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# DS08MB200

## Dual 800 Mbps 2:1/1:2 LVDS Mux/Buffer

### General Description

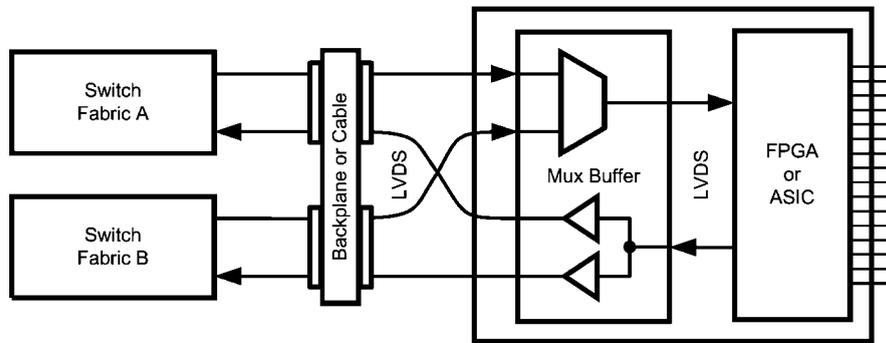
The DS08MB200 is a dual-port 1 to 2 repeater/buffer and 2 to 1 multiplexer. High-speed data paths and flow-through pinout minimize internal device jitter and simplify board layout. The differential inputs and outputs interface to LVDS or Bus LVDS signals such as those on National's 10-, 16-, and 18-bit Bus LVDS SerDes, or to CML or LVPECL signals.

The 3.3V supply, CMOS process, and robust I/O ensure high performance at low power over the entire industrial -40 to +85°C temperature range.

### Features

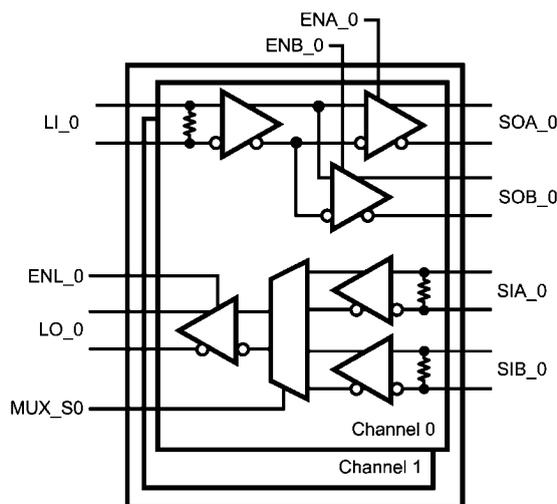
- Up to 800 Mbps data rate per channel
- LVDS/BLVDS/CML/LVPECL compatible inputs, LVDS compatible outputs
- Low output skew and jitter
- On-chip 100Ω input termination
- 15 kV ESD protection on LVDS Inputs/Outputs
- Hot plug Protection
- Single 3.3V supply
- Industrial -40 to +85°C temperature range
- 48-pin LLP Package

### Typical Application



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### Block Diagram



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FIGURE 1. DS08MB200 Block Diagram

