

# SN74LVCH16652A 16-BIT BUS TRANSCEIVER AND REGISTER WITH 3-STATE OUTPUTS

SCAS319E – NOVEMBER 1993 – REVISED JULY 1997

- Member of the Texas Instruments *Widebus™* Family
- *EPIC™* (Enhanced-Performance Implanted CMOS) Submicron Process
- Typical  $V_{OLP}$  (Output Ground Bounce)  $< 0.8$  V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- Typical  $V_{OHV}$  (Output  $V_{OH}$  Undershoot)  $> 2$  V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- Power Off Disables Inputs/Outputs, Permitting Live Insertion
- Supports Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltage With 3.3-V  $V_{CC}$ )
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model ( $C = 200$  pF,  $R = 0$ )
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Package Options Include Plastic 300-mil Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages

## description

This 16-bit bus transceiver and register is designed for 2.7-V to 3.6-V  $V_{CC}$  operation.

The SN74LVCH16652A consists of D-type flip-flops and control circuitry arranged for multiplexed transmission of data directly from the data bus or from the internal storage registers. The device can be used as two 8-bit transceivers or one 16-bit transceiver.

Complementary output-enable (OEAB and  $\overline{\text{OEBA}}$ ) inputs control the transceiver functions. Select-control (SAB and SBA) inputs select whether real-time or stored data is transferred. A low input level selects real-time data, and a high input level selects stored data. The circuitry used for select control eliminates the typical decoding glitch that occurs in a multiplexer during the transition between stored and real-time data. Figure 1 illustrates the four fundamental bus-management functions that can be performed with the SN74LVCH16652A.

DGG OR DL PACKAGE  
(TOP VIEW)

1OEAB	1	56	1 $\overline{\text{OEBA}}$
1CLKAB	2	55	1CLKBA
1SAB	3	54	1SBA
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
2SAB	26	31	2SBA
2CLKAB	27	30	2CLKBA
2OEAB	28	29	2 $\overline{\text{OEBA}}$



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## 16-BIT BUS TRANSCEIVER AND REGISTER

### WITH 3-STATE OUTPUTS

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#### description (continued)

Data on the A or B bus, or both, can be stored in the internal D flip-flops by low-to-high transitions at the appropriate clock (CLKAB or CLKBA) inputs regardless of the levels on the select-control or output-enable inputs. When SAB and SBA are in the real-time transfer mode, it is also possible to store data without using the internal D-type flip-flops by simultaneously enabling OEAB and  $\overline{\text{OEBA}}$ . In this configuration, each output reinforces its input. When all other data sources to the two sets of bus lines are at high impedance, each set of bus lines remains at its last level configuration.

To ensure the high-impedance state during power up or power down,  $\overline{\text{OEBA}}$  should be tied to  $V_{CC}$  through a pullup resistor and OEAB should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sinking/current-sourcing capability of the driver.

Inputs can be driven from either 3.3-V or 5-V devices. This feature allows the use of these devices as translators in a mixed 3.3-V/5-V system environment.

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

The SN74LVCH16652A is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

FUNCTION TABLE

INPUTS						DATA I/O†		OPERATION OR FUNCTION
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA	A1–A8	B1–B8	
L	H	H or L	H or L	X	X	Input	Input	Isolation
L	H	↑	↑	X	X	Input	Input	Store A and B data
X	H	↑	H or L	X	X	Input	Unspecified‡	Store A, hold B
H	H	↑	↑	X‡	X	Input	Output	Store A in both registers
L	X	H or L	↑	X	X	Unspecified‡	Input	Hold A, store B
L	L	↑	↑	X	X‡	Output	Input	Store B in both registers
L	L	X	X	X	L	Output	Input	Real-time B data to A bus
L	L	X	H or L	X	H	Output	Input	Stored B data to A bus
H	H	X	X	L	X	Input	Output	Real-time A data to B bus
H	H	H or L	X	H	X	Input	Output	Stored A data to B bus
H	L	H or L	H or L	H	H	Output	Output	Stored A data to B bus and stored B data to A bus

† The data-output functions may be enabled or disabled by a variety of level combinations at OEAB or  $\overline{\text{OEBA}}$ . Data-input functions are always enabled; i.e., data at the bus terminals is stored on every low-to-high transition of the clock inputs.

‡ Select control = L; clocks can occur simultaneously.

Select control = H; clocks must be staggered to load both registers.

