

# NCX2200

## Low voltage comparator

Rev. 6.1 — 21 November 2019

Product data sheet

### 1. General description

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The NCX2200 provides a single low voltage low power comparator.

The NCX2200 has a very low supply current of 6  $\mu\text{A}$  and is guaranteed to operate at a low voltage of 1.3 V and is fully operational up to 5.5 V which makes this device convenient for use in both 3.0 V and 5.0 V systems.

### 2. Features and benefits

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- Wide supply voltage range from 1.3 V to 5.5 V (functional operating range)
- Rail-to-rail input/output performance
- Very low supply current of 6  $\mu\text{A}$  (typical)
- Very low-power consumption
- No phase inversion with overdriven input signals
- Internal hysteresis
- Propagation delay of 0.8  $\mu\text{s}$  (typical)
- ESD protection:
  - ◆ HBM JESD22-A114F Class 3A. Exceeds 2000 V
  - ◆ CDM JESD22-C101E exceeds 1000 V
- Multiple package options
- Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$

### 3. Applications

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- Cellular telephones
- Alarm and security systems
- Personal Digital assistants



## 4. Ordering information

Table 1. Ordering information

| Type number | Topside mark <sup>[1]</sup> | Package |   |          |
|-------------|-----------------------------|---------|---|----------|
|             |                             | Name    | Description   | Version  |
| NCX2200GW   | q1                          | TSSOP5  | plastic thin shrink small outline package; 5 leads; body width 1.25 mm                                    | SOT353-1 |
| NCX2200GM   | q1                          | XSON6   | plastic extremely thin small outline package; no leads; 6 terminals; body 1 × 1.45 × 0.5 mm               | SOT886   |
| NCX2200GM   | X0                          | XSON6   | plastic extremely thin small outline package; no leads; 6 terminals; body 1 × 1.45 × 0.5 mm; requires SSB | SOT886   |
| NCX2200GF3  | q3                          | XSON6   | plastic extremely thin small outline package; no leads; 6 terminals; body 1 × 1 × 0.5 mm                  | SOT891   |
| NCX2200GS   | q1                          | XSON6   | extremely thin small outline package; no leads; 6 terminals; body 1.0 × 1.0 × 0.35 mm                     | SOT1202  |

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

### 4.1 Ordering options

Table 2. Ordering options

| Type number | Orderable part number        | Package | Packing method                    | Minimum order quantity | Temperature     |
|-------------|------------------------------|---------|-----------------------------------|------------------------|-----------------|
| NCX2200GW   | NCX2200GW,125                | TSSOP5  | reel 7" q3 ndp                    | 3000                   | -40 °C to 85 °C |
| NCX2200GM   | NCX2200GM,115 <sup>[1]</sup> | XSON6   | reel 7" q1 ndp                    | 5000                   | -40 °C to 85 °C |
| NCX2200GM   | NCX2200GMAZ                  | XSON6   | reel 7" q1 ndp SSB <sup>[3]</sup> | 5000                   | -40 °C to 85 °C |
| NCX2200GM   | NCX2200GM,132 <sup>[2]</sup> | XSON6   | reel 7" q1/q3 ndp                 | 5000                   | -40 °C to 85 °C |
| NCX2200GM   | NCX2200GMBZ                  | XSON6   | reel 7" q3 ndp SSB <sup>[3]</sup> | 5000                   | -40 °C to 85 °C |
| NCX2200GF3  | NCX2200GF3,132               | XSON6   | reel 7" q1/q3 ndp                 | 5000                   | -40 °C to 85 °C |
| NCX2200GS   | NCX2200GSH                   | XSON6   | reel 7" q3 ndp                    | 5000                   | -40 °C to 85 °C |

[1] Will go EOL - migrate to new leadframe orderable part number NCX2200GMAZ.

[2] Will go EOL - migrate to new leadframe orderable part number NCX2200GMBZ.

[3] This packing method uses a Static Shielding Bag (SSB) solution. Material is to be kept in the sealed bag between uses.

