

# 54AC16472, 74AC16472 18-BIT REGISTERED TRANSCIEVERS WITH 3-STATE OUTPUTS

SCAS165A – JUNE 1990 – REVISED APRIL 1996

- Members of the Texas Instruments *Widebus*™ Family
- 3-State True Outputs
- Flow-Through Architecture Optimizes PCB Layout
- Distributed  $V_{CC}$  and GND Pin Configuration Minimizes 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 300-mil Shrink Small-Outline (DL) Package Using 25-mil Center-to-Center Pin Spacings and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Pin Spacings

## description

The 'AC16472 are 18-bit registered transceivers that contain two sets of D-type latches for temporary storage of data flowing in either direction. They can be used as two 9-bit transceivers or one 18-bit transceiver. Separate latch-enable ( $\overline{LEAB}$  or  $\overline{LEBA}$ ) and output-enable ( $\overline{OEAB}$  or  $\overline{OEBA}$ ) inputs are provided for each register to permit independent control in either direction of data flow.

When  $\overline{OEAB}$  and  $\overline{LEAB}$  are both low, the A-to-B latches are transparent; a subsequent low-to-high transition of  $\overline{LEAB}$  puts the A latches in the storage mode. With  $\overline{OEAB}$  low, the B outputs are active and reflect the data present at the output of the A latches. Data flow from B to A is similar, but requires the use of the  $\overline{LEBA}$  and  $\overline{OEBA}$  inputs.

The 74AC16472 is packaged in TI's shrink small-outline package (DL), which provides twice the I/O pin count and functionality of standard small-outline packages in the same printed-circuit-board area.

The 54AC16472 is characterized for operation over the full military temperature range of –55°C to 125°C. The 74AC16472 is characterized for operation from –40°C to 85°C.

54AC16472 . . . WD PACKAGE  
74AC16472 . . . DL PACKAGE  
(TOP VIEW)

|                    |    |    |                    |
|--------------------|----|----|--------------------|
| $\overline{1OEAB}$ | 1  | 56 | $\overline{1OEBA}$ |
| $\overline{1LEAB}$ | 2  | 55 | $\overline{1LEBA}$ |
| 1A1                | 3  | 54 | 1B1                |
| GND                | 4  | 53 | GND                |
| 1A2                | 5  | 52 | 1B2                |
| 1A3                | 6  | 51 | 1B3                |
| $V_{CC}$           | 7  | 50 | $V_{CC}$           |
| 1A4                | 8  | 49 | 1B4                |
| 1A5                | 9  | 48 | 1B5                |
| 1A6                | 10 | 47 | 1B6                |
| GND                | 11 | 46 | GND                |
| 1A7                | 12 | 45 | 1B7                |
| 1A8                | 13 | 44 | 1B8                |
| 1A9                | 14 | 43 | 1B9                |
| 2A1                | 15 | 42 | 2B1                |
| 2A2                | 16 | 41 | 2B2                |
| 2A3                | 17 | 40 | 2B3                |
| GND                | 18 | 39 | GND                |
| 2A4                | 19 | 38 | 2B4                |
| 2A5                | 20 | 37 | 2B5                |
| 2A6                | 21 | 36 | 2B6                |
| $V_{CC}$           | 22 | 35 | $V_{CC}$           |
| 2A7                | 23 | 34 | 2B7                |
| 2A8                | 24 | 33 | 2B8                |
| GND                | 25 | 32 | GND                |
| 2A9                | 26 | 31 | 2B9                |
| $\overline{2LEAB}$ | 27 | 30 | $\overline{2LEBA}$ |
| $\overline{2OEAB}$ | 28 | 29 | $\overline{2OEBA}$ |



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**TEXAS  
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# 54AC16472, 74AC16472

