

## DS10BR150 1.0 Gbps LVDS Buffer / Repeater

Check for Samples: [DS10BR150](#)

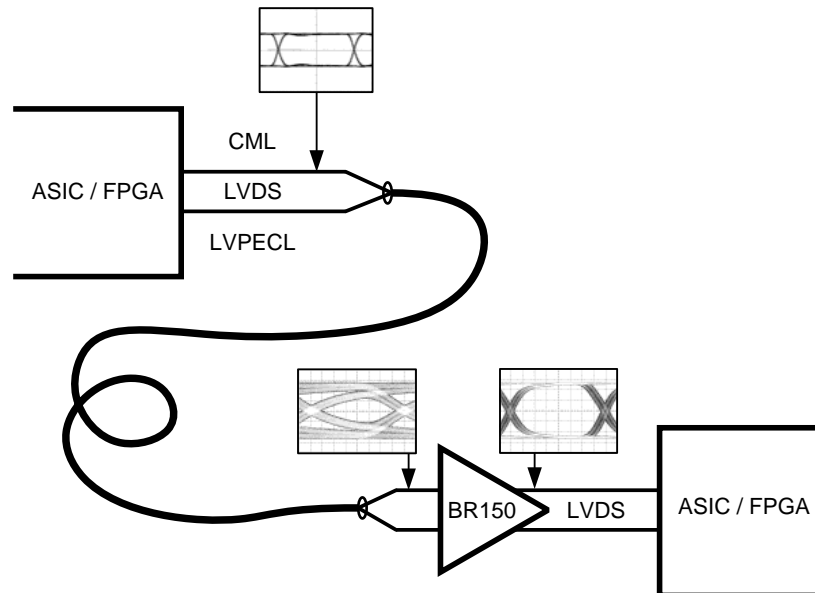
### FEATURES

- DC - 1.0 Gbps Low Jitter, High Noise Immunity, Low Power Operation
- On-chip 100Ω Input and Output Termination Minimizes Insertion and Return Losses, Reduces Component Count and Minimizes Board Space
- 7 kV ESD on LVDS I/O Pins Protects Adjoining Components
- Small 3 mm x 3 mm 8-WSO Space Saving Package

### APPLICATIONS

- Clock and Data Buffering
- OC-12 / STM-4
- FireWire 800

### Typical Application



### DESCRIPTION

The DS10BR150 is a single channel 1.0 Gbps LVDS buffer optimized for high-speed signal transmission over lossy FR-4 printed circuit board backplanes and balanced cables. Fully differential signal paths ensure exceptional signal integrity and noise immunity.

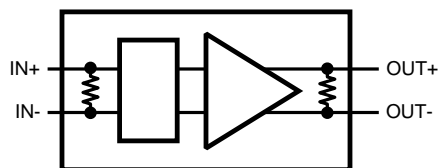
Wide input common mode range allows the receiver to accept signals with LVDS, CML and LVPECL levels; the output levels are LVDS. A very small package footprint requires a minimal space on the board while the flow-through pinout allows easy board layout. The differential inputs and outputs are internally terminated with a 100Ω resistor to lower device input and output return losses, reduce component count and further minimize board space.



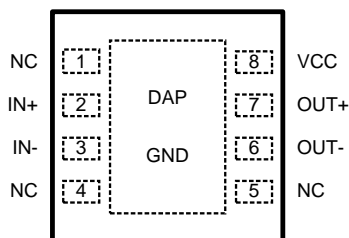
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## Block Diagram



## Pin Diagram



**DS10BR150**  
See Package Number NGQ0008A

### PIN DESCRIPTIONS

Pin Name	Pin Name	Pin Type	Pin Description
NC	1	NA	"NO CONNECT" pin.
IN+	2	Input	Non-inverting LVDS input pin.
IN-	3	Input	Inverting LVDS input pin.
NC	4	NA	"NO CONNECT" pin.
NC	5	NA	"NO CONNECT" pin.
OUT-	6	Output	Inverting LVDS output pin.
OUT+	7	Output	Non-inverting LVDS Output pin.
VCC	8	Power	Power supply pin.
GND	DAP	Power	Ground pad (DAP - die attach pad)



