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ADVANCEMENTS IN MICROSTRIP PATCH ANTENNA DESIGN FOR SATELLITE APPLICATIONS

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***Abstract*:** A new design has been implemented in satellite communication and data communication areas. These microstrip antenna is one of the most important antenna nowadays due to their attractive features such as low profile, light weight, low cost and ease in fabrication. A Ku-band microstrip rectangular patch antenna is been designed and simulated using CST Microwave Studio. The design was carried out using Roger 5880 as the substrate with a dielectric constant of 2.2, and a thickness of 0.127 mm. It is fed by a 50 Ω inset feedline. This proposed antenna resonates at 14.9 GHZ which is in the range of Ku (12-18GHz) band. The antenna is designed with return loss of -30.7 dB, a Gain of 6.130 dBi, a directivity of 8.13 dBi, VSWR of 1.04 and an antenna efficiency of -2.083 dB.

Index Terms : Microstrip Antenna, CST Microwave Studio, Ku band, Inset feedline.

I. INTRODUCTION

An antenna can convert radio frequency to electrical power or vice versa. In modern times, antenna theory and design become one of the significant subjects for the wireless communication system. Among the various type of antennas, Microstrip Patch Antenna (MPA) is the modest form of the antenna arrangement. Modern antennas use the microstrip technique for the fabrication purpose to keep the antenna size small. Moreover, the most significant advantage of this type of antennas are- they can be simply imposed on a circuit board. Patch antennas are little in cost and are simply made-up. There are numerous different contacting and non contacting methods for feeding microstrip patch antennas. In contacting methods, RF power is given directly to the radiating patch through the connecting link, which is a microstrip line. Electromagnetic field coupling is achieved by transmitting electricity from a microstrip line to a radiating patch while remaining non contact. The primary goal of this study is to assess the effectiveness of a compact inset-fed rectangular microstrip patch antenna for Ku band applications using a partial ground plane that operates in the frequency range of 12 GHz to 18 GHz..

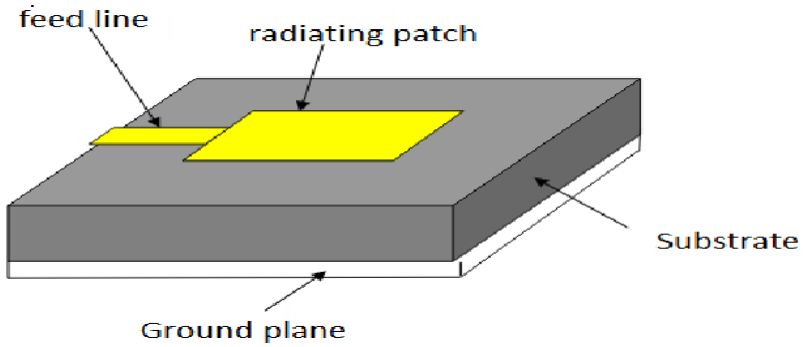

Fig:1. Microstrip Patch Antenna

II EXISTING SYSTEM

To improve the gain, various techniques are implemented by researchers, like using numerous feeding mechanism and impedance matching, use of different types of slots above the patch, using a thick the substrate of low dielectric constant. In the exsiting antenna[1], a rectangular patch is imposed over FR-4 substrate with a dielectric constant of 4.3, and a thickness of 1.4 mm. This microstrip patch antenna at designed frequency 15.5 GHz using CST with a return loss of -22.312 dB, a bandwidth of 2.73 GHz , VSWR of 1.17, a gain of 3.843 dBi, a directivity of 5.926 dBi, and an antenna efficiency of -2.083 dB . The design parameters of length (L), width (W) and resonant frequency are optimized for the better return loss. For satellite applications gain must be high.

A high gain MPA is recommended with the patch size of 40 x 40 mm2 is designed for Ku-band applications [7]. Although this antenna provides high gain its fabrication process is complicated. For improving the parameters, a W the shaped antenna is presented with the dimension of 50 x 72 mm2 [9]. Due to large, it's not suitable for satellite communication.

In this paper, L shape slot will be inserted on the right side corner of the patch in order to improve some performance parameters such as return loss, VSWR, efficiency, directivity, and Voltage Standing Wave Ratio (VSWR).

III. METHODOLOGY

Different shapes of Microstrip Patch Antennas are available. However, this antenna uses a rectangular shape. There are several methods of modeling an antenna, but the proposed antenna is designed by using Transmission Line Model (TEM).

This model is used because of its simplicity and its comparatively the most comfortable model to design an MPA. Hence, this proposed antenna is designed by applying these traditional equations. The equations are,

Step 1: Size of the Width, W: for designing this proposed antenna, the primary step is to determine the width of the patch. This value is determined by this following equation:

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

Where, W = patch width, €r = substrate's relative permittivity, fr = desired resonant frequency, c = speed of light.

