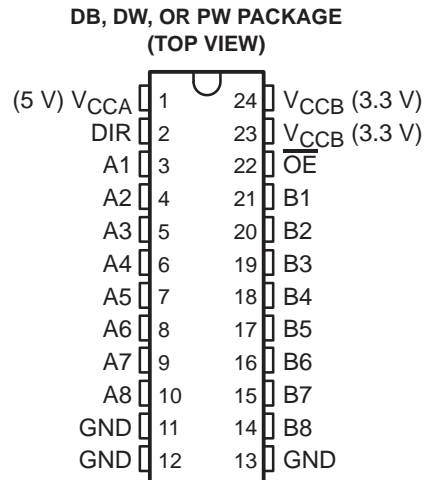


# SN74LVC4245A

## OCTAL BUS TRANSCEIVER AND 3.3-V TO 5-V SHIFTER WITH 3-STATE OUTPUTS

SCAS375D – MARCH 1994 – REVISED JUNE 1998

- **EPIC™ (Enhanced-Performance Implanted CMOS) Submicron Process**
- **3.3-V to 5-V Bidirectional Level Shifter**
- **Latch-Up Performance Exceeds 250 mA Per JESD 17**
- **Package Options Include Plastic Small-Outline (DW), Shrink Small-Outline (DB), and Thin Shrink Small-Outline (PW) Packages**



### description

This 8-bit (octal) noninverting bus transceiver contains two separate supply rails; B port has  $V_{CCB}$ , which is set at 3.3 V, and A port has  $V_{CCA}$ , which is set at 5 V. This allows for translation from a 3.3-V to a 5-V environment, and vice versa.

The SN74LVC4245A is designed for asynchronous communication between data buses. The device transmits data from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable ( $\overline{OE}$ ) input can be used to disable the device so the buses are effectively isolated.

The SN74LVC4245A pinout allows the designer to switch to a normal all-3.3-V or all-5-V 20-pin '245 device without board re-layout. The designer uses the data paths for pins 2–11 and 14–23 of the SN74LVC4245A to align with the conventional '245 pinout.

The SN74LVC4245A is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

**FUNCTION TABLE**

INPUTS		OPERATION
$\overline{OE}$	DIR	
L	L	B data to A bus
L	H	A data to B bus
H	X	Isolation



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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  
INSTRUMENTS**

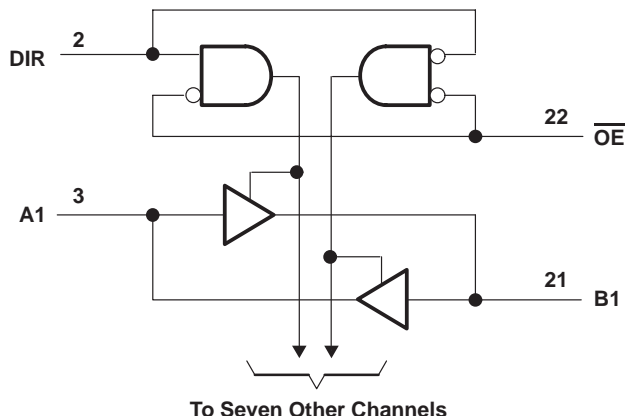
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**logic diagram (positive logic)**



**absolute maximum ratings over operating free-air temperature range for  $V_{CCA} = 5\text{ V}$  (unless otherwise noted)†**

Supply voltage range, $V_{CCA}$ .....	-0.5 V to 6.5 V
Input voltage range, $V_I$ : A port (see Note 1) .....	-0.5 V to $V_{CCA} + 0.5\text{ V}$
Control inputs .....	-0.5 V to 6 V
Output voltage range, $V_O$ : A port (see Note 1) .....	-0.5 V to $V_{CCA} + 0.5\text{ V}$
Input clamp current, $I_{IK}$ ( $V_I < 0$ ) .....	-50 mA
Output clamp current, $I_{OK}$ ( $V_O < 0$ ) .....	-50 mA
Continuous output current, $I_O$ .....	$\pm 50\text{ mA}$
Continuous current through each $V_{CCA}$ or GND .....	$\pm 100\text{ mA}$
Package thermal impedance, $\theta_{JA}$ (see Note 2): 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. This value is limited to 6 V maximum.  
 2. The package thermal impedance is calculated in accordance with JESD 51.



