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A Pentagon shaped slot antenna with three circle stack patch for Wireless Applications

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Abstract: ***The paper presents a triple wideband slot antenna for WLAN and Wi-Max applications. The proposed antenna consists of a pentagonal slot with three circle stack patch with a CPW feed. The proposed antenna with a compact size of 32mm x 38mm x 1.6mm is prototyped on Flame Resistive FR-4 Epoxy substrate of thickness 1.6mm and dielectric constant 4.4. The proposed structure operates at three frequency bands (2.69 GHz to 3.56 GHz) 3.14 GHz, (5.69 GHz to 6.19 GHz) 5.95 GHz, (6.98 GHz – 7.66 GHZ) 7.35 GHz respectively. The basic antenna parameters like Return Loss, VSWR etc., satisfied the antenna standards. A comparative analysis is made by changing the dimensions of the feed line. Simulation tool, based on Finite Element method Ansoft HFSS has been used to simulate and analyze the proposed antenna structure.***

Keywords: CPW feed, Return Loss, Triple band, VSWR, Wi-Max, WLAN.

I. INTRODUCTION

The Wireless Communication technologies [1] are increasing day by day such as Wireless Local Area Networks (WLAN) and Worlwide Interoperability for Microwave Access (WiMax) etc. WLAN and WIMAX have different application ranges and different data transfer rates. The design of an antenna with wide frequency range of operation at multiple frequencies with compact size, low cost and easy integration is a challenge. For wireless applications, there are different types of antennas like Planar Inverted Folded Antennas, monopole antennas [2-4] and slot antennas [5-7] with different shapes such as U-shape, rectangular and trapezoidal shapes etc., which provide multiple frequency operations with a narrow bandwidths.

For the enhancement of the bandwidth, Coplanar waveguide transmission lines are used as feeding in networks. CPW feed provides wide bandwidth along with ease of monolithic Integrated circuit integration and fabrication, easy impedance matching, less dispersion, less radiation leakage and better isolation. A CPW fed slot antennas in [8] and [9] operate at triple bands for WiMax and WLAN applications but couldn't cover all frequency bands and have less bandwidths.

In this paper, a CPW fed pentagon shaped slot antenna with three circle stack patch is proposed which produce triple wideband operation that covers two WLAN frequency bands and one WIMAX frequency band. The input impedance to the proposed antenna is 50Ω. By varying the central feed length 'hs' of the CPW feed, the variation in impedance matching is studied. Also, by varying the shape of the slot from pentagon to rectangle, the difference in impedance matching is observed. The Antenna geometry and analysis are produced in this paper.

II. ANTENNA GEOMETRY

The configuration of the proposed antenna is shown in figure 1. The antenna is prototyped on FR4-epoxy substrate with a thickness of 1.6mm and relative permittivity of 4.4. The size of the antenna is 32mm x 38mm x 1.6mm and it is fed by Co-Planar waveguide (CPW) feed with an impedance matching of 50Ω feed line.

