LSF0101

1-bit bidirectional multi-voltage level translator; open-drain; push-pull

Rev. 3 — 8 February 2022 Product data sheet

1. General description

The LSF0101 is an 1 channel bidirectional multi-voltage level translator for open-drain and push-pull applications. It supports up to 100 MHz up translation and ≥ 100 MHz down translation at ≤ 30 pF capacitive load. There is no need for a direction pin which minimizes system effort. The LSF0101 supports 5 V tolerant I/O pins for compatibility with TTL levels in a variety of applications. The ability to set up different voltage translation levels on each channel makes the device very flexible and suitable for a lot of different applications.

2. Features and benefits

- Bidirectional voltage translation with no direction pin
- Up translation
  - ≤ 100 MHz; C_L = 30 pF
  - ≤ 40 MHz; C_L = 50 pF
- Down translation
  - ≥ 100 MHz; C_L = 30 pF
  - ≤ 40 MHz; C_L = 50 pF
- Hot insertion
- Bidirectional voltage level translation between:
  - 0.95 V and 1.8 V, 2.5 V, 3.3 V and 5.0 V
  - 1.2 V and 1.8 V, 2.5 V, 3.3 V and 5.0 V
  - 1.8 V and 2.5 V, 3.3 V and 5.0 V
  - 2.5 V and 3.3 V and 5.0 V
  - 3.3 V and 5.0 V
- Low standby current
- 5 V tolerant I/O pins to support TTL
- Low R_{ON} provides less signal distortion
- High-impedance I/O pins for EN = Low.
- Flow-through pinout for easy PCB trace routing.
- Latch-up performance exceeds 100 mA per JESD78 class II level A
- ESD protection:
  - HBM ANSI/ESDA/JEDEC JS-001 exceeds 2000 V
  - CDM ANSI/ESDA/JEDEC JS-002 exceeds 1000 V
- Multiple package options
- Specified from -40 °C to +125 °C

3. Applications

- GPIO, MDIO, PMBus, SMBus, SDIO, UART, I^2C, and other interfaces in Telecom infrastructure
- Industrial
- Personal computing

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4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
LSF0101GW	-40 °C to +125 °C	TSSOP6	plastic thin shrink small outline package; 6 leads; body width 1.25 mm	SOT363-2
LSF0101GM	-40 °C to +125 °C	XSON6	plastic extremely thin small outline package; no leads; 6 terminals; body 1 × 1.45 × 0.5 mm	SOT886
LSF0101GX	-40 °C to +125 °C	X2SON6	plastic thermal enhanced extremely thin small outline package; no leads; 6 terminals; body 1.0 × 0.8 × 0.32 mm	SOT1255-2

5. Marking

Table 2. Marking

Type number	Marking code[1]
LSF0101GW	h1
LSF0101GM	h1
LSF0101GX	h1

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

6. Functional diagram

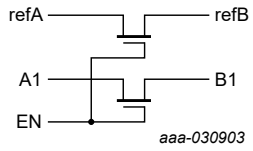


Fig. 1. Logic symbol

7. Pinning information

7.1. Pinning

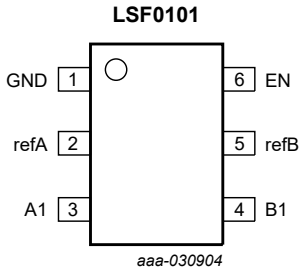
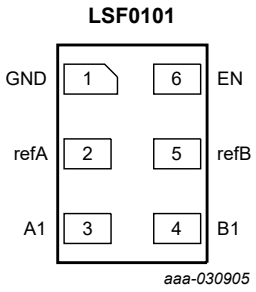
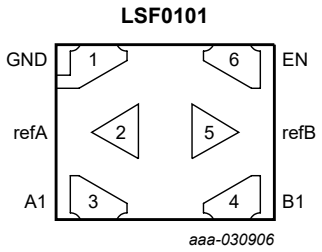


Fig. 2. Pin configuration SOT363-2 (TSSOP6)



Transparent top view

Fig. 3. Pin configuration SOT886 (XSON6)



Transparent top view

Fig. 4. Pin configuration SOT1255-2 (X2SON6)

7.2. Pin description

Table 3. Pin description

Symbol	Pin	Description
GND	1	ground (0 V)
refA	2	reference voltage A
A1	3	data input/output A
B1	4	data input/output B
refB	5	reference voltage B
EN	6	enable input (active HIGH)

8. Functional description

Table 4. Function table

H = HIGH voltage level; L = LOW voltage level; Z = high-impedance OFF-state.

