<u>4-Element Microstrip Patch Linear Antenna Array</u>

<u>Preliminary Report</u>

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ELG 4118 – Wave Propagation and Antennas

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Disclaimer

As this preliminary report is not for marks and an outline has been not been specified in the lab manual, we (Nick really) don't really care about this. Furthermore, we (Nick really) don't think this is worth the time it takes to read. Things seem to be going well other than AWR sucking and not working reliably. To the point that it doesn't give the same behavior from one day to the next. No idea why. That being said, the PCB has been fabricated by Jean-Noel and it looks acceptable. Now on to the testing.

Before you say it, yes the final report will be better and we will put thought into it.

Introduction

The main objective of this project is to design a microstrip patch antenna with a given center frequency using the AWR application. This paper demonstrates the design of an array of four by one (4x1) patch array microstrip antenna, with a microstrip line feeding based on quarter wave impedance matching techniques. For this particular project, the center frequency is given to operate at 5 GHz. The 4x1 patch array antenna was then fabricated on the substrate type RT/Duroid 5880 with a dielectric constant of 2.2 and thickness of 1.574mm. This antenna offers a return loss of [-7.774] db. Most notably, through simulation study using AWR, the 4x1 patch array antenna outperforms the single patch antenna in terms of radiation gain, directivity, and bandwidth.

Hardware & Software

aaa

Design, Selection, & Refinement

For the design of this microstrip antenna, the substrate considered was the RT/Duroid 5880 with its low loss tangent (which will not reduce antenna efficiency) and its relatively low dielectric constant of 2.2. In order to build the array antenna, a single patch antenna was considered first. Table 1 below shows the known specifications of the patch antenna.

Table 1: Specifications

Center Frequency	Substrate	Dielectric Constant	Dialectic Thickness	Loss Tangent	Copper Thickness
5Ghz	RT/Duroid 5880	2.2	1.574mm	0.0009	0.035mm

From there, the design of a single microstrip patch antenna is done using a patch, quarter-wave transformer, and feedline. To find the initial Width and Length of the patch, the following code was used:

```
f = 5*1e9; %input frequency in Hz
Er = 2.2; %input dielectric constant of the substrate
h = 1.754/1000; %input height of substrate in m
c = 3e8; % speed of light


%  Width and Length of the Patch
W = ( c / ( 2 * f ) ) * ( ( 2 / ( Er + 1 ) )^0.5); %Patch Width
Er_eff = (Er+1)/2 + (( Er -1 )/2)*(1/(sqrt(1+(12*(h/W)))));
L_eff = c/(2*f*sqrt(Er_eff));
a1 = ( Er_eff + 0.3 ) * ( ( W / h ) + 0.264 );
a2 = ( Er_eff - 0.258 ) * ( ( W / h ) + 0.8 );
delta_L = (0.412 * ( a1 / a2 )) * h; %Patch Length
L = L_eff - 2*delta_L;


str=['Patch Width = ', num2str(W*1000), ' mm']
str=['Patch Length = ', num2str(L*1000), ' mm']


% Input impedance of the patch
Zo = 90 * Er^2*(L/W)^2/(Er-1);
str=['Input Impedance=', num2str(Zo), ' ohms']
```

From here, it was obtained that the ideal Width and Length is 23.7mm and 19.2mm respectively, and that the input impedance is approximately 237.7Ω. These values are used as a base to then match the input impedance at the line to the antenna patch. Quarter-wave impedance transformers were used to achieve this:

A matching network was created with the patches to design for the appropriate input impedance of 50 Ω and a low return loss. The following is the diagram of the antenna network and patches.

