ENABLING CLEAN ENERGY: ADVANCED SENSING FOR A SAFER, MORE SUSTAINABLE FUTURE

Honeywell | Powell

CONTENT

INTRODUCTION

Honeywell's Sensor Technologies

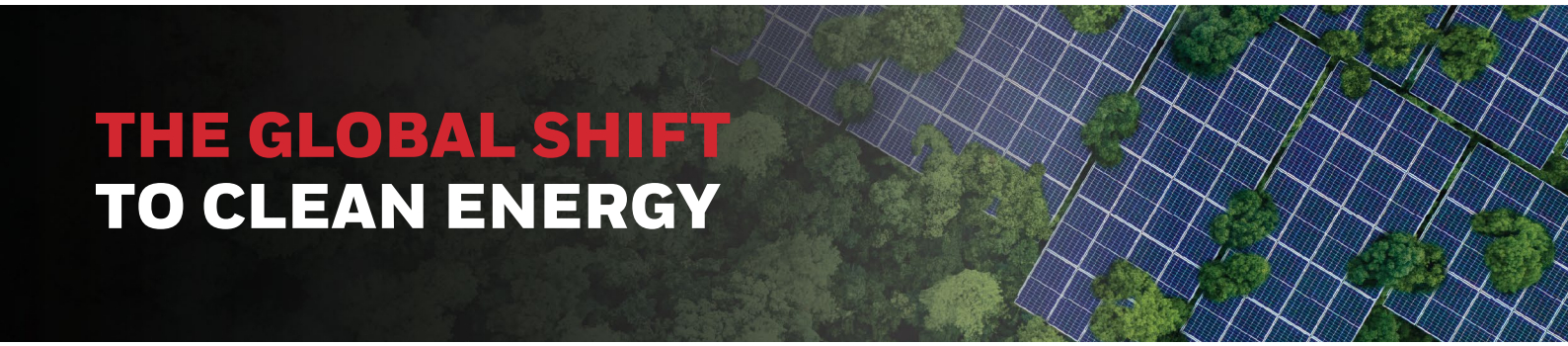
Honeywell is enabling clean energy through its advanced electrification and battery safety sensing technologies. Offering a broad portfolio of sensors, the company's current, pressure, aerosol, and electrolyte vapor detectors deliver exceptional accuracy, reliability, and value across a wide range of electrification applications.

Whether it is high-precision monitoring in battery management systems, motor control, and fault detection or detecting early signs of thermal runaway within lithium-ion battery packs, these technologies provide both performance and safety assurance. By providing these cutting-edge sensing solutions through Powell, Honeywell is empowering the transition to a more sustainable future.

Honeywell Solutions from Powell Electronics

Powell Electronics builds its entire approach around customer needs, offering adaptable services and solutions tailored to each project. Whether choosing from ready-made products or requesting a fully customized design, Powell ensures the selected technology fits the project's exact specifications. Clear communication and steady coordination are prioritized to keep expectations aligned at every stage.

With no minimum order requirements, the capabilities of a major supplier, and the personalized attention of a smaller operation, Powell delivers flexibility, minimizes risk, accelerates timelines, and gives the freedom to experiment with designs without the pressure of high-volume orders.



THE GLOBAL SHIFT TO CLEAN ENERGY

Challenges and Opportunities of the Clean Energy Transition

An unprecedented global shift from oil and other fossil fuels to electrification and alternative energy sources is transforming how we live and driving meaningful environmental gains. The technologies powered by these new energy sources, including home energy storage systems and hydrogen-powered and electric vehicles, are set to play a critical role in building a future with lower emissions and reduced energy consumption. However, this transition introduces a new set of technical requirements, particularly the need for higher and more complex levels of safety, efficiency, and reliability across three key technologies.

