

## 74LVT322245 • 74LVTH322245

### Low Voltage 32-Bit Transceiver with 3-STATE Outputs and 25Ω Series Resistors in A Port Outputs

#### General Description

The LVT322245 and LVTH322245 contain thirty-two non-inverting bidirectional buffers with 3-STATE outputs and are intended for bus oriented applications. The device is byte controlled. Each byte has separate control inputs which can be shorted together for full 32-bit operation. The T/R inputs determine the direction of data flow through the device. The OE inputs disable both the A and B ports by placing them in a high impedance state.

The LVT322245 and LVTH322245 are designed with equivalent 25Ω series resistance in both the HIGH and LOW states on the A Port outputs. This design reduces line noise in applications such as memory address drivers, clock drivers, and bus transceivers/transmitters.

The LVTH322245 data inputs include bushold, eliminating the need for external pull-up resistors to hold unused inputs.

These non-inverting transceivers are designed for low-voltage (3.3V) V<sub>CC</sub> applications, but with the capability to provide a TTL interface to a 5V environment. The LVT322245 and LVTH322245 are fabricated with an advanced BiCMOS technology to achieve high speed operation similar to 5V ABT while maintaining a low power dissipation.

#### Features

- Input and output interface capability to systems at 5V V<sub>CC</sub>
- Bushold data inputs eliminate the need for external pull-up resistors to hold unused inputs (74LVTH322245)
- Also available without bushold feature (74LVT322245)
- Live insertion/extraction permitted
- Power Up/Power Down high impedance provides glitch-free bus loading
- A Port outputs include equivalent series resistance of 25Ω making external termination resistors unnecessary and reducing overshoot and undershoot
- A Port outputs source/sink ±12 mA  
B Port outputs source/sink –32 mA/+64 mA
- ESD performance:  
Human-body model > 2000V  
Machine model > 200V  
Charged-device model > 1000V
- Packaged in plastic Fine-Pitch Ball Grid Array (FBGA)

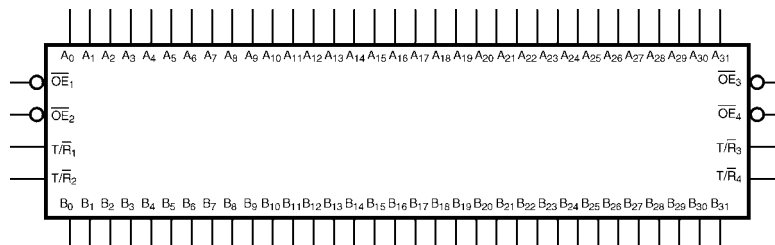
#### Ordering Code:

| Order Number                       | Package Number          | Package Description                                                 |
|------------------------------------|-------------------------|---------------------------------------------------------------------|
| 74LVT322245G<br>(Note 1) (Note 2)  | BGA96A<br>(Preliminary) | 96-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide |
| 74LVTH322245G<br>(Note 1) (Note 2) | BGA96A                  | 96-Ball Fine-Pitch Ball Grid Array (FBGA), JEDEC MO-205, 5.5mm Wide |

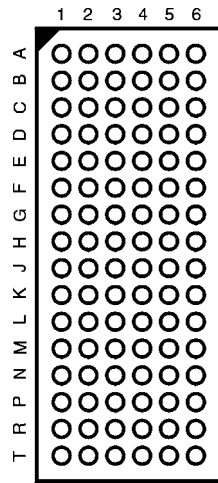
**Note 1:** Ordering code "G" indicates TRAYS.

**Note 2:** Devices also available in TAPE and REEL. Specify by appending the suffix letter "X" to the ordering code.

#### Logic Symbol



## Connection Diagram



(Top Thru View)

## FBGA Pin Descriptions

| Pin Names          | Description                      |
|--------------------|----------------------------------|
| $\overline{OE}_n$  | Output Enable Input (Active LOW) |
| $T/\overline{R}_n$ | Transmit/Receive Input           |
| $A_0$ – $A_{31}$   | Side A Inputs/3-STATE Outputs    |
| $B_0$ – $B_{31}$   | Side B Inputs/3-STATE Outputs    |

