Fourth Year Antenna Lab

Name : ______________________________ Student ID#: ______________________________

Contents

1 Wire Antennas

1.1 Objectives

- Plot the radiation pattern of simple $\lambda/2$ dipole antenna at 600 MHz.
- Measure the guided wavelength along a 50 Ω microstrip transmission line at 600 MHz.
- Measure the input impedance of imple $\lambda/2$ dipole antenna at 600 MHz.
- Sense the $\lambda/2$ dipole antenna current distribution at 300 MHz.

1.2 Equipments

- Antenna Training Lab Transmitter
- Antenna Training Lab Reciever
- 1 wire dipole antennas
- 3 Yagi-Uda wire array
- Rogowski Coil current Probe

1.3 Procedure:

1.3.1 Radiation Pattern of $\lambda/2$ wire dipole

1. Connect the arms of the three element Yagi-Uda antenna and set their dimensions to that shown in the Figure.

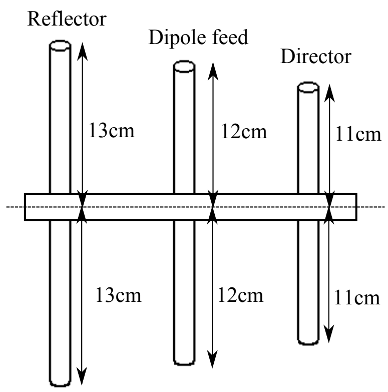


Figure 1: Insert 3 elements Yagi-Uda antenna with dimensions from the manual

2. Attach the Yagi-Uda antenna to the tripod stand, and connect it to the transmitter output port in the 87-898 MHz module through a 20 dB attenuator.
3. Set the transmitter frequency to 600 MHz.
4. Set the dipole total length 25 cm and attach it to the mast on the stepper motor.
5. connect it to the receiver input port in the 48-860 MHz module. Make the distance between the Tx and Rx antennas about 1 m.
6. Set the receiver frequency to 600 MHz (the same as the transmitter). You may need to use the a 20 dB attenuator in the RF receiver input if the received power exceeds -35 dBm. Also set the memory count to 1.
7. Set the stepper motor to 0° and it step to 5°.
8. Connect the trigger out from the stepper motor controller to the stepper Trig. port in the receiver using the provided BNC cable.
9. Turn on the PC connected to the receiver serial port, and run the antenna training program.
10. Select radiation pattern plot, and the memory locations from 1 to 72.
11. Click on the real time measurement button.
12. Set the training receiver to Auto mode.
13. Set the stepper motor motor to Auto.
14. Now the program starts to plot the radiation pattern point by point. When it is done, sketch the pattern you got in Figure *.

