



## Power Generation and Storage

# Battery Management System

A novel circuit that provides simple, reliable, and safe battery management for high-voltage battery systems

NASA seeks interested parties to license the Battery Management System (BMS) developed by innovators at Johnson Space Center. NASA's BMS features the ability to monitor and balance the charge of individual battery cells that are in series and provide fault detection of individual cells in parallel within a battery pack of hundreds of cells. The circuit uses fewer connections (pins) than competing technologies, which reduces complexity and improves reliability. It offers a safe and potentially low-cost management system for high-voltage battery systems, including lithium-ion (Li-ion) battery systems that are used in electric vehicles and other next-generation renewable energy applications.

## BENEFITS

- Safety—improves safety of high-voltage batteries and decreases the occurrence of thermal runaway and catastrophic failures
- Reliability—utilizes a low pin count, causing reduced complexity and increased reliability
- Dual-purpose—detects the individual bad cells within series and parallel cells
- Extended battery life—manages battery cells within a string, which increases the life of battery systems
- Decreased battery damage—prevents damage from too much or too little voltage
- Limited charge current—balances cells by adding charge to individual cells after main charge is complete
- Low cost—provides a less expensive alternative to existing, commercially available solutions

technology solution



# NASA Technology Transfer Program

Bringing NASA Technology Down to Earth

## THE TECHNOLOGY

This technology was initially developed to provide battery management for high-voltage critical battery systems in NASA spacecraft. It is comprised of a simple and reliable circuit that detects a single bad cell within a battery pack of hundreds of cells and it can monitor and balance the charge of individual cells in series. Johnson Space Center's BMS is cost effective and can enhance safety and extend the life of critical battery systems, including high-voltage Li-ion batteries that are used in electric vehicles and other next-generation renewable energy applications.

The BMS uses saturating transformers in a matrix arrangement to monitor cell voltage and balance the charge of individual battery cells that are in series within a battery string. The system includes a monitoring array and a voltage sensing and balancing system that integrate simply and efficiently with the battery cell array, limiting the number of pins and the complexity of circuitry in the battery. The arrangement has inherent galvanic isolation, low cell leakage currents, and allows a single bad or imbalanced cell in a series of several hundred to be identified. Cell balancing in multi-cell battery strings compensates for weaker cells by equalizing the charge on all the cells in the chain, thus extending battery life. Voltage sensing helps avoid damage from over-voltage that can occur during charging and from under-voltage that can occur through excessive discharging.

Another capability of this technology is fault detection of a single bad cell in parallel with hundreds of other cells in a battery string. Small saturating transformers in the circuit measure the current in each cell with minimal impact on the battery impedance, and provide intrinsic electrical isolation with a low pin count. This fault detection circuit can be used simultaneously with the voltage sensing circuit on a string with many cells in both series and parallel.



The NASA developed technology could be applicable in electric vehicle battery charging station technologies.

## APPLICATIONS

The technology has several potential applications:

- Electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), and hybrid electric vehicles (HEVs)
- Telecommunications backup systems
- Space mission critical battery backup systems
- Uninterruptible power systems
- Electric utility storage for renewable energy
- High-voltage critical battery systems

## PUBLICATIONS

U.S. Patent 8,183,870

U.S. Patent 8,570,047

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