DS90LV049 3V LVDS Dual Line Driver with Dual Line Receiver

Check for Samples: DS90LV049

FEATURES

- **Up to 400 Mbps Switching Rates**
- **Flow-Through Pinout Simplifies PCB Layout**
- **50 ps Typical Driver Channel-to-Channel Skew**
- **50 ps Typical Receiver Channel-to-Channel Skew**
- **3.3 V Single Power Supply Design**
- **TRI-STATE Output Control**
- **Internal Fail-Safe Biasing of Receiver Inputs**
- **Low Power Dissipation (70 mW at 3.3 V Static)**
- **High Impedance on LVDS Outputs on Power Down**
- **Conforms to TIA/EIA-644-A LVDS Standard**
- **Industrial Operating Temperature Range (−40°C to +85°C)**
- **Available in Low Profile 16 Pin TSSOP Package**

DESCRIPTION

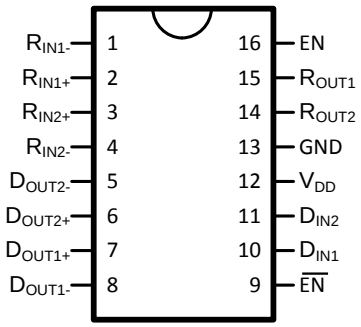
The DS90LV049 is a dual CMOS flow-through differential line driver-receiver pair designed for applications requiring ultra low power dissipation, exceptional noise immunity, and high data throughput. The device is designed to support data rates in excess of 400 Mbps utilizing Low Voltage Differential Signaling (LVDS) technology.

The DS90LV049 drivers accept LVTTL/LVCMOS signals and translate them to LVDS signals. On the other hand, the receivers accept LVDS signals and translate them to 3 V CMOS signals. The LVDS input buffers have internal failsafe biasing that places the outputs to a known H (high) state for floating receiver inputs. In addition, the DS90LV049 supports a TRI-STATE function for a low idle power state when the device is not in use.

The EN and $\overline{EN}$ inputs are ANDed together and control the TRI-STATE outputs. The enables are common to all four gates.

Connection Diagram

Dual-In-Line



Order Number DS90LV049TMT
Order Number DS90LV049TMTX (Tape and Reel)
PW0016A Package

Functional Diagram

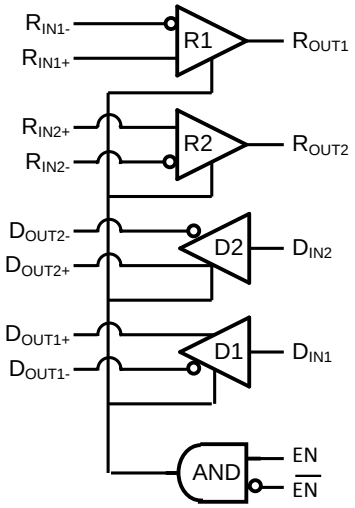


Table 1. TRUTH TABLE

EN	$\overline{EN}$	LVDS Out	LVCMOS Out
L or Open	L or Open	OFF	OFF
H	L or Open	ON	ON
L or Open	H	OFF	OFF
H	H	OFF	OFF

These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

ABSOLUTE MAXIMUM RATINGS(1)(2)

Supply Voltage (V_{DD})	−0.3 V to +4 V
LVCMOS Input Voltage (D_{IN})	−0.3 V to (V_{DD} + 0.3 V)
LVDS Input Voltage (R_{IN+}, R_{IN-})	−0.3 V to +3.9 V
Enable Input Voltage (EN, $\overline{EN}$)	−0.3 V to (V_{DD} + 0.3 V)
LVCMOS Output Voltage (R_{OUT})	−0.3 V to (V_{DD} + 0.3 V)
LVDS Output Voltage (D_{OUT+}, D_{OUT-})	−0.3 V to +3.9 V
LVCMOS Output Short Circuit Current (R_{OUT})	100 mA
LVDS Output Short Circuit Current (D_{OUT+}, D_{OUT-})	24 mA
LVDS Output Short Circuit Current Duration (D_{OUT+}, D_{OUT-})	Continuous
Storage Temperature Range	−65°C to +150°C
Lead Temperature Range	
Soldering (4 sec.)	+260°C
Maximum Junction Temperature	+150°C
Maximum Package Power Dissipation @ +25°C	
PW0016A Package	866 mW
Derate PW0016A Package	6.9 mW/°C above +25°C
ESD Rating	
(HBM, 1.5 kΩ, 100 pF)	≥ 7 kV
(MM, 0 Ω, 200 pF)	≥ 250 V

(1) "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be specified. They are not meant to imply that the devices should be operated at these limits. ELECTRICAL CHARACTERISTICS specifies conditions of device operation.
(2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/Distributors for availability and specifications.

RECOMMENDED OPERATING CONDITIONS

	Min	Typ	Max	Units
Supply Voltage (V_{DD})	+3.0	+3.3	+3.6	V
Operating Free Air Temperature (T_A)	−40	+25	+85	°C

ELECTRICAL CHARACTERISTICS

Over supply voltage and operating temperature ranges, unless otherwise specified.(1)(2)(3)

Symbol	Parameter	Conditions	Pin	Min	Typ	Max	Units
LVCMOS Input DC Specifications (Driver Inputs, ENABLE Pins)							
V_{IH}	Input High Voltage		D_{IN} EN $\overline{EN}$	2.0		V_{DD}	V
V_{IL}	Input Low Voltage			GND		0.8	V
I_{IH}	Input High Current	$V_{IN} = V_{DD}$		−10	1	+10	µA
I_{IL}	Input Low Current	V_{IN} = GND		−10	−0.1	+10	µA
V_{CL}	Input Clamp Voltage	I_{CL} = −18 mA		−1.5	−0.6		V
LVDS Output DC Specifications (Driver Outputs)							

(1) Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except: V_{TH}, V_{TL}, V_{OD} and ΔV_{OD}.
(2) All typical values are given for: V_{DD} = +3.3 V, T_A = +25°C.
(3) The DS90LV049's drivers are current mode devices and only function within datasheet specifications when a resistive load is applied to their outputs. The typical range of the resistor values is 90 Ω to 110 Ω.

