

## 8-BIT PARALLEL-LOAD SHIFT REGISTERS

Check for Samples: [SN54HC165](#), [SN74HC165](#)

### FEATURES

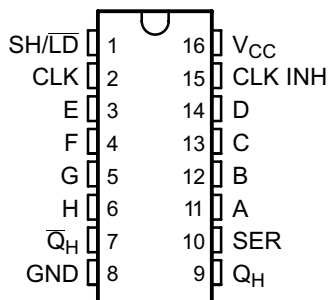
- Wide Operating Voltage Range of 2 V to 6 V
- Outputs Can Drive Up To 10 LSTTL Loads
- Low Power Consumption, 80- $\mu$ A Max  $I_{CC}$
- Typical  $t_{pd} = 13$  ns
- $\pm 4$ -mA Output Drive at 5 V
- Low Input Current of 1  $\mu$ A Max
- Complementary Outputs
- Direct Overriding Load (Data) Inputs
- Gated Clock Inputs
- Parallel-to-Serial Data Conversion

### DESCRIPTION

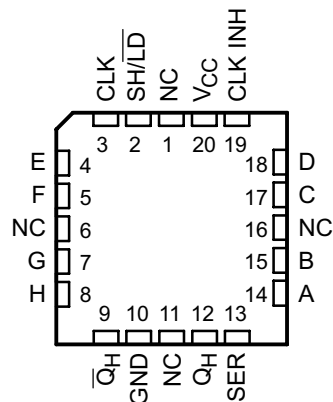
The 'HC165 devices are 8-bit parallel-load shift registers that, when clocked, shift the data toward a serial ( $Q_H$ ) output. Parallel-in access to each stage is provided by eight individual direct data (A–H) inputs that are enabled by a low level at the shift/load (SH/LD) input. The 'HC165 devices also feature a clock-inhibit (CLK INH) function and a complementary serial ( $\bar{Q}_H$ ) output.

Clocking is accomplished by a low-to-high transition of the clock (CLK) input while SH/LD is held high and CLK INH is held low. The functions of CLK and CLK INH are interchangeable. Since a low CLK and a low-to-high transition of CLK INH also accomplish clocking, CLK INH should be changed to the high level only while CLK is high. Parallel loading is inhibited when SH/LD is held high. While SH/LD is low, the parallel inputs to the register are enabled independently of the levels of the CLK, CLK INH, or serial (SER) inputs.

SN54HC165 . . . J or W PACKAGE  
SN74HC165 . . . D, DB, N, NS, OR PW PACKAGE  
(TOP VIEW)



SN54HC165 . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection



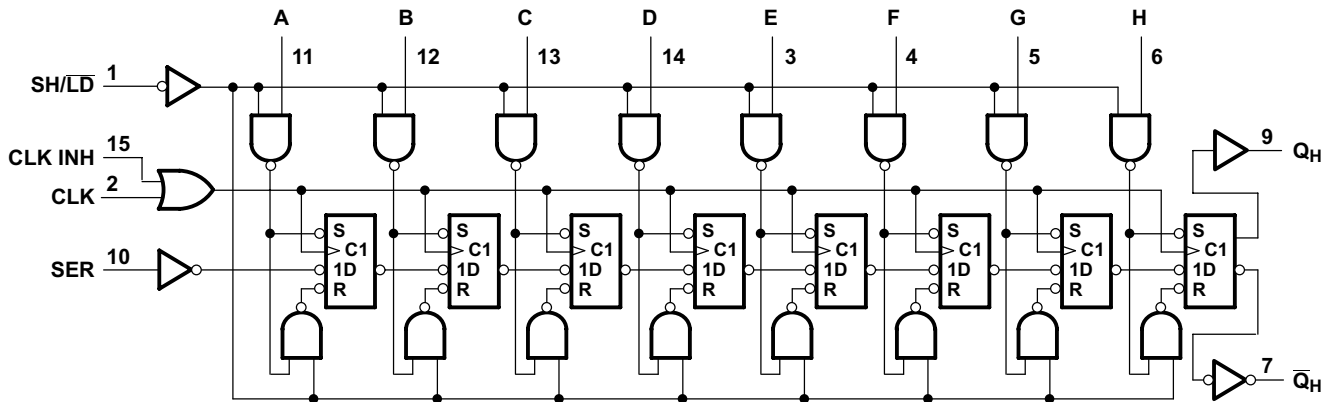
Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

