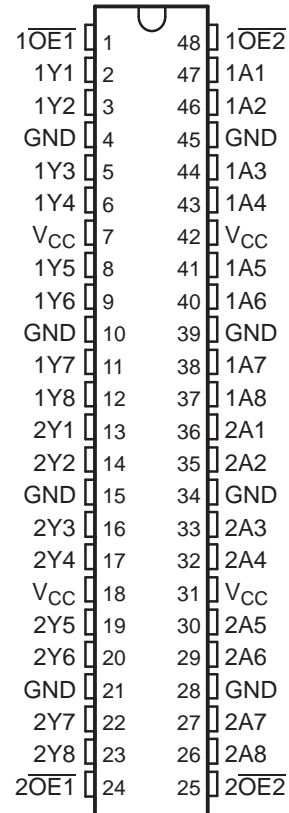


## FEATURES

- Members 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
- Output Ports Have Equivalent 22-Ω Series Resistors, So No External Resistors Are Required
- Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V<sub>CC</sub>)
- Support Unregulated Battery Operation Down to 2.7 V
- Typical V<sub>OLP</sub> (Output Ground Bounce) <0.8 V at V<sub>CC</sub> = 3.3 V, T<sub>A</sub> = 25°C
- I<sub>off</sub> and Power-Up 3-State Support Hot Insertion
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Distributed V<sub>CC</sub> and GND Pin Configuration Minimizes 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)
- 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

SN54LVTH162541 . . . WD PACKAGE  
SN74LVTH162541 . . . DGG OR DL PACKAGE  
(TOP VIEW)



## DESCRIPTION/ORDERING INFORMATION

These 16-bit buffers/drivers are designed specifically for low-voltage (3.3-V) V<sub>CC</sub> operation, but with the capability to provide a TTL interface to a 5-V system environment.

These devices are noninverting 16-bit buffers composed of two 8-bit sections with separate output-enable signals. For either 8-bit buffer section, the two output-enable (1OE1 and 1OE2 or 2OE1 and 2OE2) inputs must be low for the corresponding Y outputs to be active. If either output-enable input is high, the outputs of that 8-bit buffer section are in the high-impedance state.

The outputs, which are designed to source or sink up to 12 mA, include equivalent 22-Ω series resistors to reduce overshoot and undershoot.



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.

**SN54LVTH162541, SN74LVTH162541**  
**3.3-V ABT 16-BIT BUFFERS/DRIVERS**  
**WITH 3-STATE OUTPUTS**

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**DESCRIPTION/ORDERING INFORMATION (CONTINUED)**

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.

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

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.

The SN54LVTH162541 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74LVTH162541 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .

**ORDERING INFORMATION**

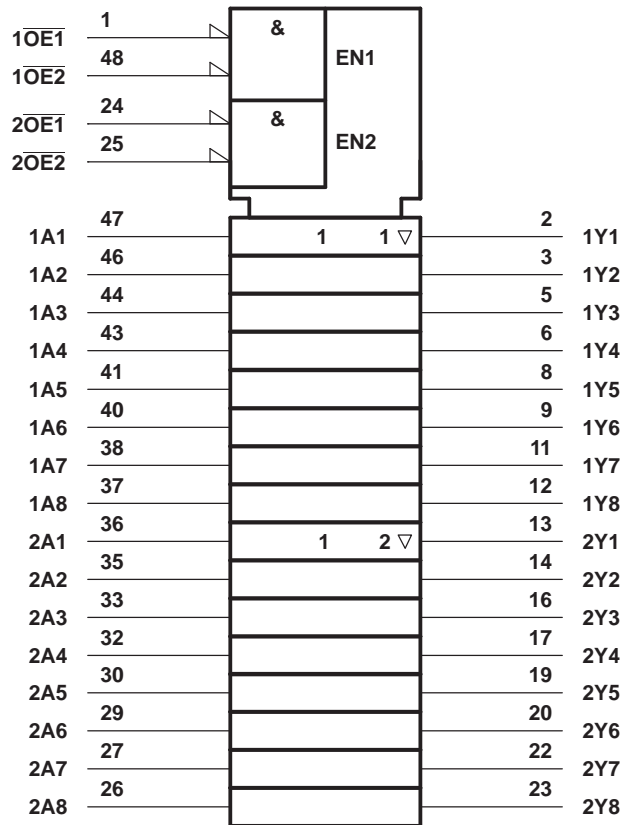
$T_A$	PACKAGE <sup>(1)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
$-40^{\circ}\text{C}$ to $85^{\circ}\text{C}$	SSOP – DL	Reel of 1000	74LVTH162541DLRG4	LVTH162541
			SN74LVTH162541DLR	
		Tube of 25	74LVTH162541DLG4	
			SN74LVTH162541DL	
	TSSOP – DGG	Reel of 2000	74LVTH162541DGGRE4	LVTH162541
			SN74LVTH162541DGGR	

