

# 74AC11648 OCTAL BUS TRANSCEIVER AND REGISTER WITH 3-STATE OUTPUTS

SCAS114 – MARCH 1990 – REVISED APRIL 1993

- Independent Registers for A and B Buses
- Multiplexed Real-Time and Stored Data
- Inverting Data Paths
- Flow-Through Architecture Optimizes PCB Layout
- Center-Pin  $V_{CC}$  and GND Configurations Minimize High-Speed Switching Noise
- **EPIC™** (Enhanced-Performance Implanted CMOS) 1- $\mu$ m Process
- 500-mA Typical Latch-Up Immunity at 125°C
- Package Options Include Plastic Small-Outline Packages and Standard Plastic 300-mil DIPs

## description

The 74AC11648 consists of bus transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal registers. Data on the A or B bus is clocked into the registers on the low-to-high transition of the appropriate clock (CLKAB or CLKBA) input. Figure 1 illustrates the four fundamental bus-management functions that can be performed with the 74AC11648.

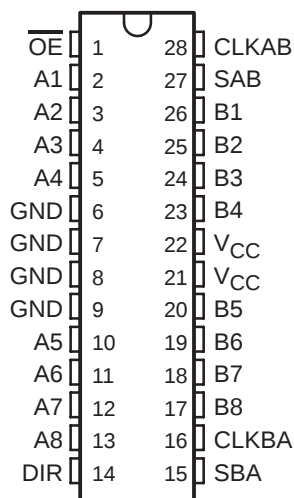
Output-enable ( $\overline{OE}$ ) and direction-control (DIR) inputs are provided to control the transceiver functions. In the transceiver mode, data present at the high-impedance port may be stored in either register or in both.

The select-control (SAB and SBA) inputs can multiplex stored and real-time (transparent mode) data. The direction control (DIR) determines which bus will receive data when  $\overline{OE}$  is low. In the isolation mode ( $\overline{OE}$  high), A data may be stored in one register and/or B data may be stored in the other register.

When an output function is disabled, the input function is still enabled and may be used to store and transmit data. Only one of the two buses, A or B, may be driven at a time.

The 74AC11648 is characterized for operation from –40°C to 85°C.

DW OR NT PACKAGE  
(TOP VIEW)



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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.