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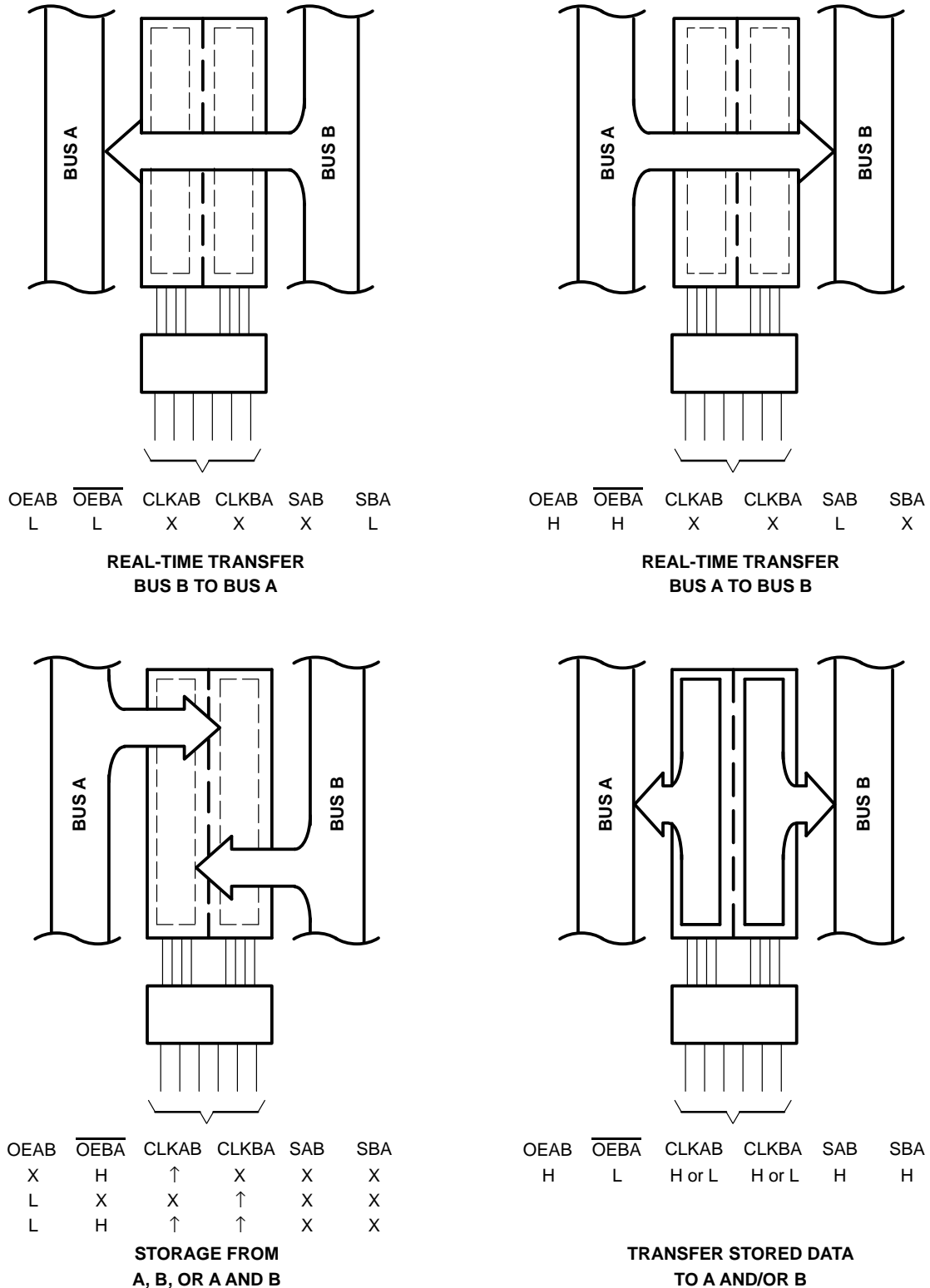


