Design and Simulation of Srichakra Shape Microstrip Tri-Band Patch Antenna

Sk. Nagurvali, S Nagakishore Bhavanam, Vasujadevi Midasala, J Lavanya

Abstract*: Today's communication demand the antennas those are capable to handle the two (or) more frequencies. Here a single patch of srichakra shape microstrip radiator is proposed. Design can be made up of the Rogers RO 3003 material of thickness 1 mm. The antenna is made by cutting the Hexagram slots in a circular patch. This can be modelled by the commercial software HFSS. From the achieved results the antenna operated in NATO J-band, Ka-band and K-bands with the gains 5.368dB, 8.13dB, 8.52dB, 8.89dB at the centre frequencies 12.2GHz, 23GHz, 25.8GHz, and 31.8GHz respectively.

***Index Terms*: Srichakra, hexagram slot, NATO J-band, Ka-band, K-band**

I. INTRODUCTION

The wireless communication is happen only with the basic device called the aerial or antenna to form the link between the sender and receiver. Due to the advantages of low profile, low cost, easy of design with small size. Usage of microstrip antennas are increasing in WLAN, Wi-max, and Biomedical applications. There are many different shapes of the patches are available based on the credentials of the usage and the size considerations. Here the circular shape structure is choosen for the design below fig.1 shows the basic configuration. Microstrip patch antennas are easily manufactured based on their operation of different band of applications. Mostly many techniques are proposed for designing the antenna. One of the easy methods is the slotting techniques for achieving the multiple bands. The communication needs the single antenna which can be eliminate the usage of the many other antennas for a every frequency. These makes the multiband concept.

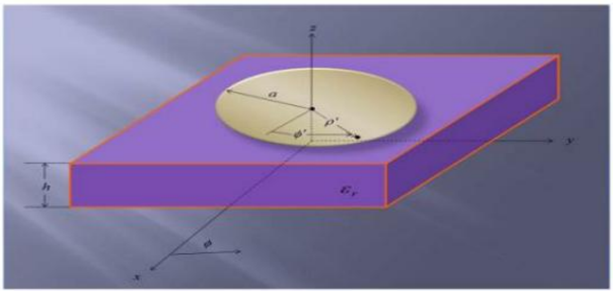

Fig.1 Basic circular patch configuration

In the related work [1], a triple frequency operated antenna can be design with the shorting pin and slots using the co-axial feed. In [2], pentagonal spiral microstrip antenna model for the multiband applications utilizing the army navigation, wireless communication & satellite communication. In [3], compact circular patch antenna analyzed by incorporating the circular slots to achieve the triple frequency. [4], Dual frequency operated antenna designed to get the wide bandwidth by changing the feed positions. In the proposed paper a circular patch antenna with slots of srichakra shapes and also a circular gaps to achieve the higher peak gains and covers three frequencies bands of NATO J-band (10-20GHz), K-band(18-26GHz), and Ka-band(26-40GHz) for the training & planning of electronic warfare activities and wireless computer networks.

II. ANTENNA DESIGN CONSIDERATIONS

Microstrip circular patch antenna modelled by considering the below design considerations. And the Proposed antenna structure is given in fig.2 also the design iteration stages shown by fig.3

(i) Operation frequency

The frequency of operation for the design is selected as the 5 to 50GHz. Hence the antenna is operated in the NATO J-band, Ka-band & K-bands. The frequency solution set up established for the simulation is 40GHz.

(ii) Substrate material and height

The substrate Rogers RO3003(tm) material is taken as the dielectric medium with permitivity =3 for better efficiency this must be choosen as possible low. And the stature of the substrate is h=1mm. Length and width considerations are 40mm x 40mm.

(iii) Design equations of patch and Feed

Patch is placed on the substrate with these material assigned is perfect E. And the actual radius calculation of the circular patch is given in eq (1) and the Effective radius of the patch is taken as eq (2). Width of the Microstrip feed will taken as 2mm and the length is 9mm.

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

$$a_e = a\left\{1+\left(\frac{2h}{\pi a \in_r}\right)\left[\ln\left(\frac{\pi a}{2h}\right)+1.7726\right]\right\}^{1/2} \quad (2)$$

$$F = \frac{8.791\times 10^9}{f_r\sqrt{\in_r}} \quad (3)$$

(iv) Ground plane

The length and width of the ground plane 40mm X 40mm are taken with material assignment of perfect conductor.

