

# SN74ALVCH16601

## 18-BIT UNIVERSAL BUS TRANSCEIVER

### WITH 3-STATE OUTPUTS

SCES027 – JULY 1995

- Member of the Texas Instruments *Widebus™* Family
- *UBT™* (Universal Bus Transceiver) Combines D-Type Latches and D-Type Flip-Flops for Operation in Transparent, Latched, Clocked, or Clock-Enabled Mode
- *EPIC™* (Enhanced-Performance Implanted CMOS) Submicron Process
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- ESD Protection Exceeds 2000 V Per MIL-STD-883C, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)
- Latch-Up Performance Exceeds 250 mA Per JEDEC Standard JESD-17
- Package Options Include Plastic 300-mil Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages

#### description

This 18-bit universal bus transceiver is designed for 2.3-V to 3.6-V  $V_{CC}$  operation.

The SN74ALVCH16601 combines D-type latches and D-type flip-flops to allow data flow in transparent, latched, and clocked modes.

Data flow in each direction is controlled by output-enable ( $\overline{OEAB}$  and  $\overline{OEBA}$ ), latch-enable ( $\overline{LEAB}$  and  $\overline{LEBA}$ ), and clock ( $\overline{CLKAB}$  and  $\overline{CLKBA}$ ) inputs. The clock can be controlled by the clock-enable ( $\overline{CLKENAB}$  and  $\overline{CLKENBA}$ ) inputs. For A-to-B data flow, the device operates in the transparent mode when  $\overline{LEAB}$  is high. When  $\overline{LEAB}$  is low, the A data is latched if  $\overline{CLKAB}$  is held at a high or low logic level. If  $\overline{LEAB}$  is low, the A-bus data is stored in the latch/flip-flop on the low-to-high transition of  $\overline{CLKAB}$ . Output enable  $\overline{OEAB}$  is active low. When  $\overline{OEAB}$  is low, the outputs are active. When  $\overline{OEAB}$  is high, the outputs are in the high-impedance state.

Data flow for B to A is similar to that of A to B but uses  $\overline{OEBA}$ ,  $\overline{LEBA}$ ,  $\overline{CLKBA}$ , and  $\overline{CLKENBA}$ .

To ensure the high-impedance state during power up or power down,  $\overline{OE}$  should be tied to  $V_{CC}$  through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

The SN74ALVCH16601 is available in TI's shrink small-outline (DL) and thin shrink small-outline (DGG) packages, which provide twice the I/O pin count and functionality of standard small-outline packages in the same printed-circuit-board area.

The SN74ALVCH16601 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

DGG OR DL PACKAGE  
(TOP VIEW)

$\overline{OEAB}$	1	56	$\overline{CLKENAB}$
$\overline{LEAB}$	2	55	$\overline{CLKAB}$
A1	3	54	B1
GND	4	53	GND
A2	5	52	B2
A3	6	51	B3
$V_{CC}$	7	50	$V_{CC}$
A4	8	49	B4
A5	9	48	B5
A6	10	47	B6
GND	11	46	GND
A7	12	45	B7
A8	13	44	B8
A9	14	43	B9
A10	15	42	B10
A11	16	41	B11
A12	17	40	B12
GND	18	39	GND
A13	19	38	B13
A14	20	37	B14
A15	21	36	B15
$V_{CC}$	22	35	$V_{CC}$
A16	23	34	B16
A17	24	33	B17
GND	25	32	GND
A18	26	31	B18
$\overline{OEBA}$	27	30	$\overline{CLKBA}$
$\overline{LEBA}$	28	29	$\overline{CLKENBA}$



