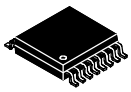


5,0 mm x 6,4 mm

DUAL LVDS DIFFERENTIAL DRIVERS AND RECEIVERS

FEATURES

- **DS90LV049 Compatible**
- **Up to 400 Mbps Signaling Rates**
- **Flow-Through Pin-out**
- **50 ps Driver Channel-to-Channel Skew (Typ)**
- **50 ps Receiver Channel-to-Channel Skew (Typ)**
- **3.3-V Power Supply**
- **High-Impedance Disable for all Outputs**
- **Internal Failsafe Biasing of Receiver Inputs**
- **1.4 ns Driver Propagation Delay (Typ)**
- **1.9 ns Receiver Propagation Delay (Typ)**
- **High Impedance Bus Pins on Power Down**
- **ANSI TIA/EIA-644-A Compliant**
- **Receiver Input and Driver Output ESD Exceeds 10 kV**
- **16-pin TSSOP Package**

APPLICATIONS

- **Full-duplex LVDS Communications of Clock and Data**
- **Printers**

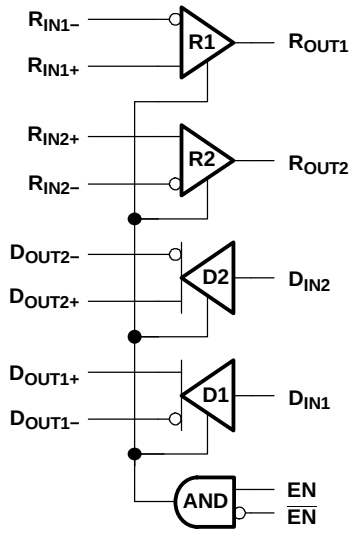
DESCRIPTION

The SN65LVDS049 is a dual flow-through differential line driver-receiver pair that uses low-voltage differential signaling (LVDS) to achieve signaling rates as high as 400 Mbps. The TIA/EIA-644-A standard compliant electrical interface provides a minimum differential output voltage magnitude of 250 mV into a 100-Ω load and receipt of signals with up to 1 V of ground potential difference between a transmitter and receiver. The LVDS receivers have internal failsafe biasing that places the outputs into a known high state for unconnected differential inputs.

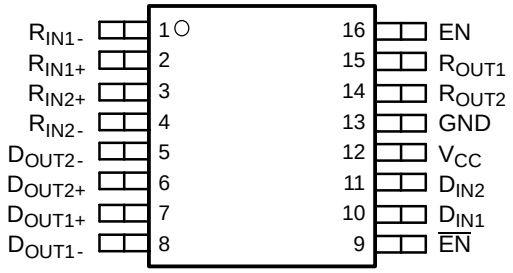
The intended application of this device and signaling technique is for point-to-point baseband data transmission over controlled impedance media of approximately 100-Ω characteristic impedance. The transmission media may be printed-circuit board traces, backplanes, or cables. (Note: The ultimate rate and distance of data transfer is dependent upon the attenuation characteristics of the media, the noise coupling to the environment, and other application specific characteristics)

The SN65LVDS049 is characterized for operation from –40°C to 85°C

FUNCTIONAL DIAGRAM



PW PACKAGE (Marked as LVDS049)
(TOP VIEW)



DRIVER TRUTH TABLE

INPUT	ENABLES		OUTPUTS (1)	
DIN	EN	$\overline{EN}$	D_{OUT+}	D_{OUT-}
L	H	L or OPEN	L	H
H			H	L
X	All other conditions		Z	Z

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off)

RECEIVER TRUTH TABLE

DIFFERENTIAL INPUT	ENABLES		OUTPUT (1)
$R_{IN-} - R_{IN+}$	EN	$\overline{EN}$	R_{OUT}
$V_{ID} \geq 100$ mV	H	L or OPEN	H
$V_{ID} \leq -100$ mV			L
Open/short or terminated			H
X	All other conditions		Z

(1) H = high level, L = low level, X = irrelevant, Z = high impedance (off)

ENABLE FUNCTION TABLE

ENABLES		OUTPUTS	
EN	EN	LVDS Out	LVCMOS Out
L or Open	L or Open	DISABLED	DISABLED
H	L or Open	ENABLED	ENABLED
L or Open	H	DISABLED	DISABLED
H	H	DISABLED	DISABLED

POWER DISSIPATION RATING

PACKAGE	CIRCUIT BOARD MODEL	$T_A \leq 25°C$ POWER RATING	DERATING FACTOR (1) ABOVE $T_A = 25°C$	$T_A = 85°C$ POWER RATING
PW	Low-K (2)	774 mW	6.2 mW/°C	402 mW

(1) This is the inverse of the junction-to-ambient thermal resistance when board-mounted and with no air flow.
(2) In accordance with the Low-K thermal metric definitions of EIA/JESD51-3.

