DESIGN OF RECTANGULAR MICROSTRIP PATCH ANTENNA ARRAY FOR C- BAND APPLICATIONS

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***Abstract* - In this paper a rectangular Microstrip patch antenna array has been designed. The parameters of the microstrip patch antenna have been optimized to obtain the multi band characteristics at 3GHz, 7.5GHz,9.5GHz. All the three frequencies can cater to satellite communication. According to IEEE standards,the frequencies between 2GHz -4GHz fall in the S band,4GHz-8GHz fall in theC band,8GHz-12.5GHz fall in the X band of the Radar frequency bands. The antenna designed using coaxial feeding technique for feeding the patch antenna array. The antenna has been implemented on Rogers RT/Duroid 5880 as the substrate, which has 2.2 as its dielectric constant. The return loss obtained for all the three frequencies have been found to be below-10dB which makes antenna compatible to various satellite applications. The VSWR found to be less than 2 for all the three frequencies and the gain has also been increased. The 2*2 microstrip patch array antenna shows better results than single patch antenna. The antenna design has been simulated using HFSS 13.0 software.**

Keywords-Rectangular Microstrip Patch Antenna,coaxial feed,C band,HFSS 13.0.

Ⅰ. Introduction

The growth of technology has boosted with the rapid rise of wireless communication technology. They have found huge applications in the domains of defense and satellite communication. The present satellite communication applications are hugely benefited by the small size, low profile and have good return loss and gain of the microstrip antennas.

An antenna array is a set of 2 or more antennas. The signals from the antennas are combined or processed in order to achieve improved performance over that of a single antenna.

The 2*2 array used in the design provides better return loss,VSWR and gain than single element antenna. The antenna has been radiated in C band and shown better results in S band,C band as well as in X band. Hence the antenna array has shown multi band radiation.

Ⅱ. Rectangular microstrip patch antenna

Antenna is a transducer designed to transmit or receive Electro Magnetic waves(EM waves).The rectangular microstrip patch antenna has radiating patch on one side of dielectric substrate and ground plane on the other side. Microstrip patch antennas are used widely in many practical applications than conventional microwave antennas because of its advantages like it provides better efficiency and better radiation and large operating bandwidth. Microstrip patch antennas are smaller in size and operates at microwave frequencies where the conventional antennas are not feasible to be designed. Low profile,light weight and easy fabrication are the advantages of microstrip patch antenna.