Electric Vehicles (EVs)

EVs are paving the way toward a cleaner, greener future. They offer lower operating costs, reduced emissions and noise pollution, less maintenance compared to conventional vehicles, higher torque and performance, and the convenience of home charging (Figure 1). Yet they also present challenges such as high-voltage shock risks, battery fires, real-world range limitations, battery degradation, and hydrogen and carbon monoxide vapor leakage. These are compounded by environmental stressors, including extreme temperatures, mechanical stress, power fluctuations, and repeated charge and discharge cycles.

Figure 1: *An electric vehicle safely charging outside a family home. Image used courtesy of Adobe Stock*

Battery Energy Storage Systems (BESS)

BESS systems, once installed, can help stabilize and relieve stress on the electric grid, provide emergency backup power during outages, and support the integration of renewable sources such as solar panels by storing the energy they generate for later use. They can also reduce electricity costs through computer-based algorithms that shift energy loads during peak demand periods. However, these expensive battery systems have a finite number of charge and discharge cycles before replacement is required. Technical challenges such as cell imbalances, thermal runaway, and fire risks demand sophisticated software management, particularly because battery fires are difficult to extinguish once they occur.

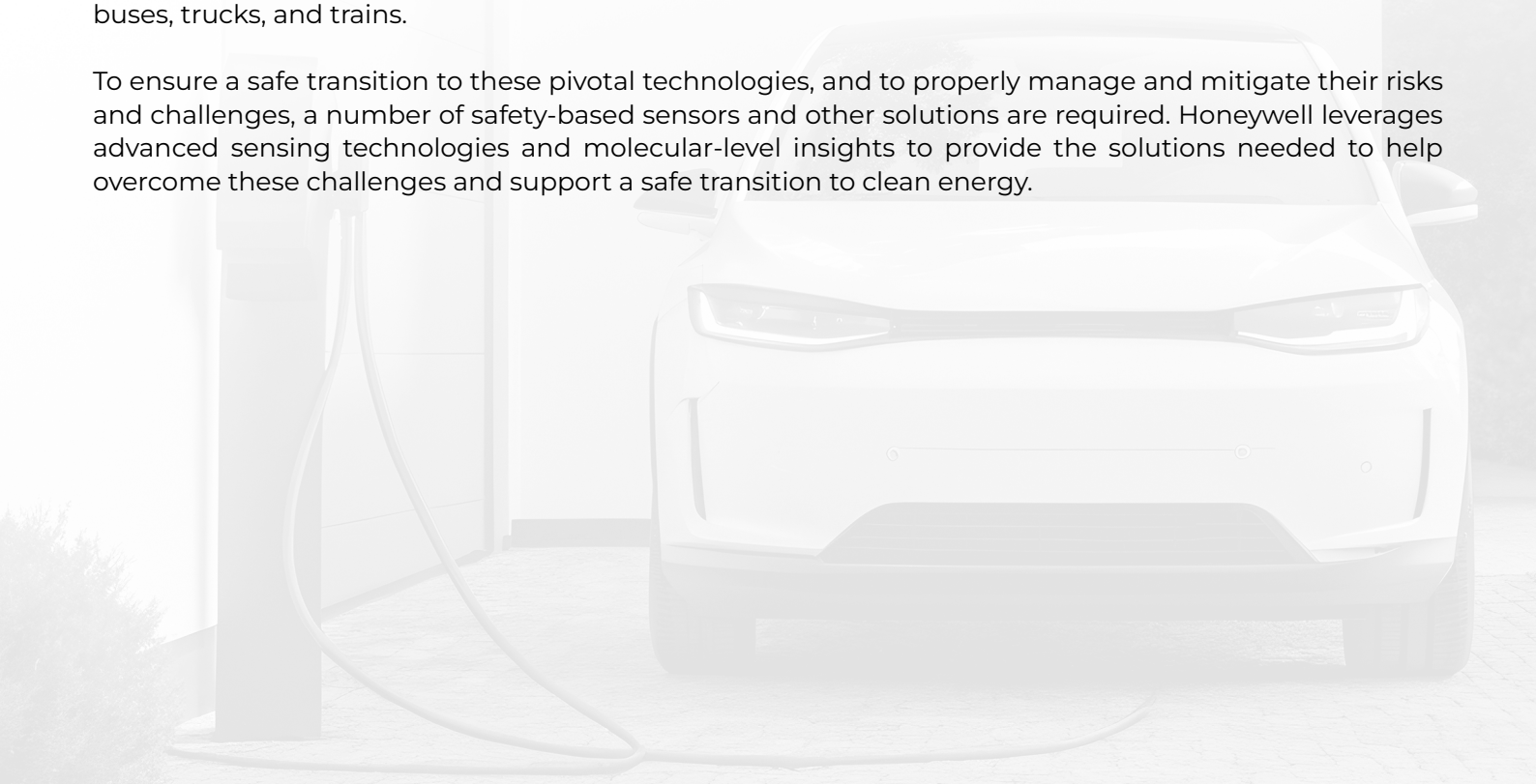
Hydrogen-Powered Systems

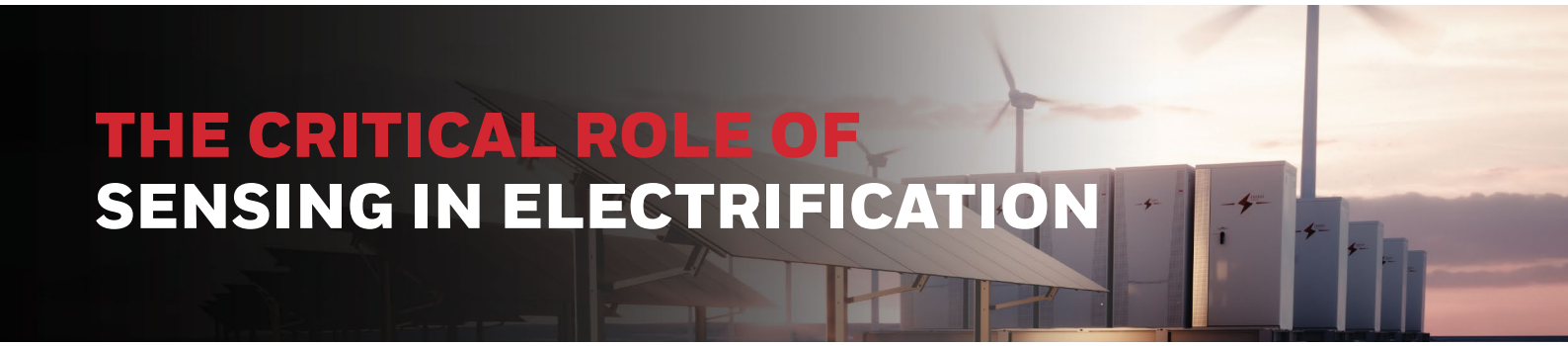
Hydrogen-powered systems show great promise as zero-emission solutions for industrial equipment, power generators, and on-road vehicles. Global adoption is rising, with more than 90,000 hydrogen fuel cell vehicles on the roads in 2024, a 14% increase from 2023. Hydrogen-powered vehicles emit only water vapor and reduce noise pollution. They also offer the shorter refueling times and longer ranges associated with traditional gasoline-powered engines. Hydrogen is also a renewable clean energy, meaning it can be produced via an electrolysis process that splits hydrogen from water using an electric current, which in turn can be powered by clean energy like wind and solar power. However, its small molecular size and high flammability can make it challenging to store, transport, and manage as fuel.

Technology that Enables Clean Energy

The transition to these clean energy technologies is set to continue increasing on a global scale. For example, more than 20% of new cars purchased in 2024 were electric. And adoption is set to continue rising as the total cost of owning an EV in the US is now lower than for a gas-powered car. BESS technology is on track to become nearly a US $100-billion market by 2033, and countries like Japan, South Korea, Germany, and China are investing in hydrogen refueling stations and production hubs, particularly for buses, trucks, and trains.

