

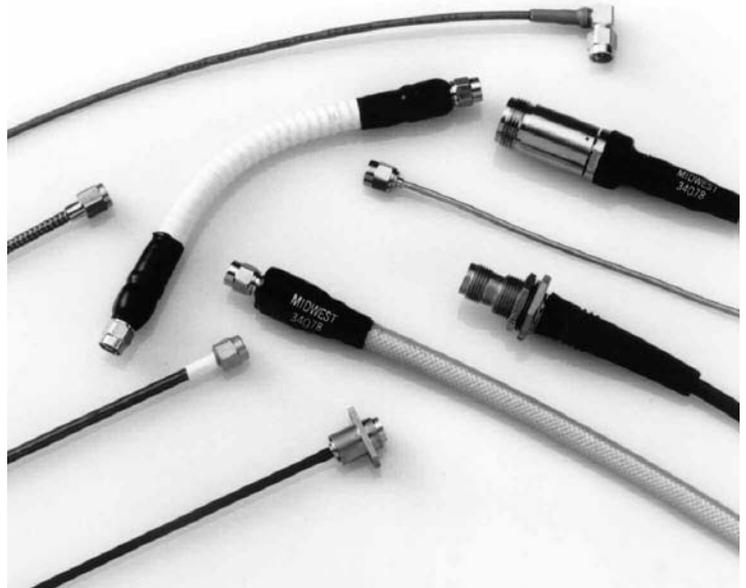


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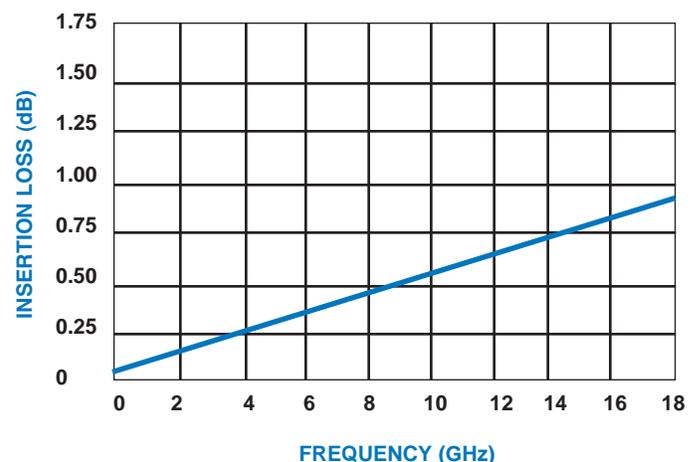
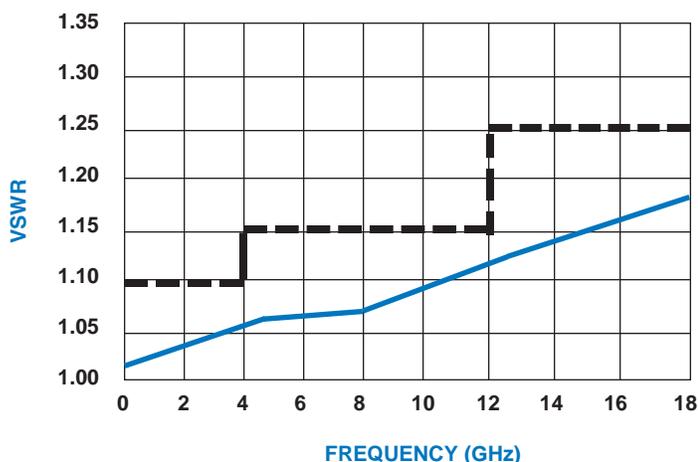
- Low Loss and Ultra-Low Loss Flexible Cable Assemblies
- Semi-Flexible and Semi-Rigid Cable Assemblies
- Phase and Temperature Stable
- Ruggedized or Armored Abrasion Resistant Construction Available
- Meets MIL-E-5400 and MIL-16400 Environmental Requirements
- SMA, BMA, N, TNC, BNC, SC, 3.5mm, and 7mm Connector Configurations

Cable Assemblies are a necessary and important part of a microwave system providing the coaxial transmission lines through which the signals received or transmitted by a system pass as they travel from or to their respective origins or destinations. Insertion Loss in these transmission lines is a very serious consideration as excessive loss can cause the system to operate inefficiently or not at all. Midwest Microwave offers this complete product line of Microwave Coaxial Cable Assemblies, ruggedly designed to provide highly reliable, low loss, phase and temperature stable signal transmission over very broad frequency ranges. These Cable Assemblies are available in a wide selection of cable construction types, each suited to the particular requirements of a system. Simple flexible cable assemblies are available from standard MIL-C-17 cable for many system requirements as well as semi-flexible and semi-rigid cable assemblies. High reliability, low loss, low VSWR, phase matched, and phase stable cable assemblies with repeatable performance over temperature are the top of the range of products offered.



Insertion and return loss test data can be supplied with each cable if desired. Cable assemblies using Midwest's standard catalog cable assembled to custom lengths are available in very short delivery schedules. Special assemblies can be custom designed by Midwest's engineering staff to accommodate unique system needs. All Midwest Cable Assemblies are completely manufactured in house and are 100% tested to insure only the highest quality performance whether for military or space use or for commercial cellular or personal communications applications.

TYPICAL VSWR AND INSERTION LOSS PERFORMANCE
ONE FOOT CABLE ASSEMBLY



Impedance - The characteristic impedance equation for a coaxial transmission line is expressed as follows:

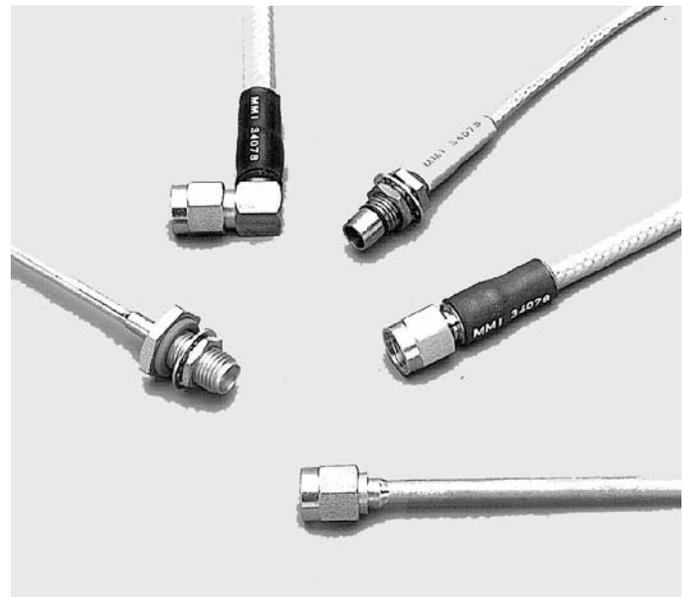
$$\text{Impedance} = Z_0 = \frac{138.06}{\sqrt{\epsilon}} \text{Log}_{10} D/d$$

where: D = diameter of outer conductor
d = diameter of center conductor
 ϵ = dielectric constant of insulation material

If the center conductor diameter of a cable is increased to reduce loss, the outer conductor diameter can only be held in check if the dielectric constant of the insulation between the inner and outer conductors is reduced. It is clear then that a lower dielectric constant will yield a smaller diameter cable for an increased center conductor diameter of a lower loss cable of constant impedance.

