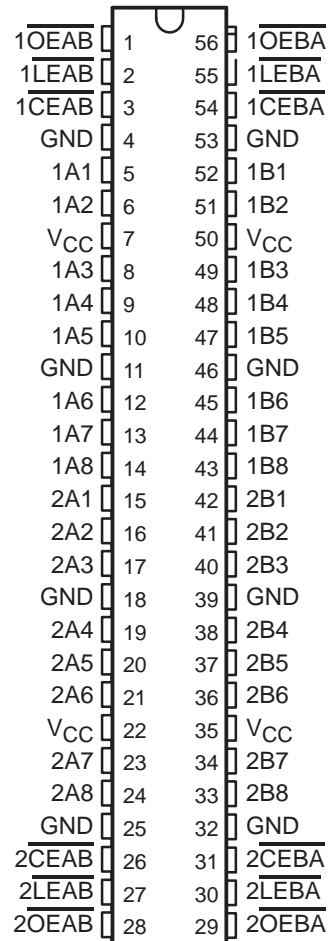


# SN54LVTH16543, SN74LVTH16543 3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS699D – JULY 1997 – REVISED APRIL 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**
- **Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V<sub>CC</sub>)**
- **Support Unregulated Battery Operation Down to 2.7 V**
- **I<sub>off</sub> and Power-Up 3-State Support Hot Insertion**
- **Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors**
- **Typical V<sub>OLP</sub> (Output Ground Bounce) < 0.8 V at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C**
- **Distributed V<sub>CC</sub> and GND Pin Configuration Minimizes High-Speed Switching Noise**
- **Flow-Through Architecture Optimizes PCB Layout**
- **Latch-Up Performance Exceeds 500 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 Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings**

SN54LVTH16543 . . . WD PACKAGE  
SN74LVTH16543 . . . DGG OR DL PACKAGE  
(TOP VIEW)



## description

The LVTH16543 devices are 16-bit registered transceivers designed for low-voltage (3.3-V) V<sub>CC</sub> operation, but with the capability to provide a TTL interface to a 5-V system environment. These devices can be used as two 8-bit transceivers or one 16-bit transceiver. Separate latch-enable ( $\overline{\text{LEAB}}$  or  $\overline{\text{LEBA}}$ ) and output-enable ( $\overline{\text{OEAB}}$  or  $\overline{\text{OEBA}}$ ) inputs are provided for each register to permit independent control in either direction of data flow.

The A-to-B enable ( $\overline{\text{CEAB}}$ ) input must be low to enter data from A or to output data from B. If  $\overline{\text{CEAB}}$  is low and  $\overline{\text{LEAB}}$  is low, the A-to-B latches are transparent; a subsequent low-to-high transition of  $\overline{\text{LEAB}}$  puts the A latches in the storage mode. With  $\overline{\text{CEAB}}$  and  $\overline{\text{OEAB}}$  both low, the 3-state B outputs are active and reflect the data present at the output of the A latches. Data flow from B to A is similar but requires using the  $\overline{\text{CEBA}}$ ,  $\overline{\text{LEBA}}$ , and  $\overline{\text{OEBA}}$  inputs.

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.

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**TEXAS  
INSTRUMENTS**

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# SN54LVTH16543, SN74LVTH16543

## 3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS

### WITH 3-STATE OUTPUTS

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#### description (continued)

When  $V_{CC}$  is between 0 and 1.5 V, the devices are in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 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.