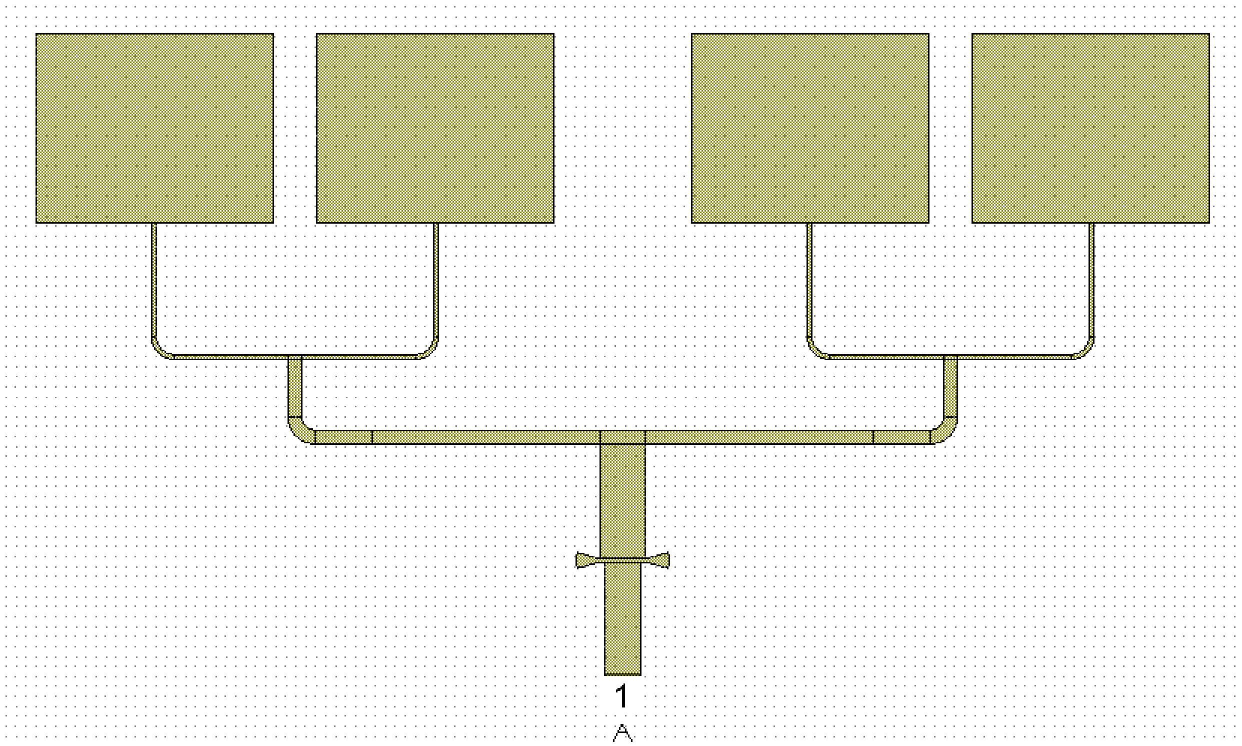

Figure 1: Antenna Schematic Diagram

The stub seen near the port of the device is designed to reduce the reactive impedance of the antenna.

From this structure we obtain the input impedance and the return loss of the antenna at the port

