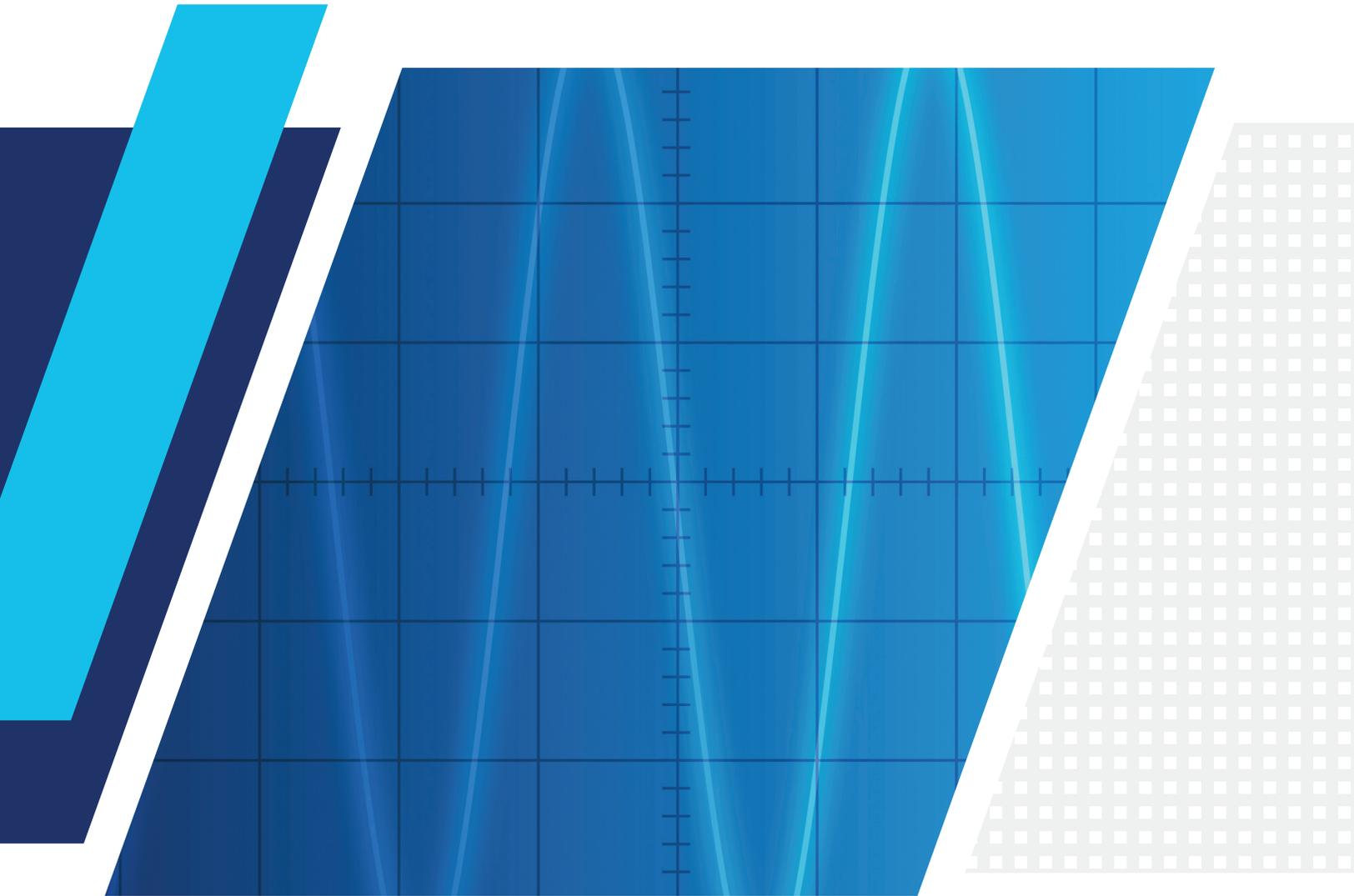


APPLICATION NOTE



Everyone Needs
Good Connections

Everyone Needs Good Connections

Introduction

Connectors are critical when designing new antenna applications. The selection of the RF connector represents important factors when designing for antenna and other RF systems and components. Critical factors include connector size, weight, performance and mechanical features as well as ruggedness. If cables couldn't be connected, but were spliced, system specs would be better, but repair would be more expensive, complicated and time consuming. Assumptions are always made that connectors are different from feed lines, but the same laws of physics apply.

