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Antenna Project Report

I. Introduction

The objective of this project was to simulate, fabricate, and test a low-cost antenna created from items found at a second-hand store. We built a complex monopole antenna from a wine rack we bought at the thrift store and modeled both a simplified version of it as well as a more accurate version in FEKO. Although it did perform qualitatively as we expected and gave us much insight into antennas, we were unable to match the results from the lab test to what we saw in the simulation. We believe that this is due to the approximation of the antenna as a PEC and the simplification of the complex geometry in the connector.

II. Setup

Because this project was more exploration-oriented, rather than design, we did not have any parameters within which to build our antenna (besides the budget), so we were free to be as creative as we wanted. We took a trip to the thrift store, and we agreed that the wine rack would make a cool antenna and that we were curious to find out how it would perform. We discussed some ways in which we might build an antenna out of it, before deciding on a monopole for its simplicity in fabrication. Before building the antenna, we simulated a few initial models in FEKO, which helped us decide to stand the antenna up on the ground plane and feed it with a single port in the middle of the lowest wire. We then constructed the antenna, with much-appreciated help from Ljuba, and reworked our FEKO model to better represent the end result. Whereas in the old model, the antenna is floating above the ground plane (not touching) with a port in its lowest wire, the newest iteration includes the connector, modeled by a coax through the ground plane with the port between the inner and outer conductors on the end. Finally, we tested our antenna with the VNA and recorded S11 and S21 with a small dipole antenna in the lab.

III. Results and Discussion

A. Comparing the Simulations

We found that our FEKO simulation results were drastically different with and without the connector modeled. The old model shows radiation directed upward, due to the net current being excited mainly in the horizontal direction, and the ground plane acting as a reflector. This model showed a clear resonance around 700 MHz. The new one radiates as we would expect of a monopole, which leads us to believe that it is a more accurate representation of the antenna that we built. At low frequencies (as shown in Figure 1), it has the characteristic “donut” shape of a dipole, due to the finite ground plane, while at higher frequencies, it still maintains the donut shape but this starts to get directed above the ground plane as well. Neither model showed a very strong resonance at 273 MHz (where we would expect it with a simple monopole of the wine rack’s height), although the latter had a very slight dip in the reflection coefficient around that frequency.

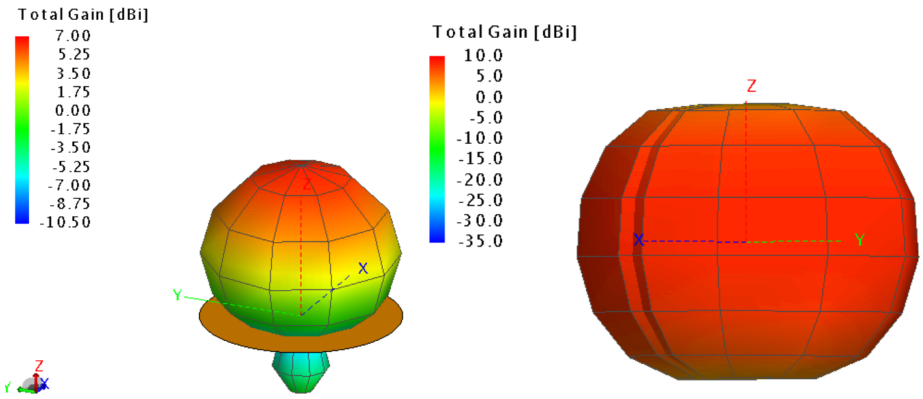


Figure 1: Radiation pattern at 250 MHz of pre-build FEKO model (left) and FEKO model including the connector (right).

B. Lab Test Results

Figure 2 displays our results from testing in the lab overlaid with the results from our last FEKO simulation. Although we saw dips in both trend lines around the same frequencies, we could not determine why they were slightly off on the horizontal axis, and drastically different in scale (magnitude of S11). We utilized the parameter sweep tool in FEKO to experiment with different measurements and to see if we could replicate our results, but we found that this had very little impact (at least with the small amounts of variation with which we experimented).

