UCSB HYPERLOOP

Weightless.
Wait less.

Mechanical Engineers:
Andrew Chiang, Edsel Pereyra, Gavin Marcon, Jackson Button, Jack Dibachi, Chin Su Liang, Nathan Rudolph, Wesley Carias, Wesley Esko, Xingchen Liu, Zhijiong (Raymond) Huang, Ryan Porteous, Pedro May

Electrical Engineers:
Rachel Reyes, Himangshu Chowdhury, Xiaochang Liu, Mihir Shevgaonkar, Jieyun Yang

Computer Engineers:
Cameron Bijan, Alex Jun, Dylan Vanmali, David Donaldson, Mark Wu, Ryan Lorica

OVERVIEW

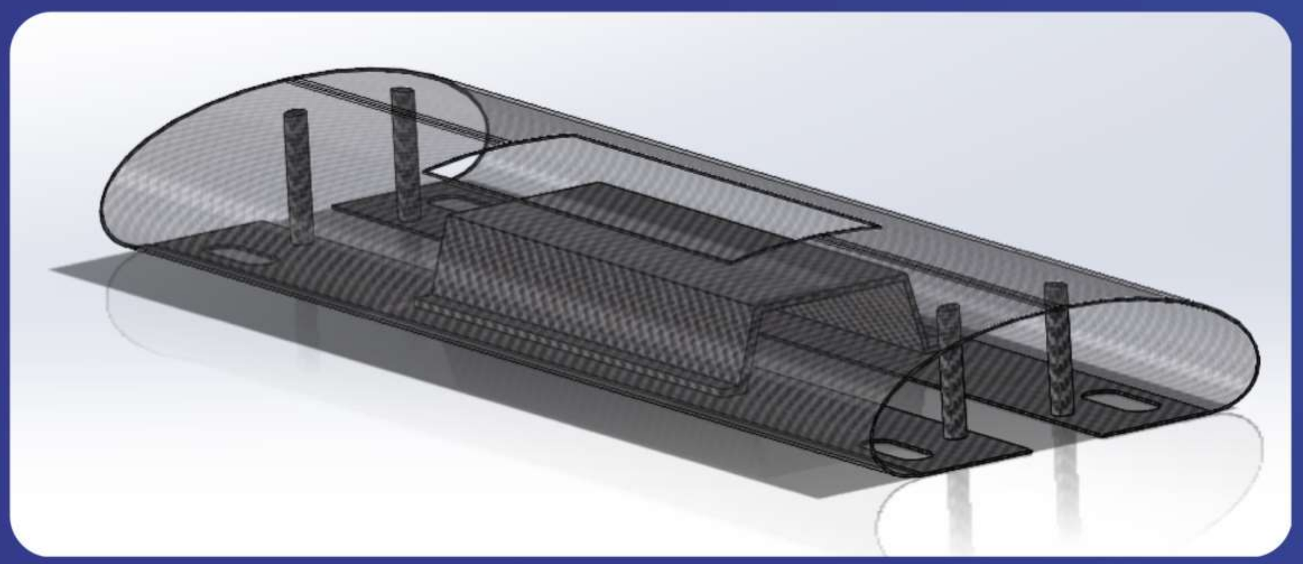
In 2013, Elon Musk proposed a futuristic transportation system: the Hyperloop, a high-speed levitating pod propelled through a low pressure vacuum tube to minimize air drag and friction.

To bring the Hyperloop concept to life, SpaceX hosts a head-to-head competition where teams from all over the world come to compete with their own Hyperloop pod designs.

This year, the team is competing in the Levitation Competition, in which the pod must levitate and translate in a there-and-back lap down a 150 ft I-beam track. The fastest pod wins!

