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DESIGN OF RECTANGULAR SLOT LOOP ANTENNA FOR X-BAND SATELLITE APPLICATIONS

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Abstract - This paper proposed a rectangular slot loop antenna for X band Satellite communications. The proposed antenna is designed on FR4 substrate with thickness of 1.6 mm and relative permittivity of 4.4 having loss tangent 0.02. The size of proposed antenna is 30 X30 X1.6 mm^3. Satellite communications are the outcome of research in the area of communications and space technologies whose objective is to achieve ever increasing ranges and capacities with the lowest possible costs. The proposed antenna operates at 7.8GHz(X-band) that is suitable for satellite communication. The proposed antenna is designed and analyzed using the Ansys HFFS software.

***Key Words*: Satellite, Loop Antenna, Rectangular Slot, X-Band**

1.INTRODUCTION

Now a days, X-band satellite antenna systems play a critical role in a range of satellite communication applications, including remote sensing, earth observation, and broadband communication Four types of patch antennas were selected and compared with H-shaped patch antenna. The results obtained clearly indicate the main factors that affect the bandwidth of a particular micro strip antenna are thickness of the dielectric substrate, the size of the metallic patch, the dielectric constant of the dielectric substrate, the feed type to be used and the coupling level to some extent [1]. The VSWR, input impedance, radiation patterns and S11 performance are used for the analysis of the different configurations [2]. Single element narrowband rectangular micro strip antenna and slot cut H-shaped micro strip antenna were designed and simulated. The simulation process has beendone through high frequency structure simulator (HFSS). The properties of antenna such as bandwidth, S parameter, VSWR has been investigated and compared between a single element rectangular and H-shaped micro strip antenna. The main concern is to study the bandwidth improvement of the micro strip antenna [4]. The bandwidth enhancement technique which is selected is the Identical Dual-Patch Micro strip Antenna with Air-Gap (IDMA). By using this technique, a bandwidth enhancement of about 11% has been achieved [5].

A compact single-layer, single-feed, dual-frequency microstrip antenna with a high frequency ratio was designed This antenna has a broadside and symmetrical radiation patterns suitable for space-borne applications [8]. An Ultra Wideband (UWB) micro strip diamond slotted patch antenna with enhanced bandwidth is presented. This antenna is simulated in CST Microwave Studio and fabricated for measurements. Its simulated result displays impedance bandwidth from 3.28 GHz to 19.64 GHz, whereas the measured result displays the frequency region from 2.01 GHz to 18.67 GHz [13].

Over the years, researchers have developed various techniques and methodologies to design and optimize X- band satellite antennas. These techniques range from traditional design methods based on analytical models to modern approaches that use simulation and optimization tools. The optimal design of X band antennas is critical for achieving reliable and efficient satellite communication systems.

2. ANTENNA DESIGN

The proposed antenna's length and width are 30x30$mm^2$and thickness of 1.6mm is designed by using FR4 substrate is shown in fig 1. The dielectric constant is $\varepsilon_r = 4.4$.

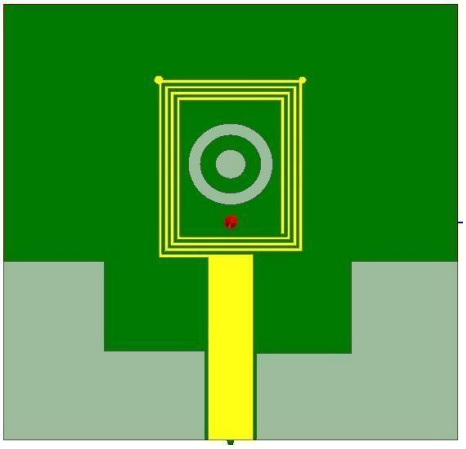


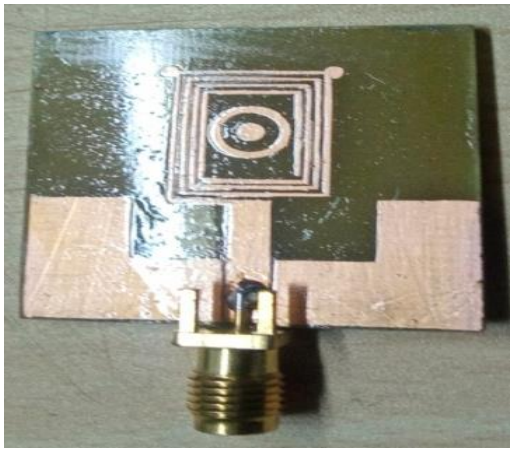
Fig 1. Structure of proposed antenna

The proposed antenna starts with the rectangular patch and a ground plane. The circular and step slots are introduced to increase the Gain and reduce return loss respectively.

Two circular slots are introduced in the patch. The Radius of the outer circular slot is 1mm, and the radius of the inner circular slot is 0.5mm. The rectangular Slots are introduced in the patch and the dimension of each rectangular slot is 12.3mm x 13.3 mm respectively.

