

SN54ABT651, SN74ABT651 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCBS083E – JANUARY 1991 – REVISED APRIL 1998

- State-of-the-Art *EPIC-IIB™* BiCMOS Design Significantly Reduces Power Dissipation
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)
- Latch-Up Performance Exceeds 500 mA Per JESD 17
- Typical V_{OLP} (Output Ground Bounce) < 1 V at $V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$
- High-Drive Outputs (–32-mA I_{OH} , 64-mA I_{OL})
- Multiplexed Real-Time and Stored Data
- Inverting Data Paths
- Package Options Include Plastic Small-Outline (DW), Shrink Small-Outline (DB), and Thin Shrink Small-Outline (PW) Packages, Ceramic Chip Carriers (FK), and Plastic (NT) and Ceramic (JT) DIPs

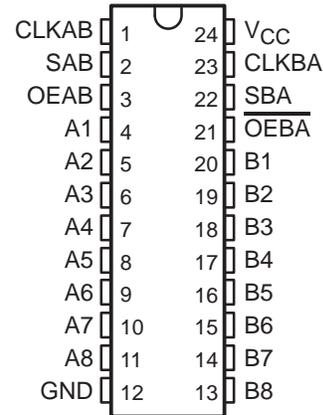
description

These devices consist of bus-transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the data bus or from the internal storage registers. Output-enable (OEAB and \overline{OEBA}) inputs are provided to control the transceiver functions. The select-control (SAB and SBA) inputs are provided to select whether real-time or stored data is transferred. A low input level selects real-time data, and a high input level selects stored data. Figure 1 illustrates the four fundamental bus-management functions that can be performed with the 'ABT651 devices.

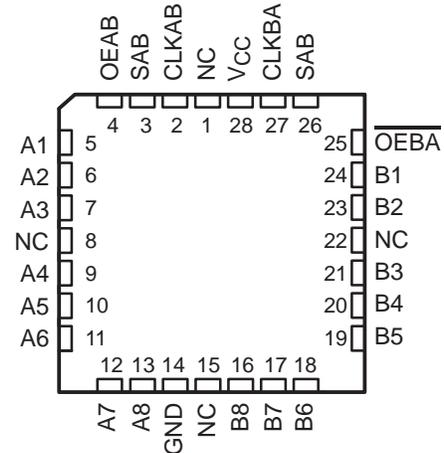
Data on the A or B bus, or both, can be stored in the internal D flip-flops by low-to-high transitions at the appropriate clock (CLKAB or CLKBA) inputs, regardless of the select- or enable-control pins. When SAB and SBA are in the real-time transfer mode, it also is possible to store data without using the internal D-type flip-flops by simultaneously enabling OEAB and \overline{OEBA} . In this configuration, each output reinforces its input. When all the other data sources to the two sets of bus lines are at high impedance, each set remains at its last state.

To ensure the high-impedance state during power up or power down, \overline{OEBA} 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 (B to A). OEAB should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver (A to B).

SN54ABT651 . . . JT PACKAGE
SN74ABT651 . . . DB, DW, NT, OR PW PACKAGE
(TOP VIEW)



SN54ABT651 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection



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 **TEXAS
INSTRUMENTS**

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SN54ABT651, SN74ABT651 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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description (continued)

The SN54ABT651 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74ABT651 is characterized for operation from -40°C to 85°C .

