

# SN54ABT162601, SN74ABT162601 18-BIT UNIVERSAL BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS247G – AUGUST 1992 – REVISED JULY 1998

- **Members of the Texas Instruments Widebus™ Family**
- **B-Port Outputs Have Equivalent 25-Ω Series Resistors, So No External Resistors Are Required**
- **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 JESD 17**
- **Typical  $V_{OLP}$  (Output Ground Bounce)  $< 0.8$  V at  $V_{CC} = 5$  V,  $T_A = 25^\circ\text{C}$**
- **High-Impedance State During Power Up and Power Down**
- **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, and clocked 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 data is stored in the latch/flip-flop on the low-to-high 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. Data flow for B to A is similar to that of A to B but uses  $\overline{OEBA}$ ,  $\overline{LEBA}$ ,  $\overline{CLKBA}$ , and  $\overline{CLKENBA}$ .

The B-port outputs, which are designed to source or sink up to 12 mA, include equivalent 25-Ω series resistors to reduce overshoot and undershoot.

When  $V_{CC}$  is between 0 and 2.1 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 2.1 V,  $\overline{OE}$  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.

SN54ABT162601 . . . WD PACKAGE  
SN74ABT162601 . . . DGG OR DL PACKAGE  
(TOP VIEW)

$\overline{OEAB}$	1	56	$\overline{CLKENAB}$
$\overline{LEAB}$	2	55	$\overline{CLKAB}$
A1	3	54	B1
GND	4	53	GND
A2	5	52	B2
A3	6	51	B3
$V_{CC}$	7	50	$V_{CC}$
A4	8	49	B4
A5	9	48	B5
A6	10	47	B6
GND	11	46	GND
A7	12	45	B7
A8	13	44	B8
A9	14	43	B9
A10	15	42	B10
A11	16	41	B11
A12	17	40	B12
GND	18	39	GND
A13	19	38	B13
A14	20	37	B14
A15	21	36	B15
$V_{CC}$	22	35	$V_{CC}$
A16	23	34	B16
A17	24	33	B17
GND	25	32	GND
A18	26	31	B18
$\overline{OEBA}$	27	30	$\overline{CLKBA}$
$\overline{LEBA}$	28	29	$\overline{CLKENBA}$



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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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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.

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#### description (continued)

The SN54ABT162601 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .  
The SN74ABT162601 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

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.

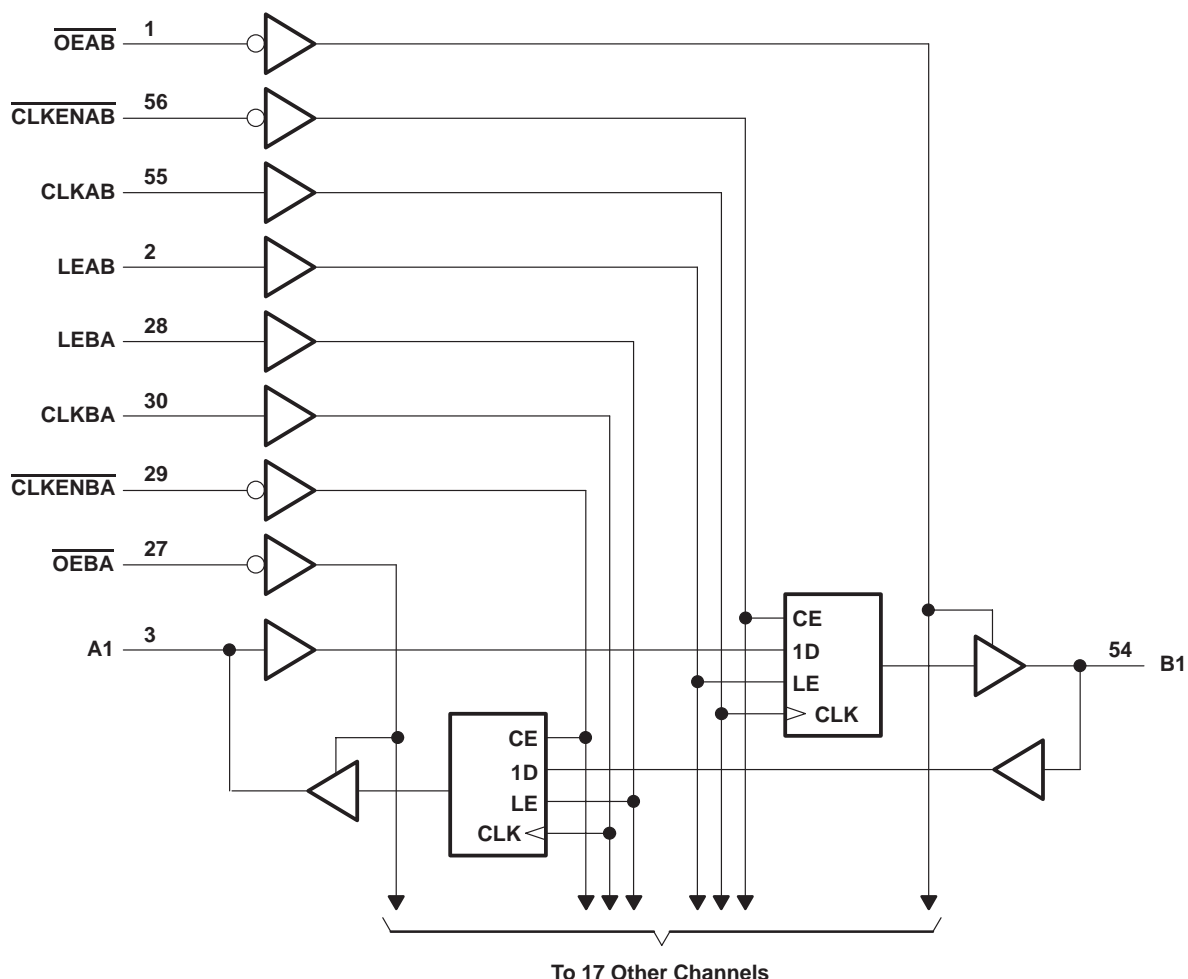
‡ Output level before the indicated steady-state input conditions were established

