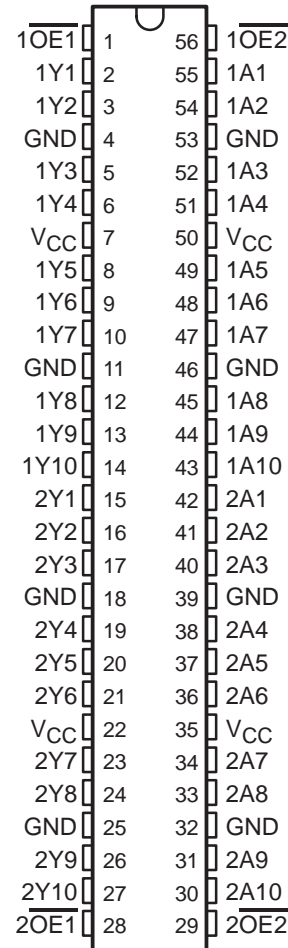


SN54ALVTH162827, SN74ALVTH162827 2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

SCES079E – JULY 1996 – REVISED DECEMBER 1998

- State-of-the-Art Advanced BiCMOS Technology (ABT) *Widebus*™ Design for 2.5-V and 3.3-V Operation and Low Static Power Dissipation
- Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 2.3-V to 3.6-V V_{CC})
- Typical V_{OLP} (Output Ground Bounce) <0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- Power Off Disables Outputs, Permitting Live Insertion
- High-Impedance State During Power Up and Power Down Prevents Driver Conflict
- Uses Bus Hold on Data Inputs in Place of External Pullup/Pulldown Resistors to Prevent the Bus From Floating
- Output Ports Have Equivalent 30- Ω Series Resistors, So No External Resistors Are Required
- Auto3-State Eliminates Bus Current Loading When Output Exceeds $V_{CC} + 0.5$ V
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model; and Exceeds 1000 V Using Charged-Device Model, Robotic Method
- Flow-Through Architecture Facilitates Printed Circuit Board Layout
- Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise
- Package Options Include Plastic Shrink Small-Outline (DL), Thin Shrink Small-Outline (DGG), Thin Very Small-Outline (DGV) Packages, and 380-mil Fine-Pitch Ceramic Flat (WD) Package

SN54ALVTH162827 . . . WD PACKAGE
SN74ALVTH162827 . . . DGG, DGV, OR DL PACKAGE
(TOP VIEW)



NOTE: For order entry:
The DGG package is abbreviated to G, and
the DGV package is abbreviated to V.

description

The 'ALVTH162827 devices are 20-bit buffers/line drivers designed for 2.5-V or 3.3-V V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment.



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.

Widebus is a trademark of Texas Instruments Incorporated.

UNLESS OTHERWISE NOTED this document contains PRODUCTION DATA information current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

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SN54ALVTH162827, SN74ALVTH162827

2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS

WITH 3-STATE OUTPUTS

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description (continued)

The devices are composed of two 10-bit sections with separate output-enable signals. For either 10-bit buffer section, the two output-enable ($\overline{1OE1}$ and $\overline{1OE2}$, or $\overline{2OE1}$ and $\overline{2OE2}$) inputs must be low for the corresponding Y outputs to be active. If either output-enable input is high, the outputs of that 10-bit buffer section are in the high-impedance state.

When V_{CC} is between 0 and 1.2 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.2 V, \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.

All outputs are designed to sink up to 12 mA, and include equivalent 30- Ω resistors to reduce overshoot and undershoot.

