

# 74LV1T87

## 2-input single supply translating EXCLUSIVE-NOR gate

Rev. 2 — 3 December 2019

Product data sheet

### 1. General description

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The 74LV1T87 is a single, level translating 2-input EXCLUSIVE-NOR gate. The low threshold inputs support 1.8 V input logic at  $V_{CC} = 3.3$  V and can be used in 1.8 V to 3.3 V level up translation. In addition, the 5 V tolerant input pins enable level down translation (3.3 V to 2.5 V output at  $V_{CC} = 2.5$  V). The output level is referenced to the supply voltage and supports 1.8 V, 2.5 V, 3.3 V and 5.0 V CMOS levels. The wide  $V_{CC}$  range permits the generation of output levels to connect to controllers or processors.

### 2. Features and benefits

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- Single supply voltage translator at 1.8 V, 2.5 V, 3.3 V and 5.0 V
- Up translation
  - 1.2 V to 1.8 V at  $V_{CC} = 1.8$  V
  - 1.5 V to 2.5 V at  $V_{CC} = 2.5$  V
  - 1.8 V to 3.3 V at  $V_{CC} = 3.3$  V
  - 3.3 V to 5.0 V at  $V_{CC} = 5.0$  V
- Down translation
  - 3.3 V to 1.8 V at  $V_{CC} = 1.8$  V
  - 3.3 V to 2.5 V at  $V_{CC} = 2.5$  V
  - 5.0 V to 3.3 V at  $V_{CC} = 3.3$  V
- 5 V tolerant inputs
- Latch-up performance exceeds 250 mA per JESD 78 Class II
- ESD protection:
  - HBM ANSI/ESDA/JEDEC JS-001 Class 2 exceeds 2 kV
  - CDM JESD22-C101F exceeds 1 kV
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

### 3. Applications

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- Portable applications
- PC and notebooks
- Industrial controller
- Telecom

## 4. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74LV1T87GW	-40 °C to +125 °C	TSSOP5	plastic thin shrink small outline package; 5 leads; body width 1.25 mm	SOT353-1
74LV1T87GV	-40 °C to +125 °C	SC-74A	plastic surface-mounted package; 5 leads	SOT753
74LV1T87GX	-40 °C to +125 °C	X2SON5	plastic thermal enhanced extremely thin small outline package; no leads; 5 terminals; body 0.8 x 0.8 x 0.35 mm	SOT1226

## 5. Marking

Table 2. Marking

Type number	Marking code[1]
74LV1T87GW	SD
74LV1T87GV	SD
74LV1T87GX	SD

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

## 6. Functional diagram

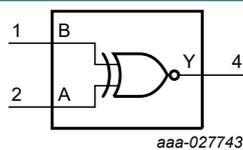


Fig. 1. Logic symbol

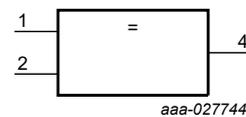


Fig. 2. IEC logic symbol

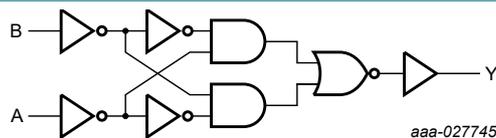


Fig. 3. Logic diagram

## 7. Pinning information

### 7.1. Pinning

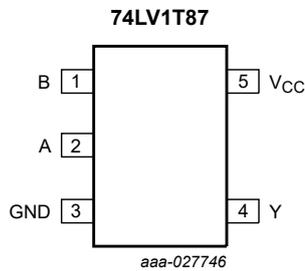


Fig. 4. Pin configuration SOT353-1 (TSSOP5) and SOT753 (SC-74A)

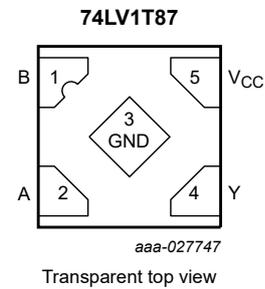


Fig. 5. Pin configuration SOT1226 (X2SON5)

