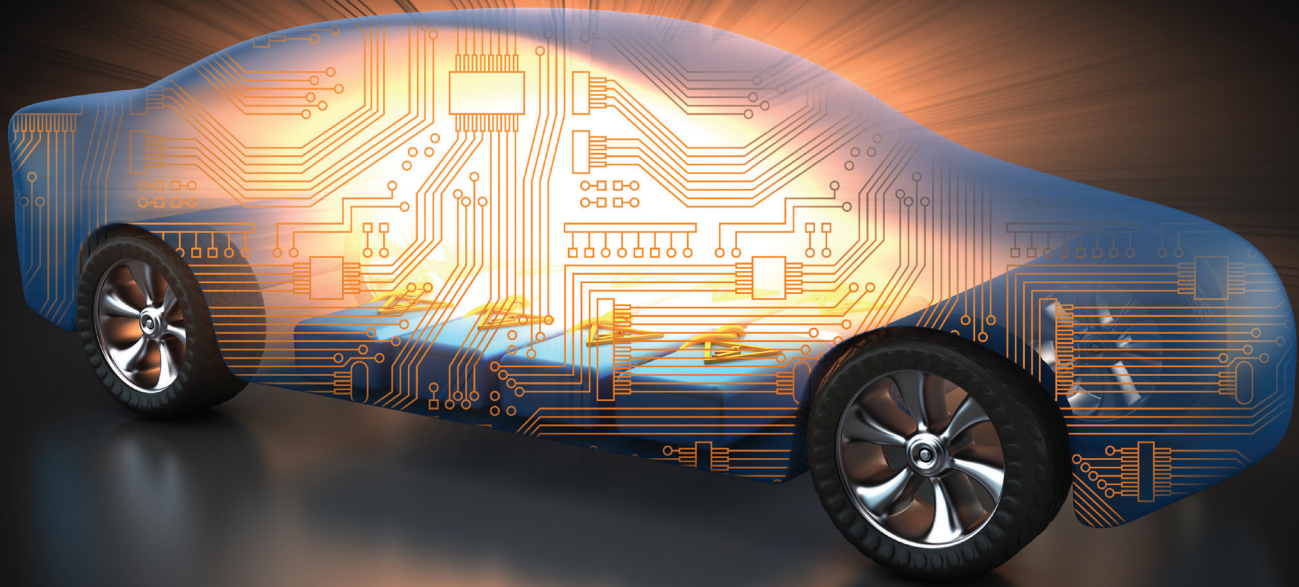




Douglas Electrical Components

WHITE PAPER

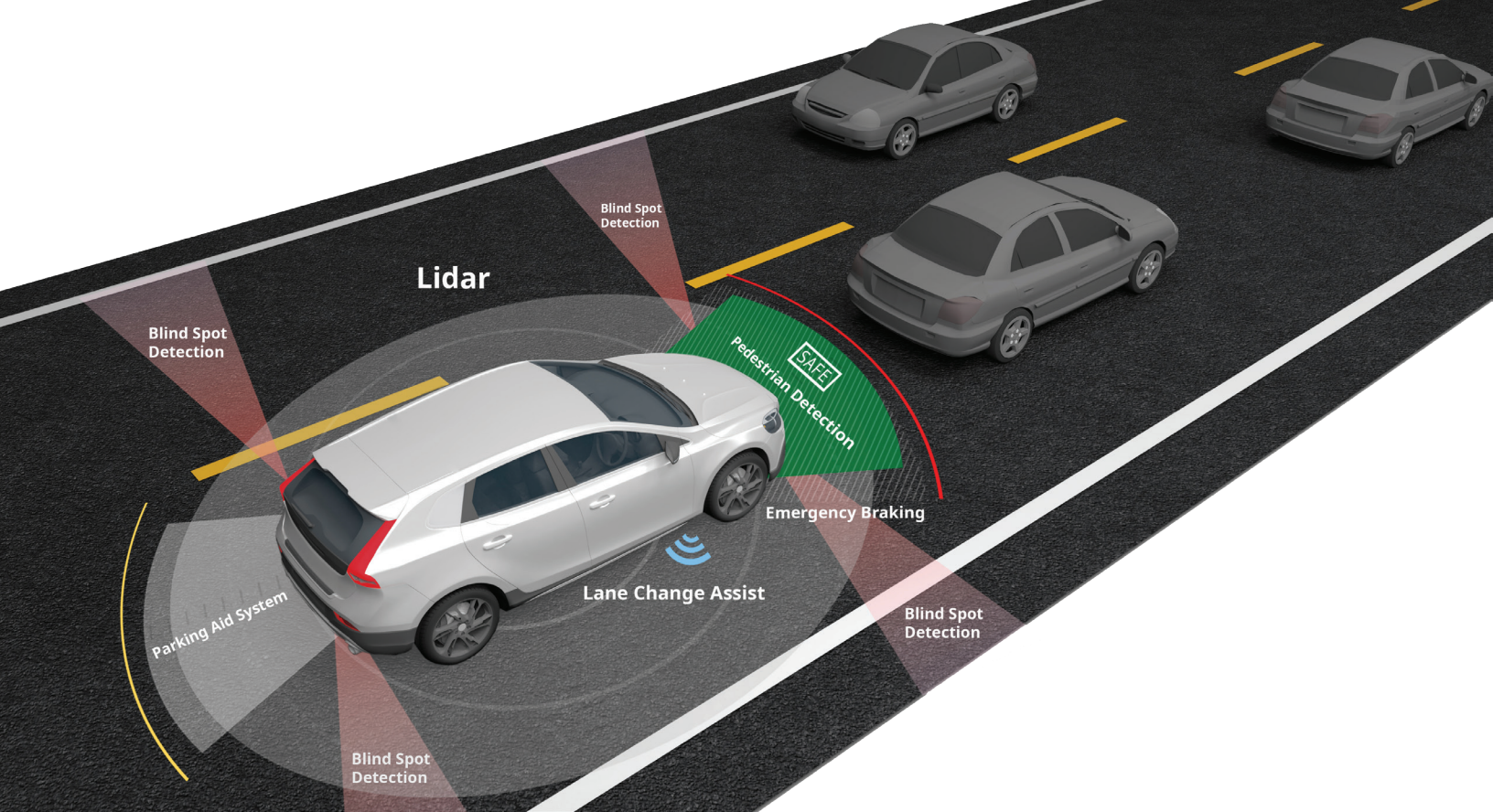


# HERMETIC FEEDTHROUGHS BLOCK MOISTURE IN TOMORROW'S AUTOMOTIVE ELECTRONICS

**Choosing the right hermetic sealing technology for sealed electrical packages keeps fail-safe systems running.**

Electronics failures can bring critical automotive functions to a sudden halt. Experts specializing in electronics failure analysis can list a host of reasons for various malfunctions, but one of the most common causes is simple moisture. Because water and electronics do not mix well, several strategies exist to protect components from moisture and condensation. One of the most successful methods of protecting key components from water hazards involves hermetically sealed electronics cavities — enabled by moisture-blocking component assemblies such as hermetic feedthrough technology.

Sealed cavities are especially important in fail-safe automotive applications where LIDAR or camera sensors are used to perform driver-assist functions like autonomous emergency braking, adaptive cruise control, forward and rear collision warning, lane change assist, intelligent parking, cross traffic alert and blind spot detection. Electronic control units and charging stations represent other important automotive applications where electronics need to be protected from water vapor and condensation.



Automotive electronics, such as those that incorporate LIDAR and camera sensors to perform driver-assist functions, are subject to failure from moisture incursion.

