

SN54ABT16501, SN74ABT16501 18-BIT UNIVERSAL BUS TRANSCEIVERS WITH 3-STATE OUTPUTS

SCBS086C – FEBRUARY 1991 – 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, or Clocked Mode
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)
- 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

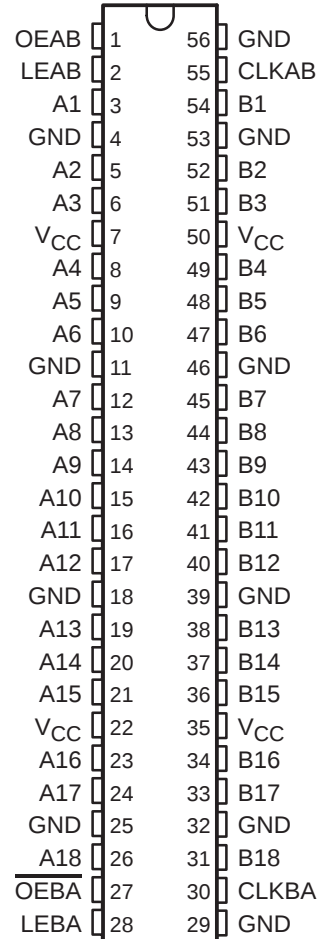
These 18-bit universal bus transceivers consist of storage elements that can operate either as D-type latches or D-type flip-flops to allow data flow in transparent or clocked modes.

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).

To ensure the high-impedance state during power up or power down, OE should be tied to GND through a pulldown resistor and $\overline{\text{OE}}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sourcing/current-sinking capability of the driver.

SN54ABT16501 . . . WD PACKAGE
SN74ABT16501 . . . DGG OR DL PACKAGE
(TOP VIEW)



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**TEXAS
INSTRUMENTS**

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SN54ABT16501, SN74ABT16501

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description (continued)

The SN54ABT16501 is characterized for operation over the full military temperature range of -55°C to 125°C .
The SN74ABT16501 is characterized for operation from -40°C to 85°C .

FUNCTION TABLE[†]

INPUTS				OUTPUT B
OEAB	LEAB	CLKAB	A	
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 [‡]
H	L	L	X	B ₀ [§]

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

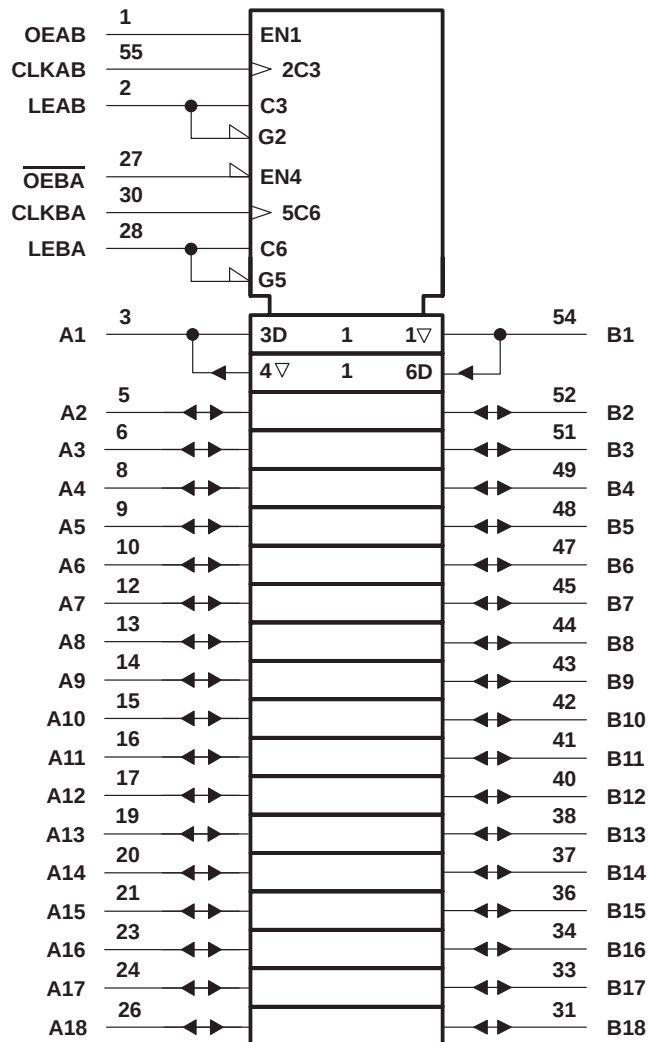
[‡] Output level before the indicated steady-state input conditions were established, provided that CLKAB was high before LEAB went low

