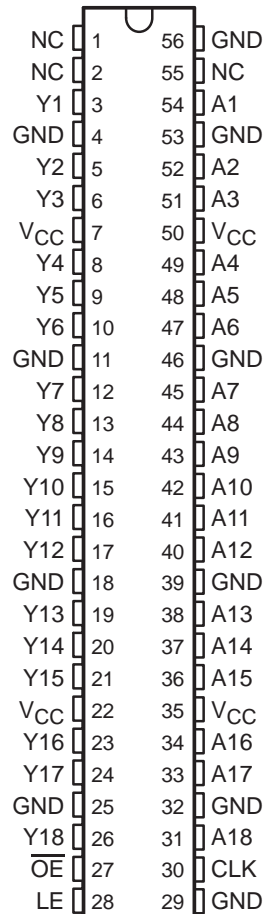


SN54LVTH16835, SN74LVTH16835 3.3-V ABT 18-BIT UNIVERSAL BUS DRIVERS WITH 3-STATE OUTPUTS

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- Members of the Texas Instruments *Widebus*™ Family
- State-of-the-Art Advanced BiCMOS Technology (ABT) Design for 3.3-V Operation and Low Static-Power Dissipation
- Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V_{CC})
- Support Unregulated Battery Operation Down to 2.7 V
- Typical V_{OLP} (Output Ground Bounce) < 0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- I_{off} and Power-Up 3-State Support Hot Insertion
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise
- 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) and Thin Shrink Small-Outline (DGG) Packages and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings

SN54LVTH16835 . . . WD PACKAGE
SN74LVTH16835 . . . DGG OR DL PACKAGE
(TOP VIEW)



NC – No internal connection

description

The 'LVTH16835 devices are 18-bit universal bus drivers designed for low-voltage (3.3-V) V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment.

Data flow from A to Y is controlled by the output-enable (\overline{OE}) input. These devices operate in the transparent mode when the latch-enable (LE) input is high. The A data is latched if the clock (CLK) input is held at a high or low logic level. If LE is low, the A data is stored in the latch/flip-flop on the low-to-high transition of the clock. When \overline{OE} is high, the outputs are in the high-impedance state.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

When V_{CC} is between 0 and 1.5 V, the devices are in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 V, \overline{OE} should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.



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 **TEXAS
INSTRUMENTS**

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description (continued)

These devices are fully specified for hot-insertion applications using I_{off} and power-up 3-state. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the devices when they are powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict.

The SN54LVTH16835 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74LVTH16835 is characterized for operation from -40°C to 85°C .

FUNCTION TABLE

| INPUTS | | | | OUTPUT |
|------------------------|----|-----|---|------------------|
| $\overline{\text{OE}}$ | LE | CLK | A | Y |
| H | X | X | X | Z |
| L | H | X | L | L |
| L | H | X | H | H |
| L | L | ↑ | L | L |
| L | L | ↑ | H | H |
| L | L | H | X | Y_0^{\dagger} |
| L | L | L | X | Y_0^{\ddagger} |

† Output level before the indicated steady-state input conditions were established, provided that CLK is high before LE goes low

