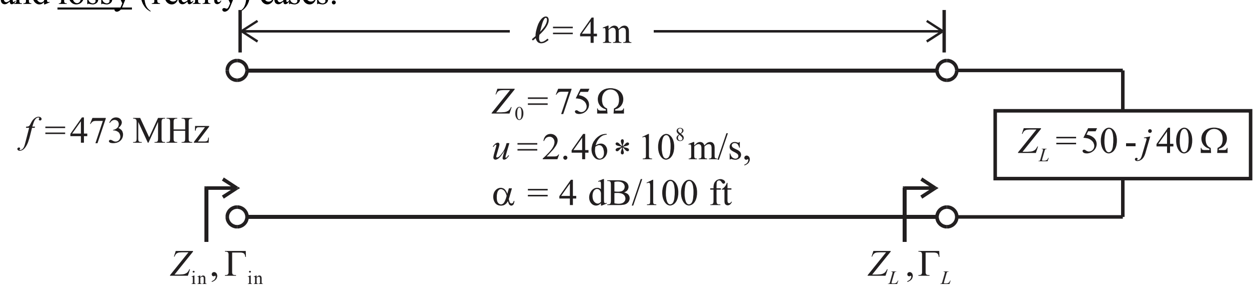
At 473 MHz, a load has an impedance of 50 - j 40 Ohms. The load is attached to a 4 m long transmission line (similar to RG-6) where $Z_0 = 75$ Ohms, $u = 2.46 \times 10^8$ m/s, & $\alpha = 4$ dB/100 ft (from the datasheet). First, calculate the phase constant, wavelength, and electrical length. Then, find the reflection coefficients at the input and load ends of the transmission line input impedance, and standing wave ratio for the lossless (assume $\alpha = 0$) and lossy (reality) cases.



Given: $f := 473 \cdot 10^6$ Hz $\quad L := 4$ m $\quad u := 2.46 \cdot 10^8$ m/s

$Z0 := 75$ Ω $\quad ZL := 50 - j \cdot 40$ Ω

Calculate phase constant β, wavelength λ, and electrical length βL:

$$\beta := \frac{2 \cdot \pi \cdot f}{u} \qquad \boxed{\beta = 12.081} \text{ rad/m} \qquad \lambda := \frac{u}{f} \qquad \boxed{\lambda = 0.5201} \text{ m}$$

$$\beta L := \beta \cdot L \qquad \boxed{\beta L = 48.324} \text{ rad} \qquad \boxed{\beta L \cdot \frac{180}{\pi} = 2768.8} \text{ deg} \qquad \boxed{\frac{\beta L}{2 \cdot \pi} = 7.691} \ \lambda$$

<u>Lossless TL</u>- Calculate reflection coefficients at input Γ_{in} and load Γ_L:

$$\Gamma L := \frac{ZL - Z0}{ZL + Z0} \qquad \boxed{|\Gamma L| = 0.3594} \qquad \boxed{\arg(\Gamma L) \cdot \frac{180}{\pi} = -104.261} \text{ deg}$$

$$\Gamma in := \Gamma L \cdot e^{-j \cdot 2 \cdot \beta \cdot L} \qquad \boxed{|\Gamma in| = 0.3594} \qquad \boxed{\arg(\Gamma in) \cdot \frac{180}{\pi} = 118.178} \text{ deg}$$

<u>Lossless TL</u>- Calculate Z_{in} and standing wave ratio:

$$Zin := Z0 \cdot \frac{1 + \Gamma in}{1 - \Gamma in} \qquad \boxed{Zin = 44.472 + 32.358i} \ \Omega$$

$$Sin := \frac{1 + |\Gamma in|}{1 - |\Gamma in|} \qquad \boxed{Sin = 2.122} \qquad Sload := \frac{1 + |\Gamma L|}{1 - |\Gamma L|} \qquad \boxed{Sload = 2.122}$$

For the <u>lossless TL</u>, note that |Γ| and the SWR did not change.

Lossy TL- Compute α and γ in MKS units:

$$\alpha := 4 \cdot \frac{1}{100} \cdot \left(\frac{1}{0.3048}\right) \cdot \left(\frac{1}{20 \cdot \log(e)}\right) \qquad \boxed{\alpha = 0.015109} \quad \text{Np/m}$$

$$\gamma := \alpha + j \cdot \beta \qquad \boxed{\gamma = 0.015109 + 12.081084i} \quad 1/\text{m}$$

Lossy TL- Calculate reflection coefficients at input Γ_{in} and load Γ_L:

$$\Gamma L := \frac{ZL - Z0}{ZL + Z0} \qquad \boxed{|\Gamma L| = 0.3594} \qquad \boxed{\arg(\Gamma L) \cdot \frac{180}{\pi} = -104.261} \quad \text{deg, same}$$

$$\Gamma in := \Gamma L \cdot e^{-2 \cdot \gamma \cdot L} \qquad \boxed{|\Gamma in| = 0.3185} \qquad \boxed{\arg(\Gamma in) \cdot \frac{180}{\pi} = 118.178} \quad \text{deg, smaller}$$

For the lossy TL, note that $|\Gamma_{in}| < |\Gamma_L|$ due to the $e^{-2\alpha\ell}$ term However, the phase of Γ_{in} is the same as for the lossless case.

Lossy TL- Calculate Z_{in} and standing wave ratio:

$$Zin := Z0 \cdot \frac{1 + \Gamma in}{1 - \Gamma in} \qquad \boxed{Zin = 48.061 + 30.032i} \quad \Omega\text{, changed}$$

$$Sin := \frac{1 + |\Gamma in|}{1 - |\Gamma in|} \qquad \boxed{Sin = 1.935} \qquad Sload := \frac{1 + |\Gamma L|}{1 - |\Gamma L|} \qquad \boxed{Sload = 2.122}$$

For the lossy TL, note both Z_{in} and SWR changed with respect to the lossless values.