## Pin Descriptions

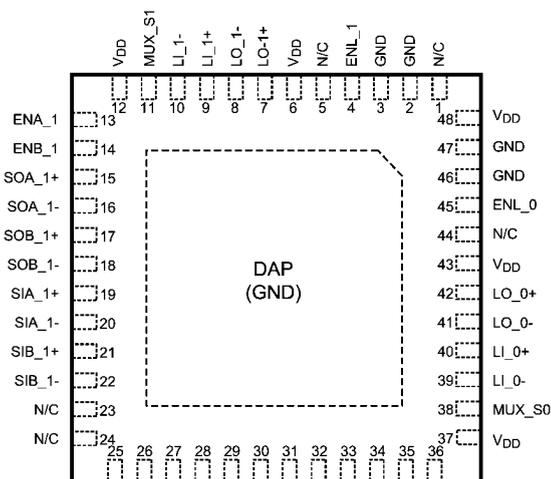
Pin Name	LLP Pin Number	I/O, Type	Description
<b>SWITCH SIDE DIFFERENTIAL INPUTS</b>			
SIA_0+	30	I, LVDS	Switch A-side Channel 0 inverting and non-inverting differential inputs. LVDS, Bus LVDS, CML, or LVPECL compatible.
SIA_0-	29		
SIA_1+	19	I, LVDS	Switch A-side Channel 1 inverting and non-inverting differential inputs. LVDS, Bus LVDS, CML, or LVPECL compatible.
SIA_1-	20		
SIB_0+	28	I, LVDS	Switch B-side Channel 0 inverting and non-inverting differential inputs. LVDS, Bus LVDS, CML, or LVPECL compatible.
SIB_0-	27		
SIB_1+	21	I, LVDS	Switch B-side Channel 1 inverting and non-inverting differential inputs. LVDS, Bus LVDS, CML, or LVPECL compatible.
SIB_1-	22		
<b>LINE SIDE DIFFERENTIAL INPUTS</b>			
LI_0+	40	I, LVDS	Line-side Channel 0 inverting and non-inverting differential inputs. LVDS, Bus LVDS, CML, or LVPECL compatible.
LI_0-	39		
LI_1+	9	I, LVDS	Line-side Channel 1 inverting and non-inverting differential inputs. LVDS, Bus LVDS, CML, or LVPECL compatible.
LI_1-	10		
<b>SWITCH SIDE DIFFERENTIAL OUTPUTS</b>			
SOA_0+	34	O, LVDS	Switch A-side Channel 0 inverting and non-inverting differential outputs. LVDS compatible (Notes 1, 3).
SOA_0-	33		
SOA_1+	15	O, LVDS	Switch A-side Channel 1 inverting and non-inverting differential outputs. LVDS compatible (Notes 1, 3).
SOA_1-	16		
SOB_0+	32	O, LVDS	Switch B-side Channel 0 inverting and non-inverting differential outputs. LVDS compatible (Notes 1, 3).
SOB_0-	31		
SOB_1+	17	O, LVDS	Switch B-side Channel 1 inverting and non-inverting differential outputs. LVDS compatible (Notes 1, 3).
SOB_1-	18		
<b>LINE SIDE DIFFERENTIAL OUTPUTS</b>			
LO_0+	42	O, LVDS	Line-side Channel 0 inverting and non-inverting differential outputs. LVDS compatible (Notes 1, 3).
LO_0-	41		
LO_1+	7	O, LVDS	Line-side Channel 1 inverting and non-inverting differential outputs. LVDS compatible (Notes 1, 3).
LO_1-	8		
<b>DIGITAL CONTROL INTERFACE</b>			
MUX_S0	38	I, LVTTTL	Mux Select Control Inputs (per channel) to select which Switch-side input, A or B, is passed through to the Line-side.
MUX_S1	11		
ENA_0	36	I, LVTTTL	Output Enable Control for Switch A-side and B-side outputs. Each output driver on the A-side and B-side has a separate enable pin.
ENA_1	13		
ENB_0	35		
ENB_1	14		
ENL_0	45	I, LVTTTL	Output Enable Control for The Line-side outputs. Each output driver on the Line-side has a separate enable pin.
ENL_1	4		
<b>POWER</b>			
V <sub>DD</sub>	6, 12, 37, 43, 48	I, Power	V <sub>DD</sub> = 3.3V ±0.3V.
GND	2, 3, 46, 47 (Note 2)	I, Power	Ground reference for LVDS and CMOS circuitry. For the LLP package, the DAP is used as the primary GND connection to the device. The DAP is the exposed metal contact at the bottom of the LLP-48 package. It should be connected to the ground plane with at least 4 vias for optimal AC and thermal performance.
N/C	1, 5, 23, 24, 25, 26, 44		No Connect

**Note 1:** For interfacing LVDS outputs to CML or LVPECL compatible inputs, refer to the applications section of this datasheet.

