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# SN54ABT162501, SN74ABT162501 18-BIT UNIVERSAL BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS243E – SEPTEMBER 1992 – REVISED FEBRUARY 1999

- **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*™ BiCMOS Design Significantly Reduces Power Dissipation**
- ***UBT*™ (Universal Bus Transceiver) Combines D-Type Latches and D-Type Flip-Flops for Operation in Transparent, Latched, or Clocked Mode**
- **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**
- **Latch-Up Performance Exceeds 500 mA Per JESD 17**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model ( $C = 200$  pF,  $R = 0$ )**
- **Package Options Include Plastic 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**

SN54ABT162501 . . . WD PACKAGE  
SN74ABT162501 . . . DGG OR DL PACKAGE  
(TOP VIEW)

OEAB	1	56	GND
LEAB	2	55	CLKAB
A1	3	54	B1
GND	4	53	GND
A2	5	52	B2
A3	6	51	B3
V <sub>CC</sub>	7	50	V <sub>CC</sub>
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 <sub>CC</sub>	22	35	V <sub>CC</sub>
A16	23	34	B16
A17	24	33	B17
GND	25	32	GND
A18	26	31	B18
OEBA	27	30	CLKBA
LEBA	28	29	GND

## description

These 18-bit universal bus transceivers consist of storage elements that can operate either as D-type latches or D-type flip-flops to allow data flow in transparent or clocked modes.

Data flow in each direction is controlled by output-enable (OEAB and  $\overline{\text{OEBA}}$ ), latch-enable (LEAB and LEBA), and clock (CLKAB and CLKBA) 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. When OEAB is high, the outputs are active. When OEAB is low, the outputs are in the high-impedance state.

Data flow for B to A is similar to that of A to B but uses  $\overline{\text{OEBA}}$ , LEBA, and CLKBA. The output enables are complementary (OEAB is active high and  $\overline{\text{OEBA}}$  is active low).

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.



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## description (continued)

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 and OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sinking/current-sourcing capability of the driver.

The SN54ABT162501 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74ABT162501 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

FUNCTION TABLE†

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

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

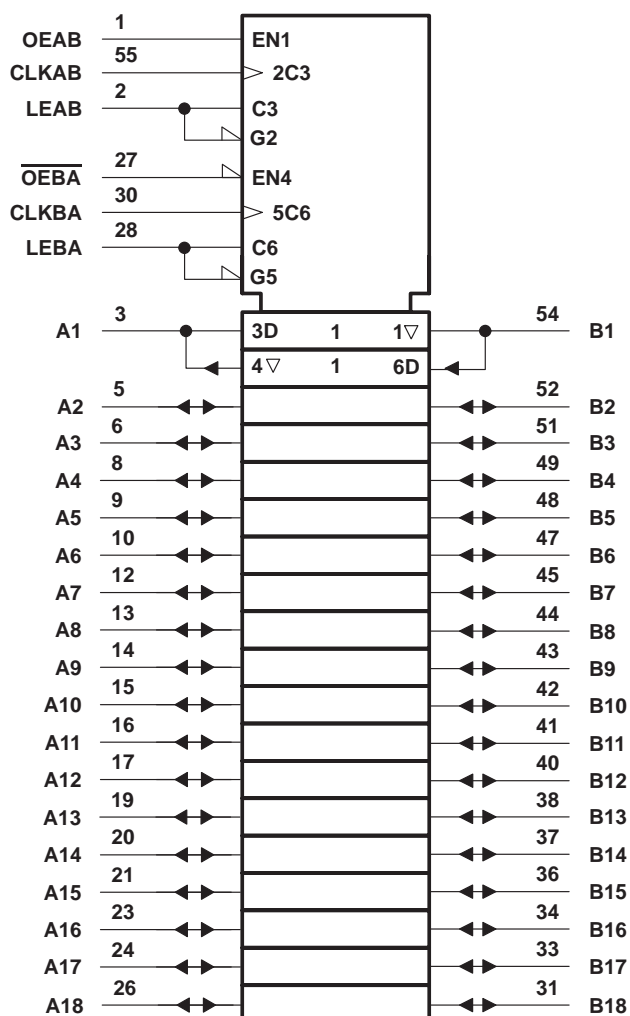
‡ Output level before the indicated steady-state input conditions were established, provided that CLKAB was high before LEAB went low