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FUNCTION TABLE†

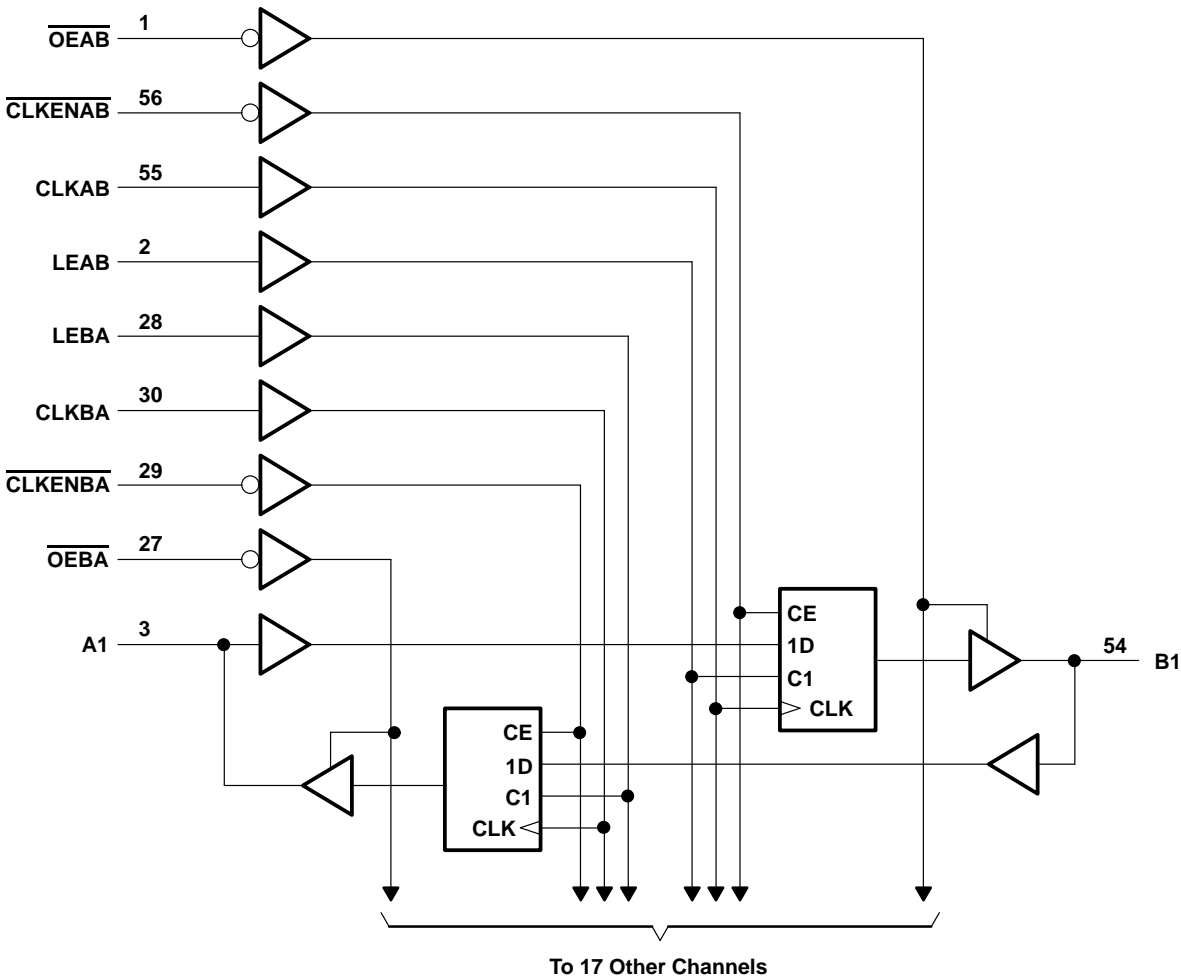
INPUTS					OUTPUT B
CLKENAB	OEAB	LEAB	CLKAB	A	
X	H	X	X	X	Z
X	L	H	X	L	L
X	L	H	X	H	H
H	L	L	X	X	B <sub>0</sub> ‡
H	L	L	X	X	B <sub>0</sub> ‡
L	L	L	↑	L	L
L	L	L	↑	H	H
L	L	L	L	X	B <sub>0</sub> ‡
L	L	L	H	X	B <sub>0</sub> §

† A-to-B data flow is shown: B-to-A flow is similar but uses OEBA, LEBA, CLKBA, and CLKENBA.

