

LSF0204-Q100

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

Rev. 2 — 28 October 2020

Product data sheet

1. General description

The LSF0204-Q100 is an 4 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 LSF0204-Q100 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.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
 - Specified from -40°C to $+125^{\circ}\text{C}$
- Bidirectional voltage translation with no direction pin
- Up translation
 - ≥ 100 MHz; $C_L = 15$ pF, 30 pF
 - ≥ 80 MHz; $C_L = 50$ pF
- Down translation
 - ≥ 120 MHz; $C_L = 15$ pF, 30 pF
 - ≥ 100 MHz; $C_L = 50$ pF
- Hot insertion
- Bidirectional voltage level translation between:
 - 0.8 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
- 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

3. Applications

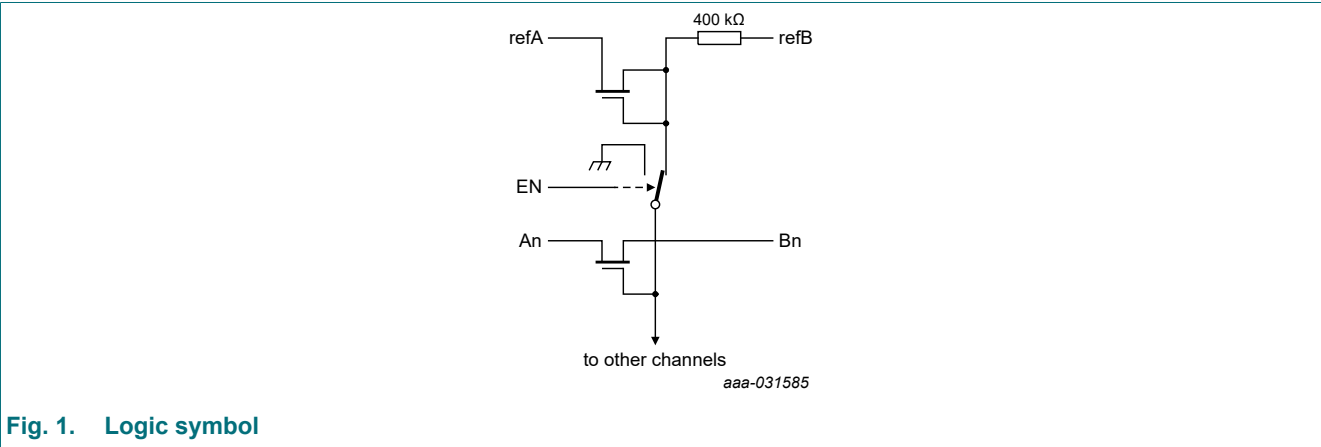
- GPIO, MDIO, PMBus, SMBus, SDIO, UART, I²C, and other interfaces in Telecom infrastructure
- Industrial
- Personal computing

4. Ordering information

Table 1. Ordering information

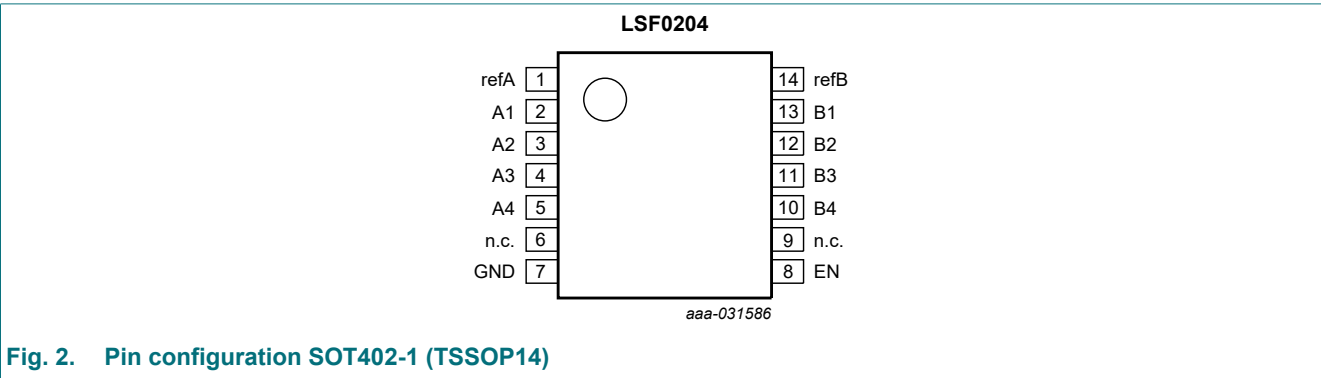
Type number	Package			
	Temperature range	Name	Description	Version
LSF0204PW-Q100	-40 °C to +125 °C	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1

