Waveguides and Antenna

3rd year - Semester - 5th

Microstrip Patch Antenna For Satellite Communication

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Microstrip Patch Antenna for Satellite Communication

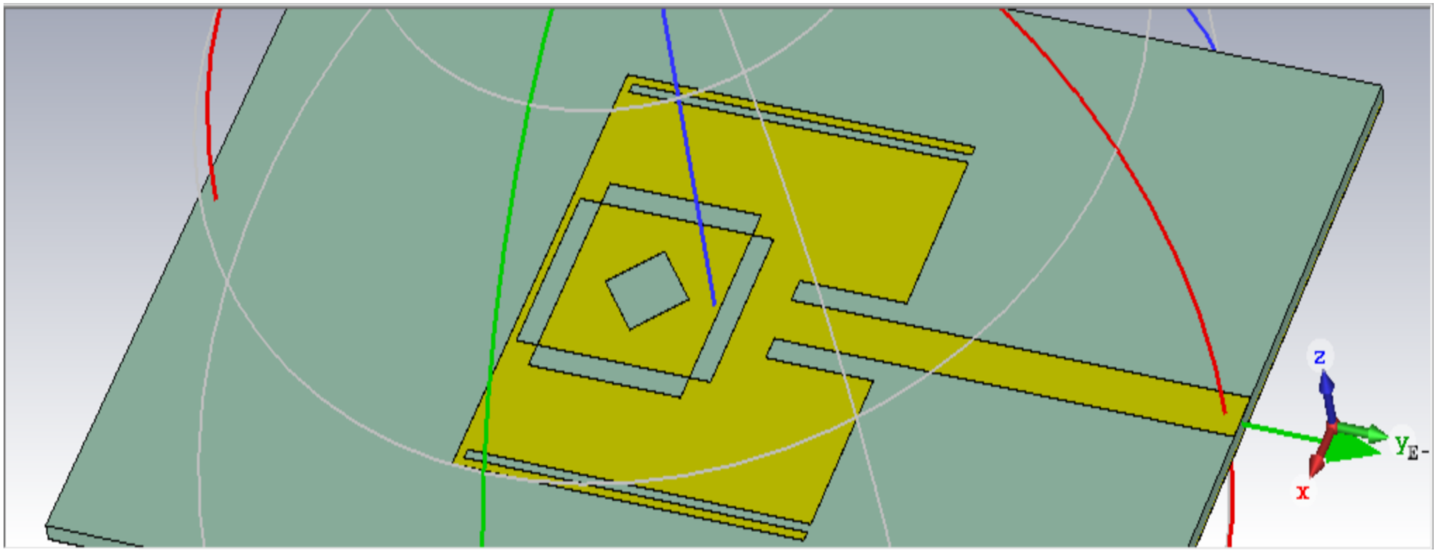
Overview

Microstrip antennas were developed four decades ago and the demand for their application is continuously on the rise, especially in the last decade. The growth of this technology has boosted with the rapid rise of wireless communication technologies. They have found huge applications in the domains of defense and satellite communication. During the last decade, the cost to develop and manufacture the microstrip antenna has reduced significantly, because of the huge advancement of its technology and increasing investment in this sector commercially. Moreover, the current satellite communication applications are benefited hugely by the small size and low profile of the microstrip antenna. These antennas are also considered to have relatively high value of return losses. Research shows that cutting slots and slits in radiating patch and ground plane shift the operating frequency and increase resonating frequencies. Most of the antennas that were proposed before had narrow slots etched on the ground place. The slots leak electromagnetic waves which deteriorate the radiation patterns of the antenna.

On similar lines this paper proposes an antenna for satellite communication using equally spaced slots and slits. A small-size rectangular patch antenna is made using a square slot surrounded by rectangular slots. Rectangular Polarization is achieved without the need of external coupler or polarizer. X band in communication engineering is defined from 7 to 11.2 GHz and the antenna's optimum working range lies within this range.

Geometry and Parameter List

The proposed antenna design is illustrated in Fig It is printed on FR-4 substrate having relative permittivity of 4.4, loss tangent of 0.021 and thickness of h=1.6 mm. It consists of an inset microstrip-fed rectangular patch antennas based on the port through which the input is given has an input impedance of 50. The rectangular patch has two slits cut from its sides. The dimensions of the microstrip patch and the substrate are shown in below Table.



The Below shown parameters are the observed-on basis of final analysis -

Parameter List

Name	Expression	Value	Description
L	= 123.39	123.39	length
B	= 83.6	83.6	breadth
k	= 50.708	50.708	patch strip size
a	= 49.41	49.41	patch length
b1	= 41.36	41.36	patch width
c	= 40.36	40.36	side cut height
hg	= 35*10^(-3)	0.035	ground thickness
hp	= 35*10^(-3)	0.035	patch thickness
e	= 18	18	middle rect cut length
j	= 17.853	17.853	dist btw side cut and patc...
i1	= 12.633	12.633	cut near patch strip
g	= 7	7	dimension of square cut
x	= 4.852	4.852	width of patch strip
f	= 2.5	2.5	middle rect cut width
n	= 2.426	2.426	cut width near patch strip
h	= 1.6	1.6	suc=bstrate thickness
d1	= 1	1	side cut margin distance
m	= 1	1	side cut width

Analysis and Results

The rectangular patch antenna has been analyzed with HFSS. Fig shows the return loss curve properties of the antenna, with varying slots. From the figure it is clear that the addition of slots to the antenna design improved the performance of the antenna. The antenna is specified to work in X band for satellite communication. Two slits have been cut from the sides to ensure enhanced directivity and gain. Rectangular slots are designed on the patch to improve performance.