Input	input/output
EN	**A1, B1 channel**
H	A1 = B1
L	Z

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_I	input voltage	pins refA, refB, A1, B1 and EN	[1]	-0.5	+7.0	V
$I_{I/O}$	input/ouput current	pins refA, refB, A1 and B1; continuous channel current		-	+128	mA
I_{IK}	input clamping current	V_I < 0 V		-50	-	mA
T_{stg}	storage temperature			-65	+150	°C
P_{tot}	total power dissipation	T_{amb} = -40 °C to +125 °C	[2]	-	250	mW

[1] The minimum input voltage rating may be exceeded if the input current rating is observed.
[2] For SOT363-2 (TSSOP6) package: P_{tot} derates linearly with 3.7 mW/K above 83 °C.
For SOT886 (XSON6) package: P_{tot} derates linearly with 3.3 mW/K above 74 °C.
For SOT1255-2 (X2SON6) package: P_{tot} derates linearly with 3.3 mW/K above 75 °C.

10. Recommended operating conditions

Table 6. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V_I	input voltage	pins refA, refB, A1, B1 and EN	0.0	5.0	V
$I_{I/O}$	input/ouput current	pins refA, refB, A1 and B1; continuous channel current	-	+64	mA
T_{amb}	ambient temperature		-40	+125	°C

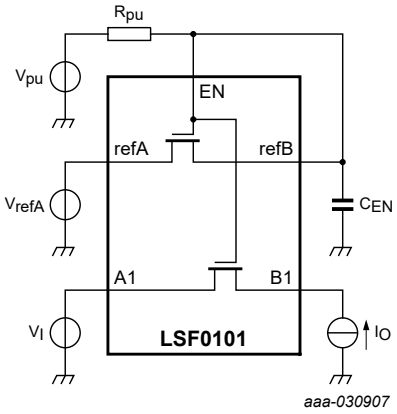
11. Static characteristics

Table 7. Static characteristics

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

Symbol	Parameter	Conditions	T_{amb} = -40 °C to +125 °C			Unit
			Min	Typ[1]	Max	
V_{IK}	input clamping voltage	V_{EN} = 0 V; I_I = -18 mA	-1.2	-	-	V
I_I	leakage current	pins A1, B1, refA, refB and EN; V_I = GND to 5.0 V	-	1	5	µA
C_I	input capacitance	pins refA, refB and EN; V_I = 0 V or 3 V	-	6	-	pF
$C_{io(off)}$	OFF-state input/output capacitance	pins A1, B1; V_O = 0 V or 3 V; V_{EN} = 0.0 V	-	3.7	6.0	pF
$C_{io(on)}$	ON-state input/output capacitance	pins A1, B1; V_O = 0 V or 3 V; V_{EN} = 3.0 V	-	6.0	12.5	pF
R_{ON}	ON resistance	see Fig. 5 [2]				
		V_I = 0 V; V_{pu} = 5.0 V; I_O = 64 mA				
		V_{refA} = 3.3 V	-	3	-	Ω
		V_{refA} = 1.8 V	-	4	-	Ω
		V_{refA} = 1.0 V	-	7	-	Ω
		V_I = 0 V; V_{pu} = 5.0 V; I_O = 32mA				
		V_{refA} = 1.8 V	-	4	-	Ω
		V_{refA} = 2.5 V	-	3	-	Ω
		V_I = 1.8 V; V_{pu} = 5.0 V; I_O = 15 mA				
		V_{refA} = 3.3 V	-	4	-	Ω
		V_I = 1.0 V; V_{pu} = 3.3 V; I_O = 10 mA				
		V_{refA} = 1.8 V	-	7	-	Ω
		V_I = 0 V; V_{pu} = 3.3 V; I_O = 10 mA				
		V_{refA} = 1.0 V	-	5	-	Ω
		V_I = 0 V; V_{pu} = 1.8 V; I_O = 10 mA				
		V_{refA} = 1.0 V	-	6	-	Ω

[1] All typical values are measured at T_{amb} = 25 °C.
[2] Measured by the voltage drop between the An and Bn pins at the indicated current through the switch. ON resistance is determined by the lowest voltage of the two (An or Bn) pins.



