

SN54LS646 THRU SN54LS649
SN74LS646 THRU SN74LS649
OCTAL BUS TRANSCEIVERS AND REGISTERS
 D2661, DECEMBER 1982 — REVISED MARCH 1988

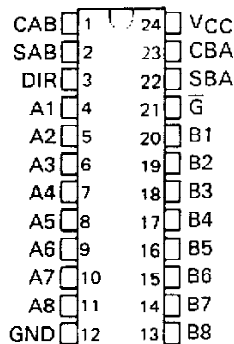
- Independent Registers for A and B Buses
- Multiplexed Real-Time and Stored Data
- Choice of True or Inverting Data Paths
- Choice of 3-State or Open-Collector Outputs
- Included Among the Package Options Are Compact 24-pin 300-mil-Wide Plastic and Ceramic DIPs, Ceramic Chip Carriers, and Plastic "Small Outline" Packages
- Dependable Texas Instruments Quality and Reliability

DEVICE	OUTPUT	LOGIC
'LS646	3-State	True
'LS647	Open-Collector	True
'LS648	3-State	Inverting
'LS649	Open-Collector	Inverting

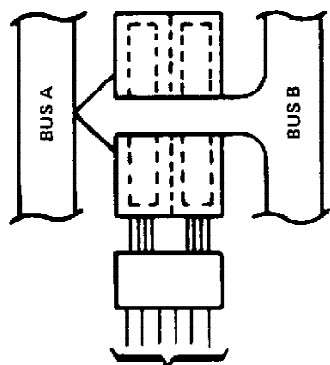
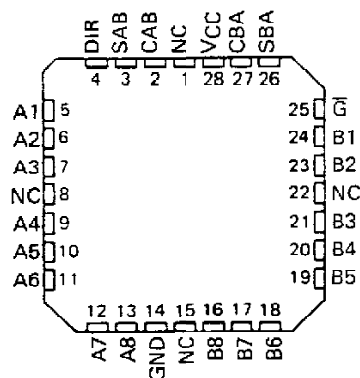
description

These devices consist of bus transceiver circuits with 3-state or open-collector outputs, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal registers. Data on the A or B bus will be clocked into the registers on the low-to-high transition of the appropriate clock pin (CAB or CBA). The following examples demonstrate the four fundamental bus-management functions that can be performed with the octal bus transceivers and registers.

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

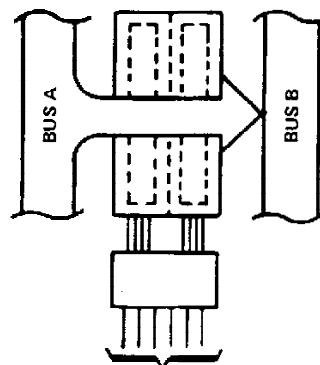


SN54LS' . . . FK PACKAGE
 (TOP VIEW)



(21) (3) (1) (23) (2) (22)
 \bar{G} DIR CAB CBA SAB SBA
 L L X H or L X L

REAL-TIME TRANSFER
 BUS B TO BUS A



(21) (3) (1) (23) (2) (22)
 \bar{G} DIR CAB CBA SAB SBA
 L H H or L X L X

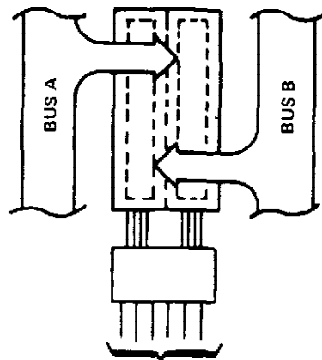
REAL-TIME TRANSFER
 BUS A TO BUS B

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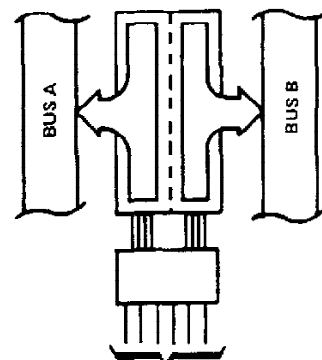
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SN54LS646 THRU SN54LS649, SN74LS646 THRU SN74LS649 OCTAL BUS TRANSCEIVERS AND REGISTERS