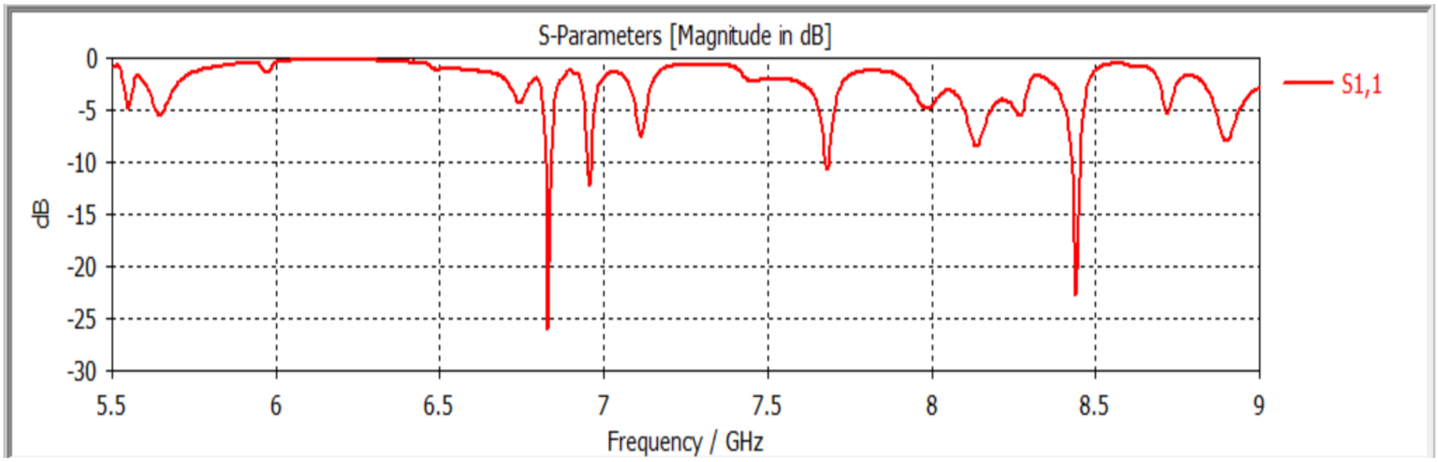
Analysis – 1

In the first Analysis we have the cut the side rectangular nano strip for rectangular polarization, here we give a margin from the outer layer is about 5 mm in length and cut the square and rectangular part in between the patch.

Then we set the far field values in the field monitor let's assume a frequency between 7.11 and 8.22 that is assume 7.61 GHz.

Now Simulate for the above parameters and check the results.

S- Parameters value -

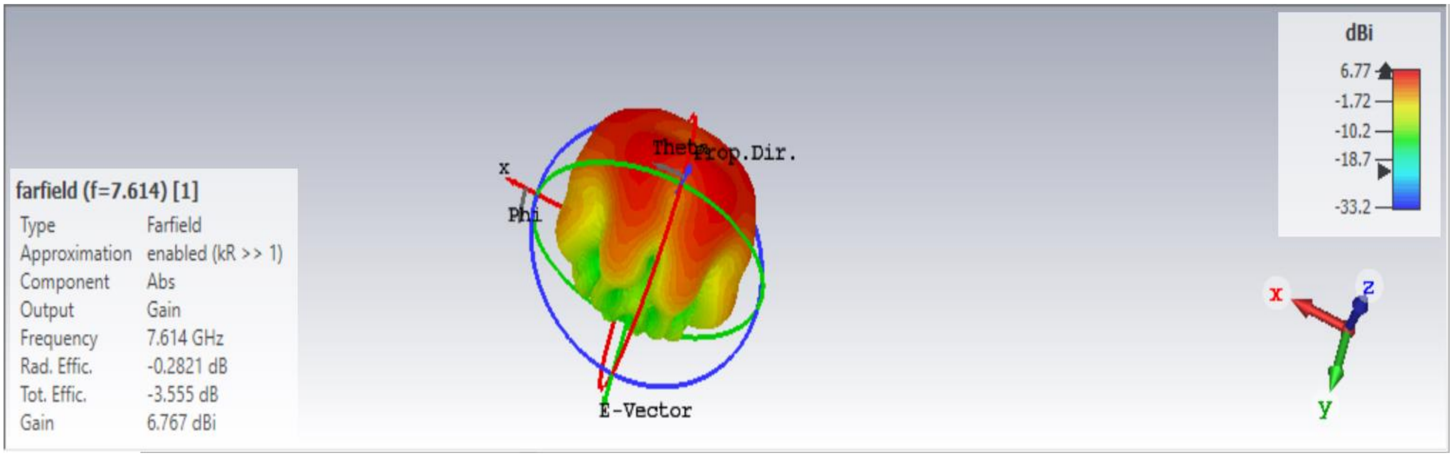


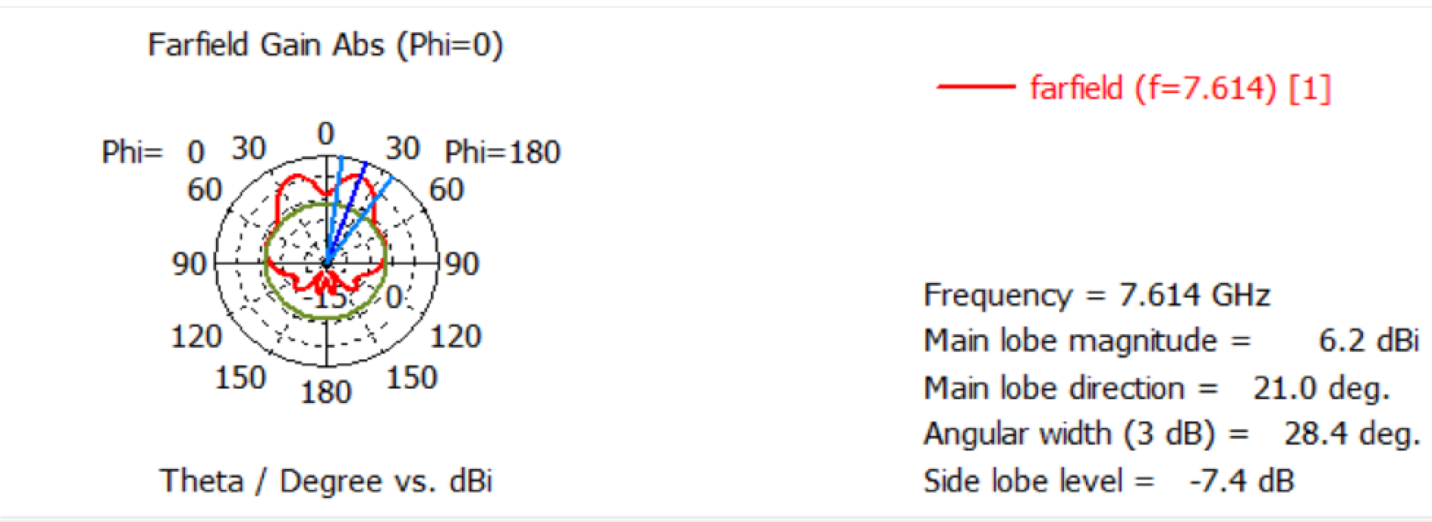
Using the far field results we can check the Gain value on our desired frequency which is show below.

