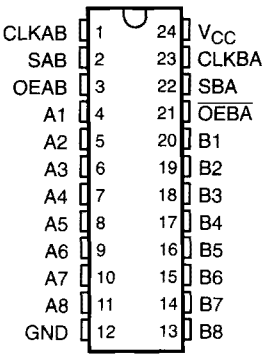
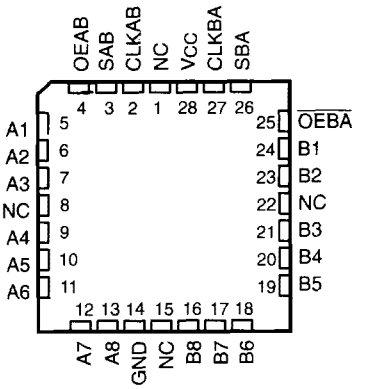
- **State-of-the-Art Advanced BiCMOS Technology (ABT) Design for 3.3-V Operation and Low-Static Power Dissipation**
- **Supports Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V_{CC})**
- **Supports Unregulated Battery Operation Down to 2.7 V**
- **Typical V_{OLP} (Output Ground Bounce) < 0.8 V at V_{CC} = 3.3 V, T_A = 25°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**
- **Package Options Include Plastic Small-Outline (SOIC), Shrink Small-Outline (SSOP), and Thin Shrink Small-Outline (TSSOP) Packages, Ceramic Chip Carriers, and Plastic and Ceramic DIPs**

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



SN54LVT652 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

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 consists 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 $\overline{\text{OEBA}}$) 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 stored and real-time 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.

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 $\overline{\text{OEBA}}$. 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.

description (continued)

The SN74LVT652 is packaged 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.

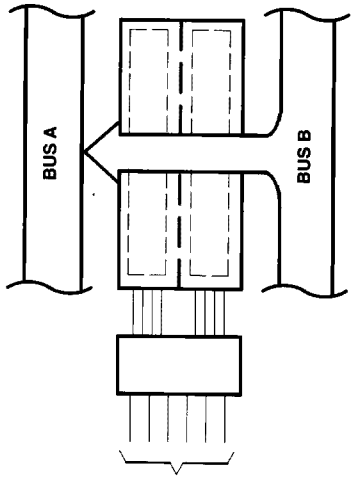
The SN54LVT652 is characterized for operation over the full military temperature range of −55°C to 125°C. The SN74LVT652 is characterized for operation from −40°C to 85°C.

FUNCTION TABLE

INPUTS						DATA I/O†		OPERATION OR FUNCTION
OEAB	$\overline{OEBA}$	CLKAB	CLKBA	SAB	SBA	A1 THRU A8	B1 THRU B8	
L	H	L	L	X	X	Input	Input	Isolation
L	H	↑	↑	X	X	Input	Input	Store A and B data
X	H	↑	L	X	X	Input	Unspecified‡	Store A, hold B
H	H	↑	↑	X‡	X	Input	Output	Store A in both registers
L	X	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	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	L	X	H	X	Input	Output	Stored A data to B bus
H	L	L	L	H	H	Output	Output	Stored A data to B bus and stored B data to A bus

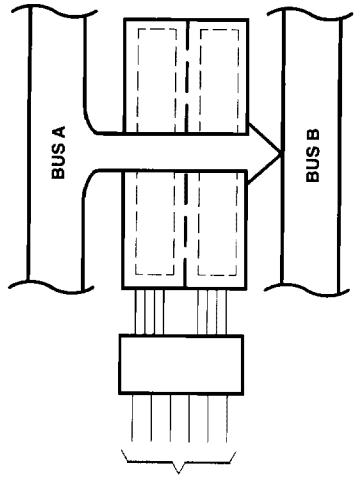
† The data output functions may be enabled or disabled by a variety of level combinations at the OEAB or $\overline{OEBA}$ inputs. Data input functions are always enabled; i.e., data at the bus pins is stored on every low-to-high transition on the clock inputs.

