



**THE DATASHEET OF
DS10BR254TSQ/NOPB**



DS10BR254 1.5 Gbps 1:4 LVDS Repeater

Check for Samples: [DS10BR254](#)

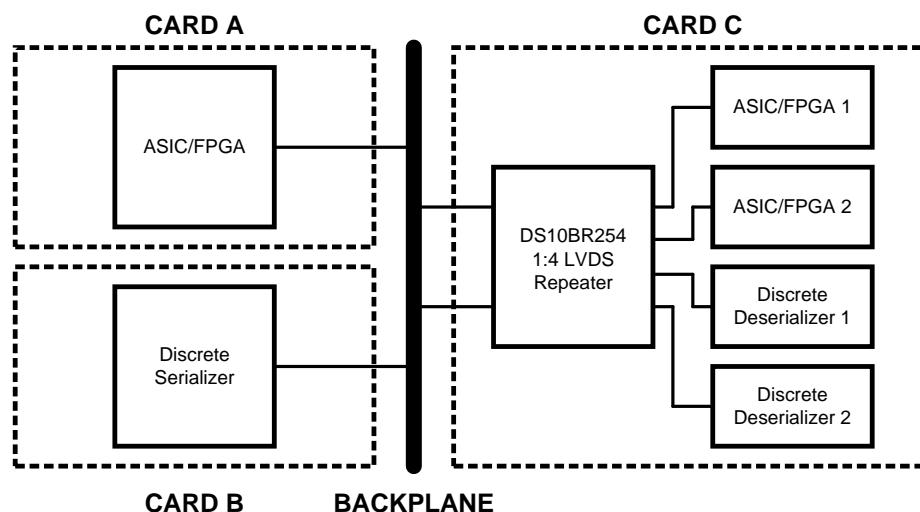
FEATURES

- DC - 1.5 Gbps Low Jitter, Low Skew, Low Power Operation
- Wide Input Common Mode Voltage Range Allows for DC-Coupled Interface to LVDS, CML and LVPECL Drivers
- Redundant Inputs
- $\overline{\text{LOS}}$ Circuitry Detects Open Inputs Fault Condition
- Integrated 100 Ω Input and Output Terminations
- 8 kV ESD on LVDS I/O Pins Protects Adjoining Components
- Small 6 mm x 6 mm WQFN-40 Space Saving Package

APPLICATIONS

- Clock Distribution
- Clock and Data Buffering and Muxing
- OC-12 / STM-4
- SD/HD SDI Routers

Typical Application



DESCRIPTION

The DS10BR254 is a 1.5 Gbps 1:4 LVDS repeater optimized for high-speed signal routing and distribution over FR-4 printed circuit board backplanes and balanced cables. Fully differential signal paths ensure exceptional signal integrity and noise immunity.

The device has two different LVDS input channels and a select pin determines which input is active. A loss-of-signal ($\overline{\text{LOS}}$) circuit monitors both input channels and a unique $\overline{\text{LOS}}$ pin is asserted when no signal is detected at that input.

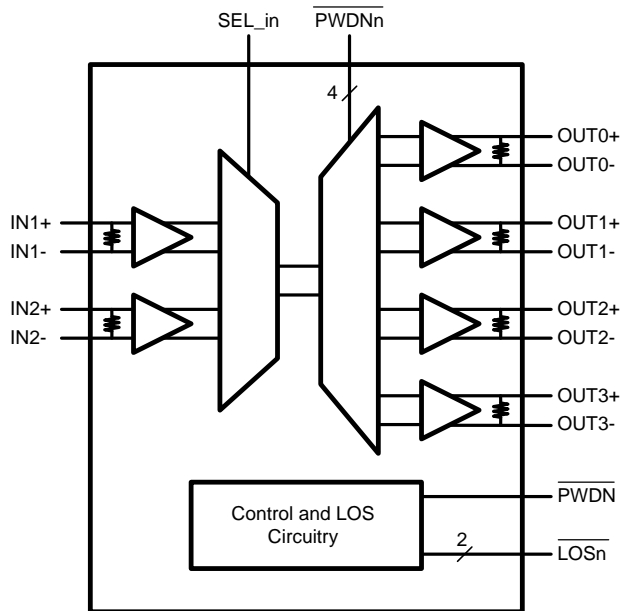
Wide input common mode range allows the switch to accept signals with LVDS, CML and LVPECL levels; the output levels are LVDS. A very small package footprint requires a minimal space on the board while the flow-through pinout allows easy board layout. Each differential input and output is internally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