ABSOLUTE MAXIMUM RATINGS

over operating free-air temperature range (unless otherwise noted) (1)

			UNIT
Supply voltage range (2), V_{CC}			-0.3 V to 4 V
Voltage range	D_{IN}, R_{OUT}, EN, or $\overline{EN}$		-0.3 V to (V_{CC} + 0.3 V)
	R_{IN+} or R_{IN-}		-0.3 V to 4 V
	D_{OUT+} or D_{OUT-}		-0.3 V to 3.9 V
ESD	Human Body Model (3)	R_{IN+}, R_{IN-}, D_{OUT+}, and D_{OUT-}	±10 kV
		All pins	±2K V
	Charged-Device Model (4)	All pins	±500 V
LVDS output short circuit duration (DOUT+, DOUT-)			Continuous
Continuous power dissipation			See Dissipation Rating Table
Storage temperature range			-65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds			260°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) All voltage values, except differential I/O bus voltages, are with respect to network ground terminal.
(3) Tested in accordance with JEDEC Standard 22, Test Method A114-A.
(4) Tested in accordance with JEDEC Standard 22, Test Method C101.

RECOMMENDED OPERATING CONDITIONS

	MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}	3	3.3	3.6	V
Receiver input voltage	GND			V
Common-mode input voltage, V_{IC}	$\frac{\lvert V_{ID}\rvert}{2}$		$2.4 - \frac{\lvert V_{ID}\rvert}{2}$	V
			V_{CC} - 0.8	V
Operating free-air temperature, T_A	-40		85	°C

DEVICE ELECTRICAL CHARACTERISTICS

over recommended operating conditions (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP (1)	MAX	UNIT
INPUT DC SPECIFICATIONS (D_{IN}, EN, $\overline{EN}$)						
V_{IH}	Input high voltage		2.0		V_{CC}	V
V_{IL}	Input low voltage		GND		0.8	V
I_{IH}	Input high current	$V_{IN} = V_{CC}$	-10	3	10	µA
I_{IL}	Input low current	V_{IN} = GND	-10	1	10	µA
V_{CL}	Input clamp voltage	I_{CL} = -18 mA	-1.5	-0.8		V
LVDS Output DC Specifications (D_{OUT+}, D_{OUT-})						
$\|V_{OD}\|$	Differential output voltage	R_L = 100 Ω, See Figure 1	250	350	450	V
$\Delta\|V_{OD}\|$	Change in magnitude of V_{OD} for complimentary output states		-35	1	35	mV
V_{OS}	Offset voltage		1.125	1.2	1.375	V
ΔV_{OS}	Change in magnitude of V_{OS} for complimentary output states		-25	1	25	mV
I_{OS}	Output short circuit current	Enabled $D_{IN} = V_{CC}$ and D_{OUT+} = 0 V, or D_{IN} = GND and D_{OUT-} = 0 V		-4.5	-9	mA
I_{OSD}	Differential output short circuit current (2)	Enabled, V_{OD} = 0 V		-3.6	-9	mA
I_{OFF}	Power-off leakage	V_{CC} = 0 V or Open; VO = 0 or 3.6 V	-20	0	20	µA
I_{OZ}	Output high-impedance current	EN = 0 V and $\overline{EN}$ = V_{CC}, V_O = 0 or V_{CC}	-10	0	10	µA
LVDS Input DC Specifications (R_{IN+}, R_{IN-})						
V_{IT+}	Differential input high threshold	V_{CM} = 1.2 V, 0.05 V, 2.35 V			100	mV
V_{IT-}	Differential input low threshold		-100			mV
V_{CMR}	Common-mode voltage range	V_{ID} = ± 100 mV	0.05		2.35	V
I_{IN}	Input current	V_{CC} = 3.6 V, V_{IN} = 0 V or 2.8 V	-20		20	µA
		V_{CC}= 0 V, V_{IN} = 0 V, 2.8 V, or 3.6 V	-20		20	µA
Outputs DC Specifications (R_{OUT})						
V_{OH}	Output high voltage	I_{OH} = -0.4 mA, V_{ID} = 200 mV	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 high-impedance current	Disabled, V_{OUT} = 0 V or V_{CC}	-10	0	10	µA
Device DC Specifications						
I_{CC}	Power supply current (LVDS loaded, enabled)	EN = 3.3 V, $D_{IN} = V_{CC}$ or Gnd, 100 -Ω differential LVDS loads		17	35	mA
I_{CCZ}	High impedance supply current (disabled)	No loads, EN = 0 V		1	25	mA

(1) All typical values are at 25°C and with a 3.3 V supply.
(2) Output short circuit current (IOS) is specified as magnitude only, the minus sign indicates direction only

