Glossary
Microwave Related Terms

A

Attenuation – the reduction in signal strength that occurs when it travels over a long distance. Measured in dB.

B

Blind Mate – SMP and SMPM are blind mate or "push-on" connectors. They make interconnections without the need of coupling nuts and tools. Useful when making connections in tight spaces or in conjunction with bullets which compensate for axial or radial misalignment.

Bullets – female to female interconnects. Can help reduce insertion loss by eliminating the need for some cable assemblies with female to female connections. Bullets also compensate for radial and/or axial misalignment when blind mating.

C

Center Line Spacing – the distance from the center of adjacent contacts as installed in a system and/or within a connector housing. Varies depending on the mounting configuration and can be as low as .160" on the SMP connectors. Critical for high density spacing appli-cations.

Contact Resistance – area of potential power loss in a system due to the contact itself. For low loss in a microwave transmission sys-tem, contacts are plated in gold or silver because of their low resistance characteristics. The specific plating can be requested and may depend on the application. Expressed in milliohms.

Corona Level – the minimum voltage level at which there is no breakdown of air gaps between the conductors. This is a situation that can develop in low pressure conditions experienced, for example, at high altitudes. Corona will create noise and distort the transmission signal.

D

Decibel – the basic unit is a "Bel" named for Alexander Graham Bell. A decibel then is 1/10th of a Bel. The number expresses the loss in power or voltage as a signal goes from point A to point B and is calculated by dividing the power the signal had at A by the power it has when it reaches B. To keep the numbers easier to express, a factored logarithmic scale is used where 10 dB is 10 to one, 20 dB is 100 to one and 30 dB is 1000 to one.

Delay Lines – devices used to slow down a signal by a time interval in an electrical network. There are two basic types: passive and active. Passive delay lines are built with analog components and can delay analog and digital signals. Active delay lines are built with digital compo-nents and are normally used to delay digital signals. Measured in units of time.

Dielectric Material – insulator material chosen to conform to specification and application to minimize power absorption and hence power loss in the system due to the connectors. For example, we use Expanded Teflon for low loss applications.

Dielectric Withstanding Voltage (DWV) – the maximum voltage the insulator in the connector can withstand without breaking down. For example, the value for TFE is 150 volt rms but other considerations may come into play. In circumstances where high radiation will be a factor (space applications) other materials will be required.

F

Flexible Cable – braided and or helically wrapped outer conductor covered by a flexible outer jacket, conductor can be 1 to 3 layers. Center conductor can be solid or stranded wire, dielectric can be solid or low-loss. Ranges in diameter from .050" to .500" and bend ra-dius capability is determined by the cable diameter and construction. Average to excellent performance.

Force to Mate & Unmate – the amount of force required to mate or unmate a connector expressed in maximum or minimum pounds. An SMP with full detent has a mating (engaging) force of 15 lbs max and an unmating (disengaging) force of 5 lbs min.

Frequency – the number of cycles per second of a given wavelength and expressed in Hz. So, 1 Hz = 1 cps, 1 MHz = 1 million cps, GHz = 1 billion cps, etc. An RF signal is an AC waveform.

Frequency Range or Operating Frequency – that range of frequencies the connector must work within. Typical ranges for micro-wave products are K band (18-26 GHz), X band (8-12.4GHz), mm range (40-100 GHz) and C (4-8 GHz). The frequency range a major consideration in selecting the appropriate connector and cable to fit design requirements and price requirements.

H

Hand-conformable cable – solder-dipped, braided outer conductor. Gives better flexibility than semi-rigid but lower performance (higher VSWR and lower operating frequencies). Sizes limited to .047", .086" and .141" and have limited bend radius. Not available with low-loss dielectric.

Hermetic – permanent seal by fusion, solder or other means to prevent incursion of air, moisture, vapor or any other gases. Since all materials have some degree of permeability, customer spec will define acceptable levels for "sealing."

Hertz (Hz) – expresses a unit of one cycle per second (cps), named for Heinrich Hertz. The number of cycles per second defines the Frequency and the distance covered in one cycle is the Wavelength. The higher the frequency the shorter the wavelength.

I

Impedance – the normal standard for microwave systems is 50Ω. Of concern in RF/Microwave systems is impedance mismatch where components in the system do not have the same impedance. For example, a 50Ω connector on a 75Ω cable. Ideally all components would be matched to the same impedance reducing signal loss, a situation which becomes especially important in the microwave range.

Glossary
Microwave Related Terms

I ...Continued

Insertion Loss – indicates the total loss in power reaching the load point after installing the connector in the transmission line. Insertion Loss can also be due to the power absorbed by the component itself. Other factors contributing to Insertion Loss are Insulation Resis-tance, Contact Resistance, RF Leakage, Reflection and Attenuation. Directly related to the lengths of cables since cable has an expected insertion loss expressed in a per foot value.

Insulation Resistance – loss due to power being absorbed by the dielectric material. Expressed in Megohms, typical measurement is 5,000 Megohms.

Isolation from Ground – the outer conductor of the cable acts as a shield and carries the signal ground and is a key part of RF/Microwave transmissions. The signal ground of the cable and the connectors need to be isolated from the system (or enclosure) ground to avoid ground loops which in turn directly affect the signal integrity.