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 <sup>(1)(2)</sup>

Supply Voltage ( $V_{CC}$ )	-0.3V to +4V
LVDS Input Voltage (IN+, IN-)	-0.3V to +4V
Differential Input Voltage  VID	1V
LVDS Output Voltage (OUT+, OUT-)	-0.3V to ( $V_{CC} + 0.3V$ )
LVDS Differential Output Voltage ((OUT+) - (OUT-))	0V to 1V
LVDS Output Short Circuit Current Duration	5 ms
Junction Temperature	+150°C
Storage Temperature Range	-65°C to +150°C
Lead Temperature Range	
Soldering (4 sec.)	+260°C
Maximum Package Power Dissipation at 25°C	
NGQ Package	2.08W
Derate NGQ Package	16.7 mW/°C above +25°C
Package Thermal Resistance	
$\theta_{JA}$	+60.0°C/W
$\theta_{JC}$	+12.3°C/W
ESD Susceptibility	
HBM <sup>(3)</sup>	≥7 kV
MM <sup>(4)</sup>	≥250V
CDM <sup>(5)</sup>	≥1250V

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur, including inoperability and degradation of device reliability and/or performance. Functional operation of the device and/or non-degradation at the Absolute Maximum Ratings or other conditions beyond those indicated in the Recommended Operating Conditions is not implied. The Recommended Operating Conditions indicate conditions at which the device is functional and the device should not be operated beyond such conditions.
- (2) If Military/Aerospace specified devices are required, please contact the Texas Instruments Sales Office/ Distributors for availability and specifications.
- (3) Human Body Model, applicable std. JESD22-A114C
- (4) Machine Model, applicable std. JESD22-A115-A
- (5) Field Induced Charge Device Model, applicable std. JESD22-C101-C

### Recommended Operating Conditions

	Min	Typ	Max	Units
Supply Voltage ( $V_{CC}$ )	3.0	3.3	3.6	V
Receiver Differential Input Voltage ( $V_{ID}$ )	0		1	V
Operating Free Air Temperature ( $T_A$ )	-40	+25	+85	°C

## DC Electrical Characteristics

Over recommended operating supply and temperature ranges unless otherwise specified. <sup>(1)(2)(3)</sup>

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
<b>LVDS OUTPUT DC SPECIFICATIONS (OUT+, OUT-)</b>							
$V_{OD}$	Differential Output Voltage	$R_L = 100\Omega$	250	350	450	mV	
$\Delta V_{OD}$	Change in Magnitude of $V_{OD}$ for Complimentary Output States		-35		35	mV	
$V_{OS}$	Offset Voltage	$R_L = 100\Omega$	1.05	1.2	1.375	V	
$\Delta V_{OS}$	Change in Magnitude of $V_{OS}$ for Complimentary Output States		-35		35	mV	
$I_{OS}$	Output Short Circuit Current <sup>(4)</sup>	OUT to GND		-30	-50	mA	
		OUT to $V_{CC}$		7.5	50	mA	
$C_{OUT}$	Output Capacitance	Any LVDS Output Pin to GND		1.2		pF	
$R_{OUT}$	Output Termination Resistor	Between OUT+ and OUT- Pins		100		$\Omega$	
<b>LVDS INPUT DC SPECIFICATIONS (IN+, IN-)</b>							
$V_{ID}$	Input Differential Voltage	$V_{CM} = +0.05V$ or $V_{CC}-0.05V$	0		1	V	
$V_{TH}$	Differential Input High Threshold				0	+100	mV
$V_{TL}$	Differential Input Low Threshold			-100	0		mV
$V_{CMR}$	Common Mode Voltage Range	$V_{ID} = 100$ mV	0.05		$V_{CC} - 0.05$	V	
$I_{IN}$	Input Current	$V_{IN} = 3.6V$ or $0V$ $V_{CC} = 3.6V$ or $0V$		$\pm 1$	$\pm 10$	$\mu A$	
$C_{IN}$	Input Capacitance			1.7		pF	
$R_{IN}$	Input Termination Resistor	Between IN+ and IN- Pins		100		$\Omega$	
<b>SUPPLY CURRENT</b>							
$I_{CCD}$	Total Supply Current			16	21	mA	

- (1) The [Electrical Characteristics](#) tables list ensured specifications under the listed Recommended Operating Conditions except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not ensured.
- (2) Current into device pins is defined as positive. Current out of device pins is defined as negative. All voltages are referenced to ground except  $V_{OD}$  and  $\Delta V_{OD}$ .
- (3) Typical values represent most likely parametric norms for  $V_{CC} = +3.3V$  and  $T_A = +25^\circ C$ , and at the Recommended Operation Conditions at the time of product characterization and are not ensured.
- (4) Output short circuit current ( $I_{OS}$ ) is specified as magnitude only, minus sign indicates direction only.

