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ABSTRACT

There is an increasing number of hosts and SSD devices with USB 3.2 Gen 2x2 support released. The USB 3.2 Gen 2x2 delivers a strong performance boost to meet essential demands for USB storage. This application note introduces how to achieve 20-Gbps transfer rate by the USB Type-C® connector. A USB 3.2 Gen 2x2 application is also presented by using TI TUSB1104 device.

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1 Introduction

USB 3.2 Gen 2x2 is a multi-lane operation for new hosts and devices, allowing for up to two lanes of 10Gbps operation to realize a theoretical 20Gbps data transfer rate.

The USB 3.2 Gen 2x2 allows the user to transfer data between devices quicker, and supports backwards compatibility, addressing any concerns related to functionality with older technology. Backwards compatibility implies that new drives support existing USB specifications.

A USB Type-C connector has four pairs of metal pins functioning as *lanes* that transfer and receive data. USB 3.2 Gen 1 (5Gbps) and USB 3.2 Gen 2 (10Gbps) use one TX lane and one RX lane, based on the positioning of the connector. USB 3.2 Gen 2x2 takes advantage of all four lanes to achieve up to the theoretical 20Gbps transfer rate.

2 USB 3.2 Gen 2x2

2.1 What is USB 3.2 Gen 2x2?

While USB 4 is the latest and fastest generation, the most common USB ports on PCs and peripherals have a 3 in the version number, specifically USB 3.2 or USB 3.1, or even 3.0. When looking at spec sheets, note that there are generation numbers after the USB 3.2 or 3.1. For example, USB 3.2 Gen 1, USB 3.2 Gen 2, and also USB 3.2 Gen 2x2. And yet some ports with different version numbers actually have the same speed. [Table 2-1](#) shows different USB 3 versions and speeds.

Table 2-1. USB 3.2, USB 3.1, and USB 3.0 Versions and Speeds

USB Version	Speed	Alternate Name	Connector Type	Identical to
USB 3.2 Gen 1	5 Gbps	SuperSpeed	Type-A, Type-C, Type-B, Micro	USB 3.1 Gen 1, USB 3.0
USB 3.2 Gen 2 / Gen 2x1	10 Gbps	SuperSpeed+10Gbps	Type-A, Type-C	USB 3.1 Gen 2
USB 3.2 Gen 2x2	20 Gbps	SuperSpeed+20Gbps	Type-C	N/A
USB 3.1 Gen 1	5 Gbps	SuperSpeed	Type-A, Type-C, Type-B, Micro	USB 3.1 Gen 1, USB 3.0
USB 3.1 Gen 2	10 Gbps	SuperSpeed+10Gbps	Type-A, Type-C	USB 3.1 Gen 2
USB 3.0	5 Gbps	SuperSpeed	Type-A, Type-C, Type-B, Micro	USB 3.1 Gen 1

The 20 Gbps speed is named USB 3.2 Gen 2x2, because it uses two 10 Gbps lanes to give the 20 Gbps speed. There is also a lesser-used version called USB 3.2 Gen 1x2, which is 10 Gbps and nearly identical to USB 3.2 Gen 2. The difference is that, while USB 3.2 Gen 2 has a single, 10 Gbps data lane, USB 3.2 Gen 1x2 uses two 5 Gbps lanes to get to the 10 Gbps total.

Both the 5 Gbps and 10 Gbps speeds are available with either USB Type-A or USB Type-C connectors. USB Type-A ports have the traditional, rectangular connectors that can only be inserted one way. USB Type-C ports are smaller, oval-shaped and reversible.

However, if using USB 3.2 Gen 2x2 (20 Gbps), then the USB Type-C is being used. The Type-A ports cap out at 10 Gbps. Also, though rare, the USB 3.2 Gen 1x2 (also 10 Gbps) can only use USB Type-C.

When using a USB 3.2 Gen 2 port, and need to take advantage of the 10 Gbps speed, use a cable that supports 10 Gbps and a peripheral that does the same. If need to get 20 Gbps speeds, all three pieces: the *port*, the *peripheral*, and the *cable*, must support that speed.

2.2 TUSB1104 Introduction

TI TUSB1104 is a 10 Gbps USB 3.2 x2 linear redriver for USB-C applications enabling up to 20 Gbps total data throughput.

The TUSB1104 is intended to reside between a Host and a USB-C receptacle or between a USB device and a USB-C receptacle. The TUSB1104 will automatically detect whether or not the interface is operating at USB 3.2 x2 or x1. If it determines the USB interface is operating at USB 3.2 x1, then it will disable the unused lane to conserve power.

