Engineering ElectroMagnetism
Experiment- 8

Simulation of 2 element patch antenna array using HFSS.

Submitted to: Prof. Ashwani Sharma

Submitted BY:

Group No.-11

Parth Joshi-2018eeb1170

Preetesh Verma-2018eeb1171

Puneet Bansal-2018eeb1172

Ritesh Chaudhari -2018eeb1174

Aim:

To simulate, and analyse a 2 x 1 circular patch antenna.

Components and software used:

HFSS.

Theory and formulas:

A patch antenna is a type of antenna that is designed so that it can be mounted on a large sheet of metal(acting as ground). Generally, these antennas are designed to work at low bandwidth of about 3%.

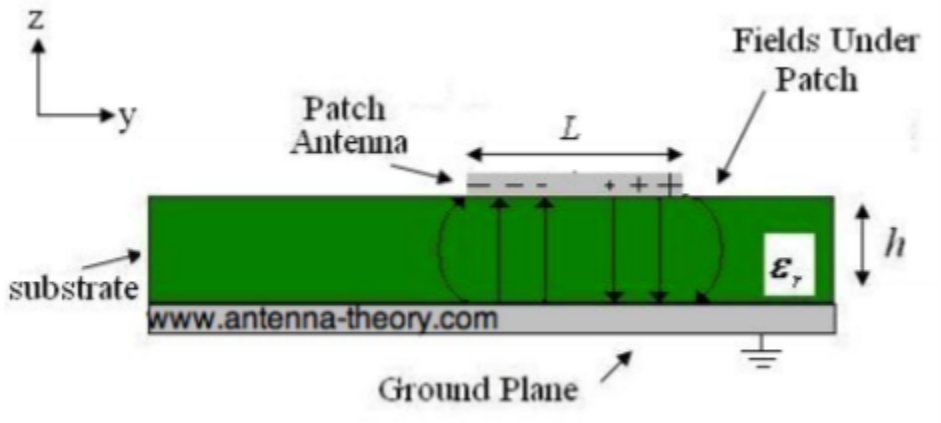
Also due to the **fringing field effect,** often the resonant frequency is less than what is expected.

Current distribution:

1. At ends the current is minimum
2. In the centre the current is maximum.

Voltage distribution:

1. In the end, it is max
2. At the centre it is minimum



In our diagram, we will have all the fringing fields in the +y direction. Hence in the end all the fields add up to produce radiations. Also, patch antenna is:-**voltage radiator** and wire antennas are:- **current radiators.**

Relationships between various parameters of patch antenna:-

1. Lower permittivity implies wider fringes and vice versa,
2. Permittivity is also inversely proportional to antennas bandwidth,
3. Also, impedance is maximum at ends and minimum at the centre.

Formulas used:

1. Here '*h' is in cm, interelement distance is between lambda/2 and lambda*

$$a = \frac{F}{\{1 + \frac{2h}{\pi\varepsilon F}\left[ln(\frac{\pi F}{2h}) + 1.7726\right]\}^{\frac{1}{2}}}$$