Frequency - The highest frequency of operation by a cable assembly is determined by the "TEM" mode frequency (Transverse Electromagnetic Mode) or the frequency at which the electromagnetic field departs from the "TEM" mode. This upper frequency mode limitation is controlled by the transmission line size which means that the higher the frequency of operation desired, the smaller in diameter the coaxial line size must be, for a given dielectric constant of the dielectric insulation between the inner and outer conductor of the cable. The requirement for lower insertion loss in a coaxial cable is unfortunately a driving force toward a larger physical size of the cable (for a given dielectric constant of the insulation), which improves the ability of the cable to dissipate the heat generated by the microwave power being transmitted through it. These opposing forces cause a classic compromise to be made between higher frequency operation and loss characteristics unless a lower dielectric constant insulation material can be used. Physical size and weight restrictions of most microwave systems as well as the requirement for higher frequency operation provide the impetus for smaller diameter cable assemblies that are low in insertion loss.

Insertion Loss - Insertion loss in a cable assembly is the result of a combination of several types of losses; attenuation loss (*dissipative*) or loss attributed to the center conductor size or material, dielectric losses, shield skin effect and shield leakage; and Impedance mismatch loss (*reflective*), most often referred to as VSWR losses. Mismatch loss, identified with high VSWR measurement is often caused by the attachment of coaxial connectors to the cable. The design of these connectors and their compatibility with the coaxial cable being used are important considerations when attempting to attain loss efficient performance of a cable assembly. In well shielded cable such as semi-rigid or multiple shield flexible cable, skin effect and shield leakage losses are very low but



Cable Assemblies for Laboratory or System

center conductor skin effect losses are significant and dielectric losses increase with increasing signal frequency. For this reason a low dielectric constant insulation serves two important purposes; a larger diameter center conductor may be used for a given diameter cable thereby lowering the loss per unit length as well as the capacitance of the cable; and higher frequency of operation can be achieved because the line size can be kept small while the loss requirements are met.

VSWR - Reflections due to impedance mismatches and other discontinuities in a coaxial cable assembly are most often introduced through the attachment of the connectors to the cable. The proper design of the connector itself as well as the technique used to attach it to the cable are important factors in attaining low VSWR and low insertion loss.

Wave Propagation Velocity - The wave propagation velocity is the measure of the speed that an electromagnetic signal will travel through a given dielectric material as compared to the speed of light through an air dielectric. It is usually expressed in percent (%), 100% being equal to the speed of light through air. As can be seen from the formula below, the propagation velocity increases as the dielectric constant (ϵ) decreases.

$$\text{Velocity of Propagation} = v = \frac{100}{\sqrt{\epsilon}} = \% v_0$$

where: v_0 = Speed of Light through air
 ϵ = Dielectric Constant of material

Electrical Length - The electrical length, sometimes referred to as phase length, of a coaxial cable assembly is determined by the number of wavelengths in degrees or radians that the physical length of the cable assembly, (including connectors), contains when measured at a specific frequency. This property is a function of the dielectric constant of the insulation material used between the inner and outer conductor of the cable and the wave propagation velocity attained with that dielectric. This relationship is shown in the expression below.

$$\text{Wavelength} = \lambda = \frac{v_o}{f \sqrt{\epsilon}}$$

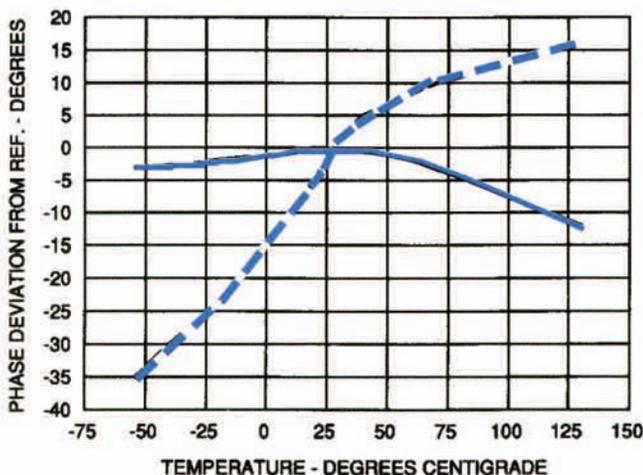
where: v_o = speed of light through air
 f = frequency of signal
 ϵ = dielectric constant of insulation material

Phase Stability with Temperature - The ability of a cable assembly to maintain its phase relationship over temperature variations is enhanced when low dielectric constant material is used because less mass is present in the dielectric which provides a lower coefficient of thermal expansion thereby relieving the problem of physical length and phase changes over temperature. In addition the cable can be pre-conditioned before assembly by temperature cycling it repeatedly through the temperature range of desired operation such that it becomes stable when exposed to those same temperature variations.

