

# LSF0102

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

Rev. 3 — 4 September 2020

Product data sheet

## 1. General description

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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  $\geq 100$  MHz down translation at  $\leq 30$  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

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- Bidirectional voltage translation with no direction pin
- Up translation
  - $\leq 100$  MHz;  $C_L = 30$  pF
  - $\leq 40$  MHz;  $C_L = 50$  pF
- Down translation
  - $\geq 100$  MHz;  $C_L = 30$  pF
  - $\leq 40$  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

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

## 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 <sup>[1]</sup>
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

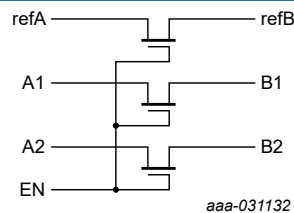
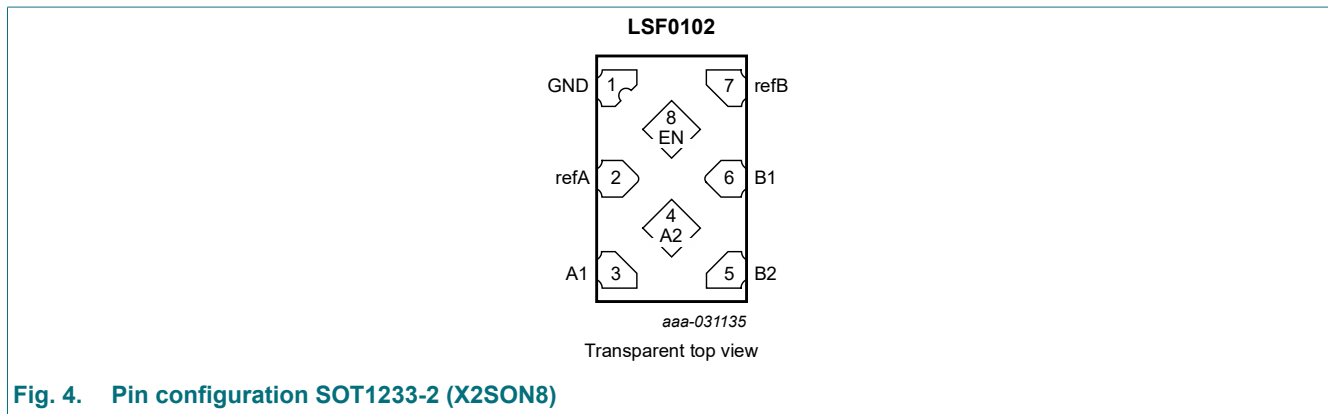
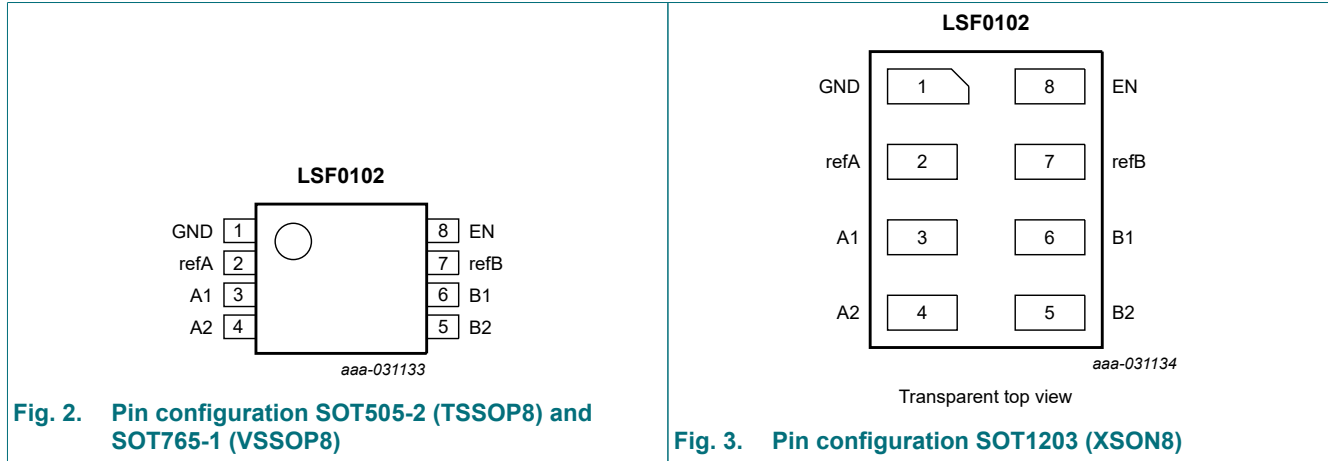