**Note 2:** Note that the DAP on the backside of the LLP package is the primary GND connection for the device when using the LLP package.

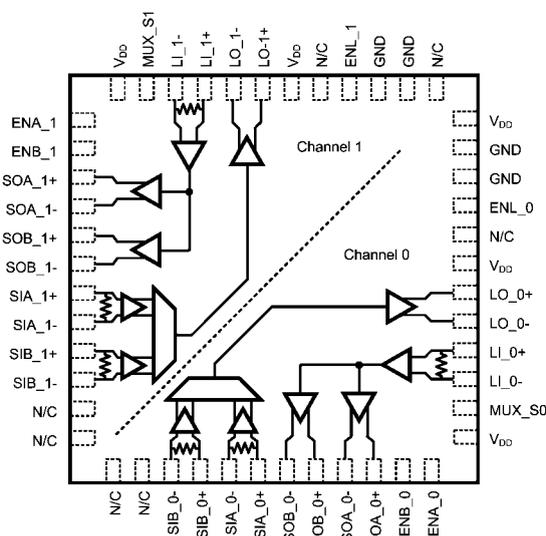
**Note 3:** The LVDS outputs do not support a multidrop (BLVDS) environment. The LVDS output characteristics of the DS08MB200 device have been optimized for point-to-point backplane and cable applications.

## Connection Diagrams



Top View  
DAP = GND

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Directional Signal Paths Top View  
(Refer to pin names for signal polarity)

20157403

## TRI-STATE and Powerdown Modes

The DS08MB200 has output enable control on each of the six onboard LVDS output drivers. This control allows each output individually to be placed in a low power TRI-STATE mode while the device remains active, and is useful to reduce power consumption on unused channels. In TRI-STATE mode, some outputs may remain active while some are in TRI-STATE.

When all six of the output enables (all drivers on both channels) are deasserted (LOW), then the device enters a Powerdown mode that consumes only 0.5mA (typical) of supply current. In this mode, the entire device is essentially powered off, including all receiver inputs, output drivers and internal bandgap reference generators. When returning to active mode from Powerdown mode, there is a delay until valid data is presented at the outputs because of the ramp to power up the internal bandgap reference generators.

Any single output enable that remains active will hold the device in active mode even if the other five outputs are in TRI-STATE.

When in Powerdown mode, any output enable that becomes active will wake up the device back into active mode, even if the other five outputs are in TRI-STATE.

## Input Failsafe Biasing

External pull up and pull down resistors may be used to provide enough of an offset to enable an input failsafe under open-circuit conditions. This configuration ties the positive LVDS input pin to VDD thru a pull up resistor and the negative LVDS input pin is tied to GND by a pull down resistor. The pull up and pull down resistors should be in the 5kΩ to 15kΩ range to minimize loading and waveform distortion to the driver. Please refer to application note AN-1194, "Failsafe Biasing of LVDS Interfaces" for more information.

## Output Characteristics

The output characteristics of the DS08MB200 have been optimized for point-to-point backplane and cable applications, and are not intended for multipoint or multidrop signaling.

## Multiplexer Truth Table (Note 4)

Data Inputs		Control Inputs		Output
SIA_0	SIB_0	MUX_S0	ENL_0	LO_0
X	valid	0	1	SIB_0
valid	X	1	1	SIA_0
X	X	X	0 (Note 5)	Z

X = Don't Care

Z = High Impedance (TRI-STATE)

## Repeater/Buffer Truth Table (Note 4)

Data Input	Control Inputs		Outputs	
LI_0	ENA_0	ENB_0	SOA_0	SOB_0
X	0	0	Z (Note 5)	Z (Note 5)
valid	0	1	Z	LI_0
valid	1	0	LI_0	Z
valid	1	1	LI_0	LI_0

X = Don't Care

Z = High Impedance (TRI-STATE)

**Note 4:** Same functionality for channel 1

**Note 5:** When all enable inputs from both channels are Low, the device enters a powerdown mode. Refer to the applications section titled TRI-STATE and Powerdown modes.