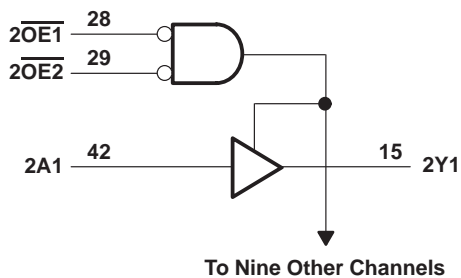
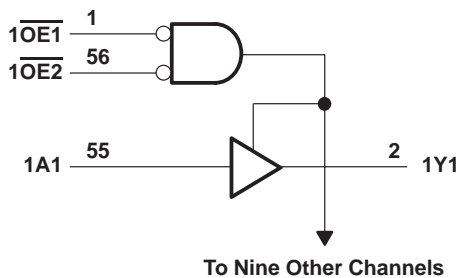
Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

The SN54ALVTH162827 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74ALVTH162827 is characterized for operation from -40°C to 85°C .

FUNCTION TABLE
(each 10-bit section)

INPUTS			OUTPUT
$\overline{OE1}$	$\overline{OE2}$	A	Y
L	L	L	L
L	L	H	H
H	X	X	Z
X	H	X	Z

logic diagram (positive logic)



SN54ALVTH162827, SN74ALVTH162827
2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS
WITH 3-STATE OUTPUTS

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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 4.6 V
Input voltage range, V_I (see Note 1)	–0.5 V to 7 V
Voltage range applied to any output in the high-impedance or power-off state, V_O (see Note 1)	–0.5 V to 7 V
Voltage range applied to any output in the high state, V_O (see Note 1)	–0.5 V to 7 V
Output current in the low state, I_{OL} : SN54ALVTH162827	96 mA
SN74ALVTH162827	128 mA
Output current in the high state, I_{OH} : SN54ALVTH162827	–48 mA
SN74ALVTH162827	–64 mA
Input clamp current, I_{IK} ($V_I < 0$)	–50 mA
Output clamp current, I_{OK} ($V_O < 0$)	–50 mA
Package thermal impedance, θ_{JA} (see Note 2): DGG package	81°C/W
DGV package	86°C/W
DL package	74°C/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. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions, $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$ (see Note 3)

	SN54ALVTH162827			SN74ALVTH162827			UNIT
	MIN	TYP	MAX	MIN	TYP	MAX	
V_{CC} Supply voltage	2.3		2.7	2.3		2.7	V
V_{IH} High-level input voltage	1.7			1.7			V
V_{IL} Low-level input voltage			0.7			0.7	V
V_I Input voltage	0	V_{CC}	5.5	0	V_{CC}	5.5	V
I_{OH} High-level output current			–6			–8	mA
I_{OL} Low-level output current			8			12	mA
$\Delta t/\Delta v$ Input transition rise or fall rate	Outputs enabled		10			10	ns/V
$\Delta t/\Delta V_{CC}$ Power-up ramp rate	200			200			$\mu\text{s}/V$
T_A Operating free-air temperature	–55		125	–40		85	°C

NOTE 3: All unused control inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

SN54ALVTH162827, SN74ALVTH162827
2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS
WITH 3-STATE OUTPUTS

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recommended operating conditions, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (see Note 3)

		SN54ALVTH162827			SN74ALVTH162827			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
V_{CC}	Supply voltage	3		3.6	3		3.6	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}	5.5	0	V_{CC}	5.5	V
I_{OH}	High-level output current			-8			-12	mA
I_{OL}	Low-level output current			8			12	mA
$\Delta t/\Delta v$	Input transition rise or fall rate		Outputs enabled	10			10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate	200			200			$\mu\text{s/V}$
T_A	Operating free-air temperature	-55		125	-40		85	$^{\circ}\text{C}$

NOTE 3: All unused control inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

SN54ALVTH162827, SN74ALVTH162827
2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS
WITH 3-STATE OUTPUTS