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## OCTAL BUS TRANSCEIVER AND 3.3-V TO 5-V SHIFTER WITH 3-STATE OUTPUTS

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### absolute maximum ratings over operating free-air temperature range for $V_{CCB} = 3.3\text{ V}$ (unless otherwise noted)†

Supply voltage range, $V_{CCB}$ .....	-0.5 V to 4.6 V
Input voltage range, $V_I$ : B port (see Note 3) .....	-0.5 V to $V_{CCB} + 0.5\text{ V}$
Output voltage range, $V_O$ : B port (see Note 3) .....	-0.5 V to $V_{CCB} + 0.5\text{ V}$
Input clamp current, $I_{IK}$ ( $V_I < 0$ ) .....	-50 mA
Output clamp current, $I_{OK}$ ( $V_O < 0$ ) .....	-50 mA
Continuous output current, $I_O$ .....	$\pm 50\text{ mA}$
Continuous current through $V_{CCB}$ or GND .....	$\pm 100\text{ mA}$
Package thermal impedance, $\theta_{JA}$ (see Note 2): 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: 2. The package thermal impedance is calculated in accordance with JESD 51.  
3. This value is limited to 4.6 V maximum.

### recommended operating conditions for $V_{CCA} = 5\text{ V}$ (see Note 4)

	MIN	MAX	UNIT
$V_{CCA}$ Supply voltage	4.5	5.5	V
$V_{IH}$ High-level input voltage	2		V
$V_{IL}$ Low-level input voltage		0.8	V
$V_I$ Input voltage	0	$V_{CCA}$	V
$V_O$ Output voltage	0	$V_{CCA}$	V
$I_{OH}$ High-level output current		-24	mA
$I_{OL}$ Low-level output current		24	mA
$T_A$ Operating free-air temperature	-40	85	°C

NOTE 4: All unused inputs of the device must be held at the associated  $V_{CC}$  or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

### recommended operating conditions for $V_{CCB} = 3.3\text{ V}$ (see Note 4)

	MIN	MAX	UNIT
$V_{CCB}$ Supply voltage	2.7	3.6	V
$V_{IH}$ High-level input voltage	$V_{CCB} = 2.7\text{ V to }3.6\text{ V}$		V
$V_{IL}$ Low-level input voltage	$V_{CCB} = 2.7\text{ V to }3.6\text{ V}$		V
$V_I$ Input voltage	0	$V_{CCB}$	V
$V_O$ Output voltage	0	$V_{CCB}$	V
$I_{OH}$ High-level output current	$V_{CCB} = 2.7\text{ V}$		mA
	$V_{CCB} = 3\text{ V}$		
$I_{OL}$ Low-level output current	$V_{CCB} = 2.7\text{ V}$		mA
	$V_{CCB} = 3\text{ V}$		
$T_A$ Operating free-air temperature	-40	85	°C

NOTE 4: All unused inputs of the device must be held at the associated  $V_{CC}$  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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**WITH 3-STATE OUTPUTS**

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**electrical characteristics over recommended operating free-air temperature range for  $V_{CCA} = 5\text{ V}$  (unless otherwise noted) (see Note 5)**

PARAMETER		TEST CONDITIONS	$V_{CCA}$	MIN	TYP†	MAX	UNIT
$V_{OH}$		$I_{OH} = -100\ \mu\text{A}$	4.5 V	4.3		V	
			5.5 V	5.3			
		$I_{OH} = -24\ \text{mA}$	4.5 V	3.7			
			5.5 V	4.7			
$V_{OL}$		$I_{OL} = 100\ \mu\text{A}$	4.5 V	0.2		V	
			5.5 V	0.2			
		$I_{OL} = 24\ \text{mA}$	4.5 V	0.55			
			5.5 V	0.55			
$I_I$	Control inputs	$V_I = V_{CCA}$ or GND	5.5 V	$\pm 1$		$\mu\text{A}$	
$I_{OZ}^\ddagger$	A port	$V_O = V_{CCA}$ or GND	5.5 V	$\pm 5$		$\mu\text{A}$	
$I_{CCA}$		$V_I = V_{CCA}$ or GND, $I_O = 0$	5.5 V	80		$\mu\text{A}$	
$\Delta I_{CCA}^\S$		One input at 3.4 V, Other inputs at $V_{CCA}$ or GND	5.5 V	1.5		mA	
$C_i$	Control inputs	$V_I = V_{CCA}$ or GND	Open	5		pF	
$C_{io}$	A port	$V_O = V_{CCA}$ or GND	5 V	11		pF	

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

‡ For I/O ports, the parameter  $I_{OZ}$  includes the input leakage current.