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Block Diagram



Connection Diagram

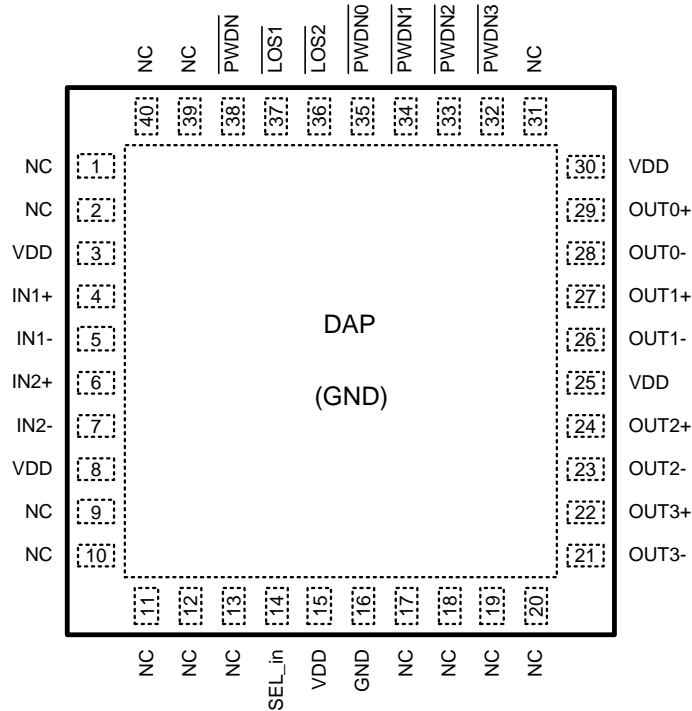


Figure 1. DS10BR254 Pin Diagram
See Package Number RTA0040A

PIN DESCRIPTIONS

| Pin Name | Pin Number | I/O, Type | Pin Description |
|--|--|-----------|---|
| IN1+, IN1-, IN2+, IN2-, | 4, 5, 6, 7, | I, LVDS | Inverting and non-inverting high speed LVDS input pins. |
| OUT0+, OUT0-, OUT1+, OUT1-, OUT2+, OUT2-, OUT3+, OUT3- | 29, 28, 27, 26, 24, 23, 22, 21 | O, LVDS | Inverting and non-inverting high speed LVDS output pins. |
| SEL_in | 14 | I, LVCMOS | This pin selects which LVDS input is active. |
| $\overline{\text{LOS}}_1$, $\overline{\text{LOS}}_2$ | 37, 36 | O, LVCMOS | Loss Of Signal output pins, $\overline{\text{LOS}}_n$ report when an open input fault condition is detected at the input, INn. These are open drain outputs. External pull up resistors are required. |
| $\overline{\text{PWDN}}_0$, $\overline{\text{PWDN}}_1$, $\overline{\text{PWDN}}_2$, $\overline{\text{PWDN}}_3$ | 35, 34, 33, 32 | I, LVCMOS | Channel output power down pin. When the $\overline{\text{PWDN}}_n$ is set to L, the channel output OUTn is in the power down mode. |
| $\overline{\text{PWDN}}$ | 38 | I, LVCMOS | Device power down pin. When the $\overline{\text{PWDN}}$ is set to L, the device is in the power down mode. |
| VDD | 3, 8, 15, 25, 30 | Power | Power supply pins. |
| GND | 16, DAP | Power | Ground pin and a pad (DAP - die attach pad). |
| NC | 1, 2 9, 10, 11, 12, 13, 17, 18, 19, 20, 31, 39, 40 | NC | NO CONNECT pins. May be left floating. |



