

# MPS Battery Management

BMS System Webinar

Key Considerations when Designing Battery Management

June 2023

Webinar will begin at 10:00 AM CEST | 1:00 AM PDT | 4:00 AM EDT



# Presenters Introduction



**Albert Rodriguez**

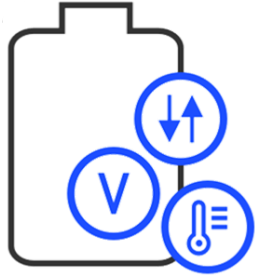
- Senior Battery Applications Engineer at MPS since 2019
- MS and PhD in battery controls at UCSS
- Deeply involved in:
  - Battery modeling, simulation, and identification
  - Fuel gauge algorithm development



**Miguel Angel Sanchez**

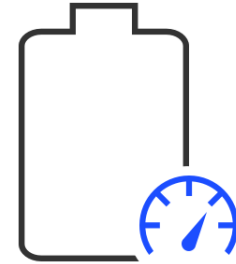
- MPS Battery Applications Engineer since 2020
- Deeply involved in:
  - Creating reference designs and complete BMS solutions
  - New BMS products definition and architectures
- Technical Point of Contact in Europe and US for BMS Products

# BMS Design Key Considerations



**BATTERY  
PROTECTION**

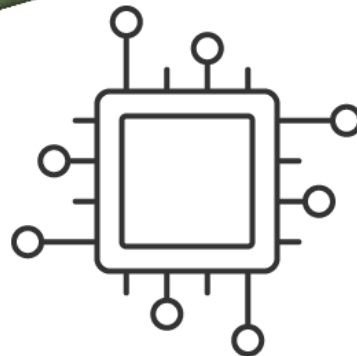
**BALANCING**



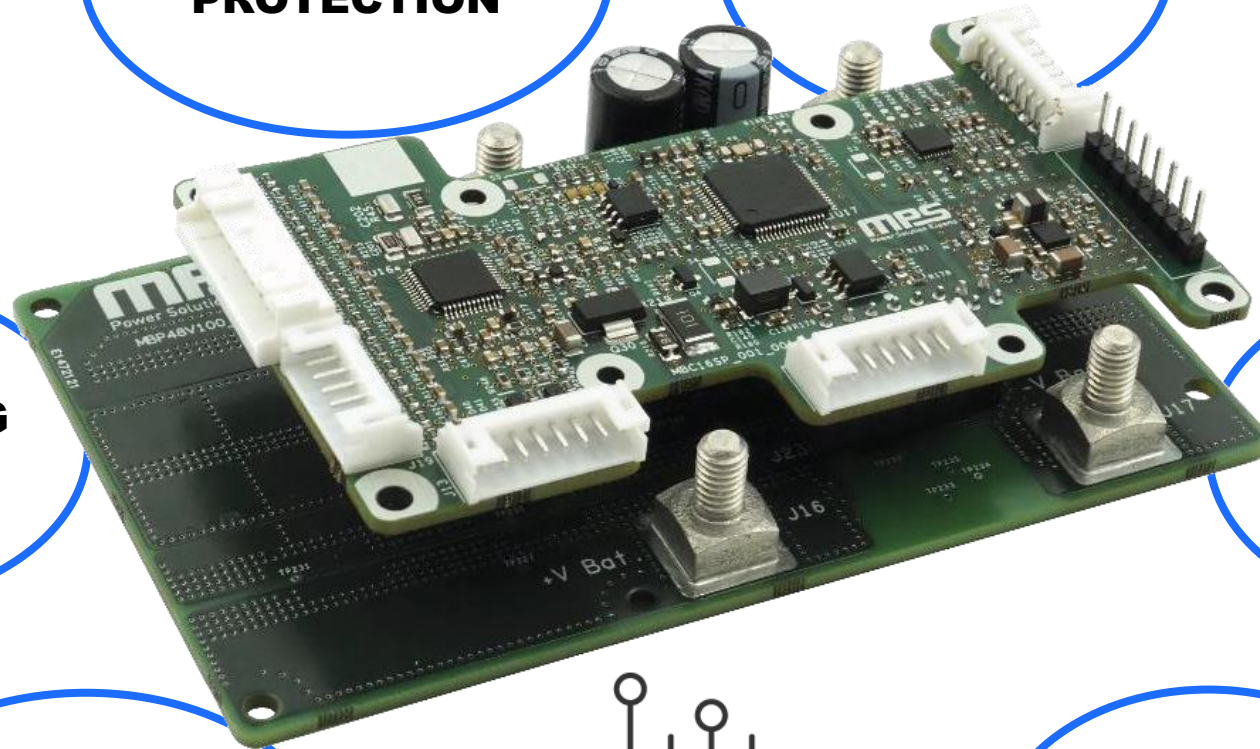
**SOC/SOH  
ESTIMATION  
AND MORE...**

**BATTERY  
MONITORING  
AND FAULT  
DIAGNOSIS**


