

# TYPES SN54LS651 THRU SN54LS654 SN74LS651 THRU SN74LS654 OCTAL BUS TRANSCEIVERS AND REGISTERS

D2637, JANUARY 1981 — REVISED DECEMBER 1983

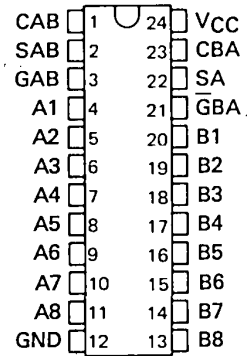
- Bus Transceivers/Registers
- Independent Registers and Enables for A and B Buses
- Multiplexed Real-Time and Stored Data
- Choice of True and Inverting Data Paths
- Choice of 3-State or Open-Collector Outputs to A Bus
- Dependable Texas Instruments Quality and Reliability

DEVICE	A OUTPUT	B OUTPUT	LOGIC
LS651	3-State	3-State	Inverting
LS652	3-State	3-State	True
LS653	Open-collector	3-State	Inverting
LS654	Open-collector	3-State	True

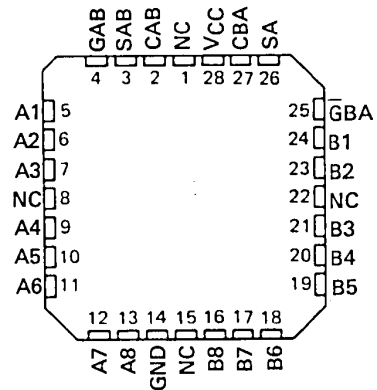
## description

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. Enable GAB and  $\bar{G}BA$  are provided to control the transceiver functions. SAB and SBA control pins are provided to select whether real-time or stored data is transferred. A low input level selects real-time data, and a high selects stored data. The following examples demonstrate the four fundamental bus-management functions that can be performed with the 'LS651, 'LS652, 'LS653, and 'LS654.

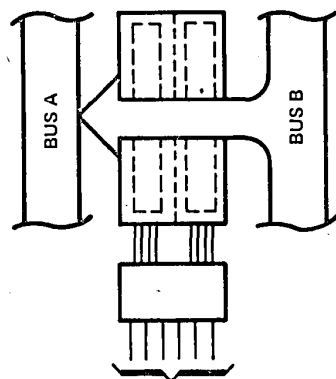
SN54LS' ... JT PACKAGE  
SN74LS' ... DW, JT OR NT PACKAGE  
(TOP VIEW)



SN54LS' ... FK PACKAGE  
SN74LS' ... FN PACKAGE  
(TOP VIEW)

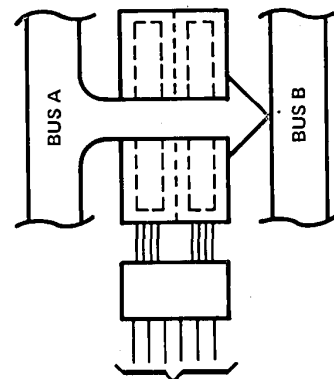


NC — No internal connection



GAB  $\bar{G}BA$  CAB CBA SAB SBA  
L L X X X L

REAL-TIME TRANSFER  
BUS B TO BUS A



GAB  $\bar{G}BA$  CAB CBA SAB SBA  
H H X X L X

REAL-TIME TRANSFER  
BUS A TO BUS B

## PRODUCTION DATA

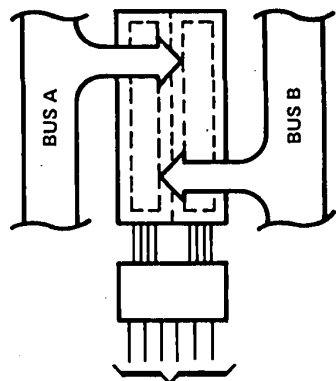
This document contains information current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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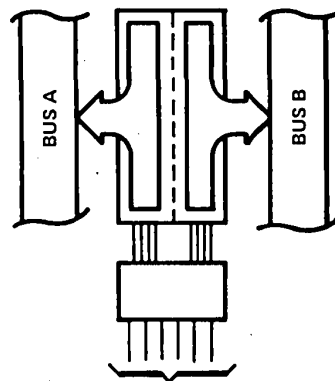
TTL DEVICES