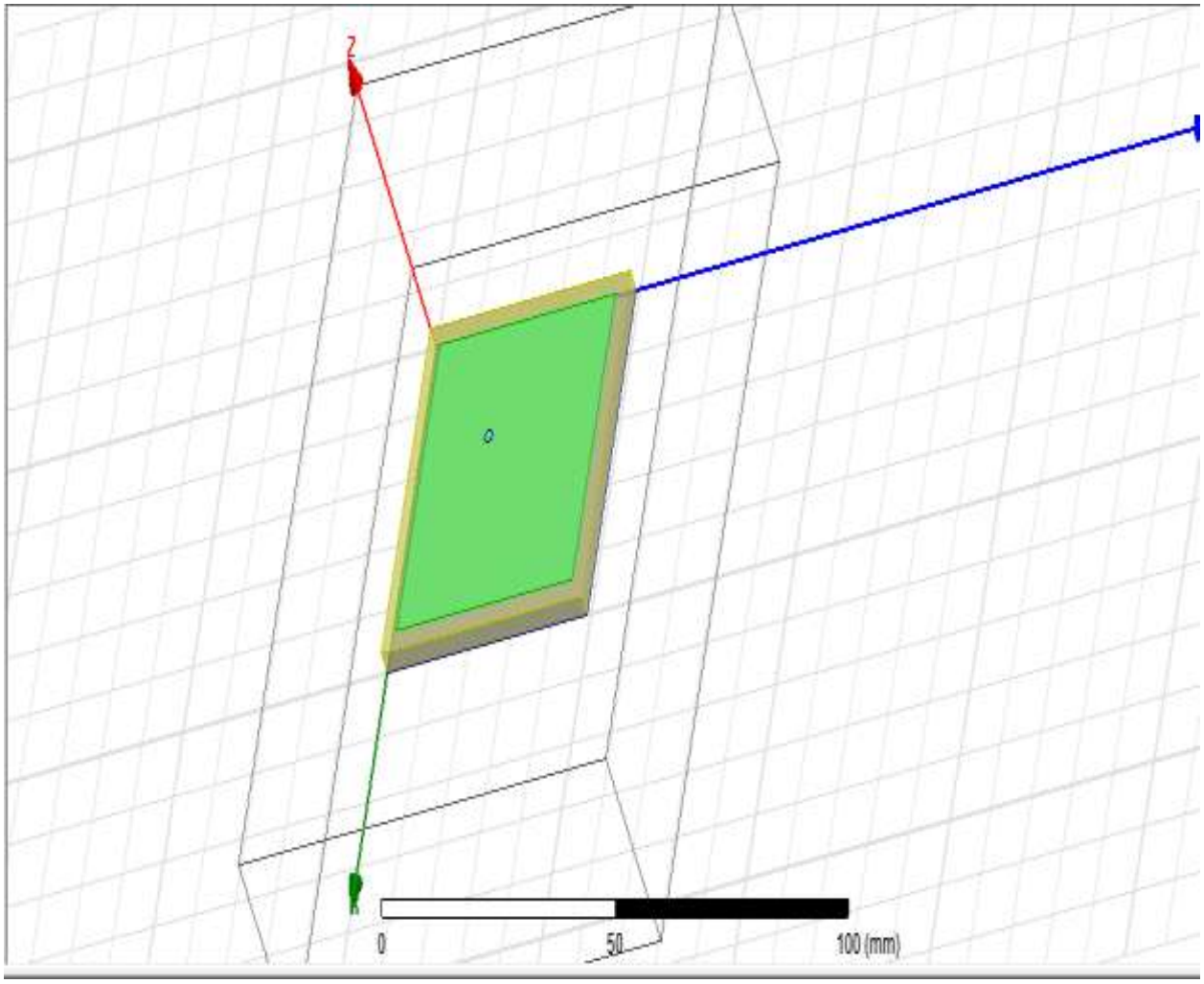

Fig 1: Microstrip patch antenna

Ⅲ. Antenna design and its parameters

In this design, the patch is placed on the substrate which has ground on other side. The substrate material used is Rogers RT/Duroid 5880 which has the relative permittivity 2.2 and the thickness of substrate material taken is 3.2mm.

The feeding technique used is coaxial feeding technique. In this,the inner conductor of the coaxial is attached to the radiation patch of the antenna while the outer conductor is connected to the ground plane. Easy fabrication,easy to match and low spurious radiation are the main advantages of coaxial feeding technique.

Design specifications of proposed antenna

The substrate material used in the design is Rogers RT/Duroid 5880which has relative permittivity 2.2. The thickness of substrate material is 3.2mm.The ground plane is placed beneath the substrate and the ground is made of copper or gold. The length and width of substrate are same as that of ground plane.

Table 1 : Design specifications

S.No	Design parameter	Values
1	Dielectric constant	2.2
2	Centre frequency	6GHz
3	Substrate thickness	3.2mm
4	Substrate length	33.8mm
5	Substrate width	38.9mm
6	Patch length	14.6mm
7	Patch width	19.7mm
8	Ground length	33.8mm
9	Ground width	38.9mm

The equations to calculate the dimensions of an antenna are

1) Width of the patch

$$W = \frac{c}{2f_o\sqrt{\frac{(\varepsilon_r + 1)}{2}}}$$

Where,

W=width of the patch

C=frequency of light=3*10^8m/s

ε_r=relative permittivity of substrate

F_0=resonating frequency

2) Effective dielectric constant

$$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-\frac{1}{2}}$$

Where,

h=thickness of substrate

w=width of patch

3) Effective length:

$$L_{eff} = \frac{c}{2f_o\sqrt{\varepsilon_{eff}}}$$

4) Patch length extension:

$$\Delta L = 0.412h\frac{(\varepsilon_{eff}+0.3)\left(\frac{W}{h}+0.264\right)}{(\varepsilon_{eff}-0.258)\left(\frac{W}{h}+0.8\right)}$$

5) Length of the patch:

$$L = L_{eff} - 2\Delta L$$

6) Length of the ground

$L_g = 6h + L$

7) Width of ground

$W_g = 6h + W$

Design of an antenna array:

Antenna array is group of antennas or antenna elements arranged to provide desired directional characteristics and it is composed of several similar radiating elements. In the design the elements of the array are placed such that the patches are seperated by λ/2.

Different materials has been used while designing coaxial feed.the outer conductor of coaxial cable is made of Teflon based material for which it relative permittivity is 2.08 and it is connected to the ground plane. Feed pin is made of pec of which its relative permittivity is 1and it is connected directly to the patch.the increased signal strength,high gain and directivity are obtained by using antenna array.

