Design of Electric Snow Machine

Presentation by Kayla Harrison and Ben Neubauer

Overview

- Introduction
- Operator perspective
- Dealership perspective
- Environmental perspective
- Verification and component summary

Introduction

- EV3-lite exceeds criteria set for scientific research in the North and South Poles
- Tested zero-emissions sled, does not contaminate fragile environments
- Comfortable and attractive
- Optimal power and range
- EV3-lite is safe, durable, easy to use
- Serviceable design and low cost

Operator Perspective

Comfortable, Attractive, Easy to Use

Body

- Based on Ski-Doo XP chassis
- Most efficient chassis available
- Maintains stock appearance
- Comfortable
- Center of mass at drive shaft

User Friendly

Machine behaves like electric start IC

- "Run" on key initializes system and BMS display
- "Crank" starts machine
  - Only if positive kill switch, tether, temperature switch, and Bender
- Computer display available when HV disabled


Easy-to-use Display
LCD screen displays important info like pack voltage and current draw
Buttons allow access to BMS menus
READY
CRANK
FAULT
LED indicators display status

Range

- Tests averaged 300 Wh/mile without load
- 1.461 kWh battery pack, 80% depth of discharge
- 1.169 kWh useable
- Estimated 3.55 mile range

Power

- Pulling power limited by traction
- Best traction on packed snow
- Studless design uses BRP “Silentrack”
- Production machine could use screw in studs

Dealer Perspective

Low cost, Easy to Service, Durable

Cost

- Our cost to build: $5,000
- Adjusted MSRP: $14,459
- Expected reduction if buying in bulk

Serviceability

- Any component can be removed and serviced
- All fasteners easily accessible
- Most fasteners employ “blind nuts”
- Utilizes 8-piece toolkit

Simple Toolkit

High Voltage Tools

Basic Maintenance

Service Time

- Drive belt can be tensioned: 15 minutes
- Stripping chassis down to motor: < 2 hours
- Removal of central battery system: < 1.5 hours
- Tested

Carbon Fiber Enhancements

- 6-layer reinforced tunnel
  - Rigid, light, space saving

- Steering post brace
  - High clearance, strong, light

Environmental Perspective

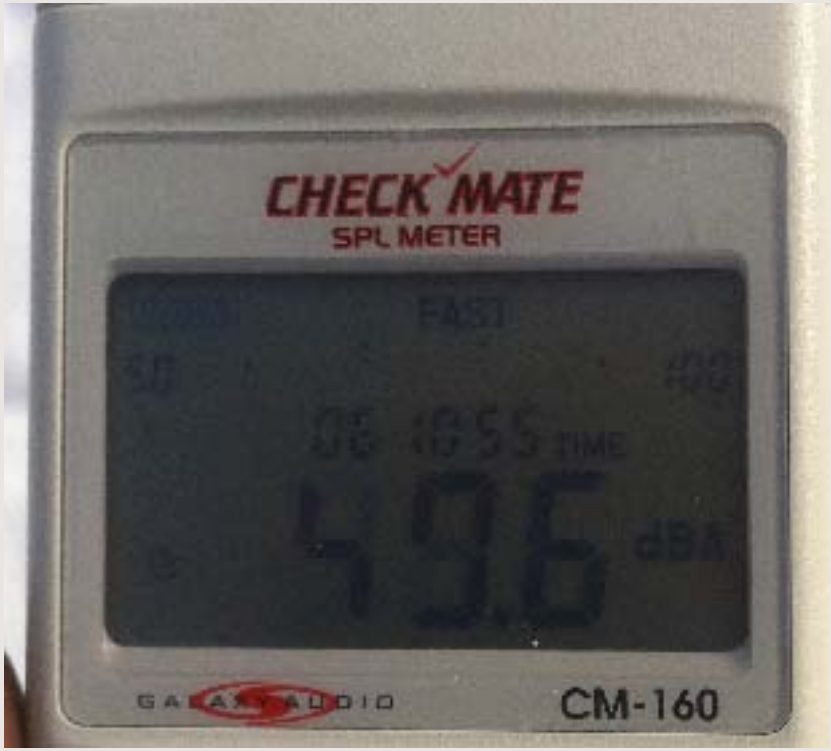
Low Noise, Low Pollution

Environmental Efforts

- Track uses BRP Silentrack
- Idler wheels ride on extra rubber
- Fluid systems sealed
- Tested in Greenland

