

SN54ABT162500, SN74ABT162500 18-BIT UNIVERSAL BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS242E – JUNE 1992 – REVISED FEBRUARY 1999

- **Members of the Texas Instruments Widebus™ Family**
- **B-Port Outputs Have Equivalent 25-Ω Series Resistors, So No External Resistors Are Required**
- **State-of-the-Art EPIC-II B™ BiCMOS Design Significantly Reduces Power Dissipation**
- **UBT™ (Universal Bus Transceiver) Combines D-Type Latches and D-Type Flip-Flops for Operation in Transparent, Latched, or Clocked Mode**
- **Typical V_{OLP} (Output Ground Bounce) < 0.8 V at V_{CC} = 5 V, T_A = 25°C**
- **High-Impedance State During Power Up and Power Down**
- **Flow-Through Architecture Optimizes PCB Layout**
- **Latch-Up Performance Exceeds 500 mA Per JESD 17**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)**
- **Package Options Include Plastic Shrink Small-Outline (DL) Package and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings**

description

These 18-bit universal bus transceivers combine D-type latches and D-type flip-flops to allow data flow in transparent, latched, and clocked modes. Data flow in each direction is controlled by output-enable (OEAB and $\overline{\text{OEBA}}$), latch-enable (LEAB and LEBA), and clock ($\overline{\text{CLKAB}}$ and $\overline{\text{CLKBA}}$) inputs.

For A-to-B data flow, the device operates in the transparent mode when LEAB is high. When LEAB is low, the A data is latched if $\overline{\text{CLKAB}}$ is held at a high or low logic level. If LEAB is low, the A data is stored in the latch/flip-flop on the high-to-low transition of $\overline{\text{CLKAB}}$. Output-enable OEAB is active high. When OEAB is high, the outputs are active. When OEAB is low, the outputs are in the high-impedance state.

Data flow for B to A is similar to that of A to B but uses $\overline{\text{OEBA}}$, LEBA, and $\overline{\text{CLKBA}}$. The output enables are complementary (OEAB is active high and $\overline{\text{OEBA}}$ is active low).

The B-port outputs, which are designed to source or sink up to 12 mA, include equivalent 25-Ω series resistors to reduce overshoot and undershoot.

SN54ABT162500 . . . WD PACKAGE
SN74ABT162500 . . . DL PACKAGE
(TOP VIEW)

| | | | |
|-----------------|----|----|-----------------|
| OEAB | 1 | 56 | GND |
| LEAB | 2 | 55 | CLKAB |
| A1 | 3 | 54 | B1 |
| GND | 4 | 53 | GND |
| A2 | 5 | 52 | B2 |
| A3 | 6 | 51 | B3 |
| V _{CC} | 7 | 50 | V _{CC} |
| A4 | 8 | 49 | B4 |
| A5 | 9 | 48 | B5 |
| A6 | 10 | 47 | B6 |
| GND | 11 | 46 | GND |
| A7 | 12 | 45 | B7 |
| A8 | 13 | 44 | B8 |
| A9 | 14 | 43 | B9 |
| A10 | 15 | 42 | B10 |
| A11 | 16 | 41 | B11 |
| A12 | 17 | 40 | B12 |
| GND | 18 | 39 | GND |
| A13 | 19 | 38 | B13 |
| A14 | 20 | 37 | B14 |
| A15 | 21 | 36 | B15 |
| V _{CC} | 22 | 35 | V _{CC} |
| A16 | 23 | 34 | B16 |
| A17 | 24 | 33 | B17 |
| GND | 25 | 32 | GND |
| A18 | 26 | 31 | B18 |
| OEBA | 27 | 30 | CLKBA |
| LEBA | 28 | 29 | GND |



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**TEXAS
INSTRUMENTS**

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SN54ABT162500, SN74ABT162500

18-BIT UNIVERSAL BUS TRANSCEIVERS

WITH 3-STATE OUTPUTS

SCBS242E – JUNE 1992 – REVISED FEBRUARY 1999

description (continued)

When V_{CC} is between 0 and 2.1 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 2.1 V, \overline{OE} should be tied to V_{CC} through a pullup resistor and OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sinking/current-sourcing capability of the driver.

The SN54ABT162500 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74ABT162500 is characterized for operation from -40°C to 85°C .

