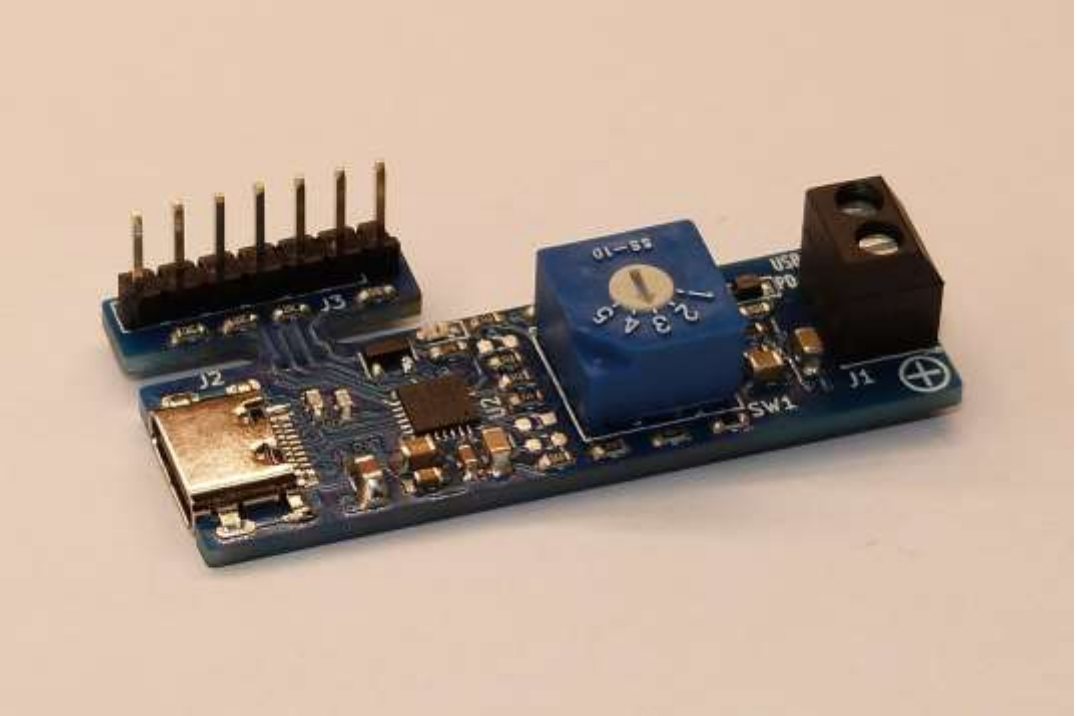

P42 USB-C Power Sink
BCR (Barrel Connector Replacement
Rev2.0

Designed by Pier42 Electronics Design

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https://www.tindie.com/stores/pier42/

https://hackaday.io/project/168762-usb-c-power-delivery-sink-bcr

https://github.com/wolfgangfriedrich/

Table of Contents

Introduction

USB-C PD offers the option to negotiate power delivery from a compatible power supply. This board plays the role of a sink device, enabling any device to be powered from a USB power supply. Any type of power connector can be attached through a 2-pin screw terminal or directly soldered into the PCB for a lower profile.

The voltage can be set to 5V, 9V, 12V, 15V or 20V and the current is set fix to 3A. Current up to 5A is possible, but some heat management for the 2 FETs on the back of the board is required.

BCR stands for Barrel Connector Replacement, the term is invented by Cypress, the manufacturer of the controller chip in use here.

This board has the goal to replace random power adapters with a standardized way to use a USB-C power delivery (USB PD) adapter instead. For regular operation, no programming or software configuration is involved with this design. All options are set through resistor values.

If needed an I2C interface to a microcontroller is available, to access status and control registers. This part of the board is separated through a break-off tab (mouse bits) and can be snapped off.

I made the conscious design decision to not add a USB-A connector option at the output end. I did not want to build a device, that is capable of putting more than 5V on the VBUS pin of a regular USB cable and potentially destroy the device that is plugged in.

All Features:

- USB-C PD Power Delivery Sink
- Selector switch for 5V, 9V, 12V, 15V or 20V
- Max current 5A, settable in 250mA steps through resistor options
- Red LED to indicate failed power request
- I2C telemetry interface to controller chip
- Snap off option for telemetry interface
- For fixed voltage, the switch can be replaced by wire jumper
- small form factor to be heat shrinked as part of the power cable
- Size 48mm x 15mm (without telemetry interface)
- Height 12mm with screw terminal and switch, 6mm without.
- 2oz copper to safely handle 5A
- Lead free RoHS compliant

Hardware

The USB-C PD Sink is designed as small as possible to be assembled in-line with the power cord that is going to be upgraded to USB-C. Alternatively it can be connected to a microcontroller through I2C and some IOs to access telemetry configuration and status.