ELECTRICAL CHARACTERISTICS (continued)

Over supply voltage and operating temperature ranges, unless otherwise specified.(1)(2)(3)

Symbol	Parameter	Conditions	Pin	Min	Typ	Max	Units
$\lvert V_{OD} \rvert$	Differential Output Voltage	R_L = 100 Ω (Figure 1)	D_{OUT-} D_{OUT+}	250	350	450	mV
ΔV_{OD}	Change in Magnitude of V_{OD} for Complementary Output States				1	35	|mV|
V_{OS}	Offset Voltage			1.125	1.23	1.375	V
ΔV_{OS}	Change in Magnitude of V_{OS} for Complementary Output States				1	25	|mV|
I_{OS}	Output Short Circuit Current(4)	ENABLED, D_{IN} = V_{DD}, D_{OUT+} = 0 V or D_{IN} = GND, D_{OUT-} = 0 V			−5.8	−9.0	mA
I_{OSD}	Differential Output Short Circuit Current(4)	ENABLED, V_{OD} = 0 V			−5.8	−9.0	mA
I_{OFF}	Power-off Leakage	V_{OUT} = 0 V or 3.6 V, V_{DD} = 0 V or Open		−20	±1	+20	µA
I_{OZ}	Output TRI-STATE Current	EN = 0 V and $\overline{EN}$ = V_{DD}, V_{OUT} = 0 V or V_{DD}		−10	±1	+10	µA
LVDS Input DC Specifications (Receiver Inputs)							
V_{TH}	Differential Input High Threshold	V_{CM} = 1.2 V, 0.05 V, 2.35 V	R_{IN+} R_{IN-}		−15	35	mV
V_{TL}	Differential Input Low Threshold			-100	−15		mV
V_{CMR}	Common-Mode Voltage Range	V_{ID} = 100 mV, V_{DD}=3.3 V		0.05		3	V
I_{IN}	Input Current	V_{DD}=3.6 V, V_{IN} =0 V or 2.8 V		−12	±4	+12	µA
		V_{DD}=0 V, V_{IN} =0 V or 2.8 V or 3.6 V		−10	±1	+10	µA
LVCMOS Output DC Specifications (Receiver Outputs)							
V_{OH}	Output High Voltage	I_{OH} = -0.4 mA, V_{ID}= 200 mV	R_{OUT}	2.7	3.3		V
V_{OL}	Output Low Voltage	I_{OL} = 2 mA, V_{ID} = 200 mV			0.05	0.25	V
I_{OZ}	Output TRI-STATE Current	Disabled, V_{OUT} =0 V or V_{DD}		-10	±1	+10	µA
General DC Specifications							
I_{DD}	Power Supply Current(5)	EN = 3.3 V	V_{DD}		21	35	mA
I_{DDZ}	TRI-State Supply Current	EN = 0 V			15	25	mA

(4) Output short circuit current (I_{OS}) is specified as magnitude only, minus sign indicates direction only.
(5) Both driver and receiver inputs are static. All LVDS outputs have 100 Ω load. All LVCMOS outputs are floating. None of the outputs have any lumped capacitive load.

SWITCHING CHARACTERISTICS

V_{DD} = +3.3V ± 10%, T_A = −40°C to +85°C[1] [2]

Symbol	Parameter	Conditions	Min	Typ	Max	Units
LVDS Outputs (Driver Outputs)						
t_{PHLD}	Differential Propagation Delay High to Low	R_L = 100 Ω (Figure 2 and Figure 3)		0.7	2	ns
t_{PLHD}	Differential Propagation Delay Low to High			0.7	2	ns
t_{SKD1}	Differential Pulse Skew $\|t_{PHLD} - t_{PLHD}\|$[3][4]		0	0.05	0.4	ns
t_{SKD2}	Differential Channel-to-Channel Skew[3][5]		0	0.05	0.5	ns
t_{SKD3}	Differential Part-to-Part Skew[3][6]		0		1.0	ns
t_{TLH}	Rise Time[3]		0.2	0.4	1	ns
t_{THL}	Fall Time[3]		0.2	0.4	1	ns
t_{PHZ}	Disable Time High to Z	R_L = 100 Ω (Figure 4 and Figure 5)		1.5	3	ns
t_{PLZ}	Disable Time Low to Z			1.5	3	ns
t_{PZH}	Enable Time Z to High		1	3	6	ns
t_{PZL}	Enable Time Z to Low		1	3	6	ns
f_{MAX}	Maximum Operating Frequency[7]		200	250		MHz
LVCMOS Outputs (Receiver Outputs)						
t_{PHL}	Propagation Delay High to Low	(Figure 6 and Figure 7)	0.5	2	3.5	ns
t_{PLH}	Propagation Delay Low to High		0.5	2	3.5	ns
t_{SK1}	Pulse Skew $\|t_{PHL} - t_{PLH}\|$[8]		0	0.05	0.4	ns
t_{SK2}	Channel-to-Channel Skew[9]		0	0.05	0.5	ns
t_{SK3}	Part-to-Part Skew[10]		0		1.0	ns
t_{TLH}	Rise Time[3]		0.3	0.9	1.4	ns
t_{THL}	Fall Time[3]		0.3	0.75	1.4	ns
t_{PHZ}	Disable Time High to Z	(Figure 8 and Figure 9)	3	5.6	8	ns
t_{PLZ}	Disable Time Low to Z		3	5.4	8	ns
t_{PZH}	Enable Time Z to High		2.5	4.6	7	ns
t_{PZL}	Enable Time Z to Low		2.5	4.6	7	ns
f_{MAX}	Maximum Operating Frequency[11]		200	250		MHz

(1) All typical values are given for: V_{DD} = +3.3 V, T_A = +25°C.
(2) Generator waveform for all tests unless otherwise specified: f = 1 MHz, Z_O = 50 Ω, t_r ≤ 1 ns, and t_f ≤ 1 ns.
(3) These parameters are specified by design. The limits are based on statistical analysis of the device performance over PVT (process, voltage, temperature) ranges.
(4) t_{SKD1} or differential pulse skew is defined as $|t_{PHLD} - t_{PLHD}|$. It is the magnitude difference in the differential propagation delays between the positive going edge and the negative going edge of the same driver channel.
(5) t_{SKD2} or differential channel-to-channel skew is defined as the magnitude difference in the differential propagation delays between two driver channels on the same device.
(6) t_{SKD3} or differential part-to-part skew is defined as $|t_{PLHD\ Max} - t_{PLHD\ Min}|$ or $|t_{PHLD\ Max} - t_{PHLD\ Min}|$. It is the difference between the minimum and maximum specified differential propagation delays. This specification applies to devices at the same V_{DD} and within 5°C of each other within the operating temperature range.
(7) f_{MAX} generator input conditions: $t_r = t_f$ < 1 ns (0% to 100%), 50% duty cycle, 0 V to 3 V. Output Criteria: duty cycle = 45%/55%, V_{OD} > 250 mV, all channels switching.
(8) t_{SK1} or pulse skew is defined as $|t_{PHL} - t_{PLH}|$. It is the magnitude difference in the propagation delays between the positive going edge and the negative going edge of the same receiver channel.
(9) t_{SK2} or channel-to-channel skew is defined as the magnitude difference in the propagation delays between two receiver channels on the same device.
(10) t_{SK3} or part-to-part skew is defined as $|t_{PLH\ Max} - t_{PLH\ Min}|$ or $|t_{PHL\ Max} - t_{PHL\ Min}|$. It is the difference between the minimum and maximum specified propagation delays. This specification applies to devices at the same V_{DD} and within 5°C of each other within the operating temperature range.
(11) f_{MAX} generator input conditions: $t_r = t_f$ < 1 ns (0% to 100%), 50% duty cycle, V_{ID} = 200 mV, V_{CM} = 1.2 V . Output Criteria: duty cycle = 45%/55%, V_{OH} > 2.7 V, V_{OL} < 0.25 V, all channels switching.