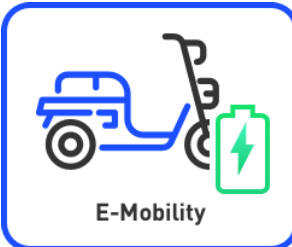



**APP-SPECIFIC  
TASKS**



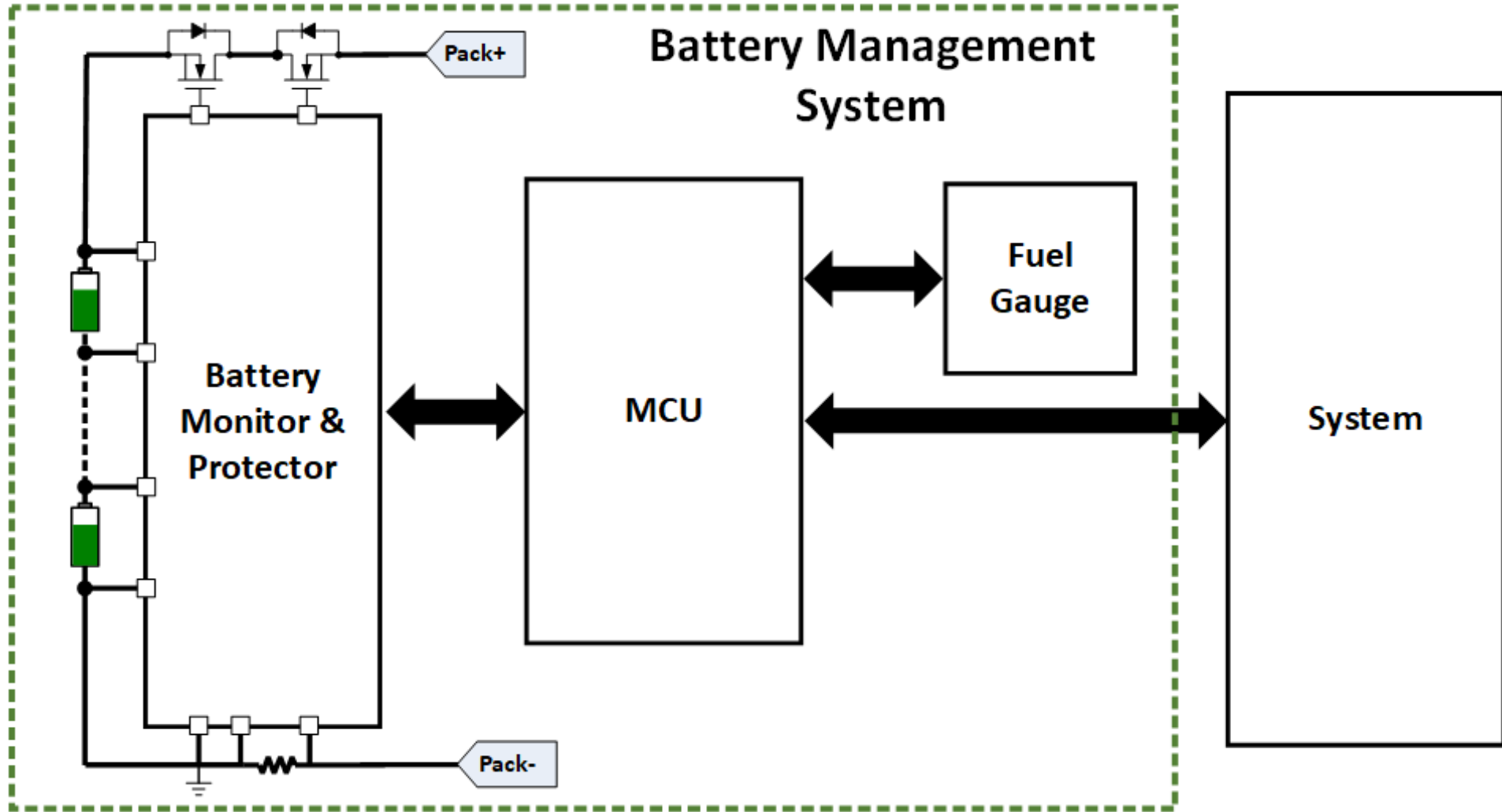
**SYSTEM  
INTERFACE**



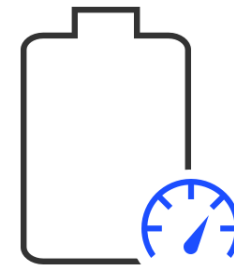
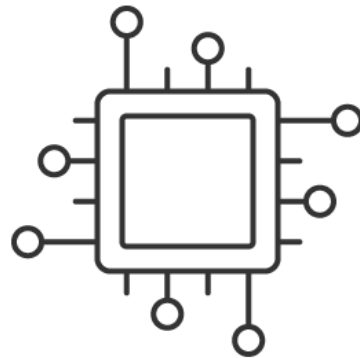
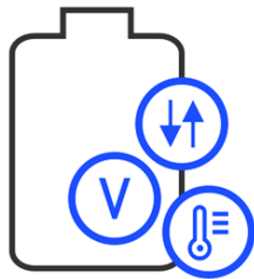
# BMS Target Applications

 <p>Power &amp; Gardening Tools</p> <p>Power Tools Vacuums Gardening Tools Scrubbers Sweepers</p>	 <p>E-Mobility</p> <p>E-Bikes Pedelecs Mopeds Scooters Golf Carts</p>	 <p>Battery Backup</p> <p>Datacenters Medical Security Lighting A/V Equipment</p>	 <p>Supply Chain Automation</p> <p>Forklifts Pallet Jacks AGVs Robotics Drones</p>	 <p>Energy Storage</p> <p>Portable Residential Commercial Utility</p>
<p><b>5 to 24 Cells</b> <b>Power Cells</b> <b>High Charging rate</b></p>	<p><b>10 to 24 Cells</b> <b>Regeneration</b> <b>Connected</b></p>	<p><b>14 to 22 Cells</b> <b>Battery Parallelization</b> <b>Long No-Use Time</b></p>	<p><b>16 to 24 Cells</b> <b>High Charging Rate</b> <b>20-80% SOC</b> <b>Working Area</b></p>	<p><b>48V Up to 1000V</b> <b>Scalability</b> <b>Special Architectures</b></p>

