

# SN54LVTH541, SN74LVTH541 3.3-V ABT OCTAL BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

SCBS682G – MARCH 1997 – REVISED OCTOBER 2003

- Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V  $V_{CC}$ )
- Typical  $V_{OLP}$  (Output Ground Bounce)  $<0.8$  V at  $V_{CC} = 3.3$  V,  $T_A = 25^\circ\text{C}$
- Support 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
- Latch-Up Performance Exceeds 500 mA Per JESD 17
- ESD Protection Exceeds JESD 22
  - 2000-V Human-Body Model (A114-A)
  - 200-V Machine Model (A115-A)

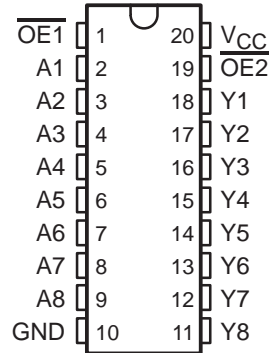
## description/ordering information

These octal buffers/drivers are designed specifically for low-voltage (3.3-V)  $V_{CC}$  operation, but with the capability to provide a TTL interface to a 5-V system environment.

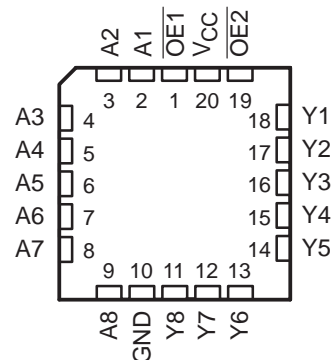
The 'LVTH541 devices are ideal for driving bus lines or buffer-memory address registers. These devices feature inputs and outputs on opposite sides of the package that facilitate printed circuit board layout.

The 3-state control gate is a 2-input AND gate with active-low inputs so that, if either output-enable ( $\overline{OE1}$  or  $\overline{OE2}$ ) input is high, all outputs are in the high-impedance state.

SN54LVTH541 . . . J OR W PACKAGE  
SN74LVTH541 . . . DB, DW, NS, OR PW PACKAGE  
(TOP VIEW)



SN54LVTH541 . . . FK PACKAGE  
(TOP VIEW)



## ORDERING INFORMATION

$T_A$	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	SOIC – DW	Tube	SN74LVTH541DW	LVTH541
		Tape and reel	SN74LVTH541DWR	
	SOP – NS	Tape and reel	SN74LVTH541NSR	LVTH541
	SSOP – DB	Tape and reel	SN74LVTH541DBR	LXH541
-55°C to 125°C	TSSOP – PW	Tube	SN74LVTH541PW	LXH541
		Tape and reel	SN74LVTH541PWR	
	CDIP – J	Tube	SNJ54LVTH541J	SNJ54LVTH541J
	CFP – W	Tube	SNJ54LVTH541W	SNJ54LVTH541W
	LCCC – FK	Tube	SNJ54LVTH541FK	SNJ54LVTH541FK

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



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 **TEXAS  
INSTRUMENTS**

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# SN54LVTH541, SN74LVTH541

## 3.3-V ABT OCTAL BUFFERS/DRIVERS

### WITH 3-STATE OUTPUTS

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#### description/ordering information (continued)

Active bus-hold circuitry holds unused or undriven inputs at a valid logic state. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended.

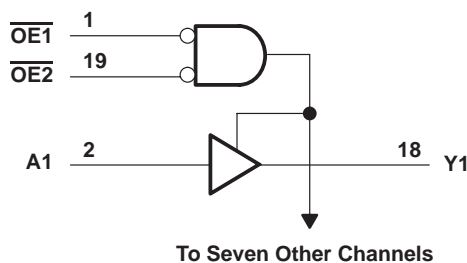
When  $V_{CC}$  is between 0 and 1.5 V, the devices are in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 V,  $\overline{OE}$  should be tied to  $V_{CC}$  through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

These devices are 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 devices when they are 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.