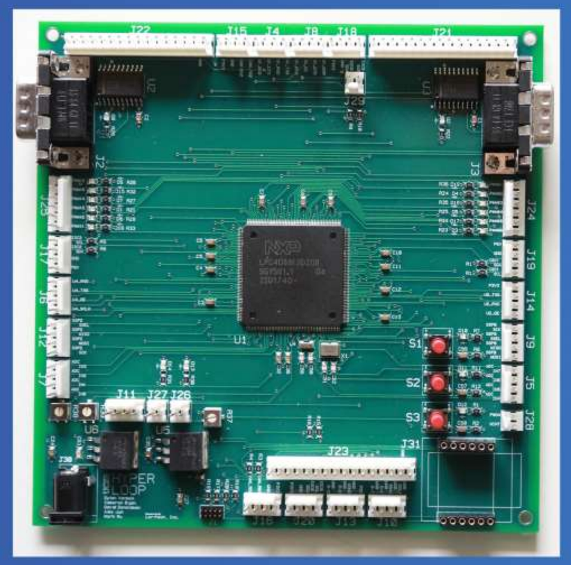
THE SHELL

- Stiff and lightweight carbon fiber serves as combined structural frame and aerodynamic shell
- Honeycomb core offers higher strength-to-weight ratio than carbon laminates alone

