

At 200 MHz, match an antenna ($Z_A = 42 + j39 \Omega$) to a feeding transmission line ($Z_0 = 60 \Omega$ & $u = 2.4 \times 10^8$ m/s) using a quarterwave transformer (QWT) placed as close to the antenna as possible. Assume the wavelength λ' of the QWT is 110% of λ for the feeding transmission line. Draw a fully labeled sketch of final design.

- The wavelength is $\lambda = u/f = 2.4 \times 10^8 / 200 \times 10^6 \Rightarrow \lambda = 1.2 \text{ m} = 120 \text{ cm}$.
- Given, the QWT wavelength is $\lambda' = 1.1 \lambda = 1.1 (1.2) \Rightarrow \lambda' = 1.32 \text{ m} = 132 \text{ cm}$.

Steps

- 1) Calculate the normalized impedance for the antenna $z_A = Z_A / Z_0 = (42 + j39) / 60 \Rightarrow z_A = \mathbf{0.7 + j0.65 \Omega/\Omega}$ and plot on **Smith chart** (see Figure 2).
- 2) Draw circle, centered on Smith chart, through z_A point. This circle of constant $|\Gamma|$ includes the locus of all possible z_{in} (and y_{in}) along the transmission line with this load.
- 3) The two match points where the circle of constant $|\Gamma|$ intersects the real axis are $r_{m,1} = r_{max} = 2.3$ [or $R_{max} = 2.3(60) = 138 \Omega$] and $r_{m,2} = r_{min} = 0.436$. Select the $r_{m,1} = r_{max} = \mathbf{2.3}$ match point as it is closest to z_A .
- 4) Find the distance d_1 from z_A to $r_{m,1} = r_{max}$ using scales on Smith chart, $d_1 = 0.25\lambda - 0.1194\lambda \Rightarrow \mathbf{d_1 = 0.1306\lambda}$ or $d_1 = 0.1306 (120 \text{ cm}) \Rightarrow \mathbf{d_1 = 15.672 \text{ cm}}$.
- 5) Starting at distance d_1 from z_A , insert the QWT. The QWT will have a characteristic impedance $Z'_{0,min} = \sqrt{Z_0 R_{max}} = \sqrt{60(138)} \Rightarrow \mathbf{Z'_0 = 90.9945 \Omega}$ and a length $\lambda'/4 = 132/4 \Rightarrow \mathbf{\lambda'/4 = 33 \text{ cm}}$.
- 6) As shown on Figure 1, everywhere toward the source from the QWT sees an input impedance of $Z_{in} = Z_0 = 60 \Omega$.

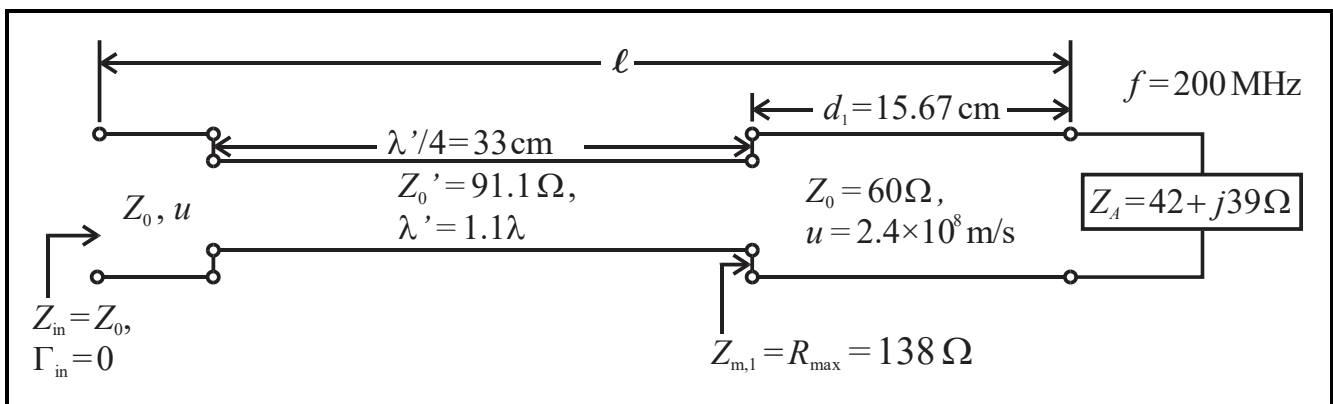


Figure 1 Matching an antenna using a QWT.