**TYPES SN54LS651 THRU SN54LS654  
SN74LS651 THRU SN74LS654  
OCTAL BUS TRANSCEIVERS AND REGISTERS**



GAB	$\overline{\text{GBA}}$	CAB	CBA	SAB	SBA
X	H	↑	X	X	X
L	X	X	↑	X	X
L	H	↑	↑	X	X

STORAGE FROM  
A AND/OR B



GAB	$\overline{\text{GBA}}$	CAB	CBA	SAB	SBA
H	L	H or L	H or L	H	H

TRANSFER  
STORED DATA  
TO A AND/OR B

Data on the A or B data bus, or both, can be stored in the internal D flip-flop by low-to-high transitions at the appropriate clock pins (CAB or CBA) regardless of the select or enable control pins. 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 GAB and  $\overline{\text{GBA}}$ . In this configuration each output reinforces its input. Thus, when all other data sources to the two sets of bus lines are at high impedance, each set of bus lines will remain at its last state.

The SN54LS651 through SN54LS654 are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74LS651 through SN74LS654 are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

FUNCTION TABLE

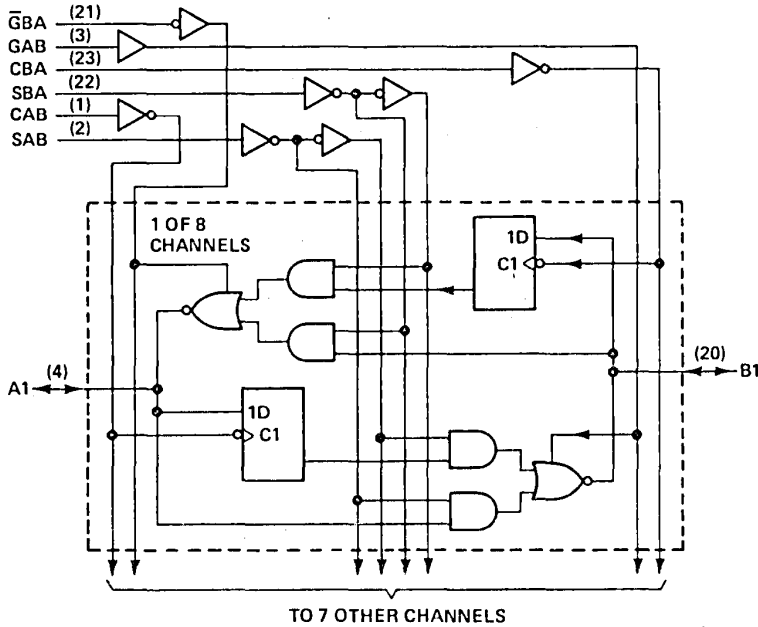
INPUTS						DATA I/O*		OPERATION OR FUNCTION	
GAB	$\overline{\text{GBA}}$	CAB	CBA	SAB	SBA	A1 THRU A8	B1 THRU B8	'LS651, 'LS653	'LS652, 'LS654
L	H	H or L	H or L	X	X	Input	Input	Isolation	Isolation
L	H	↑	↑	X	X	Input	Input	Store A and B Data	Store A and B Data
X	H	↑	H or L	X	X	Input	Not specified	Store A, Hold B	Store A, Hold B
H	H	↑	↑	X	X	Input	Output	Store A in both registers	Store A in both registers
L	X	H or L	↑	X	X	Not specified	Input	Hold A, Store B	Hold A, Store B
L	L	↑	↑	X	X	Output	Input	Store B in both registers	Store B in both registers
L	L	X	X	X	L	Output	Input	Real-Time $\overline{\text{B}}$ Data to A Bus	Real-Time B Data to A Bus
L	L	X	H or L	X	H	Output	Input	Stored $\overline{\text{B}}$ Data to A Bus	Stored B Data to A Bus
H	H	X	X	L	X	Input	Output	Real-Time $\overline{\text{A}}$ Data to B Bus	Real-Time A Data to B Bus
H	H	H or L	X	H	X	Input	Output	Stored $\overline{\text{A}}$ Data to B Bus	Stored A Data to B Bus
H	L	H or L	H or L	H	H	Output	Output	Stored $\overline{\text{A}}$ Data to B Bus and Stored $\overline{\text{B}}$ Data to A Bus	Stored A Data to B Bus and Stored B Data to A Bus

\* The data output functions may be enabled or disabled by various signals at the GAB and  $\overline{\text{GBA}}$  inputs. Data input functions are always enabled, i.e., data at the bus pins will be stored on every low-to-high transition on the clock inputs.

