

# SN74ABTE16246

## 11-BIT INCIDENT-WAVE SWITCHING BUS TRANSCEIVER WITH 3-STATE AND OPEN-COLLECTOR OUTPUTS

SCBS227J – JULY 1993 – REVISED AUGUST 2003

- Member of the Texas Instruments Widebus™ Family
- Supports the VME64 ETL Specification
- Reduced TTL-Compatible Input Threshold Range
- High-Drive Outputs ( $I_{OH} = -60\text{ mA}$ ,  $I_{OL} = 90\text{ mA}$ ) Support Equivalent 25- $\Omega$  Incident-Wave Switching
- $V_{CCBIAS}$  Pin Minimizes Signal Distortion During Live Insertion
- Internal Pullup Resistor on  $\overline{OE}$  Keeps Outputs in High-Impedance State During Power Up or Power Down
- Distributed  $V_{CC}$  and GND Pins Minimize High-Speed Switching Noise
- Equivalent 25- $\Omega$  Series Damping Resistor on B Port
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors

### description/ordering information

The SN74ABTE16246 is an 11-bit noninverting transceiver designed for asynchronous two-way communication between buses. This device has open-collector and 3-state outputs. The device allows data transmission from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable ( $\overline{OE}$ ) input can be used to disable the device so that the buses are effectively isolated. When  $\overline{OE}$  is low, the device is active.

The B port has an equivalent 25- $\Omega$  series output resistor to reduce ringing. Active bus-hold inputs on the B port hold unused or floating inputs at a valid logic level.

The A port provides for the precharging of the outputs via  $V_{CCBIAS}$ , which establishes a voltage between 1.3 V and 1.7 V when  $V_{CC}$  is not connected.

Active bus-hold circuitry holds unused or undriven inputs at a valid logic state. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended.

DGG OR DL PACKAGE  
(TOP VIEW)

11 $\overline{OE}$	1	48	$V_{CCBIAS}$
11DIR	2	47	11A
11B	3	46	10DIR
GND	4	45	GND
10B	5	44	10A
9B	6	43	9A
$V_{CC}$	7	42	$V_{CC}$
8BI	8	41	9DIR
8BO	9	40	8A
GND	10	39	GND
7BO	11	38	7A
6BI	12	37	7BI
6BO	13	36	6A
5BO	14	35	5A
GND	15	34	GND
4BO	16	33	5BI
4BI	17	32	4A
$V_{CC}$	18	31	$V_{CC}$
3BO	19	30	3A
2BI	20	29	3BI
GND	21	28	GND
2BO	22	27	2A
1BO	23	26	1A
1BI	24	25	$\overline{OE}$

### ORDERING INFORMATION

$T_A$	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	SSOP – DL	Tube	SN74ABTE16246DL	ABTE16246
		Tape and reel	SN74ABTE16246DLR	
	TSSOP – DGG	Tape and reel	SN74ABTE16246DGGR	ABTE16246