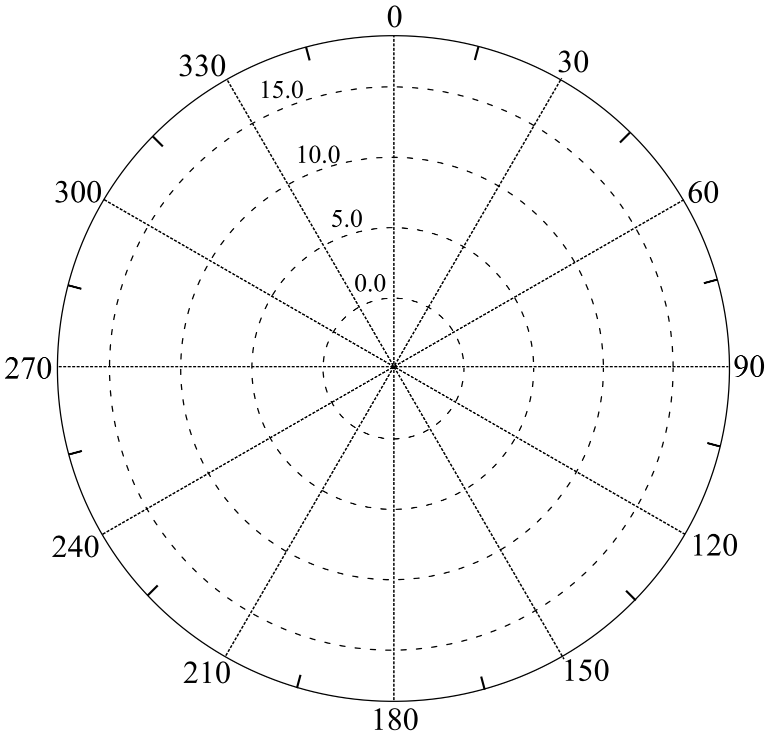


Figure 2: Empty polar plot for recording the radiation pattern

1.3.2 Radiation Pattern of the three-elements Yagi Udah

Repeat the previous procedure steps after interchanging the dipole and the Yagi Udah antennas.
Sketch the pattern you got in Figure *.

Set the stepper motor to 0° and it step to 5°.

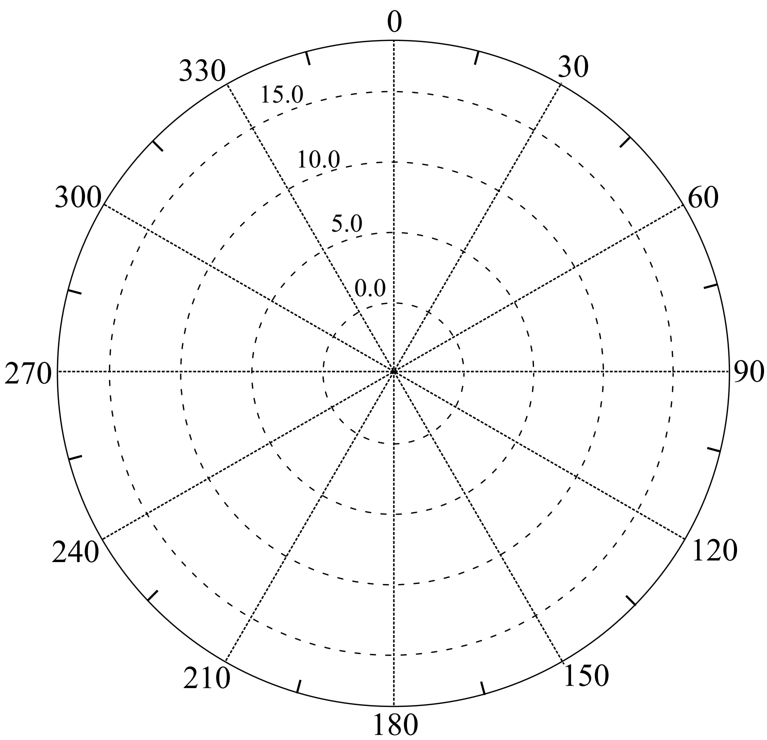


Figure 3: Empty polar plot for recording the radiation pattern

The forward to backward radiation ratio=············ dB.

1.3.3 $\lambda/2$ Dipole Input Impedance

- Measuring the guided wavelength

  1. Connect the transmitter to one side of the slotted line, and connect the sliding port to the receiver. You may need to use 20 dB attenuators at the Tx and Rx.
  2. Connect the short circuit termination to the other terminal port of the slotted line, see Figure **.

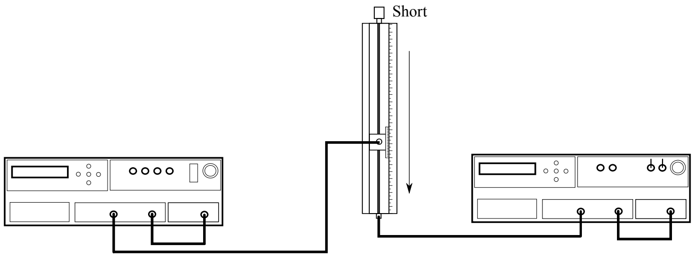


Figure 4: Schematic of the connection with short circuit termination

  3. Set the Tx and Rx frequency to 600 MHz.
  4. Record the positions d_1 and d_2 of two successive minima.

  Guided Wavelength $\lambda_g =$ ········· cm.

