ $V_{CC} = 1.65\text{ V to }5.5\text{ V}$	-	-	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] -	$\pm 0.1$	$\pm 5$	$\mu\text{A}$
$I_{CC}$	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	$\mu\text{A}$
$C_I$	input capacitance	$V_{CC} = 3.3\text{ V}; V_I = \text{GND to }V_{CC}$	-	5	-	pF

**Table 7. Static characteristics ...continued**

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

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
<b>T<sub>amb</sub> = -40 °C to +125 °C</b>						
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 1.65 V to 5.5 V	0.8 × V <sub>CC</sub>	-	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 1.65 V to 5.5 V	-	-	0.2 × V <sub>CC</sub>	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; V <sub>CC</sub> = 1.65 V to 5.5 V	V <sub>CC</sub> - 0.1	-	-	V
		I <sub>O</sub> = -4 mA; V <sub>CC</sub> = 1.65 V	0.95	-	-	V
		I <sub>O</sub> = -8 mA; V <sub>CC</sub> = 2.3 V	1.7	-	-	V
		I <sub>O</sub> = -12 mA; V <sub>CC</sub> = 2.7 V	1.9	-	-	V
		I <sub>O</sub> = -24 mA; V <sub>CC</sub> = 3.0 V	2.0	-	-	V
		I <sub>O</sub> = -32 mA; V <sub>CC</sub> = 4.5 V	3.4	-	-	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; V <sub>CC</sub> = 1.65 V to 5.5 V	-	-	0.1	V
		I <sub>O</sub> = 4 mA; V <sub>CC</sub> = 1.65 V	-	-	0.7	V
		I <sub>O</sub> = 8 mA; V <sub>CC</sub> = 2.3 V	-	-	0.45	V
		I <sub>O</sub> = 12 mA; V <sub>CC</sub> = 2.7 V	-	-	0.6	V
		I <sub>O</sub> = 24 mA; V <sub>CC</sub> = 3.0 V	-	-	0.8	V
		I <sub>O</sub> = 32 mA; V <sub>CC</sub> = 4.5 V	-	-	0.8	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = 5.5 V or GND; V <sub>CC</sub> = 0 V to 5.5 V	-	-	±20	μA
I <sub>CC</sub>	supply current	V <sub>I</sub> = 5.5 V or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 1.65 V to 5.5 V	-	-	40	μA

[1] All typical values are measured at T<sub>amb</sub> = 25 °C.[2] These typical values are measured at V<sub>CC</sub> = 3.3 V.

## 11. Dynamic characteristics

**Table 8. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V). For test circuit see [Figure 6](#).

Symbol	Parameter	Conditions	-40 °C to +85 °C			-40 °C to +125 °C		Unit
			Min	Typ <sup>[1]</sup>	Max	Min	Max	
t <sub>pd</sub>	propagation delay	nA to nY; see <a href="#">Figure 5</a> <sup>[2]</sup>						
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.5	2.3	5.0	0.5	6.3	ns
		V <sub>CC</sub> = 2.3 V to 2.7 V	0.3	1.8	4.0	0.3	5.0	ns
		V <sub>CC</sub> = 2.7 V	0.3	2.6	4.5	0.3	5.6	ns
		V <sub>CC</sub> = 3.0 V to 3.6 V	0.3	2.3	3.7	0.3	4.5	ns
		V <sub>CC</sub> = 4.5 V to 5.5 V	0.3	1.7	3.0	0.3	3.8	ns
C <sub>PD</sub>	power dissipation capacitance	V <sub>I</sub> = GND to V <sub>CC</sub> ; V <sub>CC</sub> = 3.3 V <sup>[3]</sup>	-	7.8	-			pF

[1] Typical values are measured at T<sub>amb</sub> = 25 °C and V<sub>CC</sub> = 1.8 V, 2.5 V, 2.7 V, 3.3 V and 5.0 V respectively.

[2] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.

[3] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> 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<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

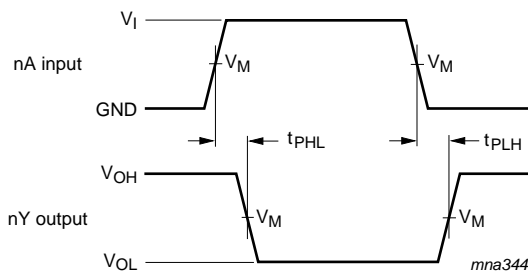
C<sub>L</sub> = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

∑(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of outputs.