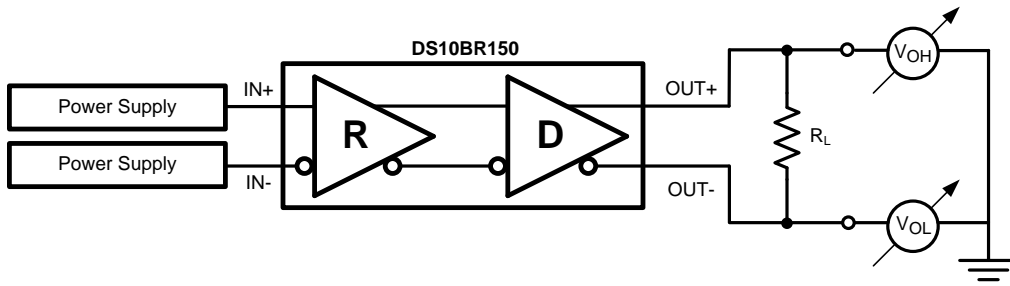
## AC Electrical Characteristics <sup>(1)</sup>

Over recommended operating supply and temperature ranges unless otherwise specified. <sup>(2)(3)</sup>

Symbol	Parameter	Conditions	Min	Typ	Max	Units	
<b>LVDS OUTPUT AC SPECIFICATIONS (OUT+, OUT-)</b>							
$t_{PHLD2}$	Differential Propagation Delay High to Low	$R_L = 100\Omega$		380	600	ps	
$t_{PLHD2}$	Differential Propagation Delay Low to High			410	600	ps	
$t_{SKD1}$	Pulse Skew $ t_{PLHD} - t_{PHLD} $ <sup>(4)</sup>			30	150	ps	
$t_{SKD2}$	Part to Part Skew <sup>(5)</sup>			45	160	ps	
$t_{LHT}$	Rise Time	$R_L = 100\Omega$		165	400	ps	
$t_{HLT}$	Fall Time			155	400	ps	
<b>JITTER PERFORMANCE Figure 5</b>							
$t_{DJ}$	Deterministic Jitter (Peak-to-Peak Value) (See <sup>(6)</sup> )	$V_{ID} = 350\text{ mV}$ $V_{CM} = 1.2\text{V}$ K28.5 (NRZ)	622 Mbps		12	39	ps
			1.06 Gbps		15	42	ps
$t_{RJ}$	Random Jitter (RMS Value) <sup>(7)</sup>	$V_{ID} = 350\text{ mV}$ $V_{CM} = 1.2\text{V}$ Clock (NRZ)	311 MHz		0.6	1.3	ps
			503 MHz		0.6	1.1	ps
$t_{TJ}$	Total Jitter (Peak to Peak Value) <sup>(8)</sup>	$V_{ID} = 350\text{ mV}$ $V_{CM} = 1.2\text{V}$ PRBS-23 (NRZ)	622 Mbps		0.02	0.04	UI <sub>p-p</sub>
			1.06 Gbps		0.02	0.05	UI <sub>p-p</sub>

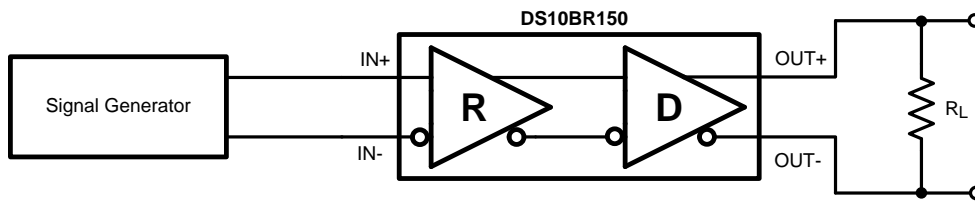
- (1) Specification is ensured by characterization and is not tested in production.
- (2) The [Electrical Characteristics](#) tables list ensured specifications under the listed Recommended Operating Conditions except as otherwise modified or specified by the Electrical Characteristics Conditions and/or Notes. Typical specifications are estimations only and are not ensured.
- (3) Typical values represent most likely parametric norms for  $V_{CC} = +3.3\text{V}$  and  $T_A = +25^\circ\text{C}$ , and at the Recommended Operation Conditions at the time of product characterization and are not ensured.
- (4)  $t_{SKD1}$ ,  $|t_{PLHD} - t_{PHLD}|$ , is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel.
- (5)  $t_{SKD2}$ , Part to Part Skew, is defined as the difference between the minimum and maximum specified differential propagation delays. This specification applies to devices at the same  $V_{CC}$  and within  $5^\circ\text{C}$  of each other within the operating temperature range.
- (6) Tested with a combination of the 1100000101 (K28.5+ character) and 0011111010 (K28.5- character) patterns. Input stimulus jitter is subtracted algebraically.
- (7) Measured on a clock edge with a histogram and an accumulation of 1500 histogram hits. Input stimulus jitter is subtracted geometrically.
- (8) Measured on an eye diagram with a histogram and an accumulation of 3500 histogram hits. Input stimulus jitter is subtracted.

