

# SN54ALS652, SN54ALS653, SN54AS651, SN54AS652 SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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- Bus Transceivers/Registers
- Independent Registers and Enables for A and B Buses
- Multiplexed Real-Time and Stored Data
- Choice of True or Inverting Data Paths
- Choice of 3-State or Open-Collector Outputs to A Bus
- Package Options Include Plastic Small-Outline (DW) Packages, Ceramic Chip Carriers (FK), and Standard Plastic (NT) and Ceramic (JT) 300-mil DIPs

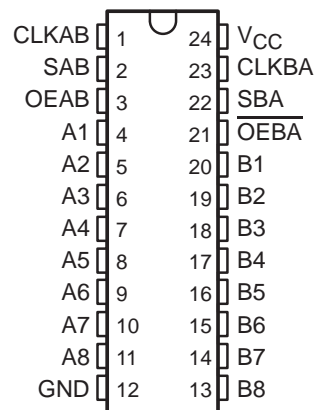
DEVICE	A OUTPUT	B OUTPUT	LOGIC
SN74ALS651A, 'AS651	3 State	3 State	Inverting
SN54ALS652, SN74ALS652A, 'AS652	3 State	3 State	True
'ALS653	Open Collector	3 State	Inverting
SN74ALS654	Open Collector	3 State	True

## description

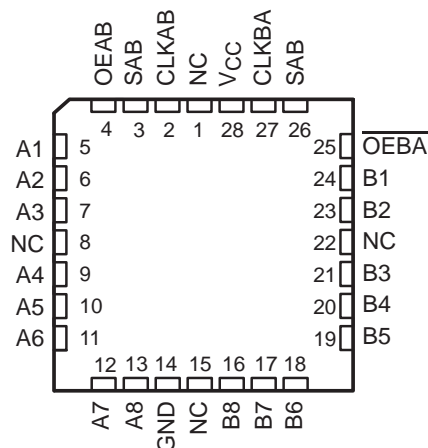
These devices consist of bus-transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the data bus or from the internal storage registers. Output-enable (OEAB and OEBA) inputs are provided to control the transceiver functions. Select-control (SAB and SBA) inputs are provided to select real-time or stored data transfer. 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 level selects real-time data, and a high input level selects stored data. Figure 1 illustrates the four fundamental bus-management functions that can be performed with the octal bus transceivers and registers.

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) terminals, regardless of the select- or output-control terminals. 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 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.

SN54ALS', SN54AS' ... JT PACKAGE  
SN74ALS', SN74AS' ... DW OR NT PACKAGE  
(TOP VIEW)



SN54ALS', SN54AS' ... 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  
INSTRUMENTS**

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SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
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**description (continued)**

The -1 versions of the SN74ALS651A and SN74ALS652A are identical to the standard versions except that the recommended maximum  $I_{OL}$  for the -1 versions is increased to 48 mA. There are no -1 versions of the SN54ALS652, SN54ALS653, SN74ALS653, and SN74ALS654.

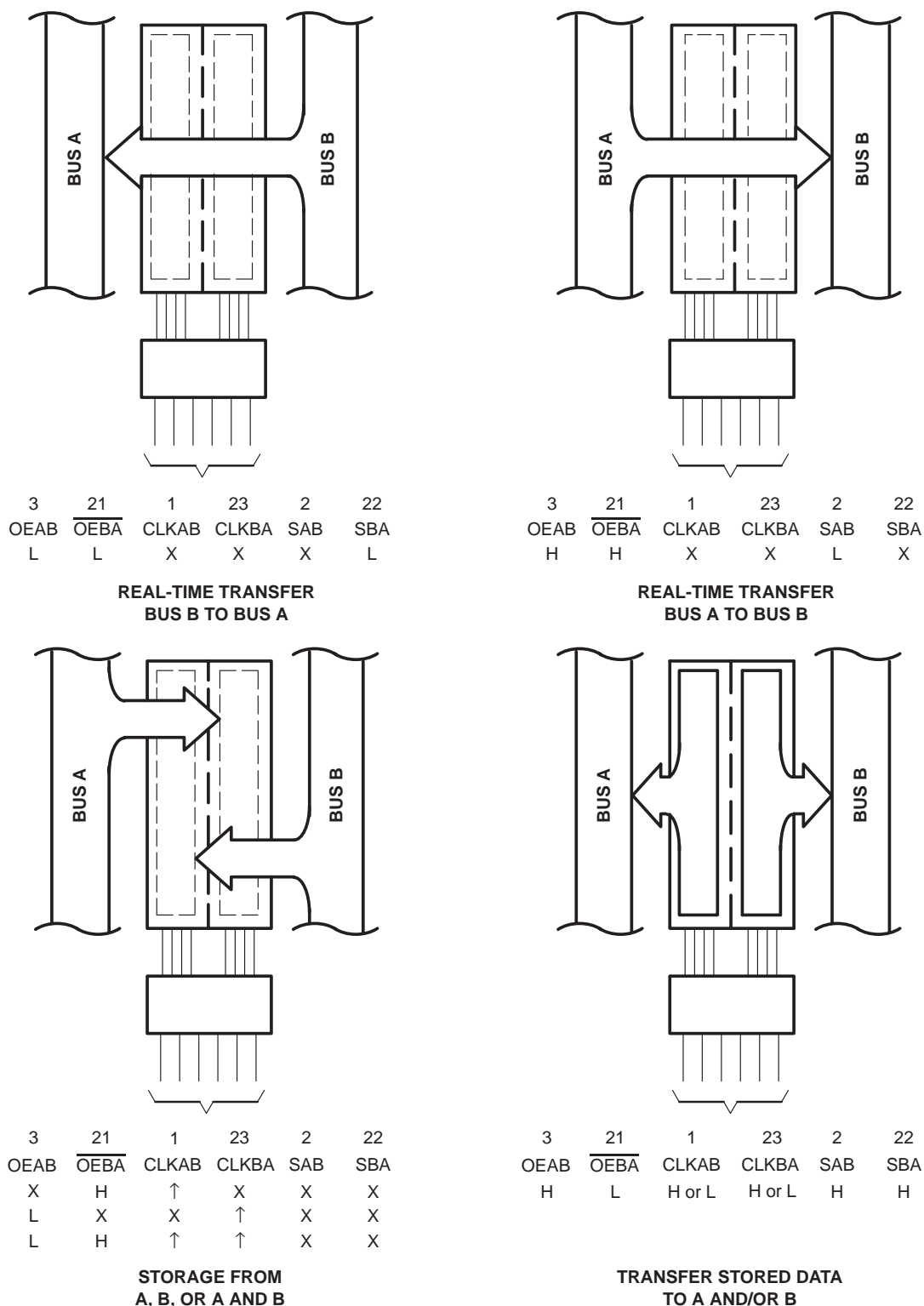
The SN54ALS' and SN54AS' families are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74ALS' and SN74AS' families are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .



