



**An IoT Chain is Only as Strong  
as its Weakest Link. Have you  
Considered the Challenges of  
the Connector in Your Harsh  
Environment IoT Design?**

---





**The Internet of Things (IoT) is a general description for the network of physical objects (i.e., “things”) that are embedded with electronics, sensors, and software to connect and exchange data with other devices and systems over the Internet.**



**Figure 1: Bulgin’s M-series circular connectors suit a wide range of requirements in harsh IoT environments. (Source: Bulgin)**

IoT technology is used in many applications, but the industrial environment is particularly challenging for connectors. Industrial IoT (IIoT) applications subject connectors to mechanical stresses such as extreme temperatures, vibration, shock, or pressure; chemical stresses such as salt water or corrosive chemicals; and a range of electrical stresses. As automation increases and applications add internet connectivity, there is more pressure than ever before to develop reliable and robust interconnected production and motion control systems. Examples of common industrial applications include:

- Industrial Robotics
- Pharmaceutical Manufacturing
- Automotive Manufacturing
- Food & Beverage Processing
- Material Handling Equipment
- Packaging Equipment
- Process Control Systems
- Machining & Metal Processing
- Semiconductor Manufacturing
- Factory Automation Machines

Connectors play a key role routing signals and power between industrial machines. They also act as the interface between industrial electronics and the outside world and protect sensitive internal electronics. It is important to select a connector that not only facilitates reliable communication but also withstands external conditions and maintains the integrity of the case design.

This white paper will review the characteristics of typical harsh environments in industrial IoT applications, discuss some of the design features required by connectors, and spotlight some connector families for IIoT applications.

## Connector Challenges in IoT Applications

How do the IIoT characteristics mentioned above pose a threat to safe and reliable operation of connectors and other electronic systems?

- **Temperature extremes.** Operating temperatures outside the range of -55 °C to +150 °C are considered harsh. The majority of environmentally-caused failures within this “normal” range are a result of excessive temperature or temperature cycling. Most are a result of thermal stress brought on by differences in the coefficients of thermal expansion (CTE) of different materials.

Temperature extremes also affect a connector’s mechanical components. Rubber seals and plastics tend to harden and resist deformation, causing leaks or cracks.

- **Pressure.** Deep-sea and downhole applications must operate reliably under high-pressure conditions. A subsea robot working at 5000m (16,400 ft) encounters a pressure of 500 bar (7,250 psi). The pressure at the bottom of a deep-sea well can exceed 30,000 psi, with temperatures exceeding 200 °C.
- **Shock & Vibration.** Mechanical vibration and shock are ubiquitous in electronic equipment; they can cause mechanical stress, which manifests itself in solder joint cracks, loosening of screws and other fasteners, and metal fatigue. Connectors on industrial equipment are continuously subject to these mechanical stresses.
- **Explosion risk** is a concern in environments such as coal mining, oil & gas, and wood processing where there may be flammable gases, vapor, dust, or powder. In this case, the making or breaking of a contact may result in a spark with catastrophic results.
- **Corrosion.** In many harsh IoT environments, corrosion caused by exposure to chemicals is one of the main dangers. The most common combination is high relative humidity coupled with salt fog, which can wreak havoc with electronic components in industrial, automotive, marine, and many other applications.

Table 1							
IoT Application	Temperature	Shock/Vibration	Pressure	Corrosion	Explosion	Liquids	Dust
Medical	X			X		X	
Automotive	X	X		X		X	
Industrial	X	X		X		X	X
Oil & Gas	X	X	X	X	X	X	X
Agricultural	X	X		X	X	X	X
Marine/Undersea	X	X	X	X		X	

Common industrial chemicals can also cause corrosion. Examples include both acids – for example hydrochloric, sulfuric, chromic, acetic, or hydrofluoric acid - and bases such as ammonium, potassium, or sodium hydroxides.

- **Rough handling.** Many connectors in harsh environments are connected and disconnected multiple times in a day, often hurriedly, which increases the risk of wear and tear on the connector. Connectors being dropped or dragged along hard surfaces can also cause damage to the components inside the connector and affect the integrity of power, signal or data connections being passed through the cable.

Many IoT applications experience multiple environmental hazards, as shown in Table 1.

## Overview of Applicable Standards

Connectors designed for operation in industrial IoT environments must meet a range of standards that vary by application.

- If dangerous voltages or currents are present, connectors must meet the relevant **safety standards** for the markets in which they are sold. Examples include CCC mark for products sold in China, Underwriters Laboratories (UL), CSA & VDE approvals.
- The European Union (EU) **ATEX** standards define safety standards for operation in environments where there is a risk of explosion. The **IECEx** certification scheme applies to countries outside the EU.
- **IEC 60068** includes numerous procedures to test the ability of a connector to perform under a range of environmental conditions including extreme cold; dry heat; vibration, shocks, and bumps; and corrosive substances such as salt spray.
- **IP ratings** rate the degree of protection against intrusion from solids such as dust, and liquids such as water. The first digit in an IP rating indicates the level of ingress protection against solid objects ; from IP0x (no protection) to IP6x (complete protection against dust). The second digit refers to protection from liquids: from IPx0 (no protection) to IPx9 (protection against water jets).

Depending on the level of liquid protection required, Bulgin connectors meet IP standards IP66, IP67, IP68 & IP69K. An IP69K rating certifies the connector against both dust and high-pressure, high-temperature water jets.

## Key Design Features of a Harsh Environment Connector

The design of a connector for harsh environments depends on its intended use. Connectors in industrial environments encounter water, vibration, chemicals, and extreme temperatures. Many industrial production lines are also prone to dust & liquid build up. Connectors for use in the oil and gas industry are exposed to high pressure, extreme temperatures, vibrations, and shock explosions. Medical connectors must withstand various medical sterilization processes including autoclave, Sterrad, EtO, gamma and chemical sterilization. A medical interconnect system must also be sealed against water and dust and other potential hazards.