## Pin Assignments for FBGA

|   | 1        | 2        | 3                  | 4                 | 5        | 6        |
|---|----------|----------|--------------------|-------------------|----------|----------|
| A | $B_1$    | $B_0$    | $T/\overline{R}_1$ | $\overline{OE}_1$ | $A_0$    | $A_1$    |
| B | $B_3$    | $B_2$    | GND                | GND               | $A_2$    | $A_3$    |
| C | $B_5$    | $B_4$    | $V_{CC1}$          | $V_{CC1}$         | $A_4$    | $A_5$    |
| D | $B_7$    | $B_6$    | GND                | GND               | $A_6$    | $A_7$    |
| E | $B_9$    | $B_8$    | GND                | GND               | $A_8$    | $A_9$    |
| F | $B_{11}$ | $B_{10}$ | $V_{CC1}$          | $V_{CC1}$         | $A_{10}$ | $A_{11}$ |
| G | $B_{13}$ | $B_{12}$ | GND                | GND               | $A_{12}$ | $A_{13}$ |
| H | $B_{14}$ | $B_{15}$ | $T/\overline{R}_2$ | $\overline{OE}_2$ | $A_{15}$ | $A_{14}$ |
| J | $B_{17}$ | $B_{16}$ | $T/\overline{R}_3$ | $\overline{OE}_3$ | $A_{16}$ | $A_{17}$ |
| K | $B_{19}$ | $B_{18}$ | GND                | GND               | $A_{18}$ | $A_{19}$ |
| L | $B_{21}$ | $B_{20}$ | $V_{CC2}$          | $V_{CC2}$         | $A_{20}$ | $A_{21}$ |
| M | $B_{23}$ | $B_{22}$ | GND                | GND               | $A_{22}$ | $A_{23}$ |
| N | $B_{25}$ | $B_{24}$ | GND                | GND               | $A_{24}$ | $A_{25}$ |
| P | $B_{27}$ | $B_{26}$ | $V_{CC2}$          | $V_{CC2}$         | $A_{26}$ | $A_{27}$ |
| R | $B_{29}$ | $B_{28}$ | GND                | GND               | $A_{28}$ | $A_{29}$ |
| T | $B_{30}$ | $B_{31}$ | $T/\overline{R}_4$ | $\overline{OE}_4$ | $A_{31}$ | $A_{30}$ |

## Truth Tables

| Inputs            |                    | Outputs                                       |
|-------------------|--------------------|-----------------------------------------------|
| $\overline{OE}_1$ | $T/\overline{R}_1$ |                                               |
| L                 | L                  | Bus $B_0$ – $B_7$ Data to Bus $A_0$ – $A_7$   |
| L                 | H                  | Bus $A_0$ – $A_7$ Data to Bus $B_0$ – $B_7$   |
| H                 | X                  | HIGH-Z State on $A_0$ – $A_7$ , $B_0$ – $B_7$ |

| Inputs            |                    | Outputs                                             |
|-------------------|--------------------|-----------------------------------------------------|
| $\overline{OE}_2$ | $T/\overline{R}_2$ |                                                     |
| L                 | L                  | Bus $B_8$ – $B_{15}$ Data to Bus $A_8$ – $A_{15}$   |
| L                 | H                  | Bus $A_8$ – $A_{15}$ Data to Bus $B_8$ – $B_{15}$   |
| H                 | X                  | HIGH-Z State on $A_8$ – $A_{15}$ , $B_8$ – $B_{15}$ |

H = HIGH Voltage Level  
L = LOW Voltage Level  
X = Immaterial  
Z = High Impedance

