

- State-of-the-Art Advanced BiCMOS Technology (ABT) Design for 3.3-V Operation and Low-Static Power Dissipation
- 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
- Package Options Include Plastic Small-Outline (DW), Shrink Small-Outline (DB), and Thin Shrink Small-Outline (PW) Packages, Ceramic Chip Carriers (FK), and Ceramic (JT) DIPs

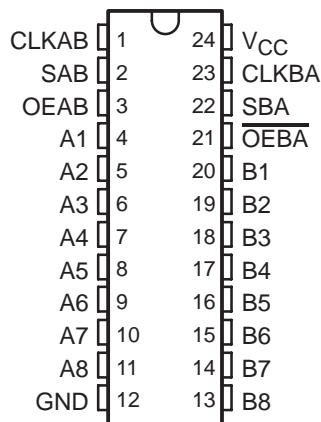
### description

These bus transceivers and registers are designed specifically for low-voltage (3.3-V)  $V_{CC}$  operation, but with the capability to provide a TTL interface to a 5-V system environment.

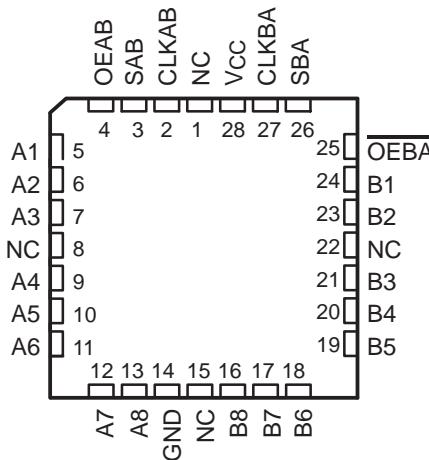
The 'LVT652 consist of bus transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the data bus or from the internal storage registers.

Output-enable (OEAB and 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 real-time and stored 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 can be performed with the 'LVT652.

SN54LVT652 . . . JT PACKAGE  
SN74LVT652 . . . DB, DW, OR PW PACKAGE  
(TOP VIEW)



SN54LVT652 . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection



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.

# SN54LVT652, SN74LVT652

## 3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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### description (continued)

Data on the A or B data bus, or both, can be 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 OEAB and  $\overline{OEBA}$ . In this configuration, each output reinforces its input; therefore, 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.

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

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. OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver.

The SN74LVT652 is available in TI's shrink small-outline package (DB), which provides the same I/O pin count and functionality of standard small-outline packages in less than half the printed-circuit-board area.

The SN54LVT652 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74LVT652 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

FUNCTION TABLE

OEAB	$\overline{OEBA}$	INPUTS			DATA I/O <sup>†</sup>		OPERATION OR FUNCTION	
		CLKAB	CLKBA	SAB	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 <sup>‡</sup>	Store A, hold B
H	H	↑	↑	X <sup>‡</sup>	X	Input	Output	Store A in both registers
L	X	H or L	↑	X	X	Unspecified <sup>‡</sup>	Input	Hold A, store B
L	L	↑	↑	X	X <sup>‡</sup>	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

