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A DUAL BAND MICROSTRIP DOUBLE SLOT ANTENNA FOR WI-FI AND WIMAX APPLICATIONS

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Abstract

In this paper a dual band microstrip slotted antenna is proposed. Making simple structure of microstrip antennas can easily be designed for realizing dual band characteristics. This structure are simulated and analysis using High Frequency Structure Simulator (HFSS) software. Measurements are done after fabricated through Vector Network Analyzer. We obtained good results in testing. The radiating patch is placed on a dielectric substrate FR-4 (ε_r=4.4, tan δ = 0.02) with conducting ground. The Co-axial feeding technique is used. In the Operating frequency range of 2.4-2.48 GHz, have a return loss of less than -10 dB for Wi-Fi applications. Operating frequency range of 2.66-2.77 GHz, 4.28-4.4 GHz and have a return loss of less than -10 dB for WIMAX applications.

Keywords: Slot antenna, WIMAX, Wi-Fi, Return loss.

I. INTRODUCTION

In a modern world, multiband antenna has been playing a very important role for wireless service requirements. Now a day's mobile devices such as handheld computers and intelligent phones are applied in Wireless fidelity (Wi-Fi) and Worldwide Interoperability for Microwave Access (WIMAX). Wi-Fi and WiMAX techniques have been widely recognized as a viable, cost-effective, high-speed data connectivity solution, enabling user mobility. A proposed dual band microstrip slot antenna is used for Wi-Fi and WIMAX applications. The antenna consists of a radiating patch, a conducting ground plane, FR-4 , a substrate and a coaxial feed on which some simple slots are etched in the radiating patch. Dual frequencies and broadband operation at high frequency are achieved by rectangular and trapezoid slots. The standard in IEEE 802.16e WIMAX consist of 2.6 GHz (2.6–2.7 GHz), 4.2 GHz (4.2-4.4 GHz) frequency bands and Wi-Fi of 2.4-2.48 GHz frequency bands. At present the wireless communication system, antenna design has focused on wide multiple band and small simple structures that makes easy to fabricate. As shown in Fig.1. Embedded etching slots on the radiating patch, so it can be much easier to fabricate.

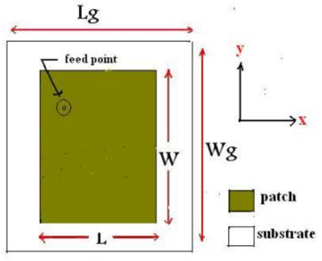

Fig. 1. Proposed Microstrip Slot Antenna

In this a rectangular microstrip slot antenna, asymmetrical horizontal strips embedded in the rectangular slot. The main usage of this is to excite the additional resonant mode. Compared to the other antenna, the dual band double slot antenna has a simple structure, easy to fabricate and it achieve coaxial feed. The antenna measured with Vector Network Analyzer, the result shows a good multiband characteristic to satisfy the requirement of WIMAX in the 2.6-2.7 GHz & 4.2-4.4 GHz bands and Wi-Fi in 2.4 GHz. Operating at frequency of 2.6 GHz with permittivity of 4.4 of tangent loss of 0.02 (h=1.6 mm). The design parameter dimension of proposed antenna is 35×30×1.6 mm. The antennas are designed and analysis in this paper both simulated in HFSS and measured in VNA the result shows good agreement with compared simulated ones.

The dual band micro strip double slot antenna have good omni directional radiation characteristics and relatively uniform gains in the two operating dual bands, so it can emerge as an excellent candidate for multiband generation of wireless. The gain of the antenna must be a peak value of 3 dBi at 2.6 GHz, 6 dBi at 4.3 GHz, and 9 dBi at 4.4 GHz respectively.

