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Bandwidth Enhancement of Compact Slot Loaded Rectangular Microstrip Patch Antenna using IE3D

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ABSTRACT: In this research paper, a compact microstrip patch antenna had been design and analyzed. The proposed antenna get the required impedance bandwidth is 77.85%. The design antenna has resonant frequency of 2.2GHz. The bandwidth enhanced by changing parameters of rectangular microstrip patch antenna. The variation made in the design structure antenna is cut different slot on patch and simulate the result of design structure. The proposed antenna is used for band (2.057GHz to 4.679GHz) suitable for wireless communication. A line feed of 50Ω is introduced to the given rectangular shape radiating patch antenna. The antenna is suitable for application such as Mobile satellite services 2.2GHz is realized.

KEYWORDS: Compact, Bandwidth, Patch, Rectangular, Radiating, Wireless. Line feed.

I. INTRODUCTION

Wireless communication devices make increment of demand of compact and low profile antenna. This compact antenna design work in S band frequency at frequency 2.2GHz. S band frequency between 2.0 to 2.2GHz is used as Mobile satellite services (MSS). Frequency 1.98GHz to 2.01GHz is allocated for Earth to satellite communication and frequency 2.17GHz to 2.2GHz for space to Earth communications. Further in some of countries this frequency as well used for Direct-to-Home satellite television. This is similar service most countries use in Ku band. The design frequency 3.3GHz used called a name as WiMAX. WiMAX is a part of wireless communication standards. Transmission of different types of multimedia services[1]such as (voice, internet, email, games and others) at a very high data rate is also done by WiMAX technology .WiMAX technology is intricate to analyses but it is very beneficial technique. The WiMAX technology is define in thousands of pages of IEEE 802.16 standards and amendments documents. There are some WiMAX frequency which is mainly used in south east Asia are 2.3, 2.5, 3.3 and 5.8 GHz [1].In this we can take help of paper [8] gain and bandwidth enhancement technique is used and gain-enhanced patch antennas with loading of shorting pins [9].In this a rectangular patch antenna bandwidth will be enhanced for improvement of its gain, efficiency, return loss and as well as bandwidth.

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II. BASIC PARAMETERS FOR ANTENNA DESIGN

For calculation of dimension of antenna, several parameter which are resonant frequency (f_r), substrate thickness (h), loss tangent ($\tan\delta$), and dielectric constant (ϵ_r) [10] given in table 1

Table 1: Antenna design specifications

S.No.	Antenna Parameter	Values
1	Design Frequency (f_r)	3.3GHz
2	Substrate thickness (h)	1.6 mm
3	Dielectric constant (ϵ_r)	4.4
4	Loss tangent ($\tan \delta$)	0.001

III. GEOMETRY OF PROPOSED ANTENNA DESIGN

In the design of proposed antenna we make firstly design of a rectangular patch with calculated dimension of patch and ground plane and make design on the patch. Dimensional parameters of proposed antenna are list below table 2. Then we cut a slot on rectangular patch like a mirror image of c shape after this we measure the gain, return loss and all other parameters then we cut another slot by its corner of shape and again measure all parameters, finally we cut a slot from other edge corner and noted down all parameters. By operating this way the resonant peak shifted towards lower frequency side and as a result the bandwidth has been enhanced.

Table 2: Calculated dimensions of proposed antenna

S.No	Antenna Dimension	Values(mm)
1	Ground Length (L_g)	30.84
2	Ground Width (W_g)	37.26
3	Patch Length (L_p)	21.24
4	Patch Width (W_p)	27.66

Initially, a conventional antenna of length 21.24mm and width 27.66mm radiating patch has been design with ground plane of length 30.84mm and width 37.26mm. After designing ground plane and patch, a rectangular notch of 10.62mm x 13.83mm is cut from its left edges at coordinate (10.11mm, 18.63mm) and a line feed of 50Ω is applied at top edge of patch. Fig 1 represents the geometry of proposed antenna with notch.

