

# 74LVTH32245

3.3 V 32-bit bus transceiver; 3-state

Rev. 01 — 23 January 2008

Product data sheet

## 1. General description

The 74LVTH32245 is a high-performance BiCMOS product designed for  $V_{CC}$  operation at 3.3 V. The 74LVTH32245 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 ( $\overline{nOE}$ ) inputs for easy cascading and four send/receive ( $\overline{nDIR}$ ) inputs for direction control. Pin  $\overline{nOE}$  controls the outputs so that the buses are effectively isolated. Bus hold on data inputs eliminates the need for external pull-up resistors to hold unused inputs.

## 2. Features

- 32-bit bidirectional bus interface
- 3-state buffers
- Output capability: +64 mA and -32 mA
- TTL input and output switching levels
- Input and output interface capability to systems at 5 V supply
- Bus hold data inputs eliminate need for external pull-up resistors to hold unused inputs
- Live insertion and extraction permitted
- Power-up 3-state
- No bus current loading when output is tied to 5 V bus
- Latch-up protection:
  - ◆ JESD78 Class II level A exceeds 500 mA
- ESD protection:
  - ◆ HBM JESD22-A114E exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V

## 3. Ordering information

Table 1. Ordering information

| Type number   | Package           |         |   |          |
|---------------|-------------------|---------|---|----------|
|               | Temperature range | Name    | Description   | Version  |
| 74LVTH32245EC | -40 °C to +85 °C  | LFPGA96 | plastic low profile fine-pitch ball grid array package; 96 balls; body 13.5 × 5.5 × 1.05 mm | SOT536-1 |