**FUNCTION TABLE**

| SH/ $\overline{\text{LD}}$ | INPUTS     |            | FUNCTION             |
|----------------------------|------------|------------|----------------------|
|                            | CLK        | CLK INH    |                      |
| L                          | X          | X          | Parallel load        |
| H                          | H          | X          | No change            |
| H                          | X          | H          | No change            |
| H                          | L          | $\uparrow$ | Shift <sup>(1)</sup> |
| H                          | $\uparrow$ | L          | Shift <sup>(1)</sup> |

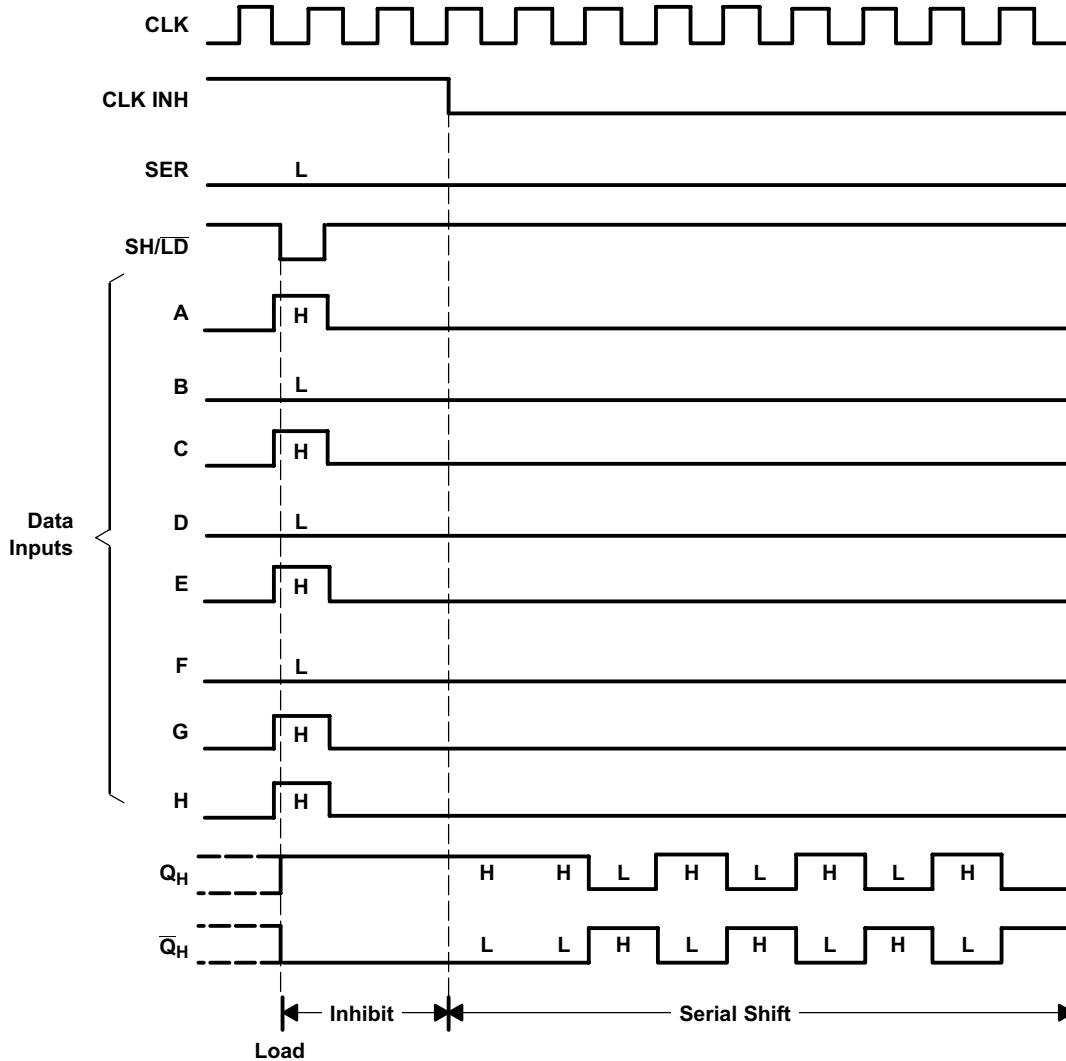
(1) Shift = content of each internal register shifts toward serial output  $Q_H$ . Data at SER is shifted into the first register.