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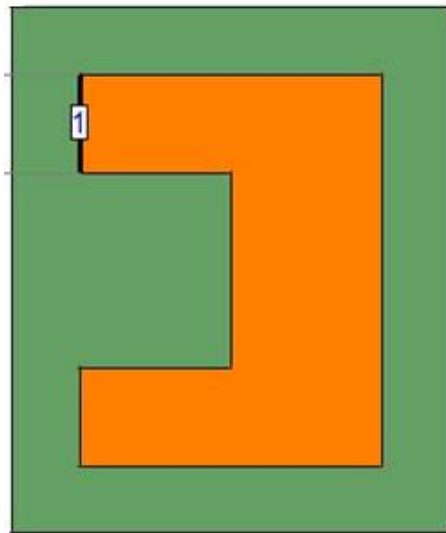


Fig.1 Geometry of proposed antenna with notch

The proposed antenna is simulated between 1GHz to 5GHz. The design antenna is resonating at 2.38GHz with lower frequency about 2.14GHz and higher frequency about 2.86GHz. Bandwidth is come 28.69% with return loss is -19.147dB. S parameter display and VSWR display are shown in fig. 1(a) and fig. 1(b).

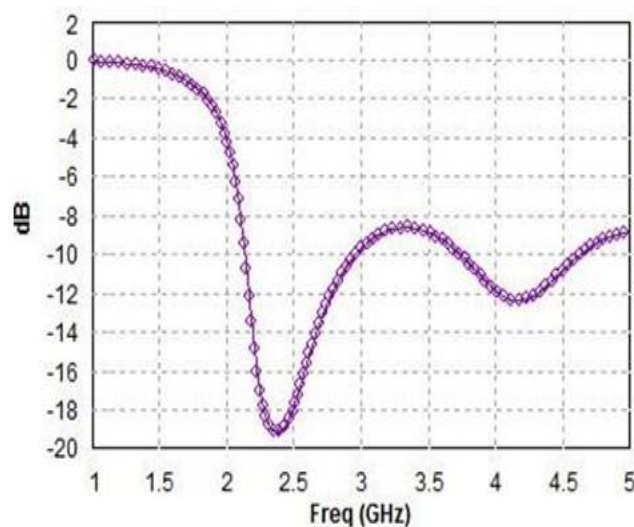


Fig 1(a) S parameter display

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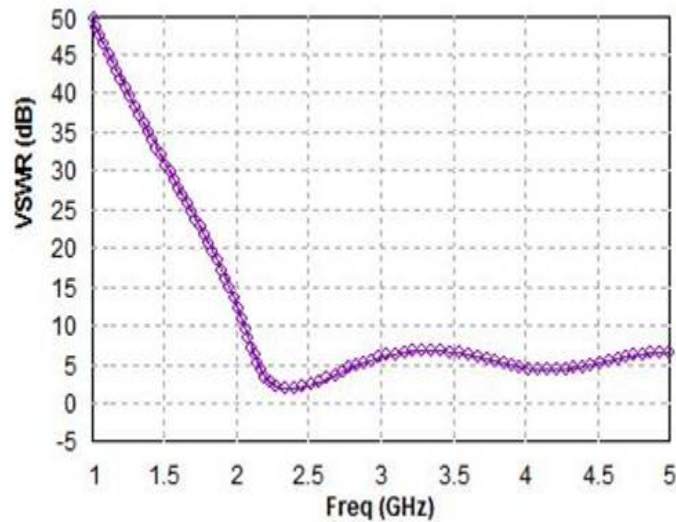


Fig 1(b) VSWR display

After this, a slot of dimension 5mm x 5mm is cut at coordinate (15.275mm, 25.5mm) in the rectangular notch. The geometry of proposed antenna with first slot is shown in fig 2. By introducing this slot, the bandwidth is come 68.33 %, with the resonant frequency 3.814 GHz. The lower frequency is about 2.133GHz and higher frequency is about 4.347GHz and return loss is -22.00dB and S parameter display and VSWR display are shown in fig. 2(a) and fig. 2(b)

