SN74LVTH16543-EP
3.3-V ABT 16-BIT REGISTERED TRANSCEIVER 3-STATE OUTPUTS

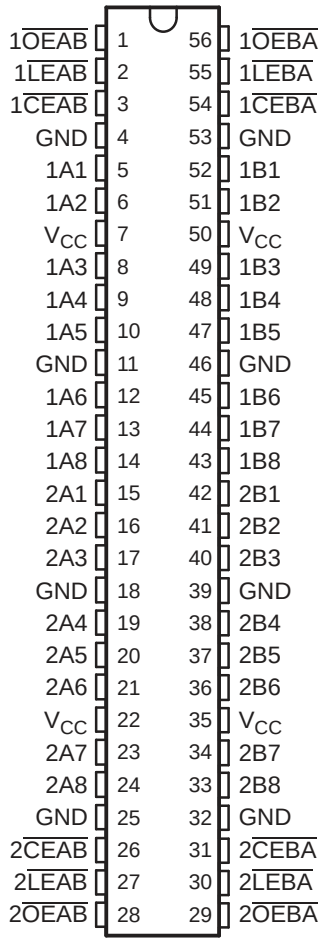
SCBS785B – NOVEMBER 2003 – REVISED JUNE 2006

FEATURES

- **Controlled Baseline**
  - **One Assembly/Test Site, One Fabrication Site**
- **Enhanced Diminishing Manufacturing Sources (DMS) Support**
- **Enhanced Product-Change Notification**
- **Qualification Pedigree** (1)
- **Member of the Texas Instruments Widebus™ Family**
- **State-of-the-Art Advanced BiCMOS Technology (ABT) Design for 3.3-V Operation and Low Static-Power Dissipation**
- **Supports Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V_{CC})**
- **Supports Unregulated Battery Operation Down to 2.7 V**
- **I_{off} and Power-Up 3-State Support Hot Insertion**
- **Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors**
- **Typical V_{OLP} (Output Ground Bounce) <0.8 V at V_{CC} = 3.3 V, T_A = 25°C**
- **Distributed V_{CC} and GND Pins Minimize High-Speed Switching Noise**
- **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)**

(1) Component qualification in accordance with JEDEC and industry standards to ensure reliable operation over an extended temperature range. This includes, but is not limited to, Highly Accelerated Stress Test (HAST) or biased 85/85, temperature cycle, autoclave or unbiased HAST, electromigration, bond intermetallic life, and mold compound life. Such qualification testing should not be viewed as justifying use of this component beyond specified performance and environmental limits.

DGG OR DL PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

The SN74LVTH16543 is a 16-bit registered transceiver designed for low-voltage (3.3-V) V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment. This device can be used as two 8-bit transceivers or one 16-bit transceiver. Separate latch-enable ($\overline{LEAB}$ or $\overline{LEBA}$) and output-enable ($\overline{OEAB}$ or $\overline{OEBA}$) inputs are provided for each register to permit independent control in either direction of data flow.

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

The A-to-B enable ($\overline{CEAB}$) input must be low to enter data from A or to output data from B. If $\overline{CEAB}$ is low and $\overline{LEAB}$ is low, the A-to-B latches are transparent; a subsequent low-to-high transition of $\overline{LEAB}$ puts the A latches in the storage mode. With $\overline{CEAB}$ and $\overline{OEAB}$ both low, the 3-state B outputs are active and reflect the data present at the output of the A latches. Data flow from B to A is similar, but requires using the $\overline{CEBA}$, $\overline{LEBA}$, and $\overline{OEBA}$ inputs.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

When V_{CC} is between 0 and 1.5 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 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.

This device is fully specified for hot-insertion applications using I_{off} and power-up 3-state. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict.

ORDERING INFORMATION

T_A	PACKAGE(1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	TSSOP – DGG	Tape and reel	CLVTH16543IDGGREP	LH16543EP
–55°C to 125°C	SSOP – DL	Tape and reel	CLVTH16543MDLREP	LH16543MEP

