Power Depot FJ Overland Build

Using Power Depot Distribution PCBs in a FJ Cruiser Overlanding Build.

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V 1.0

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2 Overview

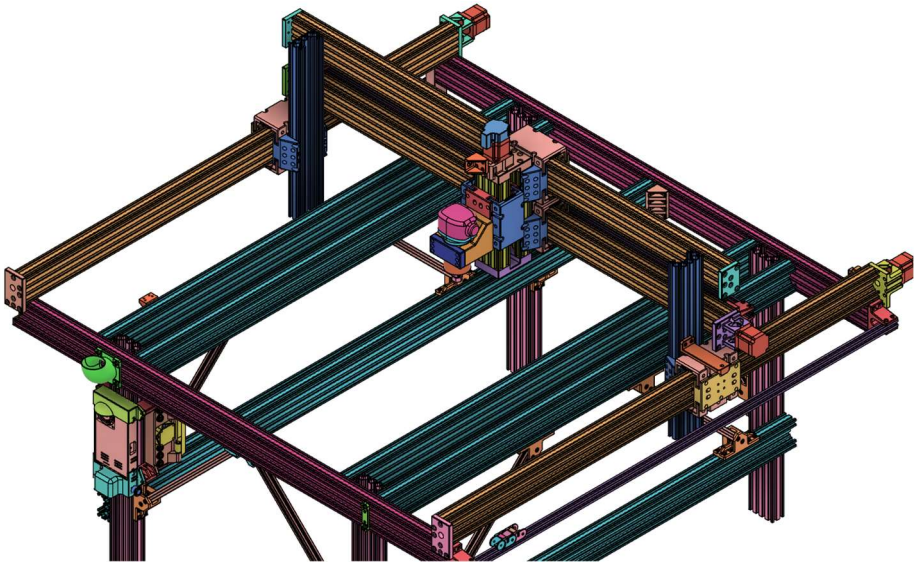
The project started out with the goal of building a simple drawer system for my FJ. That simple goal turned into this Power Depot project! I may decide to split this project into 2 in the future as the Power Depot electronics evolve but for now the electrical and drawer system is presented as a single project.

I have done a fair amount of hiking and the challenge of limiting what I take with in order to limit the weight and size of the pack has always been a challenge I enjoyed.

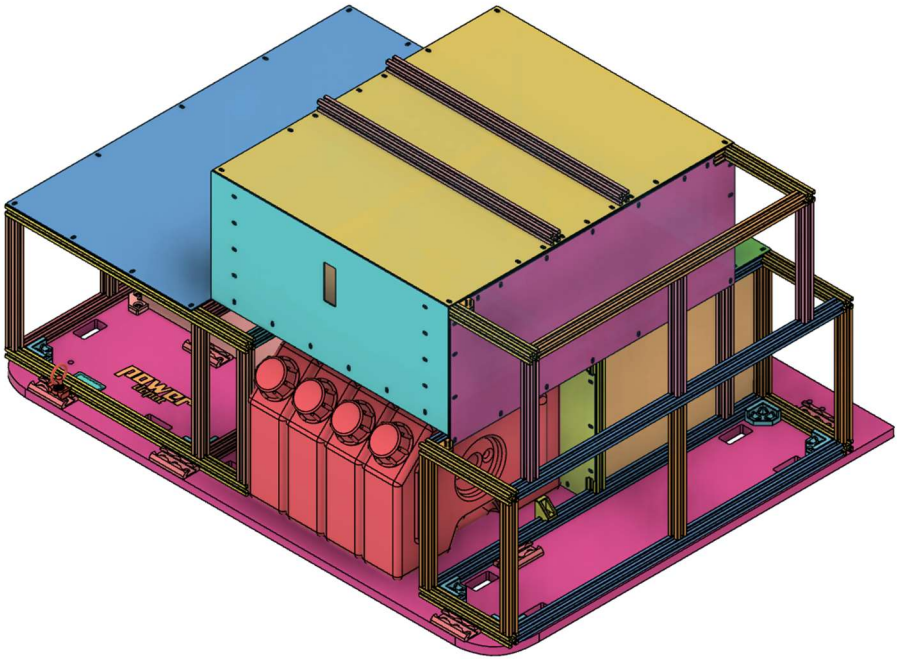
I like to think of this as a "backpack for your FJ". My goals were as follows:

- the FJ has limit space in the back and I was determined to fit everything I would need for a trip in the back.
- a place for water
- a place for the electrical system, this would need to cater for the auxiliary battery being charged from
    - the vehicle alternator
    - being charged from AC shore power
    - being charged from solar panels
- a place for the auxiliary battery, I chose the back of the vehicle as I did not want the aux battery exposed to the high temperatures under the bonnet of the vehicle.
- a place for camping gear like
    - A compact table
    - 2 compact chairs
    - A tent
    - Sleeping bags
- a drawer for storing groceries and cooking gear
- a toolbox for storing tools and basic recovery gear

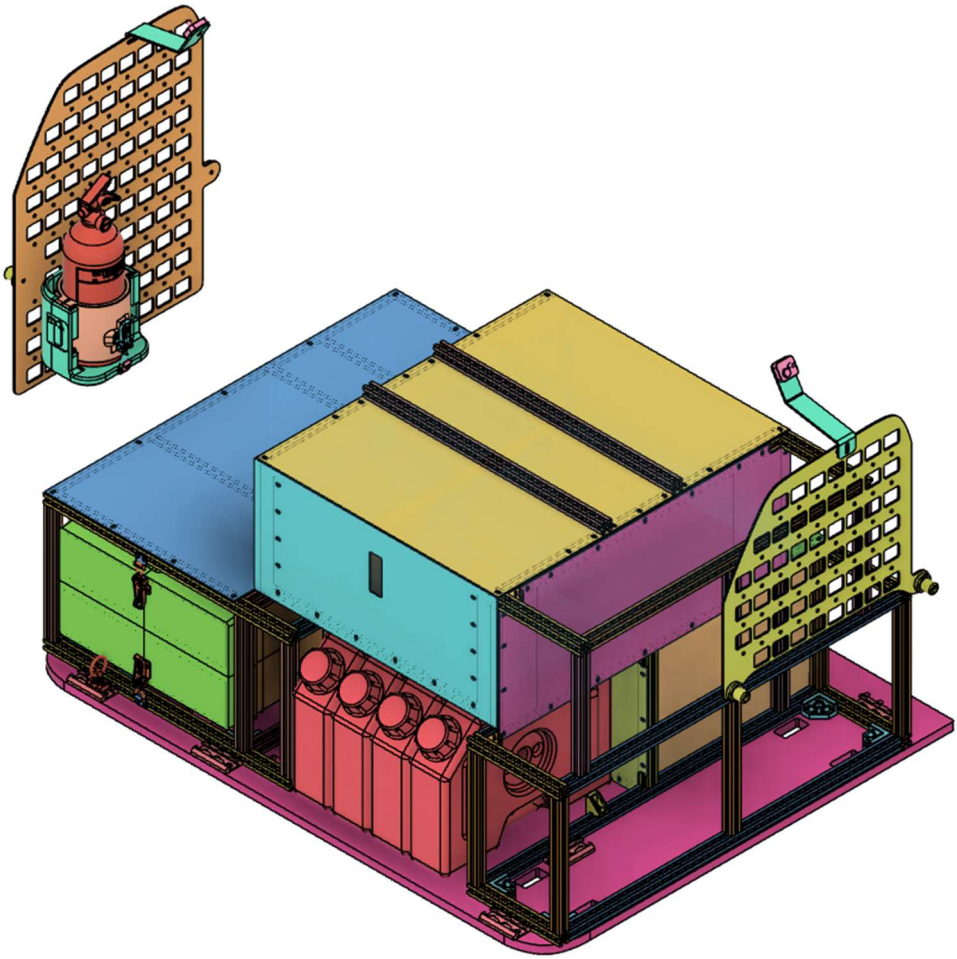
- a place for a refrigerator
- no removal of the rear seats
- only existing mounting points to be used.
- clothing and toiletries can go in a rug sack on the backseat of the vehicle.
- system must be modular and cater for future expansion and modification
- system must be built with the tools at my disposal or parts outsourced must be done for a reasonable cost. The only parts outsourced were the laser cutting of the 2mm aluminium panels, the powder coating of those and the laser cutting of the 2mm stainless steel panel used in the electrical system. The MDF base panel I routed on my home-built CNC router, another project I plan on open sourcing in the future.



- use 3d printing wherever possible using a basic Ender 3 or equivalent printer.
- Design the electrical PCB's to minimize physical wiring, try to be as "plug and play" as possible



The picture above shows the base unit, I later added the toolbox, mole panels and extinguisher mount. After taking the system on a 2000km overlanding trip I can say it worked out great, I was concerned that there would be rattles considering the construction technique used, but so far, the system has been solid and has met all my requirements.



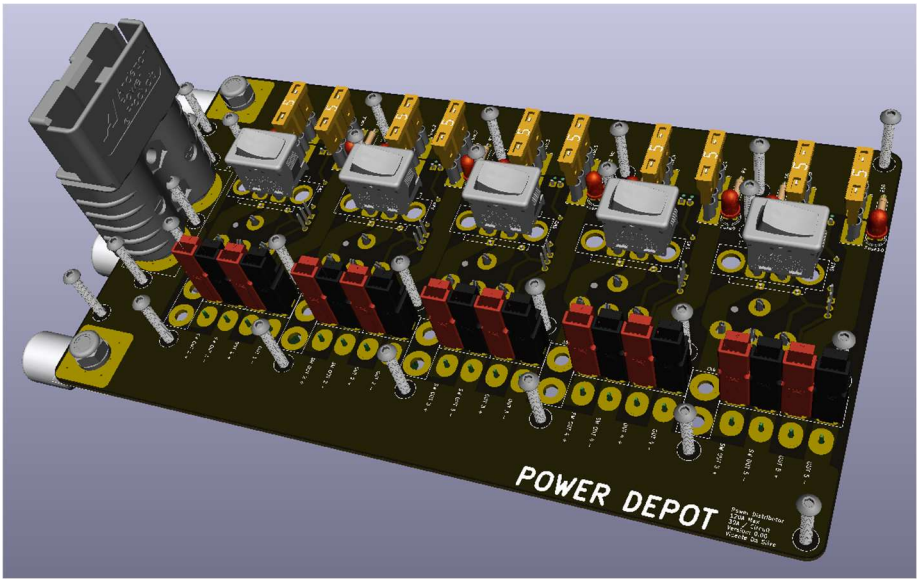
The toolbox is a work in progress, more of a prototype at this stage.

3 Power Depot PCB's

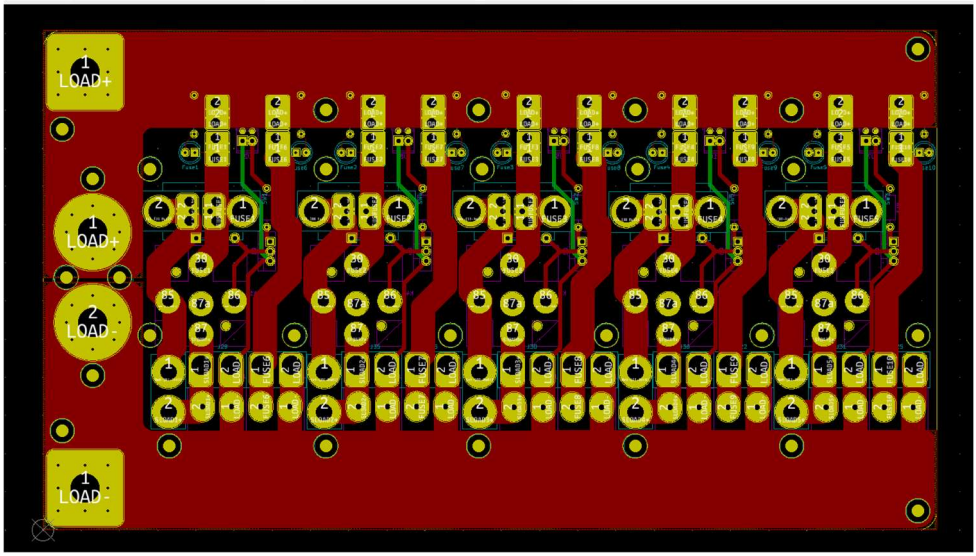
3.1 Power Depot Auxiliary Distribution PCB

This is the Power Depot Auxiliary Distribution PCB. Schematics and PCB layout are on the Github page, KiCad was used.

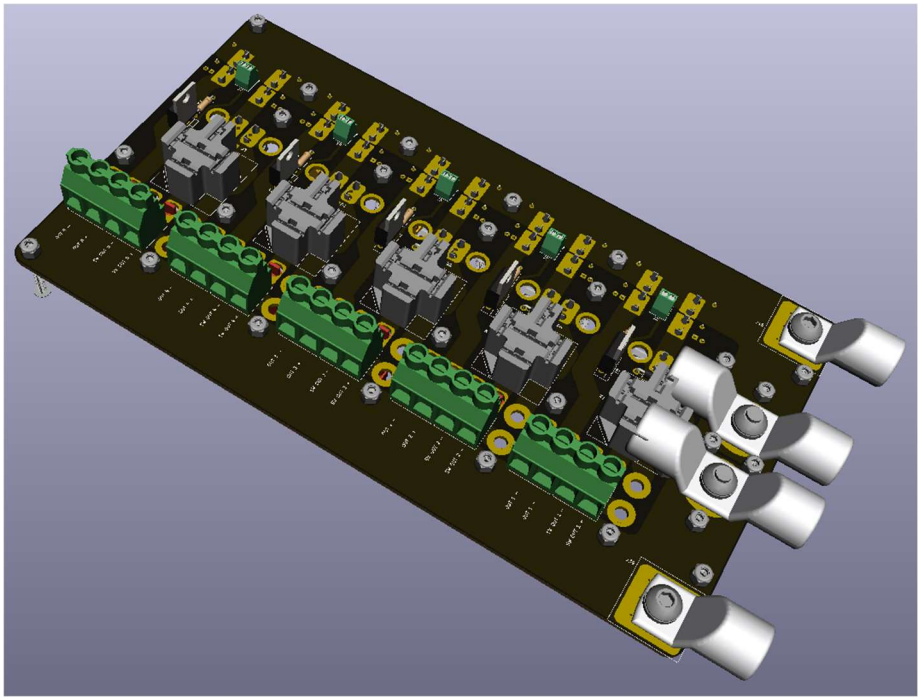
- It allows for connection to 12V via 5 automotive relay switched fuse protected circuits and 5 non switched fuse protected circuits.
- Each circuit has a LED which lights up should a fuse blow, providing a load is connected.
- Each circuit has a 30A Max capacity.
- Transistors can be connected to the board to allow remote switching of the relay-based circuits. If this feature is not used a jumper must be connected for each circuit to bypass this feature.
- The switched circuits can be configured in a number of ways by adding jumpers or using different mount points on the board, e.g. the 5 circuits can be configured to not use a relay. See the schematic for details.
- Multiple footprints are provided for the switches allowing different switch configurations to be used. I used the following switch https://www.digikey.co.za/en/products/detail/e-switch/R1966ABLKBLKFF/210519
- The Max capacity of the board is 120A. This is based on the track widths and thickness used when manufacturing the PCB. Tracks are duplicated on both sides of the board to increase current carrying capacity.
- Connection to the circuits can be made via a Power Pole Anderson connector or via the screw terminals on the other side of the PCB.
- Input power to the board is made via either a Board Mounted 120A Anderson plug or via 2 lugs.



KiCad rendering



Top Layer



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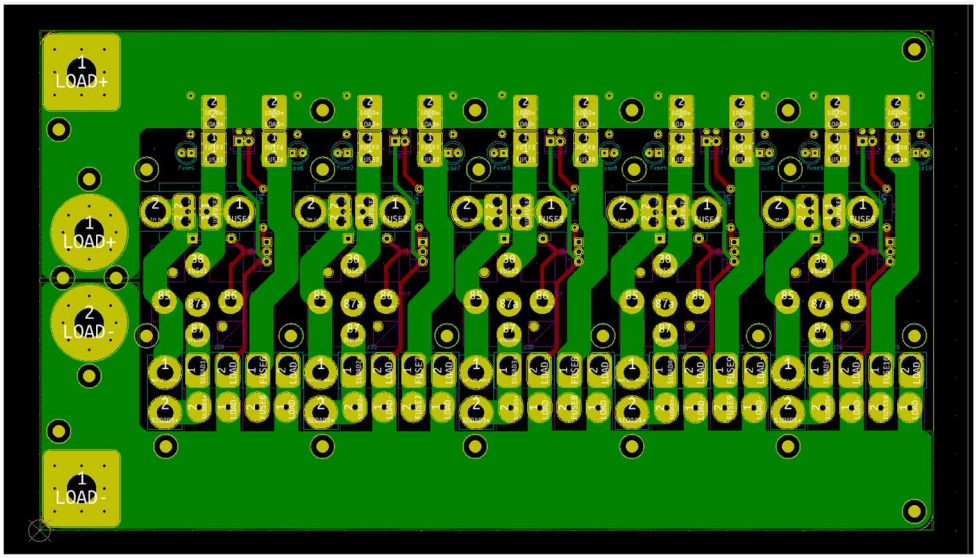

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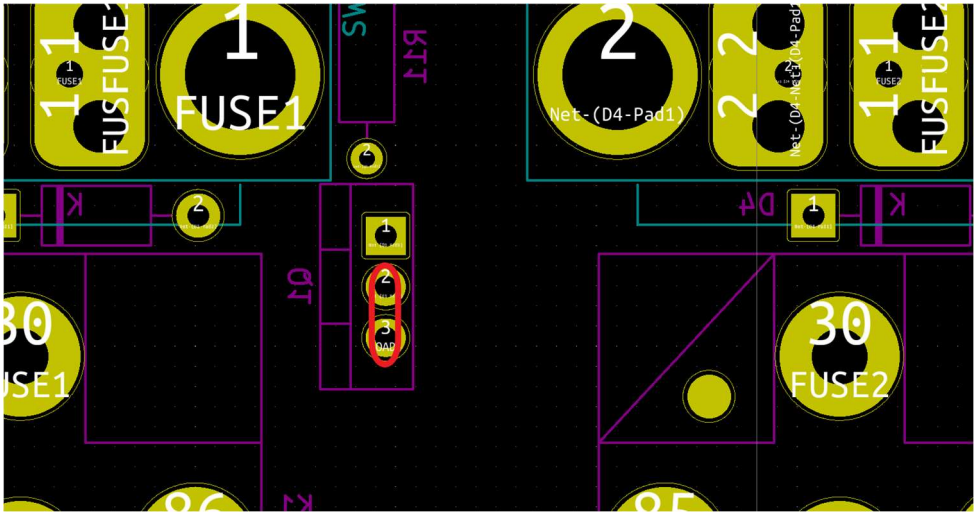
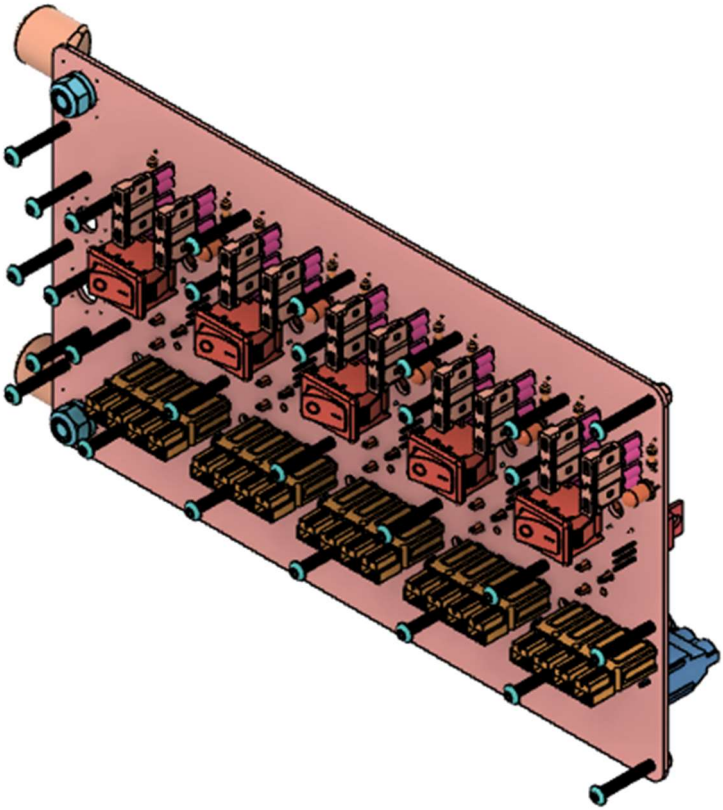


Jumper location needed for each switched circuit (5 of) if no remote relay switching used.

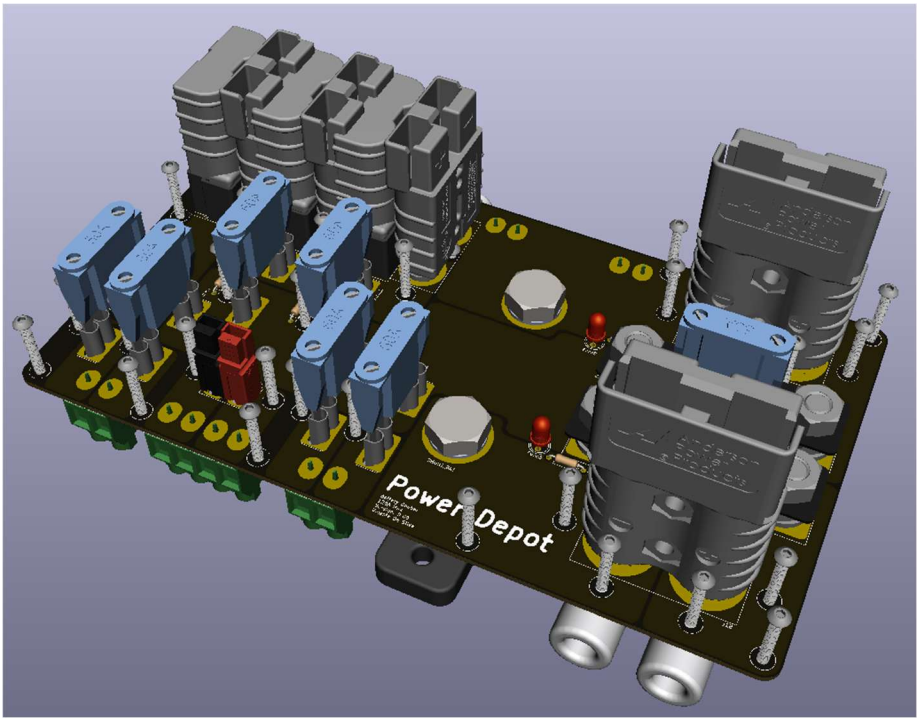


PCB in Frame model

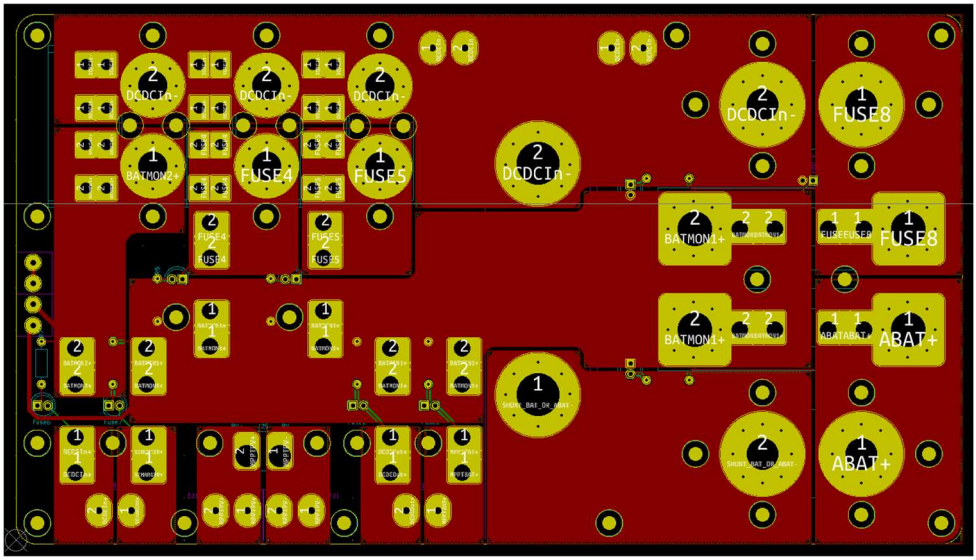
3.2 Power Depot Battery Distribution PCB

This is the Power Depot Battery Distribution PCB.Schematics and PCB layout are on the Github page, KiCad was used.