FUNCTION TABLE

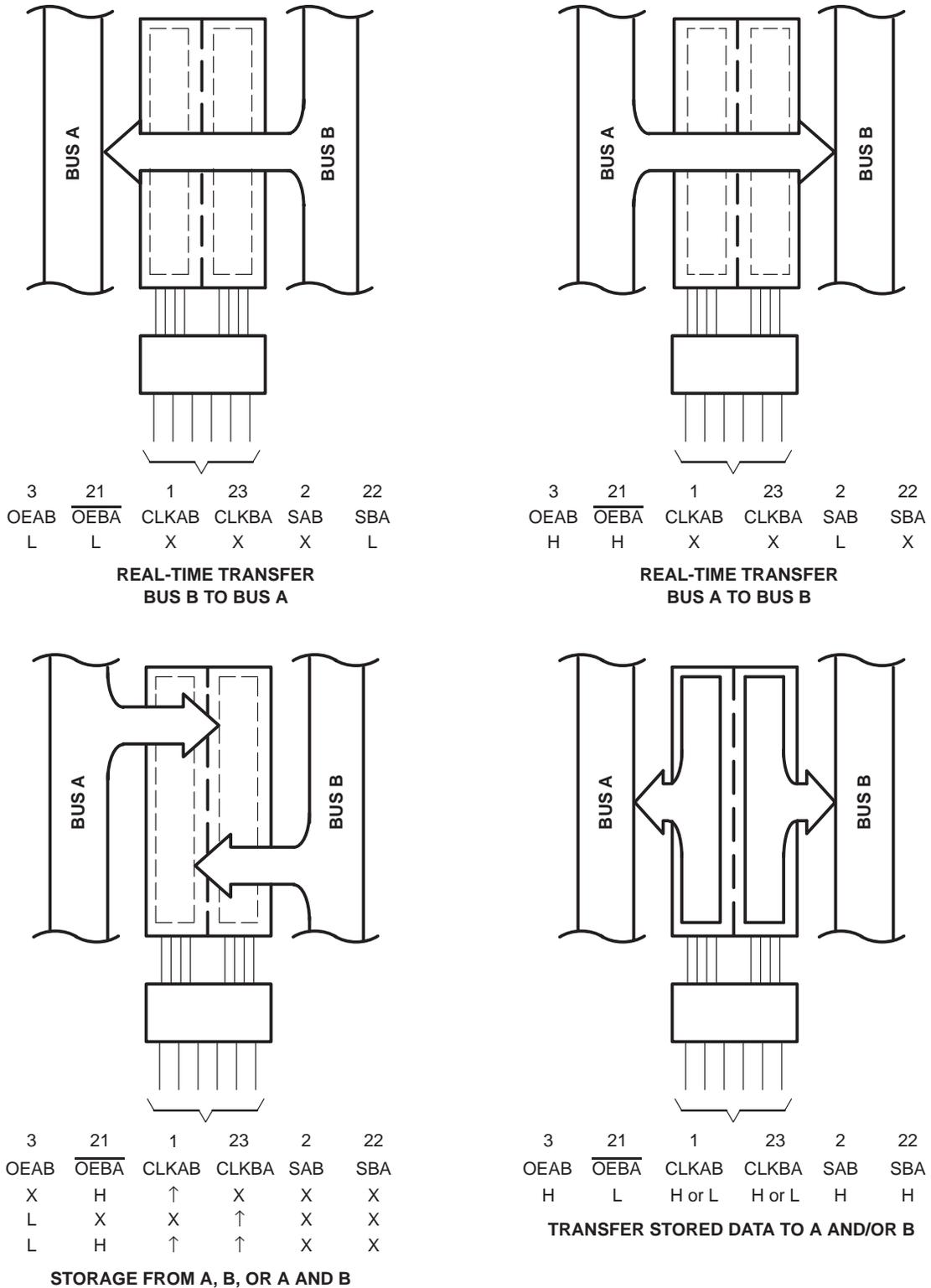
| INPUTS | | | | | | DATA I/O | | OPERATION OR FUNCTION |
|--------|--------------------------|------------|------------|----------------|----------------|--------------------------|--------------------------|---|
| OEAB | $\overline{\text{OEBA}}$ | CLKAB | CLKBA | SAB | SBA | A1–A8 | B1–B8 | |
| L | H | H or L | H or L | X | X | Input | Input | Isolation |
| L | H | \uparrow | \uparrow | X | X | Input | Input | Store A and B data |
| X | H | \uparrow | H or L | X | X | Input | Unspecified [†] | Store A, hold B |
| H | H | \uparrow | \uparrow | X [‡] | X | Input | Output | Store A in both registers |
| L | X | H or L | \uparrow | X | X | Unspecified [†] | Input | Hold A, store B |
| L | L | \uparrow | \uparrow | X | X [‡] | Output | Input | Store B in both registers |
| L | L | X | X | X | L | Output | Input | Real-time $\overline{\text{B}}$ data to A bus |
| L | L | X | H or L | X | H | Output | Input | Stored $\overline{\text{B}}$ data to A bus |
| H | H | X | X | L | X | Input | Output | Real-time $\overline{\text{A}}$ data to B bus |
| H | H | H or L | X | H | X | Input | Output | Stored $\overline{\text{A}}$ data to B bus |
| H | L | H or L | H or L | H | H | Output | Output | Stored $\overline{\text{A}}$ data to B bus and stored $\overline{\text{B}}$ data to A bus |

