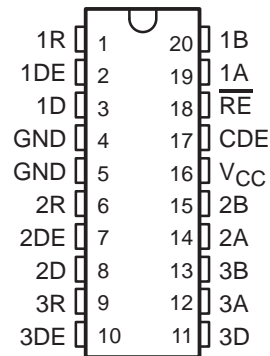


# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

SLLS056D – AUGUST 1987 – REVISED SEPTEMBER 1995

- Three Bidirectional Transceivers
- Driver Meets or Exceeds the Requirements of ANSI EIA/TIA-422-B and RS-485 and ITU Recommendation V.11
- Two Skew Limits Available
- Designed to Operate Up to 20 Million Data Transfers per Second (FAST-20 SCSI)
- High-Speed Advanced Low-Power Schottky Circuitry
- Low Pulse Skew . . . 5 ns Max
- Designed for Multipoint Transmission on Long Bus Lines in Noisy Environments
- Features Independent Driver Enables and Combined Receiver Enables
- Wide Positive and Negative Input/Output Bus Voltages Ranges
- Driver Output Capacity . . .  $\pm 60$  mA
- Thermal Shutdown Protection
- Driver Positive- and Negative-Current Limiting
- Receiver Input Impedances . . . 12 k $\Omega$  Min
- Receiver Input Sensitivity . . .  $\pm 300$  mV Max
- Receiver Input Hysteresis . . . 60 mV Typ
- Operates From a Single 5-V Supply
- Glitch-Free Power-Up and Power-Down Protection

DW OR J PACKAGE  
(TOP VIEW)



## description

The SN75ALS171 and the SN75ALS171A triple differential bus transceivers are monolithic integrated circuits designed for bidirectional data communication on multipoint bus transmission lines. They are designed for balanced transmission lines, and each driver meets ANSI Standards EIA/TIA-422-B and RS-485 and both the drivers and receivers meet ITU Recommendation V.11. The SN75ALS171A is designed for FAST-20 SCSI and can transmit or receive data pulses as short as 30 ns with a maximum skew of 5 ns.

The SN75ALS171 and the SN75ALS171A operate from a single 5-V power supply. The drivers and receivers have individual active-high and active-low enables, respectively, which can be externally connected together to function as a direction control. The driver differential output and the receiver differential input pairs are connected internally to form differential input/output (I/O) bus ports that are designed to offer minimum loading to the bus when the driver is disabled or V<sub>CC</sub> is at 0 V. These ports feature wide positive and negative common-mode voltage ranges making the device suitable for party-line applications.

The SN75ALS171 and the SN75ALS171A are characterized for operation from 0°C to 70°C.



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.

PRODUCTION DATA information is 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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# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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## Function Tables

### EACH DRIVER

INPUT D	ENABLES		OUTPUTS	
	DE	CDE	A	B
H	H	H	H	L
L	H	H	L	H
X	L	X	Z	Z
X	X	L	Z	Z

### EACH RECEIVER

DIFFERENTIAL INPUTS A-B	ENABLE $\overline{RE}$	OUTPUT R
$V_{ID} \geq 0.3 V$	L	H
$-0.3 V < V_{ID} < 0.3 V$	L	?
$V_{ID} \leq -0.3 V$	L	L
X	H	Z
Open	L	H

H = high level, L = low level, ? = indeterminate, X = irrelevant,  
Z = high impedance (off)

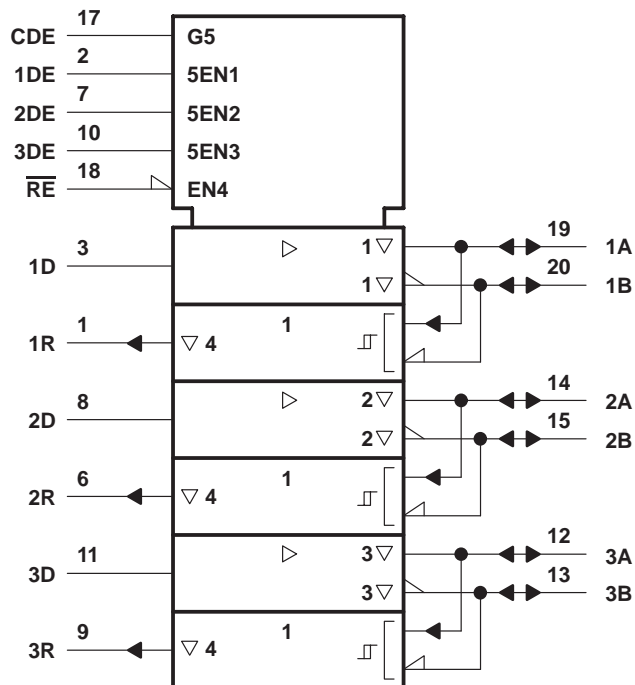
### AVAILABLE OPTIONS

SKEW LIMIT	PART NUMBER	
	10 ns	SN75ALS171DW
5 ns	SN75ALS171ADW	

# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

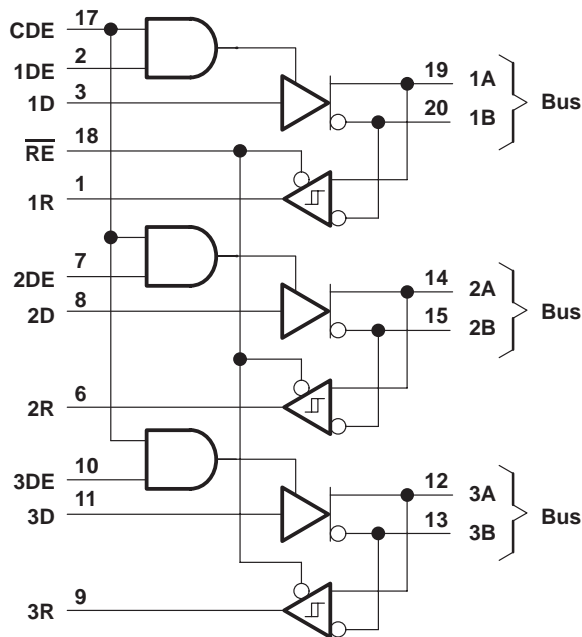
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## logic symbol†

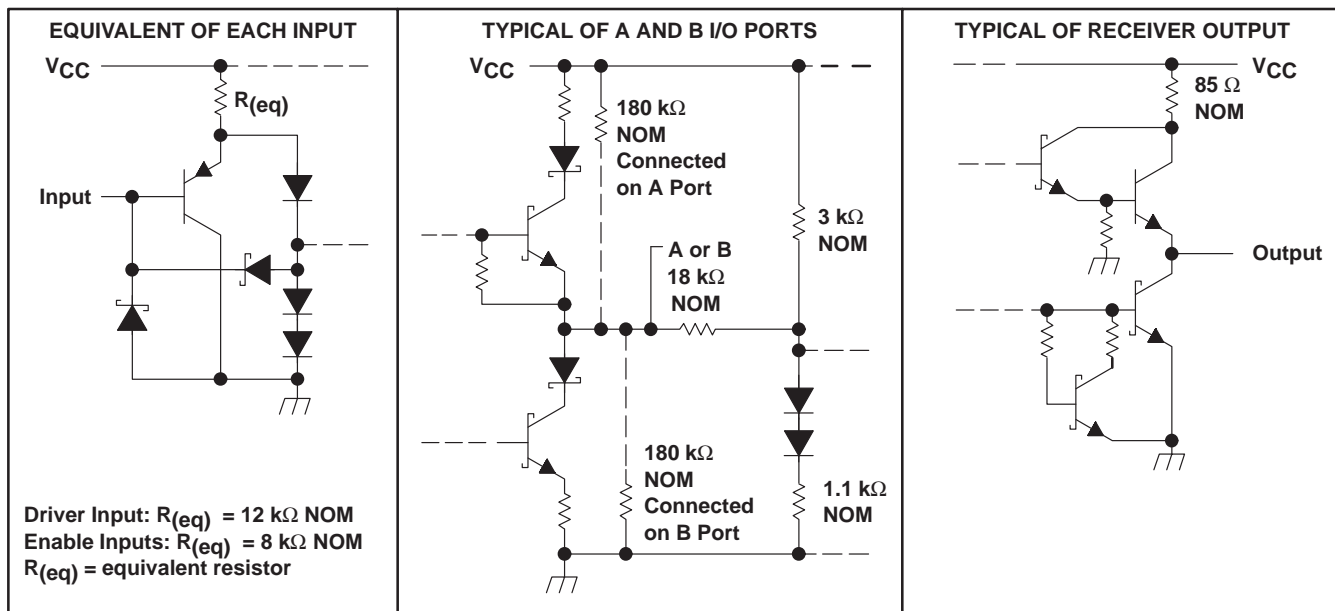


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

## logic diagram (positive logic)



## schematics of inputs and outputs



# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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