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

# SN54ABT162601, SN74ABT162601 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)<sup>†</sup>

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, $I_O$ : SN54ABT162601 (A port)	96 mA
SN74ABT162601 (A port)	128 mA
B port	30 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

<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.

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

			SN54ABT162601		SN74ABT162601		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	A port		–24		–32	mA
		B port		–12		–12	
$I_{OL}$	Low-level output current	A port		48		64	mA
		B port		12		12	
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled		10		10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200		200		$\mu s/V$
$T_A$	Operating free-air temperature		–55	125	–40	85	°C

NOTE 3: All unused inputs of the devices must be held at  $V_{CC}$  or GND to ensure proper device operation. Refer to the TI application note, *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		T <sub>A</sub> = 25°C			SN54ABT162601		SN74ABT162601		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>	A port	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				
			I <sub>OH</sub> = -32 mA	2*					2		
	B port	V <sub>CC</sub> = 4.5 V, I <sub>OH</sub> = -1 mA		3.35			3.3		3.35		
		V <sub>CC</sub> = 5 V, I <sub>OH</sub> = -1 mA		3.85			3.8		3.85		
		V <sub>CC</sub> = 4.5 V	I <sub>OH</sub> = -3 mA	3.1			3		3.1		
			I <sub>OH</sub> = -12 mA	2.6					2.6		
V <sub>OL</sub>	A port	V <sub>CC</sub> = 4.5 V	I <sub>OL</sub> = 48 mA	0.55			0.55				V
	I <sub>OL</sub> = 64 mA		0.55*					0.55			
	B port	V <sub>CC</sub> = 4.5 V, I <sub>OL</sub> = 12 mA	0.8			0.8		0.8			
V <sub>hys</sub>				100							mV
I <sub>I</sub>	Control inputs	V <sub>CC</sub> = 0 to 5.5 V, V <sub>I</sub> = V <sub>CC</sub> or GND		±1			±1		±1		μA
	A or B ports	V <sub>CC</sub> = 2.1 V to 5.5 V, V <sub>I</sub> = V <sub>CC</sub> or GND		±20			±20		±20		
I <sub>OZPU</sub>		V <sub>CC</sub> = 0 to 2.1 V, V <sub>O</sub> = 0.5 V to 2.7 V, $\overline{OE}$ = X		±50			±50**		±50		μA
I <sub>OZPD</sub>		V <sub>CC</sub> = 2.1 V to 0, V <sub>O</sub> = 0.5 V to 2.7 V, $\overline{OE}$ = X		±50			±50**		±50		μA
I <sub>OZH</sub> ‡		V <sub>CC</sub> = 2.1 V to 5.5 V, V <sub>O</sub> = 2.7 V, $\overline{OE}$ ≥ 2 V		10			10		10		μA
I <sub>OZL</sub> ‡		V <sub>CC</sub> = 2.1 V to 5.5 V, V <sub>O</sub> = 0.5 V, $\overline{OE}$ ≥ 2 V		-10			-10		-10		μA
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> §	A port	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.5 V		-50	-100	-180	-50	-180	-50	-180	mA
	B port			-25	-55	-100	-25	-100	-25	-100	
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.

