Application Report
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Increase Current Drive Using LVDS

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ABSTRACT

The most common configuration for an LVDS connection is the one-way transmission topology. A single driver transmits data through a 100 Ω characteristic impedance transmission line terminated into 100-Ω to a single receiver. For half-duplex nodes, the driver's load is reduced to 50 Ω, and the resulting signal amplitude is reduced by half. The multipoint configuration is implemented with many drivers and receivers on a single transmission line. Since LVDS drivers have low output capacitance, when they are coupled with the capacitance of multiple connectors and stubs, the characteristic impedance of a backplane can be reduced to 50 Ω or less.

This paper addresses these problems by connecting TI LVDS drivers in parallel to increase the output signal. First, two parallel LVDS drivers with a common input and with outputs tied together are employed to double the output current and restore the signal amplitude of the half-duplex topology to standard LVDS levels. Next, four parallel drivers are employed in the same way to drive a 25-Ω load to standard LVDS levels.

Introduction

The high data-rates that are possible with differential transmission require a well-defined line impedance and correct line termination matching this line impedance. Signal reflections radiate back and forth on a transmission line when termination impedance mismatches occur.

The one-way point-to-point, simplex and multidrop topologies are the easiest to manage with regard to impedance matching. However, the half-duplex topologies are complicated by parallel termination resistors and the added capacitance of stub connections, as displayed in Figure 1.