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**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
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Pin numbers are for the DW, JT, and NT packages.

**Figure 1. Bus-Management Functions**

**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
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**FUNCTION TABLES**

**SN54ALS653, SN54AS651,  
SN74ALS651A, SN74ALS653, SN74AS651**

INPUTS						DATA I/O†		OPERATION OR FUNCTION
OEAB	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 $\overline{B}$ data to A bus
L	L	X	H or L	X	H	Output	Input	Stored $\overline{B}$ data to A bus
H	H	X	X	L	X	Input	Output	Real-time $\overline{A}$ data to B bus
H	H	H or L	X	H	X	Input	Output	Stored $\overline{A}$ data to B bus
H	L	H or L	H or L	H	H	Output	Output	Stored $\overline{A}$ data to B bus and stored $\overline{B}$ data to A bus

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

‡ Select control = L; clocks can occur simultaneously.

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

**SN54ALS652, SN54AS652,  
SN74ALS652A, SN74ALS654, SN74AS652**

INPUTS						DATA I/O†		OPERATION OR FUNCTION
OEAB	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 OEBA. Data input functions are always enabled; i.e., data at the bus terminals is stored on every low-to-high transition on the clock inputs.

‡ Select control = L; clocks can occur simultaneously.

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

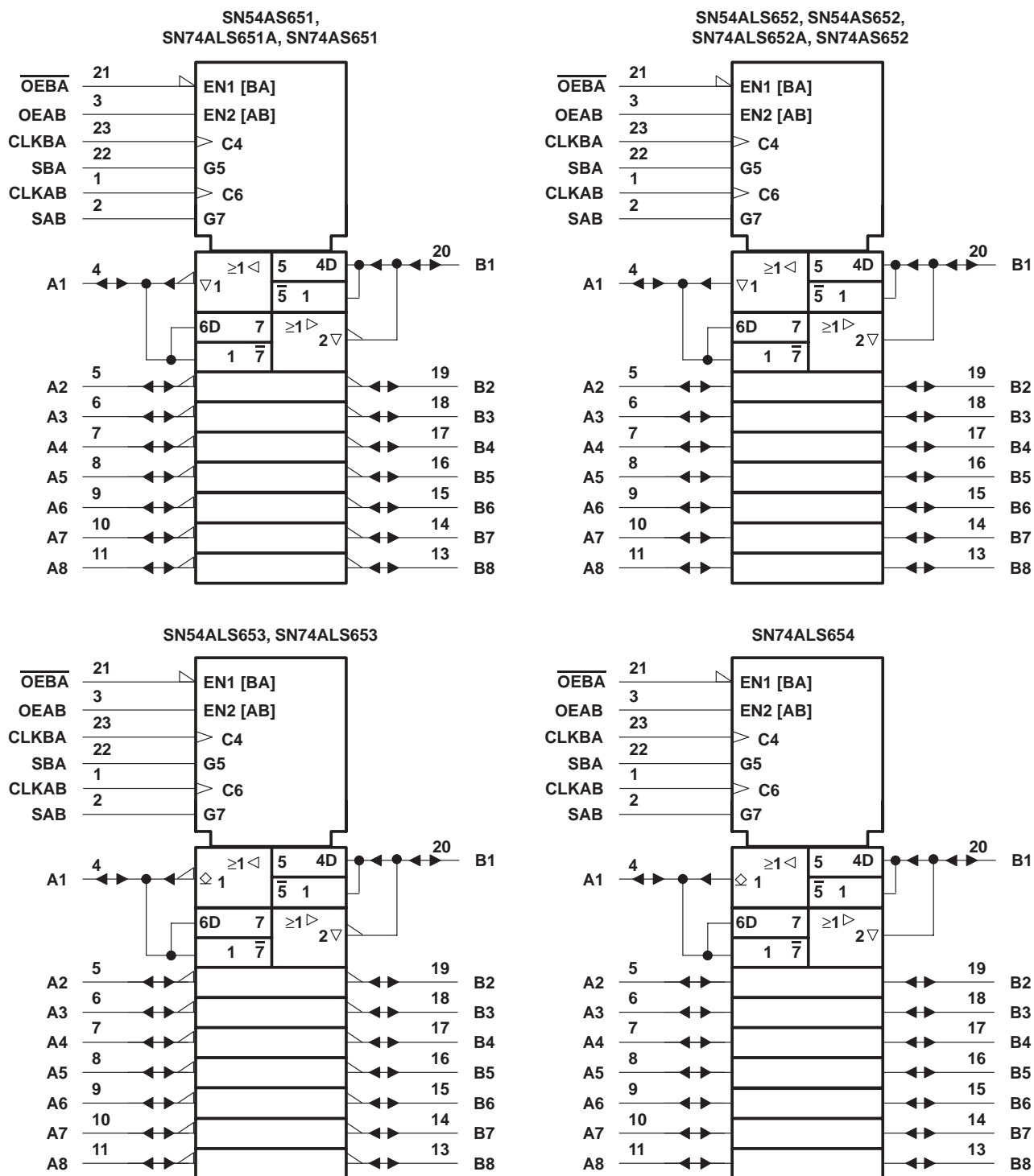


# SN54ALS652, SN54ALS653, SN54AS651, SN54AS652 SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652

## OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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### logic symbols†