**DC Test Circuits**

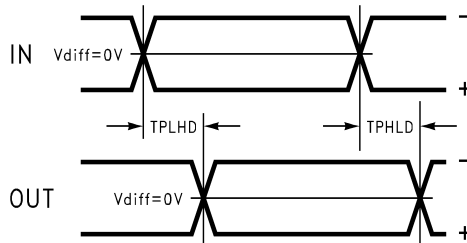


**Figure 1. Differential Driver DC Test Circuit**

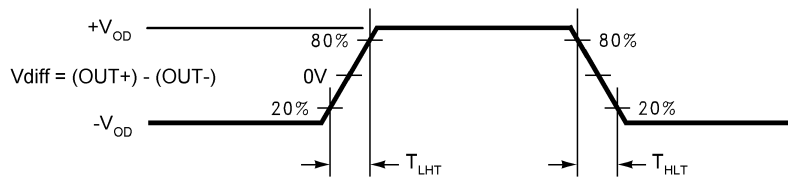
**AC Test Circuits and Timing Diagrams**



**Figure 2. Differential Driver AC Test Circuit**



**Figure 3. Propagation Delay Timing Diagram**



**Figure 4. LVDS Output Transition Times**

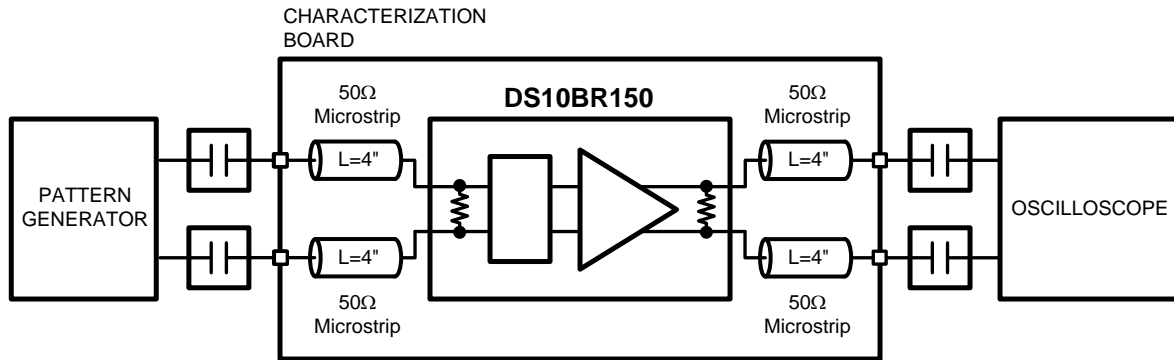


Figure 5. Jitter Measurements Test Circuit

## DEVICE OPERATION

### INPUT INTERFACING

The DS10BR150 accepts differential signals and allows simple AC or DC coupling. With a wide common mode range, the DS10BR150 can be DC-coupled with all common differential drivers (i.e. LVPECL, LVDS, CML). The following three figures illustrate typical DC-coupled interface to common differential drivers. Note that the DS10BR150 inputs are internally terminated with a 100Ω resistor.