## 5. Functional diagram

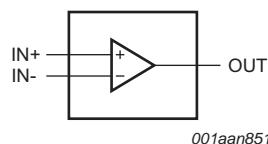


Fig 1. Logic symbol

## 6. Pinning information

### 6.1 Pinning



### 6.2 Pin description

Table 3. Pin description

| Symbol   | Pin      |        |        |         | Description                 |
|----------|----------|--------|--------|---------|-----------------------------|
|          | SOT353-1 | SOT886 | SOT891 | SOT1202 |                             |
| OUT      | 1        | 1      | 6      | 6       | comparator output           |
| $V_{EE}$ | 2        | 2      | 1      | 1       | supply voltage              |
| IN+      | 3        | 3      | 4      | 4       | comparator input (positive) |
| IN-      | 4        | 4      | 3      | 3       | comparator input (negative) |
| n.c.     | -        | 5      | -      | -       | not connected               |
| $V_{CC}$ | 5        | 6      | 2, 5   | 2, 5    | supply voltage              |

## 7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to  $V_{EE}$ .

| Symbol       | Parameter                    | Conditions                                 | Min  | Max            | Unit |
|--------------|------------------------------|--|------|----------------|------|
| $V_{CC}$     | supply voltage               |  | -    | 7.0            | V    |
| $V_I$        | input voltage                | IN-, IN+ inputs                            | -0.5 | $V_{CC} + 0.5$ | V    |
| $t_{sc(o)}$  | output short-circuit time    |  | [1]  | indefinite     | s    |
| $T_{j(max)}$ | maximum junction temperature |  | -    | +150           | °C   |
| $T_{stg}$    | storage temperature          |  | -65  | +150           | °C   |
| $P_{tot}$    | total power dissipation      | $T_{amb} = -40\text{ °C to }+85\text{ °C}$ | -    | 250            | mW   |

[1] The maximum total power dissipation must not be exceeded.

## 8. Recommended operating conditions

Table 5. Recommended operating conditions

| Symbol    | Parameter           | Conditions                 | Min      | Typ | Max      | Unit |
|-----------|---------------------|----------------------------|----------|-----|----------|------|
| $V_{CC}$  | supply voltage      | $V_{CC}$ to $V_{EE}$       |          |     |          |      |
|           |                     | full spec operating range  | 1.6      | -   | 5.5      | V    |
|           |                     | functional operating range | 1.3      | -   | 5.5      | V    |
| $V_I$     | input voltage       |                            | $V_{EE}$ | -   | $V_{CC}$ | V    |
| $T_{amb}$ | ambient temperature |                            | -40      | -   | +85      | °C   |

## 9. Static characteristics

Table 6. Static characteristics

At recommended operating conditions.  $V_{CC} = 1.6\text{ V to }5.5\text{ V}$ ,  $V_{EE} = 0\text{ V}$ ;  $V_{CM} = 0.5V_{CC}$  unless otherwise specified.

| Symbol                 | Parameter                    | Conditions   | 25 °C |                      |     | -40 °C to +85 °C |      | Unit |
|------------------------|------------------------------|--|-------|----------------------|-----|------------------|------|------|
|                        |                              |  | Min   | Typ                  | Max | Min              | Max  |      |
| $V_H$                  | hysteresis voltage           |  | 6     | 9                    | 13  | -                | -    | mV   |
|                        |                              | $V_{CC} = 1.3\text{ V}$                              | -     | 20                   | -   | -                | -    | mV   |
| $V_{I(\text{offset})}$ | offset input voltage         | [1]  | -30   | 0.5                  | +30 | -30              | +30  | mV   |
|                        |                              | $V_{CC} = 1.3\text{ V}$                              | [1]   | -                    | 3   | -                | -    | -    |
| $V_{OH}$               | HIGH-level output voltage    | $I_O = -0.5\text{ mA}$ ; $V_{CC} = 1.3\text{ V}$     | -     | 1.24                 | -   | -                | -    | V    |
|                        |                              | $I_O = -0.5\text{ mA}$ ; $V_{CC} = 1.6\text{ V}$     | -     | 1.55                 | -   | 1.35             | -    | V    |
|                        |                              | $I_O = -3\text{ mA}$ ; $V_{CC} = 3.0\text{ V}$       | -     | 2.85                 | -   | 2.7              | -    | V    |
|                        |                              | $I_O = -5\text{ mA}$ ; $V_{CC} = 5.5\text{ V}$       | -     | 5.33                 | -   | 5.2              | -    | V    |
| $V_{OL}$               | LOW-level output voltage     | $I_O = 0.5\text{ mA}$ ; $V_{CC} = 1.3\text{ V}$      | -     | 0.05                 | -   | -                | -    | V    |
|                        |                              | $I_O = 0.5\text{ mA}$ ; $V_{CC} = 1.6\text{ V}$      | -     | 0.04                 | -   | -                | 0.25 | V    |
|                        |                              | $I_O = 3\text{ mA}$ ; $V_{CC} = 3.0\text{ V}$        | -     | 0.14                 | -   | -                | 0.3  | V    |
|                        |                              | $I_O = 5\text{ mA}$ ; $V_{CC} = 5.5\text{ V}$        | -     | 0.20                 | -   | -                | 0.3  | V    |
| $V_{CM}$               | common-mode voltage          | $V_{CC} = 1.3\text{ V to }5.5\text{ V}$              | -     | $V_{EE}$ to $V_{CC}$ | -   | -                | -    | V    |
| $I_{OS}$               | output short-circuit current | $V_{CC} = 5.5\text{ V}$ ; $V_O = V_{EE}$ or $V_{CC}$ | -     | 68                   | -   | -                | -    | mA   |
| CMRR                   | common-mode rejection ratio  | $\Delta V_{CM} = V_{CC}$                             | -     | 70                   | -   | -                | -    | dB   |
| PSRR                   | power supply rejection ratio | $\Delta V_{CC} = 1.95\text{ V}$                      | 45    | 80                   | -   | -                | -    | dB   |
| $I_{IB}$               | input bias current           |  | -     | 1.0                  | -   | -                | -    | pA   |
| $I_{CC}$               | supply current               |  | -     | 6.0                  | -   | -                | 9.0  | μA   |