\*\* On products compliant to MIL-PRF-38535, this parameter is not production tested.

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

‡ The parameters I<sub>OZH</sub> and I<sub>OZL</sub> 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<sub>CC</sub> or GND.



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### WITH 3-STATE OUTPUTS

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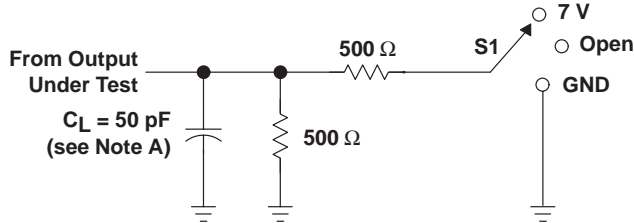
timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted)(see Figure 1)

				SN54ABT162601		SN74ABT162601		UNIT
				MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Clock frequency			0	150	0	150	MHz
t <sub>w</sub>	Pulse duration	LEAB or LEBA high		2.5		2.5		ns
		CLKAB or CLKBA high or low		3.3		3		
t <sub>su</sub>	Setup time	A before CLKAB↑ or B before CLKBA↑		4.8		4.3		ns
		A before LEAB↓ or B before LEBA↓	CLK high	2.5		2.5		
			CLK low	1.2		1		
		CLKEN before CLK↑		2.7		2.7		
t <sub>h</sub>	Hold time	A after CLKAB↑ or B after CLKBA↑		0.5		0		ns
		A after LEAB↓ or B after LEBA↓		2		0.5		
		CLKEN after CLK↑		0.5		0		

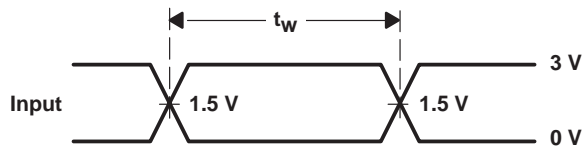
switching characteristics over recommended ranges of supply voltage and operating free-air temperature,  $C_L = 50$  pF (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$			SN54ABT162601		SN74ABT162601		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
$f_{\text{max}}$			150			150		150		MHz
$t_{\text{PLH}}$	A	B	1.5	2.8	4	1.5	5.1	1.5	4.8	ns
$t_{\text{PHL}}$			2	3.7	5.2	2	6.1	2	5.7	
$t_{\text{PLH}}$	B	A	1	2.5	3.6	1	4.5	1	4	ns
$t_{\text{PHL}}$			2	3.3	4.5	2	5.1	2	4.9	
$t_{\text{PLH}}$	LEBA	A	2	3.3	4.5	2	5.6	2	5	ns
$t_{\text{PHL}}$			2	3.6	4.7	2	5.4	2	5	
$t_{\text{PLH}}$	LEAB	B	2	3.4	4.8	2	6.1	2	5.6	ns
$t_{\text{PHL}}$			2	3.8	5.2	2	6.4	2	5.9	
$t_{\text{PLH}}$	CLKBA	A	1.5	3.1	4.7	1.5	5.4	1.5	5.3	ns
$t_{\text{PHL}}$			1.5	3.1	4.3	1.5	5.2	1.5	5	
$t_{\text{PLH}}$	CLKAB	B	1.5	3.3	4.7	1.5	6	1.5	5.5	ns
$t_{\text{PHL}}$			1.5	3.5	4.8	1.5	5.8	1.5	5.3	
$t_{\text{PZH}}$	$\overline{\text{OEBA}}$	A	2	3.5	4.6	2	5.5	2	5.1	ns
$t_{\text{PZL}}$			2	3.7	4.7	2	5.8	2	5.4	
$t_{\text{PZH}}$	$\overline{\text{OEAB}}$	B	2	3.8	5.3	1.5	6.6	2	6.1	ns
$t_{\text{PZL}}$			2	3.6	5.1	2	6.2	2	5.7	
$t_{\text{PHZ}}$	$\overline{\text{OEBA}}$	A	2	3.6	5.4	1.4	6.6	2	6.2	ns
$t_{\text{PLZ}}$			1.5	3.2	4.7	1.5	5.8	1.5	5.4	
$t_{\text{PHZ}}$	$\overline{\text{OEAB}}$	B	2	3.4	4.8	1.4	5.6	2	5.4	ns
$t_{\text{PLZ}}$			1.5	3.2	4.5	1.5	5.7	1.5	5.2	

