

# CBTD3384

10-bit level shifting bus switch with 5-bit output enables

Rev. 5 — 19 November 2010

Product data sheet

## 1. General description

The CBTD3384 provides ten bits of high-speed TTL-compatible bus switching. The low ON resistance of the switch allows connections to be made with minimal propagation delay.

The CBTD3384 device is organized as two 5-bit bus switches with two separate output enable (1OE, 2OE) inputs. When nOE is LOW, the switch is on and port A is connected to the B port. When nOE is HIGH, each switch is disabled.

The CBTD3384 is characterized for operation from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$ .

## 2. Features and benefits

- Designed to be used in 5 V to 3.3 V level shifting applications with internal diode
- $5\ \Omega$  switch connection between two ports
- TTL-compatible control input levels
- Multiple package options
- Latch-up protection exceeds 100 mA per JESD78
- ESD protection:
  - ◆ HBM JESD22-A114E exceeds 2000 V
  - ◆ CDM JESD22-C101C exceeds 1000 V

## 3. Ordering information

Table 1. Ordering information

| Type number | Package   |                       |  |          |
|-------------|---|-----------------------|--|----------|
|             | Temperature range   | Name                  | Description  | Version  |
| CBTD3384D   | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SO24                  | plastic small outline package; 24 leads; body width 7.5 mm                             | SOT137-1 |
| CBTD3384DB  | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SSOP24                | plastic shrink small outline package; 24 leads; body width 5.3 mm                      | SOT340-1 |
| CBTD3384DK  | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | SSOP24 <sup>[1]</sup> | plastic shrink small outline package; 24 leads; body width 3.9 mm; lead pitch 0.635 mm | SOT556-1 |
| CBTD3384PW  | $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$ | TSSOP24               | plastic thin shrink small outline package; 24 leads; body width 4.4 mm                 | SOT355-1 |

[1] Also known as QSOP24 package



## 4. Functional diagram

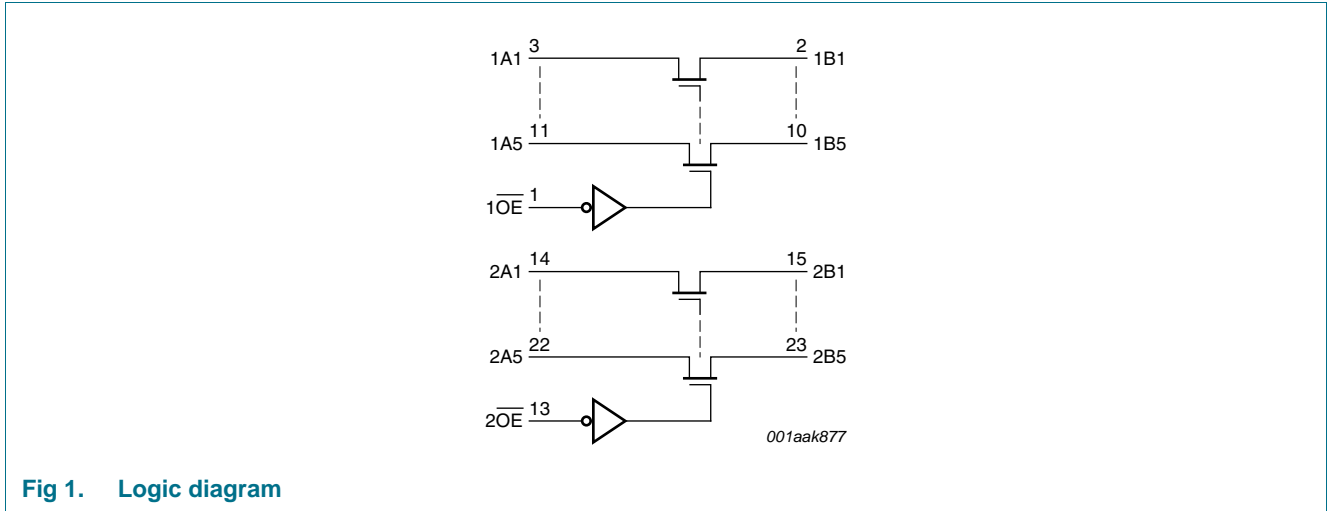
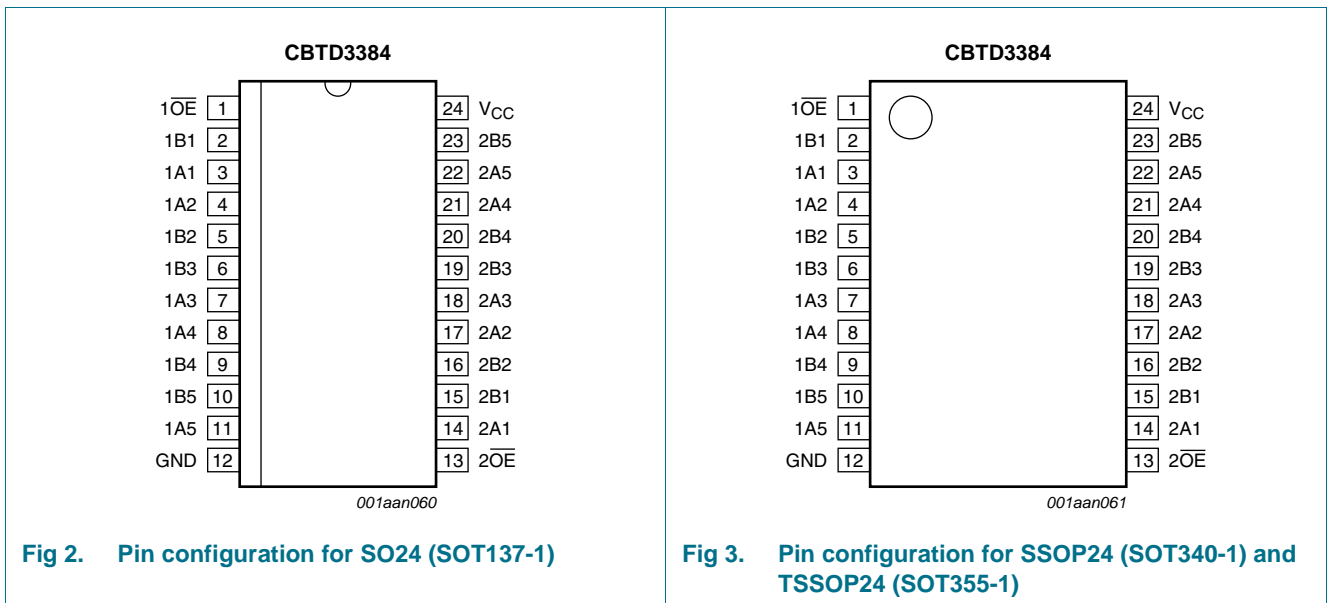