Supply voltage, $V_{CC}$ (see Note 1)	7 V
Voltage range at any bus terminal	-7 V to 12 V
Enable input voltage, $V_I$	7 V
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range, $T_A$	0°C to 70°C
Storage temperature range, $T_{stg}$	-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds: DW package	260°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds: J package	300°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.

NOTE 1: All voltage values, except differential I/O bus voltage, are with respect to network ground terminal.

DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$	$T_A = 70^\circ\text{C}$ POWER RATING
DW	1125 mW	9.0 mW/°C	720 mW
J	1025 mW	8.2 mW/°C	656 mW

## recommended operating conditions

	MIN	NOM	MAX	UNIT
Supply voltage, $V_{CC}$	4.75	5	5.25	V
Voltage at any bus terminal (separately or common mode), $V_I$ or $V_{IC}$	-7		12	V
High-level input voltage, $V_{IH}$	D, CDE, DE, and $\overline{RE}$		2	V
Low-level input voltage, $V_{IL}$	D, CDE, DE, and $\overline{RE}$		0.8	V
Differential input voltage, $V_{ID}$ (see Note 2)			±12	V
High-level output current, $I_{OH}$	Driver		-60	mA
	Receiver		-400	µA
Low-level output current, $I_{OL}$	Driver		60	mA
	Receiver		8	
Operating free-air temperature, $T_A$	0		70	°C

NOTE 2: Differential-input/output bus voltage is measured at the noninverting terminal A with respect to the inverting terminal B.



# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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## DRIVER SECTION

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

PARAMETER		TEST CONDITIONST		MIN	TYP‡	MAX	UNIT		
V <sub>IK</sub>	Input clamp voltage	I <sub>I</sub> = -18 mA				-1.5	V		
V <sub>O</sub>	Output voltage	I <sub>O</sub> = 0		0		6	V		
V <sub>OH</sub>	High-level output voltage	V <sub>CC</sub> = 4.75 V, V <sub>IL</sub> = 0.8 V,	V <sub>IH</sub> = 2 V, I <sub>OH</sub> = -55 mA	2.7			V		
V <sub>OL</sub>	Low-level output voltage	V <sub>CC</sub> = 4.75 V, V <sub>IL</sub> = 0.8 V,	V <sub>IH</sub> = 2 V, I <sub>OL</sub> = 55 mA			1.7	V		
V <sub>OD1</sub>	Differential output voltage	I <sub>O</sub> = 0		1.5		6	V		
V <sub>OD2</sub>	Differential output voltage	R <sub>L</sub> = 100 Ω,	See Figure 1	1/2 V <sub>OD1</sub> or 2§	2.5	5	V		
		R <sub>L</sub> = 54 Ω,	See Figure 1	1.5	2.5	5			
V <sub>OD3</sub>	Differential output voltage	V <sub>test</sub> = -7 V to 12 V, See Figure 2		1.5		5	V		
Δ V <sub>OD</sub>	Change in magnitude of differential output voltage¶	R <sub>L</sub> = 54 Ω or 100 Ω, See Figure 1				±0.2	V		
V <sub>OC</sub>	Common-mode output voltage					3	-1	V	
Δ V <sub>OC</sub>	Change in magnitude of common-mode output voltage¶							±0.2	V
I <sub>O</sub>	Output current	Output disabled, See Note 3		V <sub>O</sub> = 12 V		1	mA		
				V <sub>O</sub> = -7 V		-0.8			
I <sub>IH</sub>	High-level enable-input current	D and DE CDE		V <sub>IH</sub> = 2.7 V		20	μA		
						60			
I <sub>IL</sub>	Low-level enable-input current	D and DE CDE		V <sub>IL</sub> = 0.4 V		-100	μA		
						-900			
I <sub>OS</sub>	Short-circuit output current					V <sub>O</sub> = -6 V	-250		
						V <sub>O</sub> = 0	-150		
						V <sub>O</sub> = V <sub>CC</sub>	250		
						V <sub>O</sub> = 8 V	250		
I <sub>CC</sub>	Supply current	No load				Outputs enabled	69	90	mA
						Outputs disabled	57	78	

† The power-off measurement in ANSI Standard EIA/TIA-422-B applies to disabled outputs only and is not applied to combined inputs and outputs.

‡ All typical values are at V<sub>CC</sub> = 5 V and T<sub>A</sub> = 25°C.

§ The minimum V<sub>OD2</sub> with 100-Ω load is either 1/2 V<sub>OD2</sub> or 2 V, whichever is greater.

¶ Δ|V<sub>OD</sub>| and Δ|V<sub>OC</sub>| are the changes in magnitude of V<sub>OD</sub> and V<sub>OC</sub>, respectively, that occur when the input is changed from a high level to a low level.

NOTE 3: This applies for both power on and off; refer to EIA Standard RS-485 for exact conditions. The EIA/TIA-422-B limit does not apply for a combined driver and receiver terminal.

# SN75ALS171, SN75ALS171A

## TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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switching characteristics over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
t <sub>d(OD)</sub>	Differential output delay time	ALS171	R <sub>L</sub> = 54 Ω, See Figure 3, C <sub>L</sub> = 50 pF	3		13	ns
		ALS171A					
		ALS171	R <sub>L1</sub> = R <sub>L3</sub> = 165 Ω, C <sub>L</sub> = 60 pF, R <sub>L2</sub> = 75 Ω, V <sub>TERM</sub> = 5 V, See Figure 6	3		13	
		ALS171A					
t <sub>sk(p)</sub>	Pulse skew‡	R <sub>L</sub> = 54 Ω, See Figure 3, C <sub>L</sub> = 50 pF,		1		5	ns
		R <sub>L1</sub> = R <sub>L3</sub> = 165 Ω, C <sub>L</sub> = 60 pF, R <sub>L2</sub> = 75 Ω, See Figure 6		1		5	ns
t <sub>sk(lim)</sub>	Skew limit§	ALS171	R <sub>L</sub> = 54 Ω, See Figure 3			10	ns
		ALS171A					
		ALS171	R <sub>L1</sub> = R <sub>L3</sub> = 165 Ω, C <sub>L</sub> = 60 pF, R <sub>L2</sub> = 75 Ω, See Figure 6			10	
		ALS171A					
t <sub>t(OD)</sub>	Differential-output transition time	R <sub>L</sub> = 54 Ω, See Figure 3, C <sub>L</sub> = 50 pF,		3	8	13	ns
		R <sub>L1</sub> = R <sub>L3</sub> = 165 Ω, C <sub>L</sub> = 60 pF, R <sub>L2</sub> = 75 Ω, V <sub>TERM</sub> = 5 V, See Figure 6		3	8	13	
t <sub>pZH</sub>	Output enable time to high level	R <sub>L</sub> = 110 Ω, See Figure 4			30	50	ns
t <sub>pZL</sub>	Output enable time to low level	R <sub>L</sub> = 110 Ω, See Figure 5			30	50	ns
t <sub>PHZ</sub>	Output disable time from high level	R <sub>L</sub> = 110 Ω, See Figure 4		3	8	13	ns
t <sub>PLZ</sub>	Output disable time from low level	R <sub>L</sub> = 110 Ω, See Figure 5		3	8	13	ns
t <sub>pDE</sub>	Differential-output enable time	R <sub>L1</sub> = R <sub>L3</sub> = 165 Ω, C <sub>L</sub> = 60 pF, R <sub>L2</sub> = 75 Ω, See Figure 7		8	30	45	ns
t <sub>pDZ</sub>	Differential-output disable time			5	10	45	ns

† All typical values are at V<sub>CC</sub> = 5 V and T<sub>A</sub> = 25°C.