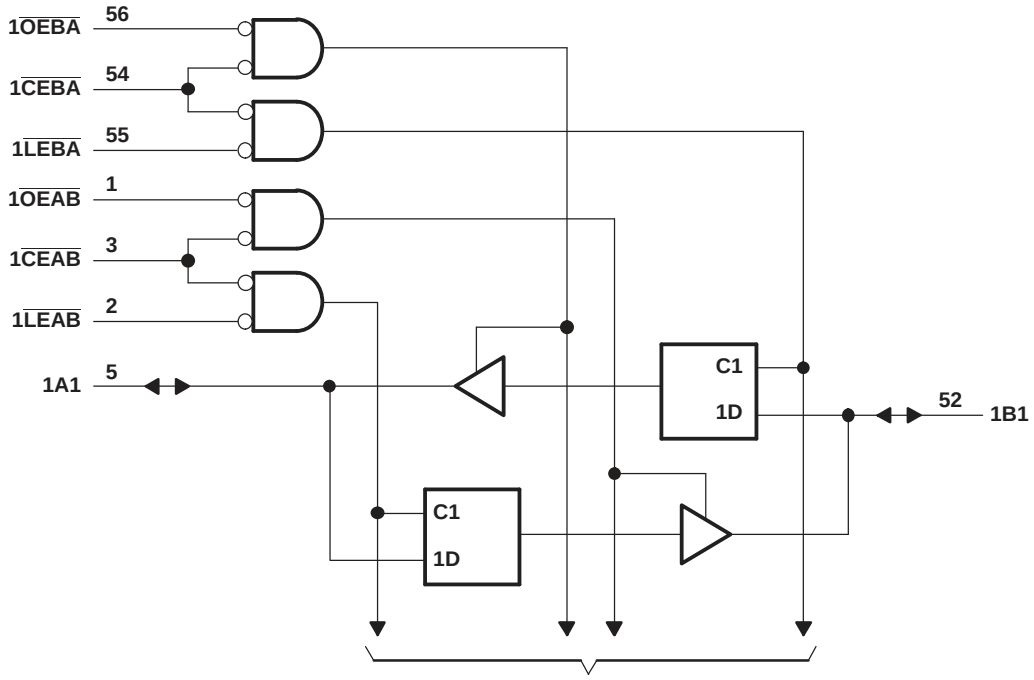
(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

FUNCTION TABLE(1) (each 8-bit section)

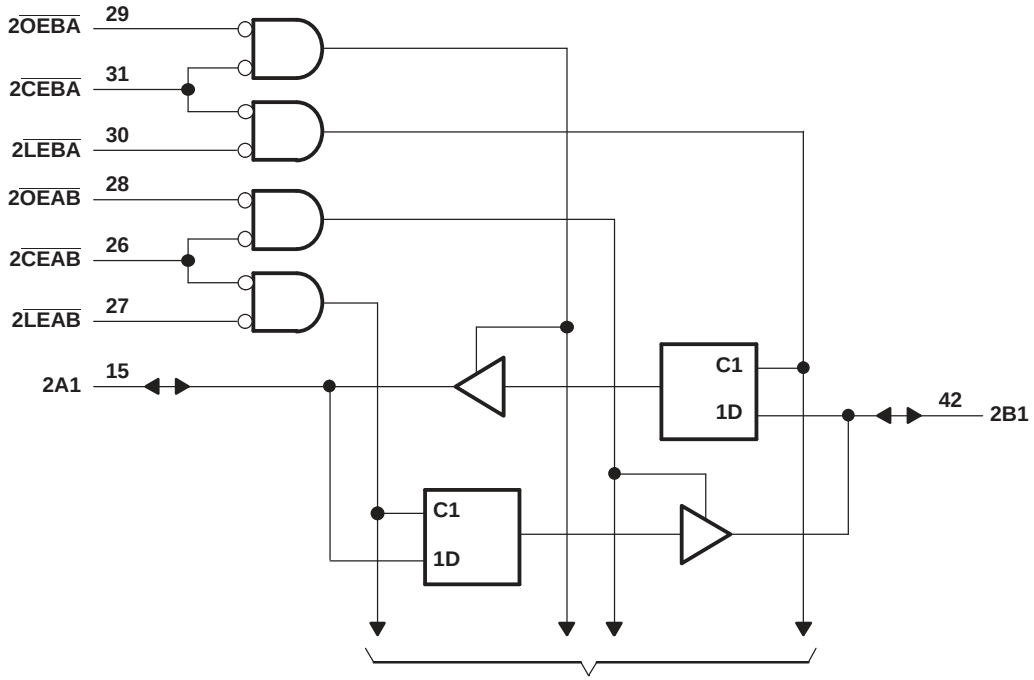
INPUTS				OUTPUT B
$\overline{CEAB}$	$\overline{LEAB}$	$\overline{OEAB}$	A	
H	X	X	X	Z
X	X	H	X	Z
L	H	L	X	B_0(2)
L	L	L	L	L
L	L	L	H	H

(1) A-to-B data flow is shown; B-to-A flow control is the same, except that it uses $\overline{CEBA}$, $\overline{LEBA}$, and $\overline{OEBA}$.
(2) Output level before the indicated steady-state input conditions were established

LOGIC DIAGRAM (POSITIVE LOGIC)



To Seven Other Channels



To Seven Other Channels

Absolute Maximum Ratings(1)