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

<sup>‡</sup> Select control = L; clocks can occur simultaneously

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

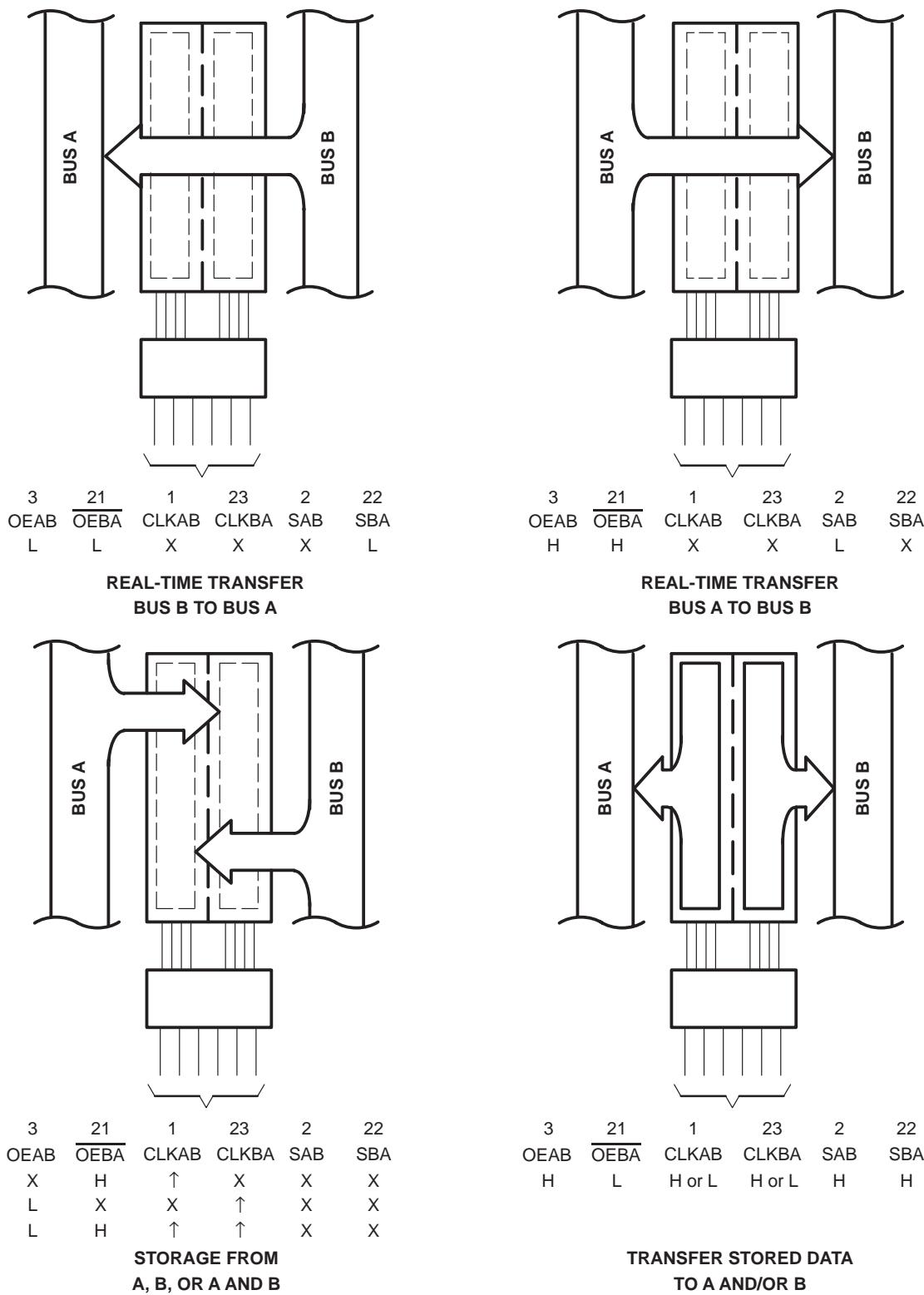


Figure 1. Bus-Management Functions

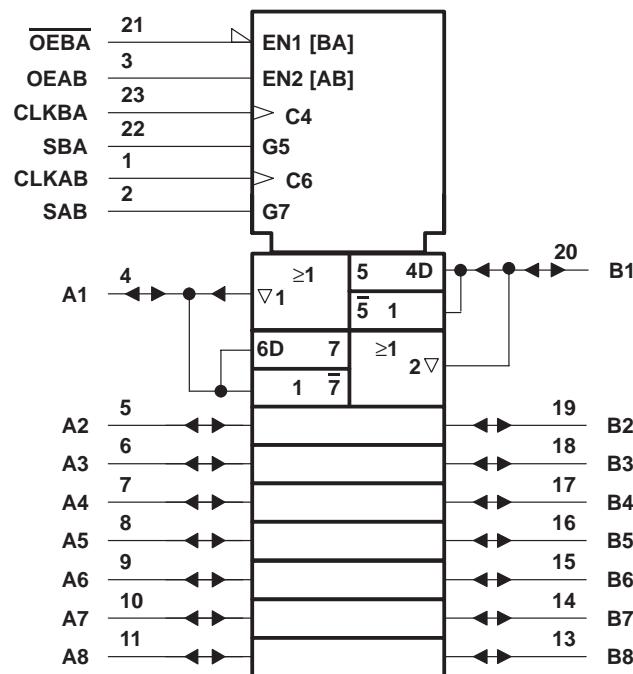
Pin numbers shown are for the DB, DW, JT, and PW packages.

