



ARTICLE

# How to Design Small USB-C PD and PPS Adapters

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The pressure on the designer is relentless - develop ever-smaller chargers and adapters that deliver full USB-C Power Delivery (PD), Programmable Power Supply (PPS) functionality, and faster charging times for smartphones, tablets, notebooks and other portable devices. Keys to designing smaller chargers and adapters include reducing component count and maximizing efficiency: easy to say, challenging to achieve.

With the new USB protocols, it's not enough to deliver a compact and highly-efficient power conversion solution with low quiescent power. The new USB power protocols require precise two-way communication between the device being powered and the power source. USB PD enables the load and power supply to set multiple power delivery and voltage levels with power up to 100 W (even higher power is now being proposed). PPS is targeted primarily at faster changing for batteries and goes one step further, enabling the load to request changes while power delivery is active. Those changes include micro-stepping voltage in increments of 20 mV and micro-stepping current in increments of 50 mA.

To implement advanced USB power protocols, designers have needed to use a dedicated USB controller IC, or a microcontroller, in addition to the flyback controller. There's also the need for low latency communication between the two ICs, making sure the overall solution conforms with the USB protocols

## Problem solved

To address these challenges, designers can now turn to a family of highly integrated flyback switcher ICs with on-chip USB PD controllers. The InnoSwitch™3-PD family of ICs from Power Integrations are the most highly integrated solution for USB Type-C, PD, and PPS adapters and include both a USB-C and PD controller, in addition to the primary power switch and multi-mode quasi-resonant flyback controller (Figure 1). Depending on the model, designers have a choice of a high-voltage silicon MOSFET or PowiGaN™ power switch, together with secondary-side sensing, FluxLink™ isolated digital control, and a synchronous-rectification driver.

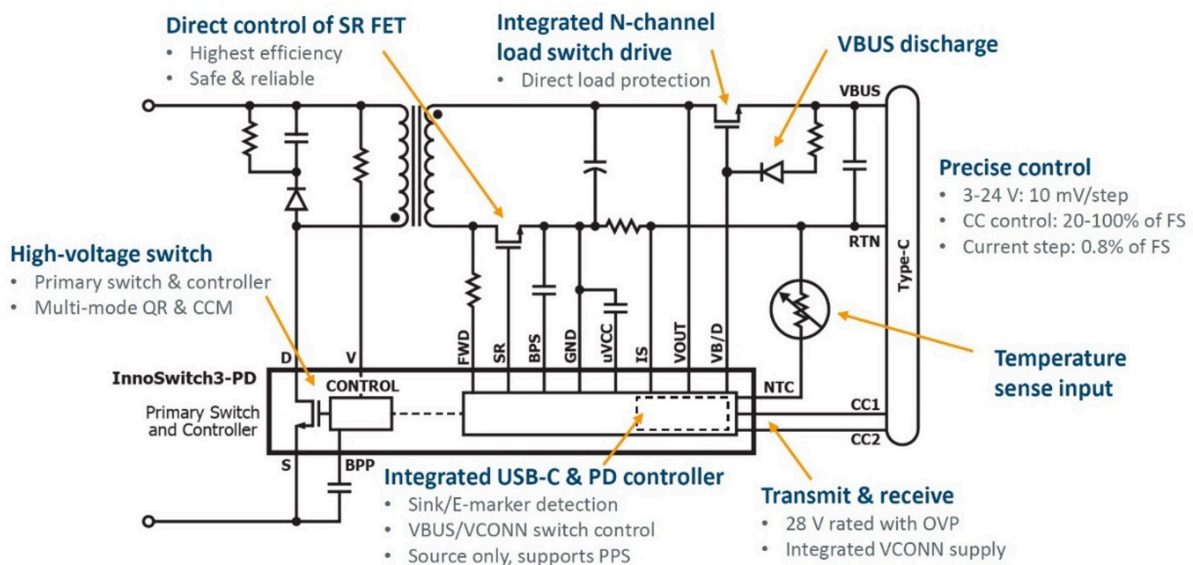


Figure 1: InnoSwitch3-PD reduces bill of materials and simplifies the design of USB-C PD and PPS adapters.

