

# SN54LVC652A, SN74LVC652A OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCAS303H – JANUARY 1993 – REVISED AUGUST 1998

- **EPIC™ (Enhanced-Performance Implanted CMOS) Submicron Process**
- **Typical  $V_{OLP}$  (Output Ground Bounce) < 0.8 V at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$**
- **Typical  $V_{OHV}$  (Output  $V_{OH}$  Undershoot) > 2 V at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$**
- **Support 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 ( $C = 200\text{ pF}$ ,  $R = 0$ )**
- **Package Options Include Plastic Small-Outline (DW), Shrink Small-Outline (DB), Thin Shrink Small-Outline (PW) Packages, and Ceramic Chip Carriers (FK)**

## description

The SN54LVC652A octal bus transceiver and register is designed for 2.7-V to 3.6-V  $V_{CC}$  operation, and the SN74LVC652A octal bus transceiver and register is designed for 1.65-V to 3.6-V  $V_{CC}$  operation.

These devices consist of bus transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the data bus or from the internal storage registers.

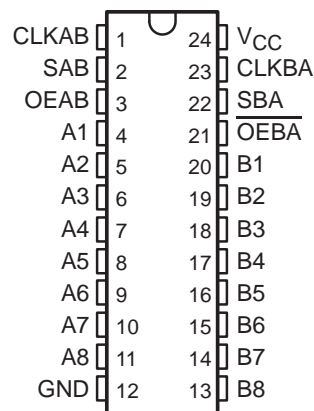
Output-enable ( $\overline{OEAB}$  and  $\overline{OEBA}$ ) inputs are provided to control the transceiver functions. Select-control (SAB and SBA) inputs are provided to select whether real-time or stored data is transferred. The circuitry used for select control eliminates the typical decoding glitch that occurs

in a multiplexer during the transition between stored and real-time data. A low input selects real-time data, and a high input selects stored data. Figure 1 illustrates the four fundamental bus-management functions that are performed with the 'LVC652A.

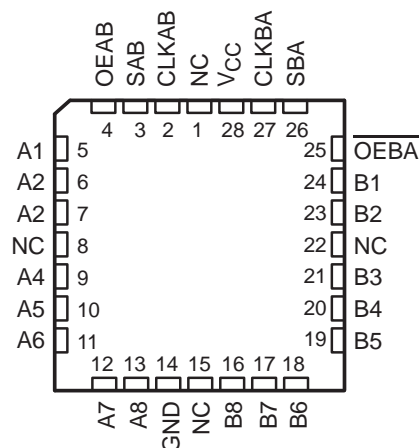
Data on the A or B data bus, or both, is stored in the internal D-type flip-flops by low-to-high transitions at the appropriate clock (CLKAB or CLKBA) inputs, regardless of the select- or enable-control pins. When SAB and SBA are in the real-time transfer mode, it is possible to store data without using the internal D-type flip-flops by simultaneously enabling  $\overline{OEAB}$  and  $\overline{OEBA}$ . 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 state.

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.

SN74LVC652A . . . DB, DW, OR PW PACKAGE  
(TOP VIEW)



SN54LVC652A . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection



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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  
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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

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## description (continued)

To ensure the high-impedance state during power up or power down,  $\overline{OEBA}$  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.

The SN54LVC652A is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74LVC652A is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