[1] Differential input switching level is guaranteed at the minimum or maximum offset voltage, minus or plus half the maximum hysteresis voltage.

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

Voltages are referenced to  $V_{EE}$  ( $V_{EE} = 0\text{ V}$ );  $V_{CC} = 1.6\text{ V to }5.5\text{ V}$ ;  $V_{CM} = 0.5V_{CC}$  unless otherwise specified.

| Symbol    | Parameter                          | Conditions                                     | 25 °C |     |     | Unit |               |
|-----------|------------------------------------|--|-------|-----|-----|------|---------------|
|           |                                    |  | Min   | Typ | Max |      |               |
| $t_{pd}$  | propagation delay                  | 20 mV overdrive; $C_L = 15\text{ pF}$          | [1]   | -   | 0.8 | -    | $\mu\text{s}$ |
| $t_{THL}$ | HIGH to LOW output transition time | $V_{CC} = 5.5\text{ V}$ ; $C_L = 50\text{ pF}$ | [2]   | -   | 10  | -    | ns            |
| $t_{TLH}$ | LOW to HIGH output transition time | $V_{CC} = 5.5\text{ V}$ ; $C_L = 50\text{ pF}$ | [2]   | -   | 10  | -    | ns            |

[1]  $t_{pd}$  is the same as  $t_{PLH}$  and  $t_{PHL}$ .

[2] Input signal: 1 kHz, squarewave signal with 10 ns edge rate.

## 11. Graphs



$V_{CC} = 5.0\text{ V}$ .

**Fig 5. Supply current versus temperature**



$T_{amb} = 25\text{ °C}$ ;  $C_L = 15\text{ pF}$ .

(1)  $V_{CC} = 2.7\text{ V}$ .

(2)  $V_{CC} = 5.0\text{ V}$ .

**Fig 6. Supply current versus output transition frequency**



- (1)  $T_{amb} = -40\text{ }^{\circ}\text{C}$ .
- (2)  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .
- (3)  $T_{amb} = 85\text{ }^{\circ}\text{C}$ .

**Fig 7. Supply current versus supply voltage**



$T_{amb} = 25\text{ }^{\circ}\text{C}$ .  
 $V_{CC} = 5.0\text{ V}$ .

**Fig 8. HIGH-level output voltage versus output current**



$T_{amb} = 25\text{ }^{\circ}\text{C}$ .  
 $V_{CC} = 5.0\text{ V}$ .

**Fig 9. LOW-level output voltage versus output current**



$I_O = -4.0\text{ mA}$ .  
 $V_{CC} = 5.0\text{ V}$ .