‡ Output level before the indicated steady-state input conditions were established

§ Output level before the indicated steady-state input conditions were established, provided that CLKAB was high before LEAB went low

logic diagram (positive logic)



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

Supply voltage range, $V_{CC}$	–0.5 V to 4.6 V
Input voltage range, $V_I$ : Except I/O ports (see Note 1)	–0.5 V to 4.6 V
I/O ports (see Notes 1 and 2)	–0.5 V to $V_{CC} + 0.5$ V
Output voltage range, $V_O$ (see Notes 1 and 2)	–0.5 V to $V_{CC} + 0.5$ V
Input clamp current, $I_{IK}$ ( $V_I < 0$ )	–50 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 each $V_{CC}$ or GND	±100 mA
Maximum power dissipation at $T_A = 55^\circ\text{C}$ (in still air) (see Note 3): 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 negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.  
2. This value is limited to 4.6 V maximum.  
3. The maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils. For more information, refer to the *Package Thermal Considerations* application note in the 1994 *ABT Advanced BiCMOS Technology Data Book*, literature number SCBD002B.

**recommended operating conditions (see Note 4)**

			MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage		2.3	3.6	V
V <sub>IH</sub>	High-level input voltage	V <sub>CC</sub> = 2.3 V to 2.7 V	1.7		V
		V <sub>CC</sub> = 2.7 V to 3.6 V	2		
V <sub>IL</sub>	Low-level input voltage	V <sub>CC</sub> = 2.3 V to 2.7 V	0.7		V
		V <sub>CC</sub> = 2.7 V to 3.6 V	0.8		
V <sub>I</sub>	Input voltage		0	V <sub>CC</sub>	V
V <sub>O</sub>	Output voltage		0	V <sub>CC</sub>	V
I <sub>OH</sub>	High-level output current	V <sub>CC</sub> = 2.3 V	−12		mA
		V <sub>CC</sub> = 2.7 V	−12		
		V <sub>CC</sub> = 3 V	−24		
I <sub>OL</sub>	Low-level output current	V <sub>CC</sub> = 2.3 V	12		mA
		V <sub>CC</sub> = 2.7 V	12		
		V <sub>CC</sub> = 3 V	24		
Δt/Δv	Input transition rise or fall rate		0	10	ns/V
T <sub>A</sub>	Operating free-air temperature		−40	85	°C

NOTE 4: Unused control inputs must be held high or low to prevent them from floating.

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

PARAMETER		TEST CONDITIONS	V <sub>CC</sub> <sup>†</sup>	MIN	TYP <sup>‡</sup>	MAX	UNIT
V <sub>OH</sub>	I <sub>OH</sub> = −100 μA		MIN to MAX	V <sub>CC</sub> − 0.2			V
	I <sub>OH</sub> = −6 mA, V <sub>IH</sub> = 1.7 V		2.3 V	2			
	I <sub>OH</sub> = −12 mA	V <sub>IH</sub> = 1.7 V	2.3 V	1.7			
		V <sub>IH</sub> = 2 V	2.7 V	2.2			
		V <sub>IH</sub> = 2 V	3 V	2.4			
	I <sub>OH</sub> = −24 mA, V <sub>IH</sub> = 2 V		3 V	2			
V <sub>OL</sub>	I <sub>OL</sub> = 100 μA		MIN to MAX			0.2	V
	I <sub>OL</sub> = 6 mA, V <sub>IL</sub> = 0.7 V		2.3 V			0.4	
	I <sub>OL</sub> = 12 mA	V <sub>IL</sub> = 0.7 V	2.3 V			0.7	
		V <sub>IL</sub> = 0.8 V	2.7 V			0.4	
	I <sub>OL</sub> = 24 mA, V <sub>IL</sub> = 0.8 V		3 V			0.55	
I <sub>I</sub>	V <sub>I</sub> = V <sub>CC</sub> or GND		3.6 V			±5	μA
I <sub>I</sub> (hold)	V <sub>I</sub> = 0.7 V		2.3 V	45			μA
	V <sub>I</sub> = 1.7 V			−45			
	V <sub>I</sub> = 0.8 V		3 V	75			
	V <sub>I</sub> = 2 V			−75			
	V <sub>I</sub> = 0 to 3.6 V		3.6 V			±500	
I <sub>OZ</sub> <sup>§</sup>	V <sub>O</sub> = V <sub>CC</sub> or GND		3.6 V			±10	μA
I <sub>CC</sub>	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0		3.6 V			40	μA
ΔI <sub>CC</sub>	One input at V <sub>CC</sub> − 0.6 V, Other inputs at V <sub>CC</sub> or GND		3 V to 3.6 V			750	μA
C <sub>i</sub>	Control inputs	V <sub>I</sub> = V <sub>CC</sub> or GND	3.3 V	4			pF
C <sub>io</sub>	A or B ports	V <sub>O</sub> = V <sub>CC</sub> or GND	3.3 V	8			pF