To ensure a safe transition to these pivotal technologies, and to properly manage and mitigate their risks and challenges, a number of safety-based sensors and other solutions are required. Honeywell leverages advanced sensing technologies and molecular-level insights to provide the solutions needed to help overcome these challenges and support a safe transition to clean energy.





THE CRITICAL ROLE OF SENSING IN ELECTRIFICATION

The Battery Imperative: Mitigating Thermal Runaway

Lithium-ion batteries have played a major role in transforming our electronic world. Their high energy density allows for lightweight energy storage, rapid charging, and long retention due to a low self-discharge rate. They require no maintenance, can be designed in a variety of form factors, and deliver consistent, reliable voltage outputs. However, these versatile batteries carry a major risk known as thermal runaway—a self-sustaining, uncontrolled chain reaction that occurs when the temperature reaches a critical point. This reaction can generate heat and gases on its own, potentially causing the battery pack to ignite or explode (**Figure 2**).

For these reasons, devices containing lithium-ion batteries can face restrictions in sensitive areas or during transport on vehicles such as airplanes. They also pose risks to infrastructure, including homes and businesses, when used in BESS, as well as to passengers in EVs, particularly during accidents when the batteries are more prone to damage. For companies producing these devices, failing to address these safety hazards can result in consequences far beyond asset damage or brand reputation. Therefore, early detection is essential to preventing catastrophic lithium-ion battery failures.

Figure 1: *Most electric vehicles use lithium ion battery packs, which carry a risk known as thermal runaway that can cause them to ignite or explode. Image used courtesy of Adobe Stock*

The Efficiency Equation: The Need for Precision Current Monitoring

Battery management is essential for ensuring the safety, reliability, and performance of modern rechargeable batteries and systems, including those in cellphones, EVs, and BESSs. A battery management system (BMS) monitors voltage, temperature, and overall system health; balances battery cells; and provides early alerts to potential issues. It protects against hazards such as overcharging, short lifespans, lithium plating, and fire, all of which can permanently reduce a battery's capacity. To optimize battery life, maximize performance, and maintain safety, a BMS must be capable of precise current measurement, fault detection, and motor control.

The Hydrogen Horizon: Overcoming the Leak Detection Challenge

The small molecular size and high diffusivity of hydrogen make it inherently difficult to transport and store safely. The gas is colorless, odorless, highly flammable, and produces flames that are nearly invisible to the human eye. Hydrogen can diffuse into the microstructure of metals, causing brittleness, and its small size allows it to leak more easily through seals than other gases. As a result, it must be stored at cryogenic temperatures (below -253°C) and properly insulated to prevent gradual boil-off, safety hazards, and energy loss. Traditional leak detection methods, such as catalytic beads, can be inaccurate, have short lifespans, and are susceptible to chemical poisoning from substances like silicone or sulfur, which may prevent them from distinguishing between different gases. Reliable, continuous monitoring and early detection are therefore critical to enabling hydrogen as a practical clean energy source.