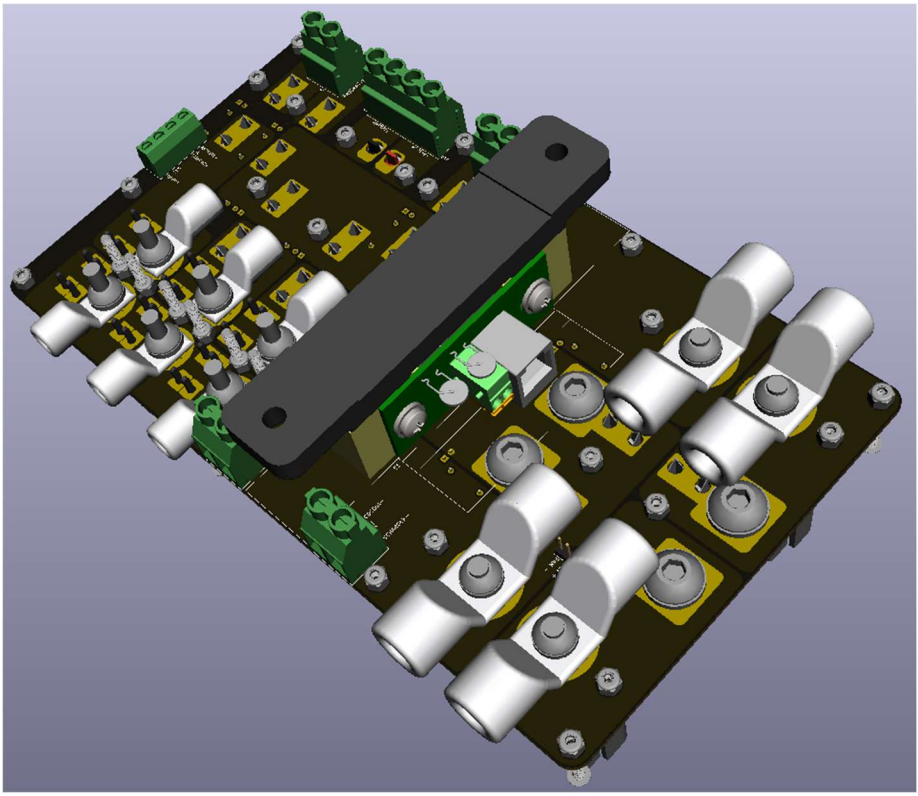
- It has 2 high current outputs via a female 50A Anderson plug socket or via 2 board mounted Anderson plugs. 50A capacity
- Input for the house battery via a female 50A Anderson plug socket or via 2 board mounted Anderson plugs. 50A capacity
- Input for the Auxiliary battery via a 120A Anderson plug or via 2 Lugs.120A capacity.
- Inputs for a DC DC charger, Solar charger or an AC Shore charger. These inputs are made via screw in terminal blocks. These inputs have a 30A max capacity.
- All inputs and outputs protected by a Maxi or Mega fuse.
- The Victron BM712 shunt is attached directly to the board.
- Each circuit has a LED which lights up should a fuse blow.



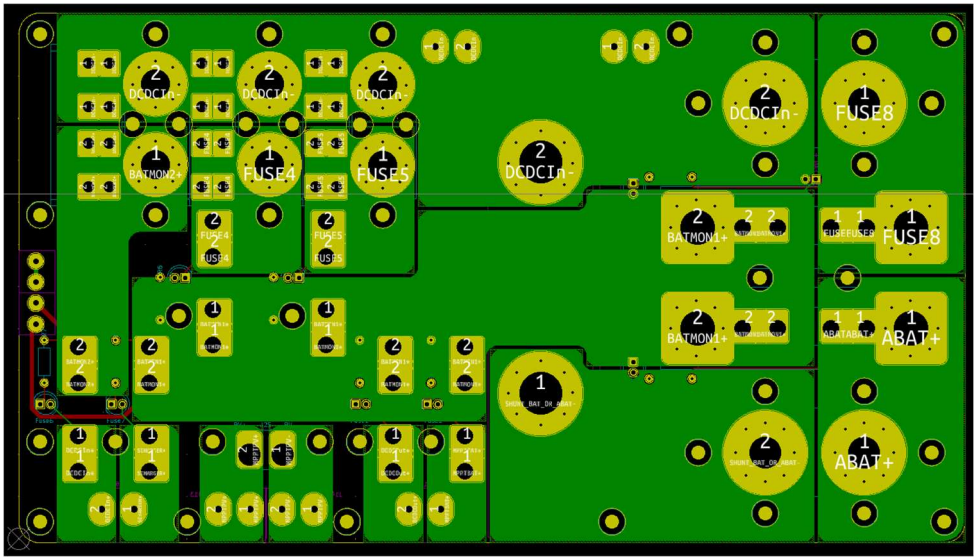
KiCad rendering


DCDCIn-
DCDCIn-
DCDCIn-
BATMON2+
FUSE4
FUSE5
DCDCIn-
DCDCIn-
FUSE8
BATMON1+
BATMON1+
FUSE8
ABAT+
ABAT+

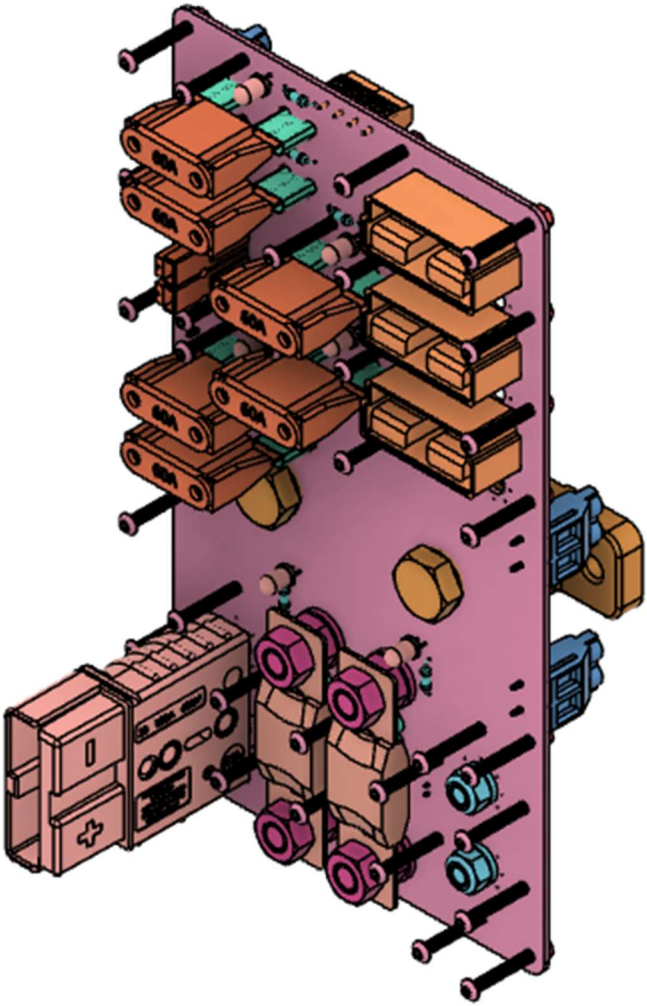
Top Layer



KiCad rendering



Bottom Layer



PCB in Frame model

4 Materials Used

Electrical components used

http://www.digikey.co.za/short/n338fh0p

Other connectors from

http://uk.anen-power.com/mkljq.html

The following materials were used.

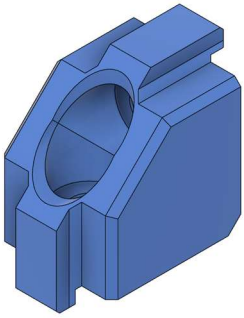
- 1 Power Depot Battery Distribution board
- 1 Power Depot Auxiliary Distribution Board
- 16mm MDF for base plate
- T-Slot Extrusion (I used V-Slot Extrusion)
- 2mm Aluminium Panels (laser cut)
- 2mm Stainless steel for electrical panel (laser cut)
- Stainless Steel screws and nylon nuts, mostly M5, various lengths
- Drop In M5 T Nuts
    - https://www.amazon.com/dp/B086MKNYDS?psc=1&ref=ppx_yo2_dt_b_product_details
- $6mm^2$, $16mm^2$,$35mm^2$ cable
- 100AH Lead Acid Battery
- Drawer Slides
    - https://4x4direct.co.za/615-loose-slides
- 1m Cargo Track extrusion
    - https://4x4direct.co.za/603-cargo-tracks-and-fittings
- Cargo Track fittings
    - https://4x4direct.co.za/cargo-tracks-and-fittings/5953-cargo-track-fitting-single-stud-anchor-0606110661928.html
- 5L Adventure Tanks

    - https://www.pioneerplastics.co.za/collections/outdoor-water-tanks/products/plastic-adventure-tank-5l-tank
- Dometic CFX28
    - https://www.dometic.com/en-us/professional/mobile-delivery-solutions/compressor-coolers/dometic-cfx-28-145540
- Victron DC DC Charger (I used the 18A 12V version)
    - https://www.victronenergy.com/dc-dc-converters/orion-tr-smart
- Victron BM712 Monitor
    - https://www.victronenergy.com/battery-monitors/bmv-712-smart
- Victron Blue Smart Charger (30A)
    - https://www.victronenergy.com/chargers/blue-smart-ip22-charger
- Victron Solar Charger (not shown in pictures, future upgrade)
    - https://www.victronenergy.com/solar-charge-controllers/smartsolar-mppt-75-10-75-15-100-15-100-20
- Handle for Drawer
    - https://4x4direct.co.za/locks-and-catches/6292-canopy-locks-small-single.html
- Cable Lugs
    - https://www.tsawelding.co.za/products/cable-lug
- In Line Fuses
    - https://www.outdoorwarehouse.co.za/product/national-luna-heavy-duty-4-way-fuse-holder/?gclid=Cj0KCQiAw9qOBhC-ARIsAG-rdn7mA8lDtxQRkOV1sKHvnKQP-tQPcvUWbgQ9oL8-lQMtGJTZoILqVwAaAmtpEALw_wcB
- Latches

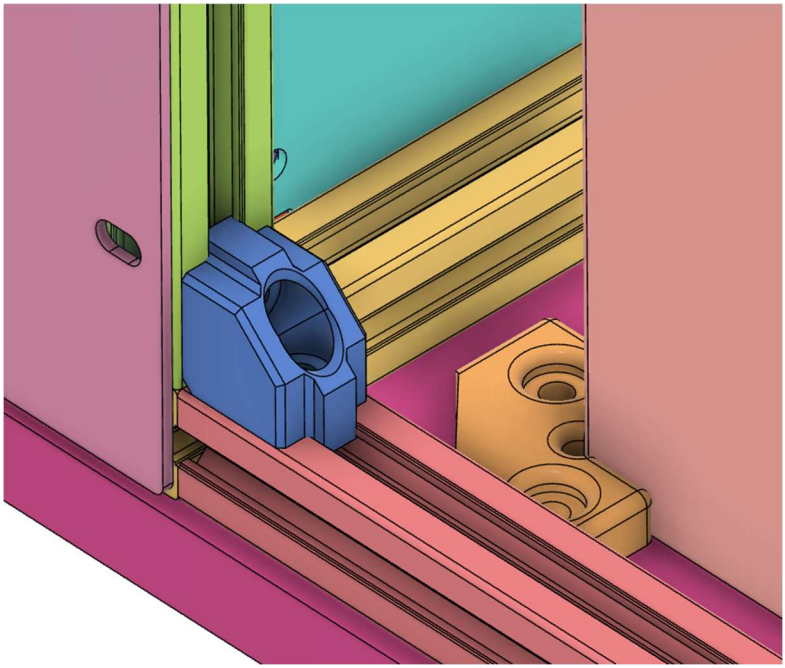
    - https://4x4direct.co.za/locks-and-catches/8471-throw-over-catch-small-72-82mm.html
- Straps
    - https://seatosummit.com/product/bomber-tie-down/
- Lots of 3D Printed parts

5 Base Assembly

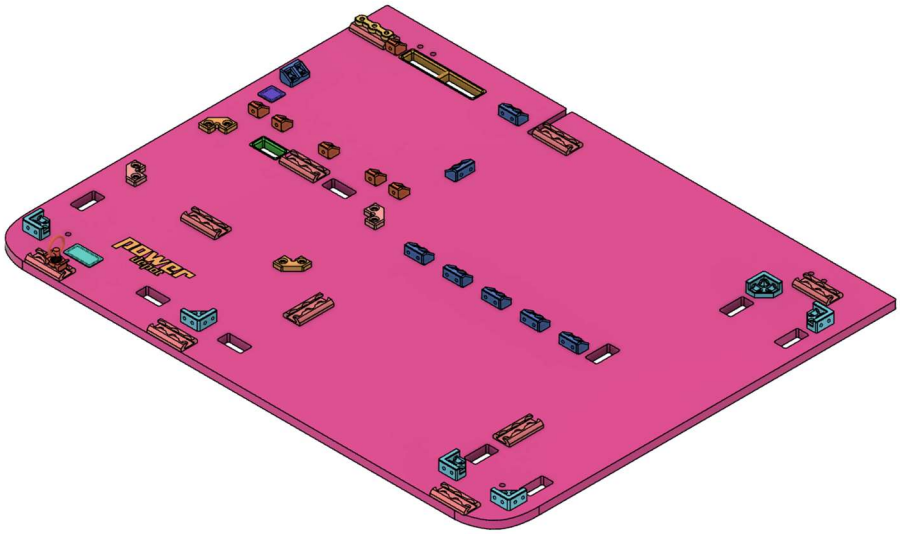
5.1 Extrusion Connections



To connect the extrusions, I used the FrameTieV3 3D printed part. Each Tie is mounted with 2x M5 12mm Button Head Hex screws and 2x M5 drop in T-Nuts. Over 100 of these Ties were used. The Step model does not include all of them, insert them in as many corners as you can.

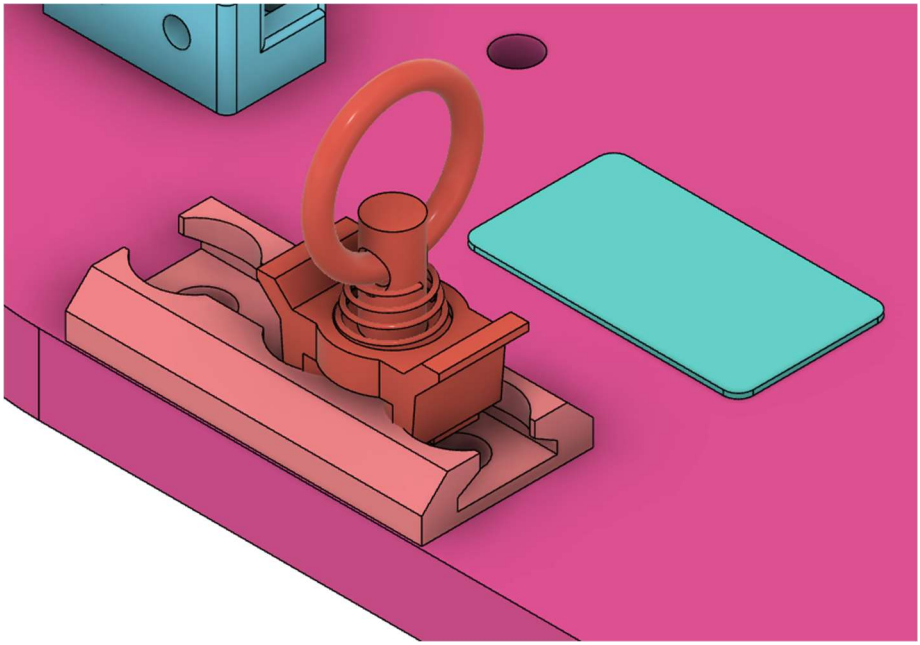


5.2 Base Plate

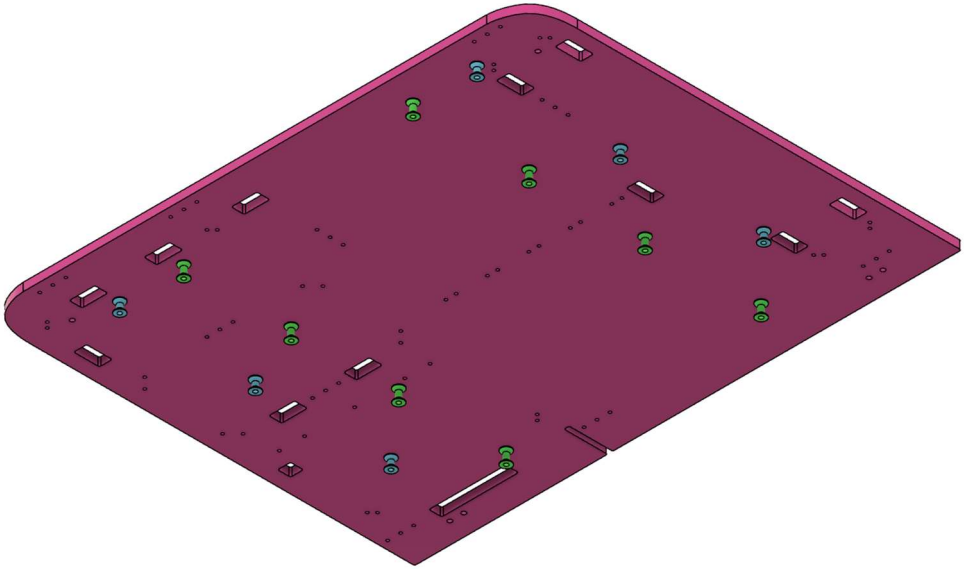


The base plate is 16mm MDF. Various brackets are mounted on it for attaching the extrusion, the battery mounts and the cargo tracks. The rectangular holes allow for routing cables underneath the panel for future projects.

There are 3D printed parts for filling in these holes where they are not used, or for lining the holes where they are. The model only contains 1 of each type, print as many as you need.

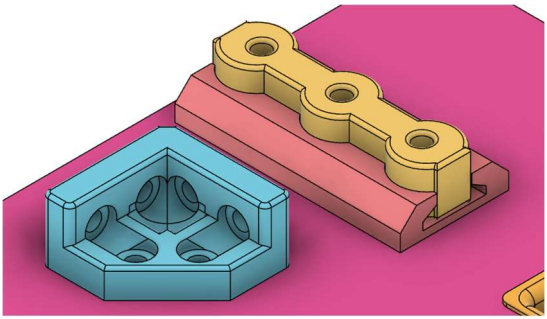


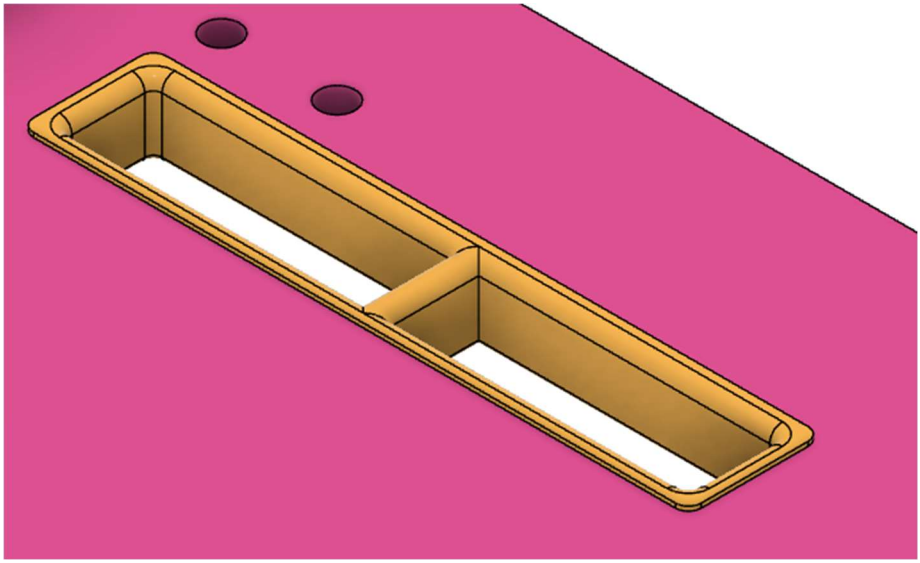
I am using cargo rack mounts, which I cut from a 1m length of aluminium cargo rack extrusion. These mounts allow me to secure straps to tie down the battery, water containers and fridge.

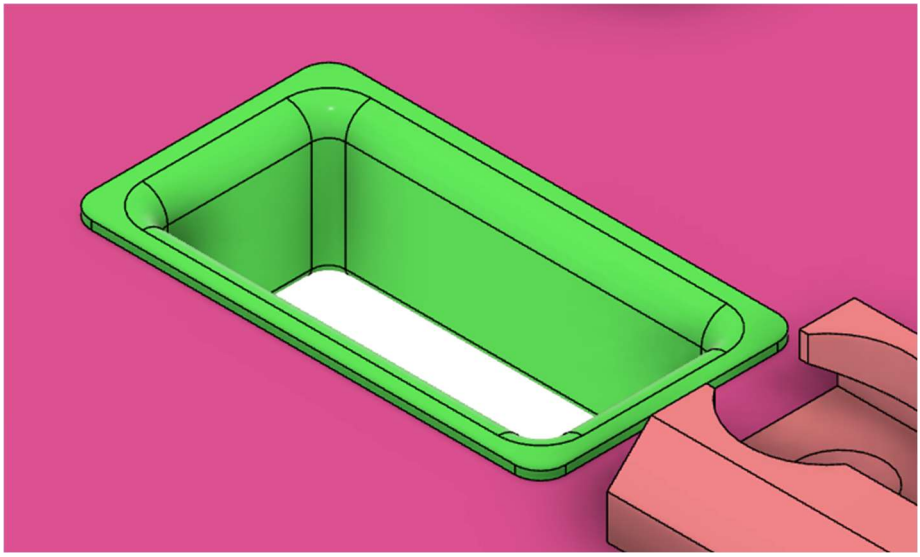


Under the base plate are a number of spacers used to ensure the base plates has sufficient contact points with the sheet metal bottom in the back of the FJ. The model contains 2mm holes to easily locate the spacers when mounting them.

The pic below shows a 3D printed guide to be used when drilling the mounting holes in the cargo track.



