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Texas Instruments
DS10BR150TSD/NOPB

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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-WSON Space Saving Package**

APPLICATIONS

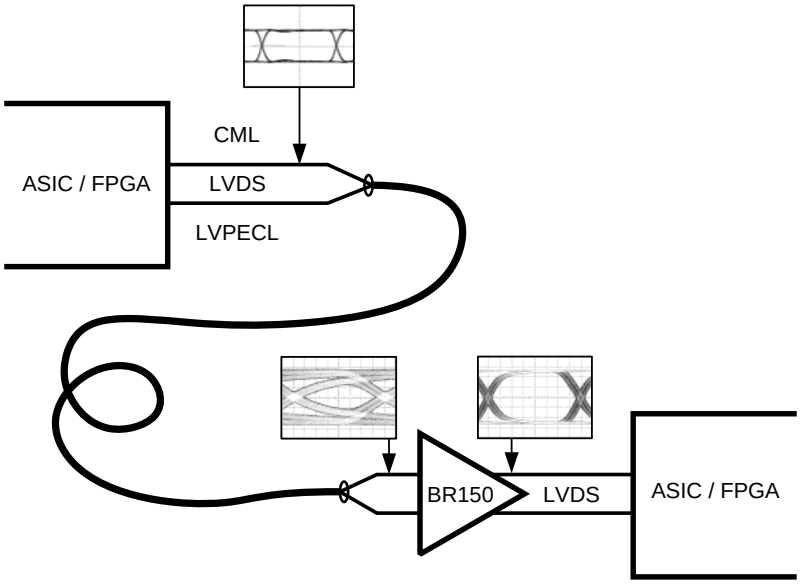
- **Clock and Data Buffering**
- **OC-12 / STM-4**
- **FireWire 800**

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.

Typical Application



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.

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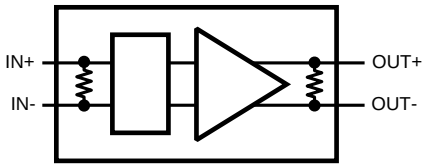
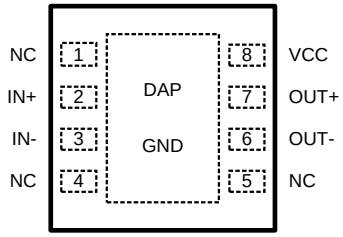
Block Diagram



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 (1)(2)

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	
θ_{JA}	+60.0°C/W
θ_{JC}	+12.3°C/W
ESD Susceptibility	
HBM (3)	≥7 kV
MM (4)	≥250V
CDM (5)	≥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. (1)(2)(3)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
LVDS OUTPUT DC SPECIFICATIONS (OUT+, OUT-)						
V_{OD}	Differential Output Voltage	R_L = 100Ω	250	350	450	mV
ΔV_{OD}	Change in Magnitude of V_{OD} for Complimentary Output States		-35		35	mV
V_{OS}	Offset Voltage	R_L = 100Ω	1.05	1.2	1.375	V
ΔV_{OS}	Change in Magnitude of V_{OS} for Complimentary Output States		-35		35	mV
I_{OS}	Output Short Circuit Current (4)	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		Ω
LVDS INPUT DC SPECIFICATIONS (IN+, IN-)						
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		±1	±10	µA
C_{IN}	Input Capacitance			1.7		pF
R_{IN}	Input Termination Resistor	Between IN+ and IN- Pins		100		Ω
SUPPLY CURRENT						
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 ΔV_{OD}.
(3) Typical values represent most likely parametric norms for V_{CC} = +3.3V and T_A = +25°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 (1)

Over recommended operating supply and temperature ranges unless otherwise specified. (2)(3)

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

(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} = +3.3V and T_A = +25°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°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