FUNCTION TABLE

INPUTS						DATA I/O†		OPERATION OR FUNCTION
OEAB	$\overline{OEBA}$	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 can be enabled or disabled by a variety of level combinations at OEAB or  $\overline{OEBA}$ . Data-input functions always are 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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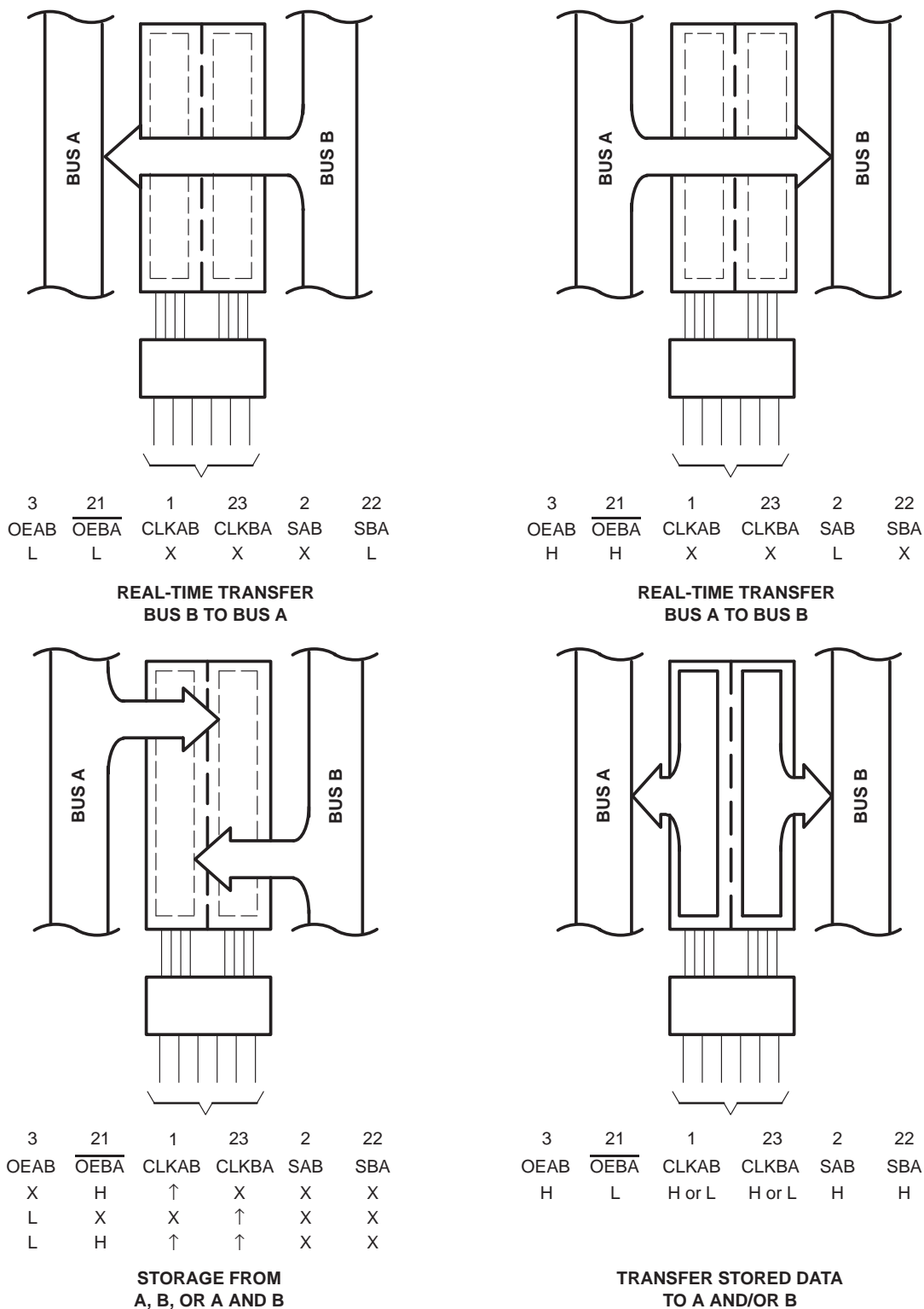
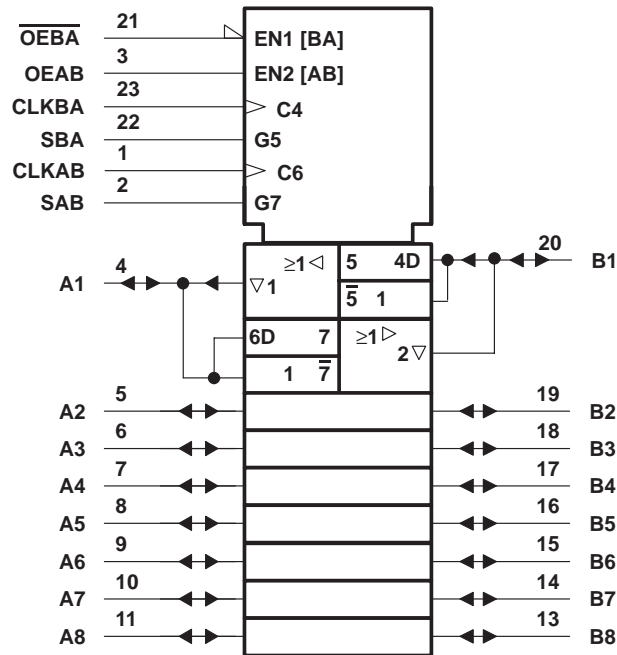


