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LVDS Compatibility with RS422 and RS485 Interface Standards

Abstract

Low Voltage Differential Signaling (LVDS) technology offers one of the best serial data transmission profiles available today for physical layer interfaces. With many existing interface standards to choose from, this applications note provides guidelines on the inter-operation of LVDS devices with other differential interface standards such as RS-422/485. An example is included of an LVDS receiver configured to be inter-operable with an RS-422 driver.

Interface Standards

With so many electrical interface standards having separately evolved within particular industries, many serial data interface standards now exist. To simplify designers' choices, the following table summarizes some of the key electrical specifications for the different serial data interface standards listed.

TABLE 1. Interface Standards Specifications

Parameter	RS-422	RS-485	RS-644 (LVDS)
Differential Voltage Swing (typ)	3.0V	3.0V	350mV
Common Mode Voltage	1.8V	1.8V	1.2V
Driver Output Rise Time	10%tui	30%tui	30%tui
Receiver Common-Mode Voltage	± 7V	−7V/+12V	0V to +2.4V
Receiver Sensitivity	± 200mV	± 200mV	± 100mV
Signaling Rate	< 50Mbp/s	< 50Mbp/s	> 400Mbp/s
Transmission Distance (Note 1)	≤1200m	≤1200m	≤100m

Note 1: The transmission distance is shorter with faster signaling rates.

The three standards in Table 1 are hardware specifications that define the driver and receiver electrical characteristics. Software protocols are not discussed in any of the standards, and it is up to the system designer to define a protocol suitable for their system. The RS-422 differential standard was established to provide a balanced interconnect system (in preference to the single-ended interface) for use at higher signaling rates. The RS-422 standard is suited for point-to-point and multi-drop interconnects and not so well suited for multipoint systems. The RS-485 differential standard was issued to provide the driver/receiver electrical characteristics for balanced multipoint systems. One of the principle differences between RS-422 and RS-485 standards is that the RS-485 driver can be placed into a high impedance tristate mode, allowing drivers to transmit over the same pair of wires.

Compatibility with RS-422 and RS-485 Standards

The LVDS interface circuit is not intended for direct inter-operation with other interface technologies, like RS-422, RS-485, or even Positive Emitter Coupled Logic (PECL).

Under certain conditions, inter-operation of LVDS with other interface circuits mentioned above may be possible but may require modification in the interface or within the equipment. Limitations on certain performance parameters, like common mode range, may be required; satisfactory operation is not assured and additional provisions may need to be employed.

In determining whether direct inter-operation of LVDS TIA/EIA-644 compliant devices is possible with other interface standards, it is necessary to compare the generator (driver) output and the receiver input electrical specifications. Specifically the driver's differential output voltage (V_{OD}) and the driver offset voltage (V_{OS}) must be within the bounds of the LVDS RS-644 receiver's input ranges. Correspondingly, the receiver's input thresholds and voltage range must be able to accept the LVDS RS-644 driver's output levels.

Drivers compliant to the TIA/EIA-644 standard feature a current source capable of delivering a loop current in the range of 2.5 to 4.5mA. As illustrated in Figure 1, the resulting differential voltage (V_{OD}) will be a minimum of 250 mV up to a maximum of 450mV across the 100Ω termination resistor. The driver offset voltage (V_{OS}), also referred to as the center point, is typically +1.2V referenced to circuit common ground.

Any balanced receiver that guarantees the input voltage range of 0V to +2.4V and input thresholds of 200mV or less may be compatible and directly inter-operate with other balanced drivers. Compatibility is possible provided the balanced driver does not violate the maximum receiver input voltage range and develops a differential voltage (V_{OD}) of at least 100mV and not greater than 600mV. Inter-operation with drivers with larger output differential voltages is possible by using an attenuation circuit with the interface points of the components. Refer to Figure 2 for the illustration.

Compatibility with RS-422 and RS-485 Standards (Continued)

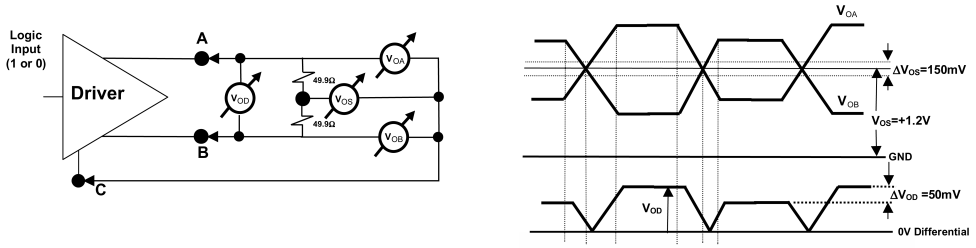

FIGURE 1. Driver Output Levels

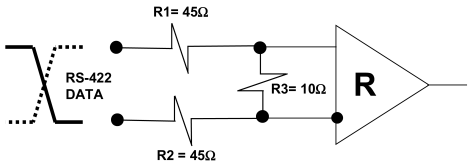

FIGURE 2. Application of RS-422 Data to an LVDS Receiver

The R1, R2, and R3 resistor divider network collectively is a total differential load of 100Ω to match the characteristic impedance of the transmission line and reduces the typical RS-422 differential signal amplitude of 3.3V down to a 330mV level. Essentially, the resistor network is a 10:1 attenuation circuit. Refer to the equation below to calculate the voltage drops across the resistors.

The majority (90%) of the RS-422 voltage is dropped across resistors R1 and R2, leaving the remaining voltage to be dropped across R3 which is compatible to the LVDS receiver.

$I_{TOT} = V_{TOT}/R_{TOT}$ (Current through the resistor network)
$= 3.3V / (R1 + R2 = R3)$
$= 3.3V / 100\Omega$
$= 33\ mA$

(Voltage across R1)
$V1 = I_{TOT} * R1$
$= (33mA)(45\Omega)$
$= 1.485V$

(Voltage across R2)
$V2 = I_{TOT} * R2$
$= (33mA)(45\Omega)$
$= 1.485V$

(Voltage across R3)
$V3 = I_{TOT} * R3$
$= (33mA)(10\Omega)$
$= 330mV$

Summary

Compatibility of TIA/EIA-644 LVDS drivers and receivers with other interface standards can be achieved by employing additional attenuation circuitry within the interface points of the system. When inter-operation of LVDS compliant devices is desired, provisions should be made to implement the attenuation circuitry that adjusts the differential amplitude voltages of the balanced driver to be within the receiver voltage range. As always, application specific requirements and needs may dictate what design techniques must be implemented to make a reliable interconnect system.

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