DALHOUSIE UNIVERSITY
FACULTY OF ENGINEERING

ECE Senior Year Project I

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Elcora Advanced Materials Corp.

Department of Electrical and Computer Engineering

Building a Low Cost Tester for Lithium Ion Batteries

Project Description

The Project is Sponsored by Dr. Shane Beattie. The Main Objective is to Build a Low-Cost Circuit that Can Run Tests on Lithium Ion Batteries. The Cell is to be Placed in a Cell Holder for Testing. The Specifications Required are:

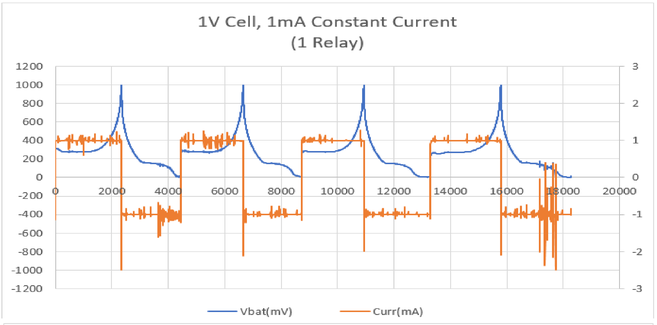
- Standard Constant Current Charging and Discharging (1A Range with 1mA Increments)
- Ability to Run Multiple Cycles
- Ability to Save Data (Voltage and Current Variations with Respect to Time) to a Computer
- One Cycle is: Charging from 3V to 4.2V, Holding at 4.2V, then Discharging to 3V

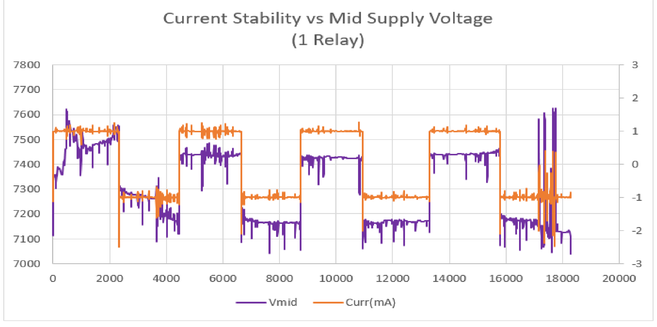
Scope of Work

- Improve an Existing Prototype Breadboard Circuit (Pi Clops V2) that Cycles Lithium Ion Batteries in Charging and Discharging modes.
- Develop and Build a Printed Circuit Board of the Prototype.
- Provide a Full Summary Report explaining: Modifications, Prototyping Instructions, Results achieved, and Limitations of the Circuit.

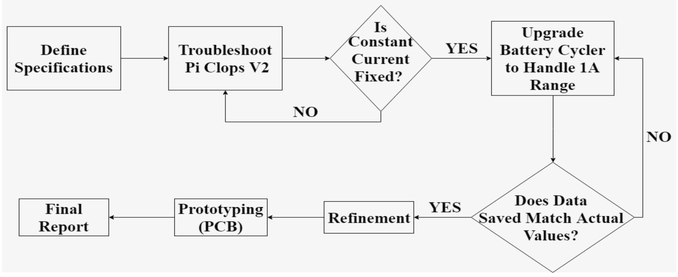
Pi Clops V2

- A Circuit Built in Previous Co-op Electrical Terms
- The Circuit Achieves Both Constant Current and Constant Voltage Charging and Discharging
- The Current Range Handled is 10mA with 1 mA Increments
- It uses ATMEGA 328 Chip with PUTTY Serial Configuration for Data Collection
- Issues: Noisy Current (Below Graphs)





Design Process

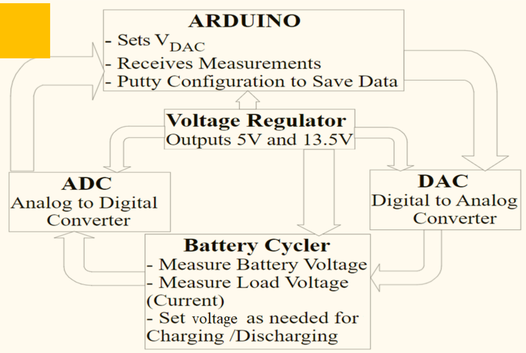


Details of Design

To the Right is a Block Diagram of the Previous Full Circuit

Our Design Consists of:

