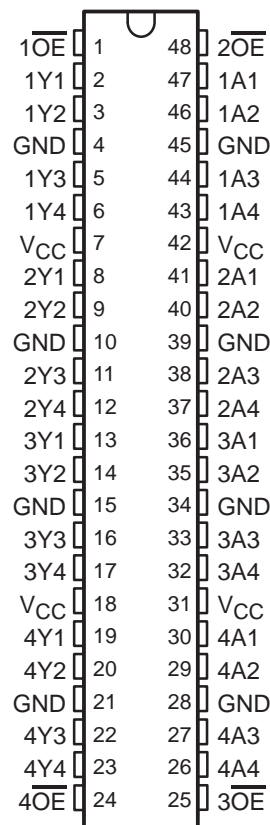


SN54ALVTH16244, SN74ALVTH16244 2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

SCES070G – JUNE 1996 – REVISED MAY 1999

- Members of the Texas Instruments *Widebus™* Family
- State-of-the-Art Advanced BiCMOS Technology (ABT) Design for 3.3-V Operation and Low Static-Power Dissipation
- 5-V I/O Compatible
- High Drive Capability (–32 mA/64 mA)
- Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V_{CC})
- Support Unregulated Battery Operation Down to 2.3 V
- Typical V_{OLP} (Output Ground Bounce) < 0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- Auto3-State Eliminates Bus Current Loading When Voltage at the Output Exceeds V_{CC}
- I_{off} and Power-Up 3-State Support Hot Insertion
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- 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 ($C = 200$ pF, $R = 0$)
- Package Options Include Plastic 300-mil Shrink Small-Outline (DL), Thin Shrink Small-Outline (DGG), Thin Very Small-Outline (DGV) Packages, and 380-mil Fine-Pitch Ceramic Flat (WD) Package

SN54ALVTH16244 . . . WD PACKAGE
SN74ALVTH16244 . . . DGG, DGV, OR DL PACKAGE
(TOP VIEW)



NOTE: For tape and reel order entry:
The DGGR package is abbreviated to GR, and
the DGVR package is abbreviated to VR.

description

The 'ALVTH16244 devices are 16-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. These devices can be used as four 4-bit buffers, two 8-bit buffers, or one 16-bit buffer.

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



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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SN54ALVTH16244, SN74ALVTH16244

2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS

WITH 3-STATE OUTPUTS

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description (continued)

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, the output-enable (\overline{OE}) input 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.

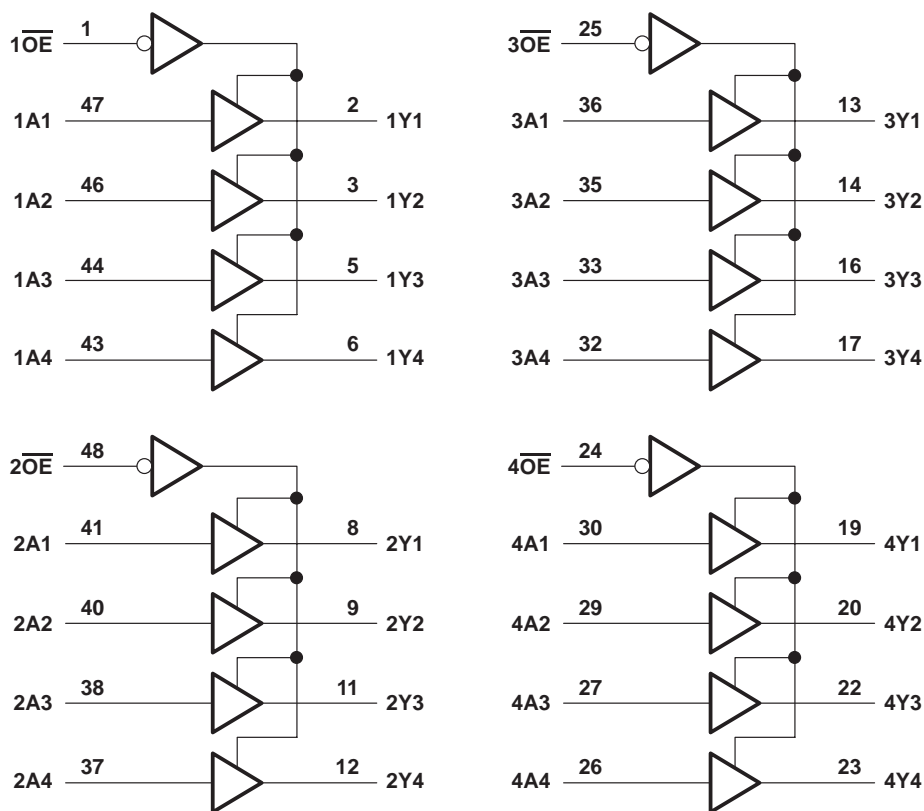
These devices are fully specified for hot-insertion applications using I_{off} and power-up 3-state. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the devices when they are powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict.