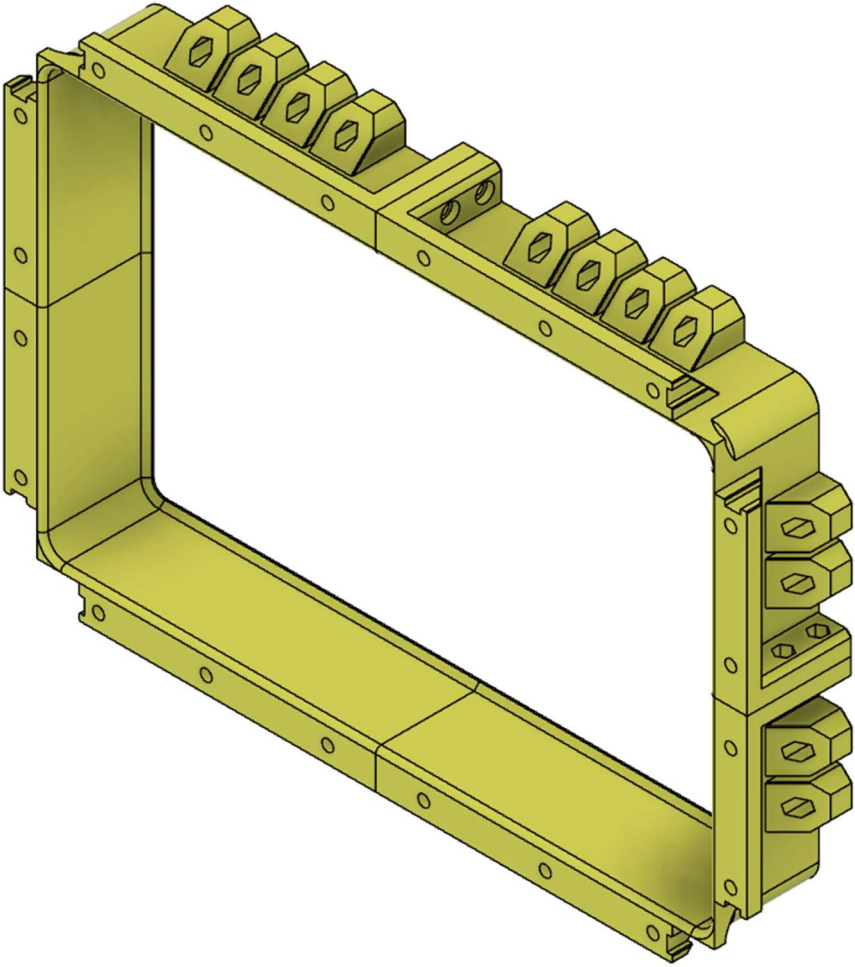




5.3 Electrical Assembly

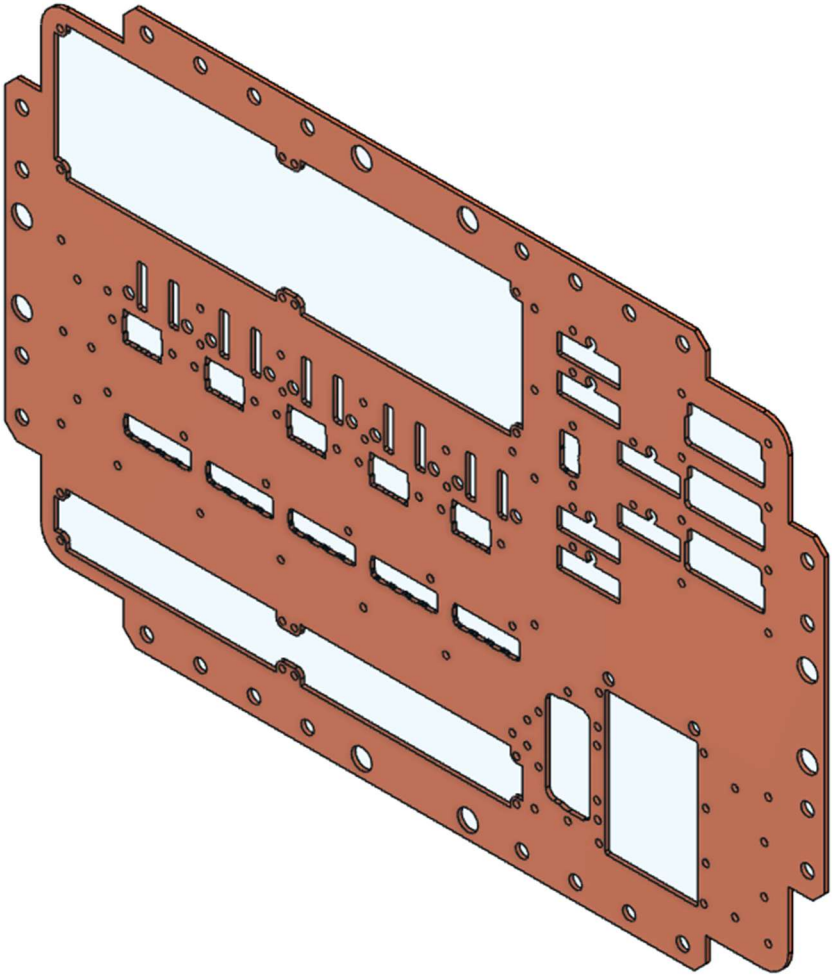
5.3.1 Offset Frame

The electrical assembly consists of a 3D printed frame to offset the PCB's from the fromt of the Electrical Frame. It is printed as 4 separate pieces and bolted together.



5.3.2 PCB Mount Panel

The panel on which the PCB's are mounted is a 2mm laser cut stainless stell panel. 2mm stainless steel was chosen instead of 2mm aluminiums (as per the other panles) because of it being a lot more rigid and will better prevent excessive flex in the PCB's.

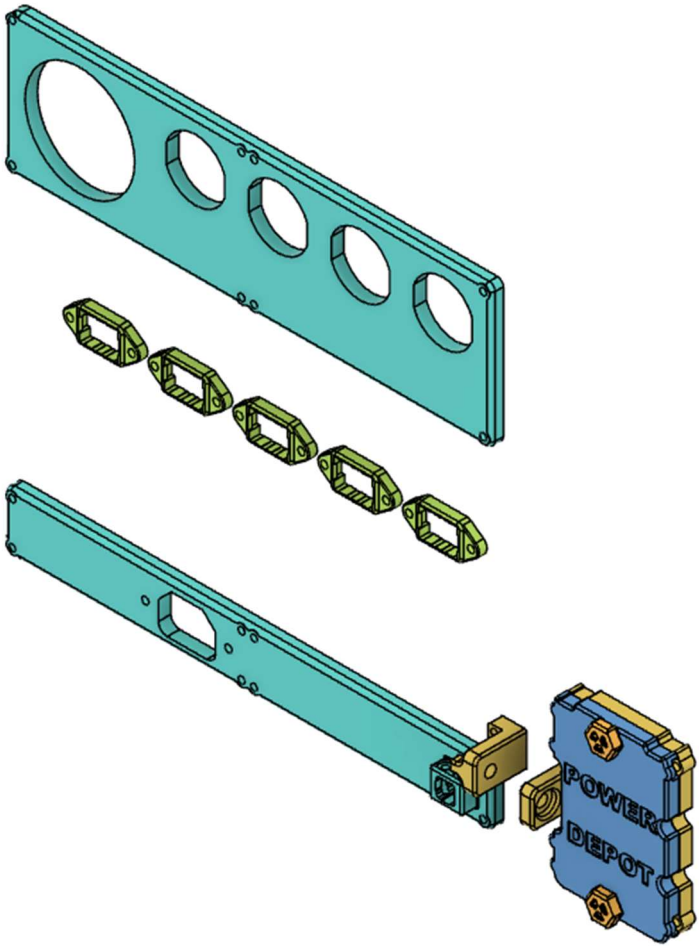


5.3.3 PCB Mount Panel 3D Prints

These prints can be customized to suit your needs. The top panel caters for the Victron BM712 monitor and 4 holes for panel mounted accessories such as USB chargers, Hella plugs or Cigarette Plug Sockets

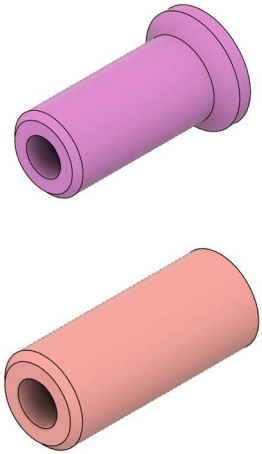
The bottom panel houses an AC plug used for connected AC power to the Victron Blue Smart AC charger.

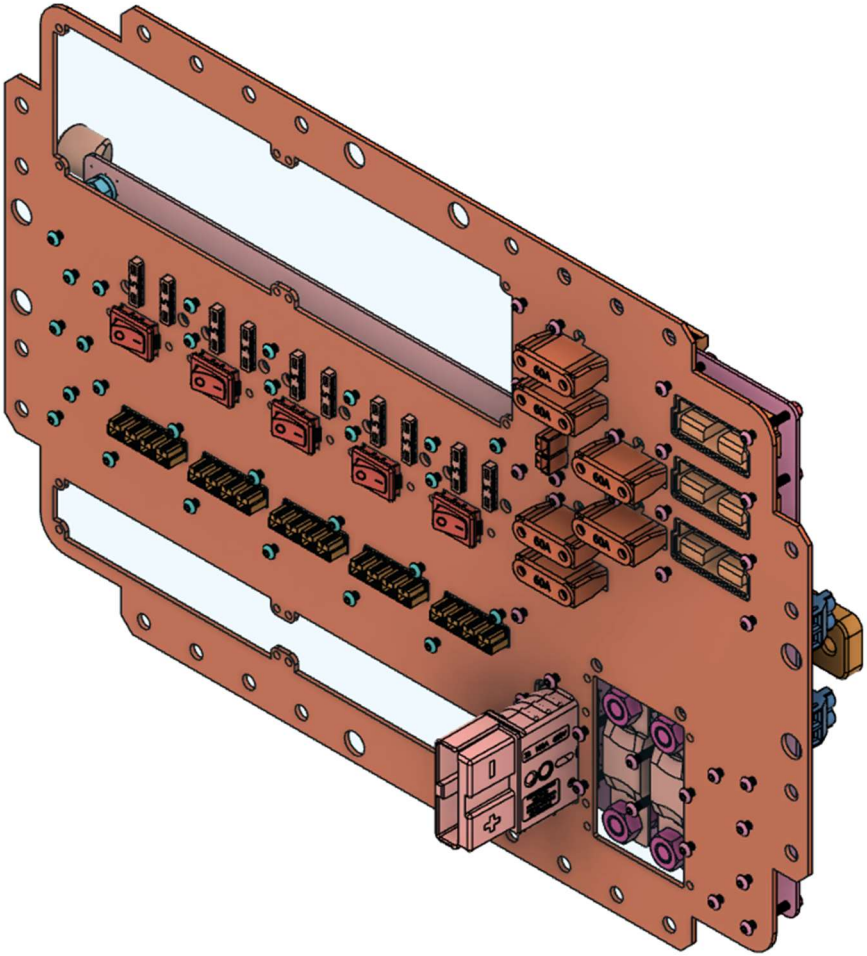
There is also a removable fuse cover for the MEGA fuses on the battery distribution board and some switch facia prints.


POWER
DEPOT

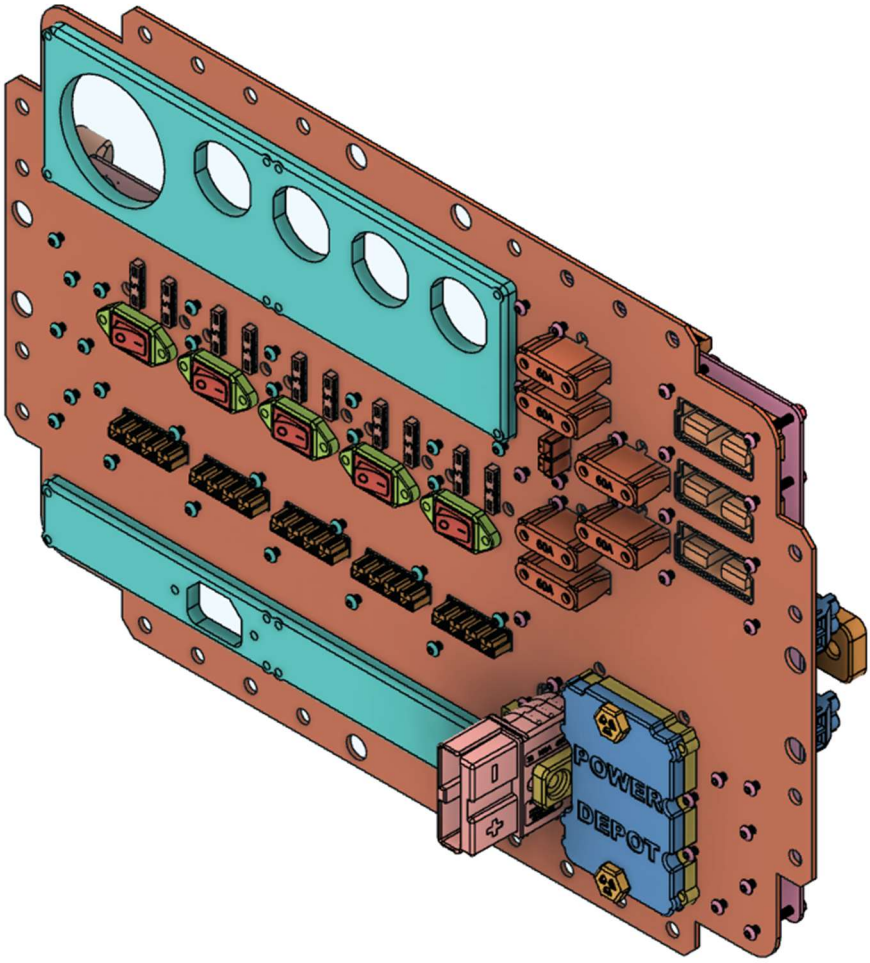
5.3.4 PCB board spacers

These spacers are used on all the PCB board M3 bolts, these space the board away from the panel. This allows the switches, connectors and fuses to protrude through the panel.

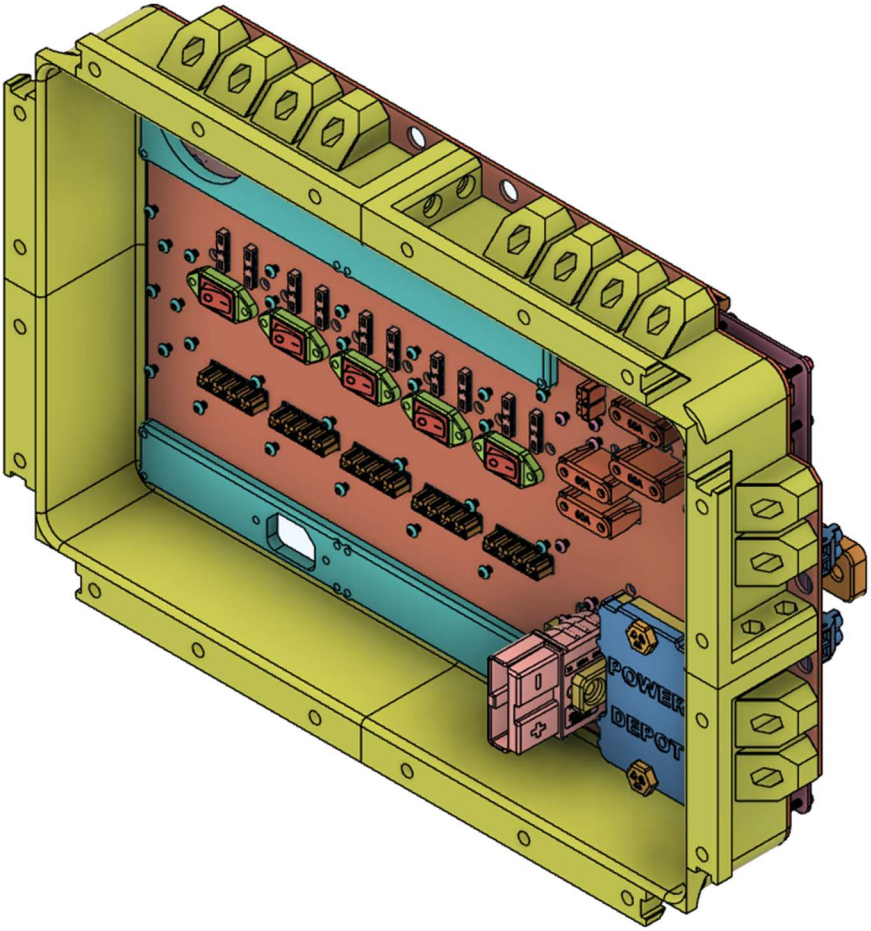




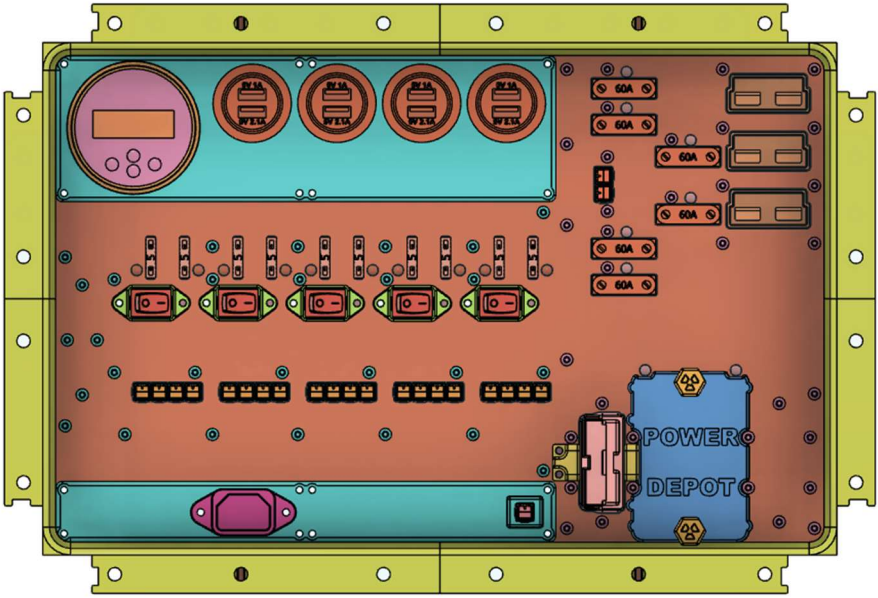
PCB’s mounted to the PCB Mount Panel.



PCB prints mounted to panel.



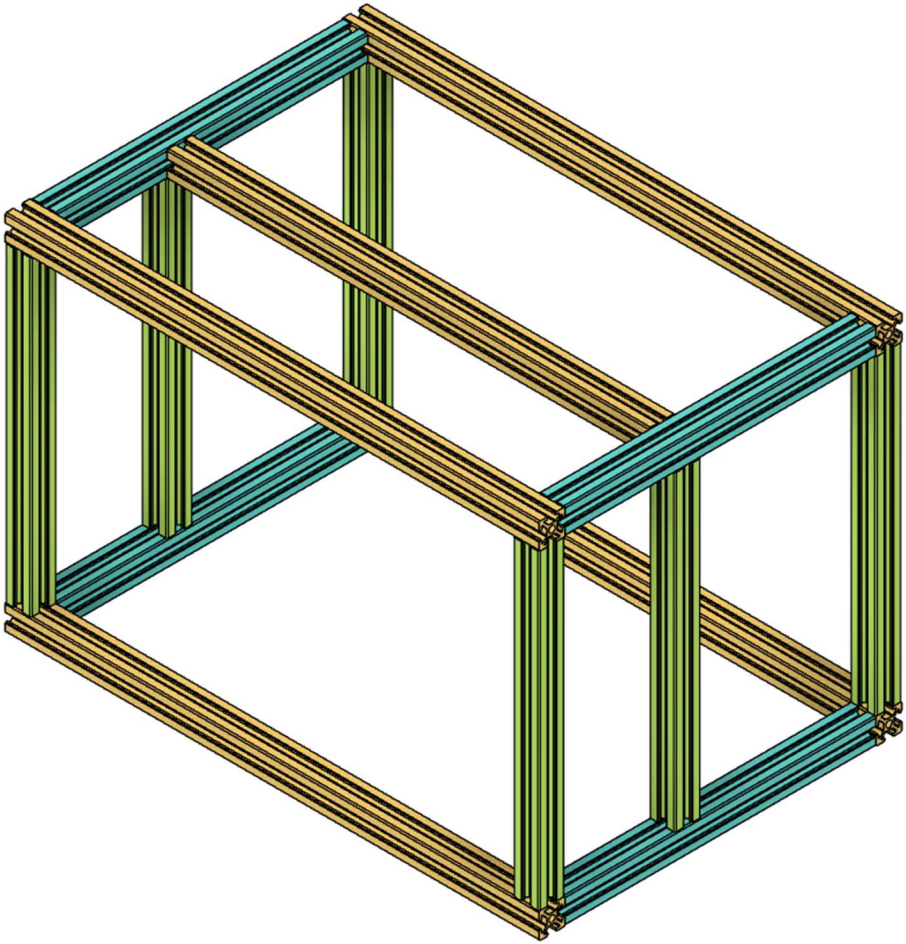
Offset frame mounted to PCB mount panel.