II. THE DESIGN OF TRAPEZOIDAL SLOT ANTENNA

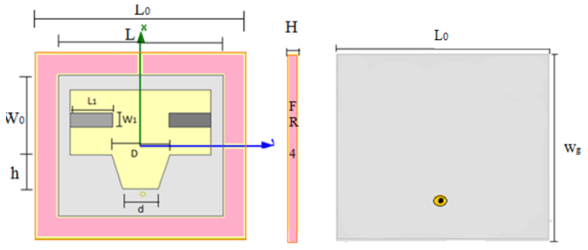

Fig. 2. Simulated Microstrip Antenna (Top & Back View)

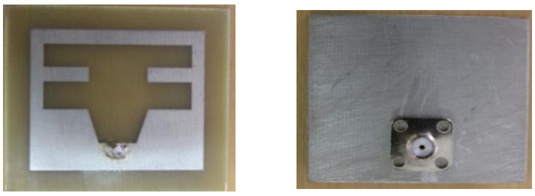

Fig. 3. Photograph of Fabricated Antenna (Top & Back View)

The simulated structure of the dual band slot antenna as shown in Fig. 2 is designed and fabricated structure as shown in Fig. 3 on a substrate with FR4, relative permittivity of 4.4, and a loss tangent of 0.02. The designed parameter of the antenna size is 30×35×1.6 mm. The most popular feeding technique is used without loss of generality; a 50 Ω coaxial feed with inner radii of 0.5 mm is adopted for centrally feeding the antenna at one side of the substrate.

The microstrip slot antenna, is to operate in the frequency of 2.6 GHz effectively, the f_r is chosen as it. So the width of the patch is selected from equation(1).

$$W = c/2f_r\sqrt{(\varepsilon_r + 1)/2} \qquad (1)$$

As the inclusion, the dielectric property of the air present in substrate, the ε_{eff} is calculated.

By making these calculations, the designed dimensions of the slot antenna are finalized as in table-1 after the trial and error methods in simulation (shown in Fig. 3).

TABLE-1. Dimensions of Proposed Antenna

Parameter	**Dimensions (mm)**
L_1	9
L_0	30
L	35
W_0	14
W_1	3
W_g	44.6
L_g	39.6
D	18
d	3
H	1.6

III.EMBEDDED STRIPS

The application of embedded strips in the slot mainly generates the center frequency. Similarly the current centralizes in the region nearby the trapezoidal slot that generates the maximum frequency. Continues by adding a pair of symmetrical horizontal strips to the slot, the center frequency can be achieved. After trial and error methods changes the length and width of the strip making in the domain of current distribution so that the resonance performance can be quite influenced. It can be seen that as the length L_1 of strip increases, the second and third resonances shift toward the lower side. The strip width W_1 has much effect on the return-loss characteristics apparently, and an optimum coaxial radius of 0.5 mm is selected for achieving good impedance matching of the antenna not only that it also depends on the height of trapezoidal slot. Because it affects impedance matching at the highest resonant frequency and the length of upper bottom controls impedance matching.

In the ground plane currents are located in a smaller region as frequency increases. At the edge of the rectangular slot the current flows are high due to the lowest resonant frequency is generated by etching the rectangular slot on the patch. The current flows mainly along the edge of the ground plane upward to the upper side of the rectangular slot. Therefore, the embedded strips in the slot mainly generate the middle frequency.

FEEDING TECHNIQUE

Although the numbers of feeding techniques are available for micro strip patch antenna, the coaxial feed is selected to achieve the good impedance matching to 50 Ω. The feeding points are selected from the following equations:

$$X_f = L/2\sqrt{\varepsilon_{reff}}$$
$$Y_f = W/2$$

IV.SIMULATED ANTENNA

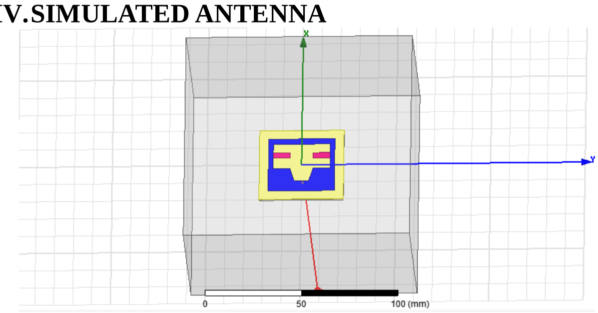

Fig. 4. Designed Microstrip Slot Antenna for 2.6 GHz

In designing Dual-Band rectangular and trapezoidal microstrip slot antenna using HFSS software, we simulate with analysis method and the advantage of fast, easy and output with graphical interfaces. The design of antenna follows four types of setup namely, planar EM design setup, model setup, excitation setup and analysis setup.