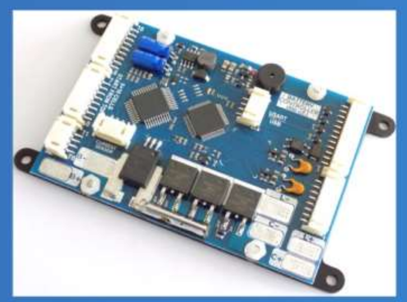


ELECTRONIC CONTROLS UNDER THE SHELL

LIDAR
Uses laser to detect nearby wall and engage emergency



PCB
Primary control unit and sensor monitoring system

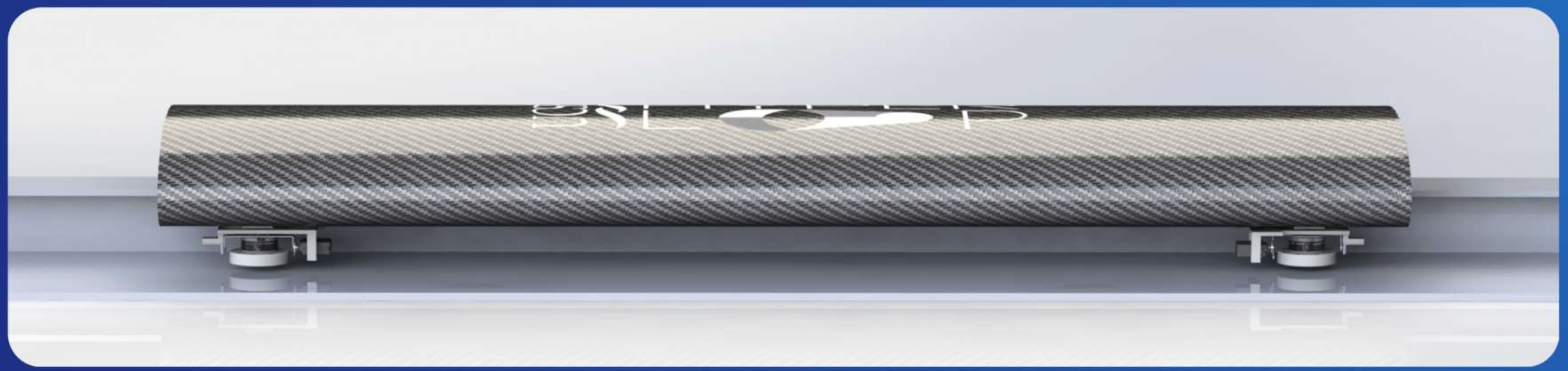


BMS
Monitors battery & protects from over-current and over-discharge

IMU
Gives acceleration and rotation of pod in all 3 axes

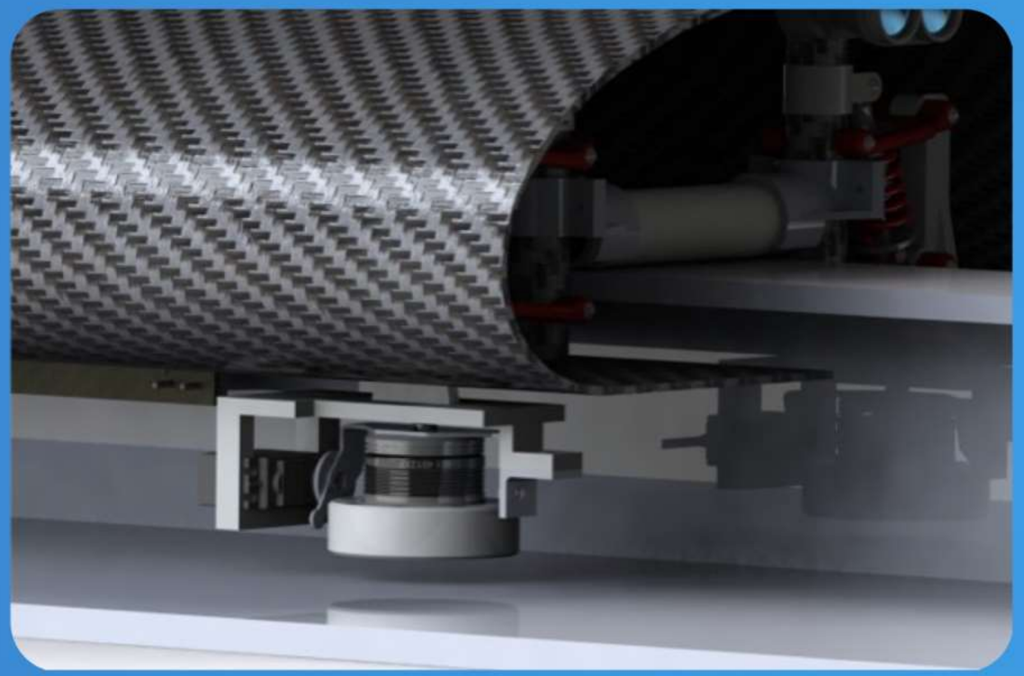
Battery
Lithium-Polymer

GPS
Gives position of pod along I-beam in real time



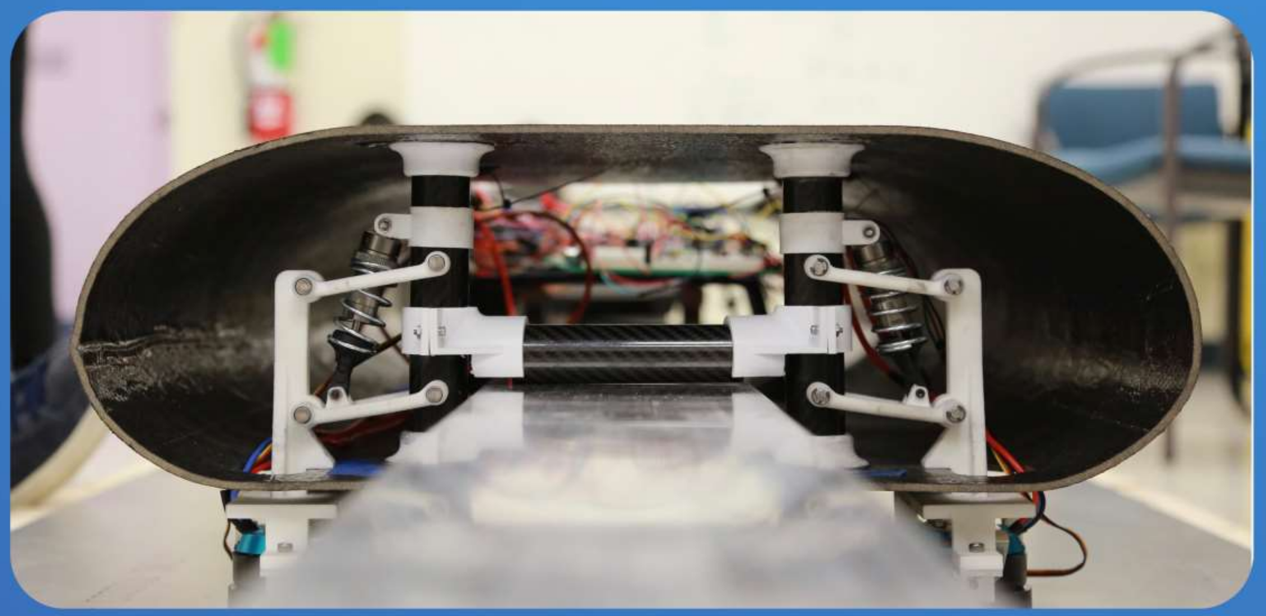
MAGNETIC LEVITATION

- Four custom maglev hover engines generate lift and propulsion
