

SN54ABT16652, SN74ABT16652 16-BIT BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCBS215B – FEBRUARY 1991 – REVISED JANUARY 1997

- Members of the Texas Instruments *Widebus™* Family
- State-of-the-Art *EPIC-II B™* BiCMOS Design Significantly Reduces Power Dissipation
- Latch-Up Performance Exceeds 500 mA Per JEDEC Standard JESD-17
- Typical V_{OLP} (Output Ground Bounce) < 1 V at $V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$
- Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise
- Flow-Through Architecture Optimizes PCB Layout
- High-Drive Outputs ($-32\text{-mA } I_{OH}$, $64\text{-mA } I_{OL}$)
- Package Options Include Plastic 300-mil Shrink Small-Outline (DL) Package and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings

description

The 'ABT16652 are 16-bit bus transceivers that consist of D-type flip-flops and control circuitry arranged for multiplexed transmission of data directly from the data bus or from the internal storage registers. These devices can be used as two 8-bit transceivers or one 16-bit transceiver.

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 'ABT16652.

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 inputs. 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. 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.

SN54ABT16652 . . . WD PACKAGE
SN74ABT16652 . . . DL PACKAGE
(TOP VIEW)

1OEAB	1	56	1OEBA
1CLKAB	2	55	1CLKBA
1SAB	3	54	1SBA
GND	4	53	GND
1A1	5	52	1B1
1A2	6	51	1B2
V_{CC}	7	50	V_{CC}
1A3	8	49	1B3
1A4	9	48	1B4
1A5	10	47	1B5
GND	11	46	GND
1A6	12	45	1B6
1A7	13	44	1B7
1A8	14	43	1B8
2A1	15	42	2B1
2A2	16	41	2B2
2A3	17	40	2B3
GND	18	39	GND
2A4	19	38	2B4
2A5	20	37	2B5
2A6	21	36	2B6
V_{CC}	22	35	V_{CC}
2A7	23	34	2B7
2A8	24	33	2B8
GND	25	32	GND
2SAB	26	31	2SBA
2CLKAB	27	30	2CLKBA
2OEAB	28	29	2OEBA



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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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description (continued)

To ensure the high-impedance state during power up or power down, $\overline{OEBA}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver (B to A). OEAB should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sourcing capability of the driver (A to B).

The SN54ABT16652 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74ABT16652 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–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 $\overline{OEBA}$. Data-input functions are always enabled; i.e., data at the bus terminals is stored on every low-to-high transition of the clock inputs.

[‡] Select control = L; clocks can occur simultaneously.