The SN54ALVTH16244 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74ALVTH16244 is characterized for operation from -40°C to 85°C .

FUNCTION TABLE
(each buffer)

INPUTS		OUTPUT
\overline{OE}	A	Y
L	H	H
L	L	L
H	X	Z

logic diagram (positive logic)



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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 V_{CC} to 7V
Output current in the low state, I_O : SN54ALVTH16244	96 mA
SN74ALVTH16244	128 mA
Output current in the high state, I_O : SN54ALVTH16244	–48 mA
SN74ALVTH16244	–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	89°C/W
DGV package	93°C/W
DL package	94°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)

		SN54ALVTH16244		SN74ALVTH16244		UNIT
		MIN	MAX	MIN	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	5.5	0	5.5	V
I_{OH}	High-level output current		–6		–8	mA
I_{OL}	Low-level output current		6		8	mA
	Low-level output current; current duty cycle $\leq 50\%$; $f \geq 1\text{ kHz}$		18		24	
$\Delta t/\Delta v$	Input transition rise or fall rate		10		10	ns/V
	Outputs enabled					
$\Delta t/\Delta V_{CC}$	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.

SN54ALVTH16244, SN74ALVTH16244
2.5-V/3.3-V 16-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)

		SN54ALVTH16244		SN74ALVTH16244		UNIT
		MIN	MAX	MIN	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	5.5	0	5.5	V
I_{OH}	High-level output current		-24		-32	mA
I_{OL}	Low-level output current		24		32	mA
	Low-level output current; current duty cycle $\leq 50\%$; $f \geq 1\text{ kHz}$		48		64	
$\Delta t/\Delta v$	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.

SN54ALVTH16244, SN74ALVTH16244
2.5-V/3.3-V 16-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	SN54ALVTH16244		SN74ALVTH16244		UNIT	
			MIN	TYP†	MAX	MIN		TYP†
V_{IK}		$V_{CC} = 2.3 \text{ V}$, $I_I = -18 \text{ mA}$			-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	
		$V_{CC} = 2.3 \text{ V}$	1.8		1.8			
V_{OL}		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$, $I_{OL} = 100 \mu\text{A}$	0.2		0.2		V	
		$V_{CC} = 2.3 \text{ V}$	$I_{OL} = 6 \text{ mA}$	0.4				
			$I_{OL} = 8 \text{ mA}$			0.4		
			$I_{OL} = 18 \text{ mA}$	0.5				
			$I_{OL} = 24 \text{ mA}$			0.5		
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	$V_{CC} = 2.7 \text{ V}$, $V_I = V_{CC}$	1		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	
$I_{I(\text{hold})}$	Data inputs	$V_{CC} = 2.3 \text{ V}$	$V_I = 0.7 \text{ V}$		115		μA	
			$V_I = 1.7 \text{ V}$		-10			
		$V_{CC} = 2.7 \text{ V}^\ddagger$, $V_I = 0 \text{ to } 2.7 \text{ V}$	± 300		± 300			
I_{EX}^\S		$V_{CC} = 2.3 \text{ V}$, $V_O = 5.5 \text{ V}$	125		125		μA	
$I_{OZ(\text{PU/PD})}^\parallel$		$V_{CC} \leq 1.2 \text{ V}$, $V_O = 0.5 \text{ V to } V_{CC}$, $V_I = \text{GND or } V_{CC}$, $\overline{OE} = \text{don't care}$	± 100		± 100		μA	
I_{OZH}		$V_{CC} = 2.7 \text{ V}$, $V_O = 2.3 \text{ V}$, $V_I = 0.7 \text{ V or } 1.7 \text{ V}$	5		5		μA	
I_{OZL}		$V_{CC} = 2.7 \text{ V}$, $V_O = 0.5 \text{ V}$, $V_I = 0.7 \text{ V or } 1.7 \text{ V}$	-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		mA	
			Outputs low		2.3 4.5			
			Outputs disabled		0.04 0.1			
C_i		$V_{CC} = 2.5 \text{ V}$, $V_I = 2.5 \text{ V or } 0$	3		3		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 $V_{CC} = 2.5 \text{ V}$, $T_A = 25^\circ\text{C}$.