**Absolute Maximum Ratings** (Note 6)

Supply Voltage ( $V_{DD}$ )	-0.3V to +4.0V
CMOS Input Voltage	-0.3V to ( $V_{DD}+0.3V$ )
LVDS Receiver Input Voltage (Note 7)	-0.3V to ( $V_{DD}+0.3V$ )
LVDS Driver Output Voltage	-0.3V to ( $V_{DD}+0.3V$ )
LVDS Output Short Circuit Current	+40 mA
Junction Temperature	+150°C
Storage Temperature	-65°C to +150°C
Lead Temperature (Solder, 4sec)	260°C
Max Pkg Power Capacity @ 25°C	5.2W
Thermal Resistance ( $\theta_{JA}$ )	24°C/W
Package Derating above +25°C	41.7mW/°C
ESD Last Passing Voltage	
HBM, 1.5k $\Omega$ , 100pF	8kV
LVDS pins to GND only	15kV

EIAJ, 0 $\Omega$ , 200pF  
CDM250V  
1000V**Recommended Operating Conditions**

Supply Voltage ( $V_{CC}$ )	3.0V to 3.6V
Input Voltage ( $V_I$ ) (Note 7)	0V to $V_{CC}$
Output Voltage ( $V_O$ )	0V to $V_{CC}$
Operating Temperature ( $T_A$ )	
Industrial	-40°C to +85°C

**Note 6:** Absolute maximum ratings are those values beyond which damage to the device may occur. The databook specifications should be met, without exception, to ensure that the system design is reliable over its power supply, temperature, and output/input loading variables. National does not recommend operation of products outside of recommended operation conditions.

**Note 7:**  $V_{ID}$  max < 2.4V**Electrical Characteristics**

Over recommended operating supply and temperature ranges unless other specified.

Symbol	Parameter	Conditions	Min	Typ (Note 8)	Max	Units
<b>LVTTL DC SPECIFICATIONS</b> (MUX_Sn, ENA_n, ENB_n, ENL_n)						
$V_{IH}$	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	$V_{IN} = V_{DD} = V_{DDMAX}$	-10		+10	$\mu$ A
$I_{IL}$	Low Level Input Current	$V_{IN} = V_{SS}, V_{DD} = V_{DDMAX}$	-10		+10	$\mu$ A
$C_{IN1}$	Input Capacitance	Any Digital Input Pin to $V_{SS}$		3.5		pF
$C_{OUT1}$	Output Capacitance	Any Digital Output Pin to $V_{SS}$		5.5		pF
$V_{CL}$	Input Clamp Voltage	$I_{CL} = -18$ mA	-1.5	-0.8		V
<b>LVDS INPUT DC SPECIFICATIONS</b> (SIA $\pm$ , SIB $\pm$ , LI $\pm$ )						
$V_{TH}$	Differential Input High Threshold (Note 9)	$V_{CM} = 0.8V$ or 1.2V or 3.55V, $V_{DD} = 3.6V$		0	100	mV
$V_{TL}$	Differential Input Low Threshold (Note 9)	$V_{CM} = 0.8V$ or 1.2V or 3.55V, $V_{DD} = 3.6V$	-100	0		mV
$V_{ID}$	Differential Input Voltage	$V_{CM} = 0.8V$ to 3.55V, $V_{DD} = 3.6V$	100		2400	mV
$V_{CMR}$	Common Mode Voltage Range	$V_{ID} = 150$ mV, $V_{DD} = 3.6V$	0.05		3.55	V
$C_{IN2}$	Input Capacitance	IN+ or IN- to $V_{SS}$		3.5		pF
$I_{IN}$	Input Current	$V_{IN} = 3.6V, V_{DD} = V_{DDMAX}$	-15		+15	$\mu$ A
		$V_{IN} = 0V, V_{DD} = V_{DDMAX}$	-15		+15	$\mu$ A
<b>LVDS OUTPUT DC SPECIFICATIONS</b> (SOA_n $\pm$ , SOB_n $\pm$ , LO_n $\pm$ )						
$V_{OD}$	Differential Output Voltage, (Note 9)	$R_L$ is the internal 100 $\Omega$ between OUT+ and OUT-	250	360	500	mV
$\Delta V_{OD}$	Change in $V_{OD}$ between Complementary States		-35		35	mV
$V_{OS}$	Offset Voltage (Note 10)		1.05	1.22	1.475	V
$\Delta V_{OS}$	Change in $V_{OS}$ between Complementary States		-35		35	mV
$I_{OS}$	Output Short Circuit Current	OUT+ or OUT- Short to GND		-21	-40	mA
$C_{OUT2}$	Output Capacitance	OUT+ or OUT- to GND when TRI-STATE		5.5		pF

