

# SN54LVT16543, SN74LVT16543 3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS148C – MAY 1992 – REVISED JULY 1995

- State-of-the-Art Advanced BiCMOS Technology (ABT) Design for 3.3-V Operation and Low-Static Power Dissipation
- Members of the Texas Instruments *Widebus*™ Family
- Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V  $V_{CC}$ )
- Support Unregulated Battery Operation Down to 2.7 V
- Typical  $V_{OLP}$  (Output Ground Bounce) < 0.8 V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- 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 500 mA Per JEDEC Standard JESD-17
- Bus-Hold Data Inputs Eliminate the Need for External Pullup Resistors
- Support Live Insertion
- Distributed  $V_{CC}$  and GND Pin Configuration Minimizes High-Speed Switching Noise
- Flow-Through Architecture Optimizes PCB Layout
- Package Options Include Plastic 300-mil 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

SN54LVT16543 . . . WD PACKAGE  
SN74LVT16543 . . . DGG OR DL PACKAGE  
(TOP VIEW)

1OEAB	1	56	1OEBA
1LEAB	2	55	1LEBA
1CEAB	3	54	1CEBA
GND	4	53	GND
1A1	5	52	1B1
1A2	6	51	1B2
$V_{CC}$	7	50	$V_{CC}$
1A3	8	49	1B3
1A4	9	48	1B4
1A5	10	47	1B5
GND	11	46	GND
1A6	12	45	1B6
1A7	13	44	1B7
1A8	14	43	1B8
2A1	15	42	2B1
2A2	16	41	2B2
2A3	17	40	2B3
GND	18	39	GND
2A4	19	38	2B4
2A5	20	37	2B5
2A6	21	36	2B6
$V_{CC}$	22	35	$V_{CC}$
2A7	23	34	2B7
2A8	24	33	2B8
GND	25	32	GND
2CEAB	26	31	2CEBA
2LEAB	27	30	2LEBA
2OEAB	28	29	2OEBA

## description

The 'LVT16543 are 16-bit registered transceivers designed for low-voltage (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 two 8-bit transceivers or one 16-bit transceiver. Separate latch-enable ( $\overline{LEAB}$  or  $\overline{LEBA}$ ) and output-enable ( $\overline{OEAB}$  or  $\overline{OEBA}$ ) inputs are provided for each register to permit independent control in either direction of data flow.

The A-to-B enable ( $\overline{CEAB}$ ) input must be low in order to enter data from A or to output data from B. If  $\overline{CEAB}$  is low and  $\overline{LEAB}$  is low, the A-to-B latches are transparent; a subsequent low-to-high transition of  $\overline{LEAB}$  puts the A latches in the storage mode. With  $\overline{CEAB}$  and  $\overline{OEAB}$  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  $\overline{CEBA}$ ,  $\overline{LEBA}$ , and  $\overline{OEBA}$  inputs.

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



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# SN54LVT16543, SN74LVT16543

## 3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS

### WITH 3-STATE OUTPUTS

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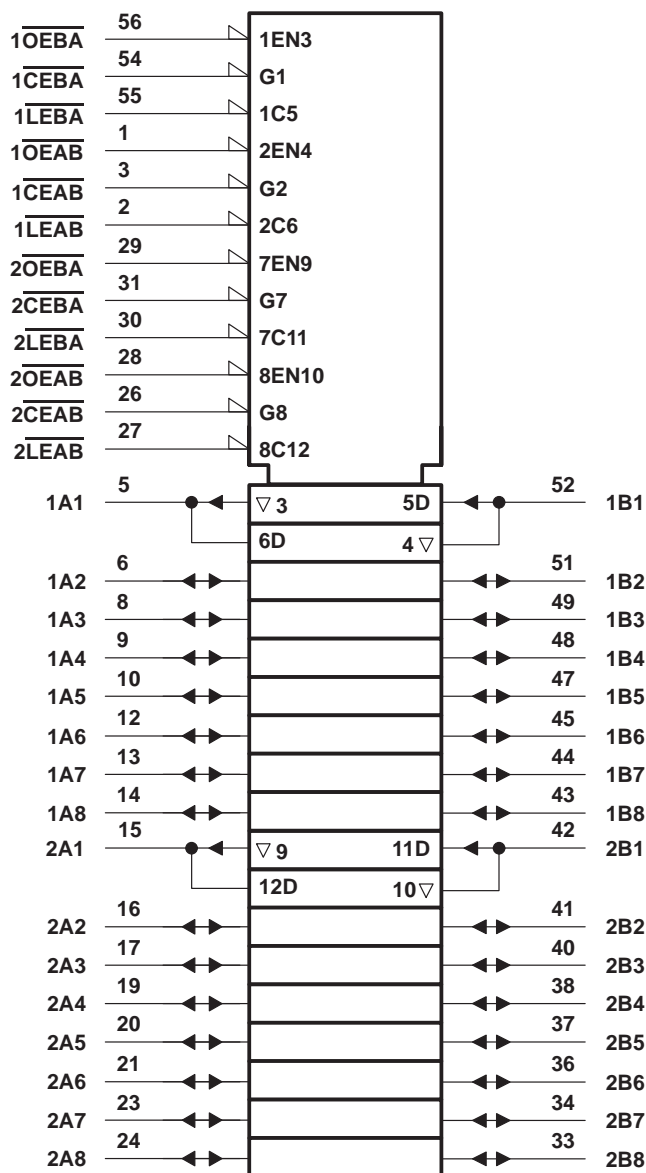
#### description (continued)

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.

