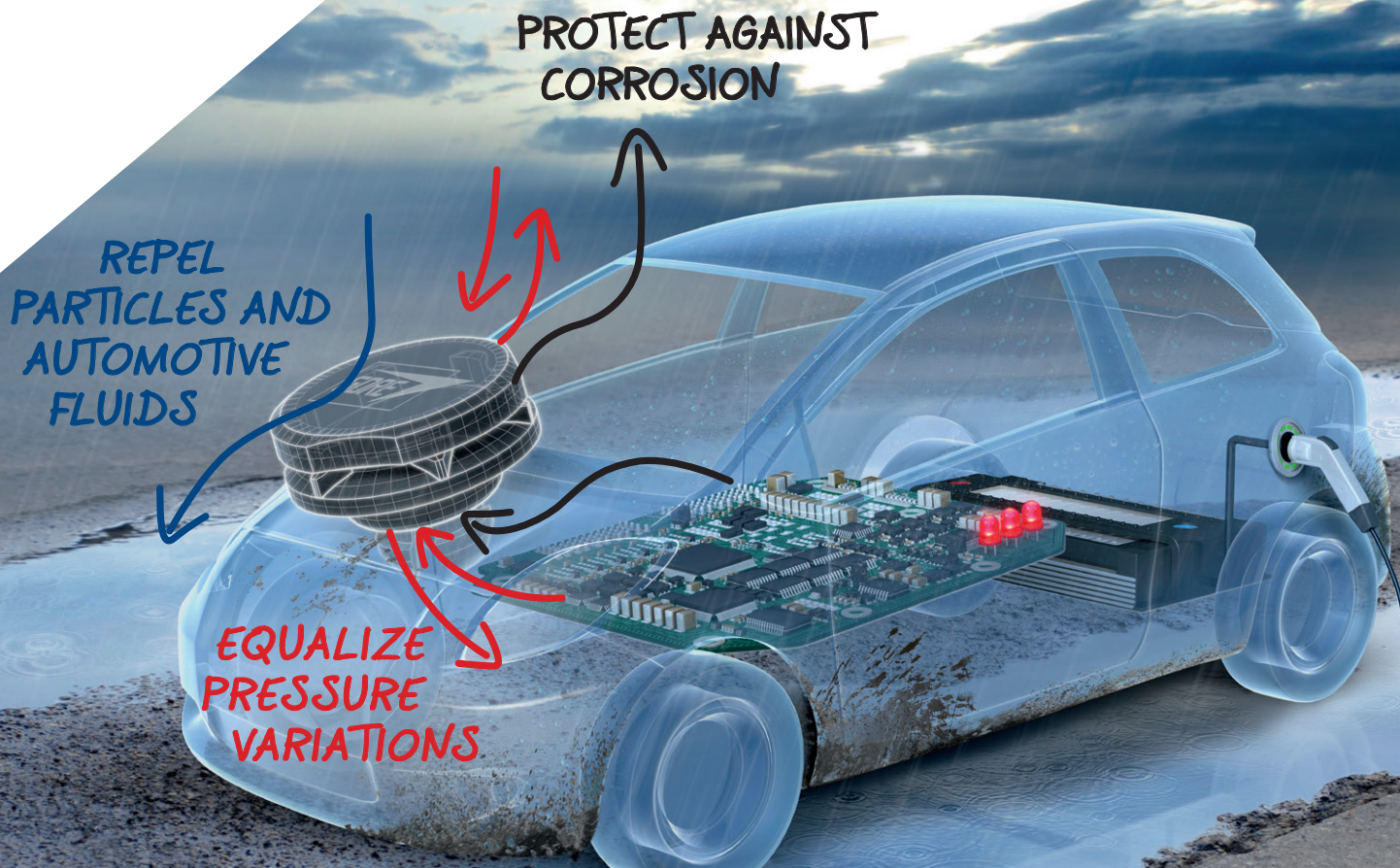


GORE® Automotive Vents
for automotive electronics

Together, improving life



YOU COUNT ON YOUR CAR'S
RELIABILITY. OUR VENTS
HELP TO ENABLE IT.