‡ This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

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

¶ High-impedance state during power up/power down

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2.5-V/3.3-V 16-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		SN54ALVTH16244		SN74ALVTH16244		UNIT
			MIN	TYP†	MAX	MIN	
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
	$V_{CC} = 3\text{ V}$	$I_{OH} = -24\text{ mA}$	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
	$V_{CC} = 3\text{ V}$	$I_{OL} = 16\text{ mA}$			0.4		
		$I_{OL} = 24\text{ mA}$	0.5				
		$I_{OL} = 32\text{ mA}$			0.5		
		$I_{OL} = 48\text{ mA}$	0.55				
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	$V_{CC} = 3.6\text{ V}$, $V_I = 5.5\text{ V}$	20		20		
		$V_{CC} = 3.6\text{ V}$, $V_I = V_{CC}$	1		1		
		$V_I = 0$	-5		-5		
I_{off}	$V_{CC} = 0$, V_I or $V_O = 0$ to 4.5 V				± 100		μA
$I_{I(\text{hold})}$	Data inputs	$V_{CC} = 3\text{ V}$, $V_I = 0.8\text{ V}$	75		75		μA
		$V_{CC} = 3\text{ V}$, $V_I = 2\text{ V}$	-75		-75		
		$V_{CC} = 3.6\text{ V}^\ddagger$, $V_I = 0$ to 3.6 V	± 500		± 500		
I_{EX}^\S	$V_{CC} = 3\text{ V}$, $V_O = 5.5\text{ V}$		125		125		μA
$I_{OZ(\text{PU/PD})}^\parallel$	$V_{CC} \leq 1.2\text{ V}$, $V_O = 0.5\text{ V to } V_{CC}$, $V_I = \text{GND or } V_{CC}$, $\overline{OE} = \text{don't care}$		± 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	3.2	5	
		Outputs disabled	0.07	0.1	0.07	0.1	
$\Delta I_{CC}^\#$	$V_{CC} = 3\text{ V to } 3.6\text{ V}$, 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		3		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 $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

‡ This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

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

¶ High-impedance state during power up/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.

PRODUCT PREVIEW information concerns products in the formative or design phase of development. Characteristic data and other specifications are design goals. Texas Instruments reserves the right to change or discontinue these products without notice.



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2.5-V/3.3-V 16-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)	SN54ALVTH16244		SN74ALVTH16244		UNIT
			MIN	MAX	MIN	MAX	
t_{PLH}	A	Y	1	3.1	1	3	ns
t_{PHL}			1	3.6	1	3.5	
t_{PZH}	\overline{OE}	Y	1.1	6	1.1	5.9	ns
t_{PZL}			1.1	4.8	1.1	4.7	
t_{PHZ}	\overline{OE}	Y	1.5	4.5	1.5	4.4	ns
t_{PLZ}			1	3.5	1	3.4	

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)	SN54ALVTH16244		SN74ALVTH16244		UNIT
			MIN	MAX	MIN	MAX	
t_{PLH}	A	Y	1	2.6	1	2.4	ns
t_{PHL}			1	2.6	1	2.5	
t_{PZH}	\overline{OE}	Y	1	3.9	1	3.8	ns
t_{PZL}			1	3	1	2.9	
t_{PHZ}	\overline{OE}	Y	1.5	4.3	1.5	4.2	ns
t_{PLZ}			1.5	3.7	1.5	3.6	

PRODUCT PREVIEW information concerns products in the formative or design phase of development. Characteristic data and other specifications are design goals. Texas Instruments reserves the right to change or discontinue these products without notice.

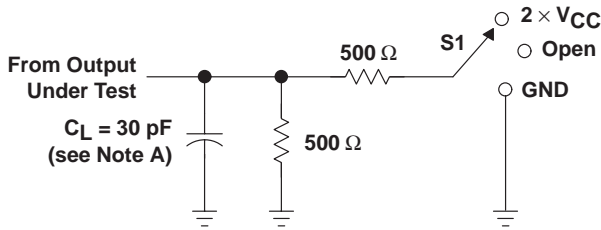


SN54ALVTH16244, SN74ALVTH16244
2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS
WITH 3-STATE OUTPUTS

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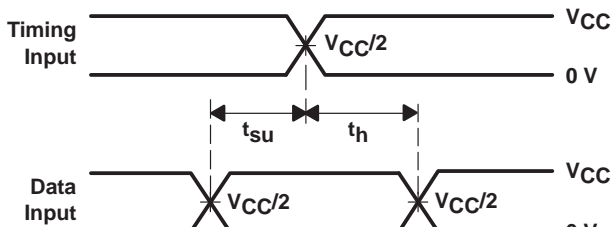
PARAMETER MEASUREMENT INFORMATION

