

Task 7.4 - Power Distribution System PCB

Final Design

Team I – Lunar ROADSTER

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Design Considerations

Power Source

Battery: 3x Vanon Power Tools Batteries

Nominal Voltage: 20V

Nominal Capacity: 5.0Ah

Energy: 100Wh

Chemistry: Li-ion

Cell Configuration: 5s2p

Number of Cells: 10

Monitoring: Using Turnigy® Watt Meter and Power Analyzer (180A).

Specifications:

- Operating Voltage Range: 4.6~60 V
- Measured Voltage Range: 0~60 V
- Current Range: 0~180 A

Overvoltage Protection:

- Primary: 30 A Blade Fuse (each)
- Secondary: Push Button Emergency Stop

Subsystems

Subsystem	Voltage Range	Regulation Required	Continuous Current/Peak Current	Number of Connectors	Current Capacity of Connectors (Current/Peak)
2x Drive Motors	6~12 VDC	Yes	1.7 A/20 A	1 each (XT- 30)	15 A/30 A
2x Steering Motors	6~12 VDC	Yes	1.7 A/20 A	1 each (XT- 30)	15 A/30 A
Linear Actuator	12 VDC	Yes	~246mA	1 (JST-XH)	3A

3x Roboclaw Motor Controllers	6~34 VDC	Yes	15 A/30 A	6 Screw Terminals 1 JST-XH	– 3A (JST-XH)
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Table continued

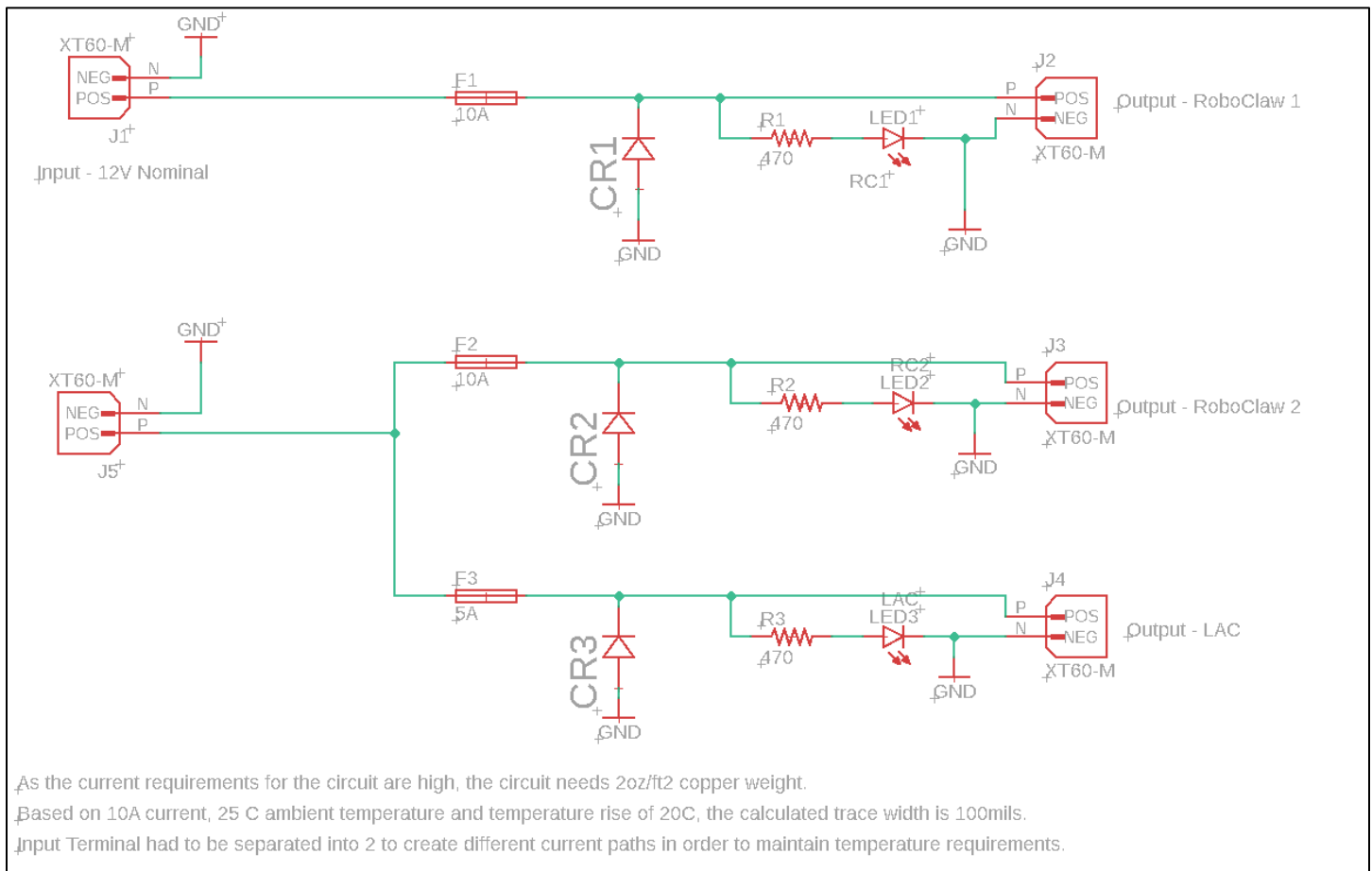
Subsystem	Desired Efficiency	Output Voltage after regulation	Peak output current	Maximum required operating voltage	Overvoltage Protection
2x Drive Motors	60%	12 VDC	20 A (per motor)	12 VDC	10 A Blade Fuse
2x Steering Motors	60%	12 VDC	20 A (per motor)	12 VDC	10 A Blade Fuse
Linear Actuator	60%	12 VDC	246 mA	12 VDC	5 A Blade Fuse
3x Roboclaw Motor Controllers	60%	12 VDC	30 A (per controller)	12 VDC	10 A Blade Fuse

