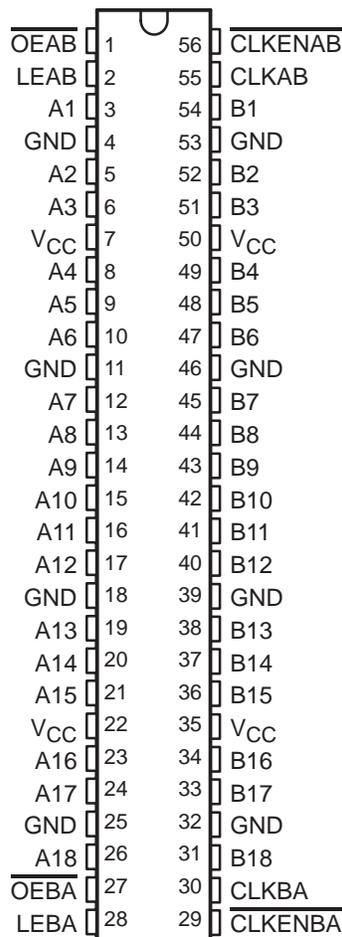


# SN54ABT16601, SN74ABT16601 18-BIT UNIVERSAL BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS210C – JUNE 1992 – REVISED JANUARY 1997

- **Members of the Texas Instruments Widebus™ Family**
- **State-of-the-Art EPIC-II B™ 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**
- **Latch-Up Performance Exceeds 500 mA Per JEDEC Standard JESD-17**
- **Typical  $V_{OLP}$  (Output Ground Bounce) < 0.8 V at  $V_{CC} = 5 V$ ,  $T_A = 25^\circ C$**
- **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**

SN54ABT16601 . . . WD PACKAGE  
SN74ABT16601 . . . DGG OR DL PACKAGE  
(TOP VIEW)



## 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 (LEAB and LEBA), and clock (CLKAB and 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 LEAB is high. When LEAB is low, the A data is latched if CLKAB is held at a high or low logic level. If LEAB is low, the A data is stored in the latch/flip-flop on the low-to-high transition of 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.

Data flow for B to A is similar to that of A to B, but uses  $\overline{OEBA}$ , LEBA, 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 SN54ABT16601 is characterized for operation over the full military temperature range of  $-55^\circ C$  to  $125^\circ C$ . The SN74ABT16601 is characterized for operation from  $-40^\circ C$  to  $85^\circ C$ .



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.

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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  
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**SN54ABT16601, SN74ABT16601**  
**18-BIT UNIVERSAL BUS TRANSCEIVERS**  
**WITH 3-STATE OUTPUTS**

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**FUNCTION TABLE†**

INPUTS					OUTPUT B
CLKENAB	OEAB	LEAB	CLKAB	A	
X	H	X	X	X	Z
X	L	H	X	L	L
X	L	H	X	H	H
H	L	L	X	X	B <sub>0</sub> ‡
H	L	L	X	X	B <sub>0</sub> ‡
L	L	L	↑	L	L
L	L	L	↑	H	H
L	L	L	L	X	B <sub>0</sub> ‡
L	L	L	H	X	B <sub>0</sub> §

† A-to-B data flow is shown; B-to-A flow is similar but uses OEBA, LEBA, CLKBA, and CLKENBA.

