2-Cycle Power System

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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

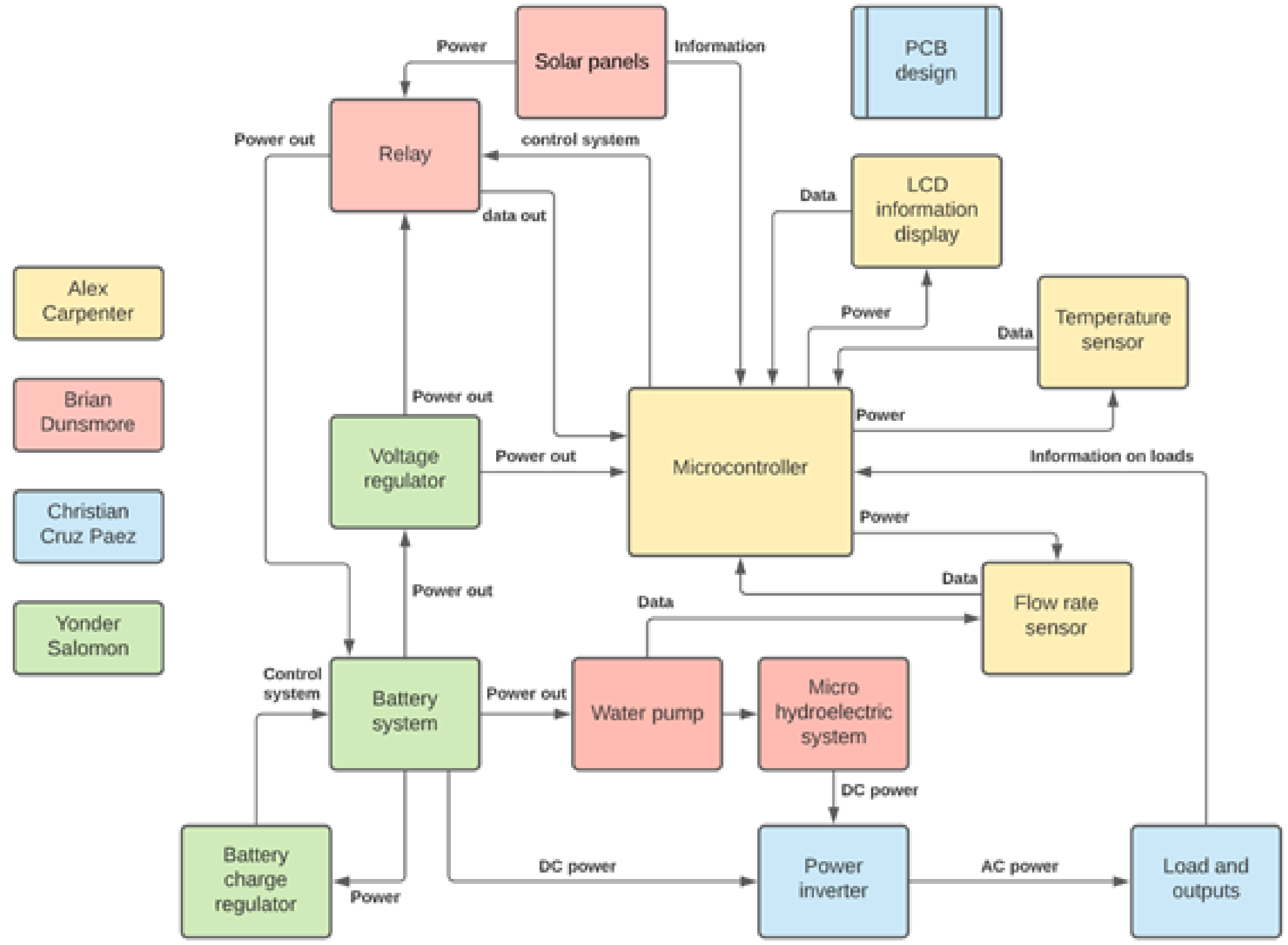
Goals and Objectives

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

Overall block diagram



Specifications

#	
1.0	The system shall have the ability to generate 20 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 conform to applicable safety standards.
1.6	The system shall have the ability to switch between generating power from solar panels and the hydro-generator within 5 minutes.
1.7	The system shall have the ability to engage both power generation sources simultaneously at a predetermined load power threshold (6 Watts).
1.8	The system shall be able to be implemented into pre-existing households within 2 hours.
1.9	The sensor's measuring power shall remain accurate within 0.2 Watts.

Solar Panels

- Topsolar
- 20-watt output
- 2.32 x 13.86 x 17.13 inches
- 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

Panel comparison

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

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	Power	Noise
Pmasanzy	0-80 Volts	.22 Amps	10 Watts	55 dB
Savemore	12 Volts	.133 Amps	10 Watts	55 dB
Dinctery	12 Volts	.22 Amps	10 Watts	55 dB

Hydro Generators

Battery comparison

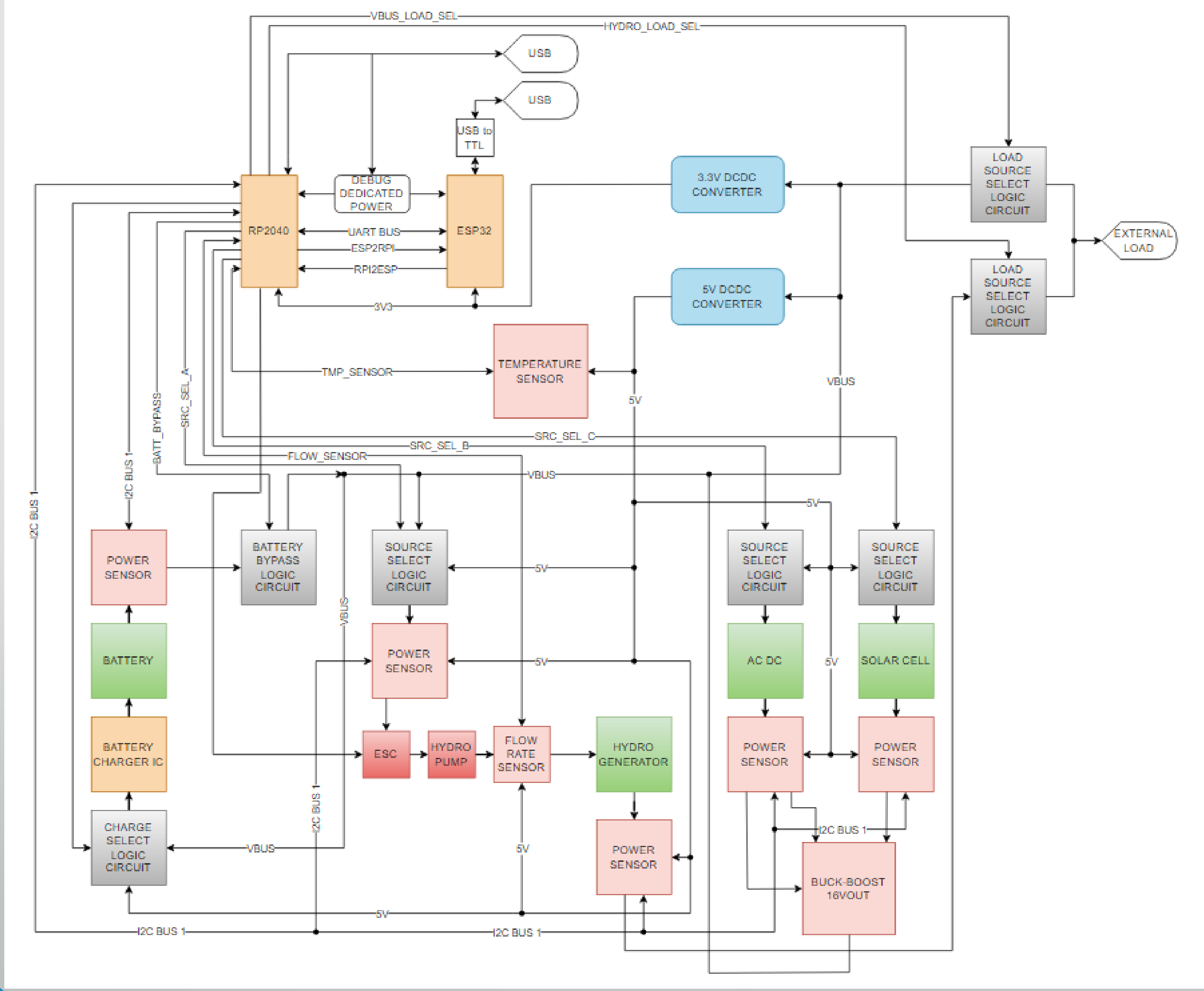
	Lithium-ion	Nickel Metal Hydride	Lead Acid	Zinc-ion
Capacity	3.3 Ah	11 Ah	7.7 Ah	7 Ah
Life Cycles	1000	1000	500	15000
Battery Size	12 volt	12 volt	12 volt	12 volt
Discharge	.65 Amps	.55 Amps	.66 Amps	.65 Amp
Power type	Lithium graphite	Nickel Hydride	Sealed lead acid	Zinc manganese
Price	$300	$24	$20	$50