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



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FUNCTION TABLE

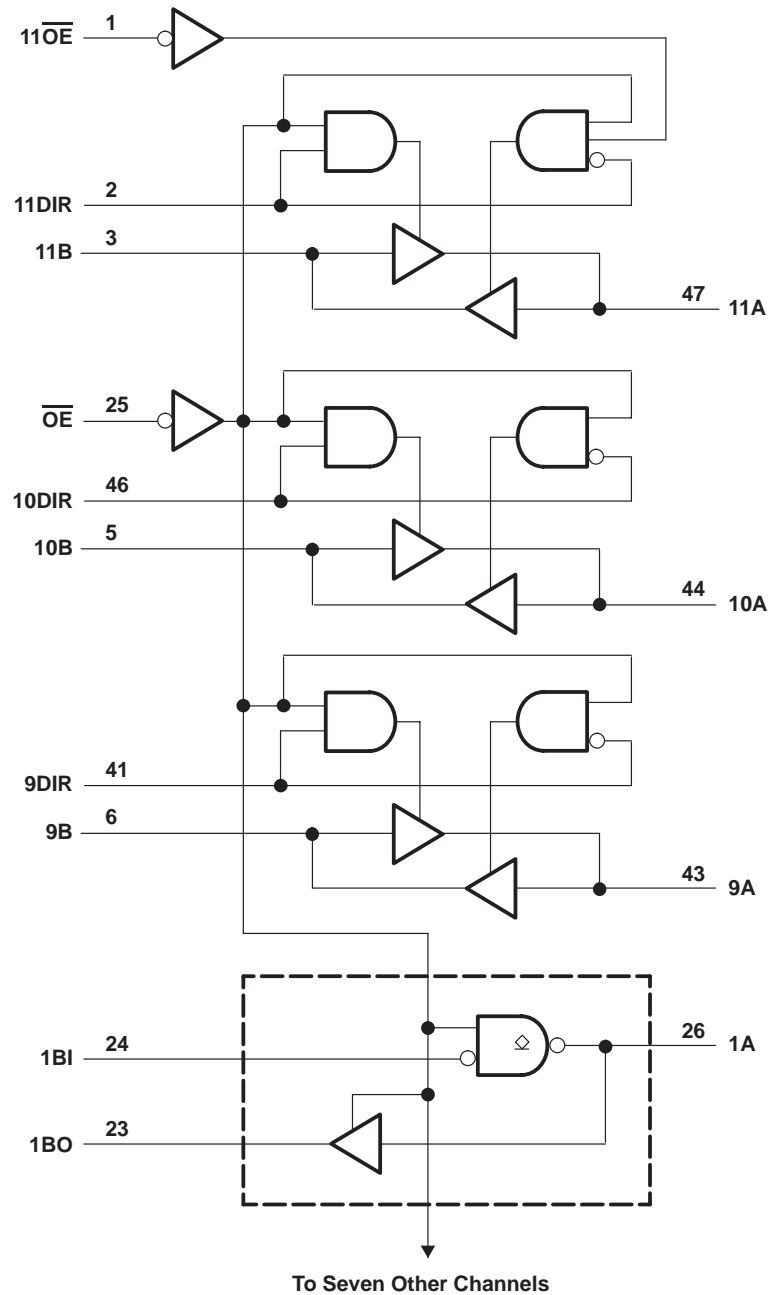
INPUTS					OPERATION
$\overline{OE}$	9DIR	10DIR	11DIR	11 $\overline{OE}$	
H	X	X	X	X	Isolation
L	X	X	X	X	1BI–8BI data to 1A–8A bus (OC <sup>†</sup> ), 1A–8A data to 1BO–8BO bus
L	L	X	X	X	9A data to 9B bus
L	H	X	X	X	9B data to 9A bus
L	X	L	X	X	10A data to 10B bus
L	X	H	X	X	10B data to 10A bus
L	X	X	L	L	11A data to 11B bus
L	X	X	L	H	11A, 11B isolation
L	X	X	H	X	11B data to 11A bus

<sup>†</sup> OC = Open-collector outputs

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logic diagram (positive logic)



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#### absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

Supply voltage range, $V_{CC}$ and $V_{CCBIAS}$	–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, $I_O$	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, $\theta_{JA}$ (see Note 2): DGG package	70°C/W
DL package	63°C/W
Storage temperature range, $T_{stg}$	–65°C to 150°C

<sup>†</sup> 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 51-7.

#### recommended operating conditions (see Note 3)

		MIN	NOM	MAX	UNIT
$V_{CC}$ , $V_{CCBIAS}$	Supply voltage	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	$\overline{OE}$	2		V
		Except $\overline{OE}$	1.6		
$V_{IL}$	Low-level input voltage	$\overline{OE}$		0.8	V
		Except $\overline{OE}$		1.4	
$V_{OH}$	High-level output voltage	1A–8A	0	5.5	V
$V_I$	Input voltage		0	$V_{CC}$	V
$I_{OH}$	High-level output current	B bus		–12	mA
		9A–11A		–64	
$I_{OL}$	Low-level output current	B bus		12	mA
		A bus		90	
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled		10	ns/V
$T_A$	Operating free-air temperature		–40	85	°C

NOTE 3: All unused control 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.