- Measuring the SWR

  1. Now, remove the short circuit termination and connect the $\lambda/2$ wire dipole instead, see Figure **.

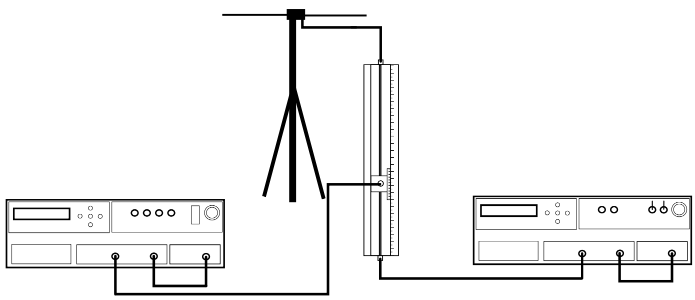


Figure 5: Schematic of the connection with the $\lambda/2$ dipole antenna as a load

  2. Measure the maximum and minimum power reading dBm along the slotted line

  $p_{max} =$ ············ dBm $p_{min} =$ ············ dBm

  SWR(dB)=$p_{max} - p_{min} =$ ············ dB SWR=············

- Measuring the input impedance

  1. Move the slide towards the generator and measure the distance the minimum has moved towards the generator d, see Fig **.

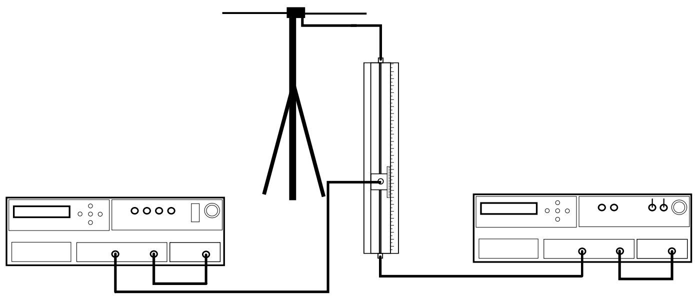


Figure 6: Schematic of the connection with the $\lambda/2$ dipole antenna as a load

$d = \cdots\cdots\cdots\cdots$ cm, Phase of the reflection coefficient $\theta = 2\pi d/\lambda_g = \cdots\cdots\cdots\cdots\cdots$ rad.

$$Z_{antenna} = Z_0 \frac{1 - j\,(\mathrm{SWR})\tan\theta}{(\mathrm{SWR}) - j\tan\theta} = \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \quad \Omega.$$

2 Patch antenna with inset feed (1.62 GHz)

2.1 Objectives

- Measure the radiation pattern of simple microstrip patch antenna.
- Measure the directional pattern characteristics.
- Measure the patch antenna with inset feed return loss versus frequency.

2.2 Equipments

- Antenna Training Lab Transmitter
- Antenna Training Lab Reciever
- $\lambda/2$ wire dipole antennas
- Microstrip patch antenna with inset feed.
- Directional coupler.

2.3 Procedure

2.3.1 Radiation Pattern

1. Attach the microstrip patch antenna to the mast on the stepper motor, and connect it to input port of the 861-2000 MHz down-converter module. You need to connect the output of the down-converter to the 48-860 MHz, see Fig **.
2. Attach the $\lambda/2$ dipole antenna to the tripod stand, and connect it to the transmitter output port in the 861-2000 MHz down-converter module. You need to connect the output port of the 87-898 MHz module through a 20 dB attenuator to the input of the upconverter, see Fig. **.