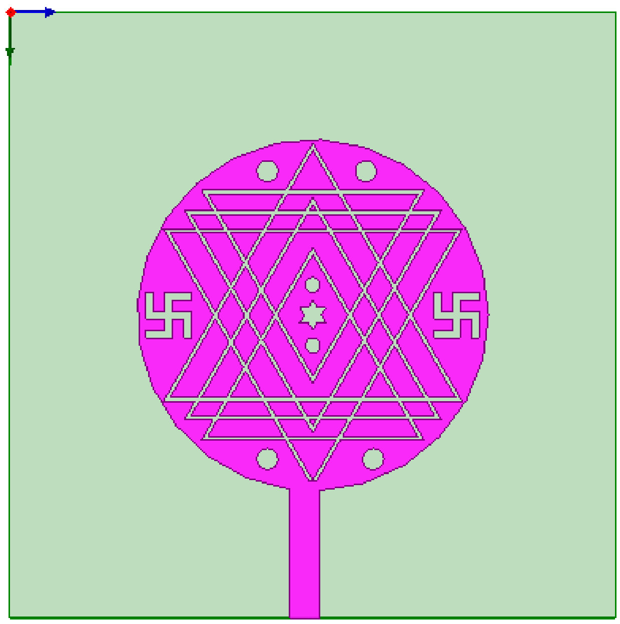

Fig.2 Proposed Srichakra slotted circular patch antenna

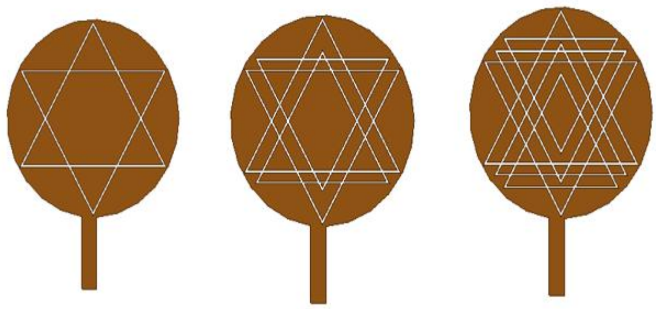

Fig.3 Design Iterations of the proposed antenna

III. SIMULATION RESULTS

The proposed antenna is designed using the HFSS (High Frequency Structure Simulator) software 14.0 version.

A. Returnloss

When impedance mismatch occurs when the propagation of a signal is reflected back this is phenomenon is known as return loss. Return loss is zero for a perfect matched transmission line. It is calculated as follows

$$RL = -20\log_{10}^{|\Gamma|} \text{(dB)}$$

The simulated results S_{11} of the designed antenna are -18.54(dB),-27.45(dB),-24.52(dB) and -16.37(dB) at 12.2GHz, 23GHz, 25.8GHz and 31.2GHz respectively.

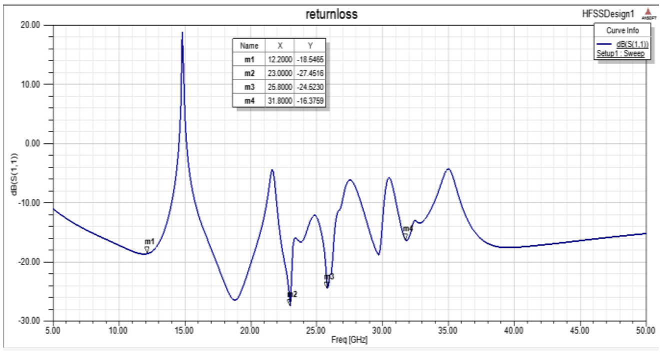

Fig.4 Returnloss of the proposed antenna

A. VSWR

It is a function of Reflection Coefficient and its a measure of power reflected from an antenna.

$$VSWR = \frac{1+|\Gamma|}{1-|\Gamma|}$$

Simulated voltage standing wave ratio results are 1.26, 1.08, 1.12 and 1.36 at 12.2GHz, 23GHz, 25.8GHz and 31.8 GHz respectively.

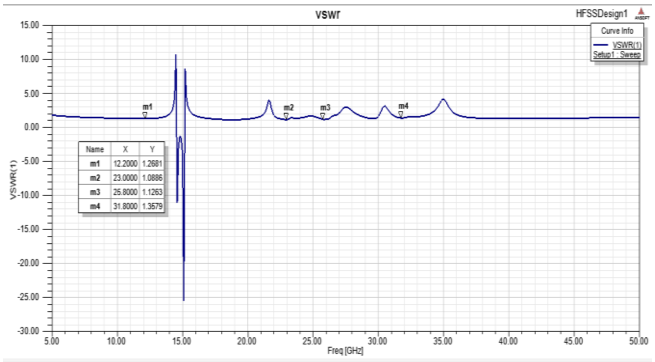

Fig.5 voltage standing wave ratio of the proposed antenna

B. Gain

It is nothing but the amount of power transmitted in the direction of peak radiation of the isotropic source.

