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Offset-Fed Microstrip Patch Antenna for Multiband Communication Purpose in the field of Communication

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Abstract— Many techniques have been introduced to increase the number of bands, including the use of feed line asymmetry and fractals. Feeding system plays an important role to increase the number of bands[3].One of the original excitation methods for the microstrip patch antenna is edge fed or microstrip line fed technique. The proposed antenna structure consist of a I-shaped microstrip feed line and open slots of very small size in ground. Offset Feed increases overall performance of antenna to fulfill requirements of multiband communication. Further relationship of slots cut in ground to bandwidth performance has been analyzed.

Keywords:Feedline,Fractals,Bandwidth,Slots,Offset,Excitation,Microstrip

1 Introduction

For some applications in wireless communications, it is quite desirable to design a patch antenna covering two or three frequency bands which are close to each other [1].Wireless applications such a radar, telemetry and communication system require high gain, high efficiency, low profile, light weight and low cost along with the research in miniaturization of system devices being undertaken [5].

It is very difficult to get all such requirement in a single antenna. The high conductor loss reduces the gain and efficiency [8]. Various methods can be used to increase the bandwidth of Microstrip antennas such as using thicker substrate or substrate with lower dielectric constants, employing numerous feeding techniques and using slot antenna geometry. Although the bandwidth and the size of antenna are generally mutually conflicting[9]. Improving one characteristic normally results in degrading the other outcome[7].

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The conductor loss can be reduced by constructing the feed network using low transmission media such as microstrip line offset feed [12].Further to improve results defected ground structures(DGS) has been used,which includes slots in ground of different sizes and shapes[6]. DGS is realized by etching the ground plane of microstrip antenna, this disturbs the shield current distribution in the ground plane which influences the input impedance and current flow of the antenna. The geometry of DGS can be one or few etched structures which are simpler and do not need a large area to implement it. [4]. This paper discusses the influence of rectangle shape DGS towards the improvement of impedance bandwidth and radiation properties[8]. By adding the DGS, the surface wave propagation in the dielectric layer is suppressed, resulting into enhancement in impedance bandwidth by retaining almost the same radiation pattern and gain[2].

An efficient performance of the antenna requires a proper feeding structure, which here employs feed line on back side of ground [6]. One merit of this configuration is a good isolation between the incident radiation and the feeding circuits [5]. The width of feeding microstrip is W, corresponding to characteristic impedance of 50 Ω.Coupling between the microstrip and the slot is achieved with microwave open stub [1].This paper introduces contacting feed method using off set microstrip feed line in which microstrip feed line is slightly offset from the middle [2].Results shows multiband operated microstrip patch antenna with VSWR≤1.

I. ANTENNA CONFIGURATION

ANTENNA GEOMETRY

The proposed antenna structure consists of a cross-shaped microstrip feed line and multiple open slots in the ground surface[4]. By properly selecting dimensions of slots various bands can be obtained. Initially no slots are cut on the ground and results are observed. Further by introducing slots on the ground, effects on bands are observed. A compact micro strip-fed slot antenna with multi band operation is presented for wireless communication system. Substrate used is FR4 with the relative dielectric constant of 4.4.Thickness of antenna is 1.6mm.The overall dimension of the proposed antenna is 34X14X1.6 mm³.Slots are cut on ground to introduce more bands .On the other hand. The slots are electromagnetically fed by a microstrip feed line on the other side of board. The modified feed line is shown further, which is protruded with stub of width W.

A) Design I

Fig 1 shows the configuration of the proposed offset fed microstrip patch antenna. It consists of a I-shaped radiator with offset position and a ground without any slot in it. The first step of designing is to determine the size and dimensions of patch. The antenna is fabricated on a low cost FR-4 substrate with the thickness of 1.6mm, a relative permittivity of 4.4 and a total size of W X L. The radiated microstrip line has size W_P X L_P.A stub is further attached to micrstrip line to enhance the results.

