

# SN54ALS652, SN54ALS653, SN54AS651, SN54AS652 SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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- Bus Transceivers/Registers
- Independent Registers and Enables for A and B Buses
- Multiplexed Real-Time and Stored Data
- Choice of True or Inverting Data Paths
- Choice of 3-State or Open-Collector Outputs to A Bus

| DEVICE                          | A OUTPUT       | B OUTPUT | LOGIC     |
|---------------------------------|----------------|----------|-----------|
| SN74ALS651A, 'AS651             | 3-State        | 3-State  | Inverting |
| SN54ALS652, SN74ALS652A, 'AS652 | 3-State        | 3-State  | True      |
| 'ALS653                         | Open Collector | 3-State  | Inverting |
| SN74ALS654                      | Open Collector | 3-State  | True      |

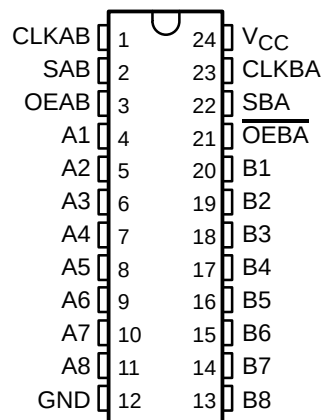
## description

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  $\overline{\text{OEBA}}$ ) inputs are provided to control the transceiver functions. Select-control (SAB and SBA) inputs are provided to select real-time or stored data transfer. The circuitry used for select control eliminates the typical decoding glitch that occurs in a multiplexer during the transition between stored and real-time data. 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 octal bus transceivers and registers

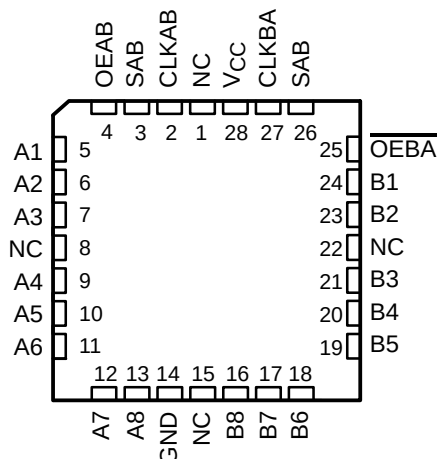
Data on the A or B data bus, or both, can be stored in the internal D-type flip-flops by low-to-high transitions at the appropriate clock (CLKAB or CLKBA) terminals, regardless of the select- or output-control terminals. When SAB and SBA are in the real-time transfer mode, it is possible to store data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

The -1 versions of the SN74ALS651A and SN74ALS652A are identical to the standard versions except that the recommended maximum  $I_{OL}$  for the -1 versions is increased to 48 mA. There are no -1 versions of the SN54ALS652, SN54ALS653, SN74ALS653, and SN74ALS654.

SN54ALS', SN54AS' ... JT PACKAGE  
SN74ALS', SN74AS' ... DW OR NT PACKAGE  
(TOP VIEW)



SN54ALS', SN54AS' ... FK PACKAGE  
(TOP VIEW)



NC – No internal connection



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

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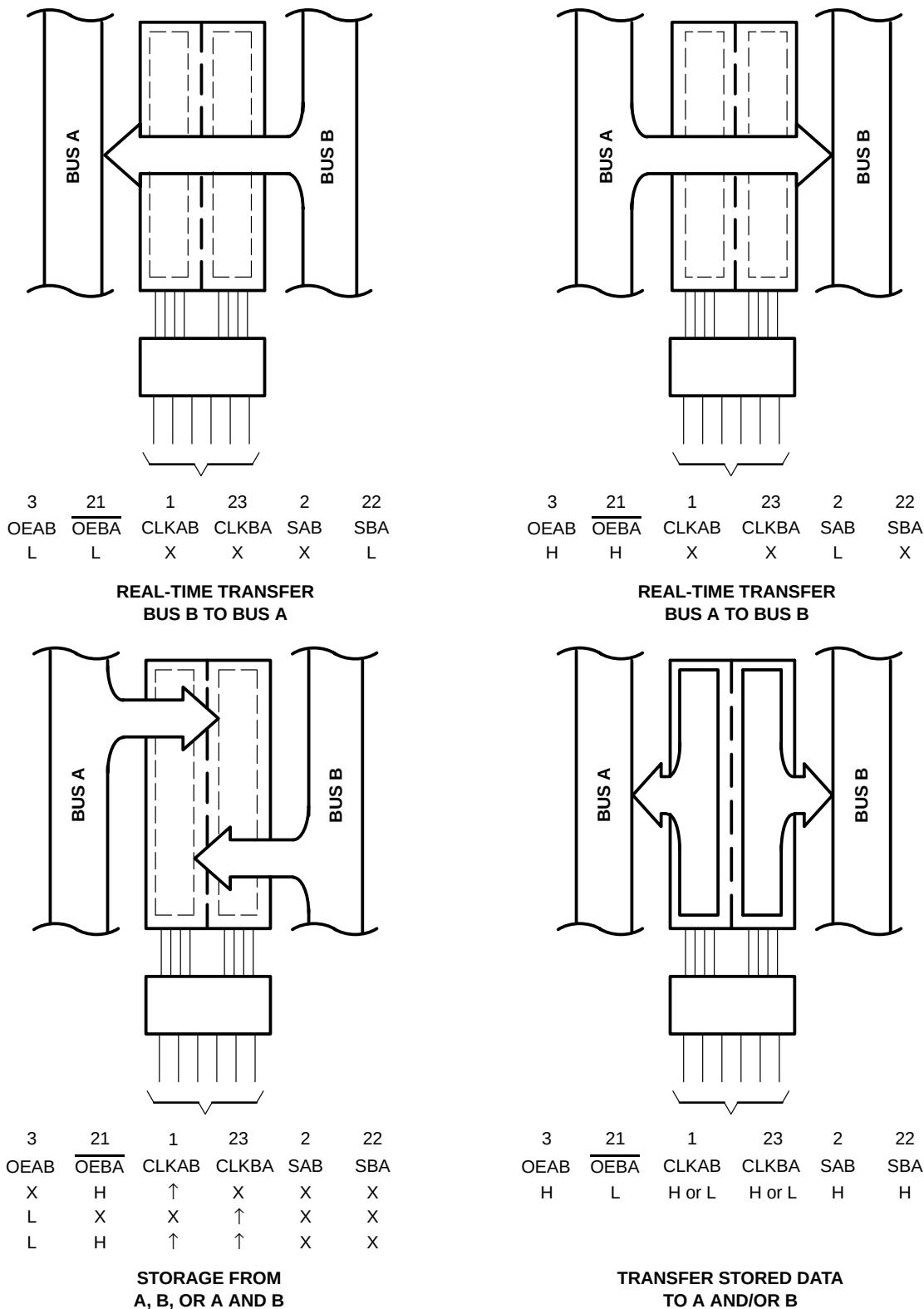
**ORDERING INFORMATION**

| <b>T<sub>A</sub></b> | <b>PACKAGE<sup>†</sup></b> |               | <b>ORDERABLE<br/>PART NUMBER</b> | <b>TOP-SIDE<br/>MARKING</b> |
|----------------------|----------------------------|---------------|----------------------------------|-----------------------------|
| 0°C to 70°C          | PDIP – NT                  | Tube          | SN74ALS651ANT                    | SN74ALS651ANT               |
|                      |                            |               | SN74ALS652ANT                    | SN74ALS652ANT               |
|                      |                            |               | SN74ALS653NT                     | SN74ALS653NT                |
|                      |                            |               | SN74ALS654NT                     | SN74ALS654NT                |
|                      |                            |               | SN74AS651NT                      | SN74AS651NT                 |
|                      |                            |               | SN74AS652NT                      | SN74AS652NT                 |
|                      | SOIC – DW                  | Tube          | SN74ALS651ADW                    | ALS651A                     |
|                      |                            | Tape and reel | SN74ALS651ADWR                   |                             |
|                      |                            | Tube          | SN74ALS652ADW                    | ALS652A                     |
|                      |                            | Tape and reel | SN74ALS652ADWR                   |                             |
|                      |                            | Tube          | SN74ALS653DW                     | ALS653                      |
|                      |                            | Tape and reel | SN74ALS653DWR                    |                             |
|                      |                            | Tube          | SN74ALS654DW                     | ALS654                      |
|                      |                            | Tape and reel | SN74ALS654DWR                    |                             |
|                      |                            | Tube          | SN74AS651DW                      | AS651                       |
|                      |                            | Tape and reel | SN74AS651DWR                     |                             |
|                      |                            | Tube          | SN74AS652DW                      | AS652                       |
|                      |                            | Tape and reel | SN74AS652DWR                     |                             |
| –55°C to 125°C       | CDIP – JT                  | Tube          | SNJ54ALS652JT                    | SNJ54ALS652JT               |
|                      |                            |               | SNJ54ALS653JT                    | SNJ54ALS653JT               |
|                      |                            |               | SNJ54AS651JT                     | SNJ54AS651JT                |
|                      |                            |               | SNJ54AS652JT                     | SNJ54AS652JT                |
|                      | LCCC – FK                  | Tube          | SNJ54ALS652FK                    | SNJ54ALS652FK               |
|                      |                            |               | SNJ54ALS653FK                    | SNJ54ALS653FK               |
|                      |                            |               | SNJ54AS651FK                     | SNJ54AS651FK                |
|                      |                            |               | SNJ54AS652FK                     | SNJ54AS652FK                |

<sup>†</sup> Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

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

**Figure 1. Bus-Management Functions**

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## Function Tables

SN54ALS653, SN54AS651,  
SN74ALS651A, SN74ALS653, SN74AS651

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

<sup>†</sup> The data output functions can be enabled or disabled by a variety of level combinations at OEAB or OEBA. Data input functions always are enabled; i.e., data at the bus terminals is stored on every low-to-high transition on the clock inputs.