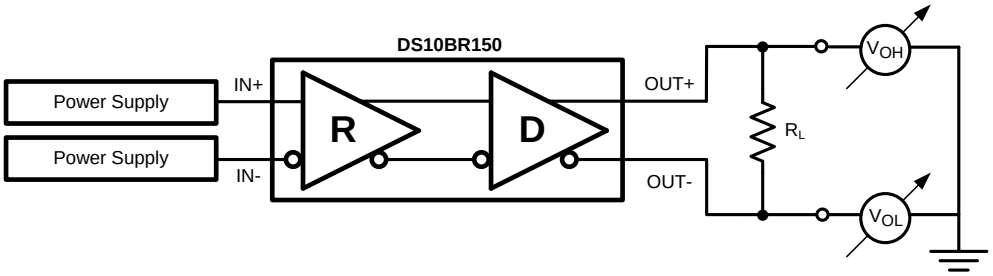


Figure 1. Differential Driver DC Test Circuit

AC Test Circuits and Timing Diagrams

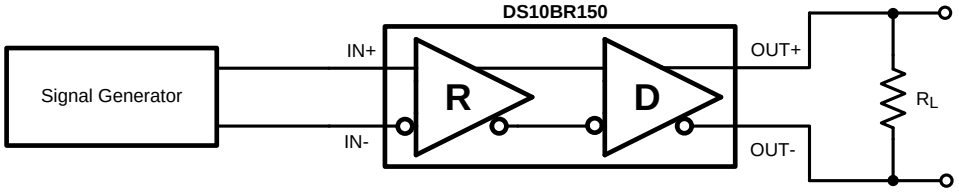


Figure 2. Differential Driver AC Test Circuit

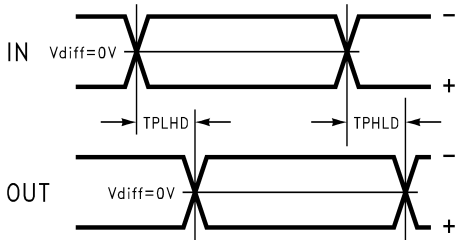


Figure 3. Propagation Delay Timing Diagram

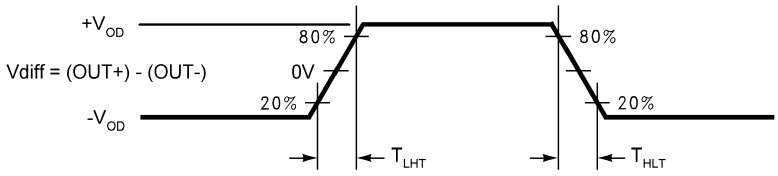


Figure 4. LVDS Output Transition Times

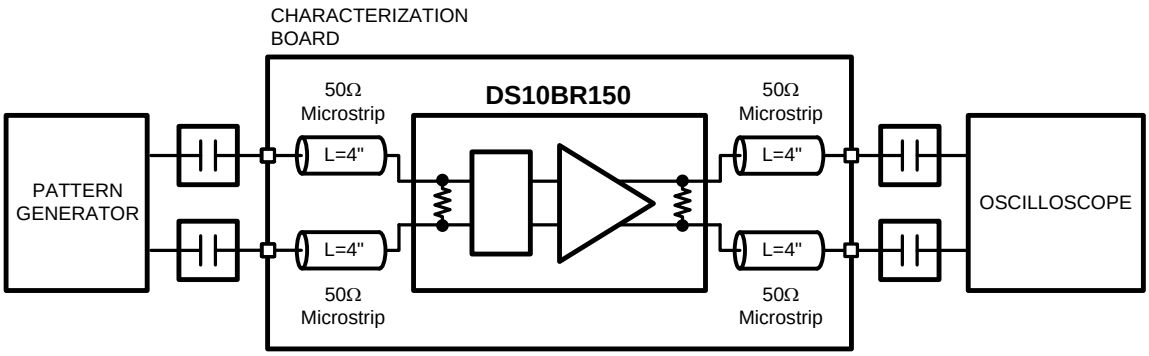


Figure 5. Jitter Measurements Test Circuit

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.

