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Battery Sealing Strategies

Hermetic epoxies seals protect lithium ion batteries

Whether they take to the streets in electric vehicles or stand still in energy storage systems, lithium-based battery modules pose a tough challenge from a wire sealing standpoint. Modern battery modules have a variety of power and signal conductors running between their individual electrochemical cells and through the battery pack's exterior casing. Some or all of these conductors typically require hermetic feedthroughs to protect against contaminants, humidity and leakage.

For safety reasons, these feedthroughs have to be absolutely dependable—even when subject to recurring shock-and-vibration loads, temperature extremes and potentially corrosive electrolytes.

Increasingly, battery makers are looking to epoxy-based feedthroughs as an alternative to glass-to-metal seals. Epoxies have a unique balance of mechanical, electrical, thermal and chemical-resistance properties that make them a good fit for battery sealing applications.

We recently helped a maker of advanced lithium ion battery systems address its wire sealing challenges with a custom hermetic feedthrough assembly for power and a hermetic circuit seal for condition monitoring signals. Here's a closer look at what we delivered:

StudSeal For Power

Our StudSeal™ hermetic feedthroughs are used in a variety of vacuum or pressure applications where high current or high voltages penetrate a barrier. In this lithium ion battery, StudSeal passes about 80 Amps through an internal gas filled casing that surrounds the individual electrochemical cells. Hermetically sealed to $1x10^{-8}$ cm^3 He/sec and pressurized, the internal casing primarily protects the battery from external humidity and ensures an ideal operating environment.

The epoxy formulations used in StudSeal feedthroughs have passed compatibility testing with traditional electrolyte battery chemistry. And these formulations are also compatible with a long list of potentially corrosive chemicals—including brake fluid, engine oil, road salt, solvents, gasoline and diesel. More importantly in this application, StudSeal epoxies also tolerate and block the flow of inert gases such as helium or argon.

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During the development of this battery system, we initially used one of our off-the-shelf StudSeals. It has a proven mounting design based on a threaded connection with an o-ring and jam nut.

As the project developed, however, we subjected the power feedthrough to a design-for-manufacturability analysis. We discovered we could reduce the mass of the feedthrough by roughly 10 percent by directly bonding the StudSeal to the internal casing—and doing away with the threaded connection. At the same time, we eliminated a potential leak path associated with the o-rings. And best of all, the direct bonding reduced the cost of the feedthrough assembly by roughly 20 percent.

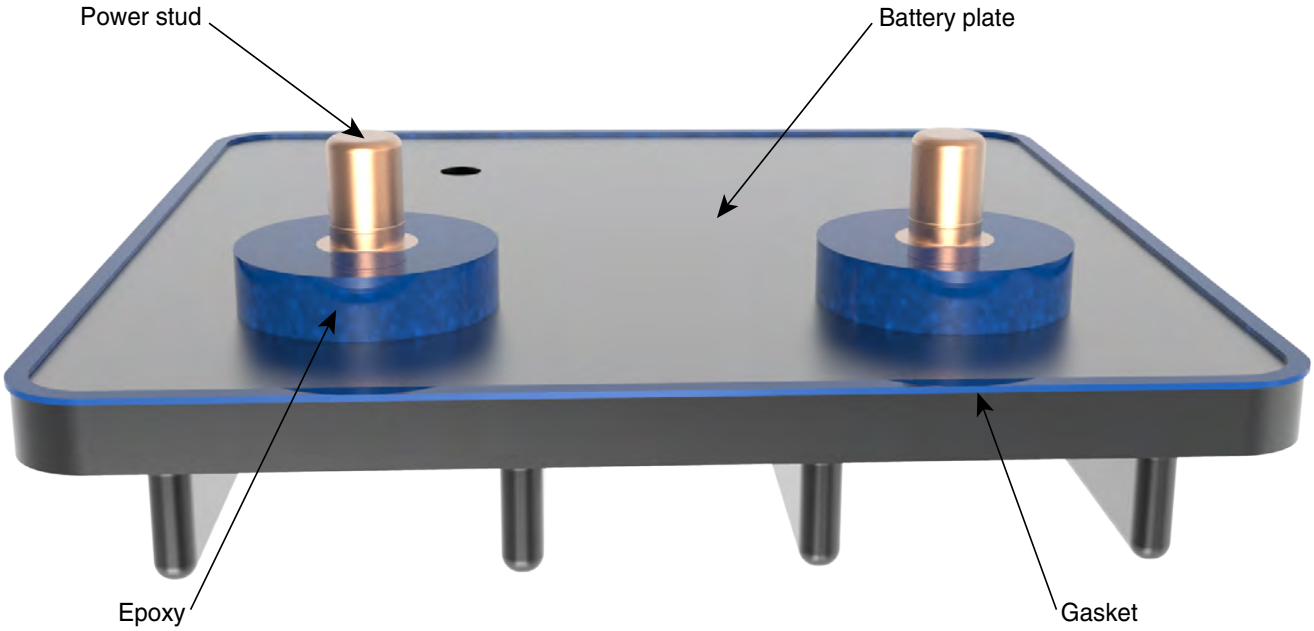
We take care of the entire StudSeal assembly operation in our shop. The battery manufacturer ships the housing blank to us, and we handle the epoxy application that permanently bonds the StudSeal to the casing while sealing it to hermetic standards.