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range		–0.5	4.6	V
V_I	Input voltage range(2)		–0.5	7	V
V_O	Voltage range applied to any output in the high-impedance or power-off state(2)		–0.5	7	V
V_O	Voltage range applied to any output in the high state(2)		–0.5	V_{CC} + 0.5	V
I_O	Current into any output in the low state			128	mA
I_O	Current into any output in the high state(3)			64	mA
I_{IK}	Input clamp current	V_I < 0		–50	mA
I_{OK}	Output clamp current	V_O < 0		–50	mA
θ_{JA}	Package thermal impedance(4)	DGG package		81	°C/W
		DL package		73.5	
T_{stg}	Storage temperature range(5)		–65	150	°C

(1) 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.
(2) The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
(3) This current flows only when the output is in the high state and $V_O > V_{CC}$.
(4) The package thermal impedance is calculated in accordance with JESD 51.
(5) Long-term high-temperature storage and/or extended use at maximum recommended operating conditions may result in a reduction of overall device life. See http://www.ti.com/ep_quality for additional information on enhanced plastic packaging.

Recommended Operating Conditions(1)

			MIN	MAX	UNIT
V_{CC}	Supply voltage		2.7	3.6	V
V_{IH}	High-level input voltage		2		V
V_{IL}	Low-level input voltage			0.8	V
V_I	Input voltage			5.5	V
I_{OH}	High-level output current			–32	mA
I_{OL}	Low-level output current			64	mA
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled		10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200		µs/V
T_A	Operating free-air temperature	I temp	–40	85	°C
		M temp	–55	125	

(1) 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.

Electrical Characteristics

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

PARAMETER		TEST CONDITIONS		MIN	TYP(1)	MAX	UNIT
V_{IK}		V_{CC} = 2.7 V,	I_I = –18 mA			–1.2	V
V_{OH}		V_{CC} = 2.7 V to 3.6 V,	I_{OH} = –100 µA	V_{CC} – 0.2			V
		V_{CC} = 2.7 V,	I_{OH} = –8 mA	2.4			
		V_{CC} = 3 V,	I_{OH} = –32 mA	2			
V_{OL}		V_{CC} = 2.7 V	I_{OL} = 100 µA			0.2	V
			I_{OL} = 24 mA			0.5	
		V_{CC} = 3 V	I_{OL} = 16 mA			0.4	
			I_{OL} = 32 mA			0.5	
			I_{OL} = 64 mA (I temp)			0.55	
I_I	Control inputs	V_{CC} = 3.6 V,	V_I = V_{CC} or GND			±1	µA
		V_{CC} = 0 or 3.6 V,	V_I = 5.5 V			10	
	A or B port(2)	V_{CC} = 3.6 V	V_I = 5.5 V (I temp)			20	
			V_I = 5.5 V (M temp)			100	
			V_I = V_{CC}			1	
			V_I = 0			–5	
I_{off}		V_{CC} = 0	V_I or V_O = 0 to 4.5 V (I temp)			±100	µA
			V_I or V_O = 0 to 4.5 V (M temp)			±550	
$I_{I(hold)}$	A or B port	V_{CC} = 3 V	V_I = 0.8 V	75			µA
			V_I = 2 V	–75			
		V_{CC} = 3.6 V,(3)	V_I = 0 to 3.6 V			±500	
I_{OZPU}		V_{CC} = 0 to 1.5 V, V_O = 0.5 V to 3 V, $\overline{OE}$ = don't care				±100	µA
I_{OZPD}		V_{CC} = 1.5 to 0 V, V_O = 0.5 V to 3 V, $\overline{OE}$ = don't care				±100	µA
I_{CC}(4)		V_{CC} = 3.6 V, I_O = 0, V_I = V_{CC} or GND	Outputs high			0.19	mA
			Outputs low			5	
			Outputs disabled			0.19	
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				0.2	mA
C_i		V_I = 3 V or 0			4		pF
C_{io}		V_O = 3 V or 0			10		pF

(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
(2) Unused pins at V_{CC} or GND
(3) This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.
(4) 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 operating free-air temperature range (unless otherwise noted) (see Figure 1)

			M TEMP				I TEMP				UNIT
			V_{CC} = 3.3 V ± 0.3 V		V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V		V_{CC} = 2.7 V		
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t_w	Pulse duration, $\overline{LEAB}$ or $\overline{LEBA}$ low		3.3		3.3		3.3		3.3		ns
t_{su}	A or B before $\overline{LEAB}$↑ OR $\overline{LEBA}$↑	Data high	0.7		0.9		0.5		0.5		ns
		Data low	1.2		1.9		0.8		1.3		
	A or B before $\overline{CEAB}$↑ or $\overline{CEBA}$↑	Data high	0.5		0.8		0		0		
		Data low	1.1		1.9		0.6		1.1		
t_h	A or B before $\overline{LEAB}$↑ OR $\overline{LEBA}$↑	Data high	1.5		1.0		1.5		0.7		ns
		Data low	1.2		1.5		1.2		1.3		
	A or B before $\overline{CEAB}$↑ or $\overline{CEBA}$↑	Data high	1.7		1.1		1.7		0.9		
		Data low	1.6		1.9		1.6		1.8		