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electrical characteristics over recommended operating free-air temperature range,
 $V_{CC} = 2.5 \text{ V} \pm 0.2 \text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS	SN54ALVTH162827		SN74ALVTH162827		UNIT	
		MIN	TYP†	MAX	MIN		TYP†
V_{IK}	$V_{CC} = 2.3 \text{ V}$, $I_I = -18 \text{ mA}$			-1.2		-1.2	V
V_{OH}	$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$, $I_{OH} = -100 \mu\text{A}$	$V_{CC}-0.2$			$V_{CC}-0.2$		V
	$V_{CC} = 2.3 \text{ V}$		1.7		1.7		
V_{OL}	$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$, $I_{OL} = 100 \mu\text{A}$			0.2		0.2	V
	$V_{CC} = 2.3 \text{ V}$			0.7			
						0.7	
I_I	Control inputs	$V_{CC} = 2.7 \text{ V}$, $V_I = V_{CC} \text{ or GND}$		± 1		± 1	μA
		$V_{CC} = 0 \text{ or } 2.7 \text{ V}$, $V_I = 5.5 \text{ V}$		10		10	
	Data inputs	$V_{CC} = 2.7 \text{ V}$		10		10	
			$V_I = 5.5 \text{ V}$		1		
		$V_I = 0$		-5		-5	
I_{off}	$V_{CC} = 0$, $V_I \text{ or } V_O = 0 \text{ to } 4.5 \text{ V}$					± 100	μA
I_{BHL}^\ddagger	$V_{CC} = 2.3 \text{ V}$, $V_I = 0.7 \text{ V}$		115		115		μA
I_{BHH}^\S	$V_{CC} = 2.3 \text{ V}$, $V_I = 1.7 \text{ V}$		-10		-10		μA
I_{BHLO}^\P	$V_{CC} = 2.7 \text{ V}$, $V_I = 0 \text{ to } V_{CC}$	300			300		μA
$I_{BHHO}^\#$	$V_{CC} = 2.7 \text{ V}$, $V_I = 0 \text{ to } V_{CC}$	-300			-300		μA
I_{EX}^\parallel	$V_{CC} = 2.3 \text{ V}$, $V_O = 5.5 \text{ V}$			125		125	μA
$I_{OZ(PU/PD)}^\star$	$V_{CC} \leq 1.2 \text{ V}$, $V_O = 0.5 \text{ V to } V_{CC}$, $V_I = \text{GND or } V_{CC}$, $\overline{OE} = \text{don't care}$			± 100		± 100	μA
I_{OZH}	$V_{CC} = 2.7 \text{ V}$			5		5	μA
I_{OZL}	$V_{CC} = 2.7 \text{ V}$			-5		-5	μA
I_{CC}	$V_{CC} = 2.7 \text{ V}$, $I_O = 0$, $V_I = V_{CC} \text{ or GND}$	Outputs high	0.04	0.1	0.04	0.1	mA
		Outputs low	2.3	5	2.3	5	
		Outputs disabled	0.04	0.1	0.04	0.1	
C_i	$V_{CC} = 2.5 \text{ V}$, $V_I = 2.5 \text{ V or } 0$			3.5		3.5	pF
C_o	$V_{CC} = 2.5 \text{ V}$, $V_O = 2.5 \text{ V or } 0$			6		6	pF

† All typical values are at $V_{CC} = 2.5 \text{ V}$, $T_A = 25^\circ\text{C}$.

‡ The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL} max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL} max.

§ The bus-hold circuit can source at least the minimum high sustaining current at V_{IH} min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH} min.

¶ An external driver must source at least I_{BHLO} to switch this node from low to high.

