2-Cycle Power System

- Group 37:
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Motivation

Create	Create a self-sustained green energy system
Develop	Develop a remote-control system for power source control
Gain	Gain a better understanding of power generation controls
Lessen	Lessen the need for large scaled power generation facilities

Goals and Objectives

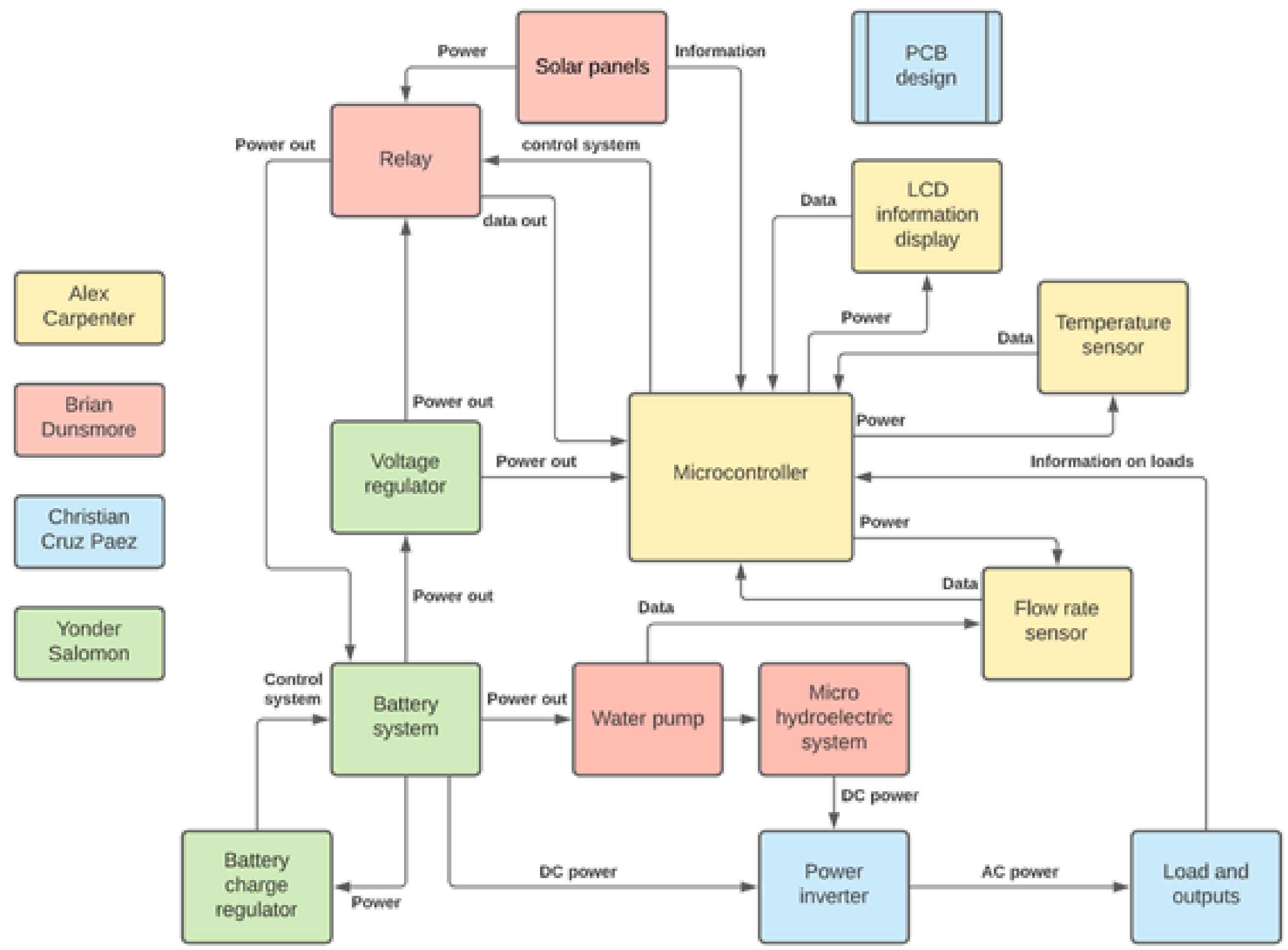
Solar panel supply power to both internal and external loads and charger system.

Have the system switch between voltage sources

Wireless transmission of system data

Specifications

#	
1.0	The system shall have the ability to generate 10 watts of power from solar panels.
1.1	The system shall have the ability to pump at least 240 gallons per hour from the micro hydro-generator.
1.2	The system shall have the ability to charge a 7 amp-hour battery.
1.3	The system shall have the ability to control when the solar panel and the hydro-generator are operated.
1.4	The system shall be able to be remotely operated at a range of 25 meters.
1.5	The system shall have the ability to switch between generating power from solar panels and the hydro-generator within 5 minutes.
1.6	The system shall have the ability to engage both power generation sources simultaneously at a predetermined load power threshold (6 Watts).
1.7	The system shall be able to be implemented into pre-existing households within 2 hours.
1.8	The sensor's measuring power shall remain accurate within 0.2 Watts.



Overall block diagram

Solar Panels

- Topsolar
- 20-watt output
- Monocrystal
- The panel comes with the ability to adjust the angle to any degree needed for power generation
- Initial panel testing done with a program pv-watts

Brand	Wattage	Efficiency Rating	Voltage Load	Installation
Sunsol	20 Watts	23% rating	12 volts	Easy, with a 180-degree adjustable
Top solar	20 Watts	24% rating	12 volts	Easy, with a 180-degree adjustable
Sunmind	3.5 Watts	18% rating	12 volts	Fixed position, no installation needed

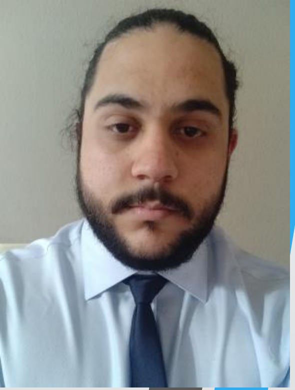
Panel comparison

Water pump

Brand	Voltage	Gallons per Hour	Power draw	Size
Echpow	12 Volts	63	4.2 Watts	51mm x 34mm x 42.7mm
AEO	12 Volts	240	5 Watts	5" x 2.28" x 3.54"
GENEDEY	12 Volts	210	19 Watts	77mm x 63mm x 49mm

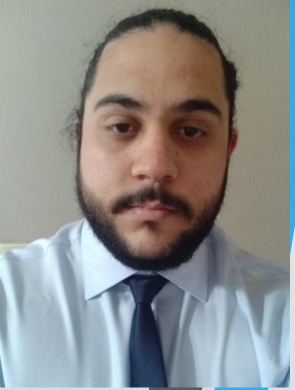
Brand	Voltage	Charge Current	Starting Pressure	Size
Samfox	5-80 Volts	.22 Amps	0.05 MP	8.66" x .39" x .39 "
Savemore	12 Volts	.133 Amps	0.06 MP	8.8 cm x 5.8 cm x 3.9 cm
Beduan	5-12 Volts	.23 Amps	.07 MP	5.75" x 2.76" x 1.38"

Hydro Generators



Battery comparison

	Lithium-ion	Nickel Metal Hydride	Zinc-ion	Lead Acid
Capacity	10 Ah	11 Ah	7 Ah	7.7 Ah
Life Cycles	2000	500	15000-50000	500
Dimensions LxWxH	5.94 x 2.56 x 3.7 inches	6.7 x 2.75 x 3.79 inches	TBD	6.0 x 2.5 x 3.8 inches
Power type	Lithium & graphite	Nickel & Hydride	Zinc & manganese	Sealed lead acid
Price	$70	$50	~$50	$20