‡ Pulse skew is defined as the |t<sub>d(ODH)</sub> - t<sub>d(ODL)</sub>| of each channel.

§ Skew limit is the maximum difference in propagation delay times between any two channels of one device and between any two devices. This parameter is applicable at one V<sub>CC</sub> and operating temperature within the recommended operating conditions.

### SYMBOL EQUIVALENTS

DATA-SHEET PARAMETER	EIA/TIA-422-B	RS-485
V <sub>O</sub>	V <sub>0a</sub> , V <sub>0b</sub>	V <sub>0a</sub> , V <sub>0b</sub>
V <sub>OD1</sub>	V <sub>0</sub>	V <sub>0</sub>
V <sub>OD2</sub>	V <sub>t</sub> (R <sub>L</sub> = 100 Ω)	V <sub>t</sub> (R <sub>L</sub> = 54 Ω)
V <sub>OD3</sub>		V <sub>t</sub> (Test Termination Measurement 2)
V <sub>tst</sub>		V <sub>tst</sub>
Δ V <sub>OD</sub>	V <sub>t</sub>   -  V̄ <sub>t</sub>	V <sub>t</sub>   -  V̄ <sub>t</sub>
V <sub>OC</sub>	V <sub>os</sub>	V <sub>os</sub>
Δ V <sub>OC</sub>	V <sub>os</sub> - V̄ <sub>os</sub>	V <sub>os</sub> - V̄ <sub>os</sub>
I <sub>OS</sub>	I <sub>sa</sub>  ,  I <sub>sb</sub>	
I <sub>O</sub>	I <sub>xa</sub>  ,  I <sub>xb</sub>	I <sub>ia</sub> , I <sub>ib</sub>



# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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## RECEIVER SECTION

**electrical characteristics over recommended ranges of common-mode input voltage, supply voltage, and operating free-air temperature (unless otherwise noted)**

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
$V_{IT+}$	Positive-going input threshold voltage	$V_O = 2.7\text{ V}$ ,	$I_O = -0.4\text{ mA}$			0.3	V
$V_{IT-}$	Negative-going input threshold voltage	$V_O = 0.5\text{ V}$ ,	$I_O = 8\text{ mA}$	$-0.3\ddagger$			V
$V_{hys}$	Hysteresis voltage ( $V_{IT+} - V_{IT-}$ )				60		mV
$V_{IK}$	Enable-input clamp voltage	$I_I = -18\text{ mA}$				-1.5	V
$V_{OH}$	High-level output voltage	$V_{ID} = 300\text{ mV}$ , See Figure 8	$I_{OH} = -400\text{ }\mu\text{A}$ ,	2.7			V
$V_{OL}$	Low-level output voltage	$V_{ID} = -300\text{ mV}$ , See Figure 8	$I_{OL} = 8\text{ mA}$ ,			0.45	V
$I_{OZ}$	High-impedance-state output current	$V_O = 0.4\text{ V to }2.4\text{ V}$				$\pm 20$	$\mu\text{A}$
$I_I$	Line input current	Other input = 0 V, See Note 4	$V_I = 12\text{ V}$			1	mA
			$V_I = -7\text{ V}$			-0.8	
$I_{IH}$	High-level enable-input current	$V_{IH} = 2.7\text{ V}$				60	$\mu\text{A}$
$I_{IL}$	Low-level enable-input current	$V_{IL} = 0.4\text{ V}$				-300	$\mu\text{A}$
$r_i$	Input resistance			12			k $\Omega$
$I_{OS}$	Short-circuit output current	$V_{ID} = 300\text{ mV}$ ,	$V_O = 0$	-15		-85	mA
$I_{CC}$	Supply current	No load	Outputs enabled		69	90	mA
			Outputs disabled		57	78	

† All typical values are at  $V_{CC} = 5\text{ V}$  and  $T_A = 25^\circ\text{C}$ .

‡ The algebraic convention, in which the less positive (more negative) limit is designated minimum, is used in this data sheet for common-mode input voltage and threshold voltage levels only.

NOTE 4: This applies for both power on and off; refer to EIA Standard RS-485 for exact conditions.

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature range**

PARAMETER		TEST CONDITIONS	MIN	TYP†	MAX	UNIT
$t_{PLH}$	Propagation delay time, low- to high-level output	$V_{ID} = -1.5\text{ V to }1.5\text{ V}$ , $C_L = 15\text{ pF}$ , $T_A = 25^\circ\text{C}$ , See Figure 9	9		19	ns
			11		16	
$t_{PHL}$	Propagation delay time, high- to low-level output	See Figure 9	9		19	ns
			11		16	
$t_{sk(p)}$	Pulse skew§	$V_{ID} = -1.5\text{ V to }1.5\text{ V}$ , $C_L = 15\text{ pF}$ , See Figure 9		2	5	ns
$t_{sk(lim)}$	Skew limit¶		ALS171			10
		ALS171A			5	
$t_{PZH}$	Output enable time to high level	$C_L = 15\text{ pF}$ , See Figure 10		7	14	ns
$t_{PZL}$	Output enable time to low level			7	14	ns
$t_{PHZ}$	Output disable time from high level	$C_L = 15\text{ pF}$ , See Figure 10		20	35	ns
$t_{PLZ}$	Output disable time from low level			8	17	ns

† All typical values are at  $V_{CC} = 5\text{ V}$  and  $T_A = 25^\circ\text{C}$ .

§ Pulse skew is defined as the  $|t_{PLH} - t_{PHL}|$  of each channel.

¶ Skew limit is the maximum difference in propagation delay times between any two channels of one device and between any two devices. This parameter is applicable at one  $V_{CC}$  and operating temperature within the recommended operating conditions.



# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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## PARAMETER MEASUREMENT INFORMATION