An external driver must sink at least I_{BHHO} to switch this node from high to low.

|| Current into an output in the high state when $V_O > V_{CC}$

☆ High-impedance state during power up or power down

SN54ALVTH162827, SN74ALVTH162827

2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS

WITH 3-STATE OUTPUTS

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electrical characteristics over recommended operating free-air temperature range,
 $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SN54ALVTH162827			SN74ALVTH162827			UNIT	
			MIN	TYP†	MAX	MIN	TYP†	MAX		
V_{IK}	$V_{CC} = 3\text{ V}$, $I_I = -18\text{ mA}$		-1.2			-1.2			V	
V_{OH}	$V_{CC} = 3\text{ V to } 3.6\text{ V}$, $I_{OH} = -100\text{ }\mu\text{A}$		$V_{CC}-0.2$			$V_{CC}-0.2$			V	
	$V_{CC} = 3\text{ V}$	$I_{OH} = -8\text{ mA}$	2			2				
V_{OL}	$V_{CC} = 3\text{ V to } 3.6\text{ V}$, $I_{OL} = 100\text{ }\mu\text{A}$		0.2			0.2			V	
	$V_{CC} = 3\text{ V}$	$I_{OL} = 8\text{ mA}$	0.8							
		$I_{OL} = 12\text{ mA}$				0.8				
I_I	Control inputs	$V_{CC} = 3.6\text{ V}$, $V_I = V_{CC}$ or GND	± 1			± 1			μA	
		$V_{CC} = 0$ or 3.6 V , $V_I = 5.5\text{ V}$	10			10				
	Data inputs	$V_{CC} = 3.6\text{ V}$	$V_I = 5.5\text{ V}$	10			10			
			$V_I = V_{CC}$	1			1			
		$V_I = 0$	-5			-5				
I_{off}	$V_{CC} = 0$, V_I or $V_O = 0$ to 4.5 V					± 100			μA	
I_{BHL}^\ddagger	$V_{CC} = 3\text{ V}$, $V_I = 0.8\text{ V}$		75			75			μA	
I_{BHH}^\S	$V_{CC} = 3\text{ V}$, $V_I = 2\text{ V}$		-75			-75			μA	
I_{BHLO}^\P	$V_{CC} = 3.6\text{ V}$, $V_I = 0$ to V_{CC}		500			500			μA	
$I_{BHHO}^\#$	$V_{CC} = 3.6\text{ V}$, $V_I = 0$ to V_{CC}		-500			-500			μA	
I_{EX}^\parallel	$V_{CC} = 3\text{ V}$, $V_O = 5.5\text{ V}$		125			125			μA	
$I_{OZ(PU/PD)}^\star$	$V_{CC} \leq 1.2\text{ V}$, $V_O = 0.5\text{ V to } V_{CC}$, $V_I = \text{GND or } V_{CC}$, $\overline{OE} = \text{don't care}$		± 100			± 100			μA	
I_{OZH}	$V_{CC} = 3.6\text{ V}$	$V_O = 3\text{ V}$, $V_I = 0.8\text{ V or } 2\text{ V}$	5			5			μA	
I_{OZL}	$V_{CC} = 3.6\text{ V}$	$V_O = 0.5\text{ V}$, $V_I = 0.8\text{ V or } 2\text{ V}$	-5			-5			μA	
I_{CC}	$V_{CC} = 3.6\text{ V}$, $I_O = 0$, $V_I = V_{CC}$ or GND	Outputs high	0.07	0.1	0.07	0.1	mA			
		Outputs low	3.2	5.5	3.2	5.5				
		Outputs disabled	0.07	0.1	0.07	0.1				
ΔI_{CC}^\square	$V_{CC} = 3\text{ V to } 3.6\text{ V}$, One input at $V_{CC} - 0.6\text{ V}$, Other inputs at V_{CC} or GND		0.4			0.4			mA	
C_I	$V_{CC} = 3.3\text{ V}$, $V_I = 3.3\text{ V or } 0$		3.5			3.5			pF	
C_O	$V_{CC} = 3.3\text{ V}$, $V_O = 3.3\text{ V or } 0$		6			6			pF	

† All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

‡ The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL} max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL} max.

§ The bus-hold circuit can source at least the minimum high sustaining current at V_{IH} min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH} min.

¶ An external driver must source at least I_{BHLO} to switch this node from low to high.