## 18-BIT REGISTERED TRANSCIEVERS

### WITH 3-STATE OUTPUTS

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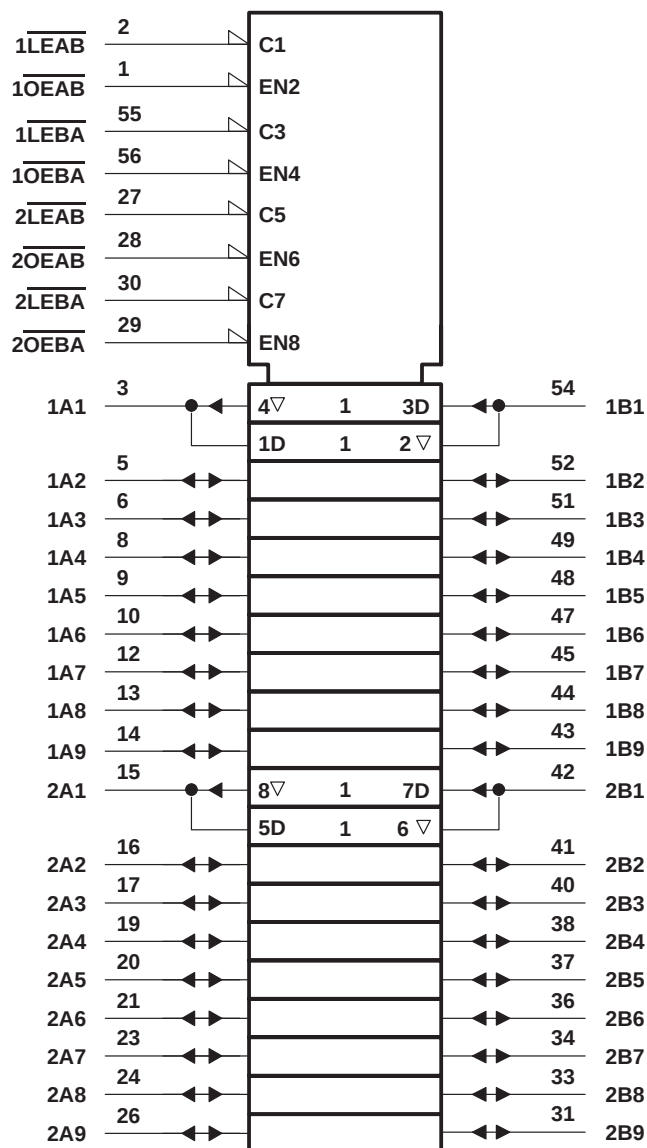
FUNCTION TABLE<sup>†</sup>

| INPUTS |      |   | OUTPUT<br>B                 |
|--------|------|---|-----------------------------|
| LEAB   | OEAB | A |                             |
| X      | H    | X | Z                           |
| H      | L    | X | B <sub>0</sub> <sup>‡</sup> |
| L      | L    | H | H                           |
| L      | L    | L | L                           |

<sup>†</sup> A-to-B data flow is shown: B-to-A flow is similar but uses  $\overline{\text{LEBA}}$  and  $\overline{\text{OEBA}}$ .

<sup>‡</sup> Output level before the indicated steady-state input conditions were established

### logic symbols<sup>§</sup>



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

## SCAS165A – JUNE 1990 – REVISED APRIL 1996



3

# 54AC16472, 74AC16472

## 18-BIT REGISTERED TRANSCIEVERS

### WITH 3-STATE OUTPUTS

SCAS165A – JUNE 1990 – REVISED APRIL 1996

#### 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                                                            | ±450 mA                    |
| Maximum power package dissipation at $T_A = 55^\circ\text{C}$ (in still air) (see Note 2): DL package | 1.4 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.

NOTES: 1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.  
2. The maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils.