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 SN54LVTH16543 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74LVTH16543 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

FUNCTION TABLE†  
(each 8-bit section)

INPUTS				OUTPUT
$\overline{CEAB}$	$\overline{LEAB}$	$\overline{OEAB}$	A	B
H	X	X	X	Z
X	X	H	X	Z
L	H	L	X	$B_0^{\ddagger}$
L	L	L	L	L
L	L	L	H	H

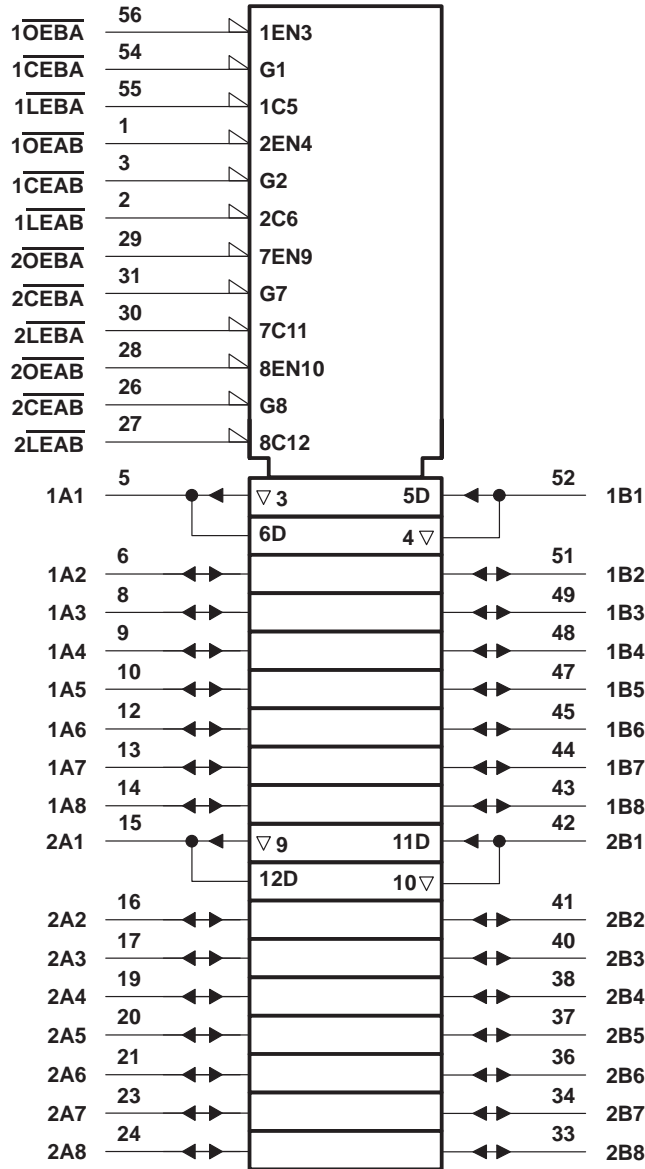
† A-to-B data flow is shown; B-to-A flow control is the same except that it uses  $\overline{CEBA}$ ,  $\overline{LEBA}$ , and  $\overline{OEBA}$ .