HONEYWELL'S ADVANCED SENSING PORTFOLIO

Proactive Battery Safety: The BES and BES LITE Series

Detect Thermal Runaway Before It Starts

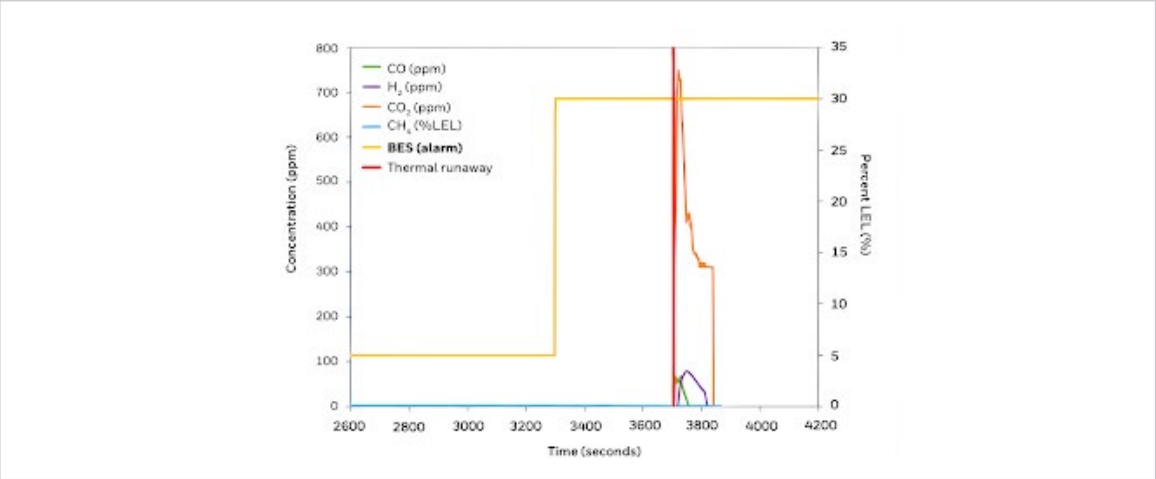
An automotive-grade sensor designed for early detection of venting and thermal runaway in battery systems, BES enhances the safety and reliability of EVs to protect both lives and assets. The BES (Figure 3) uses an advanced and patented rate of change algorithm to detect the battery electrolyte vapor commonly released during the initial venting phase and to detect the hydrogen and carbon monoxide gases released during a thermal runaway event.

Figure 4: *Honeywell's Battery Safety Electrolyte Detector, or BES, is shown on the left, and the BES-LITE is shown on the right.*

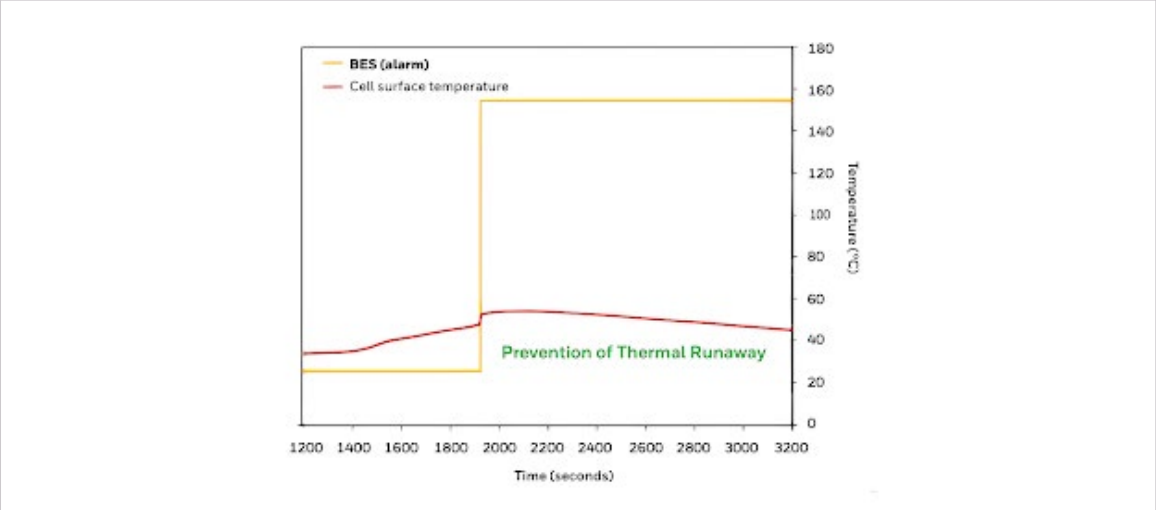
BES Features

- Detects battery electrolyte vapor released during the first vent (before thermal runaway)
- Responsive to hydrogen gas and carbon monoxide released during thermal runaway
- Patented rate of change algorithm mitigates false negatives
- Resistant to siloxane poisoning
- Compatible with all lithium-ion battery chemistries and cell types
- Automotive-grade with CAN 2.0B output and diagnostic features
- Estimated performance life of 15 years

By detecting these vapors early, the BES provides critical alerts about potential thermal runaway incidents in lithium-Ion battery packs, allowing for timely and appropriate mitigation measures to be taken (**Figure 4**). In Test A, a pouch battery cell was overcharged at 2C rate to induce thermal runaway or explosion. The BES sensor alarm activated roughly seven minutes before the event, while the H_2, CO, CO_2, and CH_4 sensors registered gas levels only at the moment of the explosion. In Test B, a pouch cell was similarly overcharged at 2C, but the BES alarm activated early enough to stop charging, allowing the cell to cool and preventing thermal runaway.