When looking at the characteristics of a conductor, the ratio of the outer diameter of the inner conductor to the inner diameter of the outer conductor determines the impedance of the connector.

Any changes in these measurements will result in a change in impedance and will cause reflected power or VSWR.

Remember, IMPEDANCE is a function of the diameters of the center conductor to the outer conductor

$$Z_0 = 138/\sqrt{\epsilon} \log_{10} (D/d)$$

- Where Z_0 = Impedance
- ϵ = the dielectric constant of the insulating material
- D = inner diameter of the outer conductor
- d = outer diameter of the inner conductor

VSWR is the ratio of maximum and minimum voltages on a transmission line caused by the combination of a forward and reflected wave.

$$VSWR = [1 + \sqrt{P_r / P_f}] / [1 - \sqrt{P_r / P_f}]$$

- P_r = Reflected Power (Watts)
- P_f = Forward Power (Watts)

All connectors, all transitions in feed systems, result in some insertion loss and some return loss as well. Type N is perhaps the most common connector for low power systems. Rigid feed lines will come with "solder on" flanges already installed, or with field flanges ready for indoor

installation. Properly installed, flanged connectors will exhibit losses and power handling capabilities that are nearly identical to the feed line. The technician should be thoroughly familiar with the installation of connectors. Many manufacturers offer special training and tools to ensure the connectors are installed properly. Properly installed connectors will add approximately 0.1dB of loss for every pair of connectors in line. The manufacturer's specifications are important in understanding the amount of loss.

All kinds of problems are associated with the improper installation of connectors on feed line. Obviously, if the connector falls off, is pulled off, or over time works its way off from the feed line, communications will be difficult. An issue that is becoming more apparent over time is the generation of passive intermodulation, (PIM), from improperly installed connectors. PIM may also be the result of connectors being connected and disconnected too many times.

Manufacturers of connectors have precision tools for preparing the feed line for installation and for connector attachment, as well as center pin depth measurement or center pin excursion measurement. Even the torque characteristics for individual connector types need to be understood and followed. Think of the connector as an extremely short piece of feedline, which it is. Any change in the diameter ratio, the circularity of the conductors, or the materials within the connector will change its impedance.

Connector problems can create headaches. Some problems are shown below.

- Poor quality
- Improperly installed or maintained
- Improper center pin depth
- Corrosion
- Water intrusion
- Broken or loosening grounds
- Frequent use
- Used with incorrect coax
- Wrong impedance
- Wind damage

Choosing a connector with the proper power handling capacity and within its operating frequency range does

not have to be problematic. Done correctly, your system will have one less problem you have to be concerned with.

Two key performance characteristics of a connector is:

- To conduct RF signals from a transmitter to a receiver with minimum losses and reflections
- Provide repeatable performance when connecting and disconnecting

Key parameters to look for are Power Handling, Cut-off Frequency, Insertion Loss, Ease of Use, Mating cycles and Impedance. Environmental concerns also need to be considered. Temperature, thermal shock, resistance, corrosion and vibration.

The most common type of RF (radio frequency) connectors are:

- Type LC-High Voltage applications DC to 1GHz
- 7/16 DIN – Superior performance for both return loss and intermodulation distortion
- HN- High Voltage applications DC to 4 GHz
- SQS- 50 Ohms, Quick change



The below graph can be used to help select which connector to use at which frequency and power. This graph is only a base-line tool. When selecting RF connectors for your system always follow the manufacturer's guidelines for assembly and you will achieve optimum performance.

