

# SN54ABT16600, SN74ABT16600 18-BIT UNIVERSAL BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS209B – JUNE 1992 – REVISED JANUARY 1997

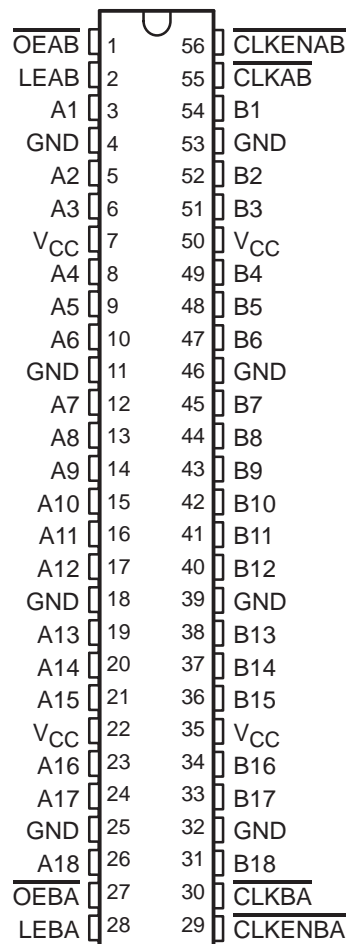
- **Members of the Texas Instruments Widebus™ Family**
- **State-of-the-Art EPIC-IIB™ BiCMOS Design Significantly Reduces Power Dissipation**
- **UBT™ (Universal Bus Transceiver) Combines D-Type Latches and D-Type Flip-Flops for Operation in Transparent, Latched, Clocked, or Clock-Enabled Mode**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015**
- **Latch-Up Performance Exceeds 500 mA Per JEDEC Standard JESD-17**
- **Typical  $V_{OLP}$  (Output Ground Bounce) < 0.8 V at  $V_{CC} = 5$  V,  $T_A = 25^\circ\text{C}$**
- **Flow-Through Architecture Optimizes PCB Layout**
- **Package Options Include Plastic 300-mil Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings**

## description

These 18-bit universal bus transceivers combine D-type latches and D-type flip-flops to allow data flow in transparent, latched, clocked, and clock-enabled modes.

Data flow in each direction is controlled by output-enable ( $\overline{OEAB}$  and  $\overline{OEBA}$ ), latch-enable ( $\overline{LEAB}$  and  $\overline{LEBA}$ ), and clock ( $\overline{CLKAB}$  and  $\overline{CLKBA}$ ) inputs. The clock can be controlled by the clock-enable ( $\overline{CLKENAB}$  and  $\overline{CLKENBA}$ ) inputs. For A-to-B data flow, the device operates in the transparent mode when  $\overline{LEAB}$  is high. When  $\overline{LEAB}$  is low, the A data is latched if  $\overline{CLKAB}$  is held at a high or low logic level. If  $\overline{LEAB}$  is low, the A-bus data is stored in the latch/flip-flop on the high-to-low transition of  $\overline{CLKAB}$ . Output enable  $\overline{OEAB}$  is active low. When  $\overline{OEAB}$  is low, the outputs are active. When  $\overline{OEAB}$  is high, the outputs are in the high-impedance state.

SN54ABT16600 . . . WD PACKAGE  
SN74ABT16600 . . . DGG OR DL PACKAGE  
(TOP VIEW)



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 **TEXAS  
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**SN54ABT16600, SN74ABT16600**  
**18-BIT UNIVERSAL BUS TRANSCEIVERS**  
**WITH 3-STATE OUTPUTS**

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**description (continued)**

Data flow for B to A is similar to that of A to B, but uses  $\overline{OEBA}$ , LEBA,  $\overline{CLKBA}$ , and  $\overline{CLKENBA}$ .

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.

The SN54ABT16600 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74ABT16600 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

**FUNCTION TABLE†**

INPUTS					OUTPUT
$\overline{CLKENAB}$	$\overline{OEAB}$	LEAB	$\overline{CLKAB}$	A	B
X	H	X	X	X	Z
X	L	H	X	L	L
X	L	H	X	H	H
H	L	L	X	X	$B_0^{\ddagger}$
H	L	L	X	X	$B_0^{\ddagger}$
L	L	L	↓	L	L
L	L	L	↓	H	H
L	L	L	H	X	$B_0^{\ddagger}$
L	L	L	L	X	$B_0^{\S}$

