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Guidelines for Choosing RF/Microwave Coaxial Cable Assemblies

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Here is a review of the basic data used to specify cable assemblies for communications systems, test equipment and high performance, high reliability applications such as space

In the process of designing and constructing RF and microwave systems, few components are more common than cable assemblies. In most communication facilities, there are many cables used to interconnect the various pieces of equipment. Within those "boxes" cables will be used to route signals among the various boards and modules. And of course, the connection to the antenna system also requires cables.

In addition to system interconnections, the test equipment used during the design, manufacture, installation and commissioning of these systems use cables to deliver and receive their test signals. Many ongoing operational test and monitoring functions also send the acquired signal samples to the monitoring equipment via cables.

Whenever possible, it is best to use manufactured cable assemblies. They are built under controlled conditions, by experienced technicians, often using special fixtures for maximum precision and repeatability. Of course, many cables need to be measured on site, with connectors installed in the field. In these situations, the experience of the installer, along with the available tools and fixtures, will determine the performance of the final assembly.

Selecting the Cable and Connectors

Now that we have firmly established the widespread use of cable assemblies, a review of the basic information necessary to specify them is in order. The first step is to choose the right cable/connector combination to meet your needs. This is far more detailed than many new engineers expect. The following list is adapted from the user-input form on the Semflex Web site and shows the range of selection criteria for cable assemblies:

Application Data
- Cabinet interconnects (Y/N)
- Cable Type
  - (flexible, semi-rigid, hand-formable)
- Low Intermodulation (Y/N)
- Outdoor / Field Uses (Y/N)
- Chemical Resistance Conditions (Y/N)
- Cable Jackets and Outer Covers (Y/N)
- Cable diameter (0.120 to 0.500)
- Jackets:
  - (FEP, Polyurethane, Armor, Ruggedized, Nomex)

Electrical Specifications
- Maximum Frequency
- VSWR @ Max Freq
- Low Insertion Loss (Y/N)
- Impedance (ohms)
- Shielding Effectiveness @Max Freq.
- Power Handling
- Conductor Types
  - (Solid, stranded, silver plated)

Environmental Requirements
- Temperature Range
- Temp/Humidity (High/Med/Low)
- Vibration Shock (High/Med/Low)
- Abrasion (High/Med/Low)

Connectors
- SMA
- Type N
- TNC

7 mm
3.5 mm/2.9 mm/2.4 mm
SMC/SMB
MCX
BNC
SC
HN
7/16
Styles:
- Straight Male
- Straight Female
- Right Angle
- Bulkhead Female
- 4-Hole Flange Female
- Swept Right Angle

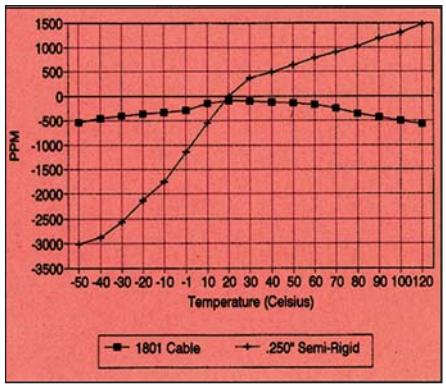

Figure 1 · Phase vs. temperature plot comparing standard 0.25 inch semi-rigid line with IW's 1801 phase stabilized cable.

Figure 2 · The Tuff-Grip adapters from Times Microwave Systems provide physical assistance for the attachment of field test cables.

High Performance Options

Beyond these basic selections, cable assemblies often have special performance requirements. Stable phase over temperature, exceptional flexibility, extreme temperatures, and repeated mating/unmating are a few of these.

For example, Storm Products provides phase stable cables according to the following customer choices (in increasing order of cost and manufacturing difficulty):

Relative phase match—a set of cable assemblies are matched to one another. Failure of one requires that all be replaced.

Absolute phase match—Cables are built to an exact standard. This is more expensive, but individual cables can be replaced.

Electrical length match over temperature—Should be used only for critical applications where the operating temperature cannot be controlled. Especially difficult to verify with short cables.

Phase stabilized cables have become more common as systems have increased in complexity, especially wireless base station equipment installed in unmanned locations. Phase stability over temperature assures performance over a wide enough range that precision air conditioning is not required. Figure 1 is a comparison by IW Microwave of standard semi-rigid cable with a phase stabilized cable.

Another high performance application is space-qualified operation. There are 50 or more applicable standards for space applications, developed by government, military, commercial and industry organizations.

Many of the necessary specifications are the same as any other cable assembly, but there are also many additional factors. According to W.L. Gore's extensive catalog of spaceflight cable assemblies, these include such things as outgassing in a vacuum environment, a temperature range of –55° to +150° C, ability to withstand launch shock and vibration, and a series of high-reliability practices including X-ray inspection.

Field-Built Assemblies

Wireless personal communications base stations make up the single largest consumer group for coaxial cable. While the base station equipment may use manufactured cable assemblies for its installation, the use of multiple antennas located at the top of towers requires that many cables are measured and cut on site, with field-installed connectors.

To address the need for maintaining high performance and precision installation in the field, cable and connector manufacturers offer appropriate tools and fixtures. These accessories allow the installation technicians to assemble connectors to cables with a precision and reliability that approaches in-house manufacturing.

Test Cables

A special subset of cable assemblies are test cables, which are designed for repeated usage, high flexibility, and reliable connection over many mating/unmating cycles. Specifications are best determined by consulting the user's manual or applications support staff at the test equipment manufacturer.

Field testing requires yet another group of cables and accessories—special adapters. Broadcast, mobile radio and wireless base station equipment often uses large-size coaxial cables and connectors, while test equipment generally has Type N, SMA or other small-size connectors with well-defined characteristics to very high frequencies. Thus, adapters are an essential part of field testing. Among the products offered is a special grip from Times Microwave Systems, shown in Figure 2.

Summary

These basics should help you begin the process when specifying cable assemblies for your module, system or test application.