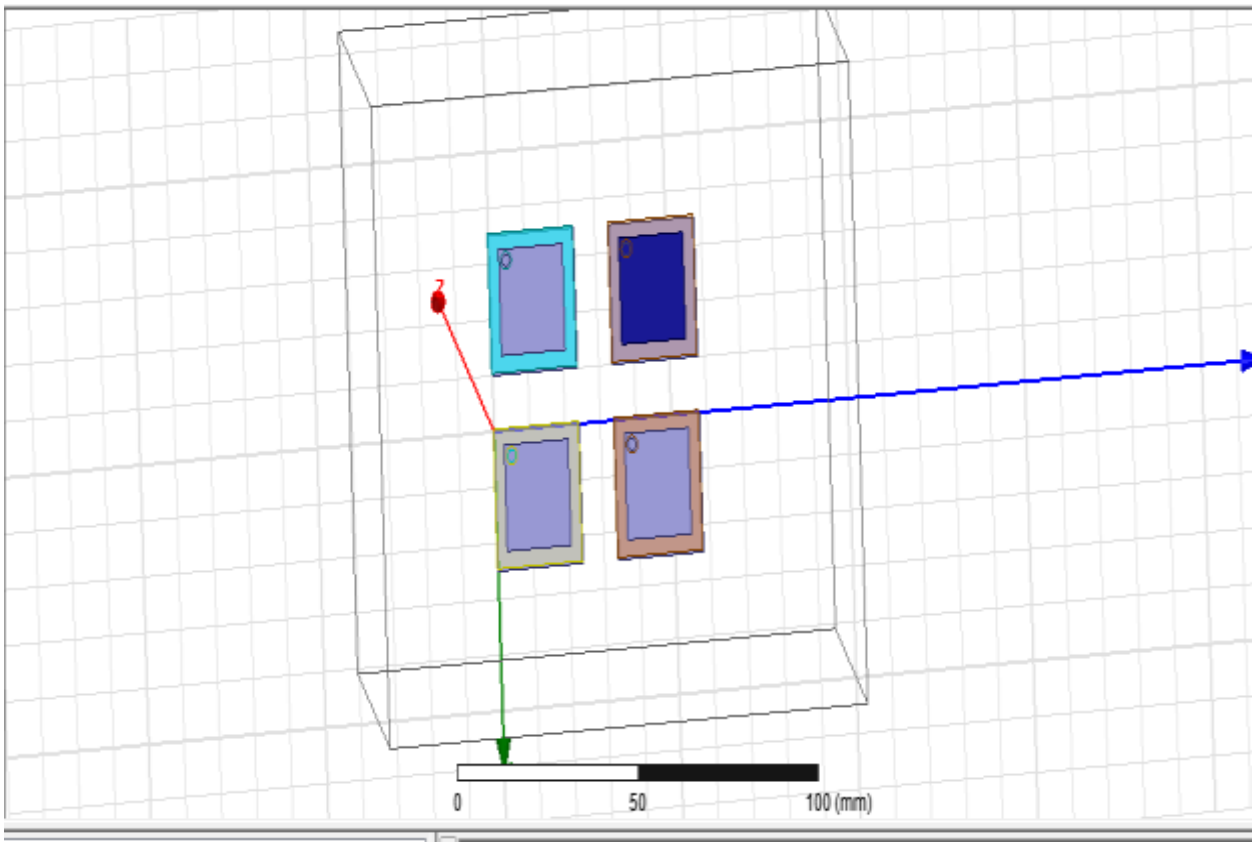

Fig 2 : The 2*2 antenna array

Ⅳ Simulated results:

HFSS 13.0 is used to simulate the antenna array. The various parameters like return loss,VSWR,directivity and gain can be obatained.The 2*2 antenna array gives better results than single patch antenna.

a)Return loss

S11 is termed as return loss is return loss of device. It measures howmuch input power given to the device is reflected back at input port.It should be less than -10dB means atleast 90% of input power is delivered to thedevice and reflected power is less than 10%.

The 2*2 antenna array design , shown the better results than single patch antenna.The return loss lessthan -10dBis shown in multiple bands.

