Automotive Vents

Selecting the Right Vent to Extend the Lifetime of Electronic Components in Vehicles

Introduction

In today's automotive industry, the number of electronic components built into vehicles is growing rapidly as more mechanical parts are being replaced with electrically powered parts, and driver assistance programs are becoming more common. This shift is pressuring automakers and suppliers to find effective ways to protect electronic components against harsh contaminants and ensure reliable performance for the entire lifetime of the vehicle.

Electronic components such as compressors, pumps, motors, control units and sensors in vehicles are exposed to rapid temperature fluctuations. For example, electronic components heat up when the vehicle is in operation; then they cool down very quickly when they come into contact with cold spray from the road or at the car wash. These temperature fluctuations can create a significant vacuum inside the housing. As a result, the housing seals can be compromised, allowing dirt particles and liquids to enter and corrode the components — eventually causing them to fail, which increases warranty issues and repair costs.

A major challenge for electric vehicles is the thermal management of high-performance electronics and batteries because they need to operate in a certain temperature range to achieve optimum performance. These components can get very hot when the vehicle is running, so fluids are frequently used to keep them cool. This causes significant temperature differentials inside the components allowing condensation to form at the coldest point in the housing, which can lead to corrosion or cause a short circuit. It is even more difficult to equalize temperature and pressure inside large batteries due to the size of the housing. For example, driving a vehicle out of a warm garage into the cold weather can produce an interior vacuum that exerts a negative pressure of 500 kilograms per square meter — lightweight housings are barely able to withstand that kind of pressure. Even minor temperature fluctuations can put enough pressure on a housing to cause deformation.

The easiest way to equalize pressure is to drill a hole in the housing to allow air to flow freely in and out. However, this allows liquid and particulates to enter the housing easily and compromise the electronics, causing them to fail.

Engineers use various ways to try to increase reliability of sealed enclosures. Some engineers use a technique called potting to create a perfectly sealed system around the component by eliminating free space inside the housing. However, this makes the component significantly heavier, adding weight to the vehicle, and it cannot be reopened and repaired if the electronics fail. Another way is to hermetically seal the housing so that the seals cannot be compromised by pressure. The drawback of this system, however, is that the housing must be able to withstand the sealing process, which results in a more expensive, heavier component that cannot be reopened for maintenance or repair. The most common solution has been to install more rugged O-rings or gaskets in a more durable housing, while increasing the number of bolts to maintain a more durable seal.

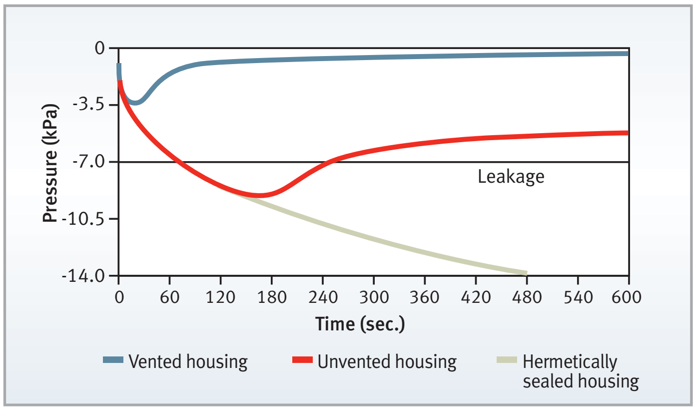
These techniques do not guarantee that sensitive electronics will be protected long-term against harsh environments (e.g., dust, dirt, water and automotive fluids) because they do not address the root cause of the failures — pressure differentials.