4. Functional diagram

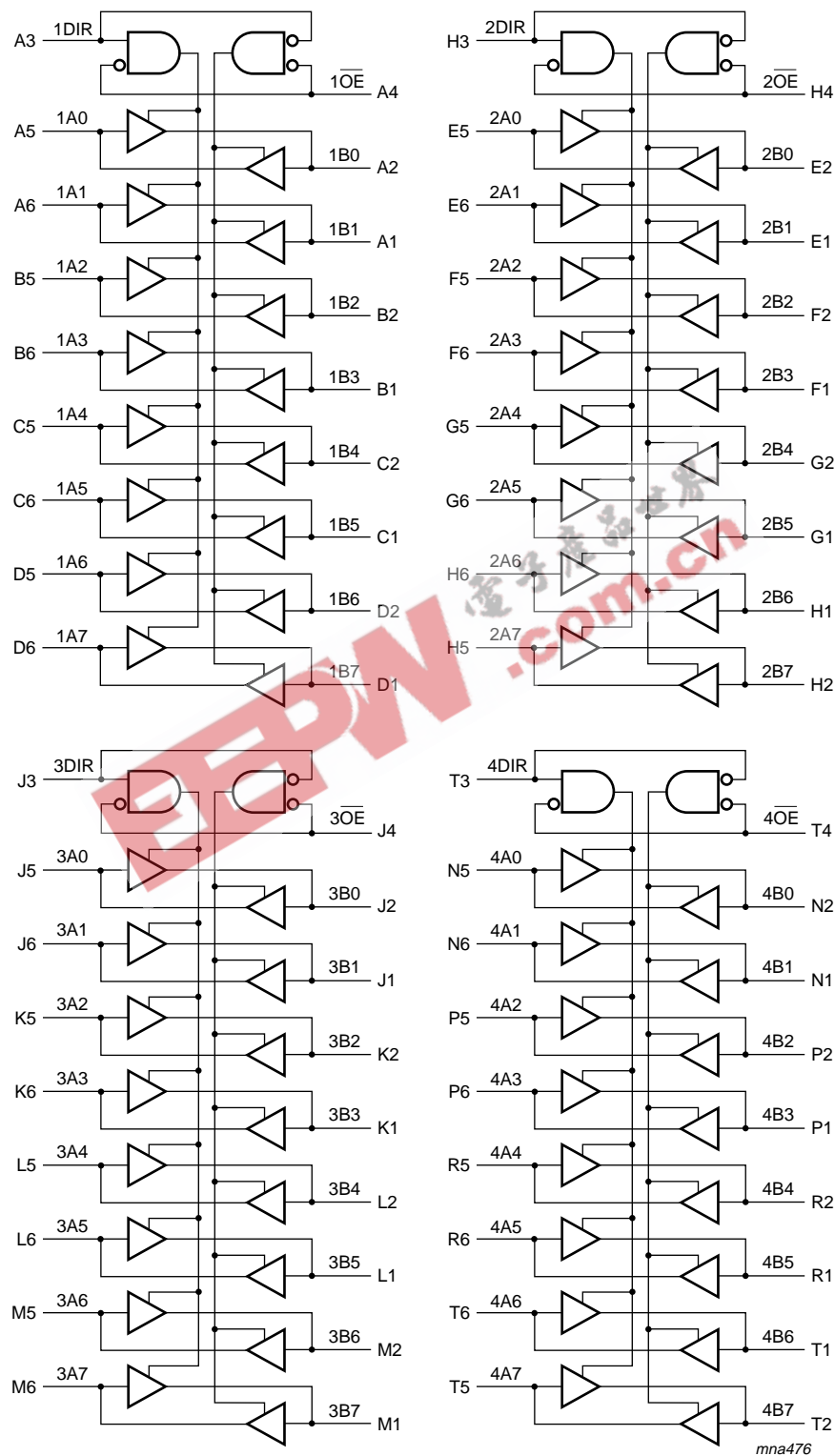
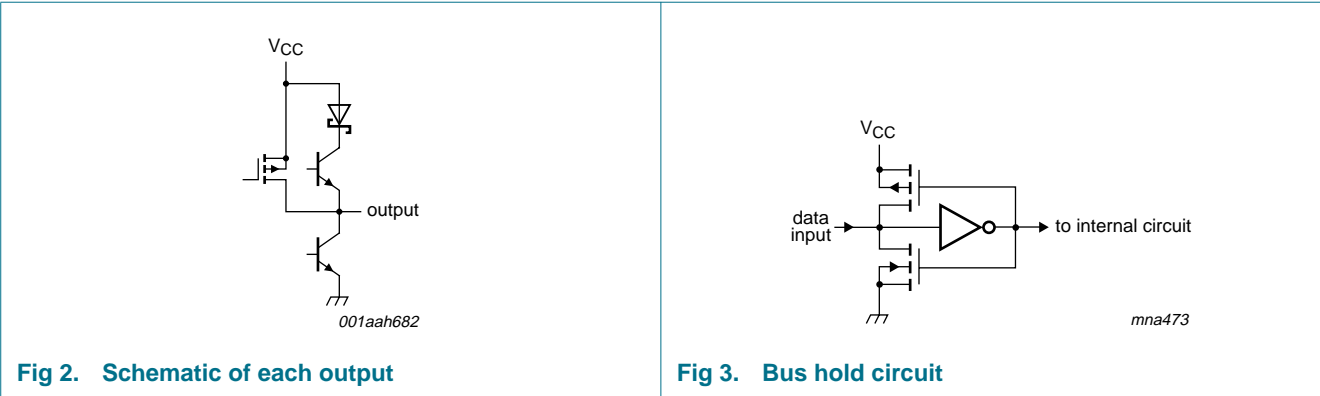
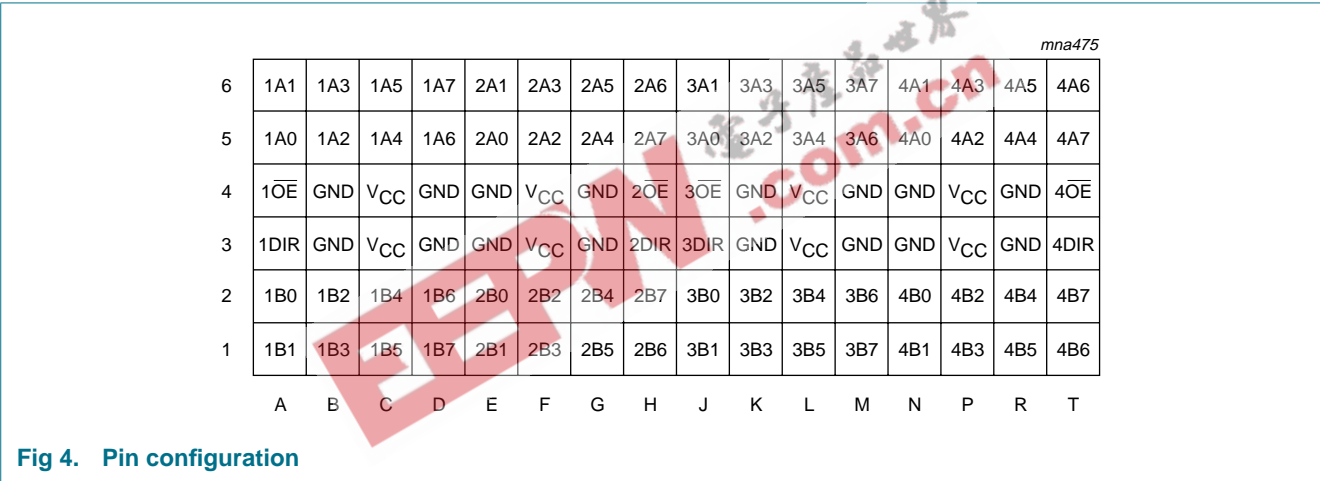