FUNCTION TABLE†

| INPUTS | | | | OUTPUT |
|--------|------|-------|---|------------------|
| OEAB | LEAB | CLKAB | A | B |
| L | X | X | X | Z |
| H | H | X | L | L |
| H | H | X | H | H |
| H | L | ↓ | L | L |
| H | L | ↓ | H | H |
| H | L | H | X | B_0^{\ddagger} |
| H | L | L | X | B_0^{\S} |

† A-to-B data flow is shown: B-to-A flow is similar but uses \overline{OEBA} , \overline{LEBA} , and \overline{CLKBA} .

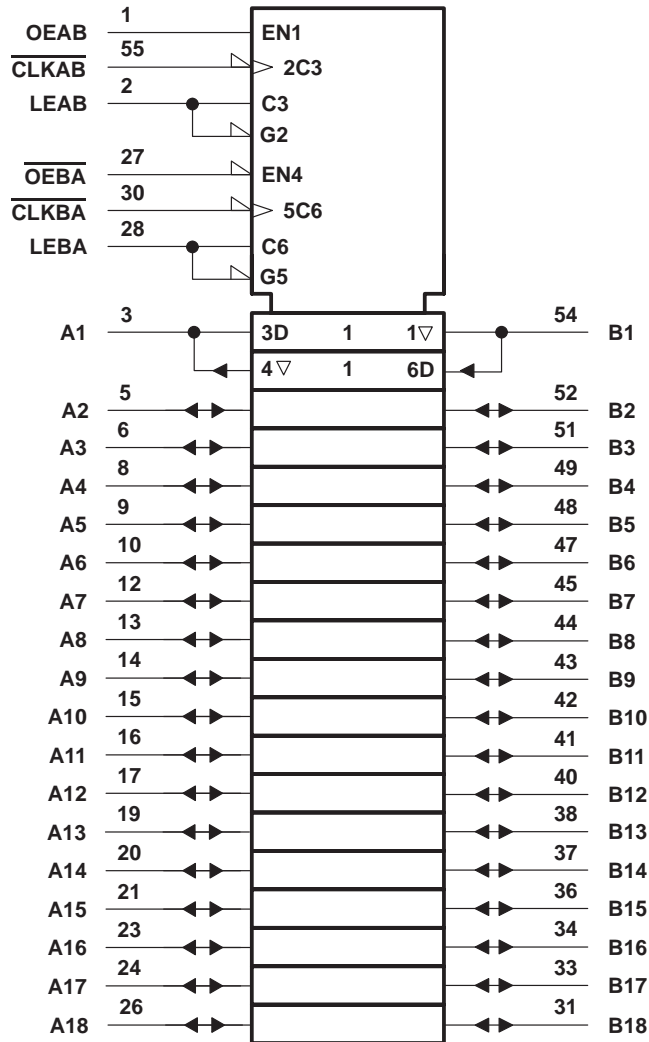
‡ Output level before the indicated steady-state input conditions were established

§ Output level before the indicated steady-state input conditions were established, provided that CLKAB was low before LEAB went low