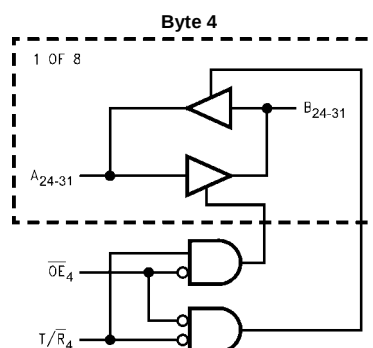
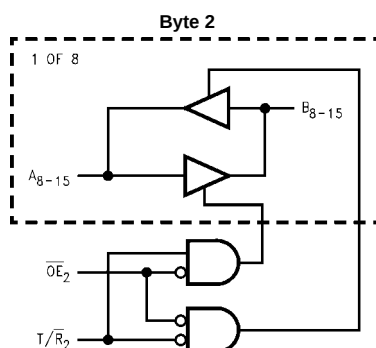
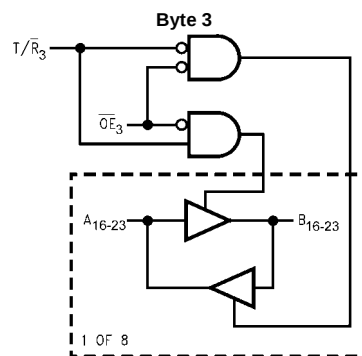
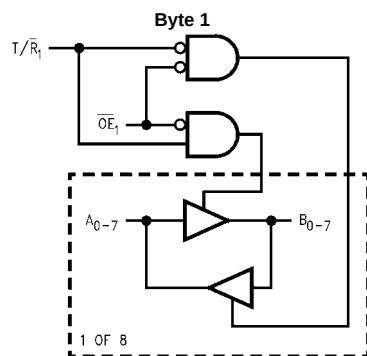
| Inputs            |                    | Outputs                                                   |
|-------------------|--------------------|-----------------------------------------------------------|
| $\overline{OE}_3$ | $T/\overline{R}_3$ |                                                           |
| L                 | L                  | Bus $B_{16}$ – $B_{23}$ Data to Bus $A_{16}$ – $A_{23}$   |
| L                 | H                  | Bus $A_{16}$ – $A_{23}$ Data to Bus $B_{16}$ – $B_{23}$   |
| H                 | X                  | HIGH-Z State on $A_{16}$ – $A_{23}$ , $B_{16}$ – $B_{23}$ |

| Inputs            |                    | Outputs                                                   |
|-------------------|--------------------|-----------------------------------------------------------|
| $\overline{OE}_4$ | $T/\overline{R}_4$ |                                                           |
| L                 | L                  | Bus $B_{24}$ – $B_{31}$ Data to Bus $A_{24}$ – $A_{31}$   |
| L                 | H                  | Bus $A_{24}$ – $A_{31}$ Data to Bus $B_{24}$ – $B_{31}$   |
| H                 | X                  | HIGH-Z State on $A_{24}$ – $A_{31}$ , $B_{24}$ – $B_{31}$ |

## Functional Description

The LVT322245 and LVTH322245 contain thirty-two non-inverting bidirectional buffers with 3-STATE outputs. The device is byte controlled with each byte functioning identically, but independent of the other. The control pins can be shorted together to obtain 16-bit or full 32-bit operation.

## Logic Diagrams



$V_{CC1}$  is associated with Bytes 1 and 2.

$V_{CC2}$  is associated with Bytes 3 and 4.

**Note:** Please note that these diagrams are provided only for the understanding of logic operations and should not be used to estimate propagation delays.

**Absolute Maximum Ratings**(Note 3)

| Symbol    | Parameter                        | Value        | Conditions                           | Units |
|-----------|----------------------------------|--------------|--------------------------------------|-------|
| $V_{CC}$  | Supply Voltage                   | −0.5 to +4.6 |                                      | V     |
| $V_I$     | DC Input Voltage                 | −0.5 to +7.0 |                                      | V     |
| $V_O$     | Output Voltage                   | −0.5 to +7.0 | Output in 3-STATE                    | V     |
|           |                                  | −0.5 to +7.0 | Output in HIGH or LOW State (Note 4) |       |
| $I_{IK}$  | DC Input Diode Current           | −50          | $V_I < \text{GND}$                   | mA    |
| $I_{OK}$  | DC Output Diode Current          | −50          | $V_O < \text{GND}$                   | mA    |
| $I_O$     | DC Output Current                | 64           | $V_O > V_{CC}$ Output at HIGH State  | mA    |
|           |                                  | 128          | $V_O > V_{CC}$ Output at LOW State   |       |
| $I_{CC}$  | DC Supply Current per Supply Pin | ±64          |                                      | mA    |
| $I_{GND}$ | DC Ground Current per Ground Pin | ±128         |                                      | mA    |
| $T_{STG}$ | Storage Temperature              | −65 to +150  |                                      | °C    |