Fig 1. Logic symbol



5. Pinning information

5.1 Pinning



5.2 Pin description

Table 2. Pin description

| Symbol            | Ball                           | Description                      |
|-------------------|--------------------------------|----------------------------------|
| nDIR (n = 1 to 4) | A3, H3, J3, T3                 | direction control                |
| nOE (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                  |

Table 2. Pin description ...continued

| Symbol          | Ball   | Description     |
|-----------------|--|-----------------|
| 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 |      | Input/output |           |
|-------|------|--------------|-----------|
| nOE   | nDIR | nAn          | nBn       |
| L     | L    | nAn = nBn    | inputs    |
| L     | H    | inputs       | nBn = nAn |
| 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)<sup>[1][2]</sup>

| Symbol           | Parameter               | Conditions                  | Min                 | Max  | Unit |
|------------------|-------------------------|-----------------------------|---------------------|------|------|
| V <sub>CC</sub>  | supply voltage          |                             | -0.5                | +4.6 | V    |
| V <sub>I</sub>   | input voltage           |                             | <sup>[3]</sup> -0.5 | +7.0 | V    |
| V <sub>O</sub>   | output voltage          | output in OFF or HIGH-state | <sup>[3]</sup> -0.5 | +7.0 | V    |
| I <sub>IK</sub>  | input clamping current  | V <sub>I</sub> < 0 V        | -50                 | -    | mA   |
| I <sub>OK</sub>  | output clamping current | V <sub>O</sub> < 0 V        | -50                 | -    | mA   |
| I <sub>O</sub>   | output current          | output in LOW-state         | -                   | 128  | mA   |
|                  |                         | output in HIGH-state        | -64                 | -    | mA   |
| T <sub>stg</sub> | storage temperature     |                             | -65                 | +150 | °C   |
| T <sub>j</sub>   | junction temperature    |                             | -                   | 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 indicated under [Section 8 "Recommended operating conditions"](#) is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- [2] The performance capability of a high-performance integrated circuit in conjunction with its thermal environment can create junction temperatures which are detrimental to reliability.
- [3] 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. Recommended operating conditions**

| Symbol           | Parameter                           | Conditions                              | Min   | Typ | Max  | Unit |
|------------------|-------------------------------------|---|-------|-----|------|------|
| V <sub>CC</sub>  | supply voltage                      |   | 2.7   | -   | 3.6  | V    |
| V <sub>I</sub>   | input voltage                       |   | 0     | -   | 5.5  | V    |
| I <sub>OH</sub>  | HIGH-level output current           |   | -32   | -   | -    | mA   |
| I <sub>OL</sub>  | LOW-level output current            | none                                    | -     | -   | 32   | mA   |
|                  |                                     | current duty cycle ≤ 50 %;<br>f ≥ 1 kHz | -     | -   | 64   | mA   |
| T <sub>amb</sub> | ambient temperature                 | in free air                             | -40   | -   | +85  | °C   |
| Δt/ΔV            | input transition rise and fall rate | outputs enabled                         | -     | -   | 10   | ns/V |
| P <sub>tot</sub> | total power dissipation             |   | [1] - | -   | 1000 | mW   |

[1] Above 70 °C the value of P<sub>tot</sub> derates linearly with 1.8 mW/K.

