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Design and Analysis of Multiband Antenna using Hexagonal Patch with Modified L-Slot and I- Slot for Wideband Applications

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Abstract:
Multiband Antennas are widely for various commercial applications. There are always challenges while designing with the antennas for lower return loss as possible. There are various shapes of the patches available for the antenna design for the wideband applications. In this work, we have presented the design and analysis of the hexagonal patch with the modified L-Slots and the I-shapes for the multiband applications. FR4 material has been used for the substrate for the design. The antenna we have designed presents the multiband response at the 3.8Ghz, 6.2 GHz, and 9.2 GHz. The simulation results have been shown for the improved performance with the optimum reflection loss and VSWR for the desired frequency.

Keywords: Multiband, VSWR, Return Loss, Modified L-Slots, I-slots, hexagonal patch

I. INTRODUCTION

With the increase in number of users and data traffic, the requirements of the small weight, small size, lesser profile antennas has grown. Here, the antenna design always is focused for the least return loss as possible in that band. Thus, these wideband antennas serve process for the wireless communication in various bands like WLAN, Wifi, WiMax etc. Miniaturization in antennas is always an important issue in the implementation. The multiband antennas can be created using the various slots for various bands. The resonant slots can be integrated with the patch to shape for the various bands in different frequency ranges. These designs offer better response performances compared to the Ultra-wide Band (UWB) antennas in this ranges. The interferences have always been a problem for the antenna design. Thus these multiband antennas offer advantages of lower return losses and VSWR. Thus, it always performs well and offers very less EMI (Electromagnetic Interference). There are various shapes of patches can be designed like rectangular, circular, pentagonal etc. These patches show different characteristics behavior and thus offer different performances. Thus, under various studies, it has been shown that hexagonal patch antennas offer improved performance than the conventional square patch antenna. Various resonator slots are introduced to improve the frequency response and multiband response. Various researches have been conducted on various types of the resonators. These resonators often improve the selectivity and offer advantages over simple patch designs for the multi-band antenna design.

II. ANTENNA DESIGN & PARAMETERS

The proposed antenna design is presented in figure 1. Here, the design shows the geometrical construction and the various dimensions of various features. In this design, the substrate used in FR4 dielectric with relative permittivity of 3.85 and tangent loss of 0.0088. The height of substrate 1.5 mm and the thickness of metal is 0.4mm. The dimension of the antenna is 27 X 34 X 1.5 mm. The antenna is designed with L-slots and the I-Slots with operating frequencies at.

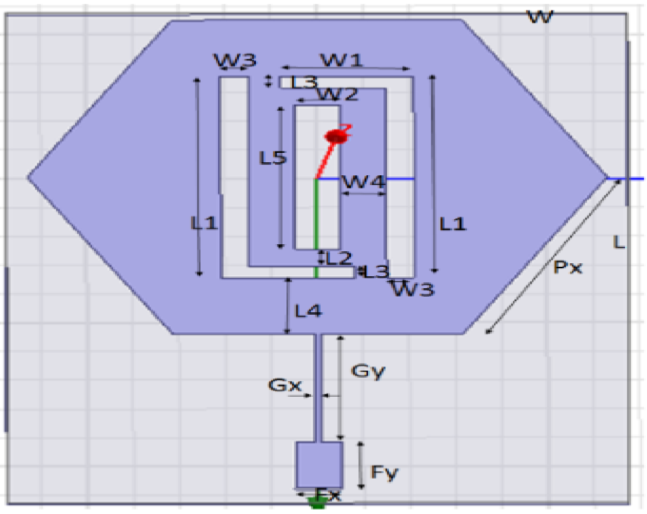

Figure.1. Geometrical representation of the proposed antenna design

Table.1. Antenna Design Parameters

Parameter Values			
Parameter	Dimensions (mm)	Parameter	Dimensions (mm)
W	27	L	34
W1	5.8	L1	14
W2	2	L2	1.8
W3	1.2	L3	0.8
W4	2	L4	4
Gx	0.3	L5	10
Fx	2	Gy	7.5
Px	12.6	Fy	3.2

Here, the design parameters has been listed in table 1. The modified L-slot and I-slot has been designed in the Hexagonal patch antenna. Here, the patch width, length and thickness has been listed. Hexagonal patch antenna can be designed and analyzed numerically on the basis of the circular patch antenna. The resonant frequency has been shown as:

$$fr = \frac{X_{mn}}{2\pi a\sqrt{\varepsilon r}}c \quad \text{----------------------------------- (i)}$$

Here, X_{mn} = 1.8411c, c = speed of light, ε_r is the relative dielectric constant of substrate, h is the height of substrate and ***a*** is the radius of circular patch.

$$a_e = a\{1 - \frac{2h}{\pi a\, \varepsilon_r}(ln\frac{\pi a}{2h} + 1.7726)\}^{0.5} \quad \text{----------------- (ii)}$$

