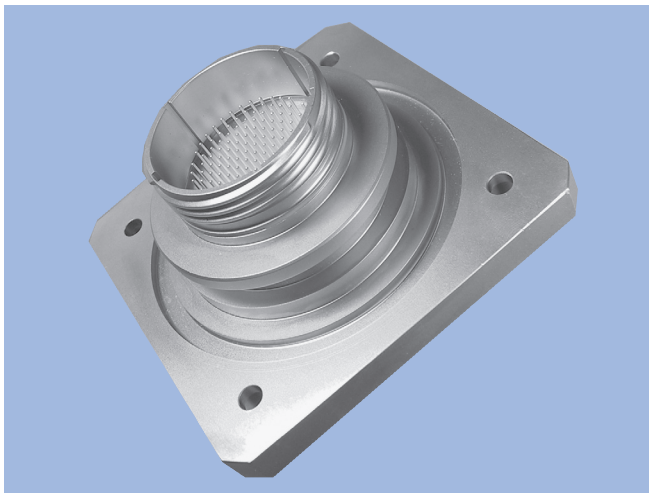


Connector Hermeticity

Hermetic connectors, such as the MIL-DTL-38999 Series I, II, III and IV supplied by Glenair, are designed for use in pressurized or severe environmental applications. Typical environments include geo-physical, medical and military aerospace—in fact, the requirement for connector hermeticity was originally driven by military electronic applications. Hermeticity is generally defined as the state or condition of being air or gas tight. In interconnect applications, hermetic refers to packaging technology designed to prevent gasses from passing through pressure barriers via the connector. The reason this is important is to prevent any moisture in the leaked



Glenair typically specifies stainless steel, titanium or Kovar for its hermetic products to provide an effective barrier against gas ingress and corrosion caused by dew point condensation. The hermetic sealing helps insure against damage to sensitive electronic systems and components.

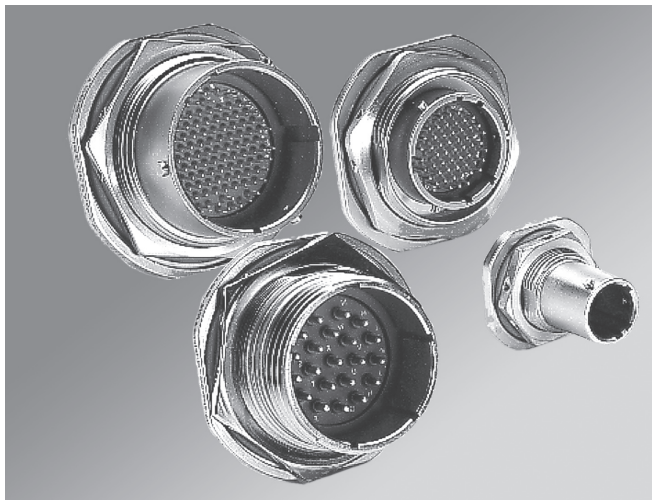
gas from condensing inside the pressurized enclosure. The point at which moisture will condense is called the “dew point”—or the precise moment when humidity, pressure, and temperature allows condensation to form.

When an electric current must pass through a high-pressure differential barrier, the potential exists for gases, and in some rare cases particulate matter, to also penetrate the barrier and, as described above, to form condensation

in the equipment enclosure. In the receptacle cabling on the vacuum side of the barrier this may result in dielectric breakdown, corrosion, and loss of insulation resistance between conductors (a properly built plug assembly on the non-vacuum side is adequately sealed with conventional environmental protections and so is impervious to moisture ingress). The classic hermetic application is a receptacle feed-through penetrating a pressurized bulkhead, or a pressurized equipment housing—such as is found in inertial navigation units in an aircraft. The introduction of moisture-laden air into such an enclosure may be enough to produce false readings and other malfunctions in the device. The ultimate purpose of hermetic sealing then is not merely to “avert the ingress of air or gas into pressurized environments to prevent corrosion resulting from dew point condensation”, but more precisely to insure malfunctions do not occur in sensitive electronic systems due to said ingress.