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

**SN54LVTH16543, SN74LVTH16543**  
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**WITH 3-STATE OUTPUTS**

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logic symbol†



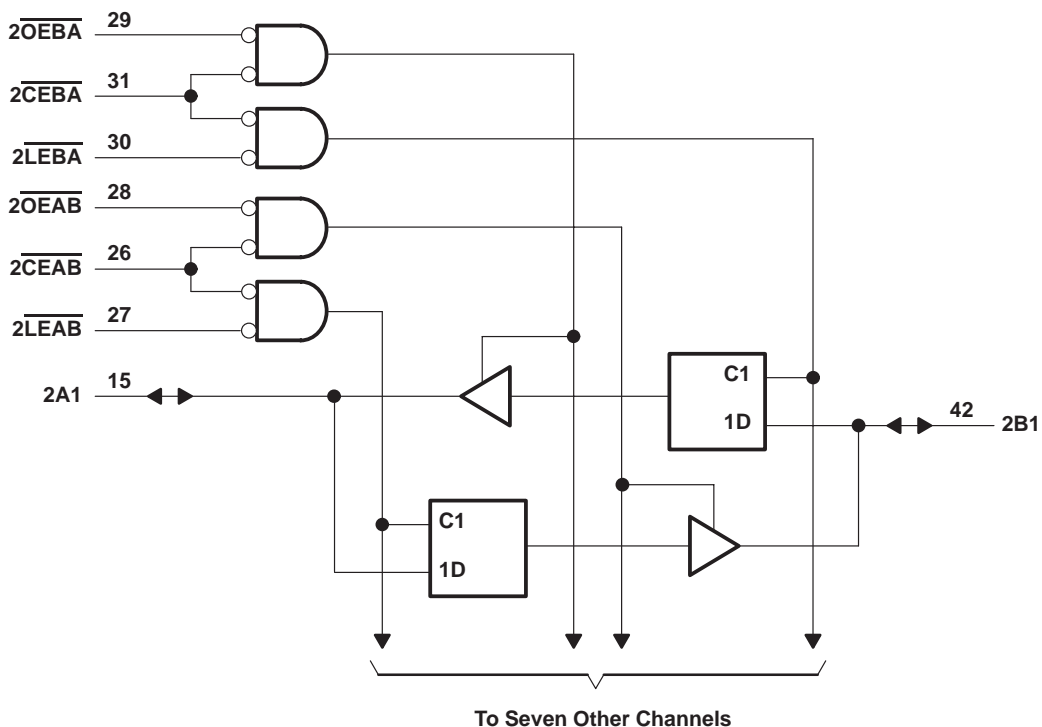
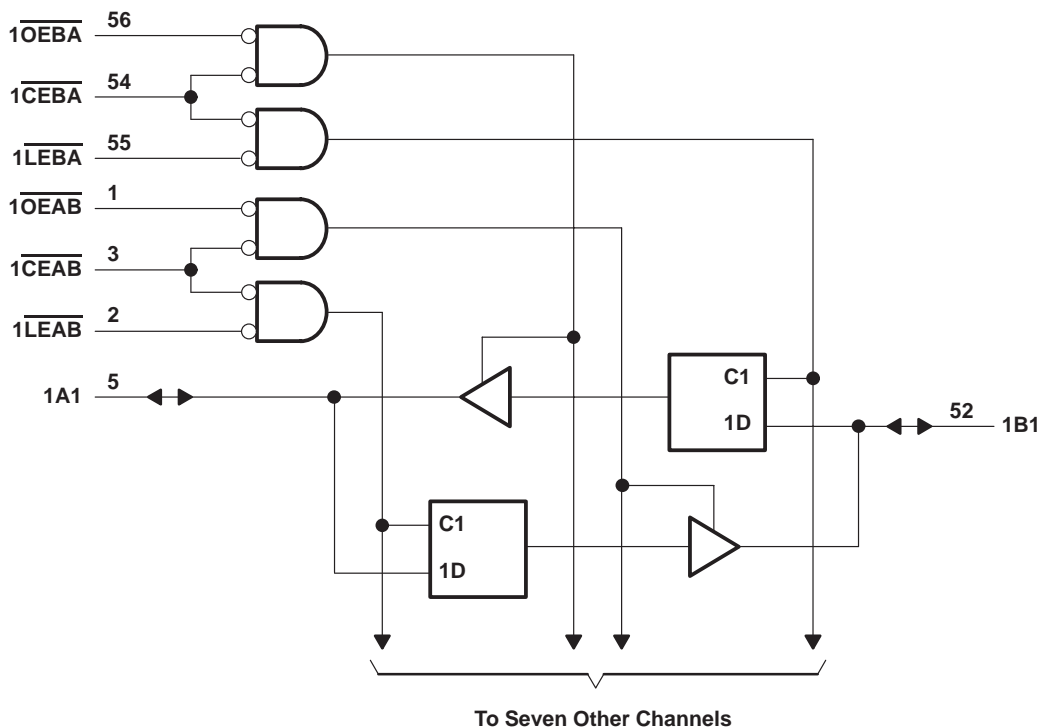
† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

# SN54LVTH16543, SN74LVTH16543

## 3.3-V ABT 16-BIT REGISTERED TRANSCIEVERS WITH 3-STATE OUTPUTS

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### logic diagram (positive logic)