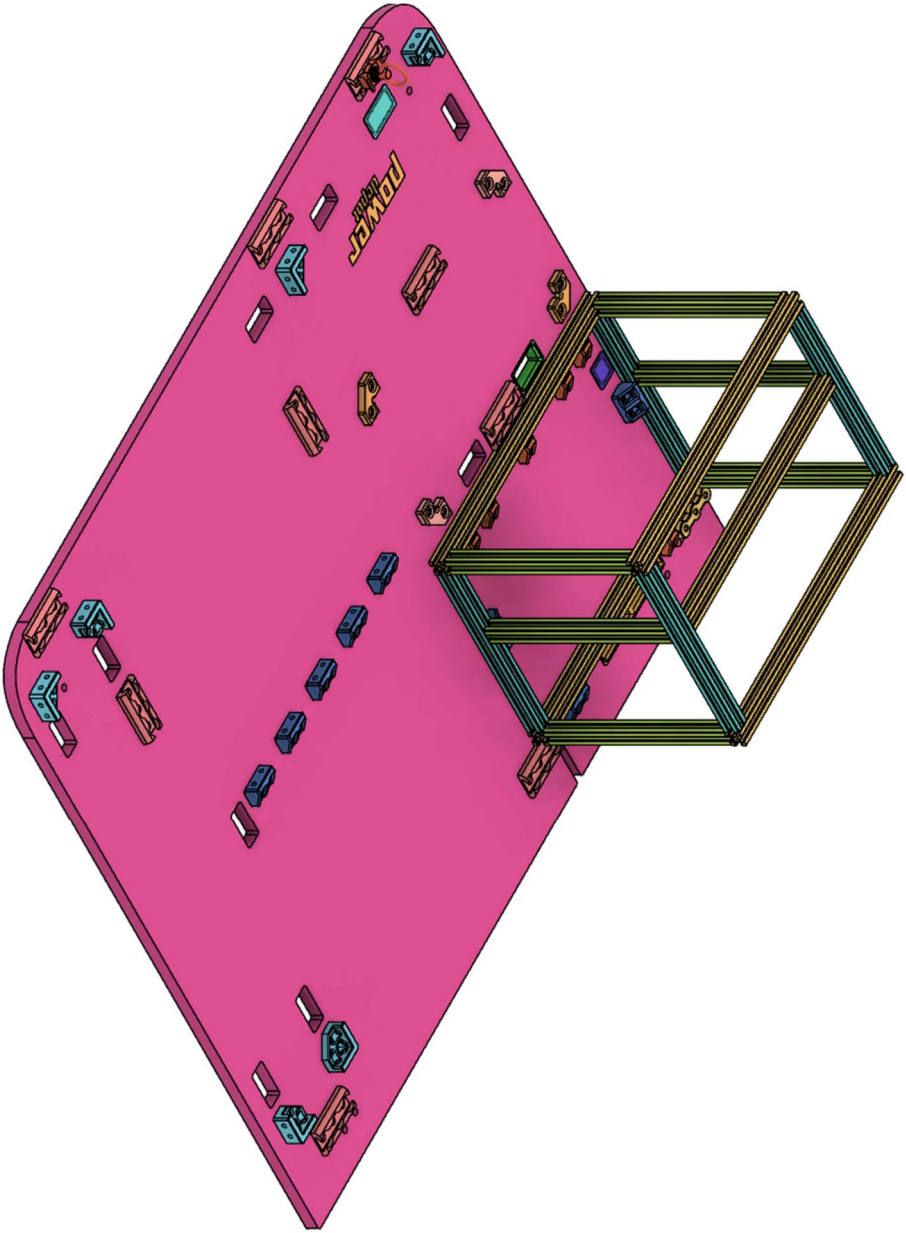


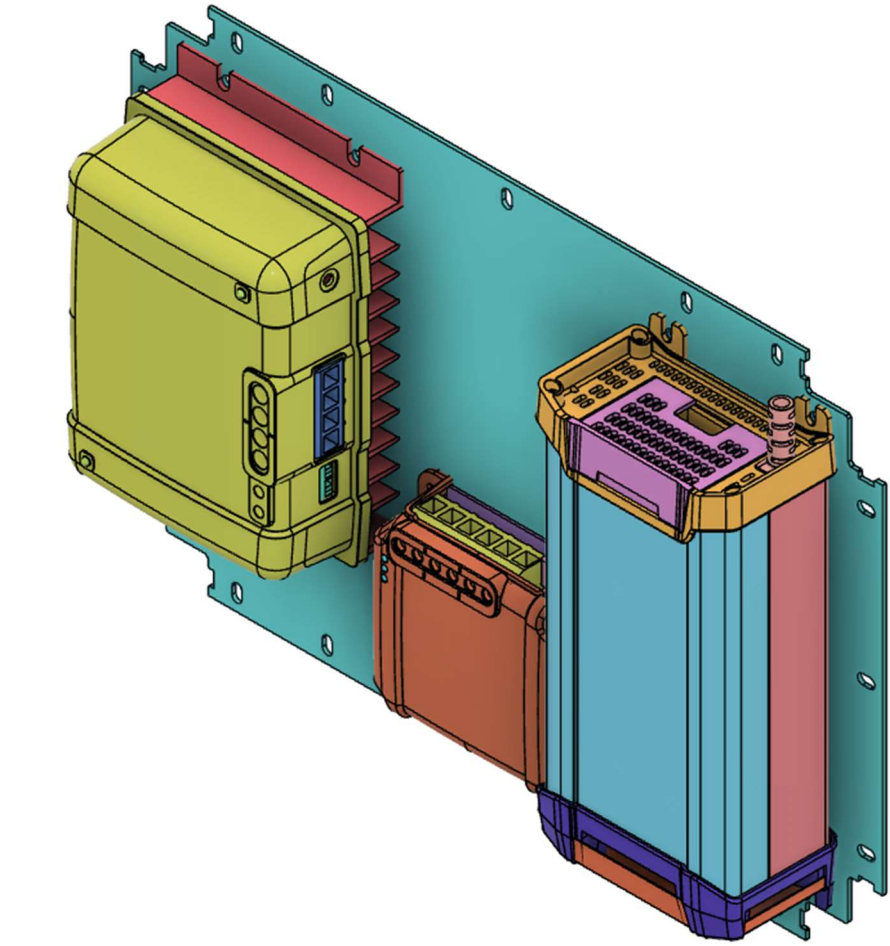
Accessories mounted in 3D printed panels.

5.4 Electrical Frame

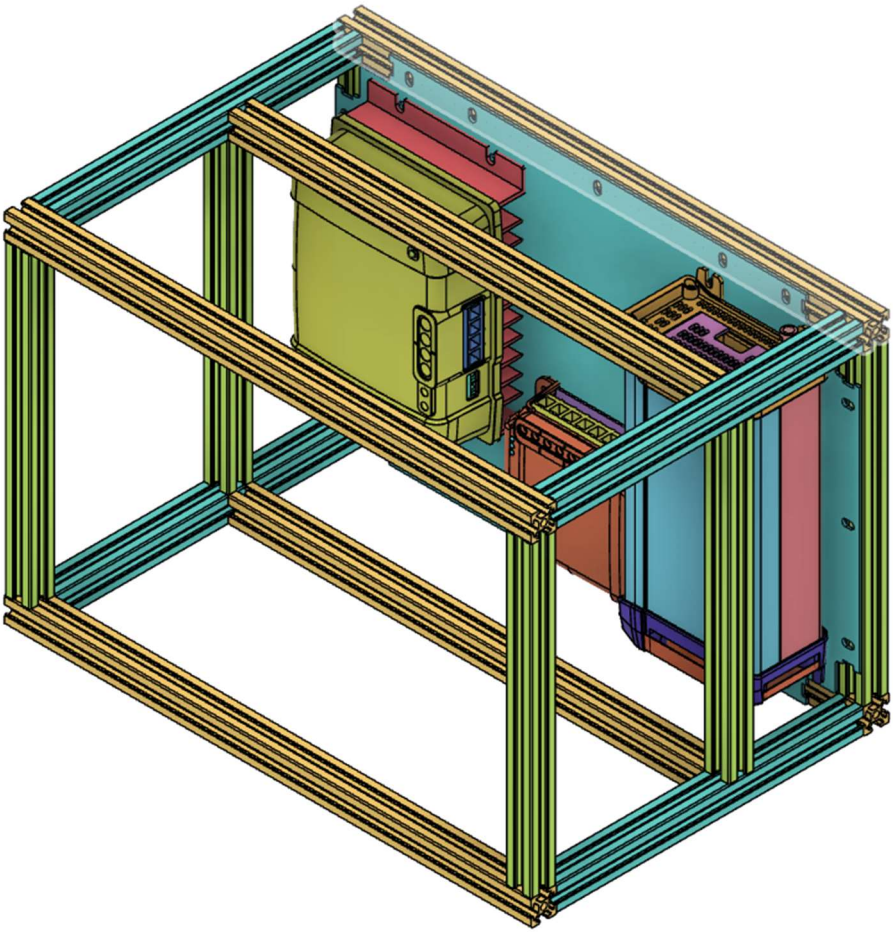
This assembly houses the Power Depot and Victron components.



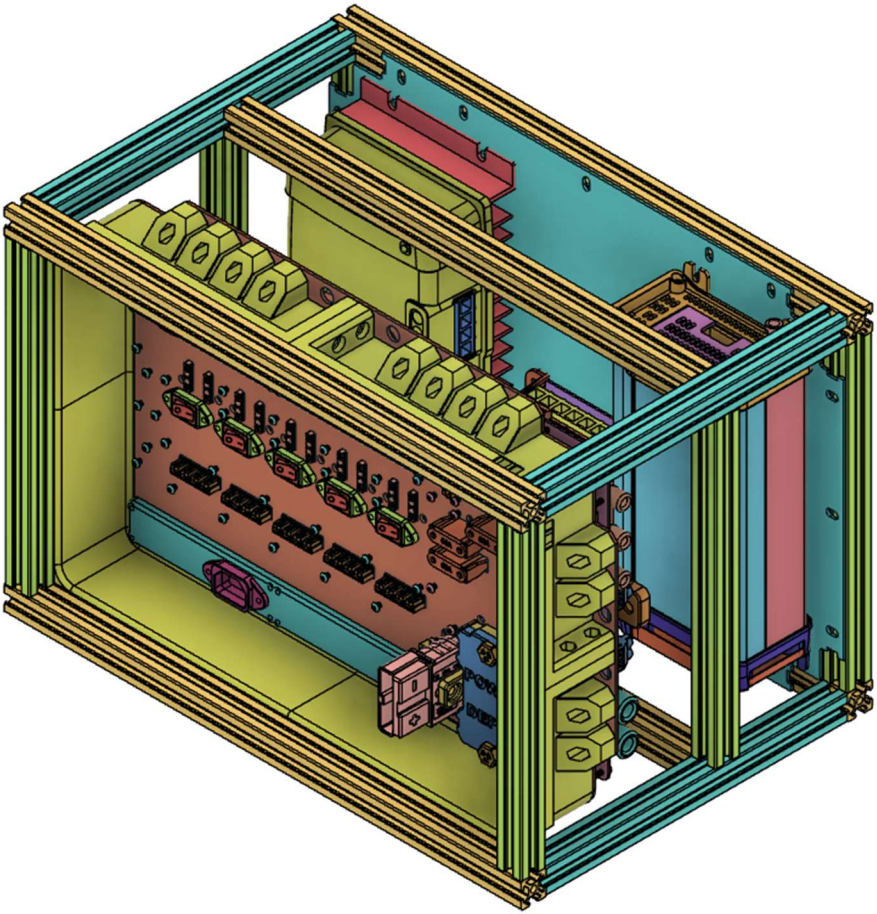

POWER



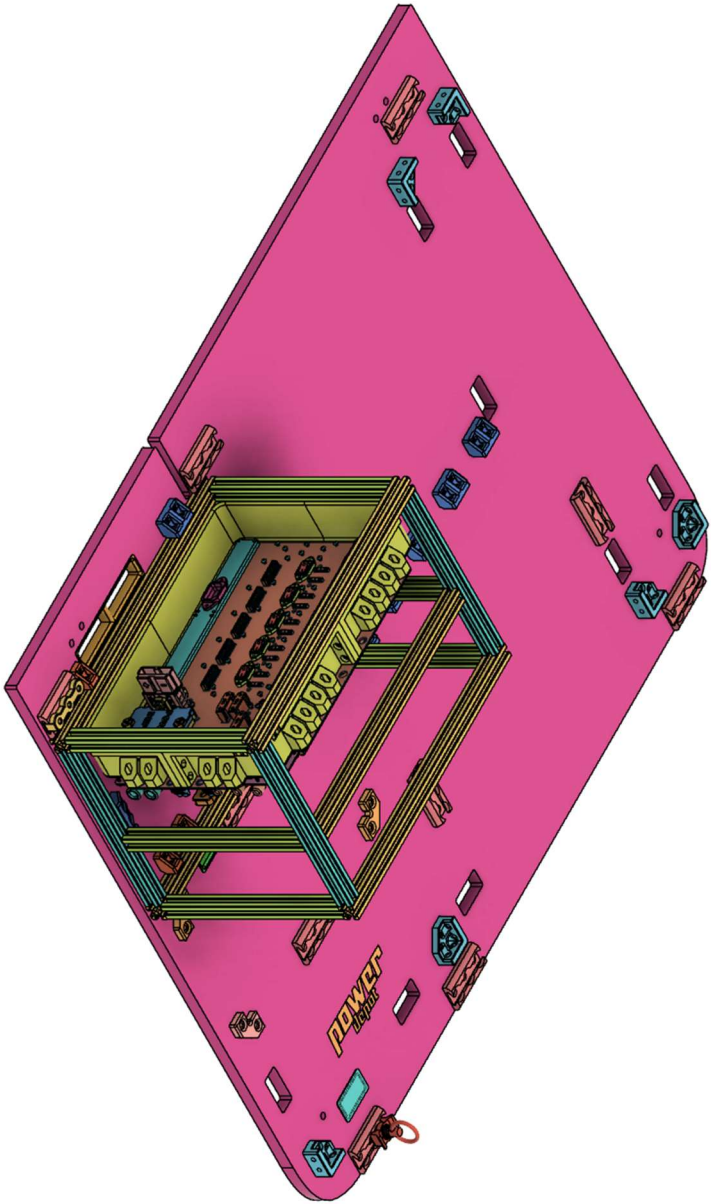
Victron Components mounted on panel



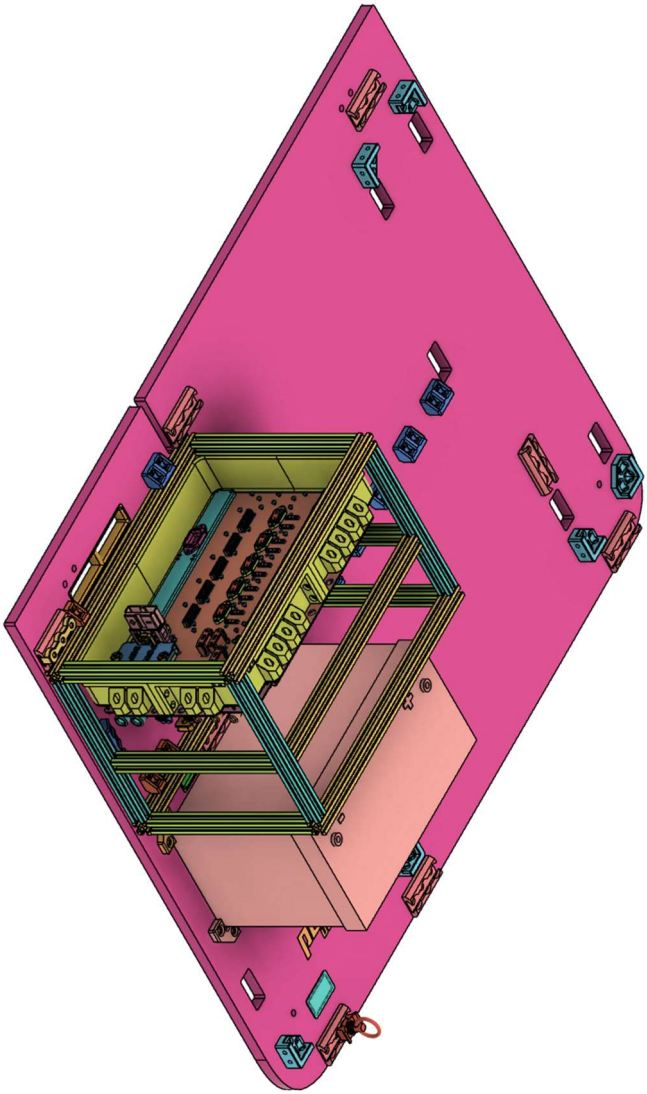
Panel mounted in frame



Electrical Assembly mounted in frame

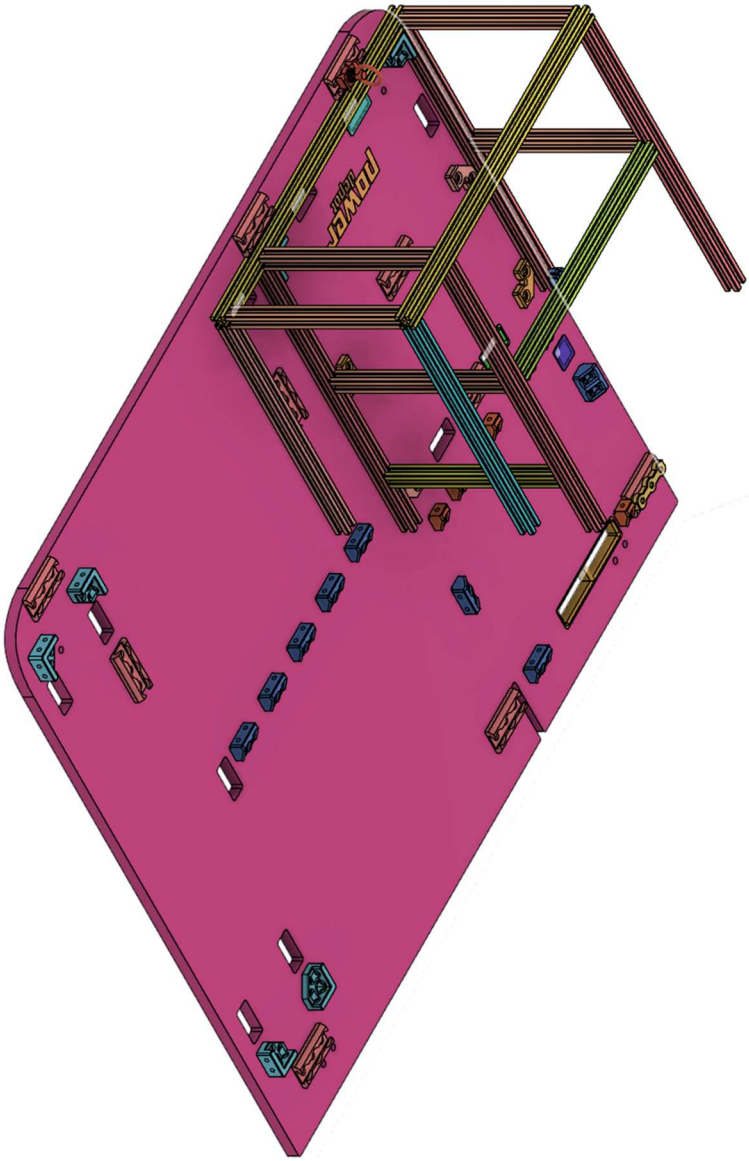


Electrical frame mounted on Base plate

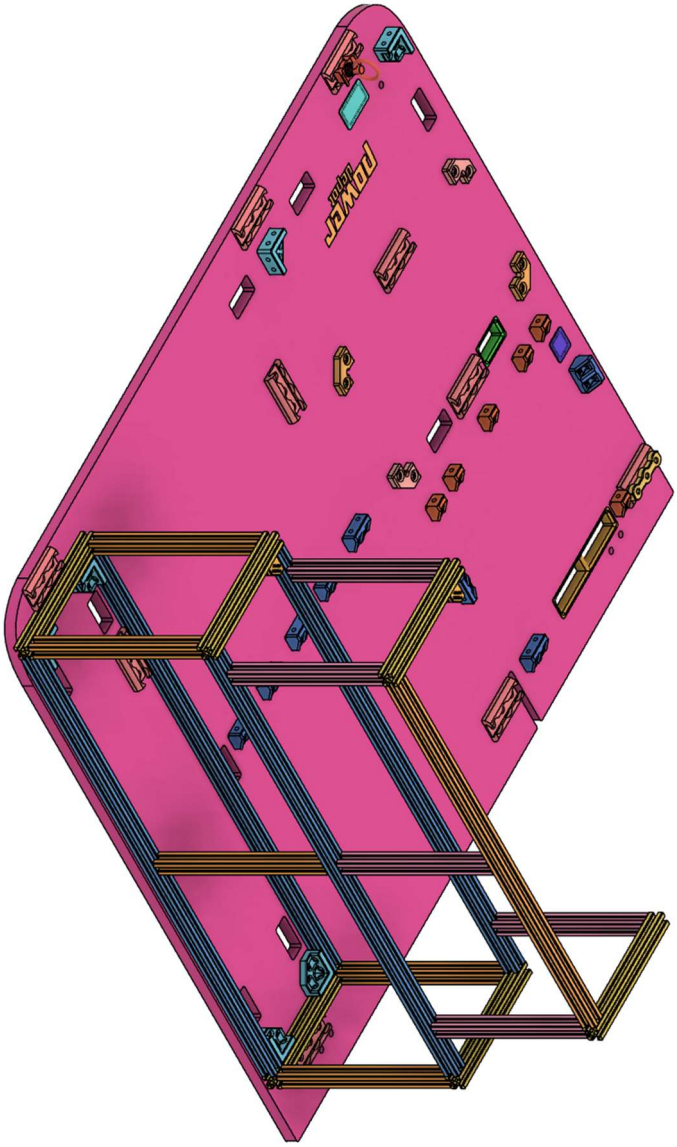


Battery located on base plate; the battery is held down by a strap mounted between the mounting rings on the cargo track on either side of the battery.

