

# SN75971B SCSI DIFFERENTIAL CONVERTER-DATA

SLLS322A – NOVEMBER 1999 – REVISED JANUARY 2000

- Provides High-Voltage Differential SCSI From Single-Ended Controller When Used With the SN75970B Control Transceiver
- Meets or Exceeds the Requirements of EIA Standard RS-485 and ISO-8482 Standards
- ESD Protection on Bus Pins to 12 kV
- Packaged in Shrink Small-Outline Package with 25 mil Terminal Pitch and Thin Small-Package with 20 mil Terminal Pitch
- Low Disabled-Supply Current 32 mA Typ
- Thermal Shutdown Protection
- Positive- and Negative-Current Limiting
- Power-Up/-Down Glitch Protection
- Open-Circuit Failsafe Receivers

## description

The SN75971B SCSI differential converter-data is a 9-channel RS-485 transceiver. When used in conjunction with its companion control transceiver, the SN75970B, the resulting chip set provides the superior electrical performance of differential SCSI from a single-ended SCSI bus or controller. A 16-bit Ultra-SCSI (or Fast-20) SCSI bus can be implemented with just three devices (two data and one control) in the space efficient, 56-pin, shrink small-outline package (SSOP) or thin shrink small outline package (TSSOP) and a few external components. An 8-bit SCSI bus requires only one data and one control transceiver.

The SN75971B is available in a B2 (20 Mxfer) version and a B1 (10 Mxfer) version.

In a typical differential SCSI node, the SCSI controller provides an enable for each external RS-485 transceiver channel. This could require as many as 27 extra terminals for a 16-bit differential bus controller or relegate a 16-bit, single-ended controller to only an 8-bit differential bus. Using the standard nine SCSI control signals, the SN75970B control transceiver decodes the state of the bus and enables the SN75971B data transceiver to transmit the single-ended SCSI input signals (A side) differentially to the cable or receive the differential cable signals (B side) and drive the single-ended outputs to the controller.

A reset function, which disables all outputs and clears internal latches, can be accomplished from two external inputs and two internally-generated signals.  $\overline{\text{RESET}}$  (reset) and DSENS (differential sense) are available to external circuits for a bus reset or to disable all outputs should a single-ended cable be inadvertently connected to a differential connector. Internally-generated power-up and thermal-shutdown signals have the same affect when the supply voltage is below approximately 3.5 V or the junction temperature exceeds 175°C.

DGG OR DL PACKAGE  
(TOP VIEW)

SDB	1	56	DSENS
DRVBUS	2	55	RESET
GND	3	54	GND
ADBP-	4	53	BDBP-
NC	5	52	BDBP+
ADB7-	6	51	BDB7-
NC	7	50	BDB7+
ADB6-	8	49	BDB6-
NC	9	48	BDB6+
ADB5-	10	47	BDB5-
NC	11	46	BDB5+
V <sub>CC</sub>	12	45	V <sub>CC</sub>
GND	13	44	GND
GND	14	43	GND
GND	15	42	GND
GND	16	41	GND
GND	17	40	GND
V <sub>CC</sub>	18	39	V <sub>CC</sub>
ABD4-	19	38	BDB4-
NC	20	37	BDB4+
ADB3-	21	36	BDB3-
NC	22	35	BDB3+
ADB2-	23	34	BDB2-
NC	24	33	BDB2+
ADB1-	25	32	BDB1-
NC	26	31	BDB1+
ADB0-	27	30	BDB0-
NC	28	29	BDB0+

Pins 13–17 and 40–44 are connected together to the package lead frame and to signal ground.

NC – No internal connection



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 **TEXAS  
INSTRUMENTS**

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# SN75971B

## SCSI DIFFERENTIAL CONVERTER-DATA

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### description (continued)

The SCSI, differential, converter-data chip operates in two modes depending on the state of the DRVBUS input. With DRVBUS low, a bidirectional latch circuit sets the direction of data transfer. Each data bit has its own latch, and each bit's direction is independent of all other bits. When neither the single-ended nor the differential sides are asserted, the latch disables both A- and B-side output drivers. When the input to either side is asserted, the latch enables the opposite side's driver and sets data flow from the asserted input to the opposite side of the device. When the input deasserts, the latch maintains the direction until the receiver on the enabled driver detects a deassertion. The latch then returns to the initial state. No parity checking is done by this device; the parity signal passes through the device like other data signals do.

When DRVBUS is high, direction is determined by the SDB signal. However, a change in SDB does not always immediately change the direction. When DRVBUS first asserts, the direction indicated by SDB is latched and takes effect immediately. When SDB changes while DRVBUS is high, the drivers that were on immediately turn off. However, the other driver set does not turn on until the receivers sense a deasserted state on all nine data lines. This is done to prevent the active drivers from turning on until all other drivers are off and the terminators pull the lines to a deasserted state.

The single-ended SCSI bus interface consists of CMOS, bidirectional inputs and outputs. The drivers are rated to  $\pm 16$  mA of output current. The receiver inputs are pulled high with approximately 4 mA to eliminate the need for external pullup resistors for the open-drain outputs of most single-ended SCSI controllers. The single-ended side of the device is not intended to drive the SCSI bus directly.

