

# 74LVC32245A

32-bit bus transceiver with direction pin; 5 V tolerant; 3-state

Rev. 01 — 20 August 2007

Product data sheet

## 1. General description

The 74LVC32245A is a 32-bit transceiver featuring non-inverting 3-state bus compatible outputs in both send and receive directions. The device features four output enable ( $\overline{\text{nOE}}$ ) inputs for easy cascading and four send/receive ( $\overline{\text{nDIR}}$ ) inputs for direction control. Pin  $\overline{\text{nOE}}$  controls the outputs so that the buses are effectively isolated.

Inputs can be driven from either 3.3 V or 5 V devices. When disabled, up to 5.5 V can be applied to the outputs. These features allow the use of these devices in mixed 3.3 V and 5 V applications.

To ensure the high-impedance state during power-up or power-down, pin  $\overline{\text{nOE}}$  should be tied to  $V_{\text{CC}}$  through a pull-up resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

## 2. Features

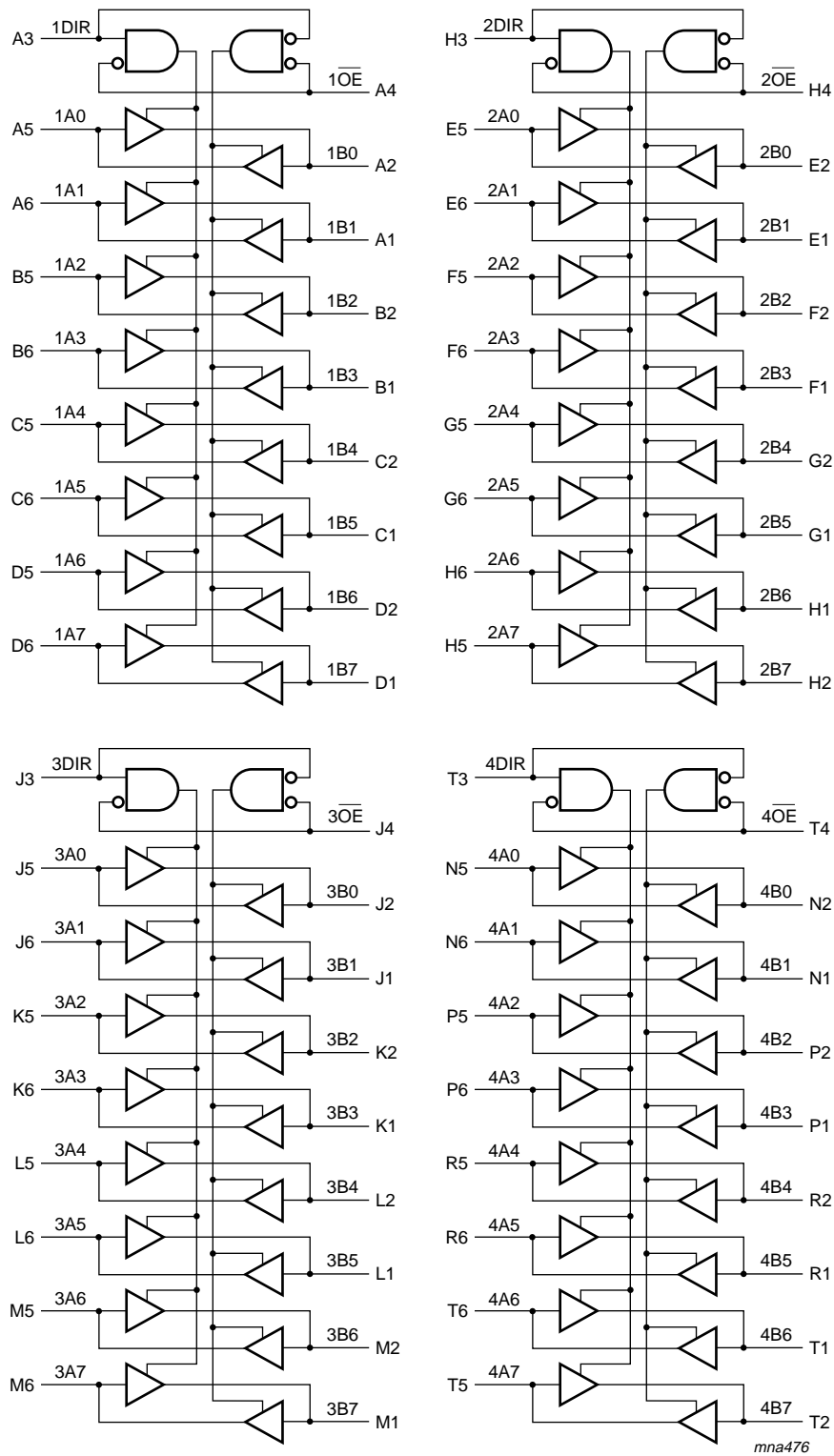
- 5 V tolerant inputs/outputs for interfacing with 5 V logic
- Wide supply voltage range from 1.2 V to 3.6 V
- CMOS low power consumption
- MULTIBYTE flow-through standard pin-out architecture
- Low inductance multiple power and ground pins for minimum noise and ground bounce
- Direct interface with TTL levels
- Inputs accept voltages up to 5.5 V
- High-impedance when  $V_{\text{CC}} = 0$  V
- Complies with JEDEC standard JESD8-B / JESD36
- ESD protection:
  - ◆ HBM EIA/JESD22-A114-B exceeds 2000 V
  - ◆ MM EIA/JESD22-A115-A exceeds 200 V
- Specified from  $-40$  °C to  $+85$  °C
- Packaged in plastic fine-pitch ball grid array package