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

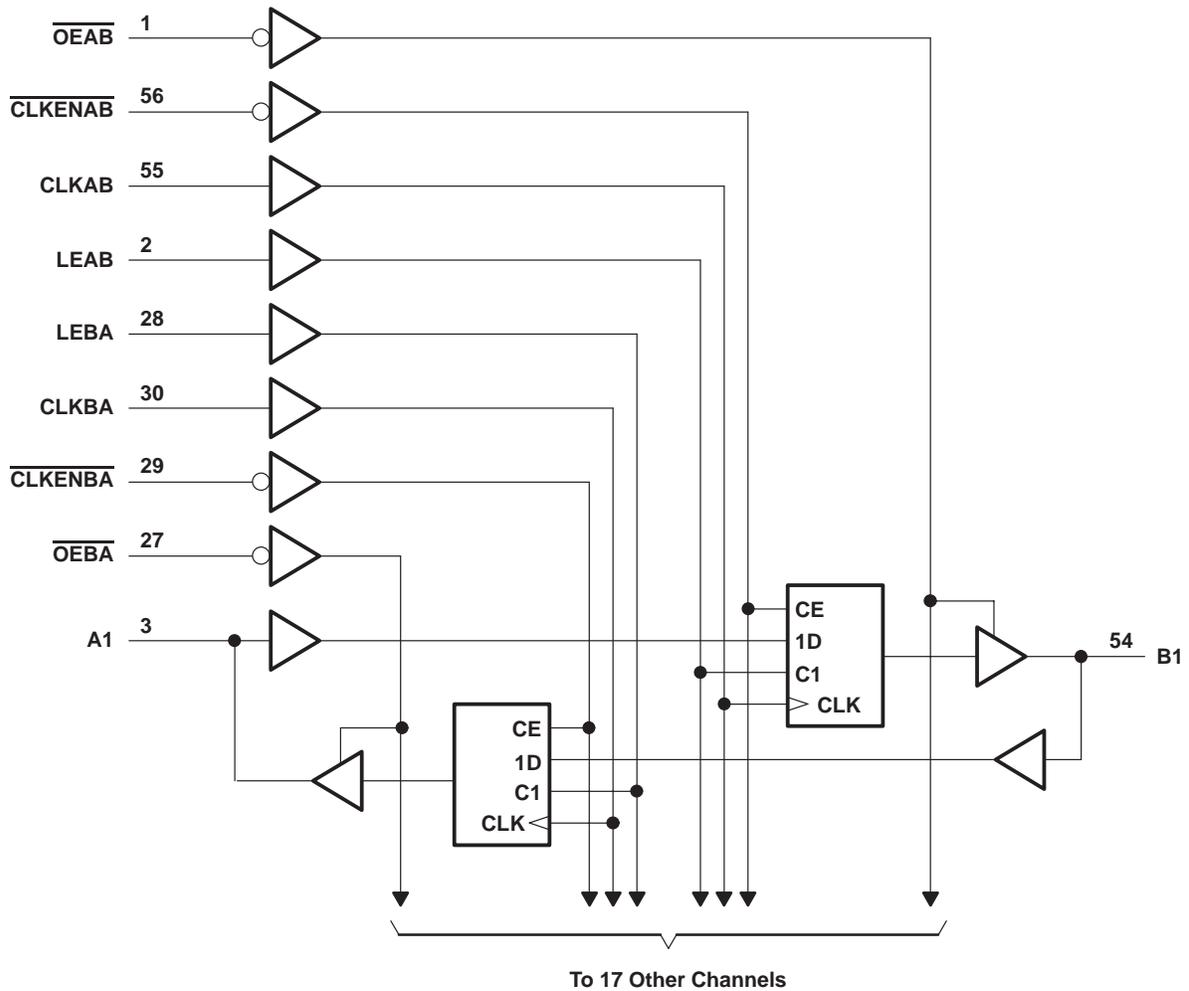
§ Output level before the indicated steady-state input conditions were established, provided that CLKAB was low before LEAB went low



**SN54ABT16601, SN74ABT16601**  
**18-BIT UNIVERSAL BUS TRANSCEIVERS**  
**WITH 3-STATE OUTPUTS**

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**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, $I_{OL}$ : SN54ABT16601 .....	96 mA
SN74ABT16601 .....	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.