[†] The data output functions may be enabled or disabled by a variety of level combinations at OEAB or $\overline{\text{OEBA}}$. Data input functions are always enabled; i.e., data at the bus terminals is stored on every low-to-high transition of the clock inputs.

[‡] When select control is low, clocks can occur simultaneously if allowances are made for propagation delays from A to B (B to A) plus setup and hold times. When select control is high, clocks must be staggered to load both registers.

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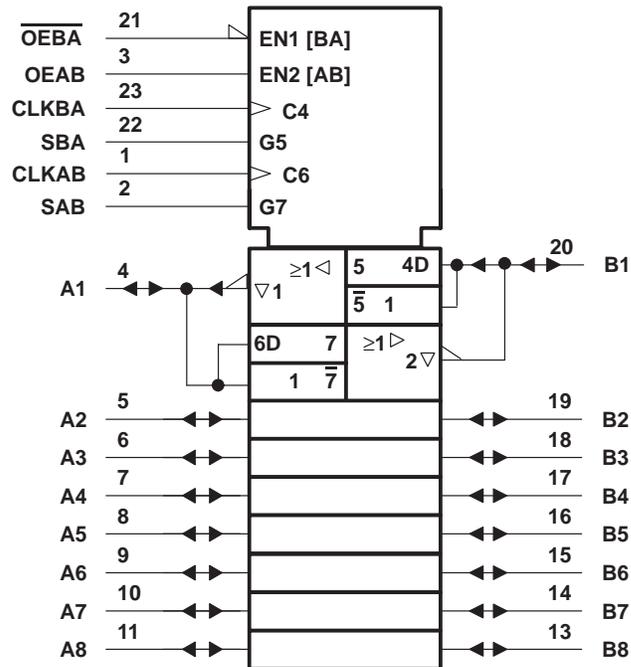
Pin numbers are for the DB, DW, JT, NT, and PW packages.

Figure 1. Bus-Management Functions

SN54ABT651, SN74ABT651 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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logic symbol†