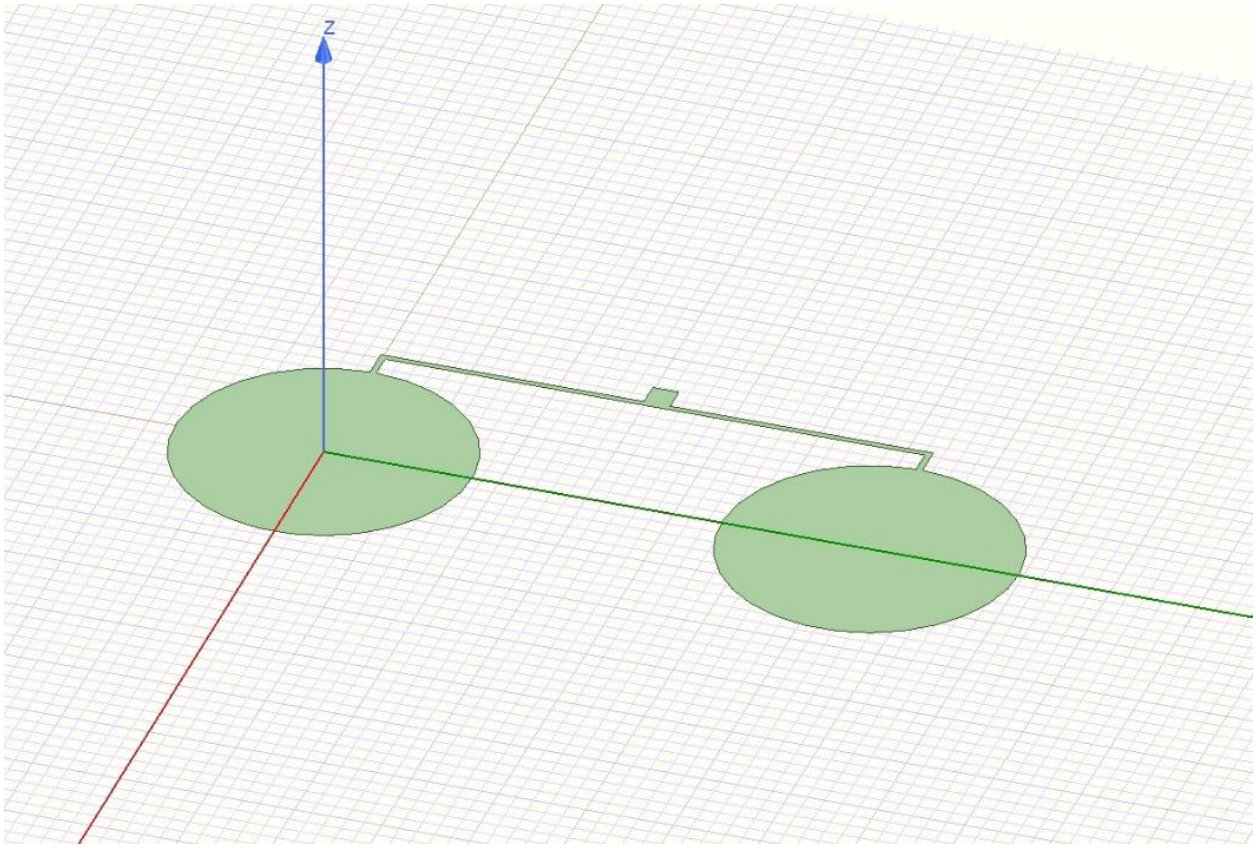
Where, $$F = \frac{8.791\times10^{9}}{f_r\sqrt{\varepsilon}}$$