Fig. 1. Logic symbol

## 7. Pinning information

### 7.1. Pinning



### 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/output 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/output current	pins refA, refB, An and Bn; continuous channel current	-	+64	mA
$T_{amb}$	ambient temperature		-40	+125	°C

## 11. Static characteristics

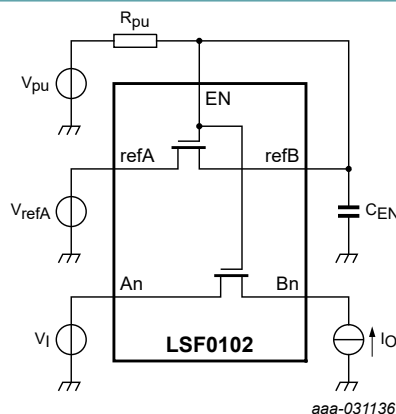
**Table 7. Static characteristics**

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

Symbol	Parameter	Conditions	T <sub>amb</sub> = -40 °C to +125 °C			Unit
			Min	Typ[1]	Max	
V <sub>IK</sub>	input clamping voltage	V <sub>EN</sub> = 0 V; I <sub>I</sub> = -18 mA	-1.2	-	-	V
I <sub>I</sub>	leakage current	pins An, Bn, refA, refB and EN; V <sub>I</sub> = GND to 5.0 V	-	1	5	μA
C <sub>I</sub>	input capacitance	pins refA, refB and EN; V <sub>I</sub> = 0 V or 3 V	-	6	-	pF
C <sub>io(off)</sub>	OFF-state input/output capacitance	pins An, Bn; V <sub>O</sub> = 0 V or 3 V; V <sub>EN</sub> = 0.0 V	-	3	6.0	pF
C <sub>io(on)</sub>	ON-state input/output capacitance	pins An, Bn; V <sub>O</sub> = 0 V or 3 V; V <sub>EN</sub> = 3.0 V	-	6	12.5	pF
R <sub>ON</sub>	ON resistance	see <a href="#">Fig. 5</a> [2]				
		V <sub>I</sub> = 0 V; V <sub>pu</sub> = 5.0 V; I <sub>O</sub> = 64 mA				
		V <sub>refA</sub> = 3.3 V	-	3	-	Ω
		V <sub>refA</sub> = 1.8 V	-	4	-	Ω
		V <sub>refA</sub> = 1.0 V	-	7	-	Ω
		V <sub>I</sub> = 0 V; V <sub>pu</sub> = 5.0 V; I <sub>O</sub> = 32 mA				
		V <sub>refA</sub> = 1.8 V	-	4	-	Ω
		V <sub>refA</sub> = 2.5 V	-	3	-	Ω
		V <sub>I</sub> = 1.8 V; V <sub>pu</sub> = 5.0 V; I <sub>O</sub> = 15 mA				
		V <sub>refA</sub> = 3.3 V	-	4	-	Ω
		V <sub>I</sub> = 1.0 V; V <sub>pu</sub> = 3.3 V; I <sub>O</sub> = 10 mA				
		V <sub>refA</sub> = 1.8 V	-	7	-	Ω
		V <sub>I</sub> = 0 V; V <sub>pu</sub> = 3.3 V; I <sub>O</sub> = 10 mA				
V <sub>refA</sub> = 1.0 V	-	5	-	Ω		
V <sub>I</sub> = 0 V; V <sub>pu</sub> = 1.8 V; I <sub>O</sub> = 10 mA						
V <sub>refA</sub> = 1.0 V	-	6	-	Ω		

[1] All typical values are measured at T<sub>amb</sub> = 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<sub>pu</sub> = 200 kΩ; C<sub>EN</sub> = 100 nF (The An and Bn pins may be exchanged.)