Connector Hermeticity may be negatively affected both by the permeability of shell materials and the quality of the sealing technology. Metal materials are typically chosen due to their relative impermeability to gas, although certain plastics may also be used. Glenair typically specifies stainless steel, titanium or Kovar for its hermetic products, as all three base materials provide an effective barrier against gas ingress. But even metal materials are permeable to gas leakage to some degree, and the minimal permeability of metal materials can be worsened when weld and solder joints are formed between connector shell materials and the base material of the bulkhead. Electrode coatings used in welding readily attract moisture in the work which can result in micro cracks and fissures. If other stresses are present, such as vibration and shock, micro-cracking can progress to fissures which are visible to the human eye. Optimizing hermeticity should therefore always include examination of welds for any cracks or fissures that could provide a leakage path.

Although moderately effective sealing may be

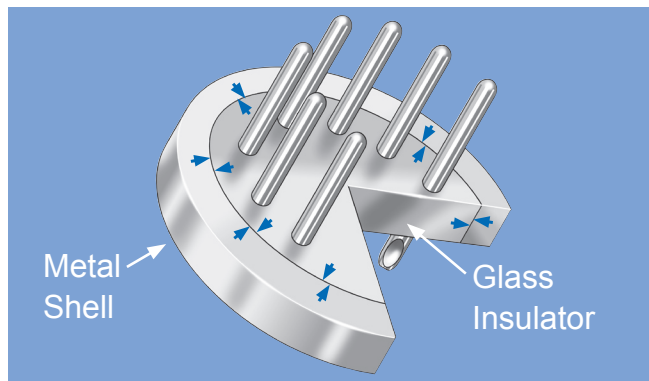


In hermetic connector manufacturing, the glass material is introduced either as separate glass beads or as a pre-formed glass seal insulator tooled to precise dimensions. The glass must be exactly selected for each application according to its ability to form a strong bond with the metal materials.

produced with simple techniques such as epoxy potting, fused glass-to-metal seals are usually specified in high-reliability applications. Glass is an excellent insulator, bonds well to metallic surfaces and is extremely corrosion resistant. And because of its robust mechanical strength and resistance to radical changes in temperature and pressure, glass seals are extremely resistant to any cracking which may introduce leaks into the hermetic package. Fused glass seals may be produced from various recipes of ground, non-crystalline solids such as silicates, borates and phosphates. When heated to high temperature and then cooled, these materials fuse into an amorphous solid called glass. In hermetic connector manufacturing, the glass material is introduced either as separate glass beads or as a pre-formed glass seal insulator tooled to precise dimensions. The glass must be exactly selected for each application according to its ability to form a strong bond with the chosen metal materials. Electrical properties, such as high withstanding voltage and dielectric strength are also considered as is thermal and shock stability. Depending on the style of connector being produced (rectangular versus circular, for

example) two distinct categories of glass-seal hermetics may be specified. These are known as Matched and Mismatched (or Compression) Seals.

In Matched Seal hermetics, the thermal expansion of the glass and metal materials are relatively close, usually within 10% of each other. This results in a product in which the stress in the glass is relatively small, since the expansion and contraction of both materials during manufacture is closely matched. This is extremely important in glass hermetic connectors such as the Micro-D since the rectangular shape of the connector shell can exert varying degrees of stress on the glass. At ambient temperatures, the glass is well wetted (bonded) to the metal shell and contacts, but under little or no pressure or stress. Matched



In Matched Seal hermetics, thermal expansion of the glass and metal materials are nearly the same. The stress in the glass is therefore relatively small—an important factor in the design of Micro-D hermetic connectors, due to varying degrees of stress on the glass caused by the rectangular shape.

Seals can withstand high thermal and mechanical shocks, and are generally easier to manufacture than Mismatched (Compression) Hermetic Seals. Kovar, a combination of iron, nickel and cobalt, is the material of choice for Match Seal hermetic receptacles—both shells and contacts. Kovar is a low-expansion metal with a coefficient of expansion rating matched to the glass material that forms the hermetic seal.