On observing we can see that the gain at frequency 7.614 GHz is about 6.76 db.

The minimum value is at the frequency 6.77 GHz.

Farfield results -





In above Results we can clearly see the required results on the basis of what the far field we set using field monitor.

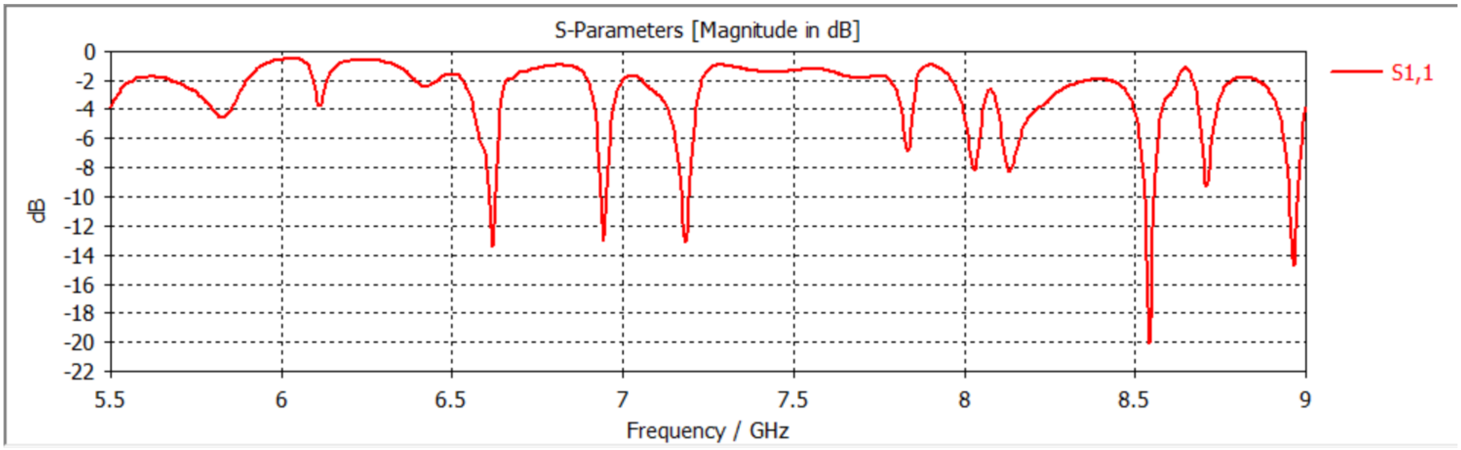
Analysis – 2

In the Second Analysis we have increased the size of rectangular slots in between the patch design we set the size is up to 3 mm in width. This width is increasing in all the for rectangular slots in patch.

Then we set the far field values in the field monitor let's assume a frequency between 7.11 and 8.22 that is assume 7.61 GHz.

Now Simulate for the above parameters and check the results.

S- Parameters value -

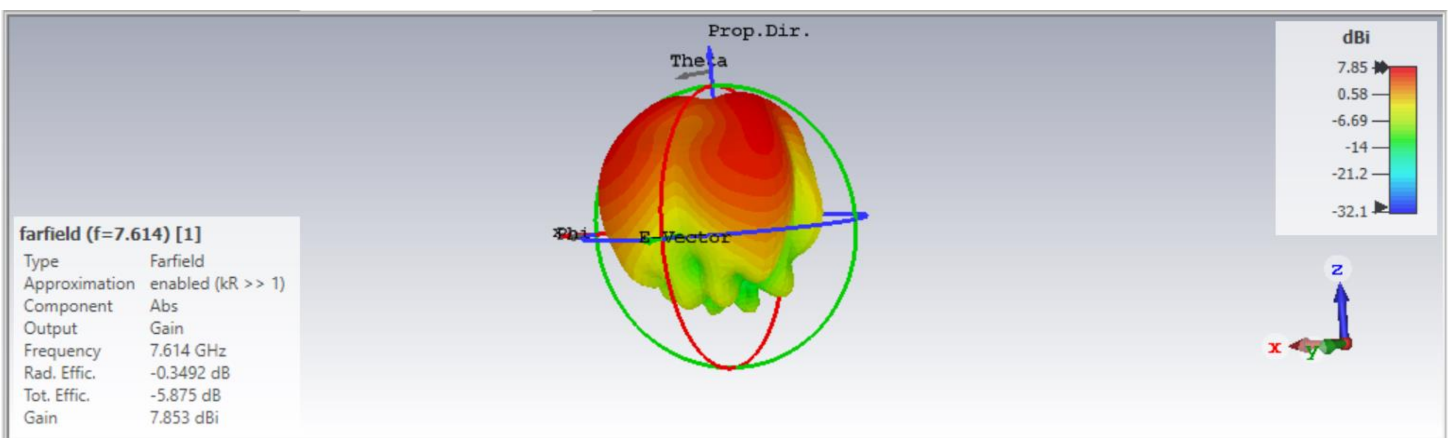


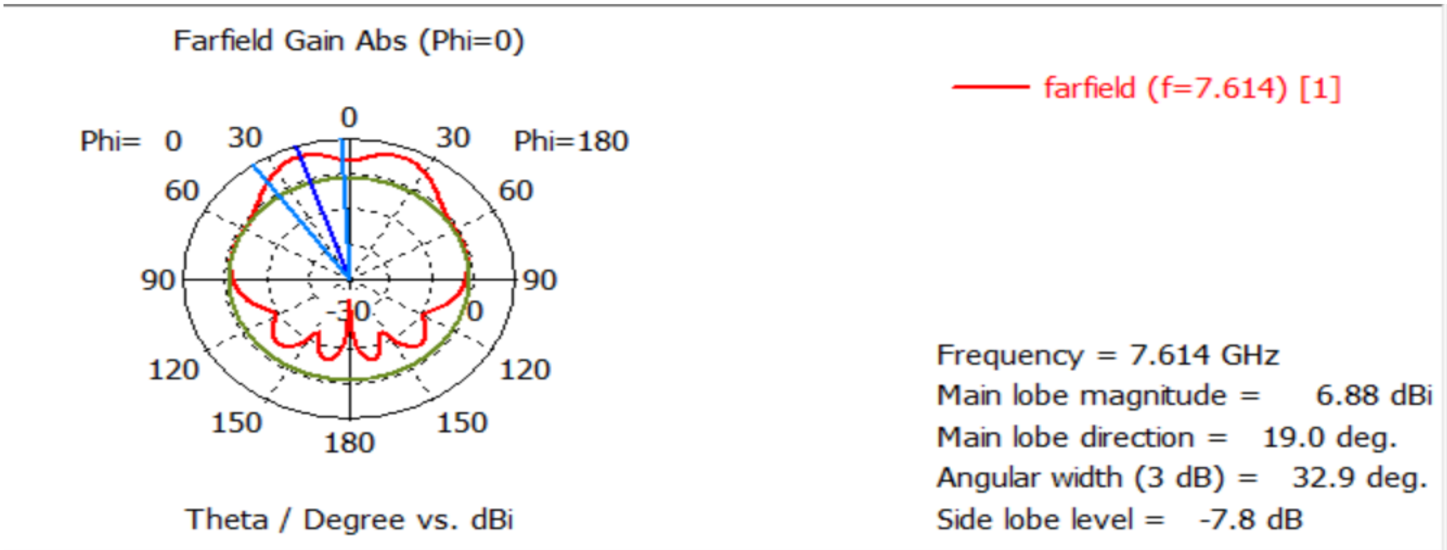
Using the far field results we can check the Gain value on our desired frequency which is show below.