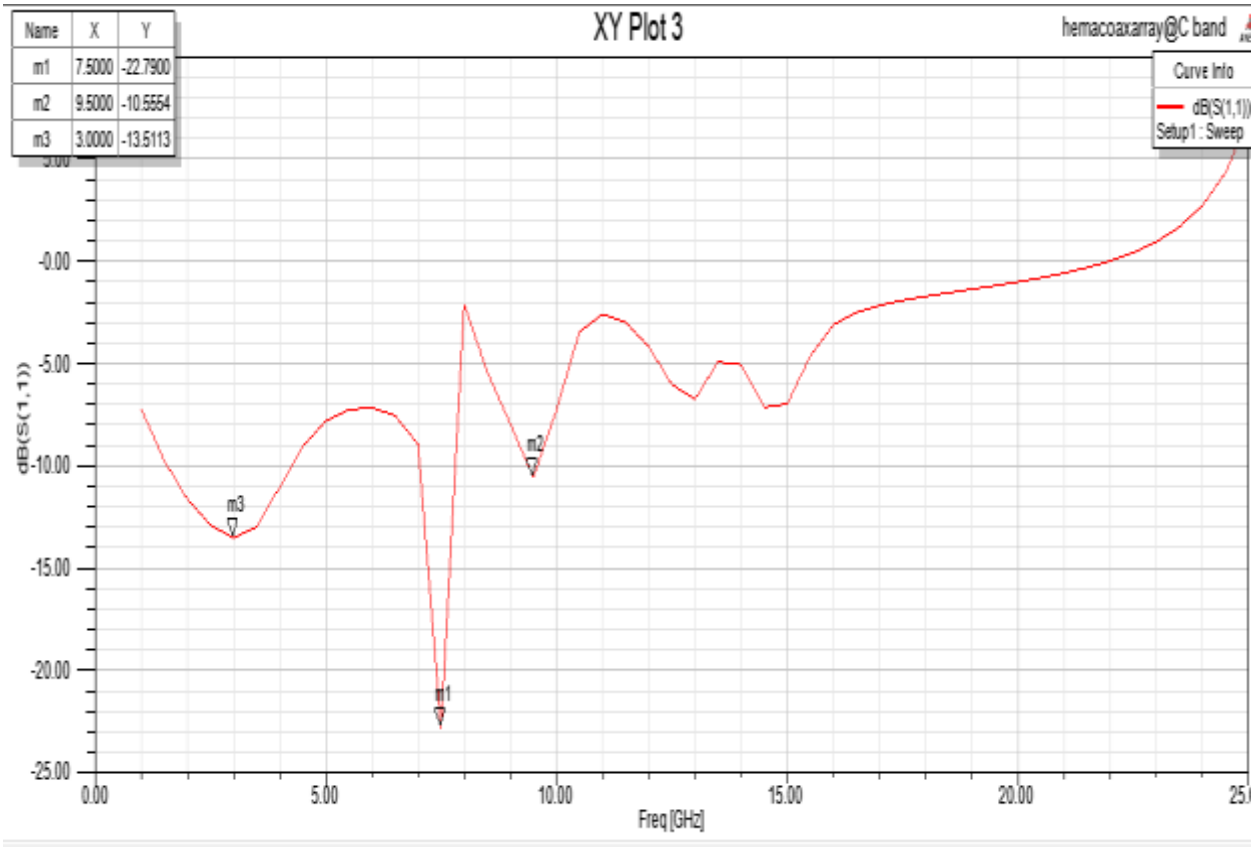

Fig 3 : Return loss of an antenna array

b)VSWR

Acronym for VSWR is Voltage Standing Wave Ratio.For antennas VSWR is always possitive and real.VSWR ranges from 1 to ∞.if VSWR of an antenna is lessthan 2 then it ia a good match means the antenn ais matched to the transmission line and more power is delivered to the antenna.

The 2*2 antenna array shows better VSWR (<2) by the array when compared to single patch antenna.

