

Coax Cable Design Equations

Impedance (ohms)

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

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

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

Velocity of Propagation and Dielectric Constant

$$V_p = \frac{1}{\sqrt{\epsilon}} \epsilon = \frac{1}{V_p^2}$$

Time Delay (nS/foot)

$$Td = \frac{1.016}{V_p} = 1.016 \sqrt{\epsilon}$$

Capacitance (pF/foot)

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

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

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

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)

$$\alpha = \frac{.4343}{Z_0 \cdot D} \left[\frac{D}{d \cdot k_s} + \text{Fbd} \right] \sqrt{F} + \frac{2.78 \cdot df \cdot F}{V_p}$$

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

Braid Factor

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

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

$$\text{Solid Tube: Fbd} = 1.0$$

Cutoff Frequency (GHz)

$$F_{co} = \frac{7.5 \cdot V_p}{(D + (d \cdot k_s))}$$

$$F_{co} = \frac{7.5}{\sqrt{\epsilon} (D + (d \cdot k_s))}$$

Electrical Length (degrees)

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

$$\phi = \frac{360 \cdot F \cdot L_{TH} \cdot \sqrt{\epsilon}}{984}$$

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 (%)

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

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

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