SN54ABT162500, SN74ABT162500
18-BIT UNIVERSAL BUS TRANSCEIVERS
WITH 3-STATE OUTPUTS

SCBS242E – JUNE 1992 – REVISED FEBRUARY 1999

logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

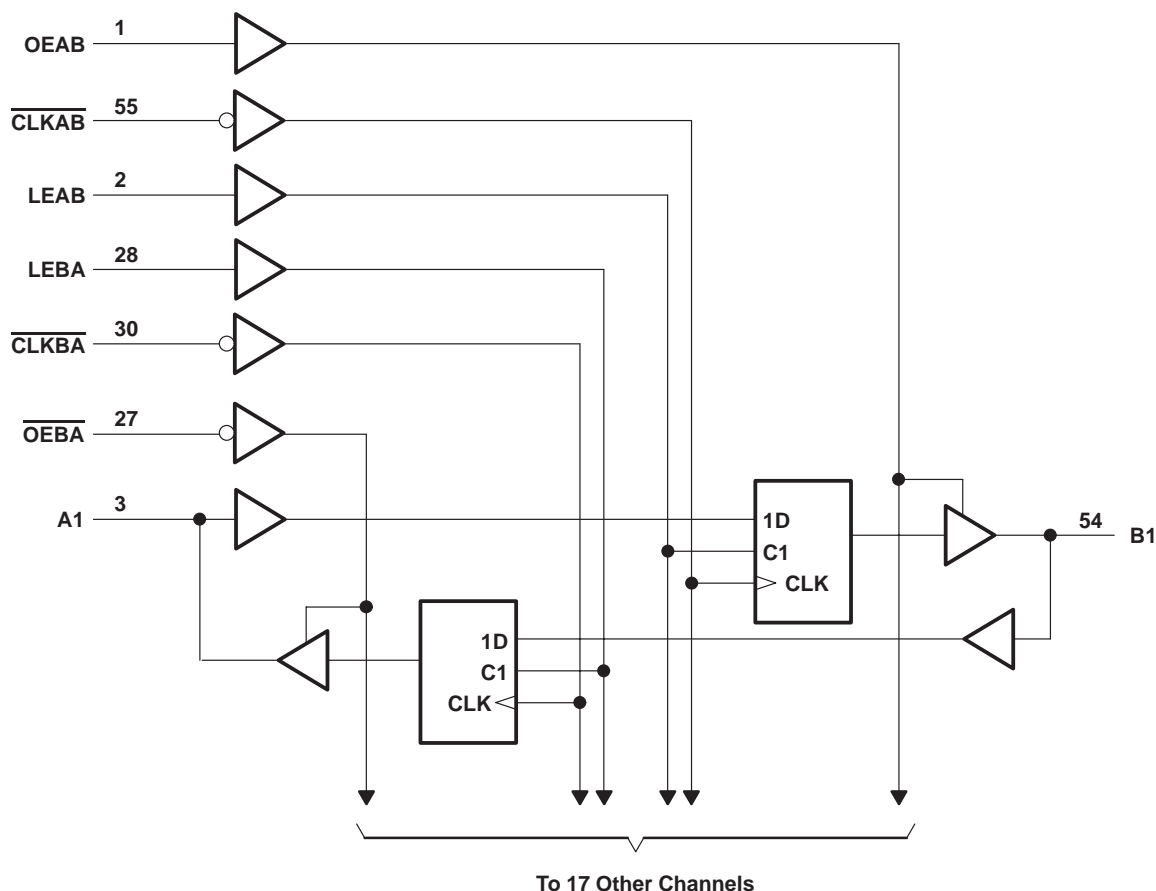
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18-BIT UNIVERSAL BUS TRANSCEIVERS

WITH 3-STATE OUTPUTS

SCBS242E – JUNE 1992 – REVISED FEBRUARY 1999

logic diagram (positive logic)



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)[†]

| | |
|---|-----------------|
| Supply voltage range, V_{CC} | –0.5 V to 7 V |
| Input voltage range, V_I (except I/O ports) (see Note 1) | –0.5 V to 7 V |
| Voltage range applied to any output in the high or power-off state, V_O | –0.5 V to 5.5 V |
| Current into any output in the low state, I_O : SN54ABT162500 (A port) | 96 mA |
| SN74ABT162500 (A port) | 128 mA |
| B port | 30 mA |
| Input clamp current, I_{IK} ($V_I < 0$) | –18 mA |
| Output clamp current, I_{OK} ($V_O < 0$) | –50 mA |
| Package thermal impedance, θ_{JA} (see Note 2): DL package | 74°C/W |
| Storage temperature range, T_{stg} | –65°C to 150°C |

[†] Stresses beyond those listed under “absolute maximum ratings” 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 “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. The package thermal impedance is calculated in accordance with JESD 51.

SN54ABT162500, SN74ABT162500

18-BIT UNIVERSAL BUS TRANSCEIVERS

WITH 3-STATE OUTPUTS

SCBS242E – JUNE 1992 – REVISED FEBRUARY 1999

recommended operating conditions (see Note 3)

| | | | SN54ABT162500 | | SN74ABT162500 | | UNIT |
|--------------------------|------------------------------------|-----------------|---------------|----------|---------------|----------|-----------|
| | | | MIN | MAX | MIN | MAX | |
| V_{CC} | Supply voltage | | 4.5 | 5.5 | 4.5 | 5.5 | V |
| V_{IH} | High-level input voltage | | 2 | | 2 | | V |
| V_{IL} | Low-level input voltage | | | 0.8 | | 0.8 | V |
| V_I | Input voltage | | 0 | V_{CC} | 0 | V_{CC} | V |
| I_{OH} | High-level output current | A port | | –24 | | –32 | mA |
| | | B port | | –12 | | –12 | |
| I_{OL} | Low-level output current | A port | | 48 | | 64 | mA |
| | | B port | | 12 | | 12 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | Outputs enabled | | 10 | | 10 | ns/V |
| $\Delta t/\Delta V_{CC}$ | Power-up ramp rate | | 200 | | 200 | | μ s/V |
| T_A | Operating free-air temperature | | –55 | 125 | –40 | 85 | °C |