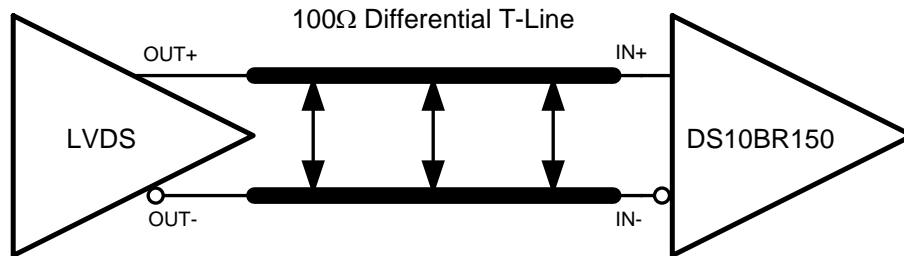


Figure 6. Typical LVDS Driver DC-Coupled Interface to DS10BR150 Input

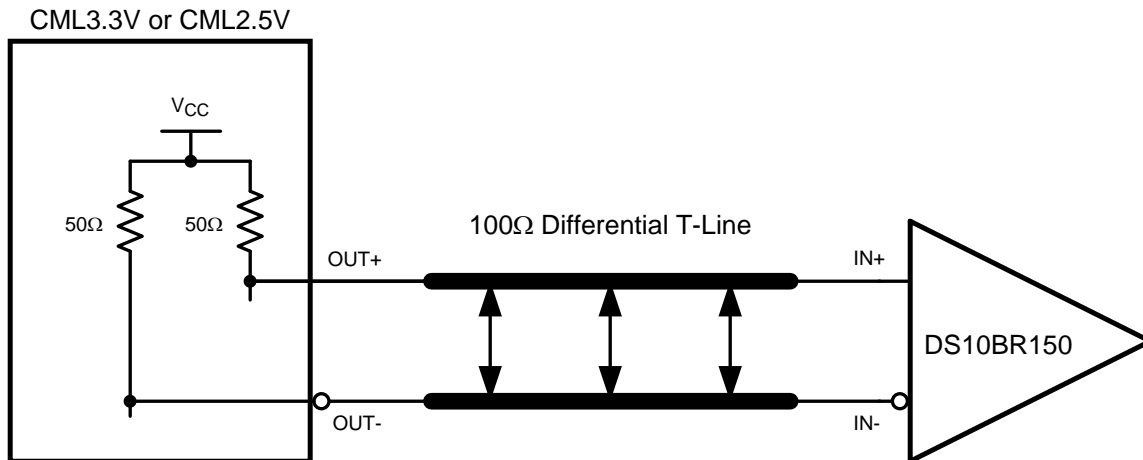


Figure 7. Typical CML Driver DC-Coupled Interface to DS10BR150 Input

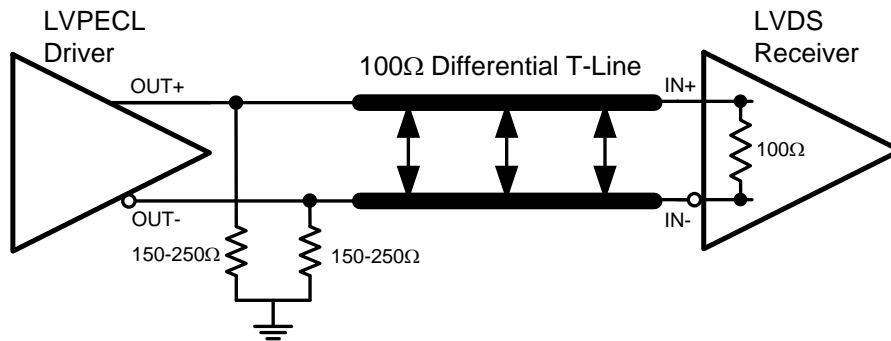


Figure 8. Typical LVPECL Driver DC-Coupled Interface to DS10BR150 Input

## OUTPUT INTERFACING

The DS10BR150 outputs signals are compliant to the LVDS standard. It can be DC-coupled to most common differential receivers. The following figure illustrates typical DC-coupled interface to common differential receivers and assumes that the receivers have high impedance inputs. While most differential receivers have a common mode input range that can accommodate LVDS compliant signals, it is recommended to check respective receiver's data sheet prior to implementing the suggested interface implementation.

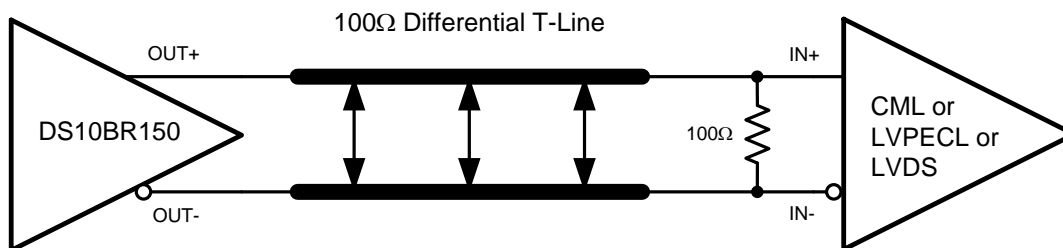


Figure 9. Typical DS10BR150 Output DC-Coupled Interface to an LVDS, CML or LVPECL Receiver



