

Ruggedizing Coaxial Connectors: To Make the Grade You Have to Take Control

Posted At : April 21, 2016 4:11 PM | Posted By : Chris Sanders

Related Categories: Ruggedized Connectors, PIM

In applications that require the highest electromechanical and environmental performance from their coaxial connections, ruggedized (aka "military-grade") coaxial connectors require a different design and manufacturing approach to ensure signal integrity through the transmission line at all times. A signal transmitted through a "commercial-grade" coax connection can experience nonlinearities and large reflections at the connector when used in extreme conditions. But common problem areas in connectors can be optimized to allow a cable to function at the highest frequencies in high pressure, and highly dynamic environments. Here's how:

Control Over Solder Joints

Solder joints are often weak links in the signal chain as solder fatigue can cause a degrade in performance and eventual failure. Oftentimes, when operating under environments with a high level of vibration, mechanical shock, or thermal stress the soldered joint between the contact and center conductor--also know as the solder-wick line--can develop microfractures and eventually solder fatigue. The conformity and reliability of the solder joints on a coaxial connector are especially important as any non-conformities can cause reflections and loss at higher frequencies.

Solder fatigue can occur at connector joints that are flexed often and in high temperature differentials. [Source](#).

Control Over Assembly

Many connector issues can start at assembly when a technician is attaching the connector to the coaxial cables. There a few areas that are critical for the longevity and reliability of the cable assembly. The solder-wick line between the center contact of the connector and the center conductor of the cable can only be soldered when the dielectric and shielding of the cable are properly stripped back. Excess heat applied at that solder joint can deform the dielectric, excess solder flow will change the contour of the pin, and insufficient solder leaves a depression at the solder joint thus changing the contour of the pin--all deformities alter the electrical performance of the cable. In cases where the connector has a crimping ferrule, equal pressure from the crimp die on all sides is essential in affixing the connector onto the coax. Whether the connector is fastened on through crimping, soldering, compression or twisting, every single step in the assembly process has to be done with precision and keen eyes.

Control Over Environmental Factors

Connectors are a critical factor in any coaxial cable installation, especially when they may have to withstand a variety of weather conditions including wind, rain, temperature extremes and extreme pressure differentials. The engineering behind the physical design of the connector must take its respective application into consideration. Mated connectors can come loose from vibration in windy environments if they are not mechanically locked in place. This can very rapidly degrade a signal and leave the dielectric and center pin more exposed to the elements. The value of a properly torqued connector increases with frequency, any physical discontinuities can vastly diminish signal transmission past 2 GHz. Pressurized connectors are often leveraged to provide weatherproofing of the connector. Still, the internal o-ring that is often used for the pressure seal can deform, become brittle, and present foreign substance (o-rings often require grease to form a seal) in the

interconnection. Over time they often need to be replaced. This process of finding and fixing small issues with cable installations can be costly and time consuming, as well.

Control of Passive Intermodulation Distortion

Passive intermodulation distortion (PIM) is a phenomena that occurs when the passive components of an RF system produce nonlinearities--the mixing of these spurious signals can create signals that interfere with transmission. Magnetic hysteresis caused by the use of ferrous metals, corrosion of connectors due to moisture, multiple vibrating piece parts, and the junction of dissimilar metals are all involved in causing PIM in connectors. To maximize PIM performance in connectors it is important to fabricate smooth surfaces, use non-ferrous metals in the connector, and to use single-piece body constructions to prevent the non-linearities that cause PIM.

Control Over Repeatability

San-tron has designed a brand of ruggedized connectors for extreme applications that have been repeatedly proven to function well into the 20 GHz region. The eSeries™ class of coaxial connectors have an extended ferrule designed to support the common failure point of the solder-wick line. Even when a cable is continuously flexed the solder joint can remain relatively stiff. The assembly of the connector is kept simple to minimize any variability and cost that comes with a more complex assembly. The connectors are designed with a "positive cable stop" in them so they can be easily placed onto a coaxial cable after the heatshrink, shielding, and dielectric have been stripped back to their proper dimensions. The connector requires one slide onto the coax and only one solder joint for a 20 GHz capability. These weatherproofed connectors also come in low-PIM models. San-tron's pSeries™ class of connectors are pressurized connector that are machine designed to maintain pressure seal without the use of an internal o-ring, thereby eliminating the need for replacing the internal o-ring. While highly sought after for use in commercial applications such as agriculture and underground wireless systems (subways, etc.), they're thought of as military grade in nature -- they're also used in military applications, such as Manpack radios.

But regardless of where they're used, a ruggedized connector is often the only way to ensure reliable signal transmission over time. Knowing what to look for, and perhaps request customization around, will prepare you for a solid working relationship with your coaxial connector and assembly manufacturer or supplier.