## 3. Ordering information

Table 1. Ordering information

| Type number   | Package              |         |   | Version  |
|---------------|----------------------|---------|---|----------|
|               | Temperature range    | Name    | Description   |          |
| 74LVC32245AEC | $-40$ °C to $+85$ °C | LFBGA96 | plastic low profile fine-pitch ball grid array package; 96 balls; body $13.5 \times 5.5 \times 1.05$ mm | SOT536-1 |

4. Functional diagram



mna476

Fig 1. Logic symbol

## 5. Pinning information

### 5.1 Pinning

|               |                   |     |                 |     |     |                 |     |                   |                   |     |                 |     |     |                 |     |                   |
|---------------|-------------------|-----|-----------------|-----|-----|-----------------|-----|-------------------|-------------------|-----|-----------------|-----|-----|-----------------|-----|-------------------|
| <i>mna475</i> |                   |     |                 |     |     |                 |     |                   |                   |     |                 |     |     |                 |     |                   |
| 6             | 1A1               | 1A3 | 1A5             | 1A7 | 2A1 | 2A3             | 2A5 | 2A6               | 3A1               | 3A3 | 3A5             | 3A7 | 4A1 | 4A3             | 4A5 | 4A6               |
| 5             | 1A0               | 1A2 | 1A4             | 1A6 | 2A0 | 2A2             | 2A4 | 2A7               | 3A0               | 3A2 | 3A4             | 3A6 | 4A0 | 4A2             | 4A4 | 4A7               |
| 4             | 1 $\overline{OE}$ | GND | V <sub>CC</sub> | GND | GND | V <sub>CC</sub> | GND | 2 $\overline{OE}$ | 3 $\overline{OE}$ | GND | V <sub>CC</sub> | GND | GND | V <sub>CC</sub> | GND | 4 $\overline{OE}$ |
| 3             | 1DIR              | GND | V <sub>CC</sub> | GND | GND | V <sub>CC</sub> | GND | 2DIR              | 3DIR              | GND | V <sub>CC</sub> | GND | GND | V <sub>CC</sub> | GND | 4DIR              |
| 2             | 1B0               | 1B2 | 1B4             | 1B6 | 2B0 | 2B2             | 2B4 | 2B7               | 3B0               | 3B2 | 3B4             | 3B6 | 4B0 | 4B2             | 4B4 | 4B7               |
| 1             | 1B1               | 1B3 | 1B5             | 1B7 | 2B1 | 2B3             | 2B5 | 2B6               | 3B1               | 3B3 | 3B5             | 3B7 | 4B1 | 4B3             | 4B5 | 4B6               |
|               | A                 | B   | C               | D   | E   | F               | G   | H                 | J                 | K   | L               | M   | N   | P               | R   | T                 |