On observing we can see that the gain at frequency 7.614 GHz is increases and it becomes about 7.853 db.

The minimum value is at the frequency also shifts and it found at the value 8.6 GHz.

Far Field Results -





In above Results we can clearly see the required results on the basis of what the far field we set using field monitor.

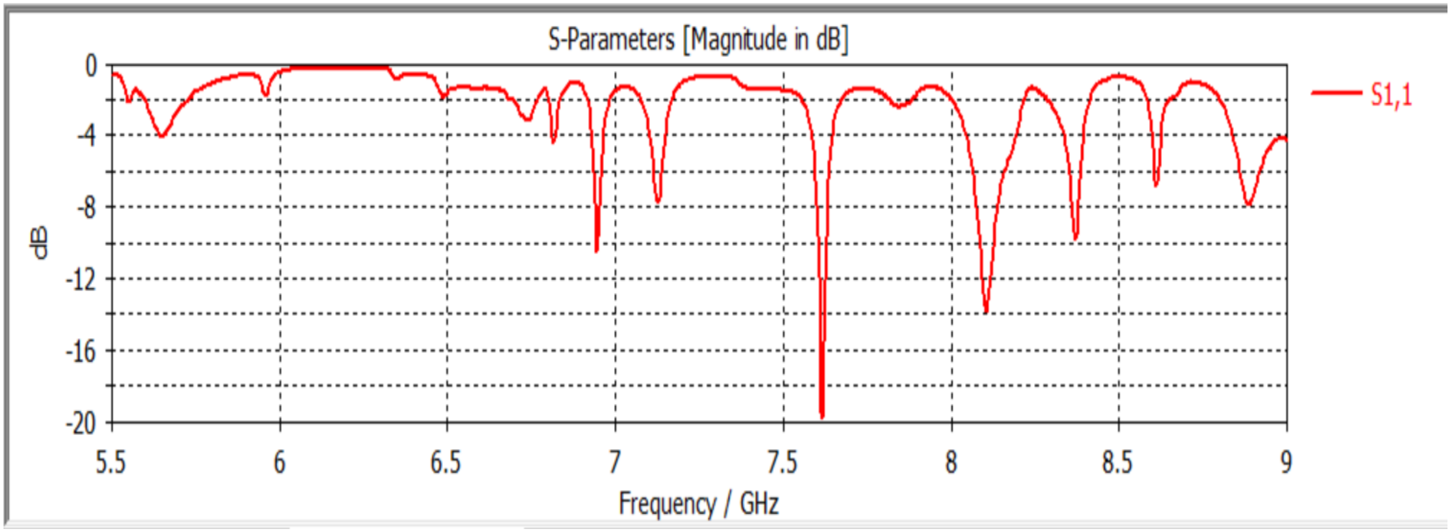
Analysis – 3

In the Third Analysis we want to create circular polarization so we have to make the diagonal of the patch design curvy to create circular polarization. We pick edge and blend the curves and takes a radius about of 1mm. Now we can result on the basis of this design.

Then we set the far field values in the field monitor let's assume a frequency between 7.11 and 8.22 that is assume 7.61 GHz.

Now Simulate for the above parameters and check the results.