Test A: *Early detection of thermal runaway with the Honeywell BES sensor rate of change algorithm compared to other ppm-based gas sensors*



Test B: *BES sensor enabling prevention of thermal runaway by removing abuse factor*

Figure 4: *Test A: Early detection of thermal runaway with the Honeywell BES sensor rate of change algorithm compared to other ppm-based gas sensors*

BES uses a patented advanced rate of change algorithm designed to identify large changes in the concentration of target gases within sealed battery packs, reducing the number of false negatives commonly seen with conventional ppm-based sensors. As an additional benefit, this algorithm eliminates the need for precise target gas threshold testing and validation, meaning it can be integrated quickly and affordably.

The BES LITE series is a cost-effective, lightweight sensor that detects battery electrolyte vapor and aerosolized particles, a key indicator of impending thermal events in lithium-ion battery packs. Like the BES, the BES LITE (Figure 3) is designed to minimize false readings, making it ideal for environments where interference from other gases may be present. BES LITE detects gases typically released during the initial phase of thermal runaway (Figure 5) and throughout the entire thermal runaway process. By promptly identifying these imminent dangers or risks, it allows for proactive responses that can prevent loss of assets and protect lives. BES LITE is compatible with all lithium-ion battery chemistries and cell types, making it versatile for use in industrial lithium-ion battery packs. As concerns over lithium-ion battery

safety continue to rise, BES LITE stands out as the ideal battery safety detector, ensuring the protection of both personnel and assets. With a low-profile construction and mounting flanges, it is ideal for installation in tight spaces.

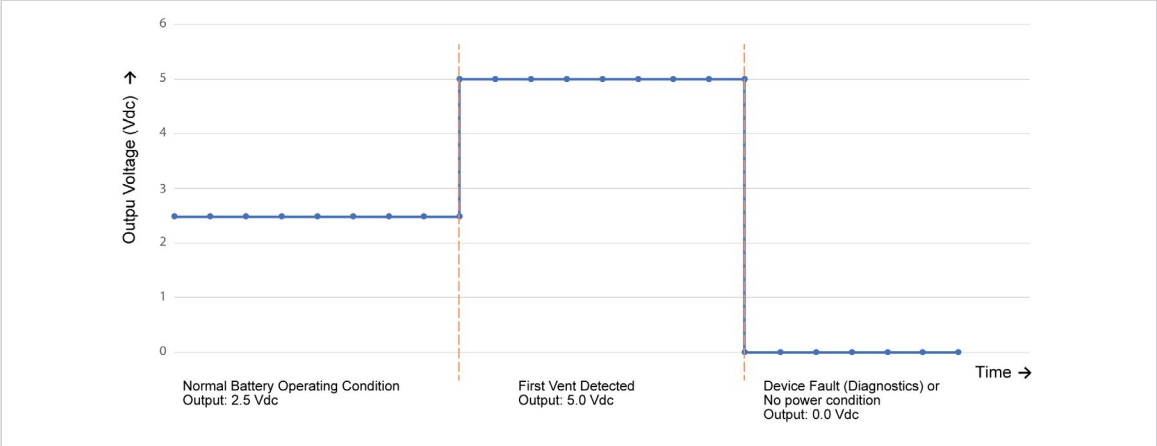


Figure 5: *The three-state outputs of a BES LITE: normal conditions, vent detection, and device fault/no power.*