Automotive Vents

Venting to Improve Reliability and Durability

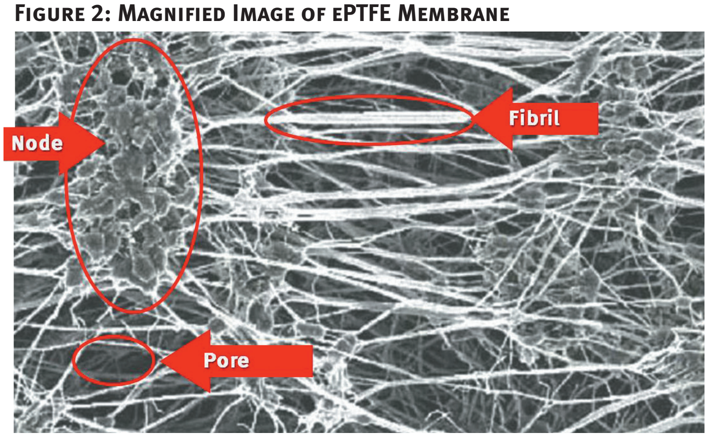
Incorporating a vent into a housing can reduce pressure differentials that compromise the component's integrity. In an unvented housing, as little as seven kilopascals (kPa) of pressure can cause seals to fail after several temperature cycles. Vented housings equalize pressure and avoid seal leakage (Figure 1). These vents are constructed with a breathable membrane that equalizes the pressure inside the housing while preventing the ingress of liquids and dirt particles.

Figure 1: Internal Pressure of Vented and Unvented Housings



Gore uses expanded polytetrafluoroethylene (ePTFE) as the membrane in its automotive venting products because of its unique microstructure. The ePTFE is specially engineered to create very fine pores in which nodes are interconnected by fibrils (Figure 2). This material is extremely hydrophobic (water-resistant) thanks to its low surface tension, which means that any water droplets on the surface are unable to penetrate the membrane structure. The membrane is also oleophobic (oil-resistant). Expanded PTFE's oil-repelling properties are particularly important for automotive applications, because it is very likely that the electronic components will come into contact with motor oil, cleaning agents or other automotive fluids.

Figure 2: Magnified Image of ePTFE Membrane



In addition, ePTFE withstands temperatures ranging from -150°C to 240°C. Until recently, electronic housings were designed to withstand temperatures up to 125°C. However, the trend toward smaller, high-performance engines and electric car technology has pushed this threshold to temperatures above 150°C.

Airflow and Water Entry Pressure

Airflow and water entry pressure are two fundamental characteristics that determine a membrane's performance. Airflow describes how much air can pass through the membrane in a given period at a given differential pressure (i.e., how long it would take to equalize a pressure differential inside a sealed component). Water entry pressure (WEP) is the minimum hydrostatic pressure that the membrane must be able to withstand before it leaks.

Both parameters are influenced by factors such as the pore size of the membrane, so the venting supplier must determine the ideal combination of airflow and water entry pressure for an individual application. The trend toward increasingly compact electronic components means that vents must also be smaller. This in turn requires greater airflow per membrane surface area, resulting in a lower water entry pressure. Gore draws on more than 50 years of expertise in fluoropolymer technology to engineer ePTFE membrane structure to match the specific airflow and WEP requirements of an application.

Testing to Ensure Durable Performance

In its global testing facilities, Gore verifies that its products meet the real-world challenges that they will encounter on the road to ensure reliability of the venting solution and extend the component's service life. The specific tests that Gore performs depend upon the electronic component and the type of challenges it will encounter. For example, the challenges for a sensor inside the passenger compartment are different from those encountered by a wiper motor. Some of the more common tests that Gore performs include ingress protection, chemical resistance and temperature resistance.

Ingress protection

Typically, a completed system is tested according to the International Electrotechnical Commission (IEC) protocol IEC 60529 to determine its protection level against solid objects and liquids. Defined by two digits (IPXY), the ingress protection rating varies depending on the type of testing done. The first digit (X) indicates the protection rating against ingress of solid foreign objects; the second digit (Y) indicates the level of protection against ingress of liquids (Figure 3). For example, IPX9k shows how well a vented housing remains watertight when exposed to steam jets. The IPX9k test is carried out in a testing chamber in which the vented housing is exposed to a steam jet from a distance of 100 to 150 millimeters (mm) at angles of 0, 30, 60 and 90 degrees. The water rate is kept between 14 and 16 liters per minute (l/min), water pressure is maintained between 8,000 and 10,000 kPa, and temperature is constant at 80°C.