Figure 1. Bus-Management Functions

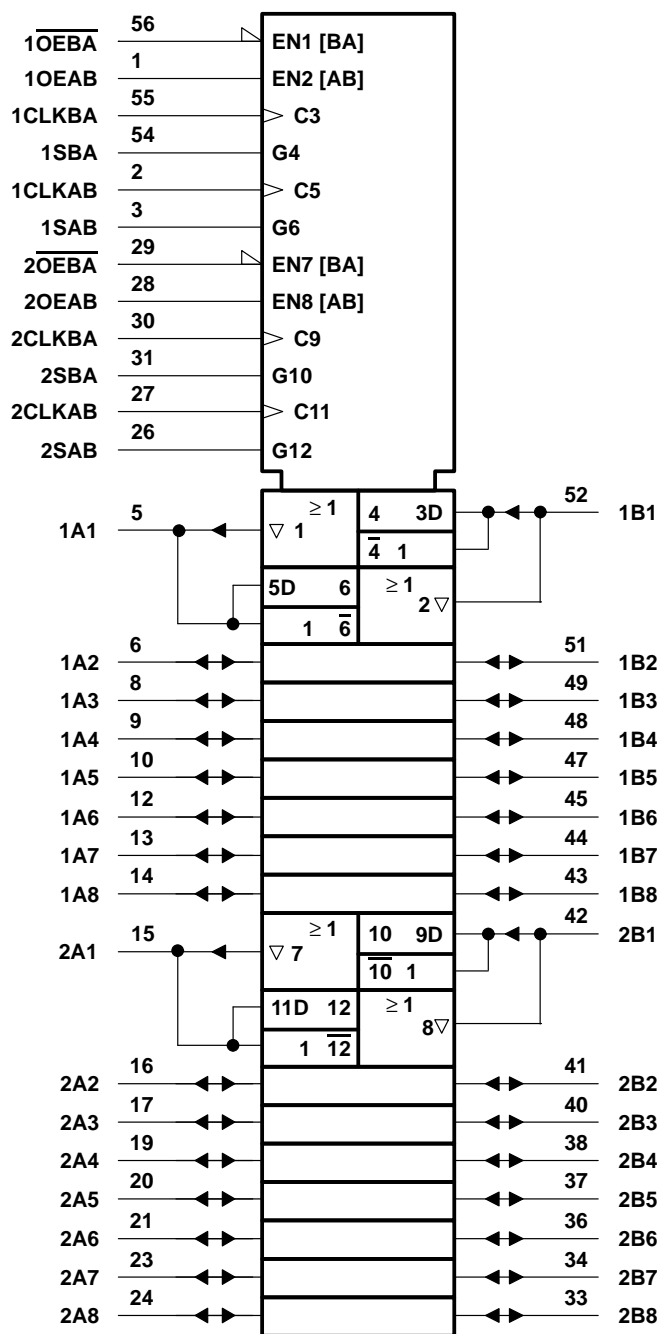
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## 16-BIT BUS TRANSCEIVER AND REGISTER