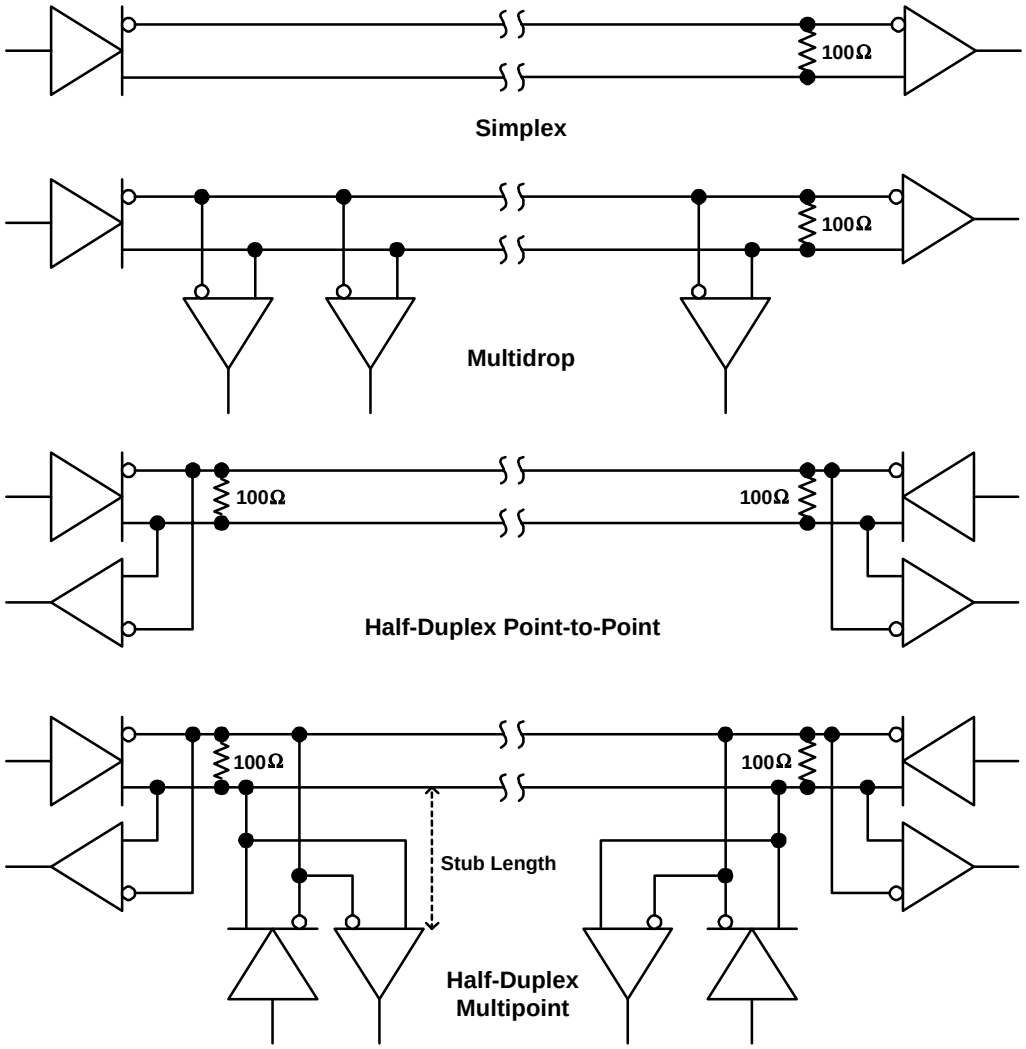

Figure 1. The Simplex, Multidrop, Half-Duplex, and Multipoint Topologies

The parallel termination required by the half-duplex point-to-point and half-duplex multipoint topologies halves the effective impedance and the resulting signal level. Therefore, to maintain standard LVDS signal levels on the bus, the driver current needs to be doubled.

A receiver's detection window is displayed in Figure 2 on a typical LVDS output signal. When a receiver's differential input voltage-level drops, the system noise margin is reduced. Lowering the signal amplitude enters the input voltage threshold of a receiver, eventually closing the eye and corrupting data. Jitter content decreases the time available for accurate reception. For this presentation, 30% jitter content is arbitrarily selected as the allowable limit. Jitter content depends on the application and may at times exceed 50%. To read more about the terms and sources of jitter, see *Jitter Analysis*, application report number SLLA075.

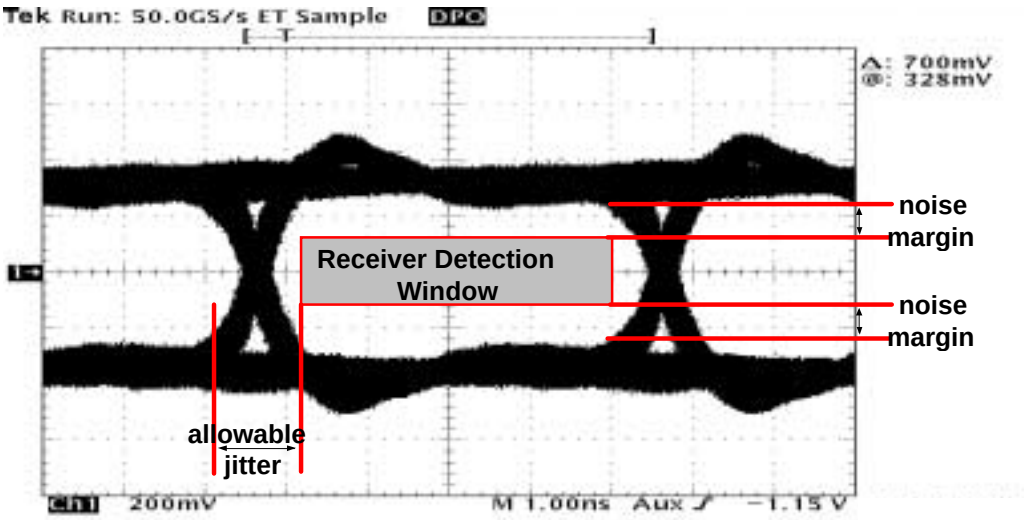

Figure 2. Receiver Detection Window in a Typical LVDS Driver Output into a 100-Ω Load

To overcome the reduced signal levels of the half-duplex point-to-point and half-duplex multipoint topologies, the TI LVDS current-drivers in Figure 3 can be connected in parallel to increase an output signal level. This paper presents the results of tests with two drivers tied together to drive a 50-Ω load and four drivers paralleled to drive a 25-Ω load.

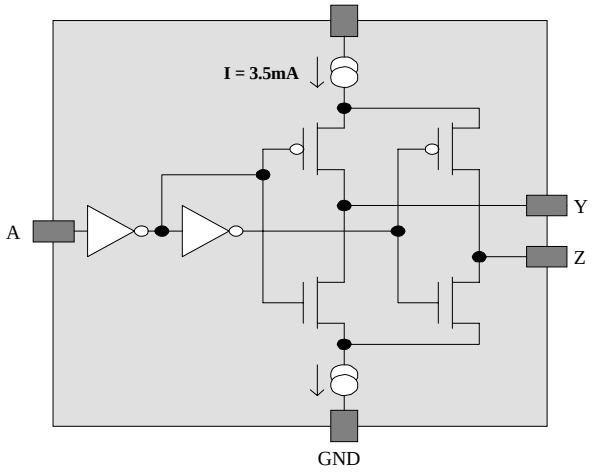

Figure 3. LVDS Current-Driver Model

Half-Duplex Point-to-Point

The parallel 100-Ω termination results in a 50-Ω steady-state load for an LVDS driver. Since the typical LVDS current-driver output is about 3.5 mA, the resulting signal amplitude in Figure 4 is about 175 mV (1/2 of the differential display), leaving little noise margin to the receiver threshold.

