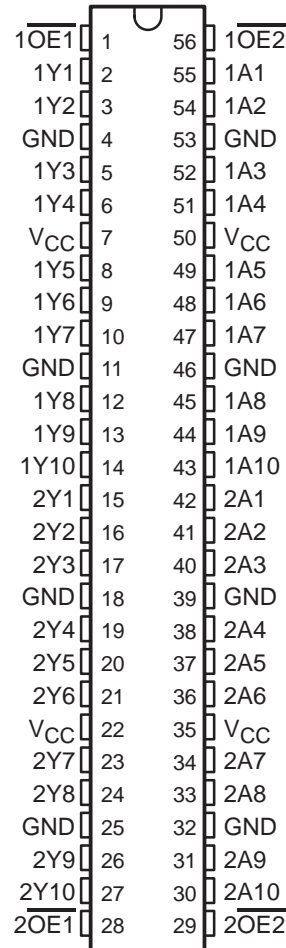


SN54ALVTH162827, SN74ALVTH162827 2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

SCES079E – JULY 1996 – REVISED DECEMBER 1998

- State-of-the-Art Advanced BiCMOS Technology (ABT) *Widebus*™ Design for 2.5-V and 3.3-V Operation and Low Static Power Dissipation
- Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 2.3-V to 3.6-V V_{CC})
- Typical V_{OLP} (Output Ground Bounce) <0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- Power Off Disables Outputs, Permitting Live Insertion
- High-Impedance State During Power Up and Power Down Prevents Driver Conflict
- Uses Bus Hold on Data Inputs in Place of External Pullup/Pulldown Resistors to Prevent the Bus From Floating
- Output Ports Have Equivalent $30\text{-}\Omega$ Series Resistors, So No External Resistors Are Required
- Auto3-State Eliminates Bus Current Loading When Output Exceeds $V_{CC} + 0.5$ V
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model; and Exceeds 1000 V Using Charged-Device Model, Robotic Method
- Flow-Through Architecture Facilitates Printed Circuit Board Layout
- Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise
- Package Options Include Plastic Shrink Small-Outline (DL), Thin Shrink Small-Outline (DGG), Thin Very Small-Outline (DGV) Packages, and 380-mil Fine-Pitch Ceramic Flat (WD) Package

SN54ALVTH162827 . . . WD PACKAGE
SN74ALVTH162827 . . . DGG, DGV, OR DL PACKAGE
(TOP VIEW)



NOTE: For order entry:

The DGG package is abbreviated to G, and
the DGV package is abbreviated to V.

description

The 'ALVTH162827 devices are 20-bit buffers/line drivers designed for 2.5-V or 3.3-V V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment.



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.

Widebus is a trademark of Texas Instruments Incorporated.

UNLESS OTHERWISE NOTED this document contains PRODUCTION DATA information 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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SN54ALVTH162827, SN74ALVTH162827
2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS
WITH 3-STATE OUTPUTS

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recommended operating conditions, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (see Note 3)

			SN54ALVTH162827			SN74ALVTH162827			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{CC}	Supply voltage		3		3.6	3		3.6	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}	5.5	0	V_{CC}	5.5	V
I_{OH}	High-level output current				–8			–12	mA
I_{OL}	Low-level output current				8			12	mA
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled			10			10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200			200			$\mu\text{s/V}$
T_A	Operating free-air temperature		–55		125	–40		85	°C

NOTE 3: All unused control 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.

SN54ALVTH162827, SN74ALVTH162827
2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS
WITH 3-STATE OUTPUTS