The differential SCSI bus interface consists of bipolar, bidirectional inputs and outputs that meet or exceed the requirements of EIA-485 and ISO 8482-1982/TIA TR30.2 referenced by American National Standard of Information Systems (ANSI) X3.131-1994 Small Computer System Interface-2 (SCSI-2) and SCSI-3 Fast-20 Parallel Interface (Fast-20) X3.277:1996.

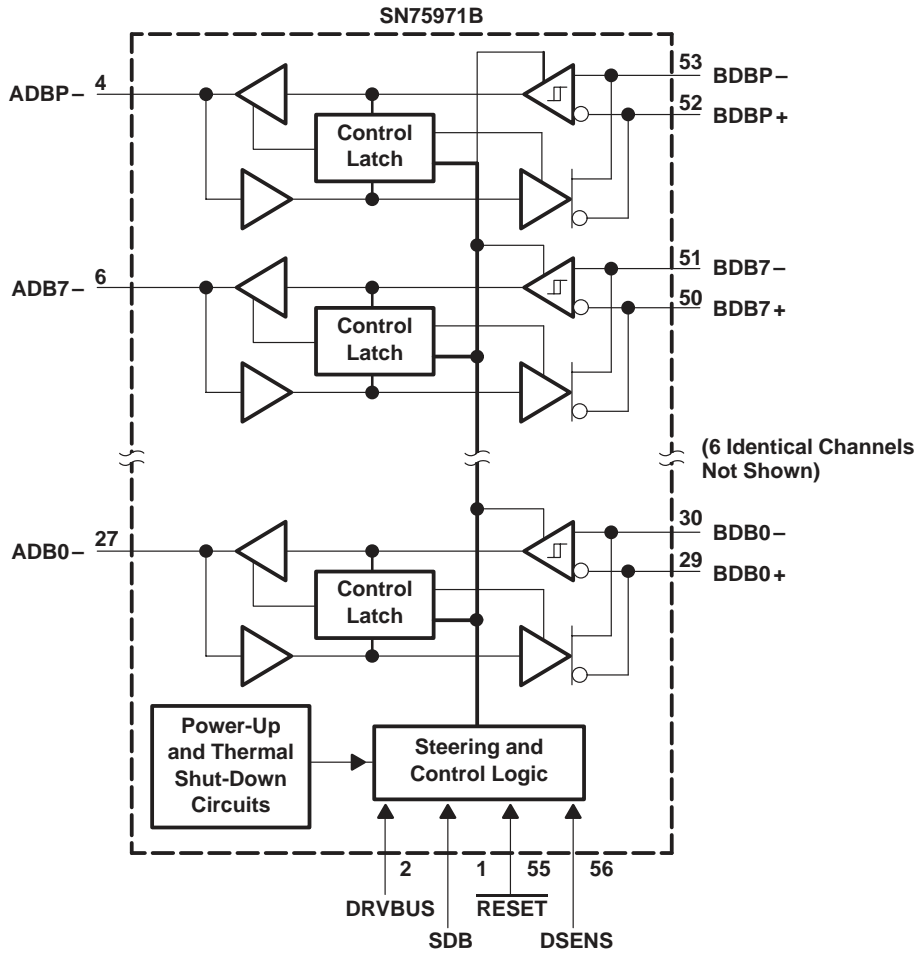
The SN75971B is characterized for operation over the temperature range of 0°C to 70°C.

### Terminal Functions

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
ADBn-, where n = {0,1,2,3,4,5,6,7,P}	4, 6, 8, 10, 19, 21, 23, 25, 27	I/O, Single-ended SCSI voltage levels, Strong pullup	Bidirectional I/O for data and parity bits to and from the single-ended SCSI controller. As outputs, these terminals can source or sink 16 mA. As inputs, they are pulled up with about 4-mA to eliminate external resistors.
BDBn+, where n = {0,1,2,3,4,5,6,7,P}	29, 31, 33, 35, 37, 46, 48, 50, 52	I/O, RS-485, Weak pulldown	Bidirectional I/O for data and parity to and from the differential SCSI bus.
BDBn-, where n = {0,1,2,3,4,5,6,7,P}	30, 32, 34, 36, 38,47, 49, 51, 53	I/O, RS-485, Weak pulldown	Bidirectional I/O for the complement of data and parity to and from the differential SCSI bus.
DRVBUS	2	Input, TTL levels, Weak pulldown	A high-level logic signal from the control transceiver enables either the single-ended or differential drivers as directed by SDB.
DSSENS	56	Input, TTL levels, Weak pullup	A low-level input initializes the internal latches and disables all drivers.
RESET	55	Input, TTL levels, Weak pullup	A low-level input initializes the internal latches and disables all drivers.
SDB	1	Input, TTL levels, Weak pulldown	A high-level logic signal from the control transceiver sends data from the differential bus to the single-ended bus. A low-level signal reverses the flow.



