

LSF0204

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

Rev. 3 — 28 November 2023

Product data sheet

1. General description

The LSF0204 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 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; $C_L = 15$ pF, 30 pF
 - ≤ 50 MHz; $C_L = 50$ pF
- Down translation
 - ≥ 100 MHz; $C_L = 15$ pF, 30 pF
 - ≥ 50 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 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, I²C, and other interfaces in Telecom infrastructure
- Industrial
- Personal computing

4. Ordering information

Table 1. Ordering information

| Type number | Package | | | Version |
|-----------------------------|-------------------|---------|--|---------------------------|
| | Temperature range | Name | Description | |
| LSF0204PW | -40 °C to +125 °C | TSSOP14 | plastic thin shrink small outline package; 14 leads; body width 4.4 mm | SOT402-1 |
| LSF0204GU12 | -40 °C to +125 °C | XQFN12 | plastic, extremely thin quad flat package; no leads; 12 terminals; body 1.70 × 2.0 × 0.50 mm | SOT1174-1 |

5. Functional diagram

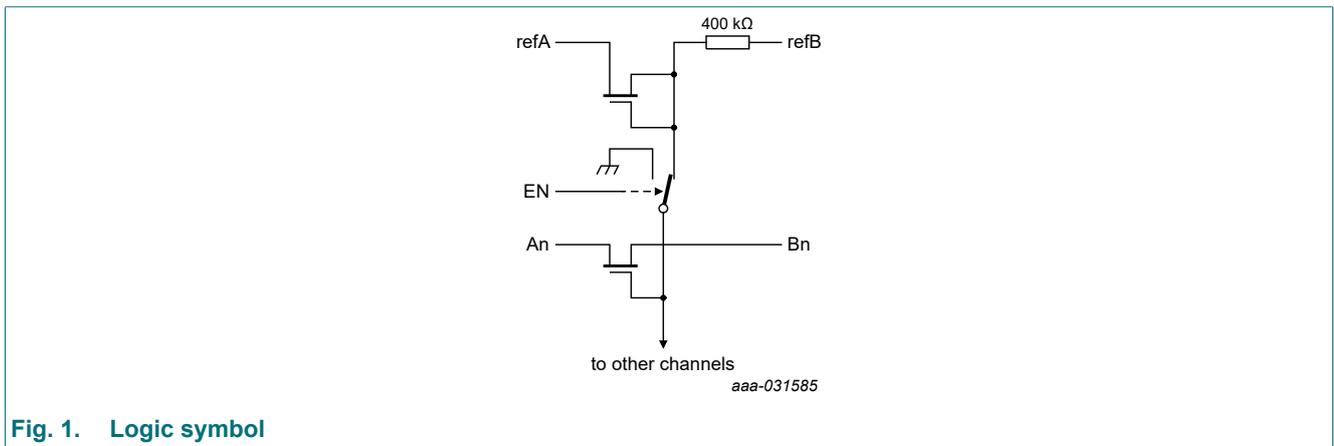


Fig. 1. Logic symbol

6. Pinning information

6.1. Pinning

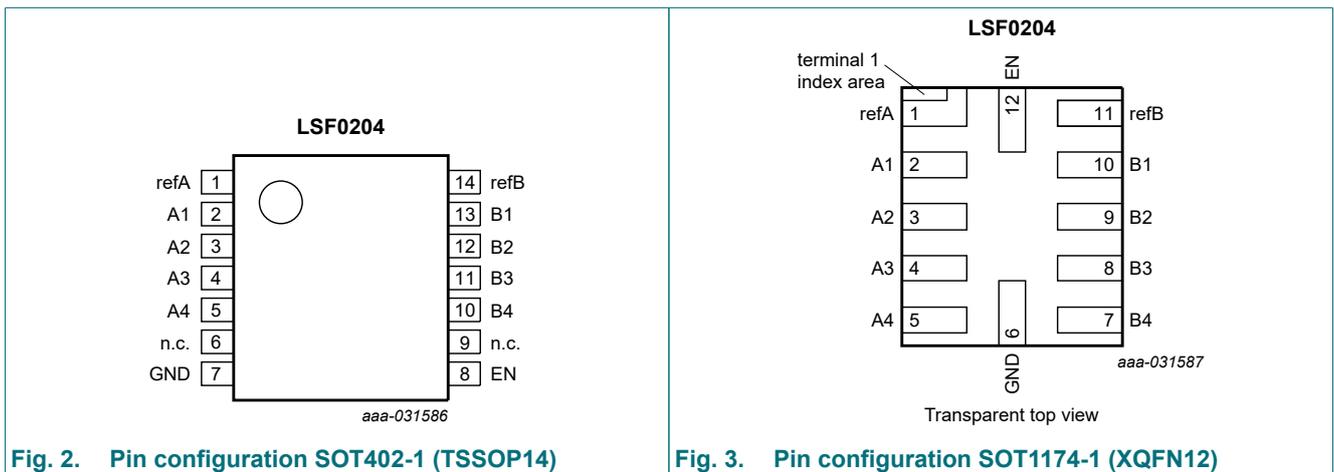


Fig. 2. Pin configuration SOT402-1 (TSSOP14)

Fig. 3. Pin configuration SOT1174-1 (XQFN12)

6.2. Pin description

Table 2. Pin description

| Symbol | Pin | | Description |
|----------------|----------------|-------------|--|
| | TSSOP14 | XQFN12 | |
| refA | 1 | 1 | reference voltage A (EN input circuit is referenced to refA) |
| A1, A2, A3, A4 | 2, 3, 4, 5 | 2, 3, 4, 5 | data input/output A |
| n.c. | 6, 9 | - | not connected |
| GND | 7 | 6 | ground (0 V) |
| EN | 8 | 12 | enable input (active HIGH) |
| B1, B2, B3, B4 | 13, 12, 11, 10 | 10, 9, 8, 7 | data input/output B |
| refB | 14 | 11 | 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 | TSSOP14 package [2] | - | 500 | mW |
| | | XQFN12 package | - | 250 | 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

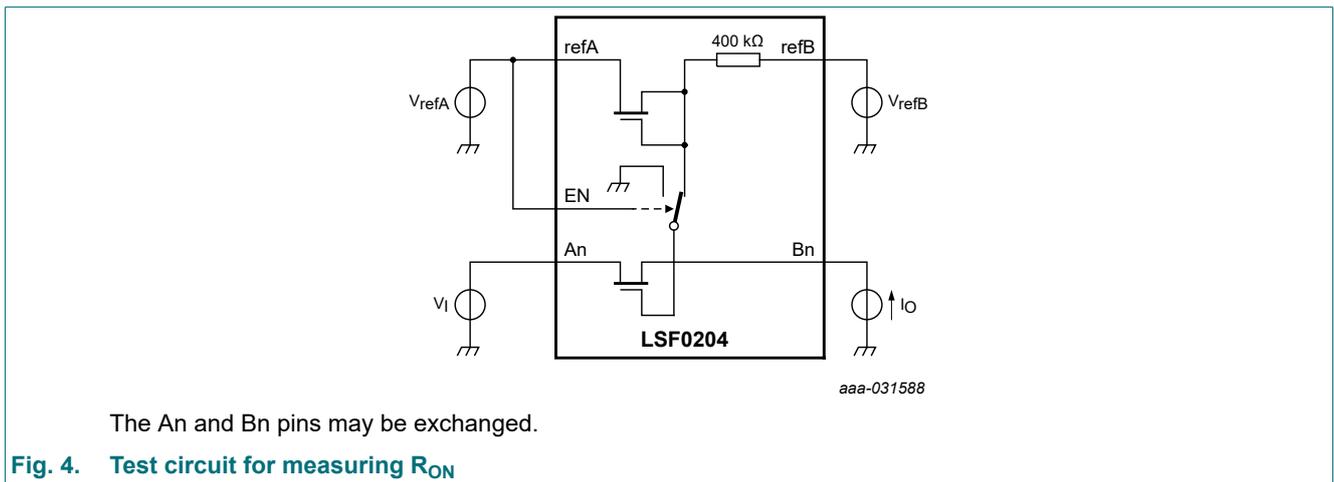
At recommended operating conditions voltages are referenced to GND (ground = 0 V).