**Fig 2. Pin configuration**

### 5.2 Pin description

**Table 2. Pin description**

| Pin name                       | Ball   | Description                      |
|--------------------------------|--|----------------------------------|
| nDIR (n = 1 to 4)              | A3, H3, J3, T3   | direction control                |
| n $\overline{OE}$ (n = 1 to 4) | A4, H4, J4, T4   | output enable input (active LOW) |
| 1A[0:7]                        | A5, A6, B5, B6, C5, C6, D5, D6                                 | input or output                  |
| 1B[0:7]                        | A2, A1, B2, B1, C2, C1, D2, D1                                 | input or output                  |
| 2A[0:7]                        | E5, E6, F5, F6, G5, G6, H6, H5                                 | input or output                  |
| 2B[0:7]                        | E2, E1, F2, F1, G2, G1, H1, H2                                 | input or output                  |
| 3A[0:7]                        | J5, J6, K5, K6, L5, L6, M5, M6                                 | input or output                  |
| 3B[0:7]                        | J2, J1, K2, K1, L2, L1, M2, M1                                 | input or output                  |
| 4A[0:7]                        | N5, N6, P5, P6, R5, R6, T6, T5                                 | input or output                  |
| 4B[0:7]                        | N2, N1, P2, P1, R2, R1, T1, T2                                 | input or output                  |
| GND                            | B3, B4, D3, D4, E3, E4, G3, G4, K3, K4, M3, M4, N3, N4, R3, R4 | ground (0 V)                     |
| V <sub>CC</sub>                | C3, C4, F3, F4, L3, L4, P3, P4                                 | supply voltage                   |

## 6. Functional description

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

| Input             |      | Output |        |
|-------------------|------|--------|--------|
| n $\overline{OE}$ | nDIR | nAn    | nBn    |
| L                 | L    | A = B  | inputs |
| L                 | H    | inputs | B = A  |
| H                 | X    | Z      | Z      |

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; Z = high-impedance OFF-state

## 7. 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 |
|-----------|-------------------------|-------------------------------|----------|----------------|------|
| $V_{CC}$  | supply voltage          |                               | -0.5     | +6.5           | V    |
| $I_{IK}$  | input clamping current  | $V_I < 0$ V                   | -50      | -              | mA   |
| $V_I$     | input voltage           |                               | [1] -0.5 | +6.5           | V    |
| $I_{OK}$  | output clamping current | $V_O > V_{CC}$ or $V_O < 0$ V | -        | $\pm 50$       | mA   |
| $V_O$     | output voltage          | output HIGH or LOW state      | [2] -0.5 | $V_{CC} + 0.5$ | V    |
|           |                         | output 3-state                | [2] -0.5 | +6.5           | V    |
| $I_O$     | output current          | $V_O = 0$ V to $V_{CC}$       | -        | $\pm 50$       | mA   |
| $I_{CC}$  | supply current          |                               | [3] -    | 200            | mA   |
| $I_{GND}$ | ground current          |                               | [3] -200 | -              | mA   |
| $T_{stg}$ | storage temperature     |                               | -65      | +150           | °C   |
| $P_{tot}$ | total power dissipation | $T_{amb} = -40$ °C to +85 °C  | [4] -    | 1000           | mW   |

[1] The minimum input voltage ratings may be exceeded if the input current ratings are observed.

[2] The output voltage ratings may be exceeded if the output current ratings are observed.

[3] All supply and ground pins connected externally to one voltage source.

[4] Above 70 °C the value of  $P_{tot}$  derates linearly with 1.8 mW/K.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

| Symbol              | Parameter                           | Conditions                    | Min | Typ | Max      | Unit |
|---------------------|-------------------------------------|-------------------------------|-----|-----|----------|------|
| $V_{CC}$            | supply voltage                      | for maximum speed performance | 2.7 | -   | 3.6      | V    |
|                     |                                     | for low-voltage applications  | 1.2 | -   | -        | V    |
| $V_I$               | input voltage                       |                               | 0   | -   | 5.5      | V    |
| $V_O$               | output voltage                      | output HIGH or LOW state      | 0   | -   | $V_{CC}$ | V    |
|                     |                                     | output 3-state                | 0   | -   | 5.5      | V    |
| $T_{amb}$           | ambient temperature                 | in free air                   | -40 | -   | +85      | °C   |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC} = 1.2$ V to 2.7 V     | -   | -   | 20       | ns/V |
|                     |                                     | $V_{CC} = 2.7$ V to 3.6 V     | -   | -   | 10       | ns/V |