TUSB1104 configured for USB 3.2 x2 mode will determine if the link is operating in USB 3.2 x2 or in USB 3.1 x1. If the link is USB 3.2 x2, then TUSB1104 will operate with one port operating as a USB 3.2 x1 port and the remaining port following the lead of the other port. The port functioning as a USB 3.1 x1 port is called the config lane. The determination of the config lane is based solely on the Type-C orientation. For normal orientation (FLIP = L), Port 1 is the config lane. For the flipped orientation (FLIP = H), Port 2 is the config lane. [Table 2-2](#) shows the selection of config lane.

Table 2-2. TUSB1104 Config Lane Selection

Flip	Configure Lane	Non-Configure Lane
L	CRX1-SSRX1	CRX2-SSRX2
	SSTX1-CTX1	SSTX2-CTX2
H	CRX2-SSRX2	CRX1-SSRX1
	SSTX2-CTX2	SSTX1-CTX1

2.3 USB 3.2 Gen 2x2 Application With TUSB1104

A typical application of the TUSB1104 device is shown in [Figure 2-1](#). The device can be configured either through its GPIO pins or through its I2C interface. In the following example, a Type-C PD controller or microcontroller is used to configure the device through the I2C interface. In I2C mode, the equalization settings for each receiver can be independently controlled through I2C registers.

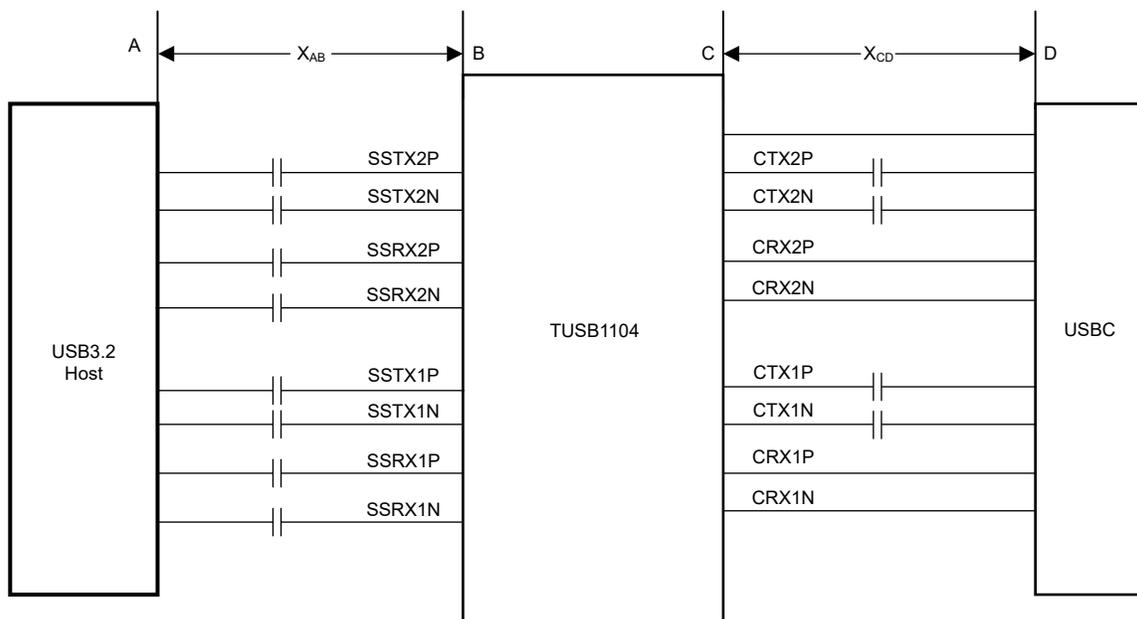


Figure 2-1. Typical USB 3.2 Gen2x2 Application with TUSB1104

For pre-channel A to B PCB trace length X_{AB} , a good rule for FR4 trace insertion loss at 5 GHz is ≈ -1 dB per inch. If X_{AB} is 8 inches, the TUSB1104 SSEQ should be programmed to -8 dB. For post-channel C to D PCB trace length X_{CD} , TUSB1104 will determine the best settings regardless if the channel is short, long or somewhere in between with fully Adaptive EQ setting.

3 Summary

USB 3.2 Gen 2x2 takes advantage of all four lanes of type-c connector and delivers a strong performance boost for USB storage with 20Gbps data transfer rate. This application note explained the difference between different USB revisions and speed and presented a typical USB 3.2 Gen 2x2 application with TI TUSB1104 part.

4 References

- Texas Instruments [TUSB1104 USB Type-C 10 Gbps USB 3.2 x2 Adaptive Linear Redriver](#) data sheet.

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