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# 74AC11648

## OCTAL BUS TRANSCEIVER AND REGISTER WITH 3-STATE OUTPUTS

SCAS114 – MARCH 1990 – REVISED APRIL 1993

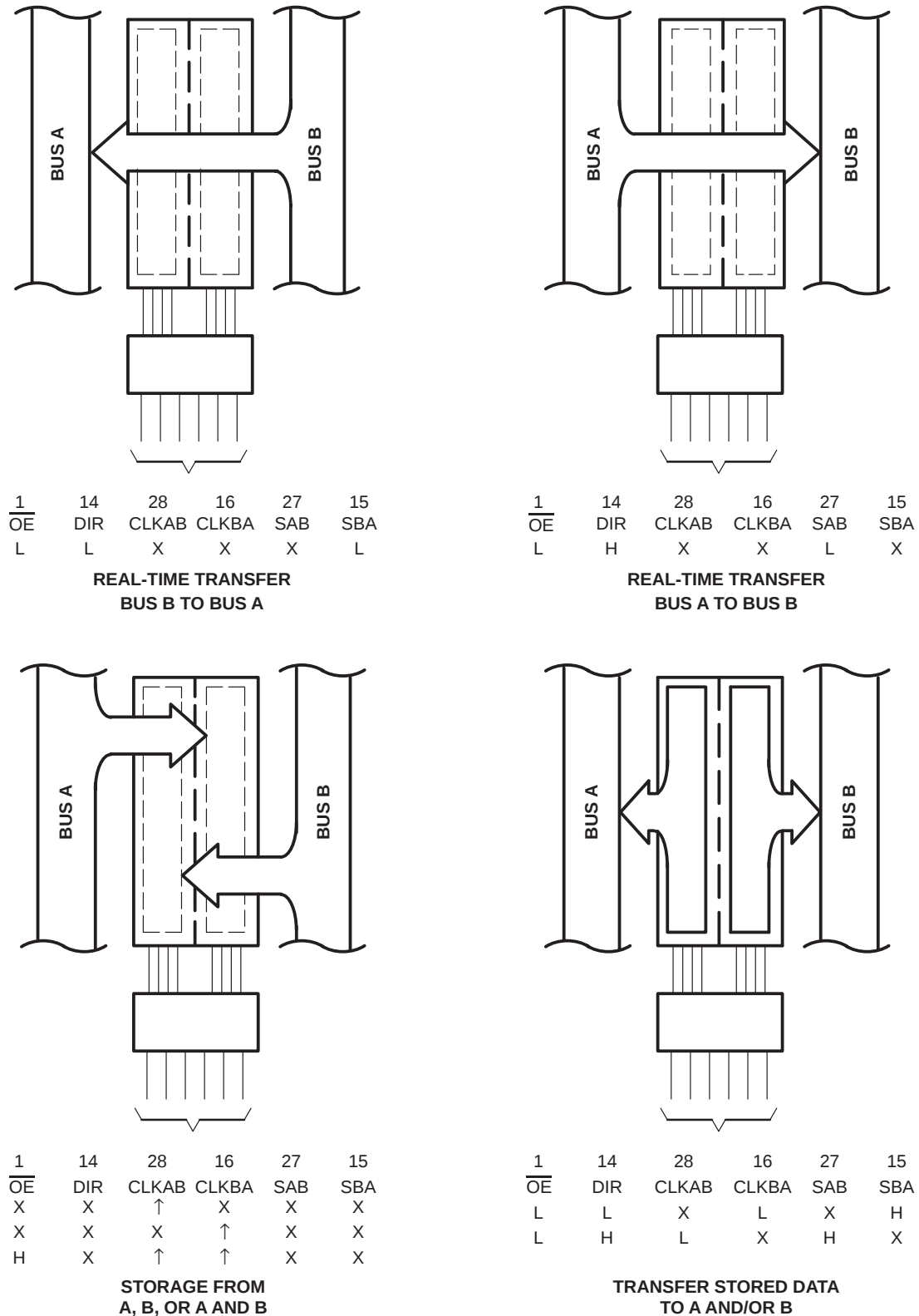


Figure 1. Bus-Management Functions

74AC11648

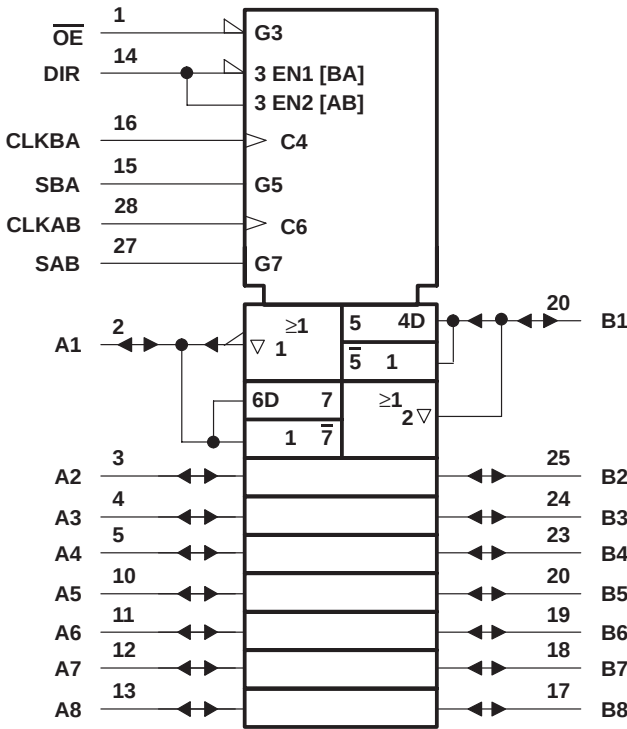
OCTAL BUS TRANSCEIVER AND REGISTER  
WITH 3-STATE OUTPUTS

SCAS114 – MARCH 1990 – REVISED APRIL 1993

| FUNCTION TABLE  |     |            |            |     |     |                          |                          |                                        |
|-----------------|-----|------------|------------|-----|-----|--------------------------|--------------------------|----------------------------------------|
| INPUTS          |     |            |            |     |     | DATA I/O                 |                          | OPERATION OR FUNCTION                  |
| $\overline{OE}$ | DIR | CLKAB      | CLKBA      | SAB | SBA | A1 THRU A8               | B1 THRU B8               |                                        |
| X               | X   | $\uparrow$ | X          | X   | X   | Input                    | Unspecified <sup>†</sup> | Store A, B unspecified <sup>†</sup>    |
| X               | X   | X          | $\uparrow$ | X   | X   | Unspecified <sup>†</sup> | Input                    | Store B, A unspecified <sup>†</sup>    |
| H               | X   | $\uparrow$ | $\uparrow$ | X   | X   | Input                    | Input                    | Store A and B data                     |
| H               | X   | L          | L          | X   | X   | Input disabled           | Input disabled           | Isolation, hold storage                |
| L               | L   | X          | X          | X   | L   | Output                   | Input                    | Real-time $\overline{B}$ data to A bus |
| L               | L   | X          | L          | X   | H   | Output                   | Input                    | Stored $\overline{B}$ data to A bus    |
| L               | H   | X          | X          | L   | X   | Input                    | Output                   | Real-time $\overline{A}$ data to B bus |
| L               | H   | L          | X          | H   | X   | Input                    | Output                   | Stored $\overline{A}$ data to B bus    |