Solar charge controller

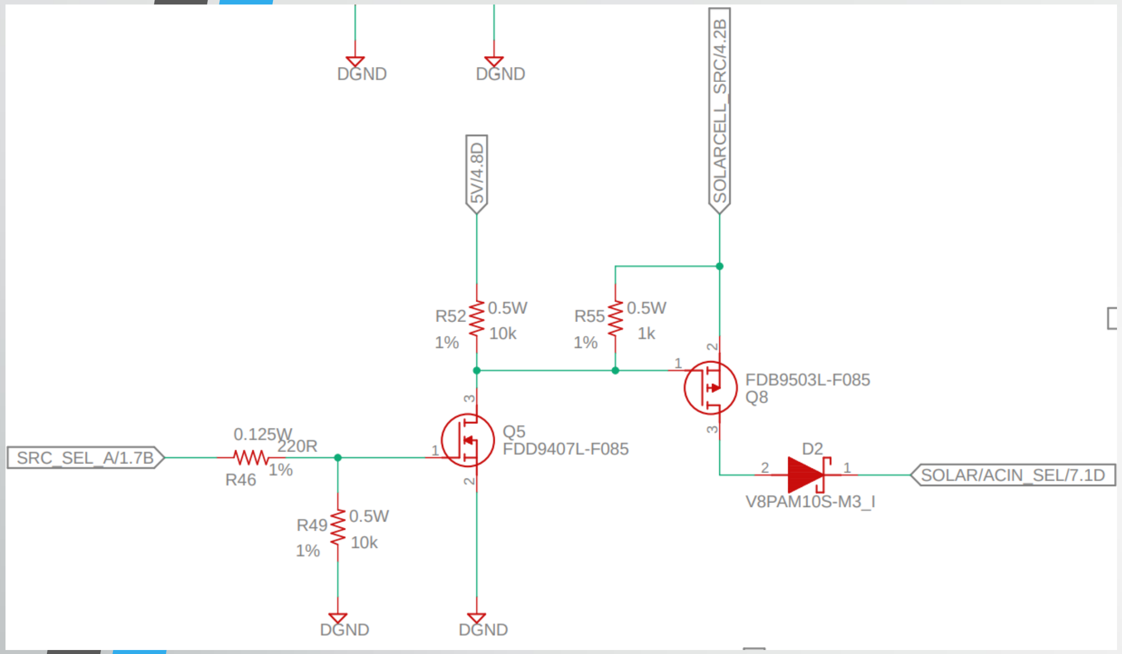
- Charge controllers are essential for safety
- Charge controllers help charge more efficiently
- Gives us accurate data to pull from

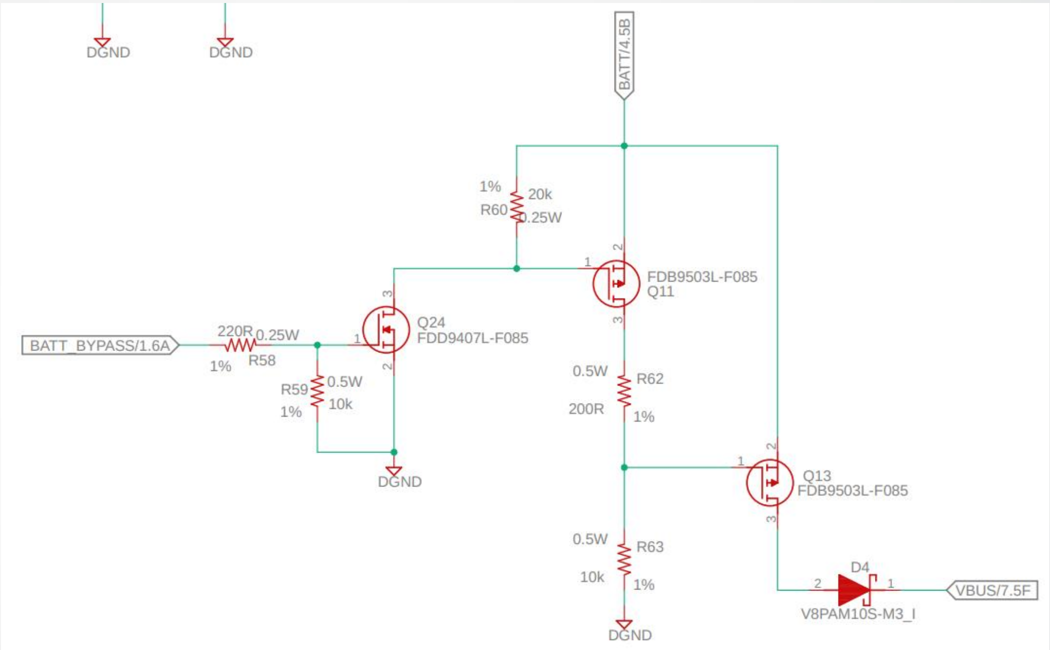
MODEL	KLD1210	KLD1220	KLD1230	KLD4820	KLD4830
Batt voltage	12V/24V auto			48V	
Charge current	10A	20A	30A	20A	30A
Discharge current	10A	20A	30A	20A	30A
Max Solar input	<50V			<80V	
Equalization	B01 sealed	B02 Gel	B03 flood		
	14. 4V	14. 2V	14. 6V		
Float charge	13.7V(defaul,adjustable)				
Discharge stop	10.7V(defaul,adjustable)				
Discharge reconnect	12.6V(defaul,adjustable)				
USB output	5V/3A				
Self-consume	<10mA				
Operating temperature	-35~+60 ℃				
Size/Weight	150*78*35mm /150g				