Figure 1. Bus-Management Functions

# SN54LVC652A, SN74LVC652A OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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## logic symbol†

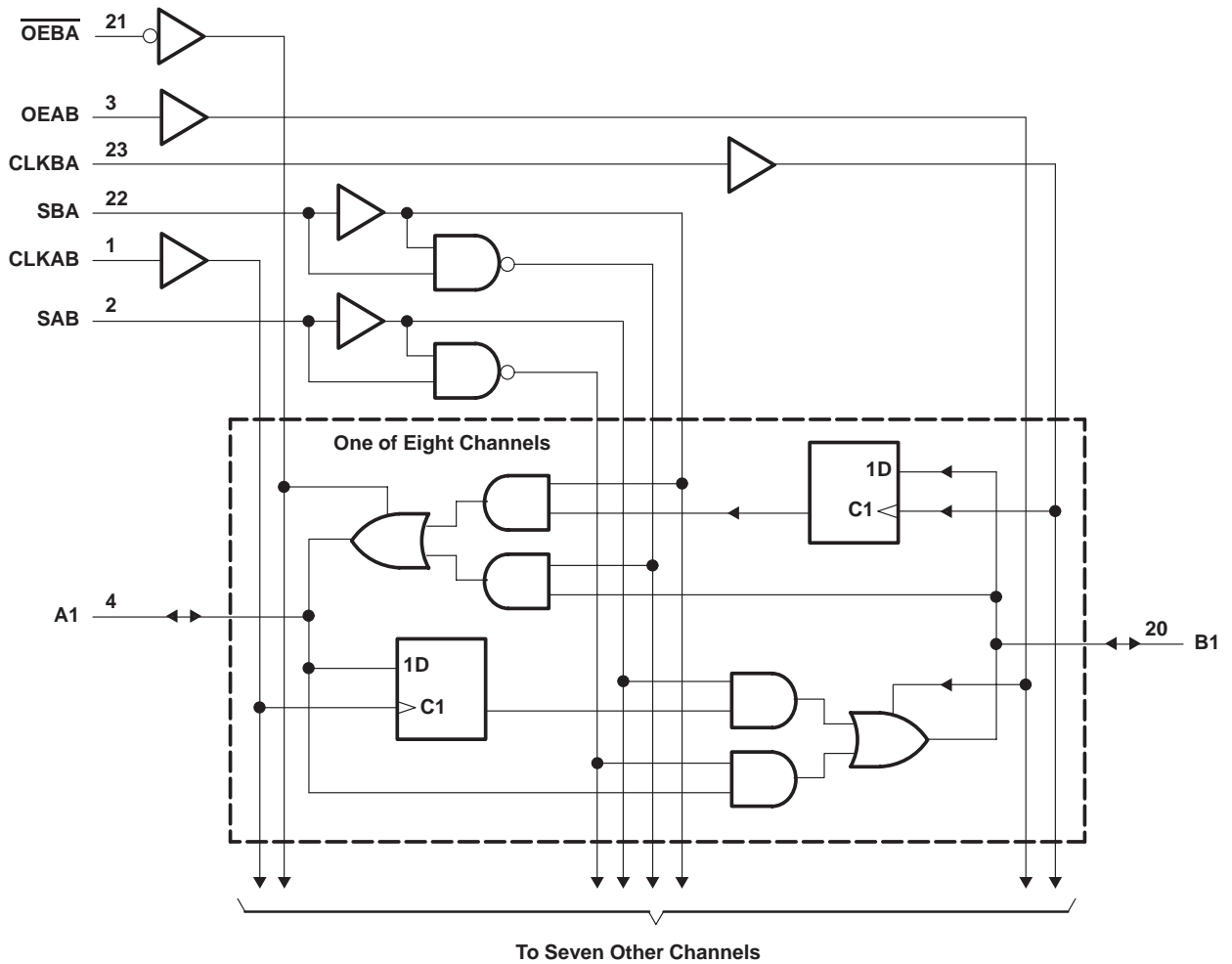


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.  
Pin numbers shown are for the DB, DW, and PW packages.

# SN54LVC652A, SN74LVC652A OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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## logic diagram (positive logic)



Pin numbers shown are for the DB, DW, and PW packages.

# SN54LVC652A, SN74LVC652A OCTAL BUS TRANSCEIVERS AND REGISTERS 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 6.5 V
Input voltage range, $V_I$ (see Note 1)	–0.5 V to 6.5 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, $I_{OK}$ ( $V_O < 0$ )	–50 mA
Continuous output current, $I_O$	±50 mA
Continuous current through $V_{CC}$ or GND	±100 mA
Package thermal impedance, $\theta_{JA}$ (see Note 3): DB package	104°C/W
DW package	81°C/W
PW package	120°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 negative-voltage and output voltage ratings may be exceeded if the input and output 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)

