

小型8-cell電池管理系統的設計分享



A Leading Provider of Smart, Connected and Secure Embedded Control Solutions



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Microchip Proprietary and Confidential

S&SC Function Team

May 8, 2023

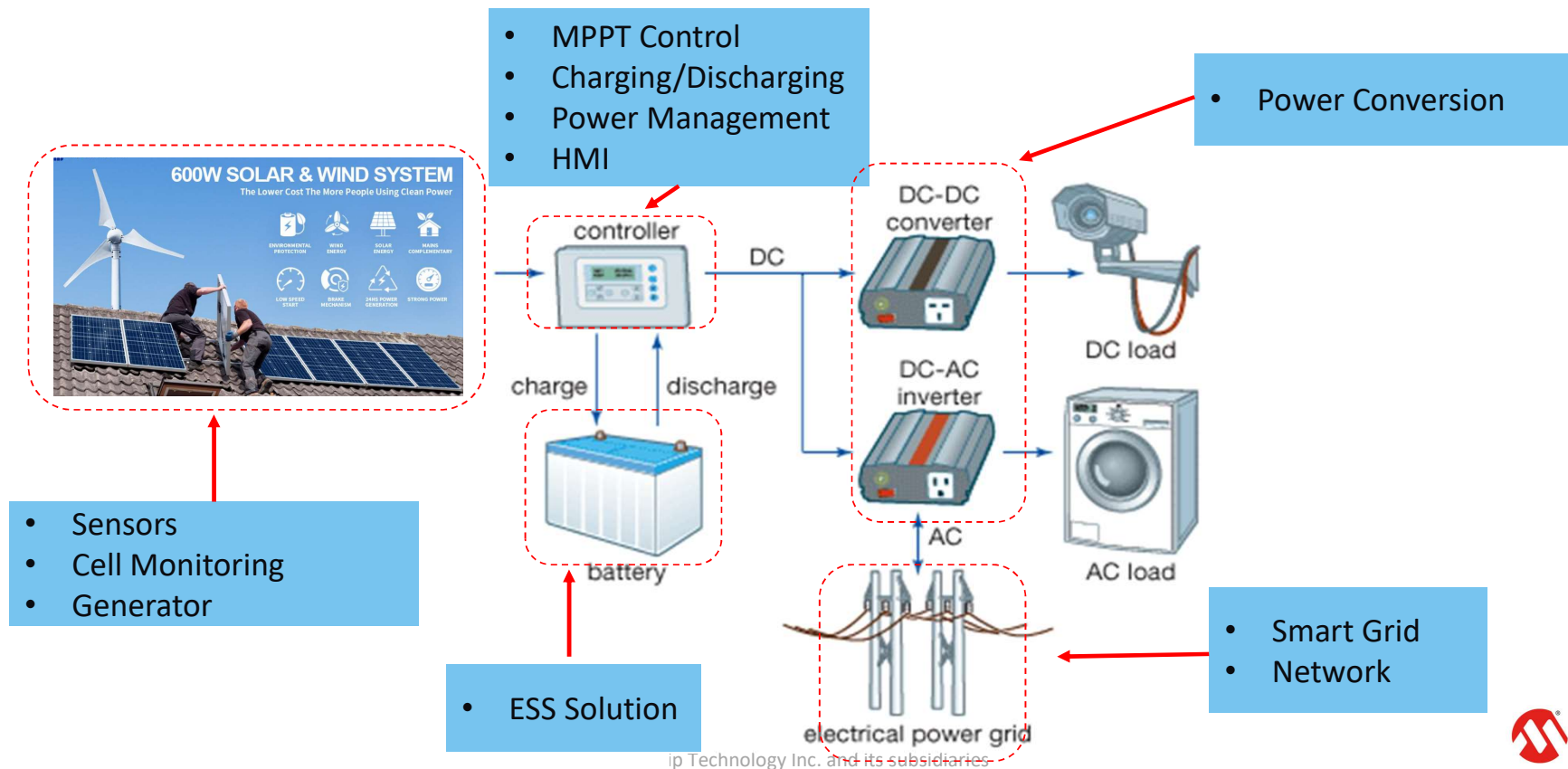
Agenda

- **BMS application**
- **Microchip BMS EVB Block diagram**
- **Q&A**

Energy Generation, Storage and Distribution

Solar & Wind Turbines Power Systems

- Technology that uses electricity generated from wind and solar power and delivers the remaining electricity to a battery or power grid.
- Technology : Power Conversion / Power Monitoring / Sensors / Charging&Discharging / Wireless & Wired / HMI

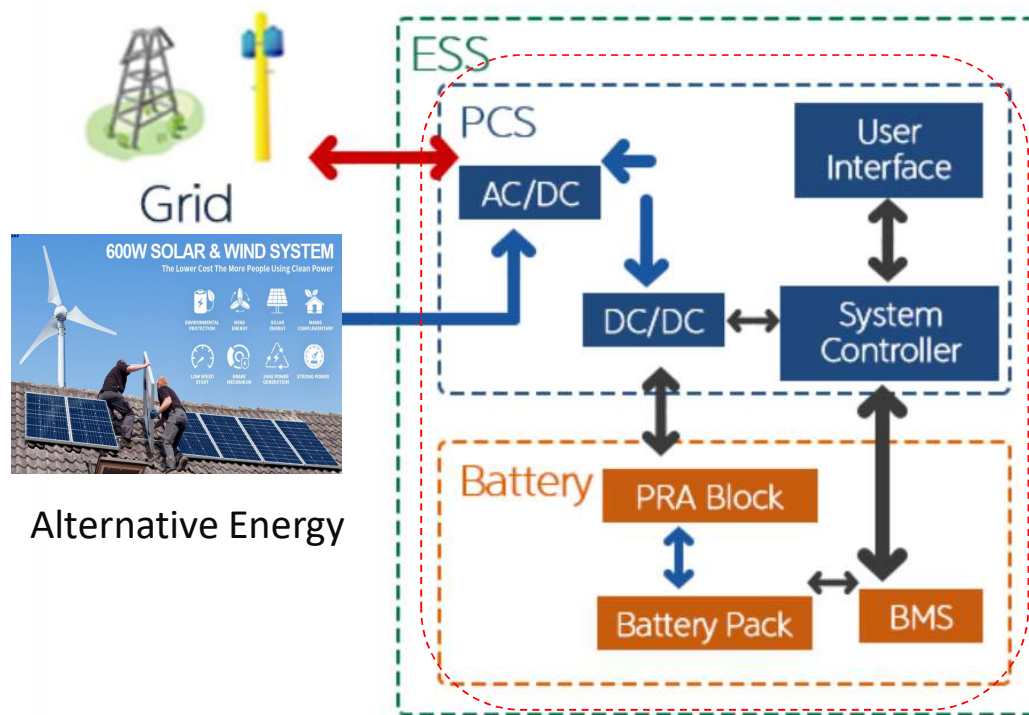


ip Technology Inc. and its subsidiaries

Energy Generation, Storage and Distribution

Energy Storage Systems

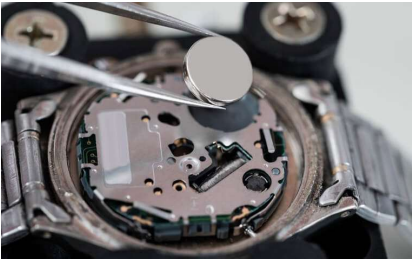
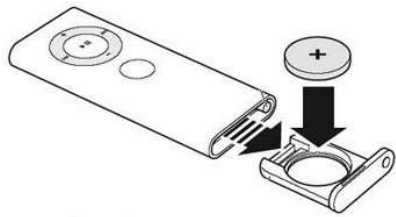
- Storage device that can store new and renewable energy such as solar and wind power, which is difficult to produce at a desired time, in advance and use it at the required time
- Technology : Sensors / Power Conversion / Power Monitoring / Charging&Discharging / Wireless & Wired / HMI