FUNCTION TABLE

INPUTS			OUTPUT
$\overline{OE1}$	$\overline{OE2}$	A	Y
L	L	L	L
L	L	H	H
H	X	X	Z
X	H	X	Z

#### logic diagram (positive logic)



# SN54LVTH541, SN74LVTH541 3.3-V ABT OCTAL BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

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## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, $V_{CC}$ .....	–0.5 V to 4.6 V
Input voltage range, $V_I$ (see Note 1) .....	–0.5 V to 7 V
Voltage range applied to any output in the high-impedance or power-off state, $V_O$ (see Note 1) .....	–0.5 V to 7 V
Voltage range applied to any output in the high state, $V_O$ (see Note 1) .....	–0.5 V to $V_{CC} + 0.5$ V
Current into any output in the low state, $I_O$ : SN54LVTH541 .....	96 mA
SN74LVTH541 .....	128 mA
Current into any output in the high state, $I_O$ (see Note 2): SN54LVTH541 .....	48 mA
SN74LVTH541 .....	64 mA
Input clamp current, $I_{IK}$ ( $V_I < 0$ ) .....	–50 mA
Output clamp current, $I_{OK}$ ( $V_O < 0$ ) .....	–50 mA
Package thermal impedance, $\theta_{JA}$ (see Note 3): DB package .....	70°C/W
DW package .....	58°C/W
NS package .....	60°C/W
PW package .....	83°C/W
Storage temperature range, $T_{stg}$ .....	–65°C to 150°C

† 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. This current flows only when the output is in the high state and  $V_O > V_{CC}$ .  
 3. The package thermal impedance is calculated in accordance with JESD 51-7.

## recommended operating conditions (see Note 4)

	SN54LVTH541		SN74LVTH541		UNIT
	MIN	MAX	MIN	MAX	
$V_{CC}$ Supply voltage	2.7	3.6	2.7	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		5.5		5.5	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		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 4: 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.

# SN54LVTH541, SN74LVTH541

## 3.3-V ABT OCTAL BUFFERS/DRIVERS

### WITH 3-STATE OUTPUTS

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

PARAMETER	TEST CONDITIONS		SN54LVTH541			SN74LVTH541			UNIT
			MIN	TYP†	MAX	MIN	TYP†	MAX	
$V_{IK}$	$V_{CC} = 2.7\text{ V}$ , $I_I = -18\text{ mA}$		-1.2			-1.2			V
$V_{OH}$	$V_{CC} = 2.7\text{ V to }3.6\text{ V}$ , $I_{OH} = -100\text{ }\mu\text{A}$		$V_{CC}-0.2$			$V_{CC}-0.2$			V
	$V_{CC} = 2.7\text{ V}$ , $I_{OH} = -8\text{ mA}$		2.4			2.4			
	$V_{CC} = 3\text{ V}$	$I_{OH} = -24\text{ mA}$	2			2			
$V_{OL}$	$V_{CC} = 2.7\text{ V}$		$I_{OL} = 100\text{ }\mu\text{A}$		0.2			0.2	V
			$I_{OL} = 24\text{ mA}$		0.5			0.5	
	$V_{CC} = 3\text{ V}$		$I_{OL} = 16\text{ mA}$		0.4			0.4	
			$I_{OL} = 32\text{ mA}$		0.5			0.5	
			$I_{OL} = 48\text{ mA}$		0.55				
			$I_{OL} = 64\text{ mA}$					0.55	
$I_I$	$V_{CC} = 0\text{ or }3.6\text{ V}$ , $V_I = 5.5\text{ V}$		10			10			$\mu\text{A}$
	Control inputs	$V_{CC} = 3.6\text{ V}$ , $V_I = V_{CC}\text{ or GND}$	$\pm 1$			$\pm 1$			
	Data inputs	$V_{CC} = 3.6\text{ V}$	$V_I = V_{CC}$		1			1	
$V_I = 0$			-5			-5			
$I_{off}$	$V_{CC} = 0$ , $V_I\text{ or }V_O = 0\text{ to }4.5\text{ V}$					$\pm 100$			$\mu\text{A}$
$I_{I(\text{hold})}$	Data inputs	$V_{CC} = 3\text{ V}$	$V_I = 0.8\text{ V}$		75			75	$\mu\text{A}$
			$V_I = 2\text{ V}$		-75			-75	
		$V_{CC} = 3.6\text{ V}\ddagger$ , $V_I = 0\text{ to }3.6\text{ V}$					$\pm 500$		
$I_{OZH}$	$V_{CC} = 3.6\text{ V}$ , $V_O = 3\text{ V}$		5			5			$\mu\text{A}$
$I_{OZL}$	$V_{CC} = 3.6\text{ V}$ , $V_O = 0.5\text{ V}$		-5			-5			$\mu\text{A}$
$I_{OZPU}$	$V_{CC} = 0\text{ to }1.5\text{ V}$ , $V_O = 0.5\text{ V to }3\text{ V}$ , OE = don't care		$\pm 100^*$			$\pm 100$			$\mu\text{A}$
$I_{OZPD}$	$V_{CC} = 1.5\text{ V to }0$ , $V_O = 0.5\text{ V to }3\text{ V}$ , OE = don't care		$\pm 100^*$			$\pm 100$			$\mu\text{A}$
$I_{CC}$	$V_{CC} = 3.6\text{ V}$ , $I_O = 0$ , $V_I = V_{CC}\text{ or GND}$		Outputs high		0.19			0.19	mA
			Outputs low		5			5	
			Outputs disabled		0.19			0.19	
$\Delta I_{CC}\S$	$V_{CC} = 3\text{ V to }3.6\text{ V}$ , One input at $V_{CC} - 0.6\text{ V}$ , Other inputs at $V_{CC}\text{ or GND}$		0.2			0.2			mA
$C_i$	$V_I = 3\text{ V or }0$		3			3			pF
$C_o$	$V_O = 3\text{ V or }0$		7			7			pF