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 | | -0.3V to +4V |
| LVC MOS Input Voltage | | -0.3V to ($V_{CC} + 0.3V$) |
| LVC MOS Output Voltage | | -0.3V to ($V_{CC} + 0.3V$) |
| LVDS Input Voltage | | -0.3V to +4V |
| Differential Input Voltage VID | | 1V |
| LVDS Output Voltage | | -0.3V to ($V_{CC} + 0.3V$) |
| LVDS Differential Output Voltage | | 0.0V 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 | SQA Package | 4.65W |
| | Derate SQA Package | 37.2 mW/°C above +25°C |
| Package Thermal Resistance | θ_{JA} | +26.9°C/W |
| | θ_{JC} | +3.8°C/W |
| ESD Susceptibility | HBM ⁽³⁾ | ≥8 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 |

Electrical Characteristics

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

| Symbol | Parameter | Conditions | Min | Typ | Max | Units |
|--------------------------------------|--|---|------|------|------------------------|-------|
| LVC MOS DC SPECIFICATIONS | | | | | | |
| V _{IH} | High Level Input Voltage | | 2.0 | | V _{DD} | V |
| V _{IL} | Low Level Input Voltage | | GND | | 0.8 | V |
| I _{IH} | High Level Input Current | V _{IN} = 3.6V V _{CC} = 3.6V | | 0 | ±10 | µA |
| I _{IL} | Low Level Input Current | V _{IN} = GND V _{CC} = 3.6V | | 0 | ±10 | µA |
| V _{CL} | Input Clamp Voltage | I _{CL} = -18 mA, V _{CC} = 0V | | -0.9 | -1.5 | V |
| V _{OL} | Low Level Output Voltage | I _{OL} = 4 mA | | 0.26 | 0.4 | V |
| LVDS INPUT DC SPECIFICATIONS | | | | | | |
| V _{ID} | Input Differential Voltage | | 0 | | 1 | V |
| V _{TH} | Differential Input High Threshold | V _{CM} = +0.05V or V _{CC} -0.05V | | 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 | Any LVDS Input Pin to GND | | 1.7 | | pF |
| R _{IN} | Input Termination Resistor | Between IN+ and IN- | | 100 | | Ω |
| LVDS OUTPUT DC SPECIFICATIONS | | | | | | |
| V _{OD} | Differential Output Voltage | | 250 | 350 | 450 | mV |
| ΔV _{OD} | Change in Magnitude of V _{OD} for Complimentary Output States | R _L = 100Ω | -35 | | 35 | mV |
| V _{OS} | Offset Voltage | | 1.05 | 1.2 | 1.375 | V |
| ΔV _{OS} | Change in Magnitude of V _{OS} for Complimentary Output States | R _L = 100Ω | -35 | | 35 | mV |
| I _{OS} | Output Short Circuit Current ⁽⁴⁾ | OUT to GND | | -35 | -55 | mA |
| | | OUT to V _{CC} | | 7 | 55 | mA |
| C _{OUT} | Output Capacitance | Any LVDS Output Pin to GND | | 1.2 | | pF |
| R _{OUT} | Output Termination Resistor | Between OUT+ and OUT- | | 100 | | Ω |
| SUPPLY CURRENT | | | | | | |
| I _{CC} | Supply Current | $\overline{\text{PWN}} = \text{H}$ | | 113 | 135 | mA |
| I _{CCZ} | Power Down Supply Current | $\overline{\text{PWN}} = \text{L}$ | | 50 | 60 | 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

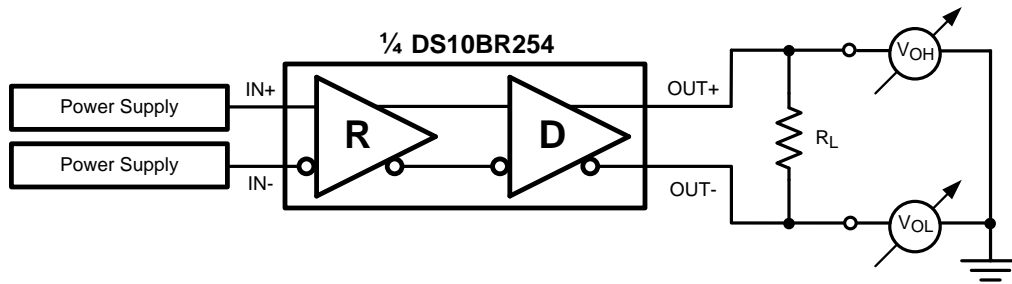
Over recommended operating supply and temperature ranges unless otherwise specified.