## 9. Static characteristics

**Table 6. Static characteristics**

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

| Symbol                                    | Parameter                 | Conditions   | V <sub>CC</sub> (V)      | Min             | Typ <sup>[1]</sup>    | Max             | Unit |   |
|---|---------------------------|--|--------------------------|-----------------|-----------------------|-----------------|------|---|
| <b>T<sub>amb</sub> = -40 °C to +85 °C</b> |                           |  |                          |                 |                       |                 |      |   |
| V <sub>IH</sub>                           | HIGH-level input voltage  |  | 1.2                      | V <sub>CC</sub> | -                     | -               | V    |   |
|   |                           |  | 2.7 to 3.6               | 2.0             | -                     | -               | V    |   |
| V <sub>IL</sub>                           | LOW-level input voltage   |  | 1.2                      | -               | -                     | GND             | V    |   |
|   |                           |  | 2.7 to 3.6               | -               | -                     | 0.8             | V    |   |
| V <sub>OH</sub>                           | HIGH-level output voltage | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                    |                          |                 |                       |                 |      |   |
|   |                           |  | I <sub>O</sub> = -100 μA | 2.7 to 3.6      | V <sub>CC</sub> - 0.2 | V <sub>CC</sub> | -    | V |
|   |                           |  | I <sub>O</sub> = -12 mA  | 2.7             | V <sub>CC</sub> - 0.5 | -               | -    | V |
|   |                           |  | I <sub>O</sub> = -18 mA  | 3.0             | V <sub>CC</sub> - 0.6 | -               | -    | V |
| V <sub>OL</sub>                           | LOW-level output voltage  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub>                                    |                          |                 |                       |                 |      |   |
|   |                           |  | I <sub>O</sub> = 100 μA  | 2.7 to 3.6      | -                     | GND             | 0.20 | V |
|   |                           |  | I <sub>O</sub> = 12 mA   | 2.7             | -                     | -               | 0.40 | V |
|   |                           |  | I <sub>O</sub> = 24 mA   | 3.0             | -                     | -               | 0.55 | V |
| I <sub>I</sub>                            | input leakage current     | V <sub>I</sub> = 5.5 V or GND  | 3.6                      | -               | ±0.1                  | ±5              | μA   |   |
| I <sub>OZ</sub>                           | OFF-state output current  | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ;<br>V <sub>O</sub> = 5.5 V or GND | 3.6                      | <sup>[2]</sup>  | ±0.1                  | ±5              | μA   |   |
| I <sub>OFF</sub>                          | power-off leakage current | V <sub>I</sub> or V <sub>O</sub> = 5.5 V   | 0.0                      | -               | ±0.1                  | ±10             | μA   |   |
| I <sub>CC</sub>                           | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A                          | 3.6                      | -               | 0.1                   | 40              | μA   |   |
| ΔI <sub>CC</sub>                          | additional supply current | per input pin;<br>V <sub>I</sub> = V <sub>CC</sub> - 0.6 V; I <sub>O</sub> = 0 A       | 2.7 to 3.6               | -               | 5                     | 500             | μA   |   |
| C <sub>I</sub>                            | input capacitance         | V <sub>I</sub> = GND to V <sub>CC</sub>  | 0 to 3.6                 | -               | 5.0                   | -               | pF   |   |
| C <sub>I/O</sub>                          | input/output capacitance  | V <sub>I</sub> = GND to V <sub>CC</sub>  | 0 to 3.6                 | -               | 10                    | -               | pF   |   |

[1] All typical values are measured at V<sub>CC</sub> = 3.3 V (unless stated otherwise) and T<sub>amb</sub> = 25 °C.

[2] For I/O ports the parameter I<sub>OZ</sub> includes the input leakage current.