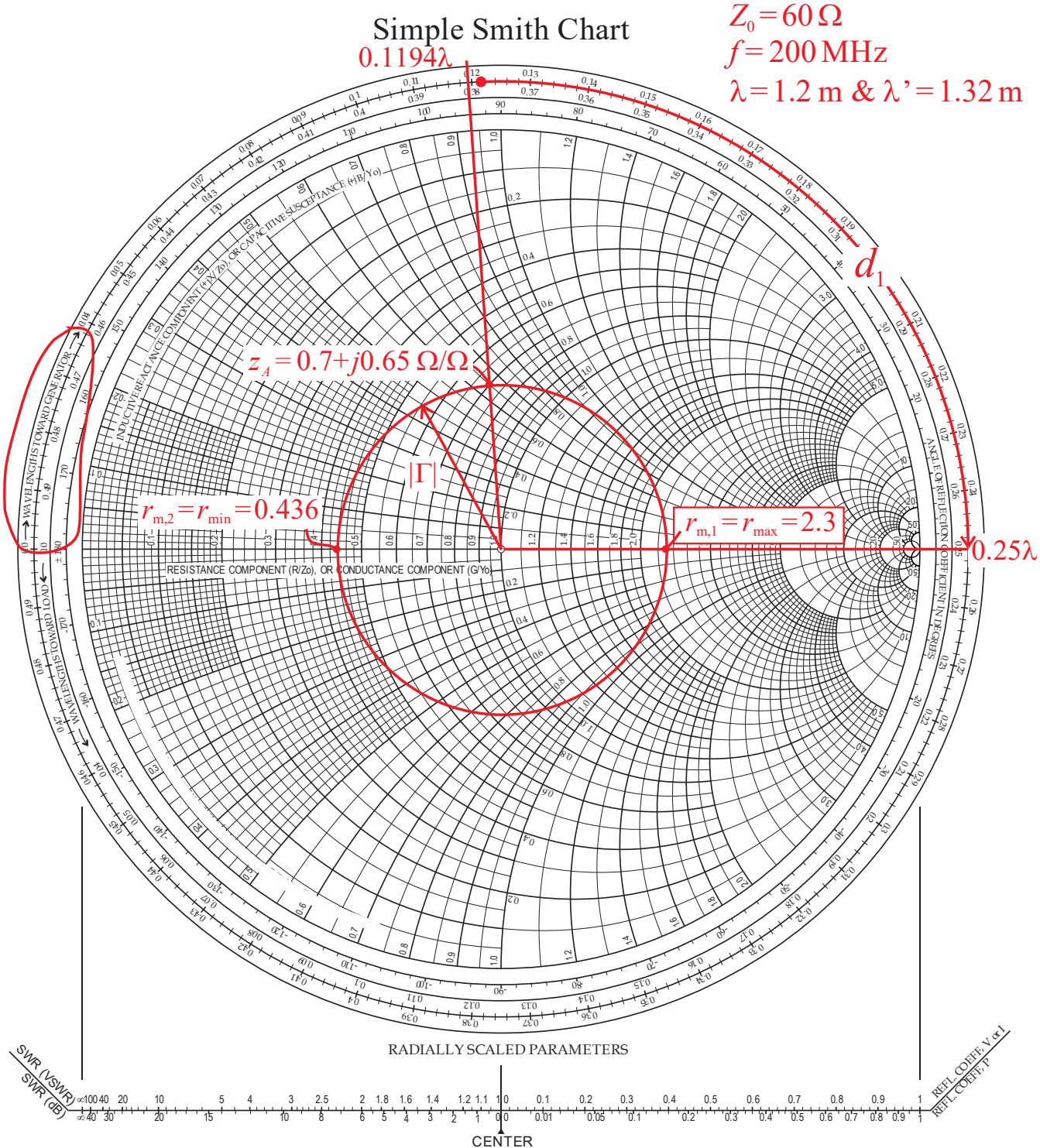


Figure 2 Smith chart for matching an antenna using a QWT.