### 7.2. Pin description

Table 3. Pin description

Symbol	Pin	Description
B	1	data input
A	2	data input
GND	3	ground (0 V)
Y	4	data output
V <sub>CC</sub>	5	supply voltage

## 8. Functional description

Table 4. Function table

*H = HIGH voltage level; L = LOW voltage level.*

Input		Output
A	B	Y
L	L	H
L	H	L
H	L	L
H	H	H

## 9. 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	+7.0	V
$V_I$	input voltage	[1]	-0.5	+7.0	V
$V_O$	output voltage	output HIGH or LOW state [2][3]	-0.5	$V_{CC} + 0.5$	V
		output in power-off state [2]	-0.5	4.6	V
$I_{IK}$	input clamping current	$V_I < 0$ V	-20	-	mA
$I_{OK}$	output clamping current	$V_O < 0$ V or $V_O > V_{CC}$	-	$\pm 20$	mA
$I_O$	output current	$V_O = 0$ V to $V_{CC}$	-	$\pm 25$	mA
$I_{CC}$	supply current		-	50	mA
$I_{GND}$	ground current		-50	-	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	total power dissipation	$T_{amb} = -40$ °C to +125 °C [4]	-	250	mW

[1] If the input current ratings are observed, the minimum input voltage ratings may be exceeded.

[2] If the output current ratings are observed, the output voltage ratings may be exceeded.

[3] This value is limited to 7 V maximum.

[4] For SOT353-1 package: above 74 °C the value of  $P_{tot}$  derates linearly with 3.3 mW/K.

For SOT753 package: above 85 °C the value of  $P_{tot}$  derates linearly with 3.8 mW/K.

For SOT1226 package: above 67 °C the value of  $P_{tot}$  derates linearly with 3.0 mW/K.

## 10. 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		1.6	5.0	5.5	V
$V_I$	input voltage		0	-	5.5	V
$V_O$	output voltage	output HIGH or LOW state	0	-	$V_{CC}$	V
$T_{amb}$	ambient temperature		-40	+25	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 1.8$ V to 5.0 V	-	-	20	ns/V