# SN54LVTH16543, SN74LVTH16543 3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS 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 $V_{CC} + 0.5$ V
Current into any output in the low state, $I_O$ : SN54LVTH16543 .....	96 mA
SN74LVTH16543 .....	128 mA
Current into any output in the high state, $I_O$ (see Note 2): SN54LVTH16543 .....	48 mA
SN74LVTH16543 .....	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, $\theta_{JA}$ (see Note 3): DGG package .....	81°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. This current flows only when the output is in the high state and  $V_O > V_{CC}$ .  
 3. The package thermal impedance is calculated in accordance with JESD 51.

## recommended operating conditions (see Note 4)

		SN54LVTH16543		SN74LVTH16543		UNIT
		MIN	MAX	MIN	MAX	
$V_{CC}$	Supply voltage	2.7	3.6	2.7	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		5.5		5.5	V
$I_{OH}$	High-level output current		–24		–32	mA
$I_{OL}$	Low-level output current		48		64	mA
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled			10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200		200	μs/V
$T_A$	Operating free-air temperature	–55	125	–40	85	°C

NOTE 4: 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.

**SN54LVTH16543, SN74LVTH16543**  
**3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS**  
**WITH 3-STATE OUTPUTS**

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

PARAMETER		TEST CONDITIONS	SN54LVTH16543			SN74LVTH16543			UNIT
			MIN	TYP†	MAX	MIN	TYP†	MAX	
V <sub>IK</sub>		V <sub>CC</sub> = 2.7 V, I <sub>I</sub> = -18 mA	-1.2			-1.2			V
V <sub>OH</sub>		V <sub>CC</sub> = 2.7 V to 3.6 V, I <sub>OH</sub> = -100 μA	V <sub>CC</sub> -0.2			V <sub>CC</sub> -0.2			V
		V <sub>CC</sub> = 2.7 V, I <sub>OH</sub> = -8 mA	2.4			2.4			
		V <sub>CC</sub> = 3 V	2			2			
V <sub>OL</sub>		V <sub>CC</sub> = 2.7 V	I <sub>OL</sub> = 100 μA		0.2		0.2		V
			I <sub>OL</sub> = 24 mA		0.5		0.5		
		V <sub>CC</sub> = 3 V	I <sub>OL</sub> = 16 mA		0.4		0.4		
			I <sub>OL</sub> = 32 mA		0.5		0.5		
			I <sub>OL</sub> = 48 mA		0.55		0.55		
			I <sub>OL</sub> = 64 mA				0.55		
I <sub>I</sub>		Control inputs	V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = V <sub>CC</sub> or GND		±1		±1		μA
			V <sub>CC</sub> = 0 or 3.6 V, V <sub>I</sub> = 5.5 V		10		10		
		A or B ports‡	V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = 5.5 V		20		20		
			V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = V <sub>CC</sub>		1		1		
		V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = 0		-5		-5			
I <sub>off</sub>		V <sub>CC</sub> = 0, V <sub>I</sub> or V <sub>O</sub> = 0 to 4.5 V				±100		μA	
I <sub>I</sub> (hold)		V <sub>CC</sub> = 3 V	V <sub>I</sub> = 0.8 V		75		75		μA
			V <sub>I</sub> = 2 V		-75		-75		
		V <sub>CC</sub> = 3.6 V§, V <sub>I</sub> = 0 to 3.6 V						±500	
I <sub>OZPU</sub>		V <sub>CC</sub> = 0 to 1.5 V, V <sub>O</sub> = 0.5 V to 3 V, OE = don't care		±100*		±100		μA	
I <sub>OZPD</sub>		V <sub>CC</sub> = 1.5 V to 0, V <sub>O</sub> = 0.5 V to 3 V, OE = don't care		±100*		±100		μA	
I <sub>CC</sub>		V <sub>CC</sub> = 3.6 V, I <sub>O</sub> = 0, V <sub>I</sub> = V <sub>CC</sub> or GND	Outputs high		0.19		0.19		mA
			Outputs low		5		5		
			Outputs disabled		0.19		0.19		
ΔI <sub>CC</sub> ¶		V <sub>CC</sub> = 3 V to 3.6 V, One input at V <sub>CC</sub> - 0.6 V, Other inputs at V <sub>CC</sub> or GND		0.2		0.2		mA	
C <sub>i</sub>		V <sub>I</sub> = 3 V or 0		4		4		pF	
C <sub>io</sub>		V <sub>O</sub> = 3 V or 0		10		10		pF	

