

# NCA9306-Q100

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

Rev. 1 — 11 February 2022

Product data sheet

## 1. General description

The NCA9306-Q100 is a 2 channel bidirectional I<sup>2</sup>C and SMBus multi-voltage level translator with an enable (EN) pin input. It allows voltage translation between 0.95 V and 5 V without the use of a direction pin. It supports up to 100 MHz up translation and >100 MHz down translation at  $\leq 30$  pF capacitive load. There is no need for a direction pin which minimizes the system effort. The NCA9306-Q100 supports 5 V tolerant I/O pins to support mixed mode signal operation. 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.

The low ON-state resistance  $R_{ON}$  of the switch allows connections to be made with minimal propagation delay. When EN is HIGH, the translator switch is on, and the SCLA and SDAA I/O are connected to the SCLB and SDAB I/O respectively, allowing bidirectional data flow between ports. When EN is LOW, the translator switch is off, and a high-impedance state exists between ports. As with the standard I<sup>2</sup>C bus-system, pull-up resistors are required to provide the logic HIGH levels on the translators bus. The NCA9306-Q100 has a standard open-drain configuration of the I<sup>2</sup>C-bus. The size of these pull-up resistors depend on the system. Each side of the translator must have a pull-up resistors. NCA9306-Q100 is designed to work with Standard-mode, Fast-mode and Fast-mode plus I<sup>2</sup>C bus devices in addition to the SMBus devices.

When the SDAA or SDAB pin is LOW, the clamp is in the ON-state and a low resistance connections exists between the SDAA and SDAB ports. Assuming the higher voltage is on the SDAB port when the SDAB port is HIGH, the voltage on the SDAA port is limited to the voltage set by refA. When the SDAA port is HIGH, the SDAB port is pulled to the refB supply voltage by the pull-up resistors. The SCLA or SCLB pins also follows the same behavior as described for SDAA or SDAB pins.

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 °C
- 2-channel bidirectional voltage translator for SDA and SCL lines in mixed mode I<sup>2</sup>C bus applications
- Open-drain I<sup>2</sup>C-bus I/O ports (SCLA, SDAA, SCLB and SDAB)
- Provides bidirectional voltage translation with no direction pin
- High-impedance SCLA, SDAA, SCLB and SDAB for EN = LOW
- 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

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

- 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<sup>2</sup>C-bus I/O pins to support mixed mode signal operation
- Low R<sub>ON</sub> 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

3. Applications

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

4. Ordering information

Table 1. Ordering information

| Type number    | Package           |        |   |          |
|----------------|-------------------|--------|---|----------|
|                | Temperature range | Name   | Description   | Version  |
| NCA9306DC-Q100 | -40 °C to +125 °C | VSSOP8 | plastic very thin shrink small outline package;<br>8 leads; body width 2.3 mm | SOT765-1 |

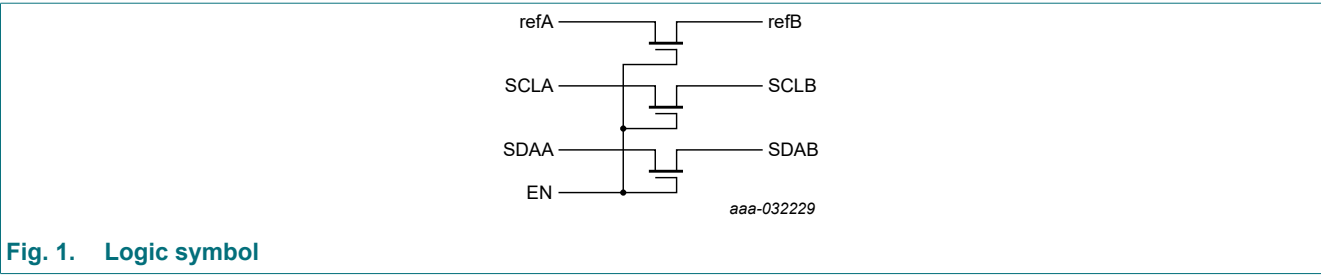
5. Marking

Table 2. Marking

| Type number    | Marking code <sup>[1]</sup> |
|----------------|-----------------------------|
| NCA9306DC-Q100 | h9                          |

