

CABLE ASSEMBLY DESIGN GUIDELINES

CABLE ASSEMBLIES: ONE OF THE MOST CRITICAL LINKS

Coaxial or RF cable assemblies are often overlooked, or one of the last items designed into an RF or microwave system, and expected to be inexpensive. Actually, cable assemblies are one of the most critical links.

Yes, there are plenty of inexpensive RF connectors and cable assemblies out there, but as the old cliché goes, “you get what you pay for.” It’s important to use careful thought when selecting components of a cable assembly being implemented in your system. In addition to **cost**, take time to consider the **reputation** of the manufacturer, **design** and **quality** of the component.

Any initial cost saved by using an inferior product can potentially lead to future burden onto engineers and technicians due to poor design and quality. Incidences like this have put additional costs to OEM’s as well. Once informed that the components designed in will not meet their electrical requirements, the costly ECO process begins.

COMPONENT SELECTION

Proper component selection plays a more significant role than ever before in designing a quality cable assembly. Selecting the proper cable assembly involves knowing your **frequency range**, **electrical performance** (return and insertion loss), **environmental** and **mechanical requirements** along with **cost**.

A QUALITY CABLE ASSEMBLY STARTS AT THE CONNECTOR....

Aren’t all connectors the same? Connectors are for the most part designed and manufactured to the **MIL-STD-348** and **MIL-C-39012**.

MIL-STD-348 is the standardization of the coaxial connector interface. While this guarantees mechanical form, fit and function of a connector, MIL-STD-348 does not address electrical performance.

MIL-C-39012 is a more detailed standard that covers electrical performance in addition to mechanic interface, but is limited to certain connector families and RG-type coaxial cable. Many connector interfaces did not exist when the standard was written.

ELECTRICAL PERFORMANCE

Electrical performance of a connector is left to the design of individual connector manufacturers. **Optimal electrical performance is achieved by minimizing signal reflection in cable-to-connector interface via impedance matching.** This can only be achieved by modeling, prototyping, testing and refinement of the connector design.

Unless the manufacturer controls the dimensional tolerance to maintain the correct impedance via proper pin, dielectric and connector body design, a connector will not perform throughout the full range of the generic specification. As frequencies increase, impedance matching becomes even more critical.

For example, an N-type connector has a generic frequency range from 0-11 GHz, but not all connectors will work throughout the full range. Actual working frequency ranges can vary from DC-1 GHz, DC-3 GHz, DC-6 GHz or DC-11 GHz, depending on the design of the connector.

The true electrical characteristics of a connector can't be determined until a S-parameters test using a network analyzer is performed with the connectors installed on a short cable assembly. Most manufacturers only list a generic electrical specification for the connector type, but not for the specific connector itself.

There are reliable manufacturers with quality reputations that have the expertise and take the time to properly design a connector, but unfortunately there are other manufacturers who attempt to clone connectors and cut corners with detrimental effects.

CONNECTOR MATERIALS

Material selection plays a very important role in long-term reliability of a connector.

Common connector body materials are brass and stainless steel.

Brass is a good economical choice for commercial applications. Passivated stainless steel is suggested for high reliability and harsh environments.

Signal contacts are usually made from brass, beryllium copper, or phosphorous bronze. These materials are acceptable to use as a male pin contact, however, exercise caution when specifying a material for a female contact.

Heat-treated beryllium copper has been the industry standard and the best choice for many years due to it's' ability to maintain contact resilience after repeated mating. Brass or phosphorous bronze are also specified by some companies, however, should be avoided as they fail to maintain contact pressure on the mating pin contact after repeated matings, which can lead to signal degradation and noise.

Plating is also another area of concern. **Make sure the plating on a connector is thick enough to withstand repeated matings.** Without the proper thickness for your application, the plating can erode down to bare metal causing oxidation and conductivity problems after repeated matings.

SELECTING CABLES

The additional part of the cable assembly equation is the cable. **Once you've specified the correct connector for you application, choose the largest cable that matches the connectors for optimal performance.** There is more to this than meets the eye. For as many connectors manufactured, there are many different types of cable, and the same concerns apply. Like connectors, cable types are not all the same.

Most types of cable are standardized to MIL-C-17 specification. There can be several variations of the same cable type, especially in the commercial market. Each will slightly differ in material and design affecting performance.

Again, keep in mind, you get what you pay for. **A reputable cable manufacturer should be able to provide you with a detailed datasheet with complete material and electrical specifications.**

ESM CABLE CORP. CUSTOM CABLE ASSEMBLIES

ESM Cable Corporation does not manufacture its own connectors or cable. There are enough reputable companies in the RF connector industry that have the expertise to design and manufacture high quality connector and cable.

We work in conjunction with these companies to design custom connectors to our specifications when needed. We also utilize this resource to develop a library of their standard connector offerings that meet our performance and reliability specifications. This allows us to evaluate the strengths and weakness of each manufacturer's design to find the best performing connector while keeping cost low.

We work with our customers customizing their cable assembly needs, thus delivering cable assemblies that always meet or exceed their electrical requirements.

**Not sure which cable assembly will work best for your application?
Let an ESM Engineer help design the best assembly for the job.**

Call (209) 892-3347 or e-mail sales@esmcorp.com