| Symbol | Parameter | Conditions | $T_{amb} = -40\text{ °C to }+125\text{ °C}$ | | | Unit |
|---------------|------------------------------------|--|---|---------|---------------|---------------|
| | | | Min | Typ [1] | Max | |
| V_{IK} | input clamping voltage | $V_{I(EN)} = 0\text{ V}; I_I = -18\text{ mA}$ | -1.2 | - | - | V |
| I_{IH} | HIGH-level input current | $V_I = 5\text{ V}; V_{I(EN)} = 0\text{ V}$ | - | - | 5 | μA |
| I_I | input current | EN input; $V_{refA} = 4.5\text{ V}; V_{refB} = 5.5\text{ V}; V_{I(EN)} = 0\text{ V to }V_{refA}; I_O = 0\text{ A}$ | - | - | ± 1 | μA |
| V_{IH} | HIGH-level input voltage | EN input | | | | |
| | | $V_{refA} = 1.5\text{ V to }4.5\text{ V}$ | $0.7V_{refA}$ | - | - | V |
| | | $V_{refA} = 1.0\text{ V to }1.5\text{ V}$ | $0.8V_{refA}$ | - | - | V |
| V_{IL} | LOW-level input voltage | EN input | | | | |
| | | $V_{refA} = 1.5\text{ V to }4.5\text{ V}$ | - | - | $0.3V_{refA}$ | V |
| | | $V_{refA} = 1.0\text{ V to }1.5\text{ V}$ | - | - | $0.3V_{refA}$ | V |
| I_{refB-A} | leakage current refB to refA | $V_{refA} = V_{I(EN)} = 1.8\text{ V}; V_{refB} = 3.3\text{ V}; I_O = 0\text{ A}; V_I = 3.3\text{ V or GND}$ | - | - | 3.5 | μA |
| I_{GND} | ground current | $V_{refA} = V_{I(EN)} = 1.8\text{ V}; V_{refB} = 3.3\text{ V}; I_O = 0\text{ A}; V_I = 3.3\text{ V or GND}$ | - | 0.2 | - | μA |
| I_{OFF} | power-off leakage current | $V_{refA} = V_{refB} = V_{I(EN)} = 0\text{ V}; I_O = 0\text{ A}; V_I = 5\text{ V or GND}$ | - | - | ± 1 | μA |
| C_I | input capacitance | pins refA, refB and EN; $V_I = 3\text{ V or }0\text{ V}$ | - | 7 | - | pF |
| $C_{io(off)}$ | OFF-state input/output capacitance | pins An, Bn; $V_O = 0\text{ V or }3\text{ V}; V_{I(EN)} = 0\text{ V}$ | - | 3 | 6 | pF |
| $C_{io(on)}$ | ON-state input/output capacitance | pins An, Bn; $V_O = 0\text{ V or }3\text{ V}; V_{I(EN)} = 3.0\text{ V}$ | - | 8 | 13 | pF |

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 | |
| R _{ON} | ON resistance | see Fig. 4 [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.



11. Dynamic characteristics

Table 7. Dynamic characteristics

GND = 0 V; for waveforms see Fig. 5 and 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 (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 |

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 _{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 |
| 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 |

