Team 27(ME)/18(ECE): Mars Lander Robot Recharger

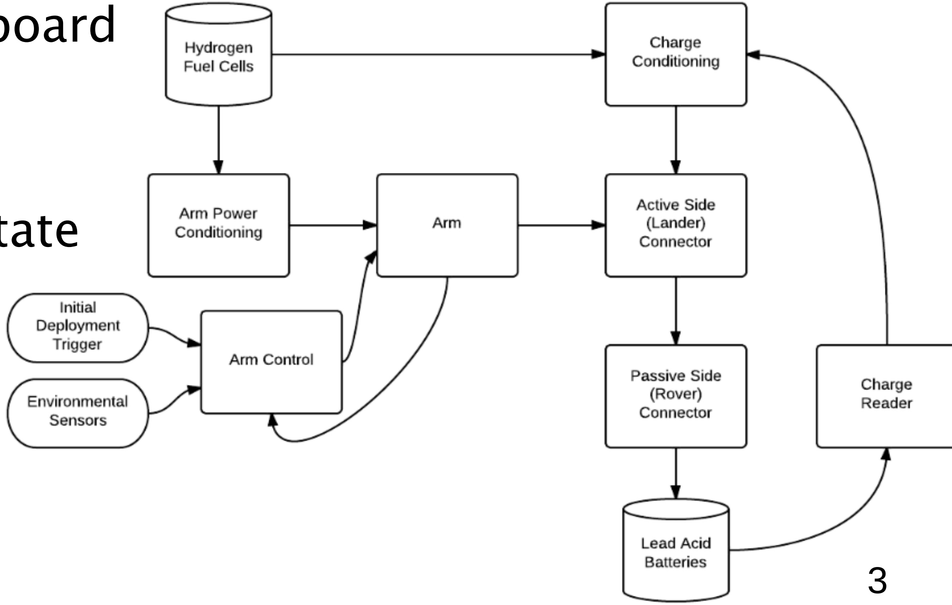
Spring Midterm 1

Team Members/Advisors

- Team Members
  - Itiel Agramonte
  - Dean Gonzalez
  - Lucas Kratofil
  - Tyler Norkus
  - James Whaley
- Advisors/Technical Contacts
  - Dr. Moore – ME Advisor
  - Dr. Arora – ECE Advisor
  - Van Townsend – Technical Point of Contact
  - Michael Solomon – Intellectual Property Point of Contact

Project Scope

- Get power from the stationary lander to the rovers
- Hydrogen fuel cell bank on board the lander
- Two 12V Lead Acid Batteries onboard the rovers
- Rovers drive up to be refueled
- Station records current charge state
- Fills batteries to 100%



Fall Semester Accomplishments

- The arm and rover connections were designed according to constraints set forth by sponsor

