Cell-Balancing & State of Charge Algorithms

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Introduction & Scope

LFEV 2105 Project: Tractive System Voltage

→ **Battery Packs**

- high voltage system
- needs to be monitored and maintained
    - AMS, VSCADA

Cell-balancing Methods

State of Charge Algorithm

Importance of Cell-balancing

Safety

- $LiFePO_4$ cells
  - Voltage maximum: 3.65 V
- overcharging can be dangerous

Maintainability

- Voltage Minimum: 2.5 V
- depleting a cell can degrade its life cycle

Active Methods

→ removing excess energy from highly charged cell and distributing it to the other cells

Ex. Charge Shuttling

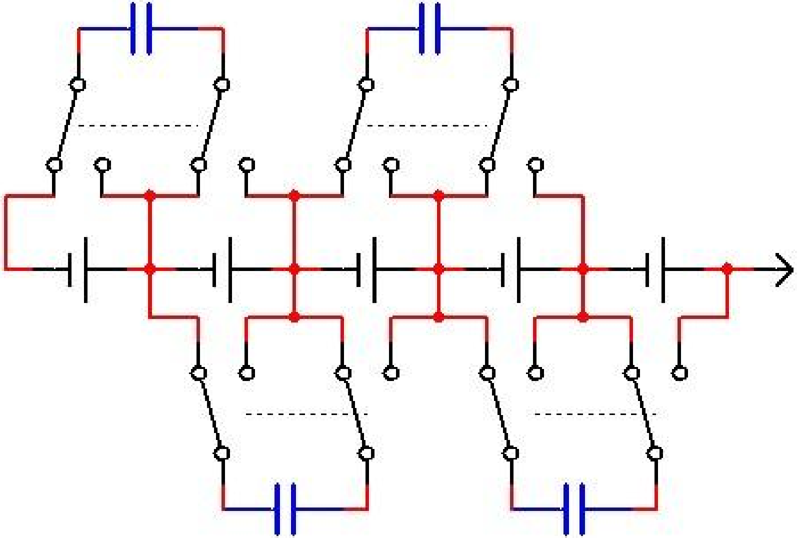
Advantages

- simple control

Disadvantages

- slow equalization rate

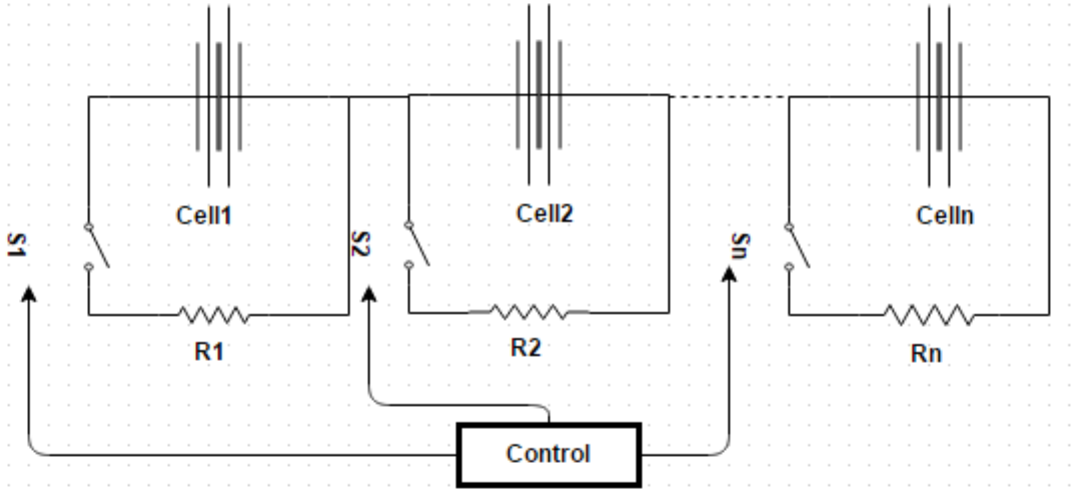
ecomodder.com



Passive Methods

→ bypasses highly charged cell to allow the other cells in the system to “catch up”

Ex. Resistive Shunt



Importance of State of Charge

→ level of available capacity of a battery

→ indicated to user as range from 0 - 100%

Algorithms

1. Open Loop Coulomb Counting
2. Closed Loop Coulomb Counting

Open Loop Coulomb Counting

$$SOC_c(t) = SOC_c(0) - (1/Q) \int_0^t I(t)\, dt$$

LFEV 2014's Algorithm

→ $y = Gx + B$

→ $G = a*x*(SOC_1 - SOC_2)$

→ $B = a*(SOC_1 - SOC_2)$

Closed Loop Coulomb Counting

→ **includes feedback from system**

Kalman Filter

$$X_t = K_t Z_t + (1 - K_t)X_{t-1}$$

- **predicts the state of a signal**

→ **$y = K*SOC_2 + (1 - K)*SOC_1$**

Conclusions

Improvements:

- active methods
- Kalman Filter application

  → unable to simulate

Questions?