The A1 and B1 pins may be exchanged.
R_{pu} = 200 kΩ
C_{EN} = 100 nF

Fig. 5. Test circuit for measuring R_{ON}

12. Dynamic characteristics

Table 8. Switching characteristics

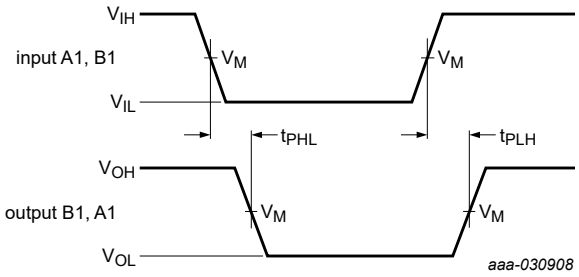
GND = 0 V; for waveform see Fig. 6; for test circuit see Fig. 7

Symbol	Parameter	Conditions	T_{amb} = -40 °C to +125 °C			Unit
			Min	Typ[1]	Max	
Translating down						
t_{PLH}	LOW to HIGH propagation delay	A1 to B1 or B1 to A1;				
		$V_{IH} = V_{pu} = V_{refA} + 1$ V				
		V_{refA} = 1.5 V; C_L = 15 pF	-	0.35	-	ns
		V_{refA} = 1.5 V; C_L = 30 pF	-	0.8	-	ns
		V_{refA} = 1.5 V; C_L = 50 pF	-	1.2	-	ns
		V_{refA} = 2.3 V; C_L = 15 pF	-	0.3	-	ns
		V_{refA} = 2.3 V; C_L = 30 pF	-	0.7	-	ns
		V_{refA} = 2.3 V; C_L = 50 pF	-	1.1	-	ns
t_{PHL}	HIGH to LOW propagation delay	A1 to B1 or B1 to A1;				
		$V_{IH} = V_{pu} = V_{refA} + 1$ V				
		V_{refA} = 1.5 V; C_L = 15 pF	-	0.5	-	ns
		V_{refA} = 1.5 V; C_L = 30 pF	-	1.0	-	ns
		V_{refA} = 1.5 V; C_L = 50 pF	-	1.3	-	ns
		V_{refA} = 2.3 V; C_L = 15 pF	-	0.4	-	ns
		V_{refA} = 2.3 V; C_L = 30 pF	-	0.8	-	ns
		V_{refA} = 2.3 V; C_L = 50 pF	-	1.2	-	ns

Symbol	Parameter	Conditions	T_{amb} = -40 °C to +125 °C			Unit
			Min	Typ[1]	Max	
Translating up						
t_{PLH}	LOW to HIGH propagation delay	A1 to B1 or B1 to A1;				
		$V_{IH} = V_{refA}$; $V_{EXT} = V_{pu} = V_{refA} + 1$ V				
		V_{refA} = 1.5 V; C_L = 15 pF	-	0.5	-	ns
		V_{refA} = 1.5 V; C_L = 30 pF	-	0.9	-	ns
		V_{refA} = 1.5 V; C_L = 50 pF	-	1.1	-	ns
		V_{refA} = 2.3 V; C_L = 15 pF	-	0.4	-	ns
		V_{refA} = 2.3 V; C_L = 30 pF	-	0.8	-	ns
		V_{refA} = 2.3 V; C_L = 50 pF	-	1.0	-	ns
t_{PHL}	HIGH to LOW propagation delay	A1 to B1 or B1 to A1;				
		$V_{IH} = V_{refA}$; $V_{EXT} = V_{pu} = V_{refA} + 1$ V				
		V_{refA} = 1.5 V; C_L = 15 pF	-	0.6	-	ns
		V_{refA} = 1.5 V; C_L = 30 pF	-	1.1	-	ns
		V_{refA} = 1.5 V; C_L = 50 pF	-	1.3	-	ns
		V_{refA} = 2.3 V; C_L = 15 pF	-	0.4	-	ns
		V_{refA} = 2.3 V; C_L = 30 pF	-	0.9	-	ns
		V_{refA} = 2.3 V; C_L = 50 pF	-	1.0	-	ns