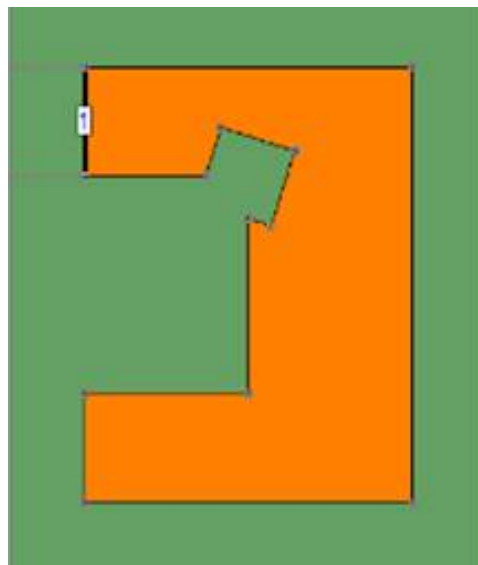


Fig 2 Geometry of proposed antenna with one slot

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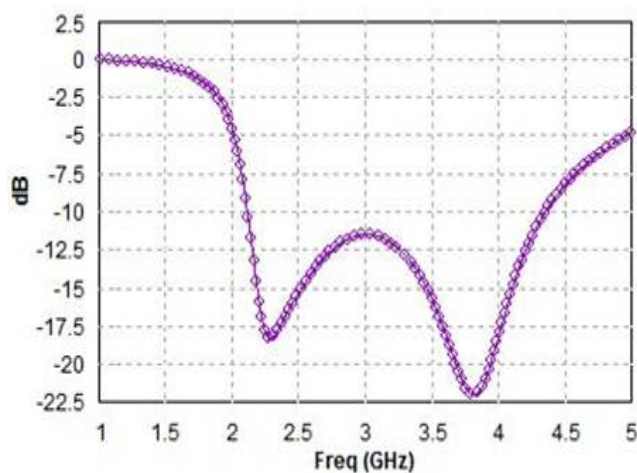


Fig 2(a) S parameter display of one slot

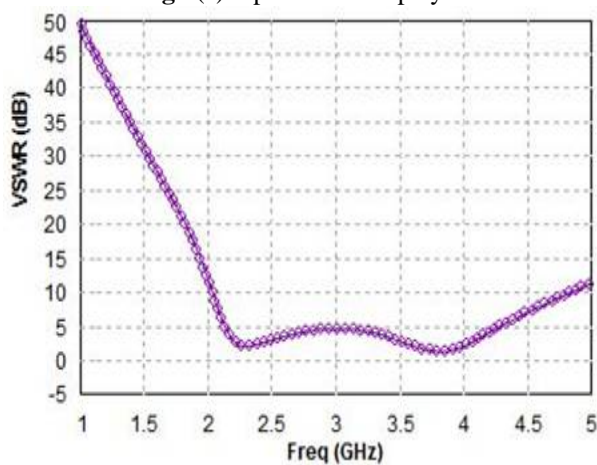


Fig 2(b) VSWR display of one slot

After loading first slot, another slot of dimension 5mm x 5mm is cut at coordinate (15.275mm, 11.475mm) in the rectangular notch. The geometry with first slot proposed antenna is shown in fig 3.

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Vol. 7, Issue 7, July 2018

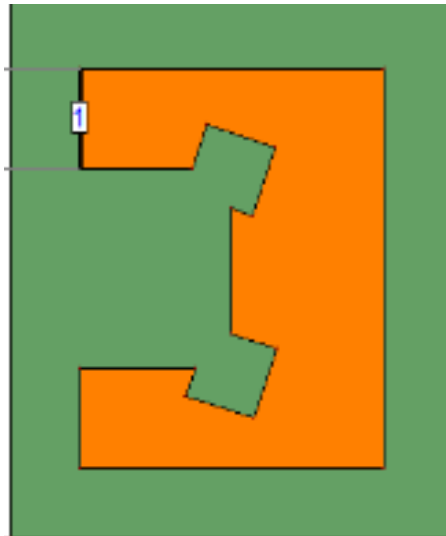


Fig 3 Geometry of proposed antenna with two slots

By introducing second slot, the bandwidth is come 77.85%, with the resonant frequency 2.2GHz. The lower frequency is about 2.057GHz and higher frequency is about 4.679GHz and return loss is -53.835dB and S parameter display and VSWR display are shown in fig. 3(a) and fig. 3(b)