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

6. Functional diagram



7. Pinning information

7.1. Pinning

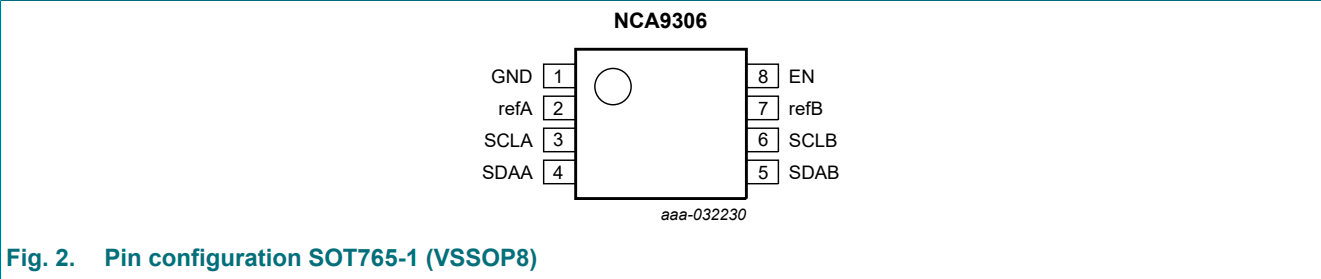


Fig. 2. Pin configuration SOT765-1 (VSSOP8)

7.2. Pin description

Table 3. Pin description

| Symbol     | Pin  | Description  |
|------------|------|--|
| GND        | 1    | ground (0 V)   |
| refA       | 2    | low-voltage side reference supply voltage for SCLA and SDAA  |
| SCLA, SCLB | 3, 6 | data input/output SCL  |
| SDAA, SDAB | 4, 5 | data input/output SDA  |
| refB       | 7    | high-voltage side reference supply voltage for SCLB and SDAB |
| 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    | SCLn, SDAn channel       |
| H     | SCLA = SCLB; SDAA = SDAB |
| 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, SCLn, SDAn and EN [1]                  | -0.5 | +7.0 | V    |
| $I_{I/O}$ | input/output current    | pins refA, refB, SCLn, SDAn; 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 SOT765-1 (VSSOP8) package:  $P_{tot}$  derates linearly with 4.9 mW/K above 99 °C.