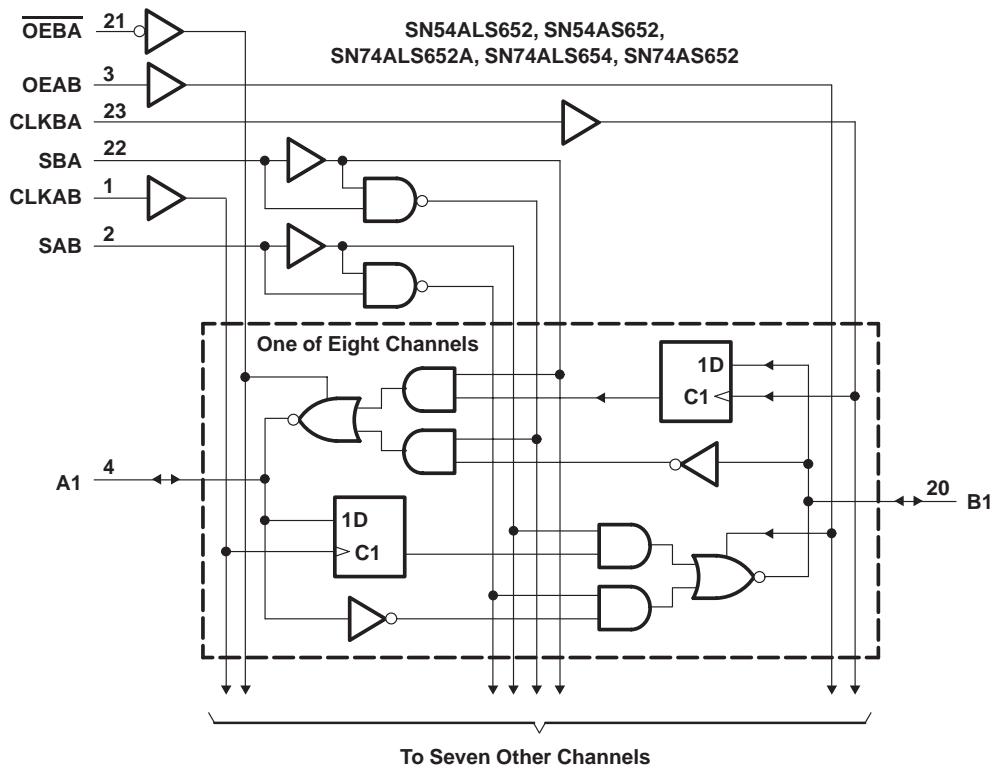
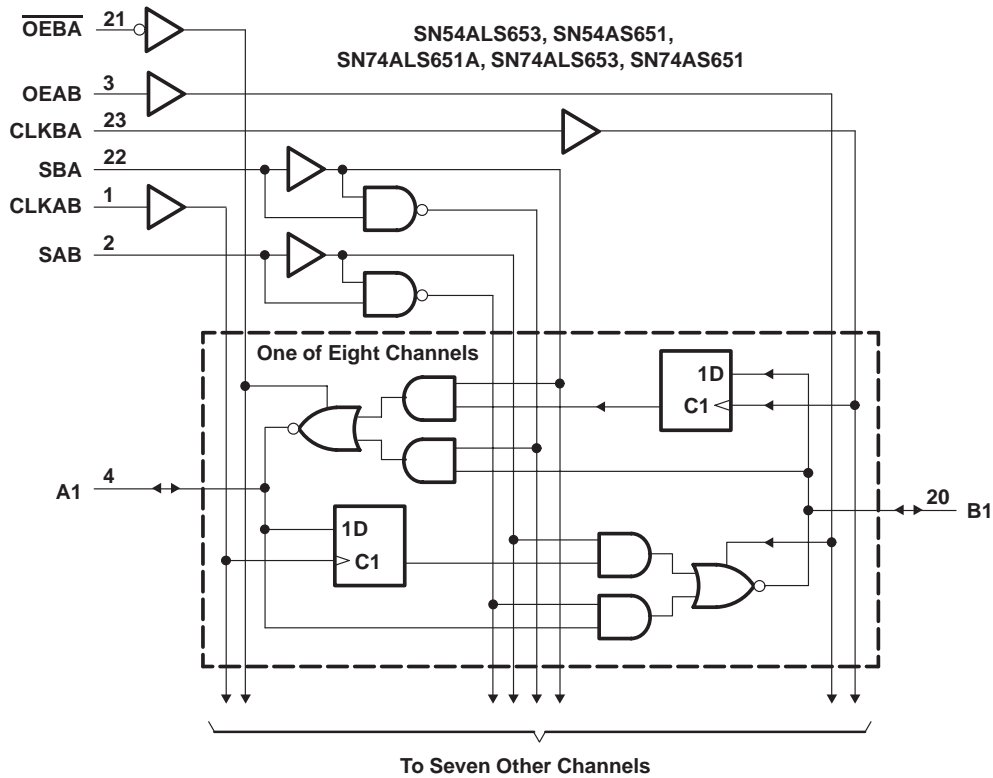


† These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12. Pin numbers shown are for the DW, JT, and NT packages.

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 SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
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logic diagrams (positive logic)



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



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**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
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)<sup>†</sup>**

Supply voltage, $V_{CC}$ .....	7 V
Input voltage, $V_I$ : Control inputs .....	7 V
I/O ports .....	5.5 V
Operating free-air temperature range, $T_A$ : SN54ALS652 .....	–55°C to 125°C
SN74ALS651A, SN74ALS652A .....	0°C to 70°C
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.