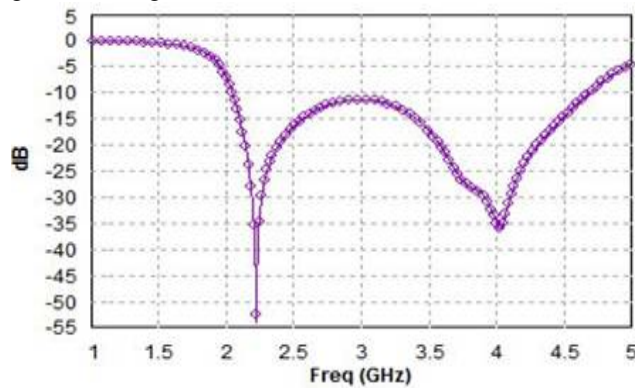


Fig 3(a) S parameter display of two slots

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Vol. 7, Issue 7, July 2018

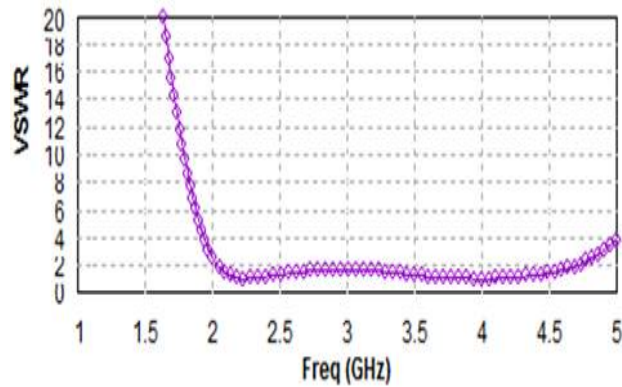


Fig 3(b) VSWR display of two slots

The comparative analysis of all three antennas with rectangular notch, one slot and two slots are shown in table 3

Table 3: Comparison between different slots

No. of slot cut	Resonant Frequency (GHz)	Return loss (dB)	Lower Frequency (GHz)	Higher Frequency (GHz)	Bandwidth (%)
1	2.38	-19.147	2.1411	2.8618	28.69%
2	3.814	-22.00	2.133	4.347	68.33%
3	2.22	-53.838	2.057	4.679	77.85%

IV. SIMULATION AND DISCUSSION

By designing software IE3D simulation software, the performance of proposed microstrip patch antenna is analyzed at resonant frequency of 2.22GHz. Final configuration of proposed antenna is shown in fig. 4. Simulation results of return loss, VSWR, 2D radiation pattern, gain, antenna efficiency and directivity are plotted for the range of frequency 1GHz to 5GHz. Calculate fractional bandwidth of proposed antenna is 77.85 % which lies between 2.057 GHz to 4.679GHz band and return loss is -53.88dB at resonance frequency 2.22 GHz has been obtained.