PHASE STABILITY VS. TEMPERATURE

6 Ft. Assembly with 3.5 Ft. Inside Temp Chamber
 Frequency = 5.5 GHz

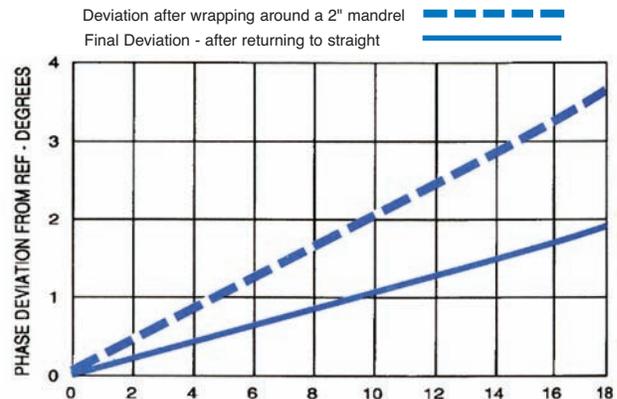
M52 Flexible Cable .141 Semi-Rigid Cable



Phase Stability with Flexure - The ability of a cable assembly to maintain its phase length with flexure is the result of mechanical techniques used in providing the shielding which controls the reflections and other impedance discontinuities that cause phase variations and can also be enhanced by pre-conditioning the cable before assembly by subjecting it to repeated flexing such that it becomes stress relieved and is not as effected by flexure. The ability of a cable assembly to remain stable with flexure can be demonstrated by making four phase measurements of the cable assembly; the first when initially measuring the phase of the assembly in a straight configuration; the second after wrapping it one full turn clockwise around a 2 inch mandrel and measuring its phase length in that configuration; the third after wrapping it one full turn counterclockwise around the mandrel; and the fourth after returning to a straight configuration. The data is then compared to determine the amount of deviation that occurred between states to evaluate the phase stability of the assembly.

PHASE STABILITY WITH FLEXURE

Low Loss M52 0.225 Dia Cable
 2 Inch Mandrel Test



Shielding Effectiveness - The solid sheath shield of semi-rigid cable is by far the most efficient shielding method yet attained. In order to accomplish effective shielding for flexible cable that approaches this efficiency, various techniques using combinations of helically wound flat foil and flat and round braid have been developed. These techniques have been largely successful in providing excellent shielding for flexible cable that exceeds -100 dB. The requirement of MIL-T-81490 (using the cavity technique) is -90dB through the frequency range of 2.0-18.0 GHz.

Vibration and Shock - The ability of a cable assembly to withstand the abusive environment of high vibration and shock is very important in all types of microwave systems. Semi-rigid cable assemblies sometimes experience cracking of the solder joints during exposure to extreme shock and vibration and under these conditions flexible cable assemblies should be employed.

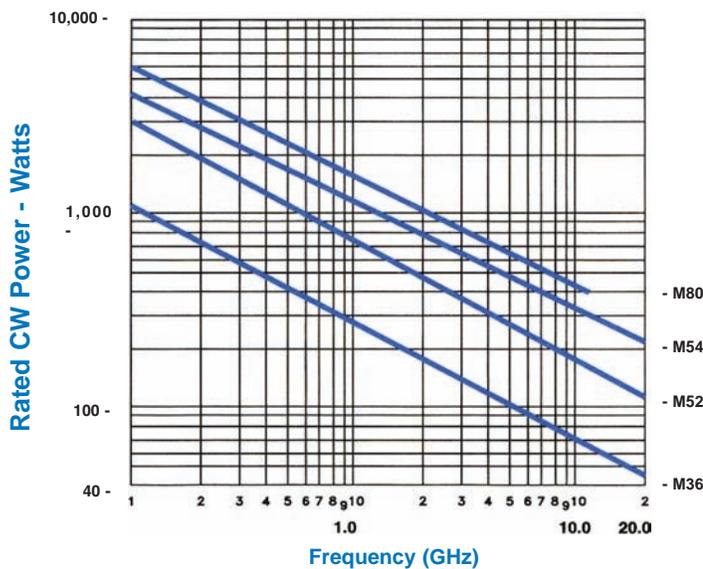
Cable Assemblies

Definition of Parameters

Power - The ability of a cable assembly to transmit power in a system is primarily a function of temperature. Heat generation is directly related to the resistive losses caused by the center conductor resistance and the VSWR resulting from discontinuities and impedance mismatches. In most cases the limiting factor is the connectors being used and the integrity of the interface between connector and cable, and not the cable itself. When determining the power performance of a cable assembly, the connector should be a key item that should be examined carefully for power performance characteristics.

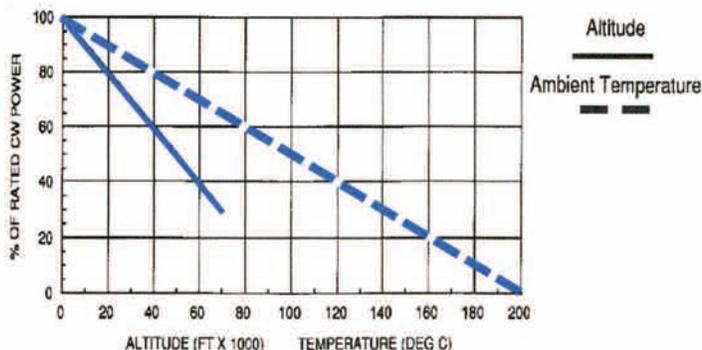
CW Power

Temperature = 25 Degrees at Sea Level
Max Load VSWR = 1.25:1



Temperature and Altitude - The graph shown above describes the approximate power rating of two of the low loss cables, at 25o ambient at sea level and an assumed maximum load VSWR of 1.25:1. As temperature and altitude increase, a percentage derating factors must be applied. The graphical illustration shown below provides approximate percentage derating factors that can be applied for other temperatures and altitudes.

Altitude and Temperature % Derating



Humidity and Moisture Resistance - Microwave coaxial cable assemblies must be capable of withstanding exposure to moisture and humidity. Moisture absorption due to variations in temperature can affect VSWR, insertion loss, insulation resistance, and dielectric withstanding voltage. Testing to MIL-STD-202 and MIL-STD-810 will assure that the assemblies are capable of meeting the required environmental specifications.

Weight - System weight is always a factor that must be considered, especially in an airborne microwave system. Low dielectric constant cable can improve the loss performance by 6 to 10% over larger and heavier cable and will simultaneously provide as much as a 50% weight savings.

Ruggedization - There are many different environmental situations that flexible cable assemblies must be able to cope with in the wide variety of microwave systems that they are used in. Some of them require more physical protection than others. Surprisingly the laboratory environment is almost as hostile as an airport ramp because when used in test systems the cable assemblies are engaged and disengaged many times over and are bent, stretched and crushed as much or more than they would be in most systems. There are four basic types of ruggedization that are provided to protect the cable assemblies from external damage during use; the first is the "Standard" type that simply provides a thick extruded FEP jacket over the outer braid that suffices for most applications and it is what normally is supplied; an optional additional protective polyurethane jacket over the FEP jacket falls within this level of protection and is called "J" type; another is called "A" type for "Armored" which provides an additional stainless steel conduit type jacket assembled over the FEP jacket to further protect the cable from pinching and crushing when used in extremely hostile field applications; another is called "B" type that uses a "Thermoflex" sheath over the FEP jacket for situations that call for severe abrasion protection where possible continual rubbing against other objects is likely; the fourth type is called "C" type for "Crushproof" and in this case a stainless steel spring is provided over the FEP jacket covered by polyurethane shrink sleeving and offers moderate crush protection.