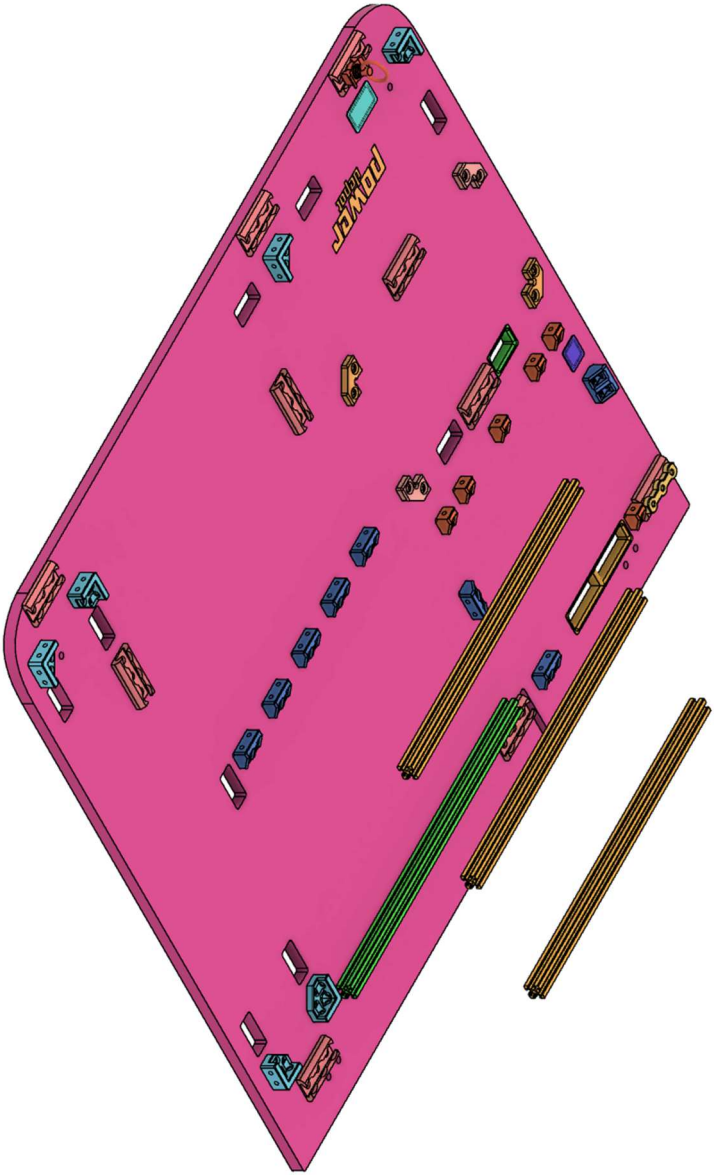
5.5 Front Left Cubby



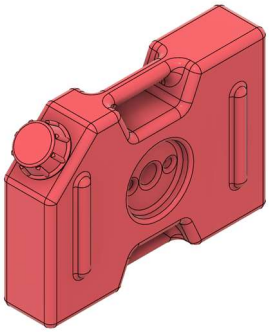
5.6 Right Cubby



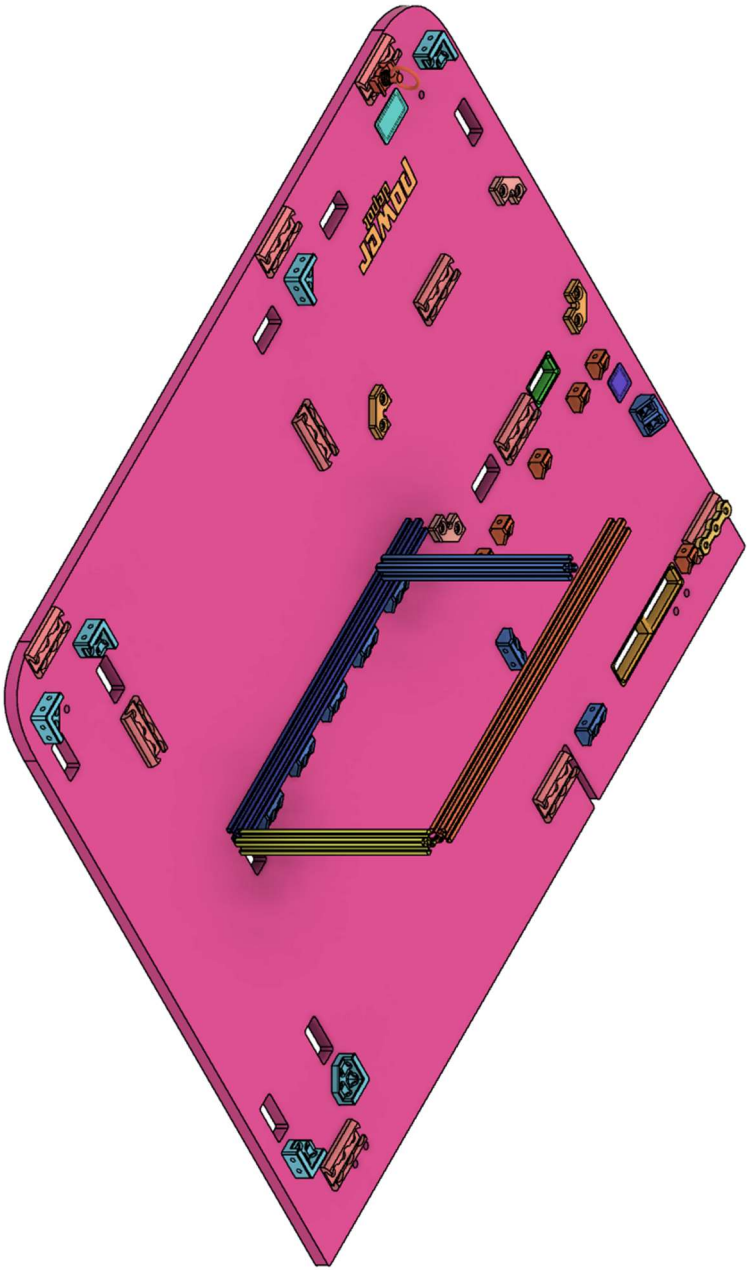
5.7 Rear Cubby

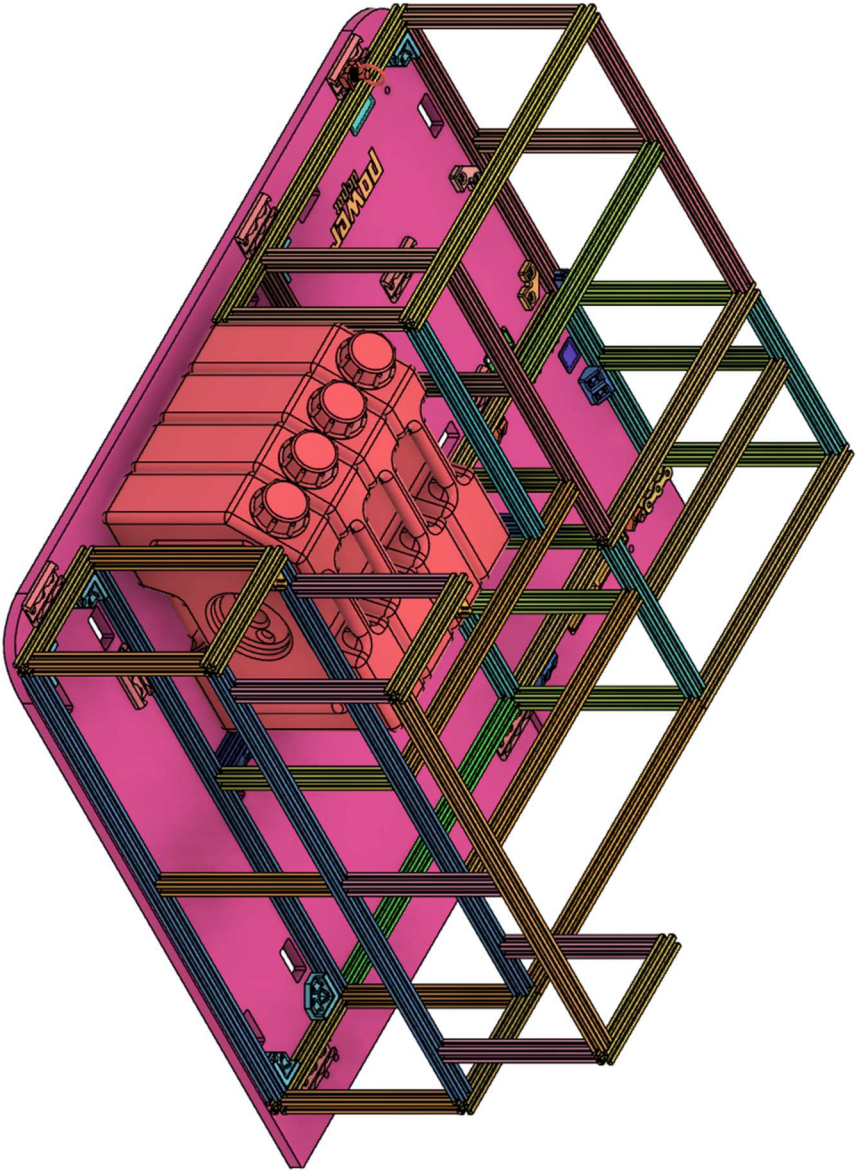


5.8 Water Frame



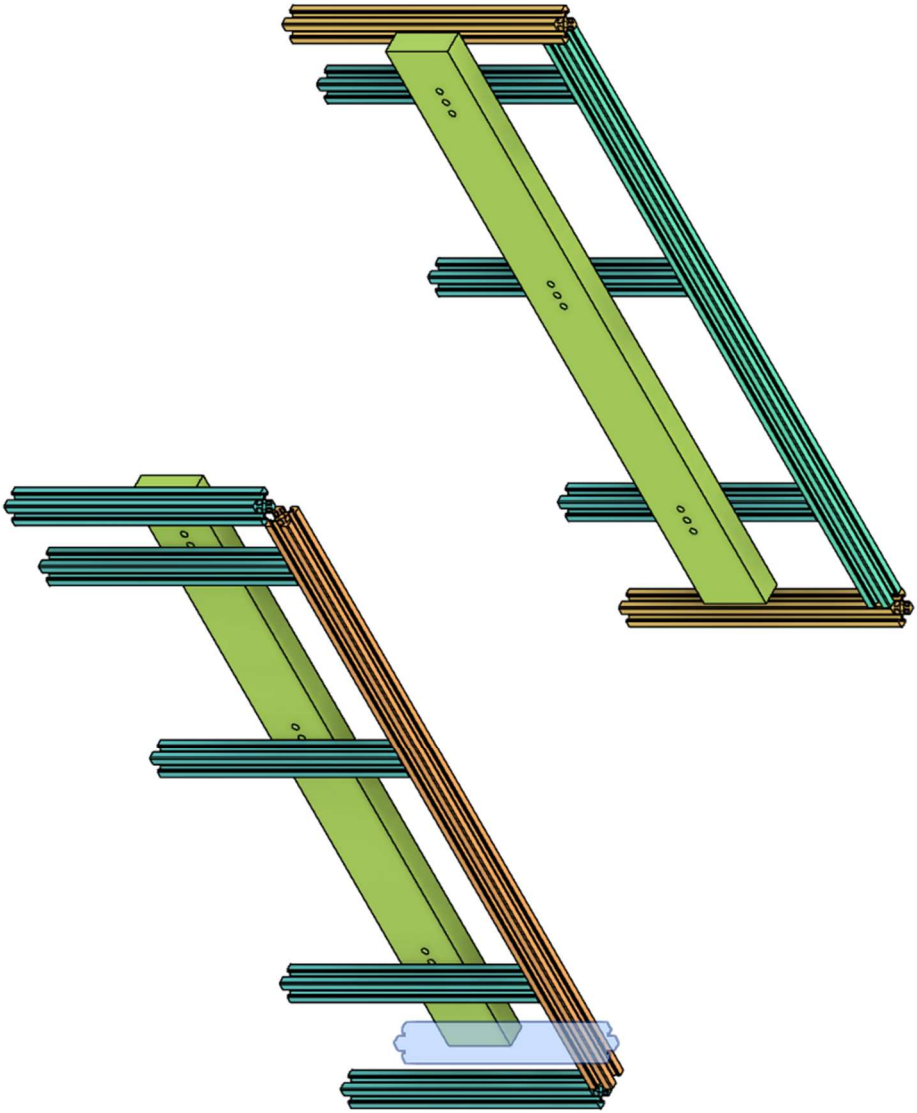
Up to 4 of the 5L containers shown above can be fitted to the water frame for a total of 20L. If you don't need to carry water, you can leave them at home and use the space for something else. The water frame width is wider than the width of the 4 tanks in the model due to the fact that the tanks can vary in width by up to 15%, the water frame width caters for this.

