

## Introduction

The introduction of the Stratix™ GX device family enables a new level of integration by combining 3.125-gigabits per second (Gbps) transceivers with a high-performance FPGA core. The Stratix GX family is the industry's most capable FPGA/transceiver combination. However, to properly interface with existing systems that use Mercury™ devices, Stratix GX devices must be able to interoperate with Mercury devices.

This application note describes the recommended approach to connect Mercury devices to Stratix GX devices. The Mercury device's transceivers support the LVDS and LVPECL I/O standards, while the Stratix GX transceivers support the 1.5-V PCML standard, resulting in a different common-mode voltage ( $V_{CM}$ ). Mercury LVDS has a recommended 2.1 V  $V_{CM}$  and the Stratix GX device has 1.1 V. However, the two devices can effectively interconnect via AC coupling. AC coupling of the transmission line removes the DC offset.



Recommendations within this application note do not differ in any way from the original Mercury LVDS board design recommendations. As a result, any existing Mercury LVDS board can maintain its current configuration while interoperating with new Stratix GX designs.

## Considerations for Connecting the Devices

Mercury clock data recovery (CDR) supports LVDS and LVPECL. The techniques for using these I/O standards have not changed since the release of Mercury devices. Stratix GX gigabit transceiver blocks support 1.5-V PCML, which may have a different  $V_{CM}$  than the Mercury I/O standards. These two devices can still interconnect when:

- They have the same  $V_{CM}$ .
- They are AC coupled. Mercury devices require an external bias.



Mercury driving LVPECL signals can go beyond the maximum limits for Stratix GX devices. Contact Altera® for recommendations.

Table 1 shows the minimum and maximum ratings on the transceivers and the recommended  $V_{CM}$ . Stratix GX devices have a programmable output differential ( $V_{OD}$ ) level, so the higher maximum output level is not an issue. It is important to always make sure that voltage margins are met, since Mercury devices have a larger minimum requirement for input.

<b>Table 1. Minimum &amp; Maximum Input &amp; Output Signal Capability</b>				
<b>Differential Voltage</b>	<b>Mercury</b>		<b>Stratix GX</b>	<b>Unit</b>
	<b>LVPECL</b>	<b>LVDS</b>	<b>1.5-V PCML</b>	
$V_{ID}$ (maximum)	2400	2400	2000	mV
$V_{OD}$ (maximum)	2400 <sup>(2)</sup>	600	1600	mV
$V_{ID}$ (minimum)	400	200	170	mV
$V_{CM}$ (input) typical	2.1	1.2 <sup>(1)</sup>	1.1	V
$V_{OS}$ (output) typical	2.1	1.25	0.75	V

**Notes for Table 1:**

- (1) AC coupled  $V_{CM}$  recommendations.
- (2) Mercury LVPECL output beyond Stratix GX input capability.

### Programmable $V_{OD}$ & Pre-Emphasis

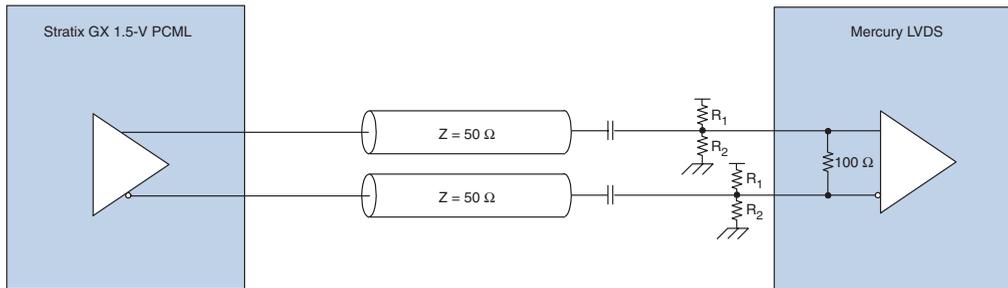
Stratix GX devices have programmable  $V_{OD}$  and pre-emphasis. You can use pre-emphasis to reduce high-frequency losses, allowing you to drive a long transmission line. The programmed output current driver level controls  $V_{OD}$ . Changing the level of  $V_{OD}$  and pre-emphasis can improve the signal quality at the end of a long trace length or back plane. You should consider these programming choices for the best signal integrity at the end of the transmission line at the Mercury device's receiver.