# SN54LVT652, SN74LVT652

## 3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

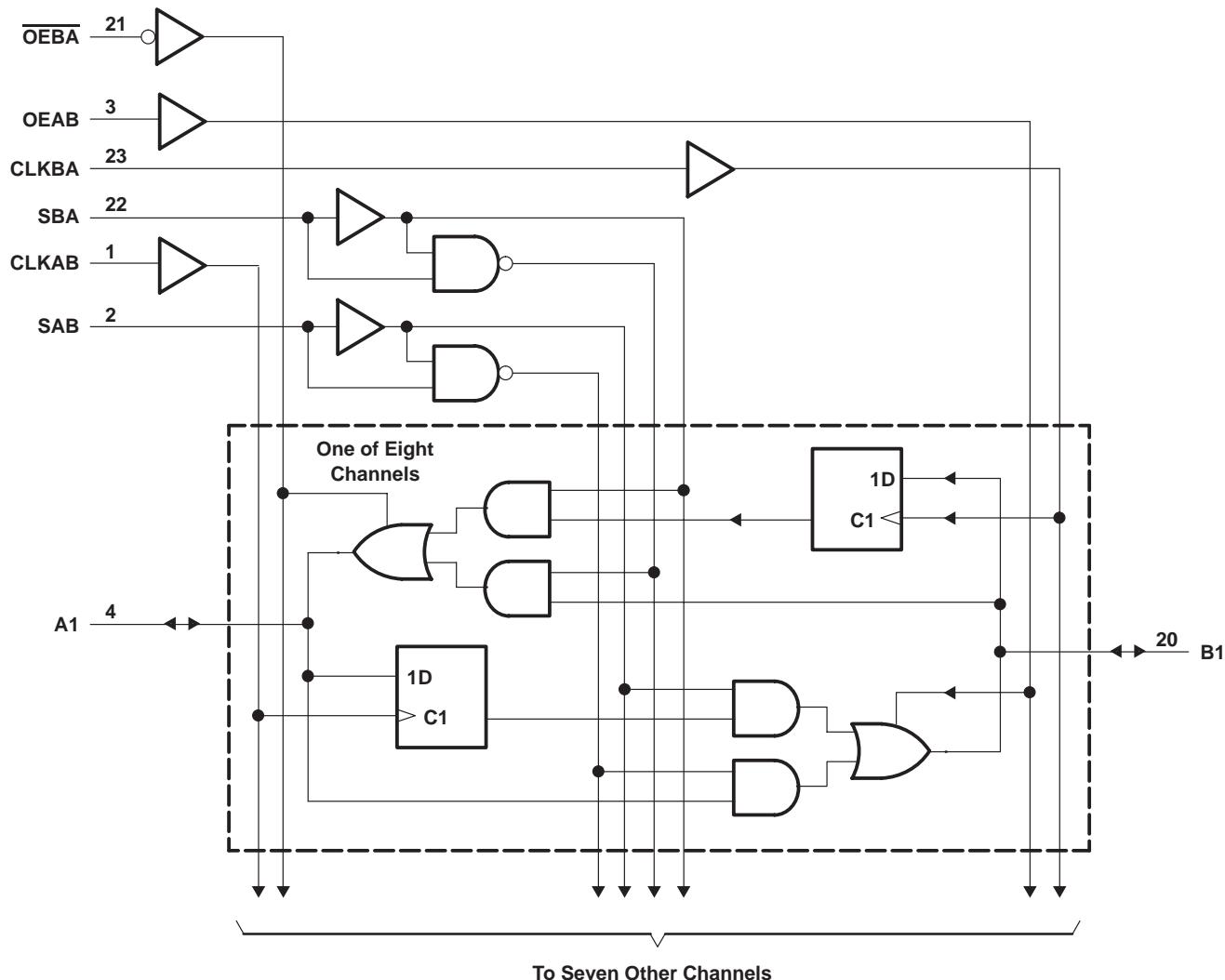
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### logic symbol†



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

**logic diagram (positive logic)**



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

## **SN54LVT652, SN74LVT652**

### 3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS

## WITH 3-STATE OUTPUTS

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

† 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)

		SN54LVT652		SN74LVT652		UNIT
		MIN	MAX	MIN	MAX	
V <sub>CC</sub>	Supply voltage	2.7	3.6	2.7	3.6	V
V <sub>IH</sub>	High-level input voltage	2		2		V
V <sub>IL</sub>	Low-level input voltage			0.8		V
V <sub>I</sub>	Input voltage			5.5		V
I <sub>OH</sub>	High-level output current			-24		-32 mA
I <sub>OL</sub>	Low-level output current			48		64 mA
Δt/Δv	Input transition rise or fall rate	Outputs enabled		10		10 ns/V
T <sub>A</sub>	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 OCTAL BUS TRANSCEIVERS AND REGISTERS**  
**WITH 3-STATE OUTPUTS**  
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**electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)**

