Every Connection Counts!

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Harsh environment connectors feature several design elements to help protect connections. *These features include durable contacts, watertight seals, rugged metal or thermoplastic shells, and a firm, secure locking mechanism. Applications for these types of connector products include ECUs, joysticks, industrial and marine engines, control boxes, lights and CAN systems, just to mention a few.*

RAYCHEM DR-25 SPECIAL PURPOSE TUBING

Flexible, Chemical and abrasion resistant tubing specially formulated for optimum high-temperature fluid resistance and long term heat resistance

- System 25 tubing
- 2:1 shrink ratio
- Flame-retardant

When specially designed products are needed to meet a customer's design specifications, TE Connectivity offers a wide variety of special purpose tubing. The special purpose tubing is available in a variety of materials, colors, shrink ratios, and sizes. Benefits of this type of tubing include compliance with AMS-DTL-23053 standards and UL/CSA recognition.

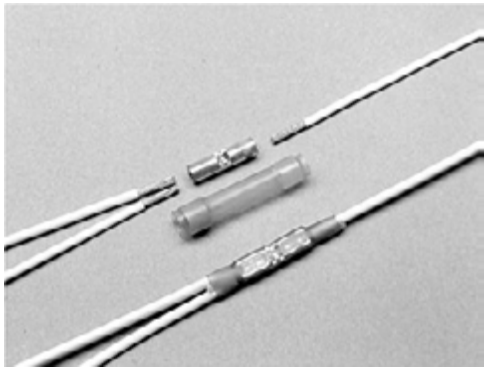
RAYCHEM VERSAFIT HEAT SHRINK TUBING AND SLEEVES

Highly Flame-Retardant, Very Flexible, Low-ShrinkTemperature, Polyolefin Tubing, VERSAFIT heat-shrinkable tubing is a cost-effective choice for many commercial and military applications.

- 2:1 shrink ratio
- Low shrink temperature; faster installation & less risk of damage to componenent
- Very flexible; doesn't easily wrinkle when bent
- Highly flame-retardant
- Hot stamps extremely well
- Environmentally friendly; Free of PBBs, PBBOs and PBBEs

RAYCHEM AS81824 D-436 MINISEAL CRIMP SPLICES

MiniSeal wire-to-wire splicing products offer solutions for hundreds of aerospace and defense applications. These environment-resistant splices provide excellent reliability, long term performance, AS81824/1 qualification, and a low installed cost.

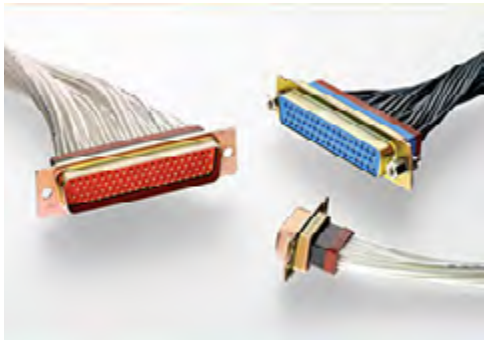


- Immersion-resistant crimp splices are on QPL for SAE-AS81824
- Small size
- Light weight
- Insulation and strain relief
- Easy installation

MiniSeal crimp splices consist of a plated copper crimp barrel and a separate, heat-shrinkable, transparent sealing sleeve. They can be used on a combination of wires, from 1:1 to 10:10. MiniSeal splices are one of the smallest, lightest, and most environment resistant splices available. They preserve the electrical integrity of the splice by preventing the penetration of liquids and the resulting chemical and galvanic corrosion.

SEALED AMPLIMITE D-SUB CONNECTORS

MIL-SPEC D-SUB Connectors with water and dust ingress protection to IP67



- Environmentally Sealed - IP67 Rated
- Grommet, interfacial seal, and internal connector sealant
- Standard and high-density versions
- Designed to meet MIL-DTL-24308
- Intermateable with standard D-Subminiature connectors

Mil-Spec AMPLIMITE connectors from TE Connectivity (TE) are now available with environmental sealing to IP67 levels. Sealed AMPLIMITE cable connectors come in two series:

- Series 109 standard-density, using Size 20 contacts
- Series 90 high-density, using Size 22 contacts

The connectors exceed IP67 performance levels, having been successfully tested by TE submerged to 1 m depth. The connectors include both grommet sealing on the wire-entry end and a one-piece interfacial seal on the mating face. The connectors are supplied with rear-release crimp contacts.