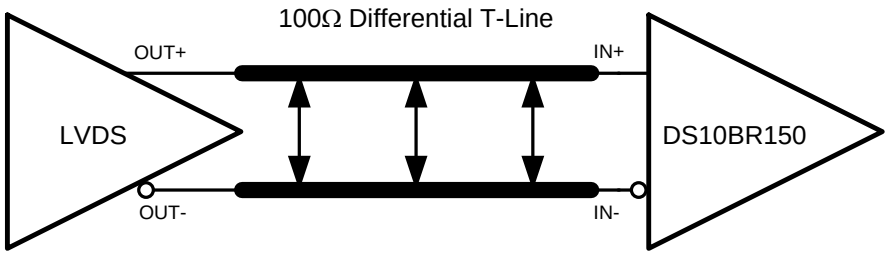


Figure 6. Typical LVDS Driver DC-Coupled Interface to DS10BR150 Input

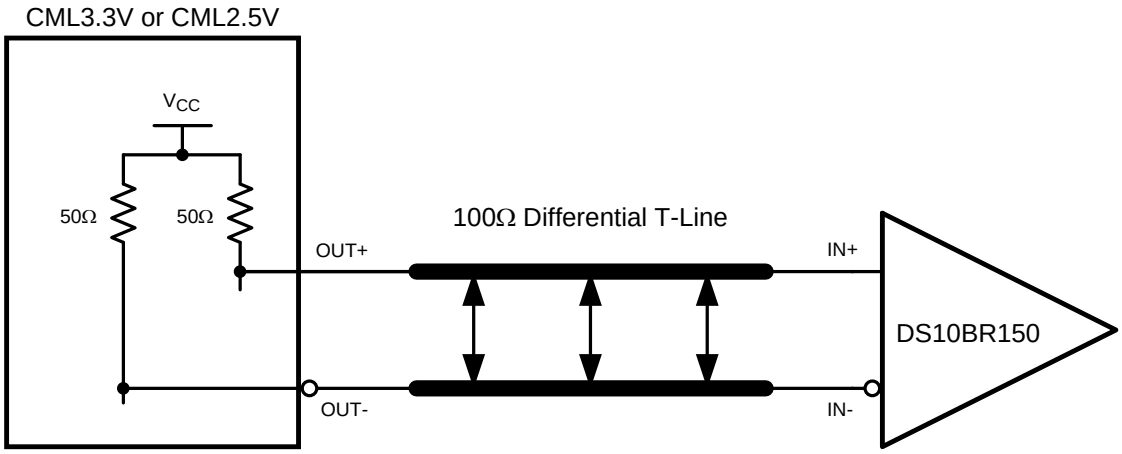


Figure 7. Typical CML Driver DC-Coupled Interface to DS10BR150 Input

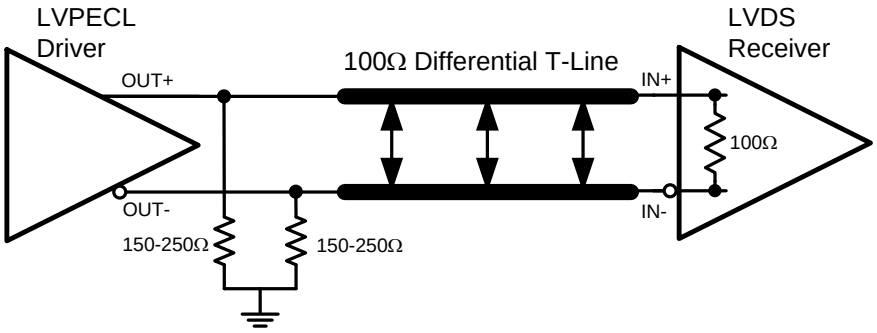


Figure 8. Typical LVPECL Driver DC-Coupled Interface to DS10BR150 Input

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 accomodate LVDS compliant signals, it is recommended to check respective receiver's data sheet prior to implementing the suggested interface implementation.

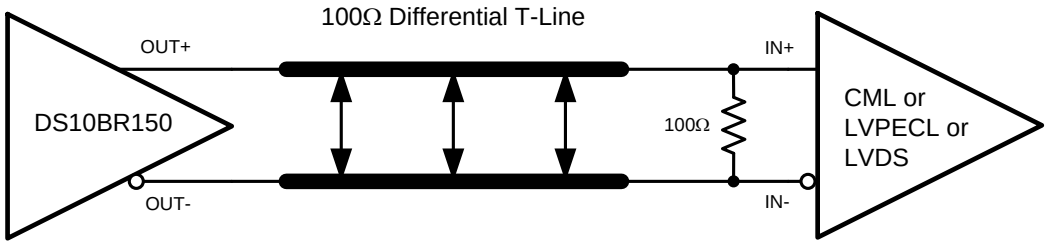


Figure 9. Typical DS10BR150 Output DC-Coupled Interface to an LVDS, CML or LVPECL Receiver