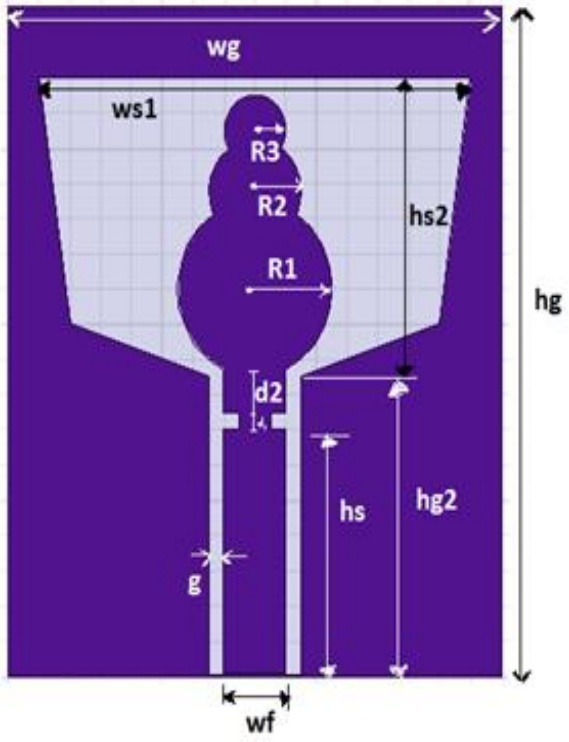


Figure 1: Proposed antenna configuration

The proposed antenna has a pentagon shaped slot with three circle stack patch as shown in figure 1. The dimensions of the antenna are as follows: wg= 32mm, hg= 38mm, g=1 mm, hs= 14mm, R1= 5mm, R2= 3mm, R3=2mm, d1=1mm, d2=3mm, wf=4mm, hg2=17mm, ws1=28mm, hs2=17mm. A comparison of return loss is made for antenna with rectangular shaped slot and pentagonal shaped slot. By varying the dimensions of the feed line, the variations in return loss is observed. All the simulations are carried out using FEM based Ansoft High Frequency Structure Simulator version 13.

III. RESULTS AND DISCUSSIONS

The proposed antenna is resonated at three frequencies 3.14 GHz, 5.95 GHz and 7.35 GHz with three bands from 2.69 GHz to 3.56 GHz, 5.69 GHz to 6.19 GHz and 6.98 GHz to 7.66 GHz respectively. The Return Loss at three resonant frequencies are -16.02 dB at 3.14 GHz, -15.17 dB at 5.95 GHz and -29.55 dB at 7.35 GHz as shown in figure 2.

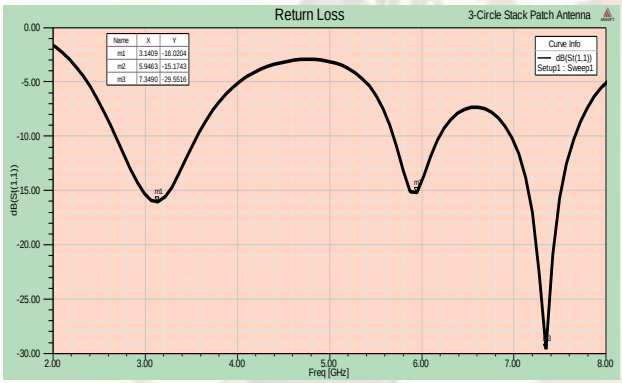


Figure 2: Return Loss (dB) versus Frequency (GHz)

By varying the dimension of feed line "hs" shown in figure 1, the variations in Return Loss are observed for different values of hs=13mm, 14mm, 15mm and the corresponding return loss is as shown in figure 3. For hs=14mm, the impedance matching is good when compared with other lengths of feed line. The reflection loss of the antenna is less for antenna with feed length 14mm.

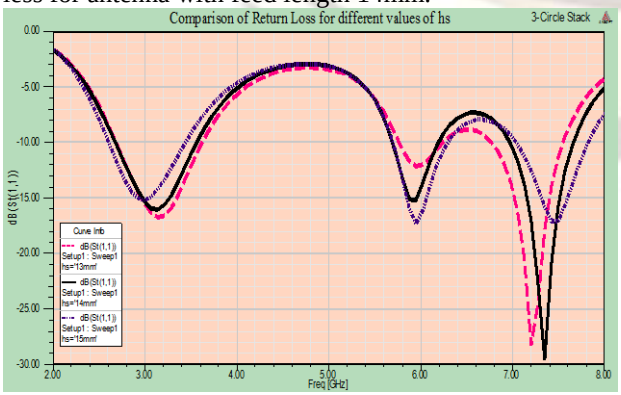
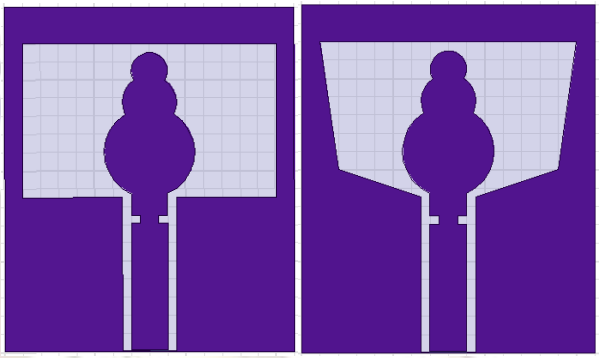