<sup>†</sup> For conditions shown as MIN or MAX, use the appropriate values under recommended operating conditions.

<sup>‡</sup> Typical values are measured at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C.

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

**timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)**

			V <sub>CC</sub> = 2.5 V ± 0.2 V		V <sub>CC</sub> = 2.7 V		V <sub>CC</sub> = 3.3 V ± 0.3 V		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Clock frequency		0	150	0	150	0	150	MHz
t <sub>w</sub>	Pulse duration	LE <sup>↑</sup>	3.3		3.3		3.3		ns
		CLK high or low	3.3		3.3		3.3		
t <sub>su</sub>	Setup time	Data before CLK <sup>↑</sup>	2.3		2.4		2.1		ns
		Data before LE <sup>↓</sup> , CLK <sup>↑</sup>	2		1.6		1.6		
		Data before LE <sup>↓</sup> , CLK <sup>↓</sup>	1.3		1.2		1.1		
		CLKEN before CLK <sup>↑</sup>	2		2		1.7		
t <sub>h</sub>	Hold time	Data after CLK <sup>↑</sup>	0.7		0.7		0.8		ns
		Data after LE <sup>↓</sup> , CLK <sup>↑</sup>	1.3		1.6		1.4		
		Data after LE <sup>↓</sup> , CLK <sup>↓</sup>	1.7		2		1.7		
		CLKEN after CLK <sup>↑</sup>	0.3		0.5		0.6		



switching characteristics over recommended ranges of supply voltage and operating free-air temperature,  $C_L = 50$  pF (unless otherwise noted) (see Figures 1 and 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
$f_{max}$			150		150		150		MHz
$t_{pd}$	A or B	B or A	1.3	4.9	4.6		4.1		ns
	LEAB or LEBA	A or B	1.2	5.6	5.3		4.7		
	CLKAB or CLKBA	A or B	1.7	6.2	5.8		5		
$t_{en}$	$\overline{OEAB}$ or $\overline{OEBA}$	B or A	1.2	6.1	6.1		5.2		ns
$t_{dis}$	$\overline{OEAB}$ or $\overline{OEBA}$	B or A	2.1	5.4	4.8		4.4		ns

operating characteristics,  $T_A = 25^\circ\text{C}$

PARAMETER			TEST CONDITIONS	$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$	$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$	UNIT
				TYP	TYP	
$C_{pd}$ Power dissipation capacitance	Outputs enabled	$C_L = 50\text{ pF}, \quad f = 10\text{ MHz}$		41	52	pF
	Outputs disabled			6	6	