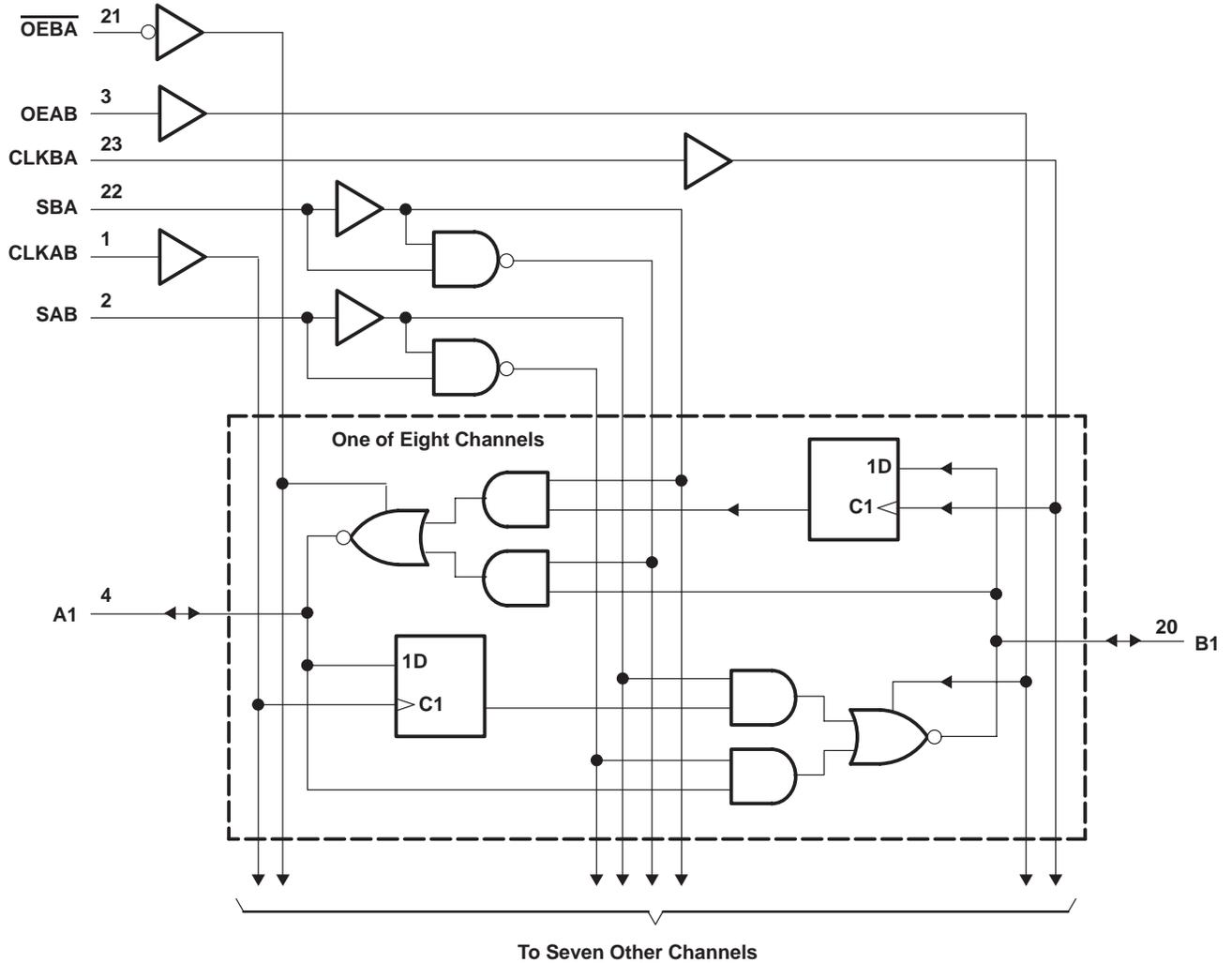


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12. Pin numbers shown are for the DB, DW, JT, NT, and PW packages.

SN54ABT651, SN74ABT651
 OCTAL BUS TRANSCEIVERS AND REGISTERS
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logic diagram (positive logic)



Pin numbers shown are for the DB, DW, JT, NT, and PW packages.

SN54ABT651, SN74ABT651 OCTAL BUS TRANSCEIVERS AND REGISTERS 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 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 : SN54ABT651 | 96 mA |
| SN74ABT651 | 128 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): DB package | 104°C/W |
| DW package | 81°C/W |
| NT package | 67°C/W |
| PW package | 120°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, except for through-hole packages, which use a trace length of zero.

recommended operating conditions (see Note 3)

| | SN54ABT651 | | SN74ABT651 | | 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 | | -24 | | -32 | mA |
| I_{OL} Low-level output current | | 48 | | 64 | mA |
| $\Delta t/\Delta v$ Input transition rise or fall rate | | 5 | | 5 | ns/V |
| T_A Operating free-air temperature | -55 | 125 | -40 | 85 | °C |

NOTE 3: All unused pins (control or I/O) 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.

SN54ABT651, SN74ABT651 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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