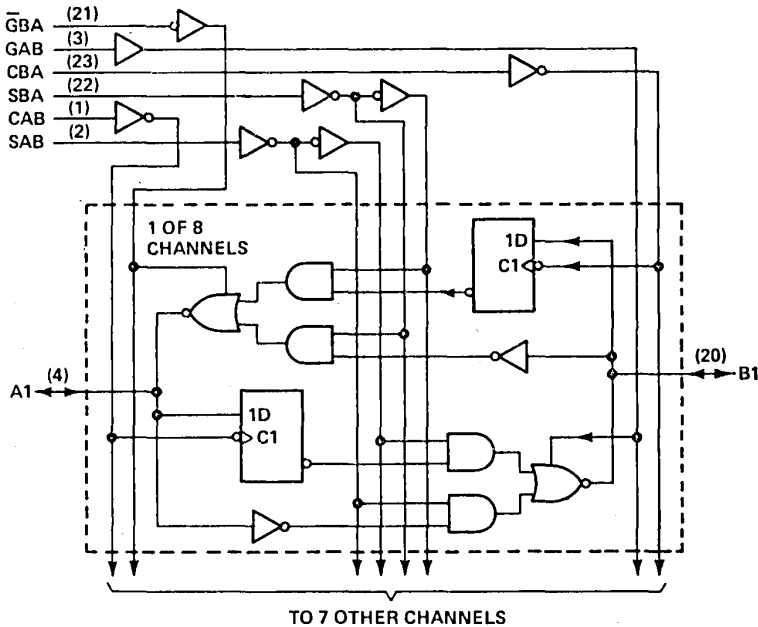
TYPES SN54LS651 THRU SN54LS654  
 SN74LS651 THRU SN74LS654  
 OCTAL BUS TRANSCEIVERS AND REGISTERS

logic diagrams (positive logic)

'LS651, 'LS653



'LS652, 'LS654



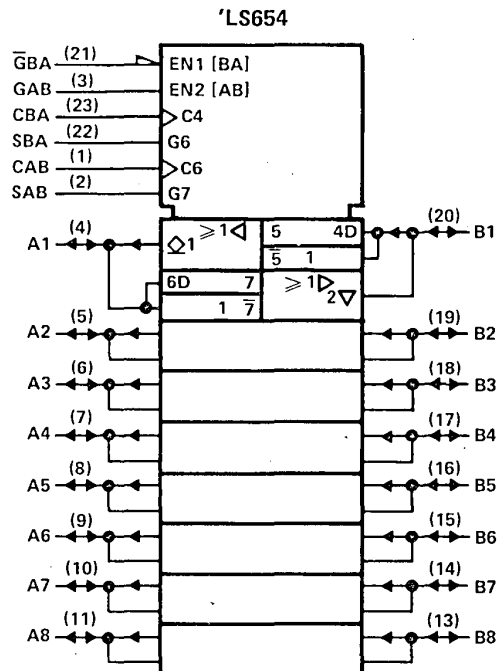
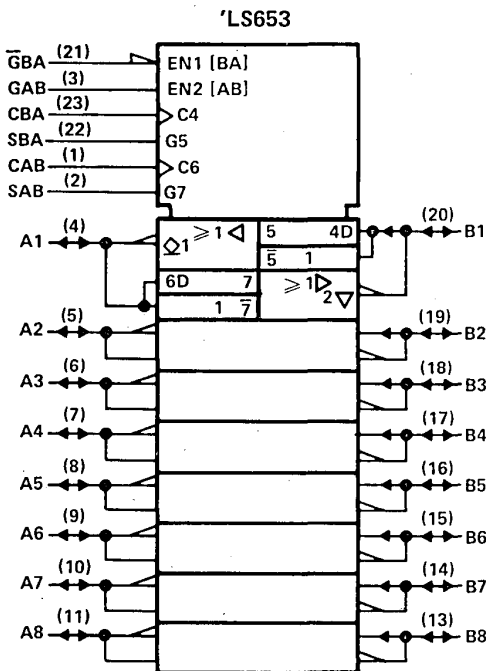
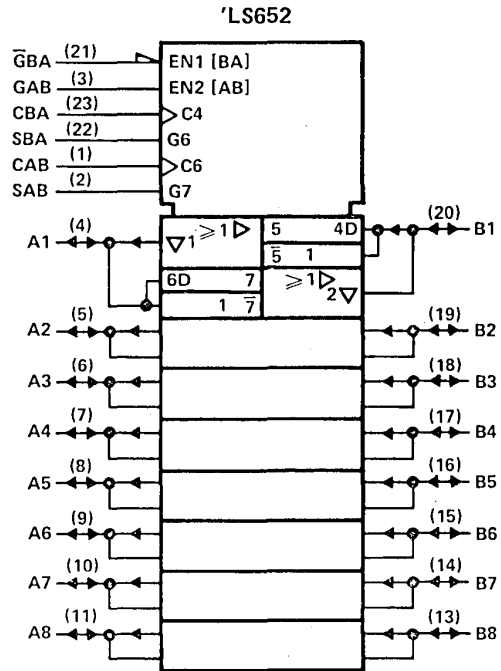
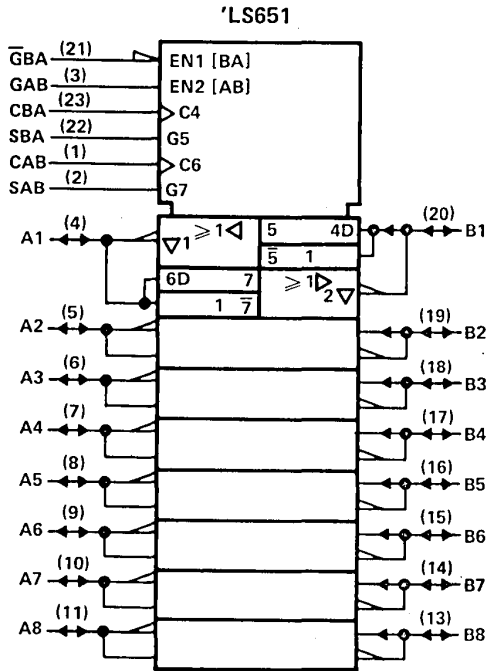
Pin numbers shown on logic notation are for DW, JT or NT packages.



