acculon energy

FUNCTIONAL SAFETY

Safety at the System Level

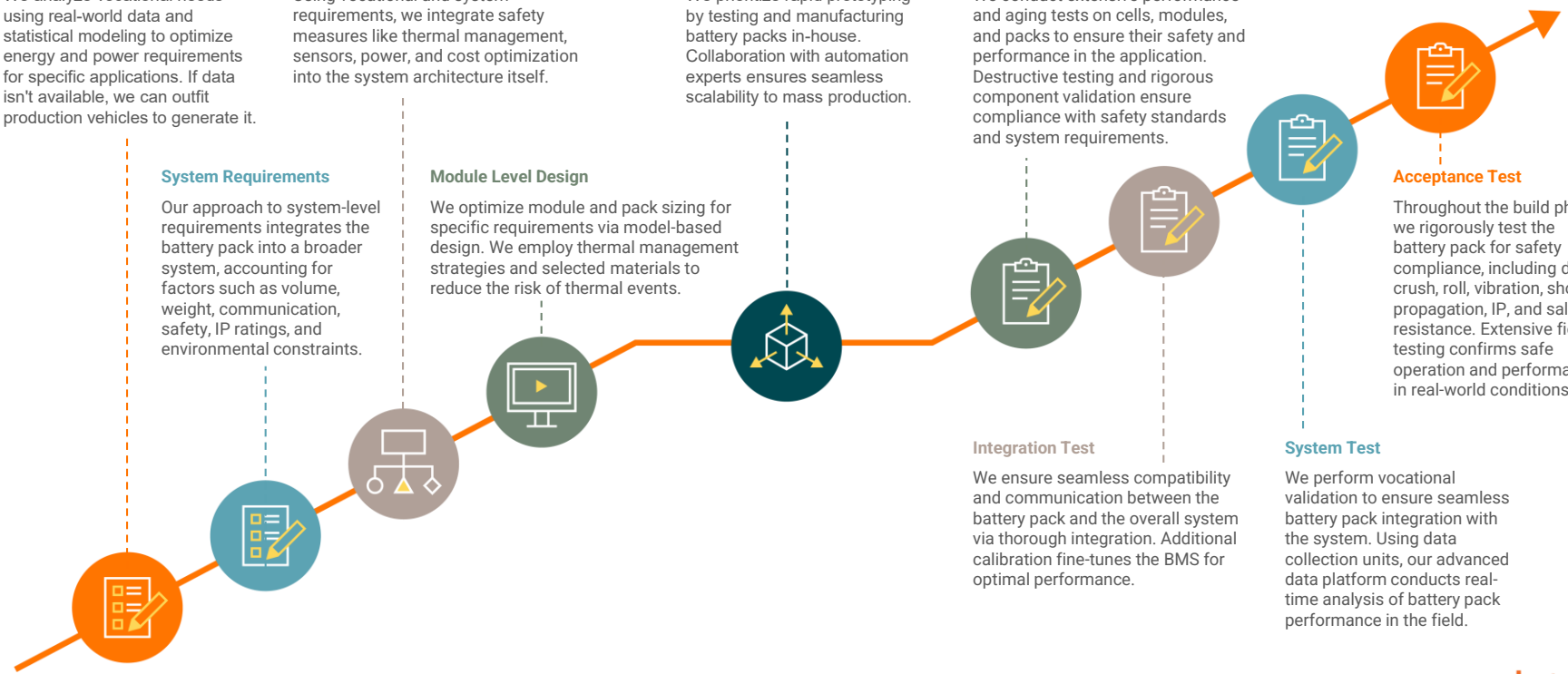
What is Functional Safety?

Functional safety refers to the concept of ensuring that a battery system operates correctly and safely, even when faced with errors, faults, or hazardous operating conditions. It is system safety and the design and manufacturing level.

Why is it Important?

Functional safety measures are implemented throughout the design, manufacturing, and operation of lithium and sodium ion battery modules and packs to minimize the risk and maximize safe, optimal performance.

Functional Development Safety Process



Vocational Requirements

We analyze vocational needs using real-world data and statistical modeling to optimize energy and power requirements for specific applications. If data isn't available, we can outfit production vehicles to generate it.

System Requirements

Our approach to system-level requirements integrates the battery pack into a broader system, accounting for factors such as volume, weight, communication, safety, IP ratings, and environmental constraints.

System Architecture

Using vocational and system requirements, we integrate safety measures like thermal management, sensors, power, and cost optimization into the system architecture itself.

Module Level Design

We optimize module and pack sizing for specific requirements via model-based design. We employ thermal management strategies and selected materials to reduce the risk of thermal events.