- Sensor
- Power Conversion
- Charging&Discharging
- Monitoring
- Network
- HMI

Many applications use batteries

Button cell
(1~3 cell in series)



Dry cell
(1~6 cell in series)



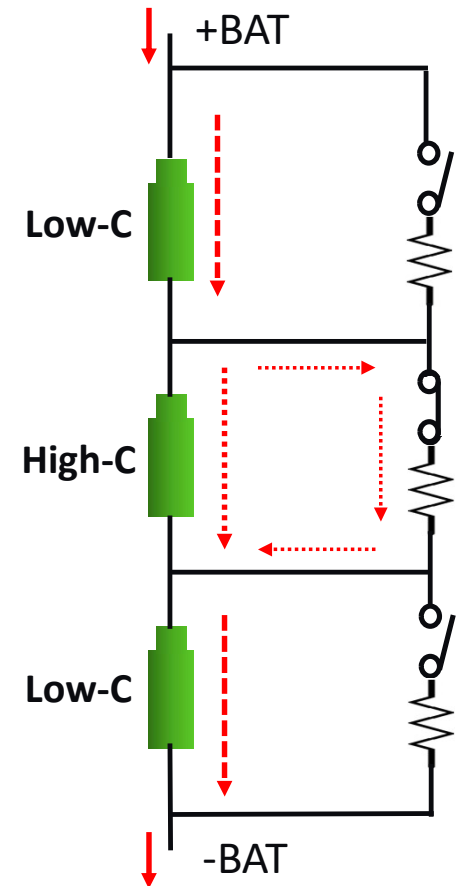
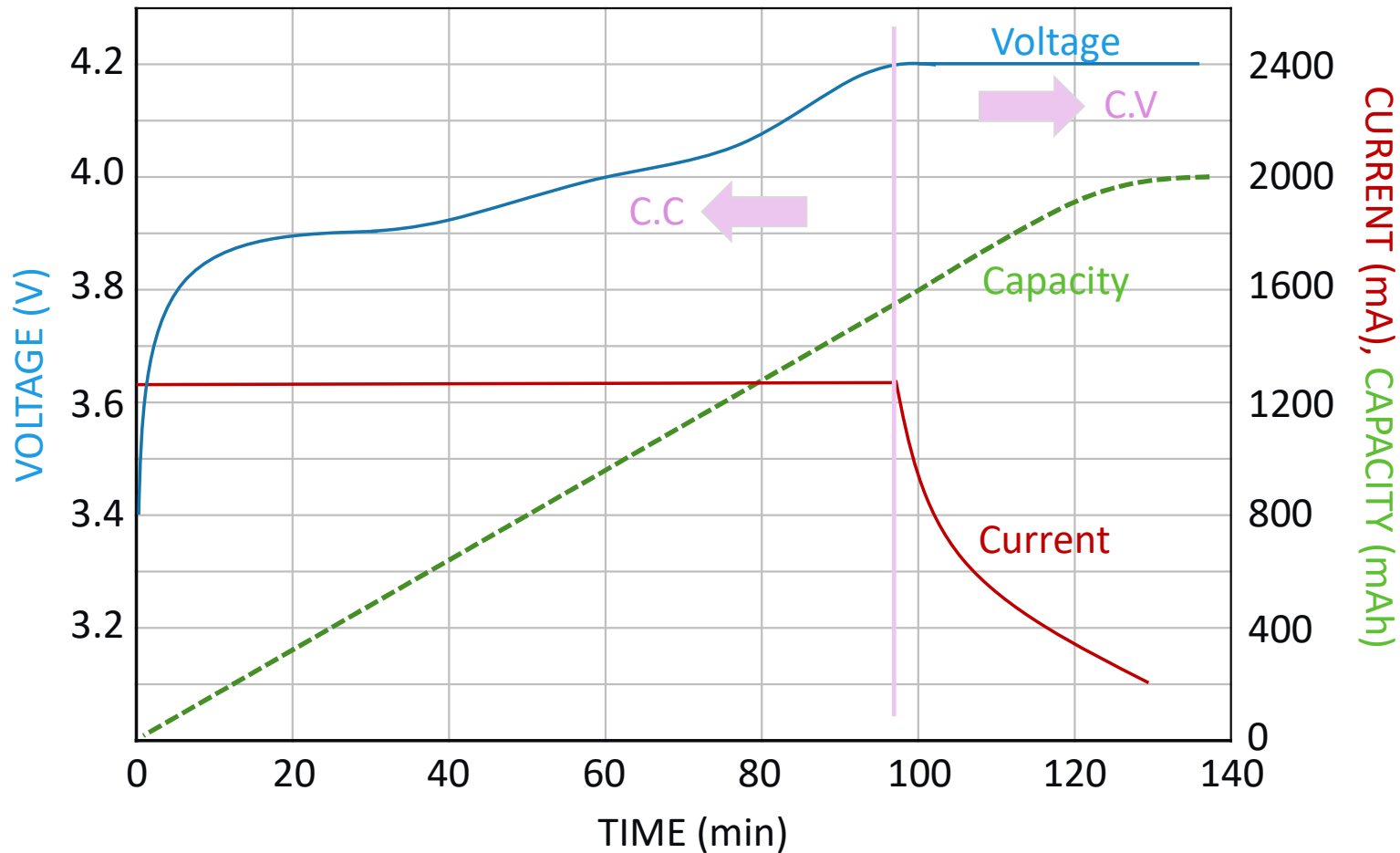
Lead-acid
(1~n cell in series)



Lithium cell
(1~n cell in series)