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**TYPES SN54LS651 THRU SN54LS654  
SN74LS651 THRU SN74LS654  
OCTAL BUS TRANSCEIVERS AND REGISTERS**

logic symbols



Pin numbers shown on logic notation are for DW, JT or NT packages.

# TYPES SN54LS651, SN54LS652, SN74LS651, SN74LS652 OCTAL BUS TRANSCEIVERS AND REGISTERS

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

Supply voltage, $V_{CC}$ .....	7 V
Input voltage: Control inputs .....	7 V
I/O ports .....	5.5 V
Operating free-air temperature range: SN54LS651, SN54LS652 .....	-55°C to 125°C
SN74LS651, SN74LS652 .....	0°C to 70°C
Storage temperature range .....	-65°C to 150°C

## recommended operating conditions

		SN54LS651 SN54LS652			SN74LS651 SN74LS652			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.75	5	5.25	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
$t_w$	Pulse duration	CBA or CAB high		15	15		ns	
		CBA or CAB low		30	30			
		Data high or low		30	30			
$t_{su}$	Setup time before CAB ↑ or CBA ↑	A or B		15	15		ns	
$t_h$	Hold time after CAB ↑ or CBA ↑	A or B		0	0		ns	
$T_A$	Operating free-air temperature	-55		125	0		70	°C

