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ESI MOTION™

ESI's SatBat

Power Storage for Space Applications

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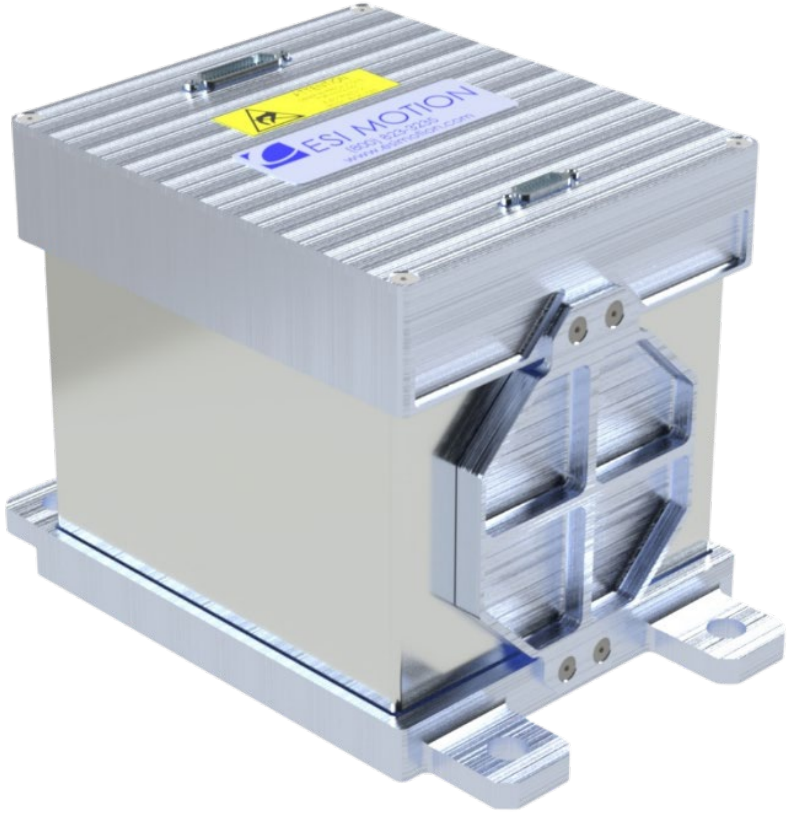
SatBat – Half The Size, Twice the Life

- ESI's SatBat is half the mass with twice the life when compared to alternate battery offerings
- SatBat is optimized for long-life, high-power LEO applications
- Pulse Power rated – eliminates the need for external super-capacitors in high power applications
- Wide Operating Temperature – allows for operating over a wide operating range
- Enables more capability in a smaller size than traditional battery cells
- SatBat is a Superior Technology for LEO Applications when compared to Li-Ion