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

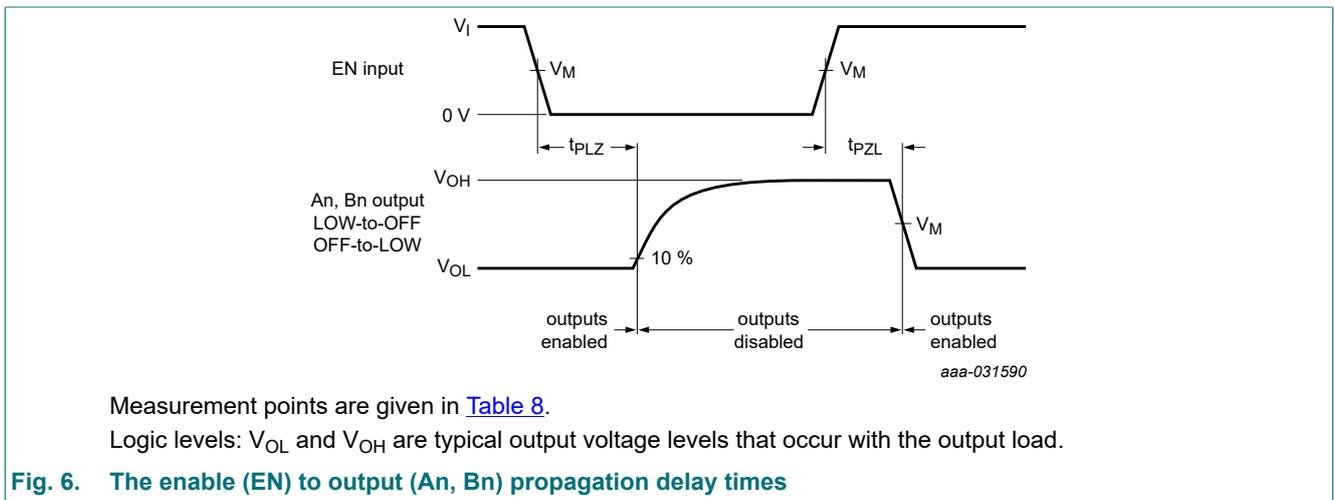
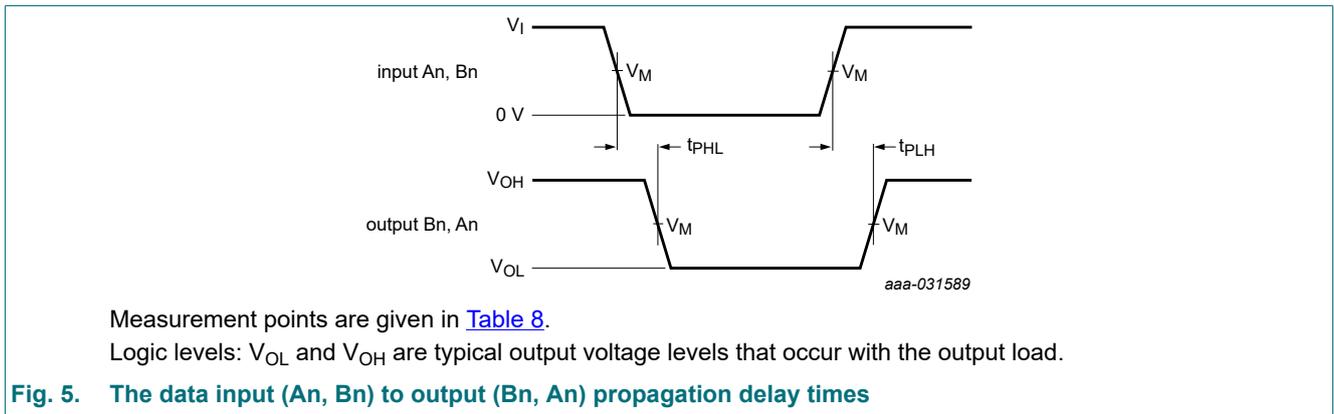
| Symbol | Parameter | Conditions | T _{amb} = -40 °C to +125 °C | | | Unit |
|--|------------------------------------|--|--------------------------------------|--------|------|------|
| | | | Min | Typ[1] | Max | |
| Translating up (1.8 V to 3.3 V) | | | | | | |
| t _{PLH} | LOW to HIGH propagation 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| 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 |
| t _{PHL} | HIGH to LOW propagation delay | C _L = 50 pF | - | 1.6 | 7.03 | 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)} = 1.2 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 °C.