NOTE 3: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

SN54ABT162500, SN74ABT162500

18-BIT UNIVERSAL BUS TRANSCEIVERS

WITH 3-STATE OUTPUTS

SCBS242E – JUNE 1992 – REVISED FEBRUARY 1999

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | | T _A = 25°C | | | SN54ABT162500 | | SN74ABT162500 | | UNIT |
|--------------------|----------------|--|--------------------------|-----------------------|------|------|---------------|------|---------------|------|------|
| | | | | MIN | TYP† | MAX | MIN | MAX | MIN | MAX | |
| V _{IK} | | V _{CC} = 4.5 V, I _I = -18 mA | | -1.2 | | | -1.2 | | -1.2 | | V |
| V _{OH} | A port | V _{CC} = 4.5 V, I _{OH} = -3 mA | | 2.5 | | | 2.5 | | 2.5 | | V |
| | | V _{CC} = 5 V, I _{OH} = -3 mA | | 3 | | | 3 | | 3 | | |
| | | V _{CC} = 4.5 V | I _{OH} = -24 mA | 2 | | | 2 | | | | |
| | | | I _{OH} = -32 mA | 2* | | | | | 2 | | |
| | B port | V _{CC} = 4.5 V, I _{OH} = -1 mA | | 3.35 | | | 3.3 | | 3.35 | | |
| | | V _{CC} = 5 V, I _{OH} = -1 mA | | 3.85 | | | 3.8 | | 3.85 | | |
| | | V _{CC} = 4.5 V | I _{OH} = -3 mA | 3.1 | | | 3 | | 3.1 | | |
| | | | I _{OH} = -12 mA | 2.6 | | | | | 2.6 | | |
| V _{OL} | A port | V _{CC} = 4.5 V | I _{OL} = 48 mA | 0.55 | | | 0.55 | | | | V |
| | | | I _{OL} = 64 mA | 0.55* | | | | | 0.55 | | |
| | B port | V _{CC} = 4.5 V, I _{OL} = 12 mA | | 0.8 | | | 0.8 | | 0.8 | | |
| V _{hys} | | | | 100 | | | | | | | mV |
| I _I | Control inputs | V _{CC} = 0 to 5.5 V, V _I = V _{CC} or GND | | ±1 | | | ±1 | | ±1 | | μA |
| | A or B ports | V _{CC} = 2.1 V to 5.5 V, V _I = V _{CC} or GND | | ±20 | | | ±20 | | ±20 | | |
| I _{OZPU} | | V _{CC} = 0 to 2.1 V, V _O = 0.5 V to 2.7 V, \overline{OE} or OE = X\$ | | ±50 | | | ±50 | | ±50 | | μA |
| I _{OZPD} | | V _{CC} = 2.1 V to 0, V _O = 0.5 V to 2.7 V, \overline{OE} or OE = X\$ | | ±50 | | | ±50 | | ±50 | | μA |
| I _{OZH} ‡ | | V _{CC} = 2.1 V to 5.5 V, V _O = 2.7 V, $\overline{OE} \geq 2$ V or OE ≤ 0.8 V | | 10 | | | 10 | | 10 | | μA |
| I _{OZL} ‡ | | V _{CC} = 2.1 V to 5.5 V, V _O = 0.5 V, $\overline{OE} \geq 2$ V or OE ≤ 0.8 V | | -10 | | | -10 | | -10 | | μA |
| I _{off} | | V _{CC} = 0, V _I or V _O ≤ 4.5 V | | ±100 | | | | | ±100 | | μA |
| I _{CEX} | | V _{CC} = 5.5 V, V _O = 5.5 V | Outputs high | 50 | | | 50 | | 50 | | μA |
| I _O ¶ | A port | V _{CC} = 5.5 V, V _O = 2.5 V | | -50 | -110 | -180 | -50 | -180 | -50 | -180 | mA |
| | B port | | | -25 | -55 | -90 | -25 | -90 | -25 | -90 | |
| I _{CC} | A or B ports | V _{CC} = 5.5 V, I _O = 0, V _I = V _{CC} or GND | Outputs high | 3 | | | 3 | | 3 | | mA |
| | | | Outputs low | 36 | | | 36 | | 36 | | |
| | | | Outputs disabled | 3 | | | 3 | | 3 | | |
| ΔI _{CC} # | | V _{CC} = 5.5 V, One input at 3.4 V, Other inputs at V _{CC} or GND | | 50 | | | 50 | | 50 | | μA |
| C _i | Control inputs | V _I = 2.5 V or 0.5 V | | 3 | | | | | | | pF |
| C _{io} | A or B ports | V _O = 2.5 V or 0.5 V | | 9 | | | | | | | pF |

