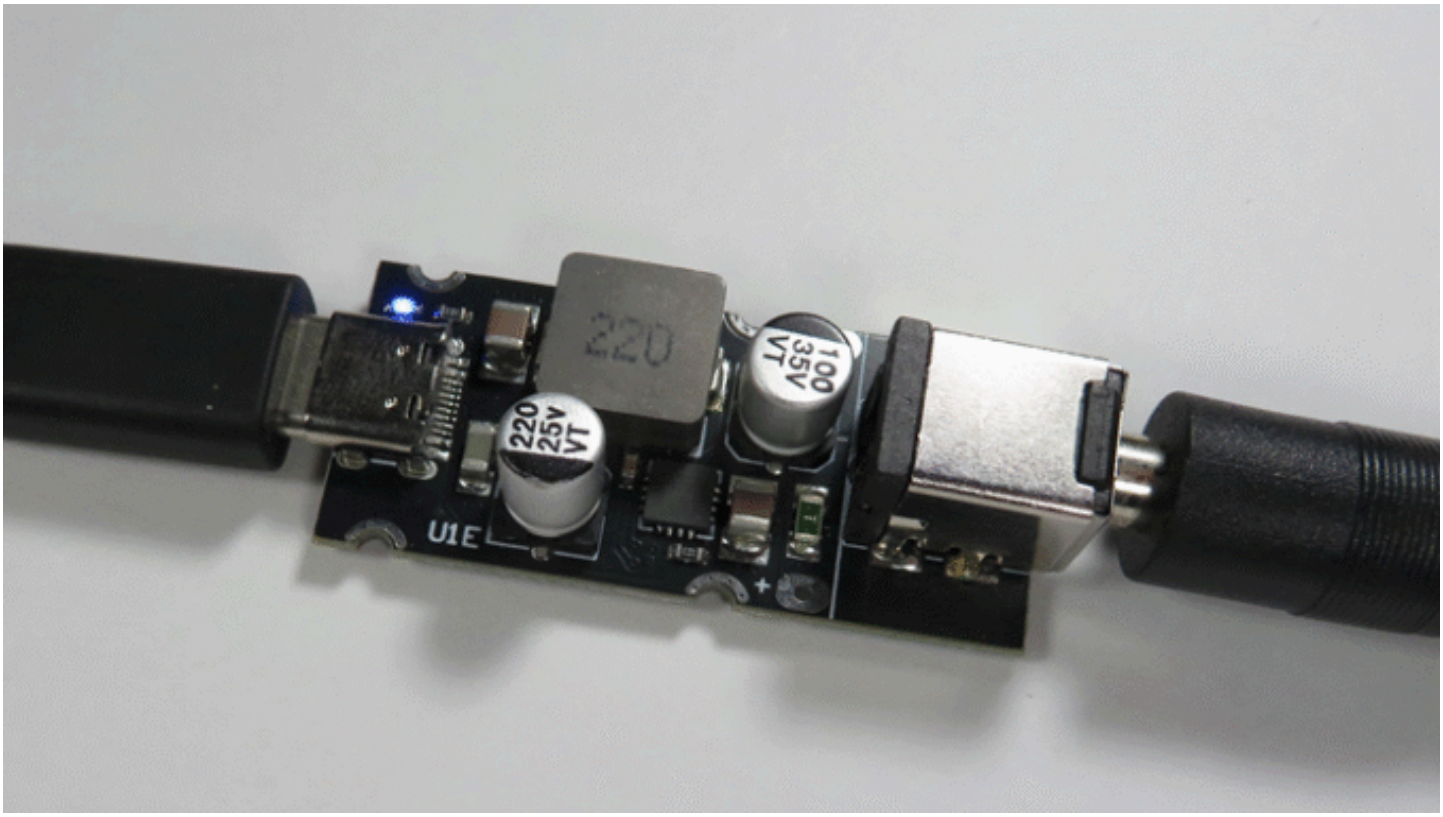
Review: USB-PD 65W Fast Charging Module (XPM52C)



This USB-PD (Power Delivery) Charging module is based on the *XPM52C 65W USB-PD Multi-protocol Buck Converter*. It allows USB devices (mobile phones, tablets, laptop computers, cameras etc) to be efficiently charged from a low voltage DC power source (8 to 30V DC) such as 12V/24V battery or power station.