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

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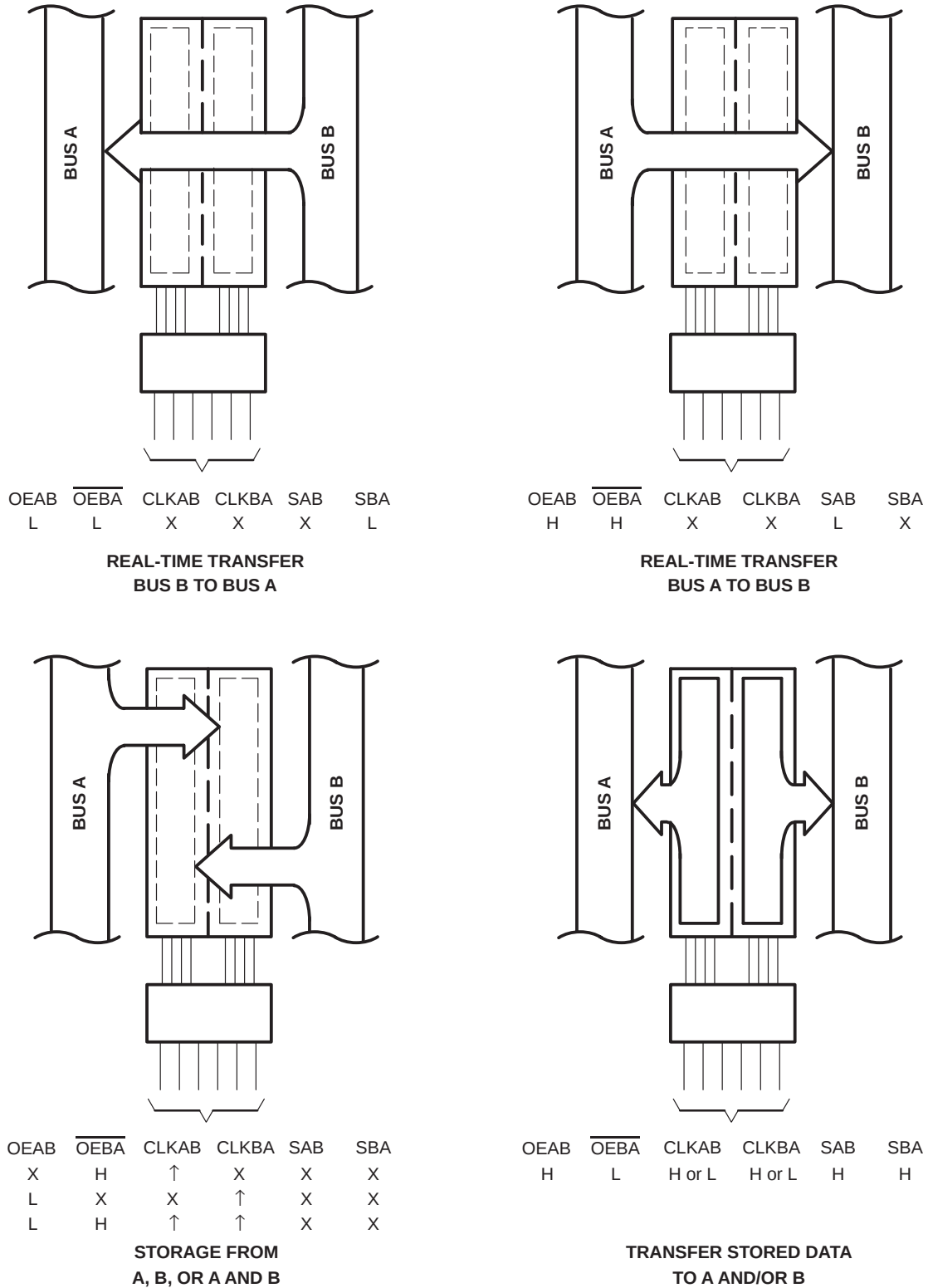


Figure 1. Bus-Management Functions

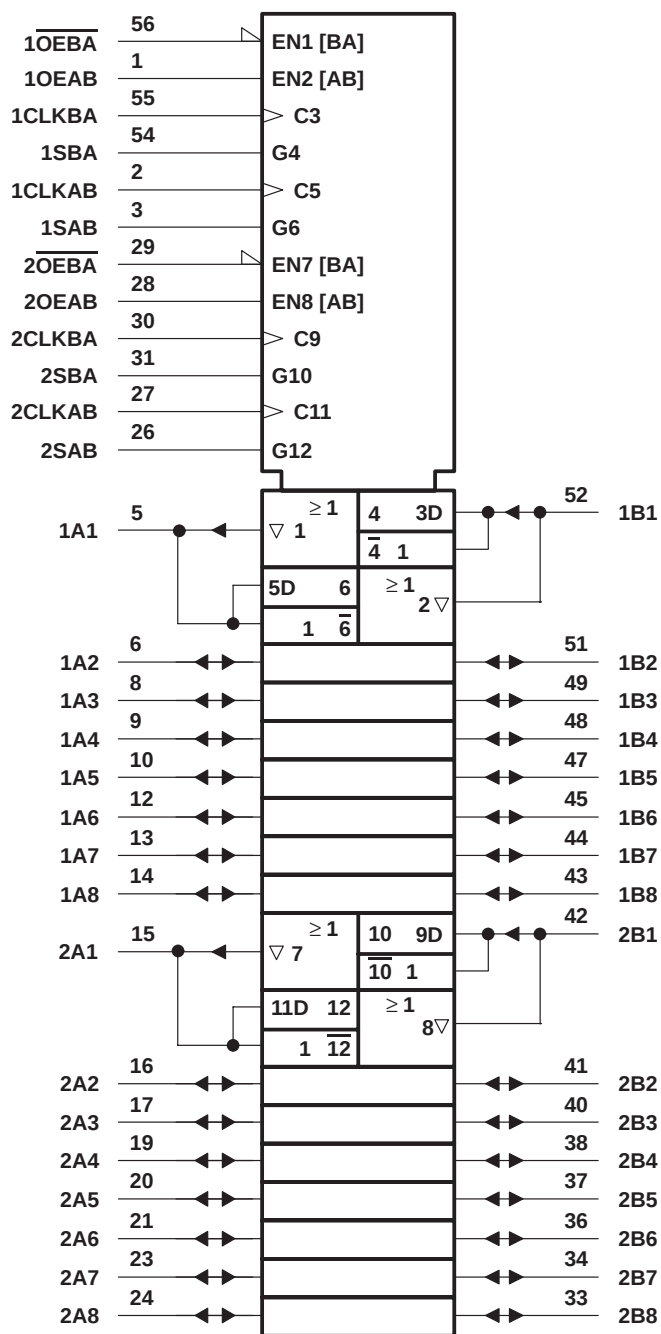
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logic symbol[†]