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electrical characteristics over recommended operating free-air temperature range,
 $V_{CC} = 2.5 \text{ V} \pm 0.2 \text{ V}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS	SN54ALVTH162827			SN74ALVTH162827			UNIT
			MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}		$V_{CC} = 2.3 \text{ V}$, $I_I = -18 \text{ mA}$			-1.2			-1.2	V
V_{OH}		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$, $I_{OH} = -100 \mu\text{A}$	$V_{CC}-0.2$			$V_{CC}-0.2$			V
		$V_{CC} = 2.3 \text{ V}$, $I_{OH} = -6 \text{ mA}$	1.7						
		$V_{CC} = 2.3 \text{ V}$, $I_{OH} = -8 \text{ mA}$				1.7			
V_{OL}		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$, $I_{OL} = 100 \mu\text{A}$			0.2			0.2	V
		$V_{CC} = 2.3 \text{ V}$, $I_{OL} = 8 \text{ mA}$			0.7				
		$V_{CC} = 2.3 \text{ V}$, $I_{OL} = 12 \text{ mA}$						0.7	
I_I	Control inputs	$V_{CC} = 2.7 \text{ V}$, $V_I = V_{CC} \text{ or GND}$			± 1			± 1	μA
		$V_{CC} = 0 \text{ or } 2.7 \text{ V}$, $V_I = 5.5 \text{ V}$			10			10	
	Data inputs	$V_{CC} = 2.7 \text{ V}$, $V_I = 5.5 \text{ V}$			10			10	
		$V_{CC} = 2.7 \text{ V}$, $V_I = V_{CC}$			1			1	
		$V_{CC} = 2.7 \text{ V}$, $V_I = 0$			-5			-5	
		$V_{CC} = 2.7 \text{ V}$, $V_I = 0$			-5			-5	
I_{off}		$V_{CC} = 0$, $V_I \text{ or } V_O = 0 \text{ to } 4.5 \text{ V}$						± 100	μA
I_{BHL}^\ddagger		$V_{CC} = 2.3 \text{ V}$, $V_I = 0.7 \text{ V}$			115			115	μA
I_{BHH}^\S		$V_{CC} = 2.3 \text{ V}$, $V_I = 1.7 \text{ V}$			-10			-10	μA
I_{BHLO}^\P		$V_{CC} = 2.7 \text{ V}$, $V_I = 0 \text{ to } V_{CC}$	300			300			μA
$I_{BHHO}^\#$		$V_{CC} = 2.7 \text{ V}$, $V_I = 0 \text{ to } V_{CC}$	-300			-300			μA
$I_{EX}^{ }$		$V_{CC} = 2.3 \text{ V}$, $V_O = 5.5 \text{ V}$			125			125	μA
$I_{OZ(PU/PD)}^\star$		$V_{CC} \leq 1.2 \text{ V}$, $V_O = 0.5 \text{ V to } V_{CC}$, $V_I = \text{GND or } V_{CC}$, $\overline{OE} = \text{don't care}$			± 100			± 100	μA
I_{OZH}		$V_{CC} = 2.7 \text{ V}$, $V_O = 2.3 \text{ V}$, $V_I = 0.7 \text{ V or } 1.7 \text{ V}$			5			5	μA
I_{OZL}		$V_{CC} = 2.7 \text{ V}$, $V_O = 0.5 \text{ V}$, $V_I = 0.7 \text{ V or } 1.7 \text{ V}$			-5			-5	μA
I_{CC}		$V_{CC} = 2.7 \text{ V}$, $I_O = 0$, $V_I = V_{CC} \text{ or GND}$							mA
		Outputs high	0.04	0.1		0.04	0.1		
		Outputs low	2.3	5		2.3	5		
		Outputs disabled	0.04	0.1		0.04	0.1		
C_i		$V_{CC} = 2.5 \text{ V}$, $V_I = 2.5 \text{ V or } 0$			3.5			3.5	pF
C_o		$V_{CC} = 2.5 \text{ V}$, $V_O = 2.5 \text{ V or } 0$			6			6	pF

† All typical values are at $V_{CC} = 2.5 \text{ V}$, $T_A = 25^\circ\text{C}$.

‡ The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL} max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL} max.

§ The bus-hold circuit can source at least the minimum high sustaining current at V_{IH} min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH} min.

¶ An external driver must source at least I_{BHLO} to switch this node from low to high.