		SN54LVC652A		SN74LVC652A		UNIT	
		MIN	MAX	MIN	MAX		
$V_{CC}$	Supply voltage	Operating	2	3.6	1.65	3.6	V
		Data retention only	1.5		1.5		
$V_{IH}$	High-level input voltage	$V_{CC} = 1.65$ V to 1.95 V			$0.65 \times V_{CC}$		V
		$V_{CC} = 2.3$ V to 2.7 V			1.7		
		$V_{CC} = 2.7$ V to 3.6 V	2		2		
$V_{IL}$	Low-level input voltage	$V_{CC} = 1.65$ V to 1.95 V			$0.35 \times V_{CC}$		V
		$V_{CC} = 2.3$ V to 2.7 V			0.7		
		$V_{CC} = 2.7$ V to 3.6 V		0.8		0.8	
$V_I$	Input voltage	0	5.5	0	5.5	V	
$V_O$	Output voltage	High or low state	0	$V_{CC}$	0	$V_{CC}$	V
		3 state	0	5.5	0	5.5	
$I_{OH}$	High-level output current	$V_{CC} = 1.65$ V				–4	mA
		$V_{CC} = 2.3$ V				–8	
		$V_{CC} = 2.7$ V		–12		–12	
		$V_{CC} = 3$ V		–24		–24	
$I_{OL}$	Low-level output current	$V_{CC} = 1.65$ V				4	mA
		$V_{CC} = 2.3$ V				8	
		$V_{CC} = 2.7$ V		12		12	
		$V_{CC} = 3$ V		24		24	
$\Delta t/\Delta v$	Input transition rise or fall rate	0	5	0	5	ns/V	
$T_A$	Operating free-air temperature	–55	125	–40	85	°C	

NOTE 4: All unused 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.