[§] 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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The diagram illustrates a 17-channel multiplexer system. The inputs are labeled as follows:

- OEAB 1
- CLKAB 55
- LEAB 2
- LEBA 28
- CLKBA 30
- OEBA 27
- A1 3

The outputs are labeled as follows:

- B1 54

The system includes two multiplexer blocks, each labeled "1D C1". The first multiplexer has a "CLK" input. The second multiplexer has a "CLK" input. The outputs of the multiplexers are connected to a common bus, which is then connected to the output channels. The diagram also shows logic gates (AND, OR, NOT) and a clock signal (CLK) for the multiplexers.

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 : SN54ABT16501	96 mA
SN74ABT16501	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, θ_{JA} (see Note 2): DGG package	81°C/W
DL package	74°C/W
Storage temperature range, T_{Stg}	−65°C to 150°C

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.

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recommended operating conditions (see Note 3)

			SN54ABT16501		SN74ABT16501		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.

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

PARAMETER		TEST CONDITIONS		TA = 25°C			SN54ABT16501		SN74ABT16501		UNIT		
				MIN	TYP†	MAX	MIN	MAX	MIN	MAX			
VIK		VCC = 4.5 V, II = –18 mA		–1.2			–1.2		–1.2		V		
VOH		VCC = 4.5 V, IOH = –3 mA		2.5			2.5		2.5		V		
		VCC = 5 V, IOH = –3 mA		3			3		3				
		VCC = 4.5 V		IOH = –24 mA			2						
				IOH = –32 mA			2*			2			
VOL		VCC = 4.5 V		IOL = 48 mA		0.55			0.55		V		
				IOL = 64 mA		0.55*			0.55				
Vhys				100							mV		
II	Control inputs	VCC = 5.5 V, VI = VCC or GND		±1			±1		±1		µA		
	±100			±100		±100							
IOZH‡		VCC = 5.5 V, VO = 2.7 V		50			50		50		µA		
IOZL‡		VCC = 5.5 V, VO = 0.5 V		–50			–50		–50		µA		
Ioff		VCC = 0, VI or VO ≤ 4.5 V		±100					±100		µA		
ICEX		VCC = 5.5 V, VO = 5.5 V		Outputs high		50			50		µA		
IO§		VCC = 5.5 V, VO = 2.5 V		–50	–100	–180	–50	–180	–50	–180	mA		
ICC	A or B ports	VCC = 5.5 V, IO = 0, VI = VCC or GND		Outputs high		3			5		3		mA
				Outputs low		76			76		76		
				Outputs disabled		3.3			5.3		3.3		
ΔICC¶	Control inputs	VCC = 5.5 V, One input at 3.4 V, Other inputs at VCC or GND		5			6		5		mA		
	A or B ports			1.5			1.5		1.5				
Ci	Control inputs	VI = 2.5 V or 0.5 V		4							pF		
Cio	A or B ports	VO = 2.5 V or 0.5 V		8							pF		

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

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

‡ The parameters I_{OZH} and I_{OZL} 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_{CC} or GND.