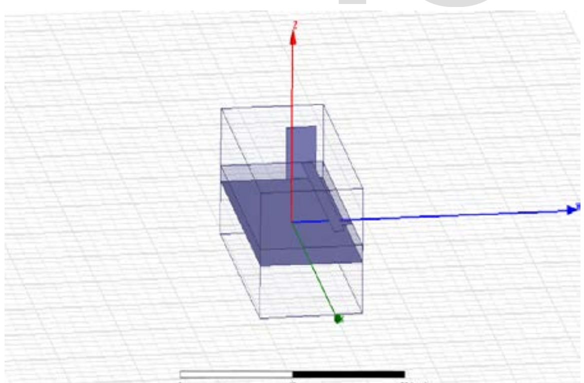

Fig.1. Patch Antenna initial geometry

Simulated Results

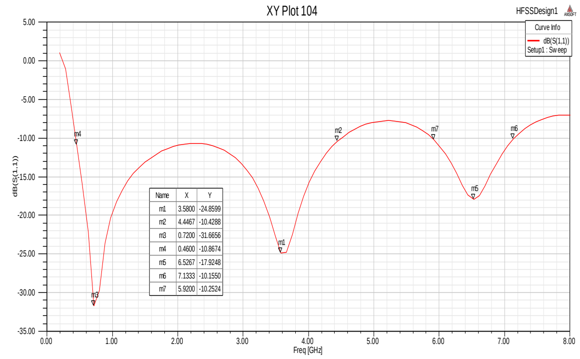

Fig. 2.Return Loss v/s Frequency

The calculated result shows that the return loss reaches a minimum value of about 31.66 dB at 0.7 GHz, 3.6 GHz & 6.5 GHz of the offset fed slot antenna. The design gives bandwidth of 547% and 18.09 %the antenna is resonant at frequency 3.66 GHz with single band operation. This antenna proposes a microstrip line patch antenna for WIMAX application at 3.6 GHz frequency.

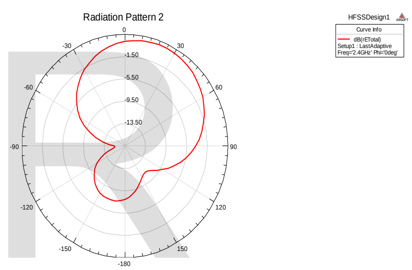

Fig. 3.Radiation Pattern

Fig.4. 3D Radiation Pattern

Fig.3 and Fig.4 shows radiation characteristics of antenna across the operating frequency. From an overall view, the antenna behaves nearly unidirectional.

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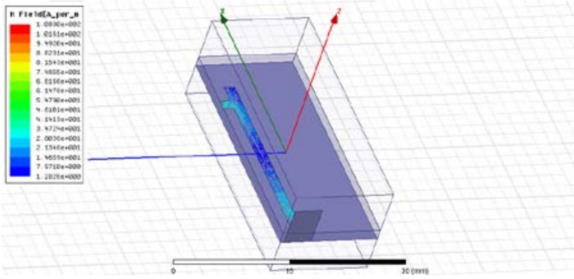

Fig.5. Current Distribution

B) Design II

Results obtained from design I are not adequate, to improve the result a slot of size aXb is cut on the ground plain and observations are made for the same.

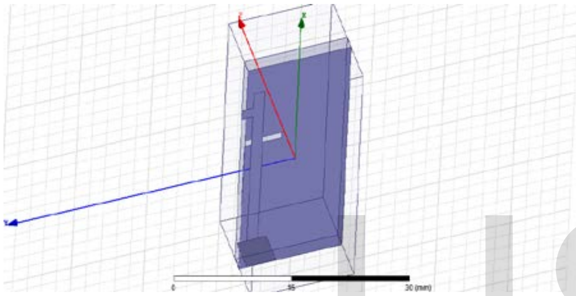

Fig .6.Single Slot in Ground Plane

The slot etched in ground plane reduces the ,enhancement of the surface wave propagation in the dielectric layer.It effects bandwidth of antenna although return loss may be improved.

Simulated Results

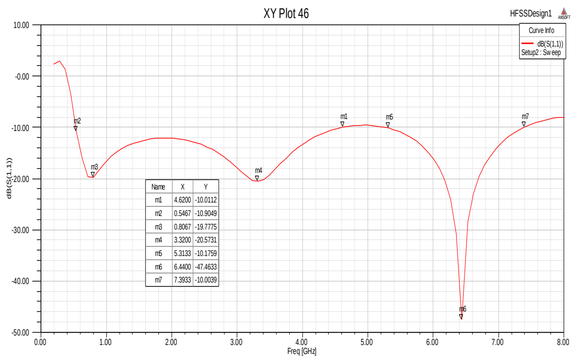

Fig. 7. Return Loss v/s Frequency

Antenna is simulated by HFSS and this design gives three bands which are resonated at 0.8 GHz, 3.3GHz & 6.4GHz. Radiation pattern is calculated, which is partially unidirectional as shown in Fig.8.

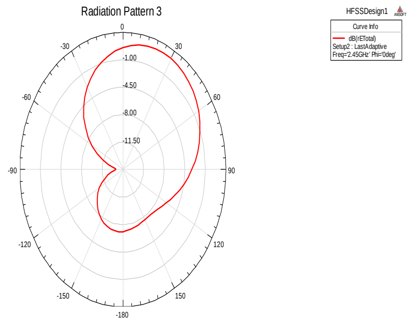

Fig.8.Radiation Pattern Measurement

C) Design III

Further to improve results, two more slots are cut in the ground plate. These slots in ground plate improve results obtained.Antenna design is simulated and results observed gives enhanced bandwidth with multiple number of bands in comparison to previous design[11].

