EE 3310 – Electromagnetics I – hearn
Input Impedance Post-Processing– Antenna Termination

Lab Exercise #5 due March 23, 2023

- *Lines and Fields in Electronic Technology*, W.D. Stanley & R.F. Harrington, pg 135-142
- *Engineering Electromagnetics*, 5th ed., W.H. Hayt Jr., pg 398-404
- *Elements of Electromagnetics*, 6th ed., M.N. Sadiku, pg 555-558

Recall the reflection coefficient is a ratio of voltages

$$\overline{\Gamma} = \frac{V^-}{V^+} = \frac{\overline{Z}_L - Z_o}{\overline{Z}_L + Z_o}$$

From Lab #3, a Vector Network Analyzer measured the scattering parameters of a two-port device. The impedance response (versus frequency) of an antenna termination of a transmission line may be determined from a one-port S_{11} measurement. S_{11} is a reflected to incident power-ratio and is related to the square of the reflection coefficient

$$\overline{S}_{11} = \overline{\Gamma}^2$$

The Return Loss $(S_{11})_{dB}$ is a measured quantity (amplitude, no phase information) used to characterize an antenna impedance match and its ability to transmit (radiate) power

$$RL_{dB} = -S_{11dB} = -10\log_{10}\left(\Gamma^2\right)$$

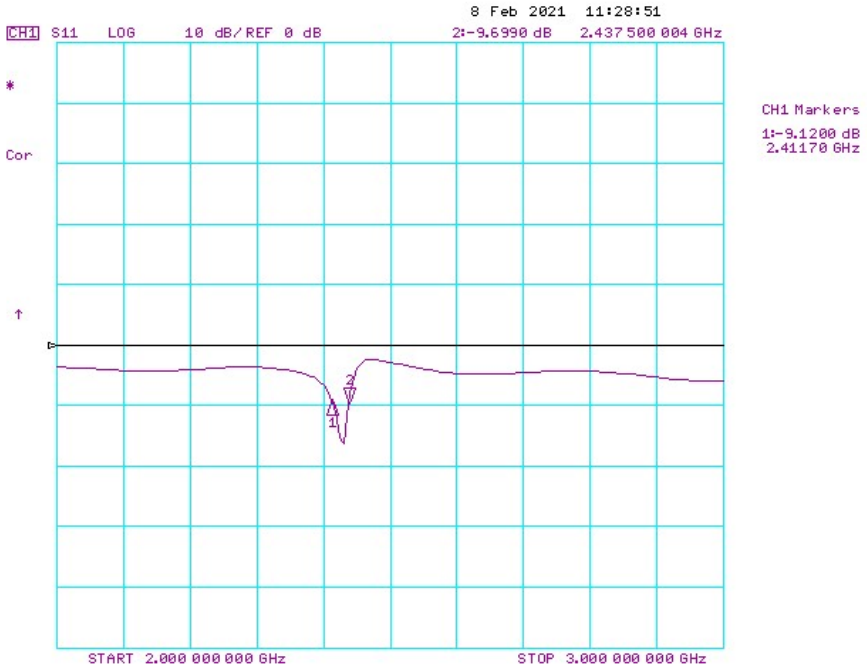

Fig. 1. Measured Antenna Impedance response for prototype Yagi antenna

Smith Chart

The Smith Chart is an important tool for visualizing conditions on a transmission line. Even with modern technology and computer visualization, the Smith chart remains a primary tool for analysis and design of transmission systems.

The VNA is used extensively in RF and microwave measurements, and provides a Smith Chart format for screen display. The Return Loss measurement shown in Figure 1 is converted to a Smith Chart format shown in Figure 2.