Typical Performance

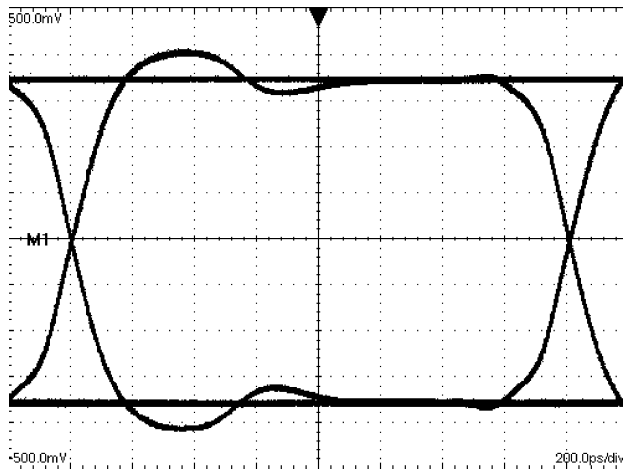


Figure 10. A 622 Mbps NRZ PRBS-7 Output Eye Diagram  
V:100 mV / DIV, H:200 ps / DIV

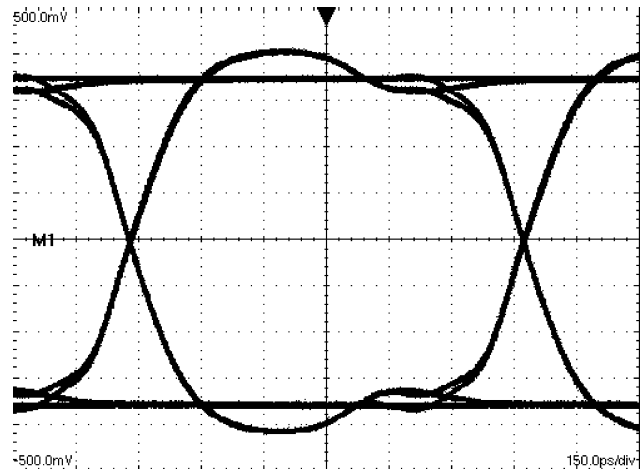


Figure 11. A 1062.5 Mbps NRZ PRBS-7 Output Eye Diagram  
V:100 mV / DIV, H:150 ps / DIV

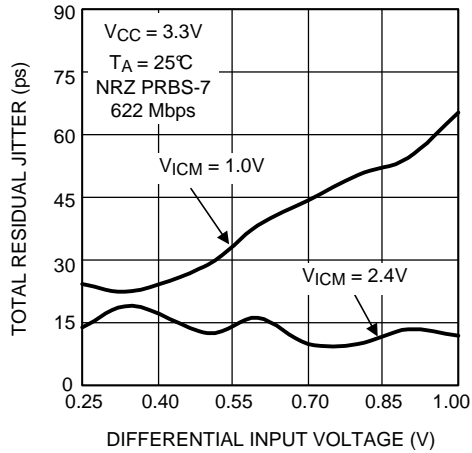


Figure 12. Total Jitter as a Function of Input Amplitude

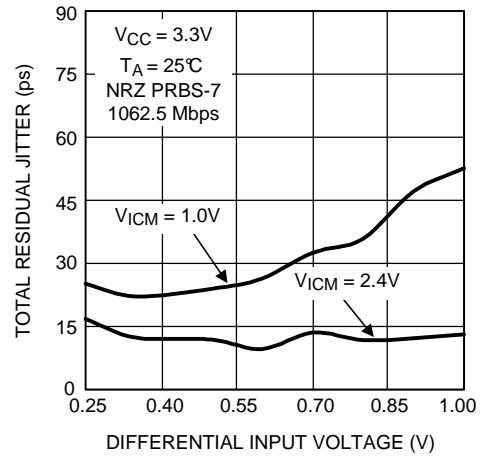


Figure 13. Total Jitter as a Function of Input Amplitude

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## REVISION HISTORY

Changes from Revision C (April 2013) to Revision D	Page
• Changed layout of National Data Sheet to TI format .....	<a href="#">9</a>

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**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
DS10BR150TSD/NOPB	ACTIVE	WSON	NGQ	8	1000	RoHS & Green	SN	Level-3-260C-168 HR	-40 to 85	1R150	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.