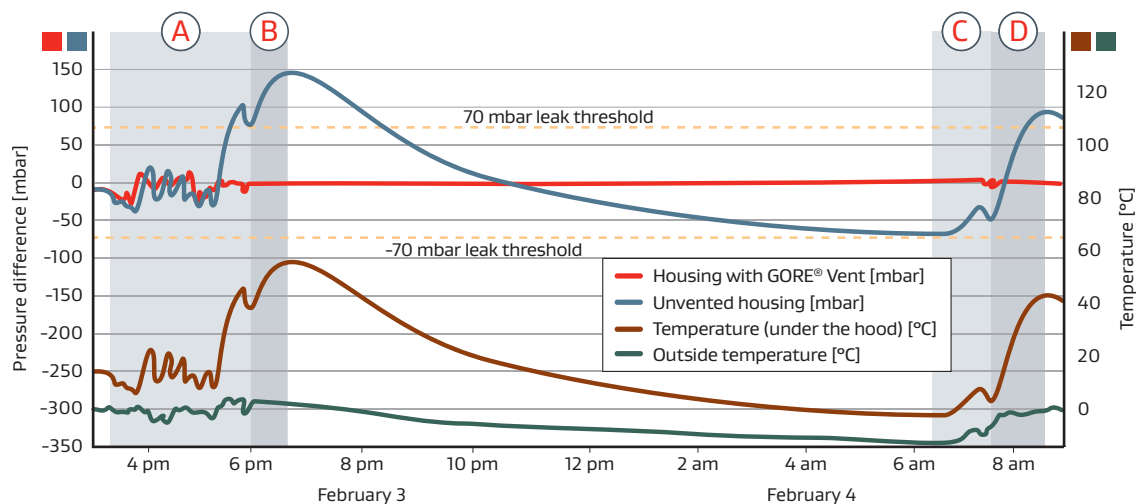
GORE® Automotive Vents protect
the integrity of sensitive
electronic components



Engine Shut-Off: a Challenge to Electronics

Whether your car is hybrid, electric or combustion-powered, its electronic components can be damaged or degraded by changes in temperature or altitude. These create pressure changes that can stress the seals of electronic enclosures — while the engine is running, and after a car is parked.

Engine start-ups and shut-offs create heat build-ups that can be particularly hard on electronic enclosures. Wind-cooling helps to compensate while the car is moving. But after the car is shut off, under-hood temperatures spike dramatically. This creates a corresponding — and potentially damaging — pressure spike within unvented enclosures. Venting is needed to preserve seal integrity.



On-Car Testing Tells the Story: Heat-Cycle Effects in Vented vs. Unvented Housings

A On the commute home, stop-and-start driving for errands creates a series of small temperature spikes, which are counteracted by wind-cooling. Later, a traffic jam causes rapid heat build-up, which is slightly offset by wind-cooling once the traffic begins moving again.

- In the unvented housing, pressure differentials spike above “safe” levels.
- The vented housing prevents the formation of dangerous pressure differentials.

B At 6 pm, the car is parked at home. After the engine is shut off, and wind-cooling has ceased, under-hood temperatures continue to rise dramatically.

- In the unvented housing, the resulting pressure differential persists at damaging levels until the night air cools things down.
- The vented housing keeps equalizing pressures even after the engine is shut off and wind-cooling effects are lost.

C The car starts up, and during the morning commute, under-hood heat builds, then dips as highway speeds create wind-cooling.

- Thus, no damaging pressure differentials occur in either vented or unvented housings.

D About 7:30 am, the car is parked at the office. Under-hood heat continues to build dramatically after the engine shuts off.

- The unvented housing suffers a dramatic pressure differential that reaches damaging levels.
- The vented housing rapidly and continuously equalizes pressures, far below the 70 mbar leak threshold.

Just 2 engine start-ups/shut-offs per workday will create more than **500 dangerous** under-hood **temperature spikes** per year. In unvented housings, the resulting pressure differentials can create premature seal failure. With GORE® Automotive Vents, these pressure differentials are rapidly and continuously equalized before they can stress seals and threaten the electronics within.

Engine Running: More Challenges Ahead

It is not only engine shut-offs that can threaten the integrity of electronic enclosures. Everyday driving exposes a vehicle to many other environmental challenges — any of which could damage enclosures, and the electronics within.