This setup involves the Ansoft designer. This involves the creations of substrate, ground, patch and slots. Also creation of infinite conductivity is involved in this method. The positions values are calculated by using the formulas for width, length. Here the material for substrate is taken as FR4-epoxy which has dielectric constant as 4.4.

TABLE–2 Special Features Of Proposed Antenna

Operating frequency	2.6 GHz
ε_r	4.4
Tanδ	0.02
H	1.6

V. SIMULATED RESULTS

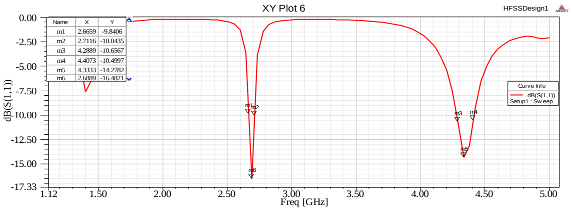

Fig. 5. Return Loss

In simulation, we obtain the return loss which is less than -10 dB. Approximately, we get -16 dB in 2.6 GHz and for 4.3 GHz is -14 dB. Also good return loss which can be in achieved

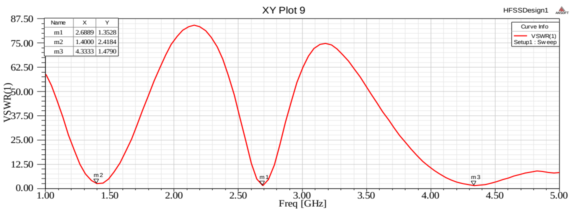

Fig. 6.VSWR

In designing the microstrip antenna using HFSS, we obtain VSWR less than 2(shown in Fig. 6). In designing the microstrip antenna using HFSS, we obtain VSWR less than 1.05 for 4.7 GHz and 2.6 GHz. At operating frequency 2.6 GHz, corresponding value is 1.4.

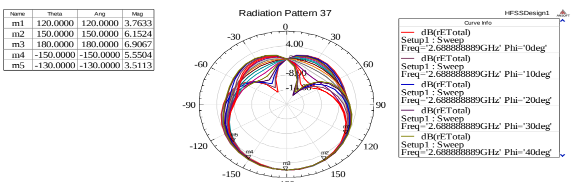

Fig. 7. Radiation Pattern At 2.6 Ghz

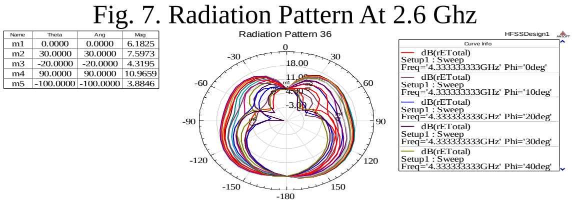

Fig. 8. Radiation Pattern At 4.4 Ghz

At our operating frequency 2.6 GHz, we get 1.3 as our value and for 4.3 GHz is 1.4. Also we determined the radiation pattern for every degree.

VI.TESTED RESULTS

The following (Fig. 9, Fig. 10, Fig. 11, Fig. 12) figures are obtained from Vector network analyzer.

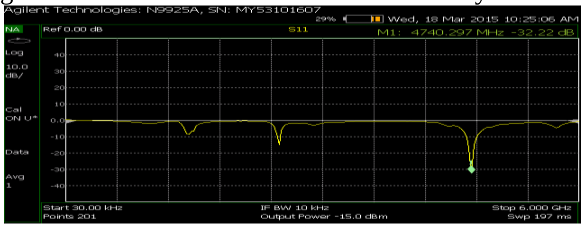

Fig. 9. Return Loss

The maximum returnloss of -32.2 dB is obtained at 4.7 GHz.

