

74AUP1T87

Low-power 2-input EXCLUSIVE-NOR gate with voltage-level translator

Rev. 1 — 28 November 2017

Product data sheet

1 General description

The 74AUP1T87 provides the single 2-input EXCLUSIVE-NOR function. This device ensures a very low static and dynamic power consumption across the entire V_{CC} range from 2.3 V to 3.6 V.

The 74AUP1T87 is designed for logic-level translation applications with input switching levels that accept 1.8 V low-voltage CMOS signals, while operating from either a single 2.5 V or 3.3 V supply voltage.

The wide supply voltage range ensures normal operation as battery voltage drops from 3.6 V to 2.3 V.

This device is fully specified for partial power-down applications using I_{OFF} . The I_{OFF} circuitry disables the output, preventing the damaging backflow current through the device when it is powered down.

Schmitt trigger inputs make the circuit tolerant to slower input rise and fall times across the entire V_{CC} range.

2 Features and benefits

- Wide supply voltage range from 2.3 V to 3.6 V
- High noise immunity
- ESD protection:
 - HBM JESD22-A114F Class 3A exceeds 5000 V
 - CDM JESD22-C101E exceeds 1000 V
- Low static power consumption; $I_{CC} = 1.5 \mu\text{A}$ (maximum)
- Latch-up performance exceeds 100 mA per JESD 78 Class II
- Inputs accept voltages up to 3.6 V
- Low noise overshoot and undershoot < 10 % of V_{CC}
- I_{OFF} circuitry provides partial power-down mode operation
- Multiple package options
- Specified from -40 °C to +85 °C and -40 °C to +125 °C

3 Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74AUP1T87GW	-40 °C to +125 °C	TSSOP5	plastic thin shrink small outline package; 5 leads; body width 1.25 mm	SOT353-1
74AUP1T87GX	-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

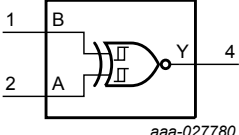
4 Marking

Table 2. Marking

Type number	Marking code ^[1]
74AUP1T87GW	5D
74AUP1T87GX	5D

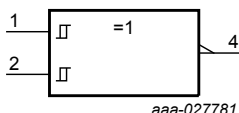
[1] The pin 1 indicator is located on the lower left corner of the device, below the marking code.

5 Functional diagram



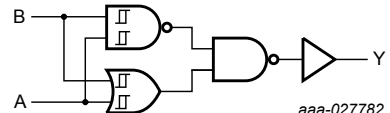
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Figure 1. Logic symbol



aaa-027781

Figure 2. IEC logic symbol

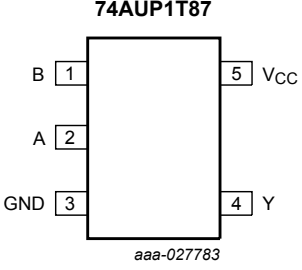


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Figure 3. Logic diagram

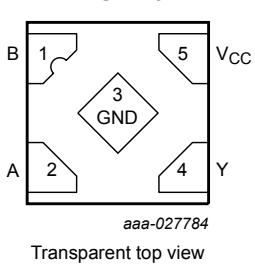
6 Pinning information

6.1 Pinning



aaa-027783

Figure 4. Pin configuration SOT353-1



aaa-027784

Transparent top view

Figure 5. Pin configuration SOT1226 (X2SON5)

6.2 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 _{CC}	5	supply voltage

7 Functional description

Table 4. Function table ^[1]

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

[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	+4.6	V
I _{IK}	input clamping current	V _I < 0 V	-50	-	mA
V _I	input voltage		-0.5	+4.6	V
I _{OK}	output clamping current	V _O < 0 V	-50	-	mA
V _O	output voltage	Active mode and Power-down mode	-0.5	+4.6	V
I _O	output current	V _O = 0 V to V _{CC}	-	±20	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	-	250	mW