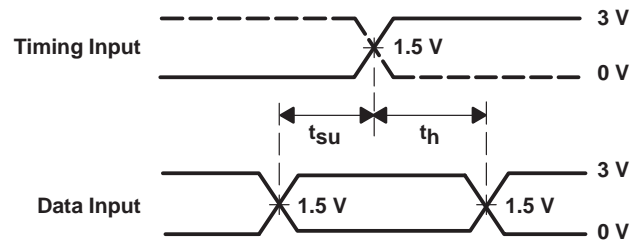
## PARAMETER MEASUREMENT INFORMATION



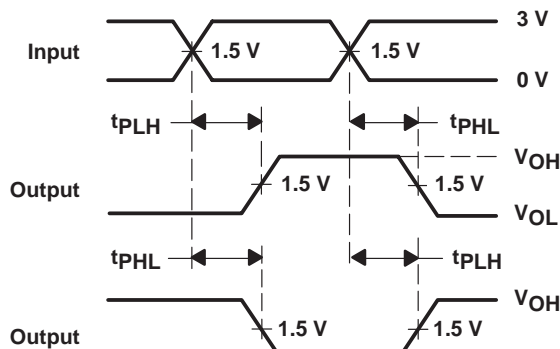
LOAD CIRCUIT



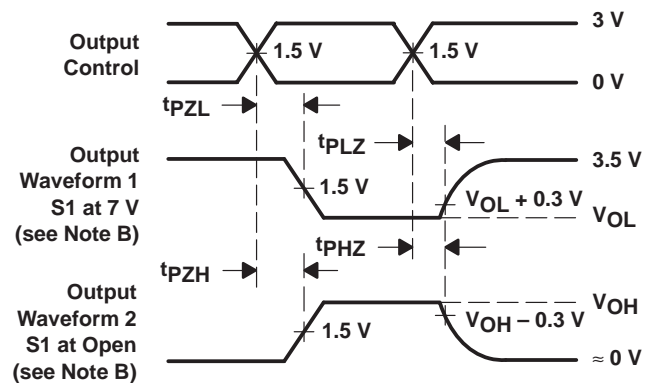
VOLTAGE WAVEFORMS  
PULSE DURATION



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:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5 \text{ ns}$ ,  $t_f \leq 2.5 \text{ ns}$ .  
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 (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
5962-9859301QXA	ACTIVE	CFP	WD	56	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-9859301QX A SNJ54ABT162601 WD	<a href="#">Samples</a>
74ABT162601DGGRE4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT162601	<a href="#">Samples</a>
74ABT162601DGGRG4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT162601	<a href="#">Samples</a>
74ABT162601DLRG4	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT162601	<a href="#">Samples</a>
SN74ABT162601DGGR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT162601	<a href="#">Samples</a>
SN74ABT162601DLG4	ACTIVE	SSOP	DL	56		TBD	Call TI	Call TI	-40 to 85	ABT162601	<a href="#">Samples</a>
SN74ABT162601DLR	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT162601	<a href="#">Samples</a>
SNJ54ABT162601WD	ACTIVE	CFP	WD	56	1	TBD	A42	N / A for Pkg Type	-55 to 125	5962-9859301QX A SNJ54ABT162601 WD	<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.