\* On products compliant to MIL-PRF-38535, this parameter is not production tested.

† All typical values are at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C.

‡ Unused pins at V<sub>CC</sub> or GND

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

¶ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V<sub>CC</sub> or GND.

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**SN54LVTH16543, SN74LVTH16543**  
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**WITH 3-STATE OUTPUTS**

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**timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1)**

			SN54LVTH16543				SN74LVTH16543				UNIT	
			$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$			
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX		
$t_w$	Pulse duration, $\overline{LEAB}$ or $\overline{LEBA}$ low		3.3		3.3		3.3		3.3		ns	
$t_{su}$	Setup time	A or B before $\overline{LEAB}\uparrow$ or $\overline{LEBA}\uparrow$	Data high	0.5		0.5		0.5		0.5		ns
			Data low	0.8		1.3		0.8		1.3		
		A or B before $\overline{CEAB}\uparrow$ or $\overline{CEBA}\uparrow$	Data high	0		0		0		0		
			Data low	0.6		1.1		0.6		1.1		
$t_h$	Hold time	A or B after $\overline{LEAB}\uparrow$ or $\overline{LEBA}\uparrow$	Data high	1.5		0.7		1.5		0.7		ns
			Data low	1.2		1.3		1.2		1.3		
		A or B after $\overline{CEAB}\uparrow$ or $\overline{CEBA}\uparrow$	Data high	1.7		0.9		1.7		0.9		
			Data low	1.6		1.8		1.6		1.8		

**switching characteristics over recommended operating free-air temperature range,  $C_L = 50\text{ pF}$  (unless otherwise noted) (see Figure 1)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVTH16543				SN74LVTH16543				UNIT	
			$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$			$V_{CC} = 2.7\text{ V}$		
			MIN	MAX	MIN	MAX	MIN	TYP†	MAX	MIN		MAX
$t_{PLH}$	A or B	B or A	1.1	3.4		3.9	1.2	2.3	3.2		3.7	ns
$t_{PHL}$			1.1	3.4		3.9	1.2	2.1	3.2		3.7	
$t_{PLH}$	$\overline{LE}$	A or B	1.2	4.1		5.1	1.3	2.5	3.9		4.9	ns
$t_{PHL}$			1.2	4.1		5.1	1.3	2.3	3.9		4.9	
$t_{PZH}$	$\overline{OE}$	A or B	1.2	4.5		5.6	1.3	2.8	4.3		5.4	ns
$t_{PZL}$			1.2	4.5		5.6	1.3	2.8	4.3		5.4	
$t_{PHZ}$	$\overline{OE}$	A or B	1.9	4.9		5.4	2	3.5	4.7		5.2	ns
$t_{PLZ}$			1.9	4.6		4.7	2	3.3	4.4		4.5	
$t_{PZH}$	$\overline{CE}$	A or B	1.2	4.7		5.8	1.3	3	4.5		5.6	ns
$t_{PZL}$			1.2	4.7		5.8	1.3	3	4.5		5.6	
$t_{PHZ}$	$\overline{CE}$	A or B	1.9	5.1		5.6	2	3.6	4.9		5.4	ns
$t_{PLZ}$			1.9	4.9		5.1	2	3.5	4.7		4.9	