**Fig. 5. Test circuit for measuring R<sub>ON</sub>**

## 12. Dynamic characteristics

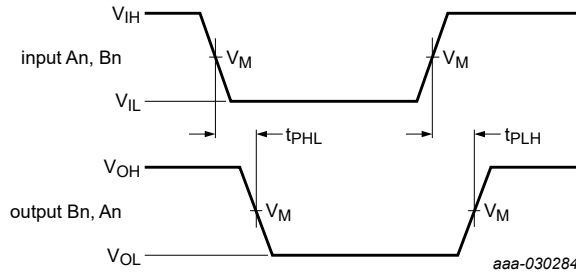
**Table 8. Switching characteristics**

$GND = 0\text{ V}$ ; for waveform see [Fig. 6](#); for test circuit see [Fig. 7](#)

Symbol	Parameter	Conditions	$T_{amb} = -40\text{ °C to }+125\text{ °C}$			Unit
			Min	Typ[1]	Max	
<b>Translating down</b>						
$t_{PLH}$	LOW to HIGH propagation delay	An to Bn or Bn to An; $V_{IH} = V_{pu} = V_{refA} + 1\text{ V}$				
		$V_{refA} = 1.5\text{ V}; C_L = 15\text{ pF}$	-	0.35	-	ns
		$V_{refA} = 1.5\text{ V}; C_L = 30\text{ pF}$	-	0.8	-	ns
		$V_{refA} = 1.5\text{ V}; C_L = 50\text{ pF}$	-	1.2	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 15\text{ pF}$	-	0.3	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 30\text{ pF}$	-	0.7	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 50\text{ pF}$	-	1.1	-	ns
$t_{PHL}$	HIGH to LOW propagation delay	An to Bn or Bn to An; $V_{IH} = V_{pu} = V_{refA} + 1\text{ V}$				
		$V_{refA} = 1.5\text{ V}; C_L = 15\text{ pF}$	-	0.5	-	ns
		$V_{refA} = 1.5\text{ V}; C_L = 30\text{ pF}$	-	1.0	-	ns
		$V_{refA} = 1.5\text{ V}; C_L = 50\text{ pF}$	-	1.3	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 15\text{ pF}$	-	0.4	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 30\text{ pF}$	-	0.8	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 50\text{ pF}$	-	1.2	-	ns
<b>Translating up</b>						
$t_{PLH}$	LOW to HIGH propagation delay	An to Bn or Bn to An; $V_{IH} = V_{refA}; V_{EXT} = V_{pu} = V_{refA} + 1\text{ V}$				
		$V_{refA} = 1.5\text{ V}; C_L = 15\text{ pF}$	-	0.5	-	ns
		$V_{refA} = 1.5\text{ V}; C_L = 30\text{ pF}$	-	0.9	-	ns
		$V_{refA} = 1.5\text{ V}; C_L = 50\text{ pF}$	-	1.1	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 15\text{ pF}$	-	0.4	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 30\text{ pF}$	-	0.8	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 50\text{ pF}$	-	1.0	-	ns
$t_{PHL}$	HIGH to LOW propagation delay	An to Bn or Bn to An; $V_{IH} = V_{refA}; V_{EXT} = V_{pu} = V_{refA} + 1\text{ V}$				
		$V_{refA} = 1.5\text{ V}; C_L = 15\text{ pF}$	-	0.6	-	ns
		$V_{refA} = 1.5\text{ V}; C_L = 30\text{ pF}$	-	1.1	-	ns
		$V_{refA} = 1.5\text{ V}; C_L = 50\text{ pF}$	-	1.3	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 15\text{ pF}$	-	0.4	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 30\text{ pF}$	-	0.9	-	ns
		$V_{refA} = 2.3\text{ V}; C_L = 50\text{ pF}$	-	1.0	-	ns