S- Parameters value -

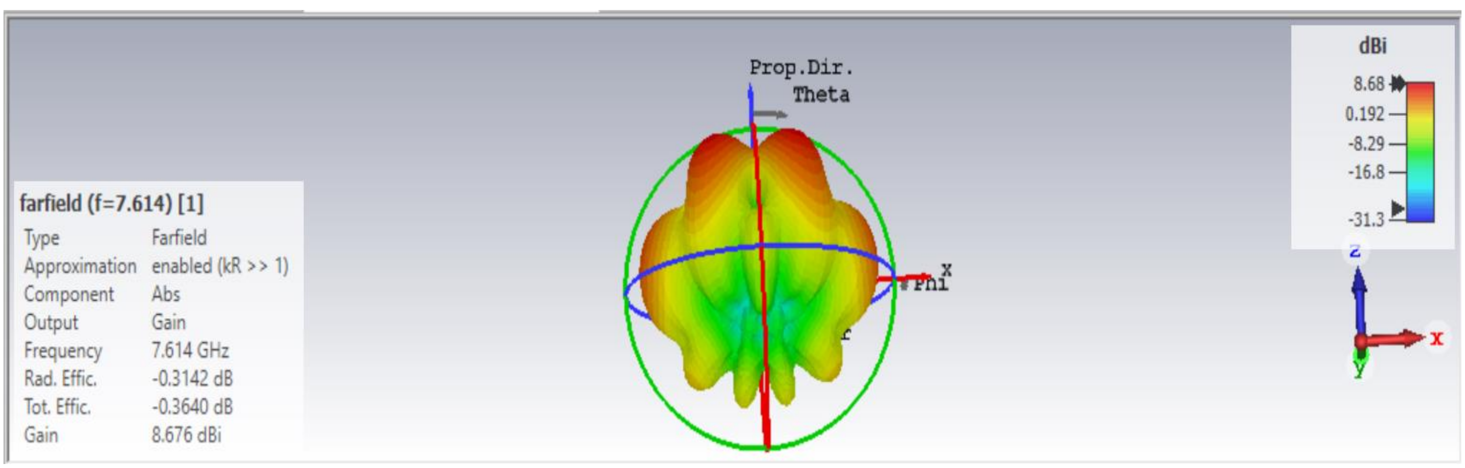


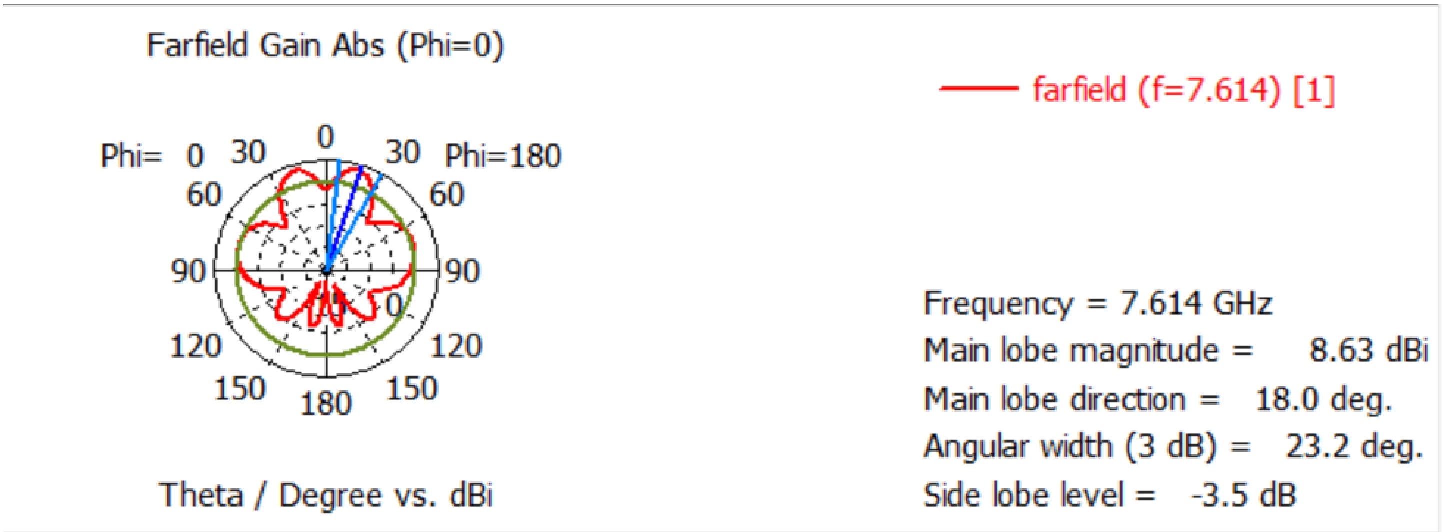
Using the far field results we can check the Gain value on our desired frequency which is show below.

On observing we can see that the gain at frequency 7.614 GHz is increases and it becomes about 8.76 db.

The minimum value is at the frequency also shifts and it found at the value 7.63 GHz. and one more band we found at the frequency 8.18 GHz whose value is about –14 db.

Far Field Results -





In above Results we can clearly see the required results on the basis of what the far field we set using field monitor.

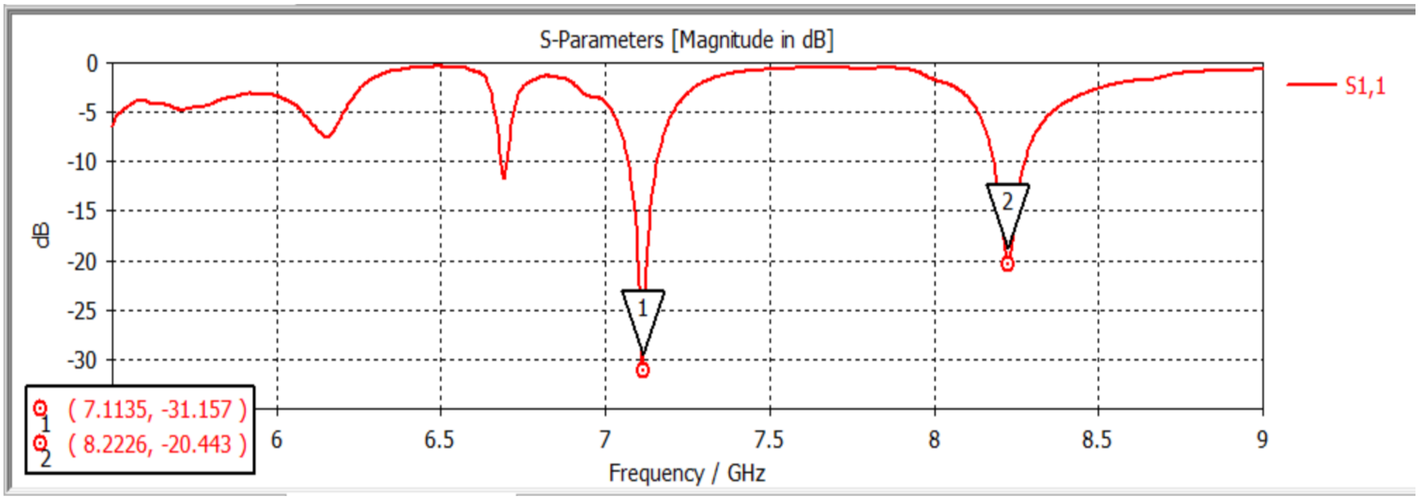
Analysis – 4 (Final Results)

In the Third Analysis we remove circular polarization and make edge of both diagonal as sharp pin. Now we created two side strips to create rectangular polarization but that not gave the desired result so we decrease the margin distance from sides and make it 1 mm from 5 mm now we check results.

Then we set the far field values in the field monitor let's assume a frequency between 7.11 and 8.22 that is assume 7.61 GHz.

Now Simulate for the above parameters and check the results.

S- Parameters value -



Using the far field results we can check the Gain value on our desired frequency which is show below.

We can clearly see the two dips are found in s parameter that are for transmitter end and for the receiver end. One at the frequency 7.1135 whose value is about –31.157 dB this is minimum value and other one is at 8.226 whose value is about –20.443 db.