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

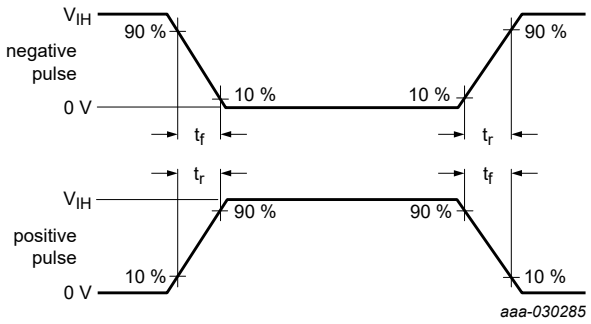
12.1. Waveforms and test circuit



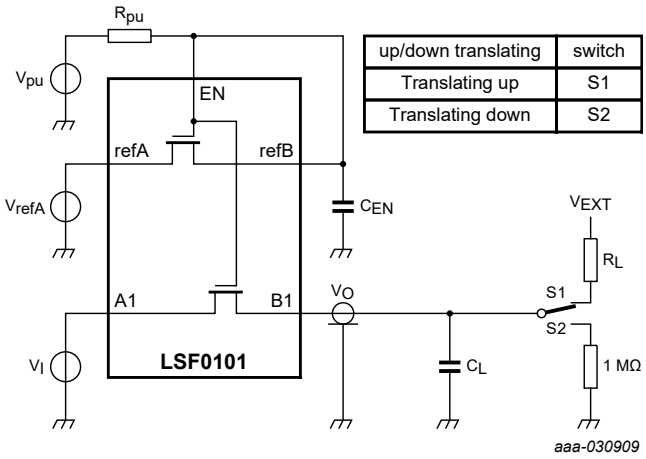
Measurement points are given in Table 9.

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

Fig. 6. The data input (A1, B1) to output (B1, A1) propagation delay times



a. V_I source waveform



up/down translating	switch
Translating up	S1
Translating down	S2

b. Test circuit

Test data is given in Table 9.
The A1 and B1 pins may be exchanged.
All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz; Z_O = 50 Ω.
Definitions test circuit:
C_L = Load capacitance including jig and probe capacitance
C_{EN} = Decoupling capacitance
R_{pu} = Pull-up resistance
R_L = Load resistance
S1/S2 = Test selection switch