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

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**logic symbol†**



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



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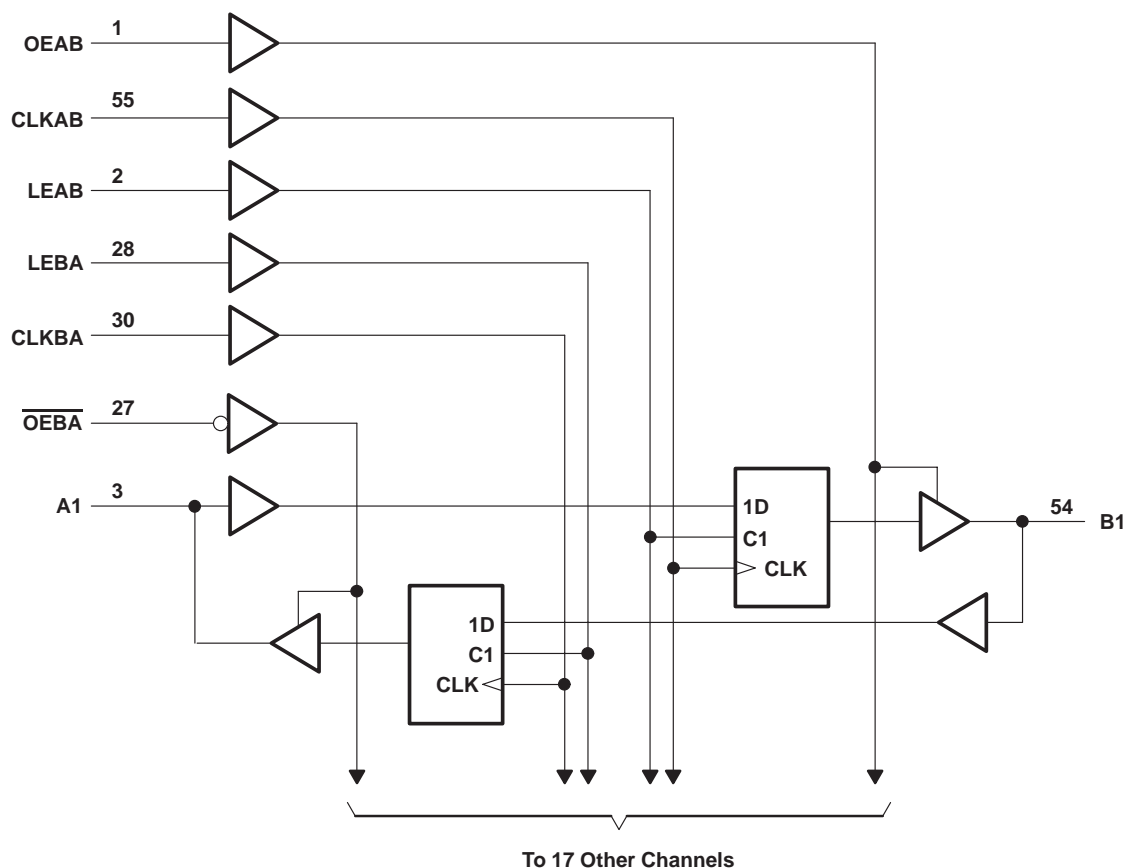
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## 18-BIT UNIVERSAL BUS TRANSCEIVERS

### 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, $I_O$ : SN54ABT162501 (A port)	96 mA
SN74ABT162501 (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)

			SN54ABT162501		SN74ABT162501		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	$^{\circ}$ 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.

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## 18-BIT UNIVERSAL BUS TRANSCEIVERS

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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			SN54ABT162501		SN74ABT162501		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, $\overline{OE}$ or 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, $\overline{OE}$ or 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, $\overline{OE} \geq 2$ V or OE ≤ 0.8 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, $\overline{OE} \geq 2$ V or OE ≤ 0.8 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>	Outputs high	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 5.5 V			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	-110	-180	-50	-180	-50	-180	mA
	B port	V <sub>CC</sub> = 5.5 V, V <sub>O</sub> = 2.5 V	-25	-55	-90	-25	-90	-25	-90	
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								mA
		Outputs high			3		3		3	
		Outputs low			36		36		36	
ΔI <sub>CC</sub> #		Outputs disabled			3		3		3	μA
		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	
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.

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

\$ For V<sub>CC</sub> between 2.1 V and 4 V, OE should be less than or equal to 0.5 V to ensure a low state.

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

				SN54ABT162501		SN74ABT162501		UNIT
				MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Clock frequency			150		150		MHz
t <sub>w</sub>	Pulse duration	LEAB or LEBA high		3		3		ns
		CLKAB or CLKBA high or low		3.3		3.3		
t <sub>su</sub>	Setup time	A before CLKAB↑		4.3		4.3		ns
		B before CLKBA↑		4.3		4.3		
		A before LEAB↓ or B before LEBA↓	CLK high	2.5		2.5		
			CLK low	1		1		
t <sub>h</sub>	Hold time	A after CLKAB↑ or B after CLKBA↑		0		0		ns
		A after LEAB↓ or B after LEBA↓		2		2		