## Stratix GX Devices Driving Mercury LVDS

A Stratix GX device can drive a Mercury device with the Mercury device's inputs receiving LVDS or LVPECL. The  $V_{OS}$  or  $V_{CM}$  is different for Mercury devices; therefore, the connection to the Stratix GX device must accommodate different voltages.

Since the transmission line is AC coupled, the Mercury device requires  $V_{CM}$  regeneration before going to the input. You can execute this regeneration by incorporating two sets of pull-up and pull-down resistors. See [Figure 1](#).

**Figure 1. Stratix GX Transceiver to Mercury LVDS Receiver Connection**



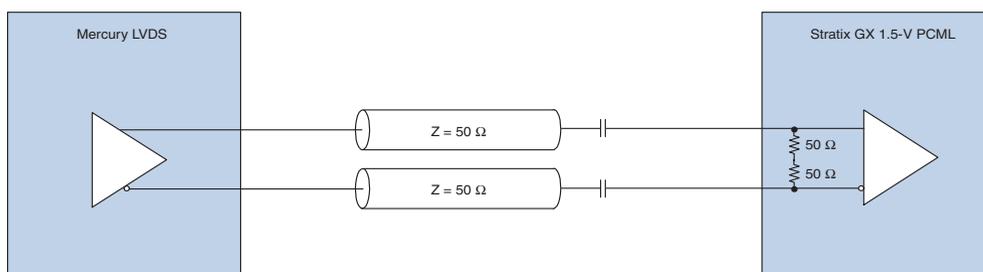
If the design is the same as the schematic in [Figure 1](#), you do not have to change the Mercury device's connections from the original design. Use the following guidelines to choose the resistor values:

- When using the internal differential termination, ensure that the resistors  $R_1$  and  $R_2$  are in the  $k\Omega$  range.
- $R_1 \parallel R_2 \parallel 50 \Omega \approx 50 \Omega$  In this equation, the  $50\text{-}\Omega$  value on the left of the equal sign comes from the fact that  $100\text{-}\Omega$  differential =  $50 \Omega$  to ground on a positive signal arm and  $+50 \Omega$  to ground on a negative signal arm.
- $R_2 / (R_1 + R_2) \times 3.3 \text{ V} = V_{CM}$ . Calculate the  $R_1$  and  $R_2$  using a value for the common-mode voltage ( $V_{CM}$ ) in the middle of the Mercury receiver tolerance. Although  $V_{CM}$  can range from 0 to 2.4 V, Altera recommends that  $V_{CM}$  be between 0 to 0.7 V or 1.8 to 2.4 V for speeds greater than 1 Gbps.
- $R_1 = 3.3 \text{ k}\Omega$  and  $R_2 = 5.6 \text{ k}\Omega$  are standard resistor values that meet the requirement for  $V_{CM} = 2.0 \text{ V}$ . However, other values are possible.

## Mercury LVDS Driving a Stratix GX Device

The Stratix GX receiver connection does not need  $V_{CM}$  reconstruction because it can accept AC-coupled signals. The Stratix GX device's  $V_{ID}$  minimum is 170 mV (see [Table 1](#)), making the receiver very sensitive to the signal range being generated by the Mercury device's transmitter. For signals that have a higher signal-to-noise ratio (SNR), Stratix GX has a programmable equalization to compensate for losses at the end of the transmission line (for more information, see the *Stratix GX FPGA Family Data Sheet*). The schematic for a Mercury device driving a Stratix GX device via LVDS is shown in [Figure 2](#). Since Stratix GX devices are 1.5 V devices, the maximum input voltage for the receiver is 1.675 V.

**Figure 2. Mercury LVDS Transceiver Output to Stratix GX Receiver**



## Conclusion

Using the programmable  $V_{OD}$  feature of Stratix GX devices and the AC coupling capability for input  $V_{CM}$  reconstruction, systems using Mercury devices with LVDS can easily interconnect with Stratix GX devices. No modifications are required to existing LVDS systems or designs, allowing these two device families to effectively communicate, and allowing new Stratix GX boards to be added to existing Mercury-based systems.

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