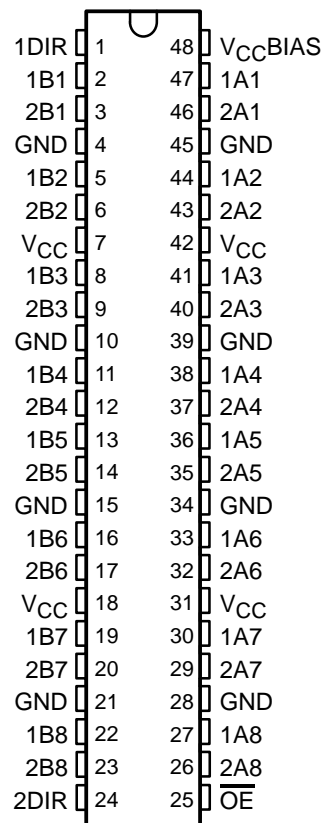# SN54ABTE16245, SN74ABTE16245
## 16-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS226F – JULY 1993 – REVISED AUGUST 1996

- **Support the VME64 ETL Specification**
- **Reduced, TTL-Compatible, Input Threshold Range**
- **High-Drive Outputs ($I_{OH}$ = –60 mA, $I_{OL}$ = 90 mA) Support 25-$\Omega$ Incident-Wave Switching**
- **$V_{CC}$BIAS Pin Minimizes Signal Distortion During Live Insertion**
- **Internal Pullup Resistor on $\overline{OE}$ Keeps Outputs in High-Impedance State During Power Up or Power Down**
- **Members of the Texas Instruments (TI) *Widebus*™ Family**
- **State-of-the-Art *EPIC*-II*B*™ BiCMOS Design Significantly Reduces Power Dissipation**
- **Distributed $V_{CC}$ and GND Pin Configuration Minimizes High-Speed Switching Noise**
- **25-$\Omega$ Series Damping Resistor on B Port**
- **Bus Hold on Data Inputs Eliminates the Need for External Pullup Resistors**
- **Package Options Include Plastic 300-mil Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages and 380-Mil Fine-Pitch Ceramic Flat (WD) Packages Using 25-mil Center-to-Center Spacings**

SN54ABTE16245 . . . WD PACKAGE
SN74ABTE16245 . . . DGG OR DL PACKAGE
(TOP VIEW)

| | | | |
|---|---|---|---|
| 1DIR | 1 | 48 | $V_{CC}$BIAS |
| 1B1 | 2 | 47 | 1A1 |
| 2B1 | 3 | 46 | 2A1 |
| GND | 4 | 45 | GND |
| 1B2 | 5 | 44 | 1A2 |
| 2B2 | 6 | 43 | 2A2 |
| $V_{CC}$ | 7 | 42 | $V_{CC}$ |
| 1B3 | 8 | 41 | 1A3 |
| 2B3 | 9 | 40 | 2A3 |
| GND | 10 | 39 | GND |
| 1B4 | 11 | 38 | 1A4 |
| 2B4 | 12 | 37 | 2A4 |
| 1B5 | 13 | 36 | 1A5 |
| 2B5 | 14 | 35 | 2A5 |
| GND | 15 | 34 | GND |
| 1B6 | 16 | 33 | 1A6 |
| 2B6 | 17 | 32 | 2A6 |
| $V_{CC}$ | 18 | 31 | $V_{CC}$ |
| 1B7 | 19 | 30 | 1A7 |
| 2B7 | 20 | 29 | 2A7 |
| GND | 21 | 28 | GND |
| 1B8 | 22 | 27 | 1A8 |
| 2B8 | 23 | 26 | 2A8 |
| 2DIR | 24 | 25 | $\overline{OE}$ |

## description

The 'ABTE16245 are 16-bit (dual-octal) noninverting 3-state transceivers designed for synchronous two-way communication between data buses. The control-function implementation minimizes external timing requirements. These devices can be used as two 8-bit transceivers or one 16-bit transceiver. They allow data transmission from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable ($\overline{OE}$) input can be used to disable the device so that the buses are effectively isolated. When $\overline{OE}$ is low, the device is active.

