

# 74LV1T86

## 2-input single supply translating EXCLUSIVE-OR gate

Rev. 5 — 14 December 2023

Product data sheet

### 1. General description

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The 74LV1T86 is a single, level translating 2-input Exclusive-OR 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 2000 V
  - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 1000 V
- 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	
<a href="#">74LV1T86GW</a>	-40 °C to +125 °C	TSSOP5	plastic thin shrink small outline package; 5 leads; body width 1.25 mm	<a href="#">SOT353-1</a>
<a href="#">74LV1T86GV</a>	-40 °C to +125 °C	SC-74A	plastic surface-mounted package; 5 leads	<a href="#">SOT753</a>
<a href="#">74LV1T86GX</a>	-40 °C to +125 °C	X2SON5	plastic thermal enhanced extremely thin small outline package; no leads; 5 terminals; body 0.8 × 0.8 × 0.32 mm	<a href="#">SOT1226-3</a>

## 5. Marking

Table 2. Marking

Type number	Marking code[1]
74LV1T86GW	SC
74LV1T86GV	SC
74LV1T86GX	SC

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

## 6. Functional diagram

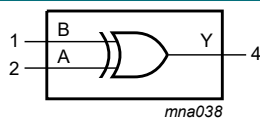


Fig. 1. Logic symbol

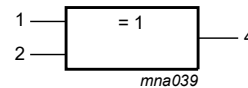


Fig. 2. IEC logic symbol

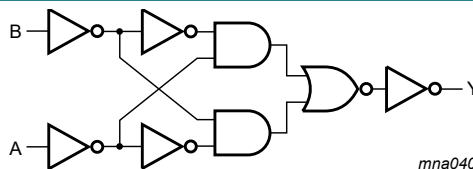


Fig. 3. Logic diagram

## 7. Pinning information

### 7.1. Pinning

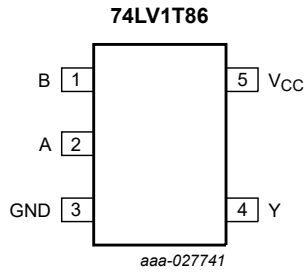


Fig. 4. Pin configuration SOT353-1 (TSSOP5) and SOT753 (SC-74A)

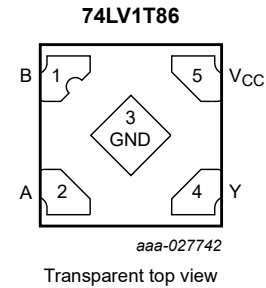


Fig. 5. Pin configuration SOT1226-3 (X2SON5)

### 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	L
L	H	H
H	L	H
H	H	L

## 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 (TSSOP5) package:  $P_{tot}$  derates linearly with 3.3 mW/K above 74 °C.

For SOT753 (SC-74A) package:  $P_{tot}$  derates linearly with 3.8 mW/K above 85 °C.

For SOT1226-3 (X2SON5) package:  $P_{tot}$  derates linearly with 3.0 mW/K above 67 °C.

## 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>CC</sub> = 5.0 V; I <sub>O</sub> = -8 mA	4.6	-	4.5	-	4.5	-	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
V <sub>CC</sub> = 4.5 V; I <sub>O</sub> = 8 mA	-	0.3	-	0.35	-	0.35	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	-	10	μA

## 2-input single supply translating EXCLUSIVE-OR 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	$\text{mA}$

## 12. Dynamic characteristics

Table 8. Dynamic characteristics

GND = 0 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	11.7	-	13.3	-	14.3	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	7.7	-	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	-	7.6	ns
		$V_{CC} = 3.3 \text{ V}$ ; $C_L = 30 \text{ pF}$	-	4.8	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; $V_I = \text{GND to } V_{CC}$ ; $C_L = 30 \text{ pF}$ ; $f = 10 \text{ MHz}$ [2]								
		$V_{CC} = 1.8 \text{ V}$	-	4.2	-	-	-	-	-	pF
		$V_{CC} = 2.5 \text{ V}$	-	5.6	-	-	-	-	-	pF
		$V_{CC} = 3.3 \text{ V}$	-	7.4	-	-	-	-	-	pF
		$V_{CC} = 5.0 \text{ V}$	-	11.5	-	-	-	-	-	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