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

† All typical values are at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

‡ This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

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

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

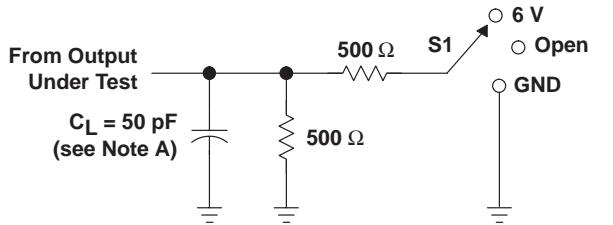
PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVTH541				SN74LVTH541				UNIT	
			$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$			$V_{CC} = 2.7\text{ V}$		
			MIN	MAX	MIN	MAX	MIN	TYP†	MAX	MIN		MAX
$t_{PLH}$	A	Y	1	3.7		4	1.1	2.4	3.5		3.9	ns
$t_{PHL}$			1	3.7		4	1.1	2.4	3.5		3.9	
$t_{PZH}$	$\overline{OE1}$ or $\overline{OE2}$	Y	1.4	5.3		6.3	1.5	3.5	5.2		6.2	ns
$t_{PZL}$			1.4	5.4		6	1.5	3.7	5.3		5.9	
$t_{PHZ}$	$\overline{OE1}$ or $\overline{OE2}$	Y	1.4	5.8		6.1	1.5	3.9	5.6		5.9	ns
$t_{PLZ}$			1.4	5.4		5.7	1.5	3	5		5.3	

† All typical values are at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

# SN54LVTH541, SN74LVTH541 3.3-V ABT OCTAL BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

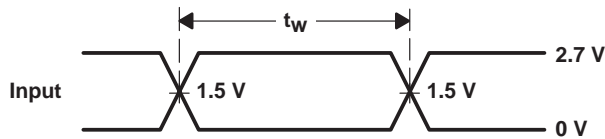
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## PARAMETER MEASUREMENT INFORMATION