Along with the PDB, we will be using an external step-down DC-DC Converter with an onboard heat sync (<https://www.mouser.com/ProductDetail/CUI-Inc/VHK200W-Q24-S12-DIN?qs=WyjIAZoYn50MbLXm0mMOA%3D%3D>).

As our current requirements are high (5-10 A), we could not find suitable regulators or step-down converters that could be part of the PDB. The PDB contains 3 outputs for each motor driver (RoboClaw), including overvoltage (using fuses) and reverse voltage (using diodes) protection. Bypass and Decoupling capacitors minimize any noise in the system from the external step-down converter. Additionally, LEDs are used to monitor the power of each output connector.

The onboard heat sync will dissipate all the heat. We will ensure that the placement of the step-down converter on the rover allows it to receive the required airflow. Additionally, the motor drivers are also equipped with onboard heat syncs to dissipate any additional heat.

Schematic



Board Design

To accommodate the high current requirements for the circuit, we shifted to two different inputs. This allows us to create 2 independent circuits with a common ground.

Trace Width Calculation Parameters:

Current – 10A

Ambient Temperature – 25°C

Temperature Rise – 20°C

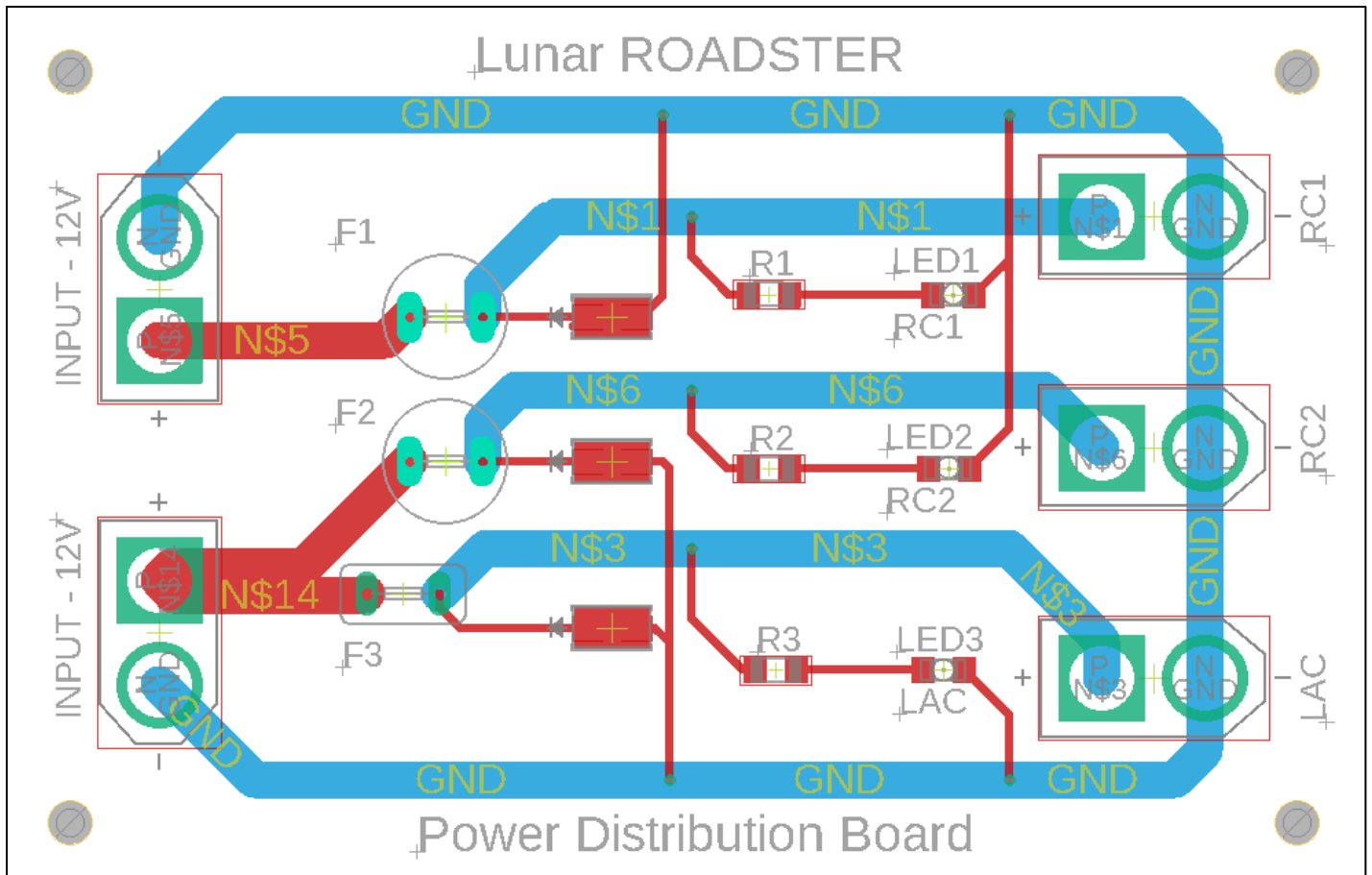
Thickness – 2oz/ft²

This gave us a minimum trace width of **93mils**.

Tool Used - <https://www.advancedpcb.com/en-us/tools/trace-width-calculator/>

Hence, the high current trace widths are 100mils and the low current widths are 20mils.

Board Design



Bill of Materials

The bill of materials (including spares) for the PDB is shown below:

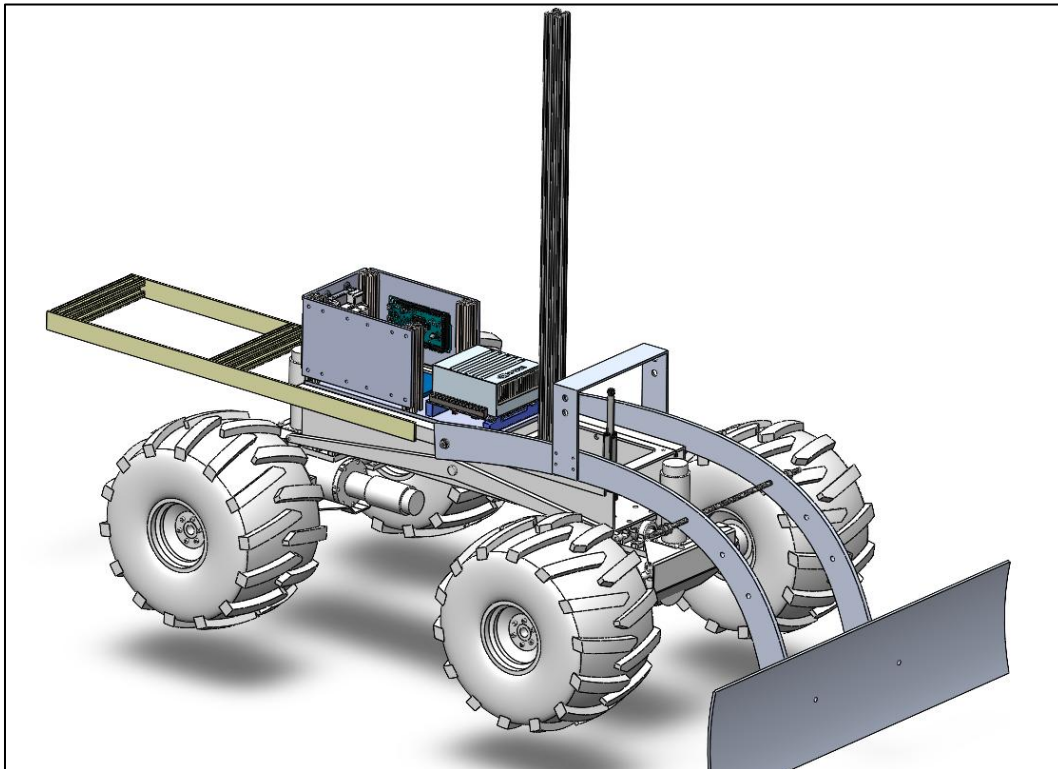
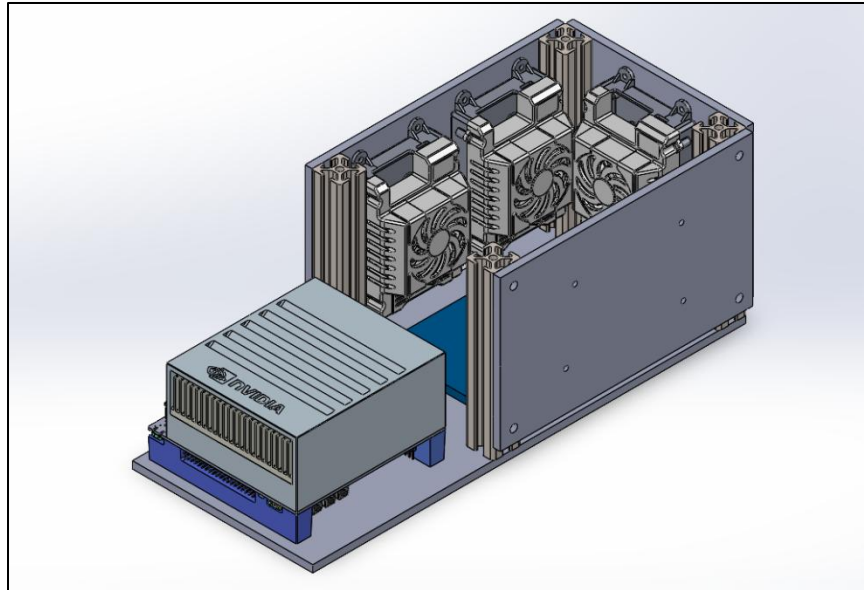
Qty	Value	Part Designator	Part Number	Vendor Link	Cost per part (\$)	Description
4	P4SMA16A	CR1, CR2, CR3	P4SMA16A	P4SMA16A	0.43	Diode
6	10A	F1, F2	TR5 - 37321000000	37321000000	1.29	Fuse
3	5A	F3	TE5 - 39515000440	39515000440	1.57	Fuse
6	XT60-M	J1, J2, J3, J4, J5	XT60-M	XT60	0.89	Connector
5	LED 1206	LED1, LED2, LED3	1206 SMD	1206 SMD	0.04	LED
5	470 Ω	R1, R2, R3	CR1206-FX-4700ELF	CR1206-FX-4700ELF	0.1	Resistor