5. Functional diagram



6. Pinning information

6.1. Pinning



6.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
refA	1	reference voltage A (EN input circuit is referenced to refA)
A1, A2, A3, A4	2, 3, 4, 5	data input/output A
n.c.	6, 9	not connected
GND	7	ground (0 V)
EN	8	enable input (active HIGH)
B1, B2, B3, B4	13, 12, 11, 10	data input/output B
refB	14	reference voltage B

7. Functional description

Table 3. Function table

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

Input	input/output
EN ^[1]	An, Bn channel
H	An = Bn
L	Z

[1] EN input circuit is referenced to refA

8. Limiting values

Table 4. 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	^[2]	-	500	mW

[1] The minimum input voltage rating may be exceeded if the input current rating is observed.

[2] For SOT402-1 (TSSOP14) package: P_{tot} derates linearly with 7.3 mW/K above 81 °C.

9. Recommended operating conditions

Table 5. 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
$\Delta t/\Delta V$	input transition rise and fall rate	EN input	-	10	ns/V

10. Static characteristics

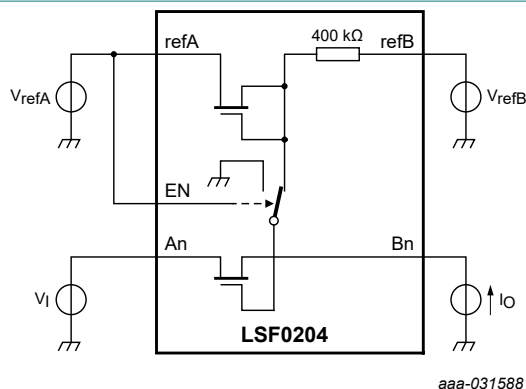
Table 6. Static characteristics

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 _{I(EN)} = 0 V; I _I = -18 mA	-1.2	-	-	V
I _{IH}	HIGH-level input current	V _I = 5 V; V _{I(EN)} = 0 V	-	-	5	μA
I _I	input current	EN input; V _{refA} = 4.5 V; V _{refB} = 5.5 V; V _{I(EN)} = 0 V to V _{refA} ; I _O = 0 A	-	-	±1	μA
V _{IH}	HIGH-level input voltage	EN input				
		V _{refA} = 1.5 V to 4.5 V	0.7V _{refA}	-	-	V
		V _{refA} = 1.0 V to 1.5 V	0.8V _{refA}	-	-	V
V _{IL}	LOW-level input voltage	EN input				
		V _{refA} = 1.5 V to 4.5 V	-	-	0.3V _{refA}	V
		V _{refA} = 1.0 V to 1.5 V	-	-	0.3V _{refA}	V
I _{refB-A}	leakage current refB to refA	V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; I _O = 0 A; V _I = 3.3 V or GND	-	-	3.5	μA
I _{GND}	ground current	V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; I _O = 0 A; V _I = 3.3 V or GND	-	0.2	-	μA
I _{OFF}	power-off leakage current	V _{refA} = V _{refB} = V _{I(EN)} = 0 V; I _O = 0 A; V _I = 5 V or GND	-	-	±1	μA
C _I	input capacitance	pins refA, refB and EN; V _I = 3 V or 0 V	-	7	-	pF
C _{io(off)}	OFF-state input/output capacitance	pins An, Bn; V _O = 0 V or 3 V; V _{I(EN)} = 0 V	-	3	6	pF
