LSF0102

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

Rev. 3 — 4 September 2020 Product data sheet

1. General description

The LSF0102 is a 2 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 LSF0102 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 Class 2 exceeds 2000 V
  - CDM ANSI/ESDA/JEDEC JS-002 Class C3 exceeds 1000 V
- 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

nexperia

4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
LSF0102DP	-40 °C to +125 °C	TSSOP8	plastic thin shrink small outline package; 8 leads; body width 3 mm; lead length 0.5 mm	SOT505-2
LSF0102DC	-40 °C to +125 °C	VSSOP8	plastic very thin shrink small outline package; 8 leads; body width 2.3 mm	SOT765-1
LSF0102GS	-40 °C to +125 °C	XSON8	extremely thin small outline package; no leads; 8 terminals; body 1.35 × 1.0 × 0.35 mm	SOT1203
LSF0102GX	-40 °C to +125 °C	X2SON8	plastic thermal enhanced extremely thin small outline package; no leads; 8 terminals; body 1.35 × 0.8 × 0.32 mm	SOT1233-2

5. Marking

Table 2. Marking

Type number	Marking code[1]
LSF0102DP	h2
LSF0102DC	h2
LSF0102GS	h2
LSF0102GX	h2

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

6. Functional diagram

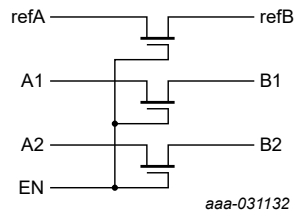


Fig. 1. Logic symbol

7. Pinning information

7.1. Pinning

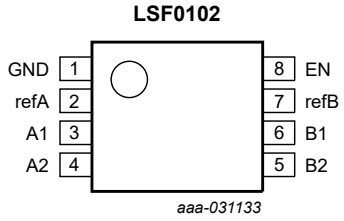


Fig. 2. Pin configuration SOT505-2 (TSSOP8) and SOT765-1 (VSSOP8)

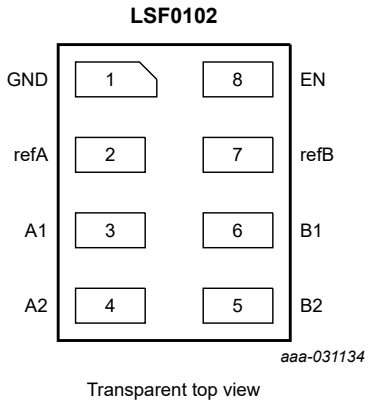


Fig. 3. Pin configuration SOT1203 (XSON8)

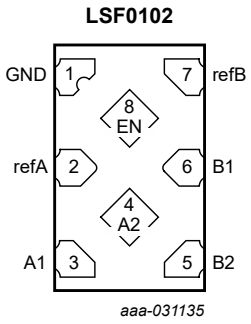


Fig. 4. Pin configuration SOT1233-2 (X2SON8)

7.2. Pin description

Table 3. Pin description

Symbol	Pin	Description
GND	1	ground (0 V)
refA	2	reference voltage A
A1, A2	3, 4	data input/output A
B1, B2	6, 5	data input/output B
refB	7	reference voltage B
EN	8	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	**An, Bn channel**
H	An = Bn
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, An, Bn and EN [1]	-0.5	+7.0	V
$I_{I/O}$	input/ouput current	pins refA, refB, An and Bn; 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 SOT505-2 (TSSOP8) package: P_{tot} derates linearly with 4.6 mW/K above 96 °C.
For SOT765-1 (VSSOP8) package: P_{tot} derates linearly with 4.9 mW/K above 99 °C.
For SOT1203 (XSON8) package: P_{tot} derates linearly with 3.6 mW/K above 81 °C.
For SOT1233-2 (X2SON8) package: P_{tot} derates linearly with 7.7 mW/K above 118 °C.

