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Design of Rectangular Micro strip Patch Antenna with Partial Ground Structure for C Band Satellite Applications

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ABSTRACT

The objective of this paper is to design rectangular microstrip patch antenna using microstrip line fed technique with enhancement in gain and bandwidth. Proposed configuration is suitable for C band (4GHz to 8GHz) applications. Transmission feed with partial ground structure is used to achieve desire bandwidth with moderate gain. In this paper the enhancement of bandwidth of proposed structure resonates at 5.75GHz. Further enhancement is achieved by etching out C slot on radiating patch .The measured result shows that the proposed antenna has operate in wide range of impedance bandwidth of 6.23GHz. Introduction of C slot and slits on patch resonates achieved bandwidth of 7.31GHz.Simulation is done using CADFEKO simulator.

Index Terms— Microstrip Line Feed, Partial ground structure, C-slot

I. INTRODUCTION

Research group presents dual band rectangular microstrip patch antenna using T- slot and capacitive loading for wireless applications. That antenna resonates at 2.50GHz and 4.80GHz, having bandwidth of 137 MHz and 123MHz with gain of 2.07dBi and 1.51dBi [1].

Authors present slot loaded microstrip patch antenna for ISM, Wi-MAX And C-Band Using U Slotted Structure.[2] Introduction of slot converts single band antenna into multiband operations which is recent need of wireless communication. Antenna designed for implemented configuration. Designed structure resonates at 2.45GHz 4.5 GHz .

Authors presented review of slotting techniques. Slotting improves the performance of microstrip patch antenna in terms of bandwidth,gain,directivity and reduction in size[3] Recently there is increase in demand for microstrip patch antenna in satellite communication applications. And they are widely used for the purpose because of their planar structure, low profile, light weight, moderate efficiency and ease of integration with active devices.[4,5]

Microstrip patch antenna is a printed type antenna consisting of a dielectric substrate sandwiched in between ground plane and a patch [6].To enhance the efficiency of antenna different dielectric substrates are used in microstrip patch antenna .it provide mechanical strength to antenna. For this design Dielectric substrate of FR4 is used. With dielectric constant is 4.4.

For a rectangular Microstrip patch, the length of the patch is basically 22mm $<L<$ 27mm.This patch is selected very thin such that thickness of patch is $\ll \lambda_0$

II. ANTENNA DESIGN

Proposed antenna geometrical structure as shown in Fig.1. The estimated dimensions of the substrate is 26mm x 30mm using equation of transmission line modeling[7,8].The excitation is launched through a microstrip feed line has a length of 13mm and width of 3mm.

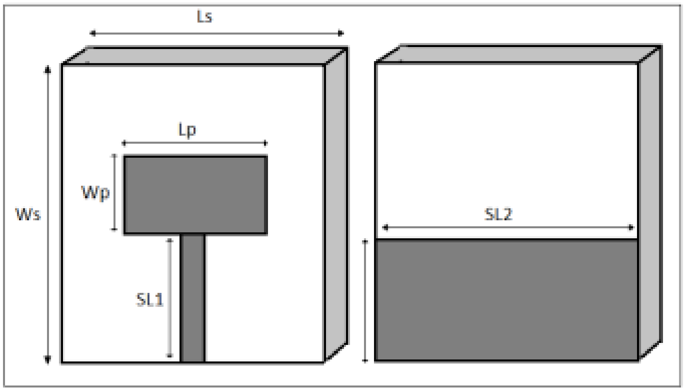

Fig1. Reference Antenna 1 with partial ground structure.

Calculation of the Patch width: The width is depends on the operating frequency and substrate dielectric constant.

$$w \equiv \frac{c\sqrt{\frac{2}{1+\epsilon r}}}{2fr} \quad (1)$$

Calculation of the Patch Length:

$$\mathrm{L} \equiv \mathrm{Leff} - 2\Delta\mathrm{L} \quad (2)$$

$$Leff = \frac{c}{2fr\sqrt{\epsilon reff}} \quad (3)$$

Calculation of Effective dielectric constant:

The effective dielectric constant is less than εr, because of fringing field around the periphery of the patch is not to the dielectric speared in the air.

$$\epsilon reff \equiv \frac{(\epsilon r+1)}{2} + \frac{(\epsilon r-1)}{2\sqrt{1+12\left(\frac{h}{w}\right)}} \quad (4)$$

Calculation of the Substrate dimensions:

$$Ls=L+6h \quad (5)$$

$$Ws=W+6h \quad (6)$$

Calculation of the ΔL:

The extended incremental length of the patch is

$$\frac{\Delta L}{h} = 0.412\,\frac{(\varepsilon reff+0.3)\left(\frac{W}{h}+0.2264\right)}{(\varepsilon reff-0.258)\left(\frac{W}{h}+0.8\right)} \quad (7)$$

The resonating frequency is given by,

$$fr = \frac{c}{2(L + 2\Delta L)\sqrt{\epsilon\ reff}} \quad (8)$$

This antenna is designed for transmission line model the operation of this model is mainly based on equivalent magnetic current distribution around the patch edges. The patch is represented by perfect electric conductors on dielectric substrate having thickness in terms of wavelength. This model was proposed for rectangular patch.