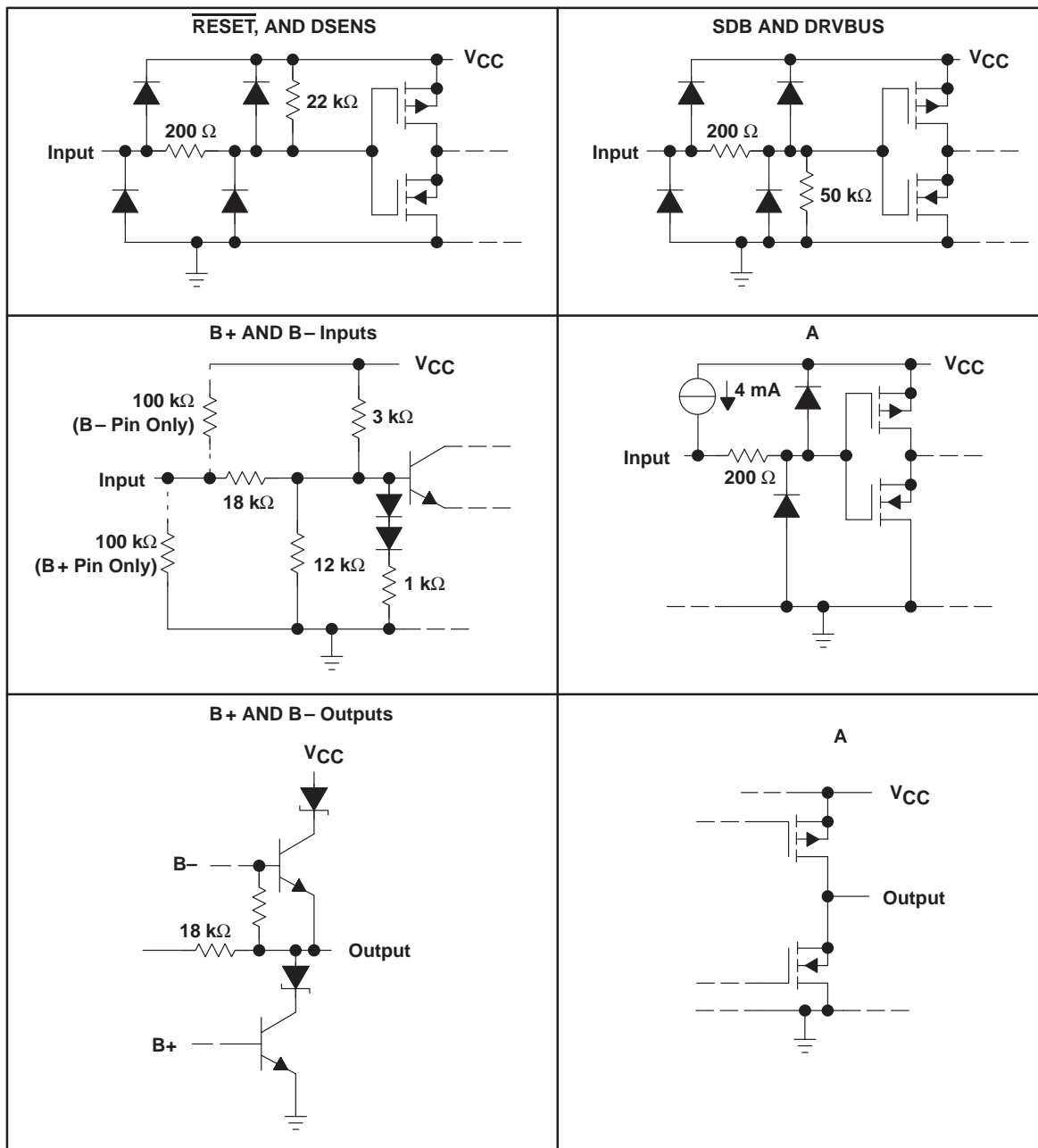
functional block diagram



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## schematics of inputs and outputs



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

Supply voltage range, $V_{CC}$ (see Note 1) .....	–0.3 V to 7 V
Differential bus voltage range (B side) .....	–10 V to 15 V
Single-ended bus voltage range (A side and control inputs) .....	–0.3 V to 7 V
Continuous total power dissipation (see Note 2) .....	Internally Limited (see Dissipation Rating Table)
Electrostatic discharge (see Note 3): Class 2 A (all pins) .....	4 kV
Class 2 B (all pins) .....	400 V
Class 3 A (B-side and GND) .....	12 kV
Class 3 B (B-side and GND) .....	400 V
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 .....	260°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. All voltage values are with respect to GND.  
 2. The maximum operating junction temperature is internally limited. Use the dissipation rating table to operate below this temperature.  
 3. This absolute maximum rating is tested in accordance with MIL-STD-883C, Method 3015.7.

**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
DGG	3333 mW	26.7 mW/°C	2133 mW
DL	3709 mW	29.7 mW/°C	2374 mW

‡ This is the inverse of the traditional junction-to-case thermal resistance ( $R_{\theta JA}$ ) for High-K (per JEDEC) PCB installations.