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

PARAMETER	TEST CONDITIONS	V <sub>CC</sub>	SN54LVC652A			SN74LVC652A			UNIT		
			MIN	TYP†	MAX	MIN	TYP†	MAX			
V <sub>OH</sub>	I <sub>OH</sub> = -100 μA	1.65 V to 3.6 V				V <sub>CC</sub> -0.2			V		
		2.7 V to 3.6 V	V <sub>CC</sub> -0.2								
	I <sub>OH</sub> = -4 mA	1.65 V				1.2					
	I <sub>OH</sub> = -8 mA	2.3 V				1.7					
	I <sub>OH</sub> = -12 mA	2.7 V	2.2			2.2					
		3 V	2.4			2.4					
V <sub>OL</sub>	I <sub>OL</sub> = 100 μA	1.65 V to 3.6 V				0.2			V		
		2.7 V to 3.6 V				0.2					
	I <sub>OL</sub> = 4 mA	1.65 V				0.45					
	I <sub>OL</sub> = 8 mA	2.3 V				0.7					
	I <sub>OL</sub> = 12 mA	2.7 V				0.4					
		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>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			±15			±10	μA	
I <sub>CC</sub>		V <sub>I</sub> = V <sub>CC</sub> or GND	I <sub>O</sub> = 0	3.6 V			10			10	μA
		3.6 V ≤ V <sub>I</sub> ≤ 5.5 V§					10			10	
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			500	μA	
C <sub>i</sub>	Control inputs	V <sub>I</sub> = V <sub>CC</sub> or GND	3.3 V			4.5			4.5	pF	
C <sub>iO</sub>	A or B ports	V <sub>O</sub> = V <sub>CC</sub> or GND	3.3 V			7.5			7.5	pF	

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

‡ 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 operating free-air temperature range (unless otherwise noted) (see Figure 4)**

		SN54LVC652A				UNIT
		V <sub>CC</sub> = 2.7 V		V <sub>CC</sub> = 3.3 V ± 0.3 V		
		MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Clock frequency	80		100		MHz
t <sub>w</sub>	Pulse duration	3.3		3.3		ns
t <sub>su</sub>	Setup time, data before CLK↑	1.6		1.5		ns
t <sub>h</sub>	Hold time, data after CLK↑	0.5		1.5		ns



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timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figures 2 through 4)

		SN74LVC652A								UNIT
		$V_{CC} = 1.8\text{ V} \pm 0.15\text{ V}$		$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$f_{\text{clock}}$	Clock frequency	†		†		80		100		MHz
$t_w$	Pulse duration	†		†		3.3		3.3		ns
$t_{\text{su}}$	Setup time, data before CLK↑	†		†		1.9		1.9		ns
$t_h$	Hold time, data after CLK↑	†		†		1.5		1.7		ns

† This information was not available at the time of publication.

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figure 4)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVC652A				UNIT
			$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		
			MIN	MAX	MIN	MAX	
$f_{\text{max}}$			80		100		MHz
$t_{\text{pd}}$	A or B	B or A	7.8		1	7.4	ns
	CLK	A or B	8.4		1	8	
	SAB or SBA	B or A	9.6		1	8.7	
$t_{\text{en}}$	$\overline{\text{OEBA}}$	A	8.9		1	7.4	ns
$t_{\text{dis}}$	$\overline{\text{OEBA}}$	A	8.1		1	7.5	ns
$t_{\text{en}}$	OEAB	B	8.6		1	7.1	ns
$t_{\text{dis}}$	OEAB	B	7.7		1	7.4	ns

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figures 2 through 4)

PARAMETER		FROM (INPUT)	TO (OUTPUT)	SN74LVC652A								UNIT
				$V_{CC} = 1.8\text{ V} \pm 0.15\text{ V}$		$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$f_{\text{max}}$				†		†		80		100		MHz
$t_{\text{pd}}$	A or B	B or A	†	†	†	†	7.8		1.5	7.4	ns	
	CLK	A or B	†	†	†	†	8.4		1.5	8		
	SAB or SBA	B or A	†	†	†	†	9.6		1.5	8.7		
$t_{\text{en}}$	$\overline{\text{OEBA}}$	A	†	†	†	†	8.9		1.5	7.4	ns	
$t_{\text{dis}}$	$\overline{\text{OEBA}}$	A	†	†	†	†	8.1		1.5	7.5	ns	
$t_{\text{en}}$	OEAB	B	†	†	†	†	8.6		1.5	7.1	ns	
$t_{\text{dis}}$	OEAB	B	†	†	†	†	7.7		1.5	7.4	ns	

† This information was not available at the time of publication.