- Servos control the tilt angle of the maglev engines for precise control of forward and reverse acceleration



STABILITY

- Double wishbone vertical suspension stabilizes height, pitch, and roll
- Leaf spring suspension stabilizes yaw and lateral movement
- Failsafe brake skids safely bring the pod to a stop in the case of failure



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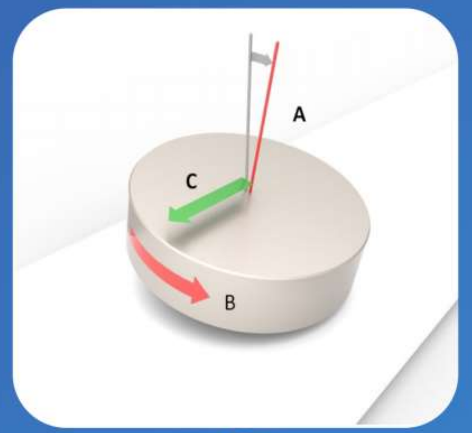
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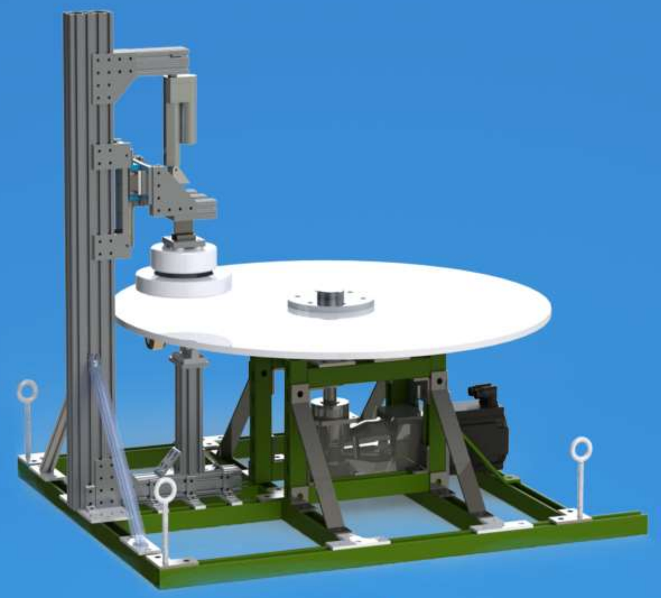
Custom Maglev Specifications:

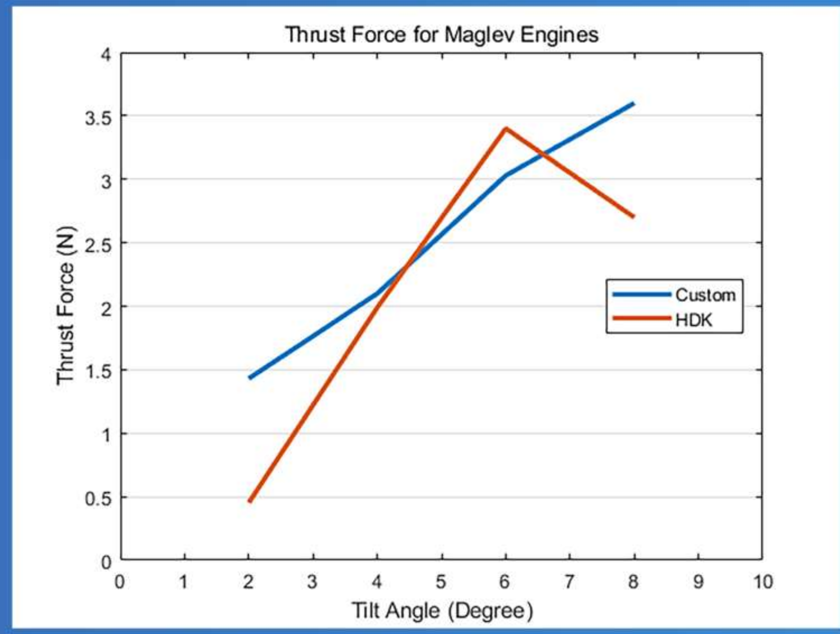
- Max Voltage: 28.8 V
- Max Current: 24 A
- Max Power: 680 W
- 8 * ½ inch cubic N52 Neodymium Magnets
- 3-inch diameter Delrin halbach array housing

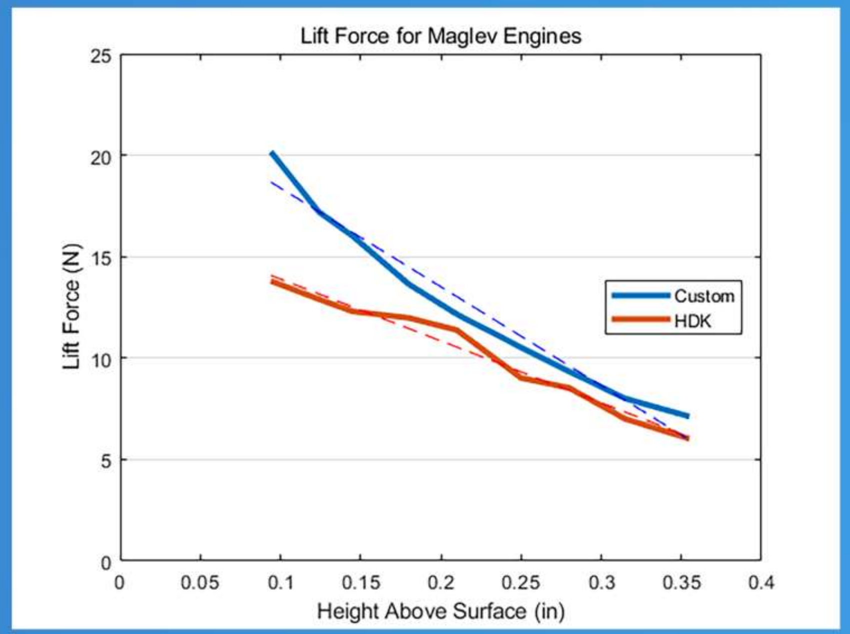
Magnetic Levitation

Levitation & Propulsion

- The team designed, implemented, and tested the custom maglev hover engines which levitate and propel the pod.
- Permanent Magnets are arranged in a Halbach Array [1] which increases the magnetic Field on one side.
- When Maglev Enginers spin, the oscillating magnetic field induces a repulsive or lift force in adjacent conducting rail.
- When tilting the engines, the drag force will become bigger on the side near the ground. The drag force makes the pod propel [2].
- The 40″ dia test rig was contructed to measure lift and propulsion of the Maglev engines. Results are shown in the graph below.