C _{io(on)}	ON-state input/output capacitance	pins An, Bn; V _O = 0 V or 3 V; V _{I(EN)} = 3.0 V	-	8	13	pF
R _{ON}	ON resistance	see Fig. 3 [2]				
		V _I = 0 V; I _O = 64 mA;				
		V _{refA} = V _{I(EN)} = 3.3 V; V _{refB} = 5 V	-	3	-	Ω
		V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 5 V	-	4	-	Ω
		V _I = 0 V; I _O = 32 mA;				
		V _{refA} = V _{I(EN)} = 1.0 V; V _{refB} = 5 V	-	7	-	Ω
		V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 5 V	-	4	-	Ω
		V _{refA} = V _{I(EN)} = 2.5 V; V _{refB} = 5 V	-	3.5	-	Ω
		V _I = 1.8 V; I _O = 15 mA; V _{refA} = V _{I(EN)} = 3.3 V; V _{refB} = 5 V	-	5	-	Ω
		V _I = 1 V; I _O = 10 mA; V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V	-	8	-	Ω
		V _I = 0 V; I _O = 10 mA; V _{refA} = V _{I(EN)} = 1 V; V _{refB} = 3.3 V	-	6	-	Ω
		V _I = 0 V; I _O = 10 mA; V _{refA} = V _{I(EN)} = 1 V; V _{refB} = 1.8 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 An and Bn pins may be exchanged.

Fig. 3. Test circuit for measuring R_{ON}

11. Dynamic characteristics

Table 7. Dynamic characteristics

$GND = 0\text{ V}$; for waveforms see [Fig. 4](#) and [Fig. 5](#); for test circuit see [Fig. 6](#)

Symbol	Parameter	Conditions	T _{amb} = -40 °C to +125 °C			Unit
			Min	Typ[1]	Max	
Translating down (3.3 V to 1.8 V)						
t _{PLH}	LOW to HIGH propagation delay	An to Bn or Bn to An				
		V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; V _I = 3.3 V; V _M = 1.15 V				
		C _L = 15 pF	-	0.3	5.19	ns
		C _L = 30 pF	-	0.5	5.29	ns
		C _L = 50 pF	-	0.7	5.49	ns
t _{PHL}	HIGH to LOW propagation delay	An to Bn or Bn to An				
		V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; V _I = 3.3 V; V _M = 1.15 V				
		C _L = 15 pF	-	0.5	4.5	ns
		C _L = 30 pF	-	0.7	4.7	ns
		C _L = 50 pF	-	0.9	4.9	ns
t _{PLZ}	LOW to OFF-state propagation delay	EN to An or Bn				
		V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; V _M = 1.15 V				
		C _L = 15 pF	-	11	15	ns
		C _L = 30 pF	-	12	16.5	ns
		C _L = 50 pF	-	13	18	ns
t _{PZL}	OFF-state to LOW propagation delay	EN to An or Bn				
		V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; V _M = 1.15 V				
		C _L = 15 pF	-	23	37	ns
		C _L = 30 pF	-	30	40	ns
		C _L = 50 pF	-	33	45	ns