High Level System Architecture



FET Based Logic Circuits

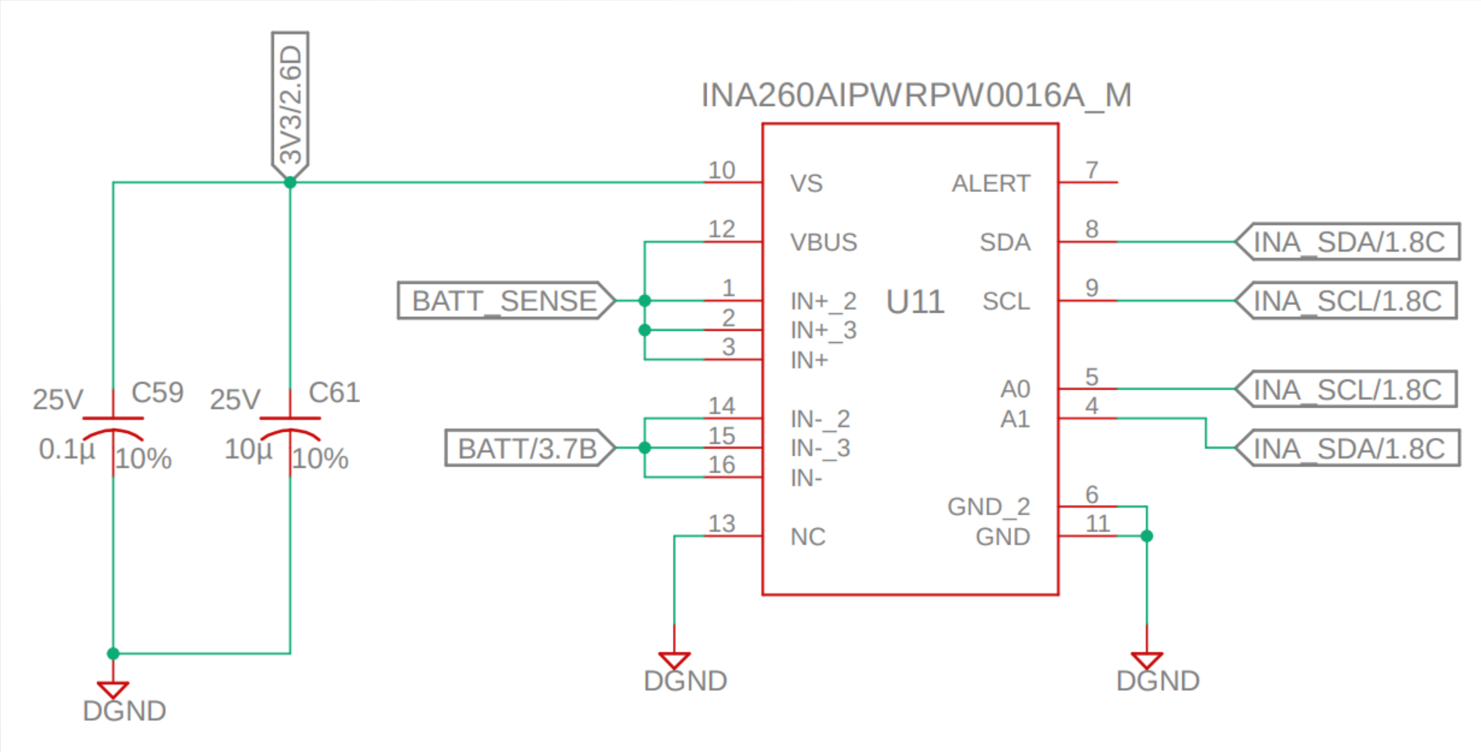




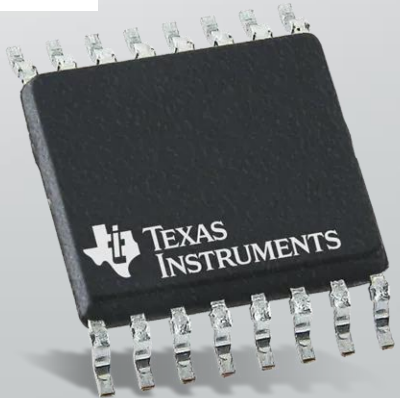
- Used to gate the input sources, software controlled.
- Based on NMOS-PMOS combinational logic using Logic Level featuring low Rds on for minimal thermal loss.

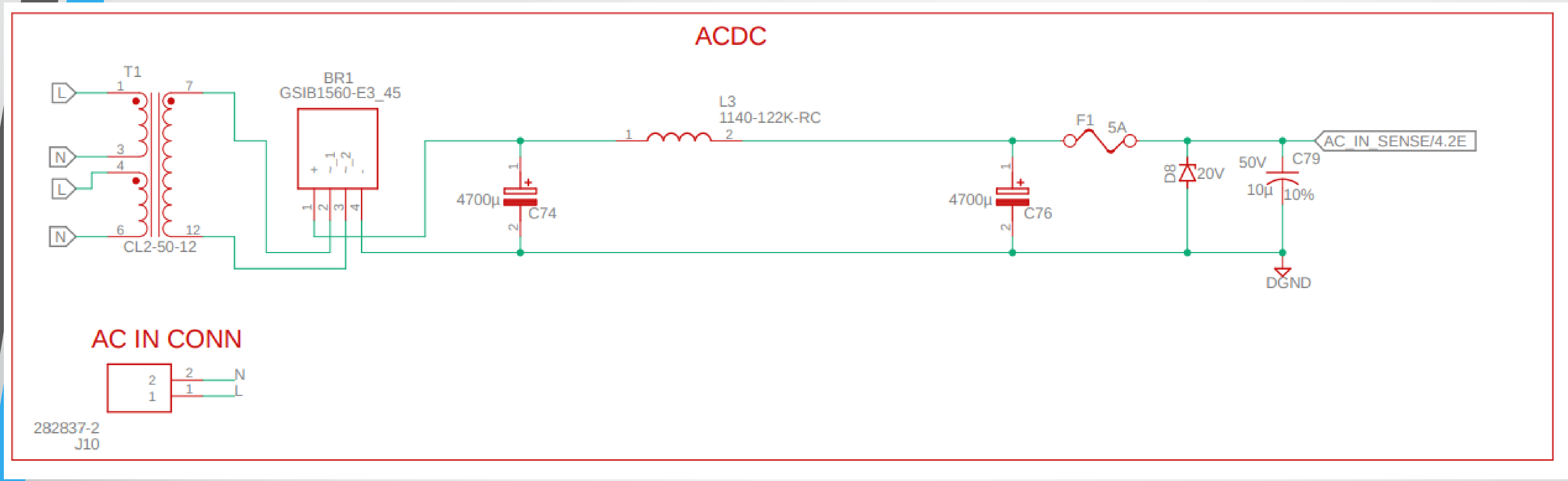
- Battery Bypass Circuit.
- Used to deviate all of the system load from the battery when charging operations are in progress.

