Building Cost-Effective Battery Management Technology To Support Future Robotics and Applications

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Cost Effective: How to do?

**Diagnose:**
What's wrong with you?

**Prescription:**
A solution for Osteoarthritis

**Herbal Cabinet:**
Crude drug

**Cook drugs**
Boil 4 bowls into 1 bowls

Application/Market
- Quacopter
- Cleaning Machine
- Robot
- Rocket
- AGV
- Machine Arm
Herbal Cabinet – Cells

Cathode Material:
- LiNi_{0.8}Co_{0.2}O_{2};
- LiMn_{2}O_{4};
- LiNi_{0.3}Co_{0.3}Mn_{0.3}O_{2};
- LiFePO_{4}

Key Material
- Separator
- Electrolyte

Manufacturing:
- Winding;
- Lamination;

Form:
- Cylindrical;
- Polymer;
- Rectangular

Cell Modeling:
- Charging/Discharging
- Different C-Rate
- Temperature
- Cycle
- Internal Resistance
Applications: Quadcopter

Product Key Requirement:
- Weight: < 1.5kg
- Flight Time: > 25 mins
- Current Discharging: ~ 25A
- Voltage: 10.8V
- Cycle Life: > 110 cycle
- Capacity Error: < 2%

Battery Cell:
- 3.6V/2600mAh LiCoO₂ (190mAh/g), Polymer Cell, Lamination Type
  - Less Weight: < 1.2kg
  - Discharging: > 5C (5 x 2.6A = 13A)
  - Low Internal Resistance: Less than 4mOhm
  - Cycle Life: 150 cycle (DOD 80%)

BMS:
- Passive Cell Balance: Extend the Cycle Life 20-30%
- Cell I/C/Temp/C-Rate Modeling: Capacity Error <2%
- Pack Configuration: 3S2P; 5200mAh, 10.8V, 26A
- SMBus Host: SOC/SOH
Applications: Cleaning Robot

**Product Key Requirement:**
- Working Time: >4 hours
- Current Discharging: > 1 A
- Voltage: 14.4V
- Cycle Life: 600 cycle
- Capacity Error: < 5%

**Battery Cell:**
- 3.6V/2200mAh \(\text{LiNi}_{0.3}\text{Co}_{0.3}\text{Mn}_{0.3}\text{O}_2\) (120mAh/g), 18650 Cell, Rolling Type
  - High Power Discharging: 0.5C (0.5 x 2.2A = 1.1A)
  - Cycle Life: 500 cycle (DOD 80%)

**BMS:**
- Passive Cell Balance: Extend the Cycle Life 20-30%
- Pack Configuration: 4S2P; 4400mAh, 14.4V, 2A
- SMBus: SOC/SOH
Application: Machine Arm

Product Key Requirement:
- Working Time: 2 hours
- Current Discharging: > 200 A
- Voltage: 96 V
- Cycle Life: 600 cycle
- Capacity Error: < 5%

Battery Cell:
- 3.2V/15Ah LiFePO4 (100mAh/g), 401318 Cell, Rolling Type
  - High Power Discharging 10C (10 x 15A = 150A)
  - Cycle Life: 800 cycle (DOD 80%)

BMS:
- Active Cell Balance: Extend the Cycle Life 15-20%
- Single Pack Configuration: 16S2P; 30Ah, 48V
- Two Pack in Series: 96V, 30Ah, 300A
- Wifi/3G Host: SOC/SOH
Application: Exoskeleton

**Product Key Requirement:**
- Working Time: >2 hours
- Voltage/Current Discharging: 48V; > 5 A
- Cycle Life: 300 cycle
- Capacity Error: < 2%
- Twin Battery Pack (Parallel Cascaded)

**Battery Cell:**
- 3.6V/2200mAh LiNi_{0.3}Co_{0.3}Mn_{0.3}O_{2} (120mAh/g), 18650 Cell,
- High Power Discharging 5C (5 x 2.2A = 11A)
- Cycle Life: 400 cycle (DOD 80%)

**BMS:**
- Passive Cell Balance: Extend the Cycle Life 20-30%
- Pack Configuration: 14S2P; 4400mAH, 48V, 20A
- RS485: SOC/SOH
- Twin Battery Design: Extra Power and Redundancy
Application: Robot

Product Key Requirement:
- Working Time: >8 hours
- Current Discharging: > 0.2 A
- Voltage: 36 V
- Cycle Life: 400 cycle
- Capacity Error: < 2%

Battery Cell:
- 3.6V/2200mAh LiNi$_{0.3}$Co$_{0.3}$Mn$_{0.3}$O$_2$ (120mAh/g), 18650 Cell, Rolling Type
  - High Power Discharging 0.2C (0.2 x 2.2A = 0.44A)
  - Cycle Life: 500 cycle (DOD 80%)

BMS:
- Passive Cell Balance: Extend the Cycle Life 20-30%
- Pack Configuration: 10S1P; 2200mAh, 36V, 0.44A
- RS232: SOC/SOH
**Application: AGV Automated Guided Vehicle**

**Product Key Requirement:**
- Working Time: 2 hours
- Voltage/Current Discharging: 48V; > 200 A
- Cycle Life: 600 cycle
- Capacity Error: < 5%

**Battery Cell:**
- 3.2V/15Ah LiFePO₄ (100mAh/g), 401318 Cell,
- High Power Discharging 10C (10 x 15A = 150A)
- Cycle Life: 800 cycle (DOD 80%)

**BMS:**
- Active Cell Balance: Extend the Cycle Life 15-20%
- Configuration: 16S10P; 150Ah, 48V
- Wifi/3G Host: SOC/SOH

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Pack Outlook  
Pack Inside  
BMS Core Module
Thank You!

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