(1) 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).

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

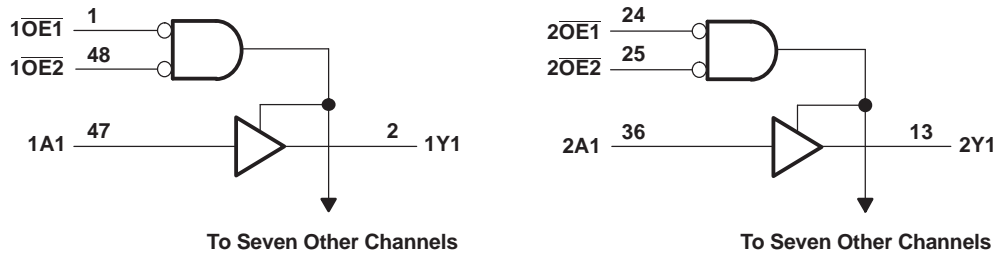
INPUTS			OUTPUT Y
$\overline{OE1}$	$\overline{OE2}$	A	
L	L	L	L
L	L	H	H
H	X	X	Z
X	H	X	Z

**LOGIC SYMBOL<sup>(1)</sup>**



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

**LOGIC DIAGRAM (POSITIVE LOGIC)**



# SN54LVTH162541, SN74LVTH162541 3.3-V ABT 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

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## Absolute Maximum Ratings<sup>(1)</sup>

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

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage range	-0.5	4.6	V
V <sub>I</sub>	Input voltage range <sup>(2)</sup>	-0.5	7	V
V <sub>O</sub>	Voltage range applied to any output in the high-impedance or power-off state <sup>(2)</sup>	-0.5	7	V
V <sub>O</sub>	Voltage range applied to any output in the high state <sup>(2)</sup>	-0.5	V <sub>CC</sub> + 0.5	V
I <sub>O</sub>	Current into any output in the low state		30	mA
I <sub>O</sub>	Current into any output in the high state <sup>(3)</sup>		30	mA
I <sub>IK</sub>	Input clamp current	V <sub>I</sub> < 0	-50	mA
I <sub>OK</sub>	Output clamp current	V <sub>O</sub> < 0	-50	mA
θ <sub>JA</sub>	Package thermal impedance <sup>(4)</sup>	DGG package	89	°C/W
		DL package	94	
T <sub>stg</sub>	Storage temperature range	-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<sub>O</sub> > V<sub>CC</sub>.
- (4) The package thermal impedance is calculated in accordance with JESD 51.

## Recommended Operating Conditions<sup>(1)</sup>

		SN54LVTH162541		SN74LVTH162541		UNIT
		MIN	MAX	MIN	MAX	
V <sub>CC</sub>	Supply voltage	2.7	3.6	2.7	3.6	V
V <sub>IH</sub>	High-level input voltage	2		2		V
V <sub>IL</sub>	Low-level input voltage		0.8		0.8	V
V <sub>I</sub>	Input voltage		5.5		5.5	V
I <sub>OH</sub>	High-level output current		-12		-12	mA
I <sub>OL</sub>	Low-level output current		12		12	mA
Δt/Δv	Input transition rise or fall rate	Outputs enabled		10	10	ns/V
Δt/ΔV <sub>CC</sub>	Power-up ramp rate	200		200		μs/V
T <sub>A</sub>	Operating free-air temperature	-55	125	-40	85	°C

