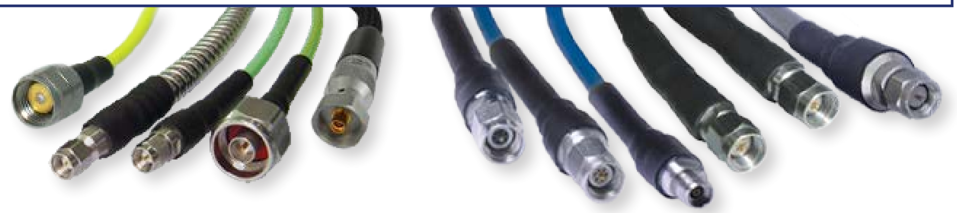
Handling High Performance Coaxial Cables

High performance cables require special handling procedures to ensure optimum electrical performance. Many of these handling procedures are outlined here in detail. Taking just a few, basic preventative measures during handling could significantly extend the life of the assembly. Always take care to prevent anything from being placed on an assembly, as this could result in internal damage caused by compression. Also, try to prevent cable from bending below its minimum bend radius as this will cause the cable to kink which results in internal damage.



Limit bend radius whenever possible:

It is recommend to use the widest possible bend radius to fit the application. This will help to keep mechanical stresses low through the bend and prolong the life of the assembly.

Avoid torquing down connector ends until both connectors are mated in position:

It is important to tighten both connectors into position before any torque is applied. If a connector is torqued down before the assembly is routed into position, excessive torsion could be applied at the torqued connector's termination during the routing. These torsion forces could cause the dielectric to change its mechanical position at the connector termination, and ultimately lead to an electrical failure.

Avoid twisting assembly to orient connectors:

When installing assemblies with right angle connectors, do not twist the cable or connectors to orient it with the mating connectors. Twisting the assembly could result in mechanically changing the dielectric position at the termination and ultimately lead to an electrical failure. Assemblies should be purchased with a specific connector offset angle to match the proper mating connector.

Avoid bending the assembly at the connector termination:

A cable assembly should never be bent at the back of the connector. Applying a bend prematurely at the end of an assembly and allowing the bend to encompass the connector could lead to the build up of excessive cable forces against the connector and through the bend area. The applied forces will cause the cable to kink, resulting in electrical degradation and possible failure.

Avoid pulling an assembly through channeling by the connector end:

Never pull an assembly by its connector when routing it through a frame work, channeling or building. Doing this could mechanically damage the connector termination. The assembly should always be pulled by the cable itself. Furthermore, the installation should be assisted by pushing the assembly through the channeling while the cable is pulled. Additionally, it is less stressful to the assembly if it is installed in phases (through individual sections) rather than a single run across the entire routing length.

Never allow an assembly to support its own weight when routed in a vertical installation:

Never allow an assembly to hang freely by its own weight. Clamp down the cable at equal intervals along its length. Cable hangers can be used when it is not possible to clamp down the assembly in a vertical installation, provided the assembly has been reinforced for such an installation. Using multiple hangers whenever possible is also recommended to help evenly distribute the assembly's weight along the run.

Avoid the use of cable ties.

Most high performance cables use an air-filled dielectric core. This makes the cable very soft. Therefore, any compressive load applied to the cable has the potential of collapsing the dielectric core within the cable. Cable ties and tie wraps are not recommended for this reason. They offer virtually no load distribution and consequently focus very high compressive forces through the tied down area. A concentrated force such as this almost always deforms the cable and significantly degrades assembly performance. For best holding results with minimal clamping forces, we recommend rubberized clamps. Be sure to select a clamp that will apply a minimum amount of compression force while still offering the desired holding strength. Selecting a clamp that is too small can do as much damage to an assembly as a cable tie.

Avoid subjecting the connector ends to cable axial loads:

Cable assembly life can be increased by clamping down the cable a few inches from the connector ends in applications where the cable will be moving (such as a moving antenna) or where a high vibration condition exists. Clamping the cable down at the cable ends reduces mechanical loads applied to the connector when the cable is moved.

Always wrap connectors in weather proofing when installing outside:

All cable connections that will be subjected to rain and snow should be wrapped in a weather proofing material. A self-fusing silicone tape is recommended to create a weather tight seal over the connection. If weather precautions are not taken, water will eventually work its way into the connector assembly causing high insertion losses.

Always provide adequate drip loops:

Always allow for a drip loop in outside applications to prevent water from flowing down the cable and onto the connector. Over time the water could work its way into the connector assembly causing high insertion losses.

Take extra care with short assemblies:

Always bend assemblies around mandrels whenever possible:
The use of mandrels or wheels will help to evenly distribute bending loads applied to the cable. This is the preferred method for bending cables.

Take caution when bending cables by hand:
Sometimes bending a cable by hand is the only option. In this case the following method should be used;

- Start at bending point keeping hands close together.
- Bend the cable a little at a time working in an outward direction along the bend.
- Return to the center point of the bend and work in an outward direction making the bend a little tighter.
- Continue to return to the center of the bend, and working outward until the desired bend is reached.

Take caution bending cables under 12" in length.

An assembly that is 12" in length and smaller can be very rigid depending on the cable type. The cable becomes rigid because its inner and outer conductors are fully (mechanically) terminated to the cable connectors. The cable is terminated this way to yield maximum electrical performance. Unfortunately, it minimizes the bending characteristics of the assembly because the cable is too short to accommodate the total material volume displacement needed for a typical bend. Often, the minimum bend radius cannot be achieved without damaging the assembly. Therefore, short cables should only be used in applications where slight jogging bends will be used. A longer assembly that uses a service loop should be considered as a replacement for a short cable in situation where a tight or sharp bend is needed.