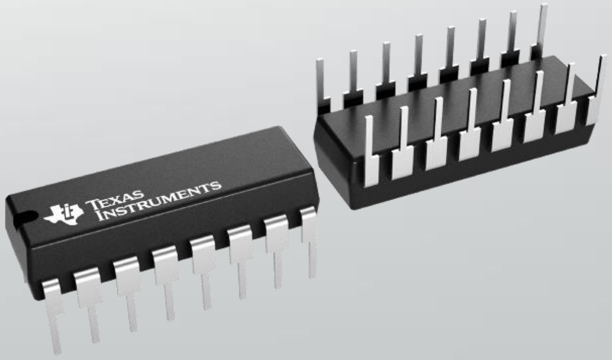


Charge controller

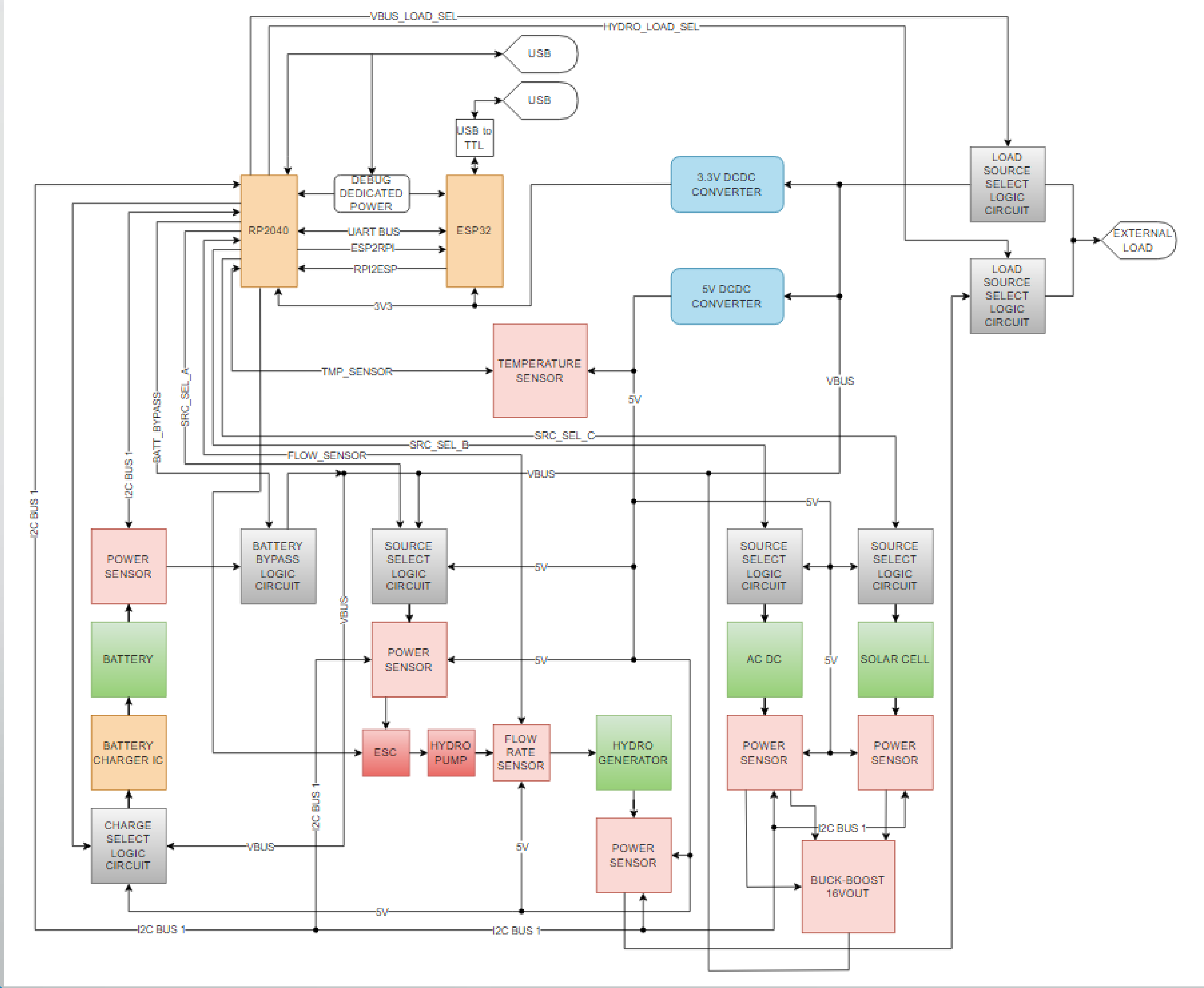
- Charge controllers are essential for safety
- Charge controllers help charge more efficiently
- Gives us accurate data to pull from
- Ultimately too expensive

Battery charger IC

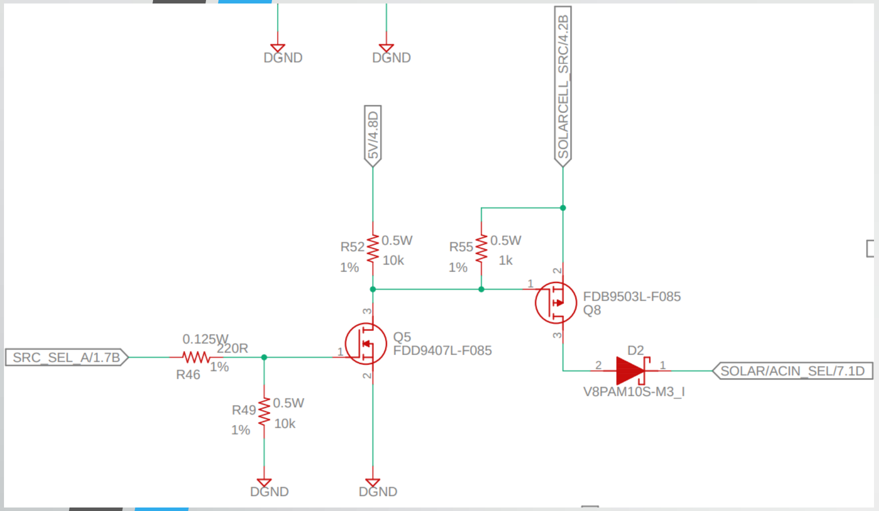
- Also allows for safety in our system
- Allows for an aspect of design
- Gives data through the IC
- Cost effective and cheap
- Common and accessible part from TI