Fig 1. Logic diagram

## 5. Pinning information

### 5.1 Pinning



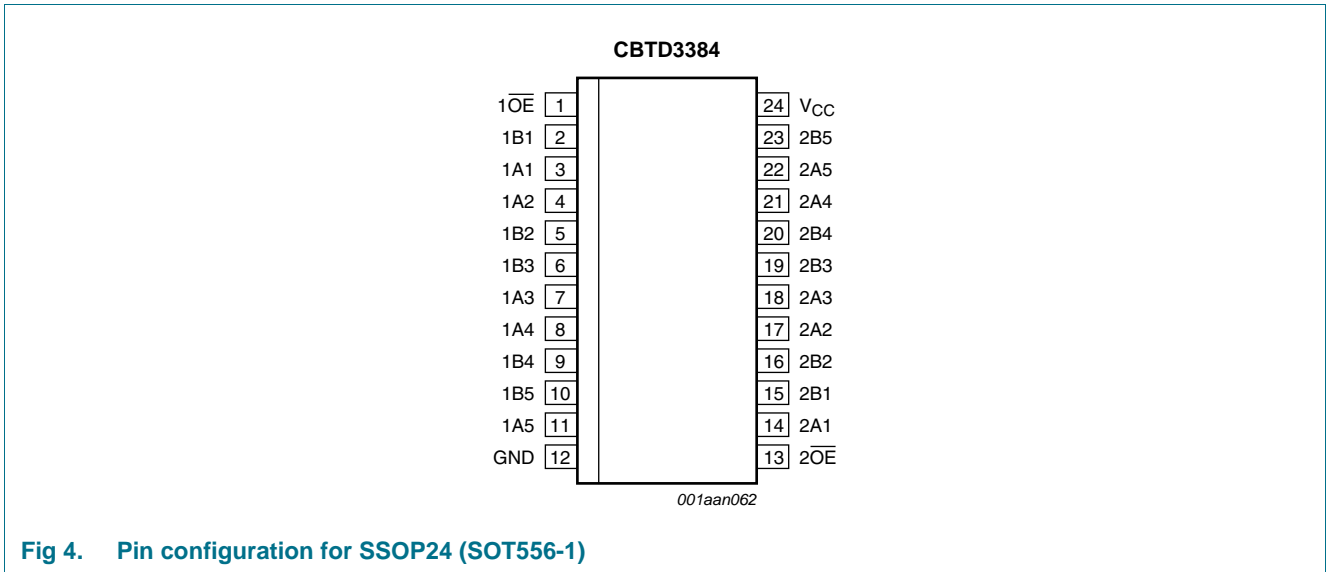


Fig 4. Pin configuration for SSOP24 (SOT556-1)

### 5.2 Pin description

Table 2. Pin description

| Symbol     | Pin                | Description                      |
|------------|--------------------|----------------------------------|
| 1OE, 2OE   | 1, 13              | output enable input (active LOW) |
| 1A1 to 1A5 | 3, 4, 7, 8, 11     | data input/output (A port)       |
| 2A1 to 2A5 | 14, 17, 18, 21, 22 | data input/output (A port)       |
| 1B1 to 1B5 | 2, 5, 6, 9, 10     | data input/output (B port)       |
| 2B1 to 2B5 | 15, 16, 19, 20, 23 | data input/output (B port)       |
| GND        | 12                 | ground (0 V)                     |
| VCC        | 24                 | positive supply voltage          |

## 6. Functional description

Table 3. Function selection<sup>[1]</sup>

| Input |     | Input/output |           |
|-------|-----|--------------|-----------|
| 1OE   | 2OE | 1An, 1Bn     | 2An, 2Bn  |
| L     | L   | 1An = 1Bn    | 2An = 2Bn |
| L     | H   | 1An = 1Bn    | Z         |
| H     | L   | Z            | 2An = 2Bn |
| H     | H   | Z            | Z         |

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

## 7. Limiting values

**Table 4. Limiting values**

In accordance with the Absolute Maximum Rating System (IEC 60134).<sup>[1]</sup>

$T_{amb} = -40\text{ °C}$  to  $+85\text{ °C}$ , unless otherwise specified.

| Symbol    | Parameter              | Conditions             | Min                 | Max       | Unit |
|-----------|------------------------|------------------------|---------------------|-----------|------|
| $V_{CC}$  | supply voltage         |                        | -0.5                | +7.0      | V    |
| $V_I$     | input voltage          |                        | <sup>[2]</sup> -0.5 | +7.0      | V    |
| $I_O$     | output current         | $V_O < 0\text{ V}$     | -                   | $\pm 128$ | mA   |
| $I_{IK}$  | input clamping current | $V_{I/O} = 0\text{ V}$ | -50                 | -         | mA   |
| $T_{stg}$ | storage temperature    |                        | -65                 | +150      | °C   |

[1] Stresses beyond those listed may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under [Section 8](#), is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

[2] The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

## 8. Recommended operating conditions

**Table 5. Operating conditions**

All unused control inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation.

| Symbol    | Parameter                | Conditions            | Min | Typ | Max | Unit |
|-----------|--------------------------|-----------------------|-----|-----|-----|------|
| $V_{CC}$  | supply voltage           |                       | 4.5 | -   | 5.5 | V    |
| $V_{IH}$  | HIGH-level input voltage |                       | 2.0 | -   | -   | V    |
| $V_{IL}$  | LOW-level input voltage  |                       | -   | -   | 0.8 | V    |
| $T_{amb}$ | ambient temperature      | operating in free air | -40 | -   | +85 | °C   |

## 9. Static characteristics

**Table 6. Static characteristics**

Voltages are referenced to GND (ground = 0 V).

