Lab 5 Report

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I. Antenna Assembly and Tuning

1. Peel off the plastic wrapping on the tea can.

2. Drill a hole in the tea can using the Dremel tool.

3. Install the bulkhead SMA connector in the hole. Solder a piece of copper wire in the acceptor pin of the SMA connector.

4. Measure the S11 of the antenna using a vector network analyzer (VNA). When the antenna is radiating at the right frequency (2.4 GHz in this lab), the S11 should be at least better than -10 dB. Cut the copper in small increments until get a good response on the VNA. Fig. 1 shows the probe feed length inside the first matched tea pot antenna (antenna 1). Fig. 2 shows the S11 figure of the experimentally matched tuned antenna 1

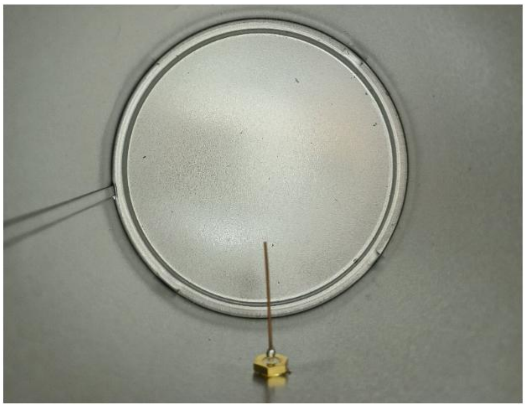

Fig. 1. The probe feed inside the tea-can antenna 1.

Fig. 2. well tuned antenna 1's S11.

5. Repeat the above step for the second antenna (antenna 2). Fig.3 shows the probe feed length inside the second matched tea pot antenna (antenna 2). Fig.4 shows the S11 figure of the experimentally matched tuned antenna 2.

Fig. 3. The probe feed inside the tea-can antenna 2.

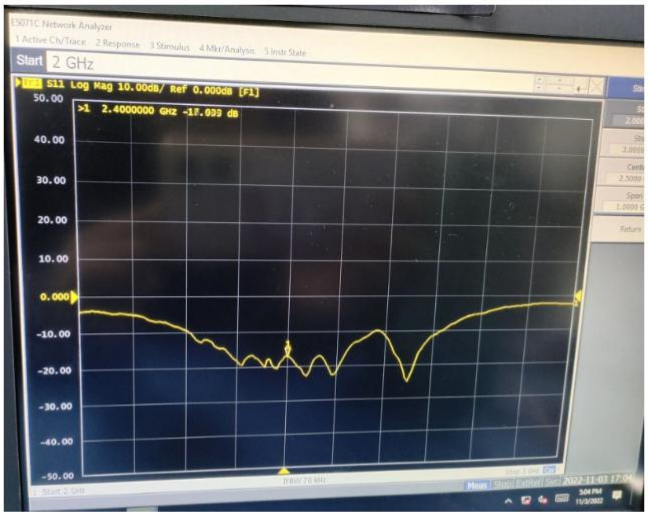

Fig. 4.well tuned antenna 2’s S11.

The 10 dB bandwidth of the second antenna (antenna 2) is 2.58-2.20=0.38GHz.

II. Measuring Antenna Characteristics

Antenna gain is generally measured using an anechoic chamber or antenna range. As a crude approximation of an antenna range, we could measure the gain of the antenna using the set-up in Fig. 5.

In this setup, two identical antennas are placed face to face with a distance of 1 m apart. The received power on antenna 2 is roughly given by.

$$P_r = \frac{P_t}{(4\pi r)^2}\lambda^2 G_1 G_2$$

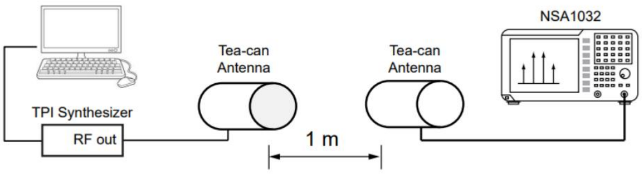

Fig. 5. Measuring antenna gain using two identical antennas.

where Pt is the transmitted power from antenna 1, r = 1 m, G1 and G2 are the gains of the antennas. Since the two antennas are essentially identical, G1 = G2. Therefore, the gain of the antenna can be expressed by

$$G = G_1 = G_2 = \frac{4\pi r}{\lambda}\sqrt{\frac{P_r}{P_t}}$$

1. Connect the TPI synthesizer to one of antennas. Set the output frequency and power of the synthesizer to 2.4 GHz and 0dBm. (This will be Pt)

2. Connect the other antenna to the GSP-730 spectrum analyzer.

3. Place the antennas 1 m apart, facing each other. Make sure that the feed pins of the two antennas are aligned in the same direction.