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

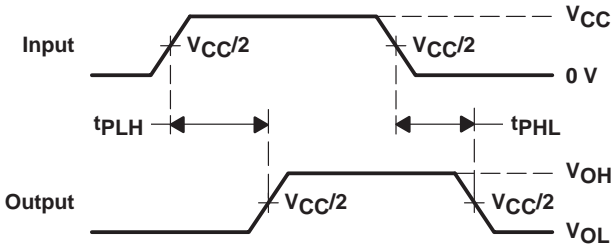


LOAD CIRCUIT

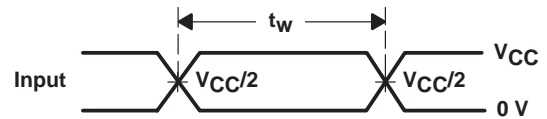
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	2 $\times V_{CC}$
t_{PHZ}/t_{PZH}	GND



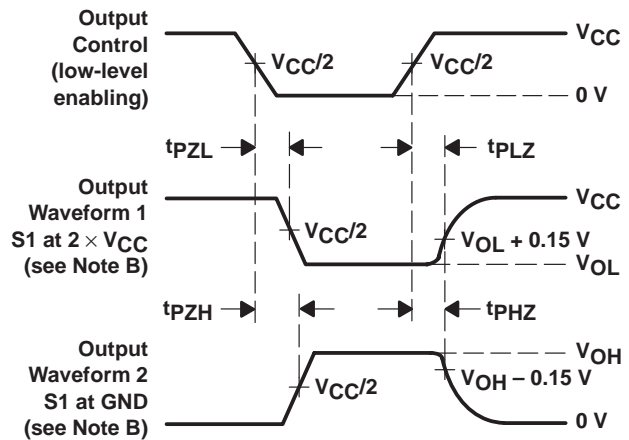
**VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES**



**VOLTAGE WAVEFORMS
PULSE DURATION**



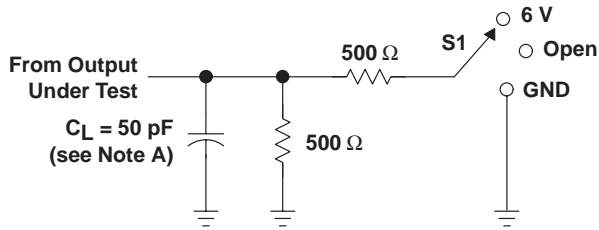
**VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES**

- 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

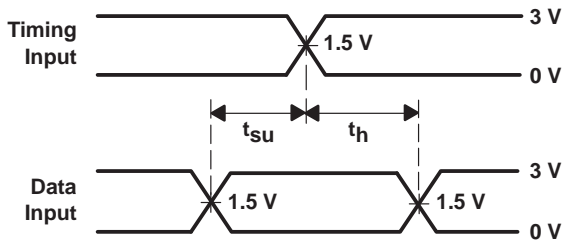
PARAMETER MEASUREMENT INFORMATION

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

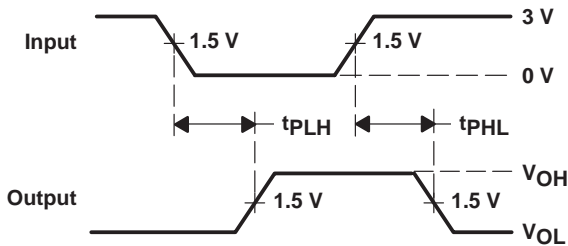


LOAD CIRCUIT

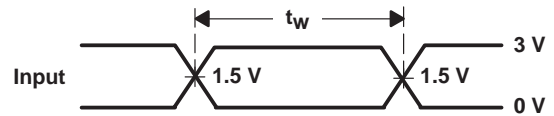
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



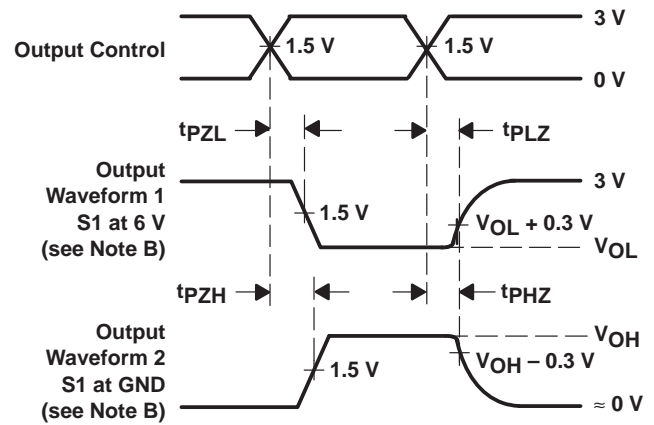
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



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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