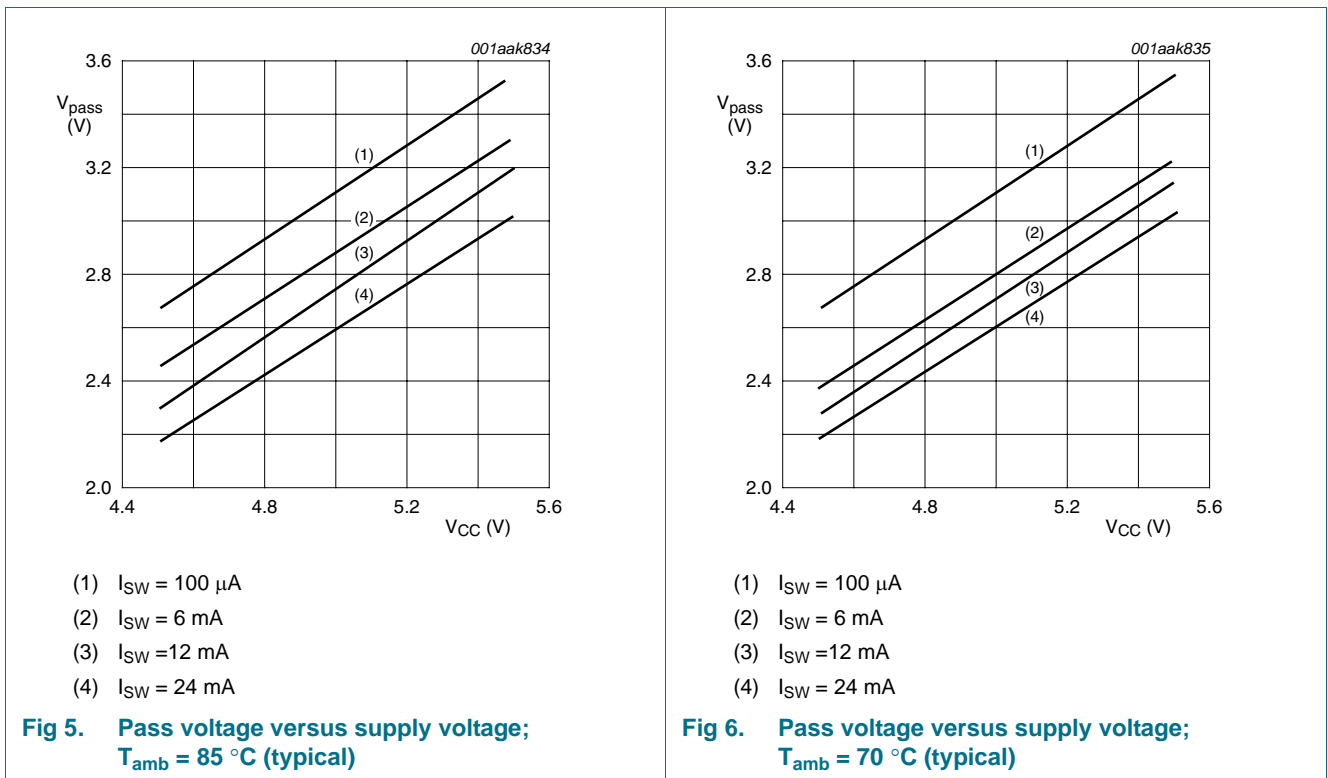
| Symbol          | Parameter                          | Conditions   | $T_{amb} = -40\text{ °C}$ to $+85\text{ °C}$ |                    |         | Unit          |
|-----------------|------------------------------------|--|--|--------------------|---------|---------------|
|                 |                                    |  | Min  | Typ <sup>[1]</sup> | Max     |               |
| $V_{IK}$        | input clamping voltage             | $V_{CC} = 4.5\text{ V}$ ; $I_I = -18\text{ mA}$  | -  | -                  | -1.2    | V             |
| $I_I$           | input leakage current              | $V_{CC} = 5.5\text{ V}$ ; $V_I = \text{GND}$ or $5.5\text{ V}$                               | -  | -                  | $\pm 1$ | $\mu\text{A}$ |
| $I_{CC}$        | supply current                     | $V_{CC} = 5.5\text{ V}$ ; $I_O = 0\text{ mA}$ ;<br>$V_I = V_{CC}$ or GND                     | -  | -                  | 1.5     | mA            |
| $\Delta I_{CC}$ | additional supply current          | per input pin; $V_{CC} = 5.5\text{ V}$ ; one input at 3.4 V, other inputs at $V_{CC}$ or GND | <sup>[2]</sup> -                             | -                  | 2.5     | mA            |
| $V_{pass}$      | pass voltage                       | see <a href="#">Figure 5</a> to <a href="#">Figure 9</a>                                     | -  | -                  | -       | V             |
| $C_I$           | input capacitance                  | control pins; $V_I = 3\text{ V}$ or $0\text{ V}$   | -  | 3.2                | -       | pF            |
| $C_{io(off)}$   | off-state input/output capacitance | port off; $V_I = 3\text{ V}$ or $0\text{ V}$ ; $\overline{nOE} = V_{CC}$                     | -  | 6.0                | -       | pF            |