10. Recommended operating conditions

Table 6. Recommended operating conditions

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

11. Static characteristics

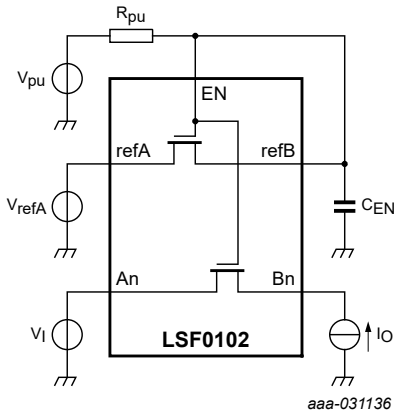
Table 7. Static characteristics

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 An, Bn, 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 An, Bn; V_O = 0 V or 3 V; V_{EN} = 0.0 V	-	3	6.0	pF
$C_{io(on)}$	ON-state input/output capacitance	pins An, Bn; V_O = 0 V or 3 V; V_{EN} = 3.0 V	-	6	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.



R_{pu} = 200 kΩ; C_{EN} = 100 nF (The An and Bn pins may be exchanged.)

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

12. Dynamic characteristics

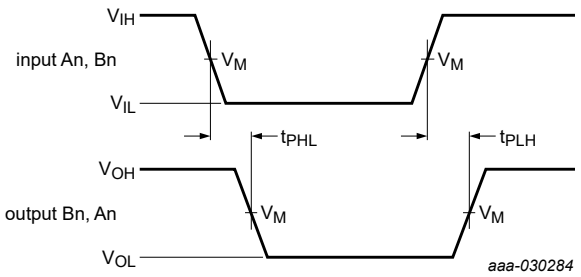
Table 8. Switching characteristics

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	An to Bn or Bn to An;				
		$V_{IH} = V_{pu} = V_{refA} + 1\ V$				
		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	An to Bn or Bn to An;				
		$V_{IH} = V_{pu} = V_{refA} + 1\ V$				
		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
Translating up						
t_{PLH}	LOW to HIGH propagation delay	An to Bn or Bn to An;				
		$V_{IH} = V_{refA}$; $V_{EXT} = V_{pu} = V_{refA} + 1\ V$				
		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	An to Bn or Bn to An;				
		$V_{IH} = V_{refA}$; $V_{EXT} = V_{pu} = V_{refA} + 1\ V$				
		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.

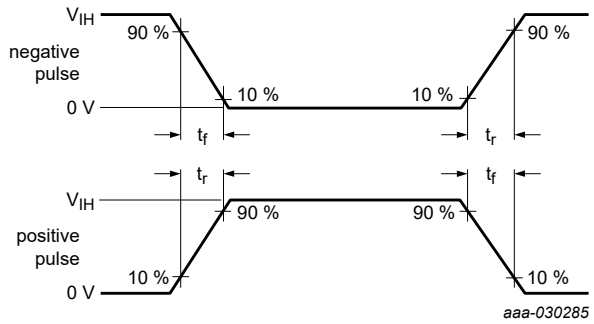
12.1. Waveforms and test circuit



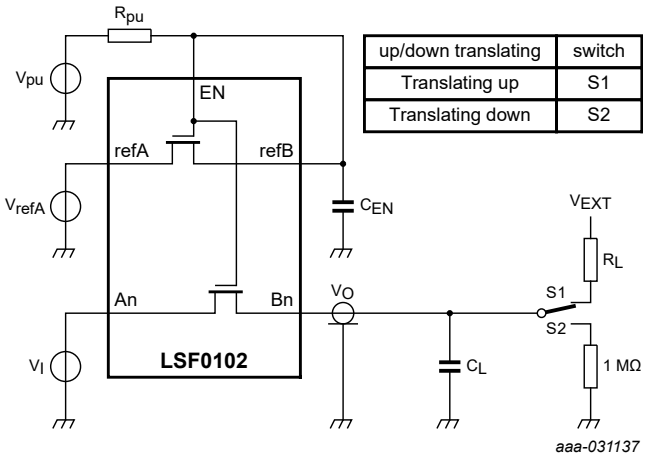
Measurement points are given in Table 9.