switching characteristics over recommended ranges of supply voltage and operating free-air temperature, C<sub>L</sub> = 50 pF (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 5 V, T <sub>A</sub> = 25°C			SN54ABT162501		SN74ABT162501		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f <sub>max</sub>			150	200		150		150		MHz
t <sub>PLH</sub>	A or B	B or A	1.5	2.6	4	1.5	5.1	1.5	4.8	ns
t <sub>PHL</sub>			2	3.4	5.2	2	6.1	2	5.7	
t <sub>PLH</sub>	LEAB or LEBA	B or A	2	3.3	4.8	2	6.1	2	5.6	ns
t <sub>PHL</sub>			2	3.8	5.2	2	6.4	2	5.9	
t <sub>PLH</sub>	CLKAB or CLKBA	B or A	1.5	3.5	4.7	1.5	6	1.5	5.5	ns
t <sub>PHL</sub>			1.5	3.5	4.8	1.5	5.8	1.5	5.3	
t <sub>PZH</sub>	OEAB or OEBA	B or A	1.5	3.4	4.6	1.5	5.6	1.5	5.3	ns
t <sub>PZL</sub>			2	3.8	4.7	2	5.6	2	5.4	
t <sub>PHZ</sub>	OEAB or OEBA	B or A	2	4.5	5.7	2	6.9	2	6.5	ns
t <sub>PLZ</sub>			1.5	3.8	5.3	1.5	6.3	1.5	5.8	

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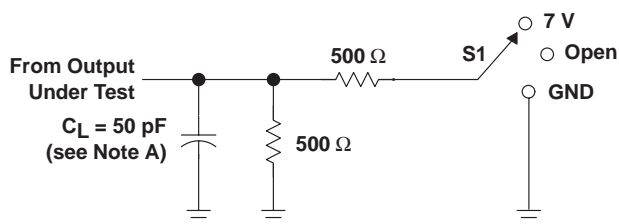
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## 18-BIT UNIVERSAL BUS TRANSCEIVERS

### WITH 3-STATE OUTPUTS

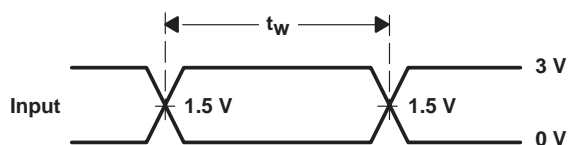
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#### PARAMETER MEASUREMENT INFORMATION

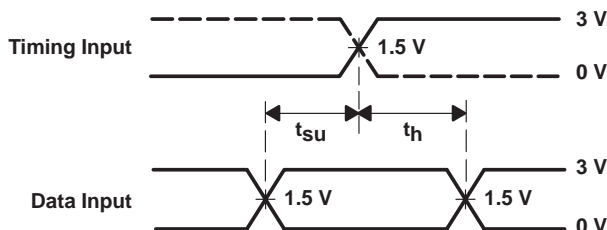


LOAD CIRCUIT

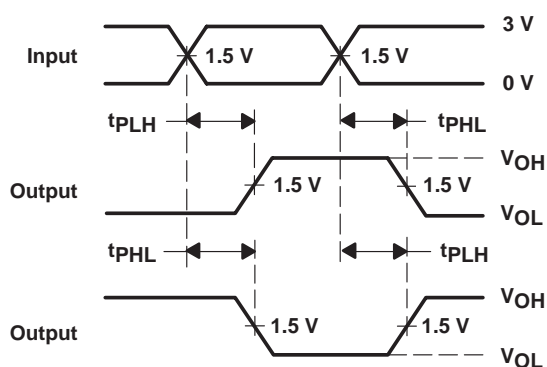
TEST	S1
$t_{PLH}/t_{PHL}$	Open
$t_{PLZ}/t_{PZL}$	7 V
$t_{PHZ}/t_{PZH}$	Open



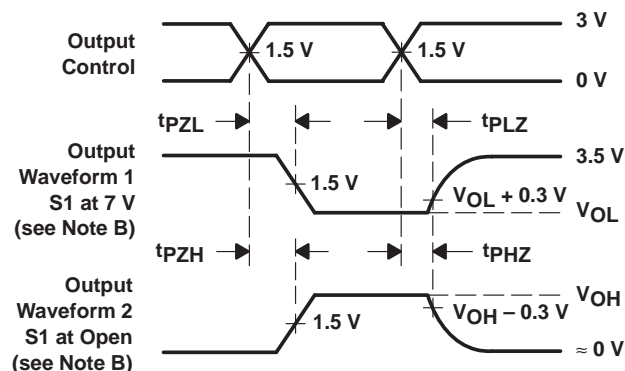
VOLTAGE WAVEFORMS  
PULSE DURATION



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)
74ABT162501DGGRE4	ACTIVE	TSSOP	DGG	56		TBD	Call TI	Call TI	
74ABT162501DGGRG4	ACTIVE	TSSOP	DGG	56		TBD	Call TI	Call TI	
74ABT162501DLRG4	ACTIVE	SSOP	DL	56		TBD	Call TI	Call TI	
SN74ABT162501DL	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74ABT162501DLG4	ACTIVE	SSOP	DL	56	20	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.

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**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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