#### recommended operating conditions (see Note 3)

|                 |                                    |                         | 54AC16472 |                 |     | 74AC16472 |                 |     | UNIT |
|-----------------|------------------------------------|-------------------------|-----------|-----------------|-----|-----------|-----------------|-----|------|
|                 |                                    |                         | MIN       | NOM             | MAX | MIN       | NOM             | MAX |      |
| V <sub>CC</sub> | Supply voltage                     |                         | 3         | 5               | 5.5 | 3         | 5               | 5.5 | V    |
| V <sub>IH</sub> | High-level input voltage           | V <sub>CC</sub> = 3 V   | 2.1       |                 |     | 2.1       |                 |     | V    |
|                 |                                    | V <sub>CC</sub> = 4.5 V | 3.15      |                 |     | 3.15      |                 |     |      |
|                 |                                    | V <sub>CC</sub> = 5.5 V | 3.85      |                 |     | 3.85      |                 |     |      |
| V <sub>IL</sub> | Low-level input voltage            | V <sub>CC</sub> = 3 V   | 0.9       |                 |     | 0.9       |                 |     | V    |
|                 |                                    | V <sub>CC</sub> = 4.5 V | 1.35      |                 |     | 1.35      |                 |     |      |
|                 |                                    | V <sub>CC</sub> = 5.5 V | 1.65      |                 |     | 1.65      |                 |     |      |
| V <sub>I</sub>  | Input voltage                      |                         | 0         | V <sub>CC</sub> |     | 0         | V <sub>CC</sub> |     | V    |
| V <sub>O</sub>  | Output voltage                     |                         | 0         | V <sub>CC</sub> |     | 0         | V <sub>CC</sub> |     | V    |
| I <sub>OH</sub> | High-level output current          | V <sub>CC</sub> = 3 V   | −4        |                 |     | −4        |                 |     | mA   |
|                 |                                    | V <sub>CC</sub> = 4.5 V | −24       |                 |     | −24       |                 |     |      |
|                 |                                    | V <sub>CC</sub> = 5.5 V | −24       |                 |     | −24       |                 |     |      |
| I <sub>OL</sub> | Low-level output current           | V <sub>CC</sub> = 3 V   | 12        |                 |     | 12        |                 |     | mA   |
|                 |                                    | V <sub>CC</sub> = 4.5 V | 24        |                 |     | 24        |                 |     |      |
|                 |                                    | V <sub>CC</sub> = 5.5 V | 24        |                 |     | 24        |                 |     |      |
| Δt/Δv           | Input transition rise or fall rate |                         | 0         | 10              |     | 0         | 10              |     | ns/V |
| T <sub>A</sub>  | Operating free-air temperature     |                         | −55       | 125             |     | −40       | 85              |     | °C   |

NOTE 3: Unused inputs must be held high or low to prevent them from floating.

**54AC16472, 74AC16472**  
**18-BIT REGISTERED TRANSCIEVERS**  
**WITH 3-STATE OUTPUTS**

SCAS165A – JUNE 1990 – REVISED APRIL 1996

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

| PARAMETER                    |                                      | TEST CONDITIONS                                             | V <sub>CC</sub> | T <sub>A</sub> = 25°C |     |      | 54AC16472 |     | 74AC16472 |     | UNIT |
|------------------------------|--------------------------------------|-------------------------------------------------------------|-----------------|-----------------------|-----|------|-----------|-----|-----------|-----|------|
|                              |                                      |                                                             |                 | MIN                   | TYP | MAX  | MIN       | MAX | MIN       | MAX |      |
| V <sub>OH</sub>              | I <sub>OH</sub> = –50 µA             |                                                             | 3 V             | 2.9                   |     |      | 2.9       |     | 2.9       |     | V    |
|                              |                                      |                                                             | 4.5 V           | 4.4                   |     |      | 4.4       |     | 4.4       |     |      |
|                              |                                      |                                                             | 5.5 V           | 5.4                   |     |      | 5.4       |     | 5.4       |     |      |
|                              | I <sub>OH</sub> = –4 mA              |                                                             | 3 V             | 2.58                  |     |      | 2.48      |     | 2.48      |     |      |
|                              |                                      |                                                             | 4.5 V           | 3.94                  |     |      | 3.8       |     | 3.8       |     |      |
|                              |                                      |                                                             | 5.5 V           | 4.94                  |     |      | 4.8       |     | 4.8       |     |      |
| V <sub>OL</sub>              | I <sub>OL</sub> = 50 µA              |                                                             | 3 V             |                       |     | 0.1  |           |     | 0.1       |     | V    |
|                              |                                      |                                                             | 4.5 V           |                       |     | 0.1  |           |     | 0.1       |     |      |
|                              |                                      |                                                             | 5.5 V           |                       |     | 0.1  |           |     | 0.1       |     |      |
|                              | I <sub>OL</sub> = 12 mA              |                                                             | 3 V             |                       |     | 0.36 |           |     | 0.44      |     |      |
|                              |                                      |                                                             | 4.5 V           |                       |     | 0.36 |           |     | 0.44      |     |      |
|                              |                                      |                                                             | 5.5 V           |                       |     | 0.36 |           |     | 0.44      |     |      |
| I <sub>OL</sub>              | I <sub>OL</sub> = 24 mA              |                                                             | 3 V             |                       |     | 0.36 |           |     | 0.44      |     | µA   |
|                              |                                      |                                                             | 4.5 V           |                       |     | 0.36 |           |     | 0.44      |     |      |
|                              |                                      |                                                             | 5.5 V           |                       |     | 0.36 |           |     | 0.44      |     |      |
|                              | I <sub>OL</sub> = 75 mA <sup>†</sup> |                                                             | 3 V             |                       |     |      |           |     | 1.65      |     |      |
|                              |                                      |                                                             | 4.5 V           |                       |     |      |           |     | 1.65      |     |      |
|                              |                                      |                                                             | 5.5 V           |                       |     |      |           |     | 1.65      |     |      |
| I <sub>I</sub>               | Control inputs                       | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 5.5 V           |                       |     | ±0.1 |           |     | ±1        |     | µA   |
| I <sub>OZ</sub> <sup>‡</sup> | A or B ports                         | V <sub>O</sub> = V <sub>CC</sub> or GND                     | 5.5 V           |                       |     | ±0.5 |           |     | ±5        |     | µA   |
| I <sub>CC</sub>              |                                      | V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0 | 5.5 V           |                       |     | 8    |           |     | 80        |     | µA   |
| C <sub>i</sub>               | Control inputs                       | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 5 V             |                       |     | 3    |           |     |           |     | pF   |
| C <sub>io</sub>              | A or B ports                         | V <sub>O</sub> = V <sub>CC</sub> or GND                     | 5 V             |                       |     | 11.5 |           |     |           |     | pF   |