## 11. Static characteristics

**Table 7. Static characteristics**

Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	25 °C		-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Max	Min	Max	Min	Max	
V <sub>IH</sub>	HIGH-level input voltage	V <sub>CC</sub> = 1.65 V to 1.8 V	0.94	-	1.0	-	1.0	-	V
		V <sub>CC</sub> = 2.0 V	0.99	-	1.03	-	1.03	-	V
		V <sub>CC</sub> = 2.25 V to 2.5 V	1.135	-	1.18	-	1.18	-	V
		V <sub>CC</sub> = 2.75 V	1.21	-	1.23	-	1.23	-	V
		V <sub>CC</sub> = 3.0 V to 3.3 V	1.35	-	1.37	-	1.37	-	V
		V <sub>CC</sub> = 3.6 V	1.47	-	1.48	-	1.48	-	V
		V <sub>CC</sub> = 4.5 V to 5.0 V	2.02	-	2.03	-	2.03	-	V
		V <sub>CC</sub> = 5.5 V	2.10	-	2.11	-	2.11	-	V
V <sub>IL</sub>	LOW-level input voltage	V <sub>CC</sub> = 1.65 V to 2.0 V	-	0.58	-	0.55	-	0.55	V
		V <sub>CC</sub> = 2.25 V to 2.75 V	-	0.75	-	0.71	-	0.71	V
		V <sub>CC</sub> = 3.0 V to 3.6 V	-	0.80	-	0.65	-	0.65	V
		V <sub>CC</sub> = 4.5 V to 5.5 V	-	0.80	-	0.80	-	0.80	V
V <sub>OH</sub>	HIGH-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;							
		V <sub>CC</sub> = 1.65 V to 5.5 V; I <sub>O</sub> = -20 µA	V <sub>CC</sub> -0.1	-	V <sub>CC</sub> -0.1	-	V <sub>CC</sub> -0.1	-	V
		V <sub>CC</sub> = 1.65 V; I <sub>O</sub> = -2 mA	1.28	-	1.21	-	1.21	-	V
		V <sub>CC</sub> = 1.8 V; I <sub>O</sub> = -2 mA	1.5	-	1.45	-	1.45	-	V
		V <sub>CC</sub> = 2.3 V; I <sub>O</sub> = -2.3 mA	2.0	-	2.0	-	2.0	-	V
		V <sub>CC</sub> = 2.3 V; I <sub>O</sub> = -3 mA	2.0	-	1.93	-	1.93	-	V
		V <sub>CC</sub> = 2.5 V; I <sub>O</sub> = -3 mA	2.25	-	2.15	-	2.15	-	V
		V <sub>CC</sub> = 3.0 V; I <sub>O</sub> = -3 mA	2.78	-	2.7	-	2.7	-	V
		V <sub>CC</sub> = 3.0 V; I <sub>O</sub> = -5.5 mA	2.6	-	2.49	-	2.49	-	V
		V <sub>CC</sub> = 3.3 V; I <sub>O</sub> = -5.5 mA	2.9	-	2.8	-	2.8	-	V
		V <sub>CC</sub> = 4.5 V; I <sub>O</sub> = -4 mA	4.2	-	4.1	-	4.1	-	V
		V <sub>CC</sub> = 4.5 V; I <sub>O</sub> = -8 mA	4.1	-	3.95	-	3.95	-	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>							
		V <sub>CC</sub> = 1.65 V to 5.5 V; I <sub>O</sub> = 20 µA	-	0.1	-	0.1	-	0.1	V
		V <sub>CC</sub> = 1.65 V; I <sub>O</sub> = 2 mA	-	0.2	-	0.25	-	0.25	V
		V <sub>CC</sub> = 2.3 V; I <sub>O</sub> = 2.3 mA	-	0.1	-	0.15	-	0.15	V
		V <sub>CC</sub> = 2.3 V; I <sub>O</sub> = 3 mA	-	0.15	-	0.2	-	0.2	V
		V <sub>CC</sub> = 3.0 V; I <sub>O</sub> = 3 mA	-	0.1	-	0.15	-	0.15	V
		V <sub>CC</sub> = 3.0 V; I <sub>O</sub> = 5.5 mA	-	0.2	-	0.252	-	0.252	V
		V <sub>CC</sub> = 4.5 V; I <sub>O</sub> = 4 mA	-	0.15	-	0.2	-	0.2	V
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 0 V to 5.5 V	-	±0.1	-	±1	-	±1	µA
		I <sub>CC</sub>	supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 1.8 V, 2.5 V, 3.3 V, 5.0 V	-	1	-	10	-

## 2-input single supply translating EXCLUSIVE-NOR gate

Symbol	Parameter	Conditions	25 °C		-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Max	Min	Max	Min	Max	
$\Delta I_{CC}$	additional supply current	per input pin; $V_{CC} = 1.8\text{ V}$ ; $V_I = 0.3\text{ V}$ or $1.1\text{ V}$ ; $I_O = 0\text{ A}$ ; other pins at $V_{CC}$ or GND	-	10	-	10	-	10	$\mu\text{A}$
		per input pin; $V_{CC} = 5.5\text{ V}$ ; $V_I = 0.3\text{ V}$ or $3.4\text{ V}$ ; $I_O = 0\text{ A}$ ; other pins at $V_{CC}$ or GND	-	1.35	-	1.5	-	1.5	mA

## 12. Dynamic characteristics

**Table 8. Dynamic characteristics**

$GND = 0\text{ V}$ . For test circuit, see Fig. 7.