Changes in temperature and altitude create pressure differentials that can stress enclosure seals to failure. This can happen anywhere: driving in mountainous terrain, getting caught in a traffic jam or sudden inclement weather — or even at the car wash.

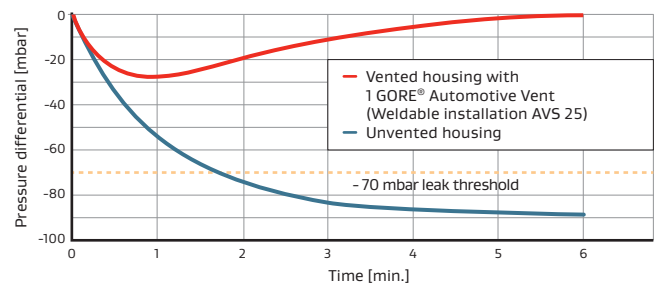


Temperature Shock: At the Car Wash

Entering the car wash, your Engine Control Unit (ECU) is at normal operating temperature. When the car is sprayed with cold wash water, a rapid temperature drop occurs.

In an **unvented housing**, this creates an interior vacuum of about 90 mbar. These sustained vacuums can pull water into the device through leak points such as wires and connectors. Typically, 70 mbar is the threshold for inducing seal failure over time. When seals fail, contaminants will readily enter the housing.

With a **GORE® Automotive Vent** installed on the ECU housing, the pressure differential is rapidly equalized and leak-inducing vacuums are averted.



Pressure Differential from Temperature Shock

- ECU Plastic Housing: 17 x 15 x 4 cm
- Free Air Volume: 0,5 liter
- Wash Water: 8-10 °C
- Temperature Drop: From 70 °C to 40 °C in 6 minutes

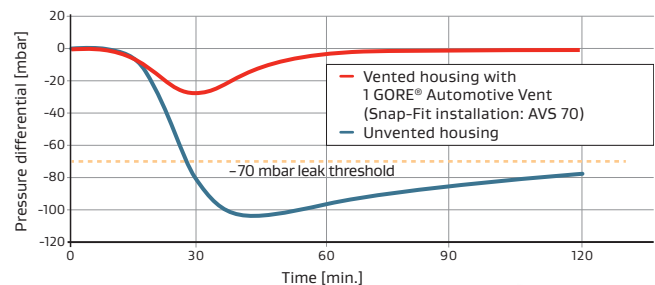


Altitude and Temperature Change: From Brenner Pass to Lake Garda

On this 2-hour drive, changes in altitude and temperature severely challenge your electric battery enclosure.

In an **unvented housing**, it takes less than half an hour to reach the critical 70 mbar vacuum — and this extreme stress continues for the remaining 1.5 hours. Under such stresses, even rugged seals will eventually fail, pulling in liquids and particulates. Also, this vacuum exerts extreme force on the housing's surface. Lightweight housings cannot long withstand such force.

With a **GORE® Automotive Vent**, the maximum vacuum is readily equalized without overtaxing the seals.



Pressure Differential from Altitude and Temperature Change

- Electric Battery Housing: 100 x 50 x 30 cm
- Free Air Volume: 50 liter
- From: Brenner Pass, 1370 MASL/0 °C
- To: Lake Garda, 65 MASL/25 °C

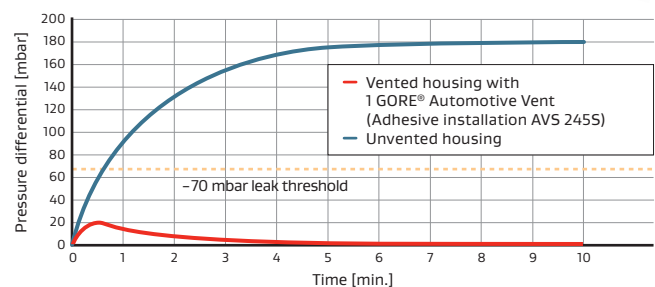


Heat Build-Up: Electronics at Work in a Traffic Jam

In the stop-and-start of a traffic jam, your car's distance radar is constantly in action — and heat levels within its enclosure are spiking.