Test Rig





Shell Fabrication

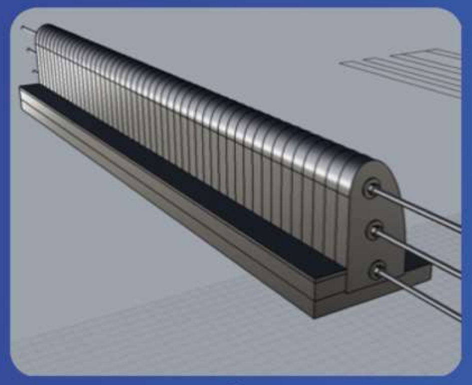
Weight: 2.6 lb

Material:

- Prepreg carbon fiber w/ honeycomb core
  - Pre-impregnated resin does not cure at ambient temperatures
- Hold resin at 250°F for 100 minutes to cure
- Honeycomb core between two plys of carbon offers a higher strength to weight ratio than solid carbon laminates alone

Method:

- Male plug constructed out of CNC'd MDF board cross sections [1]
- Plug coated with resin and block sanded to a smooth surface finish
- Two symmetrical female molds made out of molding material [2]
- Molds pulled off of plug and bolted together to form a complete mold [3]
- Carbon plys and honeycomb placed in mold, vacuumed bagged, and cured in home-built oven [4] made from thermo foam and heat lamps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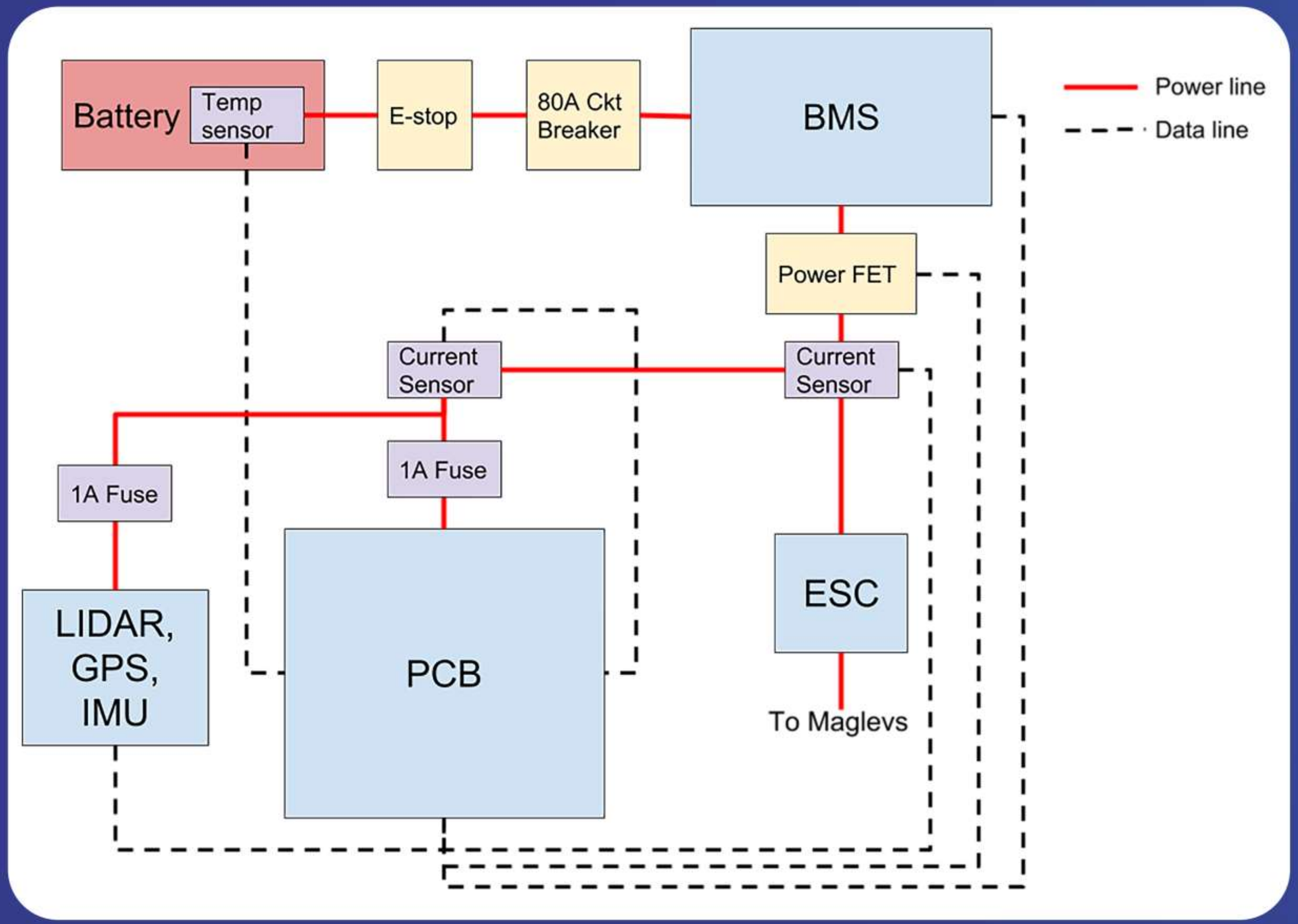
Power System