And as self-driving car technology advances toward fully autonomous operation, the advanced electronics that make it all possible will need unparalleled protection from moisture. The SAE has classified the varying degrees of autonomous operation, per its SAE J 3016 guidelines ranging from Level 0: No Automation to Level 5: Full Automation, with each level having a specific set of requirements that a vehicle must satisfy to be classified for that Level. As the industry advances its leading edge production vehicles from Level 2, Partial Automation to Level 3, Conditional Automation, advanced sensors will be vital for the safety features at this and succeeding autonomous Levels. That means these systems will need to exceed IP ratings for moisture ingress, and the grommets or RTV seals typically used to prevent moisture ingress will no longer be sufficient. For these reasons, reliable sealing for leading-edge automotive electronics involves two major considerations — accounting for moisture sources in the ambient environment and choosing a robust hermetic feedthrough that will keep moisture from wicking into the electronics cavity while allowing power and signal conductors to enter.

## IDENTIFYING WATER VAPOR AND CONDENSATION SOURCES

Electronics failures due to water vapor and condensation can occur in a number of ways, and electronic systems are one of the areas on modern cars that are still prone to corrosion and rust. Some of the most common sources include corrosion of solder joints, shorts caused by water droplets, and stress corrosion cracking of seals and electrical interface areas. Glass seals with unseen defects and those under high residual stresses can crack and fail over time, especially in cold temperatures.