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

Fig. 6. The data input (An, Bn) to output (Bn, An) propagation delay times



V_I source waveform



up/down translating	switch
Translating up	S1
Translating down	S2

Test circuit

Test data is given in Table 9.

The An and Bn 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

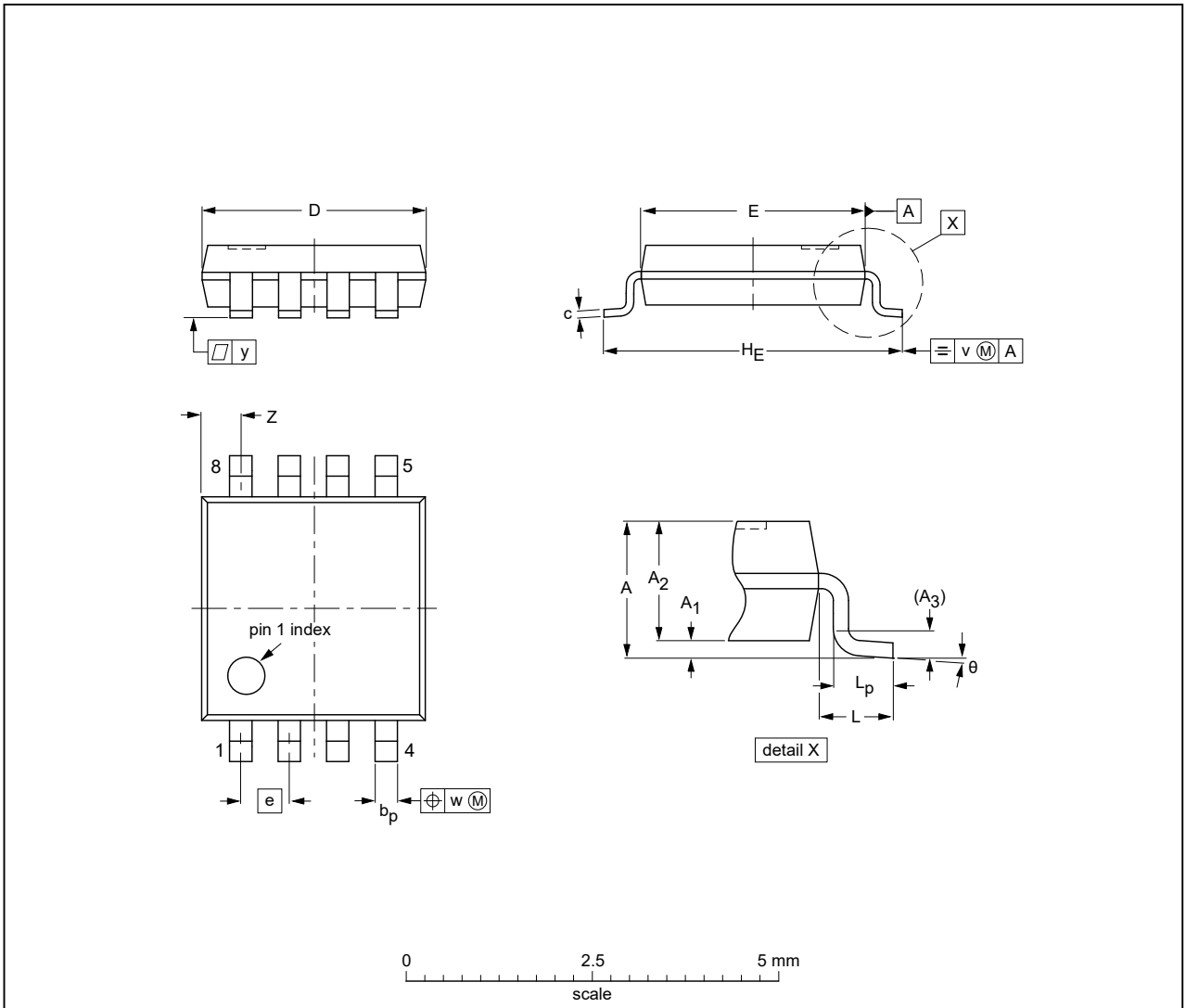
Table 9. Test data

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

TSSOP8: plastic thin shrink small outline package; 8 leads; body width 3 mm; lead length 0.5 mm SOT505-2