Here, the L and W of the microstrip patch can be given as:

$$W = \frac{c}{2fr\sqrt{(\frac{\epsilon r+1}{2})}} \quad \text{----------------- (iii)}$$

$$\text{and } L = Leff - 2\Delta L \text{, where } Leff = \frac{c}{2fr\sqrt{\epsilon reff}} \quad \text{----------------- (iv)}$$

Here ΔL and ϵreff represents the fringing factor and the effective dielectric constant and can be represented by:

$$\Delta L = 0.412h\frac{(\epsilon reff + 0.3)\left(\frac{W}{h} + 0.264\right)}{(\epsilon reff - 0.258)\left(\frac{W}{h} + 0.8\right)} \quad \text{----- (v)}$$

$$\epsilon reff = \frac{\epsilon r + 1}{2} + \frac{\epsilon r - 1}{2}\left[1 + 12\frac{h}{W}\right]^{-0.5} \quad \text{----- (vi)}$$

III. RESULTS AND DISCUSSION

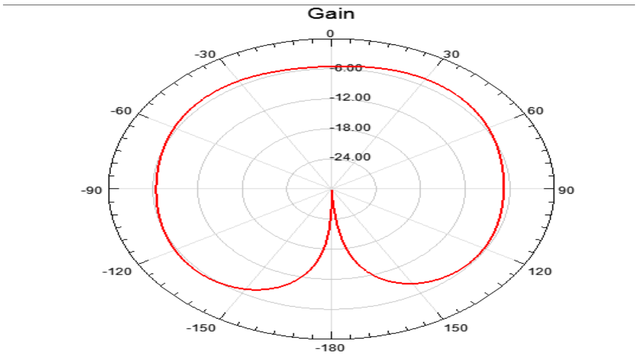

Figure. 2. Gain Plot of the Antenna design at 3 GHz

In the above figure, the gain plot has been shown. The gain is found to be maximum in the direction of the radiation. Here the radiation patterns are shown from phi = 0 to phi = 180. It infers that the designed antenna follows the desired radiation pattern.

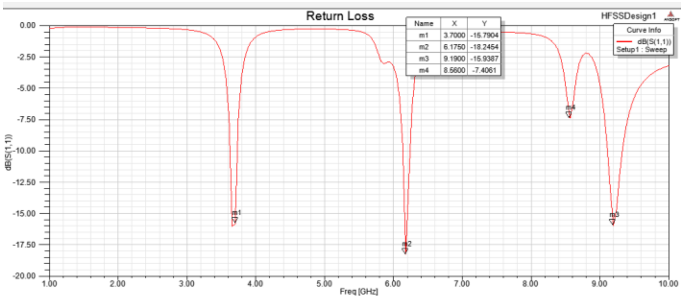

Figure. 3. Return Loss of the proposed antenna

In the figure 3, the return loss has been presented. The above figure shows the variation in the return loss of the antenna design. Here, the antennaa design has been designed for the minimum return loss for the desired frequency at the 3.8Ghz, 6.2 GHz, and 9.2 GHz. The return loss will depict the behaviour of the antenna. Thus , the HFSS simulation result verifies that the return loss for the desired multiband has been achieved.

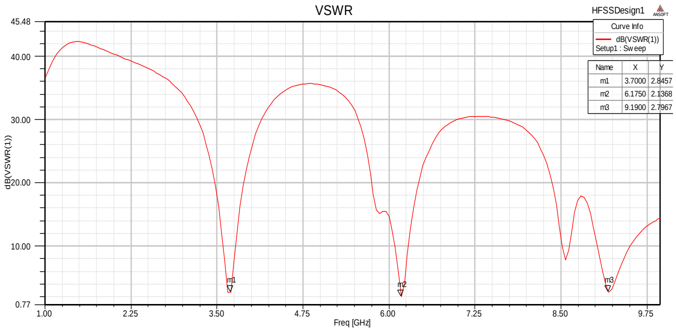

Figure. 4. VSWR Analysis of the proposed antenna

In the figure 4, the VSWR analysis has been shown. The VSWR achieved at the desired multibands is 0.77 dB. It depicts the voltage wavestanding ratio and thus the pattern and behavior of the antenna has been depitced. Thus, the proposed antenna is capable of providing the desired VSWR results. The simulation result has been obtained using HFSS simulations.

IV. CONCLUSION

In this work, we have proposed the design of the antenna has been presented for the frequencies at 3.8GHz, 6.2 GHz, and 9.2 GHz using modified L-slots and I-slots. Thus , the behavior of the proposed slotted antenna in the hexagonal patch has been shown. The simulation results has been obtained by the HFSS software. It works on the moment integral method for the design, analysis and simulation. Thus, the various results has been obtained for the VSWR, Return loss and radiation pattern has been obtained. The obtained values at minumum jsutifies that the designed antenna follows the desired response and desired return loss has been obtained.

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