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

[2] For TSSOP5 packages: above 87.5 °C the value of P_{tot} derates linearly with 4.0 mW/K.
For X2SON5 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

Symbol	Parameter	Conditions	Min	Max	Unit
V_{CC}	supply voltage		2.3	3.6	V
V_I	input voltage		0	3.6	V
V_O	output voltage	Active mode	0	V_{CC}	V
		Power-down mode; $V_{CC} = 0$ V	0	3.6	V
T_{amb}	ambient temperature		-40	+125	°C

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
$T_{amb} = 25$ °C						
V_{T+}	positive-going threshold voltage	$V_{CC} = 2.3$ V to 2.7 V	0.60	-	1.10	V
		$V_{CC} = 3.0$ V to 3.6 V	0.75	-	1.16	V
V_{T-}	negative-going threshold voltage	$V_{CC} = 2.3$ V to 2.7 V	0.35	-	0.60	V
		$V_{CC} = 3.0$ V to 3.6 V	0.50	-	0.85	V
V_H	hysteresis voltage	$(V_H = V_{T+} - V_{T-})$				
		$V_{CC} = 2.3$ V to 2.7 V	0.23	-	0.60	V
		$V_{CC} = 3.0$ V to 3.6 V	0.25	-	0.56	V
V_{OH}	HIGH-level output voltage	$V_I = V_{T+}$ or V_{T-}				
		$I_O = -20$ μ A; $V_{CC} = 2.3$ V to 3.6 V	$V_{CC} - 0.1$	-	-	V
		$I_O = -2.3$ mA; $V_{CC} = 2.3$ V	2.05	-	-	V
		$I_O = -3.1$ mA; $V_{CC} = 2.3$ V	1.9	-	-	V
		$I_O = -2.7$ mA; $V_{CC} = 3.0$ V	2.72	-	-	V
		$I_O = -4.0$ mA; $V_{CC} = 3.0$ V	2.6	-	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{T+}$ or V_{T-}				
		$I_O = 20$ μ A; $V_{CC} = 2.3$ V to 3.6 V	-	-	0.10	V
		$I_O = 2.3$ mA; $V_{CC} = 2.3$ V	-	-	0.31	V
		$I_O = 3.1$ mA; $V_{CC} = 2.3$ V	-	-	0.44	V
		$I_O = 2.7$ mA; $V_{CC} = 3.0$ V	-	-	0.31	V
		$I_O = 4.0$ mA; $V_{CC} = 3.0$ V	-	-	0.44	V
I_I	input leakage current	$V_I = \text{GND}$ to 3.6 V; $V_{CC} = 0$ V to 3.6 V	-	-	± 0.1	μ A
I_{OFF}	power-off leakage current	V_I or $V_O = 0$ V to 3.6 V; $V_{CC} = 0$ V	-	-	± 0.1	μ A
ΔI_{OFF}	additional power-off leakage current	V_I or $V_O = 0$ V to 3.6 V; $V_{CC} = 0$ V to 0.2 V	-	-	± 0.1	μ A
I_{CC}	supply current	$V_I = \text{GND}$ or V_{CC} ; $I_O = 0$ A; $V_{CC} = 2.3$ V to 3.6 V	-	-	1.2	μ A