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logic symbol†

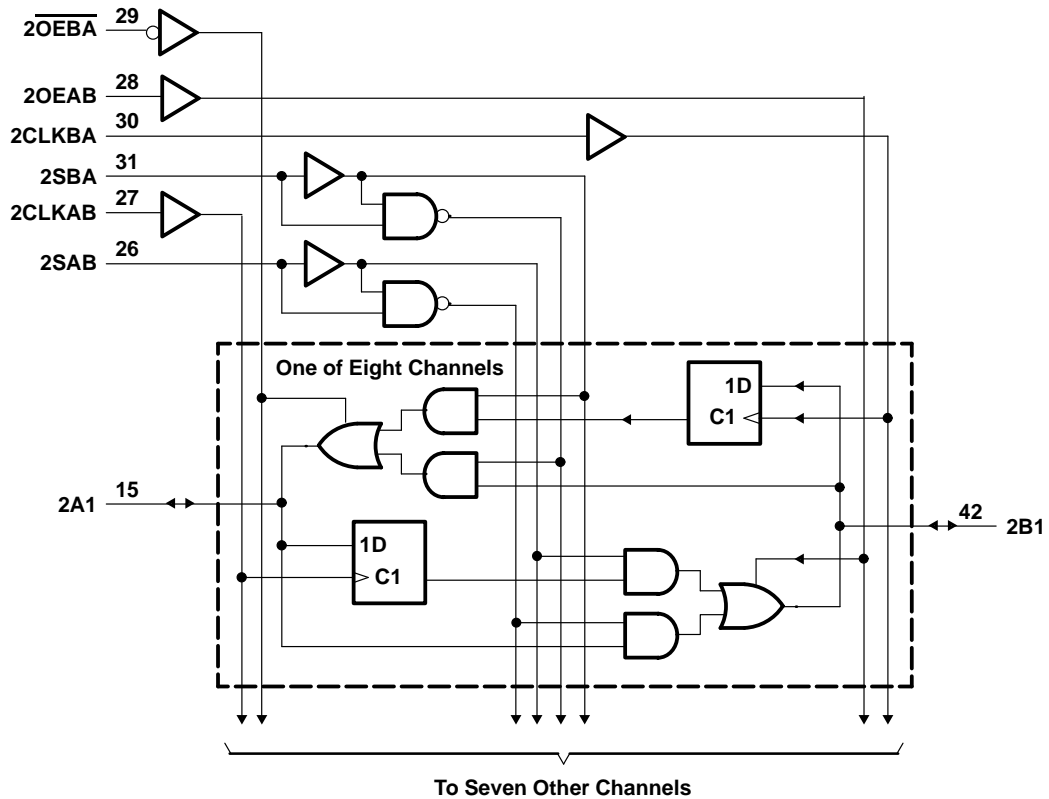
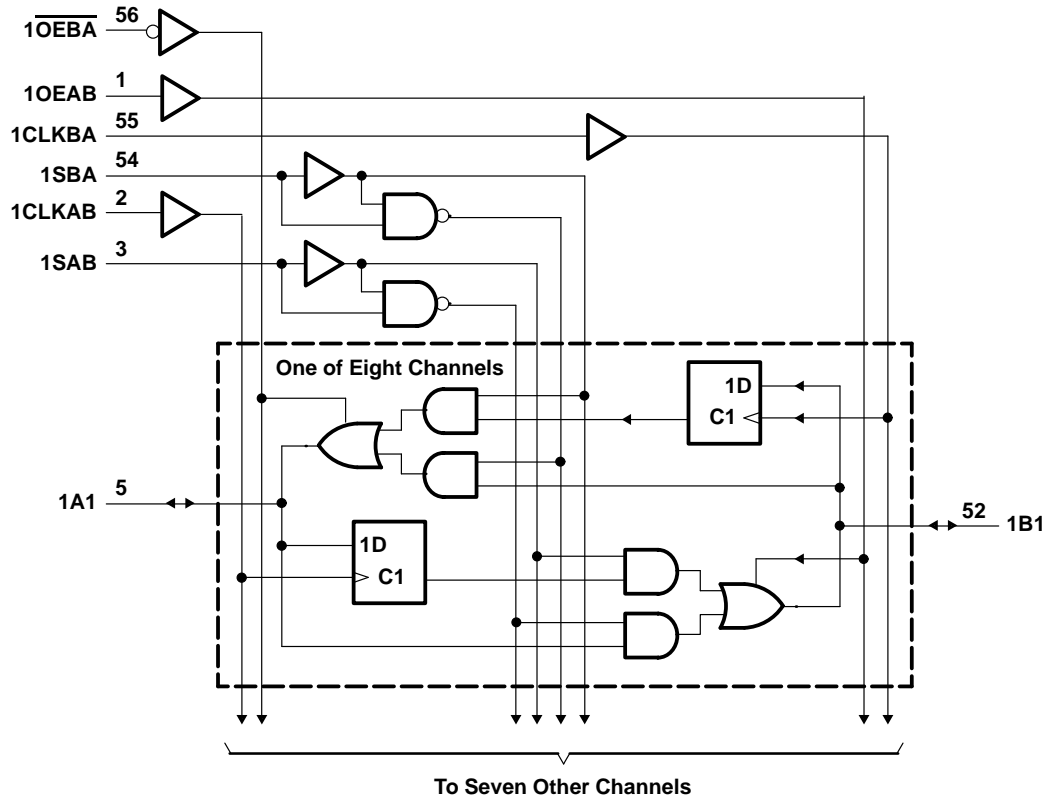


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

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logic diagram (positive logic)



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## 16-BIT BUS TRANSCEIVER AND REGISTER