Electrically Matched Cable Assembly Sets - Cable assemblies are sometimes required to be matched electrically. Matching can also be required in more than just one characteristic. They can be matched for either phase, insertion loss, or time delay and in some instances they can be matched in any combination of all three characteristics. In addition cable assemblies can be "Relatively" matched to each other using one of the assemblies as a comparative standard or "Absolutely" matched to a specific specification with specific controlling tolerances for each characteristic. In all cases the cable assemblies must use the same type cable and the exact same connectors in order to conform.

General - To define and specify the cable assembly required to meet a particular specification and to allow it to be manufactured efficiently and economically, the user and the manufacturer must be in agreement with each other on exactly what the parameters of the specification are and what limitations exist such that the resulting product will satisfy the requirements of the user and the product will in fact be able to be produced efficiently and economically. Midwest Microwave maintains an experienced staff of engineers that are ready and willing to assist in this process.

Cable Type - In selecting the type of cable to be used on a cable assembly, the user should carefully evaluate the requirements of the system that the assemblies are going to be used in. Operating frequency, insertion loss, VSWR, phase, power, connector type, physical space and weight, and all environmental exposures should be considered. Midwest Microwave offers a wide variety of cable types and ruggedization options that were designed to fit the needs of most microwave systems. The section on cable specifications describe in detail the different cable choices available.

Length Measurement and Tolerances - The overall length of a cable assembly is measured from connector end to connector end, however phase length measurements are usually from connector interface reference plane to connector interface reference plane in the case of straight connectors and in the case where a right angle connector is used, the connector center pin centerline is the measurement point. Standard length tolerances are as listed below:

LENGTH TOLERANCES

Nominal Length	Tolerance
Up to 10 Feet	± 0.250 Inch
10 to 20 Feet	± 0.500 Inch
20 to 30 Feet	± 1.0 Inch
30 to 40 Feet	± 1.5 Inch
40 to 50 Feet	± 2.0 Inch
> 50 Feet	Consult Factory

Note: Length tolerance is typically +3% -0, however tighter tolerances are available at additional cost on special request.

Connector Selection - The connectors selected should be compatible with the cable size selected so that the resulting performance of the assembly will be acceptable and will not degrade system performance. The connectors selected are most often controlled by the compatibility requirements of the system and the components used in it, however this should be kept in mind when selecting cable so that the resulting performance/cost ratio is reasonable.

Connector Orientation - For semi-rigid cable assemblies and flexible cable assemblies where "D" hole mounting connectors (and or right angle connectors) are used, the relative angular orientation must be specified such that the resulting assembly will mount and mate satisfactorily in the system. Standard tolerance for angular orientation is ± 20° for flexible assemblies and ± 5° for semi-rigid assemblies.

Cable Assembly Insertion Loss - The insertion loss of the total assembly including the connectors is an important consideration when specifying a cable assembly and it must take into consideration the operating frequency, cable size and loss characteristics, length of the cable assembly and the type and configuration of the connectors to be used. The insertion loss curves for each type of cable available are shown in the respective cable specification section. To determine the anticipated insertion loss of a cable assembly, add the loss for the length of cable used, (per the charts in the cable specification section), to the estimated loss for each connector per the table below and then add the loss attributable to VSWR (mismatch loss) as shown in table below.

TYPICAL CONNECTOR INSERTION LOSS

Frequency Range (GHz)	SMA Straight Connector	SMA Right Angle Connector	Type N, TNC and 7mm Connectors
2.0	0.03	0.08	0.05
4.0	0.05	0.10	0.08
6.0	0.06	0.12	0.10
8.0	0.07	0.14	0.11
10.0	0.08	0.16	0.13
12.0	0.09	0.18	0.14
14.0	0.10	0.20	0.15
16.0	0.11	0.22	0.16
18.0	0.12	0.25	0.18
20.0	0.13	N/A	N/A
22.0	0.14	N/A	N/A
24.0	0.15	N/A	N/A
26.5	0.16	N/A	N/A

Note: Insertion Loss is for each connector

TYPICAL MISMATCH INSERTION LOSS

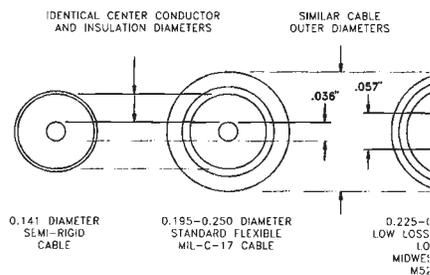
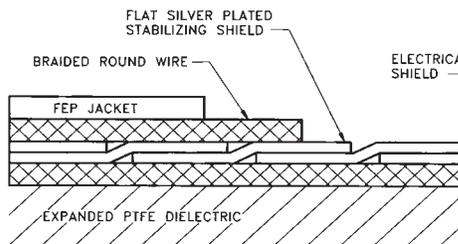
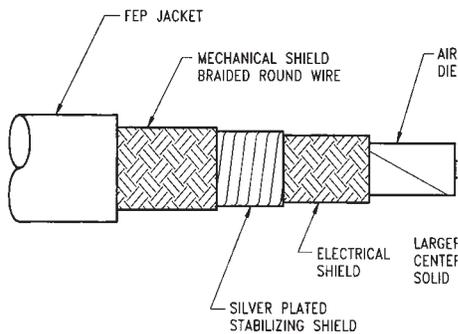
VSWR	Insertion Loss
1.20 : 1	0.04
1.25 : 1	0.06
1.30 : 1	0.07
1.35 : 1	0.10
1.40 : 1	0.12
1.45 : 1	0.15
1.50 : 1	0.18

Note: Typical VSWR shown is for SMA connectors only.

Cable Assembly VSWR - The VSWR of a cable assembly depends on the cable, connectors, signal frequency, assembly length, the termination used, and the test method and equipment used to measure it. The following table may be used as a guide in specifying VSWR:

TYPICAL CABLE ASSEMBLY VSWR

Frequency Range (GHz)	Cable Assembly with Straight Connectors	Cable Assembly with two angle Connectors	Cable Assembly with mixed Connectors
DC - 2	1.10	1.20	1.20
2 - 4	1.10	1.25	1.25
4 - 8	1.15	1.35	1.35
8 - 12	1.20	1.45	1.45
12 - 16	1.25	1.45	1.45
16 - 18	1.25	1.50	1.45
18 - 26	1.35	(N/A)	(N/A)



Low Loss Cable Design - Midwest Microwave Low Loss Cable is designed to take advantage of air-enhanced PTFE dielectrics that lower the dielectric constant and allow a flexible, phase and temperature stable high performance coaxial cable to be made available to produce high quality cable assemblies with excellent performance characteristics. In addition substantial size and weight savings are also realized because of the use of the lower dielectric constant material. Center conductors are available in both solid or stranded form depending on whether loss or flexibility is of primary concern.

