

# 54ACT16543, 74ACT16543 16-BIT REGISTERED TRANSCEIVERS WITH 3-STATE OUTPUTS

SCAS126B – MARCH 1990 – REVISED APRIL 1996

- **Members of the Texas Instruments Widebus™ Family**
- **Inputs Are TTL-Voltage Compatible**
- **3-State True Outputs**
- **Flow-Through Architecture Optimizes PCB Layout**
- **Distributed V<sub>CC</sub> and GND Pin Configurations Minimize High-Speed Switching Noise**
- **EPIC™ (Enhanced-Performance Implanted CMOS) 1-μm Process**
- **500-mA Typical Latch-Up Immunity at 125°C**
- **Package Options Include Plastic Thin Shrink Small-Outline (DGG) and 300-mil Shrink Small-Outline (DL) Packages Using 25-mil Center-to-Center Pin Spacings, and 380-mil Fine-Pitch Ceramic Flat (WD) Packages Using 25-mil Center-to-Center Pin Spacings**

## description

The 'ACT16543 are 16-bit registered transceivers that contain two sets of D-type latches for temporary storage of data flowing in either direction. The 'ACT16543 can be used as two 8-bit transceivers or one 16-bit transceiver. Separate latch enable ( $\overline{\text{LEAB}}$  or  $\overline{\text{LEBA}}$ ) and output-enable ( $\overline{\text{OEAB}}$  or  $\overline{\text{OEBA}}$ ) inputs are provided for each register to permit independent control in either direction of data flow.

The A-to-B enable ( $\overline{\text{CEAB}}$ ) and  $\overline{\text{OEAB}}$  inputs must be low to enter data from A or to output data to B. Having  $\overline{\text{CEAB}}$  low and  $\overline{\text{LEAB}}$  low makes the A-to-B latches transparent; a subsequent low-to-high transition at  $\overline{\text{LEAB}}$  puts the A latches in the storage mode. Data flow from B to A is similar, but requires using the  $\overline{\text{CEBA}}$ ,  $\overline{\text{LEBA}}$ , and  $\overline{\text{OEBA}}$  inputs.

The 74ACT16543 is packaged in TI's shrink small-outline package, which provides twice the functionality of standard small-outline packages in the same printed-circuit-board area.

The 54ACT16543 is characterized for operation over the full military temperature range of –55°C to 125°C. The 74ACT16543 is characterized for operation from –40°C to 85°C.

54ACT16543 . . . WD PACKAGE  
74ACT16543 . . . DGG OR DL PACKAGE  
(TOP VIEW)

|                           |    |    |                           |
|---------------------------|----|----|---------------------------|
| $\overline{1\text{OEAB}}$ | 1  | 56 | $\overline{1\text{OEBA}}$ |
| $\overline{1\text{LEAB}}$ | 2  | 55 | $\overline{1\text{LEBA}}$ |
| $\overline{1\text{CEAB}}$ | 3  | 54 | $\overline{1\text{CEBA}}$ |
| GND                       | 4  | 53 | GND                       |
| 1A1                       | 5  | 52 | 1B1                       |
| 1A2                       | 6  | 51 | 1B2                       |
| V <sub>CC</sub>           | 7  | 50 | V <sub>CC</sub>           |
| 1A3                       | 8  | 49 | 1B3                       |
| 1A4                       | 9  | 48 | 1B4                       |
| 1A5                       | 10 | 47 | 1B5                       |
| GND                       | 11 | 46 | GND                       |
| 1A6                       | 12 | 45 | 1B6                       |
| 1A7                       | 13 | 44 | 1B7                       |
| 1A8                       | 14 | 43 | 1B8                       |
| 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 <sub>CC</sub>           | 22 | 35 | V <sub>CC</sub>           |
| 2A7                       | 23 | 34 | 2B7                       |
| 2A8                       | 24 | 33 | 2B8                       |
| GND                       | 25 | 32 | GND                       |
| $\overline{2\text{CEAB}}$ | 26 | 31 | $\overline{2\text{CEBA}}$ |
| $\overline{2\text{LEAB}}$ | 27 | 30 | $\overline{2\text{LEBA}}$ |
| $\overline{2\text{OEAB}}$ | 28 | 29 | $\overline{2\text{OEBA}}$ |



