TIMES MICROWAVE SYSTEMS

Coax Cable Design Equations

Impedance (ohms)

$$Z_0 = 138\, V_p \log\left(\frac{D}{d \cdot k_s}\right) = 60\, V_p \ln\left(\frac{D}{d \cdot k_s}\right)$$

$$Z_0 = \frac{138}{\sqrt{\varepsilon}} \log\left(\frac{D}{d \cdot k_s}\right) = \frac{60}{\sqrt{\ }} \ln\left(\frac{D}{d \cdot k_s}\right)$$

$$Z_0 = \sqrt{L/C}$$

Velocity of Propagation and Dielectric Constant

$$V_P = \frac{1}{\sqrt{\varepsilon}} = \frac{1}{V_P^2}$$

Time Delay (nS/foot)

$$Td = \frac{1.016}{V_P} = 1.016\sqrt{\varepsilon}$$

Capacitance (pF/foot)

$$C = \frac{7.36\varepsilon}{\log\left(\frac{D}{d \cdot k_s}\right)} = \frac{16.95\varepsilon}{\ln\left(\frac{D}{d \cdot k_s}\right)}$$

$$C = \frac{7.36}{V_P^2 \log\left(\frac{D}{d \cdot k_s}\right)} = \frac{16.95}{V_P^2 \ \text{in} \left(\frac{D}{d \cdot k_s}\right)}$$

$$C = \frac{1016}{Z_0 \cdot V_P}$$

Inductance (uH/foot)

$$L = .140 \log\left(\frac{D}{d \cdot k_s}\right) = .0606 \ln\left(\frac{D}{d \cdot k_s}\right)$$

$$L = \frac{Z_0^2 \cdot C}{1 \times 10^6}$$

Attenuation (dB/foot)

$$\alpha = \frac{.4343}{Z_o \cdot D}\left[\frac{D}{d \cdot ks} + Fbd\right]\sqrt{F} + \frac{2.78 \cdot df \cdot F}{V_P}$$

$$\alpha = k_1\sqrt{F} + k_2 F$$

Braid Factor

Round Wire Braid: $Fbd = \frac{8D + 16\, ds}{C \cdot N \cdot ds}$

Flat Strip Braid: $Fbd = \frac{2\pi\,(D + 2t)}{C \cdot W}$

Solid Tube: Fbd = 1.0

Cutoff Frequency (GHz)

$$Fco = \frac{7.5 \cdot Vp}{(D + (d \cdot ks))}$$

$$Fco = \frac{7.5}{\sqrt{\varepsilon}\,(D + (d \cdot ks))}$$

Electrical Length (degrees)

$$\Phi = \frac{360 \cdot F \cdot L_{TH}}{984 \cdot V_p}$$

$$\Phi = \frac{360 \cdot F \cdot L_{TH} \cdot \sqrt{\varepsilon}}{984}$$

Phase Temperature Coefficient (ppm/C°)

$$PTC = \frac{\Delta\Phi \cdot 1 \times 10^6}{\Phi \cdot \Delta T}$$

Phase Stability (degrees)

$$\Delta\Phi = \frac{PTC \cdot \Phi \cdot \Delta T}{1 \times 10^6}$$

Return Loss (dB)

$$RL = -20 \log \Gamma$$

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

$$RL = -10 \log \frac{RFL}{FWD}$$

VSWR

$$VSWR = \frac{1 + \Gamma}{1 - \Gamma}$$

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

$$VSWR = \frac{1 + \sqrt{RFL/FWD}}{1 - \sqrt{RFL/FWD}}$$

Reflection Coefficient

$$\Gamma = 10^{-RL/20}$$

$$\Gamma = \frac{VSWR - 1}{VSWR + 1}$$

$$\Gamma = \sqrt{RFL/FWD}$$

Match Efficiency (%)

$$ME = (1 - \Gamma^2) \cdot 100$$

$$ME = \left[1 - \left(\frac{VSWR - 1}{VSWR + 1}\right)^2\right] \cdot 100$$

$$ME = \left(\frac{FWD-REL}{FWD}\right) \cdot 100$$

Match Efficiency (%)

$$MML = -10 \log (1 - \Gamma^2)$$

$$MML = -10 \log \left[1 - \left(\frac{VSWR-1}{VSWR+1}\right)^2\right]$$

$$MML = -10 \log \left(1 - \frac{RFL}{FWD}\right)$$