**recommended operating conditions**

		SN74ALS651A			UNIT
		MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	2			V
$V_{IL}$	Low-level input voltage			0.8	V
$I_{OH}$	High-level output current			–15	mA
$I_{OL}$	Low-level output current			24	mA
				48 <sup>‡</sup>	
$f_{clock}$	Clock frequency	0		40	MHz
$t_w$	Pulse duration	CLKBA or CLKAB high	12.5		ns
		CLKBA or CLKAB low	12.5		
$t_{su}$	Setup time before CLKAB <sup>↑</sup> or CLKBA <sup>↑</sup>	A or B	10		ns
$t_h$	Hold time after CLKAB <sup>↑</sup> or CLKBA <sup>↑</sup>	A or B	0		ns
$T_A$	Operating free-air temperature	0		70	°C

<sup>‡</sup> Applies only to the SN74ALS651A-1 and only if  $V_{CC}$  is maintained between 4.75 V and 5.25 V

**recommended operating conditions**

		SN54ALS652			SN74ALS652A			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	2			2			V
$V_{IL}$	Low-level input voltage			0.7			0.8	V
$I_{OH}$	High-level output current			–12			–15	mA
$I_{OL}$	Low-level output current			12			24	mA
							48 <sup>‡</sup>	
$f_{clock}$	Clock frequency	0		35	0		40	MHz
$t_w$	Pulse duration	CLKBA or CLKAB high	14.5		12.5			ns
		CLKBA or CLKAB low	14.5		12.5			
$t_{su}$	Setup time before CLKAB <sup>↑</sup> or CLKBA <sup>↑</sup>	A or B	15		10			ns
$t_h$	Hold time after CLKAB <sup>↑</sup> or CLKBA <sup>↑</sup>	A or B	5		0			ns
$T_A$	Operating free-air temperature	–55		125	0		70	°C

<sup>‡</sup> Applies only to the SN74ALS652A-1 and only if  $V_{CC}$  is maintained between 4.75 V and 5.25 V



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 SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
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electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	SN74ALS651A			UNIT
		MIN	TYP†	MAX	
$V_{IK}$	$V_{CC} = 4.5\text{ V}$ , $I_I = -18\text{ mA}$			-1.2	V
$V_{OH}$	$V_{CC} = 4.5\text{ V to }5.5\text{ V}$ , $I_{OH} = -0.4\text{ mA}$	$V_{CC} - 2$			V
	$V_{CC} = 4.5\text{ V}$	$I_{OH} = -3\text{ mA}$	2.4	3.2	
		$I_{OH} = -15\text{ mA}$	2		
$V_{OL}$	$V_{CC} = 4.5\text{ V}$	$I_{OL} = 12\text{ mA}$	0.25	0.4	V
		$I_{OL} = 24\text{ mA}$	0.35	0.5	
	$V_{CC} = 4.75\text{ V}$ , $I_{OL} = 48\text{ mA (-1 versions)}$	0.35		0.5	
$I_I$	Control inputs	$V_{CC} = 5.5\text{ V}$ , $V_I = 7\text{ V}$		0.1	mA
	A or B ports	$V_{CC} = 5.5\text{ V}$ , $V_I = 5.5\text{ V}$		0.1	
$I_{IH}$	Control inputs	$V_{CC} = 5.5\text{ V}$ , $V_I = 2.7\text{ V}$		20	$\mu\text{A}$
	A or B ports‡			20	
$I_{IL}$	Control inputs	$V_{CC} = 5.5\text{ V}$ , $V_I = 0.4\text{ V}$		-0.2	mA
	A or B ports‡			-0.2	
$I_{OS}§$	$V_{CC} = 5.5\text{ V}$ , $V_O = 2.25\text{ V}$		-30	-112	mA
$I_{CC}$	$V_{CC} = 5.5\text{ V}$	Outputs high	42	68	mA
		Outputs low	52	82	
		Outputs disabled	52	82	

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

‡ For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

§ The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current,  $I_{OS}$ .





**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
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**electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)**

PARAMETER	TEST CONDITIONS	SN54ALS652			SN74ALS652A			UNIT
		MIN	TYP†	MAX	MIN	TYP†	MAX	
$V_{IK}$	$V_{CC} = 4.5\text{ V}$ , $I_I = -18\text{ mA}$			-1.2			-1.2	V
$V_{OH}$	$V_{CC} = 4.5\text{ V to }5.5\text{ V}$ , $I_{OH} = -0.4\text{ mA}$	$V_{CC}-2$			$V_{CC}-2$			V
	$V_{CC} = 4.5\text{ V}$	$I_{OH} = -3\text{ mA}$	2.4	3.2	2.4	3.2		
		$I_{OH} = -12\text{ mA}$	2					
$V_{OL}$	$V_{CC} = 4.5\text{ V}$	$I_{OL} = 12\text{ mA}$	0.25	0.4	0.25	0.4	V	
		$I_{OL} = 24\text{ mA}$			0.35	0.5		
	$V_{CC} = 4.75\text{ V}$ , $I_{OL} = 48\text{ mA}$ (-1 versions)			0.35	0.5			
$I_I$	Control inputs	$V_{CC} = 5.5\text{ V}$ , $V_I = 7\text{ V}$				0.1	0.1	mA
	A or B ports	$V_{CC} = 5.5\text{ V}$ , $V_I = 5.5\text{ V}$				0.1	0.1	
$I_{IH}$	Control inputs	$V_{CC} = 5.5\text{ V}$ , $V_I = 2.7\text{ V}$				20	20	$\mu\text{A}$
	A or B ports‡					20	20	
$I_{IL}$	Control inputs	$V_{CC} = 5.5\text{ V}$ , $V_I = 0.4\text{ V}$				-0.2	-0.2	mA
	A or B ports‡					-0.2	-0.2	
$I_{OS}^{\S}$	$V_{CC} = 5.5\text{ V}$ , $V_O = 2.25\text{ V}$	-20		-112	-30		-112	mA
$I_{CC}$	$V_{CC} = 5.5\text{ V}$	Outputs high	47	76	47	76	mA	
		Outputs low	55	88	55	88		
		Outputs disabled	55	88	55	88		

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

‡ For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

§ The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current,  $I_{OS}$ .



