Application Report
SLLA454–April 2019

Solving Signal Integrity Challenges with USB 2.0 Redrivers

ABSTRACT

This application report examines why the use of a redriver is needed for signal conditioning in a USB 2.0 system design, and how to incorporate a redriver to simplify designs and meet USB 2.0 compliance.

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Trademarks

1 Introduction

Since its inception in 1996, Universal Serial Bus (USB) has become one of the most successful wired interfaces adopted by wide range of electronics devices and equipment across industries, such as personal electronics, automotive, industrial and enterprise systems. Even though USB data rates have evolved to support higher bandwidths over the years, currently achieving 10 Gbps per lane, it has kept the backwards compatibility of the USB 2.0 specification with up to 480 Mbps data rate for many low bandwidth applications. Even at the lower USB high speed data rate of 480 Mbps, USB signals are subject to signal degradation over cables, trace loss, and passive components in the data path, which can result in USB 2.0 compliance failures. Figure 1 shows an example.

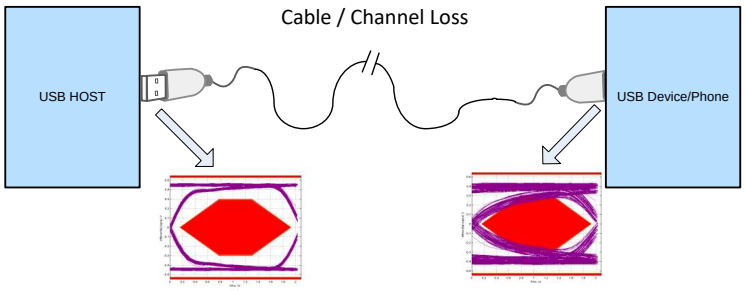

Figure 1. Signal Integrity Degradation

2 USB 2.0 Signal Integrity Challenges

USB 2.0 supports up to 480 Mbps high speed data rate along with battery charging protocols. It is a DC coupled system with wide signal swing. The USB 2.0 data path typically has many passive and active components such as switches, charging controllers, and protection devices. These components as well as connector, trace, and cable loss all contribute to the signal integrity challenges which need to be overcome in order to pass the stringent eye mask specification for USB 2.0 compliance.

3 Choosing to Use a USB 2.0 Redriver

Whether or not to use a signal conditioner in a system has always been a debate during the initial system design due to cost and board space constraints. Using a redriver can be the simplest type of signal conditioning, which also provides low latency. To ease the design effort and increase design flexibility, a USB2 redriver with small form factor and flow through trace routing can be used in the board design. Figure 2 shows the flow-through design.

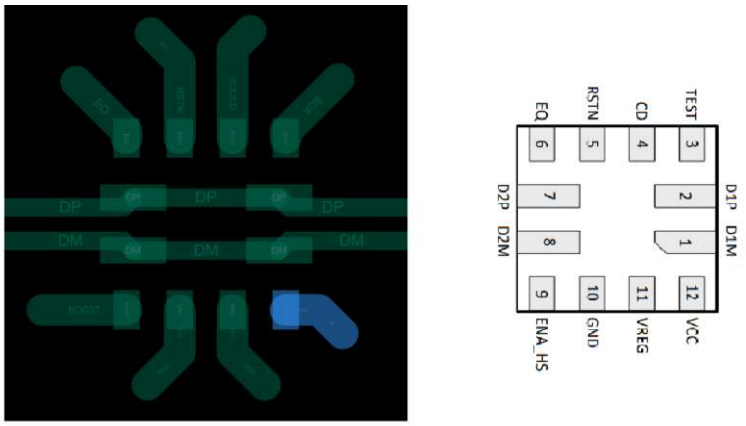

Figure 2. Flow-through Design

This allows the board designer to create one PCB board which can be populated with or without the USB2 redriver, depending on the performance needs. The board can be assembled initially without a redriver mounted. If the system were to initially fail the compliance testing, then the redriver can be easily populated on the PCB board to achieve instant compliance without the need to re-spin the board, saving valuable time and improving speed time to market cycle. The TUSB212 is an example of such a USB2 redriver. It does not break the USB 2.0 (D+ and D-) signals, and can easily be added on to the PCB to help pass USB compliance.

4 Redrivers in Automotive

Many automotive applications require long cable reach for smart phone data communication and charging between head unit or media hub ports. Some requirements include the ability to pass a near-end USB 2.0 compliance eye diagram at the connector located at the far end of the cable, that is The Remote Port. The TUSB217 can be implemented to enable support of up to a five meter cable to pass USB 2.0 near-end eye testing, CarPlay, and Android auto compliance.

Figure 3 shows a passing near-end eye diagram using the TUSB217 with a 5-m cable. The TUSB217 is also capable of passing the near-end eye diagram across various different cable lengths up to 5 m with a single configuration (with typical 28AWG USB cables).

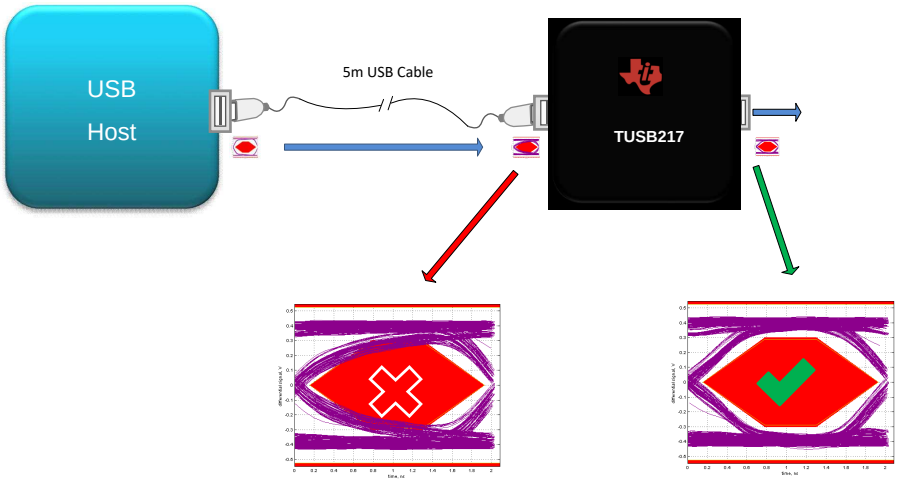

Figure 3. TUSB217 Signal Recovery

5 Summary

The Texas Instruments USB2 redriver family provides a highly efficient signal conditioning solution for wide varieties of applications to achieve instant USB compliance.

The TUSB217 is the high performance redriver capable of recovering the signal loss from a five meter cable to aid in passing USB 2.0 and CarPlay compliance testing.

The TUSB212 has a small footprint with flow though trace routing to ease the design effort and help achieve instant USB compliance.

6 References

- Texas Instruments, *TUSB212 USB 2.0 High Speed Conditioner Data Sheet*
- Texas Instruments, *TUSB217-Q1 USB High Speed Signal Conditioner Data Sheet*

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