<sup>†</sup> The data output functions may be enabled or disabled by various signals at the  $\overline{OE}$  and DIR inputs. Data input functions are always enabled; i.e., data at the bus pins will be stored on every low-to-high transition of the clock inputs.

logic symbol<sup>‡</sup>



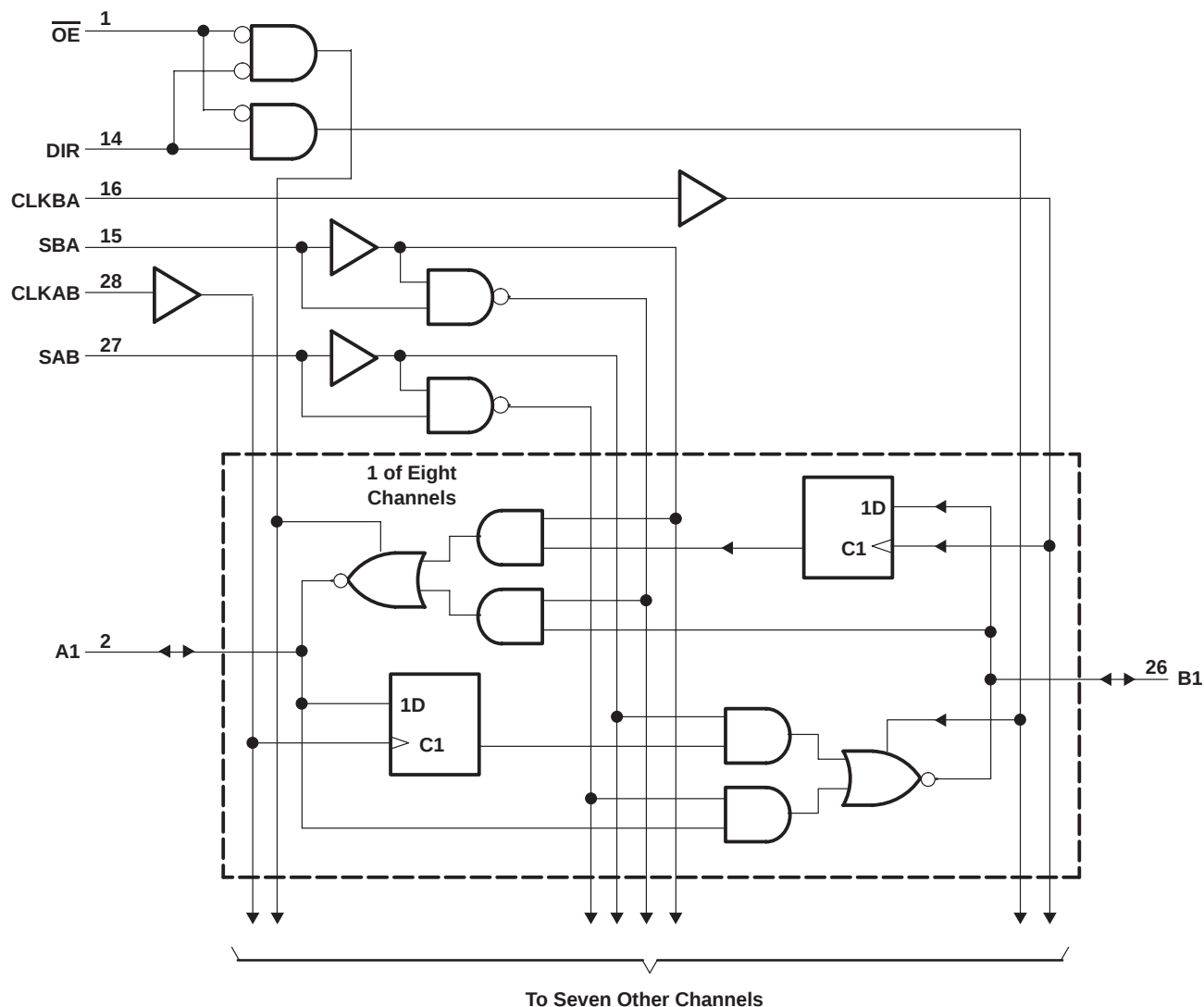
<sup>‡</sup> This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