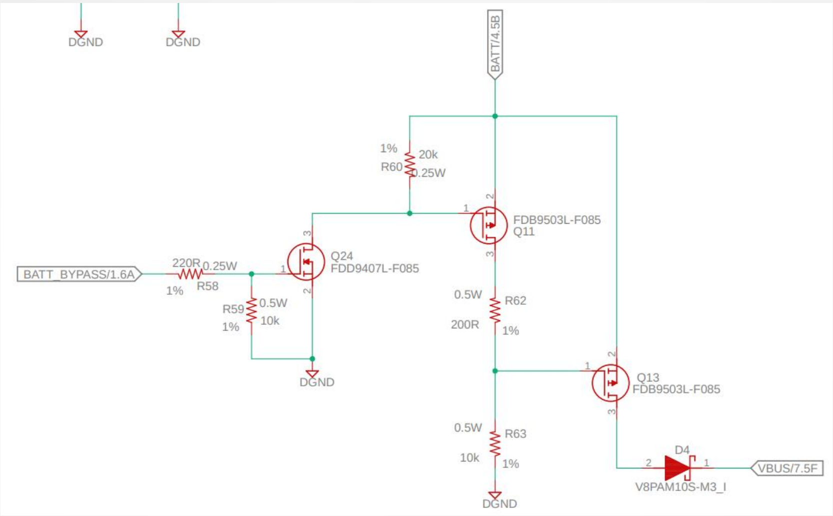


High Level System Architecture



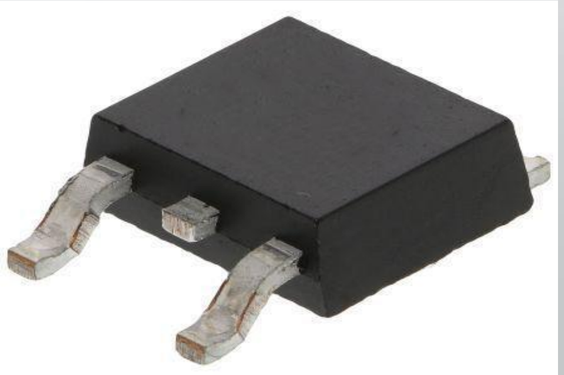
FET Based Logic Circuits



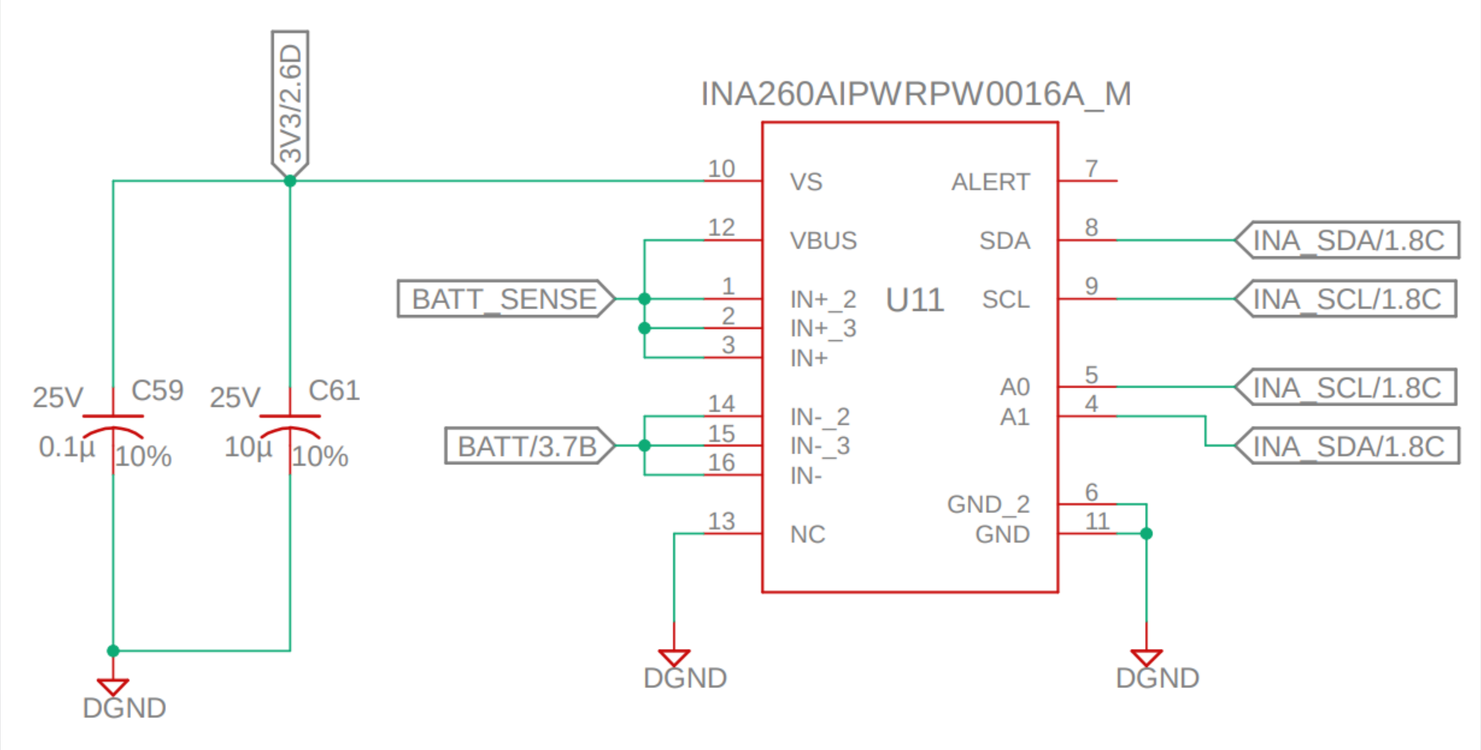


- Used to gate the input sources, software controlled.
- Based on NMOS-PMOS combinational logic using Logic Level featuring low Rds on for minimal thermal loss.

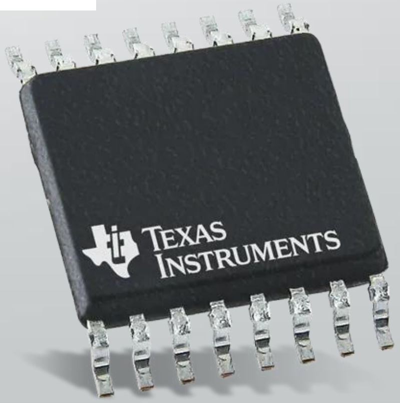
- Battery Bypass Circuit.
- Used to deviate all of the system load from the battery when charging operations are in progress.

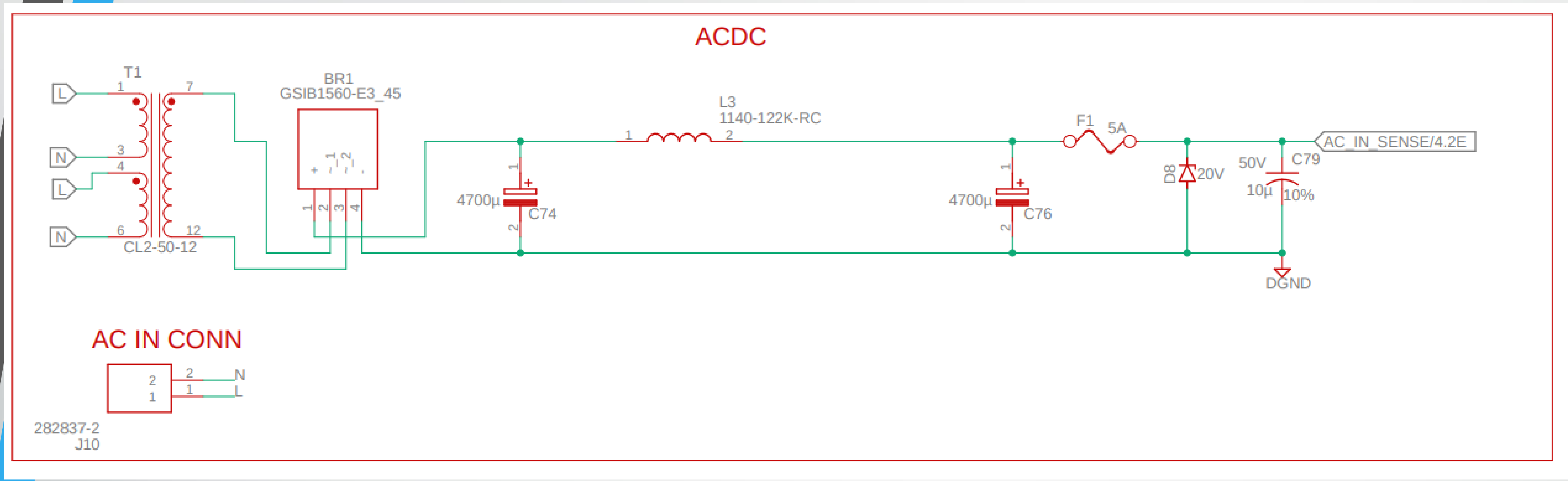


Power Sensing



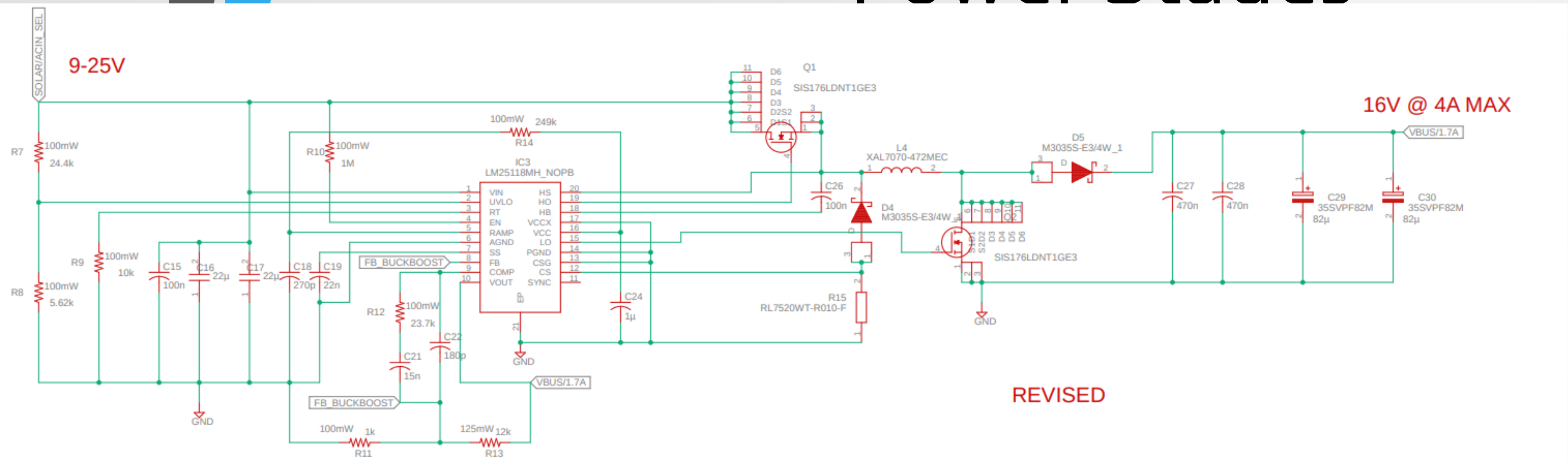
- TI's INA260
- Power sensor able to measure up to 15A @ 36V.
- Telemetry data transmitted via I2C



