Characteristic Impedance

The Characteristic Impedance of a coaxial transmission line is a function of the ratio of the inner and outer conductor diameters and the dieletric constant of the insulating medium.

$$Zo = \frac{138}{\sqrt{\varepsilon_r}} \log \frac{D}{O}$$

Where
- Z_o = Characteristic impedance
- D = Inside diameter of the outer conductor (inches)
- O = Diameter of the inner conductor (inches)
- ε_r = Dieletric constant

Voltage Standing Wave Ratio (VSWR)

VSWR is the ratio of the maximum and adjacent minimum standung wave, expressed in terms of reflection coefficient.

$$VSWR = \frac{1+|\rho|}{1-|\rho|}$$

VSWR is a real number ; a value .0 implies a perfectly matched load.

Insertion Loss

The composite Insertion Loss of a transmission line is determined by the losses associated with the inner and outer conductor, the dielectic medium and characteristic impedance mismatches.

1) Conductor Loss is a function of transmission line dimensions and materials.

$$CL = \frac{2.745 \times 10^{-4}}{Z_o \times (D+O)} \times D \times O \times L \times (\varepsilon_r \times \mu_c \times f) 1/2 \text{ dB}$$

Where :
- CL = Conductor Loss (dB)
- Zo = Characteristic impedance (Ohms)
- D = inside diameter of the outer conductor (inches)
- O = diameter of the inner conductor (inches)
- L = Conductor length (inches)
- εr = Dieletric constant
- μc = Dieletric constant
- f = Frequency (Hz)

2) Dielectric Losses

$$CL = \frac{8.686\pi \tan\delta}{C} \times L \times f \text{dB}$$

Where
- DL = Dielectric Loss (dB)
- tan δ = Loss tangent
- C = Velocity of propagation
- L = Conductor length (inches)
- f = Frequency (Hz)

3) Mismatch Loss is a function of reflected energy due to deviations from the characteristic impedandce of the transmission line system:

$$RL = 20\log \frac{(VSWR-1)}{(VSWR+1)}$$