<sup>‡</sup> Select control = L: clocks can occur simultaneously.

Select control = H: clocks must be staggered to load both registers.

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SN74ALS652A, SN74ALS654, SN74AS652

| INPUTS |      |        |        |                |                | DATA I/O <sup>†</sup>    |                          | OPERATION OR FUNCTION                             |
|--------|------|--------|--------|----------------|----------------|--------------------------|--------------------------|---------------------------------------------------|
| OEAB   | OEBA | CLKAB  | CLKBA  | SAB            | SBA            | A1–A8                    | B1–B8                    |                                                   |
| L      | H    | H or L | H or L | X              | X              | Input                    | Input                    | Isolation                                         |
| L      | H    | ↑      | ↑      | X              | X              | Input                    | Input                    | Store A and B data                                |
| X      | H    | ↑      | H or L | X              | X              | Input                    | Unspecified <sup>‡</sup> | Store A, hold B                                   |
| H      | H    | ↑      | ↑      | X <sup>‡</sup> | X              | Input                    | Output                   | Store A in both registers                         |
| L      | X    | H or L | ↑      | X              | X              | Unspecified <sup>‡</sup> | Input                    | Hold A, store B                                   |
| L      | L    | ↑      | ↑      | X              | X <sup>‡</sup> | Output                   | Input                    | Store B in both registers                         |
| L      | L    | X      | X      | X              | L              | Output                   | Input                    | Real-time B data to A bus                         |
| L      | L    | X      | H or L | X              | H              | Output                   | Input                    | Stored B data to A bus                            |
| H      | H    | X      | X      | L              | X              | Input                    | Output                   | Real-time A data to B bus                         |
| H      | H    | H or L | X      | H              | X              | Input                    | Output                   | Stored A data to B bus                            |
| H      | L    | H or L | H or L | H              | H              | Output                   | Output                   | Stored A data to B bus and stored B data to A bus |

<sup>†</sup> The data output functions can be enabled or disabled by a variety of level combinations at OEAB or OEBA. Data input functions always are enabled; i.e., data at the bus terminals is stored on every low-to-high transition on the clock inputs.

<sup>‡</sup> Select control = L: clocks can occur simultaneously.

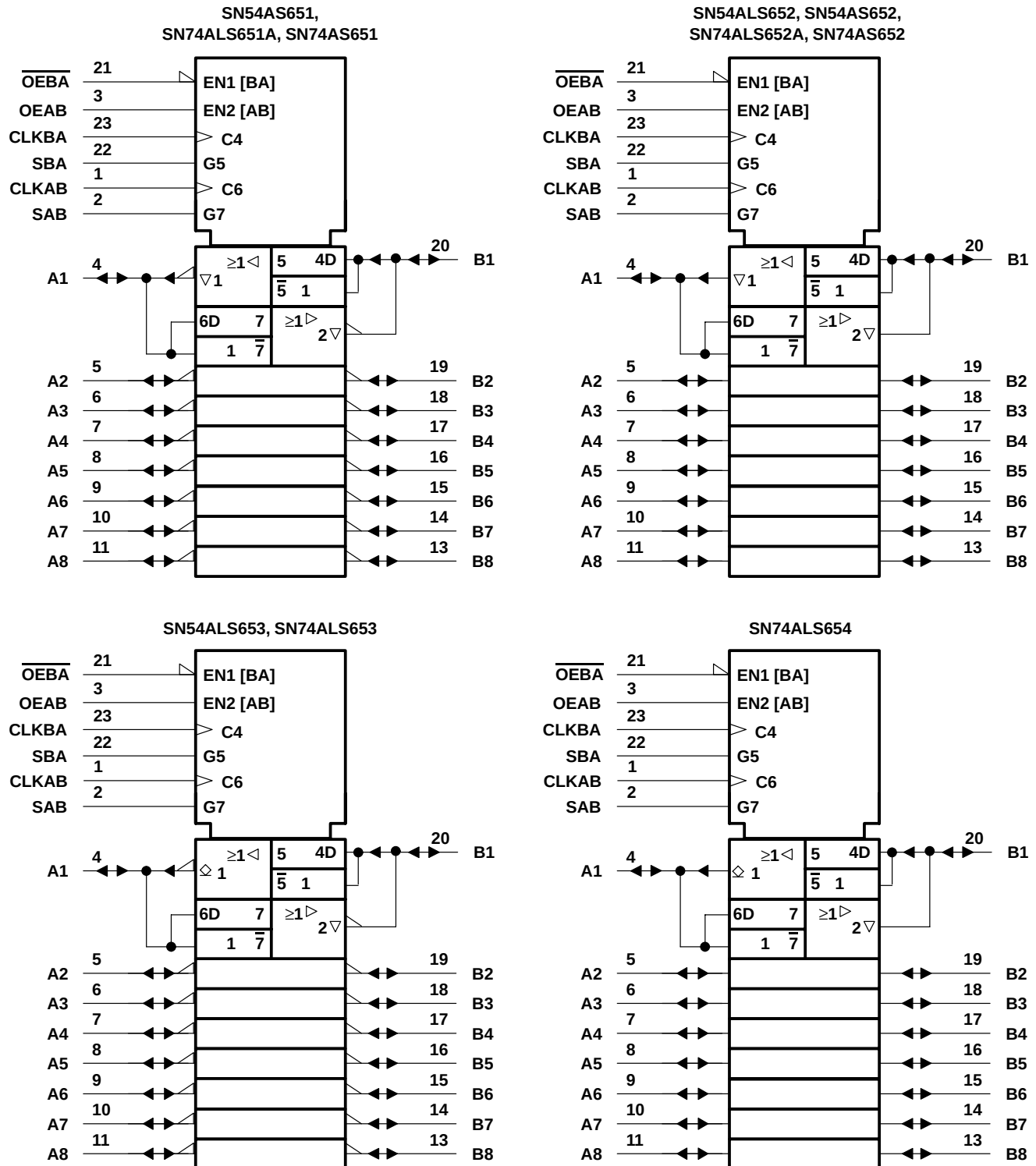
Select control = H: clocks must be staggered to load both registers.