(21)	(3)	(1)	(23)	(2)	(22)
\bar{G}	DIR	CAB	CBA	SAB	SBA
X	X	↑	X	X	X
X	X	X	↑	X	X
H	X	↑	↑	X	X

STORAGE FROM
A, B, OR A AND B



(21)	(3)	(1)	(23)	(2)	(22)
\bar{G}	DIR	CAB	CBA	SAB	SBA
L	L	X	X	X	H
L	H	X	X	H	X

TRANSFER
STORED DATA
TO A OR B

Enable (\bar{G}) and direction (DIR) pins are provided to control the transceiver functions. In the transceiver mode, data present at the high-impedance port may be stored in either register or in both. The select controls (SAB and SBA) can multiplex stored and real-time (transparent mode) data. The direction control determines which bus will receive data when enable \bar{G} is active (low). In the isolation mode (control \bar{G} high), A data may be stored in one register and/or B data may be stored in the other register.

When an output function is disabled, the input function is still enabled and may be used to store and transmit data. Only one of the two buses, A or B, may be driven at a time.

The SN54' family is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74' family is characterized for operation from 0° to 70°C .

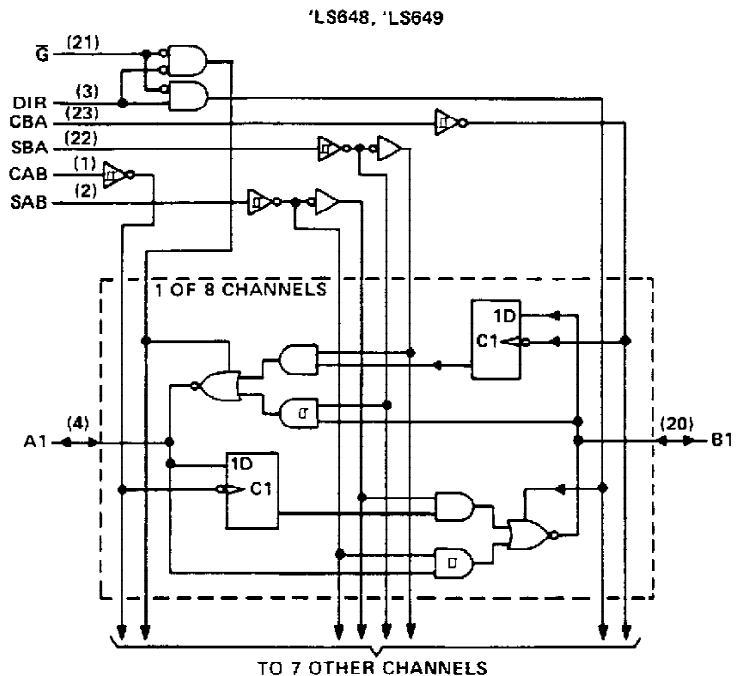
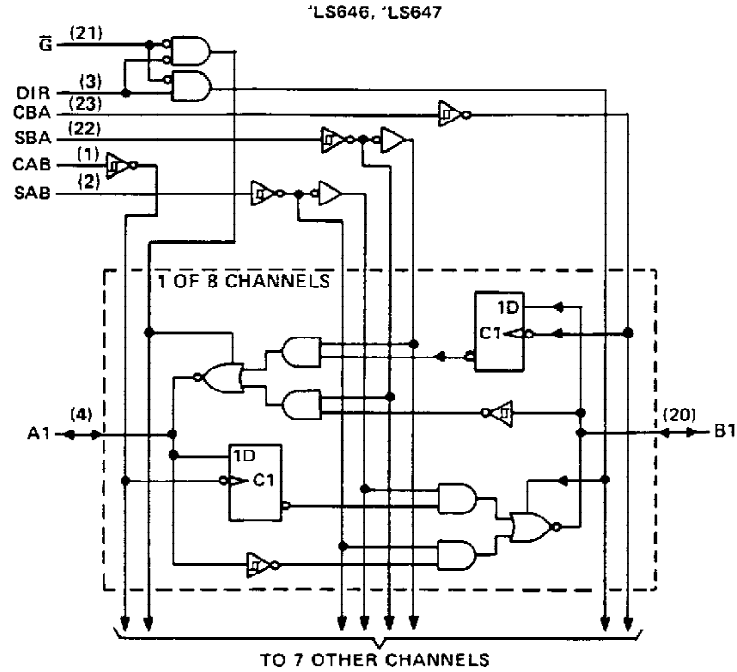
FUNCTION TABLE

