CLC001,CLC012,DS92LV1021A,DS92LV1212A

Hundreds of Megabits @ Hundreds of Meters: Extending the Transmission Length for LVDS

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Technology Edge

Hundreds of Megabits @ Hundreds of Meters: Extending the Transmission Length for LVDS

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Low-Voltage Differential Signaling (LVDS) is becoming the preferred differential interface standard as it delivers high data rates while consuming significantly less power than competing technologies. LVDS technology allows products to address applications with data rates of hundreds of Mbps in many market segments wherever the need for robust transmission of signals at high speed and low power exists.

The ability to integrate this technology into system-level ICs such as SerDes (Serializer/Deserializer) products means that LVDS interface technology is used for applications in every design that transfers data from chip-to-chip, card-to-card, shelf-to-shelf, rack-to-rack, or box-to-box. The typical transmission distances range from several inches (chip-to-chip) to several meters for an LVDS SerDes serial link driving a cable between racks. However, many systems now require the ability to extend this transmission distance to support cable lengths greater than 100 meters. This extended cable length offers some unique design challenges to the system design engineer. This design idea shows how the range of LVDS can be extended to meet these criteria by utilizing a high-speed serial digital interface (SDI) adaptive cable equalizer and cable driver products.

System-to-System Transmission

Serial cabling systems often use coaxial or twisted pair cables. All cable types provide significant attenuation of a signal which depends on both data rate (frequency) and the cable length.
Low-voltage differential signals are not exempt from cable attenuation and, as a result, can only travel limited distance.

Systems employing LVDS devices without any signal conditioning features can typically achieve transmission distances of several meters. Those employing LVDS ICs with driver pre-emphasis and receiver equalization can reach 15- to 20-meter distances. Systems that use LVDS interface devices but are required to transmit data across long distances (from several tens of meters to even hundreds of meters) must employ devices specifically designed to drive long transmission lines to work in conjunction with the LVDS devices. Figure 1 is an example of a communication channel in such a system.

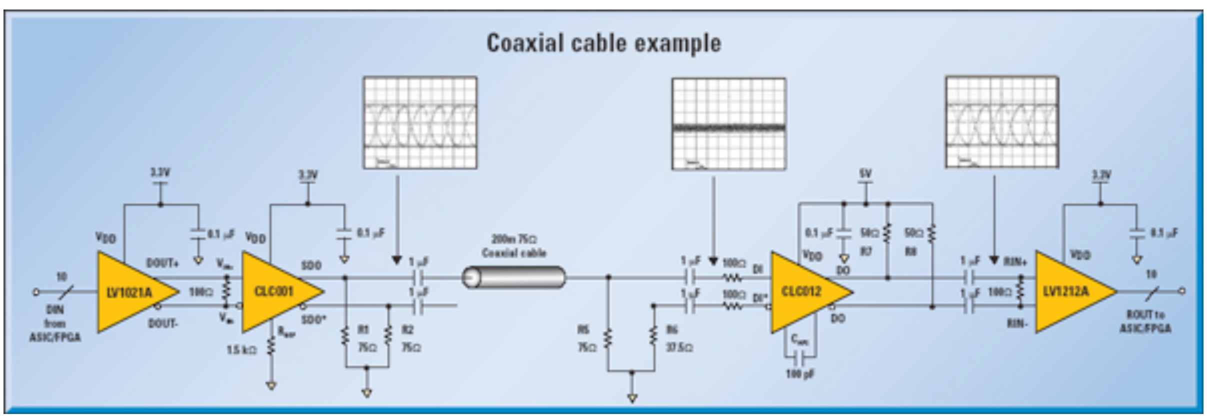

Figure 1: Example of a communication channel employing LVDS 10-bit SerDes and SDI cable driver/equalizer combo to transmit data over coaxial cable

This channel consists of National's 10-bit SerDes (DS92LV1021A and DS92LV1212A) pair and SDI cable driver / equalizer combo (CLC001 and CLC012). The SerDes pair reduces system cost by reducing connector and cable size, and brings LVDS benefits such as exceptional noise immunity, low power, minimal EMI, relaxed decoupling requirements, and simple termination scheme.