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V). For test circuit see [Figure 5](#).

| Symbol                                    | Parameter                     | Conditions  | V <sub>CC</sub> (V) | Min | Typ <sup>[1]</sup> | Max  | Unit |    |
|---|-------------------------------|---|---------------------|-----|--------------------|------|------|----|
| <b>T<sub>amb</sub> = -40 °C to +85 °C</b> |                               |   |                     |     |                    |      |      |    |
| t <sub>pd</sub>                           | propagation delay             | nAn to nBn; nBn to nAn; see <a href="#">Figure 3</a>        | 1.2                 | [2] | -                  | 13.0 | ns   |    |
|   |                               |   | 2.7                 |     | 1.0                | 2.7  | 4.7  | ns |
|   |                               |   | 3.0 to 3.6          |     | 1.0                | 2.2  | 4.5  | ns |
| t <sub>en</sub>                           | enable time                   | n $\overline{OE}$ to nAn, nBn; see <a href="#">Figure 4</a> | 1.2                 | [2] | -                  | 15.0 | ns   |    |
|   |                               |   | 2.7                 |     | 1.5                | 3.6  | 6.7  | ns |
|   |                               |   | 3.0 to 3.6          |     | 1.0                | 2.8  | 5.5  | ns |
| t <sub>dis</sub>                          | disable time                  | n $\overline{OE}$ to nAn, nBn; see <a href="#">Figure 4</a> | 1.2                 | [2] | -                  | 11.0 | ns   |    |
|   |                               |   | 2.7                 |     | 1.5                | 3.4  | 6.6  | ns |
|   |                               |   | 3.0 to 3.6          |     | 1.5                | 3.2  | 5.6  | ns |
| t <sub>sk(o)</sub>                        | output skew time              |   | 3.0 to 3.6          | [3] | -                  | -    | 1.0  | ns |
| C <sub>PD</sub>                           | power dissipation capacitance | per buffer; V <sub>I</sub> = GND to V <sub>CC</sub>         | 3.3                 | [4] | -                  | 30   | -    | pF |

[1] Typical values are measured at T<sub>amb</sub> = 25 °C and V<sub>CC</sub> = 1.2 V, 2.7 V, and 3.3 V respectively.

[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>.

[3] Skew between any two outputs of the same package switching in the same direction. This parameter is guaranteed by design.

[4] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f<sub>i</sub> = input frequency in MHz; f<sub>o</sub> = output frequency in MHz

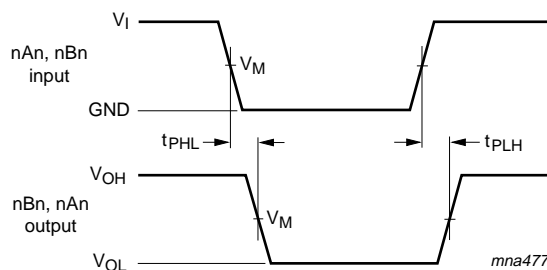
C<sub>L</sub> = output load capacitance in pF

V<sub>CC</sub> = supply voltage in Volts

N = number of inputs switching

Σ(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of the outputs.

## 11. Waveforms

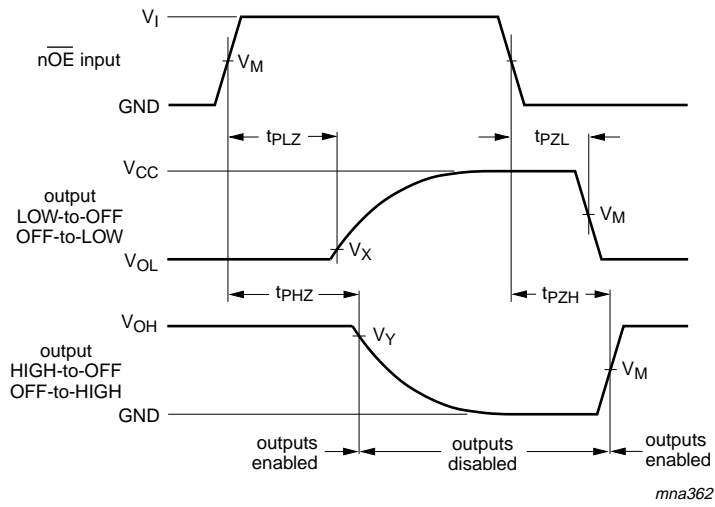


V<sub>M</sub> = 1.5 V at V<sub>CC</sub> ≥ 2.7 V.