**Recommended Operating Conditions**

| Symbol              | Parameter                                                   | Min    | Max | Units |
|---------------------|-------------------------------------------------------------|--------|-----|-------|
| $V_{CC}$            | Supply Voltage                                              | 2.7    | 3.6 | V     |
| $V_I$               | Input Voltage                                               | 0      | 5.5 | V     |
| $I_{OH}$            | HIGH Level Output Current                                   | B Port | −32 | mA    |
|                     |                                                             | A Port | −12 |       |
| $I_{OL}$            | LOW Level Output Current                                    | B Port | 64  | mA    |
|                     |                                                             | A Port | 12  |       |
| $T_A$               | Free Air Operating Temperature                              | −40    | +85 | °C    |
| $\Delta t/\Delta V$ | Input Edge Rate, $V_{IN} = 0.8V$ – $2.0V$ , $V_{CC} = 3.0V$ | 0      | 10  | ns/V  |

**Note 3:** Absolute Maximum continuous ratings are those values beyond which damage to the device may occur. Exposure to these conditions or conditions beyond those indicated may adversely affect device reliability. Functional operation under absolute maximum rated conditions is not implied.

**Note 4:**  $I_O$  Absolute Maximum Rating must be observed.

**DC Electrical Characteristics**

| Symbol                           | Parameter                                           |              | V <sub>CC</sub><br>(V) | T <sub>A</sub> = −40°C to +85°C |      | Units                    | Conditions                                                          |
|----------------------------------|-----------------------------------------------------|--------------|------------------------|---------------------------------|------|--------------------------|---------------------------------------------------------------------|
|                                  |                                                     |              |                        | Min                             | Max  |                          |                                                                     |
| V <sub>IK</sub>                  | Input Clamp Diode Voltage                           |              | 2.7                    |                                 | −1.2 | V                        | I <sub>I</sub> = −18 mA                                             |
| V <sub>IH</sub>                  | Input HIGH Voltage                                  |              | 2.7–3.6                | 2.0                             |      | V                        | V <sub>O</sub> ≤ 0.1V or<br>V <sub>O</sub> ≥ V <sub>CC</sub> − 0.1V |
| V <sub>IL</sub>                  | Input LOW Voltage                                   |              | 2.7–3.6                |                                 | 0.8  | V                        |                                                                     |
| V <sub>OH</sub>                  | Output HIGH Voltage                                 | A Port       | 3.0                    | 2.0                             |      | V                        | I <sub>OH</sub> = −12 mA                                            |
|                                  |                                                     |              | 2.7–3.6                | V <sub>CC</sub> − 0.2           |      | V                        | I <sub>OH</sub> = −100 μA                                           |
|                                  | B Port                                              | 2.7          | 2.4                    |                                 | V    | I <sub>OH</sub> = −8 mA  |                                                                     |
|                                  |                                                     | 3.0          | 2.0                    |                                 |      | I <sub>OH</sub> = −32 mA |                                                                     |
| V <sub>OL</sub>                  | Output LOW Voltage                                  | A Port       | 3.0                    |                                 | 0.8  | V                        | I <sub>OL</sub> = 12 mA                                             |
|                                  |                                                     |              | 2.7                    |                                 | 0.2  | V                        | I <sub>OL</sub> = 100 μA                                            |
|                                  | B Port                                              | 2.7          |                        | 0.5                             | V    | I <sub>OL</sub> = 24 mA  |                                                                     |
|                                  |                                                     | 3.0          |                        | 0.4                             |      | I <sub>OL</sub> = 16 mA  |                                                                     |
|                                  |                                                     | 3.0          |                        | 0.5                             |      | I <sub>OL</sub> = 32 mA  |                                                                     |
|                                  |                                                     | 3.0          |                        | 0.55                            |      | I <sub>OL</sub> = 64 mA  |                                                                     |
|                                  |                                                     |              |                        |                                 |      |                          |                                                                     |
|                                  |                                                     |              |                        |                                 |      |                          |                                                                     |
| I <sub>I(HOLD)</sub><br>(Note 5) | Bushold Input Minimum Drive                         |              | 3.0                    | 75                              |      | μA                       | V <sub>I</sub> = 0.8V                                               |
|                                  |                                                     |              |                        | −75                             |      |                          | V <sub>I</sub> = 2.0V                                               |
| I <sub>I(OD)</sub><br>(Note 5)   | Bushold Input Over-Drive<br>Current to Change State |              | 3.0                    | 500                             |      | μA                       | (Note 6)                                                            |
|                                  |                                                     |              |                        | −500                            |      |                          | (Note 7)                                                            |
| I <sub>I</sub>                   | Input Current                                       |              | 3.6                    |                                 | 10   | μA                       | V <sub>I</sub> = 5.5V                                               |
|                                  |                                                     | Control Pins | 3.6                    |                                 | ±1   |                          | V <sub>I</sub> = 0V or V <sub>CC</sub>                              |
|                                  |                                                     |              | Data Pins              | 3.6                             |      |                          | −5                                                                  |
|                                  |                                                     |              |                        |                                 |      |                          | 1                                                                   |
| I <sub>OFF</sub>                 | Power Off Leakage Current                           |              | 0                      |                                 | ±100 | μA                       | 0V ≤ V <sub>I</sub> or V <sub>O</sub> ≤ 5.5V                        |