The SDI cable driver / receiver combo works to overcome signal attenuation caused by long cables. The key device for the task is the CLC012 which is a high-value solution for equalizing data transmitted over cable. The equalizer automatically compensates for losses of any length of cable from zero meters to lengths that attenuate the signal by 40 dB at 200 MHz. This corresponds to 300 meters of high quality coax cable (such as Belden 8281) or 120 meters of Category 5 UTP (unshielded twisted pair). The equalizer reconstructs serial digital data received from the transmission line (cable) by attempting to match the inverse of the cable loss characteristic and adapting to cable length.

Figure 2 is a block diagram of a communication channel that employs LVDS 10-bit SerDes and SDI cable driver / equalizer combo to move data across twisted pair (TP) cables. The only difference between this channel and the channel in Figure 1 (besides different cable) is in resistor values of R1 through R6. These resistors were experimentally determined; they adjust signals for optimal equalization.

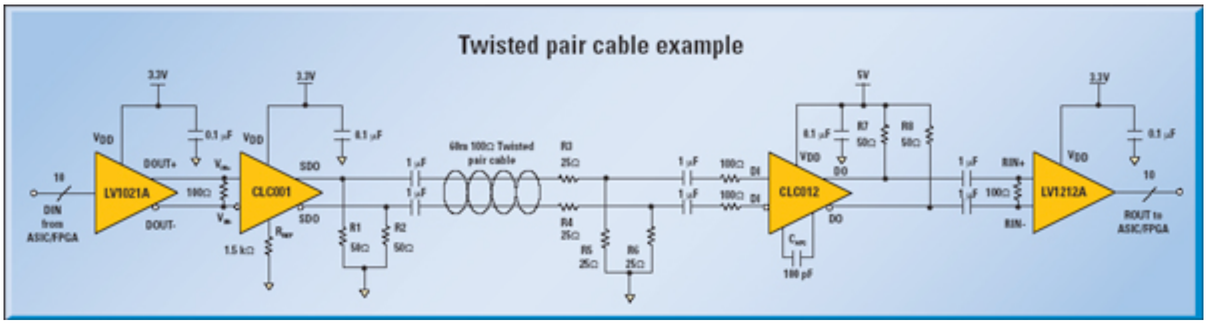

Figure 2: Example of a communication channel employing LVDS 10-bit SerDes and SDI cable driver/equalizer combo to transmit data over twisted pair cable

Experimental Results

Both circuits illustrated in Figures 1 and 2 were constructed using evaluation kits of the respective devices and tested using a bit-error rate tester. Both circuits exhibited operation without errors. The input was a 10-bit wide pseudo random bit stream (PRBS-15) latched in by a 40 MHz clock (DS92LV1021A T_{CLK}). The equivalent data rate transmitted through the cables was 480 Mbps.

Note that the circuits utilize AC coupling capacitors to isolate CLC012 PECL output levels from the DS92LV1212A receiver which expects LVDS levels. The configuration works well for the DC-balanced data. However, DC-unbalanced data would require DC coupling between the CLC012 and an LVDS receiver. A PECL-to-LVDS interface needs an attenuation resistor network. The attenuation network slows down signal edges significantly and reduces maximum data rate.

Optimization Tips

The following list provides optimization tips for a channel that employs LVDS SerDes and SDI devices to transmit data over long distances.

1. Provide proper load for the CLC001 while matching the impedance of the cable.
2. Use CLC001 R_{REF}, and R1through R6 resistors to adjust signals traveling through the cable for optimal cable equalization and proper cable termination.
3. Provide proper load for the CLC012 while matching impedance of the interconnect to the LVDS receiver.
4. Follow best PCB layout practices – see respective device datasheets for detailed information.
5. Use cables with individually shielded conductor pairs for minimal cross-talk.
6. Use controlled impedance connectors rated for gigabit operation.

Conclusion

The two example circuits illustrate how system designers can benefit from LVDS SerDes devices even when their systems require transmission distances ranging from a few tens of meters to two hundreds or more meters. The circuits were constructed using evaluation kits of the respective devices and tested with coaxial and twisted pair cables and have demonstrated error-free operation.

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