The power diagram illustrates how each component on the pod receives power and is grounded.

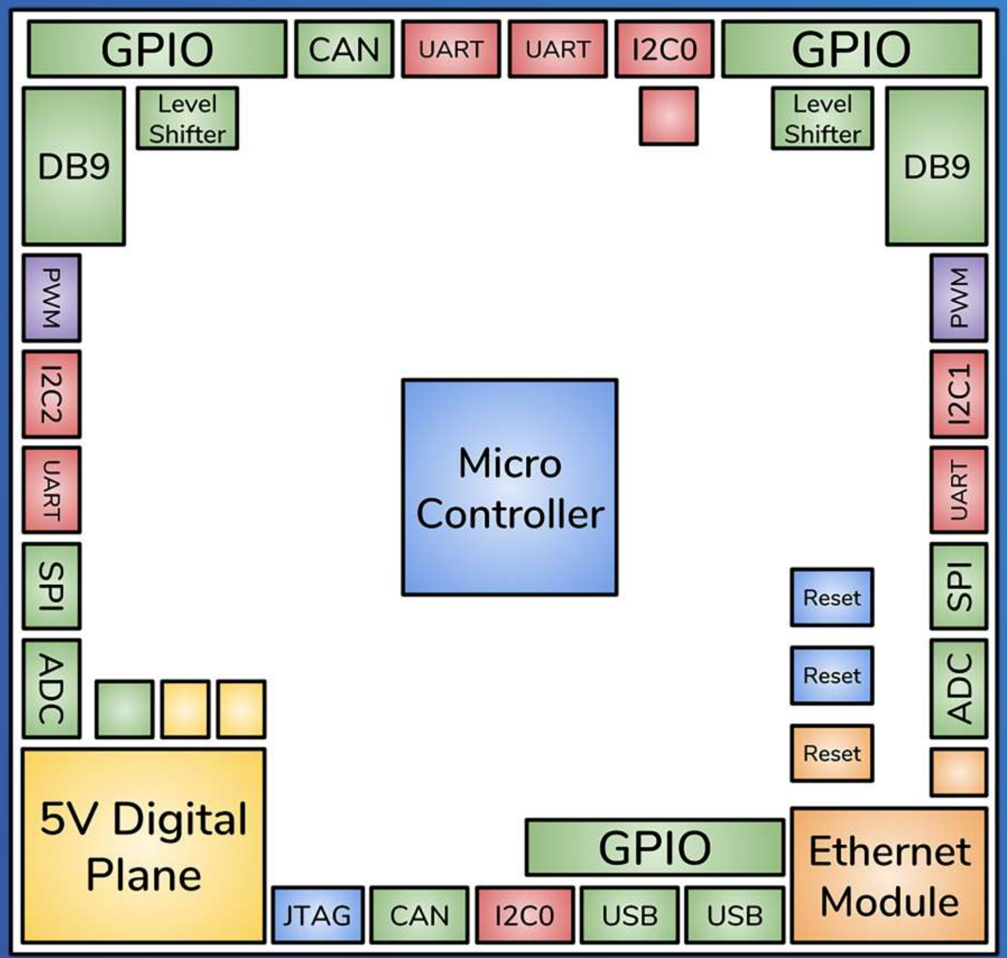


Electronic Components:

- LiPo (Lithium Polymer) battery (red) to power entire pod
- BMS (Battery Management System) to monitor battery health
- Mechanical emergency stop and electronically controlled power MOSFET (yellow) as active safety mechanisms
- 6V and 5V buck converters to convert power for PCB and sensors
- Circuit breaker and fuses (purple) to protect electronics from over-current
- Sensors for detecting current, battery temperature, pod position
- Universal ground plane (gray) to ground all electronics on pod

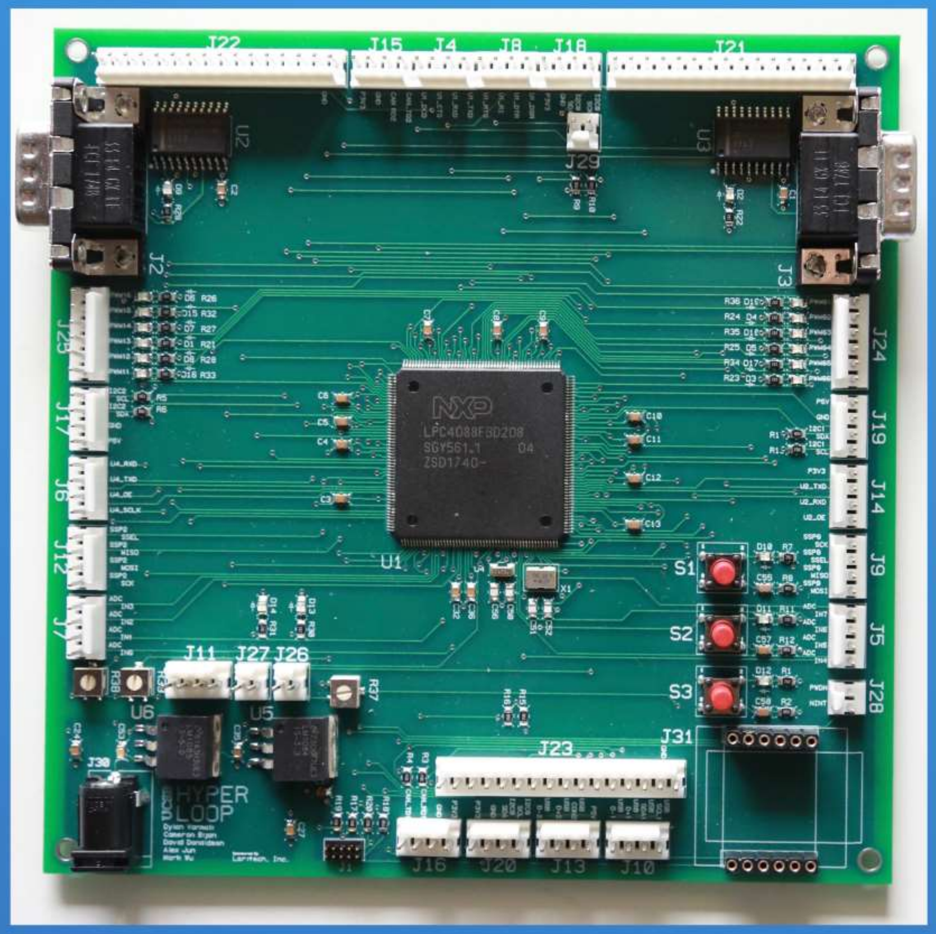
PCB & Sensors

Custom designed PCB (Printed Circuit Board) block diagram below



Legend

Blue = Computing
Red = Sensor Ports
Purple = Motor Ports
Yellow = Power
Orange = Wireless Ports
Green = Communication Ports



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