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Many thanks to our other Friends of the Board...

SCTE Spectrum

The Newsletter of the SCTE Rocky Mountain Chapter

SCTE Spectrum, Issue IV, July 1, 2004

Message from the President

From the Vice President

Rex Kohart

Rex Kohart is currently Director of engineering for Comcast's Denver Region. He has been with Comcast (AT&T Broadband) for 13 years.

There is an old saying in the industry: "The more things change the more they stay the same". For those who have been around awhile, they can relate to the cyclic nature of our industry. No matter whether we are an operator, contractor or vendor. . We usually go through growth and acquisition phases, and then spend much time, energy and resources "adjusting" this growth into our specific areas, including operations, marketing, sales, engineering, and vendor relations. Some would refer to this as evolution; a few refer to this as consolidation. Others view it as the maturity and progression of the industry. No matter, all these terms seem to fit. The interesting similarity to all this activity is that we as an industry have become very good at applying our past experiences, creating solutions to the "adjusting" I referred to earlier. So inevitably it is going to feel like we have been here before, or this has been done, or I know where this is going. Or do we?

Something lately is different with this "adjusting" dynamic we create in our operations. We now evolve, and consolidate, but during the same time we expand the technical capabilities of our infrastructure. Our industry as a whole is driven to support a whole new suite of offerings for our customers.

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Message from the Vice President (cont)

Rex Kohart

The entire industry, is gaining a whole new perspective of how we need to do business. Our motivation is to create the new “broadband” our consumers want. This technical expansion sheds light on the fact that we are creating a brand new, fresh set of experiences in our technical professionals. Running the gamut from test equipment, and set tops, to transport and billing. These are the new experiences that our industry professionals will draw upon for years to come. So again, our industry sees the benefit, and enjoys applying lessons learned from prior experiences. If our industry is to stay vibrant and progressive, we need to insure our professionals have a way of sharing experiences and learning from other sources throughout this bustling environment we call Cable.

Your most successful groups tend to be the ones with the most diverse and absorbed experiences. This Chapter has made it a goal to reach out and create seminars that are current and vital to the experience base of our members. The Board has recognized that we need to have topics that stress the key components of this broadband industry. Topics that not only train but also provoke discussions, interactions, and professional growth. Our initial seminars this year have all been successful with optimistic feedback and aggressive attendance. We have a great offering throughout the rest of the year with topics such as VOIP, VOD, Home networking, IP basics / IP in cable. We also have our annual symposium in September. This will allow all industry disciplines and professionals throughout the region to gather. This is a wonderful learning opportunity plus a great networking event. Throw in a little bit of good old cable completion, and lively golf action. I challenge everyone of our members to insure that we as The Board continue to bring pertinent topics to your operation and to the your individual experience base. I also have challenge the Board to invite members “friends” to the board meetings. All agreed to this so we can get fresh perspective on the direction and topics that are near and dear to our members. We all have an opportunity to enrich our professional knowledge, we need to ensure that as individuals, and companies that it is implemented correctly and taken advantage of.

At issue in the end is simple change. Change will be driven by the application of our past experiences to the problems we face now and in the future. To help guide us, our goal as an industry needs to be the creation of highly trained and competent professionals, but also professionals with vital, well-formed experiences. This will ensure the experience base in our environments will allow the industry to maintain an aggressive, flexible, and intuitive style. These traits allow for the intangibles to form that separates our industry and makes us tick. So latter the cycle change progresses, and does not just spin and repeat.