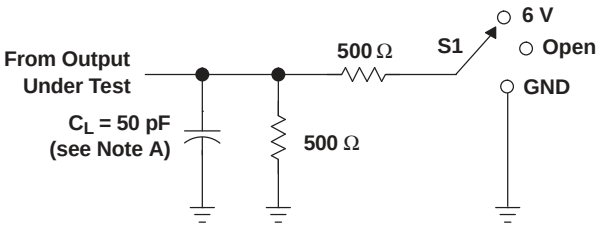
Switching Characteristics

over recommended operating free-air temperature range, C_L = 50 pF (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	M TEMP				I TEMP					UNIT
			V_{CC} = 3.3 V ± 0.3 V		V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V			V_{CC} = 2.7 V		
			MIN	MAX	MIN	MAX	MIN	TYP(1)	MAX	MIN	MAX	
t_{PLH}	A or B	B or A	1.2	4.7		6.5	1.2	2.3	3.2		3.7	ns
t_{PHL}			1.2	5.4		6.5	1.2	2.1	3.2		3.7	
t_{PLH}	$\overline{LE}$	A or B	1.3	7.3		7.8	1.3	2.5	3.9		4.9	ns
t_{PHL}			1.3	6.9		7.8	1.3	2.3	3.9		4.9	
t_{PZH}	$\overline{OE}$	A or B	1.3	6.5		7.4	1.3	2.8	4.3		5.4	ns
t_{PZL}			1.3	6.7		7.4	1.3	2.8	4.3		5.4	
t_{PHZ}	$\overline{OE}$	A or B	2	5.7		7.2	2	3.5	4.7		5.2	ns
t_{PLZ}			2	5.1		6.9	2	3.3	4.4		4.5	
t_{PZH}	$\overline{CE}$	A or B	1.3	6.5		7.6	1.3	3	4.5		5.6	ns
t_{PZL}			1.3	6.4		7.6	1.3	3	4.5		5.6	
t_{PHZ}	$\overline{CE}$	A or B	2	5.3		7.4	2	3.6	4.9		5.4	ns
t_{PLZ}			2	5.1		6.9	2	3.5	4.7		4.9	

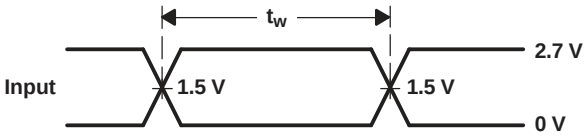
(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

PARAMETER MEASUREMENT INFORMATION

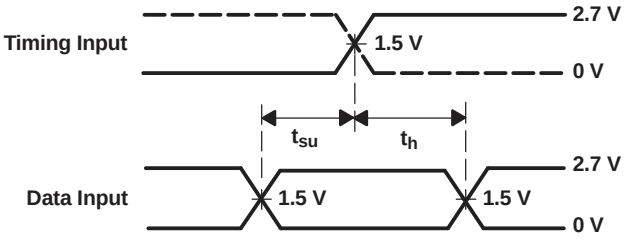


LOAD CIRCUIT

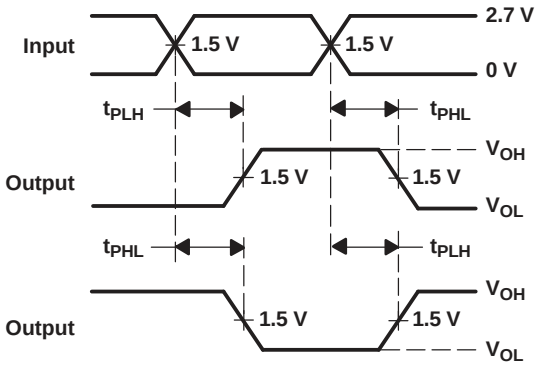
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



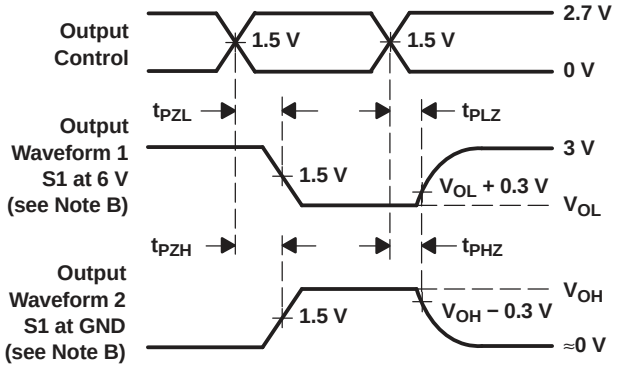
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