- Simplicity was very desirable

Budget/Procurement

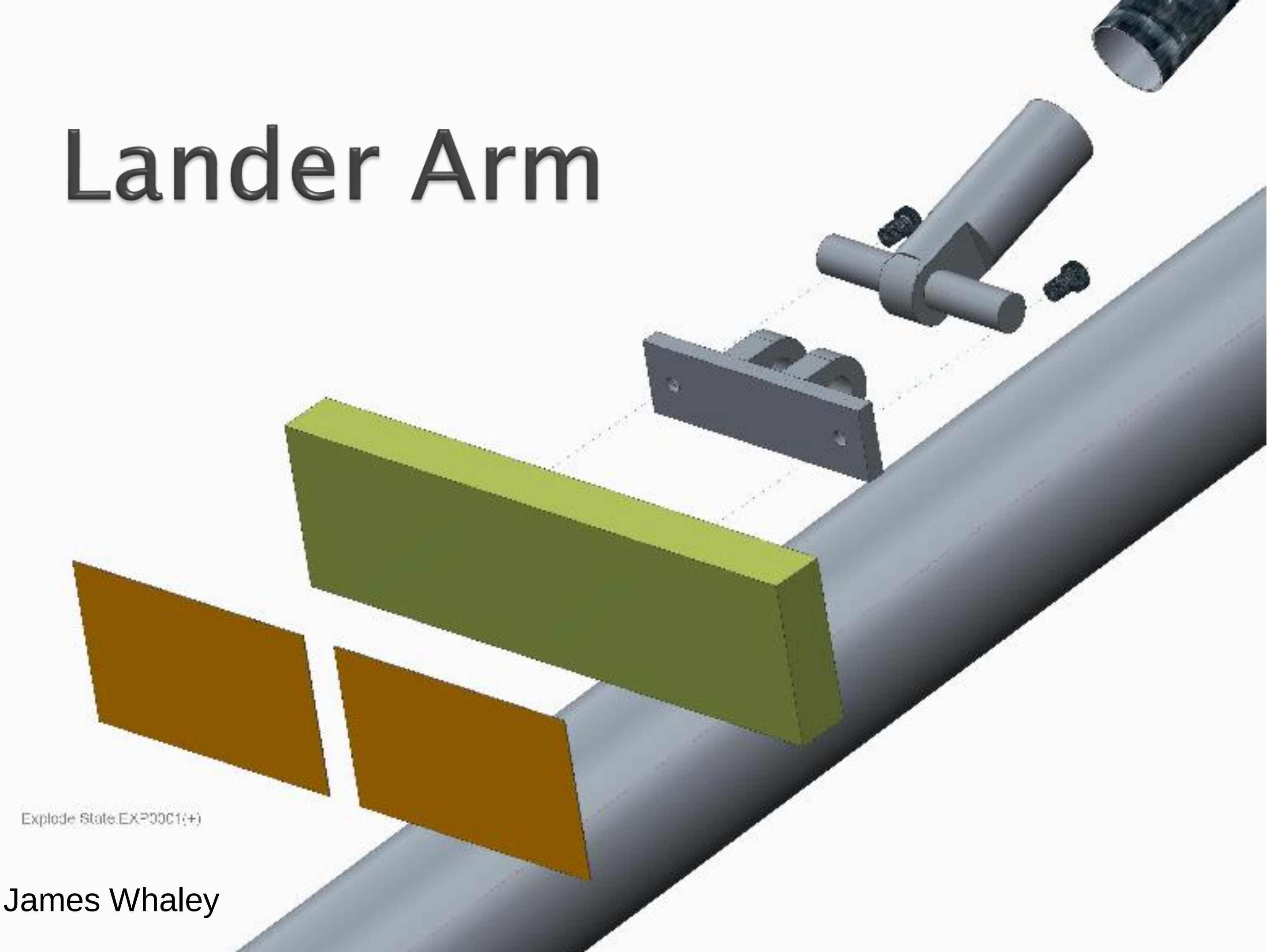
	Cost (in USD) to Prototype as Designed
Prototyping	
TOTAL COST TO PROTYPE	1099.84
Testing	
TOTAL COST TO TEST	119.27
SHIPPING AND HANDLING CHARGES	250.00
UNFORESEEN EXPENSES	530.89
GRAND TOTAL	**2000.00**

- Procurement began in November.
- Final purchase orders have been placed.