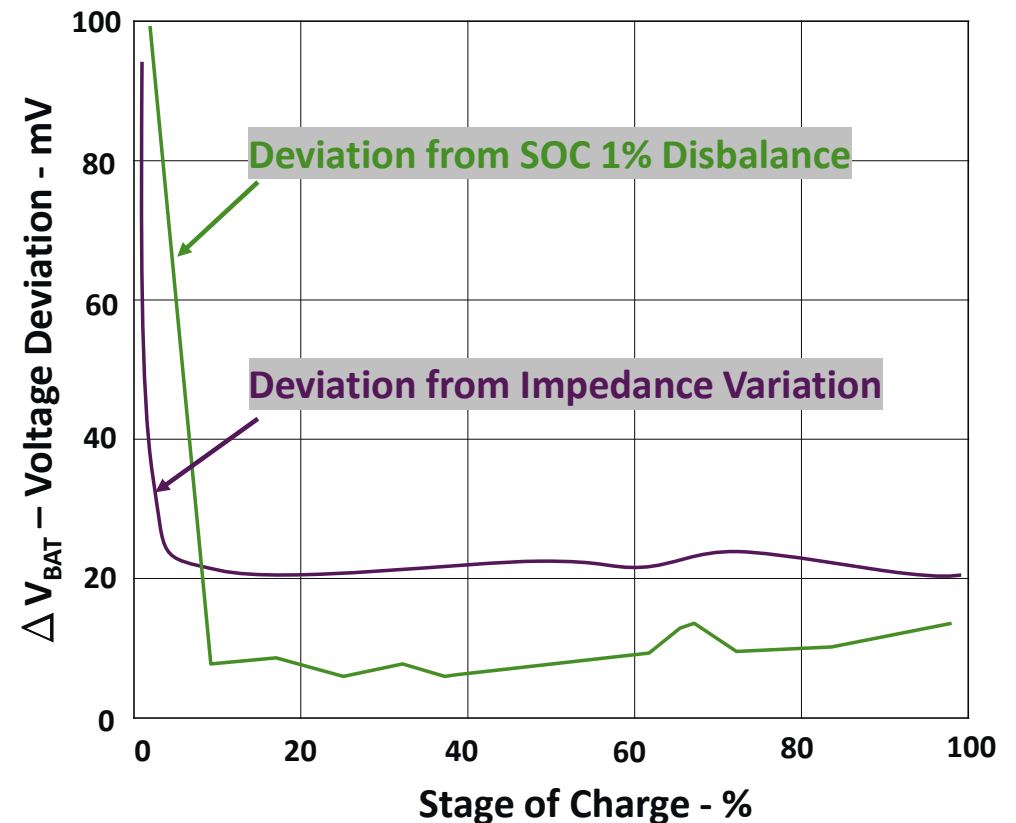
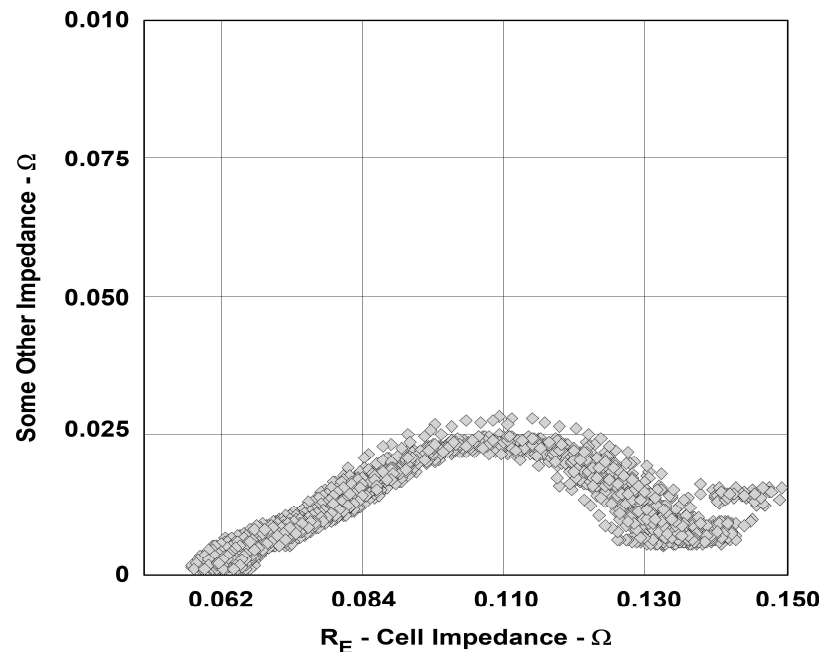


The Charging Characteristic Curve of Battery



Challenges of Connecting Cells in Series

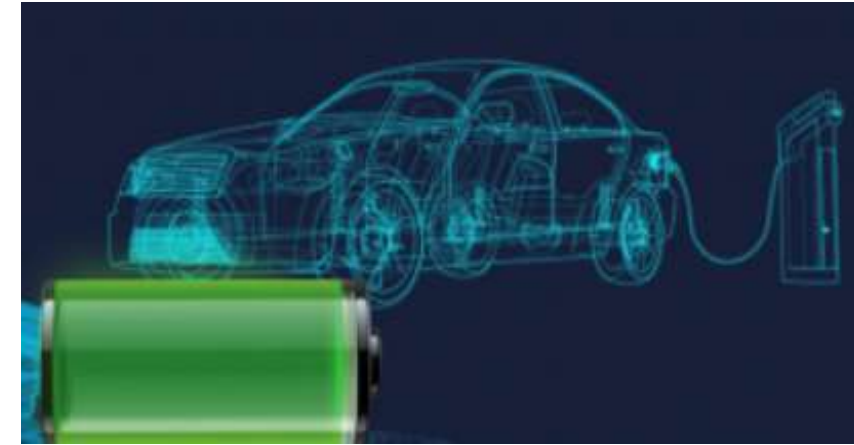
- State of Charge (SOC) Unbalance
- Total Capacity Differences
- Impedance Differences



