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# DS10BR254

## 1.5 Gbps 1:4 LVDS Repeater

### General 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 (LOS) circuit monitors both input channels and a unique 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 100Ω resistor to lower device return losses, reduce component count and further minimize board space.

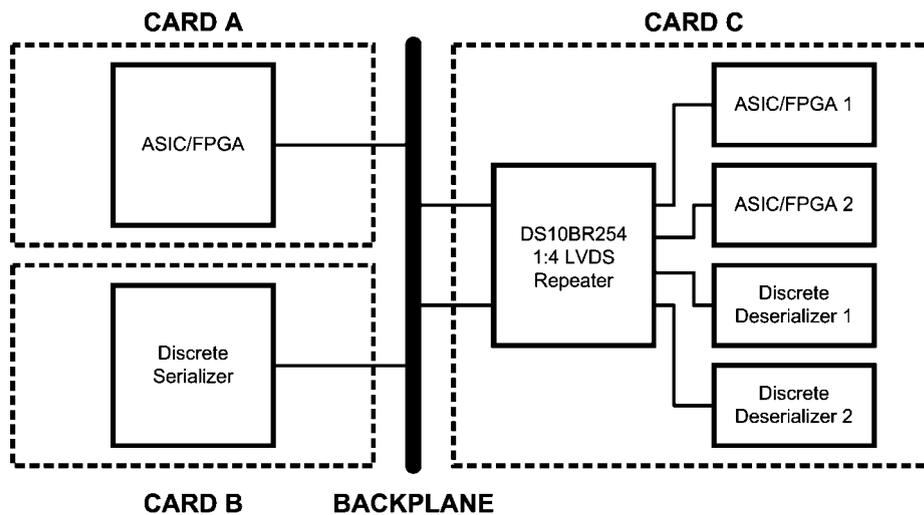
### Features

- 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
- LOS circuitry detects open inputs fault condition
- Integrated 100Ω input and output terminations
- 8 kV ESD on LVDS I/O pins protects adjoining components
- Small 6 mm x 6 mm LLP-40 space saving package

### Applications

- Clock distribution
- Clock and data buffering and muxing
- OC-12 / STM-4
- SD/HD SDI Routers

### Typical Application

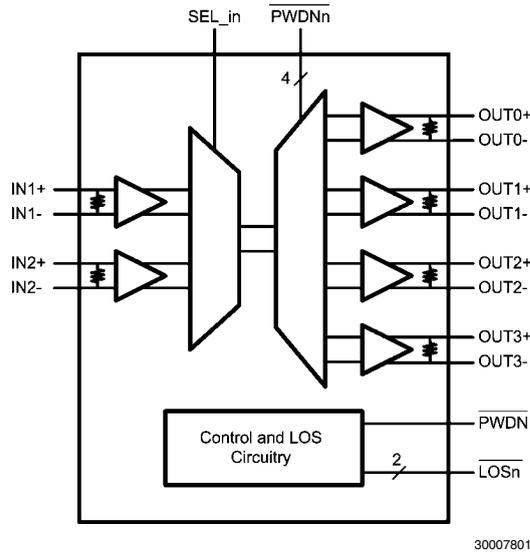


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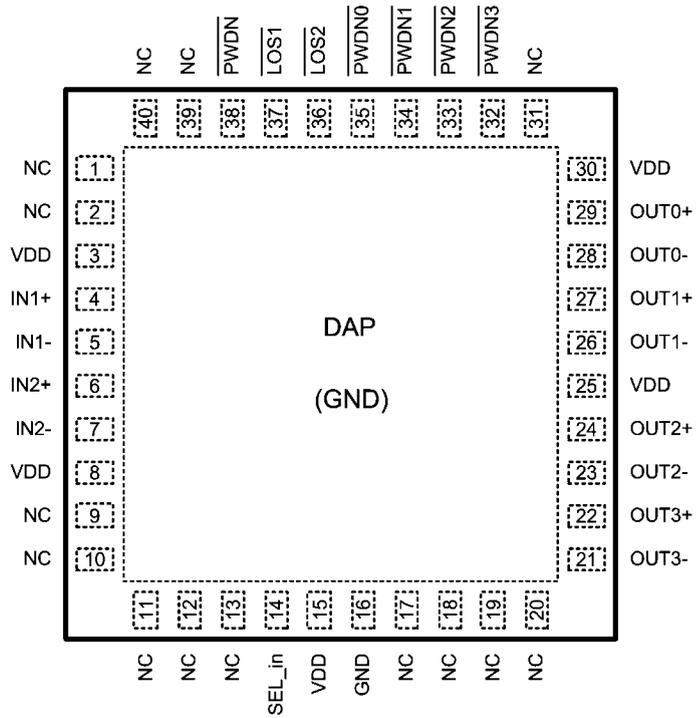
## Ordering Code