Shielding Technique - The unique and efficient shield construction technique used in Midwest Microwave cable is a key reason for the excellent phase and temperature stability that it is able to attain. This is accomplished by providing a unique flat shield over the dielectric which is then further stabilized by another sheath which not only provides additional leakage protection but adds considerably to the mechanical and electrical stability characteristics of the cable. Following this, another layer of round braided shield is provided adding strength and further leakage protection. The final cover is the FEP jacket which provides resiliency as well as moisture protection.

Center Conductor Size - The largest and single most effective deterrent to cable loss is the introduction of a larger diameter for the center conductor. The more surface area per unit length that a center conductor can provide, the lower the loss of the coaxial cable. In order to use a larger center conductor, but still retain the outer diameter, lower dielectric constant insulation must be used. Flexibility and temperature stability is enhanced by the use of the lower density dielectric. Ultra low loss is attained by using a larger diameter solid center conductor while low loss with improved flexibility is accomplished by using a larger diameter stranded center conductor.

Ruggedization for Extreme Environments

- Standard Tough FEP Jacket
- Crush Proof Protection
- Abrasion Proof Protection
- Armored Protection

Midwest Microwave offers three types of additional ruggedization that can be added over the standard FEP cable jacket. Each type is designed to provide the maximum protection for the environmental situation that may be encountered. There is no degradation in performance when ruggedization of any level is selected and strain relief boots are provided on all assemblies.



Type S = Standard FEP Jacket

**Type J = Added Polyolefin Jacket
over Standard FEP Jacket**

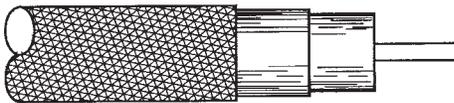
The tough, resilient extruded FEP jacket is Standard on all Midwest Microwave Cable Assemblies. It provides an excellent moisture seal and stands up to most environments. It is resistant to abrasion and most solvents. It provides the primary covering of the mechanical shield under all of the additional ruggedization schemes.

The Type J ruggedization is the provision of an additional polyurethane shrink jacket over the standard FEP jacket for additional protection from wear and abrasion. .



Type A = Armored Ruggedization

Cable Assembly Armor consists of stainless steel conduit placed over the standard FEP jacket that protects the assembly from severe pinching and crushing of up to 300 lbs per linear inch. A polyolefin heat shrink jacket is provided covering the armor. This type of harsh environmental protection is often required on flight lines and on board naval ships where the assemblies are very exposed and are apt to have vehicles ride over them.



Type B = Thermoflex Abrasion Ruggedization

This very tough abrasion proof outer covering provides extremely good protection to cable assemblies that are exposed to constant abrasion from rubbing repeatedly against other objects or moving or translating mechanisms. It consists of a Thermoflex sheath placed over the standard FEP jacket with standard strain-relief boots. Thermoflex is a high temperature (650°C) abrasion proof material.



Type C = Crushproof Ruggedization

Cable assemblies are often subjected to moderately severe treatment, even in the laboratory where reliability and repeatability is crucial. This Crushproof type of ruggedization consists of a stainless steel spring placed over the standard FEP jacket and covered with a polyolefin shrink jacket. Strain relief boots are also applied and this combination will withstand 100 lbs per linear inch of abuse.

Cable Assemblies

Low Loss Cable Characteristics

High Performance Cable Assemblies

- Ultra-Low Insertion Loss
- DC - 26.5 GHz Performance
- Phase and Temperature Stable
- Highly Flexible

Ultra Low Loss Cables - Solid Center Conductor

M-38
0.125 Dia
Designed to replace 0.141 semi-rigid cable. This cable is ideal for low loss applications where size, weight, and performance are critical criteria.

M-46
0.160 Dia
These cable will operate up to 40 and 50GHz respectively.

M-54
0.205 Dia
Designed for low loss applications where low loss is critical and high signal frequency is desired. An excellent balance of loss and size.

M-62
0.290 Dia

M-82
0.305 Dia
Designed for unsurpassed low loss with reasonable flexibility in a moderate diameter. These cables will operate to 12 and 18 GHz and exhibit extremely good phase stability characteristics.

M-92
0.450 Dia

Low Loss Cables - Stranded Center Conductor

M-36
0.125 Dia
Designed for small size, light weight high frequency applications where small size and low loss is a priority and high frequency ability is necessary.

M-44
0.160 Dia
These cables are ideal to replace .141 semi-rigid cable.

M-52
0.205 Dia
Designed for applications where low loss is a priority and flexibility and phase stability is necessary. This cable is the optimum choice for loss, size, and weight considerations.