| Symbol | Parameter | Conditions | Min | Typ | Max | Units | |
|---|---|--|-------------|-----|------|---------|-------------------|
| LVDS OUTPUT AC SPECIFICATIONS | | | | | | | |
| t_{PLHD} | Differential Propagation Delay Low to High ⁽¹⁾ | $R_L = 100\Omega$ | | 440 | 650 | ps | |
| t_{PHLD} | Differential Propagation Delay High to Low ⁽¹⁾ | | | 400 | 650 | ps | |
| t_{SKD1} | Pulse Skew $ t_{PLHD} - t_{PHLD} ^{(1)(2)}$ | | | 40 | 100 | ps | |
| t_{SKD2} | Channel to Channel Skew ⁽¹⁾⁽³⁾ | | | 40 | 125 | ps | |
| t_{SKD3} | Part to Part Skew ⁽¹⁾⁽⁴⁾ | | | 50 | 200 | ps | |
| t_{LHT} | Rise Time ⁽¹⁾ | $R_L = 100\Omega$ | | 150 | 300 | ps | |
| t_{HLT} | Fall Time ⁽¹⁾ | | | 150 | 300 | ps | |
| t_{ON} | Any $\overline{P}WD\overline{N}$ to Output Active Time | | | 8 | 20 | μ s | |
| t_{OFF} | Any $\overline{P}WD\overline{N}$ to Output Inactive Time | | | 5 | 12 | ns | |
| t_{SEL} | Select Time | | | 5 | 12 | ns | |
| JITTER PERFORMANCE⁽¹⁾ | | | | | | | |
| t_{RJ1} | Random Jitter (RMS Value) ⁽⁵⁾ | $V_{ID} = 350\text{ mV}$ $V_{CM} = 1.2\text{ V}$ Clock (RZ) | 135 MHz | | 0.5 | 1 | ps |
| t_{RJ2} | | | 311 MHz | | 0.5 | 1 | ps |
| t_{RJ3} | | | 503 MHz | | 0.5 | 1 | ps |
| t_{RJ4} | | | 750 MHz | | 0.5 | 1 | ps |
| t_{DJ1} | Deterministic Jitter (Peak to Peak Value) ⁽⁶⁾ | $V_{ID} = 350\text{ mV}$ $V_{CM} = 1.2\text{ V}$ K28.5 (NRZ) | 270 Mbps | | 6 | 22 | ps |
| t_{DJ2} | | | 622 Mbps | | 6 | 21 | ps |
| t_{DJ3} | | | 1.0625 Gbps | | 9 | 18 | ps |
| t_{DJ4} | | | 1.5 Gbps | | 9 | 17 | ps |
| t_{TJ1} | Total Jitter ⁽⁷⁾ | $V_{ID} = 350\text{ mV}$ $V_{CM} = 1.2\text{ V}$ PRBS-23 (NRZ) | 270 Mbps | | 0.01 | 0.03 | UI _{P-P} |
| t_{TJ2} | | | 622 Mbps | | 0.01 | 0.03 | UI _{P-P} |
| t_{TJ3} | | | 1.0625 Gbps | | 0.01 | 0.04 | UI _{P-P} |
| t_{TJ4} | | | 1.5 Gbps | | 0.01 | 0.06 | UI _{P-P} |