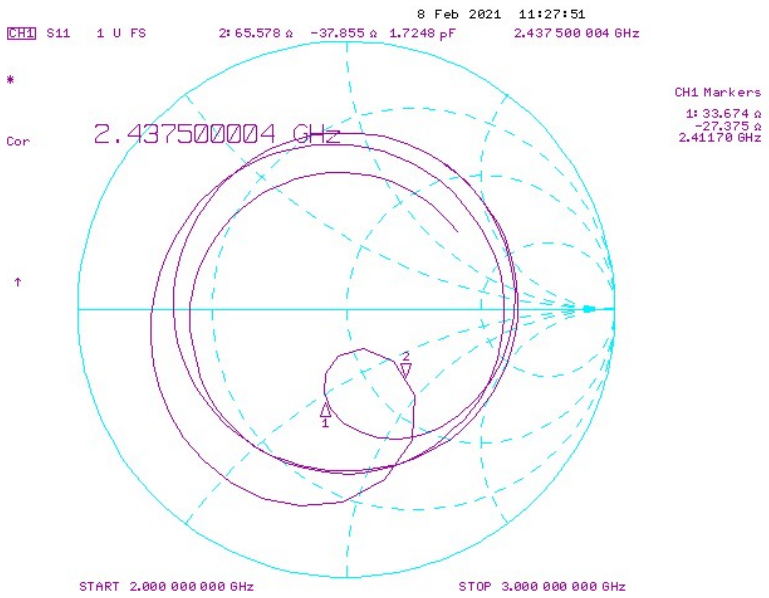

Fig. 2. Smith Chart format of measured antenna impedance response shown in Figure 1.

Also recall from Lab #3, the VSWR is directly related to the reflection coefficient

$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|}$$

Procedure:

1. Download the measured S11 data file from the canvas assignment page. A screen capture of the header file and first few lines of ASCII data are shown in Figure 4.
2. Reconstruct the Return Loss plot (Figure 1)
3. Use a compass to estimate the 2:1 VSWR response on the Smith Chart (Fig. 2)
4. Investigate Smith Chart format in MATLAB or python to reconstruct Figure 2
5. Reconstruct the VSWR curve shown in Figure 3

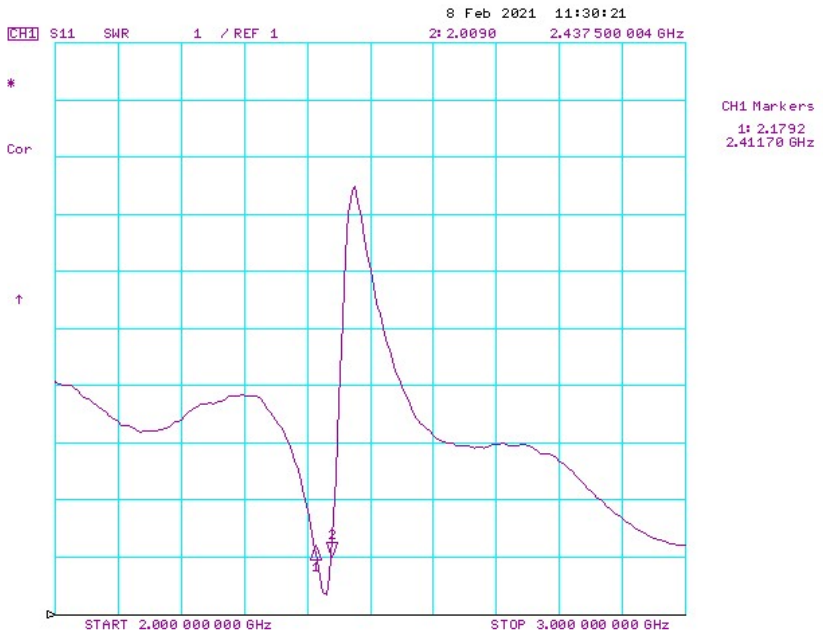

Fig. 3. VSWR format of measured antenna impedance response shown in Figure 1

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CITIFILE A.01.00
#NA VERSION HP8720ES.07.74: Oct 30, 2002
NAME DATA
VAR FREQ MAG 201
DATA S[1,1] RI
SEG_LIST_BEGIN
SEG 2000000000 3000000000 201
SEG_LIST_END
BEGIN
3.64257E-1,6.33483E-1
4.05212E-1,5.93505E-1
4.49462E-1,5.33813E-1
4.98748E-1,4.60479E-1
5.49987E-1,3.81988E-1
5.97412E-1,3.06915E-1
6.40655E-1,2.43286E-1
6.75048E-1,1.92993E-1
```

Fig. 4. ASCII data for Yagi1 prototype antenna impedance response shown in Figure 1.