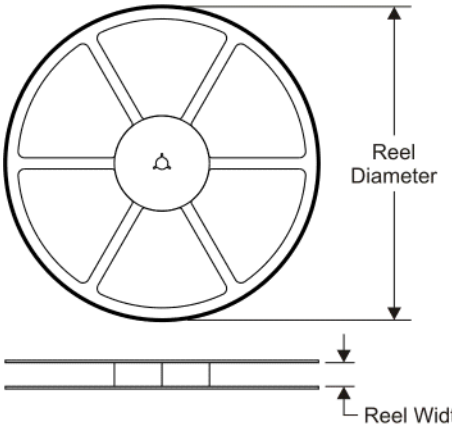
VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

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 ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 ns.
D. The outputs are measured one at a time, with one transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

TAPE AND REEL INFORMATION

REEL DIMENSIONS



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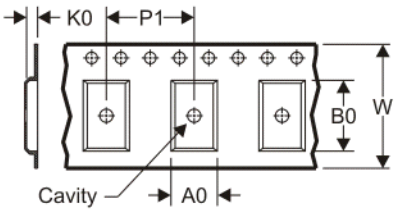
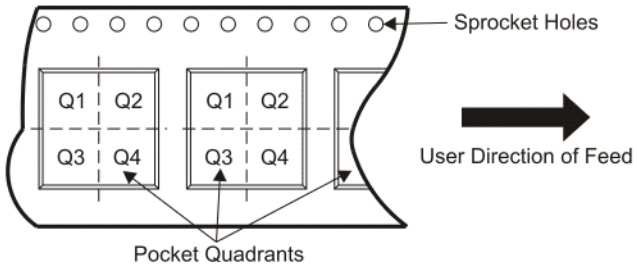


A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
CLVTH16543IDGGREP	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1
CLVTH16543MDLREP	SSOP	DL	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
CLVTH16543IDGGREP	ACTIVE	TSSOP	DGG	56	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LH16543EP	Samples
CLVTH16543MDLREP	ACTIVE	SSOP	DL	56	1000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 125	LH16543MEP	Samples
V62/04715-01XE	ACTIVE	TSSOP	DGG	56	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LH16543EP	Samples
V62/04715-02YE	ACTIVE	SSOP	DL	56	1000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-55 to 125	LH16543MEP	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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(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 finish/Ball material - Orderable Devices 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.

continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF SN74LVTH16543-EP :

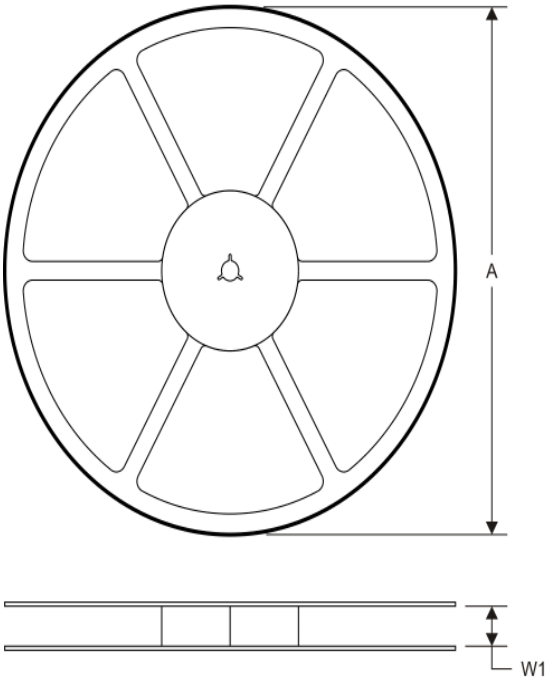
- Catalog: SN74LVTH16543

NOTE: Qualified Version Definitions:

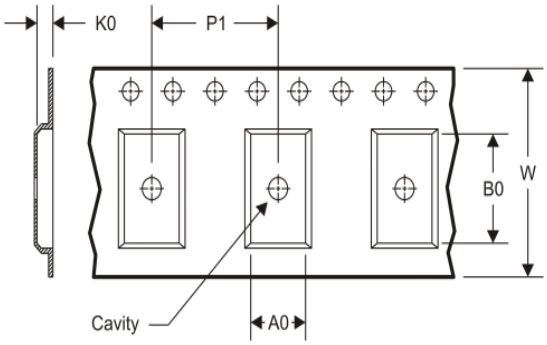
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