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**TEXAS  
INSTRUMENTS**

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FUNCTION TABLE  
(each octal register)

| INPUTS                   |                          |                          | LATCH<br>STATUS<br>A TO B† | OUTPUT<br>BUFFERS<br>B1–B8 |
|--------------------------|--------------------------|--------------------------|----------------------------|----------------------------|
| $\overline{\text{CEAB}}$ | $\overline{\text{LEAB}}$ | $\overline{\text{OEAB}}$ |                            |                            |
| H                        | X                        | X                        | Storing                    | Z                          |
| X                        | H                        | X                        | Storing                    |                            |
| X                        | X                        | H                        |                            | Z                          |
| L                        | L                        | L                        | Transparent                | Current A data             |
| L                        | H                        | L                        | Storing                    | Previous A data‡           |

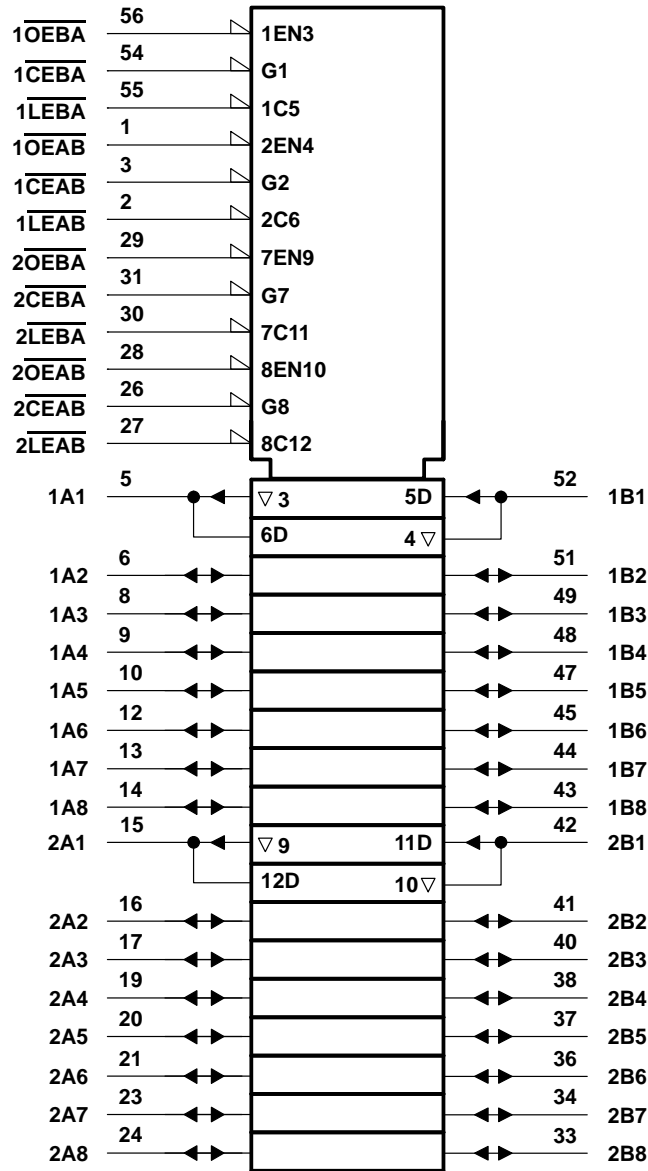
† A-to-B data flow is shown: B-to-A flow control is the same except that it uses  $\overline{\text{CEBA}}$ ,  $\overline{\text{LEBA}}$ , and  $\overline{\text{OEBA}}$ .