Low-power 2-input EXCLUSIVE-NOR gate with voltage-level translator

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
C_I	input capacitance	$V_{CC} = 0\text{ V to }3.6\text{ V}; V_I = \text{GND or }V_{CC}$	-	0.8	-	pF
C_O	output capacitance	$V_O = \text{GND}; V_{CC} = 0\text{ V}$	-	1.7	-	pF
$T_{\text{amb}} = -40\text{ °C to }+85\text{ °C}$						
V_{T+}	positive-going threshold voltage	$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	0.60	-	1.10	V
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	0.75	-	1.19	V
V_{T-}	negative-going threshold voltage	$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	0.35	-	0.60	V
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	0.50	-	0.85	V
V_H	hysteresis voltage	$(V_H = V_{T+} - V_{T-})$				
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	0.10	-	0.60	V
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}$	0.15	-	0.56	V
V_{OH}	HIGH-level output voltage	$V_I = V_{T+}$ or V_{T-}				
		$I_O = -20\text{ }\mu\text{A}; V_{CC} = 2.3\text{ V to }3.6\text{ V}$	$V_{CC} - 0.1$	-	-	V
		$I_O = -2.3\text{ mA}; V_{CC} = 2.3\text{ V}$	1.97	-	-	V
		$I_O = -3.1\text{ mA}; V_{CC} = 2.3\text{ V}$	1.85	-	-	V
		$I_O = -2.7\text{ mA}; V_{CC} = 3.0\text{ V}$	2.67	-	-	V
		$I_O = -4.0\text{ mA}; V_{CC} = 3.0\text{ V}$	2.55	-	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{T+}$ or V_{T-}				
		$I_O = 20\text{ }\mu\text{A}; V_{CC} = 2.3\text{ V to }3.6\text{ V}$	-	-	0.1	V
		$I_O = 2.3\text{ mA}; V_{CC} = 2.3\text{ V}$	-	-	0.33	V
		$I_O = 3.1\text{ mA}; V_{CC} = 2.3\text{ V}$	-	-	0.45	V
		$I_O = 2.7\text{ mA}; V_{CC} = 3.0\text{ V}$	-	-	0.33	V
		$I_O = 4.0\text{ mA}; V_{CC} = 3.0\text{ V}$	-	-	0.45	V
I_I	input leakage current	$V_I = \text{GND to }3.6\text{ V}; V_{CC} = 0\text{ V to }3.6\text{ V}$	-	-	± 0.5	μA
I_{OFF}	power-off leakage current	V_I or $V_O = 0\text{ V to }3.6\text{ V}; V_{CC} = 0\text{ V}$	-	-	± 0.5	μA
ΔI_{OFF}	additional power-off leakage current	V_I or $V_O = 0\text{ V to }3.6\text{ V}; V_{CC} = 0\text{ V to }0.2\text{ V}$	-	-	± 0.5	μA
I_{CC}	supply current	$V_I = \text{GND or }V_{CC}; I_O = 0\text{ A}; V_{CC} = 2.3\text{ V to }3.6\text{ V}$	-	-	1.5	μA
ΔI_{CC}	additional supply current	$V_{CC} = 2.3\text{ V to }2.7\text{ V}; I_O = 0\text{ A}$ ^[1]	-	-	0.6	μA
		$V_{CC} = 3.0\text{ V to }3.6\text{ V}; I_O = 0\text{ A}$ ^[2]	-	-	10	μA