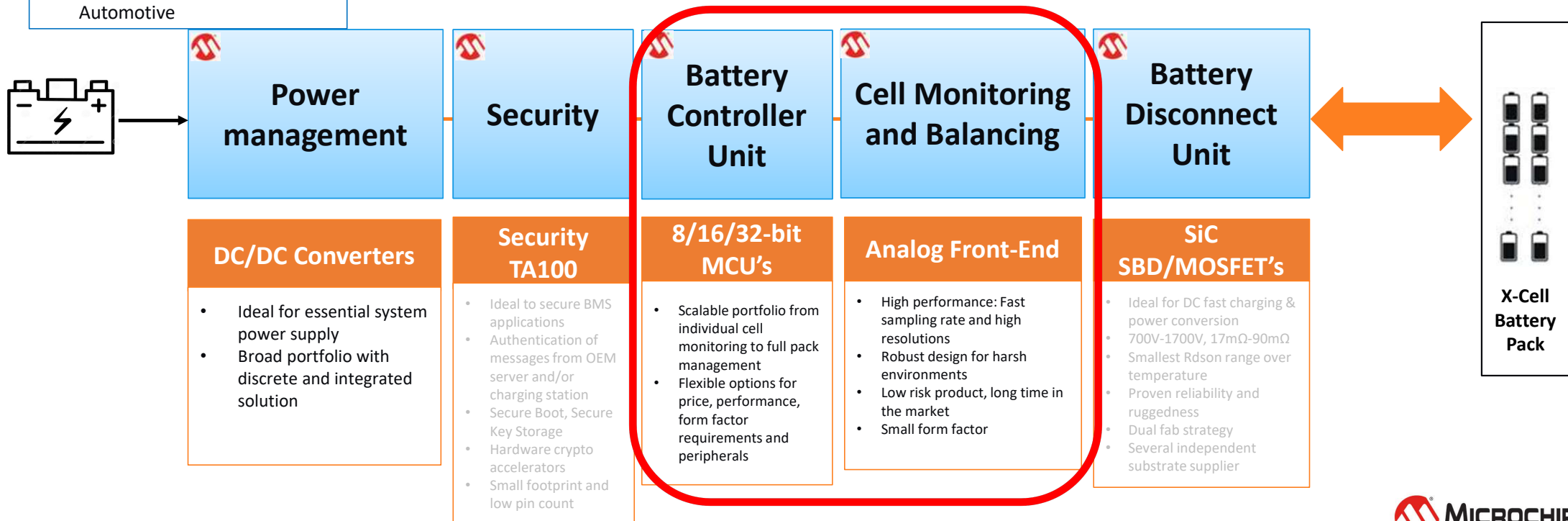
Battery Management Systems

Microchip Top Values

- One stop shop for most BMS needs
- Strong support structure
- No End-of-Life policy
- Large variety of EV reference designs and eval boards
- 25+ years experience in Automotive



Major Functions



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Battery Management System

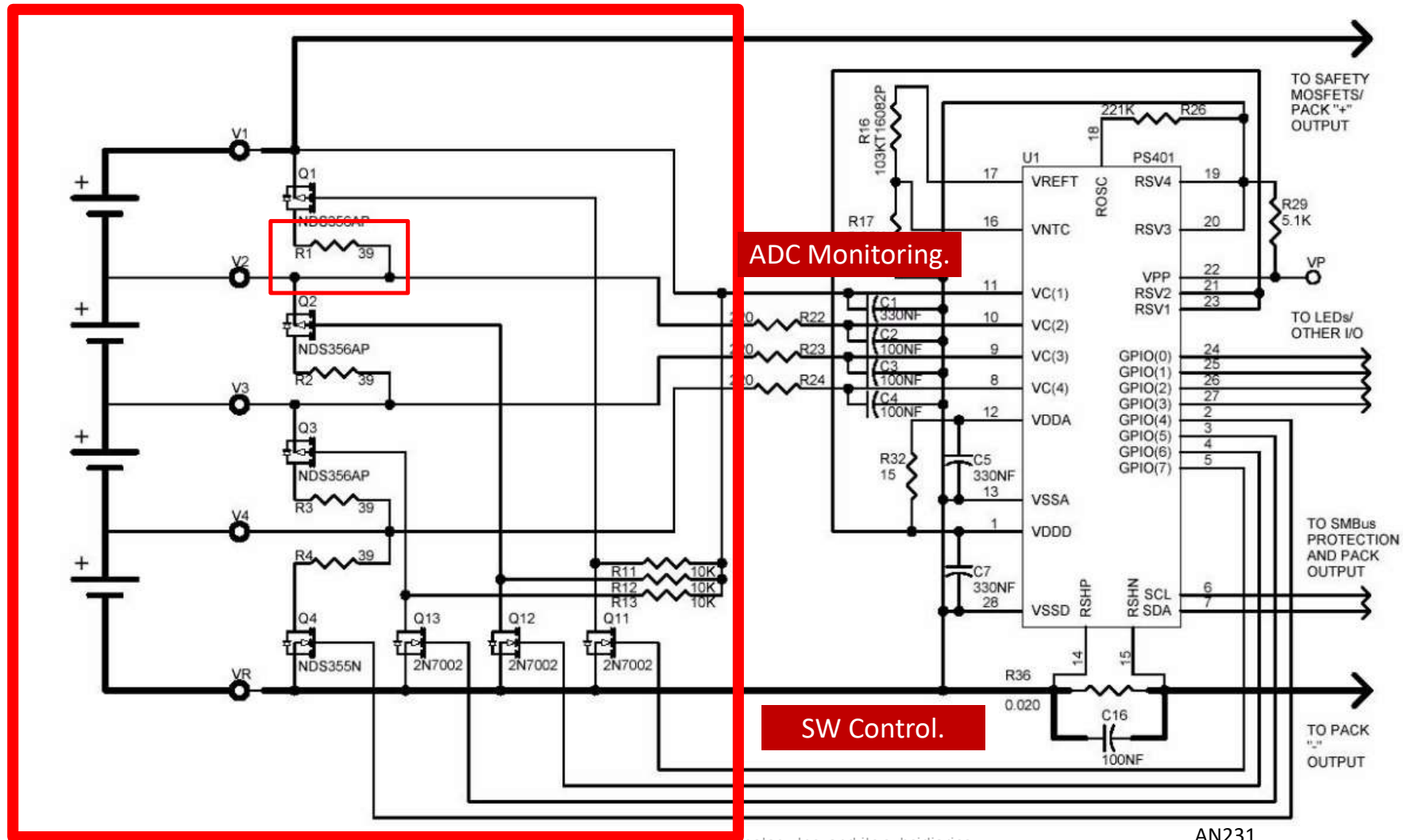
- BMS to **prevent over charge/discharge of cells** and resulting damage, it will terminate discharge if
 - Any of the cells reached **low voltage threshold**
 - The output reached **high current threshold**
 - The operating **temperature** exceeds the limit threshold
- **Cell balancing** is one of the core functions of a BMS, along with temperature monitoring, charging, and other features that help **maximize the life of a battery pack**. During balancing, higher capacity cells undergo a full charge/ discharge cycle. Without cell balancing, **the cell of the lowest capacity is a weak point**.
- **Temperature** monitoring and control
- **Current** and **voltage** monitoring:
- **Communication** and data logging
- **Safety** features