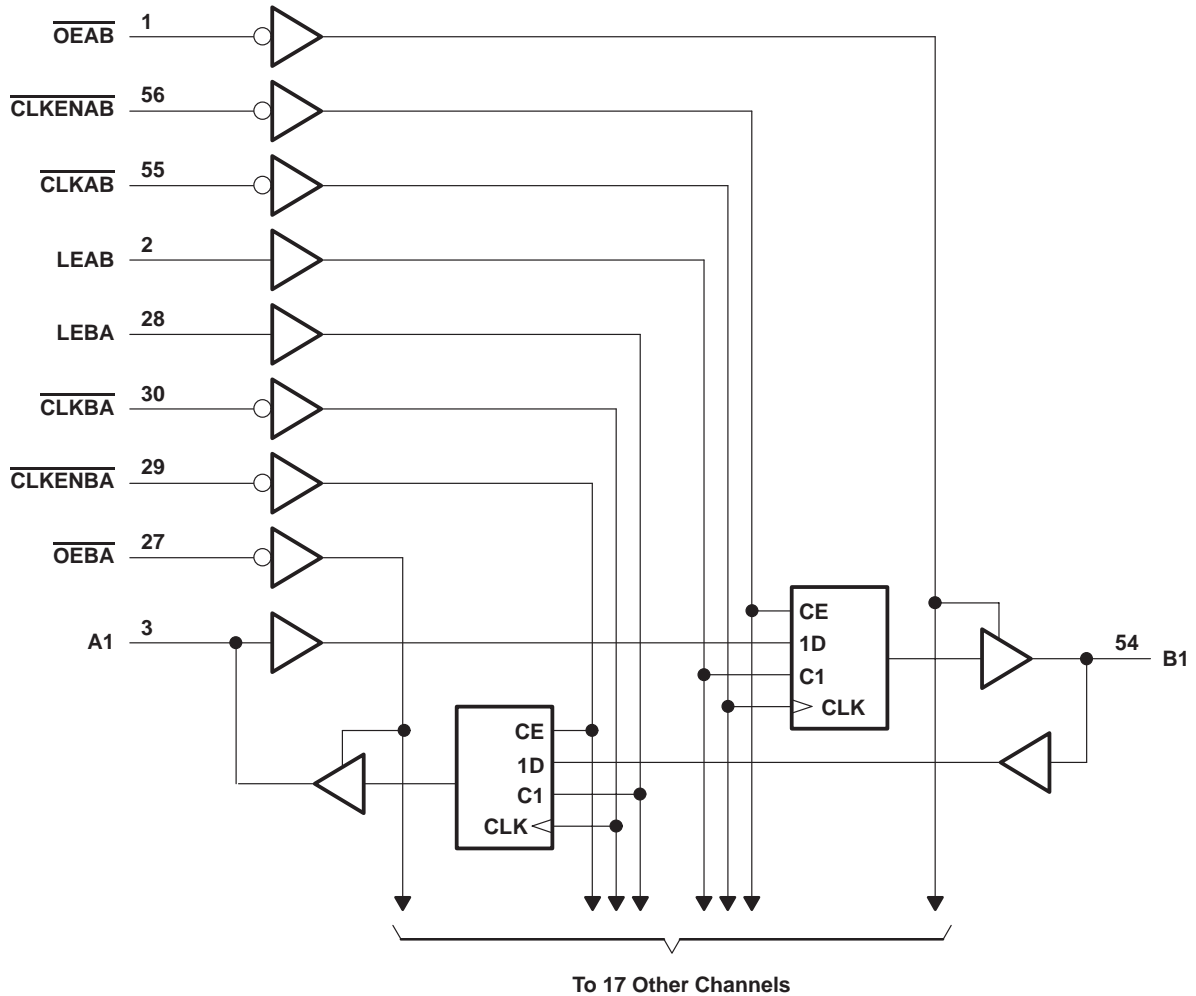
† A-to-B data flow is shown: B-to-A flow is similar but uses  $\overline{OEBA}$ , LEBA,  $\overline{CLKBA}$ , and  $\overline{CLKENBA}$ .

‡ Output level before the indicated steady-state input conditions were established

§ Output level before the indicated steady-state input conditions were established, provided that CLKAB was low before LEAB went low



logic diagram (positive logic)



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, $I_{OL}$ : SN54ABT16600 .....	96 mA
SN74ABT16600 .....	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 .....	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 EIA/JEDEC Std JESD51.