**Fig 10. HIGH-level output voltage versus temperature**



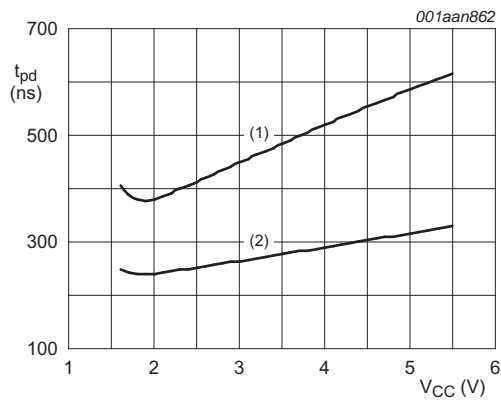
I<sub>O</sub> = 4.0 mA.  
V<sub>CC</sub> = 5.0 V.

Fig 11. LOW-level output voltage versus temperature



V<sub>CC</sub> = 5.0 V; input overdrive = 50 mV.  
(1) t<sub>PLH</sub>.  
(2) t<sub>PHL</sub>.

Fig 12. Propagation delay versus temperature



T<sub>amb</sub> = 25 °C; input overdrive = 100 mV.  
(1) t<sub>PLH</sub>.  
(2) t<sub>PHL</sub>.

Fig 13. Propagation delay versus supply voltage.

## 12. Application information

### 12.1 Operating description

The NCX2200 is a single low voltage low power comparator. This device is designed for rail-to-rail input and output performance. This device consumes only 6  $\mu\text{A}$  of supply current while achieving a typical propagation delay of 0.8  $\mu\text{s}$  at a 20 mV input overdrive. This comparator is guaranteed to operate at a low voltage of 1.3 V up to 5.5 V. The common-mode input voltage range extends 0.1 V beyond the upper and lower rail without phase inversion or other adverse effects. This device has a typical internal hysteresis of 9.0 mV. This allows for greater noise immunity and clean output switching.

### 12.2 Output stage

The NCX2200 has a complementary P and N Channel output stage that has capability of driving a rail-to-rail output swing with a load ranging up to 5.0 mA. It is designed such that shoot-through current is minimized while switching. This feature eliminates the need for bypass capacitors under most circumstances. See [Figure 14](#)

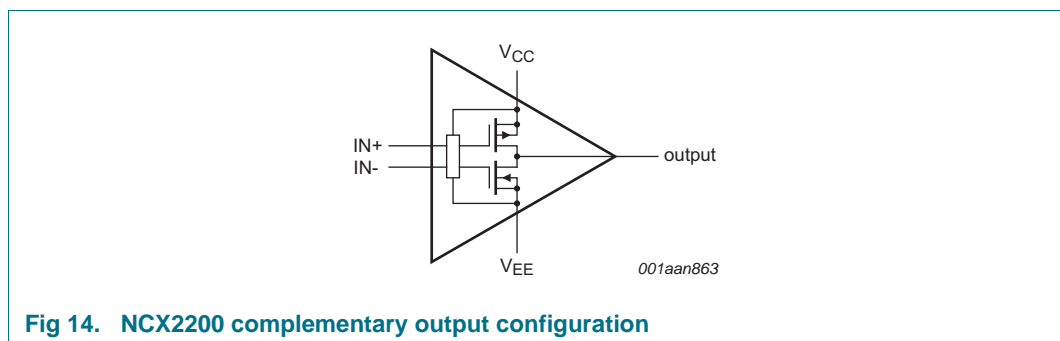


Fig 14. NCX2200 complementary output configuration



### 12.3 Schmitt trigger oscillator

Figure 15 shows the NCX2200 configured as a Schmitt trigger oscillator.