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logic symbols†

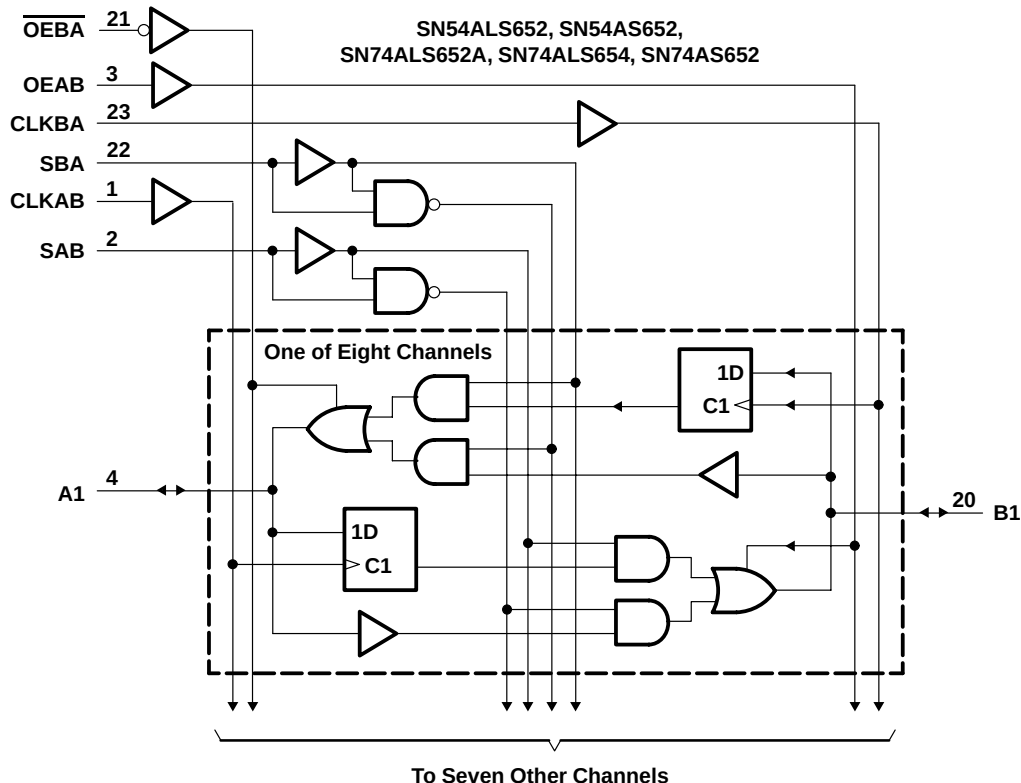
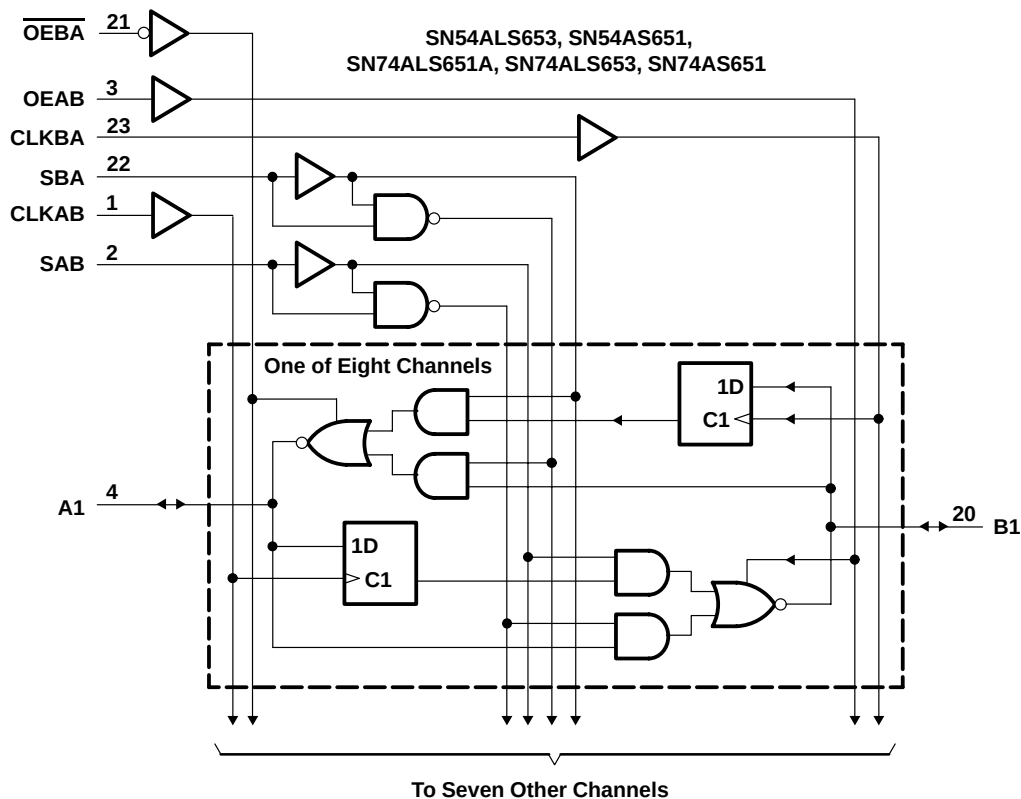


† These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.  
Pin numbers shown are for the DW, JT, and NT packages.

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## logic diagrams (positive logic)



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



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**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>**

|                                                                   |                 |
|-------------------------------------------------------------------|-----------------|
| Supply voltage range, $V_{CC}$                                    | –0.5 V to 7 V   |
| Input voltage range, $V_I$ : Control inputs                       | –0.5 V to 7 V   |
| I/O ports                                                         | –0.5 V to 5.5 V |
| Package thermal impedance, $\theta_{JA}$ (see Note 1): DW package | 46°C/W          |
| NT package                                                        | 67°C/W          |
| Storage temperature range, $T_{stg}$                              | –65°C to 150°C  |

<sup>†</sup> 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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51.

**recommended operating conditions**

|             |                                                        | SN74ALS651A         |     |                 | UNIT |
|-------------|--------------------------------------------------------|---------------------|-----|-----------------|------|
|             |                                                        | MIN                 | NOM | MAX             |      |
| $V_{CC}$    | Supply voltage                                         | 4.5                 | 5   | 5.5             | V    |
| $V_{IH}$    | High-level input voltage                               | 2                   |     |                 | V    |
| $V_{IL}$    | Low-level input voltage                                |                     |     | 0.8             | V    |
| $I_{OH}$    | High-level output current                              |                     |     | –15             | mA   |
| $I_{OL}$    | Low-level output current                               |                     |     | 24              | mA   |
|             |                                                        |                     |     | 48 <sup>‡</sup> |      |
| $f_{clock}$ | Clock frequency                                        | 0                   |     | 40              | MHz  |
| $t_w$       | Pulse duration                                         | CLKBA or CLKAB high |     | 12.5            | ns   |
|             |                                                        | CLKBA or CLKAB low  |     | 12.5            |      |
| $t_{su}$    | Setup time before CLKAB $\uparrow$ or CLKBA $\uparrow$ | A or B              |     | 10              | ns   |
| $t_h$       | Hold time after CLKAB $\uparrow$ or CLKBA $\uparrow$   | A or B              |     | 0               | ns   |
| $T_A$       | Operating free-air temperature                         | 0                   |     | 70              | °C   |

<sup>‡</sup> Applies only to the SN74ALS651A-1 and only if  $V_{CC}$  is maintained between 4.75 V and 5.25 V

**recommended operating conditions**

|                    |                                    |                     | SN54ALS652 |     |     | SN74ALS652A |     |     | UNIT |
|--------------------|------------------------------------|---------------------|------------|-----|-----|-------------|-----|-----|------|
|                    |                                    |                     | MIN        | NOM | MAX | MIN         | NOM | MAX |      |
| V <sub>CC</sub>    | Supply voltage                     |                     | 4.5        | 5   | 5.5 | 4.5         | 5   | 5.5 | V    |
| V <sub>IH</sub>    | High-level input voltage           |                     | 2          |     |     | 2           |     |     | V    |
| V <sub>IL</sub>    | Low-level input voltage            |                     | 0.7        |     |     | 0.8         |     |     | V    |
| I <sub>OH</sub>    | High-level output current          |                     | −12        |     |     | −15         |     |     | mA   |
| I <sub>OL</sub>    | Low-level output current           |                     | 12         |     |     | 24          |     |     | mA   |
|                    |                                    |                     |            |     |     | 48‡         |     |     |      |
| f <sub>clock</sub> | Clock frequency                    |                     | 0          | 35  |     | 0           | 40  |     | MHz  |
| t <sub>w</sub>     | Pulse duration                     | CLKBA or CLKAB high | 14.5       |     |     | 12.5        |     |     | ns   |
|                    |                                    | CLKBA or CLKAB low  | 14.5       |     |     | 12.5        |     |     |      |
| t <sub>su</sub>    | Setup time before CLKAB↑ or CLKBA↑ | A or B              | 15         |     |     | 10          |     |     | ns   |
| t <sub>h</sub>     | Hold time after CLKAB↑ or CLKBA↑   | A or B              | 5          |     |     | 0           |     |     | ns   |
| T <sub>A</sub>     | Operating free-air temperature     |                     | −55        | 125 |     | 0           | 70  |     | °C   |

<sup>‡</sup> Applies only to the SN74ALS652A-1 and only if  $V_{CC}$  is maintained between 4.75 V and 5.25 V