INPUTS						DATA I/O†		OPERATION OR FUNCTION	
\bar{G}	DIR	CAB	CBA	SAB	SBA	A1 THRU A8	B1 THRU B8	LS646, LS647	LS648, LS649
X	X	↑	X	X	X	Input	Not specified	Store A, B unspecified	Store A, B unspecified
X	X	X	↑	X	X	Not specified	Input	Store B, A unspecified	Store B, A unspecified
H	X	↑	↑	X	X	Input	Input	Store A and B Data	Store A and B Data
H	X	H or L	H or L	X	X	Input	Input	Isolation, hold storage	Isolation, hold storage
L	L	X	H or L	X	L	Output	Input	Real-Time B Data to A Bus	Real-Time \bar{B} Data to A Bus
L	L	X	X	X	H	Output	Input	Stored B Data to A Bus	Stored \bar{B} Data to A Bus
L	H	H or L	X	L	X	Input	Output	Real-Time A Data to B Bus	Real-Time \bar{A} Data to B Bus
L	H	X	X	H	X	Input	Output	Stored A Data to B Bus	Stored \bar{A} Data to B Bus

† The data output functions may be enabled or disabled by various signals at the \bar{G} and DIR 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.

SN54LS646 THRU SN54LS649, SN74LS646 THRU SN74LS649 OCTAL BUS TRANSCEIVERS AND REGISTERS

logic diagrams (positive logic)



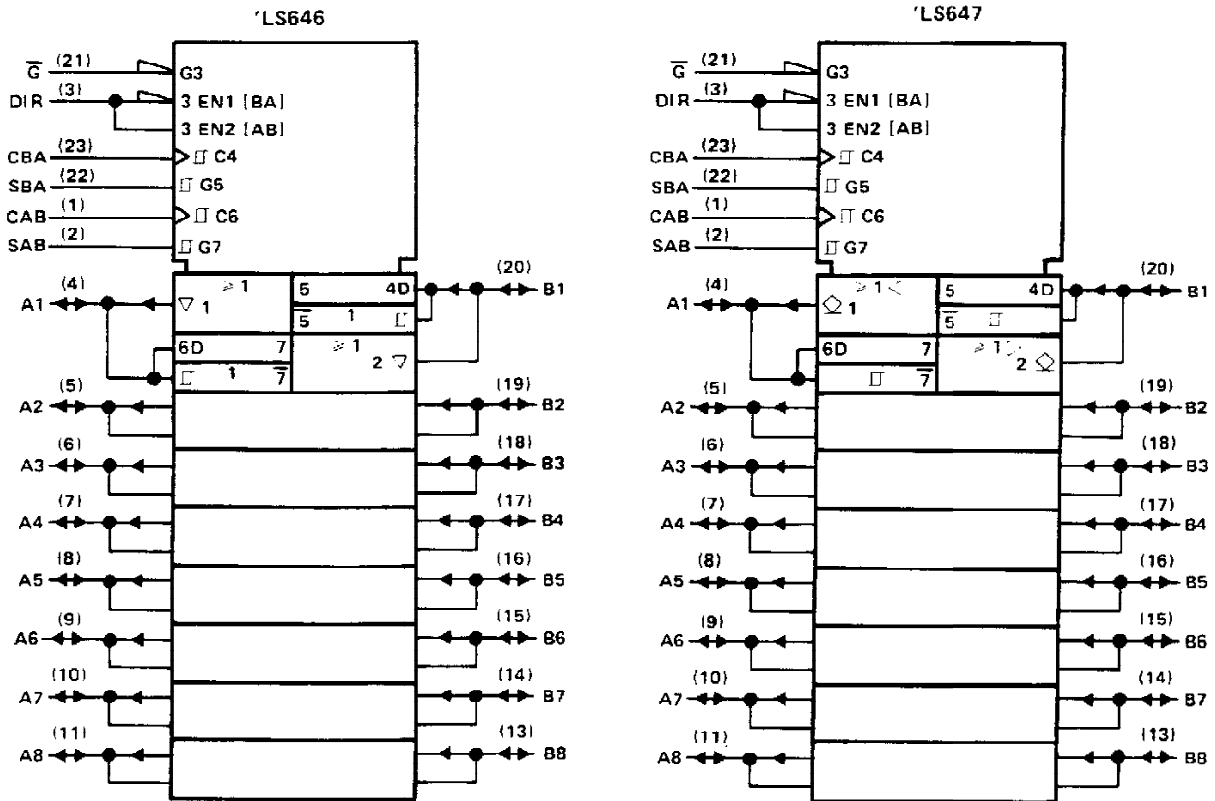
Pin numbers shown are for DW, JT, and NT packages.