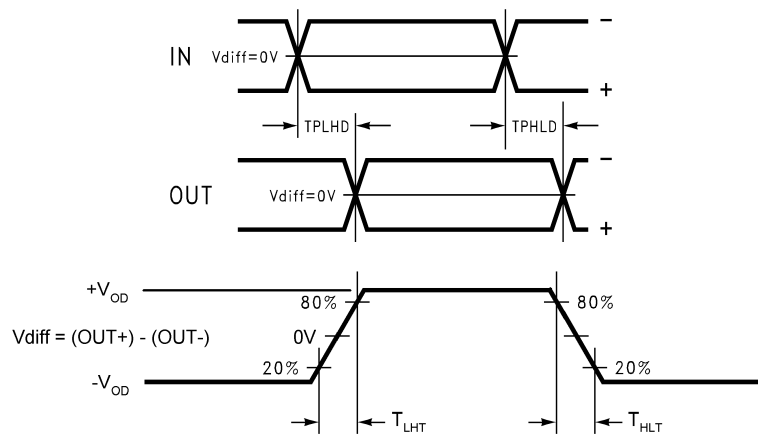
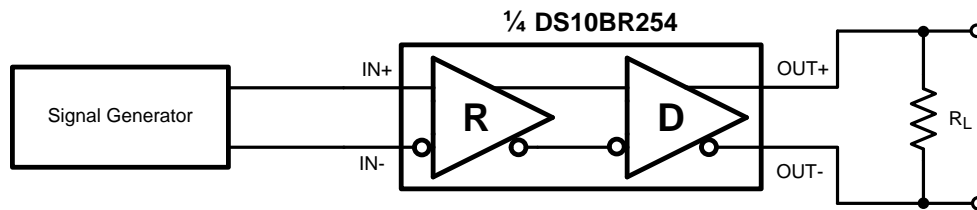
- (1) Specification is specified by characterization and is not tested in production.
- (2) t_{SKD1} , $|t_{PLHD} - t_{PHLD}|$, Pulse Skew, is the magnitude difference in differential propagation delay time between the positive going edge and the negative going edge of the same channel.
- (3) t_{SKD2} , Channel to Channel Skew, is the difference in propagation delay (t_{PLHD} or t_{PHLD}) among all output channels in Broadcast mode (any one input to all outputs).
- (4) t_{SKD3} , Part to Part Skew, is defined as the difference between the minimum and maximum 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.
- (5) Measured on a clock edge with a histogram and an accumulation of 1500 histogram hits. Input stimulus jitter is subtracted geometrically.
- (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 an eye diagram with a histogram and an accumulation of 3500 histogram hits. Input stimulus jitter is subtracted.

APPLICATION INFORMATION

DC TEST CIRCUITS



AC TEST CIRCUITS AND TIMING DIAGRAMS



FUNCTIONAL DESCRIPTION

The DS10BR254 is a 1.5 Gbps 1:4 LVDS repeater optimized for high-speed signal routing and distribution over lossy FR-4 printed circuit board backplanes and balanced cables.

Table 1. Input Select Truth Table

| CONTROL Pin (SEL_in) State | Input Selected |
|----------------------------|----------------|
| 0 | IN1 |
| 1 | IN2 |

Input Interfacing

The DS10BR254 accepts differential signals and allows simple AC or DC coupling. With a wide common mode range, the DS10BR254 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 DS10BR254 inputs are internally terminated with a 100Ω resistor.