PARAMETER MEASUREMENT INFORMATION

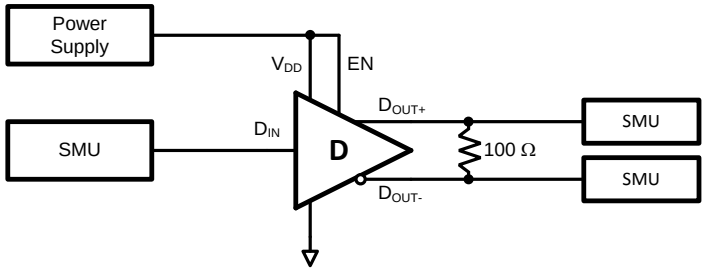


Figure 1. Driver V_{OD} and V_{OS} Test Circuit

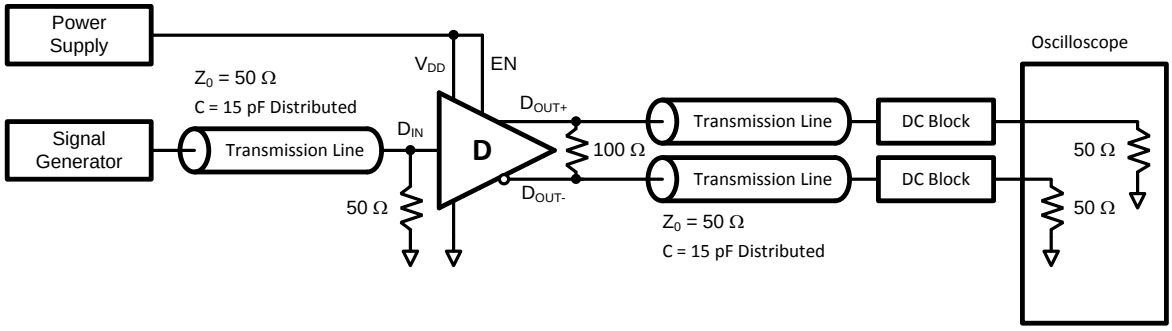


Figure 2. Driver Propagation Delay and Transition Time Test Circuit

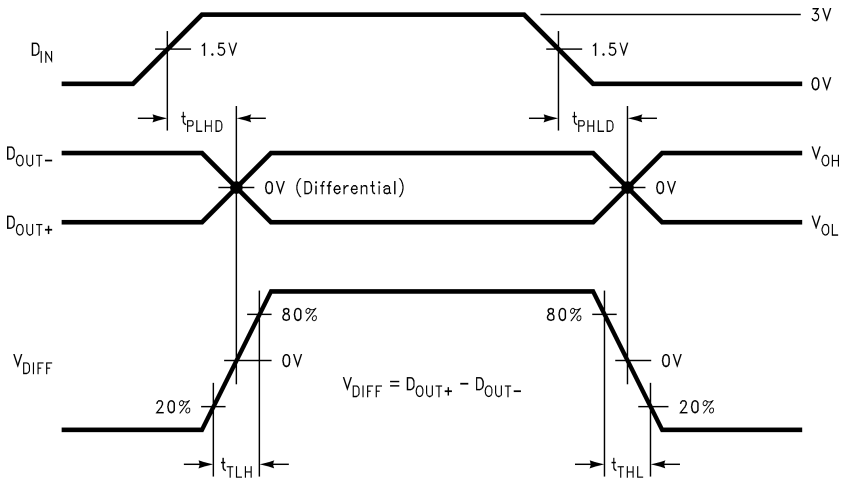


Figure 3. Driver Propagation Delay and Transition Time Waveforms

PARAMETER MEASUREMENT INFORMATION (continued)

