

# 54ACT16470, 74ACT16470 16-BIT REGISTERED TRANSCEIVERS WITH 3-STATE OUTPUTS

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- Members of the Texas Instruments *Widebus™* Family
- Inputs Are TTL-Voltage Compatible
- 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 Shrink Small-Outline 300-mil (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 'ACT16470 are 16-bit registered transceivers that contain two sets of D-type flip-flops for temporary storage of data flowing in either direction. They can be used as two 8-bit transceivers or one 16-bit transceiver. Separate clock (CLKAB or CLKBA) and output-enable ( $\overline{OEAB}$  or  $\overline{OEBA}$ ) inputs are provided for each register to permit independent control in either direction of data flow.

The A-to-B enable ( $\overline{CEAB}$ ) input must be low to enter data from A or to output data to B. If both  $\overline{CEAB}$  and CLKAB are low, then B port will have the level of A port prior to the most recent low-to-high transition of CLKAB. Data flow from B to A is similar, but requires the use of  $\overline{CEBA}$ , CLKBA, and  $\overline{OEBA}$  inputs.

To avoid false clocking of the flip-flops,  $\overline{CE}$  should not be switched from high to low while CLK is high.

The 74ACT16470 is packaged in TI's shrink small-outline package, which provides twice the I/O pin count and functionality of standard small-outline packages in the same printed-circuit-board area.

The 54ACT16470 is characterized for operation over the full military temperature range of –55°C to 125°C. The 74ACT16470 is characterized for operation from –40°C to 85°C.

54ACT16470 . . . WD PACKAGE  
74ACT16470 . . . DL PACKAGE  
(TOP VIEW)

|                     |    |    |                     |
|---------------------|----|----|---------------------|
| $\overline{1OEAB}$  | 1  | 56 | $\overline{1OEBA}$  |
| $\overline{1CLKAB}$ | 2  | 55 | $\overline{1CLKBA}$ |
| $\overline{1CEAB}$  | 3  | 54 | $\overline{1CEBA}$  |
| GND                 | 4  | 53 | GND                 |
| 1A1                 | 5  | 52 | 1B1                 |
| 1A2                 | 6  | 51 | 1B2                 |
| $V_{CC}$            | 7  | 50 | $V_{CC}$            |
| 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                 |
| $V_{CC}$            | 22 | 35 | $V_{CC}$            |
| 2A7                 | 23 | 34 | 2B7                 |
| 2A8                 | 24 | 33 | 2B8                 |
| GND                 | 25 | 32 | GND                 |
| $\overline{2CEAB}$  | 26 | 31 | $\overline{2CEBA}$  |
| $\overline{2CLKAB}$ | 27 | 30 | $\overline{2CLKBA}$ |
| $\overline{2OEAB}$  | 28 | 29 | $\overline{2OEBA}$  |