Step 2: Estimate of Effective dielectric constant, Ɛreff: This content is determined by using this equation below:

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

ubstrate.

Step 3: Estimate of Effective length, Leff :

This parameter is determined by using this equation below:

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

Step 4: Estimate of the extent in length, DL: As there is an impact of the fringing field is available throughout the patch, it seems bigger comparatively than its initial size. So, for finding the extended length of the proposed antenna, this following equation is used:

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

Step 5: Estimate of actual length of patch, L: This parameter is determined by using this following equation:

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

IV. ANTENNA DESIGN AND MEASUREMENT

The composition of the proposed antenna is depictured in Fig. 2. This antenna is 'L' in shape. It uses copper (annealed) patch imposed over Roger 5880. Table 1 illustrates the proposed antenna dimensions. The proposed microstrip patch antenna at designed frequency 15 GHz on Roger5880 substrate simulated with Computer Simulation Technology software (CST). Here, we are going to investigate only about the gain enhancement of L shape patch antenna by creating slot. The design parameters of length (L), width (W) and resonant frequency are optimized for the better return loss and gain.

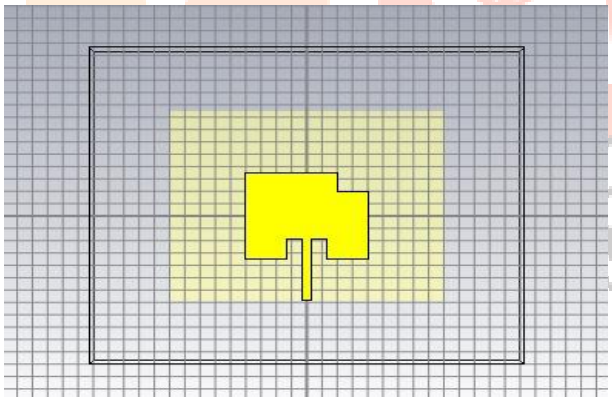

Fig. 2. Structure of proposed antenna.

Table1 Antenna dimensions.

Height of substrate	0.127mm
Dielectric constant	2.2
Substrate	Roger 5880
Thickness of the conductor	0.035mm
Design frequency	15 GHz
Conducting material	Copper

For providing the power to antenna, there is a microstrip feed line which impedance is 50Ω.This impedance is equal to the proposed antenna.

V. RESULTS

The performance of proposed antenna is discerned by using CST Microwave Studio simulation tool. The proposed antenna provides return loss (S11) which is depictured in Figs. 3. This shows the maximal return loss is-30.7 dB at the resonant frequency 14.9 GHz. The graph also depicts that below -10 dB the antenna. The voltage standing wave ratio (VSWR) is 1.06db of the proposed antenna is shown in Fig. 4 depict far field radiation directivity and far field radiation gain of proposed antenna respectively. Directivity is 8.10db and Gain is 6.13 dB shown in fig.4 and fig.5