An external driver must sink at least I_{BHHO} to switch this node from high to low.

|| Current into an output in the high state when $V_O > V_{CC}$

* High-impedance state during power up or power down

□ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

SN54ALVTH162827, SN74ALVTH162827
2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS
WITH 3-STATE OUTPUTS

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switching characteristics over recommended operating free-air temperature range, $C_L = 30\text{ pF}$, $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$ (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH162827		SN74ALVTH162827		UNIT
			MIN	MAX	MIN	MAX	
t _{PLH}	A	Y	1.7	4.1	1.7	4.1	ns
t _{PHL}			1.6	4	1.6	4	
t _{PZH}	\overline{OE}	Y	2.1	4.8	2.1	4.8	ns
t _{PZL}			1.9	4.8	1.9	4.8	
t _{PHZ}	\overline{OE}	Y	2.4	6	2.4	6	ns
t _{PLZ}			1.7	5	1.7	5	

switching characteristics over recommended operating free-air temperature range, $C_L = 50\text{ pF}$, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH162827		SN74ALVTH162827		UNIT
			MIN	MAX	MIN	MAX	
t _{PLH}	A	Y	1	3.9	1	3.9	ns
t _{PHL}			1.5	3.7	1.5	3.7	
t _{PZH}	\overline{OE}	Y	1	5.6	1	5.6	ns
t _{PZL}			1.7	4.1	1.7	4.1	
t _{PHZ}	\overline{OE}	Y	3.6	6.3	3.6	6.3	ns
t _{PLZ}			1.7	5.1	1.7	5.1	

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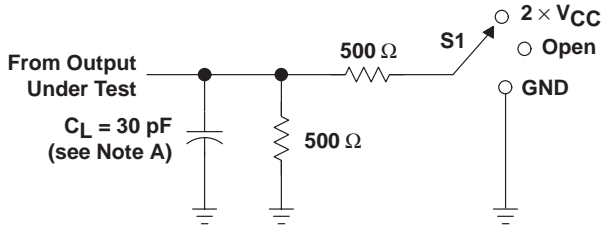
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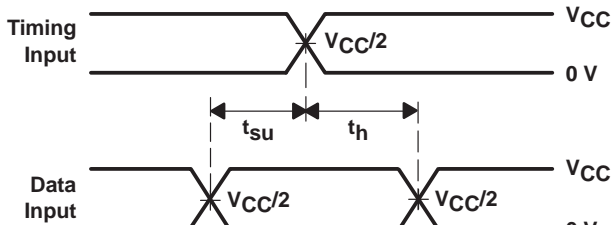
PARAMETER MEASUREMENT INFORMATION

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

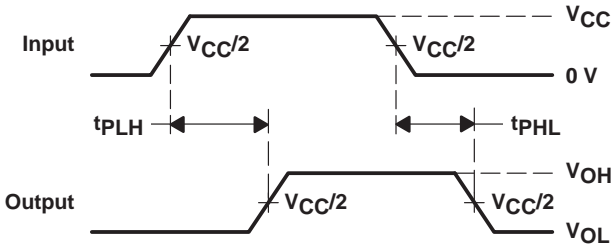


LOAD CIRCUIT

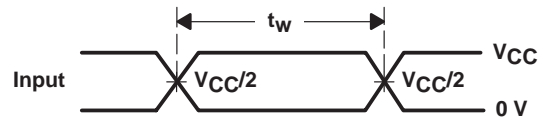
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	2 $\times V_{CC}$
t_{PHZ}/t_{PZH}	GND