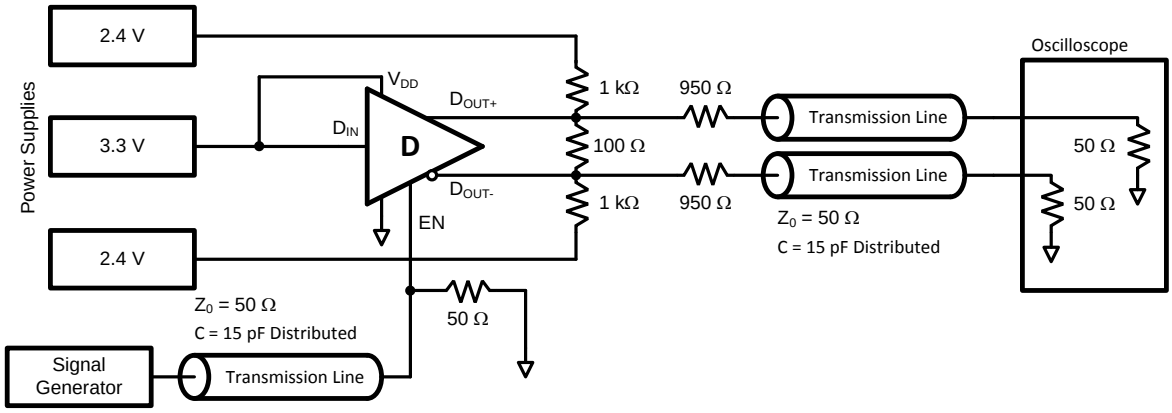


Figure 4. Driver TRI-STATE Delay Test Circuit

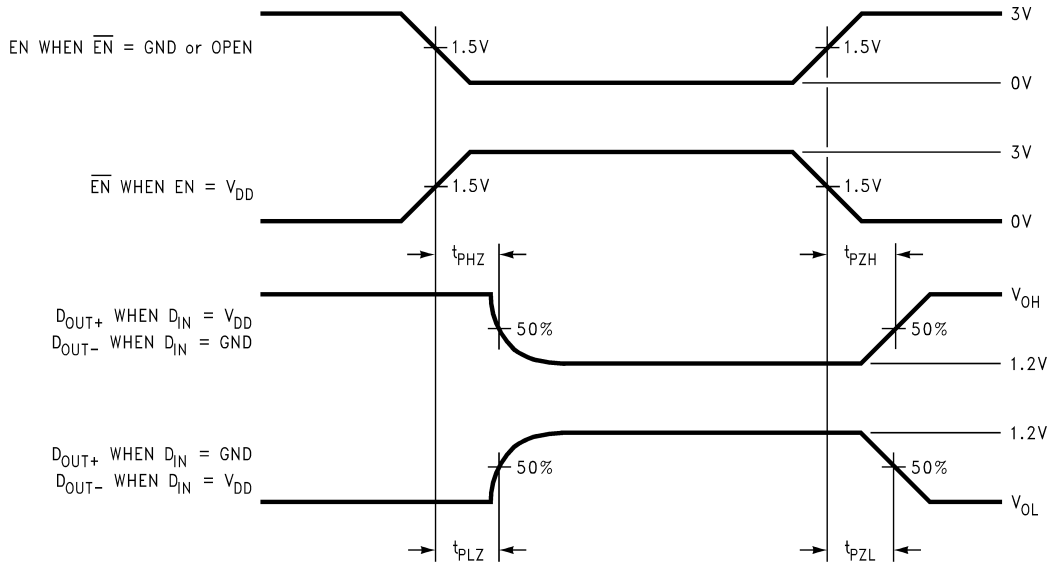


Figure 5. Driver TRI-STATE Delay Waveform

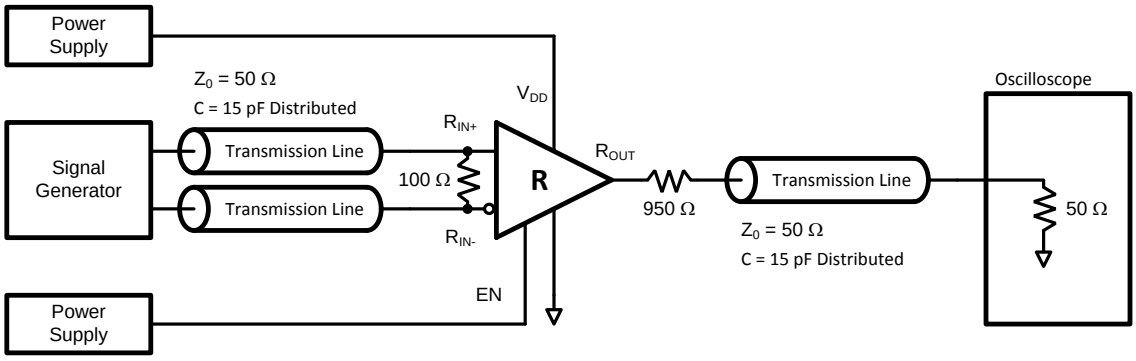


Figure 6. Receiver Propagation Delay and Transition Time Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)

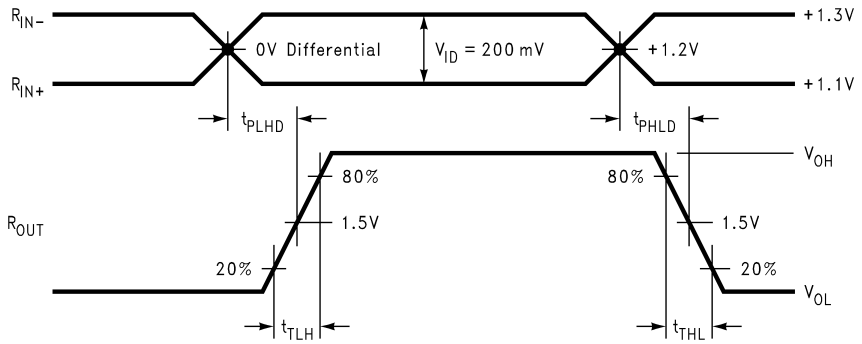


Figure 7. Receiver Propagation Delay and Transition Time Waveforms

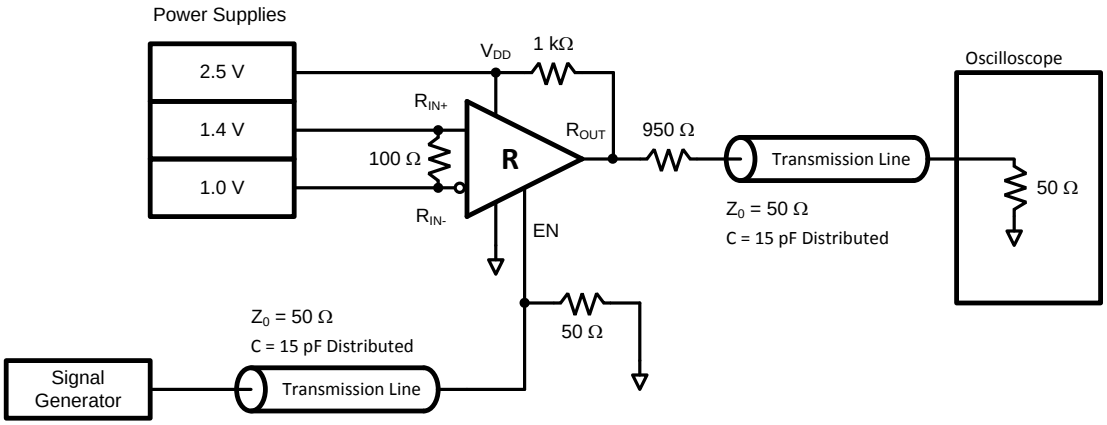


Figure 8. Receiver TRI-STATE Delay Test Circuit

PARAMETER MEASUREMENT INFORMATION (continued)