Figure 3: Return Loss for different values of "hs"

The proposed antenna is realized for two different slot shapes. First model is antenna with Rectangular slot and second model is antenna with pentagonal slot as shown in figure 4. The return losses for the corresponding two models are shown in figure 5. The pentagon shaped slot has less reflection loss from the antenna when compared with the rectangular shaped slot.



(a) (b)

Figure 4: a) Rectangular Slot b) Pentagonal Slot

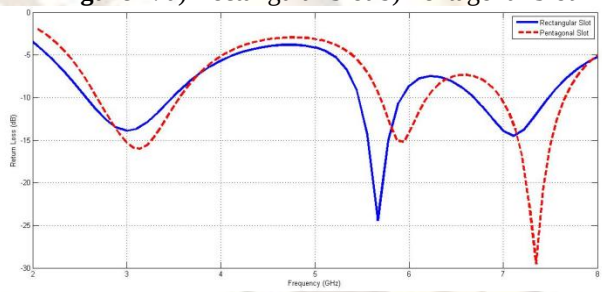


Figure 5: Return Loss vs Frequency for Rectangular and Pentagonal slots

The input impedance plot is shown in figure 6. The impedance bandwidth of the proposed antenna is obtained as 45.4%.

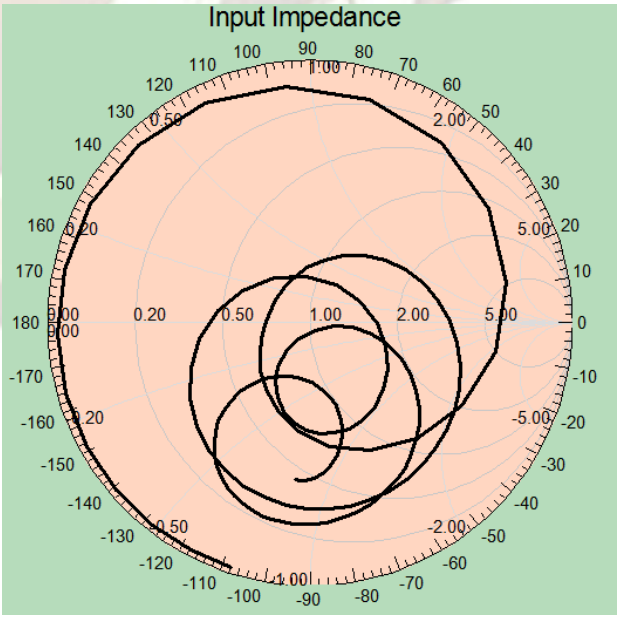


Figure 6: Input Impedance

The Voltage Standing Wave Ratio represents the power reflected from the antenna. It is a function of reflection coefficient. The minimum value of VSWR is 0 which is an ideal case at which no power is reflected from the antenna. According to the standards, the impedance matching is good if the VSWR lies between 1 and 2. Figure 7 shows the VSWR plot. The VSWR at the three resonant frequencies are 1.38, 1.42 and 1.07 respectively.

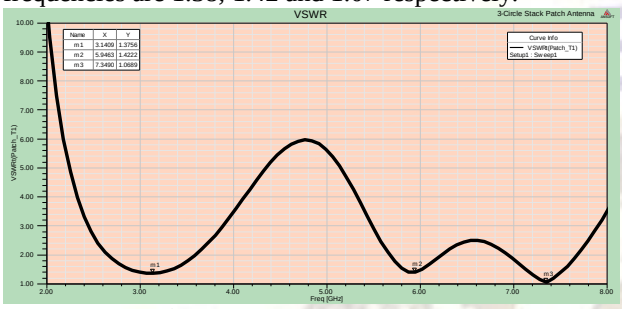


Figure 7: VSWR vs Frequency

The E-Plane Radiation patterns at 3.14 GHz, 5.95 GHz and 7.35 GHz for Phi=0 degrees and Phi=90 degrees are shown in Figure 8.