SWITCHING CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	MIN	TYP (1)	MAX	UNIT
LVDS Outputs (D_{OUT+}, D_{OUT-})						
t_{PLHD}	Differential propagation delay low to high	R_L = 100 Ω, C_L = 15 pF distributed, See Figure 2		1.3	2.0	ns
t_{PHLD}	Differential propagation delay high to low			1.4	2.0	ns
$t_{sk(p)}$	Differential pulse skew ($\|t_{PHL} - t_{PLH}\|$)		0	0.15	0.4	ns
$t_{sk(o)}$	Differential channel-to-channel skew (2)		0	0.05	0.5	ns
$t_{sk(pp)}$	Differential part-to-part skew (3)		0		1	ns
t_r	Differential rise time		0.2	0.5	1	ns
t_f	Differential fall time		0.2	0.5	1	ns
t_{PHZ}	Disable time, high level to high impedance	R_L = 100 Ω, C_L = 15 pF distributed, See Figure 3		2.7	4	ns
t_{PLZ}	Disable time, low level to high impedance			2.7	4	ns
t_{PZH}	Enable time, high impedance to high level		1	5	8	ns
t_{PZL}	Enable time, high impedance to low level		1	5	8	ns
f_{MAX}	Maximum operating frequency (4)			250		MHz
LVCMOS Outputs (R_{OUT})						
t_{PLH}	Propagation delay low to high	V_{ID}= 200 mV, C_L = 15 pF distributed, See Figure 4	0.5	1.9	3.5	ns
t_{PHL}	Propagation delay high to low		0.5	1.7	3.5	ns
$t_{sk(p)}$	Pulse skew ($\|t_{PHL} - t_{PLH}\|$)		0	0.2	0.4	ns
$t_{sk(o)}$	Channel-to-channel skew (5)		0	0.05	0.5	ns
$t_{sk(pp)}$	Part-to-part skew (6)		0		1	ns
t_r	Rise time		0.3	0.5	1.4	ns
t_f	Fall time		0.3	0.5	1.4	ns
t_{PHZ}	Disable time, high level to high impedance	C_L = 15 pF distributed, See Figure 5	3	7.2	9	ns
t_{PLZ}	Disable time, low level to high impedance		2.5	4	8	ns
t_{PZH}	Enable time, high impedance to high level		2.5	4.2	7	ns
t_{PZL}	Enable time, high impedance to low level		2	3.3	7	ns
f_{MAX}	Maximum operating frequency (7)		200	250		MHz

(1) All typical values are at 25°C and with a 3.3 V supply.

(2) $t_{sk(o)}$ is the magnitude of the time difference between the t_{PLH} or t_{PHL} of all drivers of a single device with all of their inputs connected together.

(3) $t_{sk(pp)}$ is the magnitude of the difference in propagation delay times between any specified terminals of two devices when both devices operate with the same supply voltages, at the same temperature, and have identical packages and test circuits.

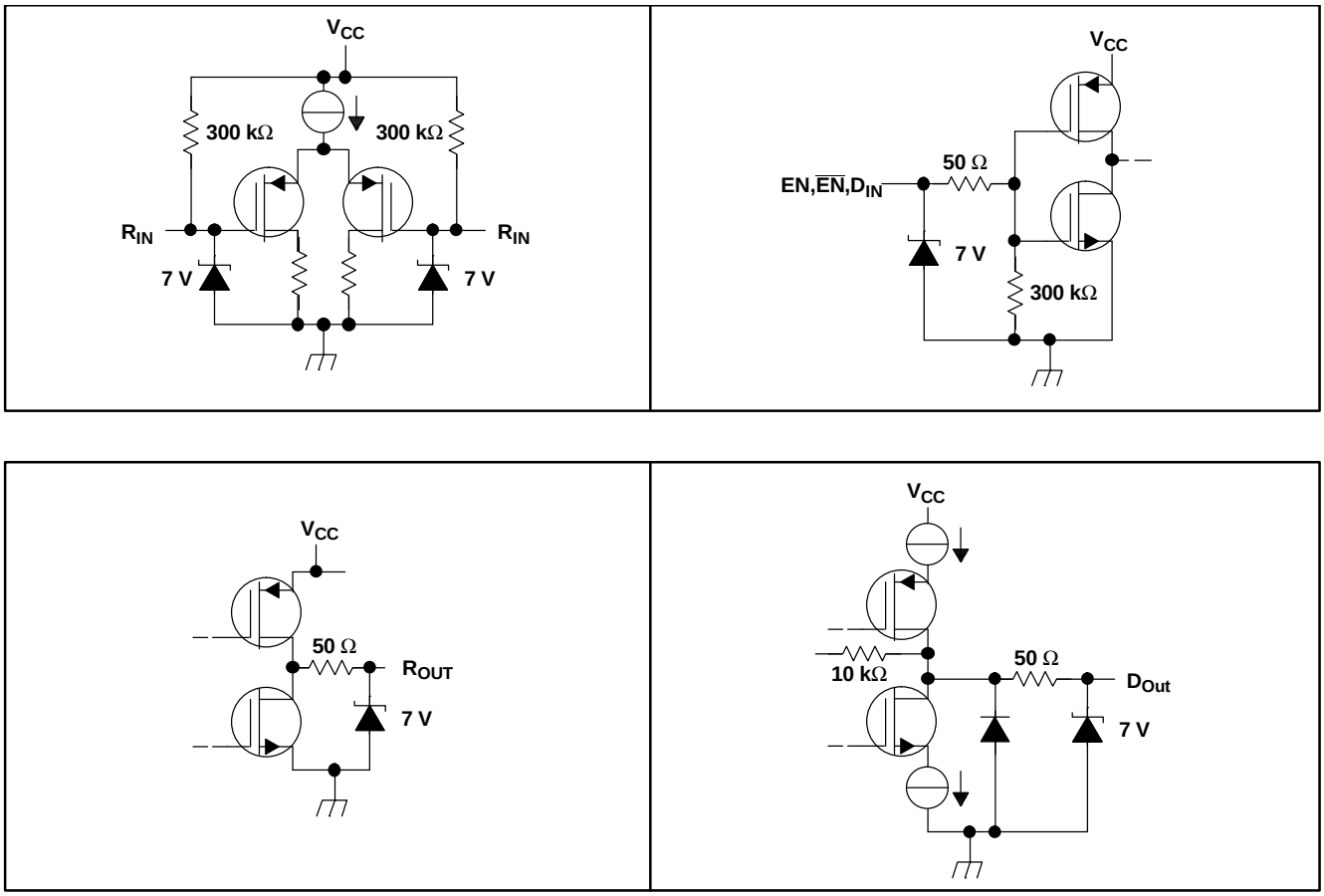
(4) $f_{(MAX)}$ generator input conditions: $t_r = t_f$ < 1 ns (0% to 100%), 50% duty cycle, 0 V to 3 V. Output Criteria: duty cycle = 45% to 55%, V_{OD} > 250 mV, all channels switching.