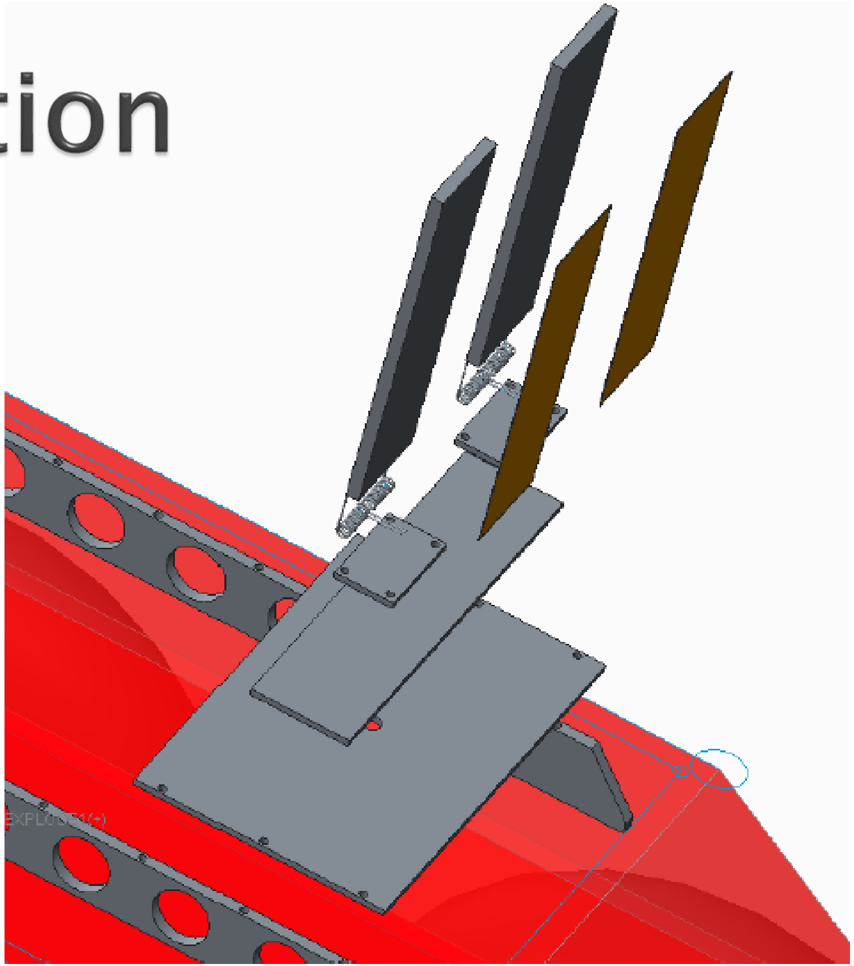
Lander Arm

James Whaley

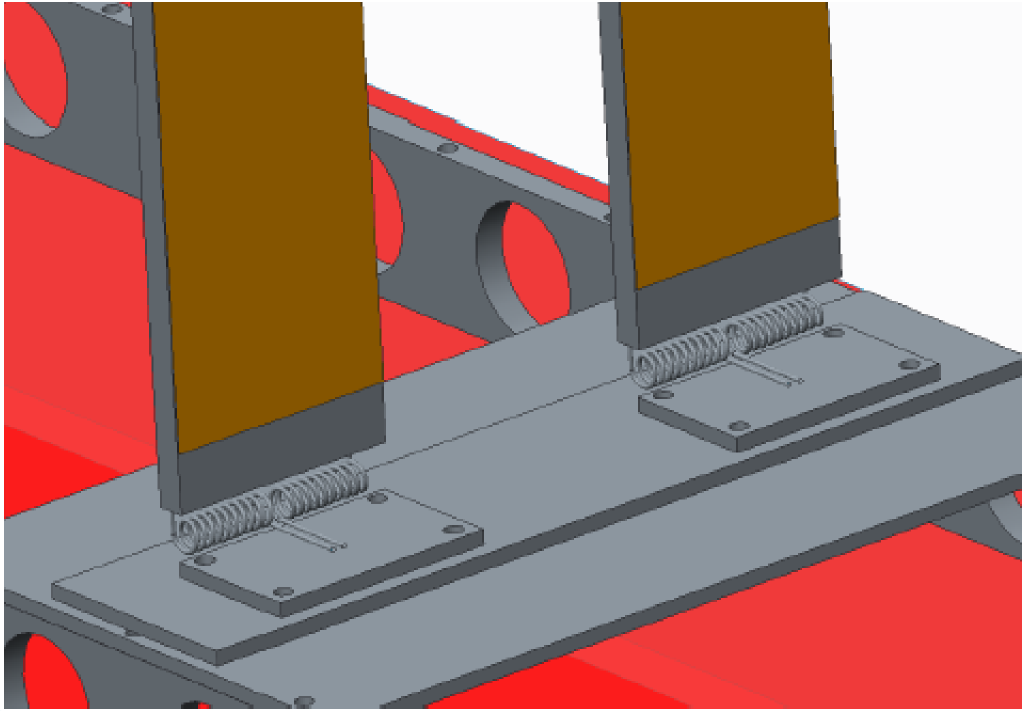
Lander Arm



Rover Connection



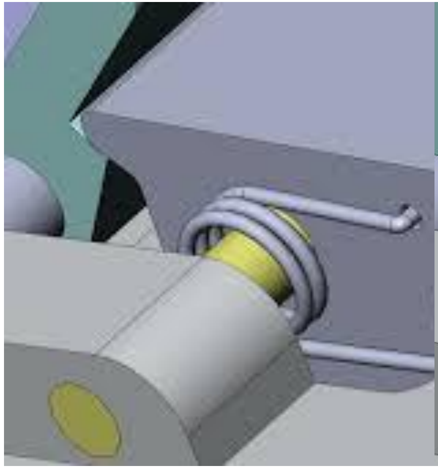
Rover Connection

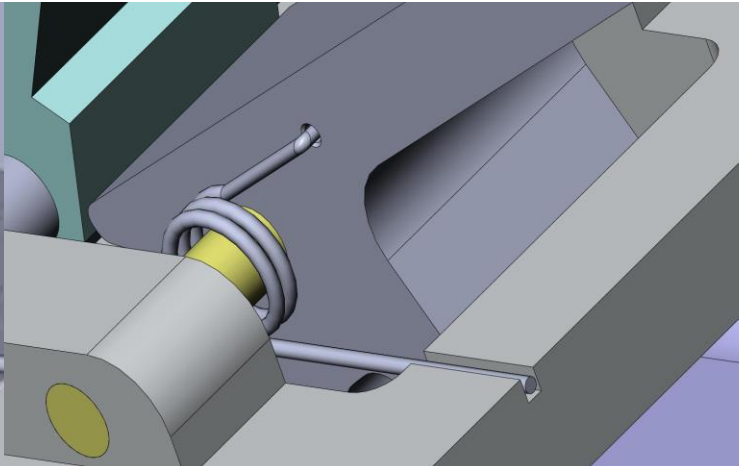


Initial Deployment

- When protective shroud is removed upon landing on Mars, the arm needs to be deployed off lander deck upon landing on Mars
- FINAL DECISION: Pre-loaded torsional spring with solenoid latch
  - Initial 5V signal upon landing to trigger solenoid and release spring
  - Once deployed arm does not need to return to original position on deck
- NASA Approved
  - Passive and very simple design
  - Does not draw significant power from fuel-cell