**SN54LVC652A, SN74LVC652A**  
**OCTAL BUS TRANSCEIVERS AND REGISTERS**  
**WITH 3-STATE OUTPUTS**

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**operating characteristics,  $T_A = 25^\circ\text{C}$**

PARAMETER		TEST CONDITIONS	$V_{CC} = 1.8\text{ V}$ $\pm 0.15\text{ V}$	$V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}$	$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$	UNIT
			TYP	TYP	TYP	
$C_{pd}$	Power dissipation capacitance per transceiver	Outputs enabled	†	†	84	pF
		Outputs disabled	†	†	9.5	

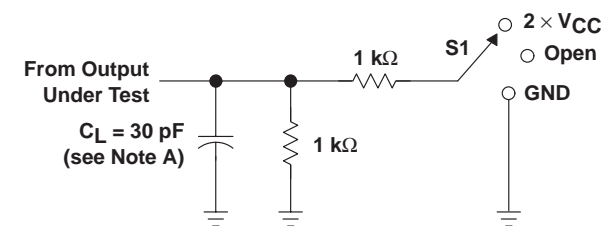
† This information was not available at the time of publication.

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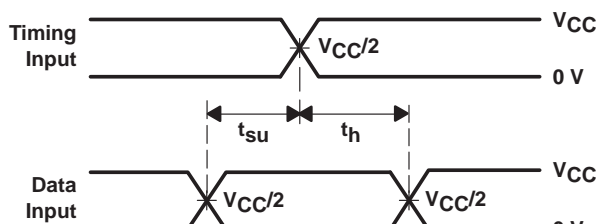
## PARAMETER MEASUREMENT INFORMATION

$$V_{CC} = 1.8\text{ V} \pm 0.15\text{ V}$$

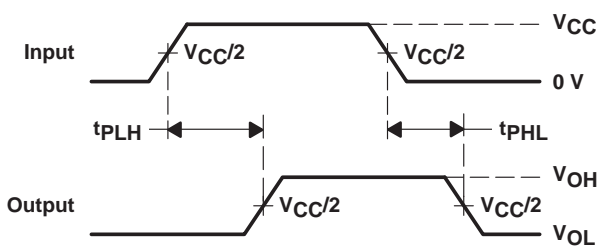


LOAD CIRCUIT

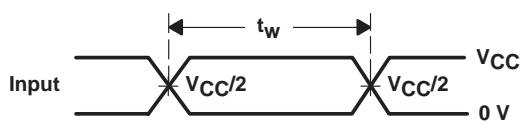
TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	2 x $V_{CC}$
$t_{PHZ}/t_{PZH}$	Open



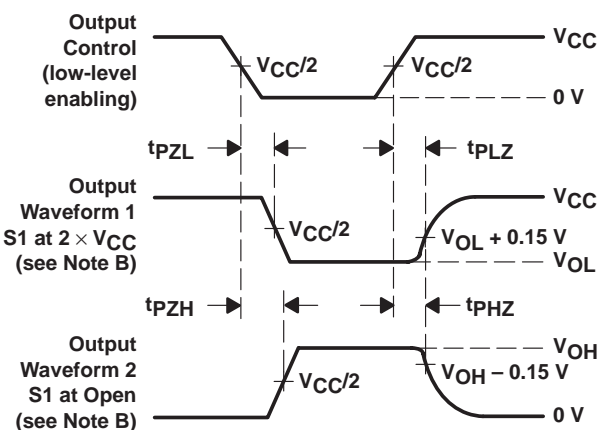
VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES

- 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:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ ,  $t_r \leq 2\text{ ns}$ ,  $t_f \leq 2\text{ ns}$ .  
 D. The outputs are measured one at a time with one transition per measurement.  
 E.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .  
 F.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .  
 G.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