# SN54ABT16601, SN74ABT16601 18-BIT UNIVERSAL BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

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## recommended operating conditions (see Note 3)

		SN54ABT16601		SN74ABT16601		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: 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	$T_A = 25^\circ\text{C}$			SN54ABT16601		SN74ABT16601		UNIT	
		MIN	TYP†	MAX	MIN	MAX	MIN	MAX		
$V_{IK}$	$V_{CC} = 4.5\text{ V}$ , $I_I = -18\text{ mA}$			-1.2		-1.2		-1.2	V	
$V_{OH}$	$V_{CC} = 4.5\text{ V}$ , $I_{OH} = -3\text{ mA}$		2.5		2.5		2.5		V	
	$V_{CC} = 5\text{ V}$ , $I_{OH} = -3\text{ mA}$		3		3		3			
	$V_{CC} = 4.5\text{ V}$	$I_{OH} = -24\text{ mA}$		2		2				
								2		
$V_{OL}$	$V_{CC} = 4.5\text{ V}$	$I_{OL} = 48\text{ mA}$		0.55		0.55			V	
		$I_{OL} = 64\text{ mA}$		0.55*				0.55		
$V_{hys}$			100						mV	
$I_I$	Control inputs	$V_{CC} = 5.5\text{ V}$ , $V_I = V_{CC}$ or GND		$\pm 1$		$\pm 1$		$\pm 1$	$\mu\text{A}$	
	A or B ports			$\pm 20^{**}$		$\pm 100$		$\pm 20$		
$I_{off}$	$V_{CC} = 0$ , $V_I$ or $V_O \leq 4.5\text{ V}$			$\pm 100$				$\pm 100$	$\mu\text{A}$	
$I_{CEX}$	$V_{CC} = 5.5\text{ V}$ , $V_O = 5.5\text{ V}$	Outputs high		50		50		50	$\mu\text{A}$	
$I_O^\ddagger$	$V_{CC} = 5.5\text{ V}$ , $V_O = 2.5\text{ V}$		-50	-100	-180	-50	-180	-50	-180	mA
$I_{OZH}^\S$	$V_{CC} = 5.5\text{ V}$ , $V_O = 2.7\text{ V}$			10		10		10	$\mu\text{A}$	
$I_{OZL}^\S$	$V_{CC} = 5.5\text{ V}$ , $V_O = 0.5\text{ V}$			-10		-10		-10	$\mu\text{A}$	
$I_{CC}$	A or B ports	$V_{CC} = 5.5\text{ V}$ , $I_O = 0$ , $V_I = V_{CC}$ or GND	Outputs high	1.9	3		2		3	mA
		Outputs low	28	36		35		36		
		Outputs disabled	1.6	3		2		3		
$\Delta I_{CC}^\parallel$	$V_{CC} = 5.5\text{ V}$ , One input at 3.4 V, Other inputs at $V_{CC}$ or GND			50				50	$\mu\text{A}$	
						1.5			mA	
$C_i$	Control inputs	$V_I = 2.5\text{ V}$ or $0.5\text{ V}$		3					pF	
$C_{iO}$	A or B ports	$V_O = 2.5\text{ V}$ or $0.5\text{ V}$		9					pF	

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

\*\* This limit applies only to the SN74ABT16601.

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

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

§ The parameters  $I_{OZH}$  and  $I_{OZL}$  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  $V_{CC}$  or GND.



# SN54ABT16601, SN74ABT16601 18-BIT UNIVERSAL BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

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

		SN54ABT16601		SN74ABT16601		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 CLKAB $\uparrow$ or B before CLKBA $\uparrow$		4.6		ns
		A before LEAB $\downarrow$ or B before LEBA $\downarrow$	CLK high	2.5		
			CLK low	1.3		
		CLKEN before CLK $\uparrow$		2.9		
$t_h$	Hold time	A after CLKAB $\uparrow$ or B after CLKBA $\uparrow$		0.4		ns
		A after LEAB $\downarrow$ or B after LEBA $\downarrow$		2.8		
		CLKEN after CLK $\uparrow$		0		