| PARAMETER | TEST CONDITIONS | T _A = 25°C | | | SN54ABT651 | | SN74ABT651 | | 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} | 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 | | |
| V _{OL} | V _{CC} = 4.5 V | | | I _{OL} = 48 mA | | 0.55 | | 0.55 | V | |
| | | | | I _{OL} = 64 mA | | 0.55* | | 0.55 | | |
| V _{hys} | | | | 100 | | | | | mV | |
| I _I | Control inputs | V _{CC} = 5.5 V, V _I = V _{CC} or GND | | | ±1 | | ±1 | | ±1 | μA |
| | A or B ports | | | | ±100 | | ±100 | | ±100 | |
| I _{OZH} ‡ | V _{CC} = 5.5 V, V _O = 2.7 V | | | 50 | | 50 | | 50 | μA | |
| I _{OZL} ‡ | V _{CC} = 5.5 V, V _O = 0.5 V | | | -50 | | -50 | | -50 | 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 § | V _{CC} = 5.5 V, V _O = 2.5 V | | | -50 -100 -180 | | -50 -180 | | -50 -180 | mA | |
| I _{CC} | V _{CC} = 5.5 V, I _O = 0, V _I = V _{CC} or GND | Outputs high | | 250 | | 250 | | 250 | μA | |
| | | Outputs low | | 30 | | 30 | | 30 | mA | |
| | | Outputs disabled | | 250 | | 250 | | 250 | μA | |
| ΔI _{CC} ¶ | V _{CC} = 5.5 V, One input at 3.4 V, Other inputs at V _{CC} or GND | | | 1.5 | | 1.5 | | 1.5 | mA | |
| C _i | Control inputs | V _I = 2.5 V or 0.5 V | | 6 | | | | | pF | |
| C _{io} | A or B ports | V _O = 2.5 V or 0.5 V | | 7.5 | | | | | 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.

§ 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.

timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 2)

| | | V _{CC} = 5 V, T _A = 25°C | | SN54ABT651 | | SN74ABT651 | | UNIT |
|--------------------|--|--|-----|------------|-----|------------|-----|------|
| | | MIN | MAX | MIN | MAX | MIN | MAX | |
| f _{clock} | Clock frequency | | 125 | | 125 | | 125 | MHz |
| t _w | Pulse duration, CLK high or low | 4 | | 4 | | 4 | | ns |
| t _{su} | Setup time, A or B before CLKAB↑ or CLKBA↑ | 3 | | 3 | | 3 | | ns |
| t _h | Hold time, A or B after CLKAB↑ or CLKBA↑ | 0 | | 0 | | 0 | | ns |

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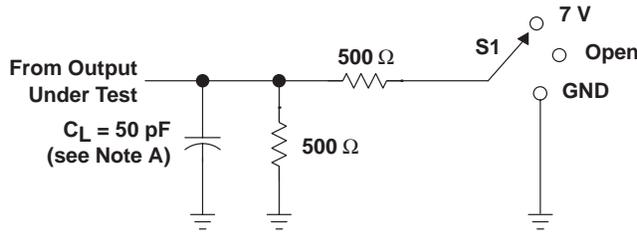
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switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L = 50$ pF (unless otherwise noted) (see Figure 2)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | $V_{CC} = 5$ V, $T_A = 25^\circ$ C | | | SN54ABT651 | | SN74ABT651 | | UNIT |
|-----------|-------------------|-------------|---------------------------------------|-----|-----|------------|-----|------------|-----|------|
| | | | MIN | TYP | MAX | MIN | MAX | MIN | MAX | |
| f_{max} | | | 125 | | | 125 | | 125 | | MHz |
| t_{PLH} | CLKBA or CLKAB | A or B | 2.2 | 4 | 5.1 | 2.2 | 5.9 | 2.2 | 5.6 | ns |
| t_{PHL} | | | 1.7 | 4 | 5.1 | 1.7 | 5.9 | 1.7 | 5.6 | |
| t_{PLH} | A or B | B or A | 1.5 | 4 | 5.1 | 1.5 | 6.4 | 1.5 | 6.2 | ns |
| t_{PHL} | | | 1.5 | 3.3 | 4.6 | 1.5 | 5.6 | 1.5 | 5.4 | |
| t_{PLH} | SAB or SBA† | A or B | 1.5 | 4 | 5.1 | 1.5 | 6.8 | 1.5 | 6.5 | ns |
| t_{PHL} | | | 1.5 | 3.6 | 4.9 | 1.5 | 6.2 | 1.5 | 5.9 | |
| t_{PZH} | \overline{OEBA} | A | 1.3 | 3.6 | 4.6 | 1.3 | 5.9 | 1.3 | 5.8 | ns |
| t_{PZL} | | | 2.5 | 5.7 | 6.8 | 2.5 | 8.9 | 2.5 | 8.5 | |
| t_{PHZ} | \overline{OEBA} | A | 1.5 | 3.2 | 4.5 | 1.5 | 6.2 | 1.5 | 5 | ns |
| t_{PLZ} | | | 1.5 | 3 | 3.8 | 1.5 | 4.3 | 1.5 | 4.1 | |
| t_{PZH} | OEAB | B | 1.8 | 4.3 | 6.1 | 1.8 | 6.7 | 1.8 | 6.5 | ns |
| t_{PZL} | | | 2.9 | 5.5 | 6.5 | 2.9 | 7.6 | 2.9 | 7.4 | |
| t_{PHZ} | OEAB | B | 1.5 | 3.3 | 4.5 | 1.5 | 6.5 | 1.5 | 5.5 | ns |
| t_{PLZ} | | | 1.5 | 3.4 | 4.4 | 1.5 | 5.2 | 1.5 | 5.1 | |