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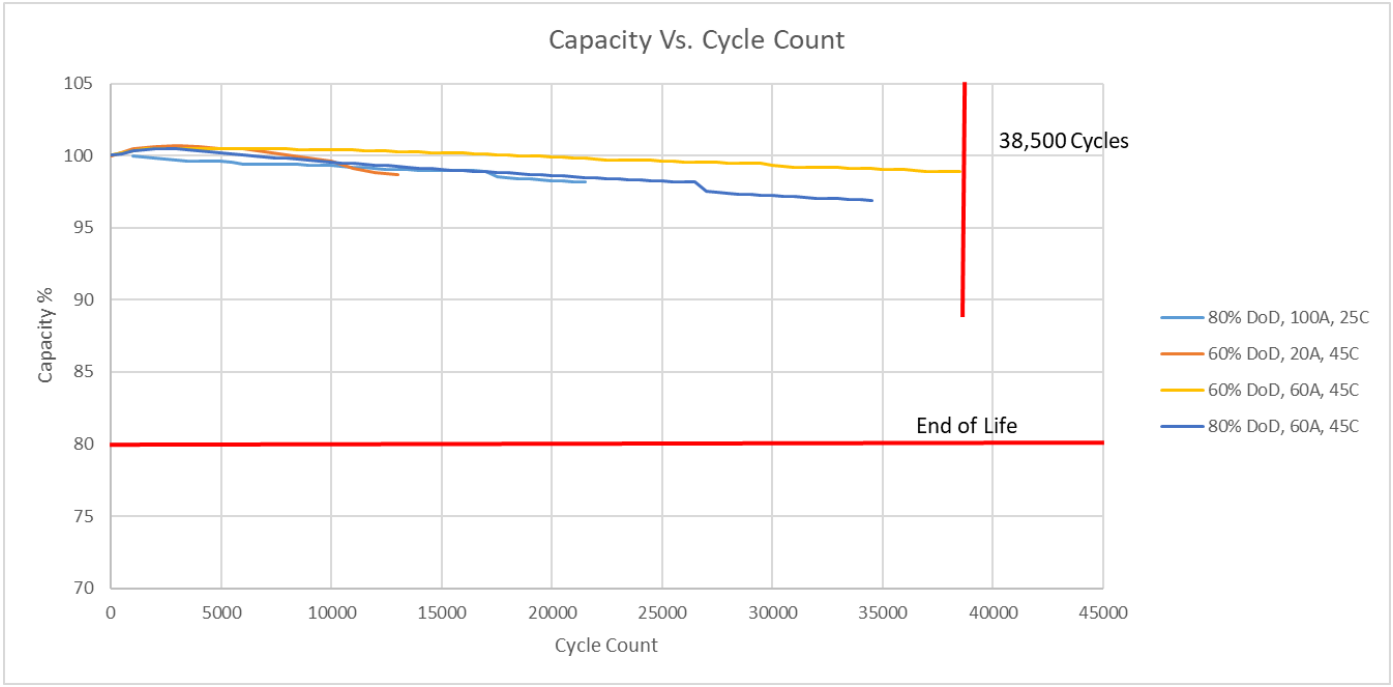
SatBat Cycle Life

- **Capacity fade is not a limiting factor in SatBat life.**
- The cell has minimal capacity reduction after a high cycle life at all operating points
  - Elevated Temperature (45C)
    - 60% and 80% DoD
    - 20A, 60A
  - Room Temperature (25C)
    - 80% DoD, 100A
- End if life is 80% capacity



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Energy Density

Summary: SatBat Useable Energy Density is Roughly Twice when Compared to Li-ion cells

- Nameplate Energy Density of the SatBat roughly 2X lower than traditional li-Ion solutions
- ***But…*** SatBat can use over 80% of it's capacity with minimal Capacity Fade
- Typical li-ion batteries use 15% - 30% of their capacity in high cycle applications
- The "Useable Watt-Hr (Wh)" of the SatBat is typically 2X greater than li-ion solutions
- DoD mapping of the SatBat to Li-ion is shown below

SatBat Vs. Li-Ion DoD Mapping		
Mapping	**SatBat**	Li-Ion
Conservative	**75%**	15%
Typical	**80%**	20%
Aggressive	**90%**	30%