§ This is the increase in supply current for each input that is at one of the specified TTL voltage levels rather than 0 V or the associated  $V_{CC}$ .

NOTE 5:  $V_{CCB} = 2.7\text{ V}$  to  $3.6\text{ V}$

**electrical characteristics over recommended operating free-air temperature range for  $V_{CCB} = 3.3\text{ V}$  (unless otherwise noted) (see Note 6)**

PARAMETER		TEST CONDITIONS	$V_{CCB}$	MIN	TYP†	MAX	UNIT
$V_{OH}$		$I_{OH} = -100\ \mu\text{A}$	2.7 V to 3.6 V	$V_{CC} - 0.2$		V	
			2.7 V	2.2			
		$I_{OH} = -12\ \text{mA}$	3 V	2.4			
			3 V	2			
$V_{OL}$		$I_{OL} = 100\ \mu\text{A}$	2.7 V to 3.6 V	0.2		V	
		$I_{OL} = 12\ \text{mA}$	2.7 V	0.4			
		$I_{OL} = 24\ \text{mA}$	3 V	0.55			
$I_{OZ}^\ddagger$	B port	$V_O = V_{CCB}$ or GND	3.6 V	$\pm 5$		$\mu\text{A}$	
$I_{CCB}$		$V_I = V_{CCB}$ or GND, $I_O = 0$	3.6 V	50		$\mu\text{A}$	
$\Delta I_{CCB}^\S$		One input at $V_{CCB} - 0.6\text{ V}$ , Other inputs at $V_{CCB}$ or GND	2.7 V to 3.6 V	0.5		mA	
$C_{io}$	B port	$V_O = V_{CCB}$ or GND	3.3 V	11		pF	

‡ For I/O ports, the parameter  $I_{OZ}$  includes the input leakage current.

§ This is the increase in supply current for each input that is at one of the specified TTL voltage levels rather than 0 V or the associated  $V_{CC}$ .

† All typical values are measured at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

NOTE 6:  $V_{CCA} = 5\text{ V} \pm 0.5\text{ V}$



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switching characteristics over recommended operating free-air temperature range,  $C_L = 50 \text{ pF}$  (unless otherwise noted) (see Figures 1 and 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CCA} = 5 \text{ V} \pm 0.5 \text{ V}$ , $V_{CCB} = 2.7 \text{ V TO } 3.6 \text{ V}$		UNIT
			MIN	MAX	
$t_{PHL}$	A	B	1	6.3	ns
$t_{PLH}$			1	6.7	
$t_{PHL}$	B	A	1	6.1	ns
$t_{PLH}$			1	5	
$t_{PZL}$	$\overline{OE}$	A	1	9	ns
$t_{PZH}$			1	8.1	
$t_{PZL}$	$\overline{OE}$	B	1	8.8	ns
$t_{PZH}$			1	9.8	
$t_{PLZ}$	$\overline{OE}$	A	1	7	ns
$t_{PHZ}$			1	5.8	
$t_{PLZ}$	$\overline{OE}$	B	1	7.7	ns
$t_{PHZ}$			1	7.8	

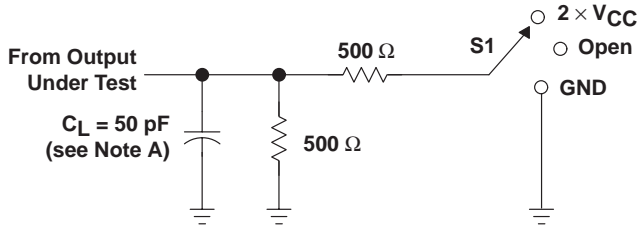
operating characteristics,  $V_{CCA} = 5 \text{ V}$ ,  $V_{CCB} = 3.3 \text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	TYP	UNIT
$C_{pd}$	Power dissipation capacitance per transceiver	Outputs enabled	39.5	pF
		Outputs disabled	5	

# SN74LVC4245A OCTAL BUS TRANSCEIVER AND 3.3-V TO 5-V SHIFTER WITH 3-STATE OUTPUTS

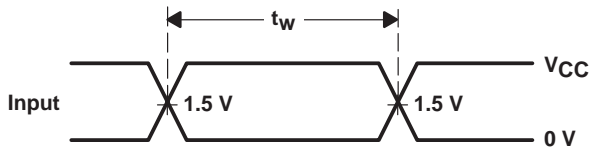
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## PARAMETER MEASUREMENT INFORMATION (A PORT)