An external driver must sink at least I_{BHHO} to switch this node from high to low.

|| Current into an output in the high state when $V_O > V_{CC}$

☆ High-impedance state during power up or power down

SN54ALVTH162827, SN74ALVTH162827

2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS

WITH 3-STATE OUTPUTS

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**electrical characteristics over recommended operating free-air temperature range,
V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted)**

PARAMETER		TEST CONDITIONS		SN54ALVTH162827			SN74ALVTH162827			UNIT	
				MIN	TYP†	MAX	MIN	TYP†	MAX		
V _{IK}		V _{CC} = 3 V, I _I = -18 mA		-1.2			-1.2			V	
V _{OH}		V _{CC} = 3 V to 3.6 V, I _{OH} = -100 μA		V _{CC} -0.2			V _{CC} -0.2			V	
		V _{CC} = 3 V, I _{OH} = -8 mA		2							
		I _{OH} = -12 mA					2				
V _{OL}		V _{CC} = 3 V to 3.6 V, I _{OL} = 100 μA		0.2			0.2			V	
		V _{CC} = 3 V, I _{OL} = 8 mA		0.8							
		I _{OL} = 12 mA					0.8				
I _I	Control inputs	V _{CC} = 3.6 V, V _I = V _{CC} or GND		±1			±1			μA	
		V _{CC} = 0 or 3.6 V, V _I = 5.5 V		10			10				
	Data inputs	V _I = 5.5 V		10			10				
		V _I = V _{CC}		1			1				
		V _I = 0		-5			-5				
I _{off}		V _{CC} = 0, V _I or V _O = 0 to 4.5 V					±100			μA	
I _{BHL} ‡		V _{CC} = 3 V, V _I = 0.8 V		75			75			μA	
I _{BHH} §		V _{CC} = 3 V, V _I = 2 V		-75			-75			μA	
I _{BHLO} ¶		V _{CC} = 3.6 V, V _I = 0 to V _{CC}		500			500			μA	
I _{BHHO} #		V _{CC} = 3.6 V, V _I = 0 to V _{CC}		-500			-500			μA	
I _{EX}		V _{CC} = 3 V, V _O = 5.5 V		125			125			μA	
I _{OZ} (PU/PD)★		V _{CC} ≤ 1.2 V, V _O = 0.5 V to V _{CC} , V _I = GND or V _{CC} , \overline{OE} = don't care		±100			±100			μA	
I _{OZH}		V _{CC} = 3.6 V	V _O = 3 V, V _I = 0.8 V or 2 V	5			5			μA	
I _{OZL}		V _{CC} = 3.6 V	V _O = 0.5 V, V _I = 0.8 V or 2 V	-5			-5			μA	
I _{CC}		V _{CC} = 3.6 V, I _O = 0, V _I = V _{CC} or GND		Outputs high		0.07	0.1	0.07		0.1	mA
				Outputs low		3.2	5.5	3.2		5.5	
				Outputs disabled		0.07	0.1	0.07		0.1	
ΔI _{CC} □		V _{CC} = 3 V to 3.6 V, One input at V _{CC} - 0.6 V, Other inputs at V _{CC} or GND		0.4			0.4			mA	
C _i		V _{CC} = 3.3 V, V _I = 3.3 V or 0		3.5			3.5			pF	
C _o		V _{CC} = 3.3 V, V _O = 3.3 V or 0		6			6			pF	

† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

‡ The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL} max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL} max.

§ The bus-hold circuit can source at least the minimum high sustaining current at V_{IH} min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH} min.

¶ An external driver must source at least I_{BHLO} to switch this node from low to high.

An external driver must sink at least I_{BHHO} to switch this node from high to low.

|| Current into an output in the high state when V_O > V_{CC}

★ High-impedance state during power up or power down

□ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

SN54ALVTH162827, SN74ALVTH162827
2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS
WITH 3-STATE OUTPUTS

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switching characteristics over recommended operating free-air temperature range, $C_L = 30\text{ pF}$, $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$ (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH162827		SN74ALVTH162827		UNIT
			MIN	MAX	MIN	MAX	
t_{PLH}	A	Y	1.7	4.1	1.7	4.1	ns
t_{PHL}			1.6	4	1.6	4	
t_{PZH}	\overline{OE}	Y	2.1	4.8	2.1	4.8	ns
t_{PZL}			1.9	4.8	1.9	4.8	
t_{PHZ}	\overline{OE}	Y	2.4	6	2.4	6	ns
t_{PLZ}			1.7	5	1.7	5	

switching characteristics over recommended operating free-air temperature range, $C_L = 50\text{ pF}$, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH162827		SN74ALVTH162827		UNIT
			MIN	MAX	MIN	MAX	
t_{PLH}	A	Y	1	3.9	1	3.9	ns
t_{PHL}			1.5	3.7	1.5	3.7	
t_{PZH}	\overline{OE}	Y	1	5.6	1	5.6	ns
t_{PZL}			1.7	4.1	1.7	4.1	
t_{PHZ}	\overline{OE}	Y	3.6	6.3	3.6	6.3	ns
t_{PLZ}			1.7	5.1	1.7	5.1	

PRODUCT PREVIEW information concerns products in the formative or design phase of development. Characteristic data and other specifications are design goals. Texas Instruments reserves the right to change or discontinue these products without notice.