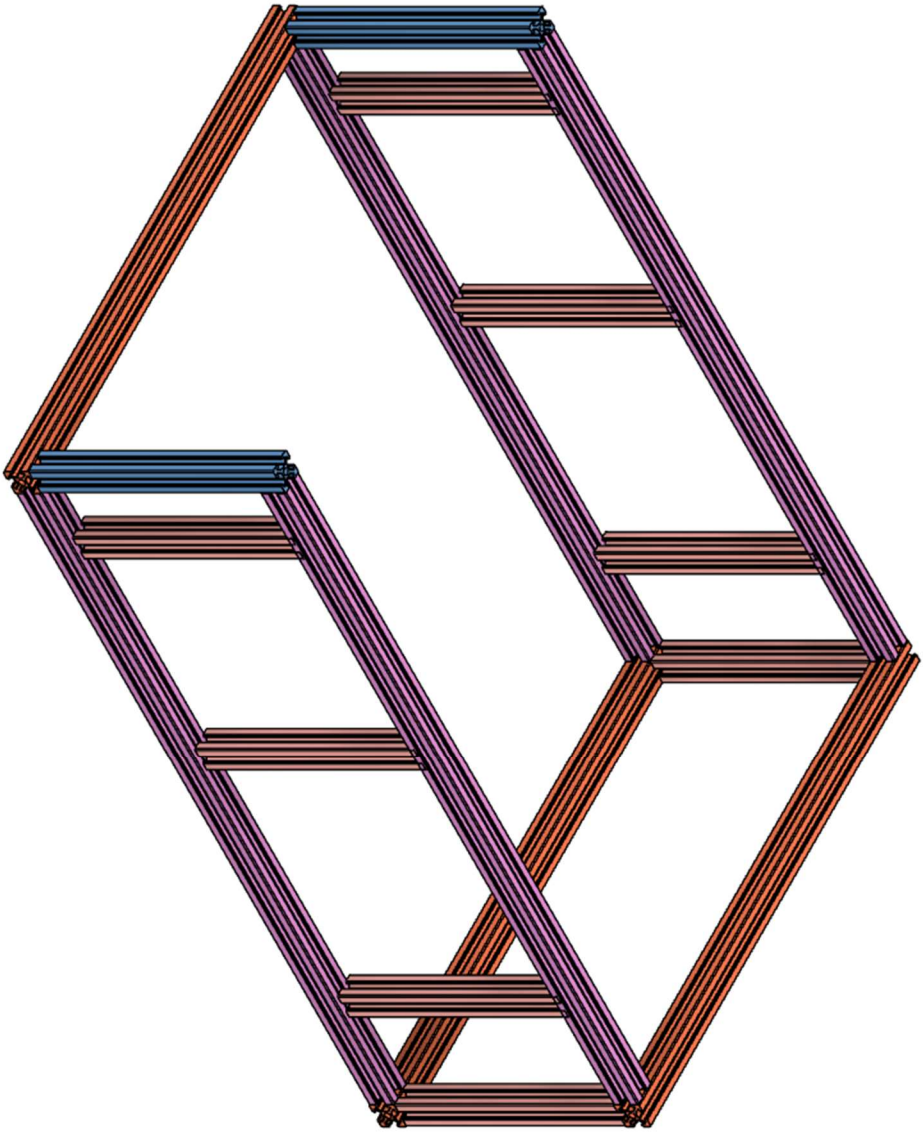

POLYCAM

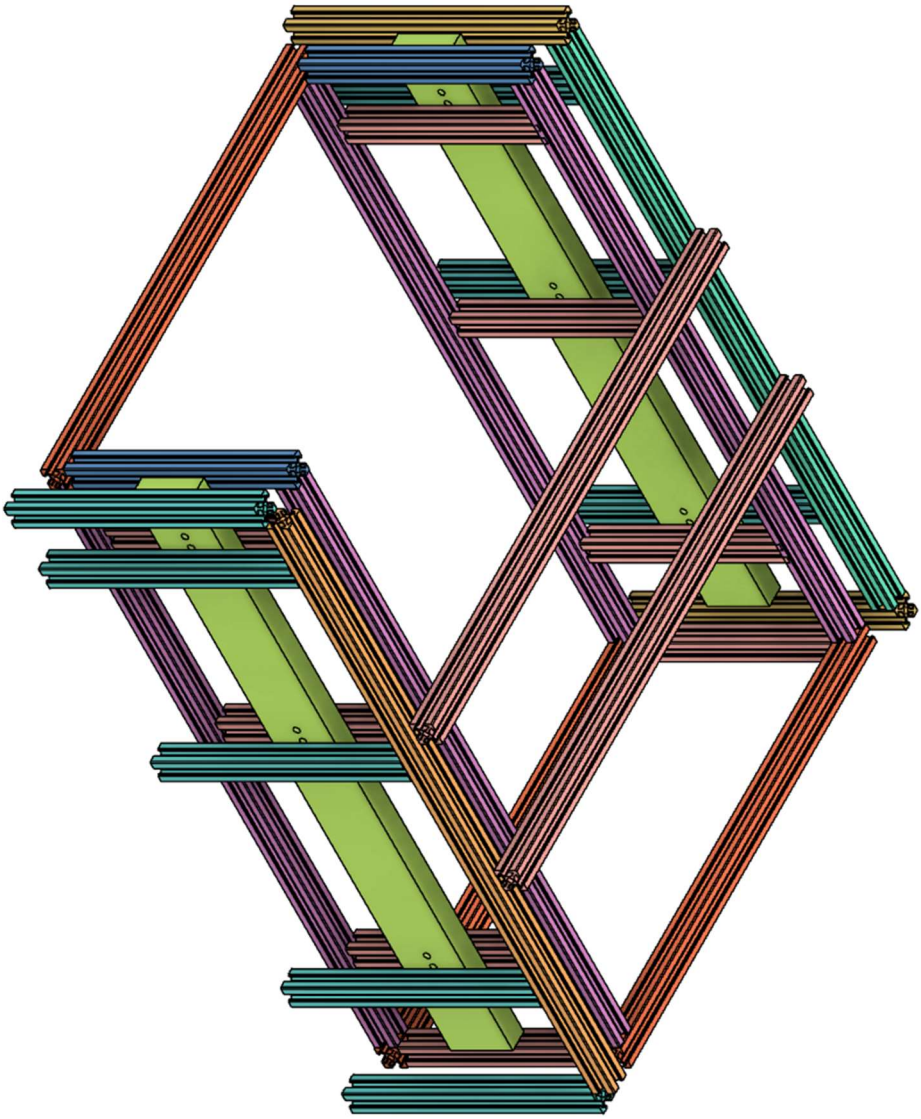


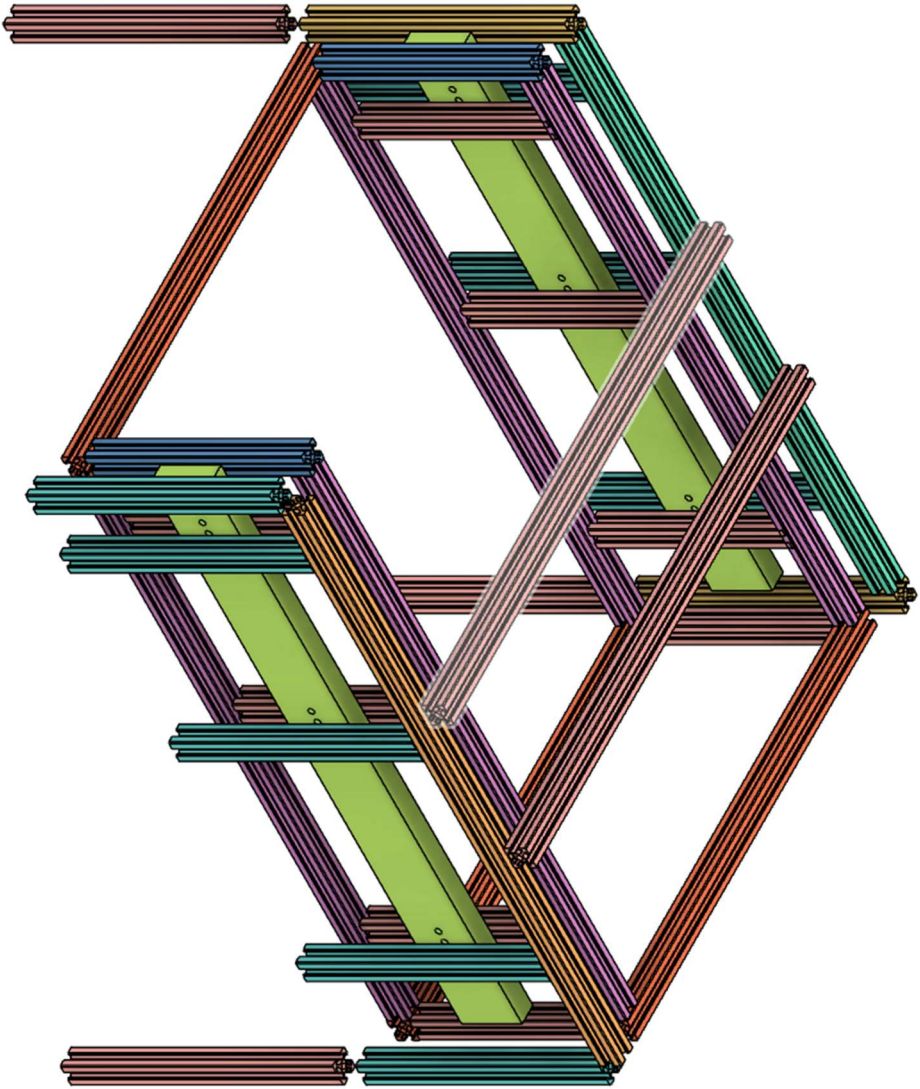
Base plate with lower frame assembly

5.9 Drawer



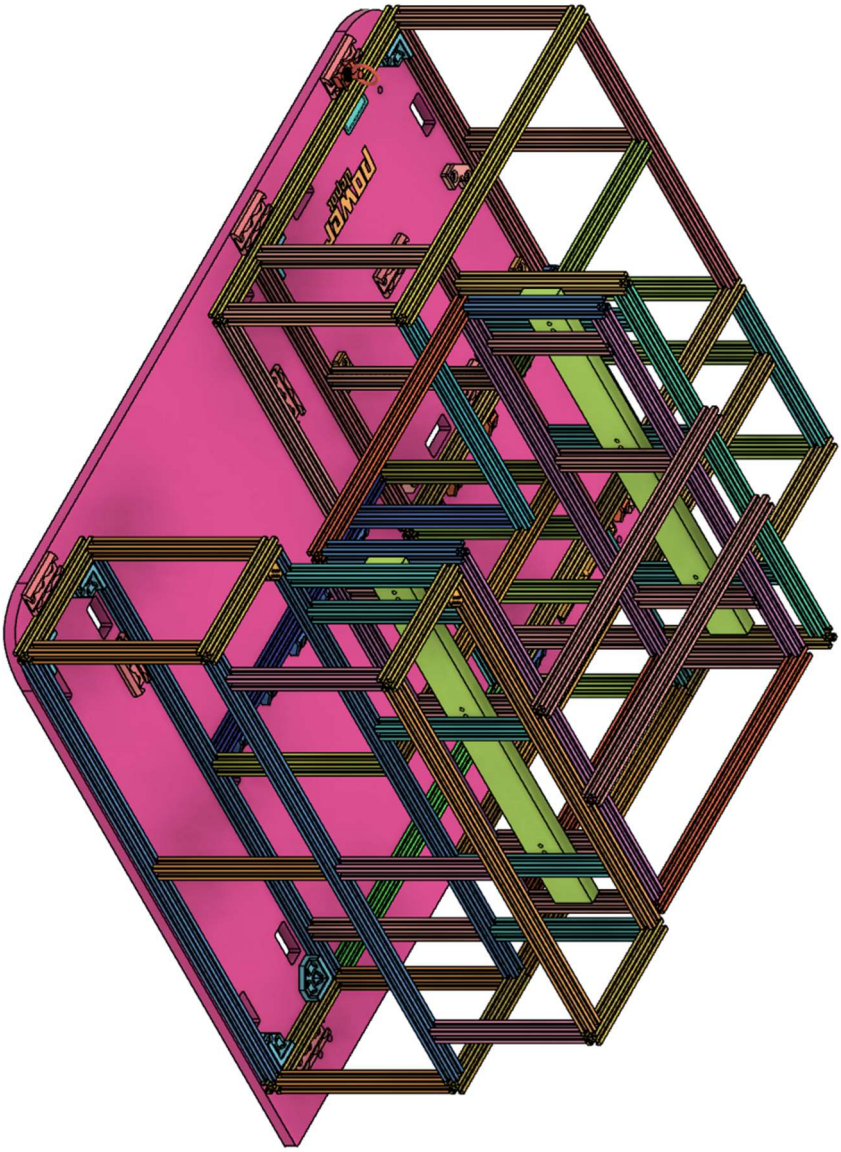




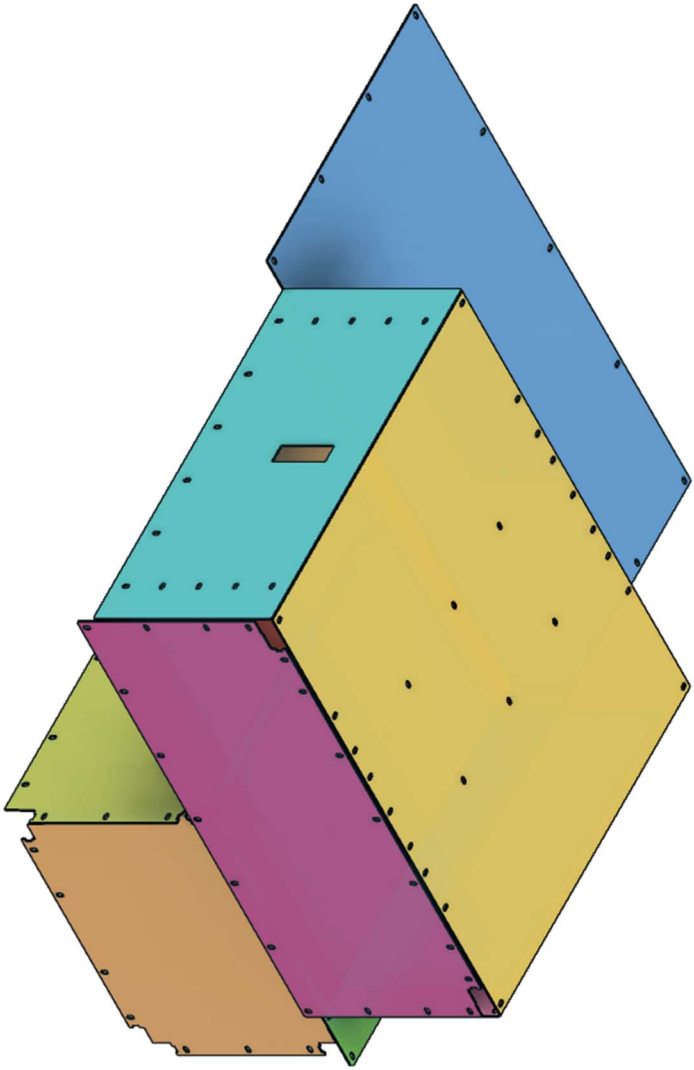


Additional 3x bottom supports, to add to frame when adding drawer to frame

5.10 Complete Frame

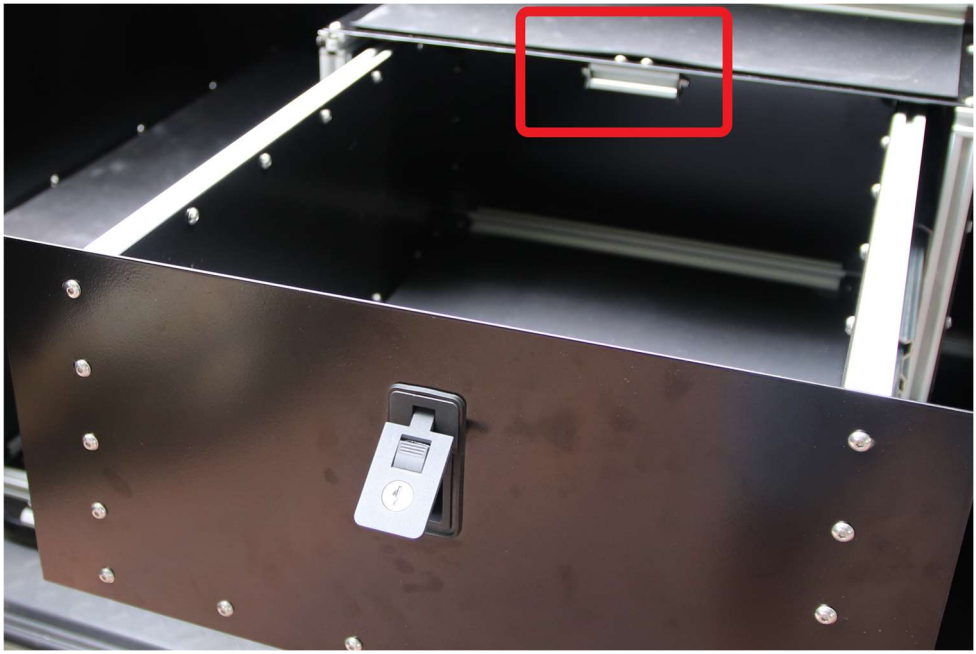


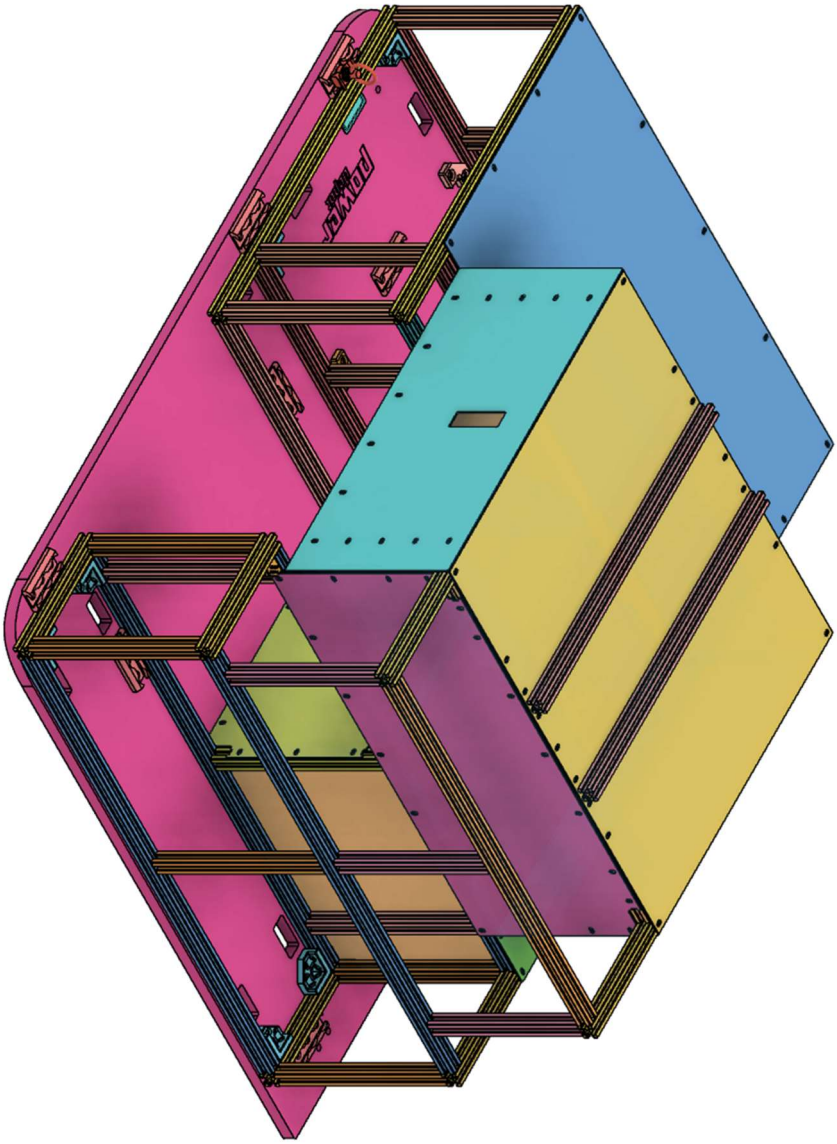
5.11 Panels



If you plan on using a different handle then the front drawer panel must be modified to cater for this, note the handle catch is not shown in the

model, it is simple a small piece of extrusion mounted to the top panel using t-nuts, the model does contains a 3D printed part to use as a template to mark the holes on the top panel, alternatively add these holes to the top panel model before laser cutting.





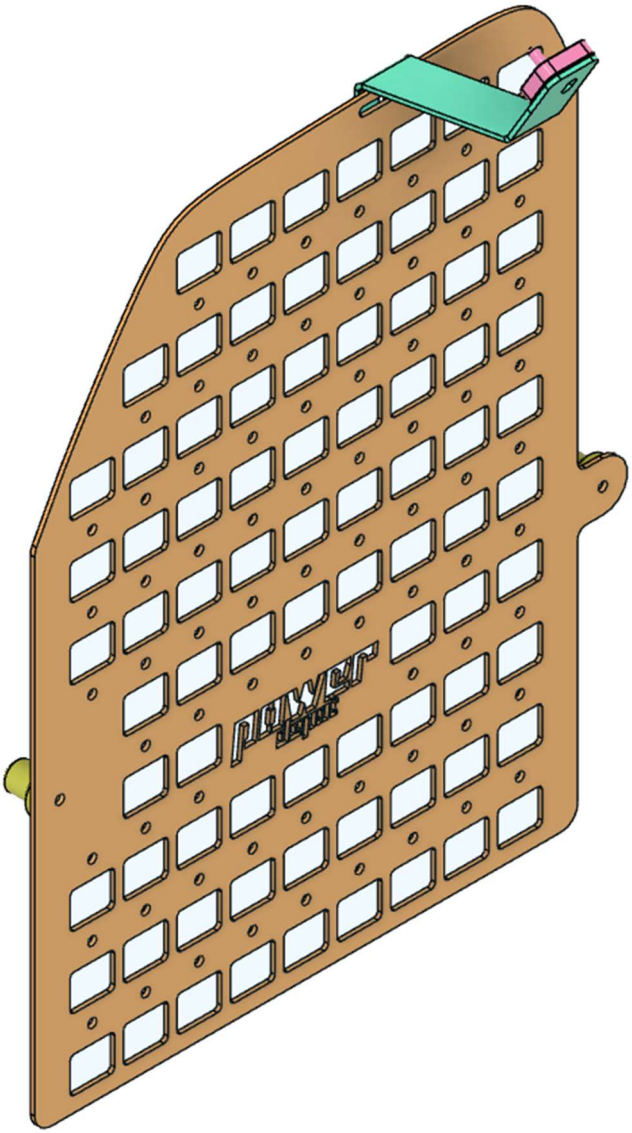
Panels are attached using M5 8 mm button stainless steel bolts and drop in t nuts

6 Ancillary Assemblies

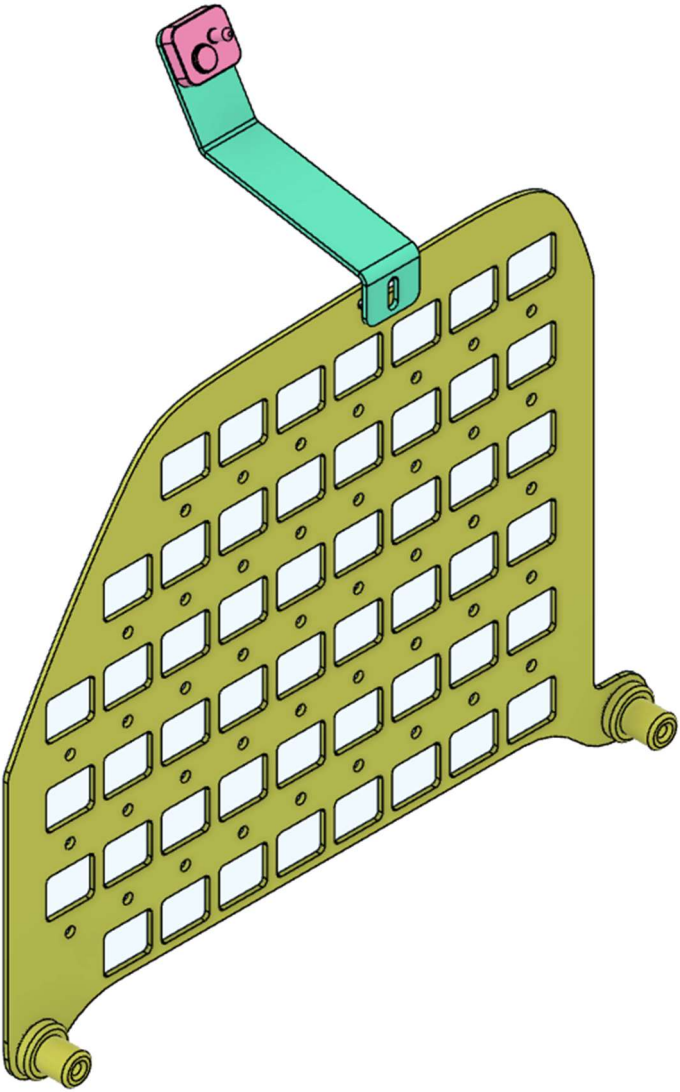
6.1 Molle Panels

These fit the existing mounting holes on the FJ, the bracket model is a sheet metal part, so can be laser cut and then bent. There are some 3D printed spacers used as well.

6.1.1 Left

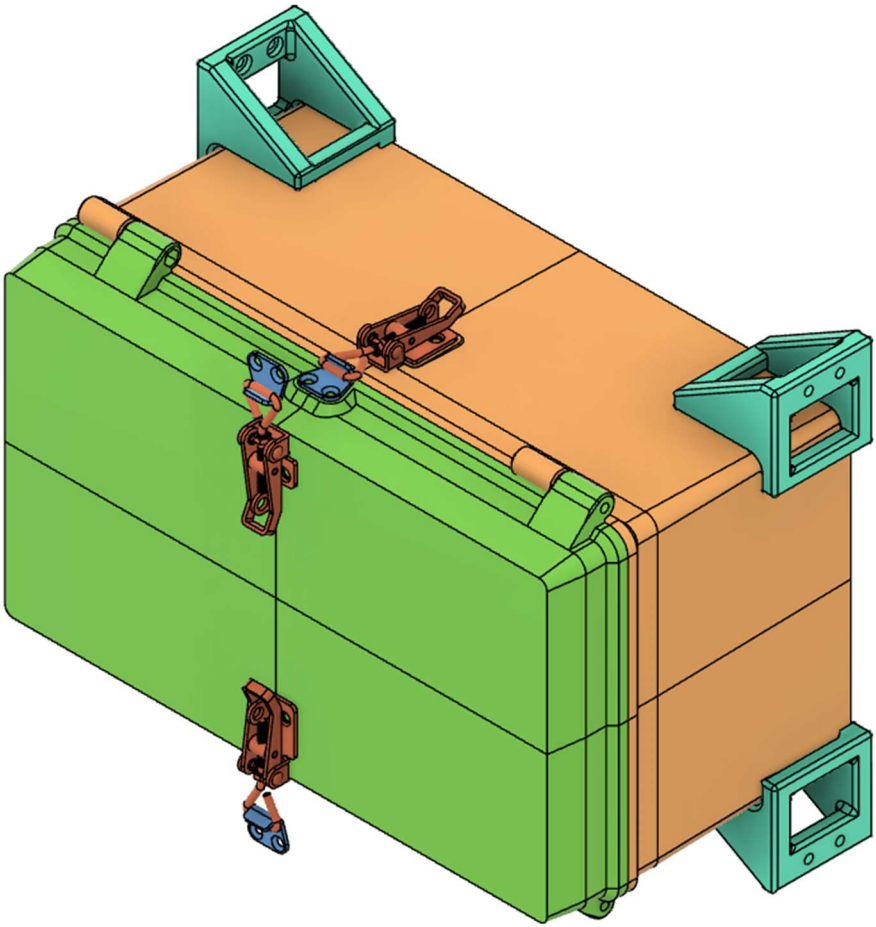


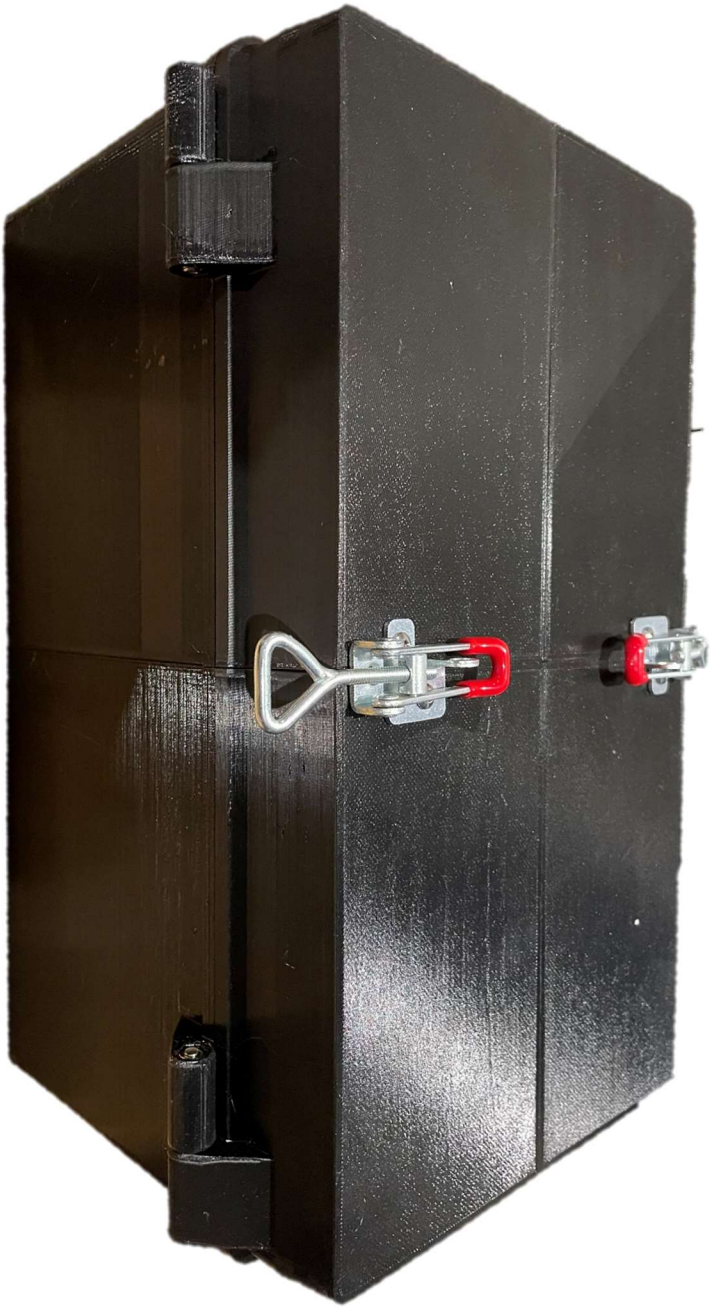
6.1.2 Right



6.2 Toolbox

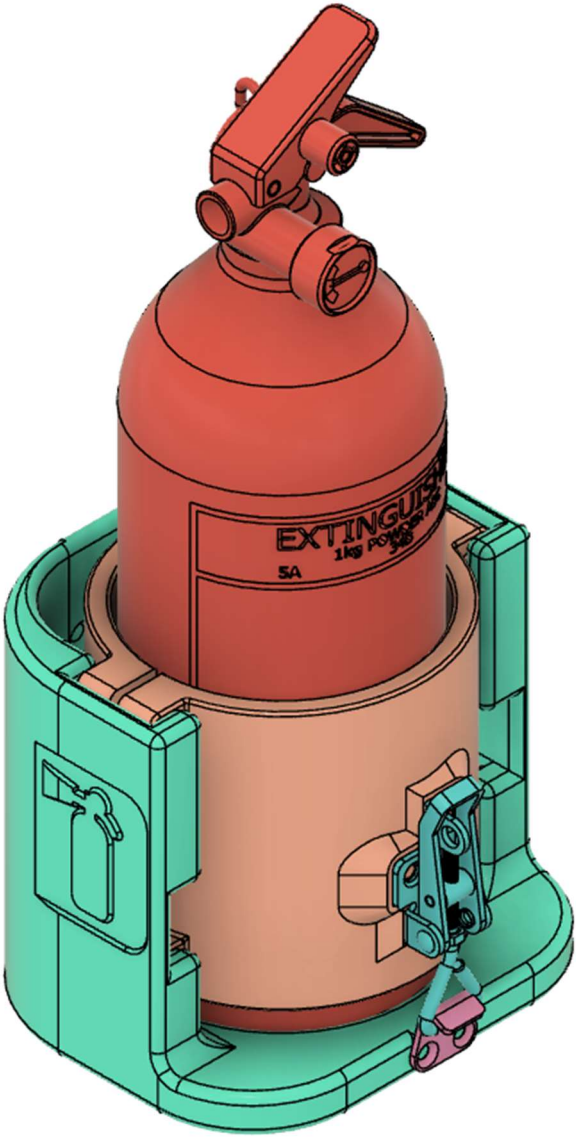
This toolbox fits in the space in front of the battery, it can be easily removed by undoing the top and bottom latches. This is still a prototype, and needs more testing.





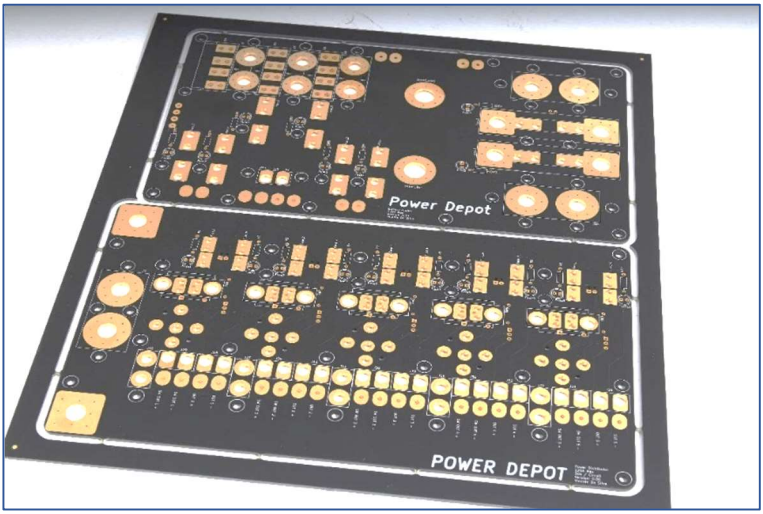
6.3 Fire Extinguisher Mount

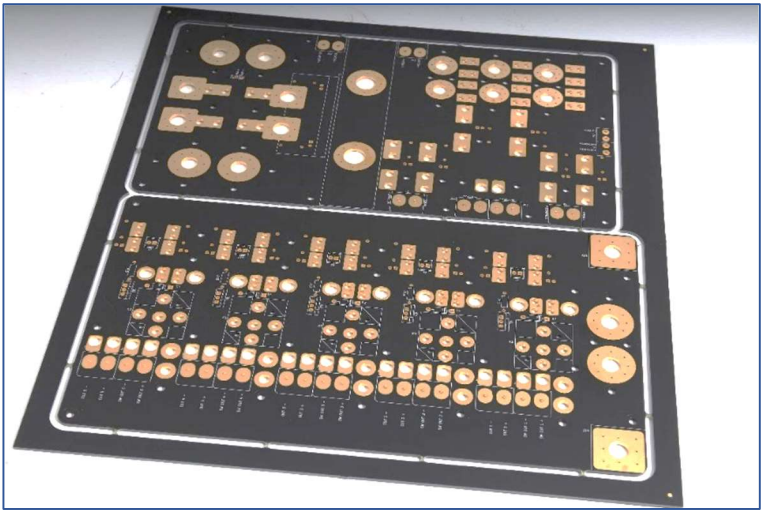
This extinguisher mount can be screwed to the Molle panels above. The inner mount circumference is oversized to allow for a 1.9mm rubber sheet to be placed in the cylinder, this allows for a better grip on the extinguisher cylinder.