V<sub>M</sub> = 0.5 × V<sub>CC</sub> at V<sub>CC</sub> < 2.7 V.

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

**Fig 3. The input (nAn, nBn) to output (nBn, nAn) propagation delays**



$V_M = 1.5 \text{ V}$  at  $V_{CC} \geq 2.7 \text{ V}$ .

$V_M = 0.5 \times V_{CC}$  at  $V_{CC} < 2.7 \text{ V}$ .

$V_X = V_{OL} + 0.3 \text{ V}$  at  $V_{CC} \geq 2.7 \text{ V}$ ;

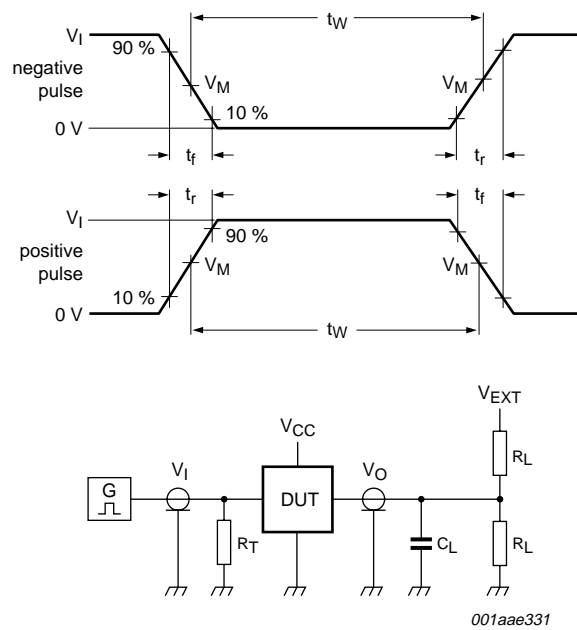
$V_X = V_{OL} + 0.15 \text{ V}$  at  $V_{CC} < 2.7 \text{ V}$ .

$V_Y = V_{OH} - 0.3 \text{ V}$  at  $V_{CC} \geq 2.7 \text{ V}$ ;

$V_Y = V_{OH} - 0.15 \text{ V}$  at  $V_{CC} < 2.7 \text{ V}$ .

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

**Fig 4. 3-state enable and disable times.**



Test data is given in [Table 8](#).

Definitions for test circuit:

$R_L$  = Load resistance.

$C_L$  = Load capacitance including jig and probe capacitance.

$R_T$  = Termination resistance should be equal to output impedance  $Z_o$  of the pulse generator.

$V_{EXT}$  = External voltage for measuring switching times.

**Fig 5. Load circuitry for switching times**

**Table 8. Test data**

| Supply voltage | Input    |               | Load  |              | $V_{EXT}$          |                    |                    |
|----------------|----------|---------------|-------|--------------|--------------------|--------------------|--------------------|
|                | $V_I$    | $t_r, t_f$    | $C_L$ | $R_L$        | $t_{PLH}, t_{PHL}$ | $t_{PLZ}, t_{PZL}$ | $t_{PHZ}, t_{PZH}$ |
| 1.2 V          | $V_{CC}$ | $\leq 2$ ns   | 50 pF | 500 $\Omega$ | open               | $2 \times V_{CC}$  | GND                |
| 2.7 V          | 2.7 V    | $\leq 2.5$ ns | 50 pF | 500 $\Omega$ | open               | $2 \times V_{CC}$  | GND                |
| 3.0 V to 3.6 V | 2.7 V    | $\leq 2.5$ ns | 50 pF | 500 $\Omega$ | open               | $2 \times V_{CC}$  | GND                |



12. Package outline

LFBGA96: plastic low profile fine-pitch ball grid array package; 96 balls; body 13.5 x 5.5 x 1.05 mm SOT536-1