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

PARAMETER		TEST CONDITIONS		MIN	TYP†	MAX	UNIT
V <sub>IK</sub>		V <sub>CC</sub> = 4.5 V, I <sub>I</sub> = −18 mA				−1.2	V
V <sub>OH</sub>	B port	V <sub>CC</sub> = 5.5 V, I <sub>OH</sub> = −100 μA				V <sub>CC</sub> −0.2	V
		V <sub>CC</sub> = 4.5 V	I <sub>OH</sub> = −1 mA	2.4			
	I <sub>OH</sub> = −12 mA		2				
	9A–11A	V <sub>CC</sub> = 5.5 V, I <sub>OH</sub> = −1 mA		4.5			
		V <sub>CC</sub> = 4.5 V	I <sub>OH</sub> = −32 mA	2.4			
			I <sub>OH</sub> = −64 mA	2			
I <sub>OH</sub>	1A–8A	V <sub>CC</sub> = 4.5 V, V <sub>OH</sub> = 5.5 V		20		μA	
V <sub>OL</sub>	B port	V <sub>CC</sub> = 4.5 V	I <sub>OL</sub> = 1 mA	0.4		V	
			I <sub>OL</sub> = 12 mA	0.8			
	A port	V <sub>CC</sub> = 4.5 V	I <sub>OL</sub> = 64 mA	0.55			
			I <sub>OL</sub> = 90 mA	0.9			
V <sub>hys</sub>				100		mV	
I <sub>I</sub> (hold)	B port	V <sub>CC</sub> = 4.5 V	V <sub>I</sub> = 0.8 V	100		μA	
			V <sub>I</sub> = 2 V	−100			
		V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = 0 to 5.5 V		±500			
I <sub>I</sub>	Control inputs	V <sub>CC</sub> = 5.5 V	V <sub>I</sub> = V <sub>CC</sub> or GND	±1		μA	
	A or B ports	V <sub>CC</sub> = 5.5 V, $\overline{OE}$ = V <sub>CC</sub>		±20			
I <sub>OZH</sub> <sup>‡</sup>	9A–11A	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.7 V		10		μA	
I <sub>OZL</sub> <sup>‡</sup>	9A–11A	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 0.5 V		−10		μA	
I <sub>O</sub>	A port	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.5 V	−50	−180		mA	
	B port		−25	−90			
I <sub>off</sub>		V <sub>CC</sub> = 0, V <sub>I</sub> or V <sub>O</sub> ≤ 4.5 V, V <sub>CC</sub> BIAS = 0		±100		μA	
I <sub>CC</sub>	A or B ports	V <sub>CC</sub> = 5.5 V, I <sub>O</sub> = 0, V <sub>I</sub> = V <sub>CC</sub> or GND	Outputs high	28	36	mA	
			Outputs low	38	48		
			Outputs disabled	20	32		
I <sub>CCD</sub>	A or B ports	V <sub>CC</sub> = 5 V, C <sub>L</sub> = 50 pF	$\overline{OE}$ high	0.02		mA/ MHz	
			$\overline{OE}$ low	0.33			
C <sub>i</sub>	Control inputs	V <sub>I</sub> = 2.5 V or 0.5 V		2.5	4	pF	
C <sub>io</sub>	I/O ports	V <sub>O</sub> = 2.5 V or 0.5 V		4.5	8	pF	

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

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

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## live-insertion specifications over recommended operating free-air temperature range

PARAMETER		TEST CONDITIONS			MIN	TYP†	MAX	UNIT
$I_{CC}$ ( $V_{CCBIAS}$ )		$V_{CC} = 0$ to 4.5 V,	$V_{CCBIAS} = 4.5$ V to 5.5 V,	$I_{O(DC)} = 0$	250	700		$\mu A$
		$V_{CC} = 4.5$ V to 5.5 V‡,	$V_{CCBIAS} = 4.5$ V to 5.5 V,	$I_{O(DC)} = 0$		20		
$V_O$	A port	$V_{CC} = 0$	$V_{CCBIAS} = 4.5$ V to 5.5 V		1.1	1.5	1.9	V
			$V_{CCBIAS} = 4.75$ V to 5.25 V		1.3	1.5	1.7	
$I_O$	A port	$V_{CC} = 0$ ,	$V_{CCBIAS} = 4.5$ V	$V_O = 0$	-20		-100	$\mu A$
				$V_O = 3$ V	20		100	

