

How to Select the Right USB Type-C™ Signal Switches



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USB Type-C™ enables the transfer of data, video and power over a single cable and connector. The flip-ability of the USB Type-C connector introduces connection pin redundancy, which requires a signal switch in order to bring the correct data path to the central processing unit (CPU) for signal processing.

There are two types of signal switches: USB only and USB plus video. [Figure 1](#) shows USB-only switches applied in a USB Type-C end-to-end system.

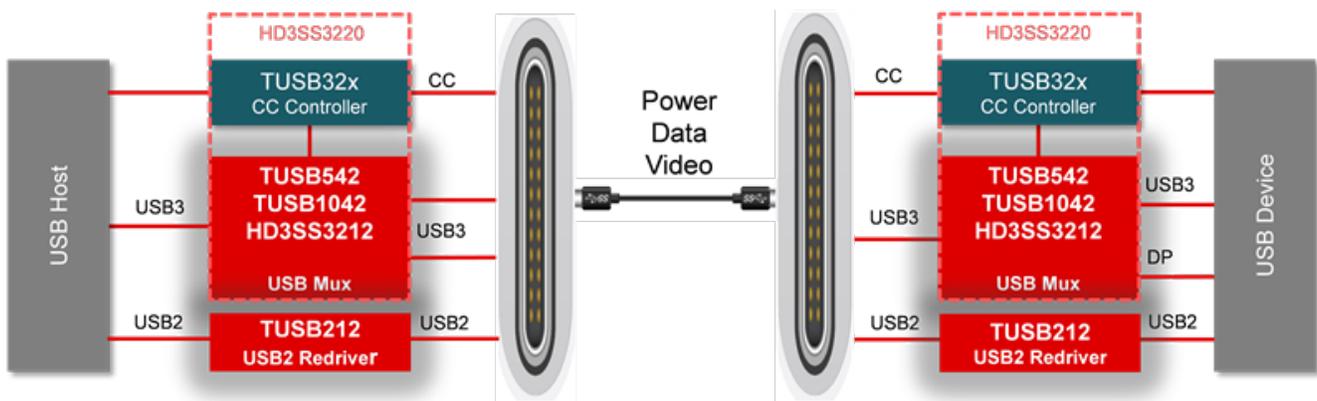


Figure 1. USB Type-C End-to-end USB Solution

The main purpose of a USB signal switch is to select the right USB 3.0 transmit (SSTX) and receive (SSRX) pins based on connector orientation from the configuration channel (CC) controller and route the active pins to the CPU. There are two types of signal switches or multiplexers: passive or active switches. The [HD3SS3212](#) is a passive switch that can support a 10Gbps USB speed. The [HD3SS3220](#) is 10Gbps passive switch with an integrated CC controller. If signal integrity is a concern in your design, you can use an active redriver switch to improve signal quality and help pass USB compliance. The [TUSB542](#) is a USB 5Gbps redriver switch and the [TUSB1042](#) is a USB 10Gbps redriver switch.

Among the many convenient features of USB Type-C, one cool advantage is the clever design of its physical layer, which enables DisplayPort™ (DP) protocol and signal pass through over its connector and cable. This brings tremendous benefits, not only because it results in a small-footprint connector and a lightweight cable, but because it enables simultaneous video and data transfer as well as power charging of the device, all through a single connection.

Video Electronics Standards Association (VESA)-specified DisplayPort Alternate Mode on USB Type-C allows four high-speed DisplayPort lane transfer over the USB Type-C high-speed data path, and auxiliary (AUX) channel signaling transfer through sideband-use (SBU) channels. The USB Type-C physical layer can deliver the DisplayPort 1.4 standard up to 8.1Gbps per lane, which is enough to support 4K or 8K video over the USB Type-C interface.

Enabling video over USB Type-C requires a signal multiplexer in the video source and a signal demultiplexer in the video sink to multiplex and demultiplex the video and USB signal. [Figure 2](#) shows the signal multiplexer choices and placement in an end-to-end USB Type-C Alternate Mode system.