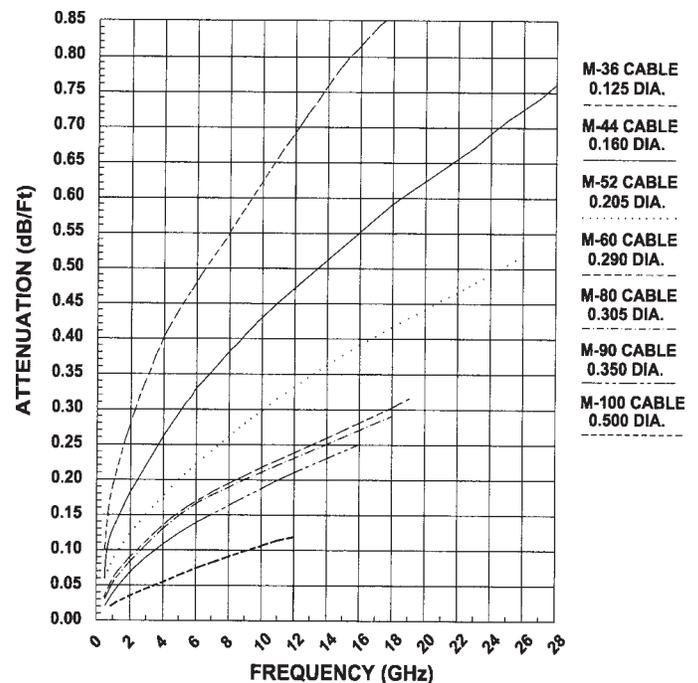
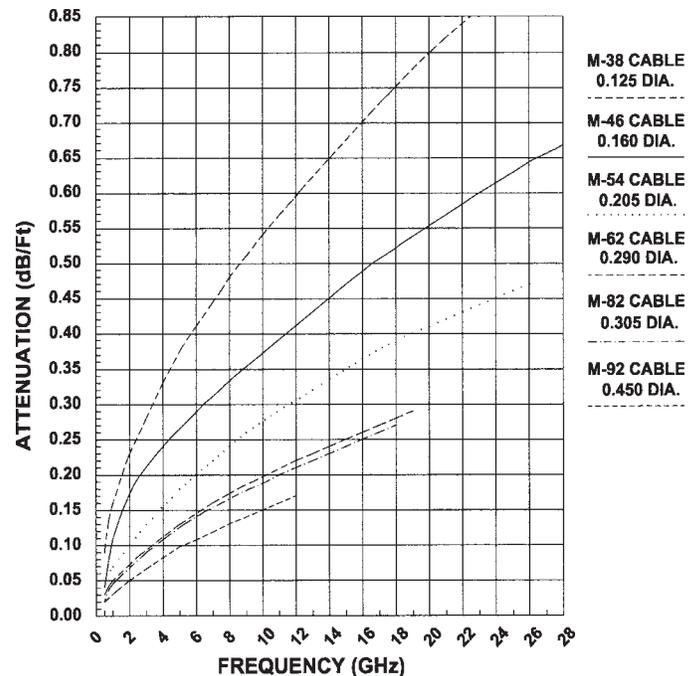
M-60
0.290 Dia

M-80
0.305 Dia
Designed for very low loss applications where a stable, relatively flexible cable is critical to the application.

M-90
0.350 Dia

M-100
0.500 Dia
Designed for very low loss applications up to 10.4 GHz where high power is anticipated.

The unique construction characteristics of this product line of Midwest Microwave low loss and ultra-low loss cables provides the highest stability available for loss, phase, VSWR, and time delay over temperature and flexure exposure. The high degree of linearity over the frequency spectrum makes them especially suited for cable assemblies with high reliability performance requiring phase, VSWR, and time delay matching.



Note: For detail cable specifications refer to pages 172 and 173.

Maximum Performance Selection

- Match Size and Loss Requirements
- DC - 26.5 GHz Frequency Performance
- Select Ruggedization Option
- SMA, BMA, 3.5mm, 7mm, N, TNC, BNC

The unique construction characteristics of this product line of Midwest Microwave low loss and ultra-low loss cables provides the highest stability available for loss, phase, VSWR, and time delay over temperature and flexure exposure. The high degree of performance linearity over the frequency spectrum makes them especially suited for cable assemblies with high reliability performance requiring phase, VSWR, and time delay matching. Cable with stranded center conductors are slightly more flexible than those with solid center conductors, however as can be seen from the specifications, the solid center conductor cables are slightly better in loss characteristics.

ULTRA-LOW LOSS CABLE SPECIFICATIONS

Midwest Cable No.	M-38	M-46	M-54	M-62	M-82	M-92
Impedance (Ohms)	50	50	50	50	50	50
Center Conductor Type	Solid	Solid	Solid	Solid	Solid	Solid
Outside Diameter -inches (mm)	0.125 (3.2)	0.160 (4.1)	0.205 (5.2)	0.290 (7.4)	0.305 (7.8)	0.450 (11.4)
Frequency Cutoff (GHz)	55	40	28	19	18	12
Insertion Loss (dB)	See Chart					
CW Power (kW) @ 5 GHz	0.13	0.25	0.85	1.85	1.85	3.15
RF Leakage (dB) @ 5 GHz	-90	-90	-90	-90	-90	-90
Capacitance (pF/ft)	27	27	27	27	27	27
Velocity of Propagation (%)	75	76	76.5	76.5	76.5	76.5
Time Delay (nS/ft)	1.35	1.34	1.33	1.33	1.33	1.33
Temperature Range (°C)	-65 to+200					
Minimum Bend Radius (In.)	0.6	0.9	1.1	1.6	1.8	2.5
Weight (Lbs/ft)	0.02	0.04	0.05	0.08	0.09	0.20

LOW LOSS CABLE SPECIFICATIONS

Midwest Cable No.	M-36	M-44	M-52	M-60	M-80	M-90	M-100
Impedance (Ohms)	50	50	50	50	50	50	50
Center Conductor Type	Stranded						
Outside Diameter -inches (mm)	0.125 (3.2)	0.160 (4.1)	0.205 (5.2)	0.290 (7.4)	0.305 (7.8)	0.350 (8.9)	0.500 (12.7)
Frequency Cutoff (GHz)	55	40	28	19	18	16.4	10.4
Insertion Loss (dB)	See Chart						
CW Power (kW) @ 5 GHz	0.13	0.25	0.85	1.85	1.85	3.15	5.75
RF Leakage (dB) @ 5 GHz	-90	-90	-90	-90	-90	-90	-90
Capacitance (pF/ft)	27	27	27	27	27	27	27
Velocity of Propagation (%)	75%	76%	76.5%	76.5%	76.5%	76.5%	76.5%
Time Delay (nS/ft)	1.33	1.33	1.33	1.33	1.33	1.33	1.33
Temperature Range (°C)	-65 to+200						
Minimum Bending Radius (In.)	0.5	0.8	1.0	1.5	1.7	2.0	2.8
Weight (Lbs/ft)	0.02	0.04	0.05	0.08	0.09	0.12	0.24

Materials and Finishes

Center Conductors - Silver-coated copper per ASTM-B-298
40 micro-inches min thick per MIL-C-17.

Dielectric Core - Air-Enhanced polytetrafluoroethylene (PTFE), tape wrapped per MIL-C-17.

Electrical Shields - Silver-coated flat copper per IPC-FC-221
40 micro-inches thick min per MIL-C-17.

Jacket - Extruded fluorinated ethylene propylene (FEP), per MIL-C-17, Type IX.

Mechanical Shields - Silver-coated copper per ASTM-B-298.
40 micro-inches thick min per MIL-C-17.

Armor - Stainless Steel per ASTM-A-582 and ASTM-A-484

Note: Select desired Midwest Cable No. designation and substitute in Cable Assembly Model No. designation as shown on page 174.