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

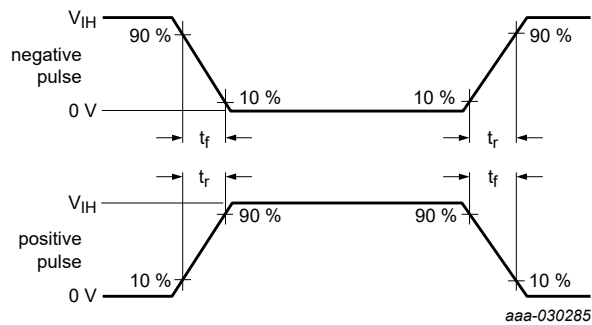
12.1. Waveforms and test circuit



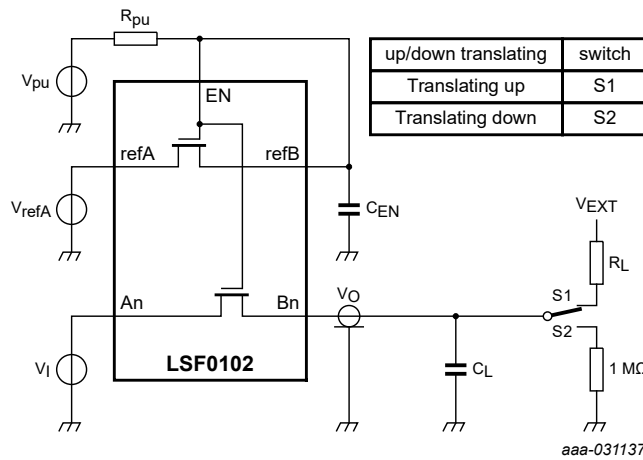
Measurement points are given in [Table 9](#).

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



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  $\leq$  10 MHz;  $Z_O = 50 \Omega$ .

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

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

Table 9. Test data

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

[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

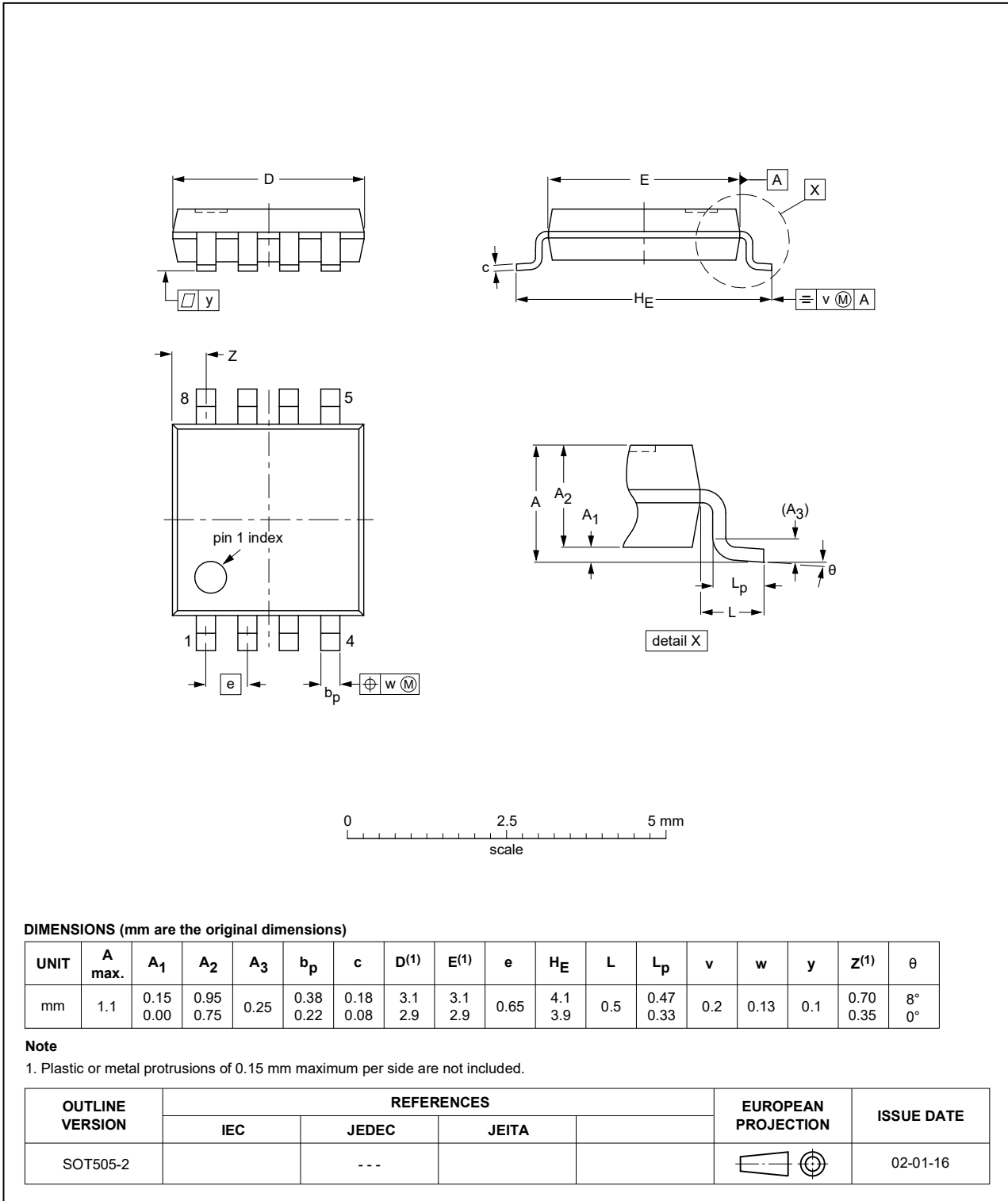


Fig. 8. Package outline SOT505-2 (TSSOP8)