In an **unvented housing**, this rapid temperature change creates a severe pressure differential — one that will exceed the critical 70 mbar threshold in less than 60 seconds! And each successive minute in the traffic jam continues this intense stress on the housing seals.

With a **GORE® Automotive Vent**, it takes only about 30 seconds before the pressure differential begins to move toward equilibrium.



Pressure Differential from Heat Build-Up

- Distance Radar, Steel Housing: 10 x 8 x 6 cm
- Free Air Volume: 0,3 liter
- Condition: Traffic Jam
- Heat Build-Up: from 35 °C to 90 °C in 10 minutes



For Every High-Value Component

Automotive electronics are proliferating. Increasingly, manufacturers replace mechanical and hydraulic components with electronic components, for higher efficiency with reduced emissions and fuel consumption.

The number of electronic driver assistance systems also increases. Along with ABS, ESP and traction control, many models feature distance radar, lane departure alerts, onboard cameras and other active safety systems.

Today's vehicles can have more than 100 sensors, 30 control units, 20 motors and actuators! GORE® Automotive Vents can help enclosures more effectively protect all of them!

GORE® VENTS FOR AUTOMOTIVE ELECTRONICS

Sensors

- ① Humidity Sensor
- ② Oxygen Sensor
- ③ Position Sensor and Actuator
- ④ Radar Sensor

Electronic Control Units

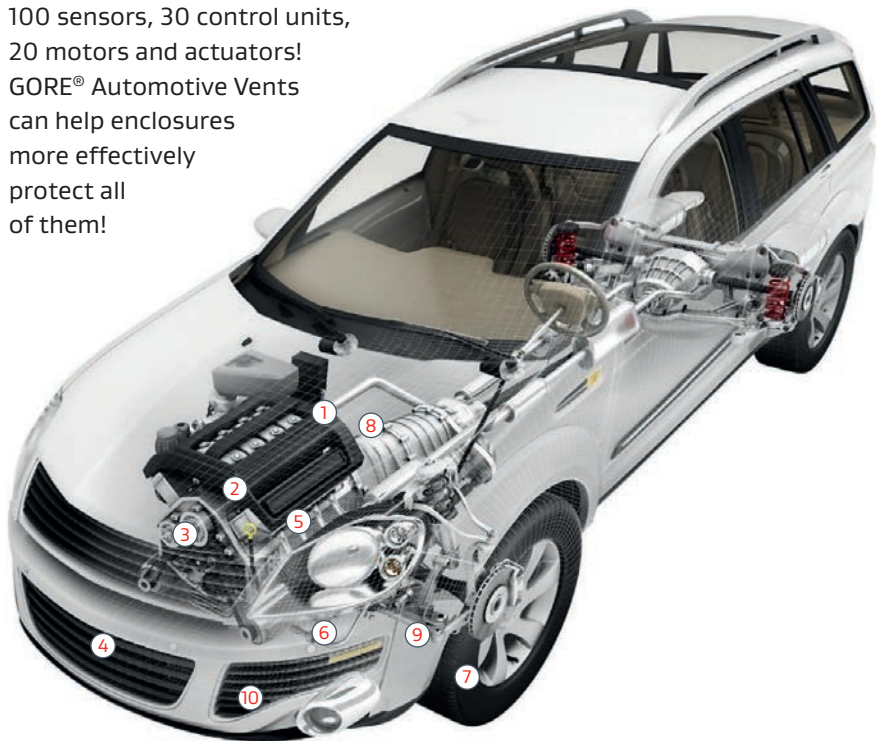
- ⑤ Engine Control Unit
- ⑥ ABS Control Unit
- ⑦ Power Steering Control Unit

Motors

- ⑧ Wiper Motor
- ⑨ Electronic Pump Motor
- ⑩ Starter Motor

Hybrid and Electric Vehicle Components

- ⑪ Battery Pack/Battery Box
- ⑫ Power Distribution Module
- ⑬ Electronic Traction Motor
- ⑭ Converter/Inverter
- ⑮ Charger



GORE® VENTS FOR OTHER AUTOMOTIVE COMPONENTS

- Powertrain Components
- Exterior Lighting

AND FOR OTHER MOBILITY APPLICATIONS

- E-mobility charging and billing systems
- Sensors for parking guidance
- E-bike motors, battery systems, control units and displays

Gore Solves Multiple Challenges

GORE® Vents outperform other approaches. They offer a more comprehensive solution to the many environmental challenges that can affect electronic components on automotive platforms worldwide.