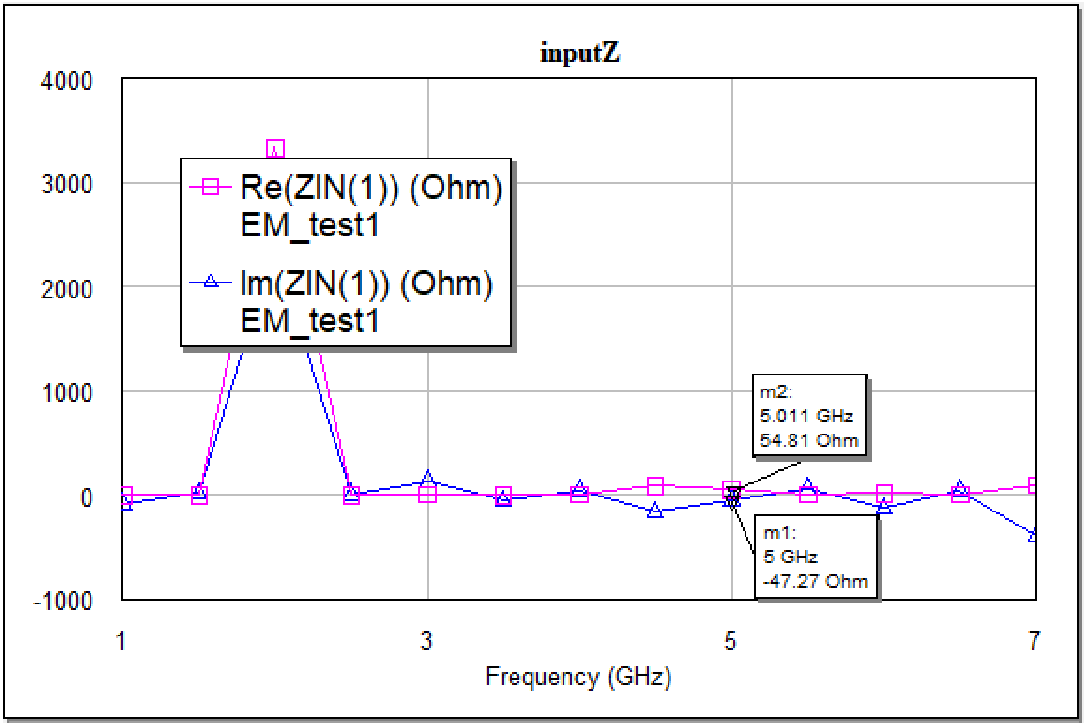

Figure 2: Input Impedance of Array Antenna

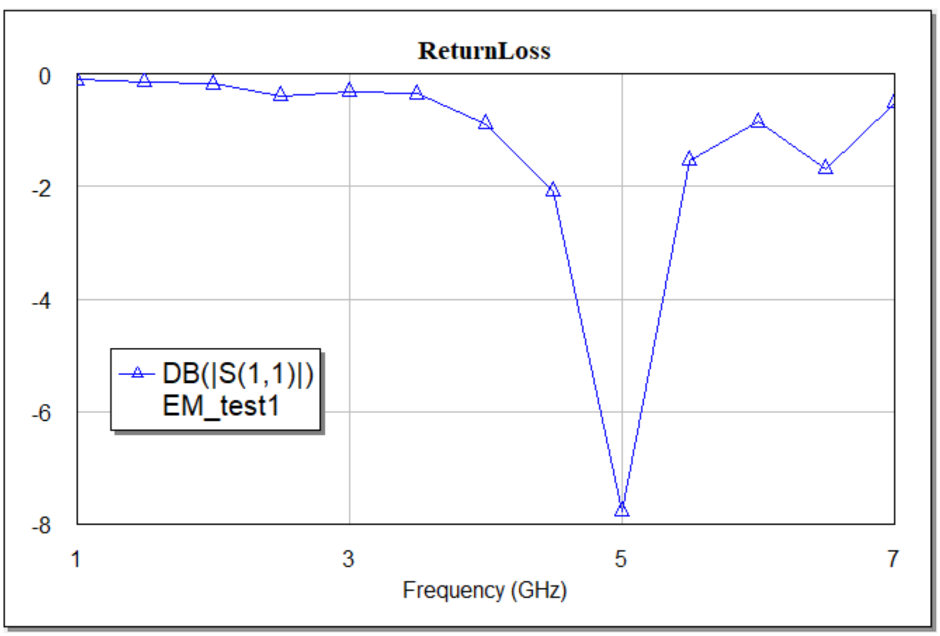

Figure 3: Return Loss of Array Antenna

The spacing of the microstrip patch antennas in the array determine the radiation pattern which can be simulated in the AWR Microwave Office environment to produce the following figures.