**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652**  
**SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652**  
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**switching characteristics (see Figure 2)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4.5 V to 5.5 V, C <sub>L</sub> = 50 pF, R <sub>1</sub> = 500 Ω, R <sub>2</sub> = 500 Ω, T <sub>A</sub> = MIN to MAX†		UNIT
			SN74ALS651A		
			MIN	MAX	
f <sub>max</sub>			40		MHz
t <sub>PLH</sub>	CLKBA or CLKAB	A or B	8	32	ns
t <sub>PHL</sub>			5	17	
t <sub>PLH</sub>	A or B	B or A	2	18	ns
t <sub>PHL</sub>			2	10	
t <sub>PLH</sub>	SBA or SAB‡ (with A or B high)	A or B	8	38	ns
t <sub>PHL</sub>			6	21	
t <sub>PLH</sub>	SBA or SAB‡ (with A or B low)	A or B	8	25	ns
t <sub>PHL</sub>			7	21	
t <sub>PZH</sub>	$\overline{OEBA}$	A	3	20	ns
t <sub>PZL</sub>			5	18	
t <sub>PHZ</sub>	$\overline{OEBA}$	A	2	9	ns
t <sub>PLZ</sub>			3	12	
t <sub>PZH</sub>	OEAB	B	3	22	ns
t <sub>PZL</sub>			6	21	
t <sub>PHZ</sub>	OEAB	B	2	12	ns
t <sub>PLZ</sub>			2	14	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.

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SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
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**switching characteristics (see Figure 2)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4.5 V to 5.5 V, C <sub>L</sub> = 50 pF, R <sub>1</sub> = 500 Ω, R <sub>2</sub> = 500 Ω, T <sub>A</sub> = MIN to MAX†				UNIT
			SN54ALS652		SN74ALS652A		
			MIN	MAX	MIN	MAX	
f <sub>max</sub>			35		40	MHz	
t <sub>PLH</sub>	CLKBA or CLKAB	A or B	10	35	8	30	ns
t <sub>PHL</sub>			5	20	5	17	
t <sub>PLH</sub>	A or B	B or A	5	20	4	18	ns
t <sub>PHL</sub>			3	15	3	12	
t <sub>PLH</sub>	SBA or SAB‡ (with A or B high)	A or B	15	40	8	35	ns
t <sub>PHL</sub>			6	23	6	20	
t <sub>PLH</sub>	SBA or SAB‡ (with A or B low)	A or B	8	30	8	25	ns
t <sub>PHL</sub>			5	24	5	20	
t <sub>PZH</sub>	$\overline{OEBA}$	A	3	20	3	17	ns
t <sub>PZL</sub>			5	22	5	18	
t <sub>PHZ</sub>	$\overline{OEBA}$	A	1	12	1	10	ns
t <sub>PLZ</sub>			2	20	2	16	
t <sub>PZH</sub>	OEAB	B	8	25	3	22	ns
t <sub>PZL</sub>			6	21	5	18	
t <sub>PHZ</sub>	OEAB	B	1	12	1	10	ns
t <sub>PLZ</sub>			2	21	2	16	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.



**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652**  
**SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652**  
**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)<sup>†</sup>**

Supply voltage, $V_{CC}$ .....	7 V
Input voltage, $V_I$ : All inputs and A I/O ports .....	7 V
B I/O ports .....	5.5 V
Operating free-air temperature range, $T_A$ : SN54ALS653 .....	-55°C to 125°C
SN74ALS653, SN74ALS654 .....	0°C to 70°C
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.

**recommended operating conditions**

		SN54ALS653			SN74ALS653			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	2			2			V
$V_{IL}$	Low-level input voltage			0.7			0.8	V
$V_{OH}$	High-level output voltage			5.5			5.5	V
$I_{OH}$	High-level output current			-12			-15	mA
$I_{OL}$	Low-level output current			12			24	mA
$f_{clock}$	Clock frequency	0		25	0		35	MHz
$t_w$	Pulse duration	CLKBA or CLKAB high		20	14.5		ns	
		CLKBA or CLKAB low		20	14.5			
$t_{su}$	Setup time before CLKAB $\uparrow$ or CLKBA $\uparrow$	A or B		15	10		ns	
$t_h$	Hold time after CLKAB $\uparrow$ or CLKBA $\uparrow$	A or B		5	0		ns	
$T_A$	Operating free-air temperature	-55		125	0		70	°C

**recommended operating conditions**

		SN74ALS654			UNIT
		MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	2			V
$V_{IL}$	Low-level input voltage			0.8	V
$V_{OH}$	High-level output voltage			5.5	V
$I_{OH}$	High-level output current			-15	mA
$I_{OL}$	Low-level output current			24	mA
$f_{clock}$	Clock frequency	0		35	MHz
$t_w$	Pulse duration	CLKBA or CLKAB high		14.5	ns
		CLKBA or CLKAB low		14.5	
$t_{su}$	Setup time before CLKAB $\uparrow$ or CLKBA $\uparrow$	A or B		10	ns
$t_h$	Hold time after CLKAB $\uparrow$ or CLKBA $\uparrow$	A or B		0	ns
$T_A$	Operating free-air temperature	0		70	°C