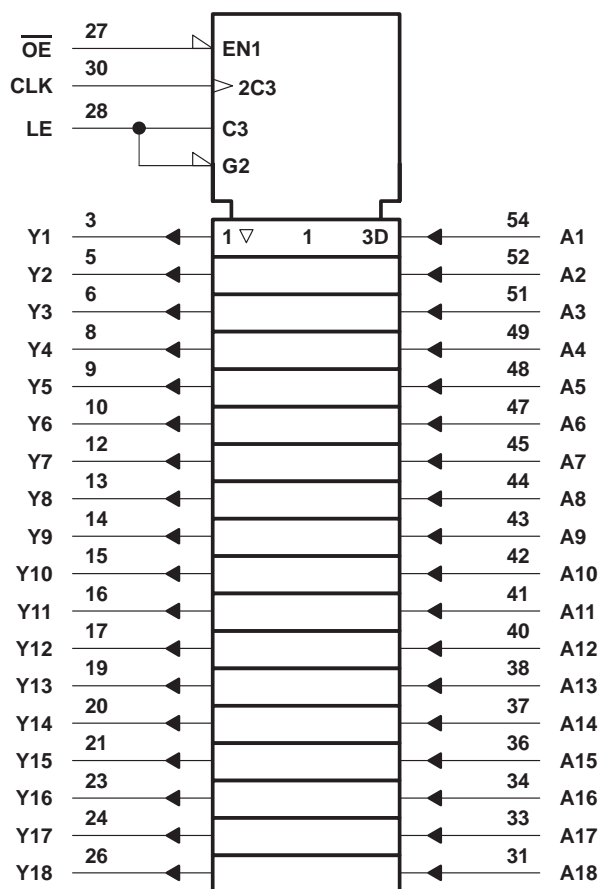
‡ Output level before the indicated steady-state input conditions were established



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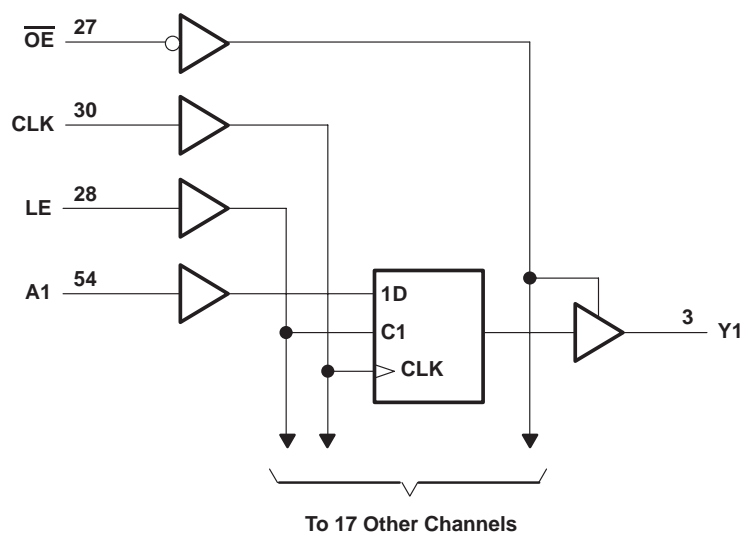
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logic symbol†



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

logic diagram (positive logic)



SN54LVTH16835, SN74LVTH16835 3.3-V ABT 18-BIT UNIVERSAL BUS DRIVERS WITH 3-STATE OUTPUTS

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

| | |
|--|----------------------------|
| Supply voltage range, V_{CC} | –0.5 V to 4.6 V |
| Input voltage range, V_I (see Note 1) | –0.5 V to 7 V |
| Voltage range applied to any output in the high-impedance or power-off state, V_O (see Note 1) | –0.5 V to 7 V |
| Voltage range applied to any output in the high state, V_O (see Note 1) | –0.5 V to $V_{CC} + 0.5$ V |
| Current into any output in the low state, I_O : SN54LVTH16835 | 96 mA |
| SN74LVTH16835 | 128 mA |
| Current into any output in the high state, I_O (see Note 2): SN54LVTH16835 | 48 mA |
| SN74LVTH16835 | 64 mA |
| Input clamp current, I_{IK} ($V_I < 0$) | –50 mA |
| Output clamp current, I_{OK} ($V_O < 0$) | –50 mA |
| Package thermal impedance, θ_{JA} (see Note 3): DGG package | 81°C/W |
| 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. This current flows only when the output is in the high state and $V_O > V_{CC}$.
3. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions (see Note 4)

| | | SN54LVTH16835 | | SN74LVTH16835 | | UNIT |
|--------------------------|------------------------------------|-----------------|-----|---------------|-----|------|
| | | MIN | MAX | MIN | MAX | |
| V_{CC} | Supply voltage | 2.7 | 3.6 | 2.7 | 3.6 | 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 | | 5.5 | | 5.5 | V |
| I_{OH} | High-level output current | | –24 | | –32 | mA |
| I_{OL} | Low-level output current | | 48 | | 64 | mA |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | Outputs enabled | | 10 | 10 | ns/V |
| $\Delta t/\Delta V_{CC}$ | Power-up ramp rate | | | 200 | 200 | μs/V |
| T_A | Operating free-air temperature | –55 | 125 | –40 | 85 | °C |

NOTE 4: All unused control 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.