**recommended operating conditions**

		MIN	NOM	MAX	UNIT
Supply voltage, $V_{CC}$		4.75	5	5.25	V
High-level input voltage, $V_{IH}$	A side and control	2			V
Low-level input voltage, $V_{IL}$	A side and control			0.8	V
Voltage at any bus terminal (separately or common-mode), $V_O$ or $V_I$	B side			12 –7	V
High-level output current, $I_{OH}$	A side			–16	mA
Low-level output current, $I_{OL}$	A side			16	mA
Operating case temperature, $T_C$		0		125	°C
Operating free-air temperature, $T_A$		0		70	°C

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## electrical characteristics over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT	
V <sub>OD(H)</sub>	Driver high-level differential output voltage	See Figure 1		-1	-2.2		V	
V <sub>OD(L)</sub>	Driver low-level differential output voltage	See Figure 1		1	1.8		V	
V <sub>OH</sub>	High-level output voltage	A side	V <sub>ID</sub> = -200 mV, I <sub>OH</sub> = -16 mA	2.5	4.2		V	
		B side	I <sub>OH</sub> = -60 mA		3.4			
V <sub>OL</sub>	Low-level output voltage	A side	V <sub>ID</sub> = 200 mV, I <sub>OL</sub> = 16 mA		0.4	0.8	V	
		B side	I <sub>OL</sub> = 60 mA		1.6			
V <sub>IT+</sub>	Receiver positive-going differential input threshold voltage	B side	I <sub>OH</sub> = -16 mA	See Figure 2		0.2	V	
V <sub>IT-</sub>	Receiver negative-going differential input threshold voltage		I <sub>OL</sub> = 16 mA	See Figure 2		-0.2§	V	
V <sub>hys</sub>	Receiver input hysteresis voltage (V <sub>IT+</sub> - V <sub>IT-</sub> )				35	45	mV	
I <sub>I</sub>	Bus input current	B or $\bar{B}$	V <sub>I</sub> = 12 V, Other input at 0 V	V <sub>CC</sub> = 5 V	0.6	1	mA	
				V <sub>CC</sub> = 0	0.7	1		
			V <sub>I</sub> = -7 V, Other input at 0 V	V <sub>CC</sub> = 5 V	-0.5	-0.8	mA	
				V <sub>CC</sub> = 0	-0.4	-0.8		
I <sub>IH</sub>	High-level input current	A side	V <sub>IH</sub> = 2 V		-2	-5	-8	mA
		$\overline{\text{RESET}}$ , DSENS			-70	-100	μA	
		SDB, DRVBUS				25		
I <sub>IL</sub>	Low-level input current	A side	V <sub>IL</sub> = 0.8 V		-6	-9	mA	
		$\overline{\text{RESET}}$ , DSENS			-66	-100		μA
		SDB, DRVBUS				±30		
I <sub>OS</sub>	Short-circuit output current	B side	V <sub>O</sub> = 5 V and 0			±250	mA	
I <sub>OZ</sub>	High-impedance-state output current	A side		-2	-5	-8		
		B side			-6	-9		
I <sub>CC</sub>	Supply current	Disabled	$\overline{\text{RESET}}$ at 0.8 V, Others open		38	46	mA	
		B to A Enabled	SDB and DRVBUS at 2 V, All other inputs open, V <sub>ID</sub> = -1 V, No load		39	50		
		A to B Enabled	SDB at 0.8 V, All other inputs open, DRVBUS at 2 V, No load		32	66		
C <sub>O</sub>	Output capacitance		V <sub>I</sub> = 0.6 sin(2π × 10 <sup>6</sup> t) + 1.5 V, BDBn to GND		18	21	pF	
C <sub>pd</sub>	Power dissipation capacitance‡		B to A, One channel		40		pF	
			A to B, One channel		100		pF	

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

‡ C<sub>pd</sub> determines the no-load dynamic current consumption, I<sub>S</sub> = C<sub>pd</sub> × V<sub>CC</sub> × f + I<sub>CC</sub>.

§ The algebraic convention with the least positive (more negative) limit is designated minimum, is used in this data sheet for the differential input voltage only.



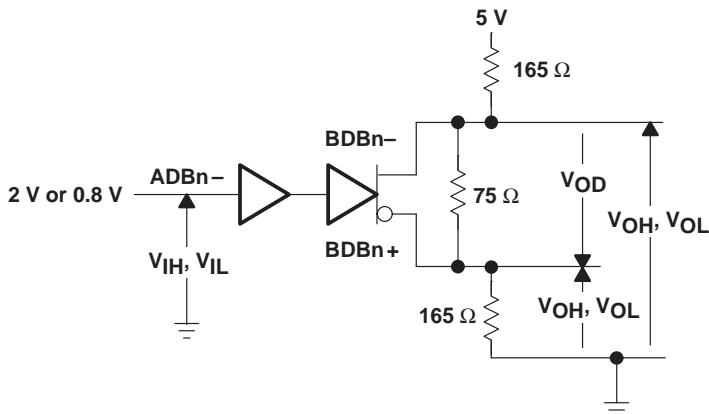
**switching characteristics over recommended of operating conditions (unless otherwise noted)**