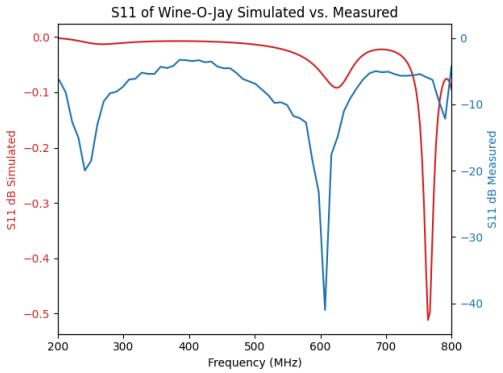
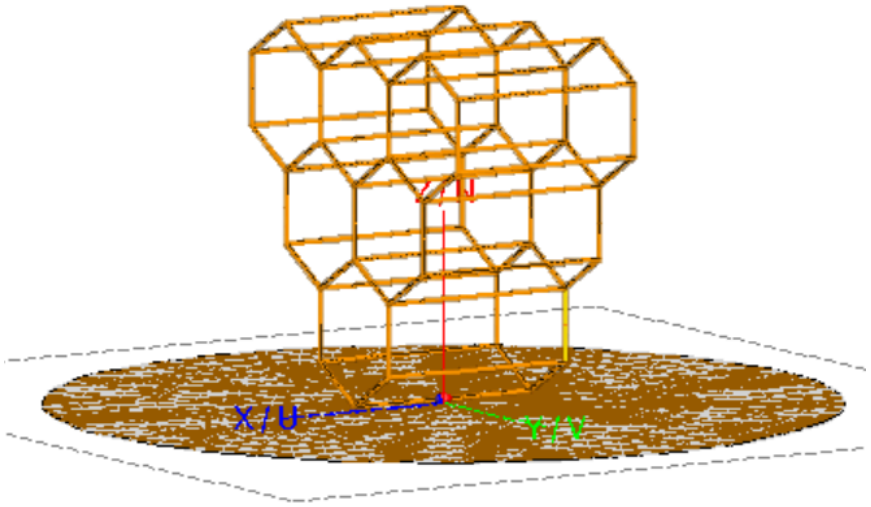


Figure 2: Lab test reflection vs. newest FEKO model (including the connector) scaled vertically for clarity

As a final lab experiment, we tested the radiation from our antenna with a small dipole antenna, and determined that our antenna's radiation was more vertically polarized (like we would expect from a monopole).

IV. Conclusion

In this project, we built a monopole antenna out of a wine rack and performed much experimentation in FEKO to compare models and simulations, learning a lot about how to use this tool. In lab tests our antenna acted as we expected, showing vertically polarized radiation and resonance at a higher frequency (~600 MHz) than for a simple thin-wire monopole of the same height. We were unable to determine why our results were so far off from our simulation, but we theorize that it may have been due to simulating our antenna as a PEC (despite being made of steel), and modeling the connector as a simplified coaxial transmission line.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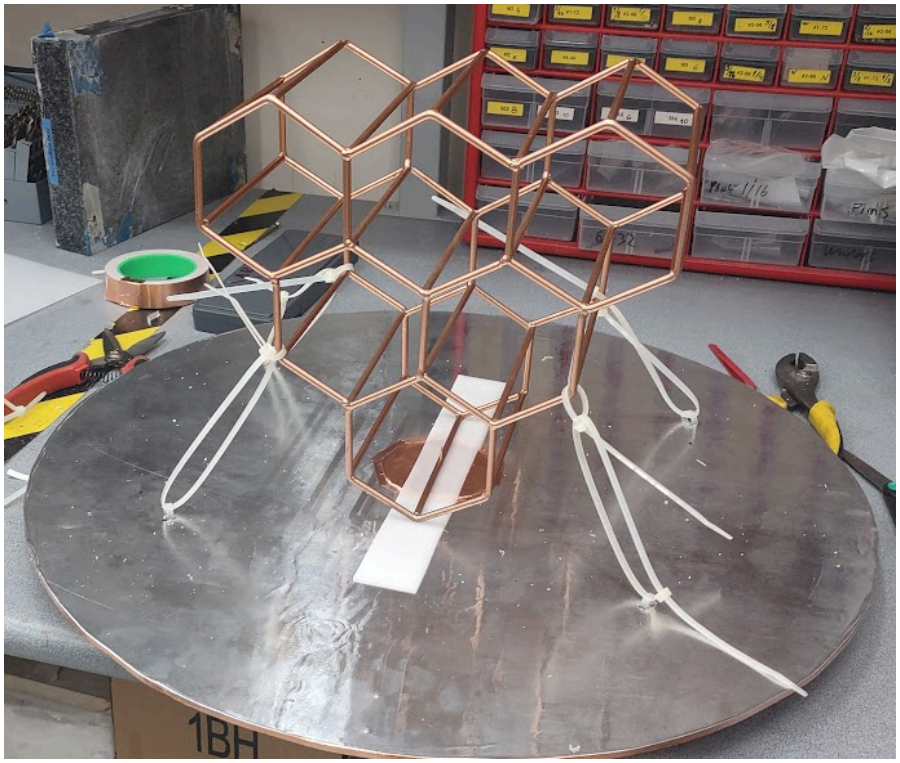
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