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

| PARAMETER | TEST CONDITIONS | SN54LVTH16835 | | | SN74LVTH16835 | | | UNIT | | |
|----------------------|--|--|----------------------|------|---------------|-----------|------|---------------|---------------|---------------|
| | | MIN | TYP† | MAX | MIN | TYP† | MAX | | | |
| V_{IK} | $V_{CC} = 2.7\text{ V}$, $I_I = -18\text{ mA}$ | | | -1.2 | | | -1.2 | V | | |
| V_{OH} | $V_{CC} = 2.7\text{ V to }3.6\text{ V}$, $I_{OH} = -100\text{ }\mu\text{A}$ | $V_{CC}-0.2$ | | | $V_{CC}-0.2$ | | | V | | |
| | $V_{CC} = 2.7\text{ V}$, $I_{OH} = -8\text{ mA}$ | 2.4 | | | 2.4 | | | | | |
| | $V_{CC} = 3\text{ V}$ | $I_{OH} = -24\text{ mA}$ | 2 | | | | | | | |
| | | $I_{OH} = -32\text{ mA}$ | | | | 2 | | | | |
| V_{OL} | $V_{CC} = 2.7\text{ V}$ | $I_{OL} = 100\text{ }\mu\text{A}$ | | | | 0.2 | | | V | |
| | | $I_{OL} = 24\text{ mA}$ | | | | 0.5 | | | | |
| | $V_{CC} = 3\text{ V}$ | $I_{OL} = 16\text{ mA}$ | | | | 0.4 | | | | |
| | | $I_{OL} = 32\text{ mA}$ | | | | 0.5 | | | | |
| | | $I_{OL} = 48\text{ mA}$ | | | | 0.55 | | | | |
| | | $I_{OL} = 64\text{ mA}$ | | | | 0.55 | | | | |
| I_I | Control inputs | $V_{CC} = 0\text{ or }3.6\text{ V}$, $V_I = 5.5\text{ V}$ | | | | 10 | | | μA | |
| | | $V_{CC} = 3.6\text{ V}$, $V_I = V_{CC}\text{ or GND}$ | | | | ± 1 | | | | |
| | A inputs | $V_{CC} = 3.6\text{ V}$ | $V_I = V_{CC}$ | | | | 1 | | | |
| | | | $V_I = 5.5\text{ V}$ | | | | 10 | | | |
| $V_I = 0$ | | | | | | -5 | | | | |
| I_{off} | $V_{CC} = 0$, $V_I\text{ or }V_O = 0\text{ to }4.5\text{ V}$ | | | | ± 100 | | | μA | | |
| $I_{I(\text{hold})}$ | A inputs | $V_{CC} = 3\text{ V}$ | $V_I = 0.8\text{ V}$ | 75 | | | 75 | | | μA |
| | | | $V_I = 2\text{ V}$ | -75 | | | -75 | | | |
| | | $V_{CC} = 3.6\text{ V}^\ddagger$, $V_I = 0\text{ to }3.6\text{ V}$ | | | | ± 500 | | | | |
| I_{OZH} | $V_{CC} = 3.6\text{ V}$, $V_O = 3\text{ V}$ | | | | 5 | | | μA | | |
| I_{OZL} | $V_{CC} = 3.6\text{ V}$, $V_O = 0.5\text{ V}$ | | | | -5 | | | μA | | |
| I_{OZPU} | $V_{CC} = 0\text{ to }1.5\text{ V}$, $V_O = 0.5\text{ V to }3\text{ V}$, OE = don't care | | | | $\pm 100^*$ | | | μA | | |
| I_{OZPD} | $V_{CC} = 1.5\text{ V to }0$, $V_O = 0.5\text{ V to }3\text{ V}$, OE = don't care | | | | $\pm 100^*$ | | | μA | | |
| I_{CC} | $V_{CC} = 3.6\text{ V}$, $I_O = 0$, $V_I = V_{CC}\text{ or GND}$ | Outputs high | | | | 0.19 | | | mA | |
| | | Outputs low | | | | 5 | | | | |
| | | Outputs disabled | | | | 0.19 | | | | |
| ΔI_{CC}^\S | $V_{CC} = 3\text{ V to }3.6\text{ V}$, One input at $V_{CC} - 0.6\text{ V}$, Other inputs at $V_{CC}\text{ or GND}$ | | | | 0.2 | | | mA | | |
| C_i | $V_I = 3\text{ V or }0$ | | | | 3.5 | | | pF | | |
| C_o | $V_O = 3\text{ V or }0$ | | | | 9 | | | pF | | |