Several key design features provide a connector with protection from harsh environment hazards.

- Locking/coupling mechanisms – a robust coupling mechanism is a must for harsh connectors. There are many different types of connector couplings, including ring, twist locking, threaded, bayonet, push-pull and quick disconnect couplings, all with different attributes for various types of applications.
- Housing and insulation – the type of material the connector is made of is an equally important consideration. For applications where the connector is likely to be exposed to extremes of temperature and plenty of moisture and dust, a corrosion-resistant metal housing may be the most appropriate option. For other uses requiring lightweight and flexible connectors, high-temperature resistant plastic composites may be more attractive. Over molded cable versions are also sometimes available as an option where it is not a requirement for the unit to be re-terminated.
- Seals & grommets – rubbery seals can be used inside the coupling for keeping the connection tightly in place and watertight.

- The shape of the connector, thread pattern or mating mechanism and positioning of pins also play an important role in the creation of a rugged and reliable connector. Circular connectors allow for better ease of engagement and disengagement as well as capacity for a wider variety of contacts and voltages. Circular connectors are also easier to seal and less likely to wear or break, and an intelligent ‘scoop proof’ design can avoid damage to the pins if the connector is mis-mated.

## How Bulgin Connectors Solve Harsh Environment Challenges in IoT

Bulgin offers a wide variety of M-series connectors optimized for IoT applications. These connectors are designed to fulfil the ever-growing demand for sensor, actuator and data connections in process control, industrial machinery, and factory automation. Figure 1 shows a few of the many options available. Depending on the connector family, M-series features include:

- Screw or solder terminals
- Field installable, panel-mount or over-molded cable options
- A choice of coding configurations
- Straight or right-angle options
- Up to 17 contacts
- Metal or plastic housings
- IP66, IP67, IP68 & IP69K ratings

Representative product families are:

**M12 series connectors** provide a high degree of mechanical and electrical stability and a cost-effective and flexible connectivity solution for onsite installations, helping to decrease downtime in process control, manufacturing automation and industrial instrumentation applications. These connectors feature a reliable industry-standard EN 61076-2-101 screw-locking mechanism.

**M8 circular connectors** over-molded cables with screw-lock coupling are mechanically and chemically robust, easy to install, minimize downtime, and help to increase production efficiency. Rated to IP67, the M8 series ensures safe, secure and reliable protection from liquids, dust, moisture and dirt whilst also providing great resistance against vibrations to ensure that connections are not disrupted.

**The M5 series of sensor connectors** are the most compact type in the M-Series range. The waterproof M5 connectors come in straight and angled forms with PVC or PUR over-molded cable connector options and a variety of panel mount receptacles. With a screw coupling mechanism and IP67 rating, the M5 product line is particularly suited to automotive, process control, commercial electronics & instrumentation applications that require reliable and robust miniature sensors.

Bulgin offers other connector families for IIoT applications. The EXPlora range of connectors, for example, shown in figure 2, is designed for use in industrial environments with hazardous or explosive atmospheres due to flammable gases, mists or vapors or combustible dusts. Independently tested for compliance to ATEX standards for use in Zone 2 and Zone 22 environments, the EXP series is manufactured from a tough, high grade UL94V-0 rated Polyester material and provides environmental sealing to IP68.



**Figure 2: A selection of Bulgin's EXPlora connectors for use in explosive environments. (Source: Bulgin)**

EXPlora is rated up to 18A, 600V AC/DC for 2, 3, 4 and 5 poles, 16A, 430V AC/DC for 7 pole and 10A, 250V AC/DC for 10 poles. The 3, 4, 5 and 7 pole versions have leading earth contacts making them suitable for single or three phase applications.

## About Bulgin

Bulgin specializes in the design and manufacture of environmentally sealed waterproof connectors and electronic components. In addition to the M-series and the EXPlora connector families, the extensive product range includes the, plus the Buccaneer IP66, IP67, IP68 and IP69K rated waterproof circular connector range (power, signal & data), mains connectors, IEC connectors, battery holders, EMI filters, fuse holders, indicators, vandal resistant LED's, vandal resistant switches, push button switches, rocker switches, toggle switches, voltage selectors and IP67 enclosures.

Products are manufactured at ISO 9001 accredited factories, carrying international approvals. Bulgin's technological expertise improves the performance and energy efficiency of electronic and electrical equipment in automotive, consumer electronics, automation, computer/peripherals, industrial, marine, telecom, oil/gas, and lighting applications.

## Conclusion

When designing equipment for operating in harsh IoT environments, it is critical that the connector can withstand the combination of temperature, pressure, dust, and corrosion that is required for the application. Bulgin has extensive experience in environmentally sealed connectors; in addition to a large portfolio of standard products, and can also design custom solutions for unique applications.





**bulgin**

[www.bulgin.com](http://www.bulgin.com)

### **Europe**

Bulgin  
200 Cambridge Science Park  
Milton Road  
Cambridge, CB4 0GZ, UK  
tel: +44 (0) 1803 407757  
e: [info@bulgin.com](mailto:info@bulgin.com)

### **Americas**

Bulgin  
10619 Painter Avenue Suite A  
Santa Fe Springs  
CA 90670, USA  
tel: 760-343-3650  
e: [info@bulgin.com](mailto:info@bulgin.com)

### **Asia Pacific**

Bulgin  
10619 Painter Avenue Suite A  
Santa Fe Springs  
CA 90670, USA  
tel: 760-343-3650  
e: [info@bulgin.com](mailto:info@bulgin.com)