## 9. Static characteristics

**Table 6. Static characteristics**

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

| Symbol  | Parameter                          | Conditions   | Min                   | Typ             | Max  | Unit |
|---|------------------------------------|--|-----------------------|-----------------|------|------|
| <b>T<sub>amb</sub> = -40 °C to +85 °C [1]</b> |                                    |  |                       |                 |      |      |
| V <sub>IK</sub>                               | input clamping voltage             | V <sub>CC</sub> = 2.7 V; I <sub>IK</sub> = -18 mA  | -1.2                  | -0.85           | -    | V    |
| V <sub>IH</sub>                               | HIGH-level input voltage           |  | 2.0                   | -               | -    | V    |
| V <sub>IL</sub>                               | LOW-level input voltage            |  | -                     | -               | 0.8  | V    |
| V <sub>OH</sub>                               | HIGH-level output voltage          | V <sub>CC</sub> = 2.7 V to 3.6 V; I <sub>OH</sub> = -100 μA  | V <sub>CC</sub> - 0.2 | V <sub>CC</sub> | -    | V    |
|   |                                    | V <sub>CC</sub> = 2.7 V; I <sub>OH</sub> = -8 mA   | 2.4                   | 2.5             | -    | V    |
|   |                                    | V <sub>CC</sub> = 3.0 V; I <sub>OH</sub> = -32 mA  | 2.0                   | 2.3             | -    | V    |
| V <sub>OL</sub>                               | LOW-level output voltage           | V <sub>CC</sub> = 2.7 V; I <sub>OL</sub> = 100 μA  | -                     | 0.07            | 0.2  | V    |
|   |                                    | V <sub>CC</sub> = 2.7 V; I <sub>OL</sub> = 24 mA   | -                     | 0.3             | 0.5  | V    |
|   |                                    | V <sub>CC</sub> = 3.0 V; I <sub>OL</sub> = 16 mA   | -                     | 0.25            | 0.4  | V    |
|   |                                    | V <sub>CC</sub> = 3.0 V; I <sub>OL</sub> = 32 mA   | -                     | 0.3             | 0.5  | V    |
|   |                                    | V <sub>CC</sub> = 3.0 V; I <sub>OL</sub> = 64 mA   | -                     | 0.4             | 0.55 | V    |
| I <sub>I</sub>                                | input leakage current              | control pins   |                       |                 |      |      |
|   |                                    | V <sub>CC</sub> = 3.6 V; V <sub>I</sub> = V <sub>CC</sub> or GND   | -                     | 0.1             | ±1   | μA   |
|   |                                    | V <sub>CC</sub> = 0 V or 3.6 V; V <sub>I</sub> = 5.5 V   | -                     | 0.1             | 10   | μA   |
|   |                                    | input/output data pins; V <sub>CC</sub> = 3.6 V  | [2]                   |                 |      |      |
|   |                                    | V <sub>I</sub> = 5.5 V   | -                     | 0.1             | 20   | μA   |
|   |                                    | V <sub>I</sub> = V <sub>CC</sub>   | -                     | 0.5             | 10   | μA   |
|   |                                    | V <sub>I</sub> = 0 V   | -5                    | -0.1            | -    | μA   |
| I <sub>OFF</sub>                              | power-off leakage current          | V <sub>CC</sub> = 0 V; V <sub>I</sub> or V <sub>O</sub> = 0 V to 4.5 V   | -                     | 0.1             | ±100 | μA   |
| I <sub>LO</sub>                               | output leakage current             | output HIGH; V <sub>O</sub> = 5.5 V; V <sub>CC</sub> = 3.0 V   | -                     | 75              | 125  | μA   |
| I <sub>O(pu/pd)</sub>                         | power-up/power-down output current | V <sub>CC</sub> ≤ 1.2 V; V <sub>O</sub> = 0.5 V to V <sub>CC</sub> ;<br>V <sub>I</sub> = GND or V <sub>CC</sub> ; nOE = don't care | [4] -                 | 40              | ±100 | μA   |