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
$t_{d1}, t_{d2}$	Delay time, A to B, high- to low-level or low- to high-level output	See Figures 3 and 4	3	14	ns
		$V_{CC} = 5\text{ V}, T_A = 25^\circ\text{C},$ See Figures 3 and 4	4	12	
		$V_{CC} = 5\text{ V}, T_A = 70^\circ\text{C},$ See Figures 3 and 4	4.9	12.9	
	SN75971B2	See Figures 3 and 4	5	12	
		$V_{CC} = 5\text{ V}, T_A = 25^\circ\text{C},$ See Figures 3 and 4	6.2	10.2	
		$V_{CC} = 5\text{ V}, T_A = 70^\circ\text{C},$ See Figures 3 and 4	6.9	10.9	
$t_{d3}, t_{d4}$	Delay time, B to A, high- to low-level or low- to high-level output	See Figures 5 and 6	5.4	18.1	ns
		$V_{CC} = 5\text{ V}, T_A = 25^\circ\text{C},$ See Figures 5 and 6	6.5	15.4	
		$V_{CC} = 5\text{ V}, T_A = 70^\circ\text{C},$ See Figures 5 and 6	7.2	16.1	
	SN75971B2	See Figures 5 and 6	7.7	15	
		$V_{CC} = 5\text{ V}, T_A = 25^\circ\text{C},$ See Figures 5 and 6	8.7	13.2	
		$V_{CC} = 5\text{ V}, T_A = 70^\circ\text{C},$ See Figures 5 and 6	9.4	13.9	
$t_{sk(pp)}$	Skew, part-to-part†	A to B	See Figures 5 and 6	8	ns
		B to A	See Figures 5 and 6	9	
		A to B	See Figures 5 and 6	4	
		B to A	See Figures 5 and 6	5	
$t_{sk(p)}$	Pulse skew‡			4	ns
$t_{dis1}$	Disable time, A to B	See Figures 3 and 4		200	ns
$t_{dis2}$	Disable time, B to A	See Figures 5 and 6		35	ns
$t_{en1}$	Enable time, A to B	See Figures 3 and 4		65	ns
$t_{en2}$	Enable time, B to A	See Figures 5 and 6		65	ns
$t_{en(TX)}$	Enable time, receive-to-transmit	See Figure 7		142	ns

† Part-to-part skew is the magnitude of the difference in propagation delay times between any two devices when both operate with the same supply voltages, the same temperature, and the same loads.

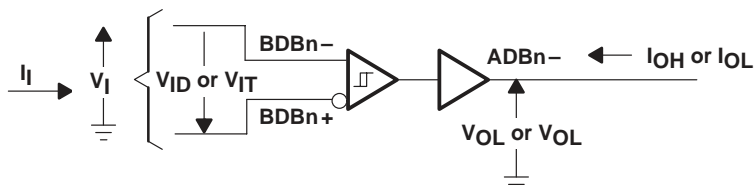
‡ Pulse skew is the difference between the high-to-low and low-to-high propagation delay times of any single channel.

PARAMETER MEASUREMENT INFORMATION



- NOTES: A. Resistance values are in ohms with a tolerance of  $\pm 5\%$ .  
 B. All input voltage levels are held to within 0.01 V.  
 C. The logical function is set with SDB at 0.8 V, DRVBUS at 3.5 V, and all others left open.

Figure 1. Differential Driver  $V_{OD}$ ,  $V_{OH}$ , and  $V_{OL}$  Test Circuit

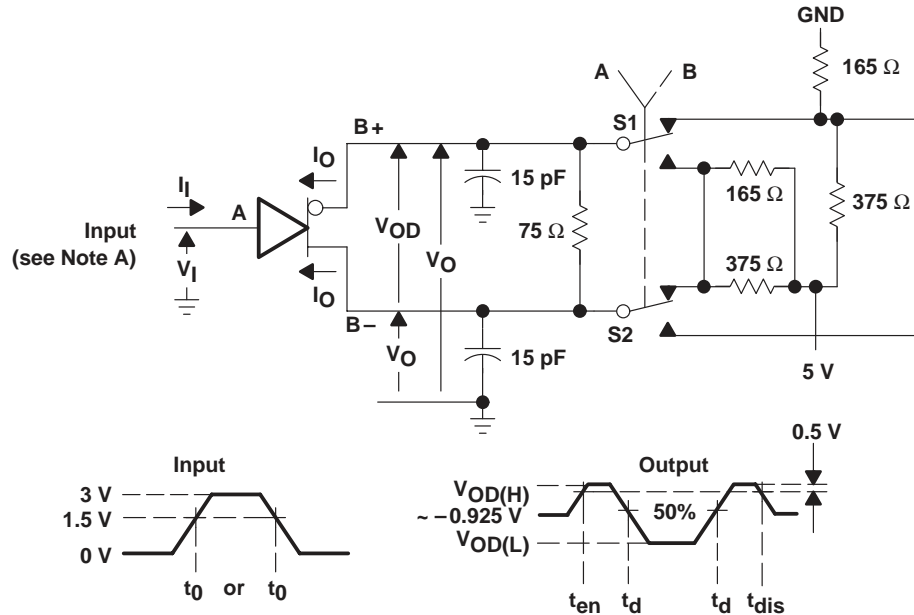


- NOTES: A. Resistance values are in ohms with a tolerance of  $\pm 5\%$ .  
 B. All input voltage levels are held to within 0.01 V.  
 C. The logical function is set with SDB and DRVBUS at 3.5 V, and all others left open.

Figure 2. Single-Ended Driver  $V_{OH}$ ,  $V_{OL}$ ,  $V_{IT+}$ , and  $V_{IT-}$  Test Circuit



PARAMETER MEASUREMENT INFORMATION



- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1 \text{ MHz}$ ,  $45\% < \text{duty cycle} < 50\%$ ,  $t_r \leq 1 \text{ ns}$ ,  $t_f \leq 1 \text{ ns}$ ,  $Z_O = 50 \Omega$ .  
 B.  $C_L$  includes probe and jig capacitance.  
 C. Resistance values are in ohms with a tolerance of  $\pm 5\%$ .  
 D. All input voltage levels are held to within 0.01 V.