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

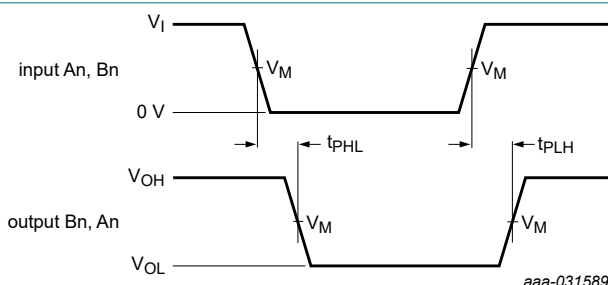
Symbol	Parameter	Conditions	T _{amb} = -40 °C to +125 °C			Unit
			Min	Typ[1]	Max	
f _{max}	maximum frequency	V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; V _I = 3.3 V; V _M = 1.15 V				
		C _L = 15 pF	-	120	-	MHz
		C _L = 30 pF	-	120	-	MHz
		C _L = 50 pF	-	100	-	MHz
Translating down (3.3 V to 1.2 V)						
t _{PLH}	LOW to HIGH propagation delay	An to Bn or Bn to An				
		V _{refA} = V _{I(EN)} = 1.2 V; V _{refB} = 3.3 V; V _I = 3.3 V; V _M = 0.85 V				
		C _L = 15 pF	-	0.3	3.8	ns
		C _L = 30 pF	-	0.5	3.9	ns
		C _L = 50 pF	-	0.8	4.1	ns
t _{PHL}	HIGH to LOW propagation delay	An to Bn or Bn to An				
		V _{refA} = V _{I(EN)} = 1.2 V; V _{refB} = 3.3 V; V _I = 3.3 V; V _M = 0.85 V				
		C _L = 15 pF	-	0.6	4.3	ns
		C _L = 30 pF	-	0.7	4.5	ns
		C _L = 50 pF	-	0.9	4.7	ns
f _{max}	maximum frequency	V _{refA} = V _{I(EN)} = 1.2 V; V _{refB} = 3.3 V; V _I = 3.3 V; V _M = 0.85 V				
		C _L = 15 pF	-	120	-	MHz
		C _L = 30 pF	-	120	-	MHz
		C _L = 50 pF	-	100	-	MHz
		Translating up (1.8 V to 3.3 V)				
t _{PLH}	LOW to HIGH propagation delay	An to Bn or Bn to An				
		V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; V _I = 1.8 V; V _M = 0.9 V				
		C _L = 15 pF	-	0.2	5.1	ns
		C _L = 30 pF	-	0.4	5.3	ns
		C _L = 50 pF	-	0.6	5.7	ns
t _{PHL}	HIGH to LOW propagation delay	An to Bn or Bn to An				
		V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; V _I = 1.8 V; V _M = 0.9 V				
		C _L = 15 pF	-	0.7	5.3	ns
		C _L = 30 pF	-	1	6.4	ns
		C _L = 50 pF	-	1.3	6.7	ns
t _{PLZ}	LOW to OFF-state propagation delay	EN to An or Bn				
		V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; V _M = 0.9 V				
		C _L = 15 pF	-	11	15	ns
		C _L = 30 pF	-	12	16.5	ns
		C _L = 50 pF	-	13	18	ns

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

Symbol	Parameter	Conditions	T _{amb} = -40 °C to +125 °C			Unit
			Min	Typ[1]	Max	
t _{PZL}	OFF-state to LOW propagation delay	EN to An or Bn				
		V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; V _M = 0.9 V				
		C _L = 15 pF	-	23	37	ns
		C _L = 30 pF	-	30	40	ns
		C _L = 50 pF	-	33	45	ns
f _{max}	maximum frequency	V _{refA} = V _{I(EN)} = 1.8 V; V _{refB} = 3.3 V; V _I = 1.8 V; V _M = 0.9 V; R _L = 100 Ω				
		C _L = 15 pF	-	100	-	MHz
		C _L = 30 pF	-	100	-	MHz
		C _L = 50 pF	-	80	-	MHz
Translating up (1.2 V to 1.8 V)						
t _{PLH}	LOW to HIGH propagation delay	An to Bn or Bn to An				
		V _{refA} = V _{I(EN)} = 1.2 V; V _{refB} = 1.8 V; V _I = 1.2 V; V _M = 0.6 V				
		C _L = 15 pF	-	0.2	6.85	ns
		C _L = 30 pF	-	0.4	7.05	ns
		C _L = 50 pF	-	0.65	7.25	ns
t _{PHL}	HIGH to LOW propagation delay	An to Bn or Bn to An				
		V _{refA} = V _{I(EN)} = 1.2 V; V _{refB} = 1.8 V; V _I = 1.2 V; V _M = 0.6 V				
		C _L = 15 pF	-	1	5.4	ns
		C _L = 30 pF	-	1.3	6.5	ns
		C _L = 50 pF	-	1.6	7.03	ns
f _{max}	maximum frequency	V _{refA} = V _{I(EN)} = 1.2 V; V _{refB} = 1.8 V; V _I = 1.2 V; V _M = 0.6 V; R _L = 100 Ω				
		C _L = 15 pF	-	100	-	MHz
		C _L = 30 pF	-	100	-	MHz
		C _L = 50 pF	-	80	-	MHz