**Table 6.** Static characteristics ...continued

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

| Symbol          | Parameter                       | Conditions  | Min     | Typ  | Max  | Unit          |
|-----------------|---------------------------------|---|---------|------|------|---------------|
| $I_{BHL}$       | bus hold LOW current            | $V_{CC} = 3\text{ V}$ ; $V_I = 0.8\text{ V}$  | 75      | 135  | -    | $\mu\text{A}$ |
| $I_{BHH}$       | bus hold HIGH current           | $V_{CC} = 3\text{ V}$ ; $V_I = 2.0\text{ V}$  | -       | -135 | -75  | $\mu\text{A}$ |
| $I_{BHLO}$      | bus hold LOW overdrive current  | $V_{CC} = 0\text{ V}$ to $3.6\text{ V}$ ; $V_I = 3.6\text{ V}$  | [3] 500 | -    | -    | $\mu\text{A}$ |
| $I_{BHHO}$      | bus hold HIGH overdrive current | $V_{CC} = 0\text{ V}$ to $3.6\text{ V}$ ; $V_I = 3.6\text{ V}$  | [3] -   | -    | -500 | $\mu\text{A}$ |
| $I_{CC}$        | supply current                  | $V_{CC} = 3.6\text{ V}$ ; $V_I = \text{GND}$ or $V_{CC}$ ; $I_O = 0\text{ A}$   |         |      |      |               |
|                 |                                 | outputs HIGH  | -       | 0.14 | 0.24 | $\text{mA}$   |
|                 |                                 | outputs LOW   | -       | 8.4  | 12   | $\text{mA}$   |
|                 |                                 | outputs disabled  | [5] -   | 0.14 | 0.24 | $\text{mA}$   |
| $\Delta I_{CC}$ | additional supply current       | per input pin; $V_{CC} = 3\text{ V}$ to $3.6\text{ V}$ ; one input at $V_{CC} - 0.6\text{ V}$ ; other inputs at $V_{CC}$ or GND | [6] -   | 0.1  | 0.2  | $\text{mA}$   |
| $C_I$           | input capacitance               | control pins; $V_O = 0\text{ V}$ or $3.0\text{ V}$  | -       | 3    | -    | $\text{pF}$   |
| $C_{I/O}$       | input/output capacitance        | input/output data pins; outputs disabled; $V_{CC} = 3.6\text{ V}$ ; $I_O = 0\text{ A}$ ; $V_I = \text{GND}$ or $V_{CC}$         | -       | 9    | -    | $\text{pF}$   |

[1] All typical values are at  $V_{CC} = 3.3\text{ V}$  and  $T_{\text{amb}} = 25\text{ }^\circ\text{C}$  unless otherwise specified.[2] Unused pins at  $V_{CC}$  or GND.

[3] This is the bus-hold overdrive current required to force the input to the opposite logic state.

[4] This parameter is valid for any  $V_{CC}$  between  $0\text{ V}$  and  $1.2\text{ V}$  with a transition time of up to  $10\text{ ms}$ . From  $V_{CC} = 1.2\text{ V}$  to  $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$  a transition time of  $100\text{ }\mu\text{s}$  is permitted. This parameter is valid for  $T_{\text{amb}} = 25\text{ }^\circ\text{C}$  only.[5]  $I_{CC}$  is measured with outputs pulled to  $V_{CC}$  or GND.[6] This is the increase in supply current for each input at the specified voltage level other than  $V_{CC}$  or GND.

## 10. Dynamic characteristics

**Table 7.** Dynamic characteristics

Voltages are referenced to GND (ground = 0 V); for load circuit see Figure 7.