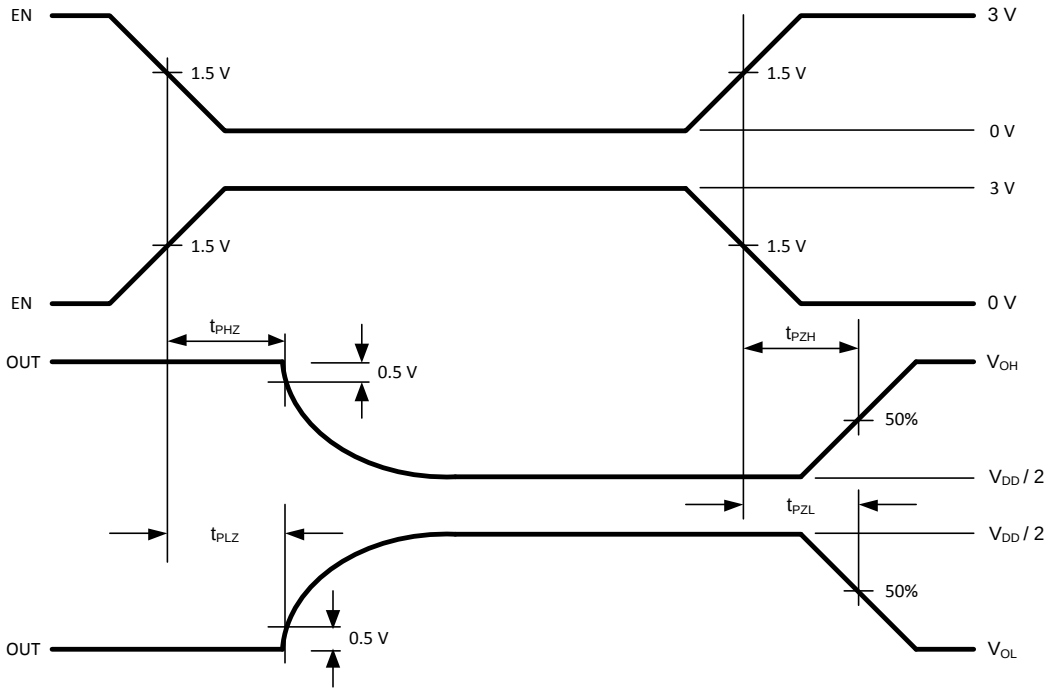


Figure 9. Receiver TRI-STATE Delay Waveforms

TYPICAL APPLICATION

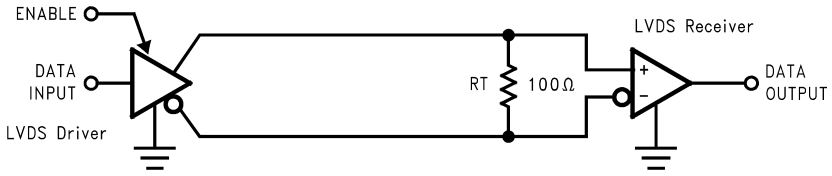


Figure 10. Point-to-Point Application

APPLICATION INFORMATION

General application guidelines and hints for LVDS drivers and receivers may be found in the following application notes: LVDS Owner's Manual (lit #550062-002), AN-808 (SNLA028), AN-977 (SNLA166), AN-971 (SNLA165), AN-916 (SNLA219), AN-805 (SNOA233), AN-903 (SNLA034).

LVDS drivers and receivers are intended to be primarily used in an uncomplicated point-to-point configuration as is shown in Figure 10. This configuration provides a clean signaling environment for the fast edge rates of the drivers. The receiver is connected to the driver through a balanced media which may be a standard twisted pair cable, a parallel pair cable, or simply PCB traces. Typically, the characteristic differential impedance of the media is in the range of 100 Ω. A termination resistor of 100 Ω (selected to match the media), and is located as close to the receiver input pins as possible. The termination resistor converts the driver output current (current mode) into a voltage that is detected by the receiver. Other configurations are possible such as a multi-receiver configuration, but the effects of a mid-stream connector(s), cable stub(s), and other impedance discontinuities as well as ground shifting, noise margin limits, and total termination loading must be taken into account.

The TRI-STATE function allows the device outputs to be disabled, thus obtaining an even lower power state when the transmission of data is not required.

The DS90LV049 has a flow-through pinout that allows for easy PCB layout. The LVDS signals on one side of the device easily allows for matching electrical lengths of the differential pair trace lines between the driver and the receiver as well as allowing the trace lines to be close together to couple noise as common-mode. Noise isolation is achieved with the LVDS signals on one side of the device and the TTL signals on the other side.

POWER DECOUPLING RECOMMENDATIONS

Bypass capacitors must be used on power pins. Use high frequency ceramic (surface mount is recommended) 0.1 µF and 0.001 µF capacitors in parallel at the power supply pin with the smallest value capacitor closest to the device supply pin. Additional scattered capacitors over the printed circuit board will improve decoupling. Multiple vias should be used to connect the decoupling capacitors to the power planes. A 10 µF (35 V) or greater solid tantalum capacitor should be connected at the power entry point on the printed circuit board between the supply and ground.

PC BOARD CONSIDERATIONS

Use at least 4 PCB layers (top to bottom); LVDS signals, ground, power, TTL signals.

Isolate TTL signals from LVDS signals, otherwise the TTL may couple onto the LVDS lines. It is best to put TTL and LVDS signals on different layers which are isolated by a power/ground plane(s).

Keep drivers and receivers as close to the (LVDS port side) connectors as possible.

DIFFERENTIAL TRACES

Use controlled impedance traces which match the differential impedance of your transmission medium (i.e. cable) and termination resistor. Run the differential pair trace lines as close together as possible as soon as they leave the IC (stubs should be < 10 mm long). This will help eliminate reflections and ensure noise is coupled as common-mode. In fact, we have seen that differential signals which are 1 mm apart radiate far less noise than traces 3 mm apart since magnetic field cancellation is much better with the closer traces. In addition, noise induced on the differential lines is much more likely to appear as common-mode which is rejected by the receiver.

Match electrical lengths between traces to reduce skew. Skew between the signals of a pair means a phase difference between signals which destroys the magnetic field cancellation benefits of differential signals and EMI will result. (Note the velocity of propagation, v = c/Er where c (the speed of light) = 0.2997 mm/ps or 0.0118 in/ps). Do not rely solely on the autoroute function for differential traces. Carefully review dimensions to match differential impedance and provide isolation for the differential lines. Minimize the number or vias and other discontinuities on the line.

Avoid 90° turns (these cause impedance discontinuities). Use arcs or 45° bevels.

Within a pair of traces, the distance between the two traces should be minimized to maintain common-mode rejection of the receivers. On the printed circuit board, this distance should remain constant to avoid discontinuities in differential impedance. Minor violations at connection points are allowable.

TERMINATION

Use a termination resistor which best matches the differential impedance or your transmission line. The resistor should be between 90 Ω and 130 Ω. Remember that the current mode outputs need the termination resistor to generate the differential voltage. LVDS will not work without resistor termination. Typically, connecting a single resistor across the pair at the receiver end will suffice.

Surface mount 1% to 2% resistors are best. PCB stubs, component lead, and the distance from the termination to the receiver inputs should be minimized. The distance between the termination resistor and the receiver should be < 10 mm (12 mm MAX).

PROBING LVDS TRANSMISSION LINES

Always use high impedance (> 100 kΩ), low capacitance (< 2 pF) scope probes with a wide bandwidth (1 GHz) scope. Improper probing will give deceiving results.

