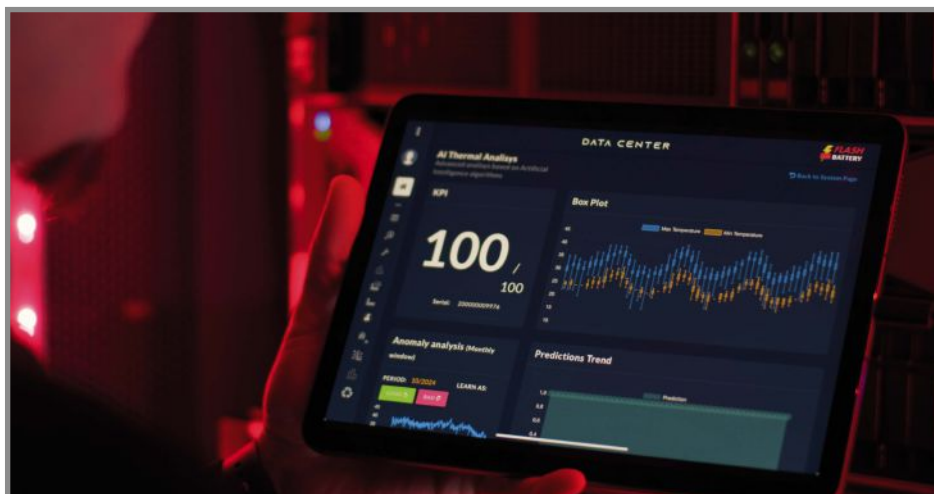


Advancing predictive diagnostics for industrial batteries

A NEW PATENT FROM FLASH BATTERY INTRODUCES IMPEDANCE SPECTRUM ANALYSIS WITHIN THE BMS, ADVANCING BATTERY HEALTH AND SAFETY MONITORING



The rapid evolution of industrial electrification is shifting attention beyond battery chemistry and cell formats. Today, one of the key challenges for OEMs and system integrators is not simply how to build better batteries, but how to better understand, manage and predict their behaviour throughout their operational life.

In this context, Flash Battery's latest patent introduces a significant advancement: the integration of impedance spectrum measurement directly within the battery management system (BMS), enabling a new approach to predictive battery management.

Beyond conventional monitoring

Traditional BMS architectures continuously monitor key parameters such as voltage, current and temperature. These measurements are essential for ensuring safe operation and reliable performance, but they provide only a partial view of a battery's actual condition.

As battery systems become more connected and increasingly strategic to industrial operations, the need for deeper diagnostic capabilities is becoming evident.

The newly patented technology builds upon Flash Battery's proprietary balancing architecture and introduces the capability to measure the

ABOVE: Flash Data Center, Flash Battery's proprietary cloud-based platform, transforms real-time battery data into predictive insights, enabling continuous monitoring, remote diagnostics and preventive maintenance

impedance spectrum of individual cells directly within the battery pack.

Impedance describes how a battery responds to electrical stimuli. When analysed across multiple frequencies, it generates a detailed electrical signature that reflects the internal condition of the cell and its evolution over time.

This methodology, known as electrochemical impedance spectroscopy (EIS), has long been employed in laboratory environments. Integrating this function into a battery system requires overcoming constraints related to cost, space, robustness and measurement accuracy. The innovation therefore lies not in the measurement itself, but in making advanced diagnostics practical for real-world industrial applications.

State of health and safety

One of the most promising outcomes of impedance-based monitoring is improved state of health (SoH) estimation. Rather than relying solely on theoretical ageing models, users can draw on impedance-based monitoring for additional information about

the actual condition of cells, helping users estimate remaining life, optimise maintenance schedules and plan future investments.

Beyond health assessment, impedance data may also contribute to a more advanced evaluation of battery safety. The objective is to detect changes in cell behaviour that could indicate degradation before it develops into a critical condition. Rather than reacting to unexpected events, operators can use early warning indicators to schedule maintenance, investigate anomalies and reduce operational risks.

This contributes to a broader concept increasingly discussed within the battery industry: the state of safety, a parameter aimed at evaluating not only how well a battery performs, but also how safely it can continue to operate.

Predictive intelligence

Generating valuable information from impedance measurements requires more than sophisticated hardware. The real value emerges when measurements are combined with large-scale operational data.

Flash Battery is combining laboratory ageing tests with data collected from batteries operating in demanding conditions typical of industrial environments. These datasets can help develop increasingly accurate predictive models linking impedance measurements with battery health, degradation and safety indicators. Advanced algorithms and artificial intelligence can further accelerate the identification of patterns within these datasets, transforming raw battery data into actionable insights for engineering and maintenance decisions.

Future BMS architectures will therefore move beyond simply monitoring what is happening inside a battery. They will increasingly be able to interpret cell behaviour, anticipate degradation and support preventive maintenance. As electrification becomes increasingly strategic for industrial vehicles, this transition from monitoring to predictive diagnostics could become a key element in improving battery reliability, safety and operational efficiency. **IVT**

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