2. Here BW=bandwidth.

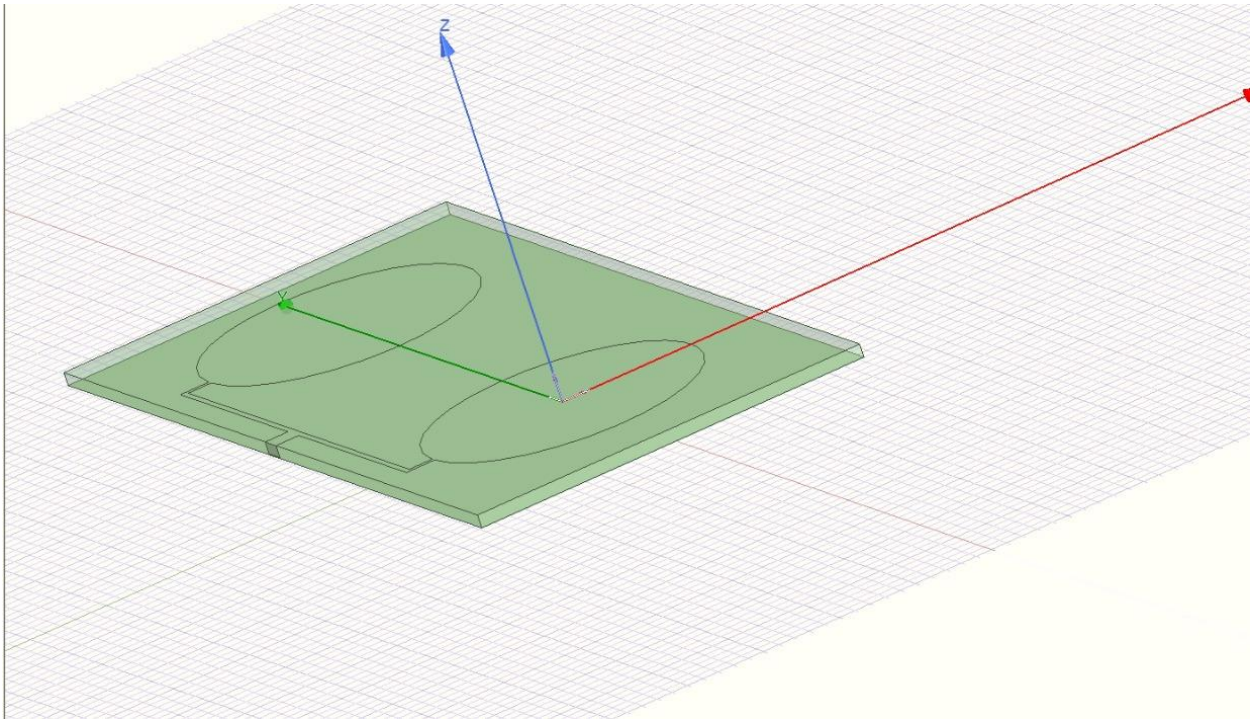
$$BW = \frac{16}{3\sqrt{2}}\left[\frac{\varepsilon_r - 1}{(\varepsilon_r)^2}\right]\frac{h}{\lambda_o}(\frac{W}{L}) = 3.771\left[\frac{\varepsilon_r - 1}{(\varepsilon_r)^2}\right]\frac{h}{\lambda_o}(\frac{W}{L})$$

Observations:

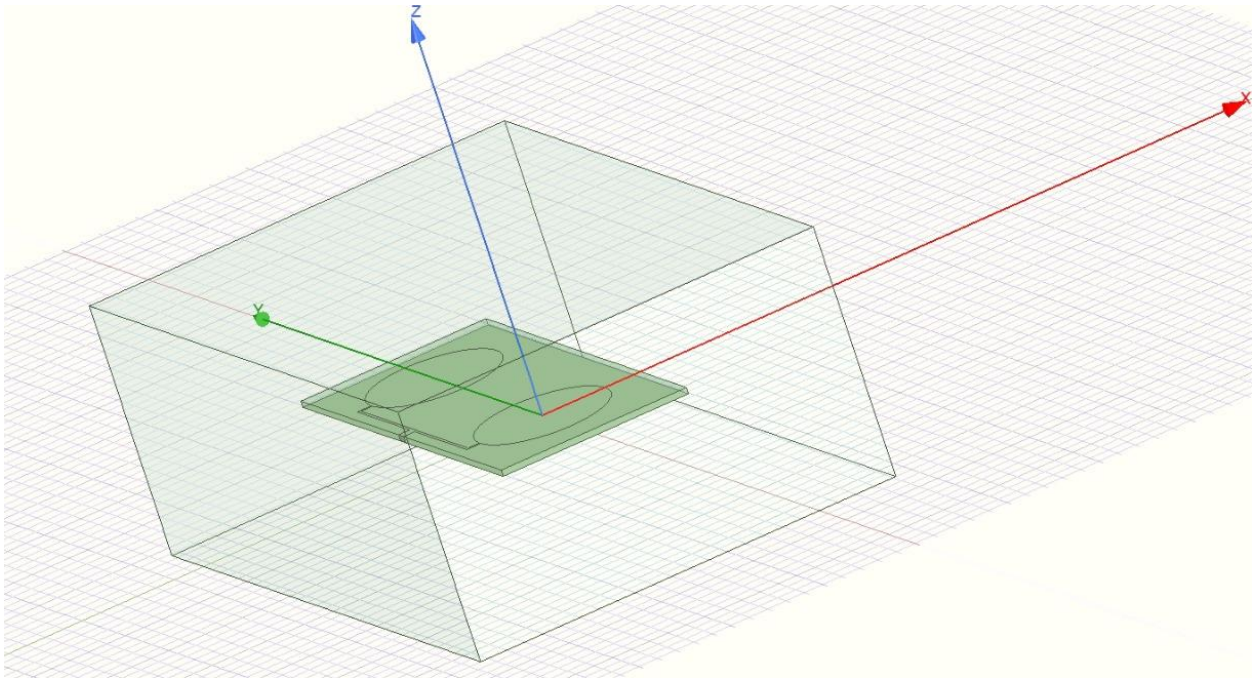
1. The initial diagram when both circles are created and joined.