CASE STUDY: AWARD-WINNING INNOVATION

Honeywell's BES LITE sensor was awarded a "Best of Sensors" award from Questex's Sensors Converge and Fierce Electronics. The BES LITE is designed to selectively detect battery electrolyte vapor typically released in the early phase of thermal runaway and to alert battery management systems about imminent danger. The awards recognize the technologies, industry experts, and companies leading the way in technology innovation. The BES LITE, which was recognized in the Best Power & Sustainability Solution category, is an innovative safety solution, addressing the increasingly important issues coming with the rise of lithium-ion batteries use globally. It uses patented polymer sensing material and an industry-first electrochemical sensor, and it can operate with very low power requirements that enable extended battery operation. It also requires no oxygen to operate, extending its application into previously unavailable areas. Click here to learn more about why Questex awarded the BES LITE.

High-Fidelity Current Monitoring: The CSNV and CSSV Series Accuracy and Reliability for Critical Power Systems

Honeywell's CSNV series current sensors (**Figure 6**) measure the current flow in battery management systems, electric vehicles, energy storage systems, and other applications that require high accuracy and reliability. They deliver superior performance and stability across a wide temperature range. They are nonintrusive and electrically isolated from the monitored circuit, ensuring safe, simple installation without power loss. And, with the ability to communicate via a CAN bus interface, they are easy to integrate and configure.

The CSNV series current sensors are available in three models (CSNV500, CSNV700, and CSNV1500) with all three using automotive-grade components, built-in diagnostics, anti-interference technology, and UL and CE certification.

Figure 6: *Honeywell's CSNV series current sensors can be tailored to exact specifications for improved time to market, lower total system costs, and enhanced reliability.*

The CSSV series advanced fluxgate current sensor combines fluxgate and open-loop Hall effect technologies to deliver high-accuracy and low-power consumption and Automotive Safety Integrity Level C (ASIL-C) compliance for safety-critical applications. These sensors can measure ±1500 A of current in battery management systems for electrified vehicles and other industries, offering a nonintrusive and electrically isolated sensing method that is resistant to magnetic interference and stable during temperature changes. Currently, CSSV sensors are used in EV applications like current sensing in battery management systems, battery disconnect units, motor control, inverters, power distribution units for overcurrent protection, battery health monitoring, system control and safety, energy efficiency, and fault detection and isolation.

The CSSV series (**Figure 7**) has a low probability of failure and high fault tolerance in case of a malfunction, and complies with CE, UKCA, REACH, and RoHS certifications, meaning it meets the environmental and health requirements of the European Union and the United Kingdom.

Figure 7: *The CSNV sensor from Honeywell provides exceptional accuracy, reliability, and high-value precision monitoring for BMS, inverters, and motor control applications.*

Uncompromising Leak Detection: The HLD Series

Ensuring Safety in Hydrogen and Beyond

Honeywell's Hydrogen Leak Detector (HLD) sensor can detect hydrogen leaks across many different applications, including automotive, industrial safety equipment, and residential power generators **(Figure 8)**. Using advanced thermal conductivity detection technology, it delivers lasting and accurate performance for 10 years without requiring manual intervention. These sensors offer advantages over catalytic-bead-based detectors, including higher accuracy, longer lifespan, and improved resistance to chemical poisoning. These features ensure reliable monitoring and protection of both lives and assets. The HLD sensor can also be customized to meet specific application requirements, accelerate time to market, and enhance reliability. Given the critical nature of these solutions, global engineering and service support is available.