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SN54LS646, SN54LS647, SN74LS646, SN74LS647 OCTAL BUS TRANSCEIVERS AND REGISTERS

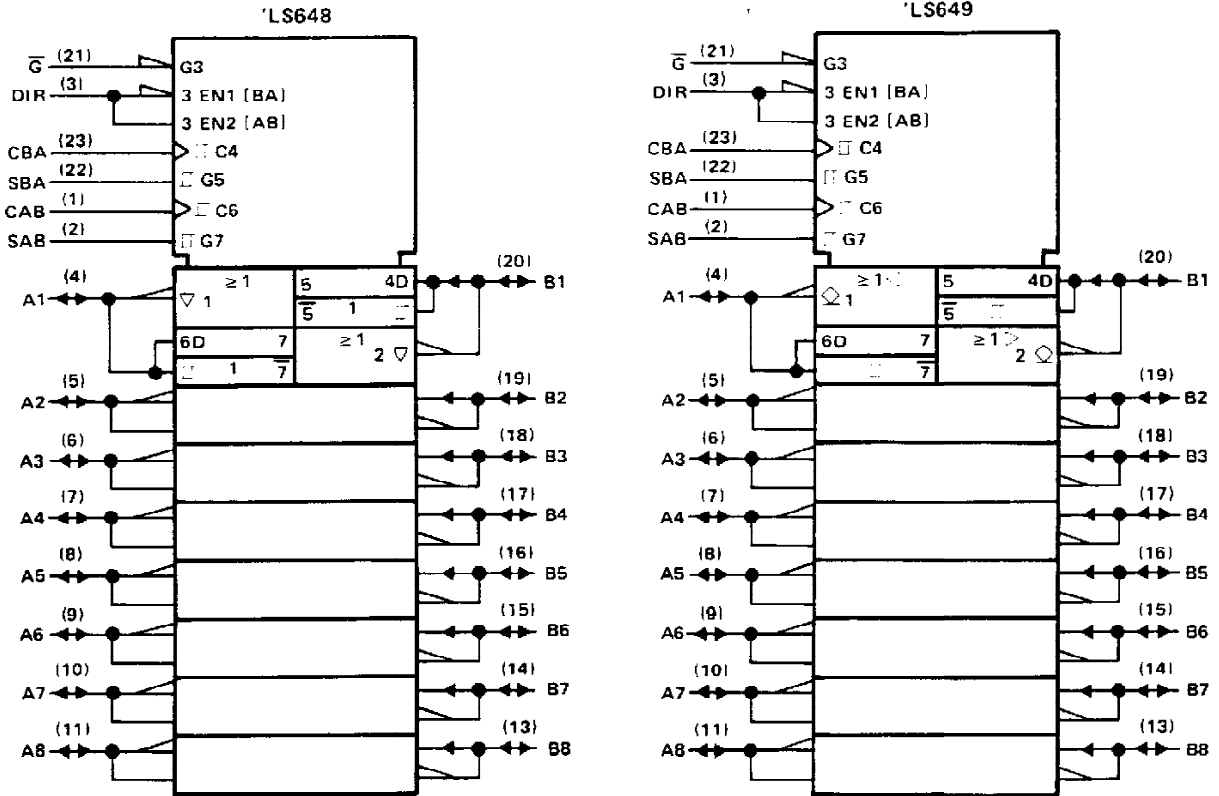
logic symbols†



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