III. SIMULATED RESULTS

The simulation of the antenna is carried out with electromagnetic software CADFEKO which is based on the MOM method. Fig 1 is the reference model of design antenna. it has a partial ground structure with dimensions of 30mm x 12mm.partial ground structure result in larger bandwidth and enhancement in gain. For this reference dimensions antenna shows 6.13GHZ bandwidth

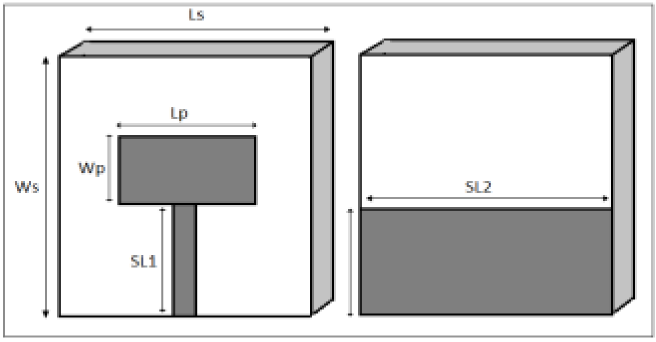

Fig: 3D Reference Model

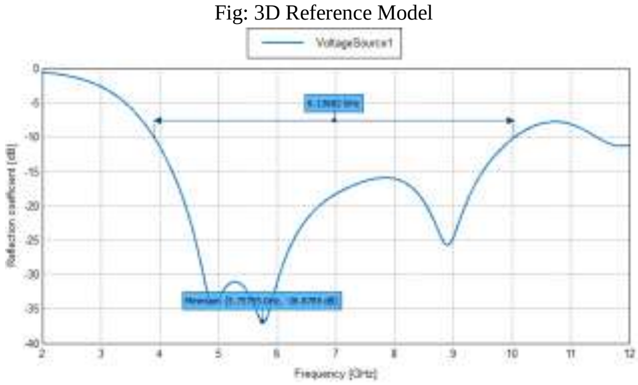

Fig 2:Reflection coefficient [S11]is a function of impédance [Résonant Frequency =5.75GHz, Bandwidth=6.13GHz]

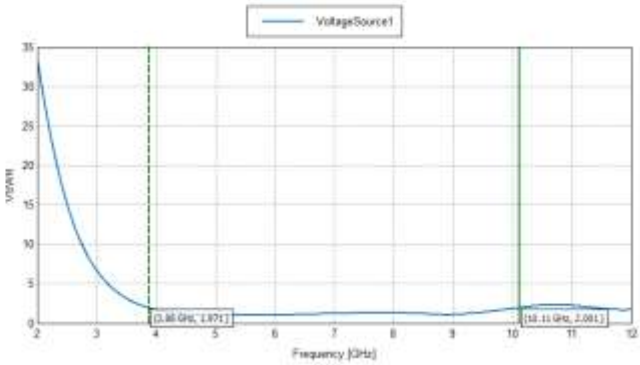

Fig 3:VSWR is a function of reflection coefficient [VSWR Bandwidth is for 6.23GHz for VSWR<2]

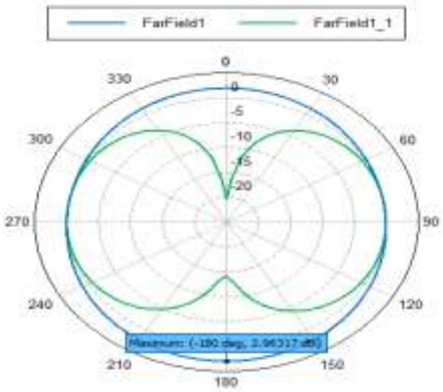

Fig 4:Gain is a function of input power [Gain=2.94dBi]

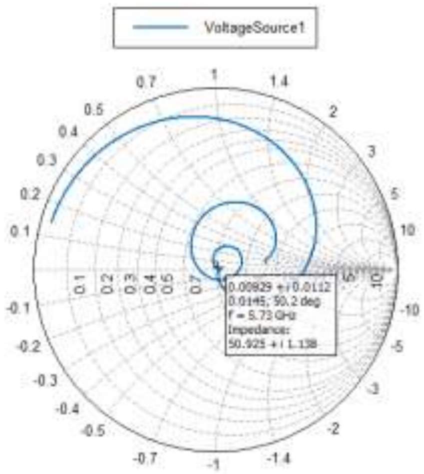

Fig 5:Impedance is function of R,L&C of MP [Impedance at 5.75 GHz is 50.92 Ω]