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

SOT765-1

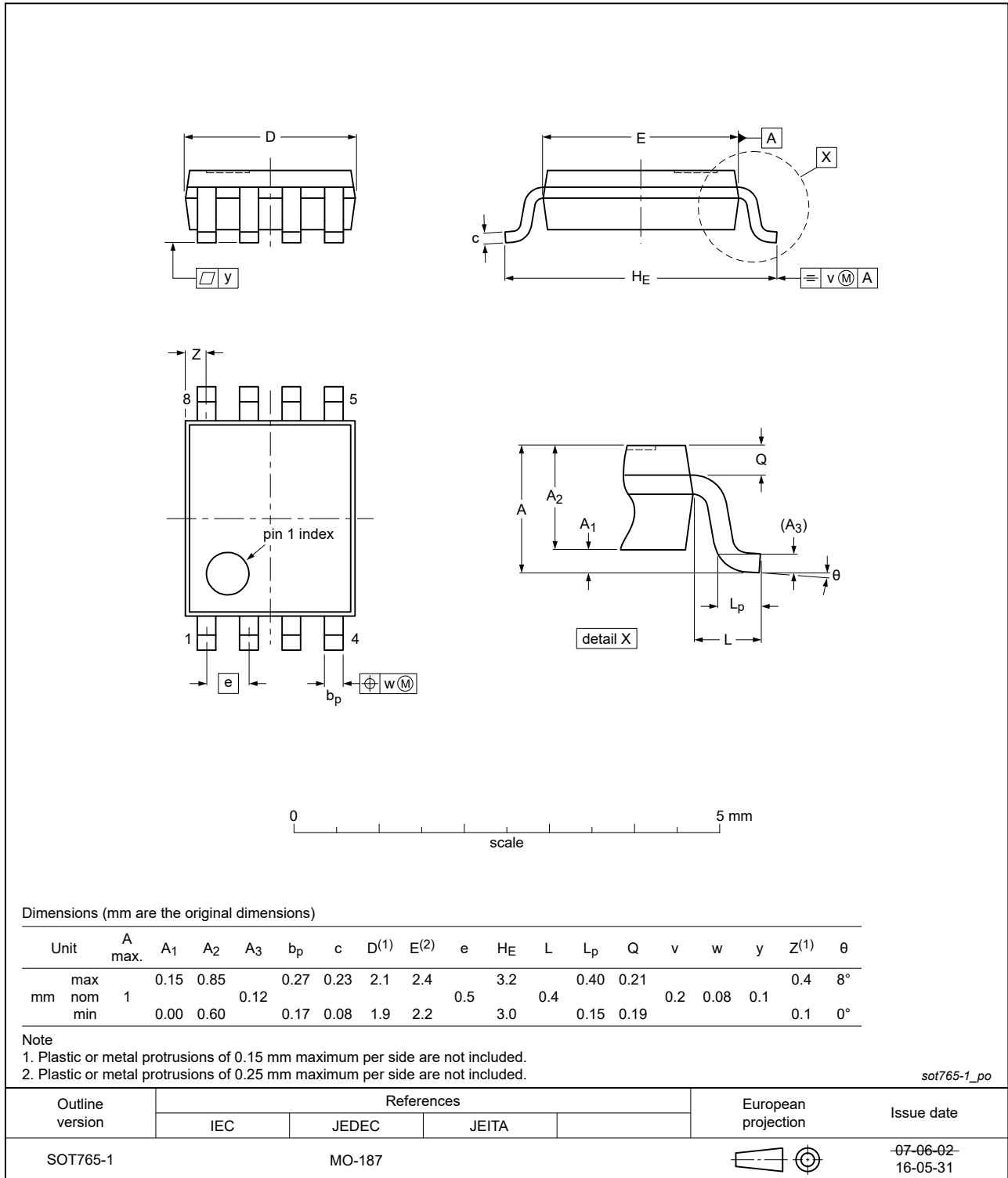


Fig. 9. Package outline SOT765-1 (VSSOP8)