Fig. 7. Test circuit for measuring switching times

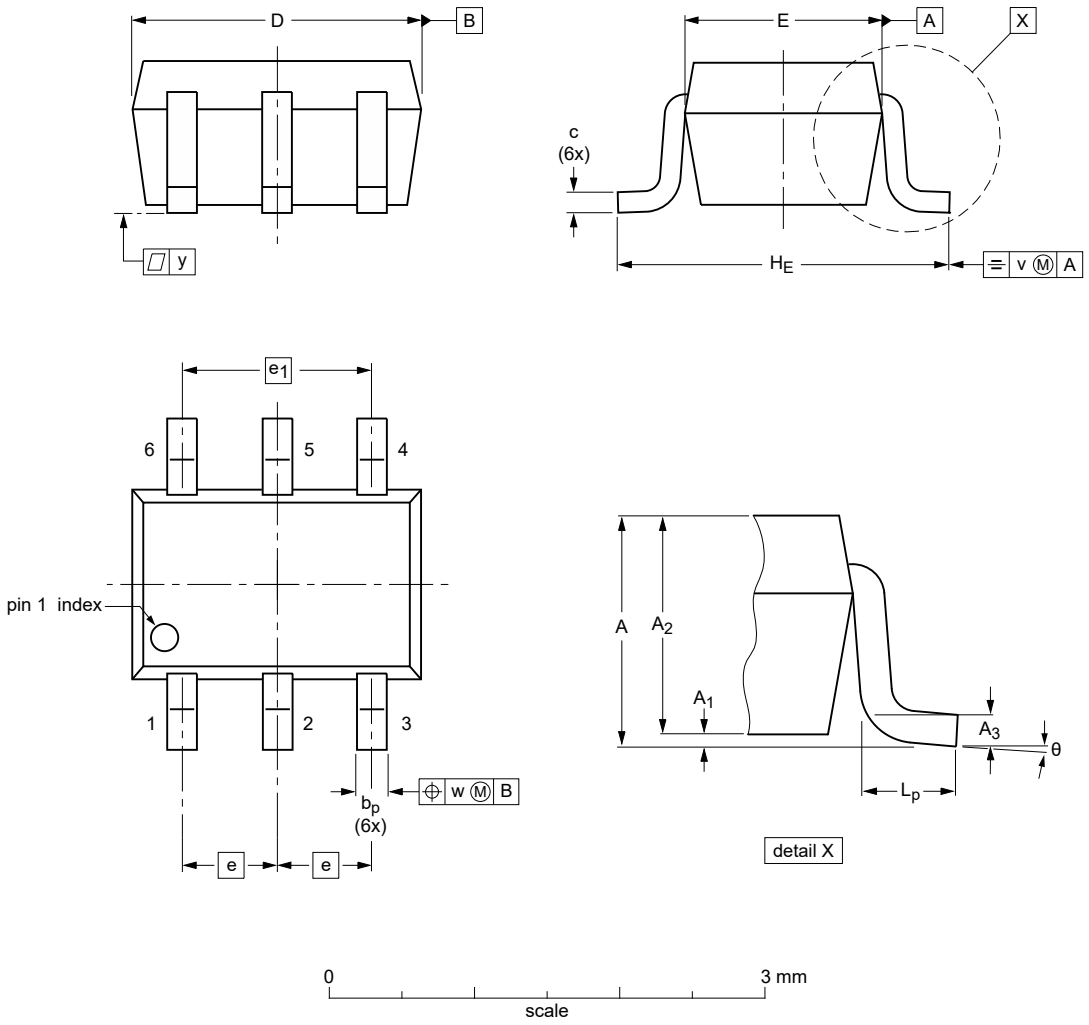
Table 9. Test data

Input		Output	Load			
t_r, t_f	V_M	V_M	C_L	C_{EN} [1]	R_L [1]	R_{pu}
≤ 2 ns	$0.5V_{refA}$	$0.5V_{refA}$	15 pF, 30 pF, 50 pF	100 nF	300 Ω	200 kΩ

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

13. Package outline

TSSOP6: plastic thin shrink small outline package; 6 leads; body width 1.25 mm **SOT363-2**



Dimensions (mm are the original dimensions)

Unit		A	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	e_1	H_E	L_p	v	w	y	θ
mm	max	1.1	0.1	1.0	0.15	0.30	0.25	2.2	1.35	0.65	1.3	2.4	0.46	0.3	0.1	0.1	8°
	min	0.8	0	0.8		0.15	0.08	1.8	1.15			1.8	0.26				0°