**SN54LS648, SN54LS649, SN74LS648, SN74LS649
OCTAL BUS TRANSCEIVERS AND REGISTERS**

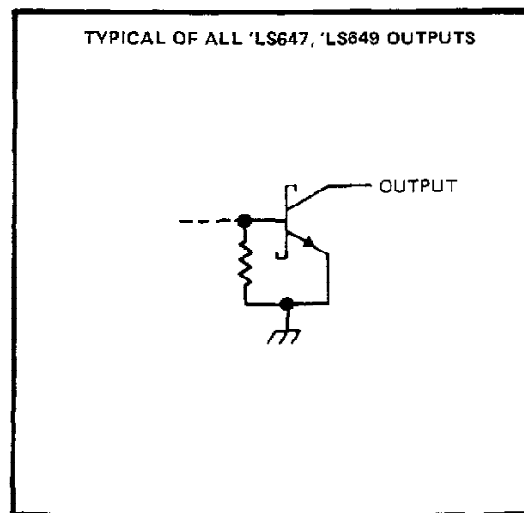
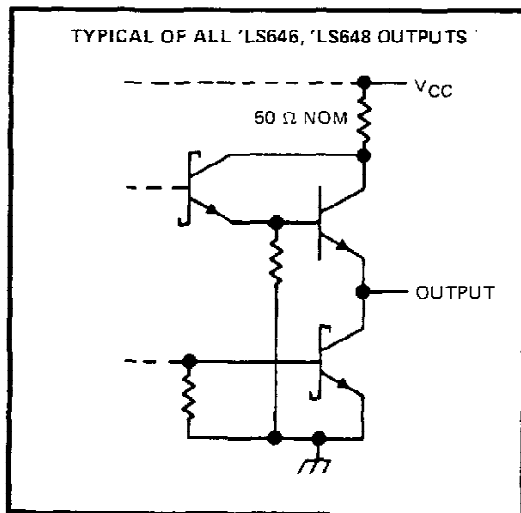
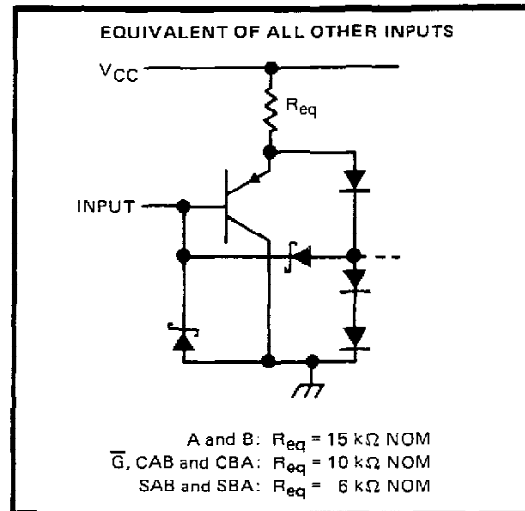
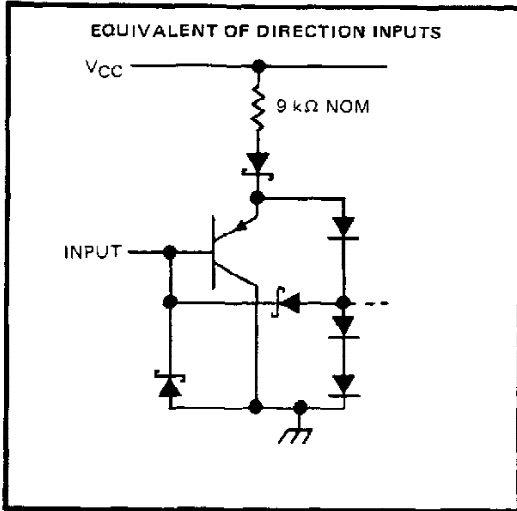
logic symbols[†] (continued)