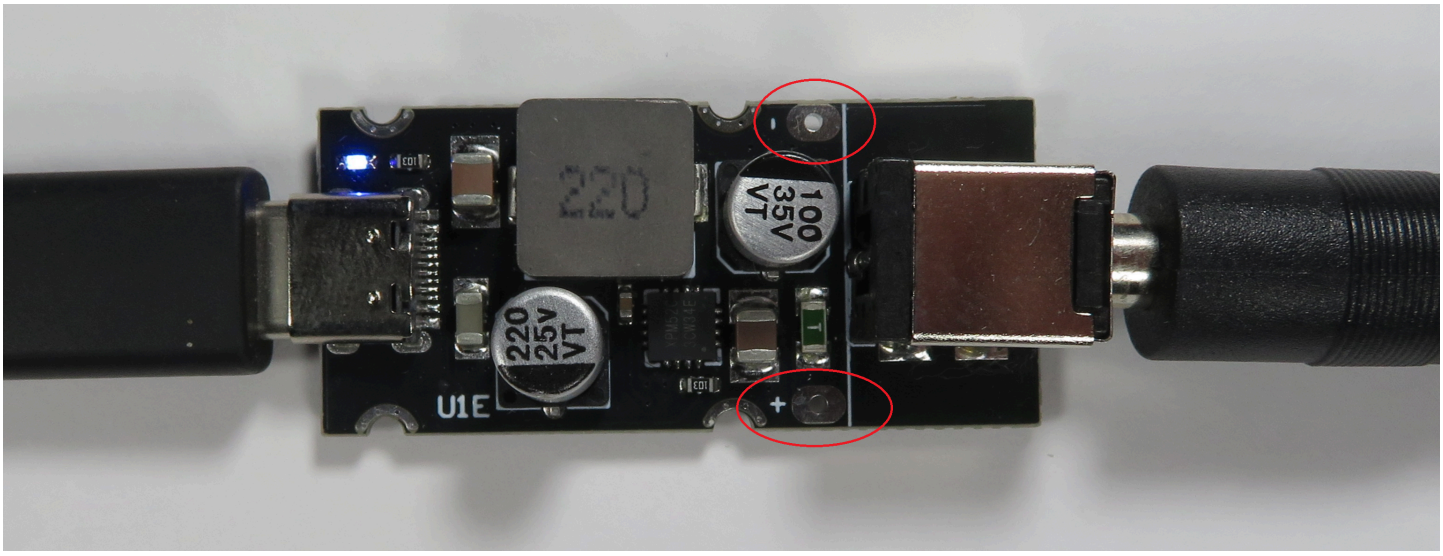
While my interest was in the USB-C power delivery capability, the device supports a range of legacy fast-charging protocols:

- USB Power Delivery PD2.0/PD3.2 including PPS
- USB Battery Charging BC1.2
- Qualcomm Quick Charge QC2.0, QC3.0 & 3.0+
- Apple 2.4A Protocol (12W)
- Samsung Adaptive Fast Charging AFC
- Huawei Fast Charging Protocols FCP/SCP/HVSCP
- MediaTek PE+1.1 and PE+2.0
- Xiaomi Charge Turbo 27W

This module is available from your usual cheap electronics sources such as **AliExpress**, **Amazon**, and Banggood. As the vendors normally don't list the main part in their descriptions, search for "PD 65W Fast Charging Module Type-C". Just make sure it has a 16 pin QFN16 device *(I suspect the SO8 variants are a different device).*

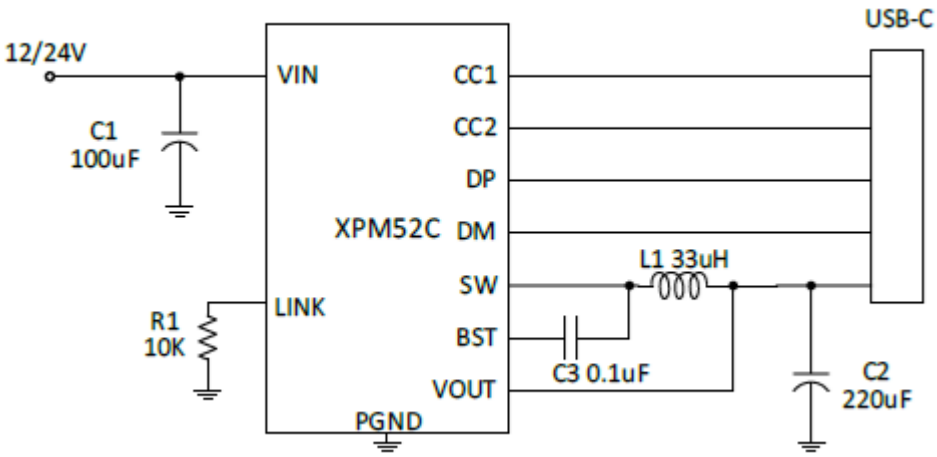
I purchased mine from Aliexpress vendor **Gaqqee Official Store** in October 2024 for $3.27 AUD (Approx $2.00 USD)

The board comes in a variety of different input supply options. There is a smaller version that allows the input to be attached by flying leads, or versions with a DC 2.1mm barrel socket (sometimes referred to as DC5521) or DC 2.5mm barrel (DC5525). I opted for the 2.1mm barrel.