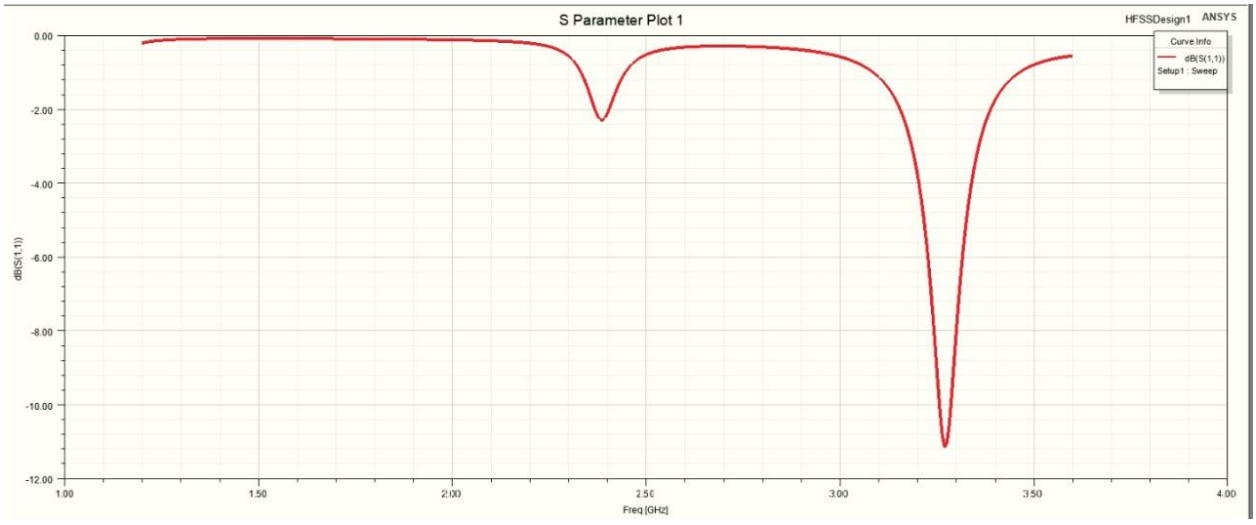
2. Now we add a ground to our design



3. Now we define radiation boundary for our design



4. S parameters

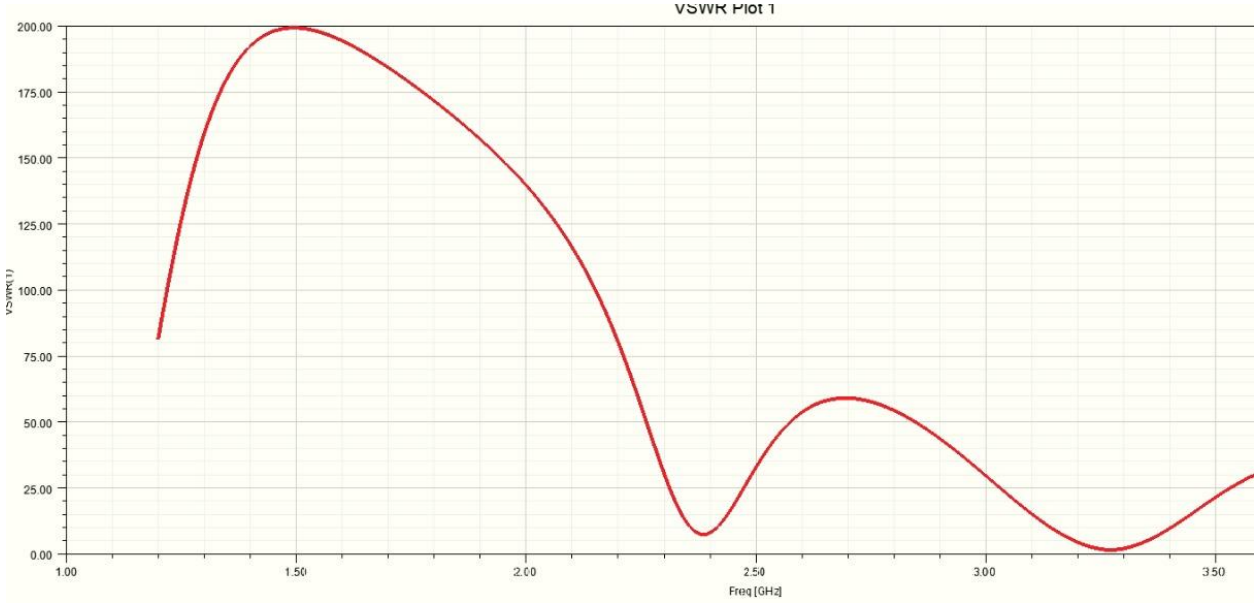


We get the following values of S parameters at 2 minimas:-