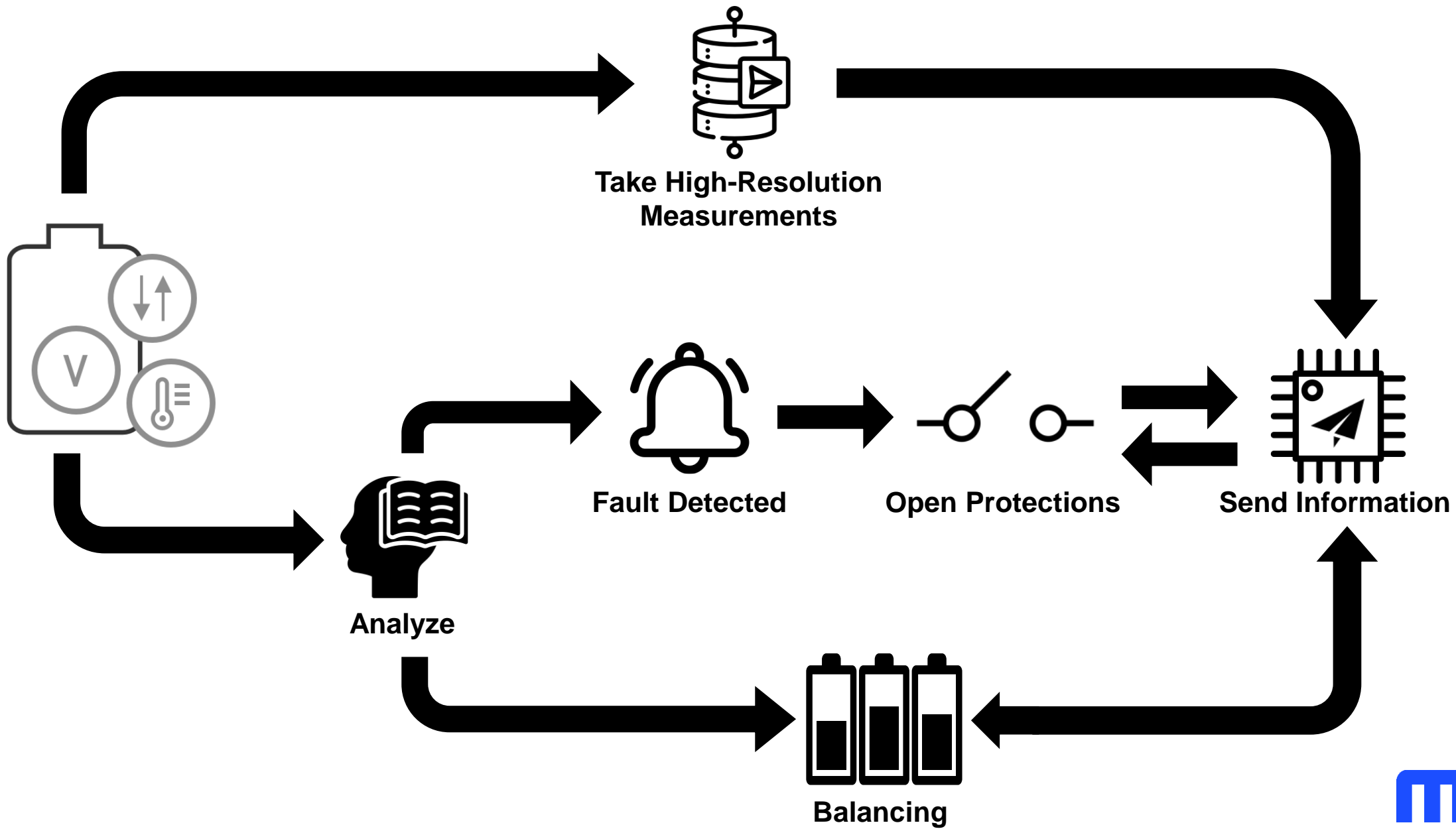
# BMS Architecture Example



# Key BMS Components

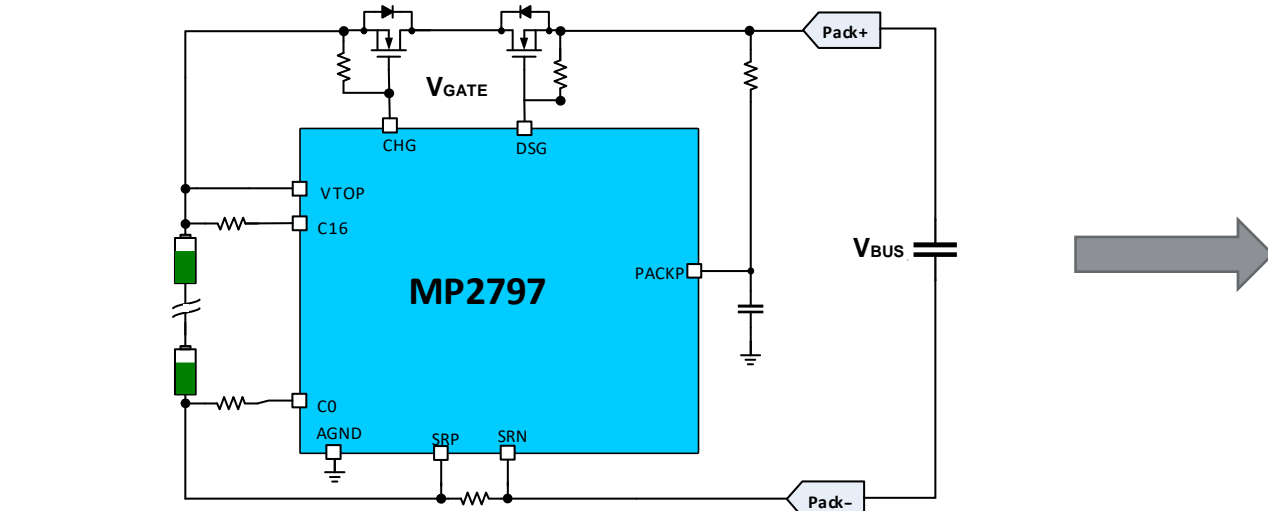


# Battery Monitor & Protector

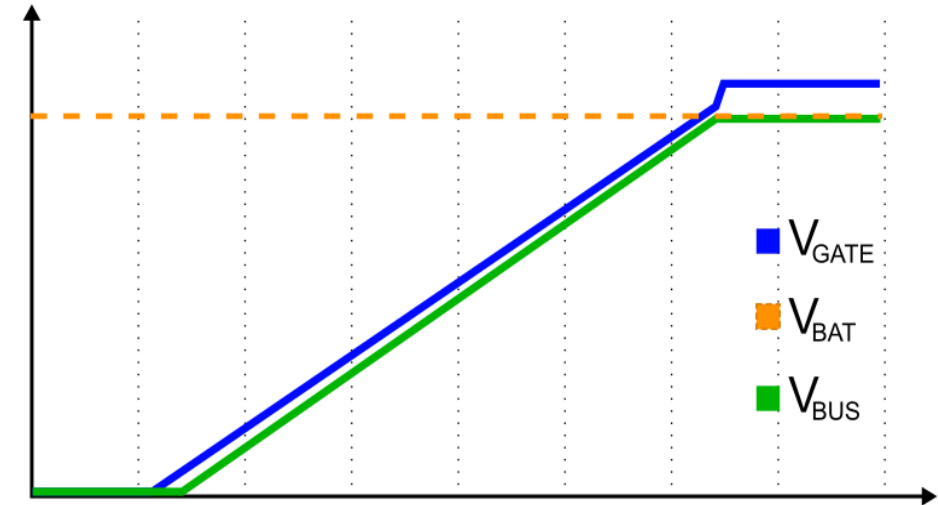


# Battery Monitor & Protector Key Features

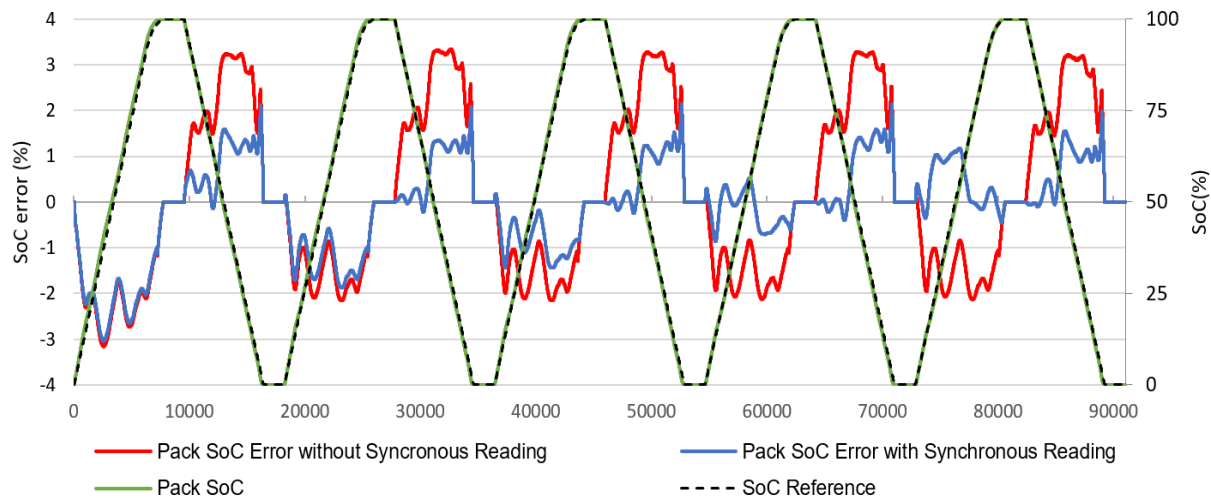
## Integrated High-Side MOSFET Driver



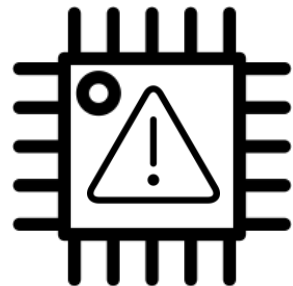
## Soft Start Capability



## Synchronous Readings

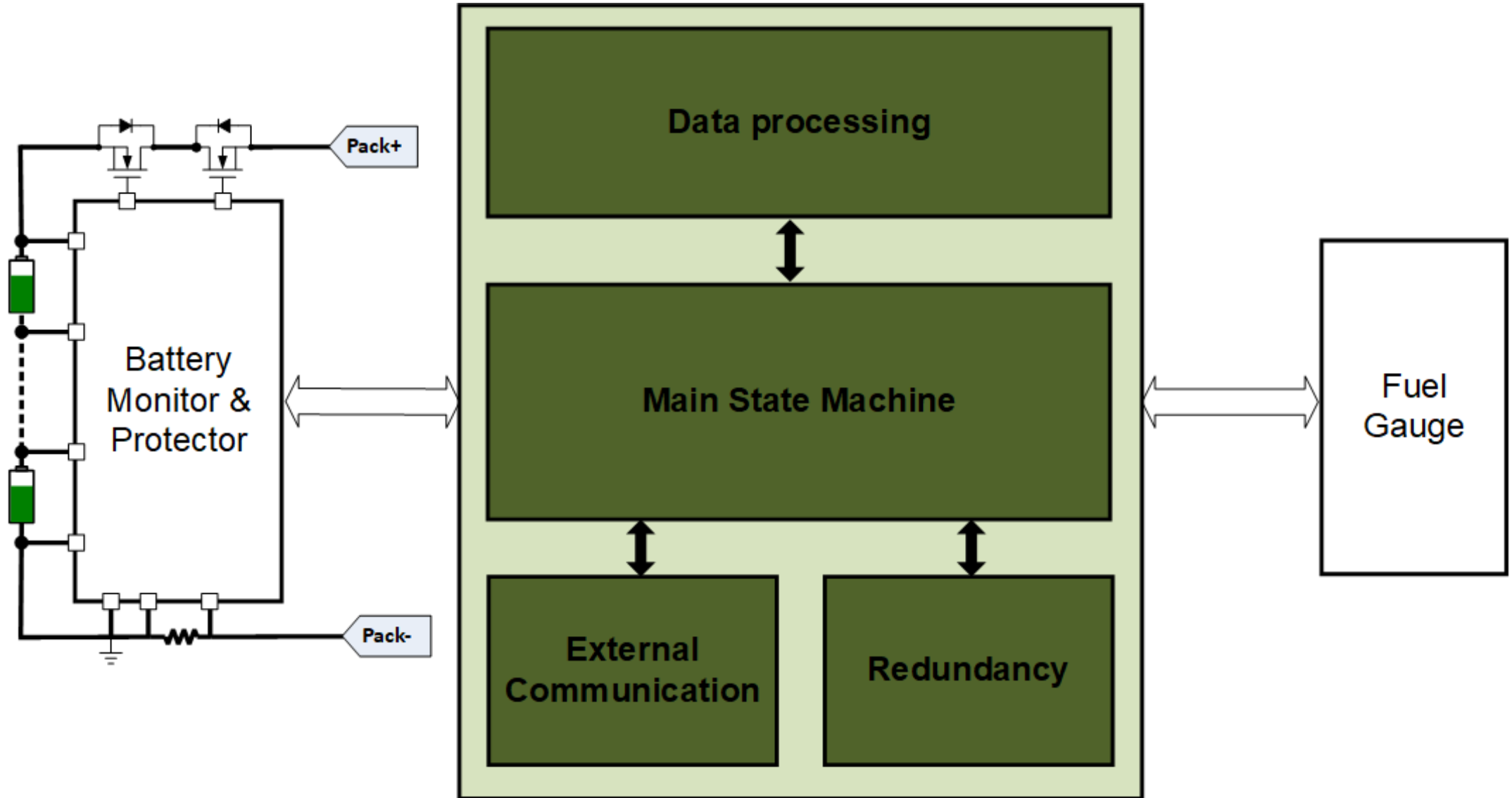


## True Hardware Protection

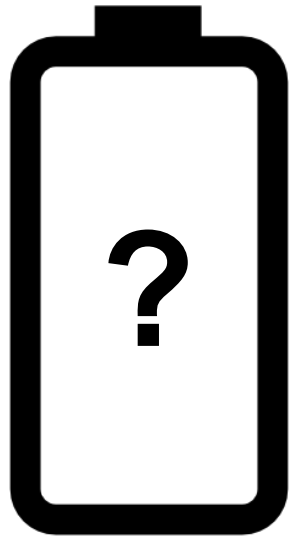