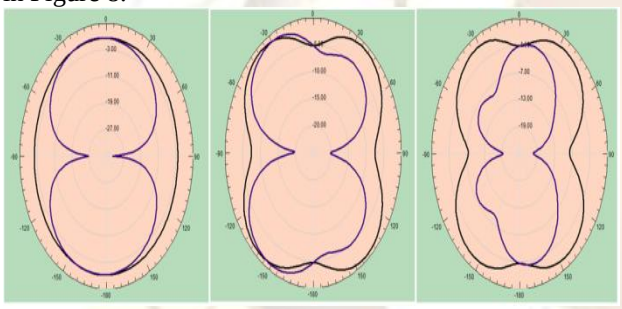


Figure 8: E-Plane Radiation Patterns at 3.14 GHz, 5.95 GHz and 7.35 GHz

The H-Plane radiation patterns at Theta=0 degrees and Theta =90 degrees are shown in figure 9.

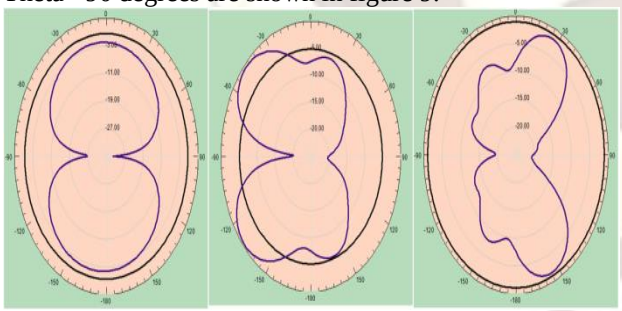


Figure 9: H-Plane Radiation Patterns at 3.14GHz, 5.95 GHz and 7.35 GHz

The surface current distributions at the corresponding resonant frequencies for the pentagon shaped slot antenna are as shown in figure 10.

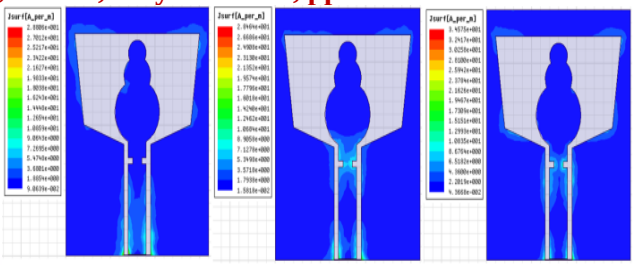


Figure 10: Surface Current Distributions

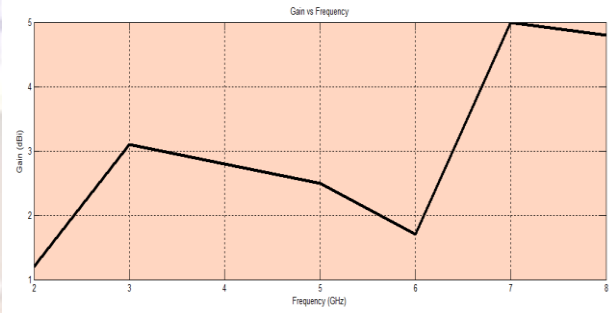


Figure 11: Gain versus Frequency

The peak gain of the antenna is 4.99 dBi for the pentagon shaped slot antenna.

IV. CONCLUSION

A CPW fed pentagon shaped slot antenna with three circle stack patch is proposed for triple wideband operation for WLAN and WIMAX applications. The antenna has a compact size of 32mm x 38mm x 1.6mm. The dependence of impedance matching on the shape of slot and the central feed length is analyzed. The peak gain is obtained as 4.99 dBi. The radiation patterns are quasi bidirectional in E-Plane. Finally, the proposed antenna is beneficial for short range wireless and mobile applications.

V. ACKNOWLEDGEMENT

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