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SN54ALVTH162827, SN74ALVTH162827

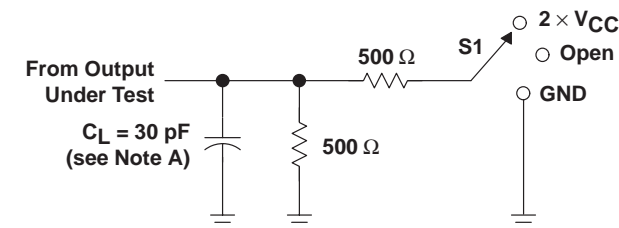
2.5-V/3.3-V 20-BIT BUFFERS/DRIVERS

WITH 3-STATE OUTPUTS

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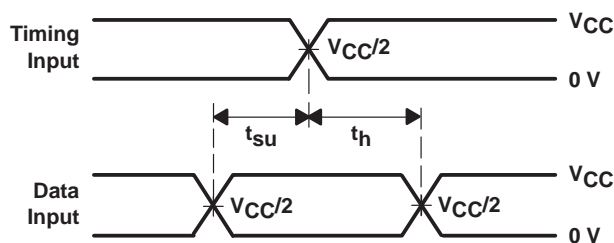
PARAMETER MEASUREMENT INFORMATION

$$V_{CC} = 2.5 \text{ V} \pm 0.2 \text{ V}$$

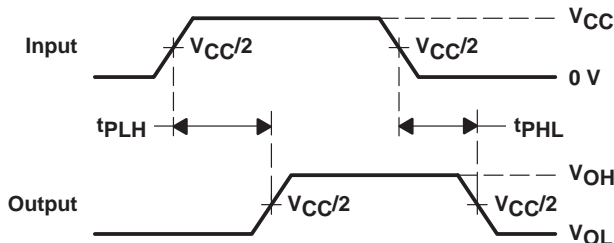


LOAD CIRCUIT

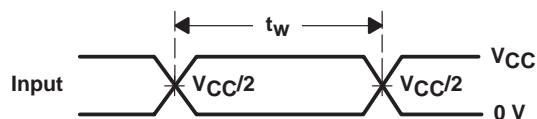
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	2 $\times V_{CC}$
t_{PHZ}/t_{PZH}	GND



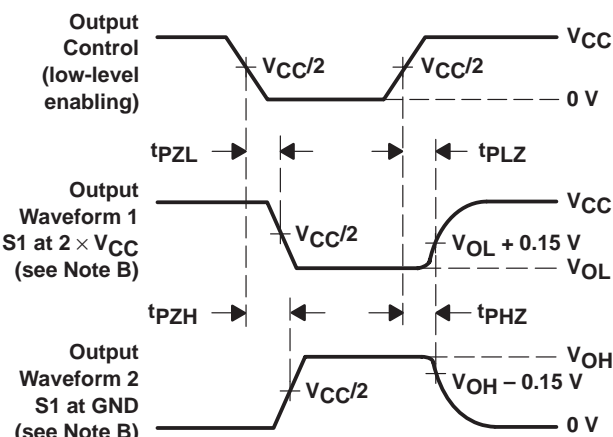
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



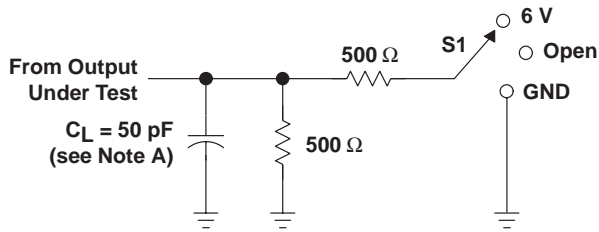
VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- 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: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2 \text{ ns}$, $t_f \leq 2 \text{ ns}$.
 - The outputs are measured one at a time with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