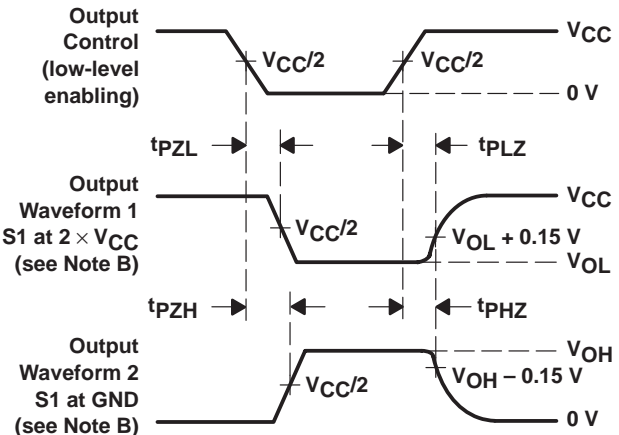
**VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES**



**VOLTAGE WAVEFORMS
PULSE DURATION**



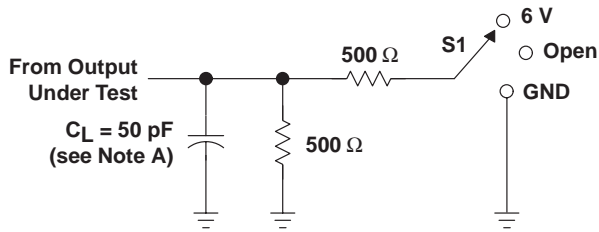
**VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES**

- 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 $\leq 10\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r \leq 2\text{ ns}$, $t_f \leq 2\text{ ns}$.
 D. The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

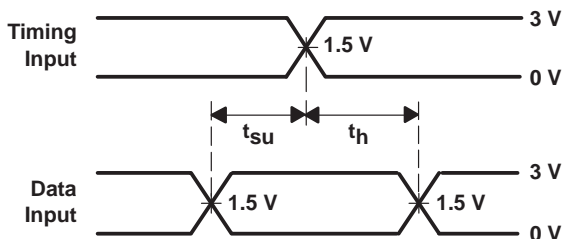
PARAMETER MEASUREMENT INFORMATION

$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$

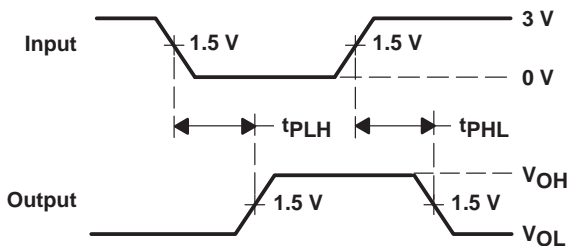


LOAD CIRCUIT

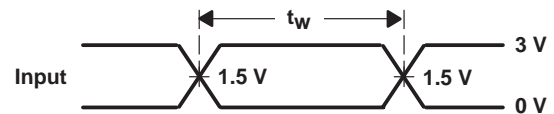
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



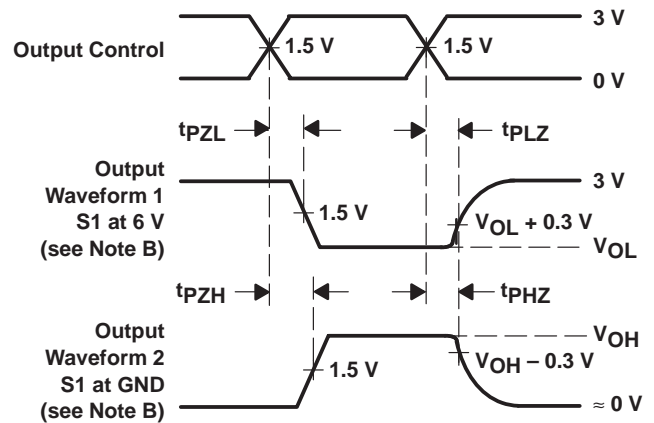
VOLTAGE WAVEFORMS
 SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
 PROPAGATION DELAY TIMES
 INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
 PULSE DURATION



VOLTAGE WAVEFORMS
 ENABLE AND DISABLE TIMES
 LOW- AND HIGH-LEVEL ENABLING

- 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.

Figure 2. Load Circuit and Voltage Waveforms

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