Designs based on InnoSwitch3-PD ICs meet all global energy-efficiency regulations and have no-load power consumption as low as 14 mW. The low thermal dissipation of these designs eliminates the need for large and expensive heatsinks, contributing to small solution sizes and low cost. Fast and accurate secondary-side regulation is supported by Power Integrations' FluxLink high-speed feedback link. Input and output voltage monitoring enables accurate input brown-in, brown-out and input overvoltage protection, and output over- and under-voltage fault detection with designer-configurable fault responses. The compact InSOP™-24D-package measures only 10.8mm x 9.4mm x 1.6mm high. The InnoSwitch3-PD family includes three ICs with integrated 650 V silicon MOSFETs and three with integrated 750 V PowiGaN™ gallium nitride power switches (see Table 1).

Part Number	Power Switch Voltage Rating (V)	Typical Maximum Output Power (W)			
		230 VAC ±15%		85-264 VAC	
		Adapter	Open Frame	Adapter	Open Frame
INN3865C	650	25	30	22	25
INN3866C	650	35	40	27	36
INN3867C	650	45	50	40	45
INN3878C	750	70	75	55	65
INN3879C	750	80	85	65	75
INN3870C	750	90	100	75	85

PowiGaN

**Table 1: InnoSwitch3-PD controllers are available for a wide variety of USB-C PD + PPD adapter power levels and input voltage ranges and include three ICs with integrated 650 V silicon MOSFETs and three with integrated 750 V PowiGaN gallium nitride power switches.**

## Fast time to market for tiny solutions

To jump start the development of tiny USB-C PD + PPS adapters and chargers and speed time-to-market, designers can choose from a variety of reference designs including 30 W, 45 W and 60 W applications. Each of the following designs features an integrated 750 V PowiGaN switch; silicon versions are also available. They all have an input voltage range of 90 to 265 VAC and meet DOE6 and CoC v5 2016 average efficiency requirements and CISPR22 / EN55022 Class B Conducted EMI limitations.

### DER-836: 30 W USB PD 3.0 Power Supply

This design example (Figure 2) uses an InnoSwitch3-PD INN3878C device. The adapter measures 1.73" (44 mm) × 1.73" (44 mm) × 0.817" (21 mm) for a power density of 12.27 W/in<sup>3</sup>, without an enclosure. The design has <18 mW no-load input power at 230 VAC. It uses only 59 components, contributing to the high power density. The USB PD/PPS source capabilities are:

- PDO1: 5 V / 3 A (fixed supply)
- PDO2: 9 V / 3 A (fixed supply)
- PDO3: 12 V / 2.5 A (fixed supply)
- PDO4: 15 V / 2.0 A (fixed supply)
- PDO5: 20 V / 1.5 A (fixed supply)
- PDO6: 3.3 V – 11 V / 3 A  
(programmable power supply, 30 W power-limited)
- PDO7: 3.3 V – 16 V / 2 A (programmable power supply)

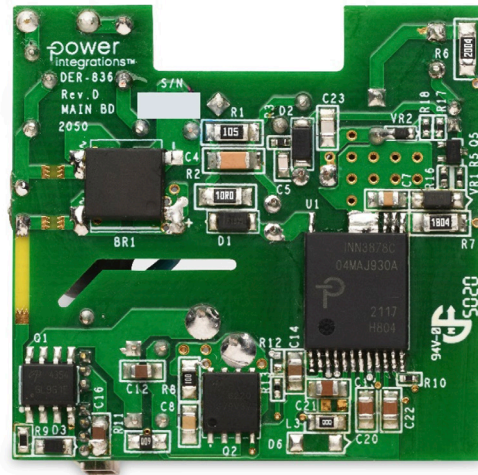


Figure 2: Reference design DER-836 delivers 30 W of power using only 59 components.