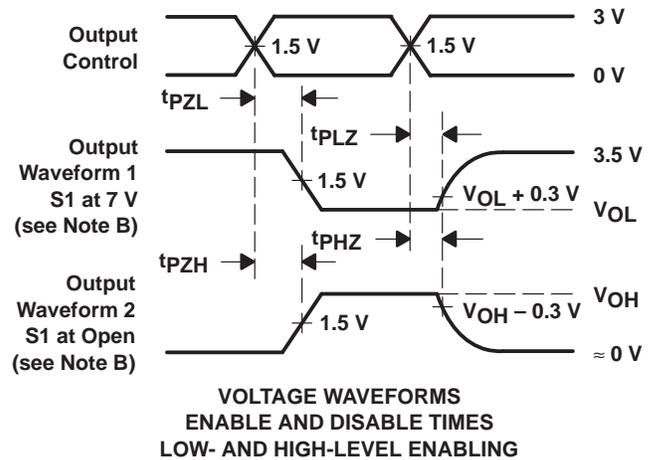
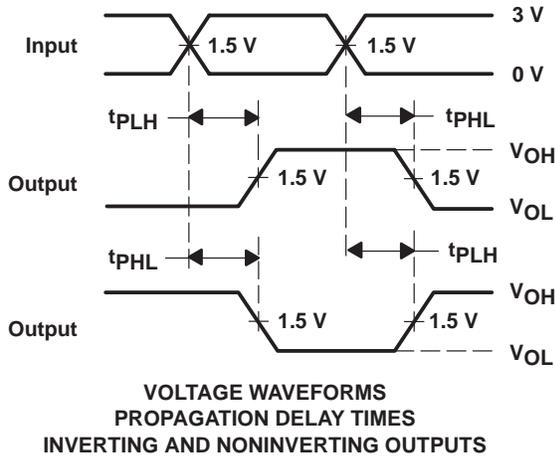
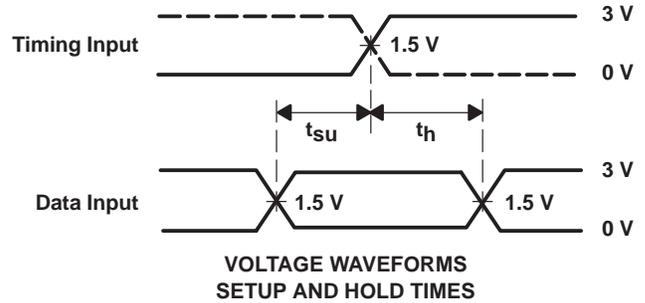
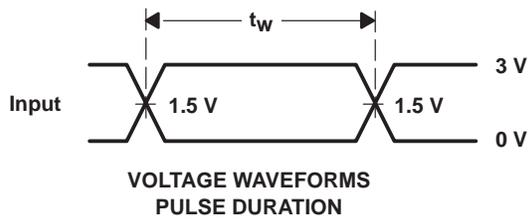
† These parameters are measured with the internal output state of the storage register opposite that of the bus input.

PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT

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



- 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: $PRR \leq 10$ MHz, $Z_O = 50 \Omega$, $t_r \leq 2.5$ ns, $t_f \leq 2.5$ ns.
 D. The outputs are measured one at a time with one transition per measurement.