**LOGIC DIAGRAM (POSITIVE LOGIC)**



Pin numbers shown are for the D, DB, J, N, NS, PW and W packages.

TYPICAL SHIFT, LOAD, AND INHIBIT SEQUENCE



## ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

|   |                           | VALUE   | UNITS    |
|---|---------------------------|---|----------|
| V <sub>CC</sub>                                   | Supply voltage range      | -0.5 to 7   | V        |
| I <sub>IK</sub>                                   | Input clamp current       | V <sub>I</sub> < 0 or V <sub>I</sub> > V <sub>CC</sub> <sup>(2)</sup> | ±20 mA   |
| I <sub>OK</sub>                                   | Output clamp current      | V <sub>O</sub> < 0 or V <sub>O</sub> > V <sub>CC</sub> <sup>(2)</sup> | ±20 mA   |
| I <sub>O</sub>                                    | Continuous output current | V <sub>O</sub> = 0 to V <sub>CC</sub>                                 | ±25 mA   |
| Continuous current through V <sub>CC</sub> or GND |                           | ±50   | mA       |
| θ <sub>JA</sub> <sup>(3)</sup>                    | Package thermal impedance | D package   | 73 °C/W  |
|   |                           | DB Package  | 82 °C/W  |
|   |                           | N package   | 67 °C/W  |
|   |                           | NS package  | 64 °C/W  |
|   |                           | PW package  | 108 °C/W |
| T <sub>stg</sub>                                  | Storage temperature range | -65 to 150  | °C       |

- (1) 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.
- (2) The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
- (3) The package thermal impedance is calculated in accordance with JESD 51-7.

## RECOMMENDED OPERATING CONDITIONS<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

|                      |                                 | SN54HC165               |     |                 | SN74HC165 |     |                 | UNIT |
|----------------------|---------------------------------|-------------------------|-----|-----------------|-----------|-----|-----------------|------|
|                      |                                 | MIN                     | NOM | MAX             | MIN       | NOM | MAX             |      |
| V <sub>CC</sub>      | Supply voltage                  | 2                       | 5   | 6               | 2         | 5   | 6               | V    |
| V <sub>IH</sub>      | High-level input voltage        | V <sub>CC</sub> = 2 V   |     | 1.5             | 1.5       |     | V               |      |
|                      |                                 | V <sub>CC</sub> = 4.5 V |     | 3.15            | 3.15      |     |                 |      |
|                      |                                 | V <sub>CC</sub> = 6 V   |     | 4.2             | 4.2       |     |                 |      |
| V <sub>IL</sub>      | Low level input voltage         | V <sub>CC</sub> = 2 V   |     |                 | 0.5       |     | V               |      |
|                      |                                 | V <sub>CC</sub> = 4.5 V |     |                 | 1.35      |     |                 |      |
|                      |                                 | V <sub>CC</sub> = 6 V   |     |                 | 1.8       |     |                 |      |
| 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    |
| Δt/Δv <sup>(2)</sup> | Input transition rise/fall time | V <sub>CC</sub> = 2 V   |     |                 | 1000      |     | ns              |      |
|                      |                                 | V <sub>CC</sub> = 4.5 V |     |                 | 500       |     |                 |      |
|                      |                                 | V <sub>CC</sub> = 6 V   |     |                 | 400       |     |                 |      |
| T <sub>A</sub>       | Operating free-air temperature  | -55                     |     | 125             | -40       |     | 125             | °C   |

- (1) All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number [SCBA004](#).
- (2) If this device is used in the threshold region (from V<sub>IL</sub> max = 0.5 V to V<sub>IH</sub> min = 1.5 V), there is a potential to go into the wrong state from induced grounding, causing double clocking. Operating with the inputs at t<sub>i</sub> = 1000 ns and V<sub>CC</sub> = 2 V does not damage the device; however, functionally, the CLK inputs are not ensured while in the shift, count, or toggle operating modes.