<sup>†</sup> Not more than one output 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<sub>OZ</sub> includes the input leakage current.

**timing requirements over recommended operating free-air temperature range,**  
**V<sub>CC</sub> = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)**

|                 |                                                                                | T <sub>A</sub> = 25°C |     | 54AC16472 |     | 74AC16472 |     | UNIT |
|-----------------|--------------------------------------------------------------------------------|-----------------------|-----|-----------|-----|-----------|-----|------|
|                 |                                                                                | MIN                   | MAX | MIN       | MAX | MIN       | MAX |      |
| t <sub>w</sub>  | Pulse duration, $\overline{\text{LEAB}}$ or $\overline{\text{LEBA}}$ low       | 4                     |     | 4         |     | 4         |     | ns   |
| t <sub>su</sub> | Setup time, data before $\overline{\text{LEAB}}$ or $\overline{\text{LEBA}}$ ↑ | 0.5                   |     | 0.5       |     | 0.5       |     | ns   |
| t <sub>h</sub>  | Hold time, data after $\overline{\text{LEAB}}$ or $\overline{\text{LEBA}}$ ↑   | 3.5                   |     | 3.5       |     | 3.5       |     | ns   |

**timing requirements over recommended operating free-air temperature range,**  
**V<sub>CC</sub> = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)**

|                 |                                                                                | T <sub>A</sub> = 25°C |     | 54AC16472 |     | 74AC16472 |     | UNIT |
|-----------------|--------------------------------------------------------------------------------|-----------------------|-----|-----------|-----|-----------|-----|------|
|                 |                                                                                | MIN                   | MAX | MIN       | MAX | MIN       | MAX |      |
| t <sub>w</sub>  | Pulse duration, $\overline{\text{LEAB}}$ or $\overline{\text{LEBA}}$ low       | 4                     |     | 4         |     | 4         |     | ns   |
| t <sub>su</sub> | Setup time, data before $\overline{\text{LEAB}}$ or $\overline{\text{LEBA}}$ ↑ | 0.5                   |     | 0.5       |     | 0.5       |     | ns   |
| t <sub>h</sub>  | Hold time, data after $\overline{\text{LEAB}}$ or $\overline{\text{LEBA}}$ ↑   | 2.5                   |     | 2.5       |     | 2.5       |     | ns   |