The B port has a 25-$\Omega$ series output resistor to reduce ringing. Active bus-hold inputs are also found on the B port to hold unused or floating inputs at a valid logic level.

The A port provides for the precharging of the outputs via $V_{CC}$BIAS, which establishes a voltage between 1.3 V and 1.7 V when $V_{CC}$ is not connected.

The SN74ABTE16245 is available in TI's shrink small-outline package (DL), which provides twice the I/O pin count and functionality of standard small-outline packages in the same printed-circuit-board area.

The SN54ABTE16245 is characterized for operation over the full military temperature range of –55°C to 125°C. The SN74ABTE16245 is characterized for operation from –40°C to 85°C.

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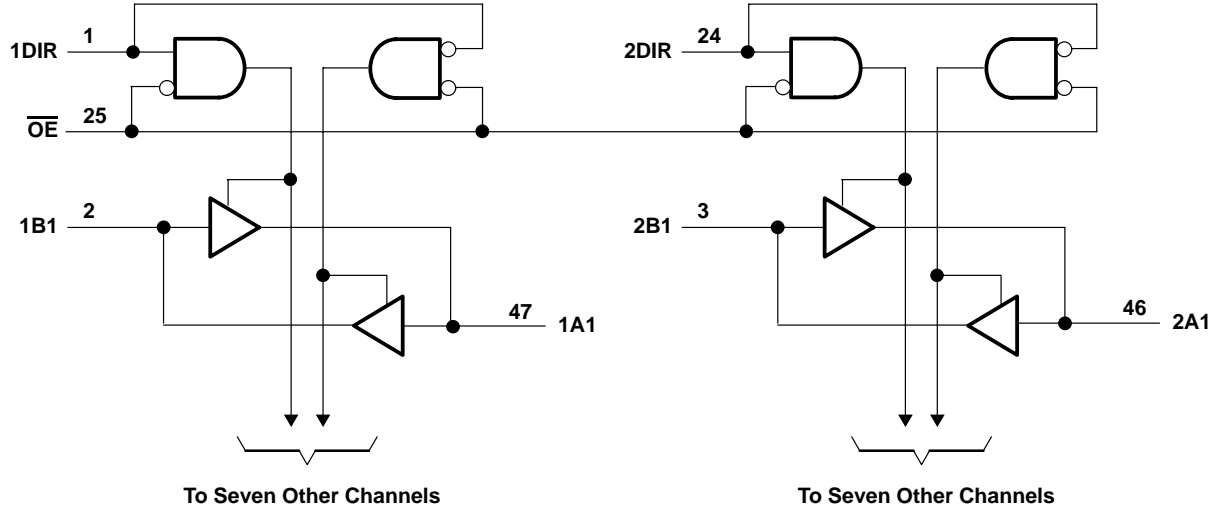
**TEXAS INSTRUMENTS**

# SN54ABTE16245, SN74ABTE16245
# 16-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVERS
# WITH 3-STATE OUTPUTS

SCBS226F – JULY 1993 – REVISED AUGUST 1996

**FUNCTION TABLE**
**(each 8-bit section)**

| INPUTS | | OPERATION |
|---|---|---|
| $\overline{OE}$ | DIR | |
| L | L | A data to B bus |
| L | H | B data to A bus |
| H | X | Isolation |

## logic diagram (positive logic)



| 1DIR | 1 |
| $\overline{OE}$ | 25 |
| 1B1 | 2 |
| | 47 | 1A1 |

**To Seven Other Channels**

| 2DIR | 24 |
| 2B1 | 3 |
| | 46 | 2A1 |

**To Seven Other Channels**

## 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 state or power-off state, $V_O$ .............. −0.5 V to 5.5 V

Current into any output in the low state, $I_O$ .................................................. 128 mA

Input clamp current, $I_{IK}$ ($V_I < 0$) ........................................................... −18 mA

Output clamp current, $I_{OK}$ ($V_O < 0$) ....................................................... −50 mA

Maximum power dissipation at $T_A = 55°C$ (in still air) (see Note 2): DGG package ................. 0.85 W

DL package .................... 1.2 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 maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils. For more information, refer to the *Package Thermal Considerations* application note in the *ABT Advanced BiCMOS Technology Data Book*.

