We are using an air-dielectric 50 Ω slotted line to determine an unknown load.

Slotted line with a short circuit termination

Measure adjacent voltage minima at distances $d = 90$ cm & $d = 50$ cm from load.

1) Find wavelength and frequency of signal

- Adjacent voltage minima are separated by half a wavelength. Therefore, $\lambda/2 = 90 - 50 = 40$ cm $\Rightarrow$ **$\lambda = 80$ cm**.
- The frequency is $f = u/\lambda = 3\times 10^8/0.8 = 375\times 10^6$ Hz $\Rightarrow$ **$f = 375$ MHz**.

Slotted line with a unknown load termination

With an unknown load attached, we measure $V_{max} = -5$ dBmV (multiple locations) and the voltage minima closest to the load as $V_{min} = -15$ dBmV at $d = 60$ cm.

1) Find VSWR and magnitude of reflection coefficient along slotted line

- Using $V_{max} = -5$ dBmV $= 20 \log_{10}(V_{max}/1\text{ mV})$, we calculate the maximum voltage magnitude $V_{max} = 10^{-5/20}$ (1 mV) $\Rightarrow$ **$V_{max} = 0.562$ mV**.
- Using $V_{min} = -15$ dBmV $= 20 \log_{10}(V_{max}/1\text{ mV})$, we calculate the minimum voltage magnitude $V_{min} = 10^{-15/20}$ (1 mV) $\Rightarrow$ **$V_{min} = 0.178$ mV**.
- By definition, the VSWR $= V_{max} / V_{min} = 10^{-5/20} / 10^{-15/20}$ $\Rightarrow$ **VSWR = 3.162**.
- Set compass using "SWR (VSWR)" scale at bottom left of Smith chart.
- Use compass to mark "REFL. COEFF., V OR I" scale on bottom right of Smith chart. Read **$|\Gamma| = 0.52$**.

2) Find unknown load impedance

- We know that voltage minima occur at the r_{min} point on circle of constant $|\Gamma|$. Using compass, draw a circle of $|\Gamma| = 0.52$. Where the circle crosses the horizontal axis to left of origin, mark V_{min} point and read $r_{min} = 0.31$ Ω/Ω.
- The voltage minima closest to the unknown load is at $d = 60$ cm. Moving toward the generator, the first location of a voltage minimum for the short circuit termination was $d = 90$ cm. The distance toward the load from the V_{min}/r_{min} point is then $l = |60 - 90| = 30$ cm or $l/\lambda = 30/80$ $\Rightarrow$ **$l/\lambda = 0.375$**.
- As the horizontal axis for V_{min}/r_{min} point is at 0 on the "WAVELENGTHS TOWARD LOAD" scale, draw a radial line from the center of the Smith chart through 0.375 on the "WAVELENGTHS TOWARD LOAD" scale.
- Where the radial line intersects the $|\Gamma| = 0.52$ circle, read/interpolate values of normalized load resistance and reactance as $r_L = 0.58$ and $x_L = 0.82$.

- Put together to get <u>normalized</u> load impedance **$\underline{z_L = 0.58 + j0.82\ \Omega/\Omega}$.**
- Find load impedance by multiplying z_L by characteristic impedance Z_0 to get $Z_L = z_L Z_0 = (0.58 + j0.82)\ 50 \Rightarrow$ **$\underline{Z_L = 29 + j41\ \Omega}$.**