



# Design of a Li-Ion Based Battery System With Very High Discharge Capability

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## Introduction

rLoop's first fully functional Hyperloop pod is powered by a lithium ion battery pack designed and tested in-house.

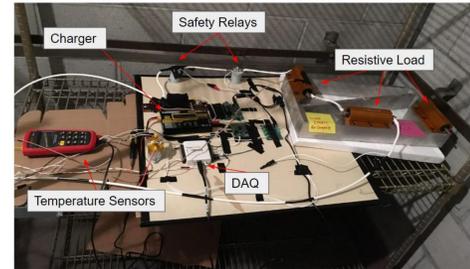
The rPod uses active levitation powered by eight Arx Pax HE3.0 Hover Engines. The hover engines require approximately 80 W/kg in order to achieve levitation.

Given the rPod's mass of 350 kg, this yields a max discharge requirement for the battery system of 30 kW at 72 V. A desired flight time of 3 minutes was used for sizing.

**The battery successfully powered all engines and levitated the rPod across several demonstration flights.**

## Cell Selection and Testing

Cells were procured from an R/C aircraft battery supplier. A qualification test program validated the cell's performance, quality, and safety.

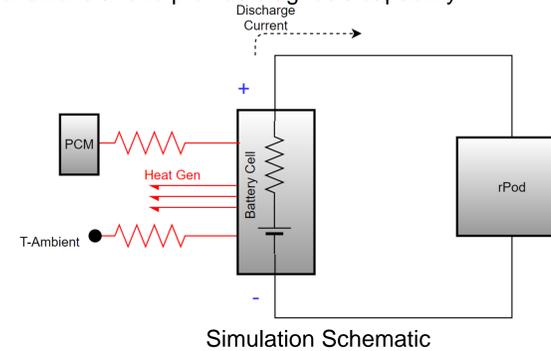


Custom cell testing system

Single Cell - Revolectrix YS5000 1S RL	
Nominal Voltage	3.7
Nominal Capacity (Ah)	5
Mass (g)	138
Max Tested Discharge Rate (A)	75

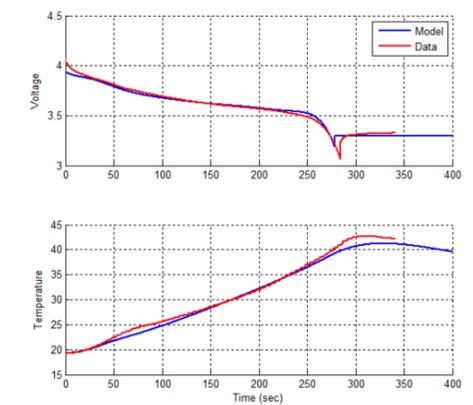
## Cell Simulation

An electrical/thermal model was built to be able to predict real use case conditions and to provide diagnosis capability.



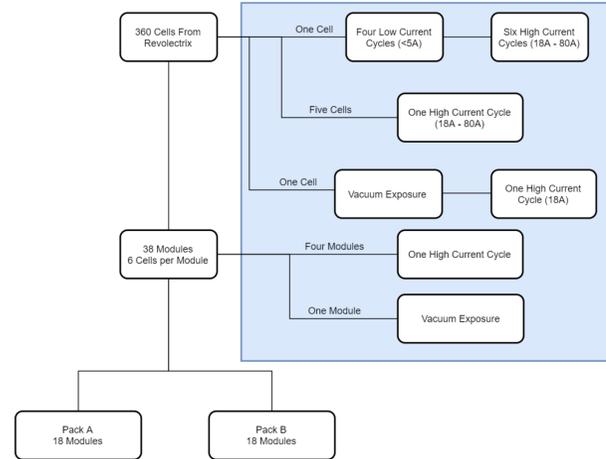
Simulation Schematic

Single Cell discharge, 0.05Ω resistor, 74A average, 15C-rate  
Simulation vs. real test data

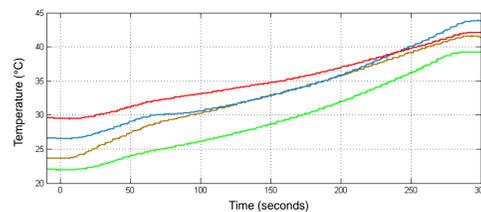
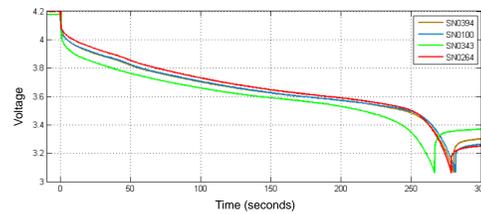


Cell test data compared with model shows good agreement and indicates predictable cell performance.