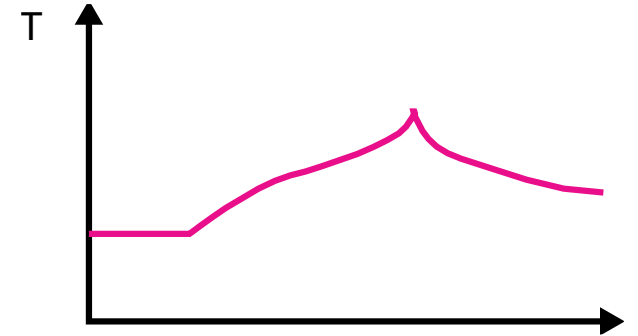
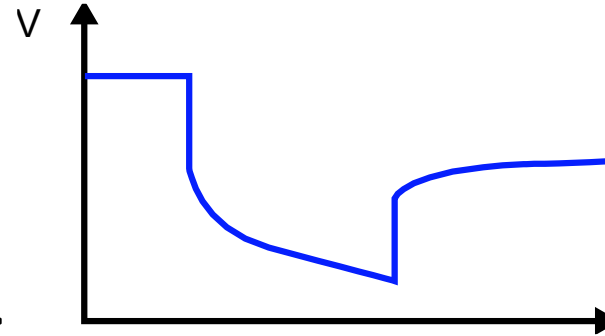
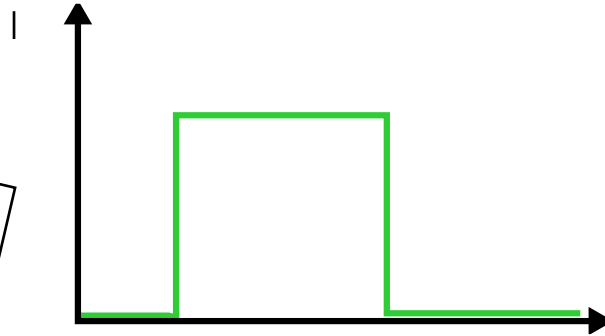
# BMS Microcontroller



# Considerations for Fuel Gauging



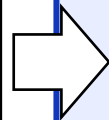
MEASURE




MODEL

**MPS**  
CELL CHARACTERIZATION  
AND MODEL EXTRACTION

Three icons are shown below the text: a book, a clock, and a multimeter.



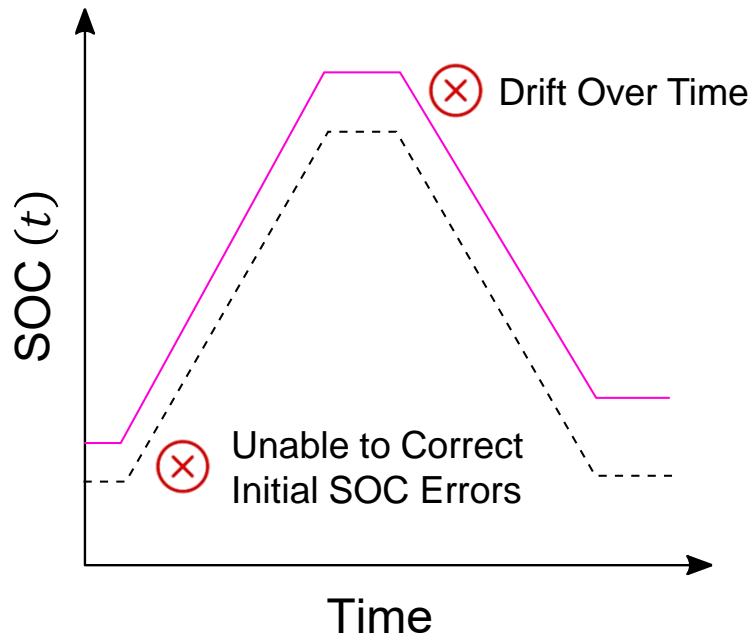
 **MPS Cell Model**

Two graphs are shown within a light blue rounded rectangle. The left graph plots Open Circuit Voltage (OCV) on the vertical axis against State of Charge (SOC) on the horizontal axis, showing two curves that rise with SOC. The right graph plots the imaginary part of impedance ( $\text{Im}\{Z\}$ ) on the vertical axis against the real part of impedance ( $\text{Re}\{Z\}$ ) on the horizontal axis, showing a red curve with multiple peaks and troughs.

# Fuel Gauge Methods

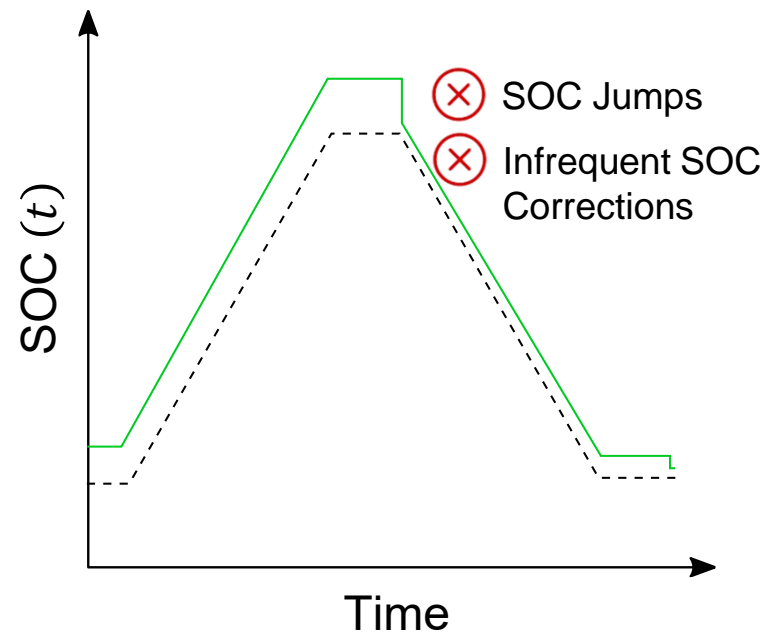
## Coulomb Counting (CC) Method

- Inputs: current
- Assumption: total capacity of battery never changes under any condition