3. RESULTS AND DISCUSSION

The proposed antenna has been designed and simulated using Ansys HFFS software. Fig. 3 represents the variation of Return Loss with Frequency. Minimum 20.0389 dB return loss is available at resonant frequency.



(a)

(b)

Fig 2 (a) Front view of Fabricated Prototype (b) Back View of Fabricated Prototype

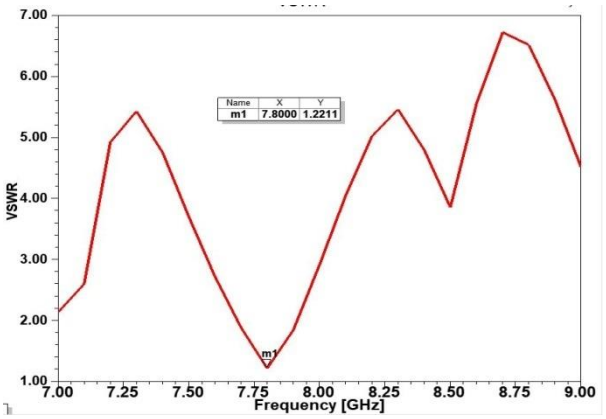


Fig 3 Return Loss vs. Frequency.

Bandwidth of the antenna is defined as the range of frequencies, over which the performance of the antenna with respect to some characteristic conforms to a specific standard. The bandwidth of the antenna depends on the patch shape, resonant frequency, dielectricconstant and the thickness of the substrate. The bandwidth enhancement of a microstrip antenna has been directed towards improving the impedance bandwidth of the antenna element. Impedance bandwidth is usually specified in terms of a return loss.

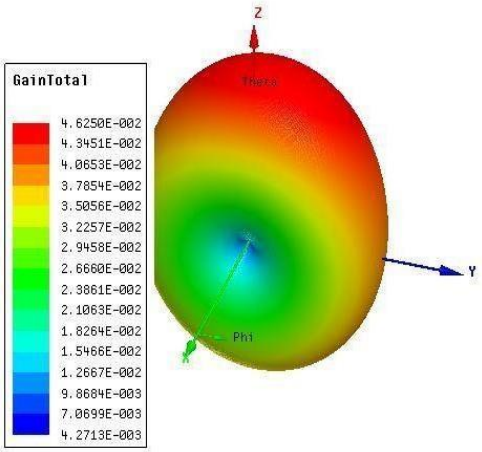


Fig 4. GainTotal.

The fig.4 depicts the gainTotal of the proposed antenna. Gain of the proposed antenna in maximum radiated directionis 4.6 which is represented in 3D.

The obtained VSWR value is 1.2 which is less than 2 which is good for impedance matching. Fig 5 depicts theVSWR of the proposed model.

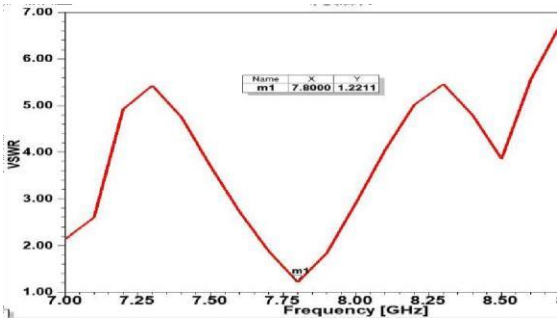


Fig.5 VSWR withrespect to Frequency.

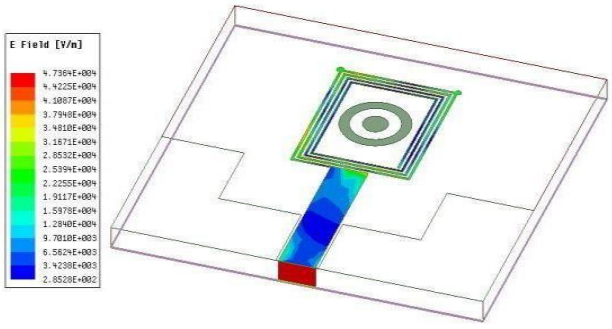


Fig. 6 Perspective view of Electric field distribution at 7.8 GHz.

The region of red color shows the region with maximum electric field distribution whereas the region of blue color has slightly less field distribution is shown in Fig 6.

3. CONCLUSIONS

A rectangular slot loop antenna for Satellite Applications is designed to obtain a gain of 1.1792dB and a return loss of -20.0389dB and the radiation characteristics are measured. Proposed antenna feature broad bandwidth, small size and low cost. Better results are found in this structure and good impedance matching with better return loss and VSWR are achieved.

A Number of rectangular loops are used to attain impedance matching. It offers single band which resonates at 7.8GHz. The Circular Slots are introduced to increase gaintotal and the Step slots are introduced for betterment of return loss.

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BIOGRAPHIES

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