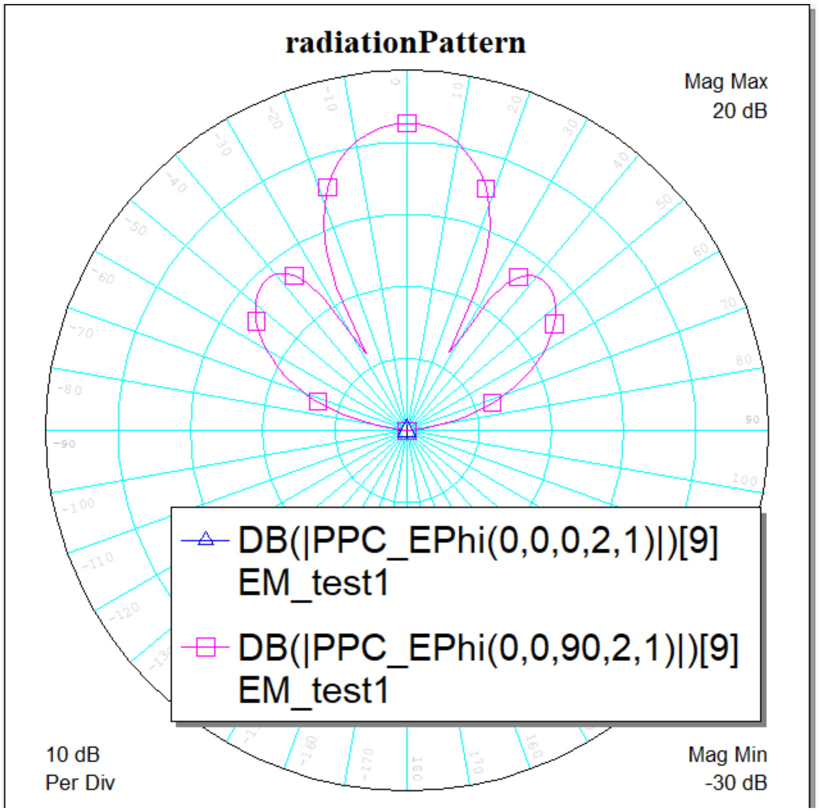

Figure 4: Circular Plot of Array Antenna Simulated Radiation Pattern

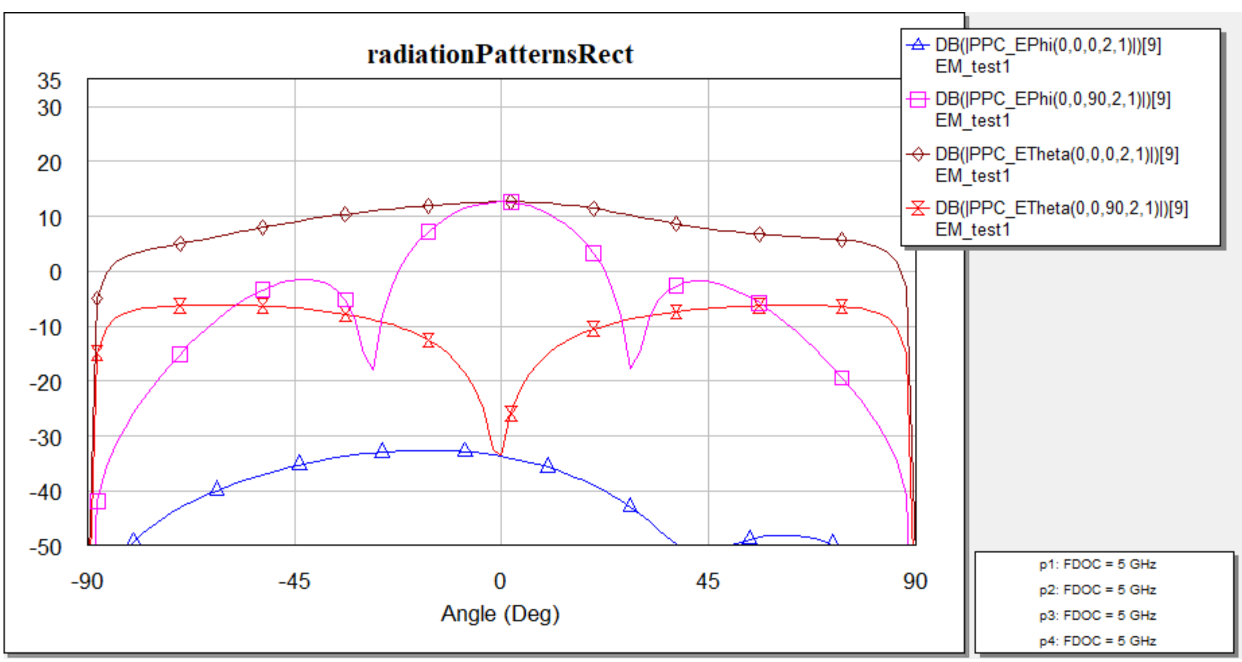

Figure 5: Rectangular Plot of Array Antenna Simulated Radiation Pattern