**DC Electrical Characteristics** (Continued)

| Symbol                        | Parameter                                                 | V <sub>CC</sub><br>(V) | T <sub>A</sub> = -40°C to +85°C |      | Units | Conditions                                                                    |
|-------------------------------|-----------------------------------------------------------|------------------------|---------------------------------|------|-------|-------------------------------------------------------------------------------|
|                               |                                                           |                        | Min                             | Max  |       |                                                                               |
| I <sub>PUIPD</sub>            | Power Up/Down<br>3-STATE Current                          | 0–1.5V                 |                                 | ±100 | μA    | V <sub>O</sub> = 0.5V to 3.0V<br>V <sub>I</sub> = GND to V <sub>CC</sub>      |
| I <sub>OZL</sub>              | 3-STATE Output Leakage Current                            | 3.6                    |                                 | -5   | μA    | V <sub>O</sub> = 0.5V                                                         |
| I <sub>OZL</sub><br>(Note 5)  | 3-STATE Output Leakage Current                            | 3.6                    |                                 | -5   | μA    | V <sub>O</sub> = 0.0V                                                         |
| I <sub>OZH</sub>              | 3-STATE Output Leakage Current                            | 3.6                    |                                 | 5    | μA    | V <sub>O</sub> = 3.0V                                                         |
| I <sub>OZH</sub><br>(Note 5)  | 3-STATE Output Leakage Current                            | 3.6                    |                                 | 5    | μA    | V <sub>O</sub> = 3.6V                                                         |
| I <sub>OZH</sub> <sup>+</sup> | 3-STATE Output Leakage Current                            | 3.6                    |                                 | 10   | μA    | V <sub>CC</sub> < V <sub>O</sub> ≤ 5.5V                                       |
| I <sub>CCH</sub>              | Power Supply Current V <sub>CC1</sub> or V <sub>CC2</sub> | 3.6                    |                                 | 0.19 | mA    | Outputs HIGH                                                                  |
| I <sub>CCL</sub>              | Power Supply Current V <sub>CC1</sub> or V <sub>CC2</sub> | 3.6                    |                                 | 5    | mA    | Outputs LOW                                                                   |
| I <sub>CCZ</sub>              | Power Supply Current V <sub>CC1</sub> or V <sub>CC2</sub> | 3.6                    |                                 | 0.19 | mA    | Outputs Disabled                                                              |
| I <sub>CCZ</sub> <sup>+</sup> | Power Supply Current V <sub>CC1</sub> or V <sub>CC2</sub> | 3.6                    |                                 | 0.19 | mA    | V <sub>CC</sub> ≤ V <sub>O</sub> ≤ 5.5V,<br>Outputs Disabled                  |
| ΔI <sub>CC</sub>              | Increase in Power Supply Current<br>(Note 8)              | 3.6                    |                                 | 0.2  | mA    | One Input at V <sub>CC</sub> - 0.6V<br>Other Inputs at V <sub>CC</sub> or GND |

**Note 5:** Applies to bushold versions only (74LVTH322245).

**Note 6:** An external driver must source at least the specified current to switch from LOW-to-HIGH.

**Note 7:** An external driver must sink at least the specified current to switch from HIGH-to-LOW.

**Note 8:** This is the increase in supply current for each input that is at the specified voltage level rather than V<sub>CC</sub> or GND.