Environmental Tests

- Brake fluid and bearing grease are sealed
- Sound Pressure Level measurement of 49.6 dB
- Approx 90% Quieter than comparable IC

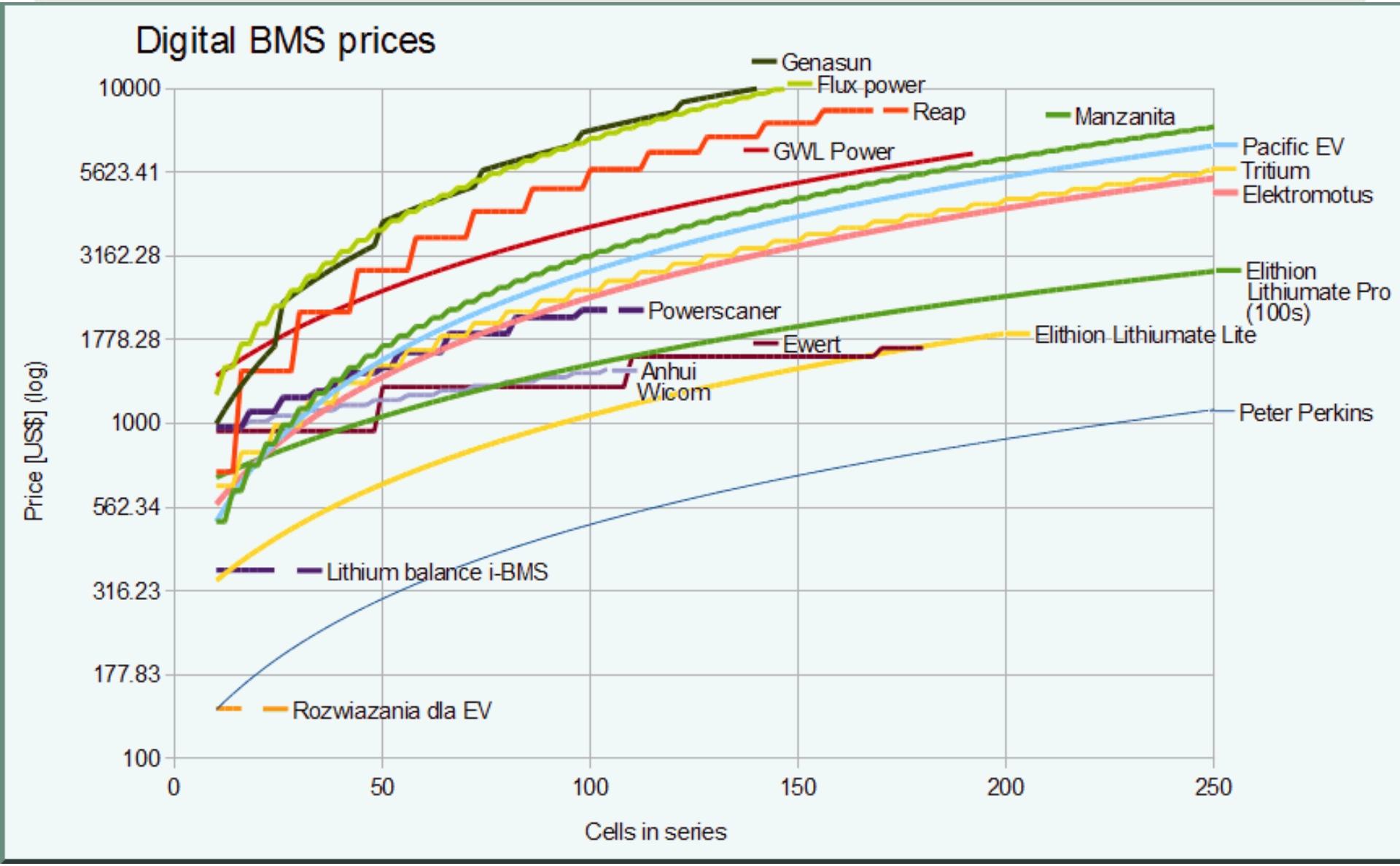


49.6 dB

Verification and Summary