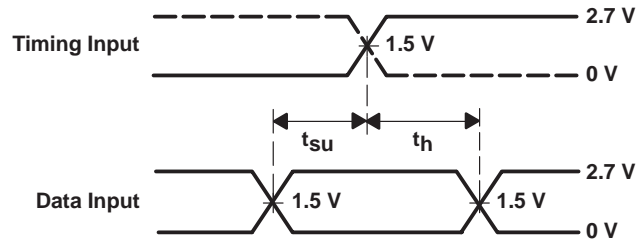


LOAD CIRCUIT

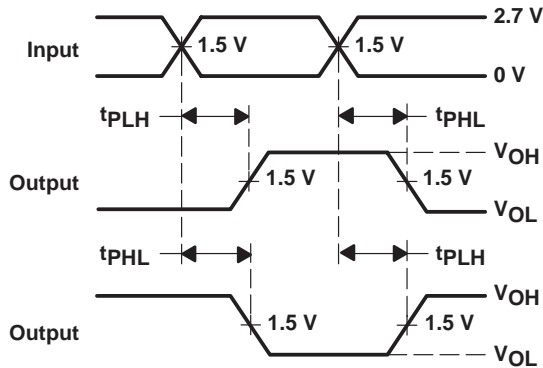
TEST	S1
$t_{PHL}/t_{PLH}$	Open
$t_{PLZ}/t_{PZL}$	6 V
$t_{PHZ}/t_{PZH}$	GND



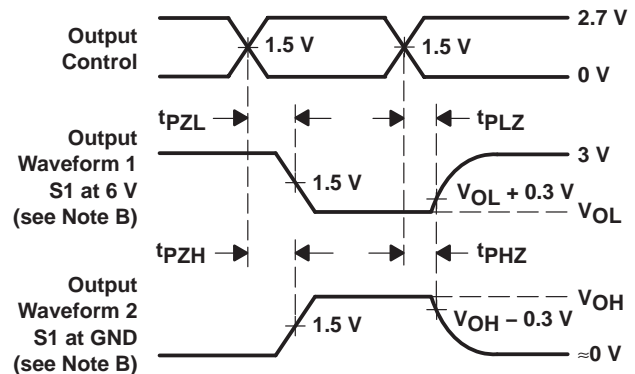
VOLTAGE WAVEFORMS  
PULSE DURATION



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:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5 \text{ ns}$ ,  $t_f \leq 2.5 \text{ ns}$ .  
 D. The outputs are measured one at a time with one transition per measurement.  
 E. All parameters and waveforms are not applicable to all devices.

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 (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74LVTH541DBLE	OBSOLETE	SSOP	DB	20		TBD	Call TI	Call TI	-40 to 85		
SN74LVTH541DBR	ACTIVE	SSOP	DB	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LXH541	<a href="#">Samples</a>
SN74LVTH541DW	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH541	<a href="#">Samples</a>
SN74LVTH541DWE4	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH541	<a href="#">Samples</a>
SN74LVTH541DWG4	ACTIVE	SOIC	DW	20	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH541	<a href="#">Samples</a>
SN74LVTH541DWR	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH541	<a href="#">Samples</a>
SN74LVTH541DWRE4	ACTIVE	SOIC	DW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH541	<a href="#">Samples</a>
SN74LVTH541NSR	ACTIVE	SO	NS	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH541	<a href="#">Samples</a>
SN74LVTH541PW	ACTIVE	TSSOP	PW	20	70	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LXH541	<a href="#">Samples</a>
SN74LVTH541PWLE	OBSOLETE	TSSOP	PW	20		TBD	Call TI	Call TI	-40 to 85		
SN74LVTH541PWR	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LXH541	<a href="#">Samples</a>
SN74LVTH541PWRG4	ACTIVE	TSSOP	PW	20	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LXH541	<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.

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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.

<sup>(4)</sup> There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

<sup>(5)</sup> 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.

<sup>(6)</sup> 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**

**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
SN74LVTH541DBR	SSOP	DB	20	2000	330.0	16.4	8.2	7.5	2.5	12.0	16.0	Q1
SN74LVTH541DWR	SOIC	DW	20	2000	330.0	24.4	10.8	13.3	2.7	12.0	24.0	Q1
SN74LVTH541NSR	SO	NS	20	2000	330.0	24.4	9.0	13.0	2.4	4.0	24.0	Q1
SN74LVTH541PWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1