PCB has solder pads for input supply. Versions are available without the DC Barrel Connector.

It is a highly integrated solution incorporating both the USB-C PD source controller and buck converter in a single QFN16 package with minimal component count.



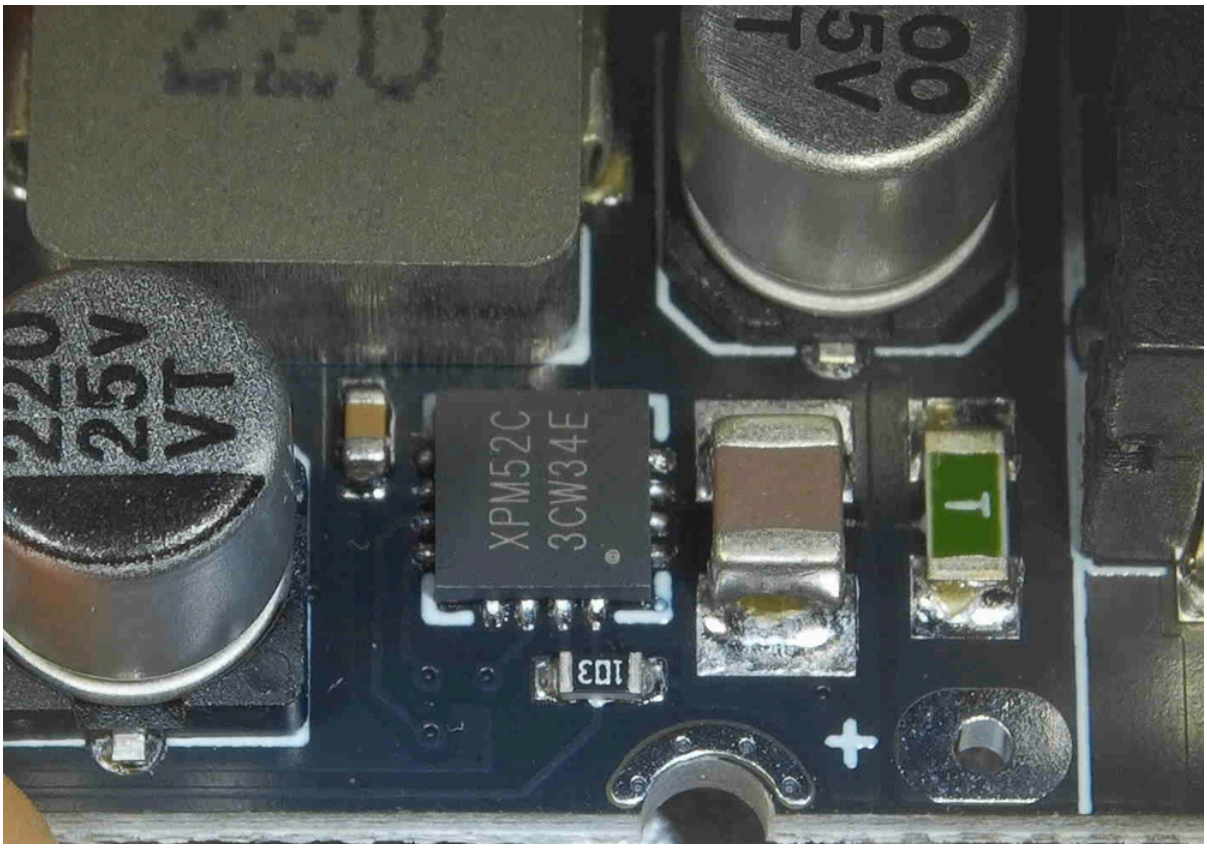
XPM52C Reference Circuit from Manufacturer's Datasheet.

Schematic

The XPM52C is made by Chinese Semiconductor manufacturer **Fine Made Microelecronics Group Co Ltd**.