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

| PARAMETER                   |                | TEST CONDITIONS                                                 |                          | SN74ALS651A         |      |     | UNIT |
|-----------------------------|----------------|-----------------------------------------------------------------|--------------------------|---------------------|------|-----|------|
|                             |                |                                                                 |                          | MIN                 | TYP† | MAX |      |
| V <sub>IK</sub>             |                | V <sub>CC</sub> = 4.5 V, I <sub>I</sub> = −18 mA                |                          | −1.2                |      |     | V    |
| V <sub>OH</sub>             |                | V <sub>CC</sub> = 4.5 V to 5.5 V, I <sub>OH</sub> = −0.4 mA     |                          | V <sub>CC</sub> − 2 |      |     | V    |
|                             |                | V <sub>CC</sub> = 4.5 V                                         | I <sub>OH</sub> = −3 mA  |                     | 2.4  | 3.2 |      |
|                             |                |                                                                 | I <sub>OH</sub> = −15 mA |                     | 2    |     |      |
| V <sub>OL</sub>             |                | V <sub>CC</sub> = 4.5 V                                         | I <sub>OL</sub> = 12 mA  |                     | 0.25 | 0.4 | V    |
|                             |                |                                                                 | I <sub>OL</sub> = 24 mA  |                     | 0.35 | 0.5 |      |
|                             |                | V <sub>CC</sub> = 4.75 V, I <sub>OL</sub> = 48 mA (-1 versions) |                          | 0.35                | 0.5  |     |      |
| I <sub>I</sub>              | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 7 V                   | 0.1                      |                     |      | mA  |      |
|                             | A or B ports   | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 5.5 V                 | 0.1                      |                     |      |     |      |
| I <sub>IH</sub>             | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 2.7 V                 | 20                       |                     |      | μA  |      |
|                             | A or B ports‡  |                                                                 | 20                       |                     |      |     |      |
| I <sub>IL</sub>             | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0.4 V                 | −0.2                     |                     |      | mA  |      |
|                             | A or B ports‡  |                                                                 | −0.2                     |                     |      |     |      |
| I <sub>O</sub> <sup>§</sup> |                | V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.25 V                | −30 −112                 |                     |      | mA  |      |
| I <sub>CC</sub>             |                | V <sub>CC</sub> = 5.5 V                                         | Outputs high             | 42 68               |      |     | mA   |
|                             |                |                                                                 | Outputs low              | 52 82               |      |     |      |
|                             |                |                                                                 | Outputs disabled         | 52 82               |      |     |      |

<sup>†</sup> All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

<sup>‡</sup> For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

<sup>§</sup> The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current,  $I_{OS}$ .



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

| PARAMETER                   |                | TEST CONDITIONS                                                 | SN54ALS652               |      |      | SN74ALS652A         |      |     | UNIT |
|-----------------------------|----------------|-----------------------------------------------------------------|--------------------------|------|------|---------------------|------|-----|------|
|                             |                |                                                                 | MIN                      | TYP† | MAX  | MIN                 | TYP† | MAX |      |
| V <sub>IK</sub>             |                | V <sub>CC</sub> = 4.5 V, I <sub>I</sub> = −18 mA                | −1.2                     |      |      | −1.2                |      |     | V    |
| V <sub>OH</sub>             |                | V <sub>CC</sub> = 4.5 V to 5.5 V, I <sub>OH</sub> = −0.4 mA     | V <sub>CC</sub> − 2      |      |      | V <sub>CC</sub> − 2 |      |     | V    |
|                             |                | V <sub>CC</sub> = 4.5 V                                         | I <sub>OH</sub> = −3 mA  |      | 2.4  | 3.2                 | 2.4  | 3.2 |      |
|                             |                |                                                                 | I <sub>OH</sub> = −12 mA |      | 2    |                     |      |     |      |
|                             |                |                                                                 | I <sub>OH</sub> = −15 mA |      |      |                     | 2    |     |      |
| V <sub>OL</sub>             |                | V <sub>CC</sub> = 4.5 V                                         | I <sub>OL</sub> = 12 mA  |      | 0.25 | 0.4                 | 0.25 | 0.4 | V    |
|                             |                |                                                                 | I <sub>OL</sub> = 24 mA  |      |      |                     | 0.35 | 0.5 |      |
|                             |                | V <sub>CC</sub> = 4.75 V, I <sub>OL</sub> = 48 mA (-1 versions) |                          |      |      |                     | 0.35 |     |      |
| I <sub>I</sub>              | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 7 V                   | 0.1                      |      |      | 0.1                 |      |     | mA   |
|                             | A or B ports   | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 5.5 V                 | 0.1                      |      |      | 0.1                 |      |     |      |
| I <sub>IH</sub>             | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 2.7 V                 | 20                       |      |      | 20                  |      |     | μA   |
|                             | A or B ports‡  |                                                                 | 20                       |      |      | 20                  |      |     |      |
| I <sub>IL</sub>             | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0.4 V                 | −0.2                     |      |      | −0.2                |      |     | mA   |
|                             | A or B ports‡  |                                                                 | −0.2                     |      |      | −0.2                |      |     |      |
| I <sub>O</sub> <sup>§</sup> |                | V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.25 V                | −20                      | −112 |      | −30                 | −112 |     | mA   |
| I <sub>CC</sub>             |                | V <sub>CC</sub> = 5.5 V                                         | Outputs high             |      | 47   | 76                  | 47   | 76  | mA   |
|                             |                |                                                                 | Outputs low              |      | 55   | 88                  | 55   | 88  |      |
|                             |                |                                                                 | Outputs disabled         |      | 55   | 88                  | 55   | 88  |      |

<sup>†</sup> All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

<sup>‡</sup> For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

<sup>§</sup> The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current,  $I_{OS}$ .

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SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
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**switching characteristics (see Figure 2)**

| PARAMETER        | FROM<br>(INPUT)                   | TO<br>(OUTPUT) | V <sub>CC</sub> = 4.5 V to 5.5 V,<br>C <sub>L</sub> = 50 pF,<br>R <sub>1</sub> = 500 Ω,<br>R <sub>2</sub> = 500 Ω,<br>T <sub>A</sub> = MIN to MAX† |     | UNIT |
|------------------|-----------------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|
|                  |                                   |                | SN74ALS651A                                                                                                                                        |     |      |
|                  |                                   |                | MIN                                                                                                                                                | MAX |      |
| f <sub>max</sub> |                                   |                | 40                                                                                                                                                 |     | MHz  |
| t <sub>PLH</sub> | CLKBA or CLKAB                    | A or B         | 8                                                                                                                                                  | 32  | ns   |
| t <sub>PHL</sub> |                                   |                | 5                                                                                                                                                  | 17  |      |
| t <sub>PLH</sub> | A or B                            | B or A         | 2                                                                                                                                                  | 18  | ns   |
| t <sub>PHL</sub> |                                   |                | 2                                                                                                                                                  | 10  |      |
| t <sub>PLH</sub> | SBA or SAB‡<br>(with A or B high) | A or B         | 8                                                                                                                                                  | 38  | ns   |
| t <sub>PHL</sub> |                                   |                | 6                                                                                                                                                  | 21  |      |
| t <sub>PLH</sub> | SBA or SAB‡<br>(with A or B low)  | A or B         | 8                                                                                                                                                  | 25  | ns   |
| t <sub>PHL</sub> |                                   |                | 7                                                                                                                                                  | 21  |      |
| t <sub>PZH</sub> | $\overline{\text{OEBA}}$          | A              | 3                                                                                                                                                  | 20  | ns   |
| t <sub>PZL</sub> |                                   |                | 5                                                                                                                                                  | 18  |      |
| t <sub>PHZ</sub> | $\overline{\text{OEBA}}$          | A              | 2                                                                                                                                                  | 9   | ns   |
| t <sub>PLZ</sub> |                                   |                | 3                                                                                                                                                  | 12  |      |
| t <sub>PZH</sub> | OEAB                              | B              | 3                                                                                                                                                  | 22  | ns   |
| t <sub>PZL</sub> |                                   |                | 6                                                                                                                                                  | 21  |      |
| t <sub>PHZ</sub> | OEAB                              | B              | 2                                                                                                                                                  | 12  | ns   |
| t <sub>PLZ</sub> |                                   |                | 2                                                                                                                                                  | 14  |      |