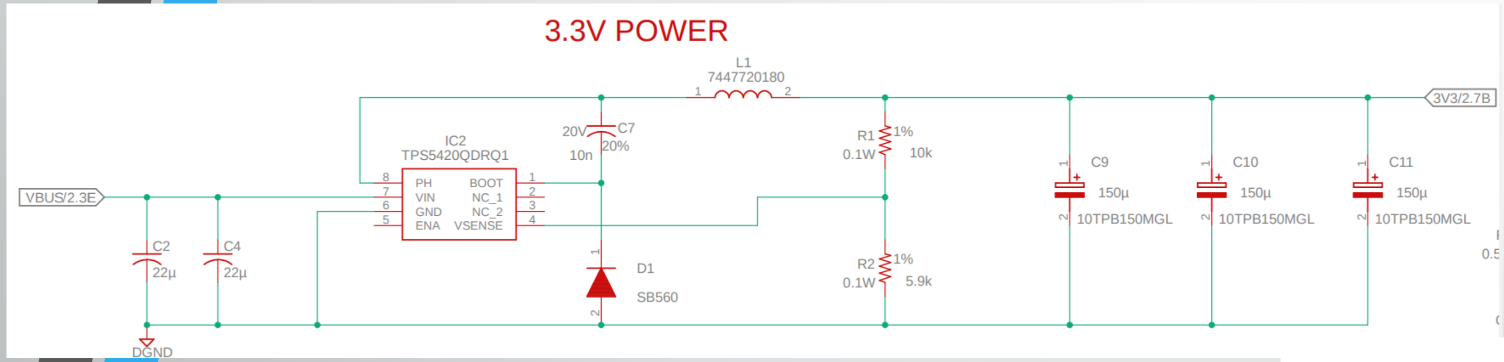


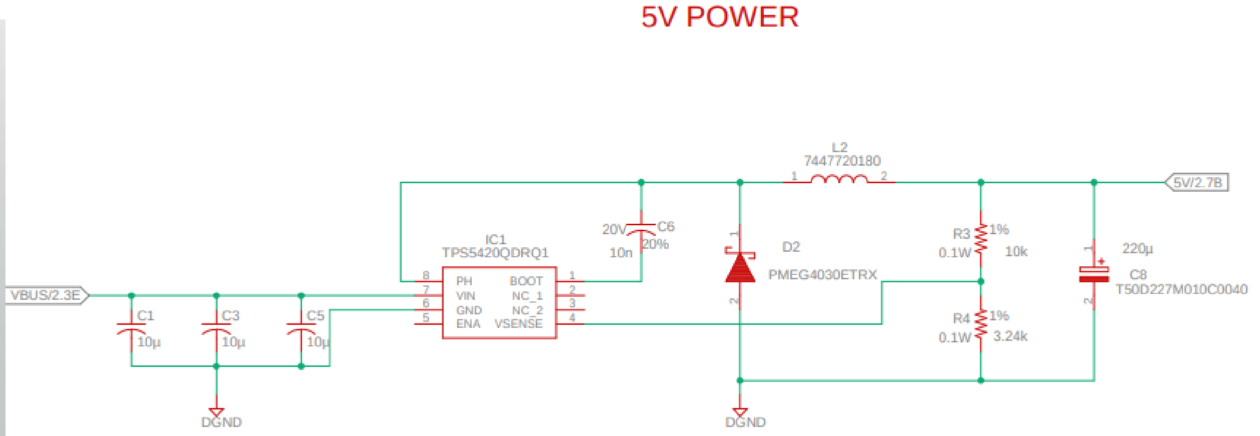
- AC to DC rectification and power conditioning
- Featuring a Pi Filter to maximize ripple reduction

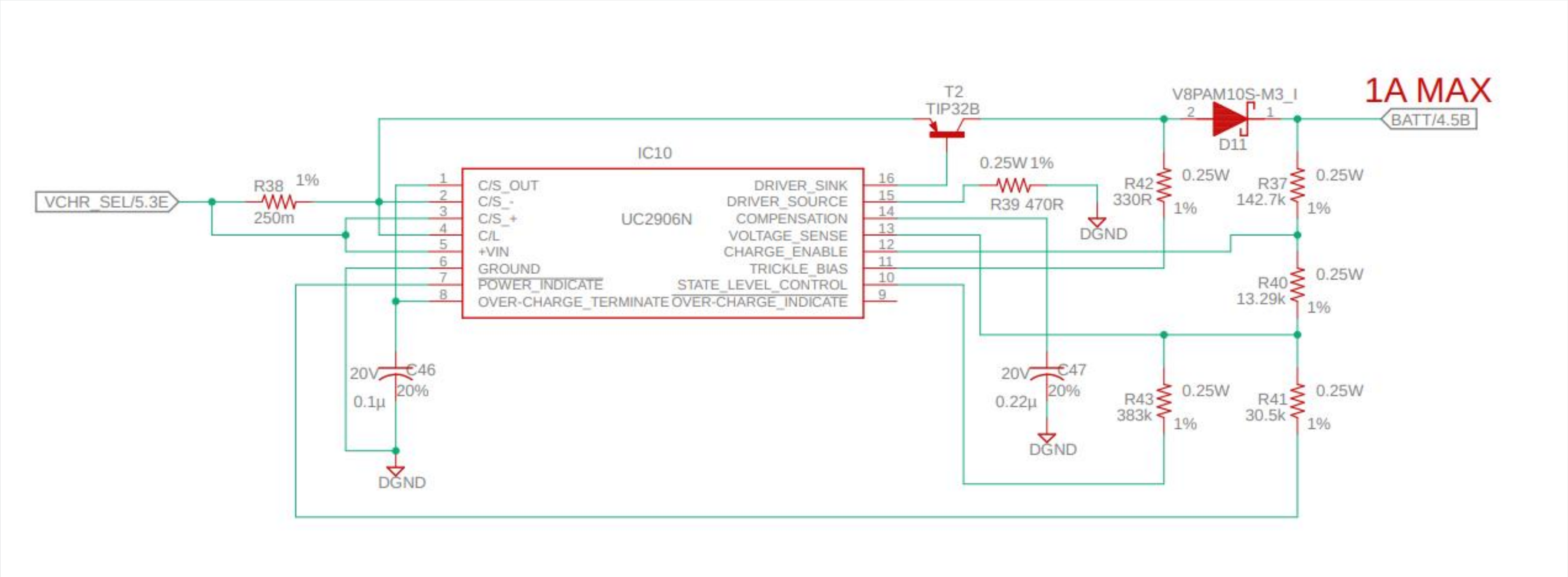
Power Stages

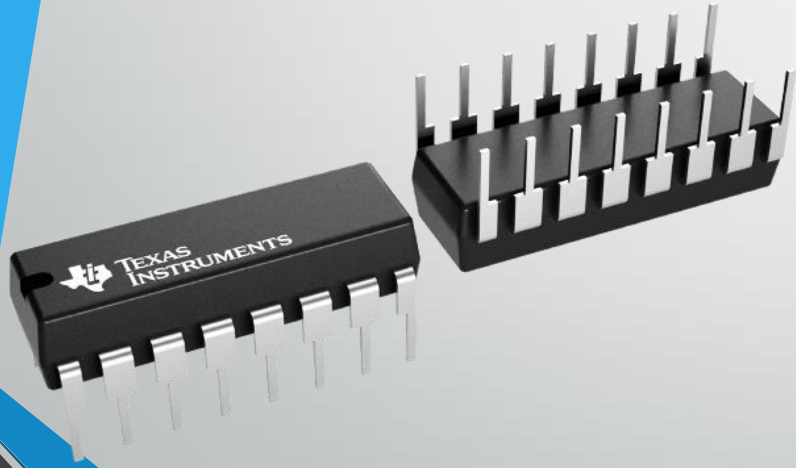


- High Efficiency TPS5420 Buck converter for 5V and 3.3V Voltage Rails.
- LM25118 Buck-Boost for main Bus voltage rail fed from AC or Solar Energy, anticipated input can range from 9 to about 20V.
- VBUS rail feeds all of the internal voltage rails (3.3V & 5V), an external load and the battery charger circuit.