(5) $t_{sk(lim)}$ is the maximum delay time difference between drivers over temperature, V_{CC}, and process.

(6) tsk(pp) is the magnitude of the difference in propagation delay times between any specified terminals of two devices when both devices operate wf(MAX) generaith the same supply voltages, at the same temperature, and have identical packages and test circuits

(7) $f_{(MAX)}$ 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% to 55%, V_{OH} > 2.7 V, V_{OL} < 0.25 V, all channels switching.

EQUIVALENT INPUT AND OUTPUT SCHEMATIC DIAGRAMS



PARAMETER MEASUREMENT INFORMATION

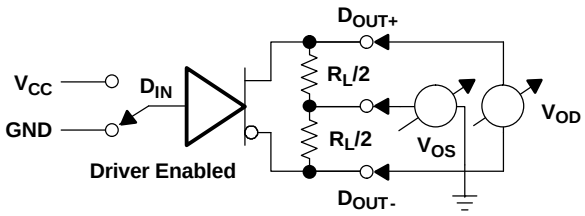


Figure 1. Driver V_{OD} and V_{OS} Test Circuit

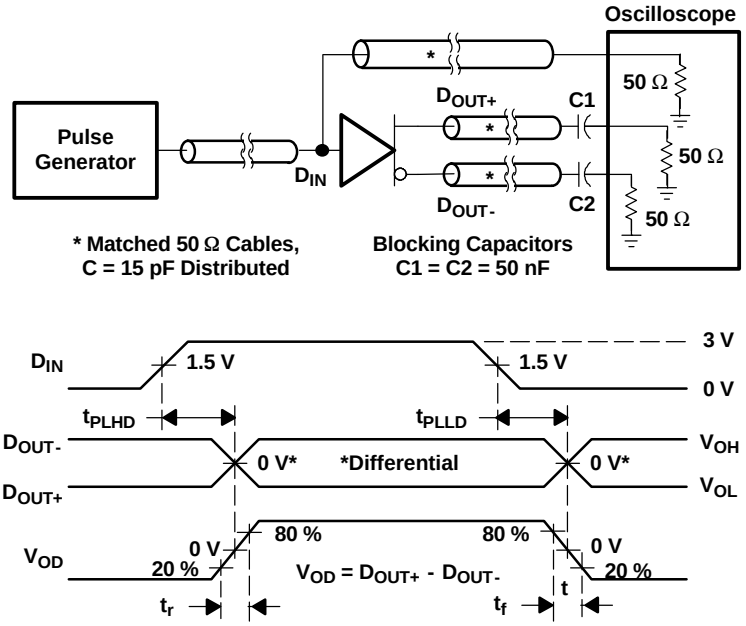


Figure 2. Driver Propagation Delay and Rise/Fall Time Test Circuit and Waveforms

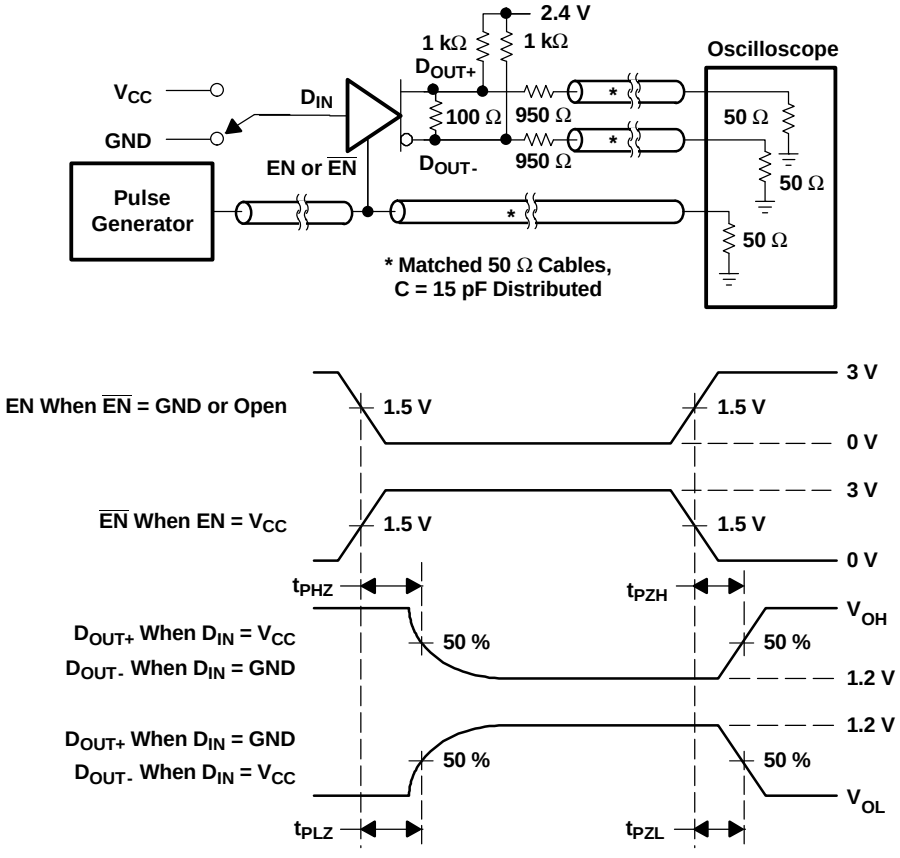


Figure 3. Driver High-Impedance State Delay Test Circuit and Waveforms

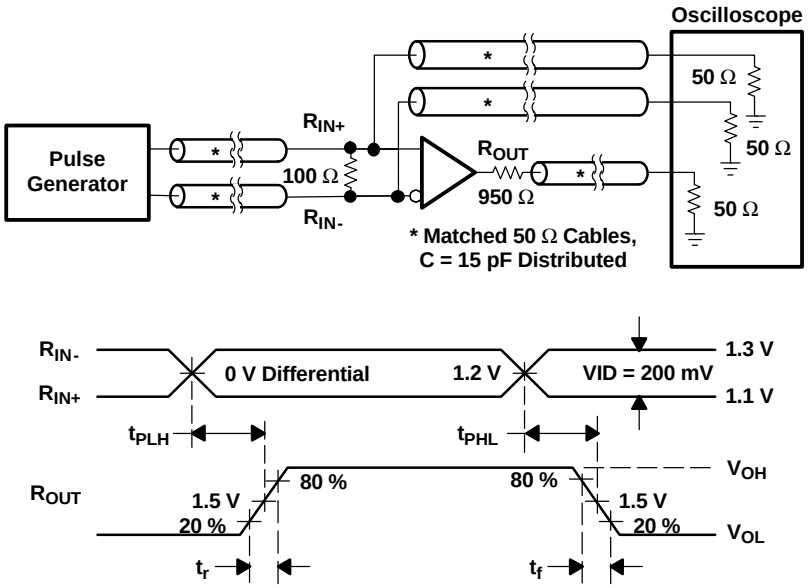


Figure 4. Receiver Propagation Delay and Rise/Fall Test Circuit and Waveforms

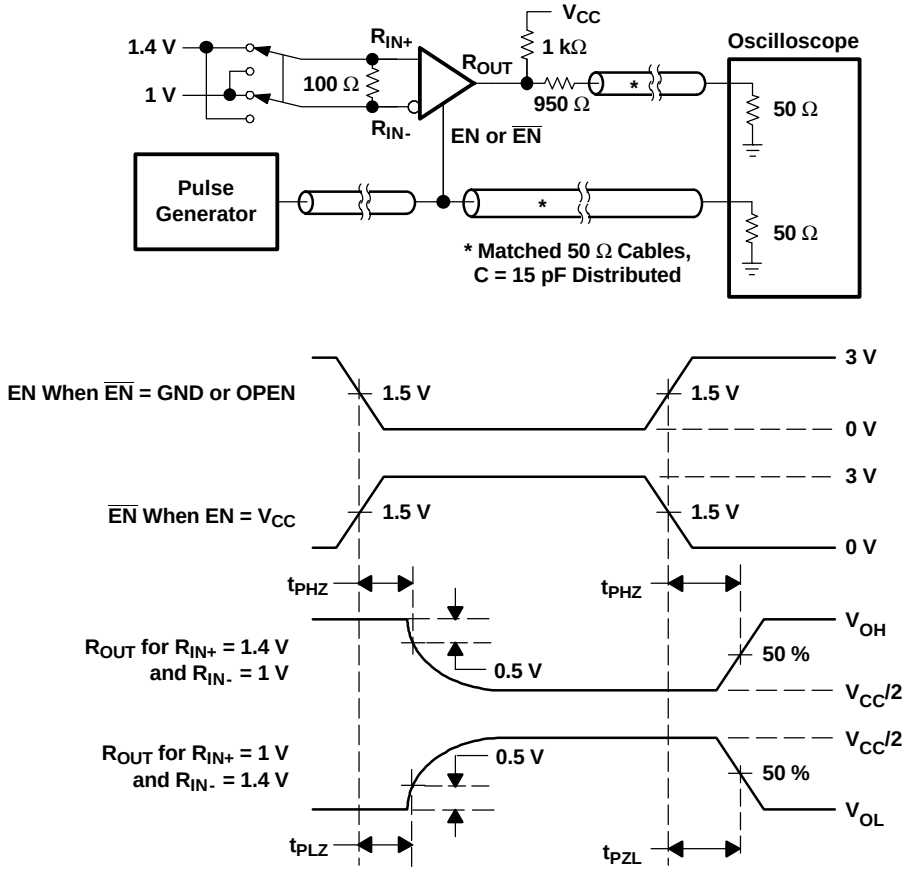


Figure 5. Receiver High-Impedance State Delay Test Circuit and Waveforms (Note, V_{CC} = 3.3 V)

TYPICAL CHARACTERISTICS

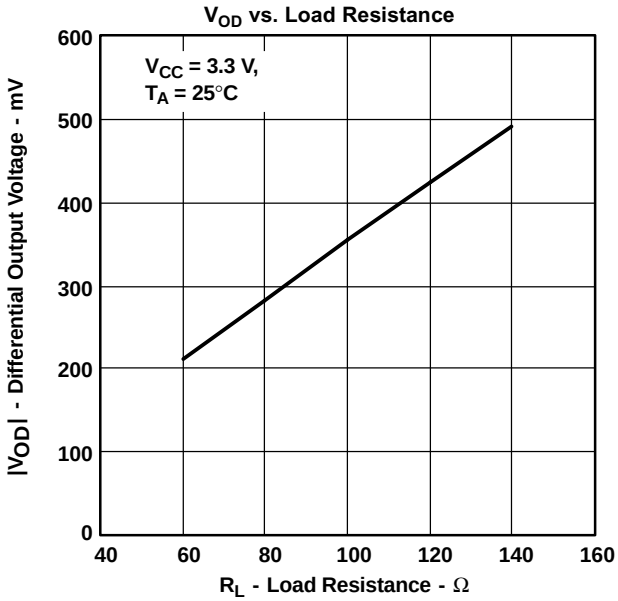


Figure 6.