**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS**

SDAS066F – DECEMBER 1983 – REVISED OCTOBER 1996

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

PARAMETER		TEST CONDITIONS	SN54ALS653			SN74ALS653			UNIT	
			MIN	TYP†	MAX	MIN	TYP†	MAX		
V <sub>IK</sub>		V <sub>CC</sub> = 4.5 V, I <sub>I</sub> = -18 mA	-1.2			-1.2			V	
V <sub>OH</sub>	B ports	V <sub>CC</sub> = 4.5 V to 5.5 V, I <sub>OH</sub> = -0.4 mA	V <sub>CC</sub> -2			V <sub>CC</sub> -2			V	
		V <sub>CC</sub> = 4.5 V	I <sub>OH</sub> = -3 mA	2.4	3.2	2.4	3.2			
			I <sub>OH</sub> = -12 mA	2						
						2				
V <sub>OL</sub>	V <sub>CC</sub> = 4.5 V		I <sub>OL</sub> = 12 mA	0.25	0.4	0.25	0.4	V		
			I <sub>OL</sub> = 24 mA			0.35	0.5			
I <sub>I</sub>	Control inputs	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 7 V	0.1			0.1			mA	
	A or B ports	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 5.5 V	0.1			0.1				
I <sub>IH</sub>	Control inputs	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 2.7 V	20			20			μA	
	A or B ports‡		20			20				
I <sub>IL</sub>	Control inputs	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0.4 V	-0.2			-0.2			mA	
	A or B ports‡		-0.2			-0.2				
I <sub>OH</sub>	A ports	V <sub>CC</sub> = 4.5 V, V <sub>OH</sub> = 5.5 V	0.1			0.1			mA	
I <sub>O</sub> §	B ports	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.25 V	-20	-112	-30	-112	mA			
I <sub>CC</sub>	V <sub>CC</sub> = 5.5 V		Outputs high			47	76	47	76	mA
			Outputs low			55	88	55	88	
			Outputs disabled			55	88	55	88	

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

‡ For I/O ports, the parameters I<sub>IH</sub> and I<sub>IL</sub> include the off-state output current.

§ The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current, I<sub>OS</sub>.



SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
 SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
 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		SN74ALS654			UNIT		
				MIN	TYP†	MAX			
V <sub>IK</sub>		V <sub>CC</sub> = 4.5 V, I <sub>I</sub> = -18 mA					-1.2	V	
V <sub>OH</sub>	B ports	V <sub>CC</sub> = 4.5 V to 5.5 V, I <sub>OH</sub> = -0.4 mA		V <sub>CC</sub> - 2				V	
		V <sub>CC</sub> = 4.5 V	I <sub>OH</sub> = -3 mA		2.4	3.2			
			I <sub>OH</sub> = -15 mA		2				
V <sub>OL</sub>		V <sub>CC</sub> = 4.5 V	I <sub>OL</sub> = 12 mA		0.25	0.4	V		
			I <sub>OL</sub> = 24 mA		0.35	0.5			
I <sub>I</sub>	Control inputs	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 7 V					0.1	mA	
	A or B ports	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 5.5 V					0.1		
I <sub>IH</sub>	Control inputs	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 2.7 V					20	μA	
	A or B ports‡						20		
I <sub>IL</sub>	Control inputs	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0.4 V					-0.2	mA	
	A or B ports‡						-0.2		
I <sub>OH</sub>	A ports	V <sub>CC</sub> = 4.5 V, V <sub>OH</sub> = 5.5 V					0.1	mA	
I <sub>O§</sub>	B ports	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.25 V					-30	-112	mA
I <sub>CC</sub>		V <sub>CC</sub> = 5.5 V	Outputs high		47	76	mA		
			Outputs low		55	88			
			Outputs disabled		55	88			

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

‡ For I/O ports, the parameters I<sub>IH</sub> and I<sub>IL</sub> include the off-state output current.

§ The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current, I<sub>OS</sub>.



**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS**

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**switching characteristics (see Figure 2)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4.5 V to 5.5 V, C <sub>L</sub> = 50 pF, R <sub>L</sub> = 680 Ω (A outputs), R <sub>1</sub> = R <sub>2</sub> = 500 Ω (B outputs), T <sub>A</sub> = MIN to MAX†				UNIT
			SN54ALS653		SN74ALS653		
			MIN	MAX	MIN	MAX	
f <sub>max</sub>			25		35	MHz	
t <sub>PLH</sub>	CLKBA	A	16	71	16	64	ns
t <sub>PHL</sub>			6	24	6	22	
t <sub>PLH</sub>	CLKAB	B	10	35	10	30	ns
t <sub>PHL</sub>			5	20	5	17	
t <sub>PLH</sub>	A	B	5	20	5	18	ns
t <sub>PHL</sub>			1.5	18	2	15	
t <sub>PLH</sub>	B	A	8	63	12	56	ns
t <sub>PHL</sub>			2	18	2	15	
t <sub>PLH</sub>	SBA‡ (with B high)	A	12	68	19	62	ns
t <sub>PHL</sub>			5	27	5	25	
t <sub>PLH</sub>	SBA‡ (with B low)	A	12	68	19	62	ns
t <sub>PHL</sub>			5	27	5	25	
t <sub>PLH</sub>	SAB‡ (with A high)	B	8	30	15	35	ns
t <sub>PHL</sub>			6	25	6	22	
t <sub>PLH</sub>	SAB‡ (with A low)	B	12	40	8	25	ns
t <sub>PHL</sub>			6	25	6	22	
t <sub>PLH</sub>	$\overline{OEBA}$	A	6	35	6	30	ns
t <sub>PHL</sub>			6	27	6	24	
t <sub>PZH</sub>	OEAB	B	7	25	8	22	ns
t <sub>PZL</sub>			6	25	6	22	
t <sub>PHZ</sub>	OEAB	B	1	16	1	14	ns
t <sub>PLZ</sub>			2	21	2	16	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.



**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
OCTAL BUS TRANSCIEVERS AND REGISTERS WITH 3-STATE OUTPUTS**

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**switching characteristics (see Figure 2)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4.5 V to 5.5 V, C <sub>L</sub> = 50 pF, R <sub>L</sub> = 680 Ω (A outputs), R <sub>1</sub> = R <sub>2</sub> = 500 Ω (B outputs), T <sub>A</sub> = MIN to MAX†		UNIT
			SN74ALS654		
			MIN	MAX	
f <sub>max</sub>			35		MHz
t <sub>PLH</sub>	CLKBA	A	16	64	ns
t <sub>PHL</sub>			6	22	
t <sub>PLH</sub>	CLKAB	B	10	30	ns
t <sub>PHL</sub>			5	17	
t <sub>PLH</sub>	A	B	5	18	ns
t <sub>PHL</sub>			2	15	
t <sub>PLH</sub>	B	A	12	56	ns
t <sub>PHL</sub>			2	21	
t <sub>PLH</sub>	SBA‡ (with B low)	A	19	62	ns
t <sub>PHL</sub>			5	25	
t <sub>PLH</sub>	SBA‡ (with B high)	A	19	62	ns
t <sub>PHL</sub>			5	25	
t <sub>PLH</sub>	SAB‡ (with A low)	B	15	35	ns
t <sub>PHL</sub>			6	22	
t <sub>PLH</sub>	SAB‡ (with A high)	B	8	25	ns
t <sub>PHL</sub>			6	22	
t <sub>PLH</sub>	$\overline{\text{OEBA}}$	A	6	30	ns
t <sub>PHL</sub>			6	24	
t <sub>PZH</sub>	OEAB	B	6	22	ns
t <sub>PZL</sub>			6	22	
t <sub>PHZ</sub>	OEAB	B	1	14	ns
t <sub>PLZ</sub>			2	16	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.