- (1) All unused control inputs of the device must be held at V<sub>CC</sub> 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		SN54LVTH162541			SN74LVTH162541			UNIT
			MIN	TYP <sup>(1)</sup>	MAX	MIN	TYP <sup>(1)</sup>	MAX	
$V_{IK}$	$V_{CC} = 2.7\text{ V}$ ,	$I_I = -18\text{ mA}$			-1.2			-1.2	V
$V_{OH}$	$V_{CC} = 3\text{ V}$ ,	$I_{OH} = -12\text{ mA}$	2			2			V
$V_{OL}$	$V_{CC} = 3\text{ V}$ ,	$I_{OL} = 12\text{ mA}$			0.8			0.8	V
$I_I$		$V_{CC} = 0\text{ or }3.6\text{ V}$ ,			$V_I = 5.5\text{ V}$			10	10
	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	$\mu\text{A}$
		$V_I = 0$		-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			
		$V_{CC} = 3.6\text{ V}$ , <sup>(2)</sup>	$V_I = 0\text{ to }3.6\text{ V}$					500 -750	
$I_{OZH}$	$V_{CC} = 3.6\text{ V}$ ,	$V_O = 3\text{ V}$			5			5	$\mu\text{A}$
$I_{OZL}$	$V_{CC} = 3.6\text{ V}$ ,	$V_O = 0.5\text{ V}$			-5			-5	$\mu\text{A}$
$I_{OZPU}$	$V_{CC} = 0\text{ to }1.5\text{ V}$ , $V_O = 0.5\text{ V to }3\text{ V}$ , $\overline{OE} = \text{don't care}$				$\pm 100$ <sup>(3)</sup>			$\pm 100$	$\mu\text{A}$
$I_{OZPD}$	$V_{CC} = 1.5\text{ V to }0$ , $V_O = 0.5\text{ V to }3\text{ V}$ , $\overline{OE} = \text{don't care}$				$\pm 100$ <sup>(3)</sup>			$\pm 100$	$\mu\text{A}$
$I_{CC}$	$V_{CC} = 3.6\text{ V}$ , $I_O = 0$ , $V_I = V_{CC}\text{ or GND}$	Outputs high			0.19			0.19	mA
		Outputs low			5			5	
		Outputs disabled			0.19			0.19	
$\Delta I_{CC}$ <sup>(4)</sup>	$V_{CC} = 3\text{ V to }3.6\text{ V}$ , One input at $V_{CC} - 0.6\text{ V}$ , Other inputs at $V_{CC}\text{ or GND}$				0.2			0.2	mA
$C_i$	$V_I = 3\text{ V or }0$				4			4	pF
$C_o$	$V_O = 3\text{ V or }0$				9			9	pF

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

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

(3) On products compliant to MIL-PRF-38535, this parameter is not production tested.

 (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.