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	v	w	y	$Z^{(1)}$	θ
mm	1.1	0.15 0.00	0.95 0.75	0.25	0.38 0.22	0.18 0.08	3.1 2.9	3.1 2.9	0.65	4.1 3.9	0.5	0.47 0.33	0.2	0.13	0.1	0.70 0.35	8° 0°

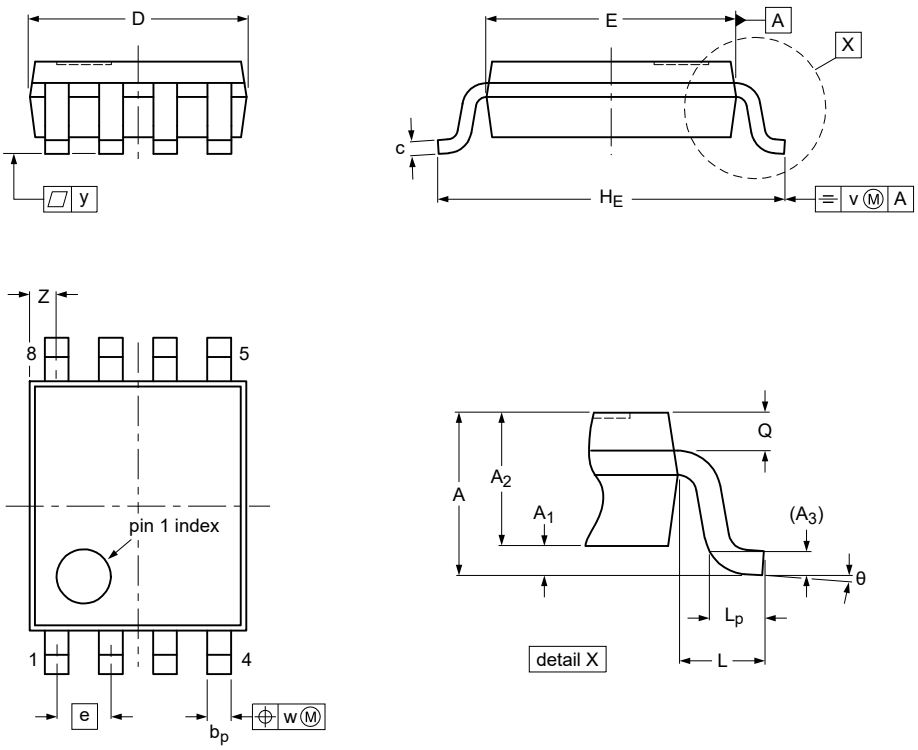
Note

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			
SOT505-2		- - -				02-01-16

Fig. 8. Package outline SOT505-2 (TSSOP8)

VSSOP8: plastic very thin shrink small outline package; 8 leads; body width 2.3 mm **SOT765-1**



Dimensions (mm are the original dimensions)

Unit	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
max		0.15	0.85		0.27	0.23	2.1	2.4		3.2		0.40	0.21				0.4	8°
mm nom	1			0.12					0.5		0.4			0.2	0.08	0.1		
min		0.00	0.60		0.17	0.08	1.9	2.2		3.0		0.15	0.19				0.1	0°