**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)	SN54ABT16601				UNIT	
			$V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$			MIN		MAX
			MIN	TYP	MAX			
$f_{\text{max}}$			150	200		150	MHz	
$t_{\text{PLH}}$	A or B	B or A	1.5	2.5	4.1	1	4.6	ns
$t_{\text{PHL}}$			1.5	3.4	4.7	1	5.1	
$t_{\text{PLH}}$	LEAB or LEBA	B or A	2	3.4	4.7	1	5.6	ns
$t_{\text{PHL}}$			2	3.7	5	1	5.5	
$t_{\text{PLH}}$	CLKAB or CLKBA	B or A	1.5	3.2	4.5	1	5.2	ns
$t_{\text{PHL}}$			1.5	3.2	4.4	1	5	
$t_{\text{PZH}}$	$\overline{\text{OEAB}}$ or $\overline{\text{OEBA}}$	B or A	2	4	5	1	5.7	ns
$t_{\text{PZL}}$			2	4.2	5.6	1	6	
$t_{\text{PHZ}}$	$\overline{\text{OEAB}}$ or $\overline{\text{OEBA}}$	B or A	2	4.5	5.8	1	6.8	ns
$t_{\text{PLZ}}$			1.5	3.4	5.3	1	6.3	

**SN54ABT16601, SN74ABT16601**  
**18-BIT UNIVERSAL BUS TRANSCEIVERS**  
**WITH 3-STATE OUTPUTS**

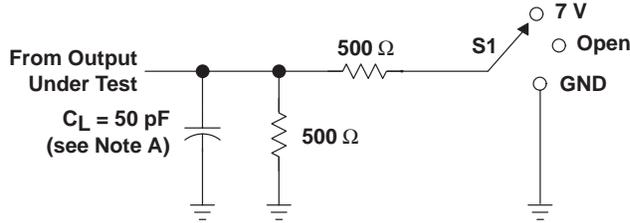
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switching characteristics over recommended ranges of supply voltage and operating free-air temperature,  $C_L = 50$  pF (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN74ABT16601				UNIT	
			$V_{CC} = 5$ V, $T_A = 25^\circ$ C			MIN		MAX
			MIN	TYP	MAX			
$f_{max}$			150	200		150	MHz	
$t_{PLH}$	A or B	B or A	1.5	2.5	3.6	1.5	4	ns
$t_{PHL}$			1.5	3.4	4.7	1.5	4.9	
$t_{PLH}$	LEAB or LEBA	B or A	2	3.4	4.7	2	5	ns
$t_{PHL}$			2	3.7	5	2	5.2	
$t_{PLH}$	CLKAB or CLKBA	B or A	1.5	3.2	4.5	1.5	4.7	ns
$t_{PHL}$			1.5	3.2	4.4	1.5	4.6	
$t_{PZH}$	$\overline{OEAB}$ or $\overline{OEBA}$	B or A	2	4	5	2	5.5	ns
$t_{PZL}$			2	4.2	5.6	2	5.8	
$t_{PHZ}$	$\overline{OEAB}$ or $\overline{OEBA}$	B or A	2	4.5	5.4	2	6.2	ns
$t_{PLZ}$			1.5	3.4	4.7	1.5	5.4	

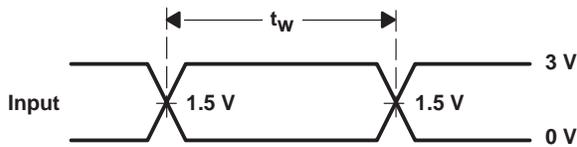


PARAMETER MEASUREMENT INFORMATION

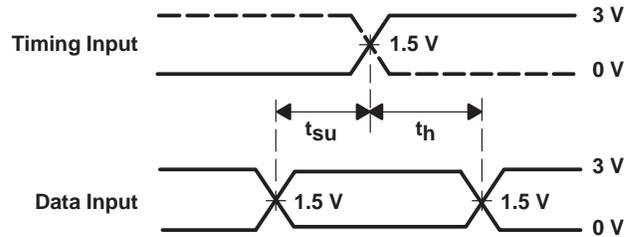


LOAD CIRCUIT

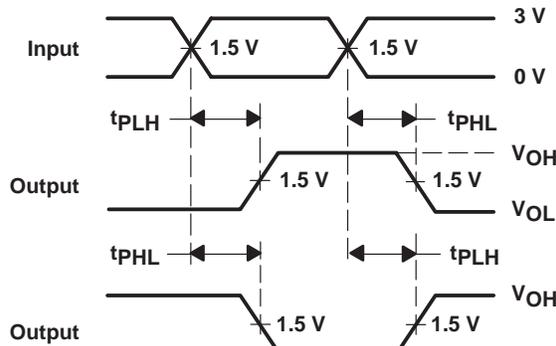
TEST	S1
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	7 V
$t_{PHZ}/t_{PZH}$	Open