# 74AC11648

## OCTAL BUS TRANSCEIVER AND REGISTER WITH 3-STATE OUTPUTS

SCAS114 – MARCH 1990 – REVISED APRIL 1993

### logic diagram (positive logic)



### 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, $V_I$ (see Note 1)                        | –0.5 V to $V_{CC} + 0.5$ V |
| Output voltage range, $V_O$ (see Note 1)                       | –0.5 V to $V_{CC} + 0.5$ V |
| Input clamp current, $I_{IK}$ ( $V_I < 0$ or $V_I > V_{CC}$ )  | ±20 mA                     |
| Output clamp current, $I_{OK}$ ( $V_O < 0$ or $V_O > V_{CC}$ ) | ±50 mA                     |
| Continuous output current, $I_O$ ( $V_O = 0$ to $V_{CC}$ )     | ±50 mA                     |
| Continuous current through $V_{CC}$ or GND                     | ±200 mA                    |
| Storage temperature range                                      | –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 input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

**74AC11648**  
**OCTAL BUS TRANSCEIVER AND REGISTER**  
**WITH 3-STATE OUTPUTS**

SCAS114 – MARCH 1990 – REVISED APRIL 1993

**recommended operating conditions**

|                     |                                    | MIN                     | NOM  | MAX      | UNIT |
|---------------------|------------------------------------|-------------------------|------|----------|------|
| $V_{CC}$            | Supply voltage                     | 3                       | 5    | 5.5      | V    |
| $V_{IH}$            | High-level input voltage           | $V_{CC} = 3\text{ V}$   | 2.1  |          | V    |
|                     |                                    | $V_{CC} = 4.5\text{ V}$ | 3.15 |          |      |
|                     |                                    | $V_{CC} = 5.5\text{ V}$ | 3.85 |          |      |
| $V_{IL}$            | Low-level input voltage            | $V_{CC} = 3\text{ V}$   |      | 0.9      | V    |
|                     |                                    | $V_{CC} = 4.5\text{ V}$ |      | 1.35     |      |
|                     |                                    | $V_{CC} = 5.5\text{ V}$ |      | 1.65     |      |
| $V_I$               | Input voltage                      | 0                       |      | $V_{CC}$ | V    |
| $V_O$               | Output voltage                     | 0                       |      | $V_{CC}$ | V    |
| $I_{OH}$            | High-level output current          | $V_{CC} = 3\text{ V}$   |      | -4       | mA   |
|                     |                                    | $V_{CC} = 4.5\text{ V}$ |      | -24      |      |
|                     |                                    | $V_{CC} = 5.5\text{ V}$ |      | -24      |      |
| $I_{OL}$            | Low-level output current           | $V_{CC} = 3\text{ V}$   |      | 12       | mA   |
|                     |                                    | $V_{CC} = 4.5\text{ V}$ |      | 24       |      |
|                     |                                    | $V_{CC} = 5.5\text{ V}$ |      | 24       |      |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | 0                       |      | 10       | ns/V |
| $T_A$               | Operating free-air temperature     | -40                     |      | 85       | °C   |