## recommended operating conditions (see Note 3)

| | | | SN54ABTE16245 | | | SN74ABTE16245 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | NOM | MAX | MIN | NOM | MAX | |
| $V_{CC}$ | Supply voltage | | 4.5 | 5 | 5.5 | 4.5 | 5 | 5.5 | V |
| $V_{IH}$ | High-level input voltage | $\overline{OE}$ | 2 | | | 2 | | | V |
| | | Except $\overline{OE}$ | 1.6 | | | 1.6 | | | |
| $V_{IL}$ | Low-level input voltage | $\overline{OE}$ | | | 0.8 | | | 0.8 | V |
| | | Except $\overline{OE}$ | | | 1.4 | | | 1.4 | |
| $V_I$ | Input voltage | | 0 | | $V_{CC}$ | 0 | | $V_{CC}$ | V |
| $I_{OH}$ | High-level output current | B bus | | | −12 | | | −12 | mA |
| | | A bus | | | −24 | | | −60 | |
| $I_{OL}$ | Low-level output current | B bus | | | 12 | | | 12 | mA |
| | | A bus | | | 64 | | | 90 | |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | Outputs enabled | | | 10 | | | 10 | ns/V |
| $T_A$ | Operating free-air temperature | | −55 | | 125 | −40 | | 85 | °C |

NOTE 3: Unused pins (input or A-bus I/O) must be held high or low to prevent them from floating.

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

| PARAMETER | | TEST CONDITIONS | | SN54ABTE16245 | | | SN74ABTE16245 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP† | MAX | MIN | TYP† | MAX | |
| $V_{IK}$ | | $V_{CC}$ = 4.5 V, | $I_I$ = –18 mA | | | –1.2 | | | –1.2 | V |
| $V_{OH}$ | B port | $V_{CC}$ = 5.5 V, | $I_{OH}$ = –100 µA | | | $V_{CC}$–0.2 | | | $V_{CC}$–0.2 | V |
| | | $V_{CC}$ = 4.5 V | $I_{OH}$ = –1 mA | 2.4 | | | 2.4 | | | |
| | | | $I_{OH}$ = –12 mA | 2 | | | 2 | | | |
| | A port | $V_{CC}$ = 5.5 V, | $I_{OH}$ = –1 mA | | | 4.5 | | | 4.5 | |
| | | $V_{CC}$ = 4.5 V | $I_{OH}$ = –32 mA | 2.4 | | | 2.4 | | | |
| | | | $I_{OH}$ = –64 mA | | | | 2 | | | |
| $V_{OL}$ | B port | $V_{CC}$ = 4.5 V | $I_{OL}$ = 1 mA | | | 0.4 | | | 0.4 | V |
| | | | $I_{OL}$ = 12 mA | | | 0.8 | | | 0.8 | |
| | A port | $V_{CC}$ = 4.5 V | $I_{OL}$ = 64 mA | | | 0.55 | | | 0.55 | |
| | | | $I_{OL}$ = 90 mA | | | | | | 0.9 | |
| $I_{I(hold)}$ | B port | $V_{CC}$ = 4.5 V | $V_I$ = 0.8 V | 100 | | | 100 | | | µA |
| | | | $V_I$ = 2 V | –100 | | | –100 | | | |
| | | $V_{CC}$ = 5.5 V, | $V_I$ = 0 to 5.5 V | | | ±500 | | | ±500 | |
| $I_I$ | Control inputs | $V_{CC}$ = 5.5 V, | $V_I$ = $V_{CC}$ or GND | | | ±1 | | | ±1 | µA |
| | A or B ports | $V_{CC}$ = 5.5 V, | $V_I$ = $V_{CC}$ or GND | | | ±20 | | | ±20 | |
| $I_{OZH}$‡ | A port | $V_{CC}$ = 5.5 V, | $V_O$ = 2.7 V | | | 10 | | | 10 | µA |
| $I_{OZL}$‡ | A port | $V_{CC}$ = 5.5 V, | $V_O$ = 0.5 V | | | –10 | | | –10 | µA |
| $I_O$ | A port | $V_{CC}$ = 5.5 V, | $V_O$ = 2.5 V | –50 | –120 | –180 | –50 | | –180 | mA |
| | B port | | | –25 | –52 | –90 | –25 | | –90 | |
| $I_{off}$ | | $V_{CC}$ = 0, $V_I$ or $V_O$ ≤ 4.5 V, $V_{CC}$BIAS = 0 | | | | ±100 | | | ±100 | µA |
| $I_{CC}$ | A or B ports | $V_{CC}$ = 5.5 V, $I_O$ = 0, $V_I$ = $V_{CC}$ or GND | Outputs high | | 28 | 36 | | 28 | 36 | mA |
| | | | Outputs low | | 38 | 48 | | 38 | 48 | |
| | | | Outputs disabled | | 20 | 32 | | 20 | 32 | |
| $I_{CCD}$ | A or B ports | $V_{CC}$ = 5 V, $C_L$ = 50 pF | $\overline{OE}$ high | | 0.02 | | | 0.02 | | mA/ MHz |
| | | | $\overline{OE}$ low | | 0.33 | | | 0.33 | | |
| $C_i$ | Control inputs | $V_I$ = 2.5 V or 0.5 V | | | 10 | | | 2.5 | 4 | pF |
| $C_{io}$ | I/O ports | $V_O$ = 2.5 V or 0.5 V | | | 13 | | | 4.5 | 8 | pF |