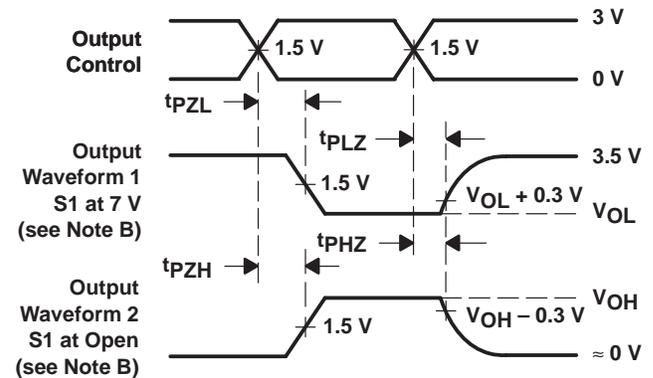
VOLTAGE WAVEFORMS  
PULSE DURATION



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 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>	Samples (Requires Login)
5962-9467101QXA	ACTIVE	CFP	WD	56	1	TBD	Call TI	Call TI	
74ABT16601DGGRE4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
74ABT16601DGGRG4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74ABT16601DGGR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74ABT16601DL	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74ABT16601DLG4	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74ABT16601DLR	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74ABT16601DLRG4	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SNJ54ABT16601WD	ACTIVE	CFP	WD	56	1	TBD	A42	N / A for Pkg Type	

<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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**OTHER QUALIFIED VERSIONS OF SN54ABT16601, SN74ABT16601 :**

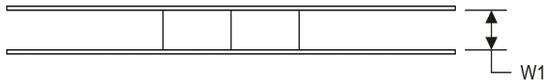
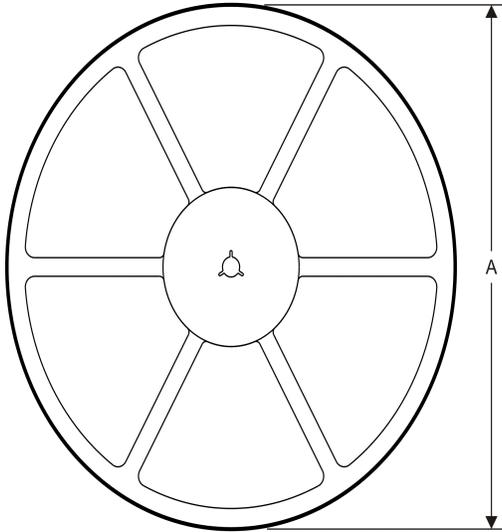
- Catalog: [SN74ABT16601](#)
- Military: [SN54ABT16601](#)

NOTE: Qualified Version Definitions:

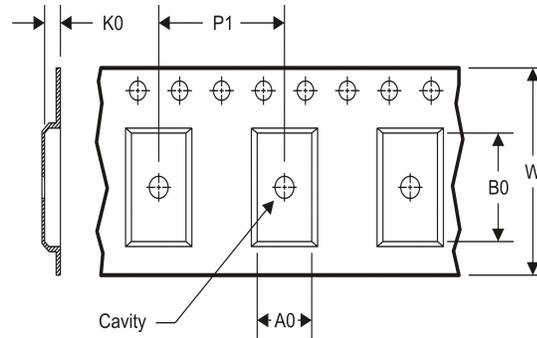
- Catalog - TI's standard catalog product
- Military - QML certified for Military and Defense Applications

**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
SN74ABT16601DGGR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1
SN74ABT16601DLR	SSOP	DL	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1