‡ Data present before low-to-high transition of  $\overline{\text{LEAB}}$  occurring while  $\overline{\text{CEAB}}$  is low

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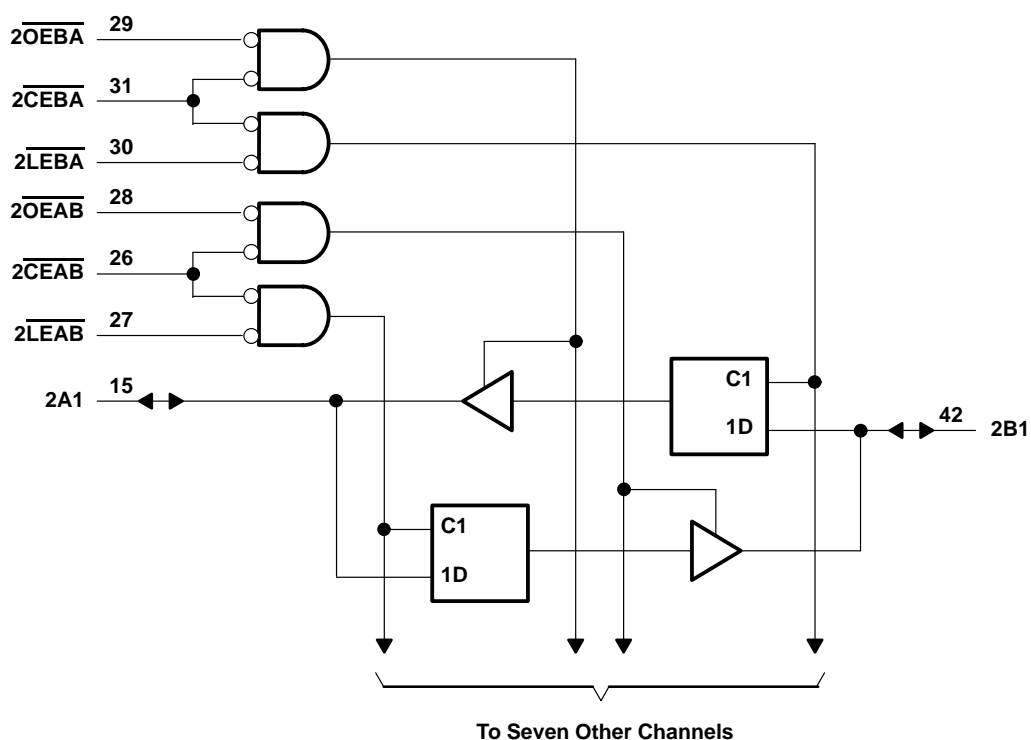
logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

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The diagram illustrates the internal logic of a 16-channel multiplexer. It features four 3-to-1 multiplexers (labeled C1 1D) and four 2-to-1 multiplexers (labeled C1 1D). The inputs are labeled 1OEBA, 1CEBA, 1LEBA, 1OEAB, 1CEAB, 1LEAB, 1A1, and 52. The outputs are labeled 56, 54, 55, 1, 3, 2, 5, and 1B1. The diagram shows how these inputs are combined through a series of multiplexing stages to produce the final output.



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

|  |                          |
|--|--------------------------|
| Supply voltage range, $V_{CC}$   | –0.5 V to 7 V            |
| Input voltage range, $V_I$ (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   | ±400 mA                  |
| Maximum power dissipation at $T_A = 55^\circ\text{C}$ (in still air) (see Note 2): DGG package | 1 W                      |
| DL package   | 1.4 W                    |
| Storage temperature range, $T_{stg}$   | –65°C to 150°C           |