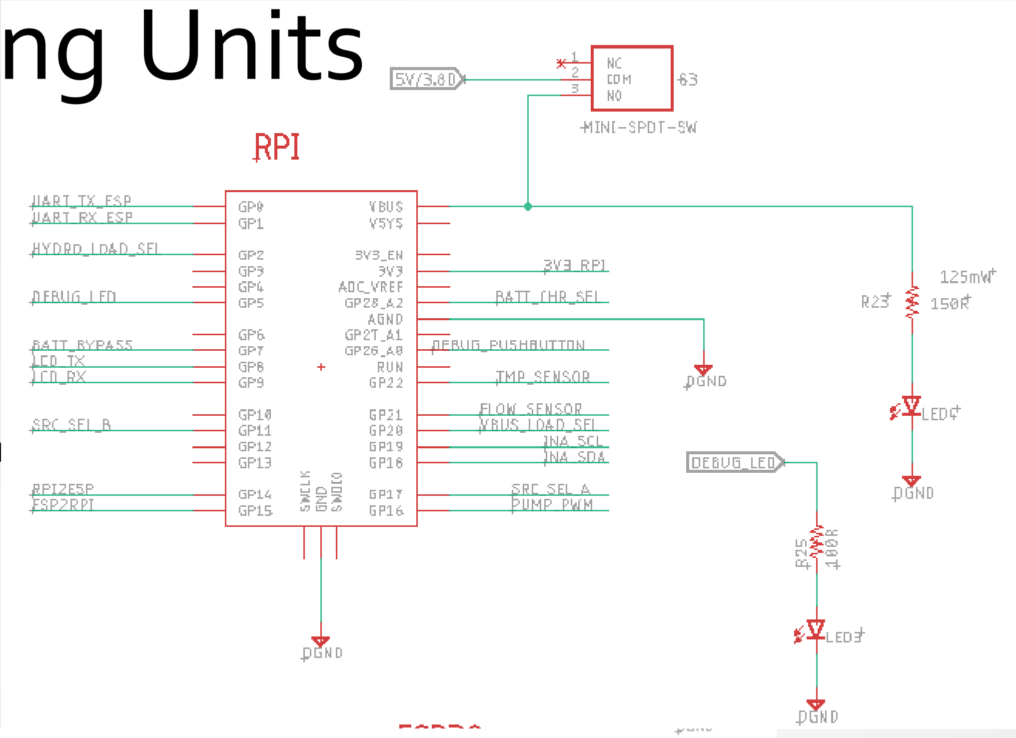


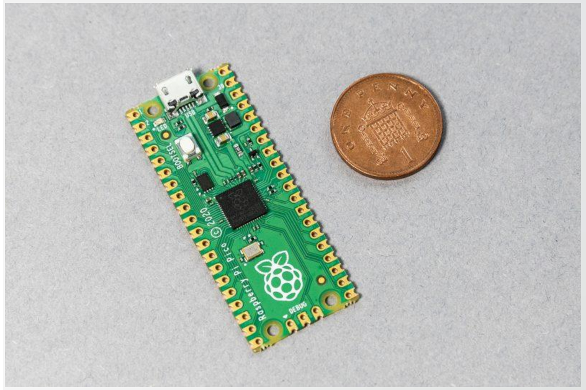


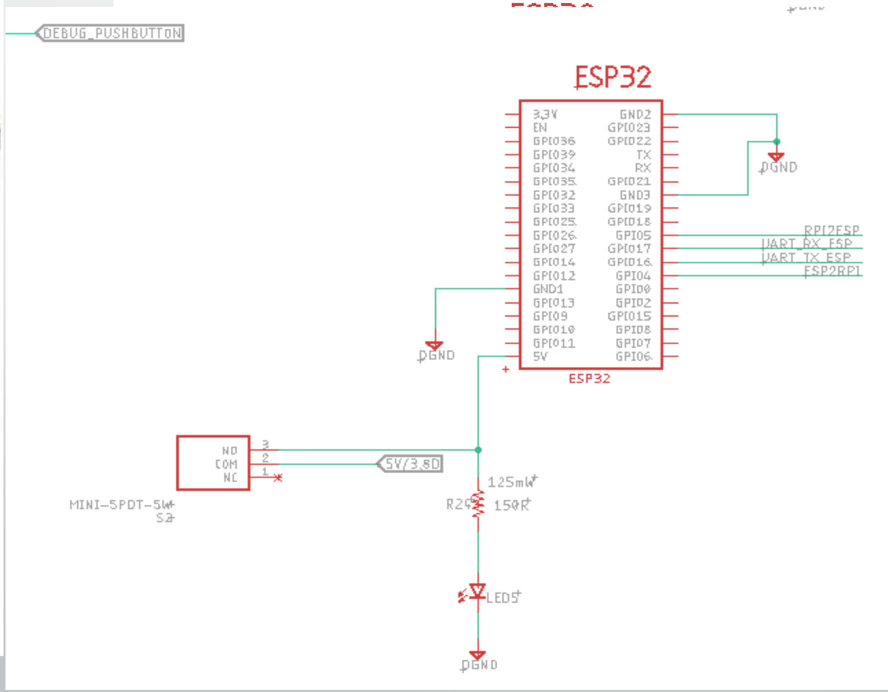
- Battery Charger IC
- Highly Reliable Resistor Configurable
- Charge Current merely dependent on T2 characteristics
- Charging current limited to 1A for a 7.2Ah Battery (C/7).

Processing Units

- Raspberry Pi's RP2040 Main processing unit.
- ESP32 as coprocessor and Wireless Communications Module.
- UART bus for Inter Board Communications.
- Interrupt lines for seamless and reliable Data Link.



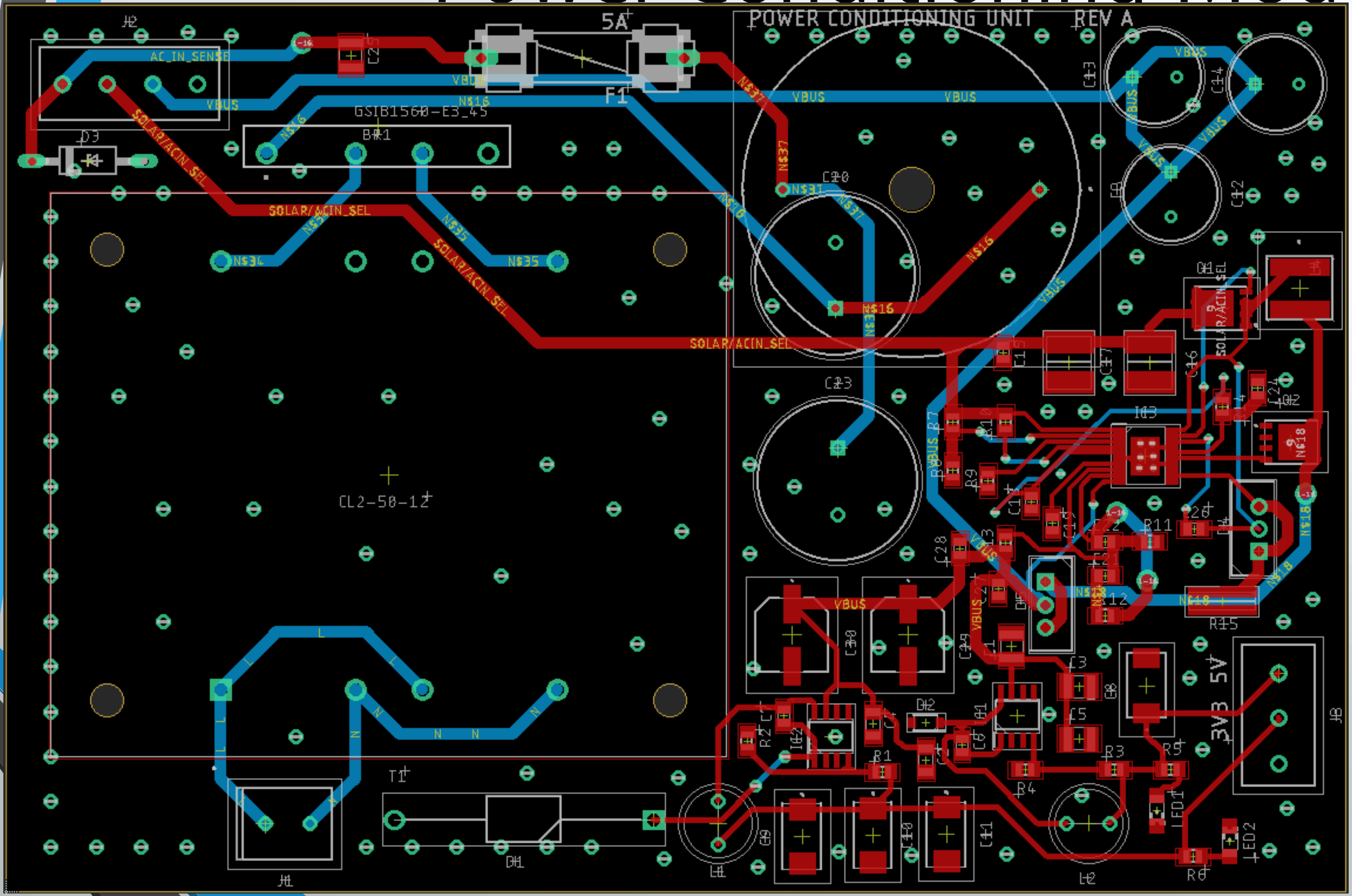




PCB Layout

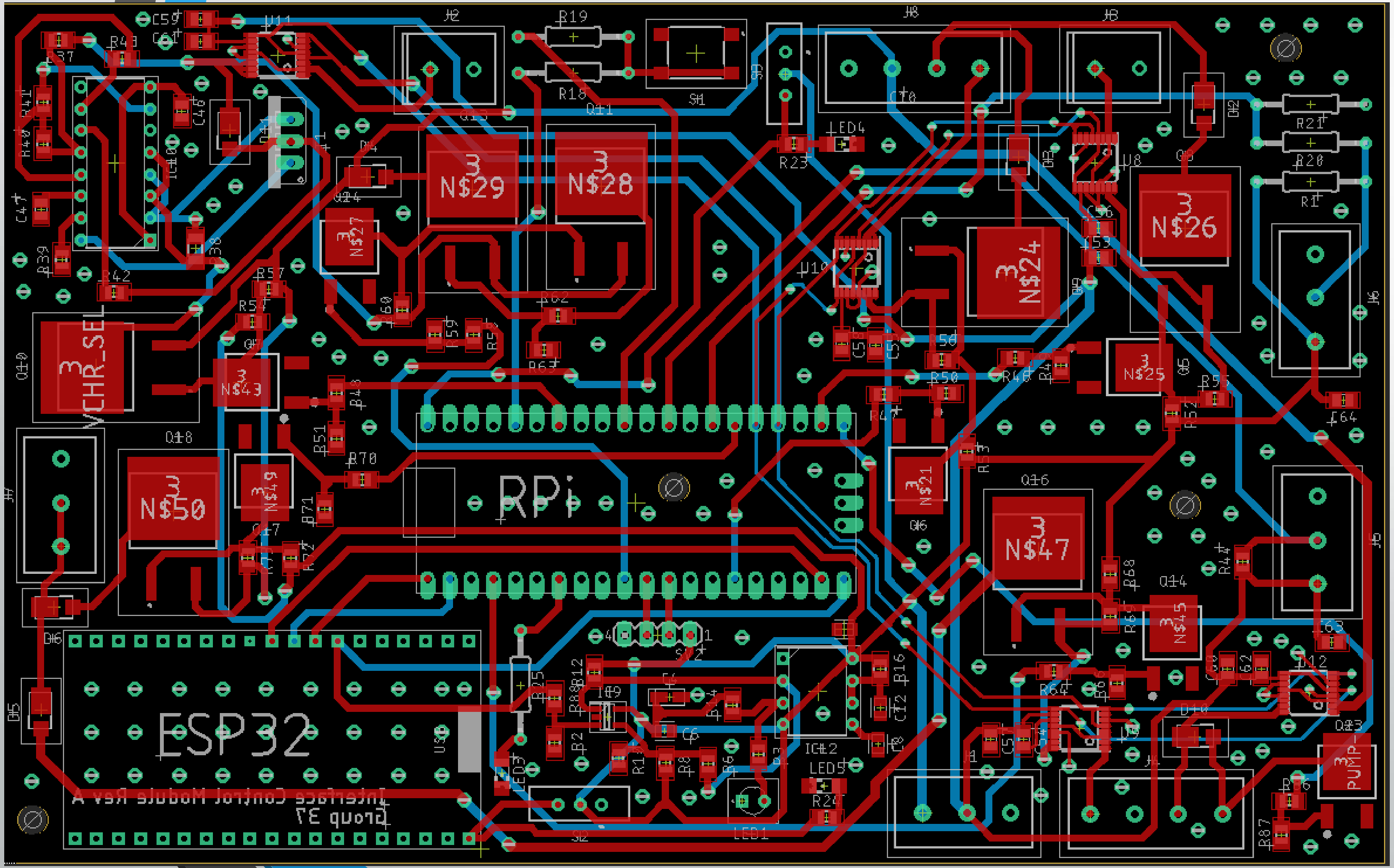
In order to facilitate troubleshooting and isolating potential issues with our design, the design was implemented using 2 PCB's. A **Power Conditioning Module** and an **Interface Module**.

