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# The Basics of Specifying RF and Microwave Connectors

This month's tutorial article covers the key points that must be covered when specifying RF and microwave connectors

In all manufacturing, the accurate specification of each component is the best assurance that the finished product will work as designed. Nowhere is this more true than RF and microwave connectors. Connectors are often the "weakest link" in a system, subject to repeated attachment and disconnection, exposed to the surrounding environment, and a place of discontinuity in an otherwise uniform coaxial cable. This article offers notes on the fundamental specifications that all engineers should understand to get the right connector for a project.

## Electrical Specifications

To being with, all connectors must provide the necessary electrical performance for the application. Typical electrical specs include:

- Dielectric Withstanding Voltage
- Insulation Resistance
- Working Voltage
- Initial Contact Resistance
- Contact Resistance After Environmental Exposure
- Impedance
- VSWR or Return Loss
- Insertion Loss
- RF Leakage (or Shielding Effectiveness)

Note that several of these specifications are frequency-dependent. Include the required frequency range, or the required performance over various frequency sub-ranges.

It is important to be familiar with the manufacturers' specifications for standard connectors, and match your specs to theirs whenever possible. Over-specifying a connector can result in an expensive special order, while under-specifying may result in the Purchasing Department selecting a lower quality connector than you intended.

## Mechanical Specifications

Connectors are manufactured from metals, plastics and other materials using mechanical processes such as casting, machining, forming, injection molding, etc. Thus, mechanical specifications are extremely important. Key mechanical specs are:

*General:*
- Materials and Finishes
- Visual Uniformity and Defects
- Mating and Withdrawal Forces (including required sleeve or nut torque)
- Radial and Axial Movement
- Dimensions and Tolerances

*Specific:*
- Connector Body
- Bayonet Sleeve
- Center Conductor Contact
- Dielectric Material
- Spring Material
- Gasket Material
- Sleeve Type and Attachment

Mechanical specifications should refer to published standards whenever possible. This can establish most of the above requirements without the need to specify them individually. Be sure to consider any requirements unique to your application, such as connector spacing, access, cable dress, etc.

### Environmental Specifications

- Operating Temperature Range
- Storage Temperature Range
- Temperature Cycling Performance
- Corrosion Resistance
- Mating/Unmating Cycles
- Axial Forces
- Ground Finger or Spring Continuity
- Shock and Vibration
- Humidity
- Altitude
- Vacuum (Space Qualified)

There are many standard environmental requirements and test procedures, particularly for MIL- and space-qualified connectors, as well as for wireline and optical networks.

Again, be sure to include requirements specific to your application. These may include a corrosive industrial environment, exceptionally high vibration, more than typical mating/unmating cycles, dampness, etc.

### Quality Specifications

- Quality Assurance Program
- Required Methods for Performance Testing (e.g. pertinent MIL or ASTM specs)
- Warranty and Remedies
- Quality Documentation

This is an area where over-specification of a general-purpose connector can be expensive. Be sure your requirements are exactly what is needed.

### Miscellaneous Specifications

- Part Marking
- Packaging
- Installation Instructions and Tooling
- Technical Documentation
- Delivery Schedule
- Access to Technical Support

Additional requirements may be needed for applications other than typical RF/microwave systems—such as CATV, video distribution, broadband networks, test fixtures and ATE systems. Be sure these are included in any specification documents.

Connectors are among the most common RF/microwave system components. In many applications, they are the most critical components for reliability. Proper specifications are the only way to assure that the necessary system performance will be achieved.