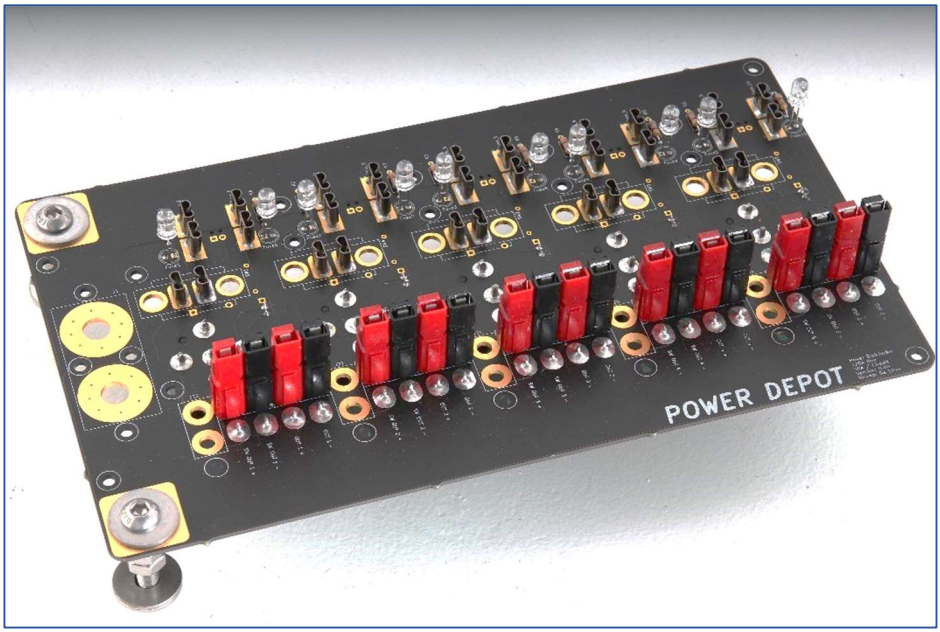

EXTINGUISH
1kg POWDER
5A

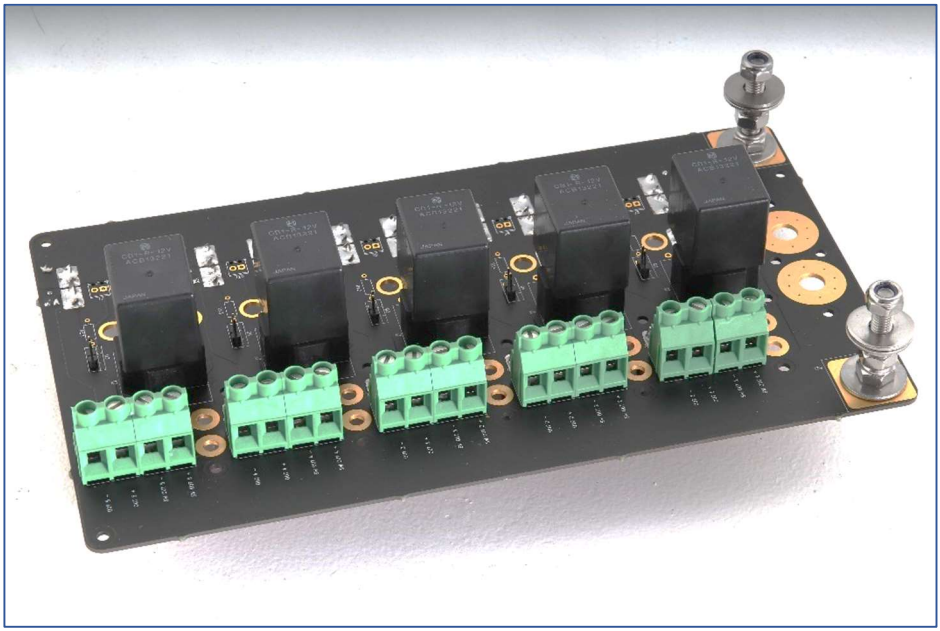

SANS 1910
INTASAFETY
A.B.C. 40% Mono Ammonium Phosphate Base
1KG
STP
Dry Chemical Powder Extinguisher
FLAMMABLE LIQUIDS
DIRECT NOZZLE AT SOURCE OF FIRE
LIVE ELECTRICAL