## 10. Recommended operating conditions

Table 6. Recommended operating conditions

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

## 11. Static characteristics

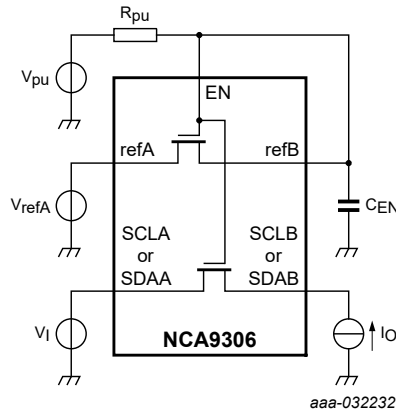
Table 7. Static characteristics

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

| Symbol        | Parameter                          | Conditions   | $T_{amb} = -40\text{ °C to }+125\text{ °C}$ |        |      | Unit |
|---------------|------------------------------------|--|---|--------|------|------|
|               |                                    |  | Min   | Typ[1] | Max  |      |
| $V_{IK}$      | input clamping voltage             | $V_{EN} = 0\text{ V}$ ; $I_I = -18\text{ mA}$                                    | -1.2  | -      | -    | V    |
| $I_I$         | leakage current                    | pins SCLn, SDAn, refA, refB and EN;<br>$V_I = \text{GND to } 5.0\text{ V}$       | -   | 1      | 5    | μA   |
| $C_I$         | input capacitance                  | pins refA, refB and EN; $V_I = 0\text{ V or } 3\text{ V}$                        | -   | 6      | -    | pF   |
| $C_{io(off)}$ | OFF-state input/output capacitance | pins SCLn, SDAn; $V_O = 0\text{ V or } 3\text{ V}$ ; $V_{EN} = 0.0\text{ V}$     | -   | 3.0    | 6.0  | pF   |
| $C_{io(on)}$  | ON-state input/output capacitance  | pins SCLn, SDAn; $V_O = 0\text{ V or } 3\text{ V}$ ; $V_{EN} = 3.0\text{ V}$     | -   | 6.0    | 12.5 | pF   |
| $R_{ON}$      | ON resistance                      | see Fig. 3   |   |        |      |      |
|               |                                    | $V_I = 0\text{ V}$ ; $V_{pu} = 5.0\text{ V}$ ; $I_O = 64\text{ mA}$ [2]          |   |        |      |      |
|               |                                    | $V_{refA} = 3.3\text{ V}$  | -   | 3      | 7    | Ω    |
|               |                                    | $V_{refA} = 1.8\text{ V}$  | -   | 4      | 10   | Ω    |
|               |                                    | $V_I = 0\text{ V}$ ; $V_{refB} = V_{EN} = 5.0\text{ V}$ ; $I_O = 32\text{ mA}$   |   |        |      |      |
|               |                                    | $V_{refA} = 1.8\text{ V}$  | -   | 4      | 9    | Ω    |
|               |                                    | $V_{refA} = 2.5\text{ V}$  | -   | 3      | 8    | Ω    |
|               |                                    | $V_I = 1.8\text{ V}$ ; $V_{refB} = V_{EN} = 5.0\text{ V}$ ; $I_O = 15\text{ mA}$ |   |        |      |      |
|               |                                    | $V_{refA} = 3.3\text{ V}$  | -   | 4      | 13   | Ω    |
|               |                                    | $V_I = 1.0\text{ V}$ ; $V_{refB} = V_{EN} = 3.3\text{ V}$ ; $I_O = 10\text{ mA}$ |   |        |      |      |
|               |                                    | $V_{refA} = 1.8\text{ V}$  | -   | 7      | 24   | Ω    |
|               |                                    | $V_I = 0\text{ V}$ ; $V_{refB} = V_{EN} = 3.3\text{ V}$ ; $I_O = 10\text{ mA}$   |   |        |      |      |
|               |                                    | $V_{refA} = 1.0\text{ V}$  | -   | 5      | 18   | Ω    |
|               |                                    | $V_I = 0\text{ V}$ ; $V_{refB} = V_{EN} = 1.8\text{ V}$ ; $I_O = 10\text{ mA}$   |   |        |      |      |
|               |                                    | $V_{refA} = 1.0\text{ V}$  | -   | 6      | 19   | Ω    |

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

[2] Measured by the voltage drop between the SCLn and SDAn pins at the indicated current through the switch. ON resistance is determined by the lowest voltage of the two (SCLn or SDAn) pins.



$R_{pu} = 200 \text{ k}\Omega$ ;  $C_{EN} = 100 \text{ nF}$  (The SCLn and SDAn pins may be exchanged.)

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

## 12. Dynamic characteristics

**Table 8. Switching characteristics**

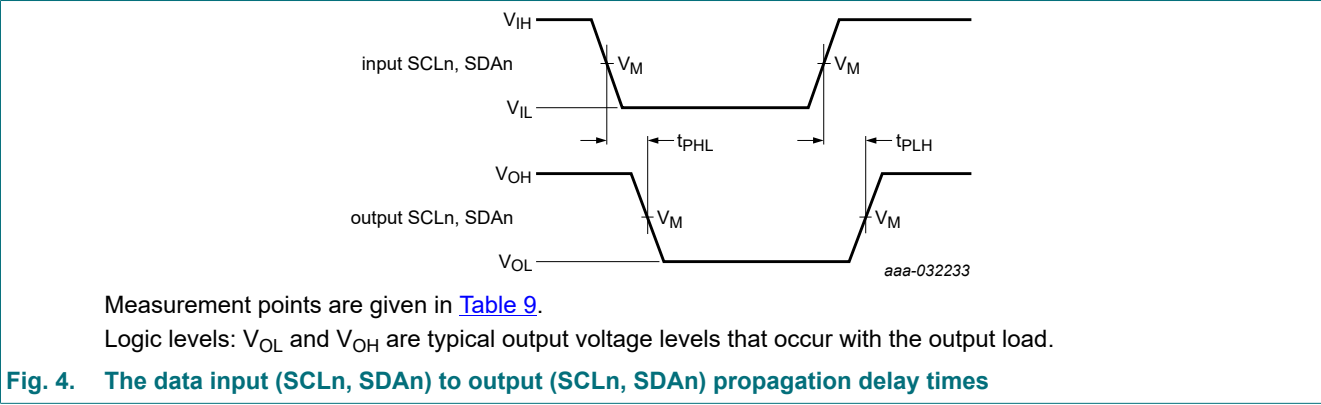
$GND = 0 \text{ V}$ ; for waveform see [Fig. 4](#); for test circuit see [Fig. 5](#)