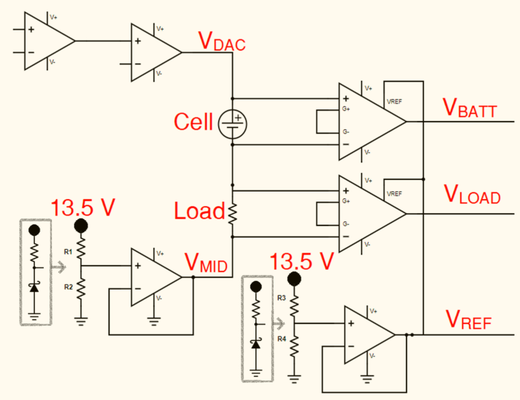
- A New Modified Battery Cycler (to Handle 1A Range): Plan A, and, Plan B or C
- Integration of New Battery Cycler with the Rest of the Existing Circuit
- Troubleshooting of Existing Software



Plan A

Fix the Current Instability:

- V_{MID} and V_{REF} were Unstable
- Reason: Unstable Input Voltage from the Regulators
- Substitute Voltage Dividers at the Input with Shunt Reference Voltages



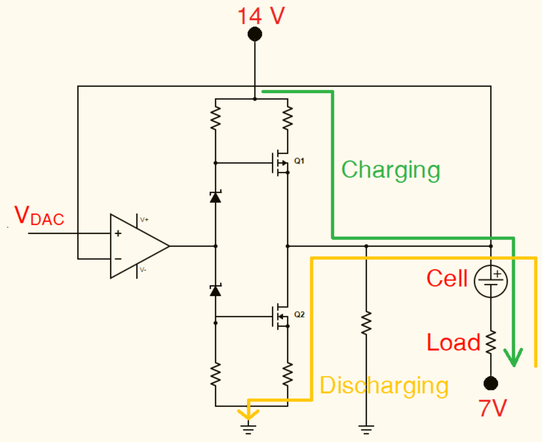
Progress:

- Built the Battery Cycler on a Separate Breadboard
- Fed Controllable Voltage Input (from DC Supply) to LM7322 Amplifiers
- Measured V_{MID}, V_{REF}, V_{DAC}, V_{BATT}, V_{LOAD}(Current)
- Achieved Constant Charging and Discharging for a 1~15 mA Current Range
- Ordered Two Shunt Voltage References LM4040 Online for Further Implementation as Mentioned Above.
- Will Build the Mid Supply, the Instrumentation Amplifiers as well as the Reference Amplifier with Shunt References at the Input
- Will Test Accuracy of Measurements, Controllability of Voltages and Currents
- Will Integrate New Battery Cycler with the Rest

Plan B

Upgrade Battery Cycler of Plan A:

- Use Enhancement MOSFETs
- Use Zener Diodes
- Bias the PNP FET to Turn ON in Charging Mode (Source Current)
- Bias the NPN FET to Turn ON in Discharging Mode (Sink Current)
- Source and Sink up to 1A Current with 1 mA Increments
- This Design is by Dr. Peter Gregson



Progress:

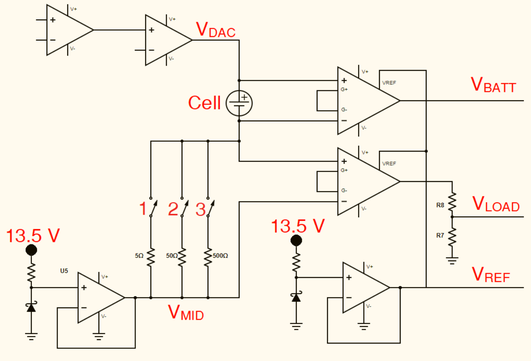
- Working on Calculations to Determine: Resistances, Zener Voltages, and FETs Parameters needed.
- Will Order the Parts and Build the Circuit on a Breadboard
- Will Test Current Controllability and Accuracy of Measurements (ADC Versus Multimeter)

Plan C

Upgrade Battery Cycler of Plan A:

- Use Several LM7322 Amplifiers in Series for V_{DAC} Amplification and V_{MID} Fixed Supply
  Resultant Amplifier and Mid Supply will Handle a Larger Current Range
- Use Multiple Resistors and Relays to Create Several Paths Corresponding to each Current Range (such that V_{LOAD} is always between 0.5V and 5V)
- Add a Voltage Divider at the Output of the Instrumentation Amplifier Measuring V_{LOAD}
- Integrate with ADC and DAC to Measure and Test

Channel #	1	2	3
Resistor Value	5Ω	50Ω	500Ω
Current Range	101~1000 mA	11~100 mA	1~10 mA
V_{LOAD} Range	0.505~5 V	0.55~5 V	0.5~5 V



Progress:

- Not Started Yet