Mounting Method

The board contains 4 M3 mounting holes at the corners. On our rover, we have designed an electronic box with custom mounting holes matching the board. An initial iteration of the design is shown below.

Once the PDB design is finalized, the placeholder (blue part on the bottom face) will be replaced, and holes will be made accordingly.

All power outputs from the PCB will be connected to components inside the box. The input comes from the batteries mounted behind the box.



DFM Results

- Link to DFM results summary - <https://www.freedfm.com/freedfm/0038175906222431/results/summary2.htm>
- Link to DFM plots - <https://www.freedfm.com/freedfm/0038175906222431/results/plots.htm>
- Link to multilayer PDF - <https://www.freedfm.com/freedfm/0038175906222431/FreeDFM-v2.0/freeDFM.pdf>

FreeDFM.com™
Summary for your design.

Congratulations!

No DFM problems were found on your board!

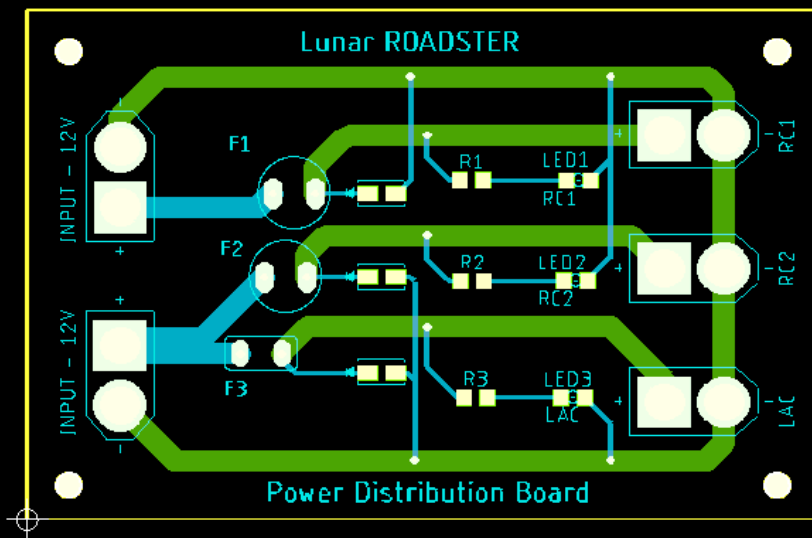
Show Stoppers

We Found None!

Problems Automatically Fixed by FreeDFM

We Found None!

Gerber Viewer



Online Gerber Viewer
www.gerber-viewer.com