Cable Insertion Loss per Foot

Frequency (GHz)	M-36	M-38	M-44	M-46	M-52	M-54	M-60	M-62	M-80	M-82	M-90	M-92	M-100
0.5	0.10	0.09	0.06	0.04	0.06	0.05	0.03	0.03	0.03	0.02	0.02	0.02	0.02
1.0	0.19	0.16	0.13	0.11	0.09	0.07	0.06	0.05	0.06	0.05	0.05	0.04	0.02
2.0	0.27	0.23	0.18	0.20	0.12	0.10	0.09	0.07	0.07	0.08	0.07	0.05	0.03
3.0	0.33	0.28	0.22	0.23	0.15	0.13	0.12	0.10	0.10	0.09	0.08	0.07	0.03
4.0	0.40	0.33	0.26	0.26	0.18	0.15	0.13	0.12	0.13	0.11	0.11	0.08	0.04
5.0	0.43	0.38	0.30	0.27	0.20	0.18	0.15	0.13	0.15	0.13	0.12	0.09	0.05
6.0	0.45	0.41	0.32	0.28	0.22	0.20	0.17	0.15	0.17	0.15	0.14	0.10	0.06
7.0	0.52	0.44	0.35	0.31	0.24	0.22	0.18	0.16	0.18	0.16	0.15	0.12	0.07
8.0	0.55	0.48	0.38	0.33	0.26	0.24	0.19	0.17	0.19	0.17	0.16	0.13	0.08
9.0	0.60	0.51	0.40	0.35	0.28	0.26	0.20	0.18	0.20	0.18	0.17	0.14	0.09
10.0	0.63	0.54	0.43	0.37	0.30	0.29	0.21	0.19	0.21	0.19	0.18	0.15	0.10
11.0	0.66	0.57	0.45	0.39	0.31	0.30	0.22	0.21	0.22	0.20	0.19	0.16	0.11
12.0	0.70	0.59	0.47	0.41	0.33	0.31	0.23	0.22	0.23	0.21	0.21	0.17	0.12
13.0	0.72	0.63	0.49	0.43	0.34	0.32	0.24	0.23	0.24	0.22	0.22		
14.0	0.76	0.66	0.51	0.45	0.36	0.33	0.25	0.24	0.25	0.23	0.23		
15.0	0.79	0.68	0.53	0.47	0.37	0.34	0.26	0.25	0.26	0.24	0.24		
16.0	0.81	0.70	0.55	0.49	0.39	0.36	0.27	0.26	0.27	0.25	0.25		
17.0	0.84	0.73	0.57	0.50	0.40	0.38	0.29	0.27	0.28	0.26			
18.0	0.87	0.75	0.59	0.52	0.41	0.39	0.30	0.28	0.29	0.27			
19.0	0.90	0.78	0.60	0.53	0.43	0.40	0.32	0.29					
20.0	0.92	0.80	0.63	0.55	0.44	0.41							
21.0	0.95	0.82	0.64	0.56	0.45	0.42							
22.0	0.97	0.84	0.66	0.58	0.46	0.43							
23.0	0.99	0.87	0.67	0.60	0.48	0.44							
24.0	1.02	0.89	0.69	0.61	0.49	0.45							
25.0	1.05	0.91	0.71	0.63	0.50	0.46							
26.0	1.07	0.93	0.72	0.64	0.52	0.47							
27.0	1.10	0.95	0.74	0.65									
28.0	1.13	0.97	0.76	0.67									
29.0	1.14	0.99	0.77	0.68									
30.0	1.16	1.02	0.79	0.70									
31.0	1.18	1.03	0.81	0.71									
32.0	1.20	1.06	0.82	0.72									
33.0	1.23	1.07	0.83	0.73									
34.0	1.25	1.09	0.84	0.74									
35.0	1.27	1.11	0.86	0.76									
36.0	1.29	1.13	0.87	0.77									
37.0	1.31	1.15	0.89	0.78									
38.0	1.33	1.17	0.90	0.80									
39.0	1.35	1.18	0.92	0.82									
40.0	1.37	1.20	0.93	0.84									
41.0	1.39	1.22											
42.0	1.41	1.24											
43.0	1.43	1.26											
44.0	1.45	1.28											
45.0	1.47	1.30											
46.0	1.49	1.32											
47.0	1.51	1.34											
48.0	1.53	1.35											
49.0	1.55	1.37											
50.0	1.57	1.38											

Average Power Rating (Watts)

Connector Peak Power (Recommended - including safety factor)

Cable Type	Frequency (GHz)					Connector Type	DC Test Voltage (KV)	Peak Power (KW)
	.05	1.0	4.0	10.0	18.0			
M-52	3,000	2,000	1,000	600	420	SMA	1.0	1.2
M-60	8,000	4,100	2,000	1,200	830	BNC, TNC	1.5	2.8
M-80	8,000	4,100	2,000	1,200	830	N	2.0	4.9
M-90	7,400	5,100	2,400	1,400		HN	2.25	5.5
M-92	12,000	8,200	3,800	2,200		SC	2.50	6.0
M-100	18,000	13,000	5,500	3,300				

Low Loss - High Performance

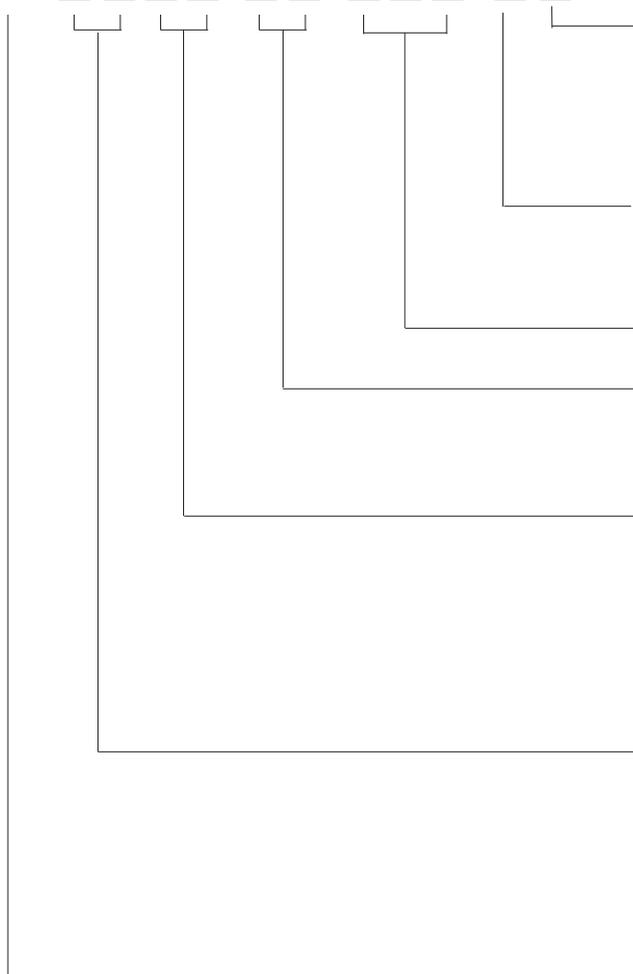
- Six Low Loss Cable options
- Wide Connector Selection
- Phase Matching available
- Crush Proof Armored Protection options

