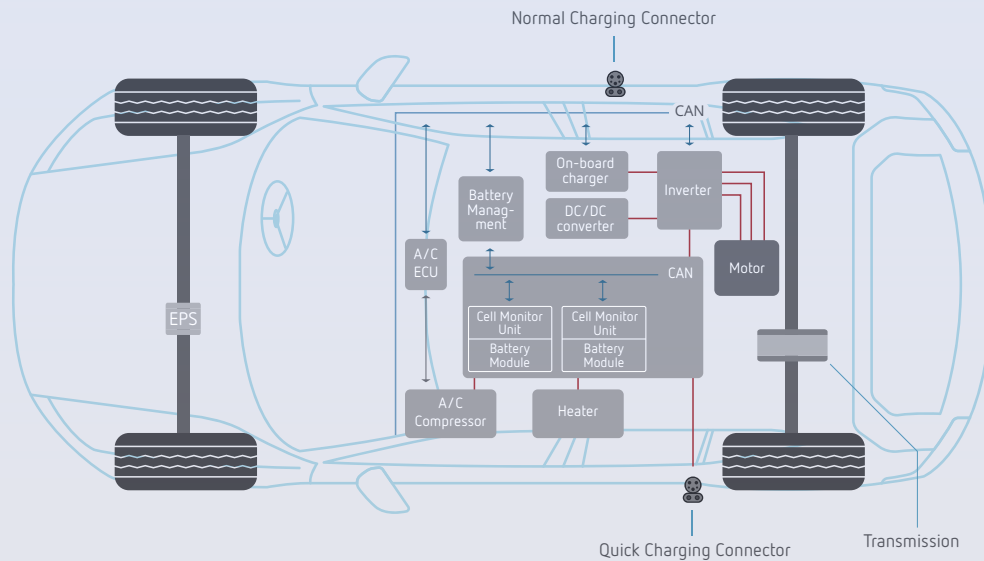


STANDARD AND CUSTOM EV ISOLATION MEASUREMENT SOLUTIONS

Empowering Automotive Efficiency





An electric vehicle (EV) business asked Standex

Detect for a solution. At the time, EVs were undergoing rapid development, as they still are today. There were few industry-wide generally accepted solutions for a number of design problems. This is a story of how one such problem was solved.

For safety reasons, an EV's battery and other high-voltage components are completely isolated from the vehicle chassis. Doing so reduces the chance of electrocution during vehicle maintenance and after vehicle crashes. High voltage (HV) is defined as 60V or more. In Figure 1, the HV components are those with red connections.

A number of factors enter into accurately measuring the isolation resistance:

- Safety standards require the breakdown voltage across the isolation barrier to be at least three times the battery voltage.
- Safety standards require a minimum isolation barrier resistance of $500 \Omega/V$. At 800 V, this is 400 k Ω , a relatively large value.
- There is significant capacitance between the chassis and the high voltage buses. Not only is there stray capacitance, but also capacitance added for electromagnetic compatibility (EMC) suppression. High resistances combined with high capacitances result in long settling times in isolation resistance measurements
- Battery voltages are increasing in order to increase efficiency and range. Battery voltages of 800 V are now common.



The Right Measure

To measure the isolation resistance, the BMS creates a temporary connection between the HV buses and the chassis. There are two reasons

for doing this. First, it is not possible to measure the isolation resistance without creating an additional connection across the isolation barrier. Second, the BMS creates a temporary connection in order to preserve the high isolation under normal operating conditions. Finding a solution to creating this connection is the problem that was solved.

As is typical with any design, the company making the EV BMS had numerous requirements for the device which spans the isolation barrier to connect the HV and chassis:

- Breakdown voltage across contacts > 4500 V
- Isolation resistance across contacts > 1012 Ω
- Dielectric strength between coil and contacts > 7000 V
- Operating temperature of 105°C
- Adherence to standards (AEC-Q200, IEC 60664-1, ISO 6469-3, etc.)

Because of Standex Detect' knowledge and use of many different technologies as well as extensive experience as an automotive component supplier, a cost-effective solution that met the requirements was quickly developed. In this particular case, the solar panel industry had a similar requirement for which Standex Detect had already provided a solution based on a standard product. The solution was a reed relay having an open-circuit breakdown voltage of more than 4500 V and isolation resistance of $>10^{12} \Omega$.

The Best Solution

Other solutions were also considered but were not the best fit for the requirements. For other suppliers with limited technological expertise, the supplier may steer the customer to a suboptimal solution because of their interest in winning the business. Standex Detect has expertise in many technologies. For example, solid-state photoMOS relays, also manufactured by Standex, was another technology that may have been used in this application but was not the best fit because very high voltage MOSFETs are high cost and not widely available. Another possible solution was an electromechanical relay not of the reed relay type. However, reed relays have many advantages over typical electromechanical relays, including:

- **Low power.** In this case, only 300 mW of power needed to be applied to the coil to activate the relay and close the electrical contacts.
- **Small size.** In this case, the size was just 9 x 11 x 30 mm.

- **High reliability.** The electrical contacts in a reed relay are hermetically sealed. This improves contact reliability, including contact resistance and isolation resistance stability.
- **No issue with small electrical loads.** Most electrical contact materials oxidize over time, creating a barrier that can be difficult to break through, particularly with small electrical loads that cannot supply significant energy. The reed relay's hermetic seal prevents contact degradation due to oxidation or corrosion.
- **Long life. Reed relays have unlimited mechanical life.** Life is limited only by contact wear induced by the electrical load. Though varying greatly with the electrical load, tens or hundreds of millions of operations are common.

Standex Detect supplies both standard off-the-shelf parts and fully custom parts to the automotive industry. Frequently, a standard part is customized to meet the needs of a specific application. In this case, the standard part was customized by increasing the breakdown voltage, improving the coil parameters and improving the resistance to shock and vibration.



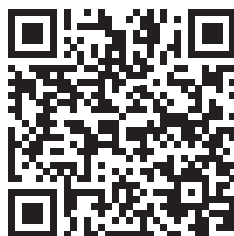


The development process in this specific case was fairly typical. The Standex sales team worked closely with the EV BMS company's procurement specialists and product design engineers. As the process continued, manufacturing and quality personnel from both companies became involved. Standex strives to work closely to meet goals, expectations and avoid miscommunication.

Because of the global nature of automotive manufacturing, it is valuable to have a supplier that is also global. In addition to a worldwide sales presence and global supply partners, Standex Detect has manufacturing and product engineering in Asia, Europe and North America. Standex Detect also has a high level of vertical integration which improves the control of quality, costs and delivery. In this case, Standex Detect manufactures not only the reed relay, but also the two major sub-components within the reed relay – the reed switch and the coil.

Although just one application and one part was highlighted here, Standex Detect has a wide range of standard and custom automotive solutions available using various reed relays, proximity sensors, fluid level sensors, inductors and transformers.

To learn more about how Standex Detect can support your high-voltage test and measurement projects with custom relay solutions, visit standexdetect.com or contact our engineering team to discuss your specific application needs.



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