† All typical values are at  $V_{CC} = 5$  V,  $T_A = 25^\circ C$ .‡  $V_{CC} - 0.5$  V <  $V_{CCBIAS}$ 

## 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)	$V_{CC} = 5$ V, $T_A = 25^\circ C$			MIN	MAX	UNIT
			MIN	TYP	MAX			
$t_{PLH}$	A	B	1.5	3.1	4.2	1.5	5.2	ns
$t_{PHL}$			1.5	3.5	4.6	1.5	5.2	
$t_{PLH}$	9B–11B	9A–11A	1.5	3	3.8	1.5	4.5	ns
$t_{PHL}$			1.5	3.2	4	1.5	4.5	
$t_{PLH}^{\S}$	1B–8B	1A–8A	1.5	3.2	4	1.5	4.5	ns
$t_{PLH}^{\P}$			7.5	8.9	9.7	7.5	10.3	
$t_{PHL}$			1.5	3.2	4	1.5	4.5	
$t_{PZH}$	$\overline{OE}$	9A–11A	2	4.3	5.3	2	6.2	ns
$t_{PZL}$		1A–11A	2	4.4	5.4	2	6.8	
$t_{PZH}$	$\overline{OE}$	B	2	4.3	6	2	7.1	ns
$t_{PZL}$			2	4.5	6.4	2	7.3	
$t_{PHZ}$	$\overline{OE}$	9A–11A	2	4.2	5.9	2	6.7	ns
$t_{PLZ}$		1A–11A	2	3.5	4.6	2	5.1	
$t_{PHZ}$	$\overline{OE}$	B	2.5	4.3	6.2	2.5	7	ns
$t_{PLZ}$			2	3.6	5	2	5.5	

§ Measurement point is  $V_{OL} + 0.3$  V.¶ Measurement point is  $V_{OL} + 1.5$  V.

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**extended 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)	LOAD	$V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$			MIN	MAX	UNIT
				MIN	TYP	MAX			
$t_{PLH}$	9B–11B	9A–11A	$R_X = 13\ \Omega$	1.5	3.2	4	1.5	4.8	ns
$t_{PHL}$				1.5	3.8	4.7	1.5	5.6	
$t_{PHL}$	1B–8B	1A–8A	$R_X = 13\ \Omega$	1.5	3.3	4.2	1.5	4.8	ns
$t_{PLH}$	9B–11B	9A–11A	$R_X = 26\ \Omega$	1.5	3.1	4	1.5	4.6	ns
$t_{PHL}$				1.5	3.5	4.4	1.5	4.9	
$t_{PHL}$	1B–8B	1A–8A	$R_X = 26\ \Omega$	1.5	3.1	4	1.5	4.4	ns
$t_{PLH}$	9B–11B	1A–8A	$R_X = 56\ \Omega$	1.5	3	3.8	1.5	4.5	ns
$t_{PHL}$				1.5	3.3	4.2	1.5	4.7	
$t_{PHL}$	1B–8B	1A–8A	$R_X = 56\ \Omega$	1.5	3	4	1.5	4.4	ns
$t_{sk(p)}$	B	A	$R_X = \text{Open}$		0.1	0.6		2	ns
	A	B	$R_X = \text{Open}$		0.4	0.8		2	
	B	A	$R_X = 26\ \Omega$		0.3	0.8		2	
$t_{sk(o)}$	B	A	$R_X = \text{Open}$		0.3	0.7		1.3	ns
	A	B	$R_X = \text{Open}$		0.7	1.1		1.3	
	B	A	$R_X = 26\ \Omega$		0.5	1		1.3	
$t_t^\dagger$	B	A	$R_X = 26\ \Omega$	0.5	0.8	1.5	0.5	1.5	ns
$t_t^\ddagger$	A	B	$R_X = \text{Open}$	3.5	5.5	7.3	3.5	7.9	ns

$^\dagger t_t$  is measured between 1 V and 2 V of the output waveform.

$^\ddagger t_t$  is measured between 10% and 90% of the output waveform.