Midwest Microwave offers six types of low loss and ultra low loss cables as well as three types of improved MIL-C-17 flexible cable and several types of conformable and semi-rigid cable. Solid center conductor types offering the lowest loss capability and stranded center conductor types offering a well balanced combination of low loss and flexibility. Most of the choices allow additional ruggedization that can be added over the standard cable jacket.



MODEL NUMBER DESIGNATION

CSY- □ □ □ □ - □ □ □ □ - □ □ □ □ - □ □



- RUGGEDIZATION AND OTHER SPECIAL DESIGNATIONS**
S = Standard Cable Jacket **H** = Hybrid combination of ruggedization types
A = Armored **J** = Added polyolefin shrink jacket over standard jacket
B = Thermoflex Abrasion Proof
C = Crushproof
T = Tin Plated cable jacket **L** = Silver Plated cable jacket
M = Special Cable Markers required
- UNIT OF MEASURE**
I = inches **P** = Phase Matched Assembly
F = Feet **S** = Special Requirements Apply*(see cust dwg.)
M = Meters **H** = Add 0.5 inches to length (length is in. only)
- LENGTH OF CABLE ASSEMBLY**
 (Alpha-Numeric coded for formed and special requirements)
- CABLE TYPE**
Low Loss Type 36, 52, 80, or 100 for stranded center conductor
Ultra-Low-Loss Type 38, 54, 82, or 92 for solid center conductor
 See pages 171-172, 175-176, and 181-184 for other Midwest Cable Type designations.
- CONNECTOR - J2**
SM = SMA male
SP = SMA panel mount female
3M = 3.5 mm male
TF = TNC female
NM = Type N male plug
7M = 7mm connector
 See Connector Selection pages 178-179 and 184-185 for complete connector designations.
- CONNECTOR - J1**
SA = SMA right angle male - cube type
SS = SMA right angle male - swept type
MF = BMA Blind Mate female plug
TP = TNC panel mounted female
CM = S C male plug
BM = BNC male plug
 See Connector Selection pages for complete designation list.
- BASIC CABLE ASSEMBLY PRODUCT LINE PREFIX**

LOW LOSS CABLE ASSEMBLY PERFORMANCE SPECIFICATIONS

Insertion Loss vs Flexure	< ± .1 dB/Ft	Phase Matching	± 1.0 ° per GHz
Insertion Loss vs Temperature	0.5% per ° C	Phase Tracking	± 0.1 ° per GHz
Insertion Loss Matching	± 0.2 dB @ 18GHz	Phase Stability vs Flexure	< ± 0.1% per GHz per Ft.
Insertion Loss Fine Grain Variation	< .1 dB per 50 MHz	Phase Stability vs Temperature	< 25 ppm per ° C

Improved MIL-C-17 Performance Cable

- Lower Loss MIL-C-17 Cable Assemblies
- Improved VSWR Performance
- Improved Phase and Temperature Stability
- Excellent Cost / Performance Ratio

Midwest Microwave offers these improved versions of the more popular sizes of MIL-C-17 cables in the form of improved performance cable assemblies. By improving the quality of the basic construction of these extruded dielectric cables and carefully designing connectors that are closely compatible to them, a very high cost / performance ratio cable assembly has been achieved. Useable on many applications where the standard cables were not acceptable, these new improved versions allow the performance criteria to be met for a much more reasonable price than other higher cost options.



Cable Type *Improved RG-316/U*

M - 16
0.120 Dia

Designed to replace conventional RG316/U cable, this cable is an excellent cost/performance value. It is ideal for system applications where size, weight, and performance for a reasonable price are critical criteria.

Cable Type *Improved SF142*

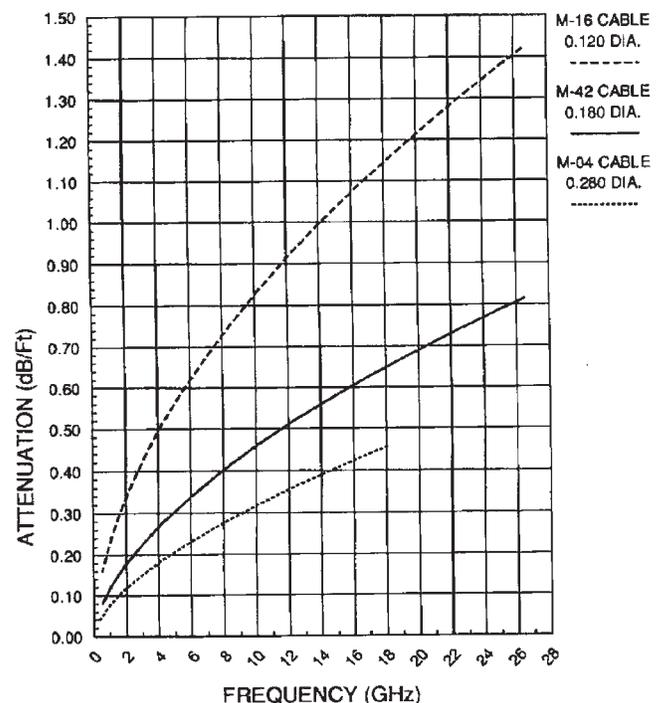
M - 42
0.180 Dia

Designed for moderate low loss applications where the cost/performance ratio is critical and high signal frequency is desired. A well balanced cable of loss vs size it is an improved version of SF142, a very popular cable in all types of systems both military and commercial.

Cable Type *Improved RG-304/U*

M - 04
0.280 Dia.

Designed as an improved version of RG304/U this cable offers some attractive performance characteristics. It posses loss characteristics that are quite acceptable for many systems both military and commercial. This cable operates for applications up to 18 GHz.



Note: To specify a cable assembly using the above cable, refer to page 174 and substitute the appropriate two digit numeric cable type number. Connectors can be selected from the connector section, simply substitute the appropriate alpha or alpha-numeric connector designations.