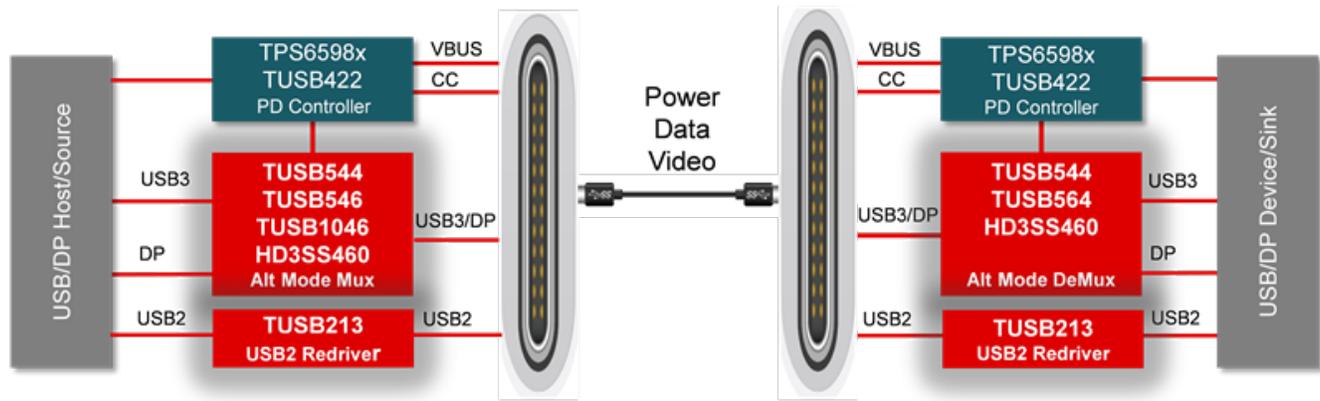


Figure 2. USB Type-C Alternate Mode End-to-end Solution

The [HS3SS460](#) is a passive Alternate Mode multiplexer that you can use in both the source and sink sides, supporting USB 3.0 and DisplayPort 1.2 at 5.4Gbps.

The [TUSB546](#) and [TUSB1046](#) are Alternate Mode redriver switches for the source side. Both are pin-to-pin compatible and support DisplayPort 1.4 at 8.1Gbps. The only difference is that the TUSB546 supports USB 3.0 at 5Gbps, while the TUSB1046 supports USB 3.1 Gen 2 at 10Gbps. In addition to supporting DisplayPort over USB Type-C Alternate Mode, these devices also support High-Definition Multimedia Interface (HDMI) over USB Type-C Alternate Mode.

The [TUSB544](#) is a bidirectional USB Type-C redriver also supporting Alternate Mode that you can use when the signal multiplexer is integrated into the CPU and you need a redriver to improve signal integrity to pass compliance.

The [TUSB564](#) is a USB Type-C Alternate Mode redriver multiplexer for the sink side, which makes it a good fit for docking, monitoring and virtual reality applications. The device supports USB 3.0 and DisplayPort 1.4 at 8.1Gbps signal demultiplexing while improving signal quality by compensating for printed circuit board (PCB) trace or cable loss, helping your system pass USB and DisplayPort compliance. [Figure 3](#) shows the TUSB564 signal path in a typical use case.