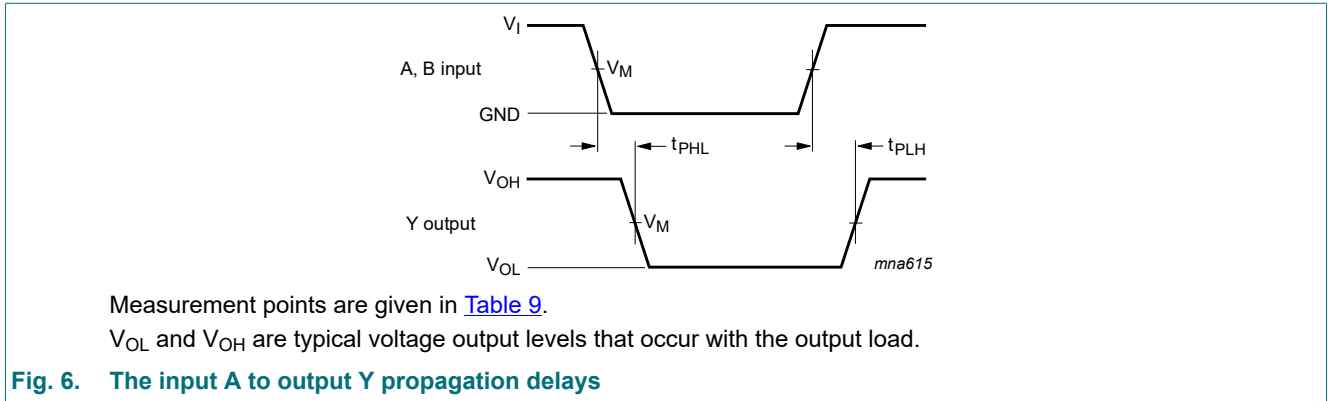


Table 9. Measurement points

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

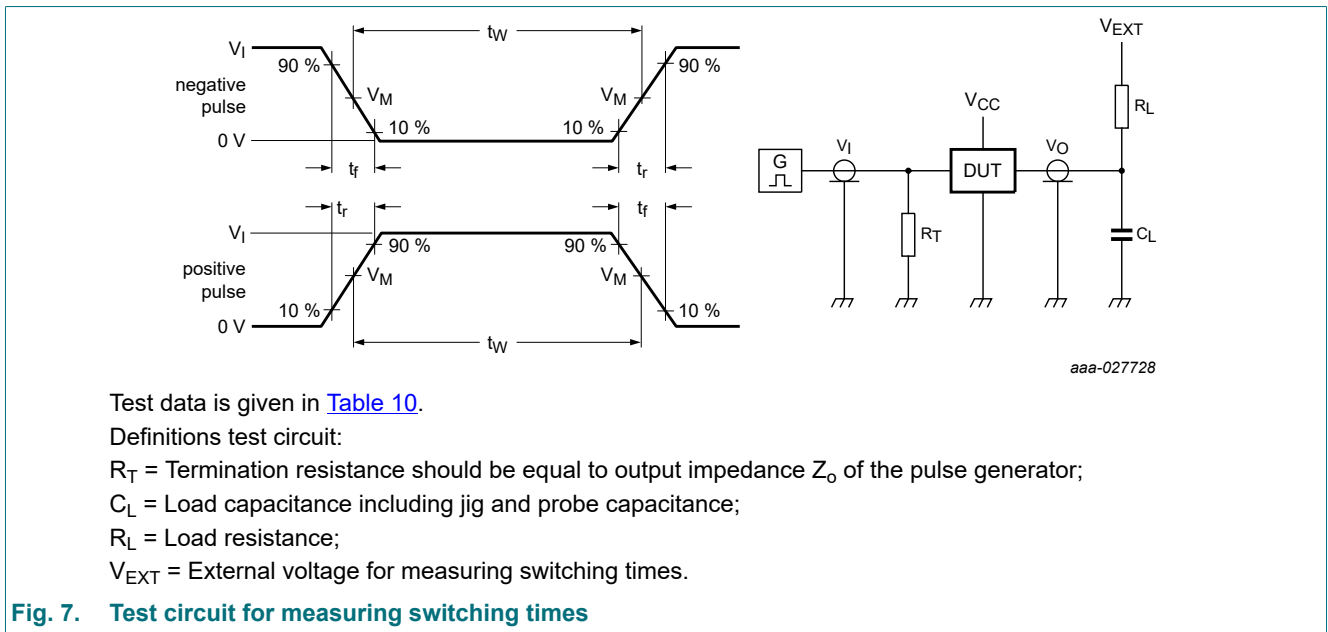


