**My microstrip line patch antenna journey**

First I need to calculate the initial length and width of the patch and microstrip line since I am following this form of the Image shown below where the feed is a 50 ohm strip line (connected to an SMA connector via soldering) followed by the quarter wave strip line for matching the 50 ohm input to the impedance of the patch for maximum power transfer.

A diagram of a square with a cable

Description automatically generated

Initially from an online calculator using the equations for patch antenna modelling, I have:

A screenshot of a computer

Description automatically generated

A screenshot of a calculator

Description automatically generated

<https://www.emtalk.com/mpacalc.php?er=4.6&h=1.6&h_units_list=hmm&fr=2.45&Operation=Synthesize&La=&L_units_list=Lmm&Wa=&W_units_list=Wmm&Rin=>

https://www.emtalk.com/mscalc.php?er=4.6&h=1.6&h\_units\_list=hmm&f=2.45&Zo=50&EL=180&Operation=Synthesize&Wa=&W\_units\_list=Wmm&La=&L\_units\_list=Lmm

My initial implementation looks like:  
  
A drawing of a diagram

Description automatically generated

I aimed for 2.45 GHz frequency of operation but I have:

A graph with a red line

Description automatically generated

Which is at around 2.47 MHz but with optimization, I can make it get centred at exactly 2.45GHz. Next, I explore antenna arrays for enhancement of gain and directivity.

I came up with the same design in ADS where I have:

A graph of a graph

Description automatically generated with medium confidence  
  
A screenshot of a video game

Description automatically generated

A graph of a function

Description automatically generated with medium confidence

I would say my EM simulation in ADS was more accurate than what I got in HFSS. I experimented with having the quarter wave matching network come first and the results were still the same like:  
A screen shot of a computer

Description automatically generated

A graph of a function

Description automatically generated

2X1 Array

Next I try a 2x1 array in ADS where I start off with drawing out my plan, my plan shows the patch, transmission lines and the quarter-wave transmission lines. My drawing is:  
A diagram of a patch diagram

Description automatically generated

Just like before where is used the online calculator to calculate the dimensions of the transmission lines with the assumption of a 180 degree phase shift for since there will be no change in the impedance seen at either end of the transmission line (impedance repeating). When there is an impedance repeat there is no mismatch in impedance from one end to another since impedances will be mirrored from one end to another. I also do the calculations with the calculator for the quarter wave sections, In the end all this is to ensure that the feed of 50 ohms Is constant regardless.

My schematic implementation is:  
  
A computer screen shot of a diagram

Description automatically generated

The layout is:  
  
A screen shot of a computer

Description automatically generated

I have the results:  
  
A graph of a function

Description automatically generated

2x2 Array

Next with my same concepts I expand into a 2x2 array, again I ensure it all matches to a 50 ohms input feed. I have the following schematic design:

A diagram of a train

Description automatically generated

I have the layout of:  
A diagram of a network

Description automatically generated with medium confidence

Mind you I made the 100 ohm transmission lines at the very bottom dispersion to be longer (full lambda or 360 degrees) so that the 2nd and 3rd patches don’t touch each other. I have the results of:  
  