NSID	Function
DS10BR254TSQ	1:4 Repeater

## Block Diagram



## Connection Diagram



DS10BR254 Pin Diagram

## 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.
LOS1, LOS2	37, 36	O, LVCMOS	Loss Of Signal output pins, $\overline{LOS}_n$ report when an open input fault condition is detected at the input, INn. These are open drain outputs. External pull up resistors are required.
$\overline{PWDN}_0$ , $\overline{PWDN}_1$ , $\overline{PWDN}_2$ , $\overline{PWDN}_3$	35, 34, 33, 32	I, LVCMOS	Channel output power down pin. When the $\overline{PWDN}_n$ is set to L, the channel output OUTn is in the power down mode.
$\overline{PWDN}$	38	I, LVCMOS	Device power down pin. When the $\overline{PWDN}$ 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.

**Absolute Maximum Ratings** (Note 4)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

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
LVDS Differential Input Voltage	0.0V to +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

$\theta_{JA}$	+26.9°C/W
$\theta_{JC}$	+3.8°C/W

ESD Susceptibility

HBM (Note 1)	≥8 kV
MM (Note 2)	≥250V
CDM (Note 3)	≥1250V

**Note 1:** Human Body Model, applicable std. JESD22-A114C**Note 2:** Machine Model, applicable std. JESD22-A115-A**Note 3:** 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. (Notes 5, 6, 7)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>LVC MOS DC SPECIFICATIONS</b>						
$V_{IH}$	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
<b>LVDS INPUT DC SPECIFICATIONS</b>						
$V_{ID}$	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

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>LVDS OUTPUT DC SPECIFICATIONS</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 (Note 8)	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		$\Omega$
<b>SUPPLY CURRENT</b>						
$I_{CC}$	Supply Current	$\overline{PWDN} = H$		113	135	mA
$I_{CCZ}$	Power Down Supply Current	$\overline{PWDN} = L$		50	60	mA

**Note 4:** "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.

**Note 5:** The Electrical Characteristics tables list guaranteed 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 guaranteed.

**Note 6:** 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  $\Delta V_{OD}$ .

**Note 7:** 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 guaranteed.

**Note 8:** 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	
<b>LVDS OUTPUT AC SPECIFICATIONS</b>							
$t_{PLHD}$	Differential Propagation Delay Low to High (Note 11)	$R_L = 100\Omega$		440	650	ps	
$t_{PHLD}$	Differential Propagation Delay High to Low (Note 11)			400	650	ps	
$t_{SKD1}$	Pulse Skew $ t_{PLHD} - t_{PHLD} $ (Notes 11, 12)			40	100	ps	
$t_{SKD2}$	Channel to Channel Skew (Notes 11, 13)			40	125	ps	
$t_{SKD3}$	Part to Part Skew (Notes 11, 14)			50	200	ps	
$t_{LHT}$	Rise Time (Note 11)	$R_L = 100\Omega$		150	300	ps	
$t_{HLT}$	Fall Time (Note 11)			150	300	ps	
$t_{ON}$	Any $\overline{PWN}$ to Output Active Time			8	20	$\mu s$	
$t_{OFF}$	Any $\overline{PWN}$ to Output Inactive Time			5	12	ns	
$t_{SEL}$	Select Time			5	12	ns	
<b>JITTER PERFORMANCE (Note 11)</b>							
$t_{RJ1}$	Random Jitter (RMS Value) (Note 15)	$V_{ID} = 350\text{ mV}$ $V_{CM} = 1.2\text{V}$ 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) (Note 16)	$V_{ID} = 350\text{ mV}$ $V_{CM} = 1.2\text{V}$ 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 (Note 17)	$V_{ID} = 350\text{ mV}$ $V_{CM} = 1.2\text{V}$ PRBS-23 (NRZ)	270 Mbps		0.01	0.03	$U_{I_{P-P}}$
$t_{TJ2}$			622 Mbps		0.01	0.03	$U_{I_{P-P}}$
$t_{TJ3}$			1.0625 Gbps		0.01	0.04	$U_{I_{P-P}}$
$t_{TJ4}$			1.5 Gbps		0.01	0.06	$U_{I_{P-P}}$

**Note 9:** The Electrical Characteristics tables list guaranteed 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 guaranteed.