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

| PARAMETER         | TEST CONDITIONS                   | $V_{CC}$                         | $T_A = 25^\circ\text{C}$ |     |           | MIN  | MAX     | UNIT          |
|-------------------|-----------------------------------|----------------------------------|--------------------------|-----|-----------|------|---------|---------------|
|                   |                                   |                                  | MIN                      | TYP | MAX       |      |         |               |
| $V_{OH}$          | $I_{OH} = -50\text{ }\mu\text{A}$ | 3 V                              | 2.9                      |     |           | 2.9  |         | V             |
|                   |                                   | 4.5 V                            | 4.4                      |     |           | 4.4  |         |               |
|                   |                                   | 5.5 V                            | 5.4                      |     |           | 5.4  |         |               |
|                   | $I_{OH} = -4\text{ mA}$           | 3 V                              | 2.58                     |     |           | 2.48 |         |               |
|                   |                                   | 4.5 V                            | 3.94                     |     |           | 3.8  |         |               |
|                   |                                   | 5.5 V                            | 4.94                     |     |           | 4.8  |         |               |
|                   | $I_{OH} = -75\text{ mA}^\dagger$  | 5.5 V                            |                          |     |           | 3.85 |         |               |
| $V_{OL}$          | $I_{OL} = 50\text{ }\mu\text{A}$  | 3 V                              |                          |     | 0.1       |      | 0.1     | V             |
|                   |                                   | 4.5 V                            |                          |     | 0.1       |      | 0.1     |               |
|                   |                                   | 5.5 V                            |                          |     | 0.1       |      | 0.1     |               |
|                   | $I_{OL} = 12\text{ mA}$           | 3 V                              |                          |     | 0.36      |      | 0.44    |               |
|                   |                                   | 4.5 V                            |                          |     | 0.36      |      | 0.44    |               |
|                   |                                   | 5.5 V                            |                          |     | 0.36      |      | 0.44    |               |
|                   | $I_{OL} = 75\text{ mA}^\dagger$   | 5.5 V                            |                          |     |           |      | 1.65    |               |
| $I_I$             | Control inputs                    | $V_I = V_{CC}$ or GND            | 5.5 V                    |     | $\pm 0.1$ |      | $\pm 1$ | $\mu\text{A}$ |
| $I_{OZ}^\ddagger$ | A or B ports                      | $V_O = V_{CC}$ or GND            | 5.5 V                    |     | $\pm 0.5$ |      | $\pm 5$ | $\mu\text{A}$ |
| $I_{CC}$          |                                   | $V_I = V_{CC}$ or GND, $I_O = 0$ | 5.5 V                    |     | 8         |      | 80      | $\mu\text{A}$ |
| $C_i$             | Control inputs                    | $V_I = V_{CC}$ or GND            | 5 V                      | 4.5 |           |      |         | pF            |
| $C_{io}$          | A or B ports                      | $V_O = V_{CC}$ or GND            | 5 V                      | 12  |           |      |         | pF            |

<sup>†</sup> Not more than one input should be tested at a time, and the duration of the test should not exceed 10 ms.

<sup>‡</sup> For I/O ports, the parameter  $I_{OZ}$  includes the input leakage current.



# 74AC11648

## OCTAL BUS TRANSCEIVER AND REGISTER WITH 3-STATE OUTPUTS

SCAS114 – MARCH 1990 – REVISED APRIL 1993

timing requirements over recommended operating free-air temperature range,  $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$  (unless otherwise noted) (see Figure 2)

|                    |                                                                | $T_A = 25^\circ\text{C}$ |     | MIN  | MAX | UNIT |
|--------------------|----------------------------------------------------------------|--------------------------|-----|------|-----|------|
|                    |                                                                | MIN                      | MAX |      |     |      |
| $f_{\text{clock}}$ | Clock frequency                                                | 0                        | 40  | 0    | 40  | MHz  |
| $t_W$              | Pulse duration, CLK high or low                                | 12.5                     |     | 12.5 |     | ns   |
| $t_{\text{su}}$    | Setup time, A or B before CLKAB $\uparrow$ or CLKBA $\uparrow$ | 6.5                      |     | 6.5  |     | ns   |
| $t_h$              | Hold time, A or B after CLKAB $\uparrow$ or CLKBA $\uparrow$   | 0                        |     | 0    |     | ns   |

timing requirements over recommended operating free-air temperature range,  $V_{CC} = 5 \text{ V} \pm 0.5 \text{ V}$  (unless otherwise noted) (see Figure 2)

|                    |                                                                | $T_A = 25^\circ\text{C}$ |     | MIN | MAX | UNIT |
|--------------------|----------------------------------------------------------------|--------------------------|-----|-----|-----|------|
|                    |                                                                | MIN                      | MAX |     |     |      |
| $f_{\text{clock}}$ | Clock frequency                                                | 0                        | 90  | 0   | 90  | MHz  |
| $t_W$              | Pulse duration, CLK high or low                                | 5.6                      |     | 5.6 |     | ns   |
| $t_{\text{su}}$    | Setup time, A or B before CLKAB $\uparrow$ or CLKBA $\uparrow$ | 4.5                      |     | 4.5 |     | ns   |
| $t_h$              | Hold time, A or B after CLKAB $\uparrow$ or CLKBA $\uparrow$   | 1                        |     | 1   |     | ns   |

switching characteristics over recommended operating free-air temperature range,  $V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$  (unless otherwise noted) (see Figure 2)