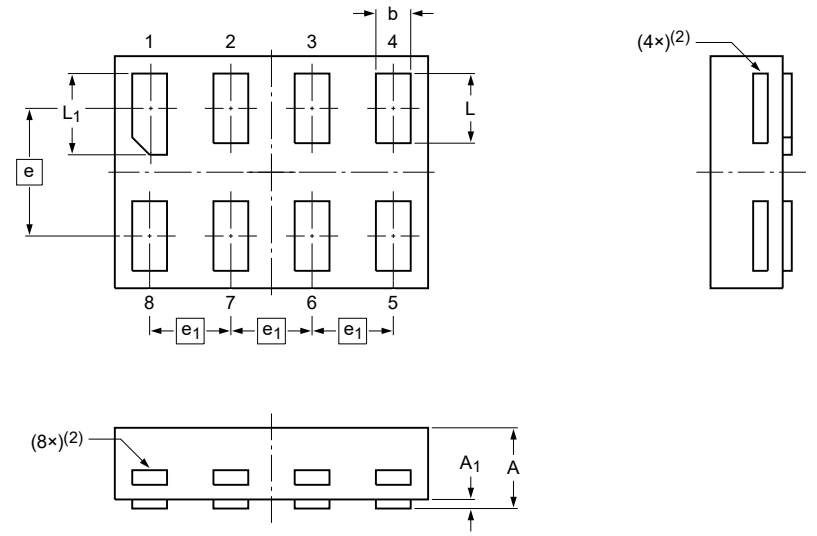
Note
1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

sot765-1_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT765-1		MO-187				~~07-06-02~~ 16-05-31

Fig. 9. Package outline SOT765-1 (VSSOP8)

XSON8: extremely thin small outline package; no leads; 8 terminals; body 1.35 x 1.0 x 0.35 mm **SOT1203**



Dimensions

Unit		A(1)	A_1	b	D	E	e	e_1	L	L_1
mm	max	0.35	0.04	0.20	1.40	1.05			0.35	0.40
	nom			0.15	1.35	1.00	0.55	0.35	0.30	0.35
	min			0.12	1.30	0.95			0.27	0.32