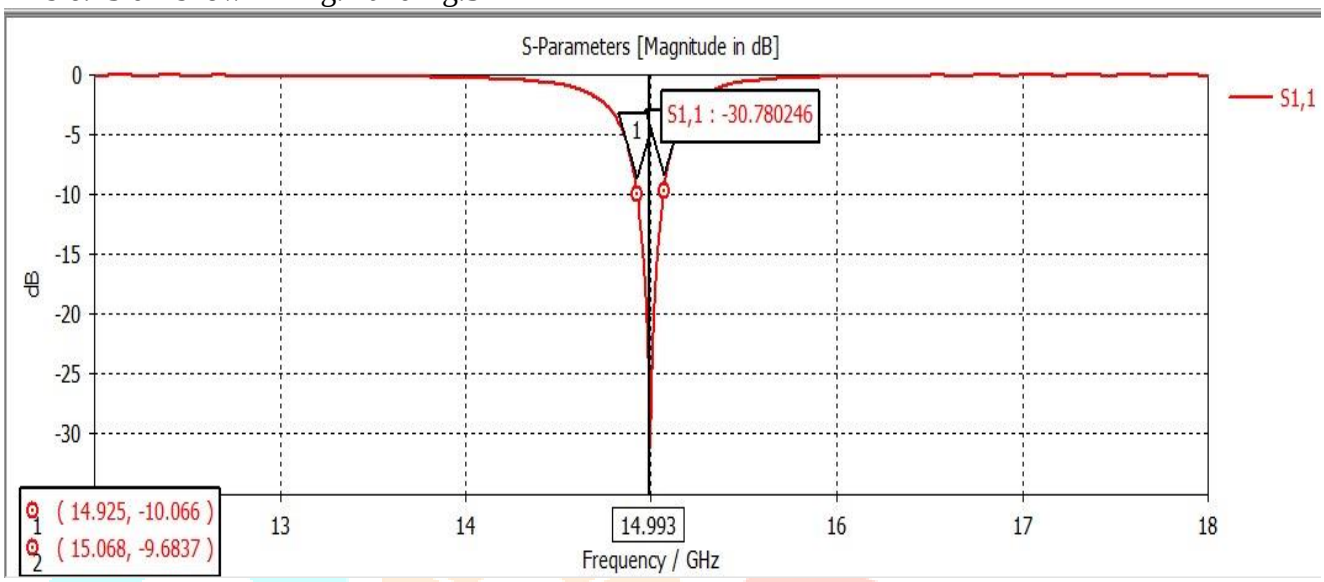

Fig. 3. Return loss vs. frequency

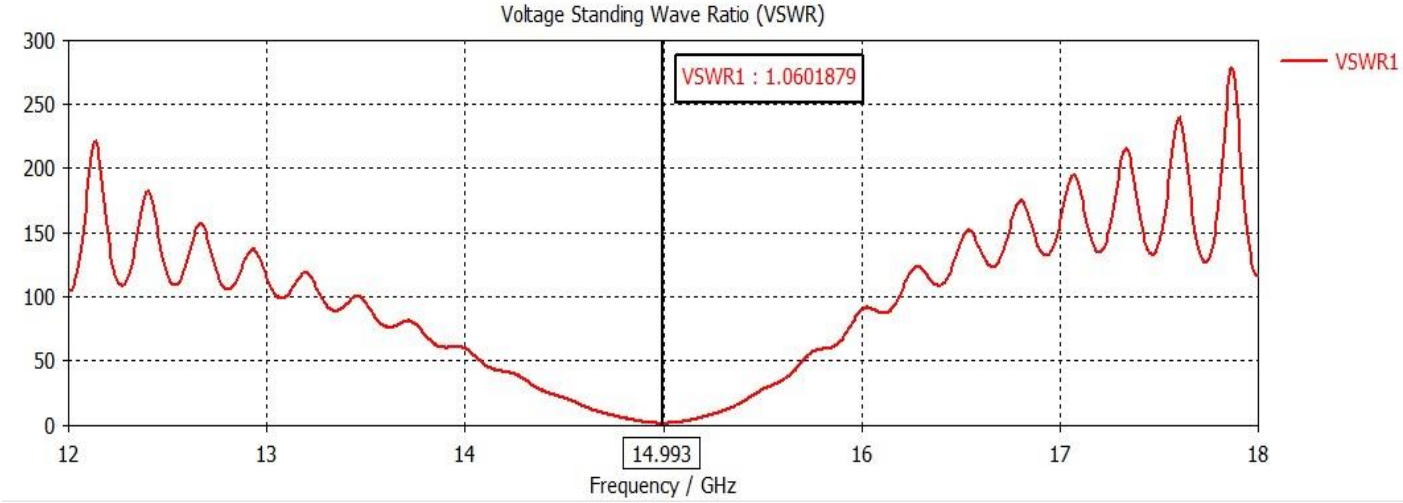

Fig. 4. Return loss vs. frequency

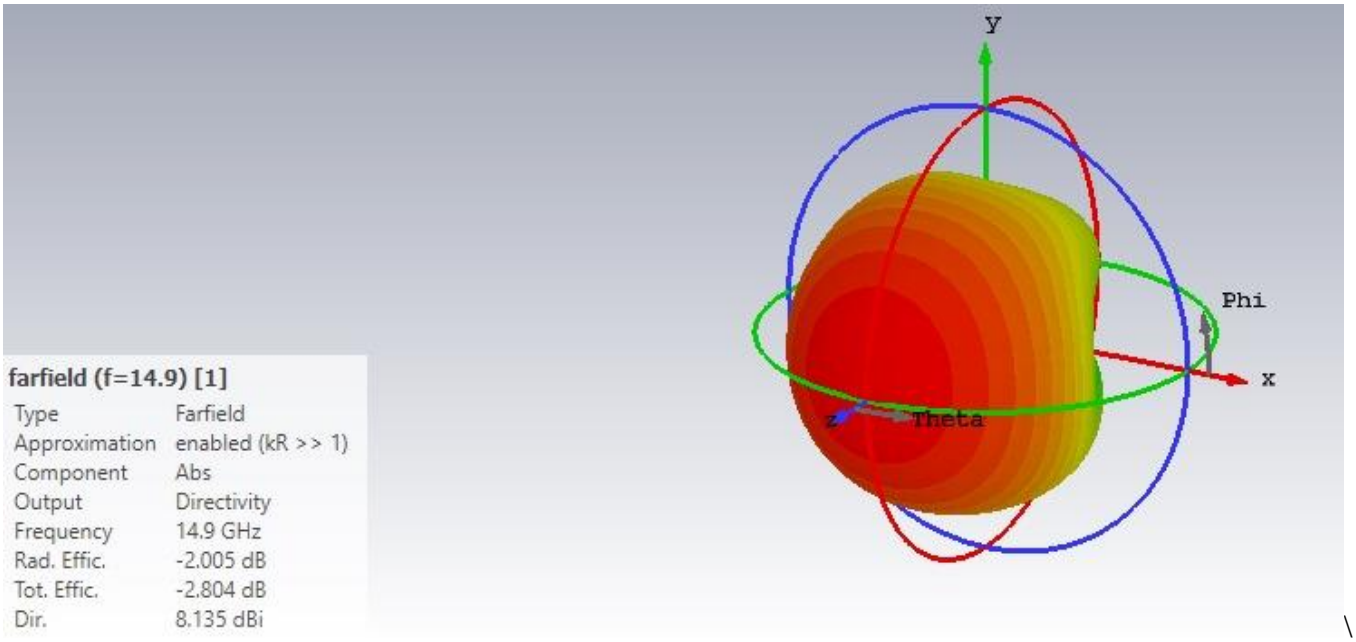

Fig.5. Directivity

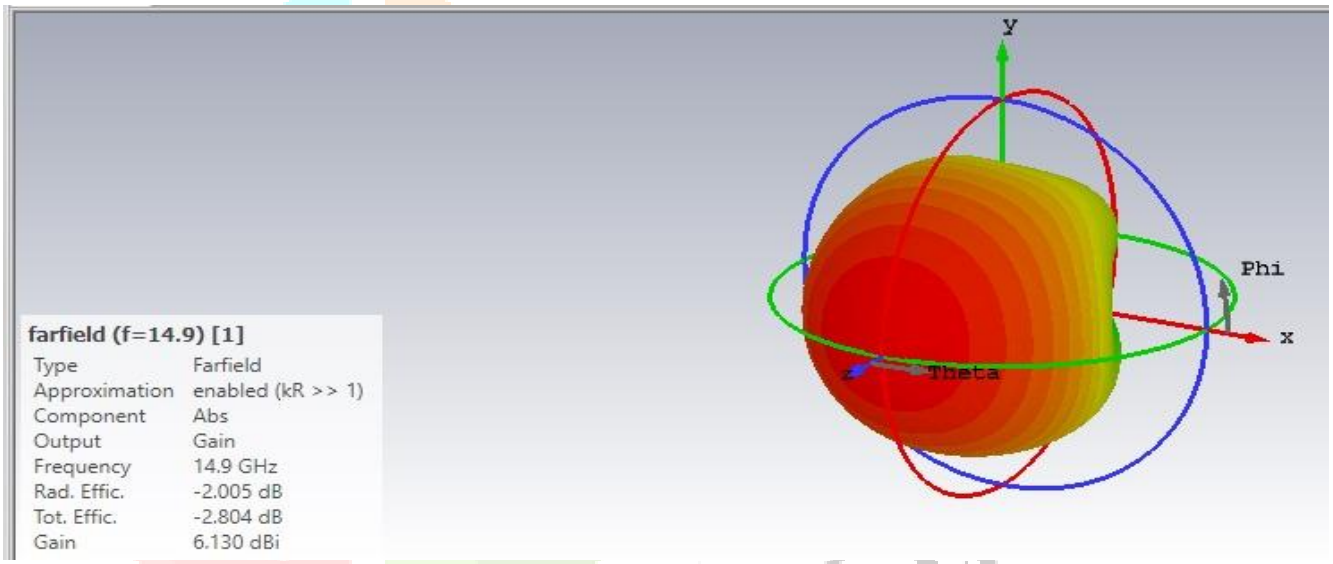

Fig 6. Gain

Table 2 Outcomes of the proposed MPA

Return Loss (S11)	-30.7 dB
VSWR	1.06 dB
Gain	6.130 dB
Directivity	8.135 dB

VI. CONCLUSION

In this study, a compact 'L' shaped microstrip patch antenna is presented for Satellite applications. The result shows that this antenna provides resonant frequency at 14.9 GHz with return loss -30.7 dB. The high gain is 6.13dBi. All results are shown in simulation results. Very thin slit or slot in the patch cause Return loss (S11) is improved.. Also 13% more return loss achieved than Return loss achieved in previous researches.

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