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

PARAMETER		TEST CONDITIONS†		SN54LS651 SN54LS652		SN74LS651 SN74LS652		UNIT		
				MIN	TYP‡	MAX	MIN		TYP‡	MAX
$V_{IK}$		$V_{CC} = \text{MIN}$ ,	$I_I = -18 \text{ mA}$			-1.5	-1.5	V		
$V_{OH}$		$V_{CC} = \text{MIN}$ , $V_{IL} = \text{MAX}$ ,	$V_{IH} = 2 \text{ V}$ ,	$I_{OH} = -3 \text{ mA}$	2.4	3.4	2.4	3.4	V	
				$I_{OH} = -12 \text{ mA}$	2					
				$I_{OH} = -15 \text{ mA}$				2		
$V_{OL}$		$V_{CC} = \text{MIN}$ , $V_{IL} = \text{MAX}$ ,	$V_{IH} = 2 \text{ V}$ ,	$I_{OL} = 12 \text{ mA}$		0.25	0.4	0.25	0.4	V
				$I_{OL} = 24 \text{ mA}$				0.35	0.5	
$I_I$	Control inputs	$V_{CC} = \text{MAX}$ , $V_I = 7 \text{ V}$				0.1	0.1	mA		
	A or B ports	$V_{CC} = \text{MAX}$ , $V_I = 5.5 \text{ V}$				0.1	0.1			
$I_{IH}$	Control inputs	$V_{CC} = \text{MAX}$ , $V_I = 2.7 \text{ V}$				20	20	µA		
	A or B ports ▲	$V_{CC} = \text{MAX}$ , $V_I = 2.7 \text{ V}$				20	20			
$I_{IL}$	Control inputs	$V_{CC} = \text{MAX}$ , $V_I = 0.4 \text{ V}$				-0.4	-0.4	mA		
	A or B ports ▲	$V_{CC} = \text{MAX}$ , $V_I = 0.4 \text{ V}$				-0.4	-0.4			
$I_{OS}$ ¶		$V_{CC} = \text{MAX}$ , $V_O = 0 \text{ V}$		-40		-225	-40	-225	mA	
$I_{CC}$	LS651	$V_{CC} = \text{MAX}$		Outputs high	95	145	95	145	mA	
				Outputs low	103	165	103	165		
				Outputs disabled	103	165	103	165		
	LS652			Outputs high	95	145	95	145		
				Outputs low	103	165	103	165		
				Outputs disabled	120	180	120	180		

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

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

¶ Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.

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

  
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TTL DEVICES

# TYPES SN54LS651, SN54LS652, SN74LS651, SN74LS652 OCTAL BUS TRANSCEIVERS AND REGISTERS

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS651			'LS652			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
$t_{PLH}$	Clock	Bus	$R_L = 667\ \Omega$ , $C_L = 45\ \text{pF}$ , See Note 2		14	24		15	25	ns
$t_{PHL}$					23	35		24	36	ns
$t_{PLH}$	Bus	Bus			9	18		12	18	ns
$t_{PHL}$					20	30		13	20	ns
$t_{PLH}$	Select, with bus input high†	Bus			31	47		23	35	ns
$t_{PHL}$					22	33		21	32	ns
$t_{PLH}$	Select, with bus input low†	Bus			23	35		33	50	ns
$t_{PHL}$					19	30		15	23	ns
$t_{PZH}$	$\bar{G}BA$	A Bus			29	44		30	45	ns
$t_{PZL}$	GAB	B Bus			40	60		36	54	ns
$t_{PZH}$					19	29		20	30	ns
$t_{PZL}$	GAB	B Bus			26	40		25	38	ns
$t_{PHZ}$				25	38		25	38	ns	
$t_{PLZ}$	$\bar{G}BA$	A Bus	$R_L = 667\ \Omega$ , $C_L = 5\ \text{pF}$ , See Note 2		19	30		19	30	ns
$t_{PHZ}$	GAB	B Bus			25	38		25	38	ns
$t_{PLZ}$					19	30		19	30	ns

$t_{PLH}$  = propagation delay time, low-to-high-level output.

$t_{PHL}$  = propagation delay time, high-to-low-level output

$t_{PZH}$  = output enable time to high level

$t_{PZL}$  = output enable time to low level

$t_{PHZ}$  = output disable time from high level

$t_{PLZ}$  = output disable time from low level

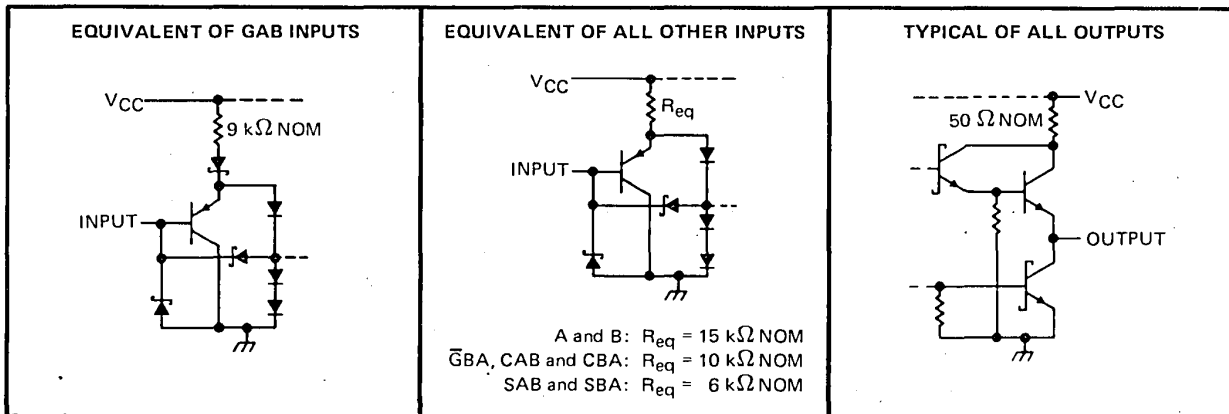
† These parameters are measured with the internal output state of the storage register opposite to that of the bus input.