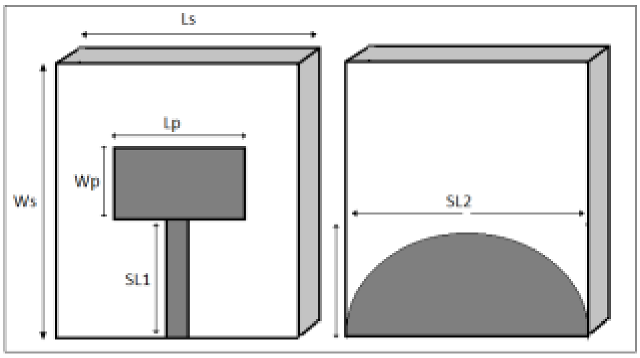

Fig 6:Partial Ground with corner cut structure

In Fig 6 Slotting is applied to partial ground structure(upper corner cut)Resulting in increase in bandwidth from 6.13GHz to 6.87 GHz.

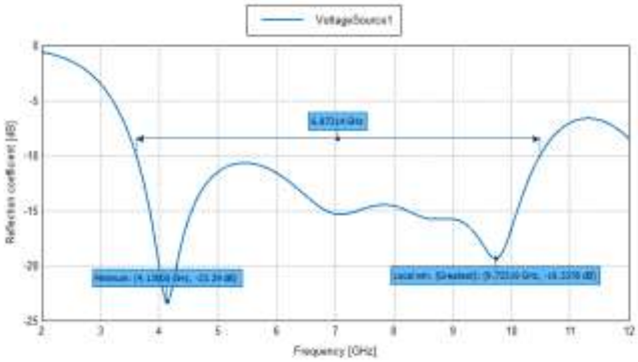

Fig 7: Reflection coefficient for Partial Ground with corner cut structure

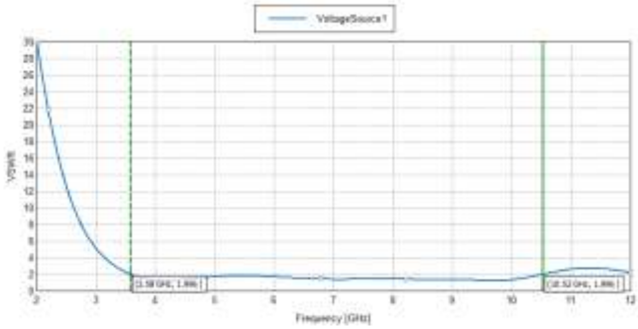

Fig 8: VSWR for Partial Ground with corner cut structure

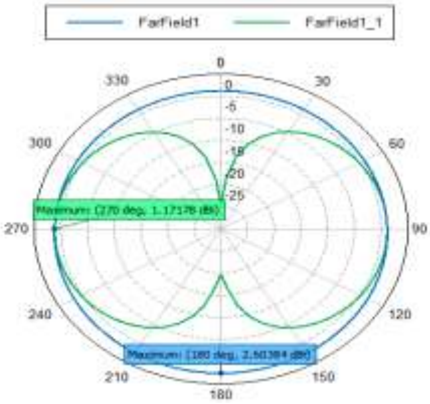

Fig 9: Gain for Partial Ground with corner cut structure

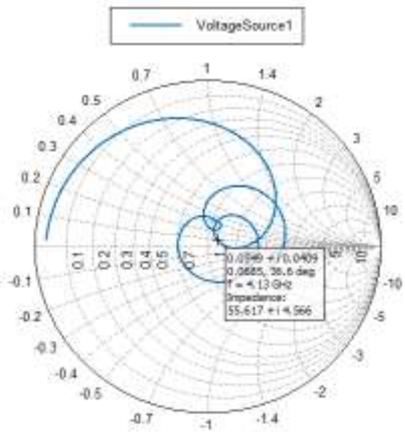

Fig 10: Impedance for Partial Ground with corner cut structure

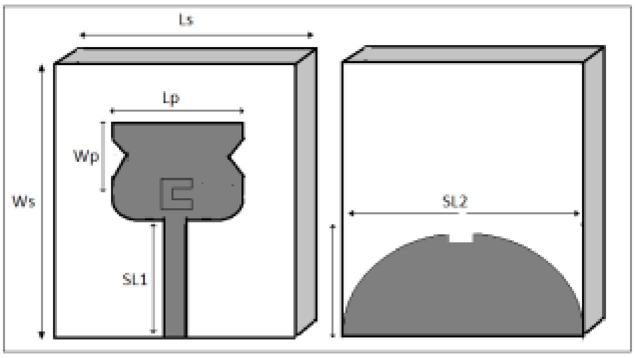

Fig 11: Patch along with designed C shape slot Antenna

This antenna has centre notch cut for partial ground

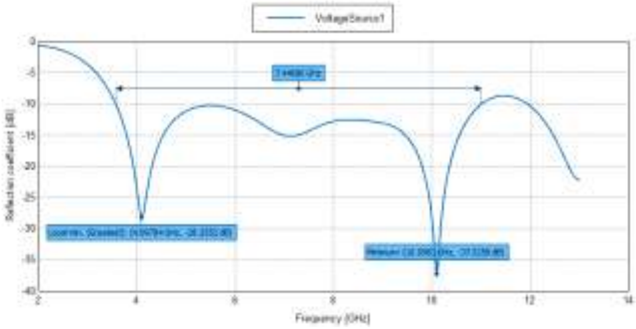

Fig 12: Reflection coefficient for Patch along with designed C shape slot Antenna

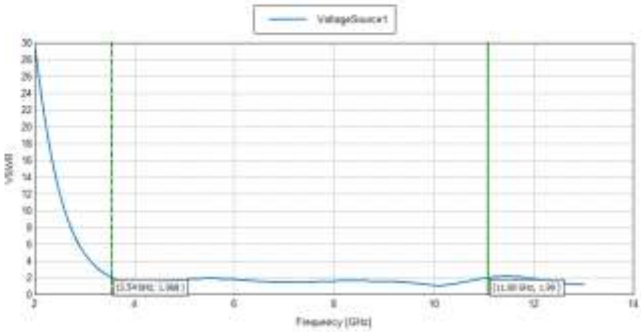

Fig 13: VSWR for Patch along with designed C shape slot Antenna

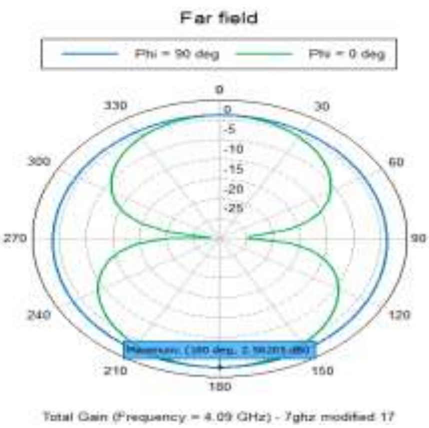

Fig 14: Gain for Patch along with designed C shape slot Antenna

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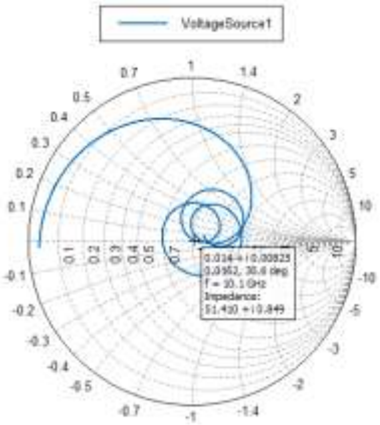

Fig 14: Impedance for Patch along with designed C shape slot Antenna

IV. Results and Discussion

Table I Simulated Results

Sr. No	Type	Bandwidth GHz	VSWR GHz	Impedance	Gain dib
1	Reference Antenna with partial ground	6.13	6.23	50.925	2.94
