

USB Programmable Power Supply | The Next Wave of Fast Charging

The USB Implementers Forum (USB-IF) and IEC 63002/62680 define the external power interoperability guidelines for Universal Serial Bus (USB-C®) data and power. This Power Delivery (PD) specification further defines the programmable power supply (PPS) feature that many new applications, including smartphone designs, are adopting.

To deliver products that work reliably on time, system architects and developers must understand how these new power requirements affect projects. Optimizing power designs over multiple cycles requires a deep understanding of power theory and must take many factors into consideration.

This article explains how the new FUSB3307 from ON Semiconductor® will help system architects and developers simplify and optimize new designs with minimum design cycles. It will further describe how the product implements USB PPS on almost any power port without special software. Readers will learn how this solution suits many AC/DC and DC/DC applications as well.

What is a PD PPS?

The USB PD3.0 specification defines a new Programmable Power Supply (PPS) protocol that allows incremental control of both the current and voltage possible between the charger and the battery. This protocol is the foundation for fast charging to the maximum power possible, allowing the fast charger and the device receiving power to negotiate the most efficient and optimal charging profile in real time. Without this ability to negotiate an optimal power agreement, the inefficiencies of fixed charging profiles limits the maximum power allowed within the given thermal constraints of the system.

The PD specification has a defined power rating up to 100 W. PPS takes advantage of this full range, allowing power device manufacturers to implement ways to provide quick charge capability of USB devices, including smartphones of up to 50-percent, in just a few minutes instead of hours.

Opportunities and challenges

According to Statista, [over 1.5 billion smartphones are shipped every year](#). This represents a major opportunity for developers.

Smartphone vendors and consumers continuously look for ways to charge their phones faster. This is true for USB ports in cars, desks, airport kiosks, or even USB ports on power-tool-charging stations. Although the USB PD specification meets the demand for fast charging head on, developers face a number of challenges:

- *Deliver products to market in the shortest possible time.* To capture narrow windows of opportunity, developers must minimize the number of design cycles. Another hurdle is software debugging, which usually takes up a great deal of engineering resources.
- *The final products need to work reliably.* There are multiple stages for developers to complete before a final product can be shipped to customers. They include project definition, prototyping, testing, field tests, pre-production, and final release for mass production. A product may work well as an engineering prototype but fail in a pre-production or pilot run.
- *Achieve design optimization.* The ultimate goal is always for developers to minimize cost and size while improving packaging convenience. This goal makes it crucial to optimize the component count for the USB chargers and the USB ports.

ON Semiconductor® solutions



To help developers overcome design challenges, ON Semiconductor® has simplified fast-charging USB PPS designs with the FUSB3307 USB PD power source controller. The FUSB3307 provides a fixed, low cost solution that is compliant to the latest PD3.0 standards and requires minimal design-in effort across a wide range of applications and use cases. The controller has integrated multiple important functions into one compact IC chip. Many end products such as USB-C® hubs, travel adapters, power banks, and automotive power used in the following applications can benefit from the device:

- Wall chargers for tablet PCs and laptop batteries
- AC/DC PD 3.0-compliant adapters
- DC/DC car chargers for individual port power control
- Wide range of complete reference designs spanning AC/DC and DC/DC applications

FUSB3307 can control single or back-to-back N-channel MOSFETs as a load switch to provide design convenience. The device is compliant to the latest USB PD standards and is compatible with legacy devices. Additionally, many protection features are built in to increase product reliability. The following are the key characteristics that would benefit developers.

USB standard compliance to ensure compatibility with other USB designs

The goal of the USB standard is to ensure that all compliant devices will be compatible. The FUSB3307 is fully compliant with PD 3.0 v2.0, Type-C 2.0, and the constant voltage (CV) and constant current limit (CC) regulations. Developers can be confident that the FUSB3307 will be compatible with their projects, whether for a new design or when adding the PPS to an existing USB port.

Built-in protection features to ensure device reliability

The FUSB3307's many built-in protection features include undervoltage protection (UVP), overvoltage protection (OVP), overcurrent protection (OCP), CC1 and CC2 pin overvoltage protection (CC_OVP) up to 26 V, VCONN overcurrent protection and fault detection (VCONN_OCP), and internal and external overtemperature protection (I_TOP and E_OTP). With a 10-bit A/D converter, output voltage, output current, IC internal temperature, and external temperature via an NTC resistor can be monitored.

The device is designed with power efficiency in mind

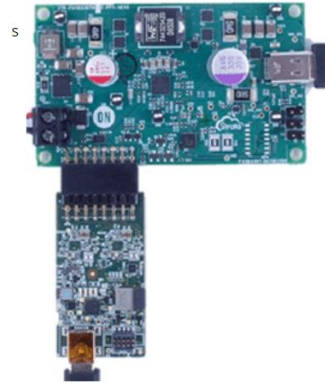
Features including a gate driver allows for low-loss, NFET load switches to be employed. Charging with PPS to reduce power loss between battery and charger increases the power efficiency and prevents thermal regulation. Finally, a small current-sensing resistor (5 mΩ) can be used for high efficiency along with the built-in output capacitor dynamic discharge function for fast discharging.

A true partnership makes taking the first step easy

The FUSB3307 has been proven to help developers reduce the number of design cycles. The FUSB3307 from ON Semiconductor® is the perfect device both for converting an existing USB design to USB PD and PPS and for developing new port designs.

Usually, debugging software in a new project can be time-consuming. The FUSB3307 is a state-machine-based solution that requires no special software and can implement USB PPS on almost any power port. This approach frees developers from getting bogged down in debugging, giving them more time to focus on design improvements.

ON Semiconductor® has many years of experience in shipping USB products. Besides offering the FUSB3307 component, ON Semiconductor® offers a complete reference design development kit.



<https://www.onsemi.com/support/evaluation-board/str-fusb3307mpx-pps-gevk>

The Strata-enabled FUSB3307 USB Power Delivery 3.0 adaptive source charging controller board offers an easy-to-use user interface (UI) within the Strata Developer Studio. Through the Strata UI, the developer can control the parts' features as well as access the most up-to-date datasheets, BOMs, schematics, and other collateral.

These reference designs have been tested and proven to work. Using these references, developers will be able to come up with a design quickly and start to optimize the ultimate solutions. ON Semiconductor® thoroughly tests the design and layout, minimizing the need for troubleshooting during the design process.

Finding the right path is winning half of the battle. Contact ON Semiconductor® for further details.