## 12. Waveforms



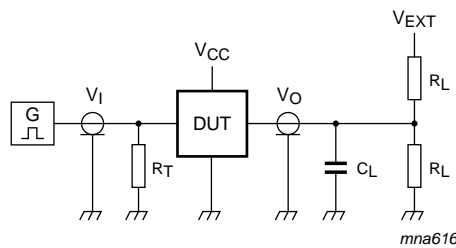
Measurement points are given in [Table 9](#).

V<sub>OL</sub> and V<sub>OH</sub> are typical output voltage levels that occur with the output load.

**Fig 5. 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	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$



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

Definitions for test circuit:

$R_L$  = Load resistance.

$C_L$  = Load capacitance including jig and probe capacitance.

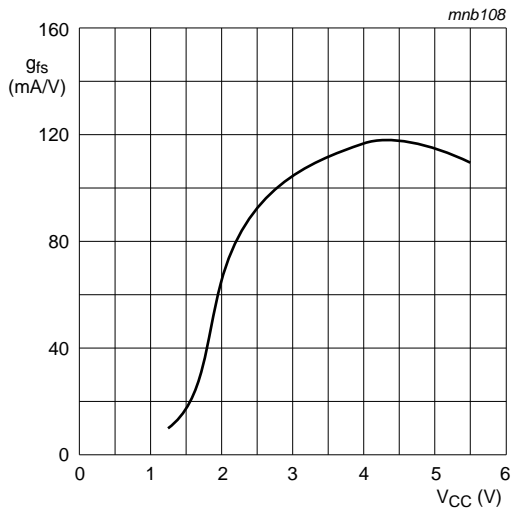
$R_T$  = Termination resistance should be equal to the output impedance  $Z_o$  of the pulse generator.

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

Fig 6. Test circuit for measuring switching times

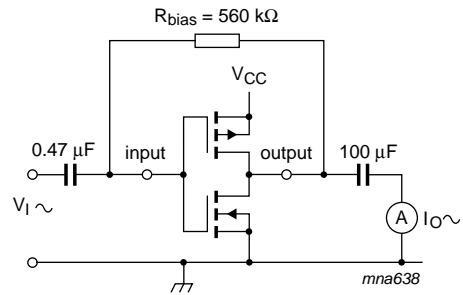
Table 10. Test data

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	$V_{CC}$	$\leq 2.0$ ns	30 pF	1 k $\Omega$	open
2.3 V to 2.7 V	$V_{CC}$	$\leq 2.0$ ns	30 pF	500 $\Omega$	open
2.7 V	2.7 V	$\leq 2.5$ ns	50 pF	500 $\Omega$	open
3.0 V to 3.6 V	2.7 V	$\leq 2.5$ ns	50 pF	500 $\Omega$	open
4.5 V to 5.5 V	$V_{CC}$	$\leq 2.5$ ns	50 pF	500 $\Omega$	open



T<sub>amb</sub> = 25 °C.

**Fig 7.** Typical forward transconductance as a function of supply voltage



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

f<sub>i</sub> = 1 kHz.

V<sub>O</sub> is constant.

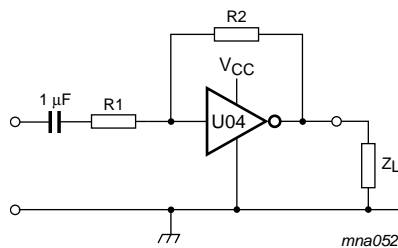
**Fig 8.** Test set-up for measuring forward transconductance

### 13. Application information

Some applications are:

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

**Remark:** All values given are typical unless otherwise specified.



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

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

$G_{OL}$  = open loop gain.

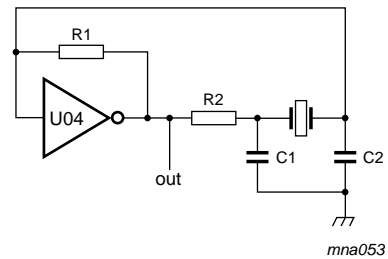
$A_u$  = voltage amplification.