J

Jacks – cable jacks mate to Plugs and typically have socket contacts

M

M39012 – Basic military spec defining RF connectors, including electrical and physical characteristics. Current designation is MIL-PRF-39012; see Mil Standards and Specs page.

MIL-C-17 – government listing for coaxial cables, replaces RG designations for military applications.

MIL-STD-202 – one of the commonly used Mil standards that gives the test method and conditions for various environmental situations. These conditions include Corrosion, Vibration and Thermal Shock.

O

Outgassing – De-aeration or other gaseous emission from materials such as plastics when exposed to pressure and/or heat. Cristek util-ized materials that minimize outgassing in all connectors and cables.

P

Permeability – the degree to which a material allows liquids or gases to pass through. Permeability is also used to indicate the magnetic properties of materials.

Phase Matching and Electrical Length – the electrical length of a connector is its physical length expressed in wavelength at a specified frequency and also in degrees of phase angle for that frequency. The Electrical Length is critical in manufacturing phase matched cable as-semblies for applications such as phased array radar. "Out of phase" components can result in misreading of the signal message but, for example, physically adjusting the length of the transmission line can cure the mismatch.

Plugs – cable plugs typically have a male pin contact and coupling nuts. Designed to mate with Receptacles or Jacks.

Power Loss – also expressed as Voltage Drop or Signal Attenuation, just means that the signal strength decreases as you go further down the transmission line. Loss is the result of the resistance in the conductor and the losses in the dielectric material. The unit of measure is a decibel or dB.

Power Rating – this is the maximum power a connector can handle and is frequency related. As the frequency increases the power han-dling capability decreases, also high altitude reduces the rating. Basically, the Power Rating is how well the connector and/or cable dissipate heat generated by high RF power.

Push-On Connectors – connectors that mate without the need for a threaded coupling nut. Can have a "snap-in" locking feature.

R

Receptacles – Typically have socket contacts and terminate to a wire rather than cable. Designed to mate to Plugs and can be mounted on a panel or chassis.

Reflection – when a connector is inserted into the line, a loss of signal strength or attenuation is seen. Some of the signal is actually re-flected back on itself and when this occurs it sets up a standing wave between the connector and the source. The result is diminished sig-nal strength. The loss is expressed in several terms including return loss, VSWR and insertion loss.

Reflection Coefficient – this is an expression of loss between a value of zero and one. Zero means no reflection and one is total reflec-tion.

Return Loss – this loss factor is stated in dB and it is the ratio of the incident power to the reflected power at a point of discontinuity in the line (such as a connector). Using the method of measurement, 0 dB means a total loss and about 67 dB means almost no loss. A way to express reflected power.

RF High Potential – the minimum voltage requirement for the connector at frequencies above 1 MHz. At this minimum voltage level, the connector will not have excessive leakage current or dielectric failure.

RF Leakage – signal that escapes from the connector or the cable. The cable shielding in coax cable prevents both outside interference and the signal escaping into the environment. Double- and triple-shielded cable may be used to prevent leakage at very high frequencies and to avoid RFI. Expressed as dB to frequency.

RG/U – stands for Radio Guide /Universal. Designation for coaxial cable sizes.

V

Voltage Rating – usually specified as the peak voltage that a connector can handle without breaking down. The voltage rating is a consid-eration in connector selection for a given application.

Voltage Standing Wave Ratio (VSWR) – this is the most widely used method of expressing the degree that components in the RF signal transmission system are matched. The ideal ratio is 1 to 1 but, for example, a respectable number would be 1.25: 1 (also expressed simple as "1.25") maximum through a frequency range. It can also be expressed as a specific VSWR at a given frequency. In general, the lower the VSWR in the system the better the RF performance. A way of expressing reflected power.

W

Wavelength – the distance covered in one cycle of a wave or the distance from peak to peak of the wave. The length of a 1 GHz wave is 30 cm or 1 MHz is 300 m.

Engineering Data

Useful Engineering Formulas And Data

ε_r - Dielectric Constant	D - ID of Outer Conductor	RL - Return Loss
C - Capacitance	d - OD of Inner Conductor	MML - Mismatch Los
Zo - Characteristic Impeda	Fco - Cut Off Frequency	Vp - Velocity of Propagation
F - Frequency	VSWR - Voltage Standing Wave Ratio	Γ - Reflection Coefficient

Characteristic Impedance	$Z_0 = \frac{59.959}{\sqrt{\varepsilon_r}} \ln\left(\frac{D}{d}\right)$	Ohms
Capacitance	$C = \frac{16.95\varepsilon_r}{\ln\left(\frac{D}{d}\right)}$	pF/ft
Velocity of Propagation	$VP = \frac{100}{\sqrt{\varepsilon_r}}$	%
Cutoff Frequency	$F_{co} = \frac{7.50}{\sqrt{\varepsilon_r}(D+d)}$	GHz
Reflection Coefficient	$\Gamma = \frac{VSWR-1}{VSWR+1}$	(None)
Voltage Standing Wave Ratio	$VSWR = \frac{1+\Gamma}{1-\Gamma} = \frac{1+10^{RL/20}}{1-10^{RL/20}}$	(None)
Return Loss	$RL = -20\log\Gamma = -20\log\frac{VSWR-1}{VSWR+1}$	dB
Mismatch Loss	$MML = -10\log(1-\Gamma)^2 = \left[1-\left(\frac{VSWR-1}{VSWR+1}\right)^2\right]\times 100$	dB