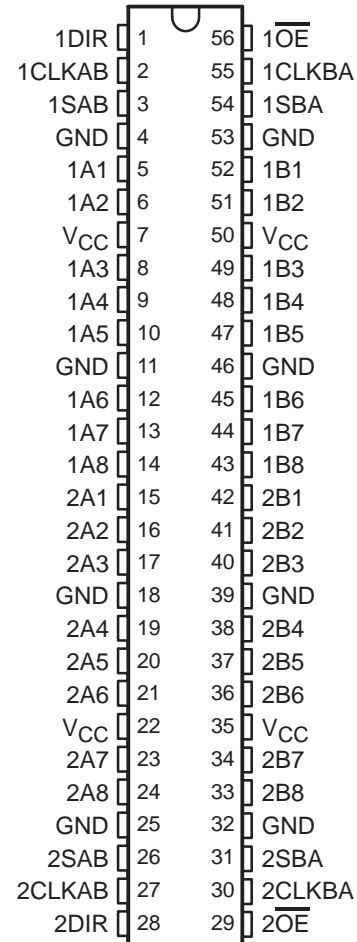


SN54ABT16646, SN74ABT16646 16-BIT BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCBS212D – JUNE 1992 – REVISED JULY 1999

- 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 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-mA I_{OH} , 64-mA I_{OL})
- Package Options Include Plastic Shrink Small-Outline (DL), Thin Shrink Small-Outline (DGG) Packages and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings

SN54ABT16646 . . . WD PACKAGE
SN74ABT16646 . . . DGG OR DL PACKAGE
(TOP VIEW)



description

The 'ABT16646 devices consist of bus-transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal registers.

These devices can be used as two 8-bit transceivers or one 16-bit transceiver. Data on the A or B bus is clocked into the registers on the low-to-high transition of the appropriate clock (CLKAB or CLKBA) input. Figure 1 illustrates the four fundamental bus-management functions that can be performed with the 'ABT16646 devices.

Output-enable (\overline{OE}) and direction-control (DIR) inputs 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-control (SAB and SBA) inputs can multiplex stored and real-time (transparent mode) data. 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. The direction control (DIR) determines which bus receives data when \overline{OE} is low. In the isolation mode (\overline{OE} high), A data can be stored in one register and/or B data can be stored in the other register.

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

To ensure the high-impedance state during power up or power down, \overline{OE} 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.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Widebus and EPIC-II B are trademarks of Texas Instruments Incorporated.

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**

POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

Copyright © 1999, Texas Instruments Incorporated
On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

SN54ABT16646, SN74ABT16646
16-BIT BUS TRANSCEIVERS AND REGISTERS
WITH 3-STATE OUTPUTS

SCBS212D – JUNE 1992 – REVISED JULY 1999

description (continued)

The SN54ABT16646 is characterized for operation over the full military temperature range of -55°C to 125°C .
 The SN74ABT16646 is characterized for operation from -40°C to 85°C .

FUNCTION TABLE

INPUTS						DATA I/O†		OPERATION OR FUNCTION
$\overline{\text{OE}}$	DIR	CLKAB	CLKBA	SAB	SBA	A1–A8	B1–B8	
X	X	↑	X	X	X	Input	Unspecified	Store A, B unspecified†
X	X	X	↑	X	X	Unspecified	Input	Store B, A unspecified†
H	X	↑	↑	X	X	Input	Input	Store A and B data
H	X	H or L	H or L	X	X	Input disabled	Input disabled	Isolation, hold storage
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
L	H	X	X	L	X	Input	Output	Real-time A data to B Bus
L	H	H or L	X	H	X	Input	Output	Stored A data to bus

† The data-output functions can be enabled or disabled by various signals at $\overline{\text{OE}}$ or DIR. Data-input functions always are enabled, i.e., data at the bus terminals is stored on every low-to-high transition of the clock inputs.