PARAMETER	TEST CONDITIONS			SN54LVT652			SN74LVT652			UNIT		
				MIN	TYP†	MAX	MIN	TYP†	MAX			
$V_{IK}$	$V_{CC} = 2.7 \text{ V}$ , $I_I = -18 \text{ mA}$			-1.2			-1.2			V		
$V_{OH}$	$V_{CC} = \text{MIN to MAX}^‡$ , $I_{OH} = -100 \mu\text{A}$			$V_{CC} - 0.2$			$V_{CC} - 0.2$			V		
	$V_{CC} = 2.7 \text{ V}$ , $I_{OH} = -8 \text{ mA}$			2.4			2.4					
	$V_{CC} = 3 \text{ V}$	$I_{OH} = -24 \text{ mA}$			2			2				
		$I_{OH} = -32 \text{ mA}$										
$V_{OL}$	$V_{CC} = 2.7 \text{ V}$	$I_{OL} = 100 \mu\text{A}$			0.2			0.2		V		
		$I_{OL} = 24 \text{ mA}$			0.5			0.5				
	$V_{CC} = 3 \text{ V}$	$I_{OL} = 16 \text{ mA}$			0.4			0.4				
		$I_{OL} = 32 \text{ mA}$			0.5			0.5				
		$I_{OL} = 48 \text{ mA}$			0.55							
		$I_{OL} = 64 \text{ mA}$						0.55				
$I_I$	$V_{CC} = 3.6 \text{ V}$ , $V_I = V_{CC} \text{ or GND}$			Control inputs	±1			±1		$\mu\text{A}$		
	$V_{CC} = 0 \text{ or MAX}^‡$ , $V_I = 5.5 \text{ V}$				10			10				
	$V_{CC} = 3.6 \text{ V}$	$V_I = 5.5 \text{ V}$			20			20				
		$V_I = V_{CC}$			5			5				
		$V_I = 0$			-10			-10				
$I_{off}$	$V_{CC} = 0$ , $V_I \text{ or } V_O = 0 \text{ to } 4.5 \text{ V}$						±100			$\mu\text{A}$		
$I_{I(\text{hold})}$	$V_{CC} = 3 \text{ V}$	$V_I = 0.8 \text{ V}$			75			75		$\mu\text{A}$		
		$V_I = 2 \text{ V}$			-75			-75				
$I_{OZH}$	$V_{CC} = 3.6 \text{ V}$ , $V_O = 3 \text{ V}$						1			$\mu\text{A}$		
$I_{OZL}$	$V_{CC} = 3.6 \text{ V}$ , $V_O = 0.5 \text{ V}$						-1			$\mu\text{A}$		
$I_{CC}$	$V_{CC} = 3.6 \text{ V}$ , $V_I = V_{CC} \text{ or GND}$	$I_O = 0$	Outputs high	0.13 0.19			0.13 0.19			$\text{mA}$		
			Outputs low	8.8 12			8.8 12					
			Outputs disabled	0.13 0.19			0.13 0.19					
$\Delta I_{CC}^¶$	$V_{CC} = 3 \text{ V to } 3.6 \text{ V}$ , One input at $V_{CC} - 0.6 \text{ V}$ , Other inputs at $V_{CC} \text{ or GND}$			0.2			0.2			$\text{mA}$		
$C_i$	$V_I = 3 \text{ V or } 0$			4.5			4.5			$\text{pF}$		
$C_{io}$	$V_O = 3 \text{ V or } 0$			11			11			$\text{pF}$		

† 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 terminals 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.