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

**SN54LS646 THRU SN54LS649,
SN74LS646 THRU SN74LS649
OCTAL BUS TRANSCEIVERS AND REGISTERS**

schematics of inputs and outputs



SN54LS646, SN54LS648, SN74LS646, SN74LS648 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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: SN54LS646, SN54LS648	- 55°C to 125°C
SN74LS646, SN74LS648	0°C to 70°C
Storage temperature range	- 65°C to 150°C

recommended operating conditions

		SN54LS646/648			SN74LS646/648			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			0.5			0.6	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†	SN54LS646/648		SN74LS646/648		UNIT		
			MIN	TYP‡	MAX	MIN		TYP‡	MAX
V_{IK}		$V_{CC} = \text{MIN}, I_I = - 18 \text{ mA}$			- 1.5		- 1.5	V	
Hysteresis ($V_{T+} - V_{T-}$)	A or B input	$V_{CC} = \text{MIN}$	0.1	0.4	0.2	0.4		V	
V_{OH}		$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = \text{MAX}$	$I_{OH} = - 3 \text{ mA}$		2.4	3.4	2.4	3.4	V
			$I_{OH} = - 12 \text{ mA}$		2				
			$I_{OH} = - 15 \text{ mA}$				2		
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			mA	
	A or B ports	$V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$			0.1				
I_{IH}	Control inputs	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$			20			µA	
	A or B ports‡				20				
I_{IL}	Control inputs	$V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$			- 0.4			mA	
	A or B ports‡				- 0.4				
$I_{OS}§$		$V_{CC} = \text{MAX}, V_O = 0 \text{ V}$	- 40	- 225	- 40	- 225		mA	
I_{CC}	LS646	$V_{CC} = \text{MAX}$	Outputs high		91	145	91	145	mA
			Outputs low		103	165	103	165	
			Outputs disabled		103	165	103	165	
	Outputs high		91	145	91	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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OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS646			'LS648			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
t_{PLH}	CAB or CBA	A or B	$R_L = 667\ \Omega$, $C_L = 45\ \text{pF}$, See Note 2	15	25		15	25	ns	
t_{PHL}				23	35		24	40	ns	
t_{PLH}	A or B	B or A		12	18		12	18	ns	
t_{PHL}				13	20		15	25	ns	
t_{PLH}	SAB or SBA [†] with Bus input high	A or B		26	40		37	55	ns	
t_{PHL}				21	35		24	40	ns	
t_{PLH}	SAB or SBA [†] with Bus input low	A or B		33	50		26	40	ns	
t_{PHL}				14	25		23	40	ns	
t_{PZH}	\overline{G}	A or B		33	55		30	50	ns	
t_{PZL}				42	65		37	55	ns	
t_{PZH}	DIR	A or B	28	45		23	40	ns		
t_{PZL}			39	60		30	45	ns		
t_{PHZ}	\overline{G}	A or B	$R_L = 667\ \Omega$, $C_L = 5\ \text{pF}$, See Note 2	23	35		28	45	ns	
t_{PLZ}				22	35		22	35	ns	
t_{PHZ}	DIR	20		30		24	35	ns		
t_{PLZ}		19		30		19	30	ns		

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

NOTE 2: Load circuits and voltage waveforms are shown in Section 1.