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

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

**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
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switching characteristics (see Figure 2)

| PARAMETER        | FROM<br>(INPUT)                               | TO<br>(OUTPUT) | V <sub>CC</sub> = 4.5 V to 5.5 V,<br>C <sub>L</sub> = 50 pF,<br>R1 = 500 Ω,<br>R2 = 500 Ω,<br>T <sub>A</sub> = MIN to MAX† |     |             |     | UNIT |
|------------------|-----------------------------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------|-----|-------------|-----|------|
|                  |                                               |                | SN54ALS652                                                                                                                 |     | SN74ALS652A |     |      |
|                  |                                               |                | MIN                                                                                                                        | MAX | MIN         | MAX |      |
| f <sub>max</sub> |                                               |                | 35                                                                                                                         |     | 40          |     | MHz  |
| t <sub>PLH</sub> | CLKBA or CLKAB                                | A or B         | 10                                                                                                                         | 35  | 8           | 30  | ns   |
| t <sub>PHL</sub> |                                               |                | 5                                                                                                                          | 20  | 5           | 17  |      |
| t <sub>PLH</sub> | A or B                                        | B or A         | 5                                                                                                                          | 20  | 4           | 18  | ns   |
| t <sub>PHL</sub> |                                               |                | 3                                                                                                                          | 15  | 3           | 12  |      |
| t <sub>PLH</sub> | SBA or SAB <sup>‡</sup><br>(with A or B high) | A or B         | 15                                                                                                                         | 40  | 8           | 35  | ns   |
| t <sub>PHL</sub> |                                               |                | 6                                                                                                                          | 23  | 6           | 20  |      |
| t <sub>PLH</sub> | SBA or SAB <sup>‡</sup><br>(with A or B low)  | A or B         | 8                                                                                                                          | 30  | 8           | 25  | ns   |
| t <sub>PHL</sub> |                                               |                | 5                                                                                                                          | 24  | 5           | 20  |      |
| t <sub>PZH</sub> | $\overline{\text{OEBA}}$                      | A              | 3                                                                                                                          | 20  | 3           | 17  | ns   |
| t <sub>PZL</sub> |                                               |                | 5                                                                                                                          | 22  | 5           | 18  |      |
| t <sub>PHZ</sub> | $\overline{\text{OEBA}}$                      | A              | 1                                                                                                                          | 12  | 1           | 10  | ns   |
| t <sub>PLZ</sub> |                                               |                | 2                                                                                                                          | 20  | 2           | 16  |      |
| t <sub>PZH</sub> | OEAB                                          | B              | 8                                                                                                                          | 25  | 3           | 22  | ns   |
| t <sub>PZL</sub> |                                               |                | 6                                                                                                                          | 21  | 5           | 18  |      |
| t <sub>PHZ</sub> | OEAB                                          | B              | 1                                                                                                                          | 12  | 1           | 10  | ns   |
| t <sub>PLZ</sub> |                                               |                | 2                                                                                                                          | 21  | 2           | 16  |      |

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

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

# SN54ALS652, SN54ALS653, SN54AS651, SN54AS652 SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652 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)<sup>†</sup>

|                                                                   |                 |
|-------------------------------------------------------------------|-----------------|
| Supply voltage range, $V_{CC}$                                    | –0.5 V to 7 V   |
| Input voltage range, $V_I$ : Control inputs                       | –0.5 V to 7 V   |
| I/O ports                                                         | –0.5 V to 5.5 V |
| Package thermal impedance, $\theta_{JA}$ (see Note 1): DW package | 46°C/W          |
| NT package                                                        | 67°C/W          |
| Storage temperature range, $T_{stg}$                              | –65°C to 150°C  |

<sup>†</sup> 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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51.

## recommended operating conditions

|             |                                                        | SN54ALS653          |     |     | SN74ALS653 |     |     | 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                               | 2                   |     |     | 2          |     |     | V    |
| $V_{IL}$    | Low-level input voltage                                |                     |     | 0.7 |            |     | 0.8 | V    |
| $V_{OH}$    | High-level output voltage                              | A ports             |     | 5.5 | 5.5        |     |     | V    |
| $I_{OH}$    | High-level output current                              | B ports             |     | –12 | –15        |     |     | mA   |
| $I_{OL}$    | Low-level output current                               |                     |     | 12  | 24         |     |     | mA   |
| $f_{clock}$ | Clock frequency                                        | 0                   |     | 25  | 0          |     | 35  | MHz  |
| $t_w$       | Pulse duration                                         | CLKBA or CLKAB high |     | 20  | 14.5       |     |     | ns   |
|             |                                                        | CLKBA or CLKAB low  |     | 20  | 14.5       |     |     |      |
| $t_{su}$    | Setup time before CLKAB $\uparrow$ or CLKBA $\uparrow$ | A or B              |     | 15  | 10         |     |     | ns   |
| $t_h$       | Hold time after CLKAB $\uparrow$ or CLKBA $\uparrow$   | A or B              |     | 5   | 0          |     |     | ns   |
| $T_A$       | Operating free-air temperature                         | –55                 |     | 125 | 0          |     | 70  | °C   |

## recommended operating conditions

|             |                                                        | SN74ALS654          |     |      | UNIT |
|-------------|--------------------------------------------------------|---------------------|-----|------|------|
|             |                                                        | MIN                 | NOM | MAX  |      |
| $V_{CC}$    | Supply voltage                                         | 4.5                 | 5   | 5.5  | V    |
| $V_{IH}$    | High-level input voltage                               | 2                   |     |      | V    |
| $V_{IL}$    | Low-level input voltage                                |                     |     | 0.8  | V    |
| $V_{OH}$    | High-level output voltage                              | A ports             |     | 5.5  | V    |
| $I_{OH}$    | High-level output current                              | B ports             |     | –15  | mA   |
| $I_{OL}$    | Low-level output current                               |                     |     | 24   | mA   |
| $f_{clock}$ | Clock frequency                                        | 0                   |     | 35   | MHz  |
| $t_w$       | Pulse duration                                         | CLKBA or CLKAB high |     | 14.5 | ns   |
|             |                                                        | CLKBA or CLKAB low  |     | 14.5 |      |
| $t_{su}$    | Setup time before CLKAB $\uparrow$ or CLKBA $\uparrow$ | A or B              |     | 10   | ns   |
| $t_h$       | Hold time after CLKAB $\uparrow$ or CLKBA $\uparrow$   | A or B              |     | 0    | ns   |
| $T_A$       | Operating free-air temperature                         | 0                   |     | 70   | °C   |



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

| PARAMETER                   |                | TEST CONDITIONS                                             |                          | SN54ALS653          |      |      | SN74ALS653          |      |     | UNIT |
|-----------------------------|----------------|-------------------------------------------------------------|--------------------------|---------------------|------|------|---------------------|------|-----|------|
|                             |                |                                                             |                          | MIN                 | TYP† | MAX  | MIN                 | TYP† | MAX |      |
| V <sub>IK</sub>             |                | V <sub>CC</sub> = 4.5 V, I <sub>I</sub> = −18 mA            |                          | −1.2                |      |      | −1.2                |      |     | V    |
| V <sub>OH</sub>             | B ports        | V <sub>CC</sub> = 4.5 V to 5.5 V, I <sub>OH</sub> = −0.4 mA |                          | V <sub>CC</sub> − 2 |      |      | V <sub>CC</sub> − 2 |      |     | V    |
|                             |                | V <sub>CC</sub> = 4.5 V                                     | I <sub>OH</sub> = −3 mA  | 2.4                 | 3.2  | 2.4  | 3.2                 |      |     |      |
|                             |                |                                                             | I <sub>OH</sub> = −12 mA | 2                   |      |      |                     |      |     |      |
|                             |                |                                                             | I <sub>OH</sub> = −15 mA |                     |      | 2    |                     |      |     |      |
| V <sub>OL</sub>             |                | V <sub>CC</sub> = 4.5 V                                     | I <sub>OL</sub> = 12 mA  | 0.25                | 0.4  | 0.25 | 0.4                 | V    |     |      |
|                             |                |                                                             | I <sub>OL</sub> = 24 mA  |                     |      | 0.35 | 0.5                 |      |     |      |
| I <sub>I</sub>              | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 7 V               | 0.1                      |                     |      | 0.1  |                     |      | mA  |      |
|                             | A or B ports   | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 5.5 V             | 0.1                      |                     |      | 0.1  |                     |      |     |      |
| I <sub>IH</sub>             | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 2.7 V             | 20                       |                     |      | 20   |                     |      | μA  |      |
|                             | A or B ports‡  |                                                             | 20                       |                     |      | 20   |                     |      |     |      |
| I <sub>IL</sub>             | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0.4 V             | −0.2                     |                     |      | −0.2 |                     |      | mA  |      |
|                             | A or B ports‡  |                                                             | −0.2                     |                     |      | −0.2 |                     |      |     |      |
| I <sub>OH</sub>             | A ports        | V <sub>CC</sub> = 4.5 V, V <sub>OH</sub> = 5.5 V            | 0.1                      |                     |      | 0.1  |                     |      | mA  |      |
| I <sub>O</sub> <sup>§</sup> | B ports        | V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.25 V            | −20                      | −112                | −30  | −112 | mA                  |      |     |      |
| I <sub>CC</sub>             |                | V <sub>CC</sub> = 5.5 V                                     | Outputs high             | 47                  | 76   | 47   | 76                  | mA   |     |      |
|                             |                |                                                             | Outputs low              | 55                  | 88   | 55   | 88                  |      |     |      |
|                             |                |                                                             | Outputs disabled         | 55                  | 88   | 55   | 88                  |      |     |      |

<sup>†</sup> All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

<sup>‡</sup> For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

<sup>§</sup> The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current,  $I_{OS}$ .