Power Sensing



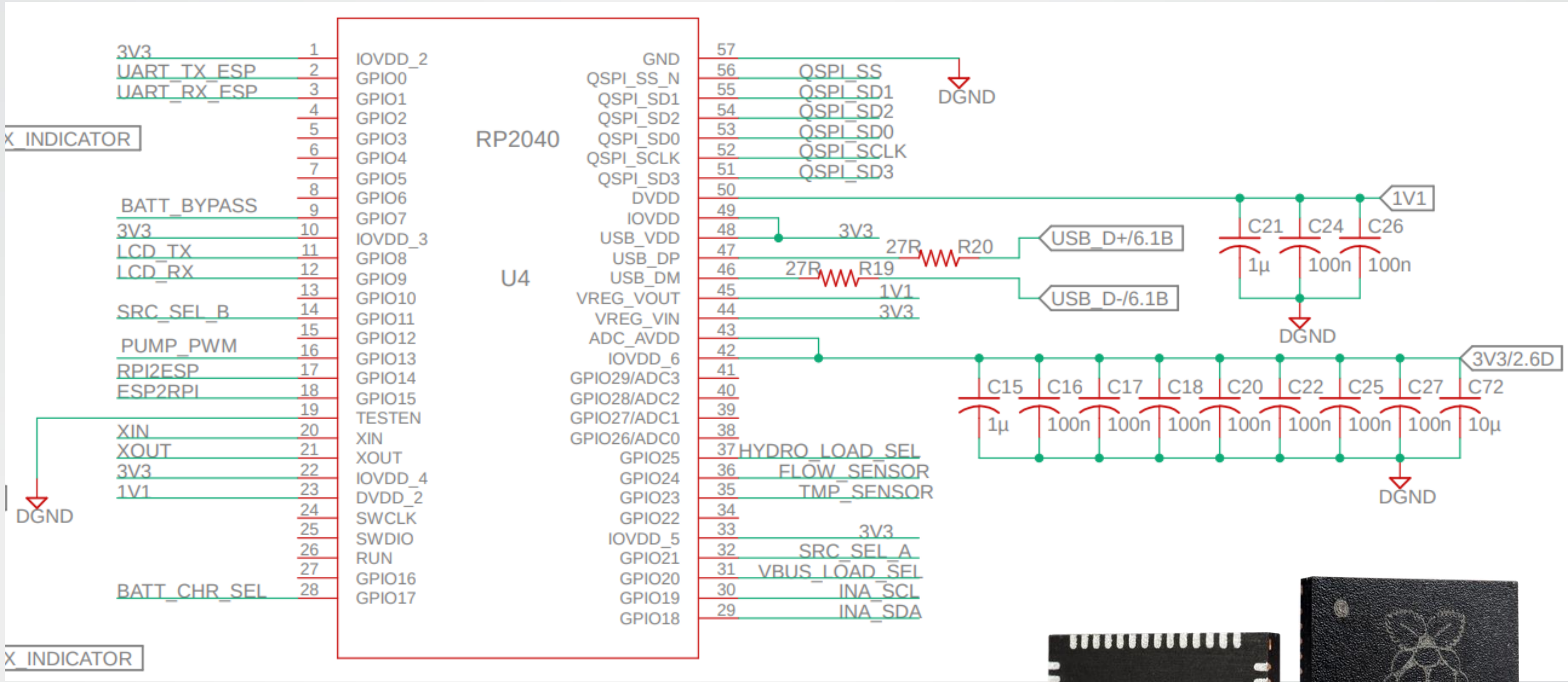
- TI's INA260
- Power sensor able to measure up to 15A @ 36V.
- Telemetry data transmitted via I2C

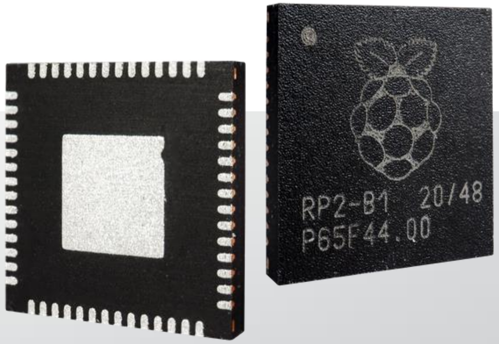


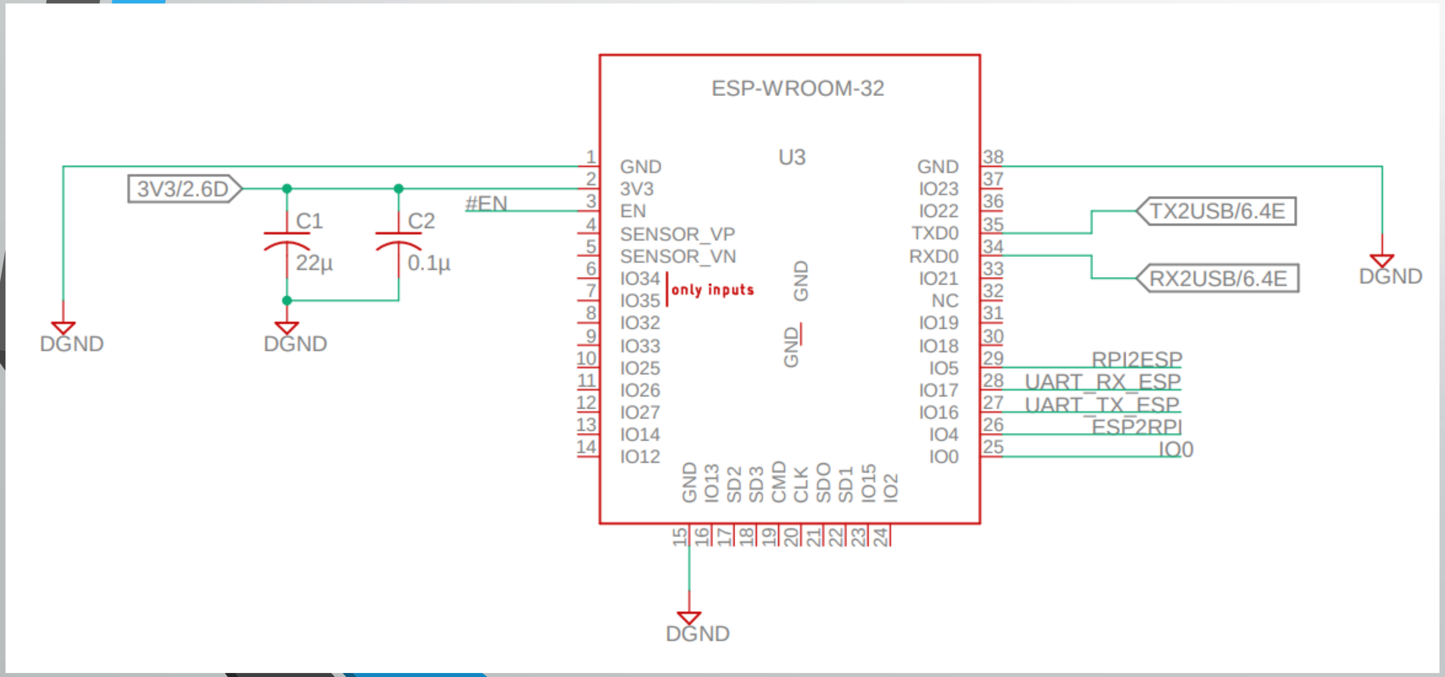


- AC to DC rectification and power conditioning
- Featuring a Pi Filter to maximize ripple reduction