**SN54LVTH162541, SN74LVTH162541**  
**3.3-V ABT 16-BIT BUFFERS/DRIVERS**  
**WITH 3-STATE OUTPUTS**

SCBS690F–MAY 1997–REVISED NOVEMBER 2006

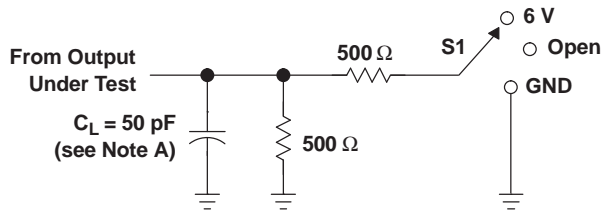
**Switching Characteristics**

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVTH162541				SN74LVTH162541				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 <sup>(1)</sup>	MAX	MIN		MAX
$t_{PLH}$	A	Y	1.1	4.3	4.9		1.2	2.9	4.1	4.7		ns
$t_{PHL}$			1.1	4.3	4.9		1.2	2.4	4.1	4.7		
$t_{PZH}$	$\overline{OE}$	Y	1.4	5.3	6.3		1.5	3.2	5	6.1		ns
$t_{PZL}$			1.4	5.1	5.8		1.5	3.3	4.8	5.5		
$t_{PHZ}$	$\overline{OE}$	Y	2.1	6.1	6.4		2.2	4.3	5.9	6.2		ns
$t_{PLZ}$			2.1	5.7	5.9		2.2	4	5.4	5.5		
$t_{sk(LH)}$								0.5	0.5		ns	
$t_{sk(HL)}$								0.5	0.5			

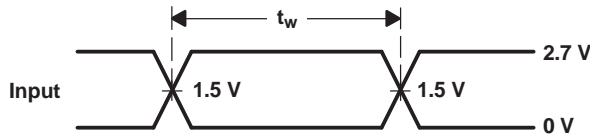
(1) All typical values are at  $V_{CC} = 3.3\text{ V}$ ,  $T_A = 25^\circ\text{C}$ .

PARAMETER MEASUREMENT INFORMATION

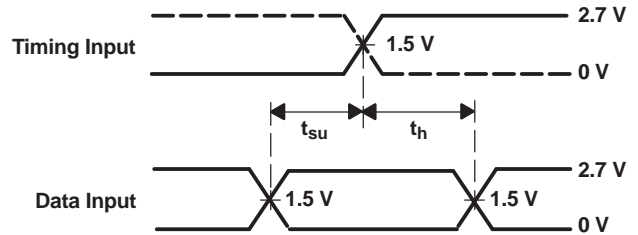


LOAD CIRCUIT

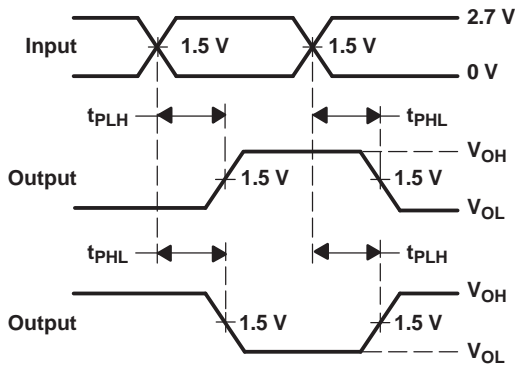
TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	6 V
$t_{PHZ}/t_{PZH}$	GND



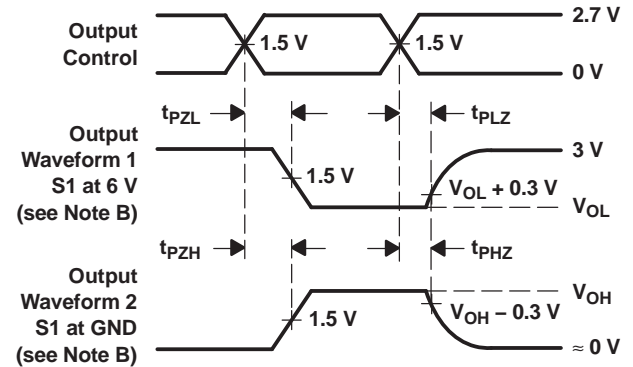
VOLTAGE WAVEFORMS  
PULSE DURATION



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.

Figure 1. Load Circuit and Voltage Waveforms

**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
SN74LVTH162541DGGR	ACTIVE	TSSOP	DGG	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH162541	<a href="#">Samples</a>
SN74LVTH162541DL	ACTIVE	SSOP	DL	48	25	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH162541	<a href="#">Samples</a>
SN74LVTH162541DLR	ACTIVE	SSOP	DL	48	1000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVTH162541	<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) **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  $\leq 1000$ ppm threshold. Antimony trioxide based flame retardants must also meet the  $\leq 1000$ ppm 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.