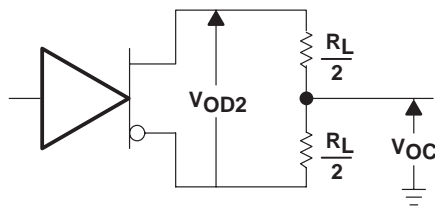


Figure 1. Driver  $V_{OD}$  and  $V_{OC}$

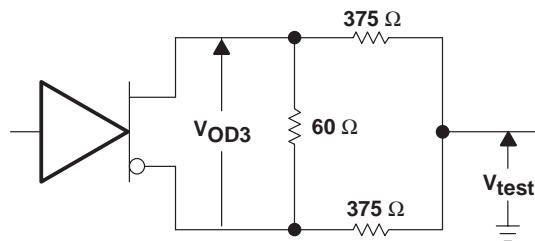
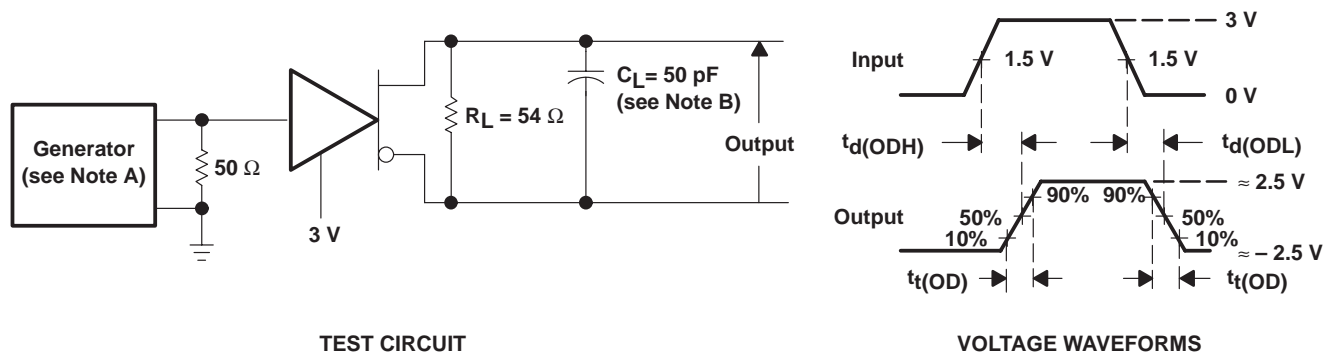


Figure 2. Driver  $V_{OD3}$

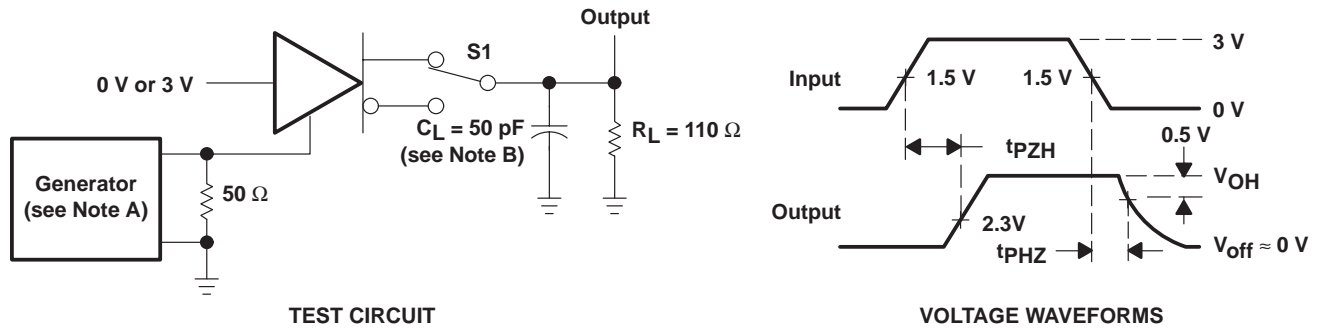


- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1$  MHz, 50% duty cycle,  $t_r \leq 6$  ns,  $t_f \leq 6$  ns,  $Z_O = 50 \Omega$ .  
 B.  $C_L$  includes probe and jig capacitance.

Figure 3. Driver Test Circuit and Voltage Waveforms

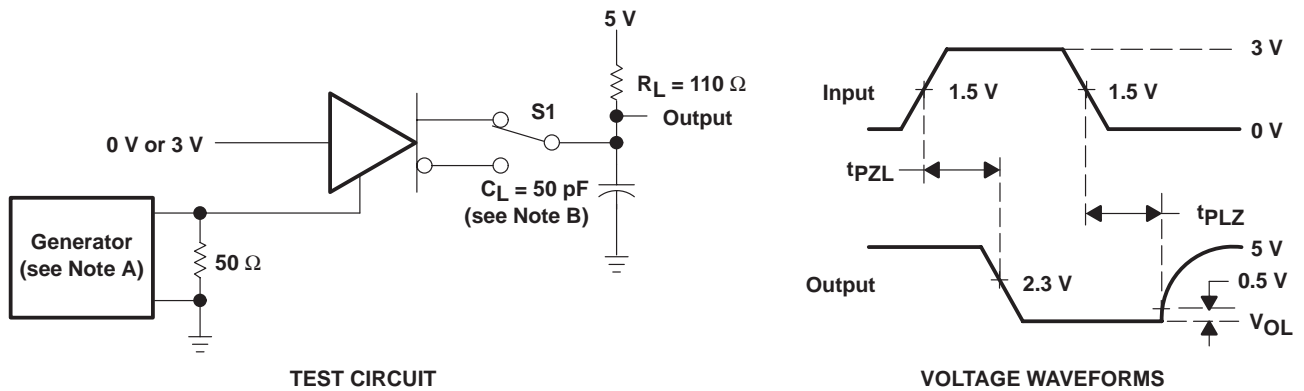


## PARAMETER MEASUREMENT INFORMATION



- NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR  $\leq$  1 MHz, 50% duty cycle,  $t_r \leq$  6 ns,  $t_f \leq$  6 ns,  $Z_O = 50 \Omega$ .  
 B.  $C_L$  includes probe and jig capacitance.

**Figure 4. Driver Test Circuit and Voltage Waveforms**



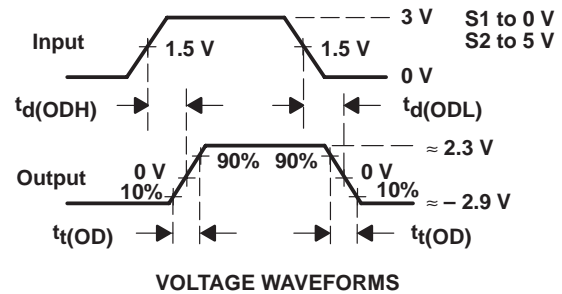
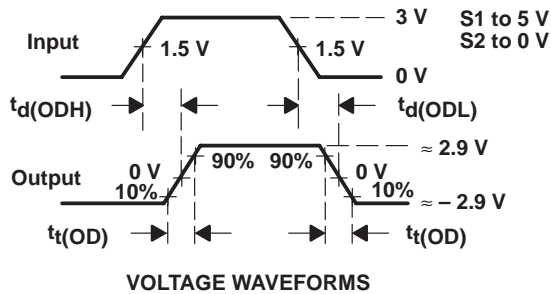
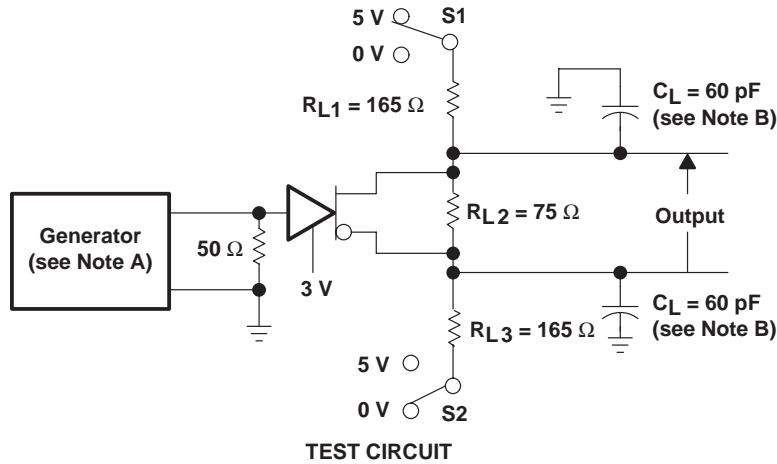
- NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR  $\leq$  1 MHz, 50% duty cycle,  $t_r \leq$  6 ns,  $t_f \leq$  6 ns,  $Z_O = 50 \Omega$ .  
 B.  $C_L$  includes probe and jig capacitance.