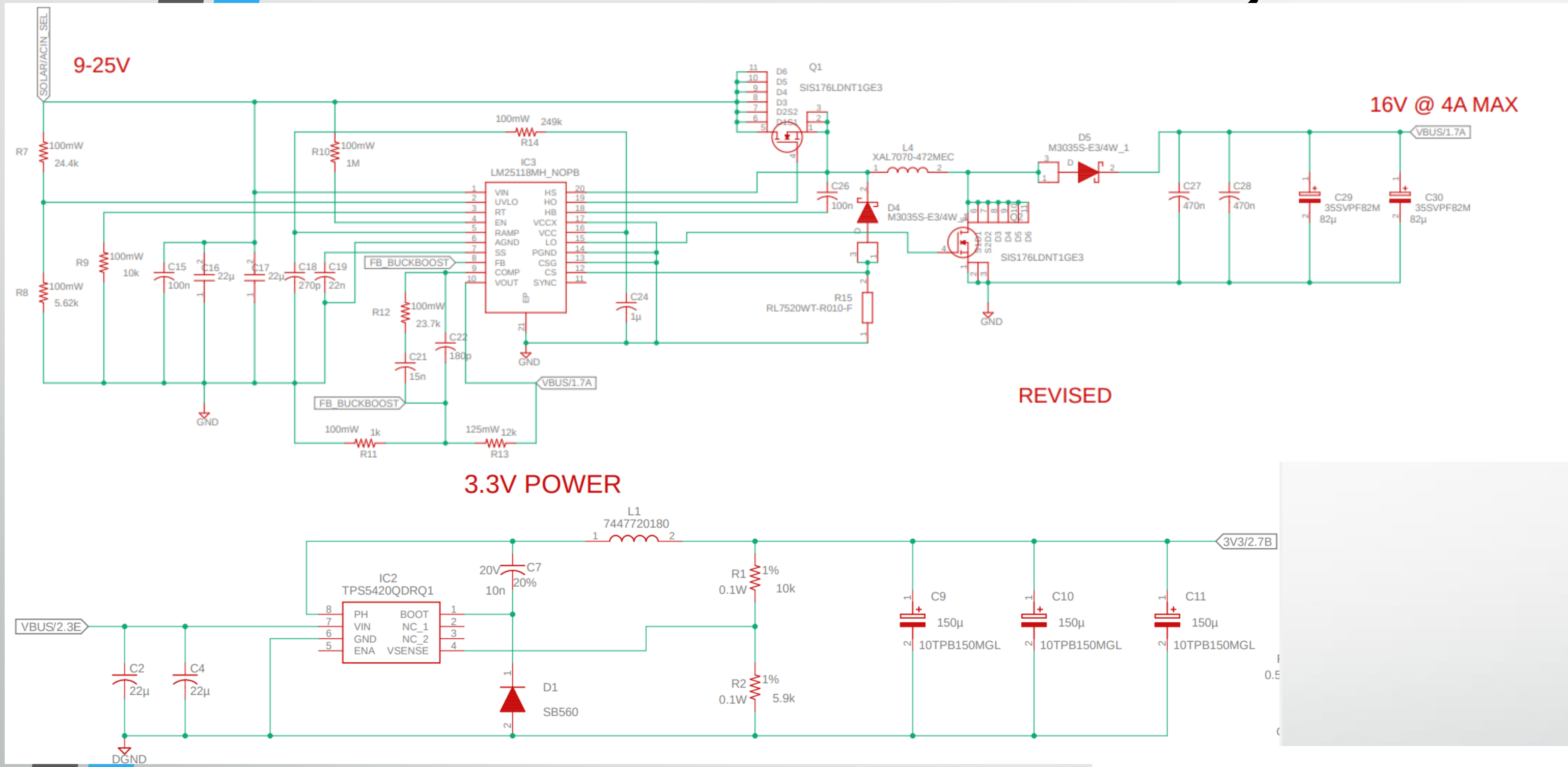
- Raspberry Pi's RP2040 Main processing unit.
- ESP32 as coprocessor and Wireless Communications Module.
- UART bus for Inter Board Communications.
- Interrupt lines for seamless and reliable communication link.