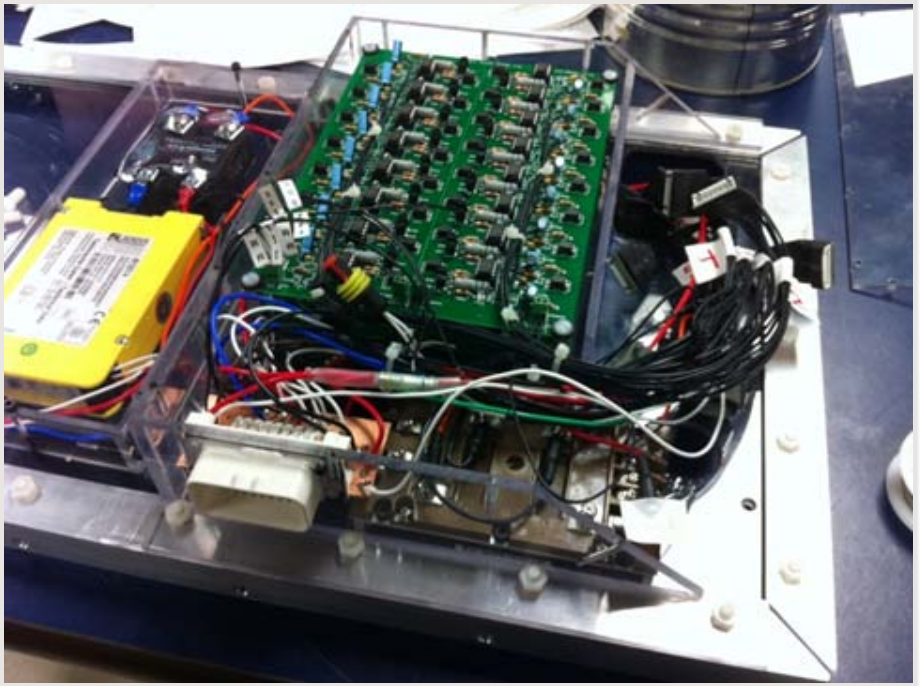
Batteries, BMS, Motor, Controller

Battery Management System



Battery Management System

- Based on Peter Perkins Design
- Open source
- Low cost, high performance
- Manages many cells
- Customizable