2	partial ground with slot	6.87	6.94	55.61	2.60
3	Antenna with C shape slot, corner cuts	7.44	7.54	51.41	3.37

Reference antenna shown in Fig 1 designed for 6GHz frequency. Which is simulated and results are observe for Bandwidth, VSWR, Impedance, Far Field & Gain. Further antenna structure shown in Fig.2 is modified by slotting technique and which shows good improvement in bandwidth. It is observed that slot is used to match impedance of antenna.

Reference antenna resonate at 5.75 GHz, gives bandwidth of 6.13GHz , impedance observed is of 50.92ohm, VSWR for the range of frequency 3.87 GHz to 10.1 GHz is maintain below 2. Gain received by this structure is of 2.94Bi.

Modified structure resonate at 4.09 and 10.09 GHz, gives bandwidth of 7.44GHz , impedance observed is of 51.41 ohm, VSWR bandwidth of 7.54 GHz and is maintain below 2. Gain received by this structure is of 3.37dBi.

V. Conclusion

Proposed antenna 26mmX 30mm Resonates at 5.75GHz GHz with bandwidth of 6.13GHz and gain of 2.94dBi. Further enhancement of bandwidth by introduction of C-slot and slits gives bandwidth of 7.44GHz.It is observed that perturbation of slots is used to match impedance of structure to 50ohm which gives wide bandwidth. Design antenna is useful in C band application. Scope of this work is to enhance Gain of antenna by using suitable gain enhancement technique.

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