4. Antenna Gain Measure a signal at 2.4 GHz on the spectrum analyzer. Record the power of this signal, which will be Pr and calculate the gain of your antennas. Make sure that take into account the loss of the connectors, adapters, and cables.

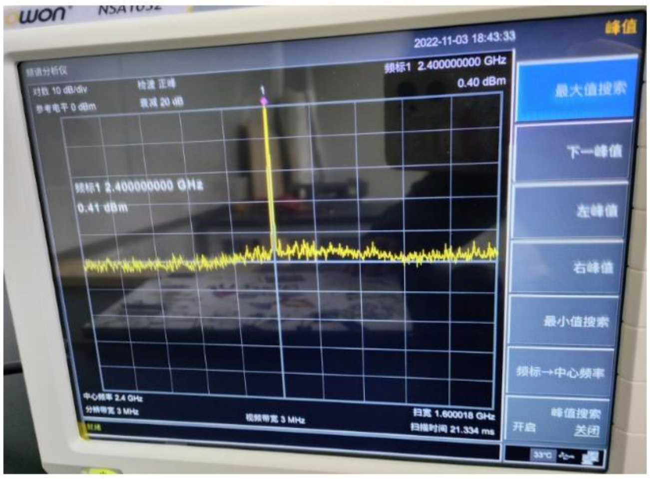

Fig. 6. Spectrum diagram of receiver when transmitting power is 0dB.

As can be seen from Fig. 6, the real transmitting power is 0.41dBm, it means Pt is 0.41dBm

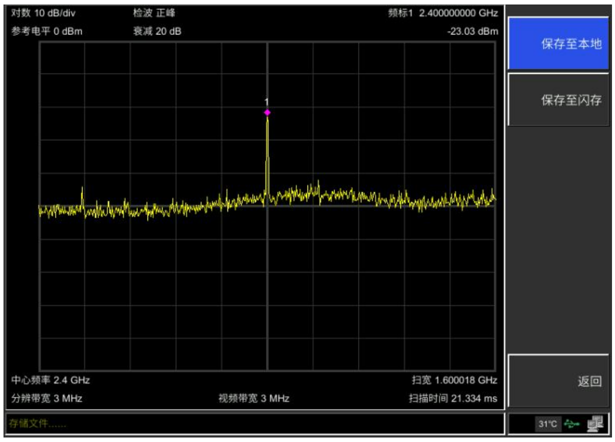

Fig. 7. Spectrum diagram of the signal at 2.4 GHz.

As can be seen from Fig. 7, the power of this signal is -23.03dBm, it means Pr is --23.03dBm.

The measured is about 16cm, the gain of the antenna can be calculated as:

$$G = G_1 = G_2 = \frac{4\pi r}{\lambda}\sqrt{\frac{P_r}{P_t}} = \frac{4\pi * 1}{0.16}\sqrt{\frac{23.03}{0.41}} = 588.63$$

5. Cross-polarization Now rotate one of the antennas 90° axially so that the two feed pins are perpendicular to each other (the antennas should still face each other). Record the power of the received signal. Explain the difference in the received powers in Step 4 and 5.

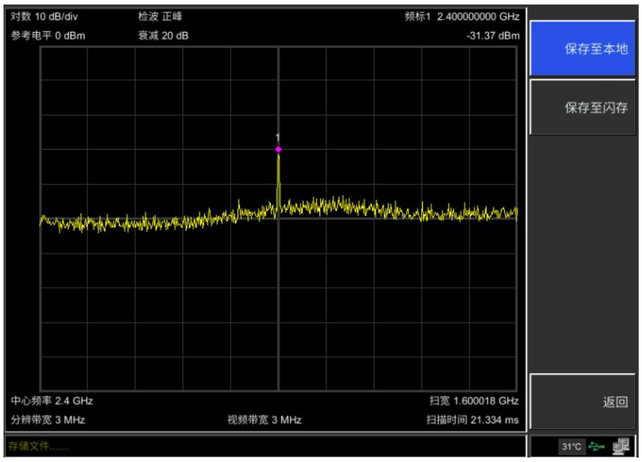

Fig. 8. Spectrum diagram of the signal at 2.4 GHz.

As can be seen from Fig. 8, the power of this signal is -31.37dBm.

The measured λ is about 16cm, the gain of the antenna can be calculated as:

$$G = G_1 = G_2 = \frac{4\pi r}{\lambda}\sqrt{\frac{P_r}{P_t}} = \frac{4\pi * 1}{0.16}\sqrt{\frac{31.37}{0.41}} = 686.99$$

The received power in Step 5 is less than in Step 4, and the loss of the antenna in Step 5 is more than in Step 5.

The antenna radiates energy along the direction of the main polarization, which is the power measured in Step 4. The energy radiated from the direction of cross-polarization is the power measured in step 5, which is not much. So the power measured in step 5 is less than that measured in step 4.