Coaxial Cable Formulae

The following formulae can be used to calculate performance characteristics of coaxial cables with various dielectric and conductor materials.

Characteristic Impedance: Coaxial cables are typically 50Ω, 75Ω, or 95Ω impedance. Cables with 50Ω impedance are the most common, because they offer the best balance between maximum power transmission and minimum loss. Where minimum attenuation is the most important consideration, such as in CATV systems, 75Ω cable is more widely used.

Attenuation: Losses occur in coaxial cables both from conductor loss and dielectric inefficiency. PTFE has become the most commonly-used dielectric in MIL-C-17 and other coaxial cables because it combines a low dielectric constant with good mechanical stability through a wide temperature and frequency range.

VSWR (Voltage–Standing Wave Ratio): VSWR is one of the most important characteristics of a coaxial cable, because it is the measure of the cable's overall efficiency in transmitting a signal at a given frequency. It is expressed as the ratio of the cable's mismatch to a perfect match, i.e. 1.25:1. Advanced, consistent cable manufacturing techniques minimize not only the overall VSWR, but can also minimize or eliminate VSWR spikes at specific frequencies.

Cutoff Frequency: The cutoff frequency of a coaxial cable is the frequency at which it no longer transmits its TEM (Transverse Electromagnetic Mode) signal.

Coaxial Cable Formulae

Capacitance (C) = $\dfrac{7.354 \times E}{\text{Log}_{10}\left(\dfrac{D+a}{d \times f}\right)}$ Picofarads per foot ohms

Impedance (Z_o) = $\sqrt{\dfrac{L}{C}} = \dfrac{138}{\sqrt{E}} \text{Log}_{10}\left(\dfrac{D+a}{d \times f}\right)$ Ohms

Time Delay = $1.0167 \times \sqrt{E}$ Nanoseconds per foot

Reflection Coefficient = I = $\dfrac{Z_r - Z_o}{Z_r + Z_o} = \dfrac{VSWR - 1}{VSWR + 1}$

Inductance (L) = $.140 \text{ Log}_{10} (D / d)$ Microhenries per foot

Velocity of Propagation = $\dfrac{100}{\sqrt{E}}$ % of speed of light

Cutoff Frequency = $\dfrac{7.50}{(D + d)\sqrt{E}}$ GHz

VSWR = $\dfrac{1 + \tilde{A}}{1 - \tilde{A}}$

d = Outside diameter of inner conductor, in inches.

D = Inside diameter of outer conductor, in inches.

E = Dielectric constant of insulation (see below).

a = Nominal shield correction factor (1/2 of the diameter of an individual shield wire).

f = Correction factor for stranded conductors:

Solid conductor:	1.00
7 strands:	.93
19 strands:	.97
37 strands:	.98

Ã = Reflection coefficient.

Log = Logarithm to base 10.

Dielectric Constants

Air	1.0	Foamed FEP	1.5–2.0	Polyimide	3.0–3.5	PVC	4.5–5.8
E Glass	6.0	Mica Glass	1.2–3.0	Polyimide/FEP film	2.2–2.3	PVF	3.0–8.4
ETFE	2.6	Nylon	4.5	Polypropylene	2.3	Silicone Rubber	2.1–3.5
Expanded PTFE	1.4–2.0	PFA	2.0	Polysulfone	3.1	Urethanes	6.7–7.5
FEP	2.0	Polyethylene	2.3	PTFE	2.0		