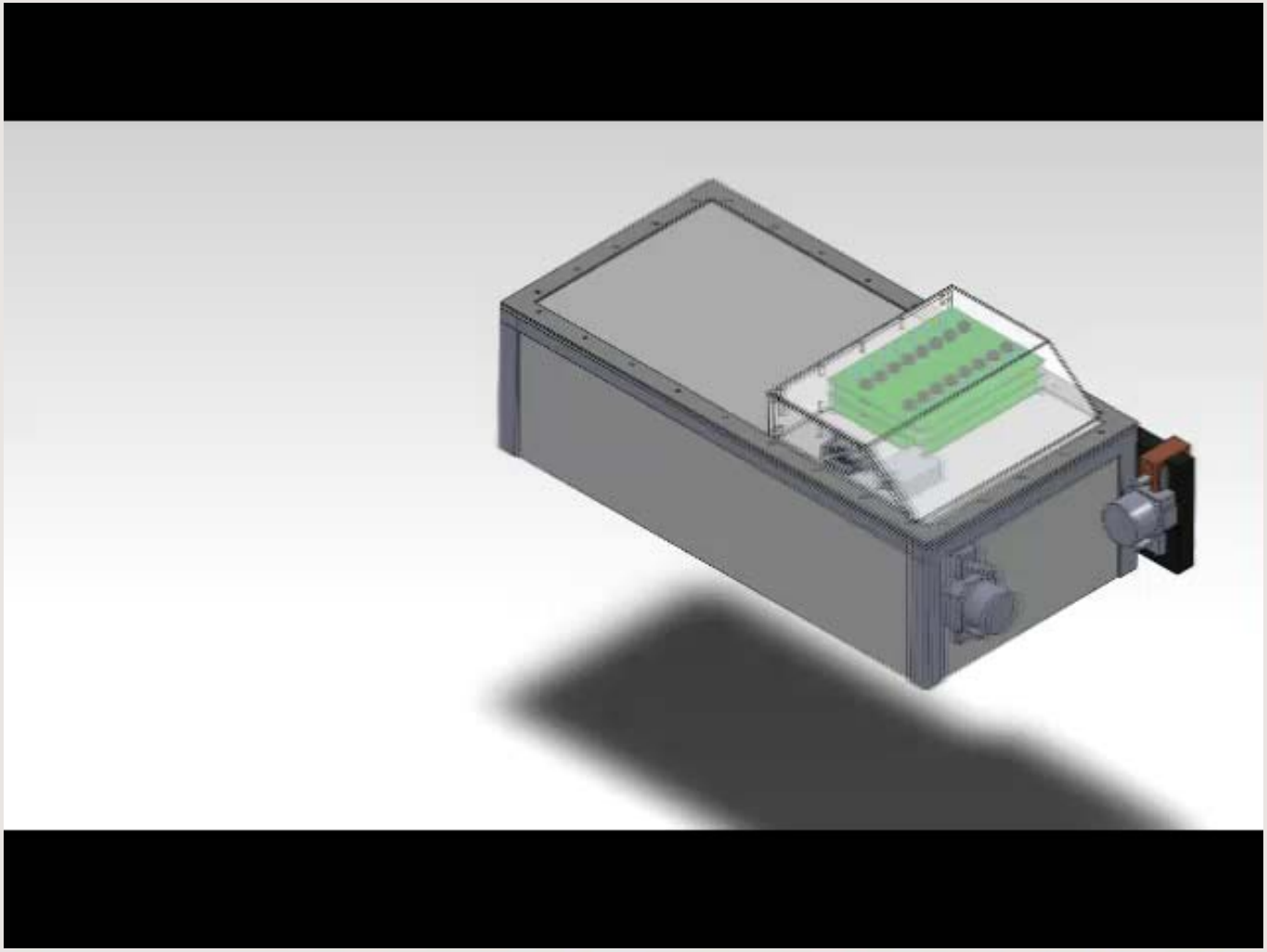


Batteries

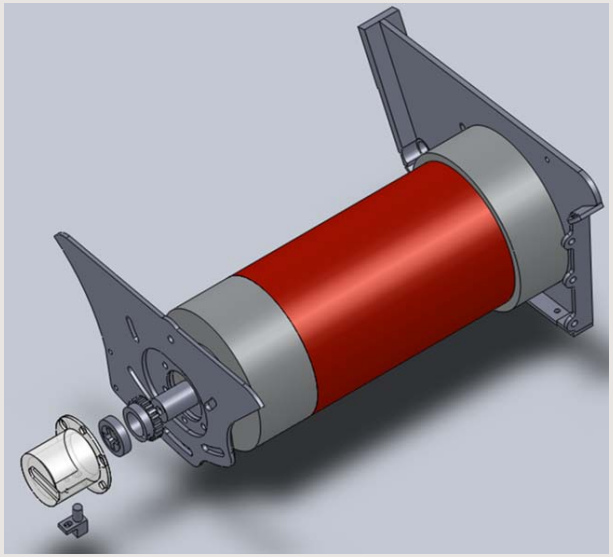
Table 2: Battery Chemistry Examined

		Nickel		Lithium-ion			
Criteria	Lead Acid	NiCd	NiMH	$LiCoO_2$	$LiMn_xNi_yCo_zO_2$	$LiFePO_4$	LiPoly Hybrid
Mass Energy Density (W·h/kg)	35	40	75	180	160	110	140
Volume Energy Density (W·h/L)	68	50	200	250	250	220	286
Power Density (W/g)	0.18	0.15	0.7	3	3	3	4.2
Cycle efficiency (% charge/discharge)	70	70	70	95	95	95	95
Self-discharge (%/month)	10	10	30	5	5	5	3
Cycle life (total cycles)	200	1000	500	500	500	2000	1000
Current cost (US Dollar/W·h)	$0.05	$0.23	$0.47	$0.60	$0.60	$0.31	$0.40
Nominal Voltage	2.1	1.2	1.2	3.7	3.7	3.2	3.7
BMS Required	No	No	No	Yes	Yes	No	Yes
Environmental	Poor	Bad	Good	Average	Average	Good	Good
Cost based on cycle life x W·h of Lead	1	0.7	1.3	1.75	1.75	0.2	0.45