**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
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, $V_{CC}$ .....	7 V
Input voltage, $V_I$ : Control inputs .....	7 V
I/O ports .....	5.5 V
Operating free-air temperature range, $T_A$ : SN54AS651, SN54AS652 .....	–55°C to 125°C
SN74AS651, SN74AS652 .....	0°C to 70°C
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.

**recommended operating conditions**

		SN54AS651 SN54AS652			SN74AS651 SN74AS652			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	2			2			V
$V_{IL}$	Low-level input voltage			0.8			0.8	V
$I_{OH}$	High-level output current			–12			–15	mA
$I_{OL}$	Low-level output current			32			48	mA
$f_{clock}^*$	Clock frequency	0		75	0		90	MHz
$t_w^*$	Pulse duration	CLKBA or CLKAB high		6	5		ns	
		CLKBA or CLKAB low		7	6			
$t_{su}^*$	Setup time before CLKAB↑ or CLKBA↑	A or B		7	6		ns	
$t_h^*$	Hold time after CLKAB↑ or CLKBA	A or B		0	0		ns	
$T_A$	Operating free-air temperature	–55		125	0		70	°C

\* On products compliant to MIL-PRF-38535, this parameter is based on characterized data but is not production tested.



**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652**  
**SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652**  
**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		SN54AS651 SN54AS652		SN74AS651 SN74AS652		UNIT
				MIN	TYP†	MAX	MIN	
$V_{IK}$		$V_{CC} = 4.5\text{ V}$ , $I_I = -18\text{ mA}$		-1.2		-1.2		V
$V_{OH}$		$V_{CC} = 4.5\text{ V to } 5.5\text{ V}$ , $I_{OH} = -2\text{ mA}$		$V_{CC} - 2$		$V_{CC} - 2$		V
		$V_{CC} = 4.5\text{ V}$		$I_{OH} = -3\text{ mA}$		2.4 3.2		
				$I_{OH} = -12\text{ mA}$		2		
$V_{OL}$		$V_{CC} = 4.5\text{ V}$		$I_{OL} = 32\text{ mA}$		0.25 0.5		V
				$I_{OL} = 48\text{ mA}$		0.35 0.5		
$I_I$	Control inputs	$V_{CC} = 5.5\text{ V}$ , $V_I = 7\text{ V}$		0.1		0.1		mA
	A or B ports	$V_{CC} = 5.5\text{ V}$ , $V_I = 5.5\text{ V}$		0.1		0.1		
$I_{IH}$	Control inputs	$V_{CC} = 5.5\text{ V}$ , $V_I = 2.7\text{ V}$		20		20		$\mu\text{A}$
	A or B ports‡			70		70		
$I_{IL}$	Control input	$V_{CC} = 5.5\text{ V}$ , $V_I = 0.4\text{ V}$		-0.5		-0.5		mA
	A or B ports‡			-0.75		-0.75		
$I_{OS}$ §		$V_{CC} = 5.5\text{ V}$ , $V_O = 2.25\text{ V}$		-30 -112		-30 -112		mA
$I_{CC}$	'AS651	$V_{CC} = 5.5\text{ V}$		Outputs high		110 185		mA
				Outputs low		120 195		
				Outputs disabled		130 195		
	'AS652	$V_{CC} = 5.5\text{ V}$		Outputs high		120 195		
				Outputs low		130 211		
				Outputs disabled		130 211		

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

‡ For I/O ports, the parameters  $I_{IH}$  and  $I_{IL}$  include the off-state output current.

§ The output conditions have been chosen to produce a current that closely approximates one-half of the true short-circuit output current,  $I_{OS}$ .



**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652  
SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652  
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**switching characteristics (see Figure 2)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4.5 V to 5.5 V, C <sub>L</sub> = 50 pF, R <sub>1</sub> = 500 Ω, R <sub>2</sub> = 500 Ω, T <sub>A</sub> = MIN to MAX†				UNIT
			SN54AS651		SN74AS651		
			MIN	MAX	MIN	MAX	
f <sub>max</sub> *			75		90	MHz	
t <sub>PLH</sub>	CLKBA or CLKAB	A or B	2	11	2	8.5	ns
t <sub>PHL</sub>			2	10	2	9	
t <sub>PLH</sub>	A or B	B or A	2	12	2	8	ns
t <sub>PHL</sub>			1	8	1	7	
t <sub>PLH</sub>	SBA or SAB‡	A or B	2	15	2	11	ns
t <sub>PHL</sub>			2	11	2	9	
t <sub>PZH</sub>	$\overline{\text{OEBA}}$	A	2	11	2	10	ns
t <sub>PZL</sub>			3	18	3	16	
t <sub>PHZ</sub>	$\overline{\text{OEBA}}$	A	2	10	2	9	ns
t <sub>PLZ</sub>			2	10	2	9	
t <sub>PZH</sub>	OEAB	B	3	12	3	11	ns
t <sub>PZL</sub>			3	20	3	16	
t <sub>PHZ</sub>	OEAB	B	2	11	2	10	ns
t <sub>PLZ</sub>			2	12	2	11	

\* On products compliant to MIL-PRF-38535, this parameter is based on characterized data but is not production tested.