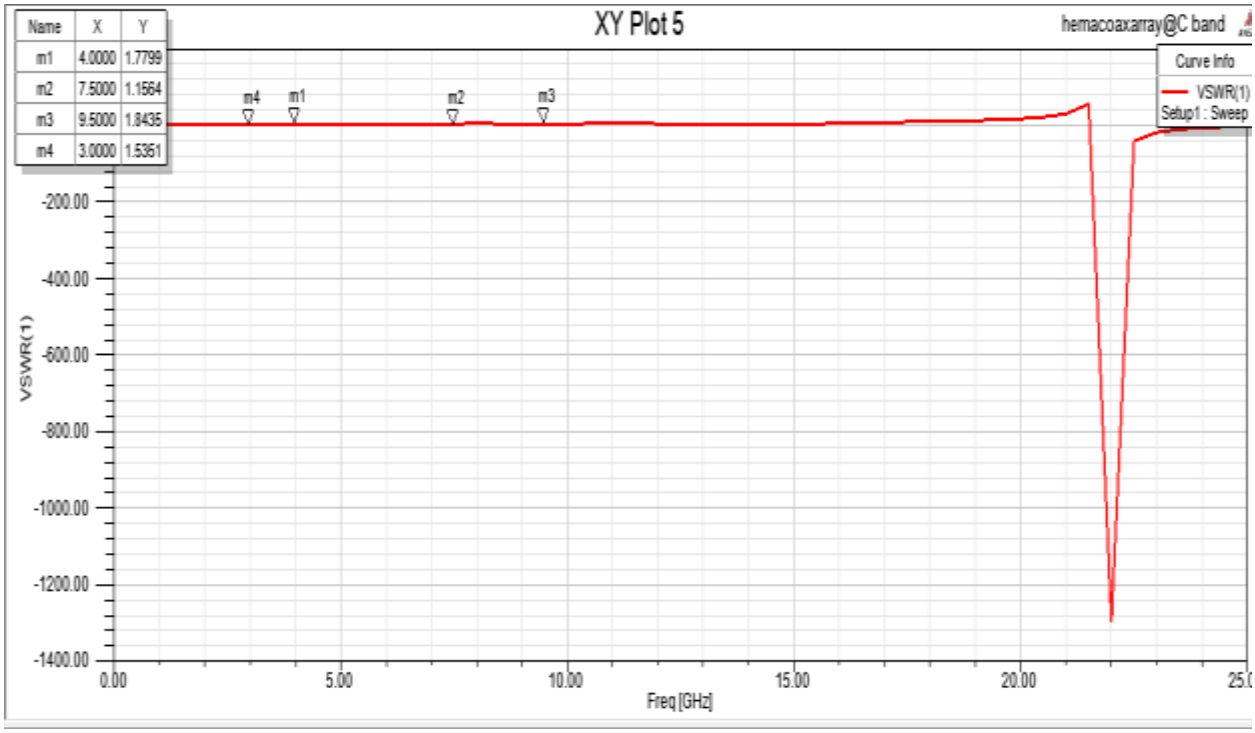

Fig 4 : VSWR of 2*2 antenna array

c)Gain

It can be described as how strong the signal of an antenna can send or receive in a specified direction.

The 2*2 antenna array shows better results than single patch antrenna.