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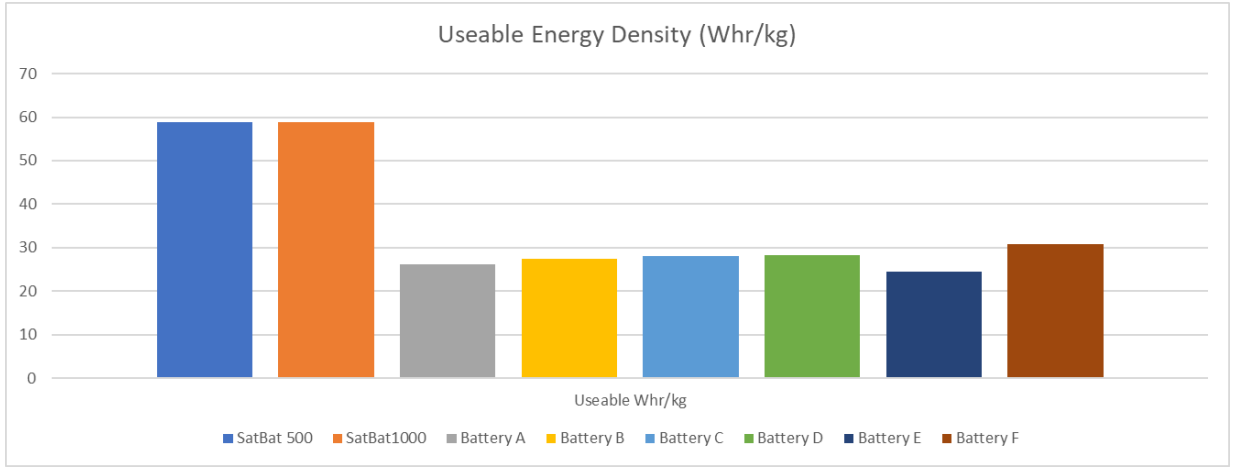
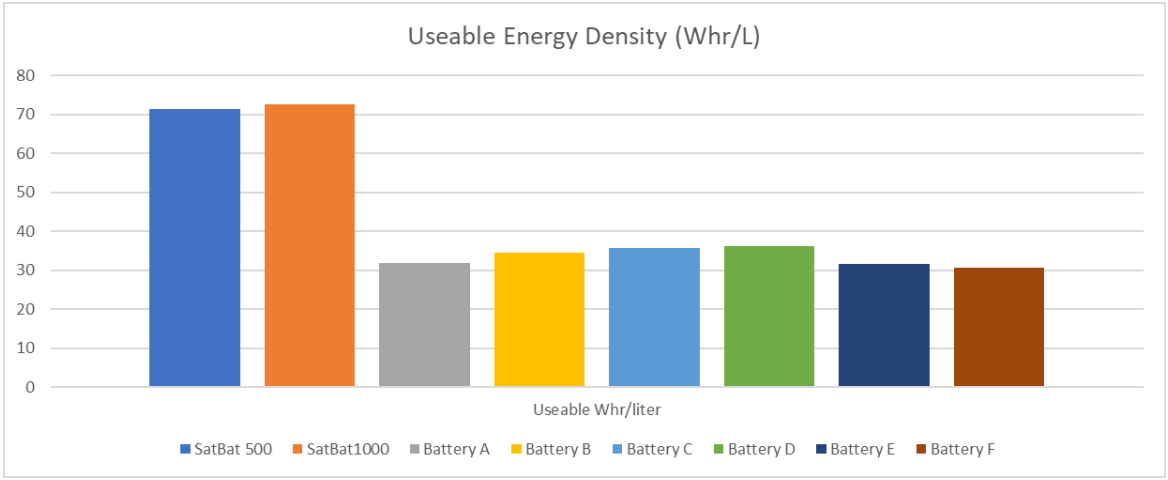
SatBat Vs. Various Batteries Volume and Weight Density

Improvement Summary

- Weight Density: **2.2X**
- Volume Density: **2.5X**

Volume and Weight Density		
	Wh/kg	Wh/L
SatBat Average	**60**	**85**
Competitor Average	28	33
Average Improvement	**2.2**	**2.5**