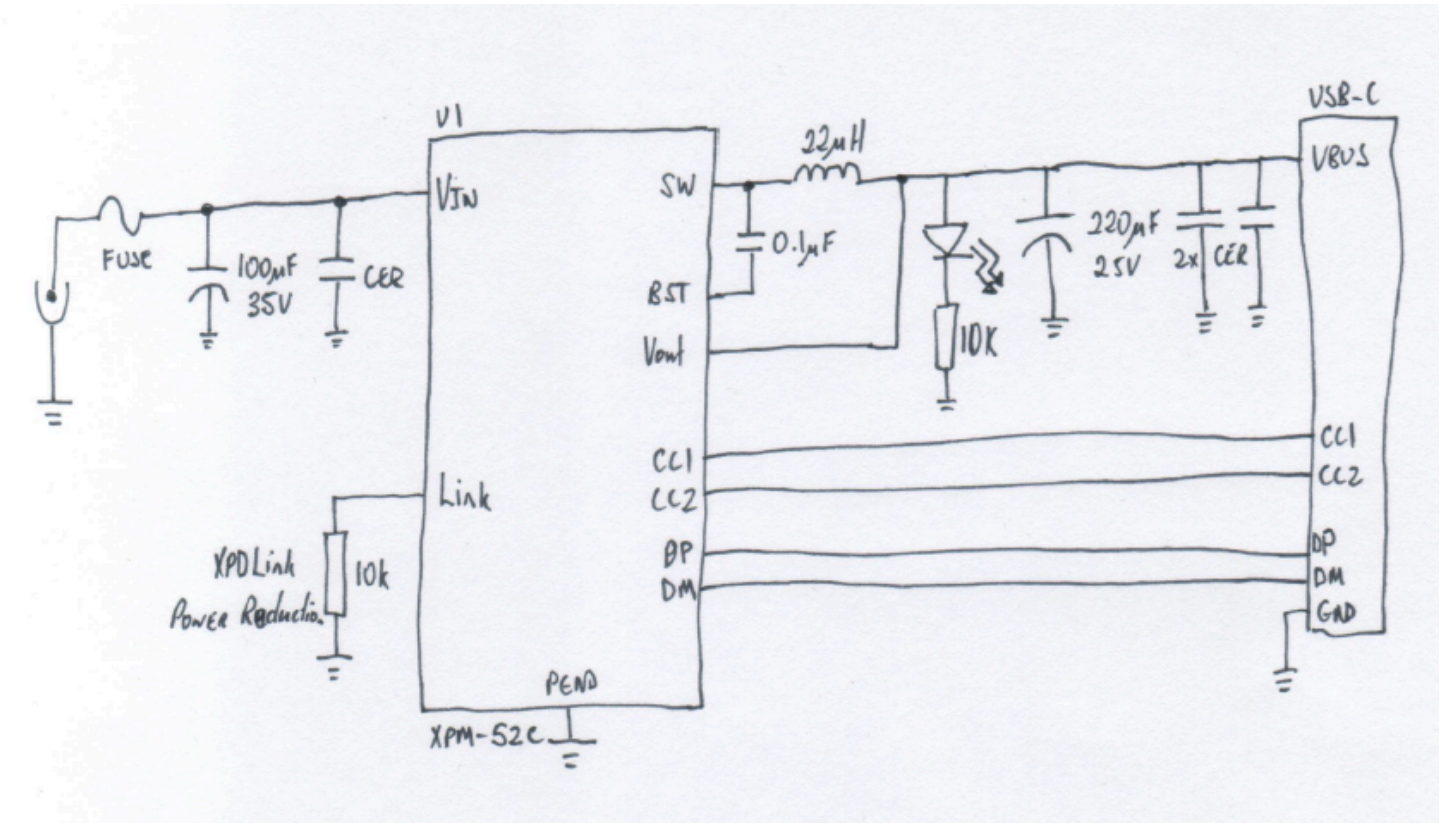
The datasheet appears to be only available in **Chinese**. However Google Translate appears to do a half reasonable job in translating it to **English (available here)**.

If you want to spin your own board or incorporate the device into your own design, the XPM52CPD65 is stocked by **LCSC** Electronics (**LCSC PN# C42460907**).



The heart of the module is the XPM52C

Below is the reverse engineered schematic of the module:



XPM52C USB-PD 65W Fast Charging Module Schematic

The PCB appears to be well designed. The module's schematic doesn't deviate too far from the manufacturer's minimal reference circuit. Fine Made calls only for a 100uF input cap and 220uF output

capacitor. The module goes beyond the minimum requirements and adds additional ceramic capacitors on both the input (x1) and output (x2) to better address higher frequency noise and ripple.