# SN54ABT16600, SN74ABT16600

## 18-BIT UNIVERSAL BUS TRANSCEIVERS

### WITH 3-STATE OUTPUTS

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

		SN54ABT16600		SN74ABT16600		UNIT
		MIN	MAX	MIN	MAX	
V <sub>CC</sub>	Supply voltage	4.5	5.5	4.5	5.5	V
V <sub>IH</sub>	High-level input voltage	2		2		V
V <sub>IL</sub>	Low-level input voltage		0.8		0.8	V
V <sub>I</sub>	Input voltage	0	V <sub>CC</sub>	0	V <sub>CC</sub>	V
I <sub>OH</sub>	High-level output current		-24		-32	mA
I <sub>OL</sub>	Low-level output current		48		64	mA
Δt/Δv	Input transition rise or fall rate	Outputs enabled		10	10	ns/V
T <sub>A</sub>	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.

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

PARAMETER	TEST CONDITIONS	T <sub>A</sub> = 25°C			SN54ABT16600		SN74ABT16600		UNIT
		MIN	TYP†	MAX	MIN	MAX	MIN	MAX	
V <sub>IK</sub>	V <sub>CC</sub> = 4.5 V, I <sub>I</sub> = -18 mA			-1.2		-1.2		-1.2	V
V <sub>OH</sub>	V <sub>CC</sub> = 4.5 V, I <sub>OH</sub> = -3 mA		2.5		2.5		2.5		V
	V <sub>CC</sub> = 5 V, I <sub>OH</sub> = -3 mA		3		3		3		
	V <sub>CC</sub> = 4.5 V, I <sub>OH</sub> = -24 mA		2		2				
V <sub>OL</sub>	V <sub>CC</sub> = 4.5 V, I <sub>OL</sub> = 48 mA			0.55		0.55			V
				0.55*			0.55		
V <sub>hys</sub>			100						mV
I <sub>I</sub>	Control inputs	V <sub>CC</sub> = 5.5 V, V <sub>I</sub> = V <sub>CC</sub> or GND		±1		±1		±1	μA
	A or B ports			±20		±20		±20	
I <sub>off</sub>	V <sub>CC</sub> = 0, V <sub>I</sub> or V <sub>O</sub> ≤ 4.5 V			±100				±100	μA
I <sub>CEX</sub>	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 5.5 V, Outputs high			50		50		50	μA
I <sub>O</sub> ‡	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.5 V	-50	-100	-180	-50	-180	-50	-180	mA
I <sub>OZH</sub> §	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.7 V			10		10		10	μA
I <sub>OZL</sub> §	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 0.5 V			-10		-10		-10	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		3		3		3	mA
		Outputs low		36		36		36	
		Outputs disabled		3		3		3	
ΔI <sub>CC</sub> ¶	V <sub>CC</sub> = 5.5 V, One input at 3.4 V, Other inputs at V <sub>CC</sub> or GND			50		50		50	μA
C <sub>i</sub>	Control inputs, V <sub>I</sub> = 2.5 V or 0.5 V			3					pF
C <sub>io</sub>	A or B ports, V <sub>O</sub> = 2.5 V or 0.5 V			9					pF

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

† All typical values are at V<sub>CC</sub> = 5 V.

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

§ The parameters I<sub>OZH</sub> and I<sub>OZL</sub> include the input leakage current.

¶ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V<sub>CC</sub> or GND.

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**timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 1)**

		SN54ABT16600		SN74ABT16600		UNIT
		MIN	MAX	MIN	MAX	
$f_{\text{clock}}$	Clock frequency	0	150	0	150	MHz
$t_w$	Pulse duration	LEAB or LEBA high		2.5		ns
		CLKAB or CLKBA high or low		3		
$t_{\text{su}}$	Setup time	A before $\overline{\text{CLKAB}}\downarrow$ or B before $\overline{\text{CLKBA}}\downarrow$		3		ns
		A before LEAB $\downarrow$ or B before LEBA $\downarrow$		2.5		
		$\overline{\text{CLKEN}}$ before CLK $\downarrow$		2.5		
$t_h$	Hold time	A after $\overline{\text{CLKAB}}\downarrow$ or B after $\overline{\text{CLKBA}}\downarrow$		0		ns
		A after LEAB $\downarrow$ or B after LEBA $\downarrow$		2		
		$\overline{\text{CLKEN}}$ after CLK $\downarrow$		1		

**switching characteristics over recommended ranges of supply voltage and operating free-air temperature,  $C_L = 50$  pF (unless otherwise noted) (see Figure 1)**