Symbol	Parameter	Conditions	Min	Typ (Note 8)	Max	Units
<b>SUPPLY CURRENT (Static)</b>						
$I_{CC}$	Supply Current	All inputs and outputs enabled and active, terminated with differential load of $100\Omega$ between OUT+ and OUT-.		225	275	mA
$I_{CCZ}$	Supply Current - Powerdown Mode	ENA_0 = ENB_0 = ENL_0 = ENA_1 = ENB_1 = ENL_1 = L		0.6	4.0	mA
<b>SWITCHING CHARACTERISTICS—LVDS OUTPUTS</b>						
$t_{LHT}$	Differential Low to High Transition Time	Use an alternating 1 and 0 pattern at 200 Mb/s, measure between 20% and 80% of $V_{OD}$ . (Note 15)		170	250	ps
$t_{HLT}$	Differential High to Low Transition Time			170	250	ps
$t_{PLHD}$	Differential Low to High Propagation Delay	Use an alternating 1 and 0 pattern at 200 Mb/s, measure at 50% $V_{OD}$ between input to output.		1.0	2.5	ns
$t_{PHLD}$	Differential High to Low Propagation Delay			1.0	2.5	ns
$t_{SKD1}$	Pulse Skew	$ t_{PLHD} - t_{PHLD} $ (Note 15)		25	75	ps
$t_{SKCC}$	Output Channel to Channel Skew	Difference in propagation delay ( $t_{PLHD}$ or $t_{PHLD}$ ) among all output channels. (Note 15)		50	115	ps
$t_{JIT}$	Jitter (Note 11)	RJ - Alternating 1 and 0 at 400 MHz (Note 12)		1.3	1.5	psrms
		DJ - K28.5 Pattern, 800 Mbps (Note 13)		15	34	psp-p
		TJ - PRBS 27-1 Pattern, 800 Mbps (Note 14)		16	34	psp-p
$t_{ON}$	LVDS Output Enable Time	Time from ENA_n, ENB_n, or ENL_n to OUT± change from TRI-STATE to active.		0.5	1.5	μs
$t_{ON2}$	LVDS Output Enable time from powerdown mode	Time from ENA_n, ENB_n, or ENL_n to OUT± change from Powerdown to active		10	20	μs
$t_{OFF}$	LVDS Output Disable Time	Time from ENA_n, ENB_n, or ENL_n to OUT± change from active to TRI-STATE or powerdown.			12	ns

**Note 8:** Typical parameters are measured at  $V_{DD} = 3.3V$ ,  $T_A = 25^\circ C$ . They are for reference purposes, and are not production-tested.