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# SN54LVT652, SN74LVT652

## 3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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

			SN54LVT652				SN74LVT652				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	MAX	MIN	MAX		
f <sub>clock</sub>	Clock frequency		0	150	0	150	0	150	0	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↑	Data high					1.2		1.2		ns	
		Data low					2		2.5			
t <sub>h</sub>	Hold time, A or B after CLKAB↑ or CLKBA↑						0.5		0.5		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)	SN54LVT652				SN74LVT652				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	TYPE <sup>†</sup>	MAX	MIN		
f <sub>max</sub>							150		150		MHz	
t <sub>PLH</sub>	CLKBA or CLKAB	A or B					1.8	3.7	6		ns	
							2	3.7	5.7			
t <sub>PLH</sub>	A or B	B or A					1.2	2.8	4.7		ns	
							1	2.6	4.6			
t <sub>PLH</sub>	SBA or SAB <sup>‡</sup>	A or B					1.4	3.7	6.4		ns	
							1.4	4	6.2			
t <sub>PZH</sub>	OEBA	A					1	2.9	5.8		ns	
							1	3	6			
t <sub>PLZ</sub>	OEBA	A					2.2	3.9	6.5		ns	
							1.8	3.2	5.8			
t <sub>PZH</sub>	OEAB	B					1	3.3	6.5		ns	
							1.2	3.4	6.3			
t <sub>PLZ</sub>	OEAB	B					1.7	4.5	7.2		ns	
							1.5	3.8	5.8			

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

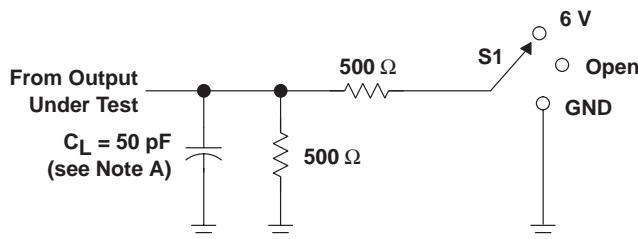
<sup>‡</sup> These parameters are measured with the internal output state of the storage register opposite to that of the bus input.

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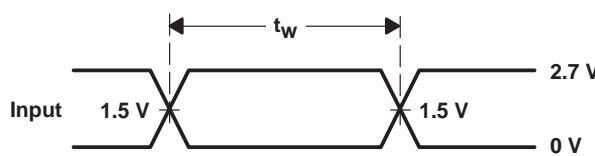
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**PARAMETER MEASUREMENT INFORMATION**

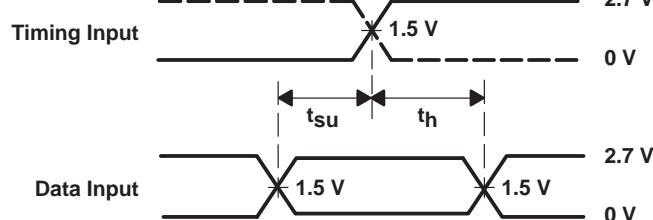


TEST	S1
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	6 V
$t_{PHZ}/t_{PZH}$	GND