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
$t_{pd}$	propagation delay	A, B to Y; see Fig. 6 [1]								
		$V_{CC} = 1.8\text{ V}$ ; $C_L = 15\text{ pF}$	-	7.3	11.6	-	13.3	-	14.2	ns
		$V_{CC} = 1.8\text{ V}$ ; $C_L = 30\text{ pF}$	-	8.4	12.9	-	14.7	-	15.8	ns
		$V_{CC} = 2.5\text{ V}$ ; $C_L = 15\text{ pF}$	-	5.1	7.8	-	8.8	-	9.5	ns
		$V_{CC} = 2.5\text{ V}$ ; $C_L = 30\text{ pF}$	-	5.8	8.6	-	9.8	-	10.6	ns
		$V_{CC} = 3.3\text{ V}$ ; $C_L = 15\text{ pF}$	-	4.2	6.2	-	7.0	-	7.5	ns
		$V_{CC} = 3.3\text{ V}$ ; $C_L = 30\text{ pF}$	-	4.7	6.9	-	7.8	-	8.4	ns
		$V_{CC} = 5.0\text{ V}$ ; $C_L = 15\text{ pF}$	-	3.4	4.6	-	5.1	-	5.4	ns
		$V_{CC} = 5.0\text{ V}$ ; $C_L = 30\text{ pF}$	-	3.9	5.1	-	5.8	-	6.1	ns
$C_I$	input capacitance	$V_I = V_{CC}$ or GND; $V_{CC} = 3.3\text{ V}$	-	1.5	10	-	10	-	10	pF
$C_O$	output capacitance	$V_O = V_{CC}$ or GND; $V_{CC} = 3.3\text{ V}$	-	2.5	-	-	-	-	-	pF
$C_{PD}$	power dissipation capacitance	per buffer; $V_I = GND$ to $V_{CC}$ ; $C_L = 30\text{ pF}$ ; $f = 10\text{ MHz}$ [2]								
		$V_{CC} = 1.8\text{ V}$	-	4.1	-	-	-	-	-	pF
		$V_{CC} = 2.5\text{ V}$	-	5.4	-	-	-	-	-	pF
		$V_{CC} = 3.3\text{ V}$	-	7.3	-	-	-	-	-	pF
		$V_{CC} = 5.0\text{ V}$	-	11.4	-	-	-	-	-	pF

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

[2]  $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ).

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

$f_i$  = 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;