**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 |       |      | SN54HC165<br>–55°C TO 125°C |     | SN74HC165<br>–40°C TO 85°C |     | Recommended<br>SN74HC165<br>–40°C TO 125°C |     | UNIT |
|-----------------|---|--------------------------|-----------------|-----------------------|-------|------|-----------------------------|-----|----------------------------|-----|--|-----|------|
|                 |   |                          |                 | MIN                   | TYP   | MAX  | MIN                         | MAX | MIN                        | MAX | MIN  | MAX |      |
| V <sub>OH</sub> | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> | I <sub>OH</sub> = –20 μA | 2 V             | 1.9                   | 1.998 |      | 1.9                         |     | 1.9                        |     | 1.9  | V   |      |
|                 |   |                          | 4.5 V           | 4.4                   | 4.499 |      | 4.4                         |     | 4.4                        |     | 4.4  |     |      |
|                 |   |                          | 6 V             | 5.9                   | 5.999 |      | 5.9                         |     | 5.9                        |     | 5.9  |     |      |
|                 |   | I <sub>OH</sub> = –4 mA  | 4.5 V           | 3.98                  | 4.3   |      | 3.7                         |     | 3.84                       |     | 3.7  |     |      |
|                 |   |                          | 6 V             | 5.48                  | 5.8   |      | 5.2                         |     | 5.34                       |     | 5.2  |     |      |
| V <sub>OL</sub> | V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> | I <sub>OL</sub> = 20 μA  | 2 V             |                       | 0.002 | 0.1  | 0.1                         |     | 0.1                        |     | 0.1  | V   |      |
|                 |   |                          | 4.5 V           |                       | 0.001 | 0.1  | 0.1                         |     | 0.1                        |     | 0.1  |     |      |
|                 |   |                          | 6 V             |                       | 0.001 | 0.1  | 0.1                         |     | 0.1                        |     | 0.1  |     |      |
|                 |   | I <sub>OL</sub> = 4 mA   | 4.5 V           |                       | 0.17  | 0.26 | 0.4                         |     | 0.33                       |     | 0.4  |     |      |
|                 |   |                          | 6 V             |                       | 0.15  | 0.26 | 0.4                         |     | 0.33                       |     | 0.4  |     |      |
| I <sub>I</sub>  | V <sub>I</sub> = V <sub>CC</sub> or 0               |                          | 6 V             |                       | ±0.1  | ±100 | ±1000                       |     | ±1000                      |     | ±1000                                      | nA  |      |
| I <sub>CC</sub> | V <sub>I</sub> = V <sub>CC</sub> or 0,              | I <sub>O</sub> = 0       | 6 V             |                       |       | 8    | 160                         |     | 80                         |     | 160  | μA  |      |
| C <sub>i</sub>  |   |                          | 2 V to 6 V      |                       | 3     | 10   | 10                          |     | 10                         |     | 10   | pF  |      |