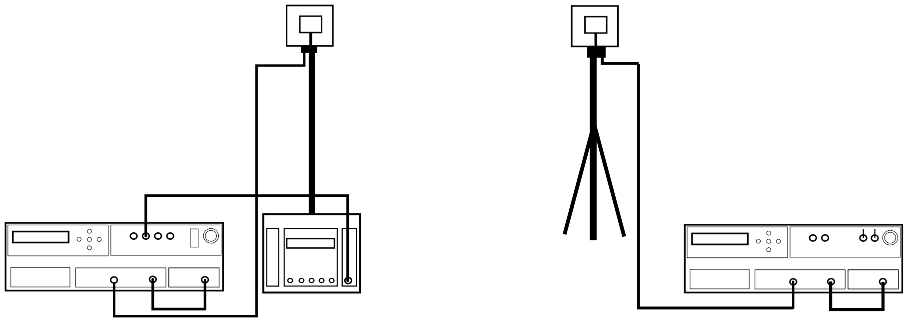


Figure 7: Insert 3 elements Yagi-Uda antenna with dimensions from the manual

3. Make sure that the patch is vertical (with port pointing down and the dipole is horizontal for E-plane; and port pointing to the side and the dipole is vertical for the H-plane).
4. Set the transmitter and reciever frequency to 1620 MHz.
5. Set the dipole total length $c/2f$, where c is the speed of light in space, and $f = 1620$ MHz.
6. You may need to use the a 20 dB attenuator in the RF receiver input if the received power exceeds -35 dBm. Also set the memory count to 1.
7. Set the stepper motor to 0° and it step to 5°.
8. Connect the trigger out from the stepper motor controller to the stepper Trig. port in the receiver using the provided BNC cable.
9. Turn on the PC connected to the receiver serial port, and run the antenna training program.
10. Select radiation pattern plot, and the memory locations from 1 to 72.
11. Click on the real time measurement button.
12. Set the training receiver to Auto mode.
13. Set the stepper motor motor to Auto.
14. Now the program starts to plot the radiation pattern point by point. When it is done, sketch the pattern you got in Figure * and * for E-plane and H-plane, respectively.