LOAD CIRCUIT FOR OUTPUTS

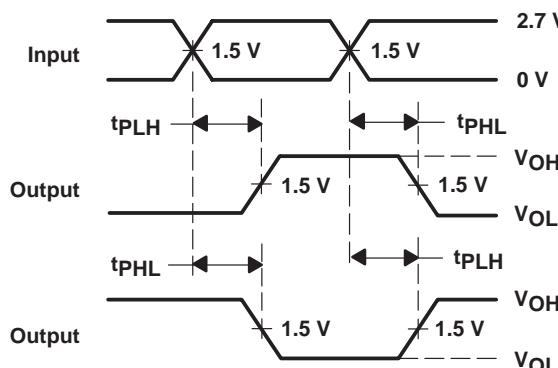


VOLTAGE WAVEFORMS  
 PULSE DURATION

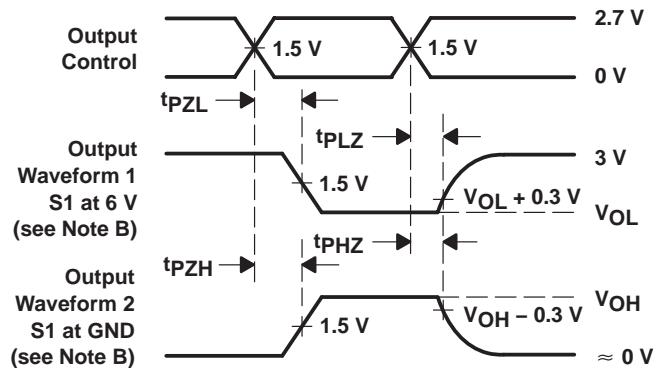


Data Input

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

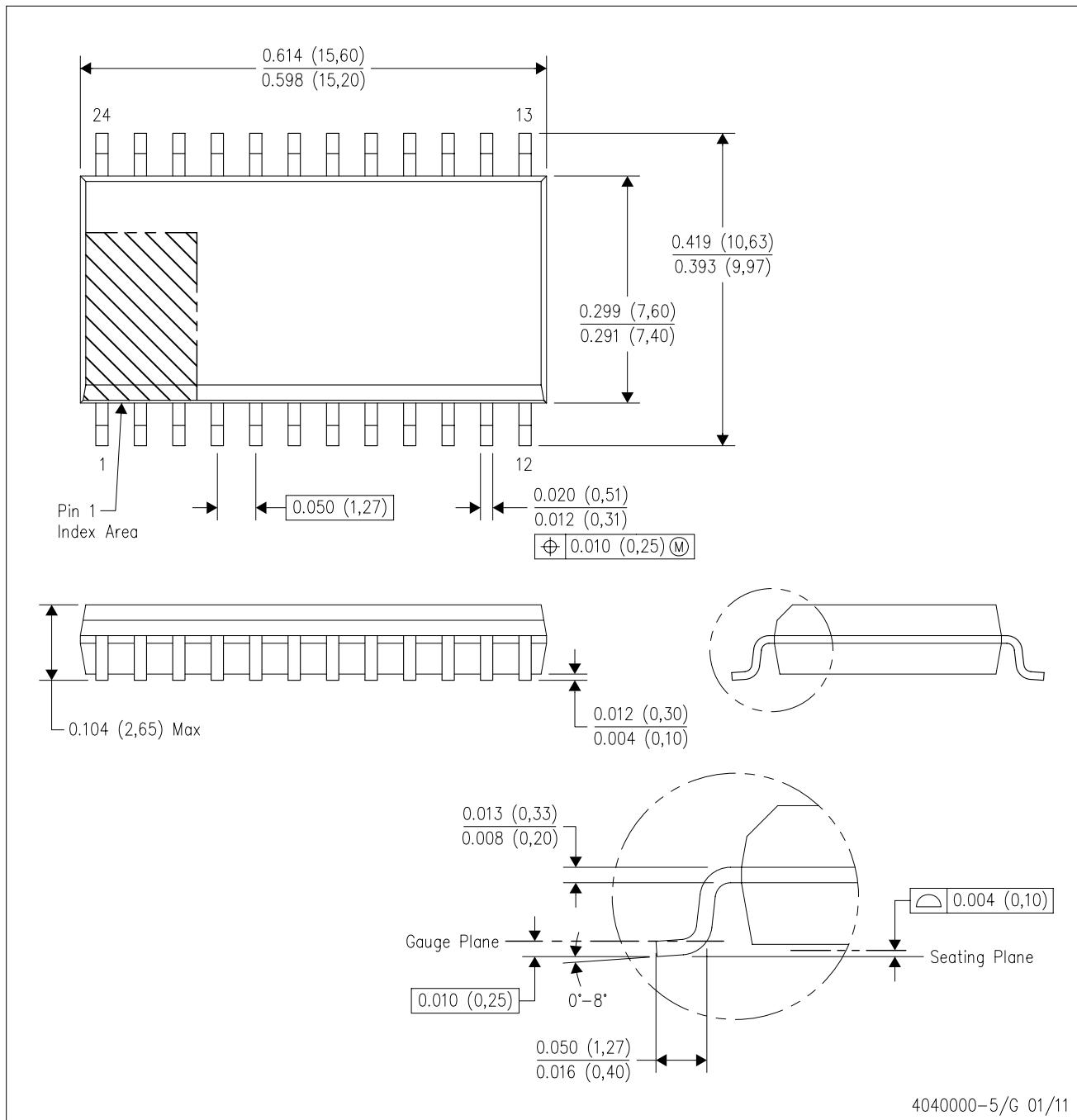
NOTES:

- $C_L$  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 MHz,  $Z_O = 50 \Omega$ ,  $t_f \leq 2.5$  ns,  $t_f \leq 2.5$  ns.
- The outputs are measured one at a time with one transition per measurement.