NOTE 2: See General Information Section for load circuits and voltage waveforms.

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TTL DEVICES

## schematics of inputs and outputs



## TYPES SN54LS653, SN54LS654, SN74LS653, SN74LS654 OCTAL BUS TRANSCEIVERS AND REGISTERS

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

Supply voltage, $V_{CC}$ .....	7 V
Input voltage: All inputs and A I/O ports .....	7 V
B I/O ports .....	5.5 V
Operating free-air temperature range: SN54LS653, SN54LS654 .....	$-55^{\circ}\text{C}$ to $125^{\circ}\text{C}$
SN74LS653, SN74LS654 .....	$0^{\circ}\text{C}$ to $70^{\circ}\text{C}$
Storage temperature range .....	$-65^{\circ}\text{C}$ to $150^{\circ}\text{C}$

### recommended operating conditions

		SN54LS653 SN54LS654			SN74LS653 SN74LS654			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.75	5	5.25	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		A ports	5.5			5.5	V
$I_{OH}$	High-level output current		B ports	-12			-15	mA
$I_{OL}$	Low-level output current			12			24	mA
$t_w$	Pulse duration		CBA or CAB high	15			15	ns
			CBA or CAB low	30			30	
			Data high or low	30			30	
$t_{su}$	Setup time before CAB $\uparrow$ or CBA $\uparrow$		A or B	15			15	ns
$t_h$	Hold time after CAB $\uparrow$ or CBA $\uparrow$		A or B	0			0	ns
$T_A$	Operating free-air temperature	-55		125	0		70	$^{\circ}\text{C}$

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

PARAMETER		TEST CONDITIONS $\dagger$	SN54LS653 SN54LS654		SN74LS653 SN74LS654		UNIT	
			MIN	TYP $\ddagger$	MAX	MIN		TYP $\ddagger$
$V_{IK}$		$V_{CC} = \text{MIN}$ , $I_I = -18 \text{ mA}$		-1.5		-1.5	V	
$V_{OH}$	B ports	$V_{CC} = \text{MIN}$ , $V_{IH} = 2 \text{ V}$ , $V_{IL} = \text{MAX}$	$I_{OH} = -3 \text{ mA}$	2.4	3.4	2.4	3.4	V
			$I_{OH} = -12 \text{ mA}$	2				
			$I_{OH} = -15 \text{ mA}$			2		
$I_{OH}$	A ports	$V_{CC} = \text{MIN}$ , $V_{OH} = 5.5 \text{ V}$		0.1		0.1	mA	
$V_{OL}$		$V_{CC} = \text{MIN}$ , $V_{IH} = 2 \text{ V}$ , $V_{IL} = \text{MAX}$	$I_{OL} = 12 \text{ mA}$	0.25	0.4	0.25	0.4	V
			$I_{OL} = 24 \text{ mA}$			0.35	0.5	
$I_I$	Control inputs	$V_{CC} = \text{MAX}$ , $V_I = 7 \text{ V}$		0.1		0.1	mA	
	A or B ports	$V_{CC} = \text{MAX}$ , $V_I = 5.5 \text{ V}$		0.1		0.1		
$I_{IH}$	Control inputs	$V_{CC} = \text{MAX}$ , $V_I = 2.7 \text{ V}$		20		20	$\mu\text{A}$	
	A or B ports $\blacktriangle$			20		20		
$I_{IL}$	Control inputs	$V_{CC} = \text{MAX}$ , $V_I = 0.4 \text{ V}$		-0.4		-0.4	mA	
	A or B ports $\blacktriangle$			-0.4		-0.4		
$I_{OS}$ $\S$	B ports	$V_{CC} = \text{MAX}$ , $V_O = 0 \text{ V}$	-40	-225	-40	-225	mA	
$I_{CC}$	LS653	$V_{CC} = \text{MAX}$	Outputs high	95	145	95	145	mA
			Outputs low	103	165	103	165	
			Outputs disabled	103	165	103	165	
	LS654		Outputs high	95	145	95	145	
			Outputs low	105	170	105	170	
			Outputs disabled	120	180	120	180	

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

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

$\S$  Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.