Figure 2. 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⁾ |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| SN74ABT651DBLE | OBSOLETE | SSOP | DB | 24 | | TBD | Call TI | Call TI |
| SN74ABT651DBR | ACTIVE | SSOP | DB | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT651DBRE4 | ACTIVE | SSOP | DB | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT651DBRG4 | ACTIVE | SSOP | DB | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT651DW | ACTIVE | SOIC | DW | 24 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT651DWE4 | ACTIVE | SOIC | DW | 24 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT651DWG4 | ACTIVE | SOIC | DW | 24 | 25 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT651DWR | ACTIVE | SOIC | DW | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT651DWRE4 | ACTIVE | SOIC | DW | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT651DWRG4 | ACTIVE | SOIC | DW | 24 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM |
| SN74ABT651NT | ACTIVE | PDIP | NT | 24 | 15 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |
| SN74ABT651NTE4 | ACTIVE | PDIP | NT | 24 | 15 | Pb-Free (RoHS) | CU NIPDAU | N / A for Pkg Type |

⁽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.

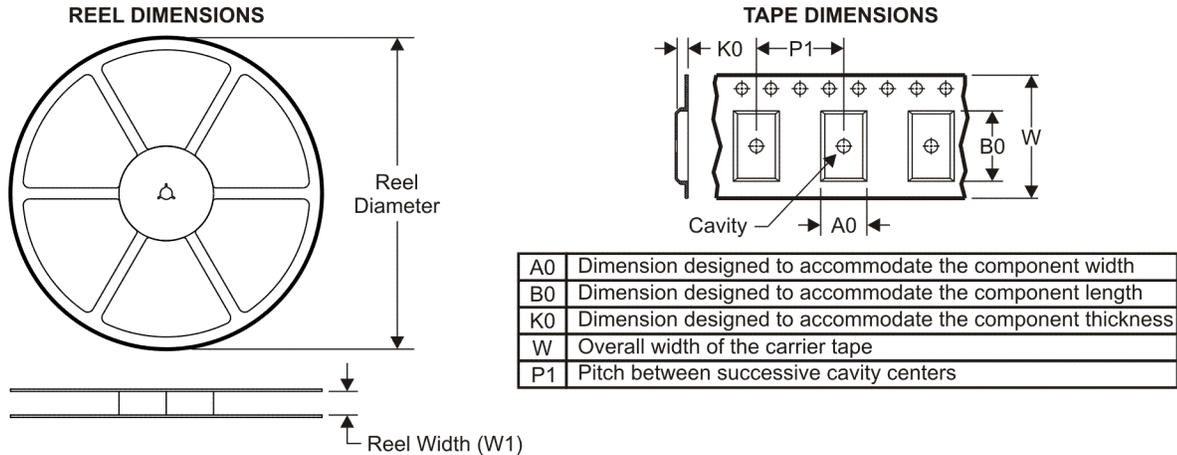
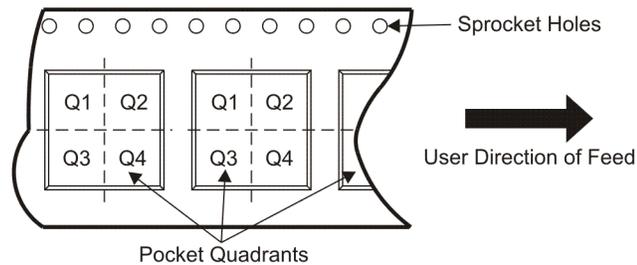
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

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

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE


*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 |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| SN74ABT651DBR | SSOP | DB | 24 | 2000 | 330.0 | 16.4 | 8.2 | 8.8 | 2.5 | 12.0 | 16.0 | Q1 |
| SN74ABT651DWR | SOIC | DW | 24 | 2000 | 330.0 | 24.4 | 10.75 | 15.7 | 2.7 | 12.0 | 24.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| SN74ABT651DBR | SSOP | DB | 24 | 2000 | 346.0 | 346.0 | 33.0 |
| SN74ABT651DWR | SOIC | DW | 24 | 2000 | 346.0 | 346.0 | 41.0 |

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