**Note 10:** 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 guaranteed.

**Note 11:** Specification is guaranteed by characterization and is not tested in production.

**Note 12:**  $t_{SKD1}$ ,  $|t_{PLHD} - t_{PHLD}|$ , 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.

**Note 13:**  $t_{SKD2}$ , 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).

**Note 14:**  $t_{SKD3}$ , 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  $5^\circ\text{C}$  of each other within the operating temperature range.

**Note 15:** Measured on a clock edge with a histogram and an accumulation of 1500 histogram hits. Input stimulus jitter is subtracted geometrically.

**Note 16:** Tested with a combination of the 110000101 (K28.5+ character) and 0011111010 (K28.5- character) patterns. Input stimulus jitter is subtracted algebraically.

**Note 17:** Measured on an eye diagram with a histogram and an accumulation of 3500 histogram hits. Input stimulus jitter is subtracted.

## DC Test Circuits

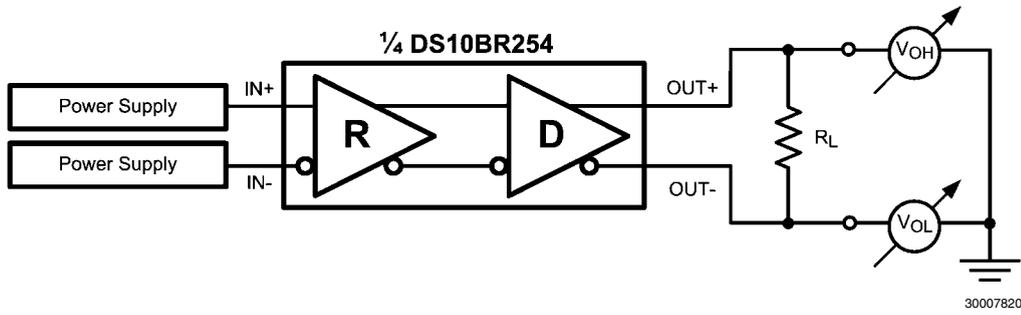