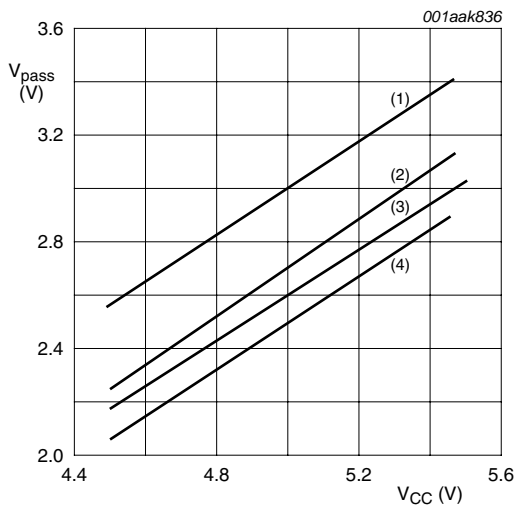
**Table 6. Static characteristics ...continued**  
 Voltages are referenced to GND (ground = 0 V).

| Symbol          | Parameter     | Conditions  | T <sub>amb</sub> = -40 °C to +85 °C |                    |     | Unit |
|-----------------|---------------|---|-------------------------------------|--------------------|-----|------|
|                 |               |   | Min                                 | Typ <sup>[1]</sup> | Max |      |
| R <sub>ON</sub> | ON resistance | V <sub>CC</sub> = 4.5 V; V <sub>I</sub> = 0 V; I <sub>I</sub> = 64 mA <sup>[3]</sup>    | -                                   | 5                  | 7   | Ω    |
|                 |               | V <sub>CC</sub> = 4.5 V; V <sub>I</sub> = 0 V; I <sub>I</sub> = 30 mA <sup>[3]</sup>    | -                                   | 5                  | 7   | Ω    |
|                 |               | V <sub>CC</sub> = 4.5 V; V <sub>I</sub> = 2.4 V; I <sub>I</sub> = -15 mA <sup>[3]</sup> | -                                   | 17                 | 50  | Ω    |

- [1] All typical values are at V<sub>CC</sub> = 5 V, T<sub>amb</sub> = 25 °C.
- [2] This is the increase in supply current for each input that is at the specified TTL voltage level rather than V<sub>CC</sub> or GND.
- [3] Measured by the voltage drop between the nAn and the nBn terminals at the indicated current through the switch. ON resistance is determined by the lowest voltage of the two (nAn or nBn) terminals.

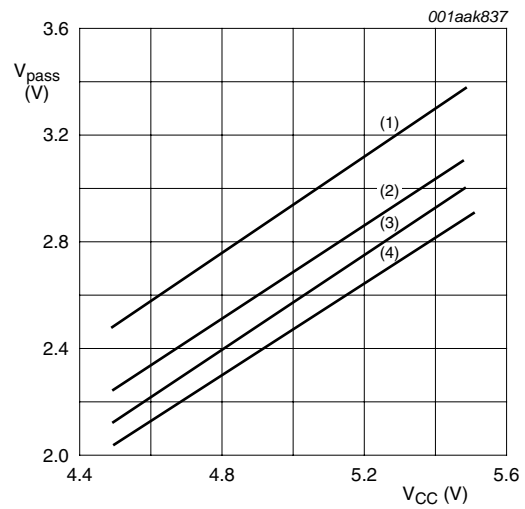
### 9.1 Typical pass voltage graphs





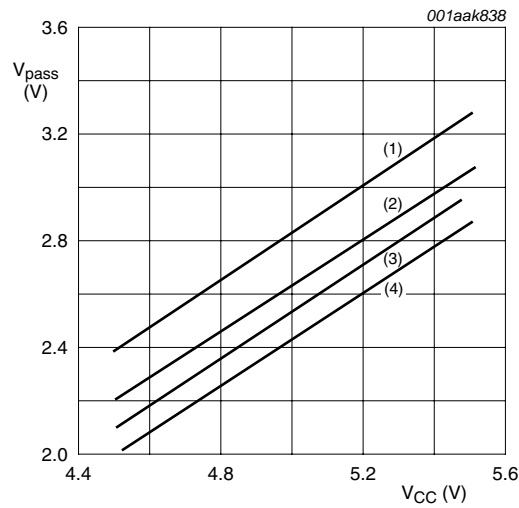
- (1) I<sub>SW</sub> = 100 μA
- (2) I<sub>SW</sub> = 6 mA
- (3) I<sub>SW</sub> = 12 mA
- (4) I<sub>SW</sub> = 24 mA

**Fig 7. Pass voltage versus supply voltage; T<sub>amb</sub> = 25 °C (typical)**



- (1) I<sub>SW</sub> = 100 μA
- (2) I<sub>SW</sub> = 6 mA
- (3) I<sub>SW</sub> = 12 mA
- (4) I<sub>SW</sub> = 24 mA

**Fig 8. Pass voltage versus supply voltage; T<sub>amb</sub> = 0 °C (typical)**



- (1) I<sub>SW</sub> = 100 μA
- (2) I<sub>SW</sub> = 6 mA
- (3) I<sub>SW</sub> = 12 mA
- (4) I<sub>SW</sub> = 24 mA

**Fig 9. Pass voltage versus supply voltage; T<sub>amb</sub> = -40 °C (typical)**

## 10. Dynamic characteristics

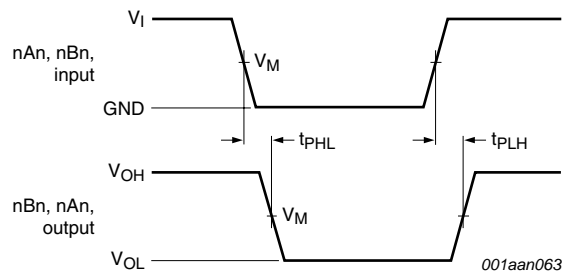
**Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V). For test circuit see [Figure 12](#).