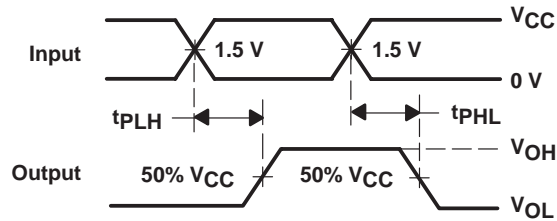


LOAD CIRCUIT

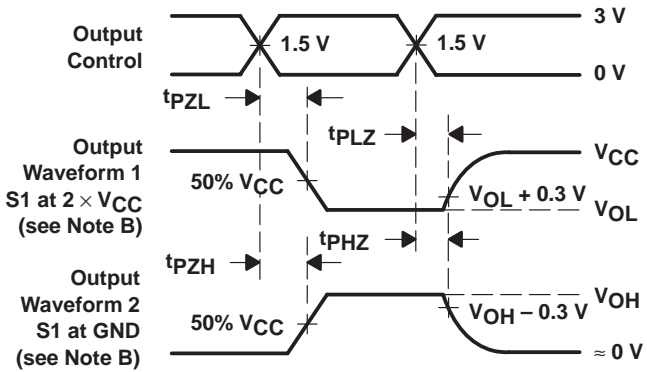
TEST	S1
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	$2 \times V_{CC}$
$t_{PHZ}/t_{PZH}$	GND



VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES  
NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES  
LOW- AND HIGH-LEVEL ENABLING

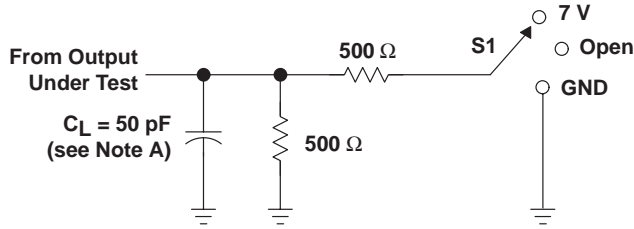
- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output 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.

Figure 1. Load Circuit and Voltage Waveforms

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**OCTAL BUS TRANSCEIVER AND 3.3-V TO 5-V SHIFTER**  
**WITH 3-STATE OUTPUTS**

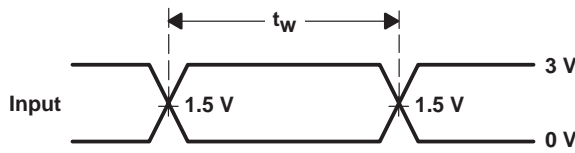
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**PARAMETER MEASUREMENT INFORMATION (B PORT)**

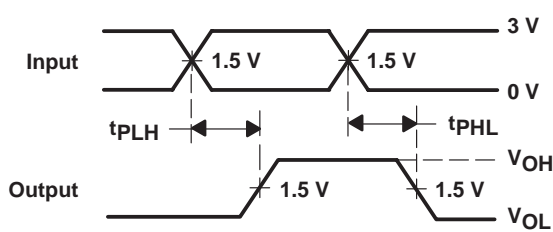


TEST	S1
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	7 V
$t_{PHZ}/t_{PZH}$	GND

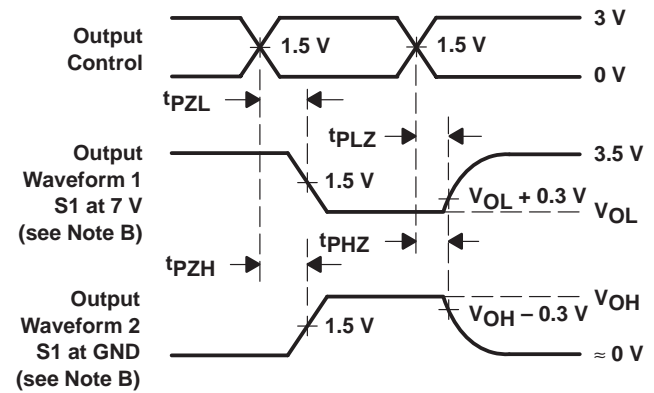
LOAD CIRCUIT



VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES  
NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES  
LOW- AND HIGH-LEVEL ENABLING

- 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.

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

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