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

Supply voltage range, $V_{CC}$	–0.5 V to 6.5 V
Input voltage range, $V_I$ : Except I/O ports (see Note 1)	–0.5 V to 6.5 V
I/O ports (see Notes 1 and 2)	–0.5 V to $V_{CC} + 0.5$ V
Voltage range applied to any output in the high-impedance or power-off state, $V_O$ (see Note 1)	–0.5 V to 6.5 V
Voltage range applied to any output in the high or low state, $V_O$ (see Notes 1 and 2)	–0.5 V to $V_{CC} + 0.5$ V
Input clamp current, $I_{IK}$ ( $V_I < 0$ )	–50 mA
Output clamp current, $I_{OK}$ ( $V_O < 0$ or $V_O > V_{CC}$ )	±50 mA
Continuous output current, $I_O$ ( $V_O = 0$ to $V_{CC}$ ) (see Note 2)	±50 mA
Continuous current through $V_{CC}$ or GND	±100 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

<sup>†</sup> 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 value of  $V_{CC}$  is provided in the recommended operating conditions table.  
3. The package thermal impedance is calculated in accordance with JESD 51.

#### recommended operating conditions (see Note 4)

		MIN	MAX	UNIT
$V_{CC}$ Supply voltage	Operating	2	3.6	V
	Data retention only	1.5		
$V_{IH}$ High-level input voltage	$V_{CC} = 2.7$ V to 3.6 V	2		V
$V_{IL}$ Low-level input voltage	$V_{CC} = 2.7$ V to 3.6 V		0.8	V
$V_I$ Input voltage		0	5.5	V
$V_O$ Output voltage	High or low state	0	$V_{CC}$	V
	3 state	0	5.5	
$I_{OH}$ High-level output current	$V_{CC} = 2.7$ V		–12	mA
	$V_{CC} = 3$ V		–24	
$I_{OL}$ Low-level output current	$V_{CC} = 2.7$ V		12	mA
	$V_{CC} = 3$ V		24	
$\Delta t/\Delta V$ Input transition rise or fall rate		0	10	ns/V
$T_A$ Operating free-air temperature		–40	85	°C

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

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

PARAMETER		TEST CONDITIONS	V <sub>CC</sub>	MIN	TYP†	MAX	UNIT
V <sub>OH</sub>		I <sub>OH</sub> = –100 μA	2.7 V to 3.6 V	V <sub>CC</sub> –0.2			V
		I <sub>OH</sub> = –12 mA	2.7 V	2.2			
			3 V	2.4			
		I <sub>OH</sub> = –24 mA	3 V	2.2			
V <sub>OL</sub>		I <sub>OL</sub> = 100 μA	2.7 V to 3.6 V			0.2	V
		I <sub>OL</sub> = 12 mA	2.7 V			0.4	
		I <sub>OL</sub> = 24 mA	3 V			0.55	
I <sub>I</sub>	Control inputs	V <sub>I</sub> = 0 to 5.5 V	3.6 V			±5	μA
I <sub>I</sub> (hold)	A or B ports	V <sub>I</sub> = 0.8 V	3 V	75			μA
		V <sub>I</sub> = 2 V	3 V	–75			
		V <sub>I</sub> = 0 to 3.6 V‡	3.6 V	±500			
I <sub>off</sub>		V <sub>I</sub> or V <sub>O</sub> = 5.5 V	0			±10	μA
I <sub>OZ</sub> §		V <sub>O</sub> = 0 to 5.5 V	3.6 V			±10	μA
I <sub>CC</sub>		V <sub>I</sub> = V <sub>CC</sub> or GND	3.6 V			20	μA
		3.6 V ≤ V <sub>I</sub> ≤ 5.5 V¶				20	
ΔI <sub>CC</sub>		One input at V <sub>CC</sub> – 0.6 V, Other inputs at V <sub>CC</sub> or GND	2.7 V to 3.6 V			500	μA
C <sub>i</sub>	Control inputs	V <sub>I</sub> = V <sub>CC</sub> or GND	3.3 V	5			pF
C <sub>io</sub>	A or B ports	V <sub>O</sub> = V <sub>CC</sub> or GND	3.3 V	8			pF

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

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

§ For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

¶ This applies in the disabled state only.