FIGURE 3: INGRESS PROTECTION RATING FORMAT: IPXY

Level of Protection	Protection against Solid Object (X)		Protection against Liquid and Moisture (Y)	
	0	No protection	0	No protection
	1	Solid objects ≥ 50 mm in diameter	1	Drops of water or condensation falling vertically on an enclosure
	2	Solid objects ≥ 12.5 mm in diameter	2	Water sprayed at an angle up to 15° on either side of vertical
	3	Solid objects ≥ 2.5 mm in diameter	3	Water sprayed at an angle up to 60° on either side of vertical
	4	Solid objects ≥ 1.0 mm in diameter	4	Water splashed against the enclosure from any direction
	5	Dust entry is limited so operation of the apparatus or safety is not compromised	5	Water projected in low-pressure jets against the enclosure from any direction
	6	No dust particulates enter the enclosure	6	Water projected in high-pressure jets against the enclosure from any direction
			7	Temporary immersion in one meter of water for 30 minutes
			8	Continuous immersion under conditions agreed upon between the buyer and seller; Gore tests at two meters of water for 60 minutes
			9k	High-pressure steam jets from any direction

Type of Protection

Chemical resistance

Gore follows ISO 16750-5 standard to test its vents' ability to withstand chemicals and liquids commonly encountered in the automotive environment (Figure 4). Tests are performed following one of two protocols: The vent is exposed to the liquid for 24 hours at room temperature (21 to 23°C), or it is heated in an oven for 96 hours at 100°C. Airflow and water entry pressure are measured before and after the test. To pass the test, both WEP and airflow must remain within Gore's aggressive specifications of 80 kPa, which exceed the requirements of most automotive standards.

FIGURE 4: TYPICAL CHEMICAL RESISTANCE TESTS

Type of Liquid	
Antifreeze fluid	Differential oil
Automatic gear oil	Engine cleaning agent
Battery acid	Gasoline (super)
Biodiesel	Hydraulic fluid
Brake fluid	Manual gear oil
Caffeinated drink	Motor oil
Coolant	Sugary soft drink
Corrosion protection agent	Urea
Corrosion protection removal agent	Windshield wiper fluid
Diesel fuel	

Temperature resistance

Gore follows ISO 16750-4 protocols to test its vents' ability to withstand extreme temperatures. In the temperature resistance test, the vent is exposed to a maximum temperature of up to 150°C for 2,000 hours or to a minimum temperature of -40°C for 1,000 hours.

In the ice dunk test, the vent is placed in a sealed housing and heated in an oven at a temperature between 80 and 120°C for 40 to 60 minutes. The housing is then rapidly cooled to between 0°C and 4°C by placing it in iced water containing 5 percent sodium chloride — a solution simulating the salt water that electronic housings are likely to encounter during the winter. This procedure is repeated ten to twenty times, with venting properties measured before and after the test.

VENTING FOR DIFFERENT APPLICATIONS

Types of electronic components are vast — electronic control units, motors, sensors, special latches, radar systems, key fobs and more. Choosing the right vent to suit a unique application and its requirements is vitally important. Variables that can affect this decision include size, type and thickness of housing; vent location; and installation method. Gore works closely with its customers to evaluate the unique challenges of an application and recommend the best venting solution. Gore's application engineers also partner with its customers' production teams to determine the best integration method, whether using manual, automated or welded options.

Appropriate for manual or automated installation, GORE® Adhesive Vents are coated with a high-performance adhesive that adheres strongly to various kinds of metal and plastic. The adhesive is long-lasting and capable of withstanding harsh conditions. These vents are suitable for vehicle components such as automotive lamps because they reduce condensation by allowing moisture vapor to escape from the component while blocking entry of dust, dirt and liquid contaminants. For electronic components, pressure equalization is also critical. Combining these benefits with their low profile and easy installation have made adhesive vents a viable option for applications such as under-the-hood ECUs as well as hybrid and electric vehicle batteries.

GORE® Snap-Fit Vents can withstand the most challenging environmental conditions and are easy to install. Manufactured by integrating the membrane directly into the vent as part of the plastic injection molding process, these vents can be attached by simply snapping them into place in an opening in the housing. This process protects the membrane from mechanical loads without having to integrate expensive and complex protective walls into the housing. Furthermore, integrating the vent does not call for special machines or qualified experts — the vent is simply inserted in the housing via the "plug-and-play" method.