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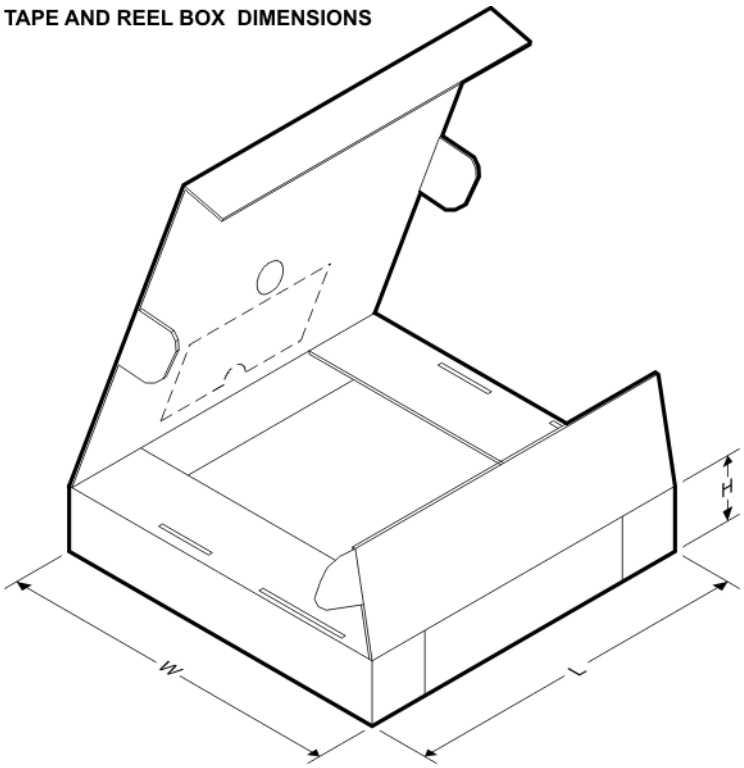
CLVTH16543MDLREP	SSOP	DL	56	1000	330.0	32.4	11.35	18.67	3.1	16.0	32.0	Q1

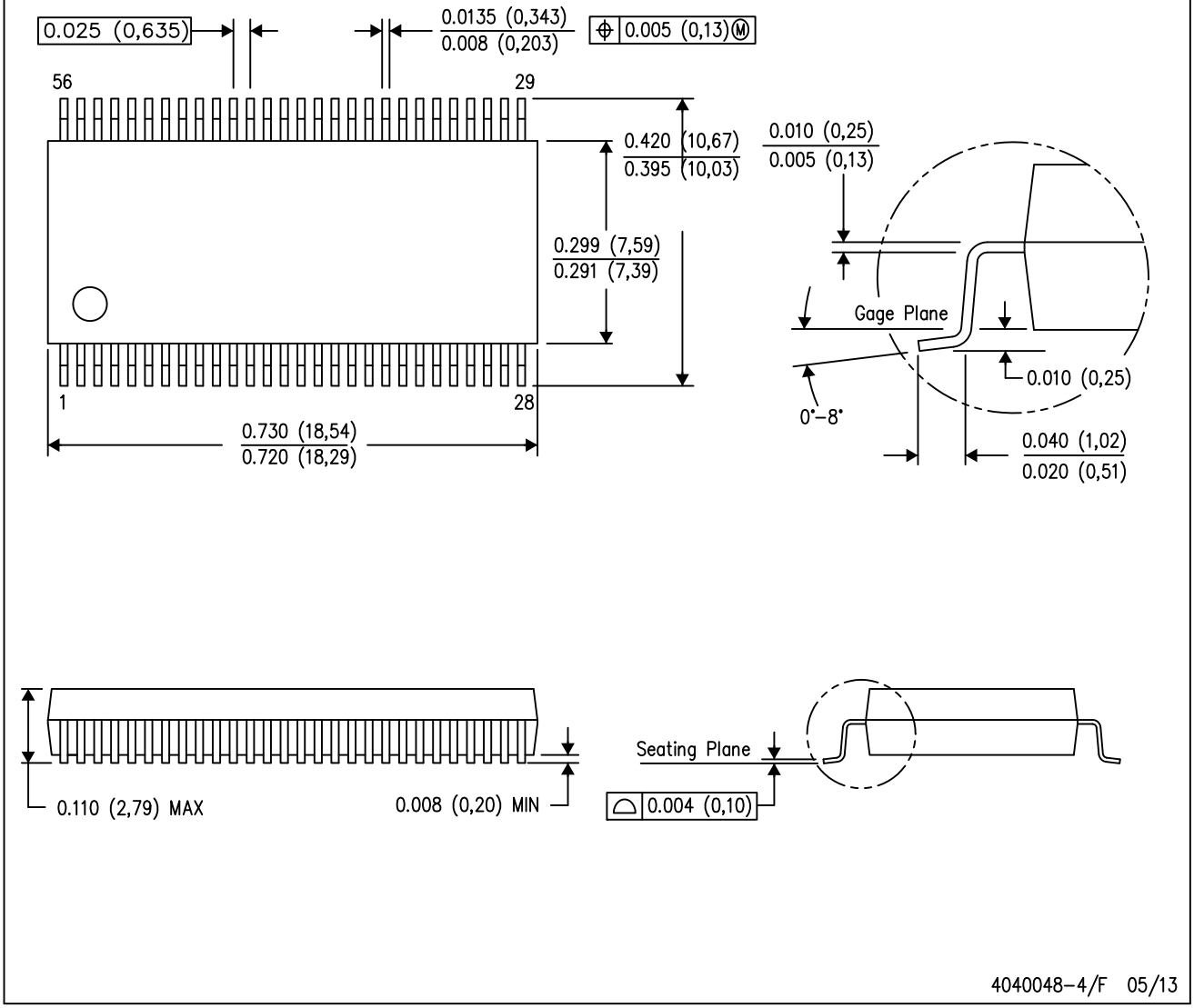
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
CLVTH16543IDGGREP	TSSOP	DGG	56	2000	367.0	367.0	45.0
CLVTH16543MDLREP	SSOP	DL	56	1000	367.0	367.0	55.0