Power Conditioning Module



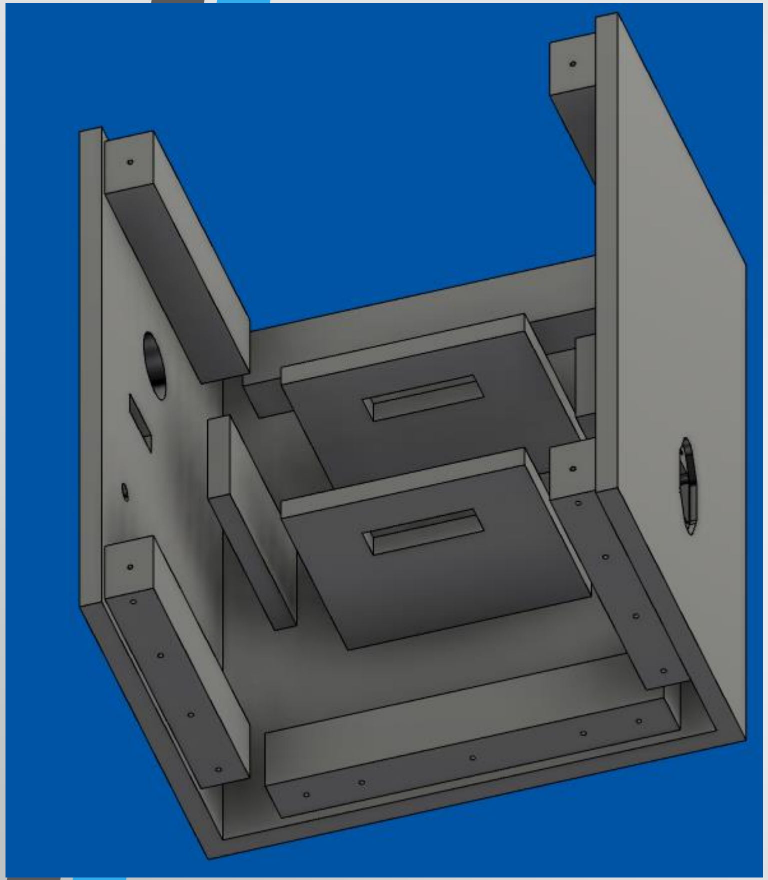
- 2 – Layers
- Houses Regulators
- 3.3V Switching Voltage Regulator
- 5V Switching Voltage Regulator
- 16V Buck-Boost Converter

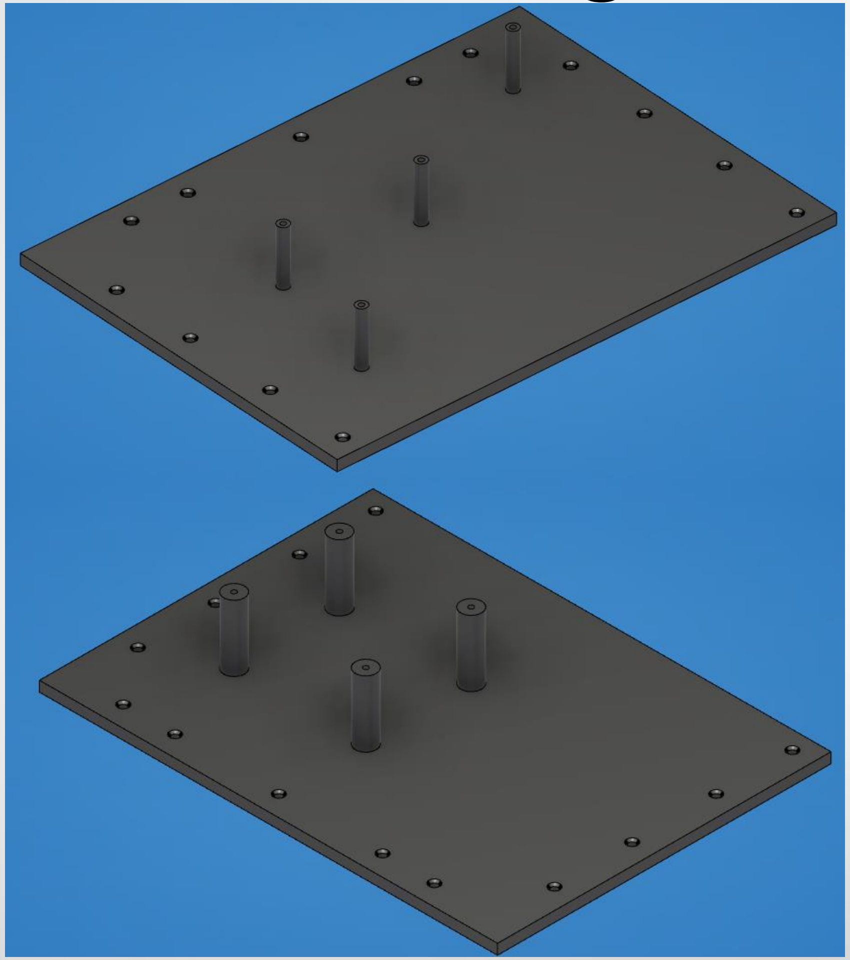
PCB Layout
Interface Module



- 2 – Layer Carrier Board for:
- All FET Logic Circuits
- Power Sensors
- Raspberry Pi Pico
- ESP32
- Battery Charger