Water vapor within hermetic packages may arise from several sources, which are important to be aware of. With die attach adhesives, water is often generated as a byproduct of the curing process itself. This is due to certain bonding agent chemistries that produce water during polymerization reactions when adhesives are curing.

To avoid this issue, be sure to finish the curing process before sealing or choose an epoxy formula that does not contain water byproducts. Pre-baking materials can also eliminate any trapped moisture in components.

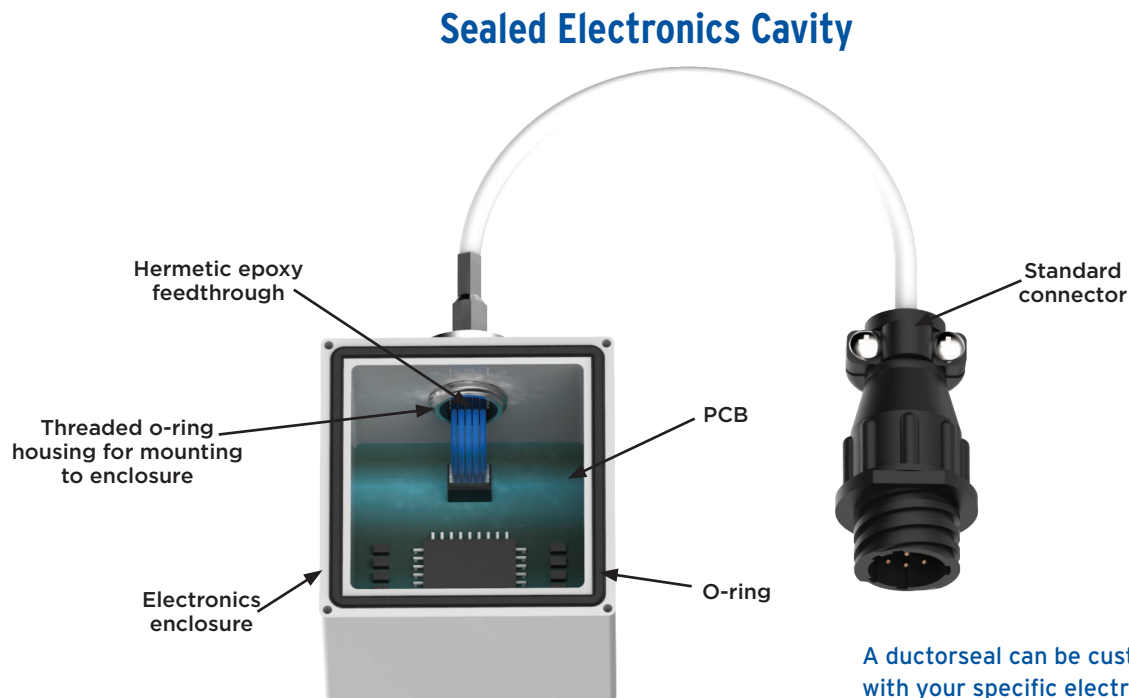
Water issues can also occur during the sealing of gas containers. To attack this potential issue, manufacturers vacuum purge and backfill hermetic cavities before sealing — typically using helium, nitrogen and dry air. However, improper gas control or faulty sealing techniques can lead to water vapor becoming trapped in tanks and cavities. Yet another source of moisture is fine package leaks. This is especially tricky because the pass-fail mark for helium fine leak testing is traditionally set at  $<1 \times 10^{-8}$  atm-cc/sec to prevent moisture ingress, but even smaller amounts of vapor ingress can cause failure in sensitive devices over time. Note that the helium leak rate can be easily converted to a water vapor leak rate by using a 0.469 multiplication factor.

To avoid these water vapor issues in hermetically sealed electronics cavities, it is important to choose the most suitable materials for all components, use careful process control when sealing and specify reliable hermetic feedthroughs such as epoxy-based units. Stringent testing is also important to evaluate the moisture resistance of various components and subassemblies. When it comes to protecting electrical components, suppliers strive to meet strict U.S. military standards as well as Ingress Protection (IP) and NEMA standards to assure customers that their parts are of the highest quality.