| PARAMETER        | FROM<br>(INPUT)                        | TO<br>(OUTPUT) | $T_A = 25^\circ\text{C}$ |      |      | MIN | MAX  | UNIT |
|------------------|----------------------------------------|----------------|--------------------------|------|------|-----|------|------|
|                  |                                        |                | MIN                      | TYP  | MAX  |     |      |      |
| $f_{\text{max}}$ |                                        |                | 40                       |      |      | 40  |      | MHz  |
| $t_{\text{PLH}}$ | A or B                                 | B or A         | 3                        | 8.7  | 12.6 | 3   | 14.3 | ns   |
| $t_{\text{PHL}}$ |                                        |                | 3.8                      | 9.3  | 14.4 | 3.8 | 15.9 |      |
| $t_{\text{PZH}}$ | $\overline{\text{OE}}$                 | A or B         | 5                        | 11.1 | 17.2 | 5   | 19.4 | ns   |
| $t_{\text{PZL}}$ |                                        |                | 5.2                      | 12.8 | 20.5 | 5.2 | 23   |      |
| $t_{\text{PHZ}}$ | $\overline{\text{OE}}$                 | A or B         | 4.1                      | 7.2  | 9.9  | 4.1 | 10.6 | ns   |
| $t_{\text{PLZ}}$ |                                        |                | 3.7                      | 6.5  | 9.1  | 3.7 | 9.7  |      |
| $t_{\text{PLH}}$ | CLKBA or CLKAB                         | A or B         | 4.3                      | 10.1 | 15.6 | 4.3 | 17.6 | ns   |
| $t_{\text{PHL}}$ |                                        |                | 5.2                      | 11.5 | 17.6 | 5.2 | 19.4 |      |
| $t_{\text{PLH}}$ | SBA or SAB $\uparrow$<br>(A or B high) | A or B         | 3.7                      | 9.1  | 14.1 | 3.7 | 15.8 | ns   |
| $t_{\text{PHL}}$ |                                        |                | 4.5                      | 10.3 | 15.9 | 4.5 | 17.4 |      |
| $t_{\text{PLH}}$ | SBA or SAB $\uparrow$<br>(A or B low)  | A or B         | 3.2                      | 8.6  | 13.6 | 3.2 | 15.3 | ns   |
| $t_{\text{PHL}}$ |                                        |                | 4.6                      | 10.3 | 15.6 | 4.6 | 17.1 |      |
| $t_{\text{PZH}}$ | DIR                                    | A or B         | 4.9                      | 11.6 | 18.2 | 4.9 | 20.6 | ns   |
| $t_{\text{PZL}}$ |                                        |                | 5.2                      | 14.2 | 21.6 | 5.2 | 24.3 |      |
| $t_{\text{PHZ}}$ | DIR                                    | A or B         | 3.8                      | 7.1  | 10.1 | 3.8 | 10.9 | ns   |

$\dagger$  These parameters are measured with the internal output state of the storage register opposite to that of the bus input.

**74AC11648**  
**OCTAL BUS TRANSCEIVER AND REGISTER**  
**WITH 3-STATE OUTPUTS**

SCAS114 – MARCH 1990 – REVISED APRIL 1993

switching characteristics over recommended operating free-air temperature range,  
 $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$  (unless otherwise noted) (see Figure 2)

| PARAMETER        | FROM<br>(INPUT)                          | TO<br>(OUTPUT) | $T_A = 25^\circ\text{C}$ |     |      | MIN | MAX  | UNIT |
|------------------|------------------------------------------|----------------|--------------------------|-----|------|-----|------|------|
|                  |                                          |                | MIN                      | TYP | MAX  |     |      |      |
| $f_{\text{max}}$ |                                          |                | 90                       |     |      | 90  |      | MHz  |
| $t_{\text{PLH}}$ | A or B                                   | B or A         | 2.6                      | 5.6 | 8.3  | 2.6 | 9.5  | ns   |
| $t_{\text{PHL}}$ |                                          |                | 3.2                      | 6.4 | 9.4  | 3.2 | 10.6 |      |
| $t_{\text{PZH}}$ | $\overline{\text{OE}}$                   | A or B         | 4.2                      | 7.8 | 11.3 | 4.2 | 12.8 | ns   |
| $t_{\text{PZL}}$ |                                          |                | 4.1                      | 8.1 | 12   | 4.1 | 13.6 |      |
| $t_{\text{PHZ}}$ | $\overline{\text{OE}}$                   | A or B         | 3.8                      | 6.3 | 8.6  | 3.8 | 9.2  | ns   |
| $t_{\text{PLZ}}$ |                                          |                | 3.5                      | 5.7 | 7.8  | 3.5 | 8.4  |      |
| $t_{\text{PLH}}$ | CLKBA or CLKAB                           | A or B         | 3.6                      | 6.9 | 10   | 3.6 | 11.4 | ns   |
| $t_{\text{PHL}}$ |                                          |                | 4.3                      | 8   | 11.4 | 4.3 | 12.8 |      |
| $t_{\text{PLH}}$ | SBA or SAB <sup>†</sup><br>(A or B high) | A or B         | 3.1                      | 6.2 | 9.2  | 3.1 | 10.4 | ns   |
| $t_{\text{PHL}}$ |                                          |                | 3.8                      | 7.6 | 10.4 | 3.8 | 11.6 |      |
| $t_{\text{PLH}}$ | SBA or SAB <sup>†</sup><br>(A or B low)  | A or B         | 2.8                      | 6.1 | 8.9  | 2.8 | 10.1 | ns   |
| $t_{\text{PHL}}$ |                                          |                | 3.8                      | 7.3 | 10.4 | 3.8 | 11.6 |      |
| $t_{\text{PZH}}$ | DIR                                      | A or B         | 4                        | 8   | 11.9 | 4   | 13.4 | ns   |
| $t_{\text{PZL}}$ |                                          |                | 4.1                      | 8.4 | 12.7 | 4.1 | 14.4 |      |
| $t_{\text{PHZ}}$ | DIR                                      | A or B         | 3.5                      | 6.1 | 8.5  | 3.5 | 9.1  | ns   |
| $t_{\text{PLZ}}$ |                                          |                | 3.4                      | 5.9 | 7.8  | 3.4 | 8.4  |      |

operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER       |                                               | TEST CONDITIONS  |                                           | TYP | UNIT |
|-----------------|-----------------------------------------------|------------------|-------------------------------------------|-----|------|
| $C_{\text{pd}}$ | Power dissipation capacitance per transceiver | Outputs enabled  | $C_L = 50\text{ pF}$ , $f = 1\text{ MHz}$ | 66  | pF   |
|                 |                                               | Outputs disabled |                                           | 17  |      |



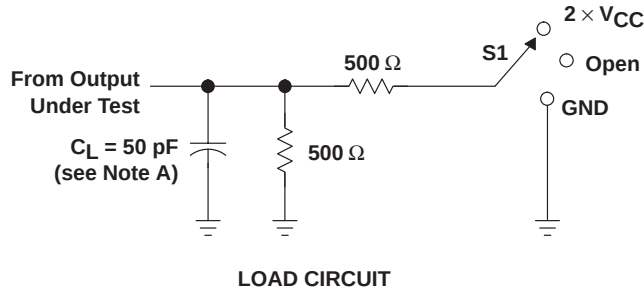
# 74AC11648

## OCTAL BUS TRANSCEIVER AND REGISTER

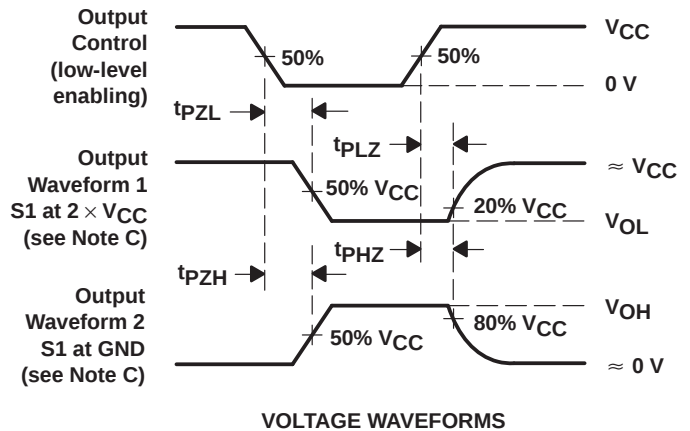
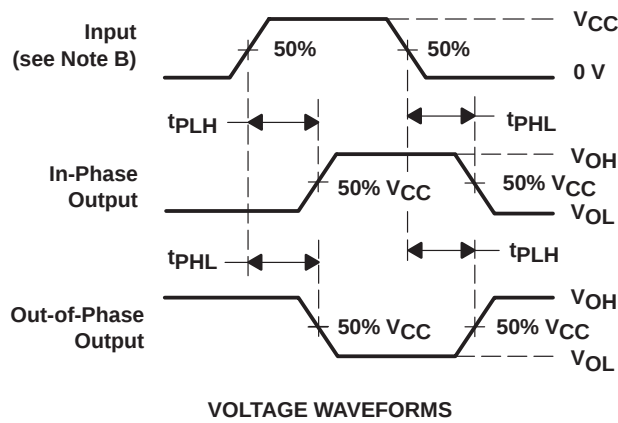
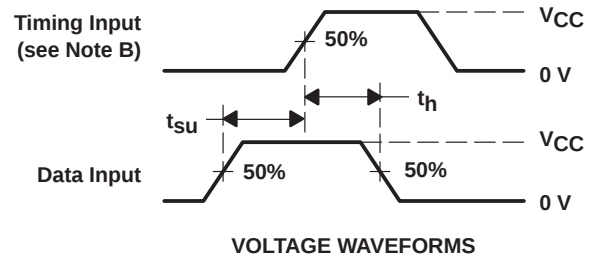
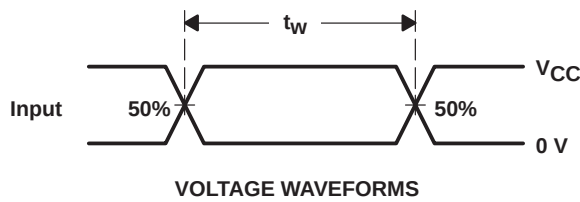
### WITH 3-STATE OUTPUTS