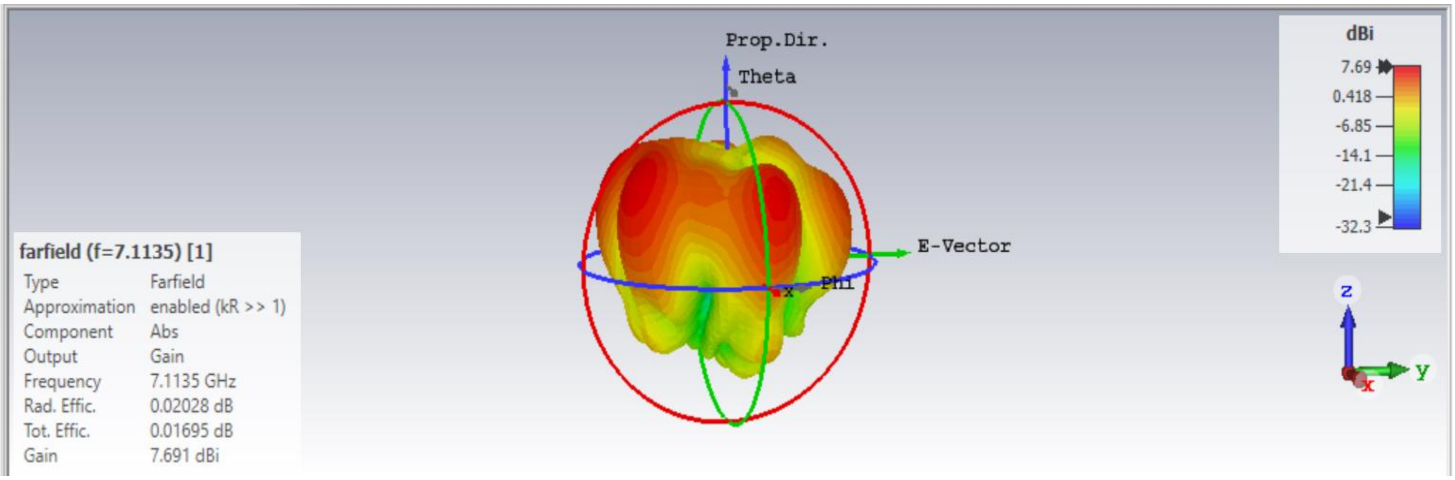
On observing we can see that the gain at frequency 7.1135 GHz is increases and it becomes about 7.69 db.

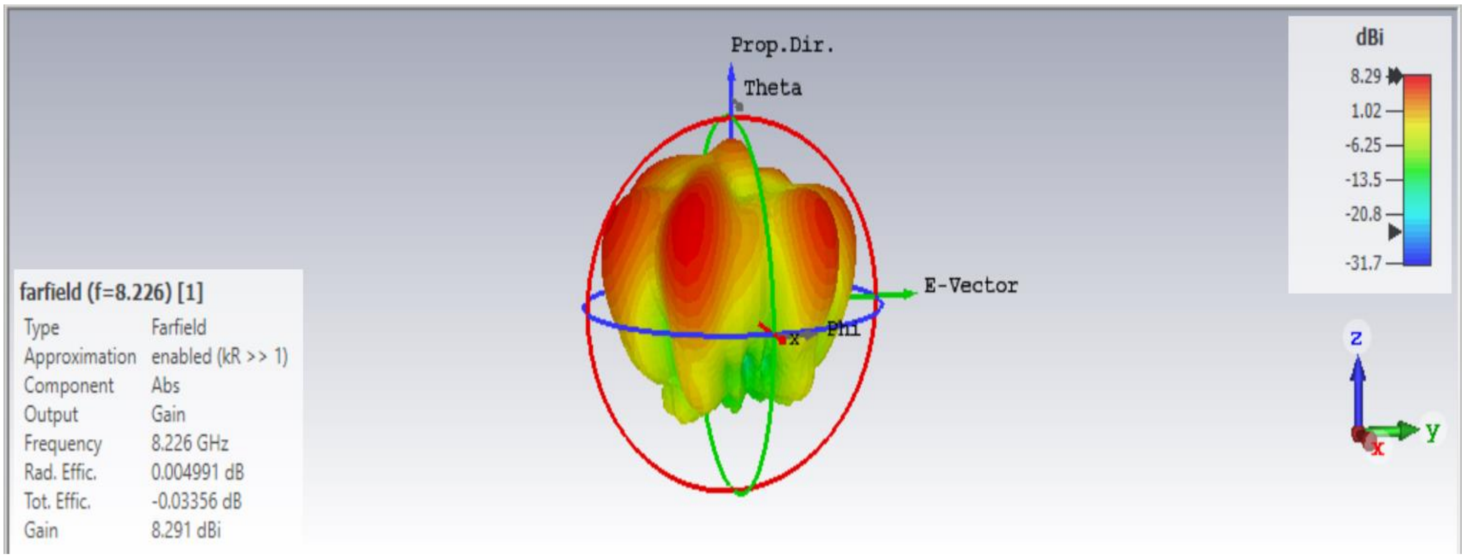
On observing we can see that the gain at frequency 8.226 GHz is increases and it becomes about 8.29 db.

On observing we can see that the gain at frequency 7.614 GHz is increases and it becomes about 7 db.