**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652**  
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**electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)**

| PARAMETER  |                           | TEST CONDITIONS                                                         |                          | SN74ALS654   |                  |      | UNIT          |
|------------|---------------------------|-------------------------------------------------------------------------|--------------------------|--------------|------------------|------|---------------|
|            |                           |                                                                         |                          | MIN          | TYP <sup>†</sup> | MAX  |               |
| $V_{IK}$   |                           | $V_{CC} = 4.5\text{ V}$ ,<br>$I_I = -18\text{ mA}$                      |                          |              |                  | -1.2 | V             |
| $V_{OH}$   | B ports                   | $V_{CC} = 4.5\text{ V to } 5.5\text{ V}$ ,<br>$I_{OH} = -0.4\text{ mA}$ |                          | $V_{CC} - 2$ |                  |      | V             |
|            |                           | $V_{CC} = 4.5\text{ V}$                                                 | $I_{OH} = -3\text{ mA}$  | 2.4          | 3.2              |      |               |
|            |                           |                                                                         | $I_{OH} = -15\text{ mA}$ | 2            |                  |      |               |
| $V_{OL}$   |                           | $V_{CC} = 4.5\text{ V}$                                                 | $I_{OL} = 12\text{ mA}$  |              | 0.25             | 0.4  | V             |
|            |                           |                                                                         | $I_{OL} = 24\text{ mA}$  |              | 0.35             | 0.5  |               |
|            |                           |                                                                         |                          |              |                  |      |               |
| $I_I$      | Control inputs            | $V_{CC} = 5.5\text{ V}$ ,<br>$V_I = 7\text{ V}$                         |                          |              |                  | 0.1  | mA            |
|            | A or B ports              | $V_{CC} = 5.5\text{ V}$ ,<br>$V_I = 5.5\text{ V}$                       |                          |              |                  | 0.1  |               |
| $I_{IH}$   | Control inputs            | $V_{CC} = 5.5\text{ V}$ ,<br>$V_I = 2.7\text{ V}$                       |                          |              |                  | 20   | $\mu\text{A}$ |
|            | A or B ports <sup>‡</sup> |                                                                         |                          |              |                  | 20   |               |
| $I_{IL}$   | Control inputs            | $V_{CC} = 5.5\text{ V}$ ,<br>$V_I = 0.4\text{ V}$                       |                          |              |                  | -0.2 | mA            |
|            | A or B ports <sup>‡</sup> |                                                                         |                          |              |                  | -0.2 |               |
| $I_{OH}$   | A ports                   | $V_{CC} = 4.5\text{ V}$ ,<br>$V_{OH} = 5.5\text{ V}$                    |                          |              |                  | 0.1  | mA            |
| $I_O^{\S}$ | B ports                   | $V_{CC} = 5.5\text{ V}$ ,<br>$V_O = 2.25\text{ V}$                      |                          | -30          |                  | -112 | mA            |
| $I_{CC}$   |                           | $V_{CC} = 5.5\text{ V}$                                                 | Outputs high             |              | 47               | 76   | mA            |
|            |                           |                                                                         | Outputs low              |              | 55               | 88   |               |
|            |                           |                                                                         | Outputs disabled         |              | 55               | 88   |               |

<sup>†</sup> All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

<sup>‡</sup> For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

<sup>§</sup> The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current,  $I_{OS}$ .

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switching characteristics (see Figure 2)

| PARAMETER        | FROM<br>(INPUT)                   | TO<br>(OUTPUT) | V <sub>CC</sub> = 4.5 V to 5.5 V,<br>C <sub>L</sub> = 50 pF,<br>R <sub>L</sub> = 680 Ω (A outputs),<br>R1 = R2 = 500 Ω (B outputs),<br>T <sub>A</sub> = MIN to MAX <sup>†</sup> |     |            |     | UNIT |
|------------------|-----------------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------|-----|------|
|                  |                                   |                | SN54ALS653                                                                                                                                                                      |     | SN74ALS653 |     |      |
|                  |                                   |                | MIN                                                                                                                                                                             | MAX | MIN        | MAX |      |
| f <sub>max</sub> |                                   |                | 25                                                                                                                                                                              |     | 35         |     | MHz  |
| t <sub>PLH</sub> | CLKBA                             | A              | 16                                                                                                                                                                              | 71  | 16         | 64  | ns   |
| t <sub>PHL</sub> |                                   |                | 6                                                                                                                                                                               | 24  | 6          | 22  |      |
| t <sub>PLH</sub> | CLKAB                             | B              | 10                                                                                                                                                                              | 35  | 10         | 30  | ns   |
| t <sub>PHL</sub> |                                   |                | 5                                                                                                                                                                               | 20  | 5          | 17  |      |
| t <sub>PLH</sub> | A                                 | B              | 5                                                                                                                                                                               | 20  | 5          | 18  | ns   |
| t <sub>PHL</sub> |                                   |                | 1.5                                                                                                                                                                             | 18  | 2          | 15  |      |
| t <sub>PLH</sub> | B                                 | A              | 8                                                                                                                                                                               | 63  | 12         | 56  | ns   |
| t <sub>PHL</sub> |                                   |                | 2                                                                                                                                                                               | 18  | 2          | 15  |      |
| t <sub>PLH</sub> | SBA <sup>‡</sup><br>(with B high) | A              | 12                                                                                                                                                                              | 68  | 19         | 62  | ns   |
| t <sub>PHL</sub> |                                   |                | 5                                                                                                                                                                               | 27  | 5          | 25  |      |
| t <sub>PLH</sub> | SBA <sup>‡</sup><br>(with B low)  | A              | 12                                                                                                                                                                              | 68  | 19         | 62  | ns   |
| t <sub>PHL</sub> |                                   |                | 5                                                                                                                                                                               | 27  | 5          | 25  |      |
| t <sub>PLH</sub> | SAB <sup>‡</sup><br>(with A high) | B              | 8                                                                                                                                                                               | 30  | 15         | 35  | ns   |
| t <sub>PHL</sub> |                                   |                | 6                                                                                                                                                                               | 25  | 6          | 22  |      |
| t <sub>PLH</sub> | SAB <sup>‡</sup><br>(with A low)  | B              | 12                                                                                                                                                                              | 40  | 8          | 25  | ns   |
| t <sub>PHL</sub> |                                   |                | 6                                                                                                                                                                               | 25  | 6          | 22  |      |
| t <sub>PLH</sub> | $\overline{\text{OEBA}}$          | A              | 6                                                                                                                                                                               | 35  | 6          | 30  | ns   |
| t <sub>PHL</sub> |                                   |                | 6                                                                                                                                                                               | 27  | 6          | 24  |      |
| t <sub>PZH</sub> | OEAB                              | B              | 7                                                                                                                                                                               | 25  | 8          | 22  | ns   |
| t <sub>PZL</sub> |                                   |                | 6                                                                                                                                                                               | 25  | 6          | 22  |      |
| t <sub>PHZ</sub> | OEAB                              | B              | 1                                                                                                                                                                               | 16  | 1          | 14  | ns   |
| t <sub>PLZ</sub> |                                   |                | 2                                                                                                                                                                               | 21  | 2          | 16  |      |

<sup>†</sup> For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

<sup>‡</sup> These parameters are measured with the internal output state of the storage register opposite that of the bus input.