FIGURE 1. Differential Driver DC Test Circuit

## AC Test Circuits and Timing Diagrams

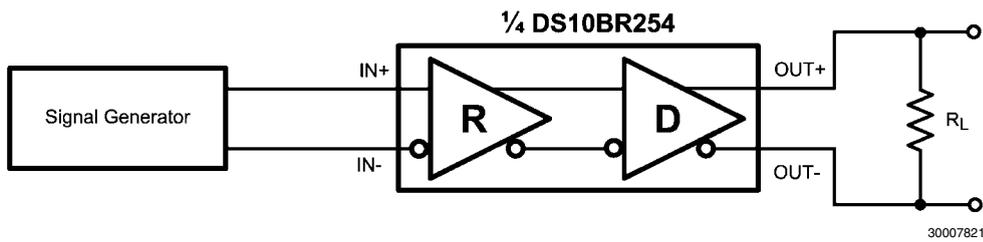


FIGURE 2. Differential Driver AC Test Circuit

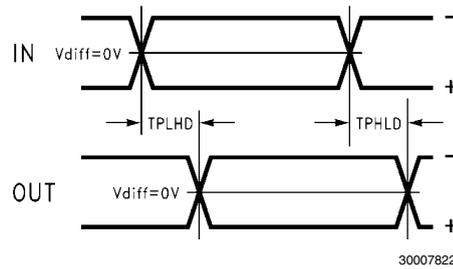


FIGURE 3. Propagation Delay Timing Diagram

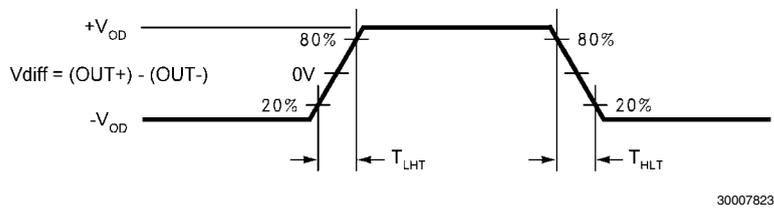


FIGURE 4. LVDS Output Transition Times

## 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.

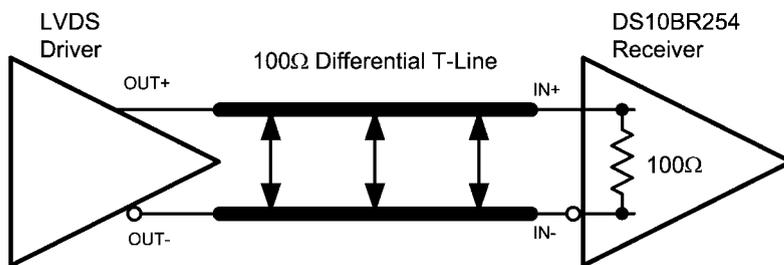
**TABLE 1. Input Select Truth Table**

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

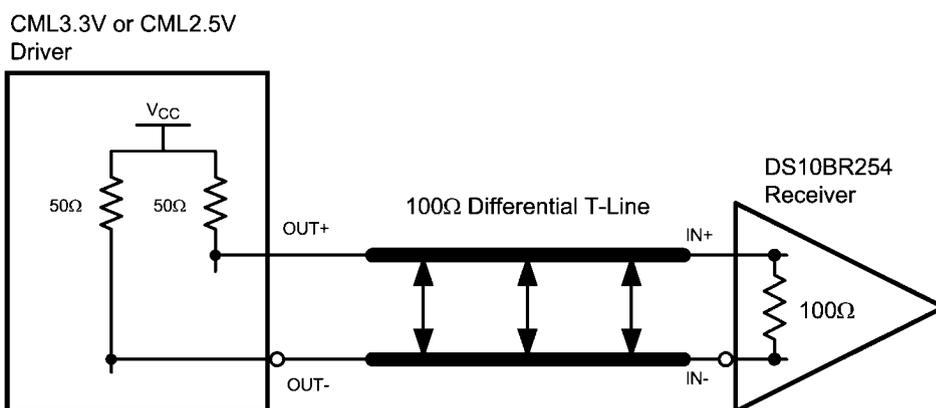
## Input Interfacing

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

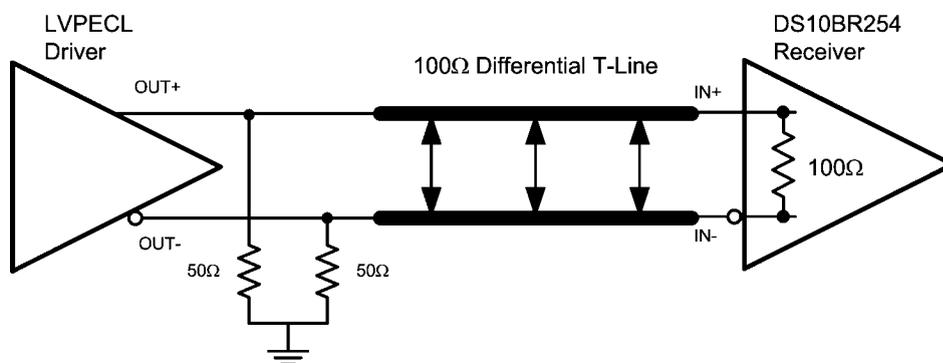
drivers (i.e. LVPECL, LVDS, CML). The following three figures illustrate typical DC-coupled interface to common differential drivers. Note that the DS10BR254 inputs are internally terminated with a 100Ω resistor.