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## 18-BIT REGISTERED TRANSCIEVERS

### WITH 3-STATE OUTPUTS

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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 1)

| PARAMETER | FROM<br>(INPUT)                        | TO<br>(OUTPUT) | $T_A = 25^\circ\text{C}$ |      |      | 54AC16472 |      | 74AC16472 |      | UNIT |
|-----------|----------------------------------------|----------------|--------------------------|------|------|-----------|------|-----------|------|------|
|           |                                        |                | MIN                      | TYP  | MAX  | MIN       | MAX  | MIN       | MAX  |      |
| $t_{PLH}$ | A or B                                 | B or A         | 3.5                      | 8    | 12.5 | 3.5       | 14.2 | 3.5       | 14.2 | ns   |
| $t_{PHL}$ |                                        |                | 3.9                      | 8.4  | 12.8 | 3.9       | 13.9 | 3.9       | 13.9 |      |
| $t_{PLH}$ | $\overline{LEBA}$ or $\overline{LEAB}$ | A or B         | 4.8                      | 10.3 | 15.6 | 4.8       | 17.9 | 4.8       | 17.9 | ns   |
| $t_{PHL}$ |                                        |                | 4.7                      | 9.7  | 14.7 | 4.7       | 16.3 | 4.7       | 16.3 |      |
| $t_{PZH}$ | $\overline{OEBA}$ or $\overline{OEAB}$ | A or B         | 3.9                      | 8.9  | 14   | 3.9       | 15.9 | 3.9       | 15.9 | ns   |
| $t_{PZL}$ |                                        |                | 5                        | 11.2 | 17.6 | 5         | 19.7 | 5         | 19.7 |      |
| $t_{PHZ}$ | $\overline{OEBA}$ or $\overline{OEAB}$ | A or B         | 4.4                      | 7    | 9.4  | 4.4       | 10   | 4.4       | 10   | ns   |
| $t_{PLZ}$ |                                        |                | 4                        | 6.4  | 8.7  | 4         | 9.4  | 4         | 9.4  |      |

switching characteristics over recommended operating free-air temperature range,  
 $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$  (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM<br>(INPUT)                        | TO<br>(OUTPUT) | $T_A = 25^\circ\text{C}$ |     |      | 54AC16472 |      | 74AC16472 |      | UNIT |
|-----------|----------------------------------------|----------------|--------------------------|-----|------|-----------|------|-----------|------|------|
|           |                                        |                | MIN                      | TYP | MAX  | MIN       | MAX  | MIN       | MAX  |      |
| $t_{PLH}$ | A or B                                 | B or A         | 2.9                      | 5.6 | 8.4  | 2.9       | 9.5  | 2.9       | 9.5  | ns   |
| $t_{PHL}$ |                                        |                | 3.1                      | 6   | 8.7  | 3.1       | 9.6  | 3.1       | 9.6  |      |
| $t_{PLH}$ | $\overline{LEBA}$ or $\overline{LEAB}$ | A or B         | 3.9                      | 7.3 | 10.3 | 3.9       | 11.7 | 3.9       | 11.7 | ns   |
| $t_{PHL}$ |                                        |                | 3.7                      | 6.9 | 9.7  | 3.7       | 10.9 | 3.7       | 10.9 |      |
| $t_{PZH}$ | $\overline{OEBA}$ or $\overline{OEAB}$ | A or B         | 3.1                      | 6.2 | 8.9  | 3.1       | 10.2 | 3.1       | 10.2 | ns   |
| $t_{PZL}$ |                                        |                | 3.9                      | 7.3 | 10.4 | 3.9       | 11.6 | 3.9       | 11.6 |      |
| $t_{PHZ}$ | $\overline{OEBA}$ or $\overline{OEAB}$ | A or B         | 4.3                      | 6.2 | 8.1  | 4.3       | 8.6  | 4.3       | 8.6  | ns   |
| $t_{PLZ}$ |                                        |                | 3.8                      | 5.7 | 7.4  | 3.8       | 8    | 3.8       | 8    |      |