CircuitSeal For Signal

The battery management systems for lithium ion batteries require condition monitoring signals—such as temperature and voltage—to pass through the sealed battery container. That's where our CircuitSeal™ technology comes in.

CircuitSeal uses epoxies and proprietary manufacturing techniques to hermetically seal and integrate printed circuit boards and connectors, creating a feedthrough assembly that saves space and weight while supporting high conductor densities.

StudSeal Assembly



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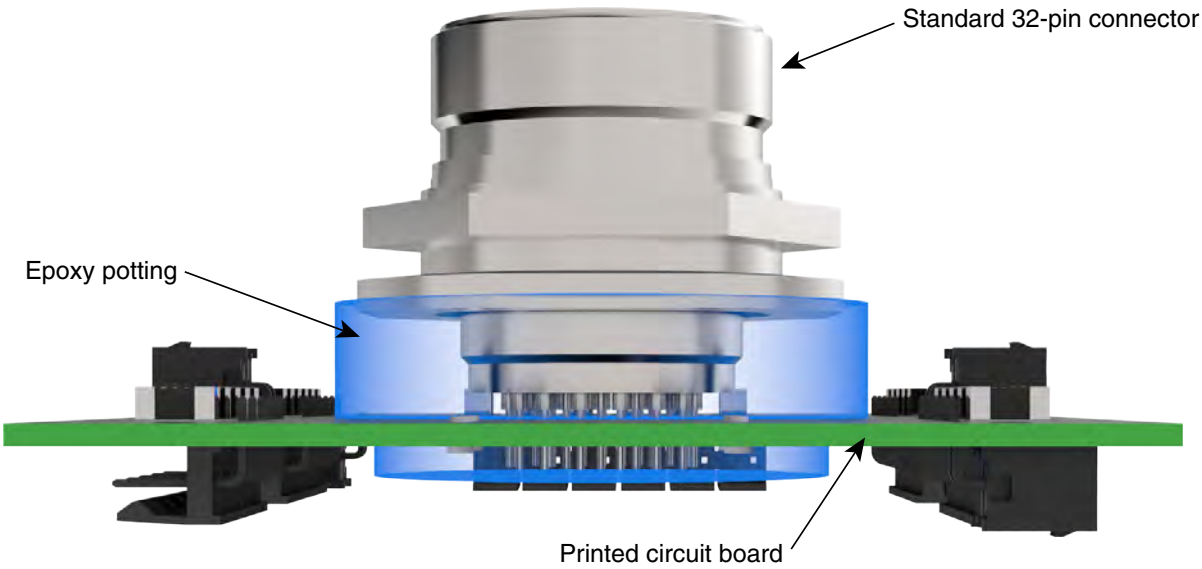
CircuitSeal Assembly



In this application, the CircuitSeal consists of a standard 32-pin connector and a PCB that processes signals for the battery management system. The feedthrough installs in the internal casing wall during the battery assembly process.

We make CircuitSeals every day, but this particular design did require some extra attention due to the inert gas environment in the battery housing. Because the dielectric constant of the inert gas environment is about three times lower than air, the potential for electrical arcing rises dramatically.

So we created a CircuitSeal design that uses an additional cap layer of epoxy potting material to provide electrical isolation between adjacent pins as well as between the pins and surface mounted components. A separate layer of the same epoxy material was used to back-pot the non-hermetic 32-pin connector and create a true hermetic seal. These back-potting operations are increasingly common for us, since we often need to work with off-the-shelf connectors that do not offer hermetic performance. By back-potting these standard connectors, we can take advantage of the low cost and design flexibility of standard connectors without sacrificing hermetic performance.

Delivering both the electrical and hermetic performance required careful formulation of the epoxy—which had to strike a delicate balance between electrical, mechanical and flow properties. And the complexity of this electrically-isolating feedthrough design involved the development of a new manufacturing process.

But the results paid off. This CircuitSeal meets the hermetic performance requirements of $1x10^{-8}$ cm^3 He/sec while readily withstanding voltages as high as 2700 Vdc.

For more information on hermetic wire and feedthrough technologies, visit www.douglaselectrical.com