**Figure 2. Load Circuit and Voltage Waveforms**

DW (R-PDSO-G24)

PLASTIC SMALL OUTLINE

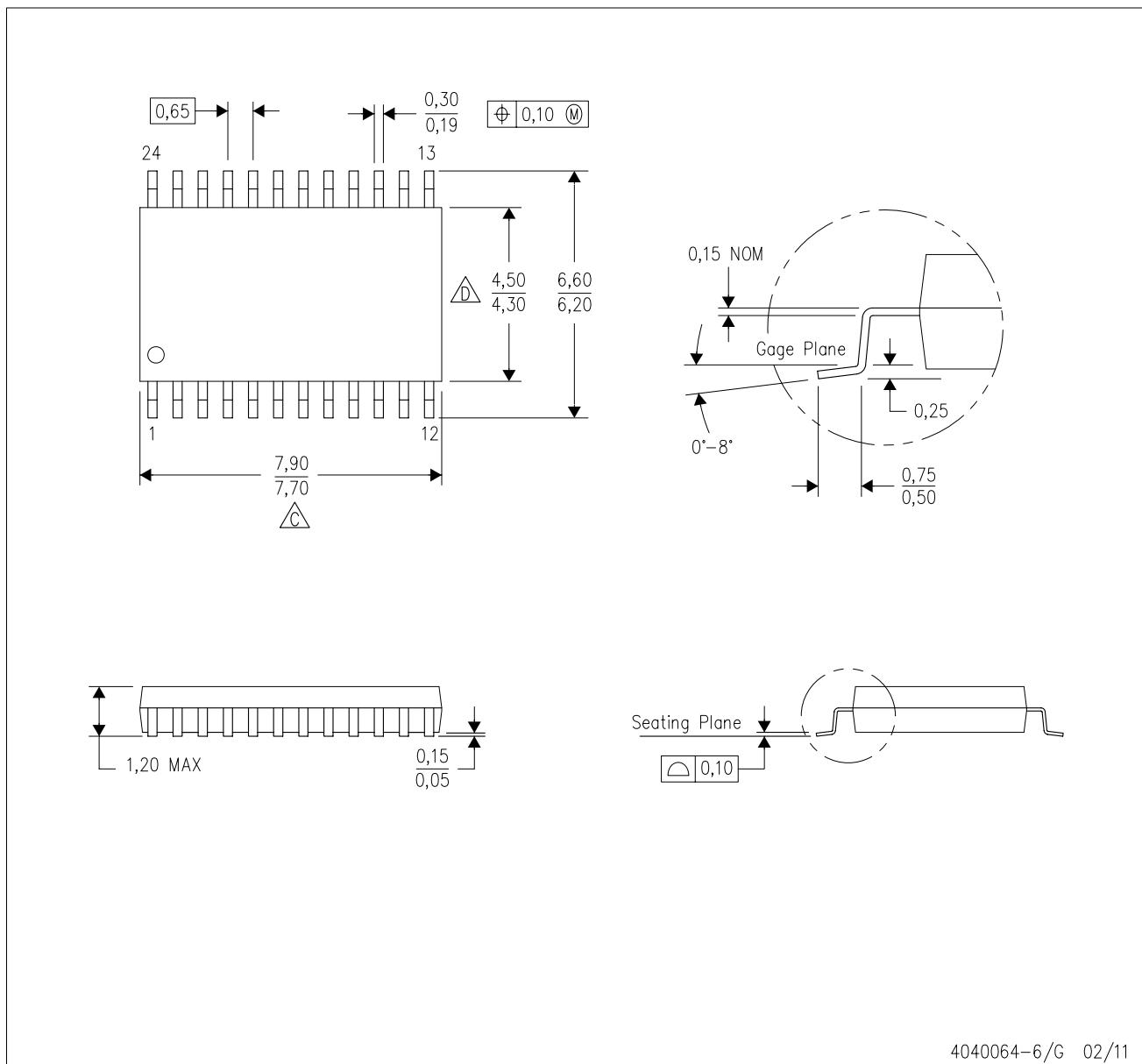


NOTES:

- All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
- This drawing is subject to change without notice.
- Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0.15).
- Falls within JEDEC MS-013 variation AD.

PW (R-PDSO-G24)