CABLES AND CONNECTORS, GENERAL COMMENTS

When choosing cable and connectors for LVDS it is important to remember:

Use controlled impedance media. The cables and connectors you use should have a matched differential impedance of about 100 Ω. They should not introduce major impedance discontinuities.

Balanced cables (e.g. twisted pair) are usually better than unbalanced cables (ribbon cable, simple coax.) for noise reduction and signal quality. Balanced cables tend to generate less EMI due to field canceling effects and also tend to pick up electromagnetic radiation a common-mode (not differential mode) noise which is rejected by the receiver.

FAIL-SAFE FEATURE

An LVDS receiver is a high gain, high speed device that amplifies a small differential signal (20 mV) to CMOS logic levels. Due to the high gain and tight threshold of the receiver, care should be taken to prevent noise from appearing as a valid signal.

The receiver's internal fail-safe circuitry is designed to source/sink a small amount of current, providing fail-safe protection (a stable known state of HIGH output voltage) for floating receiver inputs.

The DS90LV049 has two receivers, and if an application requires a single receiver, the unused receiver inputs should be left OPEN. Do not tie unused receiver inputs to ground or any other voltages. The input is biased by internal high value pull up and pull down current sources to set the output to a HIGH state. This internal circuitry will ensure a HIGH, stable output state for open inputs.

External lower value pull up and pull down resistors (for a stronger bias) may be used to boost fail-safe in the presence of higher noise levels. The pull up and pull down resistors should be in the 5 kΩ to 15 kΩ range to minimize loading and waveform distortion to the driver. The common-mode bias point should be set to approximately 1.2 V (less than 1.75 V) to be compatible with the internal circuitry.

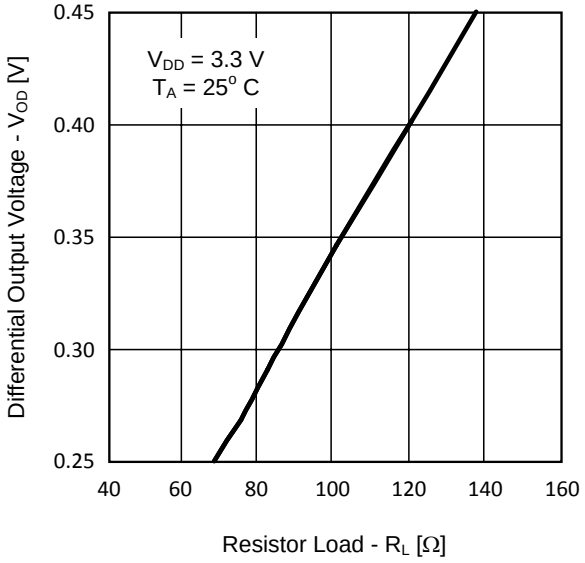
For more information on failsafe biasing of LVDS interfaces please refer to AN-1194 (SNLA051).

PIN DESCRIPTIONS

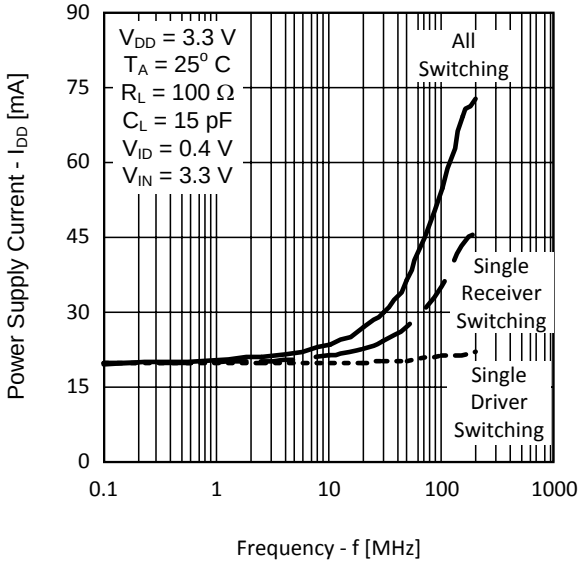
Pin No.	Name	Description
10, 11	D_{IN}	Driver input pins, LVCMOS levels. There is a pull-down current source present.
6, 7	D_{OUT+}	Non-inverting driver output pins, LVDS levels.
5, 8	D_{OUT-}	Inverting driver output pins, LVDS levels.
2, 3	R_{IN+}	Non-inverting receiver input pins, LVDS levels. There is a pull-up current source present.
1, 4	R_{IN-}	Inverting receiver input pins, LVDS levels. There is a pull-down current source present.
14, 15	R_{OUT}	Receiver output pins, LVCMOS levels.
9, 16	EN, $\overline{EN}$	Enable and Disable pins. There are pull-down current sources present at both pins.
12	V_{DD}	Power supply pin.
13	GND	Ground pin.

TYPICAL PERFORMANCE CURVES

Differential Output Voltage vs Load Resistor



Power Supply Current vs Frequency



REVISION HISTORY

Changes from Revision C (April 2013) to Revision D	Page
• Changed layout of National Data Sheet to TI format	11

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
DS90LV049TMT	NRND	TSSOP	PW	16	92	Non-RoHS & Green	Call TI	Level-1-260C-UNLIM	-40 to 85	90LV049 TMT	
DS90LV049TMT/NOPB	ACTIVE	TSSOP	PW	16	92	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	90LV049 TMT	Samples
DS90LV049TMTX/NOPB	ACTIVE	TSSOP	PW	16	2500	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	90LV049 TMT	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.

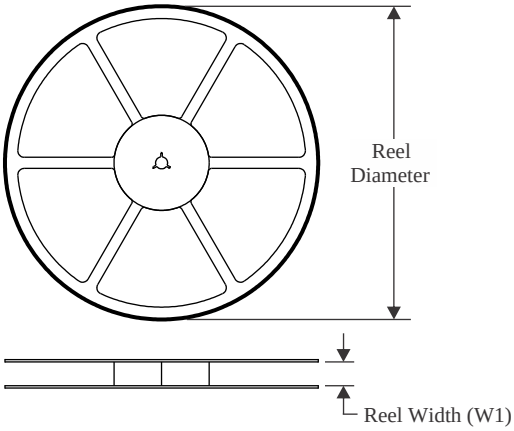
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(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.