11.1. Waveforms and test circuit



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

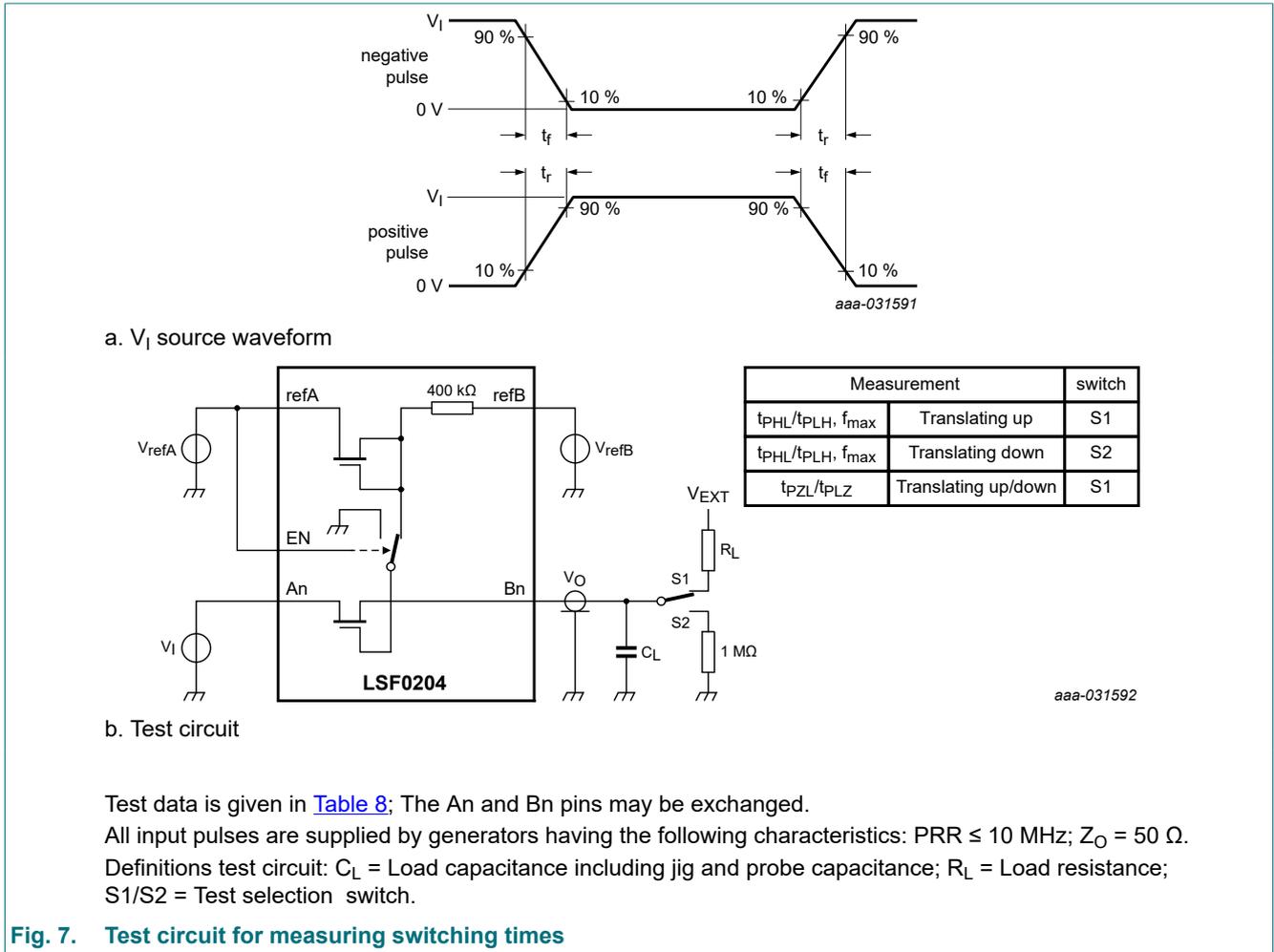


Table 8. Test data

| Input t_r, t_f | Load | | V_{EXT} | | |
|---------------------|---------------------|--------------------------------------|--------------|-----------------------------|------------------------|
| | 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] |
| ≤ 2 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