SN54ABT16646, SN74ABT16646
 16-BIT BUS TRANSCEIVERS AND REGISTERS
 WITH 3-STATE OUTPUTS

SCBS212D – JUNE 1992 – REVISED JULY 1999

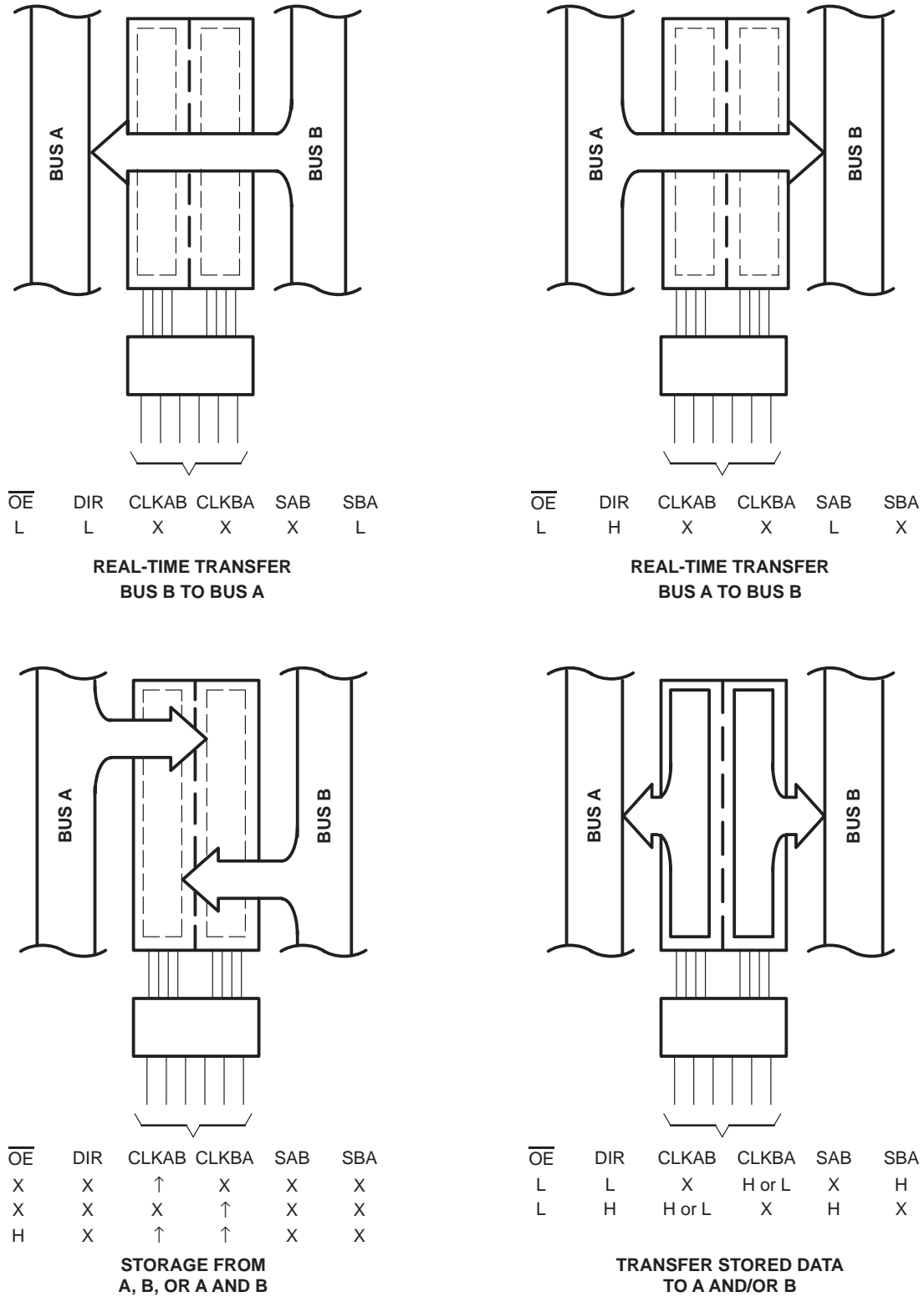
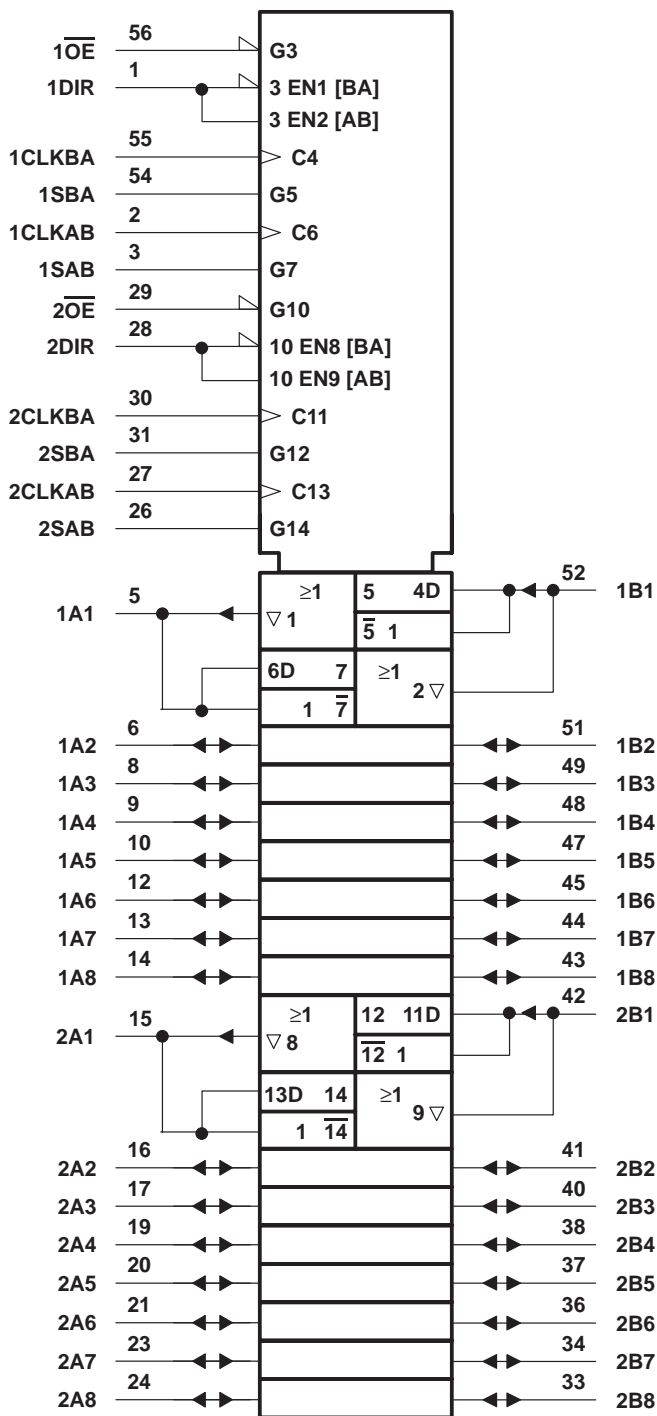