* On products compliant to MIL-PRF-38535, this parameter does not apply.

† All typical values are at V_{CC} = 5 V.

‡ The parameters I_{OZH} and I_{OZL} include the input leakage current.

§ For V_{CC} between 2.1 V and 4 V, OE should be less than or equal to 0.5 V to ensure a low state.

¶ Not more than one output should be tested at a time, and the duration of the test should not exceed one second.

This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

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SN54ABT162500, SN74ABT162500

18-BIT UNIVERSAL BUS TRANSCEIVERS

WITH 3-STATE OUTPUTS

SCBS242E – JUNE 1992 – REVISED FEBRUARY 1999

timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 1)

| | | | | SN54ABT162500 | | SN74ABT162500 | | UNIT | |
|--------------------|-----------------|----------------------------------|----------|---------------|-----|---------------|-----|------|--|
| | | | | MIN | MAX | MIN | MAX | | |
| f _{clock} | Clock frequency | | | 150 | | 150 | | MHz | |
| t _w | Pulse duration | LEAB or LEBA high | | 2.5 | | 2.5 | | ns | |
| | | CLKAB or CLKBA high or low | | 3 | | 3 | | | |
| t _{su} | Setup time | A before CLKAB↓ | | 3.3 | | 3.3 | | ns | |
| | | B before CLKBA↓ | | 3.3 | | 3.3 | | | |
| | | A before LEAB↓ or B before LEBA↓ | CLK high | | 1 | | 1 | | |
| | | | CLK low | | 2.5 | | 2.5 | | |
| t _h | Hold time | A after CLKAB↓ or B after CLKBA↓ | | 0 | | 0 | | ns | |
| | | A after LEAB↓ or B after LEBA↓ | | 2 | | 2 | | | |

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L = 50$ pF (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$ | | | SN54ABT162500 | | SN74ABT162500 | | UNIT |
|------------------|--|-------------|---|-----|-----|---------------|-----|---------------|-----|------|
| | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| f_{max} | | | 150 | 200 | | 150 | | 150 | | MHz |
| t_{PLH} | A or B | B or A | 1.5 | 2.6 | 4 | 1.5 | 5.1 | 1.5 | 4.8 | ns |
| t_{PHL} | | | 2 | 3.4 | 5.2 | 2 | 6.1 | 2 | 5.7 | |
| t_{PLH} | LEAB or LEBA | B or A | 2 | 3.3 | 4.8 | 2 | 6.1 | 2 | 5.6 | ns |
| t_{PHL} | | | 2 | 3.8 | 5.2 | 2 | 6.4 | 2 | 5.9 | |
| t_{PLH} | $\overline{\text{CLKAB}}$ or $\overline{\text{CLKBA}}$ | B or A | 1.5 | 3.7 | 4.9 | 1.5 | 6.4 | 1.5 | 5.9 | ns |
| t_{PHL} | | | 1.5 | 3.8 | 5.2 | 1.5 | 6.4 | 1.5 | 6 | |
| t_{PZH} | OEAB or $\overline{\text{OEBA}}$ | B or A | 1.5 | 3.4 | 4.6 | 1.5 | 5.6 | 1.5 | 5.3 | ns |
| t_{PZL} | | | 2 | 3.8 | 4.7 | 2 | 5.6 | 2 | 5.4 | |
| t_{PHZ} | OEAB or $\overline{\text{OEBA}}$ | B or A | 2 | 4.5 | 5.7 | 2 | 6.9 | 2 | 6.5 | ns |
| t_{PLZ} | | | 1.5 | 3.8 | 5.3 | 1.5 | 6.3 | 1.5 | 5.8 | |