Table 10. Test data

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

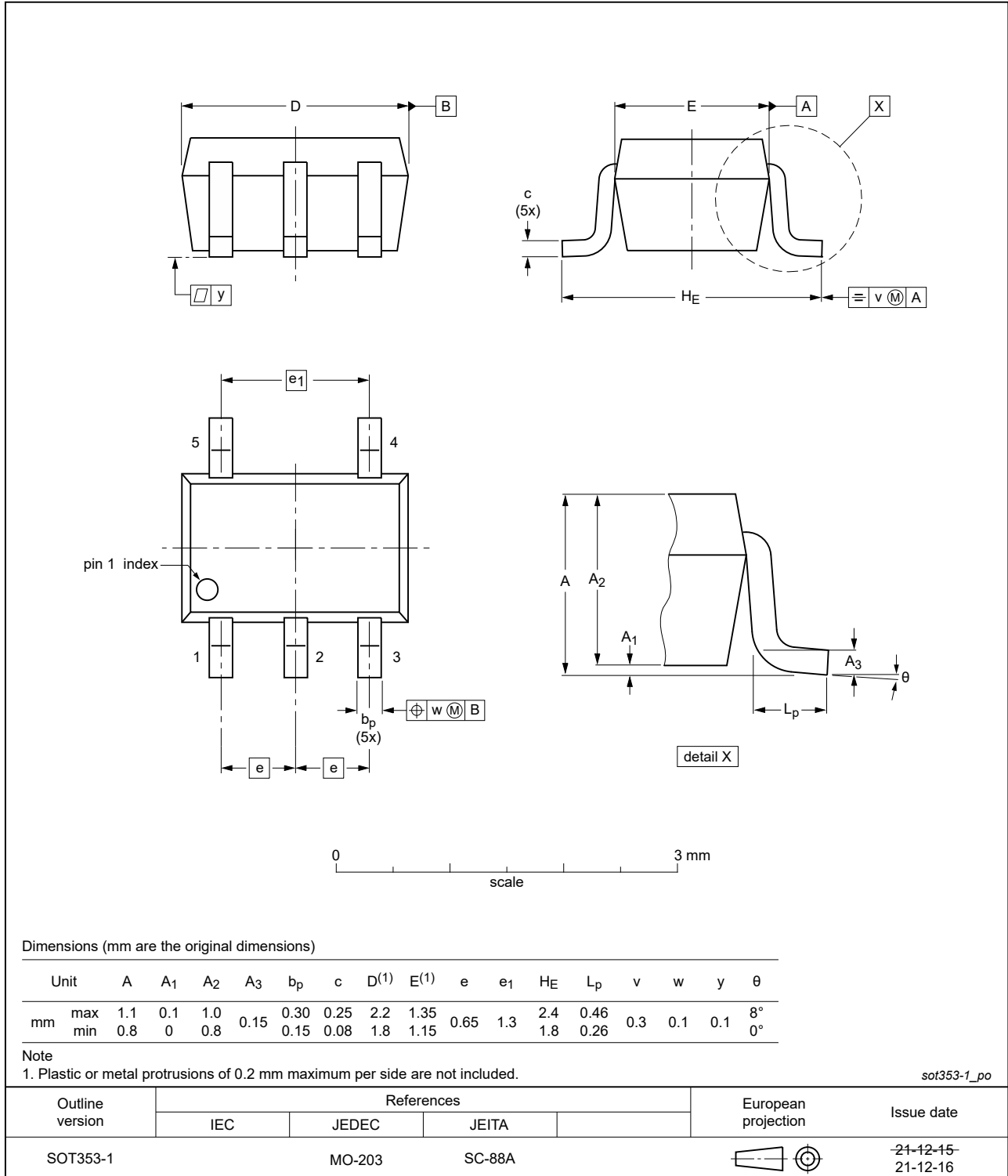


Fig. 8. Package outline SOT353-1 (TSSOP5)