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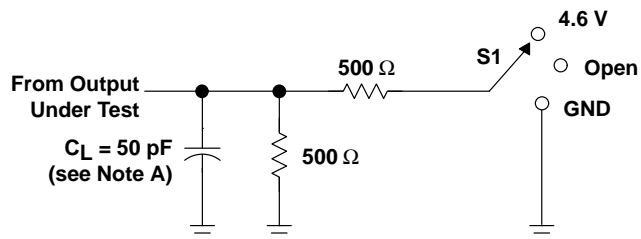
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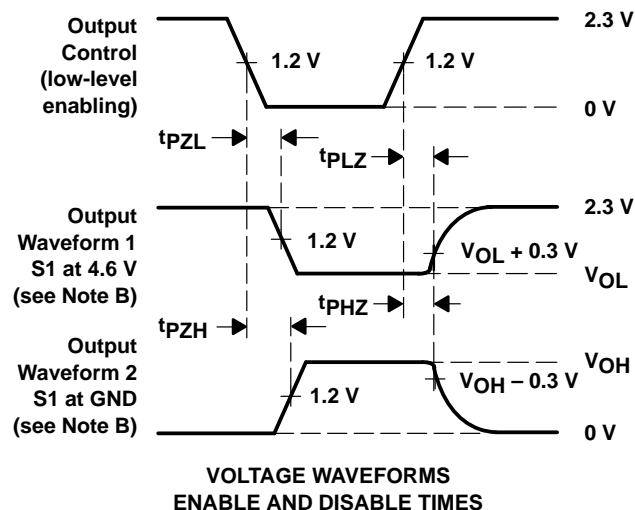
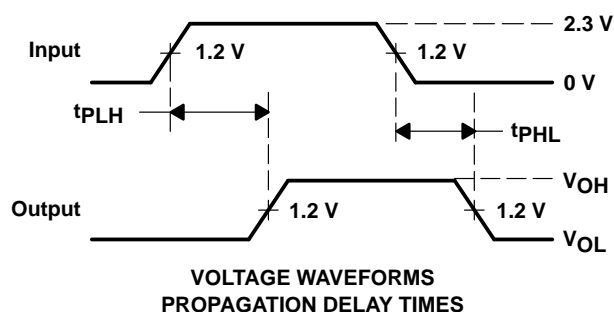
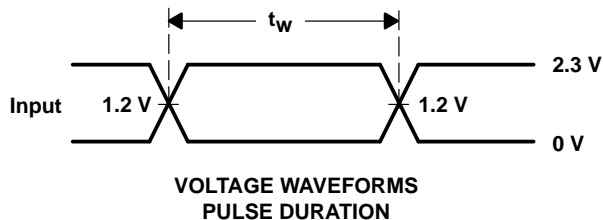
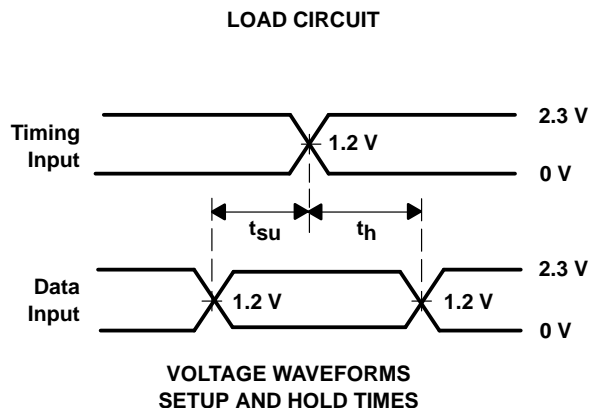
#### PARAMETER MEASUREMENT INFORMATION

$$V_{CC} = 2.5 \text{ V} \pm 0.2 \text{ V}$$



LOAD CIRCUIT

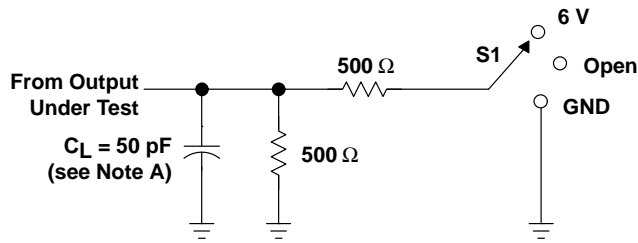
TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	4.6 V
$t_{PHZ}/t_{PZH}$	GND