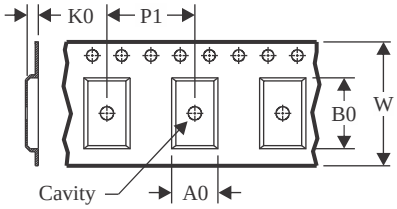
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

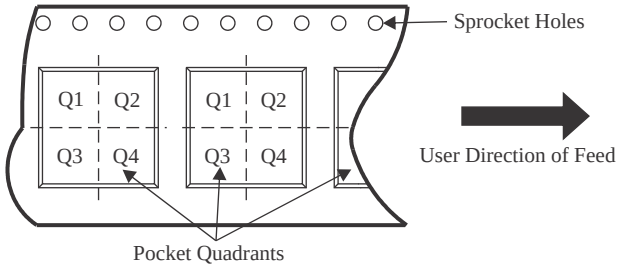


TAPE DIMENSIONS



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

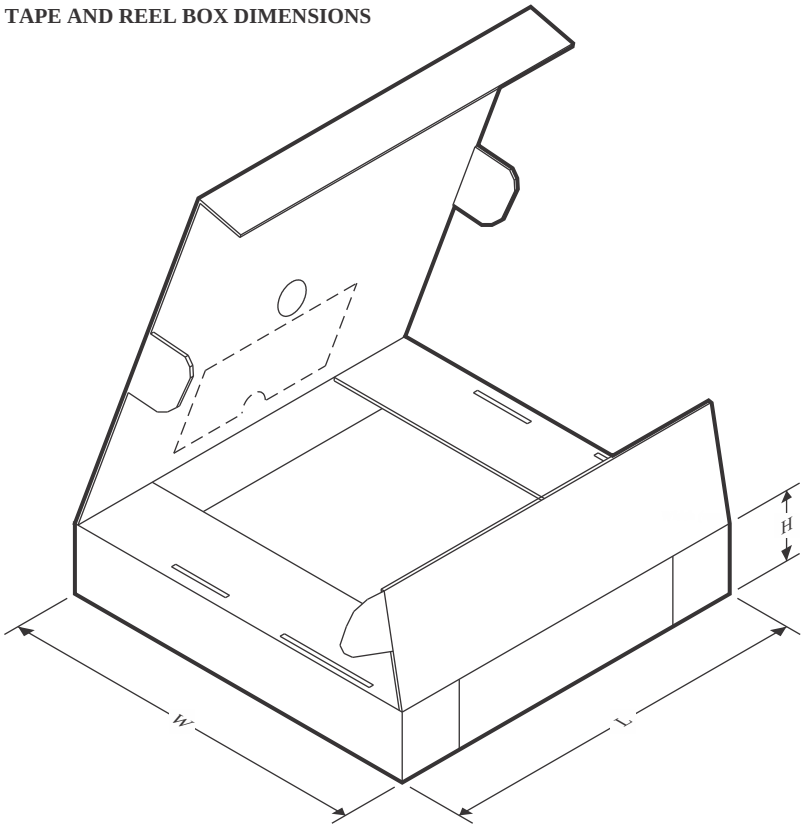
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
DS90LV049TMTX/NOPB	TSSOP	PW	16	2500	330.0	12.4	6.95	5.6	1.6	8.0	12.0	Q1

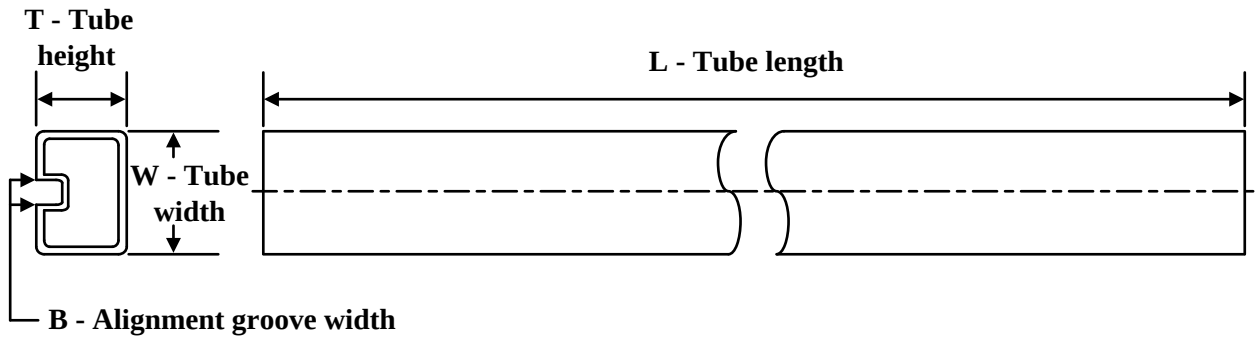
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS90LV049TMTX/NOPB	TSSOP	PW	16	2500	367.0	367.0	35.0

TUBE



*All dimensions are nominal

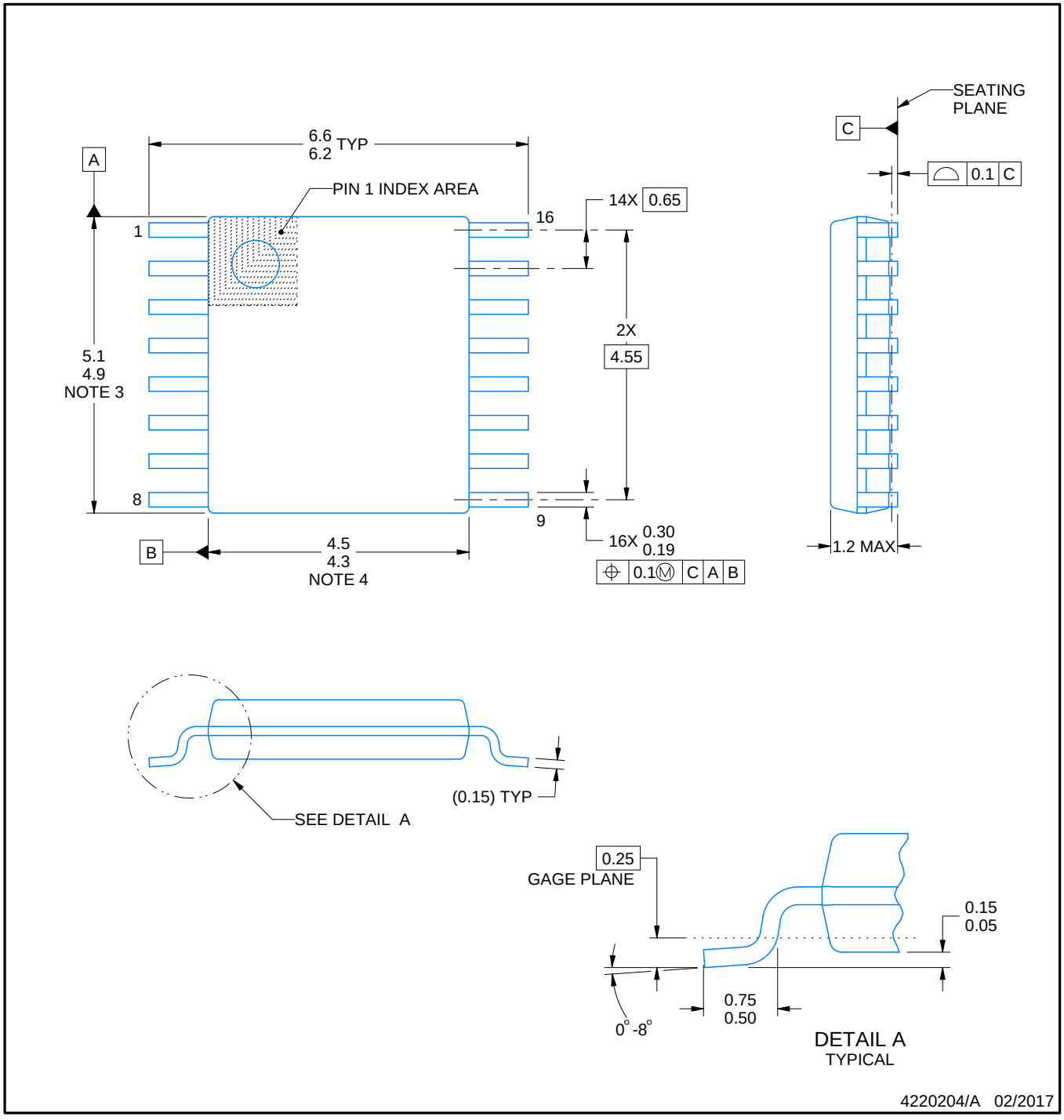
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
DS90LV049TMT	PW	TSSOP	16	92	495	8	2514.6	4.06
DS90LV049TMT	PW	TSSOP	16	92	495	8	2514.6	4.06
DS90LV049TMT/NOPB	PW	TSSOP	16	92	495	8	2514.6	4.06