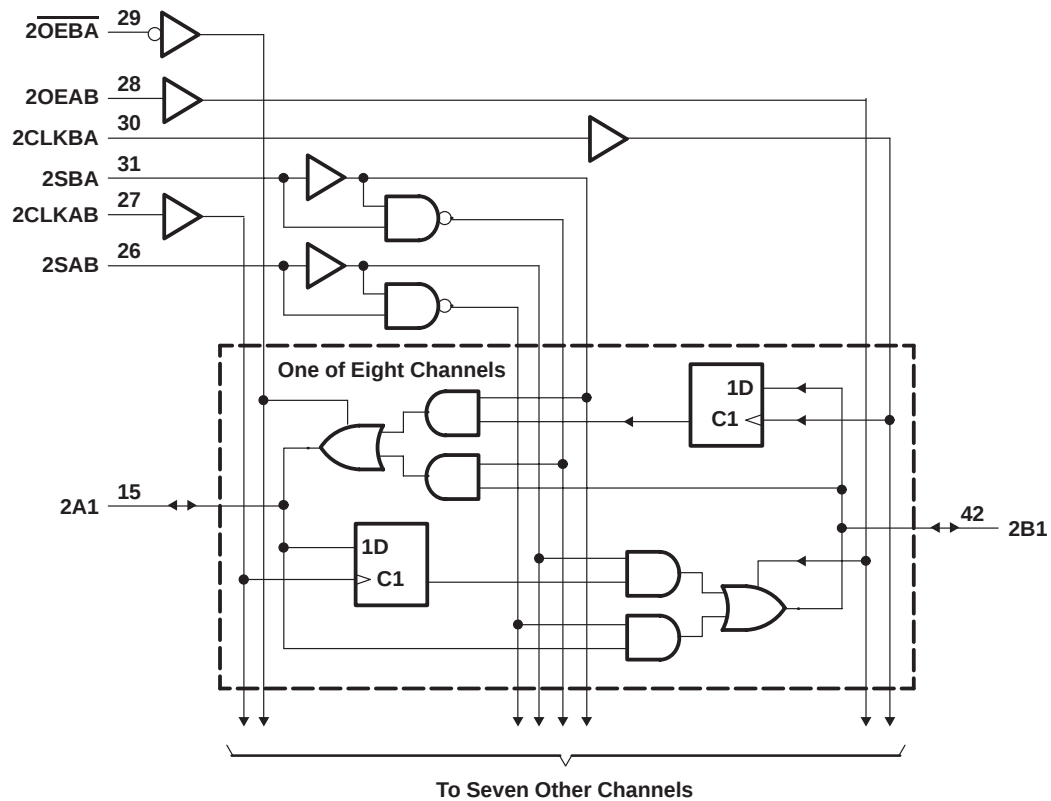
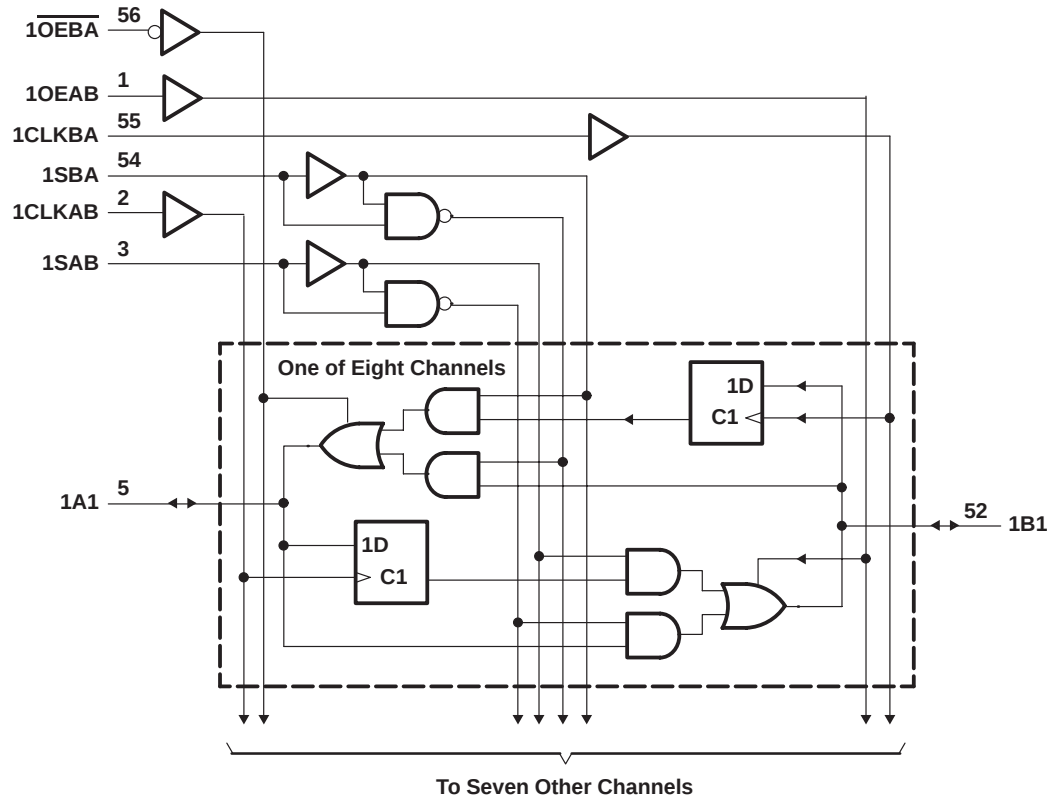