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## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



\*All dimensions are nominal

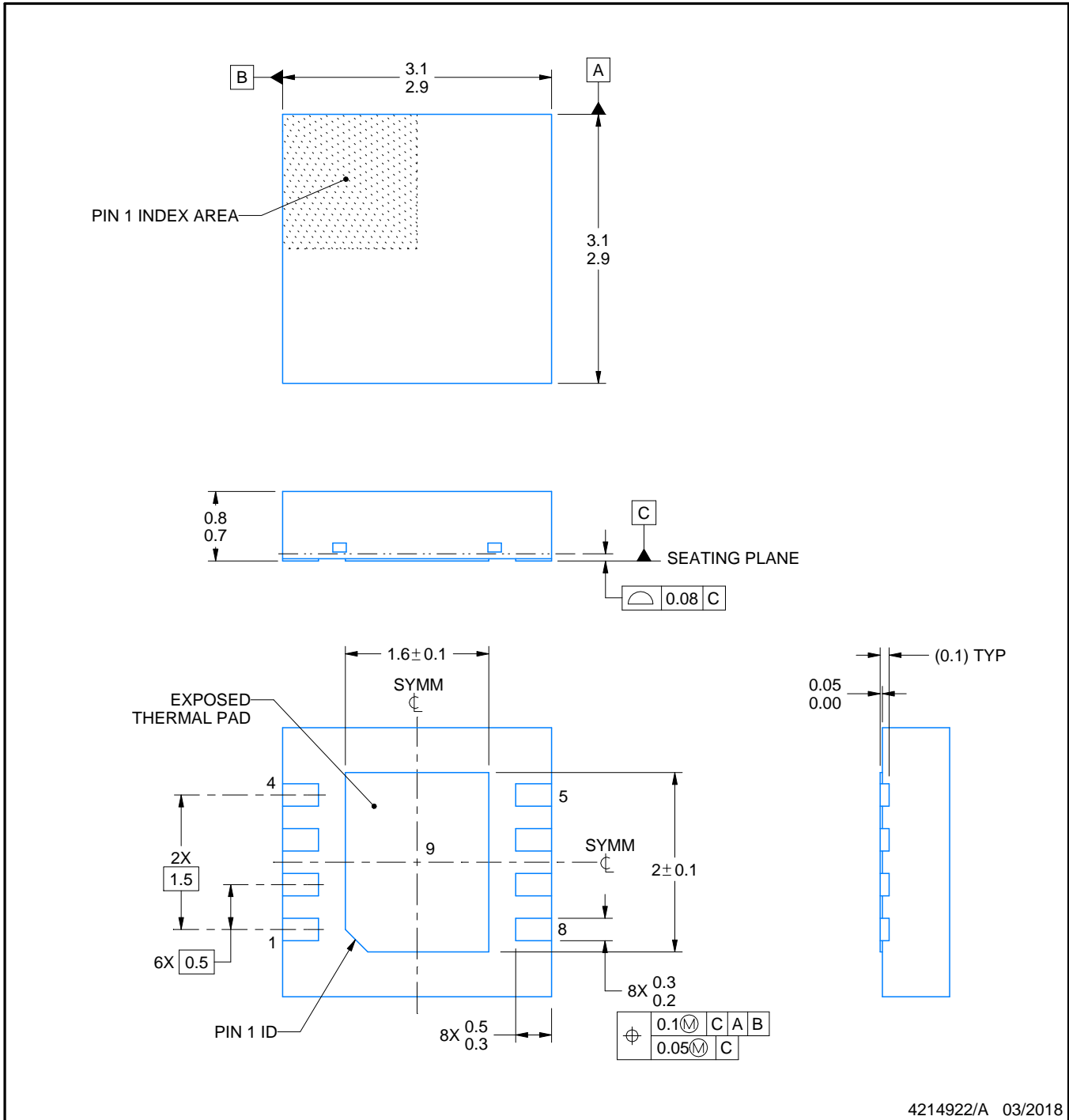
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DS10BR150TSD/NOPB	WSON	NGQ	8	1000	178.0	12.4	3.3	3.3	1.0	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS10BR150TSD/NOPB	WSON	NGQ	8	1000	210.0	185.0	35.0



4214922/A 03/2018

NOTES:

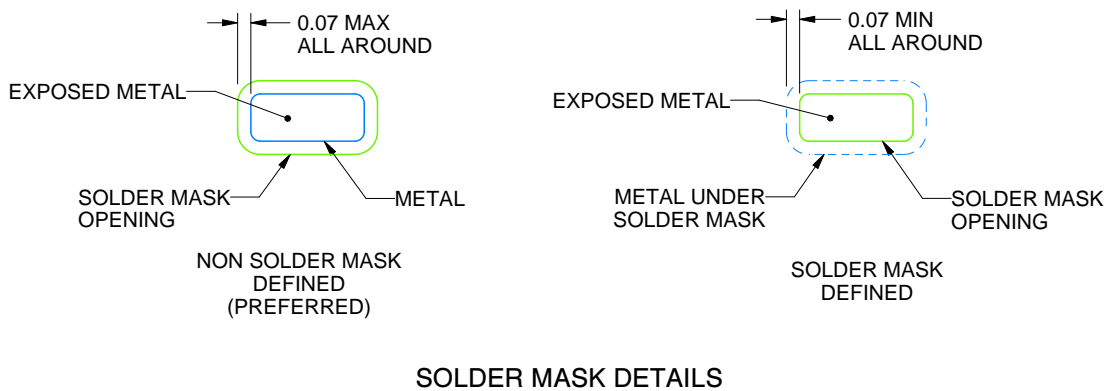
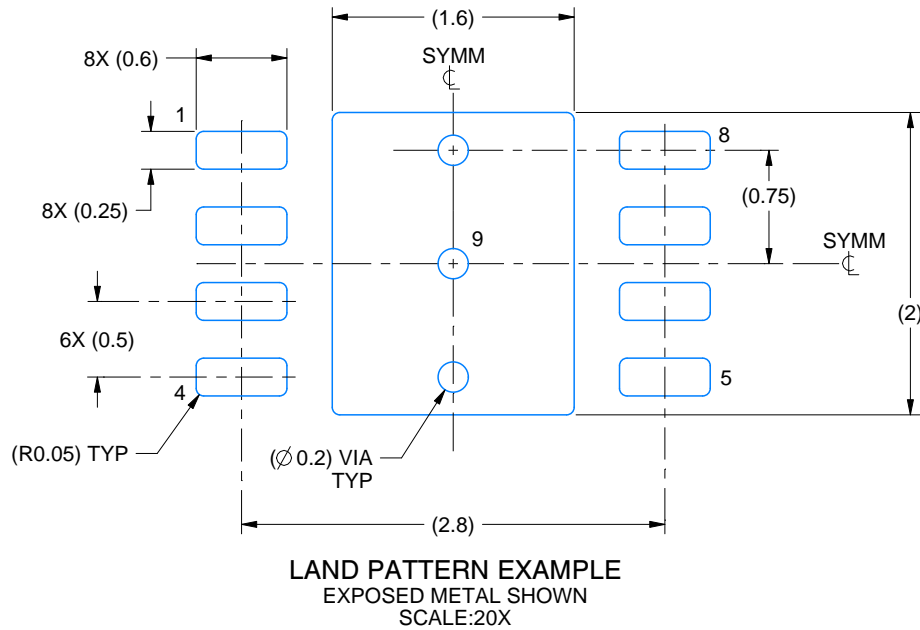
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

# EXAMPLE BOARD LAYOUT

NGQ0008A

WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



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NOTES: (continued)

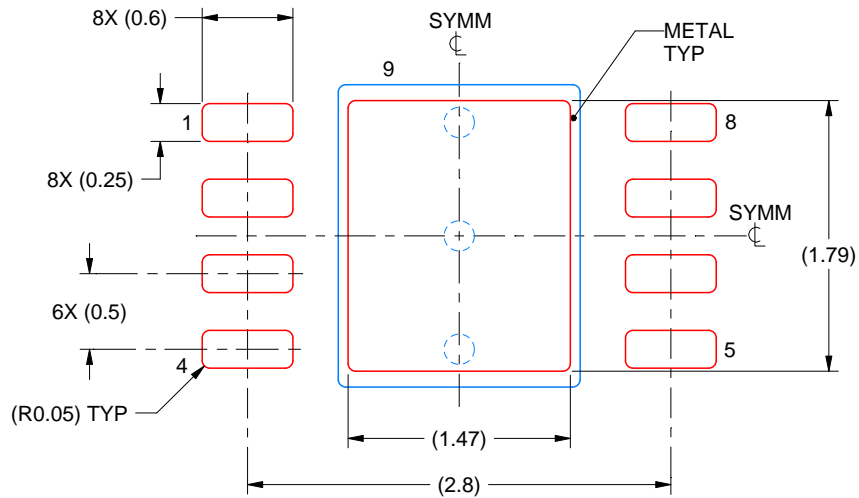
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).
5. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.

# EXAMPLE STENCIL DESIGN

NGQ0008A

WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICK STENCIL

EXPOSED PAD 9:  
82% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:20X

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NOTES: (continued)

6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.



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