AMP SUPERSEAL 1.0 MM CONNECTORS

Designed for the automotive industry, AMP SUPERSEAL connectors meet the sealing requirements outlined in IEC 529 and DIN 40050 IP67 specifications.

- Compact system minimizes packaging requirements
- Sealing reliability proven under harsh conditions
- Designed for ease of manual harness assembly, engine mounting and under hood environments
- Wire-to-Board (1.0 mm) and ECU applications, under hood or any location where sealing is required
- Suitable for automotive, truck, bus, or off-road vehicles

The cap and plug connector housings incorporate preassembled secondary locks to help insure correct and complete contact insertion into the housing and helps prevent the contacts from backing out during mating. The secondary lock cannot be closed if the contacts are not correctly inserted into the connector housing.

Harsh Environments
Applicable Product Standards

Source: Sensata

From an engineering perspective, a harsh environment application is one in which the performance or even survival of the product or system is at best difficult and at worst near to impossible. Designing products that must perform in severe circumstances and locations can be accomplished, however, by wrapping the system in a protective shell, by designing from the ground up and using components specifically meant to resist the stresses of environmental factors, or by a combination of both methods.

Whatever the method, it necessitates selecting parts that conform to one or more of the various engineering standards specifically addressing the ability of parts to meet the demands of performance in a harsh environment. While countless engineering standards exist to ensure the individual performance of all types of components, several are of key importance in the harsh environment area. Here is a review of some of the most important ones.

Protection in a Case: NEMA

In the simplest sense, keeping the environment from interfering with a product or system can be accomplished by putting it in a box or a cabinet. But, in this case, not just any box or cabinet. Enclosures are rated by the National Electrical Manufacturer's Association (NEMA) for their applications, and the environmental conditions against which they protect.

The NEMA standards used in North America apply to cabinets and enclosures used to house electronic equipment for indoor and some outdoor industrial applications. Each is rated to protect against access by hazardous parts and additional designated environmental conditions. Most NEMA product ratings do not require independent testing and leave compliance up to the manufacturer, but some do. For example, the NEMA 12 standard requires substantial testing, mainly for dust and water. NEMA specifies how an enclosure must perform, not how it is manufactured. Some of the NEMA ratings most frequently applicable to harsh or hazardous environments are:

- **NEMA 6** – protects against ingress of objects, dirt, splashed water and is undamaged by external ice buildup.
- **NEMA 7** - enclosures are designed to contain an internal explosion without causing an external hazard. These enclosures are intended for indoor use in hazardous locations.
- **NEMA 8** – enclosures are designed to prevent combustion through the use of equipment immersed in oil.
- **NEMA 9** – enclosures are designed to prevent the ignition of combustible dust.
- **NEMA 10** – designed to contain an internal explosion without causing an external hazard, these enclosures also meet requirements of the Mine Safety and Health Administration.

Switching, Sensing, Cooling and Connecting: IP Ratings

While enclosing a product or system in a protective enclosure can offer substantial protection, operating components like switches, connectors, sensors and cooling devices mounted outside of the enclosure must also perform.

In many component cases the most applicable harsh environment standards are offered by the International Electrotechnical Commission (IEC) Ingress Protection Marking (IEC 60529), or IP ratings. IP ratings are a classification system that indicate the degree of protection built into a product from solid objects, dust, accidental contact, and liquids. The American National Standards Institute (ANSI) and NEMA are members of IEN and contribute to the IP standards, some of which include the following:

- **IP20** – rated for protection from solid objects, but not water.
- **IP23** – rated for protection from solid objects & spray.
- **IP44** – rated for protection from solid objects & splashed water.
- **IP54** – rated for dust resistance & protection from splashed water.
- **IP 55** – rated for dust resistance & protection from hosed & rain water.
- **IP65** – rated for dust exclusion & protection from hosed water.
- **IP67** – rated for dust & temporary immersion protection.
- **IP68** – rated for dust exclusion & water tightness.
- **IP69K** – rated for resistance to steam and high pressure water.