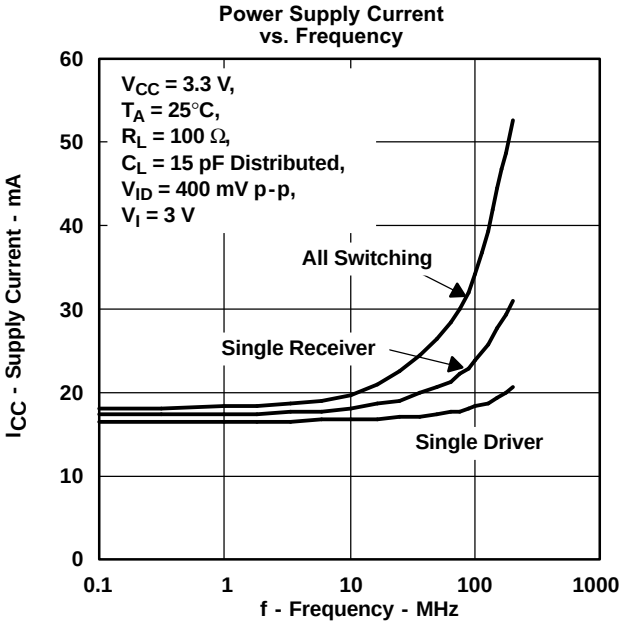


Figure 7.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
SN65LVDS049PW	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVDS049	Samples
SN65LVDS049PWG4	ACTIVE	TSSOP	PW	16	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVDS049	Samples
SN65LVDS049PWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVDS049	Samples
SN65LVDS049PWRG4	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVDS049	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.

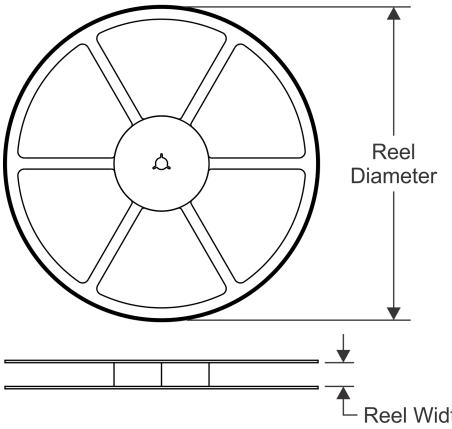
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been 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.