**TAPE AND REEL BOX DIMENSIONS**

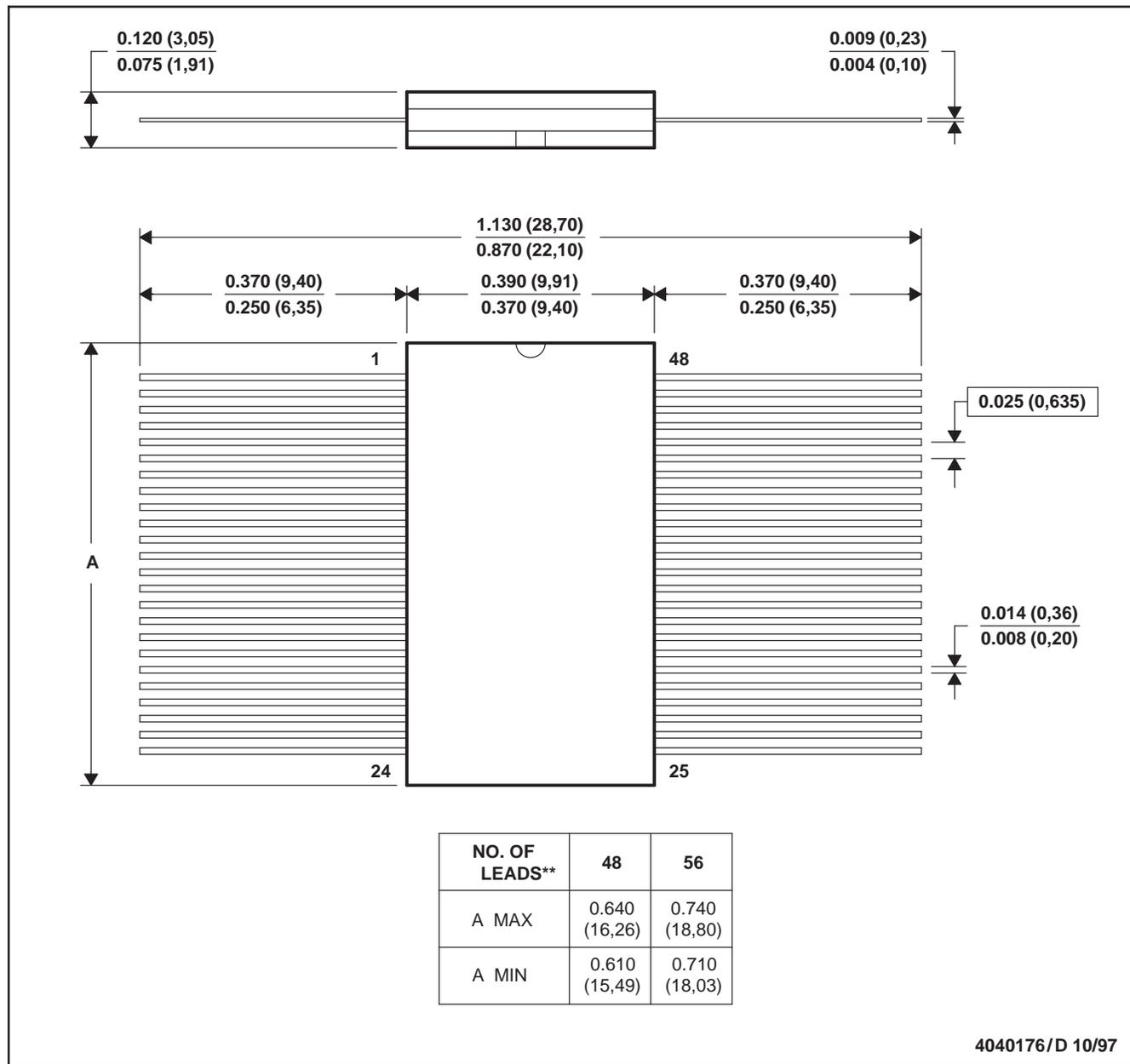

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ABT16601DGGR	TSSOP	DGG	56	2000	367.0	367.0	45.0
SN74ABT16601DLR	SSOP	DL	56	1000	367.0	367.0	55.0

WD (R-GDFP-F\*\*)