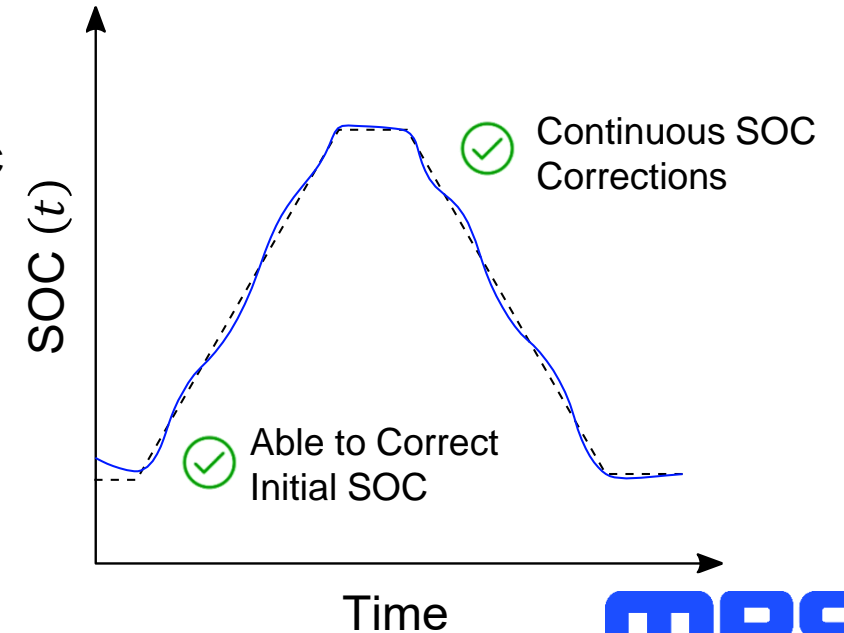
## CC + OCV Method

- Inputs: current, voltage, OCV characterization
- Assumption: Total capacity changes can be corrected by measuring OCV and comparing to lookup table



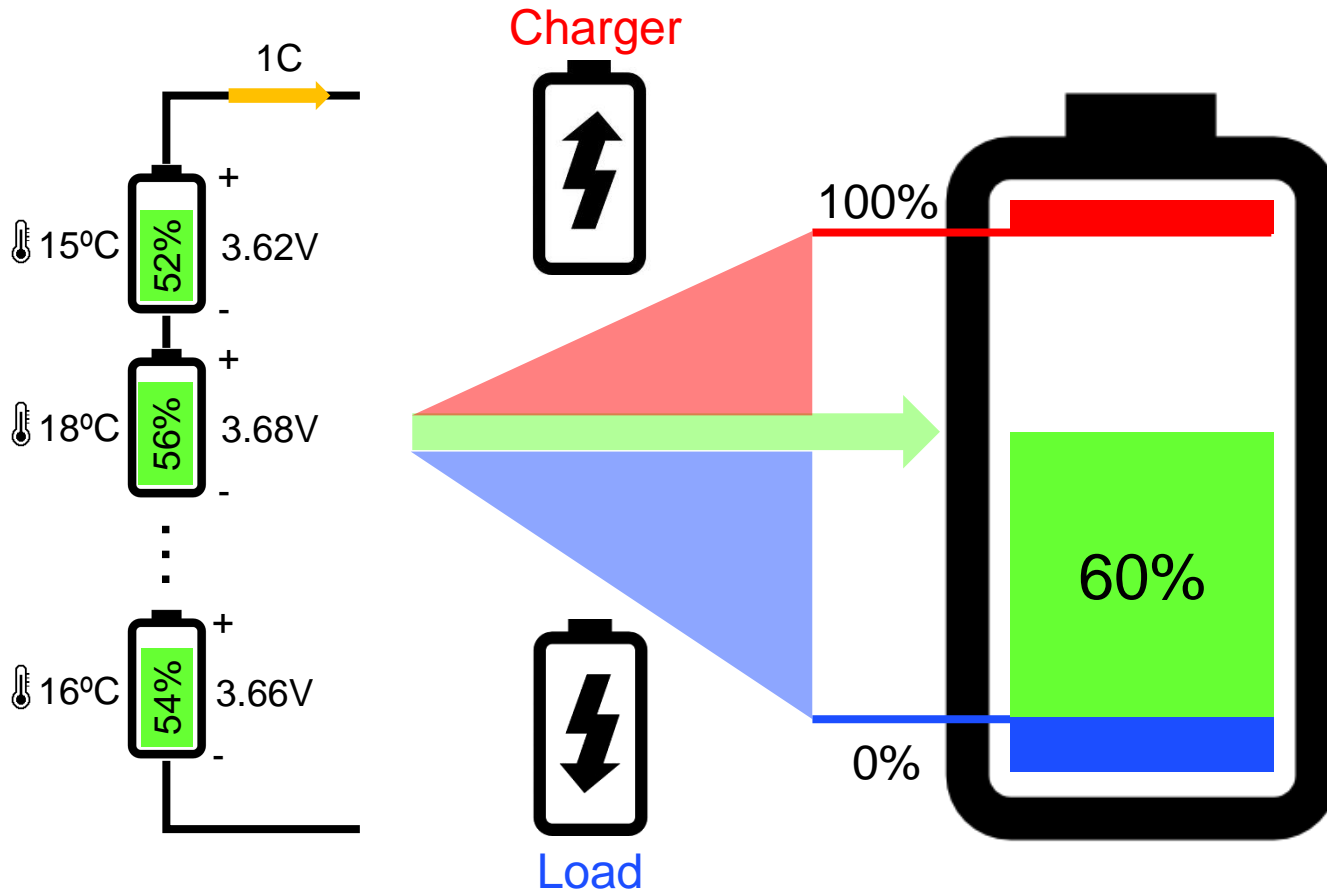
## MPS Hybrid Method

- Inputs: synchronous current + voltage, temperature, cell model
- Assumption: Accurate state of charge is dependent on many factors that require complete cell model