† All typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.
‡ The parameters $I_{OZH}$ and $I_{OZL}$ include the input leakage current.

**live-insertion specifications over recommended operating free-air temperature range**

| PARAMETER | | | TEST CONDITIONS | SN54ABTE16245 | | | SN74ABTE16245 | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP† | MAX | MIN | TYP† | MAX | |
| $I_{CC}$ ($V_{CC}$BIAS) | | | $V_{CC}$ = 0 to 4.5 V, $V_{CC}$BIAS = 4.5 V to 5.5 V, $I_{O(DC)}$ = 0 | | 250 | 700 | | 250 | 700 | µA |
| | | | $V_{CC}$ = 4.5 V to 5.5 V‡, $V_{CC}$BIAS = 4.5 V to 5.5 V, $I_{O(DC)}$ = 0 | | | 20 | | | 20 | |
| $V_O$ | A port | $V_{CC}$ = 0 | $V_{CC}$BIAS = 4.5 V to 5.5 V | 1.1 | 1.5 | 1.9 | 1.1 | 1.5 | 1.9 | V |
| | | | $V_{CC}$BIAS = 4.75 V to 5.25 V | 1.3 | 1.5 | 1.7 | 1.3 | 1.5 | 1.7 | |
| $I_O$ | A port | $V_{CC}$ = 0 | $V_O$ = 0, $V_{CC}$BIAS = 4.5 V | −20 | | −100 | −20 | | −100 | µA |
| | | | $V_O$ = 3 V, $V_{CC}$BIAS = 4.5 V | 20 | | 100 | 20 | | 100 | |

† All typical values are at $V_{CC}$ = 5 V, $T_A$ = 25°C.
‡ $V_{CC}$ − 0.5 V < $V_{CC}$BIAS

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L$ = 50 pF (unless otherwise noted) (see Figure 2)**