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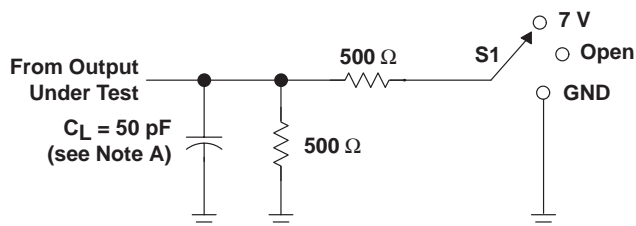
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18-BIT UNIVERSAL BUS TRANSCEIVERS

WITH 3-STATE OUTPUTS

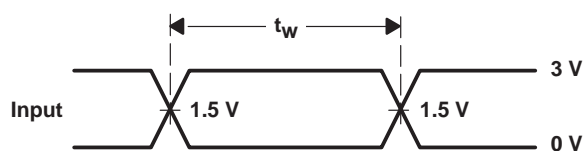
SCBS242E – JUNE 1992 – REVISED FEBRUARY 1999

PARAMETER MEASUREMENT INFORMATION

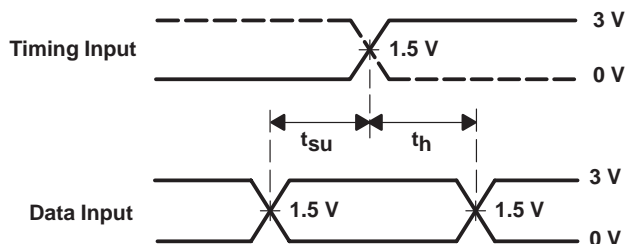


LOAD CIRCUIT

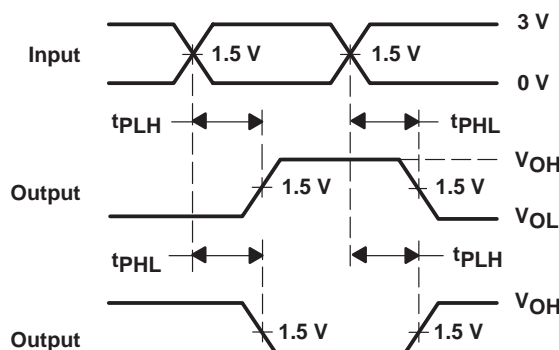
| TEST | S1 |
|-------------------|------|
| t_{PLH}/t_{PHL} | Open |
| t_{PLZ}/t_{PZL} | 7 V |
| t_{PHZ}/t_{PZH} | Open |



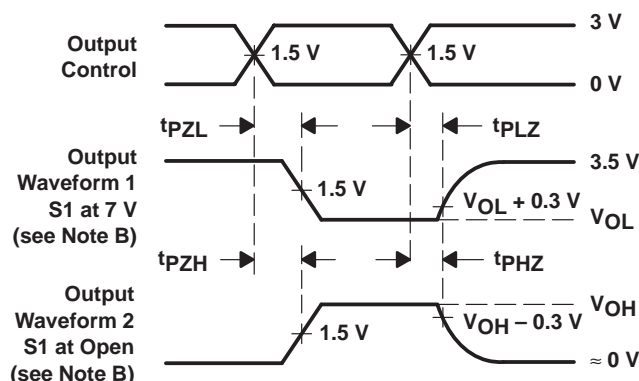
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

- NOTES:
- C_L includes probe and jig capacitance.
 - Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 - All input pulses are supplied by generators having the following characteristics: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$.
 - The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

| Orderable Device | Status ⁽¹⁾ | Package Type | Package Drawing | Pins | Package Qty | Eco Plan ⁽²⁾ | Lead/Ball Finish | MSL Peak Temp ⁽³⁾ |
|-------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 74ABT162500DLRG4 | ACTIVE | SSOP | DL | 56 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT162500DL | ACTIVE | SSOP | DL | 56 | 20 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT162500DLG4 | ACTIVE | SSOP | DL | 56 | 20 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT162500DLR | ACTIVE | SSOP | DL | 56 | 1000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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TAPE AND REEL INFORMATION



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74ABT162500DLR | SSOP | DL | 56 | 1000 | 330.0 | 32.4 | 11.35 | 18.67 | 3.1 | 16.0 | 32.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74ABT162500DLR | SSOP | DL | 56 | 1000 | 346.0 | 346.0 | 49.0 |

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