Cell Monitoring and Balancing - Market Trends

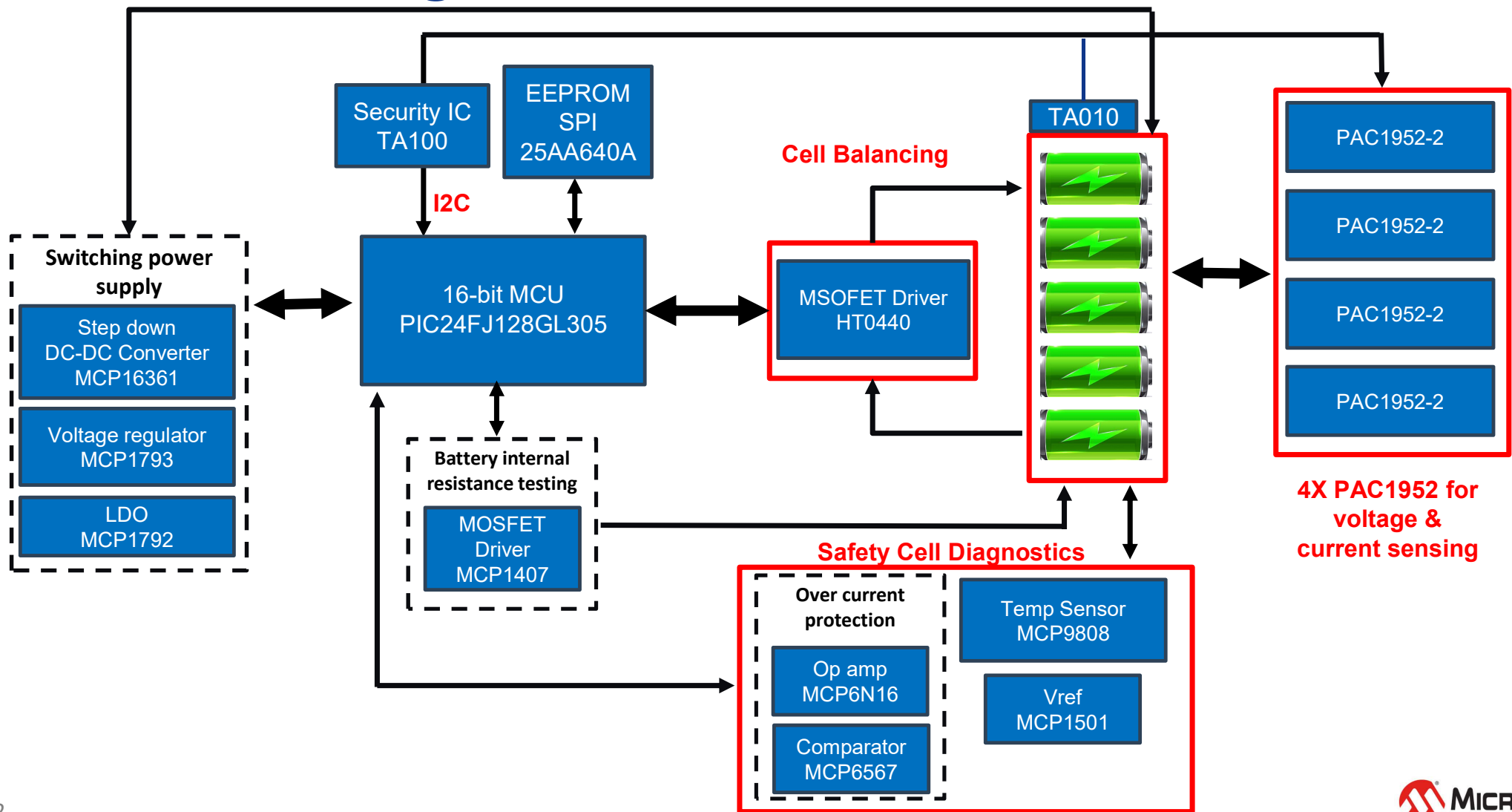
- More stringent **ASIL** requirements for primary path (accuracy) and secondary path (overcurrent/safety/redundancy)
- More channels per ADC (number of cells) and faster sample rate (quick response to faults) improve system efficiency
- **Lower drift** needed for **accuracy** over temperature

ASIL refers to **Automotive Safety Integrity Level**. It is a risk classification system defined by the ISO 26262 standard for the functional safety of road vehicles, ASIL **A** represents the lowest degree and ASIL **D** represents the highest degree of automotive hazard

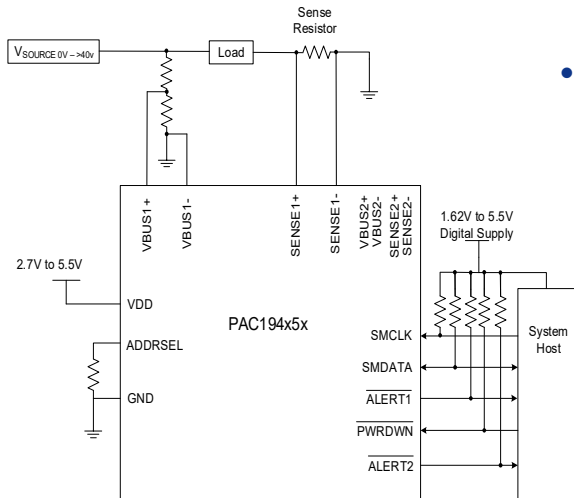
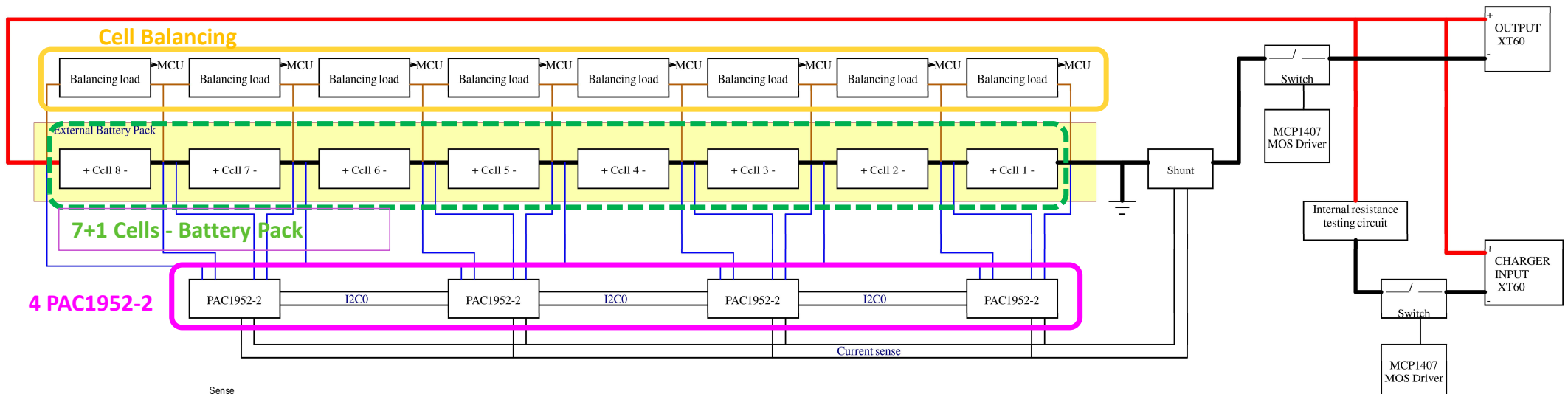
Passive battery balance example circuit



BMS Block diagram



BMS Evaluation Board (PAC BMS)