CERAMIC DUAL FLATPACK

48 LEADS SHOWN

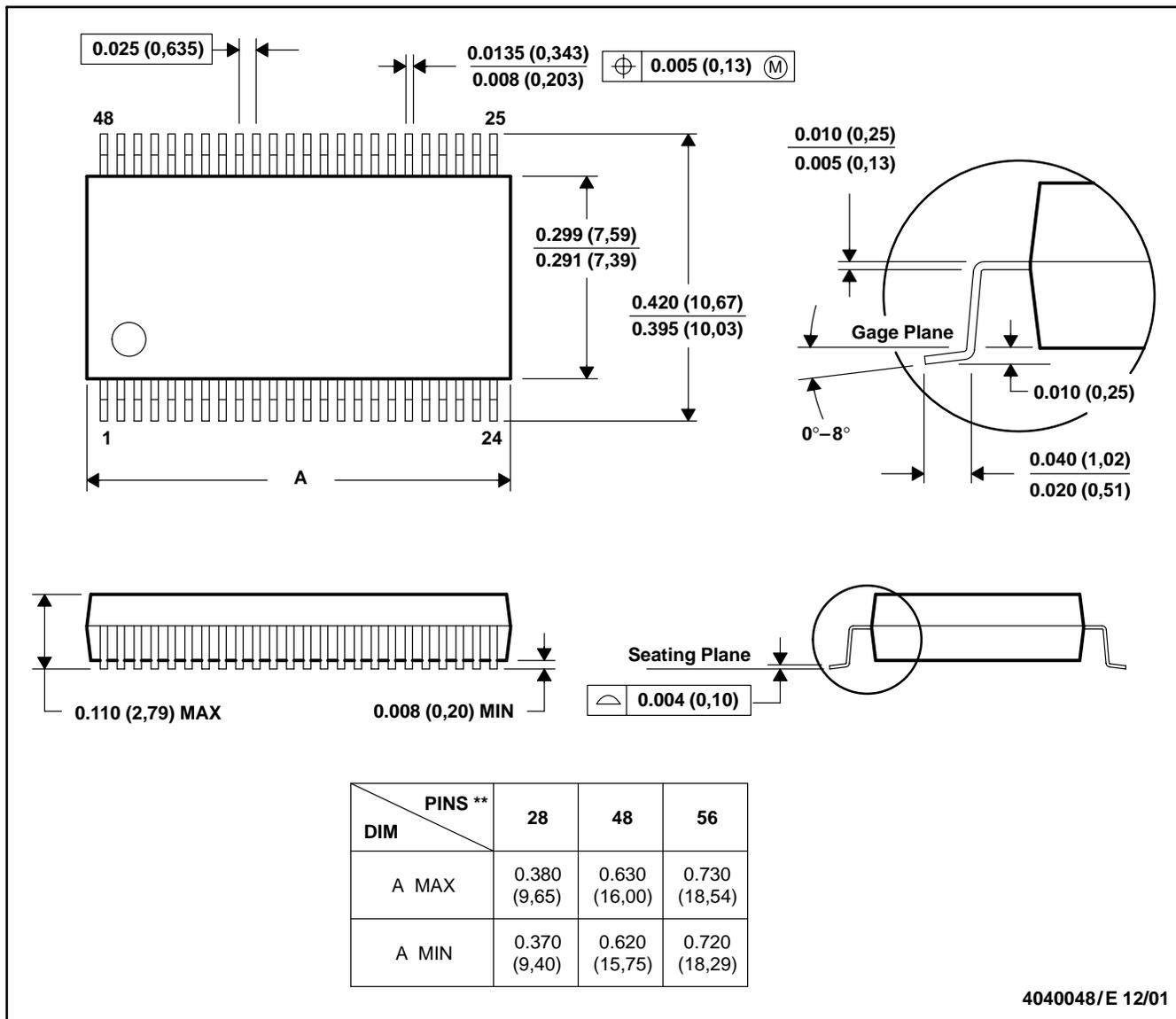


- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. This package can be hermetically sealed with a ceramic lid using glass frit.  
 D. Index point is provided on cap for terminal identification only  
 E. Falls within MIL STD 1835: GDFP1-F48 and JEDEC MO-146AA  
 GDFP1-F56 and JEDEC MO-146AB