Figure 1. Bus-Management Functions

SN54ABT16646, SN74ABT16646 16-BIT BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCBS212D – JUNE 1992 – REVISED JULY 1999

logic symbol†

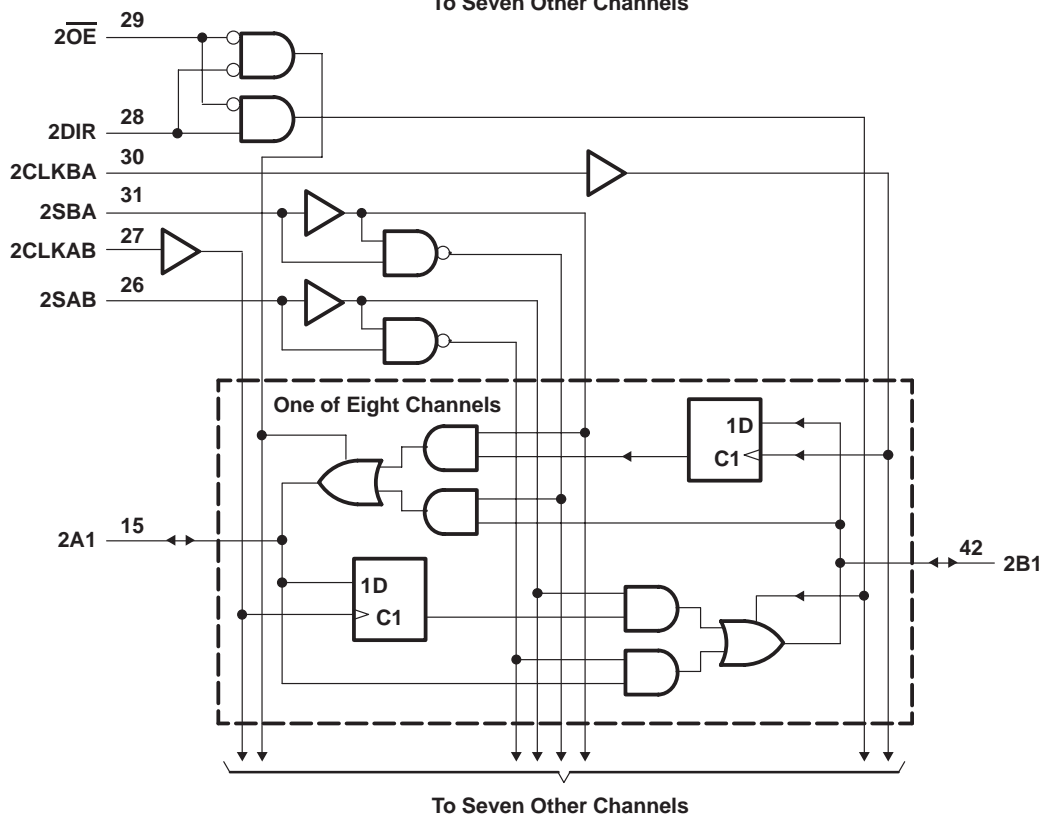
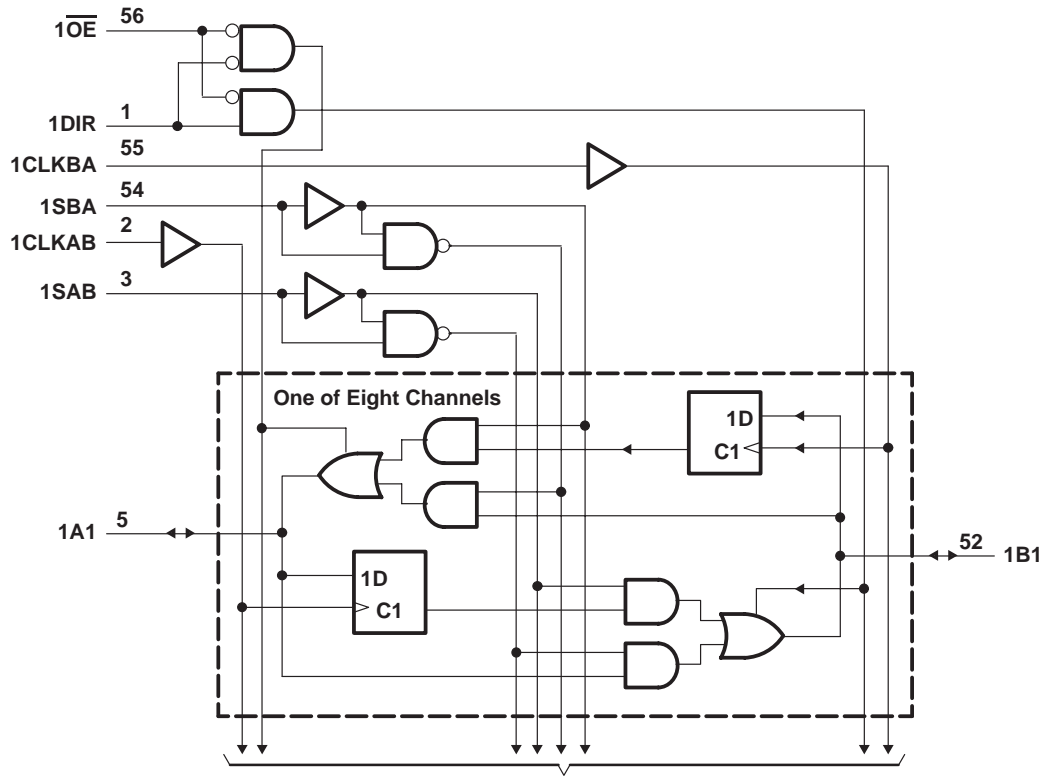


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

SN54ABT16646, SN74ABT16646
 16-BIT BUS TRANSCEIVERS AND REGISTERS
 WITH 3-STATE OUTPUTS

SCBS212D – JUNE 1992 – REVISED JULY 1999

logic diagram (positive logic)



SN54ABT16646, SN74ABT16646

16-BIT BUS TRANSCEIVERS AND REGISTERS

WITH 3-STATE OUTPUTS

SCBS212D – JUNE 1992 – REVISED JULY 1999

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 : SN54ABT16646	96 mA
SN74ABT16646	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): DGG package	81°C/W
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 JESD 51.

recommended operating conditions (see Note 3)

		SN54ABT16646		SN74ABT16646		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	10	ns/V
T_A	Operating free-air temperature	-55	125	-40	85	°C

NOTE 3: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.



