An antenna has input impedance $Z_A = 80 - j\,120\ \Omega$ at 105 MHz. Match it to a feeding transmission line ($Z_0 = 80\ \Omega$ & $u = 2.1 \times 10^8$ m/s) using a stub of the same transmission line with an short-circuit termination. Place the stub as close to the antenna as possible and make the stub as short as possible. Draw a fully labeled sketch of the final design.

- The wavelength is $\lambda = c/f = 2.1 \times 10^8/105 \times 10^6 = 2\ \text{m} = 200\ \text{cm}$.

Steps

1) Calculate normalized impedance $z_A = Z_A/Z_0 = (80 - j\,120)/80 \Rightarrow$ **$z_A = 1 - j\,1.5\ \Omega/\Omega$** 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) Go $\lambda/4$ (180°) around the circle of constant $|\Gamma|$ from z_A point to **$y_A = 0.308 + j\,0.462$ S/S** point and plot.
4) Note, there are two match points w/ normalized admittances $y_{m,i} = 1 \pm j1.5$ S/S. The closest match point is **$y_{m,1} = 1 + j1.5$ S/S**.
5) Find distance d_1 from y_A to $y_{m,1}$ using scales on Smith chart, $d_1 = 0.176\lambda - 0.074\lambda \Rightarrow$ **$d_1 = 0.102\lambda$** or, in meters, $d_1 = 0.102(2) \Rightarrow$ **$d_1 = 0.204\ \text{m} = 20.4\ \text{cm}$**.
6) At d_1, add a shunt stub with an short-circuit termination with normalized susceptance $y_{stub} = -j1.5$ S/S, i.e., start at the short circuit point ($y_{SC} = \infty$) move length l_1 in the "WAVELENGTHS TOWARD GENERATOR" direction to the $-j1.5$ S/S point on outer edge of the Smith chart. Here, **$l_1 = 0.3436\lambda - 0.25\lambda = 0.0936\lambda$** or $l_1 = 0.0936(200) \Rightarrow$ **$l_1 = 18.72\ \text{cm}$**.
7) As shown on Figure 1, everywhere toward the source from the location of the SC stub will be matched, i.e., $Z_{in} = 80\ \Omega$.

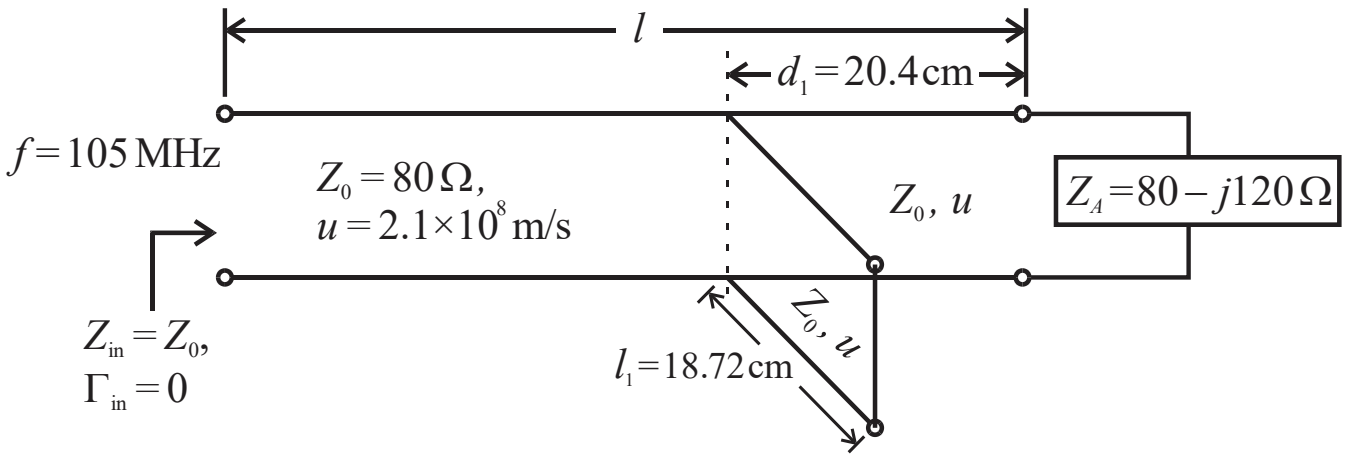

Figure 1 Matching antenna using shunt SC stub.