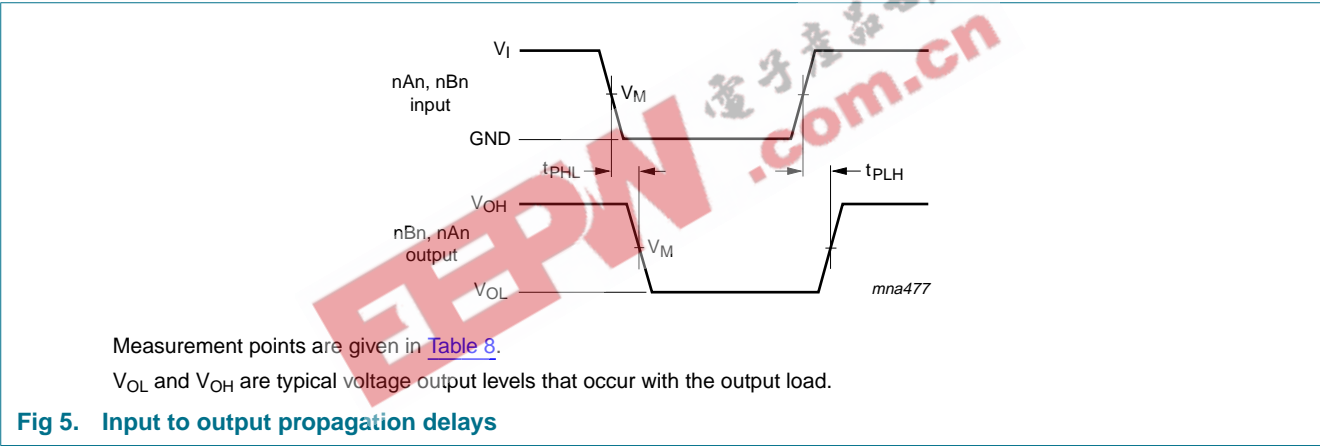
| Symbol   | Parameter                           | Conditions  | Min | Typ <sup>[1]</sup> | Max | Unit |
|--|-------------------------------------|---|-----|--------------------|-----|------|
| <b><math>T_{\text{amb}} = -40\text{ }^\circ\text{C}</math> to <math>+85\text{ }^\circ\text{C}</math></b> |                                     |   |     |                    |     |      |
| $t_{PLH}$  | LOW to HIGH propagation delay       | nAn to nBn or nBn to nAn; see Figure 5              |     |                    |     |      |
|  |                                     | $V_{CC} = 2.7\text{ V}$                             | -   | -                  | 3.5 | ns   |
|  |                                     | $V_{CC} = 3.0\text{ V}$ to $3.6\text{ V}$           | 1.0 | 1.9                | 3.3 | ns   |
| $t_{PHL}$  | HIGH to LOW propagation delay       | nAn to nBn or nBn to nAn; see Figure 5              |     |                    |     |      |
|  |                                     | $V_{CC} = 2.7\text{ V}$                             | -   | -                  | 3.5 | ns   |
|  |                                     | $V_{CC} = 3.0\text{ V}$ to $3.6\text{ V}$           | 1.0 | 1.7                | 3.3 | ns   |
| $t_{PZH}$  | OFF-state to HIGH propagation delay | $\overline{\text{nOE}}$ to nAn or nBn; see Figure 6 |     |                    |     |      |
|  |                                     | $V_{CC} = 2.7\text{ V}$                             | -   | -                  | 5.3 | ns   |
|  |                                     | $V_{CC} = 3.0\text{ V}$ to $3.6\text{ V}$           | 1.0 | 2.8                | 4.5 | ns   |

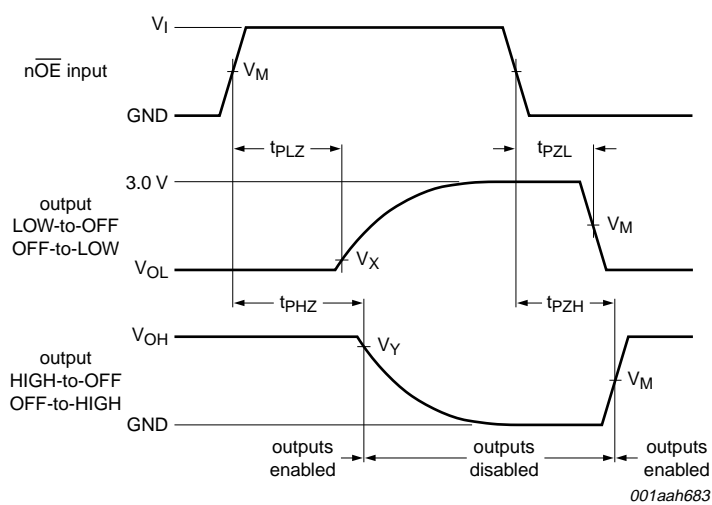
**Table 7. Dynamic characteristics ...continued**  
Voltages are referenced to GND (ground = 0 V); for load circuit see [Figure 7](#).