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

† All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

‡ This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

§ 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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timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

| | | SN54LVTH16835 | | | | SN74LVTH16835 | | | | UNIT | | |
|--------------------|-----------------|--|----------|-------------------------|-----|--|-----|-------------------------|-----|------|-----|--|
| | | $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ | | $V_{CC} = 2.7\text{ V}$ | | $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ | | $V_{CC} = 2.7\text{ V}$ | | | | |
| | | MIN | MAX | MIN | MAX | MIN | MAX | MIN | MAX | | | |
| f_{clock} | Clock frequency | 150 | | 150 | | 150 | | 150 | | MHz | | |
| t_w | Pulse duration | LE high | | 3.3 | | 3.3 | | 3.3 | | ns | | |
| | | CLK high or low | | 3.3 | | 3.3 | | 3.3 | | | | |
| t_{su} | Setup time | Data before CLK \uparrow | | 2.2 | | 2.5 | | 2.1 | | 2.4 | | |
| | | Data before LE \downarrow | CLK high | | 2.5 | | 1.7 | | 2.3 | | 1.5 | |
| | | | CLK low | | 1.5 | | 0.5 | | 1.5 | | 0.5 | |
| t_h | Hold time | Data after CLK \uparrow | | 1 | | 0 | | 1 | | 0 | | |
| | | Data after LE \downarrow | | 0.8 | | 0.8 | | 0.8 | | 0.8 | | |

switching characteristics over recommended operating free-air temperature range, $C_L = 50\text{ pF}$ (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | SN54LVTH16835 | | | | SN74LVTH16835 | | | | UNIT | | | | | | |
|------------------|------------------------|-------------|--|-----|-------------------------|-----|--|---------------|-----|-------------------------|------|-----|--|-----|--|-----|----|
| | | | $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ | | $V_{CC} = 2.7\text{ V}$ | | $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ | | | $V_{CC} = 2.7\text{ V}$ | | | | | | | |
| | | | MIN | MAX | MIN | MAX | MIN | TYP \dagger | MAX | MIN | | MAX | | | | | |
| f_{max} | | | 150 | | 150 | | 150 | | | 150 | | MHz | | | | | |
| t_{PLH} | A | Y | 1.2 | | 3.9 | | 4.3 | | 1.3 | | | 2.6 | | 3.7 | | 4 | ns |
| t_{PHL} | | | 1.2 | | 3.9 | | 4.3 | | 1.3 | | | 2.4 | | 3.7 | | | |
| t_{PLH} | LE | Y | 1.4 | | 5.3 | | 5.9 | | 1.5 | | | 3.2 | | 5.1 | | 5.7 | ns |
| t_{PHL} | | | 1.4 | | 5.3 | | 5.9 | | 1.5 | | | 3.3 | | 5.1 | | | |
| t_{PLH} | CLK | Y | 1.4 | | 5.3 | | 5.9 | | 1.5 | | | 3.5 | | 5.1 | | 5.7 | ns |
| t_{PHL} | | | 1.4 | | 5.3 | | 5.9 | | 1.5 | | | 3.4 | | 5.1 | | | |
| t_{PZH} | $\overline{\text{OE}}$ | Y | 1.2 | | 5 | | 5.9 | | 1.3 | | | 2.9 | | 4.6 | | 5.5 | ns |
| t_{PZL} | | | 1.2 | | 5 | | 5.9 | | 1.3 | | | 3 | | 4.6 | | | |
| t_{PHZ} | $\overline{\text{OE}}$ | Y | 1.6 | | 6 | | 6.5 | | 1.7 | | | 4.2 | | 5.8 | | 6.3 | ns |
| t_{PLZ} | | | 1.6 | | 6 | | 6.5 | | 1.7 | | | 3.7 | | 5.8 | | | |