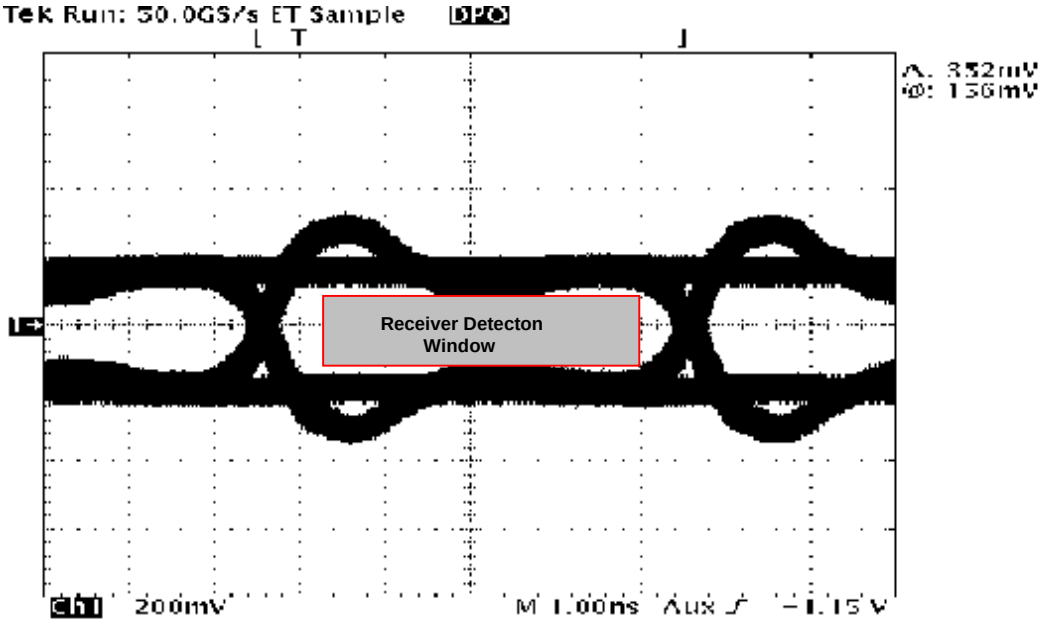

Figure 4. Output Signal With One SN65LVDS31 Driver and a 50-Ω Load

To increase the noise margin in Figure 4, two of the current-mode drivers of a quad-driver SN65LVDS31 are configured in parallel with a common input, and outputs tied together as shown in Figure 5. The resulting signal restores the output to LVDS standard levels in Figure 6 with 200 mV of noise margin.