## EPOXY-BASED FEEDTHROUGHS AND SEALING TECHNOLOGIES

Due to its excellent and robust mechanical properties and resistance to temperature extremes, epoxy is considered an ideal material for creating reliable and long-lasting hermetic seals around wires and connectors that pass into pressure or vacuum systems. For example, Douglas Electrical manufactures epoxy feedthroughs and connectors that accommodate various conductors including:

- **Discrete wires and cables.** DuctorSeal® feedthrough seals provide a hermetically sealed interconnecting harness in a single, pre-tested, ready-to-install assembly which can house virtually any wire or cable.
- **Fiber optics.** With a growing demand for complex optical systems, we have developed a variety of OptiSeal™ feedthrough solutions designed to penetrate sealed electronics cavities.
- **Circuit boards.** CircuitSeal hermetic feedthroughs can utilize rigid PCB, flex circuits and flat flex cable (FFC) while providing low weight, low cost and high conductor density for a variety of sealed electronics applications.



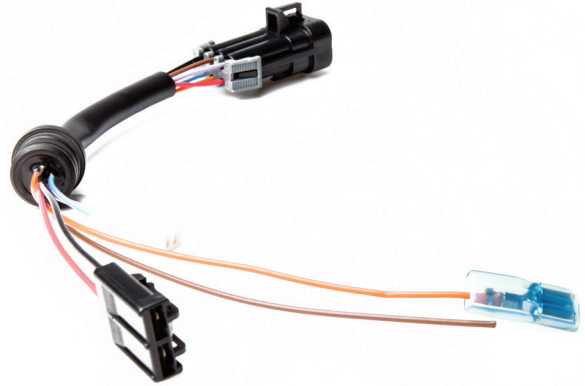
Douglas Electrical epoxy feedthroughs withstand stringent performance test requirements intended to ensure quality in the harshest environments and most difficult applications. These include the vacuum to  $1 \times 10^{-10}$  torr; pressure to 15,000 psi; temperature ranges from  $-350^{\circ}$  to  $350^{\circ}\text{F}$ ; wire gauges from 38 AWG to 500 MCM; conductor counts from one wire to 3,200 in a single feedthrough; and cable lengths to 500m. Extending these capabilities well beyond the needs of the automotive industry, our hermetically sealed cables and connectors are widely specified in demanding applications such as advanced weapon systems, downhole oil and gas equipment, medical imaging systems, high-voltage electric switchgear and semiconductor manufacturing equipment.

All of Douglas Electrical's epoxy seals easily meet the MIL-STD-883 definition of hermetic with a typical overall assemble leakage rate of  $<1 \times 10^{-9}$  cc-He/sec. Douglas even provides the hermetic seal to an OEM that manufactures extremely high accuracy moisture sensors capable of 0.1 ppb sensitivity levels. Douglas epoxy feedthroughs and seals are also designed to exceed the Ingress Protection (IP) 69 ratings for liquid protection, NEMA standards for moisture and NEMA 6 and 6P ratings for submersibility. When automotive systems designers choose Douglas hermetically sealed products, not only can they be confident their products meet or surpass strict industry standards, they're also partnering with a company with decades of experience providing the automotive industry with reliable sealing technology for fuel pumps, batteries, magnetic suspension and kinetic energy recovery systems.



CircuitSeals can integrate sensing elements, rigid boards, FFC cable, traditional wires and signal conditioning in a space-efficient package.

## Traditional Automotive Harness



A traditional Ductorseal will mount using an easy to install radial o-ring housing and incorporate a fully connectorized harness.

## UNDERSTANDING MANUFACTURING AND USAGE VARIABLES

Being proactive about moisture control is critically important to keeping sensitive electronic systems up and running, especially in harsh automotive conditions that can lead to corrosion concerns. In fact, electrochemical migration caused by corrosion often results in spotty performance and short circuits. In order to avoid failure issues, it is important to pay attention to the assembly environment and hermetic packaging materials. Ambient air containing moisture can become trapped in electronic devices and cavities during assembly. Further, temperature drops can also cause water condensation within devices.

One way to prevent — or at least reduce — water ingress is to work with an experienced electrical component supplier. This can go a long way towards minimizing electronics failures associated with moisture. Finally, selecting a reliable hermetic feedthrough technology and minimizing ambient moisture sources will help keep automotive systems in peak operating condition.

**For additional information on hermetic feedthroughs for automotive electronics, please visit <http://www.douglaselectrical.com>.**

**For sales information, contact Chris Rempel at (973) 627-8230, or at [crempel@douglaselectrical.com](mailto:crempel@douglaselectrical.com).**