Typical Performance

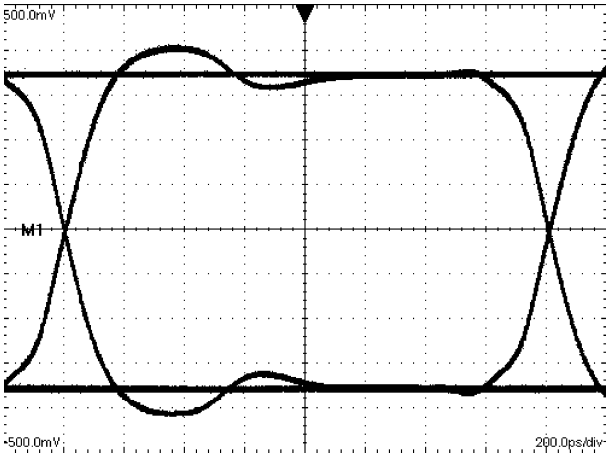


Figure 10. A 622 Mbps NRZ PRBS-7 Output Eye Diagram V:100 mV / DIV, H:200 ps / DIV

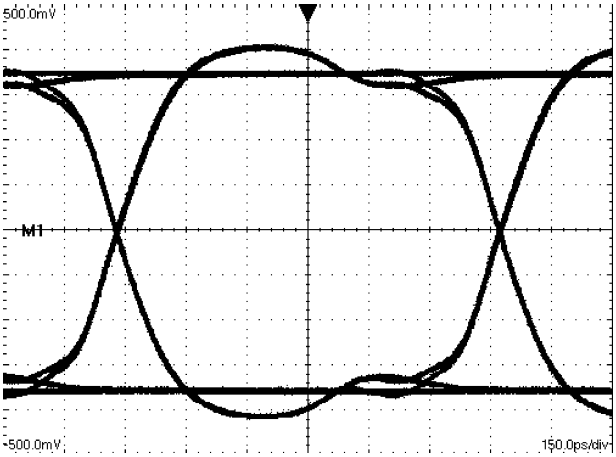


Figure 11. A 1062.5 Mbps NRZ PRBS-7 Output Eye Diagram V:100 mV / DIV, H:150 ps / DIV

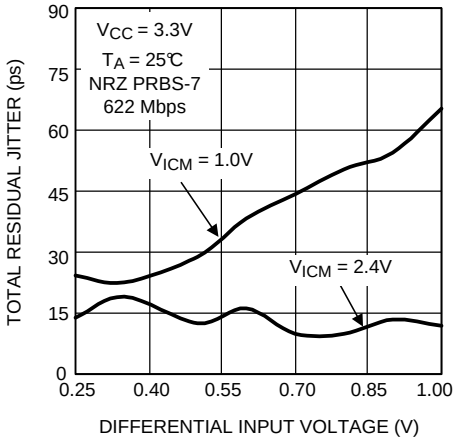


Figure 12. Total Jitter as a Function of Input Amplitude

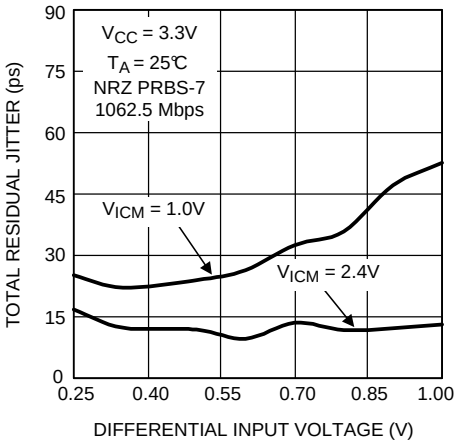


Figure 13. Total Jitter as a Function of Input Amplitude

REVISION HISTORY

Changes from Revision C (April 2013) to Revision D	Page
• Changed layout of National Data Sheet to TI format	9

