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Electromagnetics:
Electromagnetic Field Theory

Example 4 – The RG-59 Coaxial Transmission Line

1

Transmission Line Impedance

We have actually performed a very sophisticated analysis.

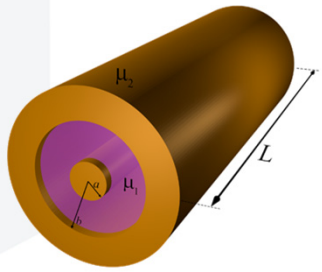
At the end of electrostatics, we derived the distributed capacitance.

$$\frac{C}{\ell}=\frac{2\pi\varepsilon}{\ln\left(\frac{a}{b}\right)}$$

At the end of magnetostatics, we derived the distributed inductance.

$$\frac{L}{\ell}=\frac{\mu}{2\pi}\left[\frac{1}{4}+\ln\left(\frac{b}{a}\right)\right]$$

We will now be able to calculate the characteristic impedance Z_0 of a coaxial transmission line!

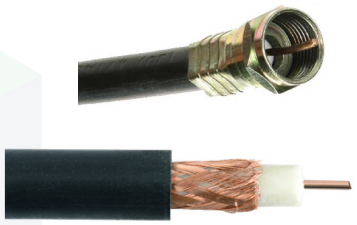


$$Z_0=\sqrt{\frac{L/\ell}{C/\ell}}$$

2

Example #7 – RG-59 Coax

A standard RG-59 coax has



Inner conductor diameter:	0.81 mm (20 AWG)
Outer conductor diameter:	3.66 mm
Dielectric constant:	2.1
Specified capacitance:	86.9 pF/m

$$\frac{C}{\ell} = \frac{2\pi\left(8.854\times10^{-12}\ \text{F/m}\right)(2.1)}{\ln\left(3.66\ \text{mm}/0.81\ \text{mm}\right)} = 7.746\times10^{-11}\ \text{F/m} = 77.46\ \text{pF/m}$$

$$\frac{L}{\ell} = \frac{1.2566\times10^{-6}\ \text{H/m}}{2\pi}\left[\frac{1}{4}+\ln\left(\frac{3.66}{0.81}\right)\right] = 3.52\times10^{-7}\ \text{H/m} = 352\ \text{nH/m}$$

$$Z_0 = \sqrt{\frac{3.52\times10^{-7}\ \text{H/m}}{7.746\times10^{-11}\ \text{F/m}}} = 64.7\ \Omega$$

The specified impedance is 75 Ω.

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Slide 3

3