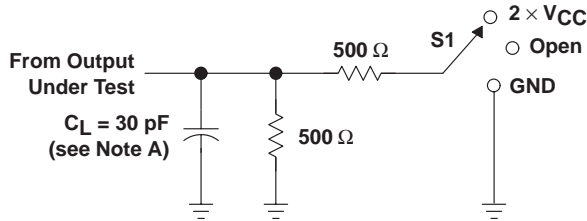
Figure 2. Load Circuit and Voltage Waveforms

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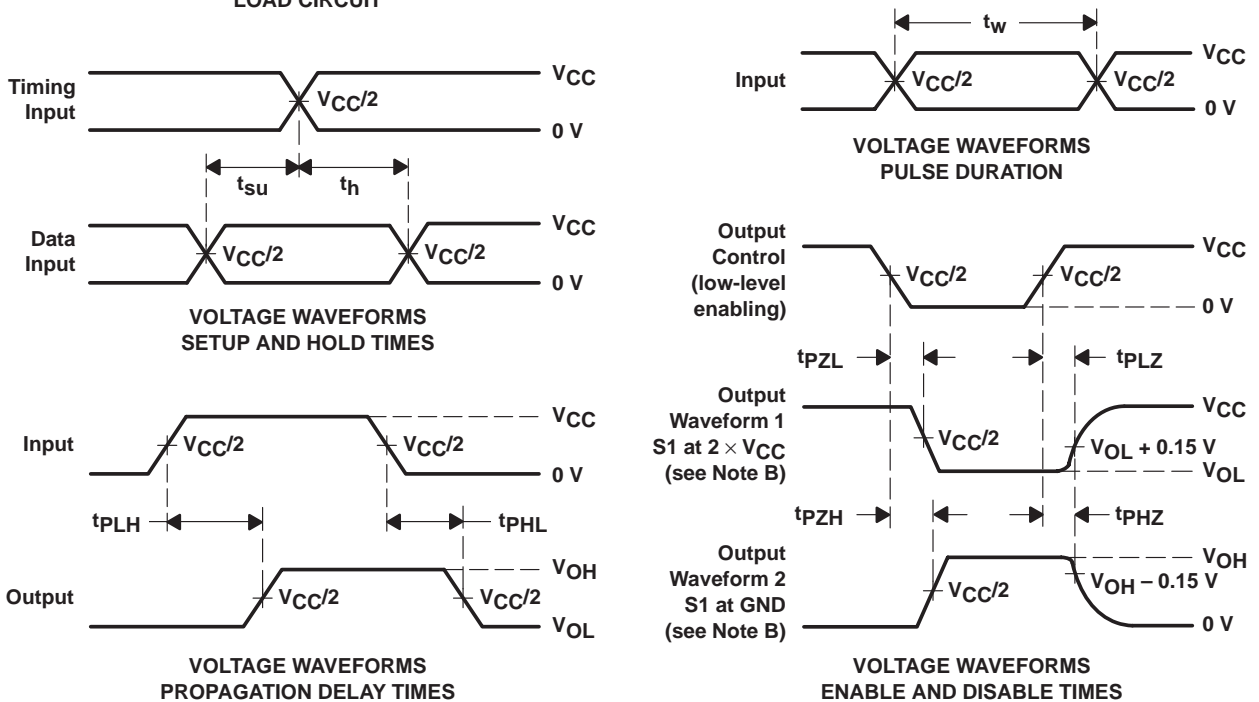
## PARAMETER MEASUREMENT INFORMATION

$V_{CC} = 2.5 \text{ V} \pm 0.2 \text{ V}$



LOAD CIRCUIT

TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	$2 \times V_{CC}$
$t_{PHZ}/t_{PZH}$	GND