Upcoming Events

SCTE

Cable-Tec Expo 2005

San Antonio, Texas

June 14 through June 17

Training

RELATED AREA OF TECHNICAL EXPERTISE

Broadband Premises Specialist (BPS)	Customer Premises
Broadband Distribution Specialist (BDS)	Distribution network

All of the above certifications are offered On-line and are a 50 question multiple guess test

Broadband Communications Technician (BCT)	Installation and maintenance of all aspects of the broadband network
Broadband Communications Engineer (BCE)	Technology behind all aspects of the broadband network

In order for you to be able to test at one of our test days we need you to notify us for scheduling and fill out an application with the SCTE on their website at least 48 hours prior to testing. For more information about the certification process and applying please go to the SCTE website; www.scte.org

Current Topics

Coaxial Cable Characteristics

By Richard Covell

Richard Covell is President of Telecommunications Technical Services Inc. (TTSI). Richard has a rich history in Cable and was inducted into the SCTE Hall of Fame in 1998. He has been very active in SCTE serving two terms as Western Vice President. He has been a past president of the Rocky Mountain SCTE Chapter and was also a National SCTE Director at Large.

Resistance is the non-frequency dependant (direct current or DC) resistance to the flow of electrons and is measured in ohms (©). Examples would be a resistor, the DC resistance in a piece of wire, cable or other circuit component.

Reactance is the frequency dependant resistance to the flow of electrons. If the power source moves from direct to alternating current, the DC resistance value may no longer represent the effective resistance of the cable, and the circuit's reactance must enter the equation to determine the actual resistance to RF electron flow (as well as determine the cable's impedance). There are two types of reactance; capacitive and inductive.

Capacitive reactance (X_C) is caused by the circuit's capacitances which are measured in Farads (typically fractions thereof, i.e. microfarads {µf} or picofarads {pf}). Any two conductive surfaces parallel to each other and separated by a non conductor will offer a capacitance between them. The greater the surface area of the conductors and the closer they are to each other, the greater the capacitance. Since there is no conductor between the two conductive surfaces of a capacitor, a DC potential placed on them will only cause current to flow until the capacitor is charged. If an alternating voltage is applied to one side of a capacitor, the other side of the capacitor tries to attain the same voltage as that of the first side and will cause a current to flow in the rest of the circuit while it attempts to "charge" the capacitor. As the AC voltage changes polarity, the process is reversed and current flows in the opposite direction. The higher the frequency the better 'side two' follows 'side one'. In other words, X_C (the resistance to current flow) decreases with higher frequencies. Capacitive reactance, in ohms, is inversely proportional to the capacitance in farads and the frequency in Hertz. The capacitance shown in the electronic equivalent of a coaxial cable (figure 1) will offer less resistance from the center conductor to the sheath at higher frequencies and will therefore cause a higher attenuation at these frequencies as its shunting effect increases.

Inductive reactance (X_L) is caused by inductances such as coils, chokes, any wire wound in a circular way, usually around a core, and in fact, even a straight piece of wire. Inductance in measured in Henries. When an inductor passes a DC current, a magnetic field proportional to the current surrounds the inductor, but once attained, it is constant and offers no resistance to the flow of current (other than the DC resistance of the wire). When an alternating current is asked to pass through the coil, the magnetic field has to change with the change in polarity of the AC waveform, and it doesn't like it. This added resistance to signal flow is called inductive reactance and it varies directly with the value of the inductance in henries and the frequency in Hertz. The greater the Henry value and the higher the frequency trying to pass through the inductor, the more resistance is encountered.

From the above description of what happens with capacitive and inductive reactance with frequency, you might think this is the reason that the attenuation of coaxial cable changes with frequency. That's what I thought, and so does a VP of engineering at a cable manufacturer. However, most of the engineers I've spoken with say that the capacitive reactance (in Farads per foot) and inductive reactance (in Henries per foot) of coaxial cable is *distributed* along it length as a *series* of capacitors and inductors and ***they only determine the cables impedance.***