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. The input and output 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)**

|                     |                                    | 54ACT16543 |     |          | 74ACT16543 |     |          | UNIT |
|---------------------|------------------------------------|------------|-----|----------|------------|-----|----------|------|
|                     |                                    | MIN        | NOM | MAX      | MIN        | NOM | MAX      |      |
| $V_{CC}$            | Supply voltage (see Note 4)        | 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    |
| $V_I$               | Input voltage                      | 0          |     | $V_{CC}$ | 0          |     | $V_{CC}$ | V    |
| $V_O$               | Output voltage                     | 0          |     | $V_{CC}$ | 0          |     | $V_{CC}$ | V    |
| $I_{OH}$            | High-level output current          |            |     | –24      |            |     | –24      | mA   |
| $I_{OL}$            | Low-level output current           |            |     | 24       |            |     | 24       | mA   |
| $\Delta t/\Delta v$ | Input transition rise or fall rate | 0          |     | 10       | 0          |     | 10       | ns/V |
| $T_A$               | Operating free-air temperature     | –55        |     | 125      | –40        |     | 85       | °C   |

- NOTES: 3. Unused pins (inputs and I/O) must be held high or low to prevent them from floating.  
4. All  $V_{CC}$  and GND pins must be connected to the proper voltage power supply.

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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 |     |      | 54ACT16543 |      | 74ACT16543 |      | UNIT |
|--------------------|----------------|---|-----------------|-----------------------|-----|------|------------|------|------------|------|------|
|                    |                |   |                 | MIN                   | TYP | MAX  | MIN        | MAX  | MIN        | MAX  |      |
| V <sub>OH</sub>    |                | I <sub>OH</sub> = -50 µA                                    | 4.5 V           | 4.4                   |     |      | 4.4        |      | 4.4        |      | V    |
|                    |                |   | 5.5 V           | 5.4                   |     |      | 5.4        |      | 5.4        |      |      |
|                    |                | I <sub>OH</sub> = -24 mA                                    | 4.5 V           | 3.94                  |     |      | 3.8        |      | 3.8        |      |      |
|                    |                |   | 5.5 V           | 4.94                  |     |      | 4.8        |      | 4.8        |      |      |
|                    |                | I <sub>OH</sub> = -75 mA†                                   | 5.5 V           |                       |     |      | 3.85       |      | 3.85       |      |      |
| V <sub>OL</sub>    |                | I <sub>OL</sub> = 50 µA                                     | 4.5 V           |                       |     | 0.1  |            | 0.1  |            | 0.1  | V    |
|                    |                |   | 5.5 V           |                       |     | 0.1  |            | 0.1  |            | 0.1  |      |
|                    |                | I <sub>OL</sub> = 24 mA                                     | 4.5 V           |                       |     | 0.36 |            | 0.44 |            | 0.44 |      |
|                    |                |   | 5.5 V           |                       |     | 0.36 |            | 0.44 |            | 0.44 |      |
|                    |                | I <sub>OL</sub> = 75 mA†                                    | 5.5 V           |                       |     |      | 1.65       |      | 1.65       |      |      |
| I <sub>I</sub>     | Control inputs | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 5.5 V           |                       |     | ±0.1 |            | ±1   |            | ±1   | µA   |
| I <sub>OZ</sub>    | A or B ports‡  | V <sub>O</sub> = V <sub>CC</sub> or GND                     | 5.5 V           |                       |     | ±0.5 |            | ±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   |            | 80   | µA   |
| ΔI <sub>CC</sub> § |                | One input at 3.4 V, Other inputs at GND or V <sub>CC</sub>  | 5.5 V           |                       |     | 0.9  |            | 1    |            | 1    | mA   |
| C <sub>i</sub>     | Control inputs | V <sub>I</sub> = V <sub>CC</sub> or GND                     | 5 V             |                       |     | 4.5  |            |      |            |      | pF   |
| C <sub>io</sub>    | A or B ports   | V <sub>O</sub> = V <sub>CC</sub> or GND                     | 5 V             |                       |     | 12   |            |      |            |      |      |

† Not more than one output should be tested at a time, and the duration of the test should not exceed 10 ms.