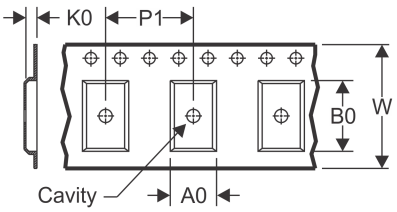
(4) Only one of markings shown within the brackets will appear on the physical device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

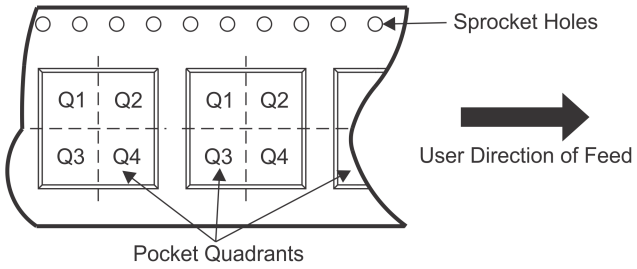


TAPE DIMENSIONS



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

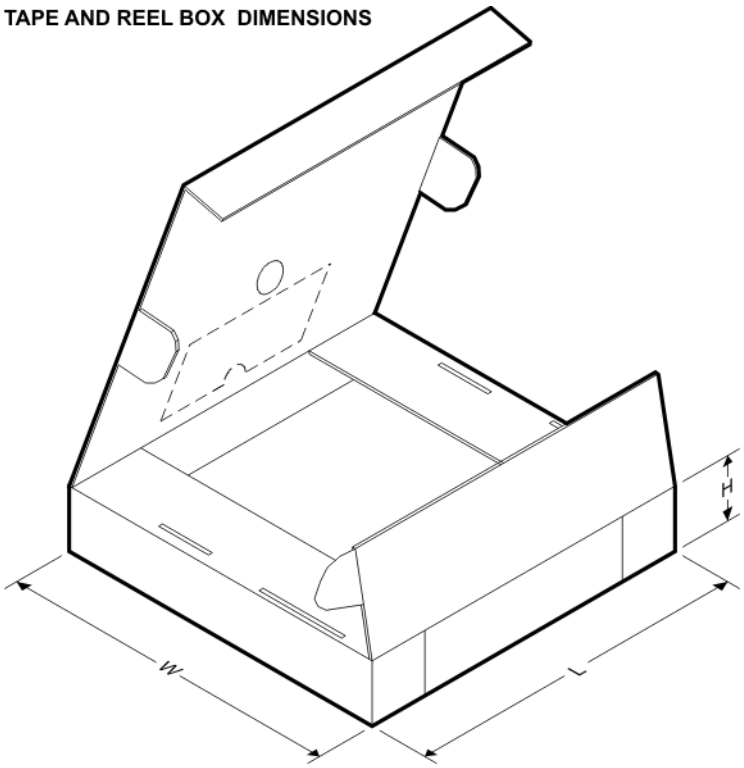
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
SN65LVDS049PWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

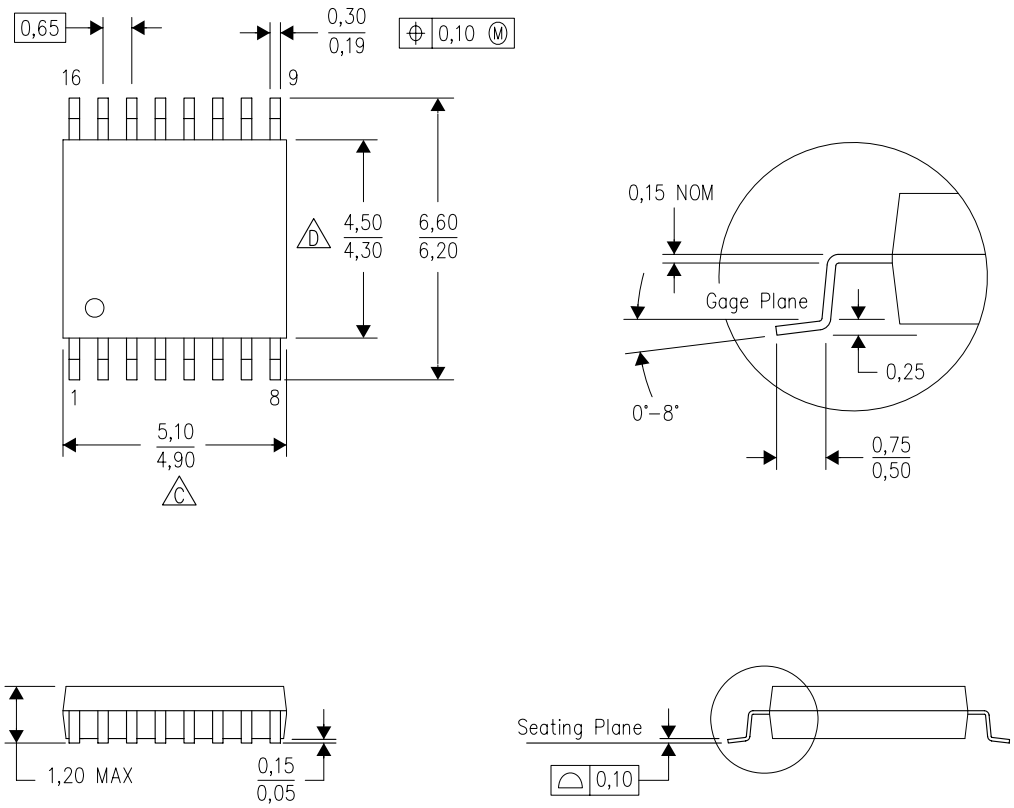
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN65LVDS049PWR	TSSOP	PW	16	2000	367.0	367.0	35.0