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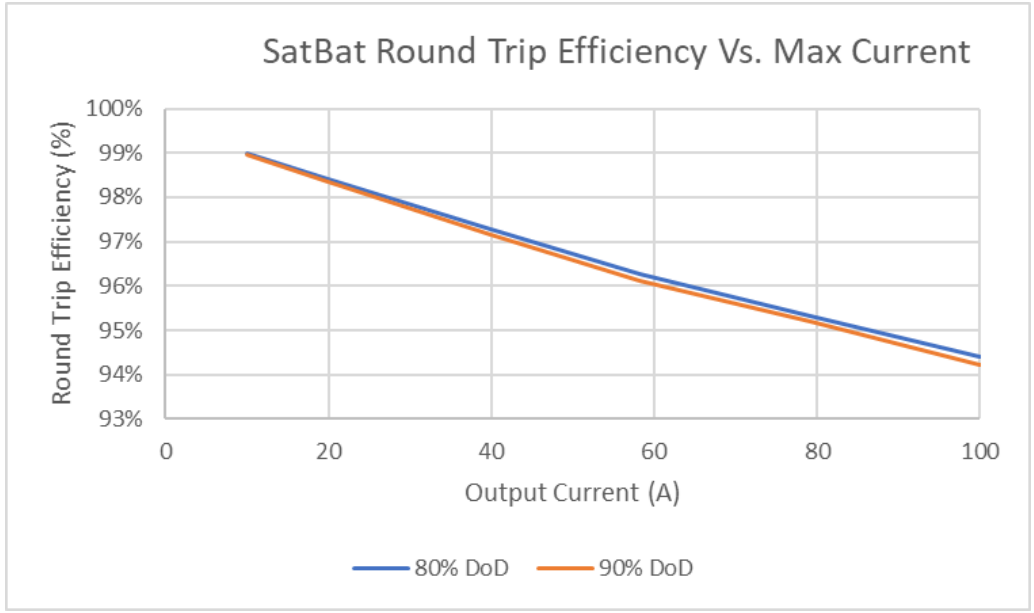
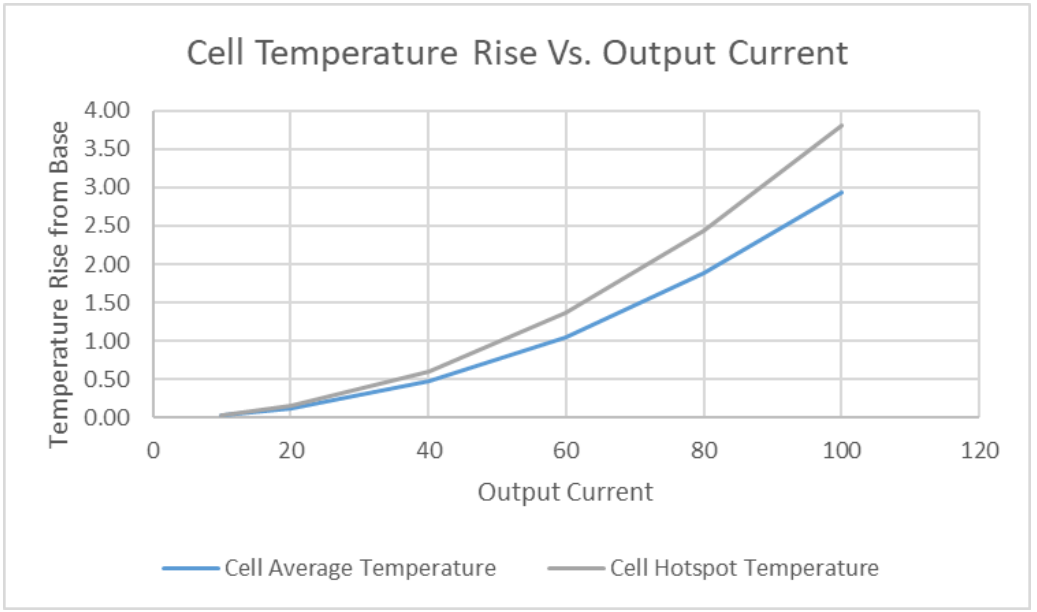
Thermal Performance

- The SatBat reduces battery temperature by:
  - Minimal heat generation
    - See chart below for Round Trip Efficiency (RTE) (45C, cell only)
  - Minimizing thermal path to the baseplate
    - Predicted hotspot and average cell temperature rise from baseplate





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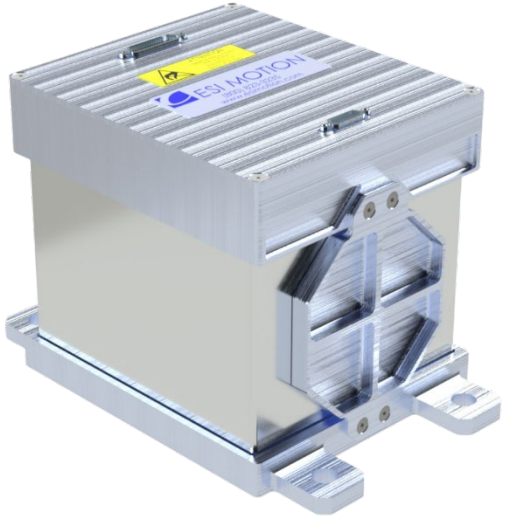
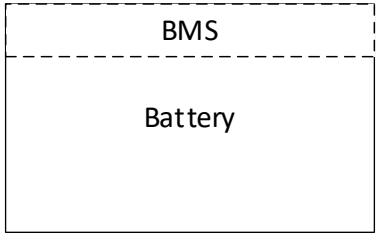
Manufacturability