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

12.1. Waveforms and test circuit

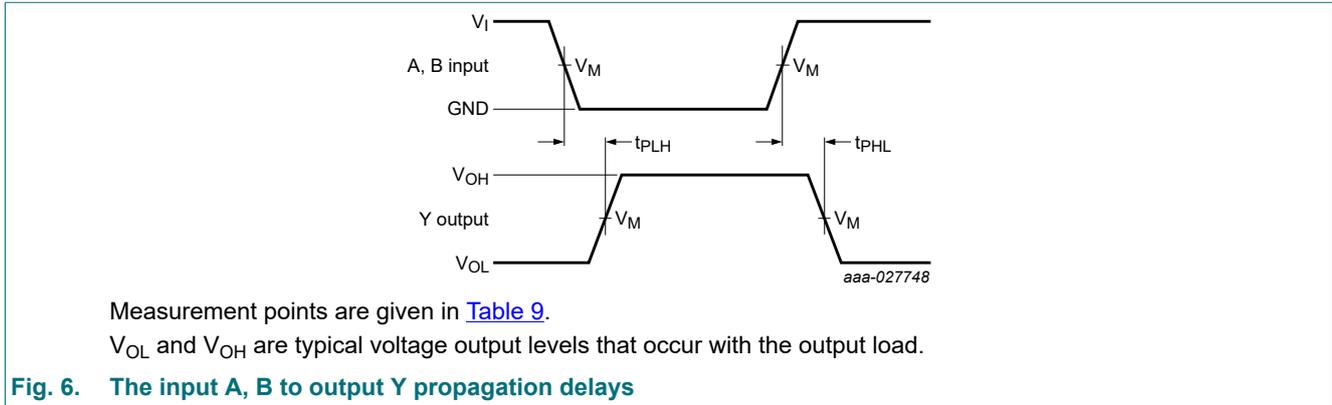


Table 9. Measurement points

Input	Output
$V_M$	$V_M$
$0.5V_I$	$0.5V_{CC}$

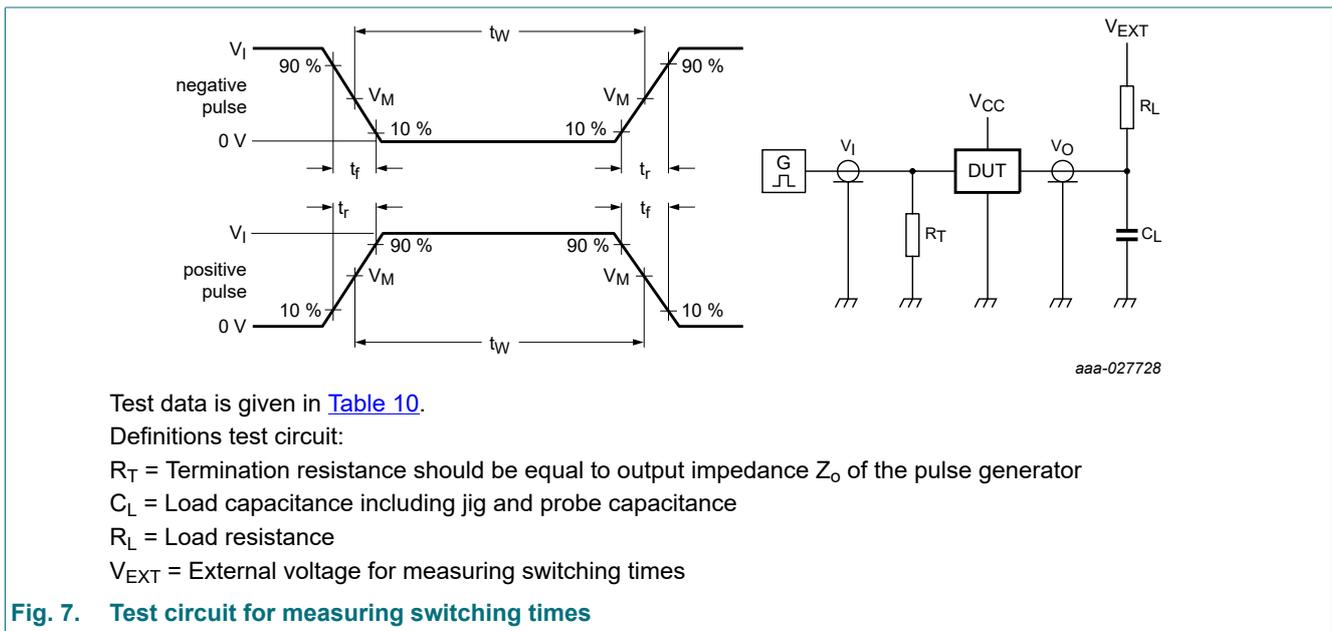


Table 10. Test data

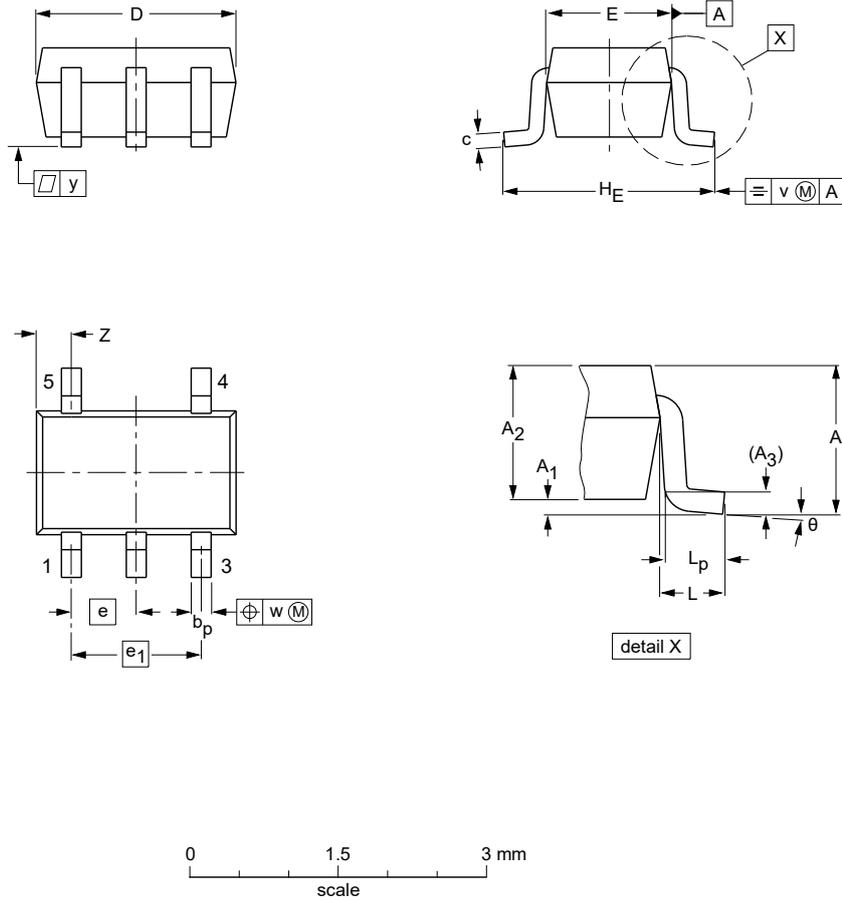
Supply voltage	Input			Load		$V_{EXT}$		
	$V_I$	$\Delta t/\Delta V$ [1]	$f_{max}$	$C_L$	$R_L$	$t_{PLH}, t_{PHL}$	$t_{PZH}, t_{PHZ}$	$t_{PZL}, t_{PLZ}$
1.8 V	$V_{CC}$	$\leq 1.0$ ns/V	15 MHz	15 pF, 30 pF	1M $\Omega$	GND	GND	$V_{CC}$
2.5 V	$V_{CC}$	$\leq 1.0$ ns/V	25 MHz	15 pF, 30 pF	1M $\Omega$	GND	GND	$V_{CC}$
3.3 V	3 V	$\leq 1.0$ ns/V	50 MHz	15 pF, 30 pF	1M $\Omega$	GND	GND	$V_{CC}$
5.0 V	3 V	$\leq 1.0$ ns/V	50 MHz	15 pF, 30 pF	1M $\Omega$	GND	GND	$V_{CC}$

[1]  $dV/dt \geq 1.0$  V/ns

13. Package outline

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

SOT353-1



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	e <sub>1</sub>	H <sub>E</sub>	L	L <sub>p</sub>	v	w	y	Z <sup>(1)</sup>	θ
mm	1.1	0.1 0	1.0 0.8	0.15	0.30 0.15	0.25 0.08	2.25 1.85	1.35 1.15	0.65	1.3	2.25 2.0	0.425	0.46 0.21	0.3	0.1	0.1	0.60 0.15	7° 0°

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT353-1		MO-203	SC-88A			00-09-01 03-02-19

Fig. 8. Package outline SOT353-1 (TSSOP5)