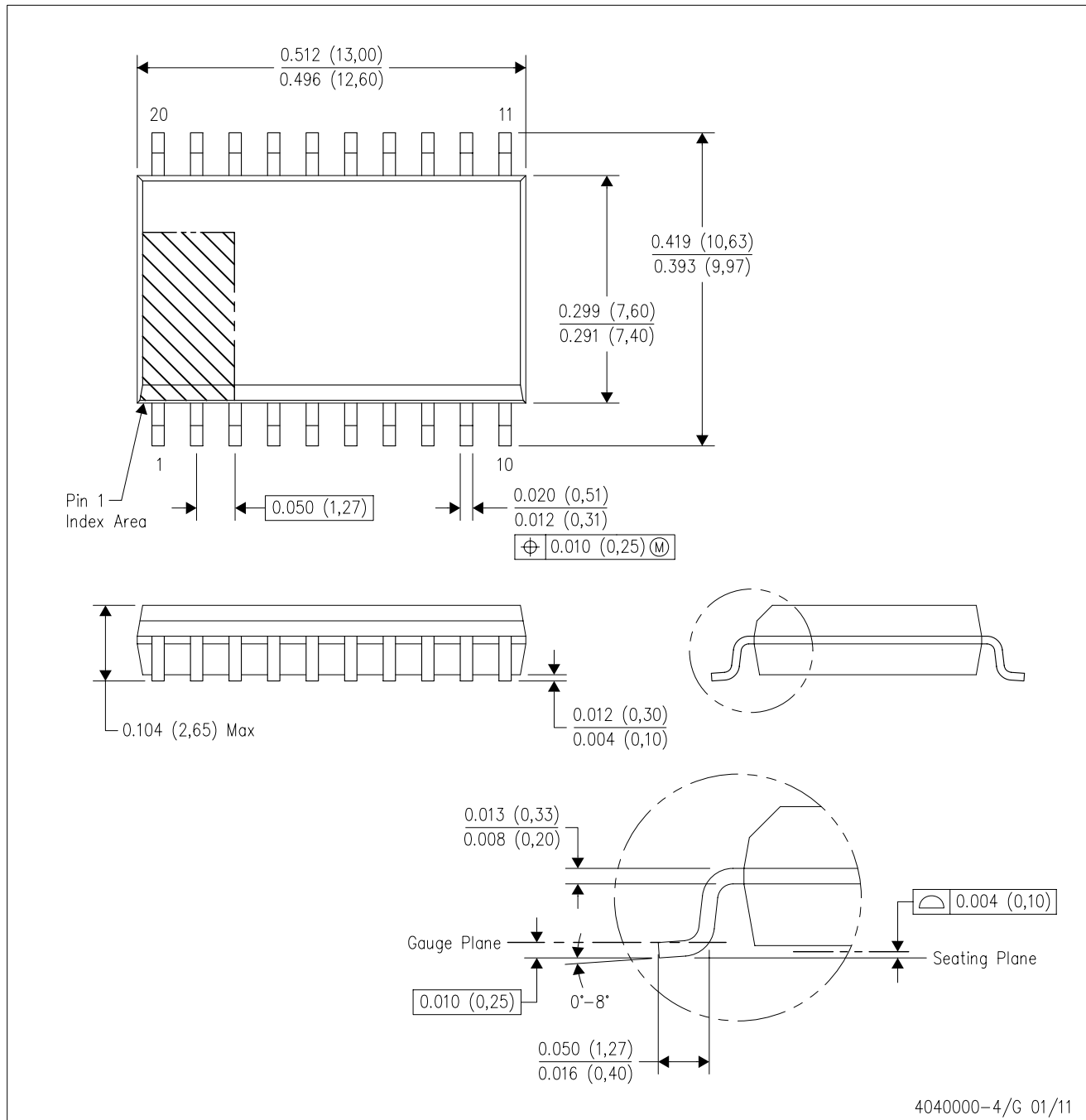
**TAPE AND REEL BOX DIMENSIONS**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LVTH541DBR	SSOP	DB	20	2000	367.0	367.0	38.0
SN74LVTH541DWR	SOIC	DW	20	2000	367.0	367.0	45.0
SN74LVTH541NSR	SO	NS	20	2000	367.0	367.0	45.0
SN74LVTH541PWR	TSSOP	PW	20	2000	367.0	367.0	38.0

DW (R-PDSO-G20)