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

				SN54ABT16501		SN74ABT16501		UNIT
				MIN	MAX	MIN	MAX	
f _{clock}	Clock frequency, CLKAB or CLKBA			0	105	0	105	MHz
t _w [#]	Pulse duration	LEAB or LEBA high		3.3		3.3		ns
		CLKAB or CLKBA high or low		4.7		4.7		
t _{su}	Setup time	A before CLKAB↑ or B before CLKBA↑		4		3.5		ns
		A before LEAB↓ or B before LEBA↓	CLK high	4		4		
			CLK low	1.5		1.5		
t _h	Hold time	A after CLKAB↑ or B after CLKBA↑		1		1		ns
		A after LEAB↓ or B after LEBA↓		2.5		2.5		

This parameter is specified by design, but not production tested.

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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)	$V_{CC} = 5$ V, $T_A = 25^\circ\text{C}$			SN54ABT16501		SN74ABT16501		UNIT
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
$f_{\max}$	CLKAB or CLKBA		105	160		105		105		MHz
t_{PLH}	A or B	B or A	1	2.6	3.4	1	3.9	1	3.7	ns
t_{PHL}			1	2.6	3.4	1	4.1	1	4	
t_{PLH}	LEAB or LEBA	B or A	1.3	3.3	4.3	1.3	5.4	1.3	5.1	ns
t_{PHL}			1.4	3.1	4.1	1.4	4.6	1.4	4.4	
t_{PLH}	CLKAB or CLKBA	B or A	1.5	3.5	4.5	1.5	5.3	1.5	5	ns
t_{PHL}			1.3	3.1	4.1	1.3	4.6	1.3	4.4	
t_{PZH}	OEAB or $\overline{\text{OEBA}}$	B or A	1	3	4	1	4.8	1	4.7	ns
t_{PZL}			2.6	4.9	5.9	2.6	6.6	2.6	6.5	
t_{PHZ}	OEAB or $\overline{\text{OEBA}}$	B or A	1.6	3.9	4.9	1.6	5.9	1.6	5.8	ns
t_{PLZ}			1.1	3.4	4.4	1.1	5.1	1.1	4.9	

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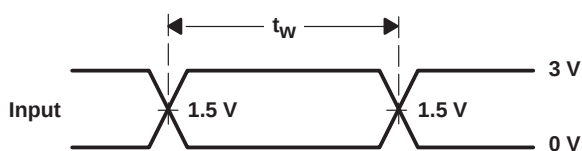
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PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT

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



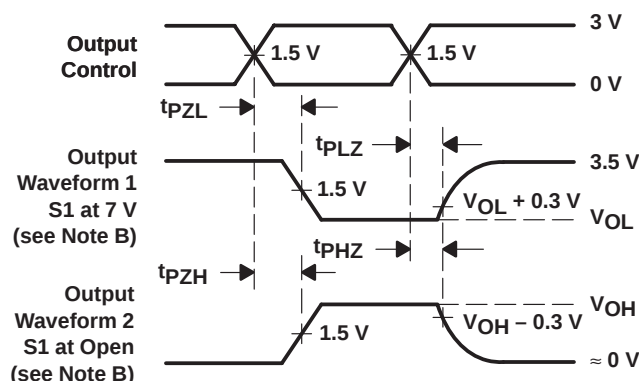
VOLTAGE WAVEFORMS
PULSE DURATION



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:
- C_L includes probe and jig capacitance.
 - 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.
 - All input pulses are supplied by generators having the following characteristics: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$.
 - The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
SN74ABT16501DGGR	Active	Production	TSSOP (DGG) 56	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16501
SN74ABT16501DGGR.B	Active	Production	TSSOP (DGG) 56	2000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16501
SN74ABT16501DL	Active	Production	SSOP (DL) 56	20 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16501
SN74ABT16501DL.B	Active	Production	SSOP (DL) 56	20 TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16501
SN74ABT16501DLR	Active	Production	SSOP (DL) 56	1000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16501
SN74ABT16501DLR.B	Active	Production	SSOP (DL) 56	1000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16501
SN74ABT16501DLRG4	Active	Production	SSOP (DL) 56	1000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16501
SN74ABT16501DLRG4.B	Active	Production	SSOP (DL) 56	1000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT16501