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**switching characteristics (see Figure 2)**

| PARAMETER        | FROM<br>(INPUT)                   | TO<br>(OUTPUT) | V <sub>CC</sub> = 4.5 V to 5.5 V,<br>C <sub>L</sub> = 50 pF,<br>R <sub>L</sub> = 680 Ω (A outputs),<br>R1 = R2 = 500 Ω (B outputs),<br>T <sub>A</sub> = MIN to MAX <sup>†</sup> |     | UNIT |
|------------------|-----------------------------------|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------|
|                  |                                   |                | SN74ALS654                                                                                                                                                                      |     |      |
|                  |                                   |                | MIN                                                                                                                                                                             | MAX |      |
| f <sub>max</sub> |                                   |                | 35                                                                                                                                                                              |     | MHz  |
| t <sub>PLH</sub> | CLKBA                             | A              | 16                                                                                                                                                                              | 64  | ns   |
| t <sub>PHL</sub> |                                   |                | 6                                                                                                                                                                               | 22  |      |
| t <sub>PLH</sub> | CLKAB                             | B              | 10                                                                                                                                                                              | 30  | ns   |
| t <sub>PHL</sub> |                                   |                | 5                                                                                                                                                                               | 17  |      |
| t <sub>PLH</sub> | A                                 | B              | 5                                                                                                                                                                               | 18  | ns   |
| t <sub>PHL</sub> |                                   |                | 2                                                                                                                                                                               | 15  |      |
| t <sub>PLH</sub> | B                                 | A              | 12                                                                                                                                                                              | 56  | ns   |
| t <sub>PHL</sub> |                                   |                | 2                                                                                                                                                                               | 21  |      |
| t <sub>PLH</sub> | SBA <sup>‡</sup><br>(with B low)  | A              | 19                                                                                                                                                                              | 62  | ns   |
| t <sub>PHL</sub> |                                   |                | 5                                                                                                                                                                               | 25  |      |
| t <sub>PLH</sub> | SBA <sup>‡</sup><br>(with B high) | A              | 19                                                                                                                                                                              | 62  | ns   |
| t <sub>PHL</sub> |                                   |                | 5                                                                                                                                                                               | 25  |      |
| t <sub>PLH</sub> | SAB <sup>‡</sup><br>(with A low)  | B              | 15                                                                                                                                                                              | 35  | ns   |
| t <sub>PHL</sub> |                                   |                | 6                                                                                                                                                                               | 22  |      |
| t <sub>PLH</sub> | SAB <sup>‡</sup><br>(with A high) | B              | 8                                                                                                                                                                               | 25  | ns   |
| t <sub>PHL</sub> |                                   |                | 6                                                                                                                                                                               | 22  |      |
| t <sub>PLH</sub> | $\overline{\text{OEBA}}$          | A              | 6                                                                                                                                                                               | 30  | ns   |
| t <sub>PHL</sub> |                                   |                | 6                                                                                                                                                                               | 24  |      |
| t <sub>PZH</sub> | OEAB                              | B              | 6                                                                                                                                                                               | 22  | ns   |
| t <sub>PZL</sub> |                                   |                | 6                                                                                                                                                                               | 22  |      |
| t <sub>PHZ</sub> | OEAB                              | B              | 1                                                                                                                                                                               | 14  | ns   |
| t <sub>PLZ</sub> |                                   |                | 2                                                                                                                                                                               | 16  |      |

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

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



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**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>**

|                                                                   |                 |
|-------------------------------------------------------------------|-----------------|
| Supply voltage range, $V_{CC}$                                    | –0.5 V to 7 V   |
| Input voltage range, $V_I$ : Control inputs                       | –0.5 V to 7 V   |
| I/O ports                                                         | –0.5 V to 5.5 V |
| Package thermal impedance, $\theta_{JA}$ (see Note 1): DW package | 46°C/W          |
| NT package                                                        | 67°C/W          |
| Storage temperature range, $T_{stg}$                              | –65°C to 150°C  |

<sup>†</sup> 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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51.

**recommended operating conditions**

|             |                                                        |                     | SN54AS651<br>SN54AS652 |     |     | SN74AS651<br>SN74AS652 |     |     | 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                               |                     | 2                      |     |     | 2                      |     |     | V    |
| $V_{IL}$    | Low-level input voltage                                |                     |                        |     | 0.8 |                        |     | 0.8 | V    |
| $I_{OH}$    | High-level output current                              |                     |                        |     | –12 |                        |     | –15 | mA   |
| $I_{OL}$    | Low-level output current                               |                     |                        |     | 32  |                        |     | 48  | mA   |
| $f_{clock}$ | Clock frequency                                        |                     | 0*                     |     | 75* | 0                      |     | 90  | MHz  |
| $t_w$       | Pulse duration                                         | CLKBA or CLKAB high | 6*                     |     |     | 5                      |     |     | ns   |
|             |                                                        | CLKBA or CLKAB low  | 7*                     |     |     | 6                      |     |     |      |
| $t_{su}$    | Setup time before CLKAB $\uparrow$ or CLKBA $\uparrow$ | A or B              | 7*                     |     |     | 6                      |     |     | ns   |
| $t_h$       | Hold time after CLKAB $\uparrow$ or CLKBA              | A or B              | 0*                     |     |     | 0                      |     |     | ns   |
| $T_A$       | Operating free-air temperature                         |                     | –55                    |     | 125 | 0                      |     | 70  | °C   |

\* On products compliant to MIL-PRF-38535, this parameter is based on characterized data but is not production tested.



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

| PARAMETER                   |                | TEST CONDITIONS                                           |                          | SN54AS651<br>SN54AS652 |       | SN74AS651<br>SN74AS652 |     | UNIT |
|-----------------------------|----------------|-----------------------------------------------------------|--------------------------|------------------------|-------|------------------------|-----|------|
|                             |                |                                                           |                          | MIN                    | TYP†  | MAX                    | MIN |      |
| V <sub>IK</sub>             |                | V <sub>CC</sub> = 4.5 V, I <sub>I</sub> = −18 mA          |                          | −1.2                   |       | −1.2                   |     | V    |
| V <sub>OH</sub>             |                | V <sub>CC</sub> = 4.5 V to 5.5 V, I <sub>OH</sub> = −2 mA |                          | V <sub>CC</sub> − 2    |       | V <sub>CC</sub> − 2    |     | V    |
|                             |                | V <sub>CC</sub> = 4.5 V                                   | I <sub>OH</sub> = −3 mA  | 2.4                    | 3.2   | 2.4                    | 3.2 |      |
|                             |                |                                                           | I <sub>OH</sub> = −12 mA | 2                      |       |                        |     |      |
|                             |                |                                                           | I <sub>OH</sub> = −15 mA |                        |       | 2                      |     |      |
| V <sub>OL</sub>             |                | V <sub>CC</sub> = 4.5 V                                   | I <sub>OL</sub> = 32 mA  | 0.25                   | 0.5   |                        |     | V    |
|                             |                |                                                           | I <sub>OL</sub> = 48 mA  |                        |       | 0.35                   | 0.5 |      |
| I <sub>I</sub>              | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 7 V             | 0.1                      |                        | 0.1   |                        | mA  |      |
|                             | A or B ports   | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 5.5 V           | 0.1                      |                        | 0.1   |                        |     |      |
| I <sub>IH</sub>             | Control inputs | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 2.7 V           | 20                       |                        | 20    |                        | μA  |      |
|                             | A or B ports‡  |                                                           | 70                       |                        | 70    |                        |     |      |
| I <sub>IL</sub>             | Control input  | V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0.4 V           | −0.5                     |                        | −0.5  |                        | mA  |      |
|                             | A or B ports‡  |                                                           | −0.75                    |                        | −0.75 |                        |     |      |
| I <sub>O</sub> <sup>§</sup> |                | V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.25 V          | −30                      | −112                   | −30   | −112                   | mA  |      |
| I <sub>CC</sub>             | ‘AS651         | V <sub>CC</sub> = 5.5 V                                   | Outputs high             | 110                    | 185   | 110                    | 185 | mA   |
|                             |                |                                                           | Outputs low              | 120                    | 195   | 120                    | 195 |      |
|                             |                |                                                           | Outputs disabled         | 130                    | 195   | 130                    | 195 |      |
|                             | ‘AS652         | V <sub>CC</sub> = 5.5 V                                   | Outputs high             | 120                    | 195   | 120                    | 195 |      |
|                             |                |                                                           | Outputs low              | 130                    | 211   | 130                    | 211 |      |
|                             |                |                                                           | Outputs disabled         | 130                    | 211   | 130                    | 211 |      |

<sup>†</sup> All typical values are at  $V_{CC} = 5\text{ V}$ ,  $T_A = 25\text{ }^{\circ}\text{C}$ .

<sup>‡</sup> For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

<sup>§</sup> The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current,  $I_{OS}$ .