| Symbol           | Parameter                           | Conditions   | Min | Typ <sup>[1]</sup> | Max | Unit |
|------------------|-------------------------------------|--|-----|--------------------|-----|------|
| t <sub>PZL</sub> | OFF-state to LOW propagation delay  | n $\overline{\text{OE}}$ to nAn or nBn; see <a href="#">Figure 6</a> |     |                    |     |      |
|                  |                                     | V <sub>CC</sub> = 2.7 V  | -   | -                  | 5.1 | ns   |
|                  |                                     | V <sub>CC</sub> = 3.0 V to 3.6 V                                     | 1.0 | 2.8                | 4.1 | ns   |
| t <sub>PHZ</sub> | HIGH to OFF-state propagation delay | n $\overline{\text{OE}}$ to nAn or nBn; see <a href="#">Figure 6</a> |     |                    |     |      |
|                  |                                     | V <sub>CC</sub> = 2.7 V  | -   | -                  | 5.7 | ns   |
|                  |                                     | V <sub>CC</sub> = 3.0 V to 3.6 V                                     | 1.5 | 3.2                | 5.1 | ns   |
| t <sub>PLZ</sub> | LOW to OFF-state propagation delay  | n $\overline{\text{OE}}$ to nAn or nBn; see <a href="#">Figure 6</a> |     |                    |     |      |
|                  |                                     | V <sub>CC</sub> = 2.7 V  | -   | -                  | 4.6 | ns   |
|                  |                                     | V <sub>CC</sub> = 3.0 V to 3.6 V                                     | 1.5 | 3.0                | 4.6 | ns   |

[1] All typical values are at V<sub>CC</sub> = 3.3 V and T<sub>amb</sub> = 25 °C.

11. Waveforms





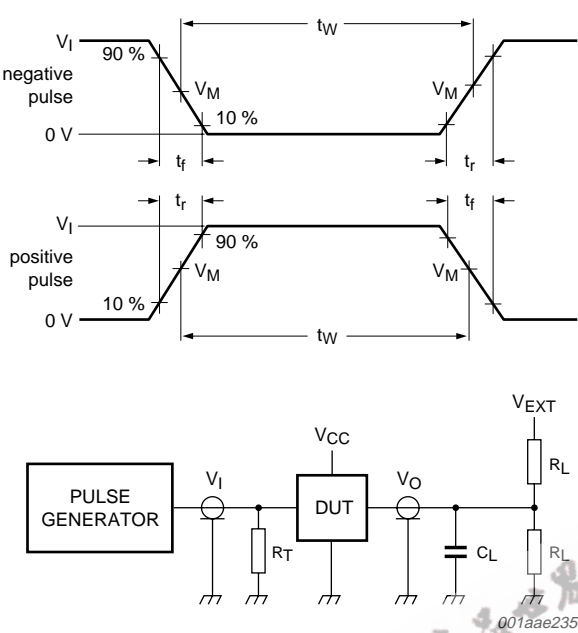
Measurement points are given in [Table 8](#).  
 $V_{OL}$  and  $V_{OH}$  are typical voltage output levels that occur with the output load.

Fig 6. enable and disable times

Table 8. Measurement points

| Supply voltage | Input | Output |                         |                         |
|----------------|-------|--------|-------------------------|-------------------------|
| $V_{CC}$       | $V_M$ | $V_M$  | $V_X$                   | $V_Y$                   |
| 2.7 V to 3.6 V | 1.5 V | 1.5 V  | $V_{OL} + 0.3\text{ V}$ | $V_{OH} - 0.3\text{ V}$ |





Test data is given in [Table 9](#).  
Definitions 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 7. Load circuitry for switching times

Table 9. Test data

| Input |               |        |               | Load         |       | $V_{EXT}$          |                    |                    |
|-------|---------------|--------|---------------|--------------|-------|--------------------|--------------------|--------------------|
| $V_I$ | $f_i$         | $t_W$  | $t_r, t_f$    | $R_L$        | $C_L$ | $t_{PHZ}, t_{PZH}$ | $t_{PLZ}, t_{PZL}$ | $t_{PLH}, t_{PHL}$ |
| 2.7 V | $\leq 10$ MHz | 500 ns | $\leq 2.5$ ns | 500 $\Omega$ | 50 pF | GND                | 6 V                | open               |