**Dynamic Switching Characteristics** (Note 9)

| Symbol           | Parameter                                    | V <sub>CC</sub><br>(V) | T <sub>A</sub> = 25°C |      |     | Units | Conditions<br>C <sub>L</sub> = 50 pF R <sub>L</sub> = 500Ω |
|------------------|----------------------------------------------|------------------------|-----------------------|------|-----|-------|------------------------------------------------------------|
|                  |                                              |                        | Min                   | Typ  | Max |       |                                                            |
| V <sub>OLP</sub> | Quiet Output Maximum Dynamic V <sub>OL</sub> | 3.3                    |                       | 0.8  |     | V     | (Note 10)                                                  |
| V <sub>OLV</sub> | Quiet Output Minimum Dynamic V <sub>OL</sub> | 3.3                    |                       | -0.8 |     | V     | (Note 10)                                                  |

**Note 9:** Characterized in SSOP package. Guaranteed parameter, but not tested.

**Note 10:** Max number of outputs defined as (n). n-1 data inputs are driven 0V to 3V. Output under test held LOW.

**AC Electrical Characteristics**

| Symbol           | Parameter                               | T <sub>A</sub> = -40°C to +85°C<br>C <sub>L</sub> = 50 pF, R <sub>L</sub> = 500Ω |     |                        |     | Units |
|------------------|-----------------------------------------|----------------------------------------------------------------------------------|-----|------------------------|-----|-------|
|                  |                                         | V <sub>CC</sub> = 3.3V ± 0.3V                                                    |     | V <sub>CC</sub> = 2.7V |     |       |
|                  |                                         | Min                                                                              | Max | Min                    | Max |       |
| t <sub>PLH</sub> | Propagation Delay Data to A Port Output | 1.0                                                                              | 4.0 | 1.0                    | 4.6 | ns    |
| t <sub>PHL</sub> |                                         | 1.0                                                                              | 3.7 | 1.0                    | 4.1 |       |
| t <sub>PLH</sub> | Propagation Delay Data to B Port Output | 1.0                                                                              | 3.5 | 1.0                    | 3.9 | ns    |
| t <sub>PHL</sub> |                                         | 1.0                                                                              | 3.5 | 1.0                    | 3.9 |       |
| t <sub>PZH</sub> | Output Enable Time for A Port Output    | 1.0                                                                              | 5.3 | 1.0                    | 6.3 | ns    |
| t <sub>PZL</sub> |                                         | 1.0                                                                              | 5.6 | 1.0                    | 7.2 |       |
| t <sub>PZH</sub> | Output Enable Time for B Port Output    | 1.0                                                                              | 4.6 | 1.0                    | 5.4 | ns    |
| t <sub>PZL</sub> |                                         | 1.0                                                                              | 5.3 | 1.0                    | 6.9 |       |
| t <sub>PHZ</sub> | Output Disable Time for A Port Output   | 1.5                                                                              | 5.6 | 1.5                    | 6.3 | ns    |
| t <sub>PLZ</sub> |                                         | 1.5                                                                              | 5.5 | 1.5                    | 5.5 |       |
| t <sub>PHZ</sub> | Output Disable Time for B Port Output   | 1.5                                                                              | 5.4 | 1.5                    | 6.1 | ns    |
| t <sub>PLZ</sub> |                                         | 1.5                                                                              | 5.1 | 1.5                    | 5.4 |       |

**Capacitance** (Note 11)

| Symbol           | Parameter                | Conditions                                                     | Typical | Units |
|------------------|--------------------------|----------------------------------------------------------------|---------|-------|
| C <sub>IN</sub>  | Input Capacitance        | V <sub>CC</sub> = 0V, V <sub>I</sub> = 0V or V <sub>CC</sub>   | 4       | pF    |
| C <sub>I/O</sub> | Input/Output Capacitance | V <sub>CC</sub> = 3.0V, V <sub>O</sub> = 0V or V <sub>CC</sub> | 8       | pF    |

**Note 11:** Capacitance is measured at frequency f = 1 MHz, per MIL-STD-883, Method 3012.