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC}$ = 5 V, $T_A$ = 25°C | | | SN54ABTE16245 | | SN74ABTE16245 | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{PLH}$ | A | B | 1.5 | 3.3 | 4.2 | 1.5 | 5.4 | 1.5 | 5.2 | ns |
| $t_{PHL}$ | | | 1.5 | 3.8 | 4.6 | 1.5 | 5.4 | 1.5 | 5.2 | |
| $t_{PLH}$ | B | A | 1.5 | 3 | 3.8 | 1.5 | 4.7 | 1.5 | 4.5 | ns |
| $t_{PHL}$ | | | 1.5 | 3.1 | 4 | 1.5 | 4.7 | 1.5 | 4.5 | |
| $t_{PZH}$ | $\overline{OE}$ | A | 2 | 3.9 | 5.3 | 2 | 6.4 | 2 | 6.2 | ns |
| $t_{PZL}$ | | | 2 | 4.4 | 5.9 | 2 | 7 | 2 | 6.8 | |
| $t_{PZH}$ | $\overline{OE}$ | B | 2 | 4.5 | 6 | 2 | 7.3 | 2 | 7.1 | ns |
| $t_{PZL}$ | | | 2 | 5 | 6.4 | 2 | 7.5 | 2 | 7.3 | |
| $t_{PHZ}$ | $\overline{OE}$ | A | 2 | 4.9 | 5.9 | 2 | 7 | 2 | 6.7 | ns |
| $t_{PLZ}$ | | | 2 | 3.7 | 4.6 | 2 | 5.4 | 2 | 5.1 | |
| $t_{PHZ}$ | $\overline{OE}$ | B | 2 | 5.2 | 6.2 | 2 | 7.2 | 2 | 7 | ns |
| $t_{PLZ}$ | | | 2 | 4 | 5 | 2 | 5.8 | 2 | 5.5 | |

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**extended switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L$ = 50 pF (unless otherwise noted) (see Note 4 and Figure 2)**

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | LOAD | $V_{CC}$ = 5 V, $T_A$ = 25°C | | | SN54ABTE16245 | | SN74ABTE16245 | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| $t_{PLH}$ | B | A | $R_X$ = 13 Ω | 1.5 | 3.2 | 4 | 1.5 | 5 | 1.5 | 4.8 | ns |
| $t_{PHL}$ | | | | 1.5 | 3.8 | 4.7 | 1.5 | 5.8 | 1.5 | 5.6 | |
| $t_{PLH}$ | B | A | $R_X$ = 26 Ω | 1.5 | 3.1 | 4 | 1.5 | 4.8 | 1.5 | 4.6 | ns |
| $t_{PHL}$ | | | | 1.5 | 3.5 | 4.4 | 1.5 | 5.2 | 1.5 | 4.9 | |
| $t_{PLH}$ | B | A | $R_X$ = 56 Ω | 1.5 | 3 | 3.8 | 1.5 | 4.7 | 1.5 | 4.5 | ns |
| $t_{PHL}$ | | | | 1.5 | 3.3 | 4.2 | 1.5 | 5.1 | 1.5 | 4.7 | |
| $t_{sk(p)}$ | B | A | $R_X$ = Open | | 0.1 | 0.6 | | 2 | | 2 | ns |
| | A | B | | | 0.4 | 0.8 | | 2 | | 2 | |
| | B | A | $R_X$ = 26 Ω | | 0.3 | 0.8 | | 2 | | 2 | |
| $t_{sk(o)}$ | B | A | $R_X$ = Open | | 0.3 | 0.7 | | 1.3 | | 1.3 | ns |
| | A | B | | | 0.7 | 1.1 | | 1.3 | | 1.3 | |
| | B | A | $R_X$ = 26 Ω | | 0.5 | 1 | | 1.3 | | 1.3 | |
| $t_t$† | B | A | $R_X$ = 26 Ω | 0.5 | 0.8 | 1.5 | 0.5 | 1.5 | 0.5 | 1.5 | ns |
| $t_t$‡ | A | B | Rise or fall time 10%–90% | 3.5 | 5.5 | 7.3 | 3.5 | 8.1 | 3.5 | 7.9 | ns |

† $t_t$ is measured between 1 V and 2 V of the output waveform.
‡ $t_t$ is measured between 10% and 90% of the output waveform.
NOTE 4:   Limits are specified but not tested.