PLASTIC SMALL OUTLINE



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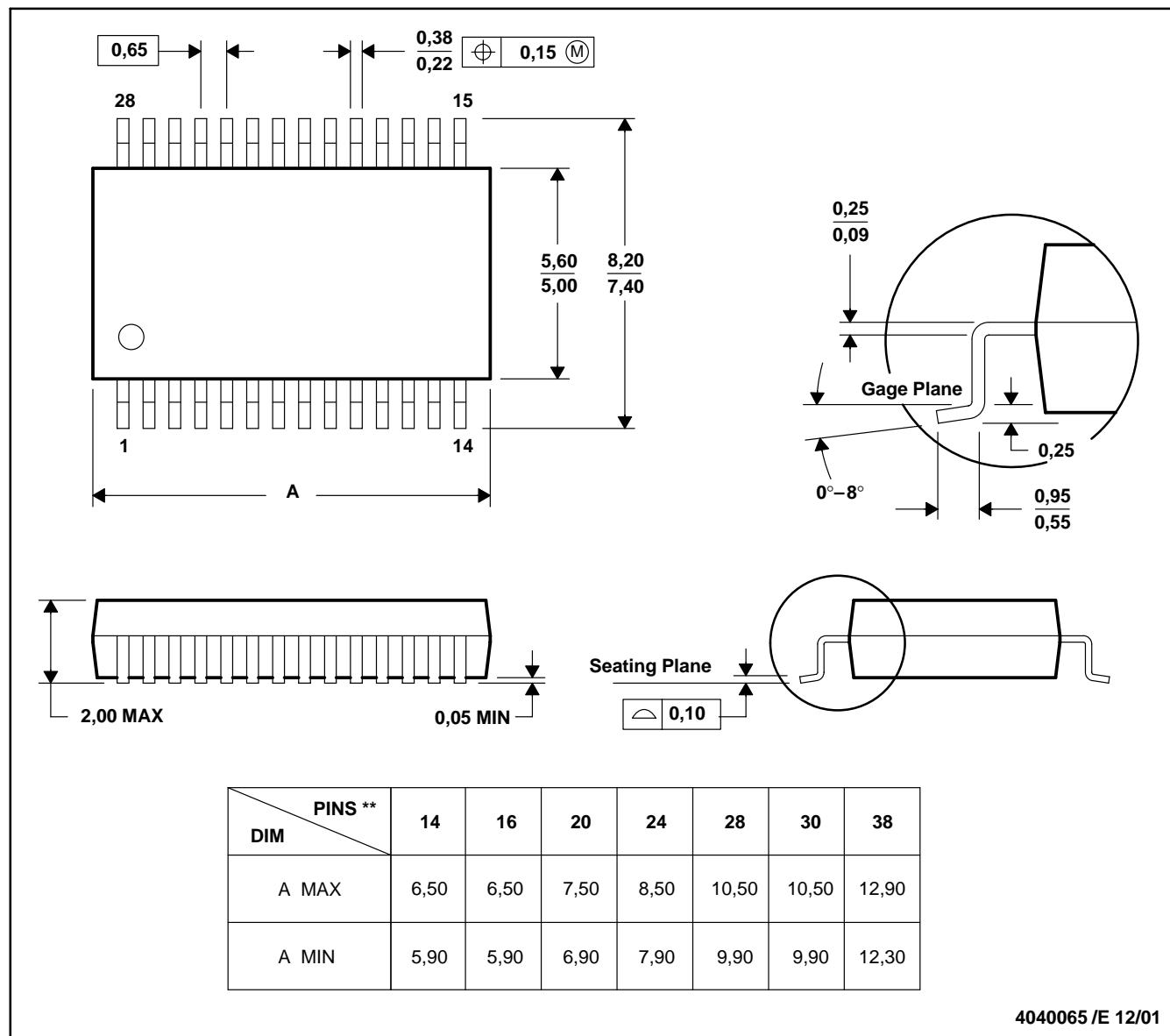
NOTES:

- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
- B. This drawing is subject to change without notice.
-  C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
-  D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
- E. Falls within JEDEC MO-153

## DB (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE

28 PINS SHOWN



NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-150

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Amplifiers	<a href="http://amplifier.ti.com">amplifier.ti.com</a>
Data Converters	<a href="http://dataconverter.ti.com">dataconverter.ti.com</a>
DLP® Products	<a href="http://www.dlp.com">www.dlp.com</a>
DSP	<a href="http://dsp.ti.com">dsp.ti.com</a>
Clocks and Timers	<a href="http://www.ti.com/clocks">www.ti.com/clocks</a>
Interface	<a href="http://interface.ti.com">interface.ti.com</a>
Logic	<a href="http://logic.ti.com">logic.ti.com</a>
Power Mgmt	<a href="http://power.ti.com">power.ti.com</a>
Microcontrollers	<a href="http://microcontroller.ti.com">microcontroller.ti.com</a>
RFID	<a href="http://www.ti-rfid.com">www.ti-rfid.com</a>
OMAP Applications Processors	<a href="http://www.ti.com/omap">www.ti.com/omap</a>
Wireless Connectivity	<a href="http://www.ti.com/wirelessconnectivity">www.ti.com/wirelessconnectivity</a>
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