I2C address

The I2C address of the chip is 0x08 (7-bit format).

All registers and communication is described in 'Cypress EZ-PD™ BCR Host Processor Interface Specification Doc. No. 002-26784' and it is somewhat tricky.

Host Port Interface

Pin Nr	Name	IO	Description
1	Vcc	Power	+3.3V, only to be used as an indication that the BCR is running, not to power any devices.
2	INT	IO	Interrupt, active low with 10K Ohm pull-up.
3	GPIO	IO	General purpose Input or Output
4	FLIP	IO	Indicates orientation of USB-C jack with 10K Ohm pull-up.
5	SDA	I2C	I2C Data line with 10K Ohm pull-up.
6	SCL	I2C	I2C Clock line with 10K Ohm pull-up.
7	GND	Power	Ground return

Table 1: Host Port Interface Pins

Voltage and Current Select

The device is pre-configured to request 3A of current and the voltage is selectable by the rotary switch to be 5V, 9V, 12V, 15V or 20V. A table on the bottom side of the board shows the mapping of the switch positions to the selected voltage.

All values can be adjusted by changing the respective resistors according to the 4 tables below. An assembly drawing to locate the resistors is appended as well.

Voltage requested [V]	Pull-up resistor R10 [Ohm]	Pull-down resistor - selected through rotary switch [Ohm]
5	open	0 (**R15**)
9	5.1 k	1 k (**R16**)
12	5.1 k	2.4 k (**R17**)
15	5.1 k	5.1 k (**R18**)
19	5.1 k	10 k - not implemented
20	5.1 k	open (**R19**)

Table 2: Maximum Voltage Select Resistors

Voltage requested [V]	Pull-up resistor R7 [Ohm]	Pull-down resistor R12 [Ohm]
5	open	5.1 k - actual setting
9	5.1 k	1 k
12	5.1 k	2.4 k
15	5.1 k	5.1 k
19	5.1 k	10 k
20	5.1 k	open

Table 3: Minimum Voltage Select Resistors

Current set [A]	Pull-up resistor R8 [Ohm]	Pull-down resistor R13 [Ohm]
0	open	0
1	5.1 k	1 k
2	5.1 k	2.4 k
3	5.1 k	5.1 k - actual setting
4	5.1 k	10 k
5	5.1 k	open

Table 4: Coarse Current Select Resistors

Current set [A]	Pull-up resistor R8 [Ohm]	Pull-down resistor R13 [Ohm]
+0	open	5.1 k - actual setting
+250	5.1 k	1 k
+500	5.1 k	2.4 k
+750	5.1 k	5.1 k
+900	5.1 k	open

Table 5: Fine Current Select Resistors

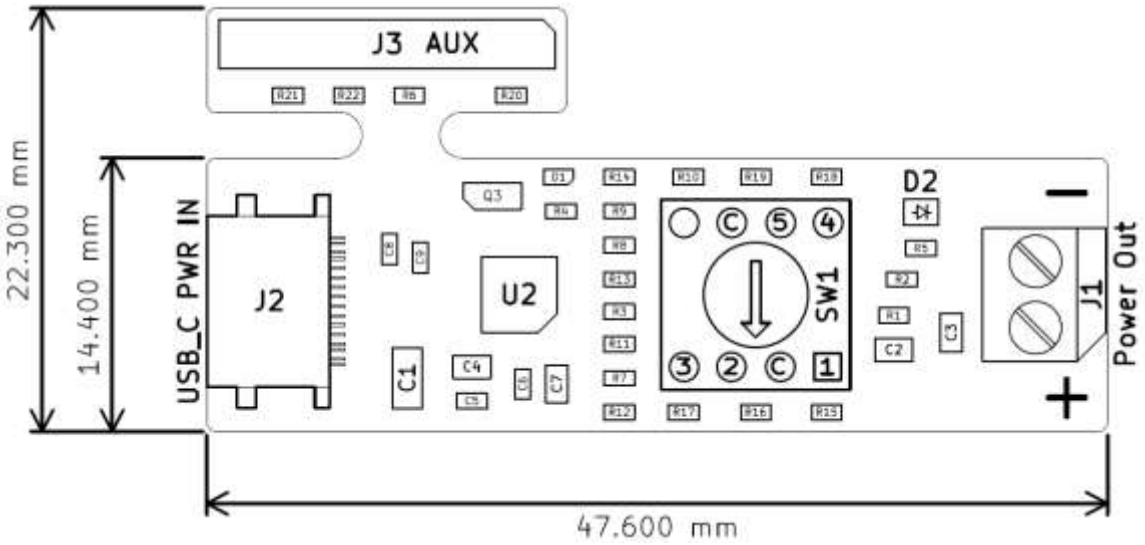

Figure 1: Assembly Drawing Top side with component designators

Figure 2: Assembly Drawing Bottom side with component designators

Software

Everything is selected through resistors and the switch, no software required. Please move along, nothing to see here.