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

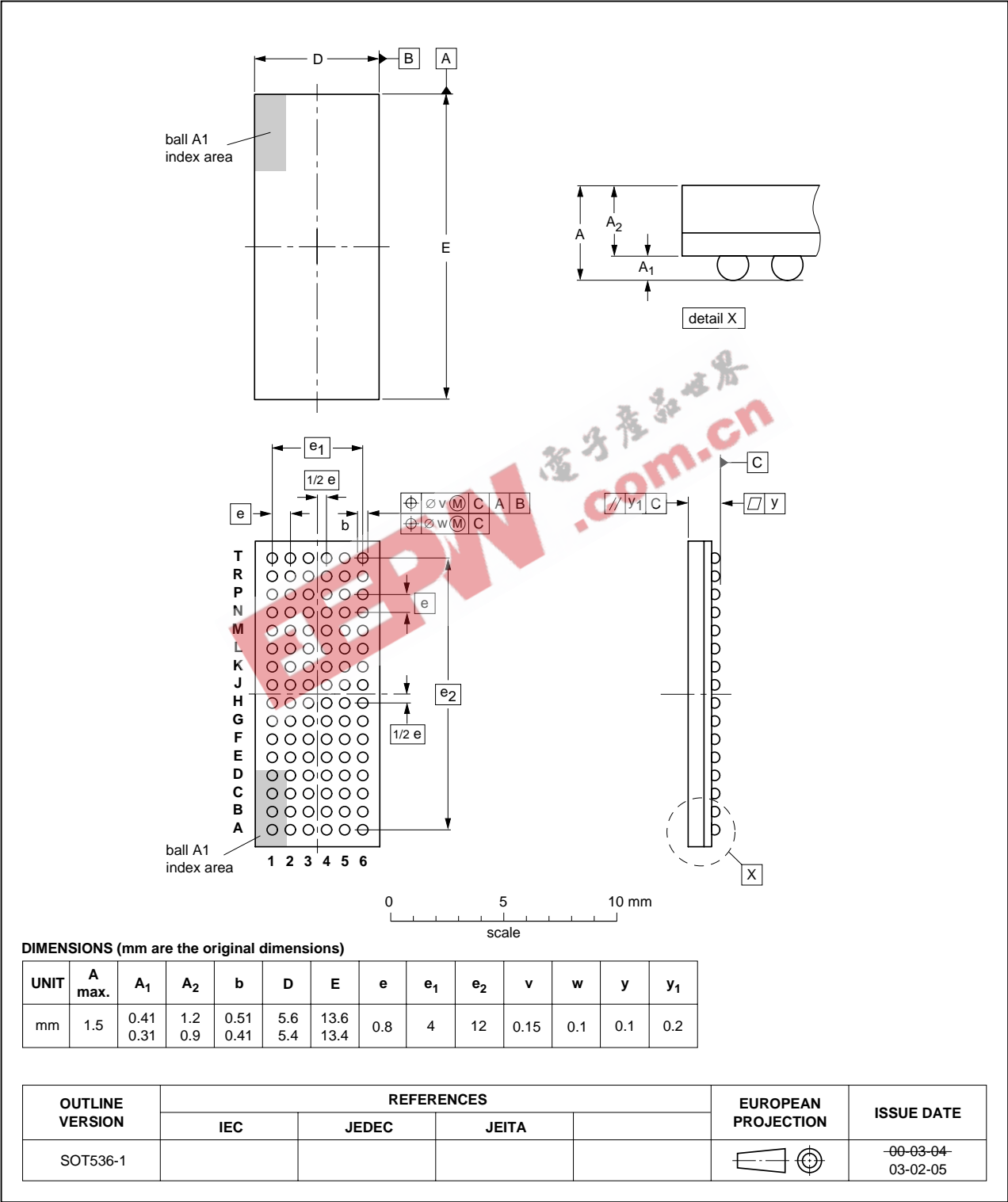


Fig 8. Package outline SOT536-1 (LFBGA96)

## 13. Abbreviations

Table 10. Abbreviations

| Acronym | Description                                     |
|---------|---|
| BiCMOS  | Bipolar Complementary Metal-Oxide Semiconductor |
| DUT     | Device Under Test                               |
| ESD     | ElectroStatic Discharge                         |
| HBM     | Human Body Model                                |
| MM      | Machine Model                                   |
| TTL     | Transistor-Transistor Logic                     |

## 14. Revision history

Table 11. Revision history

| Document ID   | Release date | Data sheet status  | Change notice | Supersedes |
|---------------|--------------|--------------------|---------------|------------|
| 74LVTH32245_1 | 20080123     | Product data sheet | -             | -          |

## 15. Legal information

### 15.1 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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