\dagger All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

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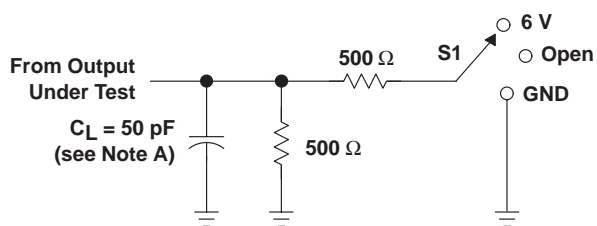


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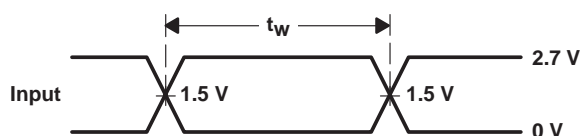
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PARAMETER MEASUREMENT INFORMATION

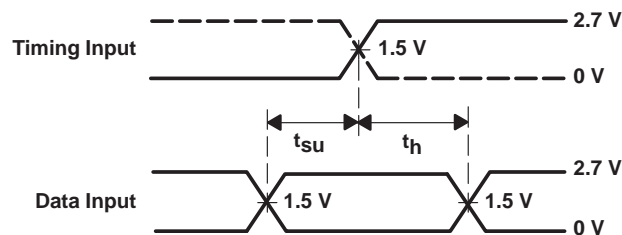


LOAD CIRCUIT

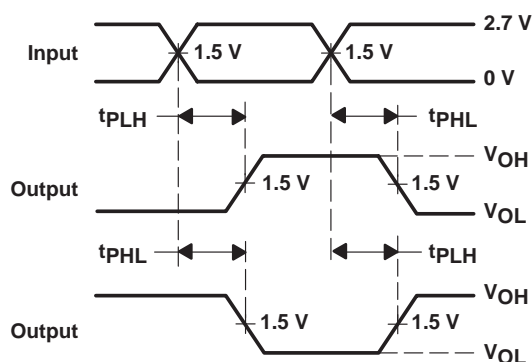
| TEST | S1 |
|-------------------|------|
| t_{PLH}/t_{PHL} | Open |
| t_{PLZ}/t_{PZL} | 6 V |
| t_{PHZ}/t_{PZH} | GND |



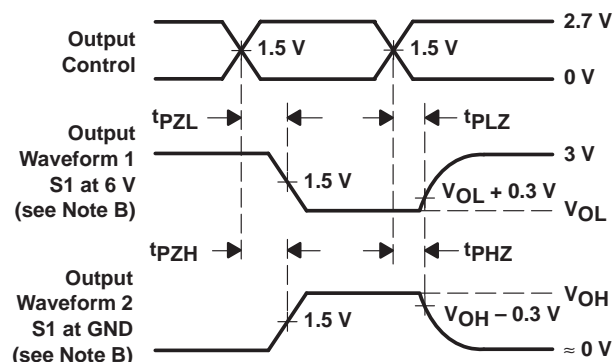
VOLTAGE WAVEFORMS
PULSE DURATION



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: A. C_L includes probe and jig capacitance.
B. 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.
C. All input pulses are supplied by generators having the following characteristics: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$.
D. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

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