‡ For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

§ This is the increase in supply current for each input that is at one of the specified TTL voltage levels rather than 0 V or V<sub>CC</sub>.

timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)

|                 |   | T <sub>A</sub> = 25°C |     | 54ACT16543 |     | 74ACT16543 |     | UNIT |
|-----------------|---|-----------------------|-----|------------|-----|------------|-----|------|
|                 |   | MIN                   | MAX | MIN        | MAX | MIN        | MAX |      |
| t <sub>w</sub>  | Pulse duration, $\overline{\text{LEAB}}$ or $\overline{\text{LEBA}}$ low                | 7.5                   |     | 7.5        |     | 7.5        |     | ns   |
| t <sub>su</sub> | Setup time, data before $\overline{\text{LEAB}}$ or $\overline{\text{LEBA}}^{\uparrow}$ | 2.5                   |     | 2.5        |     | 2.5        |     | ns   |
| t <sub>h</sub>  | Hold time, data after $\overline{\text{LEAB}}$ or $\overline{\text{LEBA}}^{\uparrow}$   | 4                     |     | 4          |     | 4          |     | ns   |

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switching characteristics over recommended ranges of supply voltage and operating free-air temperature range (unless otherwise noted) (see Figure 1)

| PARAMETER | FROM<br>(INPUT)                        | TO<br>(OUTPUT) | $T_A = 25^\circ\text{C}$ |     |      | 54ACT16543 |      | 74ACT16543 |      | UNIT |
|-----------|--|----------------|--------------------------|-----|------|------------|------|------------|------|------|
|           |  |                | MIN                      | TYP | MAX  | MIN        | MAX  | MIN        | MAX  |      |
| $t_{PLH}$ | A or B                                 | B or A         | 3.5                      | 6.9 | 9.5  | 3.5        | 10.5 | 3.5        | 10.5 | ns   |
| $t_{PHL}$ |  |                | 3.1                      | 7.3 | 10.7 | 3.1        | 11.6 | 3.1        | 11.6 |      |
| $t_{PLH}$ | $\overline{LEBA}$ or $\overline{LEAB}$ | A or B         | 3.9                      | 8.6 | 12.3 | 3.9        | 13.8 | 3.9        | 13.8 | ns   |
| $t_{PHL}$ |  |                | 3.9                      | 8.7 | 12.2 | 3.9        | 13.5 | 3.9        | 13.5 |      |
| $t_{PZH}$ | $\overline{OEBA}$ or $\overline{OEAB}$ | A or B         | 2.6                      | 7.1 | 10.3 | 2.6        | 11.4 | 2.6        | 11.4 | ns   |
| $t_{PZL}$ |  |                | 3.5                      | 8.3 | 11.9 | 3.5        | 13.2 | 3.5        | 13.2 |      |
| $t_{PHZ}$ | $\overline{OEBA}$ or $\overline{OEAB}$ | A or B         | 4.1                      | 8.2 | 10.5 | 4.1        | 11.1 | 4.1        | 11.1 | ns   |
| $t_{PLZ}$ |  |                | 5                        | 7.3 | 9.3  | 5          | 9.6  | 5          | 9.6  |      |
| $t_{PZH}$ | $\overline{CEBA}$ or $\overline{CEAB}$ | A or B         | 3.1                      | 7.3 | 10.7 | 3.1        | 11.7 | 3.1        | 11.7 | ns   |
| $t_{PZL}$ |  |                | 3.9                      | 8.5 | 12.2 | 3.9        | 13.5 | 3.9        | 13.5 |      |
| $t_{PHZ}$ | $\overline{CEBA}$ or $\overline{CEAB}$ | A or B         | 4.6                      | 8.5 | 11   | 4.6        | 11.6 | 4.6        | 11.6 | ns   |
| $t_{PLZ}$ |  |                | 5.2                      | 7.4 | 9.7  | 5.2        | 10.5 | 5.2        | 10.5 |      |