Telemetry

I managed to talk to the BCR over the I2C interface, which is not quite straight forward, as the chip adds a mandatory 3 to 5 cycle clock stretch. My solution so far is a bus pirate set to I2C 5 kHz clock speed. With those commands I am able to read out ID and status registers, even though the response does not match the datasheet for the IDs.

List of Bus Pirate commands to read registers 0x0000, 0x0002, 0x100D, 0x1008:

```
[0x10 0x00 0x00[0x11r]
[0x10 0x02 0x00[0x11rr]
[0x10 0x0D 0x10[0x11r]
[0x10 0x08 0x10[0x11r:4]
```

The telemetry connector can be removed by snapping it off along the break-off tab. For a populated board I would recommend to score a line along the holes on both sides first to put a little less stress on the components nearby.

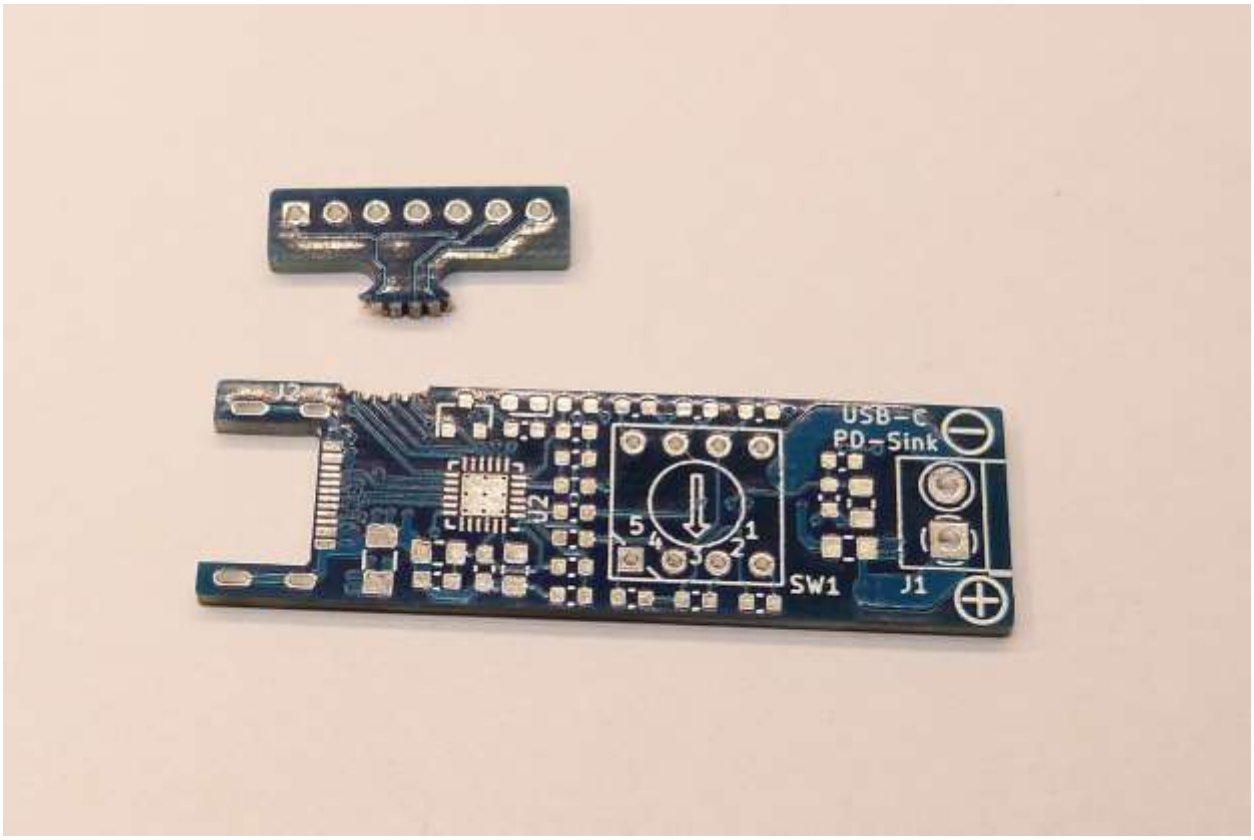

Figure 3: Break-off tab demo on a not populated board.

This is a living document. Any missing content will be added as required.

Revision Control

Version	Data	Changes
1.0	26. Jan 2020	Madman Chicken-Scratch Manifesto
	1. Feb 2020	Added 5A heat management statement