1. At 2.4GHz -2.4dB
2. At 3.25GHz -11.5dB

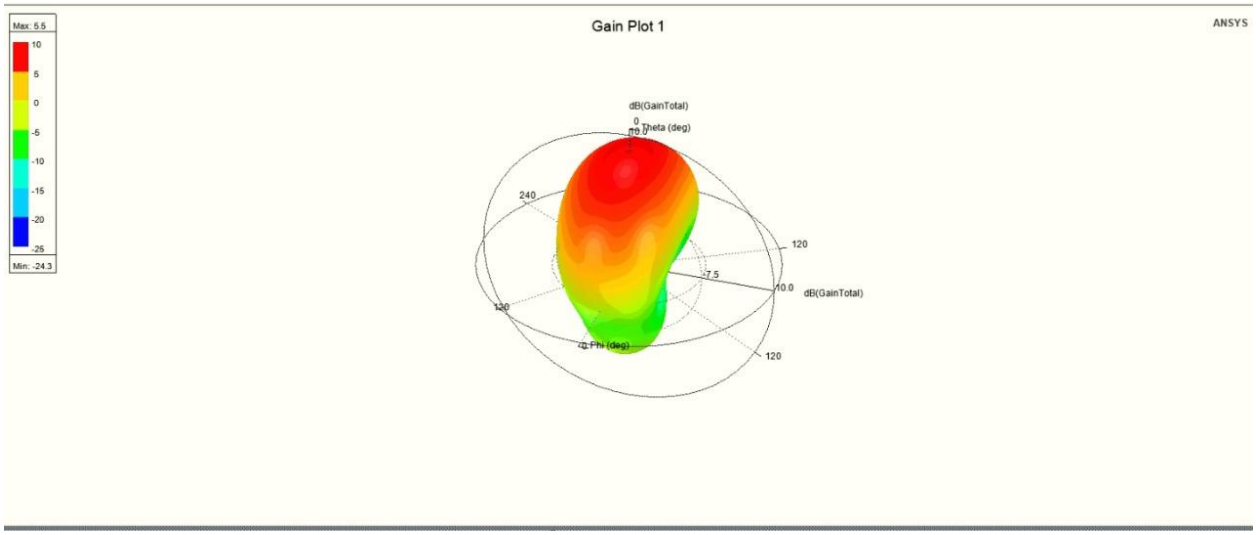
All the values below -10dB symbolise good design. Also, we can see very little bandwidth of this antenna(steep rise from minima on both sides).