| Symbol           | Parameter         | Conditions  | T <sub>amb</sub> = -40 °C to +85 °C |     |      | Unit |
|------------------|-------------------|---|-------------------------------------|-----|------|------|
|                  |                   |   | Min                                 | Typ | Max  |      |
| t <sub>pd</sub>  | propagation delay | nAn, nBn to nBn, nAn; see <a href="#">Figure 10</a> <a href="#">[1][2]</a><br>V <sub>CC</sub> = 5.0 V ± 0.5 V | -                                   | -   | 0.25 | ns   |
| t <sub>en</sub>  | enable time       | nOE to nAn or nBn; see <a href="#">Figure 11</a> <a href="#">[2]</a><br>V <sub>CC</sub> = 5.0 V ± 0.5 V       | 1.2                                 | 4.3 | 7.0  | ns   |
| t <sub>dis</sub> | disable time      | nOE to nAn or nBn; see <a href="#">Figure 11</a> <a href="#">[2]</a><br>V <sub>CC</sub> = 5.0 V ± 0.5 V       | 1.7                                 | 3.0 | 5.3  | ns   |

- [1] The propagation delay is the calculated RC time constant of the typical ON resistance of the switch and the specified load capacitance, when driven by an ideal voltage source (zero output impedance).
- [2] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.  
t<sub>en</sub> is the same as t<sub>PZL</sub> and t<sub>PZH</sub>.  
t<sub>dis</sub> is the same as t<sub>PLZ</sub> and t<sub>PHZ</sub>.

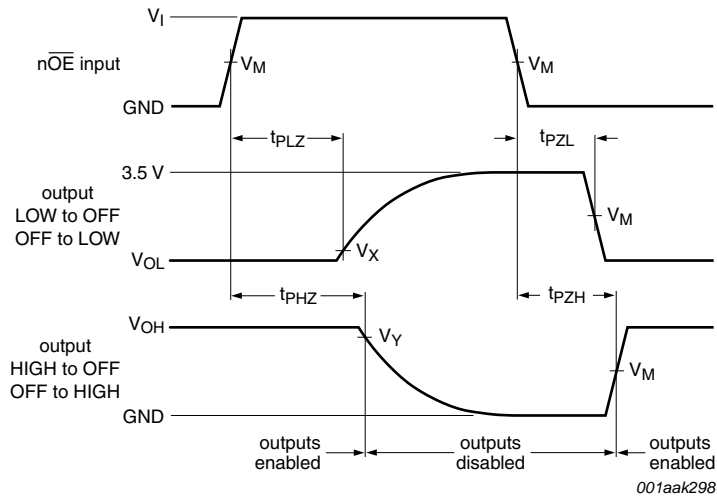
## 11. Waveforms



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

Logic levels: V<sub>OL</sub> and V<sub>OH</sub> are typical output voltage levels that occur with the output load.

**Fig 10. The data input (nAn, nBn) to output (nBn, nAn) propagation delay times**



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.

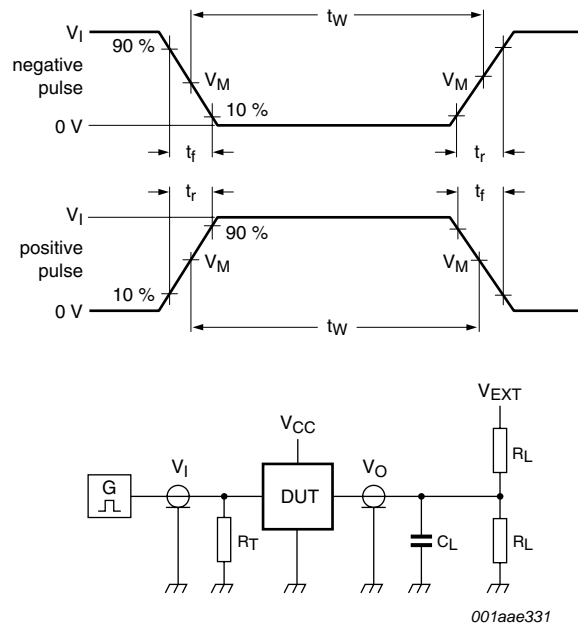
**Fig 11. Enable and disable times**

**Table 8. Measurement points**

| Supply voltage                           | Input        |       | Output |                         |                         |
|--|--------------|-------|--------|-------------------------|-------------------------|
| $V_{CC}$                                 | $V_I$        | $V_M$ | $V_M$  | $V_X$                   | $V_Y$                   |
| $V_{CC} = 5.0\text{ V} \pm 0.5\text{ V}$ | GND to 3.0 V | 1.5 V | 1.5 V  | $V_{OL} + 0.3\text{ V}$ | $V_{OH} - 0.3\text{ V}$ |



12. Test information



Test data is given in [Table 9](#).

All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz; Z<sub>o</sub> = 50 Ω.

The outputs are measured one at a time with one transition per measurement.

Definitions for test circuit:

R<sub>L</sub> = Load resistance.

C<sub>L</sub> = Load capacitance including jig and probe capacitance.

R<sub>T</sub> = Termination resistance should be equal to output impedance Z<sub>o</sub> of the pulse generator.

V<sub>EXT</sub> = External voltage for measuring switching times.