**extended output characteristics over recommended ranges of supply voltage and operating free-air temperature,  $C_L = 50$  pF (see Figures 1 and 2)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	LOAD	MIN	MAX	UNIT
$t_{sk(temp)}$	A	B	$V_{CC} = \text{constant},$ $\Delta T_A = 20^\circ\text{C}$			2.5	ns
	B	A		$R_X = 56\ \Omega$		4	
$t_{sk(load)}$	B	A	$V_{CC} = \text{constant},$ Temperature = constant	$R_X = 13, 26, \text{ or } 56\ \Omega$		4	ns

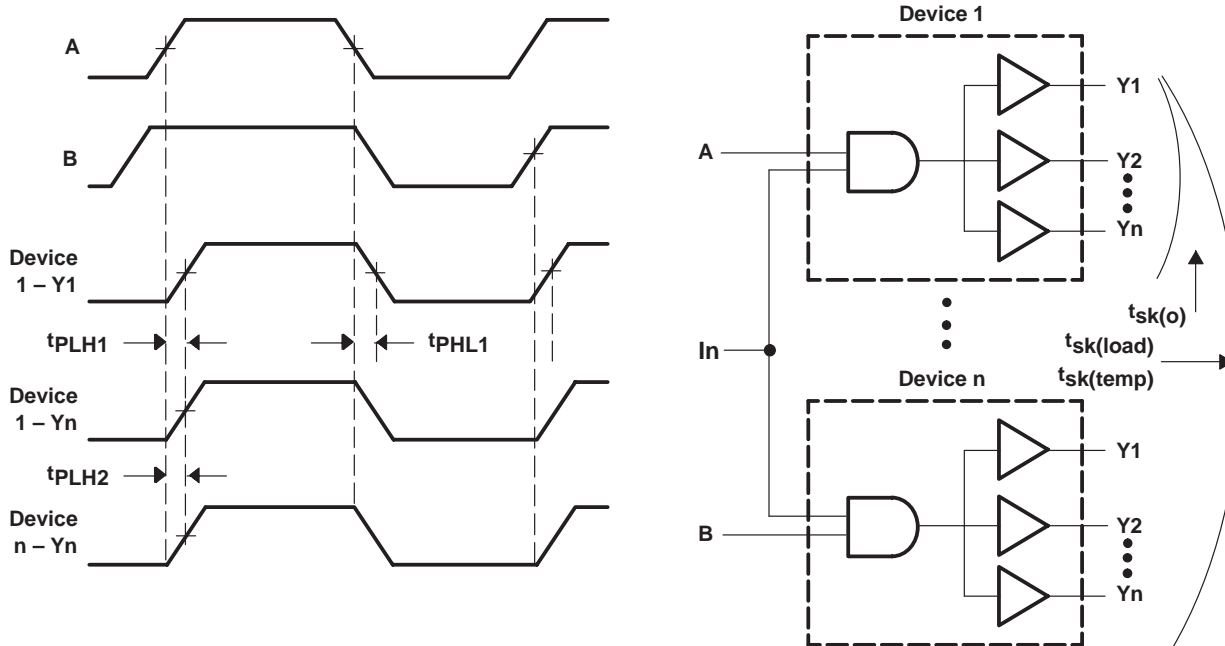
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#### PARAMETER MEASUREMENT INFORMATION



- NOTES:
- A. Pulse skew,  $t_{sk(p)}$ , is defined as the difference in propagation-delay times  $t_{PLH1}$  and  $t_{PHL1}$  on the same terminal at identical operating conditions.
  - B. Output skew,  $t_{sk(o)}$ , is defined as the difference in propagation delay of any two outputs of the same device switching in the same direction (e.g.,  $|t_{PLH1} - t_{PLH2}|$ ).
  - C. Temperature skew,  $t_{sk(temp)}$ , is the output skew of two devices, both having the same value of  $V_{CC} \pm 1\%$  and with package temperature differences of  $20^{\circ}\text{C}$ .
  - D. Load skew,  $t_{sk(load)}$ , is measured with  $R_X$  in Figure 2 at  $13\ \Omega$  for one unit and  $56\ \Omega$  for the other unit.