Other Approaches Provide Only Partial Protections:

Tortuous paths

- + Equalize pressures
- Do not prevent entry of contaminants

Ruggedized housing walls and seals

- + Good protection against environmental conditions
- Expensive and heavy

Potting / Coating

- + Encapsulates electronics against contaminants
- Adds extra unnecessary weight to the component
- Prevents later repair or recycling

Desiccants

- + Bind the relative humidity within the enclosure over a limited period of time
- Cannot equalize pressures

Only GORE® Automotive Vents Provide a Comprehensive Solution:

Minimize chances of premature component failure and associated warranty/replacement costs

- + Equalize pressures to protect housing seal integrity
- + Prevent contamination to protect electronics
- + Reduce condensation to protect against corrosion
- + Allow gases to escape, to protect against hazardous build-ups

Reliably meet the most rigorous automotive testing standards for the life of the component

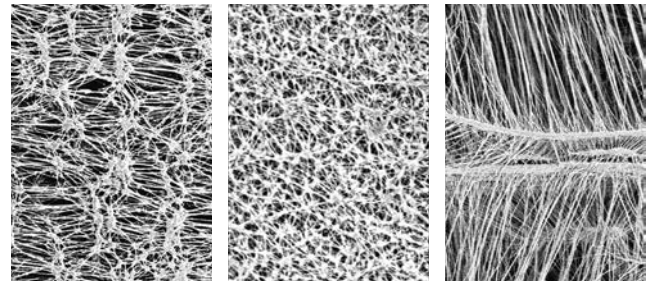
- + Temperature Tests
- + Ingress Protection Tests
- + Environmental Conditions Tests
- + Chemical Resistance Tests

The GORE Membrane for Advanced Protection

The GORE Membrane offers an advanced level of protection against the hazards common to automotive applications.

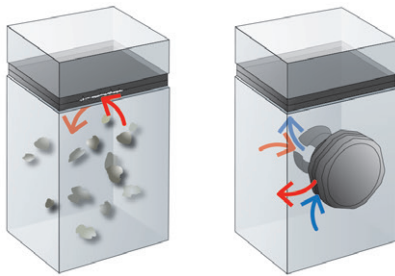
Made of chemically-inert ePTFE, it can withstand temperatures from -150 °C to +240 °C — ideal for use with today's smaller engines that can run at 150 °C or more. With holes 20,000 times smaller than a drop of water, the GORE Membrane retains high airflow while effectively blocking contaminants.

Engineered for hydrophobic and oleophobic protection in automotive applications, the GORE Membrane also delivers high roll-off. It quickly sheds water, oils and solvents after contact, so they won't cling and obstruct airflow.



Using Gore's proprietary technology, the membrane structure can be engineered in different ways, for optimal performance in different applications. Gore can help identify the best membrane for your application.

Reliable Performance for Sustained Protection



Unvented:
Failed seals let
contaminants
enter the housing

Vented:
The breathable
GORE Membrane
equalizes pressures

Equalize Pressures to Protect Housing Seal Integrity

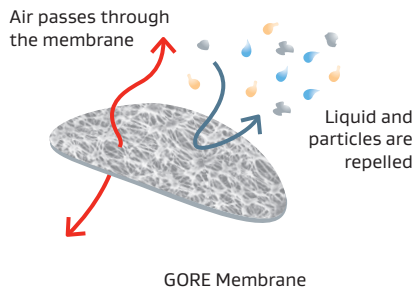
Repeated pressure differentials inside the housing will stress seals to failure, allowing ingress of contaminants that can damage electronic components. GORE® Automotive Vents rapidly equalize pressure differentials, effectively preventing the internal vacuums or pressure build-ups that stress seals.

GORE® Automotive Vents rapidly equalize pressures with continuous, bi-directional air exchange across the membrane.

Prevent Contamination to Protect Electronics

GORE® Automotive Vents reliably block ingress of all the contaminants automotive components will face over their lifetimes. GORE ePTFE Membranes offer oleophobic as well as hydrophobic protection, to repel oils and other low surface-tension automotive fluids, as well as common road hazards like water, mud, dust and dirt.