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

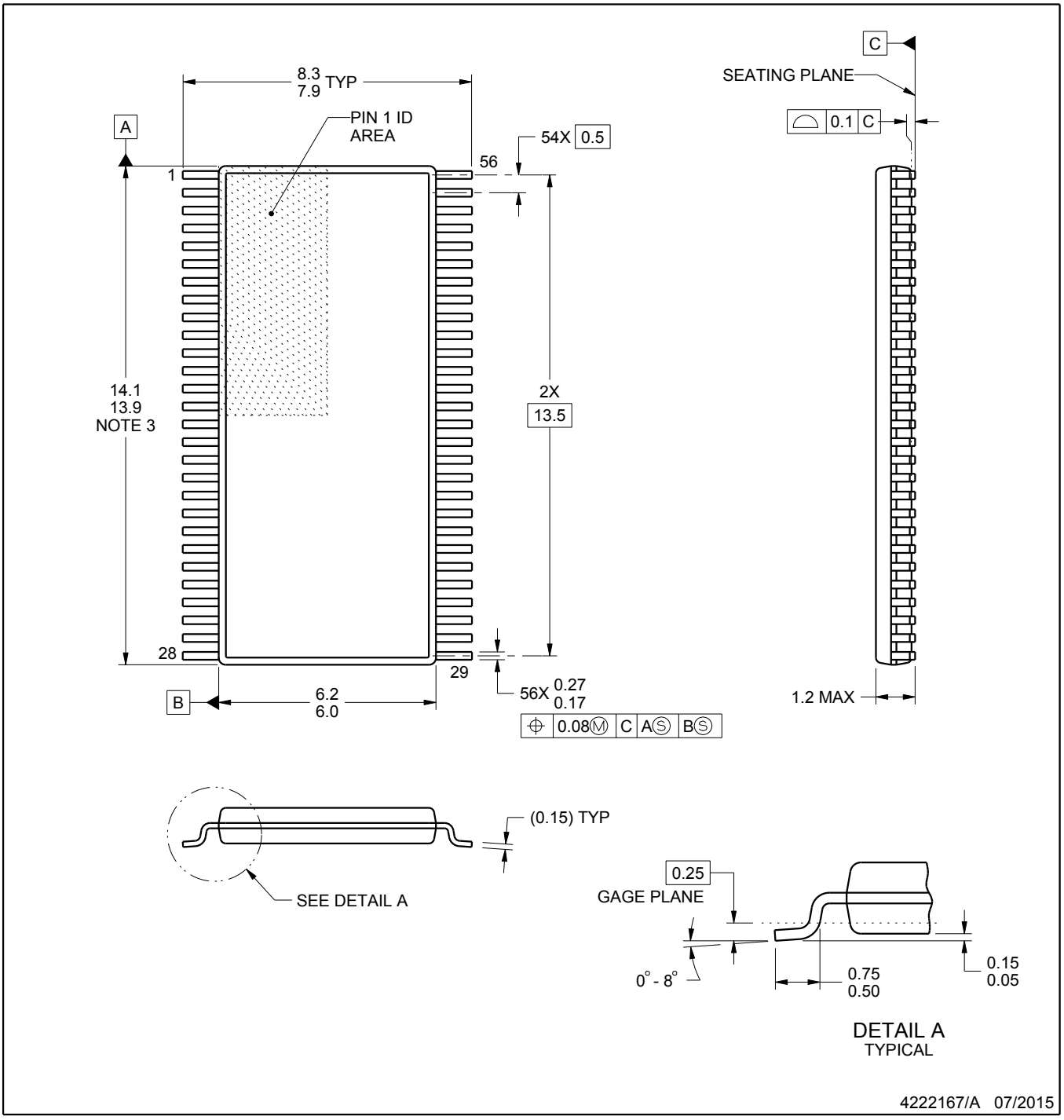
PowerPAD is a trademark of Texas Instruments.