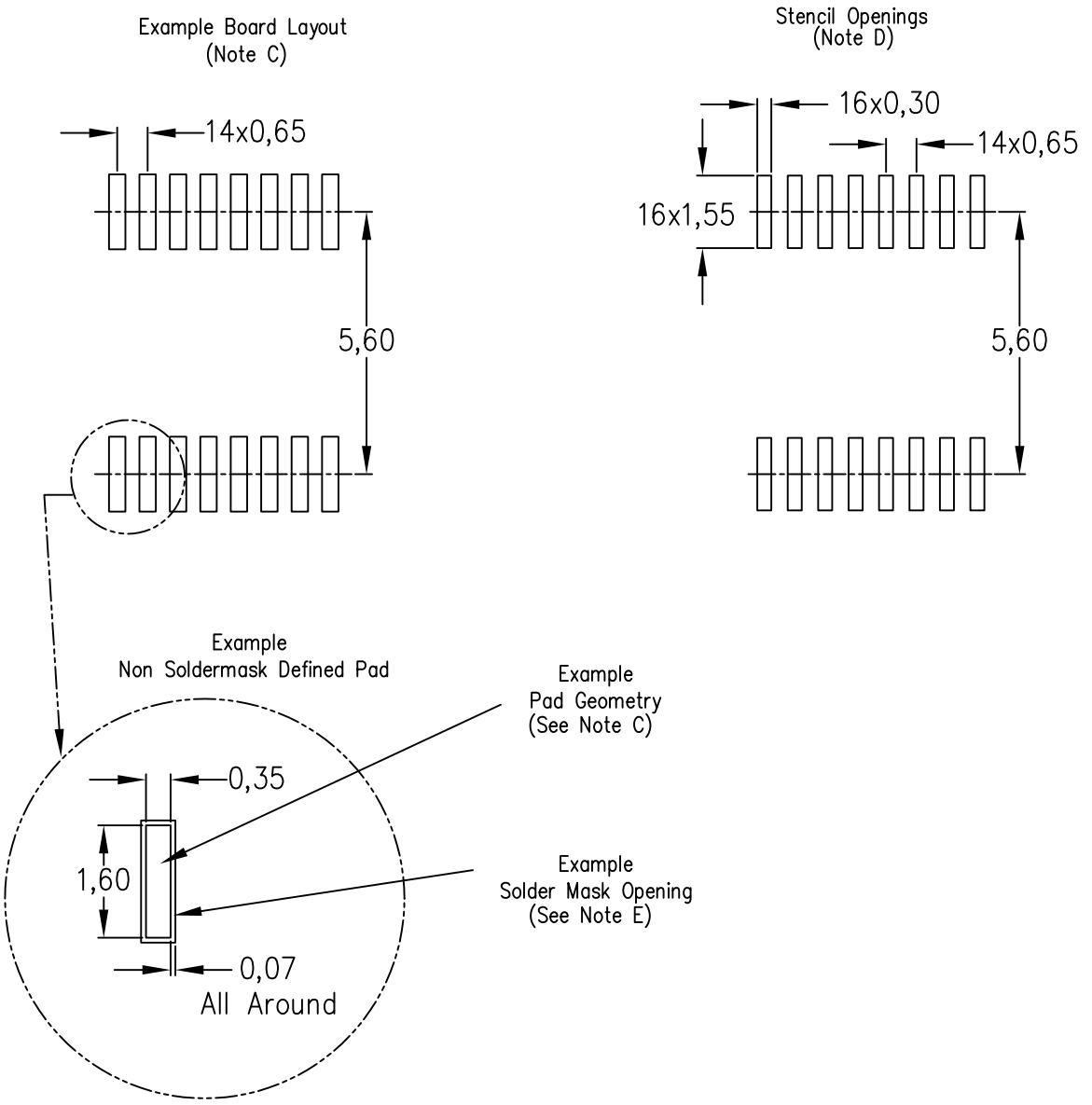
PW (R–PDSO–G16) PLASTIC SMALL OUTLINE



4040064–4/G 02/11

NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
E. Falls within JEDEC MO–153

PW (R–PDSO–G16) 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 designs.
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.

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No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or “enhanced plastic” are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have ***not*** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

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