Low-power 2-input EXCLUSIVE-NOR gate with voltage-level translator

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
T_{amb} = -40 °C to +125 °C						
V _{T+}	positive-going threshold voltage	V _{CC} = 2.3 V to 2.7 V	0.60	-	1.10	V
		V _{CC} = 3.0 V to 3.6 V	0.75	-	1.19	V
V _{T-}	negative-going threshold voltage	V _{CC} = 2.3 V to 2.7 V	0.33	-	0.64	V
		V _{CC} = 3.0 V to 3.6 V	0.46	-	0.85	V
V _H	hysteresis voltage	(V _H = V _{T+} - V _{T-})				
		V _{CC} = 2.3 V to 2.7 V	0.10	-	0.60	V
		V _{CC} = 3.0 V to 3.6 V	0.15	-	0.56	V
V _{OH}	HIGH-level output voltage	V _I = V _{T+} or V _{T-}				
		I _O = -20 μA; V _{CC} = 2.3 V to 3.6 V	V _{CC} - 0.11	-	-	V
		I _O = -2.3 mA; V _{CC} = 2.3 V	1.77	-	-	V
		I _O = -3.1 mA; V _{CC} = 2.3 V	1.67	-	-	V
		I _O = -2.7 mA; V _{CC} = 3.0 V	2.40	-	-	V
		I _O = -4.0 mA; V _{CC} = 3.0 V	2.30	-	-	V
V _{OL}	LOW-level output voltage	V _I = V _{T+} or V _{T-}				
		I _O = 20 μA; V _{CC} = 2.3 V to 3.6 V	-	-	0.11	V
		I _O = 2.3 mA; V _{CC} = 2.3 V	-	-	0.36	V
		I _O = 3.1 mA; V _{CC} = 2.3 V	-	-	0.50	V
		I _O = 2.7 mA; V _{CC} = 3.0 V	-	-	0.36	V
		I _O = 4.0 mA; V _{CC} = 3.0 V	-	-	0.50	V
I _I	input leakage current	V _I = GND to 3.6 V; V _{CC} = 0 V to 3.6 V	-	-	±0.75	μA
I _{OFF}	power-off leakage current	V _I or V _O = 0 V to 3.6 V; V _{CC} = 0 V	-	-	±0.75	μA
ΔI _{OFF}	additional power-off leakage current	V _I or V _O = 0 V to 3.6 V; V _{CC} = 0 V to 0.2 V	-	-	±0.75	μA
I _{CC}	supply current	V _I = GND or V _{CC} ; I _O = 0 A; V _{CC} = 2.3 V to 3.6 V	-	-	3.5	μA
ΔI _{CC}	additional supply current	V _{CC} = 2.3 V to 2.7 V; I _O = 0 A ^[1]	-	-	1.8	μA
		V _{CC} = 3.0 V to 3.6 V; I _O = 0 A ^[2]	-	-	18	μA

[1] One input at 0.3 V or 1.1 V, other input at V_{CC} or GND.

[2] One input at 0.45 V or 1.2 V, other input at V_{CC} or GND.

11 Dynamic characteristics

Table 8. Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); for test circuit see [Figure 7](#).

Symbol	Parameter	Conditions	25 °C			-40 °C to +125 °C			Unit
			Min	Typ ^[1]	Max	Min	Max (85 °C)	Max (125 °C)	
V_{CC} = 2.3 V to 2.7 V; V_I = 1.65 V to 1.95 V									
t _{pd}	propagation delay	A, B to Y; see Figure 6 ^[2]							
		C _L = 5 pF	2.1	3.6	5.5	0.5	6.8	7.5	ns
		C _L = 10 pF	2.6	4.2	6.2	1.0	7.9	8.7	ns
		C _L = 15 pF	2.9	4.7	6.8	1.0	8.7	9.6	ns
		C _L = 30 pF	4.0	5.9	8.1	1.5	10.8	11.9	ns
V_{CC} = 2.3 V to 2.7 V; V_I = 2.3 V to 2.7 V									
t _{pd}	propagation delay	A, B to Y; see Figure 6 ^[2]							
		C _L = 5 pF	1.7	3.5	5.6	0.5	6.0	6.6	ns
		C _L = 10 pF	2.1	4.1	6.3	1.0	7.1	7.9	ns
		C _L = 15 pF	2.5	4.6	6.8	1.0	7.9	8.7	ns
		C _L = 30 pF	3.5	5.7	8.2	1.5	10.0	11.0	ns
V_{CC} = 2.3 V to 2.7 V; V_I = 3.0 V to 3.6 V									
t _{pd}	propagation delay	A, B to Y; see Figure 6 ^[2]							
		C _L = 5 pF	1.4	3.2	5.1	0.5	5.5	6.1	ns
		C _L = 10 pF	1.8	3.8	5.7	1.0	6.5	7.2	ns
		C _L = 15 pF	2.1	4.3	6.3	1.0	7.4	8.2	ns
		C _L = 30 pF	3.2	5.5	7.7	1.5	9.5	10.5	ns
V_{CC} = 3.0 V to 3.6 V; V_I = 1.65 V to 1.95 V									
t _{pd}	propagation delay	A, B to Y; see Figure 6 ^[2]							
		C _L = 5 pF	2.1	3.0	4.0	0.5	8.0	8.8	ns
		C _L = 10 pF	2.5	3.6	4.8	1.0	8.5	9.4	ns
		C _L = 15 pF	2.8	4.0	5.4	1.0	9.1	10.1	ns
		C _L = 30 pF	3.7	5.2	7.0	1.5	9.8	10.8	ns
V_{CC} = 3.0 V to 3.6 V; V_I = 2.3 V to 2.7 V									
t _{pd}	propagation delay	A, B to Y; see Figure 6 ^[2]							
		C _L = 5 pF	1.6	2.9	4.4	0.5	5.3	5.9	ns
		C _L = 10 pF	2.0	3.5	5.1	1.0	6.1	6.8	ns
		C _L = 15 pF	2.4	3.9	5.6	1.0	6.8	7.5	ns
		C _L = 30 pF	3.5	5.1	6.9	1.5	8.5	9.4	ns