**Note 9:** Differential output voltage  $V_{OD}$  is defined as  $ABS(OUT+ - OUT-)$ . Differential input voltage  $V_{ID}$  is defined as  $ABS(IN+ - IN-)$ .

**Note 10:** Output offset voltage  $V_{OS}$  is defined as the average of the LVDS single-ended output voltages at logic high and logic low states.

**Note 11:** Jitter is not production tested, but guaranteed through characterization on a sample basis.

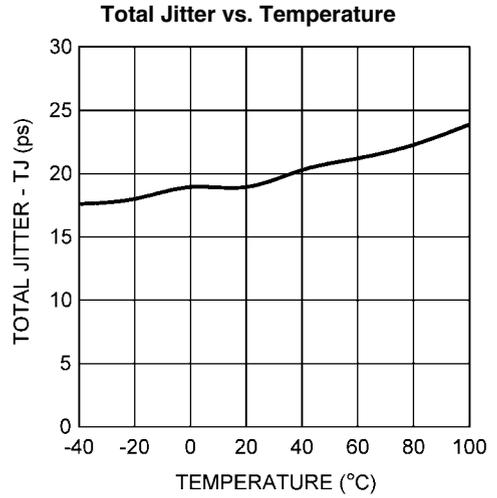
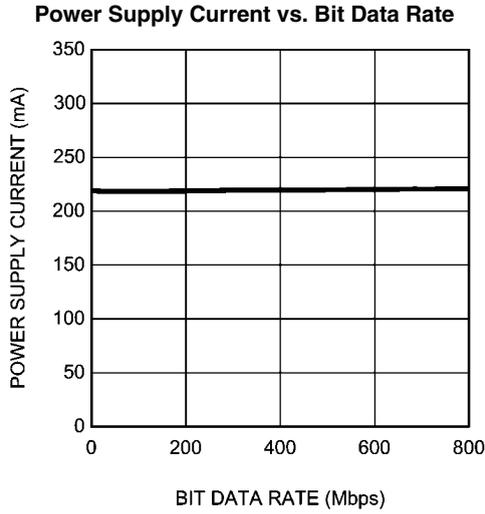
**Note 12:** Random Jitter, or RJ, is measured RMS with a histogram including 1500 histogram window hits. The input voltage =  $V_{ID} = 500mV$ , 50% duty cycle at 400 MHz,  $t_r = t_f = 50ps$  (20% to 80%).

**Note 13:** Deterministic Jitter, or DJ, is measured to a histogram mean with a sample size of 350 hits. Stimulus and fixture jitter has been subtracted. The input voltage =  $V_{ID} = 500mV$ , K28.5 pattern at 800 Mbps,  $t_r = t_f = 50ps$  (20% to 80%). The K28.5 pattern is repeating bit streams of (0011111010 110000101).

**Note 14:** Total Jitter, or TJ, is measured peak to peak with a histogram including 3500 window hits. Stimulus and fixture jitter has been subtracted. The input voltage =  $V_{ID} = 500mV$ , 27-1 PRBS pattern at 800 Mbps,  $t_r = t_f = 50ps$  (20% to 80%).

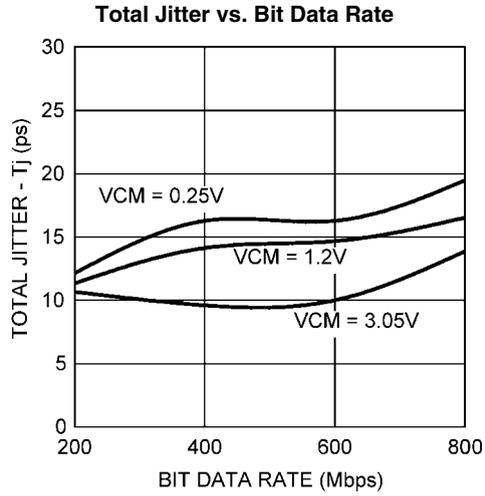
**Note 15:** Not production tested. Guaranteed by statistical analysis on a sample basis at the time of characterization.