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

11.1. Waveforms and test circuit



Measurement points are given in [Table 8](#).

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

Fig. 4. The data input (An, Bn) to output (Bn, An) propagation delay times

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

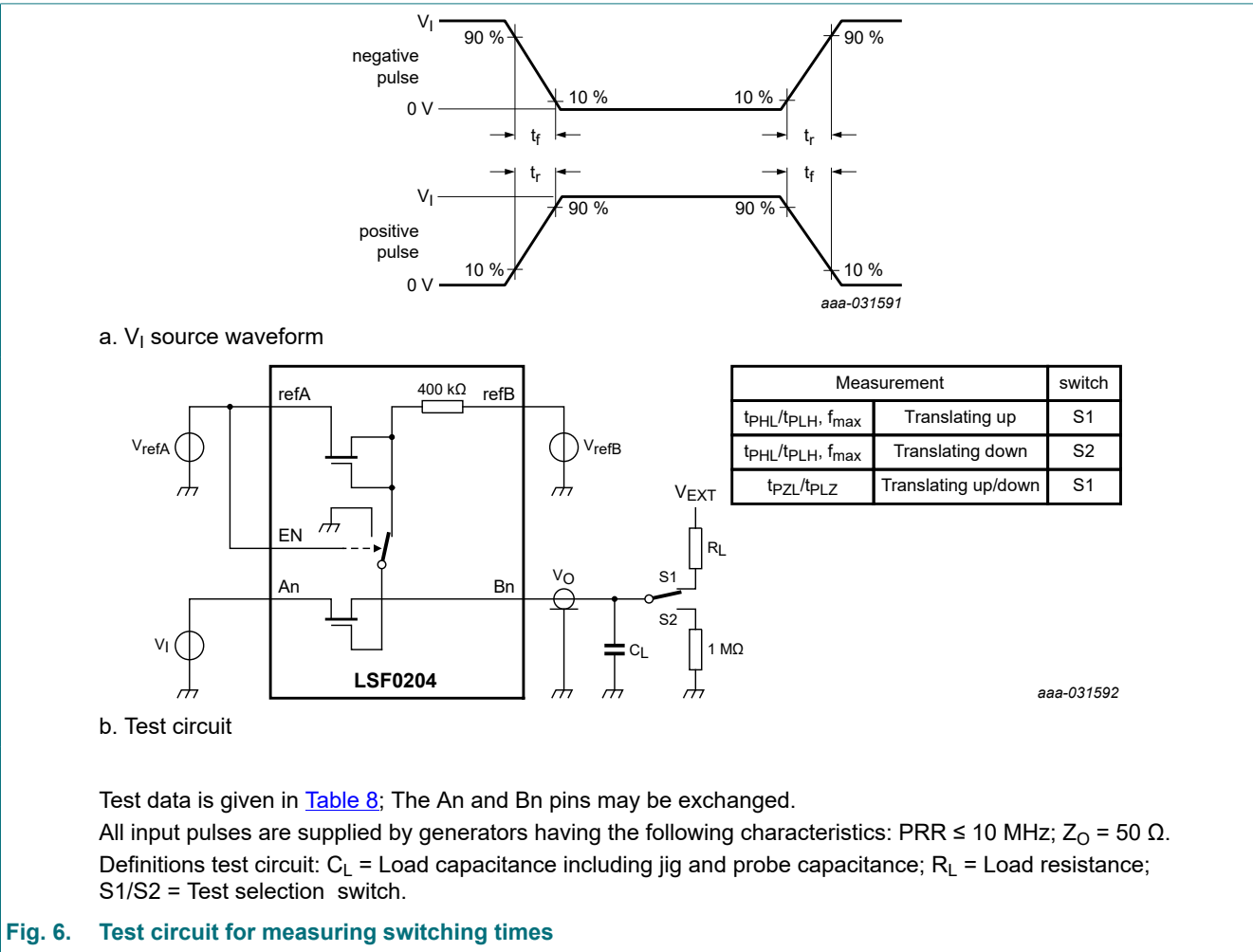
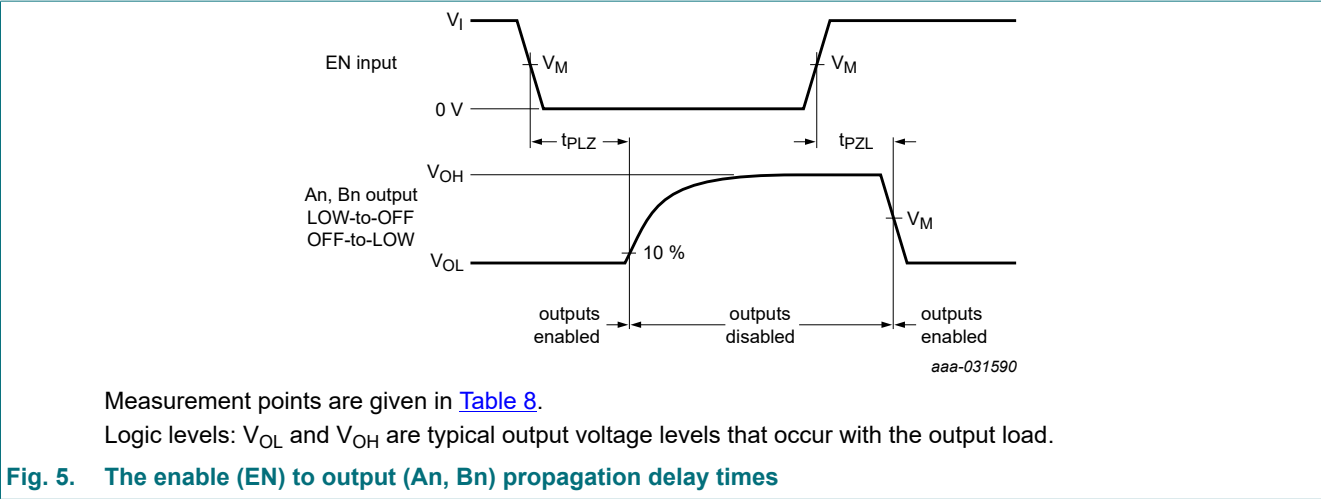