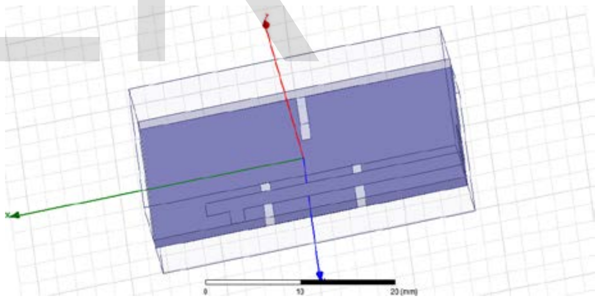

Fig .9.Triple slots in ground plane

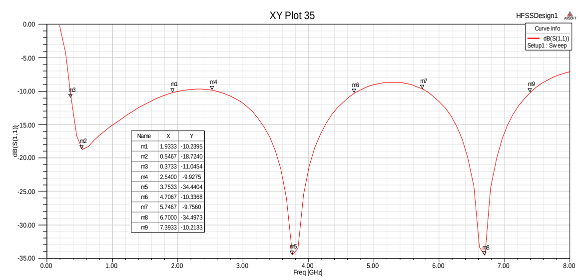

Fig .10. Return Loss v/s Frequency

Simulated Results

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Simulated results show bandwidth of 288%,58% & 23%. These bands are resonated at 0.5 GHz, 3.7GHz & 6.7GHz.

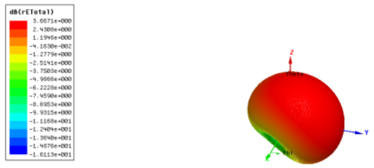

Fig.11. 3D Radiation Pattern

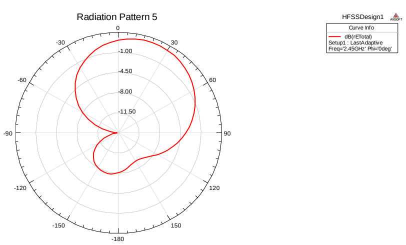

Fig.12.Radiation Pattern

D) Design IV

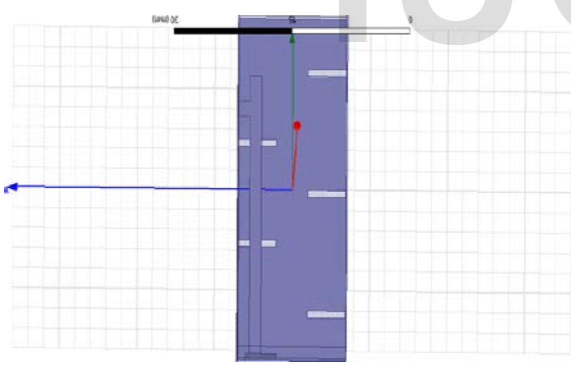

Fig .13.Penta slots in ground plane

Simulated Result

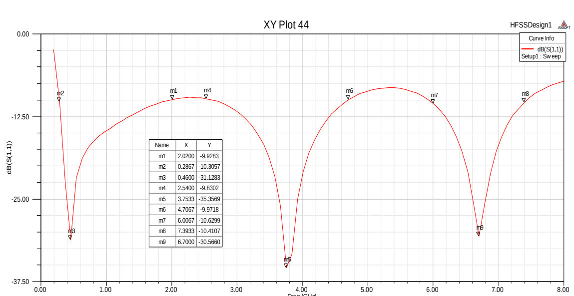

Fig .14 Return Loss v/s Frequency

Simulated results give bandwidth of 377%,58% and 20% respectively, which is better than results of previous design. Antenna is resonated at frequencies 0.4, 3.7 GHz and 6.7 GHz. This antenna is suitable for applications in S and C bands[12]. Also this antenna configuration is well suited for WIMAX application[10].

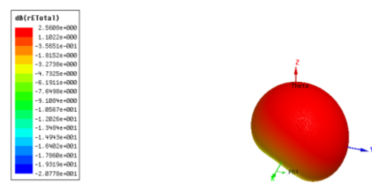

Fig.15.3D Radiation Pattern

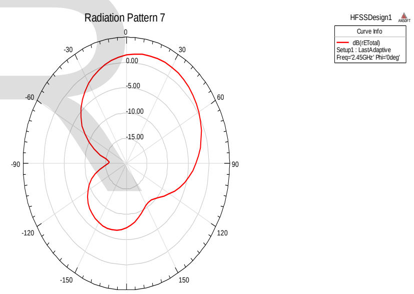

Fig.16.Raidation Pattern Measurement

Radiation pattern is partially unidirectional, which shows strong radiation in a particular part of antenna.