In Mismatched (Compression) Seals, the thermal expansion/contraction of the metal exceeds that of the glass. During the firing

Overview of Glenair Hermetic Connector Manufacturing Processes and Capabilities



process, the metal materials, usually stainless steel, expand at a greater rate than the glass. During cooling, the metals contract back into the already solidifying glass to form an extremely robust compression bond. This type of seal is consequently the most frequently specified for extreme, high-pressure applications since the seal produced is reliable to pressures as high as 14,000 psi (1000 bars).

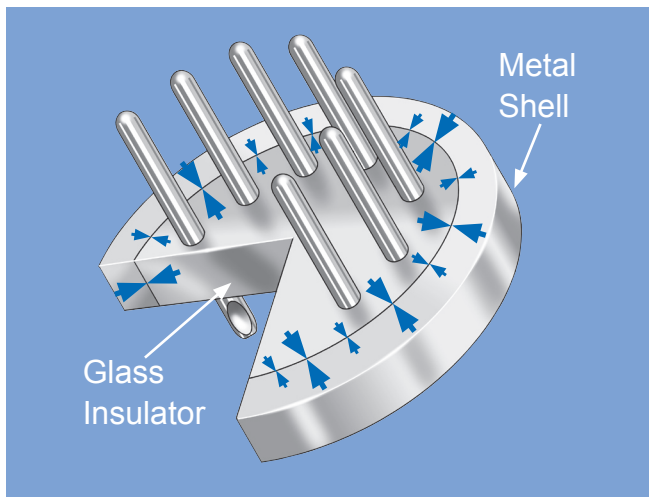
The total potential for leakage in a hermetic connector is the sum of any permeation which may occur via the metal materials themselves through cracks or open pores, and any leakage that may result from a defective seal. An additional source of leakage—uncontrolled from the connector manufacturer's perspective—results from sub-standard mounting of the hermetic package on the bulkhead or enclosure. Depending on the surface material of the bulkhead, hermetic receptacles may be welded or soldered in place. Low temperature brazing is also possible in certain applications as is the use of adhesive sealants. Finally, mechanical mounting seals such as O-ring equipped jam-nut mounts are used in applications where the cost or difficulty of welding or soldering is impractical. Regardless of the choice of mounting technology,

care must be given to ensure inadvertent leakage paths are not introduced to the system.

It is important to also note that vapor condensation in vacuum enclosures may be affected by the material makeup of devices inside the enclosure. Materials such as silicones, adhesives, lubricants and Teflon insulation can all outgas water vapor, and so contribute to the total vapor pressure inside the enclosure. As discussed above, this rise in vapor pressure will directly impact the condensation dew point of the protected environment.

Hermetic seals are qualified via various methodologies including helium testing and dye penetrant. The purpose of both types of tests is to detect and measure leakage under pressure. The dye penetrant method has the advantage of revealing the exact location of a leak, while Helium testing measures overall leakage within the hermetic device. In both types of tests, a pressure differential between the internal volume of the package and the external environment is created. The resultant pressure gradient causes the helium or liquid dye to diffuse through the connector shell, contacts and/or glass seals. Quantitative and qualitative measurements are then taken using appropriate sensing instruments.

As with other connector families, customers may specify the connector coupling style (threaded, bayonet, etc.) pin or socket count and layout, contact termination type (solder cup, flat eyelet or PCB termination), conductive or non-conductive finish, polarization and so on. Glenair is able to offer a broad range of hermetic solutions, including qualified MIL-DTL-38999 Series I, II, III and IV. Our stainless steel Series 22 Geo-Marine® product, our .76 in. contact spacing Series 80 "Mighty Mouse" Connector, and both Micro-D and D-Subminiature rectangulars. Our complete in-house capability also affords us the ability to produce a wide-range of special purpose hermetic connectors designed to meet individual and unique customer specifications. For more information on Glenair's hermetic capabilities please see our website.



In Mismatched (Compression) Seals, the thermal expansion/contraction of the metal exceeds that of the glass. During cooling, the metal contracts into the already solidifying glass to form an extremely robust compression bond.