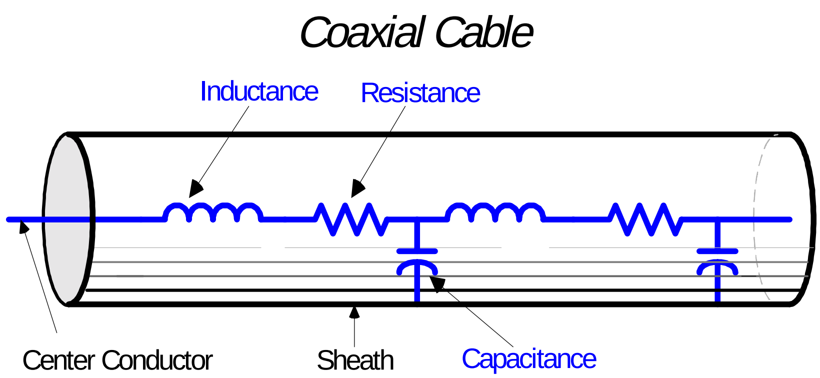


Figure 1

Impedance of a coaxial cable with no dielectric material is given by the formula:

$$Z_0 = 138 \log b/a$$

Where Z_0 is the characteristic impedance of the cable

"b" is the inside diameter of the outer conductor and

"a" is the outside diameter of the inner conductor

Since relationship between the center conductor and the sheath must be maintained, an insulating material called a dielectric is used. The closer this material is to a vacuum (air is close but, unfortunately, doesn't support the center conductor) the less effect it will have on the cable's impedance, attenuation and velocity of propagation. To include the effect of the dielectric on impedance, multiply the result of the above formula by: 1 ÷ “ K

Where "K" is the dielectric constant of the material

Let's look at what the majority of engineers I've talked with say causes the higher frequencies carried on a coaxial cable to encounter greater attenuation than lower frequencies.

The **skin effect**. The higher the channel frequency, the more the electromagnetic field it produces in a conductor moves toward its outside surface, thereby reducing the cross sectional area available for signal transport. Cable manufacturers take advantage of this fact by using less expensive aluminum for the majority of the center conductor, with a thin layer of copper coating the outside. The difference in RF attenuation is negligible compared to the savings in dollars. The downside of a copper clad center conductor would be the higher voltage drop in 60 cycle AC powering, especially where taps with electronics or house boxes are powered by the cable system.

In the typical coaxial cable with copper clad center conductor used in our systems, all frequencies are above 10 MHz travel in the cladding and don't use the aluminum.

NOTE: As you might imagine, the highest frequencies (those above 750 MHz) are using but a fraction of the thickness of the copper cladding. Damage to this surface from removing dielectric material when preparing for connection to an entrance fitting, over tightening the center conductor capture screw, or "arcing" the center conductor while hot-splicing, can cause frequency response problems near the upper band edge. Another cause of high end suck-outs is center conductor or connector pin length. If the center conductor goes past the seizure screw by more than a sixteenth of an inch, it can act as a "trap." Although one or two instances of too long a center conductor in an amplifier cascade won't necessarily cause a suck-out, a whole bunch will. If, during construction, the splicer cut all connector pins ¼ inch too long, the effect of this slight mismatch will cascade, causing a high end suck-out. The exact frequency of this perturbation depends on the center conductor's length past the capture screw. The closer these "extra" lengths are equal to each other, the deeper the suck-out.

Skin effect is the major cause of higher attenuation at higher frequencies. How does it affect the cables attenuation? It's in the following formula:

$$A_{FN} = A_{FO} \text{“} F_N / F_O$$

Where "A_{FN}" = Attenuation of the cable at the new frequency

"A_{FO}" = Attenuation of the cable at the old frequency

"F_N" = New Frequency

"F_O" = Old Frequency

It will find the attenuation at one frequency if it is known at another.

EXAMPLE:

A 100 foot section of 75© coaxial cable (750 PIII) has an insertion loss of 0.37 dB @ 55 MHz, what is the loss in this cable at 865 MHz?