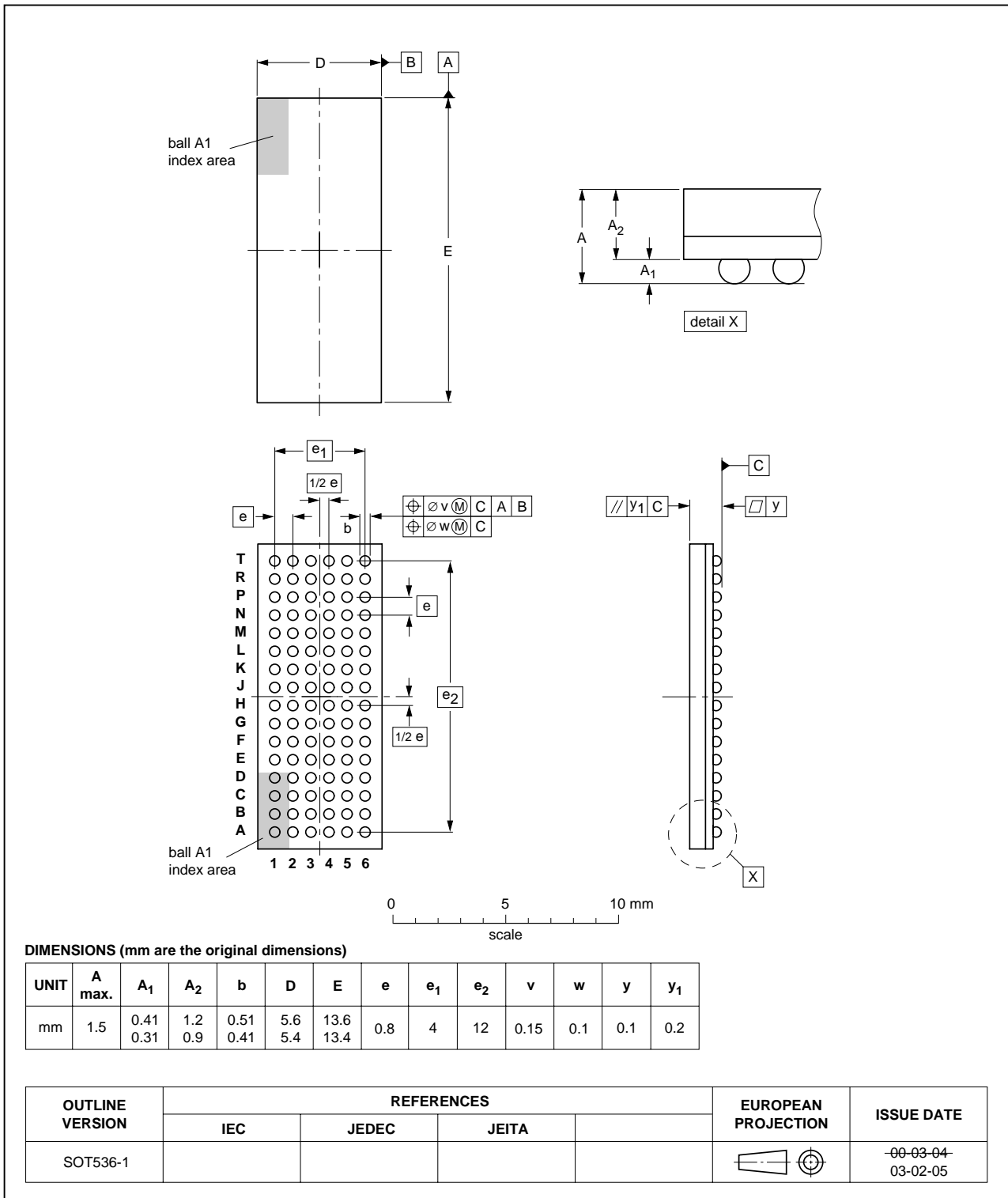


Fig 6. Package outline SOT536-1 (LFBGA96)

## 13. Abbreviations

Table 9. Abbreviations

| Acronym | Description                 |
|---------|-----------------------------|
| DUT     | Device Under Test           |
| ESD     | ElectroStatic Discharge     |
| HBM     | Human Body Model            |
| MM      | Machine Model               |
| TTL     | Transistor-Transistor Logic |

## 14. Revision history

Table 10. Revision history

| Document ID   | Release date | Data sheet status  | Change notice | Supersedes |
|---------------|--------------|--------------------|---------------|------------|
| 74LVC32245A_1 | 20070820     | Product data sheet | -             | -          |

## 15. Legal information

### 15.1 Data sheet status

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