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
DS10BR150TSD/NOPB	ACTIVE	WSON	NGQ	8	1000	Green (RoHS & no Sb/Br)	CU SN	Level-3-260C-168 HR	-40 to 85	1R150	Samples
DS10BR150TSDX/NOPB	ACTIVE	WSON	NGQ	8	4500	Green (RoHS & no Sb/Br)	CU 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) 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)

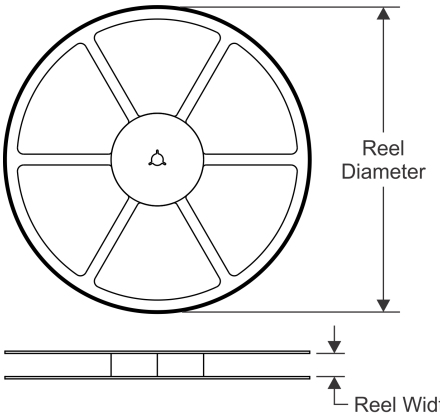
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side Marking for that device.

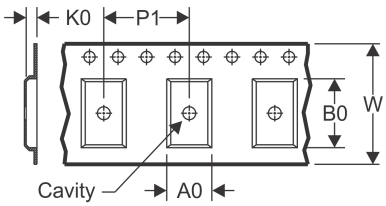
PACKAGE MATERIALS INFORMATION

TAPE AND REEL INFORMATION

REEL DIMENSIONS

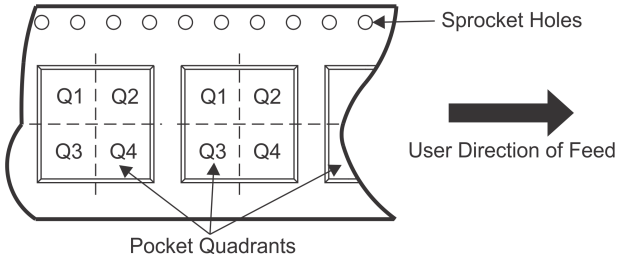


TAPE DIMENSIONS



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

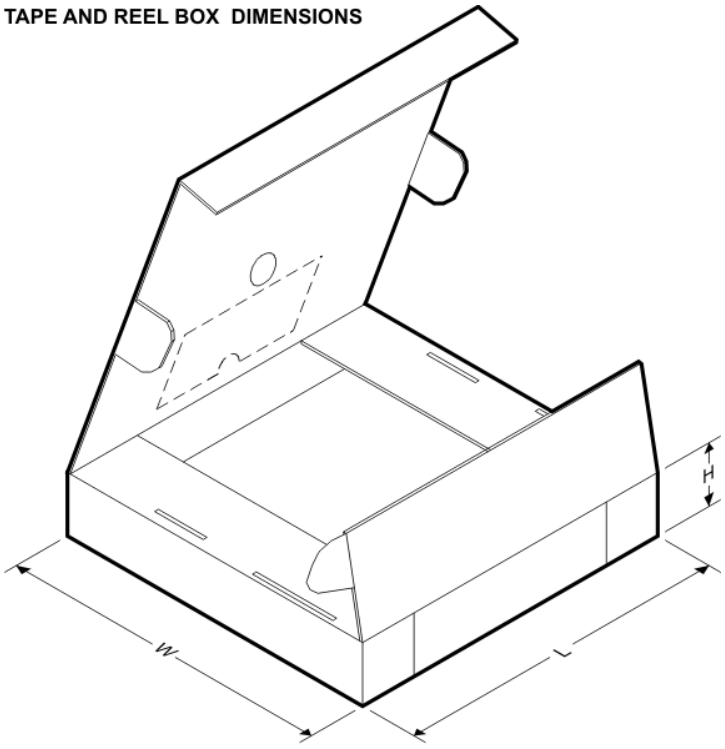


*All dimensions are nominal

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
DS10BR150TSD/NOPB	WSON	NGQ	8	1000	178.0	12.4	3.3	3.3	1.0	8.0	12.0	Q1
DS10BR150TSDX/NOPB	WSON	NGQ	8	4500	330.0	12.4	3.3	3.3	1.0	8.0	12.0	Q1