**Figure 1. Voltage Waveforms for Extended Characteristics**

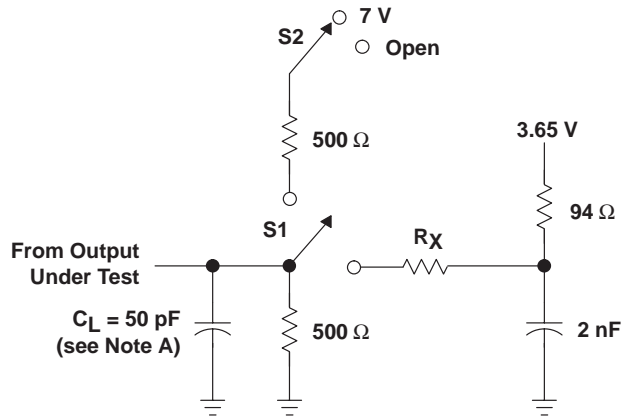


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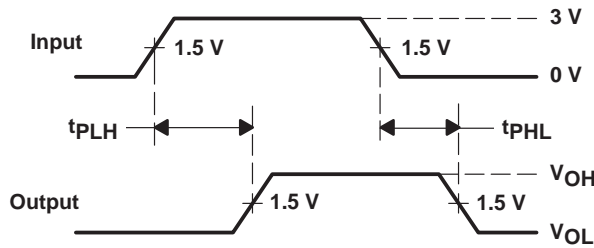
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### PARAMETER MEASUREMENT INFORMATION



$R_X = 13, 26, \text{ or } 56 \Omega$

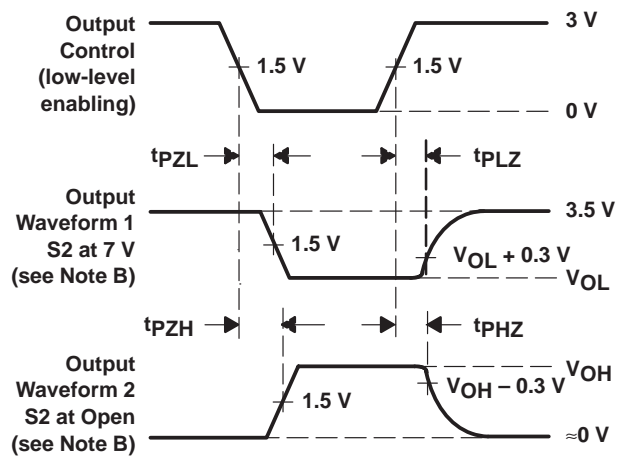
LOAD CIRCUIT



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES

SWITCHING TABLE LOADS	S1	S2
$t_{PLH}/t_{PHL}$ (9A–11A and B port)	Up	Open
$t_{PLH}/t_{PHL}$ (1A–8A)	Up	7 V
$t_{PLZ}/t_{PZL}$	Up	7 V
$t_{PHZ}/t_{PZH}$ (except 1A–8A)	Up	Open

EXTENDED SWITCHING TABLE LOADS	S1	S2
$t_{PLH}/t_{PHL}/t_{sk}$ (A port)	Down	X
$t_{PLH}/t_{PHL}/t_{sk}$ (B port)	Up	Open
$t_t$ (A port) (see Note E)	Down	X
$t_t$ (B port) (see Note F)	Up	Open



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES

- 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.  
 E.  $t_t$  is measured between 1 V and 2 V of the output waveform.  
 F.  $t_t$  is measured between 10% and 90% of the output waveform.

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
SN74ABTE16246DGGR	ACTIVE	TSSOP	DGG	48	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246	<a href="#">Samples</a>
SN74ABTE16246DL	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246	<a href="#">Samples</a>
SN74ABTE16246DLG4	ACTIVE	SSOP	DL	48	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246	<a href="#">Samples</a>
SN74ABTE16246DLR	ACTIVE	SSOP	DL	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABTE16246	<a href="#">Samples</a>

(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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(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.