5. VSWR plot



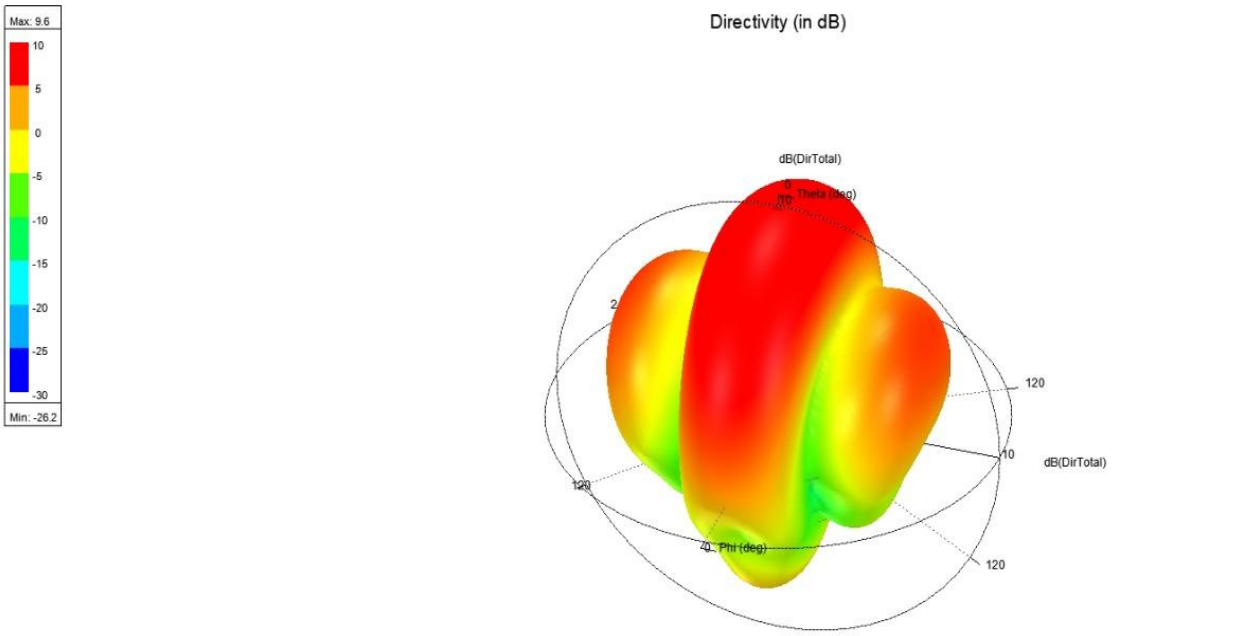
We can see in the above plot that VSWR is minima at around 3.25GHz this shows that at this frequency there is very little reflection.

6. Radiation diagram



The above gain plot represents that the output power is radiated most in the direction shown in the reddish direction(upwards).

7. directivity



This directivity plot shows us that there are lobs extended in particular directions that shows that **our antenna is directional** in nature.

Results:

We have successfully implemented a 2 x 1 patch antenna in HFSS. We were also able to observe various characteristics of this antenna.