Paving The Way for USB Type-C Connectors

Abstract:
Delivering data, video, security, and power in one small, easy-to-insert connector, the new USB Type-C connector promises to give new life to what is already one of the world's most popular interfaces. NXP helped define the spec and is paving the way for widespread adoption.

Introduction

The Universal Serial Bus is, without question, one of the most successful interface technologies ever invented. Few interfaces have lasted as long or enjoyed such widespread use. Yet, as great as USB is, it still has its limitations. The plug has to be inserted the right way, the data rate isn't always as fast as we'd like, and the charging function can be frustratingly slow when used to power larger batteries, like those used in many smartphones and tablets.

But good news is on the way. The next generation of USB is here, in the form of the USB Type-C connector. This recently completed specification, which is now with the USB-IF for ongoing management and oversight of compliance and certification programs, promises to be the best USB yet. The new connector is easier to use, supports faster data rates, and delivers higher-power charging.

Smaller, Reversible, Faster, and More Powerful

One of the most noticeable things about the Type-C connector is that it's quite small – it measures just 8.3 x 2.5 mm – and it's vertically symmetrical. Similar to the Apple Lightning connector, the Type-C connector has contacts on both sides, so it works the same either way. There's no more up or down, and no more fumbling with the plug, trying to figure out the right way to insert it.

Figure 1.
The Type-C connector is smaller and flippable.

The Type-C connector supports the new SuperSpeed USB 3.1 format, which offers data-transfer rates as high as 10 Gbps, or roughly double the speed of current USB 3.0 versions. It's still backward compatible with all the USB 2.0 formats (LS, FS, and HS), so even legacy systems will be able to take advantage of the new connector when it's designed into dongles.

While protocols like HDMI and DisplayPort do deliver power (no separate power cables are required), they do not provide charging capability. USB Power Delivery (USB-PD) over the Type-C connector can deliver power charging capability and can also transfer data fast enough to support a 4K monitor (or an array of monitors).

The Type-C connector supports a new level of charging capability, referred to as USB Power Delivery or USB PD. The PD format runs at up to 100 W, which is suitable for use with 5, 12, and 20 V systems. That's a big step up from the traditional USB Battery Charger or BC spec, which presents limitations when charging systems with larger batteries, or trying to power a hub or display.
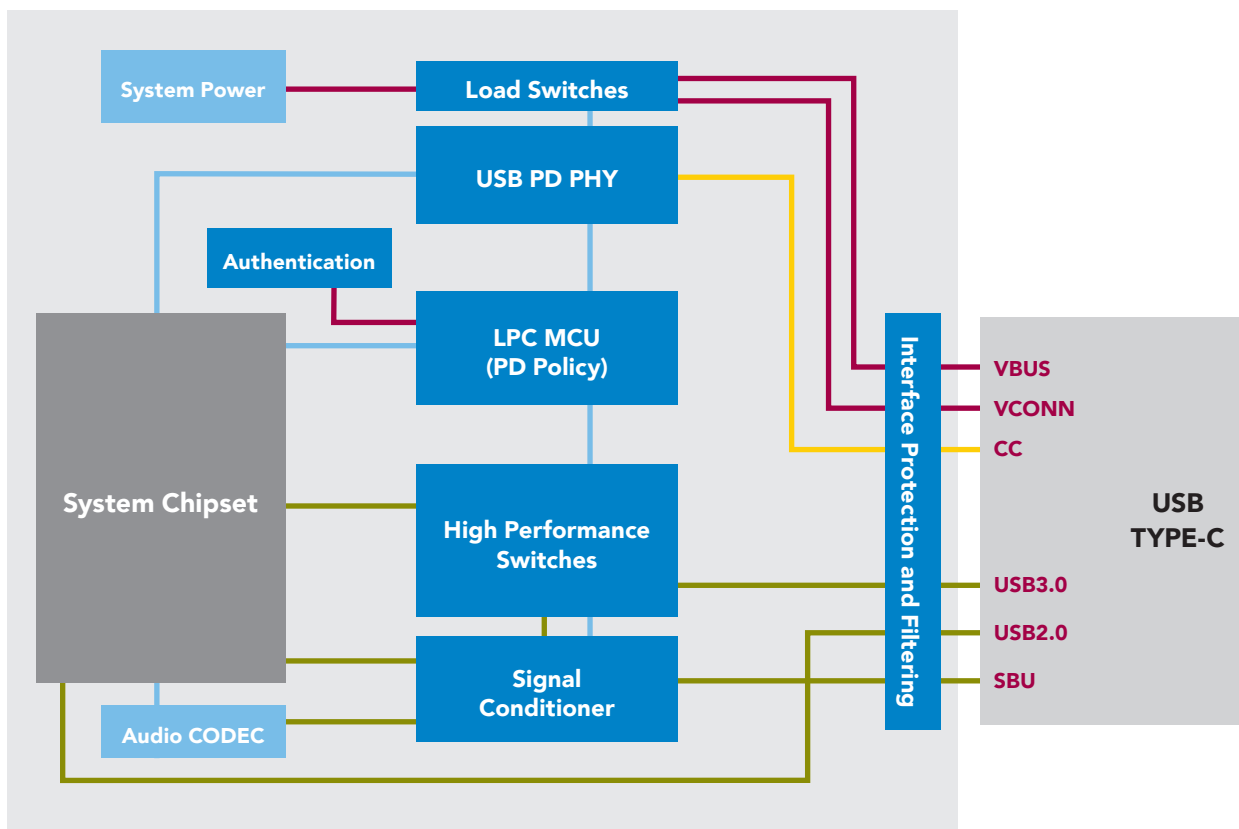
USB TYPE-C HIGHLIGHTS

