

# WHITE PAPER

## INSTRUMENTATION AND THE INTERNET OF THINGS

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# INSTRUMENTATION AND THE INTERNET OF THINGS

## SEVEN ESSENTIALS FOR RUGGED CONNECTORS IN INSTRUMENTATION APPLICATIONS

Connectivity and the Internet of Things is evolving rapidly in both the consumer world and the industrial world. The concept of devices making their own decisions based on free flowing data from other devices has been fully embraced by engineers developing instrumentation and industrial applications.

This trend, coupled with the move toward smaller and smarter devices, challenges design engineers to examine how leveraging the newest interconnect technology helps them build smaller and smarter instrumentation devices.



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## INTRODUCTION

As an engineer in the instrumentation field, you know that the use of measuring devices to monitor and control processes is critical to the smooth operation of large systems, and is an integral part of the future of the Internet of Things. Getting the key pieces of data to monitoring sites in time for people (or machines) to take the needed actions is so important to military, medical, oil and gas, automotive and industrial applications that experts expect billions of things to be connected to the internet for measuring and monitoring by the end of this decade.

Sometimes the information being passed through the Internet of Things is convenient, like being told by your cell phone that you can go to the kitchen because your burrito is done, or being able to have home automation system turn up the heat in your house to 'toasty' before you get home. Even temperamental wireless solutions are just fine for convenience. But in industry, the data is often critical. The enemy is seen through a vision system, a supply of perishables is about to overheat, or a fog bank rolls in over a crowded highway. In these critical cases, having a rugged and reliable solution secure from interference and unintended users requires that you engineer devices with a solid cable and connector solution. Knowing your application and environment, along with the essential considerations outlined below for engineering rugged interconnect solutions, will make you and your product successful in even the most extreme cases.

## TRENDS IMPACTING INSTRUMENTATION APPLICATIONS

Those who use instrumentation devices for test and measurement or sensing rely on their devices to provide pinpoint accuracy today more than ever before, as devices become smarter, talk to each other, and make changes based on shared data with or without waiting for human intervention. Even 1/1,000ths can throw off some data sets, and cause havoc in extreme cases.

While there are many trends impacting instrumentation applications, we'll address just two:

1. The impact of the Internet of Things, and
2. Miniaturization and mobility; the ongoing efforts towards adding functionality while making instrumentation devices smaller, more mobile, and more rugged.

**Connectivity and the Internet of Things** is evolving rapidly in both the consumer world and the industrial world. The concept of devices making their own decisions based on free flowing data from other devices has been fully embraced by engineers developing instrumentation and industrial applications. The seamless exchange of data from smartphones, tablets, thermostats, and other consumer products has been the most visible to the general public, but in the B2B world, moving data between and among devices has taken hold as well. Vision systems were among the first technology solutions to make decisions on their own without human intervention, viewing and reading, then kicking out mistakes, and doing it well. Process control operations also use machine to machine communication to ensure that everything is produced to exacting specifications. But most of these industrial applications are isolated, and can't take advantage of information outside their dedicated system. The concept of the Internet of Things eliminates islands of isolation, and allows devices to share information freely over secure internet connections.

**Miniaturization and Mobility** is clearly seen in the industrial and instrumentation fields, as engineers and scientists drive manufacturers to build smaller, more mobile devices that enable them to go further into the field. Examples include geology and seismology, and medicine where new body-worn sensors can read patient data discretely and create a response at the patient level or elsewhere (such as making a room hotter or colder) instantaneously.

The continued efforts by component manufacturers to make each component smaller and smarter has had a significant impact as devices shrink to sometimes half the size they were a decade ago. Getting the data from one device to another (or to many) through the best possible interconnect solution becomes more challenging as environments become harsher or where sterilization is needed. And while many indoor, non-mobile, non-critical applications are moving to wireless solutions for data, the smallest and most crucial devices cannot depend on fault-free wireless connectivity, especially in harsh environments.

Selecting a small, rugged connector and cable solution is essential to safe, reliable instrumentation applications in the age of data and the Internet of Things.

## **THE ROLE OF THE CONNECTOR AND INTERCONNECT SOLUTIONS IN INDUSTRIAL AND INSTRUMENTATION APPLICATIONS**

Obviously, there is no sense in measuring to the nth degree if you can't get the information to the right place at the right time. That means choosing the right connector, and the right interconnect solution.

High quality sealed connectors ensure repeatable, accurate connections and reliable data performance. Choosing the right connector can also help make your instrumentation design smaller, lighter and easier to handle. Cable choice can impact data transmission speed and add additional environmental protections.

With thousands of standard connector configurations and customized connector and cable assembly solutions available, you absolutely must consider these details early in the design phase to help you choose the best solution. Focusing on finding the right solution early can improve the design, usability, and cost structure of your instrumentation device. Accuracy and long-term performance with good product durability will be the result.