Fig 12. Test circuit for measuring switching times

Table 9. Test data

| Supply voltage                  | Input          |                                 | Load           |                | V <sub>EXT</sub>                    |                                     |                                     |
|---------------------------------|----------------|---------------------------------|----------------|----------------|-------------------------------------|-------------------------------------|-------------------------------------|
|                                 | V <sub>I</sub> | t <sub>r</sub> , t <sub>f</sub> | C <sub>L</sub> | R <sub>L</sub> | t <sub>PLH</sub> , t <sub>PHL</sub> | t <sub>PLZ</sub> , t <sub>PZL</sub> | t <sub>PHZ</sub> , t <sub>PZH</sub> |
| V <sub>CC</sub> = 5.0 V ± 0.5 V | GND to 3.0 V   | ≤ 2.5 ns                        | 50 pF          | 500 Ω          | open                                | 7.0 V                               | open                                |

13. Package outline

SO24: plastic small outline package; 24 leads; body width 7.5 mm

SOT137-1

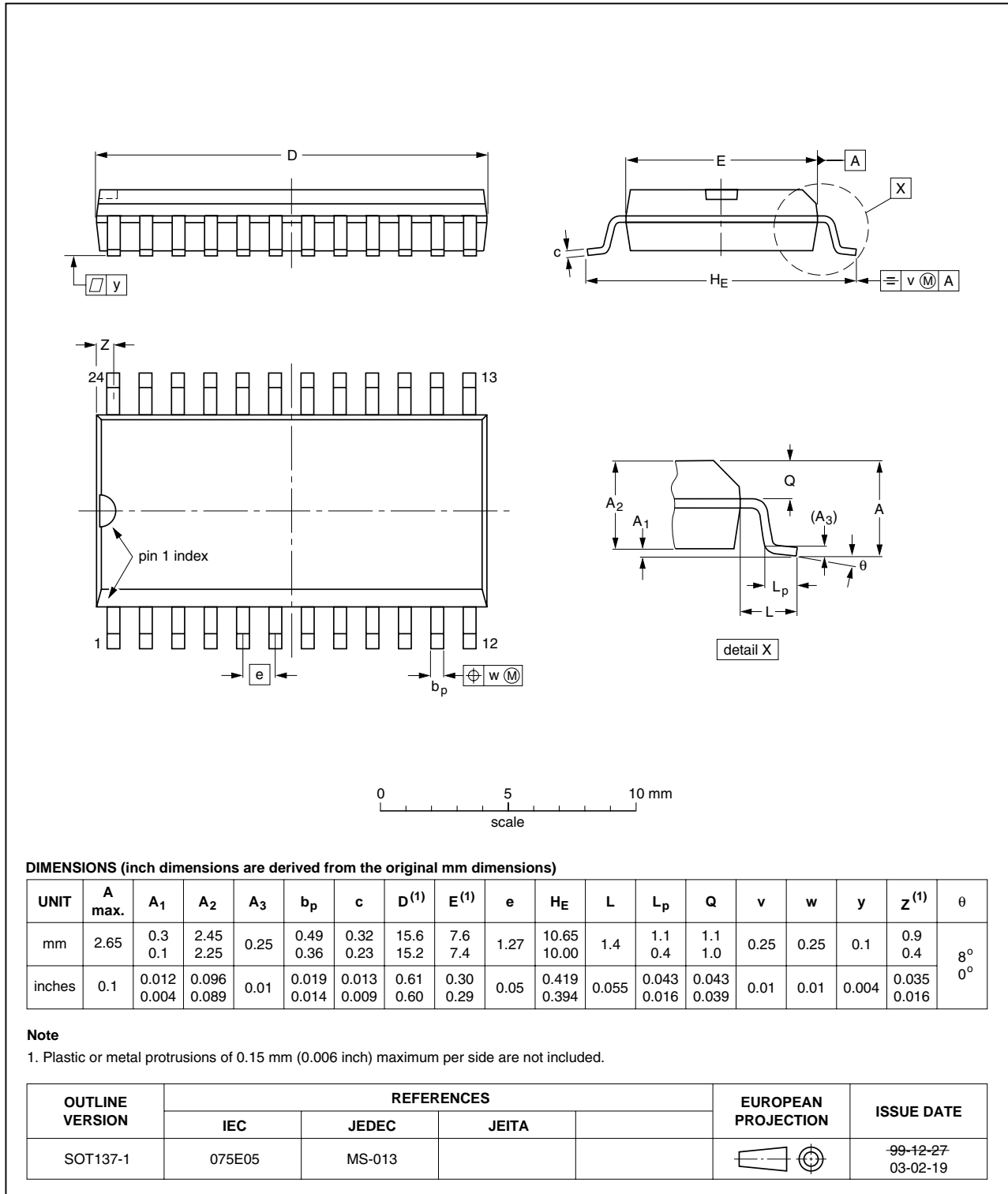


Fig 13. Package outline SOT137-1 (SO24)