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

SOT1203

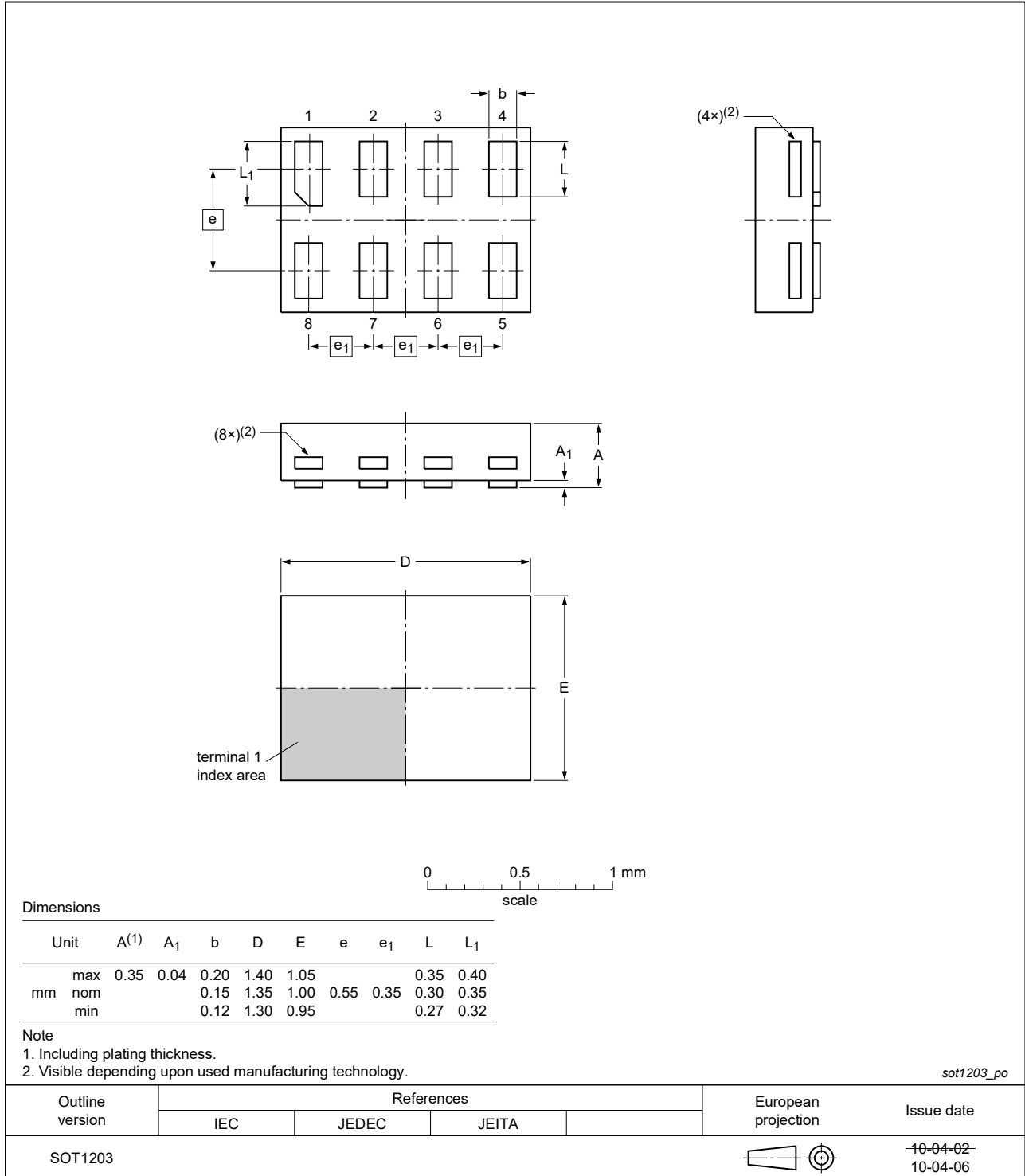


Fig. 10. Package outline SOT1203 (XSON8)