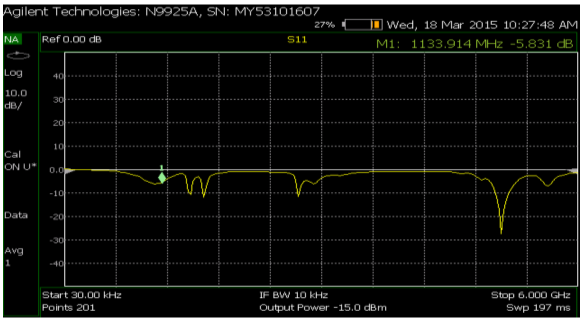

Fig. 10. Return Loss with Different Connector

By changing the radius of the connecters the Wi-Fi bands can be achieved.

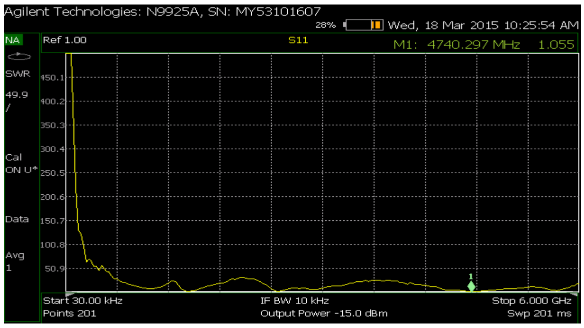

Fig. 11.VSWR

The VSWR of 1.05 is obtained at 4.7 GHz.

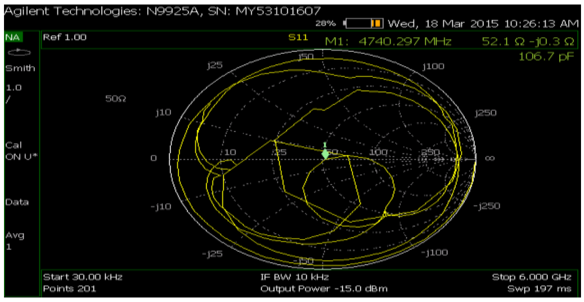

Fig. 12. Impedance Matching

The impedance matches to 50 ohms after the trial and error method in feed positions. At the frequency 4.7 GHz the impedance matching have been performed very well. Good impedance matching will lead a good performance.

In order to investigate the performance of the microstrip antenna for the required frequency range is used to simulated and measured the return loss characteristics of the proposed antenna obtained by using HFSS ver. 13 and the vector network analyzer.

The dimensions of the antenna are given in Table-1 and the simulated and fabricated antenna's are shown in fig. 2 and fig.3. It was shown the measured return loss below -10 dB bandwidth ranges from 2.4–2.48 GHz, 2.6-2.7 GHz, and 4.2-4.4 GHz (refer Fig. 9 and Fig. 10) with the relative bandwidth of 12 %, 22 % and 33 % respectively, which show approximate agreement with the simulated results. These differences take place due to the effect of the SMA connector and mismatching tolerance. It gives the current distribution of the proposed antenna at different frequencies.

VII. CONCLUSION

In this paper a dual band microstrip slotted antenna is designed and fabricated on FR-4 (lossy) substrate and measured with vector network analyaser. The measured results (fig.9, fig.10, fig.11, fig.12) show return loss below -10 dB bandwidth ranges from 2.4–2.48 GHz, 2.6-2.7 GHz, and 4.2-4.4 GHz and obtained impedance bandwidths are 22.2% (2.6–2.8 GHz), and about 33.2% (4.2-4.5 GHz), respectively, good enough for Wi-Fi and WIMAX applications. The antenna gain had a peak value of 3 dBi at 2.6 GHz, 6 dBi at 4.3 GHz, and 9 dBi at 4.4 GHz, respectively. Thus the designed antennas have the scope of emerging research in future in the applications of Wi-Fi and WIMAX.

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