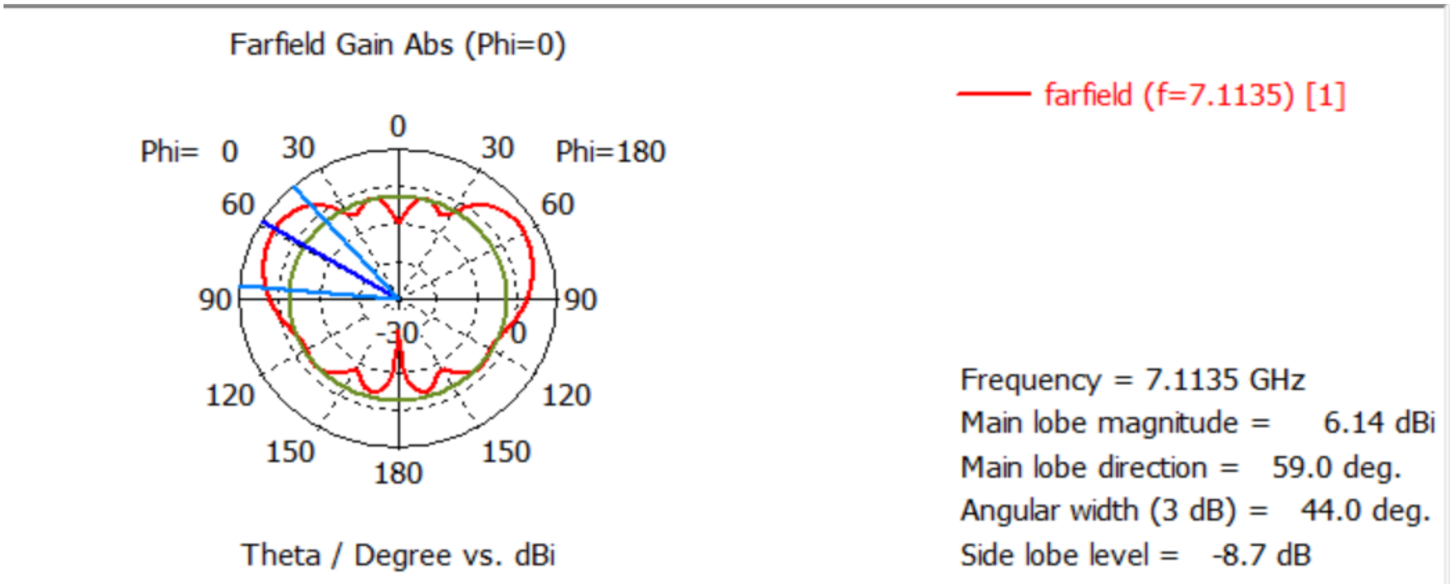
The minimum value is at the frequency also shifts and it found at the value 7.63 GHz. and one more band we found at the frequency 8.18 GHz whose value is about –14 db.

Far Field Results -

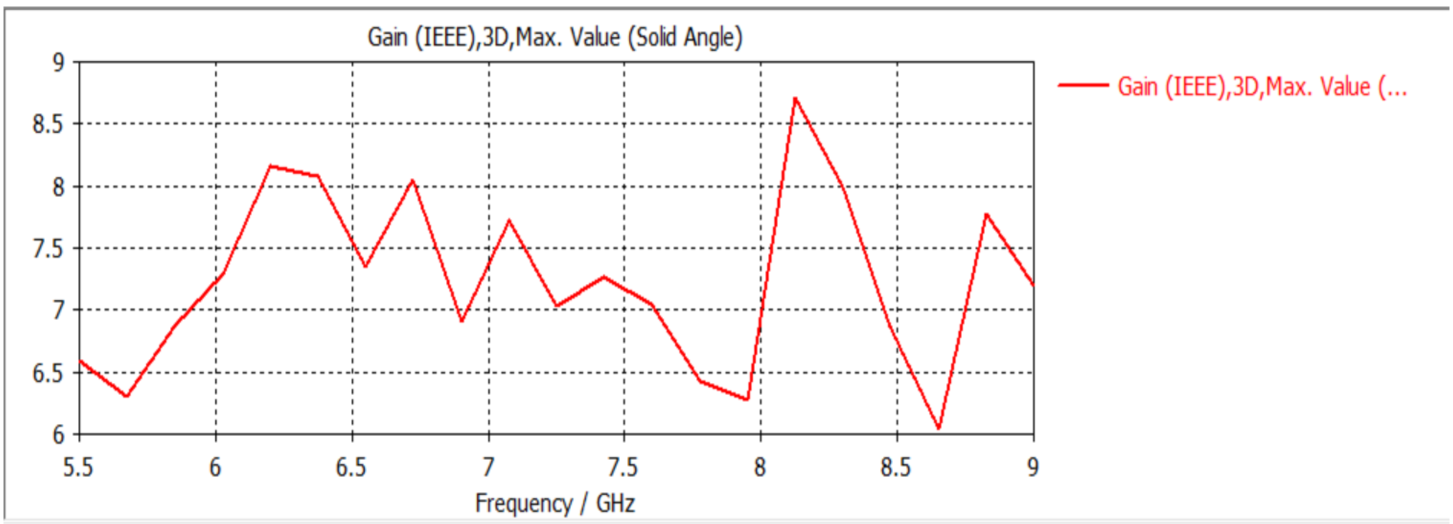




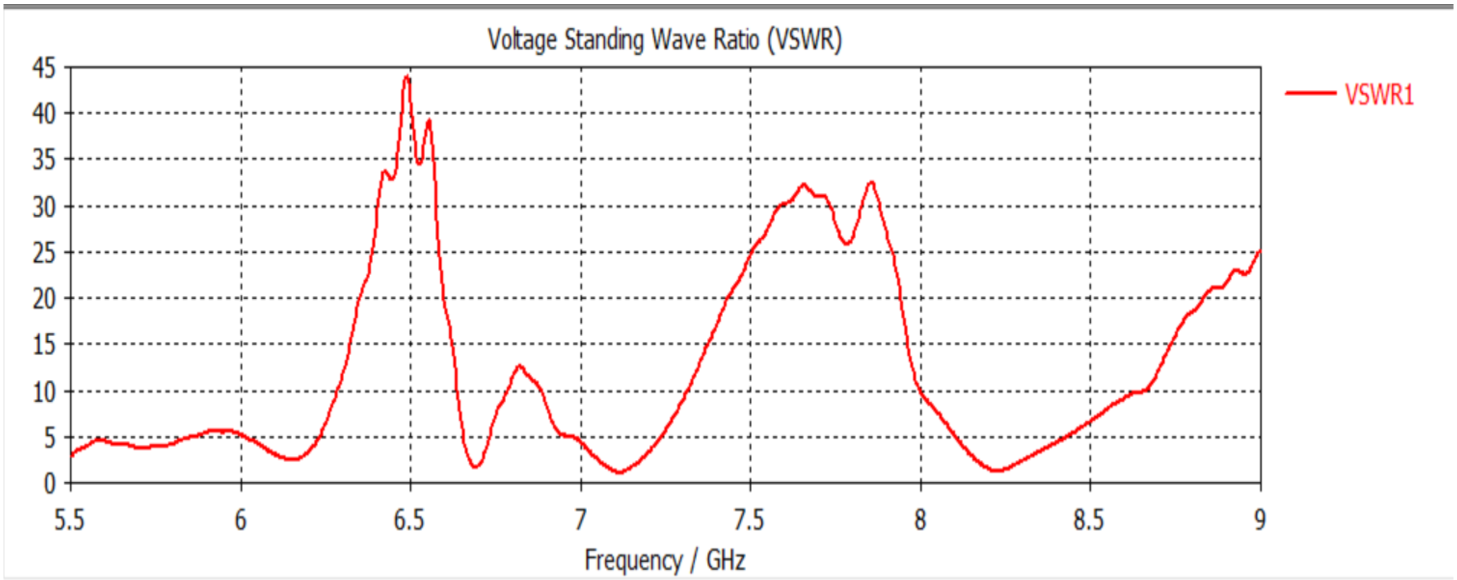
2D far field diagram at the minimum value which is found at the 7.1135 GHz -