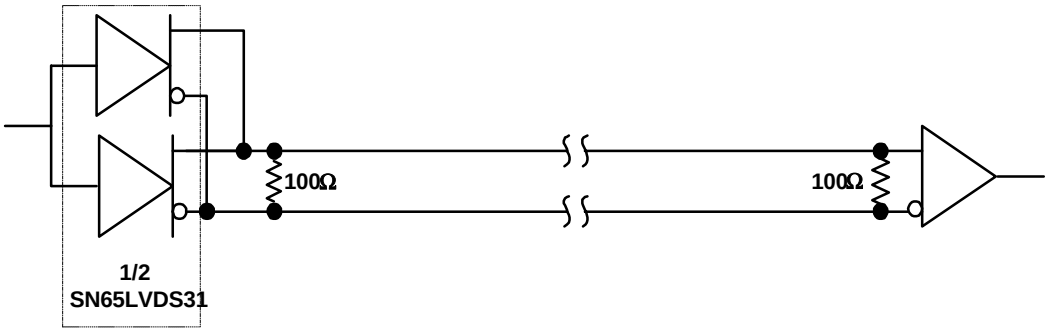

Figure 5. The SN65LVDS31 Parallel-Driver Solution

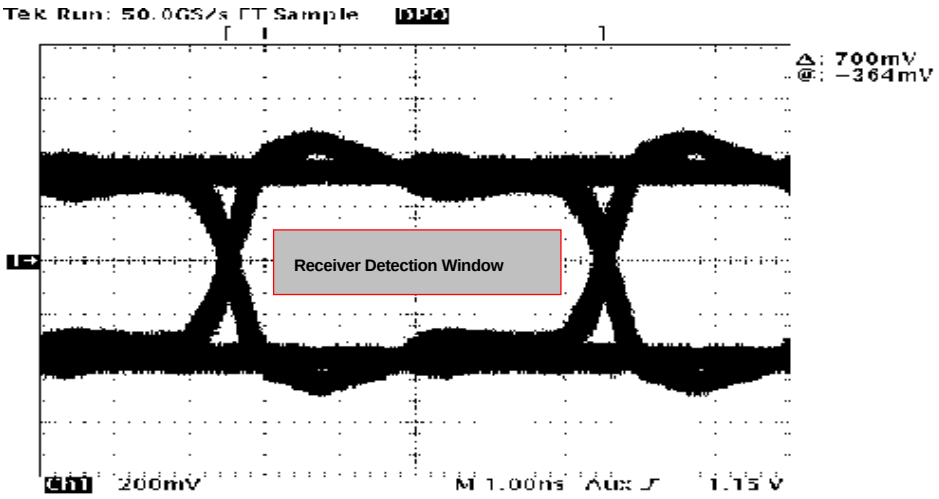

Figure 6. Output Signal With Two SN65LVDS31 Drivers Connected in Parallel and a 50-• Load

Note that the dual termination at the driver output and receiver input in Figure 5 decreases the jitter of the typical LVDS output shown in Figure 2 as compared with Figure 6.

Half-Duplex Multipoint

The half-duplex multipoint topology is most often applied in backplane applications with any number of drivers, receivers, and transceivers. The load impedance seen by a driver decreases as each additional card is plugged into a chassis. The resulting signal amplitude of a single driver can be reduced as displayed in Figure 7, and even more current than the previous example is required to drive signal levels back to acceptable levels.

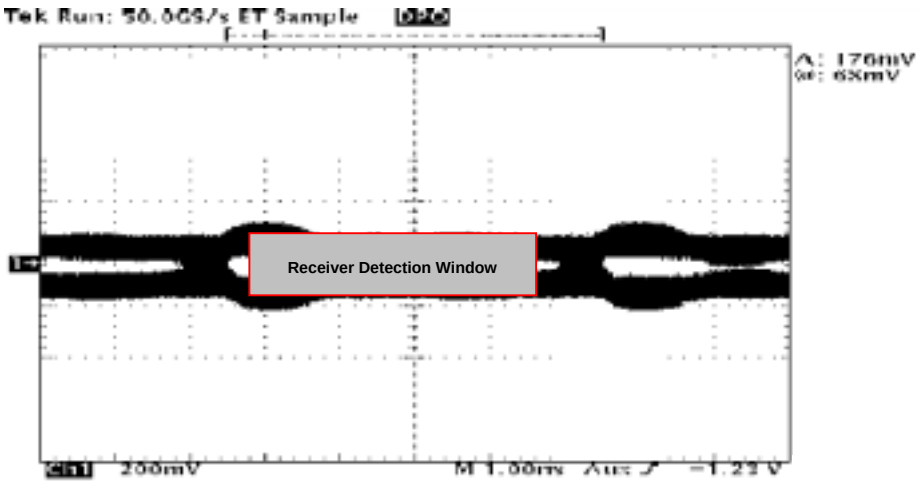

Figure 7. Output Signal With One SN65LVDS31 Driver and a 25-Ω Load

The signal amplitude in Figure 7 is near the threshold-voltage of a receiver and data may easily be corrupted by transient noise. The increased current demand of this heavily loaded backplane problem is addressed with all four of the SN65LVDS31's LVDS drivers in parallel in Figure 8, quadrupling the normal output current, and restoring the noise margins displayed in Figure 9.