## Qualification Testing



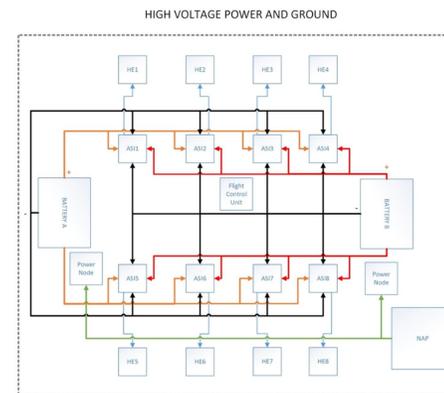
Cell usage flow chart & Qualification Plan



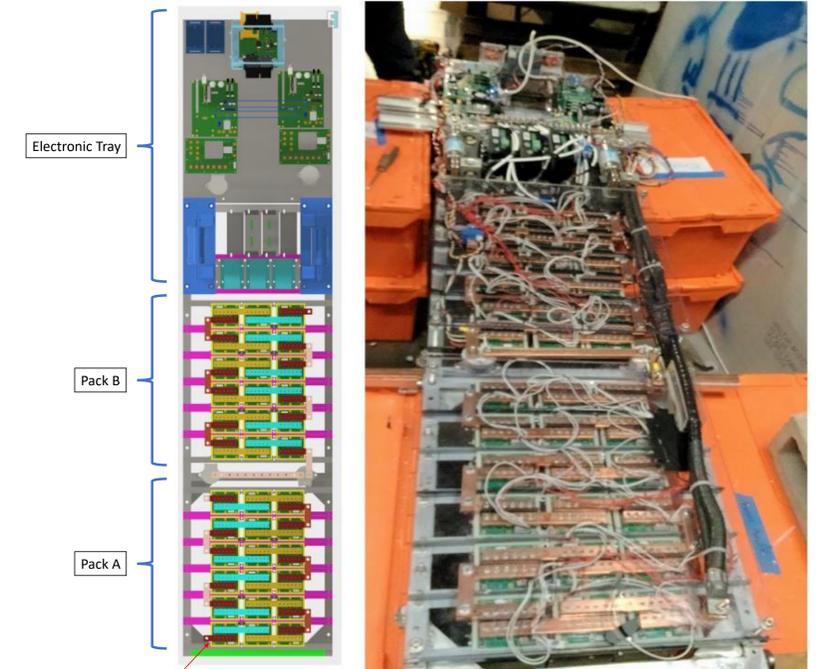
Sample qualification data: Four cells tested using a 0.05Ω discharge resistor.

## rPod Assembly

36 modules were assembled into two identical and redundant packs. BMS circuitry measured voltages and temperatures, and the packs were connected to individual power controllers for each hover engine, as well as additional electronic loads throughout rPod.



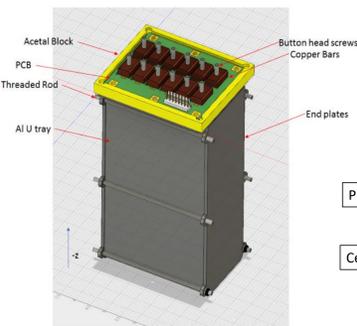
Electrical System Architecture



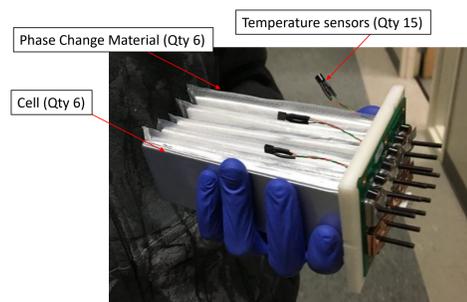
rPod Battery System (2 packs) and Electronic Tray

## Module Assembly

Six cells were placed into module assemblies. The cells were interspersed with phase change material (PCM) pouches for passive thermal control. Temperature sensors measured cell and bus bar temperature.



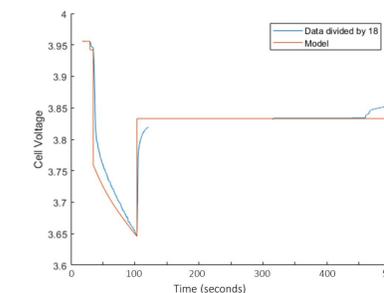
Module CAD



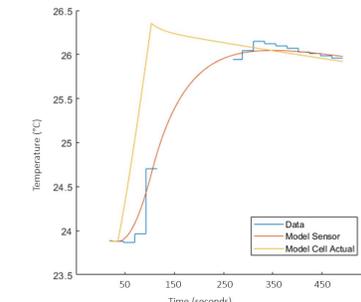
Module Internal View



Module Final Build



Data from actual rPod flight (one minute) with simulation data overlay



## Single rPod Pack – 18 Modules – 108 Cells

Configuration	6P18S
Nominal Voltage	66.6
Nominal Capacity (Ah)	30
Mass (kg)	30
Max Tested Power (kW)*	21

\*Estimated using model, not directly measured