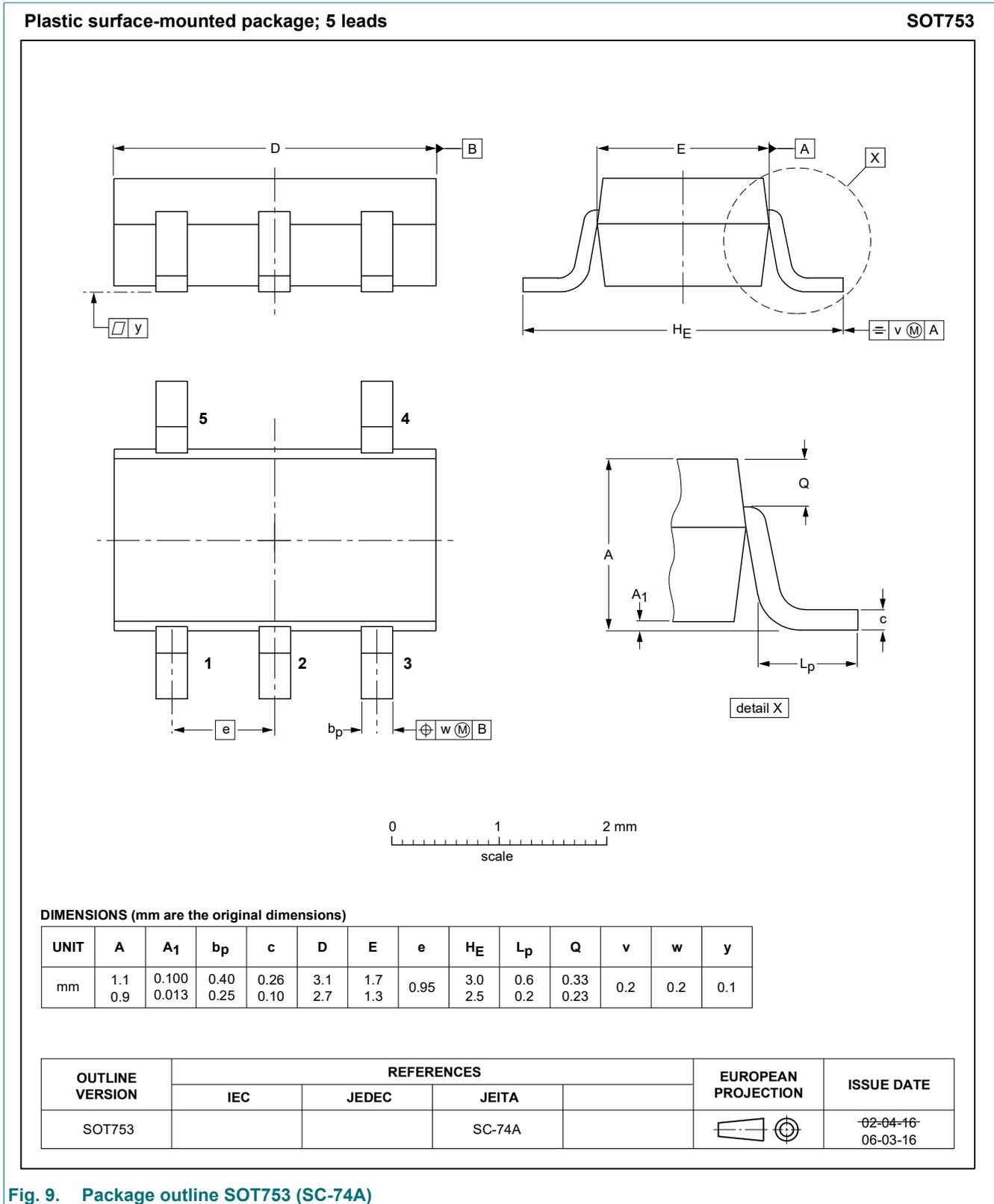
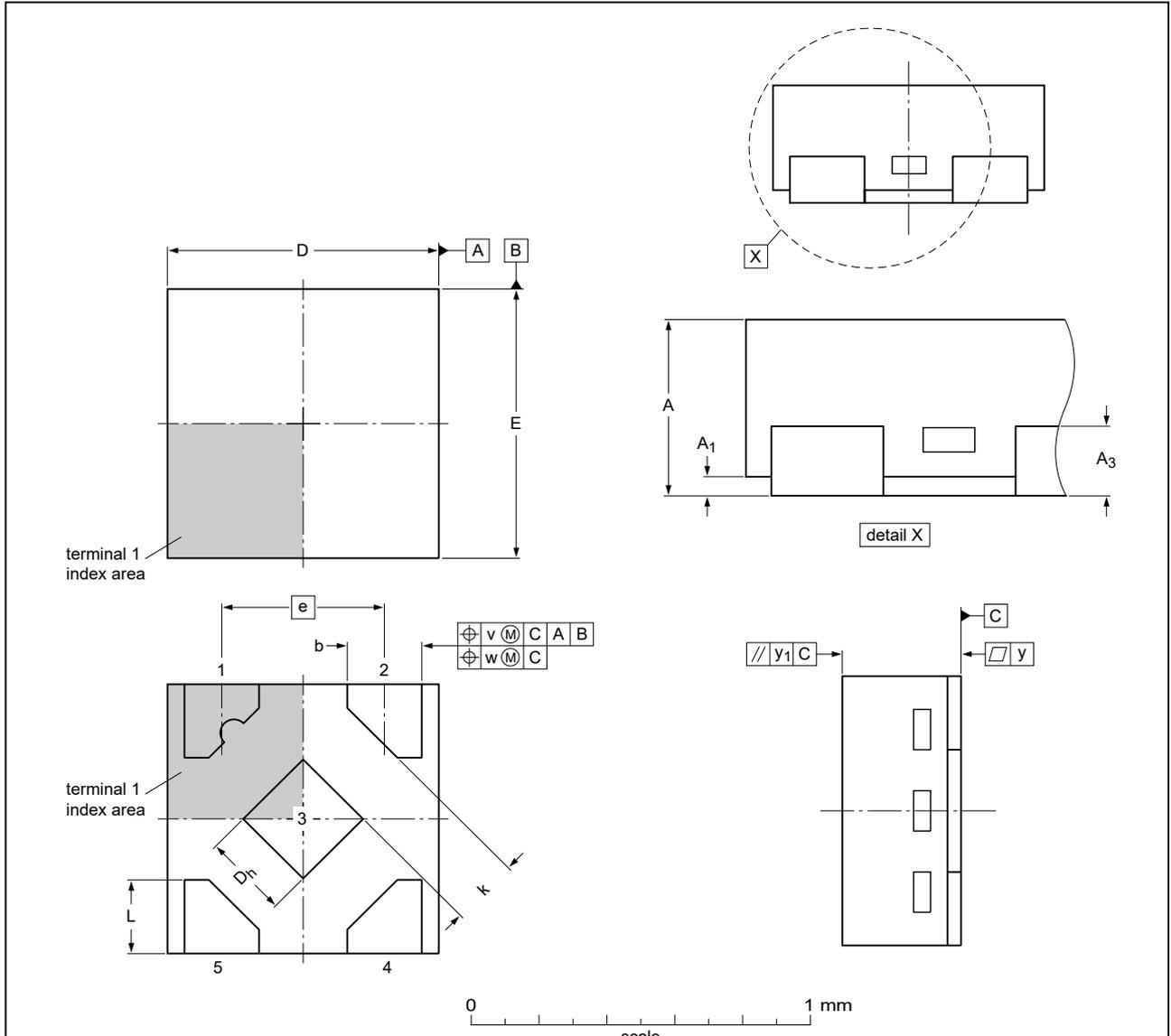