Frequency vs gain Curve -



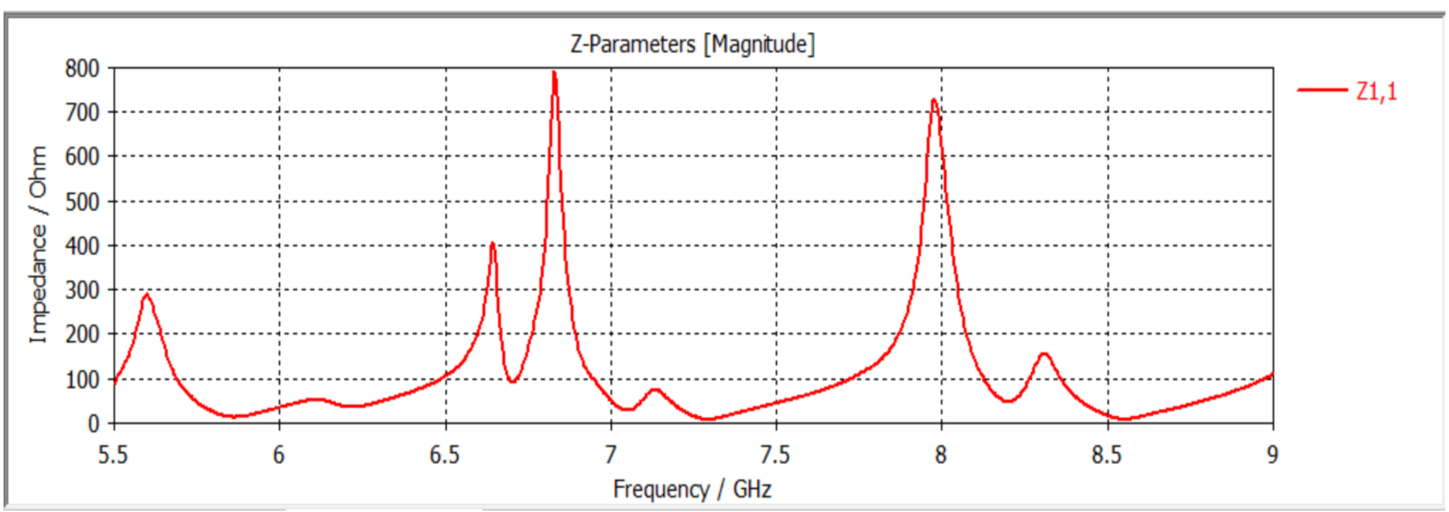
VSWR vs frequency Curve -



Here we see some other parameter values which changes according to our frequency value in our final analysis result.

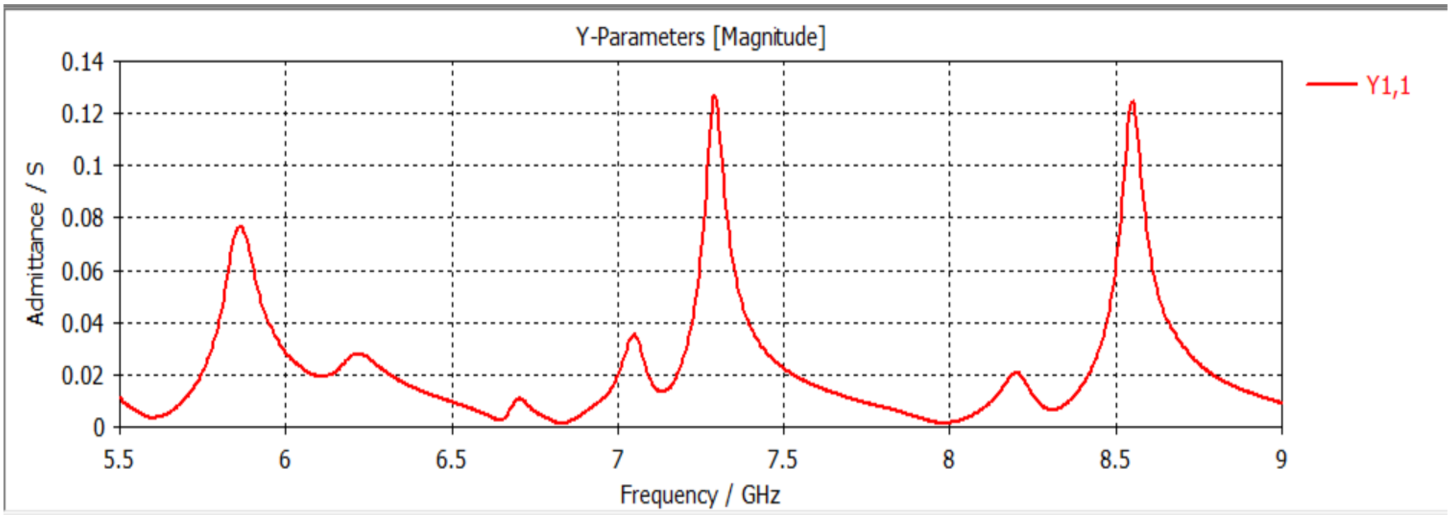
First, we see the effect of frequency on the Impedance -

The highest value of impedance is about 800 ohm that is at frequency 6.7 GHz something.



Second, we see the effect of frequency on the Admittance -

The highest value of Admittance is about 0.12 that is at frequency 7.6 GHz something.



Conclusion

a rectangular microstrip patch antenna with-out the need of an external coupler or polarizer, has been discussed. The designated X Band antenna has a bandwidth is about in a range between 6 to more the 7 something. Slits have been introduced on the sides of the patch to improve return loss and decrease solution frequency. The return loss and radiation pattern for far field have been illustrated in the paper. The simulation results show that the X Band antenna achieves a high return loss beyond 30 db. This antenna can therefore meet the various requirements for satellite communication applications. The isolation and return loss improvement technology will be studied further to obtain high gain and relatively small size with larger packing efficiency onboard satellite devices.