Figure 3. A to B Propagation Delay Time Test Circuit

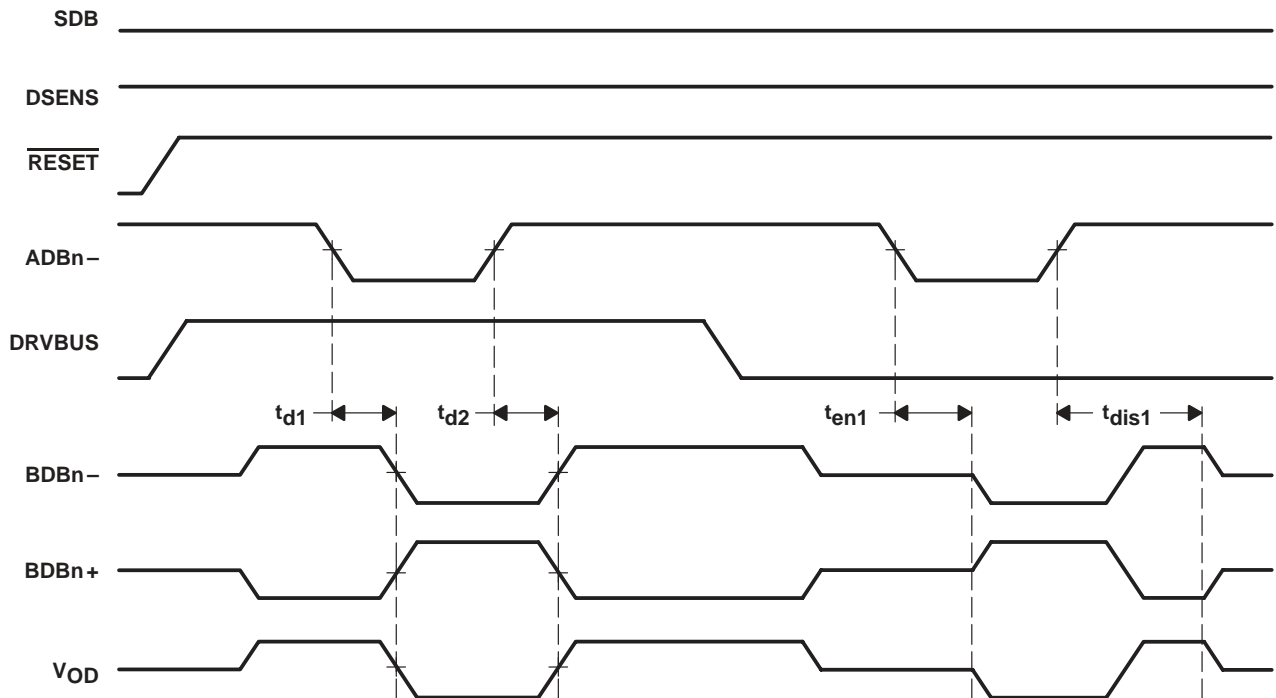
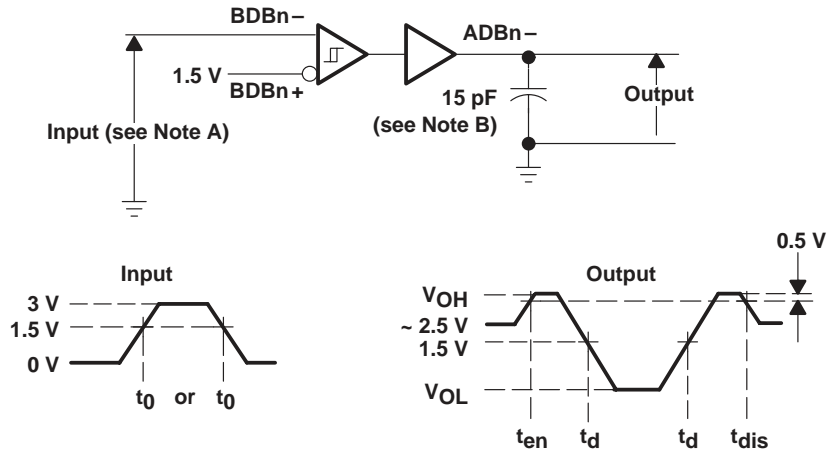


Figure 4. A to B Timing Waveforms

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## PARAMETER MEASUREMENT INFORMATION



- NOTES: A. The input pulse is supplied by a generator having the following characteristics:  $PRR \leq 1 \text{ MHz}$ ,  $45\% < \text{duty cycle} < 50\%$ ,  $t_r \leq 1 \text{ ns}$ ,  $t_f \leq 1 \text{ ns}$ ,  $Z_O = 50 \Omega$ .
- B.  $C_L$  includes probe and jig capacitance.
- C. Resistance values are in ohms with a tolerance of  $\pm 5\%$ .
- D. All input voltage levels are held to within  $0.01 \text{ V}$ .