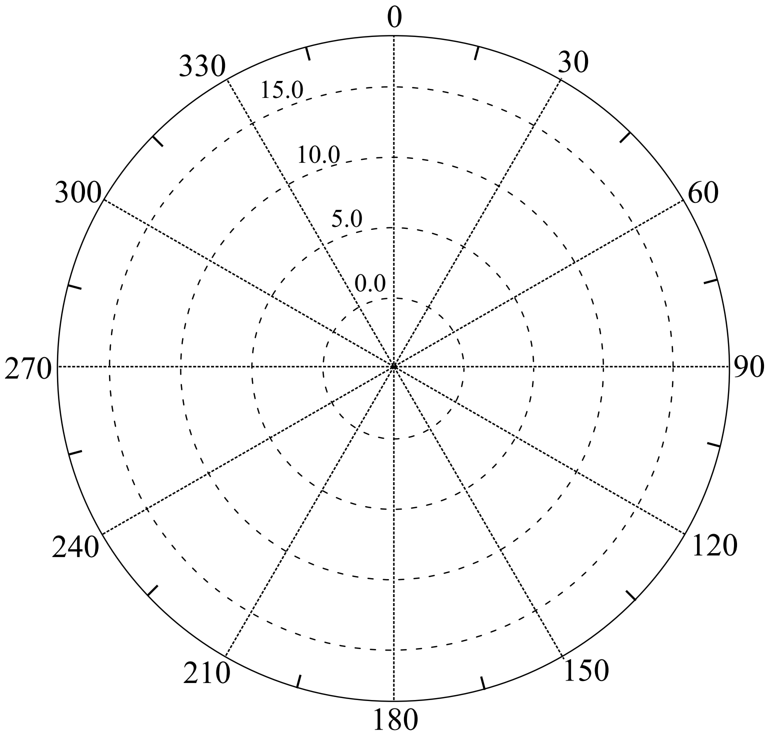


Figure 8: Empty polar plot for recording the radiation pattern

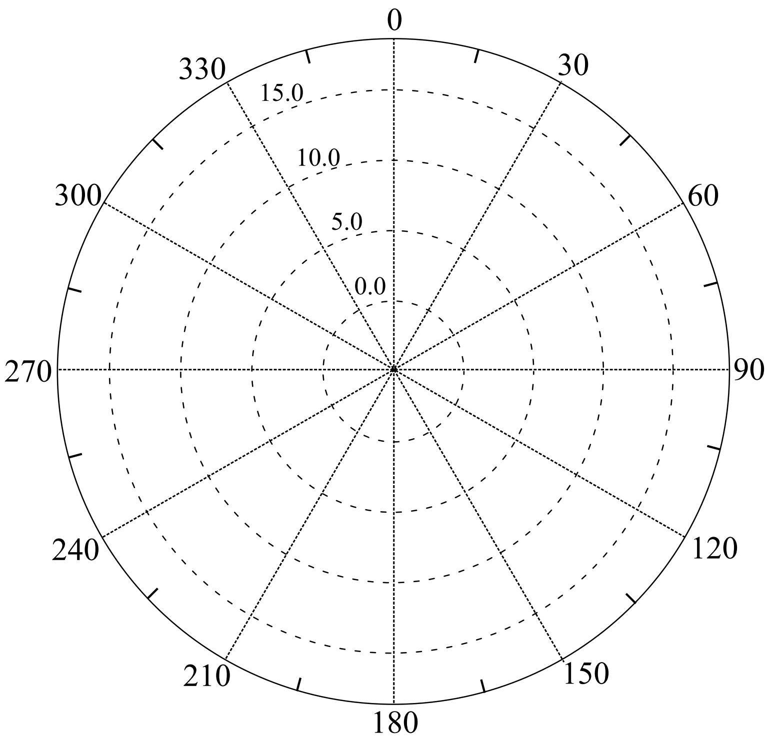


Figure 9: Empty polar plot for recording the radiation pattern

2.3.2 Directional Coupler Characteristics

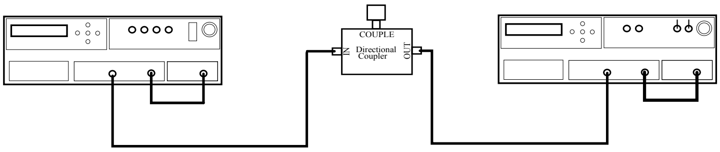


Figure 10:

1. Set the transmitter frequency to 1500 MHz using the up and down keys.
2. Connect 20 dB attenuator at transmitter out at upconverter block (with upconverter IN connected to RF OUT 87-898 MHz range using small cable).
3. Connect the output of the transmitter to the RF IN of the directional coupler.
4. Set the receiver frequency to 1500 MHz using the up and down keys.
5. Directly connect the receiver to the transmitter, you may need to insert 20 dB attenuator in the signal path to avoid saturating the receiver which saturates at -27 dBm.
6. Measure the output power from transmitter $p_{out}=\cdots\cdots\cdots\cdots\cdots$ dBm
7. Connect the receiver input to the directional coupler RF OUT.
8. Connect a matched load 50 Ω to the forward coupled port.
9. Measure the transmitted power through the coupler $p_t=\cdots\cdots\cdots\cdots\cdots$ dBm
   Device Insertion Loss IL=p_{out}(dBm) $-$ p_t(dBm)$\cdots\cdots\cdots\cdots\cdots$ dB