Gore's all-membrane cut-part vents provide a long-lasting, reliable solution for plastic housings that are exposed to high temperatures and strong chemicals. Offered in different materials and sizes to

Automotive Vents

suit the specific requirements of an application, these vents are attached using ultrasonic welding. At the weld seam, a small section of the housing material melts and flows into the porous structure of the membrane, thereby guaranteeing that the joint is sealed and solid. This process does not compromise the membrane because ePTFE's melting point is much higher than the welding temperature. The welding process can be complex, and it requires specialized tools. Also, walls have to be integrated into the housing to protect the vent from steam jets and mechanical loads. Gore's engineers work closely with customers to help design the integration process for these applications.

About W. L. Gore & Associates, Inc.

Gore is a technology-driven company focused on discovery and product innovation. Well known for waterproof, breathable GORE-TEX® fabric, the company's portfolio includes everything from high-performance fabrics and implantable medical devices to industrial manufacturing components and aerospace electronics. Gore products have remained at the forefront of creative solutions because they are engineered specifically for challenging applications requiring durable performance where other products fail.

For almost thirty years, Gore has delivered venting solutions for a variety of applications installed in rugged environments throughout the world — applications such as automotive and heavy-duty vehicles; solar, lighting, security, telecommunication and portable electronic systems; and chemical and agricultural packaging. Engineered with the latest materials and technology, Gore's vents are backed by years of research and testing to help extend product life and enhance reliable performance — all to ensure that these venting products can meet the challenging environments and application demands of today's technology.

GORE® Automotive Vents are trusted to perform reliably in real-world conditions, reducing condensation and preventing dirt, dust, debris, water and other automotive fluids from damaging sensitive automobile components. Gore's global engineering team collaborates with leading OEMs, Tier 1 and Tier 2 suppliers throughout their design and development process to select the best product from its portfolio to meet the specific application needs. GORE® Automotive Vents increase design flexibility and avoid production delays because their standard design can easily be integrated across platforms globally. In this way, Gore is able to develop venting solutions that not only meet current standards but also take into account future requirements of the automotive industry.

Headquartered in the United States, Gore employs approximately 10,000 associates in 30 countries worldwide. In Europe, Gore started its first business operations only a few years after the Enterprise's founding in 1958. Learn more at gore.com.

Please Contact Gore to Learn About the Right GORE® Automotive Vent for Your Unique Application

International Contacts

Australia	+61 2 9473 6800	Mexico	+52 81 8288 1281
Benelux	+49 89 4612 2211	Scandinavia	+46 31 706 7800
China	+86 21 5172 8299	Singapore	+65 6733 2882
France	+33 1 5695 6565	South America	+55 11 5502 7800
Germany	+49 89 4612 2211	Spain	+34 93 480 6900
India	+91 22 6768 7000	Taiwan	+886 2 2173 7799
Italy	+39 045 6209 240	United Kingdom	+44 1506 460123
Japan	+81 3 6746 2572	USA	+1 410 506 7812
Korea	+82 2 393 3411		

W. L. Gore & Associates, Inc.
401 Airport Road • Elkton, MD 21921 • USA
Phone: +1 410 506 7812 (USA) • Toll-free: +1 800 523 4673 (USA)
Fax: +1 410 506 8749 • Email: automotive.us@wlgore.com

gore.com/autovents

FOR INDUSTRIAL USE ONLY. Not for use in food, drug, cosmetic or medical device manufacturing, processing, or packaging operations.

All technical information and recommendations given here is based on Gore's previous experiences and/or test results. Gore gives this information to the best of its knowledge, but assumes no legal responsibility. Customers should check the suitability and usability in the specific application, since the performance of the product can only be judged when all necessary operating data are available. The above information is subject to change and is not to be used for specification purposes. Gore's terms and conditions of sale apply to the sale of the products by Gore.

Creative Technologies Worldwide

AVS-078-WHP-US-APR14