The module's input is fused with a SMD fuse, and a LED has been added to VBUS to show operation. This LED will be off, if no compatible sink device is attached.

The AliExpress listing indicates the input voltage is 8 to 30V. This range is also conveniently printed on the bottom silkscreen of the PCB. According to the datasheet, the XPM52C integrated circuit has an input operating range up to 31V with an absolute maximum 38V. However, it should be noted the electrolytic input capacitor is rated for 35V. The device will adapt advertised power delivery objects based on the input voltage.

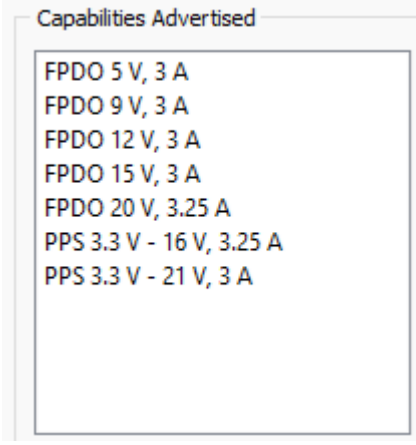
The device does have a UVLO (under voltage lock-out), but it should be noted that it probably won't protect your 12V battery. The device requires typically 7.3V to turn on (UVLO_UP) and will switch off when the voltage reaches 6.2V (UVLO_DOWN). Actual measurements with my device verified this hysteresis band.

There is not a lot of detail on the Link pin, however it allows multiple devices to be connected together and share/throttle back current. Aliexpress do have boards containing multiple XPM52C and one would assume these are linked together using this pin.

Power Delivery Objects (PDOs)

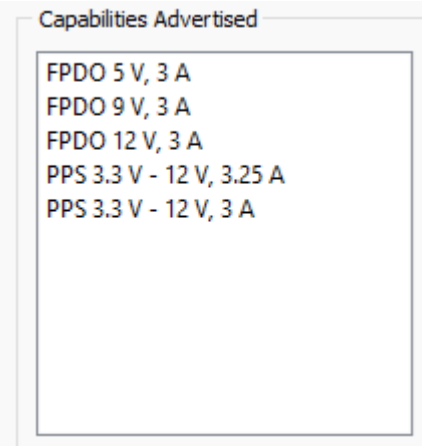
According to the XPM52C Datasheet, the device supports USB Power Delivery revision 3.1 and will adapt to the input voltage – *"Automatic adjustment of the protocol" and "Automatically identify input voltage and adjust output voltage"*. The Fixed PDOs (FPDO) are 5V, 9V, 12V 15V and 20V. In addition to the fixed PDOs, it also supports Programmable Power Supply (PPS) though advertising an Augmented PDO (APDO).

As the maximum PDO is 20V, in theory if we apply more than 20V we should obtain the device's full capability. At 24.0V, the device advertises:



As expected, we obtain the 5 Fixed PDOs up to 20V, 3.25A and two APDOs – 3.3 to 16V @ 3.25V and 3.3 to 21V @ 3A.

When a 12.0V power supply is used as the source, the device advertises the following:



This is consistent with our expectations. As the device is a buck converter running on 12V, it cannot provide 15 or 20V and hence does not advertise that capability. For the APDOs, it limits the maximum voltage range to 12V.

But the device is not perfect, and the step(s) seem quite course, or actually – binary. At 8V (minimum input voltage), the device advertises capabilities up to 12V (for both FPDO and APDO) despite not being able to deliver this. If I request 9 or 12V FPDOs, the maximum voltage I obtain is 7.86V.

Through experimentation, there seems to be a single input voltage threshold around 19V. Under 19.0V, the device will advertise FPDOs and APDOs up to 12V. Above 19.0V, the device will advertise FPDOs and APDOs up to 20V. This means if you apply 16V, you will not get the 15V FPDO.

I also observe on one device, it is no longer advertising APDOs. I suspect I issued the device something that it didn't like, but on other devices (mains powered USB Chargers) normally it will suspend advertising APDOs until the device is powered down (reset). In the case of the XPM52C, it appears this fault is stored and persistent after a power cycle. I've yet to work out how to restore functionality on that device.

Power Dissipation

According to the datasheet, the device will shutdown if the die temperature reaches 150 degC.

A load test was performed at an output voltage of 20V and load of 3.25A (Programmable DC Load). With an ambient temperature around 20 degC, the device seemed to sustain this 65W load without issue, even though the PCB is quite small and appears to be the only means of heat distribution.



Conclusion

This has become one of my favorite 12V to USB-PD chargers due to its simplicity (low part count) and extensive protocol support.