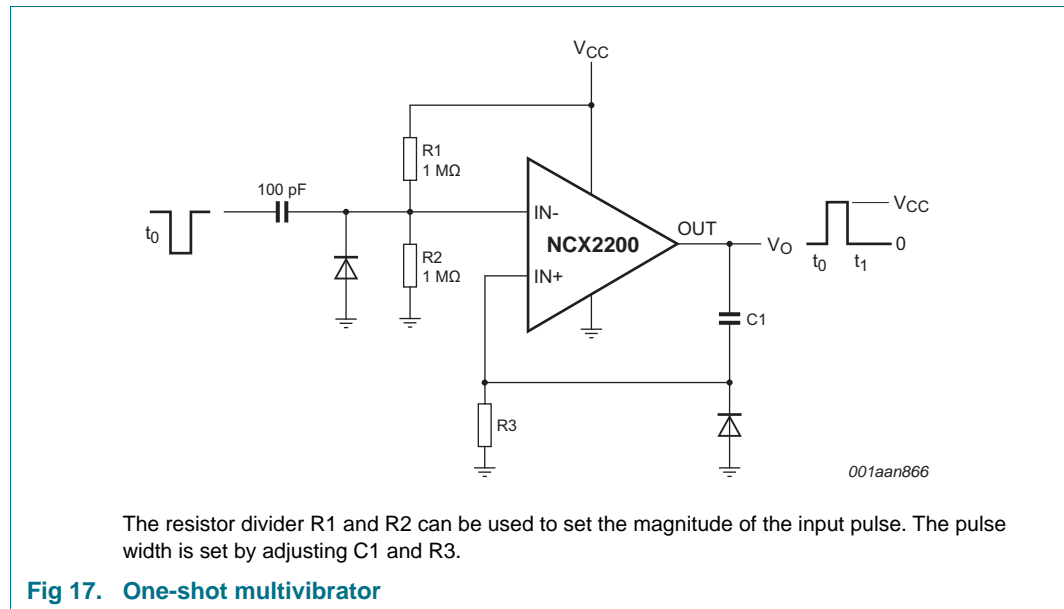
### 12.4 Zero-crossing detector

Figure 16 shows the NCX2200 configured as a zero-crossing detector.



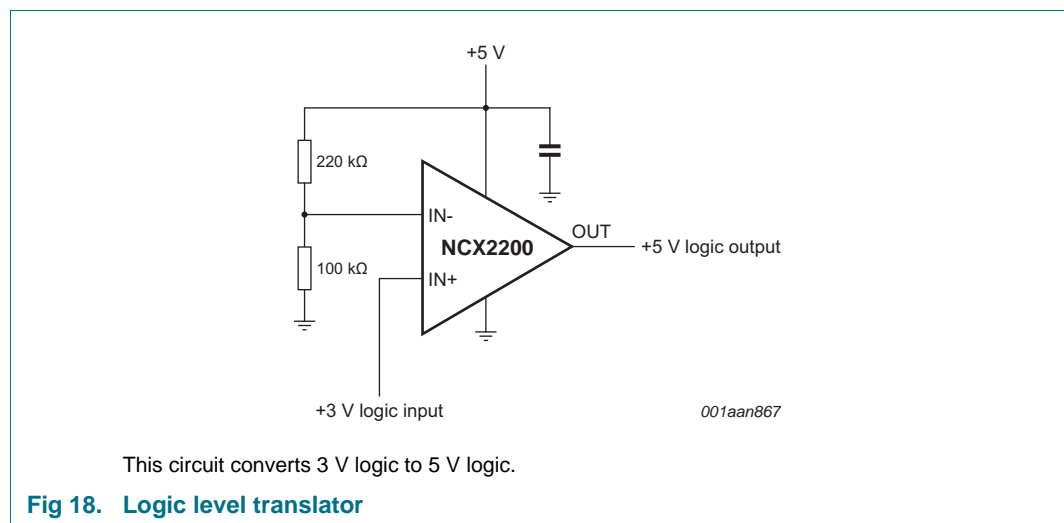
### 12.5 One-shot multivibrator

Figure 17 shows the NCX2200 configured as a one-shot multivibrator.



### 12.6 Logic level translator

Figure 18 shows the NCX2200 configured as a logic level translator.



### 13. Package outline

TSSOP5: plastic thin shrink small outline package; 5 leads; body width 1.25 mm

SOT353-1



Fig 19. Package outline SOT353-1 (TSSOP5)

XSON6: plastic extremely thin small outline package; no leads; 6 terminals; body 1 x 1.45 x 0.5 mm