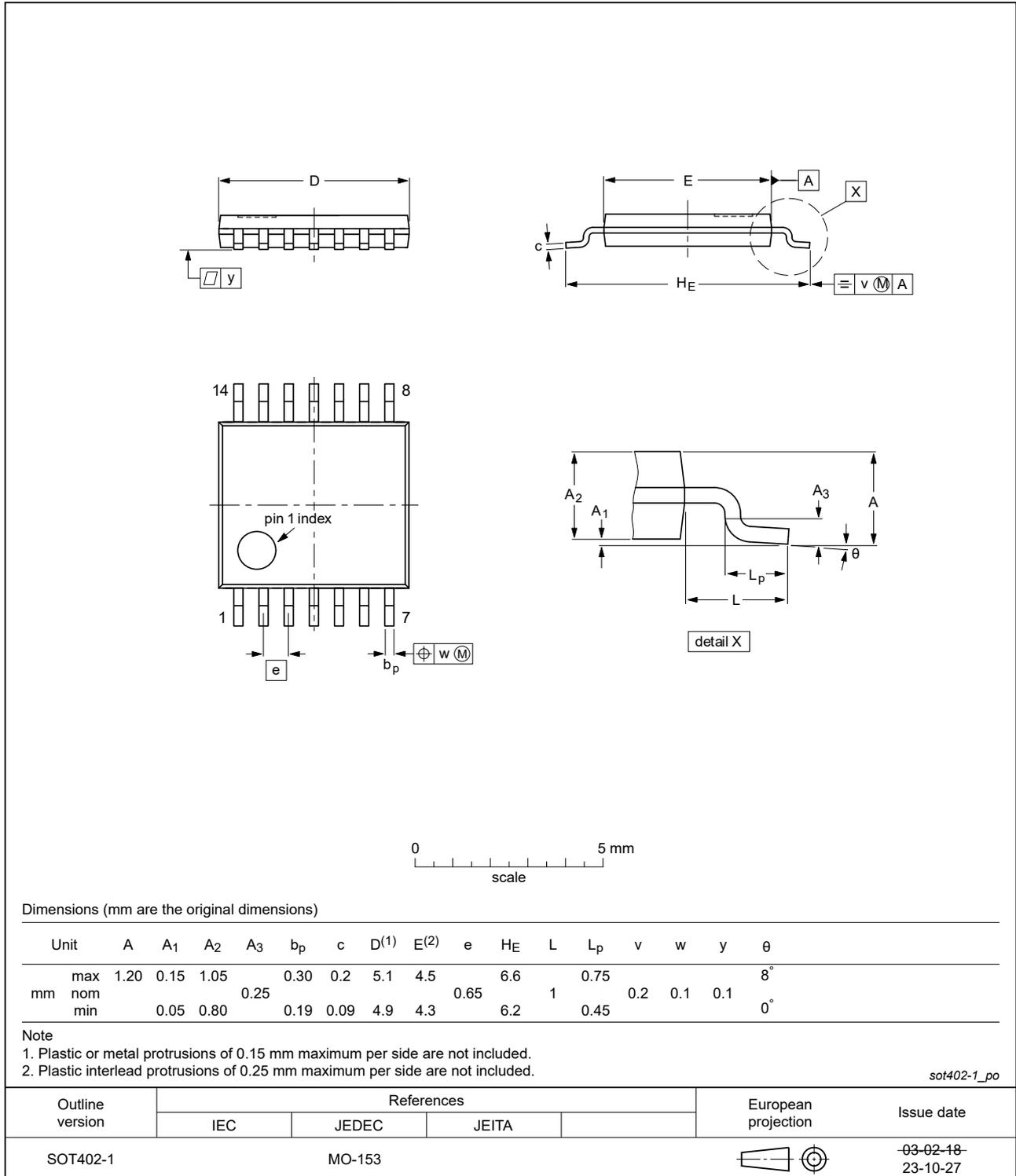


Fig. 8. Package outline SOT402-1 (TSSOP14)

XQFN12: plastic, extremely thin quad flat package; no leads;
12 terminals; body 1.70 x 2.00 x 0.50 mm