PLASTIC SMALL OUTLINE

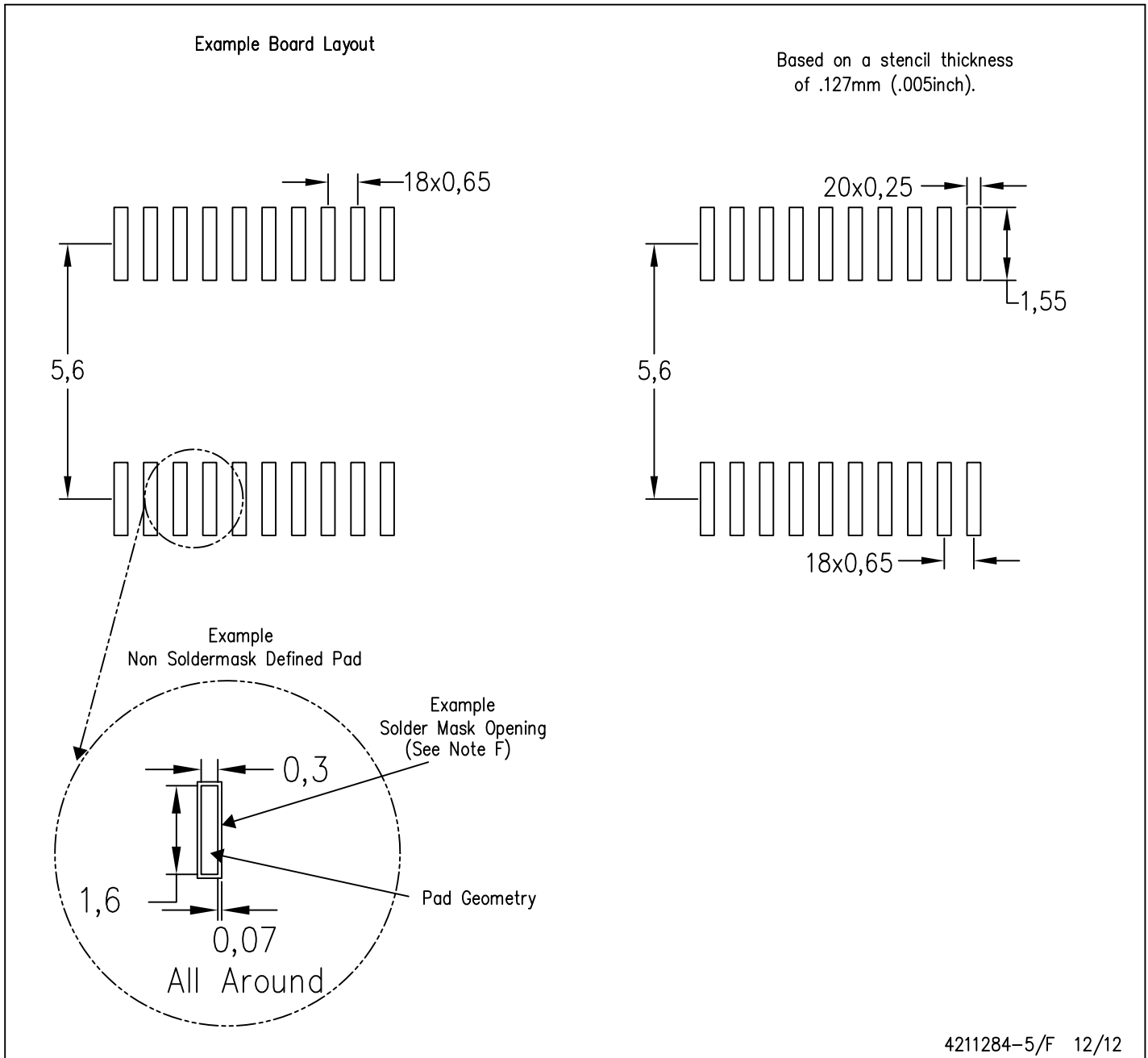


- NOTES:
- A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - D. Falls within JEDEC MS-013 variation AC.



PW (R-PDSO-G20)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate design.
  - D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

DB (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE

28 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.  
 D. Falls within JEDEC MO-150

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-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.

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