[†] This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

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logic diagram (positive logic)



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

Supply voltage range, V_{CC}	–0.5 V to 7 V
Input voltage range, V_I (except I/O ports) (see Note 1)	–0.5 V to 7 V
Voltage range applied to any output in the high or power-off state, V_O	–0.5 V to 5.5 V
Current into any output in the low state, I_O : SN54ABT16652	96 mA
SN74ABT16652	128 mA
Input clamp current, I_{IK} ($V_I < 0$)	–18 mA
Output clamp current, I_{OK} ($V_O < 0$)	–50 mA
Package thermal impedance, θ_{JA} (see Note 2): DL package	74°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. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
2. The package thermal impedance is calculated in accordance with EIA/JEDEC Std JESD51.

recommended operating conditions (see Note 3)

		SN54ABT16652		SN74ABT16652		UNIT
		MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage	4.5	5.5	4.5	5.5	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	0	V_{CC}	0	V_{CC}	V
I_{OH}	High-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	ns/V
T_A	Operating free-air temperature	–55	125	–40	85	°C

NOTE 3: Unused pins (input or I/O) must be held high or low to prevent them from floating.



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

PARAMETER		TEST CONDITIONS		T _A = 25°C			SN54ABT16652		SN74ABT16652		UNIT
				MIN	TYP†	MAX	MIN	MAX	MIN	MAX	
V _{IK}		V _{CC} = 4.5 V, I _I = –18 mA		–1.2			–1.2		–1.2		V
V _{OH}		V _{CC} = 4.5 V, I _{OH} = –3 mA		2.5			2.5		2.5		V
		V _{CC} = 5 V, I _{OH} = –3 mA		3			3		3		
		V _{CC} = 4.5 V	I _{OH} = –24 mA	2			2				
			I _{OH} = –32 mA	2*					2		
V _{OL}		V _{CC} = 4.5 V	I _{OL} = 48 mA	0.55			0.55				V
			I _{OL} = 64 mA	0.55*					0.55		
V _{hys}				100							mV
I _I	Control inputs	V _{CC} = 5.5 V, V _I = V _{CC} or GND		±1			±1		±1		μA
	A or B ports			±20			±20		±20		
I _{OZH} ‡		V _{CC} = 5.5 V, V _O = 2.7 V		10			10		10		μA
I _{OZL} ‡		V _{CC} = 5.5 V, V _O = 0.5 V		–10			–10		–10		μA
I _{off}		V _{CC} = 0, V _I or V _O ≤ 4.5 V		±100					±100		μA
I _{CEX}		V _{CC} = 5.5 V, V _O = 5.5 V	Outputs high	50			50		50		μA
I _O §		V _{CC} = 5.5 V, V _O = 2.5 V		–50	–100	–180	–50	–180	–50	–180	mA
I _{CC}	A or B ports	V _{CC} = 5.5 V, I _O = 0, V _I = V _{CC} or GND	Outputs high	2			2		2		mA
			Outputs low	32			32		32		
			Outputs disabled	2			2		2		
ΔI _{CC} ¶	Data inputs	V _{CC} = 5.5 V, One input at 3.4 V, Other inputs at V _{CC} or GND	Outputs enabled	50			50		50		μA
			Outputs disabled	50			50		50		
	Control inputs	V _{CC} = 5.5 V, One input at 3.4 V, Other inputs at V _{CC} or GND	50			50		50			
C _i	Control inputs	V _I = 2.5 V or 0.5 V		4							pF
C _{io}	A or B ports	V _O = 2.5 V or 0.5 V		8							pF