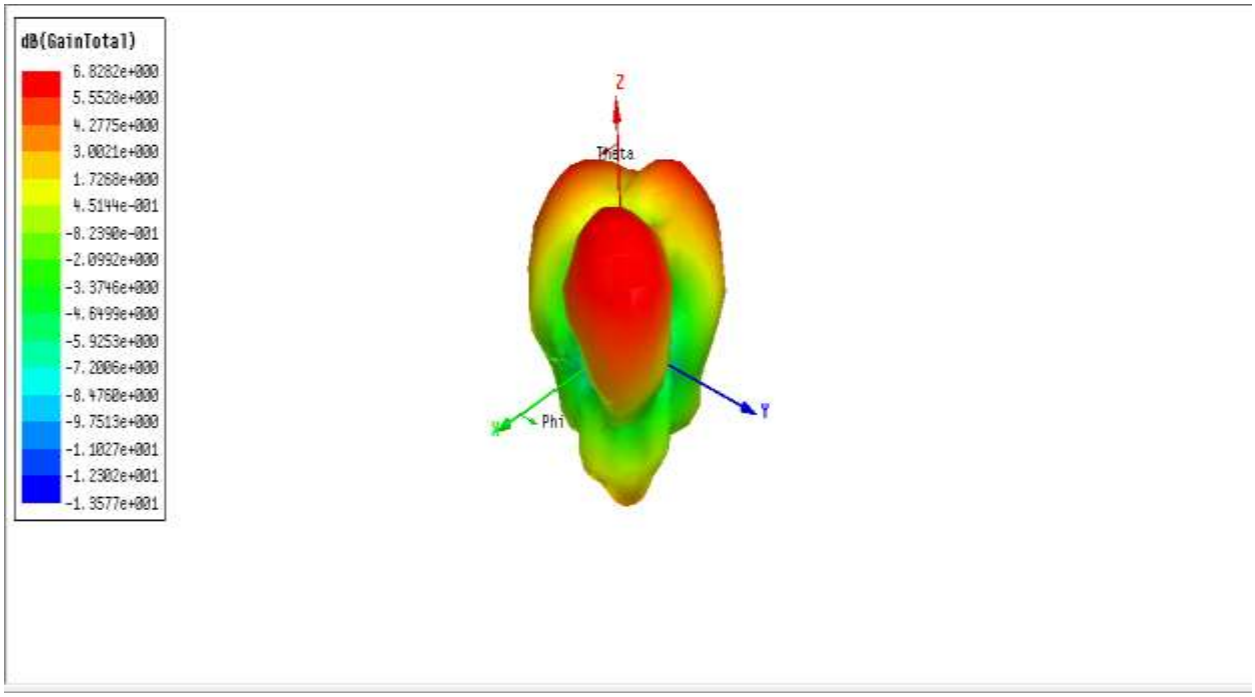

Fig 5 : Gain of 2*2 antenna array

d) Radiation pattern

The energy radiated by an antenna is represented by radiation pattern of an antenna.

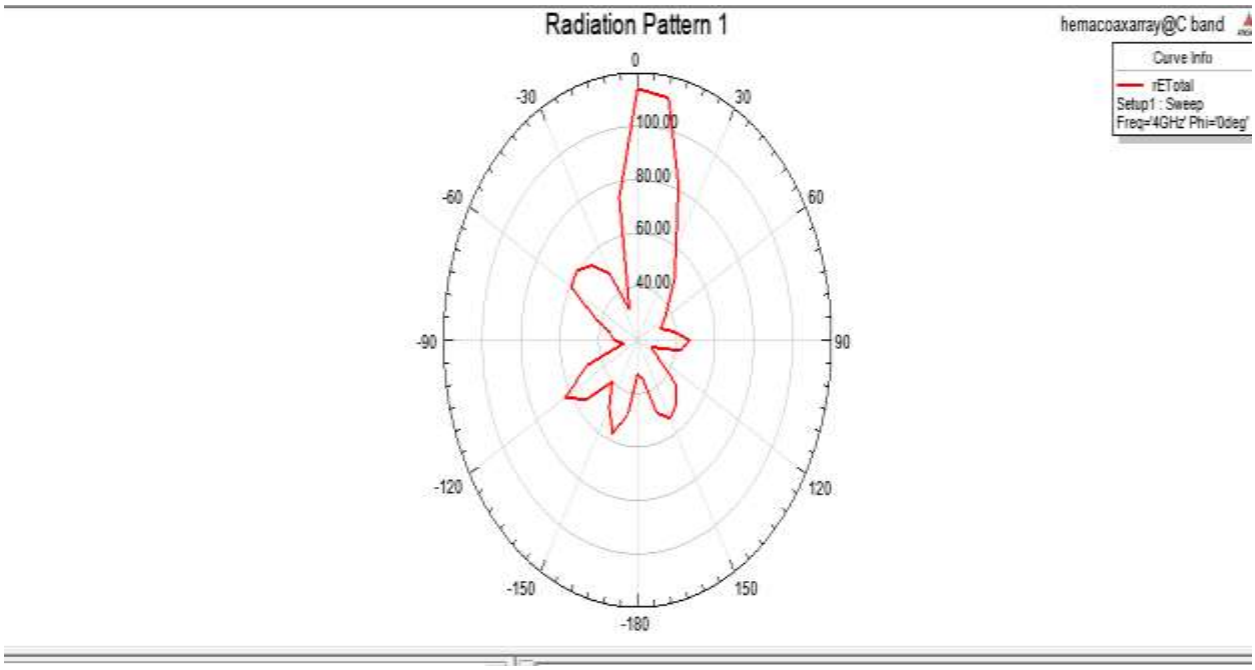

Fig 6: Directivity of 2*2 antenna array

V. Conclusion

The 2*2 antenna array is designed,validated and anlyzed using HFSS 13.0 software. The array is designed under the frequency 4GHz-8GHz which comes under C band of electro magnetic spectrum.the array shows better return loss,VSWR,directivity and gain than single patch antenna.

VI. Future scope

The antenna array gives better results than single element antenna .The 4*4 array,8*8 array and so on can be designed using this basic design.As the antenna array gives better results like return loss,VSWR,directivity and gain than single element antenna the designer prefer to design antenna array as and when required for the specific application.Also by making cuts, slots and different shapes on patch of the antenna,the better results can be obtained.

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