



DESIGNING FOR DURABILITY

Building Enclosures
That Handle Real-World
Environments



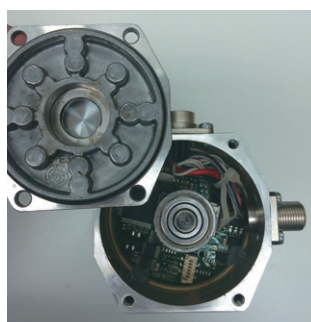
Designers tasked with developing electronics for demanding environments face a complex set of challenges. The conditions in which these products operate—ranging from extreme temperatures and humidity, to exposure to dust, salt, chemicals or high pressure washdowns—can cause long-term reliability and performance issues.

Failures observed in the field—such as corrosion caused by trapped moisture, performance issues due to contaminant ingress, or reduced acoustic functionality—are frequently the result of insufficient attention to the actual environmental and operating conditions of the electronics during the design phase. Prioritizing these considerations early in the development process is essential for ensuring that enclosures perform reliably to protect sensitive electronics throughout their intended service life.

Take action early to address key design considerations to ensure your enclosure withstands real-world demands.



Without vent installation



With vent installation



Without vent installation

With vent installation



Pressure Equalization:

Temperature swings and altitude changes create pressure differentials inside sealed enclosures. Without proper venting, these imbalances can stress seals and lead to leaks or failures.



Moisture Management:

Moisture vapor will enter the enclosure, but it's critical to prevent humidity from being trapped and condensing. Solutions should allow vapor to escape while keeping liquid water and contaminants out.



Acoustic Protection:

Devices with microphones or speakers need to transmit sound clearly while blocking contaminants. Achieving acoustic transparency without sacrificing environmental protection is a delicate balance.



Environmental Stressors:

Salt air, dust, and chemicals can degrade materials and seals over time. Selecting the right materials and protective strategies is essential for long-term reliability.



Lifecycle and Maintenance:

Products expected to last for years need solutions that won't degrade and require less maintenance. Designs should also allow for easy servicing without compromising protection.



Industry/Regulatory Compliance:

IP/UL ratings help guarantee reliability in demanding environments, while REACH and RoHS compliance ensures environmental responsibility and global acceptance.

Review this comprehensive and effective checklist while designing your enclosure. It will help mitigate the risk of failures and improve the reliability and lifespan of your electronics.

Smart Designs Start with the Right Questions

1. What are the temperature or altitude extremes and how quickly will they change?

- *Why it matters:* Sudden changes in temperature or altitude can create pressure differences inside the enclosure, which may compromise seals and allow water to enter over time.
- *Best practices:* Incorporate pressure-equalizing vents specifically engineered to respond to these pressure changes and maintain proper airflow.
- *Common pitfall:* Selecting a vent that cannot equalize pressure quickly enough before damage can occur.

2. Will the enclosure be in contact with or exposed to salt air?

- *Why it matters:* Salt air is highly corrosive and can degrade materials and seals over time.
- *Best practices:* Select corrosion-resistant materials (e.g., stainless steel, specific polymers) or coatings.
- *Common pitfall:* Assuming standard materials will withstand long-term exposure to corrosive elements.

3. Would the enclosure be exposed to a rainy or wet environment?

- *Why it matters:* Water ingress is a leading cause of electronic failure.
- *Best practices:* Use hydrophobic or oleophobic membranes and ensure all seals meet or exceed required IP ratings.
- *Common pitfall:* Neglecting to test for water ingress under real-world conditions, such as wind-driven rain.