* On products compliant to MIL-PRF-38535, this parameter does not apply.

† All typical values are at V_{CC} = 5 V.

‡ The parameters I_{OZH} and I_{OZL} include the input leakage current.

§ Not more than one output should be tested at a time, and the duration of the test should not exceed one second.

¶ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

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timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 2)

		SN54ABT16652				UNIT
		$V_{CC} = 5\text{ V},$ $T_A = 25^{\circ}\text{C}$		MIN	MAX	
		MIN	MAX			
f_{clock}	Clock frequency	0	125	0	125	MHz
t_W	Pulse duration, CLK high or low	4.3		4.3		ns
t_{su}	Setup time, A or B before CLKAB↑ or CLKBA↑	3.5		4		ns
t_h	Hold time, A or B after CLKAB↑ or CLKBA↑	0.5		0.5		ns

timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 2)

		SN74ABT16652				UNIT
		$V_{CC} = 5\text{ V}$, $T_A = 25^{\circ}\text{C}$		MIN	MAX	
		MIN	MAX			
f_{clock}	Clock frequency	0	125	0	125	MHz
t_W	Pulse duration, CLK high or low	4.3		4.3		ns
t_{su}	Setup time, A or B before CLKAB↑ or CLKBA↑	3		3		ns
t_h	Hold time, A or B after CLKAB↑ or CLKBA↑	0		0		ns

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switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L = 50$ pF (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ABT16652					UNIT
			V _{CC} = 5 V, T _A = 25°C			MIN	MAX	
			MIN	TYP	MAX			
f _{max}			125			125		MHz
t _{PLH}	CLK	B or A	1.5	3.1	4	1	5	ns
t _{PHL}			1.5	3.2	4.1	1	5	
t _{PLH}	A or B	B or A	1	2.3	3.2	0.6	4	ns
t _{PHL}			1	3	4.1	0.6	4.9	
t _{PLH}	SAB or SBA [†]	B or A	1	2.9	4.3	0.6	5.3	ns
t _{PHL}			1	3.1	4.6	0.6	5.3	
t _{PZH}	$\overline{\text{OEBA}}$	A	1	2.8	4.1	0.6	5.2	ns
t _{PZL}			1.5	3.1	4.4	1	5.4	
t _{PHZ}	$\overline{\text{OEBA}}$	A	1.5	3.4	4.7	0.8	5.3	ns
t _{PLZ}			1.5	2.7	4	1	5.3	
t _{PZH}	OEAB	B	1	2.6	3.6	0.8	4.7	ns
t _{PZL}			1.5	2.8	4.5	1	5	
t _{PHZ}	OEAB	B	2	4.2	5.9	1	6.4	ns
t _{PLZ}			1.5	3.4	4.9	1	5.9	

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

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, $C_L = 50$ pF (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN74ABT16652					UNIT
			V _{CC} = 5 V, T _A = 25°C			MIN	MAX	
			MIN	TYP	MAX			
f _{max}			125			125		MHz
t _{PLH}	CLK	B or A	1.5	3.1	4	1.5	4.9	ns
t _{PHL}			1.5	3.2	4.1	1.5	4.7	
t _{PLH}	A or B	B or A	1	2.3	3.2	1	3.9	ns
t _{PHL}			1	3	4.1	1	4.6	
t _{PLH}	SAB or SBA [†]	B or A	1	2.9	4.3	1	5	ns
t _{PHL}			1	3.1	4.3	1	5	
t _{PZH}	$\overline{\text{OEBA}}$	A	1	2.8	4.1	1	5	ns
t _{PZL}			1.5	3.1	4.4	1.5	5.3	
t _{PHZ}	$\overline{\text{OEBA}}$	A	1.5	3.4	4.4	1.5	4.9	ns
t _{PLZ}			1.5	2.7	3.6	1.5	4	
t _{PZH}	OEAB	B	1	2.6	3.6	1	4.2	ns
t _{PZL}			1.5	2.8	3.9	1.5	4.6	
t _{PHZ}	OEAB	B	2	4.2	5.5	2	5.9	ns
t _{PLZ}			1.5	3.4	4.5	1.5	5.2	