Coaxial Cable Terminology

Phase Stability over Flexure for Low Loss Coaxial Cable

Phase stability over flexure can be significantly affected by the cable assembly technique, cable bend radius, and the length of the cable assembly

Phase Stability over Temperature for Low Loss Coaxial Cable

The electrical length for a given frequency will "shift" as a result of environmental changes. The degree of change is based on mechanical stresses, connector to torque and thermal conditions.

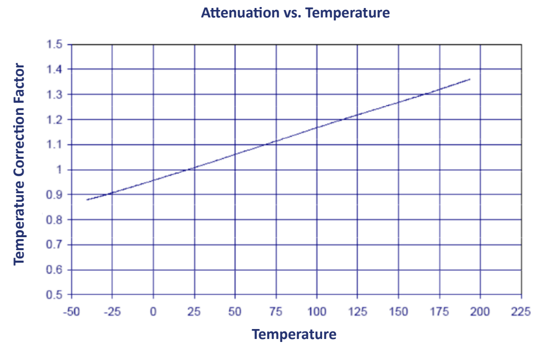
Power Handling Capability of Coaxial Cable

The power handling capabiltiy of coaxial cable is dependent either on its maximum voltage-withstanding capability for the transmission of peak power or on its thermal dissipation ability for average power transmission, which is the more common problem for RF applications. The thermal dissipation of cable depends upon its thermal resistance. For a cable in air, the thermal resistance of the surrounding air is related to the condition and radiation losses and dependent upon the surface area of the cable, the temperature of the surfaces, the ambient temperature, emissivity of the surface, and the flow of air.

The amount of heat which flows radially from the line will depend upon the composite thermal resistivity of the dielectric and insulating material of the cable, and the temperature gradients therein. The heat generated within a cable is given by the ratio of temperature rise between the inner conductor and the ambient temperature to its thermal resistance, which is equal to the difference of the input power and the output power in a matched system. The ratio of these powers is a function of the attenuation per unit length, which is directly proportional to the heat generated in the cable. For any particular cable construction, the average power rating will depend on the permissible temperature rise above a stated ambient which is limited by the maximum operating temperature that the dielectric can withstand. The generally accepted maximum operating temperature for polyethylene is 80°C and for PTFE is 250°C. Simply stated, power handling of a coaxial cable is a function of attenuation and the temperature of the dielectric. The higher the operating frequency, the lower the power handling capability.

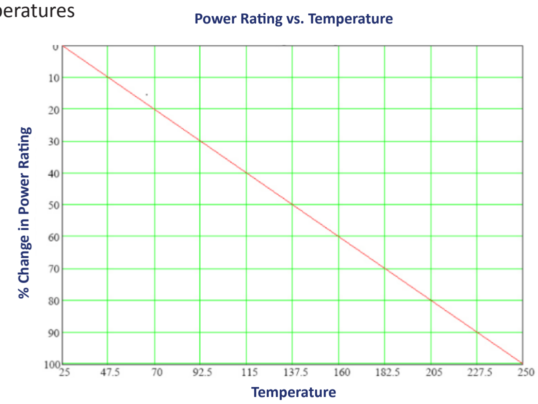
Attenuation vs. Temperature Correction Factor for Coaxial Cable

Recalculates the attenuation of a coax cable at various temperatures



Power vs. Temperature Derating Factors

Recalculates the power handling capabilities of a coax cable at various temperatures



VSWR and Return Loss of Coaxial Cables

Voltage Standing Wave Ratio (VSWR) and Structural Return Loss (SRL) are basically the same - only different. Both terms are used to characterize the uniformity of a cable's impedance along its length as it relates to reflected energy. VSWR is essentially the ratio of the Input Impedance to the average Characteristic Impedance as a result of signal losses due to reflections and is expressed as a ratio (1.xxxx:1). SRL is the measurement of reflected energy expressed in decibels (-dB). Connectors and termination techniques are major sources of reflected energy and can significantly deteriorate system VSWR or SRL. The difference between VSWR and SRL is no more than how reflected energy is measured.

Structural Return loss (SRL) is expressed as VSWR (Voltage Standing Wave Ratio) by the following formula:

$$VSWR = \frac{1 + 10^{RL/20}}{1 - 10^{RL/20}}$$

SRL	VSWR	SRL	VSWR	SRL	VSWR
40dB	1.0202:1	29dB	1.0736:1	18dB	1.2880:1
39dB	1.0227:1	28dB	1.0829:1	17dB	1.3290:1
38dB	1.0255:1	27dB	1.0935:1	16dB	1.3767:1
37dB	1.0287:1	26dB	1.1055:1	15dB	1.4326:1
36dB	1.0322:1	25dB	1.1192:1	14dB	1.4985:1
35dB	1.0362:1	24dB	1.1347:1	13dB	1.5769:1
34dB	1.0407:1	23dB	1.1524:1	12dB	1.6709:1
33dB	1.0458:1	22dB	1.1726:1	11dB	1.7849:1
32dB	1.0515:1	21dB	1.1957:1	10dB	1.9250:1
31dB	1.0580:1	20dB	1.2222:1		
30dB	1.0653:1	19dB	1.2528:1		