SOT886

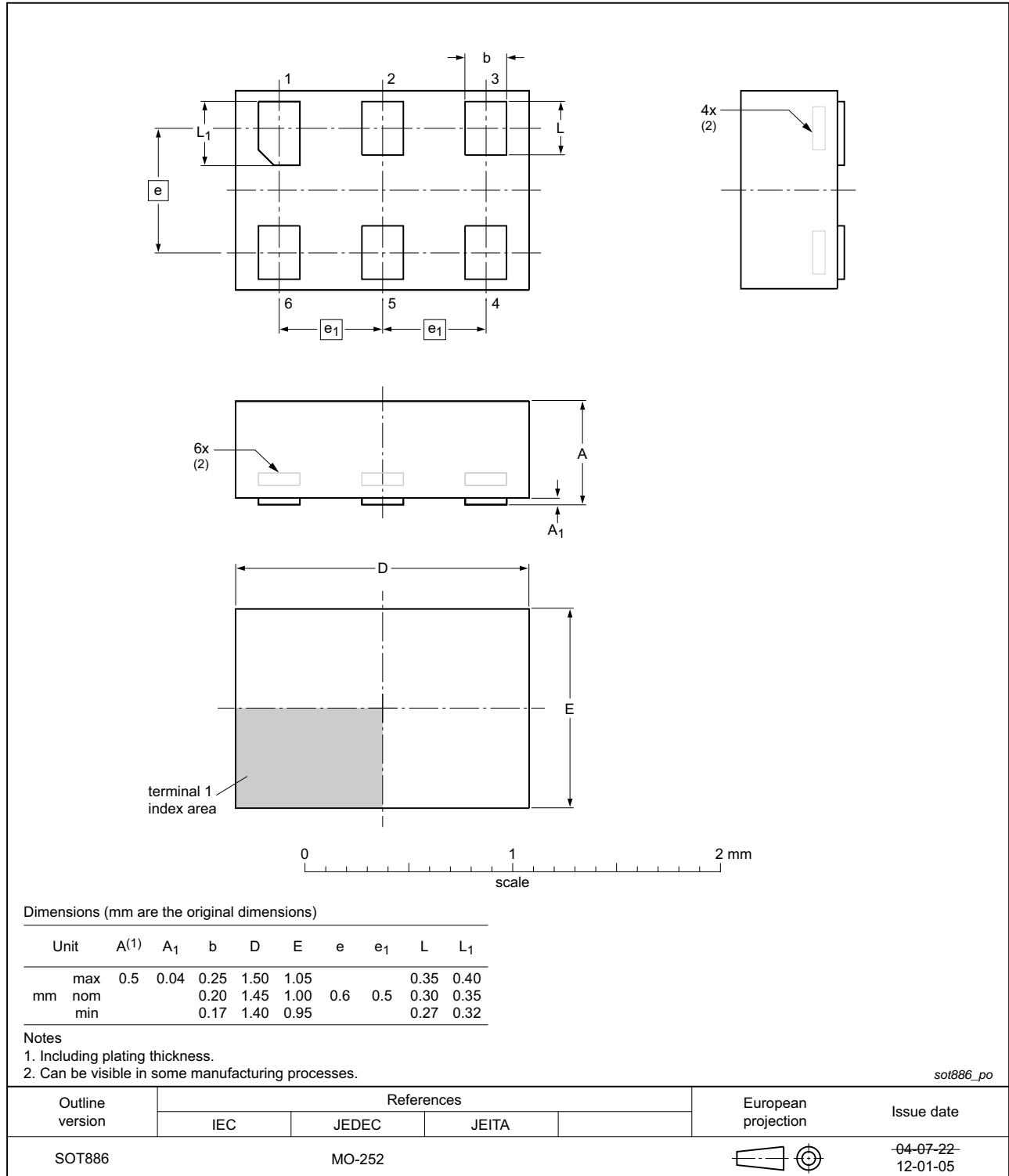


Fig 20. Package outline SOT886 (XSON6)

XSON6: plastic extremely thin small outline package; no leads; 6 terminals; body 1 x 1 x 0.5 mm