SSOP24: plastic shrink small outline package; 24 leads; body width 5.3 mm

SOT340-1

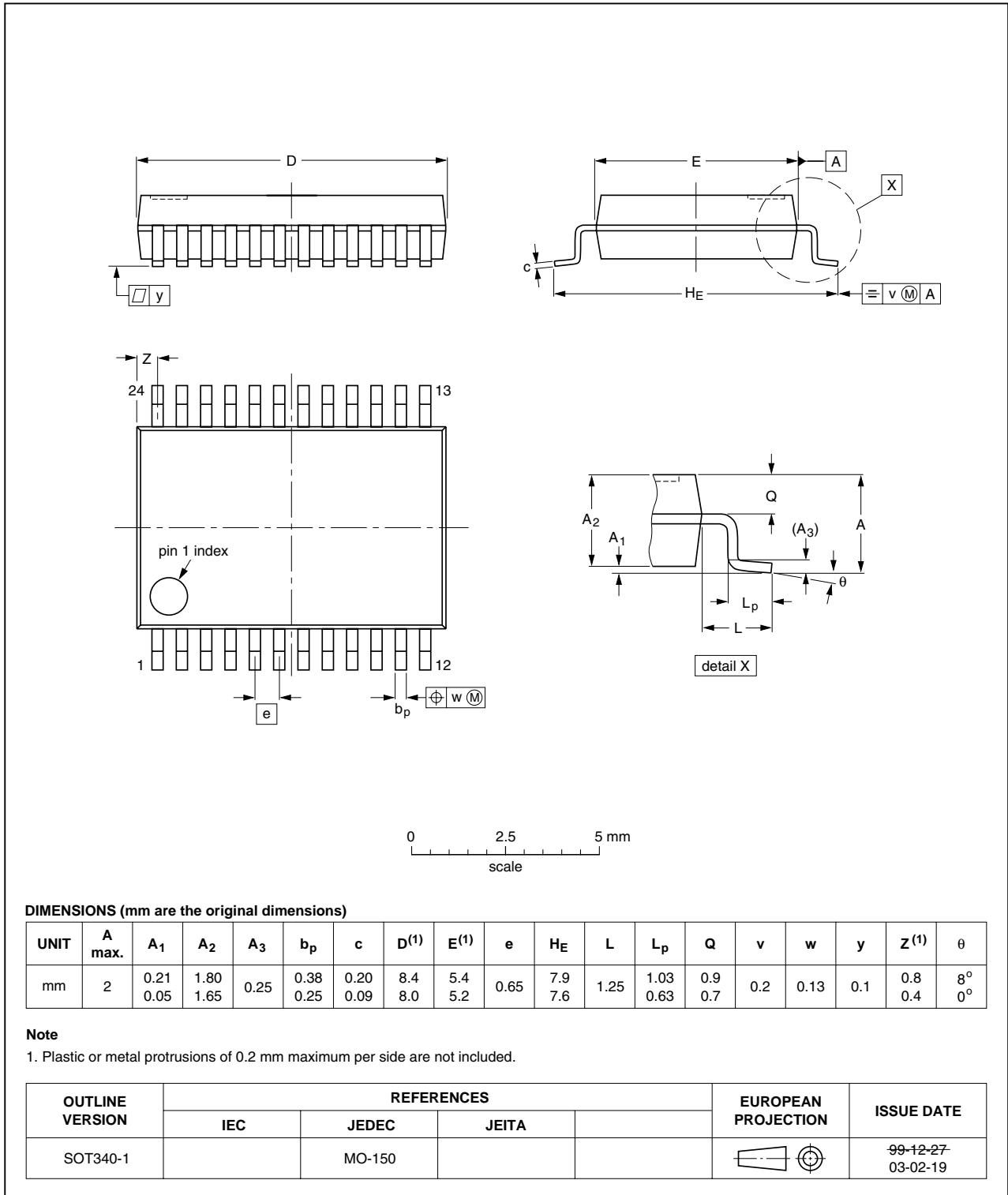


Fig 14. Package outline SOT340-1 (SSOP24)

SSOP24: plastic shrink small outline package; 24 leads; body width 3.9 mm; lead pitch 0.635 mm SOT556-1

