

defy convention.

Clarkson Electric Snowmobile Team



Clarkson
UNIVERSITY
defy convention

Overview

- Snowmobile Features
- Environmental Impact
- Battery Choice
- BMS
- Drive Train
- Test Results
- Cost
- Serviceability

Features

- Polaris 600RR Racing Chassis
- 42 hp / 37kW motor
- Zero Emissions
 - Powered by 816 LiFePO₄ cells
- Can perform as low as -40°C
- High Towing Capacity
 - Drivetrain Geared for load-pulling
- Estimated Range: 20-25 miles
 - 10 miles in endurance run (poor conditions)
- Ergonomic Design
 - No changes to stock seat
- Quiet



Environmental Impact

- Zero Emissions
- Low Noise – Quietest at last year's competition



BATTERY CHOICE



LiFePO₄ (Lithium Iron Phosphate) Batteries

- Energy Density: 103 Wh/kg
- Power Density: 795 W/kg
- Nominal Voltage: 3.2 V
- Energy: 2.6 Ah
- Cell Weight: 80.5 g
- Cell Life: >2000 cycles
- Number of Cells: 816



Safety and Reliability of the Batteries

- Proven safe without circuit board protection by:
 - Department of Energy
 - UL
 - Sandia National Labs
 - UN/DOT
 - Other government agencies.
- Patented thermal runaway protection



BATTERY MANAGEMENT SYSTEM (BMS)

Elithion Lithiumate BMS

- Features
 - Resistive balancing
 - Communication ports
 - Interfacing with the motor controller
 - Displays temperature, battery life, faults
- \$754