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FUNCTION TABLE<sup>†</sup>

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

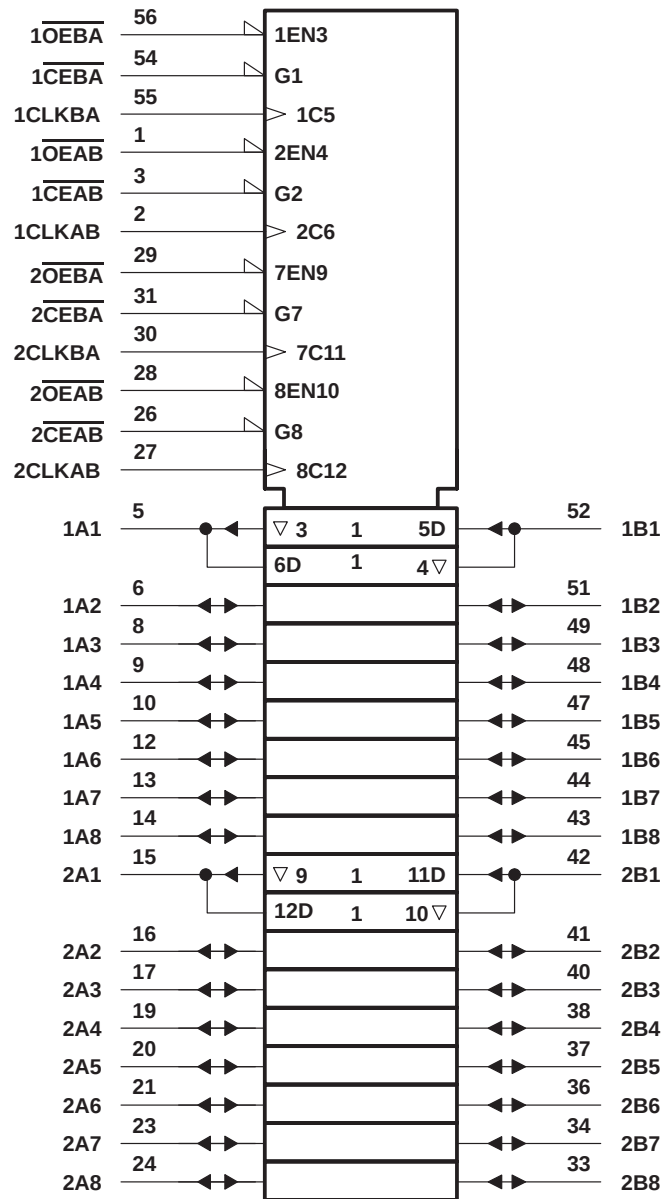
<sup>†</sup> A-to-B data flow is shown; B-to-A flow is similar but uses CEBA, CLKBA, and OEBA.

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

**54ACT16470, 74ACT16470**  
**16-BIT REGISTERED TRANSCEIVERS**  
**WITH 3-STATE OUTPUTS**

SCAS237A – JUNE 1990 – REVISED APRIL 1996

logic symbol<sup>†</sup>



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

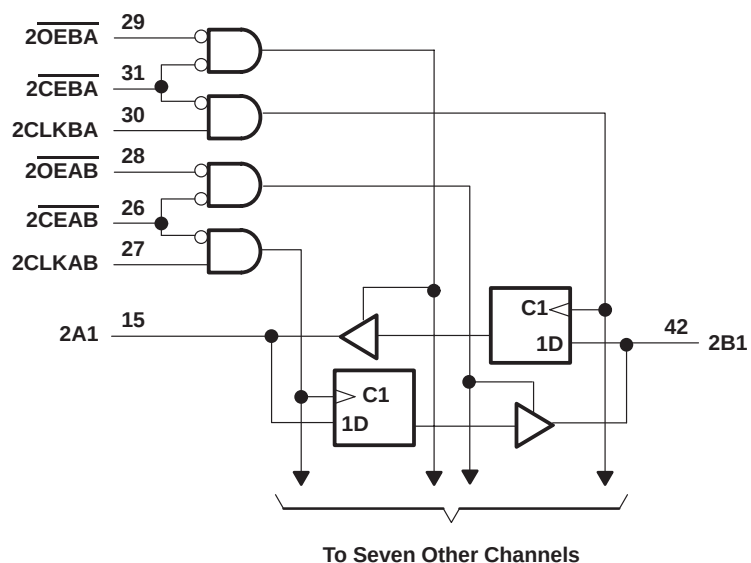
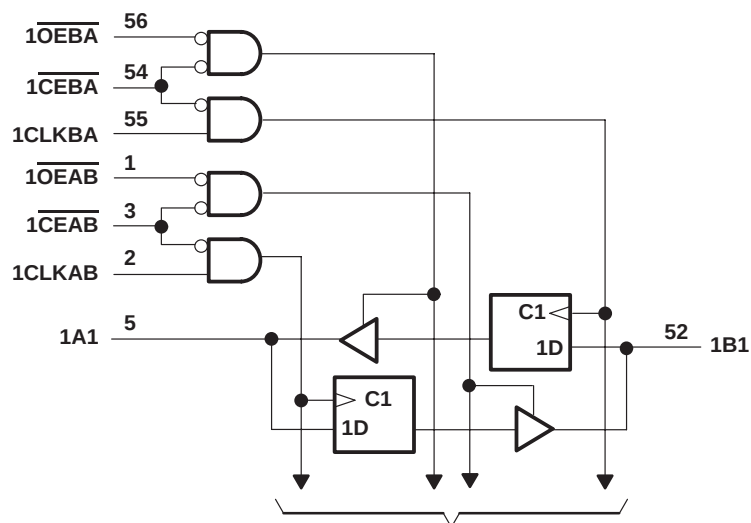
# 54ACT16470, 74ACT16470