**extended output characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L$ = 50 pF (see Note 4 and Figures 1 and 2)**

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | LOAD | SN54ABTE16245 | | SN74ABTE16245 | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | MIN | MAX | MIN | MAX | |
| $t_{sk(temp)}$ | A | B | $V_{CC}$ = Constant, $\Delta T_A$ = 20°C | | | 3 | | 2.5 | ns |
| | B | A | | $R_X$ = 56 Ω | | 4.5 | | 4 | |
| $t_{sk(load)}$ | B | B | $V_{CC}$ = Constant, Temperature = Constant | $R_X$ = 13, 26, or 56 Ω | | 4.5 | | 4 | ns |

NOTE 4: Limits are specified but not tested.
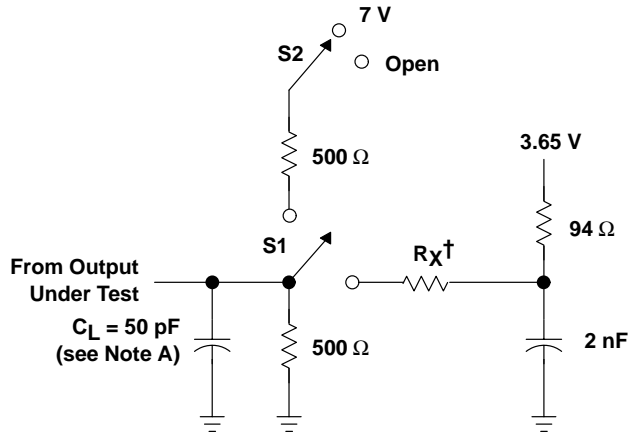
## PARAMETER MEASUREMENT INFORMATION
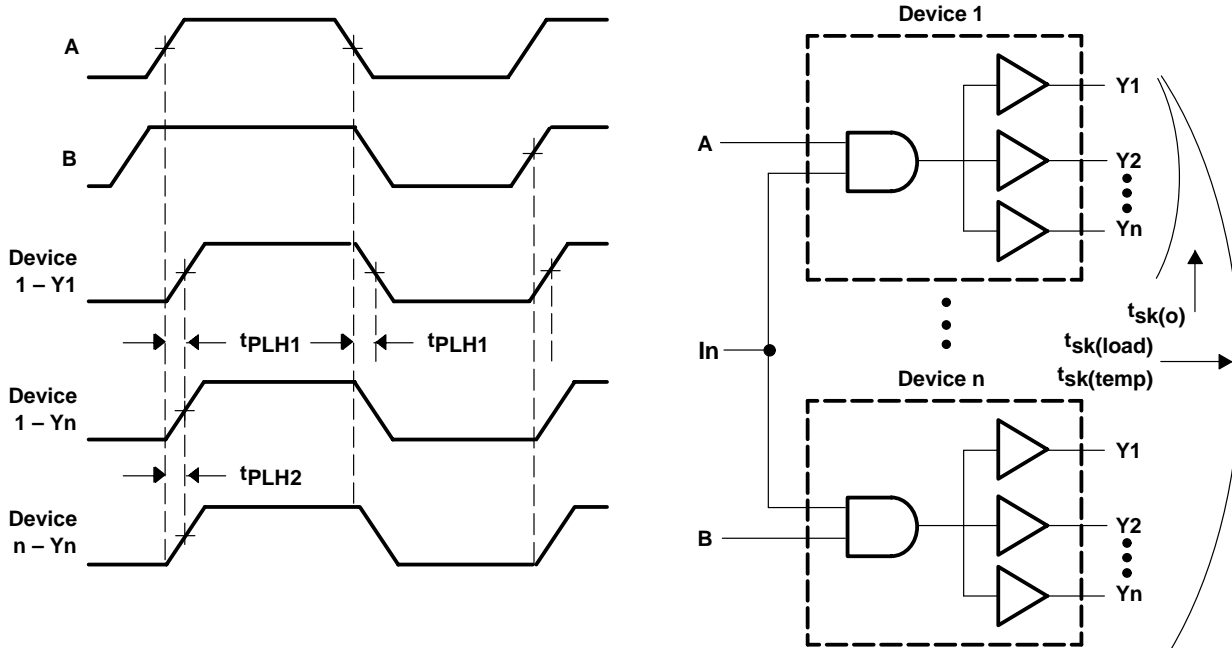