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

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

Typical unity gain bandwidth product is 5 MHz.

**Fig 9. Linear amplifier configuration**



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

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

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

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

**Fig 10. Crystal oscillator configuration**

14. Package outline

Plastic surface-mounted package; 6 leads

SOT363

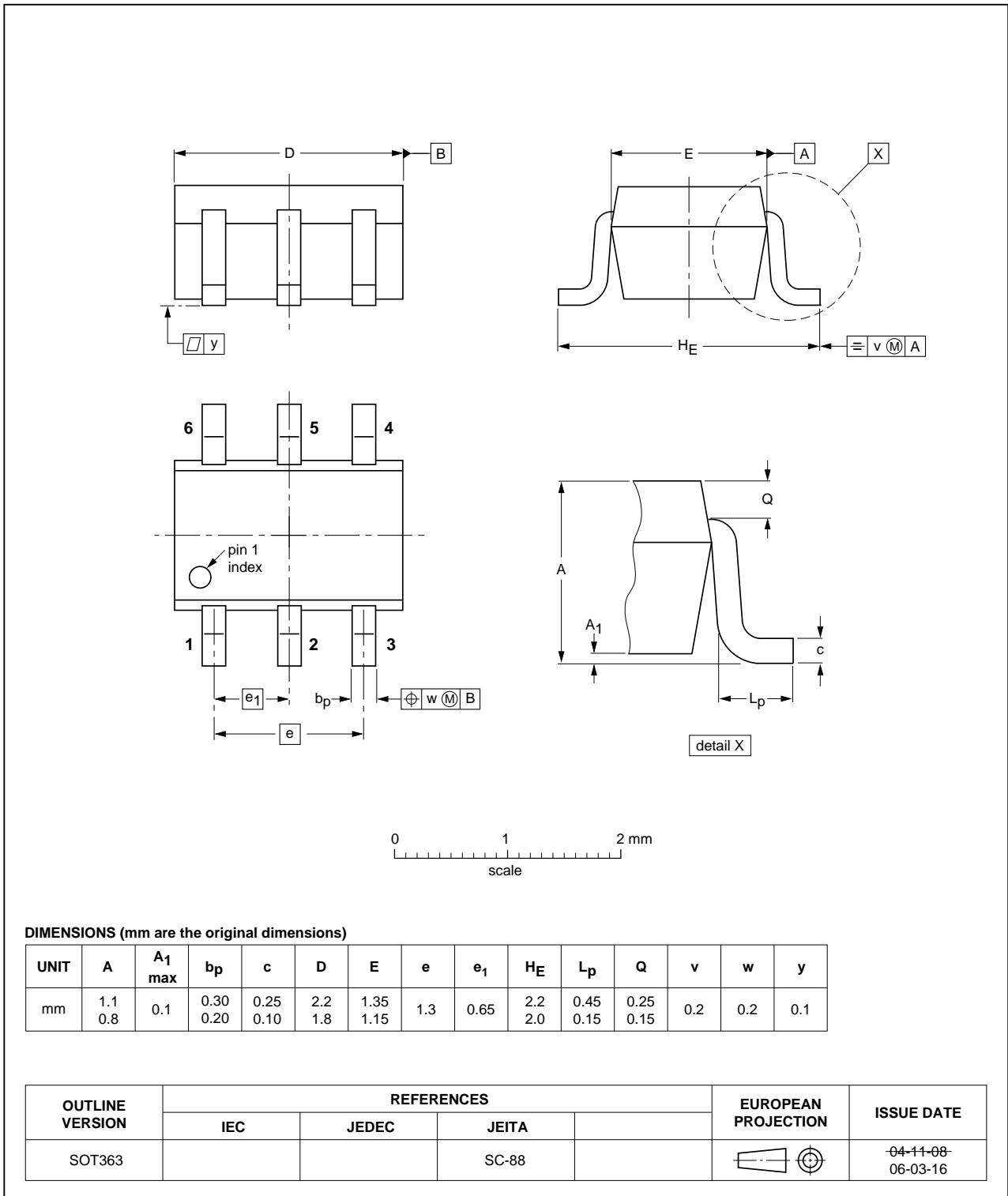


Fig 11. Package outline SOT363 (SC-88)