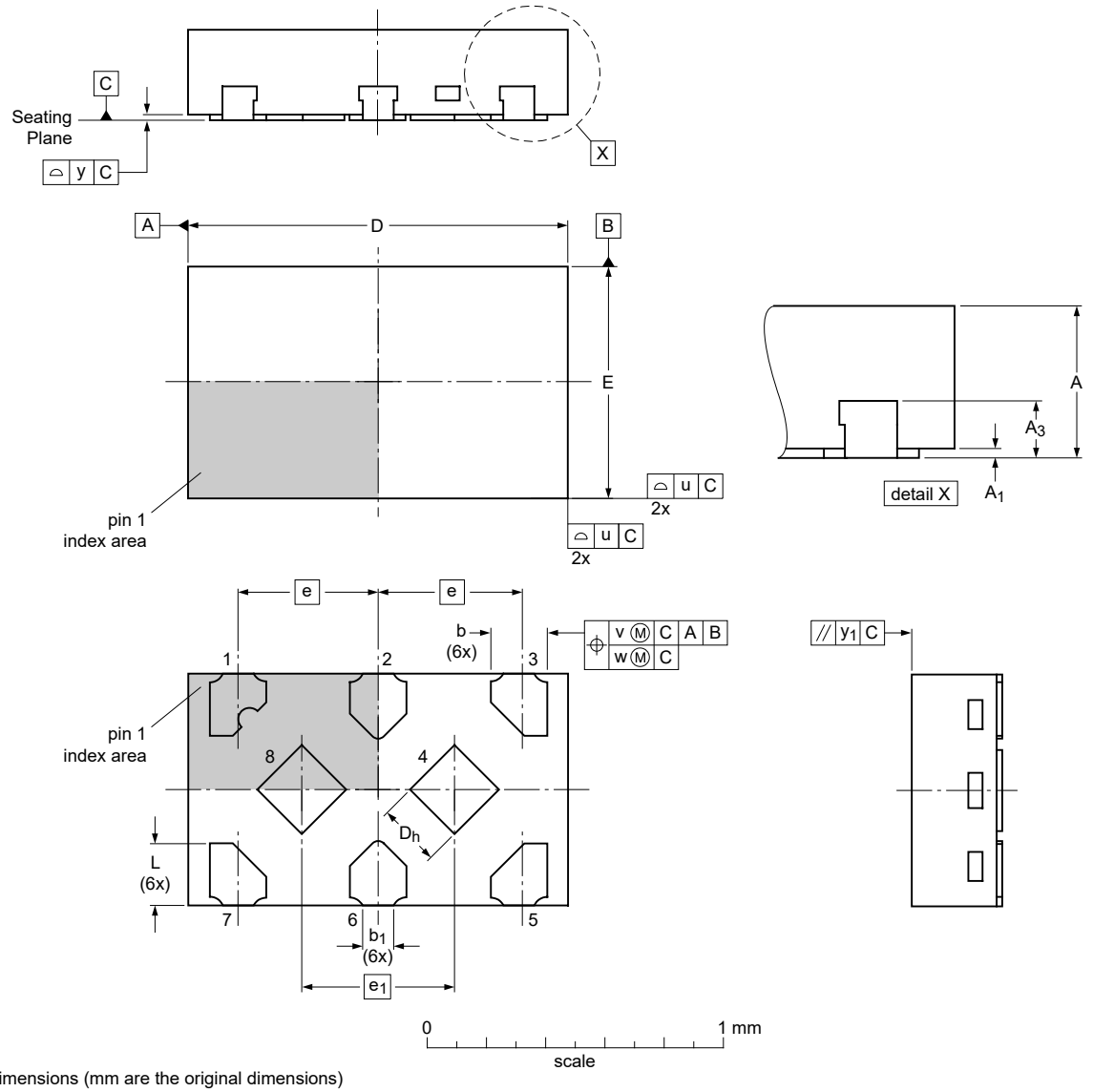
Note
1. Including plating thickness.
2. Visible depending upon used manufacturing technology.

sot1203_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1203						~~10-04-02~~ 10-04-06

Fig. 10. Package outline SOT1203 (XSON8)

X2SON8: plastic thermal enhanced extremely thin small outline package; no leads; 8 terminals; body 1.35 x 0.8 x 0.32 mm **SOT1233-2**



Dimensions (mm are the original dimensions)

Unit		A	A_1	A_3	b	b_1	D	D_h	E	e	e_1	L	u	v	w	y	y_1
mm	max	0.35	0.04	0.10 (Typ.)	0.25	0.11 (ref)	1.35	0.27	0.80	0.50	0.54	0.27	0.05	0.10	0.05	0.05	0.05
	nom	0.32	0.02		0.20			0.22				0.22					
	min	0.30	0.00		0.15			0.17				0.17					

sot1233-2_po

Outline version	References				European projection	Issue date
	IEC	JEDEC	JEITA			
SOT1233-2		---				19-11-12

Fig. 11. Package outline SOT1233-2 (X2SON8)

14. Abbreviations

Table 10. Abbreviations

Acronym	Description
CDM	Charged Device Model
ESD	ElectroStatic Discharge
HBM	Human Body Model
TTL	Transistor-Transistor Logic

15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
LSF0102 v.3	20200904	Product data sheet	-	LSF0102 v.2
Modifications:	• Type number LSF0102DC (SOT765-1/VSSOP8) added.			
LSF0102 v.2	20200818	Product data sheet	-	LSF0102 v.1
Modifications:	• LSF0102GS (SOT1203/XSON8) and LSF0102GX (SOT1233-2/X2SON8) are in production. Removed note from ordering information . • Type number LSF0102DC (SOT765-1/VSSOP8) is in development and removed from this product data sheet. A preliminary data sheet is available upon request.			
LSF0102 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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