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Vol. 7, Issue 7, July 2018

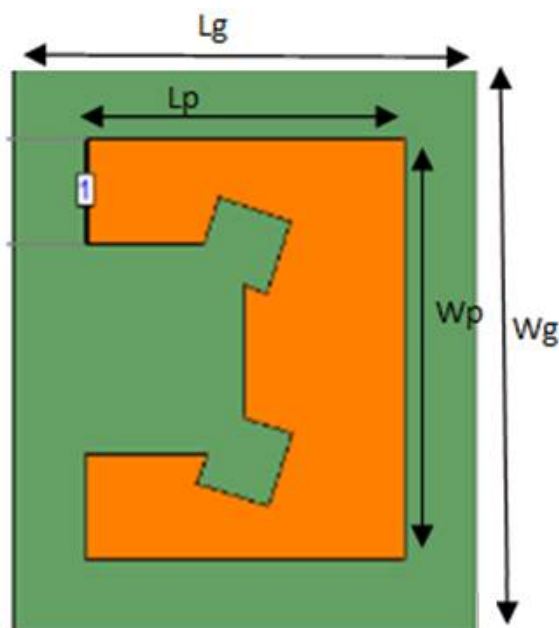


Fig. 4 Geometry and dimension of the proposed Antenna

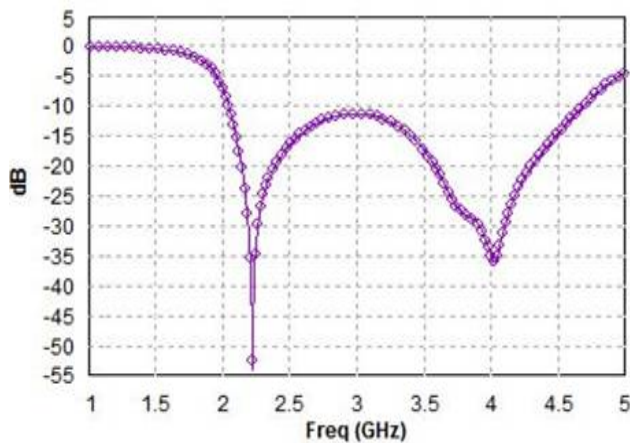


Fig. 5 Simulation result of proposed antenna

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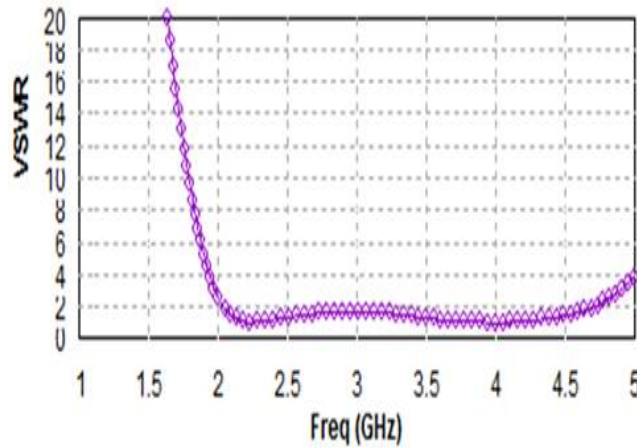