### **ESSENTIAL #1. UNDERSTAND THE DETAILS BEHIND THE IP RATINGS AND COMPARE THEM TO YOUR APPLICATION NEEDS.**

Many instrumentation applications call for IP Code (Ingress Protection) of at least IP68. These ratings classify the degree of protection provided against intrusion, dust, accidental contact, and water by mechanical casings and electrical enclosures. What many people miss is that not all IP68 ratings are created equal. The fact is that each supplier can define what IP68 means to their product. Many manufacturers define IP68 as 2 meters for 24 hours. Others define it as robust as 120 meters for 48 hours or as easy as 1.5 meters for 2 hours. Look closely at the manufacturer's testing information. There is a big difference, so be sure that you know exactly what level of protection you need for your instrumentation application.

Some instrumentation applications require vacuum sealing, including aerospace, sensor and test equipment, and mass spectrometers. These applications require tight sealing that will keep dust and water out, as well as provide a barrier to gasses down to the molecular level. Hermetic sealing for gas tightness is one of the toughest challenges you will face when specifying connectors. The connector has to be hermetic, in that it does not allow air molecules to enter the vacuum chamber.

It is important to consider the function of the specific vacuum application and understand how connectors should be manufactured and installed to achieve a hermetic seal to minimize or eliminate gas leaks. Fischer Connectors offers several products designed specifically for hermetic sealing that are subject to a 100% leak test and achieve an IP69 rating.

## **ESSENTIAL #2. EXPLORE YOUR CONNECTOR MATERIALS FOR BEST PRICE/ PERFORMANCE.**

When designing a measuring device, engineers find that many different materials are suitable for connectors; the choice depends on the specific application. Each material has advantages and disadvantages.

Applications near saltwater or that require extended exposure to the elements will require nickel-plated brass. Aluminum is a great material for handheld applications with weight concerns when the connections are not exposed to the elements for a long time. Plastic can be used in high voltage applications, because it may provide a degree of protection to the user.

If your application is in a corrosive environment where the connector might come into contact with chemicals, you'll want the connectors to be made of stainless steel. Stainless steel is more expensive than brass or aluminum, but some applications demand connectors that can withstand the most extreme conditions, such as a connector that needs chemical or nuclear decontamination/sterilization.

Material	Application
<b>Plastic</b>	Normally used in high voltage applications to protect the user from electric shock. Because of its properties, it is not appropriate for vacuum applications.
<b>Aluminum</b>	Lightweight but still rugged, use aluminum connectors when you want to reduce the weight of your device. Excellent for indoor laboratory applications, even when hermetic sealing is necessary for a vacuum. Not appropriate for caustic environments or prolonged exposure.
<b>Nickel-plated brass</b>	Great for any outdoor application where the connector might be exposed to rain, salt water, dirt, etc. Nickel-plated brass can be used with long-term exposure, including with weather sensors.
<b>Stainless steel</b>	Best choice for corrosive environments where the connector would come into contact with chemicals. Also important in cleanroom environments to stand up to harsh sterilization methods. Stainless is generally more expensive than brass or aluminum, but certain applications require a connector that can withstand extreme conditions.

### ESSENTIAL #3. SELECT YOUR CABLE AND CABLE MATERIAL.

When choosing cable for instrumentation, design engineers must again consider the end use of the device. Make sure that the cable type meets your voltage and power levels, and is designed for the type of signal(s) it will carry. Field-deployed applications require greater tensile strength than standard commercial cables to make sure they can withstand the rugged environment. For accuracy, the cable must be properly shielded to prevent any hint of interference; a rugged jacket withstands abrasion.

Thermoplastic jackets and connector overmolds have great insulating properties, and are appropriate for most instrumentation applications. The material is highly flexible and provides resistance to liquids and chemicals and provides good abrasion resistance.

Temperature probes are particularly vulnerable to cable issues when they are in either low or high heat environments. In these conditions, generally below  $-60^{\circ}$  or above  $200^{\circ}\text{C}$ , check maximum heat tolerances of your connector first. Also, consider silicone cable and overmolds for flexibility and high temperature resistance.

Cable diameter is also a consideration. If you are specifying a small, dense connector, make sure that the cable you choose is compatible with the size of the connector. The smaller and denser the connector, the easier it is to select a cable that is too big for easy and consistent assembly.

When in doubt, consult closely with your connector manufacturer on cable selection. Many have in-house cable assembly services, and the expertise to find the best solution fast using their existing library of cables that work well with their connectors.



**Customer Success:** Fischer Connectors worked with an oil & gas industry customer to help develop a connector/cable solution for their downhole measurement devices that had been experiencing failures.

Working closely with the customer, we were able to provide them with a sealed connector solution, including the multi-conductor cable they needed for their sensors, with an added Kevlar braid for strength and security.

This overall solution eliminated tangling of cables, field failures, and bad data. The new approach made their equipment more reliable, improved efficiencies, and reduced costs.