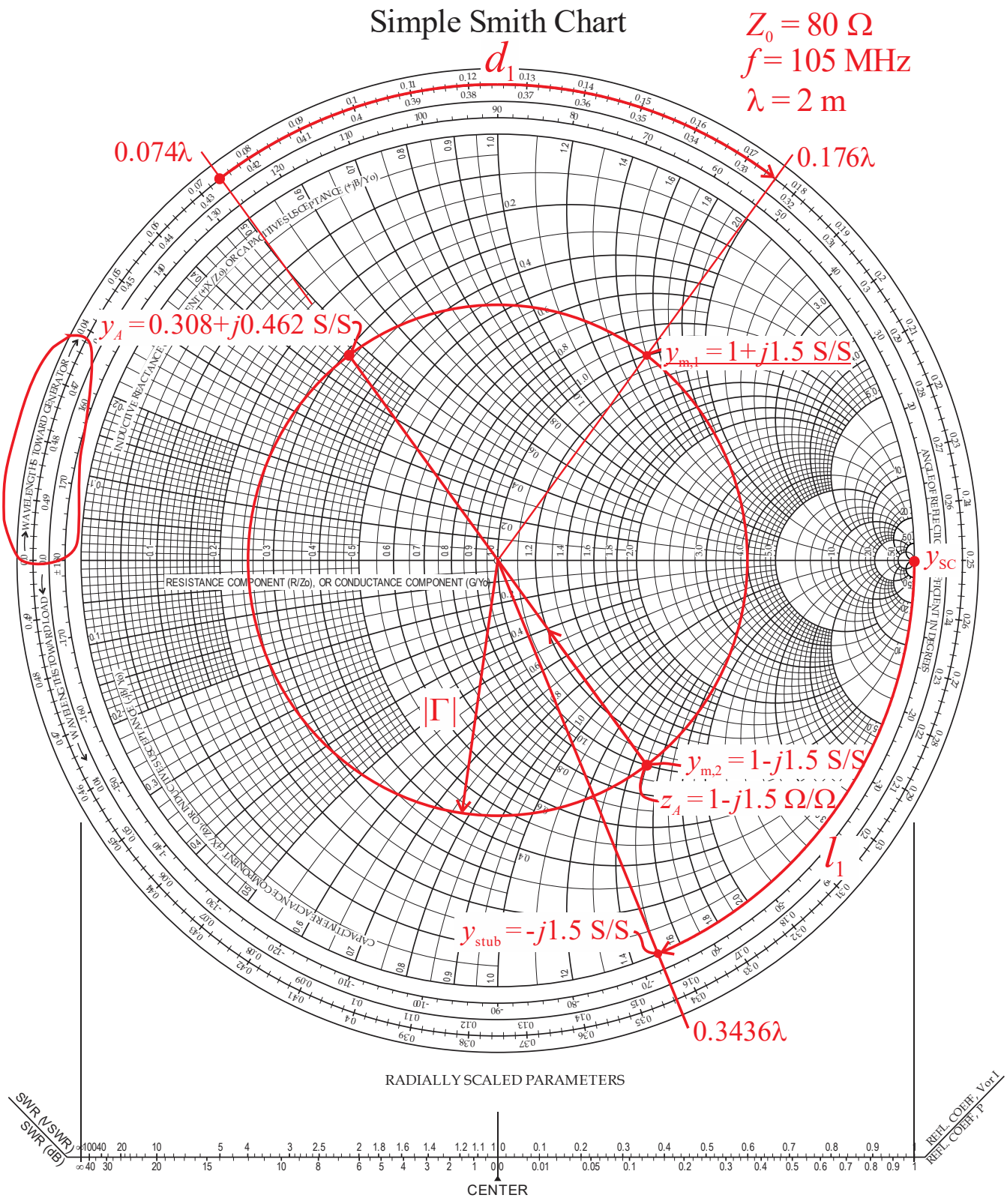

Figure 2 Smith chart for matching antenna using shunt OC stub.