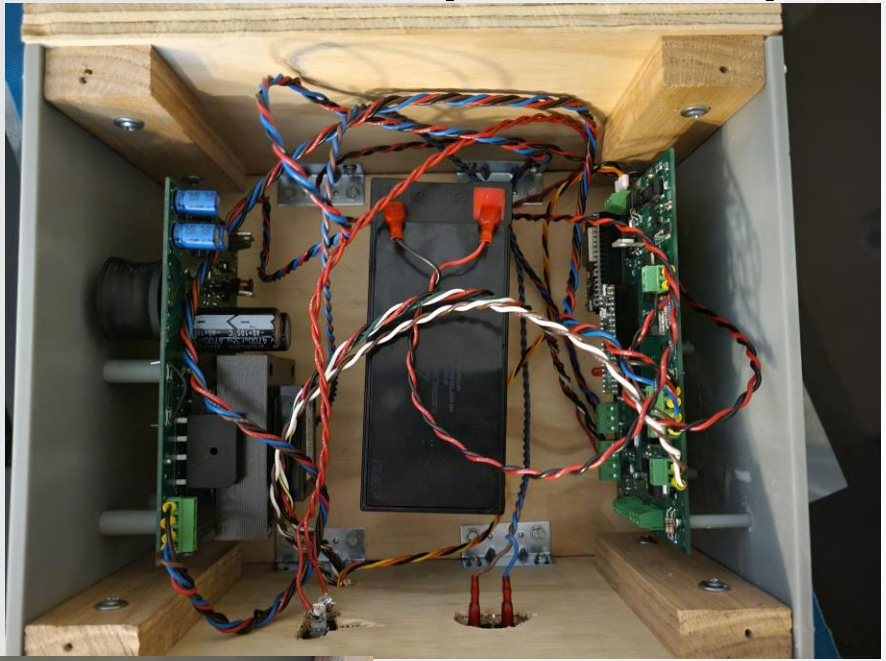
3D Printed Housing Assembly

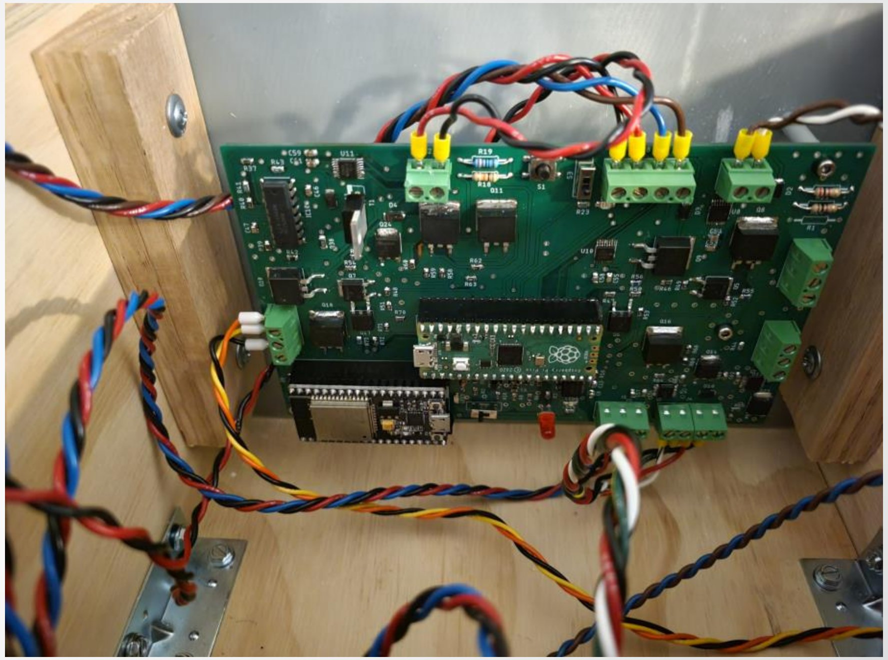


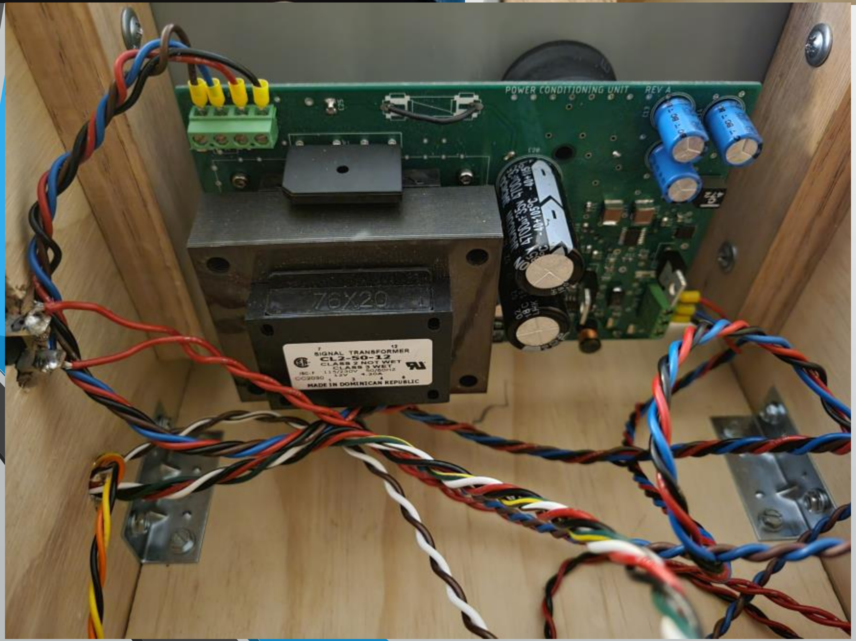


- Designed on Fusion360

Physical System







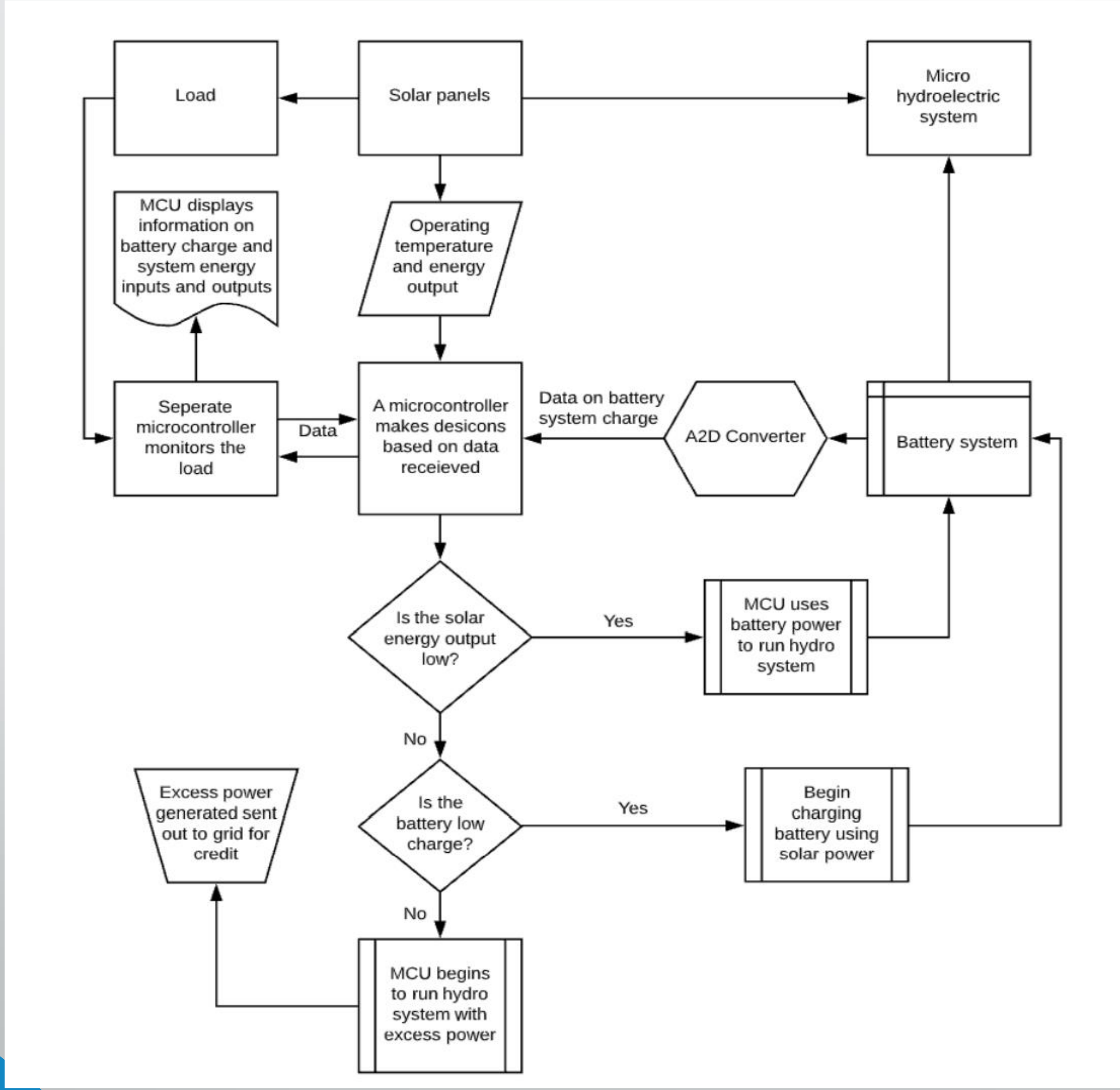
- All housing assemblies 3D printed except for bottom part shown on previous slide.

Software Development Language Selection

Topic	C, C++, C#	Java	Python
Libraries	Available with low level functionalities	Wide range of classes for various high level services	Wide range of classes for various high level services
Portability	Code must be recompiled for each different platform	Platform independent, code will work between OS	Platform independent, code will work between OS
Compiling Process	Non-interpreted language	Both compiled and interpreted language	Interpreted language
Compatibility with Raspberry Pi Pico	Yes	No	Yes
Accessibility to Microcontroller-Specific Languages	N/A	N/A	MicroPython

MicroPython

Software Flowchart Overview



System Controls & User Influence on System

Pump Control

Pump ON/OFF

Submit

The Pump is Disabled

Speed Control

0 % Submit

Energy Source Selection

Select Between Solar or AC In Power Sorces, Bypassing the Battery everytime,

The Current Source Selected is: Battery

Submit

Load Source Selection

Select Between Hydroelectric Power, if available, or common Bus Voltage to feed the External Load Output Rail