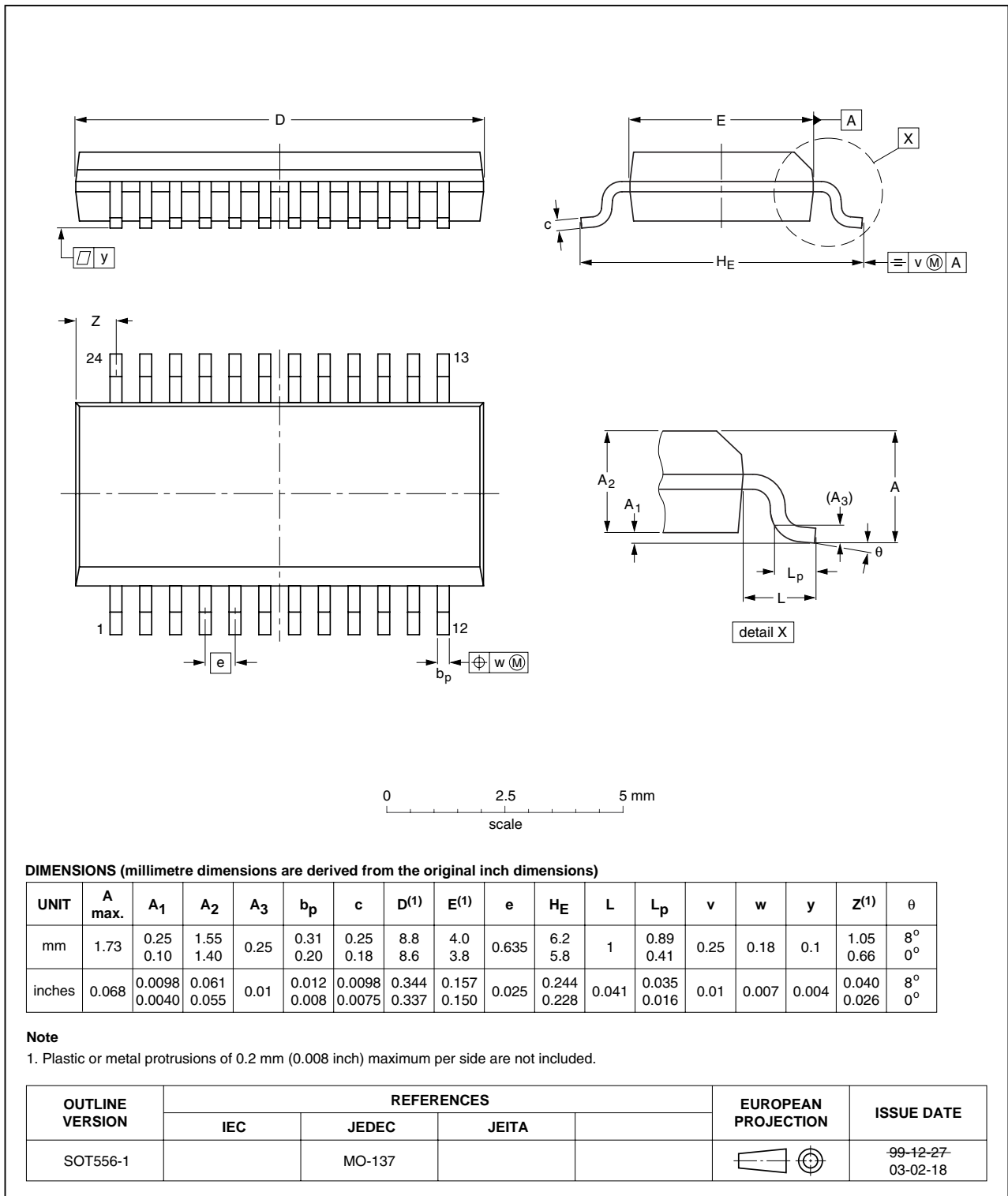


Fig 15. Package outline SOT556-1 (SSOP24)

TSSOP24: plastic thin shrink small outline package; 24 leads; body width 4.4 mm

SOT355-1

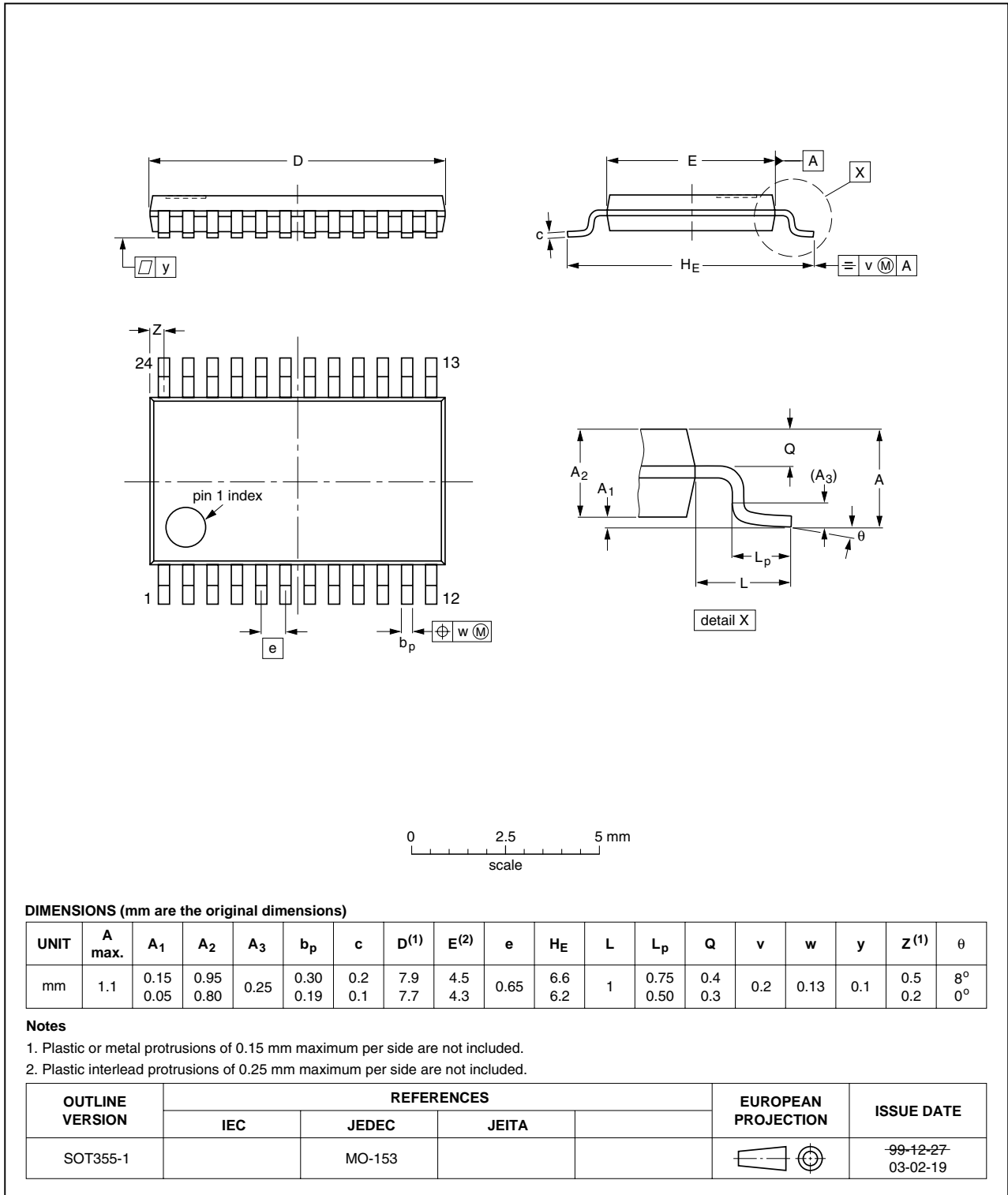


Fig 16. Package outline SOT355-1 (TSSOP24)

## 14. Abbreviations

Table 10. Abbreviations

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

## 15. Revision history

Table 11. Revision history

| Document ID    | Release date  | Data sheet status     | Change notice | Supersedes  |
|----------------|---|-----------------------|---------------|-------------|
| CBTD3384 v.5   | 20101119  | Product data sheet    | -             | CBT3384 v.4 |
| Modifications: | <ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> <li><a href="#">Table 7</a>: enable and disable times changed.</li> </ul> |                       |               |             |
| CBT3384 v.4    | 20011220  | Product specification |               | CBT3384 v.3 |
| CBT3384 v.3    | 20000830  | Product specification | -             | CBT3384 v.2 |
| CBT3384 v.2    | 20000830  | Product specification | -             | -           |

## 16. Legal information

### 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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

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