2.3.3 Patch Antenna Return Loss

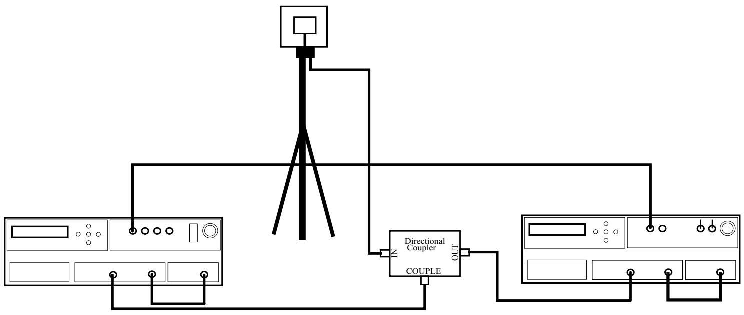
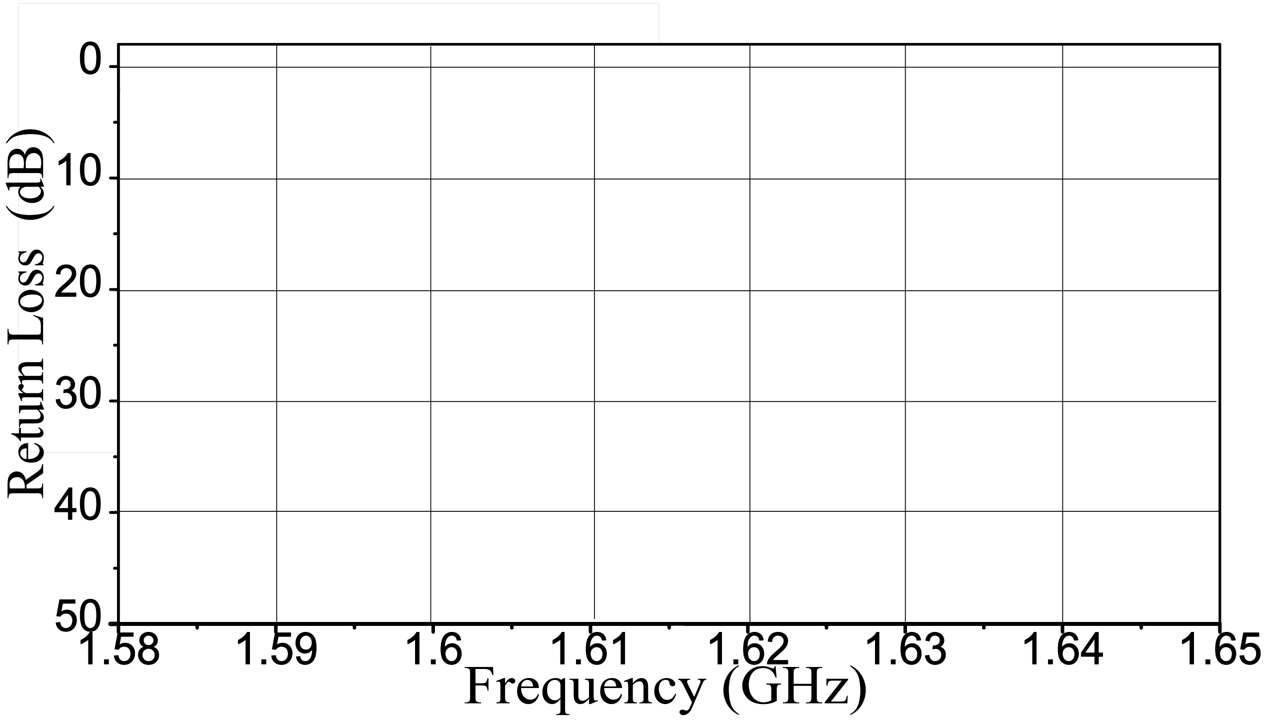


Figure 11:

1. Bring the transmitter to 1620 MHz using up and down keys.
2. Connect the upconverter input to RF OUT 87-898 MHz range using small cable.
3. Connect 20dB attenuator at transmitter output at upconverter block.
4. Bring the receiver to 1620 MHz using up and down keys.
5. Connect downconverter output to RF IN 48-860 MHz using small cable.
6. Connect the 20 dB attenuator at receiver at receiver input at downconverter block.
7. Connect directional coupler IN port to upconverter OUTPUT and sample/coupled port (CPL) to downconverter INPUT of receiver. The OUT port of coupler is terminated in antenna.
8. Plot the RL versus frequency:


Return Loss (dB)
0
10
20
30
40
50
1.58
1.59
1.6
1.61
1.62
1.63
1.64
1.65
Frequency (GHz)