# Fuel Gauge MPS Hybrid Method

*Cell-Level Quantities* + *Application Usage* = *Pack-Level Quantities*



Pack State-of-Charge (SOC)



Unavailable State-of-Charge



Runtime & Charge Time



Power Limits

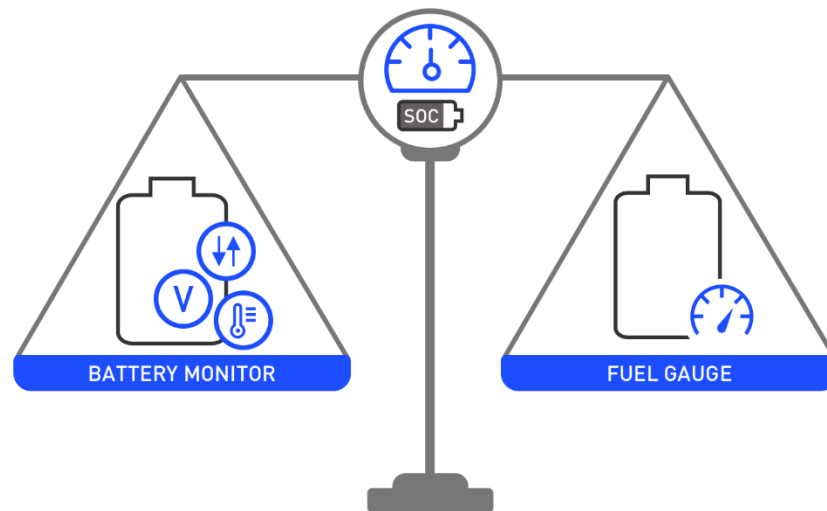


State-of-Health (SOH)



Impedance

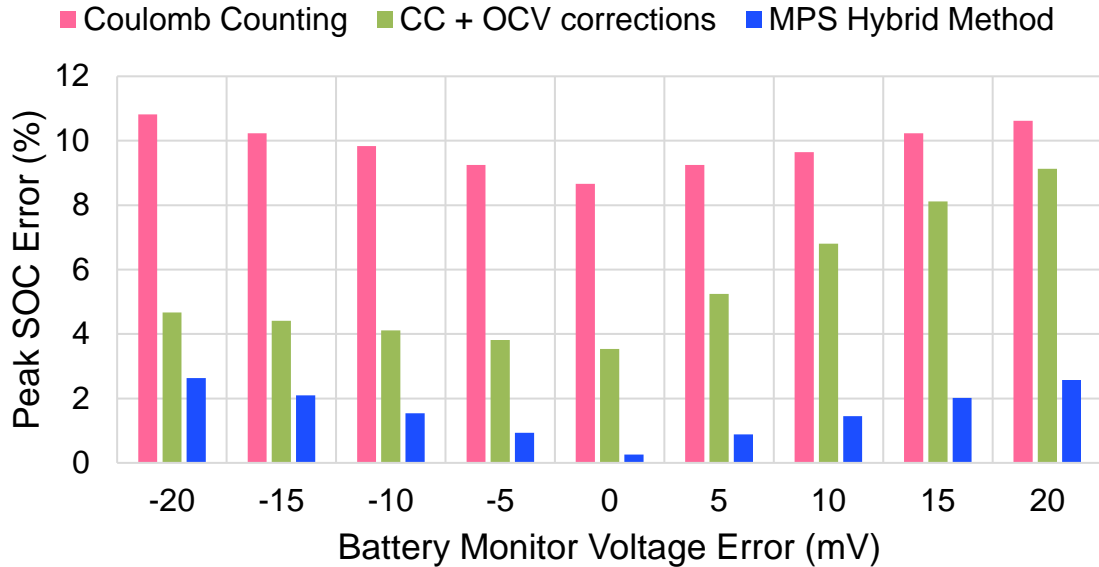
# Component Considerations



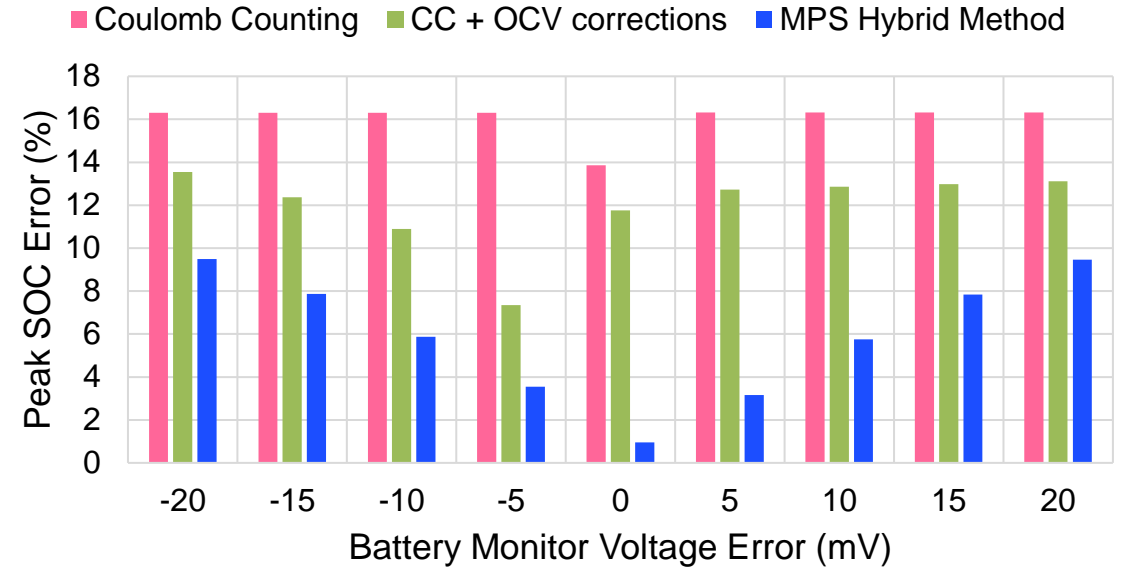
# BM & Fuel Gauge Influence on SOC Accuracy

- Conditions:**
- New Battery
  - 50% Initial SOC
  - 25°C
  - 15min Relaxations
  - 10 Cycles
  - 20mA Current Offset