- SIZE: 8.3 x 2.5 mm

- ORIENTATION: Flippable

- DATA RATE: Up to 10 Gbps

- POWER DELIVERY: Up to 100 W (5/12/20 V)

- BACKWARD COMPATIBILITY: USB 2.0 LS/FS/HS

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NXP

New Features, New Design Considerations

As one might expect, the flippable plug, the increased speed, and the new PD format introduce certain challenges, in terms of efficiency and decision-making, and introduce new requirements for protecting signals and ensuring performance in all kinds of conditions. The system-level diagram below shows the components, in dark blue, that help create an efficient, robust, and fully compliant design.

Figure 2.
System Solution for USB Type-C Connector

Summary of the Highlighted Blocks:

USB TYPE-C LOAD SWITCHES
Used for Vbus protection, these load switches automatically isolate the system from a faulty source or load. More protection is always better, so look for the integrated safety features they provide, under/over-voltage protection, reverse-current protection, over-temperature protection, and programmable current limits.

USB PD PHY
This device is the PD physical layer IC. It interfaces between the USB Type-C connector and the PD Controller. This device handles role detections/advertisement per the USB Type-C specification on CC lines. It also includes the BMC encoder/decoder for CC line communication. This device also has integrated power elements, such as LDOs and power switch, to support dead battery mode or power accessories mode. I2C, SPI and GPIO interfaces are available to pair with any MCU to run the PD policy engine.

PD MICROCONTROLLER
Type-C functionality requires a certain complexity in decision-making, and the PD microcontroller, running embedded firmware, helps streamline operations. Implemented in a standard 32-bit ARM microcontroller, it is where the back-channel communications are handled.

HIGH-PERFORMANCE SIGNAL SWITCHES
The switches provide a signal multiplex or de-multiplex function in order to redirect the transmitted signals to the same connection port (multiplex switch) or different connection ports (de-multiplex switch). For a Type-C connector to support Alternate Mode (flippable insertion) functions, either a multiplex or a de-multiplex switch function will be used, or sometimes these functions mat be combined together to become a cross-point switch.

SIGNAL CONDITIONERS
This category includes USB3 redrivers and HDMI level shifters/redrivers. They regenerate the USB signal, remove jitter, extend channel transmission, and reduce the bit error rate. They improve the eye diagram of the USB signal, extend the link distance, and help the system pass compliance testing.

INTERFACE PROTECTION AND FILTERING
This category includes dedicated ESD protection for the Type-C signal, along with Common Mode filters that help eliminate interference with wireless technologies, including GSM, LTE, and WiFi.

AUTHENTICATION
With the new USB Type-C capabilities, it is even more important to be able to authenticate that a device is trusted and is safe to use. For example, a notebook or tablet may want to determine that the power supply is not a counterfeit supply before allowing it to supply 100W of power. NXP's authentication solutions can be used to establish whether a USB device can be trusted, and which features can be safely enabled.

NXP Is Paving The Way

NXP, a long-time leader in the USB space, is a member of the USB-IF and helped define the Type-C specification. Our engineers are already familiar with the finer points of implementing Type-C solutions, and our portfolio is fully equipped to support every aspect of Type-C design. To learn more about the spec and product compliance, visit the USB-IF at www.usb.org, and for more about NXP solutions for Type-C systems, go to www.nxp.com/usb_type-c.