SN54ABT16646, SN74ABT16646 16-BIT BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCBS212D – JUNE 1992 – REVISED JULY 1999

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

PARAMETER	TEST CONDITIONS	T _A = 25°C			SN54ABT16646		SN74ABT16646		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 I _{OH} = -32 mA			2 2*		2		2		
V _{OL}	V _{CC} = 4.5 V					0.55		0.55	V	
						0.55*		0.55		
V _{hys}				100					mV	
I _I	Control inputs A or B ports	V _{CC} = 5.5 V, V _I = V _{CC} or GND					±1		±1	μA
							±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.



SN54ABT16646, SN74ABT16646
16-BIT BUS TRANSCEIVERS AND REGISTERS
WITH 3-STATE OUTPUTS

SCBS212D – JUNE 1992 – REVISED JULY 1999

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

		SN54ABT16646				UNIT
		V _{CC} = 5 V, T _A = 25°C		MIN	MAX	
		MIN	MAX			
f _{clock}	Clock frequency	125		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)

		SN74ABT16646				UNIT
		V _{CC} = 5 V, T _A = 25°C		MIN	MAX	
		MIN	MAX			
f _{clock}	Clock frequency	125		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	



SN54ABT16646, SN74ABT16646 16-BIT BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCBS212D – JUNE 1992 – REVISED JULY 1999

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)	SN54ABT16646					UNIT
			$V_{CC} = 5$ V, $T_A = 25^\circ$ C			MIN	MAX	
			MIN	TYP	MAX			
f_{max}			125			125	MHz	
t_{PLH}	CLKBA or CLKAB	A or B	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	4.3	0.6	5.3	
t_{PZH}	\overline{OE}	A or B	1	3.4	4.6	0.6	5.9	ns
t_{PZL}			1.5	3.5	5.3	1	6	
t_{PHZ}	\overline{OE}	A or B	1.5	3.9	5.6	1	6.4	ns
t_{PLZ}			1.5	3.1	4.4	1	4.7	
t_{PZH}	DIR	A or B	1	3.2	4.5	0.6	5.8	ns
t_{PZL}			1.5	3.4	5.1	1	6.7	
t_{PHZ}	DIR	A or B	2	4.2	5.9	1.2	7.1	ns
t_{PLZ}			1.5	3.6	5.1	1	6.2	

† 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)	SN74ABT16646					UNIT
			$V_{CC} = 5$ V, $T_A = 25^\circ$ C			MIN	MAX	
			MIN	TYP	MAX			
f_{max}			125			125	MHz	
t_{PLH}	CLKBA or CLKAB	A or B	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{OE}	A or B	1	3.4	4.6	1	5.5	ns
t_{PZL}			1.5	3.5	4.9	1.5	5.7	
t_{PHZ}	\overline{OE}	A or B	1.5	3.9	4.9	1.5	5.4	ns
t_{PLZ}			1.5	3.1	4.1	1.5	4.5	
t_{PZH}	DIR	A or B	1	3.2	4.5	1	5.4	ns
t_{PZL}			1.5	3.4	4.8	1.5	5.6	
t_{PHZ}	DIR	A or B	2	4.2	5.7	2	6.7	ns
t_{PLZ}			1.5	3.6	5.1	1.5	5.9	

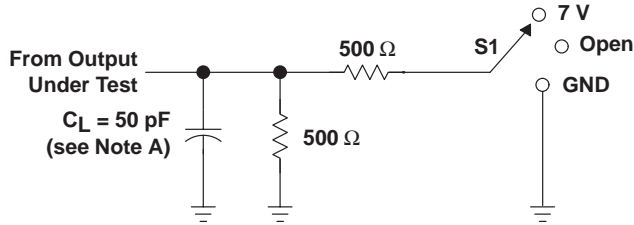
† These parameters are measured with the internal output state of the storage register opposite that of the bus input.