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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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
SN74ABT16501DGGR	TSSOP	DGG	56	2000	330.0	24.4	8.9	14.7	1.4	12.0	24.0	Q1
SN74ABT16501DLR	SSOP	DL	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1
SN74ABT16501DLRG4	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)
SN74ABT16501DGGR	TSSOP	DGG	56	2000	356.0	356.0	45.0
SN74ABT16501DLR	SSOP	DL	56	1000	356.0	356.0	53.0
SN74ABT16501DLRG4	SSOP	DL	56	1000	356.0	356.0	53.0

TUBE



*All dimensions are nominal

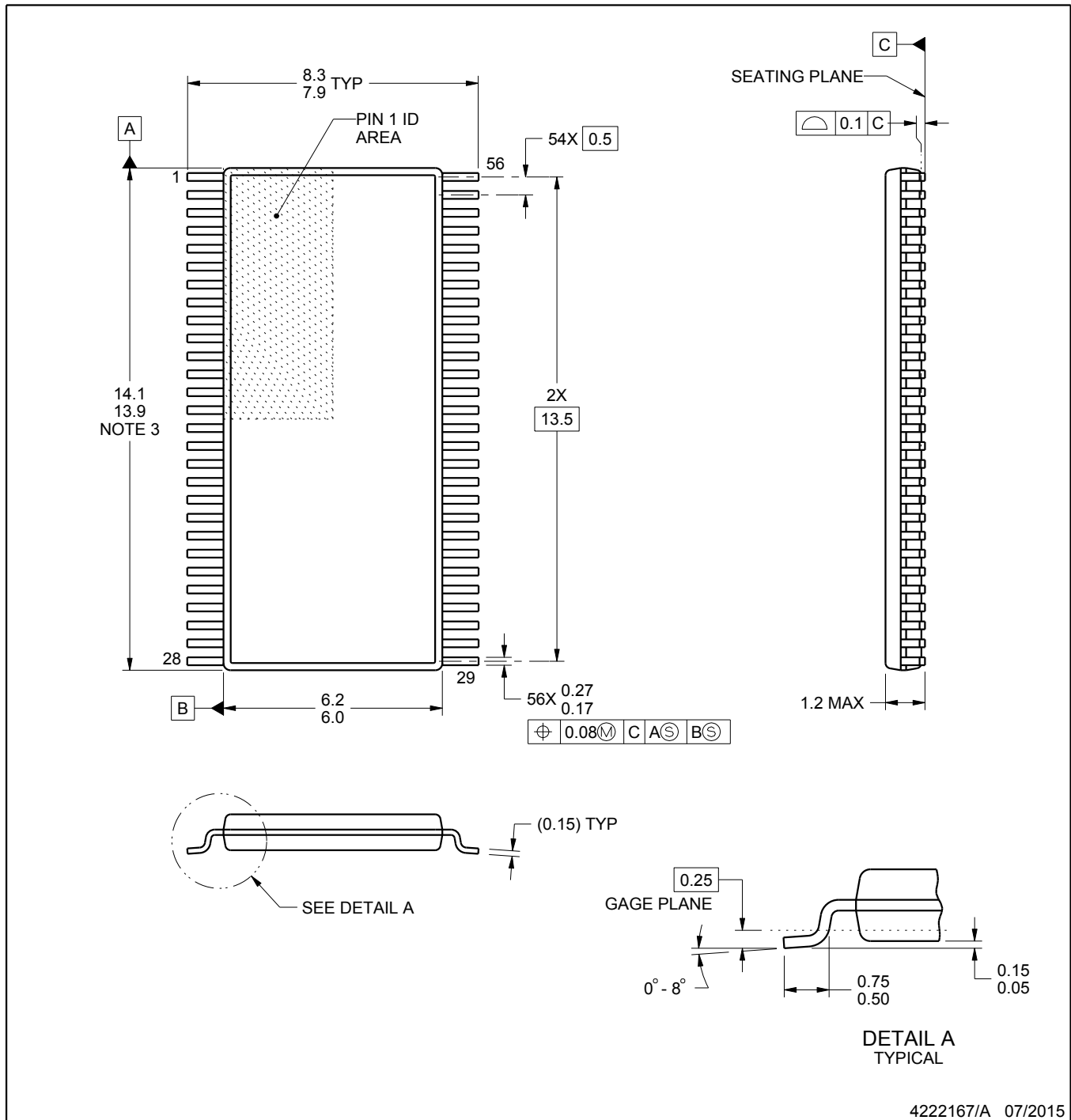
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN74ABT16501DL	DL	SSOP	56	20	473.7	14.24	5110	7.87
SN74ABT16501DL.B	DL	SSOP	56	20	473.7	14.24	5110	7.87