The SN74LVT16543 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 SN54LVT16543 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74LVT16543 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

#### logic symbol†



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

## SCBS148C – MAY 1992 – REVISED JULY 1995

### To Seven Other Channels

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## 3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS

### WITH 3-STATE OUTPUTS

SCBS148C – MAY 1992 – REVISED JULY 1995

FUNCTION TABLE†  
(each 8-bit section)

INPUTS				OUTPUT B
CEAB	LEAB	OEAB	A	
H	X	X	X	Z
X	X	H	X	Z
L	H	L	X	B <sub>0</sub> ‡
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 CEBA, LEBA, and OEBA.

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

#### 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 state or power-off state, $V_O$ (see Note 1)	–0.5 V to 7 V
Current into any output in the low state, $I_O$ : SN54LVT16543	96 mA
SN74LVT16543	128 mA
Current into any output in the high state, $I_O$ (see Note 2): SN54LVT16543	48 mA
SN74LVT16543	64 mA
Input clamp current, $I_{IK}$ ( $V_I < 0$ )	–50 mA
Output clamp current, $I_{OK}$ ( $V_O < 0$ )	–50 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 current flows only when the output is in the high state and  $V_O > V_{CC}$ .  
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)

		SN54LVT16543		SN74LVT16543		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
$T_A$	Operating free-air temperature	–55	125	–40	85	°C

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

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

SCBS148C – MAY 1992 – REVISED JULY 1995

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

PARAMETER	TEST CONDITIONS		SN54LVT16543			SN74LVT16543			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> = MIN to MAX‡, 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	I <sub>OH</sub> = − 24 mA	2							
		I <sub>OH</sub> = −32 mA				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							
		I <sub>OL</sub> = 64 mA				0.55				
		I <sub>I</sub>	V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = V <sub>CC</sub> or GND		±1			±1		
V <sub>CC</sub> = 0 or MAX‡, V <sub>I</sub> = 5.5 V			10			10				
V <sub>CC</sub> = 3.6 V	V <sub>I</sub> = 5.5 V		20			20				
	V <sub>I</sub> = V <sub>CC</sub>		5			5				
	V <sub>I</sub> = 0		−10			−10				
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			μA	
I <sub>OZH</sub>	V <sub>CC</sub> = 3.6 V, V <sub>O</sub> = 3 V		1			1			μA	
I <sub>OZL</sub>	V <sub>CC</sub> = 3.6 V, V <sub>O</sub> = 0.5 V		−1			−1			μA	
I <sub>CC</sub>	V <sub>CC</sub> = 3.6 V, V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0,		Outputs high	0.12			0.12			mA
			Outputs low	5			5			
			Outputs disabled	0.12			0.12			
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		13			13			pF	

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

‡ For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

§ Unused pins at  $V_{CC}$  or GND

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

# SN54LVT16543, SN74LVT16543

## 3.3-V ABT 16-BIT REGISTERED TRANSCEIVERS

### WITH 3-STATE OUTPUTS

SCBS148C – MAY 1992 – REVISED JULY 1995

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

			SN54LVT16543				SN74LVT16543				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	0.8		0.5		0.8		0.5	ns
			Data low	1.5		1.9		1.5		1.9	
		A or B before $\overline{CEAB}\uparrow$ or $\overline{CEBA}\uparrow$	Data high	0.7		0.4		0.7		0.4	ns
			Data low	1.6		1.9		1.6		1.9	
$t_h$	Hold time	A or B after $\overline{LEAB}\uparrow$ or $\overline{LEBA}\uparrow$	Data high	0.8		0		0.8		0	ns
			Data low	1.2		1.3		1.2		1.3	
		A or B after $\overline{CEAB}\uparrow$ or $\overline{CEBA}\uparrow$	Data high	0.8		0		0.8		0	ns
			Data low	1.3		1.4		1.3		1.4	