## 16-BIT REGISTERED TRANSCIEVERS

### WITH 3-STATE OUTPUTS

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#### logic diagram (positive logic)



# 54ACT16470, 74ACT16470 16-BIT REGISTERED TRANSCEIVERS WITH 3-STATE OUTPUTS

SCAS237A – 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 to 7 V              |
| Input voltage range, $V_I$ (see Note 1)                                                              | –0.5 to $V_{CC} + 0.5$ V |
| Input voltage range, $V_O$ (see Note 1)                                                              | –0.5 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 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)

|                                                        | 54ACT16470 |     |          | 74ACT16470 |     |          | 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    |
| $V_I$ 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   |

NOTE 3: Unused pins (input or I/O) must be held high or low to prevent them from floating.

# 54ACT16470, 74ACT16470

## 16-BIT REGISTERED TRANSCEIVERS

### WITH 3-STATE OUTPUTS

SCAS237A – 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 |     |      | 54ACT16470 |      | 74ACT16470 |      | 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 <sup>†</sup>                       | 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 <sup>†</sup>                        | 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> <sup>‡</sup>  | 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> <sup>§</sup> |                | One input at 3.4 V, Other inputs at V <sub>CC</sub> or GND  | 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             |                       |     | 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.

<sup>§</sup> 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, V<sub>CC</sub> = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)**

|                    |                                          |  | T <sub>A</sub> = 25°C |     | 54ACT16470 |     | 74ACT16470 |     | UNIT |
|--------------------|------------------------------------------|--|-----------------------|-----|------------|-----|------------|-----|------|
|                    |                                          |  | MIN                   | MAX | MIN        | MAX | MIN        | MAX |      |
| f <sub>clock</sub> | Clock frequency                          |  | 0                     | 55  | 0          | 55  | 0          | 55  | MHz  |
| t <sub>w</sub>     | Pulse duration                           |  | CLK high              |     | 4          |     | 4          |     | ns   |
|                    |                                          |  | CLK low               |     | 8.5        |     | 8.5        |     |      |
| t <sub>su</sub>    | Setup time, data before CLK <sup>↑</sup> |  | 6                     |     | 6          |     | 6          |     | ns   |
| t <sub>h</sub>     | Hold time, data after CLK <sup>↑</sup>   |  | 1                     |     | 1          |     | 1          |     | ns   |

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**54ACT16470, 74ACT16470**  
**16-BIT REGISTERED TRANSCEIVERS**  
**WITH 3-STATE OUTPUTS**

SCAS237A – JUNE 1990 – REVISED APRIL 1996

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) | $T_A = 25^\circ\text{C}$ |      |      | 54ACT16470 |      | 74ACT16470 |      | UNIT |
|------------|-----------------|----------------|--------------------------|------|------|------------|------|------------|------|------|
|            |                 |                | MIN                      | TYP  | MAX  | MIN        | MAX  | MIN        | MAX  |      |
| $f_{\max}$ |                 |                | 55                       |      |      | 55         |      | 55         |      | MHz  |
| $t_{PLH}$  | CLK             | A or B         | 3.9                      | 8.3  | 10.3 | 3.9        | 11.8 | 3.9        | 11.8 | ns   |
| $t_{PHL}$  |                 |                | 3.8                      | 8.4  | 10.3 | 3.8        | 11.7 | 3.8        | 11.7 |      |
| $t_{PZH}$  | $\overline{OE}$ | A or B         | 3.2                      | 8.3  | 10.5 | 3.2        | 11.9 | 3.2        | 11.9 | ns   |
| $t_{PZL}$  |                 |                | 3.6                      | 9.5  | 11.8 | 3.6        | 13.4 | 3.6        | 13.4 |      |
| $t_{PHZ}$  | $\overline{OE}$ | A or B         | 4.6                      | 7.4  | 9.3  | 4.6        | 9.9  | 4.6        | 9.9  | ns   |
| $t_{PLZ}$  |                 |                | 4.6                      | 7    | 8.8  | 4.6        | 9.5  | 4.6        | 9.5  |      |
| $t_{PZH}$  | $\overline{CE}$ | A or B         | 3.5                      | 8.8  | 10.9 | 3.5        | 12.5 | 3.5        | 12.5 | ns   |
| $t_{PZL}$  |                 |                | 4.2                      | 10.1 | 12.4 | 4.2        | 14.3 | 4.2        | 14.3 |      |
| $t_{PHZ}$  | $\overline{CE}$ | A or B         | 5.2                      | 8.3  | 10.3 | 5.2        | 11.2 | 5.2        | 11.2 | ns   |
| $t_{PLZ}$  |                 |                | 5.2                      | 7.9  | 10   | 5.2        | 10.9 | 5.2        | 10.9 |      |