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  | $C_L = 50\text{ pF}$ , $f = 1\text{ MHz}$ | 45  | pF   |
|           |   | Outputs disabled |   | 12  |      |

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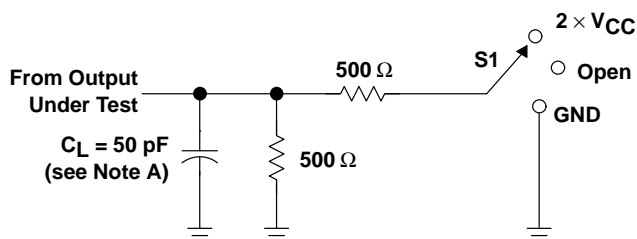


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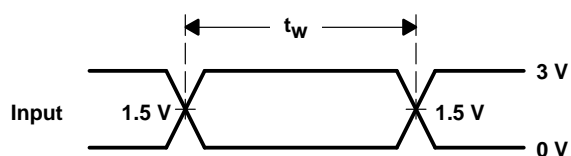
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## PARAMETER MEASUREMENT INFORMATION

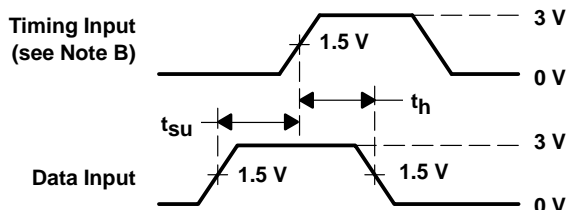


LOAD CIRCUIT

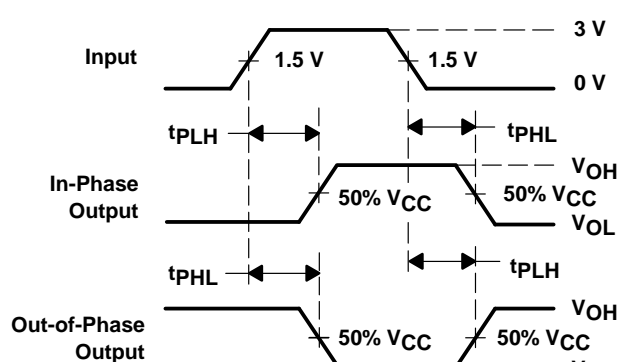
| TEST              | S1                |
|-------------------|-------------------|
| $t_{PLH}/t_{PHL}$ | Open              |
| $t_{PLZ}/t_{PZL}$ | 2 $\times V_{CC}$ |
| $t_{PHZ}/t_{PZH}$ | GND               |



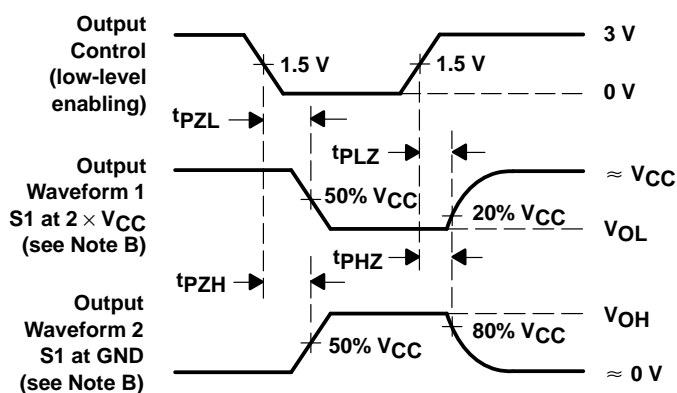
VOLTAGE WAVEFORMS



VOLTAGE WAVEFORMS



VOLTAGE WAVEFORMS



VOLTAGE WAVEFORMS

- 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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