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

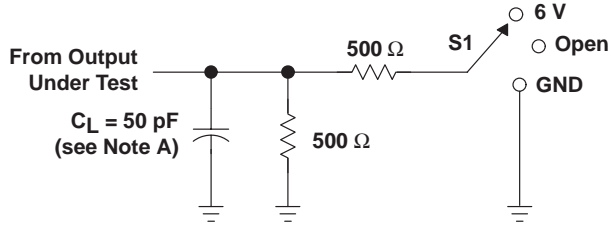
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**WITH 3-STATE OUTPUTS**

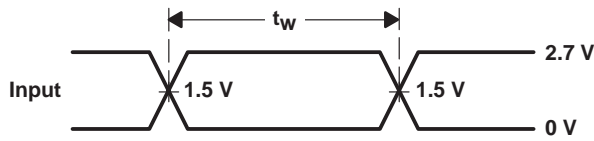
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**PARAMETER MEASUREMENT INFORMATION**

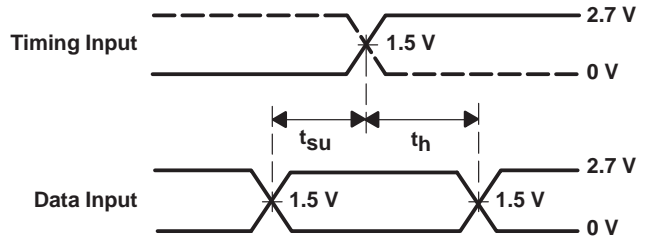


**LOAD CIRCUIT**

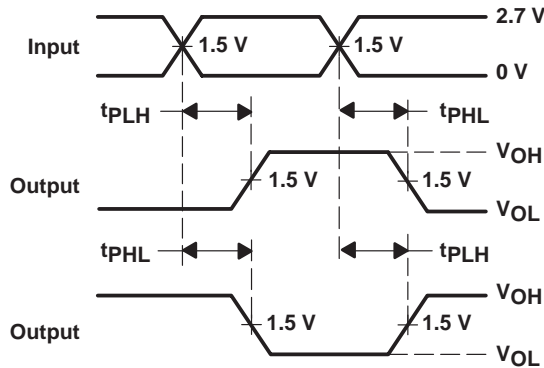
TEST	S1
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	6 V
$t_{PHZ}/t_{PZH}$	GND



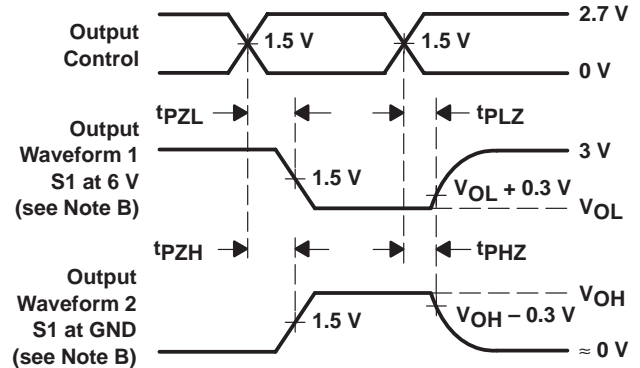
**VOLTAGE WAVEFORMS**  
**PULSE DURATION**



**VOLTAGE WAVEFORMS**  
**SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS**  
**PROPAGATION DELAY TIMES**  
**INVERTING AND NONINVERTING OUTPUTS**



**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:  $PRR \leq 10$  MHz,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5$  ns,  $t_f \leq 2.5$  ns.  
 D. The outputs are measured one at a time with one transition per measurement.

**Figure 1. Load Circuit and Voltage Waveforms**



**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
74LVTH16543DGGRE4	ACTIVE	TSSOP	DGG	56	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
74LVTH16543DLRG4	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVTH16543DGGR	ACTIVE	TSSOP	DGG	56	2000	Pb-Free (RoHS)	CU NIPDAU	Level-1-250C-UNLIM
SN74LVTH16543DL	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LVTH16543DLR	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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DL (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MO-118

DGG (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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