| Symbol           | Parameter                     | Conditions  | T <sub>amb</sub> = -40 °C to +125 °C |        |      | Unit |
|------------------|-------------------------------|---|--------------------------------------|--------|------|------|
|                  |                               |   | Min                                  | Typ[1] | Max  |      |
| Translating down |                               |   |                                      |        |      |      |
| t <sub>PLH</sub> | LOW to HIGH propagation delay | SCLA, SDAA to SCLB, SDAB or SCLB, SDAB to SCLA, SDAA;       |                                      |        |      |      |
|                  |                               | V <sub>IH</sub> = V <sub>pu</sub> = V <sub>refA</sub> + 1 V |                                      |        |      |      |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 15 pF           | -                                    | 0.13   | 0.35 | ns   |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 30 pF           | -                                    | 0.22   | 0.59 | ns   |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 50 pF           | -                                    | 0.34   | 0.94 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 15 pF           | -                                    | 0.09   | 0.25 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 30 pF           | -                                    | 0.16   | 0.43 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 50 pF           | -                                    | 0.24   | 0.69 | ns   |
| t <sub>PHL</sub> | HIGH to LOW propagation delay | SCLA, SDAA to SCLB, SDAB or SCLB, SDAB to SCLA, SDAA;       |                                      |        |      |      |
|                  |                               | V <sub>IH</sub> = V <sub>pu</sub> = V <sub>refA</sub> + 1 V |                                      |        |      |      |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 15 pF           | -                                    | 0.21   | 0.99 | ns   |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 30 pF           | -                                    | 0.36   | 1.78 | ns   |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 50 pF           | -                                    | 0.51   | 2.42 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 15 pF           | -                                    | 0.12   | 0.45 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 30 pF           | -                                    | 0.19   | 0.77 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 50 pF           | -                                    | 0.30   | 1.17 | ns   |

| Symbol           | Parameter                     | Conditions   | T <sub>amb</sub> = -40 °C to +125 °C |        |      | Unit |
|------------------|-------------------------------|--|--------------------------------------|--------|------|------|
|                  |                               |  | Min                                  | Typ[1] | Max  |      |
| Translating up   |                               |  |                                      |        |      |      |
| t <sub>PLH</sub> | LOW to HIGH propagation delay | SCLA, SDAA to SCLB, SDAB or SCLB, SDAB to SCLA, SDAA;  |                                      |        |      |      |
|                  |                               | V <sub>IH</sub> = V <sub>refA</sub> ; V <sub>EXT</sub> = V <sub>pu</sub> = V <sub>refA</sub> + 1 V |                                      |        |      |      |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 15 pF  | -                                    | 0.06   | 0.11 | ns   |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 30 pF  | -                                    | 0.14   | 0.32 | ns   |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 50 pF  | -                                    | 0.26   | 0.58 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 15 pF  | -                                    | 0.06   | 0.13 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 30 pF  | -                                    | 0.13   | 0.28 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 50 pF  | -                                    | 0.20   | 0.50 | ns   |
| t <sub>PHL</sub> | HIGH to LOW propagation delay | SCLA, SDAA to SCLB, SDAB or SCLB, SDAB to SCLA, SDAA;  |                                      |        |      |      |
|                  |                               | V <sub>IH</sub> = V <sub>refA</sub> ; V <sub>EXT</sub> = V <sub>pu</sub> = V <sub>refA</sub> + 1 V |                                      |        |      |      |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 15 pF  | -                                    | 0.34   | 1.54 | ns   |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 30 pF  | -                                    | 0.60   | 2.60 | ns   |
|                  |                               | V <sub>refA</sub> = 1.5 V; C <sub>L</sub> = 50 pF  | -                                    | 0.90   | 3.82 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 15 pF  | -                                    | 0.17   | 0.71 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 30 pF  | -                                    | 0.29   | 1.09 | ns   |
|                  |                               | V <sub>refA</sub> = 2.3 V; C <sub>L</sub> = 50 pF  | -                                    | 0.45   | 1.67 | ns   |

[1] All typical values are measured at T<sub>amb</sub> = 25 °C.