Low-power 2-input EXCLUSIVE-NOR gate with voltage-level translator

Symbol	Parameter	Conditions	25 °C			-40 °C to +125 °C			Unit
			Min	Typ ^[1]	Max	Min	Max (85 °C)	Max (125 °C)	
V_{CC} = 3.0 V to 3.6 V; V_I = 3.0 V to 3.6 V									
t _{pd}	propagation delay	A, B to Y; see Figure 6 ^[2]							
		C _L = 5 pF	1.3	2.8	4.5	0.5	4.7	5.2	ns
		C _L = 10 pF	1.7	3.4	5.1	1.0	5.7	6.3	ns
		C _L = 15 pF	2.1	3.9	5.7	1.0	6.2	6.9	ns
		C _L = 30 pF	3.1	5.0	7.0	1.5	7.8	8.6	ns
T_{amb} = 25 °C									
C _{PD}	power dissipation capacitance	f _i = 1 MHz; V _I = GND to V _{CC} ^[3]							
		V _{CC} = 2.3 V to 2.7 V	-	4	-	-	-	-	pF
		V _{CC} = 3.0 V to 3.6 V	-	5	-	-	-	-	pF

[1] All typical values are measured at nominal V_{CC}.

[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).

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

f_i = input frequency in MHz;

f_o = output frequency in MHz;

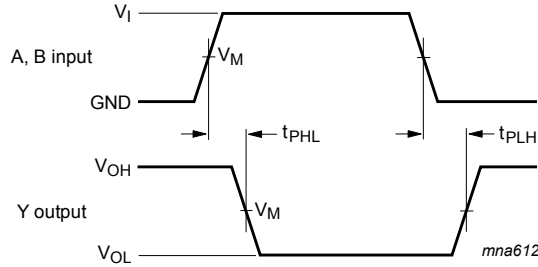
C_L = output load capacitance in pF;

V_{CC} = supply voltage in V;

N = number of inputs switching;

Σ(C_L × V_{CC}² × f_o) = sum of the outputs.

11.1 Waveforms and test circuit



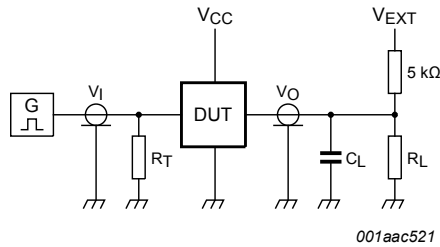
Measurement points are given in [Table 9](#)

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

Figure 6. Input A and B to output Y propagation delay times

Table 9. Measurement points

Supply voltage	Output	Input		
V_{CC}	V_M	V_M	V_I	$t_r = t_f$
2.3 V to 3.6 V	$0.5 \times V_{CC}$	$0.5 \times V_I$	1.65 V to 3.6 V	≤ 3.0 ns



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.