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

		V <sub>CC</sub> = 3.3 V ± 0.3 V		V <sub>CC</sub> = 2.7 V		UNIT
		MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Clock frequency	150		150		MHz
t <sub>w</sub>	Pulse duration, CLK high or low	3.3		3.3		ns
t <sub>su</sub>	Setup time, A or B before CLKAB↑ or CLKBA↑	3		3.4		ns
t <sub>h</sub>	Hold time, A or B after CLKAB↑ or CLKBA↑	0.2		0		ns

**switching characteristics over recommended operating free-air temperature range, C<sub>L</sub> = 50 pF (unless otherwise noted) (see Figure 2)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 3.3 V ± 0.3 V		V <sub>CC</sub> = 2.7 V		UNIT
			MIN	MAX	MIN	MAX	
f <sub>max</sub>			150		150		MHz
t <sub>pd</sub>	A or B	B or A	1.4	6.3	6.4		ns
	CLKAB or CLKBA	A or B	2.4	6.4	7.3		
	SAB or SBA	B or A	1.9	7.4	8.8		
t <sub>en</sub>	$\overline{\text{OE}}$ or OE	A or B	1.6	6.3	6.6		ns
t <sub>dis</sub>	$\overline{\text{OE}}$ or OE	A or B	1.2	6.2	6.6		ns



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## 16-BIT BUS TRANSCEIVER AND REGISTER

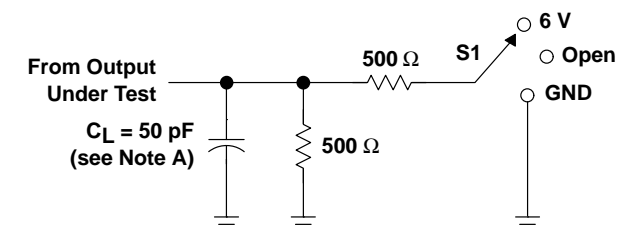
### WITH 3-STATE OUTPUTS

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operating characteristics,  $V_{CC} = 3.3 \text{ V}$ ,  $T_A = 25^\circ\text{C}$

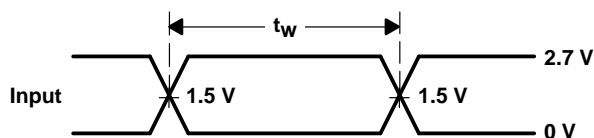
PARAMETER		TEST CONDITIONS	TYP	UNIT
$C_{pd}$	Power dissipation capacitance per transceiver	$C_L = 0$ , $f = 10 \text{ MHz}$	55	pF
	Outputs enabled		12	

## PARAMETER MEASUREMENT INFORMATION

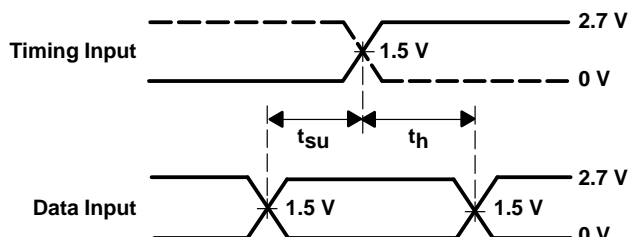


LOAD CIRCUIT

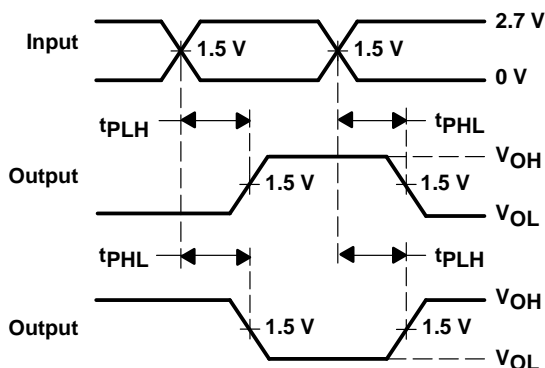
TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	6 V
$t_{PHZ}/t_{PZH}$	GND



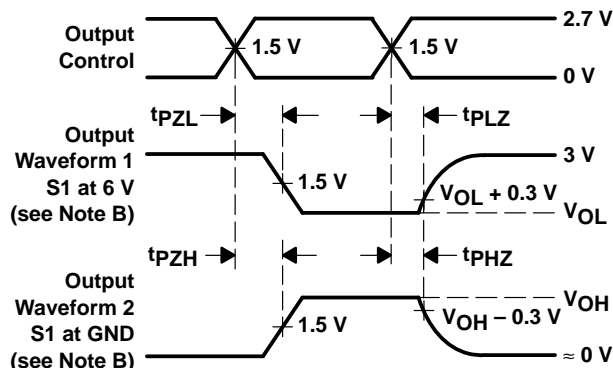
VOLTAGE WAVEFORMS  
PULSE DURATION



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:
- $C_L$  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.
  - $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
  - $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
  - $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Figure 2. Load Circuit and Voltage Waveforms



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