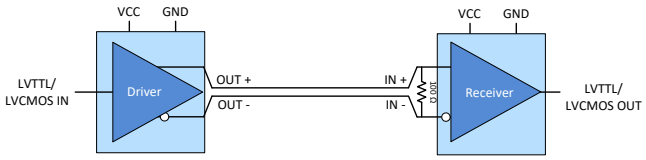
How Far, How Fast Can You Operate LVDS Drivers and Receivers?

Low Voltage Differential Signaling (LVDS) connects a driver and a receiver together with a closely coupled differential pair that is terminated with a 100 Ω resistor as shown in Figure 1. The simple termination, low power, and low noise generation generally makes LVDS the technology of choice for reducing noise in many applications. In this technical note, we discuss performance in maximum data rates and distances connecting LVDS drivers and receivers together.

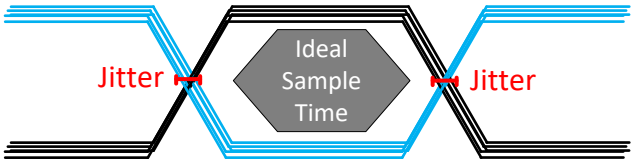
Figure 1. LVDS Typical Application



The test setup shown in Figure 3 connects a pseudo-random binary sequence (PRBS) source with LVDS Evaluation Module Boards (EVM) to an oscilloscope. The LVDS EVMs used in this experiment are DS90LV011-12A (1 channel), SN65LVDS31-33 (4 channel, wide common input mode), and DS90LV047-48A (4 channel). The tests were conducted at the following cable lengths: 1m, 5m, 10m, 50m, and 100m and each Cat5e cable was modified with female headers to connect to the male headers on the EVM boards. A Bit Error Rate Tester (BERT) generates a 2^{31}-1 PRBS pattern, sends it through the system and loops back to the analyzer, which compares the generated signal. If the pattern matches, the system is said to have no errors. The error margin to not be surpassed in this lab experiment was 1 x 10^{-12} for the bit error rate.

The signal passing through the driver and receiver is connected to an oscilloscope to be observed as an eye diagram. Eye diagrams are made when a signal is repeatedly sampled over itself and is used to measure jitter. Jitter is the measured "error" in time difference of when a system cannot tell the difference between a high or a low bit. It is measured at the crossing point of the bits in an eye diagram as shown in Figure 2.

Figure 2. Eye Diagram

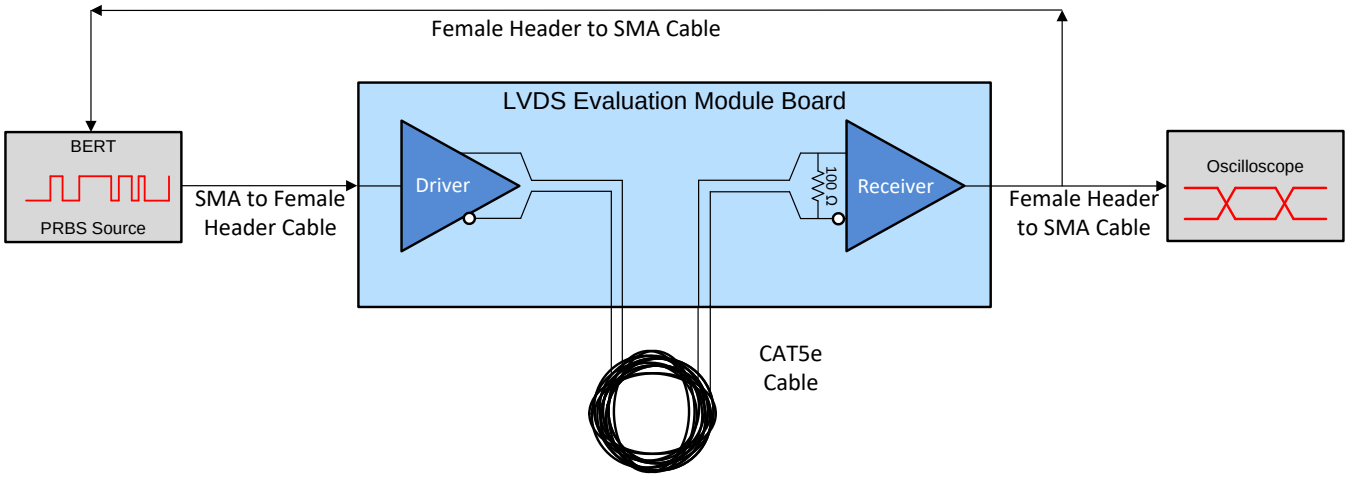


This document focuses on jitter percentage and what maximum percentage can be achieved in a potentially error free environment. Jitter percentage is the measured jitter in a given period, as shown in the example below.