SOT891

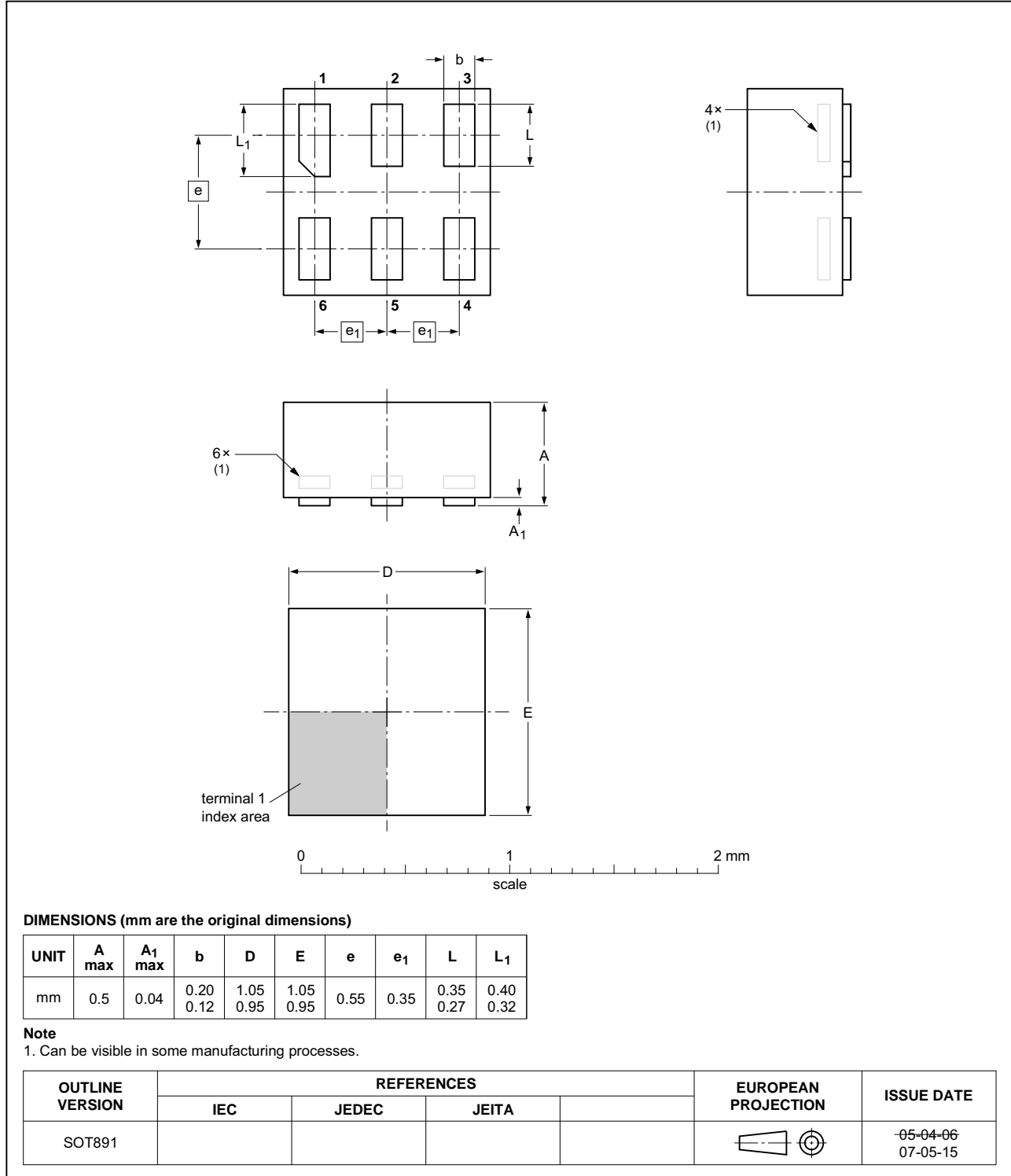


Fig 21. Package outline SOT891 (XSON6)

XSON6: extremely thin small outline package; no leads;  
6 terminals; body 1.0 x 1.0 x 0.35 mm