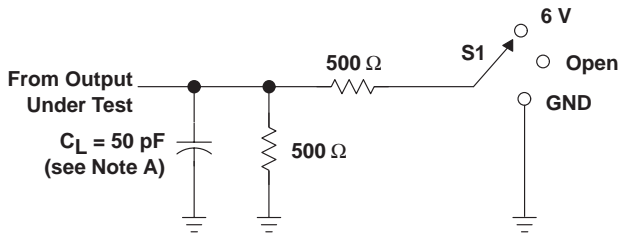
- NOTES: A.  $C_L$  includes probe and jig capacitance.  
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 C. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r \leq 2 \text{ ns}$ ,  $t_f \leq 2 \text{ ns}$ .  
 D. The outputs are measured one at a time with one transition per measurement.  
 E.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .  
 F.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .  
 G.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Figure 3. Load Circuit and Voltage Waveforms

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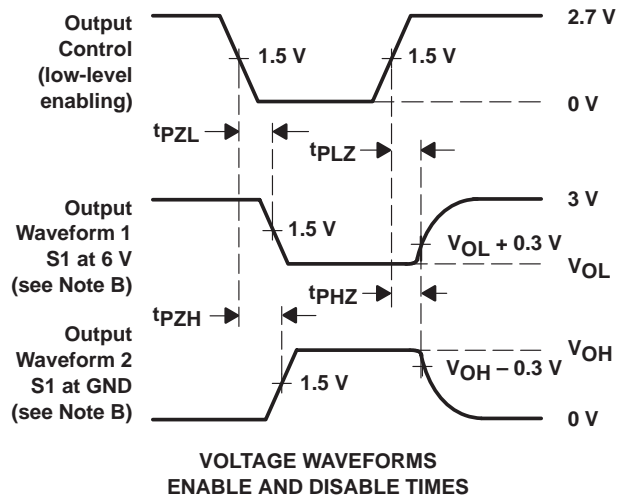
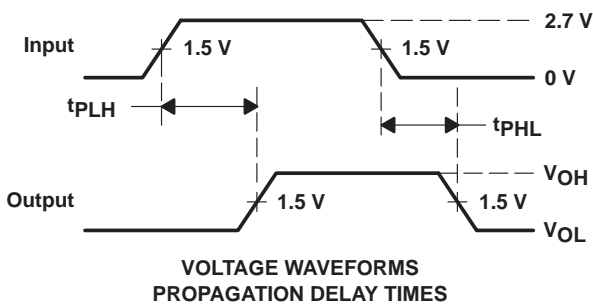
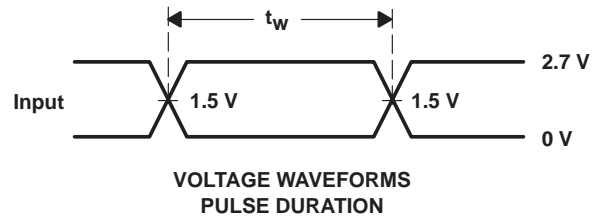
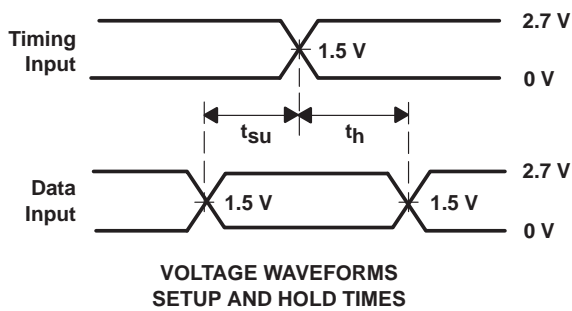
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## PARAMETER MEASUREMENT INFORMATION $V_{CC} = 2.7\text{ V AND } 3.3\text{ V} \pm 0.3\text{ V}$



LOAD CIRCUIT

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



- 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:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ ,  $t_r \leq 2.5\text{ ns}$ ,  $t_f \leq 2.5\text{ ns}$ .  
 D. The outputs are measured one at a time with one transition per measurement.  
 E.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .  
 F.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .  
 G.  $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

Figure 4. Load Circuit and Voltage Waveforms

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