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)	SN54LVT16543				SN74LVT16543				UNIT	
			V <sub>CC</sub> = 3.3 V ± 0.3 V		V <sub>CC</sub> = 2.7 V		V <sub>CC</sub> = 3.3 V ± 0.3 V		V <sub>CC</sub> = 2.7 V			
			MIN	MAX	MIN	MAX	MIN	TYP†	MAX	MIN		MAX
t <sub>PLH</sub>	A or B	B or A	1.4	5	5.8		1.4	2.7	4.6	5.5		ns
t <sub>PHL</sub>			1.3	4.7	5.9		1.3	2.9	4.6	5.8		
t <sub>PLH</sub>	LE	A or B	1.3	6.8	8.5		1.7	3.7	6.3	8.1		ns
t <sub>PHL</sub>			1.5	6.5	8.3		1.9	3.7	6	7.8		
t <sub>PZH</sub>	OE	A or B	1.4	6	7.7		1.5	3.3	5.8	7.6		ns
t <sub>PZL</sub>			1.6	6.3	8.4		1.6	3.3	6.2	8.2		
t <sub>PHZ</sub>	OE	A or B	2	6.7	7.3		2	4.1	6.5	7.1		ns
t <sub>PLZ</sub>			2.7	6	6.2		2.7	3.9	5.8	5.9		
t <sub>PZH</sub>	CE	A or B	1.4	6.2	7.7		1.5	3.3	6	7.6		ns
t <sub>PZL</sub>			1.6	6.6	8.5		1.7	3.3	6.4	8.3		
t <sub>PHZ</sub>	CE	A or B	2	6.6	7.2		2	4.1	6.4	7.1		ns
t <sub>PLZ</sub>			2.6	5.6	5.9		2.6	4	5.4	5.6		

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

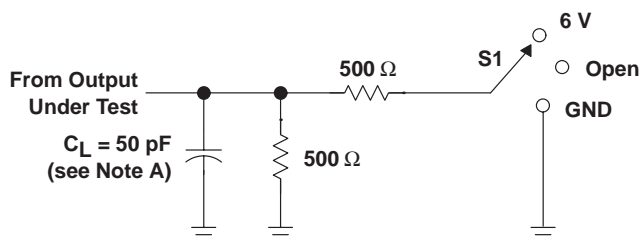
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### WITH 3-STATE OUTPUTS

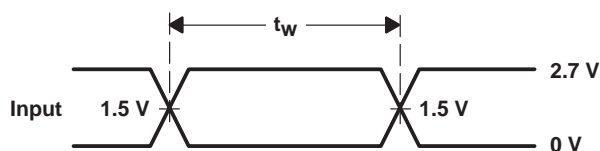
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#### PARAMETER MEASUREMENT INFORMATION

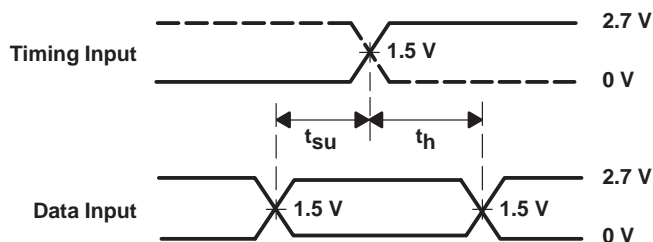


TEST	S1
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	6 V
$t_{PHZ}/t_{PZH}$	GND

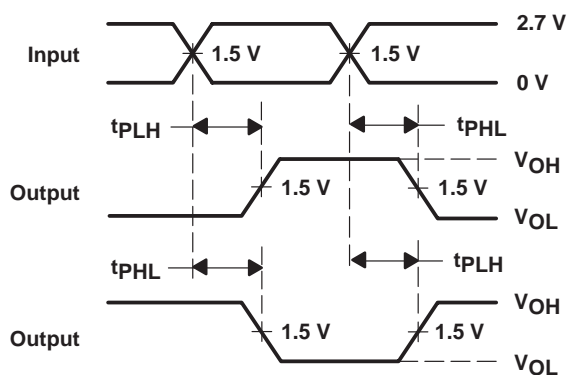
LOAD CIRCUIT FOR OUTPUTS



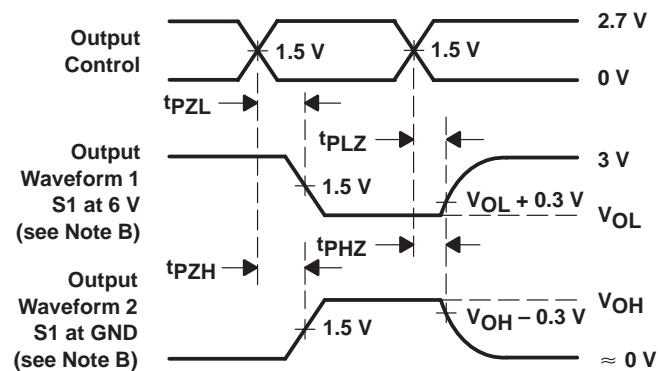
VOLTAGE WAVEFORMS  
PULSE DURATION



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:
- $C_L$  includes probe and jig capacitance.
  - 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.
  - All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5 \text{ ns}$ ,  $t_f \leq 2.5 \text{ ns}$ .
  - The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

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