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

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# TYPES SN54LS653, SN54LS654, SN74LS653, SN74LS654 OCTAL BUS TRANSCEIVERS AND REGISTERS

switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$

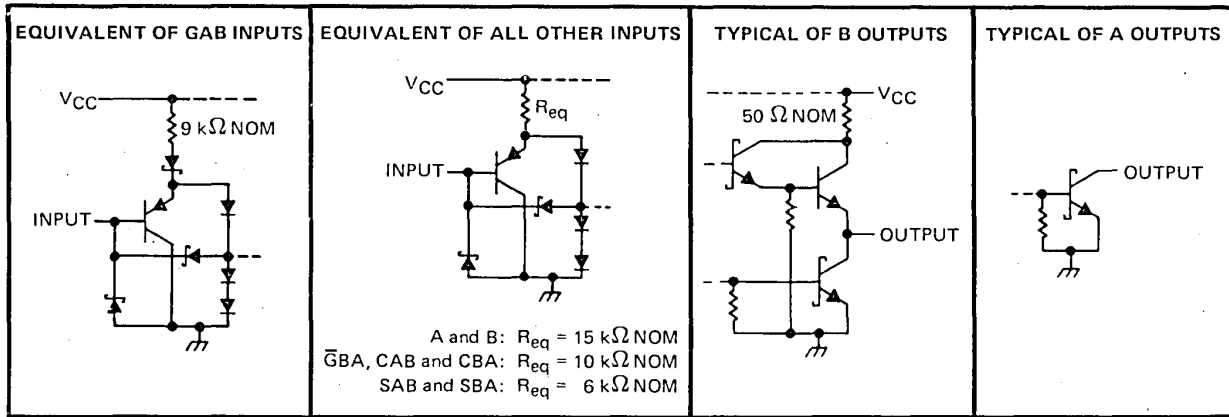
PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS653			'LS654			UNIT	
				MIN	TYP	MAX	MIN	TYP	MAX		
$t_{PLH}$	CBA	A Bus	$R_L = 667\ \Omega$ , See Note 2  $C_L = 45\ \text{pF}$		25	38		22	33	ns	
$t_{PHL}$					26	39		24	36		
$t_{PLH}$	CAB	B Bus			15	23		14	21	ns	
$t_{PHL}$					24	36		22	33		
$t_{PLH}$	A Bus	B Bus			10	18		10	18	ns	
$t_{PHL}$					20	30		20	30		
$t_{PLH}$	B Bus	A Bus			21	32		18	27	ns	
$t_{PHL}$					16	24		14	21		
$t_{PLH}$	SBA <sup>†</sup>	A Bus			38	57		32	48	ns	
$t_{PHL}$	(with B high)				26	39		21	32		
$t_{PLH}$	SBA <sup>†</sup>	A Bus			34	51		36	54	ns	
$t_{PHL}$	(with B low)				23	35		19	29		
$t_{PLH}$	SAB <sup>†</sup>	B Bus			32	48		23	35	ns	
$t_{PHL}$	(with A high)				22	33		18	27		
$t_{PLH}$	SAB <sup>†</sup>	B Bus			24	36		30	45	ns	
$t_{PHL}$	(with A low)				20	30		14	21		
$t_{PLH}$	$\overline{\text{G}}\text{BA}$	A Bus			23	35		23	35	ns	
$t_{PHL}$					37	55		35	53		
$t_{PZH}$	GAB	B Bus		$R_L = 667\ \Omega$ , See Note 2  $C_L = 5\ \text{pF}$		19	29		19	29	ns
$t_{PZL}$						25	38		22	33	
$t_{PHZ}$	GAB	B Bus			26	39		26	39	ns	
$t_{PLZ}$					19	29		19	29		

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

NOTE 2: See General Information Section for load circuits and voltage waveforms.

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## schematics of inputs and outputs



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