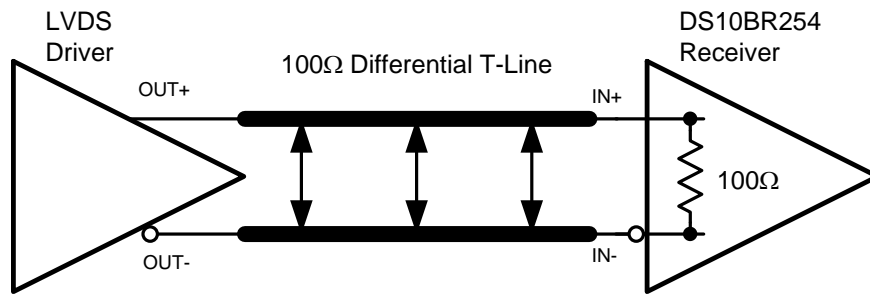


Figure 2. Typical LVDS Driver DC-Coupled Interface to an DS10BR254 Input

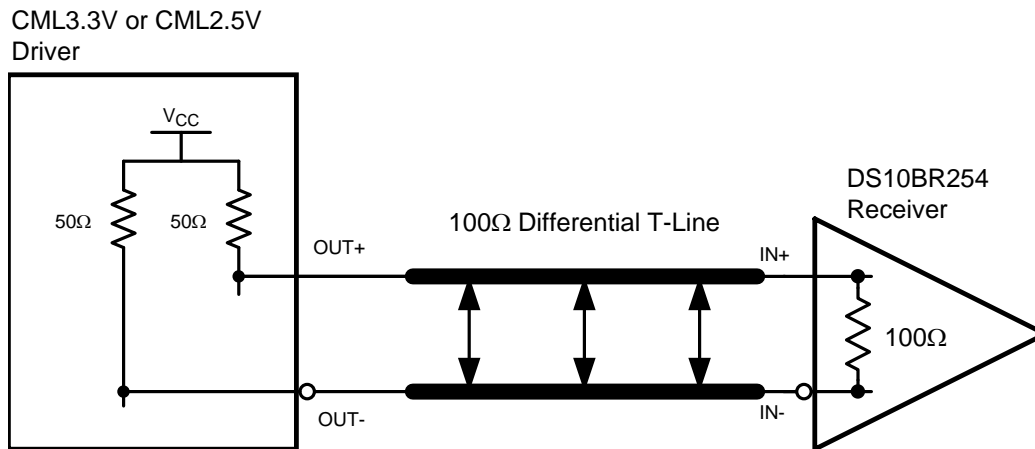


Figure 3. Typical CML Driver DC-Coupled Interface to an DS10BR254 Input

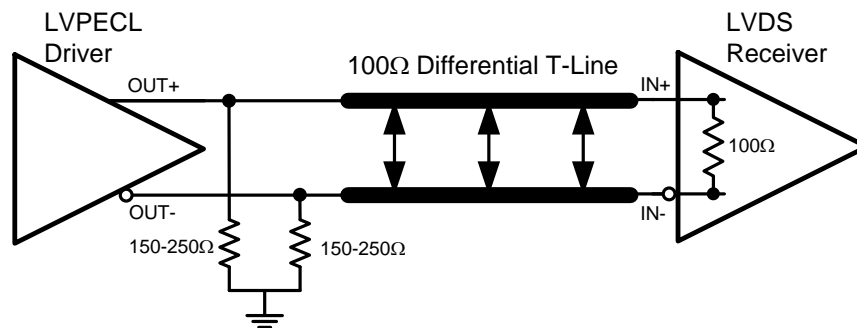


Figure 4. Typical LVPECL Driver DC-Coupled Interface to an DS10BR254 Input

Output Interfacing

The DS10BR254 outputs signals compliant to the LVDS standard. Its outputs 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.

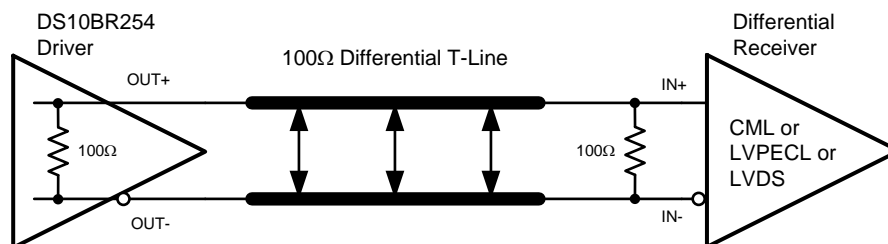


Figure 5. Typical DS10BR254 Output DC-Coupled Interface to an LVDS, CML or LVPECL Receiver

Typical Performance

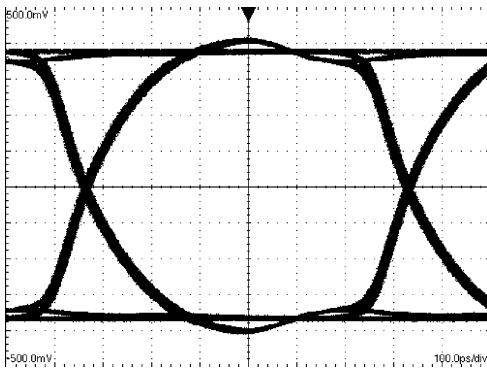


Figure 6. A 1.5 Gbps NRZ PRBS-7 After 2" Differential FR-4 Stripline
V:100 mV / DIV, H:100 ps / DIV