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

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

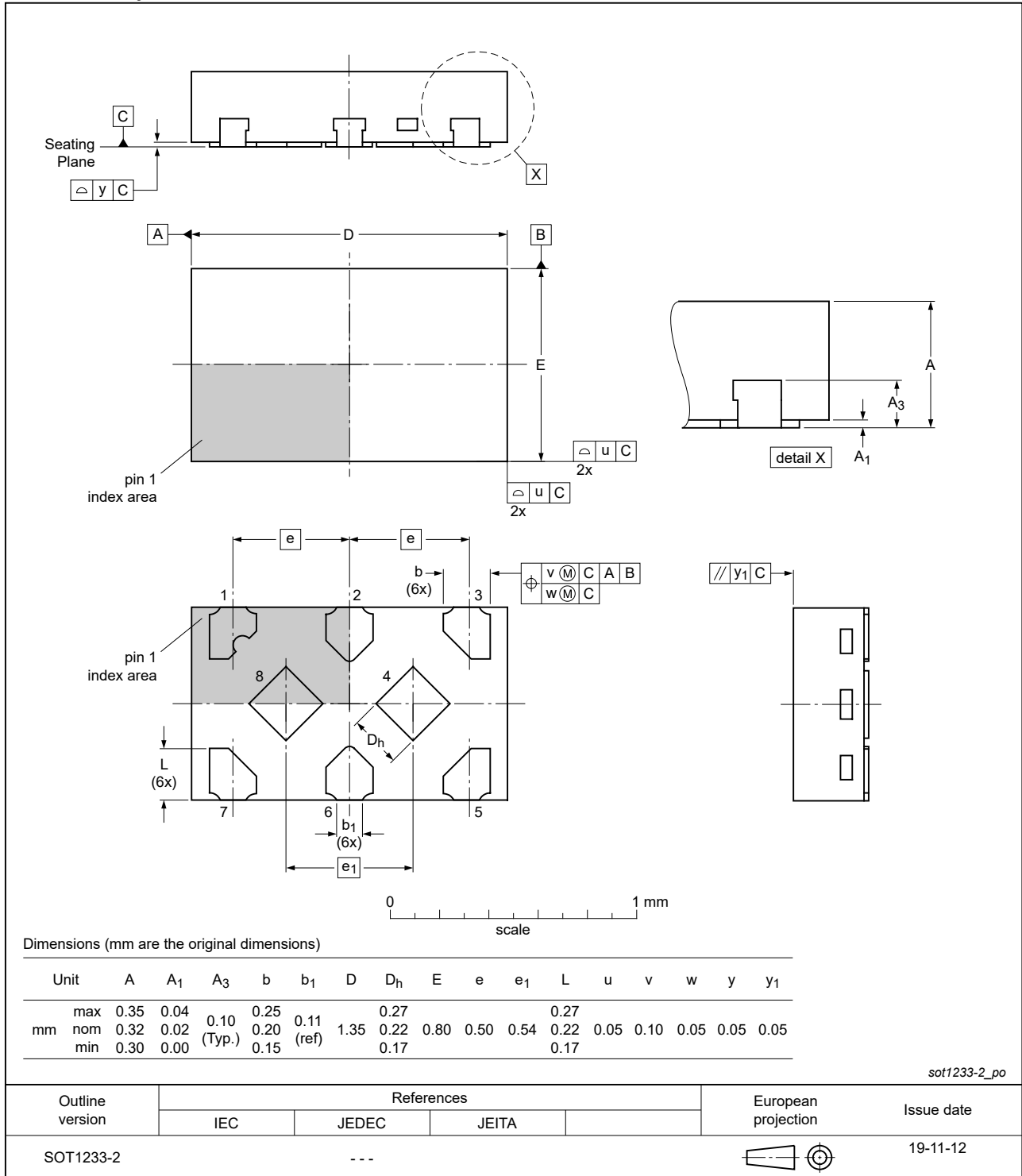


Fig. 11. Package outline SOT1233-2 (X2SON8)

## 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:	<ul style="list-style-type: none"> <li>Type number LSF0102DC (SOT765-1/VSSOP8) added.</li> </ul>			
LSF0102 v.2	20200818	Product data sheet	-	LSF0102 v.1
Modifications:	<ul style="list-style-type: none"> <li>LSF0102GS (SOT1203/XSON8) and LSF0102GX (SOT1233-2/X2SON8) are in production. Removed note from <a href="#">ordering information</a>.</li> <li>Type number LSF0102DC (SOT765-1/VSSOP8) is in development and removed from this product data sheet. A preliminary data sheet is available upon request.</li> </ul>			
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.
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