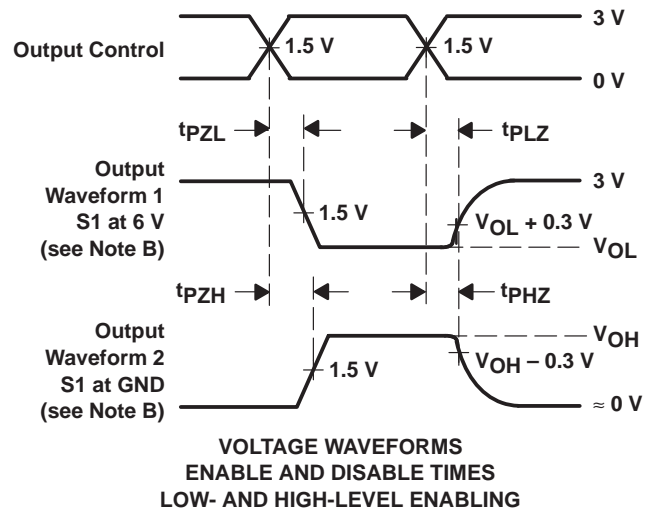
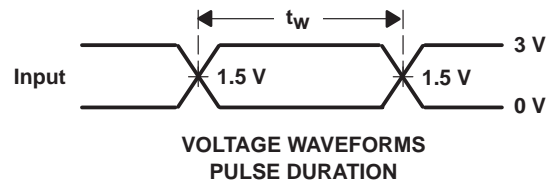
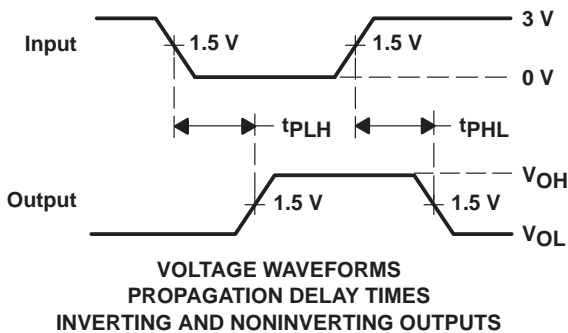
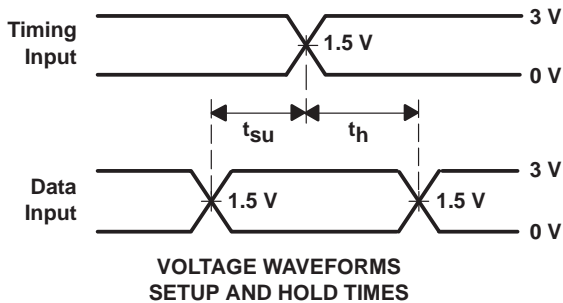
PARAMETER MEASUREMENT INFORMATION

$$V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$$



LOAD CIRCUIT

TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



- 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 2. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74ALVTH162827DL	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVTH162827	Samples
SN74ALVTH162827GR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ALVTH162827	Samples
SN74ALVTH162827VR	ACTIVE	TVSOP	DGV	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	VT2827	Samples

(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.

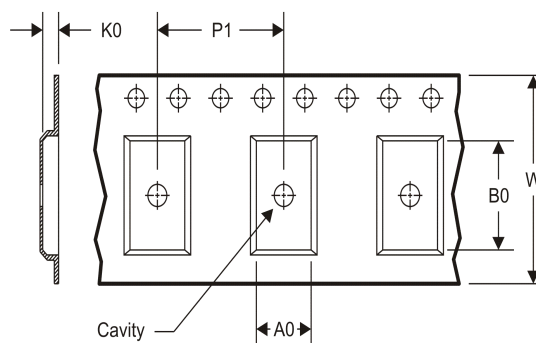
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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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
SN74ALVTH162827GR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1
SN74ALVTH162827VR	TVSOP	DGV	56	2000	330.0	24.4	6.8	11.7	1.6	12.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ALVTH162827GR	TSSOP	DGG	56	2000	367.0	367.0	45.0
SN74ALVTH162827VR	TVSOP	DGV	56	2000	367.0	367.0	45.0