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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
SN74LVTH162541DGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	12.0	24.0	Q1
SN74LVTH162541DLR	SSOP	DL	48	1000	330.0	32.4	11.35	16.2	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)
SN74LVTH162541DGGR	TSSOP	DGG	48	2000	367.0	367.0	45.0
SN74LVTH162541DLR	SSOP	DL	48	1000	367.0	367.0	55.0

**TUBE**


\*All dimensions are nominal

Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (μm)	B (mm)
SN74LVTH162541DL	DL	SSOP	48	25	473.7	14.24	5110	7.87

# MECHANICAL DATA

DL (R-PDSO-G48)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - Falls within JEDEC MO-118

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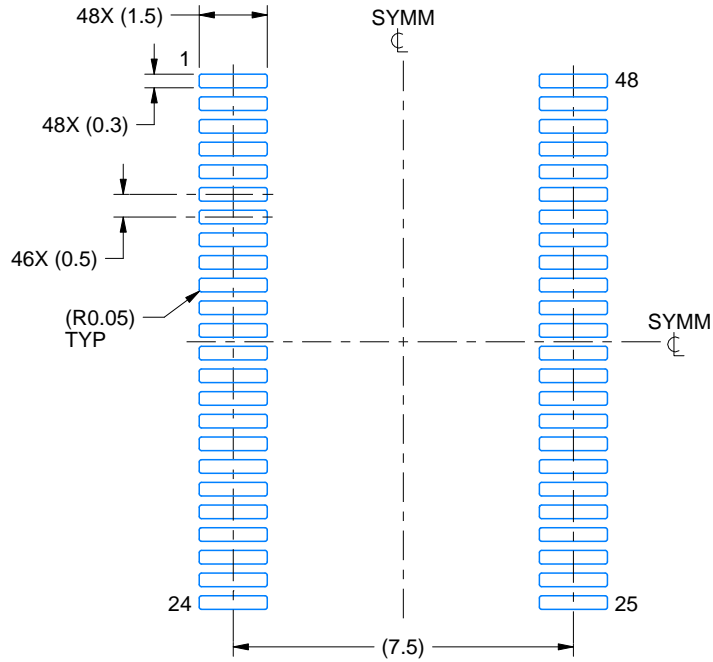


# EXAMPLE BOARD LAYOUT

DGG0048A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
SCALE:6X



SOLDER MASK DETAILS

4214859/B 11/2020

NOTES: (continued)

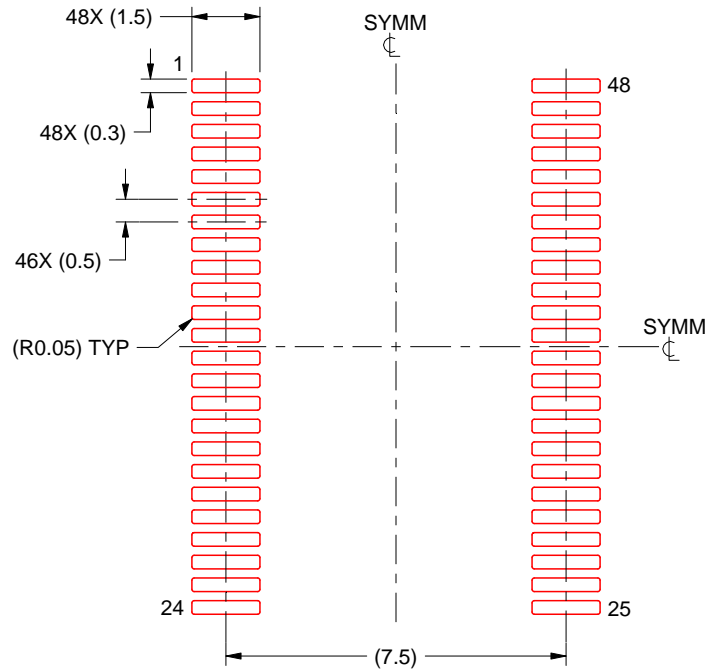
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DGG0048A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



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

4214859/B 11/2020

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.



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

PLASTIC SMALL-OUTLINE PACKAGE

48 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 protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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