SCAS114 – MARCH 1990 – REVISED APRIL 1993

#### PARAMETER MEASUREMENT INFORMATION



| TEST              | S1                |
|-------------------|-------------------|
| $t_{PLH}/t_{PHL}$ | Open              |
| $t_{PLZ}/t_{PZL}$ | 2 $\times V_{CC}$ |
| $t_{PHZ}/t_{PZH}$ | GND               |



NOTES: A.  $C_L$  includes probe and jig capacitance.

B. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r = 3 \text{ ns}$ ,  $t_f = 3 \text{ ns}$ .

C. 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.

D. The outputs are measured one at a time with one input transition per measurement.

Figure 2. Load Circuit and Voltage Waveforms

## PACKAGING INFORMATION

| Orderable Device | Status <sup>(1)</sup> | Package Type | Package Drawing | Pins | Package Qty | Eco Plan <sup>(2)</sup> | Lead/Ball Finish | MSL Peak Temp <sup>(3)</sup> |
|------------------|-----------------------|--------------|-----------------|------|-------------|-------------------------|------------------|------------------------------|
| 74AC11648NT      | OBSOLETE              | PDIP         | NT              | 28   |             | TBD                     | Call TI          | Call TI                      |

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

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

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

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

**OBSOLETE:** TI has discontinued the production of the device.

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

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

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

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

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

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### Products

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| Amplifiers                  | <a href="http://amplifier.ti.com">amplifier.ti.com</a>             |
| Data Converters             | <a href="http://dataconverter.ti.com">dataconverter.ti.com</a>     |
| DLP® Products               | <a href="http://www.dlp.com">www.dlp.com</a>                       |
| DSP                         | <a href="http://dsp.ti.com">dsp.ti.com</a>                         |
| Clocks and Timers           | <a href="http://www.ti.com/clocks">www.ti.com/clocks</a>           |
| Interface                   | <a href="http://interface.ti.com">interface.ti.com</a>             |
| Logic                       | <a href="http://logic.ti.com">logic.ti.com</a>                     |
| Power Mgmt                  | <a href="http://power.ti.com">power.ti.com</a>                     |
| Microcontrollers            | <a href="http://microcontroller.ti.com">microcontroller.ti.com</a> |
| RFID                        | <a href="http://www.ti-rfid.com">www.ti-rfid.com</a>               |
| RF/IF and ZigBee® Solutions | <a href="http://www.ti.com/lprf">www.ti.com/lprf</a>               |

### Applications

|                            |                                                                                          |
|----------------------------|------------------------------------------------------------------------------------------|
| Audio                      | <a href="http://www.ti.com/audio">www.ti.com/audio</a>                                   |
| Automotive                 | <a href="http://www.ti.com/automotive">www.ti.com/automotive</a>                         |
| Communications and Telecom | <a href="http://www.ti.com/communications">www.ti.com/communications</a>                 |
| Computers and Peripherals  | <a href="http://www.ti.com/computers">www.ti.com/computers</a>                           |
| Consumer Electronics       | <a href="http://www.ti.com/consumer-apps">www.ti.com/consumer-apps</a>                   |
| Energy                     | <a href="http://www.ti.com/energy">www.ti.com/energy</a>                                 |
| Industrial                 | <a href="http://www.ti.com/industrial">www.ti.com/industrial</a>                         |
| Medical                    | <a href="http://www.ti.com/medical">www.ti.com/medical</a>                               |
| Security                   | <a href="http://www.ti.com/security">www.ti.com/security</a>                             |
| Space, Avionics & Defense  | <a href="http://www.ti.com/space-avionics-defense">www.ti.com/space-avionics-defense</a> |
| Video and Imaging          | <a href="http://www.ti.com/video">www.ti.com/video</a>                                   |
| Wireless                   | <a href="http://www.ti.com/wireless-apps">www.ti.com/wireless-apps</a>                   |