$A_{FN} = A_{FO}$ “ F_N / F_O

= 0.37 “ 865 / 55

= 0.37 “ 15.727

= 0.37 x 3.966

= 1.47 dB

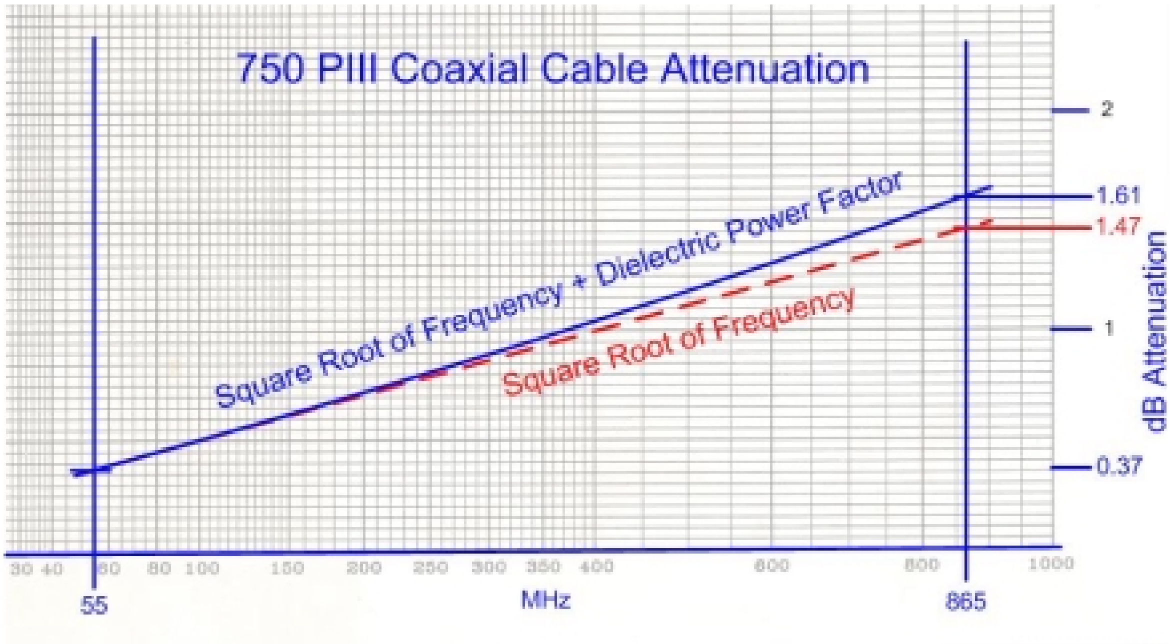
The cable has *approximately* 1.47 dB of attenuation. (It’s actually 1.61 dB at 865 MHz.) To determine the total attenuation we have to include the dielectric material’s contribution.

It varies in a linear fashion with more loss at higher frequencies than lower ones. The amount of dielectric material per unit length of cable and its composition determines the additional attenuation increase above the formula’s 1.47 dB result. (It also determines the cable’s **dielectric constant.)** It may also (and usually does) contribute even more loss at higher frequencies, in a non-linear fashion, as a function of the dielectric’s **power factor**. This power factor effect is small below 300 MHz, but is a noticeable contributor above 500 MHz.

This dielectric constant, by the way, also determines the cable’s **velocity of propagation (VP)**. Velocity of propagation is stated as a percentage and tells how fast an electronic signal will travel on the cable as compared to its speed in free space. The velocity of an RF signal in free space is the same as the speed of light, 186,280 miles per second (which, by the way, is 3600 times faster than 186,280 miles per hour!) Electromagnetic waves (RF) in a cable having a VP of 88% travel at 88% of the speed of light.

The cable’s VP also affects the wavelength of a signal, the distance traveled by one cycle of a channels frequency. It is reduced by the same 88% of its distance in free space.

Let’s graph this cable loss vs. frequency on square root of frequency paper. (Note that a square root of frequency plot {the dashed line}on square root of frequency paper is a straight line rather than curved, while the linear addition of the dielectric power factor to the that of the square root of frequency is displayed as a curved line.)



You’ve probably read more than you wanted to know about coaxial cable.

Tune in for the next bit of engineering delight.

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Address correction and forwarding requested.