SOT1202

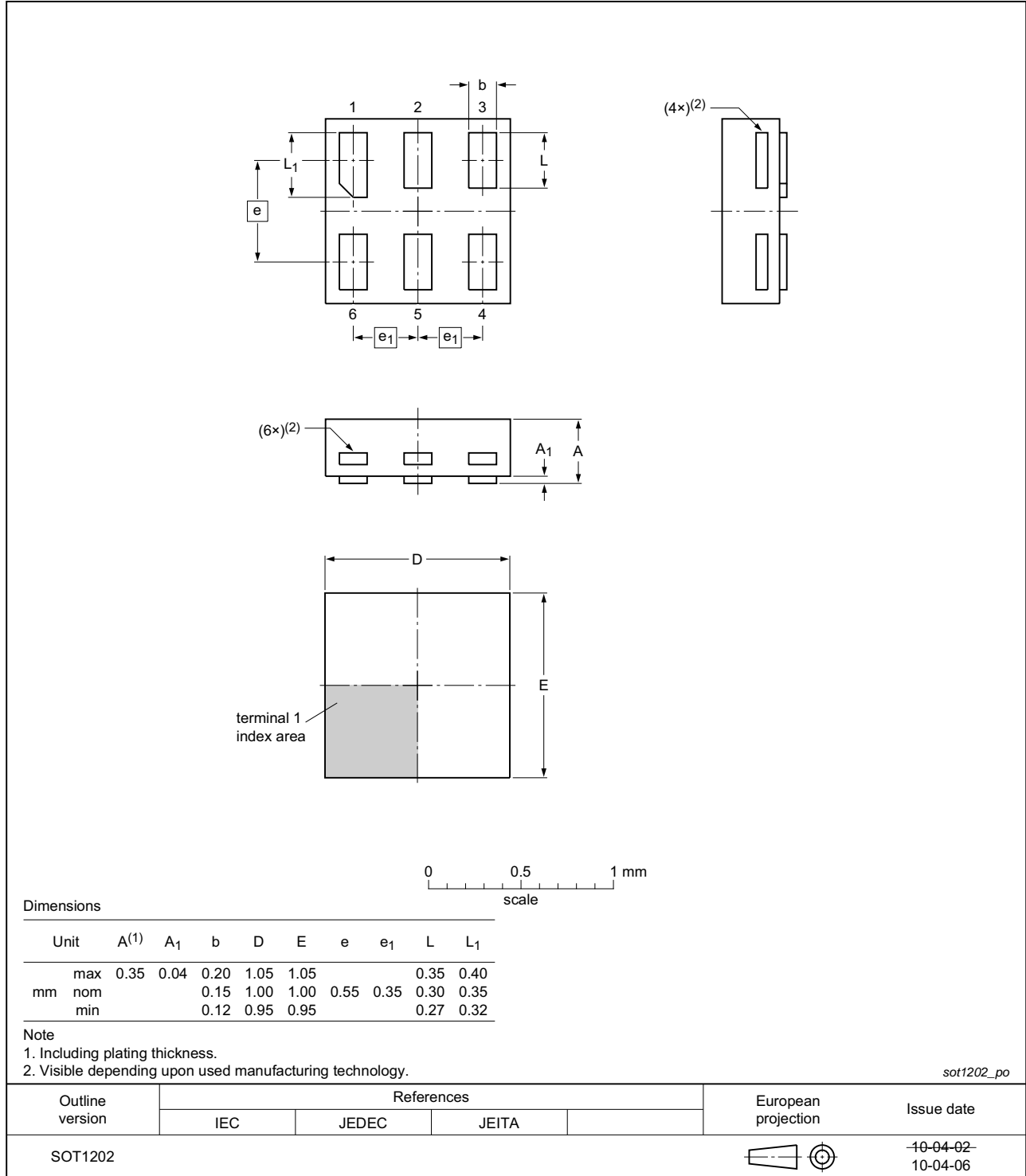


Fig 22. Package outline SOT1202 (XSON6)

## 14. Abbreviations

Table 8. Abbreviations

| Acronym | Description             |
|---------|-------------------------|
| CDM     | Charged Device Model    |
| ESD     | ElectroStatic Discharge |
| HBM     | Human Body Model        |

## 15. Revision history

Table 9. Revision history

| Document ID    | Release date  | Data sheet status  | Change notice             | Supersedes  |
|----------------|---|--------------------|---------------------------|-------------|
| NCX2200 v6.1   | 20191121  | Product data sheet | 201909001A;<br>201909026A | NCX2200 v.6 |
| Modifications: | <ul style="list-style-type: none"> <li>Package SOT886 requiring SSB added. Refer to PCN number 201909001A XSON6 (SOT886) Assembly/Test Transfer from ATGD and ATSN to ATBK</li> </ul> |                    |                           |             |
| NCX2200 v6     | 20140709  | Product data sheet | -                         | NCX2200 v.5 |
| Modifications: | <ul style="list-style-type: none"> <li>Package SOT1202 added.</li> </ul>  |                    |                           |             |
| NCX2200 v5     | 20120806  | Product data sheet | -                         | NCX2200 v.4 |
| Modifications: | <ul style="list-style-type: none"> <li>Package outline drawing of SOT886 (<a href="#">Figure 20</a>) modified.</li> </ul>   |                    |                           |             |
| NCX2200 v4     | 20111110  | Product data sheet | -                         | NCX2200 v.3 |
| Modifications: | <ul style="list-style-type: none"> <li>Legal pages updated.</li> </ul>  |                    |                           |             |
| NCX2200 v.3    | 20111014  | Product data sheet | -                         | NCX2200 v.2 |
| NCX2200 v.2    | 20110706  | Product data sheet | -                         | NCX2200 v.1 |
| NCX2200 v.1    | 20110322  | Product data sheet | -                         | -           |

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### 16.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | 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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