PACKAGE MATERIALS INFORMATION

TAPE AND REEL BOX DIMENSIONS

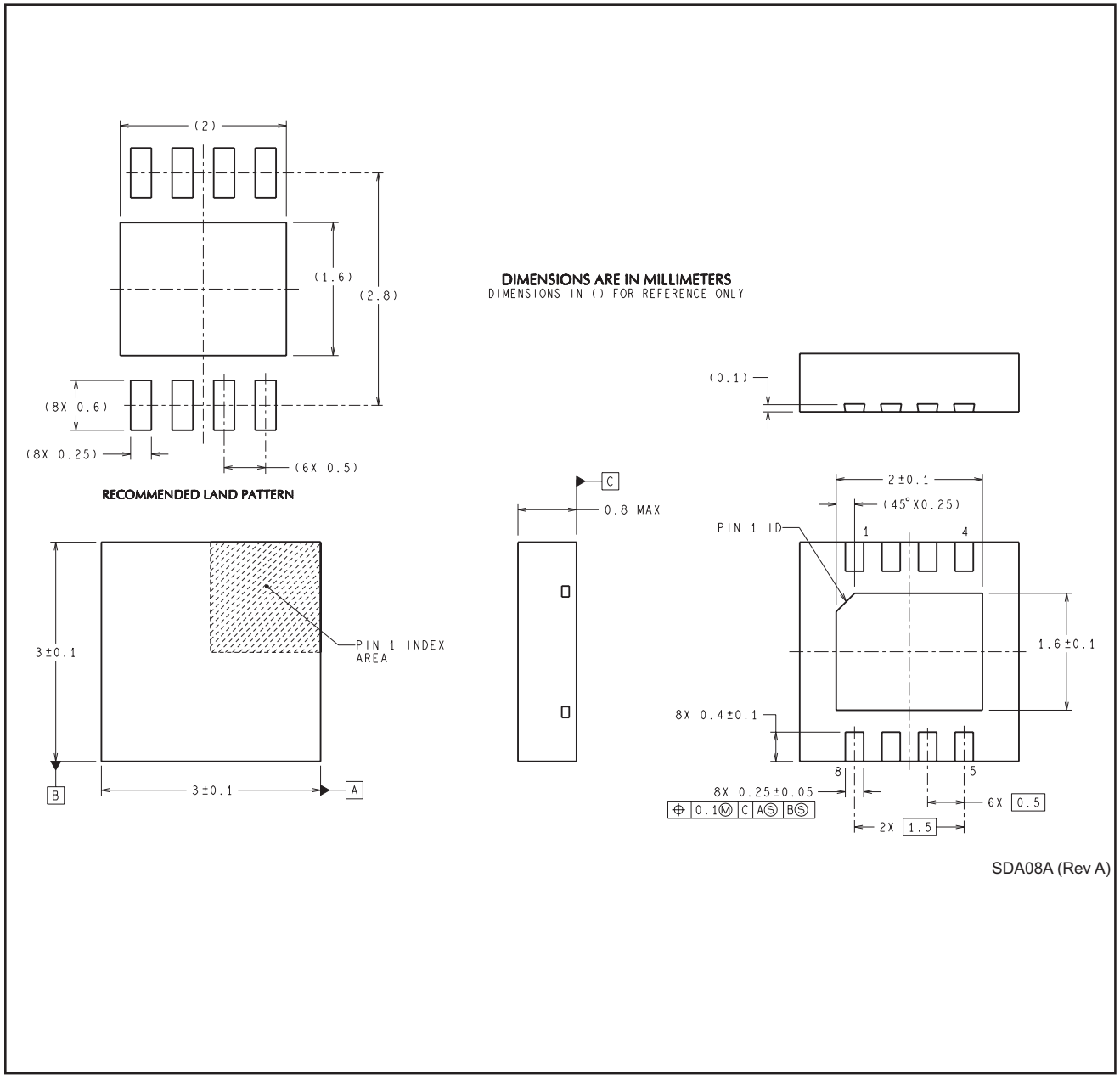


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DS10BR150TSD/NOPB	WSON	NGQ	8	1000	213.0	191.0	55.0
DS10BR150TSDX/NOPB	WSON	NGQ	8	4500	367.0	367.0	35.0

MECHANICAL DATA

NGQ0008A



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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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