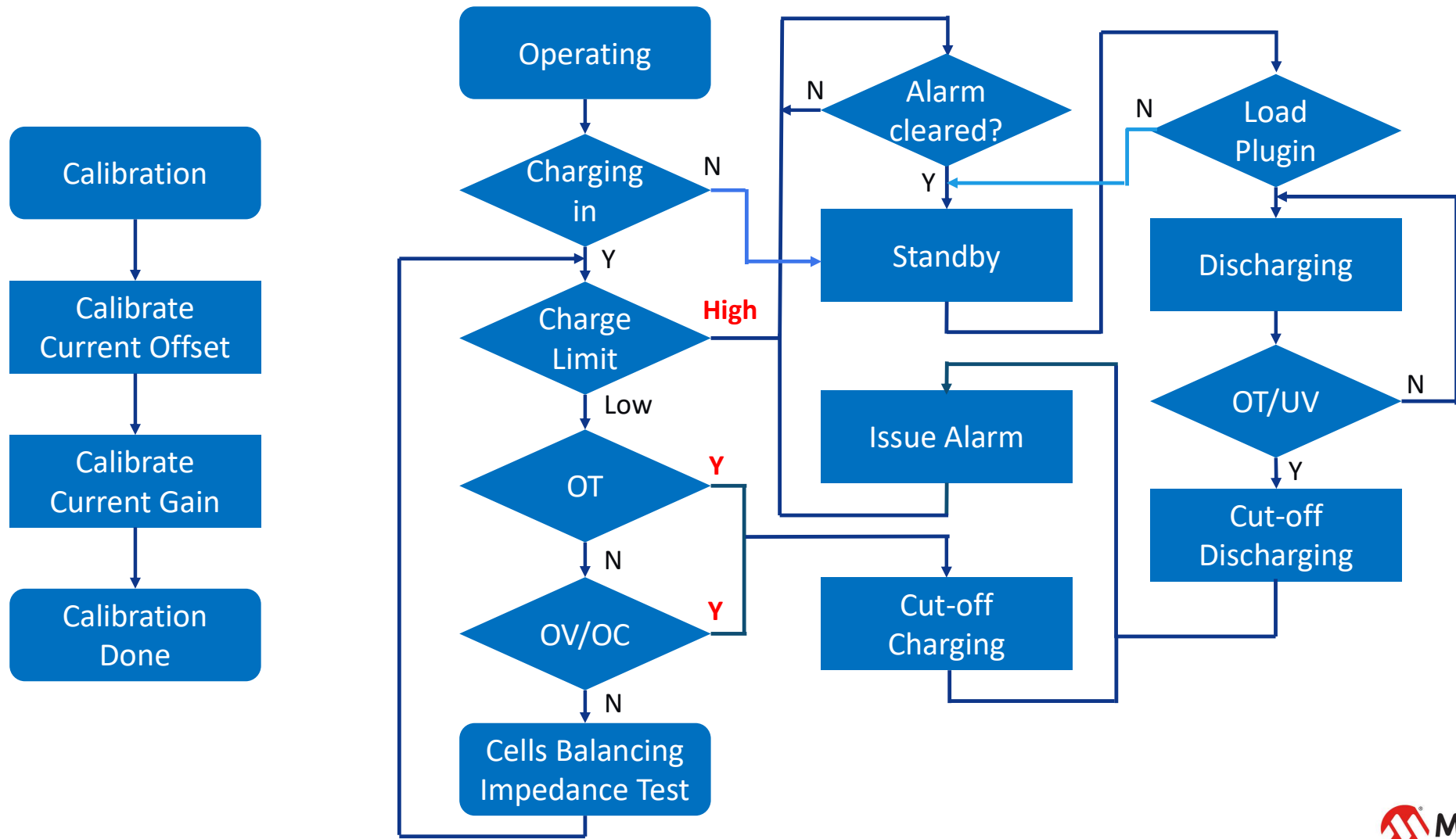
• PAC194x/5x: DC current sensing IC

- **16-bit resolution ADC** for V_{sense} and V_{bus}
- Selectable sampling rates up to 5.12 ksp/s
 - 12 μ A active current for 8 SPS
 - 1024 SPS for 4 channels
 - Burst mode
- High-side current sense monitor: 1 to 4 chan
- Voltage Monitor with Wide VBUS Range 0V to 32V FSR
- **On-chip power calculation and power accumulation registers**
- I2C for 1.8V, 3.3V, or 5V comm (up to 3.4 MHz)
- 2.215mm x 2.17mm WLCSP, 3x3 QFN-16

• Alerts

- **Alerts on limits (OV, UV, OC, UC and OP)**
- Alerts on Conversion complete, Accumulator Overflow and Count
- Fully programmable to either of 2 Alert pins
- **Low Current Draw**
 - I_{DD} @ 1024sps, 4 channels: 475ua max, 395ua typical at room
 - I_{DD} @ 8sps, 4 channels: 55ua max, 10.5ua typical at room
- **AEC-Q100 Qualified**