SOT1174-1

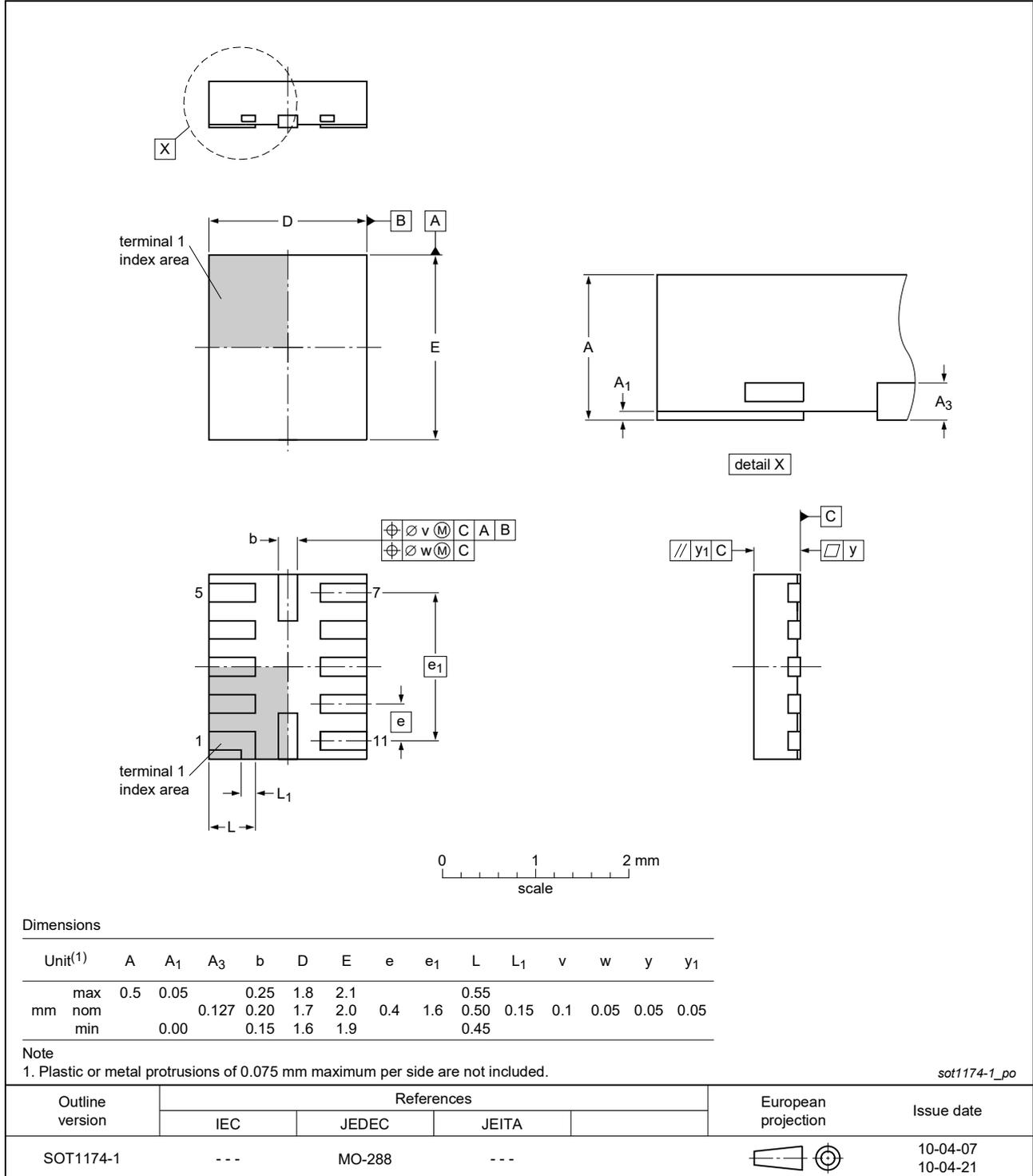


Fig. 9. Package outline SOT1174-1 (XQFN12)

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 v.3 | 20231128 | Product data sheet | - | LSF0204 v.2 |
| Modifications: | <ul style="list-style-type: none"> • Section 2: up- and down-translation typo corrected. • Fig. 8: SOT402-1 package outline drawing changed. | | | |
| LSF0204 v.2 | 20201028 | Product data sheet | - | LSF0204 v.1 |
| Modifications: | <ul style="list-style-type: none"> • Section 2 updated. • Table 7: f_{\max} values corrected. | | | |
| LSF0204 v.1 | 20200518 | 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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For more information, please visit: <http://www.nexperia.com>

For sales office addresses, please send an email to: salesaddresses@nexperia.com

Date of release: 28 November 2023