SN54LS647, SN54LS649, SN74LS647, SN74LS649 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH OPEN-COLLECTOR OUTPUTS

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

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage (control inputs)	7 V
Off-state output voltage (A and B ports)	5.5 V
Operating free-air temperature range: SN54LS647, SN54LS649	-55°C to 125°C
SN74LS647, SN74LS649	-0°C to 70°C
Storage temperature range	-65°C to 150°C

recommended operating conditions

		SN54LS647 SN54LS649			SN74LS647 SN74LS649			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			0.5			0.6	V
V_{OH}	High-level output voltage			5.5			5.5	V
I_{OL}	Low-level output voltage			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†	SN54LS647 SN54LS649		SN74LS647 SN74LS649		UNIT	
			MIN	TYP‡	MAX	MIN		TYP‡
V_{IK}		$V_{CC} = \text{MIN.}, I_I = -18 \text{ mA}$	-1.5		-1.5		V	
Hysteresis ($V_{T+} - V_{T-}$)	A or B input	$V_{CC} = \text{MIN.}$	0.1	0.4	0.2	0.4	V	
I_{OH}		$V_{CC} = \text{MIN.}, V_{IH} = 2 \text{ V.}, V_{IL} = \text{MAX.}, V_{OH} = 5.5 \text{ V}$	0.1		0.1		mA	
V_{OL}		$V_{CC} = \text{MIN.}, V_{IH} = 2 \text{ V.}, V_{IL} = \text{MAX.}$	0.25 0.4		0.25 0.4		V	
I_I	A or B	$V_{CC} = \text{MAX.}, V_I = 5.5 \text{ V}$	0.1		0.1		mA	
	All others	$V_{CC} = \text{MAX.}, V_I = 7 \text{ V}$	0.1		0.1			
I_{IH}		$V_{CC} = \text{MAX.}, V_I = 2.7 \text{ V}$	20		20		µA	
I_{IL}		$V_{CC} = \text{MAX.}, V_I = 0.4 \text{ V}$	-0.4		-0.4		mA	
I_{CC}	'LS647	$V_{CC} = \text{MAX.}, \text{Outputs open}$	Outputs high	79	130	79	130	mA
			Outputs low	94	150	94	150	
	'LS649	$V_{CC} = \text{MAX.}, \text{Outputs open}$	Outputs high	79	130	79	130	
			Outputs low	94	150	94	150	

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

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


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SN54LS647, SN54LS649, SN74LS647, SN74LS649
OCTAL BUS TRANSCEIVERS AND REGISTERS WITH OPEN-COLLECTOR OUTPUTS

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS647			'LS649			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
t_{PLH}	CAB or CBA	A or B	$R_L = 667\ \Omega$, $C_L = 45\ \text{pF}$, See Note 2	22	35		17	30	ns	
t_{PHL}				28	45		28	45	ns	
t_{PLH}	A or B	B or A		17	26		15	25	ns	
t_{PHL}				18	27		20	30	ns	
t_{PLH}	SAB or SBA† with Bus input high	A or B		33	50		37	55	ns	
t_{PHL}				29	45		28	45	ns	
t_{PLH}	SAB or SBA† with Bus input low	A or B		39	60		30	45	ns	
t_{PHL}				19	30		26	40	ns	
t_{PLH}	G	A or B		25	40		21	40	ns	
t_{PHL}				33	50		34	50	ns	
t_{PLH}	DIR	A or B		23	35		19	30	ns	
t_{PHL}				25	40		27	45	ns	

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

NOTE 2: Load circuits and voltage waveforms are shown in Section 1.

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