### DER-837: 45 W USB PD 3.0 Power Supply

This design example (Figure 3) uses an InnoSwitch3-PD INN3879C IC. It requires only 54 components and delivers a power density of 14.0 W/in<sup>3</sup>, without an enclosure, measuring 1.89" (48 mm) × 1.81" (46 mm) × 0.94" (23.8 mm). The USB PD/PPS source capabilities are:

- PDO1: 5 V / 5 A (fixed supply)
- PDO2: 9 V / 5 A (fixed supply)
- PDO3: 15 V / 3 A (fixed supply)
- PDO4: 20 V / 2.25 A (fixed supply)
- PDO5: 3.3 V – 11 V / 5 A  
(programmable power supply, 45 W power-limited)
- PDO6: 3.3 V – 16 V / 3 A (programmable power supply)
- PDO7: 3.3 V – 21 V / 2.25 A (programmable power supply)

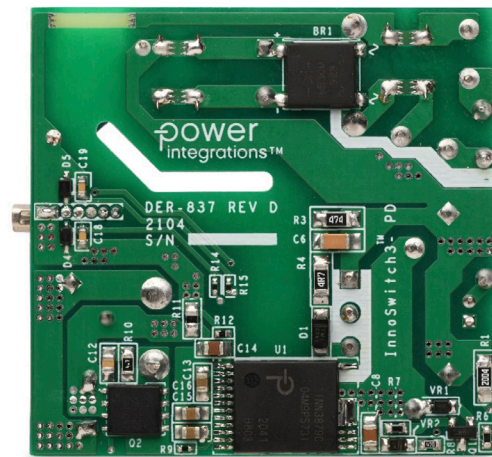
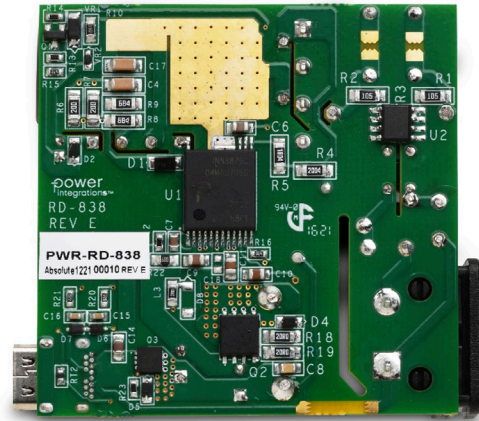


Figure 3: Reference design DER-837 delivers 45 W of power using only 54 components.

### RDR-838: 60 W USB PD 3.0 Power Supply

This reference design (Figure 4) has 61 parts and measures 2.24" (57 mm) × 2.24" (57 mm) × 0.76" (19.2 mm) for a power density or 15.7 W/in<sup>3</sup>, without an enclosure. The design is based on an INN3879C integrated controller and has fewer USB PD/PPS source functions:

- PDO1: 5 V / 3 A (fixed supply)
- PDO2: 9 V / 3 A (fixed supply)
- PDO3: 15 V / 3 A (fixed supply)
- PDO4: 20 V / 3 A (fixed supply)
- PDO5: 3.3 V – 21 V / 3 A (programmable power supply)



**Figure 4: Reference design RDR-838 delivers 60 W of power using only 61 components.**

## Summary

With the innovative InnoSwitch3-PD family of integrated flyback switcher ICs, designers have a new set of tools for rapidly developing highly efficient and low component count chargers and adapters that deliver full USB-C PD + PPS functionality. These fully-featured ICs include a choice of silicon or PowiGaN integrated power switches. They are fully protected on the input and output and enable solutions with half of the components needed for conventional designs while still delivering no-load power consumption as low as 14 mW. The compact InSOP-24D-package is optimized for high-volume manufacturing of high-density USB-C power solutions.

**For more information, please visit [www.power.com/innoswitch3-pd](http://www.power.com/innoswitch3-pd).**

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