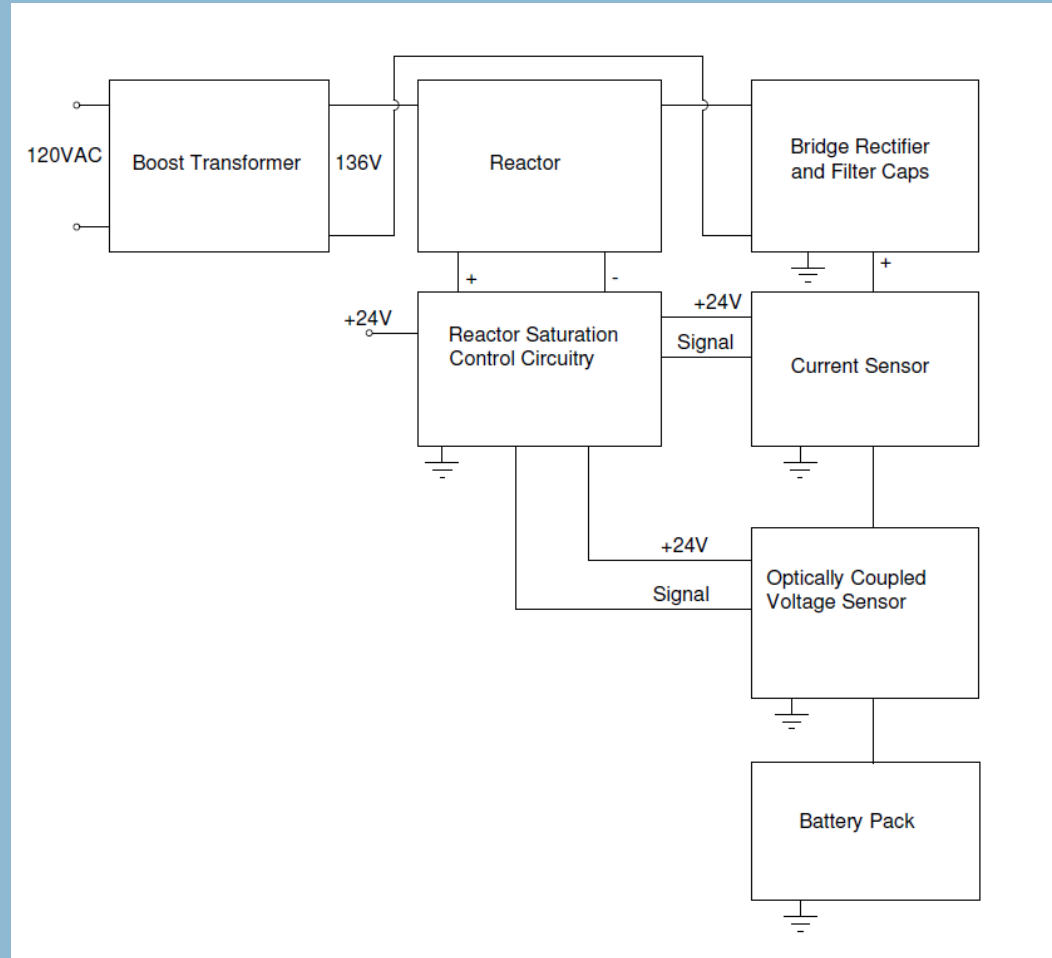


BATTERY CHARGER

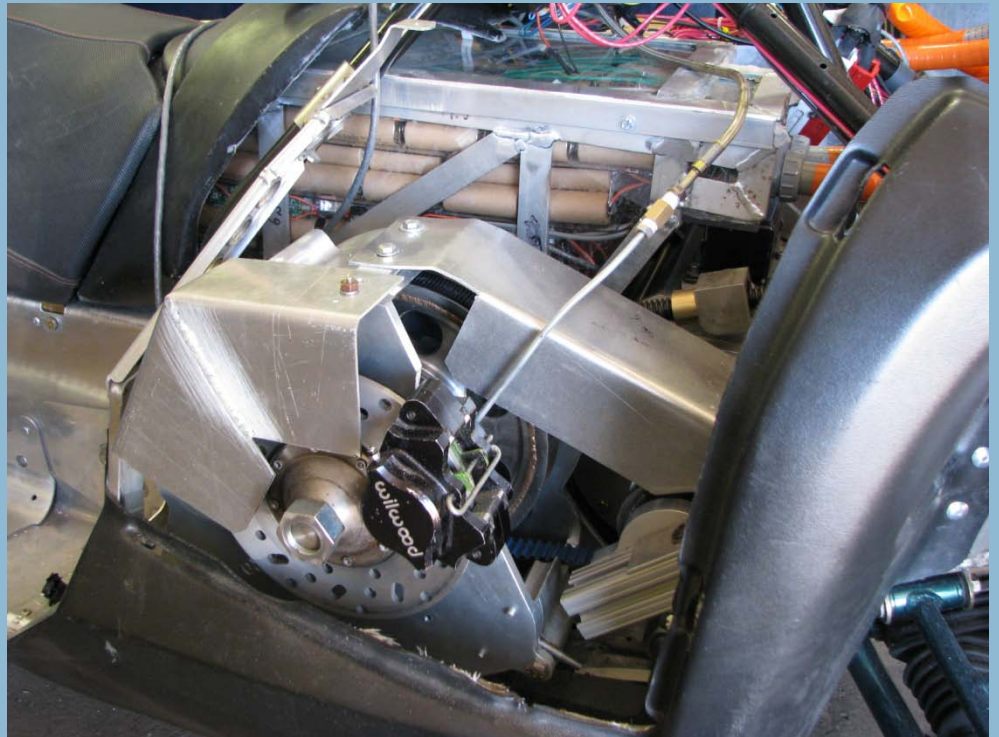


Battery Charger

- 8 hour charge time
- 89% Efficiency

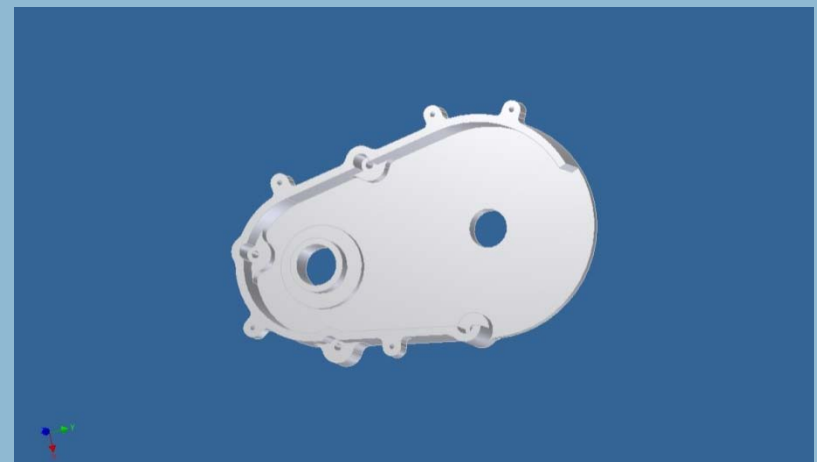


DRIVE SYSTEM



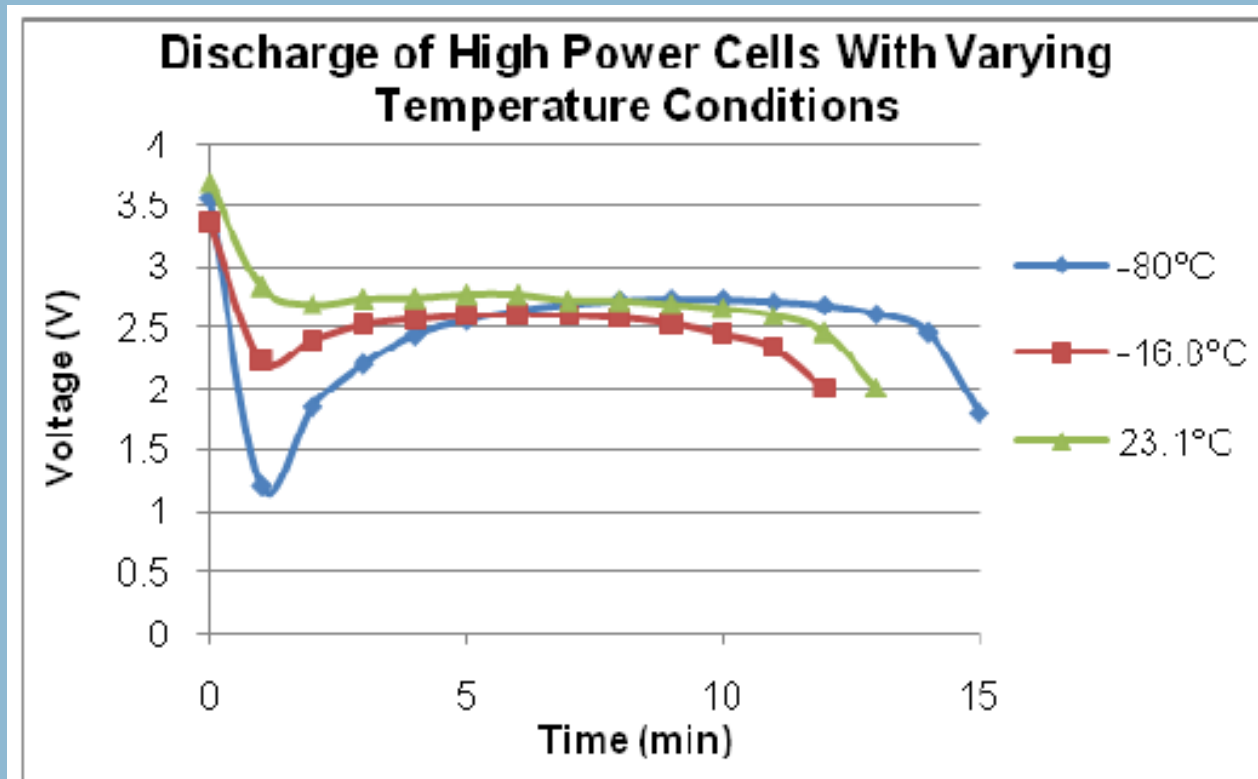
Drive Train

- The motor is coupled to the cog wheel via a Gates Polychain belt
- A new aluminum case houses the belt drive and supports the secondary shaft



Test Results

- Best in noise last year – same motor
- Battery testing results



Maintenance

Mechanical

- Belt System Requires little if any lubrication (bearings)
- Replace worn belts

Electrical

- BMS
 - Monitor cell health throughout life of snowmobile
 - requires minimal software (PUTTY and drivers)
 - Can identify any problems that the packs have.
- Pack Lifetime >5.5 years if discharged once daily

Cost

- MSRP: \$19,336
- Batteries store 12.2MWh during 2000 cycle lifespan – costs \$1558 at 11.47 cents/kWh
- Equivalent to \$3,650 in gas at \$2.75 per gallon
- Stock 2010 Polaris IQ Shift MSRP:\$8,000
- Net Lifetime cost: \$9,244 more than stock

Summary and Conclusion

- Meets Design Requirements of NSF
 - Towing Capacity
 - Range
 - Temperatures
- Good for utility applications
 - Ski resorts
 - Wildlife photographers/biologists

QUESTIONS?