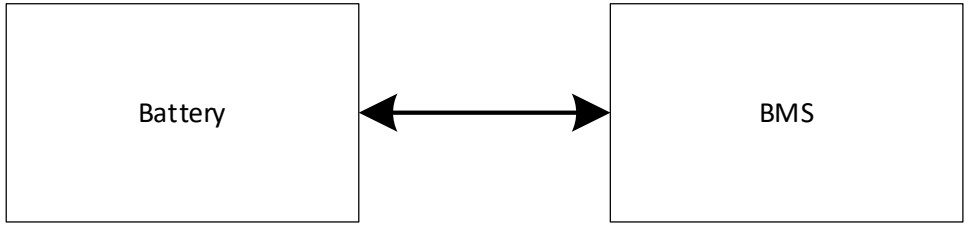
- Designed to scale to volume
- Minimized touch time
  - No Internal Wires
- Minimized System Interconnect
  - Integrated BMS and Telemetry



SatBat With Integrated BMS and Telemetry



Typical Battery Requires External BMS and Telementry



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Other Features

- **Internal Battery Management System**
  - Multiple Temperature Monitors
  - Cell Balancing
  - State of Charge / Health Reporting over CAN or RS-422
- **Radiation Tolerance**
  - TID: 100 kRad
  - Destructive LET Immunity: 75 MeV
- **Redundant Internal Heaters**
- **Operating Temperature**
  - -30C to 60C
- **Protections**
  - Launch Disconnect
  - Over Temperature
  - Over Voltage
  - Over Current
  - Under Temperature
  - Under Voltage

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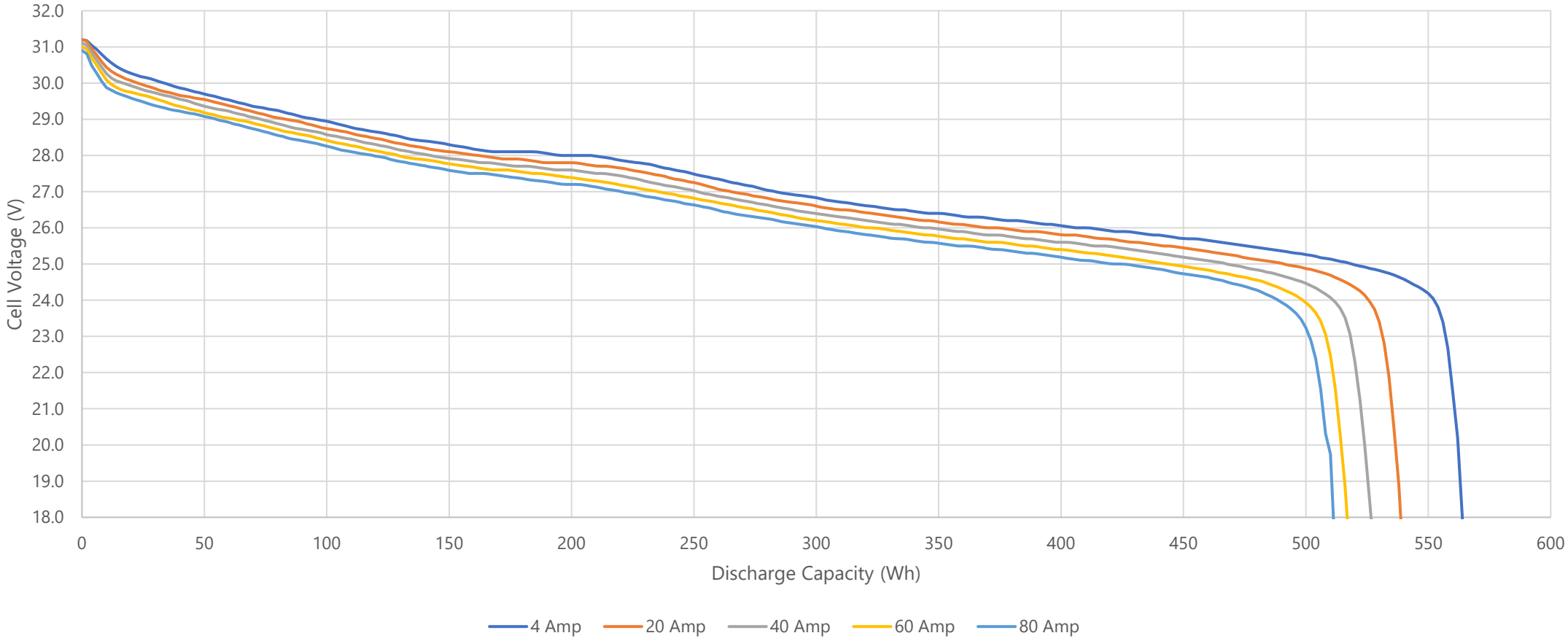
25C Discharge Curves - 500WH28V