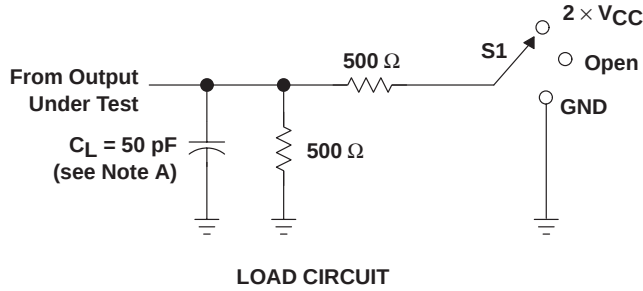
operating characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

| PARAMETER |                                               |                  | TEST CONDITIONS                           |  | TYP | UNIT |
|-----------|-----------------------------------------------|------------------|-------------------------------------------|--|-----|------|
| $C_{pd}$  | Power dissipation capacitance per transceiver | Outputs enabled  | $C_L = 50\text{ pF}$ , $f = 1\text{ MHz}$ |  | 59  | pF   |
|           |                                               | Outputs disabled |                                           |  | 6   |      |

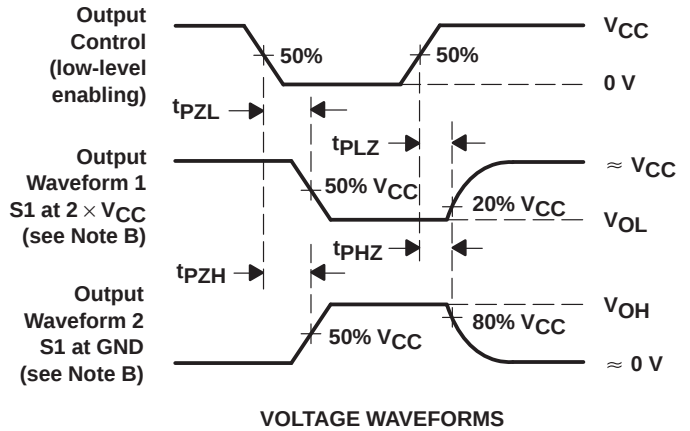
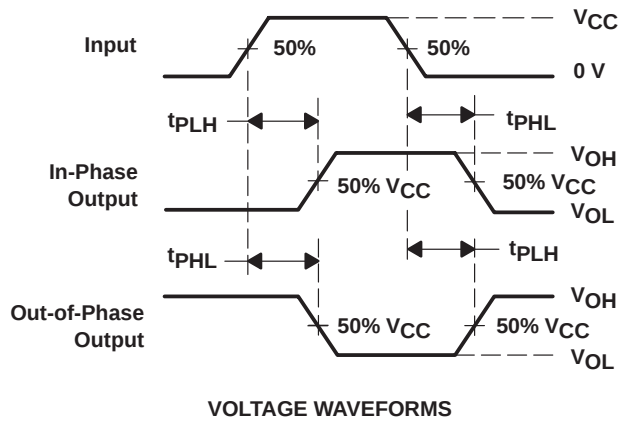
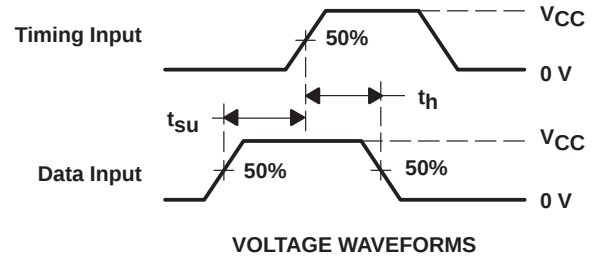
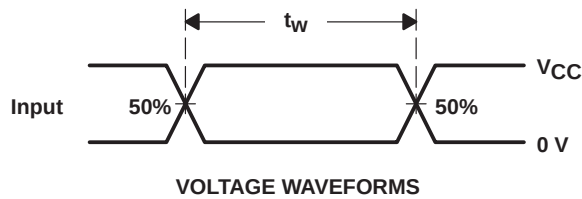
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## PARAMETER MEASUREMENT INFORMATION



| 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. 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:  $PRR \leq 1 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r = 3 \text{ ns}$ ,  $t_f = 3 \text{ ns}$ .  
D. The outputs are measured one at a time with one input transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

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