## Typical Performance Characteristics



20157412  
 Dynamic power supply current was measured with all channels active and toggling at the bit data rate. Data pattern has no effect on the power consumption.  $V_{DD} = 3.3V$ ,  $T_A = +25^\circ C$ ,  $V_{ID} = 0.5V$ ,  $V_{CM} = 1.2V$ .

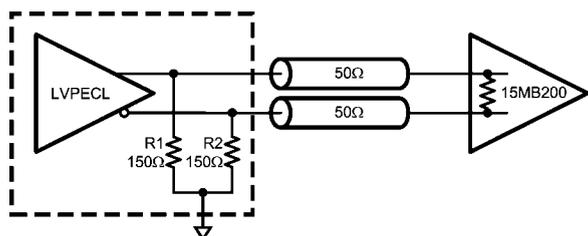
20157410  
 Total Jitter measured at 0V differential while running a PRBS 27-1 pattern with one channel active, all other channels are disabled.  $V_{DD} = 3.3V$ ,  $V_{ID} = 0.5V$ ,  $V_{CM} = 1.2V$ , 800 Mbps data rate. Stimulus and fixture jitter has been subtracted.



20157411  
 Total Jitter measured at 0V differential while running a PRBS 27-1 pattern with one channel active, all other channels are disabled.  $V_{DD} = 3.3V$ ,  $T_A = +25^\circ C$ ,  $V_{ID} = 0.5V$ . Stimulus and fixture jitter has been subtracted.

## Interfacing LVPECL to LVDS

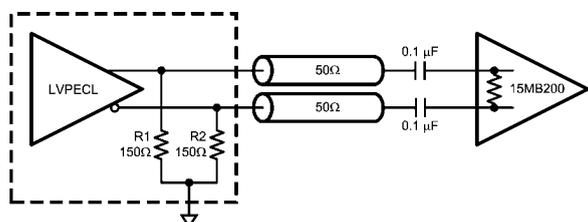
An LVPECL driver consists of a differential pair with coupled emitters connected to GND via a current source. This drives a pair of emitter-followers that require a 50 ohm to  $V_{CC}-2.0$  load. A modern LVPECL driver will typically include the termination scheme within the device for the emitter follower. If the driver does not include the load, then an external scheme must be used. The 1.3 V supply is usually not readily available on a PCB, therefore, a load scheme without a unique power supply requirement may be used.



20157461

FIGURE 2. DC Coupled LVPECL to LVDS Interface

Figure 2 is a separated  $\pi$  termination scheme for a 3.3 V LVPECL driver. R1 and R2 provides proper DC load for the driver emitter followers, and may be included as part of the driver device (Note 16). The DS08MB200 includes a 100 ohm input termination for the transmission line. The common mode voltage will be at the normal LVPECL levels – around 2 V. This scheme works well with LVDS receivers that have rail-to-rail common mode voltage,  $V_{CM}$ , range. Most National Semiconductor LVDS receivers have wide  $V_{CM}$  range. The exceptions are noted in devices' respective datasheets. Those LVDS devices that do have a wide  $V_{CM}$  range do not vary in performance significantly when receiving a signal with a common mode other than standard LVDS  $V_{CM}$  of 1.2 V.