GORE® Automotive Vents prevent contamination because they effectively block ingress of liquids and particulates.

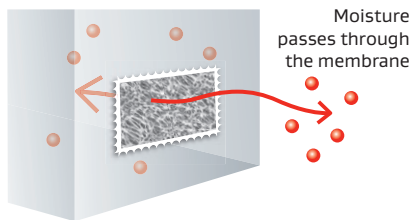


GORE Membrane

Reduce Condensation to Protect Against Corrosion and Malfunctions

Moisture can enter a housing through permeation, absorption/desorption or condensation. Without venting, moisture can remain and induce corrosion. GORE® Automotive Vents reliably release moisture that enters through all these paths, to help avert corrosion or premature component failure.

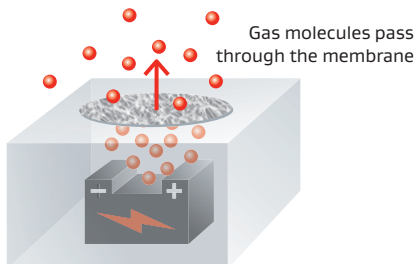
GORE® Automotive Vents reduce condensation because water vapor molecules can freely exit through the membrane.



Allow Gases to Escape, to Protect Against Hazardous Build-Ups

During normal operation and recharging cycles, e-batteries generate heat and may emit hydrogen or other potentially hazardous gases. GORE® Automotive Vents effectively dissipate hazardous gas molecules to reduce explosion hazards, while maintaining an effective barrier to liquids and particulates.

GORE® Automotive Vents prevent gas build-ups because the gas molecules can easily escape through the membrane.



Why Gore is the Better Alternative

High Quality for Improved Reliability

- Inventor of the original ePTFE membrane and subsequent innovations in advanced membrane technology.
- More than 35 years' experience in automotive electronics applications.
- Our vents meet the highest performance requirements and pass the most stringent environmental and durability tests.
- All major OEMs and Tier suppliers worldwide have installed billions of GORE® Automotive Vents.
- Gore venting solutions are trusted globally for their consistent quality and reliability, combined with worldwide engineering support.



A Broad Portfolio of Venting Products

GORE® Automotive Vents come in a variety of product forms

For Snap-Fit Installation

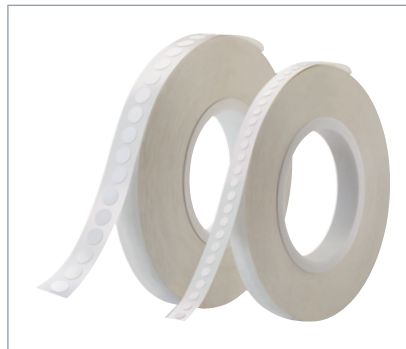
- Mechanically robust: a worry-free solution, with the membrane securely integrated and protected
- Easy installation in various housing materials



Snap-Fit Vents

For Weldable Installation

- Great connection to substrate
- Highest chemical resistance, and temperature stability up to 160 °C



Weldable Vents

For Adhesive Installation

- Good solution where space is at a premium
- Great condensation management due to larger membrane surface



Adhesive Vents

Ask how we can help you choose the best GORE® Automotive Vent for optimal performance over the lifetime of your automotive component. Contact your local Gore representative or reach out to us at [gore.com/autovents](https://www.gore.com/autovents).



A materials science company dedicated to transforming industries and improving lives

About Gore

W. L. Gore & Associates is a global materials science company dedicated to transforming industries and improving lives. Since 1958, Gore has solved complex technical challenges in demanding environments — from outer space to the world's highest peaks to the inner workings of the human body. With more than 11,000 Associates and a strong, team-oriented culture, Gore generates annual revenues of \$3.8 billion.

Gore develops products and technologies that address complex product and process challenges in a variety of markets and industries, including aerospace, automotive, pharmaceutical, mobile electronics and more. Through close collaboration with industry leaders across the globe, Gore enables customers to design their products and processes to be safer, cleaner, more productive, reliable, durable and efficient across a wide range of demanding environments.

Learn more at gore.com/autovents

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