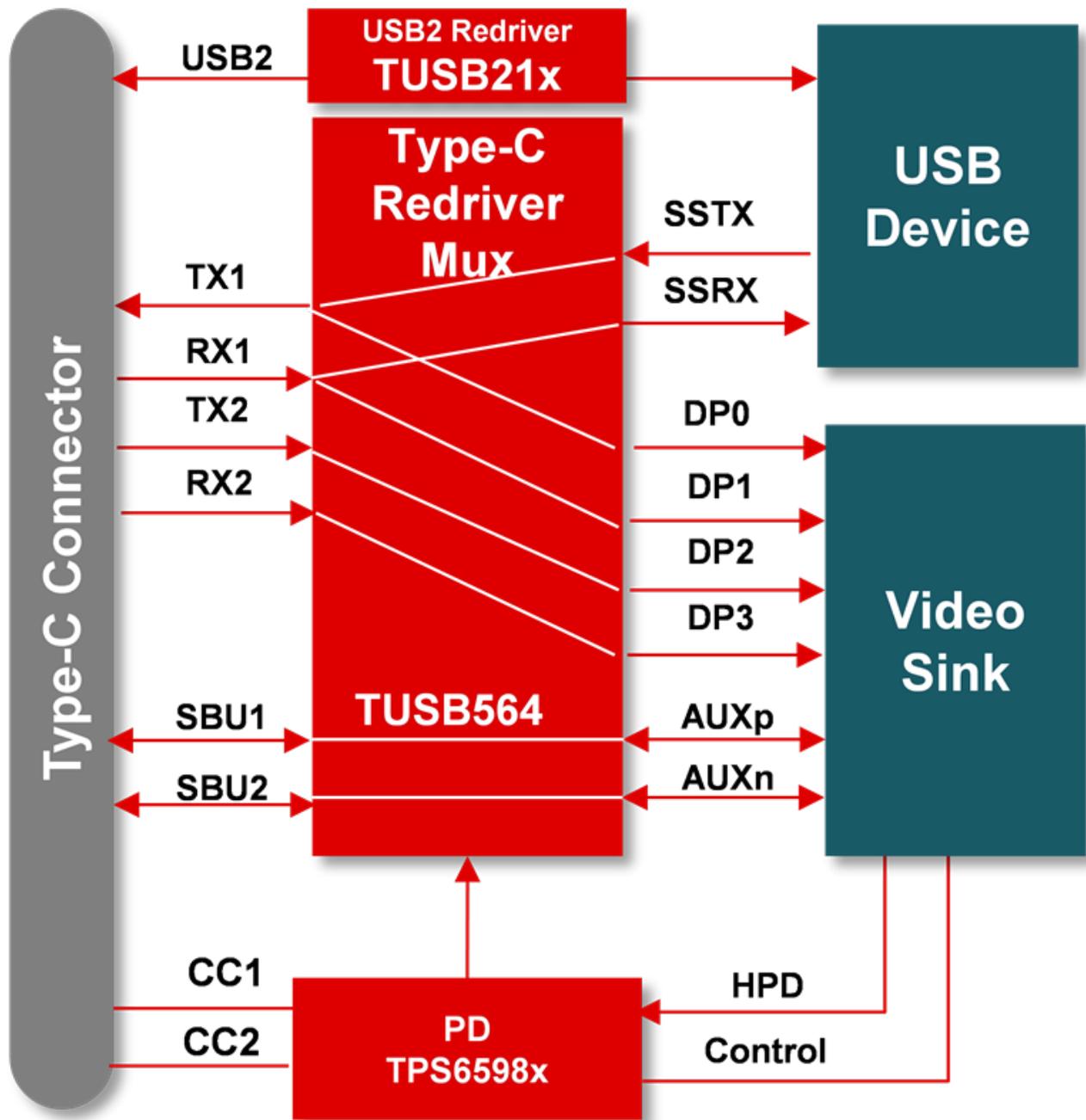


Figure 3. TUSB564 Functional Diagram

In a USB Type-C system, USB 2.0 has its own data path. Typically, the USB 2.0 D+ and D- redundancy pins are connected, so you won't need a signal switch. However, it is always wise to add a USB 2.0 redriver such as the [TUSB212](#) or [TUSB213](#) in a USB Type-C system to enable better USB 2.0 signal quality.

[Figure 4](#) summarizes USB Type-C signal switch key feature differences to help you find the most relevant solutions for your next USB Type-C project.

Device	HD3SS3212	HD3SS460	HD3SS3220	TUSB542	TUSB1042	TUSB546A	TUSB1046A	TUSB564	TUSB544
Application	Source, Sink	Source, Sink	Source, Sink	Source, Sink	Source, Sink	Source	Source	Sink	Source, Sink, Cable
Data/Video Support	USB3.1 G2	USB3.1 G1 DP1.2a Video	USB3.1 G2	USB3.1 G1	USB3.1 G2	USB3.1 G1 DP1.4 Video	USB3.1 G2 DP1.4 Video	USB3.1 G1 DP1.4 Video	USB3.1 G1 DP1.4 Video
Alternate Mode Support		✓				✓	✓	✓	✓
Max Data Rate	10Gbps	5.4Gbps	10Gbps	5Gbps	10Gbps	8.1Gbps	10Gbps	8.1Gbps	8.1Gbps
High speed lanes	2	4	2	2	2	4	4	4	4
X-Point		✓				✓	✓	✓	
Adaptive Common Mode tracking	✓	✓	✓						
Redriving MUX				✓	✓	✓	✓	✓	✓
Package (mm)	2.5x4.5	3.5x5.5	2.5x4.5	2x2.4	4x6	4x6	4x6	4x6	4x6
Pin count	20 VQFN	28 QFN	30 VQFN	18 QFN	40 WQFN	40 WQFN	40 QFN	40 QFN	40 QFN
Supply (V)	3.3	3.3	5/3.3	1.8	3.3	3.3	3.3	3.3	3.3

Figure 4. USB Type-C Signal Switch Comparison

Additional Resources

- Read my other blog post, "[How to deliver clean USB Type-C signals.](#)"
- Download the [HD3SS3212](#), [HD3SS3220](#), [TUSB542](#), [TUSB1042](#), [HS3SS460](#), [TUSB546](#), [TUSB1046](#), [TUSB544](#), [TUSB564](#), [TUSB212](#) and [TUSB213](#) data sheets.
- Check out these white papers:
 - "[Strengthening the USB Type-C signal chain through redrivers.](#)"
 - "[Alternate Mode for USB Type-C: going Beyond USB.](#)"
 - "[A primer on USB Type-C and Power Delivery applications and requirements.](#)"

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