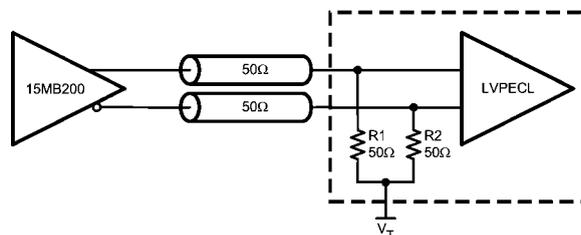
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FIGURE 3. AC Coupled LVPECL to LVDS Interface

An AC coupled interface is preferred when transmitter and receiver ground references differ more than 1 V. This is a likely scenario when transmitter and receiver devices are on separate PCBs. Figure 3 illustrates an AC coupled interface between a LVPECL driver and LVDS receiver. R1 and R2, if not present in the driver device (Note 16), provide DC load for the emitter followers and may range between 140-220 ohms for most LVPECL devices for this particular configuration. The DS08MB200 includes an internal 100 ohm resistor to terminate the transmission line for minimal reflections. The signal after ac coupling capacitors will swing around a level set by internal biasing resistors (i.e. fail-safe) which is either  $V_{DD}/2$  or 0 V depending on the actual failsafe implementation. If internal biasing is not implemented, the signal common mode voltage will slowly wander to GND level.

## Interfacing LVDS to LVPECL

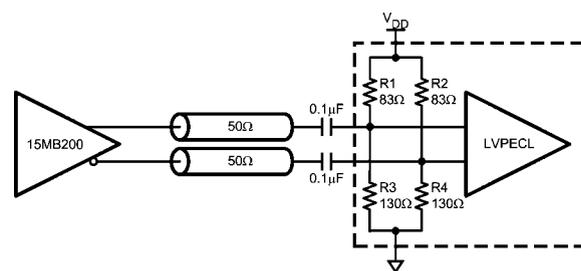
An LVDS driver consists of a current source (nominal 3.5mA) which drives a CMOS differential pair. It needs a differential resistive load in the range of 70 to 130 ohms to generate LVDS levels. In a system, the load should be selected to match transmission line characteristic differential impedance so that the line is properly terminated. The termination resistor should be placed as close to the receiver inputs as possible. When interfacing an LVDS driver with a non-LVDS receiver, one only needs to bias the LVDS signal so that it is within the common mode range of the receiver. This may be done by using separate biasing voltage which demands another power supply. Some receivers have required biasing voltage available on-chip ( $V_T$ ,  $V_{TT}$  or  $V_{BB}$ ).



20157463

FIGURE 4. DC Coupled LVDS to LVPECL Interface

Figure 4 illustrates interface between an LVDS driver and a LVPECL with a  $V_T$  pin available. R1 and R2, if not present in the receiver (Note 16), provide proper resistive load for the driver and termination for the transmission line, and  $V_T$  sets desired bias for the receiver.



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FIGURE 5. AC Coupled LVDS to LVPECL Interface

Figure 5 illustrates AC coupled interface between an LVDS driver and LVPECL receiver without a  $V_T$  pin available. The resistors R1, R2, R3, and R4, if not present in the receiver (Note 16), provide a load for the driver, terminate the transmission line, and bias the signal for the receiver.

**Note 16:** The bias networks shown above for LVPECL drivers and receivers may or may not be present within the driver device. The LVPECL driver and receiver specification must be reviewed closely to ensure compatibility between the driver and receiver terminations and common mode operating ranges.



# Notes

## Notes

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Data Converters	<a href="http://www.national.com/adc">www.national.com/adc</a>	Distributors	<a href="http://www.national.com/contacts">www.national.com/contacts</a>
Displays	<a href="http://www.national.com/displays">www.national.com/displays</a>	Green Compliance	<a href="http://www.national.com/quality/green">www.national.com/quality/green</a>
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>
Switching Regulators	<a href="http://www.national.com/switchers">www.national.com/switchers</a>		
LDOs	<a href="http://www.national.com/ldo">www.national.com/ldo</a>		
LED Lighting	<a href="http://www.national.com/led">www.national.com/led</a>		
PowerWise	<a href="http://www.national.com/powerwise">www.national.com/powerwise</a>		
Serial Digital Interface (SDI)	<a href="http://www.national.com/sdi">www.national.com/sdi</a>		
Temperature Sensors	<a href="http://www.national.com/tempsensors">www.national.com/tempsensors</a>		
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