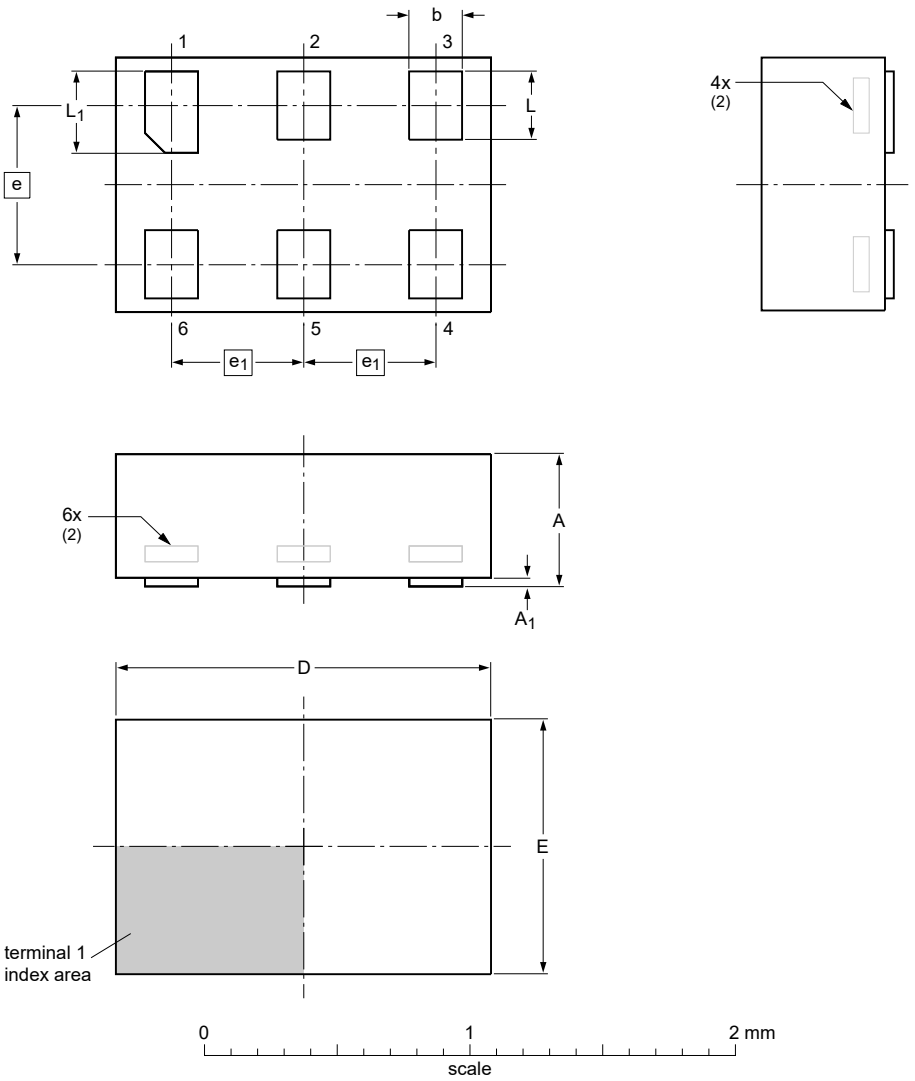
Note
1. Plastic or metal protrusions of 0.2 mm maximum per side are not included.

sot363-2_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT363-2		MO-203	SC-88A			~~21-12-15~~ 21-12-16

Fig. 8. Package outline SOT363-2 (TSSOP6)

XSON6: plastic extremely thin small outline package; no leads; 6 terminals; body 1 x 1.45 x 0.5 mm SOT886



Dimensions (mm are the original dimensions)

Unit		A(1)	A_1	b	D	E	e	e_1	L	L_1
mm	max	0.5	0.04	0.25	1.50	1.05			0.35	0.40
	nom			0.20	1.45	1.00	0.6	0.5	0.30	0.35
	min			0.17	1.40	0.95			0.27	0.32