Figure 5. B to A Propagation Delay Time Test Circuit

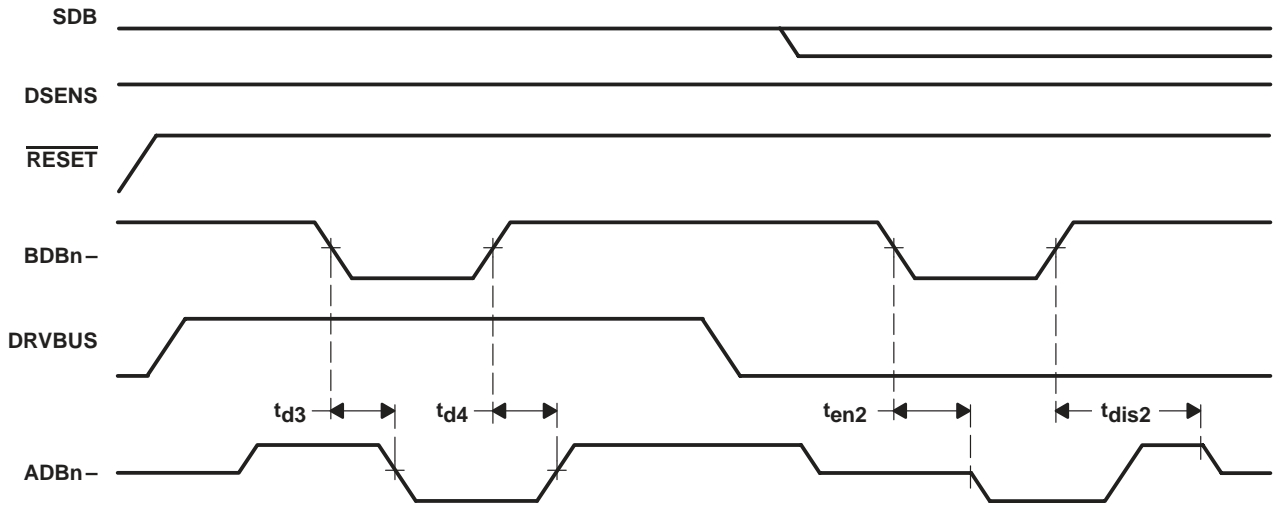


Figure 6. B to A Timing Waveforms

PARAMETER MEASUREMENT INFORMATION

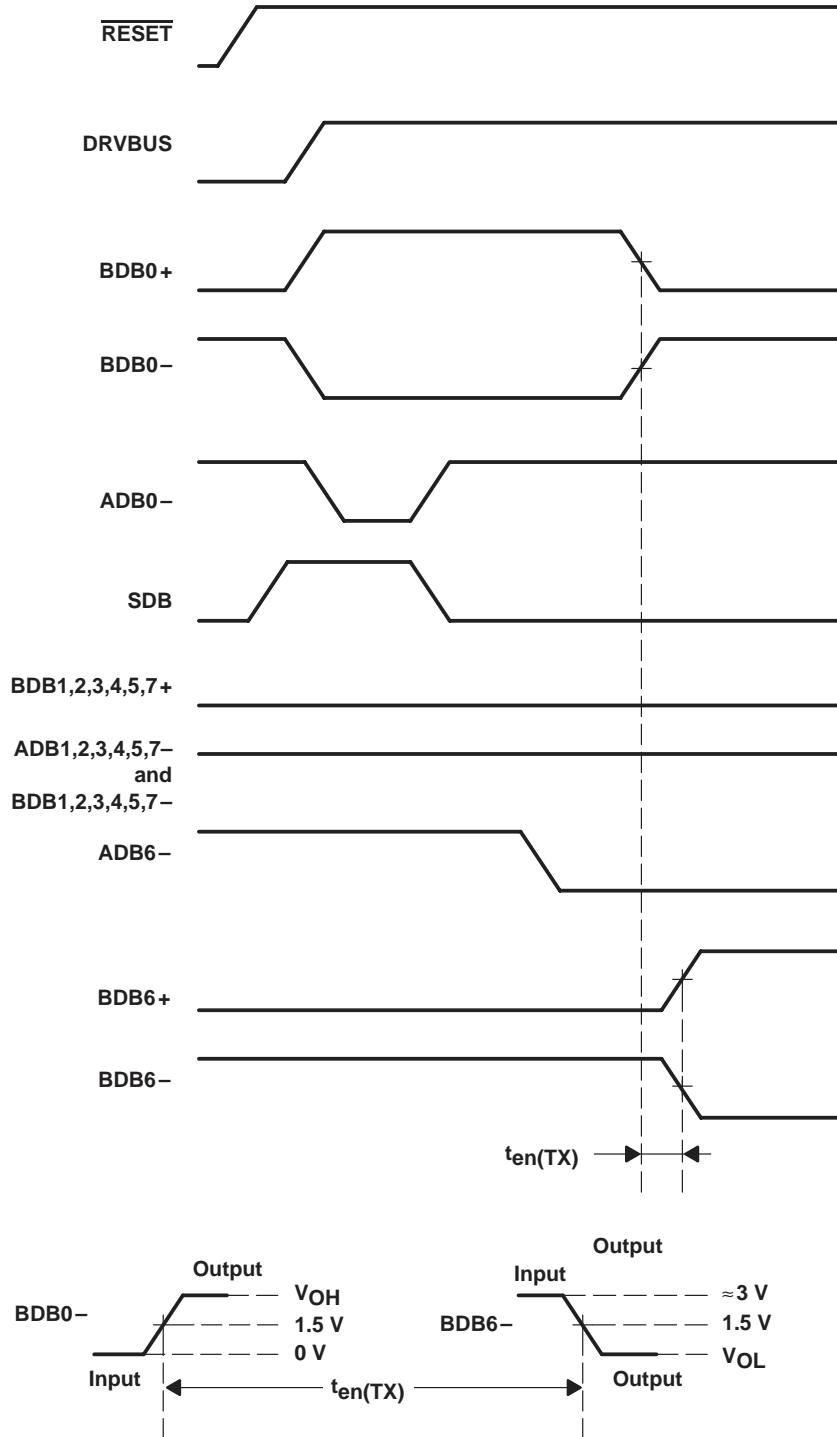
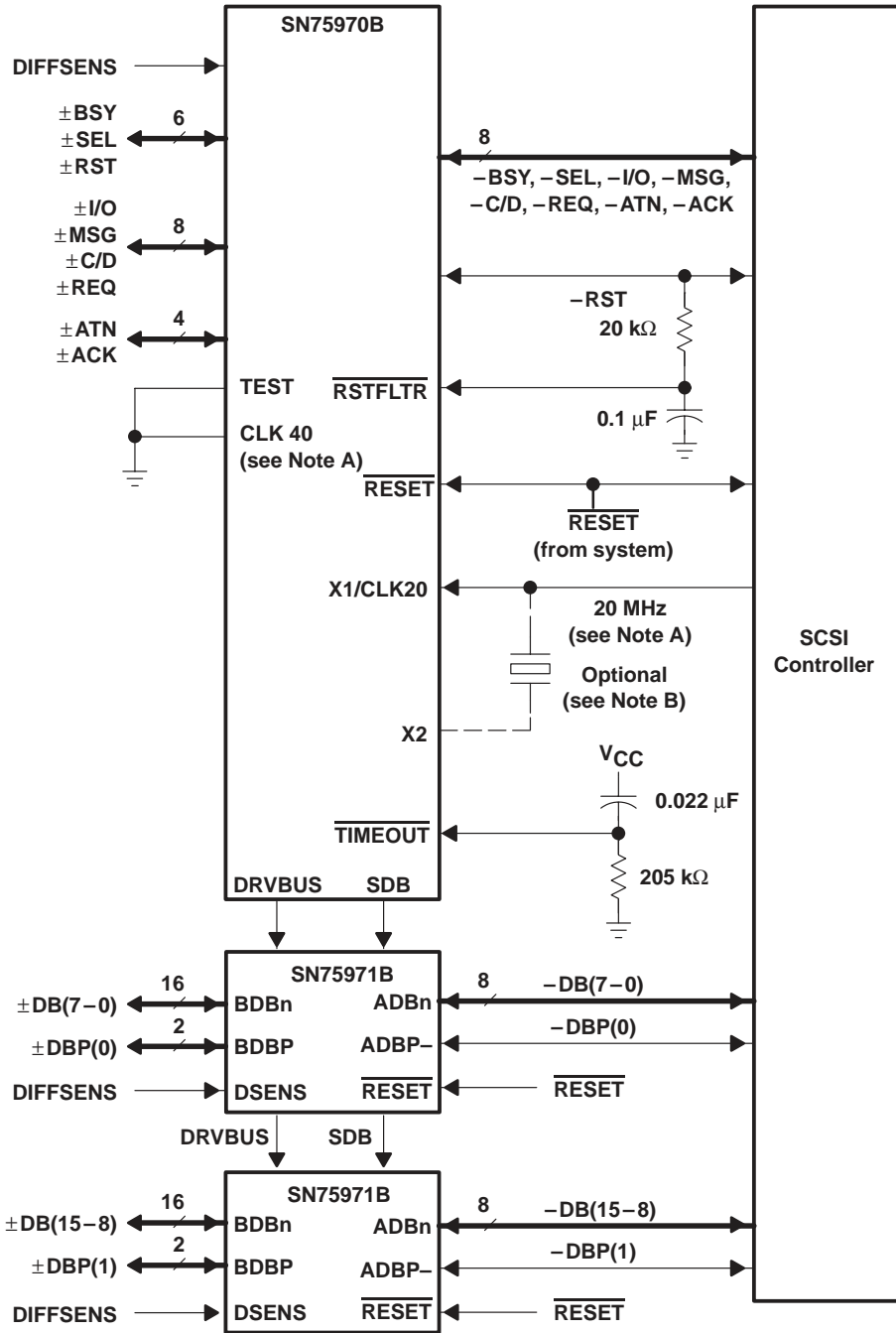


Figure 7. Receive-to-Transmit ( $t_{en(TX)}$ ) Timing Waveforms

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## APPLICATION INFORMATION



- NOTES: A. When using the 40-MHz clock input, X1 must be connected to V<sub>CC</sub>.  
 B. The oscillator cell of the SN75970B is for a series-resonant crystal and requires approximately 10 pF (including fixture capacitance) from X1 and X2 to ground in order to function.

Figure 8. Typical Application of the SN75970B and SN75971B

**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN75971B2DL	ACTIVE	SSOP	DL	56	20	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	0 to 70	SN75971B2	Samples

(1) 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.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN75971B2DL	DL	SSOP	56	20	473.7	14.24	5110	7.87

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