PACKAGE OUTLINE

DGG0056A

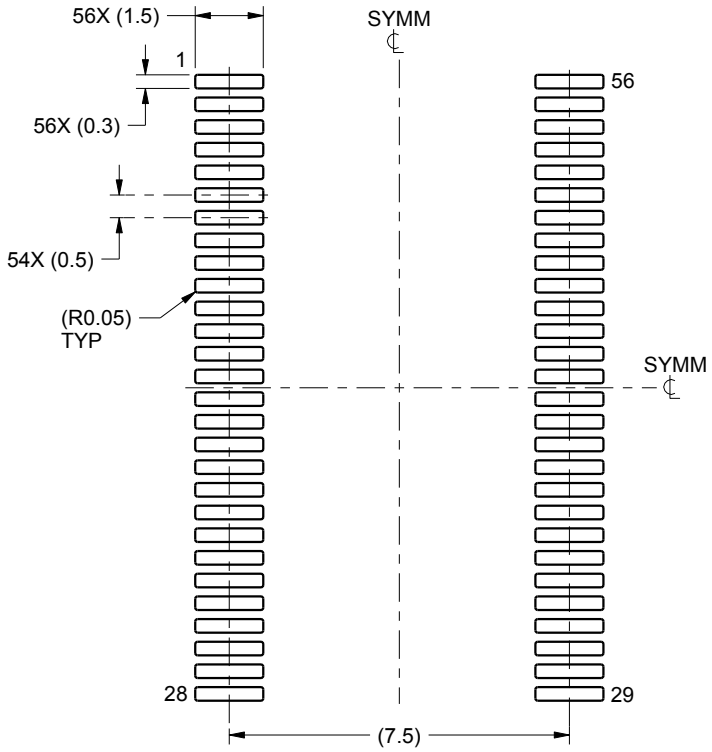
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

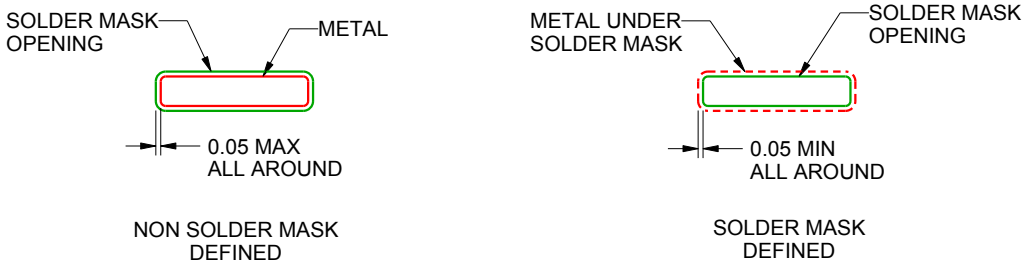


NOTES:

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.



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

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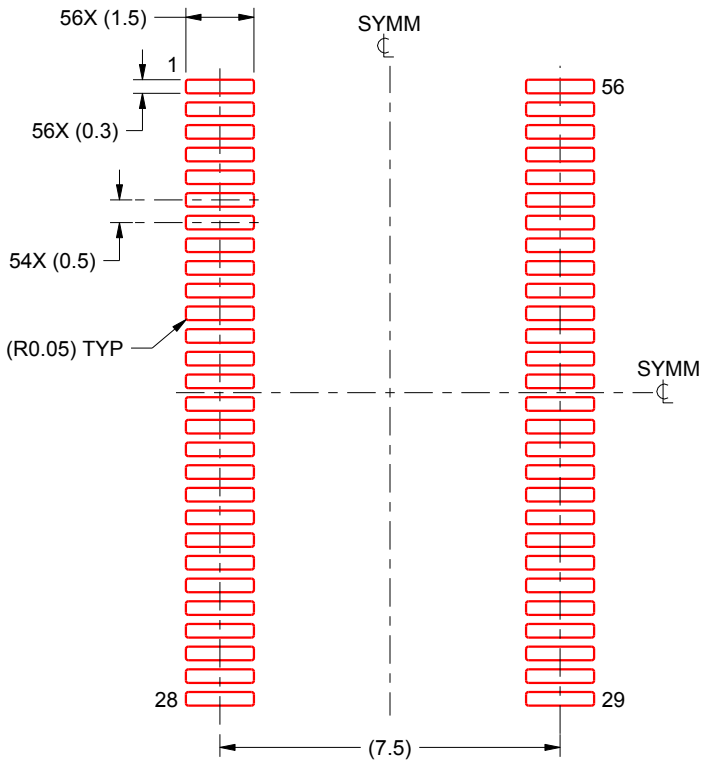
NOTES: (continued)

5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



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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