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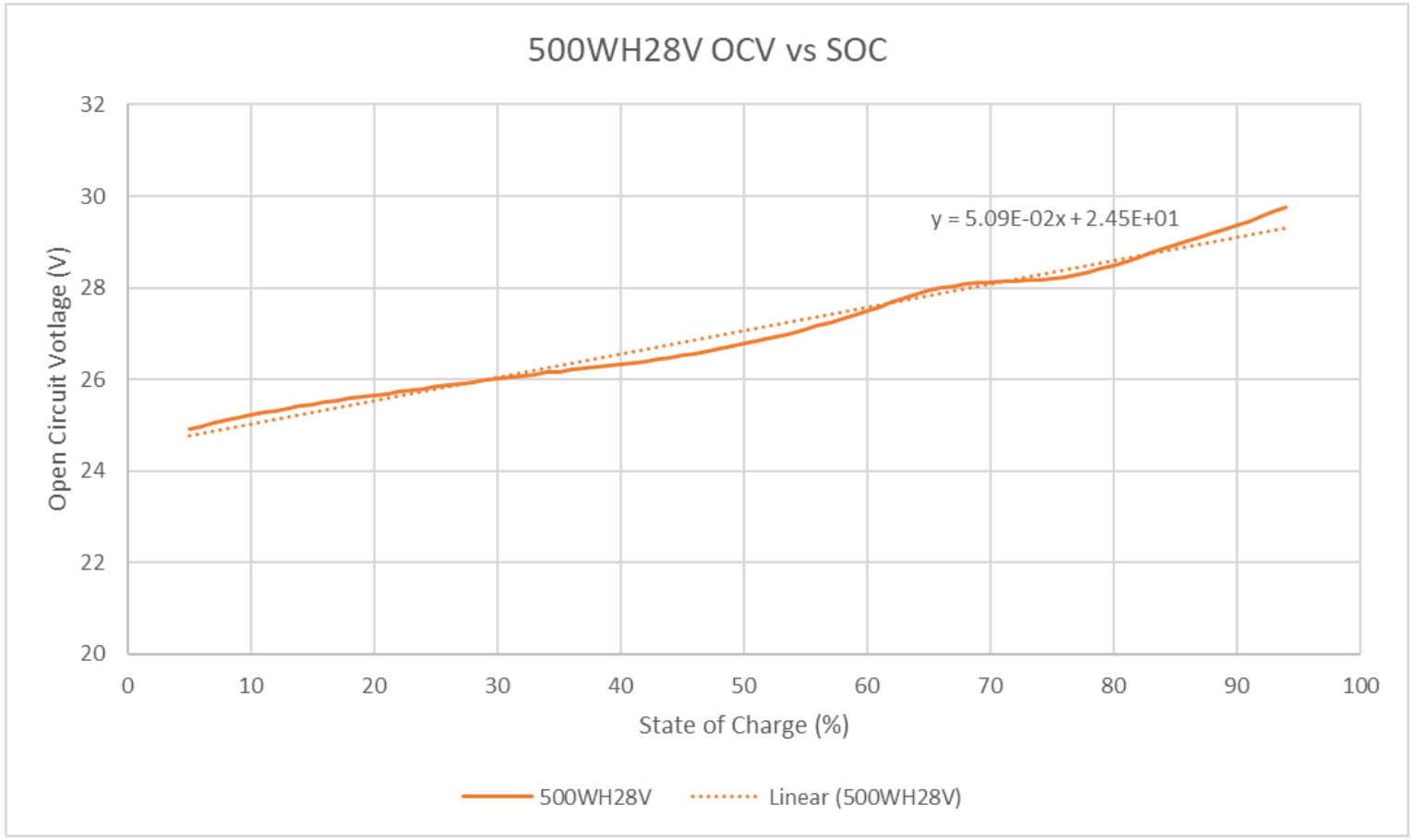
25C Discharge Curves - 500WH28V