Typical LVDS Driver DC-Coupled Interface to an DS10BR254 Input 30007831



Typical CML Driver DC-Coupled Interface to an DS10BR254 Input 30007832

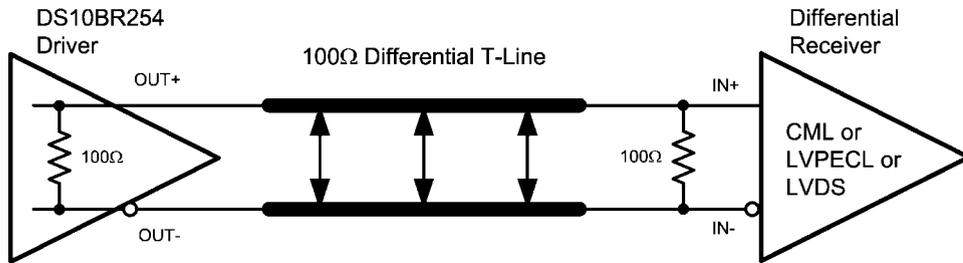


Typical LVPECL Driver DC-Coupled Interface to an DS10BR254 Input 30007833

## Output Interfacing

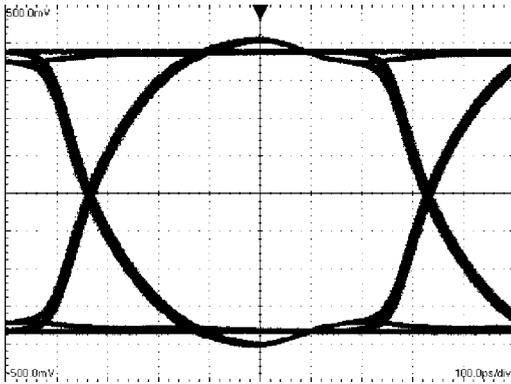
The DS10BR254 outputs signals compliant to the LVDS standard. Its outputs can be DC-coupled to most common differential receivers. The following figure illustrates typical DC-coupled interface to common differential receivers and

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.



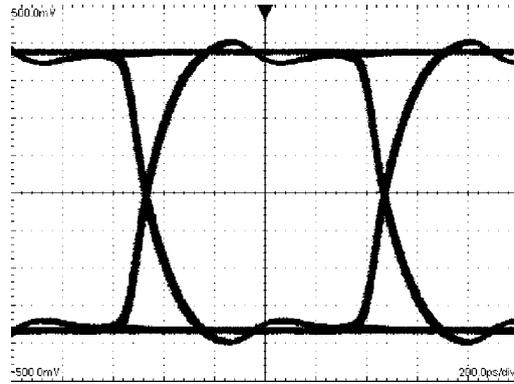
Typical DS10BR254 Output DC-Coupled Interface to an LVDS, CML or LVPECL Receiver 30007834

# Typical Performance



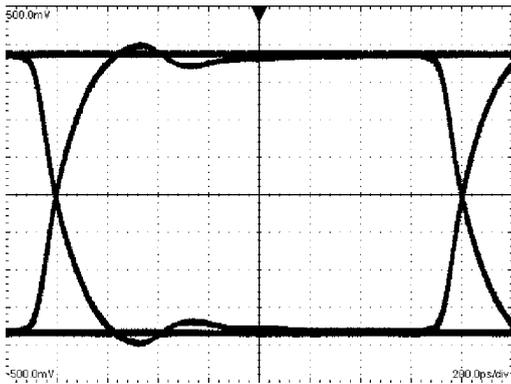
**A 1.5 Gbps NRZ PRBS-7 After 2"  
Differential FR-4 Stripline  
V:100 mV / DIV, H:100 ps / DIV**

30007863



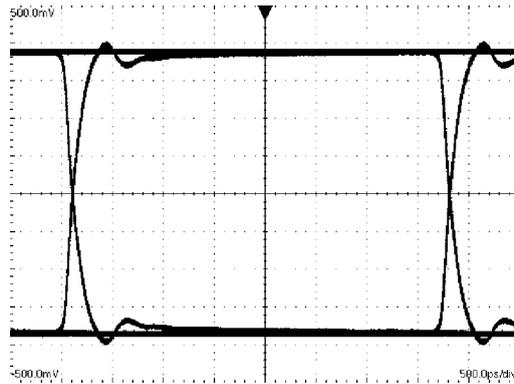
**A 1.06 Gbps NRZ PRBS-7 After 2"  
Differential FR-4 Stripline  
V:100 mV / DIV, H:200 ps / DIV**

30007862



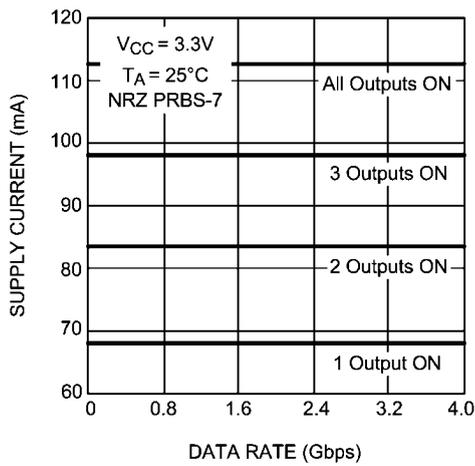
**A 622 Mbps NRZ PRBS-7 After 2"  
Differential FR-4 Stripline  
V:100 mV / DIV, H:200 ps / DIV**