**Figure 5. Driver Test Circuit and Voltage Waveforms**

# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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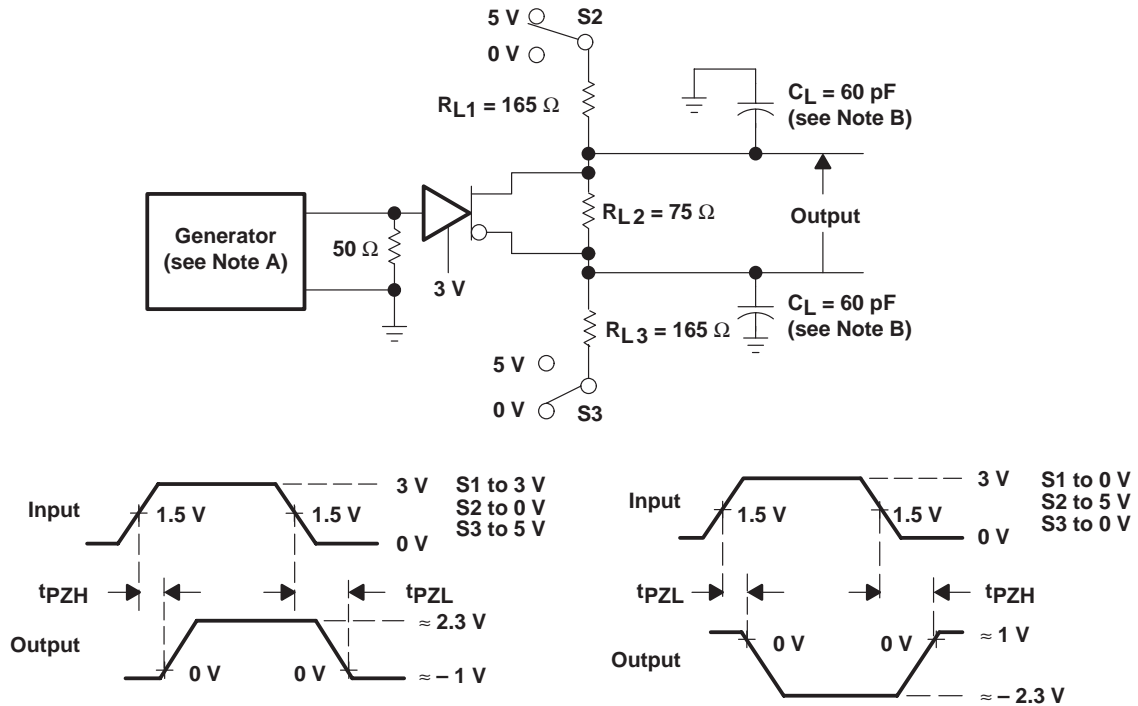
## PARAMETER MEASUREMENT INFORMATION



- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1 \text{ MHz}$ , 50% duty cycle,  $t_r \leq 6 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$ ,  $Z_0 = 50 \Omega$ .  
 B.  $C_L$  includes probe and jig capacitance.

**Figure 6. Driver Test Circuit and Voltage Waveforms  
With Double-Differential-SCSI Termination for the Load**

PARAMETER MEASUREMENT INFORMATION



- NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR ≤ 1 MHz, 50% duty cycle, t<sub>r</sub> ≤ 6 ns, t<sub>f</sub> ≤ 6 ns, Z<sub>O</sub> = 50 Ω.  
B. C<sub>L</sub> includes probe and jig capacitance.

Figure 7. Driver Differential-Enable and Disable Times With a Double-SCSI Termination

# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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## PARAMETER MEASUREMENT INFORMATION

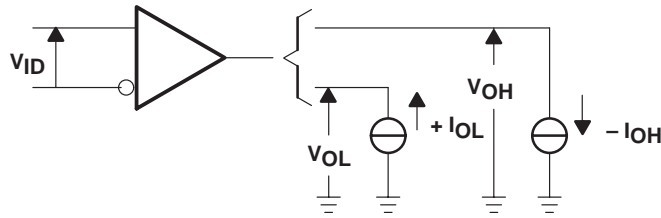
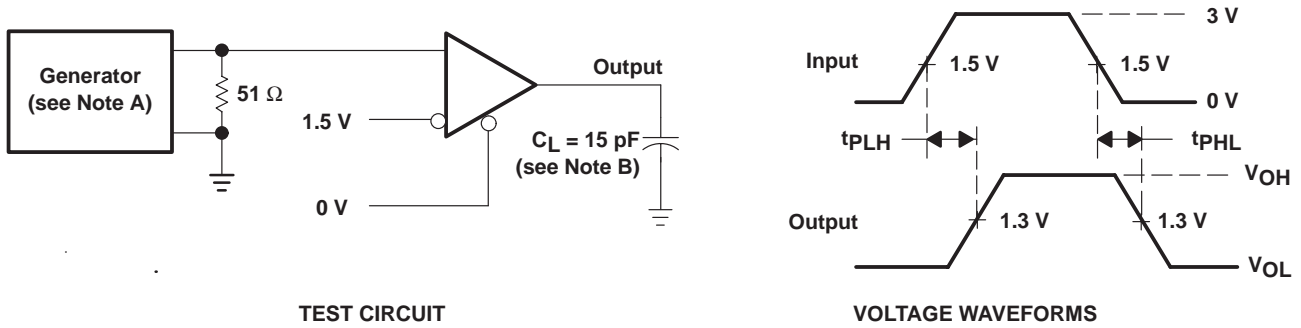


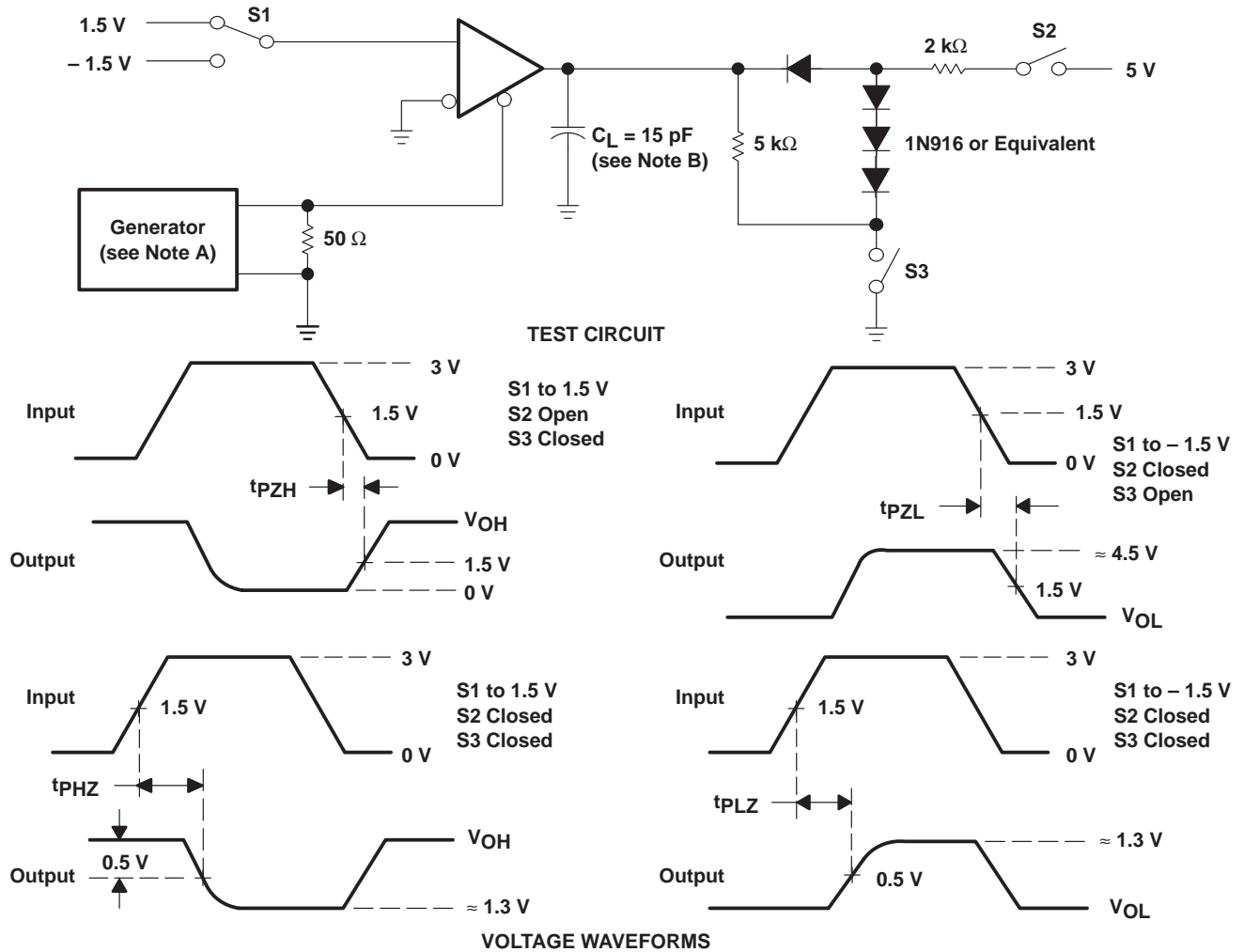
Figure 8. Receiver  $V_{OH}$  and  $V_{OL}$