$$Jitter\ (\%) = \frac{Measured\ Jitter\ (s)}{Period\ (s)} \times 100\%$$

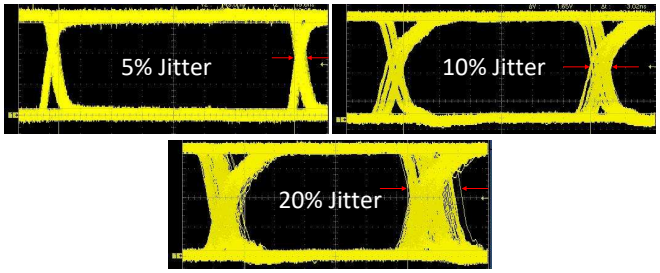
$$= \frac{290\ ps}{2.5\ ns} \times 100\% = 11.6\%$$

Figure 3. Test Setup



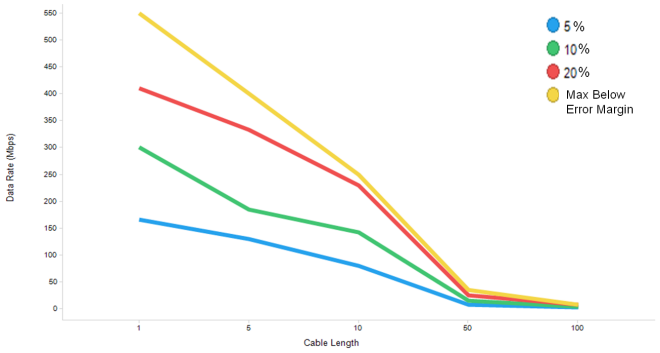
Jitter percentage is valuable when seeing what percentage of the eye will be open, providing a window of bit time to correctly sample the signal. To have a better understanding of jitter, Figure 4 shows examples of what 5%, 10%, 20% jitter can look like. Up to 20% jitter, the signal should be clean enough to get readings with no errors. Above 20% it is not guaranteed that the signal will be error free; however, higher jitter percentages were shown to be below the error margin of 1 x 10^{-12} bit error rate using the BERT.

Figure 4. Example of 5%, 10%, and 20% Jitter



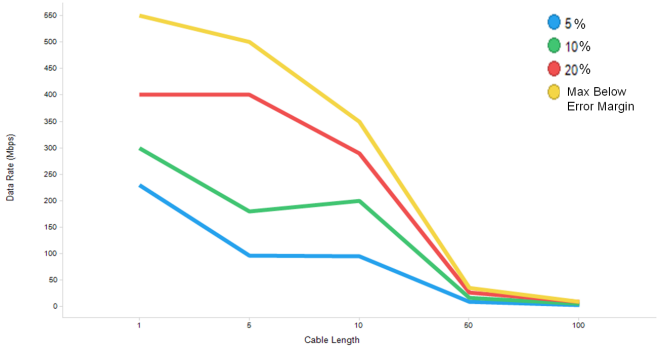
All of the parts chosen for this experiment (DS90LV011A, DS90LV012A, SN65LVDS31, SN65LVDS33, DS90LV047A, DS90LV048A) have data sheet specifications of being able to achieve signaling rates up to 400 Mbps. As you can see, in Figure 5, Figure 6, and Figure 7, all devices meet and exceed the specified up to 400 Mbps signaling rates from the data sheets.

Figure 5. DS90LV011-12A Results



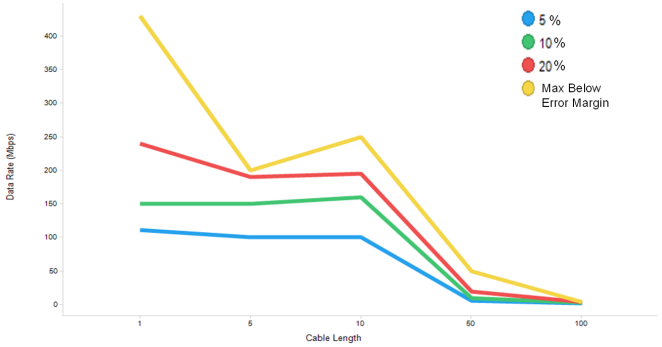
For a one channel application, the DS90LV011-12A EVM allows for data rates as high as 500 Mbps for short distances and for longer distances, like 50m, can operate around 50 Mbps.

Figure 6. DS90LV047-48A Results



For a four channel application, the DS90LV047-48A EVM provides higher than the data sheet specified signaling rate of 400 Mbps for cable lengths up to 5m.

Figure 7. SN65LVDS31-33 Results



For an application that requires wide common mode input range, the SN65LVDS31-33 EVM allows for data rates as high as 400 Mbps at short distances and for longer distances, like 50m, can also operate around 50 Mbps.

Table 1. Final Results(1)(2)

Jitter	5%			10%			20%			Max Below Error Margin		
EVM	48	33	12	48	33	12	48	33	12	48	33	12
1m	230	111	166	300	150	300	400	240	410	550	430	550
5m	98	100	130	180	150	185	400	190	333	500	200	400
10m	95	100	885	200	160	142	300	195	230	350	250	250
50m	9	6	8	17	10	15	27	20	25	35	50	35
100m	3	2	2.5	5	3	4	9	4	7	9	4	7

(1) All data values are in Mbps.

(2) '48' is representative of the DS90LV047-48A EVM; '33' is representative of the SN65LVDS31-33 EVM; '12' is representative of the DS90LV011-12A EVM

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