SN54ABT16646, SN74ABT16646 16-BIT BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

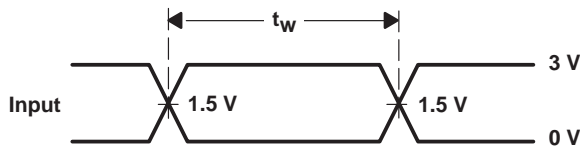
SCBS212D – JUNE 1992 – REVISED JULY 1999

PARAMETER MEASUREMENT INFORMATION

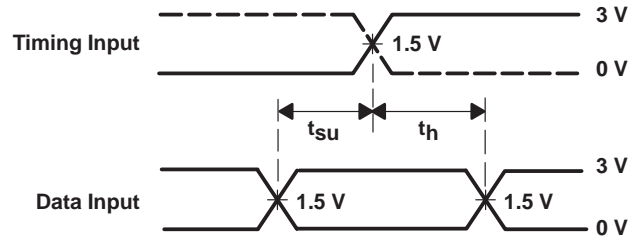


LOAD CIRCUIT

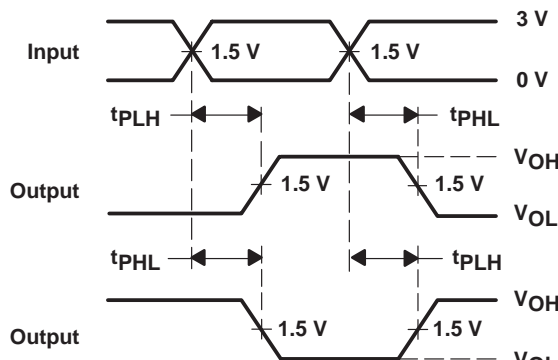
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	7 V
t_{PHZ}/t_{PZH}	Open



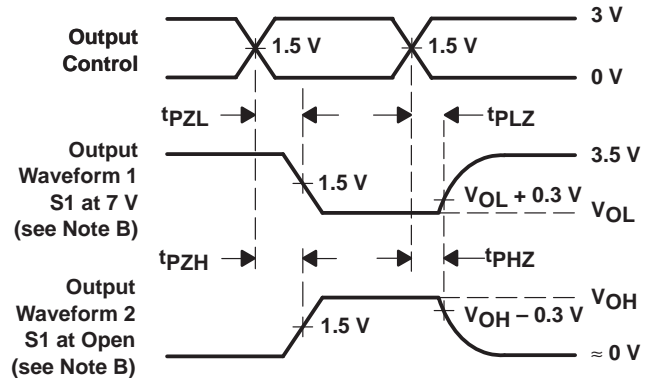
VOLTAGE WAVEFORMS
PULSE DURATION



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 Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74ABT16646DGGR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16646	Samples
SN74ABT16646DL	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16646	Samples
SN74ABT16646DLR	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16646	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

Important Information and Disclaimer:The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION
REEL DIMENSIONS

TAPE DIMENSIONS


A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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
SN74ABT16646DGGR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1
SN74ABT16646DLR	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)
SN74ABT16646DGGR	TSSOP	DGG	56	2000	367.0	367.0	45.0
SN74ABT16646DLR	SSOP	DL	56	1000	367.0	367.0	55.0

MECHANICAL DATA

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

PowerPAD is a trademark of Texas Instruments.

DGG0056A



PACKAGE OUTLINE

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



4222167/A 07/2015

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

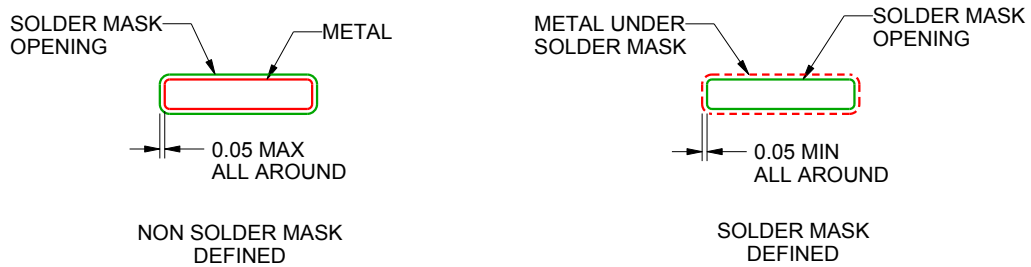
DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

4222167/A 07/2015

NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

4222167/A 07/2015

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2020, Texas Instruments Incorporated