‡ Select control = L; clocks can occur simultaneously.
Select control = H; clocks must be staggered in order to load both registers.



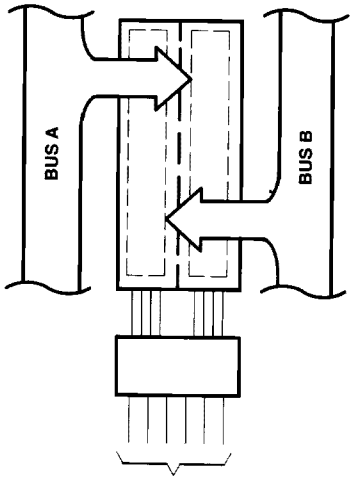
3	21	1	23	2	22
OEAB	$\overline{OEBA}$	CLKAB	CLKBA	SAB	SBA
L	L	X	X	X	L

REAL-TIME TRANSFER BUS B TO BUS A



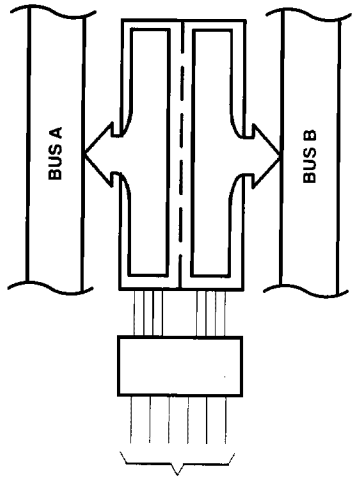
3	21	1	23	2	22
OEAB	$\overline{OEBA}$	CLKAB	CLKBA	SAB	SBA
H	H	X	X	L	X

REAL-TIME TRANSFER BUS A TO BUS B



3	21	1	23	2	22
OEAB	$\overline{OEBA}$	CLKAB	CLKBA	SAB	SBA
X	H	↑	X	X	X
L	X	X	↑	X	X
L	H	↑	↑	X	X

STORAGE FROM A, B, OR A AND B



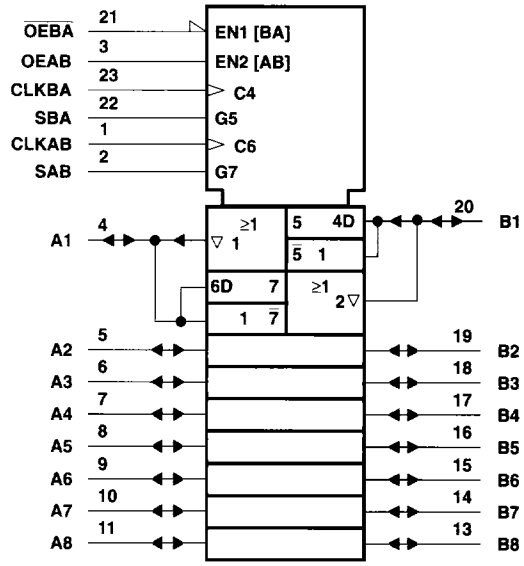
3	21	1	23	2	22
OEAB	$\overline{OEBA}$	CLKAB	CLKBA	SAB	SBA
H	L	L	L	H	H