Reference Flow-chart

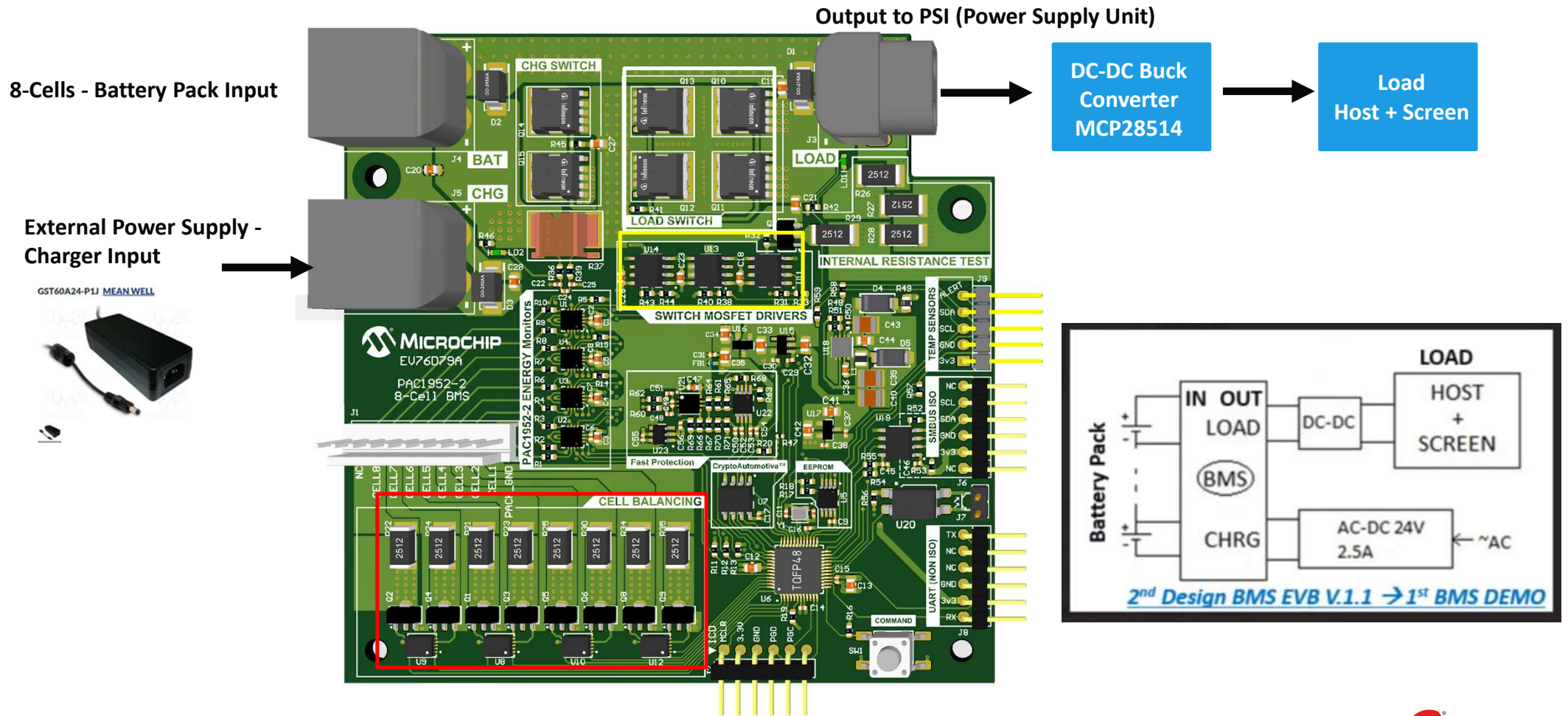


Important Specifications in the BMS

- Pack Capacity (mAh)
- Remaining Capacity (mAh; Packs and Cells)
- State of Charge (%)
- Charge Low/High Limit (%)
- Pack Voltage (V)
- Voltage of cells (V)
- Undervoltage Limit (V)
- Overvoltage limit (V)
- Overcurrent Limit (mA)
- Charging Cut-off Limit (mA)
- Internal Impedance (m Ω)
- Temperature ($^{\circ}\text{C}$)

The algorithm, in general, wants to charge the battery to 100% and will balance the cells only when the charger current drops below **~300mA**. We balance the cells when they are **>10mv** different from **high cell to low cell by PAC1952**. Once we are balanced and at 100% we stop charging and connect the load until we drop 90% where we switch back to charging