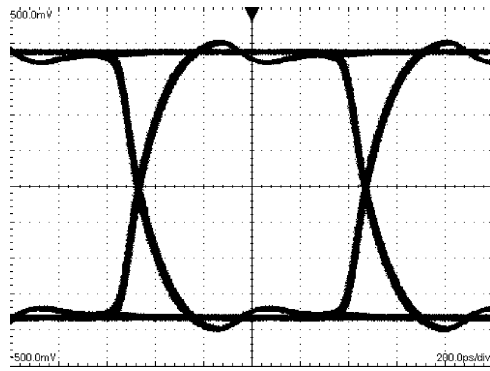


Figure 7. A 1.06 Gbps NRZ PRBS-7 After 2" Differential FR-4 Stripline
V:100 mV / DIV, H:200 ps / DIV

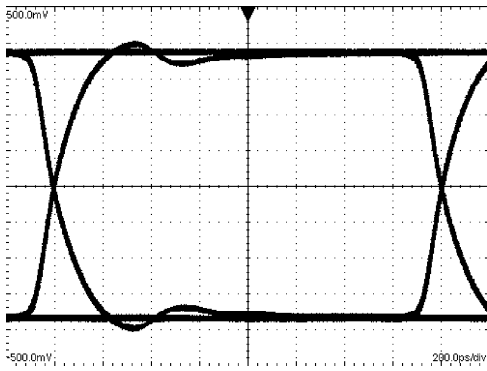


Figure 8. A 622 Mbps NRZ PRBS-7 After 2" Differential FR-4 Stripline
V:100 mV / DIV, H:200 ps / DIV

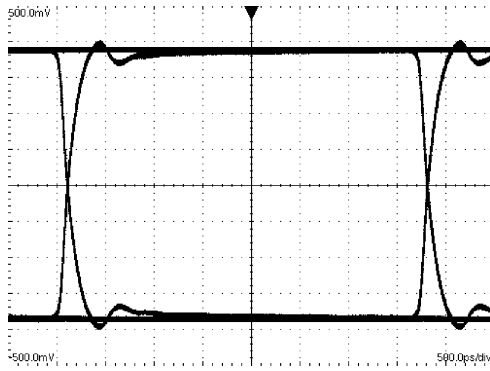


Figure 9. A 270 Mbps NRZ PRBS-7 After 2" Differential FR-4 Stripline
V:100 mV / DIV, H:500 ps / DIV

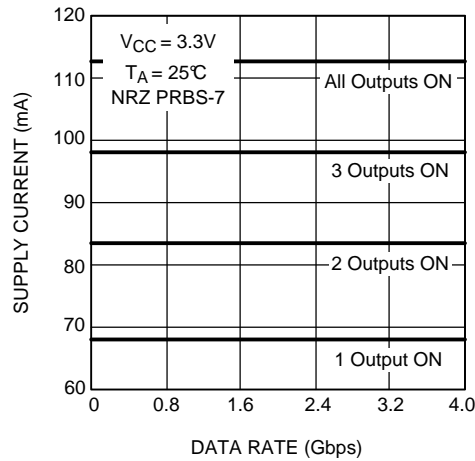


Figure 10. Supply Current as a Function of a Number of Outputs Used

REVISION HISTORY

| Changes from Revision C (April 2013) to Revision D | Page |
|--|--------------------------|
| <hr/> <ul style="list-style-type: none">• Changed layout of National Data Sheet to TI format | <hr/> 10 |

