Everyone Needs Good Connections

By Lynn Strube
Bird Technologies, Applications Engineer

Introduction

Connectors are a 21st century fact of life. If cables couldn't be connected, but were spliced, system specs would be better, but repair would be more expensive and complicated. Too many times, we think of connectors as something different from feed lines, but the same laws of physics apply. 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.

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

$Z_o = 138/\sqrt{\varepsilon} \log_{10} (D/d)$

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

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 (Pr / Pf)] / [1 - Sqrt (Pr / Pf)]

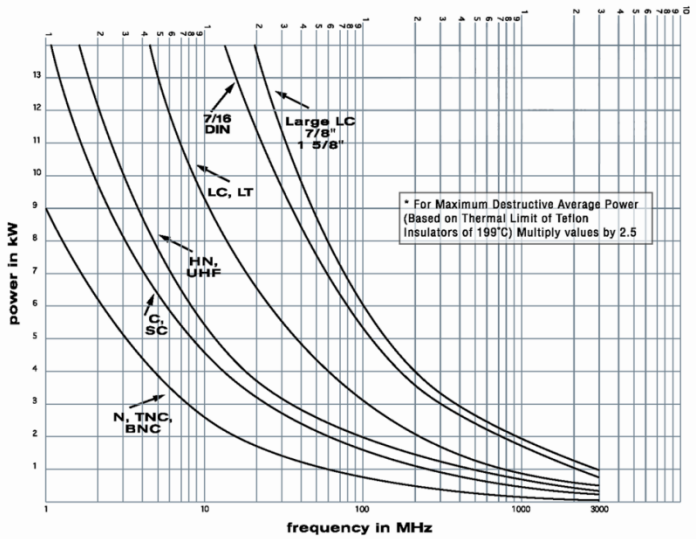
- Pr = Reflected Power (Watts)
- Pf = Forward Power (Watts)

The same as feed lines, the larger the connector, the more power and higher frequency at higher power it can handle. 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 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 of 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 feed-line, which it is. Any change in the diameter ratio, the circularity of the conductors, or the materials within the connector will change its impedance.

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.



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 the connector with the proper power handling capacity and within its operating frequency does not have to be problematic. When done correctly your system will have one less problem you have to be concerned with.