BMS Evaluation Board

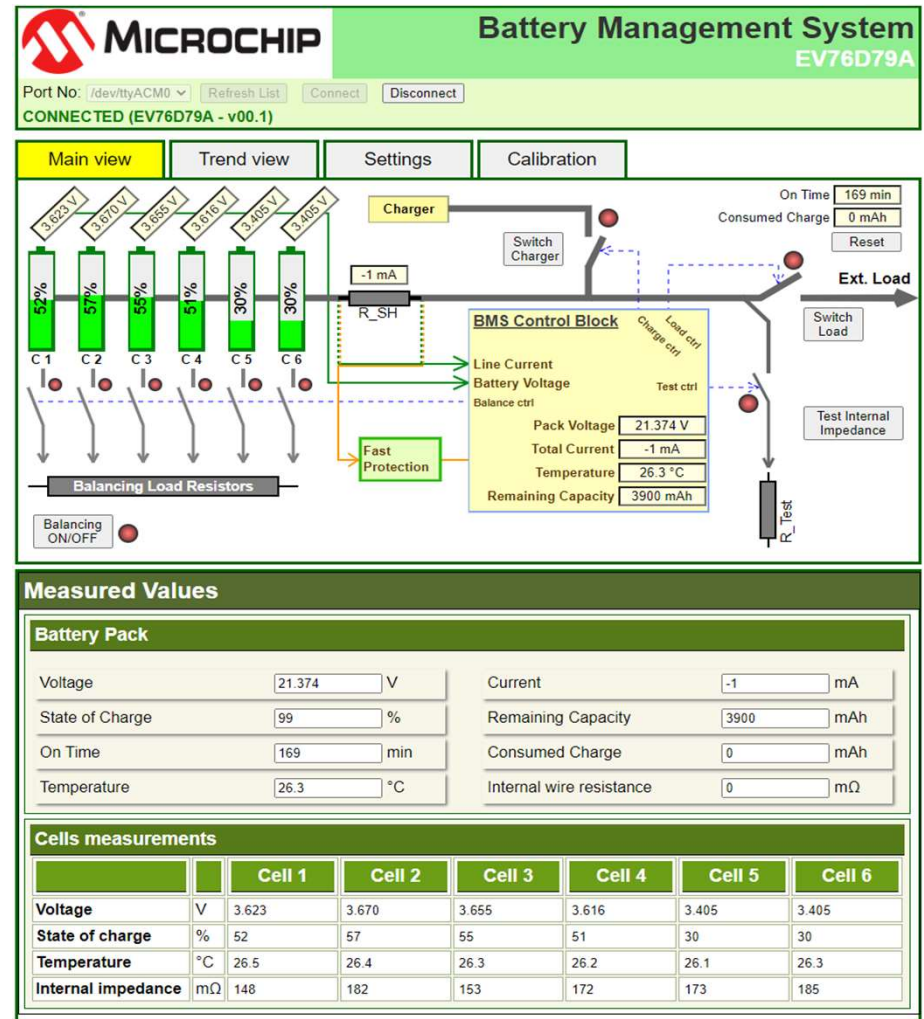


BMS Evaluation Board GUI

- **Specifications and features**

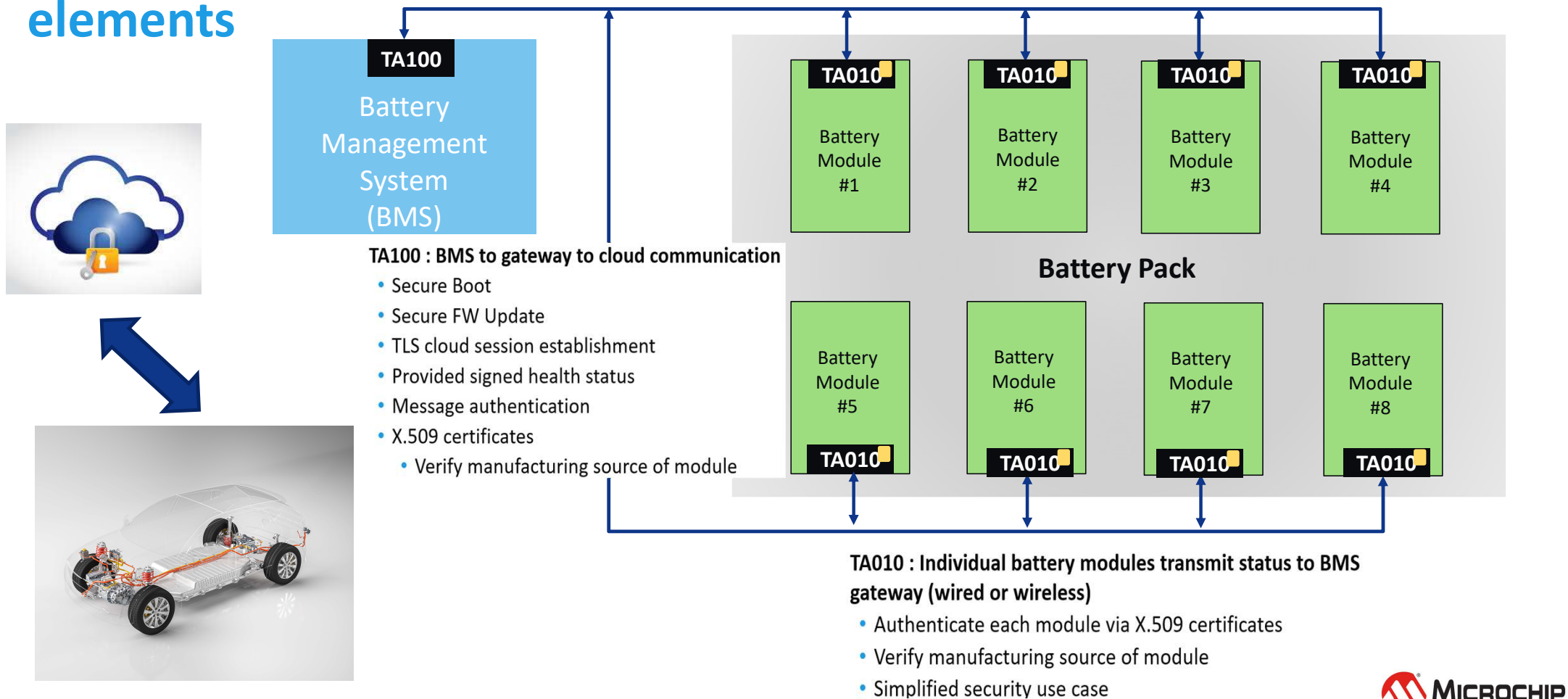
- Support for the monitoring a stack of 6 series 18650 Li-Ion batteries using the PAC1952-2
 - Animated and interactive block diagram, showing **passive cell-balancing** using a network of **discrete FETs and resistors**
- **State-of-charge** determination using **coulomb-counting**
- Supporting Commands/Capabilities:
 - Parameterization and customization of system: **charging/discharging limits**, alarming limits for **overvoltage, overcurrent, overheating**
 - Option to save data to an EEPROM device (by user request)
 - **Calibration for voltage and current measurements**
 - Runs on a WEB server and can be displayed on any terminal.
 - Test pulse for impedance measurement

BMS Evaluation Board GUI

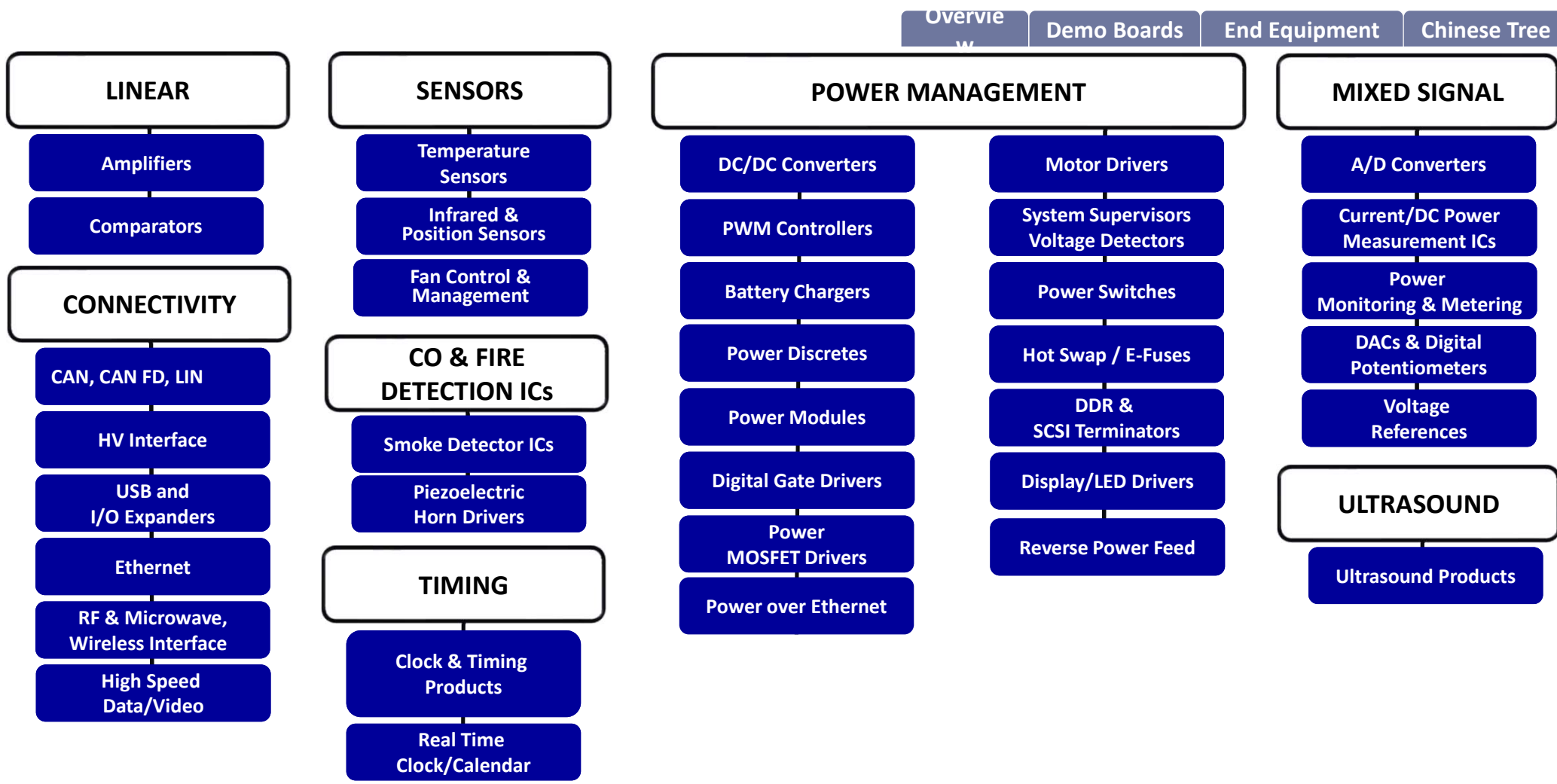


System Architecture of Battery Authentication

Microchip's HW security solution using Trust Anchor secure elements



Analog & Interface Products



Why Choose Microchip for Your BMS Designs?

Reduce Development Cost
and Time to Market

- Unrivalled technical support and design help

Help Customers to Make
Money

- Provide flexibility in design
- Lower development time and cost with easy-to-learn development tools, design collaterals and reference design for BMS solutions

Mitigate Risk

- 25+ years experience in Automotive with Proven total system solution and leading performance allowing customers to stay ahead of the game and mitigate risks resulted by poor performance
- No End-of-Life policy

Thank You

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