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|--------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| DS10BR254TSQ/NOPB | ACTIVE | WQFN | RTA | 40 | 250 | Green (RoHS & no Sb/Br) | CU SN | Level-3-260C-168 HR | -40 to 85 | 1BR254SQ | Samples |
| DS10BR254TSQX/NOPB | ACTIVE | WQFN | RTA | 40 | 2500 | Green (RoHS & no Sb/Br) | CU SN | Level-3-260C-168 HR | -40 to 85 | 1BR254SQ | 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) 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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish 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 |
|--------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DS10BR254TSQ/NOPB | WQFN | RTA | 40 | 250 | 178.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q1 |
| DS10BR254TSQX/NOPB | WQFN | RTA | 40 | 2500 | 330.0 | 16.4 | 6.3 | 6.3 | 1.5 | 12.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS

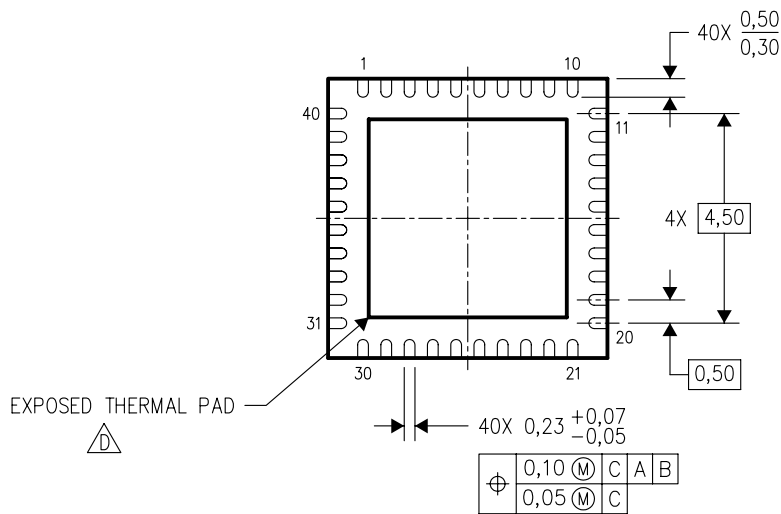
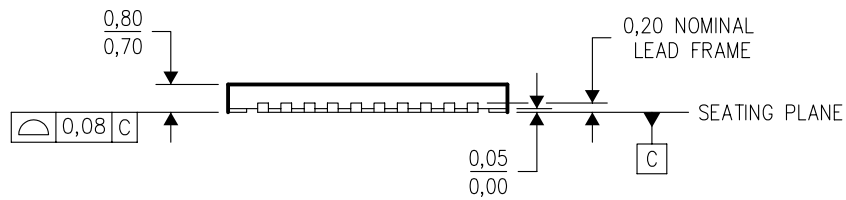
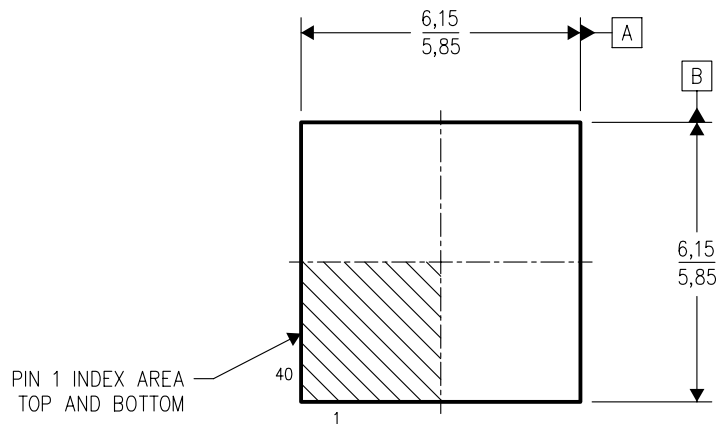


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|--------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DS10BR254TSQ/NOPB | WQFN | RTA | 40 | 250 | 210.0 | 185.0 | 35.0 |
| DS10BR254TSQX/NOPB | WQFN | RTA | 40 | 2500 | 367.0 | 367.0 | 38.0 |

RTA (S-PQFP-N40)

PLASTIC QUAD FLATPACK



4204422/B 11/04

- 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. QFN (Quad Flatpack No-Lead) Package configuration.
 - The package thermal pad must be soldered to the board for thermal and mechanical performance. See the Product Data Sheet for details regarding the exposed thermal pad dimensions.

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