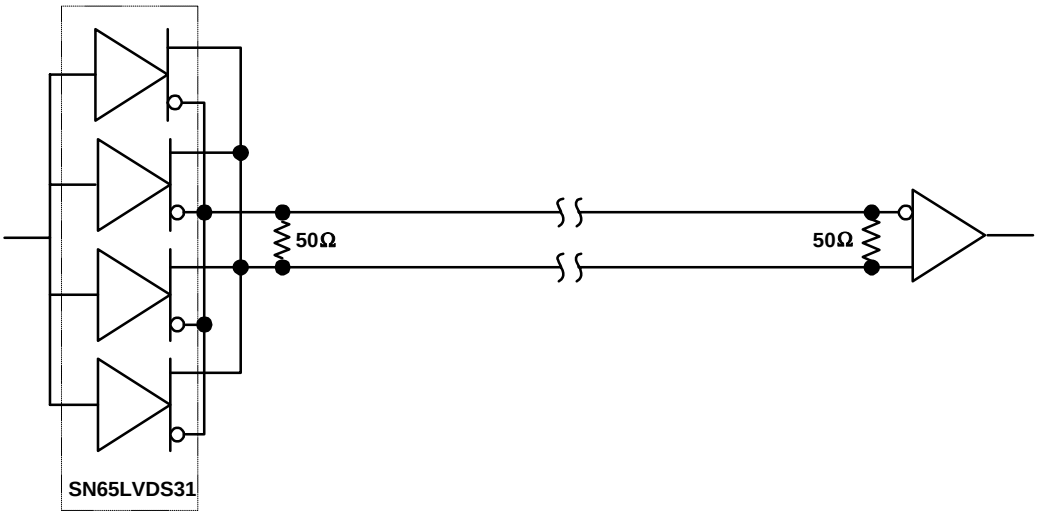

Figure 8. Four Parallel SN65LVDS31 Drivers and a 25-Ω Load

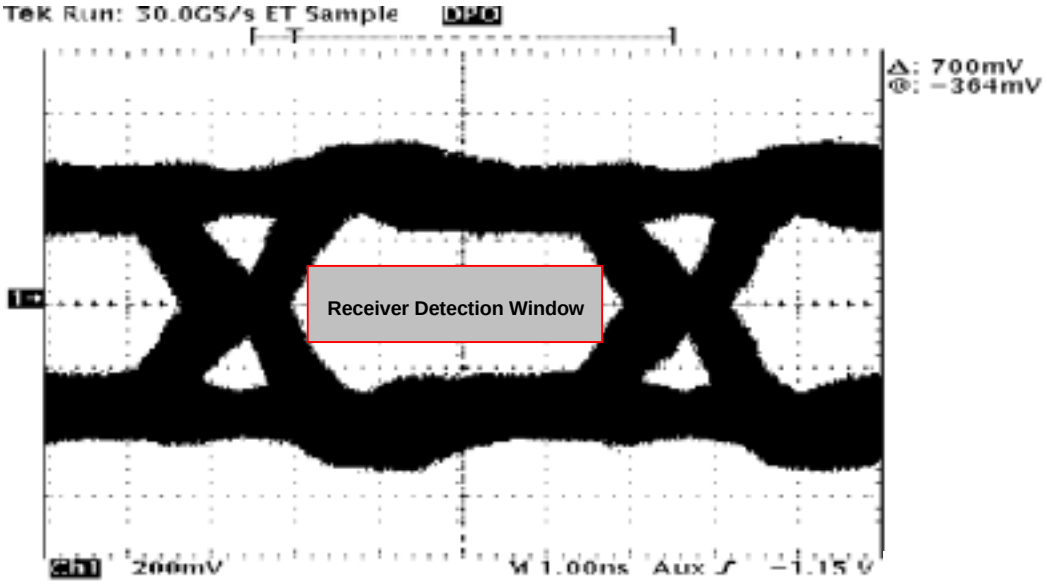

Figure 9. Output Signal With Four Parallel SN65LVDS31 Drivers and a 25-• Load

Conclusions

The test results show that it is possible to drive low-impedance loads with TI's LVDS31 line drivers by connecting them in parallel. The output currents of up to four drivers add linearly and can be used to drive loads as low as 25 Ω to standard LVDS levels.

A notable jitter increase in the 4-driver output is evident in Figure 9 and the 200 Mbps signaling rate is the highest rate recommended when using the TI LVDS31 / LVDS32 evaluation module (EVM) used in this experiment -- at least for the selected 30% jitter allowance. This is due to stub length and impedance matching limitations of the EVM in this type of experimentation. Most influenced by these limitations is the high-current 4-drive circuit, the 2-driver circuit is unnoticeably influenced.

It can be concluded from this experiment that it is possible to use these circuits as building blocks to address numerous data transmission applications, but it falls upon the designer to analyze network requirements and perform application-specific experiments.

To overcome low-termination impedance problems, however, TI offers the LVDM and M-LVDS product families with output currents double and triple respectively over that of a typical LVDS driver.

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