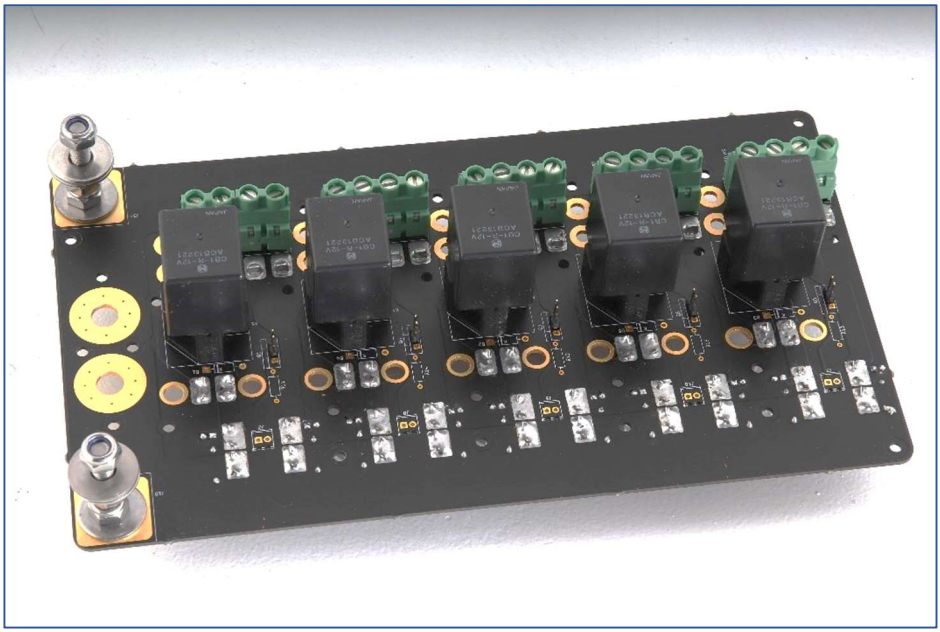
7 Pictures of Assembly



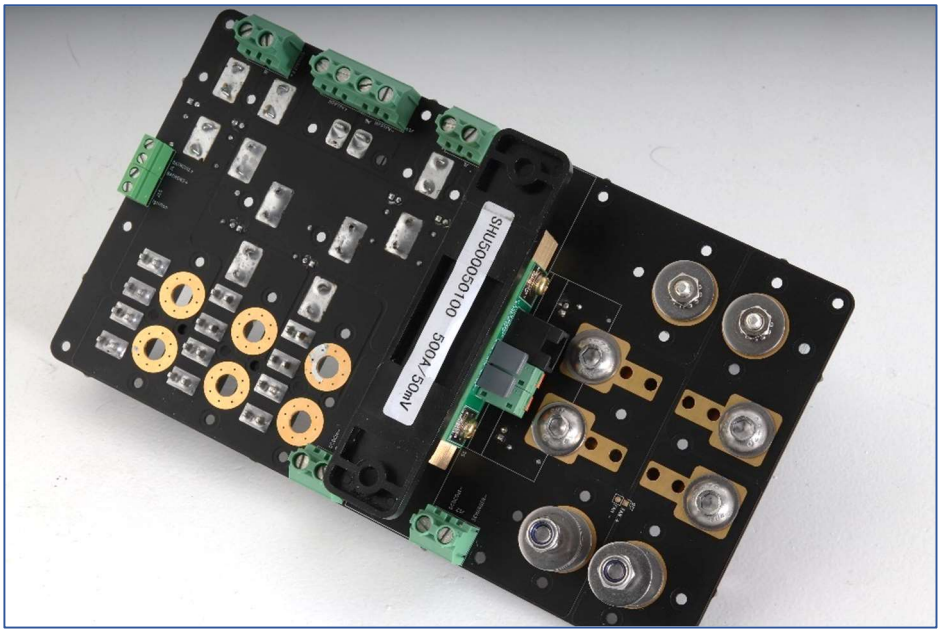


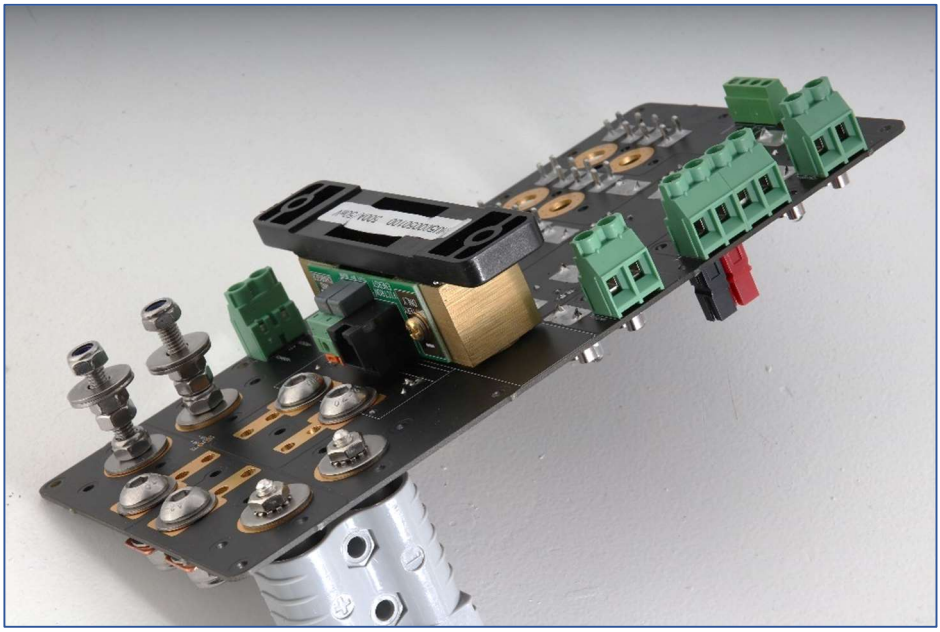

POWER DEPOT

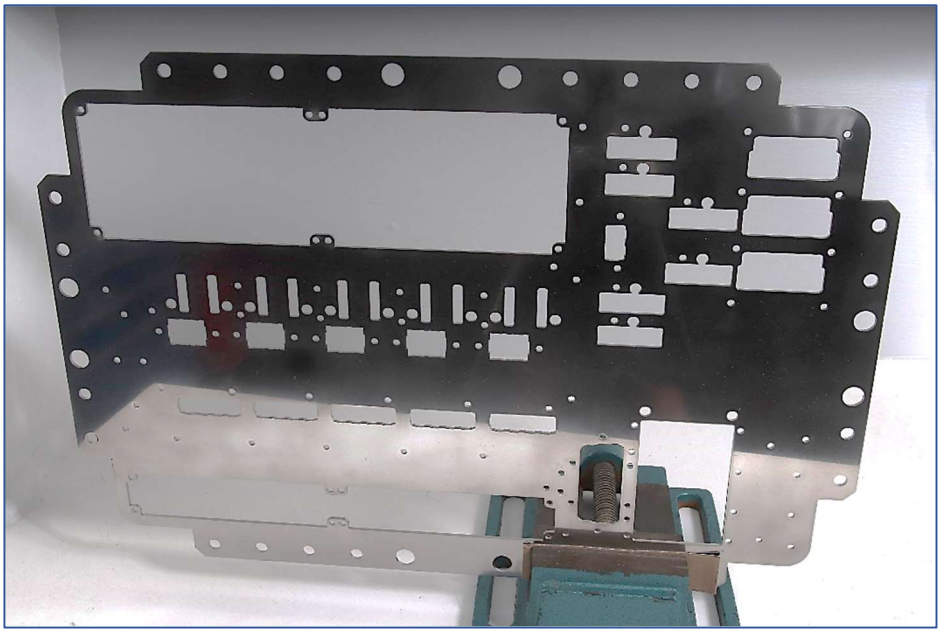


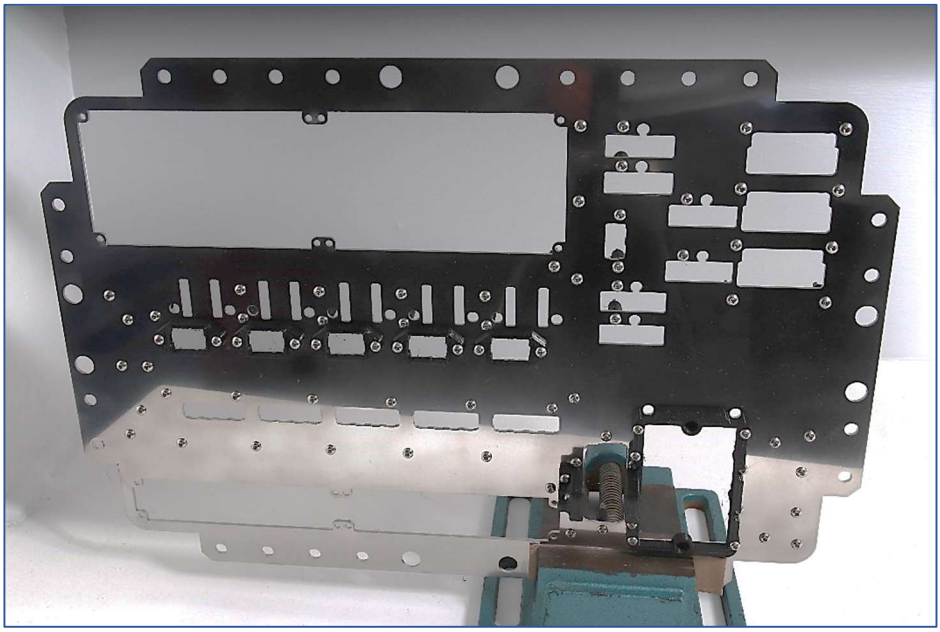


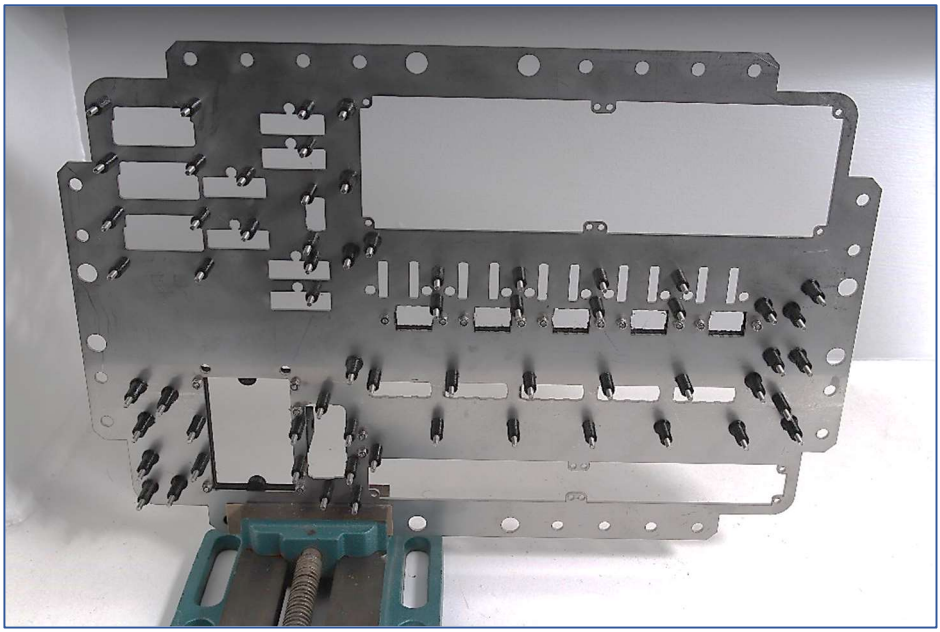

Power Depot

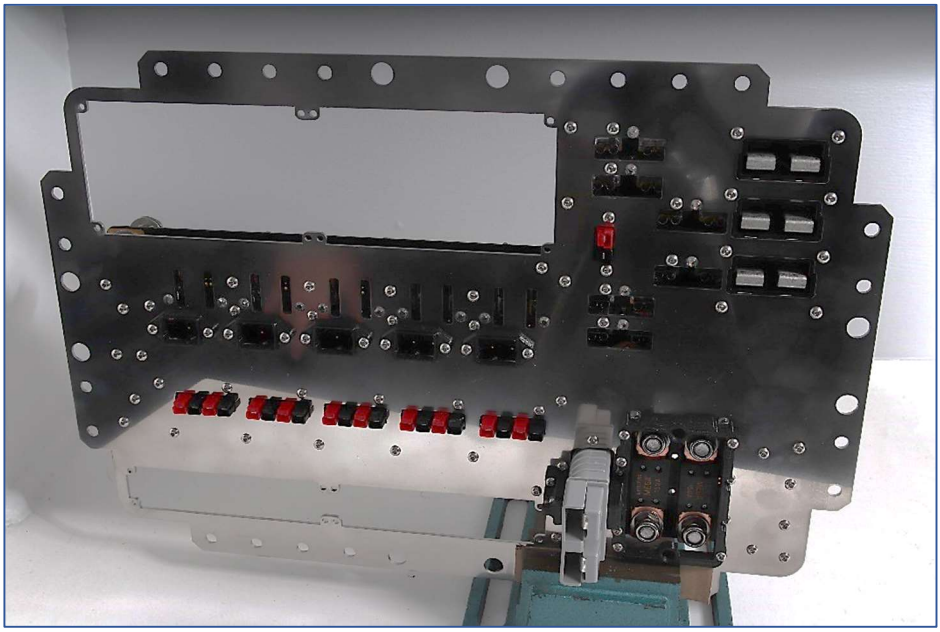

SHU500030100 500A/50mV





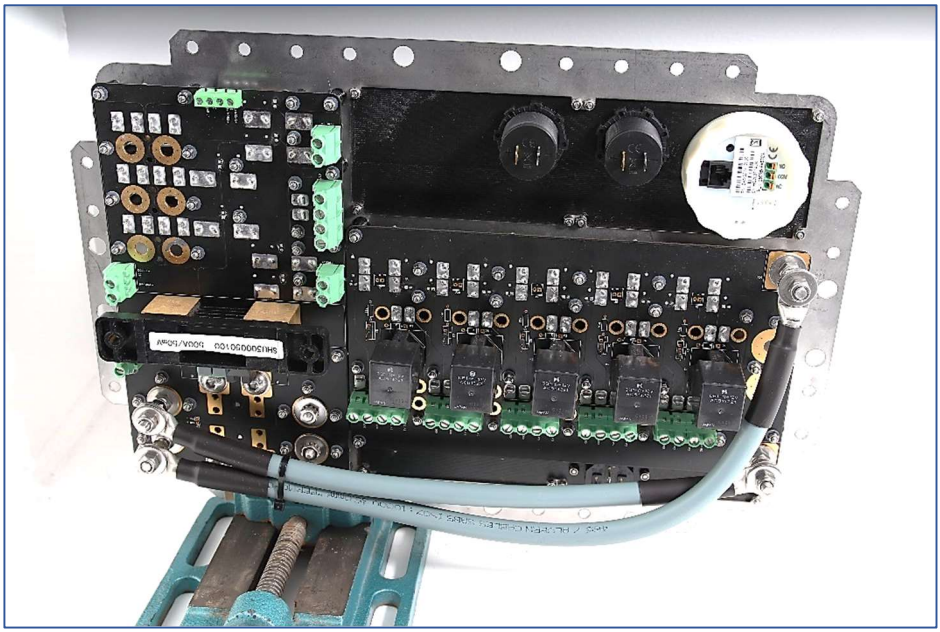


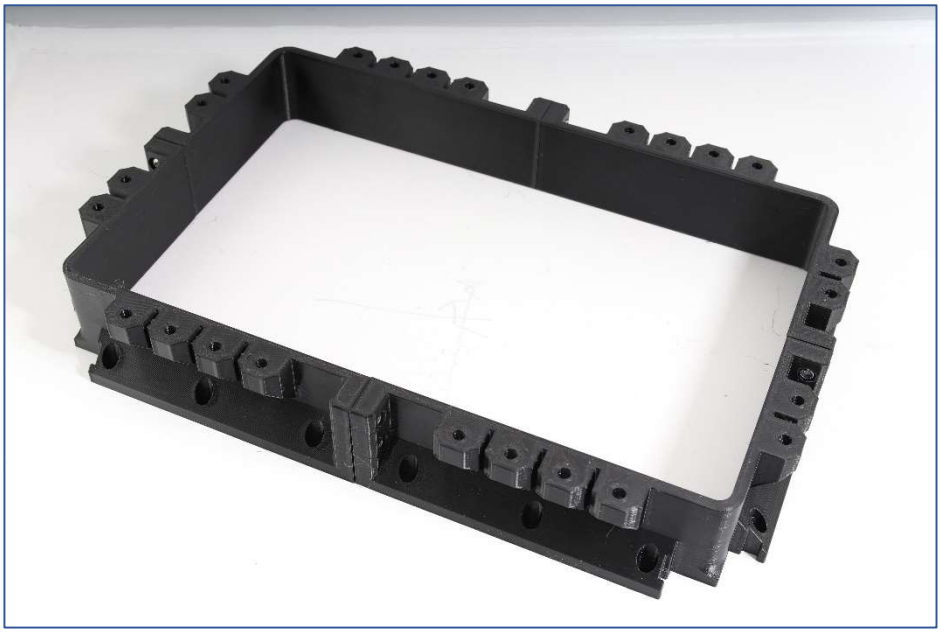


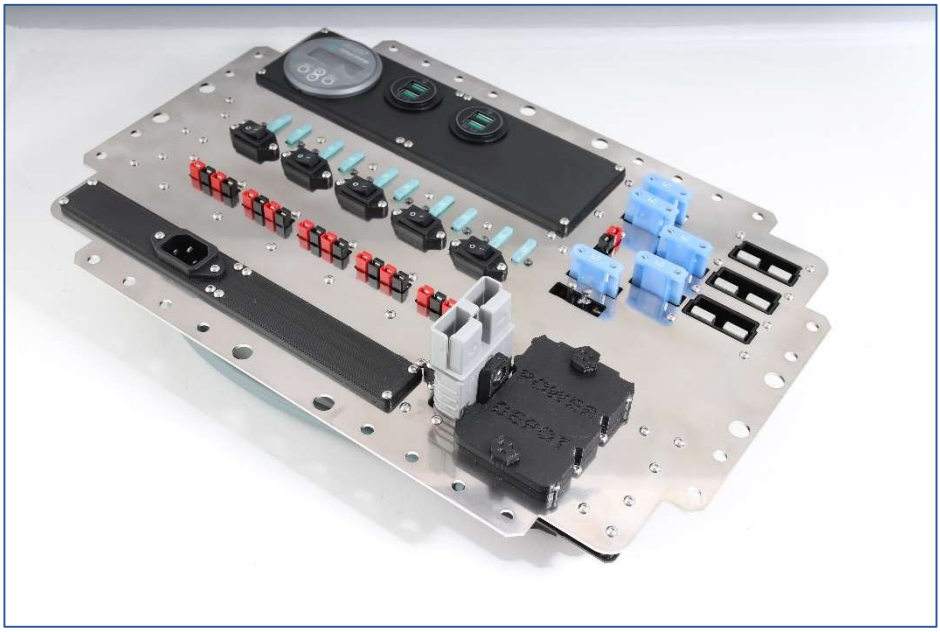


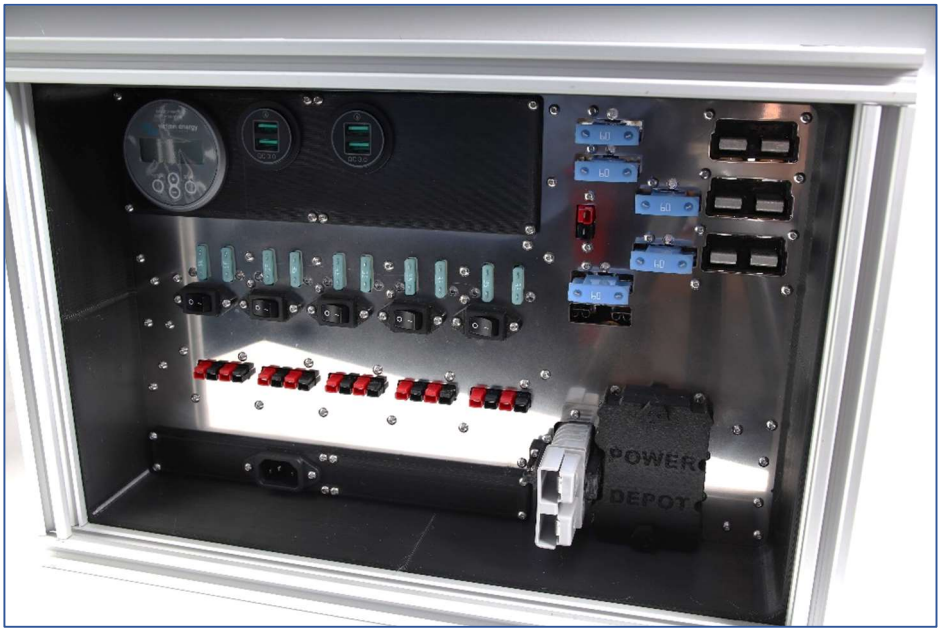

victron energy
QC 3.0
QC 3.0

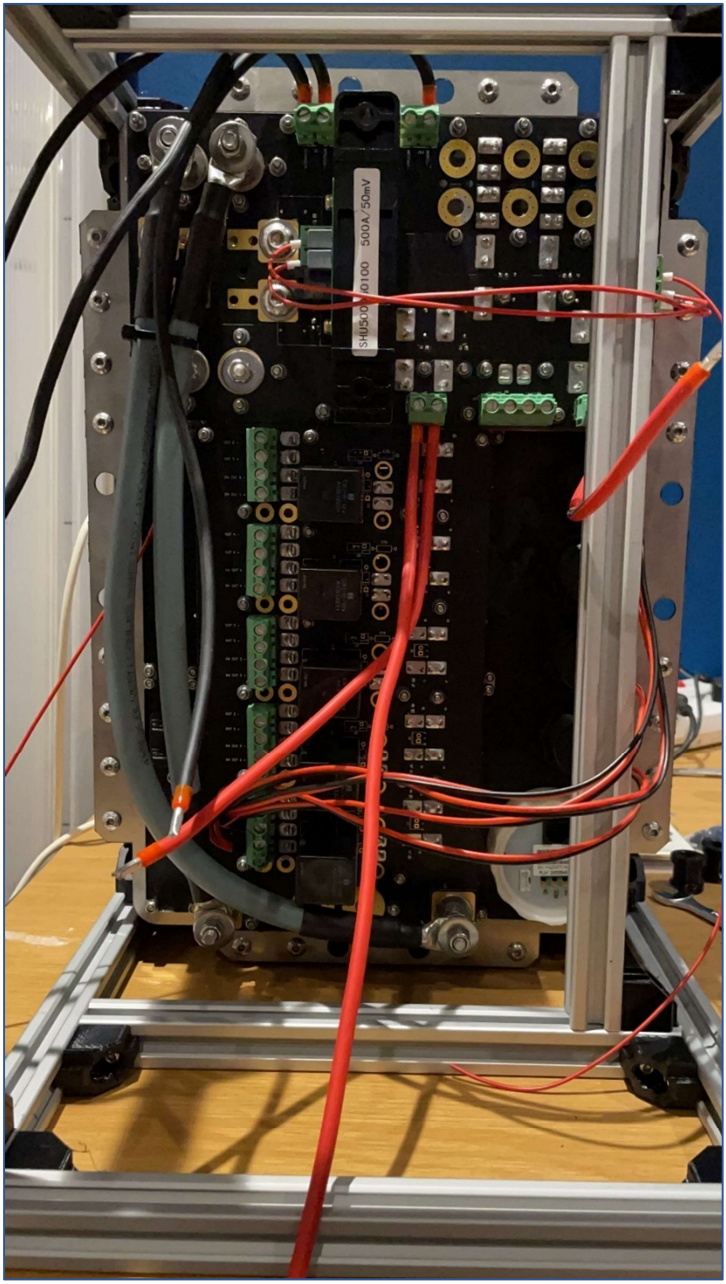

victron energy
QC 3.0
QC 3.0

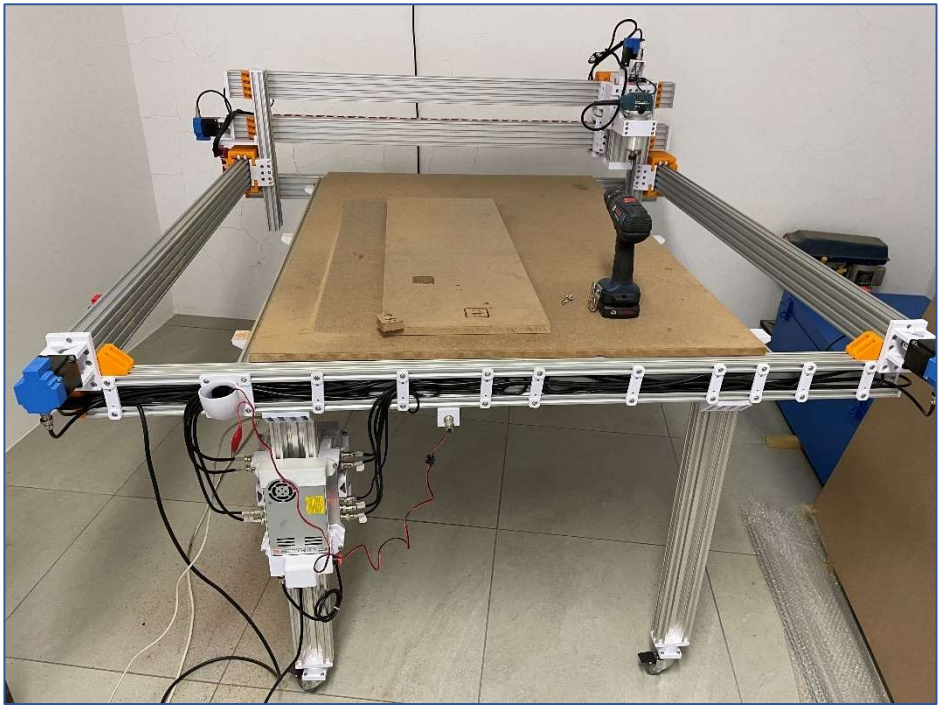


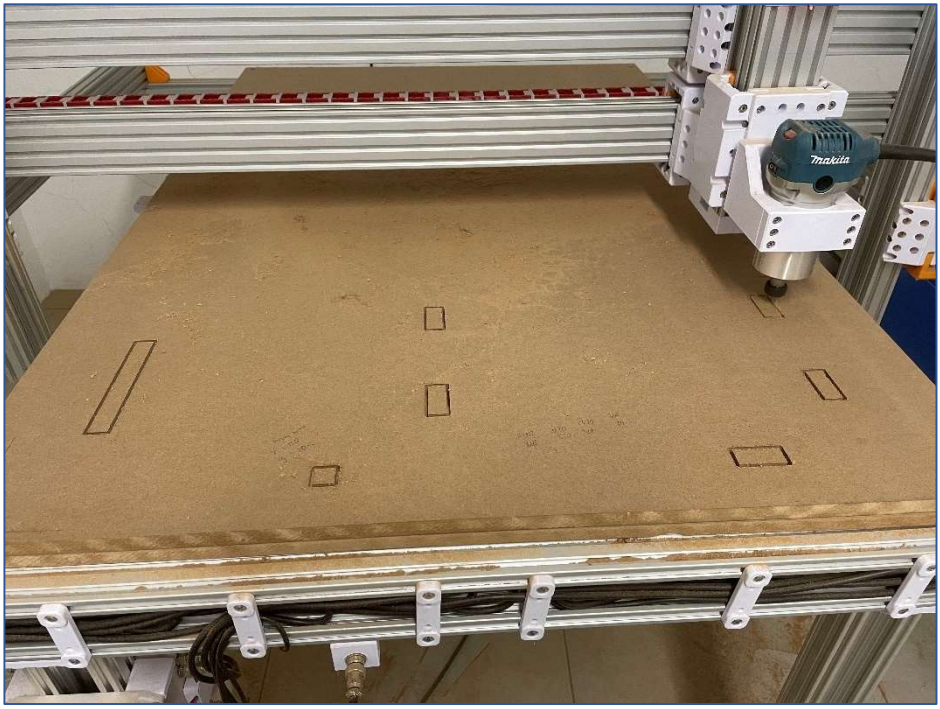


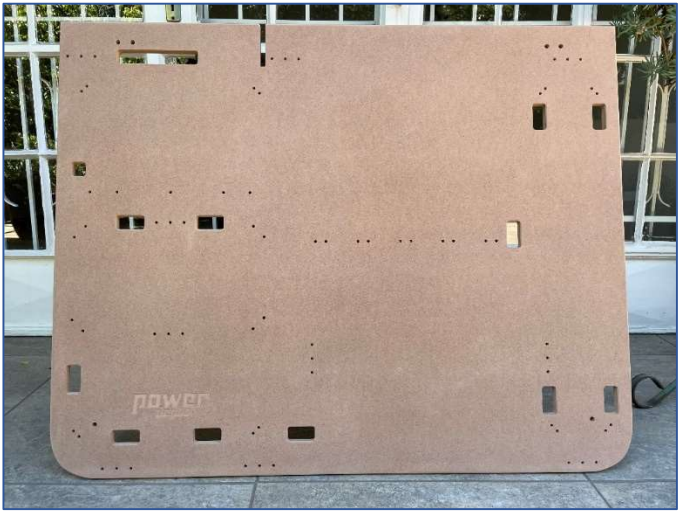



POWER
DEPOT


SHUNT 0100 500A/50mV




Makita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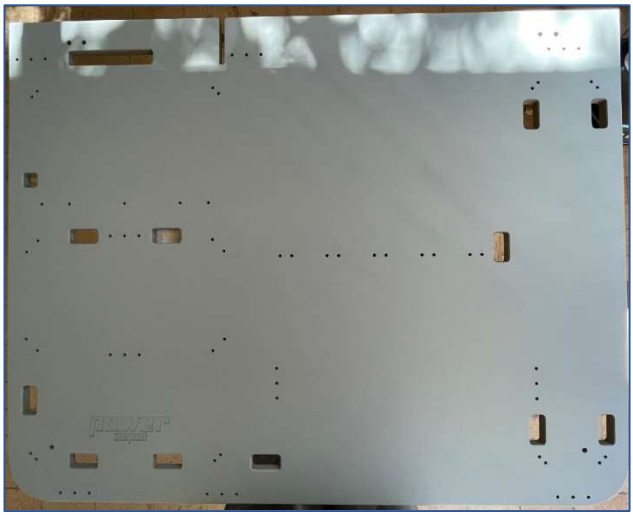

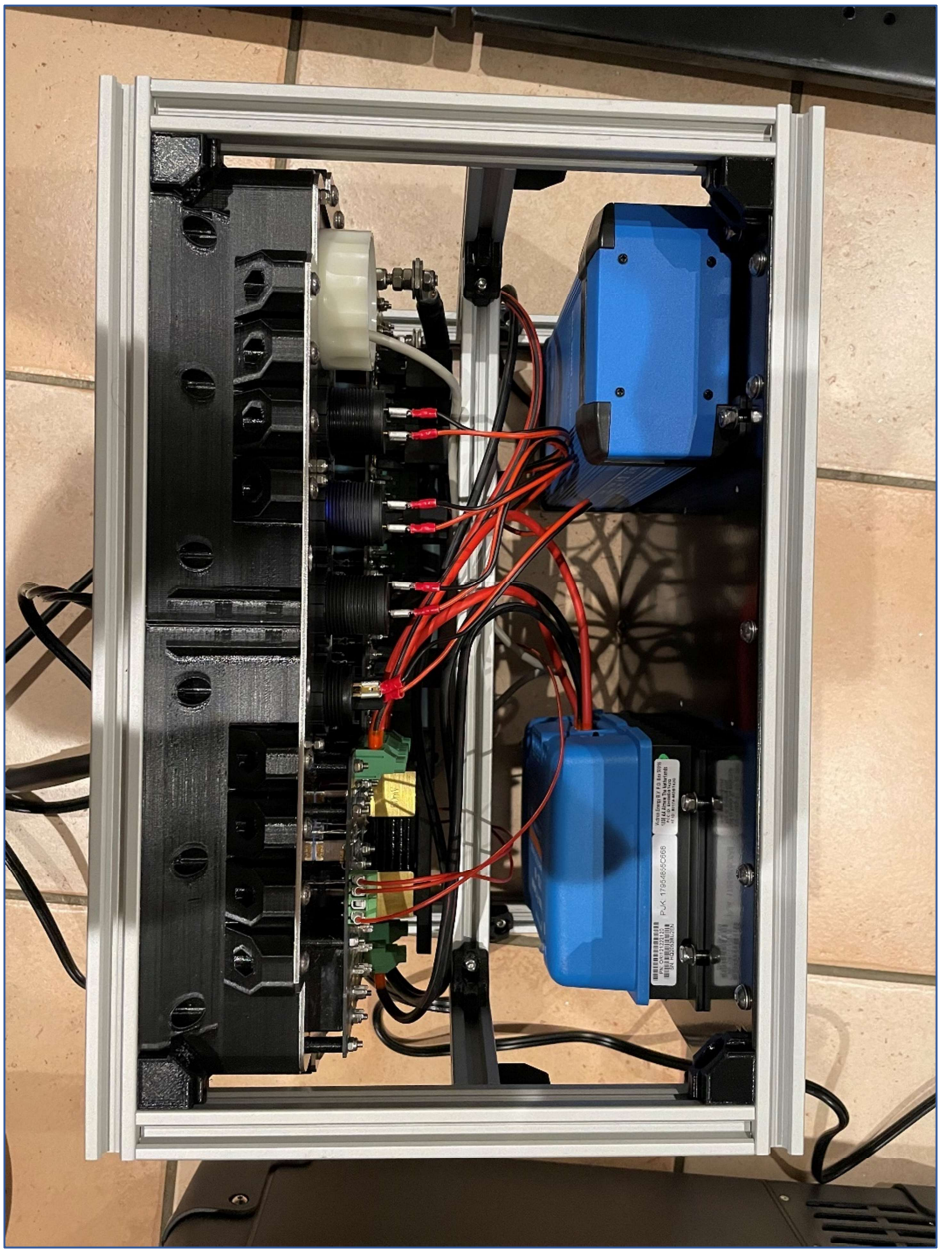

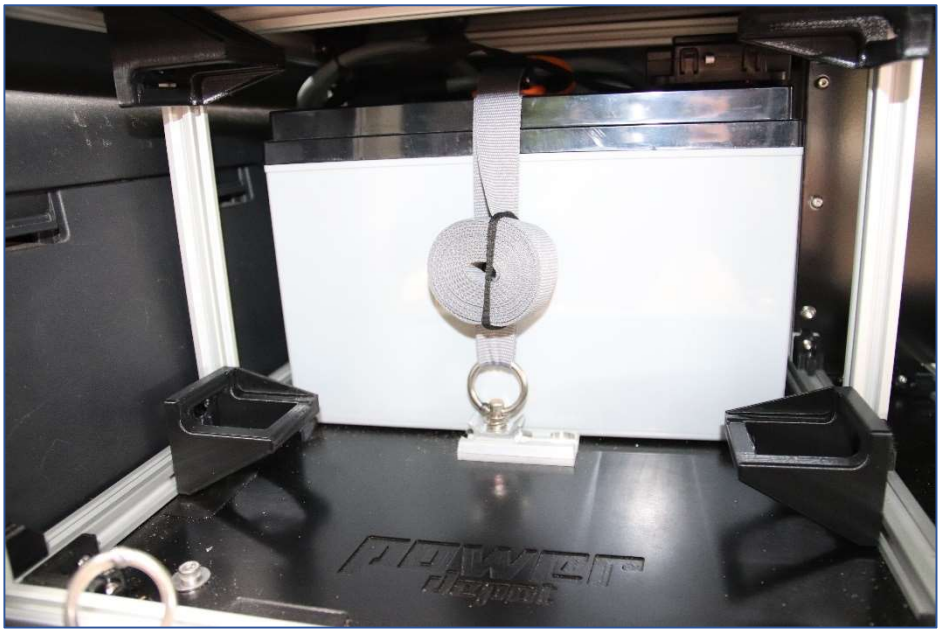

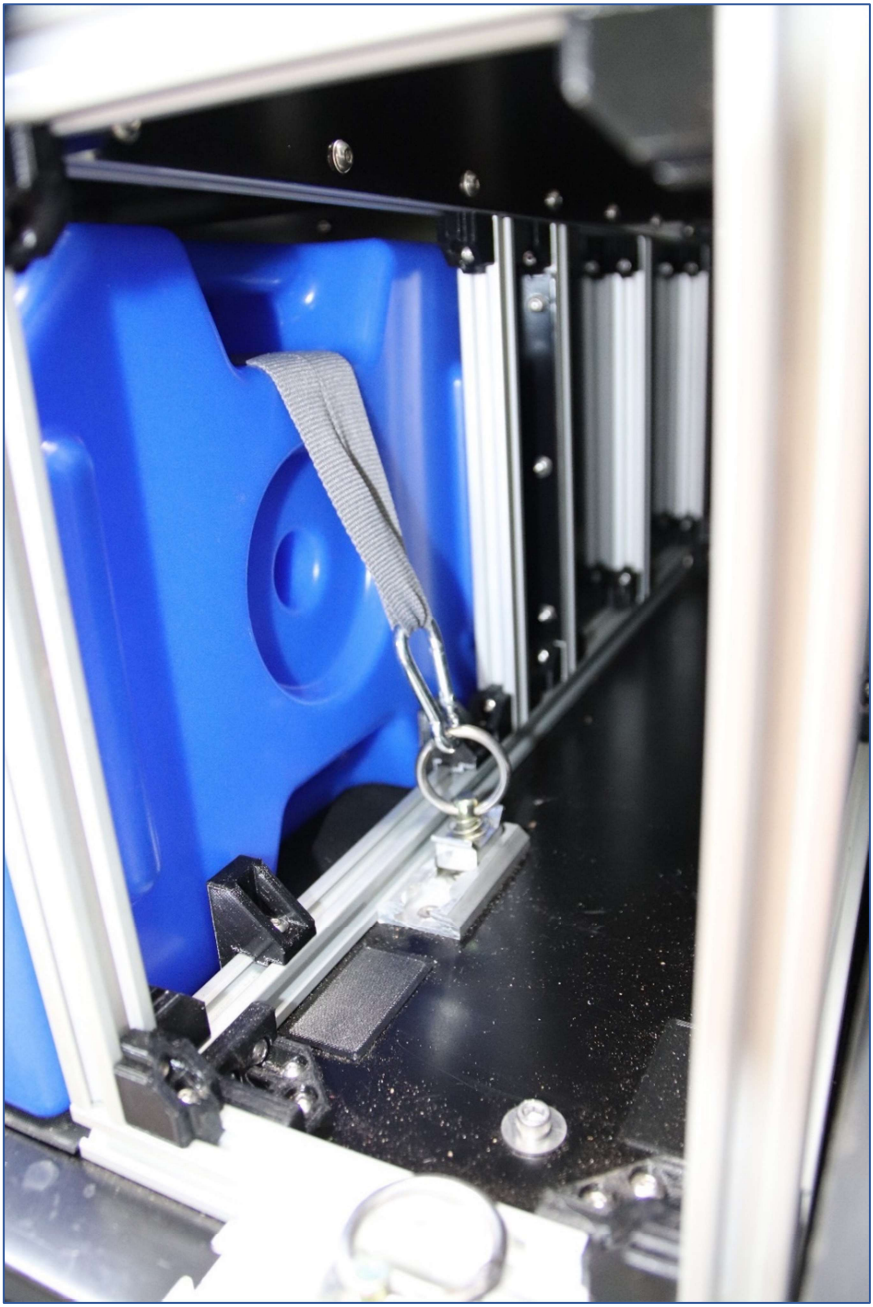

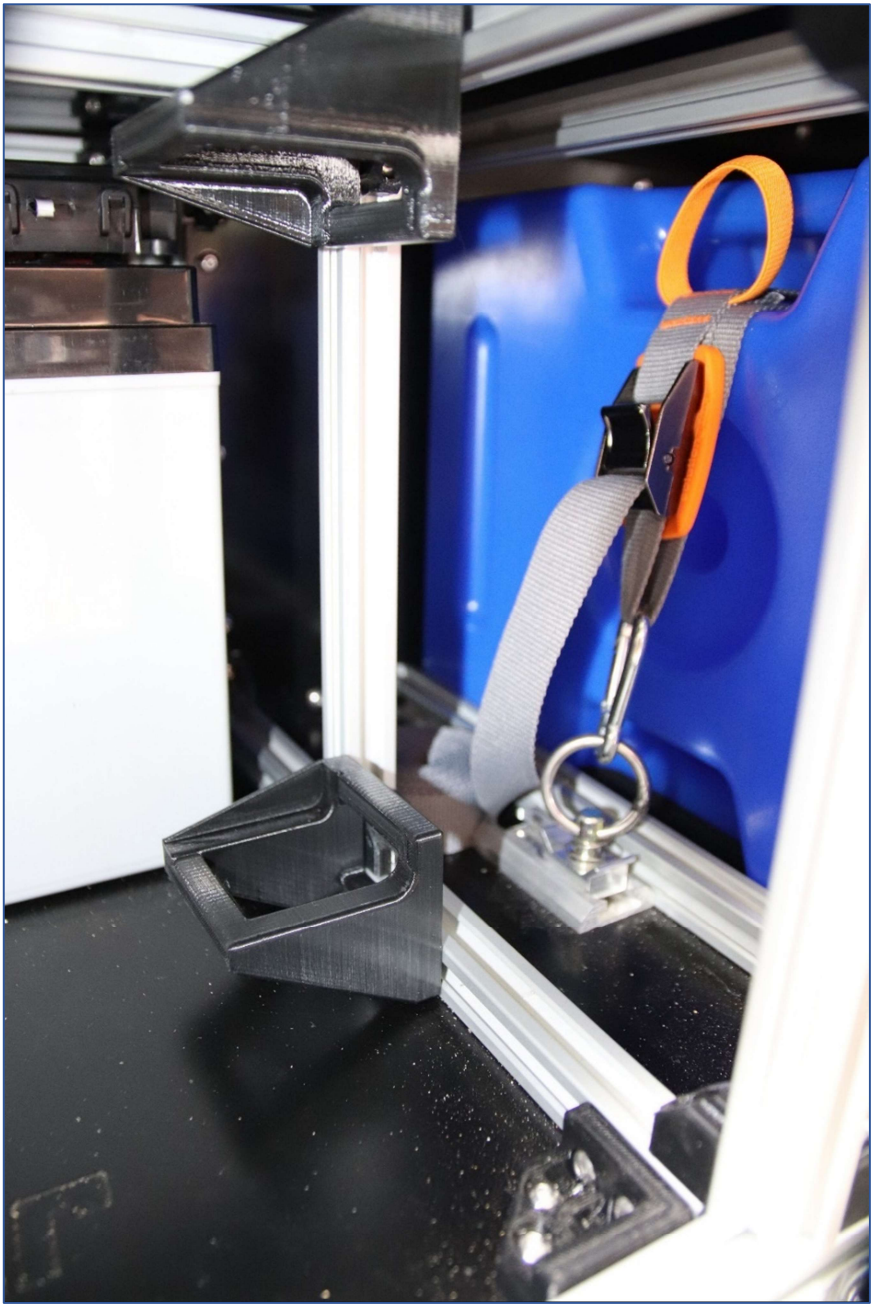


CoolFreeze CFX


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