NOTES: A. Pulse skew, $t_{sk(p)}$, is defined as the difference in propagation delay times $t_{PLH1}$ and $t_{PHL1}$ on the same terminal at identical operating conditions.
   B. Output skew, $t_{sk(o)}$, is defined as the difference in propagation delay of the fastest and slowest paths on a single device that originate at either a single input or multiple simultaneously switched inputs (e.g., $|t_{PLH1} - t_{PLH2}|$).
   C. Temperature skew, $t_{sk(temp)}$, is the output skew of two devices, both having the same value of $V_{CC} \pm 1\%$ and with package temperature differences of 20°C.
   D. Load skew, $t_{sk(load)}$, is measured with $R_X$ in Figure 2 at 13 Ω for one unit and 56 Ω for the other unit.

**Figure 1. Voltage Waveforms for Extended Characteristics**

## PARAMETER MEASUREMENT INFORMATION

| SWITCHING TABLE LOADS | S1 | S2 |
|---|---|---|
| $t_{PLH}/t_{PHL}$ (A and B port) | Up | Open |
| $t_{PLZ}/t_{PZL}$ | Up | 7 V |
| $t_{PHZ}/t_{PZH}$ | Up | Open |

| EXTENDED SWITCHING TABLE LOADS | S1 | S2 |
|---|---|---|
| $t_{PLH}/t_{PHL}/t_{sk}$ (A port) | Down | X |
| $t_{PLH}/t_{PHL}/t_{sk}$ (B port) | Up | Open |
| $t_t$ (A port) (see Note E) | Down | X |
| $t_t$ (B port) (see Note F) | Up | Open |

† $R_X$ = 13, 26, or 56 Ω

**LOAD CIRCUIT FOR OUTPUTS**
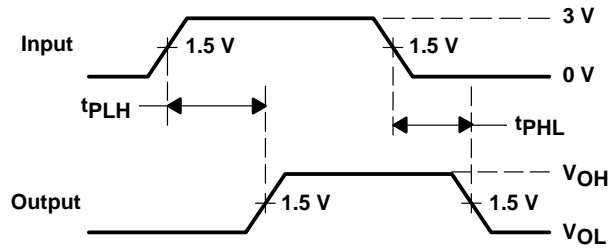
**VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES**
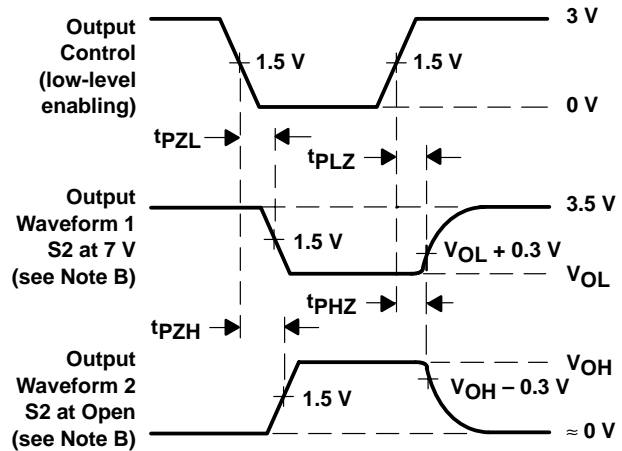
**VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES**

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 ≤ 10 MHz, $Z_O$ = 50 Ω, $t_r$ ≤ 2.5 ns, $t_f$ ≤ 2.5 ns.
D.  The outputs are measured one at a time with one transition per measurement.
E.  $t_t$ is measured between 1 V and 2 V of the output waveform.
F.  $t_t$ is measured between 10% and 90% of the output waveform.

**Figure 2. Load Circuit and Voltage Waveforms**

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