TRANSFER STORED DATA TO A AND/OR B

Figure 1. Bus-Management Functions

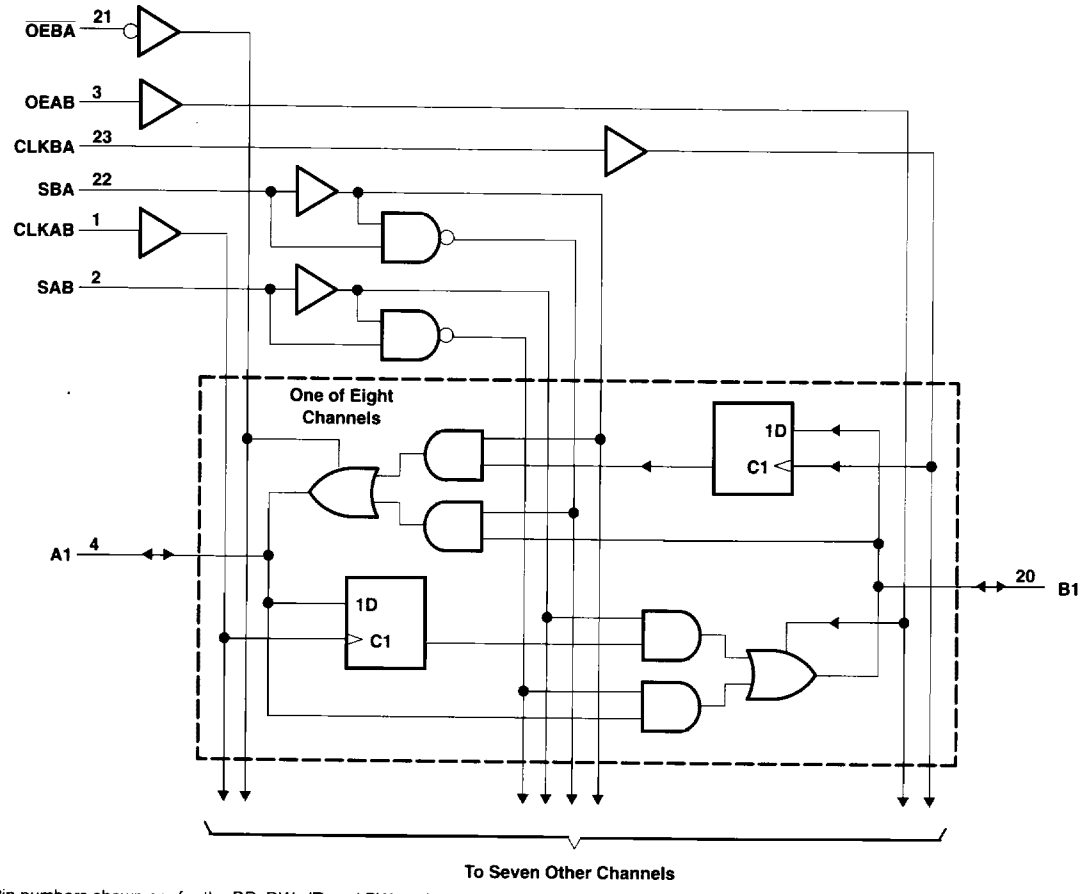
Pin numbers shown are for the DB, DW, JT, and PW packages.

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.

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

Supply voltage range, V_{CC} ..... −0.5 V to 4.6 V
Input voltage range, V_I (see Note 1) ..... −0.5 V to 7 V
Voltage range applied to any output in the high state or power-off state, V_O (see Note 1) ..... −0.5 V to 7 V
Current into any output in the low state, I_O: SN54LVT652 ..... 96 mA
SN74LVT652 ..... 128 mA
Current into any output in the high state, I_O (see Note 2): SN54LVT652 ..... 48 mA
SN74LVT652 ..... 64 mA
Input clamp current, I_{IK} ($V_I < 0$) ..... −50 mA
Output clamp current, I_{OK} ($V_O < 0$) ..... −50 mA
Maximum power dissipation at T_A = 55°C (in still air): DB package ..... 0.7 W
DW package ..... 1 W
PW package ..... 0.65 W
Storage temperature range ..... −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. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. This current will only flow when the output is in the high state and $V_O > V_{CC}$.