12.1. Waveforms and test circuit



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

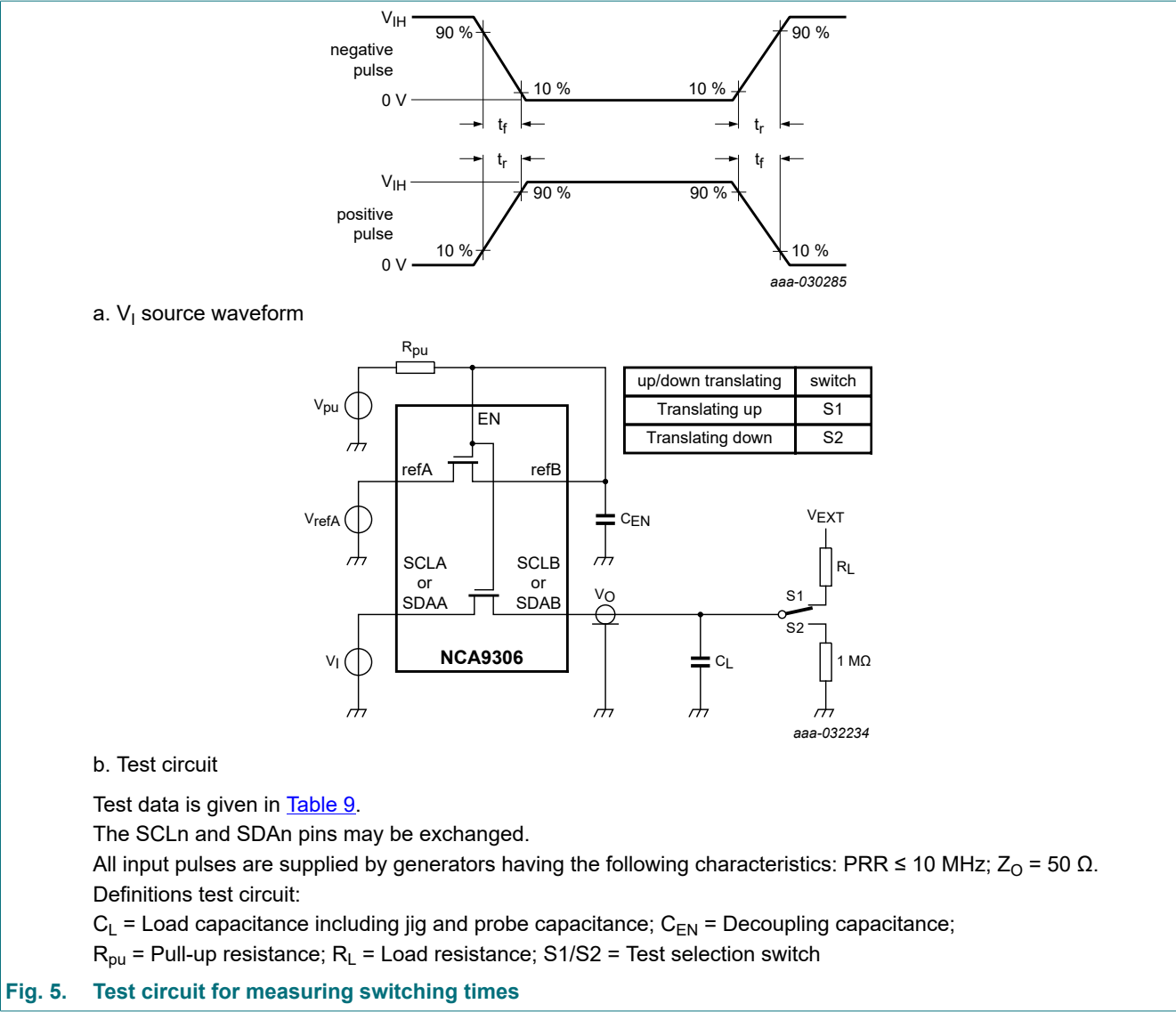


Table 9. Test data

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

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

13. Package outline

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

SOT765-1

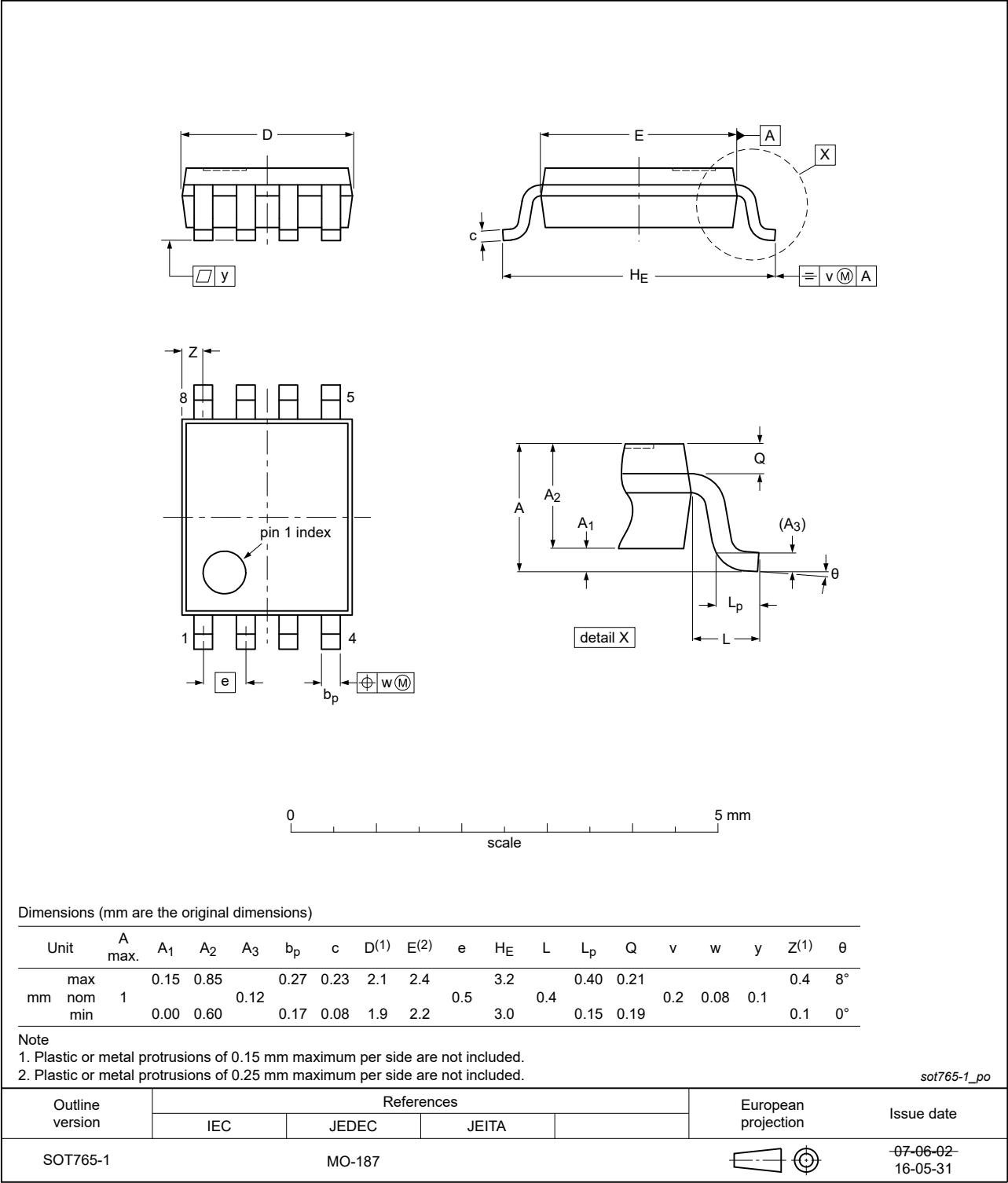


Fig. 6. Package outline SOT765-1 (VSSOP8)

## 14. Abbreviations

Table 10. Abbreviations

| Acronym          | Description              |
|------------------|--------------------------|
| CDM              | Charged Device Model     |
| ESD              | ElectroStatic Discharge  |
| HBM              | Human Body Model         |
| I <sup>2</sup> C | Inter-Integrated Circuit |
| PMBus            | Power Management Bus     |
| PRR              | Pulse Rate Repetition    |
| SMBus            | System Management Bus    |

## 15. Revision history

Table 11. Revision history

| Document ID      | Release date | Data sheet status  | Change notice | Supersedes |
|------------------|--------------|--------------------|---------------|------------|
| NCA9306_Q100 v.1 | 20220211     | Product data sheet | -             | -          |

## 16. Legal information

### Data sheet status

| Document status<br>[1][2]      | Product status [3] | Definition  |
|--------------------------------|--------------------|---|
| Objective [short] data sheet   | Development        | This document contains data from the objective specification for product development. |
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- [2] The term 'short data sheet' is explained in section "Definitions".
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