Figure 7. Test circuit for measuring switching times

Table 10. Test data

Supply voltage	Load		V_{EXT}		
V_{CC}	C_L	R_L [1]	t_{PLH}, t_{PHL}	t_{PZH}, t_{PHZ}	t_{PZL}, t_{PLZ}
2.3 V to 3.6 V	5 pF, 10 pF, 15 pF and 30 pF	5 kΩ or 1 MΩ	open	GND	$2 \times V_{CC}$

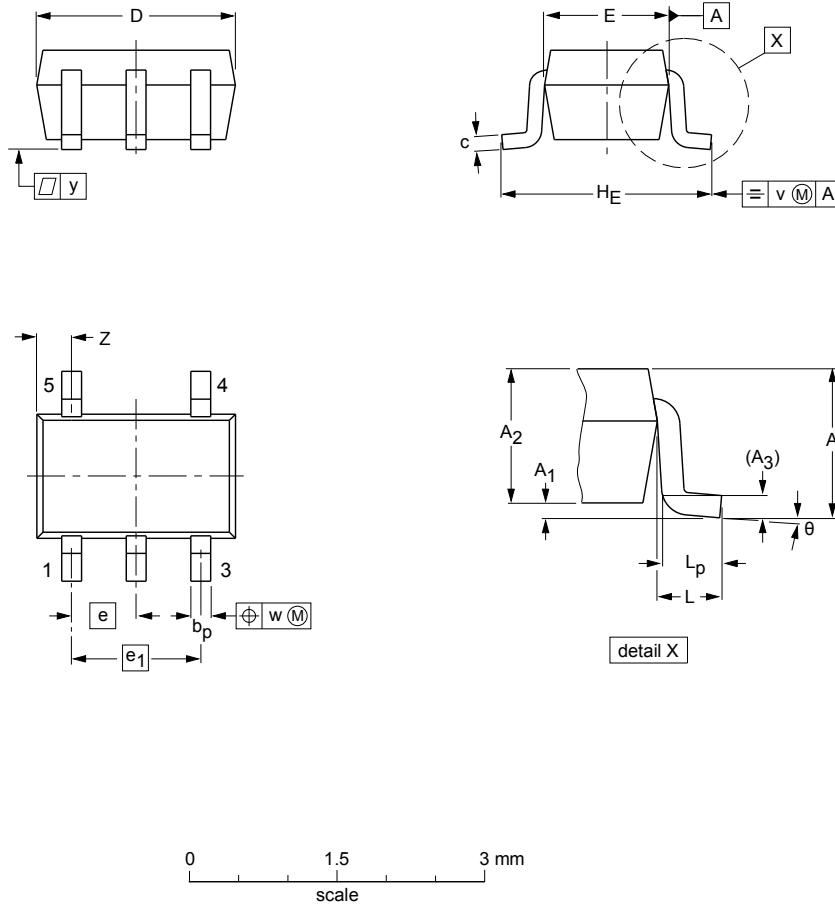
[1] For measuring enable and disable times $R_L = 5$ kΩ.

For measuring propagation delays, setup and hold times and pulse width $R_L = 1$ MΩ.

12 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 ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽¹⁾	e	e ₁	H _E	L	L _p	v	w	y	Z ⁽¹⁾	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