30007861



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

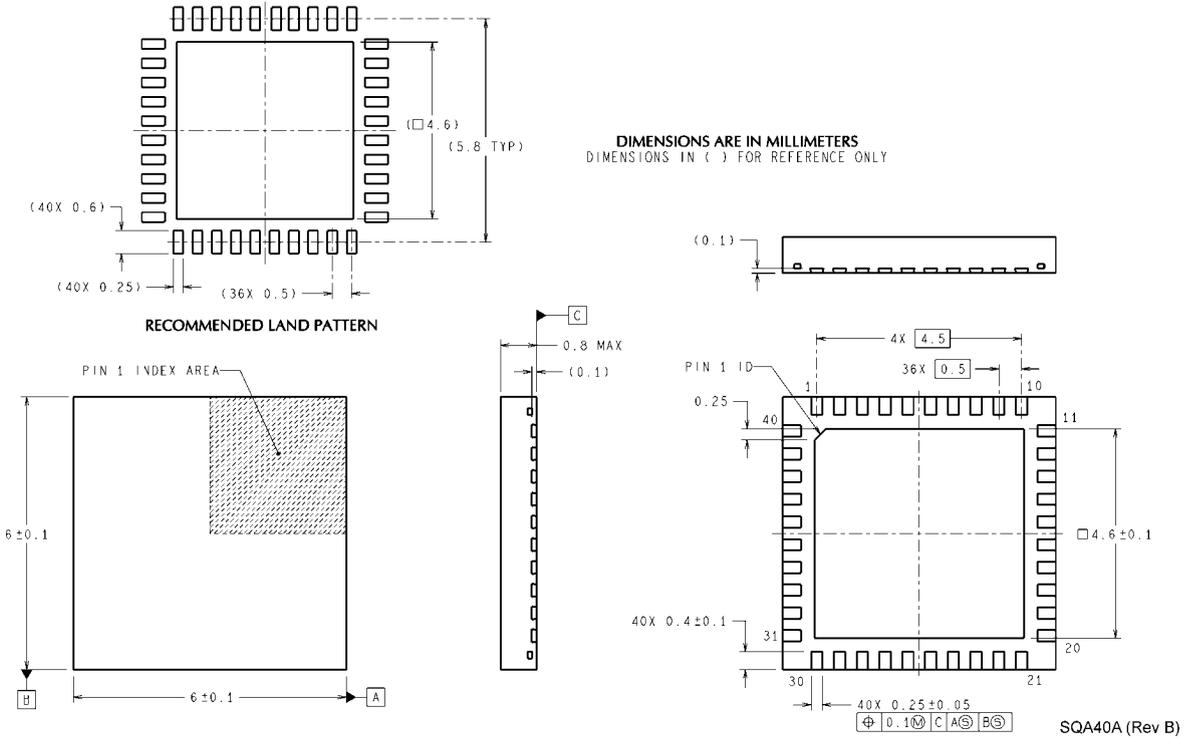
30007860



30007870

**Supply Current as a Function of a Number of Outputs Used**

**Physical Dimensions** inches (millimeters) unless otherwise noted



**Order Number DS10BR254TSQ**  
**NS Package Number SQA40A**  
**(See AN-1187 for PCB Design and Assembly Recommendations)**

# Notes

## Notes

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Ethernet	<a href="http://www.national.com/ethernet">www.national.com/ethernet</a>	Packaging	<a href="http://www.national.com/packaging">www.national.com/packaging</a>
Interface	<a href="http://www.national.com/interface">www.national.com/interface</a>	Quality and Reliability	<a href="http://www.national.com/quality">www.national.com/quality</a>
LVDS	<a href="http://www.national.com/lvds">www.national.com/lvds</a>	Reference Designs	<a href="http://www.national.com/refdesigns">www.national.com/refdesigns</a>
Power Management	<a href="http://www.national.com/power">www.national.com/power</a>	Feedback	<a href="http://www.national.com/feedback">www.national.com/feedback</a>
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Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>		
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