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 |                      |                    | 39  |      |

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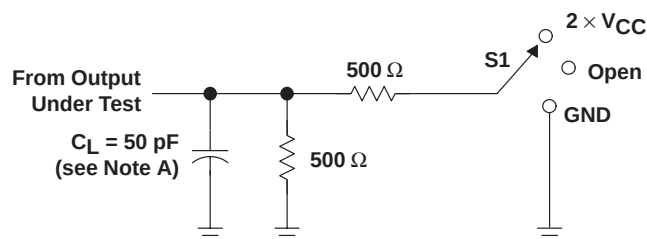


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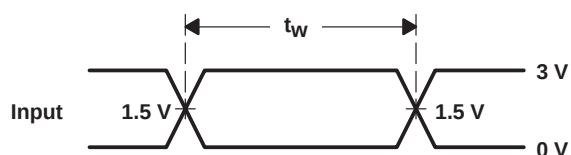
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## PARAMETER MEASUREMENT INFORMATION

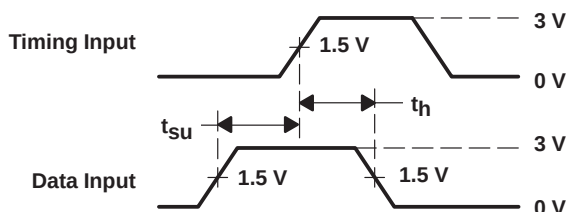


LOAD CIRCUIT

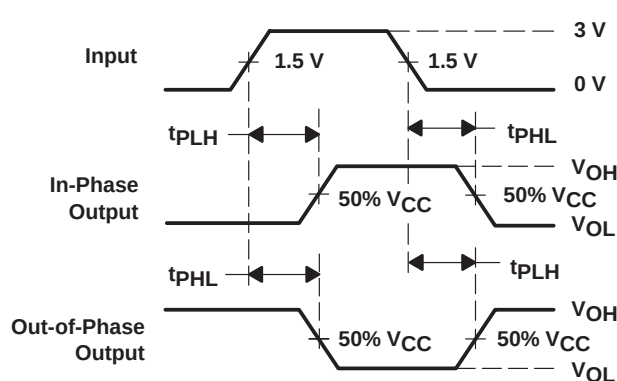
| TEST              | S1                |
|-------------------|-------------------|
| $t_{PLH}/t_{PHL}$ | Open              |
| $t_{PLZ}/t_{PZL}$ | $2 \times V_{CC}$ |
| $t_{PHZ}/t_{PZH}$ | GND               |



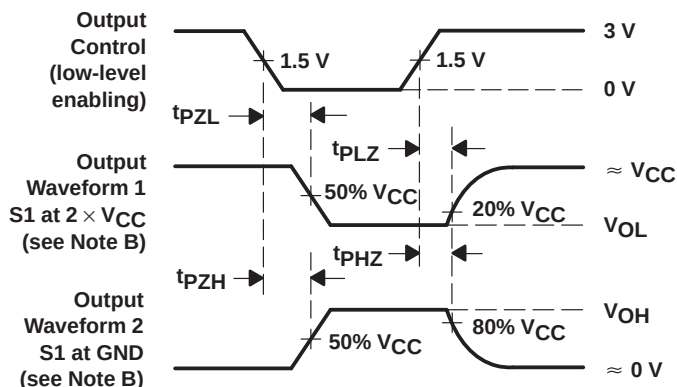
VOLTAGE WAVEFORMS



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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