Implementation

We prioritize rapid prototyping by testing and manufacturing battery packs in-house. Collaboration with automation experts ensures seamless scalability to mass production.

Unit Test

We conduct extensive performance and aging tests on cells, modules, and packs to ensure their safety and performance in the application. Destructive testing and rigorous component validation ensure compliance with safety standards and system requirements.

Integration Test

We ensure seamless compatibility and communication between the battery pack and the overall system via thorough integration. Additional calibration fine-tunes the BMS for optimal performance.

System Test

We perform vocational validation to ensure seamless battery pack integration with the system. Using data collection units, our advanced data platform conducts real-time analysis of battery pack performance in the field.

Acceptance Test

Throughout the build phase, we rigorously test the battery pack for safety compliance, including drop, crush, roll, vibration, shock, propagation, IP, and salt fog resistance. Extensive field testing confirms safe operation and performance in real-world conditions.

What are the Vocational Requirements?

- We conduct a comprehensive vocational analysis for vehicles by examining real-world duty cycles and environmental conditions
- We leverage statistical models to calculate the optimal energy and power requirements for the application
- If you don't have existing data, we can fully instrument your production vehicles to capture real-world data and build duty cycles for you
- This will help you define the vocational requirements for your vehicles

The System Requirements

We take a holistic approach when gathering system-level requirements as the battery pack is just one piece of the entire system and there are many external forces that influence the pack design, such as:

- Volume and Weight Constraints
- System and Cloud Communication
- Safety and Regulatory Certifications
- IP Ratings
- Environmental Considerations

The System Architecture

1

Using the vocational and system requirements, we layer multiple safety concepts into the system architecture

2

We incorporate a range of strategies to maintain safe cell temperature and to mitigate thermal runaway propagation through active/passive thermal management systems, intumescent materials, and optimally-sized vents based on the cell chemistry and pack capacity

3

Voltage, current, and temperature sensors are strategically placed throughout the system to ensure safe operating conditions and to create measurement redundancy

The System Architecture Continued...

4

We architect for a robust power management unit through redundant contactors, safety fuses, and manual service disconnects

5

We leverage state-of-the-art empirical and physics-based models to design a BMS with highly accurate SOC and SOH estimation

6

We architect to optimize cost while still meeting the application requirements

Pack and Module Design

We employ model-based design methodologies to optimize module and pack sizing for specific applications.

To safeguard against cell-to-cell overheating, we employ strategic cell arrangement, thermally insulating foam, and wire bonding to act as a self-combusting link.

Foaming materials serve as multifaceted safety enablers, mitigating propagation, shielding against corrosion, and absorbing vibrations.

Pack and Module Design Continued...

All components and materials are carefully curated and thoughtfully designed to mitigate the risk and impact of thermal incidents.

Manufacturing adaptability is embedded in our design methodology, enabling the pack to transition smoothly into production.

Implementation

Our prototypes packs are proudly fabricated in the US, allowing for seamless in-house production and prompt design alterations.

Partnering with manufacturing automation experts, we seamlessly transition our designs to scalable production.

Unit Testing

We rigorously test cells, modules, and packs for safe operation in your application.

We push our designs to the limit with destructive testing at the cell, module, and pack level, guaranteeing they meet all safety certifications.

We validate all system components to ensure performance.

To ensure exceptional performance, we implement a comprehensive cell selection process involving detailed teardowns and testing under a wide range of operating conditions.

The Integration Test

We leverage comprehensive system integration to guarantee perfect fitment and reliable communication for the battery pack and the system.

Advanced calibration optimizes the BMS to perfectly match the demands of your application.

The System Test

We perform rigorous vocational validation (field testing) to ensure seamless integration and optimal performance of the battery pack and the entire system.

Equipped with data collection units, we leverage our cutting-edge data platform for real-time analysis of your battery pack's performance in the field.

The Acceptance Test

During the build/prototype phase, we subject our battery packs to a battery of rigorous safety tests in pursuit of certification, including:

- Drop, Crush, & Roll Testing: Simulating real-world impacts to guarantee structural integrity
- Vibration & Shock Testing: Ensuring resilience against harsh operating environments
- Destructive & Propagation Testing: Pushing the limits to assess safety mechanisms and prevent thermal runaway
- IP and Salt Fog Testing: Verifying weatherproofing and corrosion resistance for extended lifespan

We put our battery packs to the test in extended, multi-month field trials. This ensures they not only operate safely but also deliver the performance you expect in your specific environment.

LET'S START A CONVERSATION ABOUT YOUR BATTERY PROGRAM!

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