DGV (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

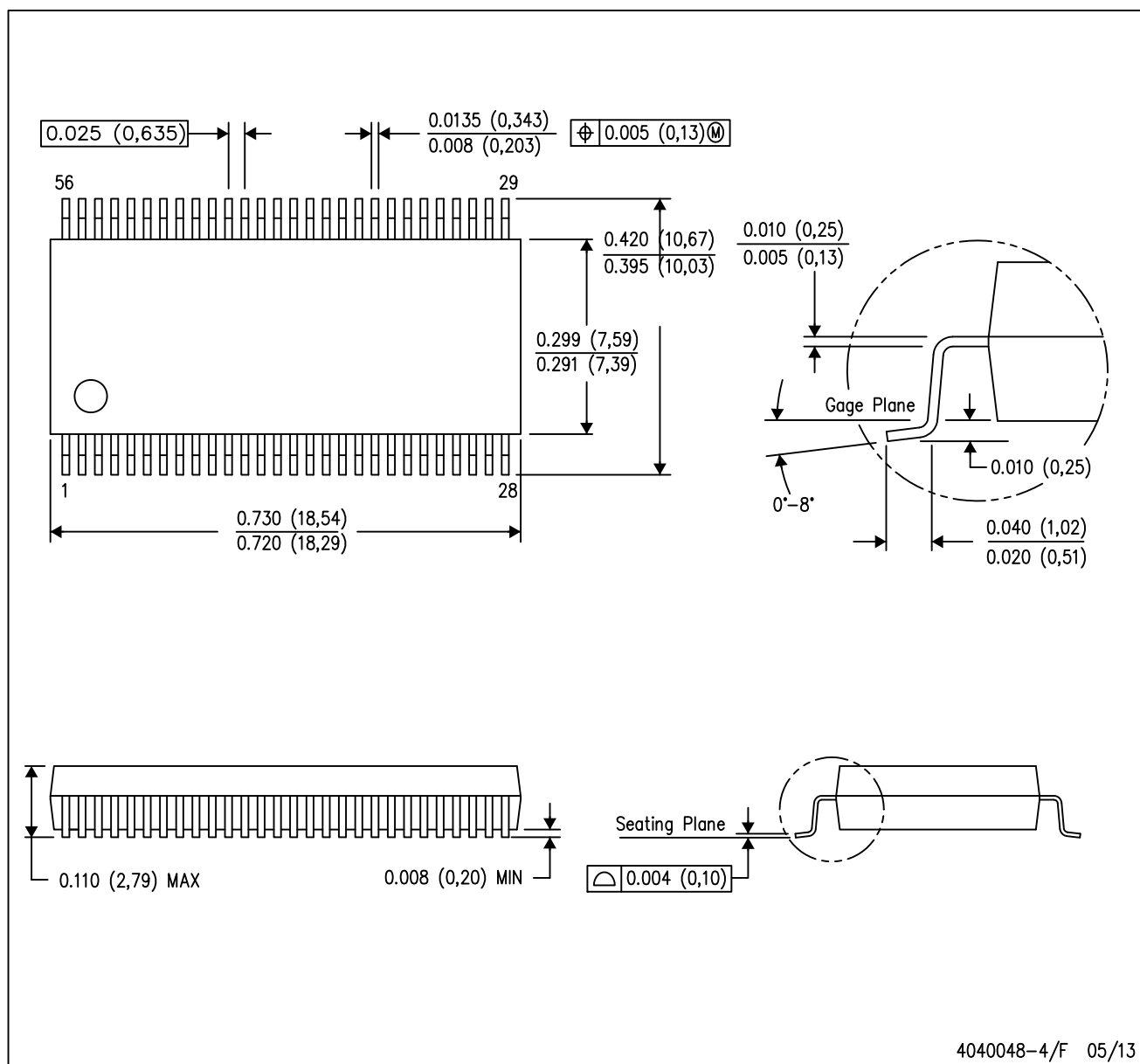
24 PINS SHOWN



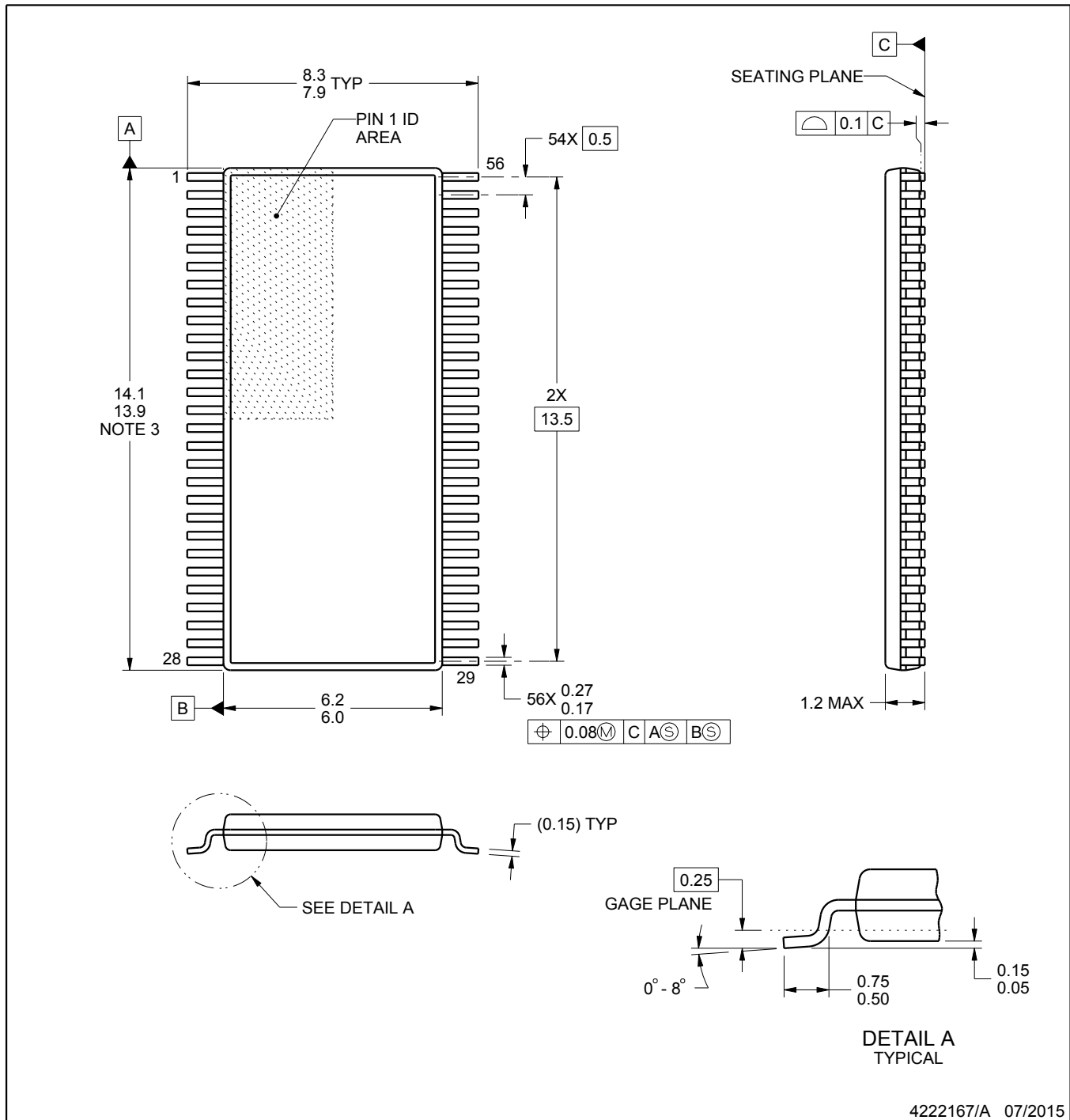
- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.
 D. Falls within JEDEC: 24/48 Pins – MO-153
 14/16/20/56 Pins – MO-194

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:

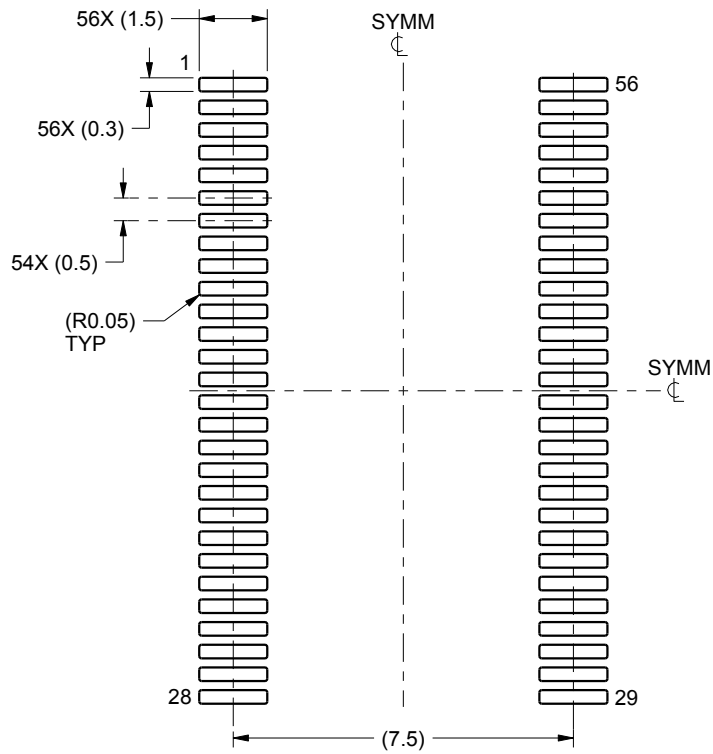
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or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

EXAMPLE BOARD LAYOUT

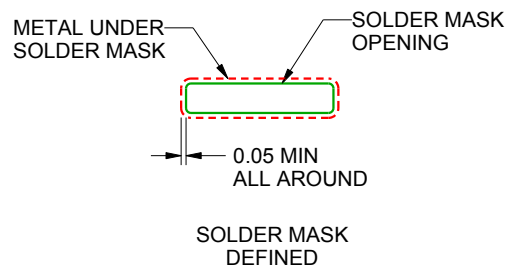
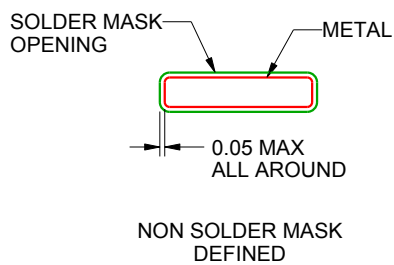
DGG0056A

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.

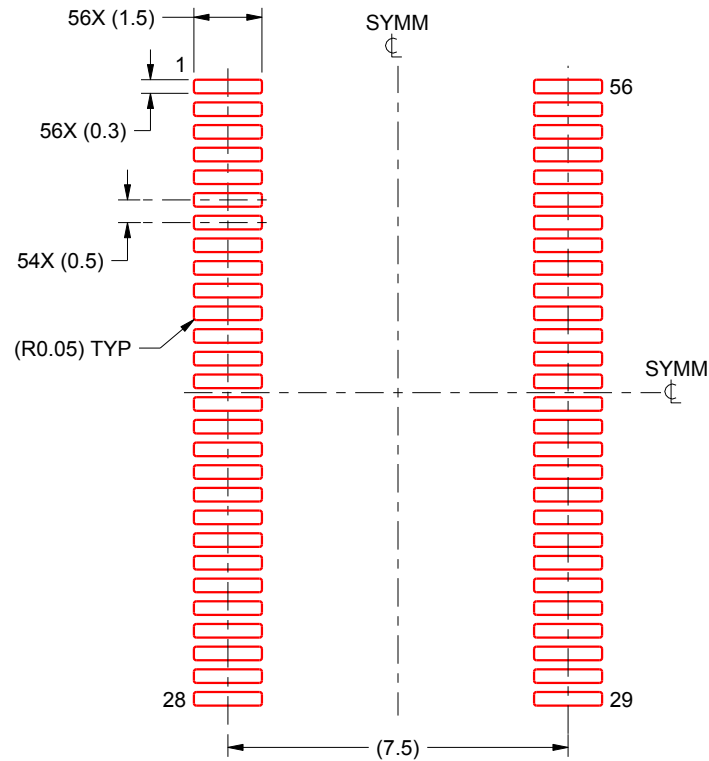
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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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