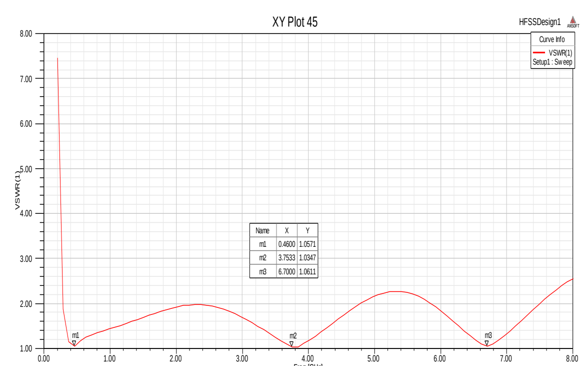

Fig.17 .VSWR Measurement

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It is obtained from fig.17 that VSWR is partially equal to 1 ,which is desirable in almost all antenna configurations[7].

CONCLUSION

It is shown that in cases where the bandwidth of printed planar antenna is limited because of restricted ground plane size, the feed line asymmetry can significantly increase the bandwidth [11]. For small size ground planes, the antenna bandwidth is unattractive unless feed-line asymmetry is used[15]. The resultant antenna can achieve wide impedance bandwidth with multi number of bands [14].Also the VSWR for each geometry results ≤1 for the resonated frequencies. These types of antennas are suitable to applications such as TV broadcasting,WIMAX,Mobile Phones,Wireless LAN,Bluetooth,GPS,Broadband Wireless,FWA,RF Powered System and various other applications.[5]

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References

[1] Wen Chung Liu,"Design of Triple Frequency microstrip-Fed Monoplole Antenna using Defected Ground Structure"IEEE Transactions on Antenna and Propogation,Vol.59,No.7,July 2011.

[2] Juhua Liu,Quan Xue,"Design and analysis of a Low-Profile and Broadband Microstrip Monopole Patch Antenna",IEEE Transactions and Propagation,Vol.61,No.1,January 2013

[3] H.G.Booker "Slot aerials and their relation to complementary wire aerials",J.IEE(London),pt.IIIA,vol.93,pp 620-626,1946.

[4] Yong-Woong Jang"Experimental Study of Large Bandwidth Three-Offset Microstrip-Fed Slot Antenna",IEEE Microwave and Wireless Componenet Letters,Vol.11,No.10,Oct 2001.

[5] Zhi Ning Chen,"Centre Fed Microstrip Patch Antenna",IEEE Transactions on Antennas and Propagation,Vol.51,no.3,March 2003.

[6] Keyoor Gosaliya,"Reduced size,Dual Polarized Microstrip Patch Antenna for Wireless communications"IEEE Transactions on Antennas and Propogation,Vol.51,No.9,Sept 2003.

[7] Aliakbar Dastranj and Habibollah Abiri "Bandwidth Enhancement of Printed E-Shaped Slot Antenna Fed by CPW and Microstrip Line",IEEE Transactions on Antennas and Propagation,Vol.58,No.4,April 2010

[8] V.P.Sarin,M.S.nishamol,D.tony,C.K.Aanandan,P.Mohanana and K.Vasudevan," Broadband L strip Fed Printed Microstrip Antenna"IEEE Transactions on Antennas and Propagation,Vol.59,no.1January 2011

[9] Wing Chi Mok,Sai Hoi Wong,Kwai Man Luk and Kai Fong Lee,"Single Layer Single Patch Dual Band and Triple Band Patch Antennas"IEEE Transactions on Antennas and Propogation,Vol.61,No.8,August 2013.

[10] Y.J.Sung,M.Kin and Y.Kim,"Harmonic Reduction with Defected Ground structure for a Microstrip Patch Antenna" IEEE Antennas and Wireless Propogation Letter,Vol.2,2003.

[11] Sun,YY;Islam.M.T;Cheung,SW;Yuk,TI;Azim,R;Misran,N"Offst-fed antenna with multi-slotted ground plane",IEEE Transaction.

[12] Liu,Y.F,Lau,K.L Que,and Chan,C.H"Experimental studies of printed wide-slot antenna for wide-band applications",IEEE Antennas wirel,Propagation.Lett,2004,3,pp.273-275.

[13] Sze,J.Y and Wong .K.L,"Bandwidth enhancement of a microstrip-line fed printed wide-slot antenna',IEEE Trans Antennas and propagation2001.

[14] Song K,Y.Z.,Yin,and B.Chen,"Triple-band open L-slot antenna with a slit and a strip for WLAN/WiMax application"Progress In Electromagnetic Research Letters,Vol.22,139-146,2011.

[15] Li,Z-Q,C.L,Ruan,L.Peng and X-H Wu,"Design of a simple multi-band antenna with a parasitic C-shaped strip,"Journal of Electromagnetic Waves and Applications,Vol.24,No.14-15