### TIMING REQUIREMENTS

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

|  |                 |   | V <sub>CC</sub> | T <sub>A</sub> = 25°C         |       | SN54HC165<br>–55°C TO 125°C |     | SN74HC165<br>–40°C TO 85°C |     | Recommended<br>SN74HC165<br>–40°C TO 125°C |     | UNIT |    |
|--|-----------------|---|-----------------|-------------------------------|-------|-----------------------------|-----|----------------------------|-----|--|-----|------|----|
|  |                 |   |                 | MIN                           | MAX   | MIN                         | MAX | MIN                        | MAX | MIN  | MAX |      |    |
| f <sub>clock</sub>                                     | Clock frequency |   | 2 V             | 6                             |       | 4.2                         |     | 5                          |     | 4.2  |     | MHz  |    |
|  |                 |   | 4.5 V           | 31                            |       | 21                          |     | 25                         |     | 21   |     |      |    |
|  |                 |   | 6 V             | 36                            |       | 25                          |     | 29                         |     | 25   |     |      |    |
| t <sub>w</sub>   | Pulse duration  | SH/ $\overline{\text{LD}}$ low                        | 2 V             | 80                            | 120   | 100                         | 120 |                            |     | ns   |     |      |    |
|  |                 |   | 4.5 V           | 16                            | 24    | 20                          | 24  |                            |     |  |     |      |    |
|  |                 |   | 6 V             | 14                            | 20    | 17                          | 20  |                            |     |  |     |      |    |
|  |                 | CLK high or low                                       | 2 V             | 80                            | 120   | 100                         | 120 |                            |     |  |     |      |    |
|  |                 |   | 4.5 V           | 16                            | 24    | 20                          | 24  |                            |     |  |     |      |    |
|  |                 |   | 6 V             | 14                            | 20    | 17                          | 20  |                            |     |  |     |      |    |
| t <sub>su</sub>  | Setup time      | SH/ $\overline{\text{LD}}$ high before CLK $\uparrow$ | 2 V             | 80                            | 120   | 100                         | 120 |                            |     | ns   |     |      |    |
|  |                 |   | 4.5 V           | 16                            | 24    | 20                          | 24  |                            |     |  |     |      |    |
|  |                 |   | 6 V             | 14                            | 20    | 17                          | 20  |                            |     |  |     |      |    |
|  |                 | SER before CLK $\uparrow$                             | 2 V             | 40                            | 60    | 50                          | 60  |                            |     |  |     |      |    |
|  |                 |   | 4.5 V           | 8                             | 12    | 10                          | 12  |                            |     |  |     |      |    |
|  |                 |   | 6 V             | 7                             | 10    | 9                           | 10  |                            |     |  |     |      |    |
|  |                 | CLK INH low before CLK $\uparrow$                     | 2 V             | 100                           | 150   | 125                         | 150 |                            |     |  |     |      |    |
|  |                 |   | 4.5 V           | 20                            | 30    | 25                          | 30  |                            |     |  |     |      |    |
|  |                 |   | 6 V             | 17                            | 25    | 21                          | 25  |                            |     |  |     |      |    |
|  |                 | CLK INH high before CLK $\uparrow$                    | 2 V             | 40                            | 60    | 50                          | 60  |                            |     |  |     |      |    |
|  |                 |   | 4.5 V           | 8                             | 12    | 10                          | 12  |                            |     |  |     |      |    |
|  |                 |   | 6 V             | 7                             | 10    | 9                           | 10  |                            |     |  |     |      |    |
|  |                 | Data before SH/ $\overline{\text{LD}}$ $\downarrow$   | 2 V             | 100                           | 150   | 125                         | 150 |                            |     |  |     |      |    |
|  |                 |   | 4.5 V           | 20                            | 30    | 25                          | 30  |                            |     |  |     |      |    |
|  |                 |   | 6 V             | 17                            | 26    | 21                          | 26  |                            |     |  |     |      |    |
|  |                 | t <sub>h</sub>  | Hold time       | SER data after CLK $\uparrow$ | 2 V   | 5                           | 5   | 5                          | 5   |  |     |      | ns |
|  |                 |   |                 |                               | 4.5 V | 5                           | 5   | 5                          | 5   |  |     |      |    |
|  |                 |   |                 |                               | 6 V   | 5                           | 5   | 5                          | 5   |  |     |      |    |
| PAR data after SH/ $\overline{\text{LD}}$ $\downarrow$ | 2 V             |   |                 | 5                             | 5     | 5                           | 5   |                            |     |  |     |      |    |
|  | 4.5 V           |   |                 | 5                             | 5     | 5                           | 5   |                            |     |  |     |      |    |
|  | 6 V             |   |                 | 5                             | 5     | 5                           | 5   |                            |     |  |     |      |    |

## SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range,  $C_L = 50$  pF (unless otherwise noted) (see [Figure 3](#))

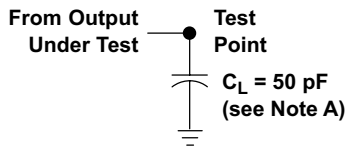
| PARAMETER | FROM<br>(INPUT)            | TO<br>(OUTPUT)            | $V_{CC}$ | $T_A = 25^\circ\text{C}$ |     |     | SN54HC165<br>–55°C TO 125°C |     | SN74HC165<br>–40°C TO 85°C |     | Recommended<br>SN74HC165<br>–40°C TO 125°C |     | UNIT |
|-----------|----------------------------|---------------------------|----------|--------------------------|-----|-----|-----------------------------|-----|----------------------------|-----|--|-----|------|
|           |                            |                           |          | MIN                      | TYP | MAX | MIN                         | MAX | MIN                        | MAX | MIN  | MAX |      |
| $f_{max}$ |                            |                           | 2 V      | 6                        | 13  |     | 4.2                         |     | 5                          |     | 4.2  | MHz |      |
|           |                            |                           | 4.5 V    | 31                       | 50  |     | 21                          |     | 25                         |     | 21   |     |      |
|           |                            |                           | 6 V      | 36                       | 62  |     | 25                          |     | 29                         |     | 25   |     |      |
| $t_{pd}$  | SH/ $\overline{\text{LD}}$ | $Q_H$ or $\overline{Q}_H$ | 2 V      |                          | 80  | 150 |                             | 225 |                            | 190 |  | 225 | ns   |
|           |                            |                           | 4.5 V    |                          | 20  | 30  |                             | 45  |                            | 38  |  | 45  |      |
|           |                            |                           | 6 V      |                          | 16  | 26  |                             | 38  |                            | 32  |  | 38  |      |
|           | CLK                        | $Q_H$ or $\overline{Q}_H$ | 2 V      |                          | 75  | 150 |                             | 225 |                            | 190 |  | 225 |      |
|           |                            |                           | 4.5 V    |                          | 15  | 30  |                             | 45  |                            | 38  |  | 45  |      |
|           |                            |                           | 6 V      |                          | 13  | 26  |                             | 38  |                            | 32  |  | 38  |      |
|           | H                          | $Q_H$ or $\overline{Q}_H$ | 2 V      |                          | 75  | 150 |                             | 225 |                            | 190 |  | 225 |      |
|           |                            |                           | 4.5 V    |                          | 15  | 30  |                             | 45  |                            | 38  |  | 45  |      |
|           |                            |                           | 6 V      |                          | 13  | 26  |                             | 38  |                            | 32  |  | 38  |      |
| $t_t$     |                            | Any                       | 2 V      |                          | 38  | 75  |                             | 110 |                            | 95  |  | 110 | ns   |
|           |                            |                           | 4.5 V    |                          | 8   | 15  |                             | 22  |                            | 19  |  | 22  |      |
|           |                            |                           | 6 V      |                          | 6   | 13  |                             | 19  |                            | 16  |  | 19  |      |