PACKAGE OUTLINE

PW0016A

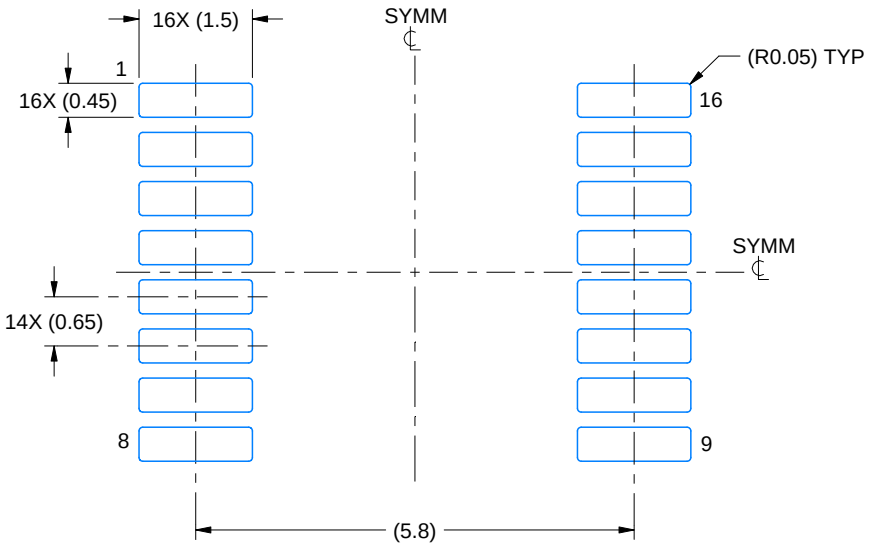
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

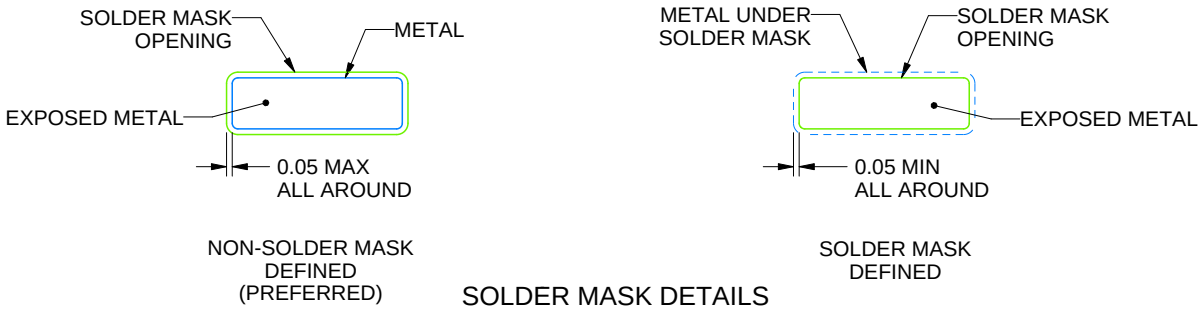


NOTES:

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. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

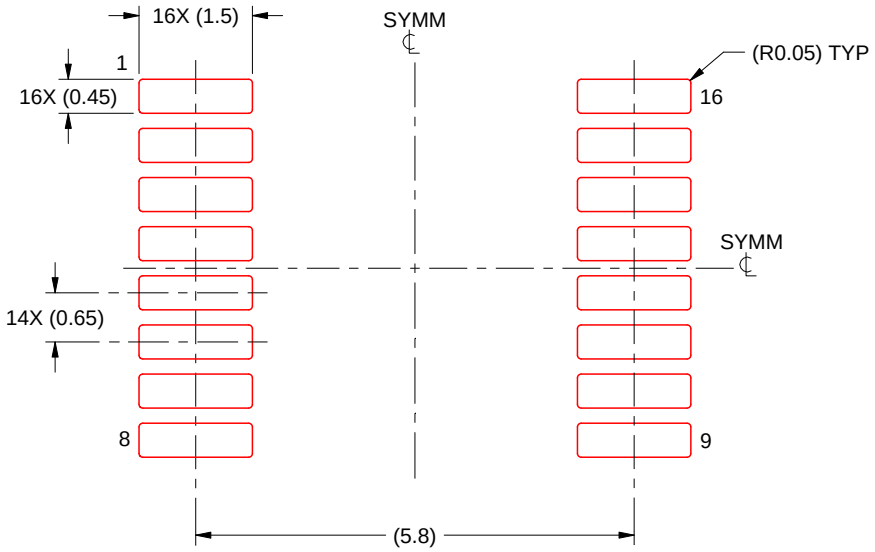


SOLDER MASK DETAILS

4220204/A 02/2017

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. 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: 10X

4220204/A 02/2017

NOTES: (continued)

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

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