Fig. 6. Test circuit for measuring switching times

Table 8. Test data

Input	Load		V_{EXT}	
t_r, t_f	C_L	R_L		
		$t_{PLH}, t_{PHL}, t_{PLZ}, t_{PZL}$	f_{max}	$t_{PLH}, t_{PHL}, f_{max}$ t_{PLZ}, t_{PZL} [1]
$\leq 2 \text{ ns}$	15 pF, 30 pF, 50 pF	500 Ω	100 Ω	V_{refB} V_{refA}, V_{refB}

[1] For measuring t_{PLZ}, t_{PZL} (translating up) $V_{EXT} = V_{refB}$.
For measuring t_{PLZ}, t_{PZL} (translating down) $V_{EXT} = V_{refA}$.

12. Package outline

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1

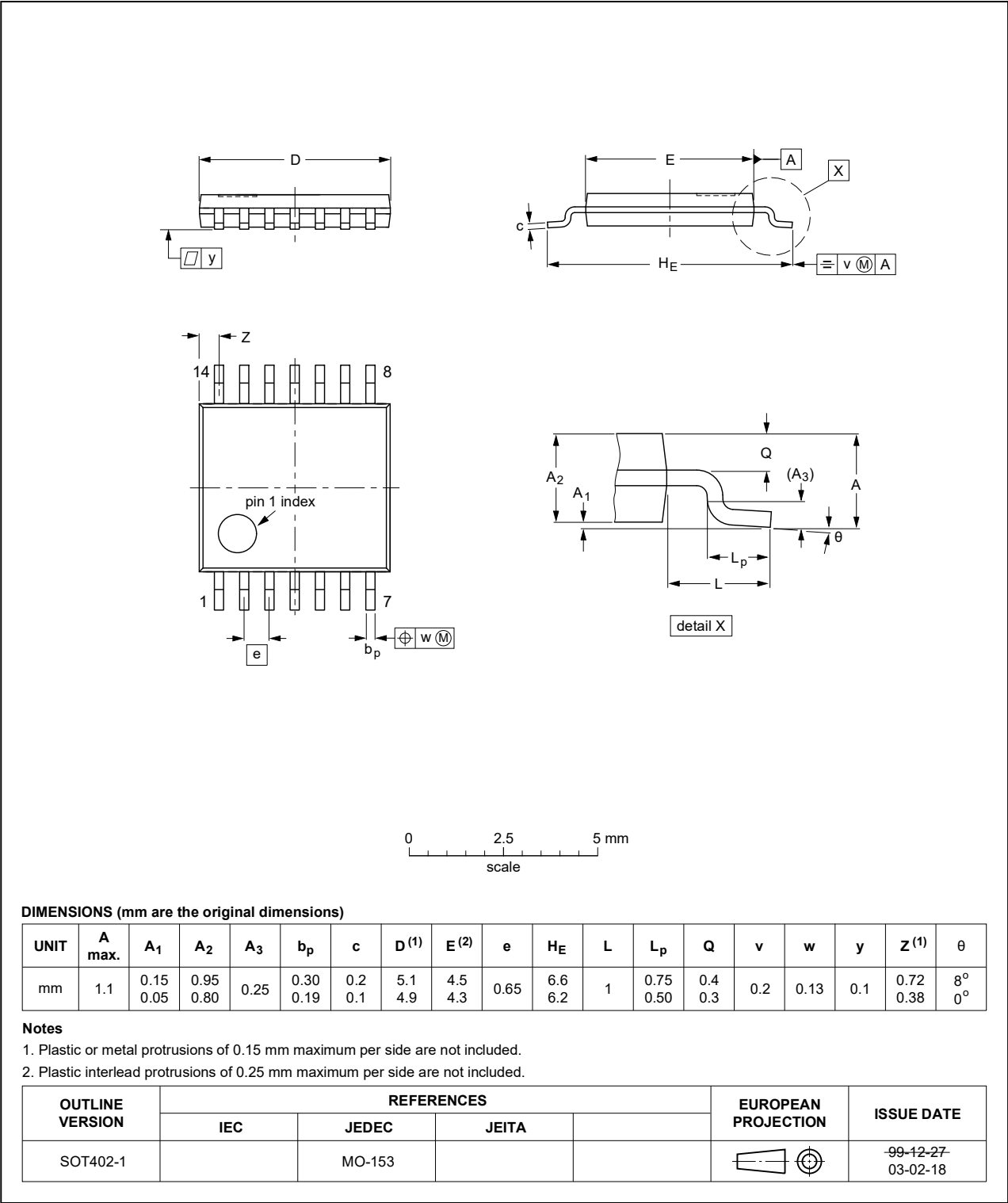


Fig. 7. Package outline SOT402-1 (TSSOP14)

13. Abbreviations

Table 9. Abbreviations

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

14. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
LSF0204_Q100 v.2	20201028	Product data sheet	-	LSF0204_Q100 v.1
Modifications:	<ul style="list-style-type: none">• Section 2 updated.• Table 7: f_{\max} values corrected.			
LSF0204_Q100 v.1	20200818	Product data sheet	-	-

15. 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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