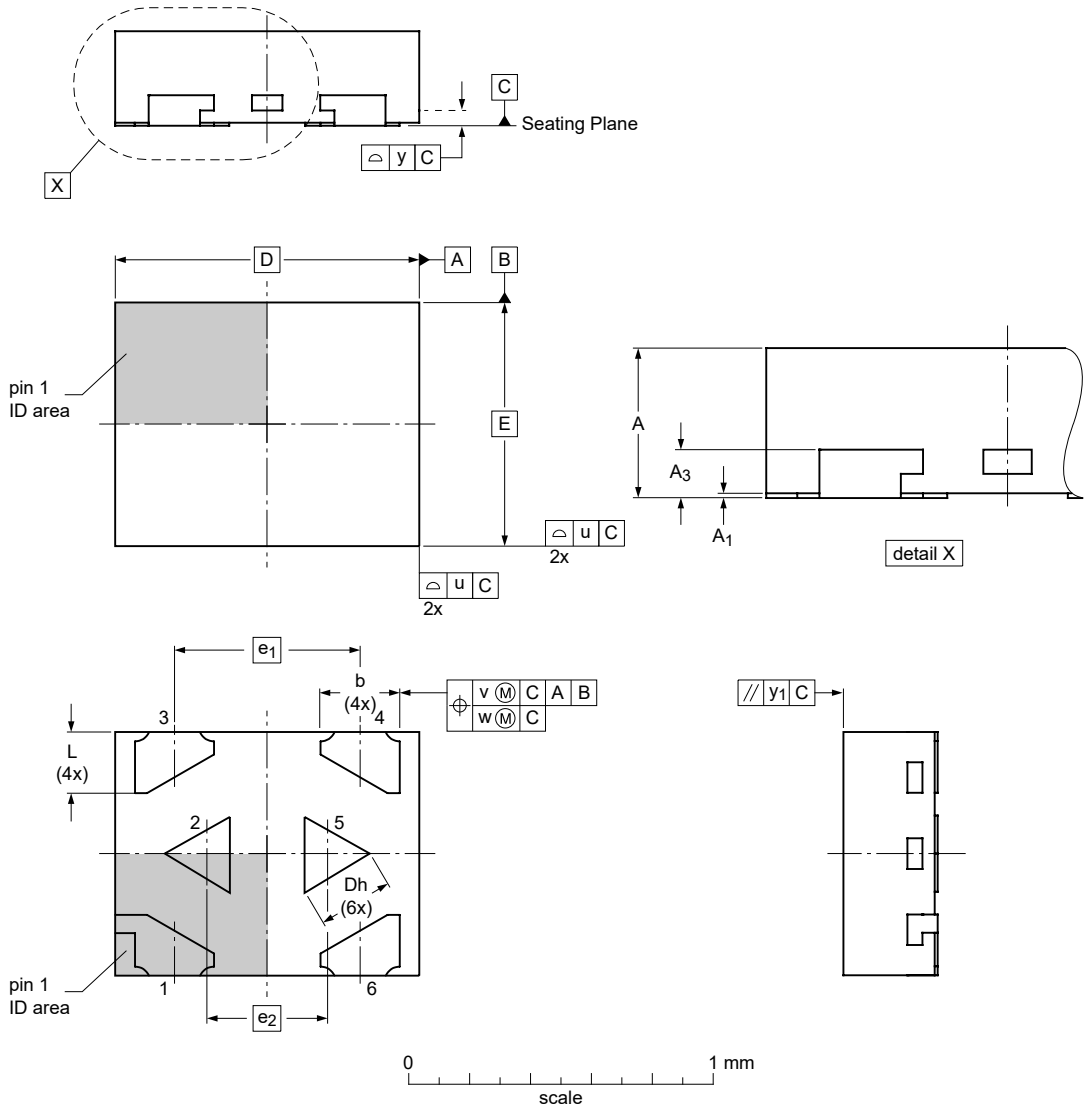
Notes
1. Including plating thickness.
2. Can be visible in some manufacturing processes.

sot886_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT886		MO-252				~~04-07-22~~ 12-01-05

Fig. 9. Package outline SOT886 (XSON6)

X2SON6: plastic thermal enhanced extremely thin small outline package; no leads; 6 terminals; body 1.0 x 0.8 x 0.32 mm **SOT1255-2**



Dimensions (mm are the original dimensions)

Unit		A	A_1	A_3	b	D	D_h	E	e_1	e_2	L	y	y_1	u	v	w
mm	max	0.35	0.04	0.10 (Typ.)	0.31	1.00	0.30	0.80	0.60	0.40	0.25	0.05	0.05	0.05	0.10	0.05
	nom	0.32	0.02		0.26		0.25				0.20					
	min	0.30	0.00		0.21		0.20				0.15					

sot1255-2_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1255-2		---				~~19-11-07~~ 19-11-08

Fig. 10. Package outline SOT1255-2 (X2SON6)

14. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal Oxide Semiconductor
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model
PRR	Pulse Rate Repetition
TTL	Transistor-Transistor Logic

15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
LSF0101 v.3	20220208	Product data sheet	-	LSF0101 v.2
Modifications:	• Package SOT363 (SC-88) changed to SOT363-2 (TSSOP6).			
LSF0101 v.2	20200923	Product data sheet	-	LSF0101 v.1.1
Modifications:	• Type number LSF0101GW (SOT363/SC-88) added.			
LSF0101 v.1.1	20200626	Product data sheet	-	LSF0101 v.1
Modifications:	• Type number LSF0101GW (SOT363/SC-88) is in development and removed from this product data sheet. Preliminary data sheet is available upon request.			
LSF0101 v.1	20200414	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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