Use of the IP ratings system is also becoming common in the consumer electronics market, as devices like mobile phones, cameras, and computers are being marketed as water resistant, waterproof, and dustproof.

For Products That "Cannot Fail": SIL

A product's Safety Integrity Level (SIL) is an IEC system (IEC 61508) that defines the relative level of risk reduction provided by a safety function: the higher the SIL level, the greater the degree of safety built into the system. The 4 SIL levels, and the relative levels of safety categorized by each, are presented in this table.

SAFETY INTEGRITY LEVEL	SAFETY	PROBABILITY OF FAILURE ON DEMAND	RISK REDUCTION FACTOR
SIL 4	> 99.99%	0.001% to 0.01%	100,000 to 10,000
SIL 3	99.9% to 99.99%	0.01% to 0.1%	10,000 to 1,000
SIL 2	99% to 99.9%	0.1% to 1%	1,000 to 100
SIL 1	90 % to 99%	1% to 10%	100 to 10

SIL is a measure of the amount of risk reduction provided by a Safety Instrumented Function (SIF). SIL 4 offers the highest level of safety integrity, and SIL 1 the lowest.

Designers using SIL certified components in a design can allow final end users of a system to achieve the level of system safety they require in a simple, efficient, and time-effective fashion. Using certified products in a design also allows engineering to calculate and claim an overall system safety rating, including Mean Time to Failure (MTF).

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Additional Standards and Certifications

Source: TE Connectivity

In the harsh environment area, additional standards come into play and are employed depending on the specific components being used, the final applications of the product or system, and the countries or markets involved. Since many products and systems are marketed worldwide, many of these standards come into play. Some of these other standards and certifications include:

ATEX Directive – the ATEX directive is a combination of two European Union (EU) directives that cover the operation and safety of equipment to be used in the presence of explosive atmospheres, like those in refineries, chemical plants, grain silos, etc. The directive defines the health and safety requirements for the equipment and protective systems to be used in the EU market. The ATEX directive is similar to OSHA or NEC standards in the United States. OSHA, however, requires equipment to be used in the US to be certified by a Nationally Recognized Testing Laboratory (NRTL) based on electrical codes and standards.

AEC Q100 – this is an industry standard specification set by the United States Automotive Electronics Council (AEC) that defines the failure mechanism-based stress test employed for components used in automotive electronics applications. AEC Q100 specifically covers packaged integrated circuits. AEC Q101 covers discrete parts, and AEC Q200 covers passive parts.

MIL-STD 810 – there are over 40 military standards (MIL-STD) required by the Department of Defense and maintained by the various armed services. These standards ensure that products meet specific defense-related performance requirements. Many manufacturers have adopted these standards in the development of harsh environment products. MIL-STD 810 is used by manufacturers to design and test the endurance and durability of ruggedized products to be used in situations of environmental risk, like low pressure, high or low temperature, solar radiation, humidity, fluid contamination, sand and dust.

ANSI/ISA 84 – maintained in the U.S. by the American National Standards Institute (ANSI) and the International Society of Automation (ISA), this standard covers the design and engineering of safety-related system hardware and software for the process industries, including chemicals, refineries, pharmaceuticals, pulp & Paper, and power. It focuses on the attainment of a specific SIL. This standard was first issued by the IEC as IEC 61058. The European standards body (CENELEC) defines this standard as EN 61511.

Engineering standards are documented, technical consensus agreements that define the important features of a part, product or system. Their importance in the harsh environment area, where performance is critical to both the system output and the safety of the operator, cannot be overstated. This article has been an attempt to highlight the relevant standards used in the development of harsh environment products, but is not an exhaustive compilation of them. As applicable standards can vary from country to country, the reader is advised to pursue additional information sources.

TE connectivity

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