recommended operating conditions

			SN54LVT652		SN74LVT652		UNIT
			MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		2.7	3.6	2.7	3.6	V
V_{IH}	High-level input voltage		2		2		V
V_{IL}	Low-level input voltage			0.8		0.8	V
V_I	Input voltage			5.5		5.5	V
I_{OH}	High-level output current			−24		−32	mA
I_{OL}	Low-level output current			24		32	mA
I_{OL}‡	Low-level output current			48		64	mA
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled		10		10	ns/V
T_A	Operating free-air temperature		−55	125	−40	85	°C

‡ Current duty cycle ≤ 50%, f ≥ 1 kHz

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 V,	I_I = −18 mA				−1.2			−1.2	V
V_{OH}	V_{CC} = MIN to MAX‡,	I_{OH} = −100 µA		V_{CC}−0.2			V_{CC}−0.2			V
	V_{CC} = 2.7 V,	I_{OH} = − 8 mA		2.4			2.4			
	V_{CC} = 3 V,	I_{OH} = − 24 mA		2						
	V_{CC} = 3 V,	I_{OH} = −32 mA					2			
V_{OL}	V_{CC} = 2.7 V,	I_{OL} = 100 µA				0.2			0.2	V
	V_{CC} = 2.7 V,	I_{OL} = 24 mA				0.5			0.5	
	V_{CC} = 3 V,	I_{OL} = 16 mA				0.4			0.4	
	V_{CC} = 3 V,	I_{OL} = 32 mA				0.5			0.5	
	V_{CC} = 3 V,	I_{OL} = 48 mA				0.55				
	V_{CC} = 3 V,	I_{OL} = 64 mA							0.55	
I_I	V_{CC} = 3.6 V,	V_I = V_{CC} or GND	Control pins			±1			±1	µA
	V_{CC} = 0 or MAX‡,	V_I = 5.5 V				10			10	
	V_{CC} = 3.6 V,	V_I = 5.5 V	A or B ports§			20			20	
	V_{CC} = 3.6 V,	V_I = V_{CC}				1			1	
	V_{CC} = 3.6 V,	V_I = 0				−5			−5	
I_{off}	V_{CC} = 0,	V_I or V_O = 0 to 4.5 V							±100	µA
$I_{I(hold)}$	V_{CC} = 3 V	V_I = 0.8 V	A or B ports	75			75			µA
		V_I = 2 V		−75			−75			
I_{OZH}	V_{CC} = 3.6 V,	V_O = 3 V				1			1	µA
I_{OZL}	V_{CC} = 3.6 V,	V_O = 0.5 V				−1			−1	µA
I_{CC}	V_{CC} = 3.6 V, V_I = V_{CC} or GND	I_O = 0,	Outputs high		0.13	0.19		0.13	0.19	mA
			Outputs low		8.8	12		8.8	12	
			Outputs disabled		0.13	0.19		0.13	0.19	
ΔI_{CC}¶	V_{CC} = 3 V to 3.6 V, Other inputs at V_{CC} or GND	One input at V_{CC} − 0.6 V,				0.2			0.2	mA
C_i	V_I = 3 V or 0				4.5			4.5		pF
C_{io}	V_O = 3 V or 0				11			11		pF

† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
‡ For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
§ Unused pins 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.

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

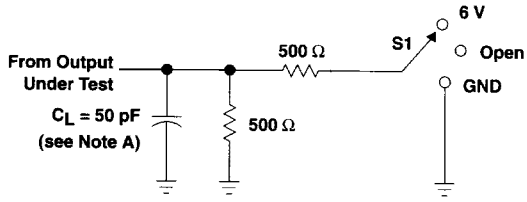
			SN54LVT652				SN74LVT652				UNIT
			V_{CC} = 3.3 V ± 0.3 V		V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V		V_{CC} = 2.7 V		
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency		0	150	0	150	0	150	0	150	MHz
t_w	Pulse duration, CLK high or low						3.3		3.3		ns
t_{su}	Setup time, A or B before CLKAB↑ or CLKBA↑	Data high					1.2		1.2		ns
		Data low					2		2.5		
t_h	Hold time, A or B after CLKAB↑ or CLKBA↑						0.5		0.5		ns