- NOTES: A. The input pulse is supplied by a generator having the following characteristics: PRR  $\leq$  1 MHz, 50% duty cycle,  $t_r \leq$  6 ns,  $t_f \leq$  6 ns,  $Z_O = 50 \Omega$ .  
 B.  $C_L$  includes probe and jig capacitance.

Figure 9. Receiver Test Circuit and Voltage Waveforms

## PARAMETER MEASUREMENT INFORMATION



- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1 \text{ MHz}$ , 50% duty cycle,  $t_r \leq 6 \text{ ns}$ ,  $t_f \leq 6 \text{ ns}$ ,  $Z_O = 50 \Omega$ .  
 B.  $C_L$  includes probe and jig capacitance.

**Figure 10. Receiver Test Circuit and Voltage Waveforms**

# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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## TYPICAL CHARACTERISTICS

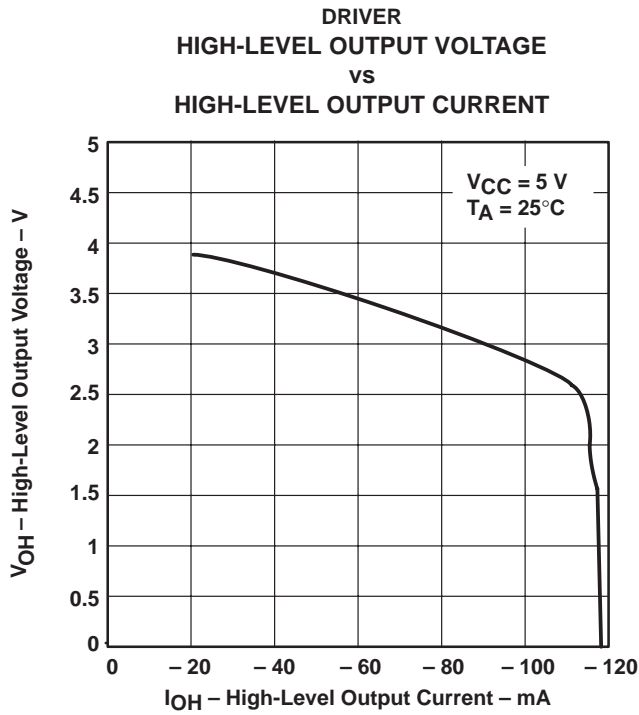


Figure 11

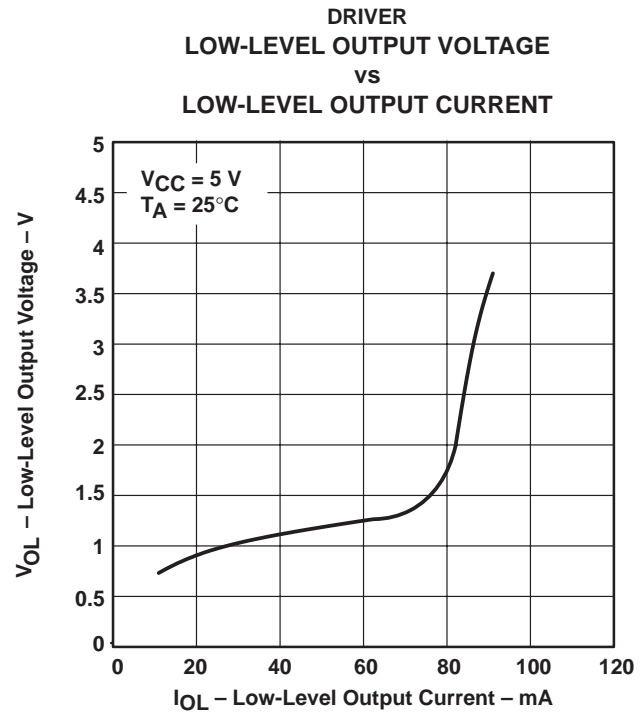


Figure 12

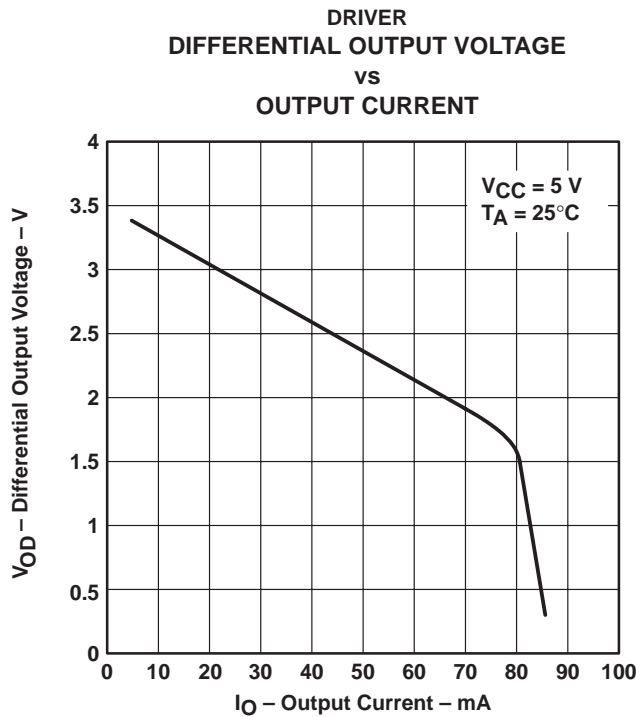


Figure 13



TYPICAL CHARACTERISTICS

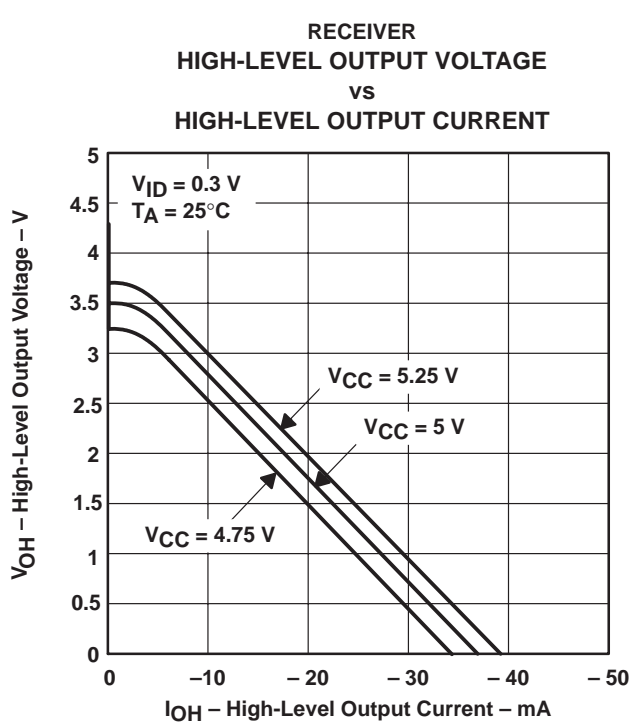


Figure 14

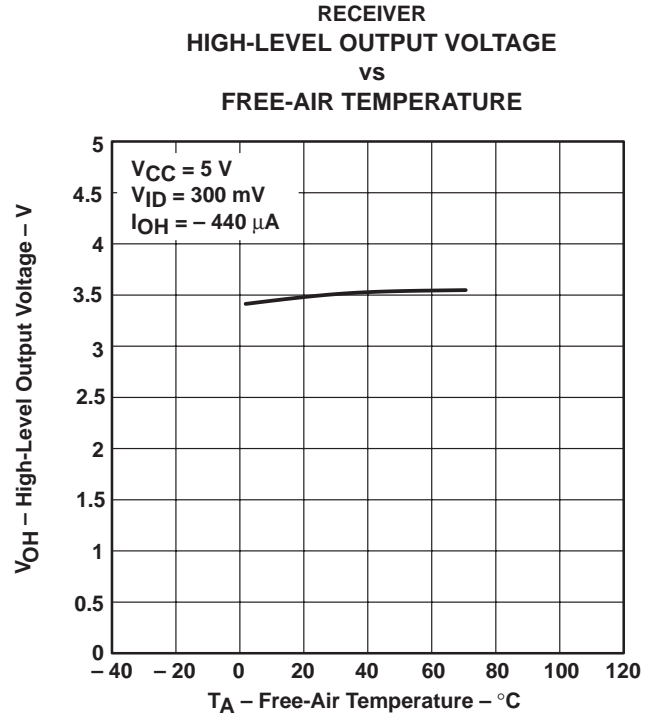


Figure 15

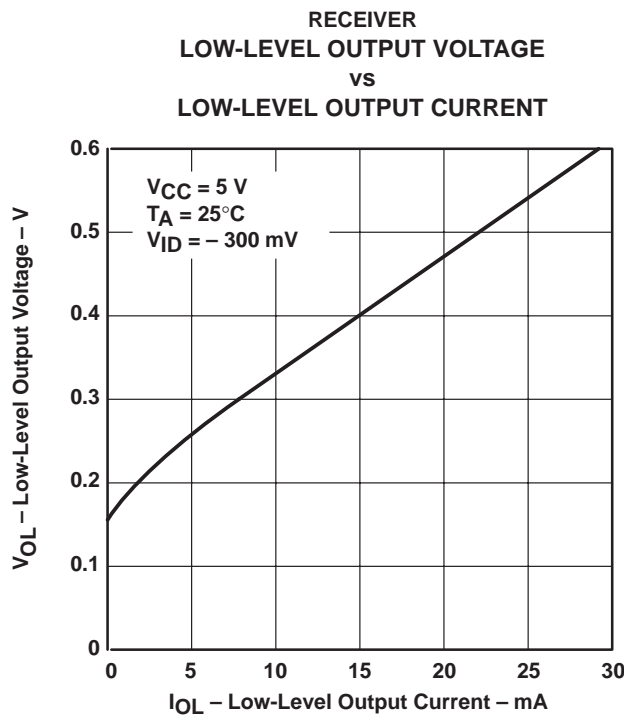


Figure 16

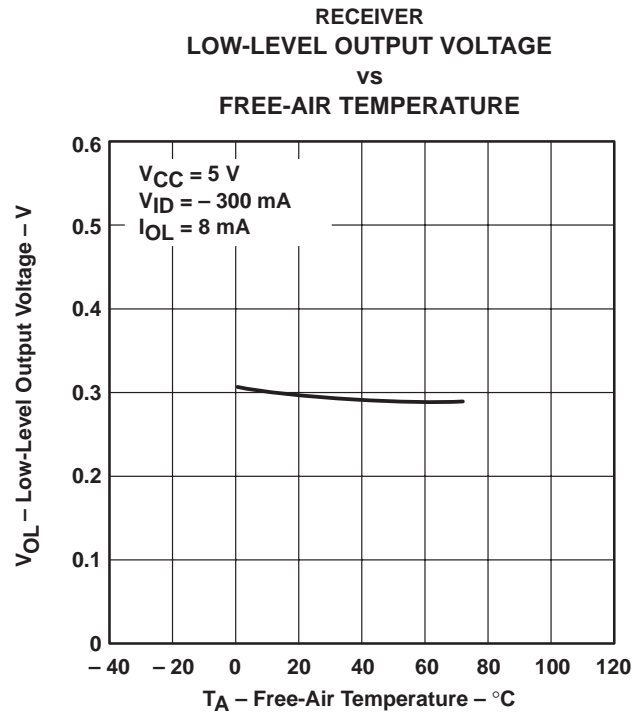


Figure 17

# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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## TYPICAL CHARACTERISTICS