Fig. 6 VSWR graph display

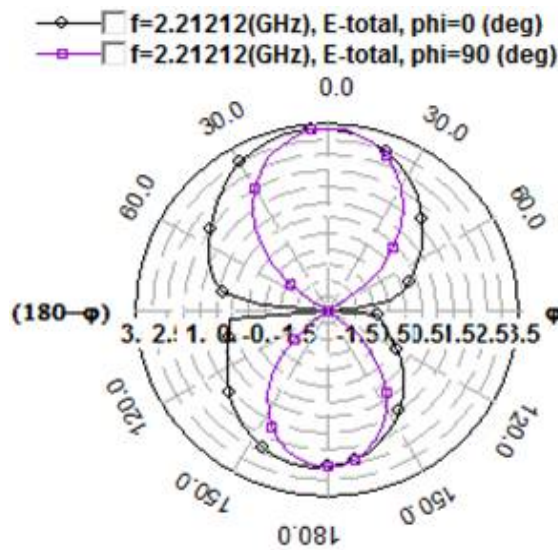


Fig 7 2D Radiation Pattern

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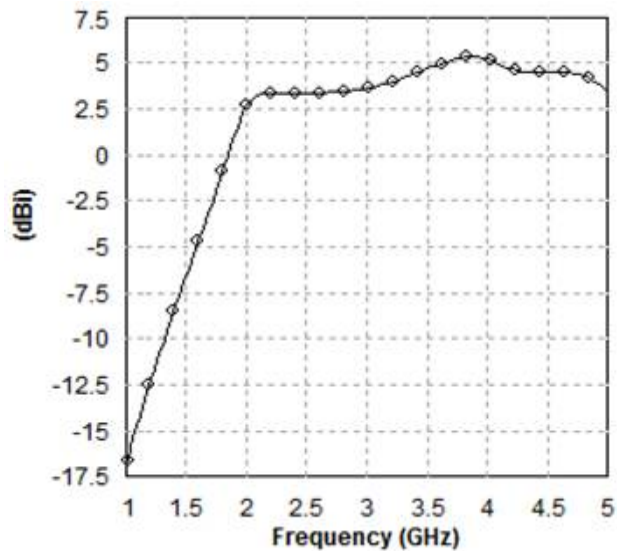


Fig 8 Gain Vs frequency graph display

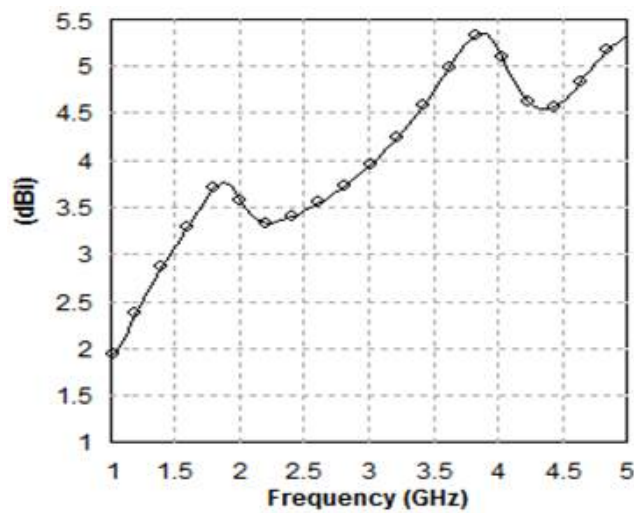


Fig 9 Directivity Vs frequency display

International Journal of Innovative Research in Science, Engineering and Technology

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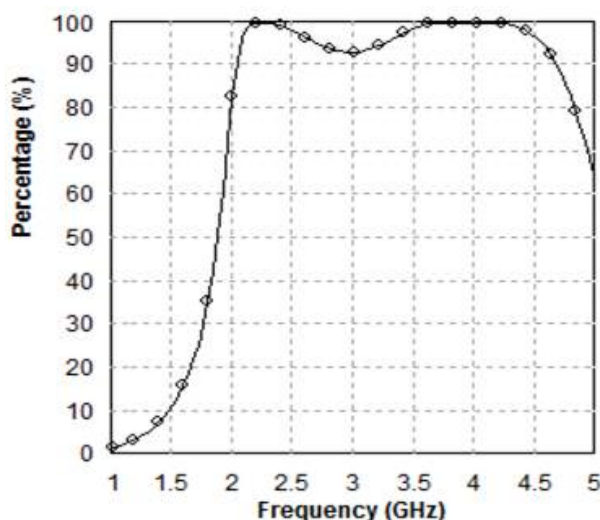


Fig 10 Efficiency Vs frequency graph display

V. CONCLUSION

A rectangular patch antenna which resonating 2.2 GHz frequency and used for MSS (Mobile satellite services) application and mobile satellite communication. IE3D simulation software used for simulation purpose the bandwidth is enhanced of a rectangular patch antenna. In compression of all three slot cut in patch, there is difference occur in BW. The BW of antenna is enhanced from 28.69% to 77.85%. Return loss of antenna also increased from -19.147 to -53.838 dB. The result of antenna gain is come 3.3269dB and Directivity is 3.32735dB. The 3dB beam width is (79.5397, 152.895) deg and antenna efficiency is 99.9894%.

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