switching characteristics over recommended operating free-air temperature range, C_L = 50 pF (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVT652				SN74LVT652					UNIT
			V_{CC} = 3.3 V ± 0.3 V		V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V			V_{CC} = 2.7 V		
			MIN	MAX	MIN	MAX	MIN	TYP†	MAX	MIN	MAX	
f_{max}							150			150		MHz
t_{PLH}	CLKBA or CLKAB	A or B					1.8	3.7	6		6.9	ns
t_{PHL}							2	3.7	5.7		6.4	
t_{PLH}	A or B	B or A					1.2	2.8	4.7		5.5	ns
t_{PHL}							1	2.6	4.6		5.3	
t_{PLH}	SBA or SAB‡	A or B					1.4	3.7	6.4		7.6	ns
t_{PHL}							1.4	4	6.2		6.8	
t_{PZH}	$\overline{OEBA}$	A					1	2.9	5.8		7.2	ns
t_{PZL}							1	3	6		7.3	
t_{PHZ}	$\overline{OEBA}$	A					2.2	3.9	6.5		6.9	ns
t_{PLZ}							1.8	3.2	5.8		5.9	
t_{PZH}	OEAB	B					1	3.3	6.5		7.5	ns
t_{PZL}							1.2	3.4	6.3		7.1	
t_{PHZ}	OEAB	B					1.7	4.5	7.2		8.1	ns
t_{PLZ}							1.5	3.8	5.8		6.3	

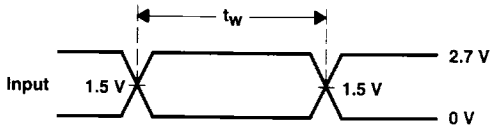
† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
‡ These parameters are measured with the internal output state of the storage register opposite to that of the bus input.

PARAMETER MEASUREMENT INFORMATION

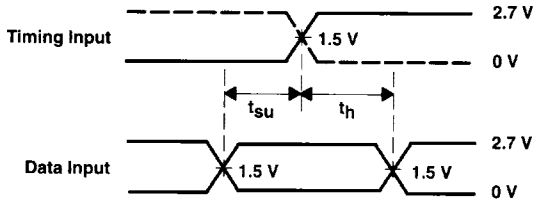


TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND

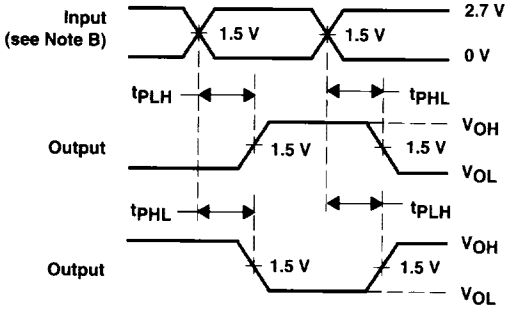
LOAD CIRCUIT FOR OUTPUTS



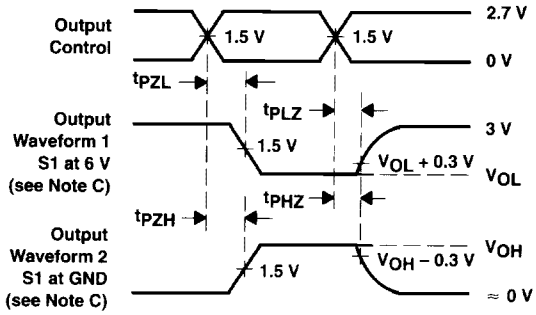
VOLTAGE WAVEFORMS
PULSE DURATION



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: A. C_L includes probe and jig capacitance.
B. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
C. 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.
D. The outputs are measured one at a time with one transition per measurement.

Figure 2. Load Circuit and Voltage Waveforms