## NMC Chemistry Example



## LFP Chemistry Example



**The fuel gauge method is really the key to achieve good results.**

### Coulomb Counting Method

- ❌ Poor initial SOC due to voltage inaccuracy
- ❌ SOC drift over time due to current inaccuracy

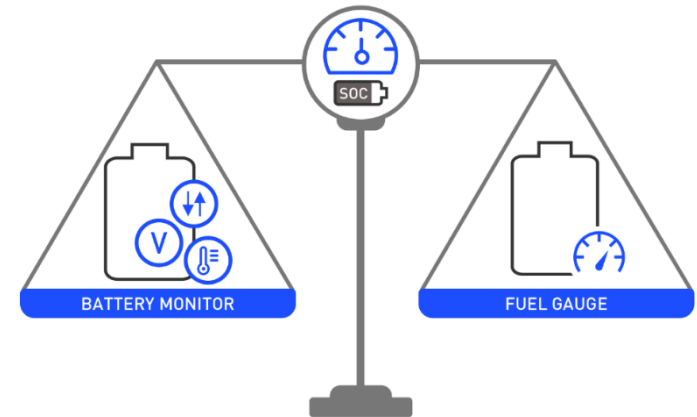
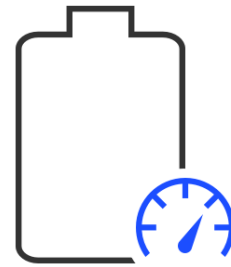
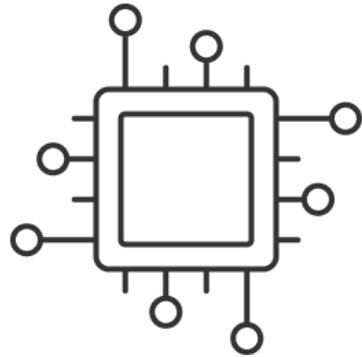
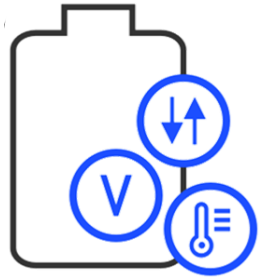
### CC + OCV Method

- ⊖ Inaccurate SOC corrections due to voltage inaccuracy (and voltage relaxation)
- ⊖ SOC drift in between OCV corrections due to current inaccuracy

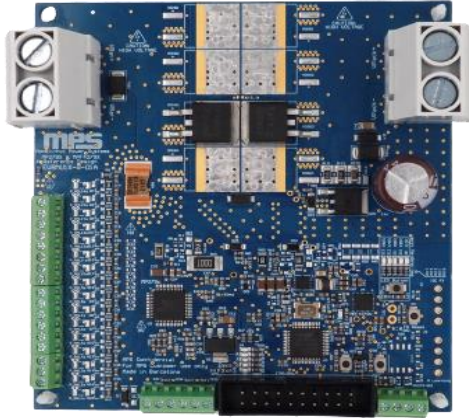
### MPS Hybrid Method

- ✅ Optimally corrects SOC (deals with voltage and current inaccuracies)
- ✅ Provides more battery insights!

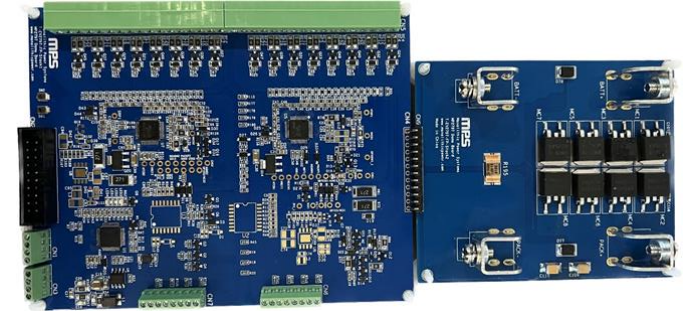
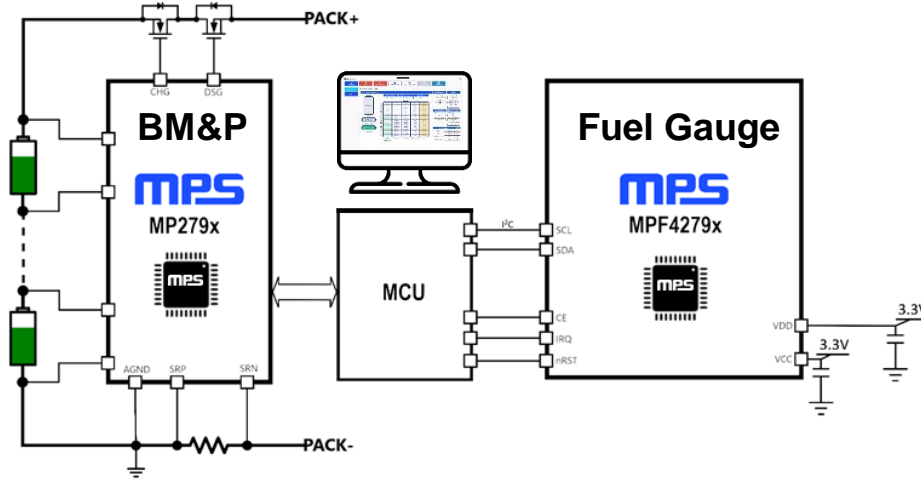
# Summary



# MPS Offers BMS Complete Solution



**Standard BMS board**  
50A Continuous Current



**Stacked MP279x**  
70A Continuous Current for 17-cell to 32-cell applications

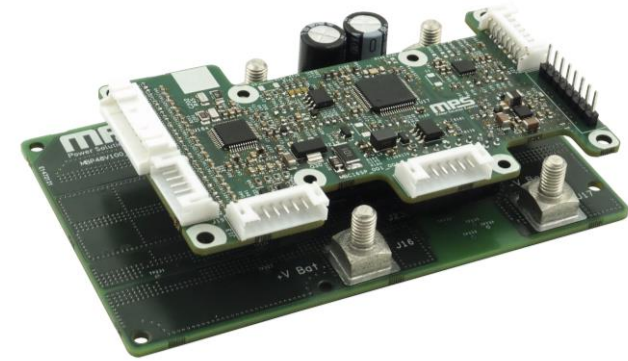


Requirements

Cell & Component  
Selection

BMS Design &  
Configuration

Validation



**Complete Solution**  
100A Continuous, 180A Peak Current





## Q&A