Voltage vs SoC (5% to 90%)



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Qualification Status

Completed Qualification Items

Electrical Characteristics
1. Capacity verification (beginning-of-life and end-of-life)
2. Charge/discharge efficiency
3. Internal resistance measurement
4. Voltage stability under loadRate capability (various C-rates)
5. Self-discharge rate
6. Cycle life testing (simulate mission duration)
7. Overcharge / overdischarge tolerance
8. Thermal Design

Thermal Qualification
1. Thermal vacuum (TVAC) testing
2. High/low temperature operational testing
3. Thermal cycling (extreme temperature swings)
4. Heat dissipation validation

Manufacturing and Quality Assurance
1. Cell screening & matching
2. Lot acceptance testing (LAT)
3. Traceability of components
4. Cleanliness & contamination control
5. Workmanship inspections
6. Acceptance test procedures (ATP)

Safety & Abuse Cell Level
1. Overcharge test
2. Short-circuit test
3. Nail penetration / crush

Other Qualification
1. Radiation testing
2. Vacuum compatibility
    1. Operation
    2. Outgassing

Mechanical Environment
1. Vibration testing
2. Shock testing
3. Structural integrity verification

Battery Management System
1. Cell balancing validation
2. Fault detection (overvoltage, undervoltage, overcurrent)
3. State of Charge (SoC) accuracy
4. State of Health (SoH) estimation
5. Telemetry

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UN 38.3 Status

	Cell Level	Module Level
Altitude Simulation (T1): Low pressure (15,000 m).	x	x
Thermal Test (T2): Extreme temperature exposure.	x	
Vibration (T3): Simulates transport movement.	x	x
Shock (T4): Simulates potential impacts.	x	x
External Short Circuit (T5): Tests protection against shorting.	x	
Impact/Crush (T6): Simulates mechanical abuse.	x	
Overcharge (T7): Assesses safety during charging.	x	
Forced Discharge (T8): Tests ability to withstand deep discharge	x	x

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SatBat Availability

PARAMETER	208WH12V	250WH14V	416WH24V	500WH28V	1000WH28V	1000WH56V
Capacity (Whr)	208	250	416	500	1000	1000
Capacity (Ahr)	18	18	18	18	36	18
Useable Capacity [1] (%)	100%	100%	100%	100%	100%	100%
Useable Capacity at 90% DoD (Whr)	188	225	375	450	900	900
Nominal Voltage	11.5	13.8	23	27.6	27.6	55.2
High Operating Voltage	12.5	15	25	30	30	60
Low Operating Voltage	10	12	20	24	48	48
Max Voltage	13.5	16.2	27	32.4	32.4	64.8
Min Voltage	7.5	9	15	18	18	36
Max Cont. Discharge Rate (A)	100	100	100	100	200	100
Typical Charge Rate (A)	40	40	40	40	80	40
Heater Power @ 28VDC (W)	30	30	60	60	120	120
Max Operating Range [1] °C	-30°C to 60°C					

- EDU and Flight Units Available Now
- First Flight August 2026
- See table for standard configurations

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Summary

- SatBat is a Superior Solution for High Cycle LEO Applications
- **½ the Size, Twice the Life**
- Very High Cycle Life
- High Round-Trip Efficiency
- High Thermal Performance
- **Highly Manufacturable**
- **Internal BMS with Intelligent Monitoring and Reporting**
- Radiation Tolerant