HLD Series Applications

Typically adjacent to the hydrogen storage tank, hydrogen gas piping, fuel cell, or vehicle cabin, the HDL from Honeywell can be used in hydrogen-powered:

- Heavy-duty trucks
- Buses
- Generators
- Automobiles
- Construction equipment
- Aircraft

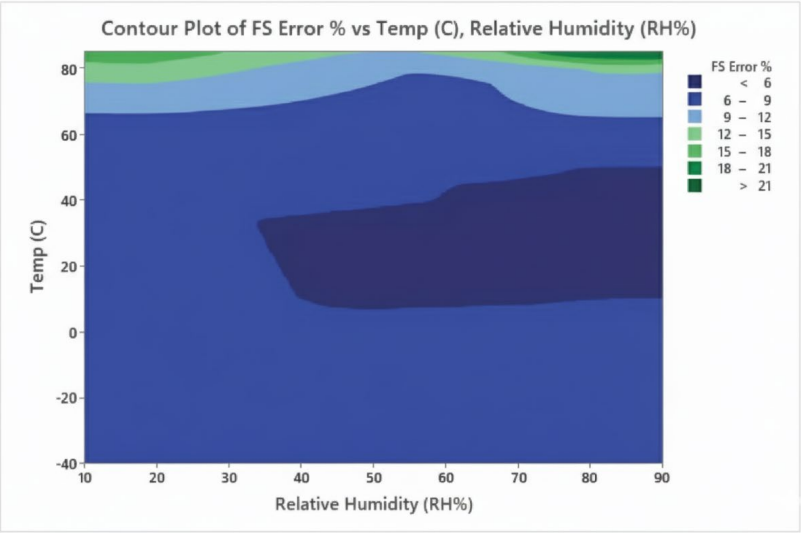


Figure 8: *Contour plot graph of the H2 sensor accuracy (as a percentage of the sensor's full-scale range) of the HLD Series from Honeywell as a function of application temperature and humidity.*

CASE STUDY: BRINGING SAFETY TO THE GLOBAL HYDROGEN ECONOMY

BWR Innovations is an early adopter of the Honeywell HLD solution, using it to enhance safety as it modernizes energy infrastructure with hydrogen solutions. The company's Oncore Energy system—a versatile hydrogen fuel cell generator for home and commercial applications—features Honeywell's HLD sensors. Unlike other hydrogen detection technologies that require frequent calibration, the HLD sensor is designed to operate without regular manual intervention, meaning it can be installed adjacent to a hydrogen storage tank, gas piping, fuel cell, or vehicle cabin and not require adjustment or manual calibration for 10 years. Learn more here about how Honeywell and BWR Innovations are increasing the safety of the global hydrogen economy with the HLD leak detection sensor.

CONCLUSION: BUILDING A SUSTAINABLE FUTURE TOGETHER

Why Honeywell and Powell Are the Right Choice for Your Clean Energy Projects

The transition to clean energy represents both a tremendous opportunity and a complex technical challenge. It demands solutions from a trusted provider of reliable products that inspire consumer confidence. Honeywell's advanced portfolio of battery safety, current sensing, and leak detection solutions enables companies to navigate this transition safely and effectively. Through the partnership with Powell, customers gain several key differentiators, including:

- A comprehensive portfolio that serves as a single source for a wide range of critical sensing solutions.
- Engineering expertise backed by decades of experience and deep application knowledge.
- Global scale and support via a reliable supply chain and support network to meet global demand.
- Commitment to quality and an unwavering dedication to reliability and performance.
- Access to future-focused innovation from trusted suppliers of next-generation clean energy technology.

- Honeywell leads the way in clean energy innovation with its advanced electrification and battery safety sensing technologies. As a trusted partner and distributor, Powell ensures easy access and clear understanding of Honeywell's broad portfolio of sensors—including current, pressure, aerosol, and electrolyte vapor detectors. Together, Honeywell and Powell can help you enable the safe and effective adoption of clean energy.

RESOURCES AND NEXT STEPS

Ready to power the future with safe and reliable solutions?

Let's discuss how Honeywell and Powell can support your electrification and clean energy projects.

Contact an Expert Today!

Explore Our Solutions:

- Battery Safety Solutions | Honeywell
- High Accuracy Transportation Current Sensors | Honeywell
- BES LITE Series | Honeywell
- BES Series | Honeywell
- HLD Series | Honeywell
- Hydrogen Leak Detector | Honeywell
- Sensors Solutions for Electric Vehicles | Honeywell
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