Plastic surface-mounted package; 5 leads

SOT753

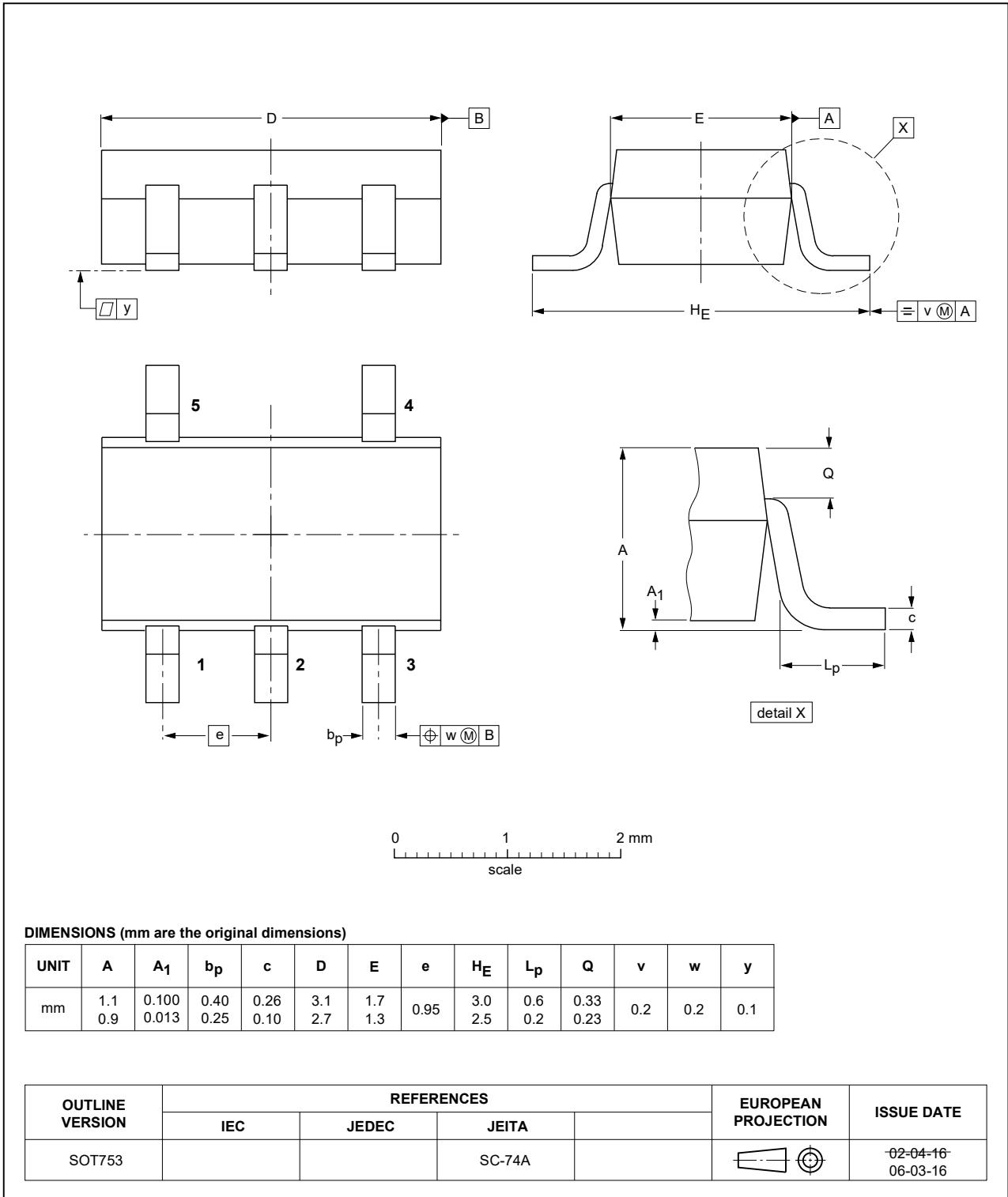


Fig. 9. Package outline SOT753 (SC-74A)

X2SON5: plastic thermal enhanced extremely thin small outline package; no leads;  
5 terminals; body 0.8 x 0.8 x 0.32 mm