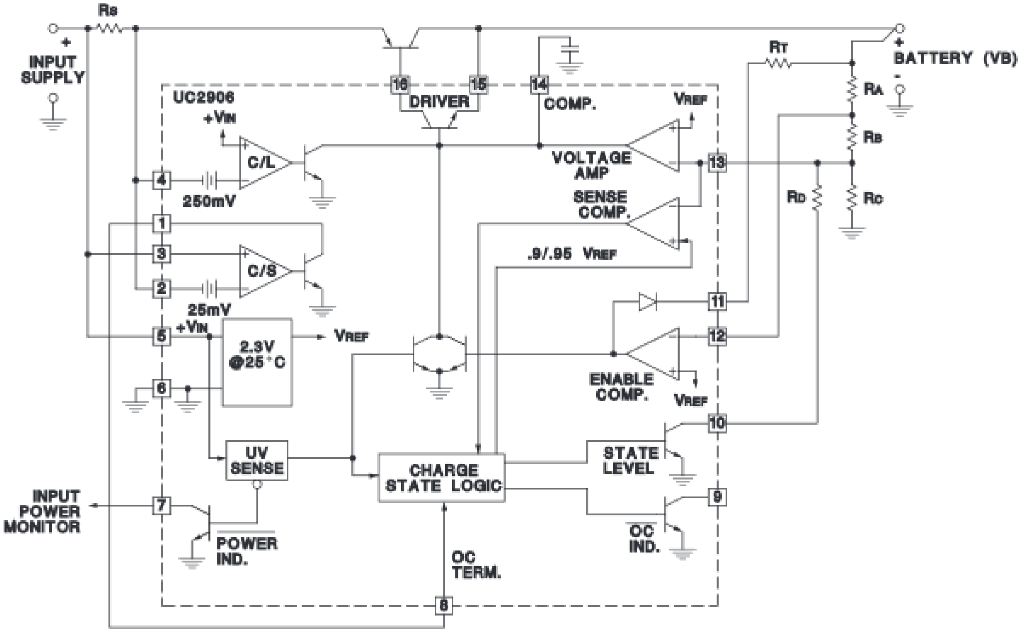
Initial Deployment



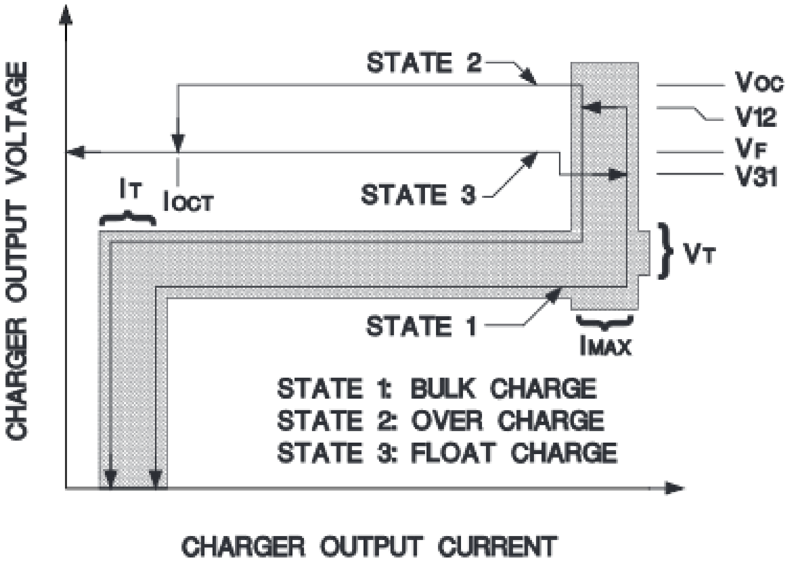


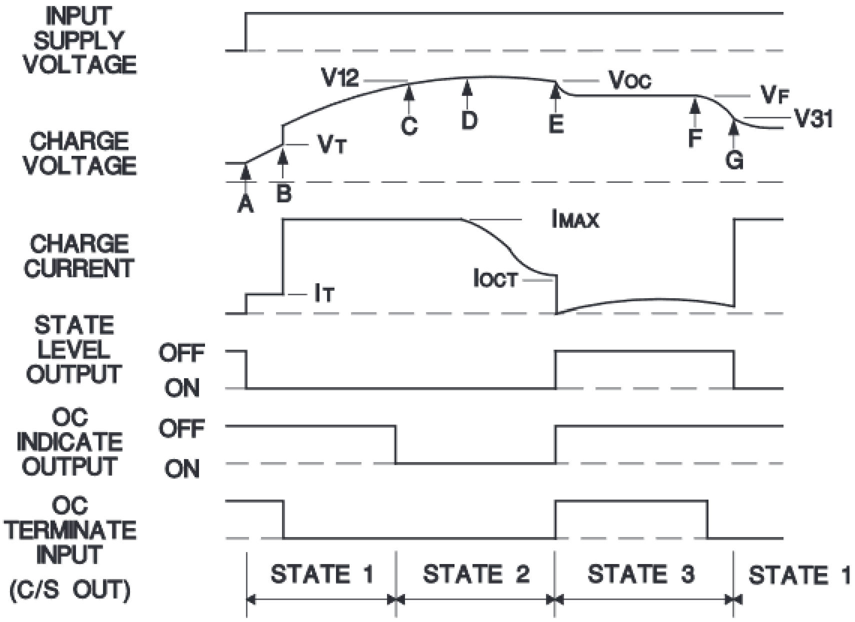
Charge Control

- UC3906 IC
  - 24 Volt, sealed lead acid battery charger
  - Adjustable thresholds
  - 4 stage charging algorithm



Four State Charging





Alternate Charge Control

- Power Stream PST-BC2424-10 DC-DC charger
- 85% efficiency
- Four state charging
- Short Circuit Polarity Protection

Safety and Ergonomics

- Up to 28 V and 25 Amps coming off lander hydrogen fuel cell
  - Creates a high risk of danger for workers in a lab setting

Risk:

- Possibility for shocks/burns to occur if human hand were to be placed on plate
- Possibility for metal tools to short plates creating a sudden large current that could burn out the lander circuit

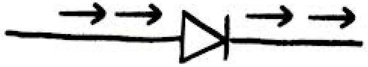
Prevention:

- Will create a circuit on lander side connection that ONLY activates when a voltage potential is present

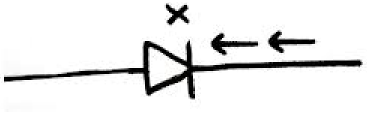
Safety Circuit

- Current decision
  - Deep Cycle Batteries
  - Trickle Charge State (50 mA)
  - Diode at base of positive terminal

When the charger is connected, current flows



If a wrench were to call a cross the terminals



Conclusions/Analysis

- Full arm design completed
  - Simple/Robust/Reliable
  - NASA Approves
- Completed lander and rover connection designs
  - Effective design for the application, efficient, and safe
- Materials selection process
  - Lightweight, within mass constraints of <4kg
  - Low forces/stresses experienced
- Procurement completed
  - Through NASA, under budget

Future Work

- Finalize initial deployment design
  - Within next two weeks

- Finalize charge and safety circuits analysis and design
  - Late February

- Build final prototype
  - Early March
    - Simulate Lander deck using wood
    - Working prototype of arm
    - Initial deployment successful
    - Test using ATRV-Jr at acceptable angles of approach and elevation angles

- Test circuit (measure efficiency to ensure within requirement of >75%

References

- [1] http://www1.eere.energy.gov/hydrogenandfuelcells/fuelcells/fc_types.html
- [2] http://www.afcenergy.com/technology/advantages_of_alkali_fuel_cells.aspx
- [3] http://www1.eere.energy.gov/hydrogenandfuelcells/fuelcells/pdfs/fc_comparison_chart.pdf
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- [10] http://www.jpl.nasa.gov/news/press_kits/MSLLaunch.pdf

Questions, Comments?