Fig. 9. Package outline SOT753 (SC-74A)

X2SON5: plastic thermal enhanced extremely thin small outline package; no leads;  
5 terminals; body 0.8 x 0.8 x 0.35 mm

SOT1226



Dimensions

Unit	A <sup>(1)</sup>	A <sub>1</sub>	A <sub>3</sub>	D	D <sub>h</sub>	E	b	e	k	L	v	w	y	y <sub>1</sub>
max	0.35	0.04	0.128	0.85	0.30	0.85	0.27			0.27				
mm nom				0.80	0.25	0.80	0.22	0.48		0.22	0.1	0.05	0.05	0.05
min			0.040	0.75	0.20	0.75	0.17		0.20	0.17				

Note

- Dimension A is including plating thickness.
- Plastic or metal protrusions of 0.075 mm maximum per side are not included.

sot1226\_po

Outline version	References			European projection	Issue date
	IEC	JEDEC	EIAJ		
SOT1226					<del>12-04-10</del> 12-04-25

Fig. 10. Package outline SOT1226 (X2SON5)

## 14. Abbreviations

Table 11. Abbreviations

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

## 15. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74LV1T87 v.2	20191203	Product data sheet	-	74LV1T87 v.1
Modifications:	<ul style="list-style-type: none"> <li>Type number 74LV1T87GV (SOT753/SC-74A) added.</li> <li><a href="#">Table 5</a>: Derating values for <math>P_{tot}</math> total power dissipation updated.</li> </ul>			
74LV1T87 v.1	20171128	Product data sheet	-	-

## 16. Legal information

### 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".
- [3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at <https://www.nexperia.com>.

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