**ESSENTIAL #4. LOOK INTO FIBER OPTIC BENEFITS.**

Rugged fiber optic connectors are a great choice for long-term monitoring situations that require moving a high volume of data over a great distance. Fiber optic cabling and connectors are a lightweight, secure way to install a fast and reliable data link. As with copper cables, be sure to test connectors with the specified cable to make sure that the solution works with your equipment. For applications where multiple mating cycles are typical, such as a temporary setup at a sporting event, look for fiber optic connectors that are field-cleanable. Some fiber optic cables also provide power and fiber in a single connector.

Fiber optics are also used in sensing applications to gather information about the environment, using the physical interaction of light along the fiber. This technology can be used for acoustic, strain, thermal expansion, or temperature measurement. For example, in oil drilling monitoring applications, sensing instrumentation allows real-time information about the geological properties being drilled due to the sound that is produced. Engineers can evaluate the information and make adjustments to the process. The oil & gas industry also uses light waveguide interactions as a sensing device. This allows easier structural, temperature and acoustic monitoring for drilling extraction and carrying activities. We can find fiber optics used in downhole, pipeline monitoring, fracking, surface communications, etc.

Fiber optics are also the best candidate to carry data over large distances, and can be an easy way to build an Ethernet network between locations further than 1 mile apart.

The Fischer FiberOptic Series allows you to choose from cable assemblies in multi-mode, single-mode and single-mode APC for perfect integration in fiber optic sensing applications. The rugged and sealed bodies ensure a high degree of mechanical protection without compromising the optical performance.

**ESSENTIAL #5. TAKE ADVANTAGE OF HYBRID CONNECTORS WHENEVER YOU CAN.**

Instrumentation, especially geophysical exploration or medical applications, often demands a device that is capable of handling complex and multiple functions, but also needs to be small and compact.

Hybrid connectors can reduce the complexity that often comes along with your customer demands for increased functionality. Mixing signal and power, coax and signal, and mixed signals are common requests. Even fluid and signal hybrids are possible as customized solutions, although they may require longer lead times. Power mixed with fiber optic can also reduce the number of connections required. The benefits of mixed functionality in connectors include better usability, less overall weight, and lower overall component costs.

**ESSENTIAL #6. GET SMALL. BUT NOT SO SMALL THAT YOU CAN'T EASILY CONNECT AND DISCONNECT.**

Of course we all want a smaller device and a smaller connector, but getting too small can be an issue, especially if the user is wearing gloves. Look for connectors that are dense without creating interference. Make sure you examine the details, including pin size, especially if you are running

power. Many of the smallest connectors are designed only for signal. If you connect and disconnect frequently, you want a mini connector that has up to 5,000 mating cycles. And of course the connectors have to be sealed to withstand dirt, grime and weather when instrumentation devices are outside in the elements. The Fischer MiniMax™ Series is an excellent solution for a variety of applications, including medical instruments. For equipment used out in the field, miniature components like the MiniMax connector help lower the weight of the device without sacrificing functionality or reliability.

### ESSENTIAL # 7. CHECK NETWORKING PROTOCOLS.

Instrumentation applications often demand the transmission of a high quantity of data in real-time or near real-time. Many rugged connectors are built for fast data transmission, including industry-standard networking protocols and USB speeds.

Keep in mind that the connector is only one contributor to the performance of the cable assembly; be sure to consider the cable quality, process and length. Test your data rates and protocols with the connector and cable together. The connector and cable may pass tests individually, but should be considered together to ensure reliable performance.



FISCHER MINIMAX™ SERIES



FISCHER ULTIMATE™ SERIES

The Fischer MiniMax™ Series and Fischer UltiMate™ Series provide high speed performance suited for a wide range of protocols. Check with your representative to find the best solution for your application.

### A BRIEF NOTE ABOUT LEAD TIMES

Connectors for rugged applications are sometimes available off-the-shelf, but custom connectors and cable solutions can mean longer delivery times. Even in stocked connectors, certain popular configurations will be available faster than others that aren't always in use. If you are flexible in the number of contacts you design into your solution, you may be able to influence delivery dates. Work closely with your connector partner to understand what can be delivered quickly, and what configurations might be pushed into a 12-week or longer lead time.

### SUMMARY

The challenge of selecting the best interconnect solution for an industrial or instrumentation application in a rugged environment always means starting early and considering the entire system. Knowing the end use temperatures and conditions, and how the user behaves in the field will influence your decisions, so apply that knowledge to your connector selection. New connector technology is being released frequently, as connector manufacturers bring smaller, more dense products that are still rugged to market to meet the expanding needs. Stay current with the newest technology to build smaller, smarter, more reliable devices that integrate the best interconnect solution for your unique application.





### **ABOUT FISCHER CONNECTORS**

Fischer Connectors has been designing, manufacturing and distributing high-performance connectors and cable assembly solutions for more than 60 years. Known for their reliability, precision and resistance to demanding and harsh environments, Fischer Connectors' products are commonly used in fields requiring faultless quality, such as medical equipment, industrial instrumentation, measuring and testing devices, broadcast, telecommunication and military forces worldwide.

Primary design and manufacturing facilities are located in Saint-Prex, Switzerland, with subsidiaries and distributors located worldwide.



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