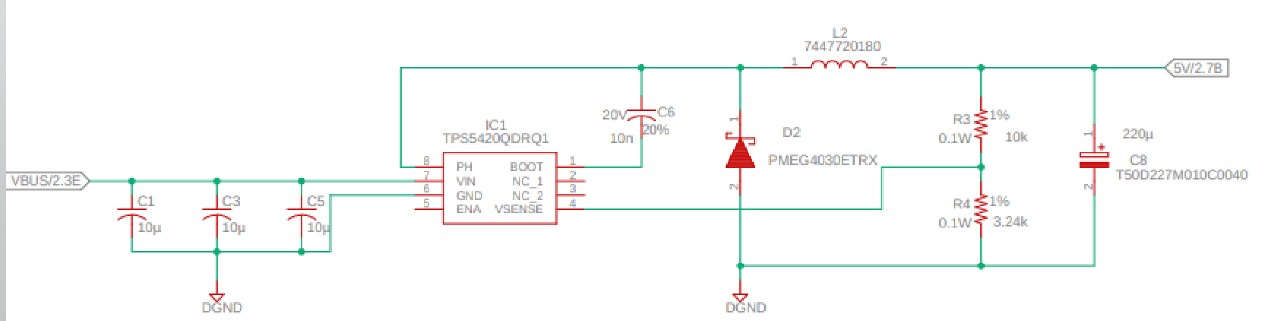


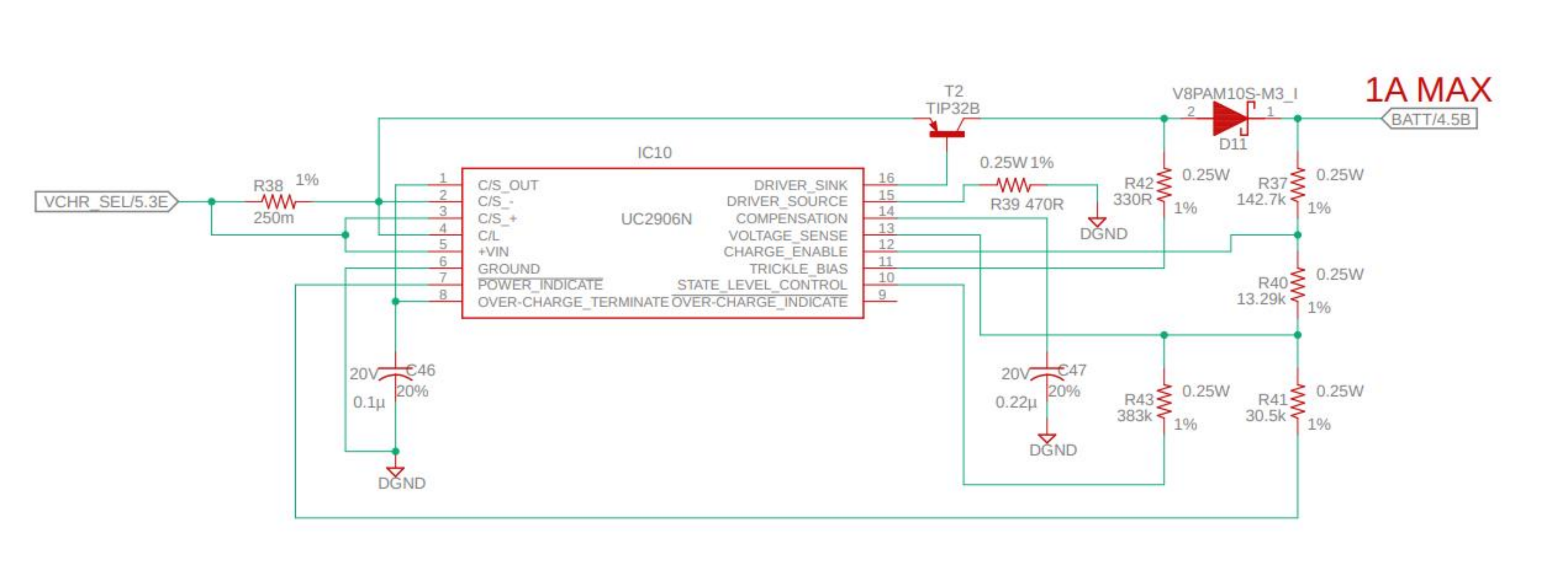


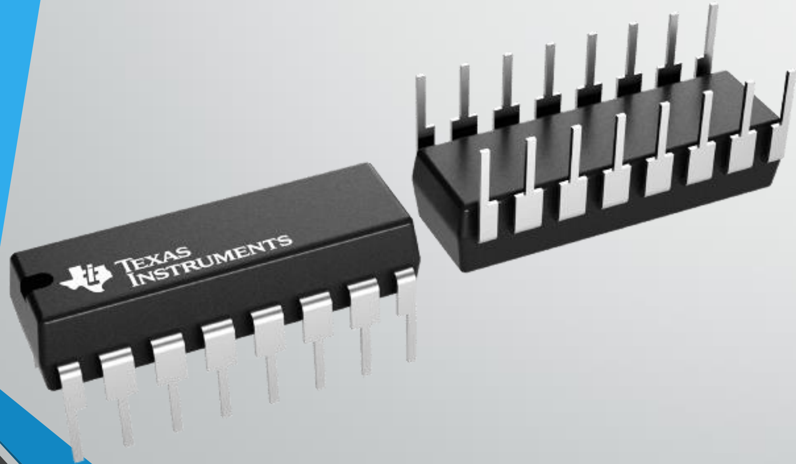
Power Stages



- 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.