DL (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

48 PINS SHOWN

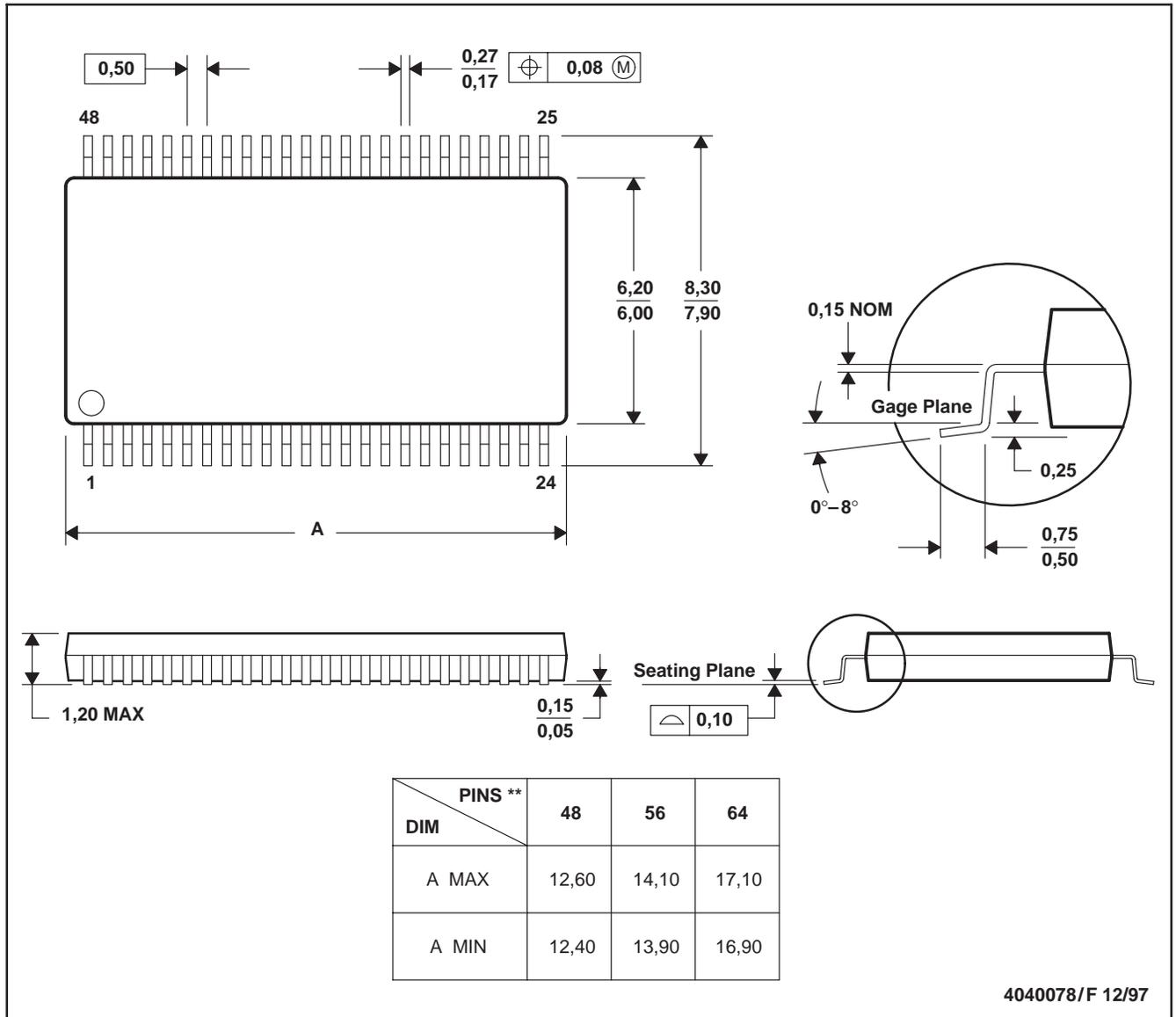


- NOTES: A. All linear dimensions are in inches (millimeters).  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).  
 D. Falls within JEDEC MO-118

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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