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**OTHER QUALIFIED VERSIONS OF SN54ABT162601, SN74ABT162601 :**

- Catalog: [SN74ABT162601](#)
- Military: [SN54ABT162601](#)

**NOTE: Qualified Version Definitions:**

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

**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
SN74ABT162601DGGR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1
SN74ABT162601DLR	SSOP	DL	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1

## TAPE AND REEL BOX DIMENSIONS



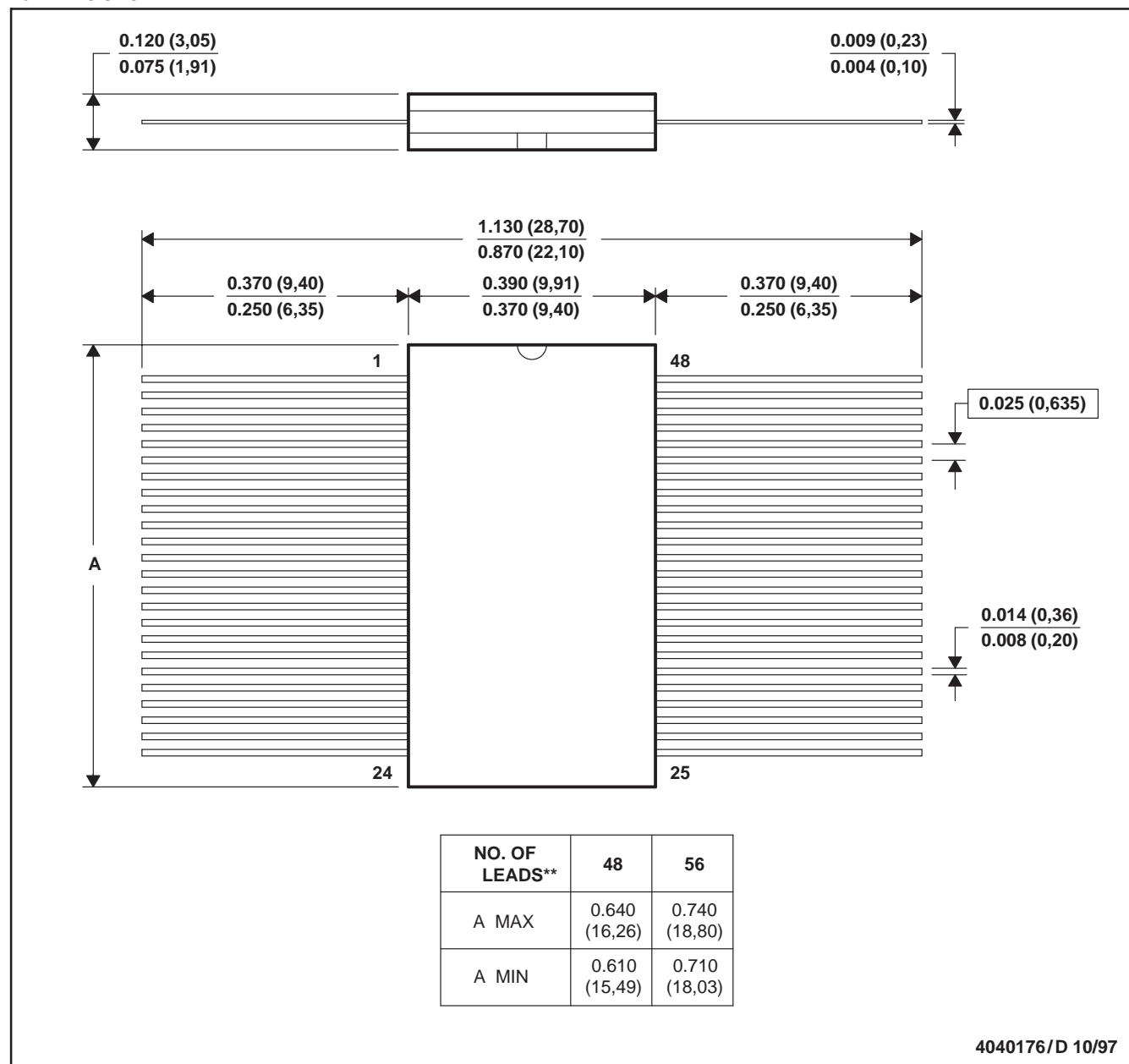
\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ABT162601DGGR	TSSOP	DGG	56	2000	367.0	367.0	45.0
SN74ABT162601DLR	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-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

## 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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