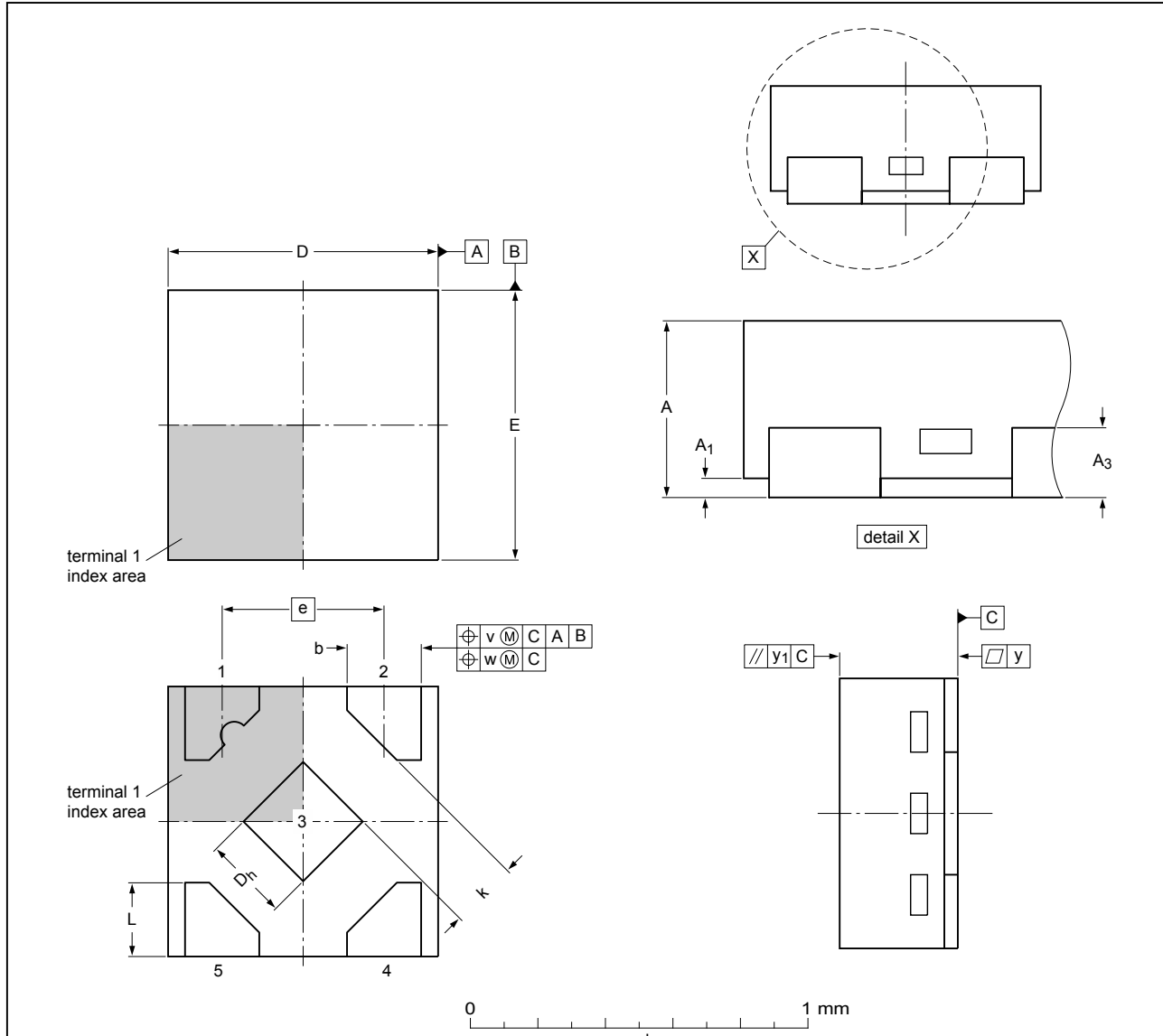
1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

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

Figure 8. Package outline SOT353-1 (TSSOP5)

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 ⁽¹⁾	A ₁	A ₃	D	D _h	E	b	e	k	L	v	w	y	y ₁
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						12-04-10 12-04-25

Figure 9. Package outline SOT1226 (X2SON5)

13 Abbreviations

Table 11. Abbreviations

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

14 Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74AUP1T87 v.1	20171128	Product data sheet	-	-

15 Legal information

15.1 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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