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Lab 9

Introduction/Background

This lab was meant to teach us about the design of a patch antenna. We were expected to calculate the dimensions of the patch, simulated it in HFSS, and then construct it using copper tape in the lab.

Design

In this lab we designed and built a patch antenna. In the actual lab portion, we made and edge fed patch antenna, whereas in HFSS we built a probe fed antenna. We designed the patch antenna using the following values:

- f = 3 Ghz
- εr = 4.1
- h = 1.5748 mm
- $Z\,0$= 50 ohm

We used these to find the following values:

- width = 31.3 mm
- εeff = 4.5128
- $\triangle L$ = 0.715 mm
- L = 22.1 mm

We then tweaked it to get the final product:

- width = 32.55 mm
- εeff = 4.488
- $\triangle L$ = 0.716 mm
- L = 23.85 mm
- $Probe\ location:$ 5.1195 mm from center (halfway between center and edge)

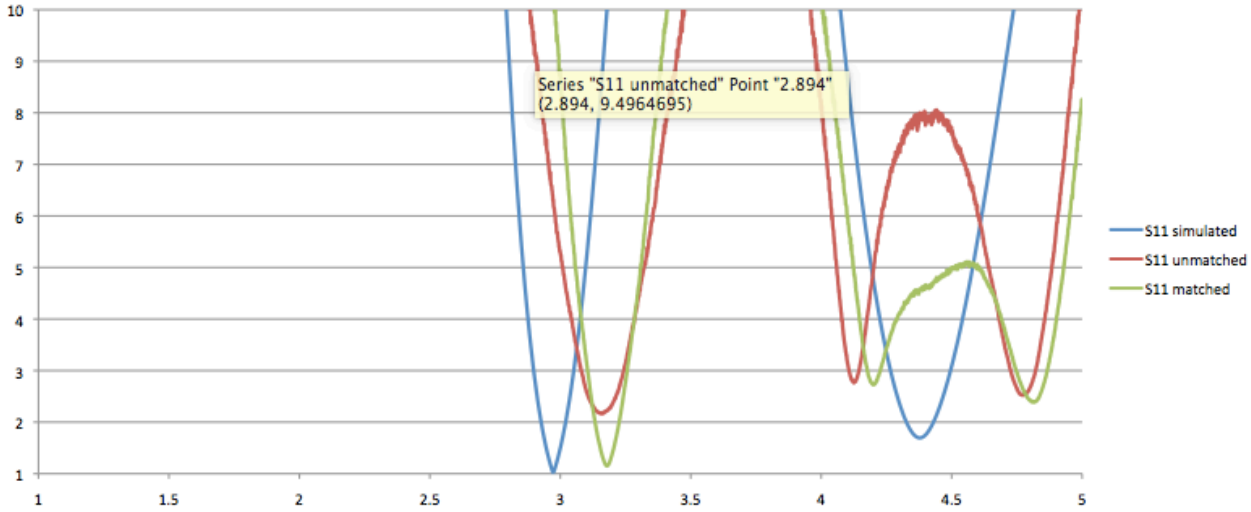
In Lab Procedure

In lab we built the general patch antenna with just a 50 ohm feed line out of copper tape and then had David test it with network analyzer to show the operating frequency and impedance of the antenna. David then told us to implement the single stub tuner using the smith chart to calculate the dimensions of the stub. We normalized our antenna's impedance with 50 ohms and plotted on the Smith chart. Then the point was rotated a quarter wavelength in order to match the network. To find the length, we rotated the point until we hit the VSWR = 1 circle. When David ran our circuit through the network analyzer again, we were able to see that the operating frequency was 3.066 GHz.

The first instantiation of the in lab patch antenna was a simple edge fed patch antenna (build to the original calculated length and width), with a 50 ohm feed line. David measured the performance of this unmatched antenna using the network analyzer. We then implemented a quarter wave transformer in copper tape. We found the position of the QWT by finding the impedance of our antenna, normalizing, performing smith chart operations.

Results and Discussion

Below is the graph of the HFSS data and our lab data of the patch antenna.



We can see from the graph above that our simulated and measured patch performed very well. The simulated antenna is nearly exactly at 3 GHz and 1 on the VSWR. The matched patch antenna is only slightly above 3 Ghz and is very near to 1 on the VSWR as well. One can see that by adding the tuner, we managed to bring the peak frequencies peak down much closer to 1 on the VSWR.

Conclusion

The main point of this lab was to show us the design process of building a patch antenna

Hindsight

I wish I had reviewed smith chart operations before the lab.

Reflection

The most challenging and the most rewarding part of this lab was continuously tweaking and re-simulating the HFSS design of the patch antenna until it was very nearly perfect. This helped me learn how different changes to the design could affect the performance of the design.