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.



**SN54ALS652, SN54ALS653, SN54AS651, SN54AS652**  
**SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652**  
**OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS**

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**switching characteristics (see Figure 2)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4.5 V TO 5.5 V, C <sub>L</sub> = 50 PF, R <sub>1</sub> = 500 Ω, R <sub>2</sub> = 500 Ω, T <sub>A</sub> = MIN TO MAX†				UNIT
			SN54AS652		SN74AS652		
			MIN	MAX	TYP	MAX	
f <sub>max</sub> *			75		90	MHz	
t <sub>PLH</sub>	CLKBA or CLKAB	A or B	2	11	2	8.5	ns
t <sub>PHL</sub>			2	10	2	9	
t <sub>PLH</sub>	A or B	B or A	2	12	2	9	ns
t <sub>PHL</sub>			1	8	1	7	
t <sub>PLH</sub>	SBA or SAB‡	A or B	2	15	2	11	ns
t <sub>PHL</sub>			2	11	2	9	
t <sub>PZH</sub>	$\overline{\text{OEBA}}$	A	2	11	2	10	ns
t <sub>PZL</sub>			3	18	3	16	
t <sub>PHZ</sub>	$\overline{\text{OEBA}}$	A	2	10	2	9	ns
t <sub>PLZ</sub>			2	10	2	9	
t <sub>PZH</sub>	OEAB	B	3	12	3	11	ns
t <sub>PZL</sub>			3	20	3	16	
t <sub>PHZ</sub>	OEAB	B	2	11	2	10	ns
t <sub>PLZ</sub>			2	12	2	11	

\* On products compliant to MIL-PRF-38535, this parameter is based on characterized data but is not production tested.

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

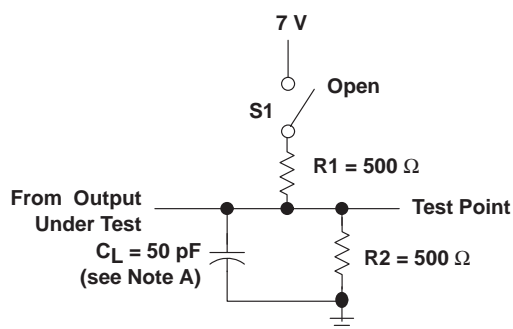
‡ These parameters are measured with the internal output state of the storage register opposite that of the bus input.



# SN54ALS652, SN54ALS653, SN54AS651, SN54AS652 SN74ALS651A, SN74ALS652A, SN74ALS653, SN74ALS654, SN74AS651, SN74AS652 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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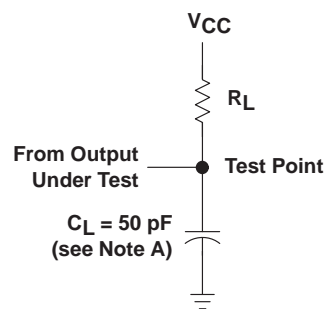
## PARAMETER MEASUREMENT INFORMATION



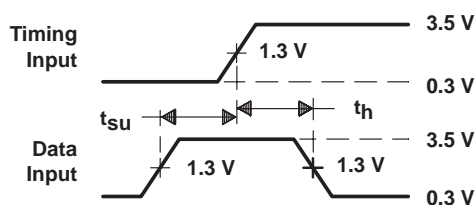
**LOAD CIRCUIT  
FOR 3-STATE OUTPUTS**

**SWITCH POSITION TABLE**

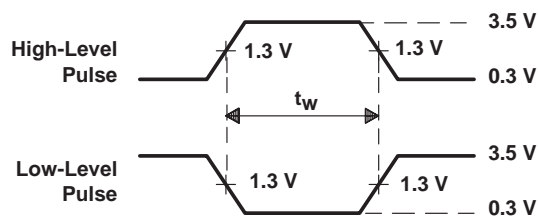
TEST	S1
$t_{PLH}$	Open
$t_{PHL}$	Open
$t_{PZH}$	Open
$t_{PZL}$	Closed
$t_{PHZ}$	Open
$t_{PLZ}$	Closed



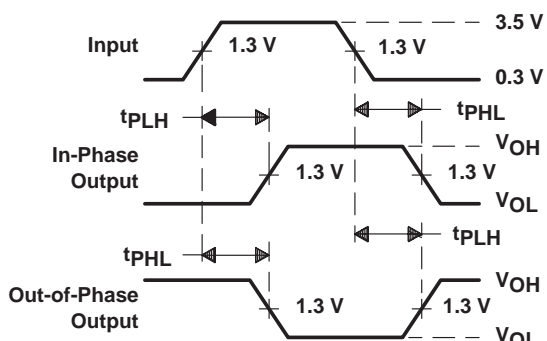
**LOAD CIRCUIT  
FOR OPEN-COLLECTOR OUTPUTS**



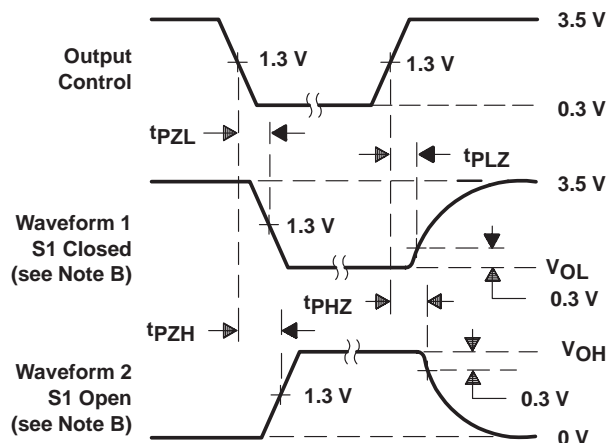
**VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS  
PULSE DURATION**



**VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES**



**VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS**

- 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:  $PRR \leq 1$  MHz,  $Z_O = 50 \Omega$ ,  $t_r \leq 2$  ns,  $t_f \leq 2$  ns.  
 D. The outputs are measured one at a time with one transition per measurement.

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

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