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



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NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

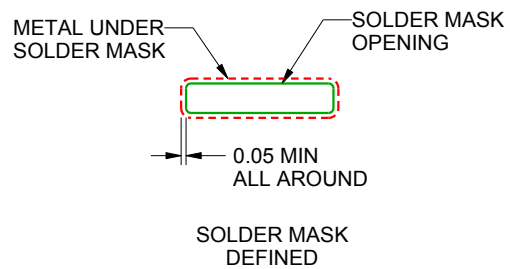
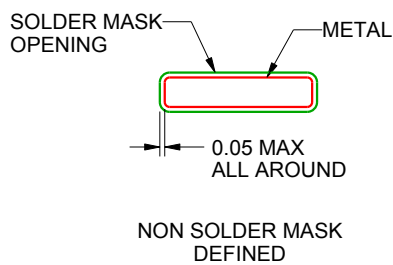
DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

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NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.

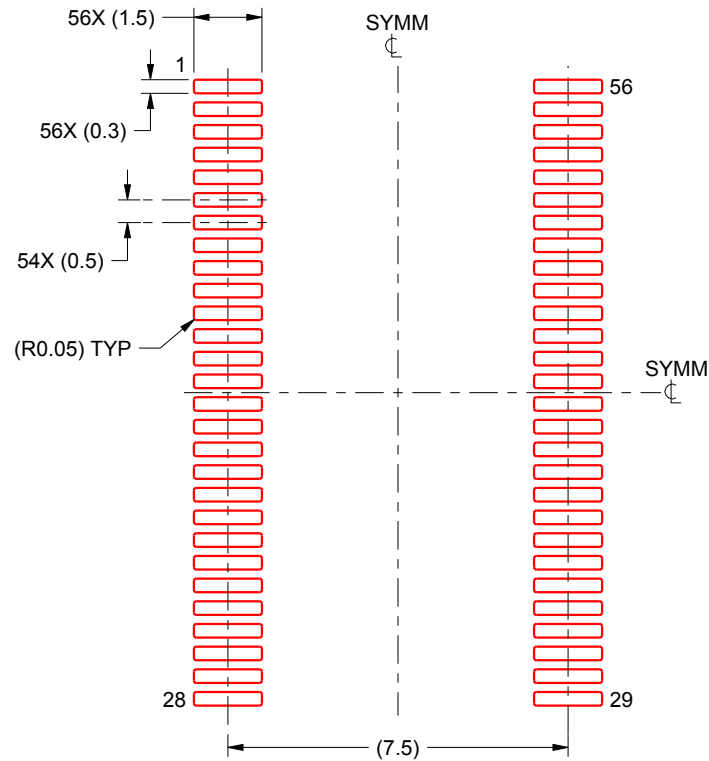
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DGG0056A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

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NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

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