SOT1226-3

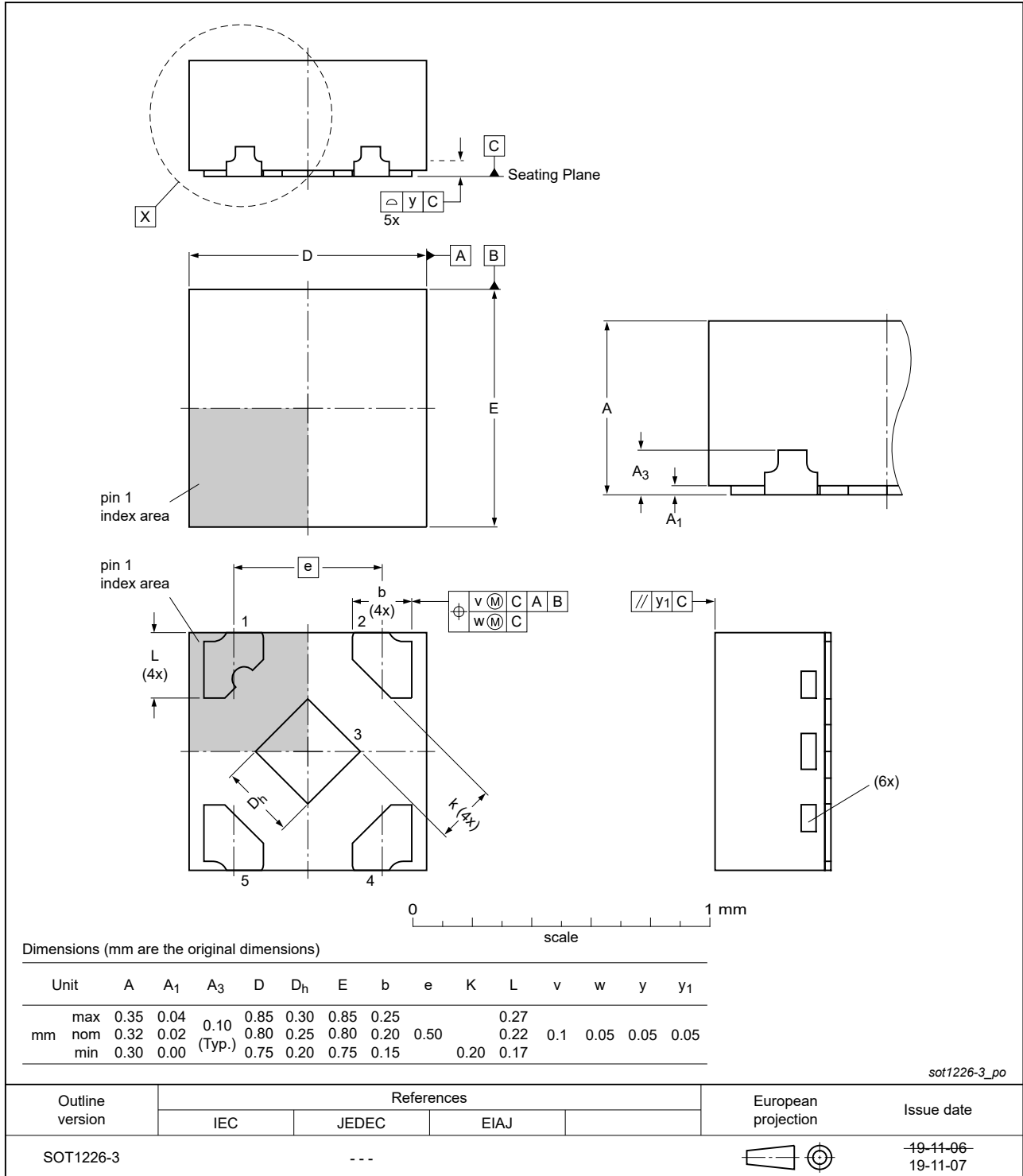


Fig. 10. Package outline SOT1226-3 (X2SON5)

## 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
74LV1T86 v.5	20231214	Product data sheet	-	74LV1T86 v.4
Modifications:	<ul style="list-style-type: none"> <li><a href="#">Section 2</a>: ESD specification updated according to the latest JEDEC standard.</li> </ul>			
74LV1T86 v.4	20220816	Product data sheet	-	74LV1T86 v.3
Modifications:	<ul style="list-style-type: none"> <li>Package SOT1226 (X2SON5) has changed to SOT1226-3 (X2SON5).</li> </ul>			
74LV1T86 v.3	20220210	Product data sheet	-	74LV1T86 v.2
Modifications:	<ul style="list-style-type: none"> <li><a href="#">Fig. 8</a>: Package outline drawing SOT353-1 (TSSOP5) has changed.</li> </ul>			
74LV1T86 v.2	20191203	Product data sheet	-	74LV1T86 v.1
Modifications:	<ul style="list-style-type: none"> <li>Type number 74LV1T86GV (SOT753/SC-74A) added.</li> <li><a href="#">Table 5</a>: Derating values for <math>P_{tot}</math> total power dissipation updated.</li> </ul>			
74LV1T86 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".
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