4. Is the enclosure exposed to cleaning chemicals or high-pressure washdowns?

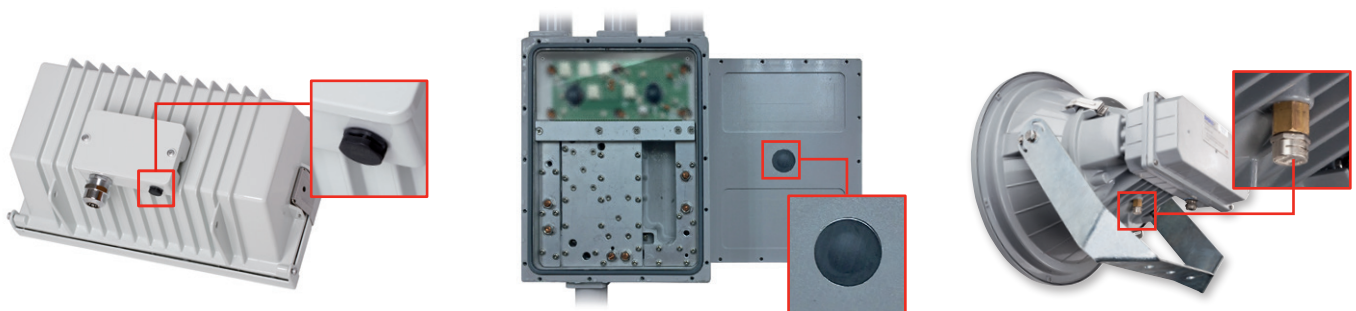
- *Why it matters:* Chemicals and high-pressure water can compromise seals and materials. Damage can accumulate over time.
- *Best practices:* Specify chemical-resistant materials and design for IP69K protection if needed.
- *Common pitfall:* Overlooking enclosure compatibility with cleaning agents used in the field.

5. Will it be exposed to a lot of dust or fine particulates?

- *Why it matters:* Dust can block vents and infiltrate enclosures, affecting performance.
- *Best practices:* Use venting solutions designed to repel particulates. Ensure seals are rated for dust protection (e.g., IP6X).
- *Common pitfall:* Not considering the size and type of particulates present in the operating environment and how they could affect vent performance over time.

6. How long are the electronics expected to operate?

- *Why it matters:* Long lifecycle products require durable solutions that will continue to operate reliably.
- *Best practices:* Choose materials and venting solutions with proven long-term reliability. Validate with accelerated aging tests.
- *Common pitfall:* Selecting components based solely on initial cost rather than lifecycle performance and total cost of ownership.



From outdoor telecom units to industrial control boxes and lighting systems, Gore's broad range of protective vents safeguard sensitive electronics against pressure buildup and environmental stress.

7. Do the electronics require regular maintenance?

- *Why it matters:* Maintenance needs can affect enclosure integrity and accessibility.
- *Best practices:* Design for easy access without compromising environmental protection.
- *Common pitfall:* Making enclosures difficult to access or reseal properly after maintenance.

8. What are the cost considerations?

- *Why it matters:* Balancing performance and budget is crucial for project success.
- *Best practices:* Evaluate total cost of ownership, not just initial material costs. Consider the cost of potential failures and field repairs.
- *Common pitfall:* Sacrificing critical protection features for short-term savings.

9. Are there size or installation constraints?

- *Why it matters:* Tight spaces or complex geometries can limit venting and sealing options.
- *Best practices:* Select compact vent formats (adhesive, snap-in, screw-in, weldable) and plan for installation during early design.
- *Common pitfall:* Waiting until late in the design process to address fit and installation issues.

10. Are there Ingress Protection (IP) or UL rating requirements?

- *Why it matters:* Compliance to industry or regulatory standards are essential for market acceptance and safety.
- *Best practices:* Design and understand how to test to meet or exceed required standards. Document compliance and validation results.
- *Common pitfall:* Assuming compliance without thorough testing or documentation.

Contact Us

Our team of experienced application engineers is here to support your electronic design challenges. Whether you're tackling pressure equalization in sealed enclosures, optimizing acoustic performance, or managing moisture ingress, we offer expert guidance to help you make informed decisions.

Reach out to discuss your design requirements and discover how our technical insight can help you enhance reliability, long-term performance, and protection in your application.

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