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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
SN74ABTE16246DGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	15.8	1.8	12.0	24.0	Q1
SN74ABTE16246DLR	SSOP	DL	48	1000	330.0	32.4	11.35	16.2	3.1	16.0	32.0	Q1

## TAPE AND REEL BOX DIMENSIONS

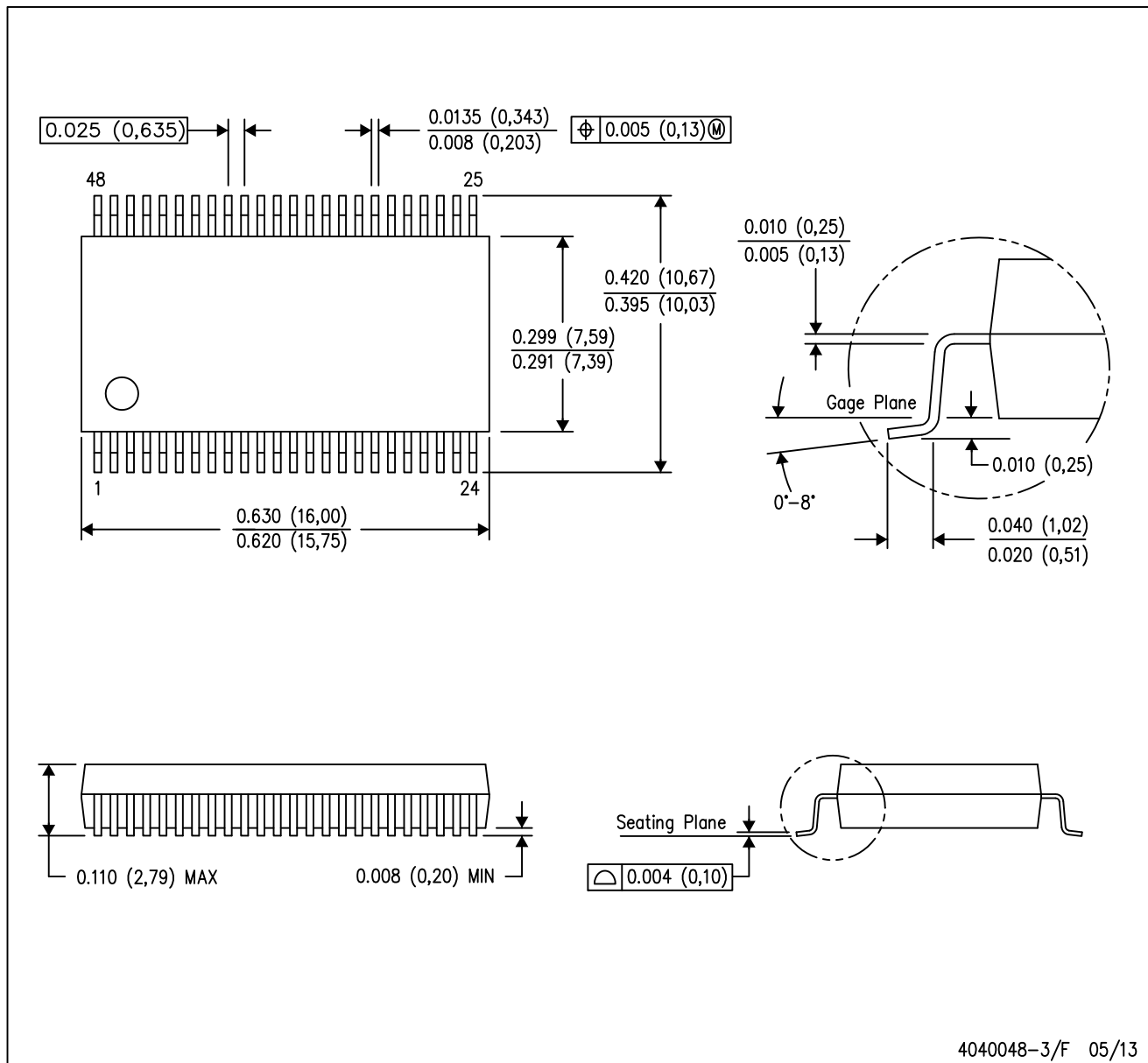


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ABTE16246DGGR	TSSOP	DGG	48	2000	367.0	367.0	45.0
SN74ABTE16246DLR	SSOP	DL	48	1000	367.0	367.0	55.0

DL (R-PDSO-G48)

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

## DGG (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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