Plastic surface-mounted package (TSOP6); 6 leads

SOT457

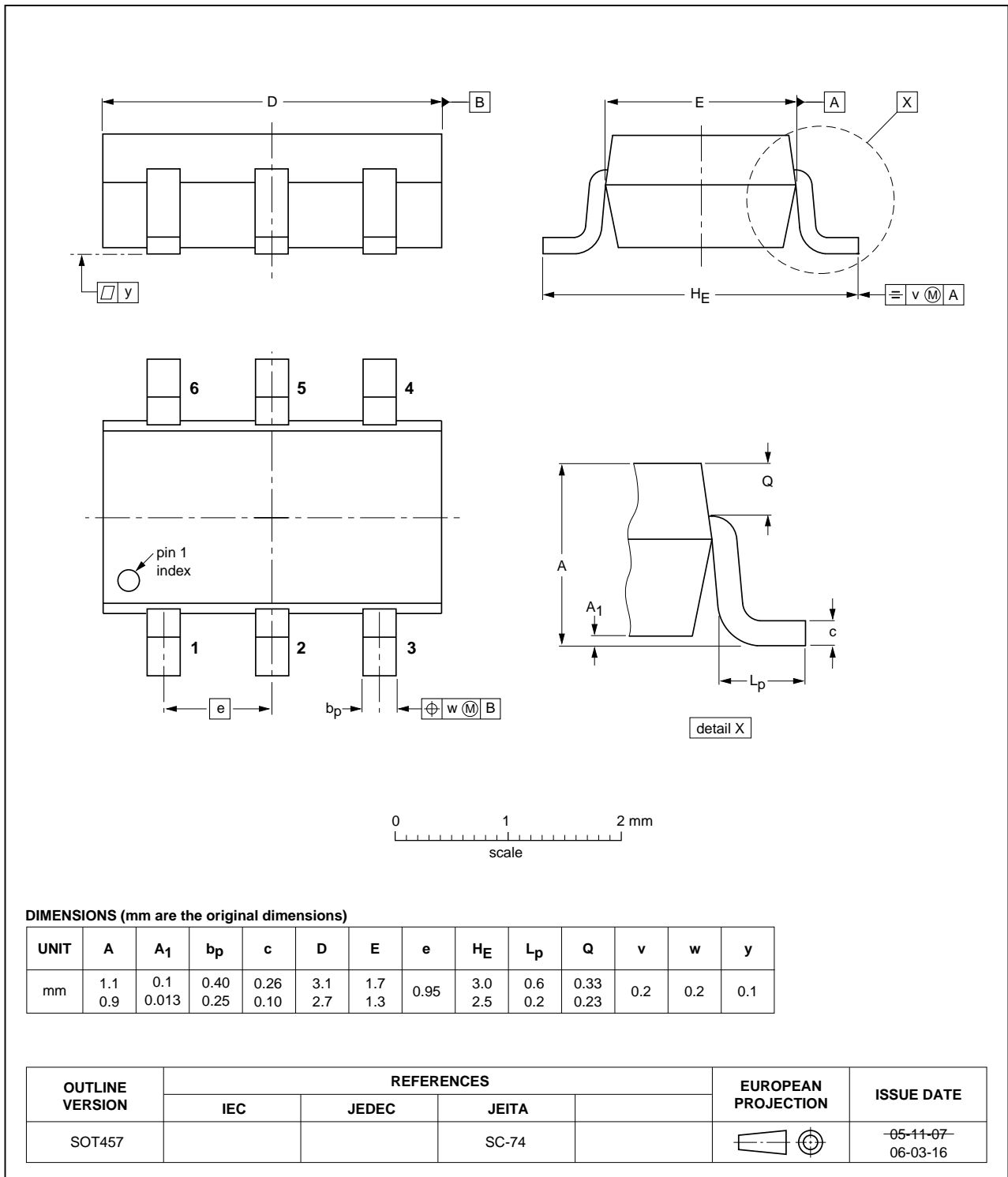


Fig 12. Package outline SOT457 (TSOP6)

## 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
MIL	Military

## 16. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74LVC2GU04_Q100 v.1	20120731	Product data sheet	-	-

## 17. Legal information

### 17.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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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