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 5\text{ V}, T_A = 25^\circ\text{C}$			SN54ABT16600		SN74ABT16600		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
$f_{\text{max}}$			150			150		150		MHz
$t_{\text{PLH}}$	A or B	B or A	1.5	2.5	3.6	1.5	4.2	1.5	4	ns
$t_{\text{PHL}}$			1.5	3.2	4.5	1.5	5.1	1.5	4.9	
$t_{\text{PLH}}$	LEAB or LEBA	B or A	2	3.2	4.5	2	5.6	2	5	ns
$t_{\text{PHL}}$			2	3.4	4.5	2	5.4	2	5	
$t_{\text{PLH}}$	$\overline{\text{CLKAB}}$ or $\overline{\text{CLKBA}}$	B or A	2	3.5	4.7	2	5.4	2	5.3	ns
$t_{\text{PHL}}$			2	3.5	4.3	2	5.2	2	5	
$t_{\text{PZH}}$	$\overline{\text{OEAB}}$ or $\overline{\text{OEBA}}$	B or A	1.5	3.4	4.6	1.5	5.3	1.5	5.1	ns
$t_{\text{PZL}}$			2	3.8	4.7	2	5.6	2	5.4	
$t_{\text{PHZ}}$	$\overline{\text{OEAB}}$ or $\overline{\text{OEBA}}$	B or A	2	4.5	5.4	2	6.6	2	6.2	ns
$t_{\text{PLZ}}$			1.5	3.4	4.7	1.5	5.8	1.5	5.4	

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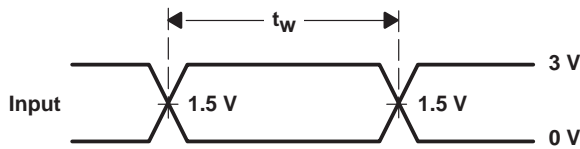
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**PARAMETER MEASUREMENT INFORMATION**

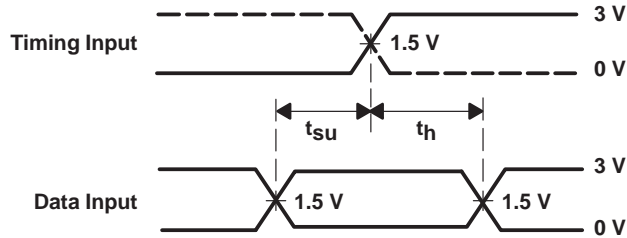


TEST	S1
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	7 V
$t_{PHZ}/t_{PZH}$	Open

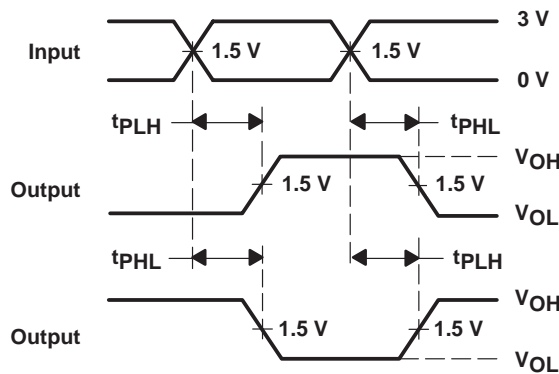
**LOAD CIRCUIT**



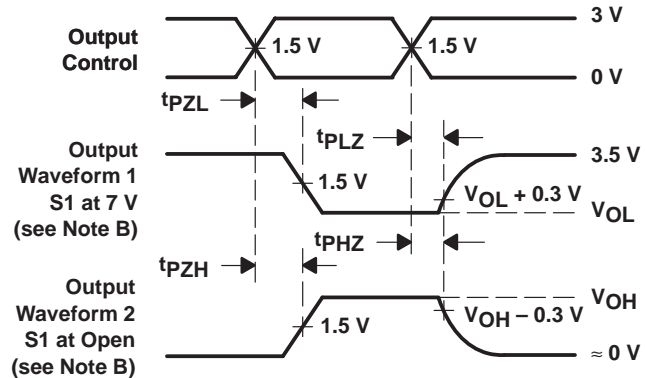
**VOLTAGE WAVEFORMS**  
**PULSE DURATION**



**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:  $PRR \leq 10$  MHz,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5$  ns,  $t_f \leq 2.5$  ns.  
 D. The outputs are measured one at a time with one transition per measurement.

**Figure 1. Load Circuit and Voltage Waveforms**



**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
74ABT16600DGGRE4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ABT16600DGGRG4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ABT16600DGGR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ABT16600DL	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ABT16600DLG4	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ABT16600DLR	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ABT16600DLRG4	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

**OBSELETE:** TI has discontinued the production of the device.

<sup>(2)</sup> 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)

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

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**TAPE AND REEL INFORMATION**



**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**



\*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
SN74ABT16600DGGR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1
SN74ABT16600DLR	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)
SN74ABT16600DGGR	TSSOP	DGG	56	2000	346.0	346.0	41.0
SN74ABT16600DLR	SSOP	DL	56	1000	346.0	346.0	49.0

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