Battery Box Demo



Improved WarP 7 DC Motor

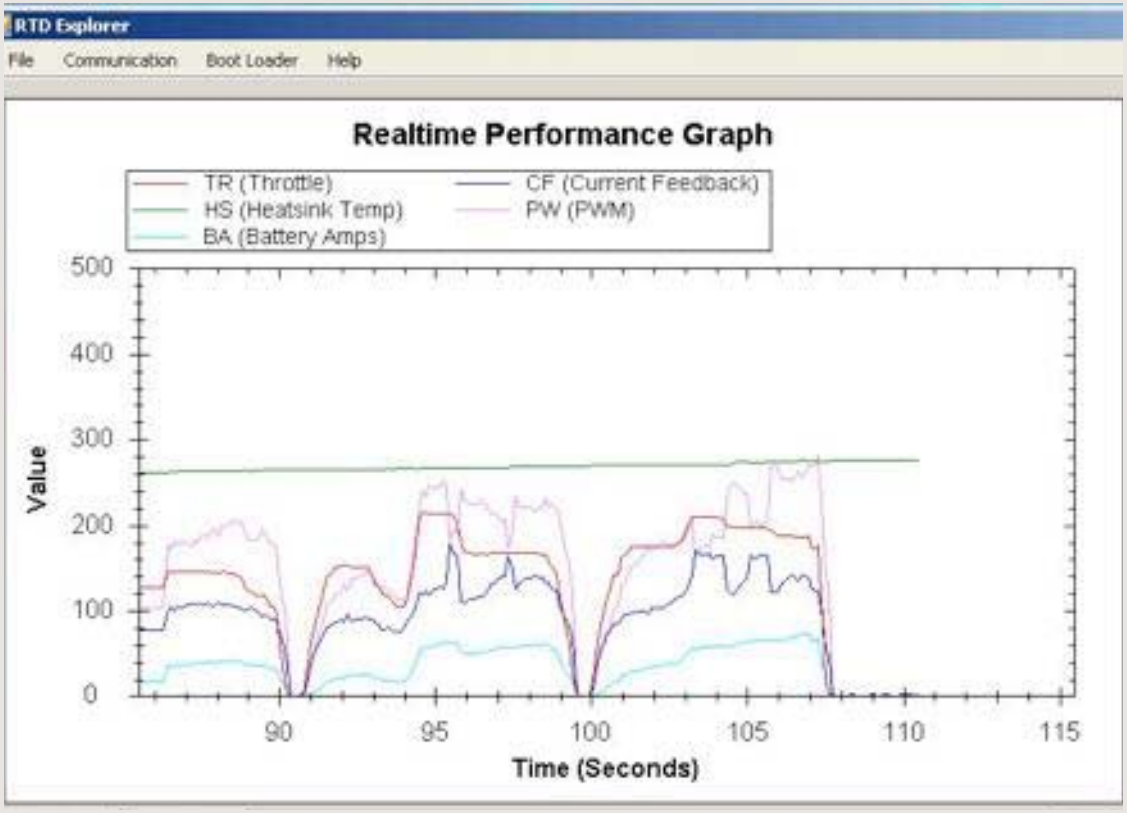


15.47 kW continuous power

- Replaced brushes
- Ceramic bearings
- 3% more efficient

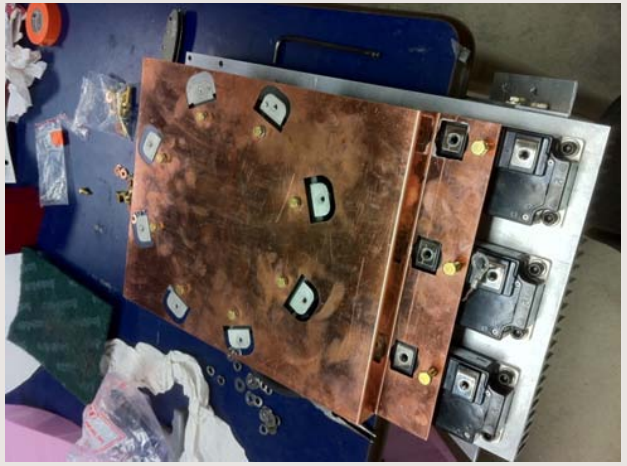
ReVolt Open Source Controller

- Cost Effective
- High Performance
- Customizable
- Microprocessor Control



SB Electronics Capacitor

- Power ring capacitor
- Uses film technology
- Extremely low resistance
- 600 V rating
- 1000 µF
- Handles 500 A ripple



Track Efficiency Data

	Very Loose	Loose	Tight
Power Consumption (Wh/mi)	98.727	86.346	131.222
Max Speed (mi/hr)	10	9	7
Power output (W)	987.272	777.115	918.555
Output (W/A)	216.033	170.047	200.997

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