## OPERATING CHARACTERISTICS

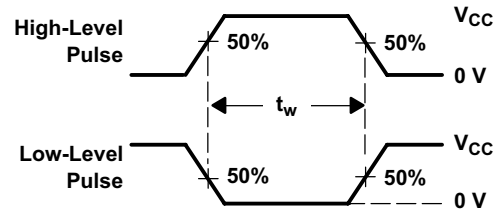
$T_A = 25^\circ\text{C}$

| PARAMETER                              | TEST CONDITIONS | TYP | UNIT |
|--|-----------------|-----|------|
| $C_{pd}$ Power dissipation capacitance | No load         | 75  | pF   |

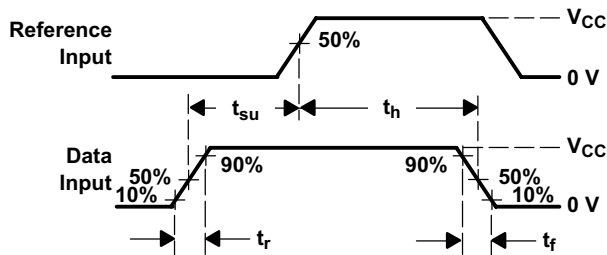
PARAMETER MEASUREMENT INFORMATION



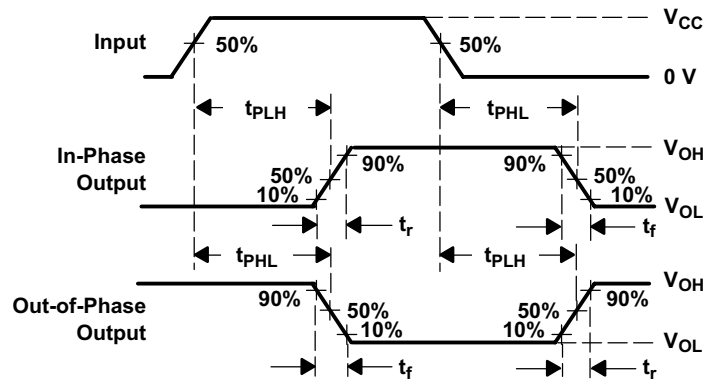
LOAD CIRCUIT



VOLTAGE WAVEFORMS  
PULSE DURATIONS



VOLTAGE WAVEFORMS  
SETUP AND HOLD AND INPUT RISE AND FALL TIMES



VOLTAGE WAVEFORMS  
PROPAGATION DELAY AND OUTPUT TRANSITION TIMES

- NOTES: A.  $C_L$  includes probe and test-fixture capacitance.  
 B. Phase relationships between waveforms were chosen arbitrarily. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 1 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r = 6 \text{ ns}$ ,  $t_f = 6 \text{ ns}$ .  
 C. For clock inputs,  $f_{max}$  is measured when the input duty cycle is 50%.  
 D. The outputs are measured one at a time with one input transition per measurement.  
 E.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Figure 1. Load Circuit and Voltage Waveforms