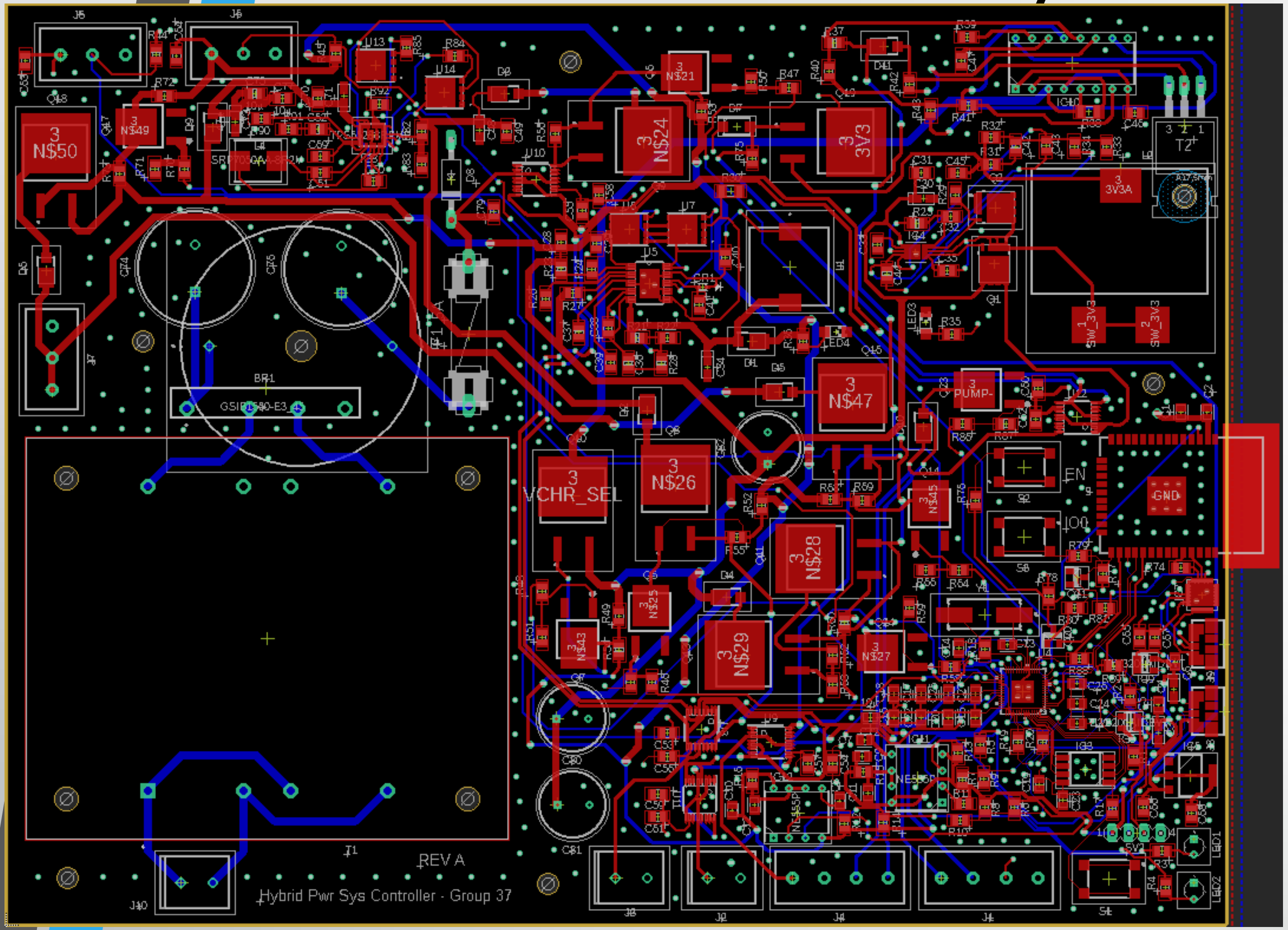


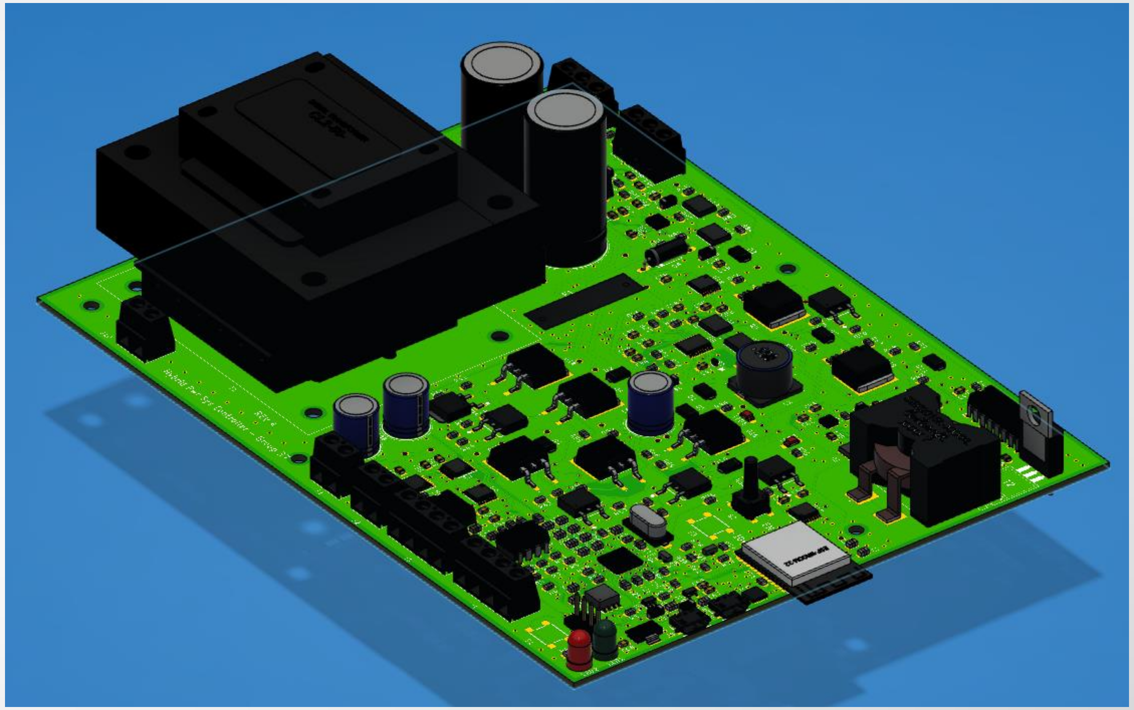




- Battery Charger IC
- Highly Reliable Resistor Configurable
- Charge Current merely dependent on T2 characteristics
- Charging current limited to 1A for a 7.2Ah Battery (C/7).

PCB Layout & 3D Model



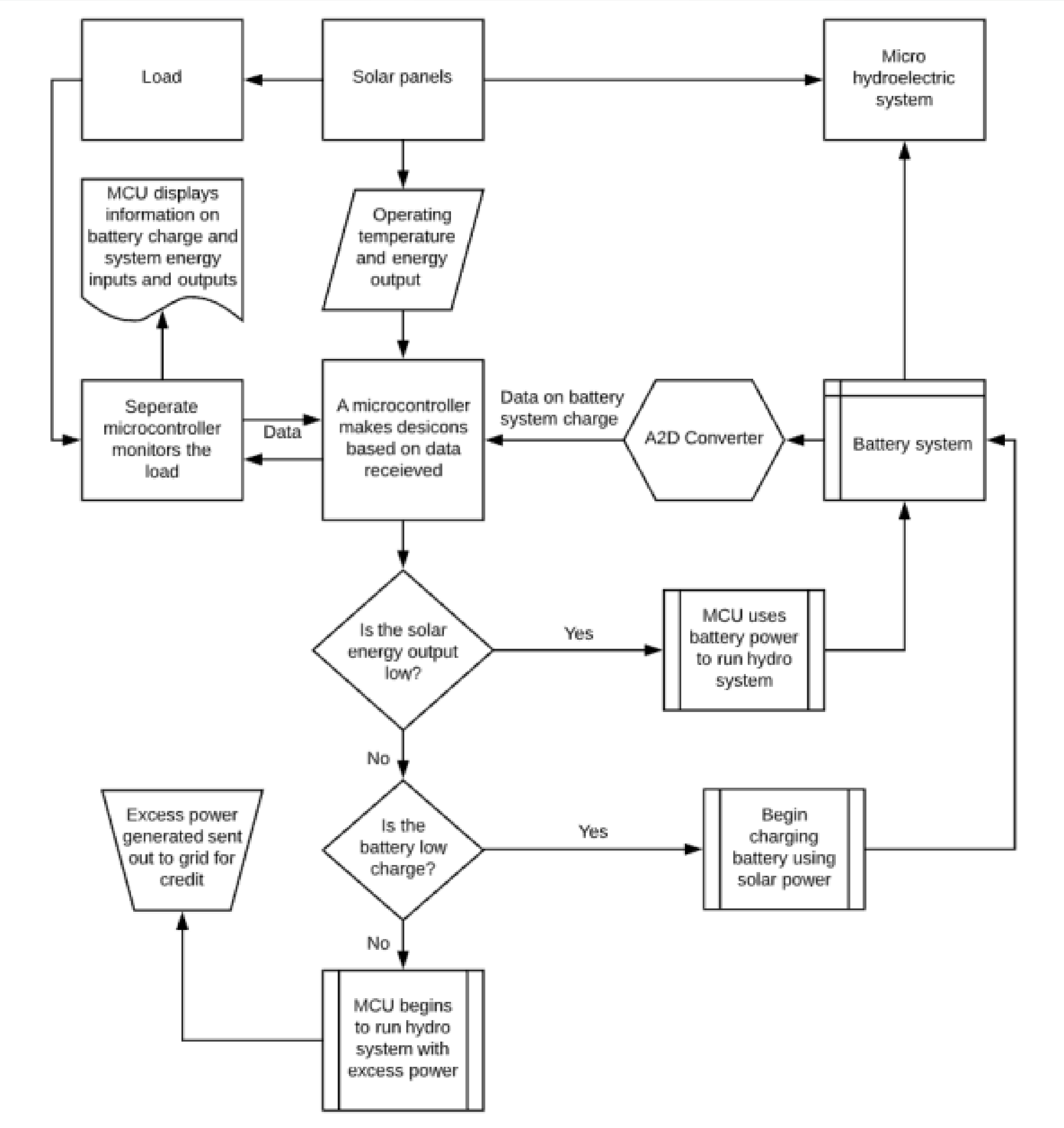


- 4 Layer Board
  Layer Stackup:
  -Ground / Signals
  -Ground
  -3v3 Net
  -Ground / Signals