- 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:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5 \text{ ns}$ ,  $t_f \leq 2.5 \text{ ns}$ .
  - D. The outputs are measured one at a time with one transition per measurement.
  - E.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
  - F.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
  - G.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

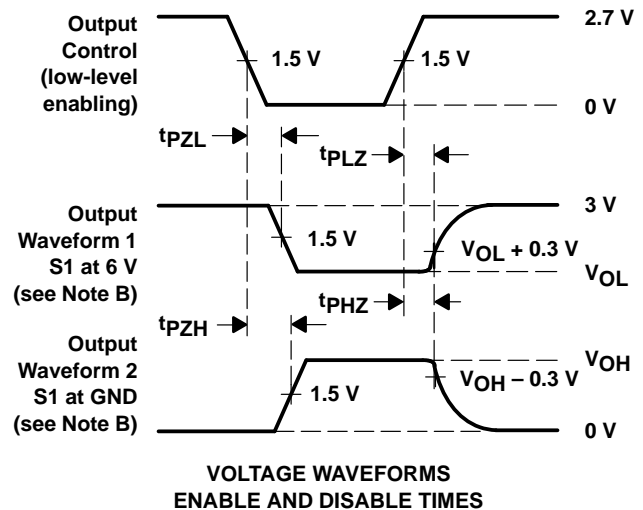
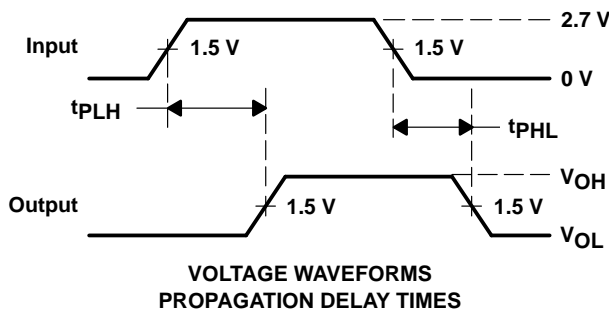
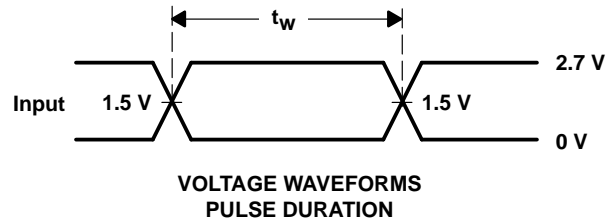
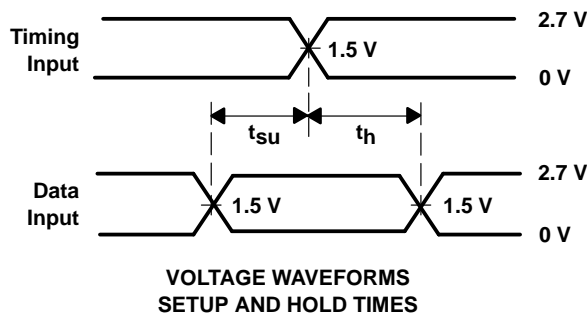
Figure 1. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION  
 $V_{CC} = 2.7\text{ V}$  AND  $3.3\text{ V} \pm 0.3\text{ V}$



LOAD CIRCUIT

TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	6 V
$t_{PHZ}/t_{PZH}$	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:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ ,  $t_r \leq 2.5\text{ ns}$ ,  $t_f \leq 2.5\text{ ns}$ .
  - D. The outputs are measured one at a time with one transition per measurement.
  - E.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
  - F.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
  - G.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Figure 2. Load Circuit and Voltage Waveforms

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