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switching characteristics (see Figure 2)

| PARAMETER        | FROM<br>(INPUT)          | TO<br>(OUTPUT) | V <sub>CC</sub> = 4.5 V to 5.5 V,<br>C <sub>L</sub> = 50 pF,<br>R1 = 500 Ω,<br>R2 = 500 Ω,<br>T <sub>A</sub> = MIN to MAX† |     |           |     | UNIT |
|------------------|--------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------|-----|-----------|-----|------|
|                  |                          |                | SN54AS651                                                                                                                  |     | SN74AS651 |     |      |
|                  |                          |                | MIN                                                                                                                        | MAX | MIN       | MAX |      |
| f <sub>max</sub> |                          |                | 75*                                                                                                                        |     | 90        |     | MHz  |
| t <sub>PLH</sub> | CLKBA or CLKAB           | A or B         | 2                                                                                                                          | 11  | 2         | 8.5 | ns   |
| t <sub>PHL</sub> |                          |                | 2                                                                                                                          | 10  | 2         | 9   |      |
| t <sub>PLH</sub> | A or B                   | B or A         | 2                                                                                                                          | 12  | 2         | 8   | ns   |
| t <sub>PHL</sub> |                          |                | 1                                                                                                                          | 8   | 1         | 7   |      |
| t <sub>PLH</sub> | SBA or SAB‡              | A or B         | 2                                                                                                                          | 15  | 2         | 11  | ns   |
| t <sub>PHL</sub> |                          |                | 2                                                                                                                          | 11  | 2         | 9   |      |
| t <sub>PZH</sub> | $\overline{\text{OEBA}}$ | A              | 2                                                                                                                          | 11  | 2         | 10  | ns   |
| t <sub>PZL</sub> |                          |                | 3                                                                                                                          | 18  | 3         | 16  |      |
| t <sub>PHZ</sub> | $\overline{\text{OEBA}}$ | A              | 2                                                                                                                          | 10  | 2         | 9   | ns   |
| t <sub>PLZ</sub> |                          |                | 2                                                                                                                          | 10  | 2         | 9   |      |
| t <sub>PZH</sub> | OEAB                     | B              | 3                                                                                                                          | 12  | 3         | 11  | ns   |
| t <sub>PZL</sub> |                          |                | 3                                                                                                                          | 20  | 3         | 16  |      |
| t <sub>PHZ</sub> | OEAB                     | B              | 2                                                                                                                          | 11  | 2         | 10  | ns   |
| t <sub>PLZ</sub> |                          |                | 2                                                                                                                          | 12  | 2         | 11  |      |

\* On products compliant to MIL-PRF-38535, this parameter is based on characterized data but is not production tested.

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

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

**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652**  
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**switching characteristics (see Figure 2)**

| PARAMETER        | FROM<br>(INPUT)          | TO<br>(OUTPUT) | V <sub>CC</sub> = 4.5 V TO 5.5 V,<br>C <sub>L</sub> = 50 PF,<br>R1 = 500 Ω,<br>R2 = 500 Ω,<br>T <sub>A</sub> = MIN TO MAX <sup>†</sup> |     |           |     | UNIT |
|------------------|--------------------------|----------------|----------------------------------------------------------------------------------------------------------------------------------------|-----|-----------|-----|------|
|                  |                          |                | SN54AS652                                                                                                                              |     | SN74AS652 |     |      |
|                  |                          |                | MIN                                                                                                                                    | MAX | TYP       | MAX |      |
| f <sub>max</sub> |                          |                | 75*                                                                                                                                    |     | 90        |     | MHz  |
| t <sub>PLH</sub> | CLKBA or CLKAB           | A or B         | 2                                                                                                                                      | 11  | 2         | 8.5 | ns   |
| t <sub>PHL</sub> |                          |                | 2                                                                                                                                      | 10  | 2         | 9   |      |
| t <sub>PLH</sub> | A or B                   | B or A         | 2                                                                                                                                      | 12  | 2         | 9   | ns   |
| t <sub>PHL</sub> |                          |                | 1                                                                                                                                      | 8   | 1         | 7   |      |
| t <sub>PLH</sub> | SBA or SAB <sup>‡</sup>  | A or B         | 2                                                                                                                                      | 15  | 2         | 11  | ns   |
| t <sub>PHL</sub> |                          |                | 2                                                                                                                                      | 11  | 2         | 9   |      |
| t <sub>PZH</sub> | $\overline{\text{OEBA}}$ | A              | 2                                                                                                                                      | 11  | 2         | 10  | ns   |
| t <sub>PZL</sub> |                          |                | 3                                                                                                                                      | 18  | 3         | 16  |      |
| t <sub>PHZ</sub> | $\overline{\text{OEBA}}$ | A              | 2                                                                                                                                      | 10  | 2         | 9   | ns   |
| t <sub>PLZ</sub> |                          |                | 2                                                                                                                                      | 10  | 2         | 9   |      |
| t <sub>PZH</sub> | OEAB                     | B              | 3                                                                                                                                      | 12  | 3         | 11  | ns   |
| t <sub>PZL</sub> |                          |                | 3                                                                                                                                      | 20  | 3         | 16  |      |
| t <sub>PHZ</sub> | OEAB                     | B              | 2                                                                                                                                      | 11  | 2         | 10  | ns   |
| t <sub>PLZ</sub> |                          |                | 2                                                                                                                                      | 12  | 2         | 11  |      |

\* On products compliant to MIL-PRF-38535, this parameter is based on characterized data but is not production tested.

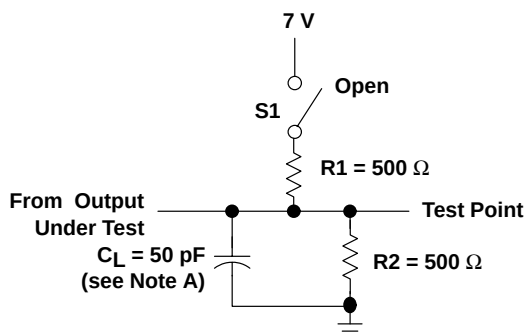
† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

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

# SN54ALS652, SN54ALS653, SN54AS651, SN54AS652 SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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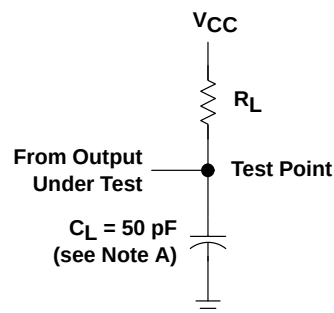
## PARAMETER MEASUREMENT INFORMATION



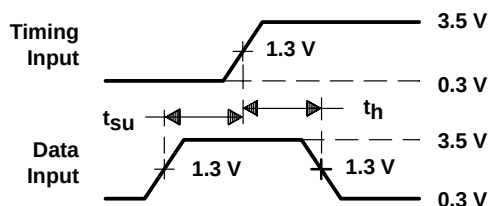
LOAD CIRCUIT  
FOR 3-STATE OUTPUTS

SWITCH POSITION TABLE

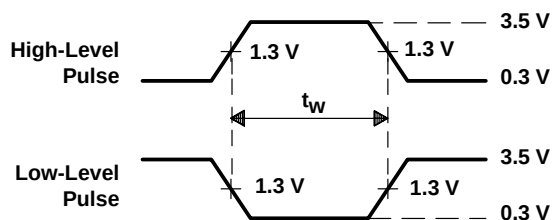
| TEST      | S1     |
|-----------|--------|
| $t_{PLH}$ | Open   |
| $t_{PHL}$ | Open   |
| $t_{PZH}$ | Open   |
| $t_{PZL}$ | Closed |
| $t_{PHZ}$ | Open   |
| $t_{PLZ}$ | Closed |



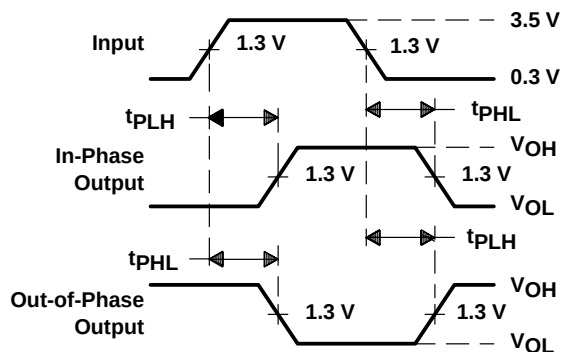
LOAD CIRCUIT  
FOR OPEN-COLLECTOR OUTPUTS



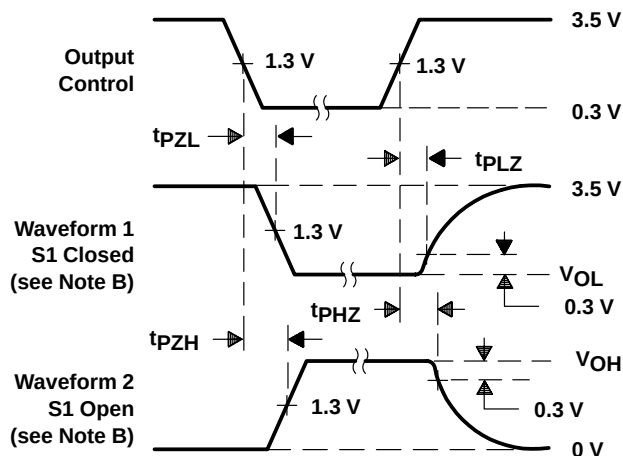
VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS

- 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:  $PRR \leq 1$  MHz,  $Z_0 = 50 \Omega$ ,  $t_r \leq 2$  ns,  $t_f \leq 2$  ns.  
D. The outputs are measured one at a time with one transition per measurement.

Figure 2. Load Circuits and Voltage Waveforms

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