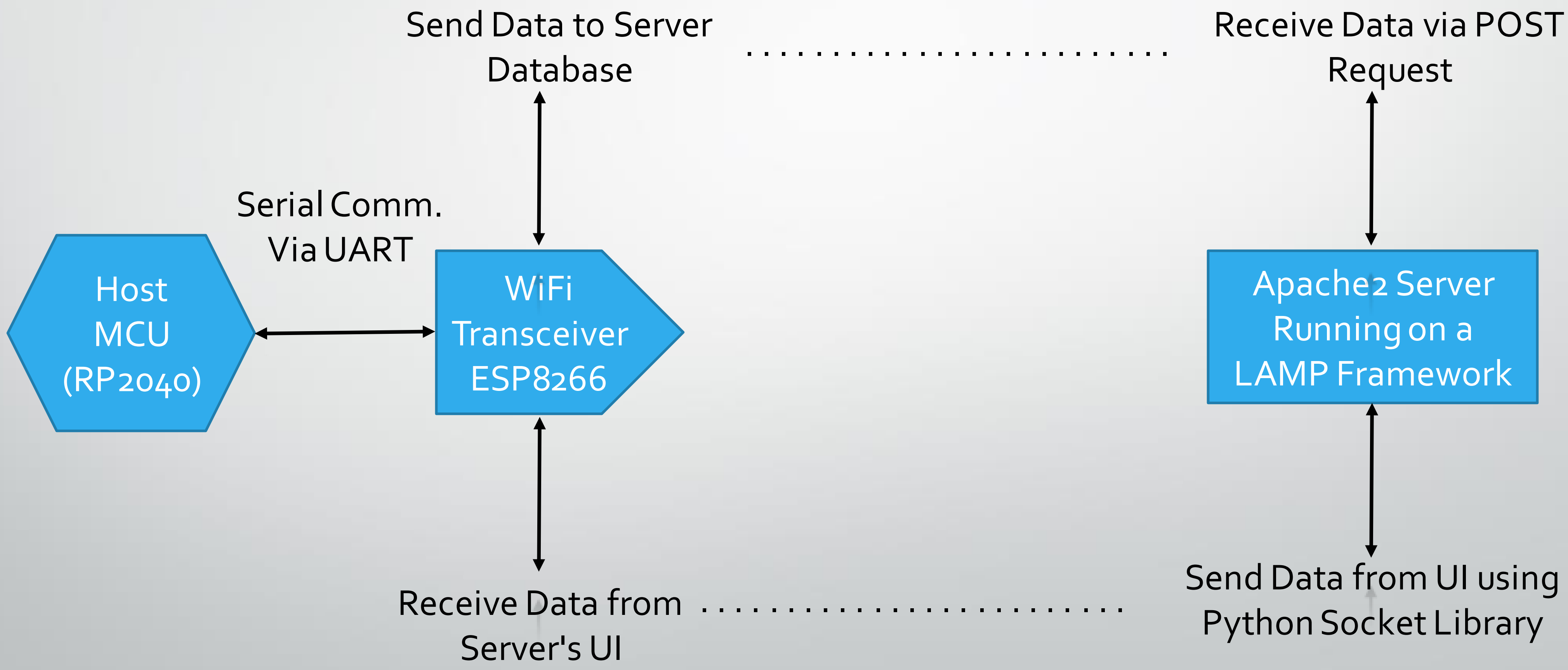
Submit

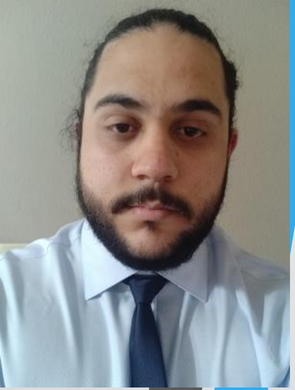
Battery Charge Selection

Opt to charge the Battery if an external source is available

Submit

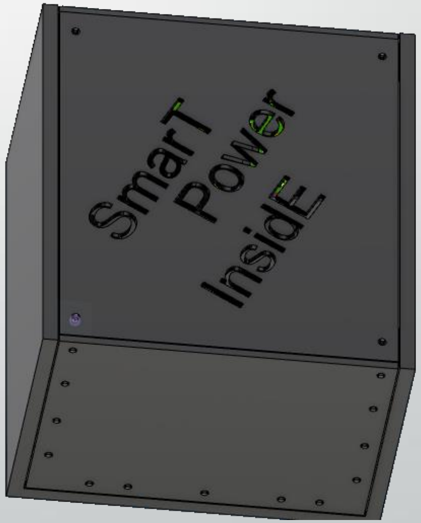
Wireless Transmission of System Data

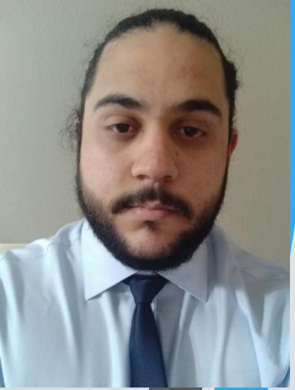




Total project costs

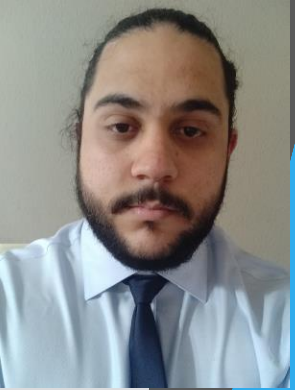
Part	Cost
Raspberry Pi Pico (RP2040)	$15
Solar panels	$50
Submersible water pumps	$65
Battery bank	$30
Project housings	$100
LCD Display	$20
PCB	$100
PCB Components	$118
All sensors	$25
Additional components	$115
Total Parts cost	**~$640**

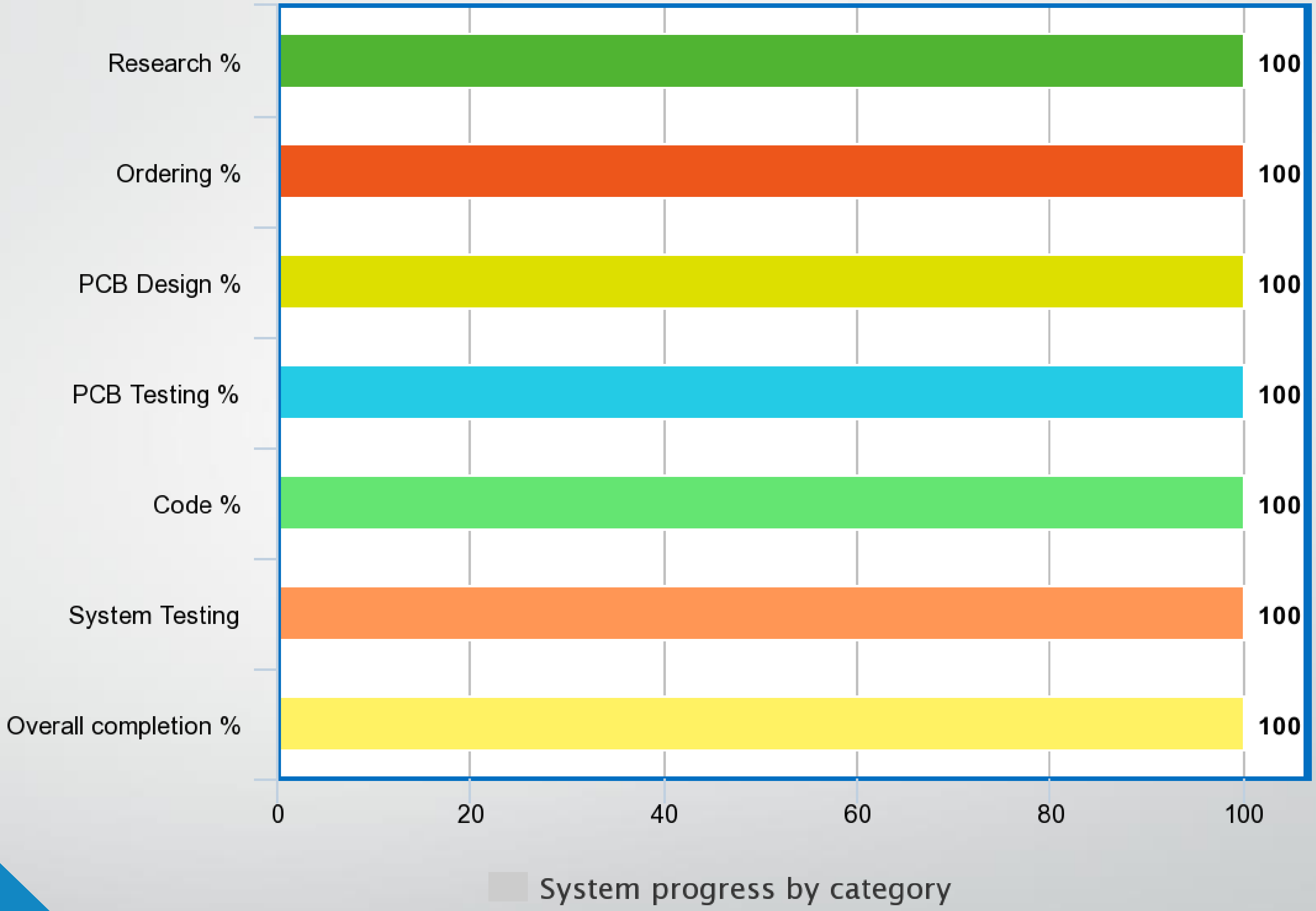




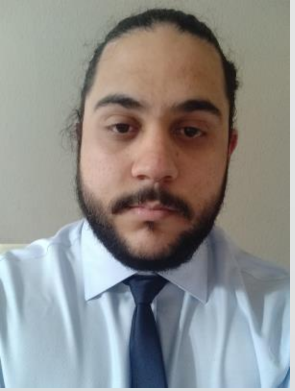
Work distribution

	Alex Carpenter	Chris Cruz-Paez	Brian Dunsmore	Yonder Salomon
PCB controllers	-	P	-	S
System software	P	S	-	-
Hardware design	S	-	P	-
Power management	-	-	S	P





Finalized project progress



Major Project challenges

- Initially developed PCB with lithium-ion compatible chip
- Attempted to cook PCB in UCF reflow oven to no avail
- First PCB printing was done incorrectly by company, forcing us to remake
- Coding was slow and tedious
- Unexpected costs due to complexity of PCB and reprinting
- Housing for our system was unexpectedly expensive