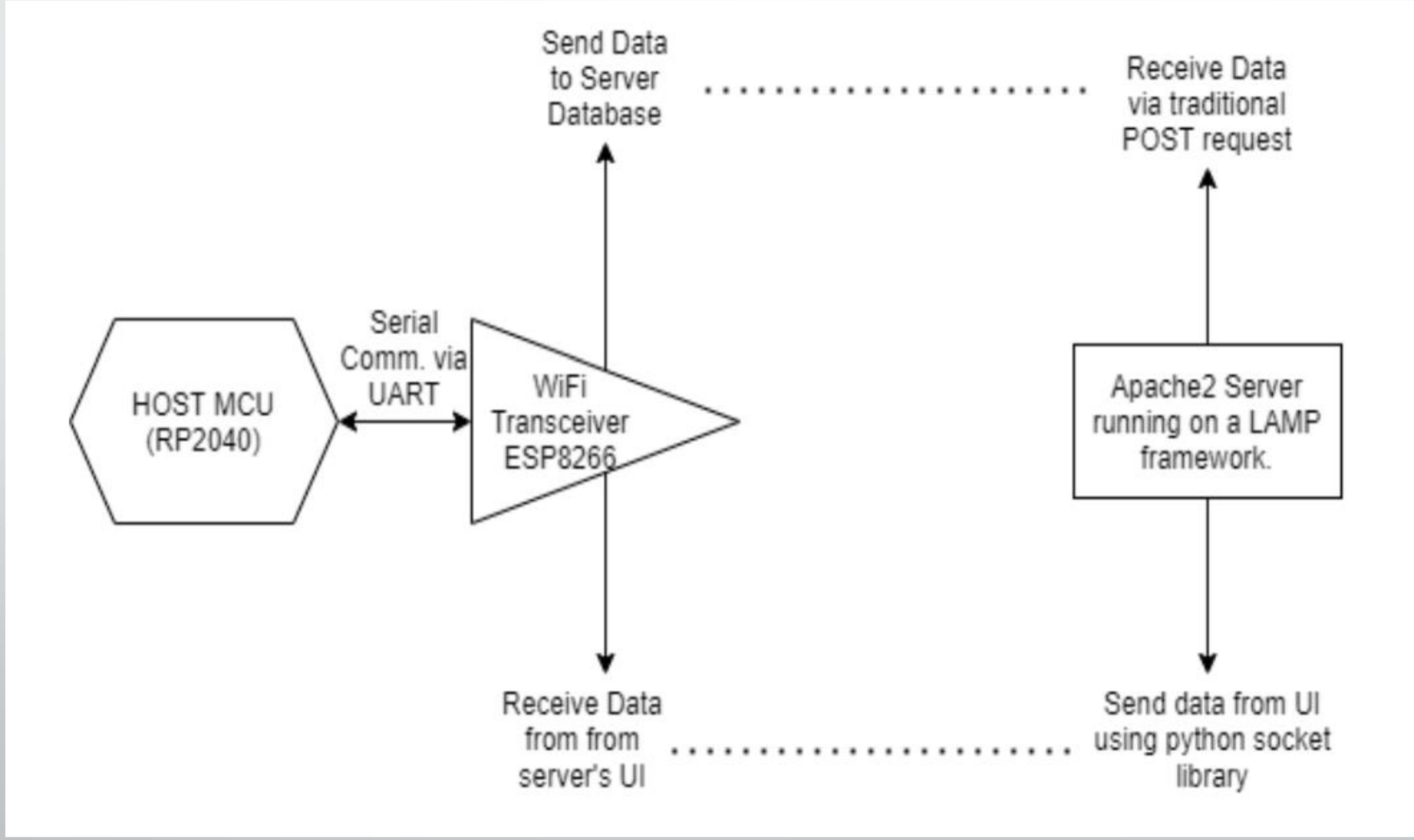
Software Development Language

- Micropython:
  - High-Level language
    - Exception error handling
  - Existing Libraries for Power/voltage sensors and water-flow sensors
  - Cheap/energy efficient Microcontrollers

Software Flowchart

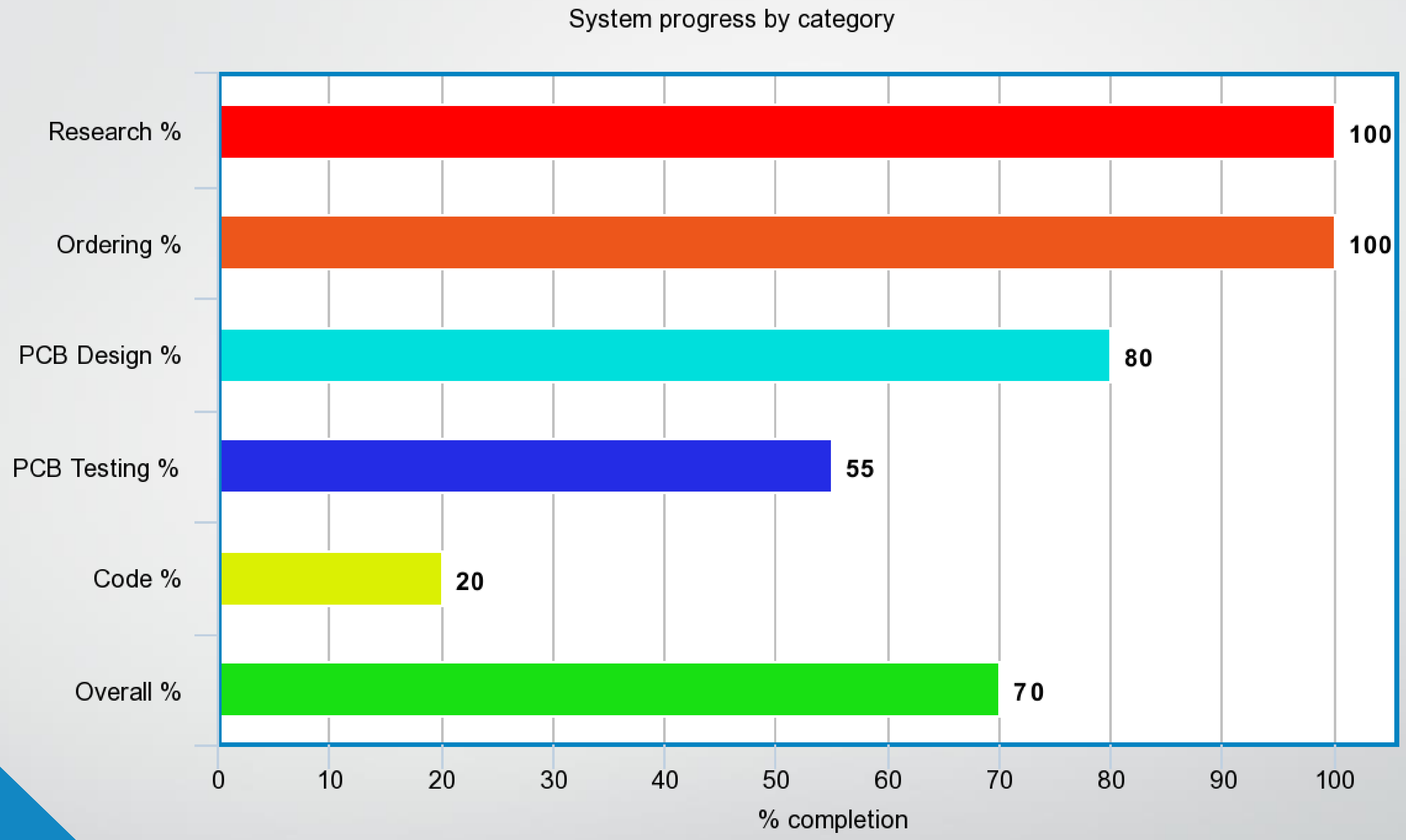


Wireless Transmission of System Data



Total projected costs

Part	Cost
Raspberry Pi Pico (RP2040)	
Solar panels	
Submersible water pumps	
Battery bank	
Battery charge regulator	
LCD Display	
PCB	
PCB Components	
All sensors	
Additional components	
Total Parts cost	**~$600**



Current project progress

Project challenges

- Initially developed PCB with lithium-ion compatible chip
- Attempted to cook PCB in UCF reflow oven to no avail
- Code structuring has been slow to start

Current project estimates

- PCB fully tested by Februrary 26th
- System platform and enclosures completed by March 6th
- Software completion by March 13th
- System integration and testing by March 27th
- Final system testing performed by April 1st