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



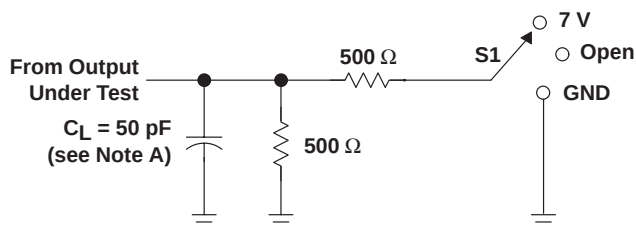
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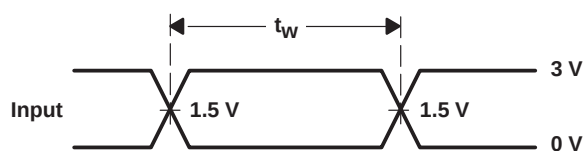
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PARAMETER MEASUREMENT INFORMATION

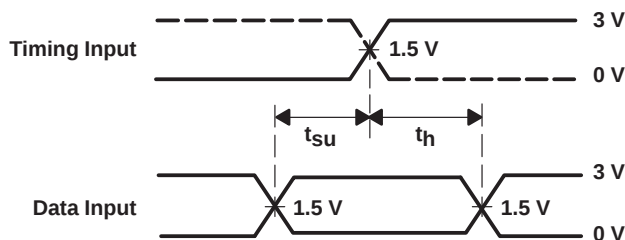


LOAD CIRCUIT

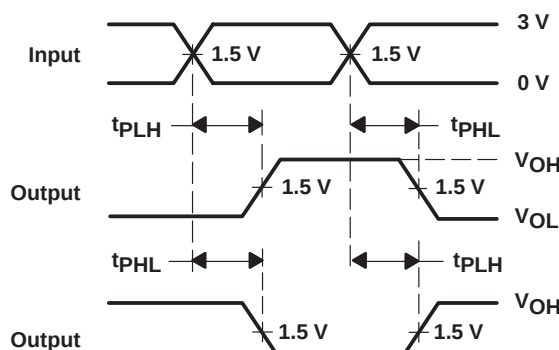
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	7 V
t_{PHZ}/t_{PZH}	Open



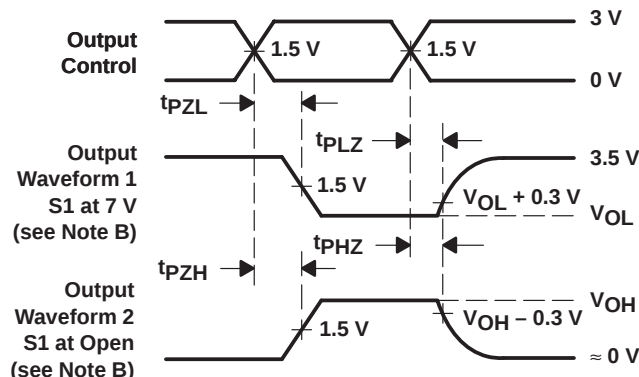
VOLTAGE WAVEFORMS
PULSE DURATION



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. 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

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
SN74ABT16652DL	Active	Production	SSOP (DL) 56	20 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16652
SN74ABT16652DL.B	Active	Production	SSOP (DL) 56	20 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16652
SN74ABT16652DLR	Active	Production	SSOP (DL) 56	1000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16652
SN74ABT16652DLR.B	Active	Production	SSOP (DL) 56	1000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16652

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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TAPE AND REEL INFORMATION



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74ABT16652DLR	SSOP	DL	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ABT16652DLR	SSOP	DL	56	1000	356.0	356.0	53.0

TUBE



*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN74ABT16652DL	DL	SSOP	56	20	473.7	14.24	5110	7.87
SN74ABT16652DL.B	DL	SSOP	56	20	473.7	14.24	5110	7.87

DL (R-PDSO-G56)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
 - D. Falls within JEDEC MO-118

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