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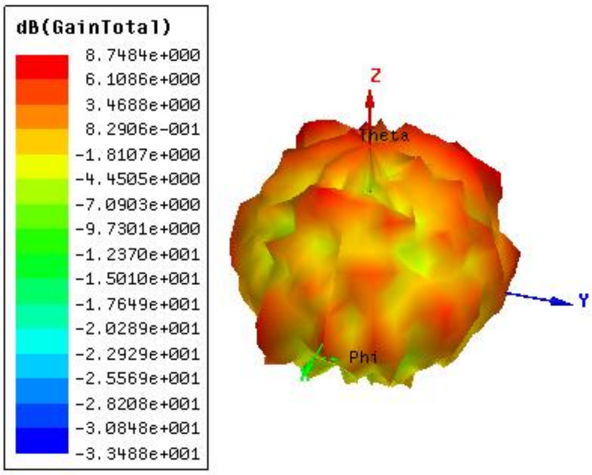

Fig.6 Total Gain of the Proposed antenna

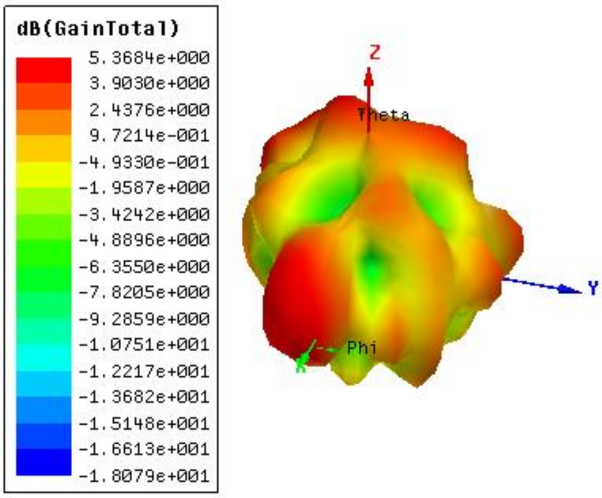

Fig.7 Peak gain at 12.2GHz

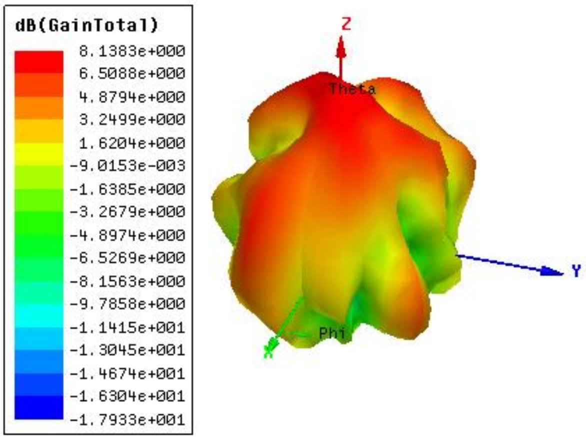

Fig.8 Peak gain at 23GHz

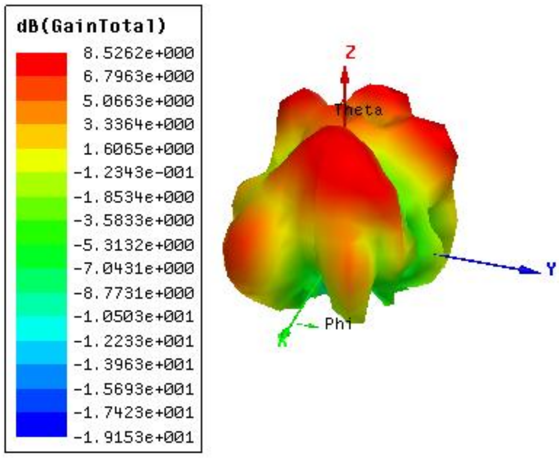

Fig.9 Peak gain at 25.8GHz

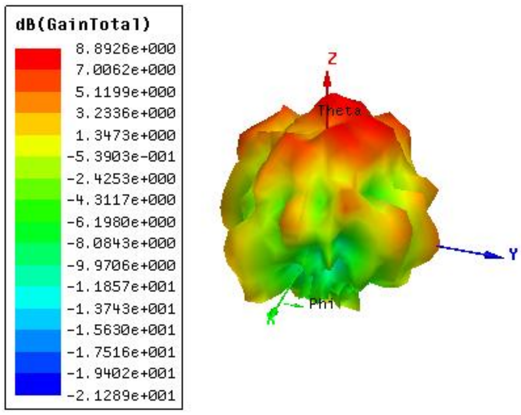

Fig.10 Peak gain at 31.8 GHz

Table1: Comparison table of simulation results of proposed antenna design

S.No	Frequency(GHz)	S11(dB)	VSWR	Gain(dB)
1	12.2	-18.54	1.26	5.36
2	23	-27.45	1.08	8.13
3	25.8	-24.52	1.12	8.52
4	31.8	-16.37	1.36	8.89

The above table represents the S_{11}, VSWR and Gain values in detail manner.

IV. CONCULSION

The proposed srichakra shaped antenna is small volume compact antenna to be capable of operating multiple bands such as NATO-J Band, Ka band and K band. The designed antenna is mostly preferred to be applicable in electronic warfare activities, wireless computer networks and military services. The designed srichakra antenna can be analysed by using HFSS software 14.0 version.

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