RECEIVER  
OUTPUT VOLTAGE  
vs  
ENABLE VOLTAGE

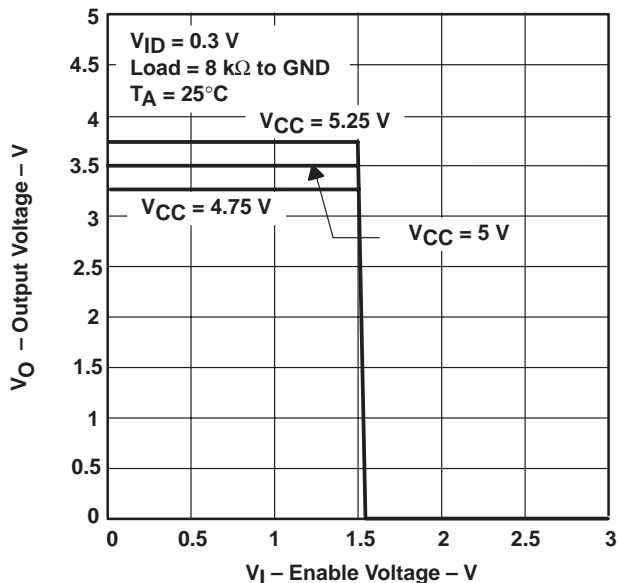


Figure 18

RECEIVER  
OUTPUT VOLTAGE  
vs  
ENABLE VOLTAGE

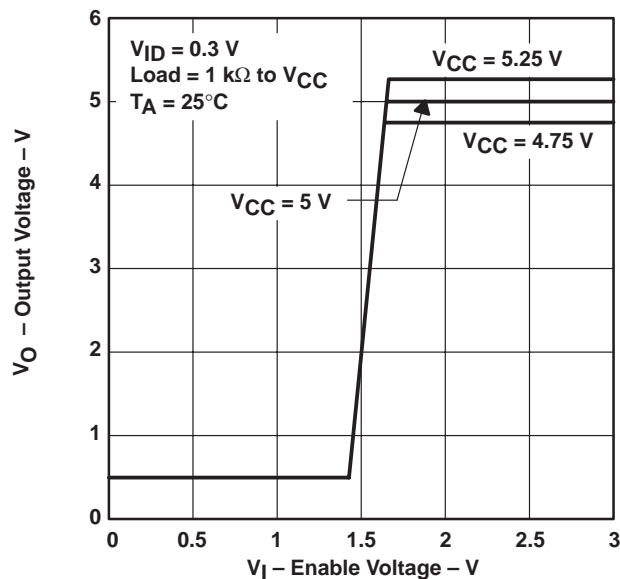
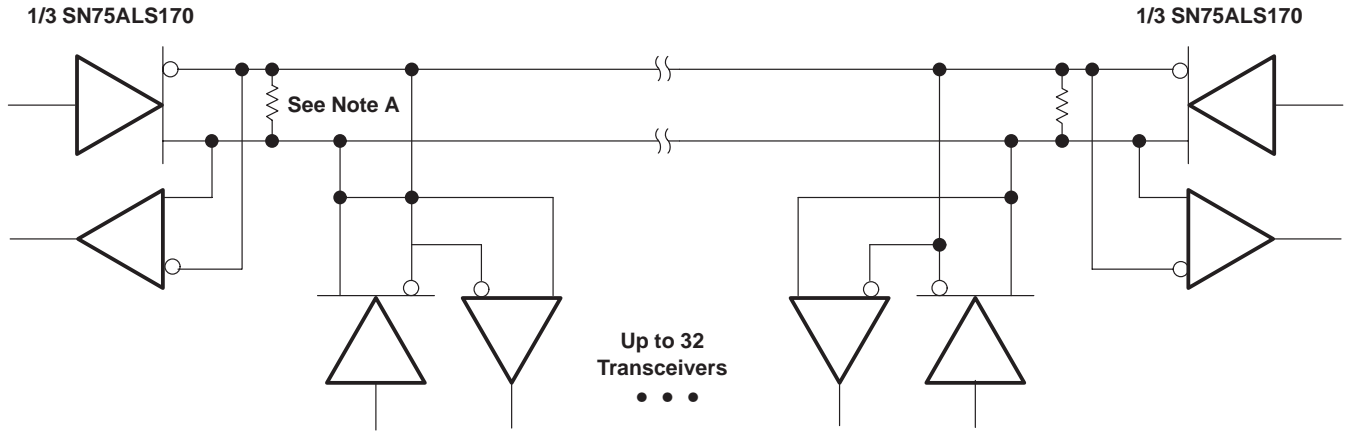


Figure 19



## APPLICATION INFORMATION



NOTE A: The line should be terminated at both ends in its characteristic impedance. Stub lengths off the main line should be kept as short as possible.

Figure 20. Typical Application Circuit

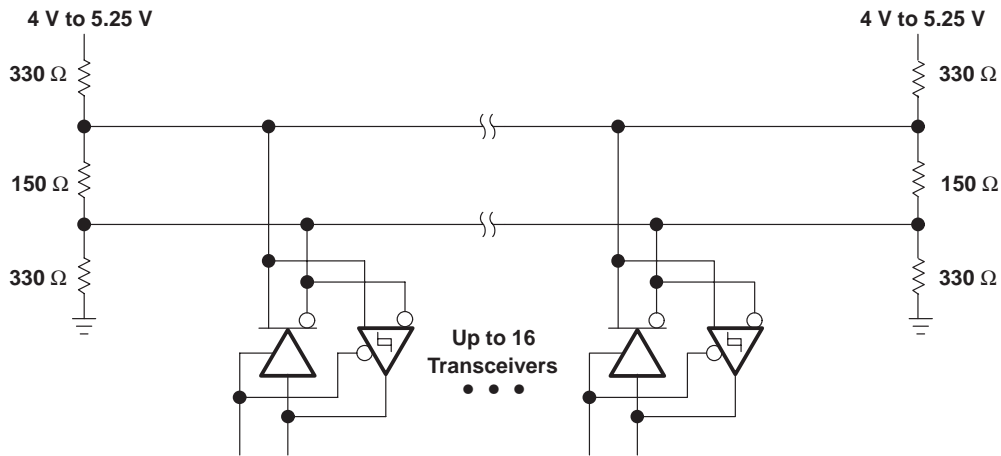


Figure 21. Typical Differential SCSI Application Circuit

# SN75ALS171, SN75ALS171A TRIPLE DIFFERENTIAL BUS TRANSCEIVERS

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## APPLICATION INFORMATION

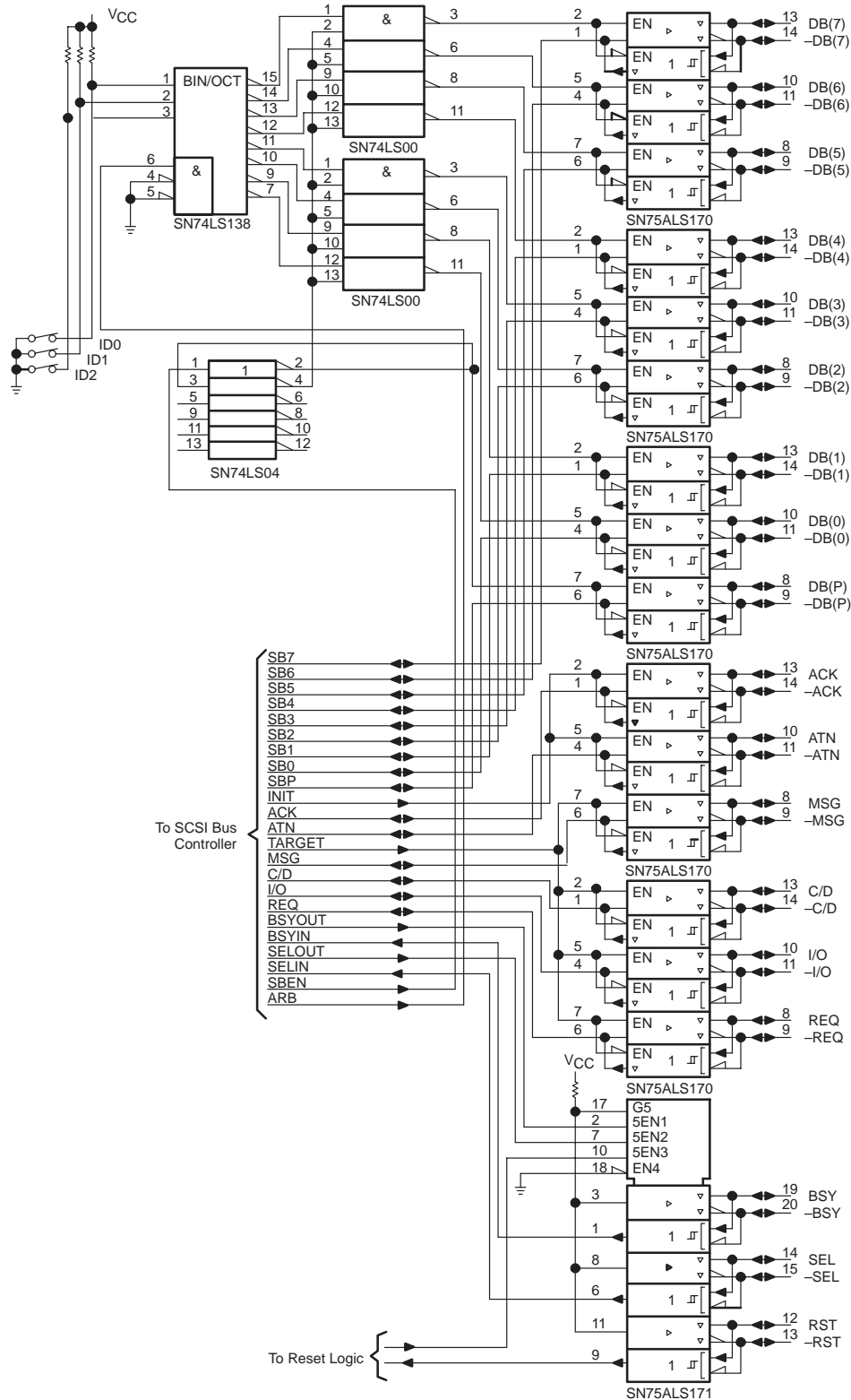


Figure 22. Typical Differential SCSI Bus Interface Implementation



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